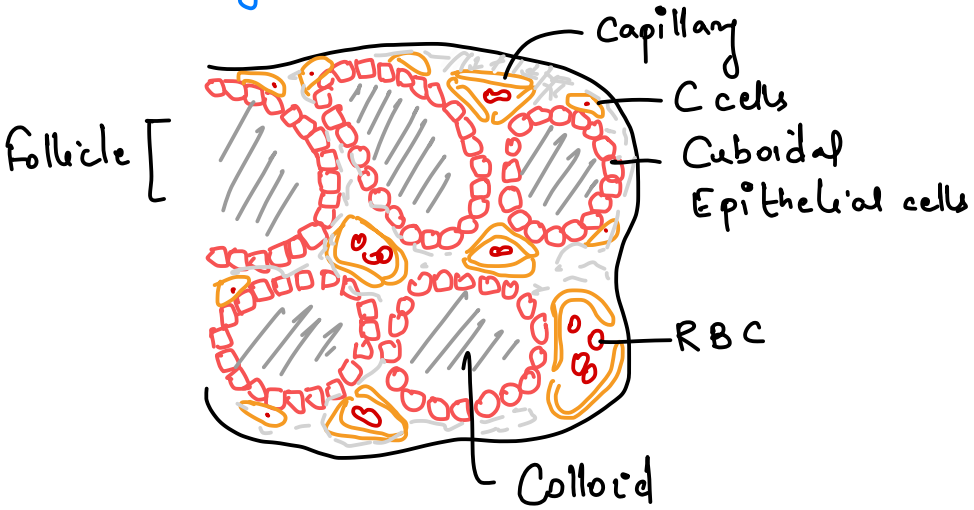
Thyroid Gland

- Weighing 15-20 g in adults
- Mainly secretes T_3 (Triiodothyronine), T_4 (Thyroxine) & Calcitonin
- Stimulated by TSH (by pituitary)
- Thyroid secretes 93% of T_4 & 7% of T_3 but all the thyroxine (T_4) is eventually converted to T_3 in tissues.
- T_3 is 4 times more potent than T_4, but T_3 is present in blood in much smaller quantities.

Anatomy



- Large no. of closed follicles (100-300 μm in diameter) filled with secretory substance called Colloid.
- Major Constituent of Colloid is large glycoprotein thyroglobulin which contains thyroid hormones.
- C-cells secretes Calcitonin that regulates Ca^{2+} level in plasma.

- Body needs 1 mg of Iodides every week:
  [common salt is 1 part NaI to every 100,000 parts NaCl]
- Most Iodides are excreted by Kidney but 1/5th are selectively removed by cells of Thyroid gland and used for synthesis of thyroid hormones.

Biosynthesis of Thyroid Hormones:

- The thyroid cells are typical protein-secreting glandular cells.
- Thyroglobulin, a large glycoprotein molecule is synthesized by

ER & Golgi bodies & secreted into the follicles.

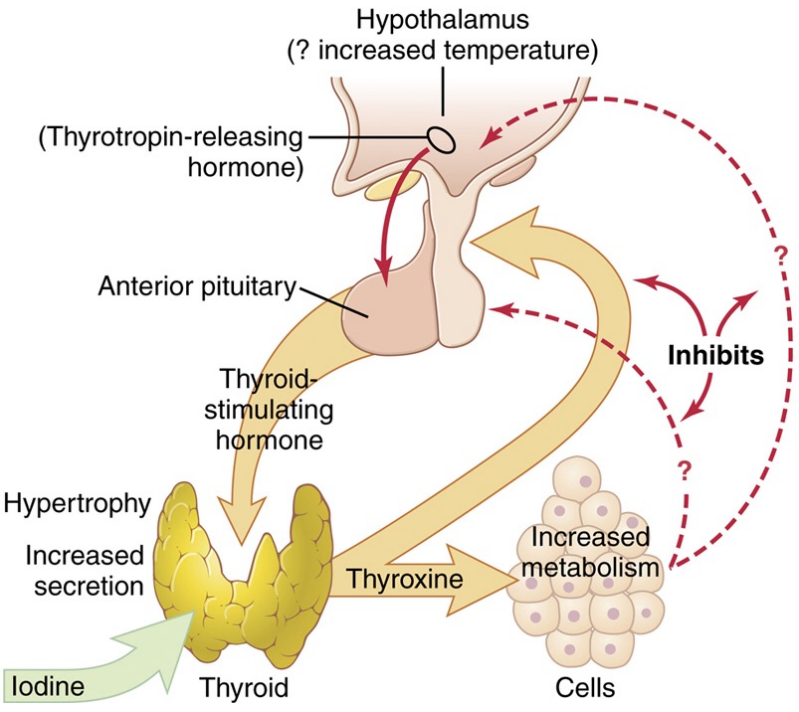
- Each thyroglobulin contains about 70 tyrosine amino acids, and they combine with Iodine to form Thyroid hormones.

Steps :

(a) Iodine trapping (by $Na^+ - I^-$ symporter)
(b) Oxidation of Iodide ion. (I^- to I_3^-)
(c) Organification of thyroglobulin (binding of Iodine to thyroglobulin)
(d) Coupling of iodotyrosine residues
(e) Release of T_3 & T_4 into blood.

