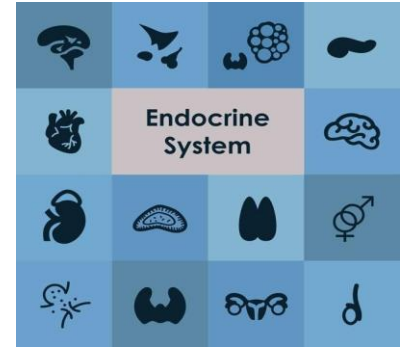




BAU-Medicine



Sheet No.2

Lecture Date: 27th of Dec 2020

Lecture Title: **Histology and embryology of the endocrine glands 1**

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If you come by any mistake (whether it be spelling, grammatical or scientific) while browsing this sheet, kindly report it to the **Academic team Facebook account**.

دعاء لزميلنا رشيد

اللهم اغفر له وارحمه وعافه واعف عنه وأكرم نزله ووسع مدخله واغسله بالماء والثلج والبرد ونقه من الخطايا، كما نقيت الثوب الأبيض من الدنس وأبدله دارا خيرا من داره وأهلا خيرا من أهله، وزوجا خيرا من زوجه وأدخله الجنة ، واعذه من عذاب القبر ومن عذاب النار

Try to watch the lecture , it'll help you in understanding the sheet

start up your motivation,
fire up your determination,
and conquer some goals today!



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Thyroid gland

- Thyroid problems are common in Jordan, because we have a deficiency of iodine (which is important for thyroid function), this is why the government ordered to add iodine to the salt.

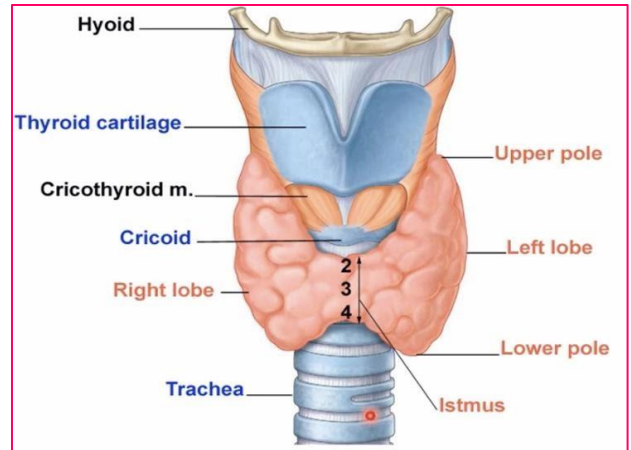
Butterfly-shaped endocrine gland

Location

- It's located anteriorly in the neck.
- Anterior and inferior to the larynx.
- Anterior to trachea.

Consists of 2 lobes:

- Left lobe
 - Right lobe
- They are united by a bridge called "**isthmus**"
 - Each lobe is pear-shaped with narrow upper pole and a broad lower pole.
- The isthmus attaches firmly to the 2nd, 3rd, 4th tracheal rings.
 - During tracheostomy, care should be taken not to injure isthmus or the blood supply for thyroid gland



Thyroid gland has 2 capsules:

- Inner**, thin fibrous (surrounds thyroid gland only)
- Outer**, from pretracheal fascia

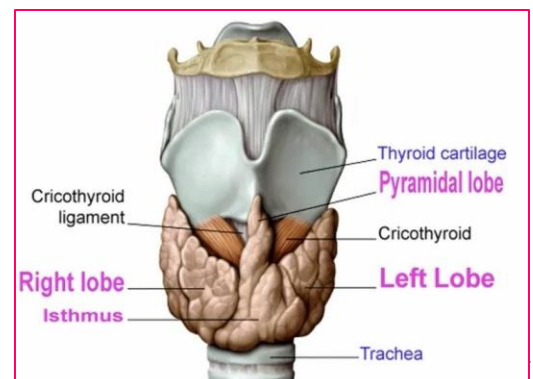
Clinical Note:

During physical examination of the thyroid gland we ask the patient to swallow, if we find that the thyroid gland is moving up and down with swallowing or speaking which is called an oscillating movement then the patient has an enlarged thyroid gland.

This movement is contributed to the pretracheal fascia

Pyramidal lobe

- In about **50%** of population an additional thyroid tissue may extend upward and to the left from the isthmus to the hyoid bone, forming the **pyramidal lobe (A Third Lobe)**.



