

FACE

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I. OVERVIEW: FACE IS UNIQUE - Skin on face is thin and moveable; has many sebaceous glands and sweat glands. Superficial fascia of face is loose, except at nose; facial muscles (i.e. muscles of facial expression) are embedded in superficial fascia; there is NO deep fascia over face.

A. Facial muscles (embedded in superficial fascia) take origin from underlying bones (mostly) and insert onto skin.

Note: **Facial transplant** - In severe damage to face, facial transplants are required because muscles of facial expression insert onto skin rather than tendons (therefore, cannot use grafts of other body muscles); transplants contain muscles and skin.

B. Neural control of Facial muscles - Facial muscles are under both voluntary and involuntary (emotional) control.

C. Detecting action of Facial muscles - Muscles of face have no (or very few) muscle spindles; muscle contractions are thought to be detected by stretching of skin.

D. Facial paralysis - is a defining symptom in Bell's Palsy

Bell's palsy - paralysis of facial muscles; lower motor neuron syndrome of facial nerve (CN VII); thought to be associated with **viral infection** (herpes simplex); **Symptoms unilateral**: sudden onset **paralysis or paresis of all facial muscles on one side**; drooling; inability to close eye; also hyperacusis (sounds seem too loud), loss of taste to anterior tongue; pain in or behind ear.

Note: **Upper motor neuron lesions affecting facial nerve** (ex. **cortical stroke** = vascular insufficiency) - '**Sparing**' of upper face - Often **only muscle of lower face are paralyzed on one side, muscles of upper face not affected** (ex. brow, orbicularis oculi); cortical projections bilateral to upper face; unilateral (contralateral) to lower face.

II. ARTERIAL SUPPLY

A. Overview of Arterial supply to Head (see Diagrams of Arterial Supply attached); Common Carotid arteries ascend in neck and divided into External and Internal Carotid Arteries (at upper border of thyroid cartilage); Arterial supply to Face derived from branches of - extensive; vessels have many anastomoses.

1. branches to face of External Carotid artery (major blood supply to head).

a. Facial artery - course: extremely winding and tortuous; artery arises from anterior side of External Carotid, first courses medial to mandible, then appears on face anterior to the mandible (site of pulse of Facial artery); artery ascends lateral to lips and ends medial and inferior to orbit. Branches on face:

i) Superior and Inferior Labial arteries - upper and lower lips.
ii) Angular artery = main part of facial artery adjacent to nose and to angle (corner) of eye.

b. Superficial Temporal artery - one of two terminal branches of External Carotid; course - arises anterior to external auditory meatus (opening to ear), deep to parotid salivary gland; has many branches to scalp; named small branch on face Transverse Facial artery.

2. branches to face of Internal Carotid artery (major blood supply to brain, orbit)

a. Ophthalmic artery - many branches to orbit but also has a number of named branches to face, forehead and nose:

- i) Supraorbital artery (above orbit)
- ii) Supratrochlear artery (on medial and superior side of orbit)

Note: Orbit (= eye socket) contains the eye and muscles that move the eye; orbit is also a **major route for nerves/blood vessels to get to other places**, (ex. to face, nasal cavity).

III. VENOUS DRAINAGE OF FACE - veins of face generally follow arteries; **have no valves**; veins drain both into the skull and down face to the neck; have **extensive anastomoses**.

Clinical Note: Prolonged infections on face (pimples or acne) are dangerous because veins of face anastomose, have no valves and drain both to the brain and down to the neck; **infections can spread via anastomoses from face into venous sinuses inside of skull** (ex. through orbit) and involve cranial nerves to muscles of eye (**clinical sign is 'blurred vision' = diplopia**); infections on face lateral to nose are particularly dangerous.

IV. SENSORY INNERVATION OF FACE - Sensory supply - via branches of Trigeminal nerve (cranial nerve V); Trigeminal nerve has three divisions: Ophthalmic division (V1), Maxillary division (V2) and Mandibular division (V3).

1. branches of Ophthalmic division - to skin above orbit; Supraorbital, Supratrochlear, Infrotrochlear, Lacrimal and External Nasal nerves.

2. branches of Maxillary division - to skin of cheek below orbit; Infraorbital, Zygomaticofacial and Zygomaticotemporal nerves.

3. branches of Mandibular division - to skin of jaw and face below angle of mouth; Mental nerve, Auriculotemporal nerve and Buccal branch of Trigeminal nerve.

V. MUSCLES OF FACIAL EXPRESSION - move skin of face, close eyes and close and open mouth; allow you to convey emotions by facial gestures (ex. sneering and contempt); most are attached to bones and insert upon skin; many named for their actions or Latin or Greek words; movements elicited in test for Facial Nerve function

1. Orbicularis oculi - has palpebral (eyelid) and orbital part (edge of orbit); action - close eyelids (note: orbital part 'buries' eyelids, as closing eyes in a sandstorm).

2. Orbicularis oris - surrounds and closes mouth.

3. Muscles of nose - a. Compressor naris - acts to compress nasal cartilages; b. Dilator naris - dilates nostrils; c. Procerus - wrinkles skin of nose.

4. Muscles of upper lip - a. Levator labii superioris - lifts upper lip; b. Zygomaticus major and minor - raise and pull upper lip laterally.

5. Muscles at angle of mouth - a. Levator anguli oris - raises corner of mouth; b. Risorius - smiling muscle; b. Depressor anguli oris - tragedy muscle.

6. Muscle of lower lip and chin - a. Depressor labii inferioris - depresses lower lip; b. Mentalis - wrinkles skin of chin.

7. Buccinator - muscle in cheek; compresses mouth and keeps food between teeth when chewing; buccinator is latin for trumpeter.

Clinical: **Facial nerve damage – can produce difficulty eating** (chewing) because food not kept between teeth after **paralyze Buccinator** (this was board question)

8. Frontalis and Occipitalis – muscles in scalp attached to Epicranial Aponeurosis, skin; Frontalis raises eyebrows.

Clinical: **Test Facial nerve - raise eyebrows with Frontalis.**

9. Platysma - extends in neck from mandible to fascia over Pectoralis Major muscle; moves skin of neck.

VI. MOTOR INNERVATION TO MUSCLES OF FACIAL EXPRESSION - via Facial nerve (cranial nerve VII); nerve leaves skull via stylomastoid foramen; enters parotid gland; divides into 5 terminal branches: superior to inferior

1. Temporal

2. Zygomatic

3. Buccal - (not to be confused with Buccal branch of V)

4. Mandibular

5. Cervical

VII. DEVELOPMENT OF FACE

A. Five facial primordia - form in fourth week in development and surround developing stomodeum (= primitive mouth) (Note: the term process is the same thing as prominence)

1. Frontonasal process - formed by mesenchyme below brain; unpaired
2. Maxillary processes - from first branchial arch; paired.
3. Mandibular processes - from first branchial arch, inferior to maxillary processes.

B. Sequence of Development

1. Thickenings (Nasal placodes) form on each side of Frontonasal process.
2. Medial and Lateral Nasal processes form at margins of Nasal placodes.
3. Upper parts of Medial and Lateral Nasal processes fuse to form upper part of nostril.
4. Inferior part of Medial Nasal processes fuse with Maxillary process on each side to form upper lip.

Note: **Cleft Lip (Cheiloschisis (Gk. Cheilos, lip))** - results from **failure of fusion of Medial Nasal processes with Maxillary process** on that side; can be unilateral or bilateral; occurs in 1 in 1000 births.

5. Nasolacrimal duct - connects anterior eye to nasal cavity; drains tears; forms in development as a solid epithelial cord that extends from medial angle of eye to nasal cavity; cord becomes canalized to form duct.

Note: **Obstructed Nasolacrimal duct** - results from failure of duct to canalize; must be opened for tears to drain to nasal cavity.

TABLE OF MUSCLES OF FACIAL EXPRESSION

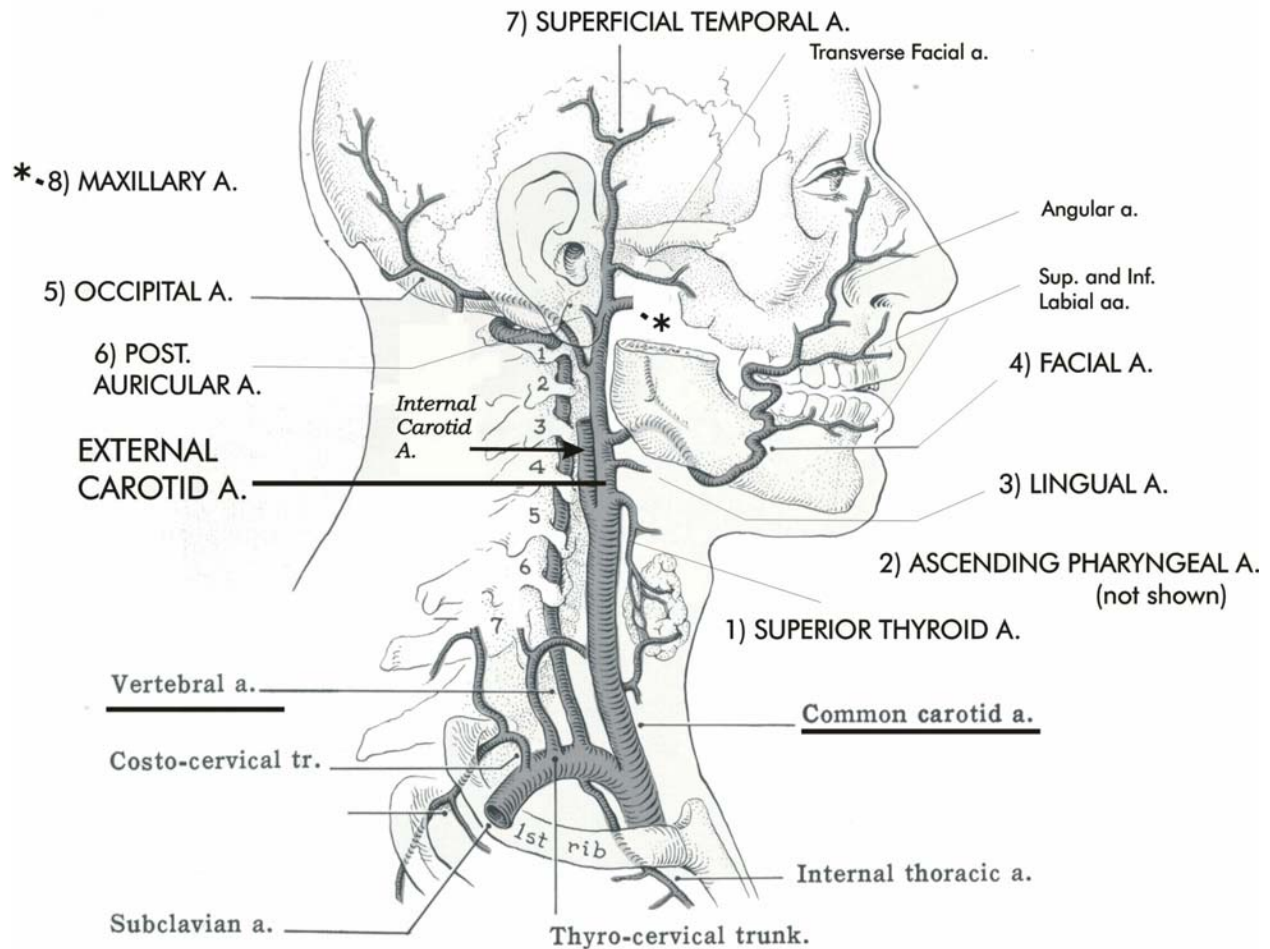
Muscle	Action	Clinical Note
Eye		
Orbicularis oculi	Orbital part (surrounds eyelids) – ‘buries’ eyelids (as in sandstorm) Palpebral part (within eyelids) – closes eyelid	Closing eyelid is essential to prevent damage to cornea - cover, sew eyelids shut (neonates) in Facial paralysis
Nose		
Compressor naris	compress nasal cartilages	
Dilator naris	dilates nostrils	
Procerus	wrinkles skin of nose.	
Mouth		
Orbicularis Oris	closes mouth (surrounds lips)	
Levator labii superioris	lifts upper lip	
Zygomaticus major and minor -.	raise and pull upper lip laterally	
Levator anguli oris -	raises corner of mouth	drooping of corner of mouth in Bell's palsy
Risorius (Latin for smiling)	smiling muscle	
Depressor anguli oris	tragedy muscle	
Depressor labii inferioris	depresses lower lip	
Other		
Mentalis	wrinkles skin of chin	
Buccinator (latin for trumpeter)	compresses mouth and keeps food between teeth when chewing	patients with Bell's palsy have difficulty 'eating food', drooling
Frontalis and Occipitalis	move scalp (attach to Epicranial Aponeurosis); frontalis raises eyebrows	drooping of eye brow in Bell's palsy (Clinical test - raise eyebrows)
Platysma	stretches skin of neck	

SEE VIDEO: FACIAL MUSCLES FOR ILLUSTRATION OF LOCATION



OVERVIEW OF BLOOD SUPPLY TO HEAD

(EXCLUDING BRANCHES OF INTERNAL CAROTID A.)



EXTERNAL CAROTID ARTERY

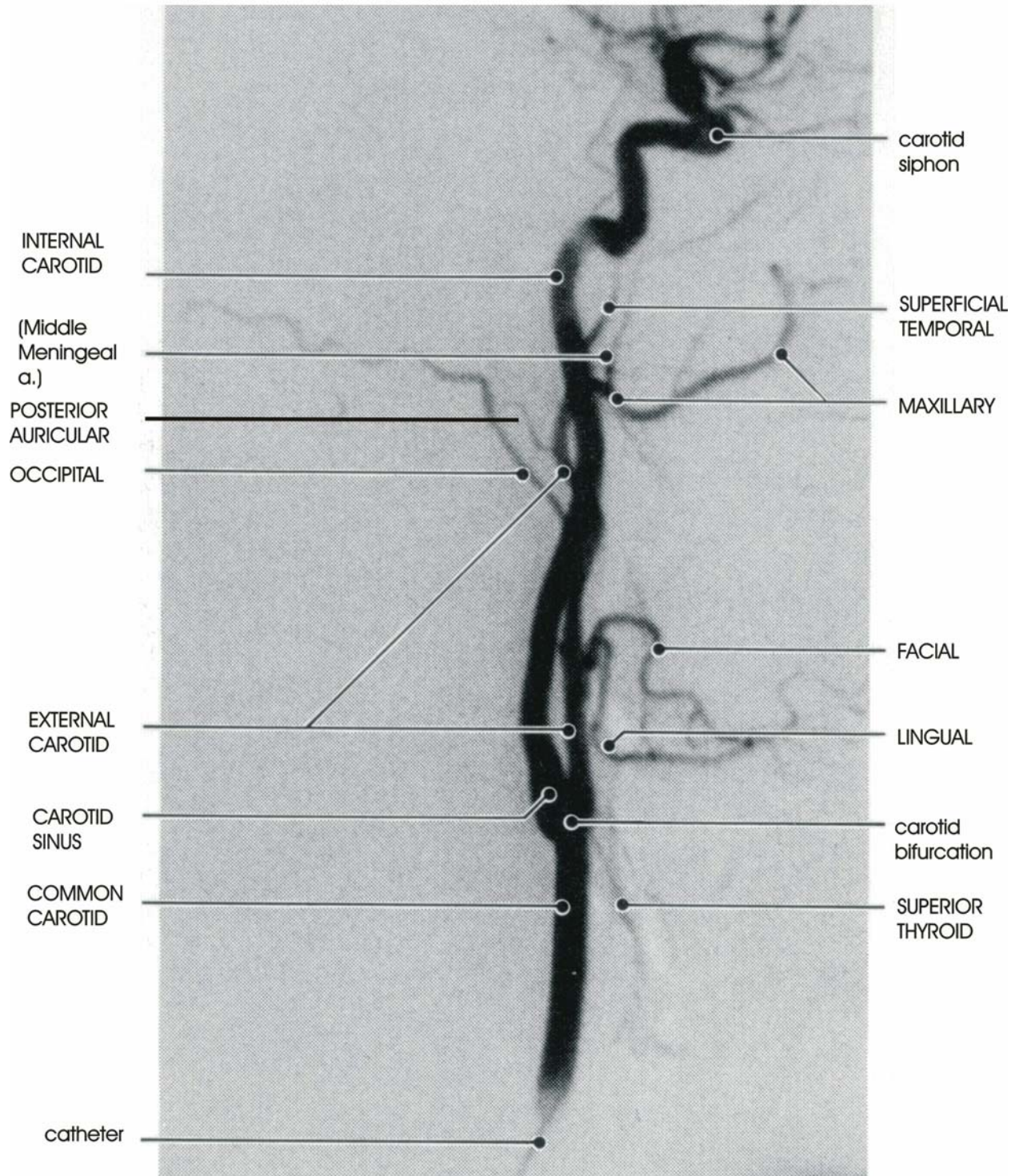
- 1) Superior Thyroid a.
- 2) Ascending Pharyngeal a.
- 3) Lingual a.
- 4) Facial a.
- 5) Occipital a.
- 6) Post. Auricular a.
- 7) Superficial Temporal a.
- 8) Maxillary a.

SUBCLAVIAN ARTERY

- Vertebral a.
- Internal Thoracic a.
- Thyrocervical trunk
- Costocervical trunk

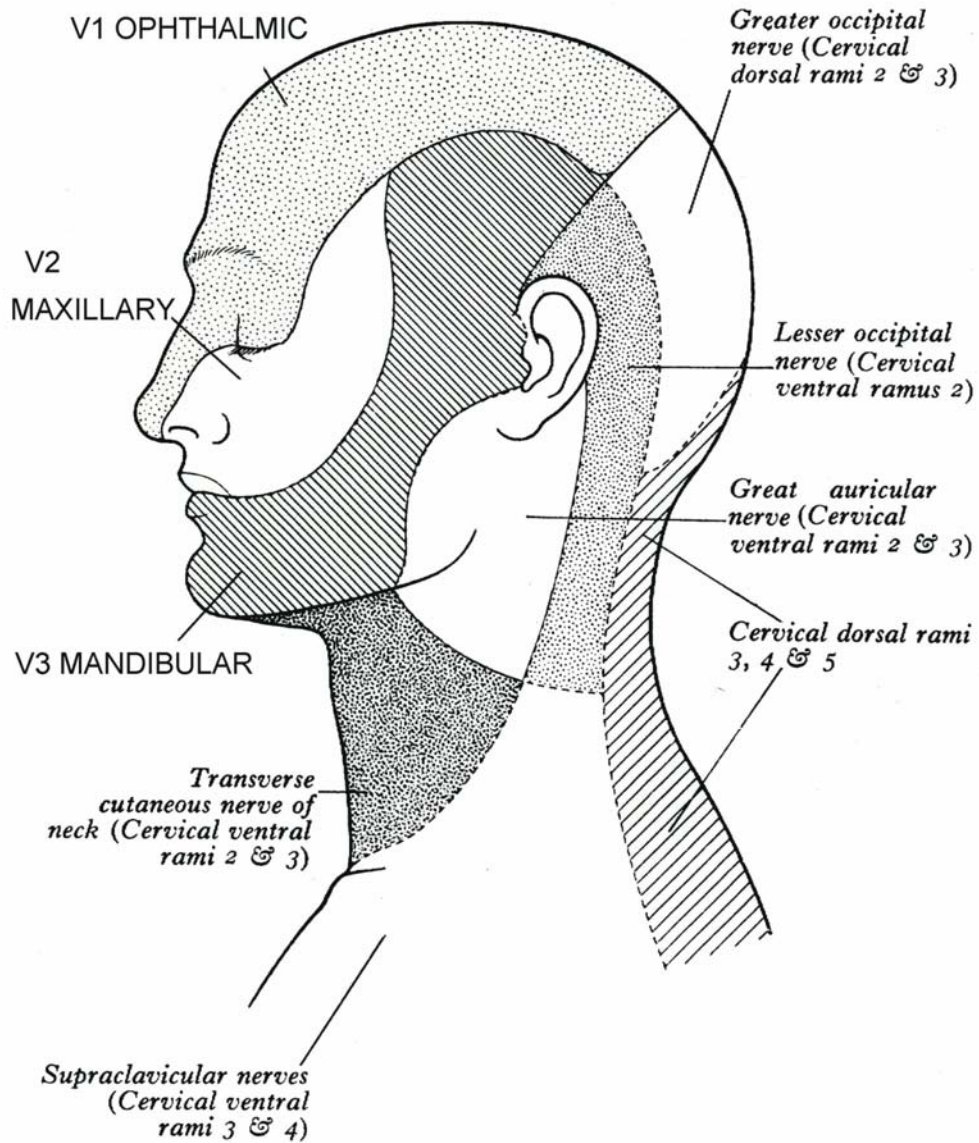
ORIENTATION: NOSE---->

CAROTID ARTERIOGRAM



CUTANEOUS INNERVATION OF HEAD AND NECK

TRIGEMINAL NERVE (V) - three divisions - V1 Ophthalmic,
V2 Maxillary, V3 Mandibular



REFERENCE HANDOUT (DO NOT MEMORIZE): TRIGEMINAL NERVE BRANCHES

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V1 Ophthalmic - Somatic Sensory only (GSA) - through Superior Orbital Fissure to Orbit

Nerve	Branches	Innervates
1. Frontal Nerve	a. Supraorbital Nerve	Scalp forehead, upper eyelid
	b. Supratrochlear Nerve	Scalp forehead, upper eyelid
2. Lacrimal Nerve		Upper eyelid
3. Nasociliary Nerve	a. Long Ciliary Nerve	Cornea of eye
	b. Ant. and Post. Ethmoidal Nerves	Nasal cavity, ethmoid sinus, tip of nose
	c. Infratrochlear Nerve	Upper eyelid, nose

V2 Maxillary - Somatic Sensory (GSA) only - through Foramen Rotundum to Pterygopalatine Fossa

Nerve	Branches	Innervates
1. Meningeal branches		Dura of mid. Cranial fossa
2. Ganglionic branches	a. Greater Palatine Nerve	Hard Palate
	b. Lesser Palatine Nerve	Soft Palate
	c. Nasopalatine Nerve	Nasal Cavity, Hard Palate
	d. Nasal branches	Nasal Cavity
3. Post. Sup. Alveolar Nerve		Maxillary teeth
4. Infraorbital nerve		Lower eyelid, nose, upper lip
	a. Ant. Sup. Alveolar Nerve	Maxillary teeth
	b. Mid. Sup. Alveolar Nerve	Maxillary teeth
5. Zygomatic nerve	a. Zygomaticofacial Nerve	Skin of cheek
	b. Zygomaticotemporal Nerve	Skin of temporal region

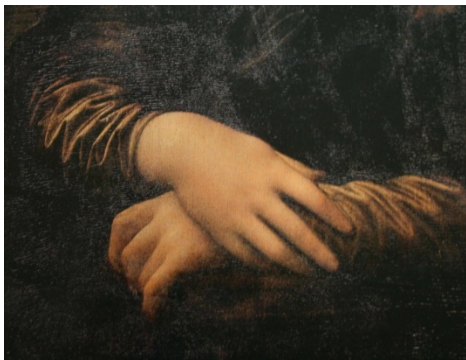
V3 Mandibular - Somatic Sensory (GSA) and Branchiomotor (SVE) - Foramen Ovale to Infratemporal Fossa

Nerve	Branches	Innervates
1. Nervous spinosus		Sensory to Dura of mid Cranial fossa
2. Motor branches		Motor to Med. Pterygoid, Tens. Tympani, Tensor Palati
3. Anterior division	a. Nerve to Lateral Pterygoid	Motor to Lateral Pterygoid
	b. Masseteric Nerve	Motor to Masseter
	c. Deep Temporal Nerve	Motor to Temporalis
	d. Buccal Nerve	Sensory to Cheek
4. Posterior Division	a. Auriculotemporal Nerve	Sensory to external auditory meatus, tympanic membrane, TMJ, lateral scalp
	b. Lingual Nerve	Sensory (touch) ant. 2/3 tongue
	c. Inferior Alveolar Nerve i. Nerve to Mylohyoid ii. Mental Nerve	Sensory to Mandibular teeth Motor to Mylohyoid, ant. Digastric Sensory to Chin, Lower lip

I. FACE IS UNIQUE - skin of face is thin and moveable



'Window of the soul' -
Face has moveable skin
for facial expression



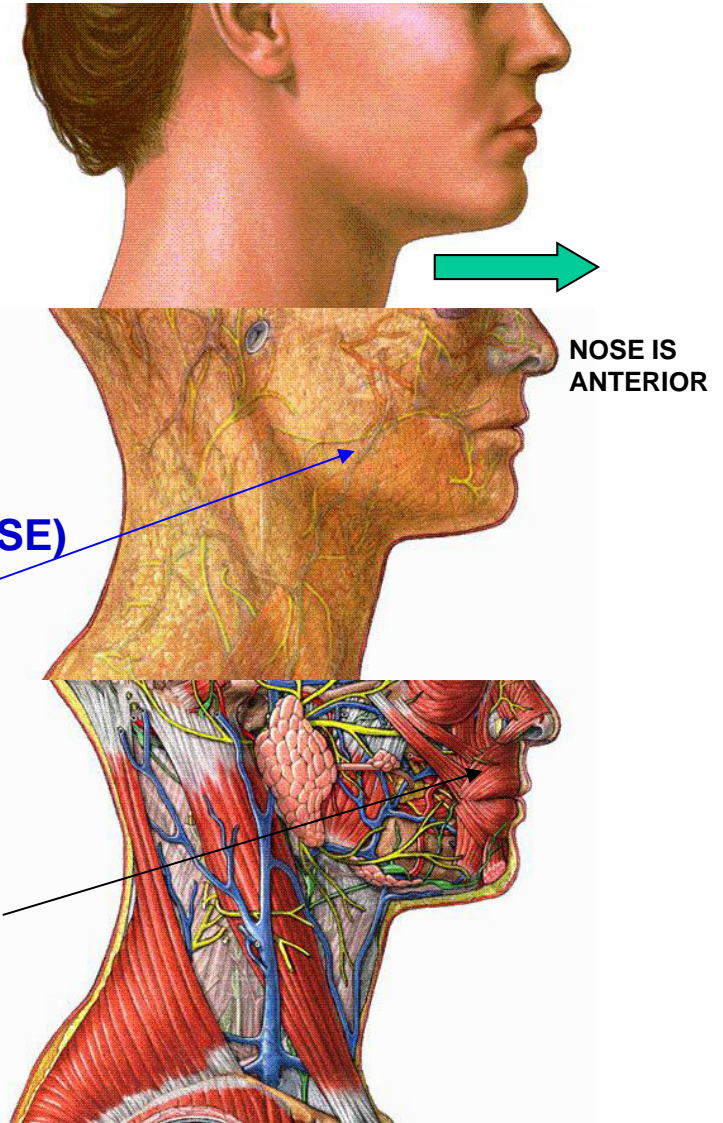
Mona Lisa's Hands

DISSECTION DONE
AS SUPERFICIAL AS
POSSIBLE

SKIN HAS MANY
SEBACEOUS GLANDS
AND SWEAT GLANDS

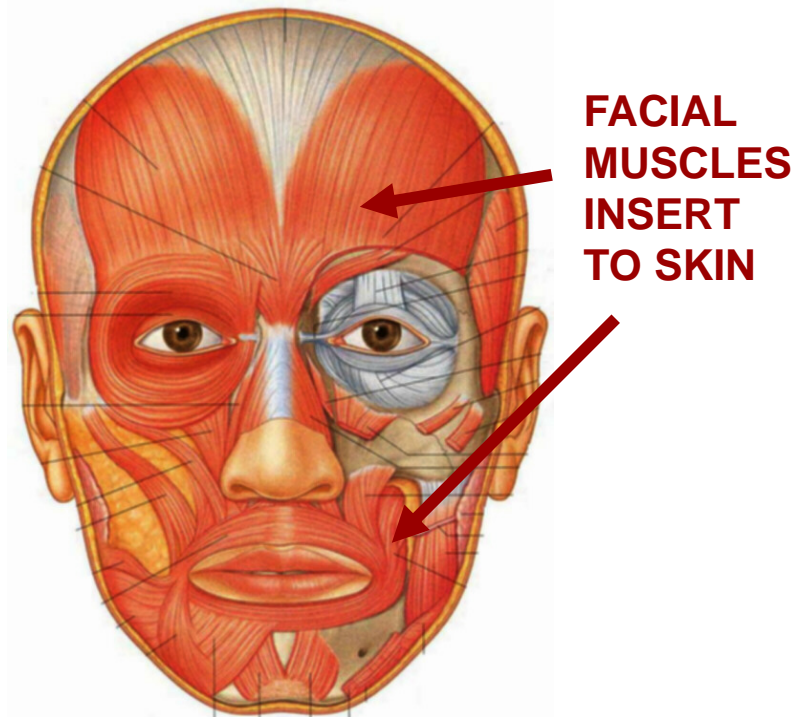
SUPERFICIAL FASCIA –
LOOSE (EXCEPT AT NOSE)
NO DEEP FASCIA
OVER FACE

MUSCLES OF FACIAL
EXPRESSION
EMBEDDED IN
SUPERFICIAL FASCIA
INNERVATION –
FACIAL NERVE
(CRANIAL NERVE VII)



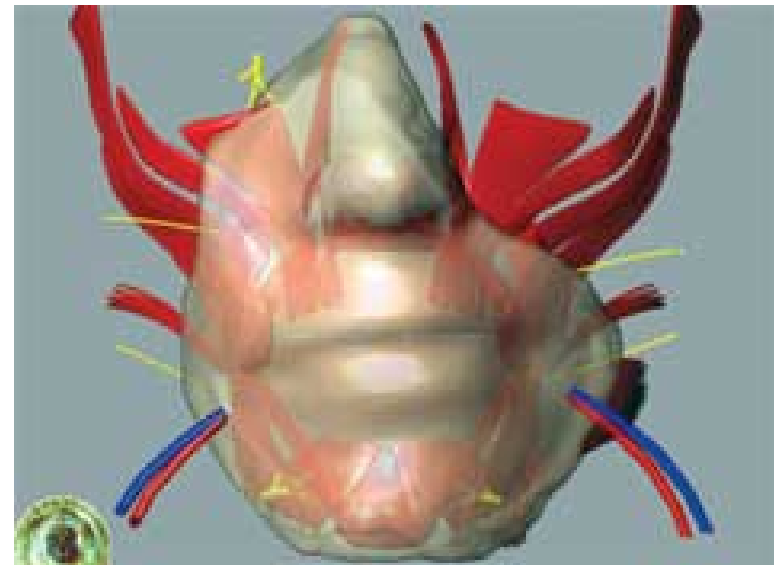
OVERVIEW OF FACIAL MUSCLES

FACIAL MUSCLES HAVE UNIQUE PROPERTIES



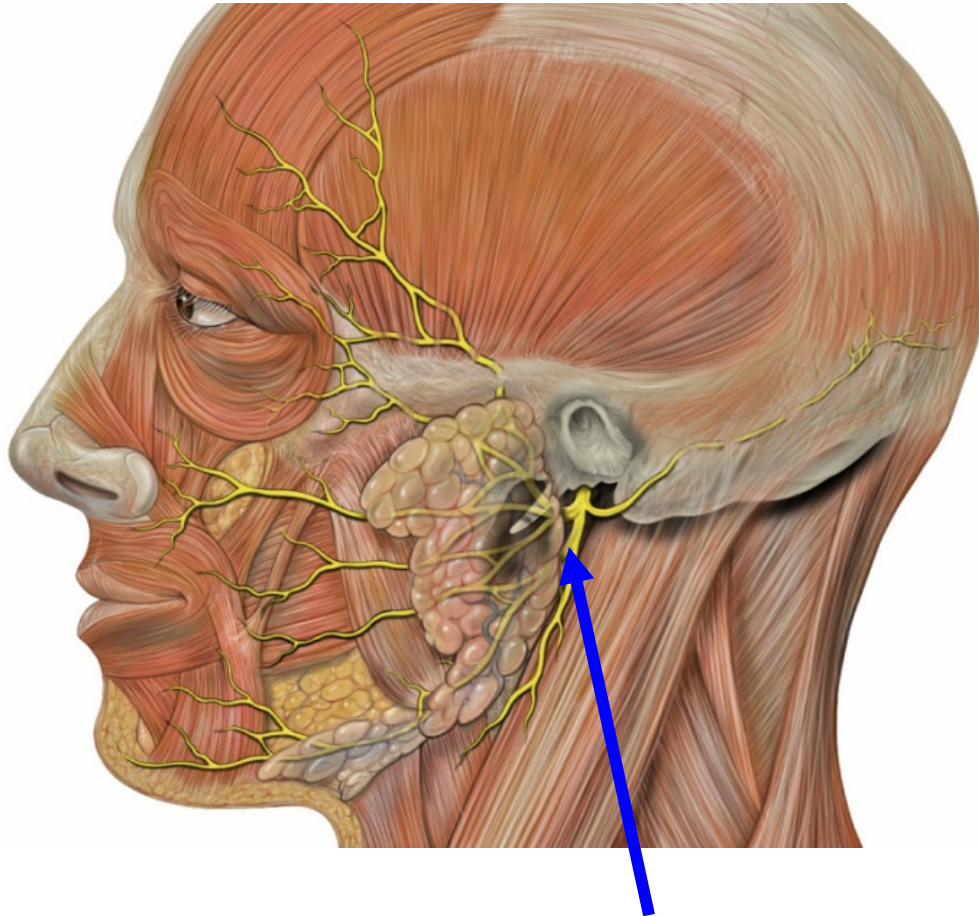
A. Facial muscles are embedded in superficial fascia - take origin from underlying bones (mostly); insert onto skin

FACIAL TRANSPLANT



Note: In severe damage to face, facial transplants are required because muscles of facial expression insert onto skin rather than tendons (therefore, cannot use grafts of other body muscles).

OVERVIEW OF FACIAL MUSCLES



**FACIAL NERVE
(Cranial Nerve VII)**

B. Neural control of Facial muscles - Facial muscles are under both voluntary and emotional (involuntary) control.

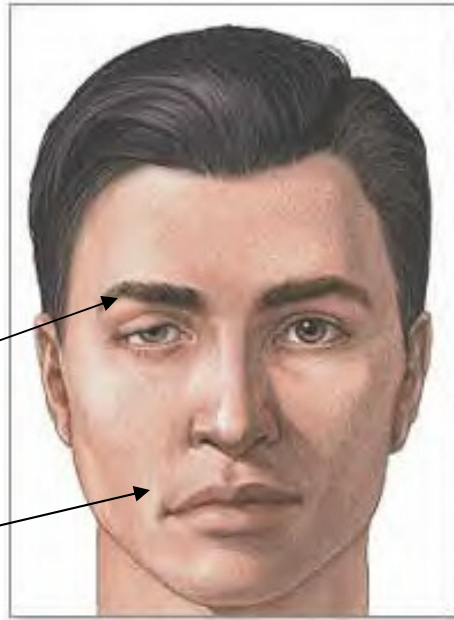
C. Detecting action of Facial muscles - muscles of face have no (or very few) muscle spindles; muscle contractions are thought to be detected by stretching of skin.

OVERVIEW OF FACIAL MUSCLES: FACIAL PARALYSIS

FACIAL PARALYSIS - BELL'S PALSY - CN VII

'drooping' eyebrow

'drooping' upper lip

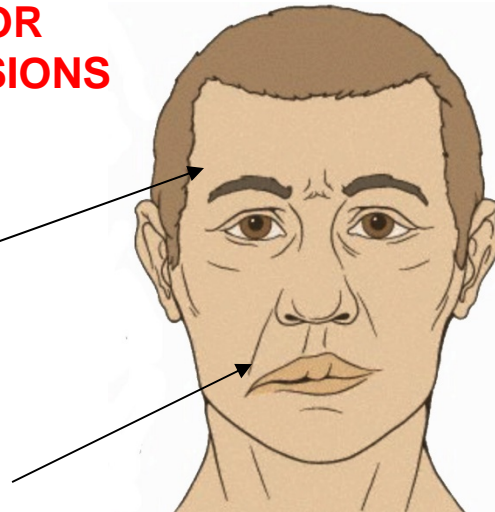


BELL'S PALSY- Lower Motor Neuron (Alpha motor neuron) disorder of Facial Nerve (CN VII): associated with viral infection (herpes simplex); Symptoms unilateral: sudden onset **paralysis of all facial muscles on one side**; SYMPTOMS: drooling; inability to close eye; **loss of taste to anterior tongue**; pain in or behind ear; hyperacusia

UPPER MOTOR NEURON LESIONS

MUSCLES OF UPPER FACE NOT AFFECTED

'drooping' upper lip



UPPER MOTOR NEURONS DISORDERS OF VII - 'sparing' of upper face - After cortical strokes, often **only muscle of lower face are paralyzed** on one side, muscles of upper face are not paralyzed (ex. brow, orbicularis oculi); cortical projections are bilateral to upper face.

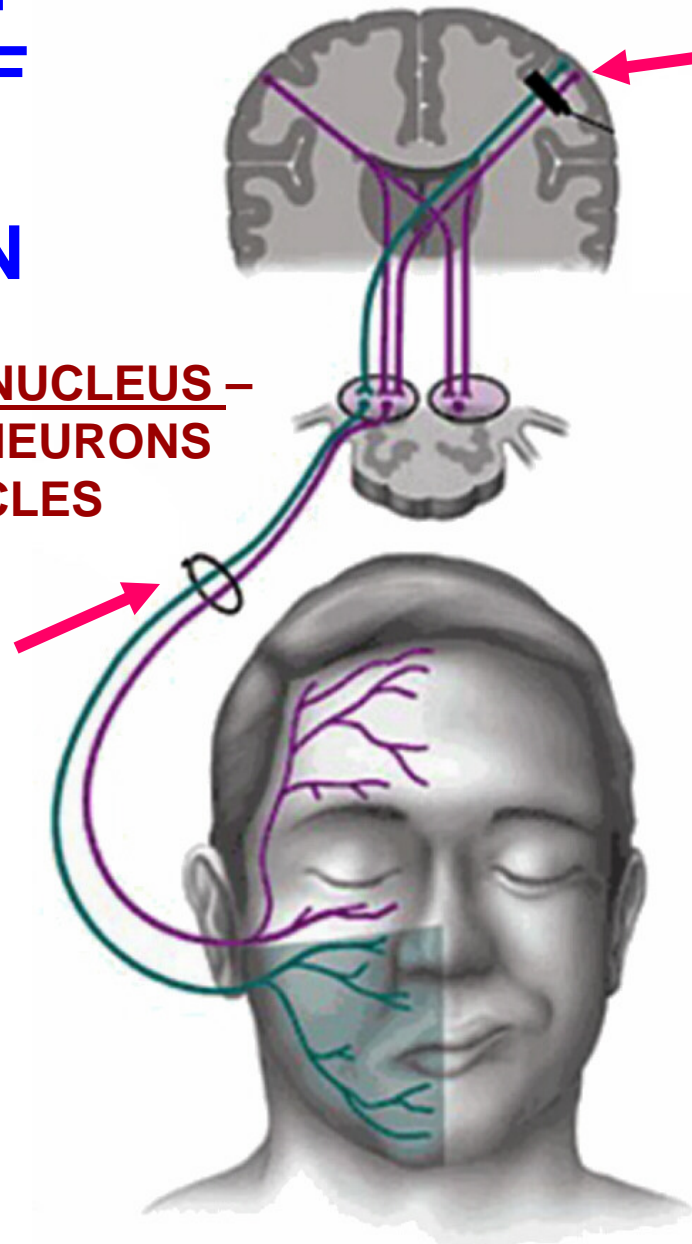
CONTROL OF MUSCLES OF FACIAL EXPRESSION

FACIAL MOTOR NUCLEUS –
ALPHA MOTOR NEURONS
TO FACIAL MUSCLES

LOWER MOTOR
NEURON LESION

- ex. BELL'S
PALSY -

AFFECTS ALL
MUSCLES OF
FACIAL
EXPRESSION



UPPER MOTOR
NEURON LESION -
ex. CORTICAL
STROKE (vascular
occlusion)

AFFECTS ONLY
MUSCLES OF LOWER
FACE ('SPARING OF
UPPER FACE')

UPPER FACE CONTROL
IS BILATERAL (both
sides of Cortex)

LOWER FACE CONTROL
IS UNILATERAL (ONLY
CONTRALATERAL
CORTEX)

BLOOD FLOW TO HEAD - WHERE DOES IT COMES FROM?

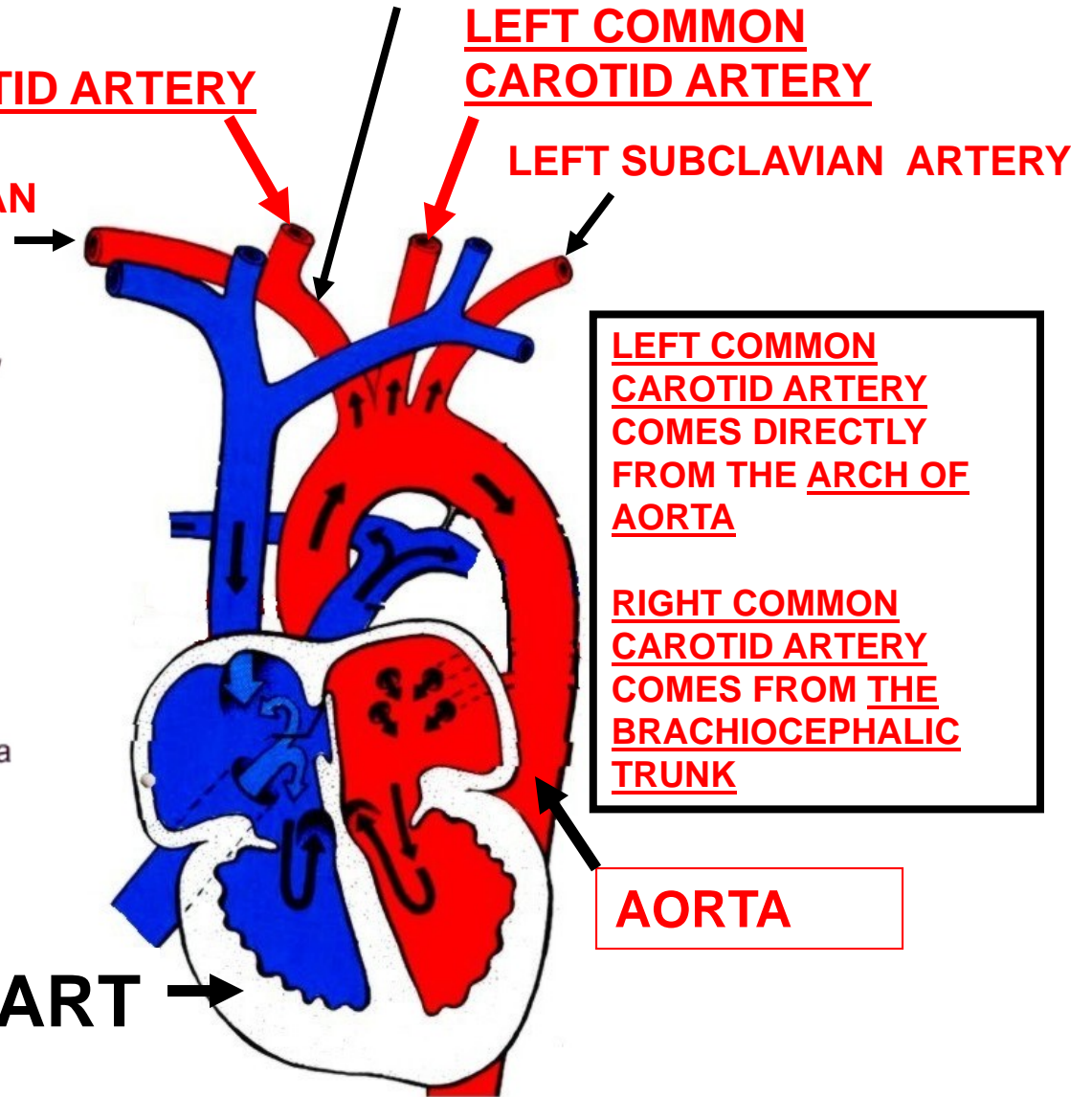
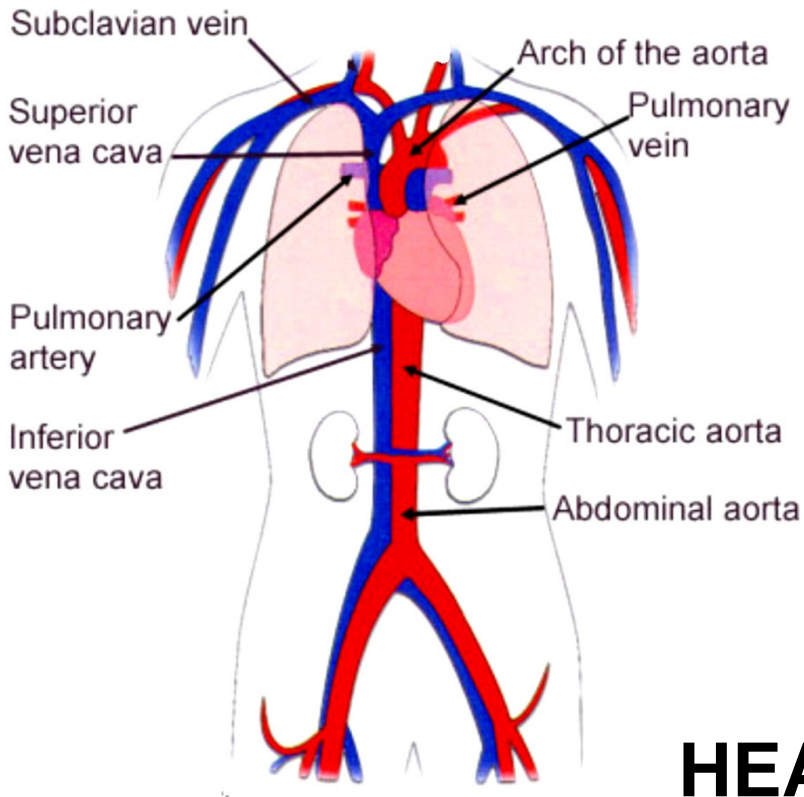
BRACHIOCEPHALIC TRUNK

RIGHT COMMON CAROTID ARTERY

LEFT COMMON CAROTID ARTERY

LEFT SUBCLAVIAN ARTERY

RIGHT SUBCLAVIAN ARTERY



OVERVIEW OF BLOOD SUPPLY TO HEAD

1) COMMON CAROTID ARTERY DIVIDES TO EXTERNAL AND INTERNAL CAROTID ARTERIES

2) INTERNAL CAROTID ARTERY AND VERTEBRAL ARTERY SUPPLY BRAIN

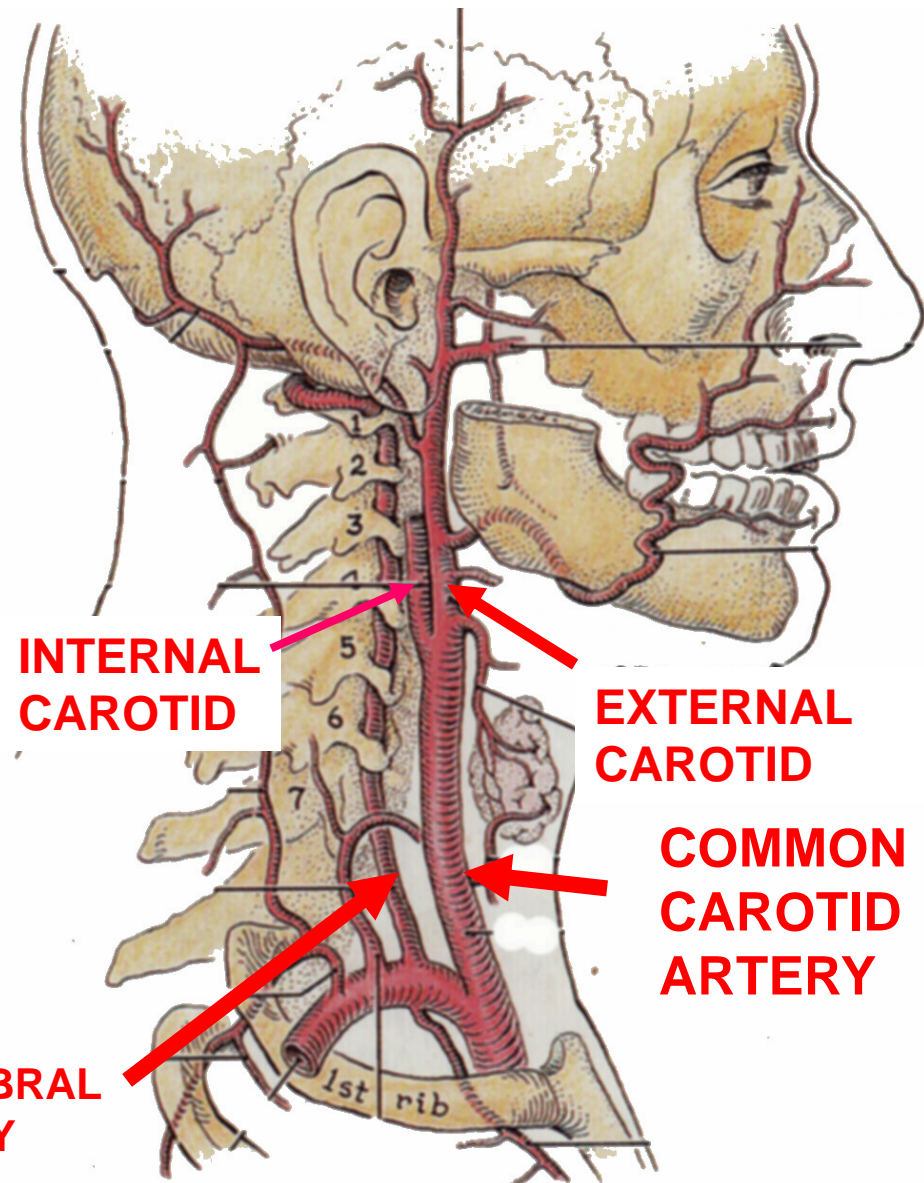
3) EXTERNAL CAROTID ARTERY SUPPLIES FACE AND HEAD

Branches:

1. SUPERIOR THYROID
2. ASCENDING PHARYNGEAL
3. LINGUAL
4. FACIAL
5. OCCIPITAL
6. POSTERIOR AURICULAR
7. SUPERFICIAL TEMPORAL
8. MAXILLARY

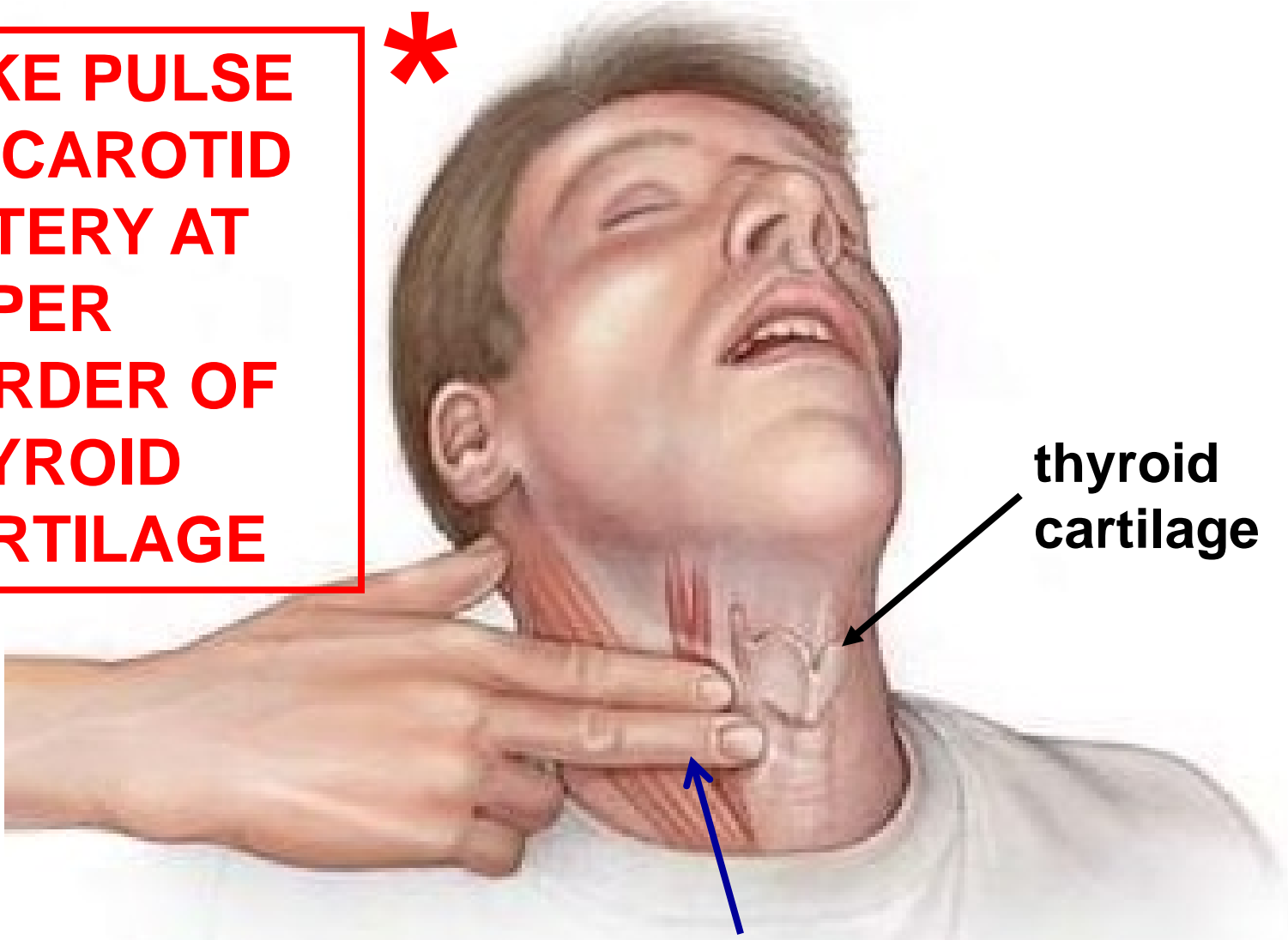
Mnemonic - 'Some Anatomists Like Freaking Out Poor Medical Students'

VERTEBRAL ARTERY



PALPATE CAROTID BIFURCATION AT UPPER BORDER OF THYROID CARTILAGE

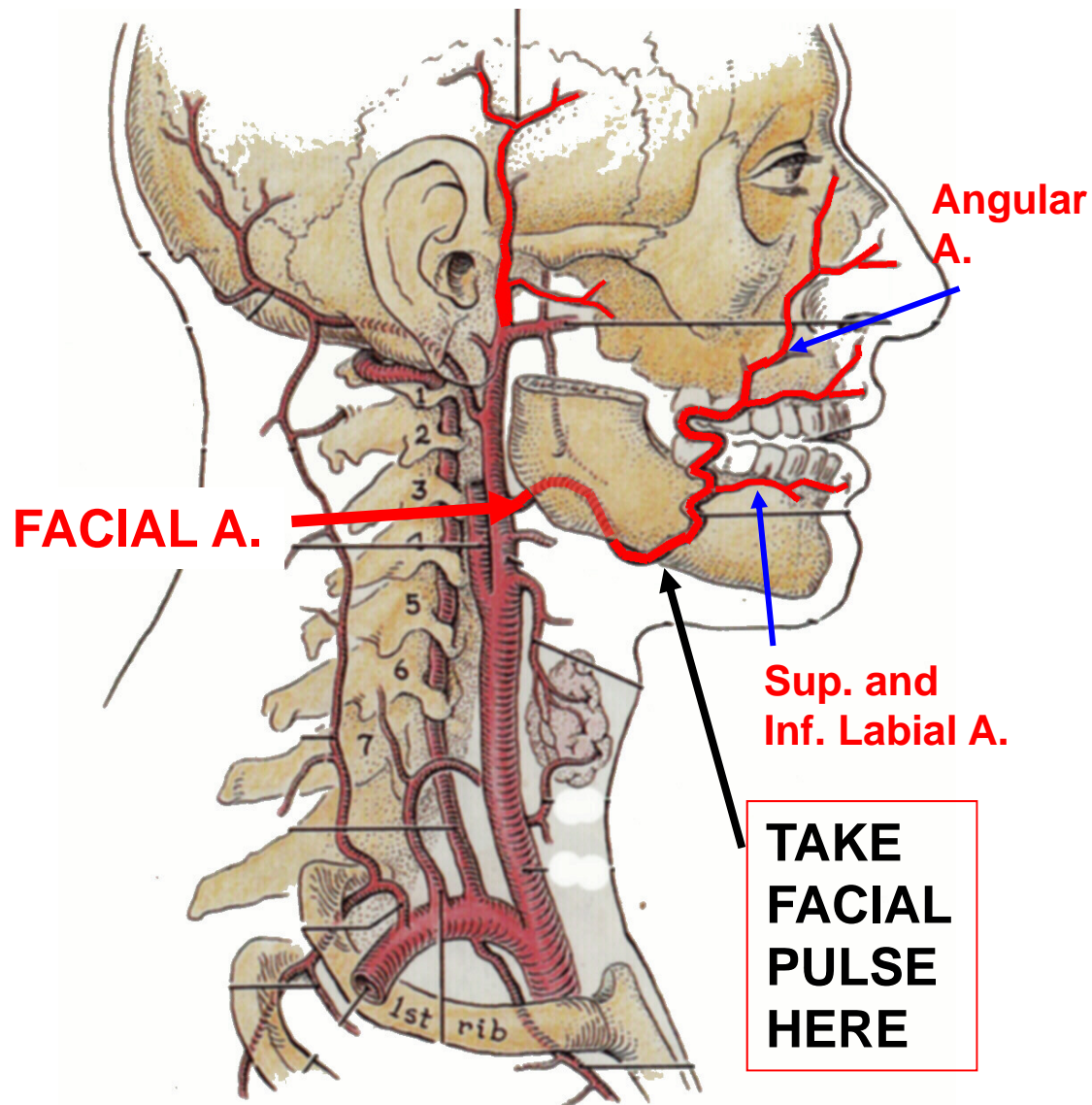
TAKE PULSE OF CAROTID ARTERY AT UPPER BORDER OF THYROID CARTILAGE



thyroid cartilage

VERTEBRAL LEVEL C4

II. ARTERIAL SUPPLY TO FACE - mainly from Facial and Superficial Temporal Arteries



a) Facial A.

