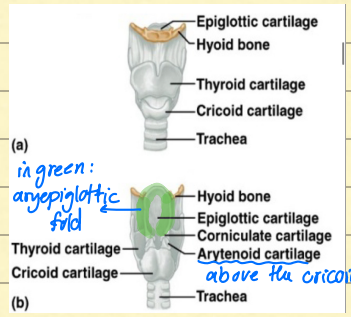
* Larynx :- الحنجرة
  - A box of cartilage
    - 3 single → ① epiglottis ② thyroid ③ cricoid
    - 3 pairs → ① Arytenoid (post.) ② Corniculate ③ Cuneiform

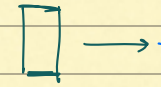


- extends from the 3rd cervical vertebra (C3) → to C6 (Lower border of cricoid cartilage)
  - ↓
  - then : trachea begins

* Hyoid bone is on the upper border of the larynx (not a part of the larynx)

* inlet of the larynx → the opening between the pharynx & larynx
  - ↓
  - Mainly determined by: epiglottis + aryepiglottic fold
    - ↓
    - (a fold between the epiglottis & the arytenoid cartilage)
  - → just for air passage → if a food particle enters → coughing
    - During deglutition or swallowing, the inlet should be closed
    - HOW does the closure happen ?
    - The epiglottis is pushed by the bolus backwards downwards, & the larynx cartilage moves upwards

* Functions :-
  - acts as an open valve in respiration (for passage of air during inspiration)
  - During deglutition → Closure of the valve → HOW? epiglottis move with the bolus backwards downwards & the larynx moves upwards
  - Acts as a partially closed valve in the phonation/articulation/production of voice: (Vibration of true vocal cords) → HOW? Adduction of true vocal cords during expiration
    - ↓ so: they form :
    - compressed column of air below
    - ↓
    - Then: vibrations → abduction / adduction
    - leading to:
    - partitioning of the compressed air column
    - ↓
    - Final result :- Production of voice



* in coughing → closure of the true vocal cords so: → compressed column of air is formed below
  - ↓ Imp as a reflex when any particle enters the larynx accidentally
  - ↓ coughing :-
  - Sudden opening → after closure → لطلع الهواء → coughing
    - (انا بحبس الهواء وبضغطه بهون بطلعه فجأة وبقوة فبطرد اي اشي عالحنجرة (larynx

* Components of the larynx :-

1- Box of cartilages (3 single + 3 pairs)

2- Mucosa → respiratory epi → pseudostratified ciliated columnar epi with goblet cells
(cover the larynx from inside)

↓

Except : The true vocal cords (Responsible for articulation)
↓
it's stratified squamous non-keratinized

عشان هيك لما نحكي طول اليوم بروح صوتنا

WHY? ↳ injury of epi of the true vocal cords
↓
الصوت يرجع بعدين بسبب نوع ال epi المميز تبعهم
↳ the stratified squamous non-keratinized epi can undergo mitosis and replace the injured epithelium

3- Ligaments & membranes

Ligaments ↓
- thicker
- on midline or lateral

Membranes ↓
- thinner
- between the cartilages

4- Muscles → They all work on the true vocal cords [except: for inlet muscles]
↳ work on the inlet

↓

* muscles responsible for :-

- vibration (abduction & adduction)
  - abduction ↳ posterior cricoarytenoid
  - adduction ↳ Lateral crico arytenoid

- Tension of the true vocal cords → ONLY one muscle : cricothyroid muscle (from cricoid to thyroid)
  producing: ↳ High pitch of the voice (صوت رفيع / عالي)

عكسه:

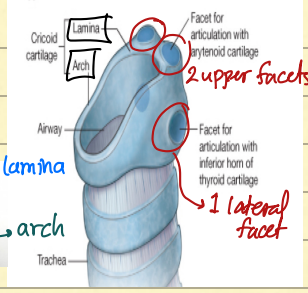
- Relaxation of true vocal cords → vocalis muscle
  ↳ Low pitch of the voice

* in puberty in →

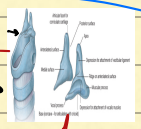
- males → testosterone
  - → low pitch voice (long & relaxed vocal cords)
  - → more heavy bones
  - → more bulky muscles
  - → acute angle of thyroid cartilage

