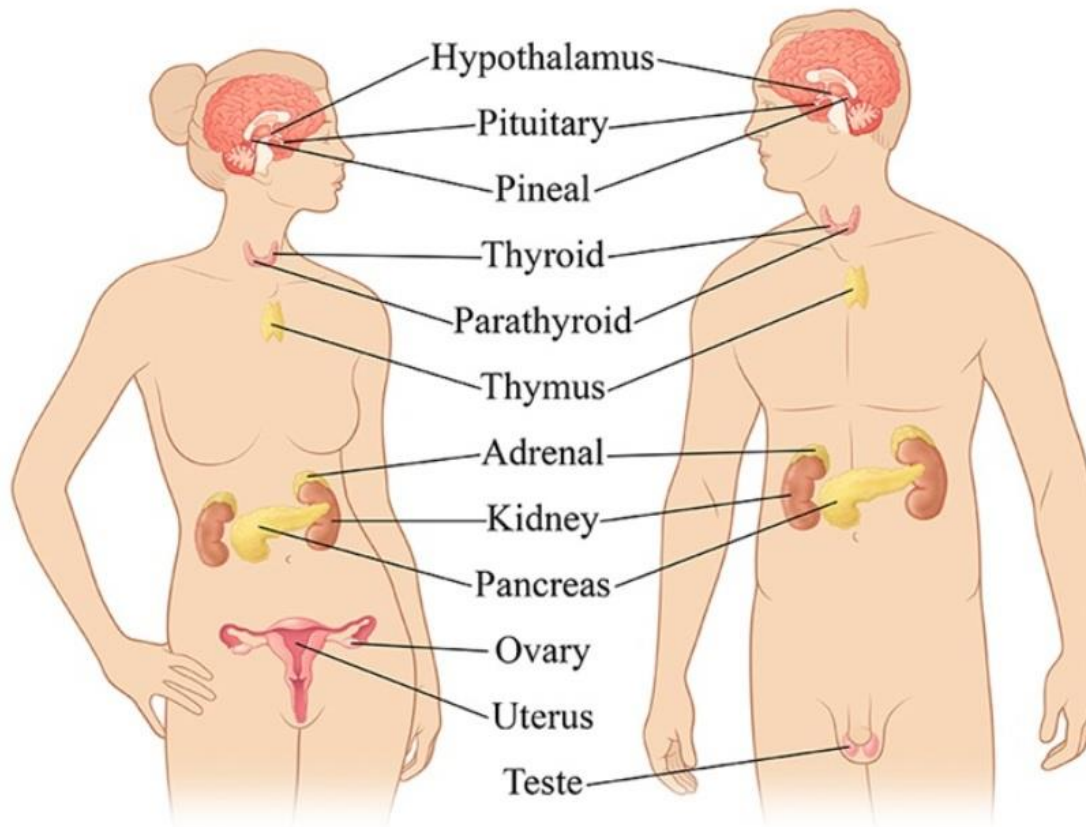
