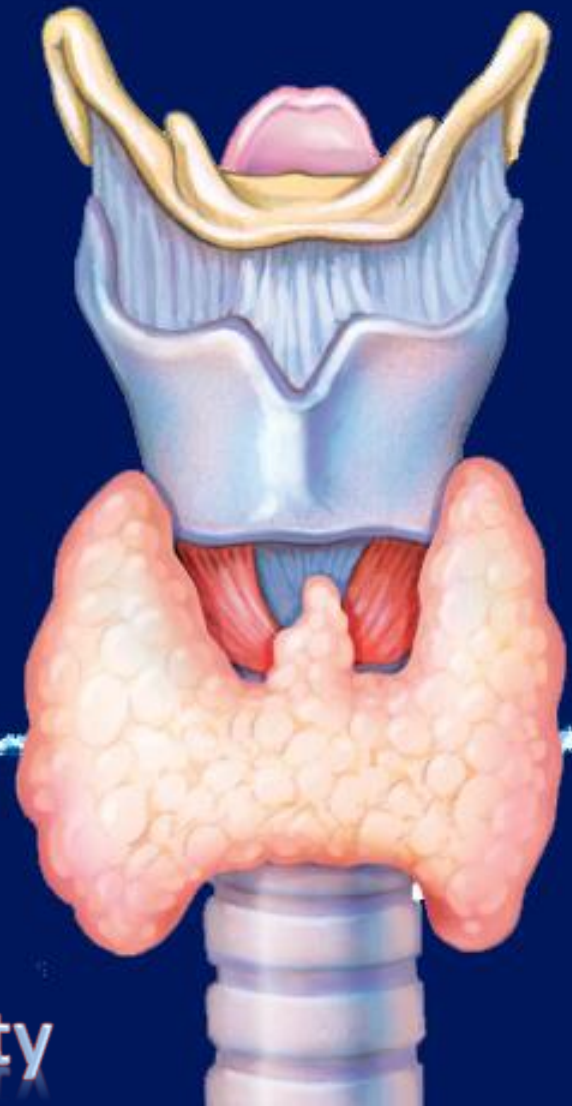


# Thyroid gland



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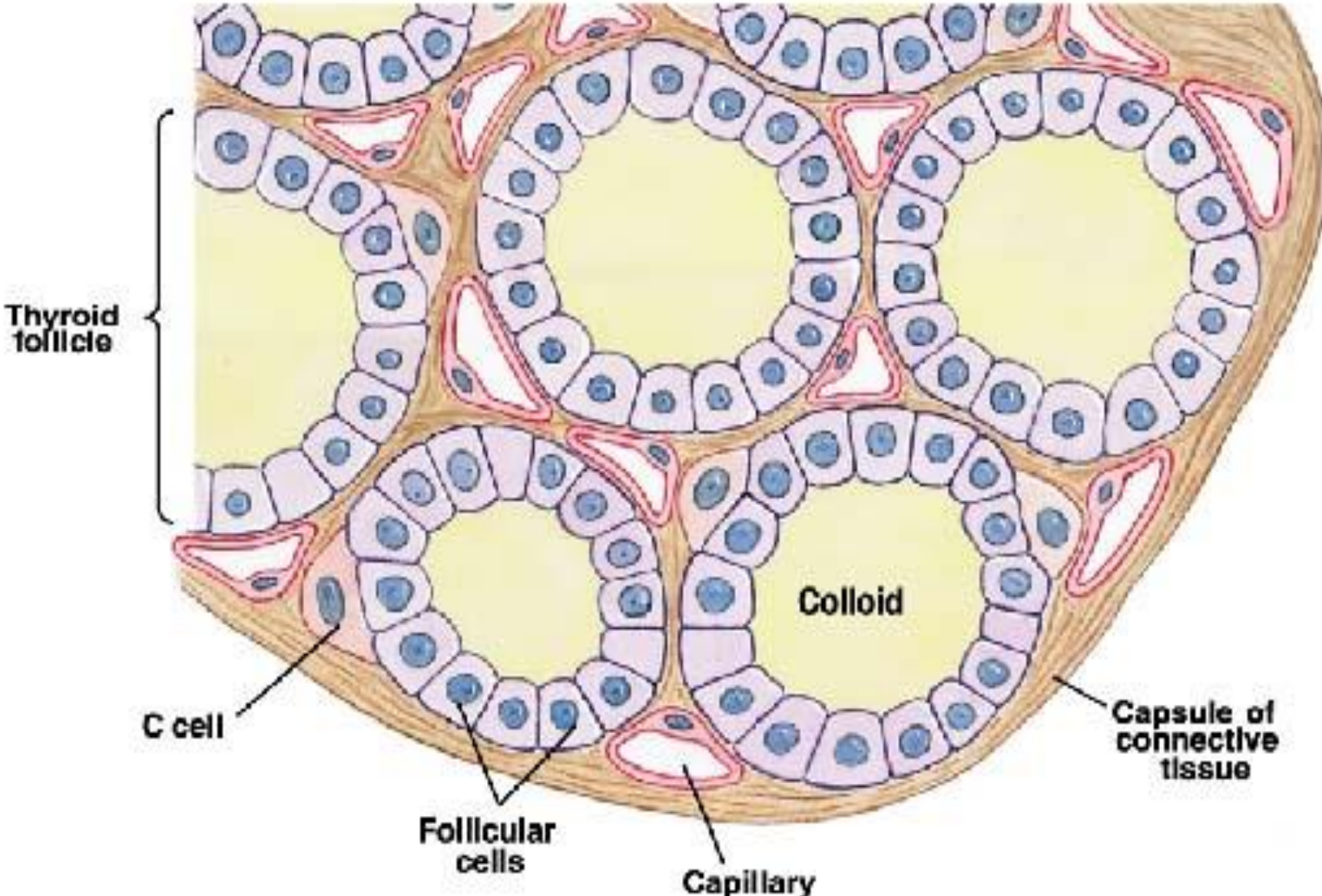
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# Structure

