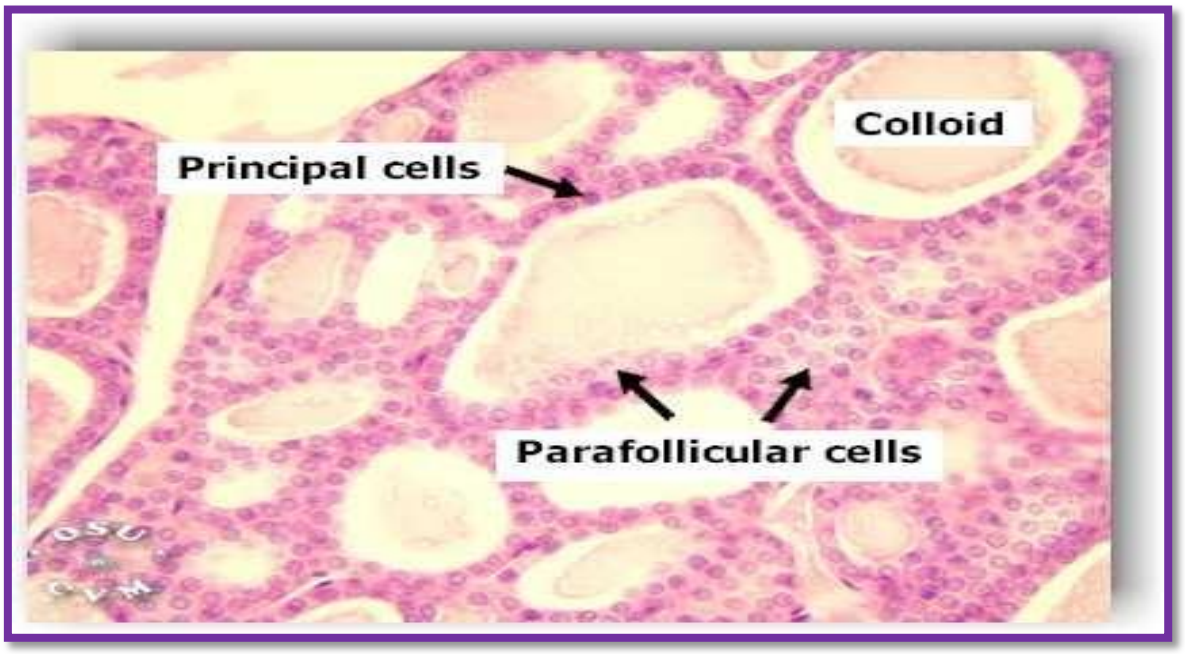
Thyroid Gland

The thyroid gland is a butterfly shaped gland located immediately below the larynx on each side of and anterior to the trachea, it is one of the largest endocrine glands, normally weighing **15** to **20** grams in adults. The thyroid secretes two major hormones, **thyroxine** and **triiodothyronine**, commonly called T4 and T3, respectively. Both of these hormones profoundly increase the **metabolic rate** of the body. The thyroid gland also secretes calcitonin, a hormone involved in calcium metabolism.

Thyroid hormone is Produced in Follicular cells precursor to thyroid hormones (**T3**, **T4**).

Parafollicular cells= Secrete **calcitonin**, a hormone that is involved with calcium homeostasis, Calcitonin a thyroid hormone that tends to lower the level of calcium in the blood plasma and inhibit reabsorption of bone by action of Parathyroid gland.



PHYSIOLOGICAL ANATOMY OF THE THYROID GLAND

1. Divided into 2 lobes, each lobe is divided into lobules, which contains 20 - 40 round to oval follicles, each 50 - 500 microns, with a single layer of **cuboidal** to low **columnar** epithelium

2. **Lumen** contains **colloid**, which is scalloped and pale in follicles with active secretory activity, densely eosinophilic in inactive follicles and more flocculent ("like a clump or tuft of wool") and basophilic in elderly

3. **Stroma** contains **C cells**, formerly called **parafollicular cells** (actually are intrafollicular), derived from neural crest

4. **C cells** represent 0.1% of gland, produce calcitonin, are present in middle and upper third of lateral lobes along central axes, are not present in extreme upper and lower poles or in isthmus Usually 10 C cells per low power field in adults

