



# Endocrine

434 Physiology team  
presents to you:

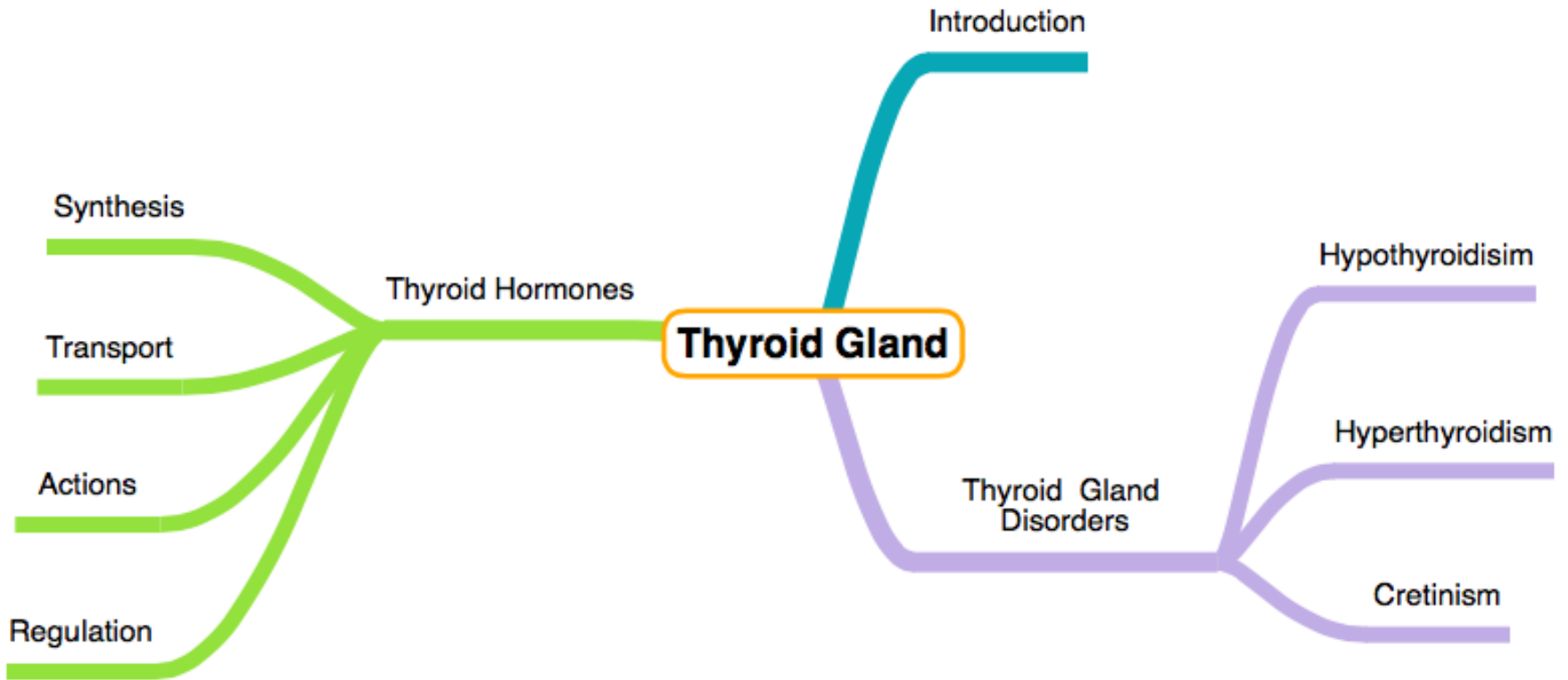
## Thyroid Gland, Hyper **and** Hypo Thyroidism

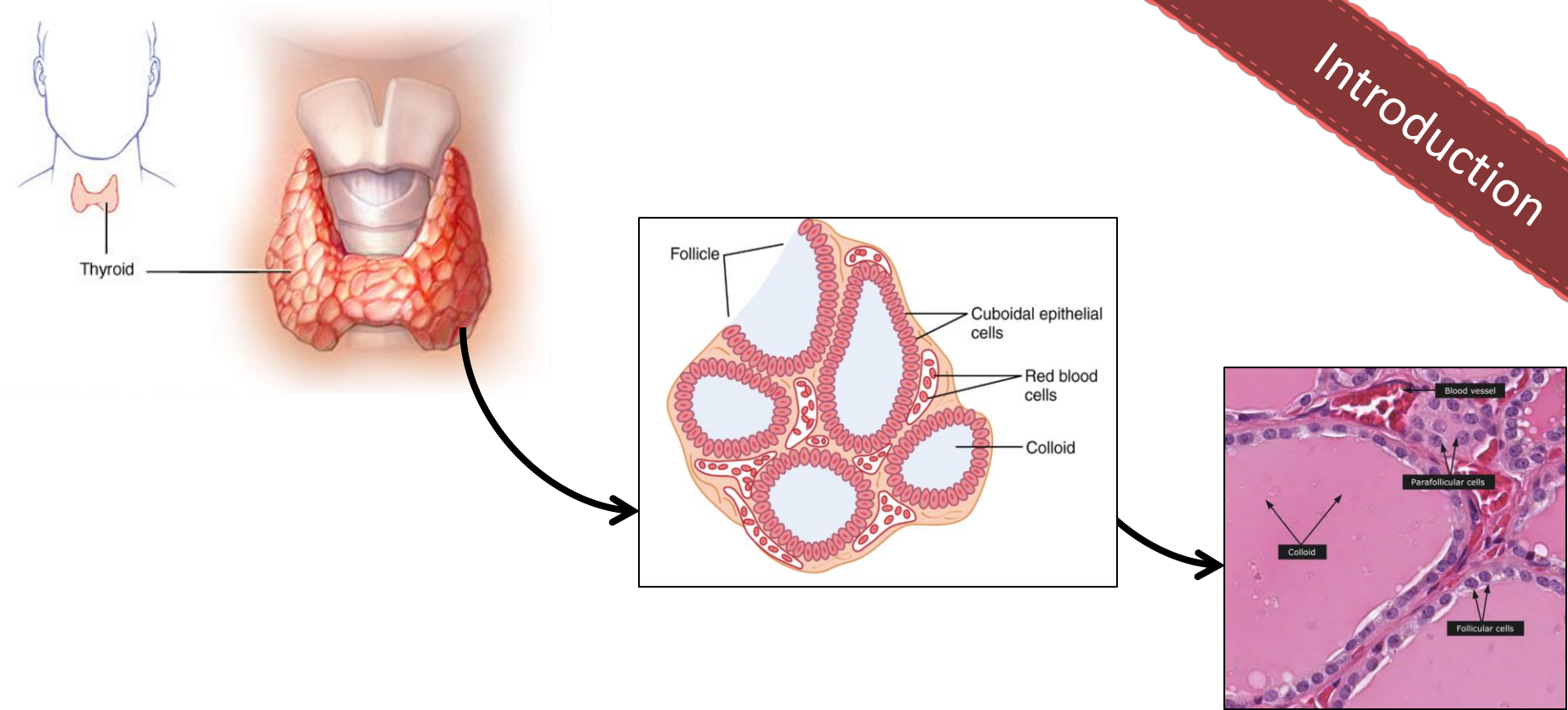
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**Please check out this link before viewing the file to know if there are any additions/changes or corrections. The same link will be used for all of our work [Physiology Edit](#)**





- ❖ Thyroid gland located below larynx on either sides and anterior to the trachea.
- ❖ The first recognized endocrine gland.
- ❖ Normally weighting 20g in adults.
- ❖ It secretes 2 major hormones, *thyroxine* & *triiodothyronine*; commonly called T3 & T4.

Other hormones secreted by Thyroid gland: *Reverse T3 (RT3)*<sup>1</sup> and *Calcitonin*.

1: it comes from the conversion of the storage hormone T4. And it's normal to have 0.9% of RT3.

