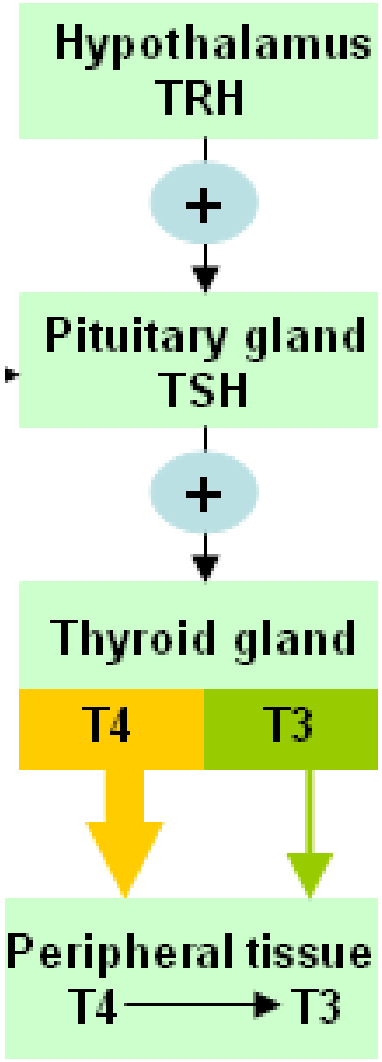
Endocrine System

Thyroid Regulation

Thyroid Regulation

- Stimulus:
  - Decrease in metabolic rate
  - Detected by hypothalamus
- Effect:
  - Hypothalamus release TRH
  - Anterior pituitary release TSH
  - Thyroid gland release thyroid hormones (T3/T4)
  - T3/T4 act on nearly every cell in the body (see next slide)
- Result:
  - Increase in metabolic rate



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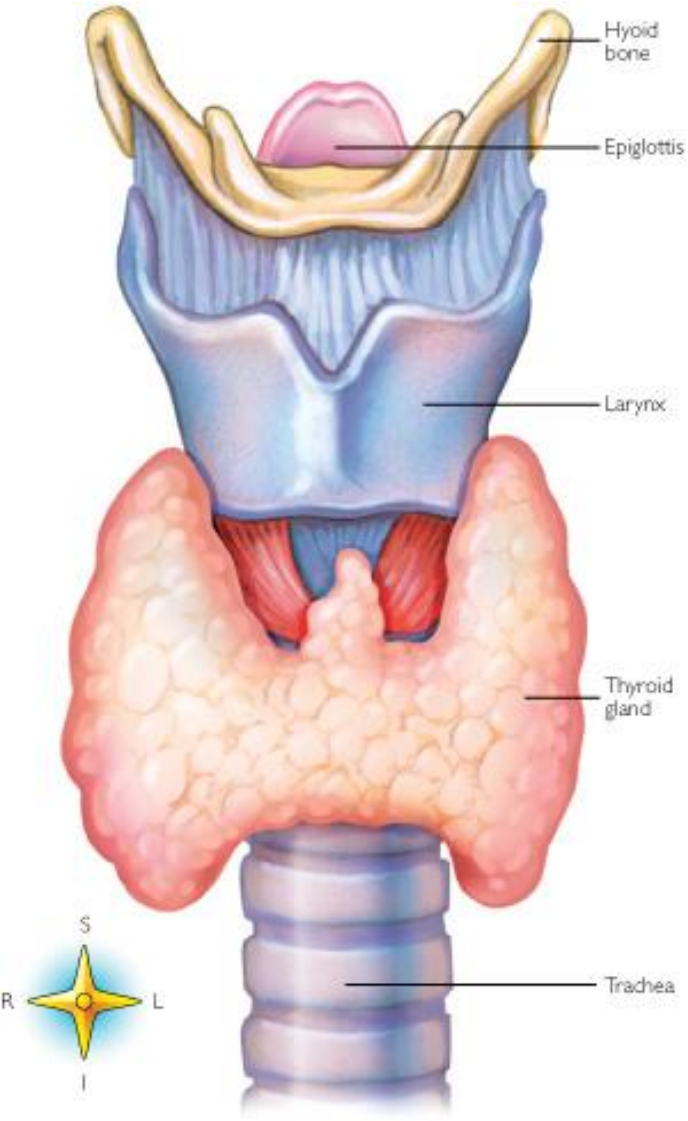
Thyroid Hormones (T3/T4) Function

