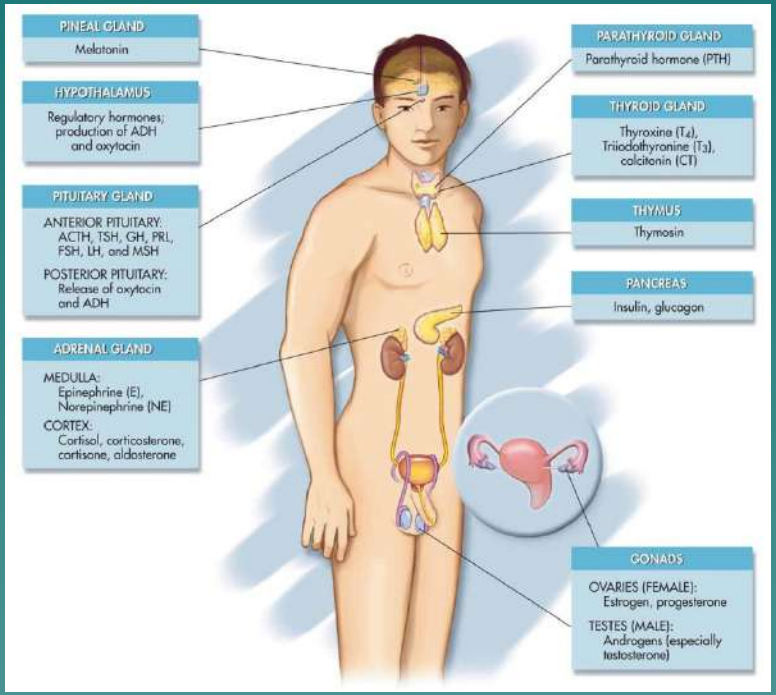
Chapter 10
The Endocrine System
The Body's Other Control System



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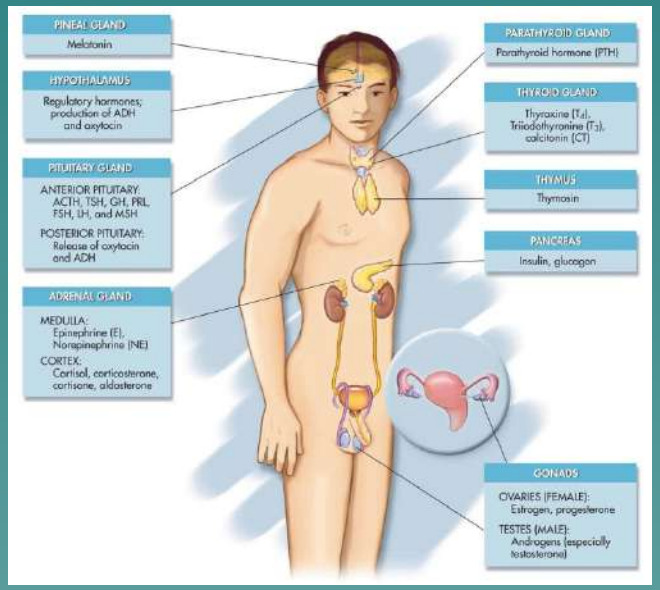
Introduction

- The nervous & endocrine system are totally interconnected & always monitor each other's activities.
- Endocrine system also collects information and sends orders but it is slower, more subtle control system; while it acts slowly, effects last longer than those of nervous system.

Organization of Endocrine System

- A series of organs & glands in body that secrete chemical messengers *into* blood stream.
- Exocrine glands, like sweat glands, secrete out of body, but are not part of endocrine system that secrete into body.



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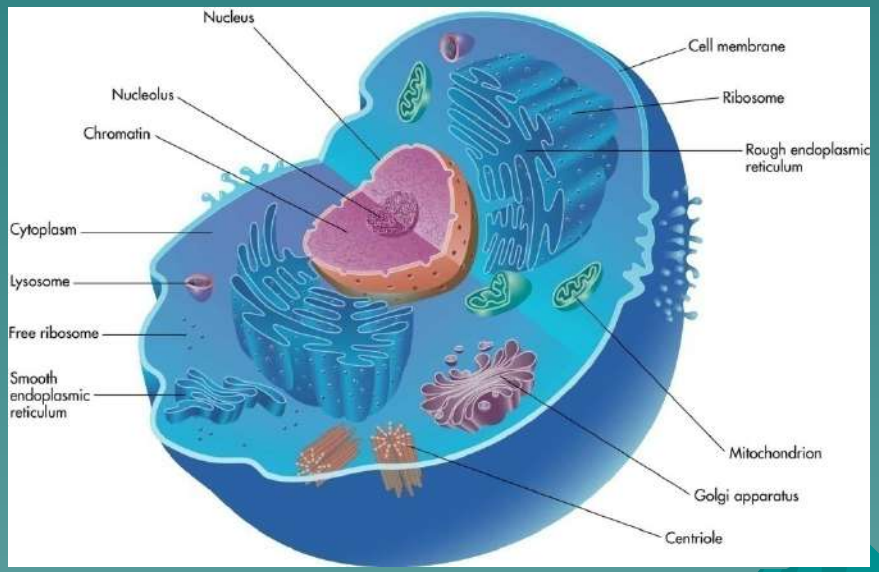
Hormones

- Chemical messengers released by endocrine glands.
- Released into blood stream & travel all over body
- Some affecting millions of cells simultaneously.
- Effects last for minutes, hours or days
- Some, like **Insulin**, are secreted all the time, with amount secreted changing PRN.

Hormones con't

- Function by binding to receptors sites on or inside of target cells.
- Can have several different effects, either changing cellular permeability or sending target cell a message that changes enzyme activity inside cell.



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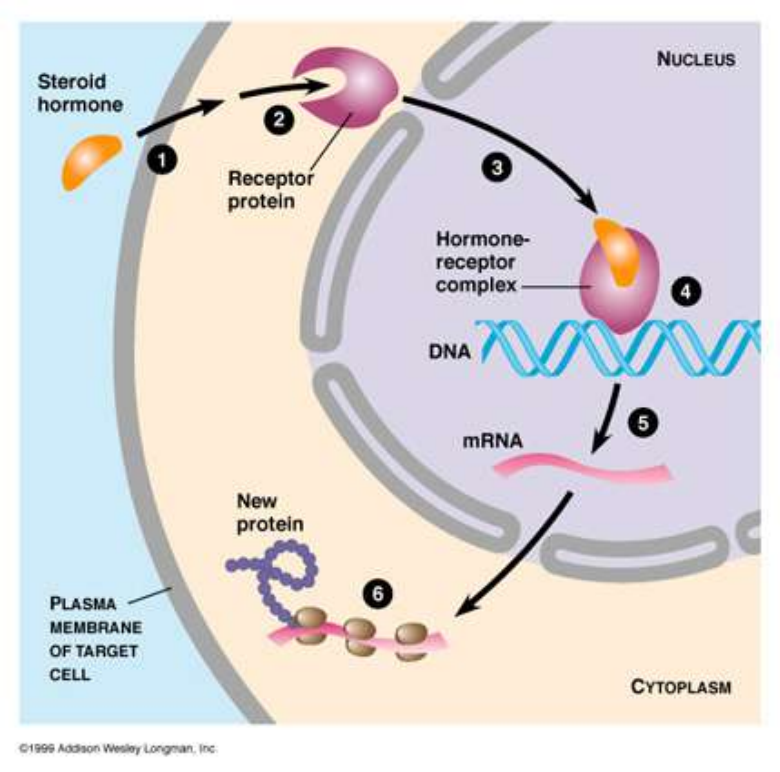
Control of Endocrine Activity

- Amount of hormone secreted changes based on situational demands.
- Many endocrine organs secrete hormones continuously.
- Many chemical & physical characteristics of body have standard level, or *set-point*, that is ideal level for that particular value.
- Examples: BP, Pao2, HR, & blood sugar.

