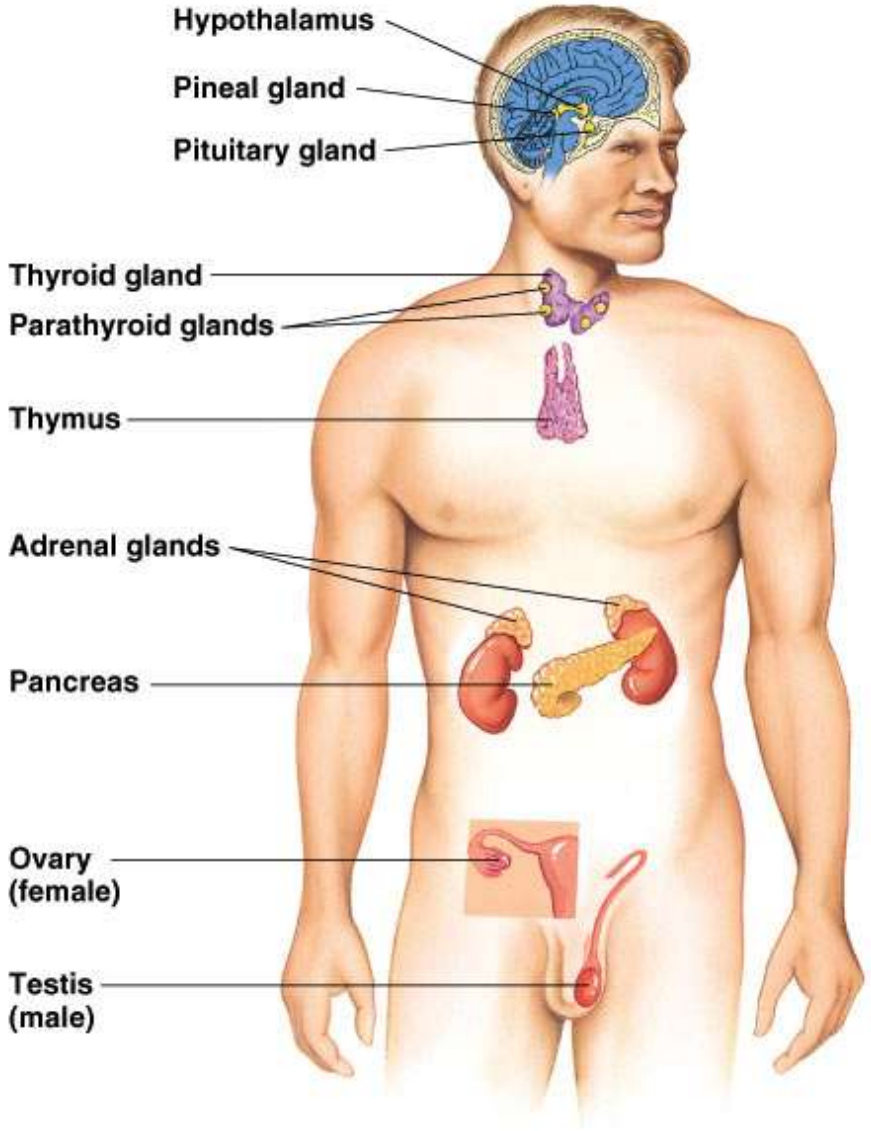
Endocrine System



- The word endocrine derives from the Greek words "endo," meaning within, and "crinis," meaning secrete
- It is the collection of glands, each of which secretes different types of hormones that regulate metabolism, growth and development, tissue function, sexual function, reproduction, sleep and mood, among other things.

Nervous System

- Communication travels in one direction from one neuron to another
- Has a clear destination (targets a specific cell)
- Fast acting, short-lived neurotransmitters

Endocrine System

- Chemical messages are released into bloodstream or extracellular fluid
- Target is less specific
- Hormones are slower-acting, longer lived (can last days, weeks or years)

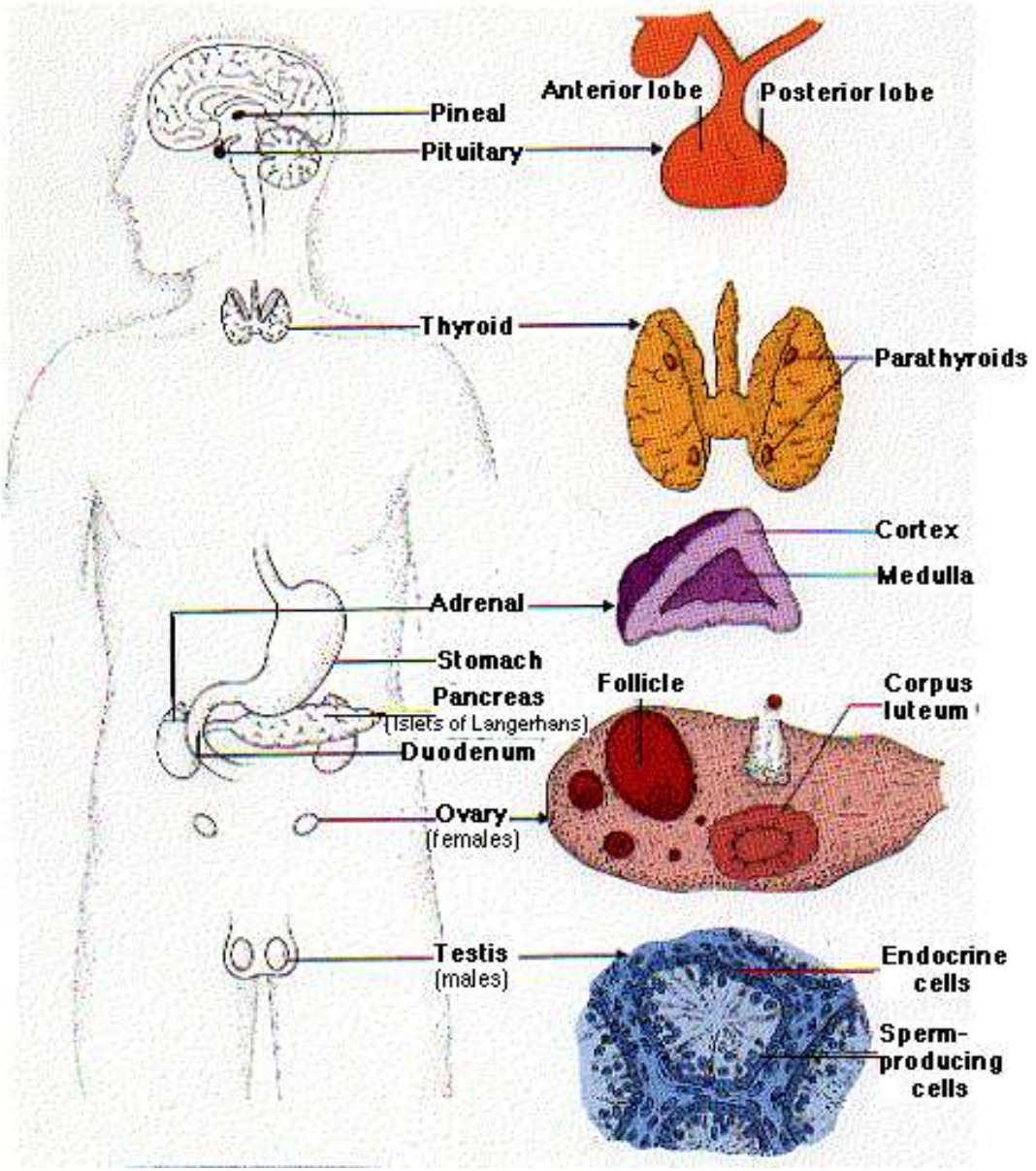
Endocrine vs. Exocrine Glands

- Endocrine Glands – Ductless organs that secrete hormones directly into the bloodstream or extracellular fluid

- Exocrine glands – Use ducts (tube-like structures) to transport substances to specific locations inside and outside the body (Ex: sweat glands, mucous glands, salivary glands)

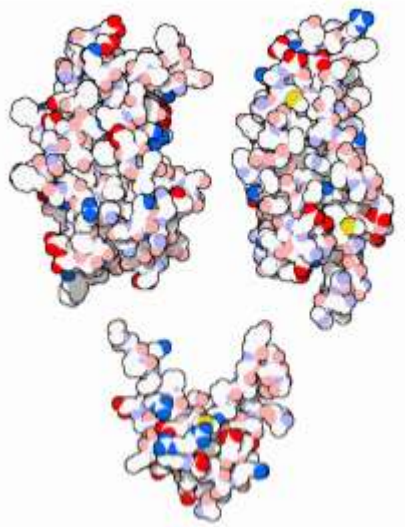
Glands

- Organ that releases hormones for homeostasis



Hormones

- Chemical messengers that effect the functions of specifically receptive organs or tissues when transported to them by body fluids
- Functions:
  1. Regulate growth, development, behavior and reproduction
  2. Coordinate production, use, and storage of energy
  3. Maintain homeostasis (body temperature, metabolism, excretion, water and salt balance)
  4. Response to external stimuli



growth hormones

Control of Hormone Release

Humoral stimuli - Changing blood levels of ions and nutrients directly stimulates secretion of hormones

Neural stimuli- Nerve fibers stimulate hormone release

Hormonal stimuli - Hormones stimulate other endocrine organs to release their hormones

Chemistry of Hormones

- Two main classes
  1. Amino acid-based hormones
     - Amines, thyroxine, peptides, and proteins
  2. Steroids
     - Synthesized from cholesterol
     - Gonadal and adrenocortical hormones

Mechanisms of Hormone Action

1. Water-soluble hormones (all amino acid–based hormones except thyroid hormone)
   - Cannot enter the target cells
   - Act on plasma membrane receptors
   - Coupled by G proteins to intracellular second messengers that mediate the target cell's response

2. Lipid-soluble hormones (steroid and thyroid hormones)
   - Act on intracellular receptors that directly activate genes