- It is formed of two lobes connected by a narrow isthmus .
- The gland is formed of thyroid follicles , each follicle is surrounded by a single layer of epithelial cells and its lumen is filled with a protein material called colloid ( which is formed and secreted by follicular cells ).
- In between the follicles there are other cells called parafollicular cells .
- The gland is richly supplied with blood vessels .

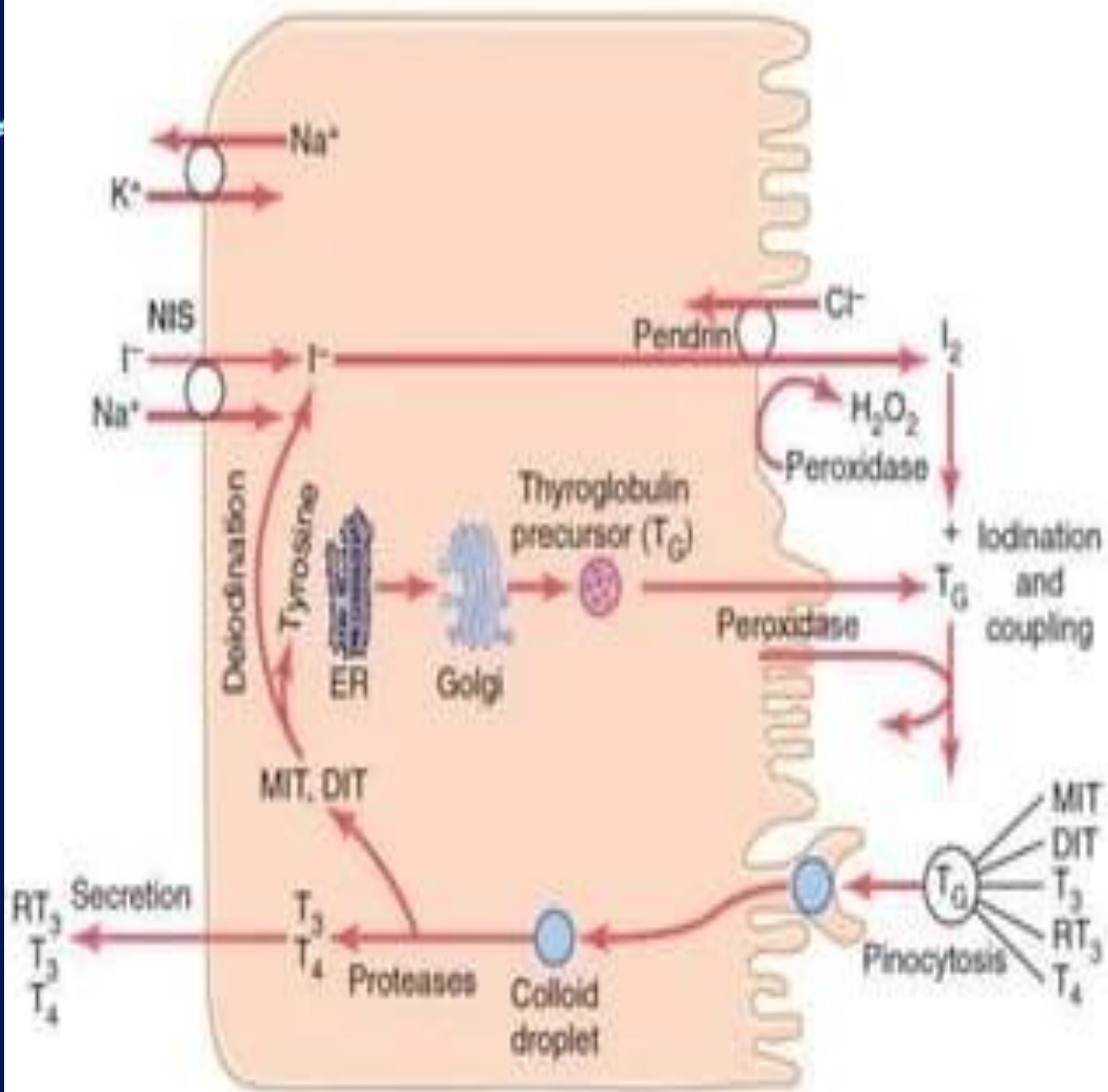


**Section of thyroid gland**



## Required Steps for $T_3$ and $T_4$ Synthesis

1. Iodide trapping	Iodine circulates in the blood as iodide ( $I^-$ ). Iodide is actively transported into the follicular cells. Because of this process, the thyroid gland contains most of the iodide in the body.
2. Synthesis of thyroglobulin	Thyroglobulin is a glycoprotein produced by follicular cells. It contains large numbers of the amino acid tyrosine. Tyrosine is the site on the Thyroglobulin molecule that will bind with iodine.
3. Oxidation of iodide	Before iodide can bind to tyrosine, it must be oxidized and combine with another iodide to form an iodine molecule ( $I_2$ ).
4. Iodination of tyrosine	The side chain of tyrosine may pick up one ( $T_1$ ) or two ( $T_2$ ) iodine molecules.
5. Coupling of $T_1$ and $T_2$ to make $T_3$ and $T_4$	As one of the last steps, two tyrosine molecules are joined to form either $T_3$ ( $T_1+T_2$ ) or $T_4$ ( $T_2+T_2$ ).