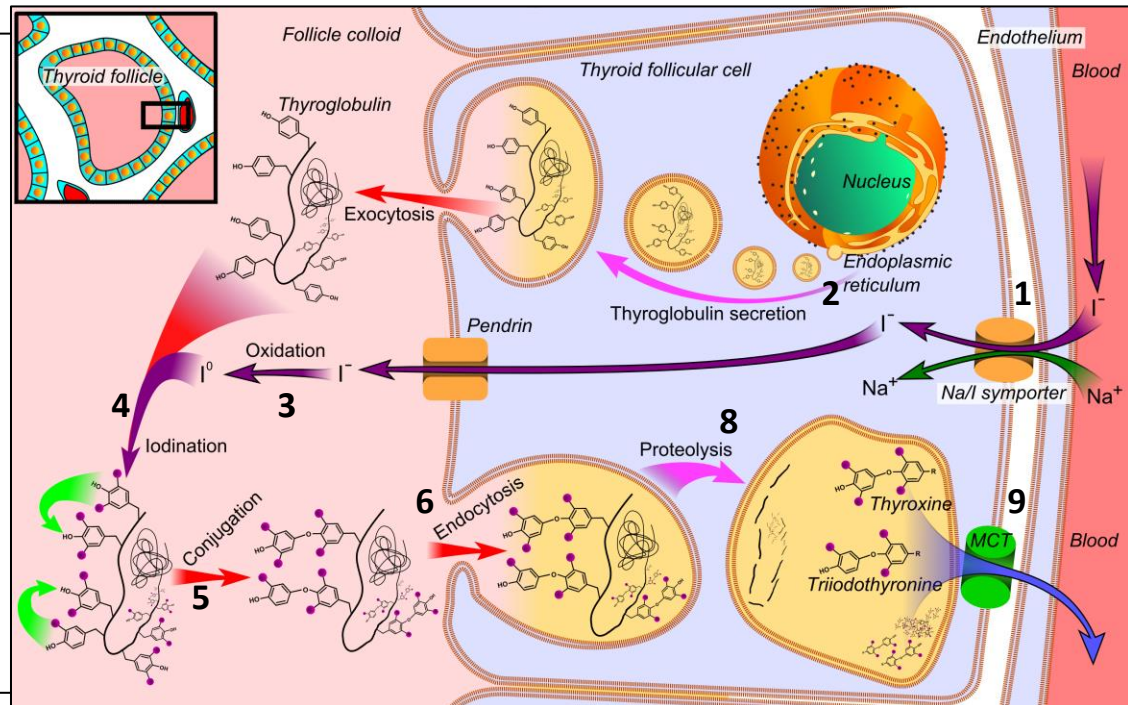
# Synthesis and Secretion of the Thyroid Hormones

- ✧ **Synthesis of Thyroid hormones has three unique features:**
- ✓ Contains large amount of iodine, which is supplied by diet, 1mg/week requirement.
- ✓ Synthesis is partially intracellular and partially extracellular.
- ✓ **Thyroxine (T4) is the major product 90%** while **triiodothyronine (T3) is 10%**.

- The functions of these two hormones are qualitatively the same, but they differ in rapidity and intensity of action.
- T3 is about four times as potent as T4.

## ✧ Steps of Synthesis

1. Iodide pump.
2. Thyroglobulin synthesis.
3. Oxidation of iodide to iodine.
4. Iodination of tyrosine.
5. Coupling.
6. Endocytosis of thyroglobulin.
7. Fusion of lysosomes. -not shown in image-
8. Hydrolysis of peptide bonds.
9. Release of T3 and T4
10. Deiodination of DIT and MIT by Thyroid deiodinase (Recycling).



We advise you to memorize those steps by heart, who knows.. SAQs.. Maybe?



# Steps of Thyroid Hormones Synthesis in more details

+ TSH  
- [Wolff-chaikoff effect](#)<sup>1</sup>

Influenced by:

- Pumping iodide **actively** (because it's against its concentration gradient) to the interior of the cell.
- The process of concentrating the iodide in the cell is called *iodide trapping*.
- - Ratio of concentration from 30-250 times.

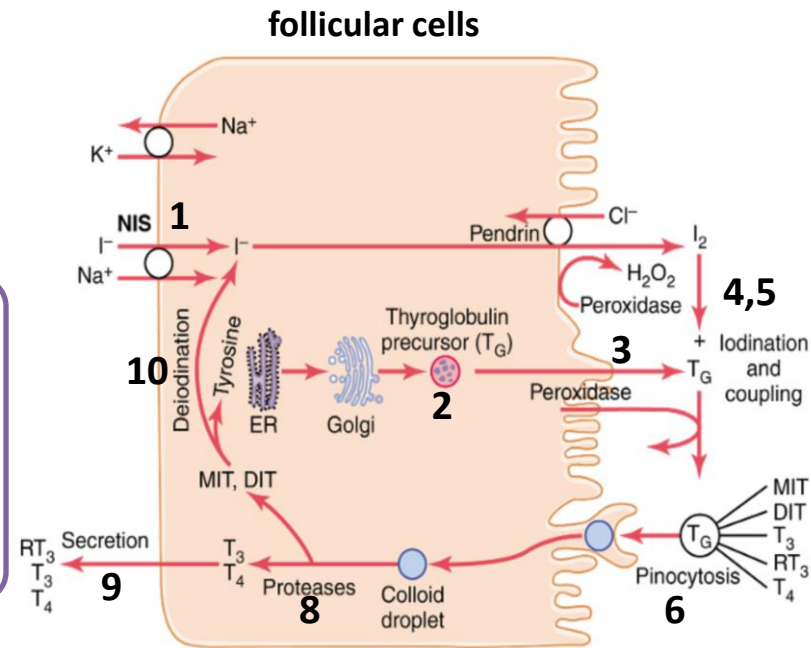
## 1 Iodide Trap

## 2 Thyroglobulin Formation & Transport

- Rough endoplasmic reticulum and Golgi apparatus secrete a *glycoprotein* called **Thyroglobulin**.
- Each molecule contains about 70 *Tyrosine* amino acids

- The oxidation of iodide to iodine is by the help of **Thyroid peroxidase**.
- It is located in or attached to the apical membrane.

## 3 Oxidation



- Organification of thyroglobulin which is the binding of iodine with thyroglobulin.
- Catalyzed by thyroid **peroxidase** as well. To form MIT<sup>2</sup> / DIT<sup>3</sup>
- It will remain attached to thyroglobulin until the gland stimulated to secrete.

## 4 Iodination

## 5 Coupling

- DIT + DIT = T<sub>4</sub> -faster-
- DIT + MIT = T<sub>3</sub>
- Catalyzed by thyroid **peroxidase**.
- It will be stored as colloid which is sufficient for 2-3 months.

## 6 Endocytosis of thyroglobulin forming a vesicle.

## 7 Fusion of lysosomes immediately with the vesicles.

Now the vesicle contains digestive enzymes from lysosomes mixed with colloid.

- Hydrolysis of the peptide bond to release *DIT+MIT+T<sub>4</sub>+T<sub>3</sub>* from the thyroglobulin in free form.

