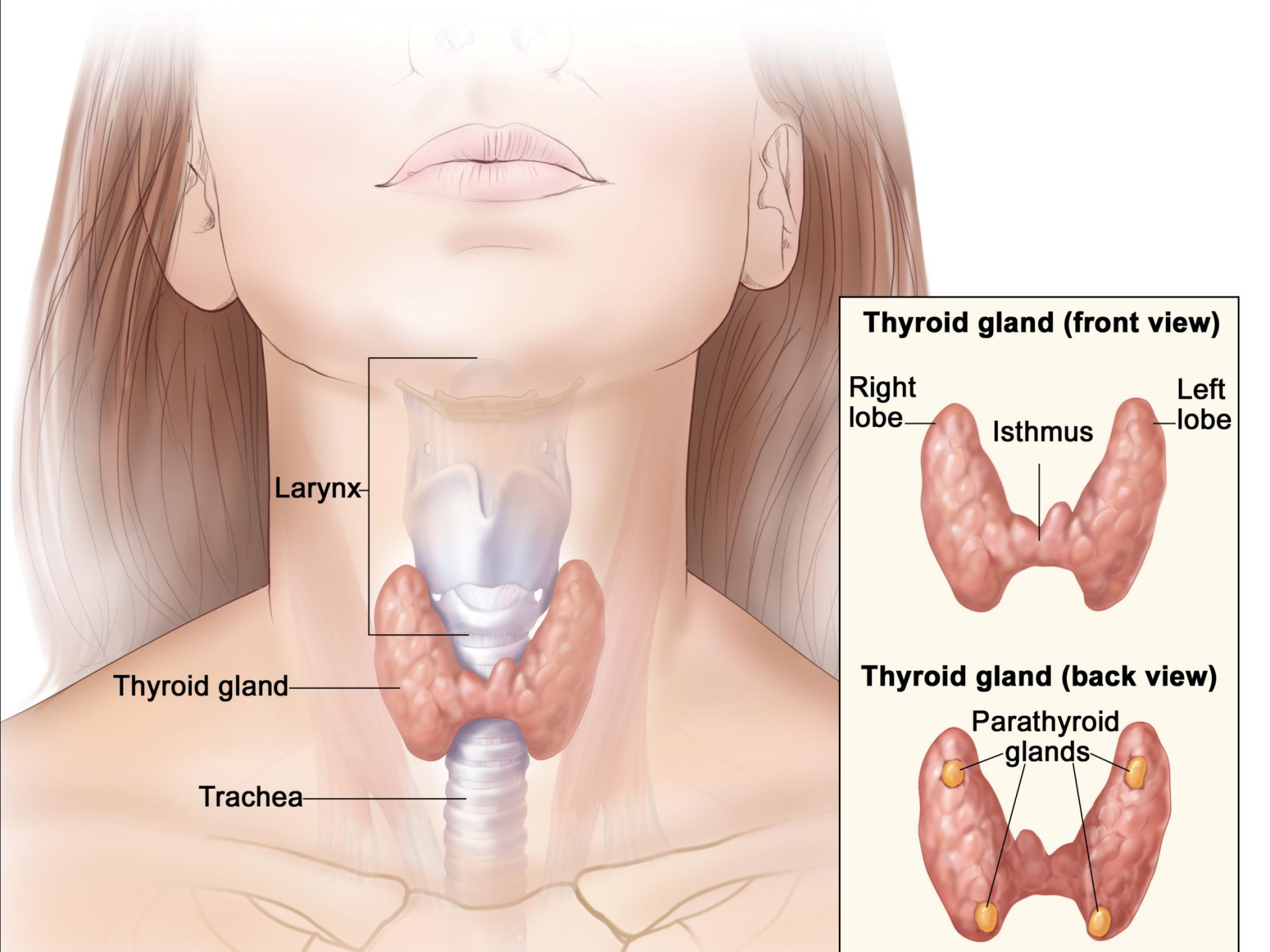
THE THYROID GLAND


Larynx
Thyroid gland
Trachea
Thyroid gland (front view)
Right lobe
Isthmus
Left lobe
Thyroid gland (back view)
Parathyroid glands

