# ENDOCRINE

## ANATOMY

**# 5**

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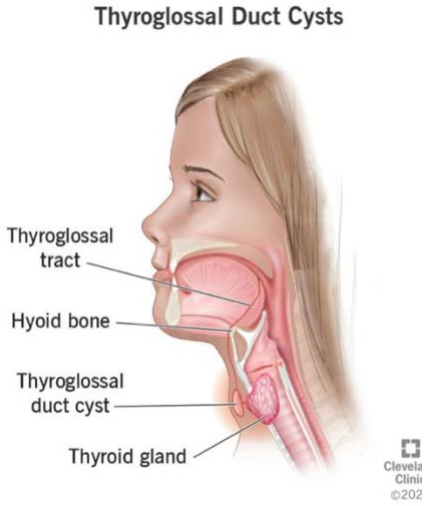
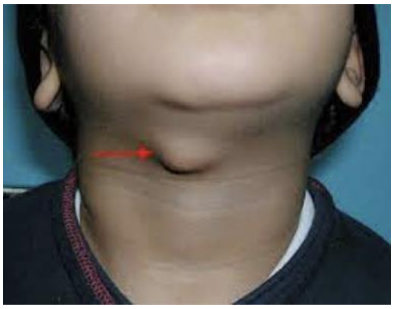
- Remember that by the 10th week of gestation, the **Thyroglossal duct** (the connection) degenerates, leaving the thyroid gland. But incomplete degeneration might happen!

# INCOMPLETE DEGENERATION OF THYROGLOSSAL DUCT HISTOLOGY




- The remnants of the thyroglossal duct will form the **thyroglossal cyst** and the **pyramidal lobe.**
- The part of the **thyroglossal duct** which was connected the thyroid gland does not disappear forming the **pyramidal lobe** of the thyroid gland**.**
- Remember that the pyramidal lobe is connected to the hyoid bone by fibrous or muscular tissue.



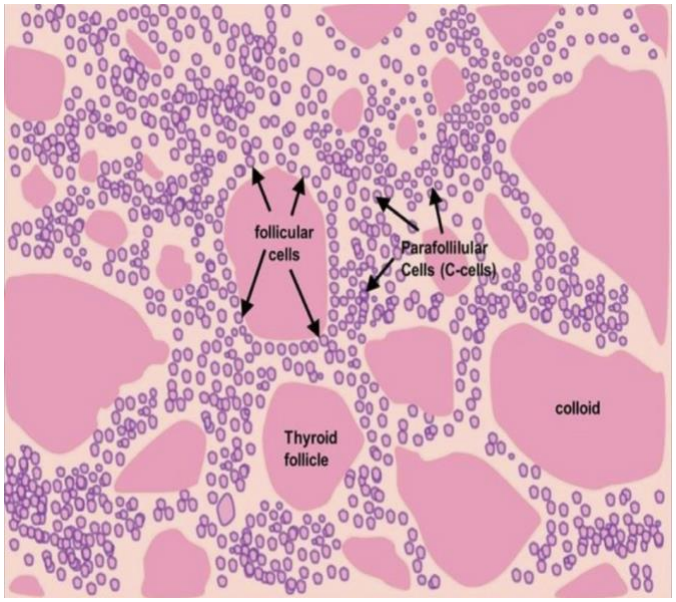
- **Thyroglossal duct cyst** ( cyst filled with fluid), is detected in young age group or younger than 10 years old.

- **Lingual thyroid** might also be due to incomplete degeneration of thyroglossal duct. But mostly is caused by failure of the thyroid gland to descend from its origin (neighboring the tongue) to its final destination in the neck.
- It will be hard to swallow having this lump sitting on the tongue.
- Lingual thyroid is rare, but can happen and be detected early in embryo.

