



# Endocrine System

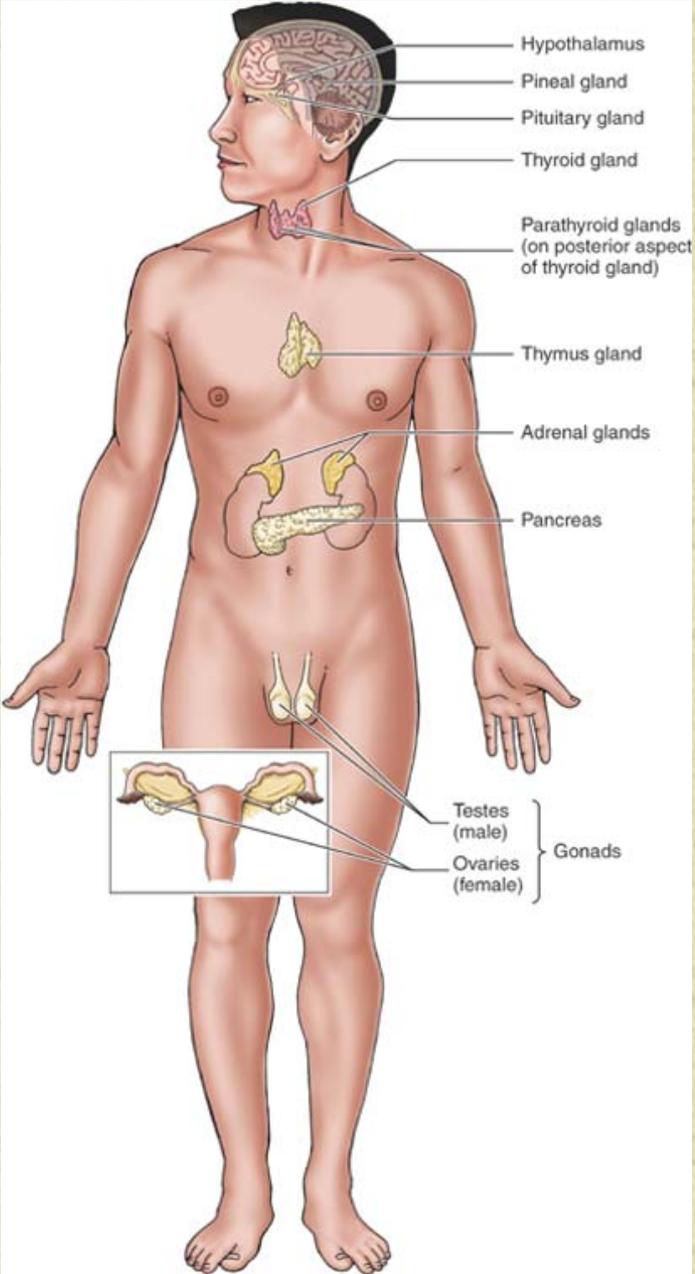
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Rita Carey-Nita R.N.  
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# Endocrine System

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✦ Consists of:

- ✦ Hypothalamus
- ✦ Pineal gland
- ✦ Pituitary gland
- ✦ Thyroid gland
- ✦ Parathyroid glands
- ✦ Thymus gland
- ✦ Adrenal gland
- ✦ Pancreas
- ✦ Gonads: ovaries & testes



# Endocrine System

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## ✦ Endocrine system:

- ✦ 2<sup>nd</sup> major communicating system in the body
- ✦ Regulates nearly all organs
- ✦ Communicates by secreting hormones
- ✦ Composed of endocrine glands
- ✦ Ductless glands that secrete hormones directly into the capillaries

# Endocrine System

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## ✦ Purpose:

- ✦ Regulates metabolism
- ✦ Role in growth & development
- ✦ Regulate water & electrolyte balance
- ✦ Help to meet the demands of stress, infection or trauma on the body

# Endocrine System

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## ✦ Hormones:

- ✦ Chemical messengers that influence or control the activities of other tissues or organs

## ✦ 2 Classes of hormones:

- ✦ Protein: most hormones in body
- ✦ Steroid: sex glands & adrenal cortex

## ✦ Targets:

- ✦ each hormone binds to a specific tissue called target tissue
- ✦ May be close or at a distance from the endocrine gland

# Endocrine System

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## ✦ Hormone Receptors:

- ◆ Hormones interact with the receptor sites of the cells of their target tissues
- ◆ Think of hormones & target tissue as a lock & key; only certain cell will be stimulated by the hormone

## ✦ Two types of receptors:

- ◆ Membrane receptors: located on outside of cell
- ◆ Intracellular receptors: located inside the cell

# Endocrine System

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## ✦ Protein Hormones:

- ✦ Protein hormones generally combine with the receptors sites located on the cell membrane
- ✦ The interaction of the hormone with its receptor stimulates the production of a 2<sup>nd</sup> messenger such as cyclic adenosine monophosphate.
- ✦ cAMP then helps to activate the enzymes in the cell

# Endocrine System

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## ✦ Steroid Hormones:

- ◆ Are lipid-soluble so they pass through the cell membrane of the target cell & bind with the receptor in the nucleus
  - The steroid-receptor complex then stimulates protein synthesis

# Endocrine System

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## ✦ Control of Hormone secretion:

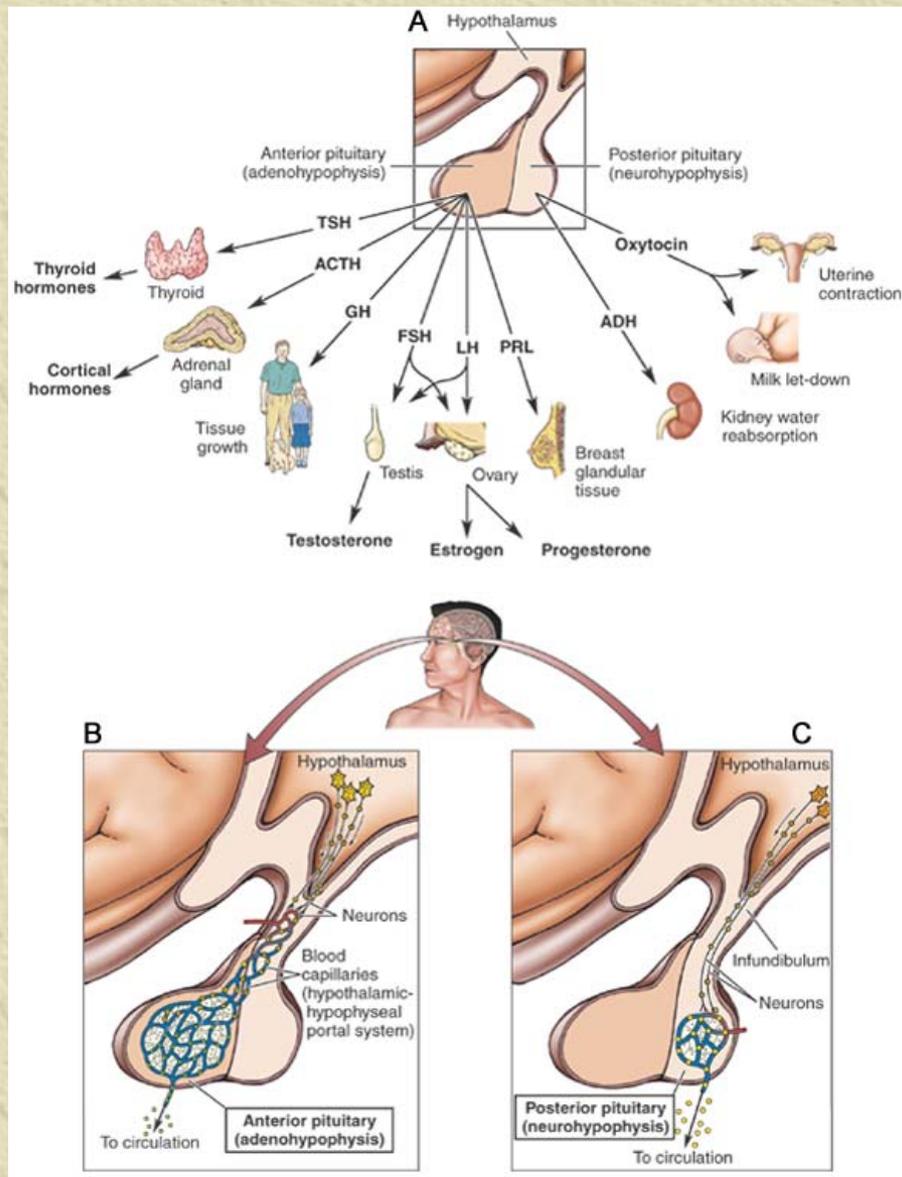
- ✦ Negative Feedback: information about the hormone & its effect are fed back to the gland that secretes the hormone; hormone is secreted by the gland until its had enough
- ✦ Biorhythms: rhythmic alteration in hormone's rate of secretion; Timed release
- ✦ Central Nervous System: controls in 2 ways
  - Activation of hypothalamus
  - Stimulation of sympathetic nervous system

# Endocrine System

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## ✦ Hypothalamus:

- ✦ considered a part of the brain & an endocrine gland
- ✦ Major integrating link between nervous & endocrine system
- ✦ Has important regulatory role in nervous system & is crucial endocrine gland
- ✦ controls the anterior pituitary gland by way of hormones secreted into a network of capillaries that connect the hypothalamus to the anterior pituitary gland
- ✦ The network of capillaries are called the hypothalamic-hypophyseal portal system
- ✦ The hypothalamic hormones that control the anterior pituitary are releasing hormones & release-inhibiting hormones



# Endocrine System

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## Pituitary Gland:

- ◆ Also called the master gland because it controls endocrine activity
- ◆ Pea-sized gland connected to the undersurface of the hypothalamus by the infundibulum & rests in the sella turcica (Turk's saddle) of the sphenoid bone
- ◆ Two main parts:
  - Anterior
  - Posterior

# Endocrine System

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## ✦ Anterior Pituitary Gland:

- ✦ Composed of glandular epithelial tissue
- ✦ AKA adenohypophysis
- ✦ Secretes 6 major hormones which control other glands & many organ systems
  - ♦ Thyroid-stimulating hormone (TSH)
  - ♦ Adreno-corticotropic hormone (ACTH)
  - ♦ Growth hormone (GH)
  - ♦ Gonadotropins: follicle-stimulating hormone (FSH) & lutenizing hormone (LH)
  - ♦ Prolactin (PRL)

# Anterior Pituitary Gland

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## ✦ Growth Hormone (GH):

- ✦ AKA somatotropin or somatotrophic hormone
- ✦ Affects the growth of skeletal muscles & long bones of the body; determining a persons size & height
- ✦ Metabolic effects:
  - Causes amino acids to be built
  - proteins & fats to be broken down for energy
  - Conversion of protein to glucose
  - Increases blood glucose
- ✦ Secretes during periods of exercise, sleep & hypoglycemia

# Anterior Pituitary Gland

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## ✦ Prolactin (PRL):

- ✦ AKA: Lactogenic hormone
- ✦ Promotes milk production in women
- ✦ Target organ is the breast
- ✦ Stimulates the growth of mammary glands & produces milk during childbirth
- ✦ As long as breastfeeding continues PRL levels remain high & milk is produced

# Anterior Pituitary Gland

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## ✦ Tropic Hormones:

- ✦ Aimed at & controls other glands
- ✦ Note the *tropin* or *tropic* in each hormones name
  - Thyrotropin or thyroid-stimulating hormone (TSH)
  - Adrenocorticotrophic hormone (ACTH)
  - Gonadotropic hormones:
    - ✦ Follicle-stimulating hormone (FSH)
    - ✦ Lutenizing hormone (LH)
    - ✦ Interstitial cell-stimulating hormone (ICSH)