- extremely winding and tortuous (skin moves)

- arises from ant. side of Ext Carotid.

- courses first medial to mandible then anterior
- site of Facial Pulse

Branches:

1) Sup. and Inf. Labial Arteries – upper and lower lips

Note: Anastomose with opposite side (cut lip can bleed profusely)

2) Angular Artery

- nose, angle (corner) of eye

ARTERIAL SUPPLY TO FACE

**TAKE
PULSE
HERE**

b) Superficial Temporal A.

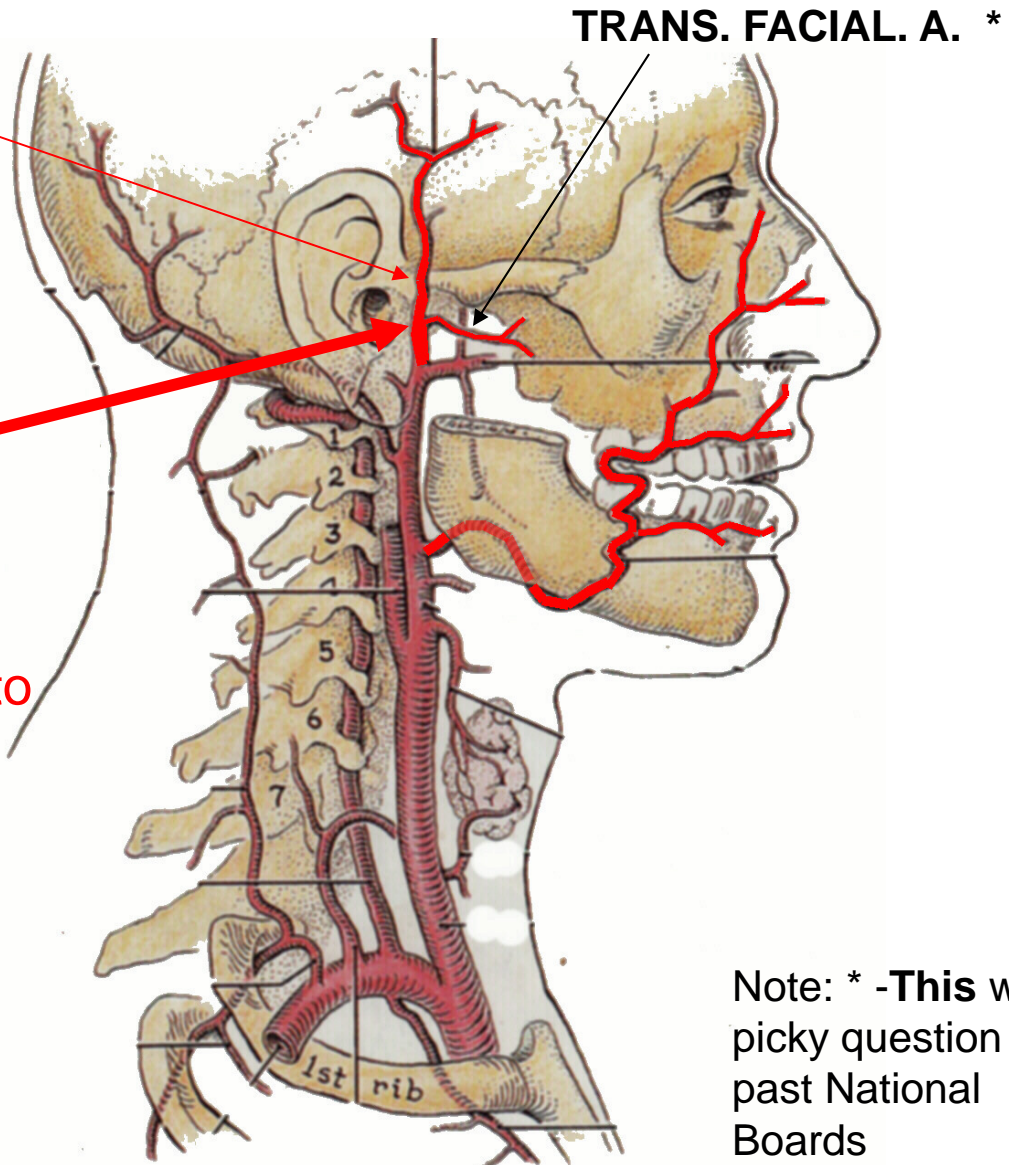
- one of terminal branches
- arises ant. to Ext.
auditory meatus (opening to
ear),

deep to parotid

- many branches to scalp

Small branches to face:

**note: CONFUSING AND
INCONSEQUENTIAL - Transverse
Facial artery**

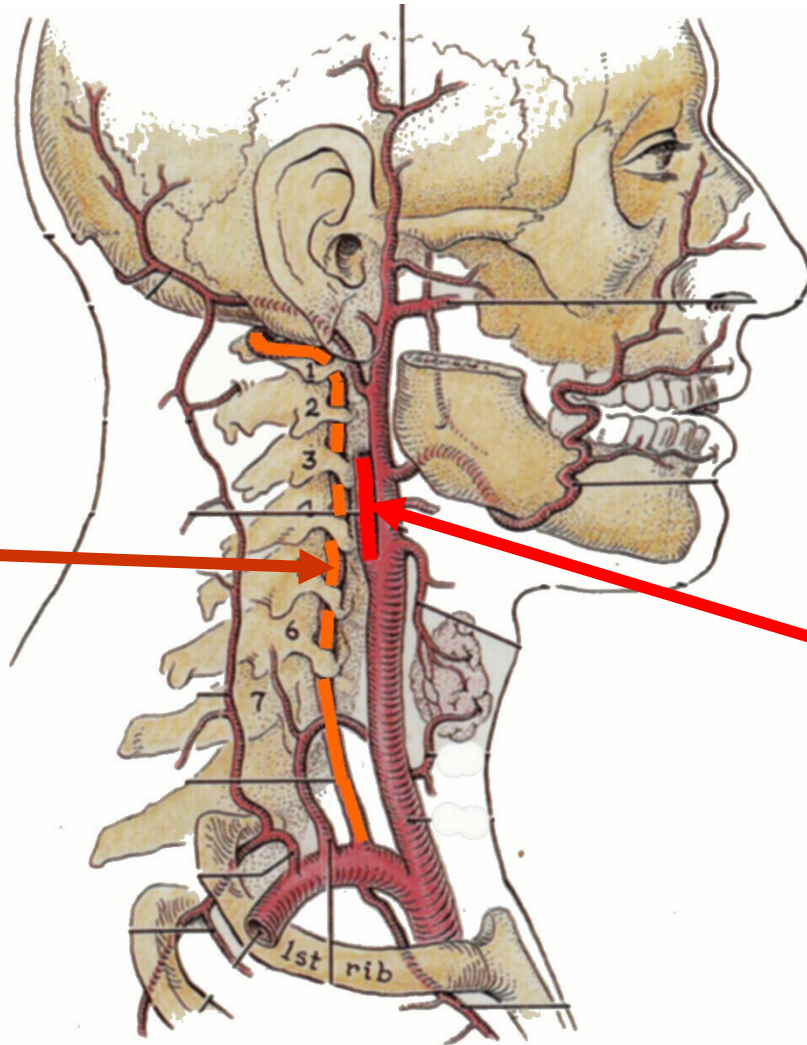


Note: * -**This** was a
picky question on
past National
Boards

OVERVIEW OF BLOOD SUPPLY TO HEAD -

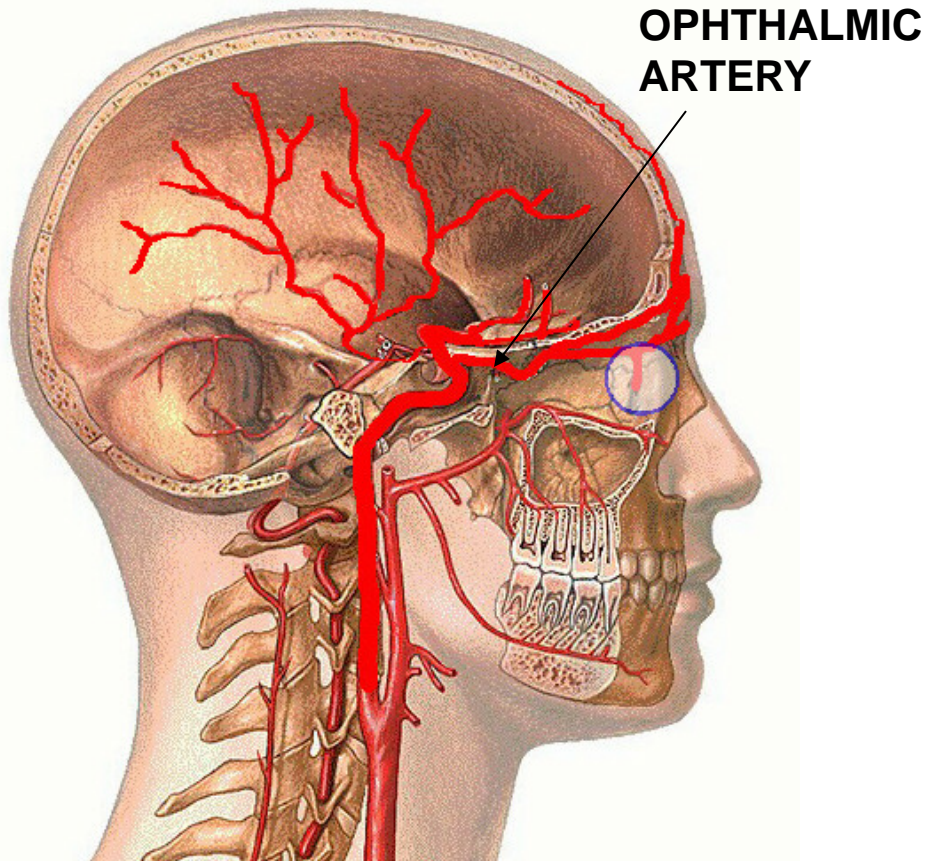
Internal Carotid supplies brain, also branches to eye, face

Vertebral A.
Courses
Through
Foramina
Transversaria
C1-C6;
supplies
brain stem,
spinal cord



Int. Carotid A.
Ascends
without
Branching
into Skull (via
Carotid
Canal)

INTERNAL CAROTID ARTERY



Note: Carotid = Karatikos in Greek = stupor; Named by Galen; Compression causes black out

Enters skull without Branching

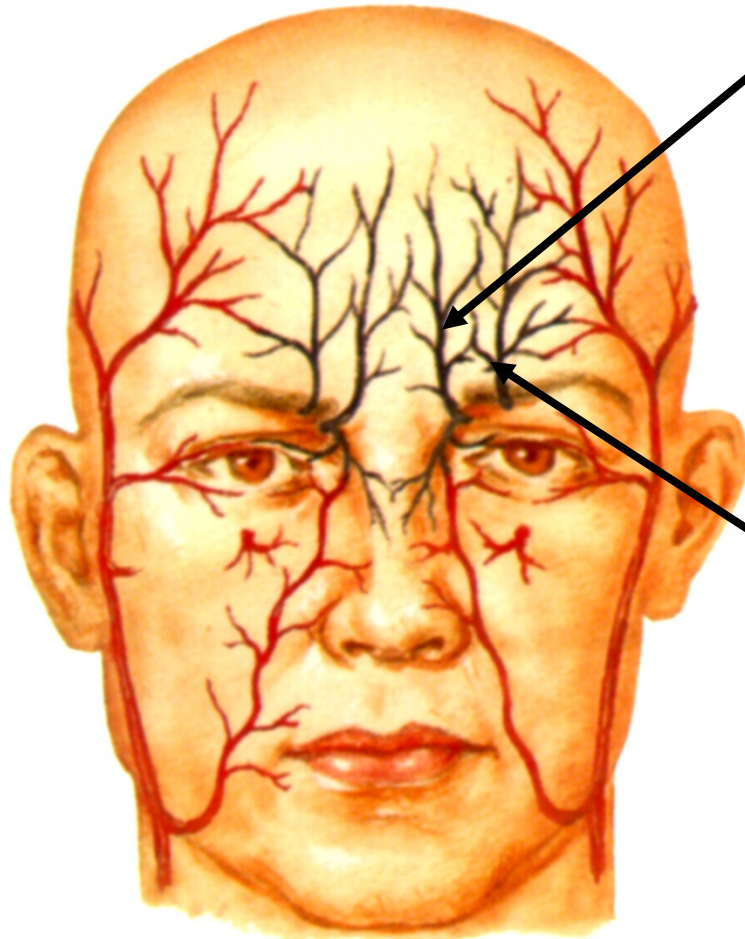
Branches to:

A. Brain

**B. Ophthalmic Artery-
Major blood supply
To eye (orbit)**

Note: Branches of Ophthalmic artery leave orbit to supply Face, Forehead, Nasal cavity

2. BRANCHES OF INTERNAL CAROTID TO FACE - From Ophthalmic Artery

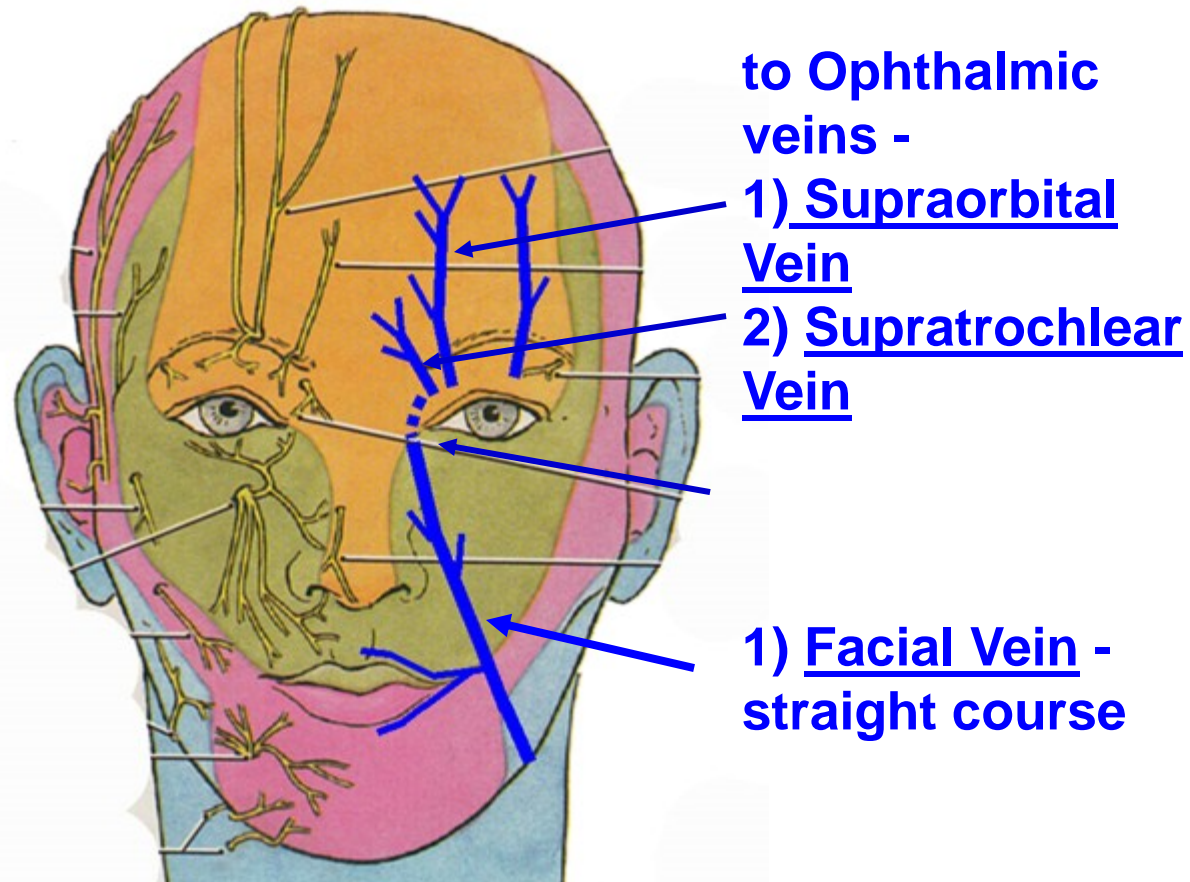


2) Supratrochlear artery-
on medial side of
Supraorbital a.
(above trochlea)

1) Supraorbital artery –
to scalp above orbit

Note: Orbit (= eye socket) is major route for nerves and blood vessels to reach face and nasal cavity

III. VENOUS DRAINAGE - branches follow arteries

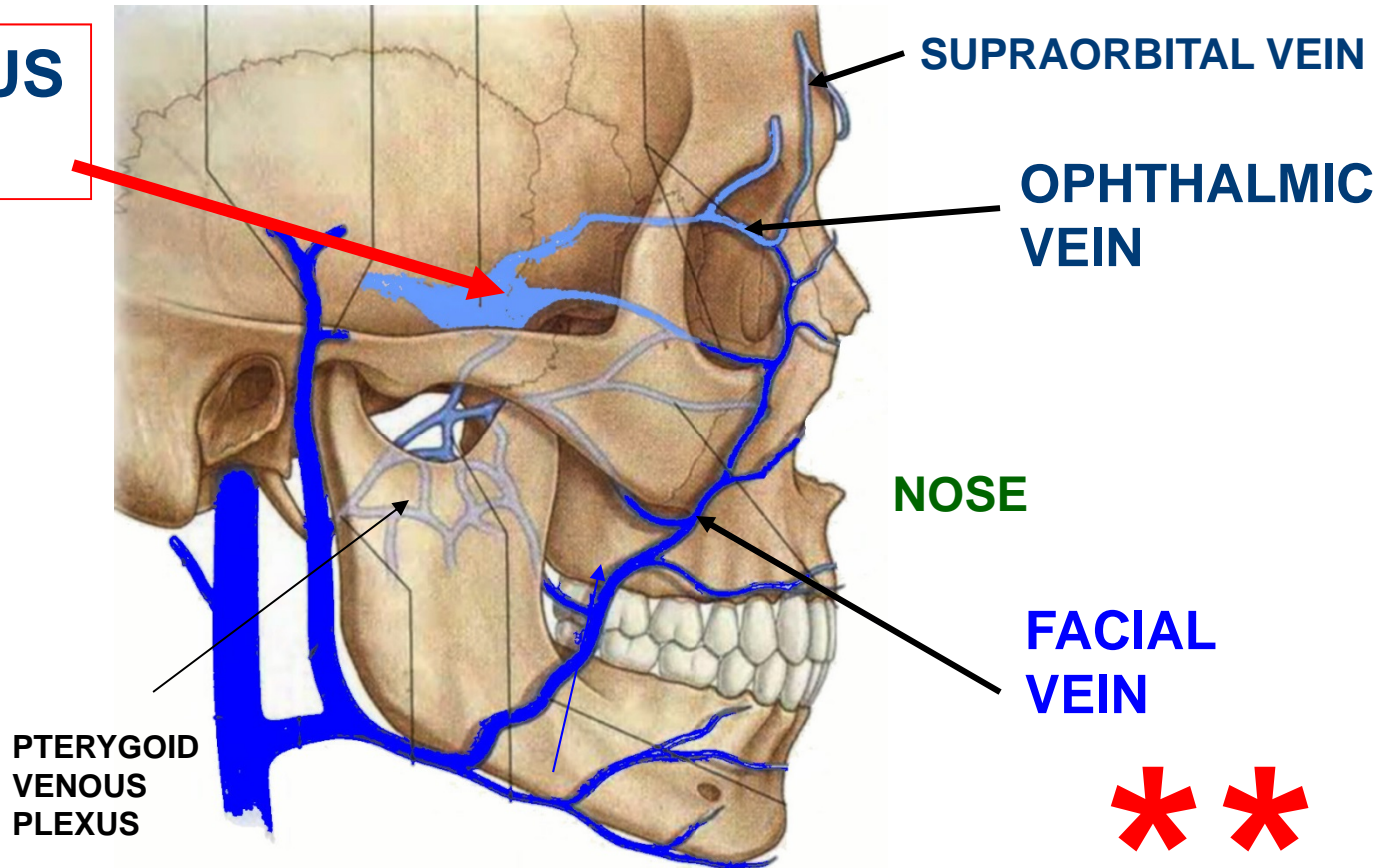


- NOTE: Veins of Face have no (OR FEW AND VARIABLE) valves; drain to neck and into skull; Extensive anastomoses between branches of Facial AND Ophthalmic Veins

SPREAD OF INFECTION FROM FACE TO BRAIN

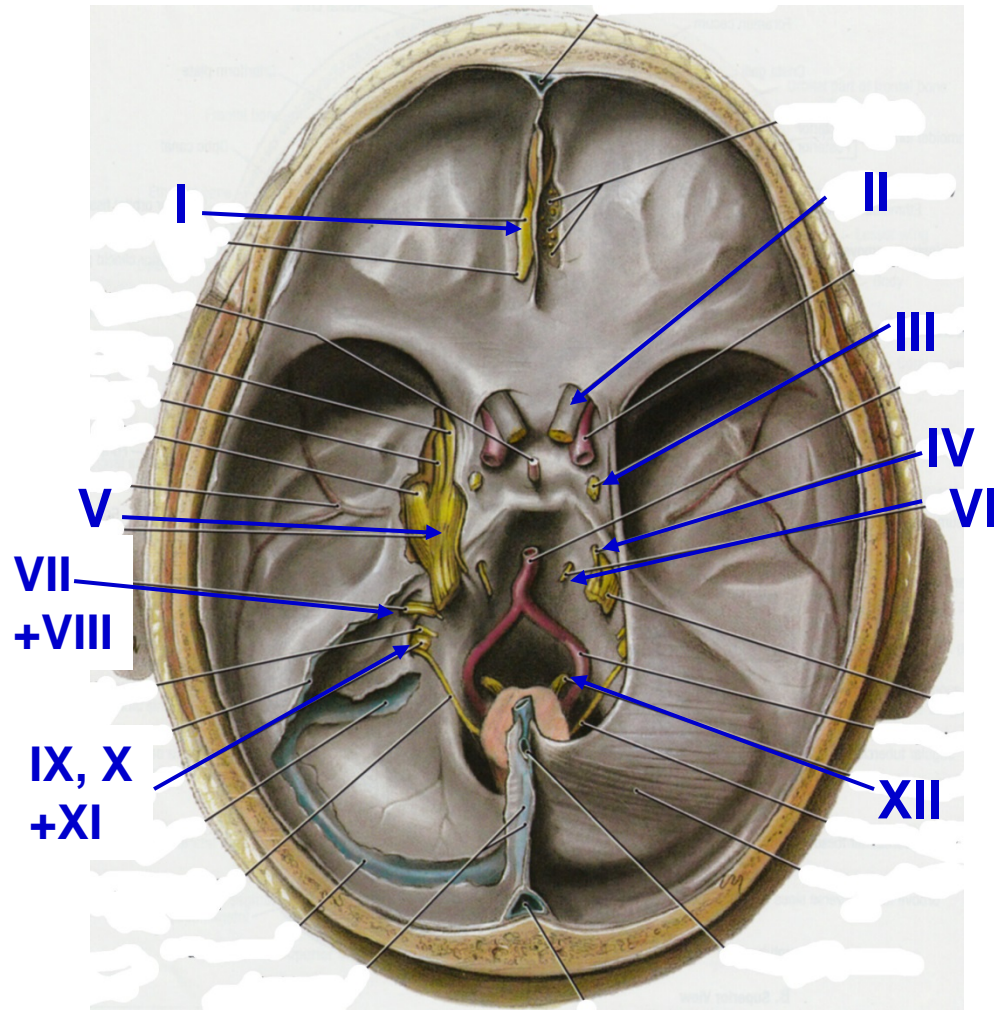
CAVERNOUS SINUS

Anastomoses of Facial and Ophthalmic Veins
- Ophthalmic veins drain to cavernous sinus (venous sinus inside skull)



- **Prolonged infections** spread via veins (pressure low, no valves)
- Pass through orbit to Cavernous Sinus - **CAVERNOUS SINUS THROMBOSIS**; infections lateral to nose particularly dangerous
- **Clinical sign: 'Blurred' vision (actually DIPLOPIA) (cranial nerves to eye muscles pass through Cavernous sinus)**

LEARN NAMES AND NUMBERS OF CRANIAL NERVES



- I. OLFACTORY - sense of smell
- II. OPTIC - vision
- III. OCULOMOTOR - eye movement
- IV. TROCHLEAR - eye movement
- V. TRIGEMINAL - touch, general sensation to skin, oral cavity, nasal cavity + more
- VI. ABDUCENS - eye movement
- VII. FACIAL - muscles of facial expression + lots more
- VIII. VESTIBULO-COCHLEAR - hearing and balance
- IX. GLOSSOPHARYNGEAL - sensory to pharynx + more
- X. VAGUS - larynx, pharynx + rest of body
- XI. ACCESSORY - sternocleidomastoid, trapezius
- XII. HYPOGLOSSAL - muscles of tongue

IV. SENSORY INNERVATION - TRIGEMINAL NERVE - TO SKIN OF HEAD – 3 DIVISIONS

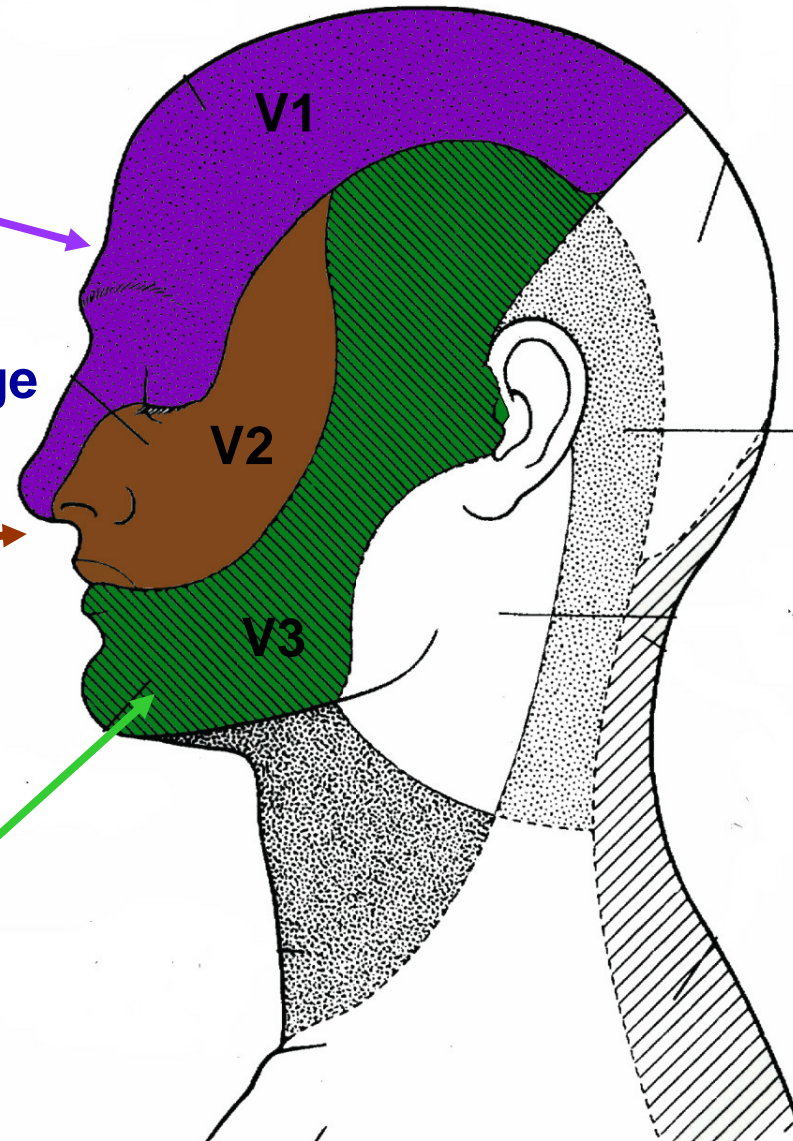
**V1 –
OPHTHALMIC
DIVISION**

Boundary-
Lateral edge
of eye

**V2 –
MAXILLARY
DIVISION**

Boundary
Lateral
edge
of mouth

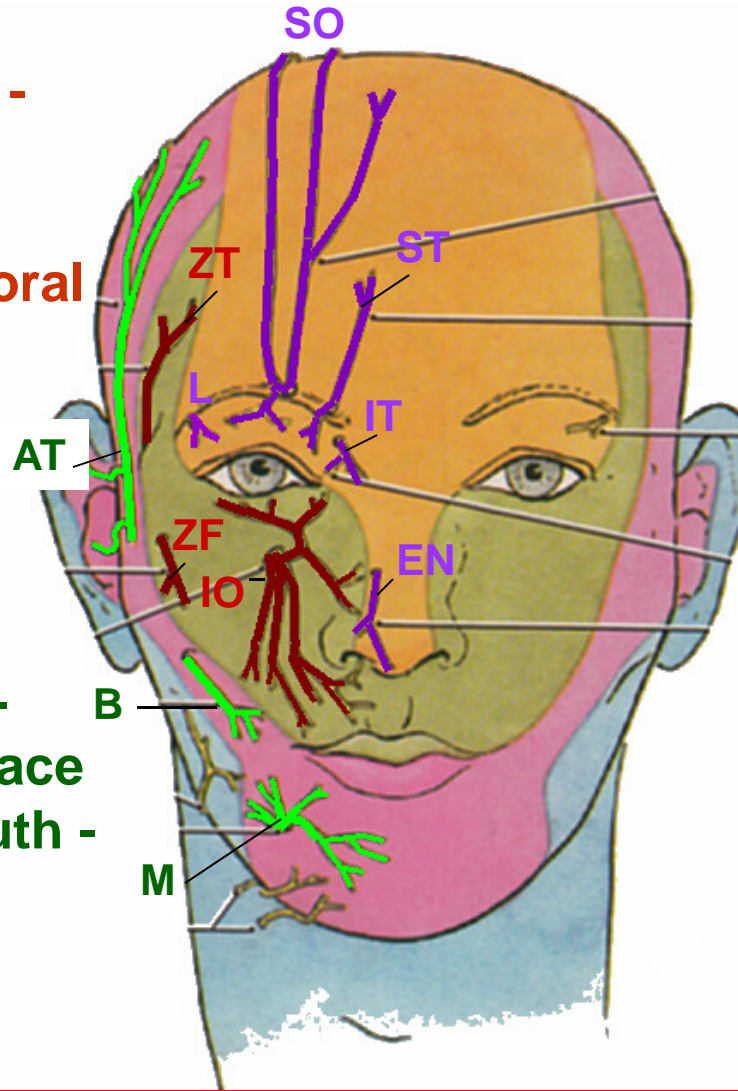
**V3 –
MANDIBULAR
DIVISION**



SENSORY SUPPLY - BRANCHES OF TRIGEMINAL NERVE TO FACE

V2 – MAXILLARY -
 to skin of cheek
 below orbit -
 Zygomaticotemporal
 Zygomaticofacial
 Infraorbital

V3- MANDIBULAR -
 to skin of jaw and face
 below angle of mouth -
 Auriculotemporal
 Buccal
 Mental



V1 – OPHTHALMIC -
 to skin above orbit -
 Lacrimal
Supraorbital
 Supratrochlear
 Infratrochlear
 External Nasal Nerve

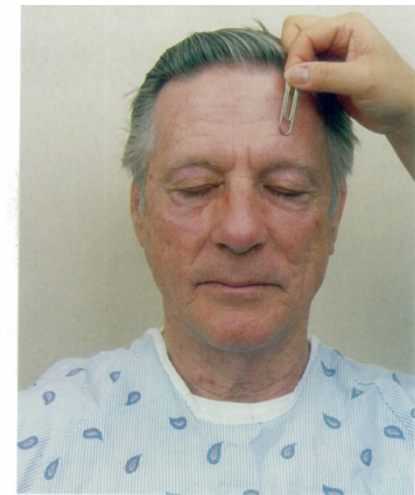


FIGURE 21-13
 Examination of the trigeminal cranial nerve

**CLINICAL TEST OF V:
 SUPRAORBITAL N.**

NOTE: These are SOME branches of V (to face), not ALL branches of V

REFERENCE HANDOUT: TRIGEMINAL NERVE BRANCHES (NOT INCLUDING HITCHHIKING PATHWAYS OF VI, IX) zll@mscom 2015

ALL BRANCHES OF TRIGEMINAL NERVE ARE LISTED IN HANDOUT

DO NOT MEMORIZE NOW BUT USE AS REFERENCE – SEE LATER

V1 Ophthalmic - Somatic Sensory only (GSA) - through Superior Orbital Fissure to Orbit

Nerve	Branches	Innervates
1. Frontal Nerve	a. Supraorbital Nerve	Scalp forehead, upper eyelid
	b. Supratrochlear Nerve	Scalp forehead, upper eyelid
2. Lacrimal Nerve		Upper eyelid
3. Nasociliary Nerve	a. Long Ciliary Nerve	Cornea of eye
	b. Ant. and Post. Ethmoidal Nerves	Nasal cavity, ethmoid sinus, tip of nose
	c. Infratrochlear Nerve	Upper eyelid, nose

V2 Maxillary - Somatic Sensory (GSA) only - through Foramen Rotundum to Pterygopalatine Fossa

Nerve	Branches	Innervates
1. Meningeal branches		Dura of mid. Cranial fossa
2. Ganglionic branches	a. Greater Palatine Nerve	Hard Palate
	b. Lesser Palatine Nerve	Soft Palate
	c. Nasopalatine Nerve	Nasal Cavity, Hard Palate
	d. Nasal branches	Nasal Cavity
3. Post. Sup. Alveolar Nerve		Maxillary teeth
4. Infraorbital nerve	a. Ant. Sup. Alveolar Nerve	Maxillary teeth
	b. Mid. Sup. Alveolar Nerve	Maxillary teeth
5. Zygomatic nerve	a. Zygomaticofacial Nerve	Skin of cheek
	b. Zygomaticotemporal Nerve	Skin of temporal region

V3 Mandibular - Somatic Sensory (GSA) and Branchiomotor (SVE) - Foramen Ovale to Infratemporal Fossa

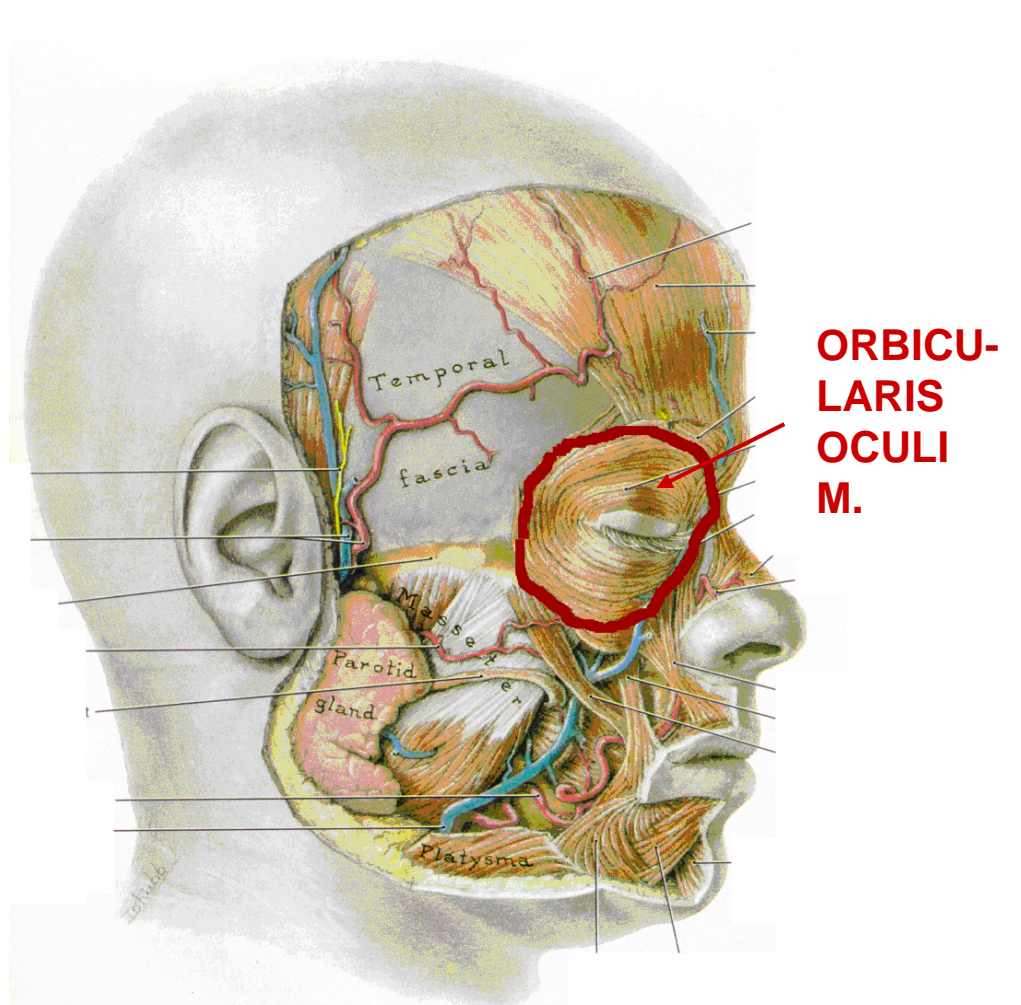
Nerve	Branches	Innervates
1. Nervous spinosus		Sensory to Dura of mid Cranial fossa
2. Motor branches		Motor to Med. Pterygoid, Tens. Tympani, Tensor Palati
3. Anterior division	a. Nerve to Lateral Pterygoid	Motor to Lateral Pterygoid
	b. Masseteric Nerve	Motor to Masseter
	c. Deep Temporal Nerve	Motor to Temporals
	d. Buccal Nerve	Sensory to Cheek
4. Posterior Division	a. Auriculotemporal Nerve	Sensory to external auditory meatus, tympanic membrane, TMJ, lateral scalp
	b. Lingual Nerve	Sensory (touch) ant. 2/3 tongue
	c. Inferior Alveolar Nerve	Sensory to Mandibular teeth
	i. Nerve to Mylohyoid	Motor to Mylohyoid, ant. Digastric
	ii. Mental Nerve	Sensory to Chin, Lower lip

V. MUSCLES OF FACIAL EXPRESSION

- move skin of face, close eyes, open/close mouth
- convey emotions by gestures (ex. sneering, contempt) - most origin – bones; insert - skin
- many named for action in Latin/Greek
- movements elicited in test for Facial Nerve function (CN VII)

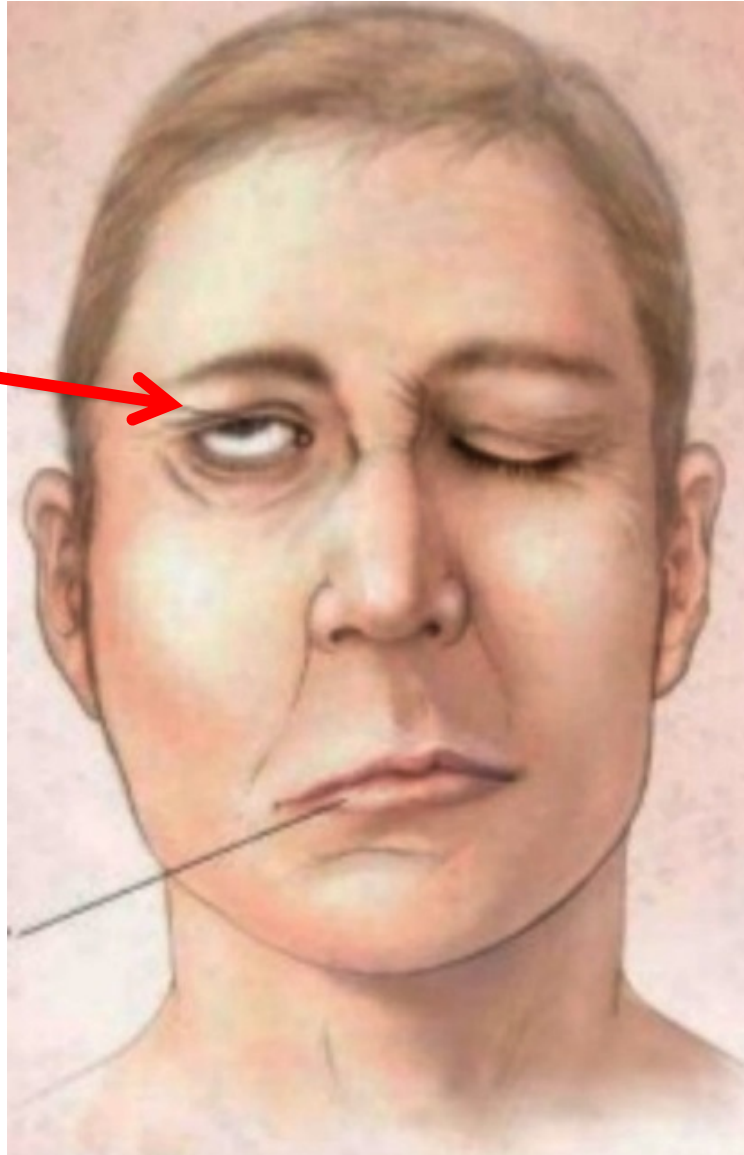
1. Orbicularis Oculi - close eye

- Palpebral part – in eyelid - Close eyelids
- Orbital part – on face - Buries eyelids, Ex. sandstorm



PARALYSIS OF ORBICULARIS OCULI

UNABLE TO
CLOSE EYE
DUE TO
PARALYSIS
OF
ORBICULARIS
OCULI
MUSCLE



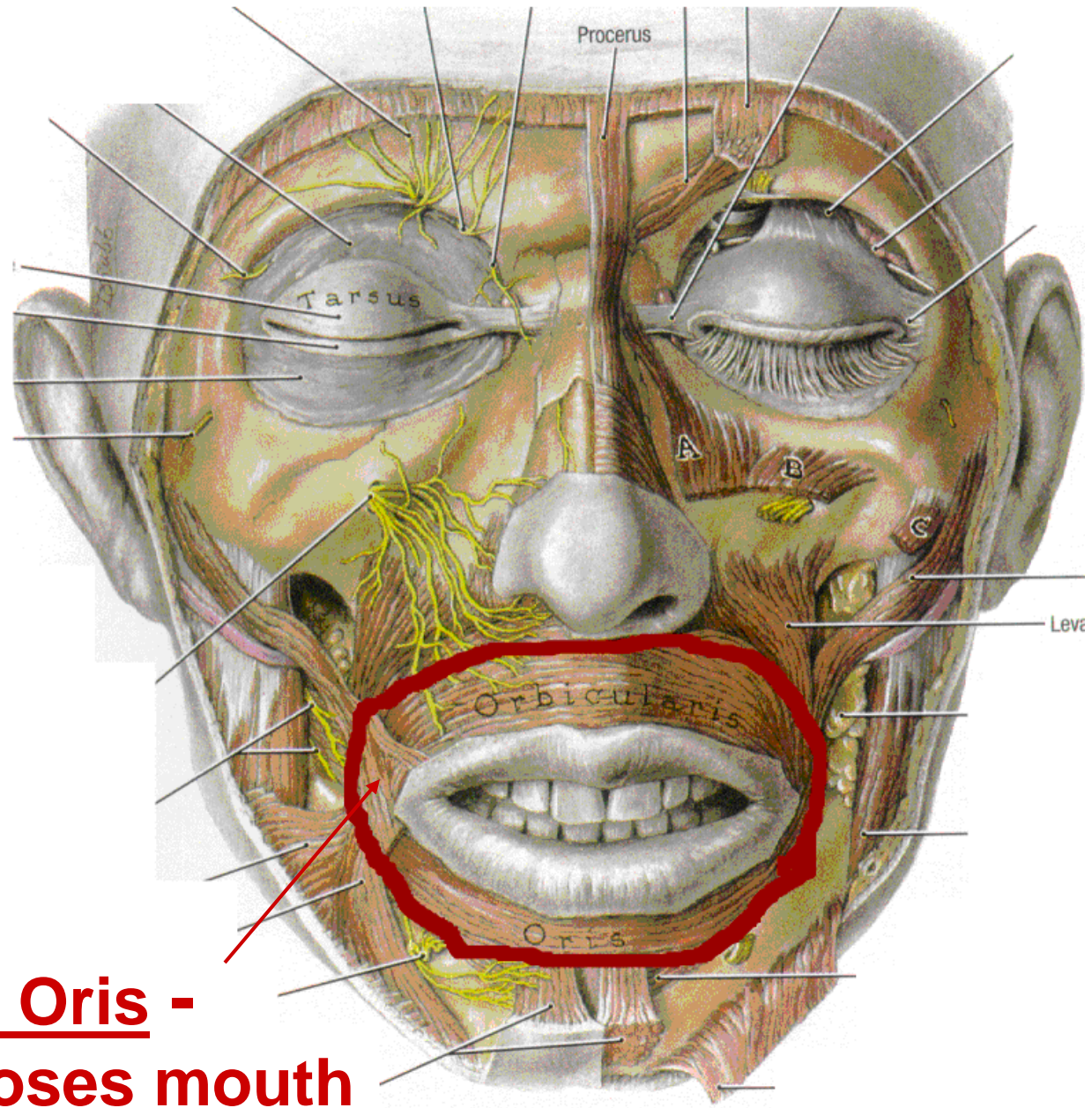
CLINICAL * *

FACIAL
PARALYSIS (as in
Bell's Palsy) can
paralyze
ORBICULARIS
OCULI MUSCLE

- patient is unable to close eye
- can damage cornea of eye
- in newborns, can sew eyelid shut to prevent corneal damage

NOTE:

- 1) CLOSE EYELIDS
= CRANIAL NERVE VII (FACIAL N.)
- 2) OPEN EYELIDS
- CRANIAL NERVE III (OCULOMOTOR)
+ SYMPATHETICS



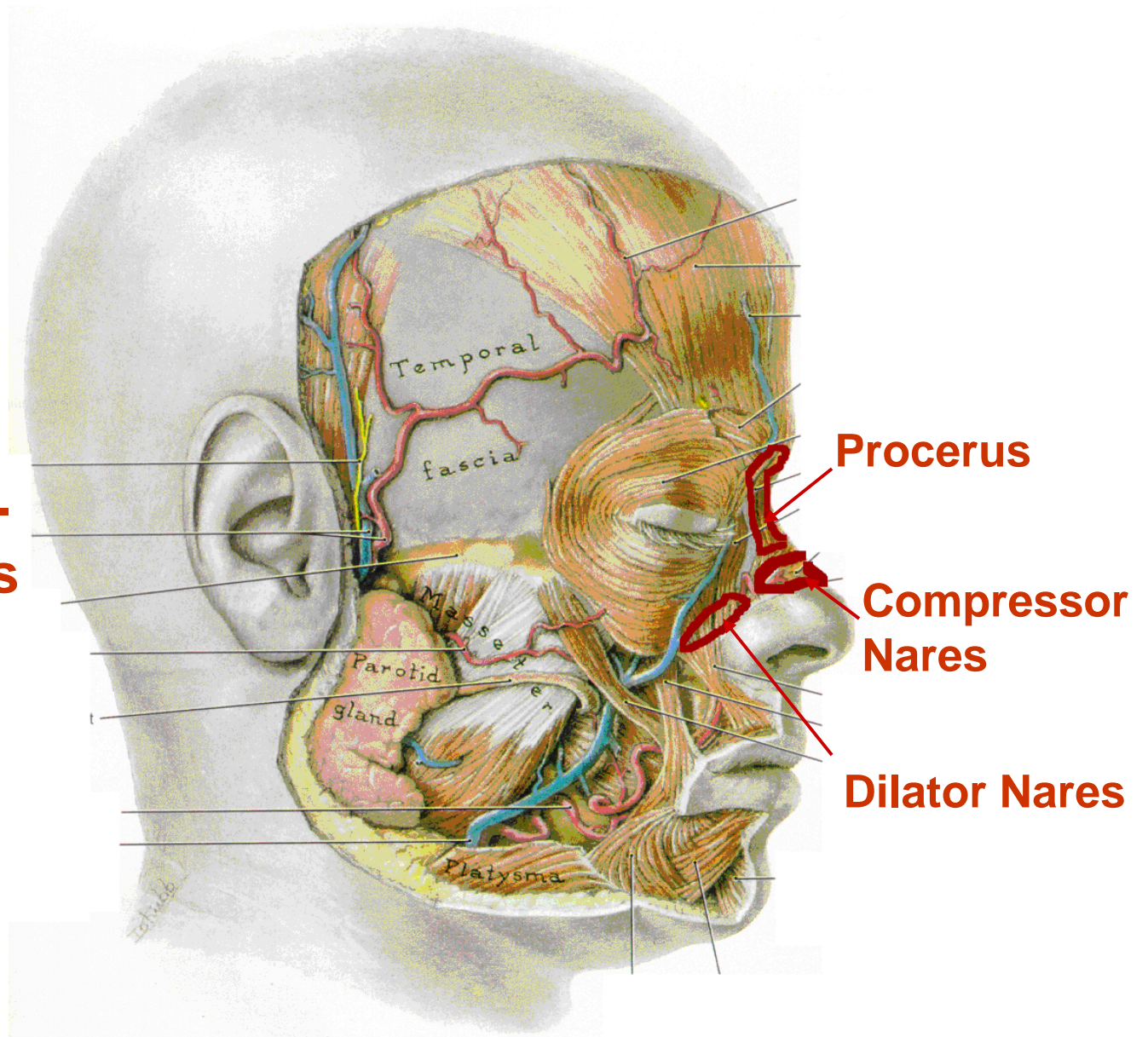
**2. Orbicularis Oris -
Surrounds/closes mouth**