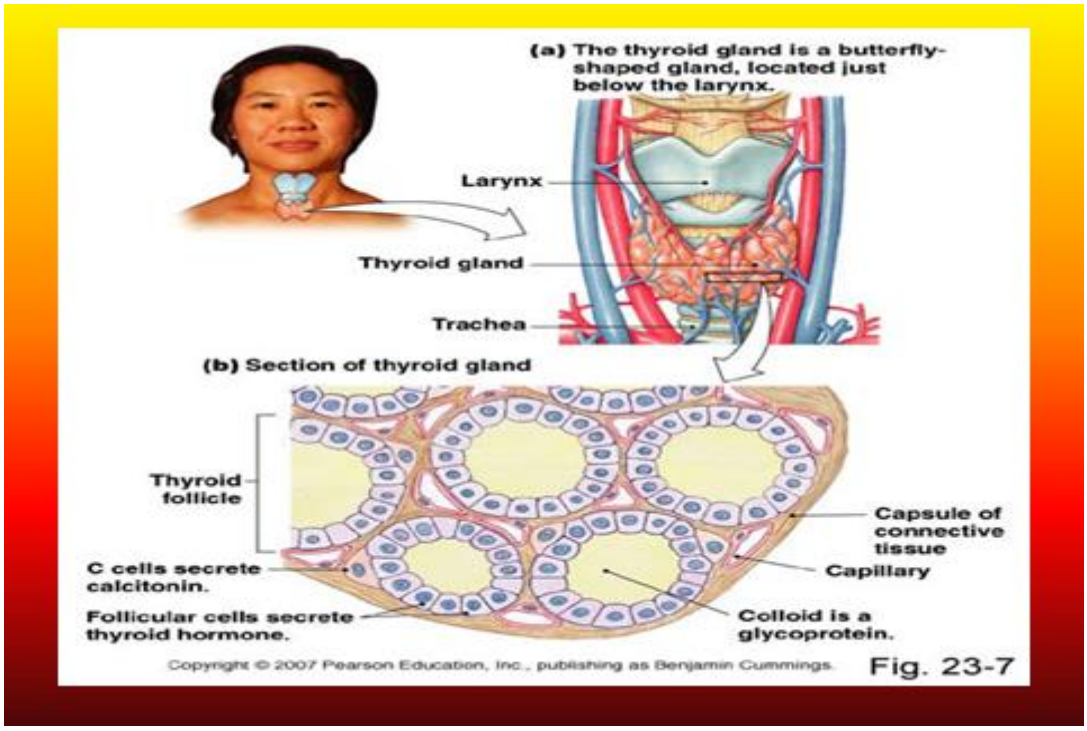
5. **C cells** are more numerous in neonates, decrease in adults, increase and appear as nodular aggregates after age 60 years

C cells have pale / clear cytoplasm, oval nuclei, difficult to identify with H&E, use calcitonin stain.

6. The major constituent of colloid is the large **glycoprotein thyroglobulin**, which contains the thyroid hormones.

7. Once the secretion has entered the follicles, it must be absorbed back through the follicular epithelium into the blood before it can function in the body.