# HISTOLOGY

**The parenchyma is composed of millions of rounded epithelial thyroid follicles of variable diameter, each with simple epithelium and**

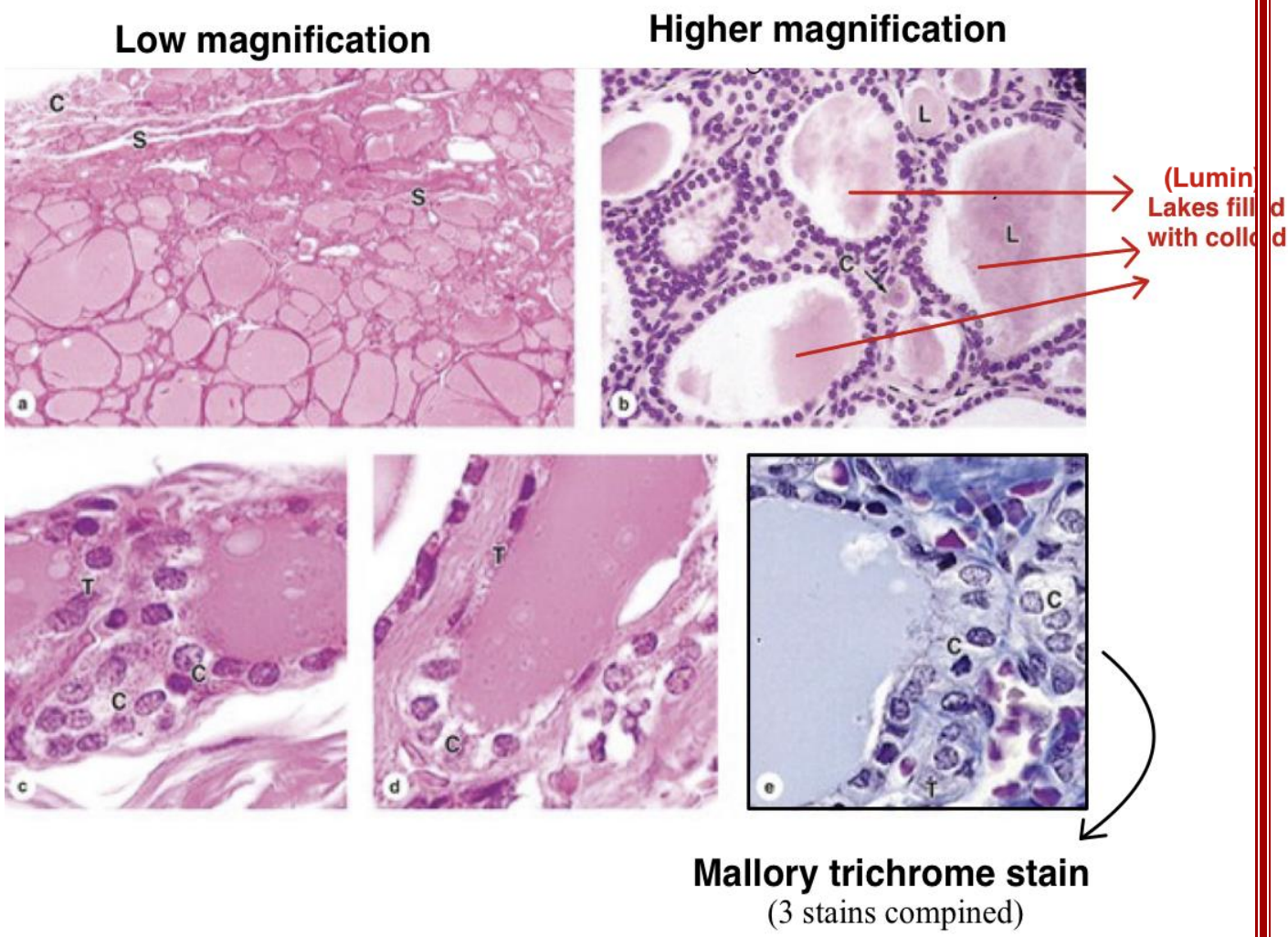
- **A central lumen densely filled with gelatinous acidophilic colloid**
- **Only endocrine gland in which a large quantity of secretory product is stored.**
- **Storage is outside the cells, in the colloid of the follicle lumen.**
- **There is sufficient hormone in follicles to supply the body for up to 3 months.**
- **Thyroid colloid contains the large glycoprotein thyroglobulin (the inactive form of the hormone)---the precursor for the active thyroid hormones.**




- We find two types of cells in the thyroid tissue: **Follicular cells (thyrocytes)** surrounding the lumin (colloid filled structures), and **parafollicular cells** which share the basal lamina of the follicular cells.

- Follicular cells synthesise the Thyroglobulin and it stores it in the colloid.