Steroids

- Bind to sites inside cells
- Lipid molecules that can pass easily through target cell membrane, allowing them to interact directly with cell's DNA to change cell activity.
- Must be carefully regulated because only small amounts are needed.



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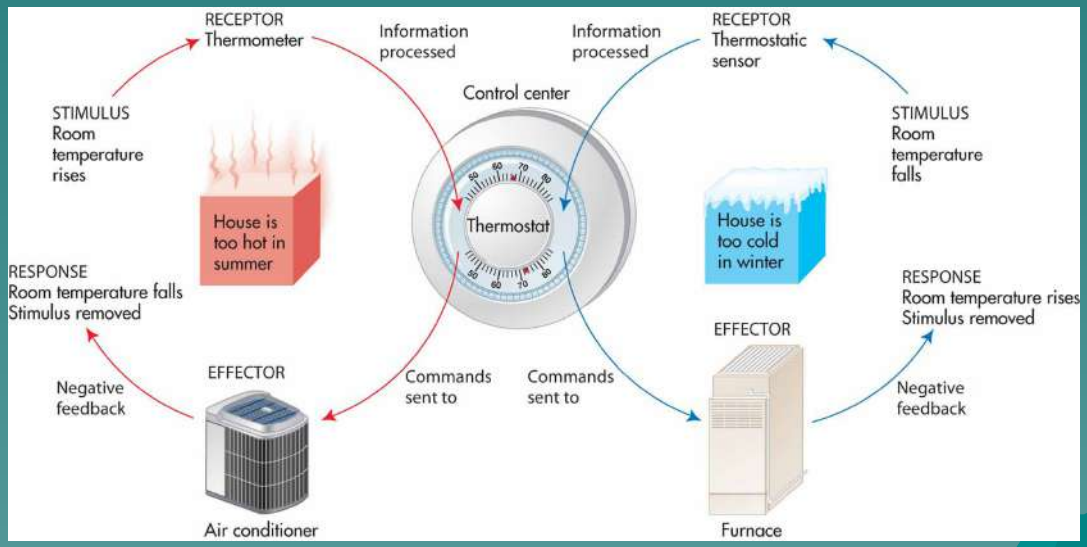
Negative Feed Back

- Endocrine & Nervous system work together to keep levels at or near homeostasis.
- Example: hypothalamus stores ideal set-point for temperature.
- If hormone levels rise, negative feedback will turn off endocrine organ that is secreting hormone.



Is this Positive or Negative Feed Back?

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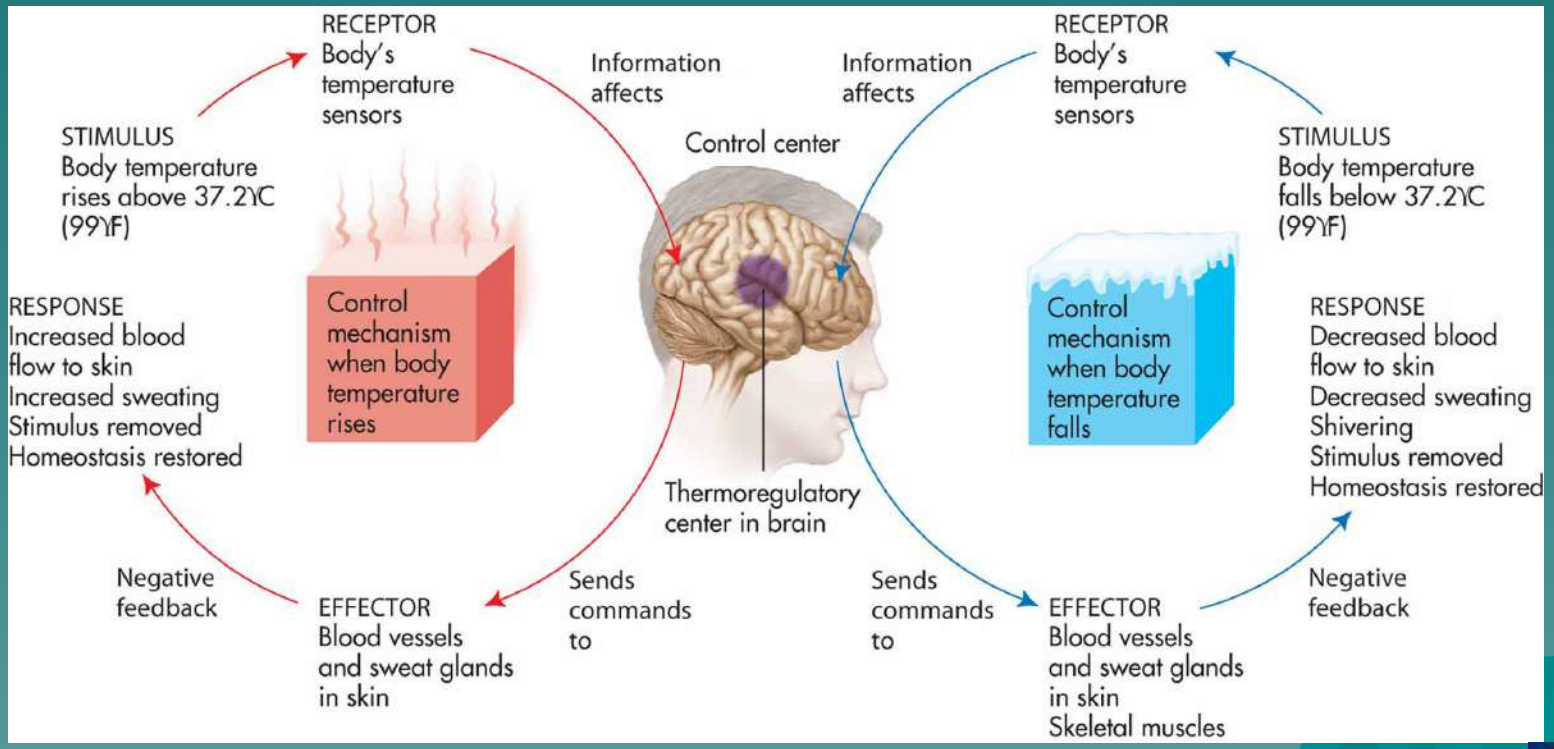
Positive Feed Back

- Increases magnitude of change
- Not a way to regulate body, since positive feedback increases change away from set point.