- females → estrogen + progesterone
  - → High-pitch voice (short & tense vocal cords)
  - → more light bones
  - → muscles become ↑ smooth
  - → obtuse angle of thyroid cartilage

* cricoid cartilage has ① arch → anteriorly
② lamina → posteriorly (زي الخاتم اللي إله ريش)



* Articulates through facets :-

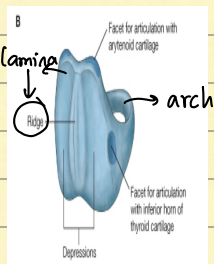


1- First 2 facets are on the upper border of the lamina
↳ Articulating with the arytenoid cartilage (so arytenoid's are above the cricoid lamina)

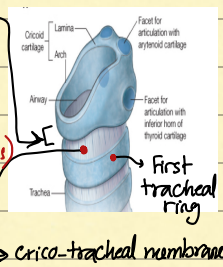
2- Facets that are lateral & inferior to the lamina → articulating with the inferior horn of thyroid cartilage

* Its lower edge is the connection between trachea + larynx (end of the larynx)

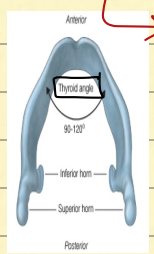
* Tracheostomy : making a hole inside the crico-tracheal membrane
↳ it's a suitable place → bcz it's below the true vocal cords
So : they will be intact



* There is a ridge on the lamina of cricoid cartilage (post.)
↳ WHY? for attachment of esophagus by an anterior membrane (of esophagus)
(remember : lamina is post. & esophagus is also post. to the trachea)

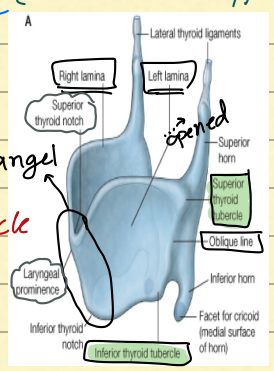


* Thyroid cartilage : 2 laminae (rt & lt) with an angle anteriorly - but it's open posteriorly
↳ on the superior part of the angle, it forms the laryngeal prominance & upper to it, we have the superior thyroid notch ⇒ together are called Adam's apple
↳ Related to the thyroid gland :-
- 2 lateral lobes → on each side of the larynx
- the isthmus → between the 2 lateral lobes
↳ in front of the 2nd, 3rd & 4th tracheal rings
Adam's apple (the prominance + the notch) (acute angle in males (90°) but obtuse in females (120°))

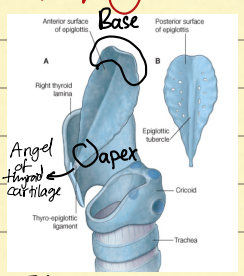


* Thyroid cartilage has 2 horns :-
Superior horn → articulates with the greater horn of the hyoid bone
Inferior horn → articulates with the lamina of cricoid cartilage
(remember : on the lateral inferior facet of cricoid)

* also it has :
Oblique line → From superior thyroid tubercle to inferior thyroid tubercle
↳ For muscles attachment → like :- - Sternothyroid m.
- Thyrohyoid m.

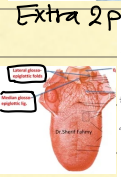


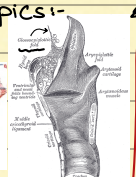
* Epiglottis → leaf-like structure
↳ has base & apex (attached to the angle of thyroid cartilage internally) ↳ through : thyro-epiglottic ligament
(upper free edge)

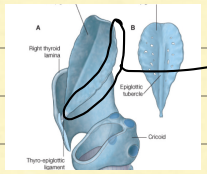


* has 2 surfaces :-
① Supero-anterior surface → smooth & connected to the tongue in the middle glosso-epiglottic fold + lateral glossoepiglottic fold ↳ vallecula (فالية)
Type of epi : Oral epi : stratified squamous non-keratinised
② Posterior surface → has tubercle + ridge in the middle
↳ type of epi : Respiratory epi : pseudostratified ciliated columnar epi