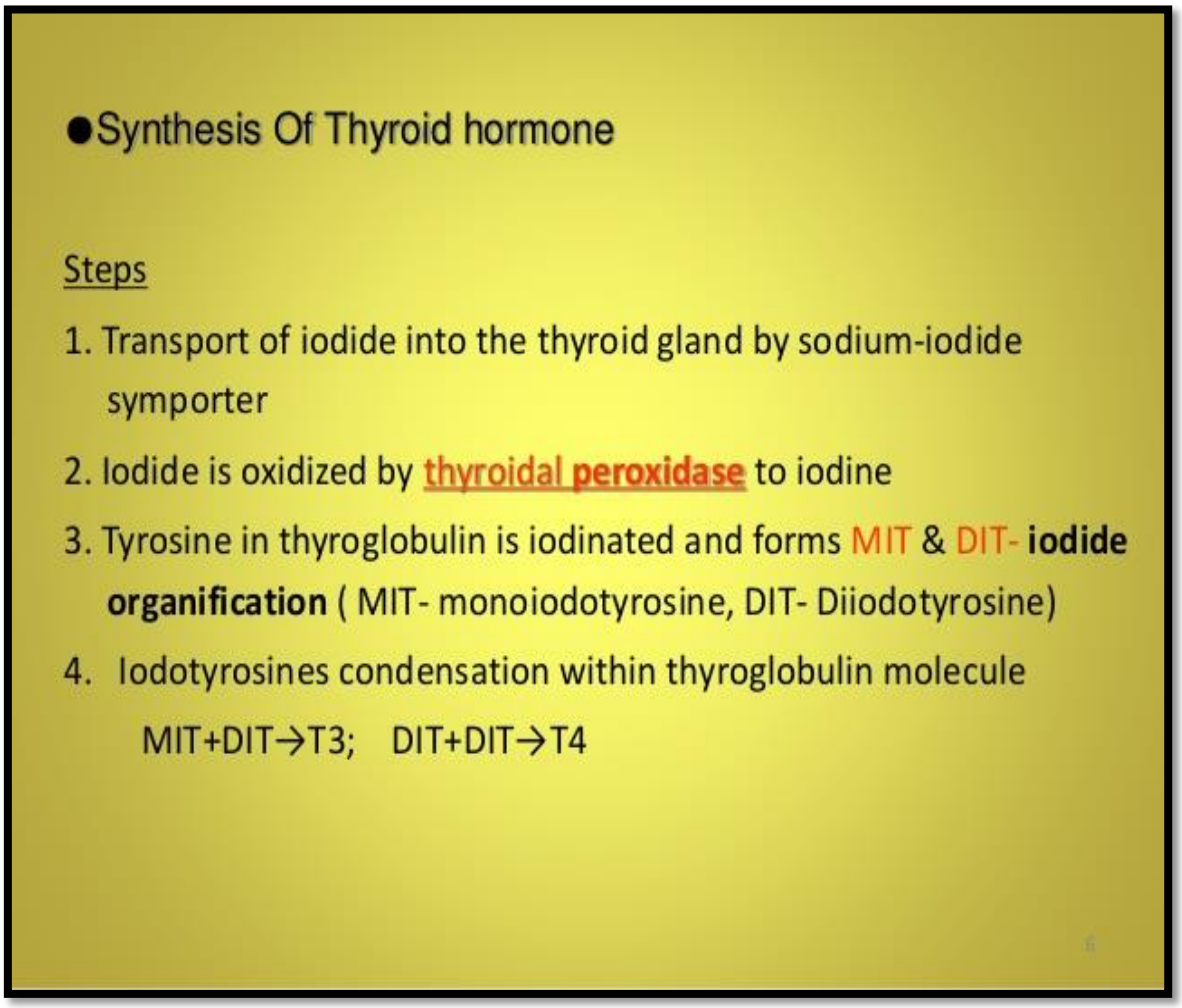
8. The thyroid gland has a blood flow about five times the weight of the gland each minute, which is a blood supply as great as that of any other area of the body.