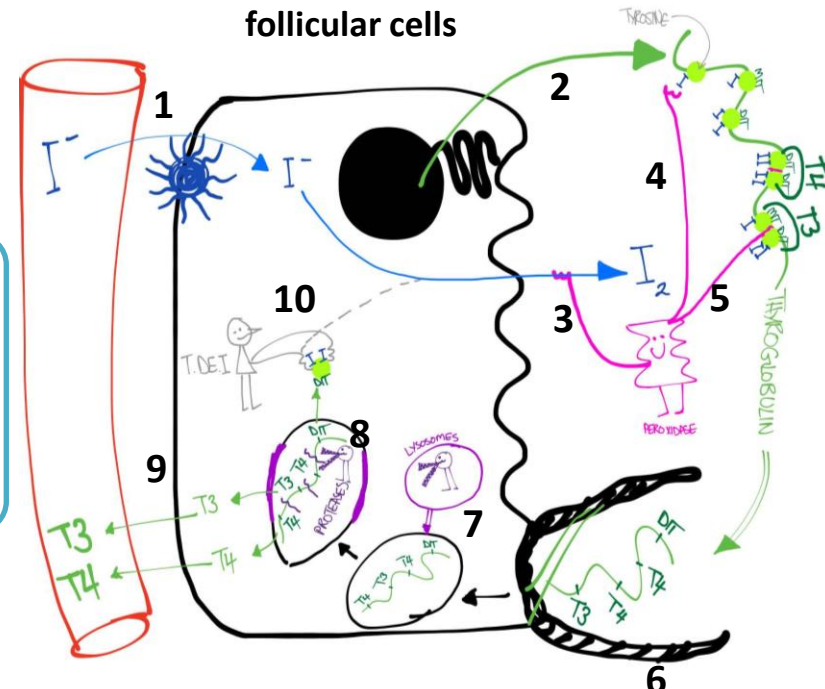
- Which is the cleavage of the T<sub>4</sub>, T<sub>3</sub> from the thyroglobulin by the **proteases** so those free hormone can readily released to circulation.

## 8 Hydrolysis

## 9 Release & Deiodination

- Delivery of T<sub>4</sub> and T<sub>3</sub> to the systemic circulation by diffusion.
- Deiodination of DIT and MIT by **thyroid deiodinase** (It will take the iodide and recycle it)

follicular cells



1: A autoregulatory phenomenon that inhibits organification, the formation and the release of thyroid hormones into the bloodstream. Which is secondary to **elevated levels of circulating iodide**

2: Monoiodotyrosine 3: Diiodotyrosine

Now thyroid hormones are in blood, how are they going to be transported to the targeted tissues?

## ❖ Thyroid Hormones in The Circulation:

Thyroxine (T4) and Triiodothyronine (T3) Are Bound to Plasma Proteins (99%)	
<ul style="list-style-type: none"> <li>On entering the blood, more <b>than 99% of T4 and T3 combines</b> immediately with several of the plasma proteins, all of these are synthesized by the liver they combine mainly with <b>thyroxine-binding globulin (TBG)</b> and much less with thyroxine-binding prealbumin and albumin.             <ul style="list-style-type: none"> <li>Much less amount will be <b>unbound (Free) 0.03% of T4 and 0.3% of T3.</b></li> </ul> </li> </ul>	
In case of:	
Hepatic Failure	Pregnancy
<ul style="list-style-type: none"> <li>• ↓ TBG</li> <li>• ↑ Free T3/T4</li> <li>• Inhibition of thyroid secretion.</li> </ul>	<ul style="list-style-type: none"> <li>• ↑ Estrogen</li> <li>• ↑ TBG</li> <li>• ↓ Free T3/T4</li> <li>• Stimulation of thyroid secretion.</li> </ul>

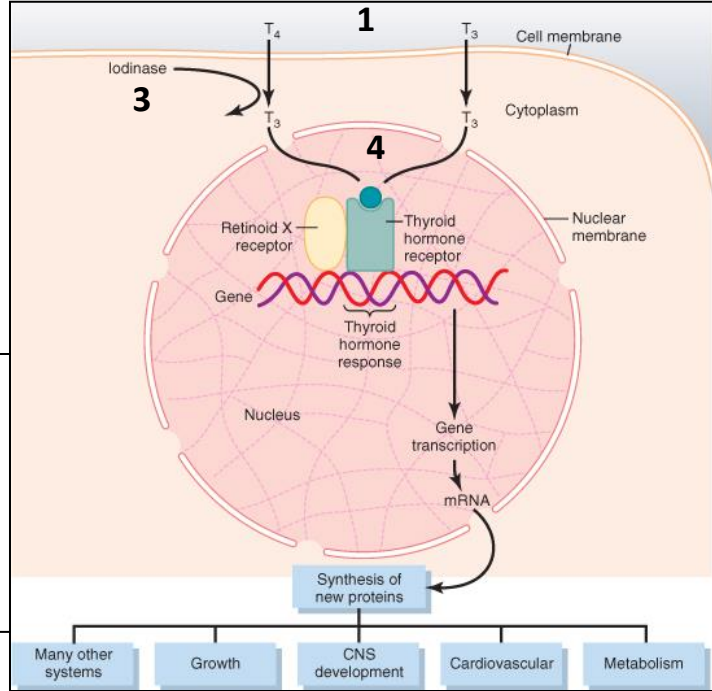


## ❖ Thyroid Hormones Release to Tissues:

Because of *high affinity* of the plasma-binding proteins for the TH, these substances -in particular T4- are released to the tissue cells **slowly**.

- ½ of T4 in the blood is released every 6 days.
- ½ of T3 in the blood is released every one day

1. T4 & T3 readily diffuse through the cell membrane.
2. Stored in the targeted tissues (days to weeks). -not shown in image-
3. 90% of T4 is deionized to T3 by **iodinase** enzyme.
4. In the nucleus, T3 mainly binds to **thyroid hormone receptor** and influence transcription of genes.



# Physiological Functions of the Thyroid Hormones

As mentioned previously:

**T3 + nuclear receptor** → Activation of thyroid regulating element on DNA → ↑ DNA transcription → Formation of mRNA → Translation of mRNA → ↑ Specific protein synthesis.

This is the main concept behind the thyroid hormones actions on the specific targeted tissues.

## ❖ Actions of Thyroid Hormone:

**1. Metabolism** TH *increases* the metabolic activities of almost all tissues of the body.

○ **Carbohydrates:** TH *stimulates* all aspects of carbohydrate metabolism:

- ✓ Increase glucose uptake by the cells.
- ✓ Increase glycogenolysis.
- ✓ Increase gluconeogenesis.
- ✓ Increase rate of absorption from the GIT.

○ **Fats:** Essentially all aspects of fat metabolism are also *enhanced* under the TH:

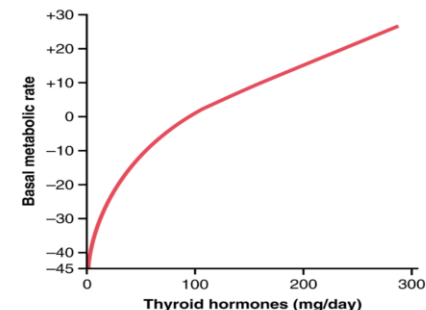
- ✓ Increase lipolysis.
- ✓ As lipolysis increases there will be free fatty acids moving around this will increase oxidation of free fatty acids.
- ✓ Decrease plasma cholesterol by increase loss in feces. That's why one diagnostic indication of *hypothyroidism* is increased blood cholesterol concentration..

○ **Proteins:** Overall effect is catabolic leading to decrease in muscle mass. In contrast to GH which has anabolic effect.

The metabolic effects are due to the induction of metabolic enzymes.



**2. Basal Metabolic Rate (BMR):** Is the energy requirement under basal condition (mental and physical rest 12-18 hours after a meal). Because TH increases metabolism in almost all cells of the body:

- Complete *lack* of thyroid hormones → There will be a 40-50% *decrease* in BMR.
- Extreme *increase* of thyroid hormones → There will be a 60-100% *increase* in BMR.