3. MUSCLES OF NOSE

a. Compressor nares - lateral to bridge of nose compresses nasal cart.

b. Dilator nares - lateral to nostrils - dilates

c. Procerus - wrinkles skin of nose



4. MUSCLES OF UPPER LIP-

a) Levator Labii Superioris - lifts upper lip

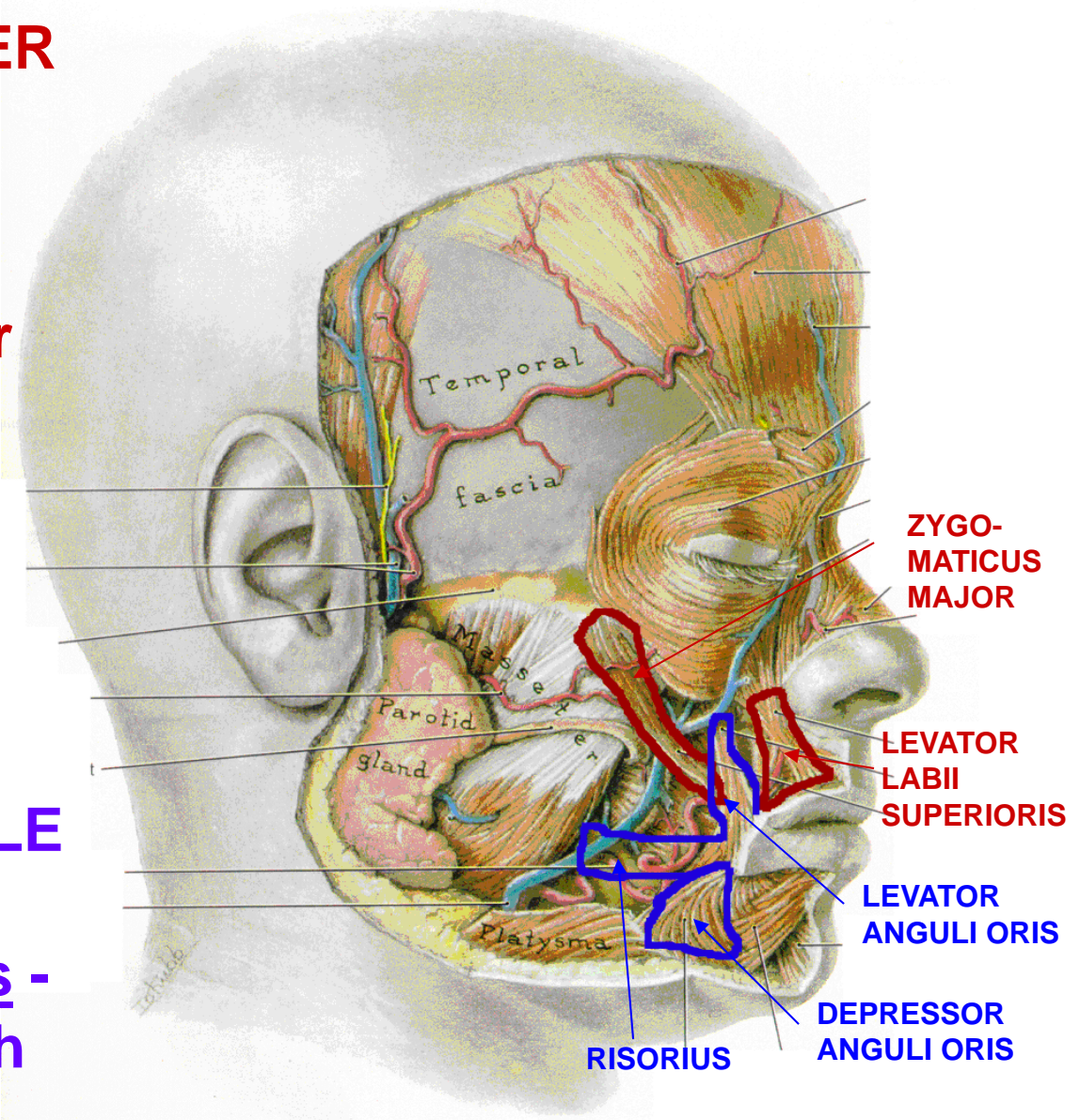
b) Zygomaticus major and minor - raise and pull upper lip laterally

5. MUSCLES AT ANGLE OF MOUTH

a) Levator Anguli Oris - Raise corner of mouth

b) Risorius - smiling

c) Depressor Anguli Oris - tragedy



6. MUSCLES OF LOWER LIP AND CHIN-

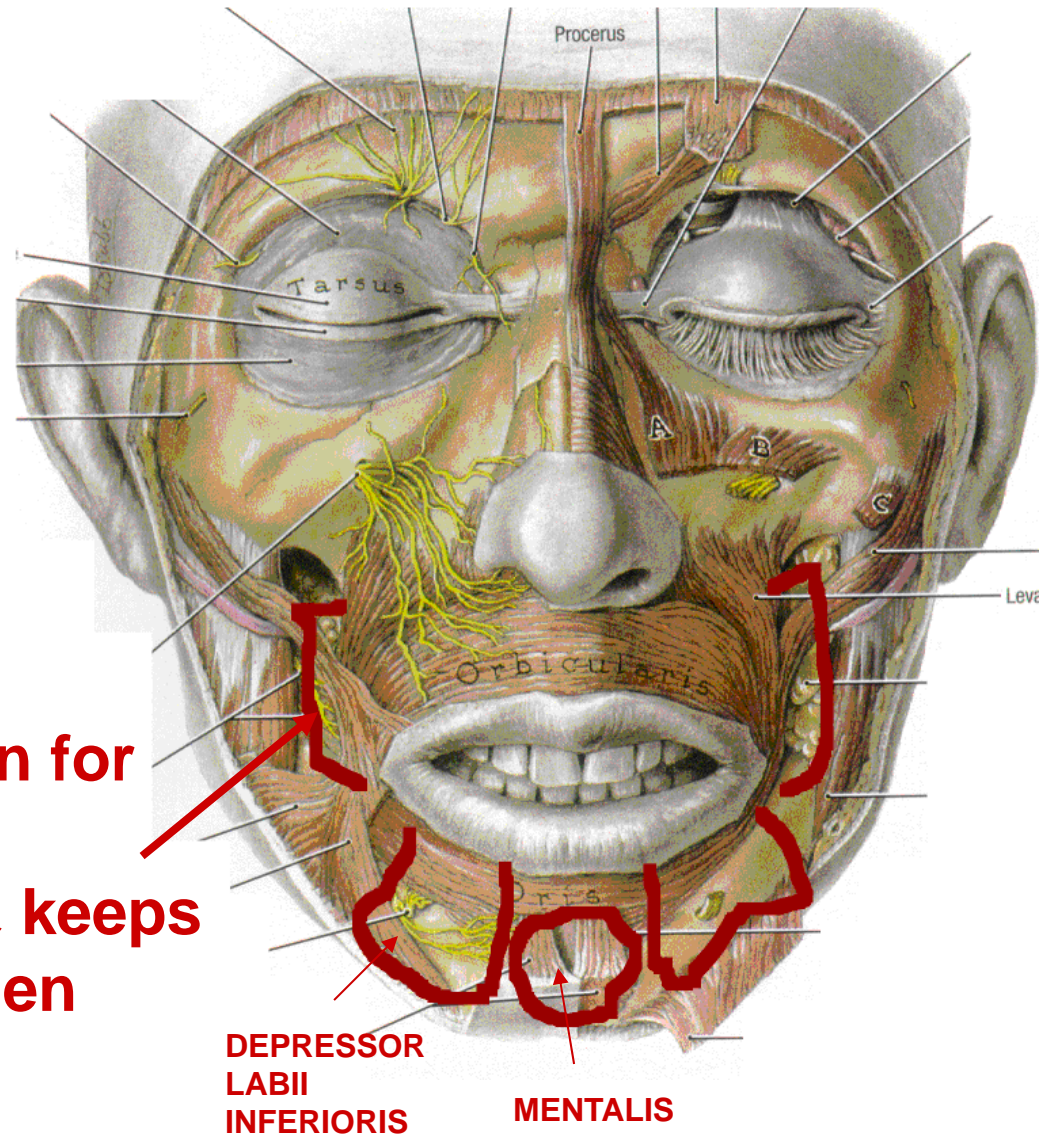
a) Depressor Labii Inferioris -

depresses low lip

b) Mentalis -

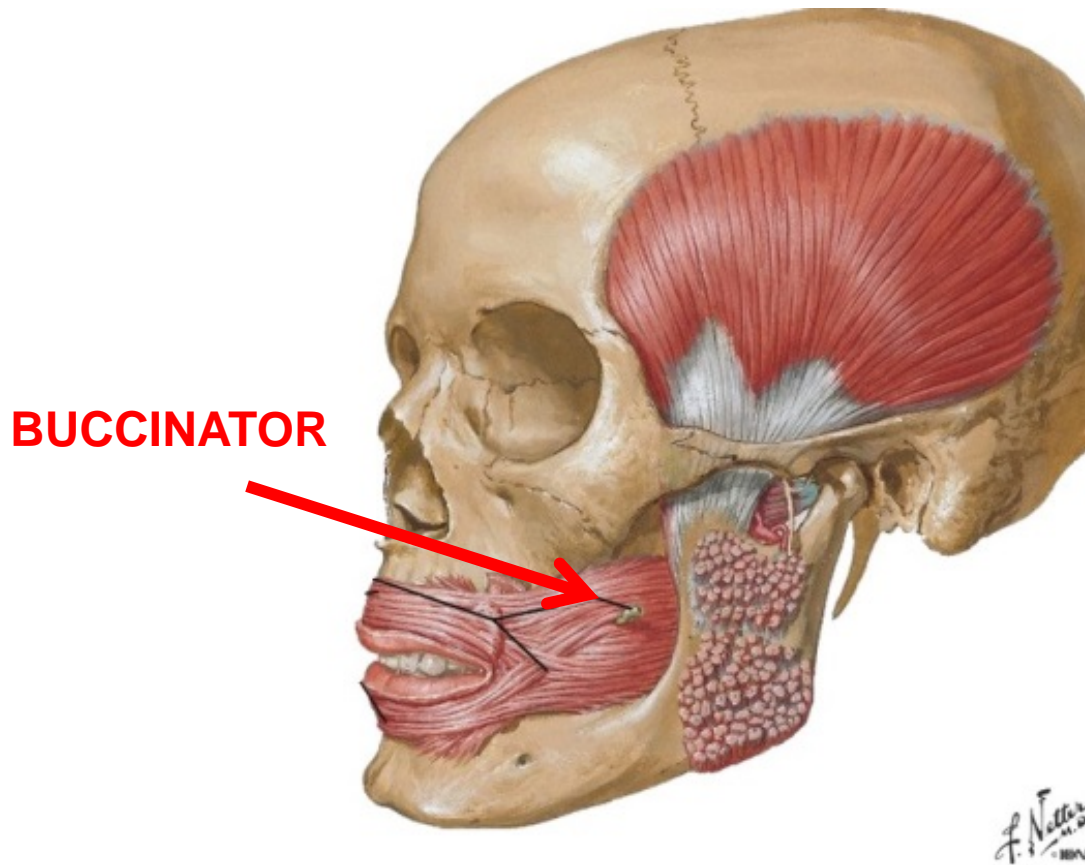
wrinkles skin of chin

7. BUCCINATOR – Latin for trumpet player
- compresses mouth & keeps food between teeth when chewing



PARALYSIS OF BUCCINATOR MUSCLE

CLINICAL * *



**FACIAL PARALYSIS
can paralyze
BUCCINATOR**

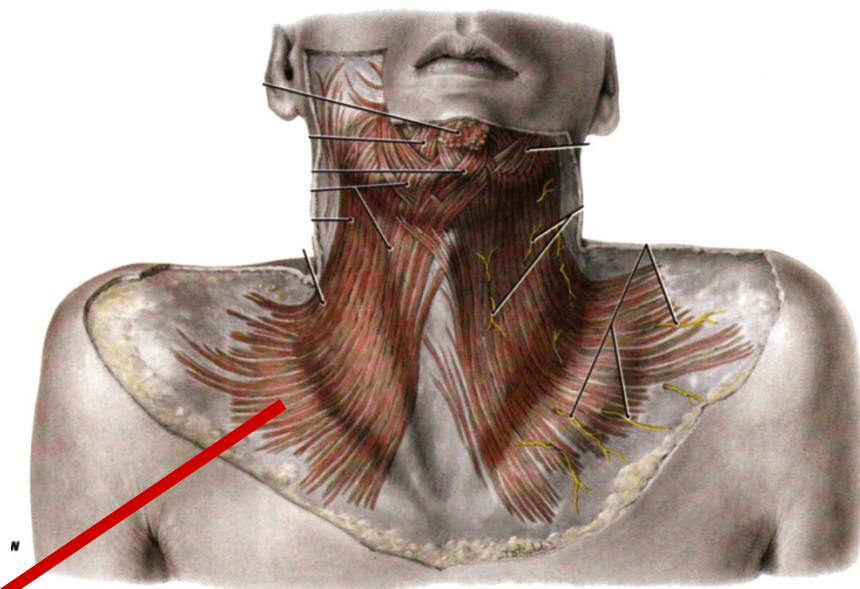
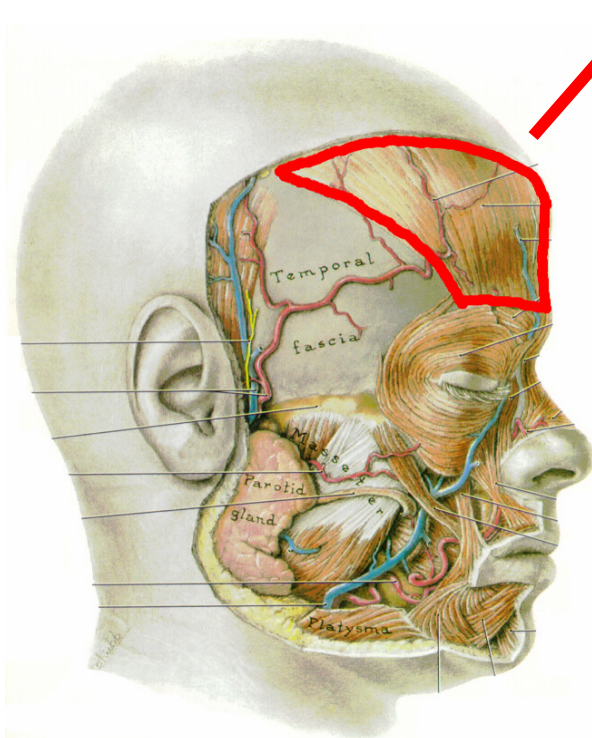
**- patient is unable to
hold food between
teeth**

BOARD QUESTION

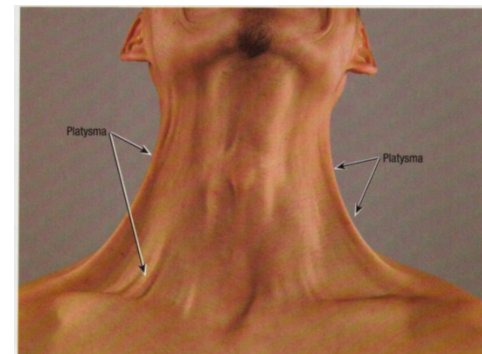
**- DIFFICULTY IN
CHEWING FOOD**

**BUCCINATOR FORMS WALL OF
MOUTH - PARALYZE UNABLE TO
HOLD FOOD BETWEEN TEETH**

8. FRONTALIS - muscle in scalp attached to Epicranial Aponeurosis; raises eyebrows (used in clinical test of Facial nerve)



9. PLATYSMA - extends from mandible to fascia over Pectoralis Major; tenses, moves skin of neck



PRACTICE USING FACIAL MUSCLES SELECTIVELY IN FRONT OF MIRROR



Palpebral Part



Orbital Part

Orbicularis Oculi

**Sneering –
Procerus** →



Procerus



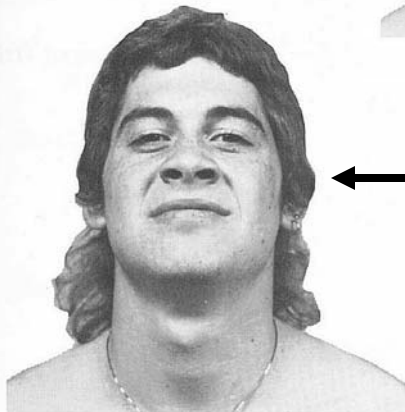
Frontalis



Corrugator Supercilii



Procerus



Nasalis

← **Contempt –
Dilator Naris**



Nasalis



Risorius



Depressor Anguli Oris

**Grading Policy -
Depressor Anguli
Oris** →



Depressor Anguli Oris



Orbicularis Oris



Zygomaticus Major



Mentalis

7-15B MUSCLES OF EXPRESSION IN ACTION

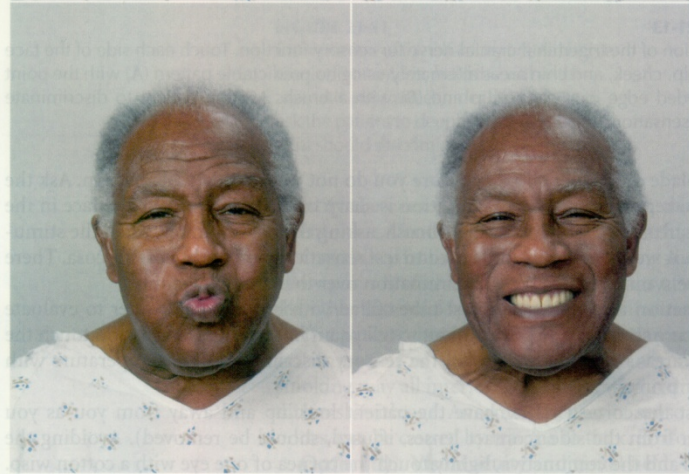
CLINICAL TEST FOR FACIAL NERVE FUNCTION

**WRINKLE
FOREHEAD BY
RAISING
EYEBROWS:
FRONTALIS**



**SMILE:
RISORIUUS**

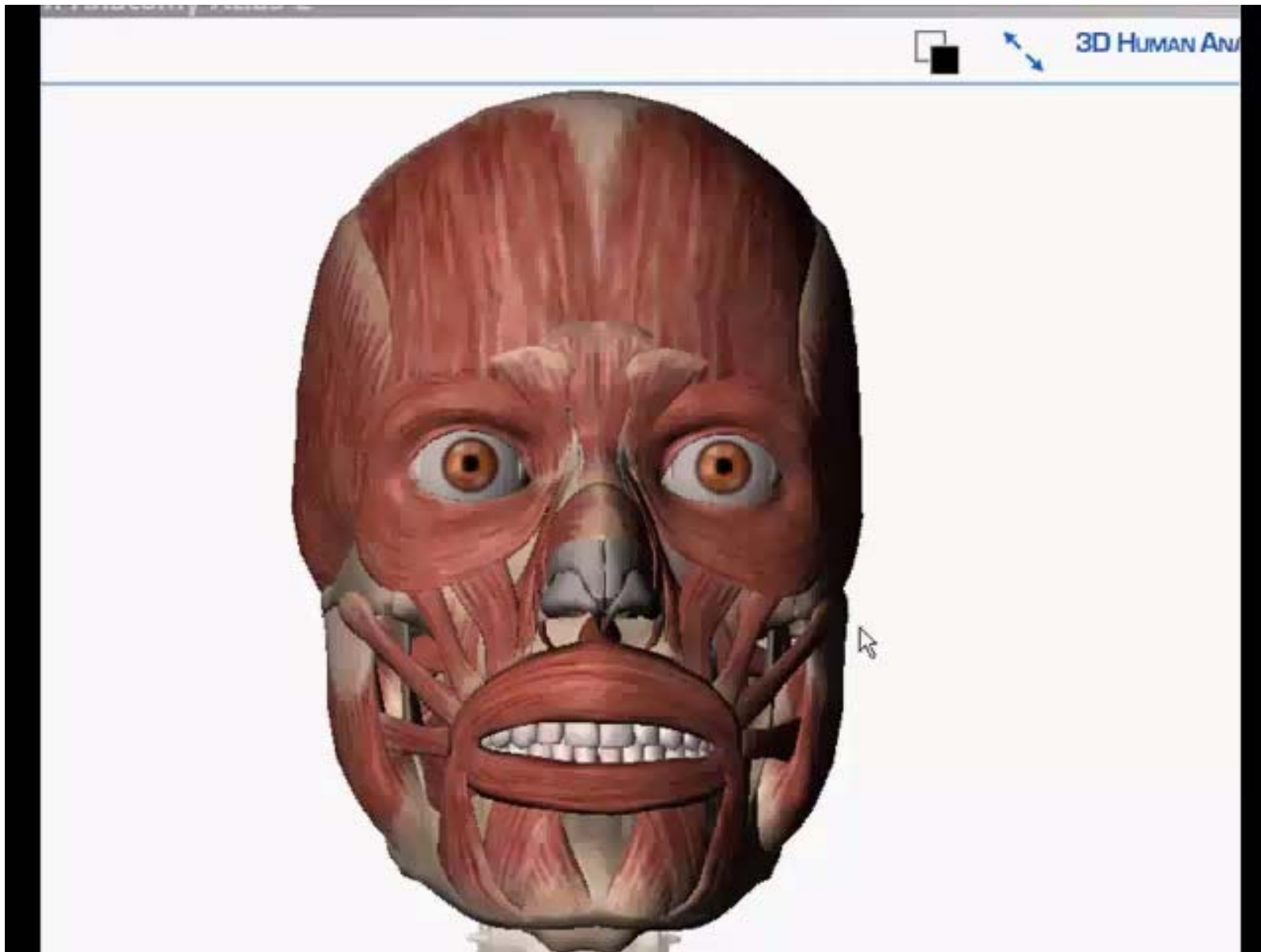
**PURSE LIPS:
ORBICULARIS
ORIS**



**SHOW TEETH:
LEVATOR LABII
SUPERIORIS,
ZYGOMATICUS
MAJOR, ETC.**

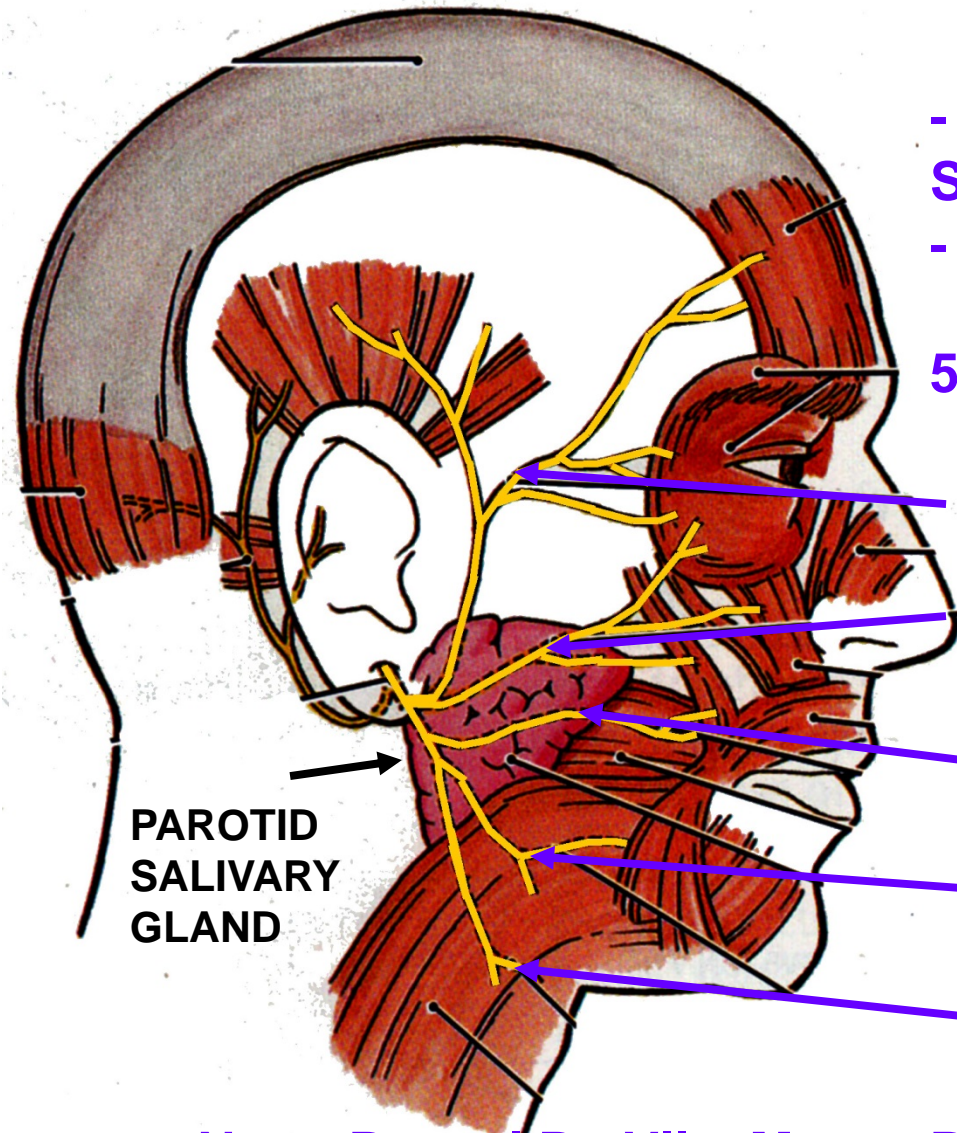
DR. PAUL FERGUSON: CRANIAL NERVE EXAM

- How to test:
 - First look for asymmetry before moving on to a laundry list of components:
 1. Squint eyes shut against resistance
 2. Raise eyebrows / wrinkle forehead
 3. Puff out cheeks
 4. Smile showing teeth
 5. Frown
 6. Purse lips



POSTED ON CURRICULUM MAP: FACIAL MUSCLES.MP4

VI. MOTOR INNERVATION TO MUSCLES OF FACIAL EXPRESSION - FACIAL NERVE (CRANIAL NERVE VII)



- leaves skull via Stylomastoid foramen
- divides in parotid gland into 5 terminal branches

1. TEMPORAL

2. ZYGOMATIC

3. BUCCAL

4. MANDIBULAR

5. CERVICAL

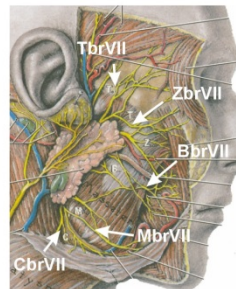
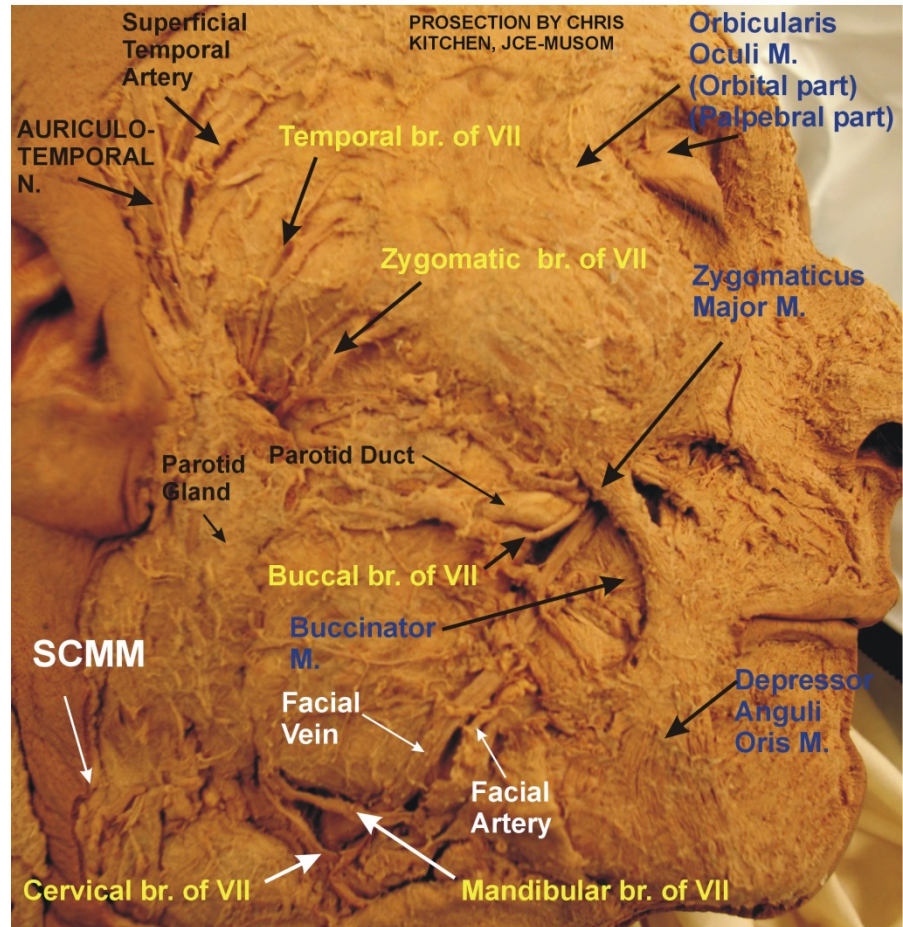
Note: Buccal Br. VII = Motor; Buccal Br. V = Sensory

FACIAL PARALYSIS



BRANCHES OF FACIAL NERVE (VII) AND SUPERFICIAL FACE

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Superficial Temporal Atery
 Auriculotemporal Nerve
 TbrVII - Temporal branch of VII
 ZbrVII - Zygomatic branch of VII
 BbrVII - Buccal branch of VII
 MbrVII - Mandibular branch of VII
 CbrVII - Cervical branch of VII
 Orbicularis oculi (orbital part)
 Zygomatikus major
 Levator Labi Superioris
 Depressor Anguli Oris

Buccinator Muscle
 Facial Vein
 Facial Artery
 Parotid Gland
 Parotid Duct
 Sternocleido-
 mastoid M.

VII. DEVELOPMENT OF FACE

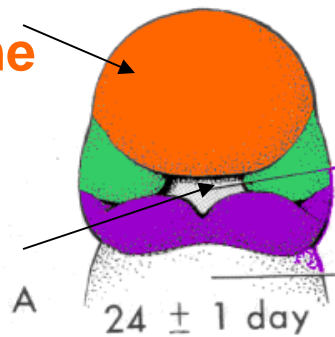
Facial Primordia (5) form in fourth week surrounding stomodeum (= primitive mouth)

Frontonasal Process (1) - formed by mesenchyme below brain

Maxillary Process (2)

Mandibular Process (2) From first branchial arch

Stomodeum

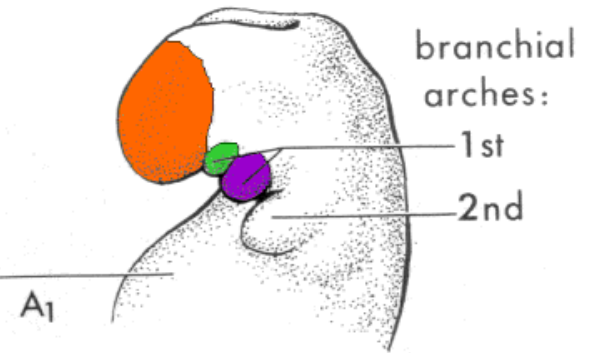


stomodeum

heart prominence

A

24 ± 1 day



branchial arches:

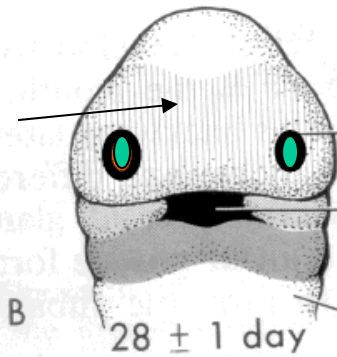
1st

2nd

A₁

1. Nasal Placodes (Thickenings) form on side of FrontoNasal process

Frontonasal Process



B

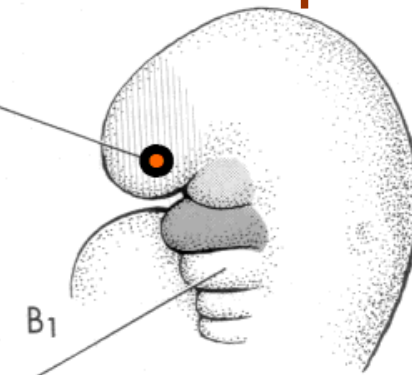
28 ± 1 day

lens placode

nasal placode

stomodeum

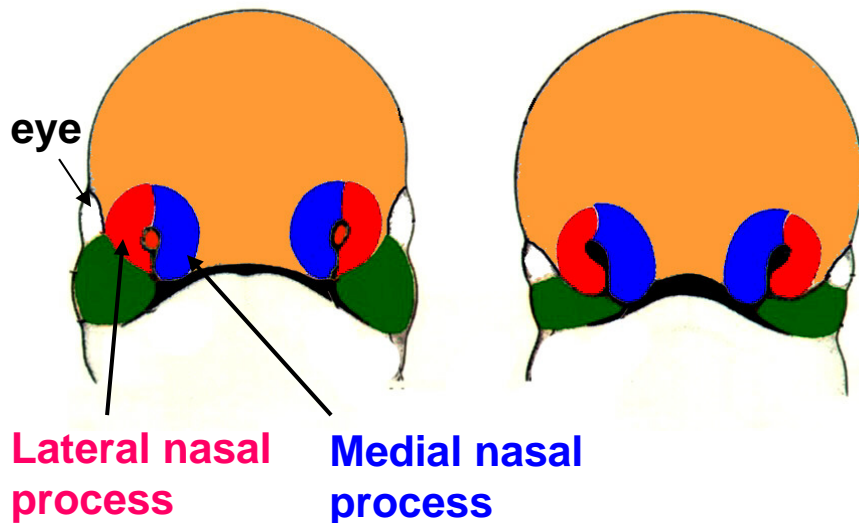
hyoid arch



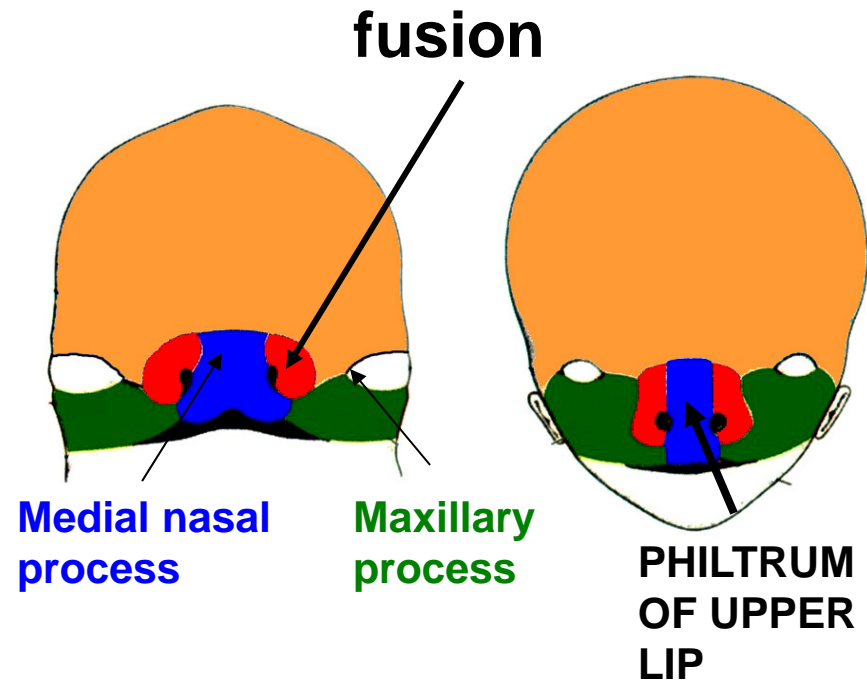
B₁

DEVELOPMENT OF FACE

2. Medial and **Lateral** Nasal Processes - form at margins of nasal placodes



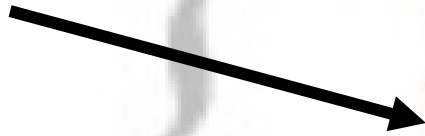
3. Medial nasal process and **Maxillary Process** - fuse to form upper lip



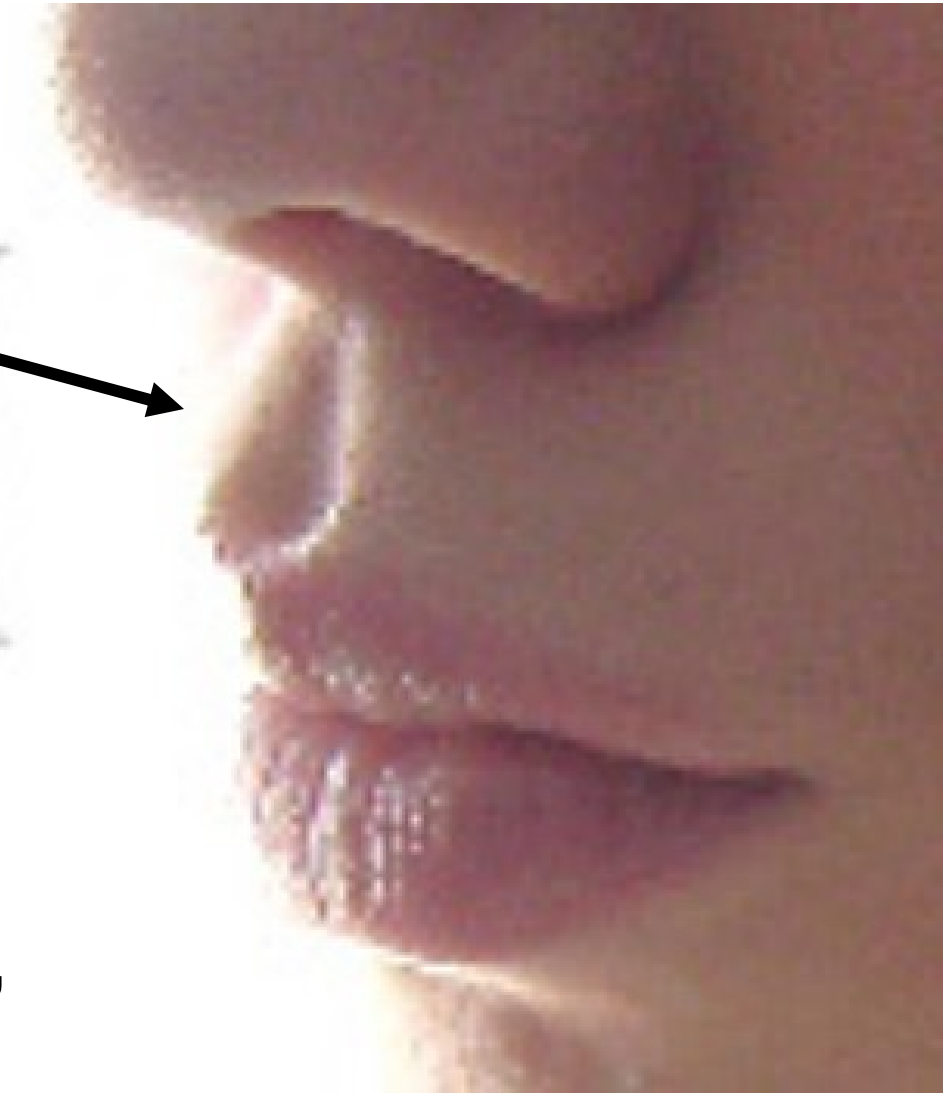
Terminology: process = prominence

Weeks 10-12

**PHILTRUM
OF LIP**



**philtron -
from
Greek to love,
to kiss**



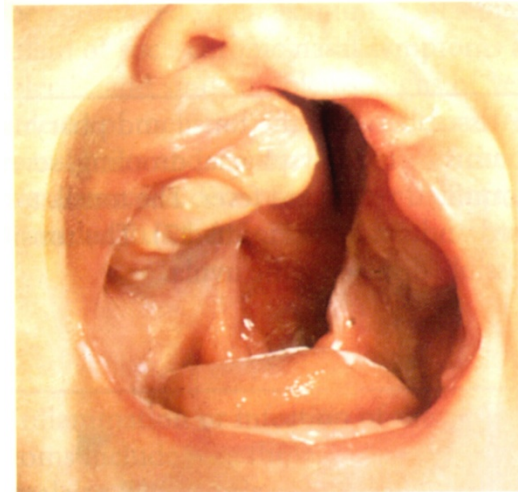
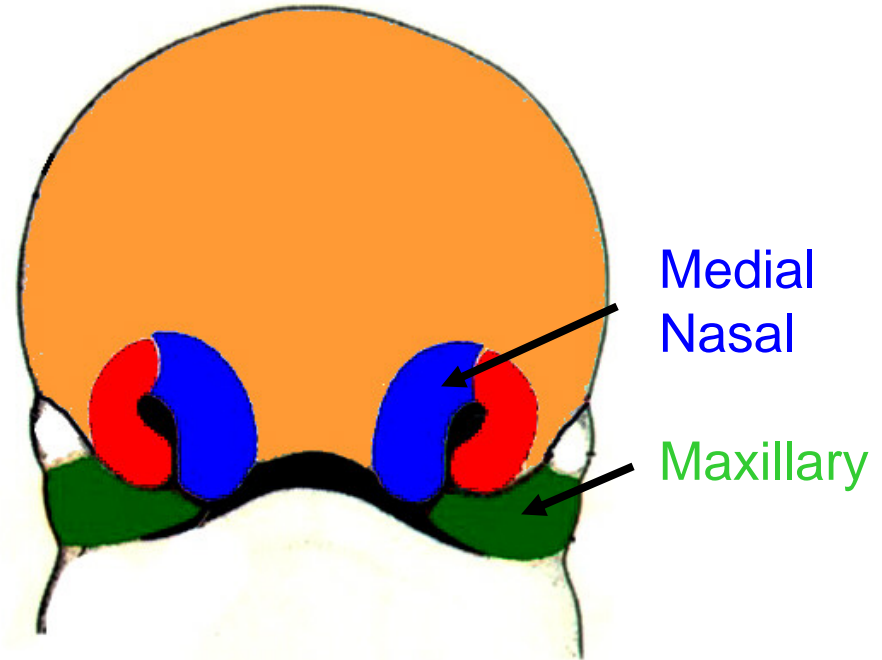
CLEFT LIP = CHEILOSCHISIS

BOARD QUESTION *

– failure of fusion of Medial Nasal Process and Maxillary process

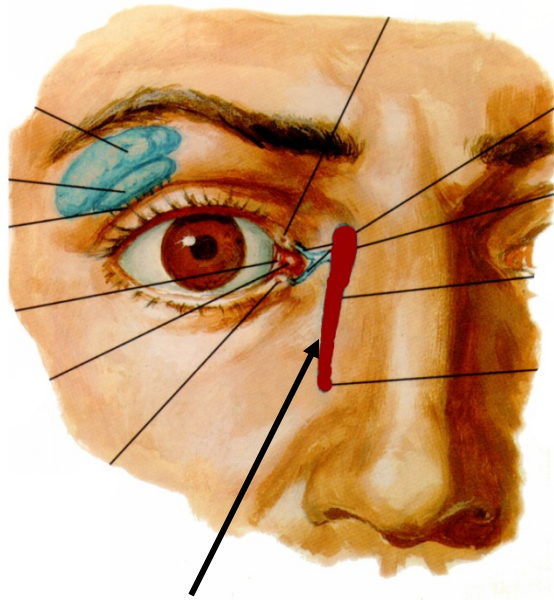
- 1/1000 Births, can be unilateral or bilateral
- At philtrum of lip

CLEFT LIP (cheiloschisis)
CAN OCCUR
IN COMBINATION WITH
CLEFT PALATE
(palatoschisis)



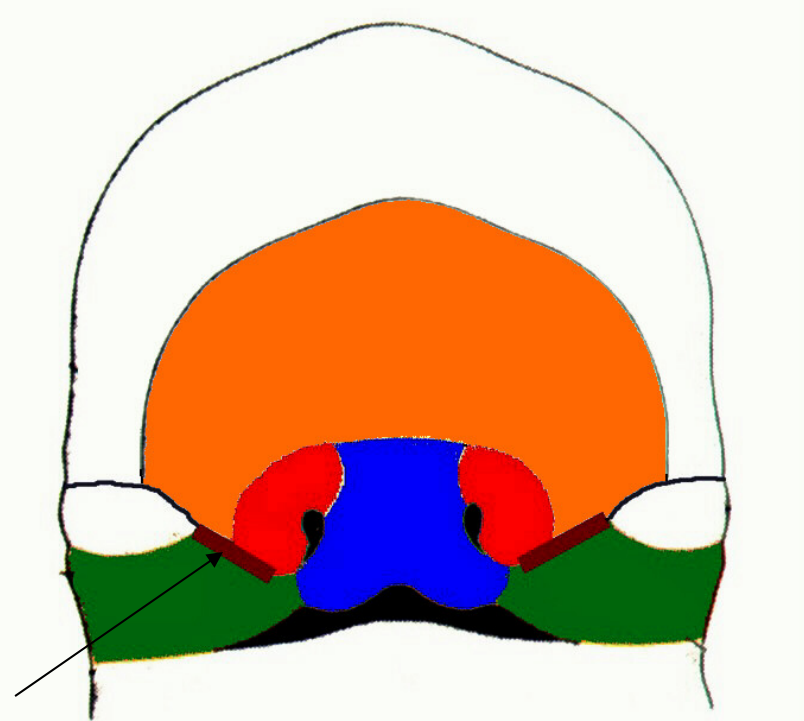
Gk. Cheilos,
Lip;
Pronounce -
KAI-LOS'-KESIS

5. DEVELOPMENT OF NASOLACRIMAL DUCT



NASOLACRIMAL DUCT

– connects anterior eye to nasal cavity

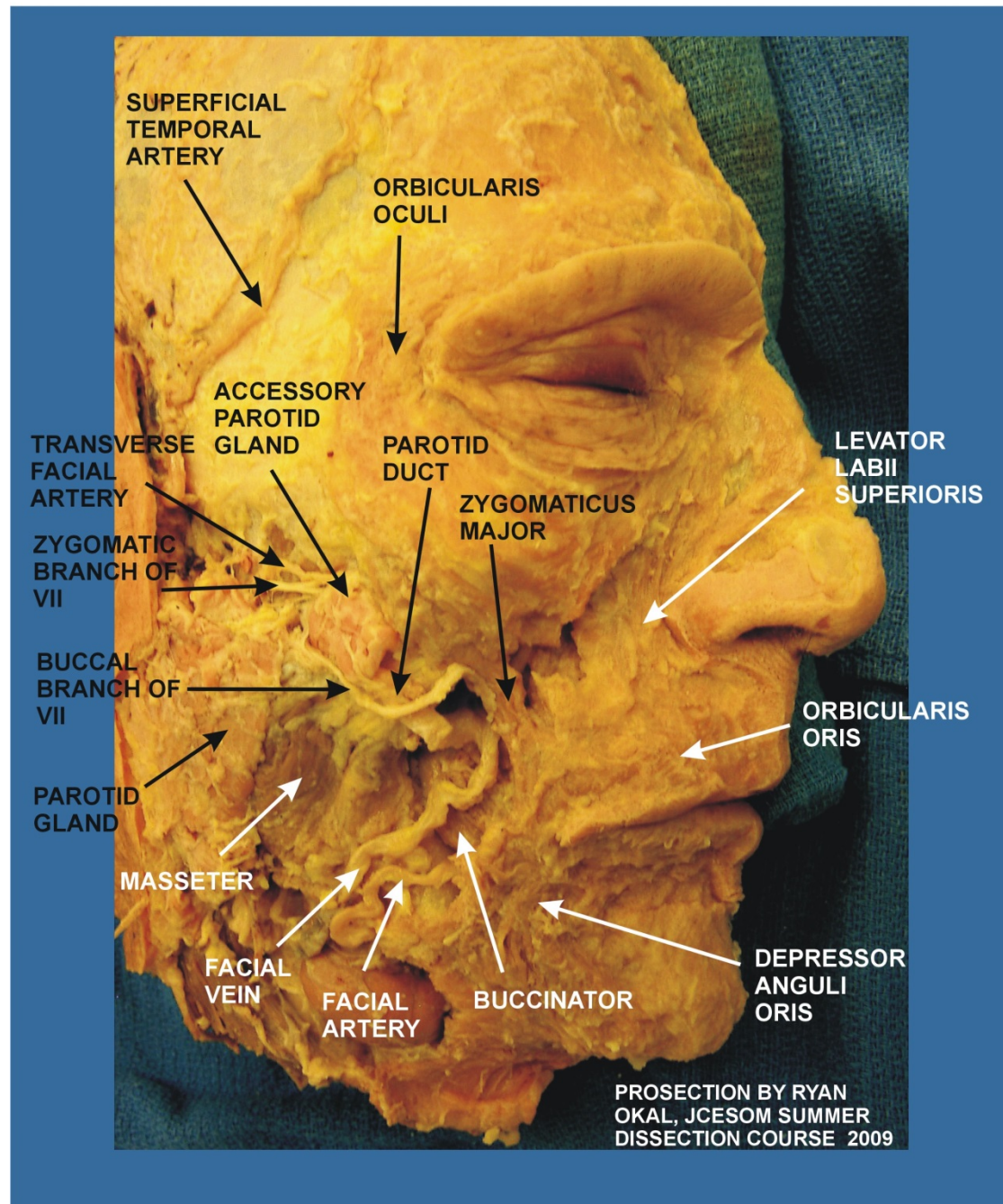


- Develops as solid cord from medial angle of eye to nasal cavity
- becomes canalized.

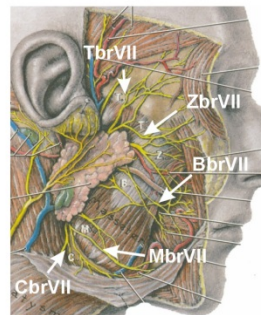
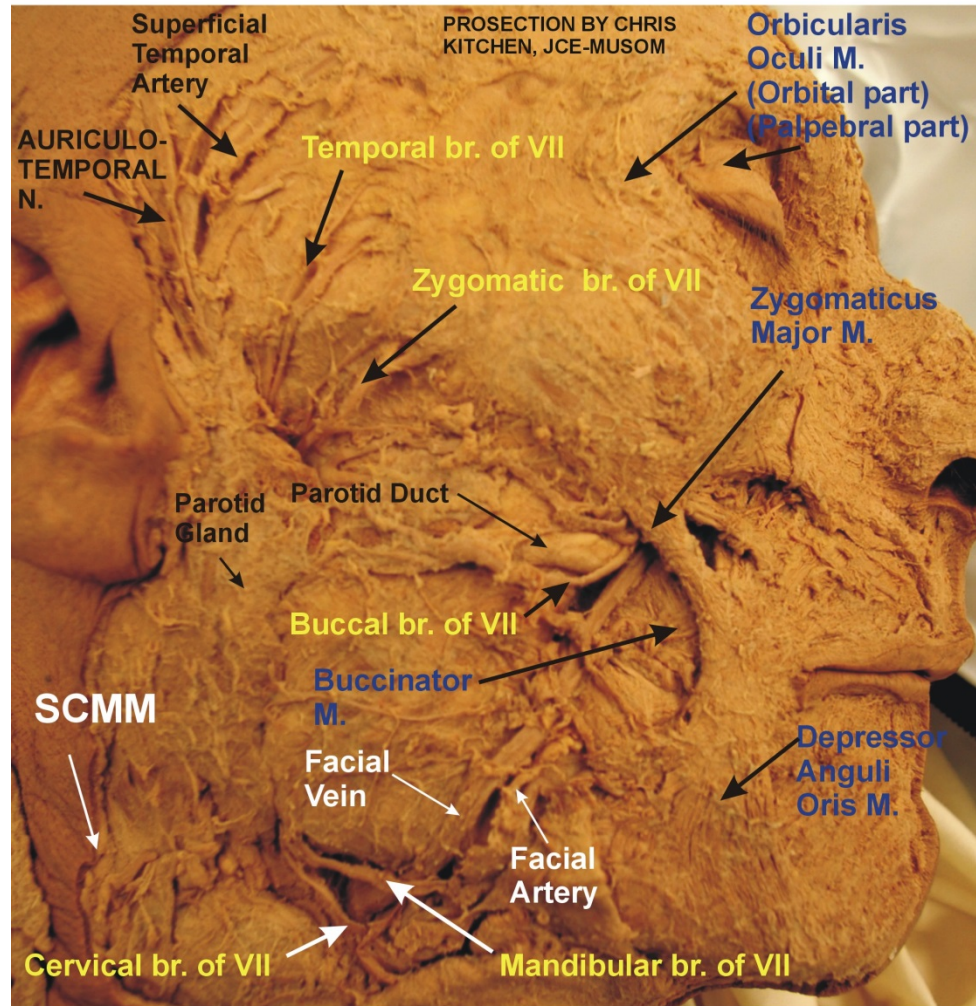
**Obstructed Duct - failure of duct to canalize;
opened surgically for tears to drain to nasal cavity**

FACIAL MUSCLES

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BRANCHES OF FACIAL NERVE (VII) AND SUPERFICIAL FACE



Superficial Temporal Artery
 Auriculotemporal Nerve
 TbrVII - Temporal branch of VII
 ZbrVII - Zygomatic branch of VII
 BbrVII - Buccal branch of VII
 MbrVII - Mandibular branch of VII
 CbrVII - Cervical branch of VII
 Orbicularis oculi (orbital part)
 Zygomaticus major
 Levator Labii Superioris
 Depressor Anguli Oris

Buccinator Muscle
 Facial Vein
 Facial Artery
 Parotid Gland
 Parotid Duct
 Sternocleidomastoid M.

CRANIAL NERVES

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1) OVERVIEW - Cranial nerves vs. Spinal nerves.

A. Cranial nerves contain inflow/outflow of brain; spinal nerves contain inflow/outflow of spinal cord.

B. Cranial nerves often contain types of neurons that are similar to types of neurons found in spinal nerves; ex. sensory axons to skin.

