Thyroid: largest pure endocrine gland, lateral lobes with isthmus, high blood flow (p 627)

Two hormones: **thyroid hormone**, **calcitonin**

**THYROID HORMONE ACTIONS:** thyroxine (T₄), tissues convert to T₃, more active

Affects every cell in body except for brain, spleen, testes, uterus and thyroid

Stimulates enzymes involved in glucose oxidation = increase **Basal Metabolic Rate (BMR)**

- Increases O₂ consumption, heat production (calorigenic effect)
- Increases adrenergic receptors in blood vessels

Regulates tissue growth & development, esp skeletal, nervous and reproductive

**SYNTHESIS:** Follicles lined by cuboidal epithelium, make **glycoprotein thyroglobulin, I-rich**

1. Thyroglobulin is synthesized on rough ER, Golgi packs, dump in to lumen, stored as colloid
2. Iodide concentrated from blood, oxidized to iodine, directed into lumen, attaches to tyrosine in thyroglobulin, making DIT or MIT (diiodotyrosine etc)
3. Follicle cells reclaim thyroglobulin by endocytosis, cleave it with lysozymes
4. Thyroxine which results diffuses into blood stream

TSH triggers secretion of thyroxine. Colloid is then restocked

90% of thyroid hormone secreted is T₄. T₃ is **10x more active than T₄**.

Tissues convert T₄ to T₃.

cAMP is second messenger, but T₃ can enter, bind to mitochondria and nucleus (increase transcription)

**Stimulus for TSH release:** increased energy requirements, pregnancy, cold weather.

(steroid hormones inhibit TSH release.)

**HYPOTHYROID:**

- **myxedema:** low BMR, slow speech, cold intolerance, constipation, thick dry skin, puffy eyes, edema, lethargy, mental sluggish. (goiter = hypertrophy, unusable colloid due to inadequate iodine)
- **cretinism:** short disproportionate body, thick neck and tongue, mentally retarded

**HYPERTHYROID:**

- **Grave's Disease:** MM: 1075- exophthalmos, tachycardia, sweating, wt. loss, nervousness, insomnia

**REGULATION OF CALCIUM BLOOD LEVELS:** (p 630)

Ca²⁺ functions extremely important:

1) Bone formation
2) Coagulation of blood
3) Maintain cell permeability
4) Neuromuscular irritability (lack causes tetany)

Two hormones regulate blood calcium

(homeostasis of calcium on p 631):

**CALCITONIN:**

(32 AA) synth in **parafollicular cells**, released due to high Ca²⁺ in blood.

1) Inhibits bone resorption (inhibits osteoclasts)
2) Stimulates cellular uptake of Ca²⁺, incorporation into bone.

**PARATHYROID:** (discovery: thyroidectomy led to tetany)

**parathormone:** most important blood Ca²⁺ regulator.

Low blood Ca²⁺ triggers its release. Inhibited by hypercalcemia. (xs parathormone = kidney stones)

Effects:
1) Activates osteoclasts
2) Enhance resorption of Ca²⁺ in kidneys
3) Increase absorption of Ca²⁺ in intestines (activates calcitriol)
Also known as suprarenal glands, about level of 12th rib, upon kidneys, retroperitoneal.

**Medulla** derived from neural crest cells, cortex from mesodermal cells

**Cortex** (p 633) Produces more than 2 dozen corticosteroids, stress response hormones made from cholesterol (or acetate if low on cholesterol) lipid rich organ = yellow alter transcription in nucleus which affects enzyme levels, which alters metabolism

Three layers of cortex:
- **Zona glomerulosa** mineral corticoids
- **Zona fasciculata** glucocorticoids
- **Zona reticulata** androgens

**Mineral Corticoids**: regulates electrolyte balance: (p 633, 991)

- **Aldosterone** most imprt (95% of total), reg Na⁺ bal, conserve Na⁺, excrete K⁺
- Mech: stim Na⁺ resorption in kidney distal convoluted tubules, therefore water is retained, ADH potentiates the effect, stimulates salt taste buds, increasing consumption of salt, release is stimulated by high K⁺, low Na⁺, low blood vol, hypotension

**Regulation, Effects of Aldosterone**: (p. 991)

- Renin-angiotensin system:
  - renin (juxtaglomerular complex) in kidney released due to hypotension, low Na⁺
  - angiotensinogen synthesized by liver: renin cleaves, becomes angiotensin
  - angiotensin I converted to angiotensin II in lung capillaries (angiotensin converting enzyme. Note ACE inhibitors)
  - angiotensin II 1) stimulates adrenal cortex to release aldosterone 2) increases secretion of ADH by Posterior Pituitary 3) Increases thirst 4) stim. cardiac output, constricts arterioles: elevates BP.
  - aldosterone activates Na⁺/K⁺ pump, stim. Na⁺ retention in the kidney
  - excess aldosterone causes hypokalemia, cardiac arrhythmia, weak contractions

**Glucocorticoids** response to stress, raises blood glucose by:
1. decrease cellular uptake of blood glucose
2. decrease amino acid incorporation into muscle
3. gluconeogenesis (break down protein to AA, deaminate, fabricate glucose)
4. mobilization of fatty acids from hips and thighs to abdomen and jowls (camel hump)
5. Inhibit inflammation, immune response

**Androgens** Alias “anabolic steroids” and comprise only 7% of corticosteroids secreted.

- Some are converted to estrogens in the blood stream (normal amounts do not affect sex characteristics).
- Stimulates libido in females. Excess ACTH, high BP, xs blood salt, edema, loss of sexual function

**Cortisone (prednisone) side-effects**: (NOTE THAT THESE ARE A SUMMARY OF ALL THE ABOVE)

- blood glucose (steroid diabetes)
- wound healing, peptic ulcers
- susceptibility to infections
- muscle wasting, osteoporosis
- negative nitrogen balance
- redistribution of fat
- ↓ ACTH, atrophy of adrenal cortex
- hirsutism
- retention of water, Na⁺
- hypertension, congestive heart failure
- ↑ intraocular pressure glaucoma
- convulsions (fr hypokalemia)
- suppress growth in children

**Cortisone**: (artificial glucocorticoid)