THYRIOID GLANGD

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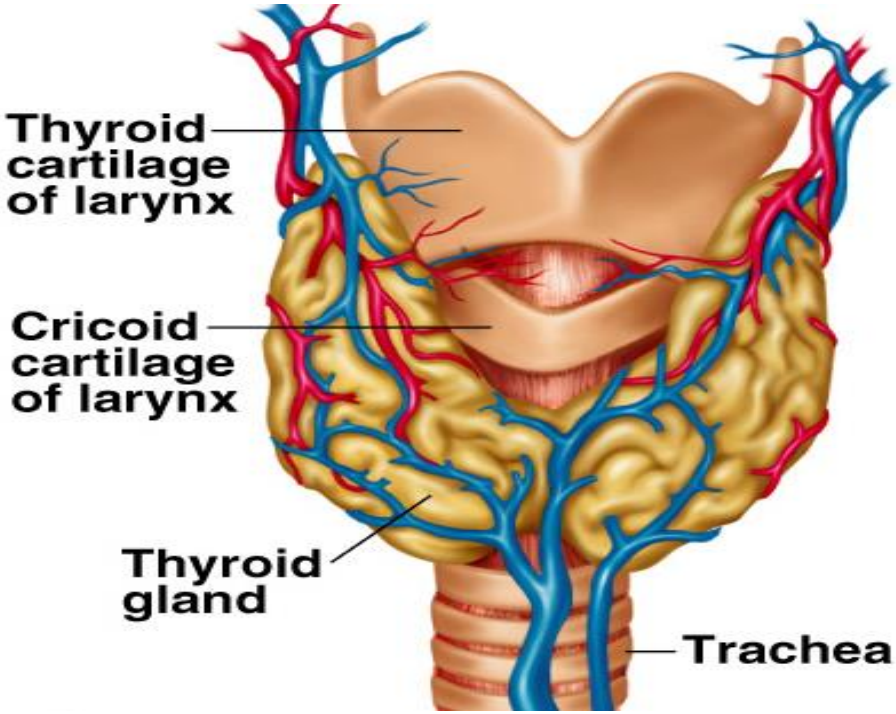
