Practical endocrinology –First course

Lecture- 3&4- ESTIMATION OF TSH, T3 AND T4

Sawa University	جامعـــــة ســـــــاوة الاهلية
College of health and medical techniques	كليـــــة التقنيـــات الصحيـة والطبيـة
Department of Medical Laboratories	قسم تقنيات المختبرات الطبية
Third Stage	المرحلـــــــــــة الثالثة

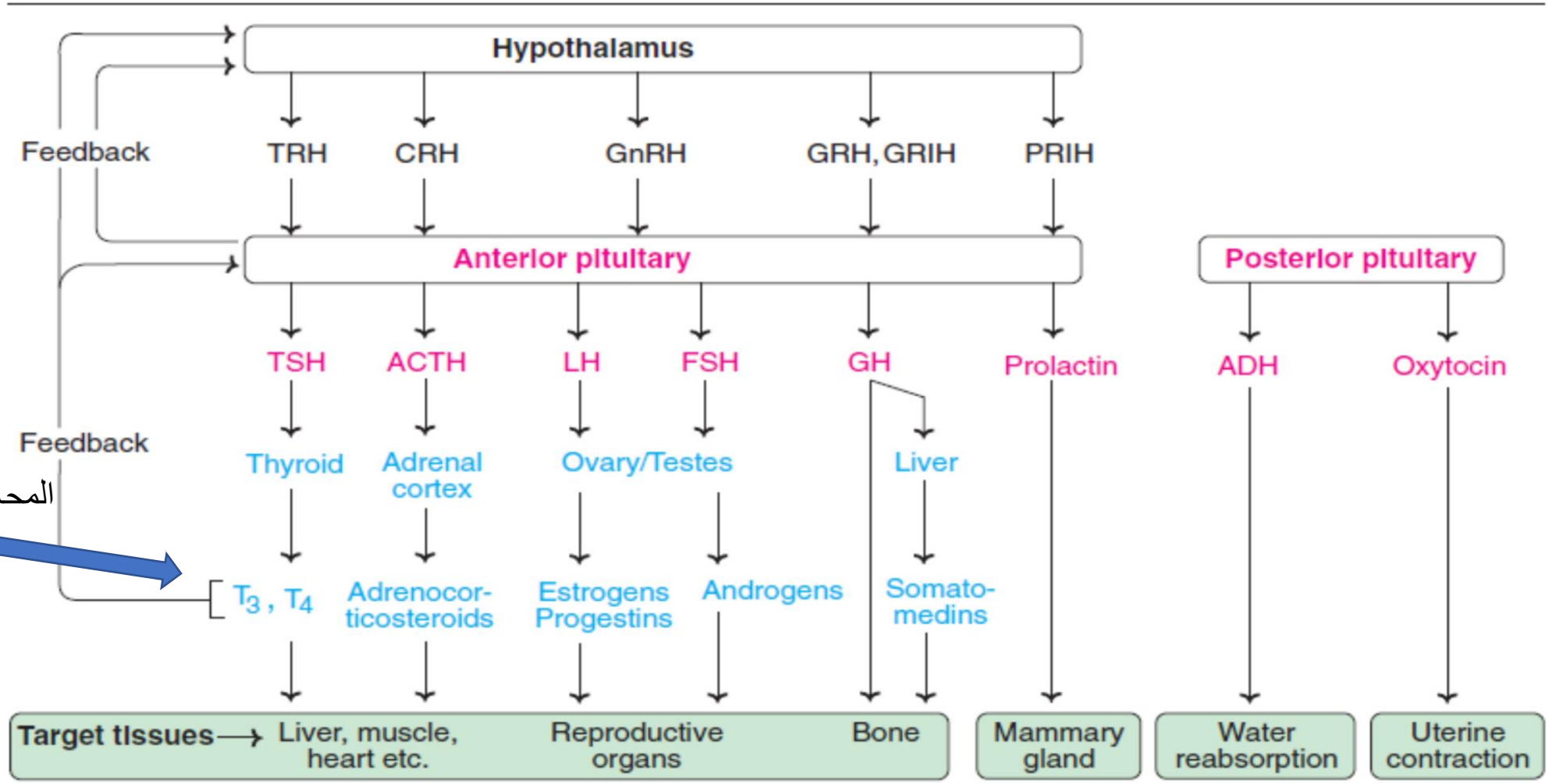
الجانب العملي محاضرة رقم 3&4

Practical Lecture No. 3&4