C. Cranial nerves can contain types of neurons not found in spinal nerves; ex. taste fibers.

D. Many cranial nerves contain more than one type of neuron.

E. In order to analyze and remember the types of neurons found in different cranial nerves we have a system of classification of types of neurons - WHY? Neurons of same type will form columns of nuclei in brainstem.

2) CLASSIFICATION OF INNERVATION - Seven types of neurons - some are the same types as found in spinal nerves; others are only found in cranial nerves

A. Same types of neurons as are found in spinal nerves

1. **Somatic motor** - Voluntary skeletal muscles (derived from somites)
2. **Somatic sensory** - Precise sensation - sensory to skin, joints, muscle and tendon receptor endings, in head, also nasal and oral cavity
3. **Visceral motor** (efferents) - AUTONOMICS - smooth muscles (including arrector pilae muscles of skin,) blood vessels; secretomotor to glands
4. **Visceral sensory** - Imprecise sensation sensory from gut, blood vessels, glands, internal organs; in head, pharynx which rostral end of gut.

B. Types of neurons only found in cranial nerves

5. **Special senses** - vision, hearing (auditory) and balance (vestibular apparatus)
6. **Chemical senses** - taste and smell
7. **Branchiomotor** - Voluntary skeletal muscles from branchial arches.

3) NAMES OF CRANIAL NERVES - nerves often referred to by name or number

- I. Olfactory - smell
- II. Optic - vision
- III. Oculomotor - eye movements; also parasympathetics to eye smooth muscles
- IV. Trochlear - eye movements
- V. Trigeminal - sensory nerve to skin, oral and nasal cavities, outer ear
- VI. Abducens - eye movements

- VII. Facial - muscles of facial expression; also taste, parasympathetics, etc.
- VIII. Vestibulo-cochlear (Stato-acoustic) - hearing and balance
- IX. Glossopharyngeal - sensory to pharynx, back of tongue (Gag reflex), etc.
- X. Vagus - motor to pharynx (most), larynx (voice box); soft palate; many others
- XI. Accessory (Spinal Accessory) - motor to sternocleidomastoid, trapezius
- XII. Hypoglossal - motor to muscles of tongue

4) SOMATIC MOTOR AXONS IN CRANIAL NERVES - like spinal nerves; innervate voluntary skeletal muscles derived from somites; two groups of muscles.

1. Eye (Extraocular) muscles - derived from pre-otic somites; innervated by
 - a. III (Oculomotor) - to Superior, Inferior and Medial Rectus, Inferior Oblique and Levator Palpebrae Superioris (skeletal part).
 - b. IV (Trochlear) - to Superior Oblique muscle.
 - c. VI (Abducens) - to Lateral Rectus muscle.
2. Intrinsic and Extrinsic Muscles of Tongue - derived from occipital somites - all innervated by XII (Hypoglossal).

5) SOMATIC SENSORY NEURONS - Precise sensation - innervate skin, oral cavity, nasal cavity, joints, muscles; sensory cell bodies in sensory ganglia attached to cranial nerves as they enter central nervous system, similar to dorsal root ganglia.

1. All of face, forehead, temporal region, oral cavity, temporo-mandibular joint innervated by V (Trigeminal); Note: cell bodies in Trigeminal ganglion (similar to dorsal root ganglia of spinal nerves).
2. Exception: skin of outer ear, external auditory meatus is innervated by V (Trigeminal), plus branches of VII (Facial), IX (Glossopharyngeal) and X (Vagus). (note: sensory cell bodies of VII in sensory ganglion called Genuiculate ganglion)

Note: In Bell's Palsy (paralysis of VII) patients can complain of ear ache due to precise sensory innervation of outer ear by Facial nerve.

6) VISCERAL MOTOR = AUTONOMIC INNERVATION OF HEAD - two neuron arcs.

1. Sympathetic innervation (thoracolumbar outflow) - NOT in cranial nerves
 - a. **First neuron arises from spinal cord levels T1, T2**; axon exits via ventral roots and white communicating rami, ascends in paravertebral sympathetic chain to synapse in Superior Cervical Ganglion.
 - b. **Second neuron in Superior Cervical Ganglion**; axon joins plexuses associated with branches of Internal and External Carotid arteries; these give off branches in two ways: i) small unnamed branches close to target; ii) small named

branches that come off arterial plexuses and join other nerves (ex. deep petrosal nerve).

2. Parasympathetic innervation (craniosacral) - in cranial nerves - first neuron in brainstem; axon goes out with cranial nerve to synapse in named ganglion located close to target; second neuron innervates target.

<u>Nerve</u>	<u>Ganglion</u>	<u>Innervates</u>
III (Oculomotor)	Ciliary ganglion	Pupillary sphincter muscle, ciliary muscle
VII (Facial) and	Pterygopalatine ganglion	Lacrimal gland, mucus glands of nose palate
	Submandibular ganglion	Submandibular and sublingual salivary glands
IX (Glossopharyngeal)	Otic Ganglion	Parotid gland
X (Vagus)	(Many ganglia in thorax, abdomen)	Provides parasympathetic innervation to many organs in thorax and abdomen.

7) VISCERAL SENSORY - distributed with both parasympathetic and sympathetic innervation; imprecise sensation, poorly localized

1. Sensory axons with Sympathetics - sensory to blood vessels, pharynx and its derivatives; cell bodies in dorsal root ganglia of spinal cord; axons travel with sympathetic efferents.

2. Sensory axons with Parasympathetic - more localized, specific

<u>Nerve</u>	<u>Innervates</u>
VII (Facial)	Nasopharynx
IX (Glossopharyngeal)	Sensation (touch, pressure) to posterior third of tongue, oropharynx, tympanic cavity and auditory tube, carotid sinus.
X (Vagus)	Sensation to laryngopharynx, larynx in head (also innervates many organs in thorax and abdomen).

8) SPECIAL SENSES - Vision, hearing, balance

1. II (Optic nerve) - vision (actually a brain tract); primary receptors (rods and cones) in retina; axons of ganglion cells of retina form optic nerve; half of axons cross over to opposite side at optic chiasm.

2. VIII (Vestibulocochlear nerve) - auditory and vestibular sensation; cell bodies in cochlear and vestibular apparatus.

9) CHEMICAL SENSES - Smell and taste.

1. Smell - I (Olfactory nerve) - cell bodies in olfactory epithelium; axons project through fila olfactoria to olfactory bulb.

2. Taste - more complex - distributed over several cranial nerves.

<u>Nerve</u>	<u>Taste sensation from</u>
VII (Facial)	Anterior two thirds of tongue
IX (Glossopharyngeal)	Posterior third of tongue
X (Vagus)	Posterior tongue, immediately anterior to epiglottis

10) BRANCHIOMOTOR - voluntary motor to skeletal muscles of face, ear, pharynx and neck that are derived from branchial arches.

<u>Nerve</u>	<u>Innervates</u>
V (Trigeminal) (all in V3)	muscles of mastication mylohyoid tensor tympani tensor palati anterior belly of digastric
VII (Facial)	muscles of facial expression stylohyoid posterior belly of digastric stapedius
IX (Glossopharyngeal)	stylopharyngeus
X (Vagus)	all muscles of pharynx (except stylopharyngeus) muscles of larynx all muscles of palate (except tensor palati)
XI (Accessory)	sternocleidomastoid trapezius

VII. SUMMARY OF TYPES OF NEURONS IN CRANIAL NERVES (parenthesis - OLD 3 Letter system)

TYPES OF NEURONS	INNERVATE	ASSOCIATED CRANIAL NERVES	CLINICAL
SOMATIC MOTOR (GSE)	Motor to voluntary skeletal muscles (derived from somites)	CN III, IV, VI - 1) Extraocular muscles (pre-otic somites) CN XII - muscles of tongue (occipital somites)	see ORBIT, TONGUE lectures
SOMATIC SENSORY (GSA)	<u>Precise sensation</u> Sensory to skin, joints (oral cavity, nasal cavity)	CN V - mostly V1 - Ophthalmic (above angle of eye) V2 - Maxillary (angle of eye to angle of mouth) V3 - Mandibular (below angle of mouth) also Skin of External (Outer) Ear - V, VII, IX, X	1) Trigeminal Neuralgia - pain in region of affected division 2) Bell's palsy (VII)- pain in outer ear
VISCERAL MOTOR (GVE) (Parasympath ethics in Cranial Nerves)	Smooth muscles, Glands, etc. (ganglia close to target organ)	III - Ciliary ganglion - Pupillary constrictor, Ciliary muscle VII - Pterygopalatine ganglion - Lacrimal gland, mucous glands of nose and palate VII - Submandibular ganglion - Submandibular, Sublingual salivary glands IX - Otic ganglion - Parotid	see Associated lectures (Orbit; Nasal, Oral Cavities; Ear)
VISCERAL SENSORY (GVA)	<u>Imprecise sensation:</u> Innervation of Gut, Blood Vessels, etc. Specific for Innervation of Pharynx, Middle Ear	Pharynx VII - Nasopharynx IX - Oropharynx X - Laryngopharynx also Middle Ear - IX	Imprecise localization in Choking on food; Middle ear infections
SPECIAL SENSES (SSA)	Vision, Audition, Balance	II - Vision VIII- Audition (hearing), Balance (vestibular apparatus)	many; see associated lectures
CHEMICAL SENSE (SVA)	Taste, Smell	Taste is distributed: VII - anterior 2/3 of tongue IX - posterior 1/3 of tongue X - taste buds anterior to epiglottis Smell - I - olfaction	Damage produces loss of taste in region of innervation
BRANCHIO-MOTOR (SVE)	Voluntary skeletal muscles derived from Branchial Arches	V - muscles of First Branchial Arch VII - muscles of Second Branchial Arch IX - muscles of Third Branchial Arch X - muscles of Fourth and Sixth Branchial Arches XI - muscles of caudal Sixth Branchial arch (disagreement among authors)	see Branchial arch chart (above); also Branchial Arch Lecture, etc.

CHART OF DISTRIBUTION OF COMPONENTS IN CRANIAL NERVES (LEARN TO DRAW THIS OR EQUIVALENT)

Nerve	SOMATIC MOTOR (GSE)	BRANCHIO-MOTOR (SVE)	VISCERAL MOTOR (GVE)	SOMATIC SENSORY (GSA)	VISCERAL SENSORY (GVA)	CHEMICAL SENSE (SVA)	SPECIAL SENSES (SSA)
III.	+		+				
IV.	+						
VI.	+						
XII.	+						
V.		+		+			
VII.		+	+	+	+	+	
IX.		+	+	+	+	+	
X.		+	+	+	+	+	
XI.		+					
I.						+	
II.							+
VIII.							+

APPENDIX - OLD CLASSIFICATION - TYPES OF NEURONS ARE CALLED FUNCTIONAL COMPONENTS

I. BASIS OF CLASSIFICATION - three letter system.

A. First letter

G = General = types of neurons found both in spinal nerves and cranial nerves.

S = Special = types of neurons only found in cranial nerves not spinal nerves.

B. Second letter

S = Somatic = types of neurons innervating structures derived from somites.

V = Visceral = types of neurons innervating gut, structures derived from or associated with gut and branchial arches; also vascular system, smooth muscle, internal organs and glands.

C. Third letter

A = Afferent = sensory neurons.

E = Efferent = motor neurons to skeletal and smooth muscle; also secretomotor neurons to glands.

II. TRANSLATING TYPES OF NEURONS TO FUNCTIONAL COMPONENTS (ALPHABET SOUP)

Like spinal nerves -

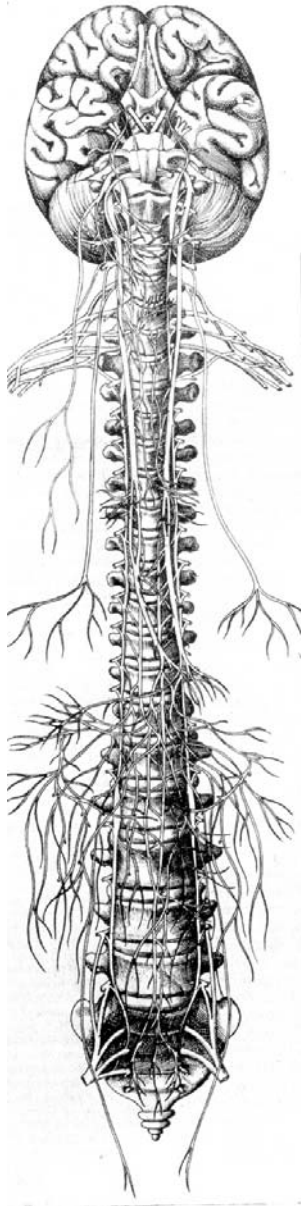
1. SOMATIC MOTOR = GSE
2. SOMATIC SENSORY = GSA
3. VISCERAL MOTOR = GVE
4. VISCERAL SENSORY = GVA

Only in cranial nerves -

5. SPECIAL SENSES = SSA
6. CHEMICAL SENSES = SVA
7. BRANCHIOMOTOR = SVE skeletal muscles from branchial

arches)

CRANIAL NERVES



OUTLINE

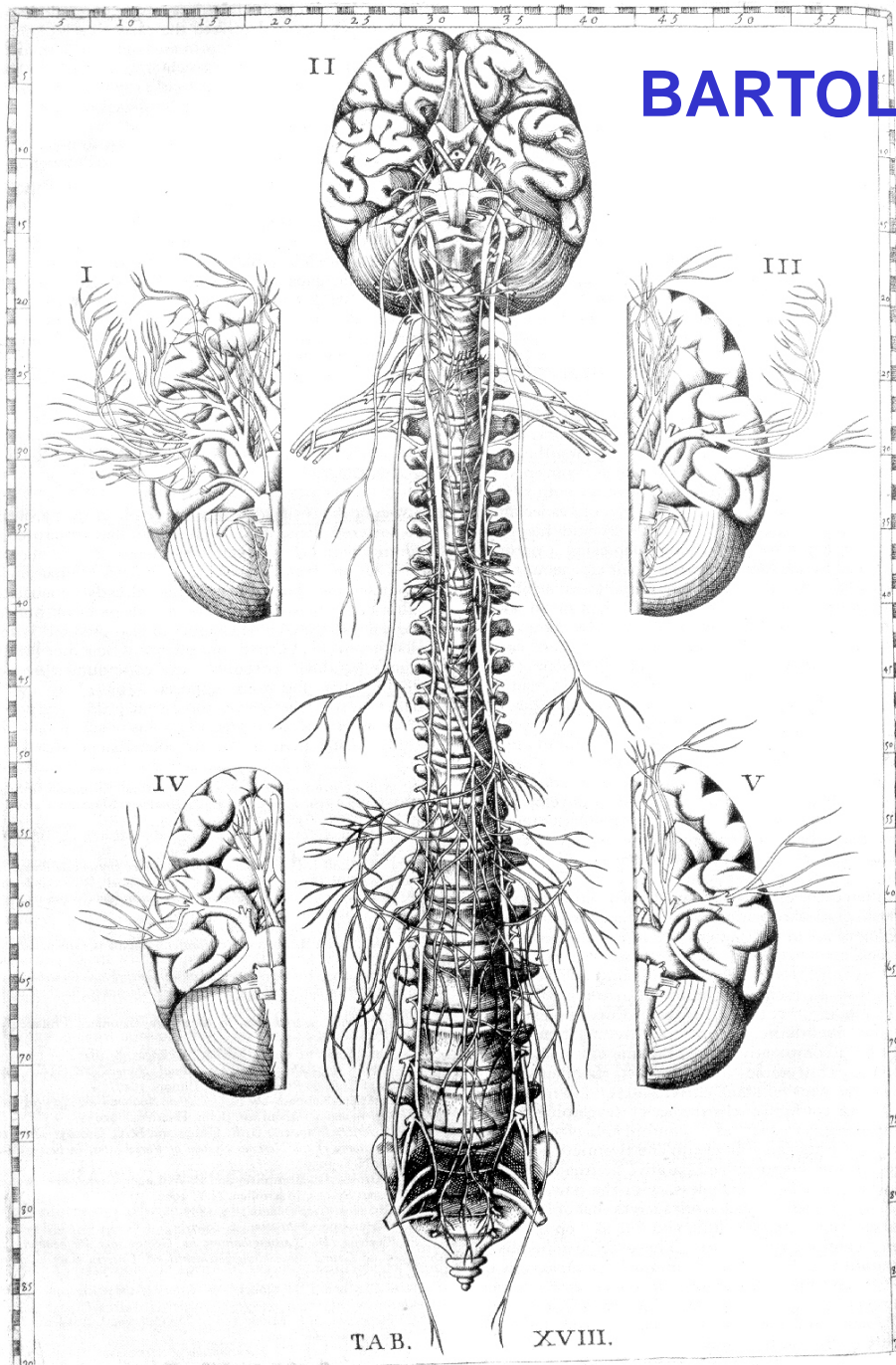
I. HISTORY OF ANATOMY

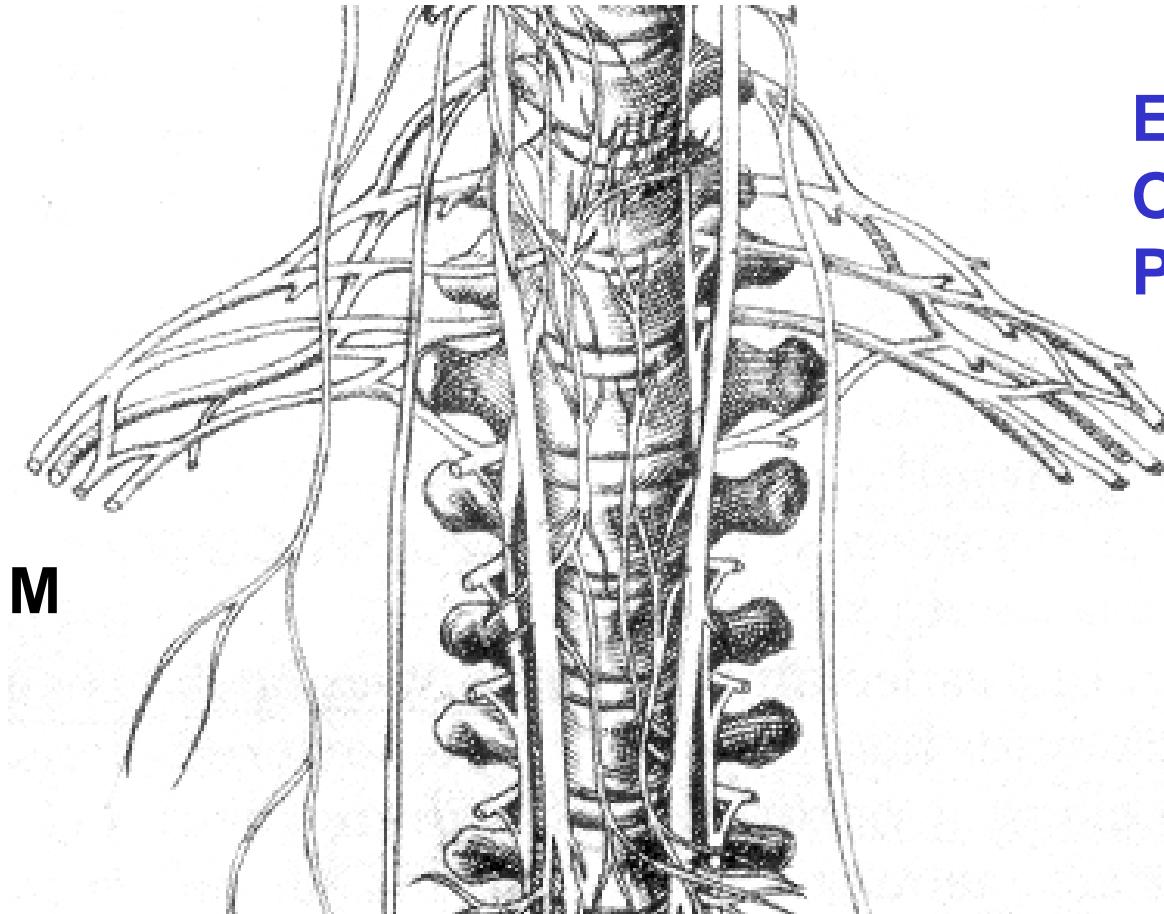
**II. CLASSIFICATION OF
TYPES OF NEURONS IN
CRANIAL NERVES**

BARTOLOMEO EUSTACHIO 1510?-1574



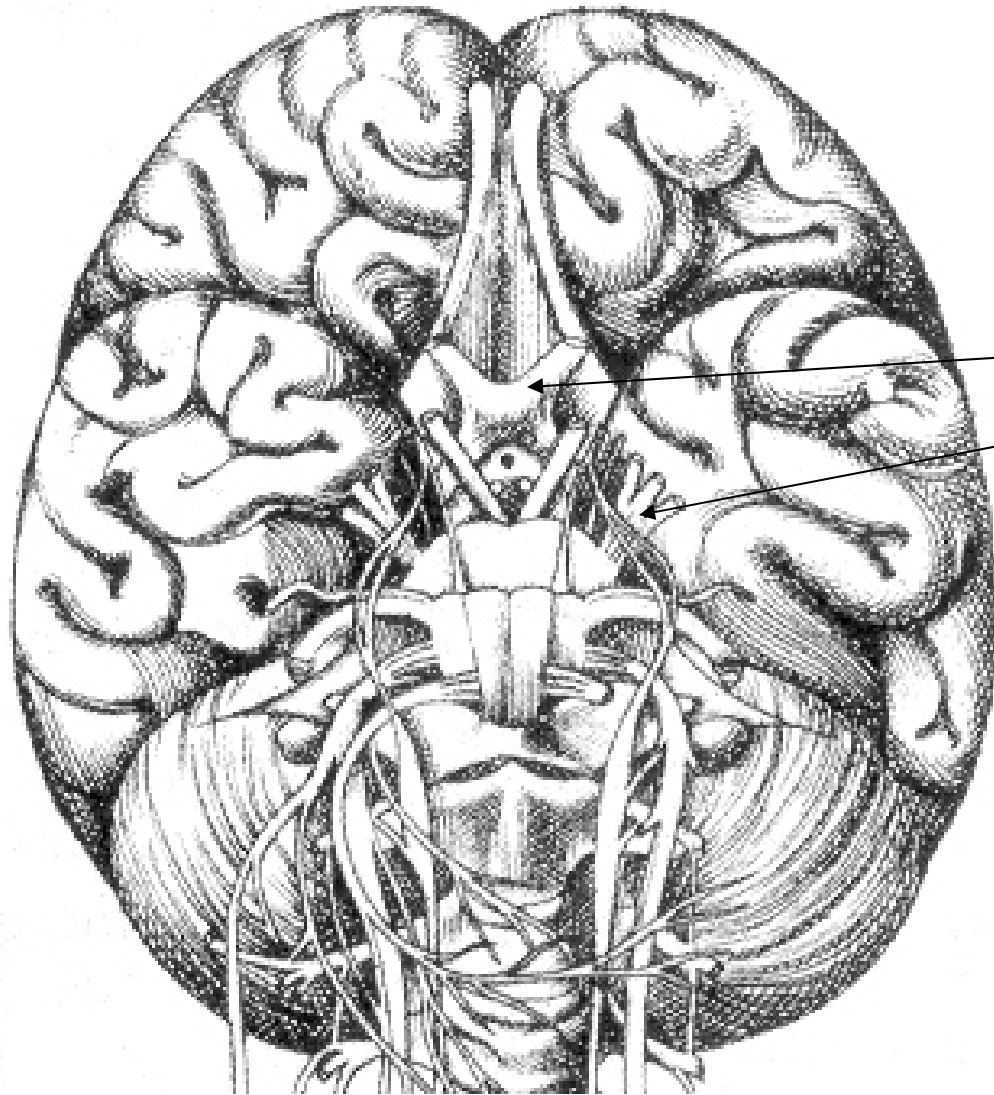
- AUDITORY TUBE = EUSTACHIAN TUBE
- DISSECT BODY IN FEW DAYS
- DRAWING IS MADE FROM MEMORY OF MANY DISSECTIONS





**ENLARGEMENT
OF BRACHIAL
PLEXUS**

M



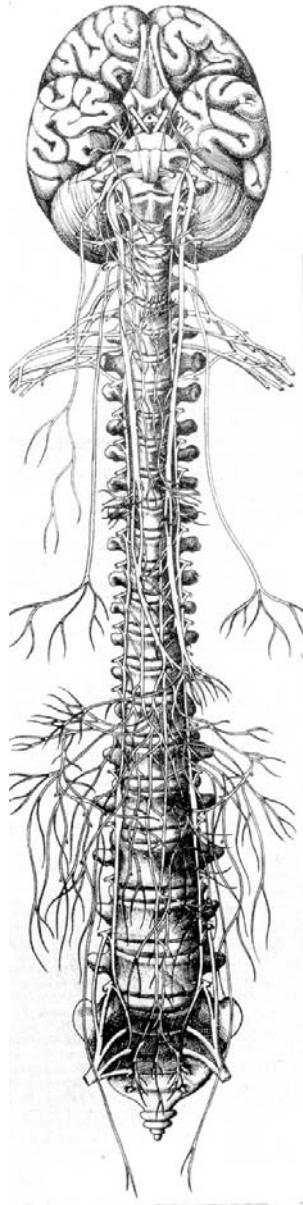
**ENLARGEMENT
OF BRAIN**

**OPTIC CHIASM
V1, V2, V3**

CRANIAL NERVES

CRANIAL
NERVES

SPINAL
NERVES



A. Contain inflow/outflow of brain;
spinal nerves contain inflow/outflow
of spinal cord.

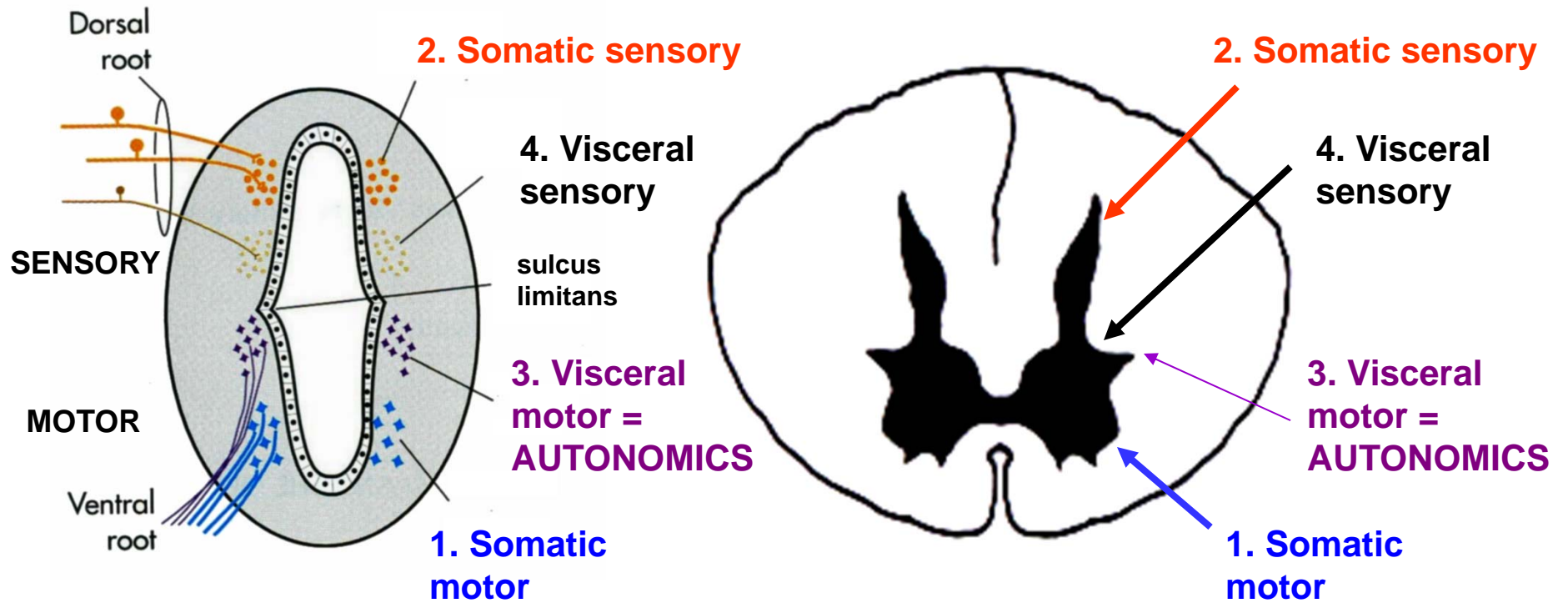
B. Contain **types of similar to those
found in spinal nerves**; ex. sensory
axons to skin.

C. **Contain types of neurons not
found in spinal nerves**; ex. taste
fibers.

D. **Many cranial nerves contain more
than one type of neuron.**

E. To analyze types of neurons in
different cranial nerves, **system of
classification of types of neurons.**

WHY DO YOU NEED TO KNOW THIS? CLASSIFICATION IS REFLECTED IN CENTRAL NERVOUS SYSTEM



Nervous system forms as a Neural Tube; cells form groups (columns); sensory dorsal, motor ventral; different types of neurons form columns that develop to adult locations

2) CLASSIFICATION OF INNERVATION

Seven types of neurons - some are the same types of neurons as are found in spinal nerves; others are only found in cranial nerves

A. Same types as spinal nerves

1. **Somatic motor** - Voluntary skeletal muscles (derived from somites)

2. **Somatic sensory** - Precise sensation to skin joints, muscle, tendon receptors (in head, also nasal and oral cavities)

3. **Visceral motor** (efferents) = AUTONOMICS - smooth muscles (including arrector pilae muscles of skin), blood vessels; secretomotor to glands.

4. **Visceral sensory** - Imprecise sensation from gut, blood vessels, glands, internal organs (in head, pharynx which is rostral end of gut)

2) CLASSIFICATION OF INNERVATION

B. Only in cranial nerves

5. **Special senses** - vision, hearing (auditory), balance (vestibular apparatus)

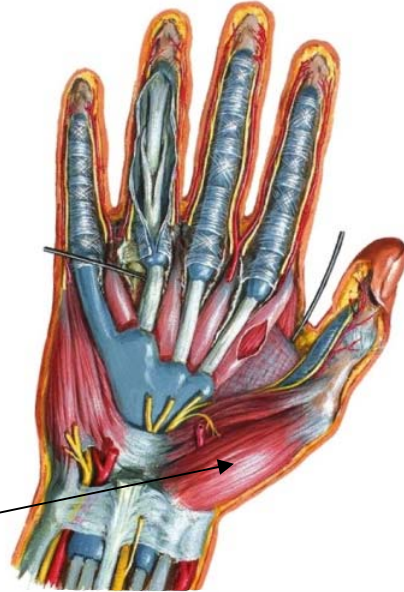
6. **Chemical senses** - taste and smell

7. **Branchiomotor** - Voluntary skeletal muscles from branchial arches

SOME TYPES OF NEURONS ARE SIMILAR TO THOSE FOUND IN THE SPINAL CORD

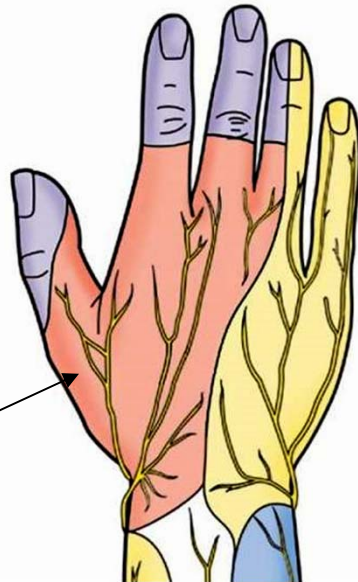
SOMATIC MOTOR - motor axons to skeletal muscles

ex. muscles of hand



SOMATIC SENSORY - sensory axons to skin ; also joints, body position

ex. skin of hand



SOMATIC NERVOUS SYSTEM

E. Major divisions of nervous system - terminology based upon function but very confusing

1. Somatic Nervous system - considered **voluntary, conscious part of nervous system**

a. **Somatic Motor (Efferents)** - control skeletal muscle; **voluntary activities** (ex. limb or eye movements, walking); conscious actions.

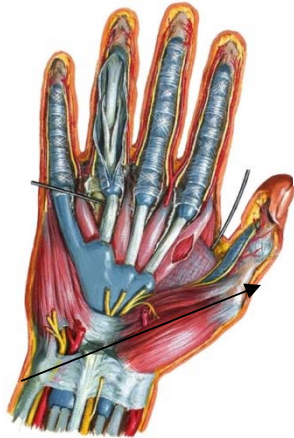
b. **Somatic Sensory (Afferents)** - sensory neurons that innervate skin, joints; provide **precise conscious sensation** of touch, pressure, pain etc to skin; also provide **sense of body position (prioception)**.

THESE TYPES OF NEURONS ARE ALSO FOUND IN CRANIAL NERVES

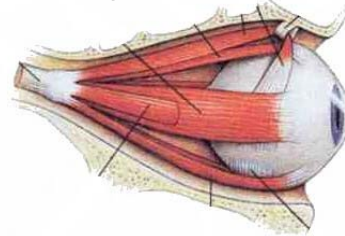
IN HEAD

SOMATIC MOTOR -
motor axons to skeletal muscles

ex. muscles of hand



eye muscles



move eyes

muscles of tongue



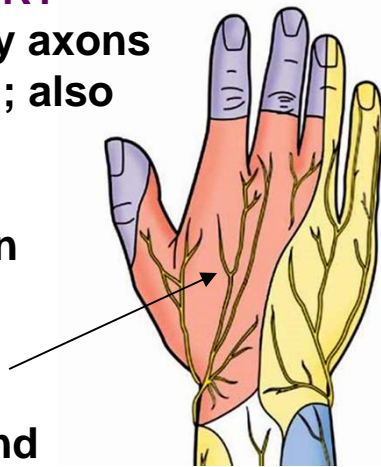
move tongue

SOMATIC MOTOR IN HEAD - limited to two groups

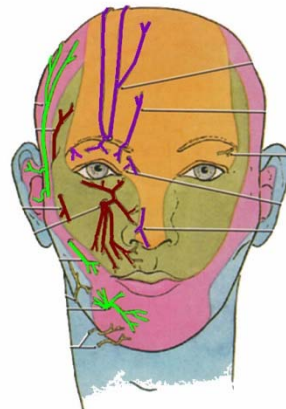
1. **EYE MUSCLES -** extraocular muscles that move eye (and lift upper eyelid)
2. **MUSCLES OF TONGUE**

SOMATIC SENSORY-
sensory axons to skin ; also joints, body position

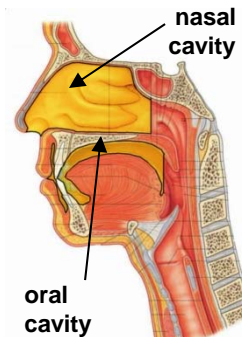
ex. skin of hand



skin of head

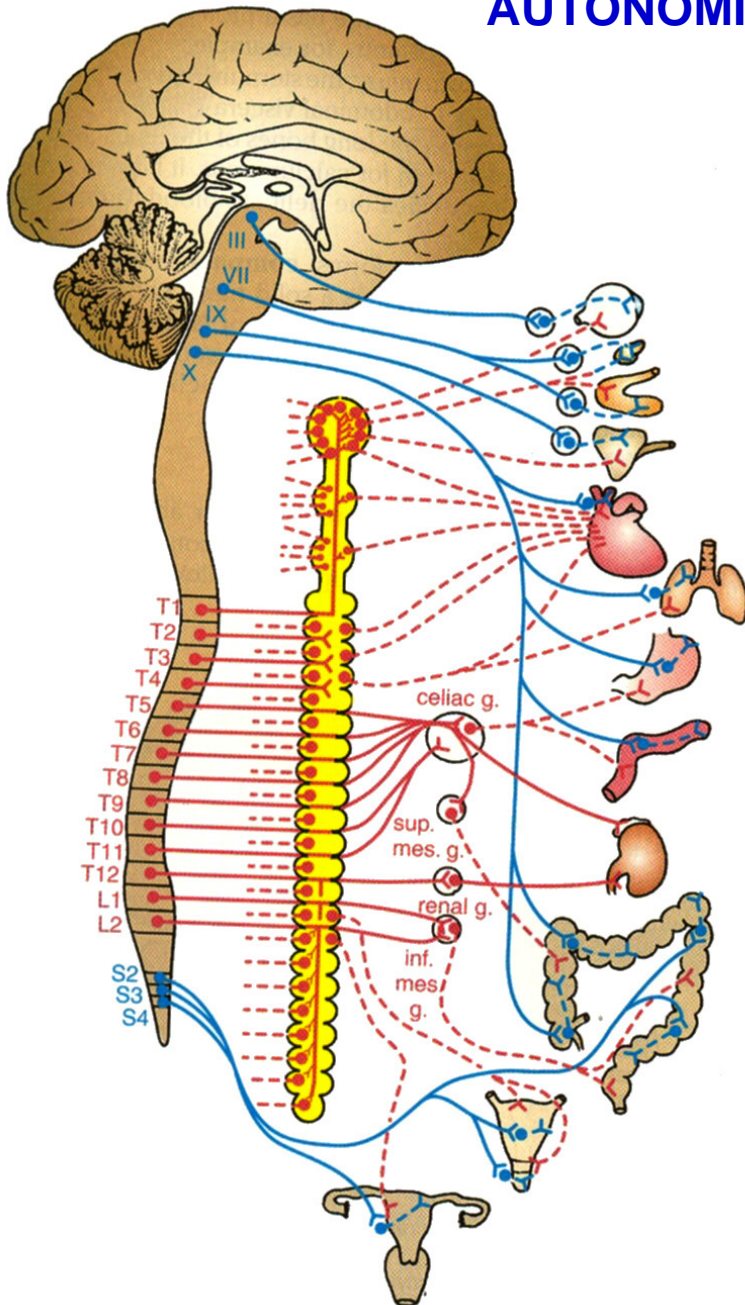


oral, nasal cavities



SOMATIC SENSORY IN HEAD - mostly in CN V - precise sensation sensory to skin ; also oral cavity (inside mouth), nasal cavity (inside nose)

AUTONOMIC = VISCERAL NERVOUS SYSTEM

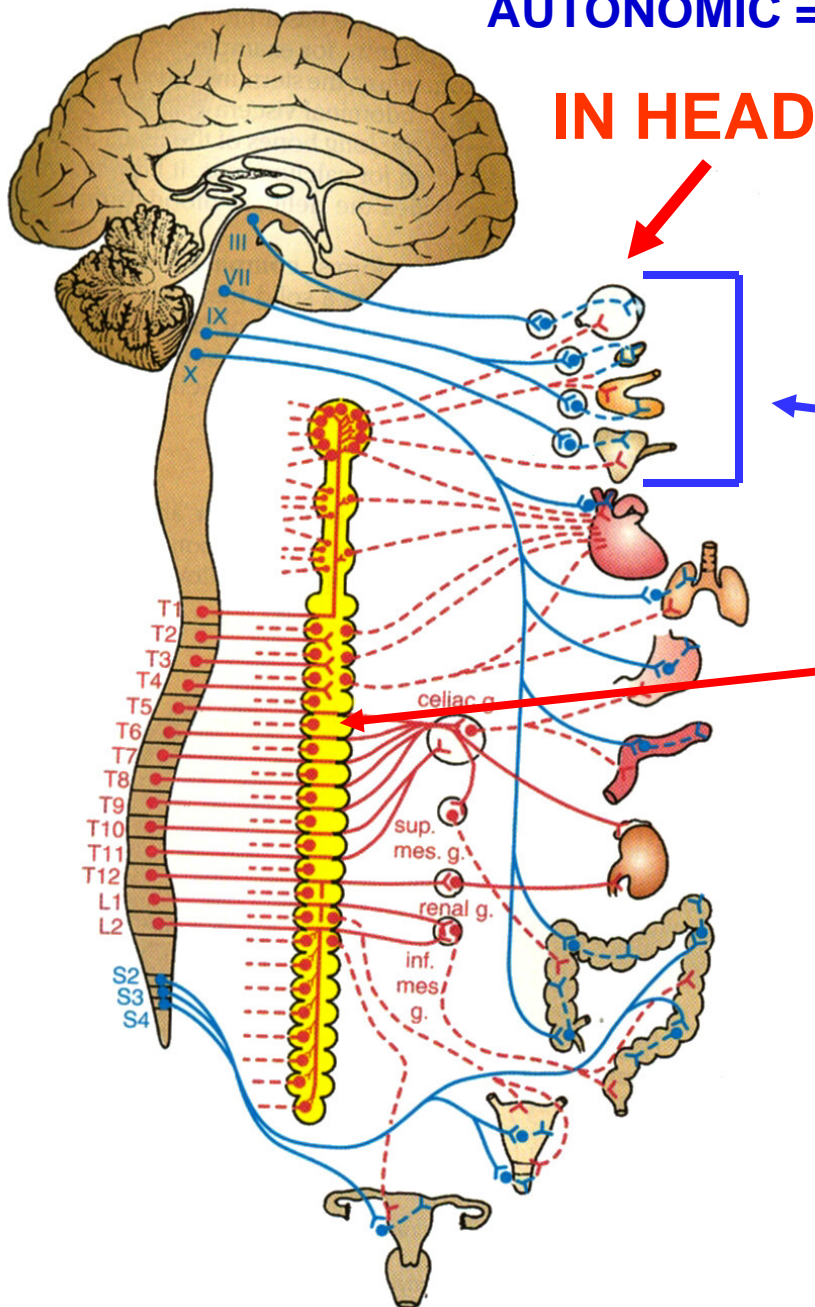


Autonomic Nervous system = Visceral nervous system - involuntary, unconscious part of nervous system

a. **Visceral Motor (parasympathetic and sympathetic efferents)** - control smooth and cardiac muscle, glands and internal organs; largely **unconscious actions (autonomic means self-regulating or automatic)**.

b. **Visceral Sensory (afferents)** - sensory neurons that innervate internal organs, blood vessels; only provide **imprecise localization of sensation** and dull sense of pressure, pain, etc.

AUTONOMIC = VISCERAL NERVOUS SYSTEM IN HEAD



VISCERAL MOTOR Autonomic

Nervous system = Visceral nervous system - involuntary, unconscious part of nervous system

a. Parasympathetic (CRANIO-SACRAL outflow - IN CRANIAL NERVES) -

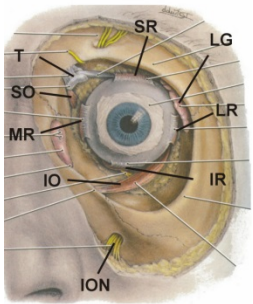
specific pathway in four cranial nerves

b. Sympathetics - not in cranial nerves - come from spinal cord - **THORACO-LUMBAR outflow**

c. Visceral Afferents - (not shown in diagram); sensory neurons that innervate internal organs, blood vessels; only provide **imprecise localization of sensation and dull sense of pressure, pain, etc.** - follow parasympathetic and **sympathetic** - in HEAD, some specific.

SOME TYPES OF NEURONS ARE ONLY FOUND IN THE HEAD (IN CRANIAL NERVES)

Special Senses - vision, audition, vestibular

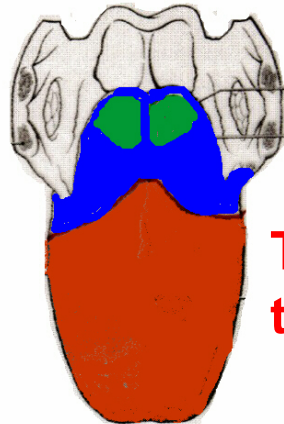


EYE

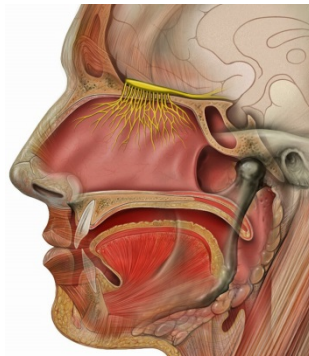


EAR

Chemical senses: taste and smell



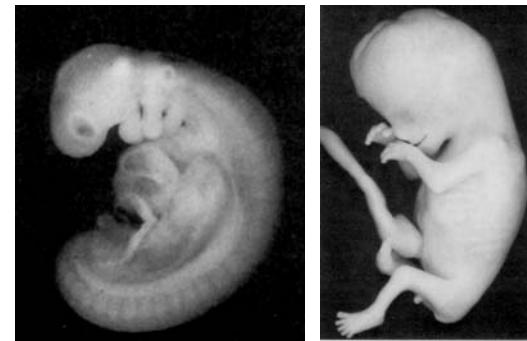
TONGUE - taste



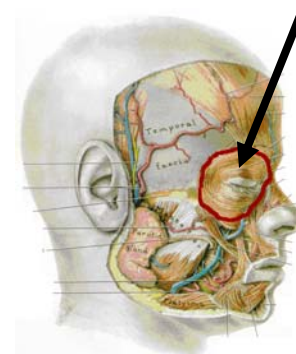
NOSE - smell

Branchiomotor - Skeletal muscles derived from branchial (gill) arches

FISH-LIKE → HUMAN



SKELETAL MUSCLES

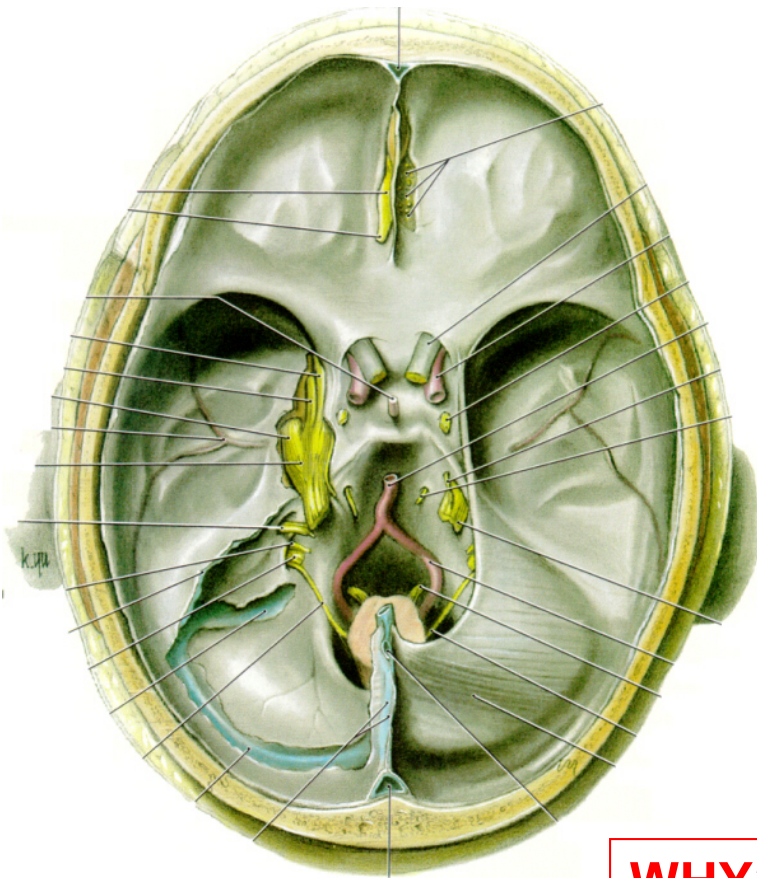


HOW ARE THESE TYPES OF NEURONS DISTRIBUTED IN CRANIAL NERVES?

TYPES OF NEURONS

1. Somatic motor
2. Somatic sensory
3. Visceral motor
4. Visceral sensory
5. Special senses
6. Chemical senses
7. Branchiomotor

CRANIAL NERVES IN CRANIAL CAVITY



CRANIAL NERVES

- | | |
|-----------------|--------------------------|
| I. Olfactory | VII. Facial |
| II. Optic | VIII. Vestibulo-cochlear |
| III. Oculomotor | IX. Glossopharyngeal |
| IV. Trochlear | X. Vagus |
| V. Trigeminal | XI. Accessory |
| VI. Abducens | XII. Hypoglossal |

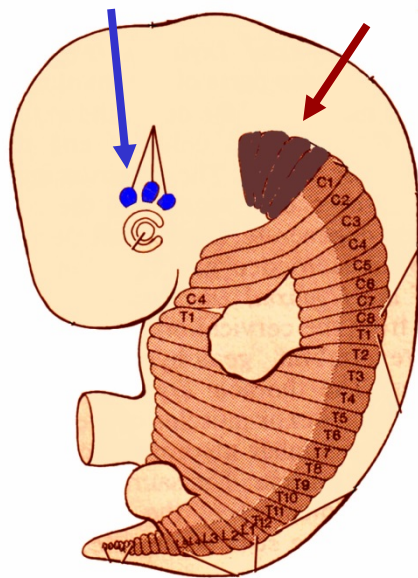
WHY? TYPES OF NEURONS CORRESPOND TO COLUMNS OF NUCLEI IN THE BRAINSTEM

SOMATIC MOTOR

motor to skeletal muscle derived from somites (myotomes) ; only two groups in head

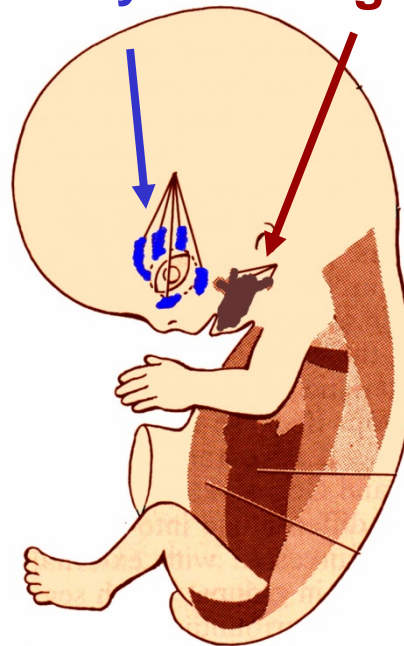
Preotic

Occipital



6 weeks

Extrinsic Muscles
of eye of tongue



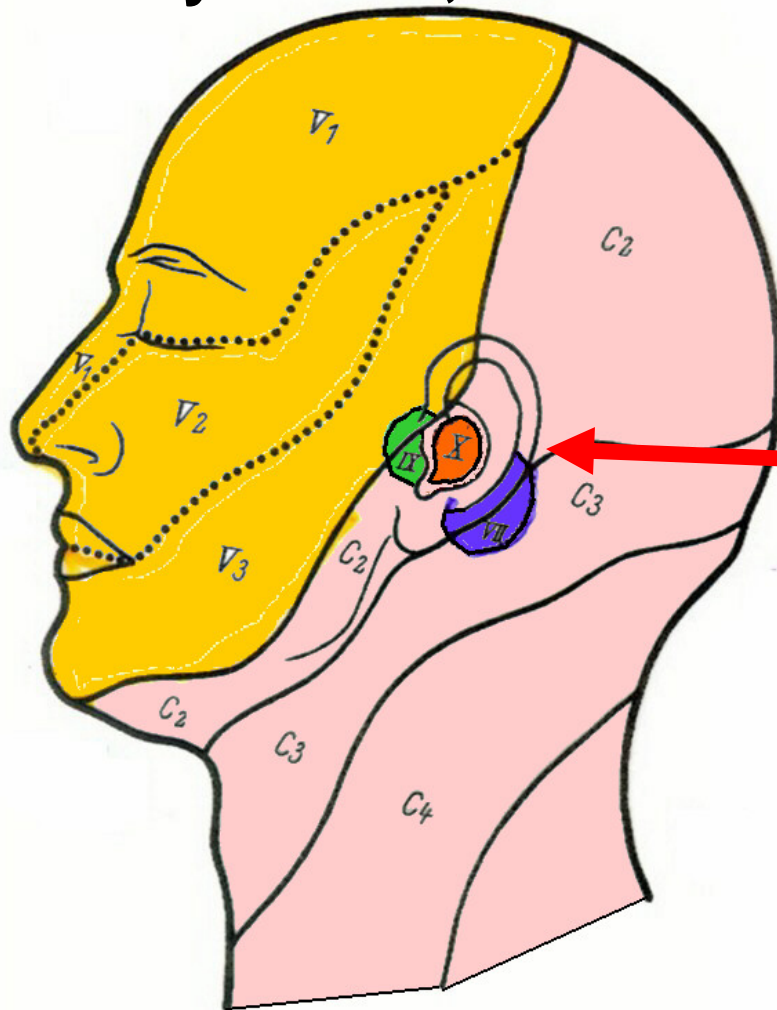
8 weeks

1) Preotic somites (somitomeres) form extrinsic muscles of EYE: in CN III - Oculomotor, IV - Trochlear, VI - Abducens.

2) Occipital somites form muscles of TONGUE - in CN XII Hypoglossal N.