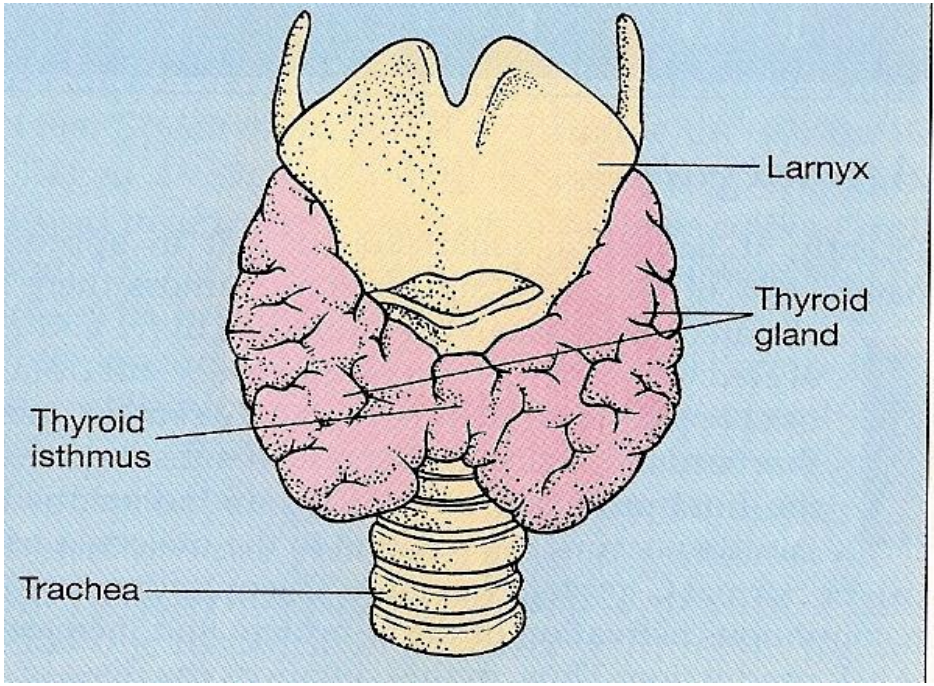
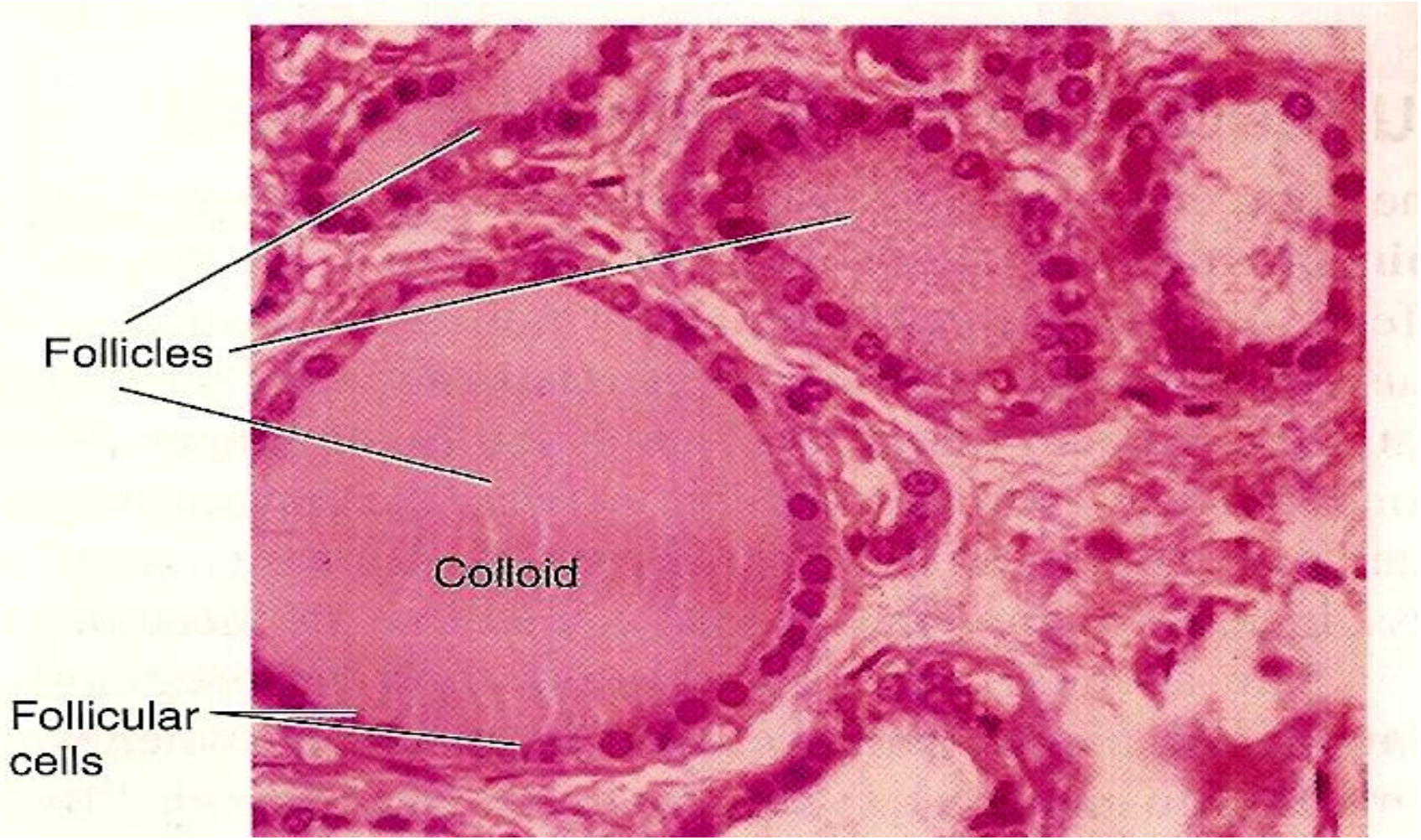
Structural consideration:

Thyroid gland is composed of 2 lobes connected by narrow band of thyroid tissue the ***isthmus*** .The lobes are lateral to the upper portion of the trachea inferior to the larynx .It is the largest endocrine gland 20 gm and highly vascular .It contains numerous small ***sphere follicles*** ,center of the follicle are filled with ***thymoglobulin ,***which is secreted and synthesized by the cells of the thyroid follicles .

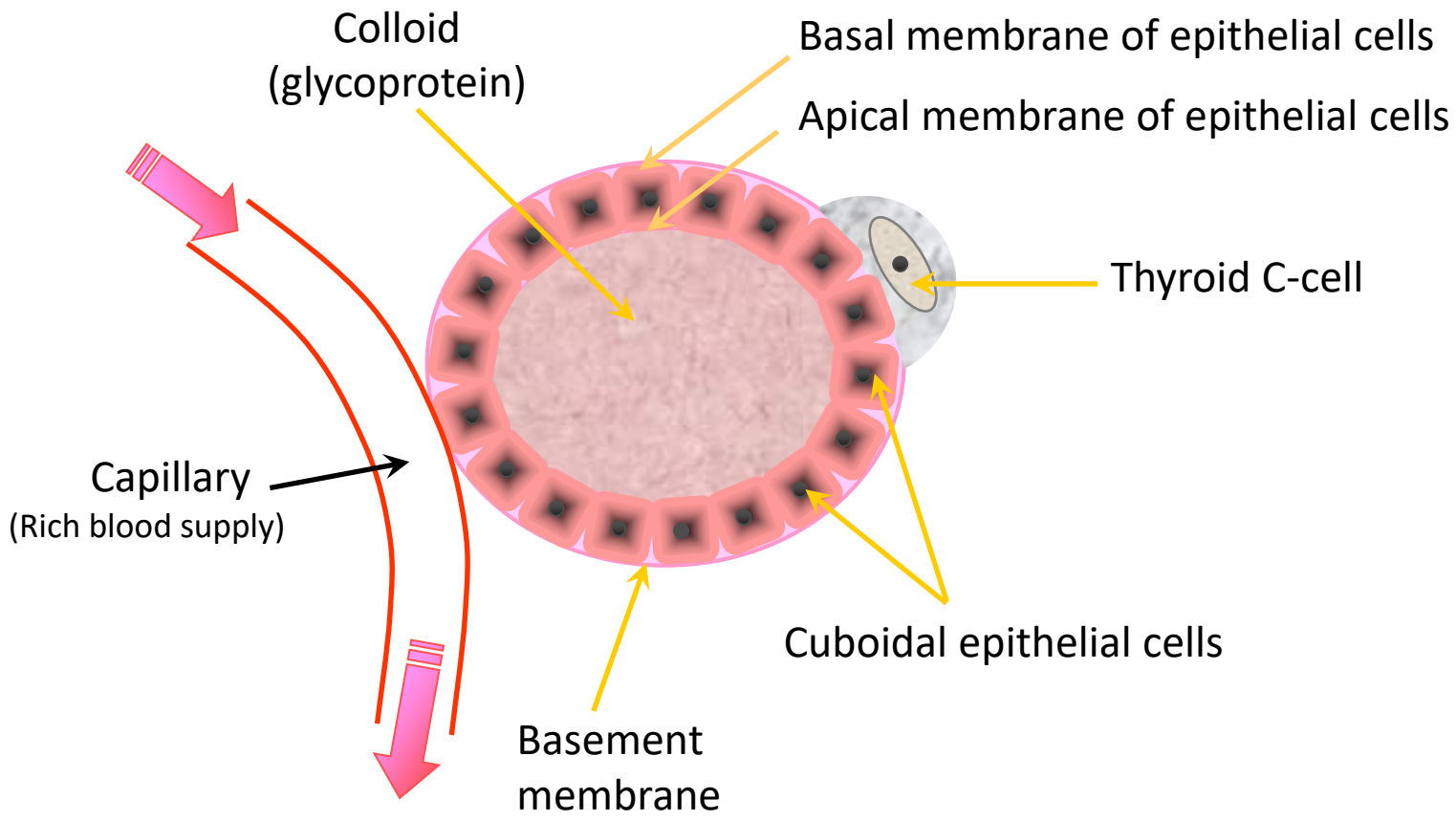
Parafollicular cells are present scattered among the follicles .These secrete ***calcitonin*** .calcitonin regulates calcium in the body fluids.


Thyroid cartilage of larynx
Cricoid cartilage of larynx
Thyroid gland
Trachea


Larnyx
Thyroid gland
Thyroid isthmus
Trachea


Follicles
Colloid
Follicular cells

Structure of thyroid follicle - Euthyroid follicle



- **Thyroid hormones :**
- Triiodothyronin (T3) :3-10%of the thyroid hormones
- Tatraiodothyronin (thyroxin)T4:90-97% of the thyroid hormones