- The pathway of pyramidal lobe represents the track of embryology of thyroid gland. **You should check whether the patient has a pyramidal lobe or not before surgery.**

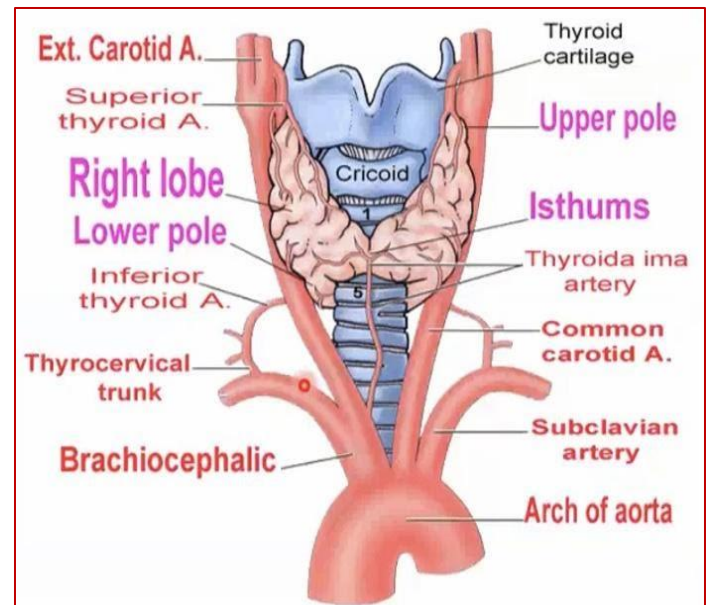
Blood supply of thyroid gland

Recap

▪ Branches of Arch of Aorta :

- 1- Brachiocephalic trunk , which divide into:
 - a) Right Common carotid artery
 - b) Right Subclavian artery
- 2- Left common carotid artery
- 3- Left subclavian artery

- Each common carotid artery is divided into :
 - 1- External carotid a.
 - 2- Internal carotid a.



The first branch of external carotid artery is **superior thyroid artery**.

- Thyroid gland is a highly vascularized gland ,receives about 40-120 ml of blood/minute.
- supplied by :

1- **Superior thyroid artery**

From the **ECA reach upper pole**, go with **external laryngeal nerve**.

- ✓ External laryngeal nerve supplies cricothyroid muscle.

Clinical Note:

During Thyroidectomy (surgical removal of thyroid gland) , the surgeon may need to ligate **superior thyroid artery** .

Ligation of the external laryngeal nerve might accidentally occur with the ligation of the superior thyroid artery and this leads to low voice (the patient can't shout due to loss of innervation of **cricothyroid muscle**)

2-**Inferior thyroid artery**

From **thyrocervical trunk** reach lower pole, go with **recurrent laryngeal N.**

- The subclavian artery is divided into 3 parts ; the first , the second and the third
- Thyrocervical trunk is a branch of the first part of subclavian artery.

- Recurrent laryngeal nerve is a branch of vagus nerve.

Clinical Note:

When we ligate inferior thyroid artery in thyroidectomy, recurrent laryngeal nerve may be **accidentally** ligated and this leads to **hoarseness of voice**.

2- Thyroid ima artery:

- ✓ From **brachiocephalic trunk or arch of aorta** to reach lower part of isthmus, **present in 3%**.
- ✓ **Ima means single.**
- Arteries anastomose freely over the surface of the gland for proper secretion.

Venous drainage of thyroid gland

Recap

- Internal jugular veins joins subclavian vein to form brachiocephalic vein
- Right brachiocephalic vein is shorter than the left one.

Drainage of the thyroid gland is by 3 parts of valveless veins:

1- Superior thyroid vein:

From upper pole to internal jugular vein, accompanies the superior thyroid artery and external laryngeal nerve.

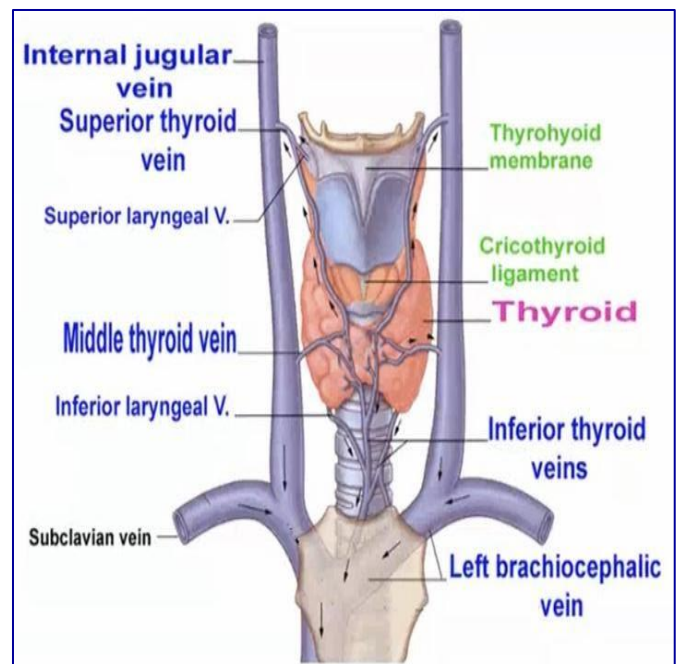
2. Middle thyroid vein:

From middle of the lobe to internal jugular vein.