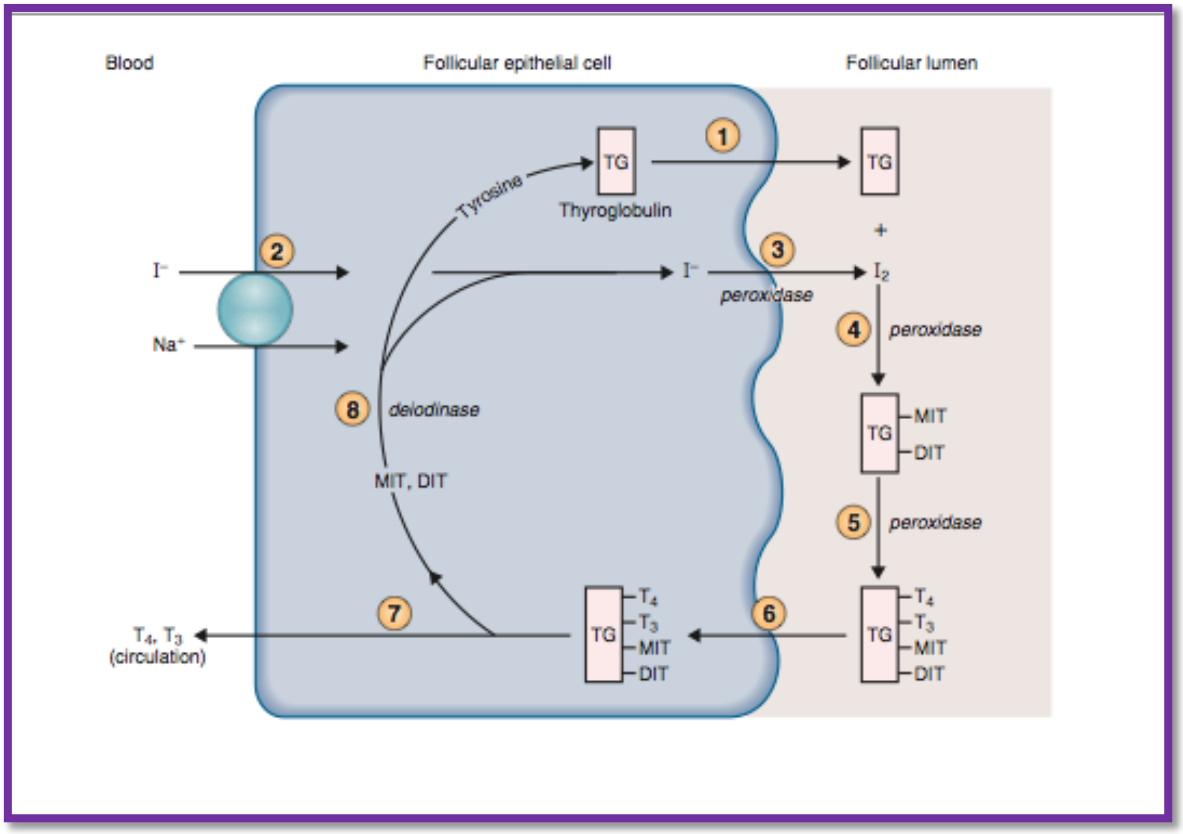


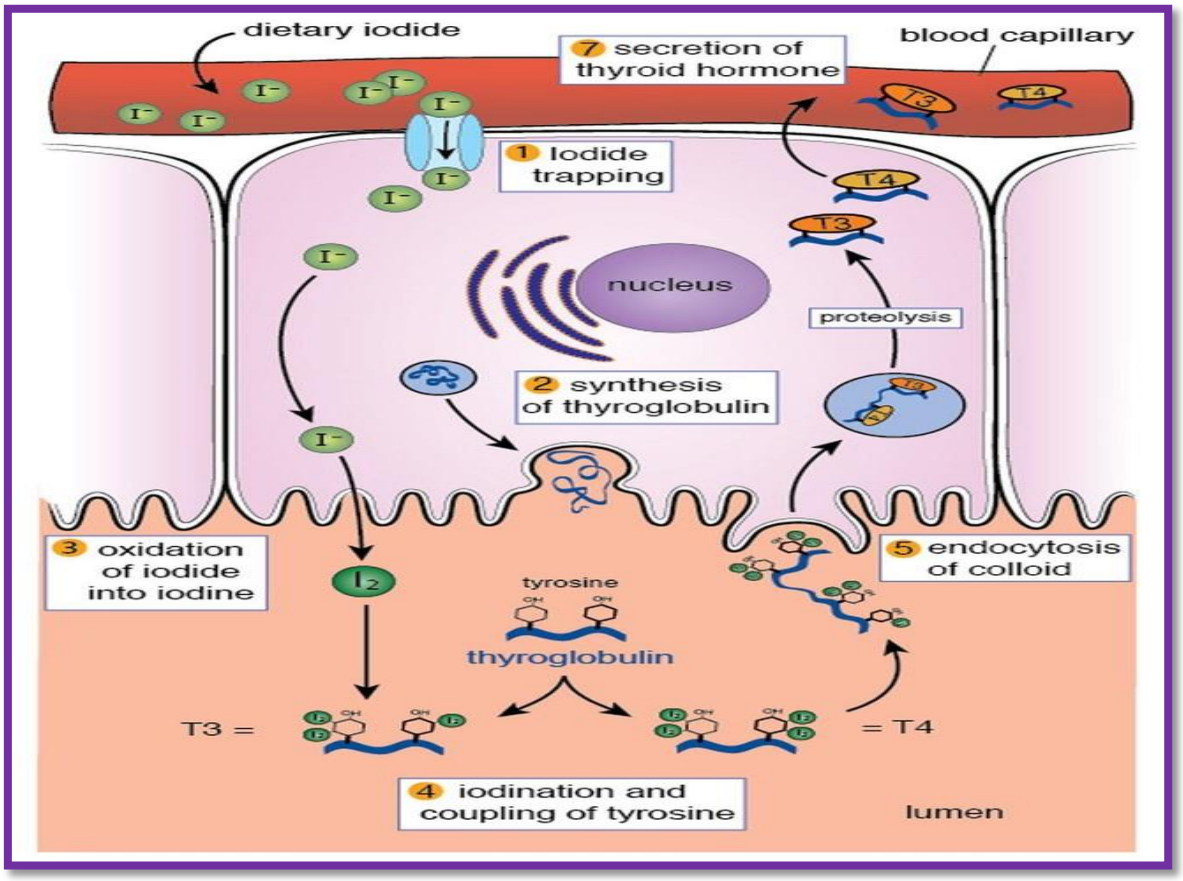
SYNTHESIS AND SECRETION OF THE THYROID METABOLIC HORMONES