# ✧ Effects of Thyroid Hormone on Various Systems of the Body:

System	Effect
<p><b>CVS</b></p> 	<ul style="list-style-type: none"> <li>○ <b>Indirectly</b> potentiating the effect of catecholamine in the circulation:               <ul style="list-style-type: none"> <li>✓ Activation of <math>\beta</math>-adrenergic receptors.</li> </ul> </li> <li>○ <b>Directly</b> induction of: The TH itself –               <ul style="list-style-type: none"> <li>✓ myocardial <math>\beta</math>-adrenergic receptors, sarcoplasmic reticulum, <math>\text{Ca}^{+2}</math> ATPase and Myosin.</li> </ul> </li> </ul> <p>Will cause the following:</p> <ul style="list-style-type: none"> <li>• <b>Increase heart rate and stroke volume = Increases cardiac output up to 60%</b></li> <li>• <b>Decrease peripheral resistance.</b></li> </ul> <p style="text-align: center;"><b>End result is increase delivery of oxygenated blood to the tissues.</b></p>
<p><b>CNS</b></p> 	<ul style="list-style-type: none"> <li>○ <b>In peri-natal period:</b> TH are essential for <i>maturation</i> of the CNS.</li> <li>✓ Decrease of hormones secretion → irreversible mental retardation</li> <li>✓ Screening is necessary to introduce hormone replacement .</li> <li>○ <b>In adults:</b> <ul style="list-style-type: none"> <li>✓ <b>Increase</b> in thyroid hormone secretion:                   <ul style="list-style-type: none"> <li>•Hyperexcitability.</li> <li>•Irritability.</li> </ul> </li> <li>✓ <b>Decrease</b> in thyroid hormones secretion:                   <ul style="list-style-type: none"> <li>•Slow movement.</li> <li>•Impaired memory.</li> <li>•Decreased Mental capacity.</li> </ul> </li> </ul> </li> </ul>
<b>Skeletal (Bones)</b>	<ul style="list-style-type: none"> <li>○ <b>Promote:</b> bone formation, ossification, fusion of bone plate and bone maturation.</li> </ul>
<b>GIT</b>	<ul style="list-style-type: none"> <li>○ <b>Increase:</b> <i>appetite</i> thus food intake, increase digestive <i>juices</i> secretion and G.I tract <i>motility</i>.</li> <li>✓ Excess TH secretion → Diarrhea.</li> <li>✓ Lack of TH secretion → Constipation</li> </ul>
<b>Respiratory</b>	<ul style="list-style-type: none"> <li>○ Increase ventilation rate</li> <li>○ Increase dissociation of oxygen from Hb by increasing RBC 2,3-DPG (2,3 diphosphoglycerate).</li> </ul>
<b>Autonomic Nervous System</b>	<p>Produced the same action as <u>catecholamines</u> via <math>\beta</math>-adrenergic receptors including:</p> <ul style="list-style-type: none"> <li>✓ Increase BMR.</li> <li>✓ Increase heat production.</li> <li>✓ Increase heart rate.</li> <li>✓ Increase stroke volume.</li> </ul> <p>i.e. <math>\beta</math>-blocker (propranolol) is used in treatment of hyperthyroidism.</p>

# Regulation of Thyroid Hormone Secretion

It is regulated by the hypothalamic-pituitary axis.

## Thyrotropin-Releasing Hormone (TRH)

A tripeptide, released from *paraventricular* nuclei of the hypothalamus, act on the **thyrotrophs of the anterior pituitary** by phospholipid second messenger system. Leads to transcription and secretion of TSH

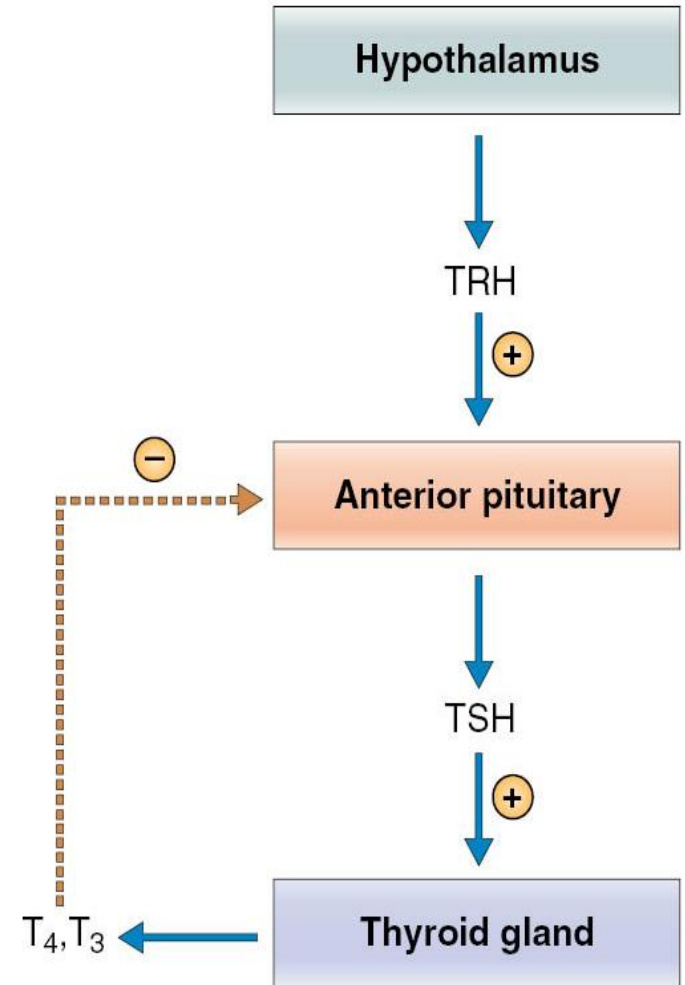
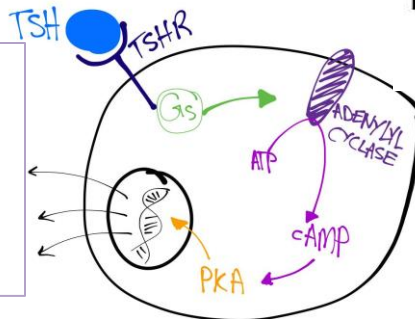
## Thyroid-Stimulating Hormone (TSH)

Glycoprotein, From Anterior pituitary. TSH secretion started at 11-12 of gestational weeks.

- Effects**
- ✓ Increase proteolysis of the thyroglobulin.
  - ✓ Increase pump activity.
  - ✓ Increase iodination of tyrosine.
  - ✓ Increase coupling reaction.
  - ✓ **Trophic effect.** Trophic hormone is a hormone that has a growth effect, hyperplasia or hypertrophy, on the tissue it is stimulating.

**MOA**

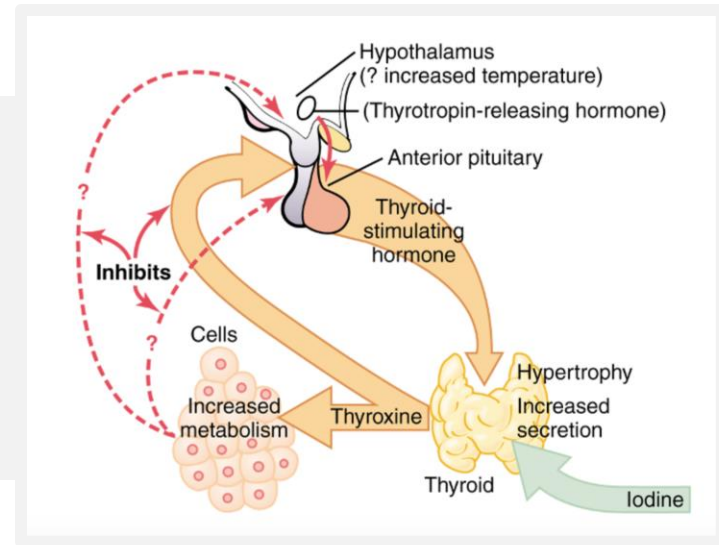
TSH + receptor → activation of adenylyl cyclase via G<sub>s</sub> protein → cAMP → activation of protein kinase → multiple phosphorylation, increases secretion and thyroid growth.