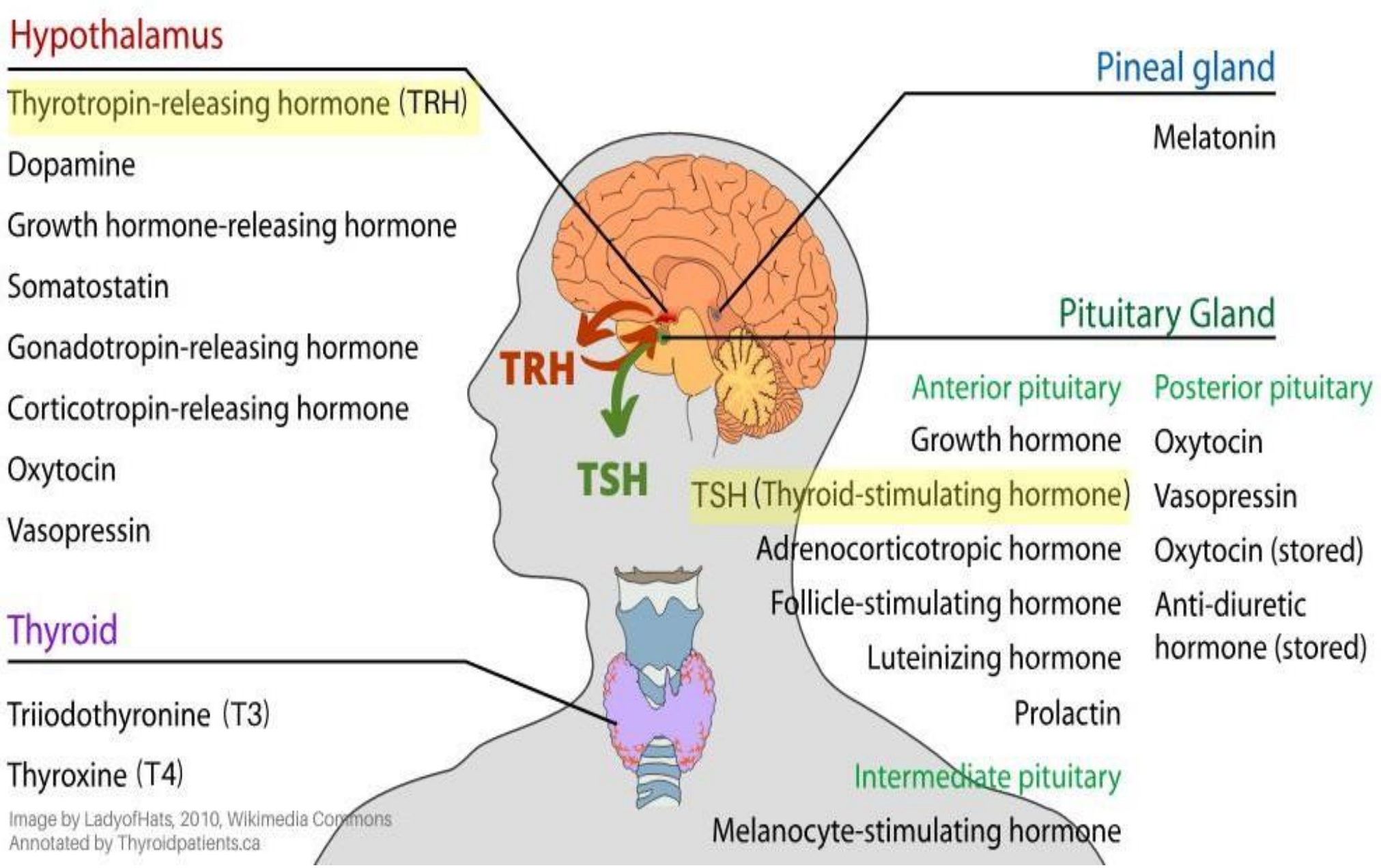
تدريسي المادة : م.م صكر عبد الكاظم صكر

مخطط مهم جدا

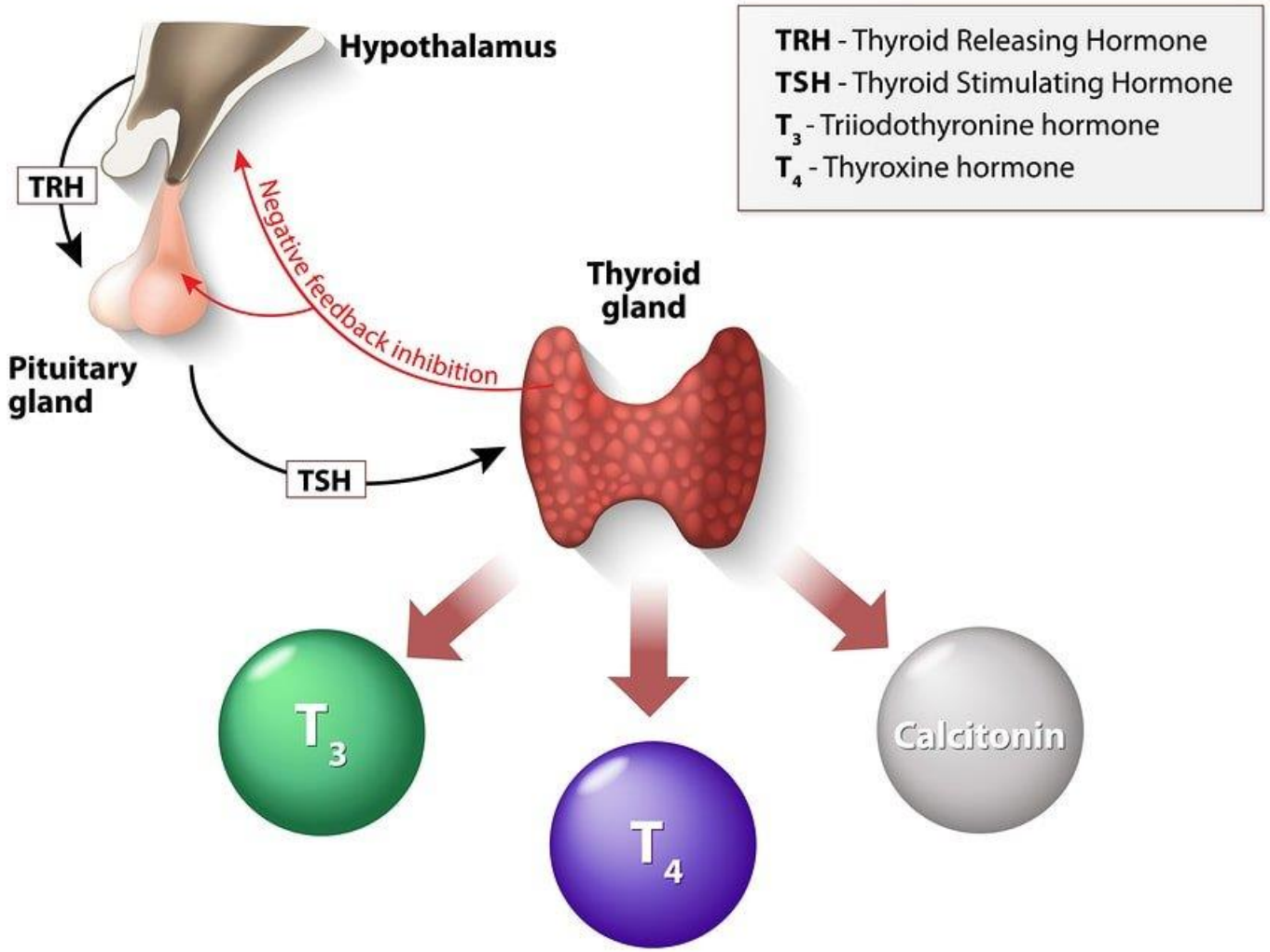
من ترك أمرهُ لله
أعطاه فوق ما يتمنّاه ..



المحاضرة تتحدث عن


Hypothalamus
Thyrotropin-releasing hormone (TRH)
Dopamine
Growth hormone-releasing hormone
Somatostatin
Gonadotropin-releasing hormone
Corticotropin-releasing hormone
Oxytocin
Vasopressin
Pineal gland
Melatonin
Pituitary Gland
TRH
TSH
Anterior pituitary
Growth hormone
TSH (Thyroid-stimulating hormone)
Adrenocorticotropic hormone
Follicle-stimulating hormone
Luteinizing hormone
Prolactin
Posterior pituitary
Oxytocin
Vasopressin
Oxytocin (stored)
Anti-diuretic hormone (stored)
Intermediate pituitary
Melanocyte-stimulating hormone
Thyroid
Triiodothyronine (T3)
Thyroxine (T4)
Image by LadyofHats, 2010, Wikimedia Commons
Annotated by Thyroidpatients.ca