Extra 2 pics :-

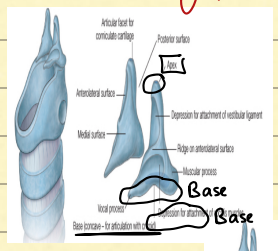




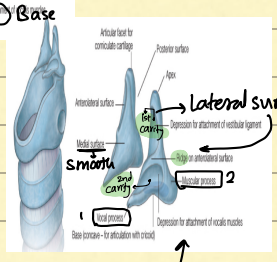


→* From this edge of the epiglottis, comes a membrane → that has a fold: Aryepiglottic fold
+ there's a muscle called: Aryepiglottic muscle
→ they both help in the muscle action on the inlet

* Arytenoid cartilage: → Base → (articulates with the lamina of cricoid)
→ 2 processes → vocal process + muscular process (2 m)
→ Apex → (articulates with the corniculate)
→ through a synovial joint

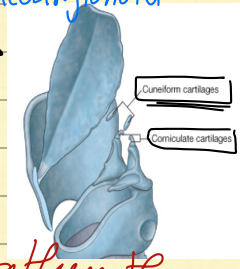


2 surfaces → medial → smooth
→ lateral → has → ridge + 2 cavities or depressions
anterolateral
→ upper: attachment of false vocal cords (vestibular ligament)
→ lower: attachment of vocalis muscle (part of the true vocal cords)



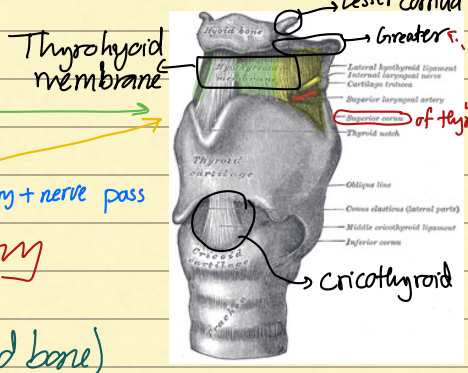
*The base has 2 processes:-
1- Vocal process (anteriorly) → attachment of true vocal cord / vocal ligament
2- Muscular process (post.) → attachment of 2 muscles (adducti- + abducti)
→ post. & lateral cricoarytenoid

* Corniculate → conical cartilage
→ attached to the apex of arytenoid (synovial joint)



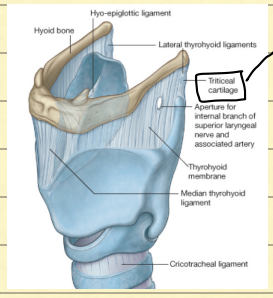
*Cuneiform → Club-shaped cartilage
→ present in the aryepiglottic fold → (to strengthen the aryepiglottic muscle)

* Ligaments: (connect cartilage)
- Thyrohyoid membrane & ligament (from thyroid to hyoid bone)
→ (lateral or in the midline → The rest: membrane)
pierced by an artery + nerve
- Artery → superior laryngeal A. → branch of superior thyroid A.
- Nerve → internal laryngeal → branch of the vagus
sensory to the larynx above the true vocal cords



* the thyrohyoid membrane 2 parts → - median (green)
- lateral (yellow)
→ Here: The artery + nerve pass

Imp:-
- Cricotracheal (between cricoid + trachea) → tracheostomy
- Cricothyroid (between cricoid + thyroid)
- hyoepiglottic membrane (between the epiglottis + hyoid bone)



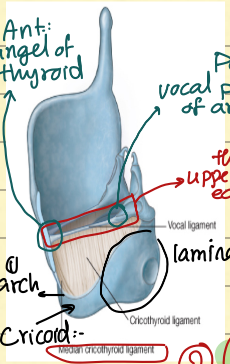
→ Triticeal cartilage: Small cartilage between the greater horn of the hyoid bone & the superior horn of the thyroid (in the lateral ligament)

*Hyoid bone has:
1- Body
2- Lesser cornuae/horn
3- Greater cornuae/horn
↓
articulates with the superior horn of thyroid

* We have intrinsic + extrinsic ligaments :-

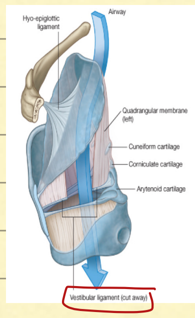
- Intrinsic ligaments/membranes → start from inside the cartilage & moving upwards / downwards
  - → fibroelastic membrane of the larynx
  - → Imp in the architecture & the framework of the laryngeal cavity