Figure 16.2 on p. 597

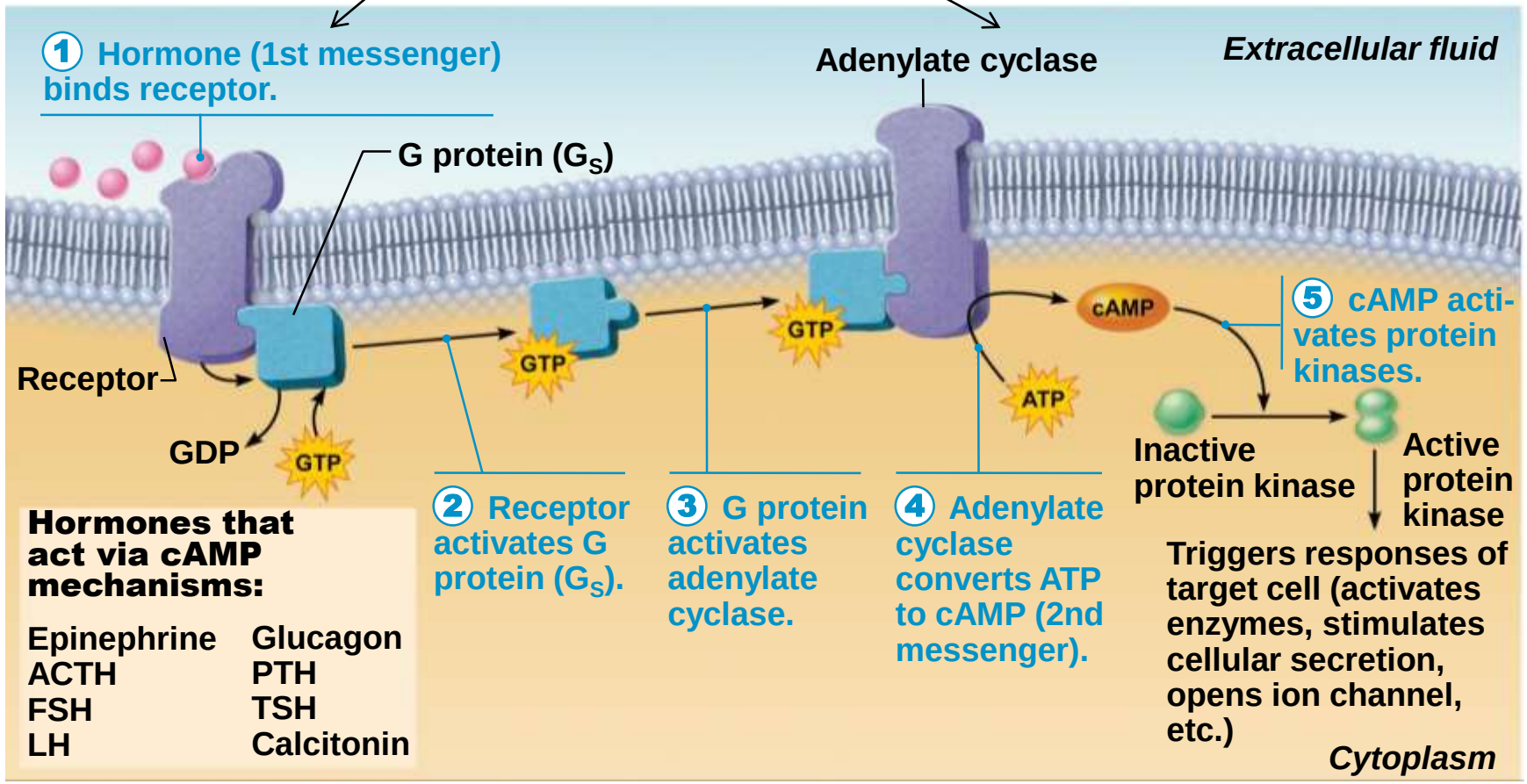


Figure 16.2, step 5

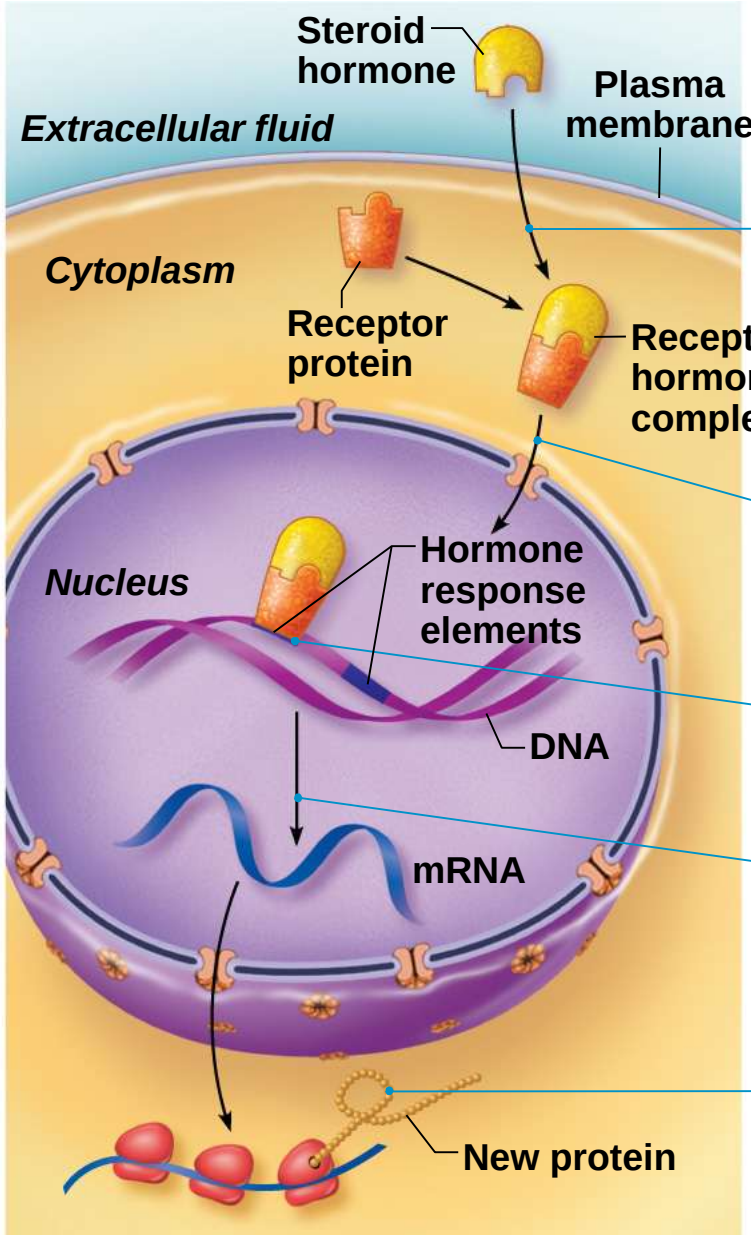
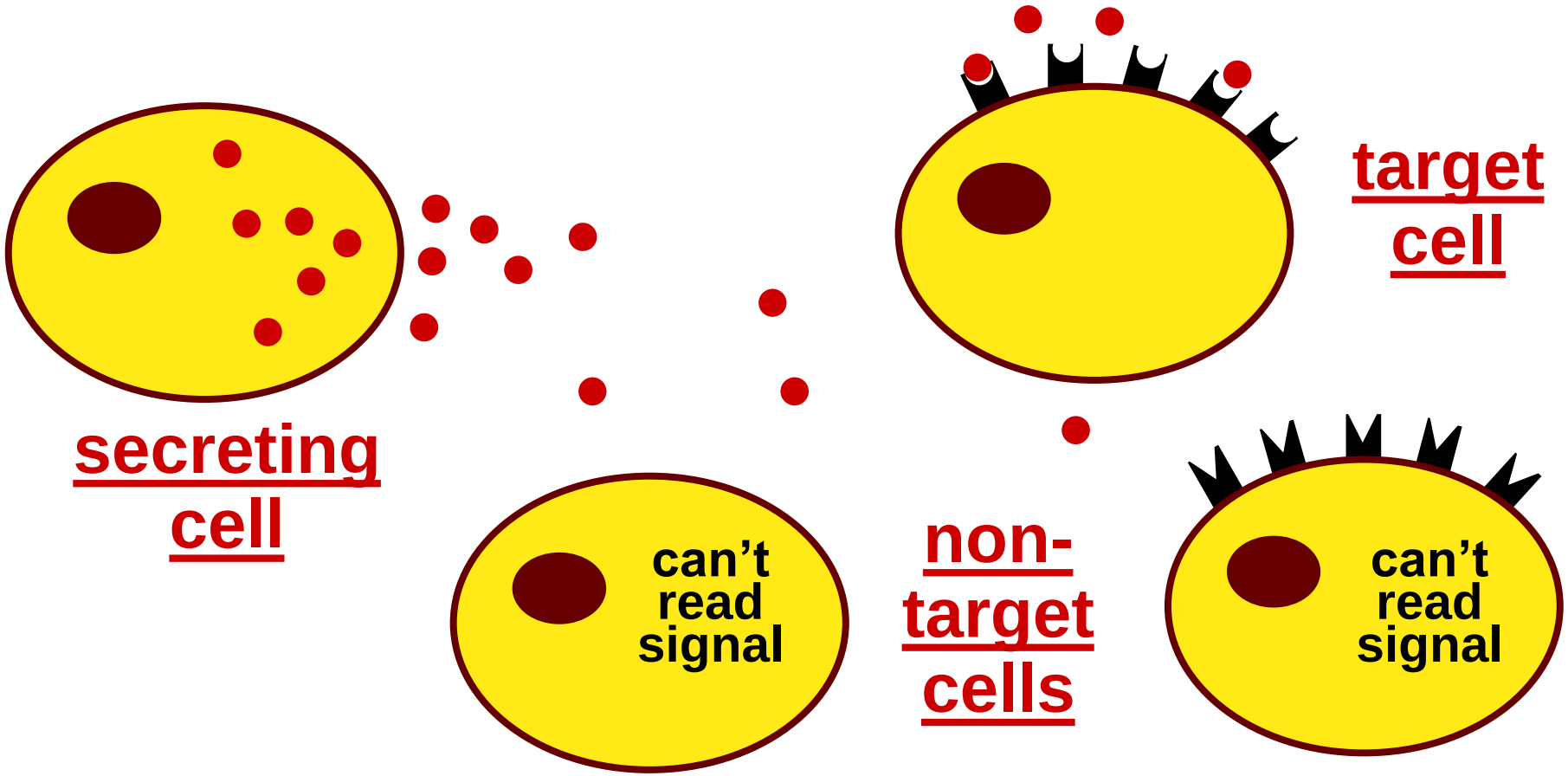

Steroid hormone
Plasma membrane
Extracellular fluid
Cytoplasm
Receptor protein
Receptor-hormone complex
Nucleus
Hormone response elements
DNA
mRNA
New protein
1 The steroid hormone diffuses through the plasma membrane and binds an intracellular receptor.
2 The receptor-hormone complex enters the nucleus.
3 The receptor- hormone complex binds a hormone response element (a specific DNA sequence).
4 Binding initiates transcription of the gene to mRNA.
5 The mRNA directs protein synthesis.

Figure 16.3

Responding to hormones

- Lock and key system
  - hormone fits receptor on “target” cell



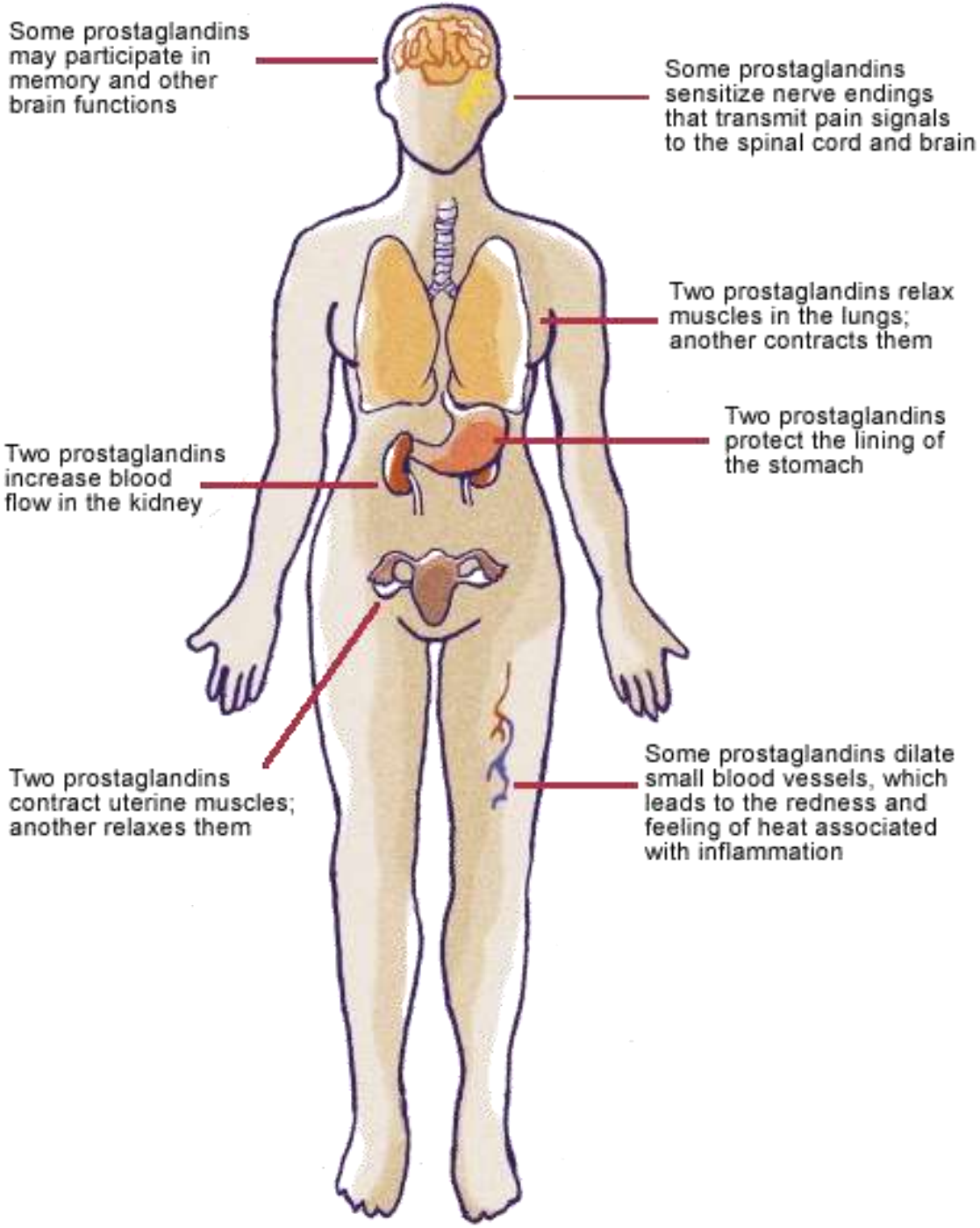
Interaction of Hormones at Target Cells

- Multiple hormones may interact in several ways
  - **Permissiveness**: one hormone cannot exert its effects without another hormone being present
  - **Synergism**: more than one hormone produces the same effects on a target cell
  - **Antagonism**: one or more hormones opposes the action of another hormone

Prostaglandins

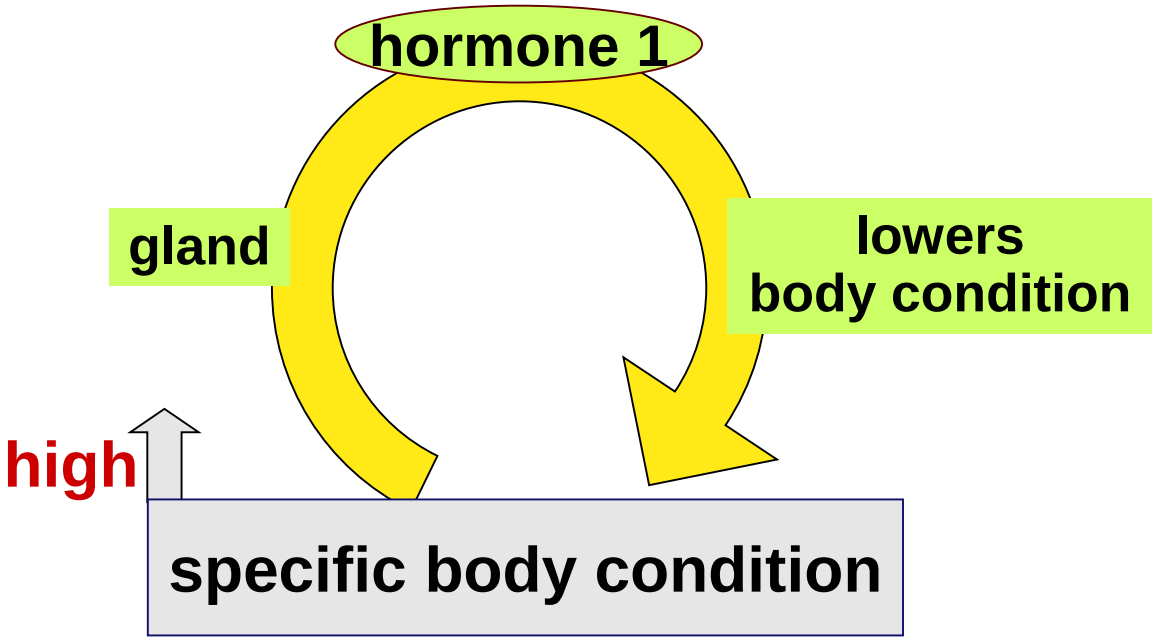
- Hormone-like substances (sometime called “localized hormones”)
- Modified fatty acids produced by a wide range of cells that affect cells and tissues nearby
- Named for the prostate where they were first discovered

