ANATOMY OF THE THYROID AND PARATHYROID GLANDS

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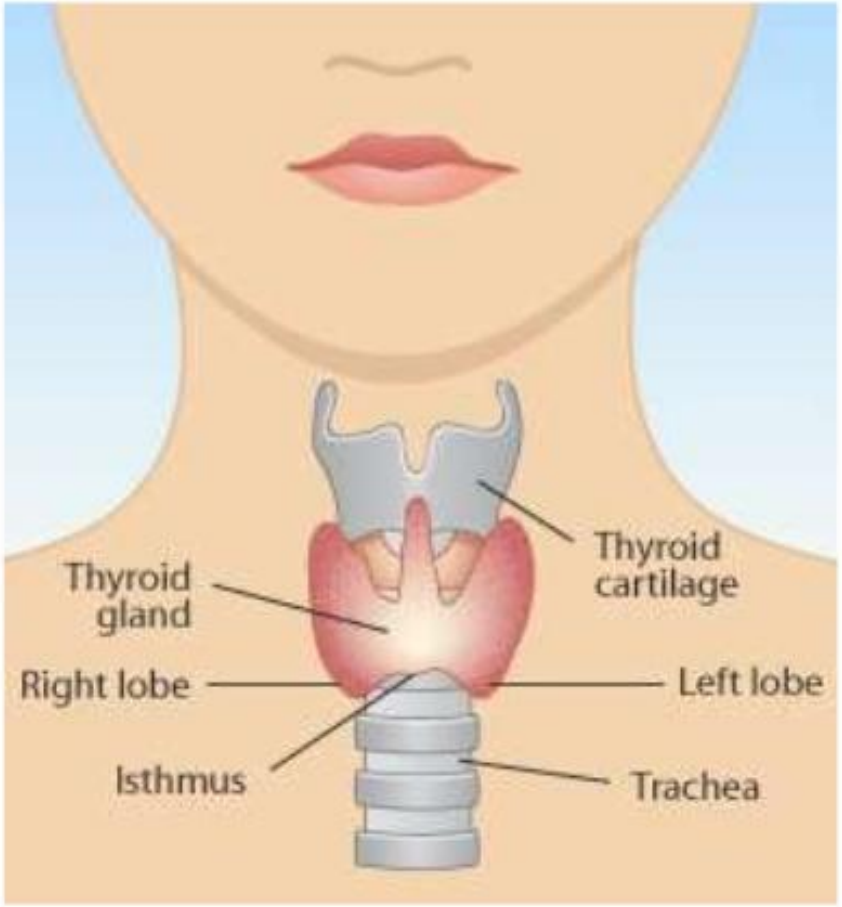
Development Of Thyroid Gland


Thyroid cartilage
Thyroid gland
Right lobe
Left lobe
Isthmus
Trachea

THYROID GLAND DEVELOPMENT

- The thyroid gland is the first of the body's endocrine glands to develop, on approximately the 24th day of gestation

- It begins its development from a median endodermal thickening in the floor of the primitive pharynx just caudal to the future site of the tuberculum impar

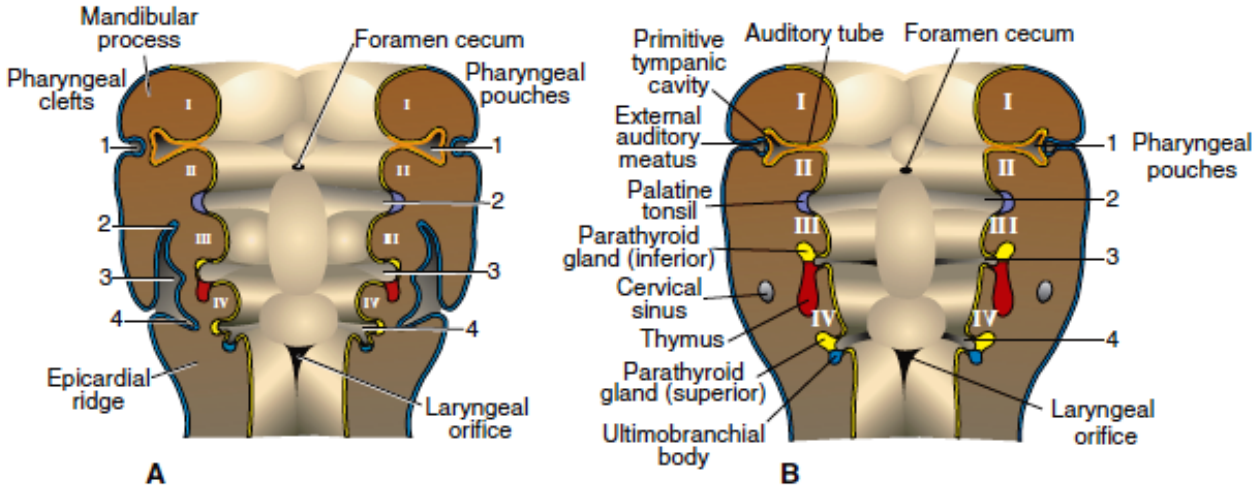


Figure 17.10 **A.** Development of the pharyngeal clefts and pouches. The second arch grows over the third and fourth arches, burying the second, third, and fourth pharyngeal clefts. **B.** Remnants of the second, third, and fourth pharyngeal clefts form the cervical sinus, which is normally obliterated. Note the structures formed by the various pharyngeal pouches.

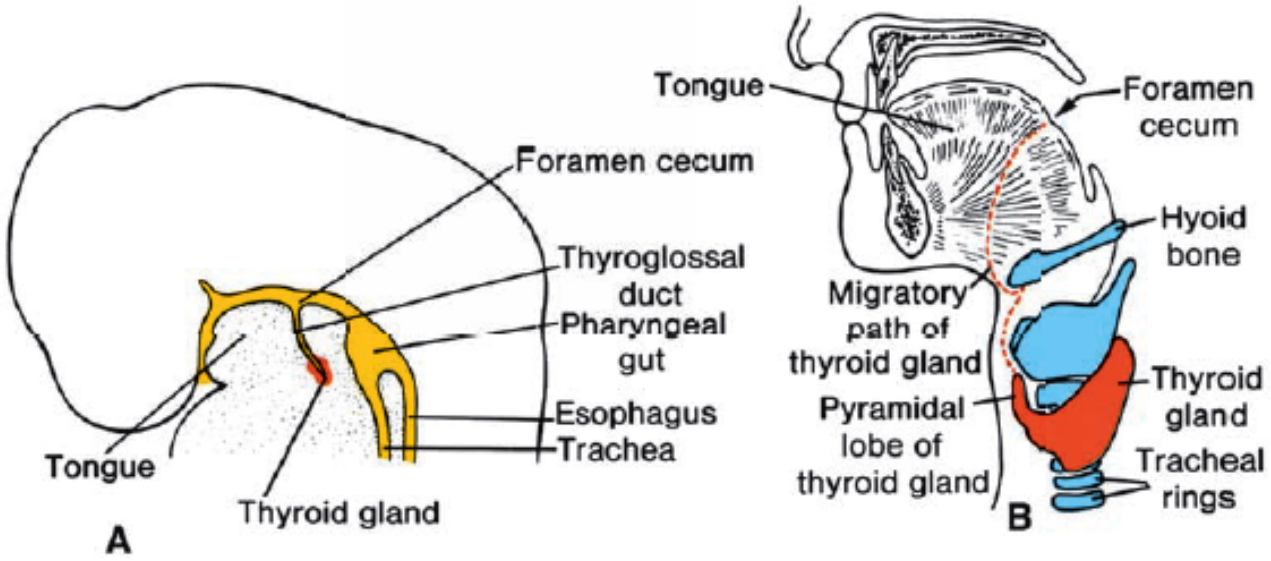


Figure 17.18 **A.** The thyroid primordium arises as an epithelial diverticulum in the midline of the pharynx immediately caudal to the tuberculum impar. **B.** Position of the thyroid gland in the adult. *Broken line*, the path of migration.

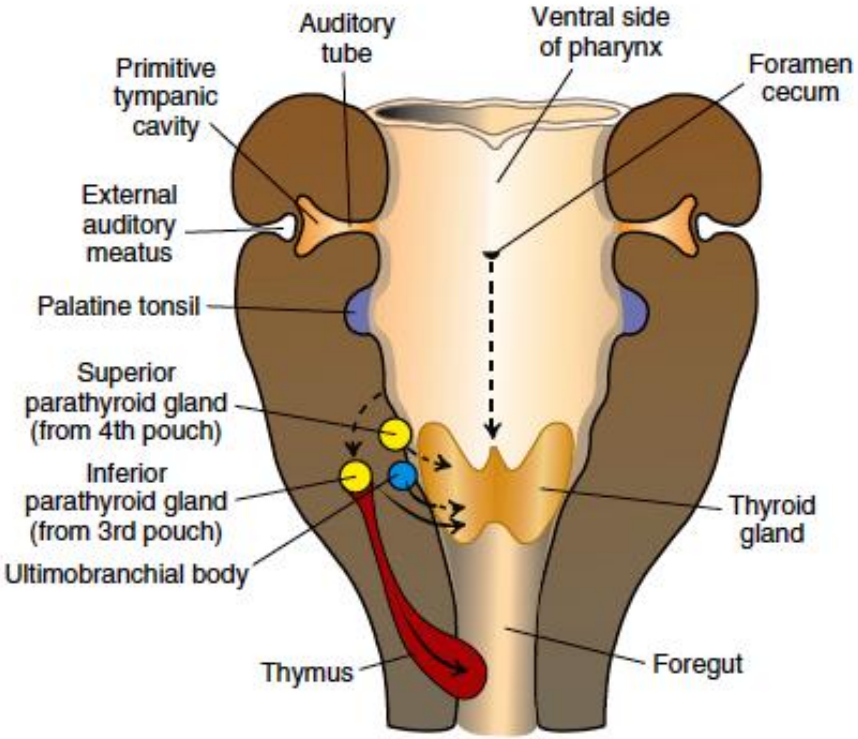


Figure 17.11 Migration of the thymus, parathyroid glands, and ultimobranchial body. The thyroid gland originates in the midline at the level of the foramen cecum and descends to the level of the first tracheal rings.

Descent of the Thyroid Gland

- Thickening forms a downgrowth, *thyroid diverticulum*, which grows into the underlying mesoderm, and as the embryo elongates and the tongue grows, the diverticulum descends in front of the neck and pharyngeal gut
- The diverticulum is connected to the tongue by a narrow canal, the *thyroglossal duct,* which opens in the tongue via the *foramen cecum,* which persists as a vestigial pit on the tongue

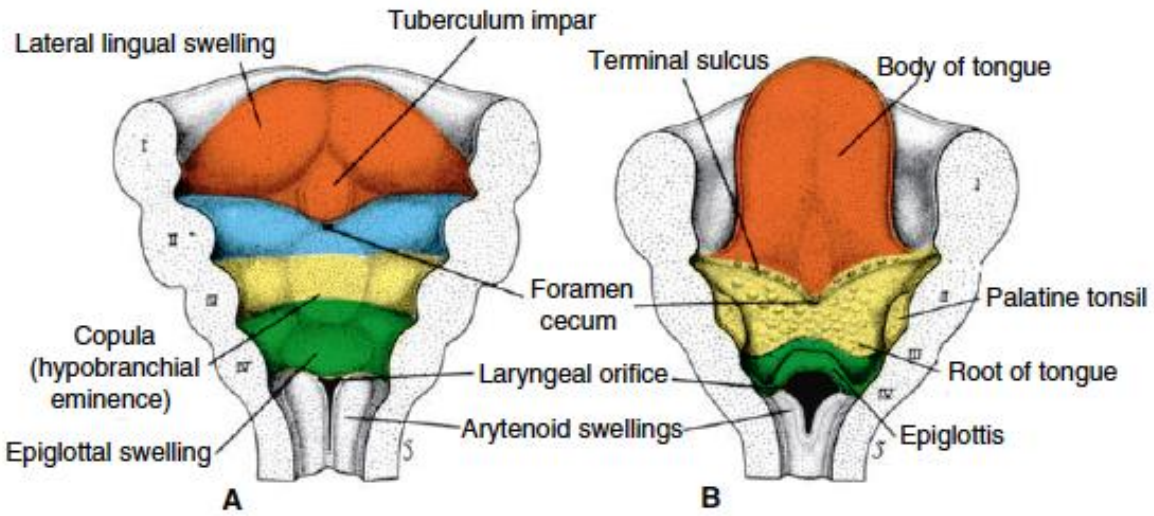
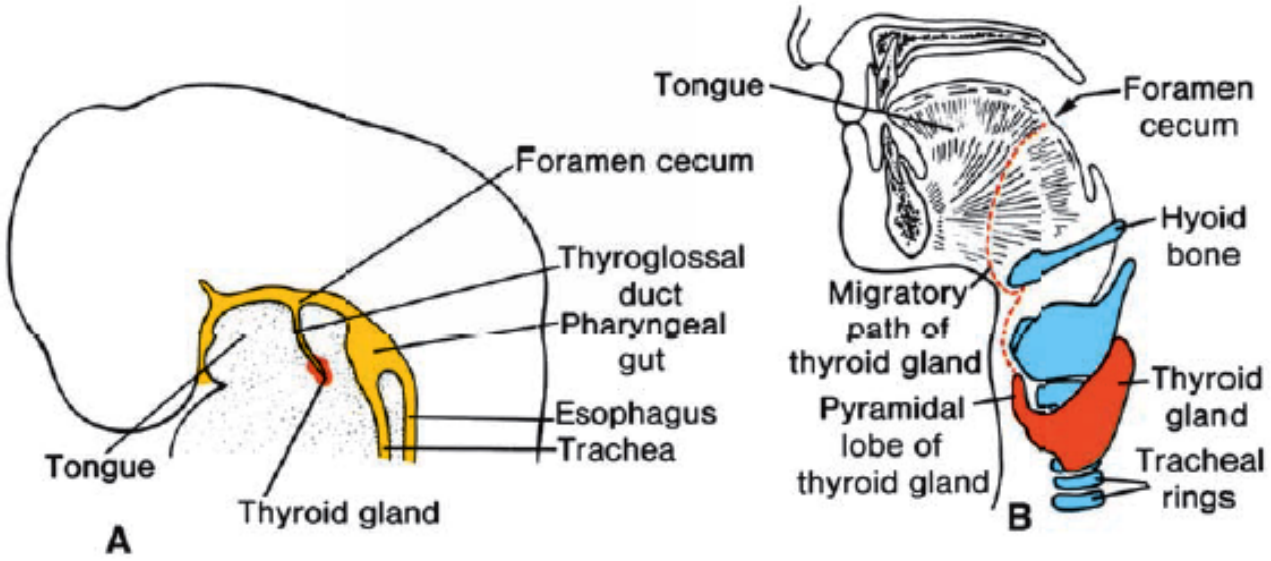


Figure 17.17 Ventral portion of the pharyngeal arches seen from above showing development of the tongue. I to IV, the cut pharyngeal arches. **A.** 5 weeks (~6 mm). **B.** 5 months. Note the foramen cecum, site of origin of the thyroid primordium.

..Cont

- Diverticulum grows rapidly and forms 2 lobes
- By week 7 of embryonic development, it reaches anterior to the trachea, having acquired a small median isthmus and 2 lateral lobes. By then, the thyroglossal duct usually has disappeared
- A pyramidal lobe of the thyroid may be observed in as many as 50% of patients. This lobe represents a persistence of the inferior end of the thyroglossal duct that has failed to obliterate.