① → Cricothyroid membrane



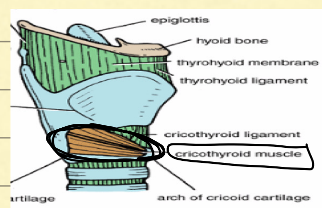
- conus elasticus → bcz it's fibroelastic
- → has an upper free edge → vocal ligament → attached to the vocal process of arytenoid (post.) & to angel of thyroid cartilage (Ant.)
  - True vocal cord أو بس الـ
- → in the midline : median cricothyroid ligament

② Quadrangular membrane → from the free edge + lateral edge of the epiglottis to → the inside of the thyroid



- → its lower free edge IS: → vestibular / false vocal ligament
- → Upper edge → imp for closure of the inlet → فيها: Aryepiglottidis muscle
  between greater & superior horn of the thyroid

* Cricothyroid muscle → is the ONLY muscle in the outer surface of the larynx

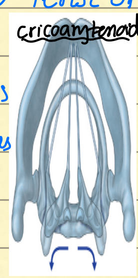


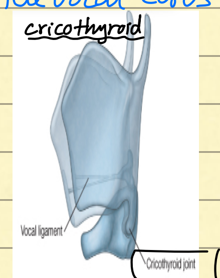
- has 2 parts : → oblique & streight parts
- Function: → tense of voice (true vocal cords)
  - → producing high-pitch voice
- N.S: → supplied by external laryngeal nerve → الوحيدة: ↓ Branch of vagus nerve
  - ★ باقي العضلات
  - ★ كلها مع الـ:
  - ★ Recurrent laryngeal nerve

* Joints of the larynx
  - → 2 synovial joints

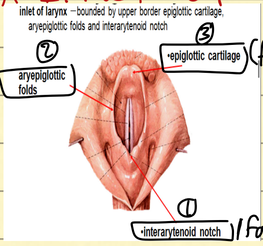
① → Cricothyroid joint : → moves by : cricothyroid muscle
- → Between : − Inferior horn of the thyroid ⊕ Lateral lamina of cricoid
- → 2 types of movement :- (by the cricothyroid muscle)
  - 1* Forward movement
  - 2* rotatory movement (tilting downwards) on the cricoid → this leads to tense of the vocal cords

② → Cricoarytenoid joint
- → type of movement : Rotatory movement ⇒ By the muscular processes of the arytenoid → which are attached to 2 muscles
  - Externally — By: posterior cricoarytenoid muscle (Abduction)
  - Internally — By: Lateral cricoarytenoid m. (Adduction)





* Inlet of larynx → Boundaries :-



(free edge) ③ · ② · ① / fold

1- Interarytenoid fold (post.)
2- Aryepiglottic fold (lateral)
3- Free edge of epiglottis (Ant)

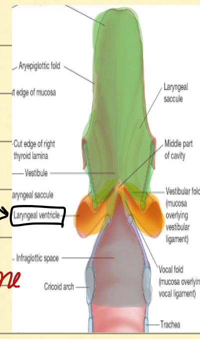
imp clinically :
→ When we want to insert an endotracheal tube → it has to pass through the inlet → then between the 2 true vocal cords → trachea

During surgeries → we put the patient on a ventilator (using endotracheal tube) → bcz otherwise, the true vocal cords adduct → Leading to suffocation (اختناق)

* True vocal cords are white → avascular
* Inferior laryngeal opening → to the trachea
* ventricle / saccule : cavity ascending upwards deep to the false vocal cords
 └→ contains glands (seromucus) → for lubrication of the true vocal cords
* The aryepiglottic fold (lateral to the inlet) ⇒ I have here : ① Carniculate / ② Cuneiform / ③ A muscle

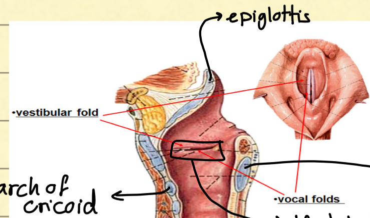
* Laryngeal cavity (3 parts) → (after the inlet)
↓ False & true vocal cords يحتوي ال

① Vestibule (green in pic) → from the inlet to the false vocal cords
② Glottic part (orange) → (between false & true) → ventricle OR saccule فيه
③ Infra-glottic part (grey) → Below the true vocal cords to → the trachea