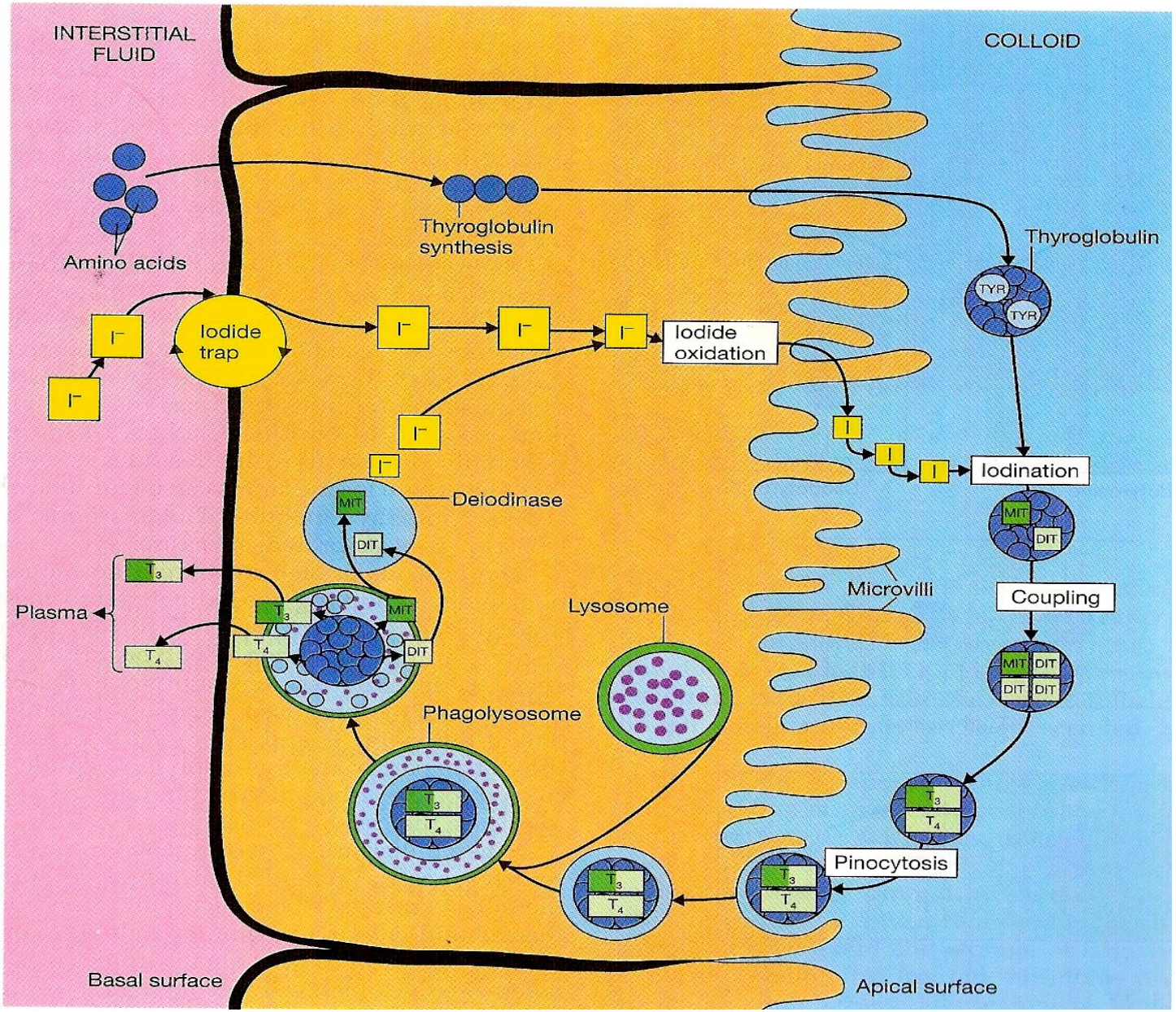
- **SYNTHESIS OF T3&T4.**
- **-Iodide I^- are taken up by thyroid follicle cells by active transport.**
- **-Thyroglobulins synthesized within the follicle cells**
- **-Iodide I^- are oxidized to form iodine I .**
- **-Either one iodine atom is bound to each of tyrosin molecule to form *monoiodotyrosin* or two iodine atoms bound to tyrosin to form *diiodotyrosin* .**
- **These events occur close to the time the thyroglobulin secreted to the lumen of the follicle by exocytosis .**
- **-In the lumen 2 diiodotyrosin combine to form T4 or 1 monoiodtyrosin combines with 1 diiodotyrosin to form T3.**
- **-Thyroglobulin is taken into the cells of the follicles by endocytosis.**
- **- Thyroglobulin breaks down to amino acids +T3+T4 by proteolytic enzymes .T3,T4diffuse out of the follicle cells and enter the circulation .**

