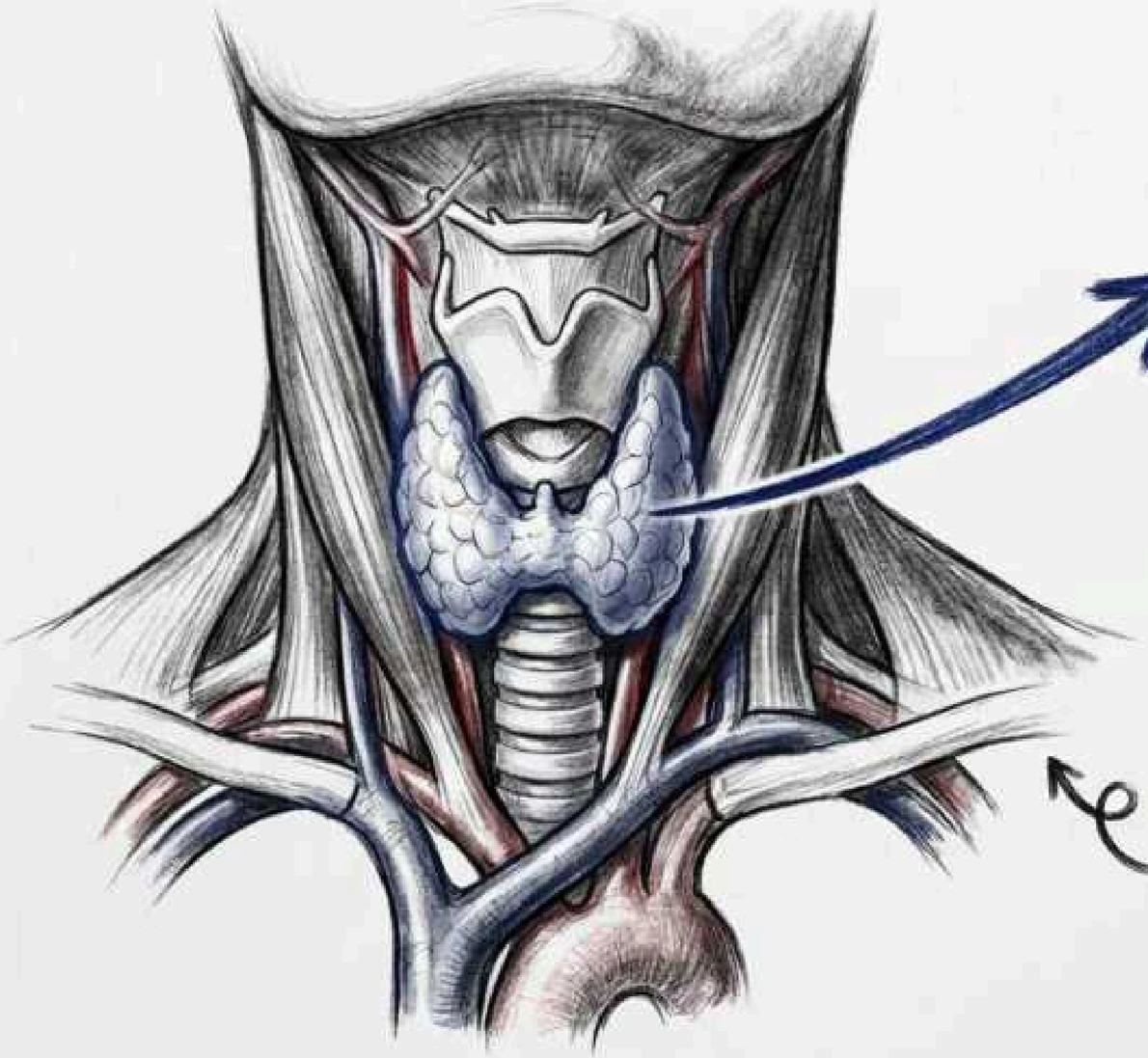
The metabolic engine at the front of the neck

¶ 2.1





Thyroxine
(Precursor)

Triiodothyronine
(Highly Active)