Thyroid hormones

Amino acid derivatives

- **Tri-iodothyronine (T3)**
- **Tetra-iodothyronine (T4 or Thyroxine))**

From **tyrosine**

Tyrosine bound into polypeptides
- **Thyroglobulin**

Secreted as colloid

Stored extra-cellularly in follicles

Summary of Biosynthesis of T4 and T3

The process includes

- Dietary iodine (I) ingestion
- Active transport and uptake of iodide (I-) by thyroid gland
- Oxidation of I-and iodination of thyroglobulin (Tg) tyrosine residues
- Coupling of iodotyrosine residues (MIT and DIT) to form T4 and T3
- Proteolysis of Tg with release of T4 and T3 into the circulation

Control of Thyroid Secretion

- Controlled by trophic hormone from anterior pituitary gland

The anterior pituitary

- Secretes a number of hormones from different cell types
  - **Luteotrophs** secrete **Luteinising** hormone and **Follicle Stimulating** Hormone (LH & FSH)
  - **Lactotrophs** secrete **Prolactin**
  - **Somatotrophs** secrete **Growth** Hormone (GH)
  - **Corticotrophs** secrete Adrenocorticotrophic Hormone (ACTH)
  - **Thyrotrophs** secrete **Thyroid Stimulating** Hormone (TSH)

Control of anterior pituitary secretion

- Each cell type controlled by a Releasing Hormone secreted from the hypothalamus
- Travels directly to anterior pituitary in Hypophyseal portal circulation
  - 'portal' means connecting two capillary beds directly
- Prevents dilution in general circulation
- Releasing hormones are secreted from nerves
  - Affected by the rest of the brain

Control of TSH secretion

- **Thyrotrophs** stimulated by **Thyrotrophin Releasing Hormone** (TRH)
  - Tripeptide
- Release **TSH**
  - Glycoprotein
  - Two subunits, α & β

Negative feedback control

- If T4 or T3 levels rise
- This reduces TSH secretion
- Which reduces secretion of T4 and T3, bringing levels back to 'set point'
- And vice-versa
- Set point determined by how strongly thyroid hormones inhibit TSH secretion
- This is determined by TRH
  - More TRH less powerful inhibition
  - Therefore thyroid hormone levels rise in a controlled way

Negative feedback control

- Like a heating thermostat
- TRH sets the thermostat
- Negative feedback controls levels at the defined setting

Transport of thyroid hormones

- **99%** of T4 and T3 in blood bound to protein
  - Total T4 **100 $nmol.l^{-1}$**
  - Total T3 **2 $nmol.l^{-1}$**
- **Thyroid Binding Globulin (TBG)**
- Very small free pool acts on tissues
  - Free T4 **20 $pmol.l^{-1}$**
  - Free T3 **8 $pmol.l^{-1}$**

Actions of Thyroid hormones

- Thyroid hormones freely cross cell membranes
- Bind to receptor in the cell to affect **gene transcription**
- Act to increase metabolic rate
  - Increase in number of mitochondria
  - Increased oxygen consumption & heat production
  - Increased nutrient utilisation

Actions of thyroid hormones

- Stimulate most metabolic pathways
- Promote normal growth and development of tissues
- Increase responsiveness to other stimuli (eg sympathetic nervous system)

Thyroid Hormone Plays a Major Role in Growth and Development

- Thyroid hormone initiates or sustains differentiation and growth
  - Stimulates formation of proteins, which exert trophic effects on tissues
  - Is essential for normal brain development
- Essential for childhood growth
  - Untreated congenital hypothyroidism or chronic hypothyroidism during childhood can result in incomplete development and mental retardation

Metabolic effects

- Stimulates lipolysis and release of free fatty acids and glycerol
- Induces expression of lipogenic enzymes
- Effects cholesterol metabolism
- Stimulates metabolism of cholesterol to bile acids
- Facilitates rapid removal of LDL from plasma
- Generally stimulates all aspects of carbohydrate metabolism and the pathway for protein degradation

Thyroid disorders

- **Hypothyroidism**
  - Too little secretion
  - T4 & T3 levels low
- **Hyperthyroidism**
  - Too much secretion
  - T4 & T3 levels high

Effects of hyperthyroidism

- **Metabolic symptoms & signs**
  - **Weight loss**
  - **Heat intolerance**
  - **Excess sweating**
  - **Increased appetite**