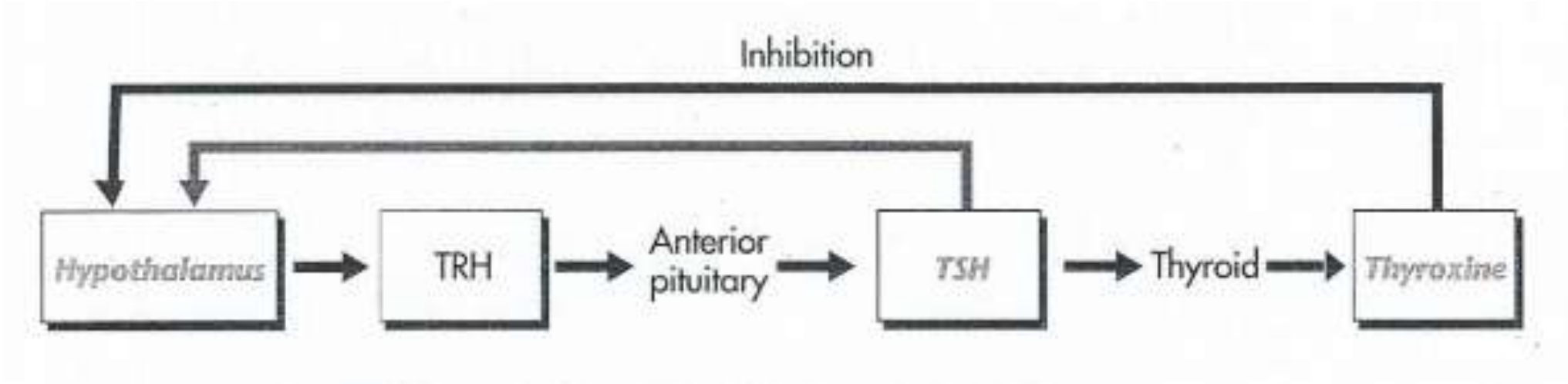
Ex: Found in smooth muscle that cause vessel contraction, stimulating uterine contraction for labor, cause aggregation or disaggregation of platelets



Negative Feedback

- Response to changed body condition that inhibits the initial stimulus
  - Ex: if body is high or low from normal level
    - signal tells body to make changes that will bring body back to normal level
  - once body is back to normal level, signal is turned off (like the thermostat in a house)




Inhibition
Hypothalamus
TRH
Anterior pituitary
TSH
Thyroid
Thyroxine

Gland Campaign

For your chosen gland you must:

- Include the name of the gland (1 point)
- Include a picture (2 points)
- Include a slogan that summarizes why your gland should be selected as the most important gland in the body (3 points)
- Explain why your gland should be selected as most important (3 points)

Gland Campaign – 1st

Gland	Student 1	Student 2	Student 3
Pituitary Gland	Randi	Danielle	
Hypothalamus	Kiersten	Summer	Chasey
Pineal Gland			
Thyroid	Katelyn	Dalton	Nicole
Parathyroid			
Thymus	Jeff	Ryan	Daniel
Adrenal Glands	Hannah	Stephanie	Kristin
Pancreas	Bethany	Lauren	
Gonads	Sarah	Brenda	Sierra

Gland Campaign – Period 2

Gland	Student 1	Student 2	Student 3
Pituitary Gland	Lauren	Brittany	Travis
Hypothalamus	Courtney	Kaleigh	
Pineal Gland	Alec	Dani	
Thyroid	Jordan	Taylor	Shannon
Parathyroid	Ashley		
Thymus	Casey	Savannah	
Adrenal Glands	Elizabeth	Efa	
Pancreas	Maddie	Sarah	
Gonads	Melody	Christina	

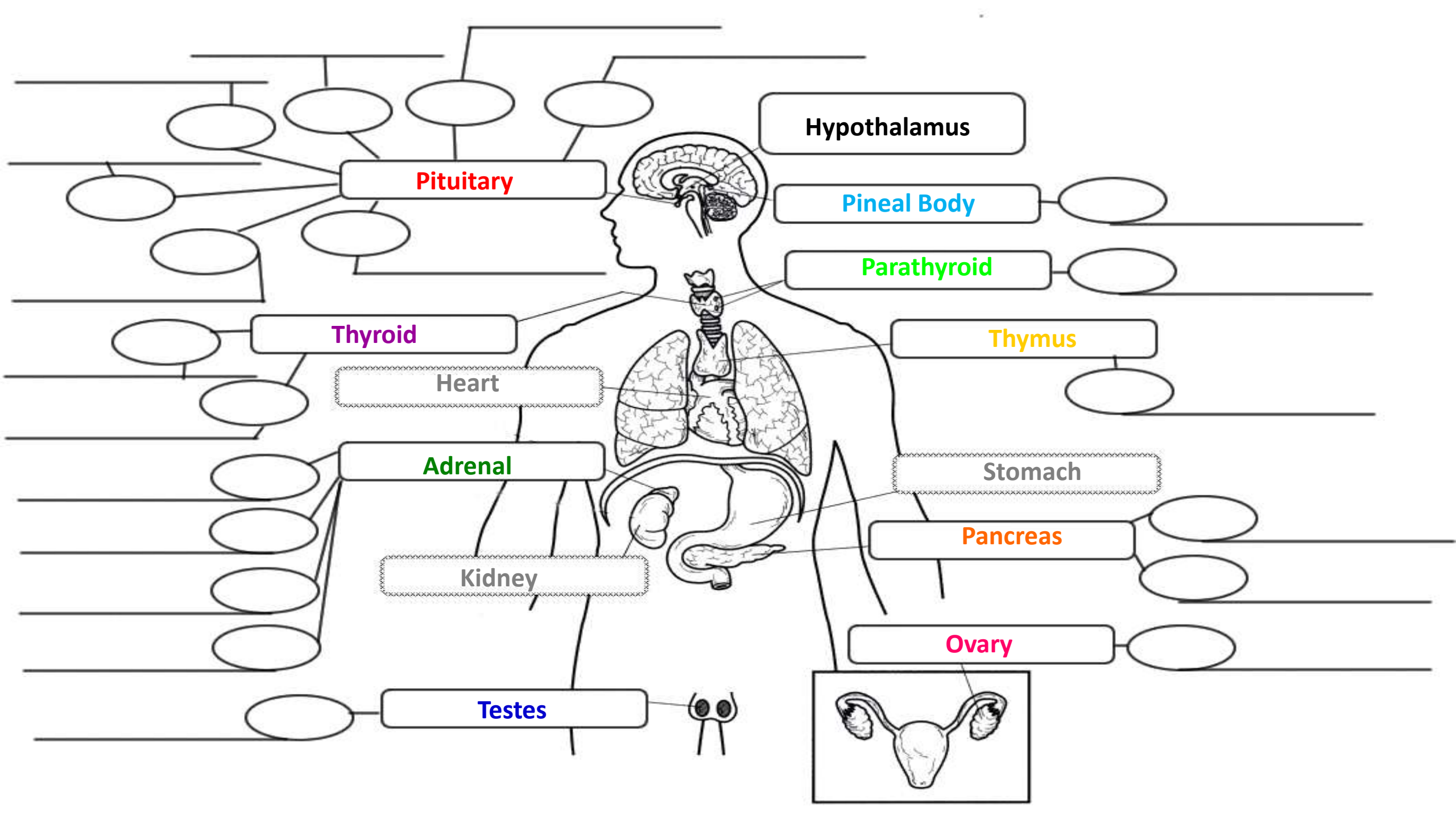
Gland Campaign

Gland	Student 1	Student 2	Student 3
Pituitary Gland	Chandler	Destry	
Hypothalamus	Laurel	Renee	Jesenia
Pineal Gland	Russ	Nick	
Thyroid	Austin	Leah	Amanda
Parathyroid			
Thymus	Jocelyn	Bethany	Alexa
Adrenal Glands	Esha	Corey	
Pancreas	Katie	Taylor	
Gonads	Kevin	Lucy	Jamie

Place the following glands in the appropriate rectangles on your concept map:

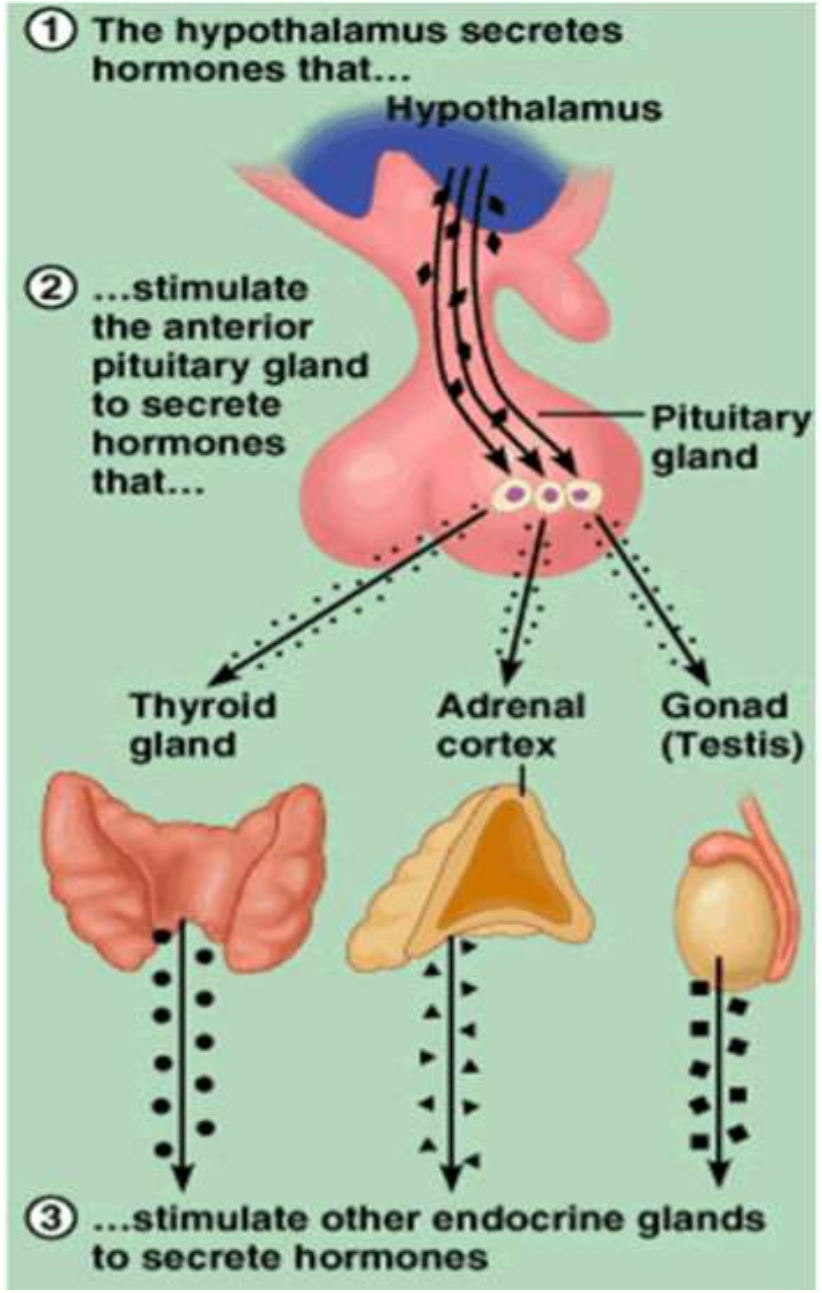
- Hypothalamus
- Pituitary
- Pineal
- Thyroid
- Parathyroid
- Thymus
- Adrenal
- Pancreas
- Teste
- Ovary

(The heart, kidney and stomach can go into the boxes with the faded outline as reference points)


Hypothalamus
Pituitary
Pineal Body
Parathyroid
Thyroid
Thymus
Heart
Adrenal
Stomach
Pancreas
Kidney
Ovary
Testes

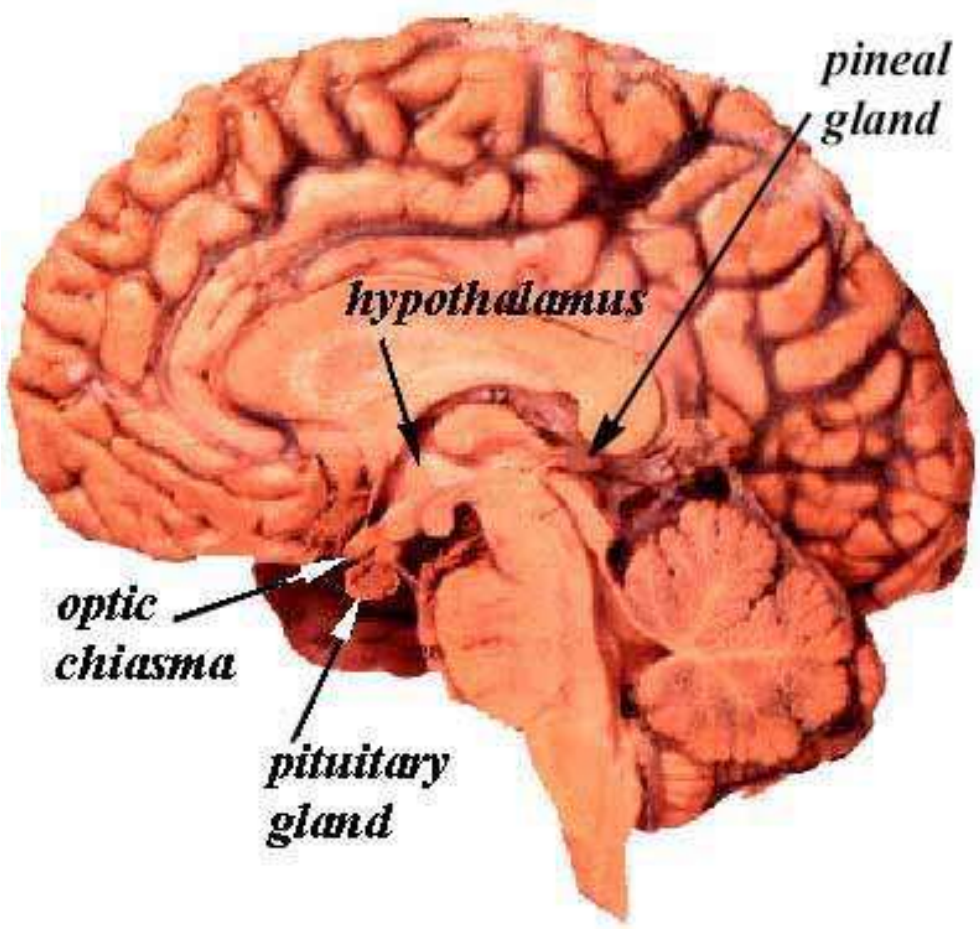
Body Regulation

- Nervous system & Endocrine system work together
  - hypothalamus
    - "master nerve control center"
    - receives information from nerves around body about internal conditions
  - communicates with pituitary gland
    - "master gland"
    - releases many hormones
      - sexual development, growth, milk production, pain-relief