THYROID HORMONES

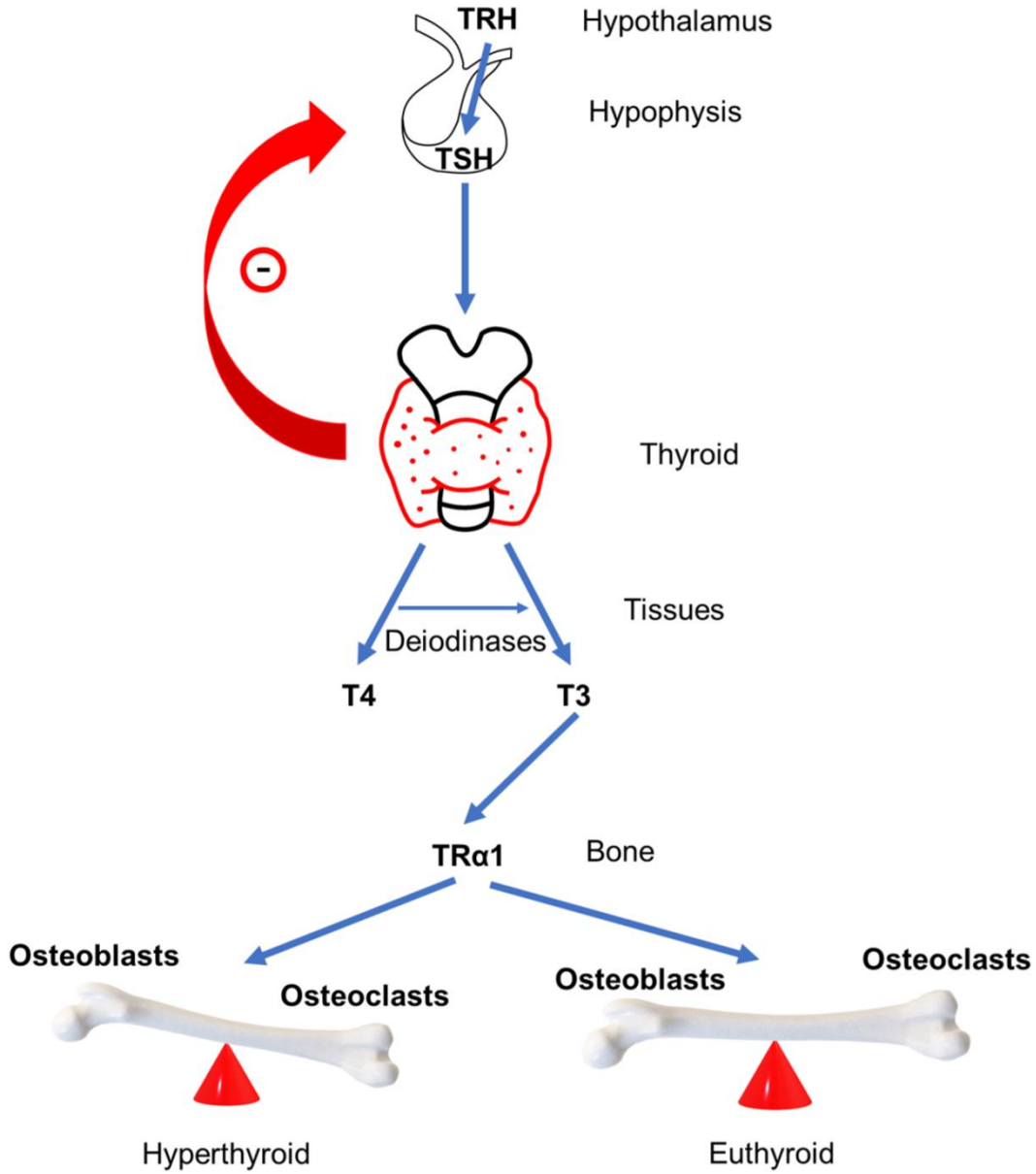


TRH - Thyroid Releasing Hormone
TSH - Thyroid Stimulating Hormone
T_3 - Triiodothyronine hormone
T_4 - Thyroxine hormone

TRa1 in bone" most commonly refers to the thyroid hormone receptor alpha 1, which plays a crucial role in bone development and maintenance,

Thyroid Hormone Receptor Alpha 1 (TRa1)

- **Role in development:**
- TRa1 is essential for normal skeletal development. Thyroid hormone, acting through TRa1, promotes bone growth by stimulating chondrocyte maturation and endochondral ossification.
- **Role in adult bone:**
- Thyroid hormone has a catabolic role in the adult skeleton. TRa1 is the predominant receptor in adult bone, where it influences bone resorption and maintenance, with imbalances linked to bone loss (osteoporosis).
- **Mechanism:**
- Thyroid hormone exerts its effects by binding to TRa1, which then influences the expression of genes involved in bone formation and remodeling.



Thyroid Hormones and Their Functions

- **TSH (Thyroid-Stimulating Hormone): Is *peptide hormone* secreted by the anterior pituitary gland, TSH regulates the production and release of T3 and T4 from the thyroid gland.**
- **T3 (Triiodothyronine): Is *amine hormones* ,the biologically active form of thyroid hormone, responsible for regulating metabolism, heart rate, and body temperature.**
- **T4 (Thyroxine): Is *amine hormones* ,the primary thyroid hormone produced, which gets converted into the active T3 form in tissues.**
- **T3 (Triiodothyronine) and T4 (Thyroxine) are amine hormones derived from tyrosine and iodine. Despite being derived from an amino acid, these hormones are lipophilic (fat-soluble), meaning they can easily pass through the cell membrane.**
- **Therefore, both T3 and T4 use intracellular receptors to exert their effects.**