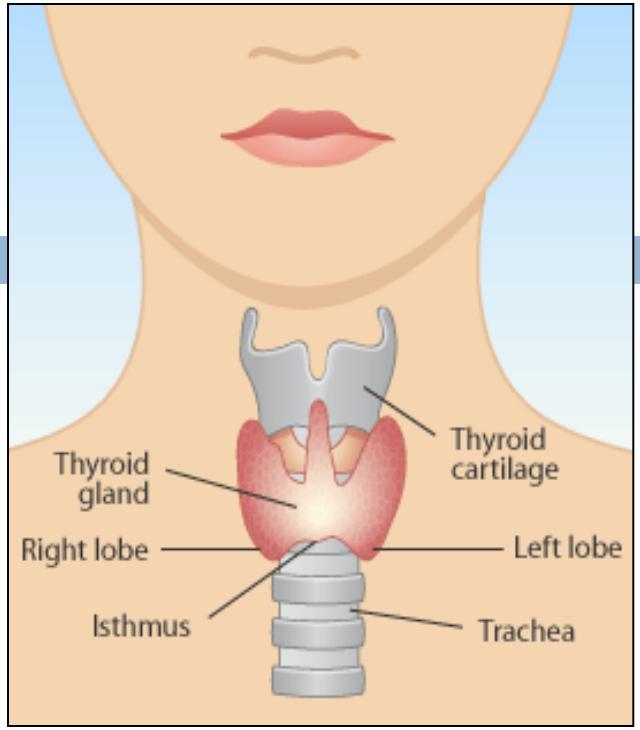
- Regulates metabolism
  - Increase glucose metabolism
  - Increase protein synthesis
  - Increase oxygen consumption (blood pressure, heart rate)
- Regulates growth and tissue differentiation
  - Digestion
  - Reproduction
  - Bone growth
  - Muscle tone
  - Development of nerve cells

Thyroid Regulation: Neuroendocrine pathway

Location	Hormone
Hypothalamus	TSH Releasing Hormone / Thyrotropin releasing hormone (TRH)
Anterior Pituitary	Thyroid Stimulating Hormone (TSH)
Thyroid gland	Thyroid hormones T_3 & T_4

Thyroid Gland





- Location:
  - base of neck
  - ventral surface of trachea
  - Below & anterior to larynx
- One of the largest endocrine glands in the body
- Functional Unit: Follicle

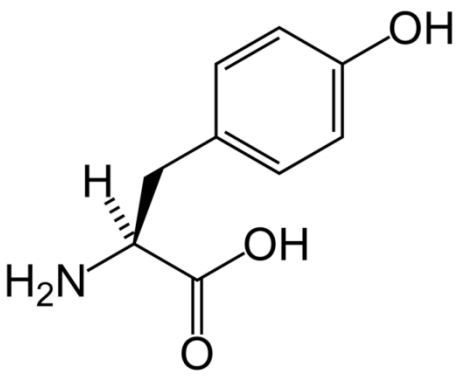
Thyroid Gland Structure

- Two lobes
- 4 cm long
- 1-2 cm wide
- connected by a narrow neck (isthmus)

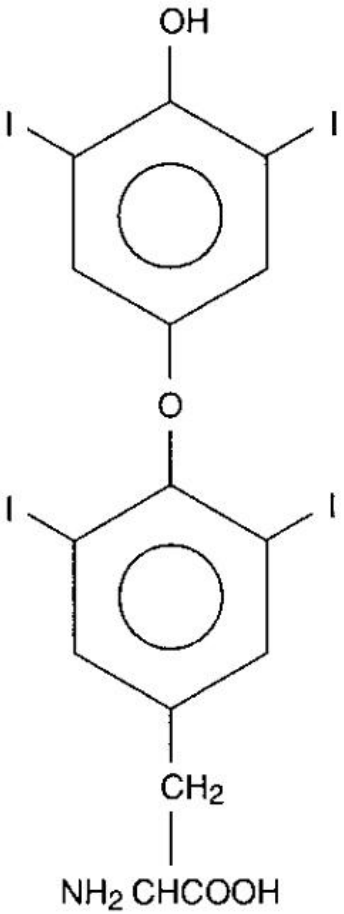
https://act.downstate.edu/courseware/haonline/imgs/00000/4000/200/4284.jpg