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Neural Control

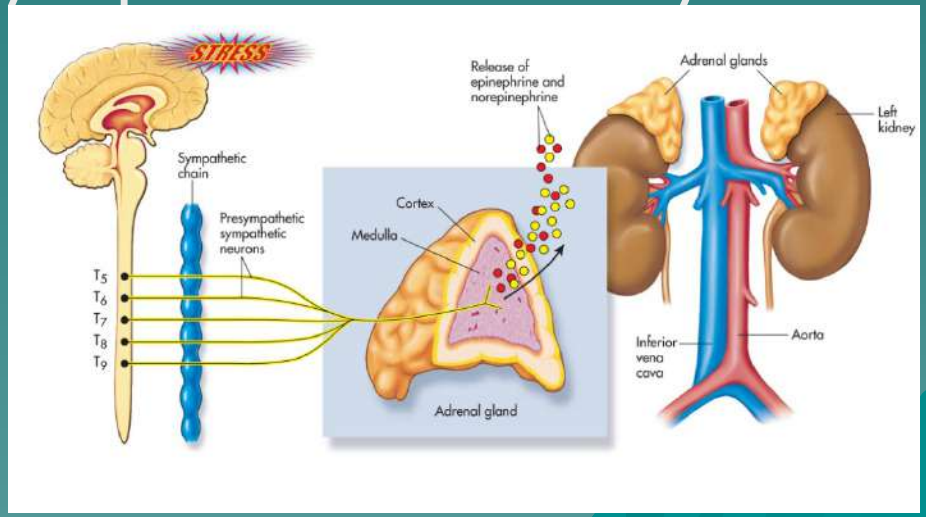
- Some hormones are directly controlled by nervous system.
- When sympathetic nervous system is active, it sends signals to adrenal glands to release epinephrine & norepinephrine.
- prolongs effects of sympathetic activity.
- Example:

  "fight or flight"

  syndrome…

  ☹☹☹

  Inspired by Madison



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Hormonal Control

- Where one gland is controlled by release of hormones from another gland up the chain
- Orders are sent from one organ to another, like a relay race.
- Feedback controls flow of orders via hormones from one part of chain to the other.
- Example:

Hypothalamus

↓

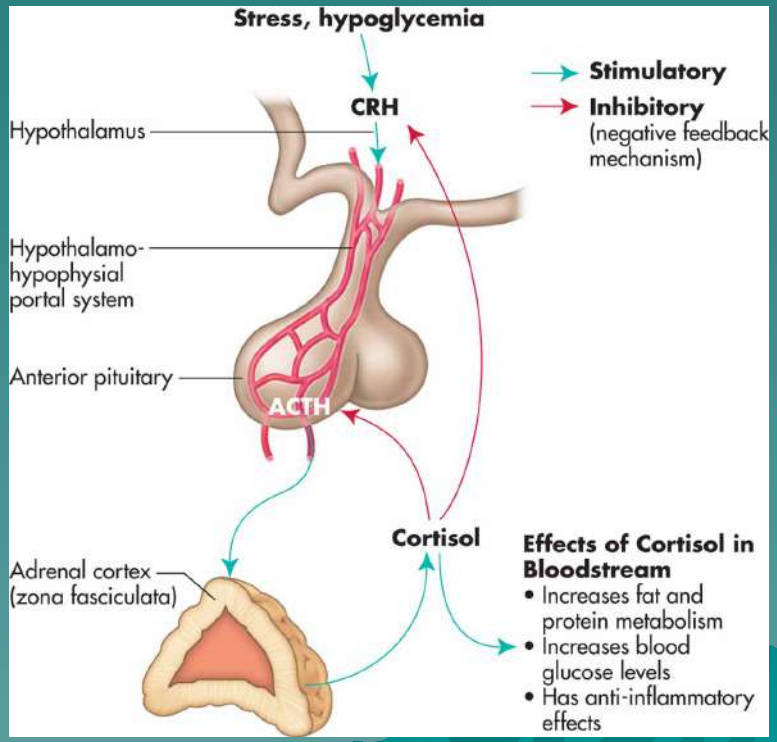
Pituitary

↓

Adrenal

↓

Secretes **Cortisol**



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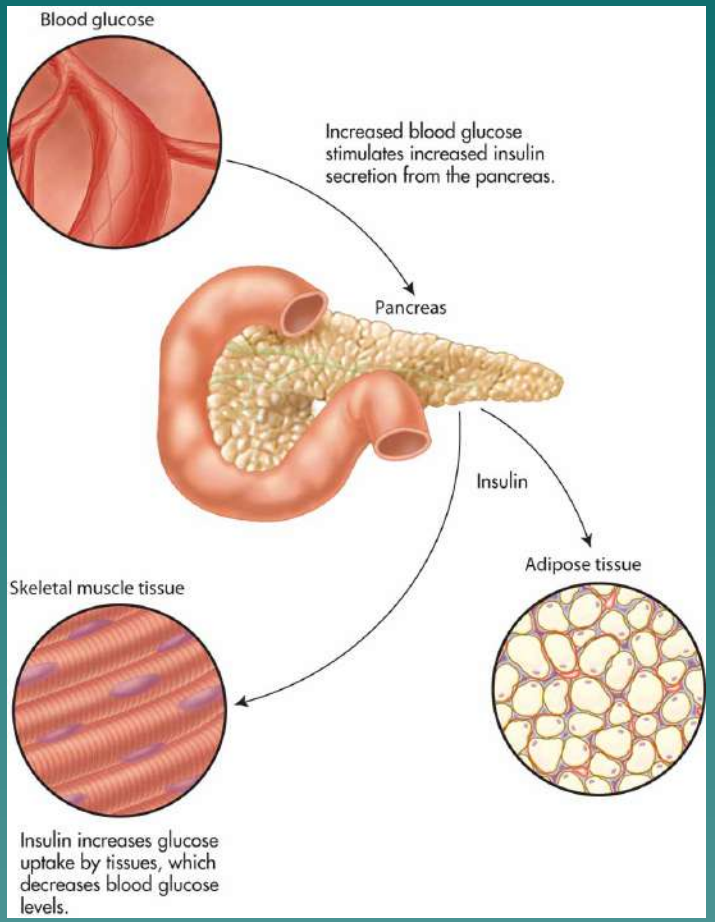
Humoral Control

- A term that pertains to body fluids or substances.
- Directly monitors body's internal environment by monitoring body fluids.
- **Example**: pancreas secretes **insulin** in response to rising blood glucose levels.