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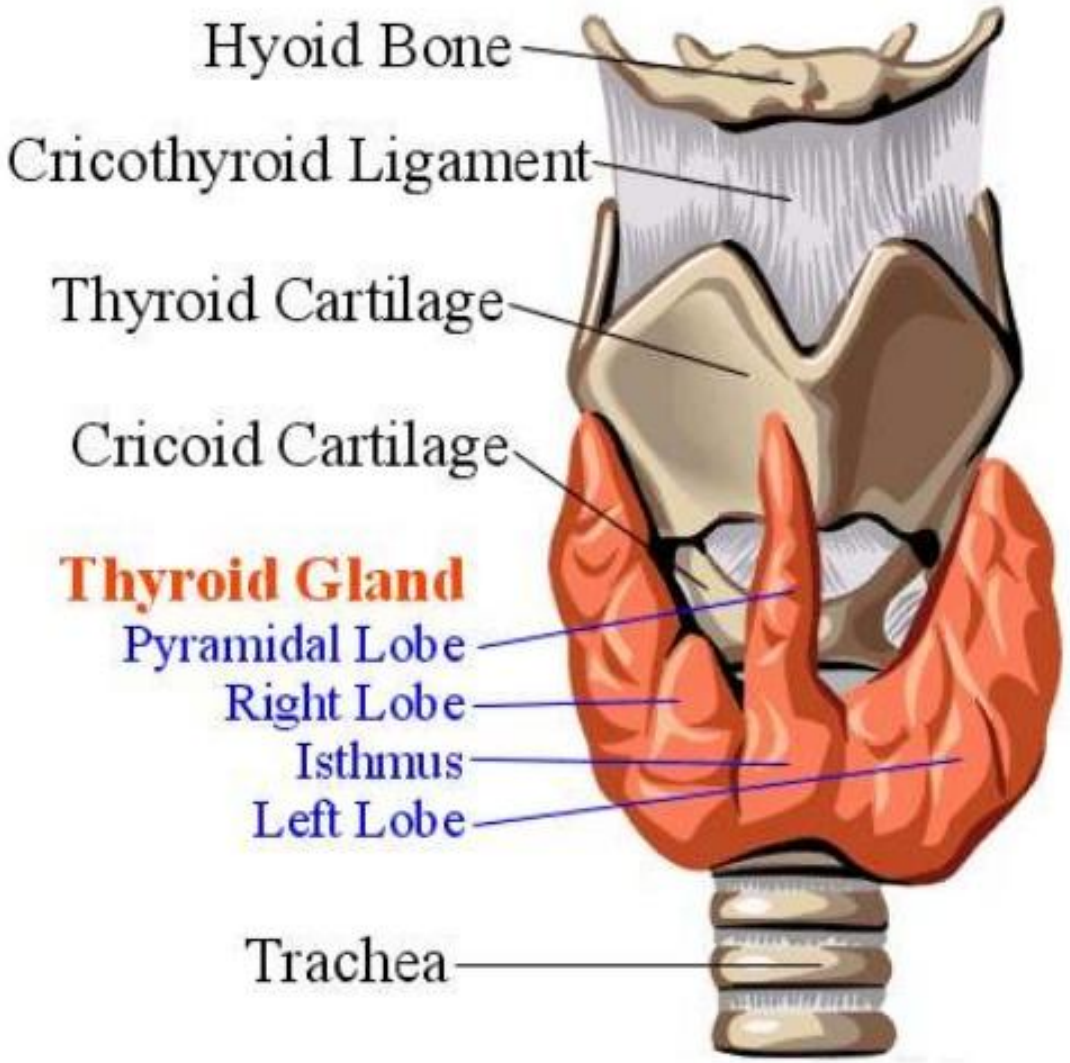
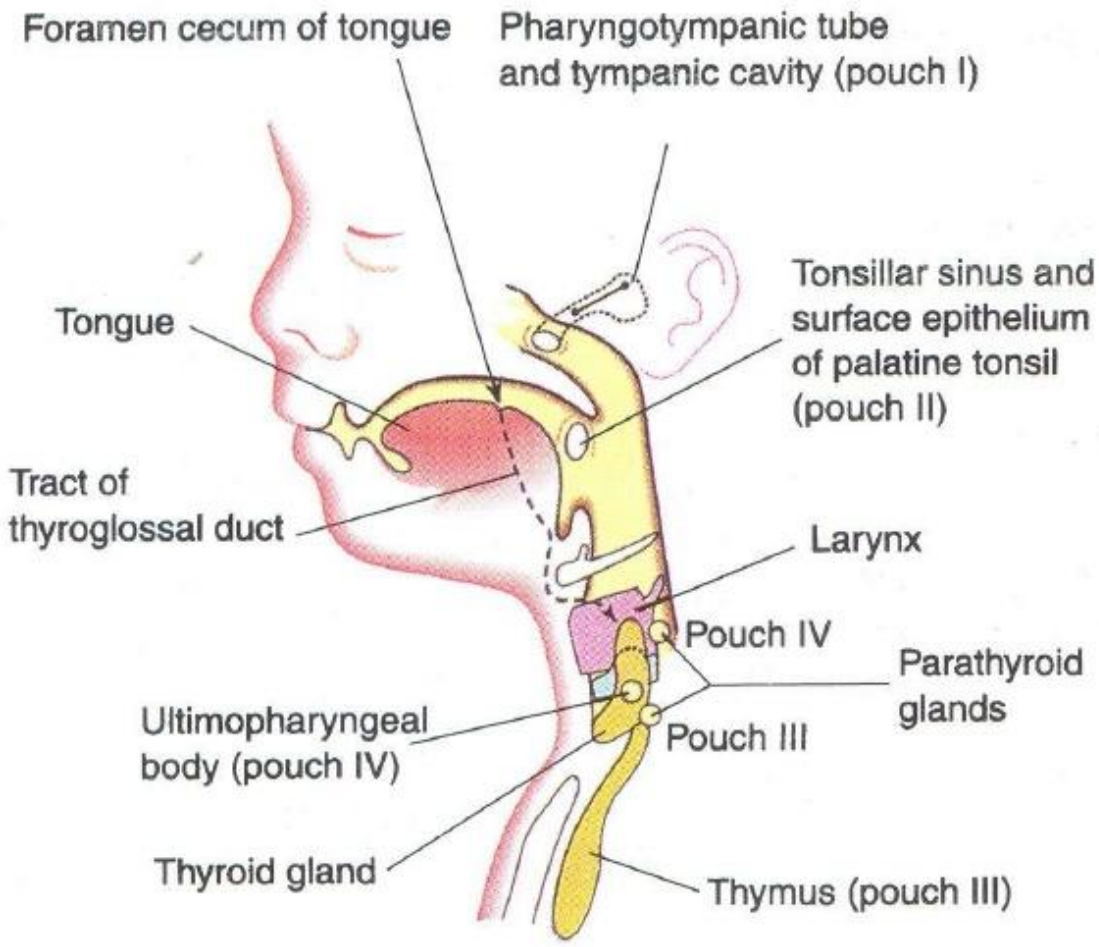
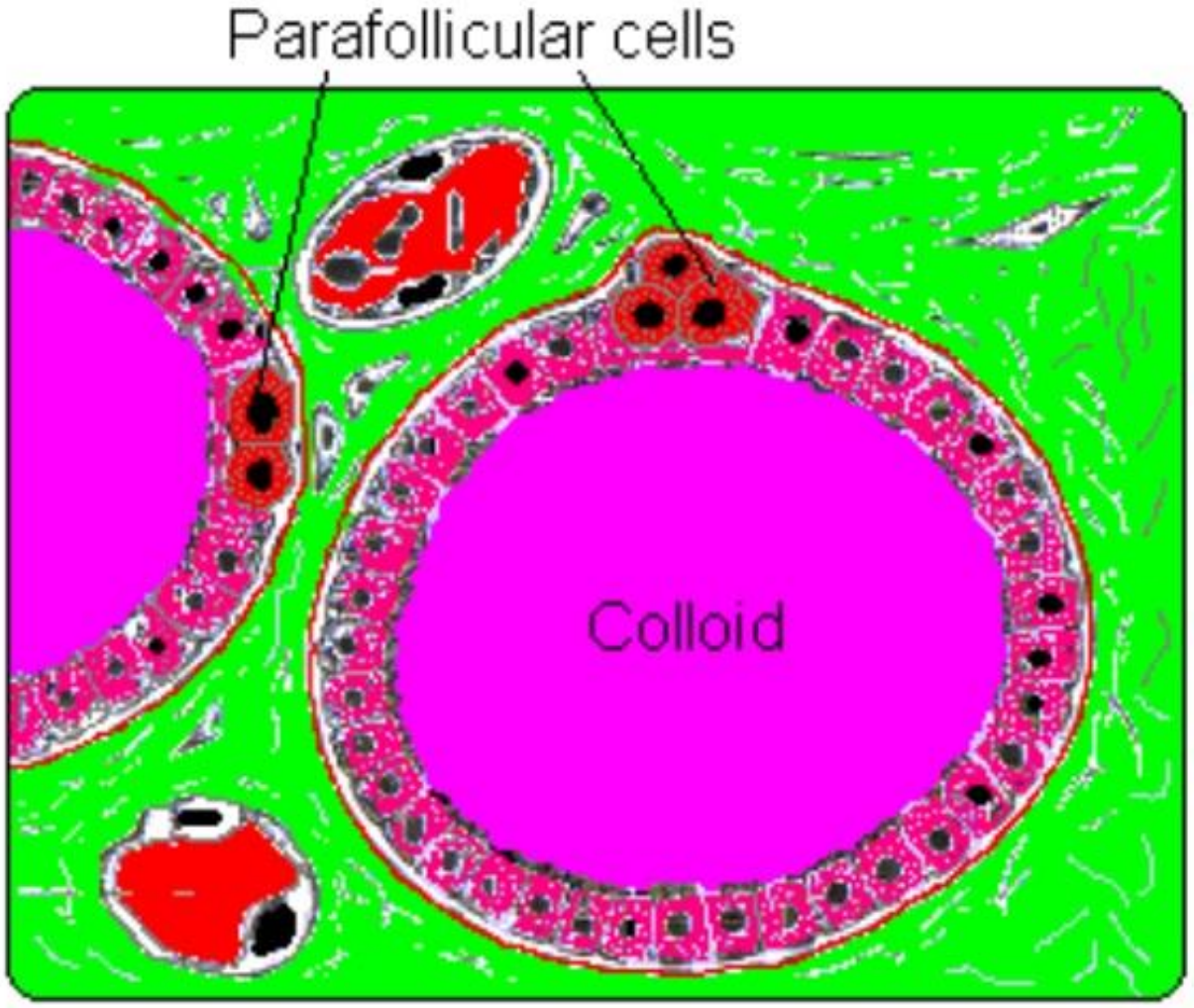

Hyoid Bone
Cricothyroid Ligament
Thyroid Cartilage
Cricoid Cartilage
Thyroid Gland
Pyramidal Lobe
Right Lobe
Isthmus
Left Lobe
Trachea


Foramen cecum of tongue
Pharyngotympanic tube and tympanic cavity (pouch I)
Tongue
Tonsillar sinus and surface epithelium of palatine tonsil (pouch II)
Tract of thyroglossal duct
Larynx
Pouch IV
Parathyroid glands
Ultimopharyngeal body (pouch IV)
Pouch III
Thyroid gland
Thymus (pouch III)

- THE THYROID GLAND begins to function at about the end of month 3, at which time, the first follicles containing colloid can be seen
- AT FIRST, THE THYROID PRIMORDIUM is made up of a solid mass of entodermal cells

- It later breaks up into a network of epithelial cords or plates by invasion of the surrounding mesenchyme
- By week 10, the cords have divided into small cellular groups, and a lumen forms in each cellular cluster. The cells then arrange themselves in a single layer around the lumen
- During week 11, colloid is seen in these follicle structures, and even thyroxine can be demonstrated


Parafollicular cells
Colloid

- Ultimobranchial bodies loose their connections with pharynx and migrate toward thyroid gland.
- Cells of ultimobranchial bodies disseminate within gland.
- These cells are parafollicular or C-cells.

REMNANTS OF THE THYROGLOSSAL DUCT

- The normal remains of the thyroglossal duct are the vestigial foramen cecum (of the tongue) and the functional pyramidal lobe of the thyroid gland

Congenital malformations

- THYROGLOSSAL DUCT CYSTS AND SINUSES

- Cysts can form anywhere along the course of the developing thyroglossal duct during descent of the developing thyroid gland from the tongue
- Remnants of the duct may persist and give rise to cysts in the tongue or in the midline of the neck, usually below the hyoid bone

(continued from previous page)

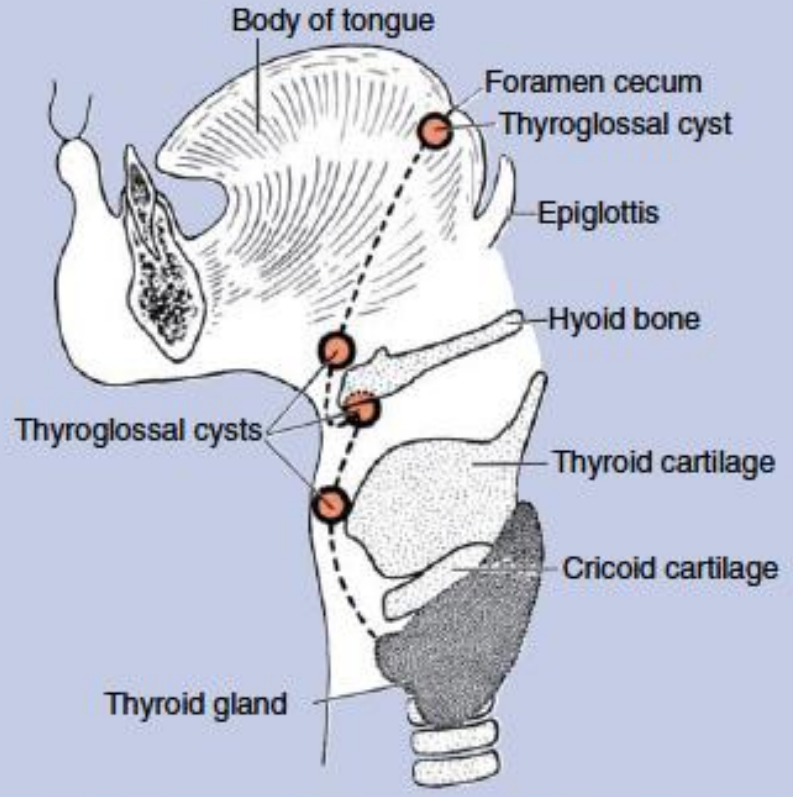


Figure 17.19 Thyroglossal cysts. These cysts, most frequently found in the hyoid region, are always close to the midline.

Thyroglossal Fistula

- Sometimes the cyst is connected to outside by a fistulous canal.
- Then it is called thyroglossal fistula.
- The fistula may be primary when it is present at birth. It may be secondary thyroglossal fistula when a cyst ruptures and communicate outside at later stage.

Figure 17.20 Thyroglossal cyst. These cysts, which are remnants of the thyroglossal duct, may be anywhere along the migration pathway of the thyroid gland. They are commonly found behind the arch of the hyoid bone. An important diagnostic characteristic is their midline location.

ACCESSORY THYROID TISSUE

- Very rarely the thyroid fails to descend from the tongue area resulting in a *lingual thyroid*
- Incomplete descent, which is rare, may result in a *cervical thyroid* that is seen in the neck at or just below the hyoid bone
- Accessory thyroid tissue often is fully functional, originates from remnants of the thyroglossal duct, thus can be found anywhere from the level of the tongue to where the thyroid gland comes to rest in the neck

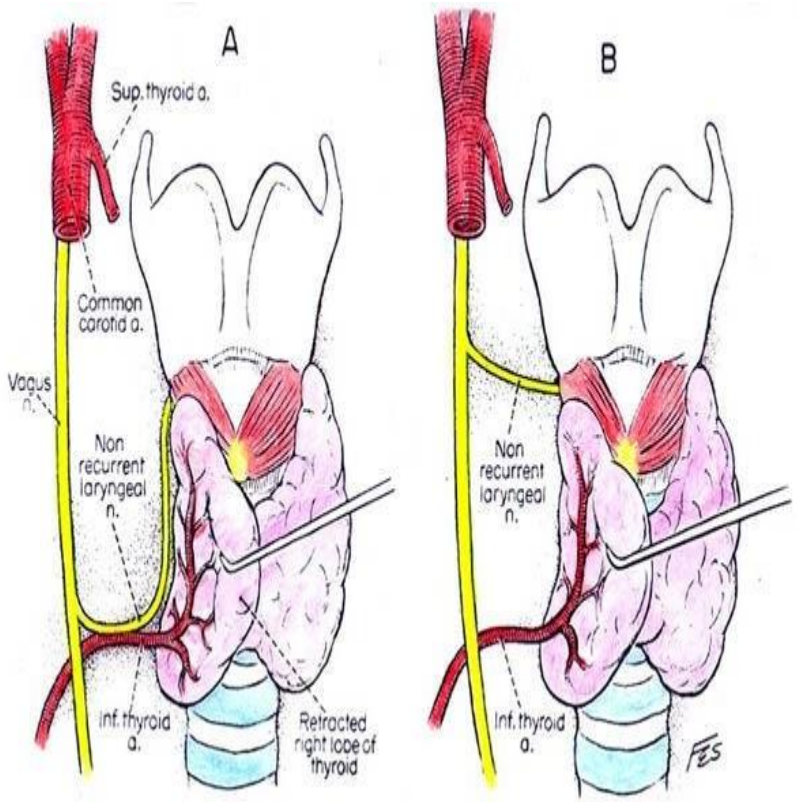
Ectopic Thyroid tissue and Agenesis

- Found in thorax in relation to trachea and bronchi or even oesophagus
- Believed to arise from endodermal cells displaced during formation of laryngotracheal tube.

- **Agenesis of the Thyroid**
- Failure of development of thyroid gland may also occur

OUTLINE

- INTRODUCTION
- EMBRYOLOGY
- GROSS ANATOMY
- BLOOD SUPPLY
- NERVE SUPPLY
- LYMPHATIC DRAINAGE
- HISTOLOGY
- APPLIED ANATOMY



INTRODUCTION

- Largest endocrine gland
- Thyroid hormones (T3 , T4)
  - BMR
- Thyrocalcitonin
  -Calcium

EMBRYOLOGY

- 1st endocrine glands to develop, 24th day of gestation.
- 2 main structures:
  -the primitive pharynx and the neural crest.

- Lateral thyroid (neural crest cells)
- median thyroid (primitive pharynx)

- Forms as a proliferation of endodermal epithelial cells (median surface of the developing pharyngeal floor).

- The site, 2 key structures, the **tuberculum impar** and **the copula (foramen cecum**).