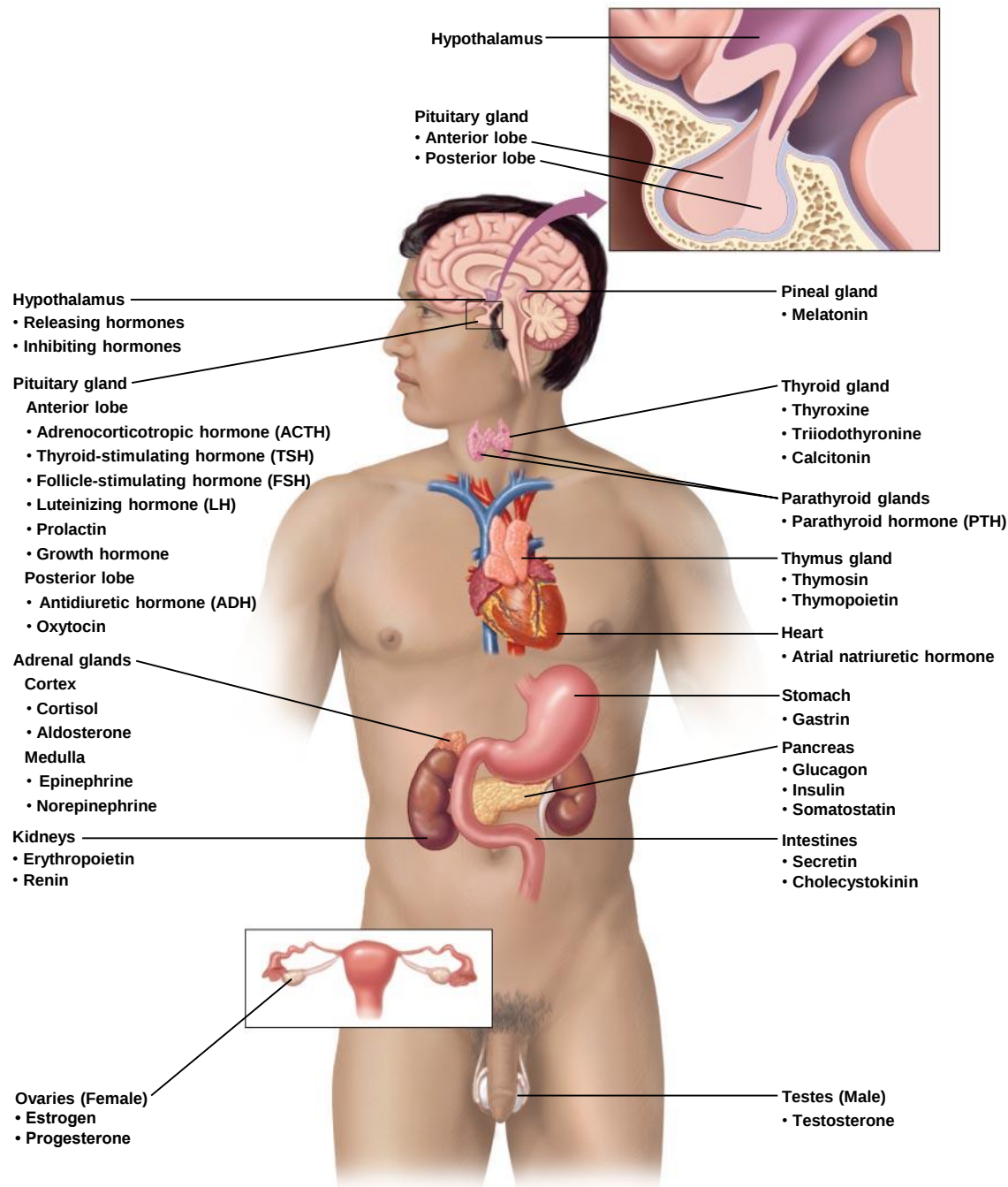