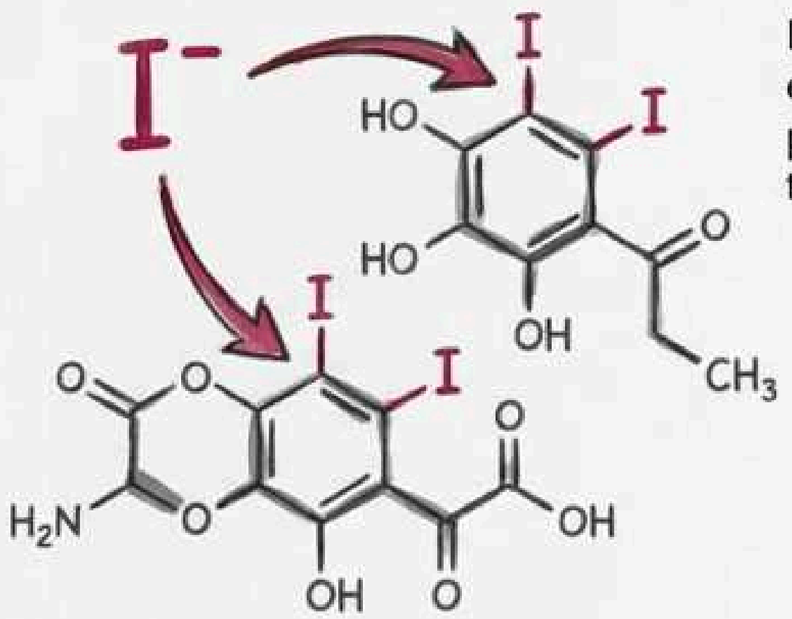
T4 is converted into active T3 in peripheral tissues

Sets the biological pace of metabolism across systemic cells:

- Energy levels
- Heart rate
- Core temperature
- Weight
- Mood

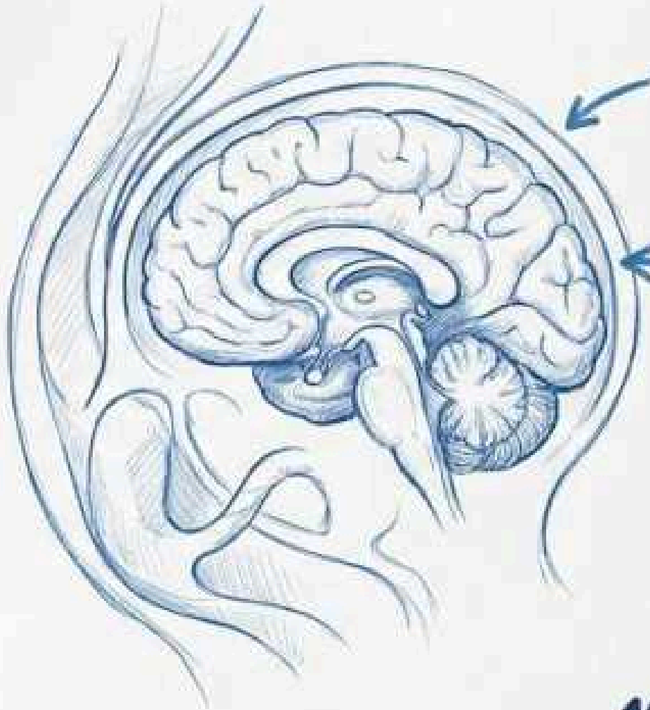
Iodine is the essential metabolic fuel for neurodevelopment

¶ 2.2



T3 & T4 Hormone Structures

Dietary iodine is biologically essential because it is a physical component of thyroid hormones.



Developing fetal and pediatric brains require thyroid hormone for structural development.