6. Pinocytosis and digestion of colloid	Once synthesized, the iodine-containing thyroglobulin reenters the follicular cells and digestive enzymes break down the molecule, releasing the $T_3$ and $T_4$ .
7. Secretion of thyroid hormones	$T_3$ and $T_4$ are lipid soluble, so they freely pass the cell membrane into the interstitial fluid and into the bloodstream.
8. Transport of $T_3$ and $T_4$ in the blood	Once in the blood stream, 99% of the secreted hormone binds to transport proteins, mainly thyroxine-binding globulin.



# Thyroid hormones

1. Thyroxine ( $T_4$ ) : tetraiodothyronine
2. Triiodothyronine ( $T_3$ )

both  $T_3$  &  $T_4$  are formed by thyroid follicles

3. Calcitonin : secreted by parafollicular cells (C cells ) it causes lowering of blood  $Ca^{++}$  level .



# Transport of thyroid hormone

- Once  $T_3$  and  $T_4$  enter the circulation , they bound to plasma proteins and only less than 1% of the hormones are free .
- This free form of the hormone is the active form that can perform its actions .
- $T_3$  is more active than  $T_4$  and  $T_4$  is converted to  $T_3$  inside target cells.



## Mechanism of action :

- Thyroid hormone enter the cells , bind to the receptor in the nucleus → increase transcription of mRNA that stimulate the production of various enzymes in the ribosomes .