EMBRYOLOGY

- The thyroid gland, originates from between the first and second pouches.
- The thyroid precursor develops to form the thyroid diverticulum.
- whose lumen, is the thyroglossal duct

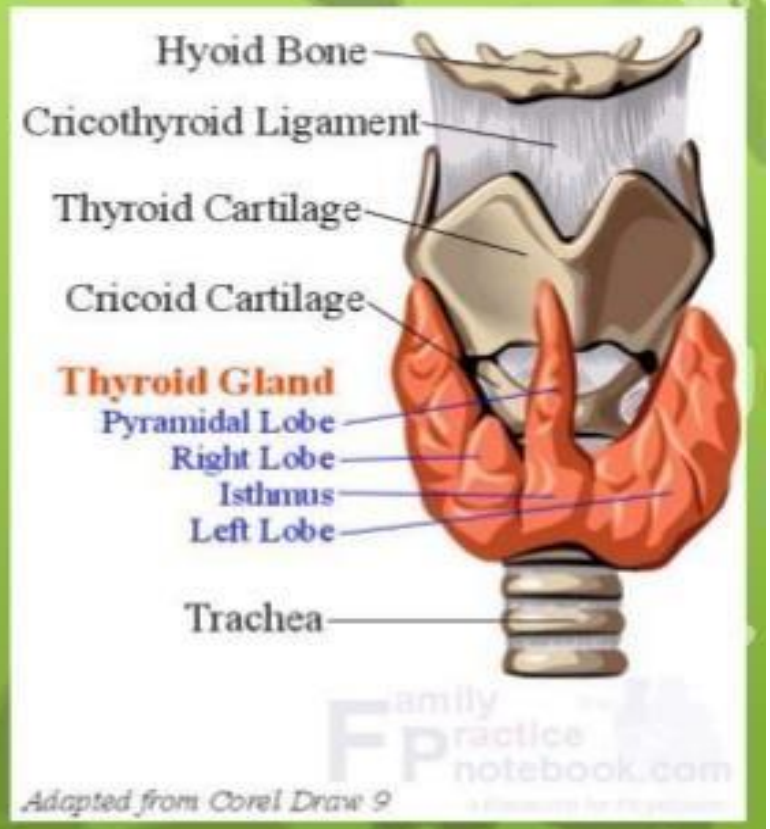
- Parafollicular cells—ULTIMOBRANCHIAL BODY

  (5^{th} pharyngeal pouch)

GROSS ANATOMY

THYROID GLAND

- Endocrine gland, situated in the lower part of the front and sides of the neck.
- *Extends :* from oblique line of thyroid cartilage to the 5th or 6th tracheal ring.
- Lie against C5,C6,C7 & T1.
- Consist Right & Left lobes, joined by isthmus.
- A 3rd pyramidal lobe may project upwards from the isthmus.
- *Capsules:* two; True & false.
- Larger in females than males.
- *Development:* from the endoderm of the floor of primitive oral cavity in the region of the future foramen caecum and ultimobranchial body.



GROSS ANATOMY cont'd

- Pyramidal lobe– isthmus to hyoid bone
  (inferior border)
- Attachment – Fibrous tissue
  -- Muscle Fibres
  (Levator Glandulae thyroideae)
  ext laryngeal nerve

*Isthmus attachment –Suspensory ligament of Berry
(cricoid cartilage and upper tracheal ring)

Thyroid movement with deglutition

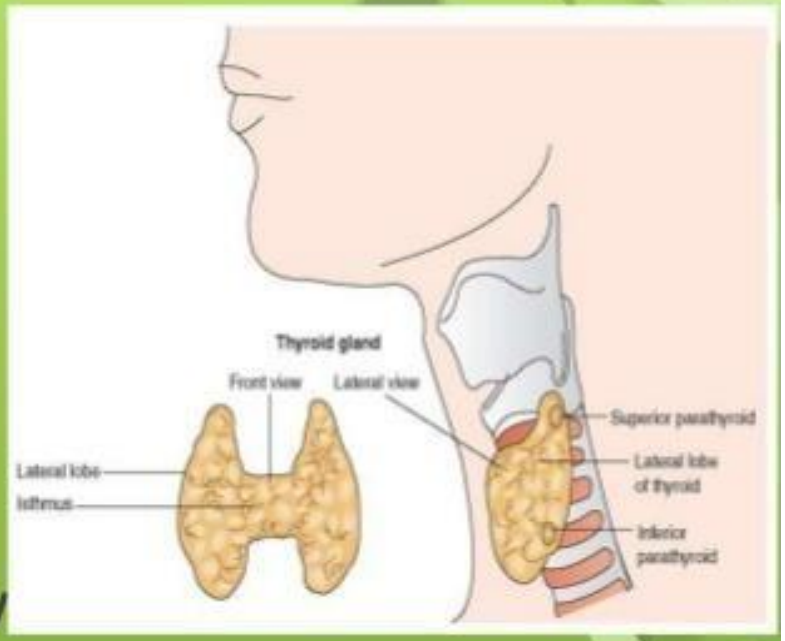
GROSS ANATOMY cont'd

- Weight = 25g
- Shape – pear or butterfly shape, each lobe conical
- 2poles – narrow upper pole
  -- broader lower pole
- Enlarges in pregnancy & menstruation

RELATIONS

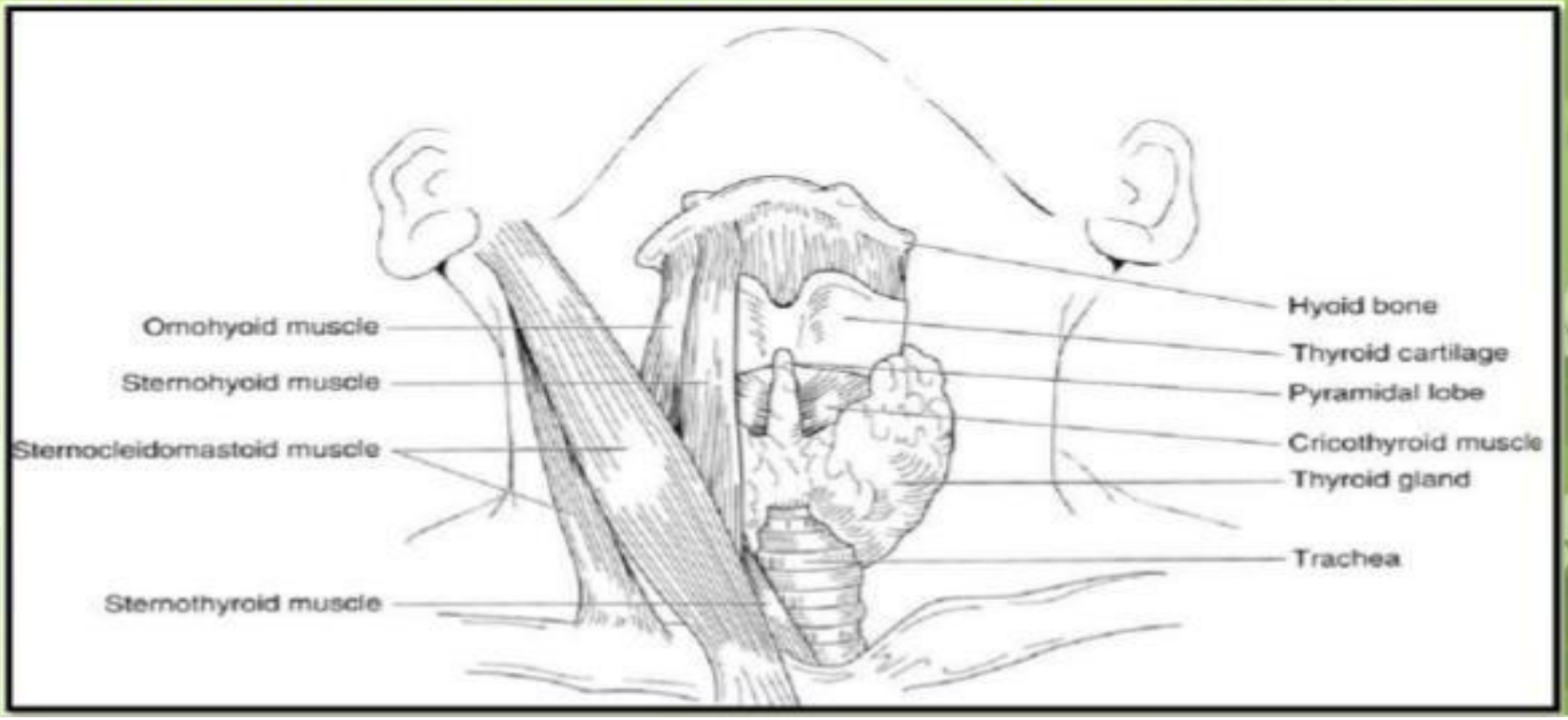
RELATIONS OF THE LOBES

- ✓ The lobes are conical in shape having:
- An apex
- A base
- Three surfaces: Lateral, medial, posterolateral
- Two borders: Anterior and posterior
- ➢ *Apex:*
- directed upwards and slightly laterally.
- ➢ *Base:* on level with the 4th or 5th tracheal ring.



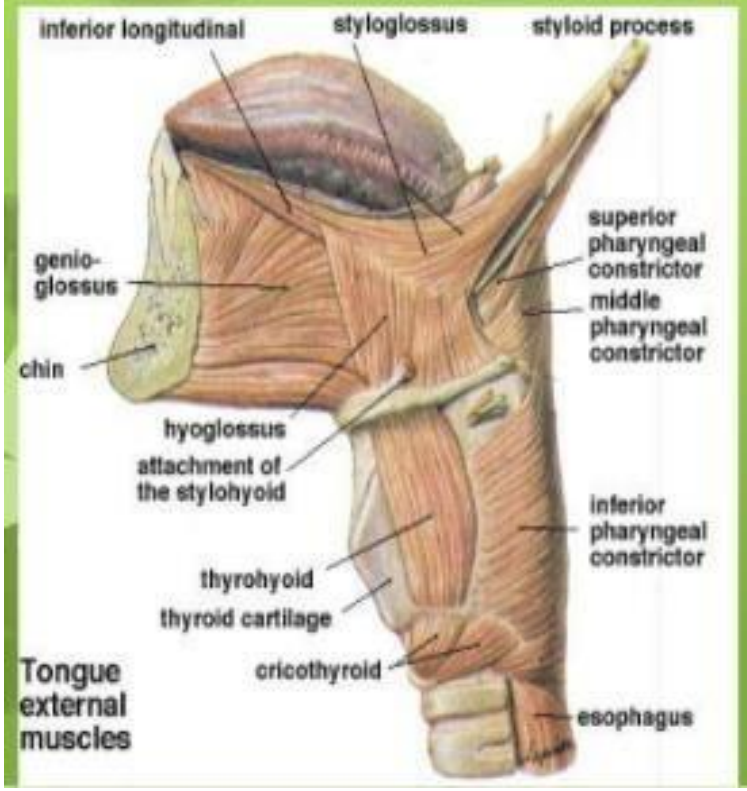
SURFACES

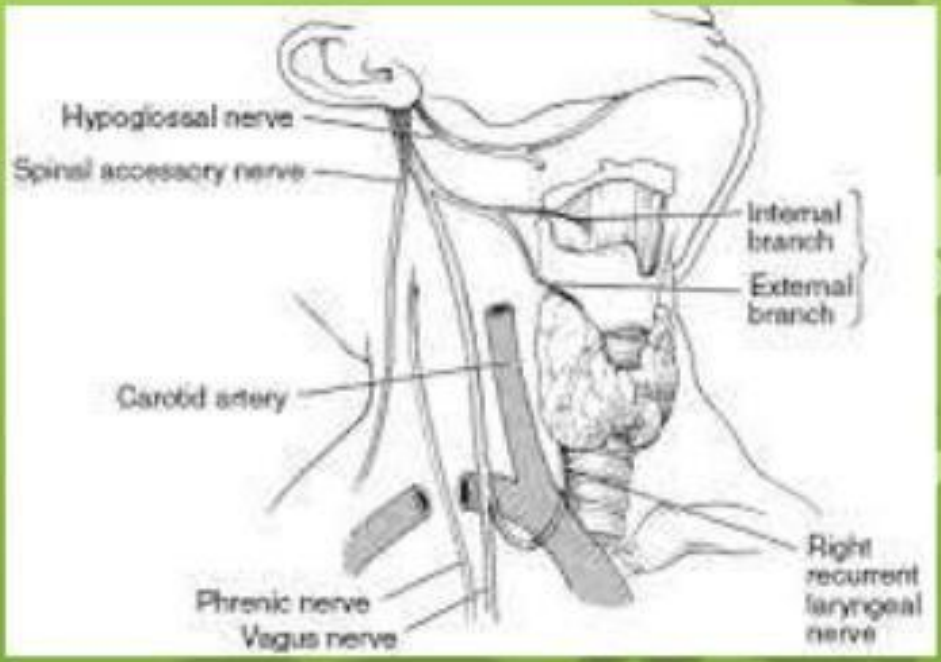
- ***Lateral surface:*** **convex and covered by**
- **Sternohyoid**
- **Superior belly of omohyoid**
- **Sternothyroid**
- **Anterior border of sternocleidomastoid**



SURFACES cont'd

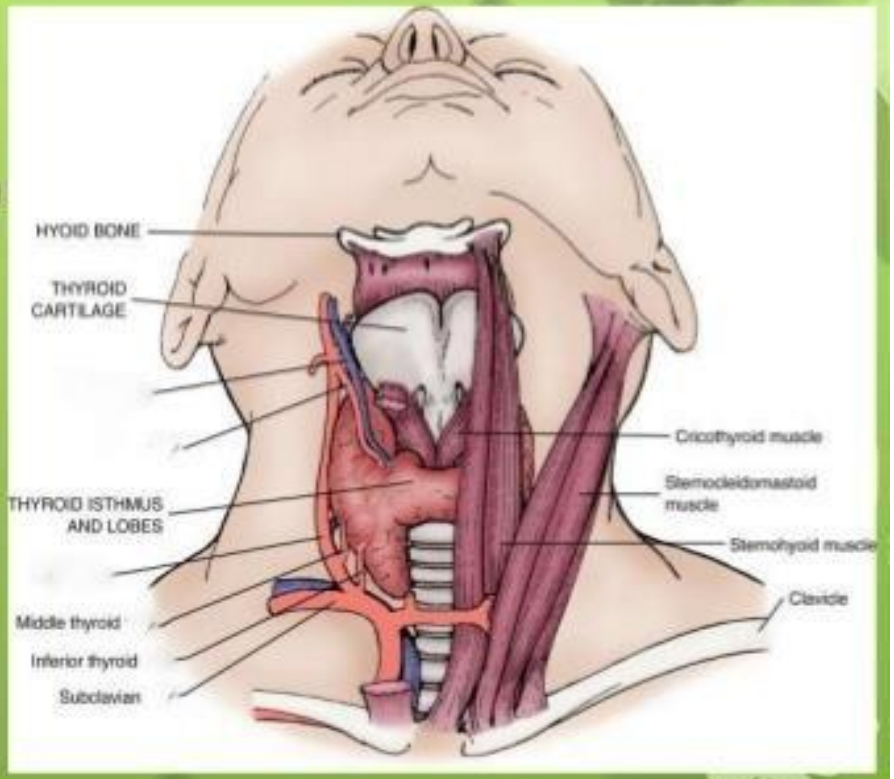
- ***Medial surface:***
- **2 tubes, trachea and oesophagus**
- **2 muscles,inferior constrictor and cricothyroid**
- **2 nerves,external laryngeal and recurrent laryngeal**



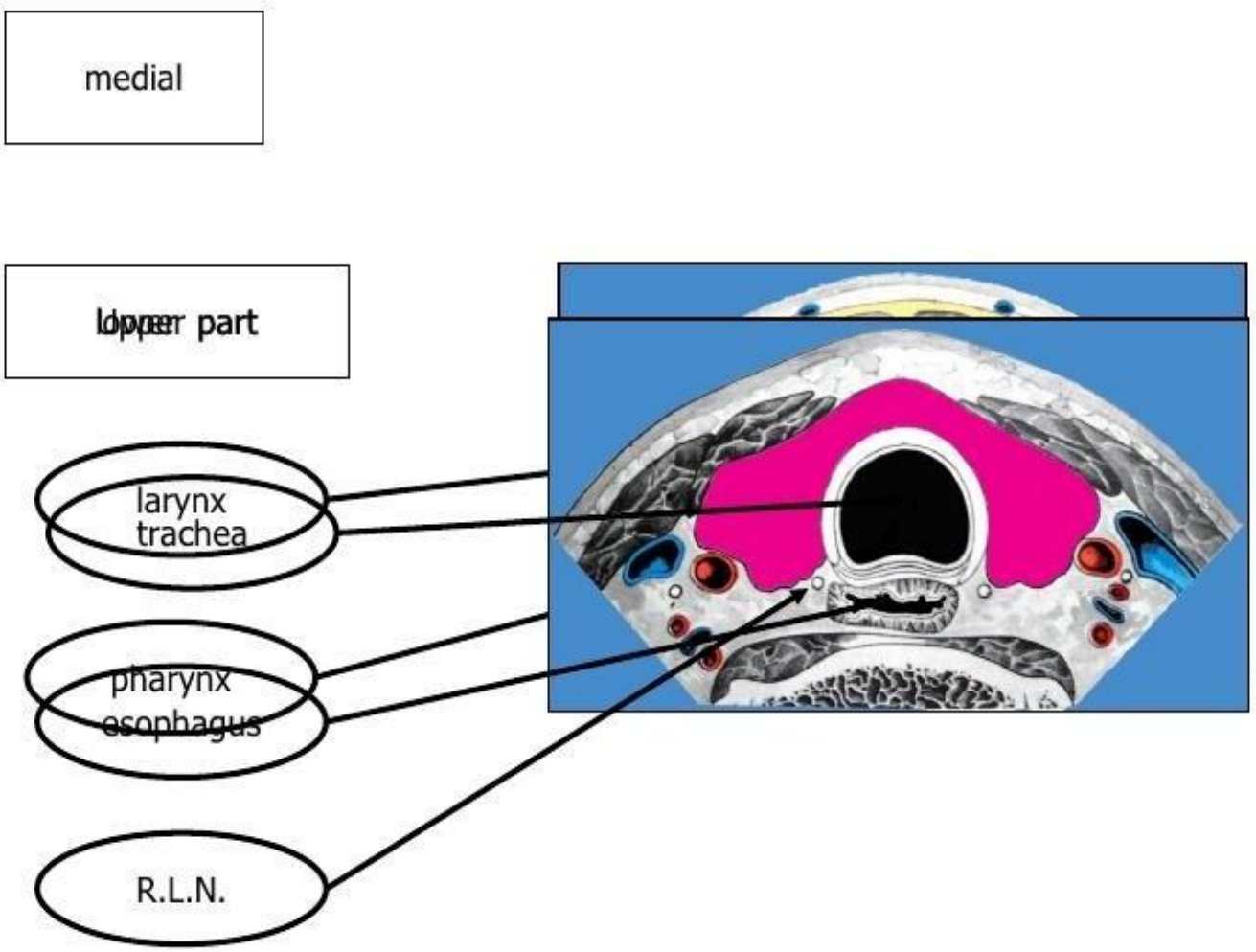


SURFACES cont'd

- ***Posterolateral surface*: carotid sheath and overlaps common carotid artery.**
- ***Anterior border:* anterior branch of superior thyroid artery**
- ***Posterior border:* separates medial and posterior surfaces.**
- **Inferior thyroid artery**
- **Anastomosis between superior and inferior thyroid arteries**
- **Parathyroid glands**
- **On left side thoracic duct**