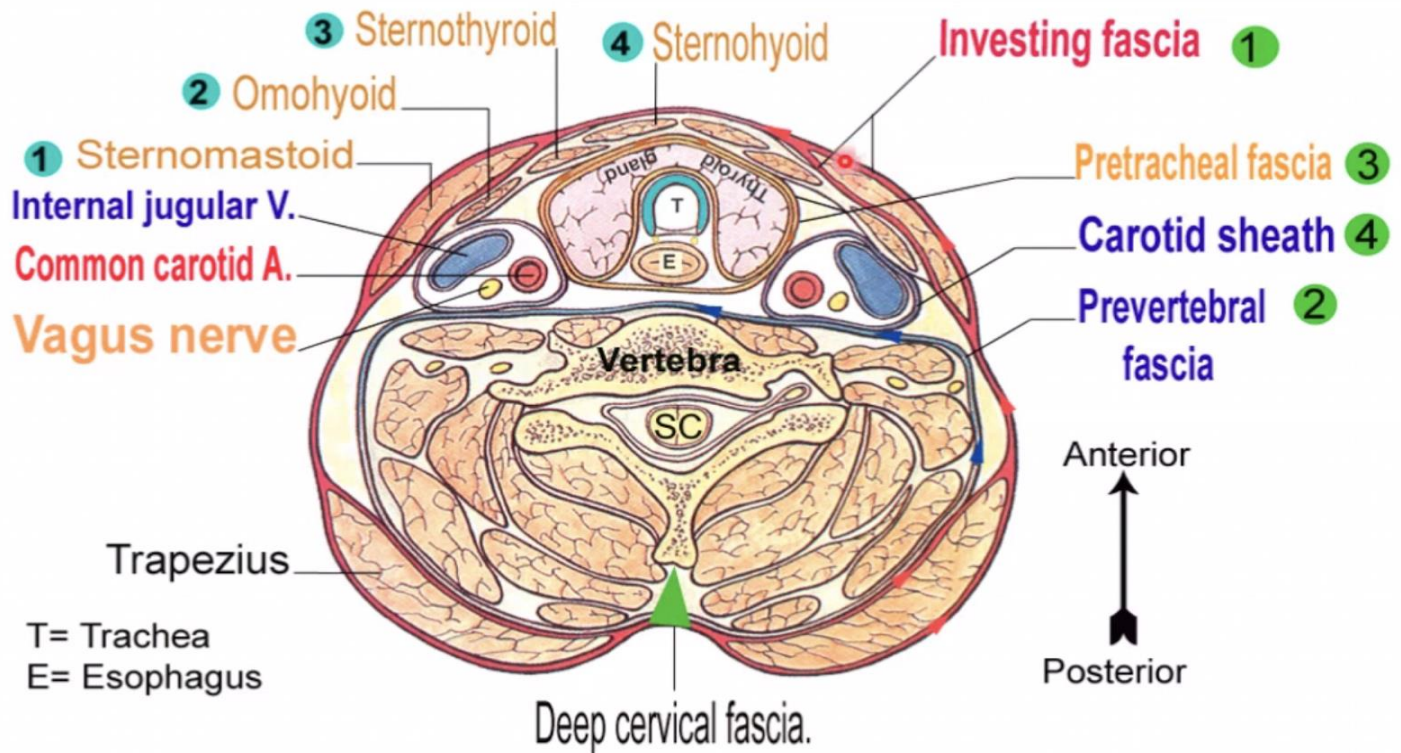
3. Inferior thyroid veins:

2 veins from isthmus, usually unites to end into **left** brachiocephalic vein. **Bleed profusely** if injured In tracheostomy.

- Both superior and middle thyroid veins drain into internal jugular vein while inferior thyroid vein drains into left brachiocephalic vein



Cross section in the neck



- Deep cervical fascia is located at the posterior aspect of the neck and spine.
- Deep cervical fascia extends laterally and then anteriorly to surround the contents of the neck.