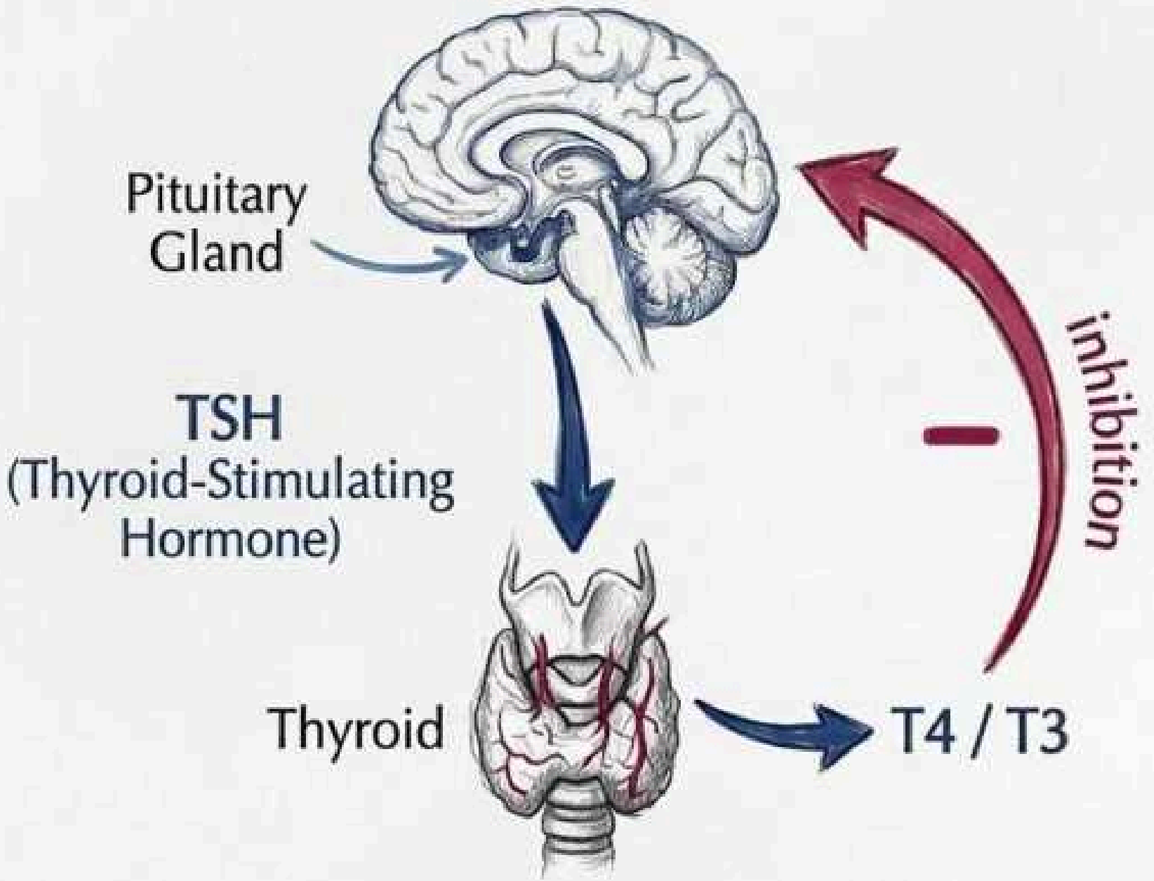
Iodine deficiency remains the world's leading preventable cause of brain damage in children.

1990s

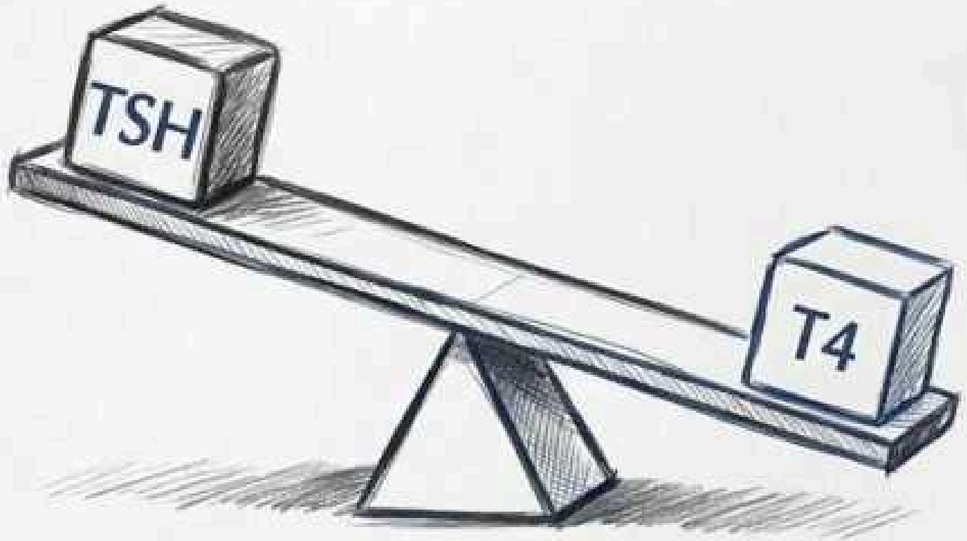
Adding iodine to salt becomes recommended globally—one of history's most effective public health interventions.

The pituitary-thyroid negative feedback loop dictates diagnostic testing

¶ 2.3



Thyroid function is commanded by TSH. Because of this feedback mechanism, TSH is the single most sensitive test.