HYPOTHALAMUS

- ‘Master Gland’
- Function : Control center
- Continuously receive information on status of body systems via nerve impulses
- Monitors composition & temperature of blood
- Messages interpreted, evaluated : outgoing messages dispatched via nerves / hormones
- Plays role in feedback systems that govern secretions of endocrine system



Pituitary

- Pea Sized Mass of Glandular Tissue
- Location: Sella Tursica (depression in sphenoid)

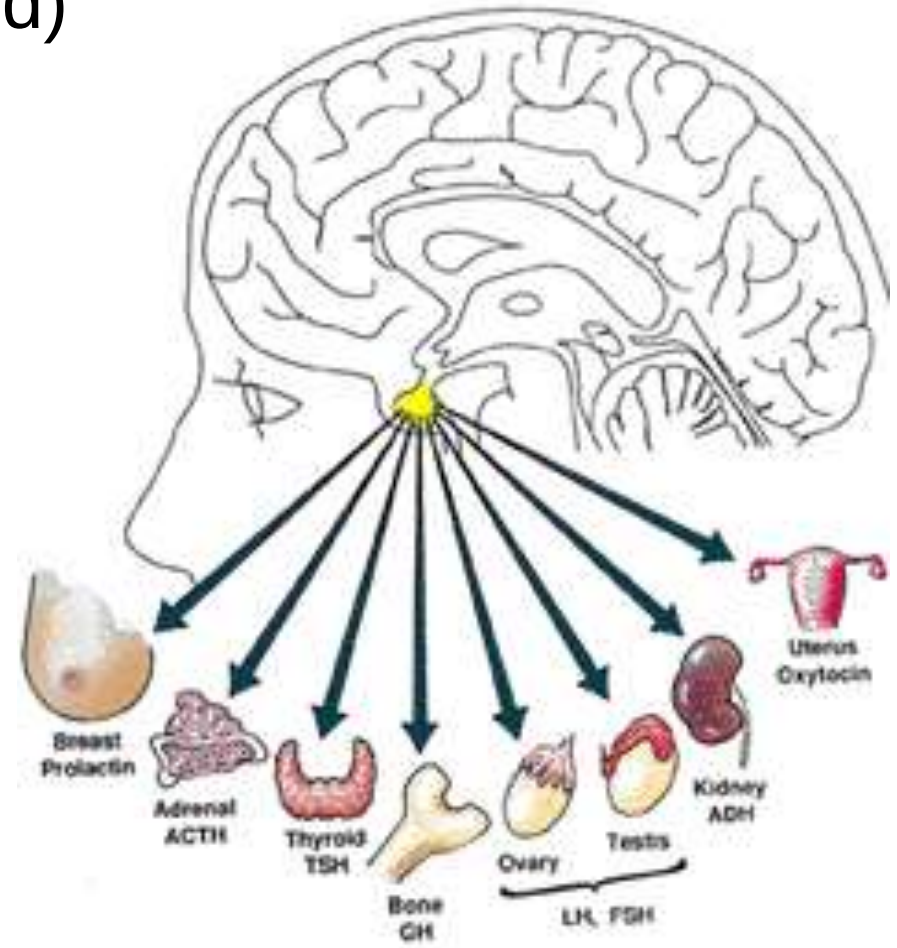
Indirectly controls:

-Growth

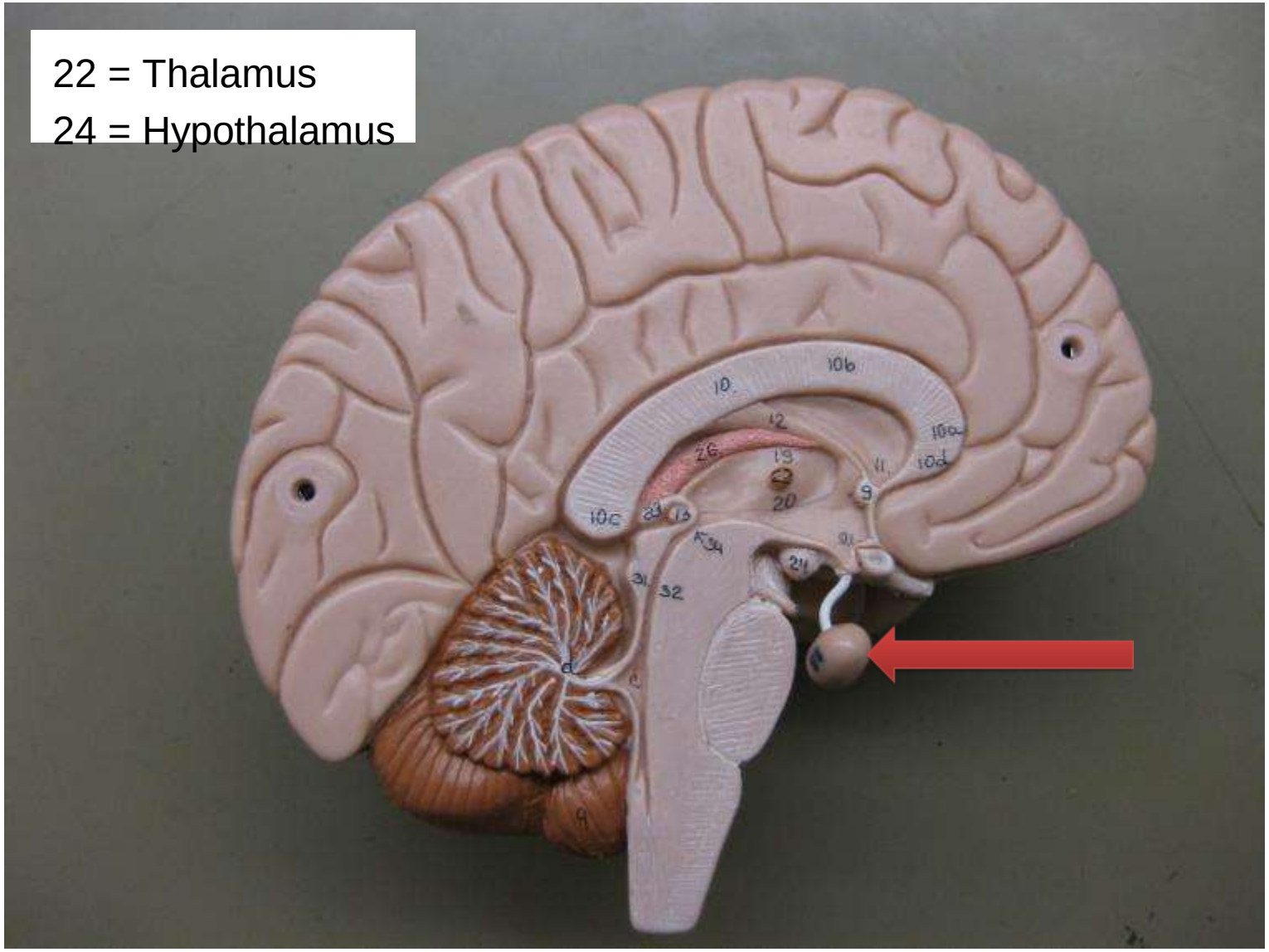
-Metabolism

-Sexual reproduction

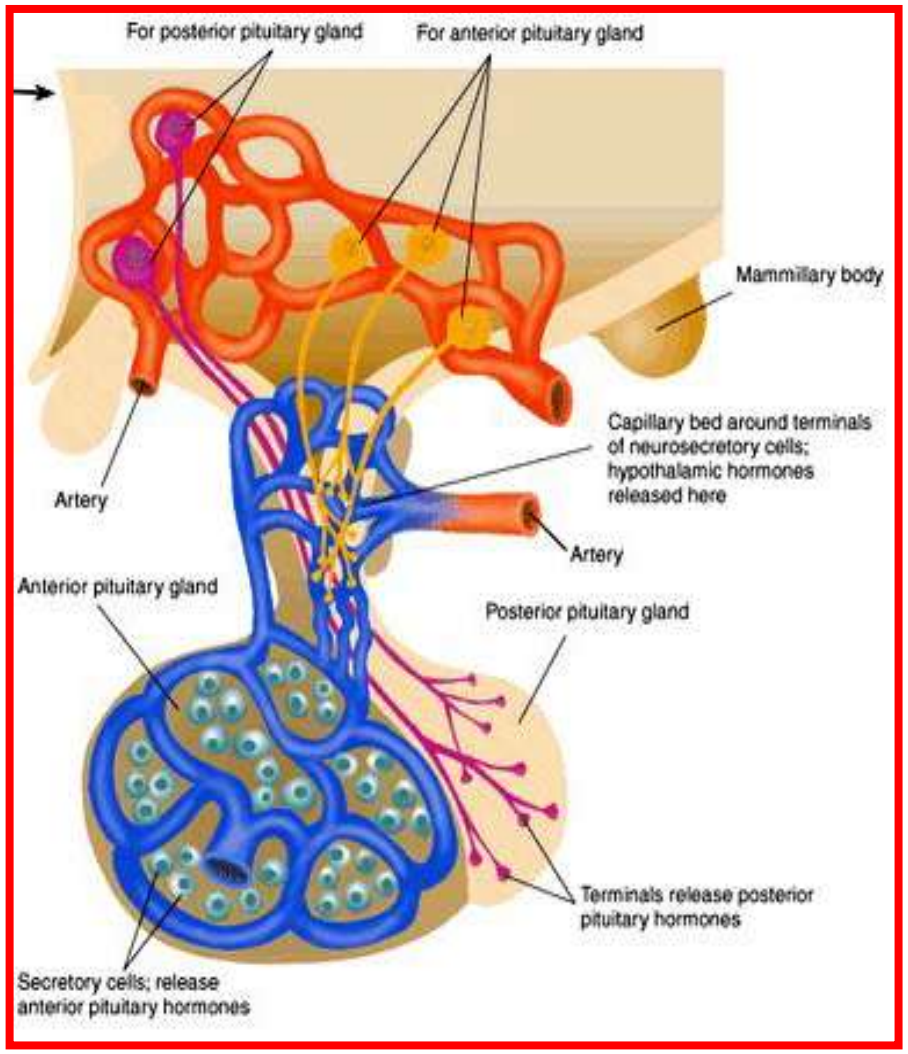
-Lactation



Pituitary Gland



PITUITARY GLAND: HORMONES



	HORMONES	EFFECTS
Posterior Pituitary	Oxytocin (OC)	Stimulates contraction of uterus & contractile cells of breast
	ADH	Prevents excess urine production
Anterior Pituitary	GH	General body growth
	ACTH	Stimulate adrenal cortex to release hormone
	TSH	Controls thyroid gland
	LH	Stimulates sexual & reproductive function
	FSH	Stimulate production of sperm & egg in ovaries & testis
	PRL	Initiates milk production

Oxytocin - Oxytocin causes milk letdown in nursing mothers and <u>contractions during childbirth</u>.

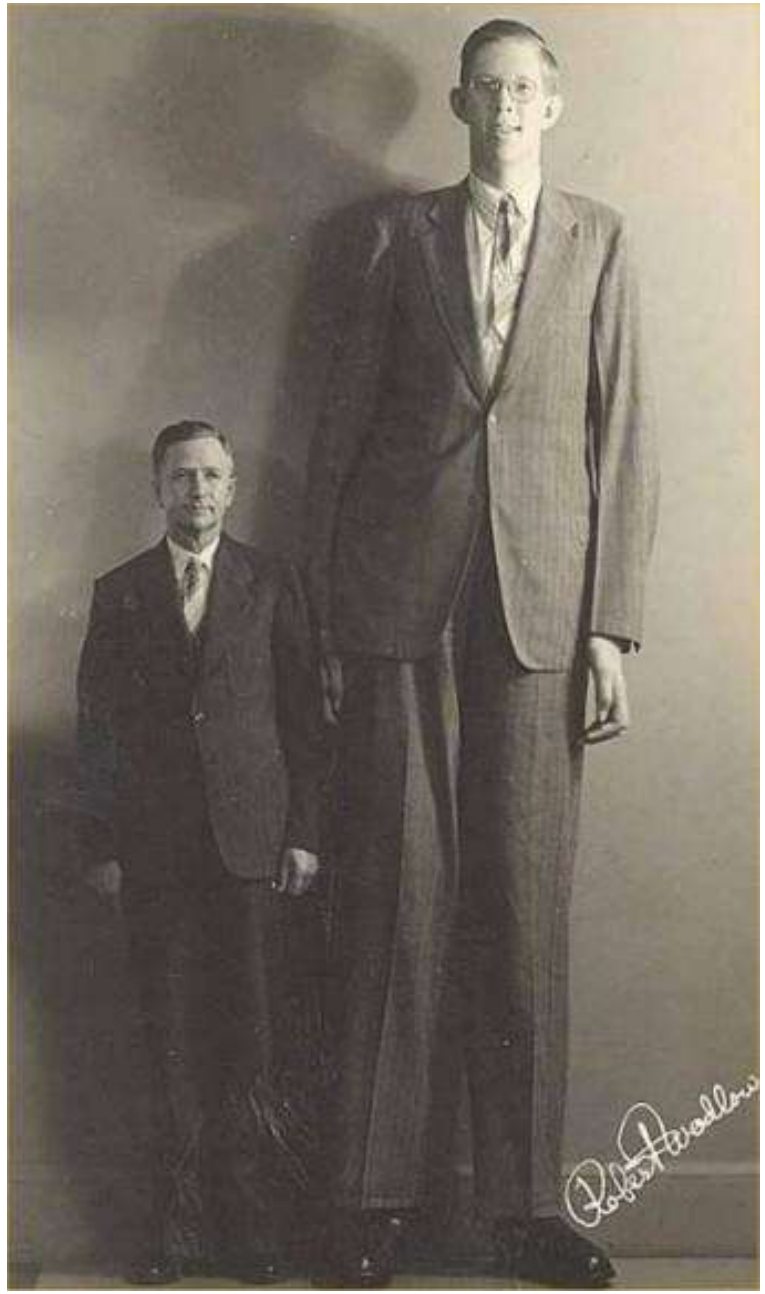
Pitocin, the synthetic form of oxytocin, can be used to induce labor, or to augment (speed up) labor.