Deep cervical fascia gives 3 fascias:

1- Investing fascia (Red in color)

- Investing means surrounding or embracing fascia
- Investing fascia is separated into 2 layers to surround **Trapezius muscle**, then these 2 layers unit then separate again to surround **sternomastoid muscle** anteriorly.
- sternomastoid is responsible for **nodding** the head (to lower or raise one's head slowly and briefly)

2-Prevertebral fascia (Blue in color)

- Surrounds the prevertebral muscles (the muscles around the vertebra)
- Part of it is called carotid sheath
- **Carotid sheath contains: (VAN)**
 - 1- Internal jugular vein
 - 2- Common carotid artery and it's continuation (internal carotid artery)
 - 3- Vagus nerve (10th cranial nerve)



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3-Pretracheal fascia

- Anterior to the trachea
- Surrounds :
 - 1- Thyroid gland.
 - 2- Respiratory portion, by surrounding larynx and trachea
 - 3- GI portion , by surrounding esophagus and pharynx (which is located superiorly to the esophagus)

So as mentioned before the pretracheal fascia is responsible for oscillation movement of thyroid gland when swallowing or speaking

Thyroid Gland, relations

Anterolateral: (muscles only)

1. Sternomastoid ,
2. Superior belly of Omohyoid ,*originates from scapula*
3. Sternohyoid
4. Sternothyroid

➤ All these muscles are named according to their origin and insertion

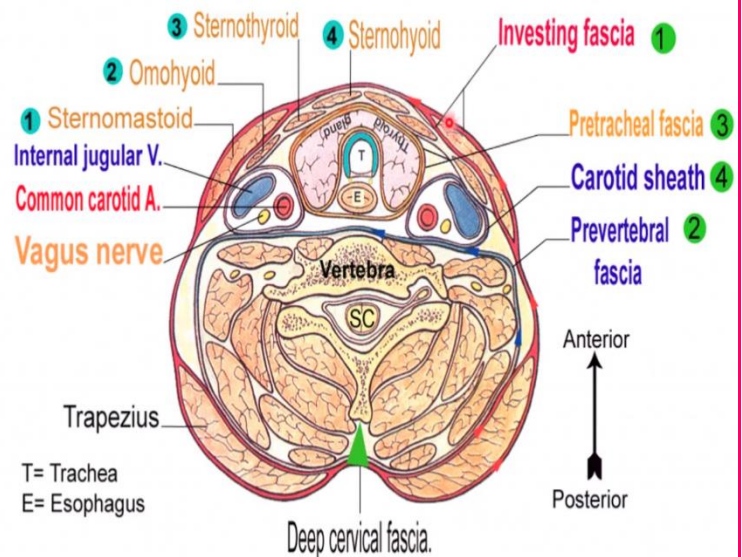
Medial:

1. Larynx , above the trachea
2. Trachea
3. Pharynx
4. Esophagus
5. Cricothyroid muscle
6. Recurrent laryngeal n.

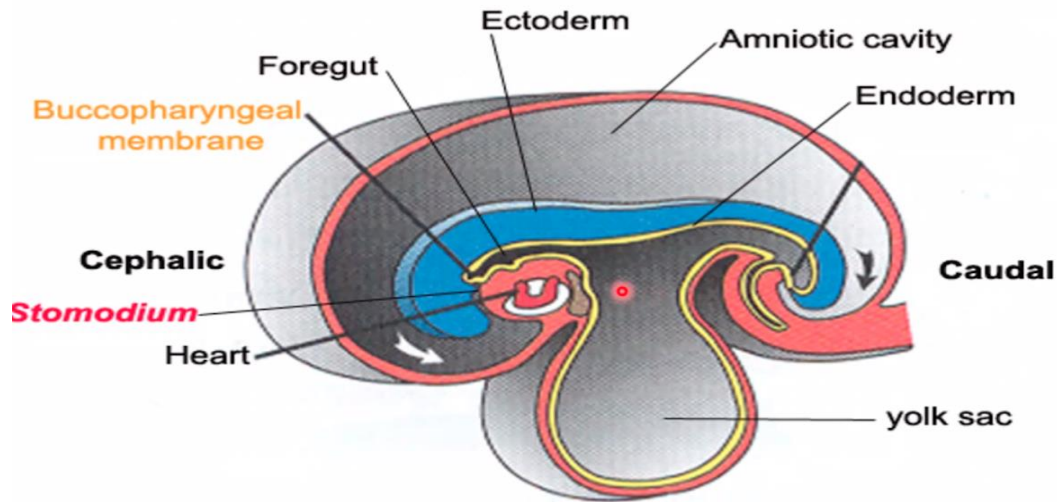
➤ We can see both cricothyroid muscle and recurrent laryngeal nerve passing between trachea and esophagus(recurrent laryngeal nerve ascending to its target in the larynx.)