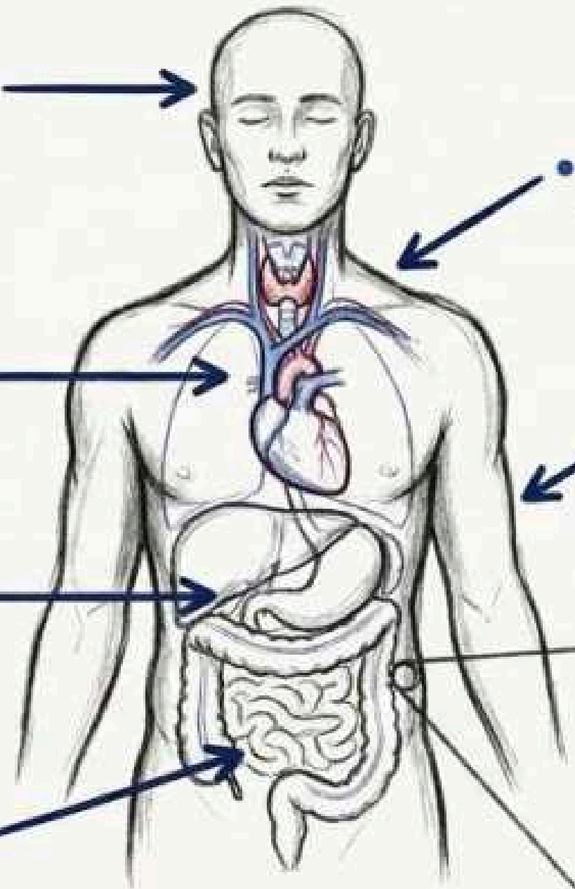
Diagnostic Logic:

- High TSH → Underactive thyroid (Pituitary is driving the engine harder)
- Low TSH → Overactive thyroid
- Free T4 levels are subsequently measured to confirm the clinical picture.

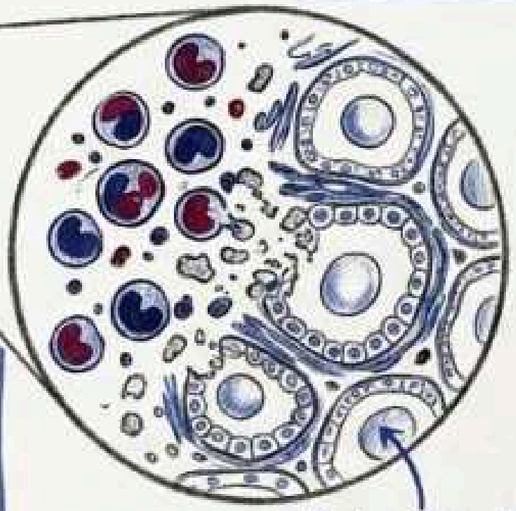
Hypothyroidism decelerates systemic metabolism

¶ 2.4

- Slowed thinking & Low mood
- Feeling persistently cold
- Tiredness
- Dry skin
- Weight gain
- Constipation