Antidiuretic hormone or ADH

- ADH, also called vasopressin, is stored in the back part of the pituitary gland and regulates water balance. If this hormone is not secreted properly, this can lead to problems of sodium (salt) and water balance, and could also affect the kidneys so that they do not work as well.

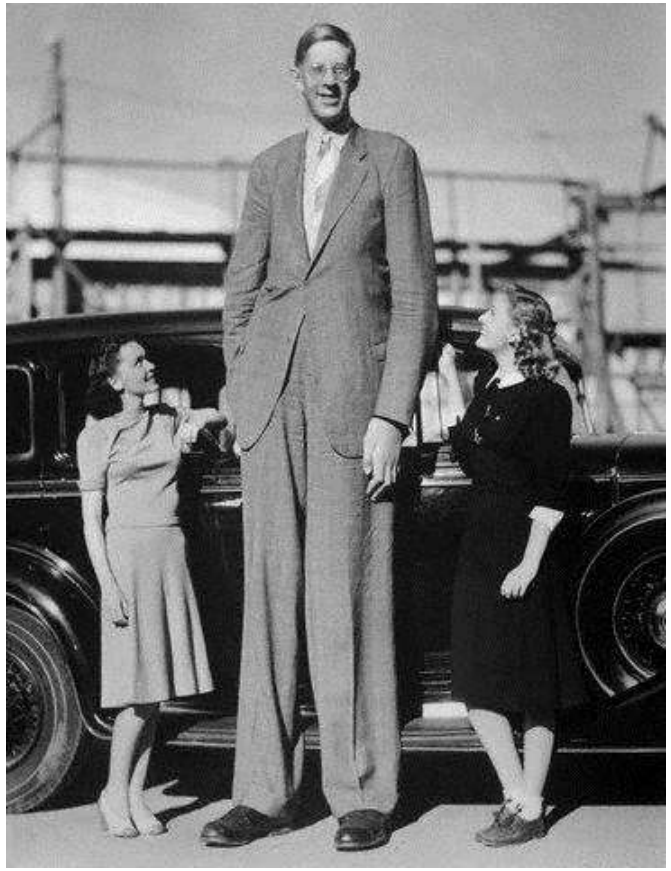
Problems with the pituitary gland can result in Dwarfism

Primordial Dwarfism



or Gigantism. These are pictures of the tallest man known as “The Alton Giant”

Robert Wadlow was 8’11”



Andre the Giant

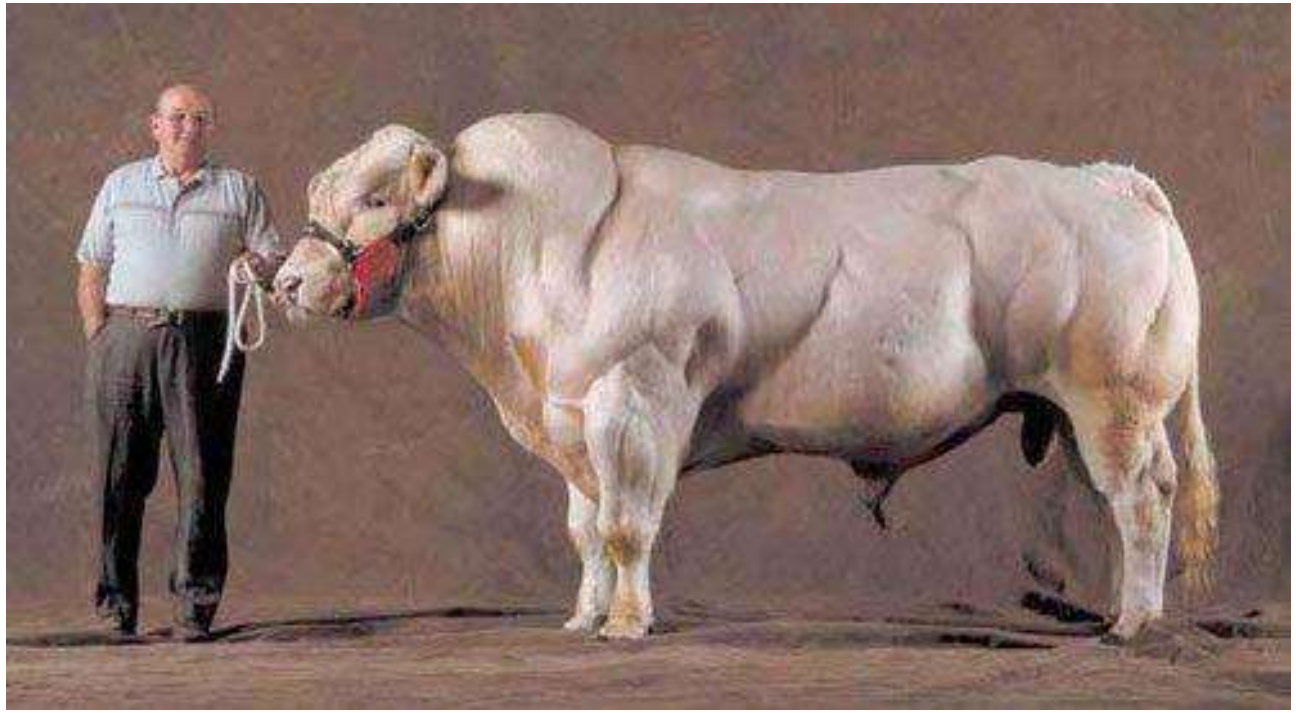
7'4" and 500 pounds

Acromegaly

- Over production of growth hormone after the epiphyseal plates have fused
- Bone shape changes
- Cartilaginous areas of skeleton enlarge
- Broad facial features
- Enlarged lower jaw

That’s a bull of the Belgian Blue breed, which has **a genetic anomaly that suppresses the production of a hormone called myostatin that inhibits muscle growth** – hence the ‘double muscling’ seen above.

Myostatin inhibitor drugs are being developed with the intent of treating muscle-wasting diseases like muscular dystrophy in humans.



Prolactin (PRL)

Stimulates milk production from a woman's breasts after childbirth and can affect sex hormone levels from the ovaries in women and the testes in men.

Story about the pharmaceutical side effect that caused lactation in young boys:

http://voices.yahoo.com/risperdal-causing-breast-development-children-as-3409314.html?cat=70

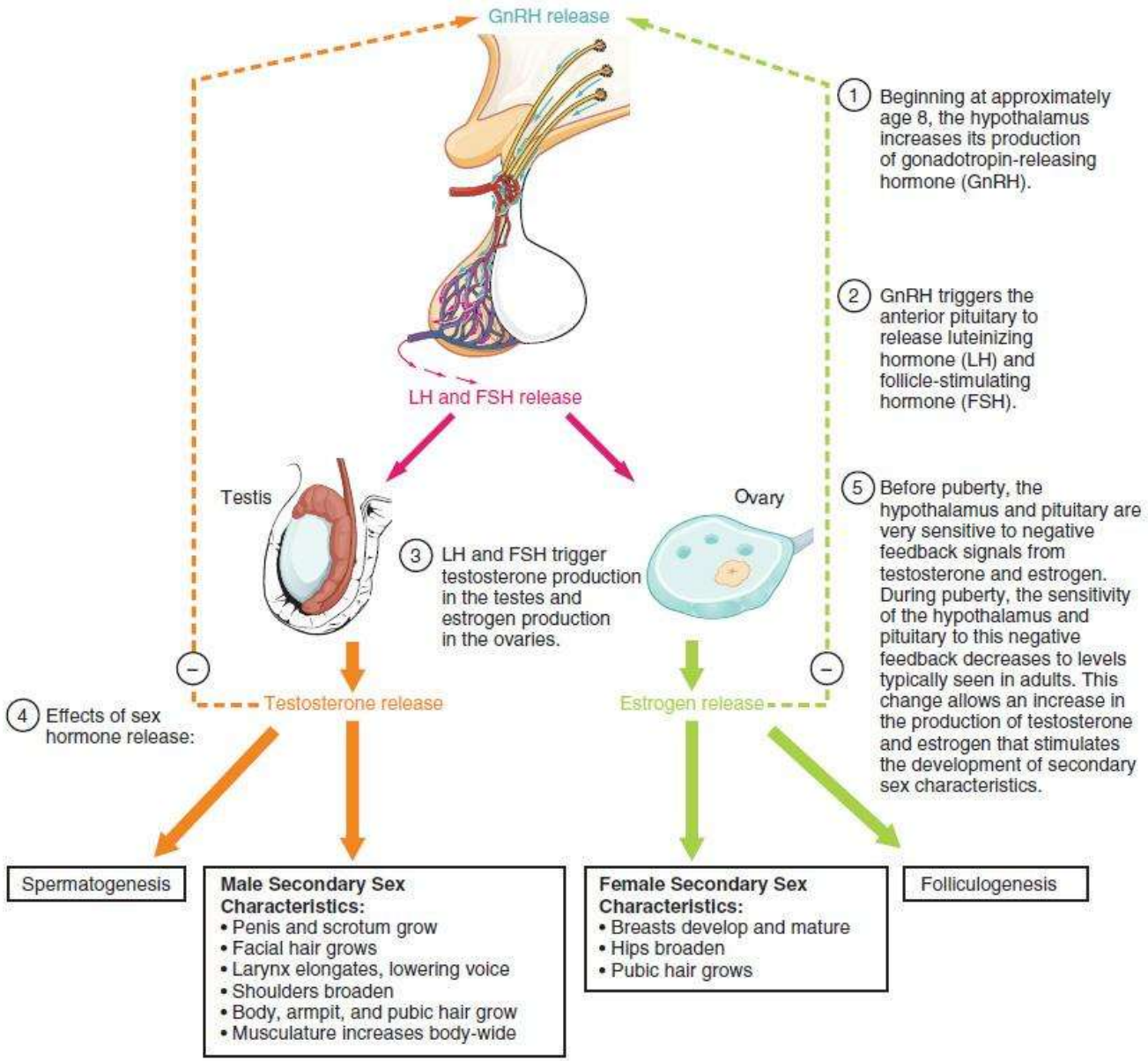
Adrenocorticotropin or ACTH - ACTH stimulates production of cortisol by the adrenal glands.

Cortisol, a so-called "stress hormone," is vital to survival. It helps maintain blood pressure and blood glucose levels.

Many diet aids claim that they block cortisol levels. Cortisol from stress may lead to fat deposits in the belly.

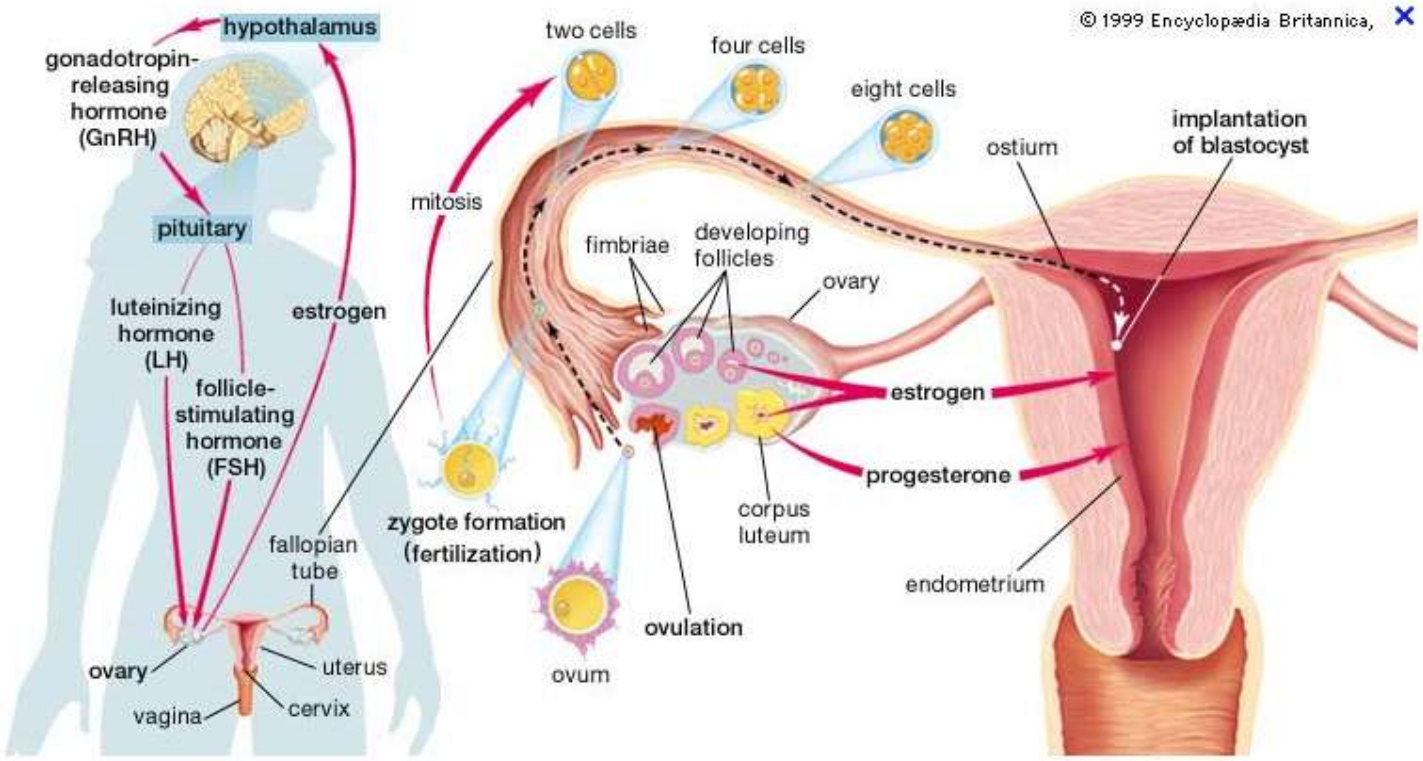
Thyroid-stimulating hormone or TSH - TSH stimulates the thyroid gland to make thyroid hormones, which, in turn, control (regulate) the body's metabolism, energy, growth and development, and nervous system activity.