Posterolateral:

Carotid sheath (contents)

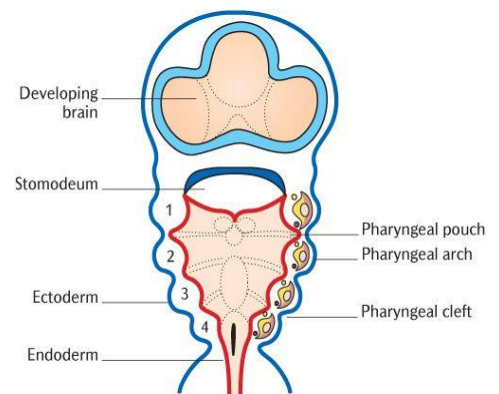


Embryology (development) of Thyroid gland



Sagittal section in embryo at Day 21 showing cephalocaudal foldings (arrows),

- **Trilaminar disc consists of 3 layers:**
 - 1- Ectoderm
 - 2- Mesoderm
 - 3- Endoderm
- **In the beginning of the 4th week, the flat embryo (Trilaminar disc) starts converting itself into a cylinder by :**
 - 1- Cephalocaudal folding
 - 2- Transverse folding
- **The yolk sac is incorporated into the cylindrical embryo and forms:**
 - 1- Foregut (Anterior GI)
 - 2- Midgut (Middle GI)
 - 3- Hindgut (posterior GI)
- Foregut starts with the primitive pharynx (first part of the foregut)
- Primitive pharynx is weak (soft), so horseshoe shaped arches (condensations) develop within it (pharyngeal arches) in order to strengthen it.
- Pharyngeal arches form pouches from the inside and clefts from the outside.
- **Stomodeum (Mouth to be) is lined by:**



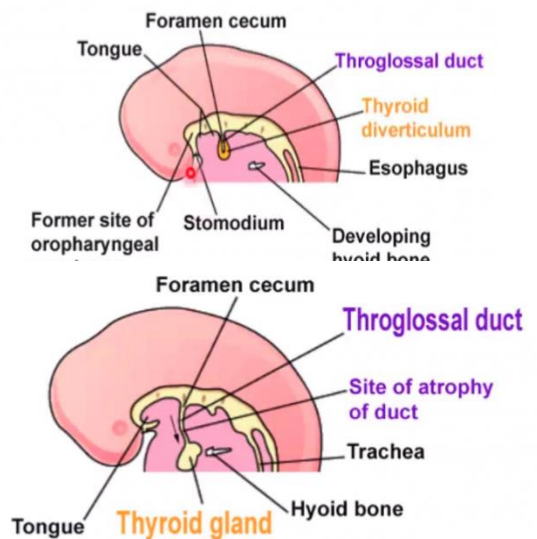
1-Ectoderm (from the outside)

2-Endoderm (from the inside)

- Stomodeum is separated from the anterior part of the foregut(endoderm) by **Buccopharyngeal membrane**
- Primitive pharynx is the site where the tongue develops.
- All external openings consist of endodermal portions and ectodermal portions including the mouth.
- Teeth and anterior 2 thirds of the tongue are ectodermal while posterior one third of the tongue is endodermal.

Development of thyroid gland

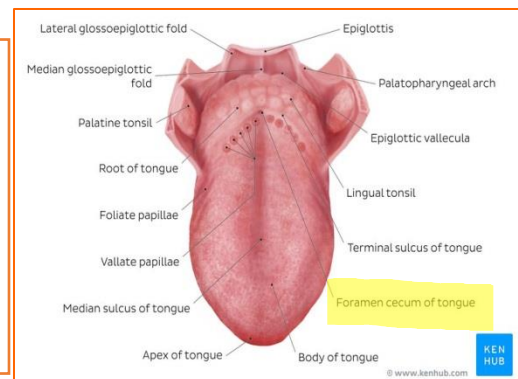
- **Thyroid gland is the first endocrine gland to develop.**
- By the end of the **4th week**, gland **primordium** appears as a small endodermal **thyroid diverticulum** (down pouching) in the floor of **primitive pharynx. (foramen cecum)**
- The thyroid diverticulum migrates down as the **thyroglossal duct**, ventral to the hyoid and larynx.
- By the end of the **5th week**, thyroglossal duct **degenerates** and the isolated thyroid, now consisting of 2 lobes connected by an isthmus. It continues to migrate, **reaching its final position by the 7th week.**