SOMATIC SENSORY

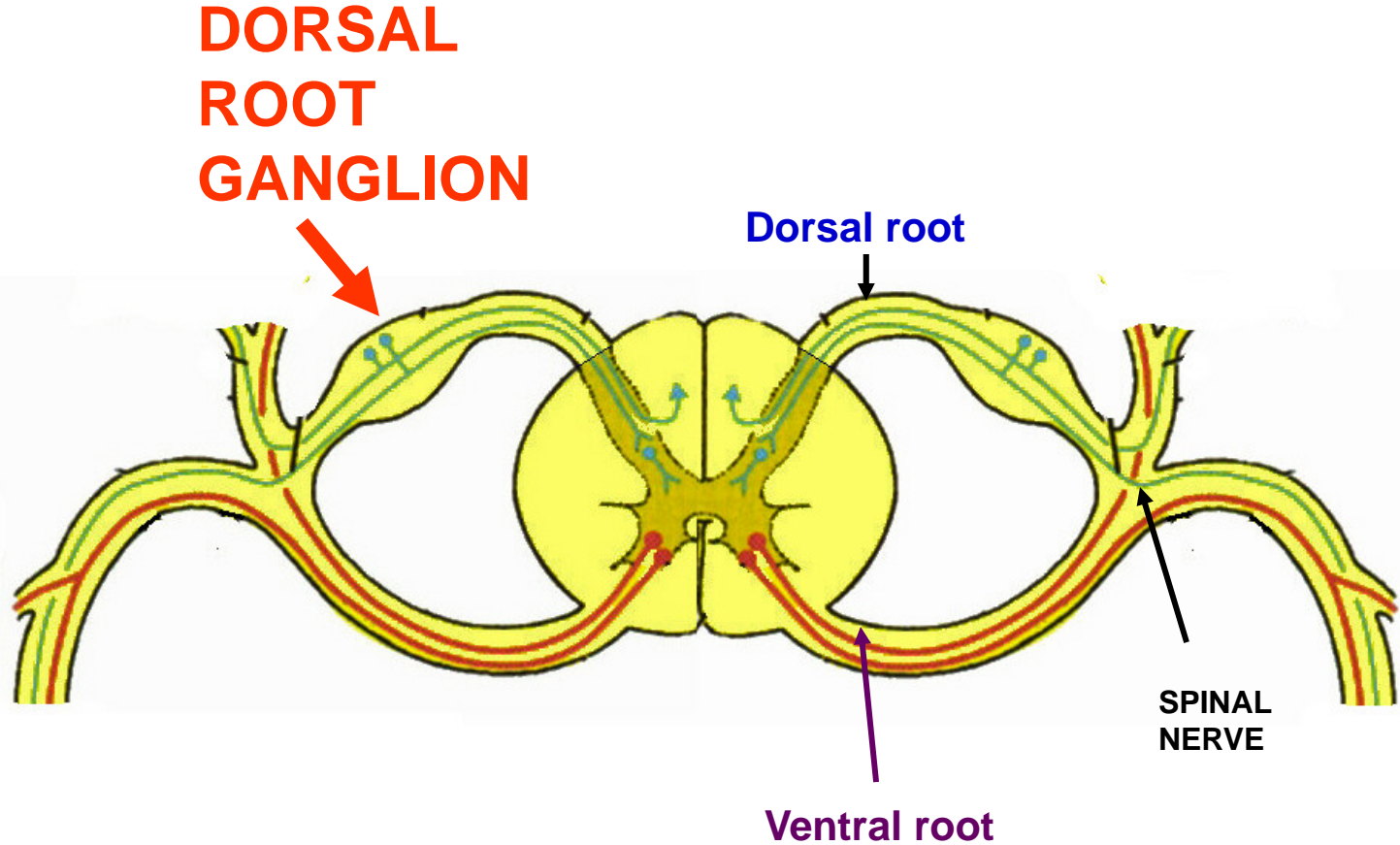
sensory to skin, ORAL cavity, NASAL cavity, joints, muscles



**ALMOST ALL
TRIGEMINAL V
EXCEPTION:
SKIN OF OUTER EAR**
1) **V - TRIGEMINAL**
ALSO
2) **VII- FACIAL**
3) **IX - GLOSSO-
PHARYNGEAL**
4) **X - VAGUS**

BELL'S PALSY (VII) - PARALYSIS OF FACIAL MUSCLES; IN RECOVERY, PATIENTS COMPLAIN OF EARACHES

SENSORY CELL BODIES IN DORSAL ROOT GANGLIA IN SPINAL CORD

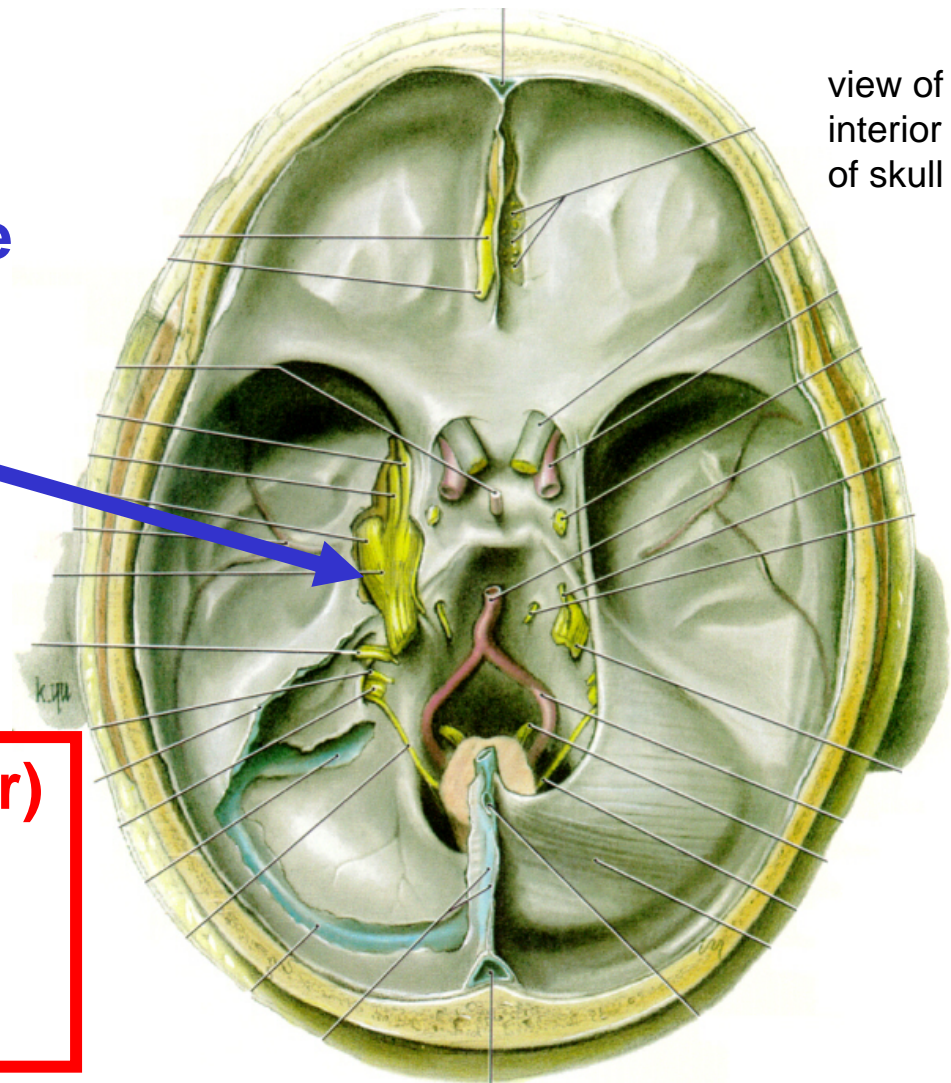


SENSORY GANGLIA ARE ATTACHED TO CRANIAL NERVES

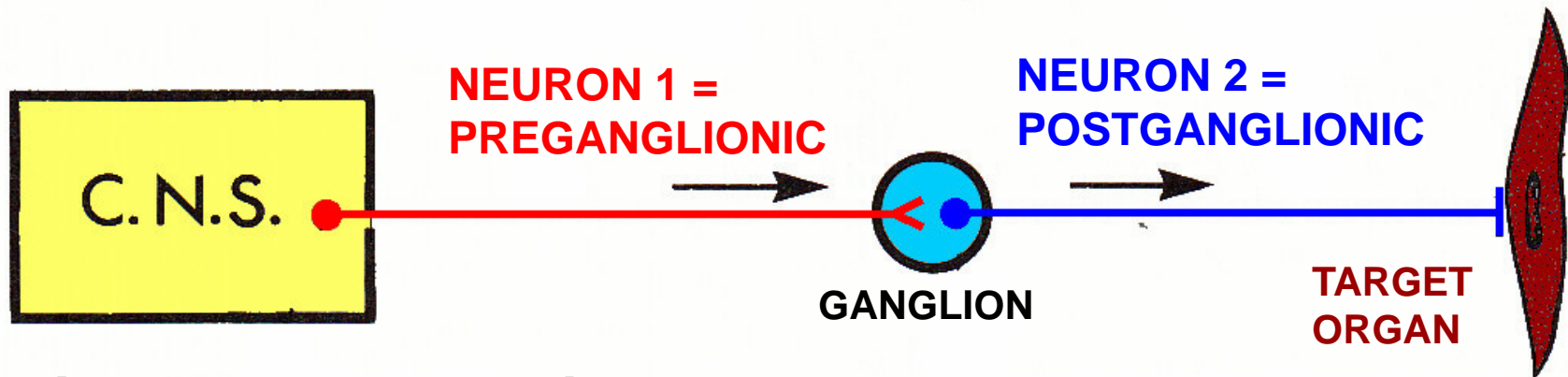
- cell bodies of sensory neurons in Trigeminal Nerve are in Trigeminal (Semilunar) Ganglion

Clinical - Mass (ex. tumor) pressing on Trigeminal Ganglion can produce numbness, intense pain

Cell bodies of sensory neurons in VII (Facial Nerve) in Geniculate Ganglion



VISCERAL MOTOR = AUTONOMIC NERVOUS SYSTEM

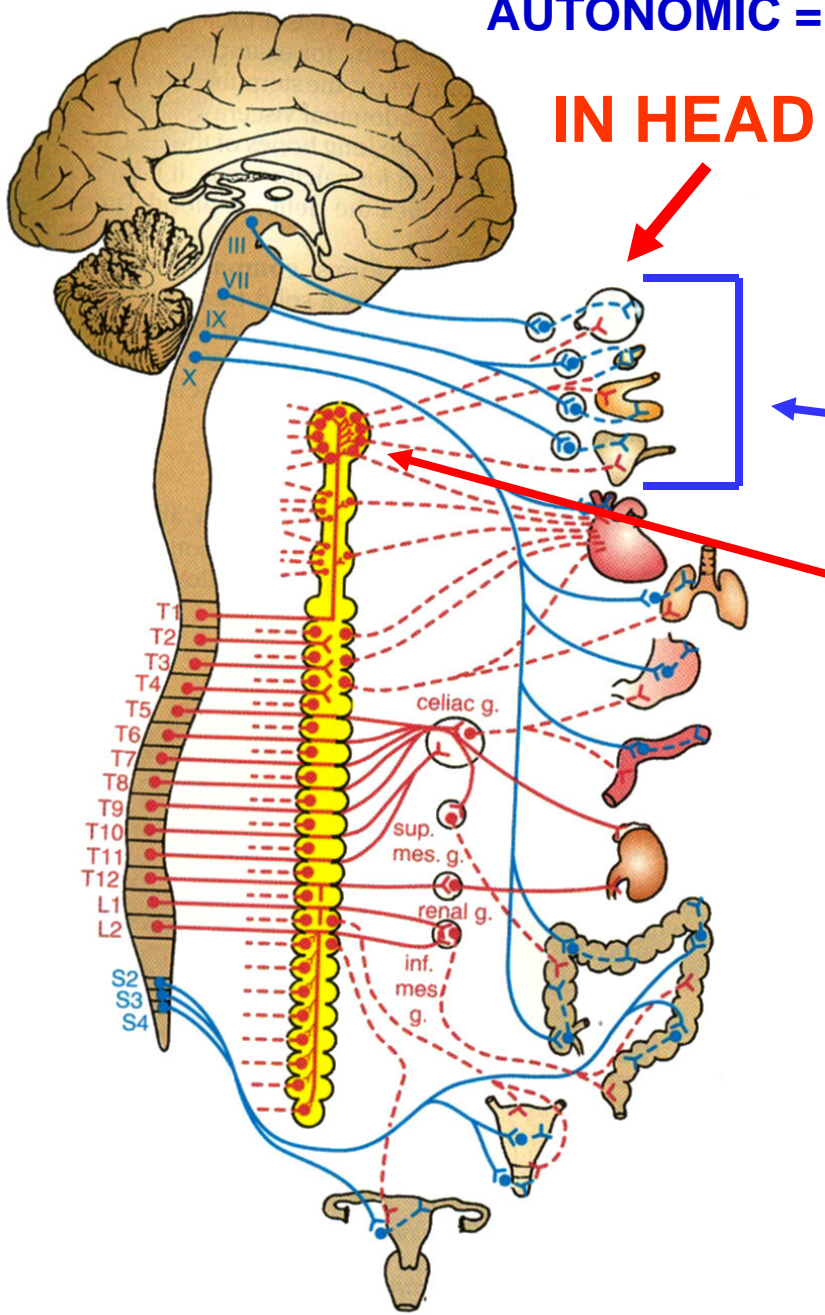


All two neuron pathways:

- 1) **Neuron 1 = Preganglionic neuron** - cell body in CNS; axon leaves CNS and synapses in autonomic ganglion
- 2) **Neuron 2 = Post ganglionic neuron** - cell body in autonomic ganglion; axon goes to target organ

note: **Sympathetic - ganglia close to vertebrae**
Parasympathetic - ganglia close to target organ

AUTONOMIC = VISCERAL NERVOUS SYSTEM IN HEAD



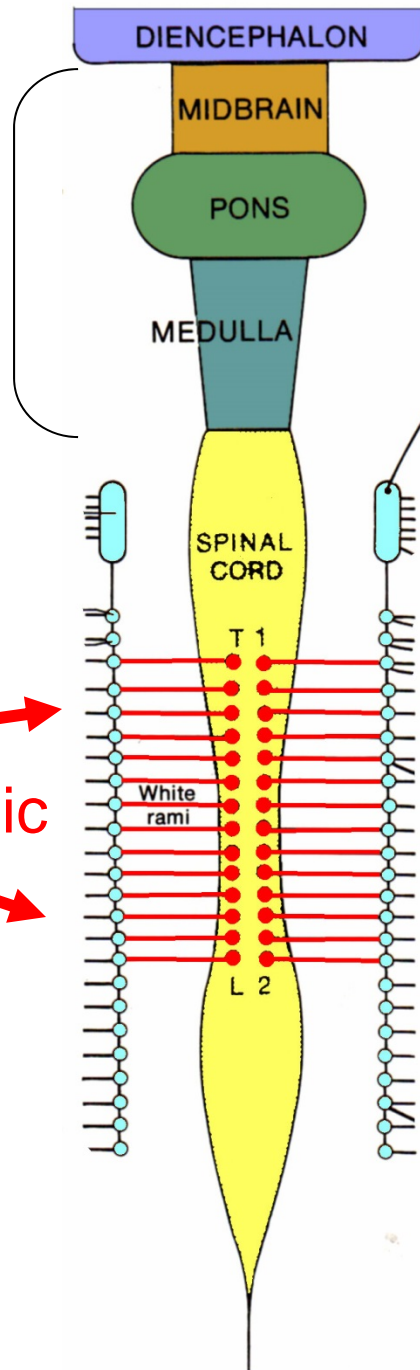
VISCERAL MOTOR Autonomic Nervous system = Visceral nervous system - involuntary, unconscious part of nervous system

a. **Parasympathetic (Cranio-sacral outflow)** - in four cranial nerves

b. **Sympathetics** - not in cranial nerves - come from spinal cord - Thoraco-lumbar outflow

c. **Visceral Afferents** - (not shown in diagram); sensory neurons that innervate internal organs, blood vessels; only provide imprecise localization of sensation and dull sense of pressure, pain, etc. - **follow parasympathetic and sympathetic** - in HEAD, some specific (see below).

BRAIN - parts of brainstem



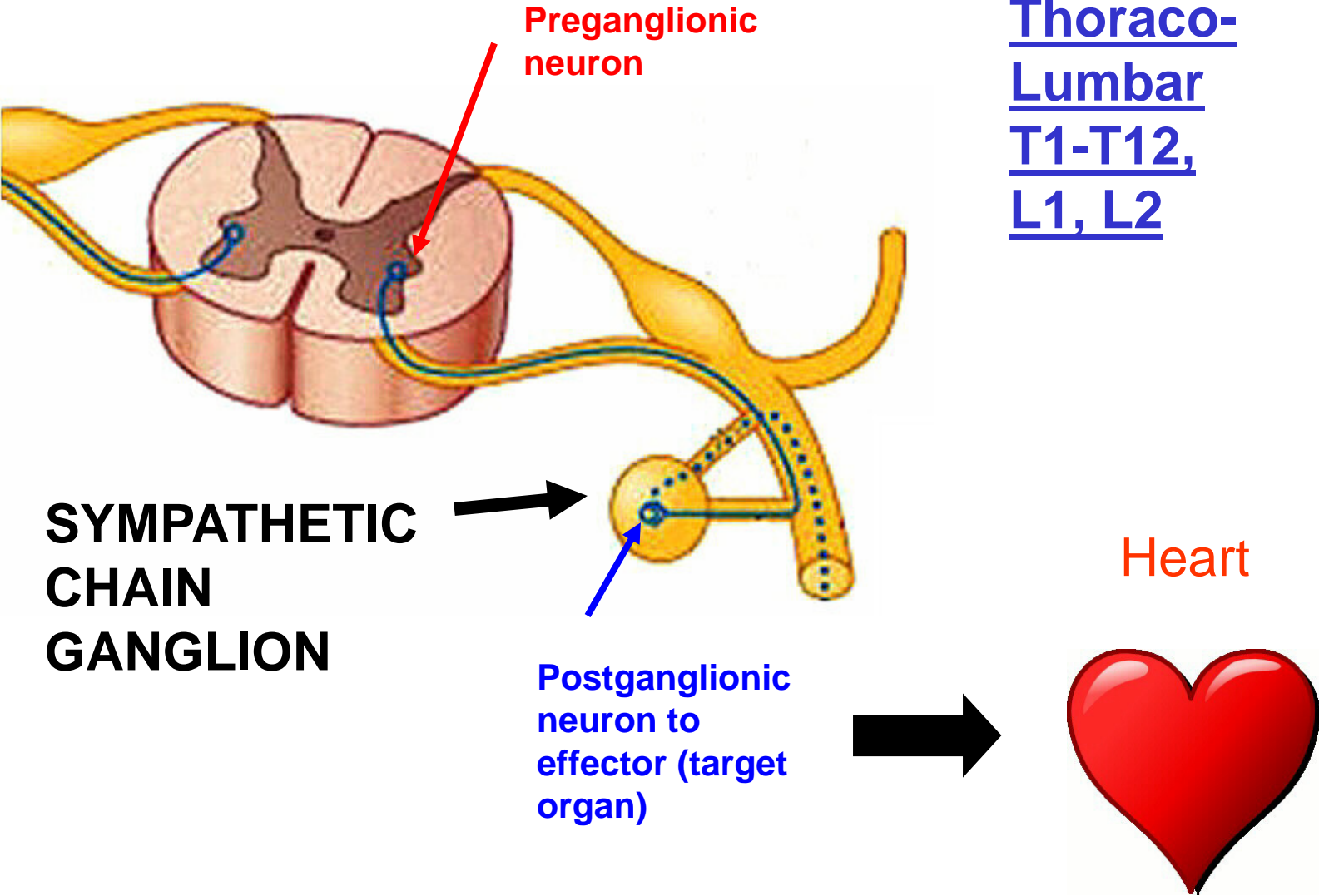
Sympathetic outflow (preganglionic neurons)

SYMPATHETIC AUTONOMICS

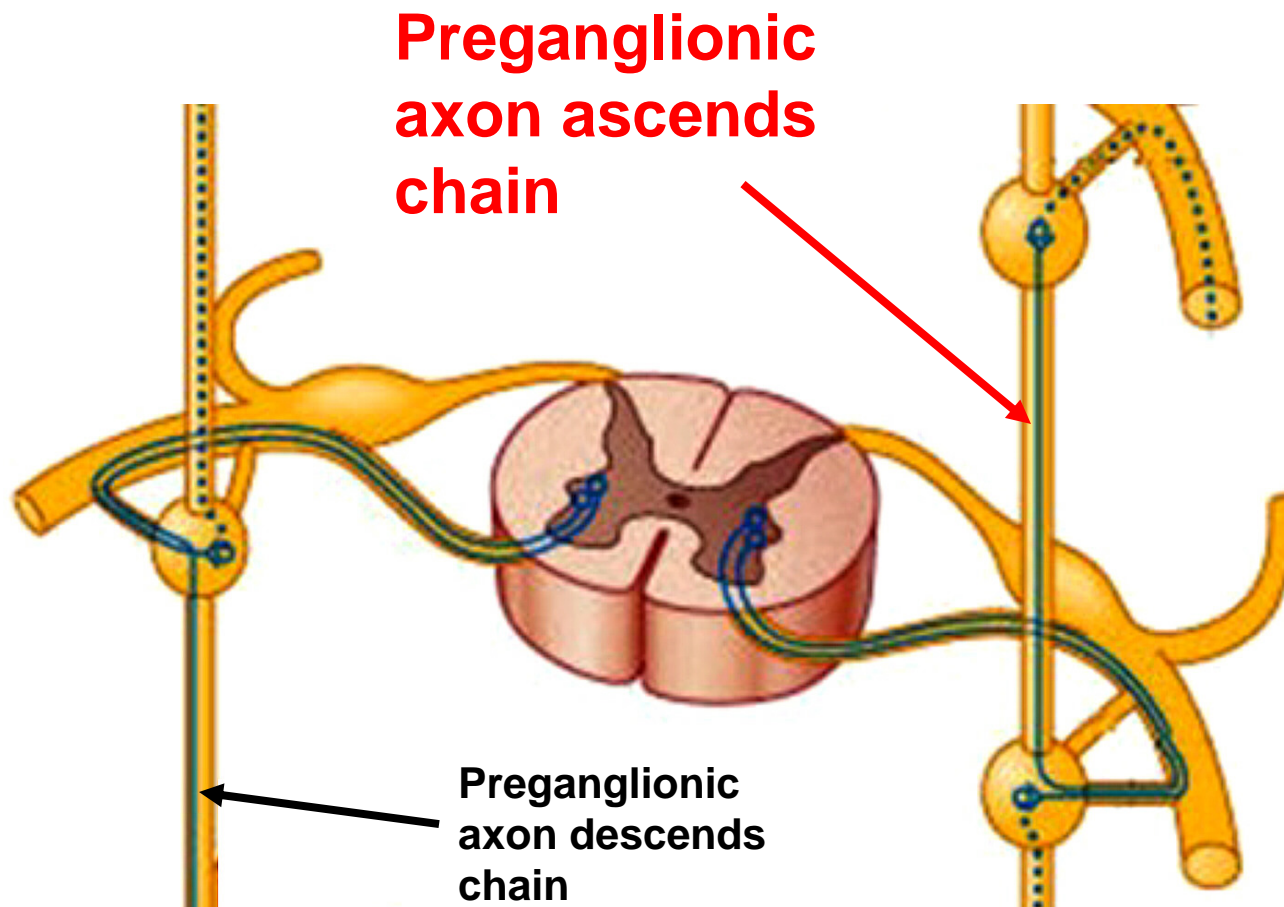
Sympathetics - not in cranial nerves - come from spinal cord - All preganglionic sympathetics come out spinal cord at **Thoracic and Lumbar levels**

To supply rest of body - some preganglionic **fibers ascend or descend** in sympathetic chain

SYMPATHETICS IN THORAX, ABDOMEN



SYMPATHETICS TO HEAD



PATHWAY TO HEAD -
Preganglionic neuron in spinal cord at T1, T2
- leaves and ascends sympathetic chain

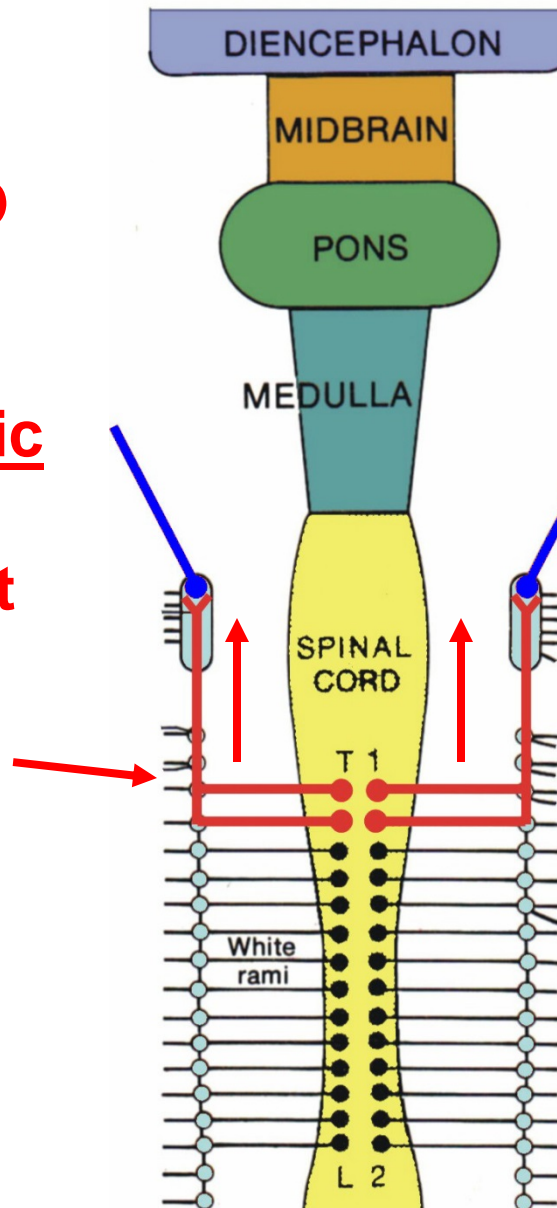
SYMPATHETICS CAN ALSO COME OUT AND ASCEND OR DESCEND SYMPATHETIC CHAIN TO TERMINATE IN OTHER GANGLIA

SYMPATHETICS TO HEAD

PATHWAY TO HEAD -

1) Neuron 1 (Preganglionic neuron) in spinal cord at T1, T2

- leaves and ascends sympathetic chain

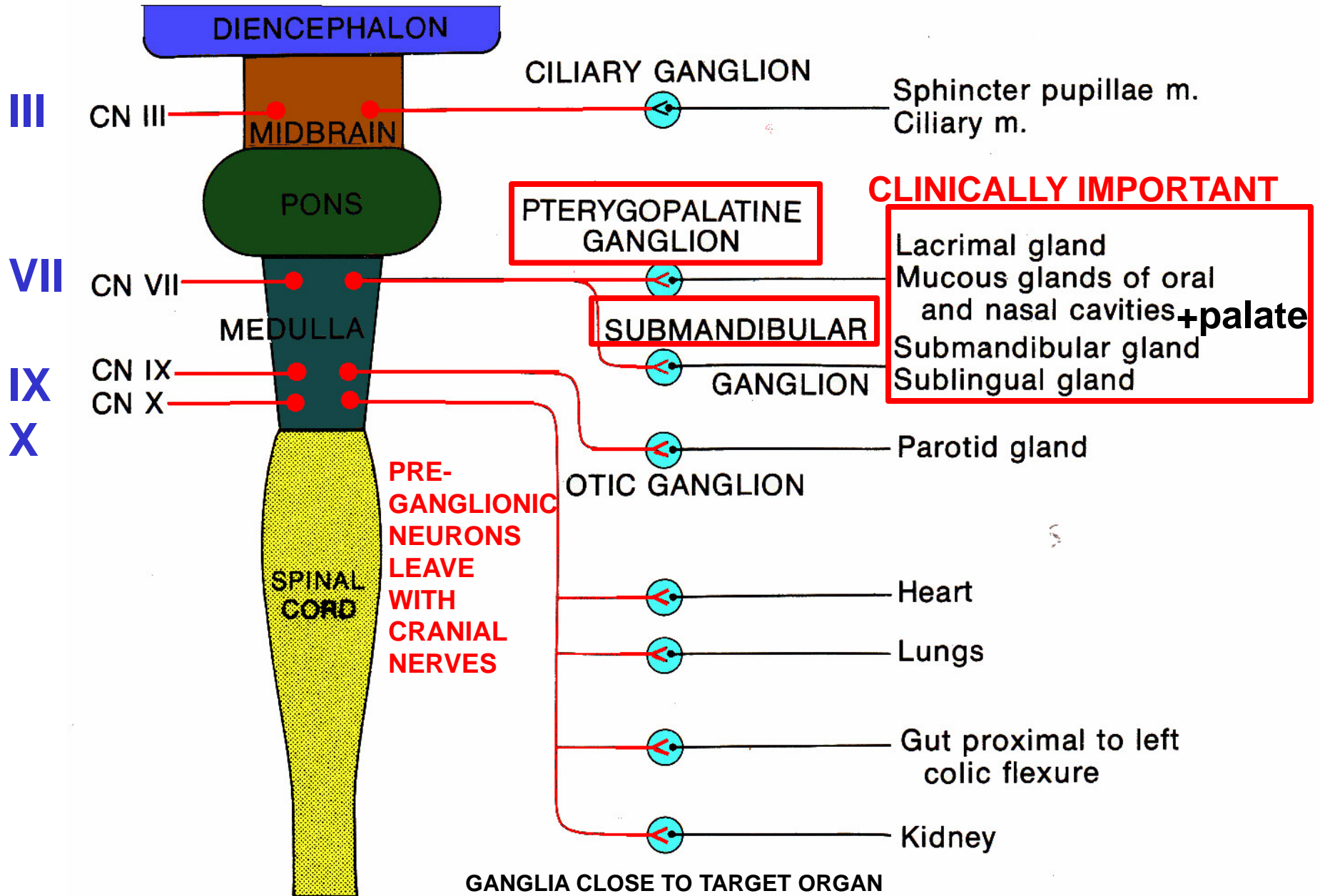


to Target Organ

Joins Plexus on Internal and External Carotid Arteries in mostly **Unnamed branches**

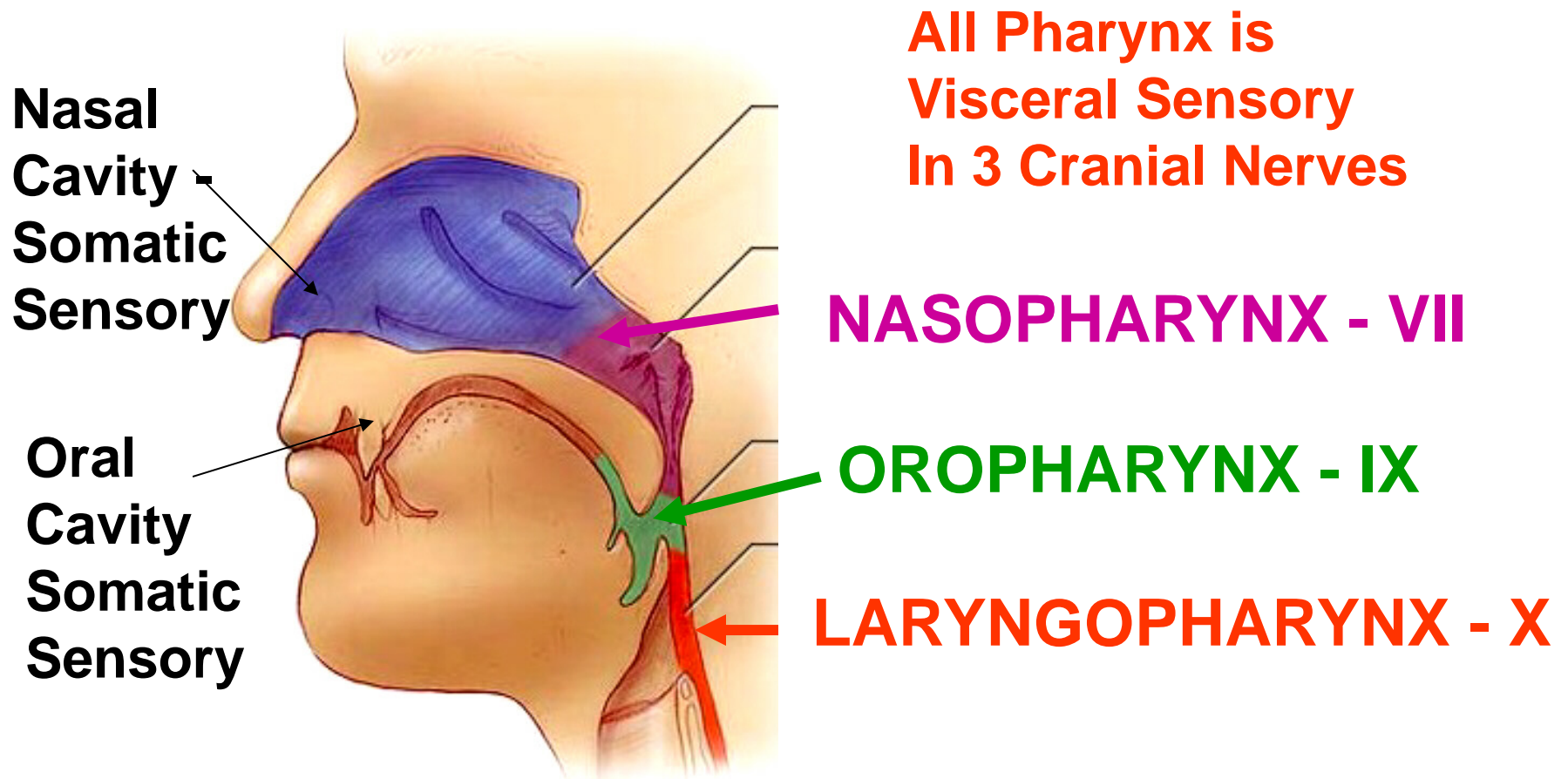
2) Neuron 2 (Postganglionic neuron) In **Superior Cervical Ganglia**

PARASYMPATHETICS - IN CRANIAL NERVES



VISCERAL SENSORY

Sensory to **Pharynx and derivatives**



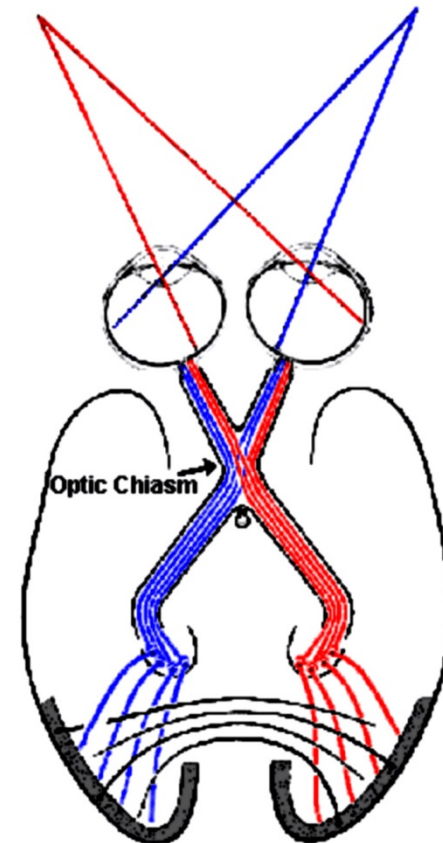
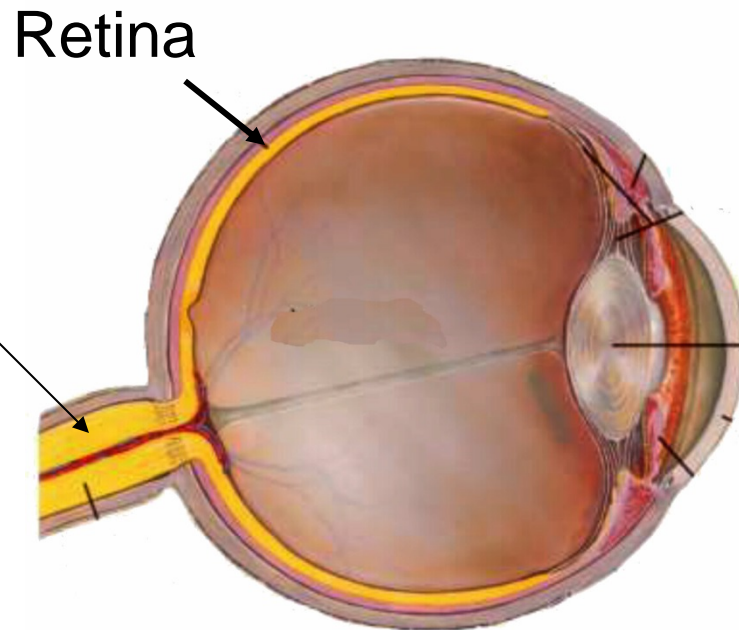
PHARYNX IS UPPER PART OF GI TRACT = VISCERAL

Note: Authors disagree on innervation of nasopharynx

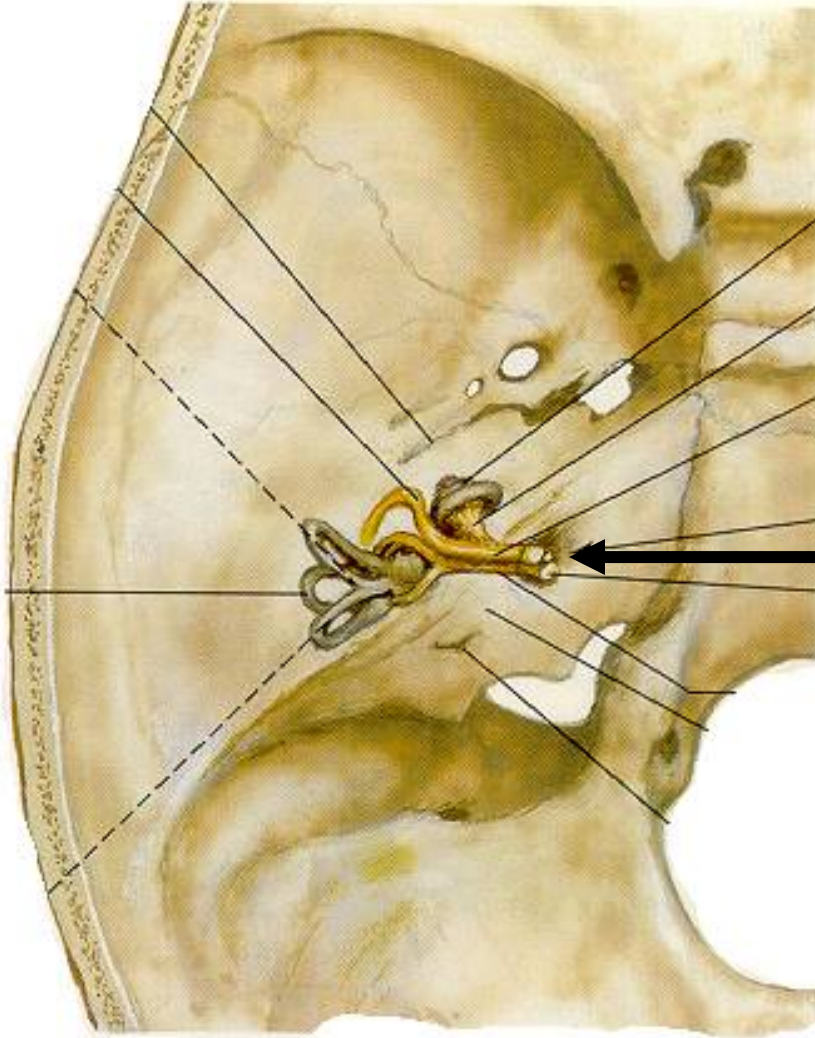
SPECIAL SENSES

Special senses only found in head - vision II,
hearing and balance VIII

II-
OPTIC
NERVE
fibers
cross at
optic
chiasm



SPECIAL SENSES



VIII

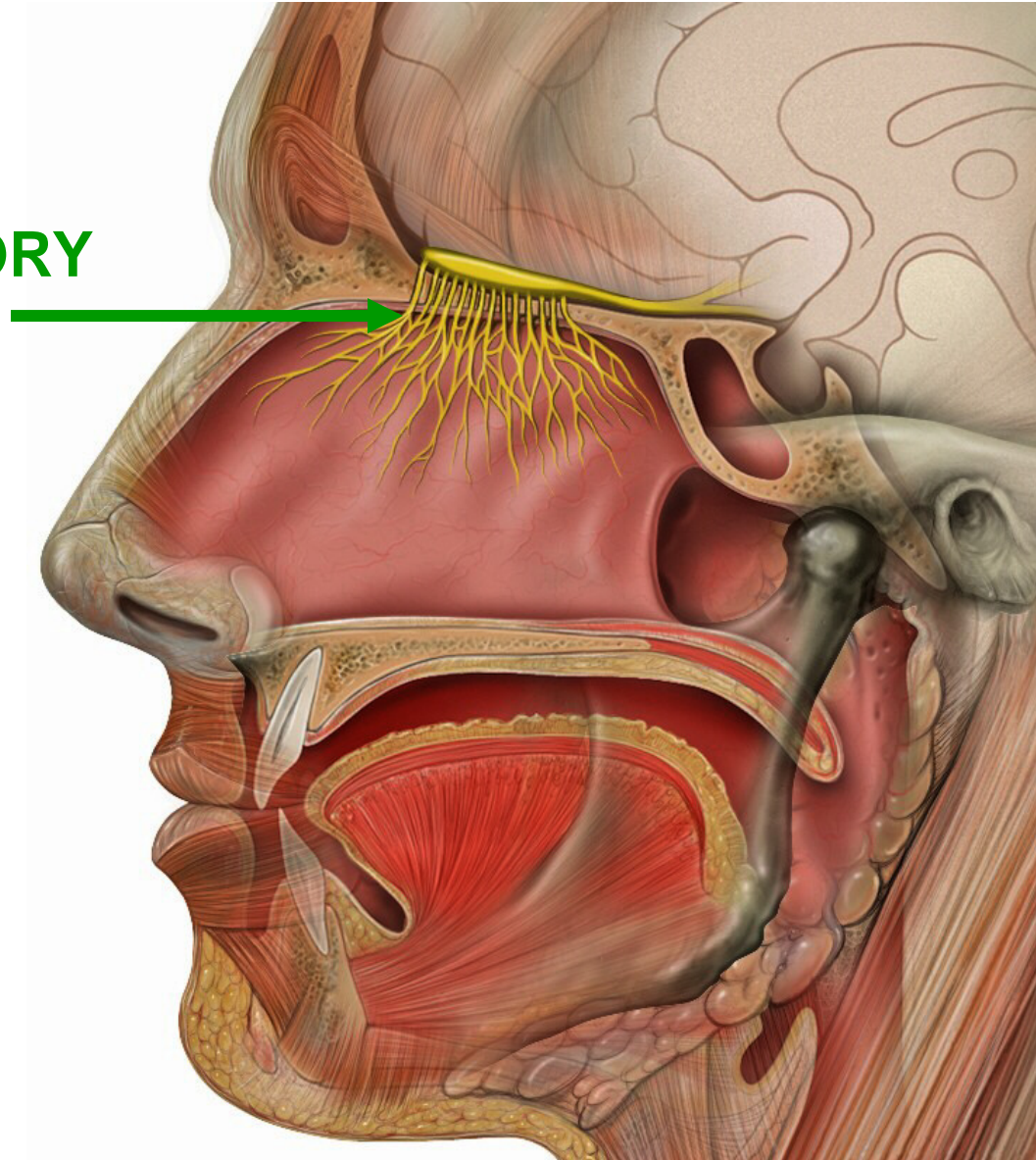
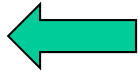
VIII -
VESTIBULO-
COCHLEAR

to 1) **cochlea** - hearing
2) **semicircular canals** -
(**vestibular apparatus**) -
balance

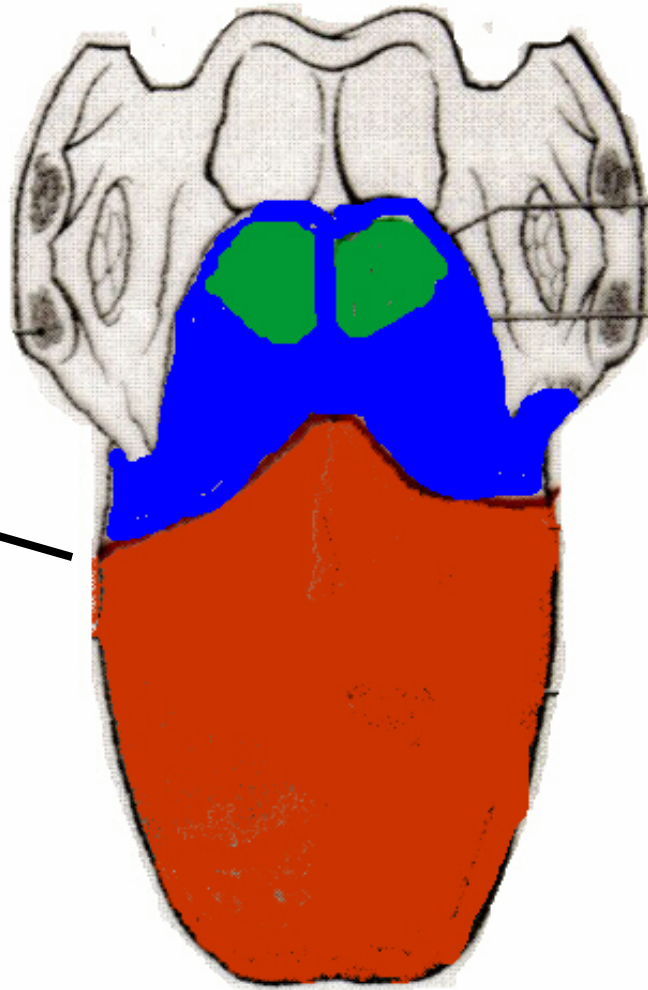
in petrous part of
temporal bone

CHEMICAL SENSES - TASTE AND SMELL

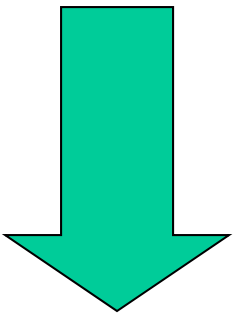
I - OLFACTORY
NERVE -
SMELL



CHEMICAL SENSES - TASTE - in three cranial nerves



TONGUE



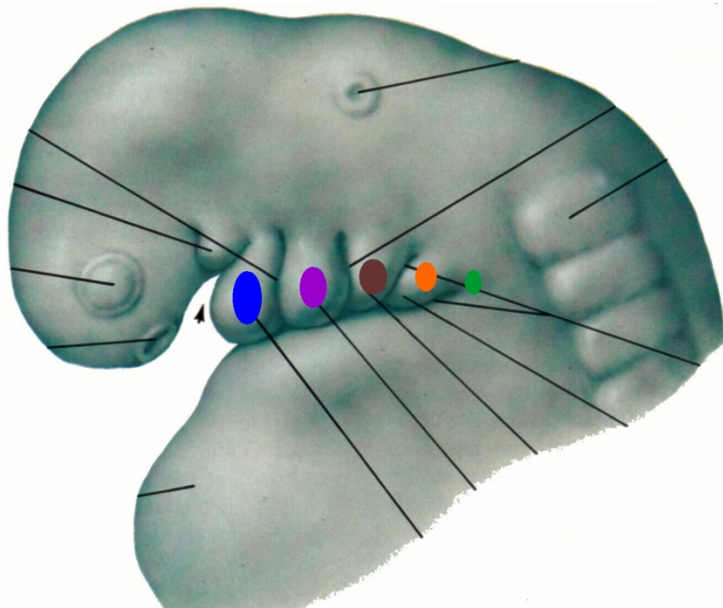
X - VAGUS -
ant. to epiglottis

**IX - GLOSSO-
PHARYNGEAL**
post. 1/3 of tongue

VII - FACIAL -
ant. 2/3 of tongue

BRANCHIOMOTOR

- motor to voluntary skeletal muscles derived from branchial arches
- 'visceral' because develop in pharynx then migrate



First -
Trigeminal
V

Second -
Facial
VII

Third
Glosso-
pharyngeal
IX

Fourth
Vagus
X

Sixth
Accessory
XI

10) BRANCHIOMOTOR - voluntary motor to skeletal muscles of face, ear, pharynx and neck that are derived from branchial arches.

