

THYROID HORMONES

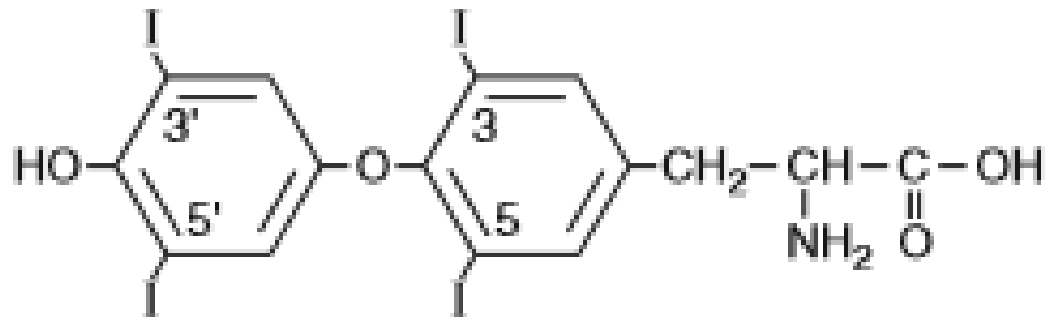
Dr Jayanti Pant

Physiological Anatomy

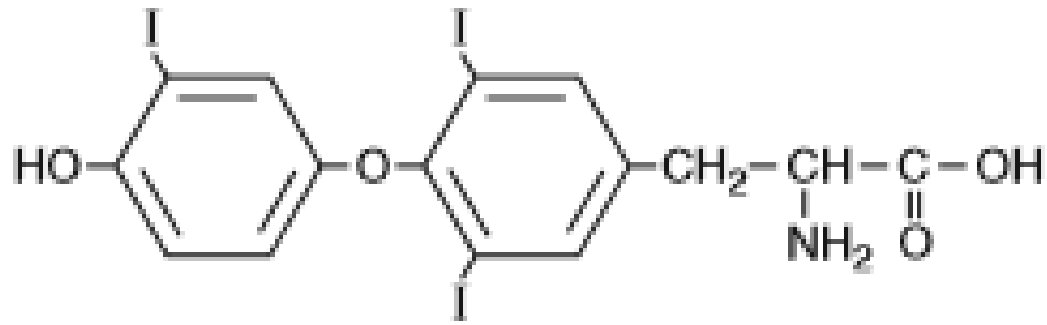
- ◉ Develops from evagination of floor of pharynx
- ◉ Thyroglossal duct marks the path of thyroid from tongue to neck
- ◉ Gland is highly vascularized and has one of the highest rates of blood flow per gram of tissue

THYROID HORMONES

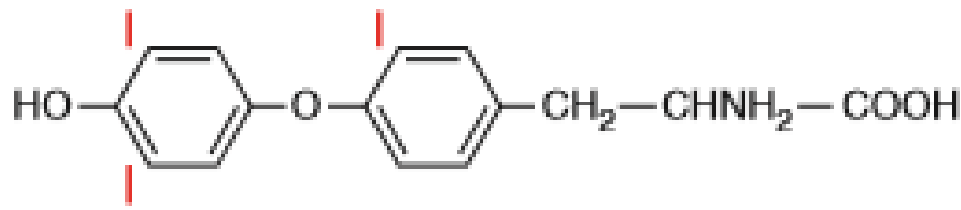
- ◉ Thyroxine (T4)- Greater amount released. Biological activity less
- ◉ Triiodothyronine (T3)- Lesser amount released. **Biologically more active.** Generated at the site of action in peripheral tissues by deiodination of T4.
- ◉ Reverse Triiodothyronine (RT3)- Small amounts



3,5,3',5'-Tetraiodothyronine (thyroxine, T₄)



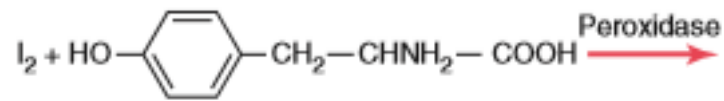
3,5,3'-Triiodothyronine (T₃)



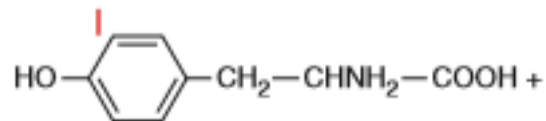
3,3',5'-Triiodothyronine (RT₃)

Diiodotyrosine + Diiodotyrosine →

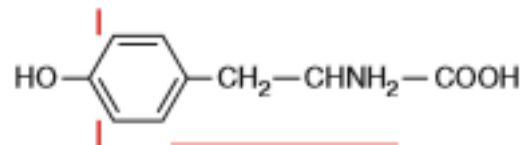
- ◉ Pendrin (Cl/I exchanger)
- ◉ Pendred syndrome- Thyroid dysfunction and deafness
- ◉ Salivary glands, Gastric mucosa, placenta, ciliary body of eye, choroid plexus, mammary glands and certain cancers of these tissues express NIS but the transporter is not affected by TSH in these tissues.