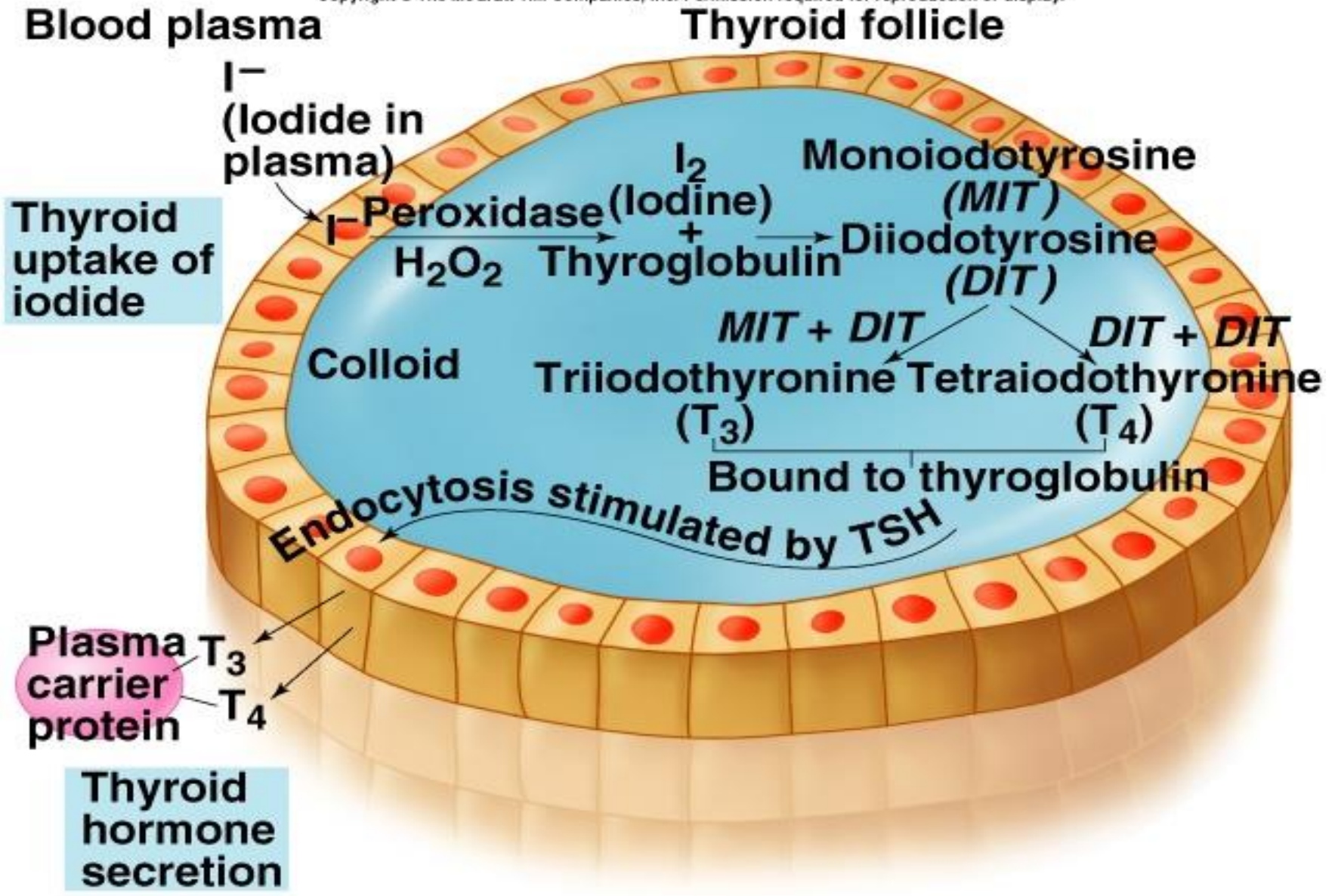
1 Iodine + 1 tyrosine $\rightarrow$ Mono-iodo-tyrosine (MIT)

iodinase

- 2 Iodine + 1 tyrosine $\rightarrow$ Di-iodo-tyrosine (DIT)

Colloid


INTERSTITIAL FLUID
COLLOID
Amino acids
Thyroglobulin synthesis
Thyroglobulin
TYR
TYR
I⁻
I⁻
Iodide trap
I⁻
I⁻
I⁻
Iodide oxidation
I
I
I
Iodination
MIT
DIT
Deiodinase
MIT
DIT
Microvilli
Coupling
MIT
DIT
DIT
DIT
Plasma
T3
T4
T3
MIT
T4
DIT
Lysosome
Phagolysosome
T3
T4
T3
T4
T3
T4
T3
T4
Pinocytosis
Basal surface
Apical surface



- **TRANSPORT OF T3,T4:**
- -70-75%circulating t3,T4are bound to ***Thyroxin binding globulin (TBG)***
- -20-30%are bound to other plasma proteins like albumin
- -30-40% of T4 is converted to T3 in the body tissues.
- -T3 is the major hormone that interacts with the target cells and is several times more potent than T4.

- **ELIMINATION OF T4:**
- Much of circulating T4 eliminated by conversion to ***Tetraiodothyroacetic*** acid .This is excreted in the urine and bile .
- Large amount of T4 is converted to inactive T3 ,rapidly metabolized and excreted .

- **EFFECT OF T3,T4**

-T3,T4 affect every tissues in the body ,but not in identical response.

-T3,T4 regulate the metabolism at a normal metabolic rate .

-↑TH level→↑the rate of metabolism of protein, fat and glucose.

-↑rate of metabolism produce s heat

-blood level of cholesterol decline.

-↑activity of Na^+-K^+ pump which lead to ↑body temperature.