Nerve

Innervates

V (Trigeminal)
(all in V3)

muscles of mastication
mylohyoid
tensor tympani
tensor palati
anterior belly of digastric

VII (Facial)

muscles of facial expression
stylohyoid
posterior belly of digastric
stapedius

IX (Glossopharyngeal)

stylopharyngeus

X (Vagus)

all muscles of pharynx (except stylopharyngeus)
muscles of larynx
all muscles of palate (except tensor palati)

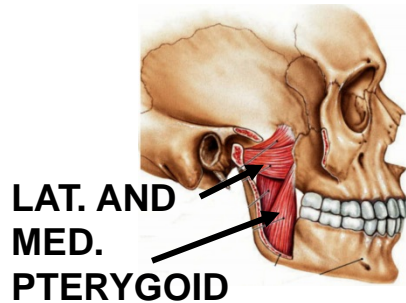
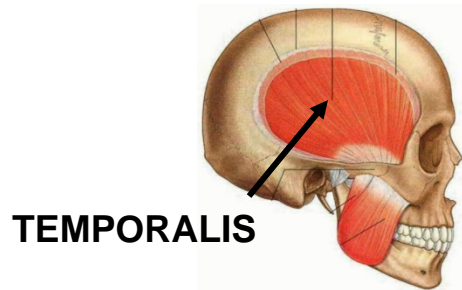
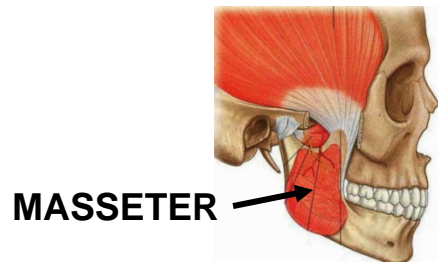
XI (Accessory)

sternocleidomastoid
trapezius

KNOW THIS FOR EXAMS (ALSO STEP 1)

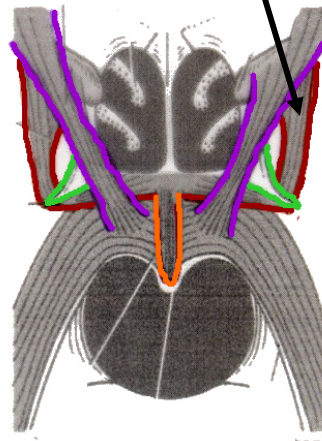
V - TRIGEMINAL - BRANCHIOMOTOR

MUSCLES OF MASTICATION

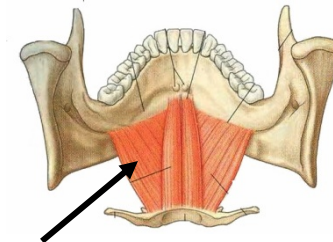
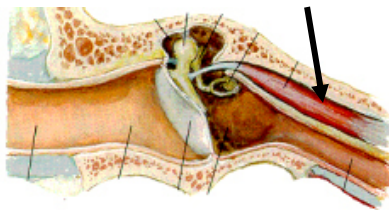


ACTIONS - MOST CLOSE MOUTH -
MASSETER, TEMPORALIS, MED. PTERYGOID
OPEN MOUTH - LAT. PTERYGOID

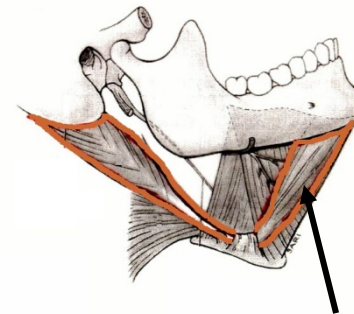
TENSOR PALATI -
tenses palate in
swallowing



TENSOR TYMPANI -
dampen sound



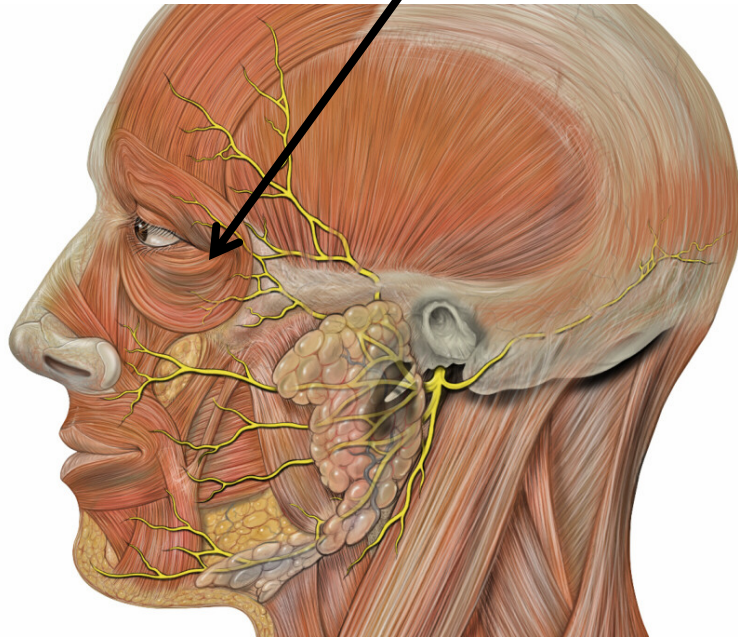
MYLOHYOID -
raise floor of
mouth in
swallowing



ANT. BELLY OF
DIGASTRIC -
opens mouth

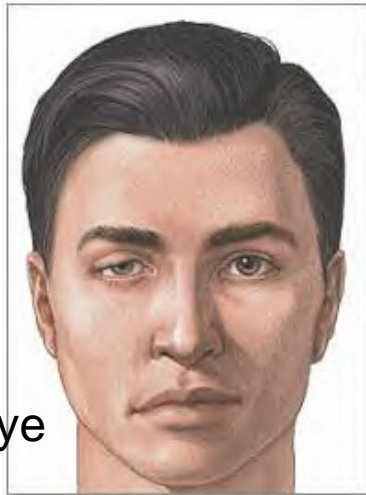
VII BRANCHIOMOTOR

MUSCLES OF FACIAL EXPRESSION

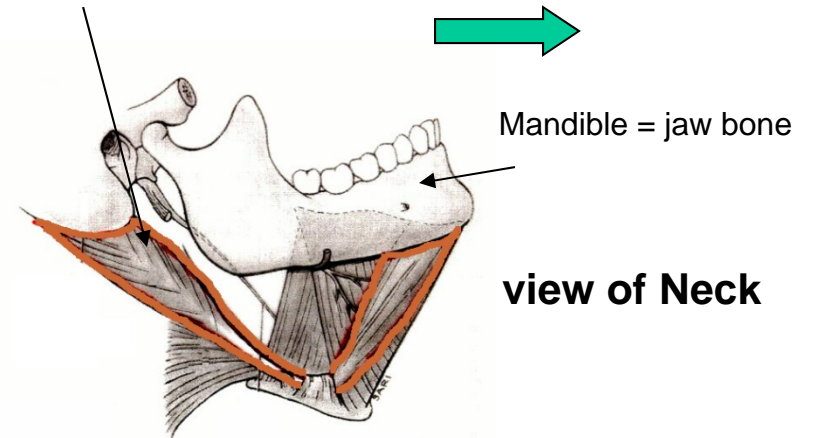


FACIAL PARALYSIS

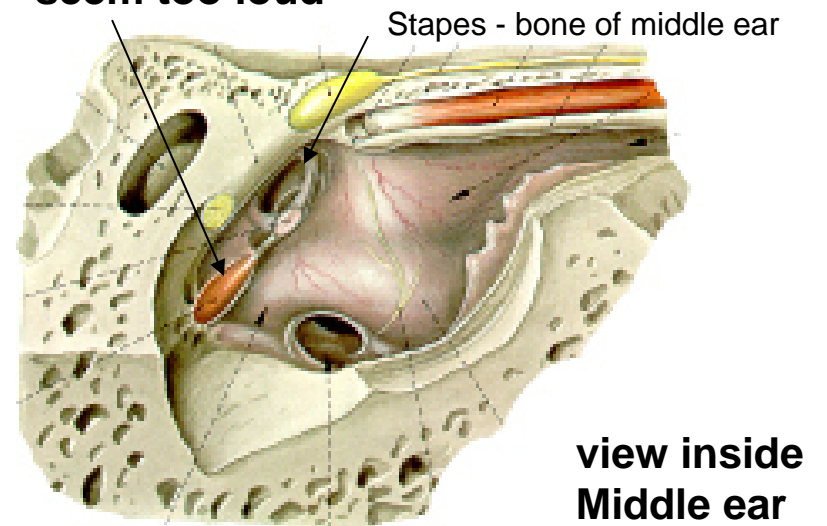
sagging face
loss of naso-labial fold
inability to close eye



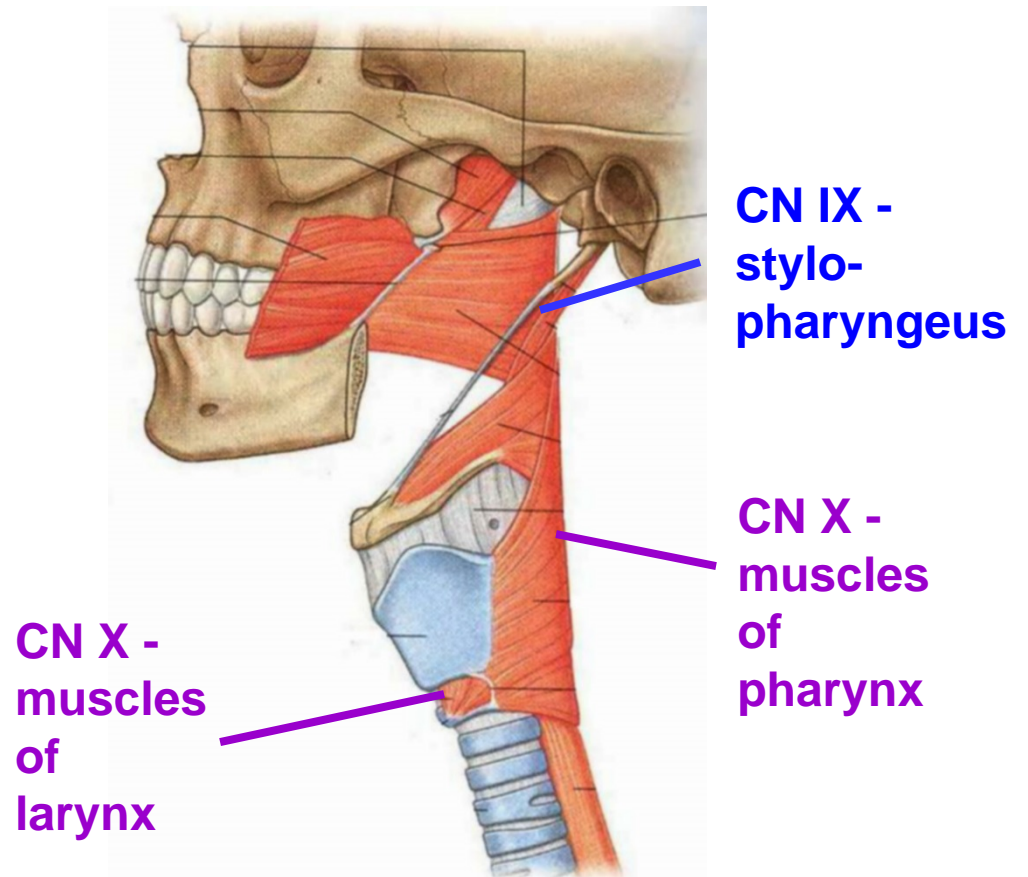
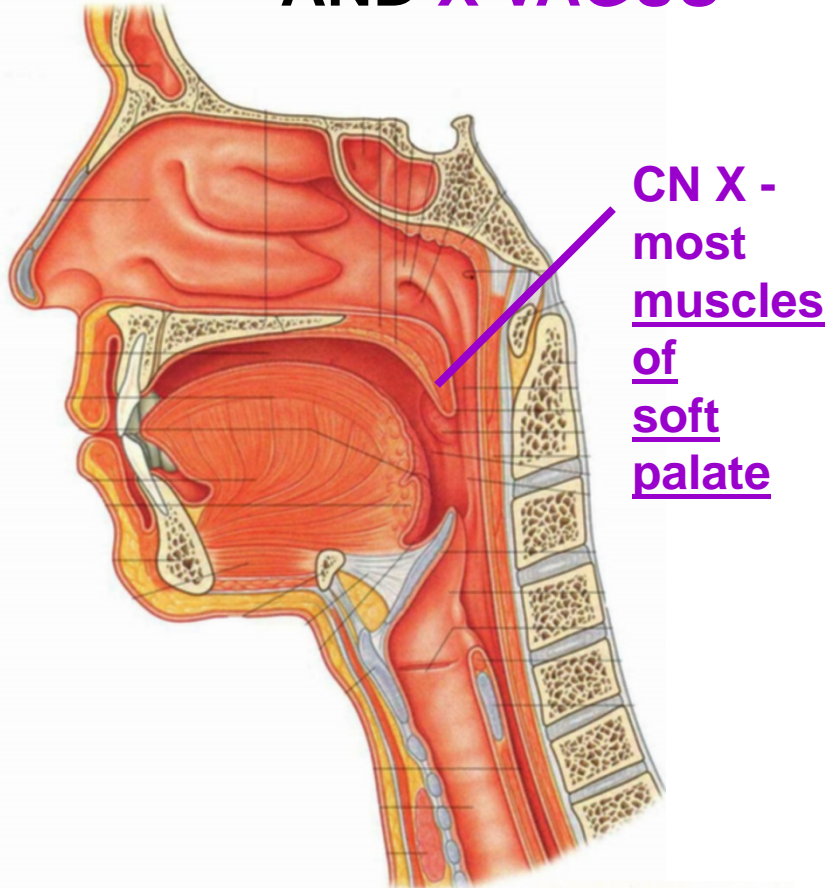
STYLOHYOID,
POST. BELLY DIGASTRIC



STAPEDIUS - dampens sound -
DAMAGE HYPERCOUSIA - sounds
seem too loud



BRANCHIOMOTOR - IX GLOSSOPHARYNGEAL AND X VAGUS

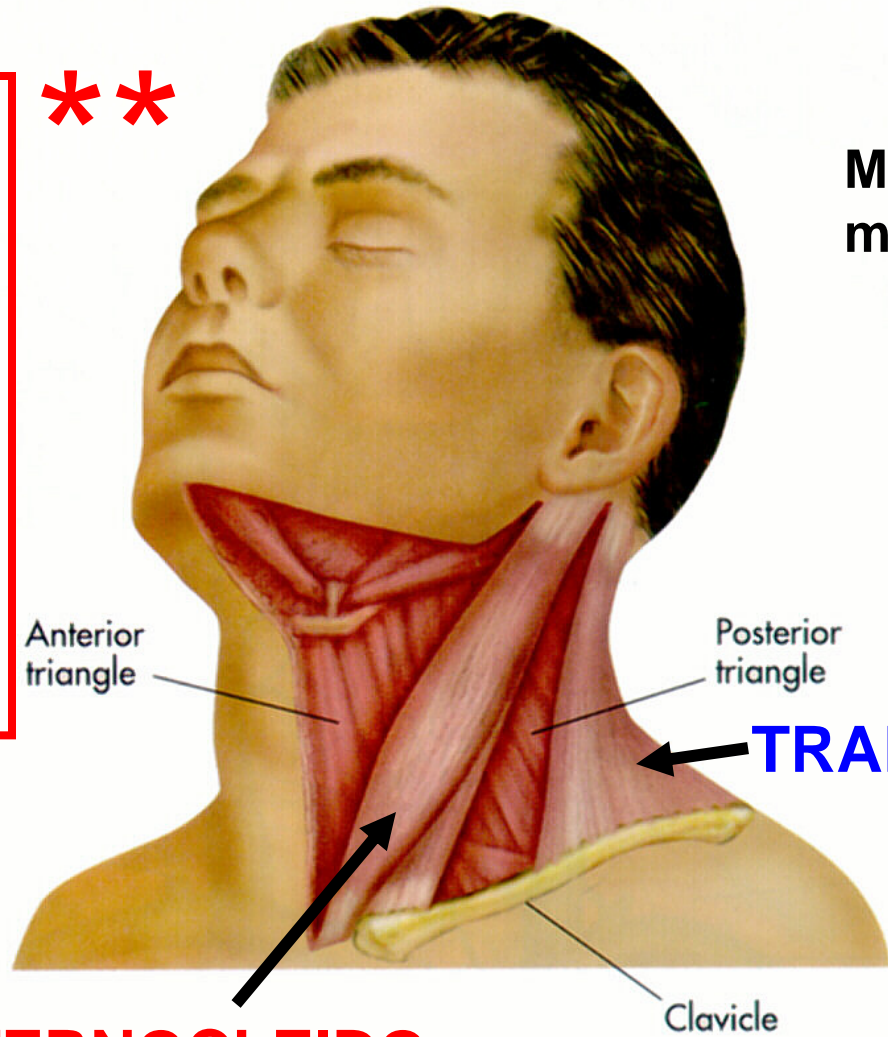


**TEST BY HAVING PATIENT
SAY AAHH!**

XI - ACCESSORY NERVE - BRANCHIOMOTOR

**Clinical Test
for
XI (Accessory
N.) -**
1) Shrug
shoulders
2) Rotate head
against
resistance

Motor to two
muscles



TRAPEZIUS

**Shrug
shoulders**

**STERNOCLEIDO-
MASTOID** Turn head

SUMMARY TYPES OF NEURONS IN CRANIAL NERVES

TYPES OF NEURONS	INNERVATE	ASSOCIATED CRANIAL NERVES	CLINICAL
SOMATIC MOTOR (GSE)	Motor to voluntary skeletal muscles (derived from somites)	CN III, IV, VI - 1) Extraocular muscles (pre-otic somites) CN XII - muscles of tongue (occipital somites)	see ORBIT, TONGUE lectures
SOMATIC SENSORY (GSA)	<u>Precise sensation</u> Sensory to skin, joints (oral cavity, nasal cavity)	CN V - mostly V1 - Ophthalmic (above angle of eye) V2 - Maxillary (angle of eye to angle of mouth) V3 - Mandibular (below angle of mouth) also Skin of External (Outer) Ear - V, VII, IX, X	1) Trigeminal Neuralgia - pain in region of affected division 2) Bell's palsy (VII)- pain in outer ear
VISCERAL MOTOR (GVE) (Parasympathetics in Cranial Nerves)	Smooth muscles, Glands, etc. (ganglia close to target organ)	III - Ciliary ganglion - Pupillary constrictor, Ciliary muscle VII - Pterygopalatine ganglion - Lacrimal gland, mucous glands of nose and palate VII - Submandibular ganglion - Submandibular, Sublingual salivary glands IX - Otic ganglion - Parotid	see Associated lectures (Orbit; Nasal, Oral Cavities; Ear)
VISCERAL SENSORY (GVA)	<u>Imprecise sensation:</u> Innervation of Gut, Blood Vessels, etc. Specific for Innervation of Pharynx, Middle Ear	Pharynx VII - Nasopharynx IX - Oropharynx X - Laryngopharynx also Middle Ear - IX	Imprecise localization in Choking on food; Middle ear infections
SPECIAL SENSES (SSA)	Vision, Audition, Balance	II - Vision VIII - Audition (hearing), Balance (vestibular apparatus)	many; see associated lectures
CHEMICAL SENSE (SVA)	Taste, Smell	Taste is distributed: VII - anterior 2/3 of tongue IX - posterior 1/3 of tongue X - taste buds anterior to epiglottis Smell - I - olfaction	Damage produces loss of taste in region of innervation
BRANCHIO-MOTOR (SVE)	Voluntary skeletal muscles derived from Branchial Arches	V - muscles of First Branchial Arch VII - muscles of Second Branchial Arch IX - muscles of Third Branchial Arch X - muscles of Fourth and Sixth Branchial Arches XI - muscles of caudal Sixth Branchial arch (disagreement among authors)	see Branchial arch chart (above); also Branchial Arch Lecture, etc. INCANTATION)

VII. SUMMARY OF TYPES OF NEURONS IN CRANIAL NERVES (parenthesis - OLD 3 Letter system)

Nerve	SOMATIC MOTOR (GSE)	BRANCHIO-MOTOR (SVE)	VISCERAL MOTOR (GVE)	SOMATIC SENSORY (GSA)	VISCERAL SENSORY (GVA)	CHEMICAL SENSE (SVA)	SPECIAL SENSES (SSA)
III.	+		+				
IV.	+						
VI.	+						
XII.	+						
V.		+		+			
VII.		+	+	+	+	+	
IX.		+	+	+	+	+	
X.		+	+	+	+	+	
XI.		+					
I.						+	
II.							+
VIII.							+

2) CLASSIFICATION OF INNERVATION - 7 types of neurons - some are the same as found in spinal nerves; others are only found in cranial nerves

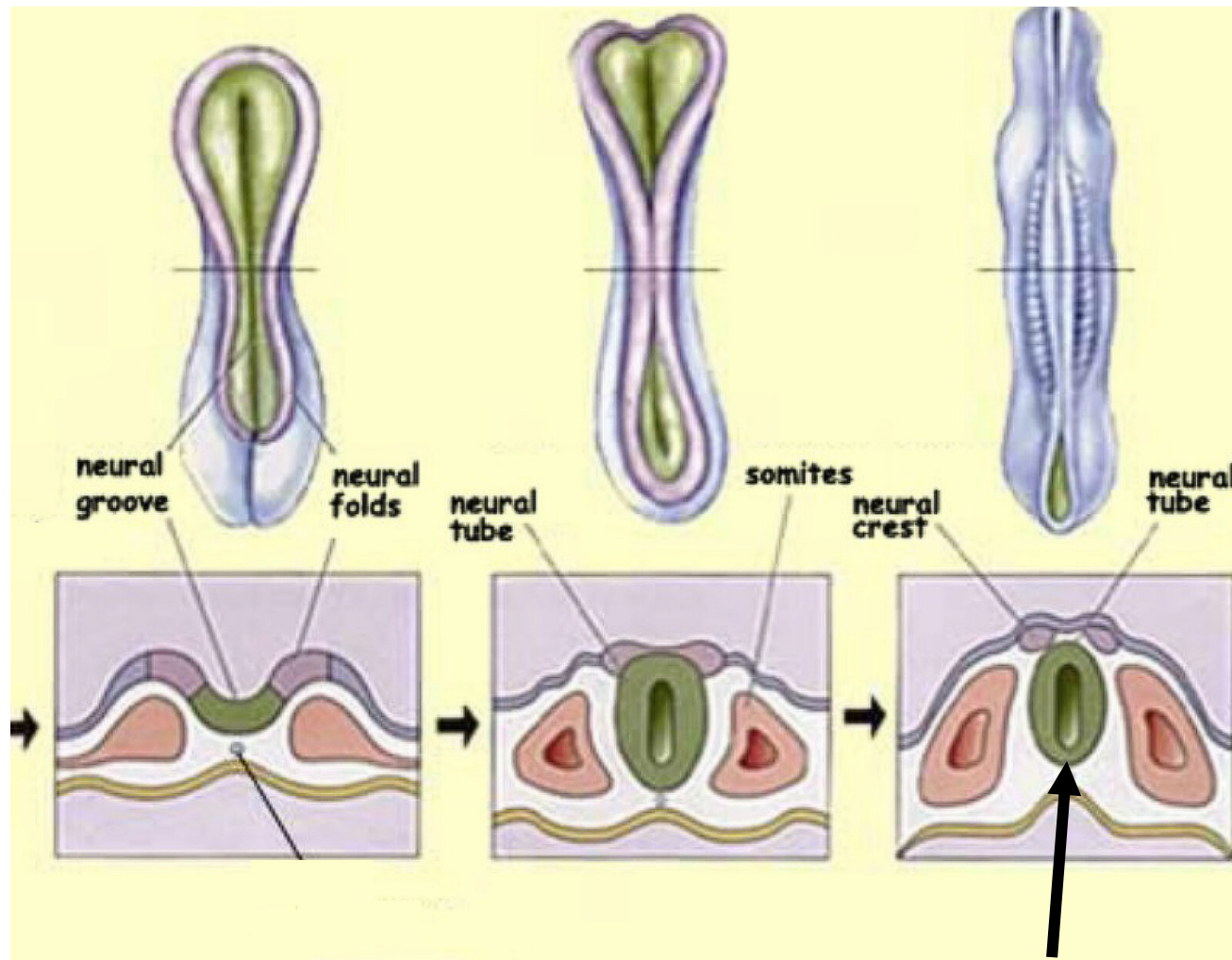
A. Same as spinal nerves

1. **Somatic motor** - Voluntary skeletal muscles (from somites)
2. **Somatic sensory** - Precise sensation - sensory to skin, joints, muscle and tendon receptor endings, nasal and oral cavity
3. **Visceral motor** (efferents) - smooth, muscle glands; smooth muscles of skin (arrector pilae muscles) and blood vessels, secretomotor to glands
4. **Visceral sensory** - Imprecise sensation sensory to gut, blood vessels, glands and internal; in head: pharynx (rostral end of gut)

B. Only in cranial nerves

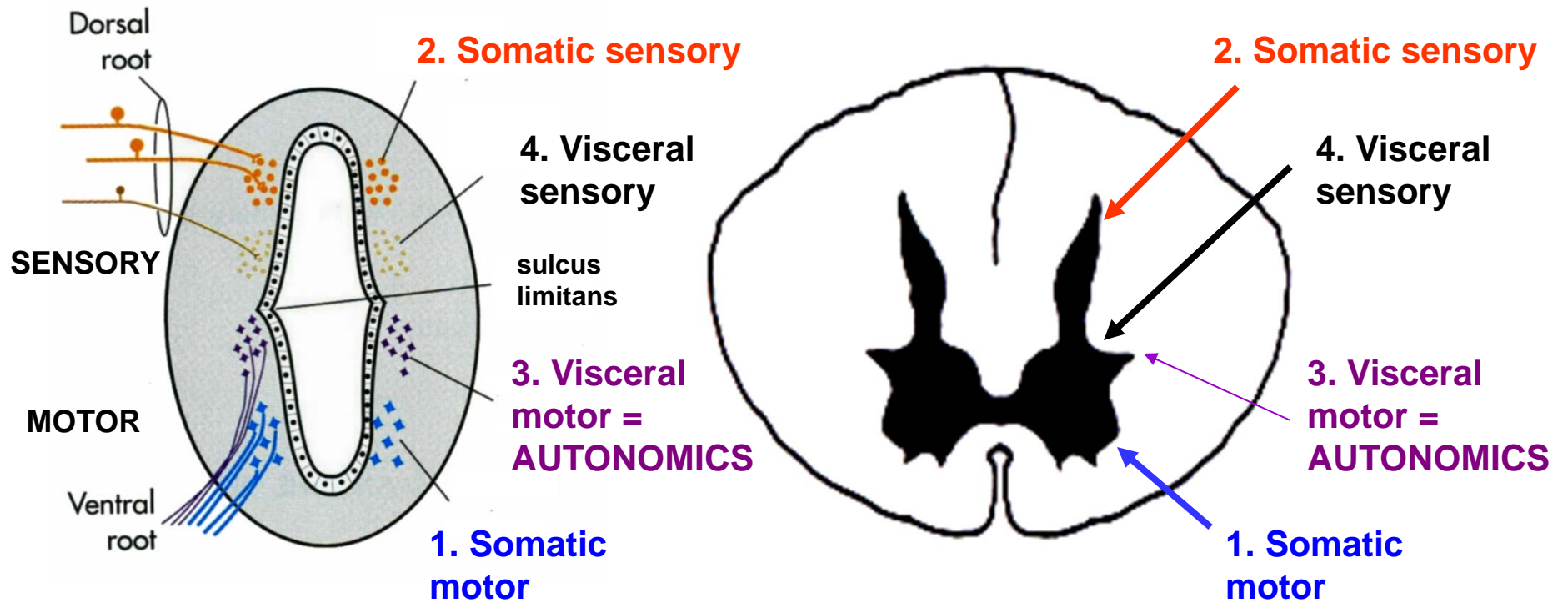
5. **Special senses** - vision, hearing (auditory) and balance (vestibular apparatus)
6. **Chemical senses** - taste and smell
7. **Branchiomotor** - Voluntary skeletal muscles from branchial arches.

WHY DO YOU NEED TO KNOW THIS? CLASSIFICATION IS REFLECTED IN CENTRAL NERVOUS SYSTEM



Nervous system forms as a Neural Tube

WHY DO YOU NEED TO KNOW THIS? CLASSIFICATION IS REFLECTED IN CENTRAL NERVOUS SYSTEM



Nervous system forms as a Neural Tube; cells form groups (**columns**); **sensory dorsal, motor ventral**; different types of neurons form columns that develop to adult locations

CRANIAL NERVE: CAPSULE SUMMARY

- I. Olfactory - smell
- II. Optic - vision
- III. Oculomotor - eye movements; also parasympathetics to eye smooth muscles
- IV. Trochlear - eye movements
- V. Trigeminal - sensory nerve to skin, also pain, temperature touch to oral and nasal cavities, (outer ear)
- VI. Abducens - eye movements
- VII. Facial - muscles of facial expression; also taste, parasympathetics
- VIII. Vestibulo-cochlear (Stato-acoustic) - hearing and balance
- IX. Glossopharyngeal - sensory to pharynx, back of tongue (Gag reflex)
- X. Vagus - motor to pharynx (most), larynx (voice box); soft palate; parasympathetics to thorax, abdomen
- XI. Accessory (Spinal Accessory) - motor to sternocleidomastoid, trapezius
- XII. Hypoglossal - motor to muscles of tongue

APPENDIX: OLDER SYSTEM: CLASSIFICATION OF INNERVATION AS FUNCTIONAL COMPONENTS

A. First letter

G = General = types of neurons found both in spinal nerves and cranial nerves.

S = Special = types of neurons only found in cranial nerves not spinal nerves.

B. Second letter

S = Somatic = types of neurons innervating structures derived from somites.

V = Visceral = types of neurons innervating gut, structures derived from or associated with gut and branchial arches; also vascular system, smooth muscle, internal organs and glands.

C. Third letter

A = Afferent = sensory neurons.

E = Efferent = motor neurons to skeletal and smooth muscle; also secretomotor neurons to glands.

CLASSIFICATION OF INNERVATION AS FUNCTIONAL COMPONENTS

II. TRANSLATING TYPES OF NEURONS TO FUNCTIONAL COMPONENTS (ALPHABET SOUP)

Like spinal nerves -

1. **SOMATIC MOTOR = GSE - General Somatic Efferent**
2. **SOMATIC SENSORY = GSA - General Somatic Afferent**
3. **VISCERAL MOTOR = GVE - General Visceral Efferent**
4. **VISCERAL SENSORY = GVA - General Visceral Afferent**

Only in cranial nerves -

5. **SPECIAL SENSES = SSA - Special Somatic Afferent**
6. **CHEMICAL SENSES = SVA - Special Visceral Afferent**
7. **BRANCHIOMOTOR = SVE - Special Visceral Efferent**

Table 9.1. Functional Components of the Cranial Nerves

No.	Name	SSA	GSA	GVA	SVA	GSE	SVE	GVE
I	Olfactory				•			
II	Optic	•						
III	Oculomotor					•		•
IV	Trochlear					•		
V	Trigeminal		•				•	
VI	Abducent					•		
VII	Facial		•	•	•		•	•
VIII	Vestibulocochlear	•						
IX	Glossopharyngeal		•	•	•		•	•
X	Vagus		•	•	•		•	•
XI	Accessory						•	
XII	Hypoglossal					•		

CAPSULE SUMMARY OF CRANIAL NERVES: **TYPES** **OF NEURONS**

GSE = SOMATIC MOTOR - voluntary skeletal muscle from somites;
two groups: eye (III, IV and VI) and tongue (XII)

GSA = SOMATIC SENSORY precise sensory – touch, pain etc. – skin,
also nasal cavity and oral cavity; also joint position, muscles; almost
all V; also Bell's palsy ear ache – VII, IX, and X to skin of outer ear

GVE = VISCERAL MOTOR autonomics - parasympathetics – see chart
– III, VII, IX, X

(note: sympathetics to head – out T1, T2; up chain; synapse Sup. Cerv.
Ganglion; post-ganglionics with arteries, unnamed branches)

GVA = VISCERAL SENSORY - imprecise sensory (blood vessels, etc);
also pharynx is VII, IX, X (popcorn); also middle ear (IX)

SSA = SPECIAL SENSES - means special senses vision (II) and
hearing and balance (VIII)

SVA = CHEMICAL SENSES - means smell (I) and taste (VII, IX, X)

SVE = BRANCHIOMOTOR - voluntary skeletal muscle from branchial
arches – V, VII, IX, X, XI – memorize incantation

SKULL

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I. CALVARIUM - skull cap.

A. Bones - Calvarium consists single Frontal, Sphenoid and Occipital bones and paired Parietal and Temporal bones (lobes of Cerebral Cortex are named for bones of skull).

B. Sutures - named fibrous joints that connect bones of calvarium:

1. **Coronal suture** - between Frontal and Parietal bones
2. **Sagittal suture** - between Parietal bones
3. **Lambdoidal suture** - between Parietal and Occipital bones

C. Landmarks:

1. **Bregma** - midpoint of Coronal Suture
2. **Lambda** - midpoint of Lambdoidal suture
3. **Pterion** - area of junction of Sphenoid, Temporal, Parietal and Frontal bones (**Note: Skull fractures in region of Pterion are clinical important, ex. Epidural Hematoma**)

D. Fontanelles - in infants, bones are further apart and joined by fontanelles; fontanelles permit cranial compression at birth, later cranial growth:

1. **Anterior Fontanelle** - at Bregma
2. **Posterior Fontanelle**- at Lambda
3. **Lateral Fontanelle**- at Pterion

Clinical: **Anterior Fontanelle** can be used to **access Superior Sagittal venous sinus in neonates**.

Forensic note: Sutures progressively fuse with age; extent of fusion can be used to estimate age of skull.

E. Internal structure of calvarium

1. Calvarium consists of **hard inner and outer tables** of cortical bone surrounding layer of **spongy bone (Diploe = double)**.

2. **Diploic veins** - course within diploe, connect both to cranial cavity and surface of skull via **Emissary veins (can transmit infection through emissary veins, see below)**.

F. Blood supply to calvarium - outer surface receives branches from arteries to scalp (see below); inner surface receives branches from Meningeal arteries (coursing immediately below bone).

II. **SCALP** - layers of skin and connective tissue overlying calvarium.

A. Layers - superficial to deep

1. **Skin** - with associated hair follicles, sweat glands and sebaceous glands.
2. **Connective tissue layer** - dense fibrous connective tissue surrounding arteries and nerves.
3. **Epicranial Aponeurosis** - thin tendinous sheet, tightly attached to skin and connective tissue above; moveable anteriorly and posteriorly; laterally attached to temporal fascia; attached to Frontalis and Occipitalis muscles.
4. **Loose Areolar tissue** - loosely connects epicranial aponeurosis to periosteum of skull; crossed by emissary veins (see below).
5. **Pericranium** - periosteum (connective tissue layer) of outer side of calvarium.

Clinical note: Infections can readily spread through loose areolar layer deep to epicranial aponeurosis.

Primitive note: When tribesmen scalp someone, they merely cut along the periphery of the scalp. It is then readily **removed between the layers of the epicranial aponeurosis and the loose areolar tissue**. Civilized people (including medical students) do not keep scalps as souvenirs.

B. Innervation

1. branches of Trigeminal nerve innervate anterior and lateral scalp: 1) Supratrochlear and 2) Supraorbital nerves (anterior scalp), 3) Zygomaticotemporal and 4) Auriculotemporal nerves (lateral scalp).
2. Cervical spinal nerves innervate lateral and posterior scalp: 1) Lesser Occipital nerves (from ventral ramus of C2) and 2) Greater Occipital nerves (from dorsal ramus of C2).

C. Arterial Supply - very rich

1. branches of Ophthalmic artery: Supratrochlear and Supraorbital arteries (anterior scalp)

2. branches of External Carotid artery - 1) Superficial Temporal artery (to lateral scalp); 2) Posterior Auricular artery (scalp above and posterior to external ear); 3) Occipital artery (posterior scalp).

Clinical note: There are extensive anastomoses between arteries to scalp; scalp wounds can bleed profusely from both sides of cut.

D. Venous drainage - by veins with same names as arteries; **also drain via emissary veins (passing into diploe) into interior of skull.**

Clinical note: Infections can spread from scalp to brain via Emissary veins.

III. **CRANIAL NERVES** - brain is bilaterally symmetrical; cortex is connected to spinal cord by brainstem; outflow/inflow of brain is via cranial nerves; cranial nerves are numbered using Roman numerals:

I. Olfactory - sense of smell

II. Optic - vision

III. Oculomotor - eye muscles

IV. Trochlear - eye muscles

V. Trigeminal - sensory to skin; motor to muscles of mastication (chewing), etc.

VI. Abducens - eye muscles

VII. Facial - motor to muscles of facial expression, etc.; taste to ant. tongue

VIII. Vestibulo-Cochlear - hearing and balance (vestibular apparatus)

IX. Glossopharyngeal - sensory to pharynx

X. Vagus - sensory and motor to larynx (voice box), etc.

XI. Accessory - motor to Trapezius and Sternocleidomastoid

XII. Hypoglossal - motor to muscles of tongue (no sensory)

IV. LANDMARKS AND BONES OF SKULL

A. Views of skull

1. Front of skull

a. Frontal bone – forms forehead, upper margin and roof of orbit

b. Orbit - bones covered in orbit lecture.

c. Zygomatic bones - form cheeks.

d. Maxilla - has sockets for upper teeth (alveolar processes); infraorbital foramen (below orbit).

- e. Nasal apertures (Choanae) - covered superiorly by nasal bones.
- f. Mandible - separate bone; alveolar processes for lower teeth; mental foramen (below second pre-molar tooth).

2. Lateral view

- a. Zygomatic arch - consists of zygomatic bones and zygomatic processes of maxillary and temporal bones.
- b. Temporomandibular joint - joint between head of mandible (upper end of ramus) and temporal bone.
- c. Temporal bone - has parts: 1) mastoid process (inferiorly), 2) squamous (flat) part laterally; 3) tympanic part forms anterior side of external auditory meatus (opening of ear); 4) petrous part is inside skull.
- d. Parietal, Temporal, Frontal and Sphenoid bones form lateral side of cranial cavity.

3. Posterior view of skull

- a. Occipital bone - has Superior and Inferior Nuchal lines; External Occipital protuberance (inion) is raised bump in middle of Superior Nuchal line.

4. Base of skull

- a. Temporal bone - has Styloid process for muscle attachment.
- b. Occipital bone - has Foramen Magnum for spinal cord and vertebral arteries; occipital condyles articulate with vertebra C1 (Atlas).
- c. Palatine bones and palatine process of maxillary bones form hard palate.

B. Individual bones of skull

- 1. Sphenoid bone - "core" of skull - forms part of orbit, lateral side of skull, base of skull, parts of all three cranial fossae.
 - a. Medial and Lateral Pterygoid plates - processes for muscle attachments.
 - b. Spine of Sphenoid - on inferior side of sphenoid for ligament attachment.
 - c. Lesser wing of Sphenoid - in interior of skull, above Superior Orbital fissure.
 - d. Greater wing of sphenoid - extends below Superior Orbital fissure, extends out laterally.
 - e. Sella Turcica (Turkish saddle) - depression above body of sphenoid (central part) between Anterior and Posterior Clinoid processes; pituitary gland is located in

Sella Turcica.

f. Clivus - central part of sphenoid that extends down to Posterior Cranial Fossa.

Clinical Note: **Parts of Sphenoid bone are important landmarks in Neurology.**

V. **CRANIAL CAVITY** - divided into depressions or fossae that are functionally related to parts of brain and facial skeleton.

- A. Anterior cranial fossa - related to roof of nasal cavity (also forms roof of orbit).
 - 1. Bones - Frontal, Ethmoid and Sphenoid bones.
 - 2. contains Olfactory bulbs and Frontal lobes of cortex.
 - 3. Foramina - in cribriform plate of ethmoid bone conduct branches (filia olfactoria) of olfactory nerve (CNI).

- B. Middle cranial fossa - related to orbit, nasal cavity and face.
 - 1. Bones - Sphenoid, Temporal and Parietal bones.
 - 2. contains - Pituitary gland, Temporal lobes of cortex and cranial nerves from rostral brainstem.
 - 3. Foramina - for nerves to orbit (Optic nerve and nerves to eye muscles), nasal cavity and face (CNII-CNVI).

- C. Posterior cranial fossa - related to face oral cavity, neck.
 - 1. Bones - Sphenoid, Temporal, Parietal and Occipital bones.
 - 3. contains - lower brainstem and cerebellum; Petrous part of Temporal bone contains cochlea (hearing) and semicircular canals (gravity).
 - 4. Foramina - for nerves to face, oral cavity (also taste), muscles of tongue and neck (CNVII-CN XII); Foramen Magnum transmits Spinal Cord and Vertebral arteries.

CHECKLIST OF FEATURES AND BONES OF SKULL TO IDENTIFY

Coronal suture - between Frontal and Parietal bones

Sagittal suture - between Parietal bones

Lambdoidal suture - between Parietal and Occipital bones

Bregma - midpoint of Coronal Suture

Lambda - midpoint of Lambdoidal suture

Pterion - junction of Sphenoid, Temporal, Parietal and Frontal bones (fracture - **Epidural Hematoma**)

Anterior Fontanelle - located at Bregma

Posterior Fontanelle - located at Lambda

Lateral Fontanelle - located at Pterion

Diploe - spongy bone in calvarium between hard inner and outer tables

Zygomatic arch - zygomatic bones and zygomatic processes of maxillary and temporal bones

Temporomandibular joint - joint between head of mandible and mandibular fossa of temporal bone

Mastoid process - inferior part of temporal bone posterior to external auditory meatus

Squamous part of Temporal bone - lateral part, contributes to calvarium

Tympanic part of Temporal bone - anterior to external auditory meatus

Petrous part of Temporal bone - hard, inside cranial cavity (contains cochlea, semicircular canals)

Superior and Inferior nuchal lines - raised ridges on posterior surface of Occipital bone

External Occipital protuberance - raised midline bump in Superior Nuchal line

Bony palate - palatine bones, palatine process of maxillary bones

Medial Pterygoid plates - inferior projection of Sphenoid bone for muscle attachment (has hamulus (hook) for Tensor Palati muscle)

Lateral Pterygoid plates - inferior projection of Sphenoid bone for muscle attachment (Pterygoid muscles)

Spine of Sphenoid - inferior projection for ligament attachment

Lesser wing of Sphenoid - smaller part of Sphenoid Superior to Superior orbital fissure

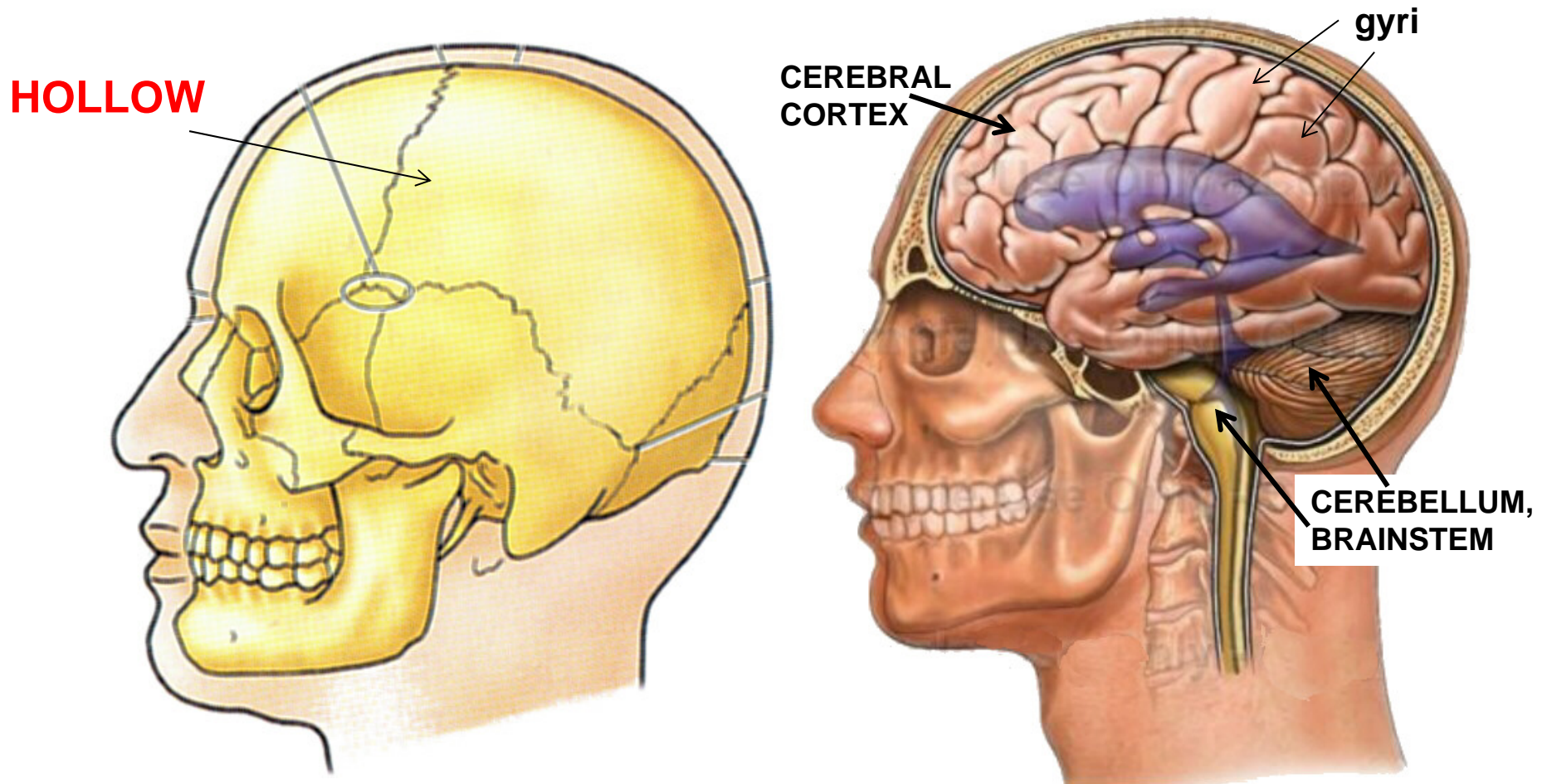
Greater wing of Sphenoid - larger part of Sphenoid, extends laterally

Sella Turcica - depression above body of sphenoid (contains pituitary gland)

Anterior and Posterior Clinoid processes - anterior and posterior projections around sella turcica

Clivus - central part of sphenoid extending into Posterior Cranial Fossa

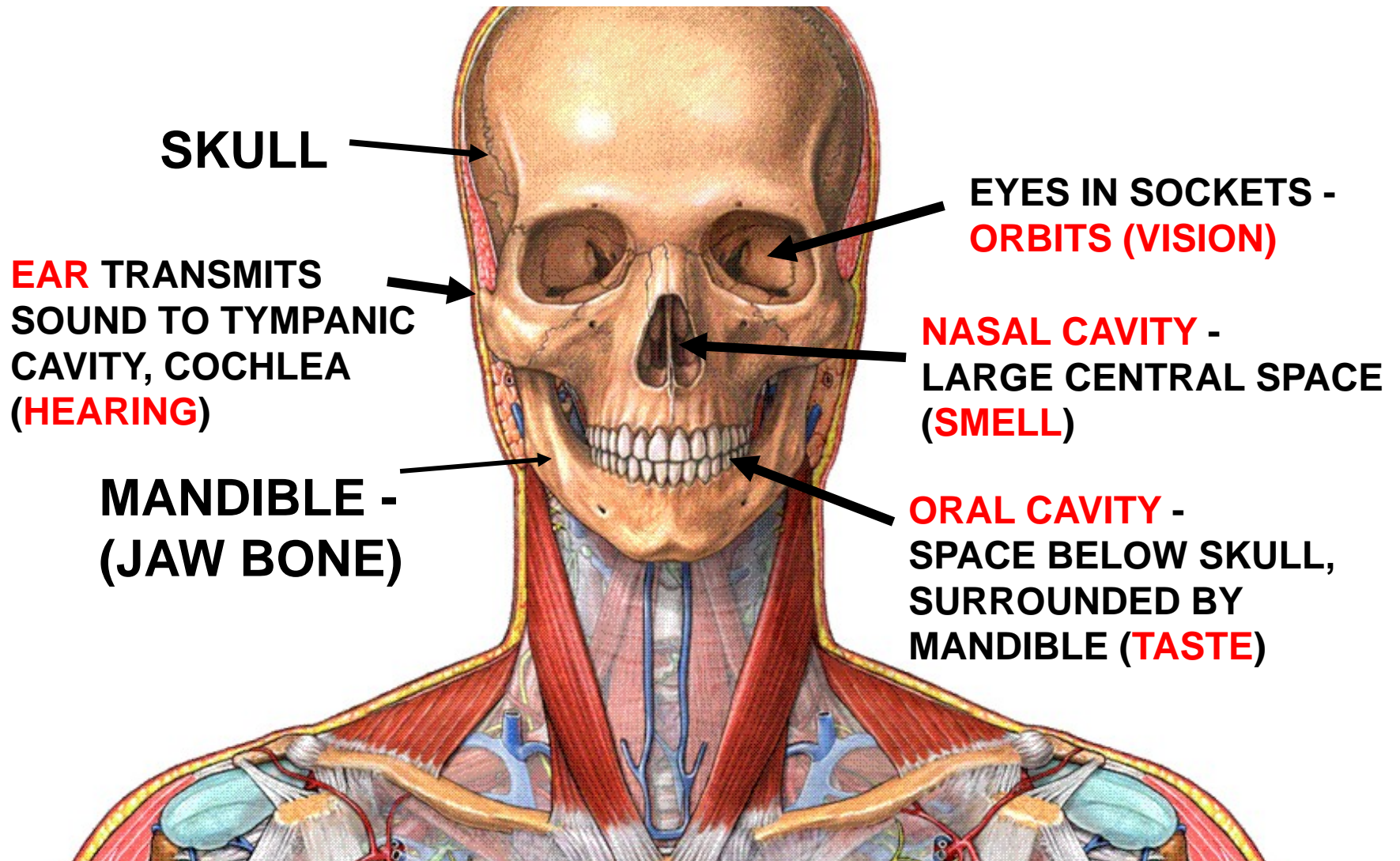
SKULL: HEAD IS SPECIALIZED TO HOUSE AND PROTECT THE BRAIN



ANATOMY OF SKULL IS COMPLEX; CLOSELY ASSOCIATED WITH AND CONTAINS BRAIN INSIDE CRANIAL CAVITY

note: Brain is in cranial cavity; cavity molded to brain like glove fitting hand; THERE IS NO OTHER ROOM INSIDE CRANIAL CAVITY

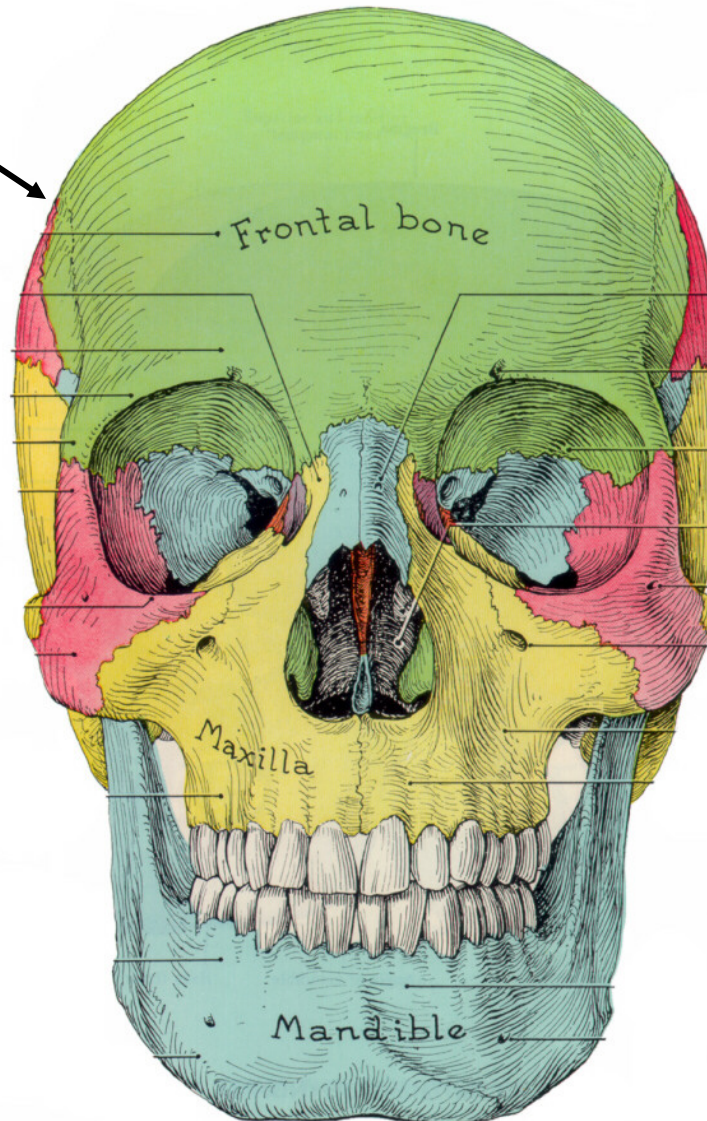
SKULL IS DESIGNED TO CONTAIN SPECIAL SENSES



HEAD AND NECK IS COMPLEX, IN PART, BECAUSE SPECIAL SENSES ARE LOCATED IN HEAD: **VISION, TASTE, SMELL, HEARING (EQUILIBRIUM)**; **THESE STRUCTURES ARE INNERVATE BY CRANIAL NERVES**

SKULL - bones rigidly connected by sutures to protect brain, attach move eyes

Sutures
Look like
Cracks
In
Bone



OUTLINE

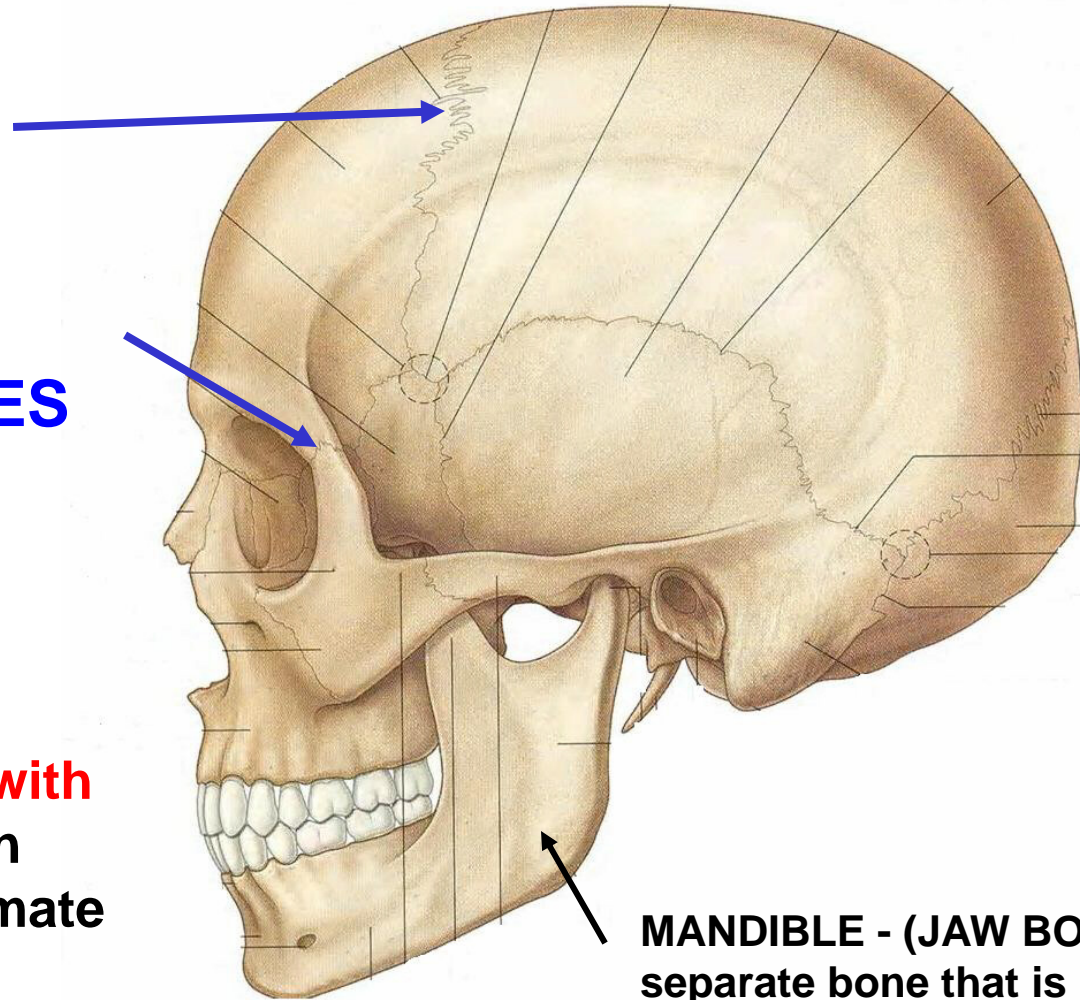
- I. CALVARIUM
- II. SCALP
- III. CRANIAL NERVES
- IV. LANDMARKS/ BONES OF SKULL
- V. CRANIAL CAVITY

Foramina covered in
Skull sessions

SKULL- bones rigidly connected by sutures to protect brain; also provides attachment to move eyes precisely

**SUTURES =
FIBROUS
CONNECTIVE
TISSUE JOINTS
BETWEEN BONES
(LOOK LIKE
CRACKS)**

Note: Sutures progressively fuse with age; extent of fusion can be used to estimate age of skull.