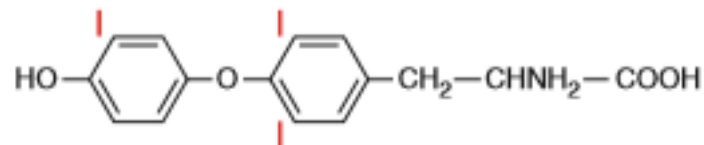
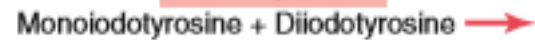
Tyrosine



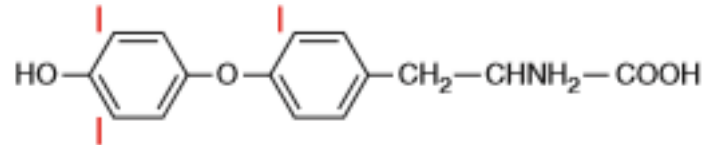
Monoiodotyrosine



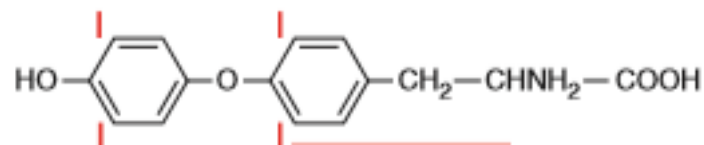
Diiodotyrosine



3,5,3'-Triiodothyronine (T₃)



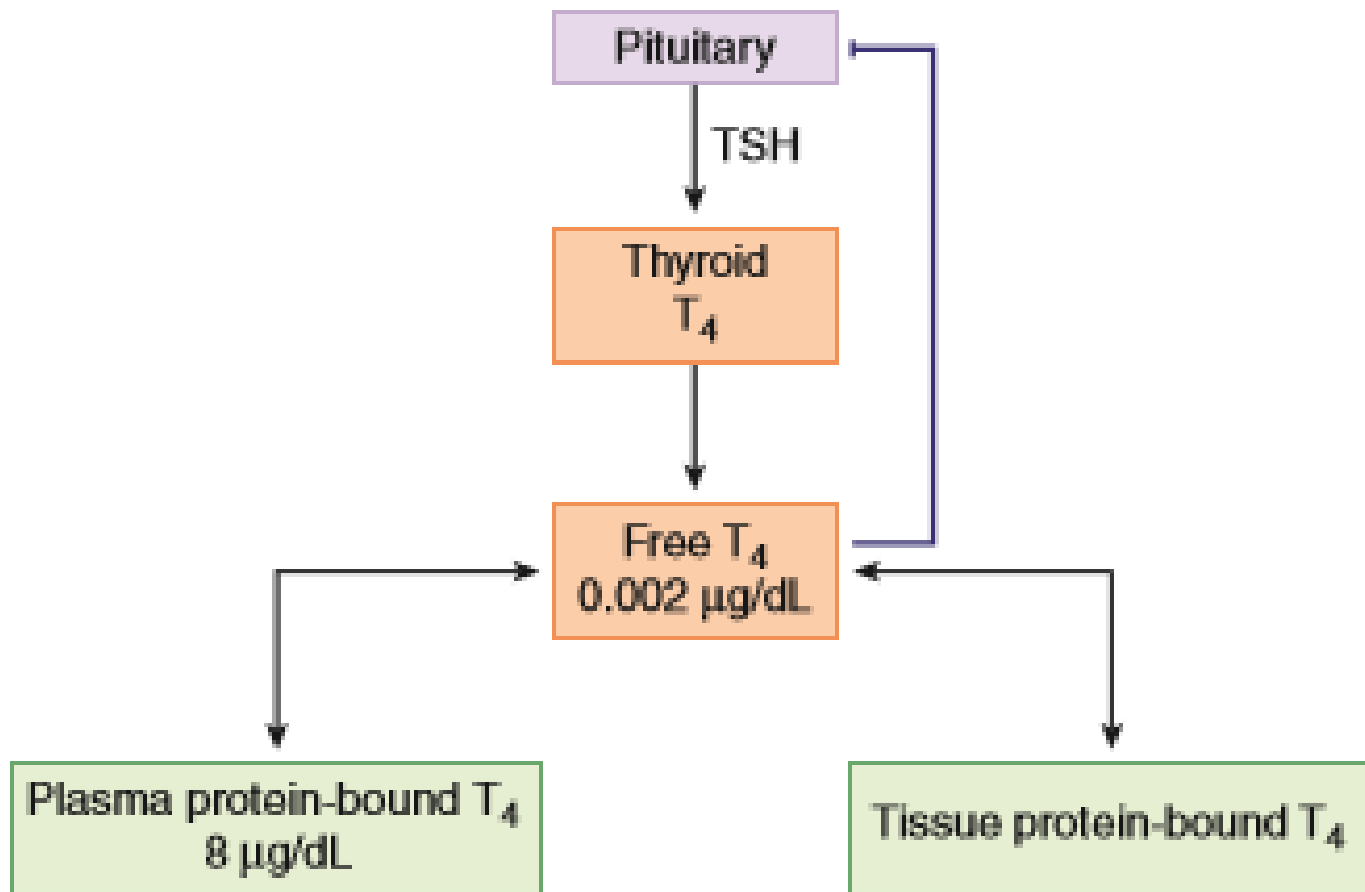
3,3',5'-Triiodothyronine (RT₃)