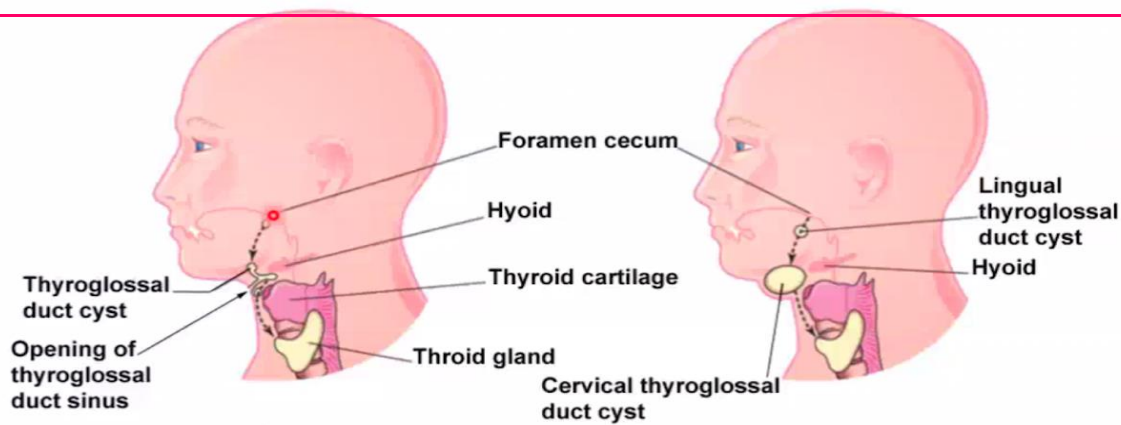
The development started in the where the foramen cecum is now between the anterior 2 thirds of the tongue and posterior one third of the tongue (between endodermal and ectodermal part of the tongue)

Foramen cecum: a small opening between the anterior 2 thirds of the tongue and posterior one third of the tongue

The posterior end of the anterior 2 thirds of the tongue is a V shaped area ,the inner angle of this V shape is the foramen cecum



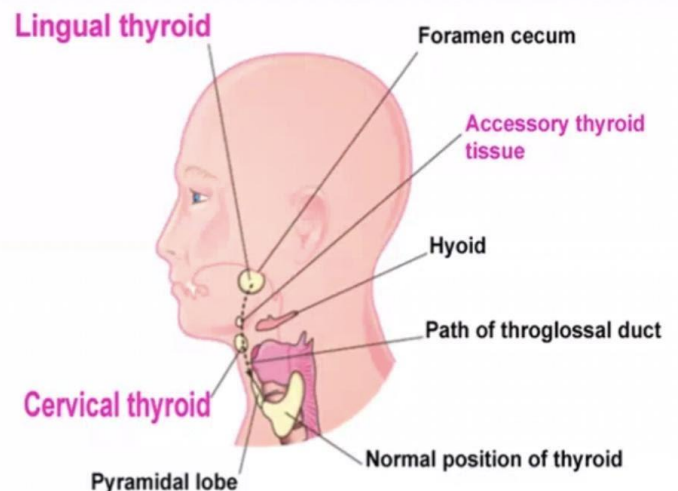
study bunnies



- Usually, thyroglossal duct degenerates and its only remnant is the foramen cecum. Occasionally, a portion of the duct persists (the duct doesn't regress completely) as an enclosed **thyroglossal cyst** (close sac, contains fluids) or as **a thyroglossal sinus** (open sac), which opens on the surface of the neck.
- The patient needs surgery in this case.
- This happens when the mother gets sick, takes drugs or doesn't eat well during pregnancy

Ectopic thyroid gland

- Infrequently, an **ectopic thyroid** is located along the normal path of its descent from the tongue. (it won't descend)
*Two types
1-lingual thyroid
2-sublingual thyroid (cervical thyroid)
- In 90% of cases this is represented by **lingual thyroid. (located within the foramen cecum)**
- **To examine lingual thyroid, we ask the baby to open his/her mouth and we will notice a frog mouth appearance.**
- Incomplete descent of thyroid results in a **sublingual thyroid** that appears high in the neck, at or just inferior to the hyoid bone (**cervical thyroid**).