* True vocal cords characteristics :-

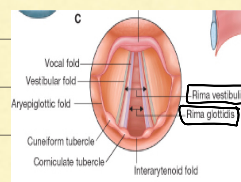
1- Has vocal ligament By: upper free edge of conus elasticus / cricothyroid membrane
2- Stratified squamous non-keratinised mucus membrane
3- Contains vocalis muscle (striated muscle) → for relaxation of true vocal cords
4- No submucosa, no BVs → Supplied with blood by diffusion
 └→ Hence : white in colour
5- Comes from arytenoid cartilage (vocal process) & ends at the angel of the thyroid cartilage internally



→ epiglottis
arch of cricoid
Lamina of cricoid
→ the black structure : ventricle
above it : False cord
below it : True cord

* Vestibular cord / false vocal cord :-

1- Has vestibular ligament ⇒ formed by the lower free edge of quadrangular membrane
2- Type of epi : respiratory epi
3- Red in colour → rich in BVs (vascularised)
4- No effect / role on the production of voice



* Rima vestibuli → the space between false vocal cords ⇒ Wider
* Rima glottidis → the space between true vocal cord ⇒ Narrower

*Larynx part 2:-

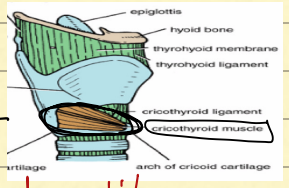
* Muscles of the larynx : intrinsic muscles that work on : – the true vocal cords
OR – the inlet of the larynx

Functions:

1 → Muscles that work on the true vocal cords :-
1- adjust the tension & relaxation of the vocal ligament → Narrowing (Adduction)
OR 2- affect the rima glottidis (space between the 2 true vocal cords) → Widening (Abduction)

2 → Affect the vestibule

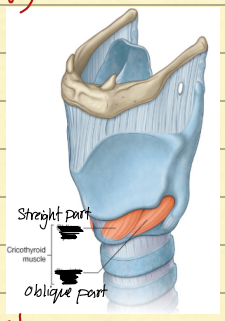
3 → Close the rima vestibuli (no true value/role for this)



*Muscles :- (Intrinsic muscles)

*Cricothyroid muscle → attached to the antero lateral surface of cricoid cartilage
→ expand superiorly & posteriorly to the thyroid cartilage (its insertion)

→ Has 2 parts :
1- Oblique part → Runs in post. direction from arch of cricoid to the inferior horn of thyroid cartilage
2- Streight part → Runs more vertically from arch of cricoid to the postero-inferior margin of the lamina of thyroid



→ Function : Affects the tension of the true vocal cords (tenses them)
(in the synovial joint between: inferior horn of thyroid + cricoid)
→ Forward movement + Rotation

→ Nerve supply :- External laryngeal nerve (branch of the superior laryngeal)
Branch of the vagus n.
The only exception
(So: Vagus → superior laryngeal ↔ internal laryngeal / external laryngeal)

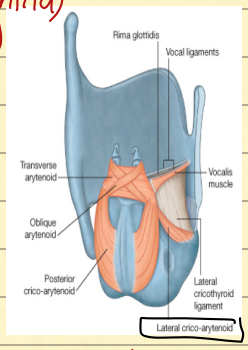
→ While all other muscles are supplied by the recurrent laryngeal nerve
(Also a branch of the vagus nerve)

* Posterior crico-arytenoid muscles → From post. surface of cricoid (lamina) then attached to the muscular process of arytenoid

→ Function : Abduction of vocal cords (pushing the muscular process outwards)

* Lateral crico-arytenoid muscles → From: the lateral wall of cricoid (upper border)
then: Goes post. & superiorly → To: Muscular process of arytenoid

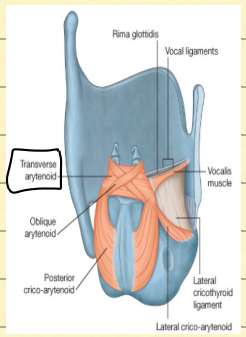
→ Function : Adduction of vocal cords (pushing the muscular process inwards) (internal rotation)



*Both posterior & lateral cricoarytenoid muscles → Are supplied by: Recurrent laryngeal nerve (Branch of the vagus)

*Adduction & abduction movements are called : vibration

* We also have :- Trans-arytenoid muscles

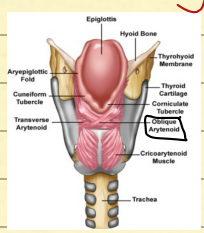


→ From: the lamina / body of arytenoid
To: The lamina of the other side → posteriorly