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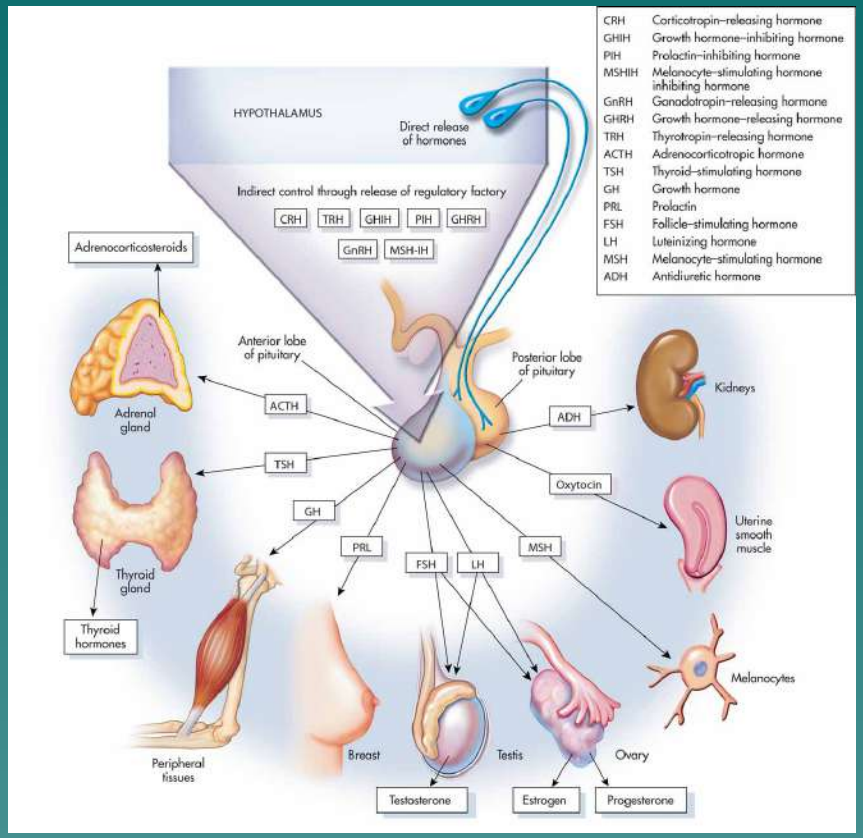
Hypothalamus

- Located in "**diencephalon**"
- Link between nervous & endocrine control systems.
- Controls hunger, thirst, fluid balance, & body temperature.
- Acts as "**commander in chief**" for other glands in endocrine system.
- Controls pituitary gland, & thus, most other glands in endocrine system.



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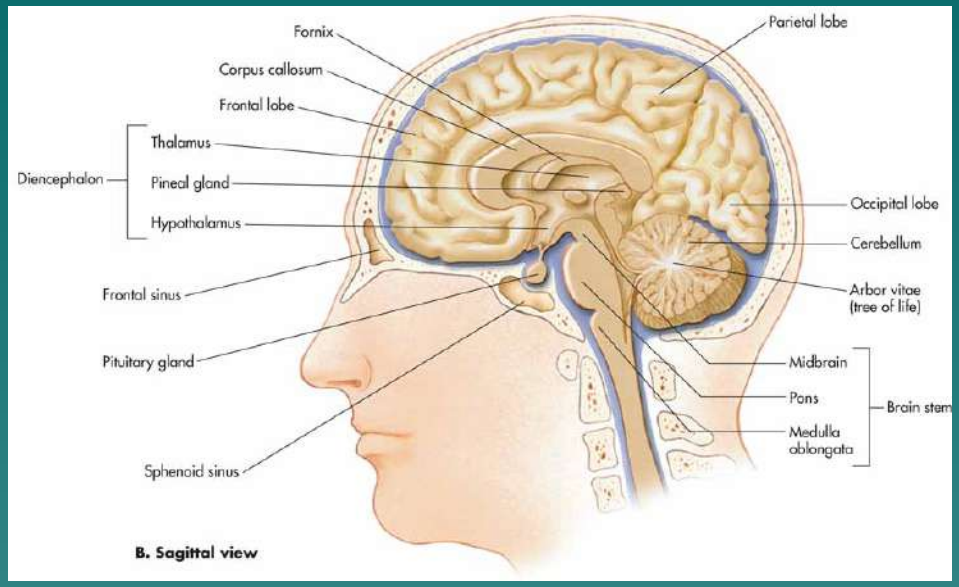
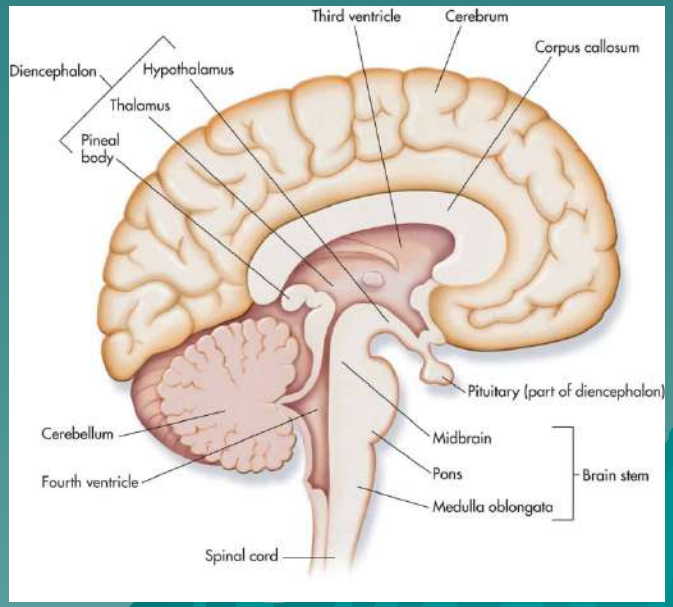
Pituitary Gland

- Part of "**diencephalon**"
- Known as the "**master gland.**"
- Acts only under orders from hypothalamus.
- If hypothalamus is "**commander in chief**," pituitary is a high ranking general.
- Split into two segments, **anterior** pituitary & **posterior** pituitary.





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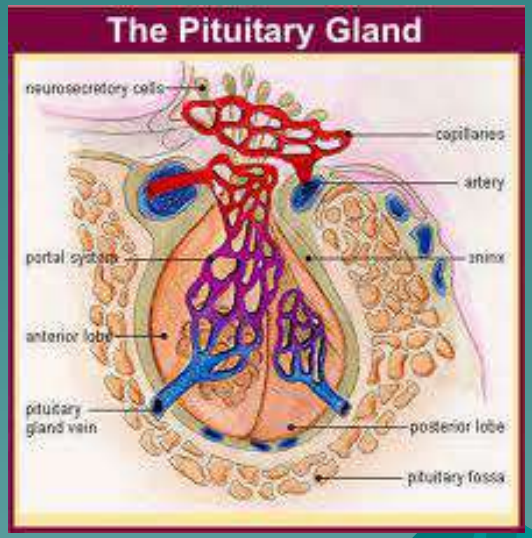
Posterior Pituitary

- Extension of hypothalamus
- Secretes **ADH** (vasopressin): Targets kidneys/decreases urination when hypothalamus senses decreased blood volume. ETOH & caffeine turn off ADH causing **dehydration**.
- Secretes **Oxytocin**: maintains uterine contractions during labor & is involved in lactation.