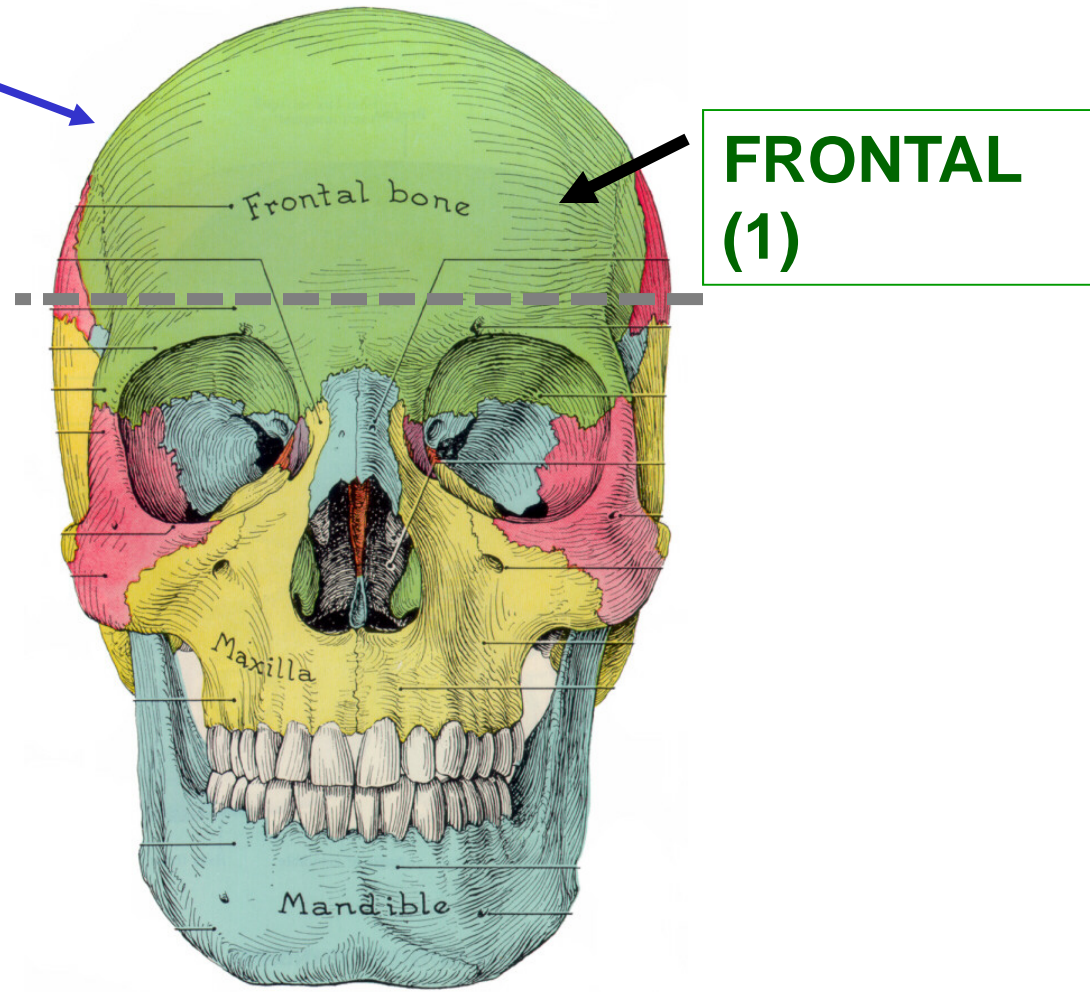


**MANDIBLE - (JAW BONE) -
separate bone that is
moveable**

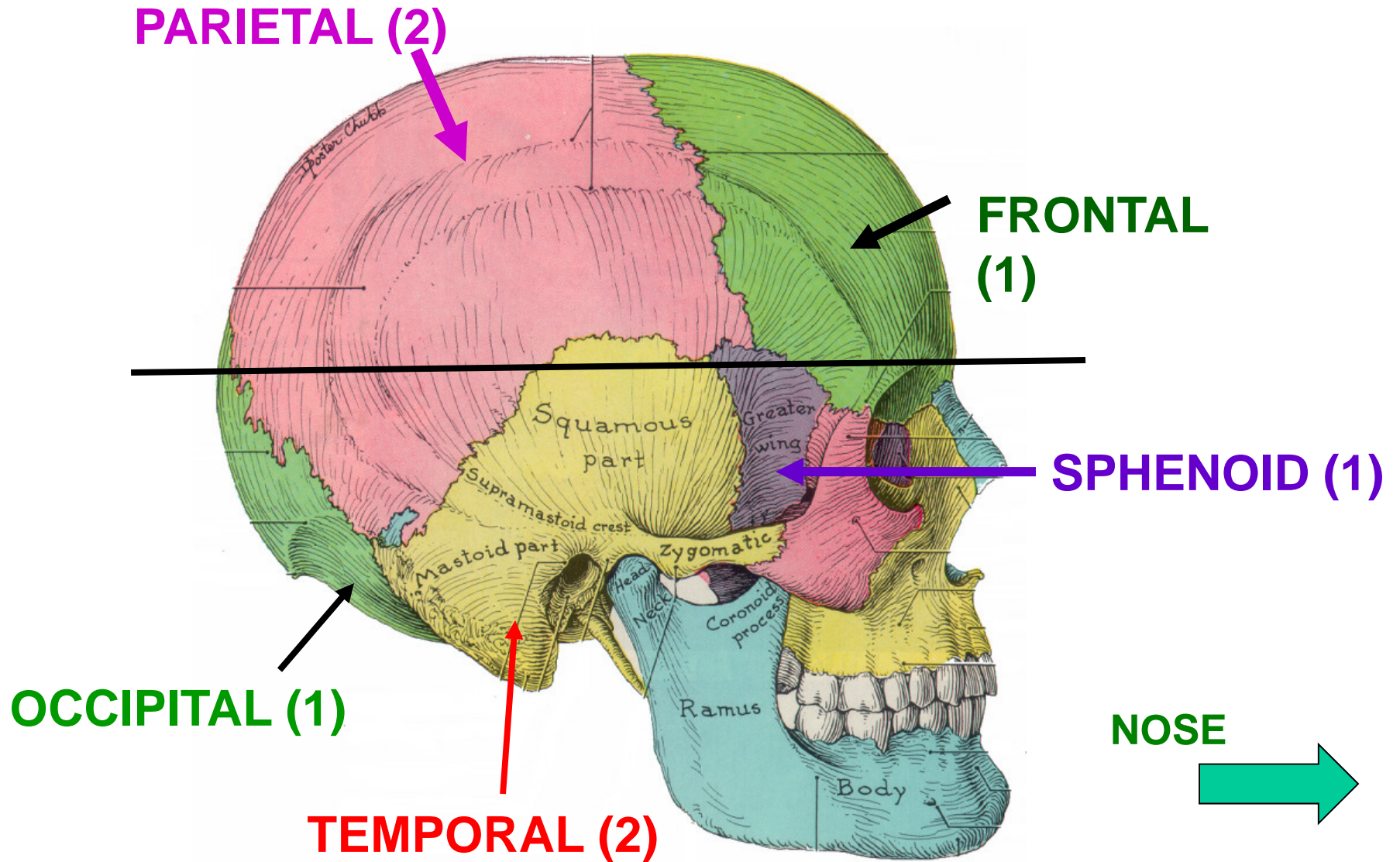
SKULL - bones rigidly connected by sutures to protect brain, attach move eyes

I. CALVARIUM = SKULL CAP -

Consists of
bones linked
by sutures

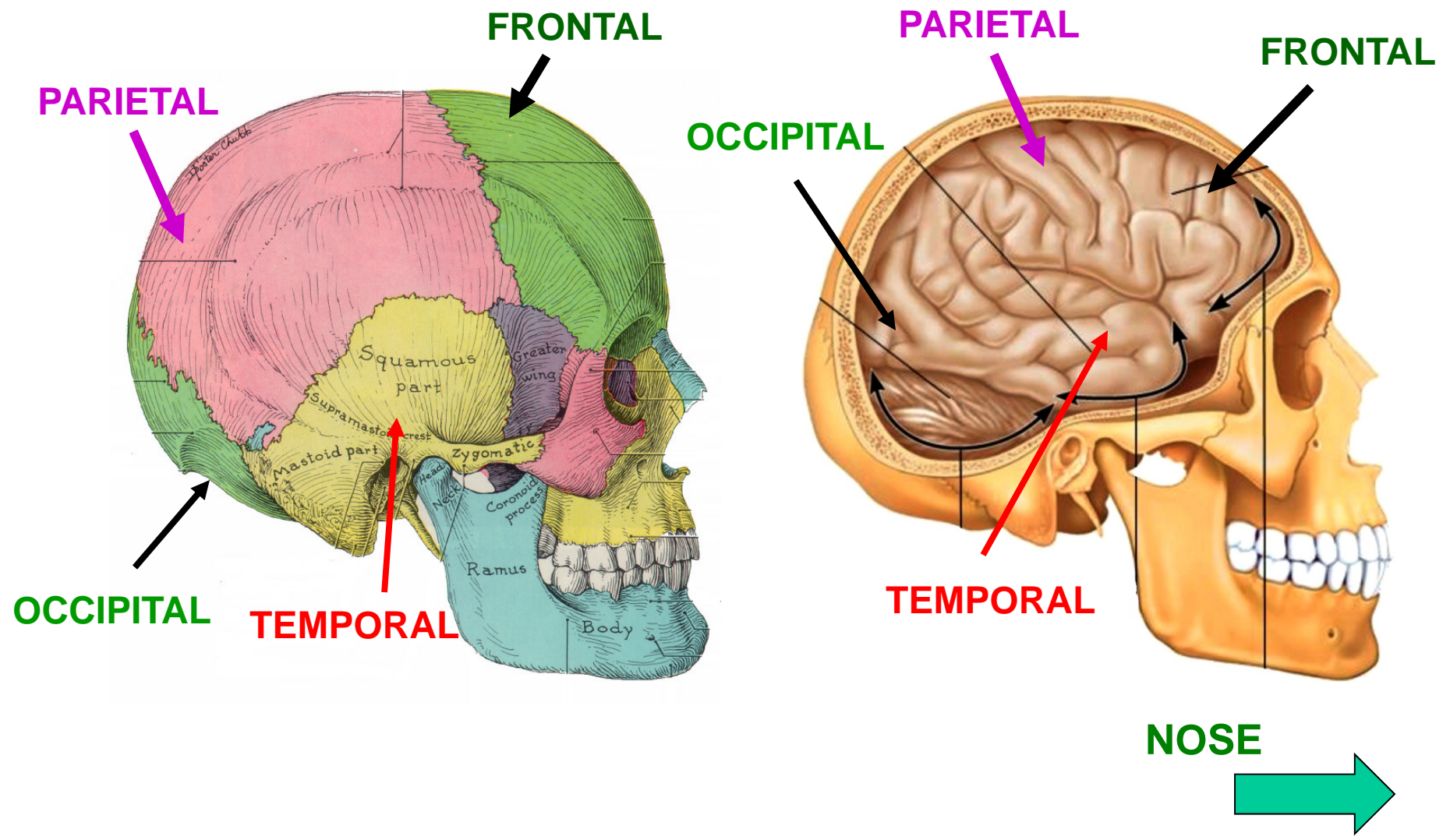


BONES OF CALVARIUM = SKULL CAP



SPHENOID (Gk) = wedge

LOBES OF CEREBRAL CORTEX OF BRAIN ARE NAMED FOR BONES OF SKULL

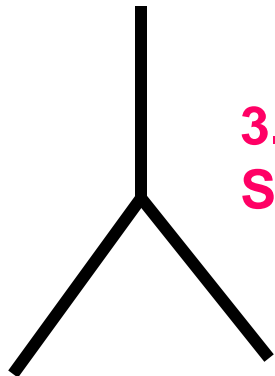


B. SUTURES

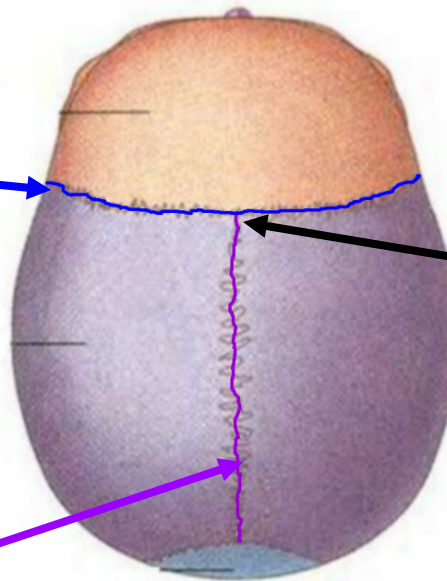
1. CORONAL SUTURE

2. SAGITTAL SUTURE

3. LAMBDOIDAL SUTURE



LAMBDA -
Greek letter



C. LANDMARKS

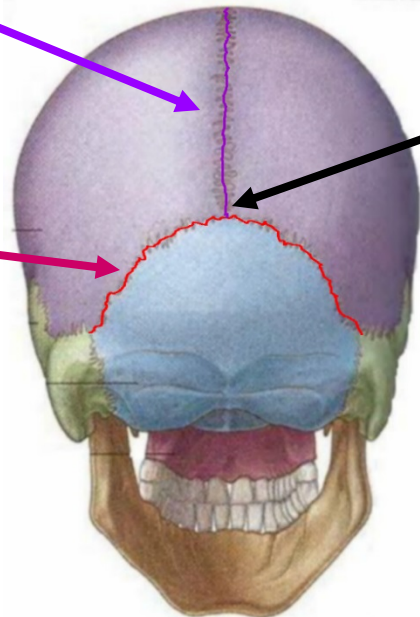
**

1. **BREGMA** - MID
POINT OF CORONAL
SUTURE

superior (top) view

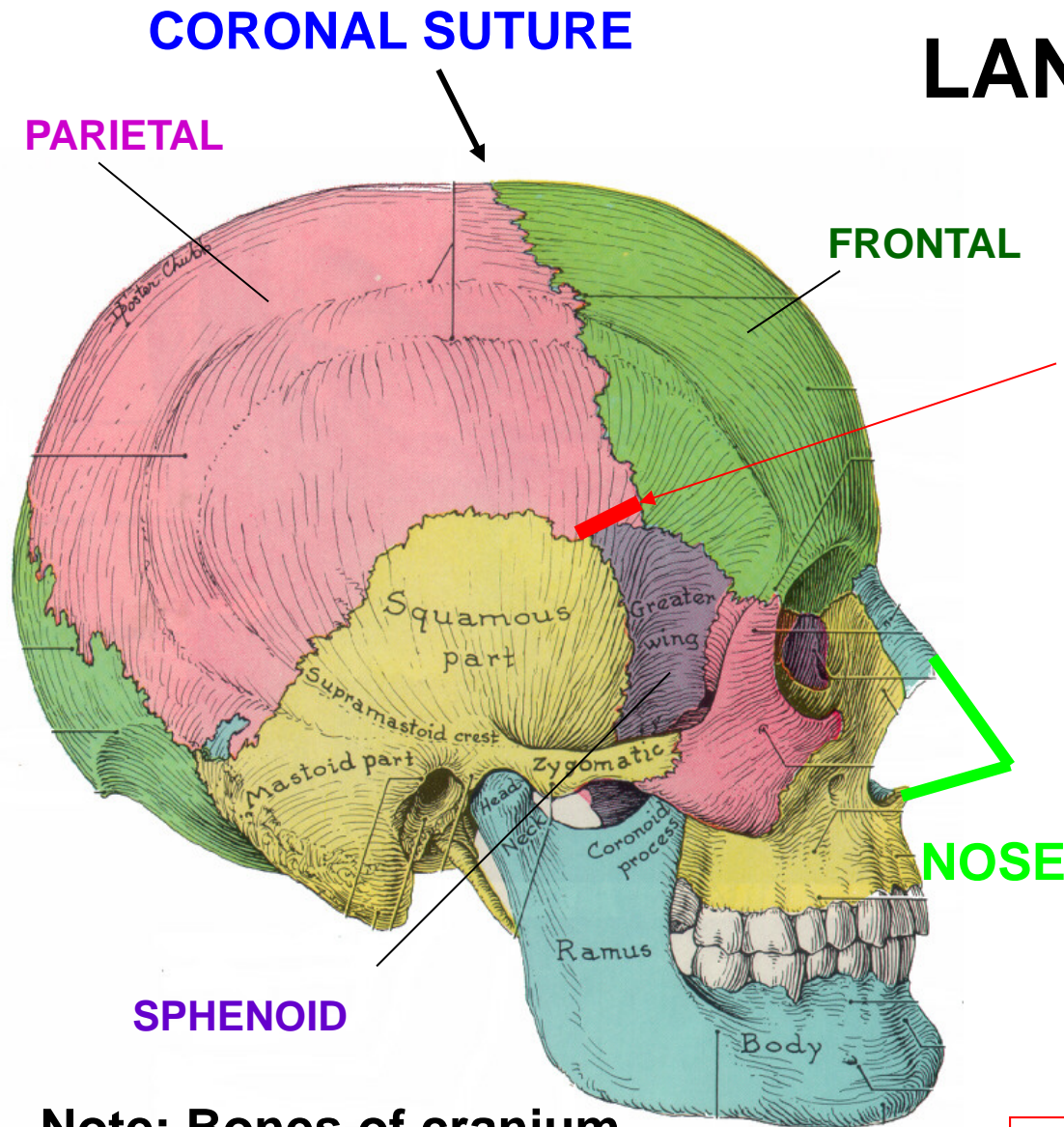
**

2. **LAMBDA** - MID
POINT OF
LAMBDOIDAL
SUTURE



posterior (back) view

LANDMARKS



3. PTERION **

- JUNCTION OF
TEMPORAL SPHENOID
PARIETAL AND FRONTAL
BONES

PIC THANKS TO DR. ALBERICO



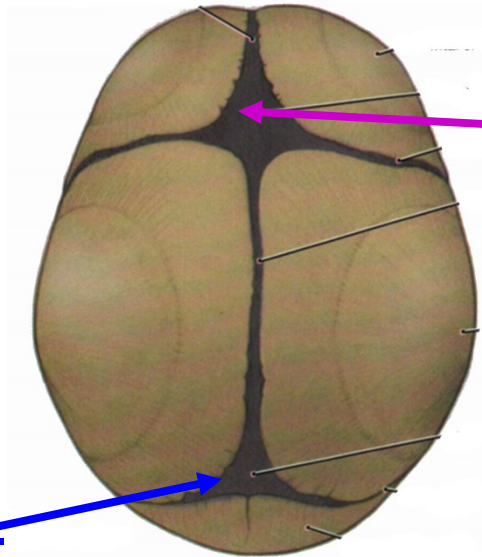
**Note: Bones of cranium
fuse (sutures disappear)
with age)**

**Note: Skull fractures in region
of pterion clinically important
(Epidural Hematoma)**

D. FONTANELLES - Membranes that link bones at birth

- FONTANELLES ('soft spots') PERMIT CRANIAL COMPRESSION AT BIRTH - CRANIAL GROWTH

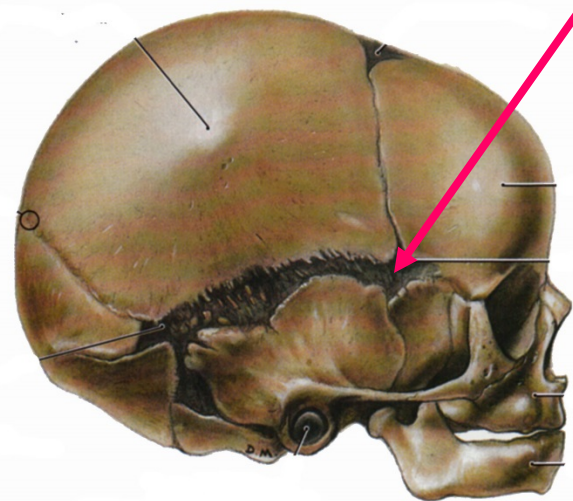
2. POSTERIOR FONTANELLE - AT LAMBDA



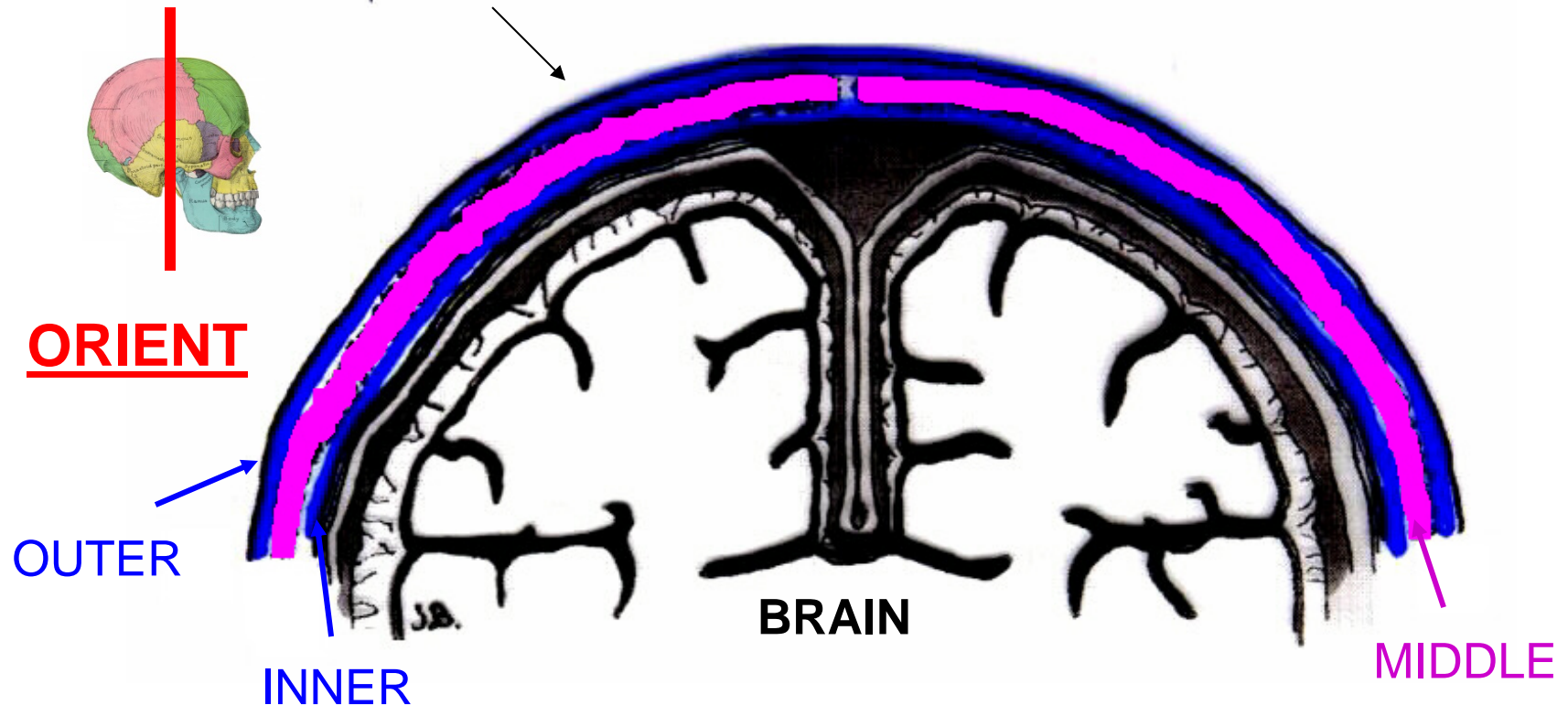
1. ANTERIOR FONTANELLE AT BREGMA

3. LATERAL FONTANELLE AT PTERION

Note: Anterior Fontanelle can be used to access Superior Sagittal venous sinus in neonates



E. INTERNAL STRUCTURE OF CALVARIUM



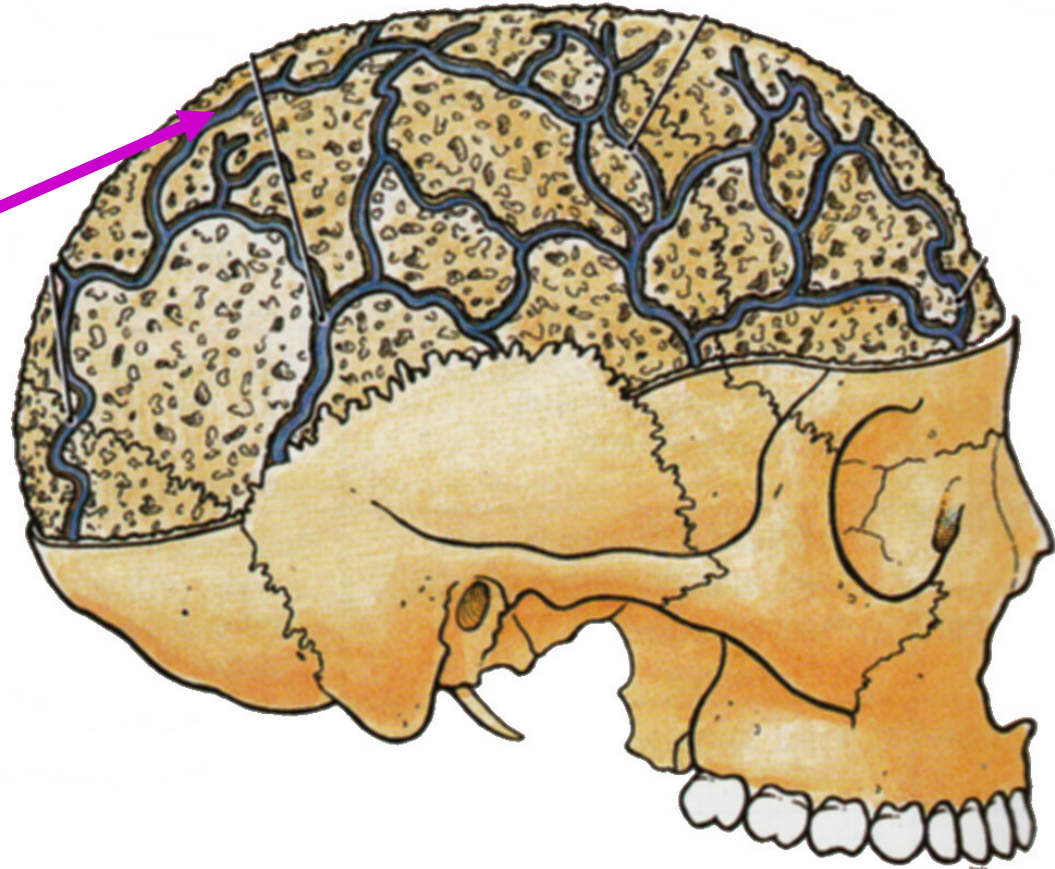
1. INNER AND OUTER TABLES - HARD CORTICAL BONE

MIDDLE LAYER - SOFT SPONGY BONE CALLED DIPLOE (= DOUBLE IN GREEK)

2. DIPLOIC VEINS

view when outer table of bone is partially removed

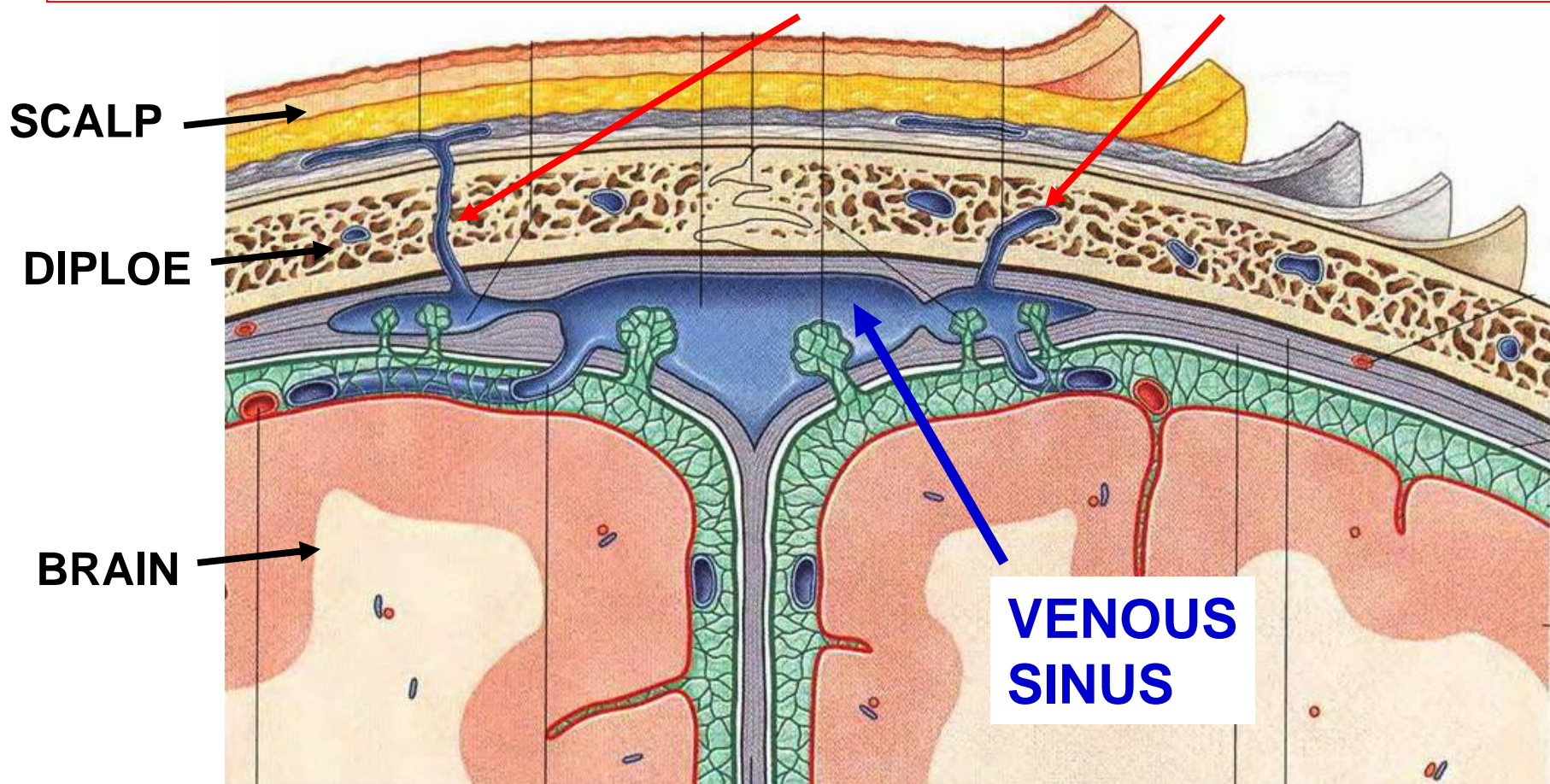
**COURSE IN
DIPLOE -
CONNECT BOTH
TO CRANIAL
CAVITY AND
SURFACE OF
SKULL**



**- CAN TRANSMIT INFECTION FROM SCALP TO
BRAIN VIA EMISSARY VEINS**

EMISSARY VEINS

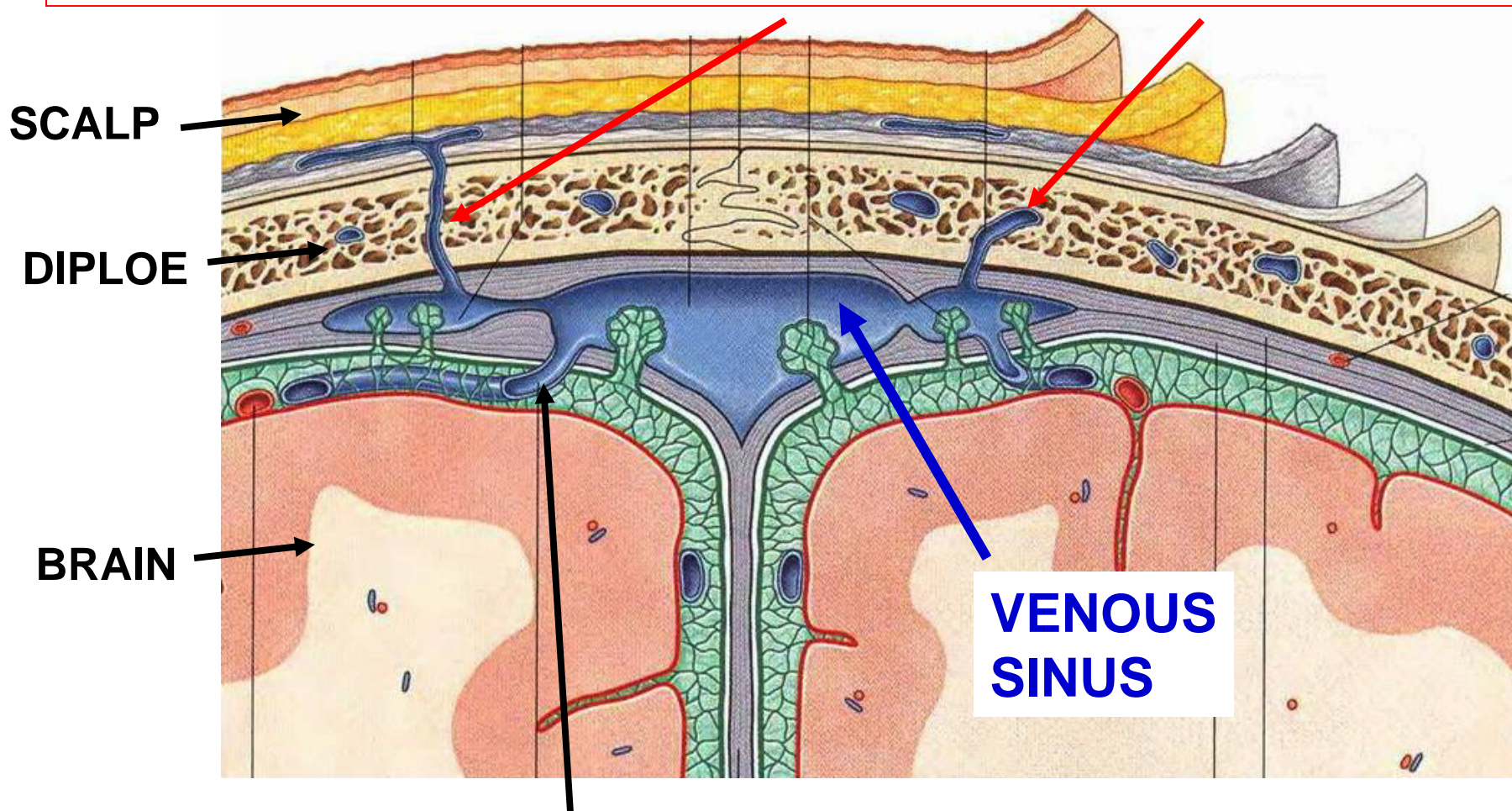
EMISSARY VEIN - SCALP TO DIPLOE, SCALP TO SINUS, DIPLOE TO SINUS



note: Emissary vein – connect 'outside' to venous sinus

EMISSARY VEINS VS BRIDGING VEINS

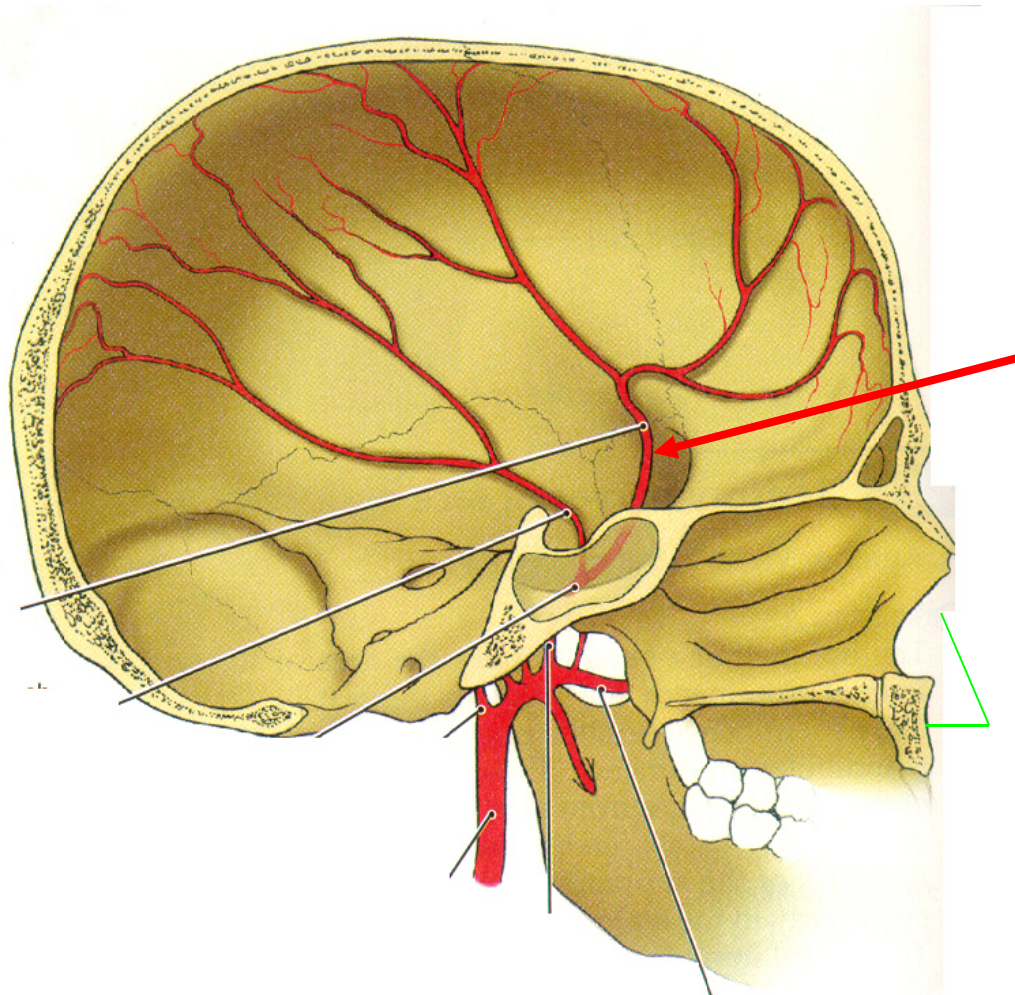
EMISSARY VEIN - SCALP TO DIPLOE, SCALP TO SINUS, DIPLOE TO SINUS



BRIDGING VEIN - SURFACE OF BRAIN (CEREBRAL VEIN) TO VENOUS SINUS

note: Emissary vein - 'outside' to sinus; Bridging vein - brain (inside) to sinus

F. BLOOD SUPPLY TO CALVARIUM



1) OUTER SURFACE –
ARTERIES TO SCALP

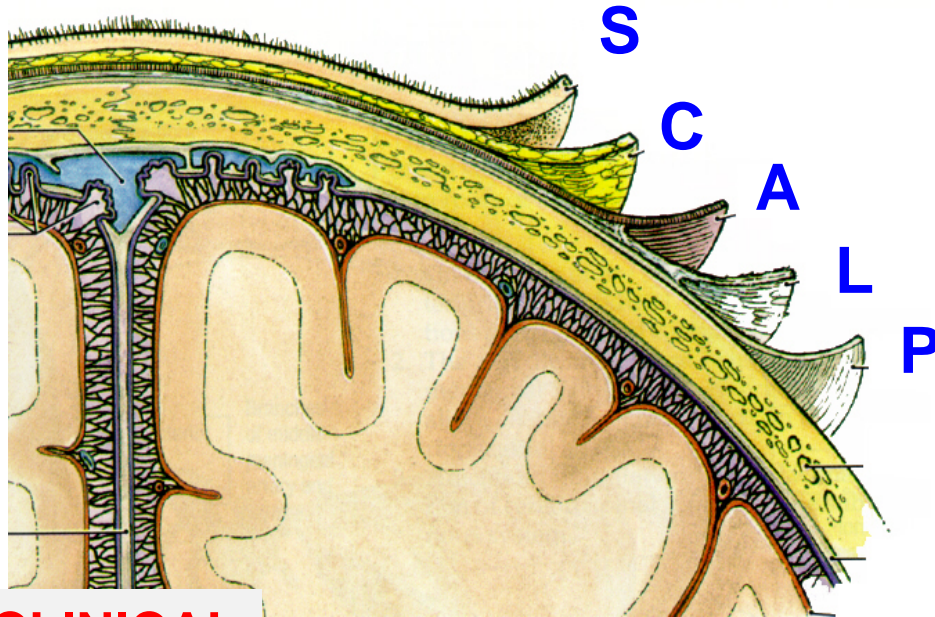
2) INNER SURFACE-
MENINGEAL ARTERIES

COURSE NEXT TO BONE;
MISNAMED - SOUND
LIKE SUPPLY MENINGES
- MOST BLOOD TO
BONES

Note: Skull fracture can cause bleeding of Meningeal arteries – EPIDURAL HEMATOMA

II. SCALP A. LAYERS

mnemonic - layers spell SCALP



CLINICAL

Clinical note: Infections can readily spread through loose areolar layer deep to epicranial aponeurosis. **

1. S **SKIN** – HAIR, SWEAT AND SEBACEOUS GLANDS
2. C **CONNECTIVE TISSUE** – SURROUND ARTERIES, VEINS (ORIGIN OF EMISSARY VEINS)
3. A **EPICRANIAL APONEUROSIS** – TENDINOUS SHEET, ATTACHES TO SCALP MUSCLES; MOVEABLE ANTERIOR AND POSTERIOR; LATERAL ATTACHES TO TEMPORALIS FASCIA
4. L **LOOSE AREOLAR TISSUE**- LOOSELY CONNECTS APONEUROSIS AND PERIOSTEUM CROSSED BY EMISSARY VIENS
5. P **PERIOSTEUM (PERICRANIUM) CT LAYER ON OUTER SIDE OF CALVARIUM**

SCALPING SOMEONE: REMOVE SCALP BETWEEN 3

(EPICRANIAL APONEUROSIS) AND 4 (LOOSE AREOLAR TISSUE);

Note: SAVING SCALP AS SOUVENIR - not done in civilized societies (including medical students)

B. NERVES OF SCALP- BRANCHES OF TRIGEMINAL (V) AND CERVICAL SPINAL NERVES

TRIGEMINAL

V1- SUPRAORBITAL N.
SUPRATROCHLEAR N.

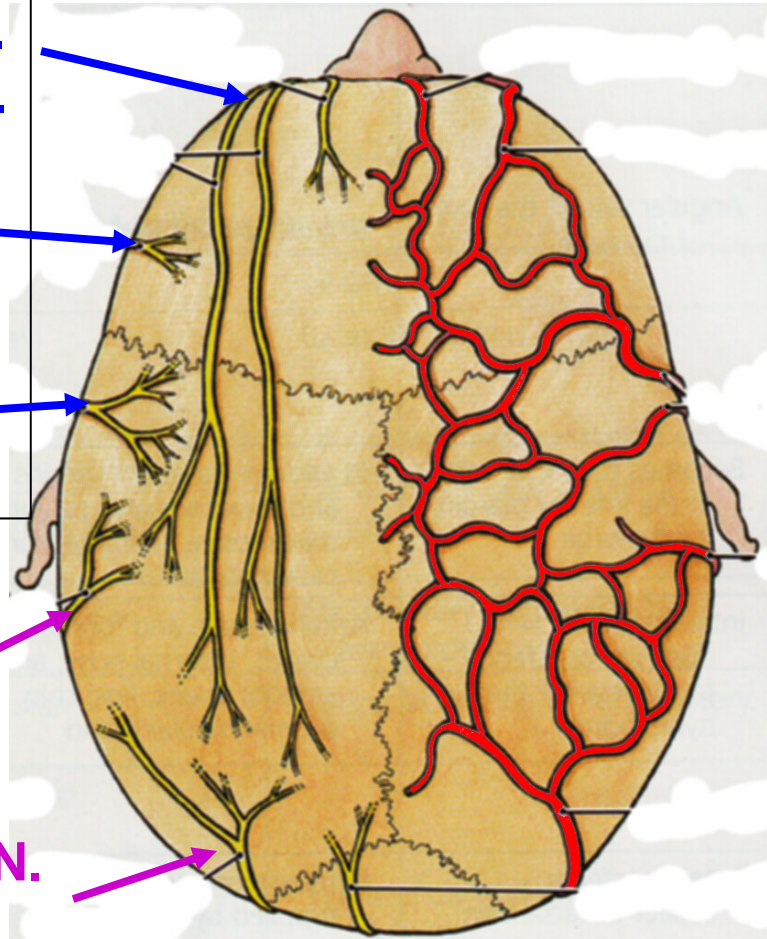
V2 – ZYGOMATICO-
TEMPORAL N.

V3 – AURICULO-
TEMPORAL N.

LESSER OCCIPITAL
N. - C2 VENTRAL
RAMUS

GREATER OCCIPITAL N.
- C2 DORSAL RAMUS

NOSE



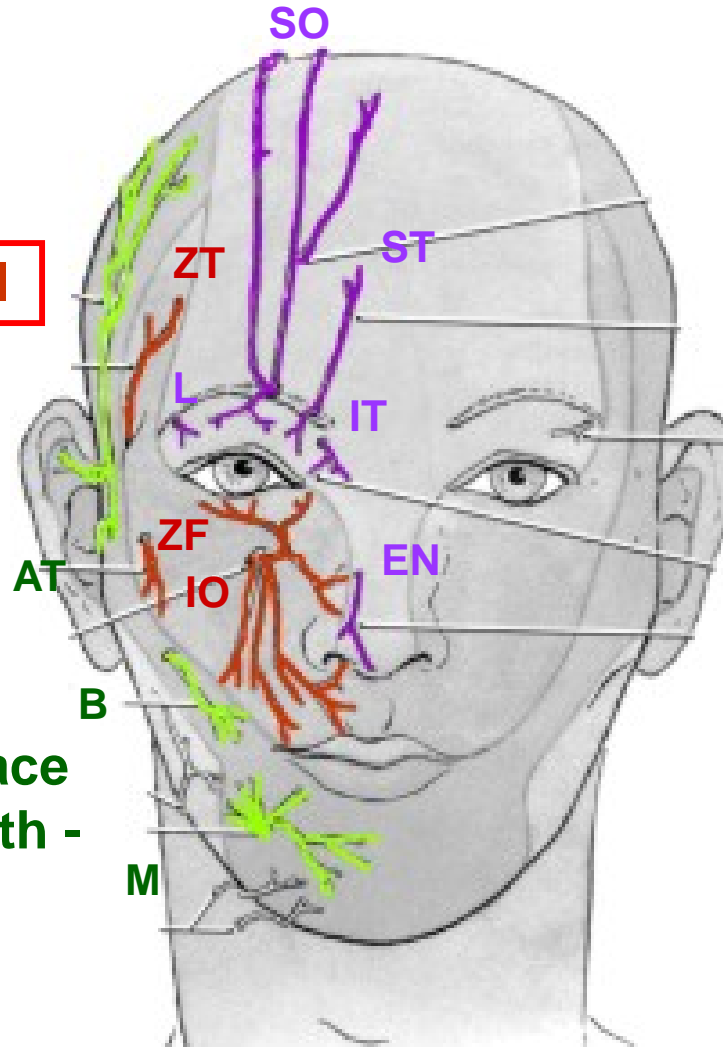
FACE LECTURE: SENSORY SUPPLY - BRANCHES OF TRIGEMINAL NERVE TO FACE

V2 – MAXILLARY -
to skin of cheek
below orbit -

Zygomatotemporal
Zygomatofacial
Infraorbital

V3- MANDIBULAR -
to skin of jaw and face
below angle of mouth -

Auriculotemporal
Buccal
Mental



NOTE: These are branches of V to face, not ALL branches of V

V1 – OPHTHALMIC -
to skin above orbit -
Lacrimal

Supraorbital
Supratrochlear
Infratrochlear
External Nasal Nerve

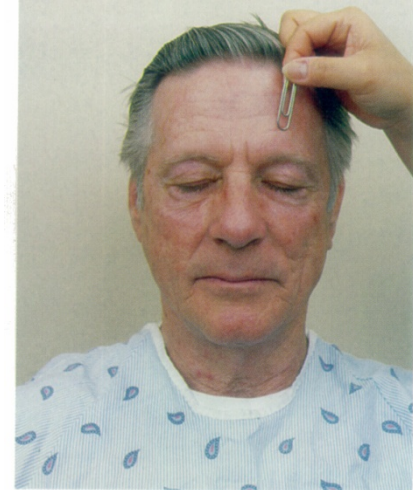
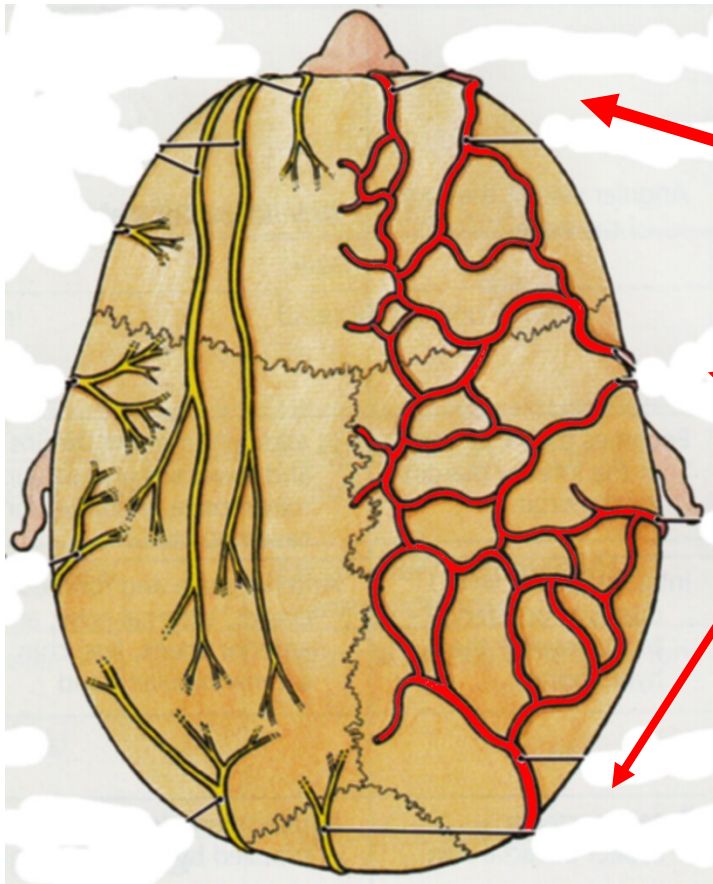


FIGURE 21-13
Examination of the trigeminal cranial nerve

**CLINICAL TEST OF V:
SUPRAORBITAL N.**

C. ARTERIES OF SCALP

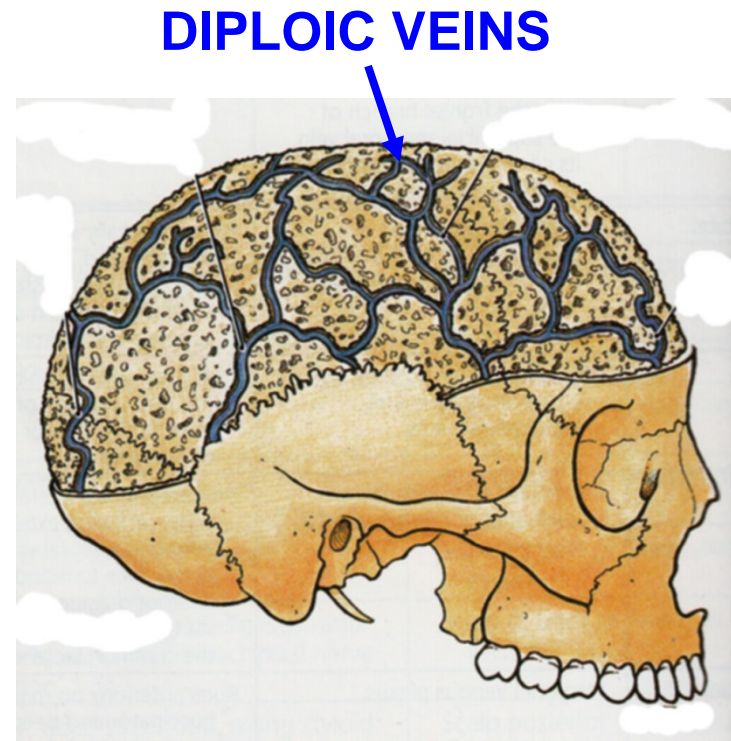
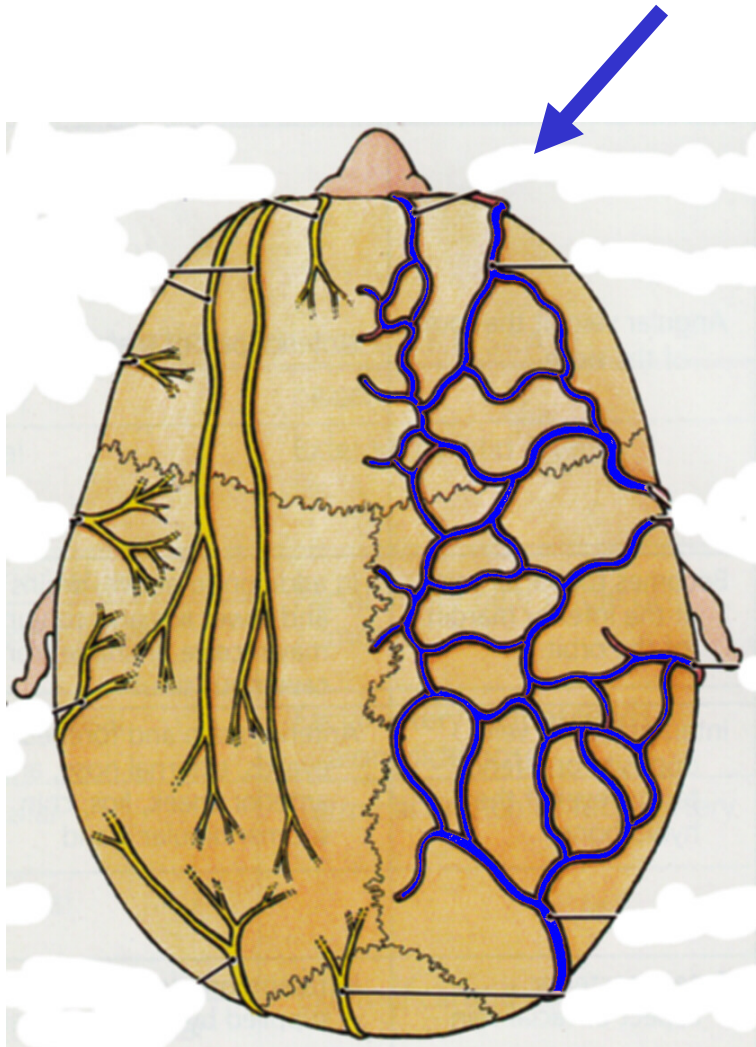
- RICH SUPPLY FROM BRANCHES OF INTERNAL AND EXTERNAL CAROTID; EXTENSIVE ANASTOMOSES - SCALP WOUND BLEEDS PROFUSELY FROM BOTH SIDES OF CUT



1. br. of OPHTHALMIC:
SUPRAORBITAL A.,
SUPRATROCHLEAR A

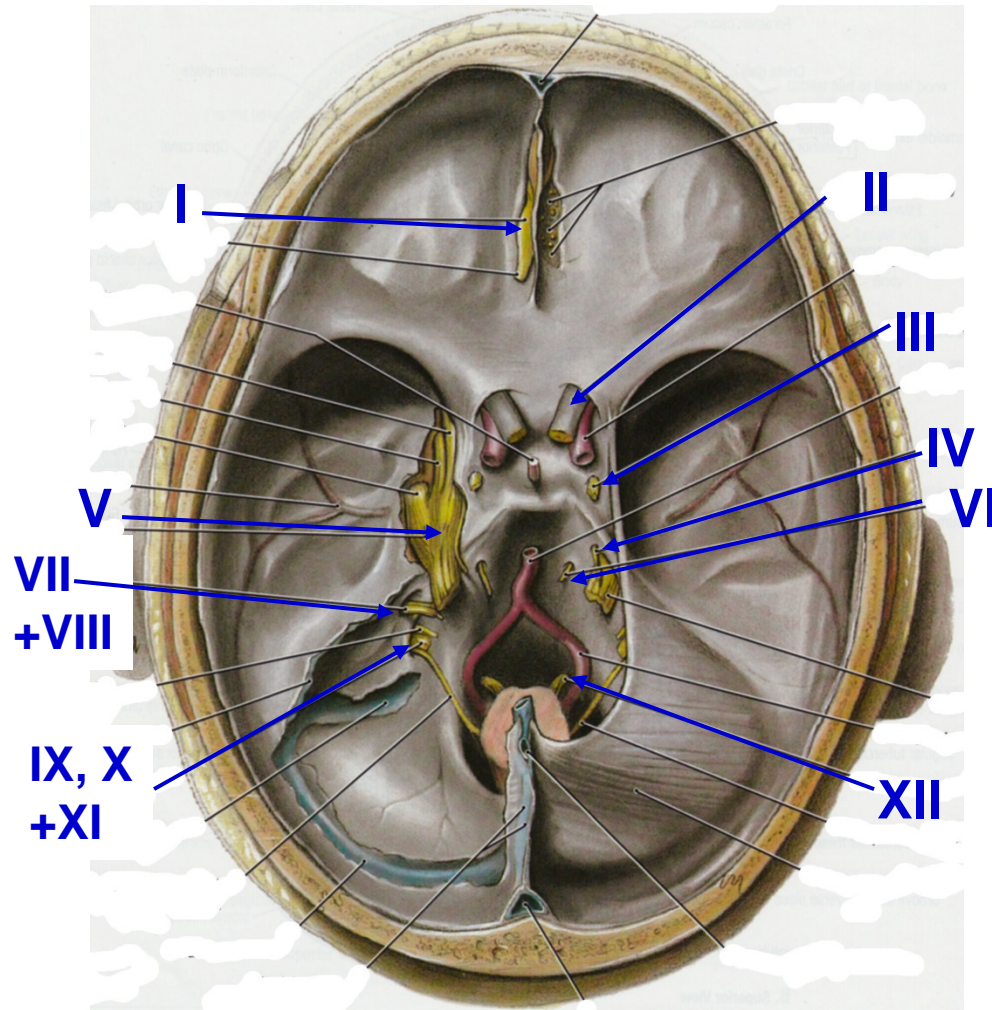
2. br. of EXTERNAL CAROTID:
SUPERFICIAL TEMPORAL A.,
POSTERIOR AURICULAR A.,
OCCIPITAL A.