Luteinizing hormone or LH - LH regulates testosterone in men and estrogen in women. (gonadotropin)



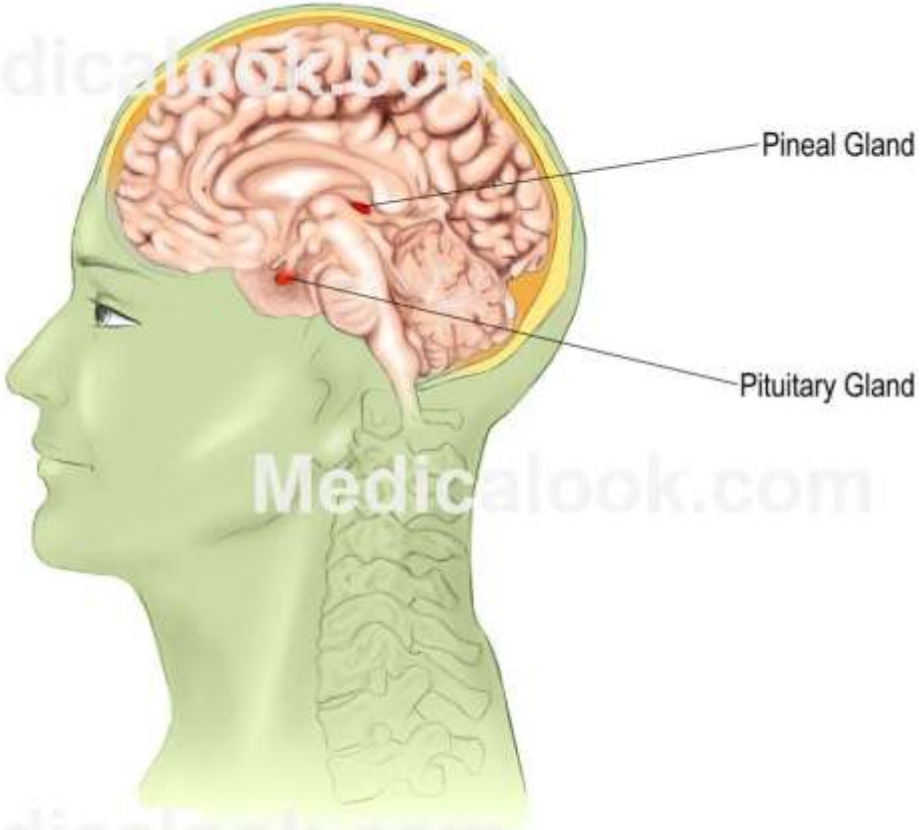
Follicle-stimulating hormone or FSH

FSH promotes sperm production in men and stimulates the ovaries to release eggs (ovulate) in women. LH and FSH work together to allow normal function of the ovaries or testes. (gonadotropin)



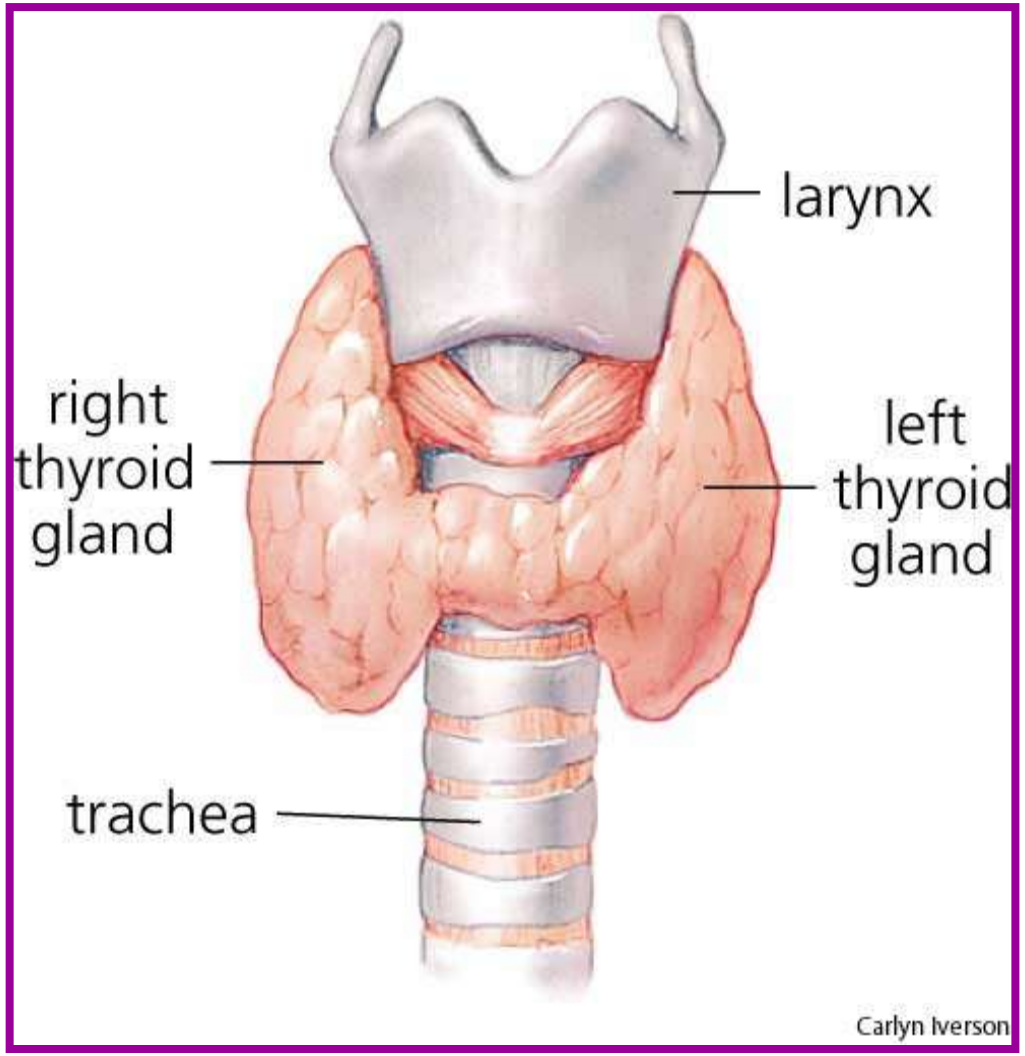
Pineal Body

- located between the cerebral hemispheres
- secretes **melatonin**, important for sleep and maintaining Circadian rhythms (light and dark activity)



THYROID GLAND

- **Located in middle anterior part of neck: below larynx, in front of trachea**
- **“Butterfly” shape**
- **Regulates metabolism**
- **↑ in size : puberty & pregnancy**
- **Rich blood supply: able to deliver high levels of hormones in short period of time**



THYROID HORMONES

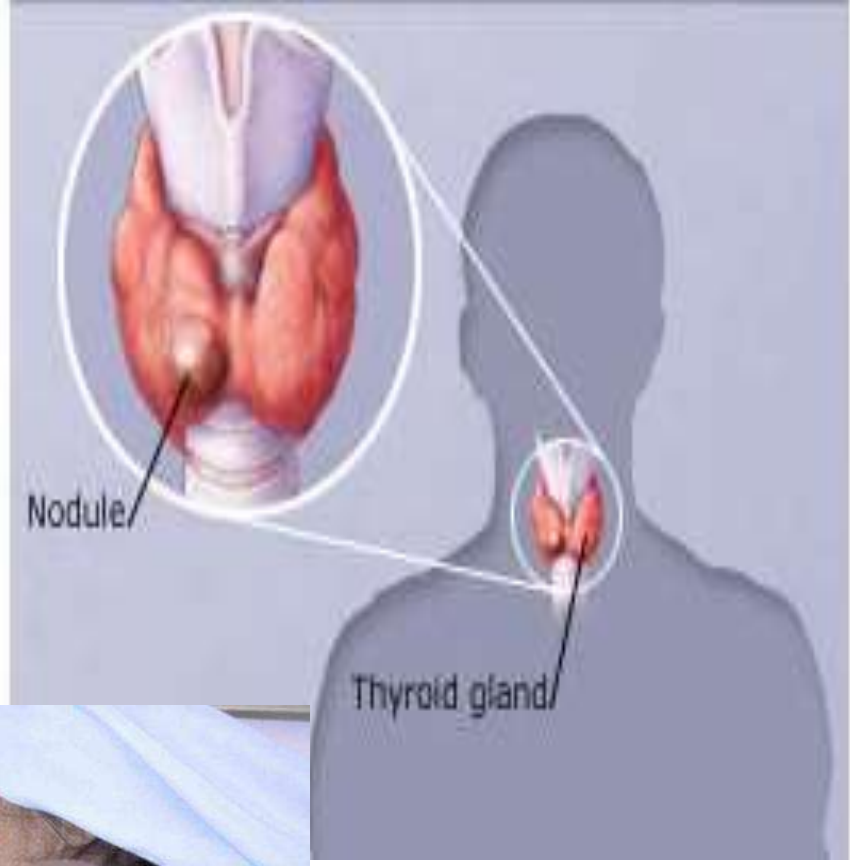
- **Thyroxin (T4) & Tri-iodothyronine (T3)** - both increase the rate at which cells release energy from carbohydrates

- **Calcitonin** – regulates the blood concentration of calcium

Goiter

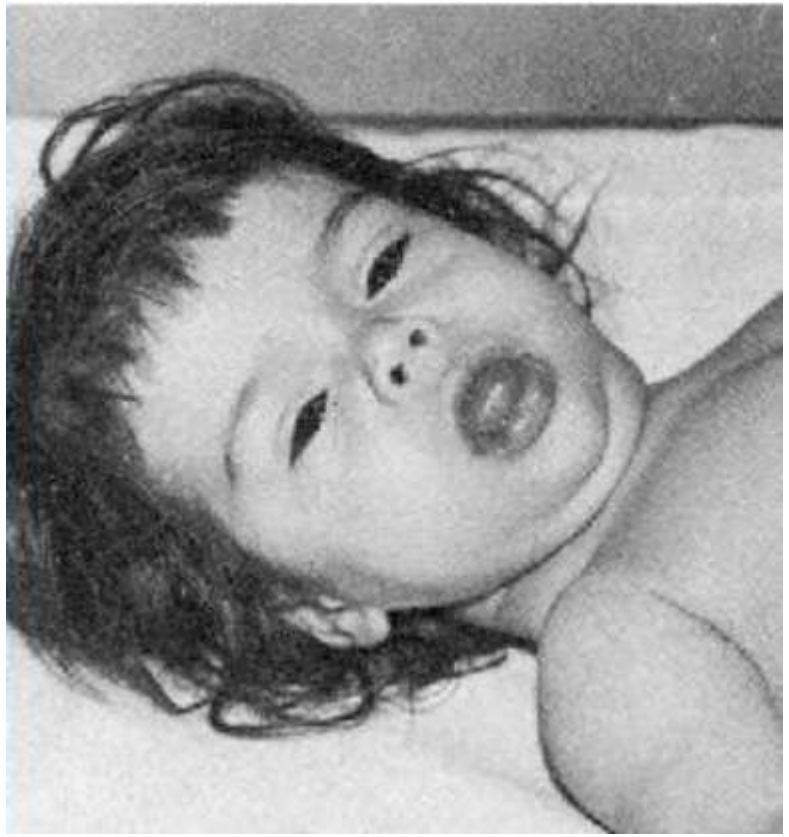
- Thyroid hormone is partly made of iodine. Iodine is essential for the formation of thyroxin. If a person doesn't eat enough iodine, they can't make thyroid hormone so it the size of the follicle grows

- Iodine is only found in seafood. If salt wasn't iodized, a lot of people wouldn't get enough iodine, and there would be a higher incidence of goiters.



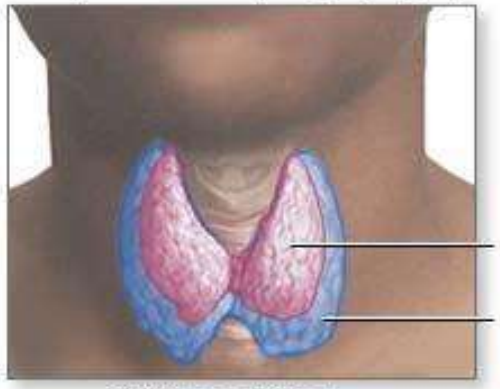
Hypothyroidism
Before and After Treatment

Cretinism (hypothyroidism in infants)



Hyperthyroidism (Grave's Disease)

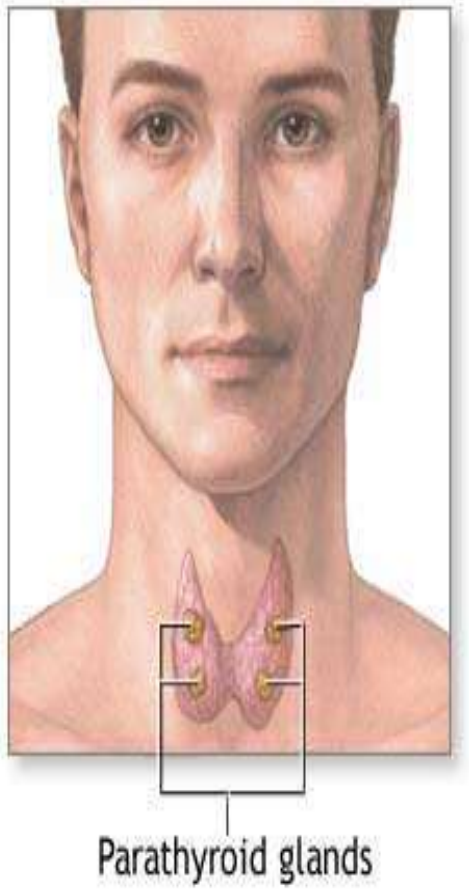
Exophthalmos (bulging eyes)



Diffuse goiter

Graves' disease is a common cause of hyperthyroidism, an over-production of thyroid hormone, which causes enlargement of the thyroid and other symptoms such as exophthalmos, heat intolerance and anxiety