• Stimulation of the Thyroid Gland

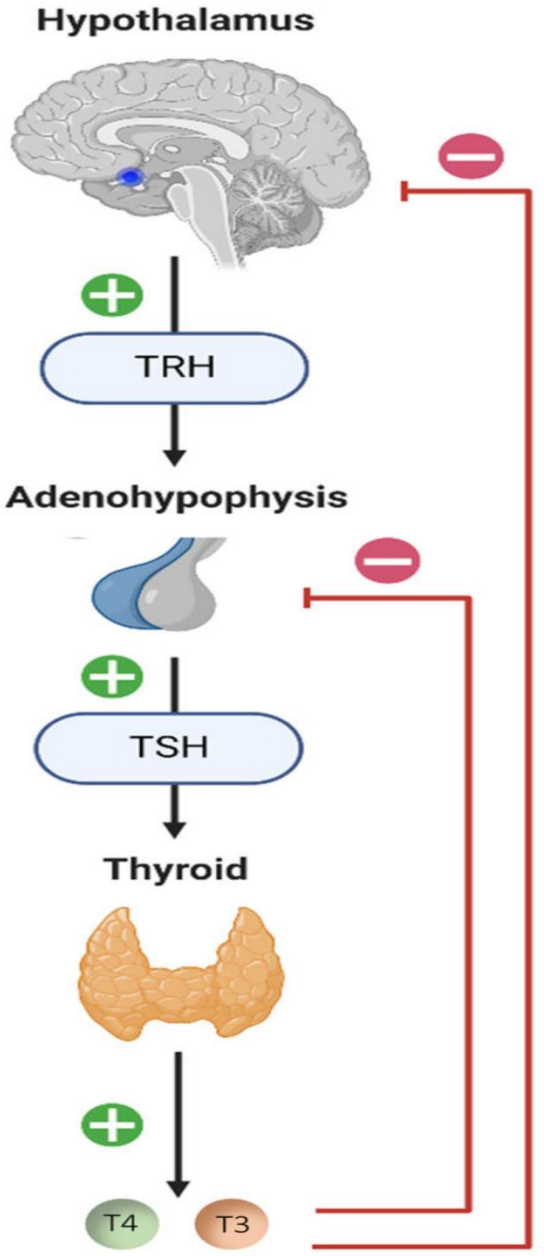
- The **hypothalamus** releases **TRH**, which travels to the **anterior pituitary gland**.
- TRH stimulates the **pituitary** to release **TSH** into the bloodstream.
- TSH binds to receptors on **thyroid follicular cells**, stimulating the synthesis and release of **T_4 (major product) and T_3**.
- T_4 is converted into the more active **T_3** in peripheral tissues by **deiodinase enzymes**.

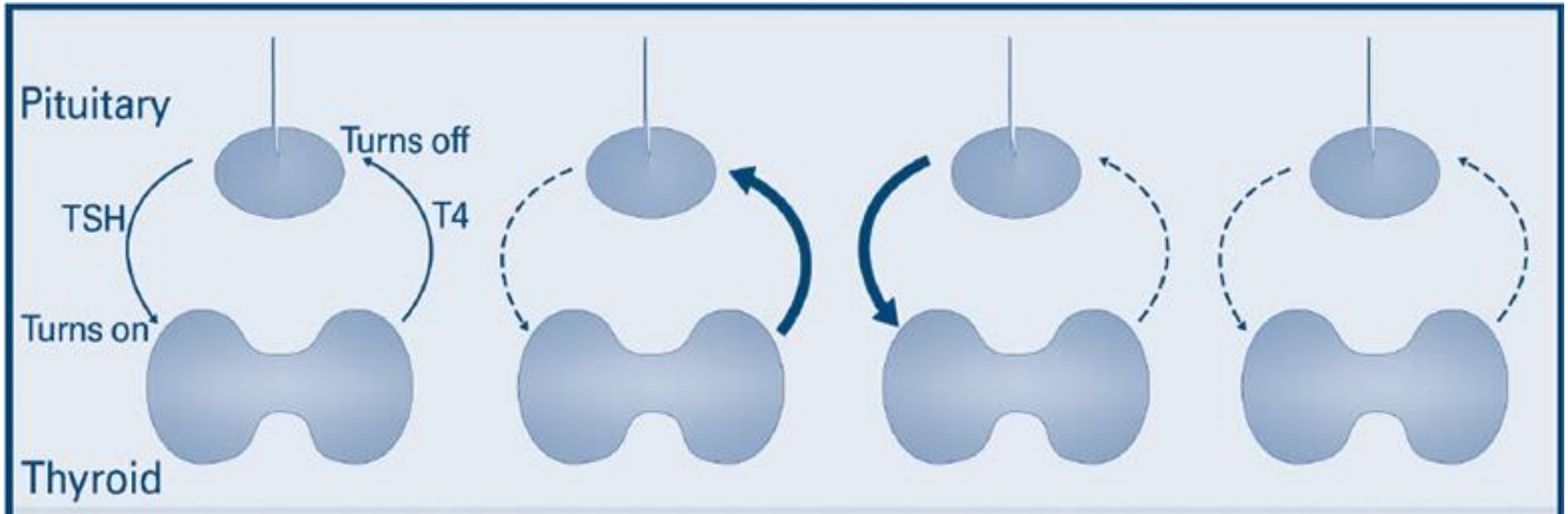
• Negative Feedback Regulation

Elevated **T_3 and T_4** levels inhibit **TRH and TSH** secretion by acting on both:

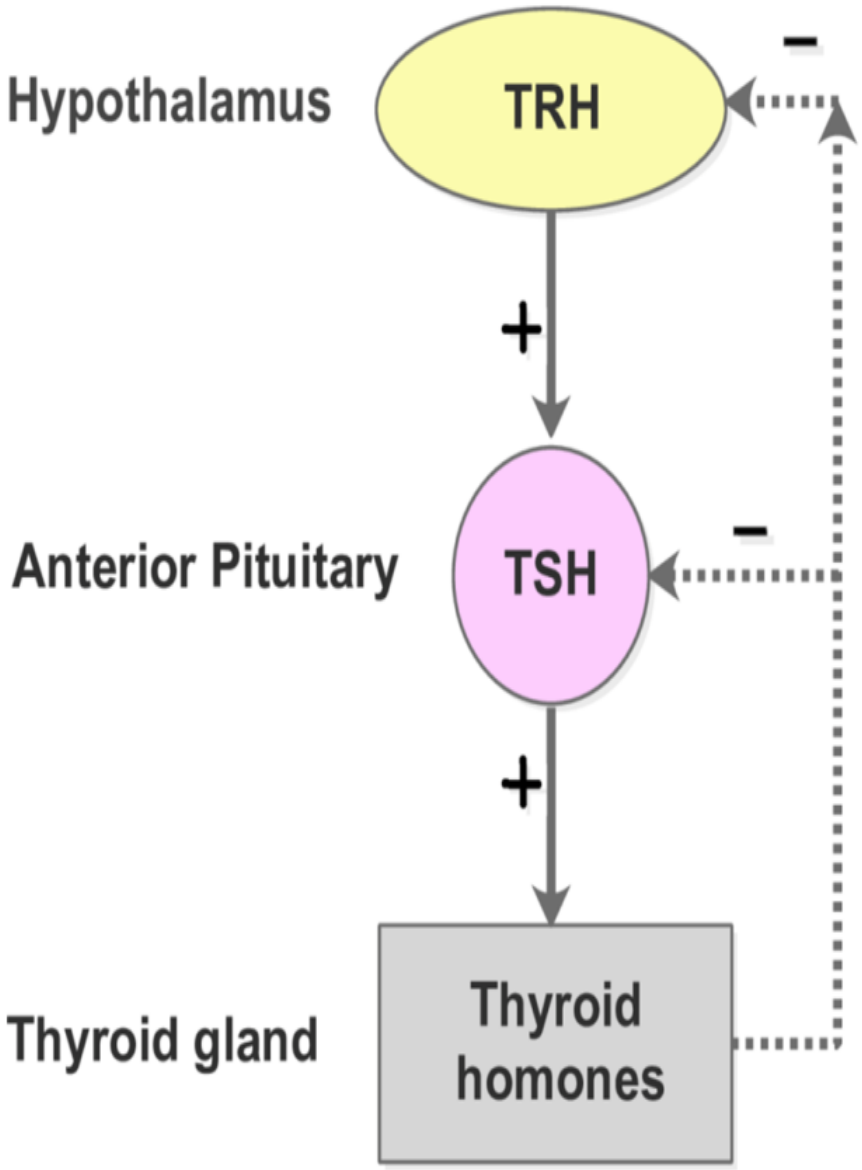
- The **hypothalamus**, reducing TRH production.
- The **pituitary**, reducing TSH secretion.

- This prevents excessive thyroid hormone production





CONDITION:	Normal	Hyperthyroidism	Hypothyroidism Primary	Hypothyroidism Secondary
TSH	Normal	Low	High	Low
T4	Normal	High	Low	Low



TSH	T3/T4	Interpretations
Low	High	Primary hyperthyroidism, most often due to Graves' disease
High	Low	Primary hypothyroidism, most often due to Hashimoto's thyroiditis
Low	Normal	Subclinical hyperthyroidism
High	Normal	Subclinical hypothyroidism
Normal to low	Low	Central hypothyroidism
Normal to high	High	May be caused when a person becomes resistant to hypothyroid treatment or has a TSH-producing pituitary adenoma

- **Regulation by External Factors**
- **Cold exposure** → Increases TRH and TSH to boost metabolism and heat production.
- **Stress (via cortisol)** → Inhibits TRH and TSH secretion, reducing thyroid function.
- **Nutritional status**:
  - **Iodine deficiency** → Decreases T_4/T_3, increasing TSH to stimulate more hormone production.
  - **Starvation/illness** → Decreases conversion of T_4 to T_3, conserving energy.