Thyroid Hormone Actions

		Actions
Metabolic functions	Carbohydrate metabolism	Stimulates all aspects of carbohydrate metabolism Enhanced glucose uptake, glycolysis, gluconeogenesis, increased insulin secretion
	Fat metabolism	Enhanced lipid mobilization from fat tissues Increased free fatty acids Decreases cholesterol, phospholipids, and triglycerides in blood
	Vitamin requirements	Increases vitamin requirements
	Basal metabolic rate	Increases BMR
General features	Body weight	Decreases body weight
Actions on specific systems/tissues/functions	Cardiovascular system	Increased heart rate Increased cardiac output Increased force of contraction
	Respiratory system	Increased rate of respiration
	Gastrointestinal system	Increased motility of the GI tract
	Central nervous system	Increases rapidity of cerebration
	Musculoskeletal system	Slight increase excites musculoskeletal system Excessive causes muscle weakness
	Endocrine glands	Increases activity in almost all glands



Regulation of Thyroid Hormone Secretion :-

- TSH increases thyroid Secretion.
- TSH is also known as Thyrotropin, is an anterior pituitary hormone.
- It increases secretion of T_4 & T_3 by the thyroid gland.

- TSH has some specific effects on thyroid gland :
  (a) Increased proteolysis of thyroglobulin
  (b) Increased activity of Iodide Pump.
  (c) Increased iodination of tyrosine
  (d) Increased size & secretory activity of thyroid cells
  (e) Increased no. of thyroid cells.

* TSH is regulated by Thyrotropin-Releasing Hormone from the hypothalamus. (TRH)

* Best stimuli for increasing TRH and thereby TSH is by exposing the animal to cold.

Diseases of Thyroid

(a) Hyperthyroidism : (Toxic Goiter, Thyrotoxicosis, Graves Disease)

↓

The thyroid gland is increased to two or three times its Normal size, with tremendous hyperplasia and infolding of follicular cell lining into the follicles.

Symptoms :

(1) High Rate of Excitability
(2) Intolerance to Heat
(3) Increased Sweating
(4) Mid / Extreme wt loss
(5) Varying degree of diarrhea
(6) Muscle weakness
(7) Nervousness
(8) Extreme fatigue
(9) Tremors (Hand)

Diagnostic Tests :

(1) BMR is +30 to +60
(2) Conct. of TSH is measured by Radioimmunoassay
(3) Conct. of TSI is measured by Radioimmunoassay.

Treatment :

- Most direct treatment for hyperthyroidism is surgical removal of most of the thyroid gland

- With modern procedures, Mortality Rate is 1 in 1000, but before it was 1 in 25.

(b) Hypothyroidism : (Thyroiditis, Endemic Colloid goiter, idiopathic colloid goiter, destruction of thyroid gland)

Symptoms :

(1) Fatigue and extreme somnolence with sleeping upto 12-14 hrs.
(2) Extreme muscular sluggishness
(3) Slowed heart rate, Dec Cardiac Output, Dec. Blood Volume
(4) Somewhat Inc. Body wt.
(5) Constipation
(6) Mental Sluggishness
(7) Depressed growth of hair, scaliness of skin, frog-like husky voice.
(8) Myxedema in Severe cases.

Diagonistic Tests :

- Opposite to Hyperthyroidism.
- Free thyroxine in blood is very Low.
- BMR → -30 to -50.

Comparison of Hyperthyroidism and Hypothyroidism

Parameter	Hyperthyroidism	Hypothyroidism
General features	Fatigue High state of excitability Weight loss Increased BMR	Fatigue Extreme sluggishness Weight gain Decreased BMR
Sleep	Decreased sleep	Extreme somnolence
Temperature	Intolerance to heat	Intolerance to cold
Skeletal muscle	Muscle weakness	Extreme muscular sluggishness
Gastrointestinal tract	Mild diarrhea	Constipation
Skin	Increased sweating	Decreased sweating Scaliness of skin
Neurological effects	Fine tremor of the hands Nervousness Other psychic disorders	Mental sluggishness
Cardiac effects	Increased heart rate Increased cardiac output	Decreased heart rate Decreased cardiac output
Menstruation	Oligomenorrhea	Menorrhagia or polymenorrhea
Sexual functions		Men: Loss of libido
		Women: Decreased libido

Cretinism

Cretinism is caused by extreme hypothyroidism during fetal life, infancy, or childhood. This condition is characterized especially by failure of body growth and by mental retardation. It results from congenital lack of a thyroid gland (*congenital cretinism*), from failure of the thyroid gland to produce thyroid hormone because of a genetic defect of the gland, or from a lack of iodine in the diet *(endemic cretinism).*

A neonate without a thyroid gland may have a normal appearance and function because it was supplied with some (but usually not enough) thyroid hormone by the mother while in utero. A few weeks after birth, however, the neonate's movements become sluggish and both physical and mental growth begin to be greatly retarded. Treatment of the neonate with cretinism at any time with adequate iodine or thyroxine usually causes normal return of physical growth, but unless the cretinism is treated within a few weeks after birth, mental growth remains permanently retarded. This state results from retardation of the growth, branching, and myelination of the neuronal cells of the central nervous system at this critical time in the normal development of the mental powers.

Skeletal growth in a child with cretinism is characteristically more inhibited than is soft tissue growth. As a result of this disproportionate rate of growth, the soft tissues are likely to enlarge excessively, giving the child with cretinism an obese, stocky, and short appearance. Occasionally, the tongue becomes so large in relation to the skeletal growth that it obstructs swallowing and breathing, inducing a characteristic guttural breathing that sometimes chokes the child.