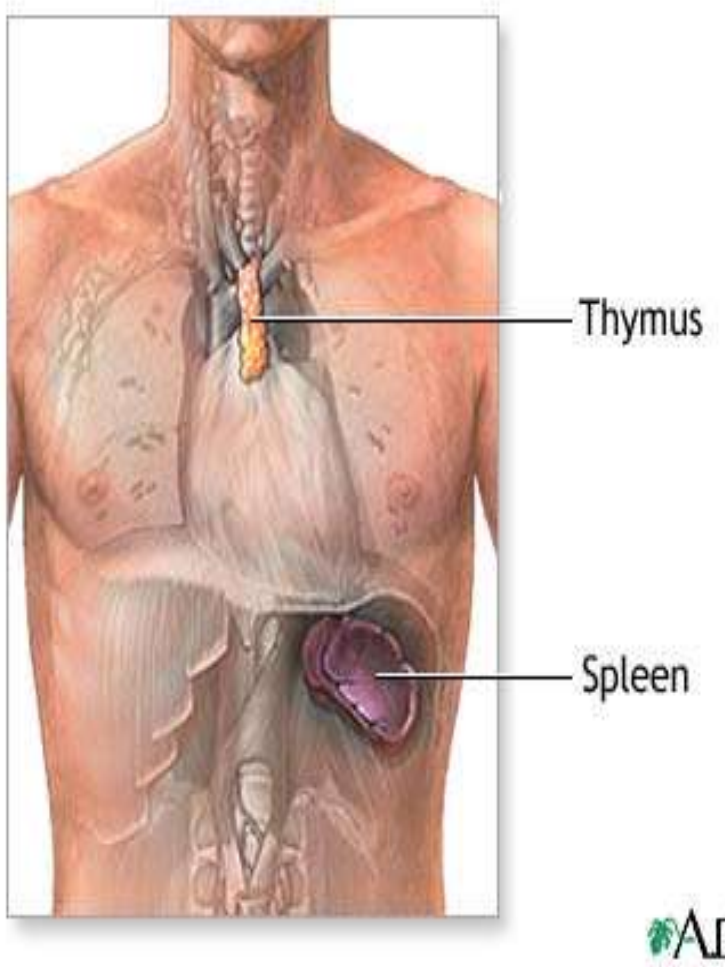
Parathyroid Glands



- Four tiny glands located behind the thyroid
- Produces Parathyroid hormone (PTH)
- Controls metabolism of calcium, taking calcium from the bones to make it available in the blood

Thymus

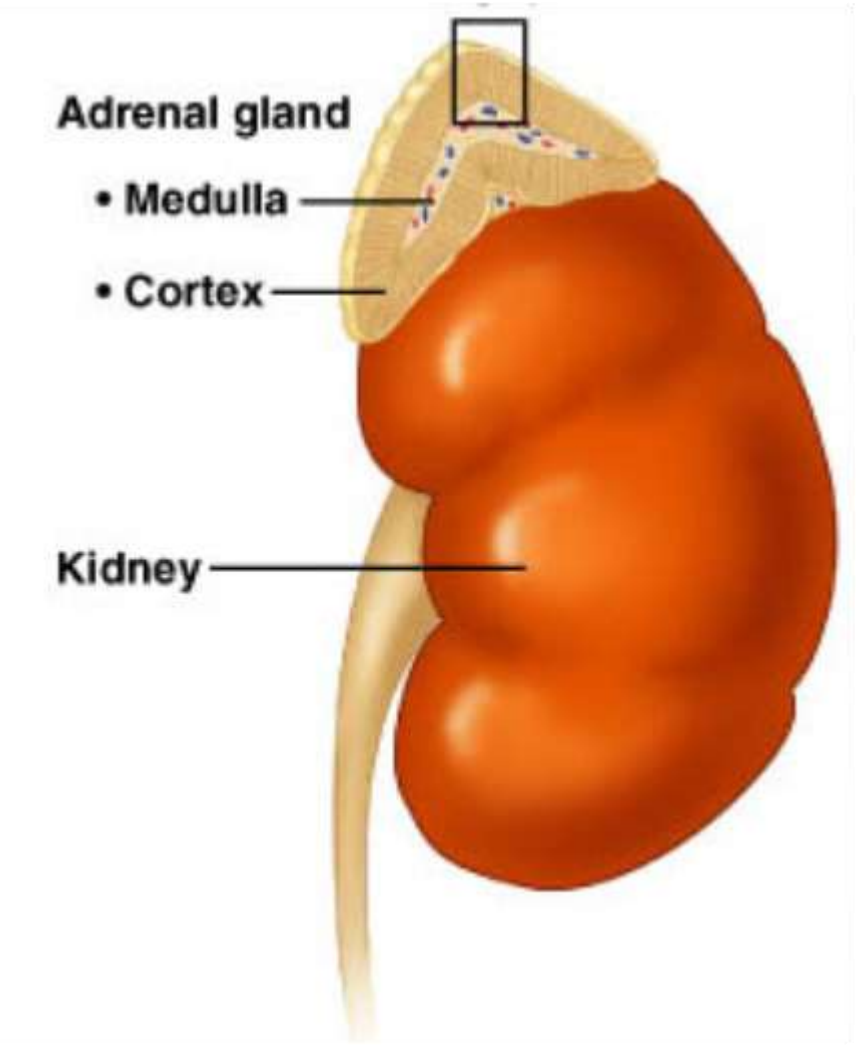
- Responsible for maturation of T-lymphocytes
- Plays a role in the immune system
- Produces thymosin, thymic humaral factor & thymic factor
- large in young children, gradually shrinks with age



Adrenal Glands

Located superior to the kidneys

Adrenal Cortex - outer area
Adrenal Medulla - inner area



Adrenal Medulla

- **Epinephrine (Adrenaline) & Norepinephrine** – increased heart rate, breathing rate, elevated blood pressure (fight or flight, response to stress)

People with severe life threatening allergies often carry injectors

Adrenal Cortex

- **Aldosterone** – a mineralcorticoid, helps kidneys conserve sodium and excrete potassium, maintaining blood pressure
- **Cortisol** – glucocortoid, keeps blood glucose levels stable
- **Adrenal Sex Hormones** - androgens (male) and estrogens (female)

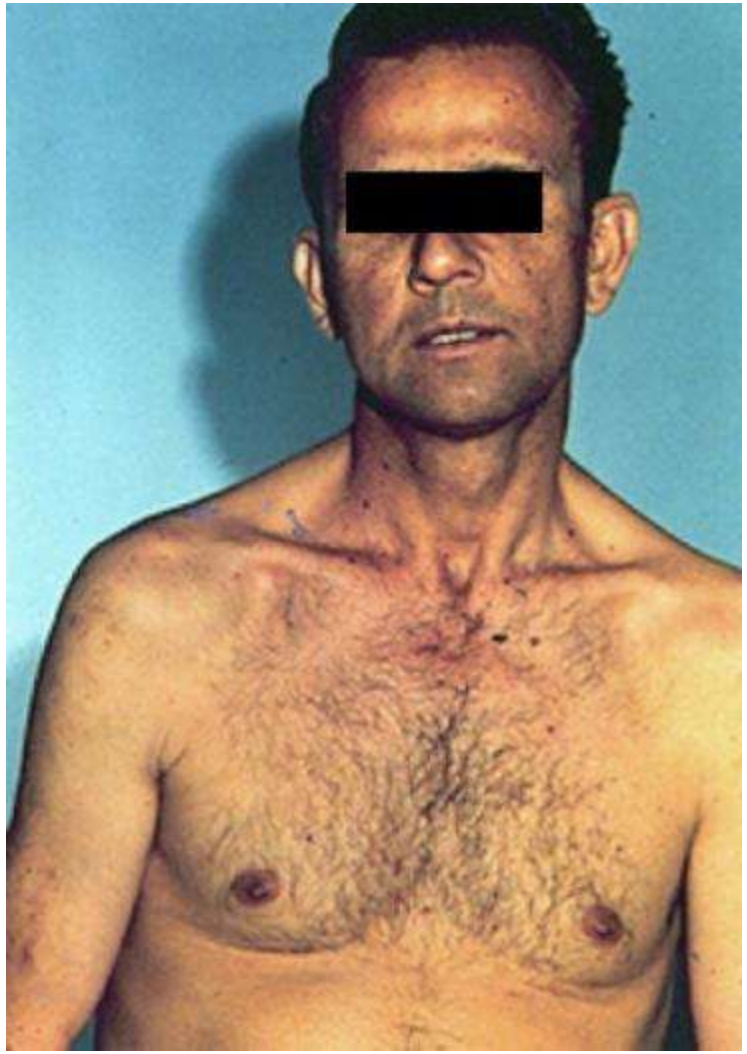
Cushing’s syndrome

- Hypersecretion of cortisol
- Adipose tissue accumulates in cheeks and base of neck resulting in round “moon” face and “buffalo hump”

Michael Santoro and his twin sister, Paula, who had Cushing's Syndrome.

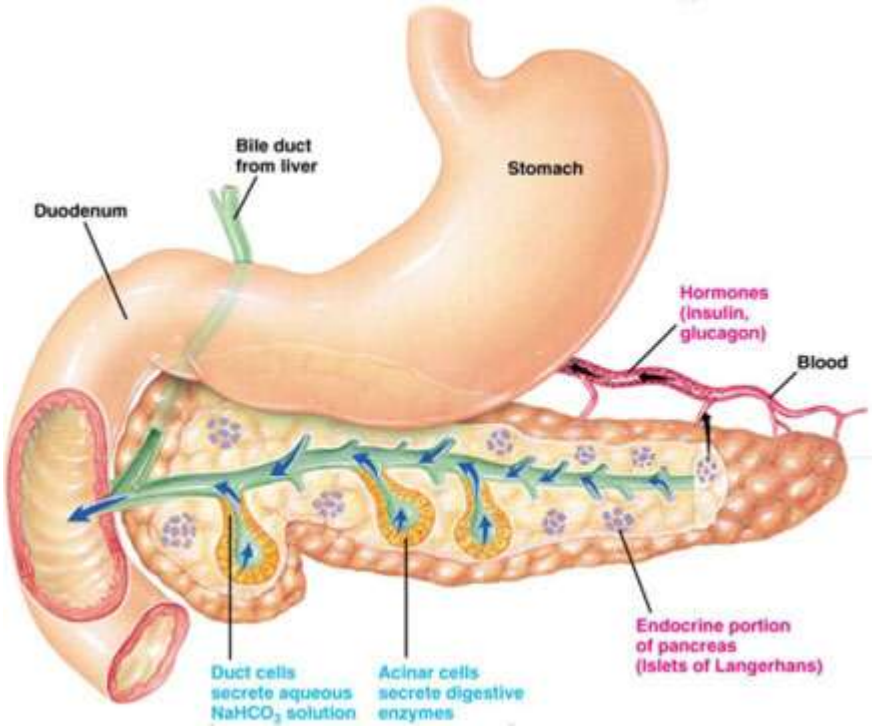
Addison’s disease

- Hyposecretion of cortisol
- Low blood pressure results
- Increased pigmentation



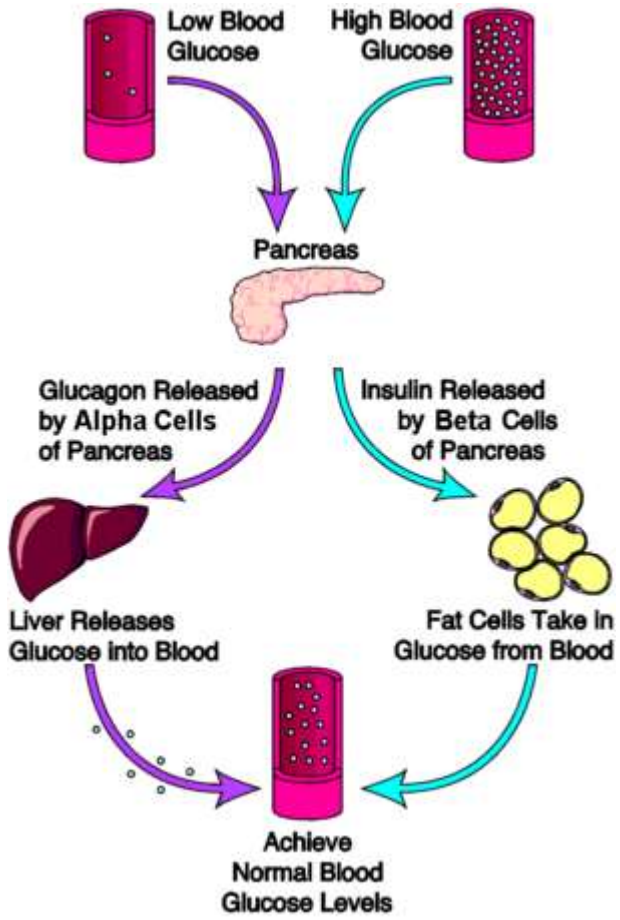
Pancreas

- The pancreas is a large gland behind your stomach that helps the body to maintain healthy blood sugar (glucose) levels.
- Contains islands of cells called the Islets of Langerhans which secrete glucagon and insulin