# Actions of $T_3$ and $T_4$

## 1. *Metabolic function*

### a. Calorigenic action :

Thyroid hormones increase  $O_2$  consumption, heat production and basal metabolic rate (BMR).

### b. On protein metabolism :

Normal level of thyroid hormones increase protein synthesis ( anabolic effect ) .

High level of thyroid hormones increase protein breakdown ( catabolic effect ) .



**c. On carbohydrate metabolism :**

Thyroid hormone increase glucose absorption from GIT so blood glucose increase after meal , but rapidly fall to normal level again due to increased uptake of glucose by the tissues to be used for energy production .

**d. On lipid and cholesterol metabolism :**

They lower blood lipid and cholesterol *despite stimulation of lipolysis in adipose tissue* by increasing its removal from circulation by the liver. It also enhances metabolism of fatty acids

**e. Stimulate conversion of carotenes to vitamin A in the liver .**



## ***2. Effect on growth and development***

**Thyroid hormones are necessary for growth and maturation of most tissues.**

## ***3. On CNS***

- Thyroid hormones are essential for normal brain development during fetal life and in children .**
- In adult , they increase response of brain to catecholamines and increase activity of reticular activating system ( RAS ) .**



## 4. On CVS

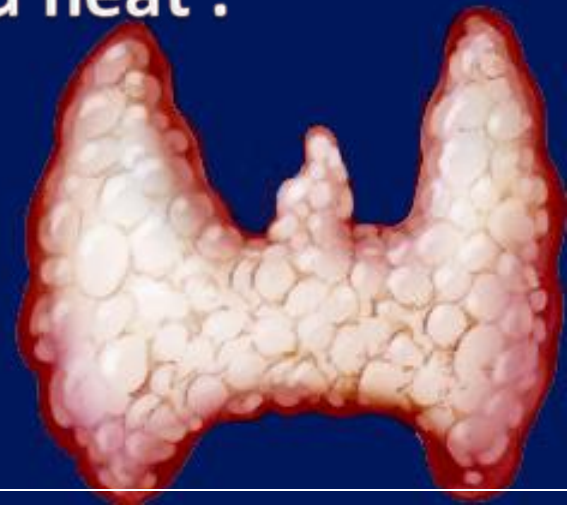
a. They increase all cardiac properties by increasing number and affinity of B adrenergic receptors ( to catecholamines ) and by direct effect which lead to :

- Increase heart rate ( H.R. )
- Increase stroke volume ( S.V. )
- Increase cardiac out put ( COP )
- Increase systolic blood pressure .

b. Cutaneous V.D occurs by the produced heat .

↓ peripheral resistance causes decreased diastolic blood pressure .

c. Increased pulse pressure.



## ***5. On respiration***

- shift of  $O_2$  curve to Rt by increasing 2,3 DPG in RBCs
- Increase pulmonary ventilation due to increased metabolic rate with more  $O_2$  utilization and more  $CO_2$  formation ( through activation of chemoreceptors ) .

## ***6. On GIT***

- Increase appetite and food intake .
- Increase GIT motility .

## ***7. On sex functions :***

- Thyroid hormone are essential for normal menstrual cycle & Spermatogenesis (normal fertility)