→ Function: Narrowing & closure of rima glottidis posteriorly
(بقرب الـ 2 lamina على بعض)

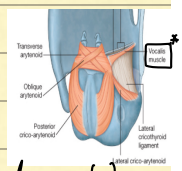
- Oblique arytenoid muscles → From: Muscular process of arytenoid
To: Apex of opposite arytenoid

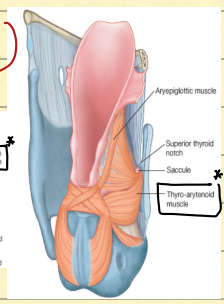
→ Function: work on the inlet of the larynx
(Narrowing of the inlet)



- Vocalis muscle (part of the thyro-arytenoid) (the part on the vocal cords)

→ Function: Relaxes the vocal cords
→ Nerve supply: Recurrent laryngeal nerve

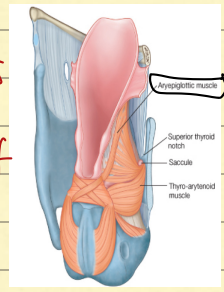




(so: cricothyroid → tension of vocal cords // vocalis → relaxation of vocal cords)

- Thyroepiglottic (aryepiglottic) muscles → on the edge of epiglottis

→ Function: When it contracts → Widening / opening of the inlet



* (Extrinsic muscles) :- From outside of the larynx (بس نحفظ أسماءهم)

① → Suprahyoid bone muscles:
- Digastric m.
- Stylohyoid m.
- Myelohyoid m.
- Geniohyoid m.

→ Elevate the larynx / pull it upwards

② → Infrahyoid bone muscles:
- Sternothyroid m.
- Sternohyoid m.
- Omohyoid m.

→ Depressors of the larynx

* Remember: Functions of the larynx: ① Respiration / ② Phonation (articulation) / ③ Help in swallowing

① Respiration → Open

② Phonation (articulation) (vibration of true vocal cords) → closure of rima glottidis (Adduction of true vocal cords) → Then: partitioning

③ Help in swallowing → closure of inlet

* Effort closure (e.g- الأثقال رفع)
→ When lifting heavy objects, the true vocal cords become completely closed → Helps in lifting

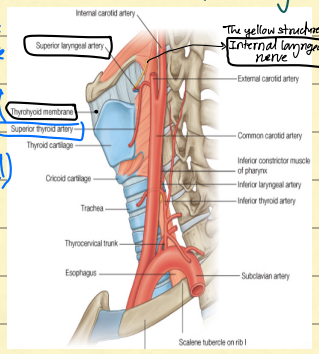
(deep inspiration: ما راضيين الأثقال بس أوا: يا خذوا أول نفس
expiration: وبعدها ينزلوا الأثقال على الأرض ← يطلعوا النفس)

Blood supply of the Larynx :-

① superior laryngeal artery → Branch of superior thyroid A.
- Internal branch of superior laryngeal nerve ⇒ (Both artery + nerve → pierce the thyrohyoid membrane)

② inferior laryngeal artery → Branch of inferior thyroid A.
- Enters the larynx by passing deep to the margin of inferior constrictor muscle of the pharynx
- Recurrent laryngeal nerve

External + * laryngeal nerve



* The superior thyroid artery : (Branch of external carotid A.)
- (common carotid A. → external carotid A. → sup. thyroid → sup. laryngeal)
- Goes to the cricothyroid m. & supplies it along with the external laryngeal nerve (branch of vagus nerve)

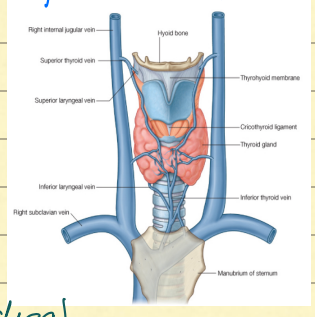
* The inferior thyroid artery :
- (subclavian A. → Thyrocervical trunk → inferior thyroid A. → inferior laryngeal A.)
- Both inferior thyroid + inf. laryngeal move along with the recurrent laryngeal nerve

* So: in thyroidectomy → we perform ligation of BVs (veins & arteries)
- ① The superior thyroid artery with its corresponding vein are ligated and cut (We should be careful not to cut the external laryngeal nerve!)
  - * But remember: external laryngeal n. supplies the cricothyroid m. which is responsible for tense of vocal cords → Now it's cut: if: ① in one side (unilateral) : Weak voice / ② in both sides (bilateral) : Hoarseness of voice
- ② The inferior thyroid artery (Be careful not to cut the recurrent laryngeal nerve!)