Thyroid Hormones: T3 and T4

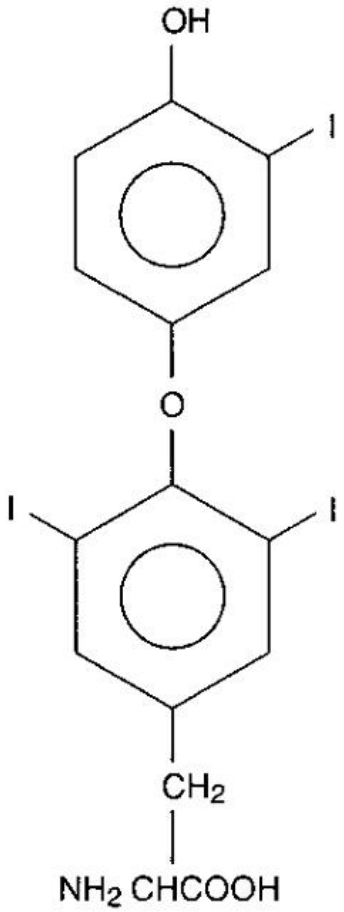
- Peptide hormone:
  - Derived from the amino acid tyrosine
  - Hydrophobic and will diffuse into cells
- Requires iodination



T4
Thyroxine
Tetraiodothyronine



T3
Triiodothyronine



Comparing T3 and T4

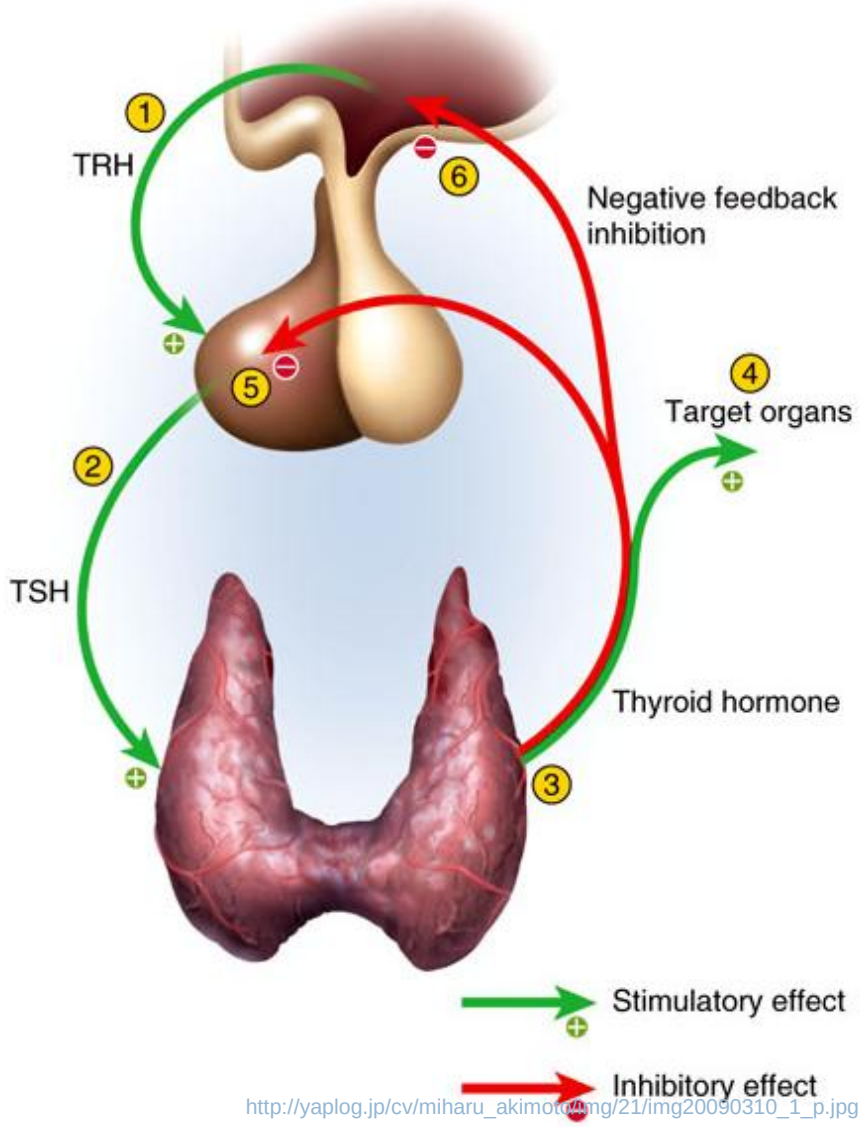
	T3 (Triiodothyronine)	T4 (Thyroxine)
# of Iodine atoms	3	4
% in blood	0.3%	0.03%
% produced by thyroid glands	~ 20%	~ 80%
Potency	4X more than T4 (receptor has greater affinity for T3)	Not very
Half Life Span	Shorter (1-2.5 d)	Longer (5-7 d)
Main Purpose	Regulate basal metabolic processes	Conversion to T3 (occurs in liver)