# Anterior Pituitary Gland

## Tropic Hormones

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✦ Thyrotropin or thyroid-stimulating hormone (TSH):

- ✦ Target organ is the thyroid gland
- ✦ TSH stimulates the thyroid gland to two thyroid hormones

✦ Adrenocorticotrophic hormone:

- ✦ Target gland is adrenal cortex
- ✦ ACTH stimulates the adrenal cortex to secrete three steroids, one being cortisol

# Anterior Pituitary Gland

## Tropic Hormones

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### ✦ Gonadotropic hormones:

- ✦ Target glands are the gonads:
  - Ovaries in ♀ & testes in ♂
- ✦ Follicle-stimulating hormone (FSH) stimulates the development of the ova in women & the development of sperm in men
- ✦ Lutenizing hormone (LH) causes ovulation in females & the secretion of sex hormones in both females & males
- ✦ Lutenizing hormones in males is called Interstitial cell-stimulating hormone (ICSH) which stimulates interstitial cells in the testes to synthesize & secrete testosterone

# Posterior Pituitary Gland

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## ✦ Posterior pituitary gland:

- ✦ Is an extension of the hypothalamus
- ✦ Composed of nervous tissue & called Neurohypophysis
- ✦ Two hormones of the posterior pituitary gland are produced in the hypothalamus & transported to the gland for storage until needed
- ✦ Nerve impulses from the hypothalamus stimulate release of posterior hormones
- ✦ The two hormones are:
  - Antidiuretic hormone & Oxytocin

# Posterior Pituitary Gland

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## ✦ Antidiuretic Hormone (ADH):

- ✦ Target organ is kidney
- ✦ ADH causes the kidney to reabsorb water & return it to the blood which decreases urine output
- ✦ ADH is released in response to a concentrated plasma which occurs in dehydration
- ✦ Plasma concentration is increased when blood volume decreases or solute in blood increases
- ✦ Other triggers include:
  - stress—trauma—morphine—nicotine
- ✦ ETOH inhibits the secretion of ADH causes ↑ urination
- ✦ ADH is called a vasopressor because it constricts the blood vessels causing an increase of blood pressure

# Posterior Pituitary Gland

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## ✦ Oxytocin:

- ✦ Target organs are the uterus & mammary glands
- ✦ Stimulates muscles of the uterus to contract & plays role in labor & delivery of a baby
- ✦ Also stimulates the contraction of smooth muscles surrounding mammary ducts causing the release of breast milk
- ✦ Referred to as the “let down” reflex

# Third Lobe of Pituitary Gland

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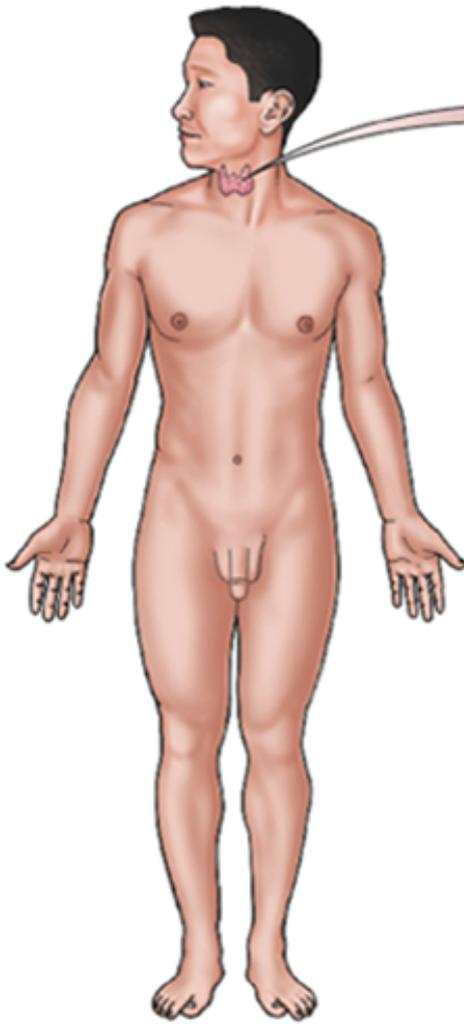
- ✦ A small third lobe of the pituitary gland secretes melanocyte-stimulating hormone (MSH)
- ✦ When stimulated, melanocytes increase the secretion of melanin increasing the pigmentation of the skin

# Thyroid Gland

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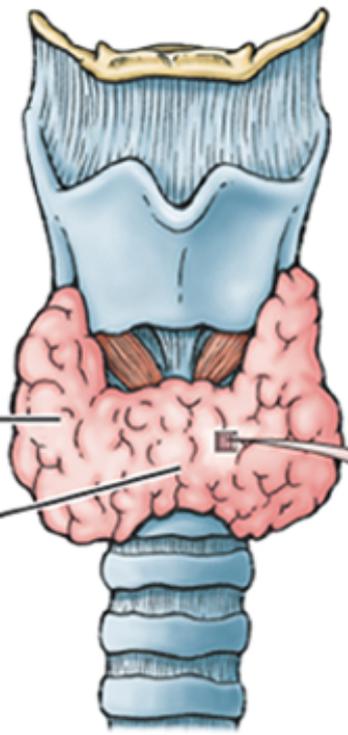
- ✦ Located in the anterior neck, on the front & sides of the trachea & below the larynx
- ✦ Two lobes connected by a band of tissue called the isthmus
- ✦ Enclosed in a connective tissue capsule
- ✦ Contains two types of cells:
  - ◆ Follicular cells within the thyroid follicle
  - ◆ Parafollicular cells between the follicles