* Veins :-
1- Superior laryngeal vein → to: Superior thyroid vein → to: internal jugular vein

2- Inferior laryngeal vein → to: Inferior thyroid vein → to: Left brachiocephalic vein

* Usually it's ONLY 1 vein (instead of 2 in both sides) — it goes to:



* Lymphatic drainage :-
- Below the vocal cords → Pass with inf. thyroid artery To: Paratracheal L.N (associated with cricothyroid ligament & the trachea)
- Above the vocal cords → Pass with sup. laryngeal artery to: Deep cervical L.N

* Innervation of larynx (nerves)

- **Superior laryngeal nerve** (from the vagus n. → from the inf. vagal ganglia)
  - → descends with the internal carotid artery
  - → 2 branches :-
    1. external laryngeal nerve
       Which descends with the superior thyroid artery
       → to: cricothyroid muscle (tension of vocal cord)
       هو الي بعمل ال Weakening + Hoarseness للصوت إذا انقطع
    2. Internal laryngeal nerve → sensory to the mucosa above the true vocal cords
       → descends with the superior laryngeal A.
- **Recurrent laryngeal nerve** (branch of vagus n.)
  - → supplies all the muscles of the larynx ⇒ Except: Cricothyroid m. (motor)
  - → Sensory to the mucosa below the true vocal cords (sensory)
  - → Differs in origin between rt & Lt sides
    - Right : in the root of the neck under the rt subclavian artery (shorter)
    - Left : descends in the chest → & gives the recurrent below the arch of the aorta (Longer)
  - → Ascends between trachea & esophagus (in a groove)
  - → Moves along with the inf. thyroid A. + inf. laryngeal A.

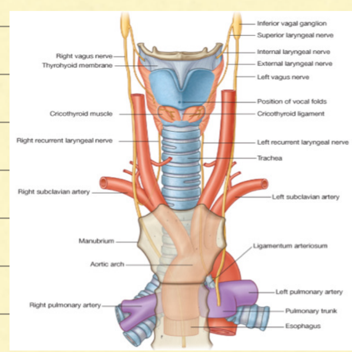
(so: larynx from inside has sensations → above true vocal cords ⇒ Internal laryngeal
→ below true vocal cords ⇒ Recurrent laryngeal)

* Relations of larynx :-

① On each side :-
The carotid sheath & its contents are present on the lateral lobe of the thyroid gland (on each side of the lateral lobes)

② Posterior → Pharynx + recurrent laryngeal nerve (ant. to the pharynx) → بعدين بنزل وبصير posterior to the trachea
→ esp. in the right side (rt recurrent)

③ Anterior → skin + fascia + Strap muscles



+ Clinical notes about recurrent laryngeal nerve:
→ supplies almost all the larynx muscles
↓
esp. the ones responsible for adduction & abduction (vibration)

- And the vocal cords are imp for 2 things
  1- Their adduction & abduction affect the respiration
  → for e.g) if there's a complete adduction → suffocation
  2- Their movement affects the speech (phonation)
  → if unilateral: weak effect / Bilateral: Hoarseness of the voice

- The recurrent laryngeal has 4 situations for its injury :-

1- Unilateral or bilateral ?

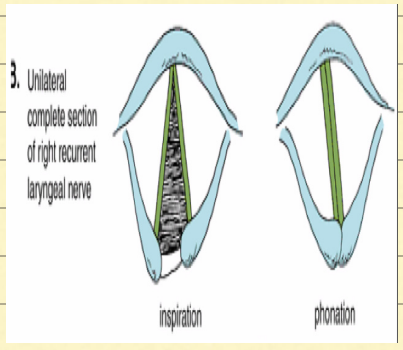
2- Complete or partial ?
يقفلوا الـ cords بالنص
- complete : The nerves are completely cut → no adduction nor abduction (لا يقفل ولا يفتح)
- partial : ONLY the outer surface of the nerve is affected → compression
  → injury to the superficial fibers