Questions

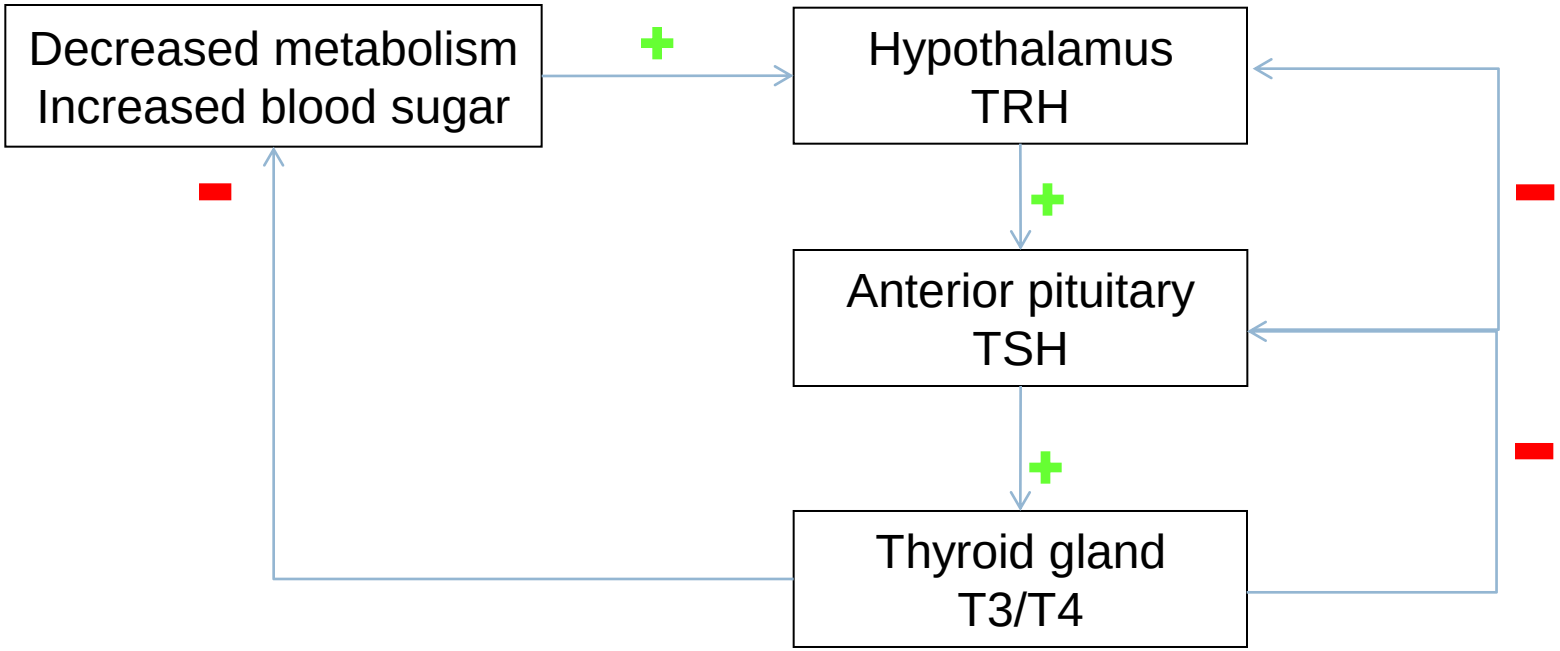
- Why is more T_4 made than T_3?
- Why have T_4 at all when T_3 is so much more effective?