# Regulation of Thyroid Hormone Secretion cont.

## TSH is regulated by:

1. TRH we discussed previously.
2. Thyroid Hormones: inhibit the secretion of TSH by down-regulation the TRH receptors.  
-negative feedback-



THIS PART WAS NOT MENTIONED IN OUR SLIDES  
HOWEVER WE ARE INCLUDING IT FOR THE  
SAKE OF COMPLETION IT'S EASY ANYWAY..



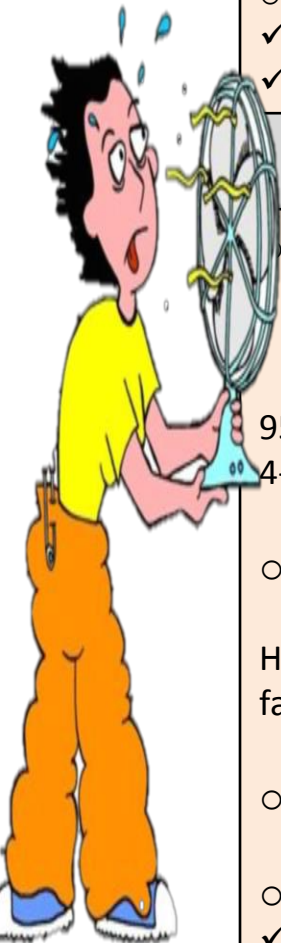
## Factors Affecting Thyroid Hormone Secretion

Stimulatory Factors	Inhibitory Factors
TSH	I <sup>-</sup> deficiency ;(T3 and T4 will decrease in the circulation)
Thyroid stimulating immunoglobulin	Deiodinase deficiency ;(T3 and T4 will decrease in the circulation)
Increases TGB levels (eg., pregnancy)	Excessive I <sup>-</sup> intake (Wolff-chaikoff effect)
	Decreased TGB levels (e.g., liver failure)
	Anti-hyperthyroidism drugs (e.g.,Perchlorate and Propylthiouracil)

Most of the points presented in this table were discussed in previous slides.

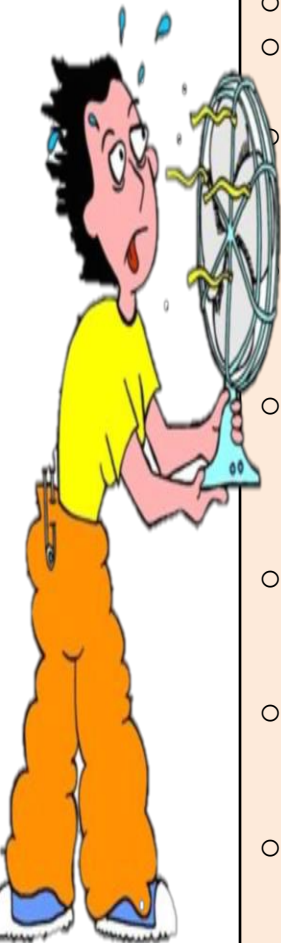
# Diseases of Thyroid Gland

<b>Hyperthyroidism</b>	<b>Hypothyroidism</b>
<p>Over activity of the thyroid gland.</p> <ul style="list-style-type: none"> <li>○ Women : men ratio (8:1).</li> <li>○ Activity of gland :</li> <li>✓ 5- 10 times increase in secretion.</li> <li>✓ 2-3 times increase in size.</li> </ul>	<p>Under activity of the thyroid gland</p> <ul style="list-style-type: none"> <li>○ More in woman ( 30- 60 years).</li> </ul>
<b>Causes</b>	
<p>○ <b>Graves' disease:</b> an autoimmune disorder. Increased circulating level of thyroid- stimulating immunoglobulins (TSI). 95% most common cause of hyperthyroidism 4-8 times more common in women than men</p> <p>○ <b>Thyroid Gland Tumor:</b> 95% is benign and 5% is malignant. History of head and neck irradiation and family history.</p> <p>○ <b>Exogenous T3 and T4</b> –rarely –</p> <p>○ <b>Excess TSH secretion:</b></p> <ul style="list-style-type: none"> <li>✓ Diseases of the hypothalamus ( TRH).</li> <li>✓ Diseases of the pituitary (TSH).</li> </ul>	<ul style="list-style-type: none"> <li>○ <b>Inherited abnormalities of thyroid hormone synthesis:</b></li> <li>✓ Peroxidase defect.</li> <li>✓ Iodide trapping defect.</li> <li>✓ Thyroglobulin defect.</li> <li>○ <b>Endemic Colloid Goiter:</b> -before table salt- : ↓iodide &gt; ↓ hormone formation &gt; ↑TSH &gt; ↑Thyroglobulin size ( &gt; 10 times)</li> <li>○ <b>Idiopathic nontoxic colloid goiter:</b> -I intake is normal-: Inflammation &gt; ↑ cell damage &gt; ↓ hormone secretion &gt; ↑TSH &gt; ↑activity of normal cells &gt; ↑size</li> <li>○ <b>Gland destruction (surgery).</b></li> <li>○ <b>Pituitary diseases or tumor.</b></li> <li>○ <b>Hypothalamus diseases or tumor</b></li> </ul>



# Diseases of Thyroid Gland cont.

<i>Hyperthyroidism</i>	<i>Hypothyroidism</i>
<b>Diagnosis/Symptoms</b>	
<ul style="list-style-type: none"> <li>○ <b>Goiter</b><sup>1</sup> in 95%.</li> <li>○ <b>Skin:</b> Smooth, warm and moist -Heat intolerance, night sweating.</li> <li>○ <b>Musculoskeletal:</b> Muscle atrophy.</li>   <li><b>Neurological:</b> tremor, enhanced reflexes and irritability.</li>   <li>○ <b>Cardiovascular:</b> increase heart rate, increase stroke volume, arrhythmias and hypertension.</li>   <li>○ <b>Gastrointestinal tract:</b> weight loss and diarrhea.</li>   <li>○ <b>Renal function:</b> ↑glomerular filtration rate.</li>   <li>○ <b>Exophthalmos:</b> anxious staring expression and protrusion of eye balls.</li>   <li>○ Menstrual cycle disturbance.</li> </ul>	<ul style="list-style-type: none"> <li>○ <b>Skin:</b> dry skin. and cold intolerance.</li>   <li>○ <b>Musculoskeletal:</b> ↑muscle bulk. ↓ in skeletal growth, muscle sluggishness and slow relaxation after contraction</li>   <li>○ <b>Neurological:</b> slow movement, impaired memory and decrease mental capacity</li>   <li>○ <b>Cardiovascular:</b> Decrease blood volume, heart rate and stroke volume.</li>   <li>○ <b>Gastrointestinal tract:</b> Increase weight and constipation.</li>   <li>○ <b>Renal function:</b> ↓glomerular filtration rate.</li>   <li>○ <b>Myxoedema:</b> An edematous appearance through out body</li> <li>○ Loss of libido<sup>1</sup>.</li> <li>○ Menstrual cycle disturbance.</li> </ul>

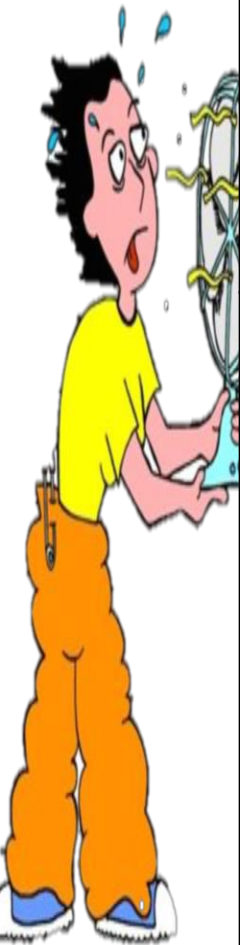


1: Colloquially known as sex drive, is a person's overall sexual drive or desire for sexual activity