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Thyroid gland

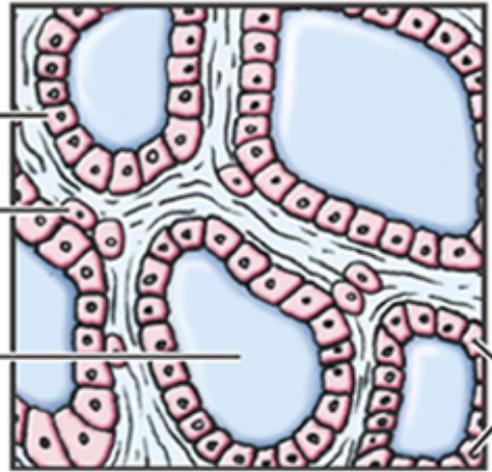
Isthmus



Follicular cell

Parafollicular cell

Colloid



Follicle

# Thyroid Gland

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## ✦ Thyroid Follicle:

- ✦ Follicles are secretory units that make up the thyroid gland
- ✦ Cavity in each follicle is lined with cuboidal cell & filled with a clear viscous substance called colloid
- ✦ Follicular cells secrete:
  - Triiodothyronine: T3
  - Tetraiodothyronine: T4 or thyroxine

# Thyroid Gland

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## ✦ What Thyroid Hormones Do:

- ✦ T3 & T4 have similar function but T3 is more potent
- ✦ Regulate metabolism of carbohydrates, proteins & fats
- ✦ Increase metabolism
- ✦ Affect growth & development & nervous system

# Thyroid Gland

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## ✦ Hypothyroidism:

- ✦ AKA myxedema
- ✦ Slowed metabolic rate
- ✦ Symptoms: slow HR, constipation, low energy, low body temperature, hair loss & weight gain

## ✦ Hyperthyroidism:

- ✦ AKA Graves Disease
- ✦ Increased metabolic rate
- ✦ Symptoms: increased HR, diarrhea, increase in body temperature, hyperactive, mood swings & weight loss

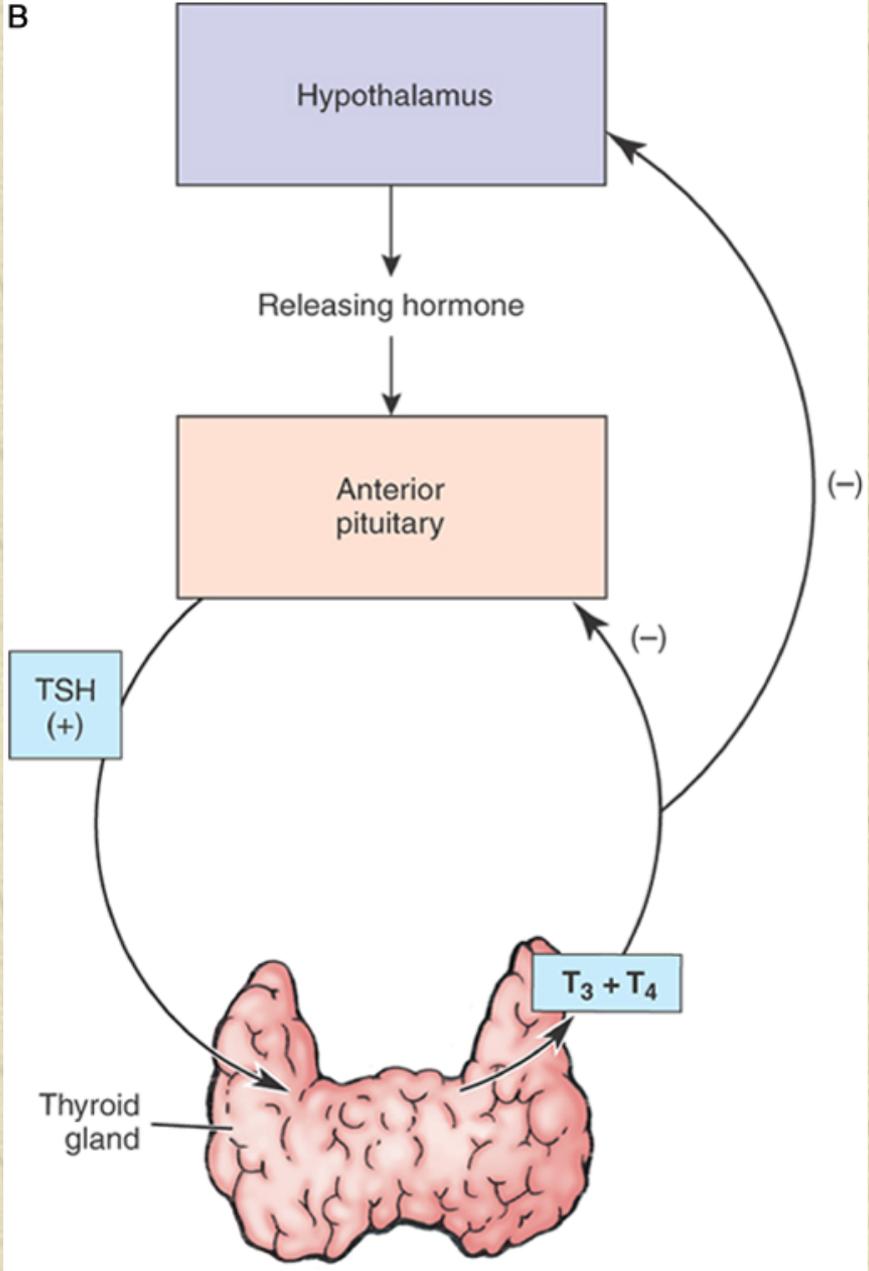
# Thyroid Gland

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## ✦ Regulation of Secretion:

- ✦ The hypothalamus secretes a releasing hormone, which stimulates the anterior pituitary to secrete TSH.
- ✦ TSH stimulates the thyroid to secrete T3 & T4
- ✦ When plasma level of T3 & T4 increase sufficiently, negative feedback prevents further secretion of TSH from the thyroid

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# Thyroid Gland

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## ✦ Need for Iodine

- ✦ The synthesis of T3 & T4 requires iodine from dietary source
- ✦ Iodine from the blood is pumped into the follicular cells of the thyroid gland where it is used in the synthesis of the thyroid hormones
- ✦ T4 (tetraiodothyronine or thyroxine) has 4 iodine atoms  
T3 (triiodothyronine) has 3 iodine atoms
- ✦ Diet low in iodine results in low T3 & T4 causing hypothyroidism & a goiter