# Regulation of thyroid hormone

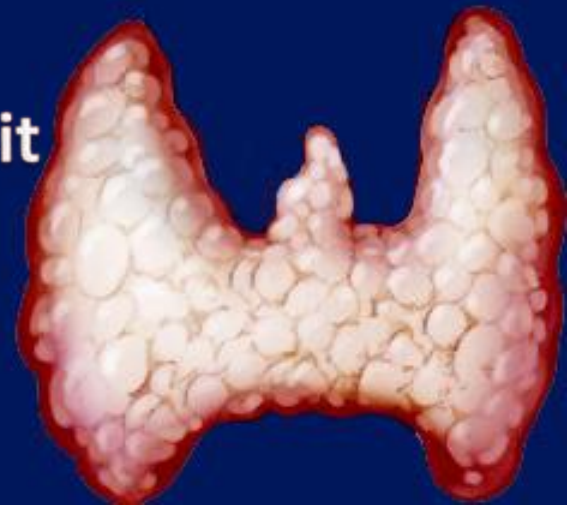
## 1. Hypothalamic regulation

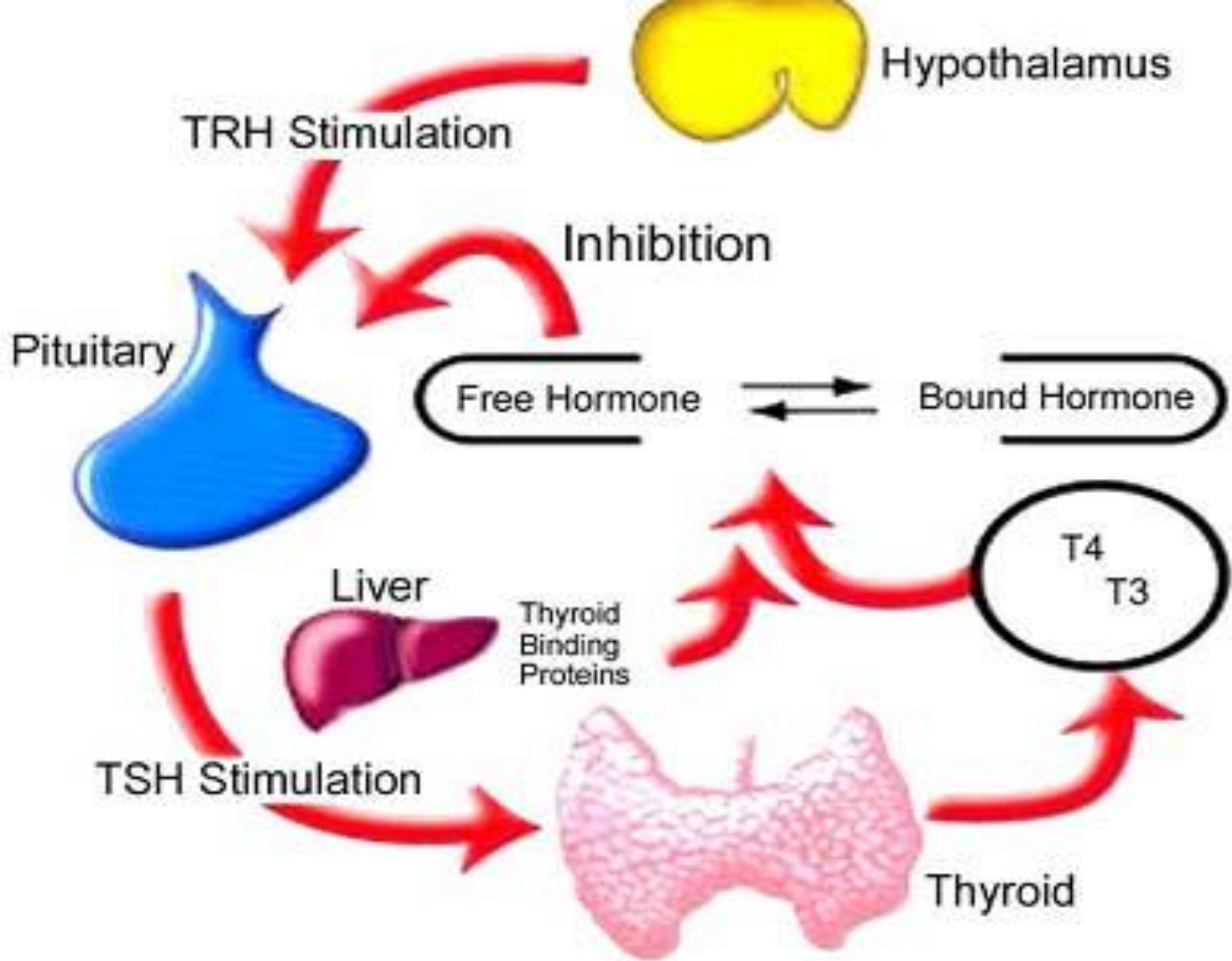
### 1. TRH ( thyrotropin releasing hormone )

- Exposure to cold **increase TRH** release
- Chronic stress with excess cortisol , emotions(depression) and warmth **decrease TRH**

### 2. Somatostatin

- It inhibit TSH secretion thus it inhibit thyroid hormone secretion .