# THYROID HISTOLOGY




**(a) thin capsule (extended part) (C), septa (S).**

**( b ) The lumen (L), present are large pale-staining parafollicular or C cells (C).**

**( c-e ) Thyrocytes (T) from parafollicular C cells (C) by their smaller size and darker staining properties**

- Thyroglobulin immuno-staining is a method used to test for a drugs that work on upregulating thyroglobulin release or synthesis.

# THYROID FOLLICULAR CELLS AND PARAFOLLICULAR CELLS.

- **Is covered by a fibrous capsule--- septa.**
  - Thyroid gland is covered with a fibrous capsule that sends septa to divide the gland into compartments (the lobes and lobules).
  - The capsule is a dense irregular type of connective tissue.
- **Follicles are densely packed together--- sparse reticular connective tissue.**
- **stroma is very well vascularized with fenestrated capillaries.**

To transport the newly produced hormones

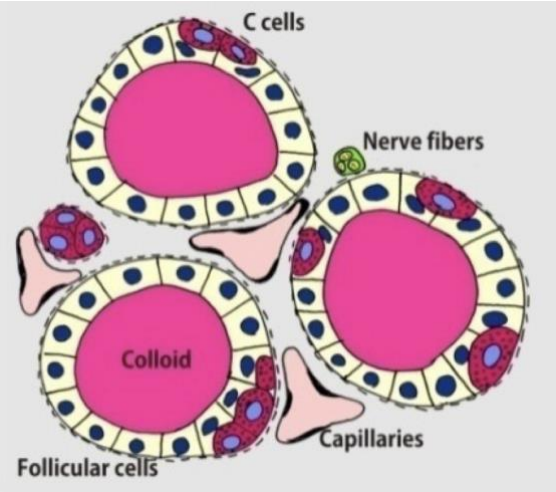
- **The follicular cells, or thyrocytes, range in shape from squamous to low columnar (activity related—TSH).**
  - Thyrocytes have no homogenous appearance, it depends on the activity of the gland
  - Higher activity of the gland ( high TSH recieved)—-> low columnar shaped cells.
  - Lower activity—-> squamous or low cuboidal shaped cells.

  - Parafollicular cells have less variation in size, because they have no receptor for TSH, meaning they don't need a stimulant to function.

- **The cells exhibit organelles indicating active protein synthesis**
- **The nucleus is generally round and central, ER/Golgi basally.**

# PARAFOLLICULAR CELLS

- **Parafollicular cell ( C cell), is also found inside the basal lamina of the follicular cells or as isolated clusters between follicles**
- **Derived from the neural crest ( in old textbooks) or endoderm (in more recent publications).**



- **Somewhat larger than follicular cells and stain less intense.**
- **Smaller amount of rough ER, large golgi complexes, and numerous small granules containing calcitonin. Secretion of calcitonin is triggered by elevated blood ca+2 levels, and it inhibits osteoclast activity.**
  - Osteoclasts originate from monocytes that left the circulation and resided in the bone to function on bone degradation (not in a pathological way) but important in bone remodeling.
  - It's a tool to get calcium in lower levels of calcium in the blood, or in deficiency of calcium in the diet.