Inside the cell:

- **T_4 is converted to T_3**, which binds to **nuclear receptors**.
- This activates **T_3-responsive genes**, regulating metabolism.
- **High levels** → Increase **basal metabolic rate (BMR)**, stimulate **protein and lipid breakdown**.
- **Low levels** → Decrease **BMR**, cause **weight gain** and **poor physical/mental development** in children

Hyperthyroidism (Overactive Thyroid)

Causes:

- **Graves' Disease** – Autoimmune stimulation of the thyroid
- **Toxic Multinodular Goiter** – Overactive thyroid nodules
- **Thyroiditis** – Inflammation causing hormone release

Symptoms:

weight loss, heat intolerance , sweating , tachycardia (fast heart rate) Anxiety, insomnia , Exophthalmos (bulging eyes in Graves' disease)

Lab Findings:

- **Primary Hyperthyroidism → ↓ TSH, ↑ FT_4, ↑ FT_3**
- **Subclinical Hyperthyroidism →**
- **↓ TSH, Normal FT_4/FT_3**

Management:

- **Antithyroid drugs**
- **Surgery (thyroidectomy)** in severe cases

Hypothyroidism (Underactive Thyroid)

Causes:

- **Primary Hypothyroidism** – Due to thyroid gland dysfunction(e.g., **Hashimoto's thyroiditis**, iodine deficiency).
- **Secondary Hypothyroidism** – Due to pituitary or hypothalamic dysfunction
- **Symptoms:**
- Fatigue, weight gain, cold intolerance , Dry skin, Depression, Bradycardia (slow heart rate), constipation .

Lab Findings:

- **Primary Hypothyroidism → ↑ TSH, ↓ FT_4**
- **Subclinical Hypothyroidism → ↑ TSH, Normal FT_4**
- **Secondary Hypothyroidism → ↓ TSH, ↓ FT_4**

Management:

- **Levothyroxine (T_4) replacement therapy**
- Monitor TSH levels every 6–8 weeks

Principles of Thyroid Function Tests

.Markers of Thyroid Function:

- **TSH: Primary test to assess thyroid function.**
- **Free T4 (FT4): Reflects the unbound, active thyroid hormone.**
- **Free T3 (FT3): Useful in diagnosing hyperthyroidism.**
- **Thyroid antibodies: Detect autoimmune thyroid diseases (**e.g., anti-TPO, anti-thyroglobulin antibodies).

Methods of Thyroid Function Testing (TSH Measurement:)

- **Principle:** Immunoassay methods (e.g., enzymelinked immunosorbent assay [ELISA], chemiluminescent immunoassay [CLIA]) detect TSH levels in the blood.

• **Clinical Relevance:** Elevated TSH indicates hypothyroidism; low TSH suggests hyperthyroidism

Free T4 and Free T3 Tests:

- **Principle:** Detect unbound T4 and T3 using immunoassays or competitive binding techniques.
- **Clinical Relevance:** Abnormal levels help differentiate primary from secondary thyroid dysfunction.

Thyroid Antibody Testing: (Additional Tests for Specific Conditions)

- **Anti-TPO Antibodies:** Detect autoimmune thyroiditis (e.g., Hashimoto's thyroiditis).
- **Anti-Thyroglobulin Antibodies:** Useful in thyroid cancer monitoring or autoimmune conditions.
- **TSH Receptor Antibodies:** Identify Graves' disease.

Normal Reference Values for Thyroid Hormones

• Thyroid-Stimulating Hormone (TSH):

- **Normal Range: 0.4–4.0 mlU/L**
- **Interpretation:**
  - **Elevated TSH: Indicates hypothyroidism or subclinical hypothyroidism.**
  - **Decreased TSH: Suggests hyperthyroidism or secondary hypothyroidism.**

• Free T4 (FT4):

- **Normal Range: 0.8–2.2 ng/dL (10–28 pmol/L)**
- **Interpretation:**
  - Elevated FT4: Indicates hyperthyroidism.
  - Decreased FT4: Indicates hypothyroidism.

• Total T4:

- **Normal Range: 5.0–12.0 µg/dL (64–154 nmol/L)**
- **Interpretation:**
  - Used less frequently, as it is affected by binding proteins.

• Free T3 (FT3):

- **Normal Range: 2.3–4.1 pg/mL (3.5–6.5 pmol/L)**
- **Interpretation:**
  - Elevated FT3: Seen in hyperthyroidism or T3 toxicosis.
  - Decreased FT3: May indicate hypothyroidism.

• Total T3:

- **Normal Range: 80–200 ng/dL (1.23–3.08 nmol/L)**
- **Interpretation:**
  - Like total T4, it is influenced by binding proteins.

Clinical Significance

1. Hypothyroidism:

- Elevated TSH due to reduced thyroid hormone production.
- **Symptoms**: fatigue, weight gain, cold intolerance, and depression.

2. Hyperthyroidism:

- Low TSH due to excessive thyroid hormone production.
- **Symptoms:** weight loss, heat intolerance, palpitations, and anxiety.