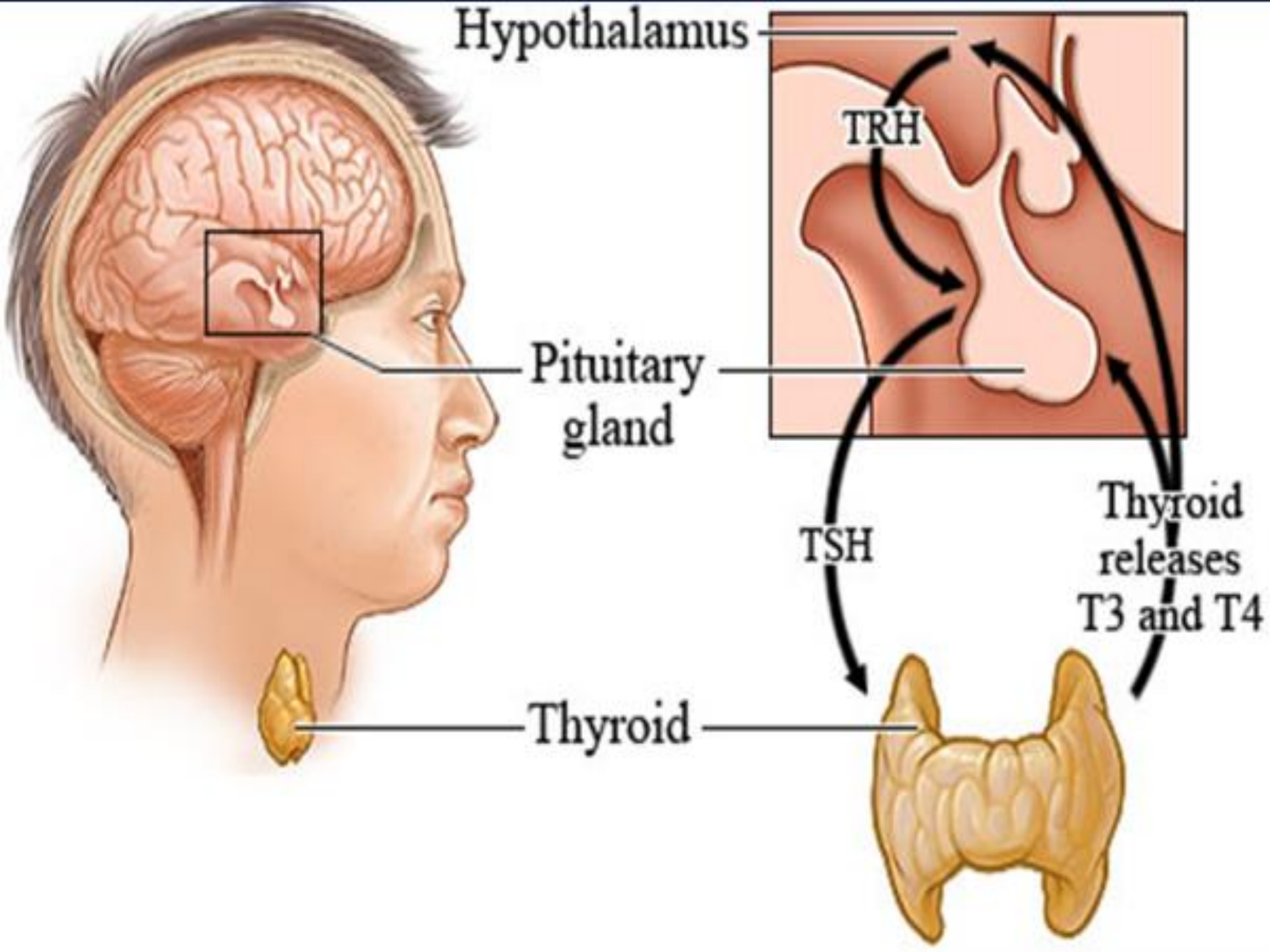
## *2. Pituitary regulation ( TSH )*

### **3. Feedback regulation :**

-  $\uparrow$  free  $T_3$  and  $T_4$  in blood inhibit TSH secretion by negative feedback on anterior pituitary and hypothalamus .

- Thus , when free  $T_3$  and  $T_4$  decreased in blood TSH secretion will be increased .