# Diseases of Thyroid Gland cont.

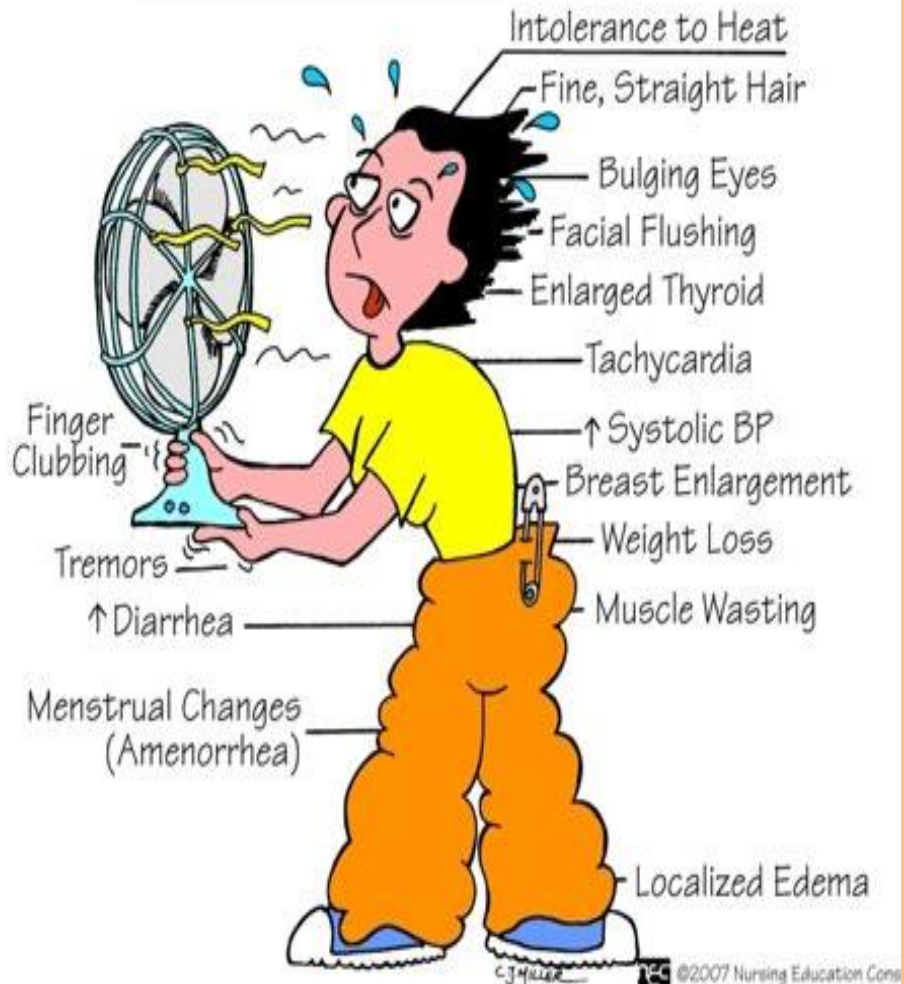
Hyperthyroidism	Hypothyroidism
<b>Investigations</b>	
<ul style="list-style-type: none"> <li>○ Serum T3, T4 are <b>high</b>.</li> <li>○ Serum TSH:               <ul style="list-style-type: none"> <li>• In primary hyperthyroidism:                   <ul style="list-style-type: none"> <li>✓ ↓ TSH.</li> </ul> </li> <li>• In <i>secondary</i> hyperthyroidism:                   <ul style="list-style-type: none"> <li>✓ ↑ TSH.</li> </ul> </li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>○ Serum T3,T4 are <b>low</b>.</li> <li>○ Serum TSH:               <ul style="list-style-type: none"> <li>• In primary hypothyroidism:                   <ul style="list-style-type: none"> <li>✓ ↑ TSH.</li> </ul> </li> <li>• In <i>secondary</i> hypothyroidism:                   <ul style="list-style-type: none"> <li>✓ ↓ TSH.</li> </ul> </li> </ul> </li> </ul>
<b>Treatment</b>	
<ul style="list-style-type: none"> <li>○ <b>Medical therapy:</b> e.g. propylthiouracil               <ul style="list-style-type: none"> <li>✓ Usually for 12-18 months course.</li> <li>✓ With 3-4 monthly monitoring.</li> </ul> </li> <li>○ <b>Surgery:</b> Subtotal thyroidectomy.               <ul style="list-style-type: none"> <li>• <b>Indication for surgery:</b> <ul style="list-style-type: none"> <li>✓ Relapse after medical treatment.</li> <li>✓ Drug intolerance.</li> <li>✓ Cosmetic<sup>1</sup>.</li> <li>✓ Suspected malignancy</li> </ul> </li> </ul> </li> </ul>	<ul style="list-style-type: none"> <li>○ <b>Medical therapy:</b> <ul style="list-style-type: none"> <li>• <b>L- thyroxine</b> <ul style="list-style-type: none"> <li>✓ Starting dose is 25-50 µg.</li> <li>✓ Increase to 200 µg.</li> <li>✓ At 2-4 weeks period.</li> </ul> </li> </ul> </li> </ul> <p style="text-align: center;">The first response seen is the weight loss</p>



# Disease of Thyroid Gland

## SUMMARY

### HYPERTHYROIDISM



### HYPOTHYROIDISM



# Diseases of Thyroid Gland cont.

## Cretinism

A condition of severely stunted physical and mental growth due to untreated congenital deficiency of thyroid hormones (congenital hypothyroidism).

### Causes

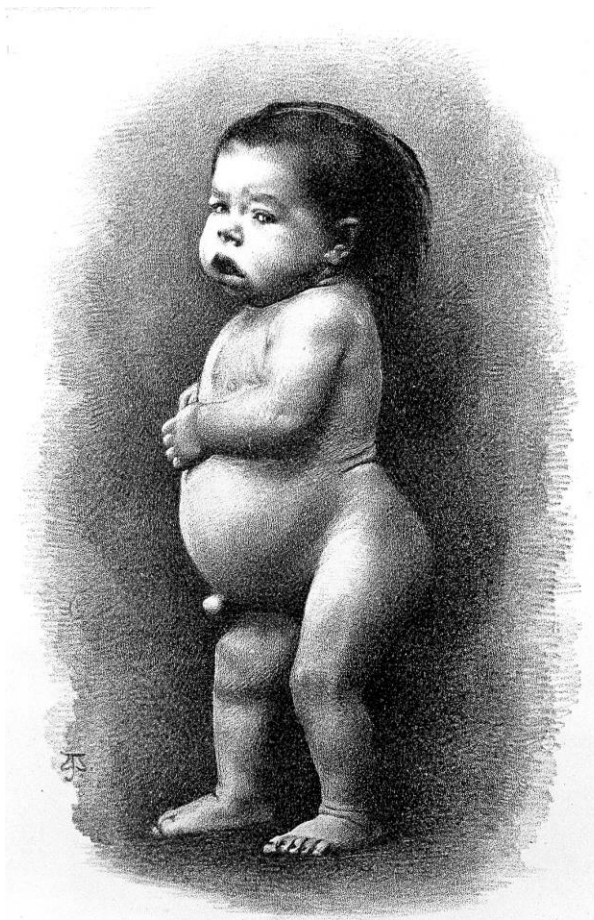
- Congenital lack of thyroid gland (congenital cretinism).
- Genetic deficiency leading to failure to produce hormone.
- Iodine lack in the diet (endemic cretinism).

### Symptoms

- Infant is normal at birth but abnormality appears within weeks.
- Protruding tongue.
- Dwarf with short limbs.
- Mental retardation.
- Often umbilical hernia.
- Delayed appearance of teeth.