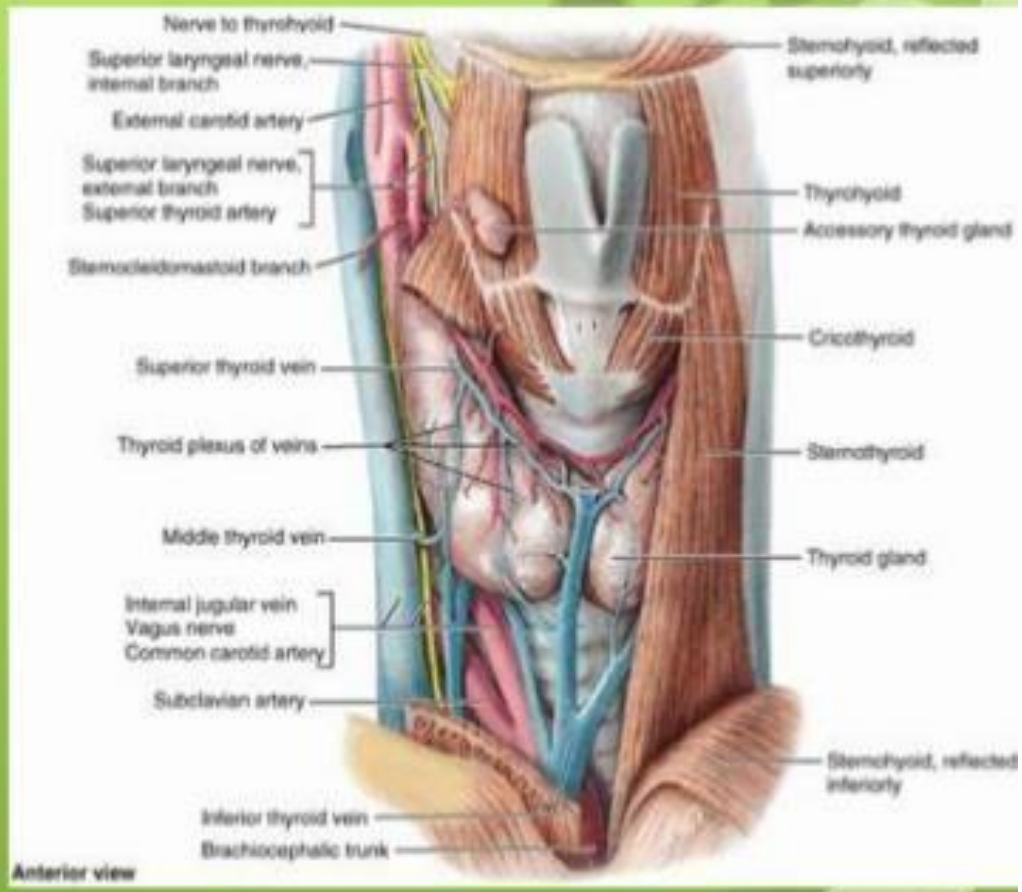


CROSS SECTIONAL SURFACE



RELATIONS OF ISTHMUS

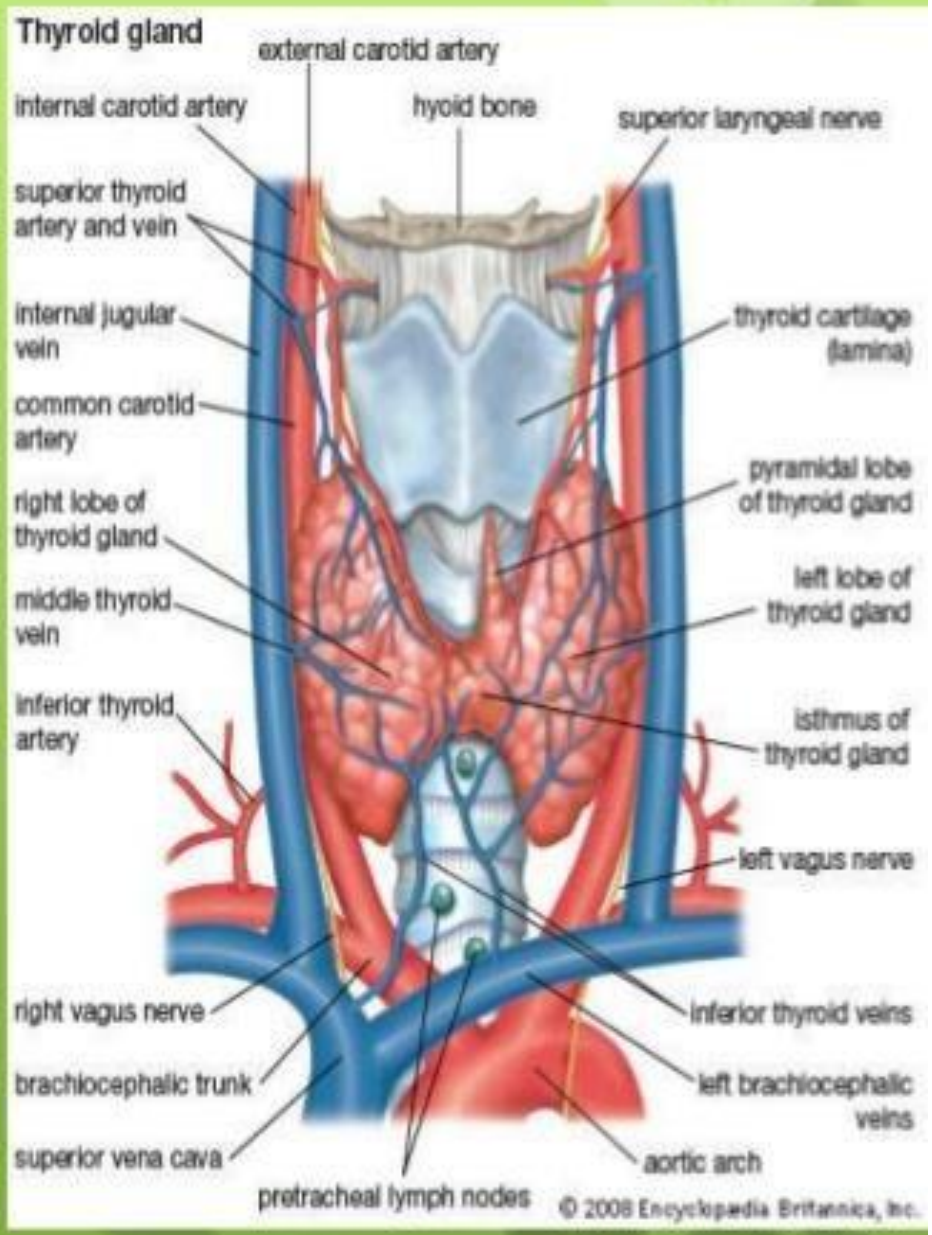
- ✓ Connects lower parts of the 2 lobes.
- ✓ *Anterior surface:* covered by,
  - Sternothyroid and sternohyoid
  - Anterior jugular vein
  - Fascia and skin
- ✓ *Posterior surface:* 2nd to 4th tracheal rings.
- ✓ *Upper border:* anastomosis between right and left superior thyroid arteries.
- ✓ *Lower border:* Inferior thyroid veins.



- ✓ ***Blood supply:***
- **Superior and inferior thyroid arteries.**
- **Superior, middle and inferior thyroid veins.**

- ✓ ***Lymphatic drainage:***
- **Upper & lower deep cervical lymph node**
- **Pretracheal and paratracheal lymph node**

- ✓ ***Nerve supply:***
- **Middle cervical ganglion**
- **Superior and inferior cervical ganglia**

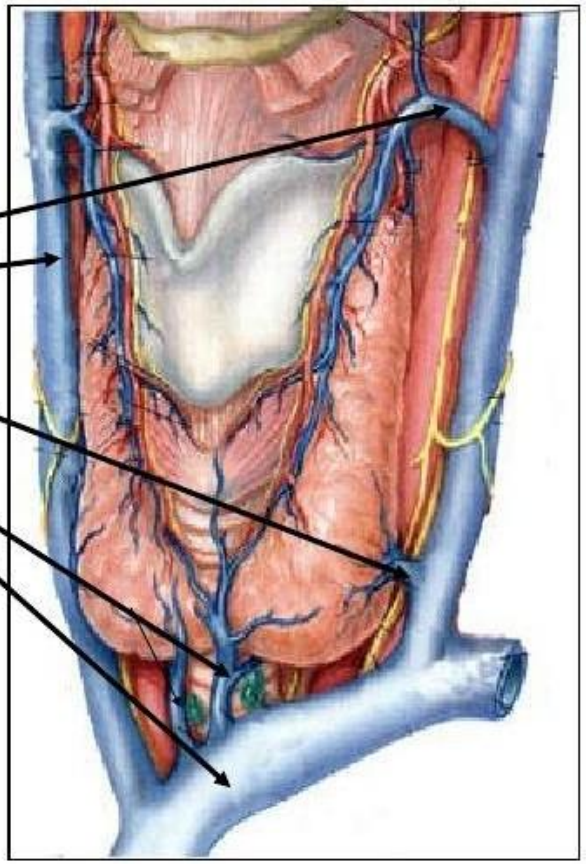


VENOUS DRAINAGE

2- venous :

Superior thyroid vein
drain to I.J.V.
middle thyroid vein
drain to I.J.V.
inferior thyroid veins
drain to left innominate vein

The middle thyroid vein
Is the shortest soit is the
1st. To be ligated



BLOOD SUPPLY CONT'D

- Inferior thyroid artery – Thyrocervical trunks

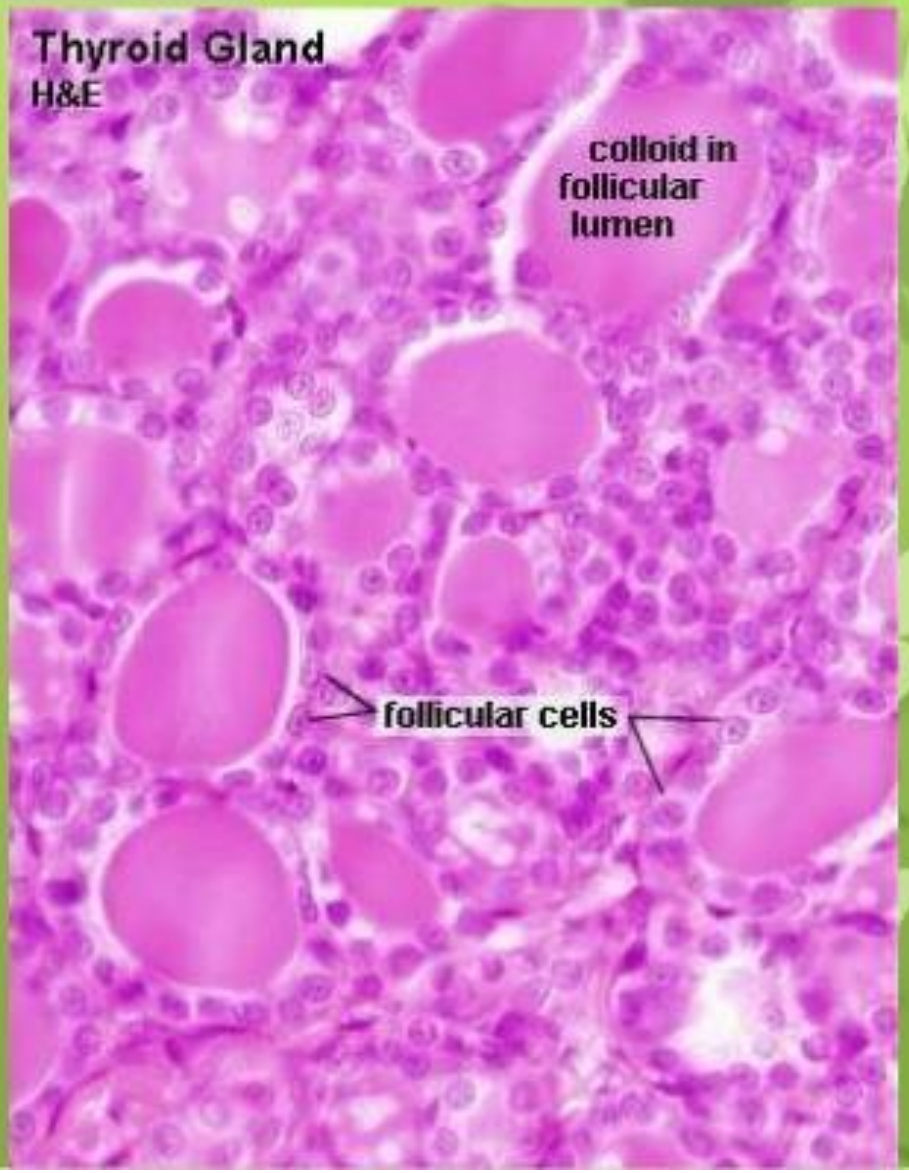
- THYROIDEA IMA ARTERY (3% individuals)
  ---Brachiocephalic trunk
  --- Arch of the Aorta
  --- Right common Carotid artery

*(Prelaryngeal nodes– Delphian nodes)

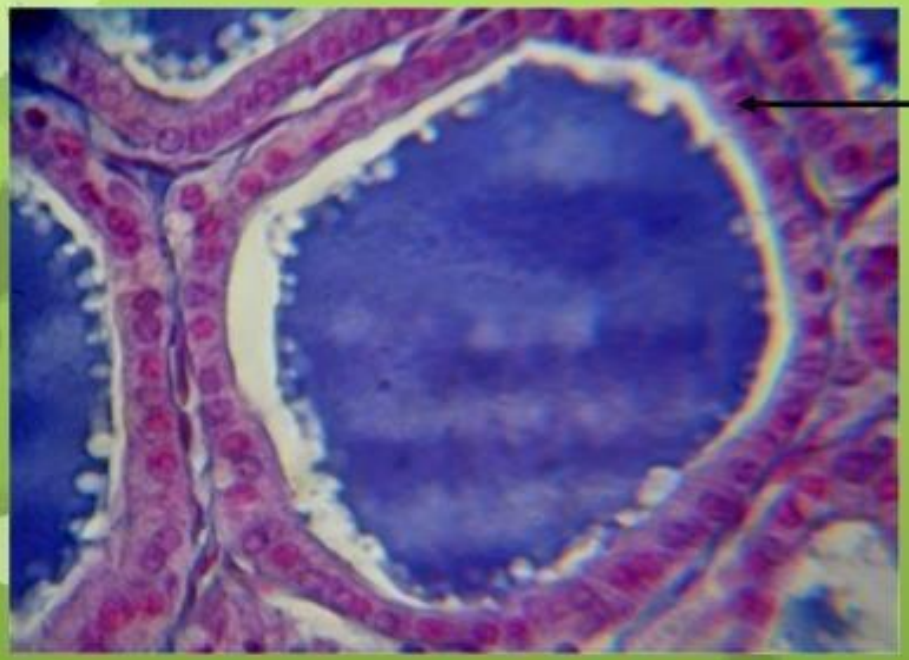
*Innervation Sympathetic vasoconstictor (superior, middle and inferior cervical ganglia)

HISTOLOGY

- ✓ *2 types of cells :*
- • follicular & parafollicular.
- ✓ The follicular cells secrete T3 & T4.
- ✓ T3 & T4 binds with glycoproteins to form the thyroglobulin (colloid).
- ✓ Most of the thyroid follicles are full of stored Thyroglobulin (colloid).
- ✓ Parafollicular cells/clear (C) cells are found among the follicular cells.
- ✓ They pale staining cells with a granular cytoplasm.
- ✓ Unlike follicular cells, they are not exposed to the follicular lumen.
- ✓ They secrete Calcitonin which help regulating blood calcium levels.