* The superficial fibers of recurrent laryngeal → supply the muscles responsible for abduction
→ so if it's injured : only abductor muscles are affected
⇓ so:
The end result: Adduction of the vocal cords → suffocation

* While if it's complete → muscles of abduction + adduction are affected

So: the partial injury is more dangerous than the complete

- Unilateral complete
  → 1 side is affected → so: position of this affected cord is between abduction & adduction
  → Speech: is not greatly affected (Unilateral) (bcz the other side's cord compensates)
  → Breathing: not that much affected (bcz it's on one side only & it's complete: in the midway between abduction & adduction → not totally adducted)



- Bilateral complete
  → Both cords are in the midway between abduction + adduction
  → Breathing: is impaired → since rima glottidis is partially closed (Complete)
  → ONLY difficulty in breathing WHY? No complete adduction
  → Speech: Loss of voice OR hoarseness of the voice (Bilateral)
  → ONLY in bilateral cases

- Unilateral partial
  - ↳ Speech: not greatly affected (Unilateral) → one side can compensate
  - ↳ Breathing: not greatly affected (it's partial – more dangerous – → But it's still unilateral)

- Bilateral partial "Most dangerous"
  - ↳ Breathing → vocal cords are completely adducted ⟹ so: suffocation + dyspnea ⟹ so: The patient becomes cyanotic
    - ↓ So we have to do: Tracheostomy

*2 types of tracheostomy :-

① Emergency → suprasternal (using any sharp object to make an opening for air to pass in)
↳ By feeling the tracheal ring (بالايد عادي نحسها)

② During surgery → the surgeon has enough time to make an opening between the cricoid & the 1st tracheal ring (cricotracheal membrane)

*When doing tracheostomy → Bleeding is possible → bcz we have in this area:
- jugular arch vein
- Anterior jugular vein
- Inferior thyroid vein

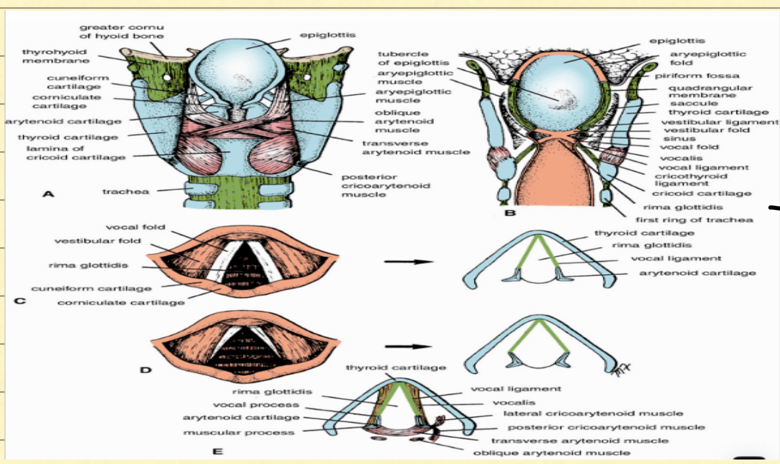
↓

But arterial bleeding is not possible

bcz: arteries are deep not superficial

& even venous bleeding is not that dangerous
↳ it will stop spontaneously in almost 2 min

Here: Supplying the brain with O_2 is our top priority
↓
ONLY 2-5 min of O_2 depreviation in the brain leads to brain death



greater cornu of hyoid bone
epiglottis
thyrohyoid membrane
cuneiform cartilage
corniculate cartilage
arytenoid cartilage
thyroid cartilage
lamina of cricoid cartilage
trachea
A
tubercle of epiglottis
aryepiglottic muscle
aryepiglottic muscle
oblique arytenoid muscle
transverse arytenoid muscle
posterior cricoarytenoid muscle
aryepiglottic fold
piriform fossa
quadrangular membrane
saccule
vestibular ligament
vestibular fold
sinus
vocal fold
vocalis
vocal ligament
cricothyroid ligament
cricoid cartilage
rima glottidis
first ring of trachea
B
vestibular fold
cuneiform cartilage
corniculate cartilage
C
vocal ligament
D
vocal process
muscular process
lateral cricoarytenoid muscle
posterior cricoarytenoid muscle
transverse arytenoid muscle
oblique arytenoid muscle
E

→ صورة تجمع كثير شغلات

Check it out!