# PRODUCTION OF THYROID HORMONE & ITS CONTROL

**The major activities of this process: look at the picture in the next page!**

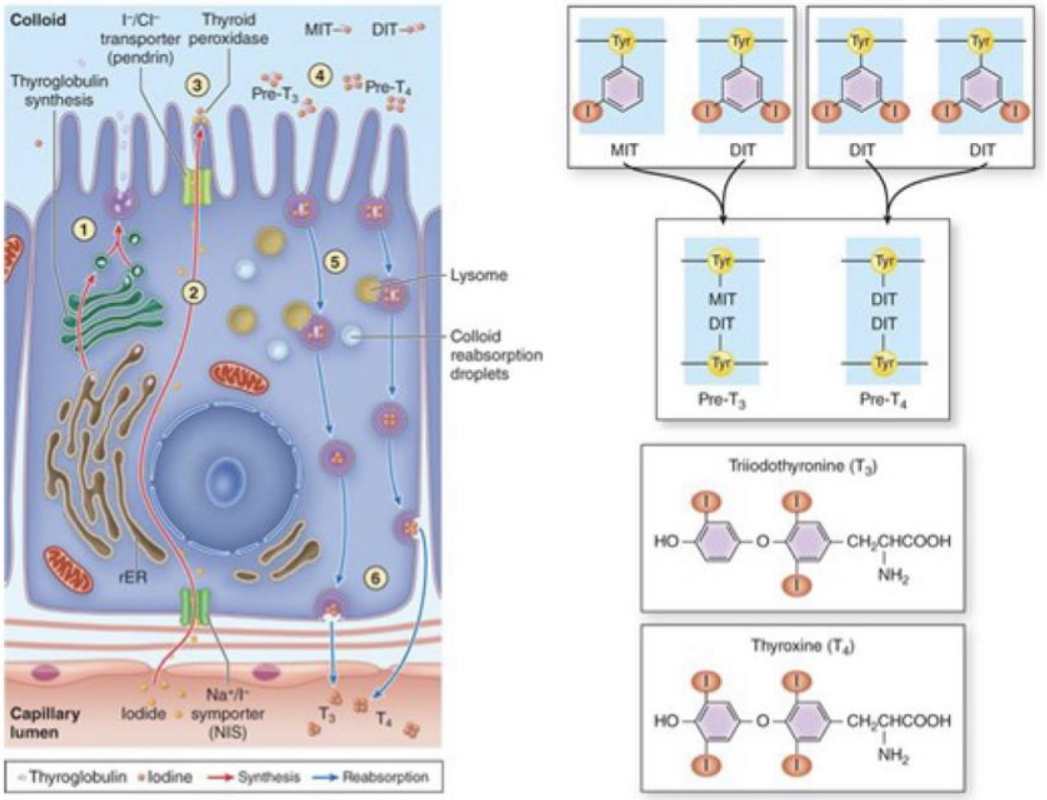
- **The production of thyroglobulin (140 tyrosyl residues)**
  - The Thyroglobulin then is sent to the lumen.
- **The uptake of iodide (30-fold concentration)**
  - The uptake of iodide from the blood into the Thyrocyte by Na+/I- symporter (NIS).
  - The Iodide is sent to the lumen by I-/Cl- transporter (pendrin).
- **Iodination of tyrosyl residues ( after oxidation of iodide)**
  - The Iodide is then converted to Iodine, by peroxidases.
  - This oxidation happens on the **microvilli** (extensions of the cytoplasm covered with cell membrane) at the apical surface of the thyrocyte.
- **Formation of T3 and T4**
  - By the Iodine binding to the tyrosyl residues of the Thyroglobulin. (In the colloid).
- **Endocytosis of iodinated thyroglobulin (lysosomal proteases)**
  - The iodinated thyroglobulin enter the thyrocyte through vesicles, ( we still don't have free T3 and T4).
  - The endocytosed vesicles will bind with lysosomes.
  - Proteases of the lysosomes will cleave the tyrosyl residues in the form of T3 and T4 (The final form of the hormone).

• **Secretion of T4 and T3**

- Secretion of T3 and T4 basally and laterally into blood capillaries.

# PRODUCTION OF THYROID HORMONES

- Note that follicular cells have **apical/luminal** side (in contact with the lumen), and **basal/vascular** side (in contact with the interstitial fluid and blood vessels).
- The vessels surrounds the follicular cell basally and laterally.




**Involve an unusual, multistage process in the thyrocytes---with both an exocrine/ endocrine phases promoted by TSH. and occur in the same cell.**

**• The diagram shows the multistep process by which thyroid hormones are produced via the stored thyroglobulin intermediate. In an exocrine phase of**