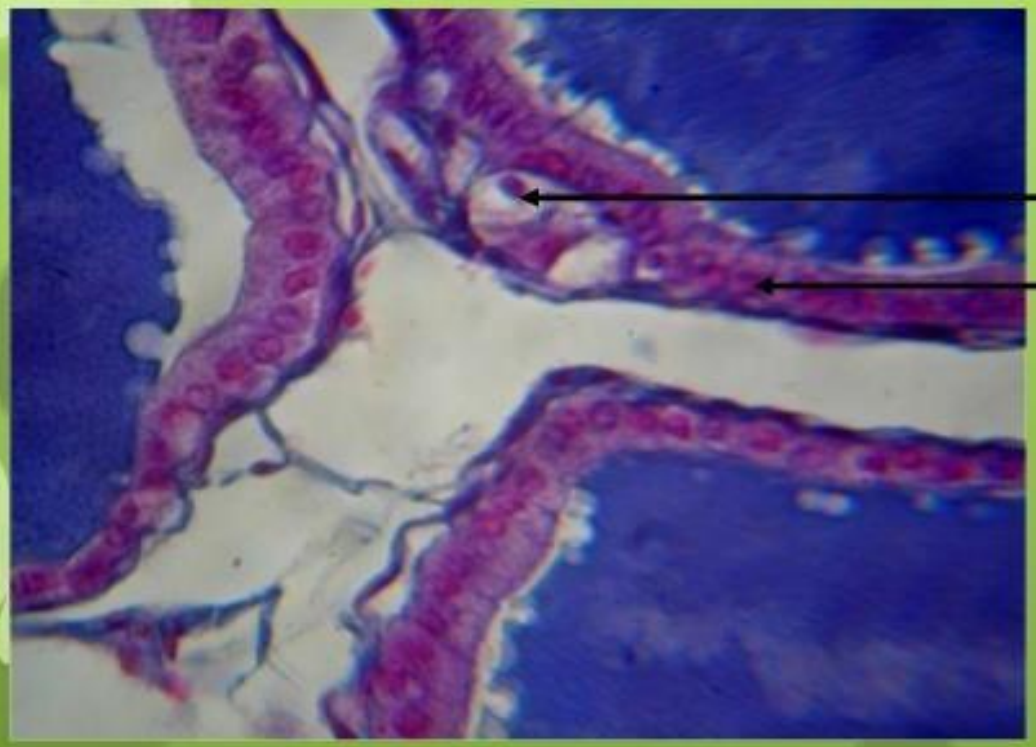


HISTOLOGY- FOLLICULAR CELLS



Thyroid: high power x 45

HISTOLOGY- PARAFOLLICULAR CELLS



Thyroid gland: high power x 45

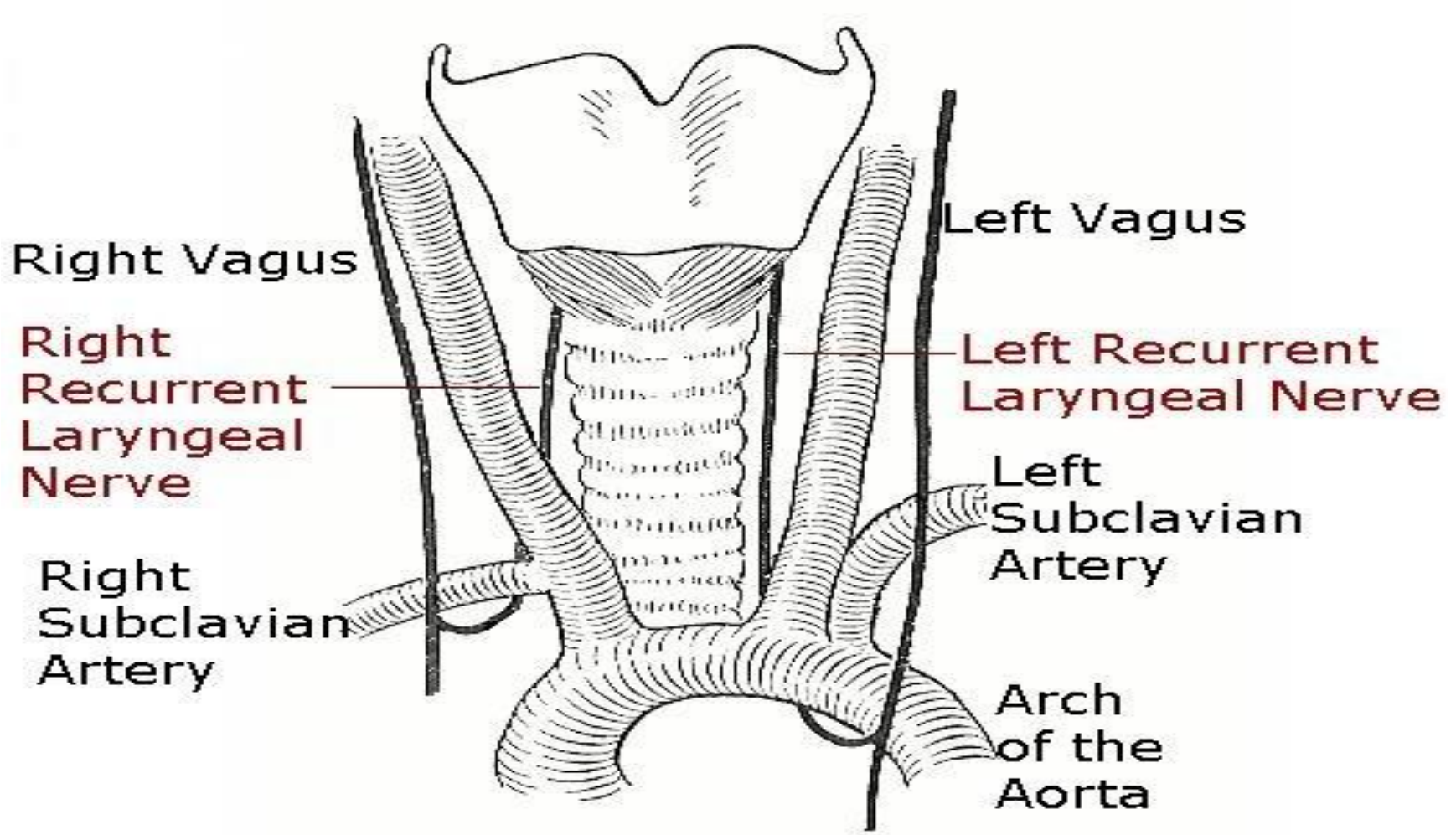
SURGICAL ANATOMY

- Sternothyroid muscles- oblique line of thyroid cartilage ,prevent the lobes from moving upwards
- Presence of isthmus makes palpating the tracheal cartilages difficult and difficult tracheostomy
- Presence of thyroidae ima A- chance of profuse bleeding procedures in neck below isthmus •

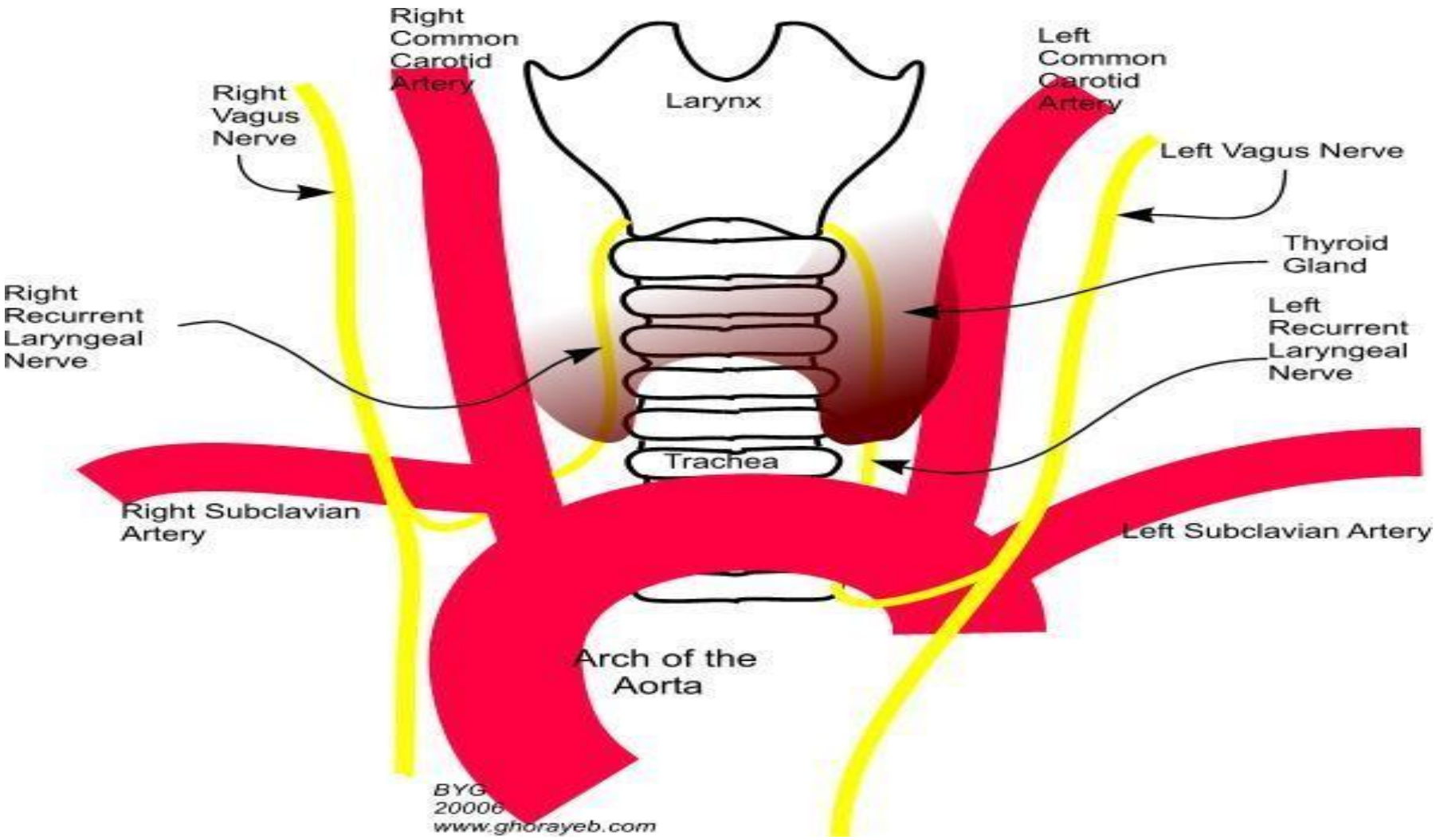
SURGICAL ANATOMY cont'd

- Thyroglossal duct cysts – remnants of thyroglossal ducts
- Pyramidal lobe and presence of levator glandulae thyroideae
- Thyroidea ima artery – Difficult/ bleeding
  (Tracheostomy)
- Ectopic thyroid glands – lingual/higher placed
- Accessory thyroid glands – (descent pathway)
  in thymus/ on thyrohyoid muscle
- Goiter

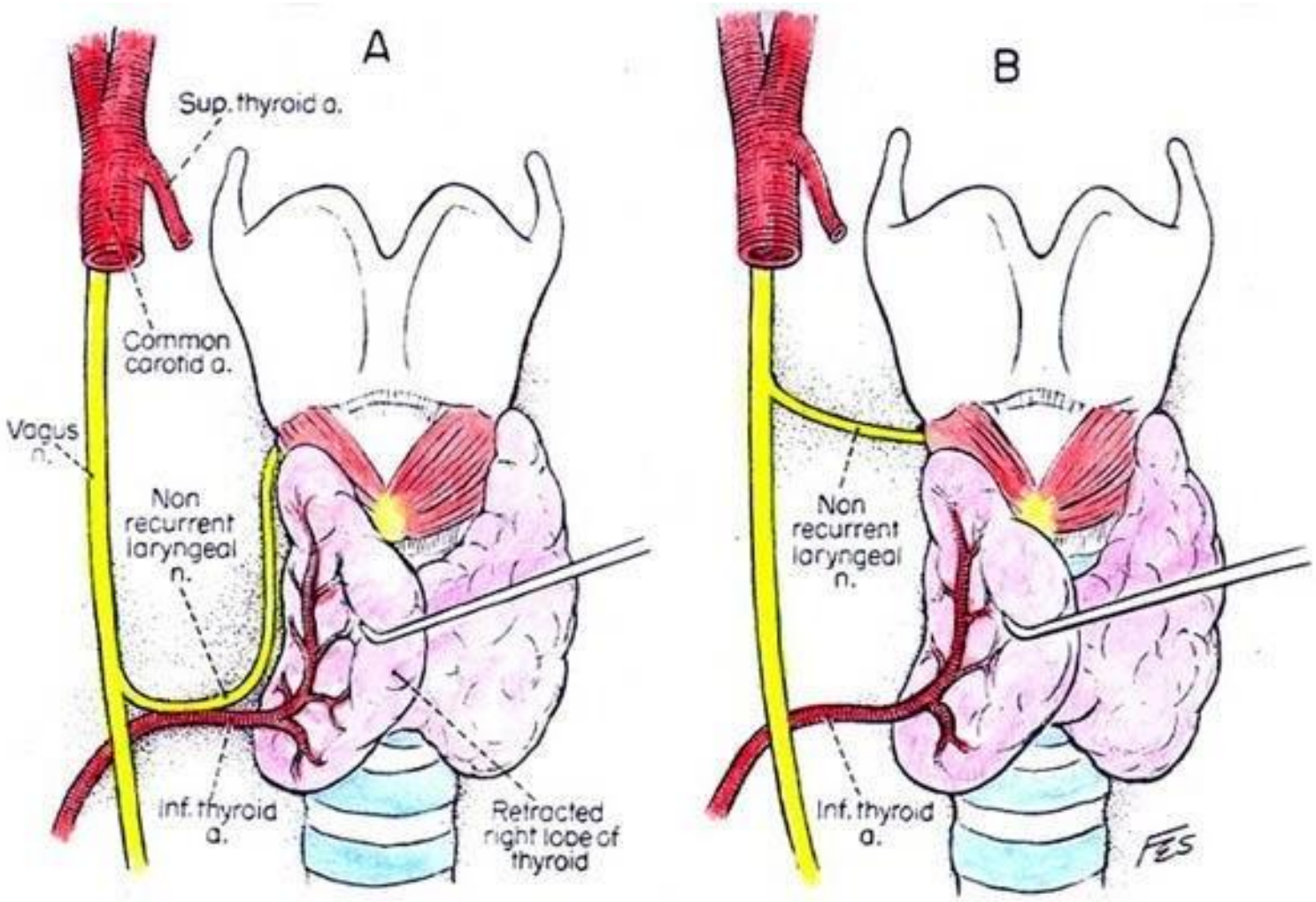
SURGICAL ANATOMY cont'd



SURGICAL ANATOMY



NON RECURRENT LARYNGEAL NERVE (<1%)



SURGICAL ANATOMY

The most common course of the nerve is within TE Groove (48.5%), NOT DEPICTED HERE

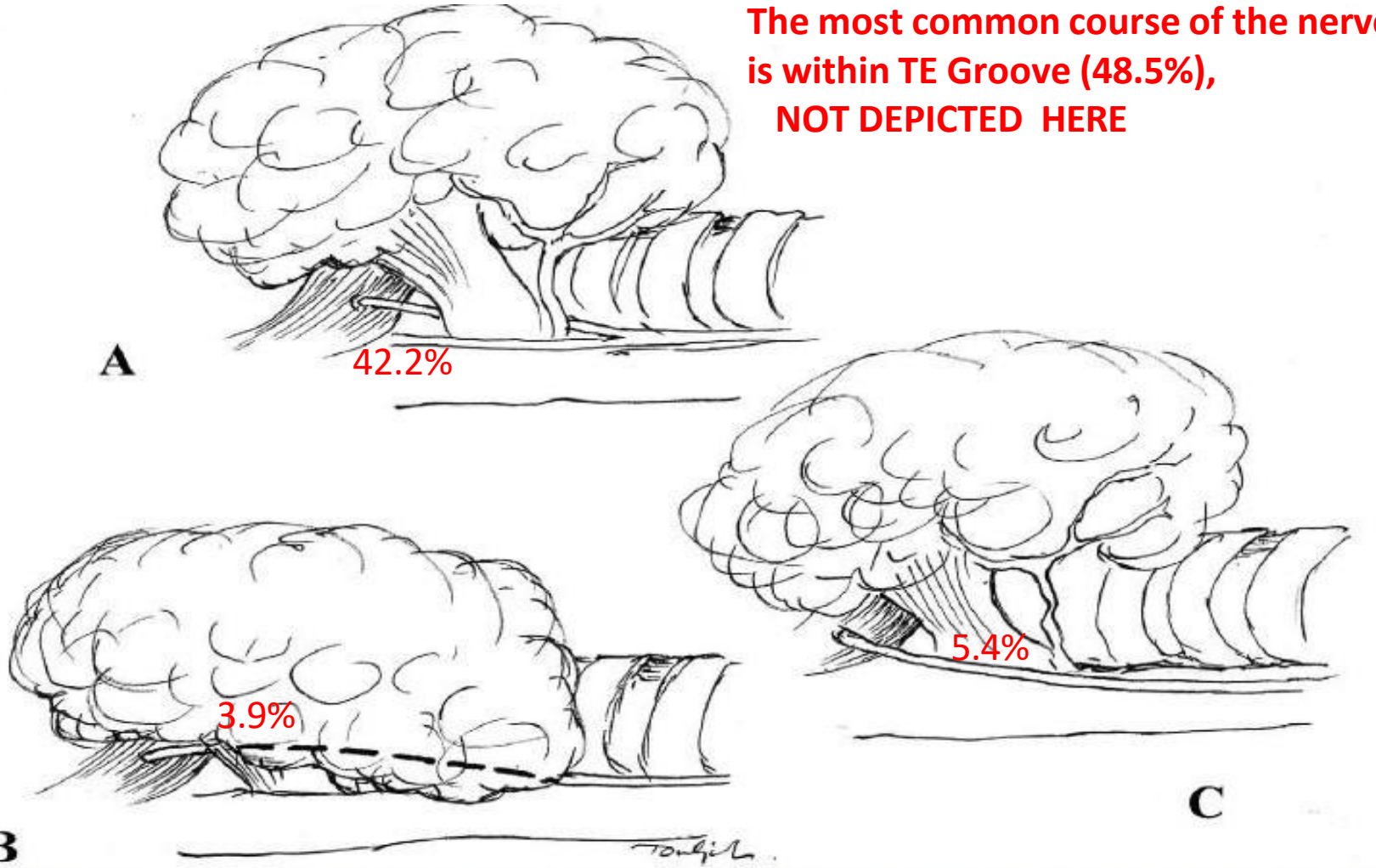


Figure 11 The recurrent laryngeal nerve may pass: (A) paratracheal, (B) within the thyroid parenchyma, or (C) paraesophageal.