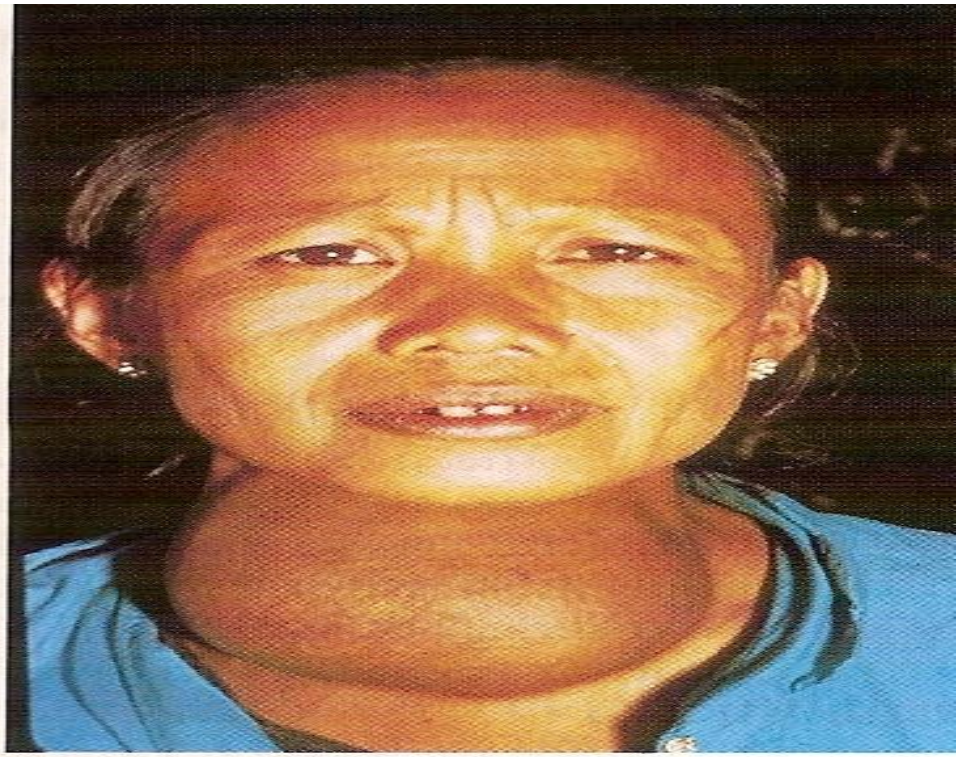
-Metabolic rate increase 60-100%when blood T3,T4are elevated .

-Low level of T3,T4→opposite effect .

-T3,T4 play a permissive role for GH .

-Potentiation of catecholamine action by stimulating activity of β-adrenergic receptors in heart and muscles

-Abnormality of thyroid conditions :***1-hyperthyroidism 2-hypothyroidism***



- **REGULATION OF THYROID HORMONES :**
- 1-TRH is released from the hypothalamus ,TRH passes through hypothalmohypophayseal portal system to the anterior pituitary gland .
- 2-TRH causes the anterior pituitary gland to secret TSH ,TSH passes through the circulation to the thyroid .
- 3-TSH causes the releasing of T3,T4 by the thyroid into the circulation.
- 4-T3,T4 act on target tissues .
- 5-T3,T4 have an inhibitory effect on the secretion of TRH ,TSH .

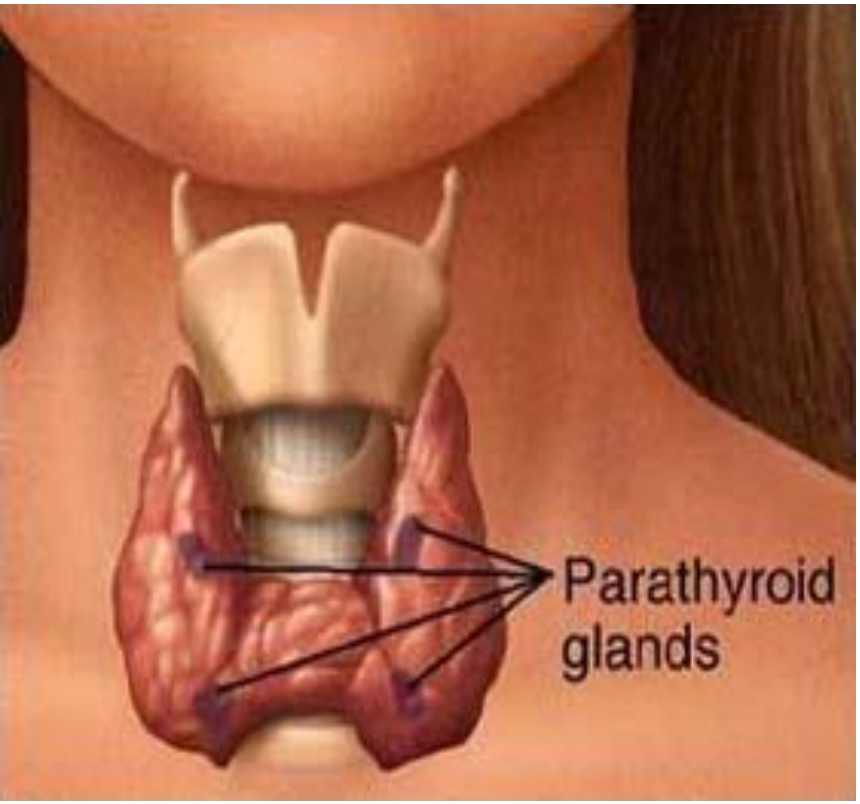
- **GOITER:** abnormal enlargement of the thyroid gland ,may result from conditions that cause hypothyroidism as well as conditions that cause hyperthyroidism **.**
- **Iodine deficiency goiter :**
- When dietary iodine intake is very low leading to decrease blood level of T3,T4 and the person may exhibit symptoms of hypothyroidism