Hashimoto's Thyroiditis

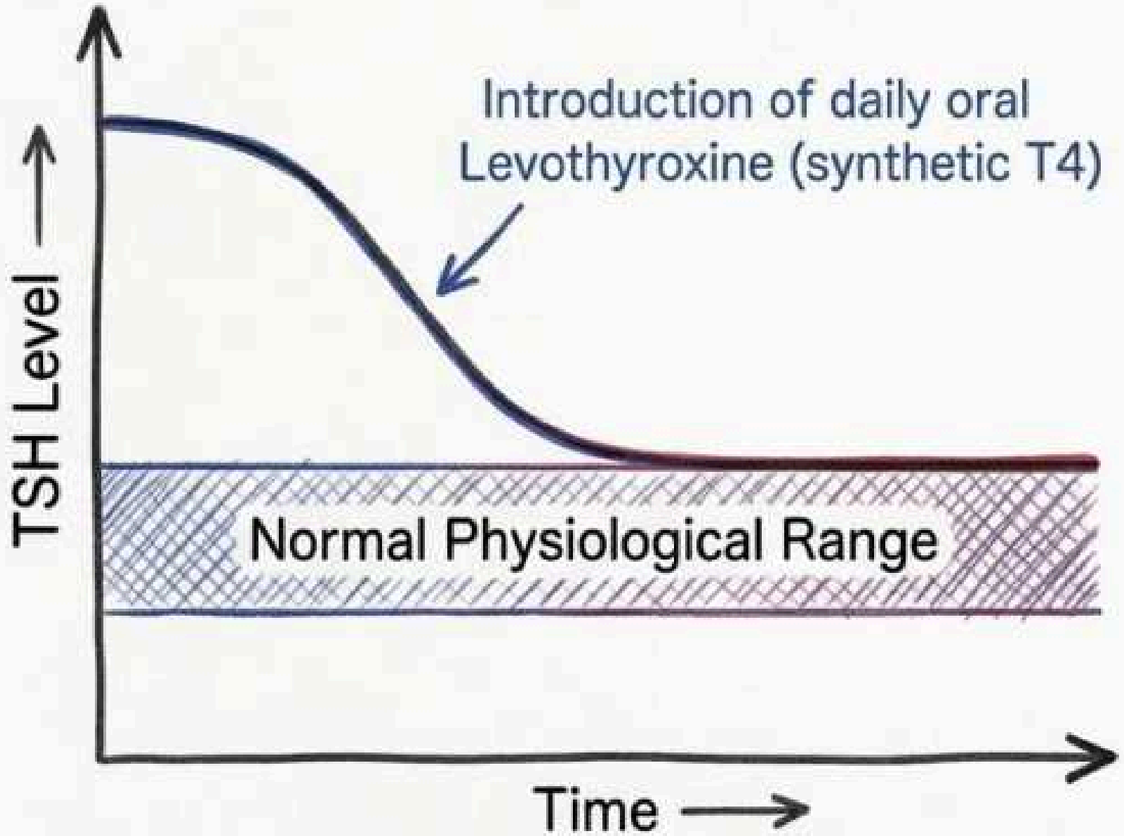


Primary Etiology in iodine-sufficient regions:
An autoimmune disease where the immune system gradually destroys the gland.

Diagnostic Challenge: Symptoms develop slowly and are highly common in the general population, making them easily missed.

Synthetic hormone replacement restores the baseline

¶ 2.5





Mechanism: The dose is precisely adjusted until TSH normalizes. Treatment is highly effective and usually lifelong.

Pediatric Protocol:

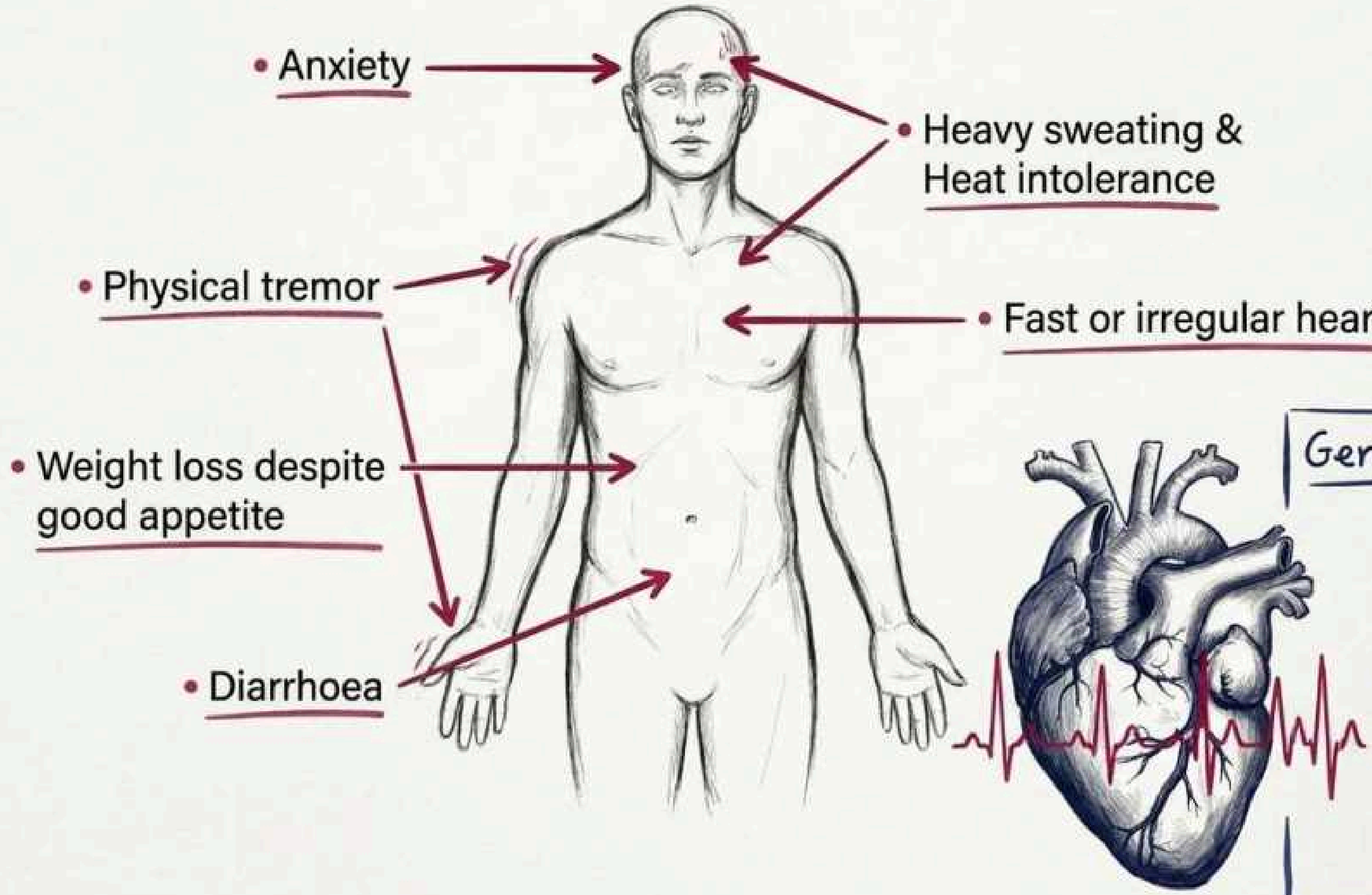
- Newborns undergo routine heel-prick screening for congenital hypothyroidism.
- If untreated: Causes severe brain damage.