SURGICAL ANATOMY cont'd

- Pressure symptoms :
  - Compression of the trachea,
  - Compression of the oesophagus
  -carotid sheath,
  -venous engorgement

SURGICAL ANATOMY cont'd

- Injury to recurrent laryngeal Nerve
  – hoarseness
  - Difficulty in breathing

- Recurrent laryngeal Nerve- supply all laryngeal muscles except *cricothyroid

- * Injury to external laryngeal N – monotonous voice(paralysis of cricothyroid) •

- Inadvertent removal of parathyroid gland – tetany (fatal)

HYPERTHYROIDISM

- Over activity of the thyroid gland.

- Women : men ratio (8:1).

- activity of gland :
  a)- 5- 10 times increase in secretion.
  b)- 2-3 times increase in size.

CAUSES

1- Graves' disease :

- an autoimmune disorder.

- increased circulating level of thyroid-stimulating immunoglobulins (TSI).

- 95%.

- 4 – 8 times more common in women than men.

2- Thyroid gland tumor:

- 95% is benign.

- history of head and neck irradiation and family history.

3- Exogenous T3 and T4:

(rarely cause)

4- Excess TSH secretion:

- diseases of the hypothalamus (TRH).

- diseases of the pituitary (TSH).

DIAGNOSIS

S+s :

1- Goiter in 95%.

2- skin:

- **smooth, warm and moist.**
- **heat intolerance, night sweating.**

3- musculoskeletal:

-Muscle atrophy.

4- Neurological:

- tremor.
- enhanced reflexes.
- irritability.

2- Surgery:

- **Subtotal thyroidectomy**.

- Indication for surgery:

a)- Relapse after medical treatment.

b)- Drug intolerance.

c)- Cosmetic.

d)- Suspected malignancy.

HYPOTHYROIDISM

Under activity of the thyroid gland

more in woman (30- 60 years).

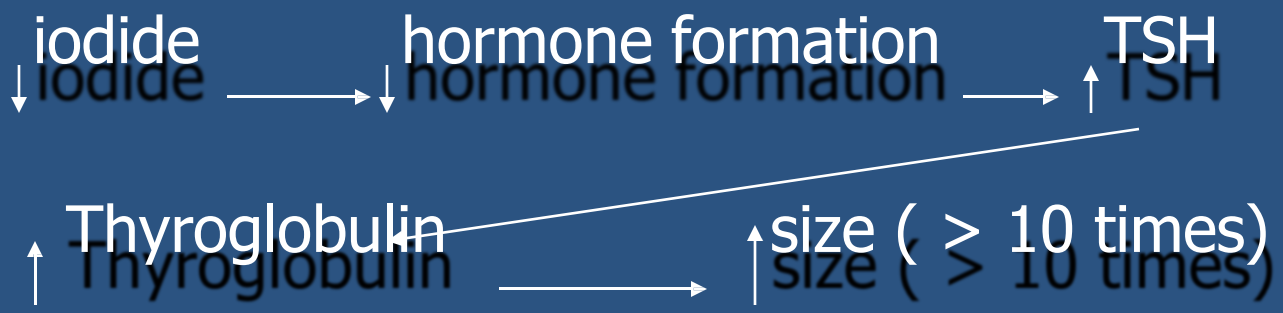
CAUSES

1- Inherited abnormalities of thyroid hormone synthesis :

- Peroxidase defect.
- Iodide trapping defect.
- Thyroglobulin defect.

2- Endemic Colloid Goiter:

- **before table salt.**



6- Myxoedema:

An edematous appearance through out body.

7- others:

- loss of libido.
- menstrual cycle disturbance.

Table 9-9 Pathophysiology of Thyroid Hormones

	Hyperthyroidism	Hypothyroidism
Symptoms	Increased basal metabolic rate Weight loss Negative nitrogen balance Increased heat production Sweating Increased cardiac output Dyspnea (shortness of breath) Tremor, muscle weakness Exophthalmos Goiter	Decreased basal metabolic rate Weight gain Positive nitrogen balance Decreased heat production Cold sensitivity Decreased cardiac output Hypoventilation Lethargy, mental slowness Drooping eyelids Myxedema Growth retardation Mental retardation (perinatal) Goiter
Causes	Graves' disease (increased thyroid-stimulating immunoglobulins) Thyroid neoplasm Excess TSH secretion Exogenous T_3 or T_4 (factitious)	Thyroiditis (autoimmune or Hashimoto's thyroiditis) Surgery for hyperthyroidism I^- deficiency Congenital (cretinism) Decreased TRH or TSH
TSH Levels	Decreased (feedback inhibition of T_3 on the anterior lobe) Increased (if defect is in anterior pituitary)	Increased (by negative feedback if primary defect is in thyroid gland) Decreased (if defect is in hypothalamus or anterior pituitary)
Treatment	Propylthiouracil (inhibits peroxidase enzyme and thyroid hormone synthesis) Thyroidectomy $^{131}I^-$ (destroys thyroid) β-Adrenergic blocking agents (adjunct therapy)	Thyroid hormone replacement therapy

CRETINISM

Extreme hypothyroidism during infancy and child hood (failure of growth).

CAUSES

1- Congenital lake of thyroid gland (congenital cretinism).

2- Genetic deficiency leading to failure to produce hormone.

3- Iodine lake in the diet (endemic cretinism).

SYMPTOMS

1- Infant is normal at birth but abnormality appears within weeks.
2- Protruding tongue.
3- Dwarf with short limbs.
4- Mental retardation.
5- Often umbilical hernia.
6- teeth.


4'
3'6"
3'

AND NOW…

THE PARATHYROID GLANDS

Ivar Sandström, a Swedish medical student, in 1879 was the first to describe the parathyroid glands.

The Legacy of Ivar Sandstrom (1852–1889)

- New Gland, the last major organ to be recognized in man, 1880.
- Discovery met with silence.
- First publication rejected.
- Two national prizes.

I.V. Sandstrom, On new gland in man and several mammals, *Bull Inst Hist Med* **6** (1938), pp. 192–222.c

"About three years ago (1877) I found on the thyroid gland of a dog a small organ, hardly as big as a hemp seed, which was enclosed in the same connective tissue capsule as the thyroid, but could be distinguished there from by a lighter color. A superficial examination revealed an organ of totally different than that of the thyroid and with a very rich versatility."

"So much the greater was my astonishment therefore when in the first individual (patient) examined I found on both sides at the inferior border of the thyroid gland an organ of the size of a small pea, which judging from its exterior did not appear to be a lymph gland nor an accessory thyroid gland and upon histological examination showed a rather peculiar structure."

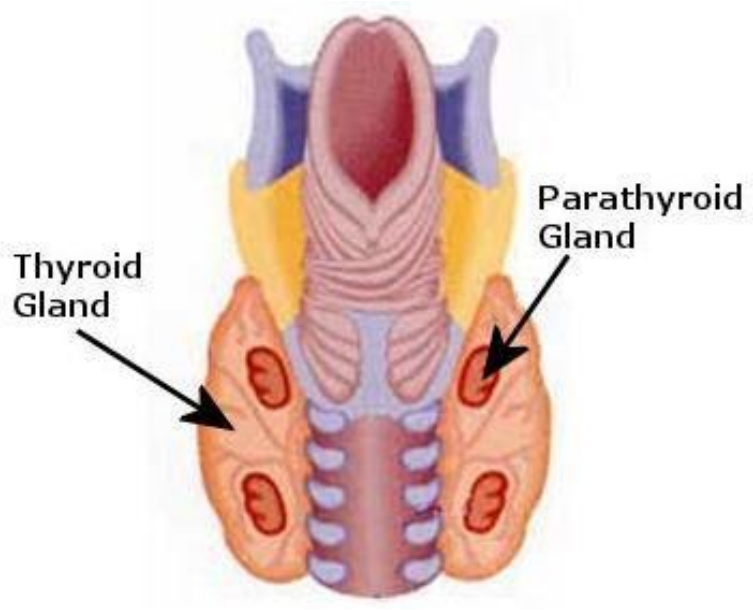
Om en ny körtel hos menniskan och åtskilliga däggdjur.

af

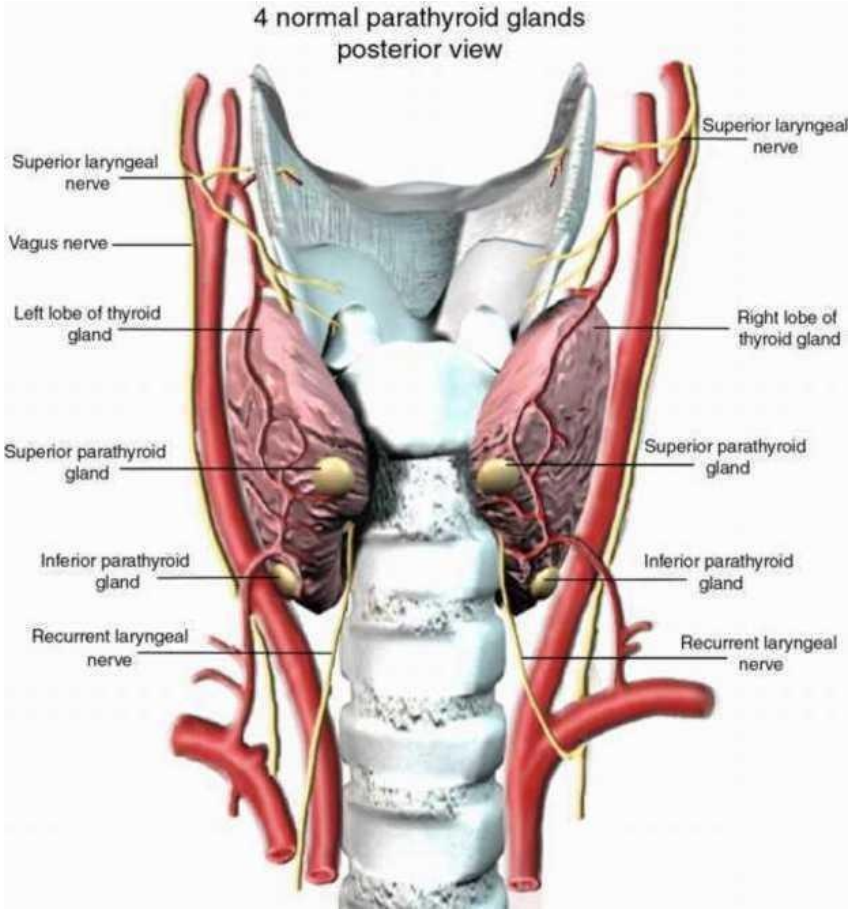
IVAR SANDSTRÖM.

För snart tre år sedan påträffade jag i sköldkörteln af en hund en liten, knappt hampfrösstor bildning, som låg innesluten i samma bindväfskapsel som denna körtel, men skiljde sig derifrån genom en ljusare färg. En flygtig undersökning visade att organ af en helt annan bygnad än sköldkörteln och med ett särdeles rikligt kärlnät, hvarföre jag också ansåg sannolikt, att hvad som förelåg, var en kärlkörtel analog med gl. carotidea. Äfven hos katt och kanin anträffades dylika bildningar. Tid och material medgåfvo emellertid ej undersökningarnes fullföljande, och det är först i vinter, som jag blifvit i tillfälle att återupptaga dem. Förekomsten af en hittills okänd körtel hos djur, som så ofta varit föremål för anatomiska undersökningar, manade till ett noggrant genomletande af trakten kring sköldkörteln äfven hos menniskan, ehuruväl sannolikheten att här anträffa något förut obemärkt förefölt så ringa, att det snarare var med uteslutande hänsyn till undersökningarnes full-

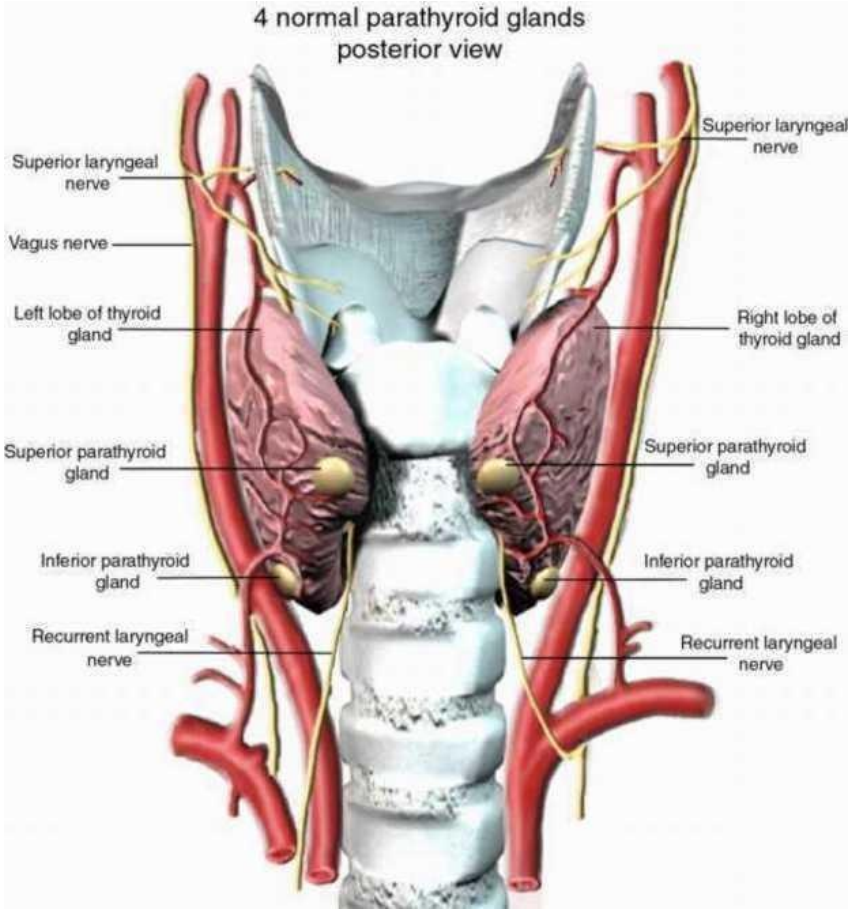
- **The parathyroid glands are oval shaped, well encapsulated and smooth, often the size of a split pea, and yellow, pink or tan in color.**
- **Normal parathyroid glands measure approximately 6 mm in length, 3–4 mm in transverse diameter, and 1–2 mm in anteroposterior diameter.**
- **They usually weighs around 29.5 mg ± 17.8, with a reported upper limit of 65 mg.**



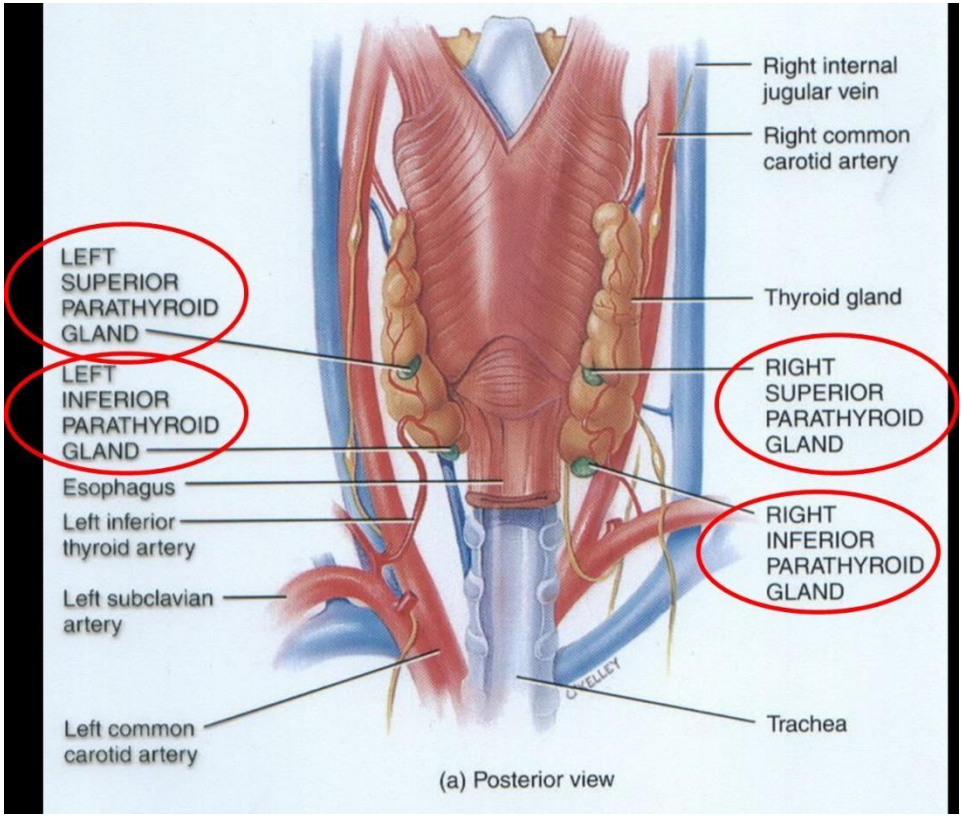
- They have a distinct, encapsulated, smooth surface that differs from the thyroid gland, which has a more lobular surface, and lymph nodes, which are more pitted in appearance.
- The color of the parathyroid glands is typically light brown to tan, which relates to their fat content, vascularity, and percentage of oxyphil cells within the glands. The yellow color may be confused with surrounding fat.
- A distinct hilar vessel is also present that can be seen if the surrounding fat does not obscure the glands' hila.