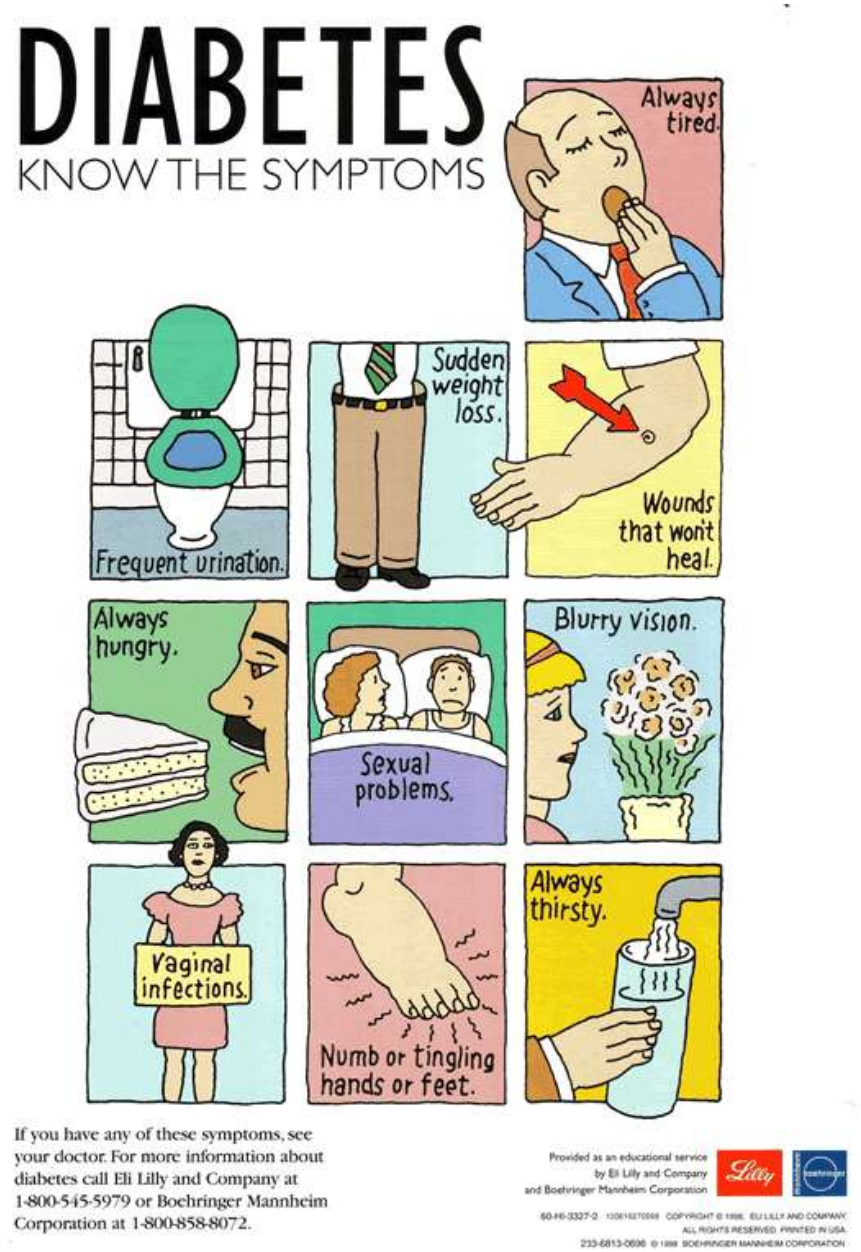


- **Glucagon** – stimulates the liver to break down glycogen, raises blood sugar concentration
- **Insulin** – decreases blood sugar concentrations, affects the uptake of glucose by cells

*Both hormones work together to maintain a balance in the blood sugar



Diabetic neuropathies are a family of nerve disorders caused by diabetes. People with diabetes can develop nerve damage throughout the body. Symptoms include pain, tingling, or numbness-loss of feeling-in the hands, arms, feet, and legs. This can result in wounds that are slow to heal.



Diabetes

- Diabetes Mellitus – results from an insulin deficiency, blood sugar rises (hyperglycemia) and excess is excreted in the urine.

- Type I - insulin dependent diabetes mellitus or juvenile onset diabetes, often caused by inherited immune disorder that destroys pancreatic cells

- Type II – mature onset diabetes (usually after the age of 40), often individuals are overweight, can be controlled with diet and exercise

Blood sugar test, device pricks the finger and measures the amount of sugar in the blood

Injection of insulin will lower the blood sugar levels

Hypoglycemia can occur if levels become too low, can be cured with direct injection of glucose or with eating something high in sugar.

Gestational Diabetes

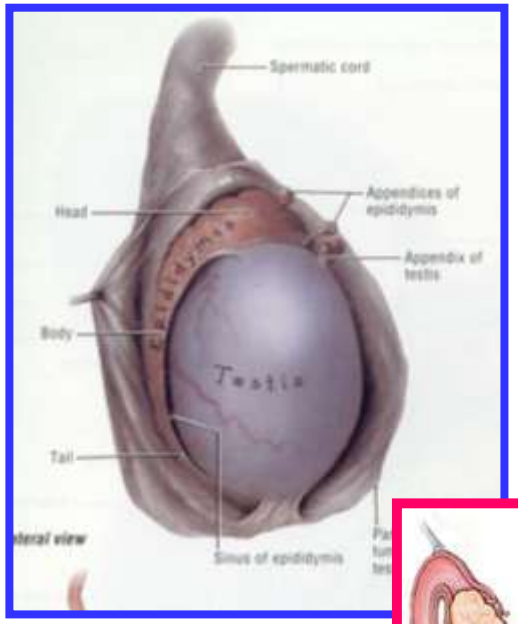
Pregnancy hormones can block insulin from doing its job. When this happens, glucose levels may increase in a pregnant woman's blood.

Gestational diabetes usually starts halfway through the pregnancy. All pregnant women should receive an oral glucose tolerance test between the 24th and 28th week of pregnancy to screen for the condition.

Gonads

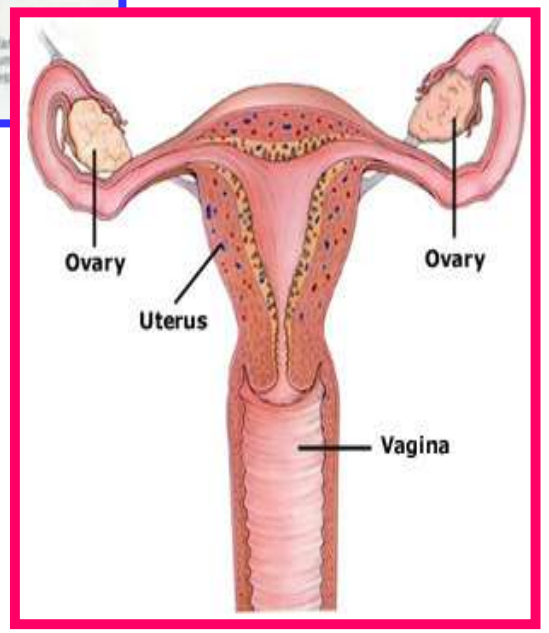
TESTES:

- **Located within scrotum**
- **Produce testosterone (an androgen)**
- **Stimulates development of male sexual characteristics**



OVARIES:

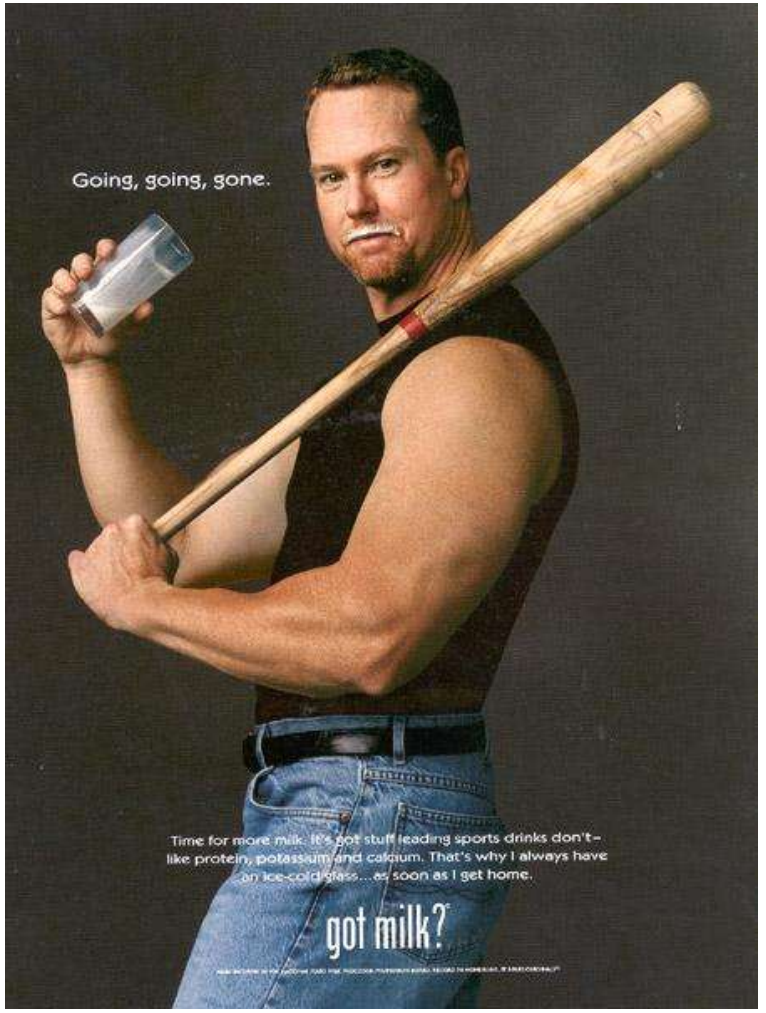
- **Located in pelvic cavity**
- **Produce estrogen & progesterone**
- **Responsible for development & maintenance of female characteristics & menstrual cycle**

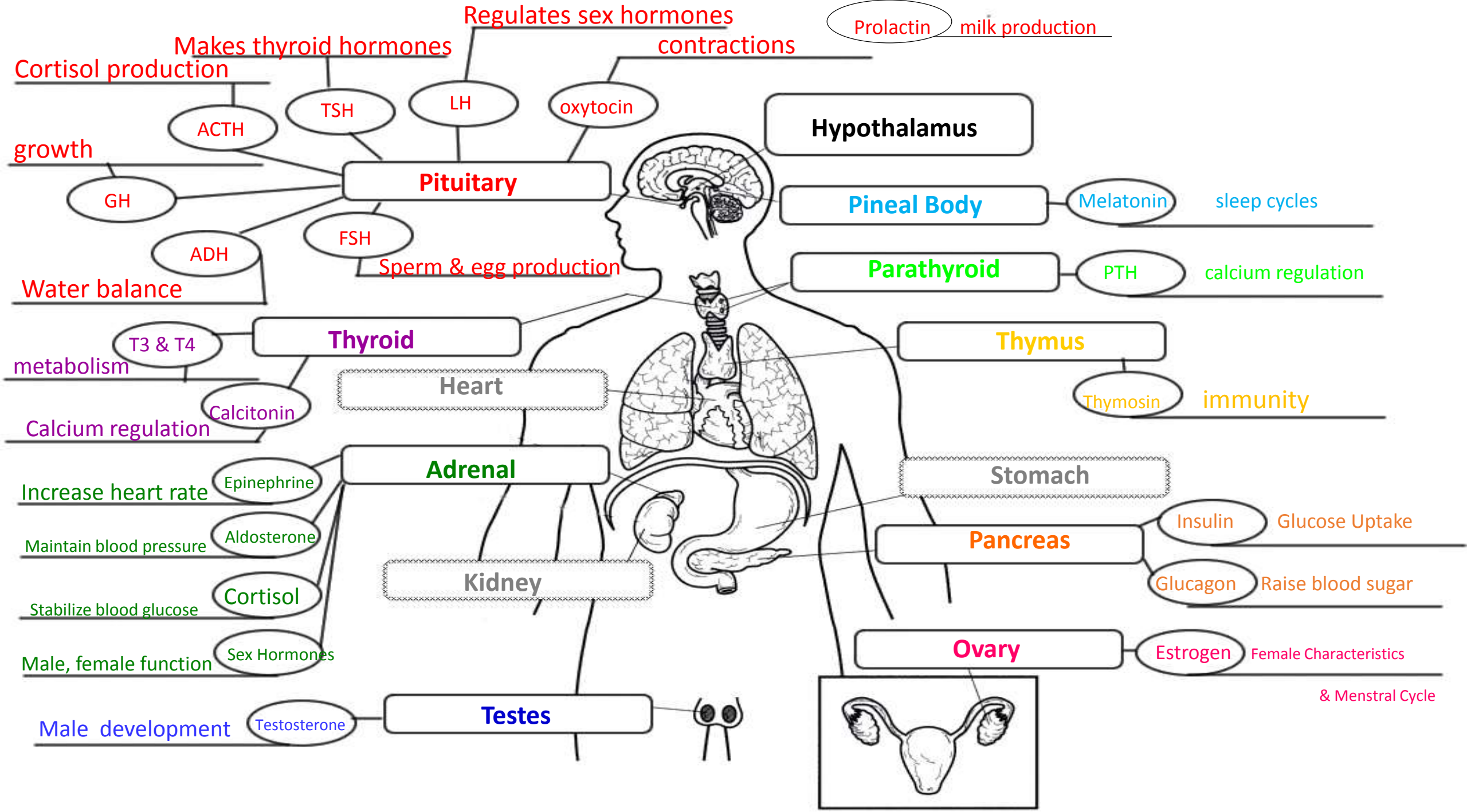


Gonadotropins - include any hormone (or group of hormones) that affect the gonads

Steroids

Anabolic steroids are artificially produced hormones that are the same as, or similar to, **androgens**, the male-type sex hormones in the body. There are more than 100 variations of anabolic steroids. The most powerful androgen is **testosterone.**




Regulates sex hormones
Prolactin
milk production
Makes thyroid hormones
contractions
Cortisol production
TSH
LH
oxytocin
ACTH
Hypothalamus
growth
Pituitary
GH
Pineal Body
Melatonin
sleep cycles
FSH
ADH
Parathyroid
PTH
calcium regulation
Sperm & egg production
Water balance
T3 & T4
Thyroid
Thymus
metabolism
Heart
Thymosin
immunity
Calcitonin
Calcium regulation
Adrenal
Stomach
Epinephrine
Increase heart rate
Insulin
Glucose Uptake
Aldosterone
Maintain blood pressure
Pancreas
Kidney
Glucagon
Raise blood sugar
Cortisol
Stabilize blood glucose
Ovary
Estrogen
Female Characteristics
Sex Hormones
Male, female function
& Menstral Cycle
Testes
Testosterone
Male development

Study tools

- Endocrine glands (6 foot 7 foot) rap - http://www.youtube.com/watch?v=uUr3j82qLQc
- Endocrine Glands Song - http://www.youtube.com/watch?v=fIJ7XN9upzs
- Khan Academy - https://www.khanacademy.org/science/mcat/organ-systems/endocrine-system/v/endocrine-gland-hormone-review