- Clinical Reality: 100% preventable with early levothyroxine treatment.

Hyperthyroidism accelerates systemic metabolism

¶ 2.6

- Anxiety
- Heavy sweating & Heat intolerance
- Physical tremor
- Fast or irregular heartbeat
- Weight loss despite good appetite
- Diarrhoea



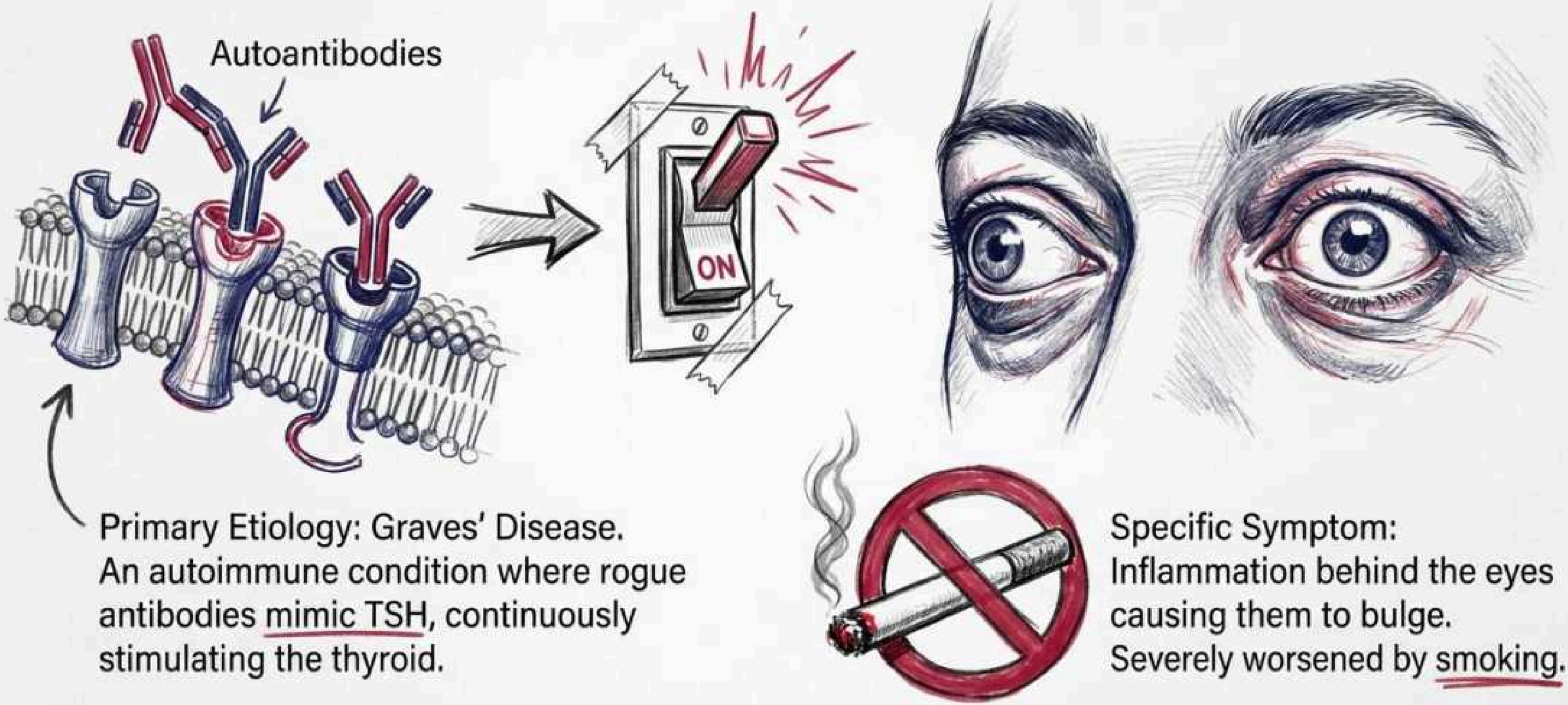
Geriatric Nuance:

In older patients, symptoms may present atypically:

- Mere weight loss and tiredness.
- Development of atrial fibrillation (as detailed in MED 521 B).

Graves' disease permanently overrides the TSH control switch

¶ 2.7



Primary Etiology: Graves' Disease.
An autoimmune condition where rogue antibodies mimic TSH, continuously stimulating the thyroid.

Specific Symptom:
Inflammation behind the eyes causing them to bulge.
Severely worsened by smoking.

Alternative causes of hyperthyroidism include overactive nodules or temporary thyroid inflammation.

Three primary interventions for an overactive thyroid



Symptom Management: Beta-blockers provide a temporary shield to quickly ease cardiac and tremor symptoms while primary treatments take effect.



1. Antithyroid Drugs

Pharmacologically block and reduce hormone production.



2. Radioactive Iodine

Taken orally; the isotope is aggressively absorbed, selectively destroying overactive tissue.



3. Surgery

Physical excision and removal of the gland.

Clinical Consequence: Destroy and Remove interventions frequently leave the patient permanently hypothyroid, requiring lifelong levothyroxine replacement.

Structural changes range from diffuse goitre to discrete nodules



Normal Gland → Goitre (Enlarged) → Nodular Disease

Primary global cause: Iodine deficiency.

Distinct lumps. Highly common with advancing age. Vast majority are benign.

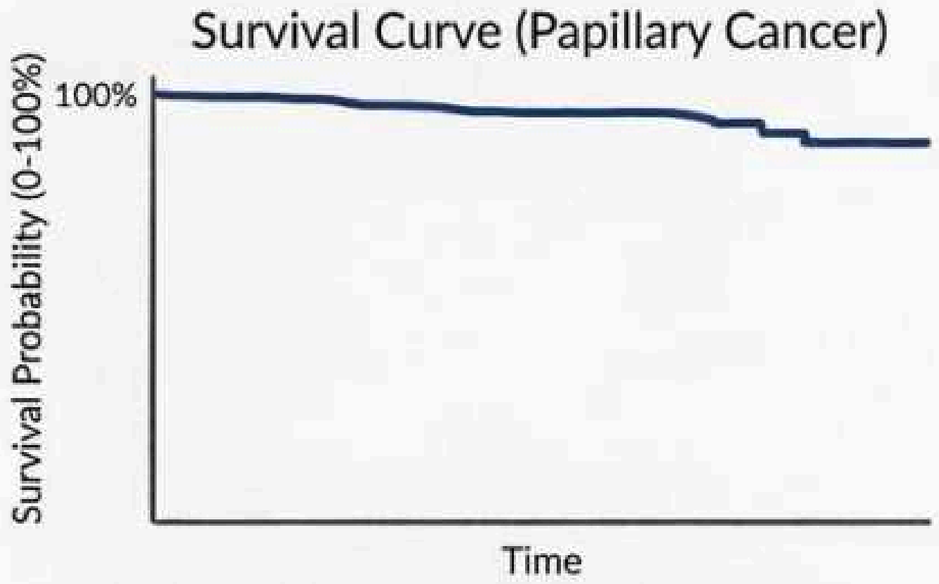
Diagnostic Pathway:

1. Incidental discovery on ultrasound is frequent.
2. Ultrasound characteristics are assessed.
3. Fine-needle aspiration (FNA) biopsy separates the rare true cancers from the many harmless nodules.