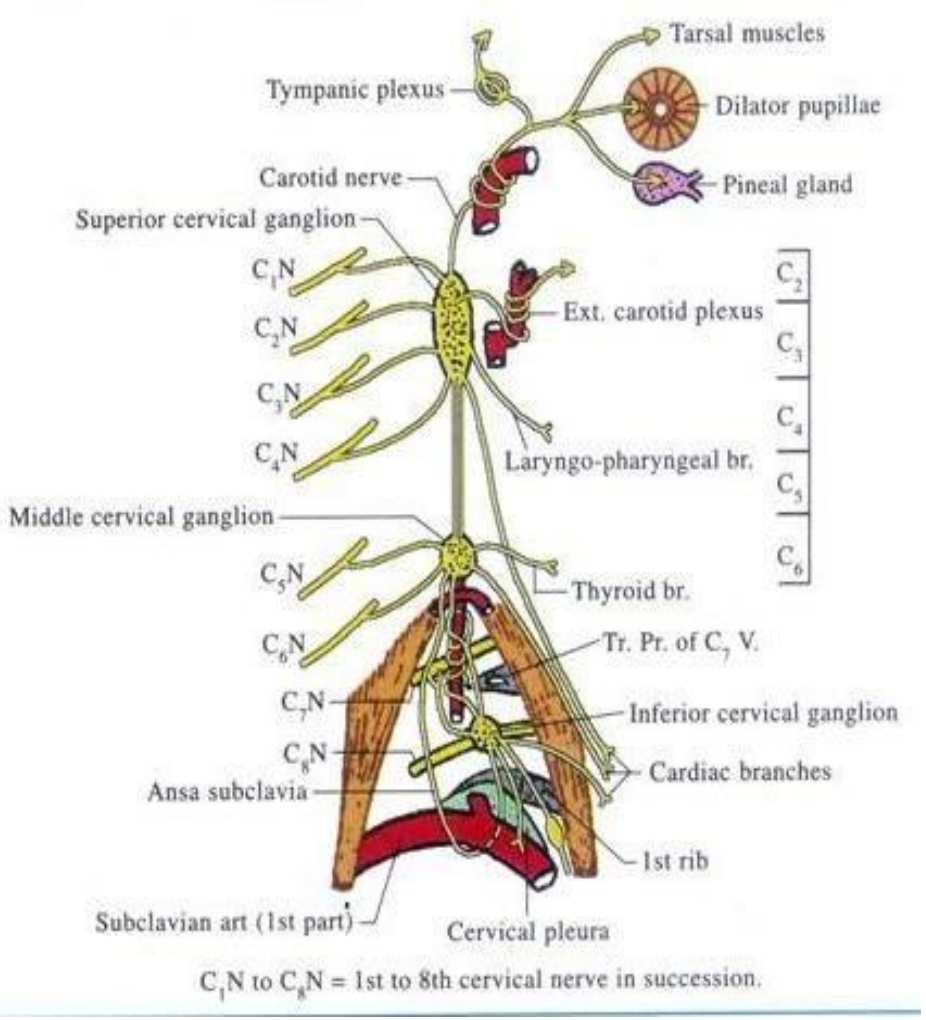
- The superior parathyroid glands are most commonly located in the posterolateral aspect of the superior pole of the thyroid gland at the cricothyroidal cartilage junction. They are most commonly found 1 cm above the intersection of the inferior thyroid artery and the recurrent laryngeal nerve .
- The inferior parathyroid glands are more variable in location and are most commonly found near the lower thyroid pole of the thyroid.



- The superior glands get 80% supply from the inferior thyroid arteries, 15% from the superior and 5% from elsewhere.
- The inferior glands are 90% supplied by the inferior thyroid arteries and 10% from the superior thyroid arteries.
- Venous drainage is into the plexus of veins on the anterior surface (front) of the thyroid comprising the superior, middle and inferior thyroid veins.



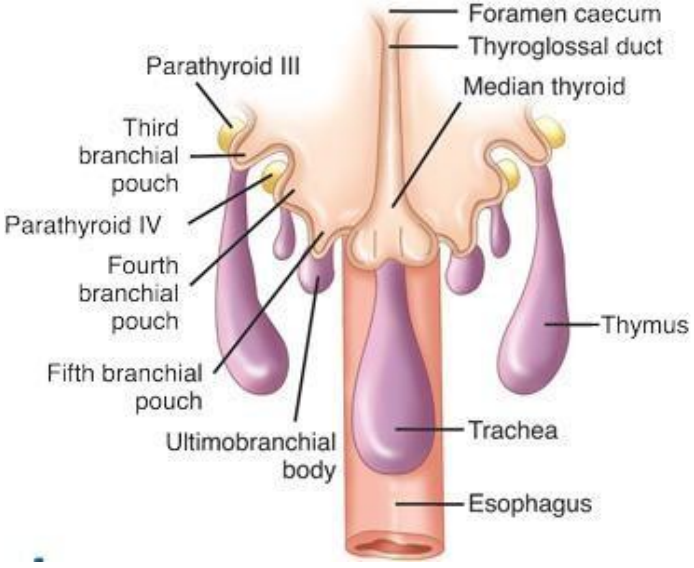
The parathyroids are supplied by thyroid branches of the cervical sympathetic ganglia with a mainly sensory function, detecting stretch within the glands that gives rise to the sensation of pain in some disorders.



- About 15-19 % of the glands can be found in ectopic locations and distant from the thyroid lobes, mostly posterior alongside the esophagus, in the upper anterior mediastinum encapsulated in the thymus, and within the carotid sheath or even rarely (0.5-4%) embedded within the thyroid itself.
- The ectopic or aberrant locations of the parathyroid gland are related to discrepancies during embryological development and descent.

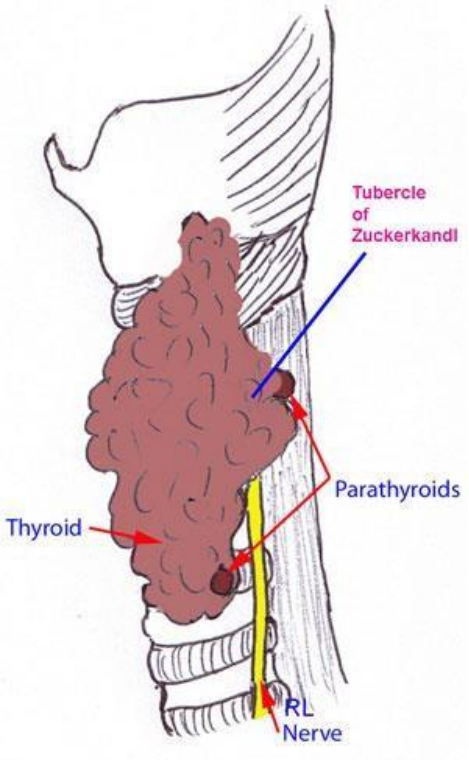
Embriology

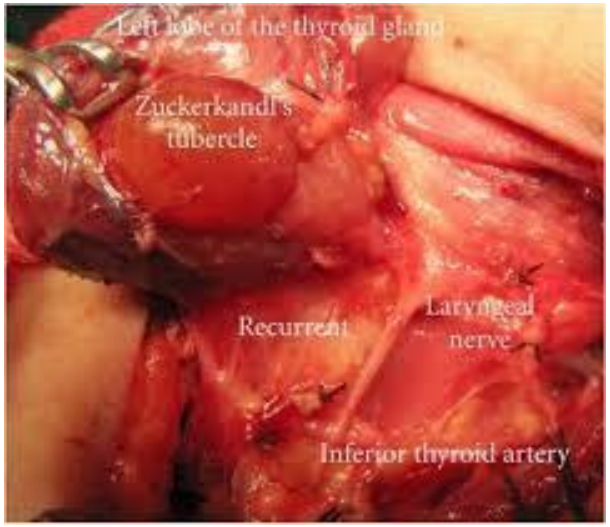
- The superior parathyroids are derived from the fourth branchial pouches (along with the ultimobranchial bodies, which differentiate into the parafollicular or C-cells, that secrete calcitonin). Because the superior parathyroid glands migrate with the ultimobranchial bodies, they remain in contact with the posterior part of the middle third of the thyroid lobes, and may come to be found at the tip of the tubercle of Zuckerkandl.
- The inferior parathyroids are derived from the third branchial pouches, along with the thymus. This embryological development of the inferior parathyroids in the same place as the thymus explains why parathyroid tumors may be found within the substance of the thymus and in the mediastinum.



Parathyroid development begins around the fifth or sixth week of life at the level of the pharynx, with all parathyroids migrating down into the neck.

- The Tubercle of Zuckerkandl (TZ), is the remnant of the lateral thyroid process.
- It is an important anatomic structure that serves as a reliable landmark for the recurrent laryngeal nerve in thyroid surgery.
- Removal of the TZ is critical for the adequate performance of a total thyroidectomy.





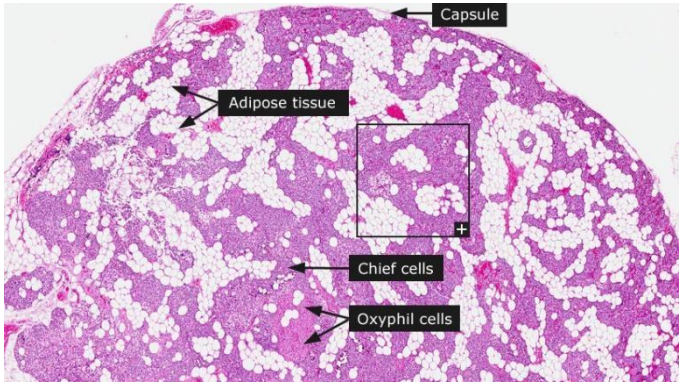
Histology

Chief cells - are more numerous and have a round nucleus surrounded by a small amount of cytoplasm; **secrete the PTH**.

Oxyphil cells - are seen in scattered groups among the chief cells. They have a slightly smaller nucleus and eosinophilic cytoplasm. They have a secretory function, and tend to become more common with age, but their precise role is not clear.

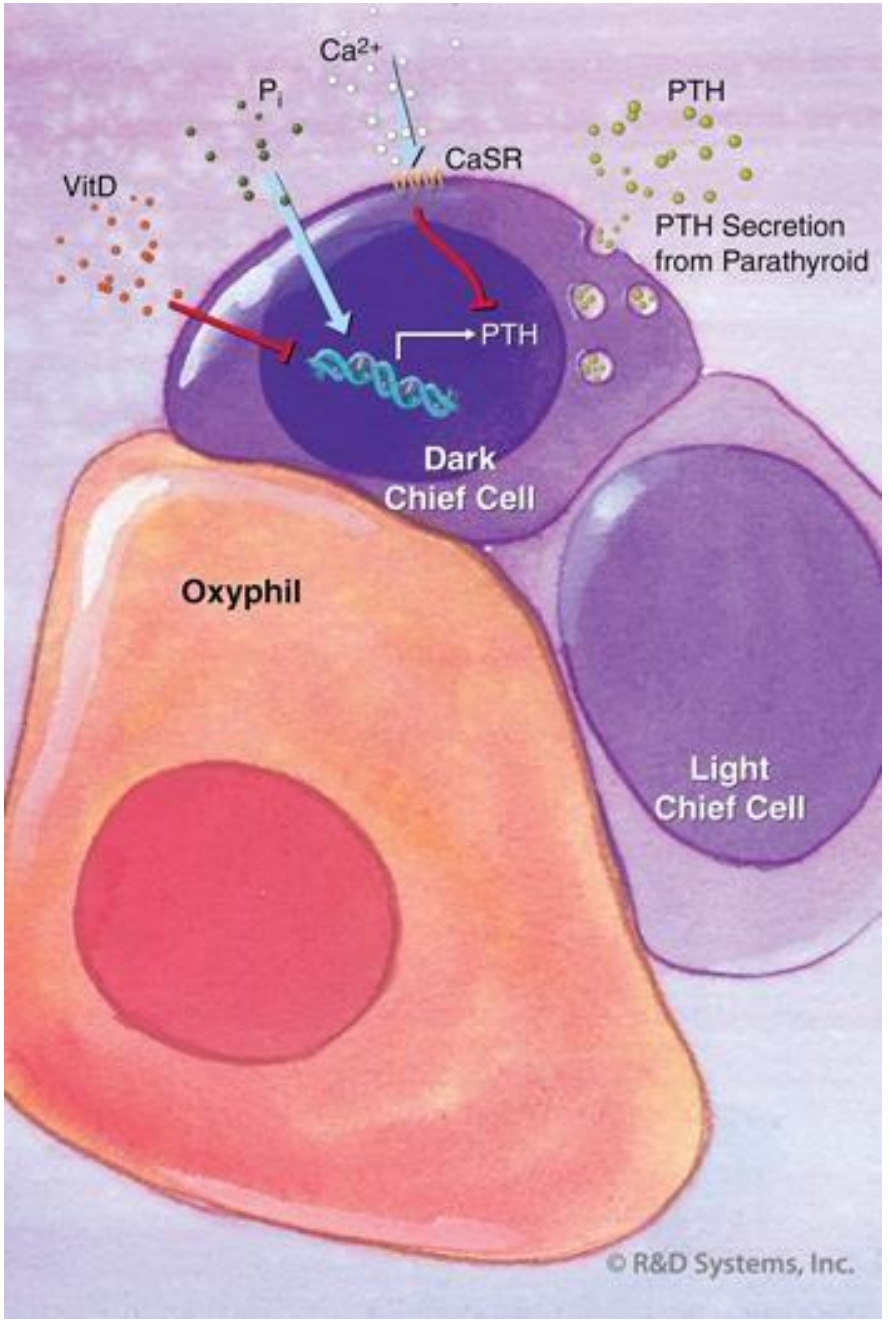
Adipose tissue - these are fat cells which add bulk to the glands and increase with age and obesity.