Thyroxine (T₄)

METABOLISM OF THYROID HORMONES

- T4 and T3 are deiodinated in liver, kidneys and other tissues
- Pituitary and cerebral cortex has high T3/T4 ratio
- Three deiodinases: D1, D2 and D3- contain selenocysteine
- D1 - present in liver, kidneys, thyroid and pituitary
- D2- present in brain, pituitary and brown adipose tissue
- D3- present in brain and reproductive tissues



CALORIGENIC ACTION

- T4 and T3 increase oxygen consumption of all metabolically active tissues **except** :
 - **Adult brain**
 - **Testes**
 - **Uterus**
 - **Lymph nodes**
 - **Spleen**
 - **Anterior pituitary**
- T4 depresses oxygen consumption of anterior pituitary because it inhibits TSH secretion

CALORIGENIC ACTION

- Thyroid hormones increase the activity of membrane bound Na-K ATPase
- Some calorigenic effect is due to metabolism of fatty acids they mobilize

Effects secondary to calorigenesis

- Nitrogen excretion is increased
- Potassium released due to protein catabolism is excreted in urine
- Increased urinary **hexosamine and uric acid excretion**
- Need for vitamins is increased due to increased BMR
- Thyroid hormones are necessary for hepatic conversion of **carotene to Vitamin A**

Thyroid hormones increase cellular metabolic activity

- ⦿ Thyroid hormones increase the number and activity of mitochondria
- ⦿ Thyroid hormones increase active transport of ions through cell membranes.

EFFECTS OF THYROID HORMONES

- ◉ Stimulation of carbohydrate metabolism
- Stimulates rapid uptake of glucose by cells
- Glycolysis is increased
- Gluconeogenesis is increased
- Increased reabsorption from GIT
- Increased insulin secretion

EFFECTS OF THYROID HORMONES

- ◉ Stimulation of fat metabolism:
 - Lipid are mobilized rapidly from fat tissue
 - Decreases fat stores of the body
 - Increases free fatty acid concentration in plasma
 - Increased thyroid hormones decrease the concentration of cholesterol, phospholipids and triglycerides in the plasma

EFFECTS OF THYROID HORMONES

- ⦿ Increase cholesterol secretion in bile
- ⦿ Increased thyroid hormones increase LDL receptors on the liver leading to rapid removal from plasma

EFFECTS OF THYROID HORMONES

- ⦿ Increased requirements of vitamins
- ⦿ Increases basal metabolic rate
- ⦿ Decreased body weight
- ⦿ Increases respiration
- ⦿ Increased gastrointestinal motility

Effects on nervous system

- ◉ Increased activation of Reticular Activating system (RAS)
- ◉ Affects brain development
- ◉ Cerebral cortex, basal ganglia and cochlea are mainly affected
- ◉ Deficiency causes during development causes **mental retardation, motor rigidity and deafness.**
- ◉ Exerts effects on reflexes- Reaction time of reflexes is increased in hypothyroidism and decreased in hyperthyroidism

Effects on nervous system

- ◉ In hypothyroidism, mentation is slow and CSF protein levels increased
- ◉ Thyroid hormones revert these changes
- ◉ Cerebral blood flow, glucose and oxygen consumption are normal in both hypo and hyperthyroidism

Effects of thyroid hormones on CVS

- ⦿ Increases blood flow and cardiac output
- ⦿ Increases heart rate
- ⦿ Increases heart strength
- ⦿ Pulse pressure increases
- ⦿ Increases expression of α -MHC, sarcoplasmic reticulum calcium ATPase, K- Channels

Effects of thyroid hormones on CVS

- ⊙ Inhibits β -MHC, Phospholamban, adenylyl cyclase, nuclear receptors, Na-Cl exchangers
- ⊙ Increases rate and force of contractions