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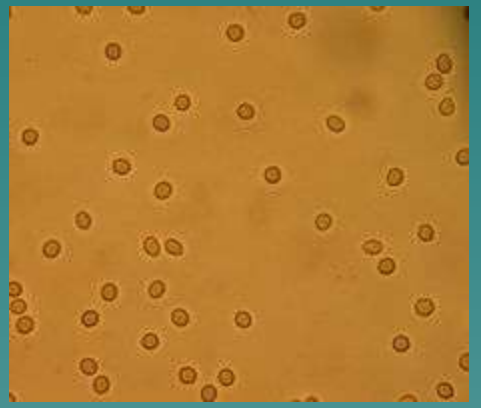
Pathology Connection
Diabetes Insipidus


Symptoms of kidney stones diagnosed will clarify the subtle distinctions of renal stone, renal cell carcinoma, and kidney tumor for an appropriate and timely medical treatment..

- Etiology: under-production of ADH
- S/S: excessive, dilute urine
- RX: fluid & hormone replacement

Normal

Mild Hematuria



Microscopic Hematuria

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Anterior Pituitary

Makes or secretes:

- GH: Growth Hormone
- TSH: thyroid-stimulating hormone
- ACTH: adrenocorticotropic hormone
- Prolactin: regulates lactation
- LH:luteinizing hormone
- FSH:follicle-stimulating hormone

Go to…

- Table 10-3

  Selected hypothalamic & Pituitary Hormones Chart.

Pathology Connection
Anterior Pituitary
Hypopituitarism

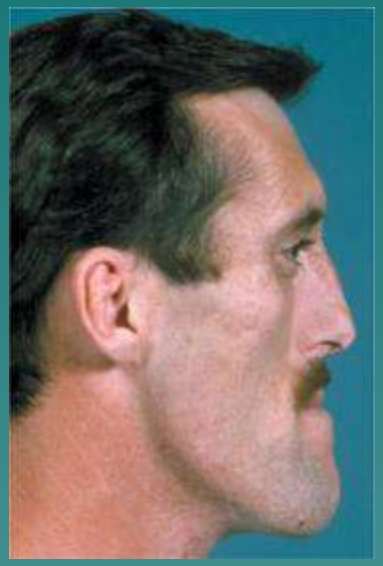
- Etiology: decrease in function due to tumor, trauma, radiation or surgery.
- S/S: vague & subtle
- Dx: imaging & serum hormone levels
- Rx: hormone replacement/tumor removal

Turner's Syndrome

End Of Slide

Pathology Connection
Anterior Pituitary
Hyperpituitarism

- Etiology: overproduction of Pituitary hormones due to tumor.
- S/S:
  - Acromegaly
  - Reproductive abnormalities
  - Cardiac dysfunction
  - Sleep apnea
  - Cushing's syndrome
  - Hyperthyroidism
- Dx: imaging & serum hormone levels
- Rx: tumor removal



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Pathology Connection
Anterior Pituitary
Cushing's Syndrome

- Etiology: over-secretion of **cortisol**: Steroids, pituitary or adrenal tumors, genetic.
- S/S: upper body obesity, round face, eccyhmosis, osteoporosis, fatigue, depression, HTN, & hyperglycemia. **Women** excess facial hair & irregular menses. **Men** may have decreased fertility & libido.
- Dx: serum analysis, MRI, biopsy
- Rx: tumor removal, hormone replacements

End Of Slide

Stature Disorders

Dwarfism:

- Etiology: Insufficient GH, genetic
- S/S: well-below-average height
- Dx: serum hormone levels
- Rx: hormone replacement injections

End Of Slide

Stature Disorders

Gigantism/Acromegaly:

- Etiology: Too much GH. Anterior Pituitary tumor.
- S/S: In children, rapid growth to height in great excess of normal; In adults, excess growth & deformity of body tissues.
- Dx: MRI, serum analysis.
- Rx: Tumor removal

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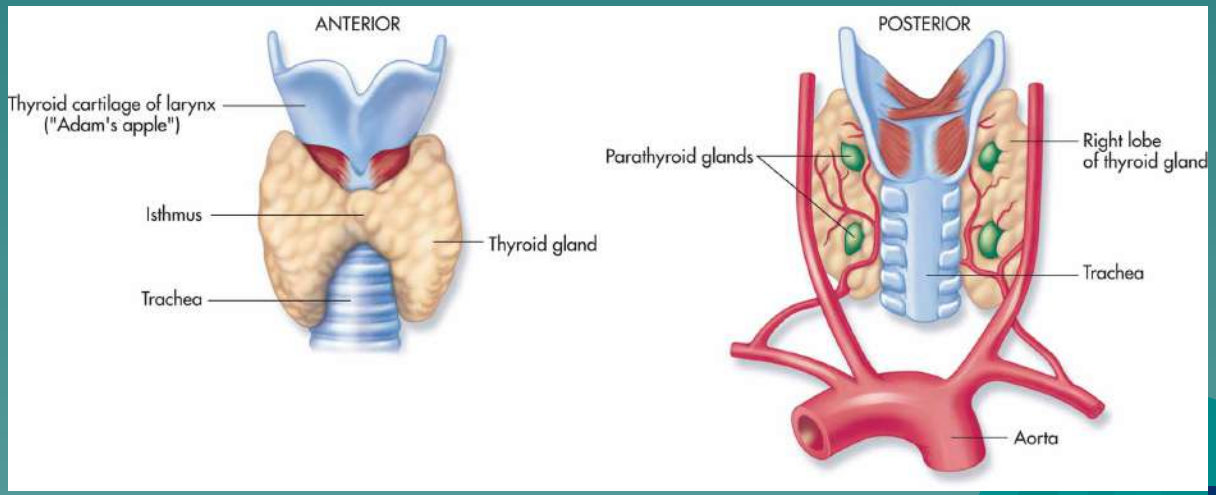
Acromegaly

Thyroid Gland

- Located in anterior portion of neck & is butterfly shaped.
- Secretes Triiodothyronine (T3) & Thyroxine (T4) under pituitary orders; & calcitonin, involved in calcium storage.
- Contains iodine & control cell metabolism & growth.



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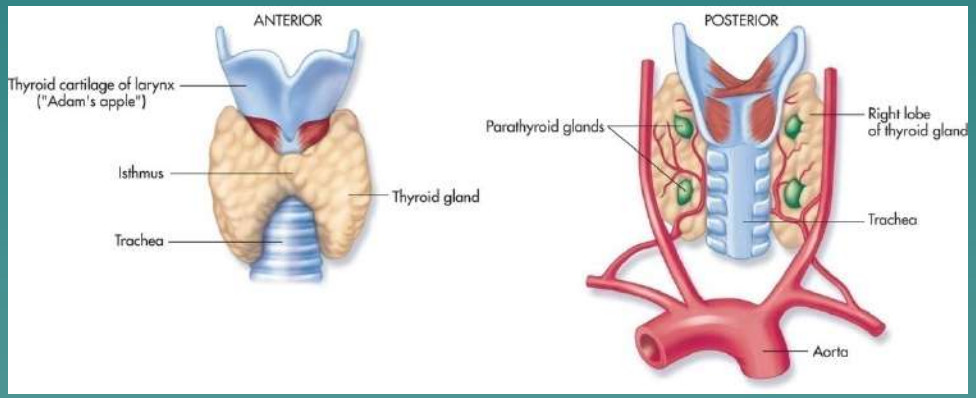
Thyroid Gland con't

- Over or underproduction cause variety of clinical symptoms.
- Essential in controlling growth & metabolism of body tissues, particularly in nervous system.
- Iodine in table salt essential for thyroid function.