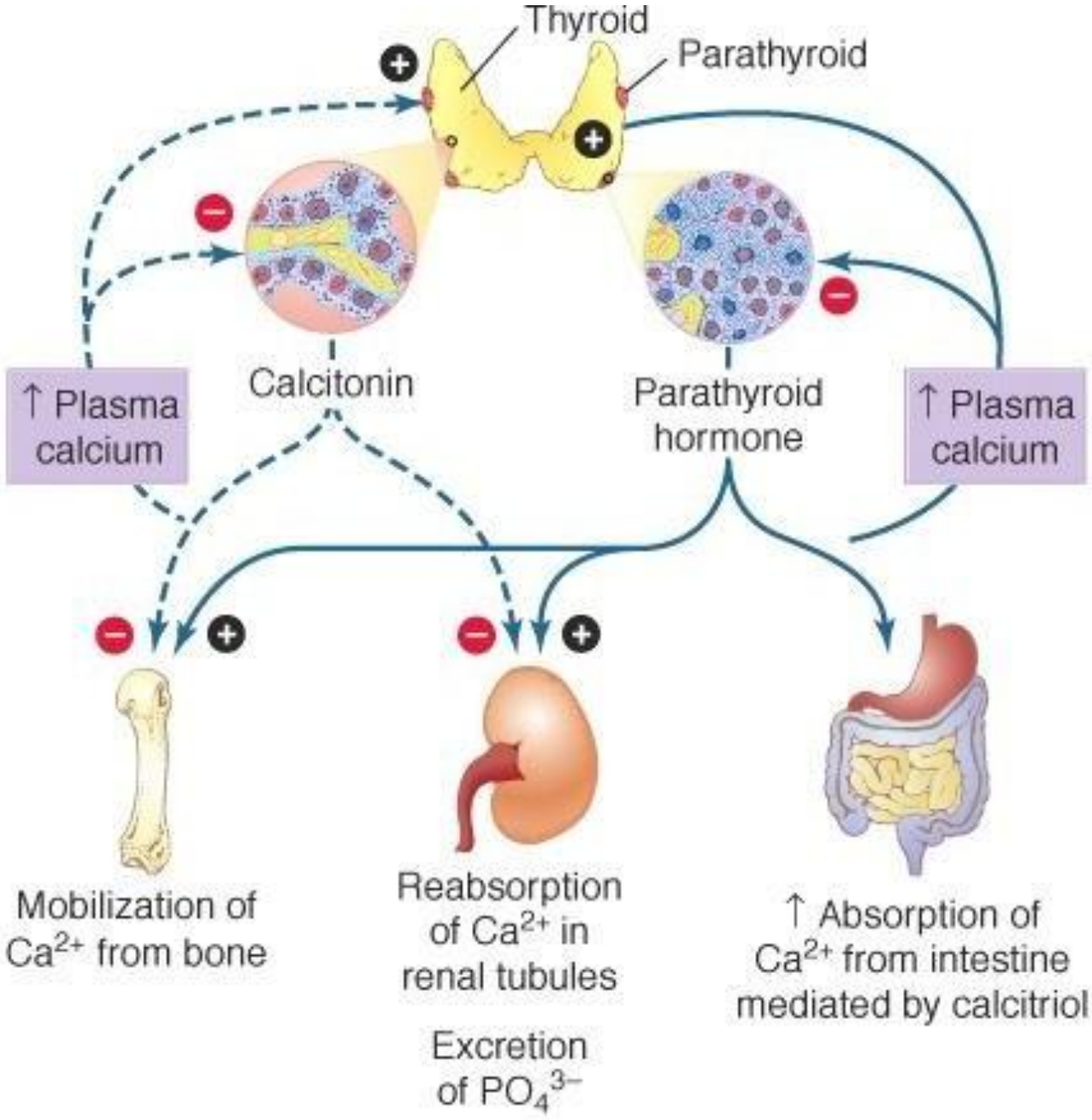
Fibrovascular stroma - this is fibrous tissue that gives form to the glands containing the capillaries supplying them with blood.

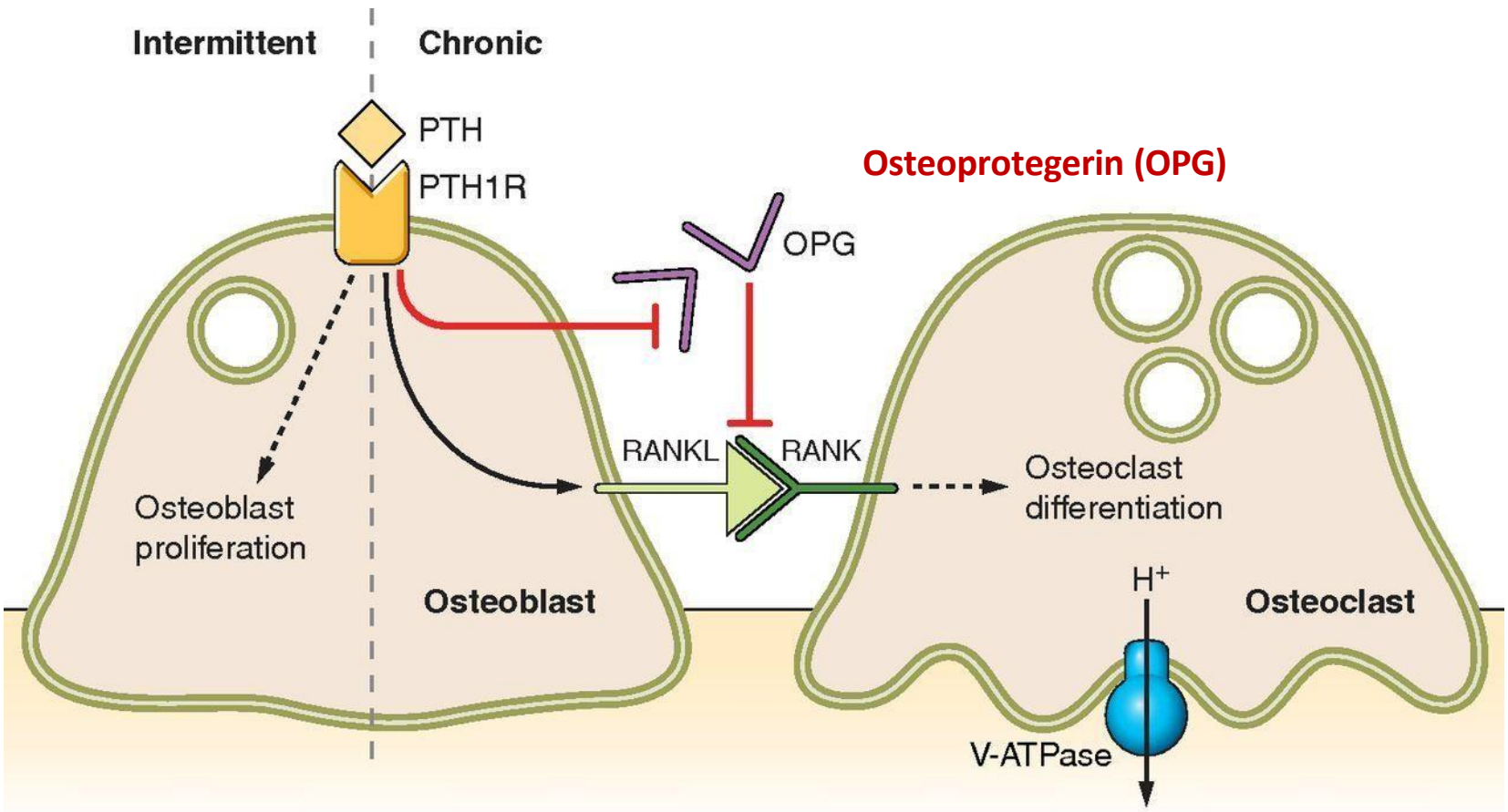


Dark and Light Chief Cells

- PTH is produced by the dark Chief Cells. Lowered extracellular Ca2+ removes Ca Sensing Receptor-dependent repression of PTH production. PTH is then free to mobilize Ca2+ from stores in bone.
- PTH production may also be regulated by Phosphate.




Thyroid
Parathyroid
↑ Plasma calcium
Calcitonin
Parathyroid hormone
↑ Plasma calcium
Mobilization of Ca^{2+} from bone
Reabsorption of Ca^{2+} in renal tubules
Excretion of PO_4^{3-}
↑ Absorption of Ca^{2+} from intestine mediated by calcitriol

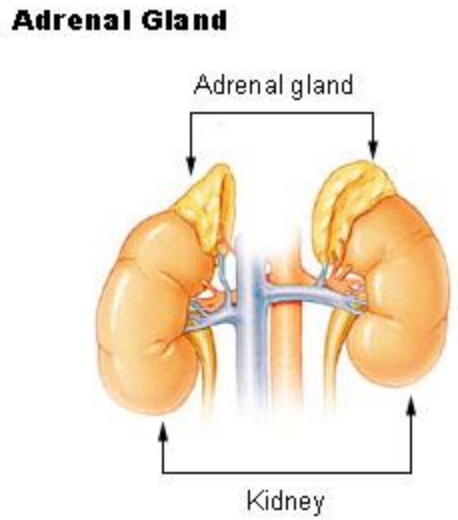


PTH has a dual effect on bone.

Intermittent PTH exposure causes osteoblast proliferation, leading to an increase in bone mass.

Continuous PTH exposure results in RANKL upregulation and concomitant OPG suppression (OPG serves as a decoy receptor for RANKL and prevents its interaction with osteoclast RANK). The stimulated RANKL-RANK interaction leads to osteoclast proliferation and increased bone turnover.

The Adrenal Glands



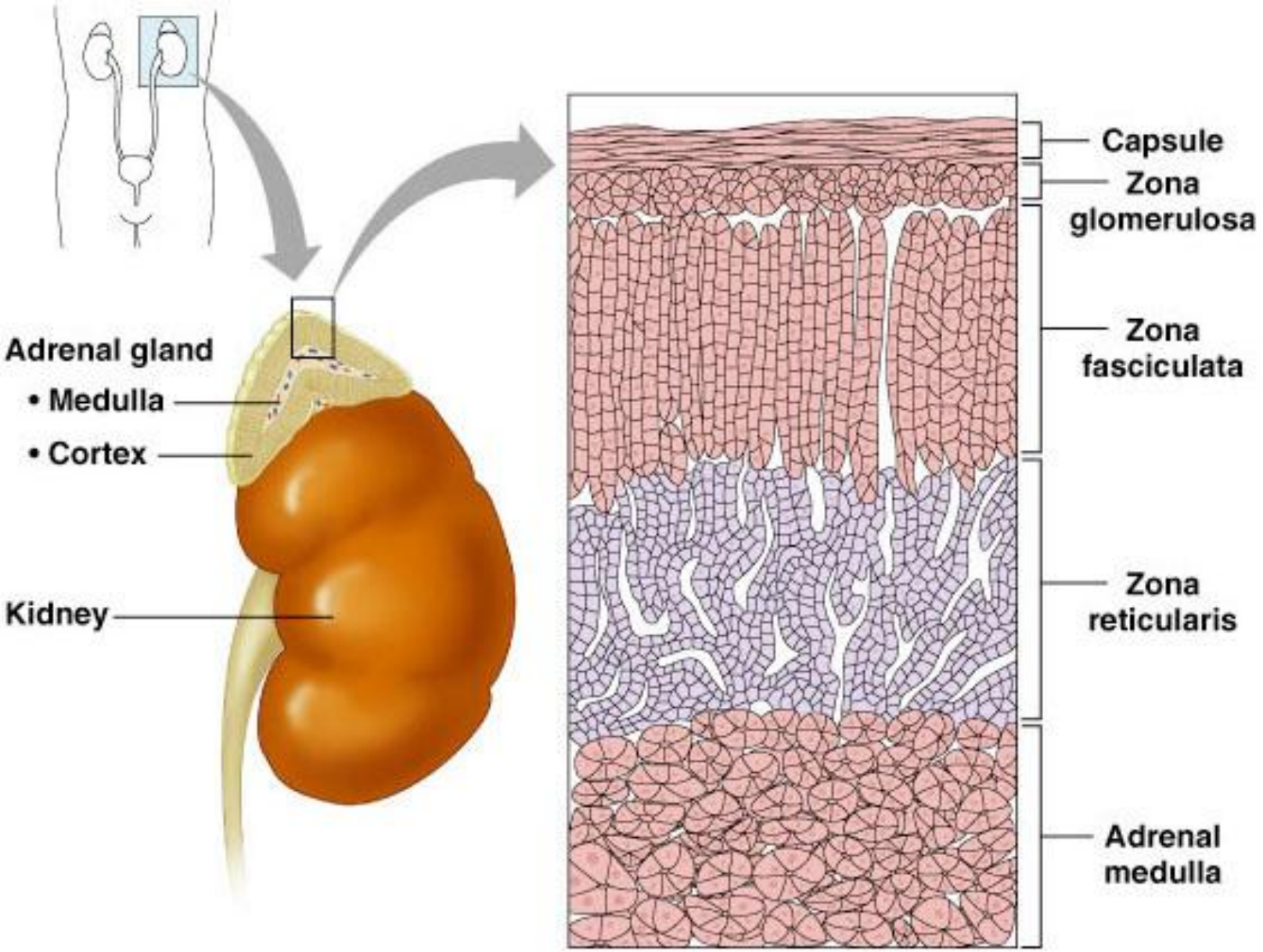
Adrenal (Suprarenal) Glands

- Adrenal glands – paired, pyramid-shaped organs atop the kidneys
- Weigh 6-10 g.
- Structurally and functionally, they are two glands in one
  - **Adrenal cortex** (80-90%)– glandular tissue derived from embryonic mesoderm
  - **Adrenal medulla** (10-20%)– formed from neural ectoderm, can be considered a modified sympathetic ganglion

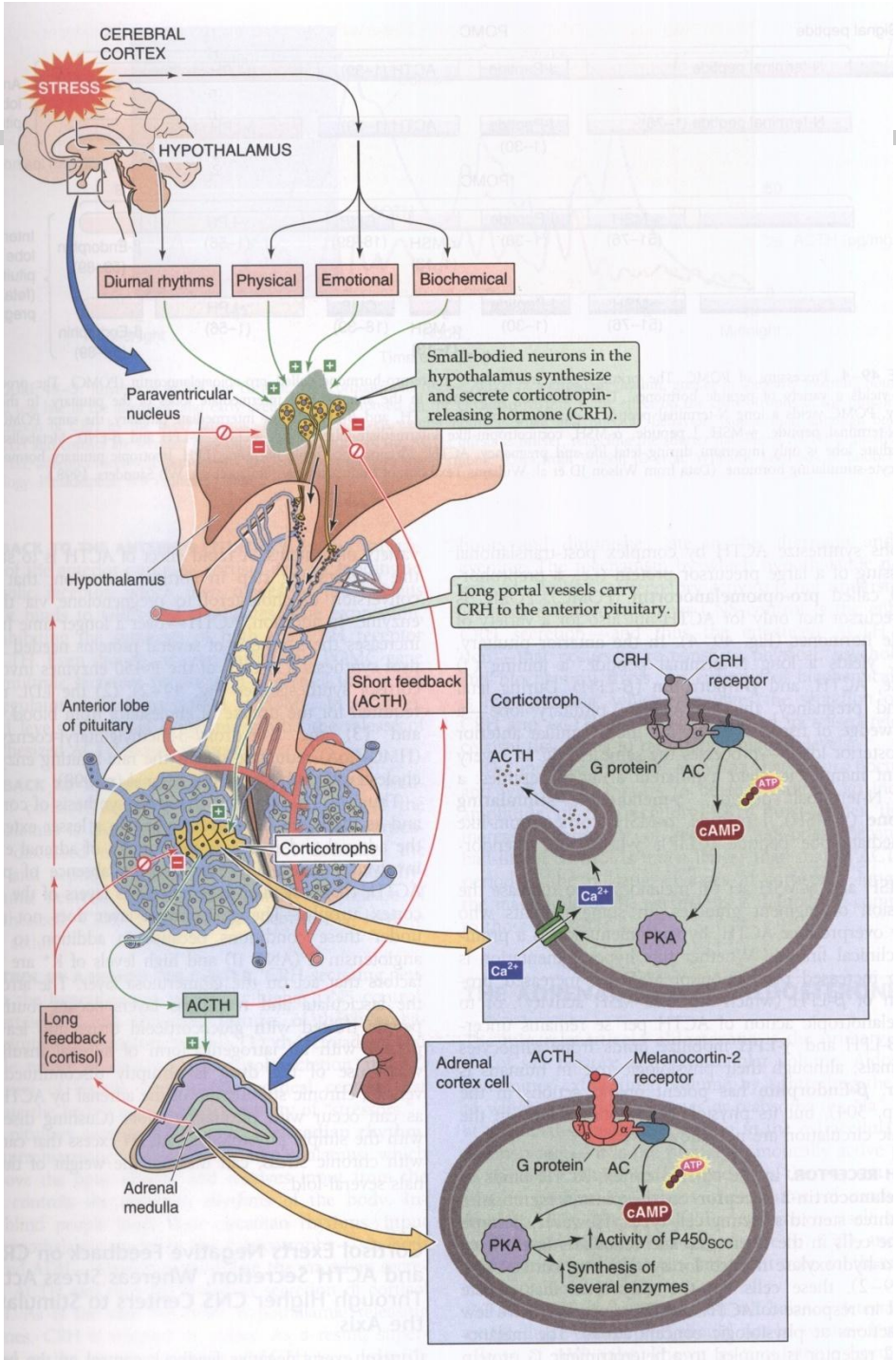
Adrenal Cortex

- Synthesizes and releases steroid hormones (corticosteroids)
- Different corticosteroids are produced in each of the **three layers:**
  - Zona glomerulosa – mineralocorticoids (mainly aldosterone)
  - Zona fasciculata – glucocorticoids +Androgens (mainly cortisol and corticosterone)
  - Zona reticularis – gonadocorticoids + glucocorticoids (mainly dehydroepiandrosterone DHEA)

Adrenal Cortex



HPA Axis


CEREBRAL CORTEX
STRESS
HYPOTHALAMUS
Diurnal rhythms
Physical
Emotional
Biochemical
Small-bodied neurons in the hypothalamus synthesize and secrete corticotropin-releasing hormone (CRH).
Paraventricular nucleus
Hypothalamus
Long portal vessels carry CRH to the anterior pituitary.
Short feedback (ACTH)
Anterior lobe of pituitary
Corticotrophs
CRH
CRH receptor
Corticotroph
ACTH
G protein
AC
ATP
cAMP
Ca^{2+}
PKA
Ca^{2+}
ACTH
Long feedback (cortisol)
Adrenal medulla
Adrenal cortex cell
ACTH
Melanocortin-2 receptor
G protein
AC
ATP
cAMP
PKA
↑Activity of $P450_{SCC}$
↑Synthesis of several enzymes

THANK YOU FOR ATTENDING DES. ANATOMY !

GOOD LUCK IN MEDICAL CAREER !