About 93 percent of the metabolically active hormones secreted by the thyroid gland is ***thyroxine***, and 7 percent is ***triiodothyronine***. However, almost all the ***thyroxine*** is eventually converted to ***triiodothyronine*** in the tissues, so both are functionally important. The functions of these two hormones are qualitatively the same, but they differ in rapidity and intensity of action. ***Triiodothyronine*** is

about **four** times as potent as ***thyroxine***, but it is present in the blood in much smaller quantities and persists for a much shorter time compared with ***thyroxine***. To form normal quantities of **thyroxine**, about **50** milligrams of ingested iodine in the form of iodides are required each year, or about **1 mg/week**.




Blood
Follicular epithelial cell
Follicular lumen
TG
Thyroglobulin
Tyrosine
1
2
3
4
5
6
7
8
I⁻
Na⁺
peroxidase
deiodinase
MIT, DIT
MIT
DIT
T4
T3
T4, T3
(circulation)


dietary iodide
blood capillary
7 secretion of thyroid hormone
1 Iodide trapping
nucleus
proteolysis
2 synthesis of thyroglobulin
3 oxidation of iodide into iodine
5 endocytosis of colloid
tyrosine
thyroglobulin
T3 =
= T4
4 iodination and coupling of tyrosine
lumen

EFFECTS OF THYROID HORMONE ON SPECIFIC BODY FUNCTIONS

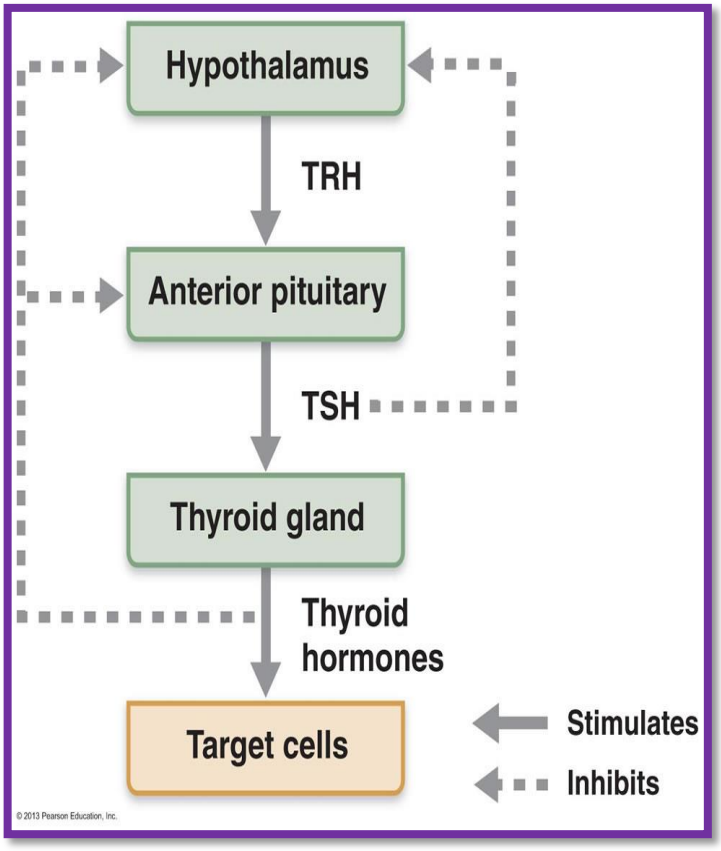
1. **Stimulation of Carbohydrate Metabolism.**
2. **Stimulation of Fat Metabolism.**
3. **Effect on Plasma and Liver Fats.**
4. **Increased Requirement for Vitamins**
5. **Increased Basal Metabolic Rate**
6. **Decreased Body Weight**
7. **Increased Blood Flow and Cardiac Output**
8. **Increased Heart Rate**
9. **Increased Heart Strength**
10. **Normal Arterial Pressure**
11. **Increased Respiration**
12. **Increased Gastrointestinal Motility**