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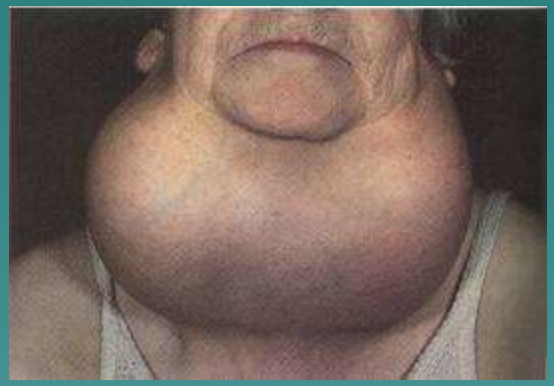
Pathology Connection
Hypothyroidism

- Etiology: Either hypothalamus, pituitary, or thyroid infection, tumor or autoimmune disease.
- S/S: Fatigue, feeling cold, dry skin, hair loss, constipation, bradycardia, leg cramps, weight gain, hyperlipidemia, hypercholesterolemia, depression, sexual dysfunction.

Mild Goiter

Moderate Goiter



Severe Goiter

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Hashimoto's Thyroiditis

- Most common cause of hypothyroidism
- Most common in women ages 30-50

Etiology: autoimmune attack on thyroid

S/S: edema, pain, dysphagia

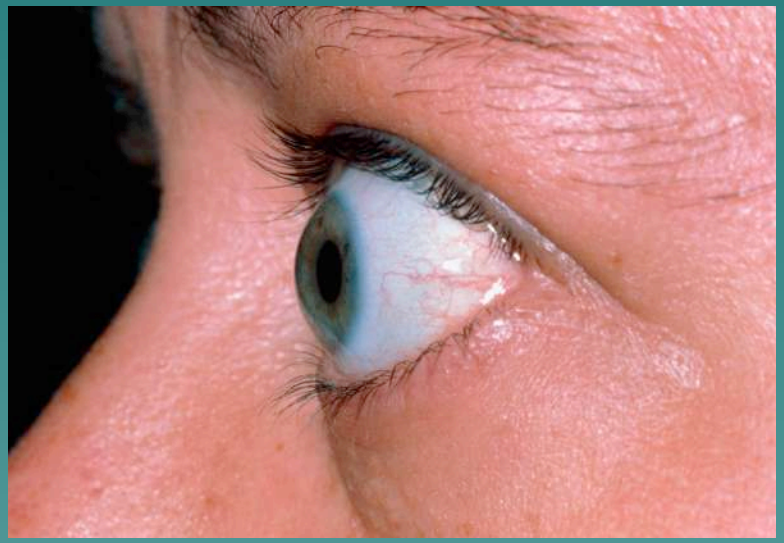
Dx: low serum T4 & elevated TSH

Rx: PO synthetic hormones

Pathology Connection:
Hyperthyroidism- Graves Disease

Etiology: Overproduction of thyroid hormones

S/S: feeling hot, muscle tremors & weakness, tachycardia, enlarged-bulging eyes, nervous-irritable, loose bowels, infertility.



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Graves Disease

- Most common form of hyperthyroidism
- More common in women of childbearing age

Etiology: autoimmune attack on TSH receptors of thyroid.

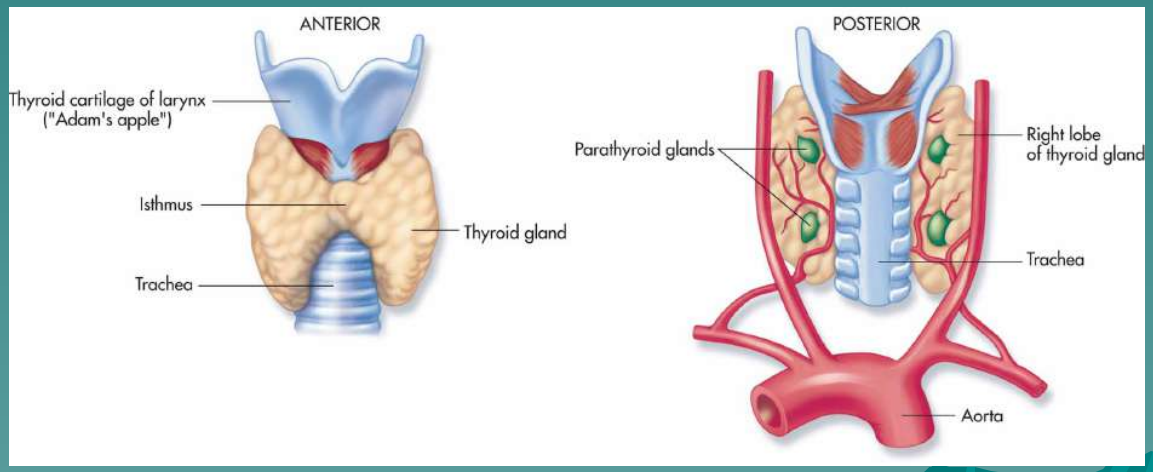
S/S: tremors, sweating, weakness, tachycardia, arrhythmia, irritability.

Dx: elevated serum T4 & low TSH. MRI thyroid with radioactive iodine; radioactive iodine uptake is increased.

Rx: Radiation, thyroidectomy, thyroid replacement meds.

Parathyroid Glands

- 2 small pairs of glands embedded in its posterior surface.
- Produce parathyroid hormone (PTH), which regulates levels of calcium in blood stream.
- If calcium levels get too low gland releases PTH, which stimulates bone dissolving cells & releases calcium into blood.



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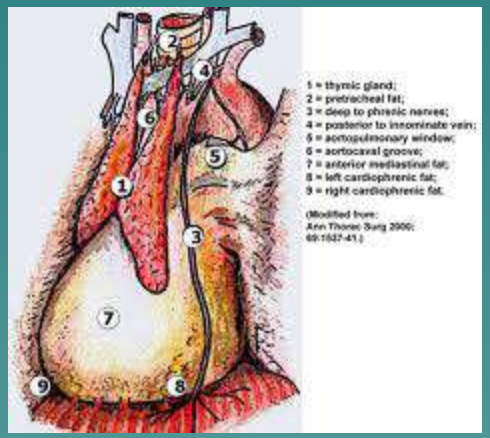
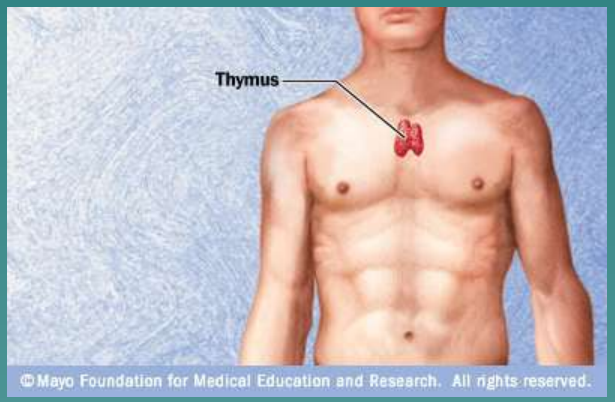
Thymus Gland

- Located in upper thorax-posterior sternum.
- Both endocrine & lymphatic organ
- Produces **Thymosin**: helps with maturation of WBCs during childhood to fight infection.
- Begins to hypertrophy during puberty.