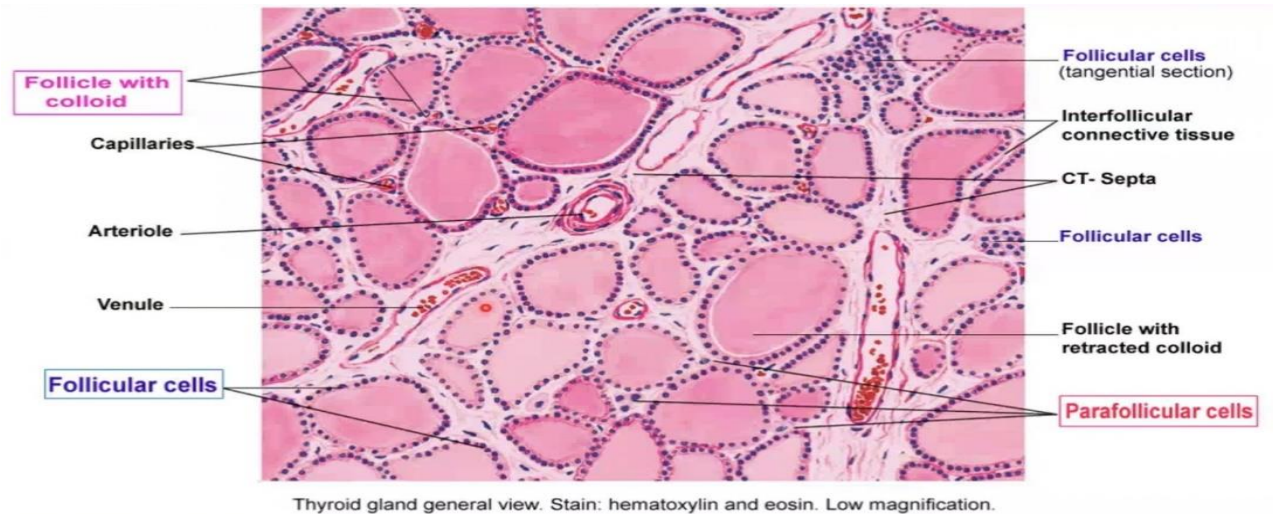
Frog mouth



In 70% of cases, an ectopic **sublingual thyroid** is the only thyroid tissue present. **?! Care should be taken to avoid accidental surgical removal of the only thyroid tissue present.**

(Because we don't want the patient to live on thyroxin for his /her entire life)

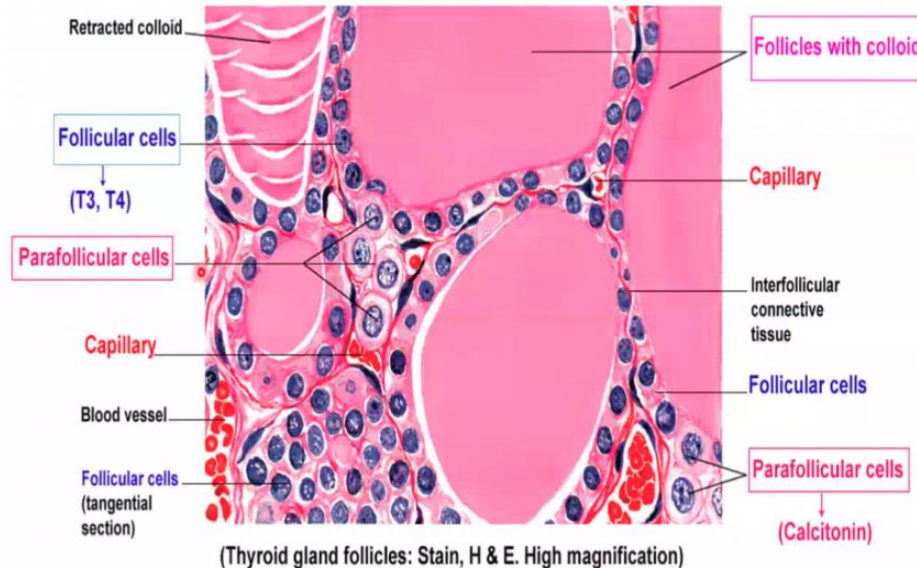
Histology of thyroid gland



Thyroid gland: Stain: H&E. Low magnification

1. **Numerous follicles** filled with **colloid**.
surrounded by dark blue cells (follicular cells)
 - Colloid is **iodide Thyroglobulin**.
 - Follicles store colloid for about **100 days** ,
 - Colloid represents a precursor for T₃ and T₄ hormones
 - Between the follicles there are numerous capillaries
 - Follicles are **acidophilic**.
 - We can say that the follicle is spherical or cyst like in shape
2. **Follicular (chief) cells**,
 - A cuboidal cell lines the follicles.
(It can be flattened depending on the state of function of the thyroid gland)
 - The follicular cells function is to synthesize and secrete the colloid and the thyroid hormones.(T₃ & T₄)
 - **Form the wall of the follicle**
 - **Their nuclei is stained blue (basophilic)**
3. **Numerous blood vessels**
 - are seen in the connective tissue septa and around follicles.
 - (Notice the venules , arterioles and capillaries in the picture above)
4. **Parafollicular cells**
 - Larger in size than follicular cells
 - Found as single or in masses on the periphery of follicles.