Thyroid Regulation: Feedback

- High levels of T3/T4 in blood turn off production of TRH and TSH



Thyroid Regulation



Thyroid Regulation: Feedback

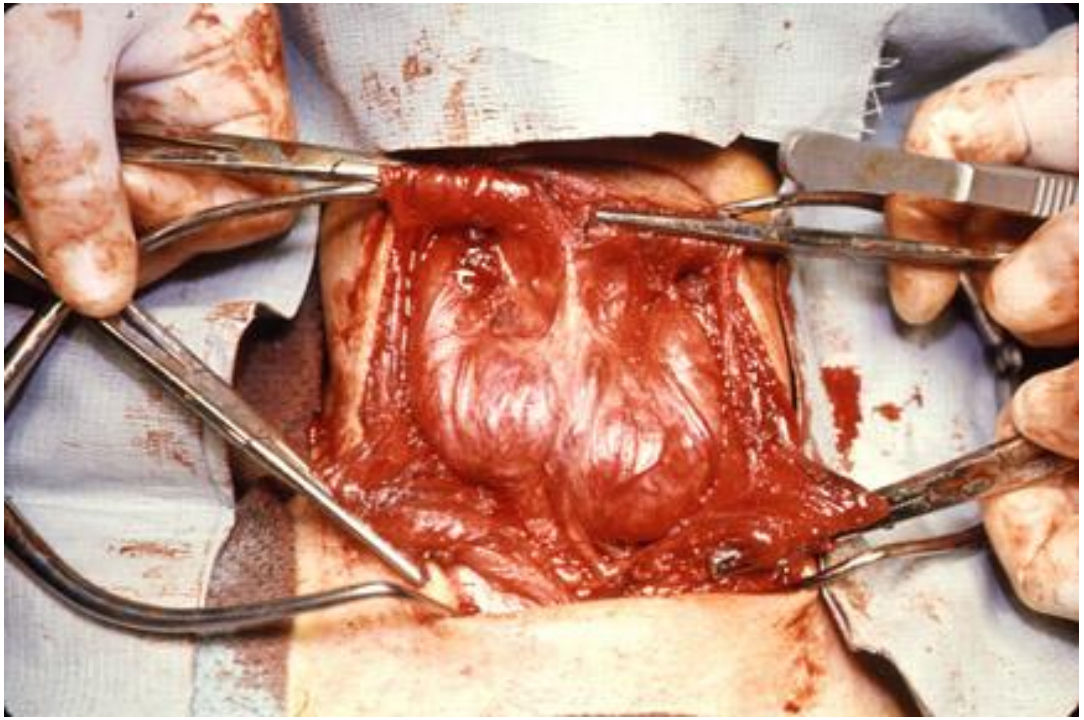
Stimulus	Low T_3/T_4	High T_3/T_4
Effect on TRH	Stimulated	Inhibited
Effect on TSH	Increase	Inhibited
Effect on T_3/T_4	Increase	Decrease

Thyroid Disorders

- Hyperthyroidism
  - Iodine deficiency
  - Plummer's disease
  - Grave's disease
- Hypothyroidism
  - Hashimoto's thyroiditis

Hyperthyroidism

- Over active thyroid gland
- Does not necessarily imply that thyroid hormones (T_3 or T_4) are elevated