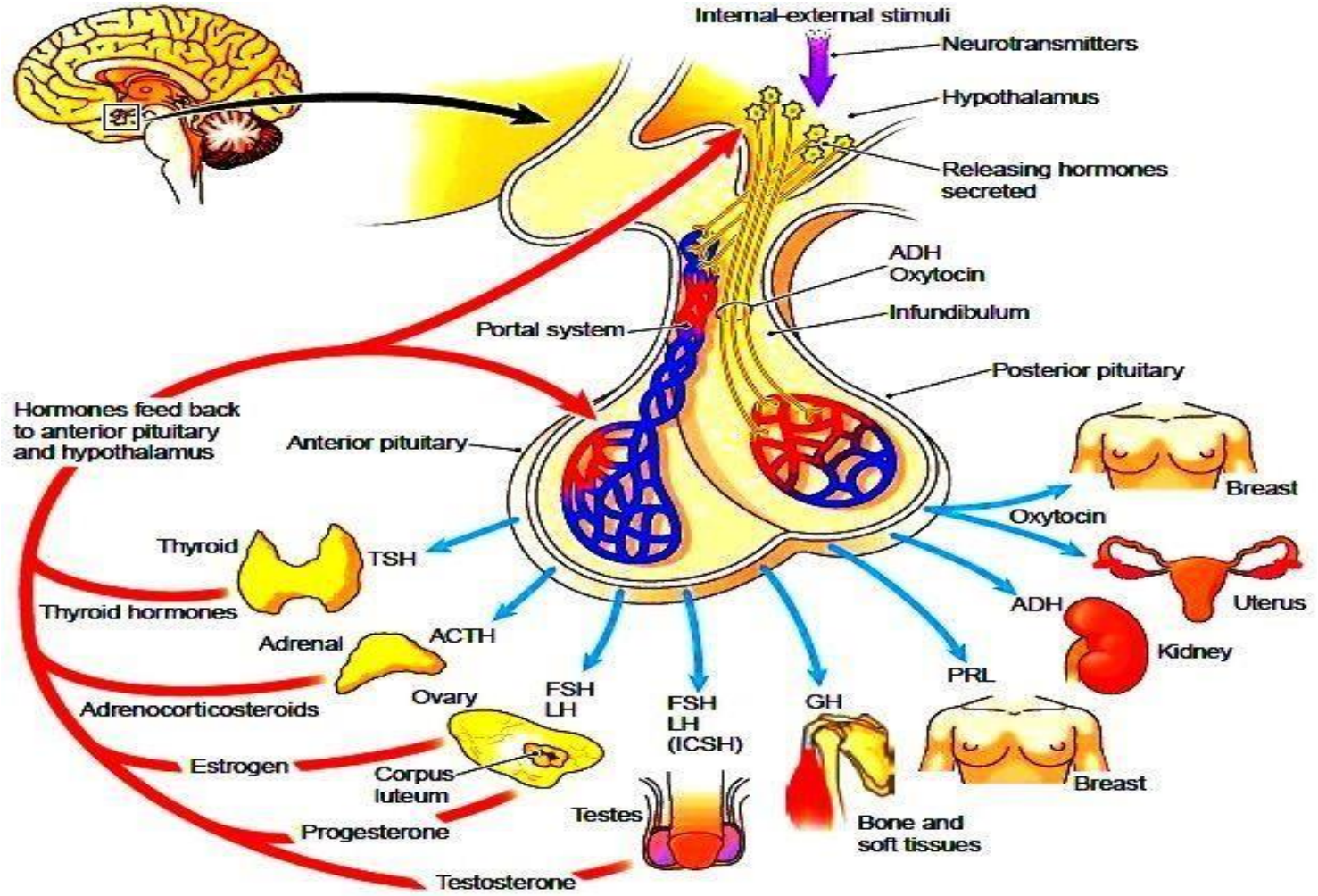
3. Pituitary Disorders:

- Secondary hypothyroidism: Low TSH with low thyroid hormones, often due to pituitary dysfunction.

• TSH-secreting adenomas (rare):
High TSH with high thyroid hormones.

reference ranges for thyroid function tests

TSH	0.5–5.5mIU/L
T4	60–135nmol/L
Free T4	9.4–25pmol/L
T3	1.1–2.8nmol/L
Free T3	3.0–8.6pmol/L


Internal-external stimuli
Neurotransmitters
Hypothalamus
Releasing hormones secreted
ADH
Oxytocin
Infundibulum
Portal system
Posterior pituitary
Hormones feed back to anterior pituitary and hypothalamus
Anterior pituitary
Breast
Oxytocin
Thyroid
TSH
Thyroid hormones
ADH
Uterus
Kidney
Adrenal
ACTH
PRL
Ovary
FSH
LH
FSH
LH
(ICSH)
GH
Adrenocorticosteroids
Estrogen
Corpus luteum
Breast
Testes
Progesterone
Bone and soft tissues
Testosterone


Thank
you