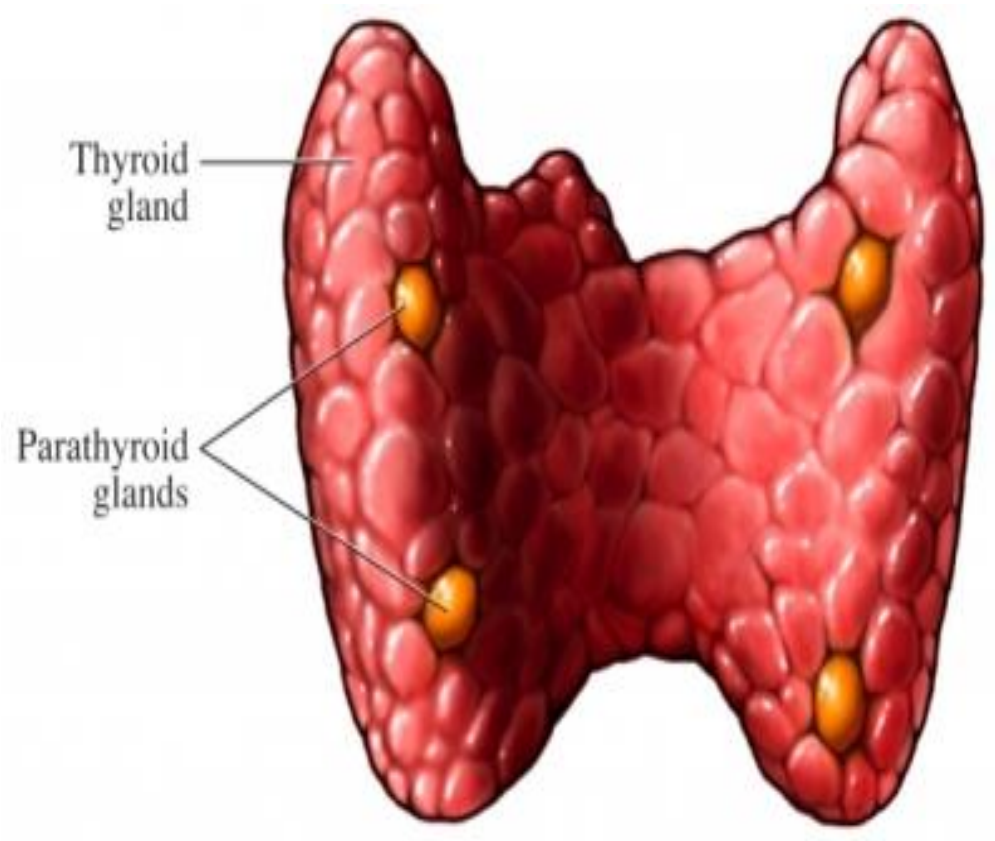
- **CALCITONIN:**
- -Secreted by parafollicular cells of the thyroid
- -↑ level of calcium in the blood →↑secretion of calcitonin .
- -The primary target tissue is the bone.
- -It causes ↓ in the osteoclast and lengthen the life span of osteoblast →decrease in the blood calcium level and phosphate level.
- -Calcitonin may play a role in the regulating food intake by decreasing appetite

- **Pharmacology note** :Amiodarone is used to treat tachyarrhythmias (atrial fibrillation)but causes hyperthyroidism (common) or hypothyroidism (rare).
- Hyperthyroidism is treated by : Propylthiouracil and methimazole.

- **Parathyroid Gland**
- Parathyroid glands are embedded in the posterior part of each lobe of the thyroid gland.
- Parathyroid glands are made up of two cell types :
- **The chief cells** :secret **parathyroid hormone(PTH)**
- **Oxyphils** with unknown function.

Parathyroid gland





- **Parathyroid hormone (PTH)**
- PTH is a polypeptide hormone. It regulates the Ca^{2+} level in the body fluid (normal Ca^{2+} level is 8-10mg/dl).
- Bone, intestine and kidney are the major target tissues.
    - ***In the bone,*** PTH stimulates **osteoclast activity**, leading to bone resorption and release of Ca^{2+} and phosphate, result in increased blood Ca^{2+} level.
    - ***In the kidney*** :
- PTH induces Ca^{2+} reabsorption, so less Ca^{2+} level leaves the body in the urine.
- PTH increases the enzymatic formation of active vitamin D.
- ***In the intestine*** :Active vitamin D causes increase in the rate of Ca^{2+} and phosphate absorption result in elevated blood Ca^{2+} level.

Calcitonin mechanism
The parafollicular cells of the thyroid gland detect the increase in blood Ca^{2+} levels.

Increased calcitonin secretion by the parafollicular cells results.

Decreased breakdown of bone matrix by osteoclasts results in the decreased release of Ca^{2+} from bones.

PTH mechanism
The parathyroid gland cells detect the increase in blood Ca^{2+} levels.