# Thyroid Gland

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## ✦ Iodine Deficiency:

- ✦ With insufficient iodine, thyroid hormones cannot be produced in enough amounts to shut off the TSH secretion through negative feedback
- ✦ Continued stimulation of the thyroid gland by TSH enlarges the thyroid gland creating a goiter

# Thyroid Gland

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## ✦ Calcitonin:

- ✦ Hormone secreted by the thyroid gland
- ✦ Secreted by the parafollicular cell in the thyroid follicles
- ✦ Regulates plasma levels of calcium
- ✦ Decreases blood calcium levels by stimulating osteoblastic activity in bones which in turn moves calcium from blood to bone
- ✦ Increases excretion of calcium in urine
- ✦ Acts as an antagonist to PTH
- ✦ Controlled by negative feedback

# Parathyroid Gland

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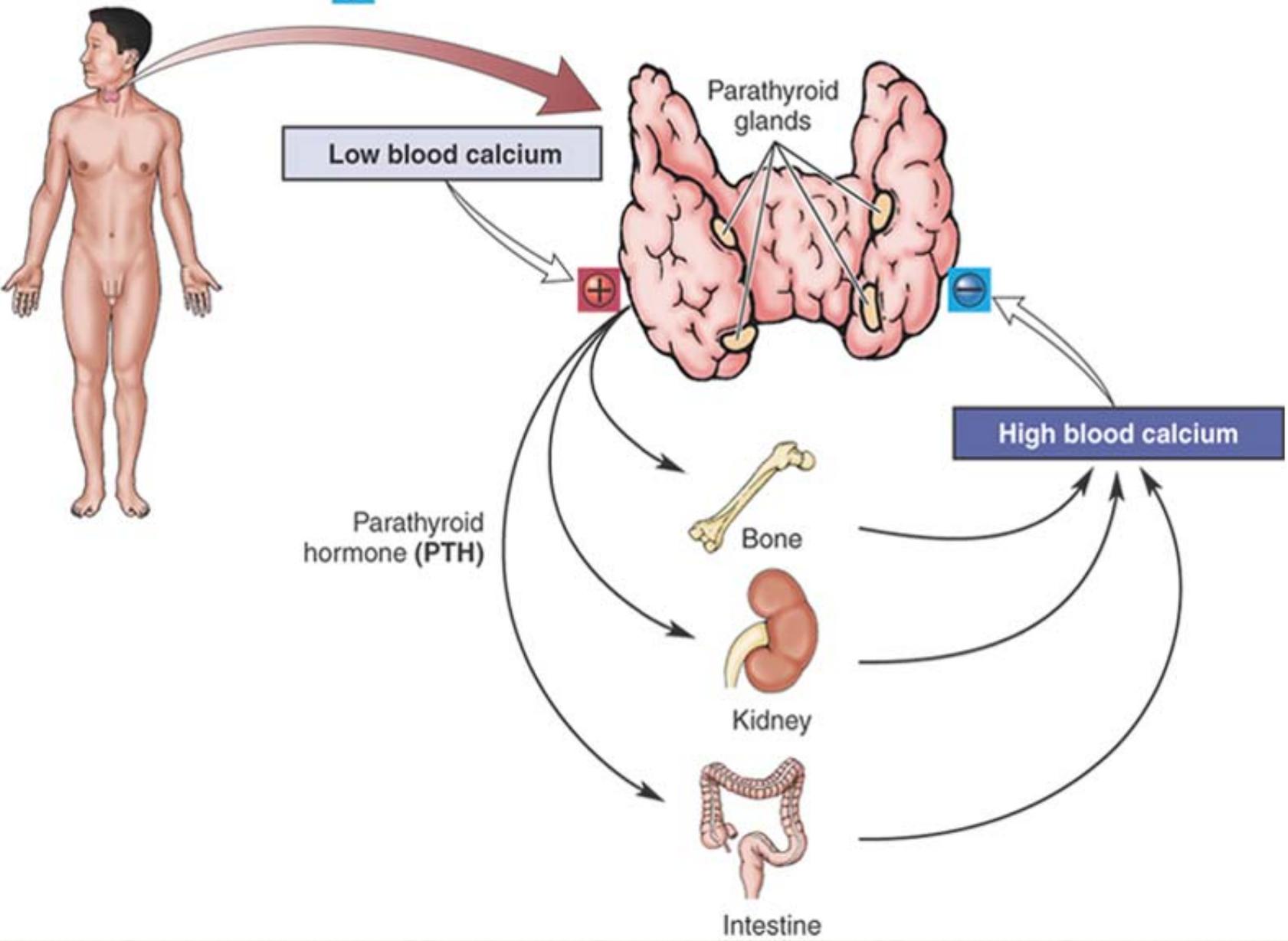
- ✦ Four tiny parathyroid glands lie along the posterior surface of the thyroid gland
- ✦ Secretes parathyroid hormone (PTH)
- ✦ Low plasma levels of calcium stimulate the release of PTH
- ✦ Controlled by negative feedback
- ✦ Three target organs: bone, intestines & kidneys
- ✦ PTH increases plasma calcium levels

# Parathyroid Gland

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- ✦ PTH increase plasma calcium in 3 ways:
1. Increases the release of calcium from bone tissue by stimulation of osteoclastic activity which in turn move calcium from bone & into the blood
  2. Stimulates the kidneys to reabsorb calcium from the urine
  3. Increases the absorption of calcium by the intestines