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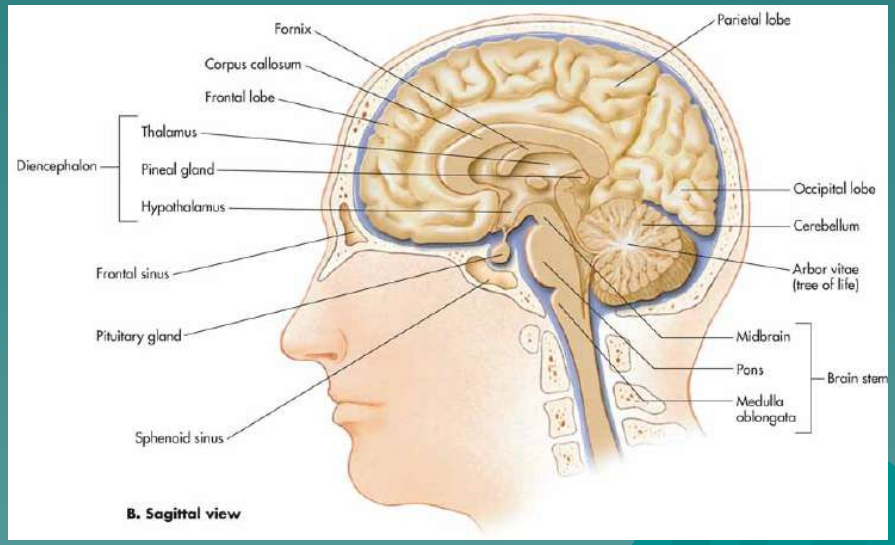
Pineal Gland

- Tiny gland found within diencephalon of brain.
- Function remains unknown
- Produces hormone **melatonin**, which rises and falls during waking & sleeping hours.



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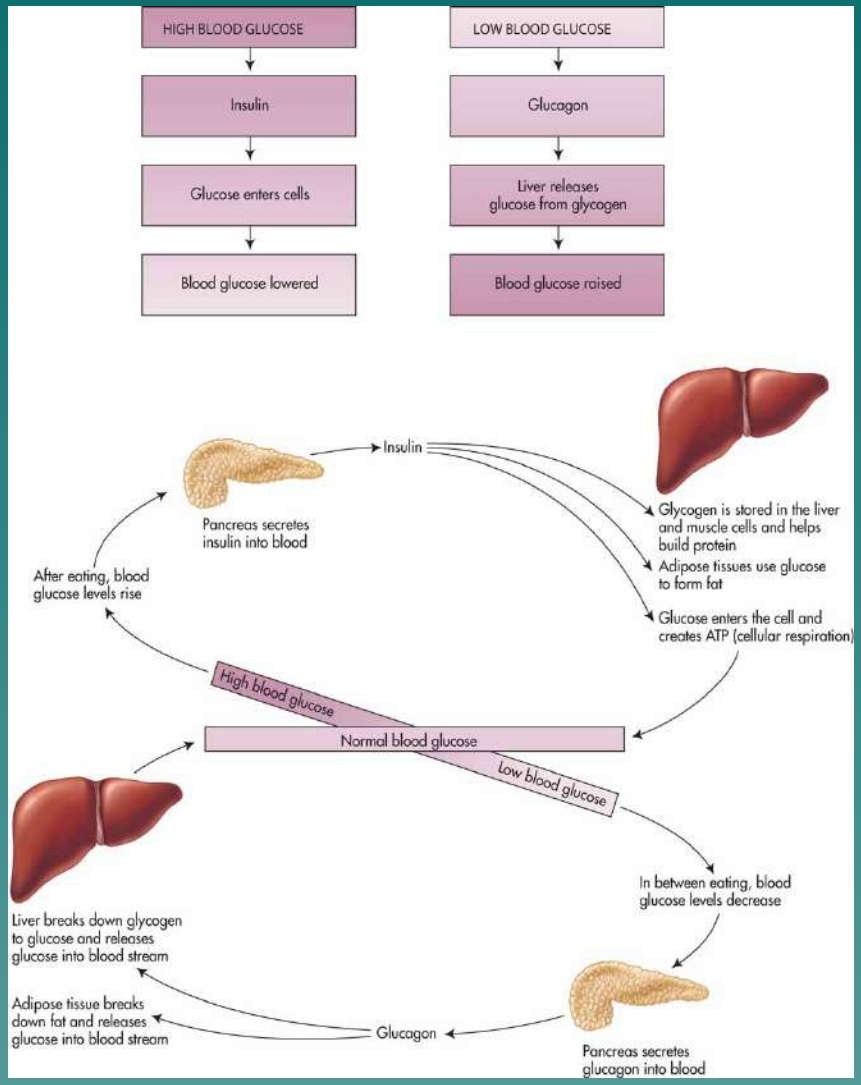
Pancreas

- Responsible for maintaining BS levels at or near set-point of 70–105.
- During hyperglycemia pancreas releases ***insulin*** which helps glucose get into cells; excess glucose affect fluid balance of cells.
- Secretes **glucagon**, which puts glucose into bloodstream during hypoglycemia; low glucose levels affect cell metabolism because all cells need glucose for cellular respiration.

Control of Blood Glucose by Pancreatic Hormones



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Pathology Connection
Diabetes Mellitus

- Abnormal pancreatic hormones
- Hyperglycemia: abnormally high blood glucose levels.
- 2 types of diabetes mellitus:

  Type I: Usually Juvenile onset

  Type II: Usually Adult onset

Pathology Connection
Type I IDDM

- Insulin-dependent diabetes mellitus (IDDM); juvenile-onset before 40 y/o.

Etiology: Auto-immune destruction of insulin producing cells of pancreas. inadequate insulin production.

S/S: usually sudden & severe, urination, extreme thirst, & weight loss.

Dx: BS, UA

Rx: Insulin replacement via injection, pump, or pancreas transplant.

End Of Slide

Taking Insulin

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Pathology Connection
Type II NIDDM

- Non-insulin-dependent diabetes mellitus (NIDDM).
- Late or adult onset

Etiology: body tissue insensitivity to insulin, obesity, sedentary life style.

S/S: more subtle than IDDM Type I

Dx: BS, UA

Rx: Diet/exercise, oral antihyperglycemics, insulin.

Pathology Connection:

Why DM Causes Problems

- Hyperglycemia cause kidneys to work overtime to secrete excess sugar.
- Results in polyuria & polydipsia, renal damage.
- glucose cannot get into cells to make ATP
- other sources of fuel for ATP production sought after.
- weight loss as body begins to break down energy stores of fat & muscle.
- metabolism changes resulting in increasingly acidic blood.