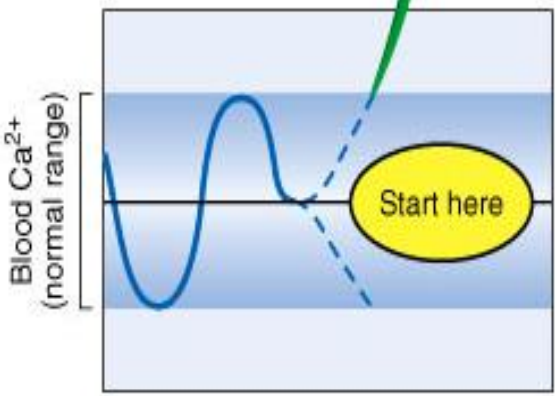
Decreased PTH secretion from the parathyroid glands results.

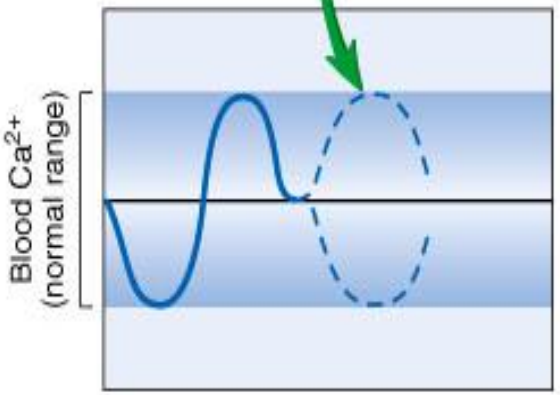
- Decreased breakdown of bone matrix by osteoclasts results in the decreased release of Ca^{2+} from bones.
- Decreased reabsorption of Ca^{2+} by the kidneys results in increased Ca^{2+} loss in the urine.
- Decreased synthesis of active vitamin D by the kidneys results in decreased Ca^{2+} absorption from the small intestine.

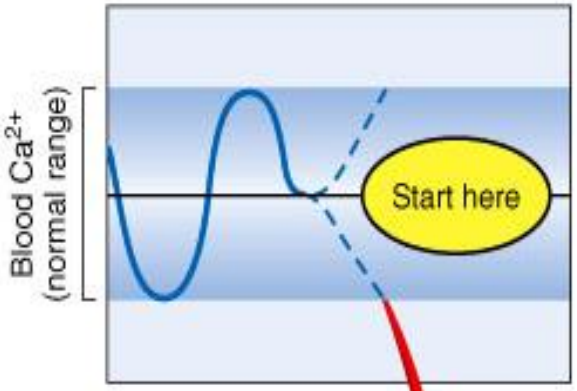
Blood Ca^{2+} levels increase.

A decrease in blood Ca^{2+} levels occurs because fewer Ca^{2+} enter the blood than leave the blood.

Follow the green arrows when blood Ca^{2+} increases.







Follow the red arrows when blood Ca^{2+} decreases.

Blood Ca^{2+} levels decrease.

PTH mechanism
Parathyroid gland cells detect the decrease in blood Ca^{2+} levels.

Increased PTH secretion from the parathyroid glands results.

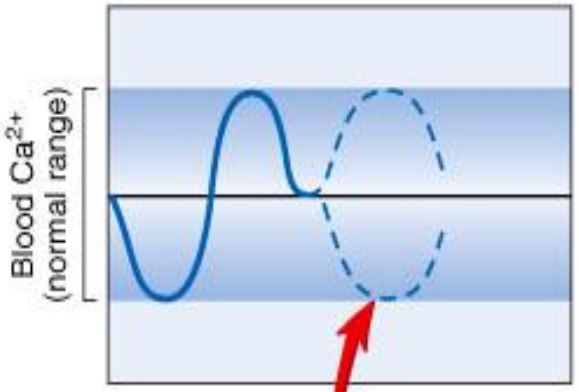
- Increased breakdown of bone matrix by osteoclasts results in the increased release of Ca^{2+} from bones.
- Increased reabsorption of Ca^{2+} by the kidneys results in decreased Ca^{2+} loss in the urine.
- Increased synthesis of active vitamin D by the kidneys results in increased Ca^{2+} absorption from the small intestine.

Calcitonin mechanism
Parafollicular cells of the thyroid gland detect the decrease in blood Ca^{2+} levels.

Decreased calcitonin secretion by the parafollicular cells results.

Increased breakdown of bone matrix by osteoclasts results in the increased release of Ca^{2+} from bones.

An increase in blood Ca^{2+} levels occurs because more Ca^{2+} enter the blood than leave the blood.



- **Pathological conditions of PTH**
- **Hyperparathyroidism**
- ***Primary Hyperparathyroidism*(↑PTH,↑Ca^{2+})**
- It caused by adenoma and hyperplasia
-
  - ***Secondary Hyperparathyroidism*(↑PTH,↓Ca^{2+})**
- It occurs during chronic stimulation of PTH due to decrease serum Ca^{2+}
    - Ex: renal failure, vitamin D deficiency, or malabsorption syndromes.
- **Hypoparathyroidism**
  - Decrease PTH occurs mainly by accidental removal of parathyroid during thyroid surgery and (or) parathyroid surgery.