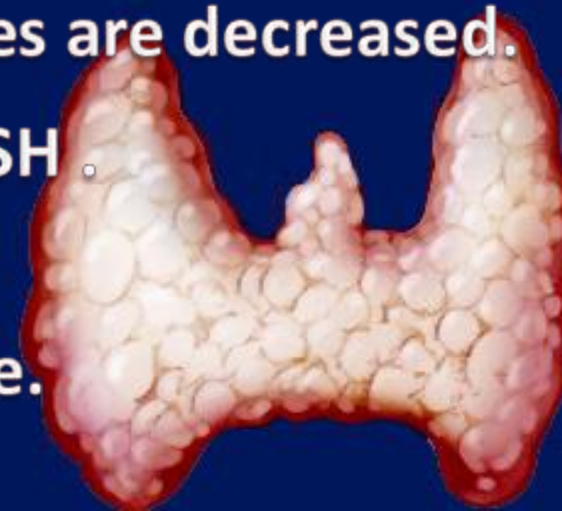


## 4. Blood iodide level :

- Adequate dietary iodine intake is essential for normal thyroid function .
- Decreased iodine intake  $\rightarrow$   $\downarrow$  T3 and T4 synthesis and release  $\rightarrow$   $\uparrow$  TSH  $\rightarrow$   $\uparrow$  size of the gland = thyroid enlargement ( goiter )
- Excess iodide in blood (*Wolff-Chaikoff effect*)  $\rightarrow$  decreases thyroid hormone in blood

as it inhibits the vascularity and all activities of thyroid gland so, the release of thyroid hormones are decreased.

- Mechanism:**
- 1-Reduce the effect of TSH .
  - 2-Inhibits proteolysis of thyroglobulin.
  - 3- Decrease the organic binding of iodine.



# Goiter

**Definition :** goiter is non-inflammatory and non-malignant thyroid enlargement .



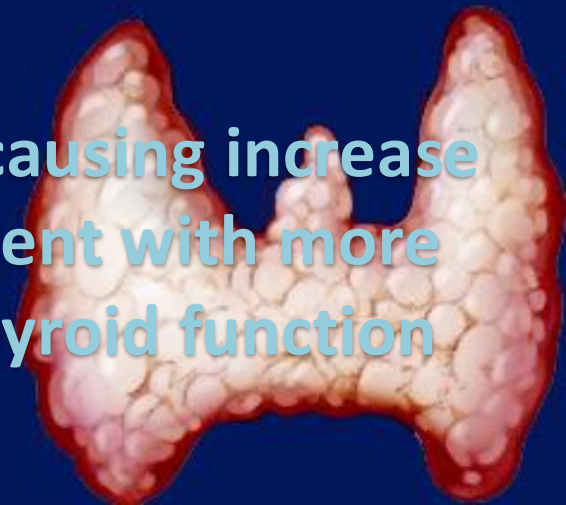
- **Types :**

1. **Simple goiter :**

It is associated with **normal thyroid function**

It is due to :

- **Mild iodine deficiency**
- **During puberty and pregnancy , due to increase need for iodine .**
- **Thyroid hormone decreased at first causing increase in TSH which causes thyroid enlargement with more formation of thyroid hormone thus thyroid function remains normal .**



## 2. Colloid Goiter :

Cause : **severe iodine deficiency**

Here , the enlarged thyroid gland can't synthesize excess thyroid hormone due to severe iodine deficiency .

It is associated with **hypothyroidism** .



**3. Toxic Goiter** : This thyroid enlargement is associated with **thyroid hyper function** .

it is called **Graves' disease** .

it is an **auto immune disease** in which the immune system secretes auto antibodies called long- acting thyroid stimulators **(LATS)** .

These antibodies activate TSH receptors producing hyperthyroidism due to increased formation of thyroid hormone .

▪ **LATS** have long duration of action .



A vibrant sunset scene with a bright sun partially obscured by dark, silhouetted mountains. The sky is a mix of deep reds, oranges, and purples, with some clouds catching the light. The sun's reflection is visible on the water in the foreground. The text 'THank you' is overlaid in a large, blue, sans-serif font with a white outline. The 'T' is all caps, while 'Hank you' is in title case.

**THank you**