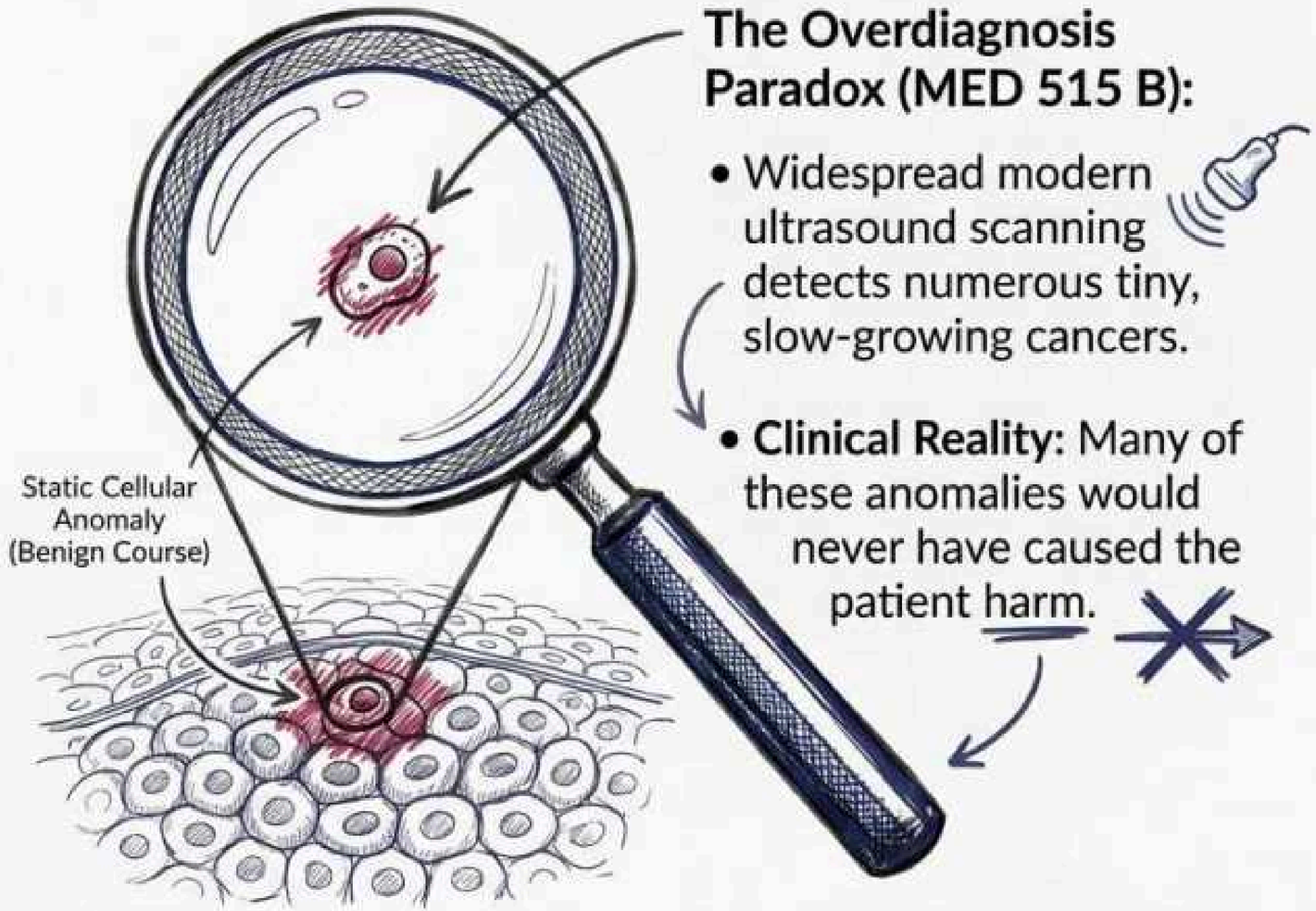
Thyroid cancer features high survival but risks overdiagnosis

¶ 2.10



Prognosis & Treatment:

- Excellent overall clinical outlook.
- Papillary cancer (most common) is frequently cured through surgery.
- Sometimes supplemented by radioactive iodine.



The Overdiagnosis Paradox (MED 515 B):

- Widespread modern ultrasound scanning detects numerous tiny, slow-growing cancers.
- **Clinical Reality:** Many of these anomalies would never have caused the patient harm.

Synthesis: Metabolism, feedback controls, and autoimmune pathology

The Engine	The Control Panel	System Failure
The thyroid acts as the ultimate pacesetter for cellular metabolism.	TSH remains the definitive, key diagnostic test due to the rigid negative feedback loop.	Autoimmune disease is the foundational mechanism underlying most cases of both failure (Hashimoto's) and overactivity (Graves').

Next Module: The adrenal glands and the hormonal mechanics of stress.