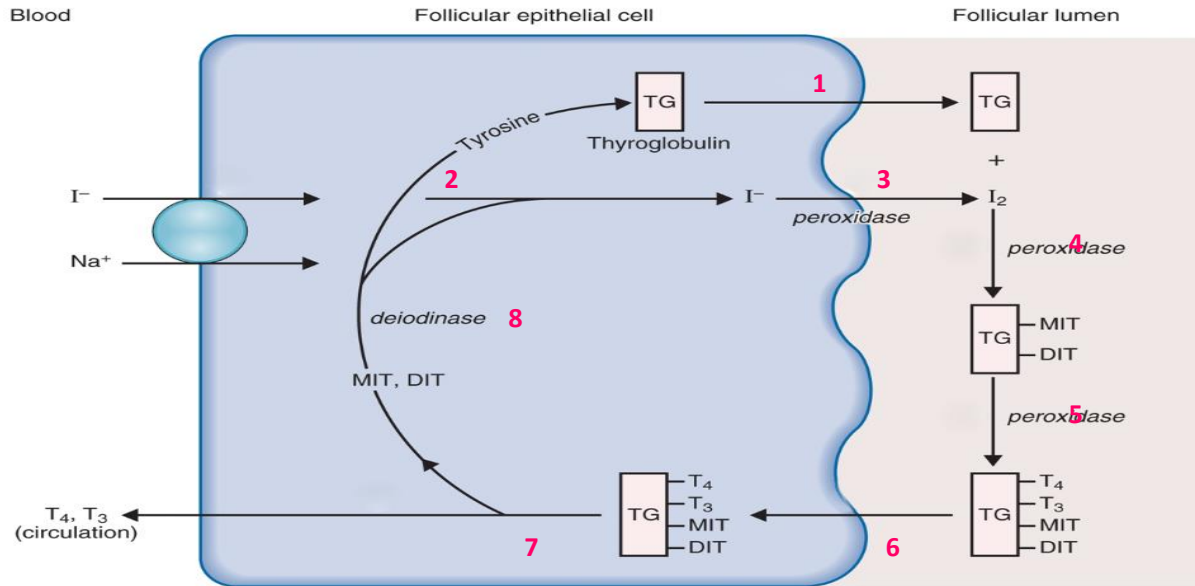
### Treatment

- Changes are irreversible unless treatment is given early.



# ✧ Biosynthesis of Thyroid Hormones

Summary



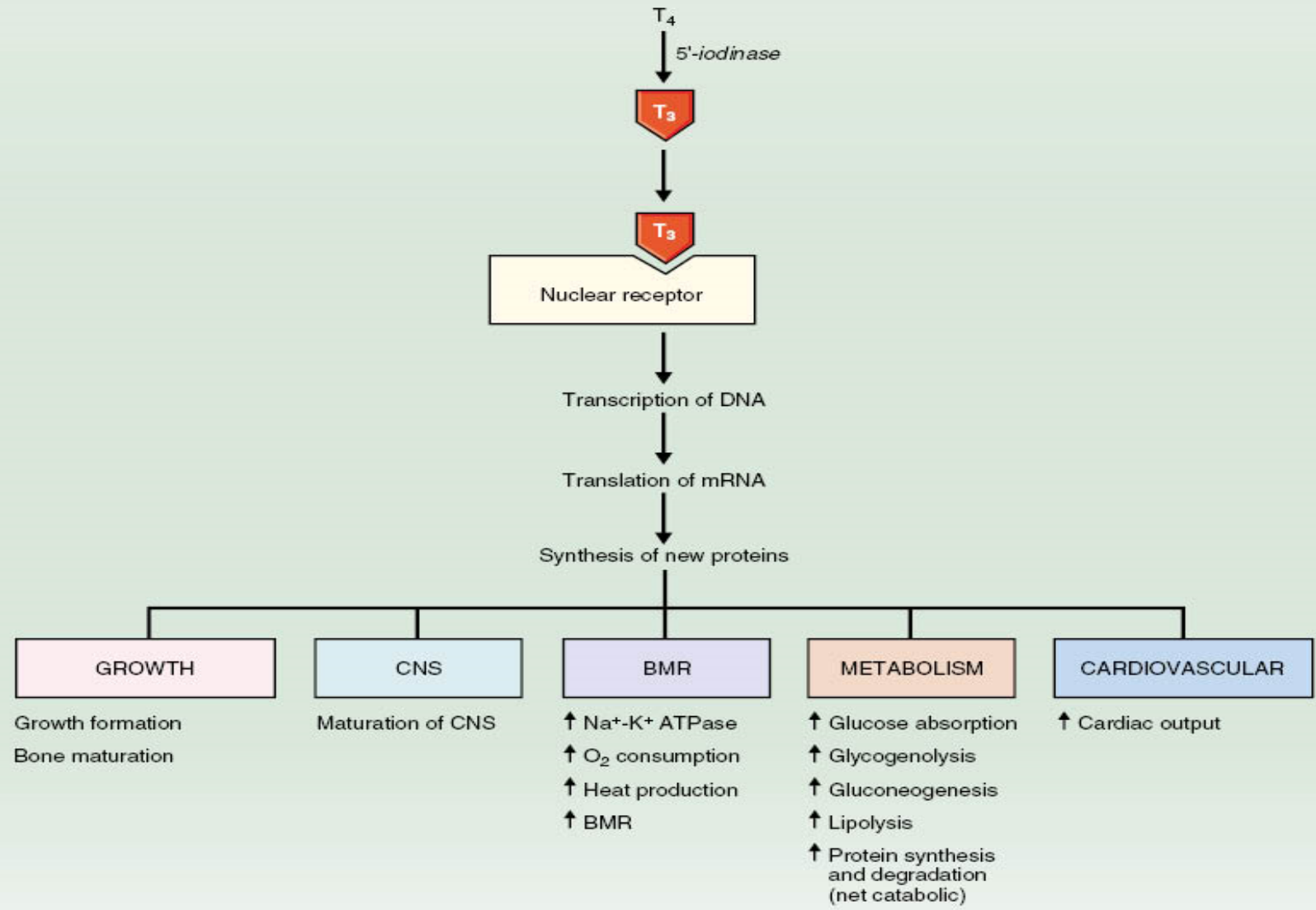
Event	Site	Enzyme	Inhibitor
1 Synthesis of TG; extrusion into follicular lumen	Rough ER, Golgi apparatus		
2 Na <sup>+</sup> - I <sup>-</sup> cotransport	Basal membrane		Perchlorate, thiocyanate
3 Oxidation of I <sup>-</sup> → I <sub>2</sub>	Apical (luminal) membrane	Peroxidase	PTU
4 Organification of I <sub>2</sub> into MIT and DIT	Apical membrane	Peroxidase	PTU
5 Coupling reaction of MIT and DIT into T <sub>3</sub> and T <sub>4</sub>	Apical membrane	Peroxidase	PTU
6 Endocytosis of TG	Apical membrane		
7 Hydrolysis of T <sub>4</sub> and T <sub>3</sub> ; T <sub>4</sub> and T <sub>3</sub> enter circulation	Lysosomes	Proteases	
8 Deiodination of residual MIT and DIT Recycling of I <sup>-</sup> and tyrosine	Intracellular	Deiodinase	