D. VEINS OF SCALP – SAME NAMES AS ARTERIES



**ALSO EMISSARY
VEINS drain to
DIPLOIC VEINS IN
DIPLOE**

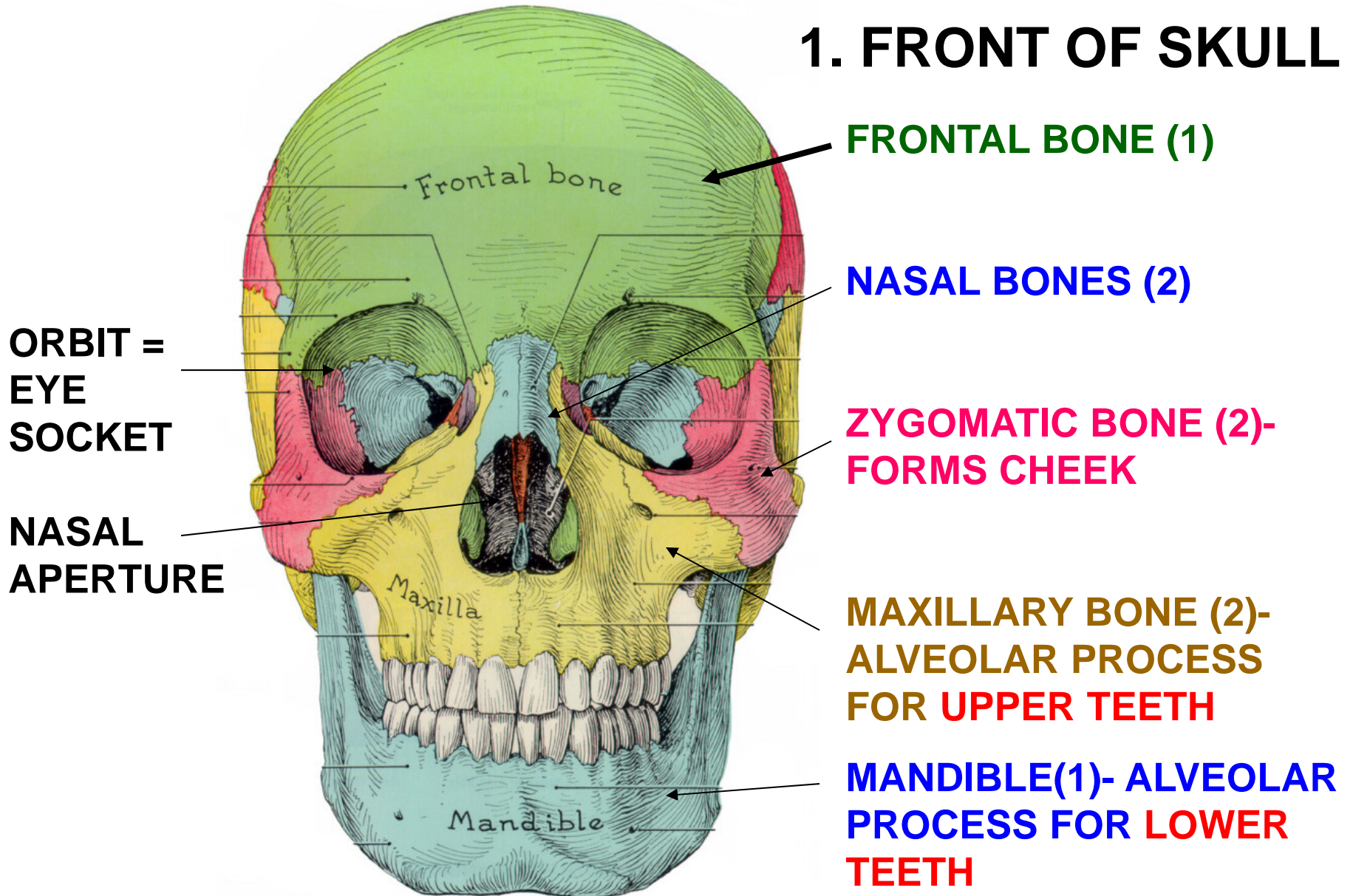
CRANIAL NERVES



- I. OLFACTORY - sense of smell
- II. OPTIC - vision
- III. OCULOMOTOR - eye movement
- IV. TROCHLEAR - eye movement
- V. TRIGEMINAL - touch, general sensation to skin, oral cavity, nasal cavity + more
- VI. ABDUCENS - eye movement
- VII. FACIAL - muscles of facial expression + lots more
- VIII. VESTIBULO-COCHLEAR - hearing and balance
- IX. GLOSSOPHARYNGEAL - sensory to pharynx + more
- X. VAGUS - larynx, pharynx + rest of body
- XI. ACCESSORY - sternocleidomastoid, trapezius
- XII. HYPOGLOSSAL - muscles of tongue

II. LANDMARKS AND BONES

1. FRONT OF SKULL



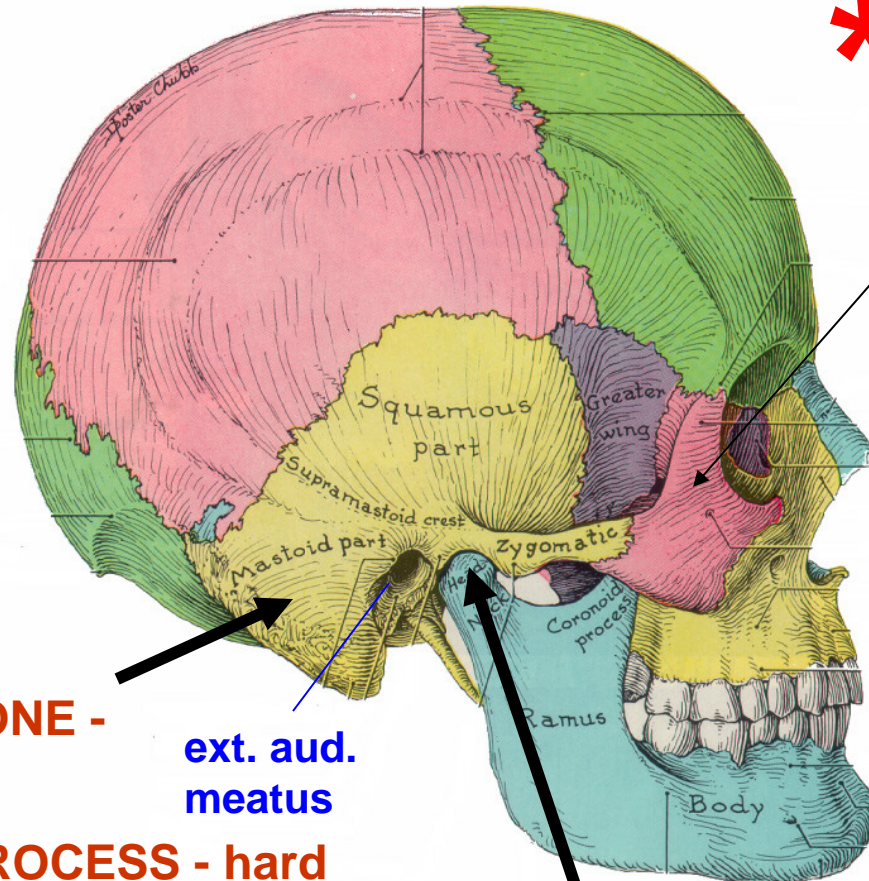
2. LATERAL VIEW OF SKULL



CLINICAL - fractures

ZYGOMATIC ARCH-

- 1) ZYGOMATIC BONE**
- 2) MAXILLARY BONE-
ZYGOMATIC PROCESS**
- 3) TEMPORAL BONE-
ZYGOMATIC PROCESS**



TEMPORAL BONE -

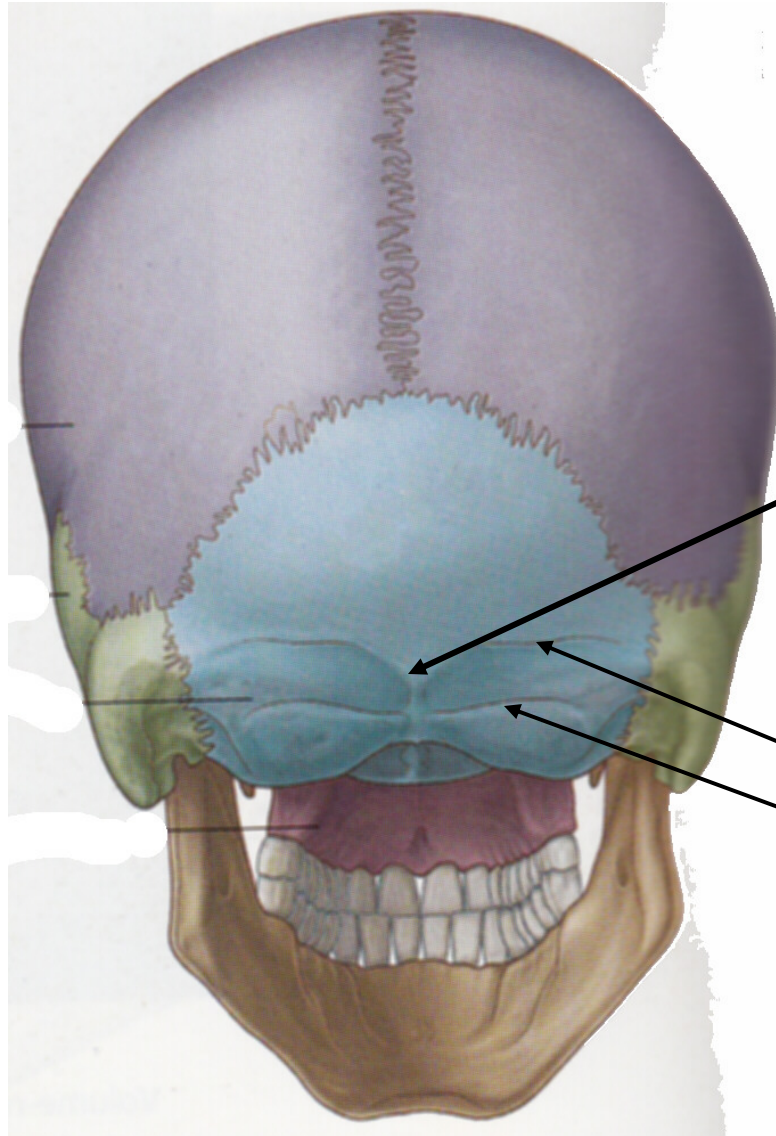
PARTS

- 1) MASTOID PROCESS - hard**
- 2) SQUAMOUS PART- flat**
- 3) TYMPANIC PART - ANT. TO
EXTERNAL AUDITORY
MEATUS**
- 4) PETROUS PART – inside
skull**

**ext. aud.
meatus**

**TEMPORO-MANDIBULAR JOINT-
FROM RAMUS OF MANDIBLE**

3. POSTERIOR VIEW OF SKULL

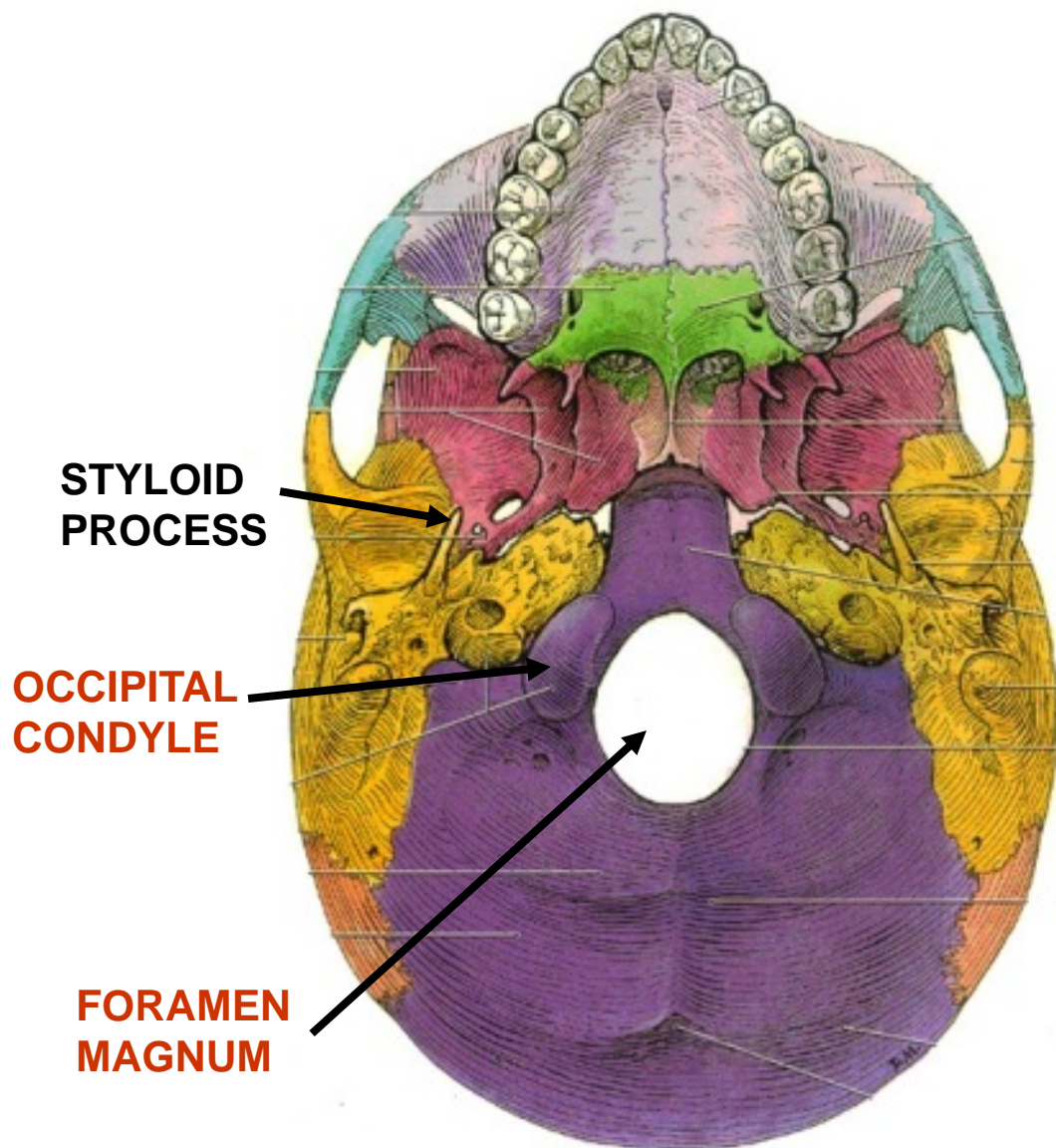


OCCIPITAL BONE

**EXTERNAL OCCIPITAL
PROTUBERANCE**

**SUPERIOR AND
INFERIOR
NUCHAL LINES**

4. BASE OF SKULL - COMPLEX



C) HARD PALATE-
PALATINE BONES AND
PALATINE PROCESS OF
MAXILLARY BONES

A) TEMPORAL BONE-
HAS STYLOID
PROCESS- MUSCLE
ATTACH

B) OCCIPITAL BONE-
HAS FORAMEN
MAGNUM - SPINAL
CORD; OCCIPITAL
CONDYLES- FOR C1-
ATLAS

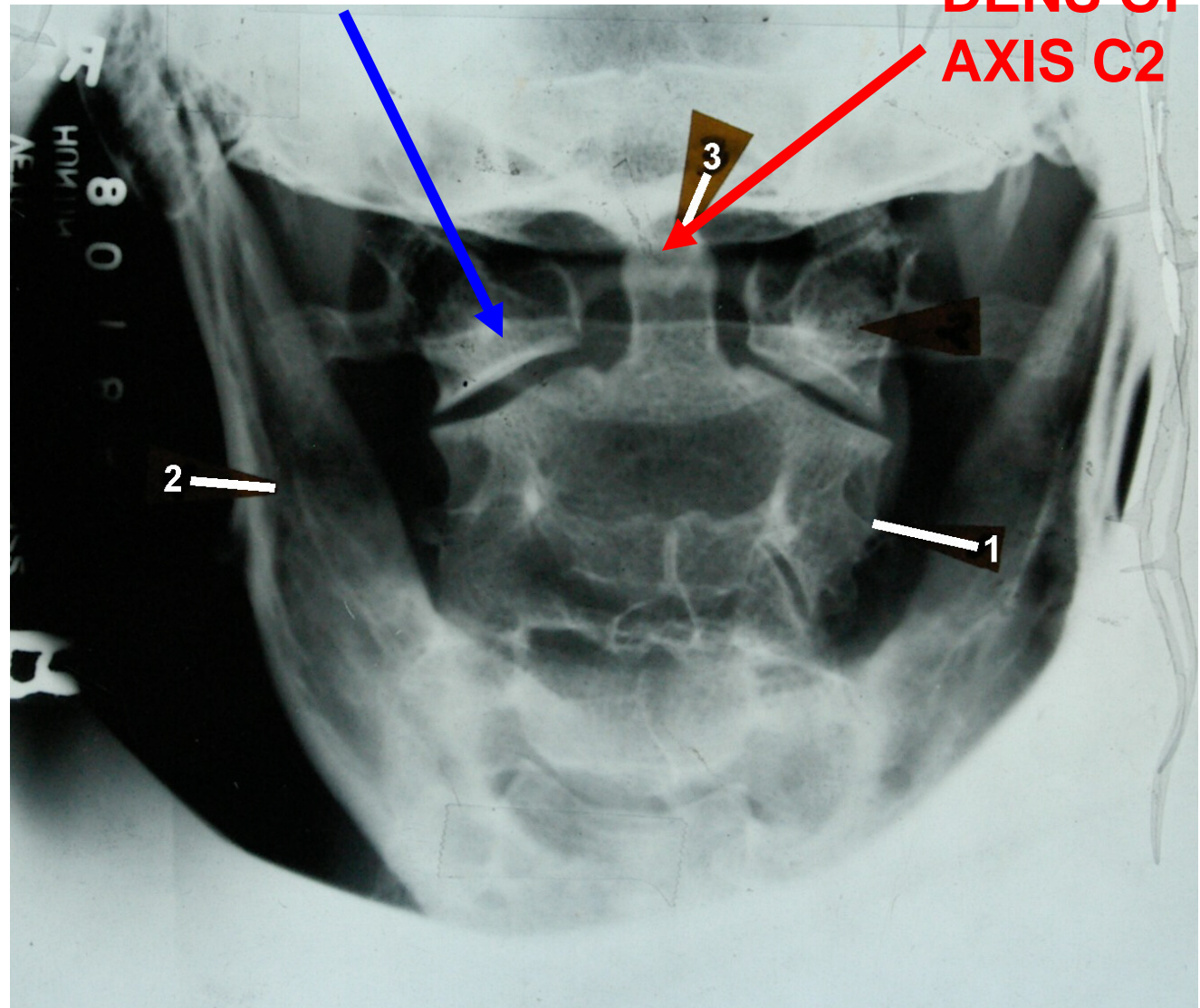
AP view

ATLAS C1

DENS OF
AXIS C2

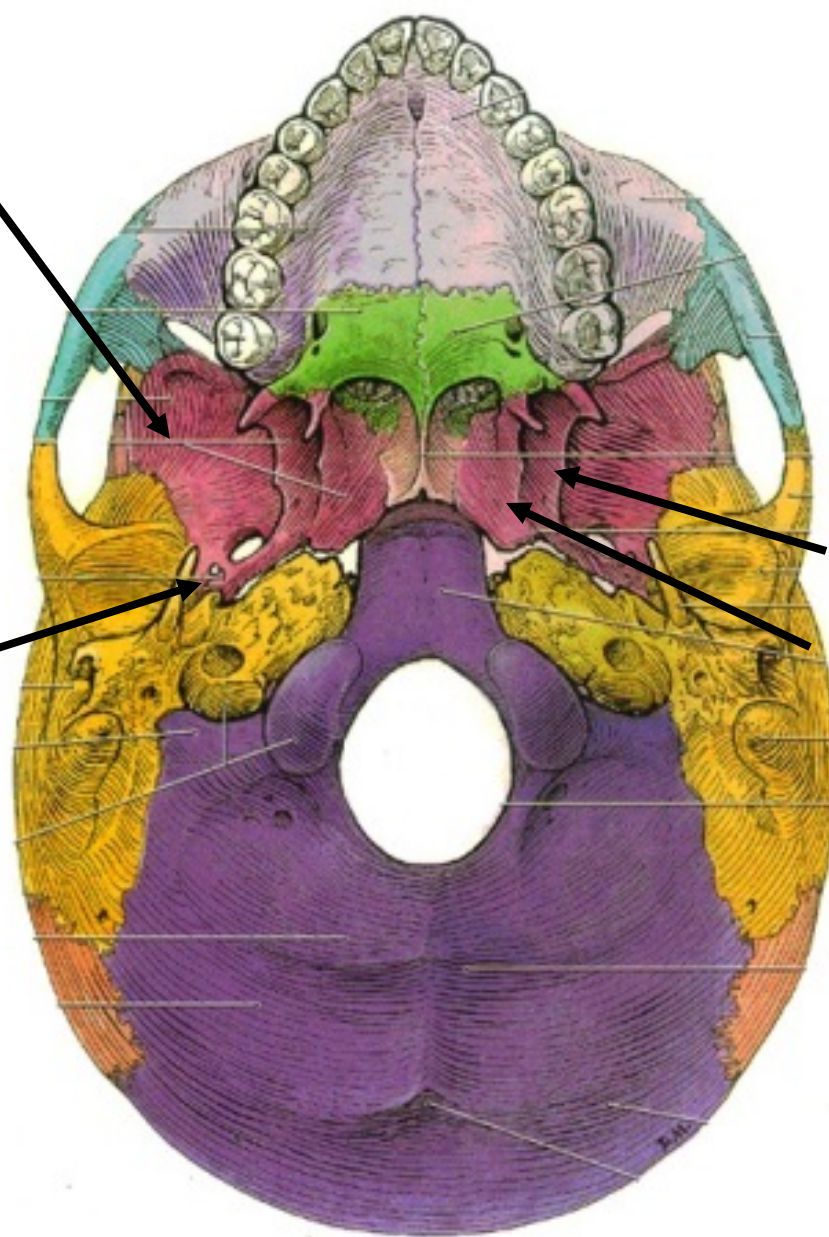
Antero-
posterior film
of with mouth
open

1. Transverse process of C2
2. Ramus of mandible
3. Odontoid process (dens) of C2



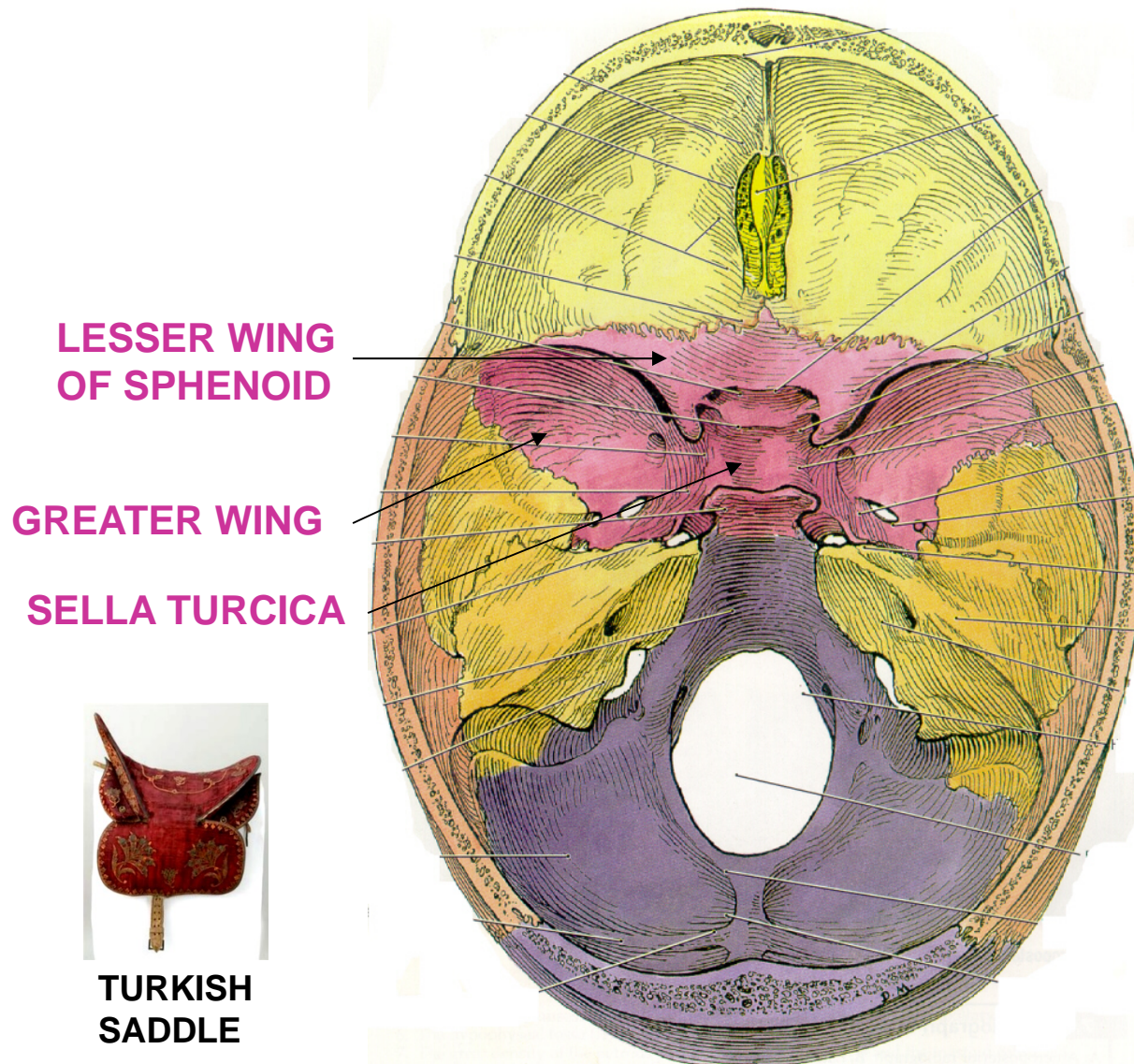
1. SPHENOID BONE – ‘CORE’ OF SKULL

2) SPIKE OF SPHENOID - INFERIOR SIDE ATTACH LIGAMENT



LATERAL AND MEDIAL PTERYGOID PLATES - MUSCLE ATTACHMENT

SPHENOID BONE - INSIDE SKULL



TURKISH SADDLE

- Sphenoid bone forms parts of all cranial fossae; has:

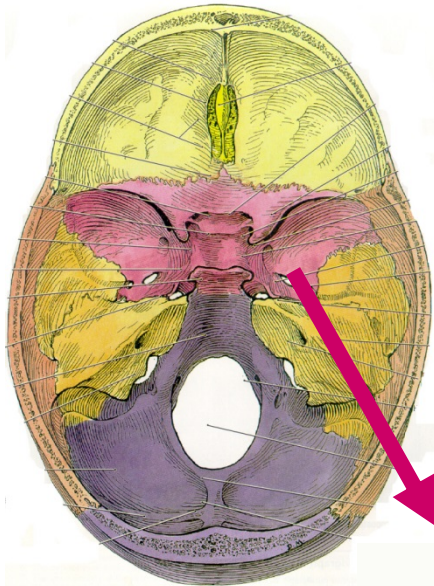
i) Lesser Wing above Superior Orbital Fissure;

ii) Greater Wing - Below Superior Orbital Fissure extends laterally;

iii) Sella Turcica - (turkish saddle) depression above main part (body)

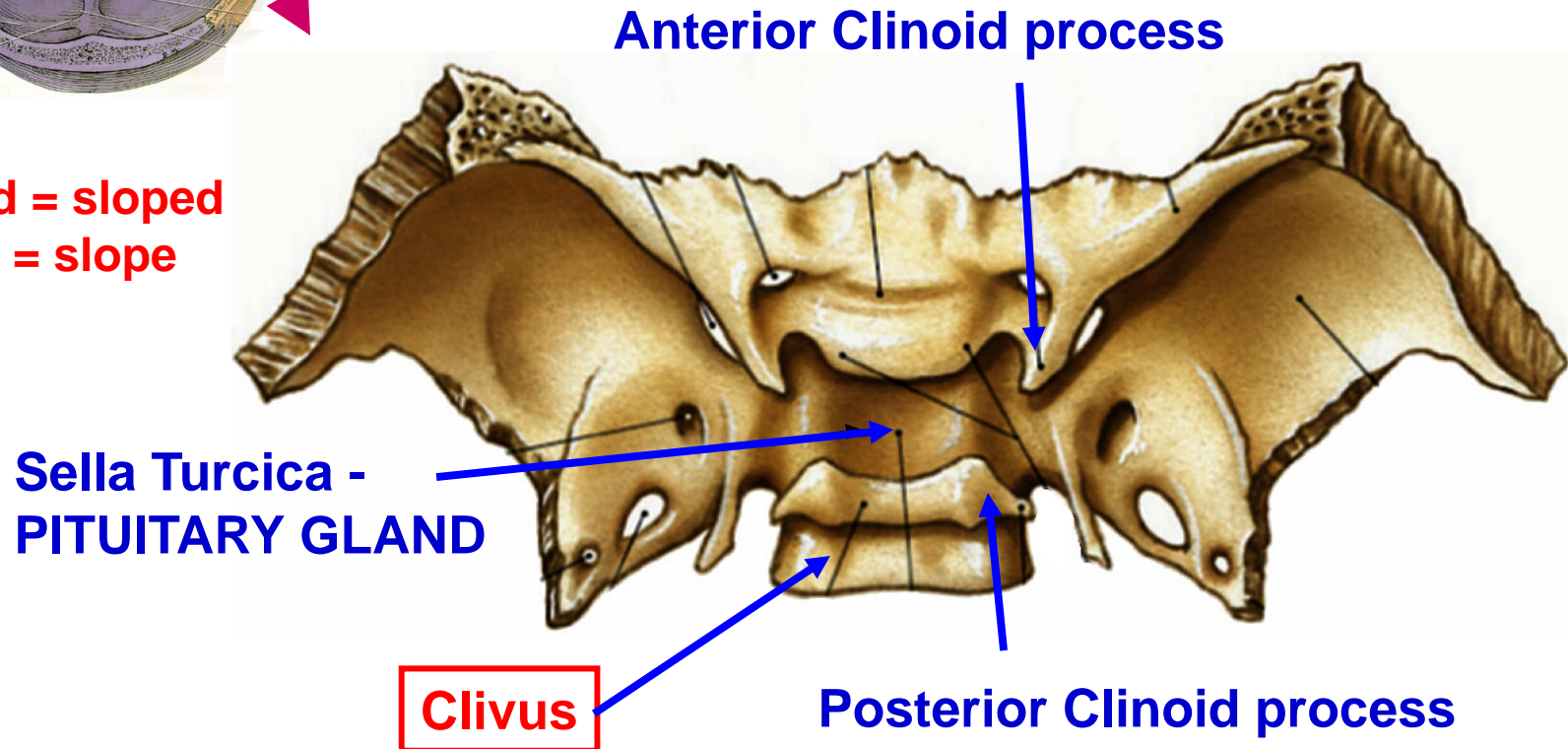
LOCATION OF PITUITARY GLAND

SPHENOID BONE - INSIDE SKULL



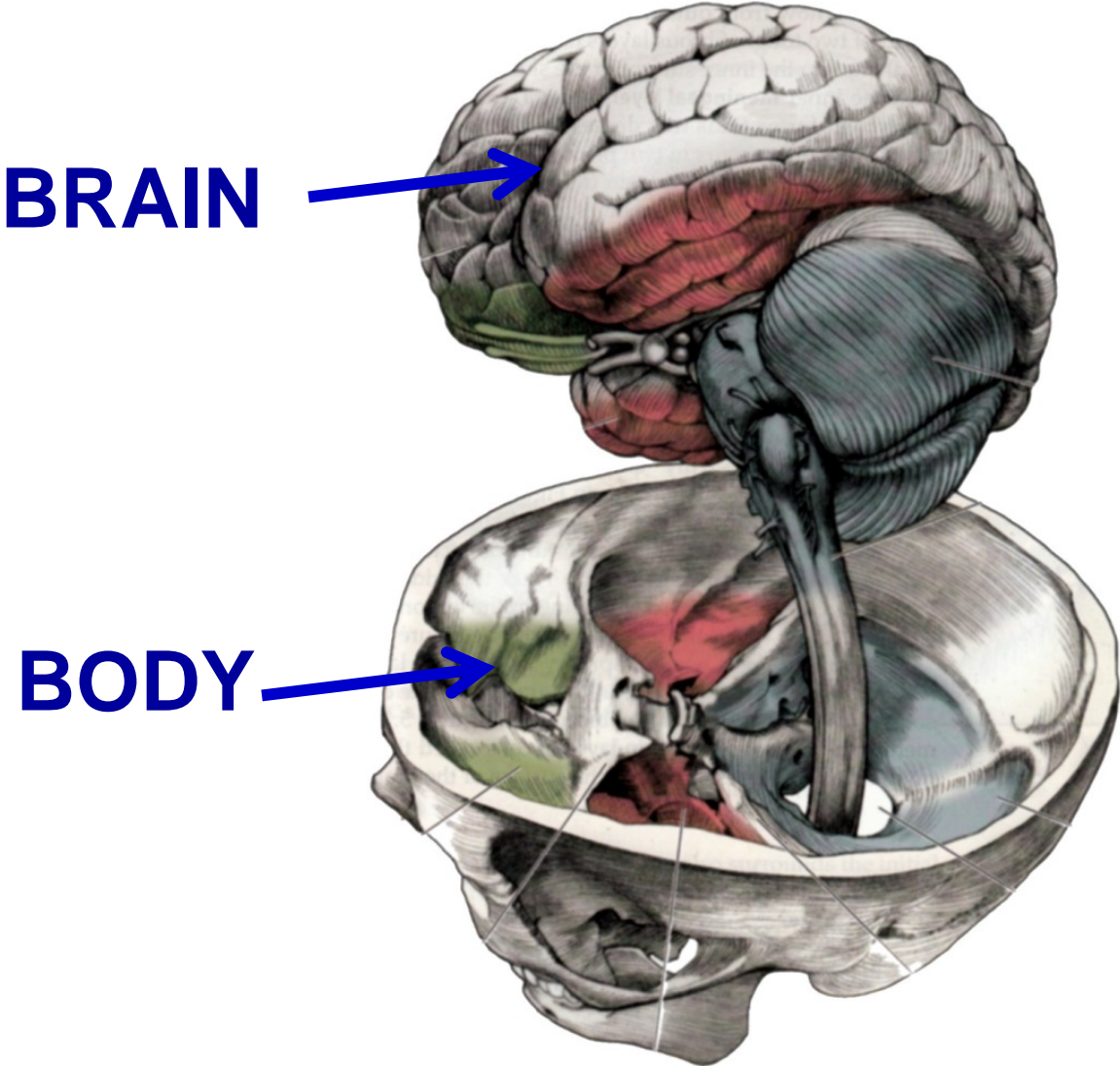
Sella Turcica - (turkish saddle) depression above body; location of PITUITARY GLAND

**Clinoid = sloped
Clivus = slope**



Note: parts of Sphenoid bone are important landmarks in Neurology

**GROSS BRAINSTEM DISSECTION: HOW THE BRAIN
FITS IN THE BODY**



SKULL LECTURE HANDOUT: CHECKLIST OF FEATURES

CHECKLIST OF FEATURES AND BONES OF SKULL TO IDENTIFY

Coronal suture - between Frontal and Parietal bones

Sagittal suture - between Parietal bones

Lambdoidal suture - between Parietal and Occipital bones

Bregma - midpoint of Coronal Suture

Lambda - midpoint of Lambdoidal suture

Pterion - junction of Sphenoid, Temporal, Parietal and Frontal bones (fracture - **Epidural Hematoma**)

Anterior Fontanelle - located at Bregma

Posterior Fontanelle - located at Lambda

Lateral Fontanelle - located at Pterion

Diploe - spongy bone in calvarium between hard inner and outer tables

Zygomatic arch - zygomatic bones and zygomatic processes of maxillary and temporal bones

Temporomandibular joint - joint between head of mandible and mandibular fossa of temporal bone

Mastoid process - inferior part of temporal bone posterior to external auditory meatus

Squamous part of Temporal bone - lateral part, contributes to calvarium

Tympanic part of Temporal bone - anterior to external auditory meatus

Petrous part of Temporal bone - hard, inside cranial cavity (contains cochlea, semicircular canals)

Superior and Inferior nuchal lines - raised ridges on posterior surface of Occipital bone

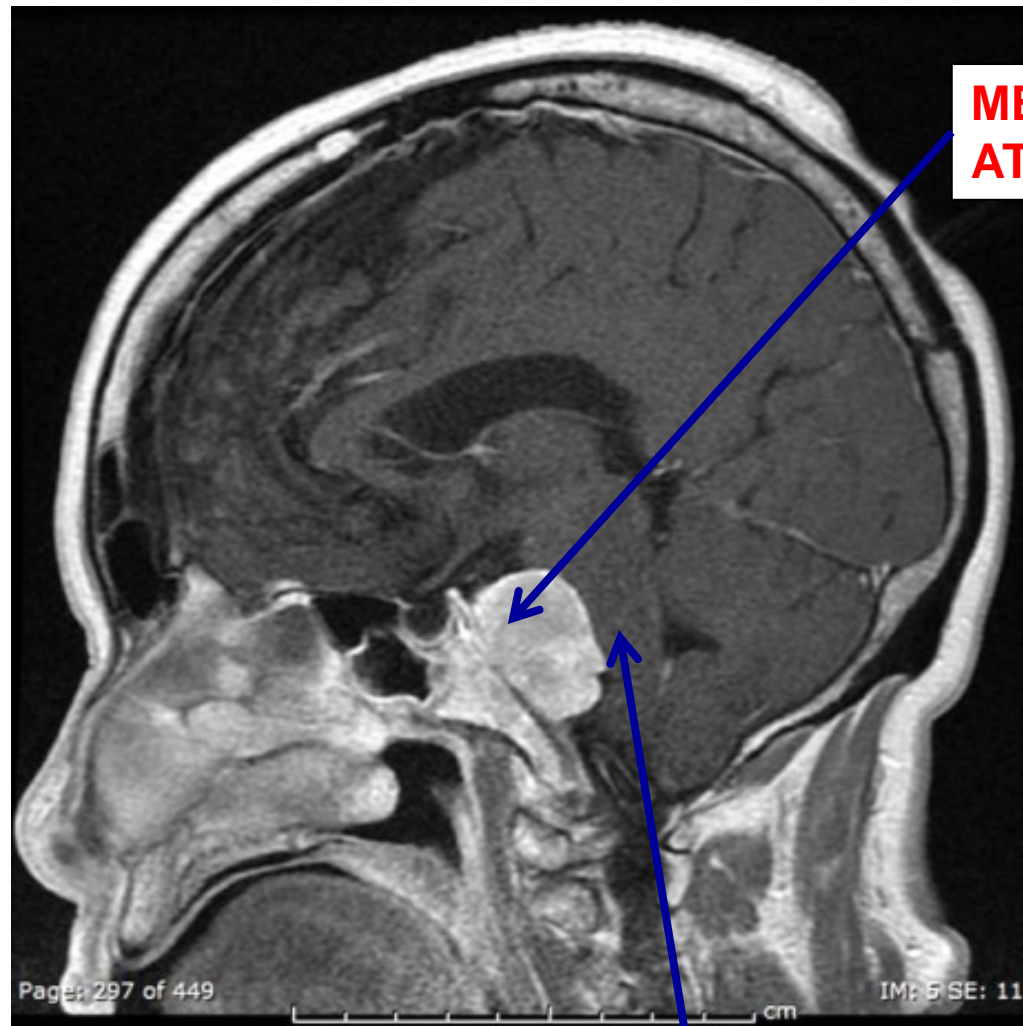
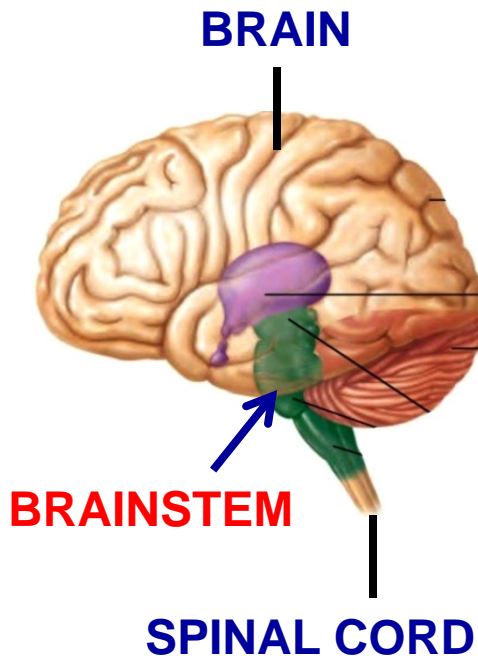
External Occipital protuberance - raised midline bump in Superior Nuchal line

Bony palate - palatine bones, palatine process of maxillary bones

Medial Pterygoid plates- inferior projection of Sphenoid bone for muscle attachment (has hamulus (hook) for Tensor Palati muscle)

Lateral Pterygoid plates - inferior projection of Sphenoid bone for muscle attachment (Pterygoid muscles)

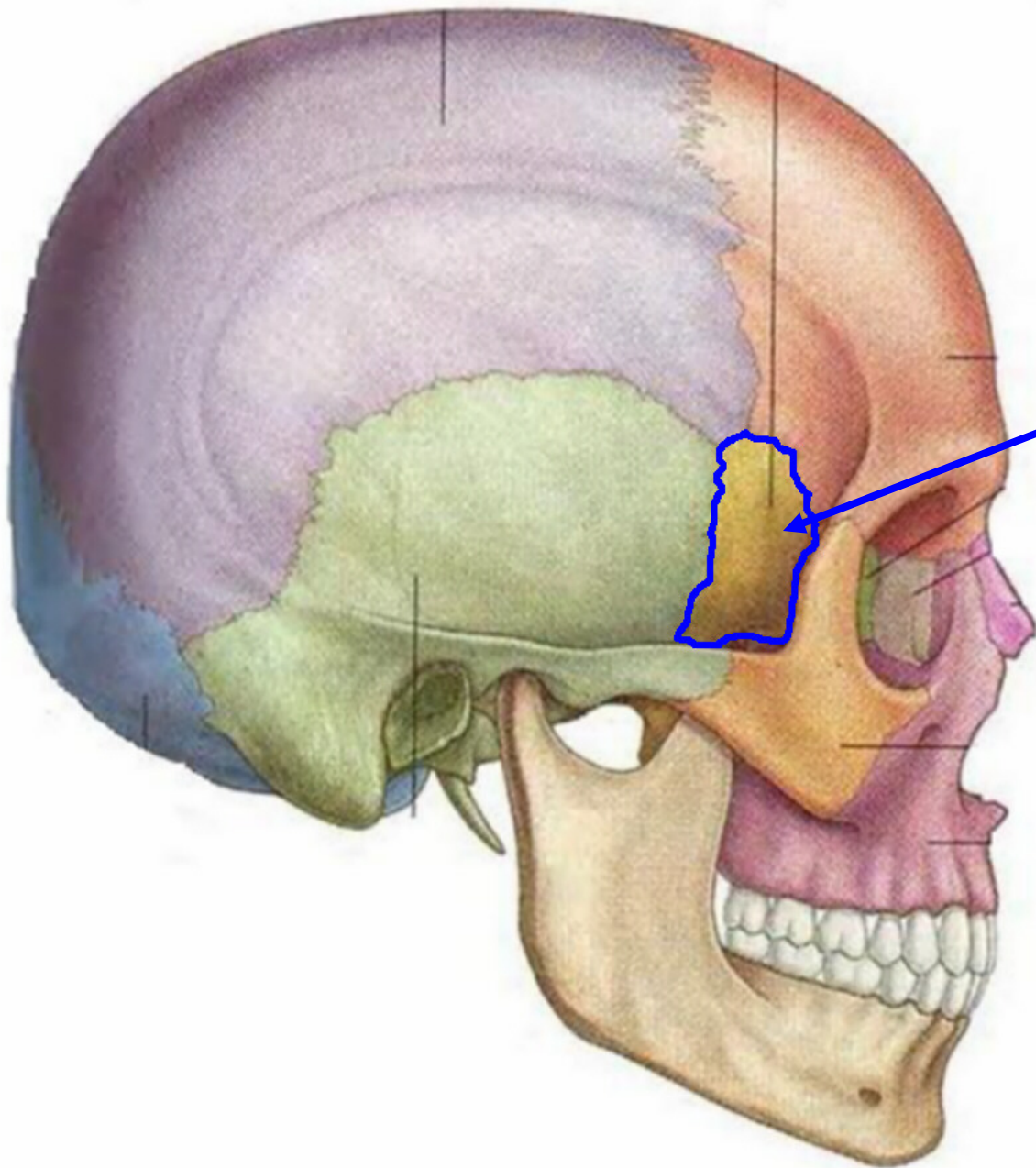
TERMINOLOGY: MENINGIOMA AT THE CLIVUS



BRAINSTEM

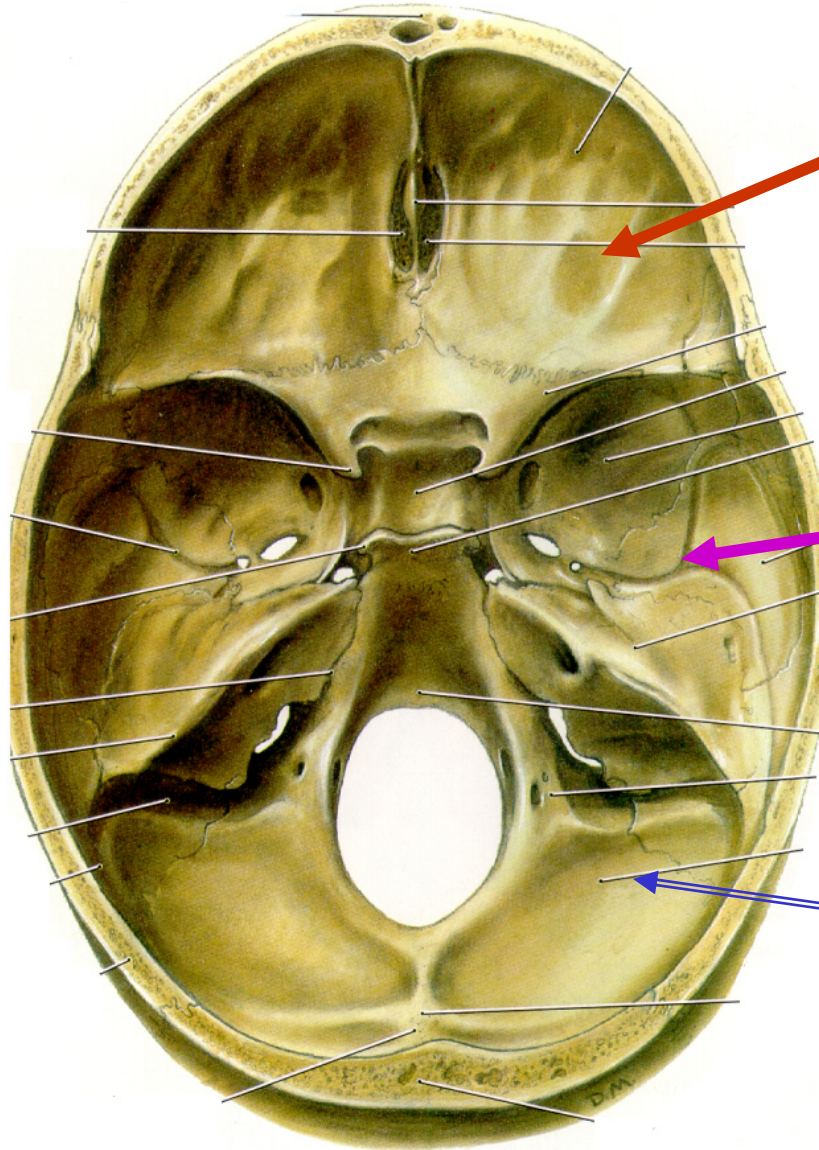
FYI (not memorize):
Symptoms (MANY) can include:

- Coordination problems (ataxia)
- Blurry vision
- Difficulty swallowing (dysphagia)
- Difficulty walking
- Headaches
- Hearing loss
- Nausea
- Optical disc swelling (papilledema)
- Sensory problems
- Vertigo (loss of balance)
- Vision problems
- Vomiting
- Weakness



**GREATER
WING OF
SPHENOID-
LATERAL
SIDE OF
SKULL**

V. CRANIAL CAVITY- DIVIDED INTO DEPRESSIONS (FOSSAE)



ANTERIOR CRANIAL FOSSA (ROOF OF NASAL CAVITY, ORBIT)

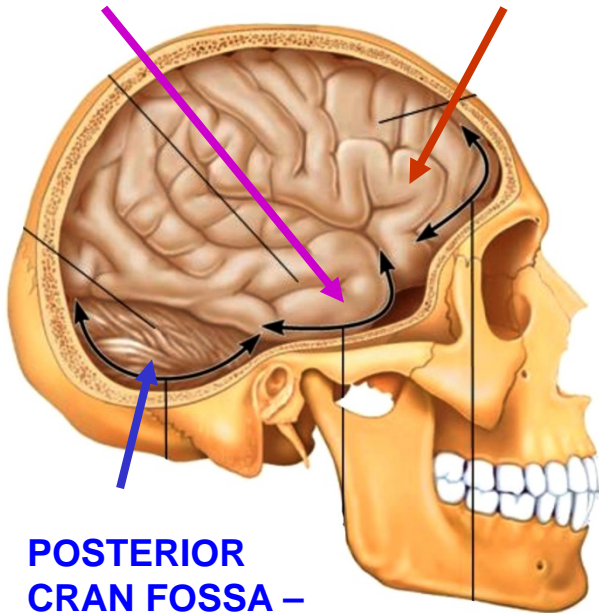
MIDDLE CRANIAL FOSSA (ORBIT, NASAL CAVITY, FACE)

POSTERIOR CRANIAL FOSSA (FACE, ORAL CAVITY, NECK)

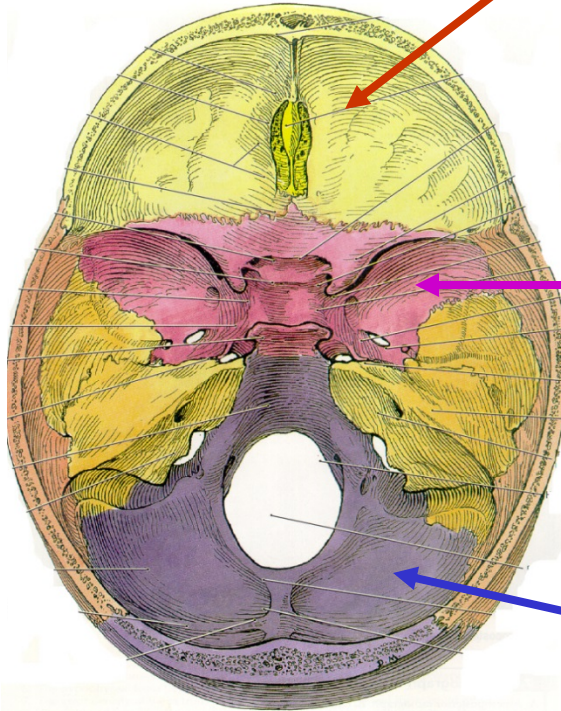
CONTENTS OF CRANIAL FOSSAE

MIDDLE CRANIAL FOSSA – TEMPORAL LOBE

ANTERIOR CRANIAL FOSSA – FRONTAL LOBES



POSTERIOR CRAN FOSSA – CEREBELLUM, BRAINSTEM



ANTERIOR CRANIAL FOSSA –
BONES: FRONTAL, ETHMOID, SPHENOID;
CONTAINS: CN I (CRIBRIFORM PLATE), FRONTAL LOBES, OLFACTORY BULB

MIDDLE CRANIAL FOSSA - BONES: SPHENOID, TEMPORAL, PARIETAL
CONTAINS: CN II-VI - TEMPORAL LOBES - PITUITARY, BRAIN STEM

POSTERIOR CRANIAL FOSSA - BONES: SPHENOID, TEMPORAL, OCCIPITAL, PARIETAL
CONTAINS - CN VII-XII - CEREBELLUM, BRAINSTEM -FORAMEN MAGNUM TRANSMITS SPINAL CORD, VERTEBRAL ARTERIES