http://www.meddean.luc.edu/lumen/meded/mech/cases/case15/endo05.jpg

Hyperthyroidism

- Possible physical effect: **goiter**
- An enlarged thyroid gland

Hyperthyroidism

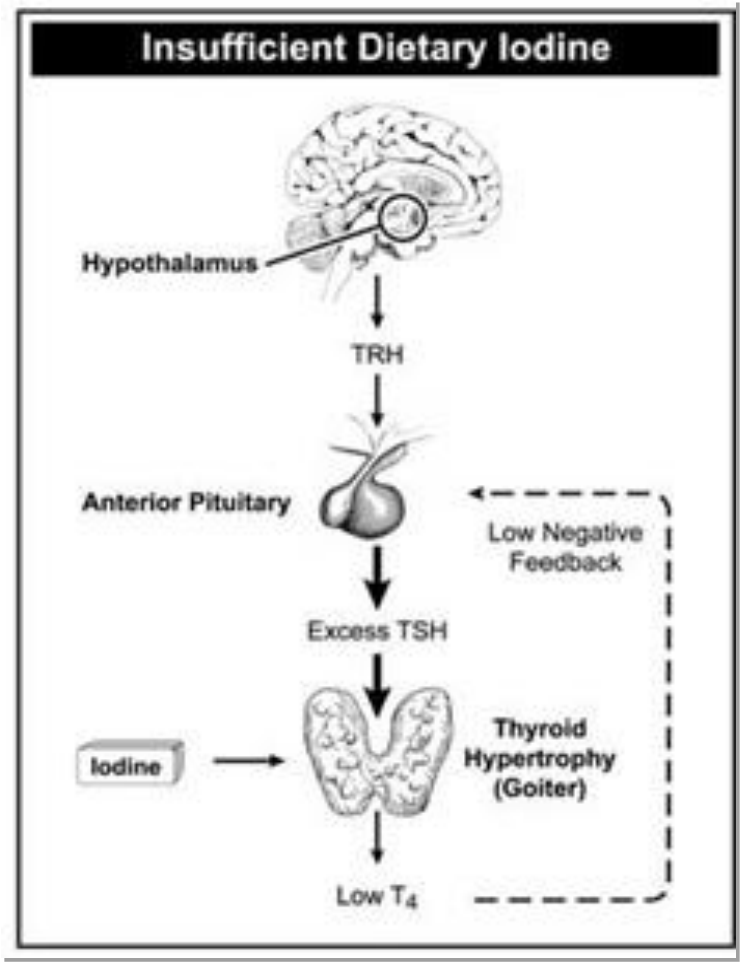
- If over active thyroid results in increased thyroid hormones (T_3/T_4), then the effect is high glucose metabolism
- Symptoms:
  - weight loss with increased appetite
  - anxiety
  - increased heat release

Hyperthyroidism: Causes

- Iodine deficiency
- Nodules (Plummer's disease)
- Autoimmunity (Grave's disease)
- Inflammation of the thyroid (thyroiditis)
- Pituitary tumors
- Too much thyroid hormone medication

Cause: Iodine deficiency

- Low iodine levels means low levels of T3/T4
- Body tries to compensate by working the thyroid gland more to make more T3/T4
- Results in an overworked and enlarged thyroid gland



Cause: Nodules (Plummer's Disease)

- Nodule: small lumps
- Toxic multinodular goiter (many nodules) results in increased T3/T4
- Cause of nodules is unknown

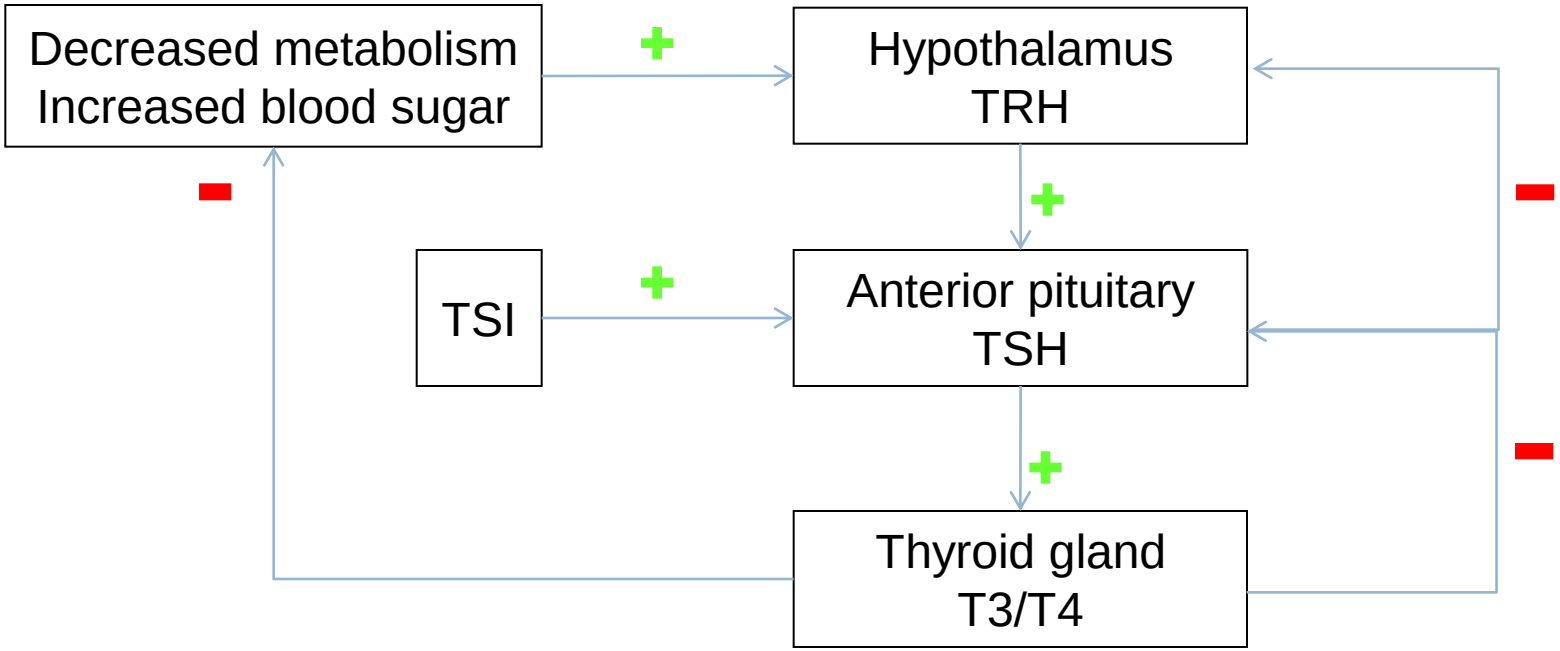
https://upload.wikimedia.org/wikipedia/commons/4/45/Human_thyroid_cancer.jpg