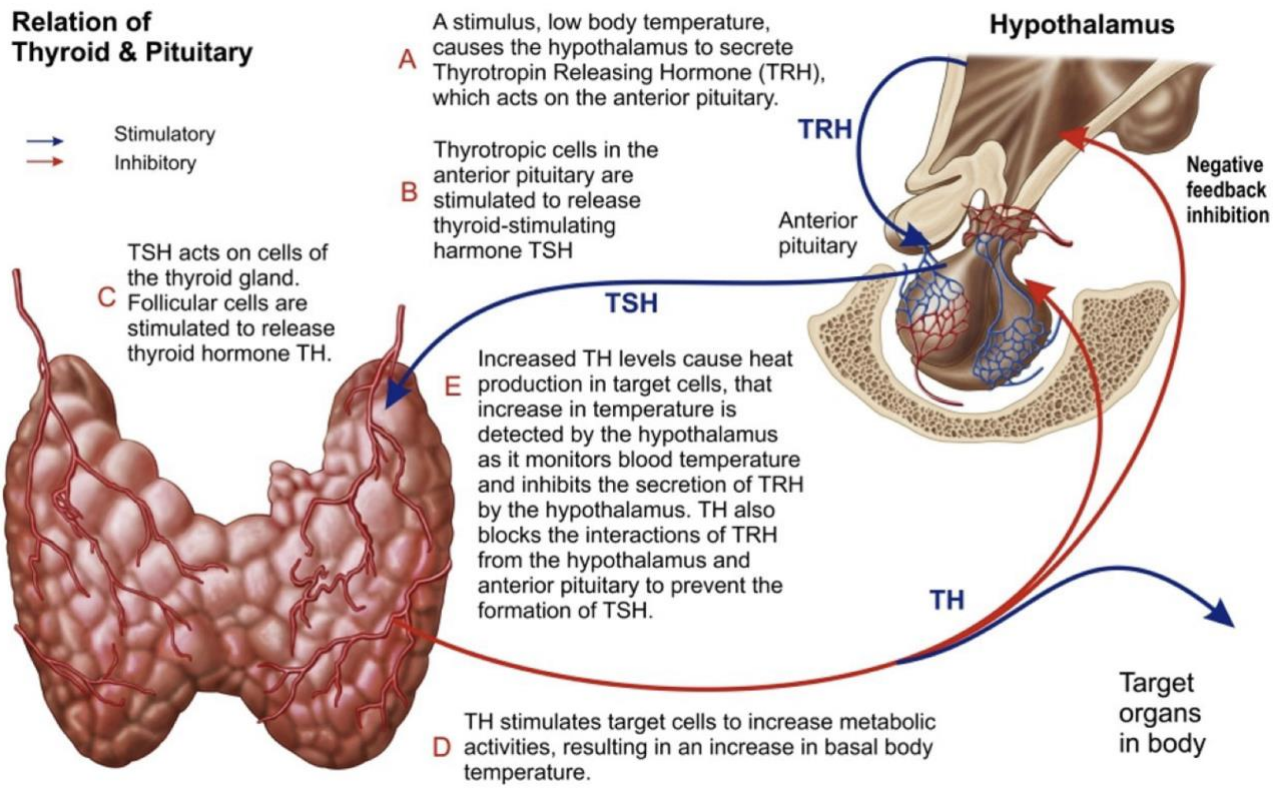
**• The process, (1) the glycoprotein thyroglobulin is made and secreted into the follicular lumen and (2) iodide is pumped across the cells into the lumen.**

**• In the lumen (3) iodide is converted to iodine by membrane- bound thyroid peroxidase and added to tyrosine residues of thyroglobulin (4) to form monoiodotyrosine (MIT) or diiodotyrosine (DIT), which are then**

**covalently coupled to form t3 and t4 still within the glycoprotein. The iodinated**

**• Thyroglobulin is then (5) endocytosed by the thyrocytes and degraded by lysosomes, (6) releasing free active T3 and T4 to the adjacent capillaries in an endocrine manner. Detailed steps are given in the text. Both phases are promoted by TSH and may occur simultaneously in the same cell.**

# NEGATIVE FEEDBACK LOOPS AFFECTING ANTERIOR PITUITARY SECRETION




- Receptors on the Hypothalamus (nueral part) measures the body temperature, so having low body temperature will stimulate it to release **TRH**.
- **TRH** (Thyrotropin releasing hormone) is secreted from the nuclei of the hypothalamus through the portal circulation to bind the **Thyrotrophs** (of the adenohypophysis).
- **Thyrotrophs** will then synthesize **TSH** ( Thyroid stimulating hormone) and will release it through the systemic circulation to bind TSH receptors on the **Thyrocytes** (follicular cells).

- **Thyrocytes** are then stimulated to produce the Thyroglobulin and then the Thyroid hormone.

- This cycle is not vicious cycle, we have checkpoints!
- It is controlled By a **Feedback Mechanism**
- The Thyroid hormones work on metabolism of cells, and some of those cells are energy producers, ( fuel burning—->heat production) increasing the body temperature which act as a **negative feedback** on the TRH secretion. (No TRH, no TSH then no Thyroid Hormone).
- But this happens gradually (not all or none), TRH and TSH levels are well monitored ,unless having a pathological condition that makes everything out of control.

**GOOD LUCK**