- They stain lighter than the follicular cells.
 - Parafollicular cells synthesize and secrete the hormone **calcitonin**.
 - **Their cytoplasm is light acidophilic but their nuclei is basophilic**
 - **Para = outside the follicle**
5. **Connective tissue** septa from capsule extend into the gland's interior and divide it into lobules.
- *within the interfollicular space we have interfollicular connective tissue ,the capillaries and blood vessels



Thyroid gland: Stain: H&E. High magnification

1. All thyroid follicles are filled with colloid.
2. **Follicular cells** are either cuboidal or flattened, influenced by the function of the individual follicles.
3. The **parafollicular cells** can be seen either
 - a. Adjacent to follicular cells or in small clusters adjacent to the thyroid follicles
 - b. They are larger than follicular cells
 - c. Oval in shape with cytoplasm staining lighter than the cytoplasm of the follicular cells , their nuclei is larger and dark.
4. Interfollicular connective tissue with numerous blood vessels and capillaries.

The doctor sent this additional slide to clarify what he explained about thyroid synthesis when I asked him:

1-Thyroid follicular cells catch iodide (I⁻) with negative charge from blood.

2-The RER produce a large glycoprotein contains tyrosine (amino acids) called thyroglobulin (TGB) then modified in the Golgi.

3-The tyrosine that will become iodinated cannot bind to the negatively charged iodide until they undergo oxidation to give the iodine (I₂), which can pass through the inner membrane into the lumen of the follicle.

4-Within the lumen, as the iodine molecules reacts with tyrosine, binding of one iodine atom (I₂) with tyrosine produce moniodotyrosine (T₁) [I₂ + Tyrosine= T₁] and a 2nd iodination produces diiodotyrosine (T₂). The iodinated TGB stored in the follicular lumen, is called colloid.

5-During the last step in synthesis of thyroid hormones, coupling of T₁ and T₂ occurs, where one T₁ + one T₂ = T₃ / two T₂ molecules join = T₄.

6-Droplets of colloid reenter the follicular cells, merge with the lysosomes that digest the colloid and release the T₃ and T₄ to diffuse through the cell membrane into the interstitial fluid and then into the blood.

This might help:

1-follicular cells catch iodide (I⁻)

2-Enter follicles and get oxidized by binding with glycoprotein (tyrosine) become iodine

3-Goes back to follicular cells to transform into T₃, T₄

4-Then to follicles to be stored when needed

Clinical correlations:

✧ **Thyroidectomy** is a surgical removal of the thyroid gland and during surgery the thyroid ima artery and inferior thyroid veins are at risk. (in addition to external and recurrent laryngeal nerves)

✧ Potential complications may include

- 1- Hemorrhage from injury of the anterior jugular veins.
- 2- Nerve paralysis, particularly of the recurrent laryngeal nerves.
- 3- Pneumothorax resulting from damage of the cervical dome of the pleura.
- 4- Esophageal injury due to its immediate posterior location to the trachea.

✧ **Goiter** is an enlargement of the thyroid gland, which is commonly caused by:

- 1- Iodine deficiency (because iodine is vital to the formation of thyroid hormone)
 - 2- Hyperthyroidism (overproduction of thyroid hormones),
 - 3- Hypothyroidism (which causes the gland to swell in its attempt to produce more hormones)
- The gland produces more ATP for energy so this why the lady may be nervous , has no apatite and complains from a high temperature or feeling hot .

• Goiter is more common in females

- The enlarged gland compresses the trachea, larynx, esophagus, and recurrent laryngeal nerve, causing symptoms of:
 - 1- Breathing difficulties (dyspnea).
 - 2- loss of speech.
 - 3- Cough.
 - 4- Wheezing.
 - 5- Swallowing difficulties (dysphagia).
 - 6- Neck vein distention.
 - 7- Dizziness.

The goiter can be treated with radioactive iodine to shrink the gland or with thyroidectomy.

Good luck

release some endorphins
and smile !