http://www.phoenity.com/diseases/goiter.html

Cause: Autoimmunity (Grave's Disease)

- Thyroid stimulating immunoglobulin (TSI)
  - An antibody that targets TSH receptors
  - Stimulate TSH secretion (from anterior pituitary)
  - TSI not subject to negative feedback
- 8x more common in women
- between ages 20 – 40

Cause: Autoimmunity (Grave's Disease)



Grave's Disease Symptoms

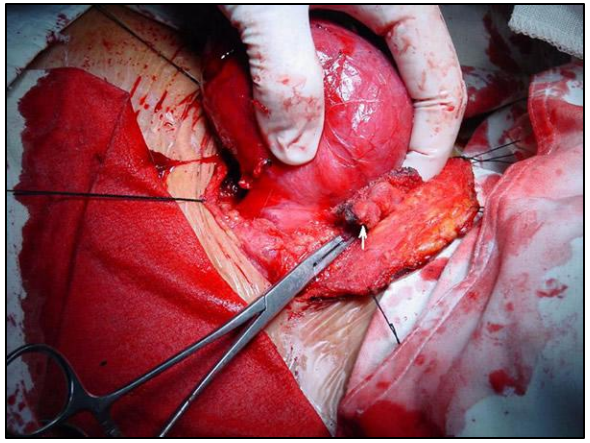
- protruding eyes
- eye irritation and double vision

Hyperthyroidism Treatment: Radioactive Iodine Therapy

- Given when drug therapy fails
- Radioactive iodine-131
- Damages thyroid cells over time
- Thyroid gland shrinks returning thyroid hormone to normal level

Hyperthyroidism Treatment: Surgery

- Thyroidectomy: removal of all or some parts of the thyroid gland
- Post-surgery, thyroid replacement drugs may be necessary, depending on how much of the thyroid gland is left.



Hypothyroidism

- Underactive thyroid gland
- Effect:
  - low thyroxine release
  - low glucose metabolism
- Symptoms:
  - weight gain
  - fatigue
  - decreased heat release
- 4x more common in women than men
- usually between ages 35 – 60

Hypothyroidism

Hypothyroidism: Causes

- Iodine deficiency
- Thyroid gland dysfunction: producing too little thyroid hormones
- After radiation therapy with radioactive iodine
- After a thyroidectomy
- Autoimmunity (Hashimoto's thyroiditis)

Cause: Autoimmunity (Hashimoto's Thyroiditis)

- Immune system attacks thyroid gland
  - Inflammation of the thyroid gland
- 20x more common in women
- between the ages 30 – 50
- Treatment: thyroid hormone supplements

Comparing Symptoms

	Hyperthyroidism	Hypothyroidism
Weight	Loss but good appetite	Gain
Body Function	Increased bowel movement Light/absent menstrual periods	Constipation Heavy menstrual periods
Temperature	Warm/moist skin, Feel hot	Feel cold
Neurological	Fatigue, Insomnia Irritability, Nervousness	Fatigue Slowed thinking
Others	Bulging eyes, goiter	Dry skin