DM Problems

- Difficult wound healing
- Peripheral neuropathy
- Changes in mentation
- Paroxysmal hyper vs hypo glycemia
- Ketoacidosis: break down of fats into ketone bodies.
- Coma
- Death

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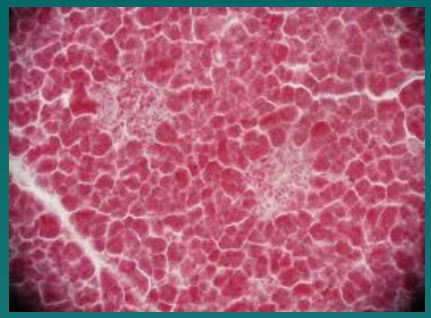
Hyperglycemia



Etiology: failure of pancreatic **Islets of Langerhan**.

S/S: polyphagia, polyuria, polydipsia, blurred vision, fatigue, wt loss.

Dx: BS, UA, pt hx

Rx: oral hypoglycemics, insulin, life-style modifications. Pt/family edu.

Hypoglycemia

Early S/S:

- hunger, nervousness, dizziness, anxiety, weakness, & difficulty speaking.

Rx:

- **STAT** replacement of sugar in blood
- Fruit juice, milk, non-diet soda, hard candy, then a regular meal.

Later S/S:

- mental confusion, seizures, coma & possibly death

Rx: **STAT** medical attention: Glucagon, IV glucose, food when alert & stable.

Body's defense against Hypoglycemia

Multiple organs attempt to correct BS deficit

- Pancreas: decreases insulin secretion, increases glucagon secretion.
- Adrenal Glands: sympathetic nervous system triggers release of epinephrine.
- Hypothalamus: triggers feelings of hunger, so patient will eat food.

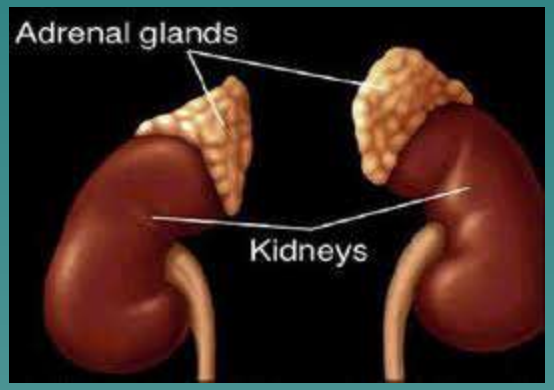
Go to…

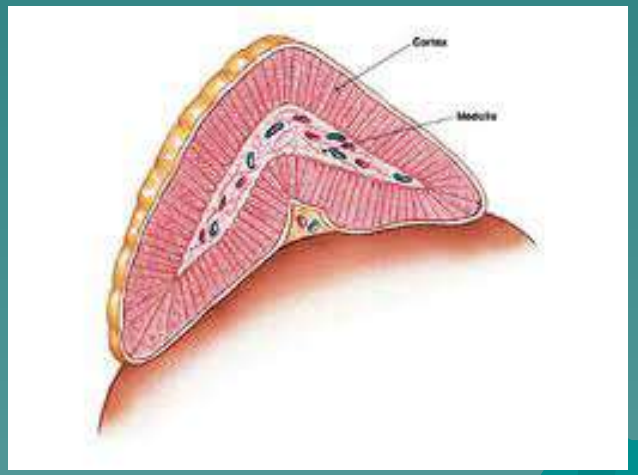
- Table 10-4

  Comparison of Type I & Type II Diabetes chart.

Adrenal Glands

- Pair of small glands that sit on kidneys, like baseball hats.
- Split into 2 Regions
- Adrenal cortex is outer layer
- Adrenal medulla is middle of the gland





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Adrenal Medulla

Releases two hormones

- Epinephrine (**adrenalin**)
- Norepinephrine (both hormone & neurotransmitter).
- Increase duration of effects of sympathetic nervous system; effects of hormones last longer than neurotransmitter.
- Effects include increased HR, BP, & respiration, diaphoresis & dry mouth.

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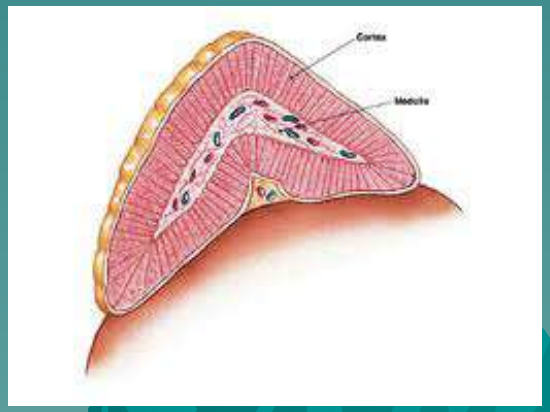
Adrenal Cortex

- Releases Adrenocorticosteroids under d stimulation of anterior pituitary.
- decrease in production could be fatal relatively quickly (Addisonian crisis).
- Regulates fluids, electrolytes, BS, reproduction, secondary sexual characteristics, cell metabolism, growth, & immune system function.



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Addison's Disease

Etiology: adrenalcorticosteroids deficiency due to autoimmune attack on adrenal cortex, cancer or infection.

S/S Mild: weakness, fatigue, hypoglycemia, depression.

Dx: imaging & blood tests for corticosteroids

Rx Mild: hormone replacement

S/S Crisis: acute hypotension, acute hypoglycemia, acidosis, coma.

Rx Crisis: IV steroids, IV NS, IV Dextrose, IV Na HCO3, O2, cardiac monitoring.

Therapeutic Steroids

- Prednisone used in treatment of inflammation, organ rejection, immune disorders.
- can have dangerous side effects including
  - Bone loss
  - Weight gain
  - Hair growth
  - Fat deposits
  - Delayed wound healing
  - Caution: Do not stop steroids suddenly! Decrease over time only!!!

End Of Slide

Illegal Anabolic Steroids

- Causes large increase in muscle mass
- Used to enhance performance or muscle size.

Side Effects Men:

- Atrophy of testicles and decreased sperm production.
- enlarged breasts

Side Effects Women:

- deepening of voice
- decreased breast size
- excessive body hair growth(yuck!!)

Anabolic Side Effects both Genders

- Increased cholesterol levels
- Cardiovascular disease
- Weakened immune function
- exposure to hepatitis B or HIV through sharing needles.
- Aggressive behavior
- Note: steroids are banned by all major professional & amateur athletic organizations.

Anabolic Side Effects

Cortisol & normal stress response

- Sympathetic nervous system activates
- Stimulates Adrenal glands
- **Epinephrine** & **norepinephrine**: raise BP, HR, respiration rate & BS; decreases digestion & other less urgent physiological functions.
- Cortisol increases blood sugar; changes immune response.
- prepares body to rapidly expend energy, beneficial in short term.

Cortisol & Chronic stress response

Chronic Cortisol secretion can result in:

- Increased appetite
- increase autoimmunity and decrease defense against infection.
- increased HR, HTN, hyperglycemia, hypercholesterolemia, abdominal fat, anxiety, depression.

Gonads

- Greek for seed
- include testes & ovaries
- function to produce & store gametes: Eggs & Sperm.
- Produce sex hormones which control reproduction: Testosterone in men & Estrogen in women.