 Stimulates  
 Inhibits

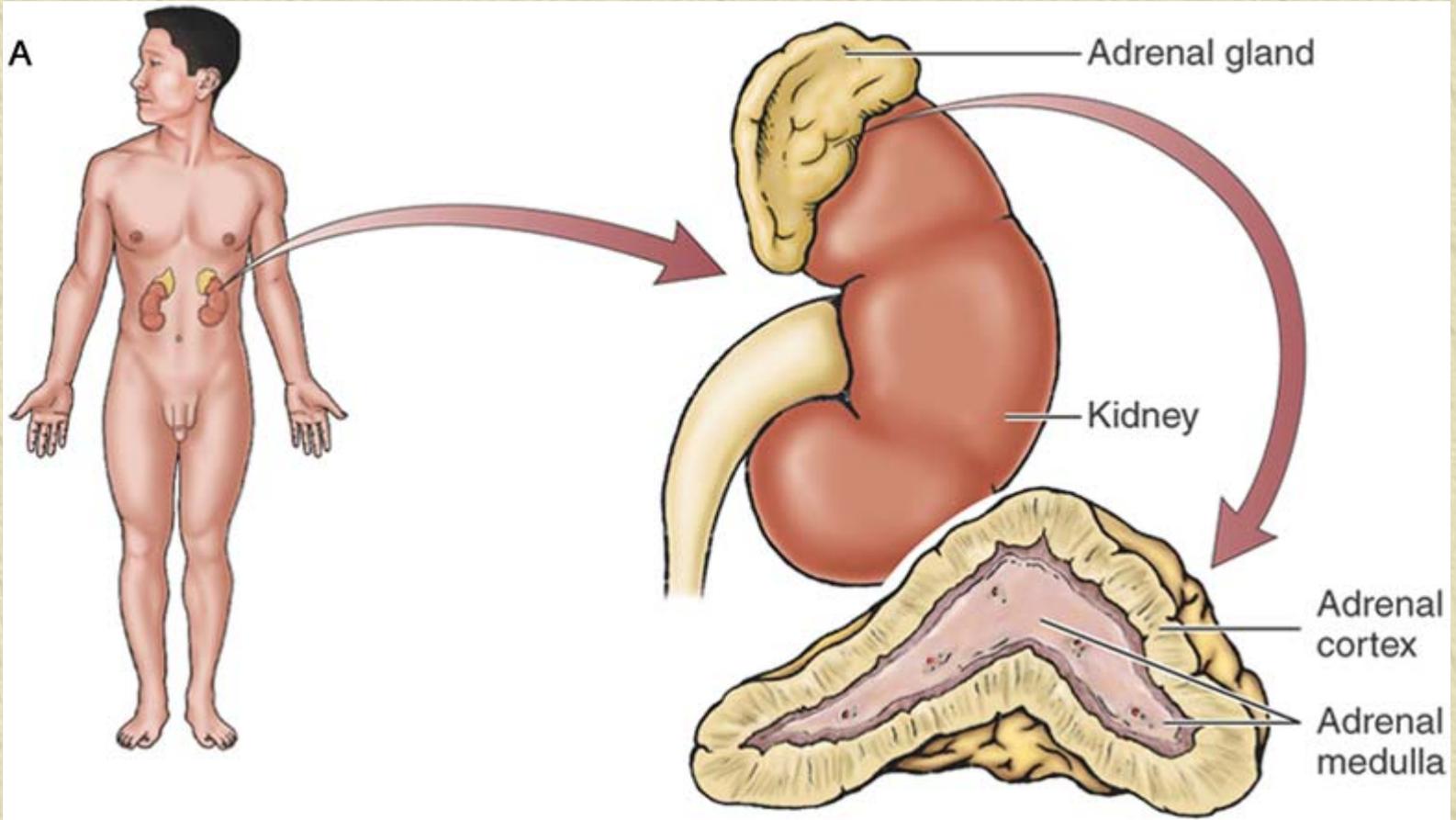


# Adrenal Gland

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- ✦ Two small glands located above the kidneys
- ✦ Consist of two regions:
  - ◆ Inner medulla & outer cortex
- ✦ Secretes different hormones
- ✦ Adrenal cortex secretes hormones essential to life
- ✦ Adrenal medulla secretes hormones non-essential to life

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# Adrenal Gland

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## ✦ Adrenal Medulla:

- ✦ Inner region of the adrenal gland
- ✦ Considered an extension of the sympathetic nervous system
- ✦ Secretes two hormones:
  - Epinephrine & norepinephrine
- ✦ Called sympathomimetic hormones because they mimic the hormones of the sympathetic nervous system

# Adrenal Gland

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- ✦ Epinephrine & norepinephrine equip the body to meet the challenges of stress or in response to the stimulation of the sympathetic nervous system
- ✦ Epinephrine & Norepinephrine are classified as amines because they contain a chemical group catechol group
- ✦ Called catecholamines which are secreted in emergency or stress situations

# Adrenal Gland

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## ✦ Catecholamines:

- ✦ ↑ HR & BP
- ✦ convert glycogen to glucose in the liver making glucose available to cells
- ✦ Increase metabolic rate of most cells, creating more energy
- ✦ Bronchodilation to increase air to lungs
- ✦ Dilates blood vessels to heart & constricts blood vessels to GI tract

# Adrenal Gland

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## ✦ Adrenal Cortex:

- ✦ Outer region of the adrenal gland
- ✦ Secretes hormones called steroids which are lipid-soluble compounds made from cholesterol
- ✦ 3 types:
  - glucocorticoids—mineralcorticoids—sex hormones
- ✦ Think of these three steroids as regulators of sugar, salt & sex

# Adrenal Gland

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## ✦ Glucocorticoids:

- ✦ Affect carbohydrates
- ✦ Convert amino acids into glucose & help maintain blood glucose levels between meals
- ✦ Ensures steady supply of glucose to brain & cells
- ✦ Affect protein & fat metabolism, burning both for energy production
- ✦ Essential for life; if not replaced when lost death is eminent

# Adrenal Gland

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- ✦ Chief glucocorticoid is cortisol
- ✦ Cortisol is a stress hormone that is secreted during times of stress
- ✦ Has anti-inflammatory affect
- ✦ The secretion of cortisol involves the hypothalamus secreting a releasing hormone that stimulates the anterior pituitary gland to secrete adrenocorticotrophic hormone (ACTH) which stimulates the adrenal cortex to secrete cortisol
- ✦ Through negative feedback cortisol inhibits the secretion of ACTH & in turn cortisol