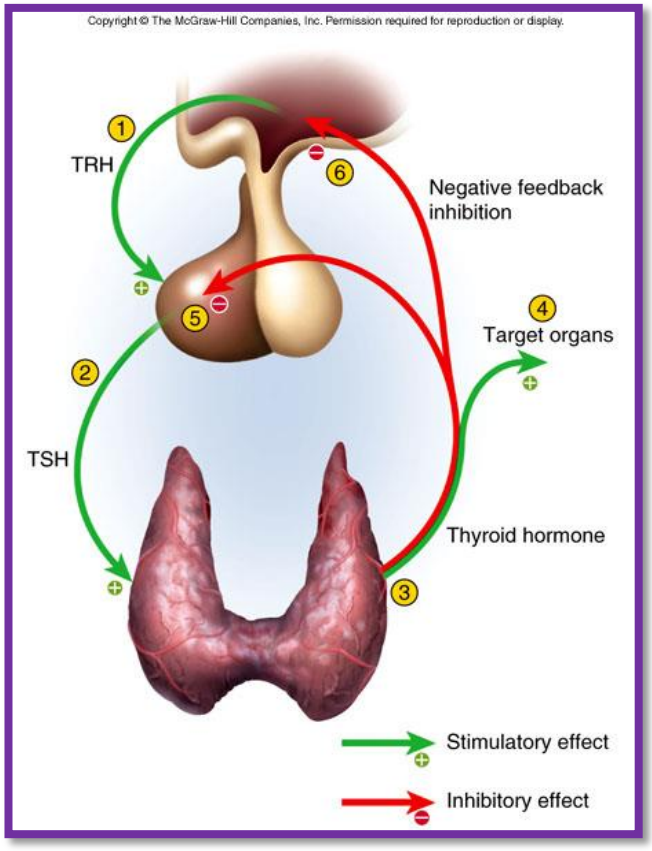
REGULATION OF THYROID HORMONE SECRETION

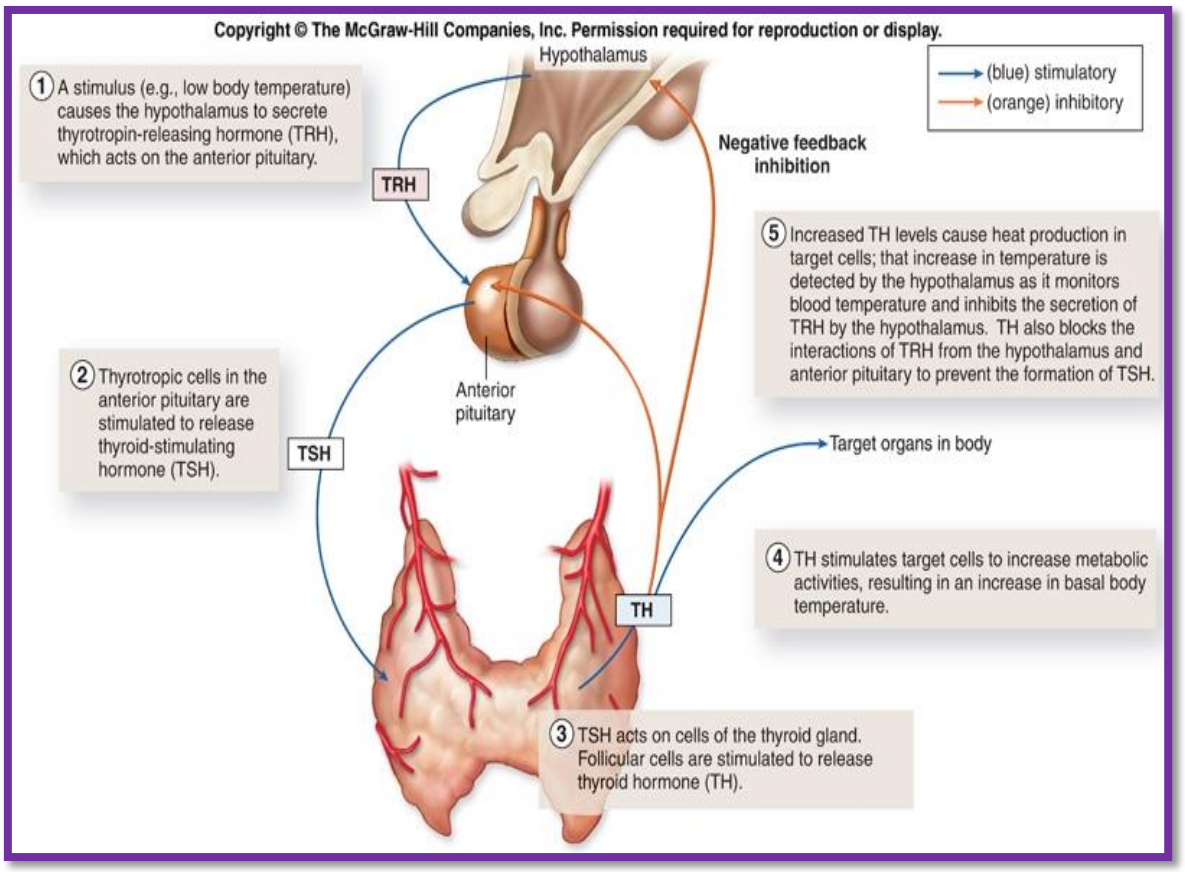
To maintain normal levels of metabolic activity in the body, precisely the right amount of thyroid hormone must be secreted at all times; to achieve this ideal level of secretion, specific **feedback mechanisms** operate through the hypothalamus and anterior pituitary gland to control the rate of thyroid secretion.

FEEDBACK EFFECT OF THYROID HORMONE TO DECREASE ANTERIOR PITUITARY SECRETION OF TSH

Increased **thyroid hormone** in the body fluids decreases secretion of **TSH** by the **anterior pituitary**. When the rate of **thyroid hormone** secretion rises to about **1.75** times normal, the rate of **TSH** secretion falls essentially to **zero**. Almost all this feedback depressant effect occurs even when the **anterior pituitary** has been separated from the hypothalamus. Therefore, it is probable that increased **thyroid hormone** inhibits **anterior pituitary** secretion of **TSH** mainly by a direct effect on the **anterior pituitary** gland itself. Regardless of the mechanism of the feedback, its effect is to maintain an almost constant concentration of free **thyroid hormones** in the circulating body fluids.







ANTERIOR PITUITARY SECRETION OF TSH IS REGULATED BY THYROTROPIN-RELEASING HORMONE FROM THE HYPOTHALAMUS

Anterior pituitary secretion of TSH is controlled by a hypothalamic hormone, *thyrotropin-releasing hormone* (TRH), which is secreted by nerve endings in the median eminence of the hypothalamus. From the median eminence, TRH is then transported to the anterior pituitary by way of the hypothalamic-hypophysial portal blood, TRH is a tripeptide amide—*pyroglutamyl-histidylproline- amide*. TRH stimulates the anterior pituitary gland cells to increase their output of TSH. When the blood portal system from the hypothalamus to the anterior pituitary gland becomes blocked, the rate of secretion of TSH by the anterior pituitary

decreases greatly but is not reduced to zero. The molecular mechanism by which TRH causes TSH-secreting cells of the anterior pituitary to produce TSH is first to bind with TRH receptors in the pituitary cell membrane. This binding in turn *activates the phospholipase second messenger system* inside the pituitary cells to produce large amounts of phospholipase C, followed by a cascade of other second messengers, including calcium ions and diacyl glycerol, which eventually leads to TSH release.