# Physiological Actions of Thyroid Hormones

Summary

## ACTIONS OF THYROID HORMONES





## ✧ Hyperthyroidism VS Hypothyroidism

	Hyperthyroidism	Hypothyroidism
<b>Symptoms</b>	<ul style="list-style-type: none"> <li>Increased basal metabolic rate</li> <li>Weight loss</li> <li>Negative nitrogen balance</li> <li>Increased heat production</li> <li>Sweating</li> <li>Increased cardiac output</li> <li>Dyspnea (shortness of breath)</li> <li>Tremor, muscle weakness</li> <li>Exophthalmos</li> <li>Goiter</li> </ul>	<ul style="list-style-type: none"> <li>Decreased basal metabolic rate</li> <li>Weight gain</li> <li>Positive nitrogen balance</li> <li>Decreased heat production</li> <li>Cold sensitivity</li> <li>Decreased cardiac output</li> <li>Hypoventilation</li> <li>Lethargy, mental slowness</li> <li>Drooping eyelids</li> <li>Myxedema</li> <li>Growth retardation</li> <li>Mental retardation (perinatal)</li> <li>Goiter</li> </ul>
<b>Causes</b>	<ul style="list-style-type: none"> <li>Graves' disease (increased thyroid-stimulating immunoglobulins)</li> <li>Thyroid neoplasm</li> <li>Excess TSH secretion</li> <li>Exogenous T<sub>3</sub> or T<sub>4</sub> (factitious)</li> </ul>	<ul style="list-style-type: none"> <li>Thyroiditis (autoimmune or Hashimoto's thyroiditis)</li> <li>Surgery for hyperthyroidism</li> <li>I<sup>-</sup> deficiency</li> <li>Congenital (cretinism)</li> <li>Decreased TRH or TSH</li> </ul>
<b>TSH Levels</b>	<ul style="list-style-type: none"> <li>Decreased (feedback inhibition of T<sub>3</sub> on the anterior lobe)</li> <li>Increased (if defect is in anterior pituitary)</li> </ul>	<ul style="list-style-type: none"> <li>Increased (by negative feedback if primary defect is in thyroid gland)</li> <li>Decreased (if defect is in hypothalamus or anterior pituitary)</li> </ul>
<b>Treatment</b>	<ul style="list-style-type: none"> <li>Propylthiouracil (inhibits peroxidase enzyme and thyroid hormone synthesis)</li> <li>Thyroidectomy</li> <li><sup>131</sup>I<sup>-</sup> (destroys thyroid)</li> <li>β-Adrenergic blocking agents (adjunct therapy)</li> </ul>	<ul style="list-style-type: none"> <li>Thyroid hormone replacement therapy</li> </ul>

1- Which of the following statements concerning thyroid *function* are correct?

- A. T3 and T4 stimulate the secretion of TSH by the anterior pituitary.
- B. Most of the iodide in the body is present in the thyroid gland
- C. Thyroid hormones are essential for the early development and maturation of the central nervous system

2- Which of the following are *NOT* symptoms of myxoedema?

- A. Constipation
- B. Dry Skin
- C. Heat-intolerance

3-A patient presents with signs of hypothyroidism. To investigate the matter, you measure the levels of T4 and TSH. You can expect the following results:

- A. T4 elevated, TSH elevated
- B. T4 reduced, TSH elevated
- C. T4 reduced, TSH normal

4-Thyroid hormones can increase cardiac output. From the following table, pick the row that correctly lists the mechanisms by which T3 increases cardiac output.

	Rate of atrial pacemaker depolarization	Expression of cardiac Na <sup>2+</sup> /exchanger	Expression of cardiac β-adrenergic receptors	Expression of Cardiac Na <sup>+</sup> ,K <sup>+</sup> -ATPase
A	Increase	Decrease	Decrease	Increase
B	Decrease	Increase	Increase	Decrease
C	Increase	Increase	Decrease	Decrease
D	Increase	Increase	Increase	Increase

A or B or C or D

5- What is the unique feature of the antibody produced in Graves' disease that stimulates growth of the thyroid gland?

- A. Enhanced secretion of TSH
- B. Has similar effect to TSH
- C. Has similar effect to TRH

6-A patient presents with signs of hyperthyroidism (thyrotoxicosis). To investigate the matter, you measure the levels of T4 and TSH. If the patient has a benign thyroid adenoma ("toxic nodule"), you can expect the following results:

- A. T4 reduced, TSH reduced
- B. T4 elevated, TSH reduced
- C. T4 elevated, TSH elevated

7- Which of the following statement regarding thyroid hormone synthesis is correct?

- A. Binding of iodine with thyroglobulin catalyzed by thyroid peroxidase enzyme
- B. Iodide is transported to the follicular cells by passive diffusion
- C. Oxidation of iodide to iodine is catalyzed by iodase enzyme

8- What is the correct relationship between changes in plasma levels of T3 & T4 and release of TRH and TSH?

	T <sub>3</sub> & T <sub>4</sub>	TRH	TSH
A	Increase	Increase	Decrease
B	Decrease	Increase	Increase
C	Decrease	Decrease	Decrease

A or B or C or D

9- Which of the following sequences is correct regarding thyroid hormone synthesis:

- A. Oxidation > Iodination > Coupling.
- B. Oxidation > Coupling > Iodination .
- C. Iodination > Oxidation > Coupling.

10- What is the correct feature regarding thyroid hormone circulation in a pregnant lady

- A. Decreased TGB
- B. Increased TBG
- C. Increases free T4/T3

11- Which of the following statement regarding Cretinism is correct?

- A. Stunted physical and mental growth
- B. Acromegaly
- C. Heat-intolerance

12- Which of the following is NOT a feature of hypothyroidism?

- A. Constipation
- B. Heat-intolerance
- C. Cold-intolerance

13- Which of the following is considered as an Inhibitory factor of thyroid hormone?

- A. TSH
- B. Thyroid stimulating immunoglobulin
- C. Wolff-chaikoff effect

**Q1: The increase in delivery of blood to tissue by TH is mediated by?**

Ans: 1- Indirect induction: Potentiate the effect of catecholamines.  
2- Direct induction of beta adrenergic receptors

**Q2: Mention the effect of TH on CNS.**

Ans: 1- Perinatal period: Maturation of CNS.  
2- Adults: Hyperexcitability and irritability.

**Q3: How does TH secretion is regulated?**

Ans: Regulated by the hypothalamic-pituitary axis > TRH > TSH.

**Q4: What are the actions of TSH?**

Ans: Increase proteolysis of the thyroglobulin.  
2- Increase pump activity.  
3- Increase iodination of tyrosine.  
4- Increase coupling reaction.

**Q5: List the steps of T4 and T3 release to the tissues.**

Ans: 1- T4 and T3 readily diffuse through the cell membrane.  
2- Stored in targeted tissue.  
3- T4 deionized to T3 by idoinase.  
4- In nucleus, T3 mainly binds to thyroid hormone receptor.  
5- Influence transcription of genes

THANKS FOR CHECKING OUR WORK

# Good Luck

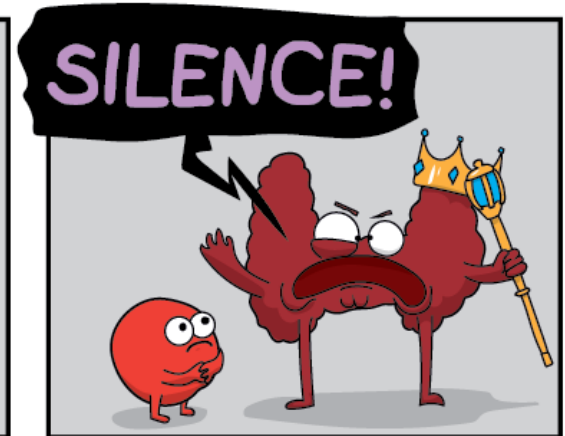
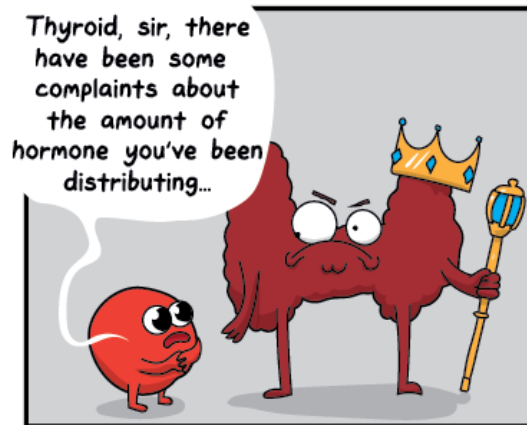
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