# Adrenal Gland

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## ✦ Mineralcorticoids:

- ✦ Chief mineralcorticoid is aldosterone
- ✦ Regulates blood volume, blood pressure & concentration of electrolytes
- ✦ Target organ is kidney
- ✦ Aldosterone conserves sodium & water & eliminates potassium
- ✦ Aldosterone release is controlled through the renin-angiotensin-aldosterone system

## ✦ Sex Hormones:

- ✦ Secreted in small amounts are estrogen (female hormones) & androgens (male hormones)

# Adrenal Gland

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- ✦ Hyposecretion & hypersecretion of cortical hormones:
- ✦ Addison's disease: insufficient secretion of adrenal cortical hormones characterized by gen. weakness, muscle atrophy, bronze skin & electrolyte & fluid loss
- ✦ Cushing's disease caused by elevated plasma levels of steroids characterized by obesity, moon face, thin skin that bruises easily, bone loss & muscle weakness

# Pancreas

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- ✦ Pancreas: is a long slender organ that lies transversely across the upper abdomen, extending from the curve of the duodenum to the spleen
- ✦ Functions as an exocrine & endocrine gland
- ✦ Secrete two hormones:
  - insulin—glucagon
- ✦ Islet of Langerhans are the hormone secreting cell of the pancreas & there are two types:
  - Alpha cells: secrete glucagon
  - Beta cells: secrete insulin
- ✦ Both regulate blood glucose levels

# Pancreas

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## ✦ Insulin:

- ✦ Is released in response to increased blood glucose levels & decreases level when released
- ✦ Has many target tissues exerting a general affect
- ✦ Affects liver, skeletal muscles & adipose tissue in two ways:
  - Helps transport glucose into cells for use as fuel
  - Helps control carb, protein & fat metabolism in cell; stimulates the cells to burn glucose as fuel
- ✦ Insulin is only hormone that lowers blood glucose

# Pancreas

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- ✦ A deficiency of insulin results in Diabetes Mellitus
- ✦ Hyperglycemia: excess glucose in blood. Caused by 2 factors:
  - ◆ Inability of glucose to enter cell
  - ◆ Making of additional glucose
- ✦ Glucosuria: kidneys cannot reabsorb excess glucose so excreted in urine
- ✦ Polyuria: excretion of large amounts of urine; when kidney must excrete large amounts of glucose, it must excrete large amounts of water

# Pancreas

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## ✦ Ketoacidosis:

- ✦ because cell cannot burn glucose as fuel, they burn fatty acids
- ✦ the incomplete breakdown of fatty acids produces strong acids, ketoacids
- ✦ The process causes the condition ketoacidosis

## ✦ Fruity odor to the breath:

- ✦ acetone is also produced from the breakdown of fatty acids
- ✦ Acetone has a fruity smell

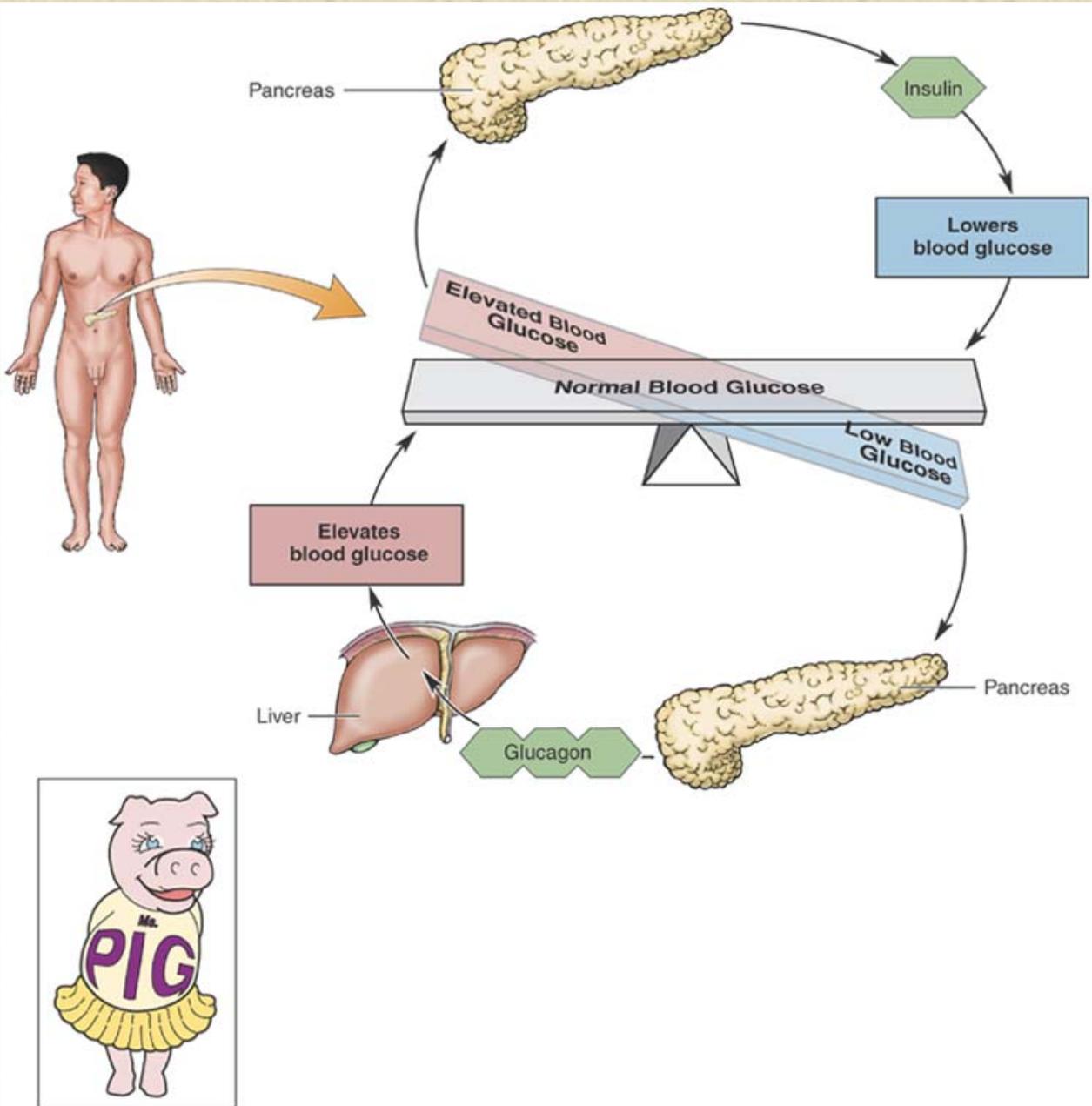
# Pancreas

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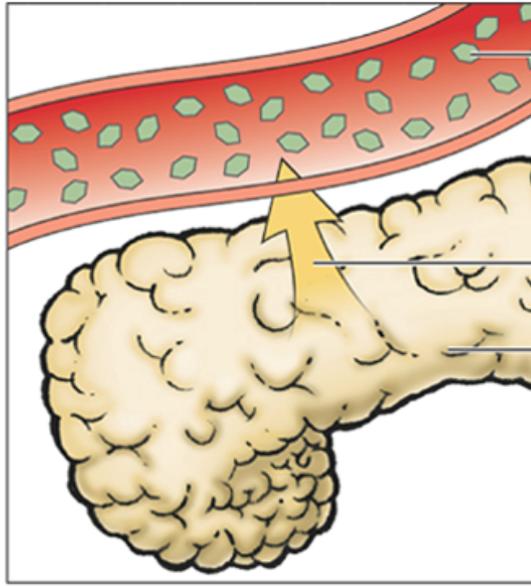


## Glucagon:

- ◆ Secreted by the alpha cell of the Islet of Langerhans
- ◆ Raises blood glucose levels in 2 ways:
  1. Stimulates the conversion of glycogen to glucose
  2. Stimulates the conversion of proteins to glucose
- ◆ Decrease in blood glucose levels stimulates the secretion of glucagon



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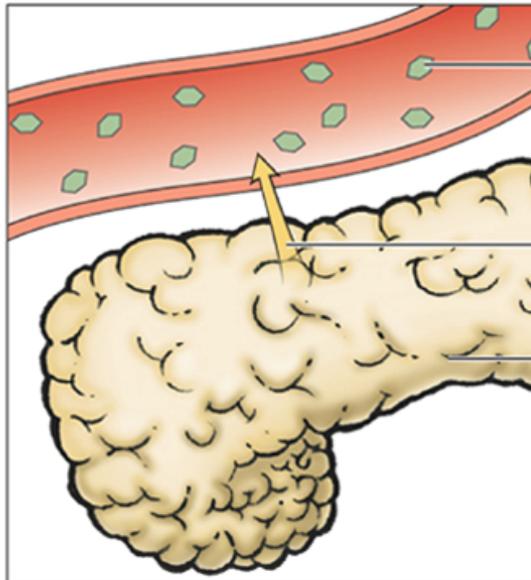


Increased glucose  
in blood vessels  
(capillaries)

Increased insulin  
secretion

Pancreas

B



Decreased glucose  
in blood vessels  
(capillaries)

Decreased insulin  
secretion

Pancreas

# Gonads

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✦ Gonads are the sex glands:

- ◆ ovaries in women & testes in men
- ◆ Produce ova, sperm & secrete hormones

✦ Ovaries:

- ◆ Two ovaries located in the pelvic cavity on each side of the uterus
- ◆ Secrete two female hormones:
  - estrogen & progesterone
- ◆ The hypothalamic releasing hormone & gonadotropin (LH & FSH) of the anterior pituitary affect the secretion of estrogen & progesterone

# Gonads

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## ✦ Ovaries:

- ✦ Estrogen & Progesterone affect the development & function of the female reproductive organs & sex characteristics
- ✦ Sex characteristics include:
  - Development of breast
  - Distribution of fat in hips, thighs & breast
  - Distribution of hair
  - Maturation of reproductive organs
  - Closure of the epiphyseal disc of long bones

# Gonads

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## ✦ Testes:

- ✦ Located in the scrotum of the male
- ✦ Testosterone, which is a steroid, is secreted by the interstitial cells of the testes
- ✦ Stimulation for secretion comes from the anterior pituitary hormone LH & controlled by hypothalamic releasing hormone
- ✦ Testosterone helps mature sperm & is responsible for sex characteristics that include:
  - Growth & development of sex organs
  - Musculoskeletal growth
  - Growth & distribution of hair
  - Larynx enlargement & voice change

# Thymus Gland

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- ✦ Thymus gland lies in the thoracic cavity behind the sternum
- ✦ Involutes so it decreases in size once child enters puberty
- ✦ Secretes hormone thymosin which plays a role in the immune system

# Pineal Gland

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- ✦ Pineal Gland is cone-shaped gland located close to the thalamus in the brain
- ✦ Called body's biological clock; controls biorhythms
- ✦ Secretes melatonin which affects the reproductive cycle & secretion of hypothalamic releasing hormones
- ✦ Affects sleep/wake cycle
- ✦ Increase release of melatonin at night which is said to have tranquilizing effect
- ✦ Amount secreted is related to amount of light

# Prostaglandins

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- ✦ Prostaglandins are chemical substances (hormones) derived from the fatty acid arachidonic
- ✦ Produced by many tissues & act near their site of secretion
- ✦ Play role in the regulation of smooth muscle contraction & inflammatory response
- ✦ Thought to increase sensitivity of pain nerve endings
- ✦ ASA, Ibuprofen & acetaminophen inhibit the synthesis of prostaglandins so are useful for pain relief & anti-inflammatory effect