The Endocrine System



Endocrine System Produces Hormones

- **Endocrine system**
 - collection of specialized cells, and tissues that secrete hormones
- **Endocrine glands**
 - ductless organs that secrete hormones into blood, interstitial fluid, lymph
- **Hormones**
 - Chemical messengers secreted by endocrine glands
 - Circulate in the bloodstream
 - Act on specific cells in the body



Endocrine System Produces Hormones

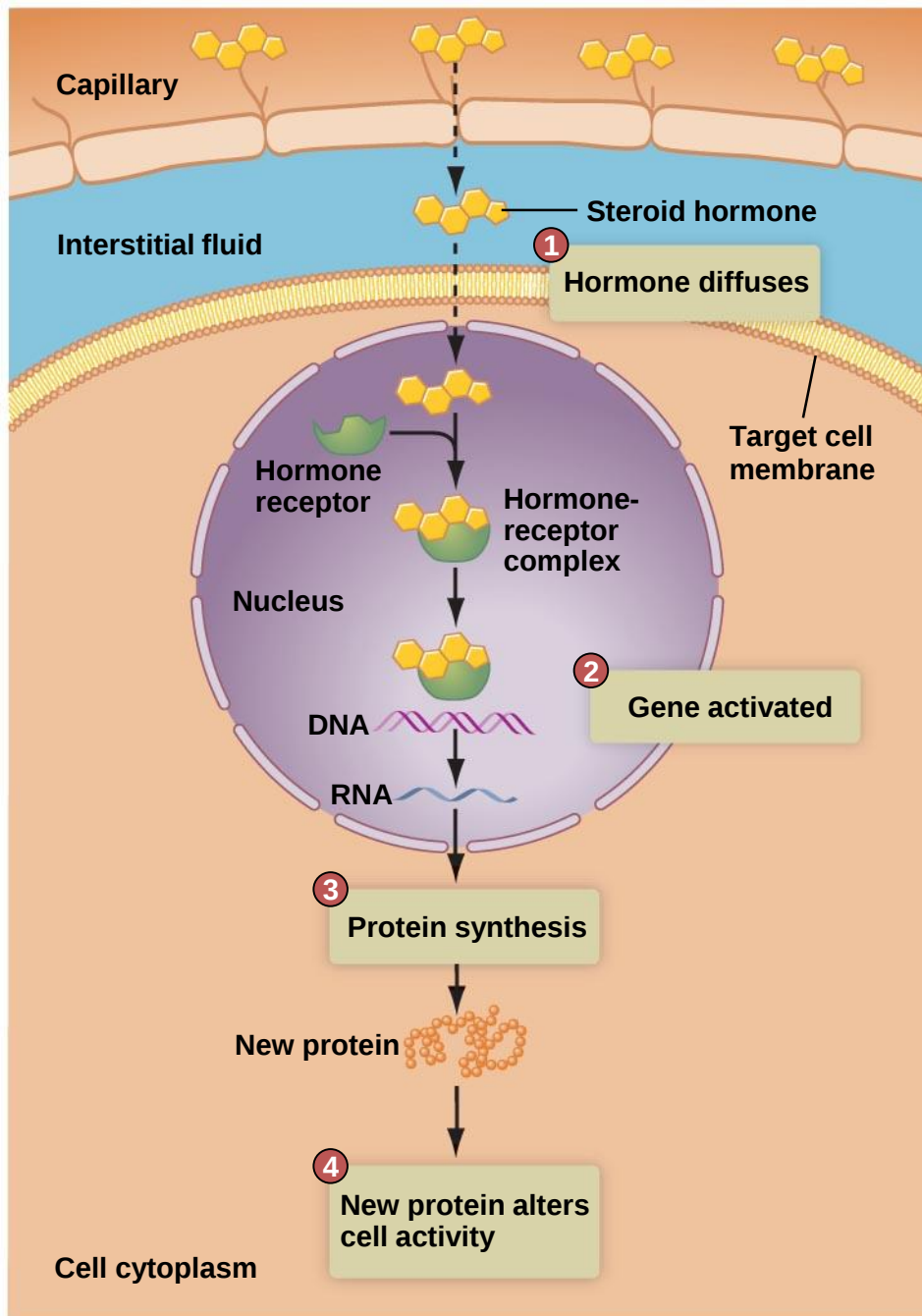
- Hormones have access to every cell
- Each hormone acts only on specific cells (target cells)
- Only specific cells have receptors for specific hormones
- Endocrine control is slower than nervous system
- Endocrine and nervous systems interact

Hormones Are Classified as Steroid and Nonsteroid

- Steroid hormones
 - Structurally related to cholesterol
 - Lipid soluble
- Nonsteroid hormones
 - Structurally related to proteins
 - Water soluble (lipid insoluble)

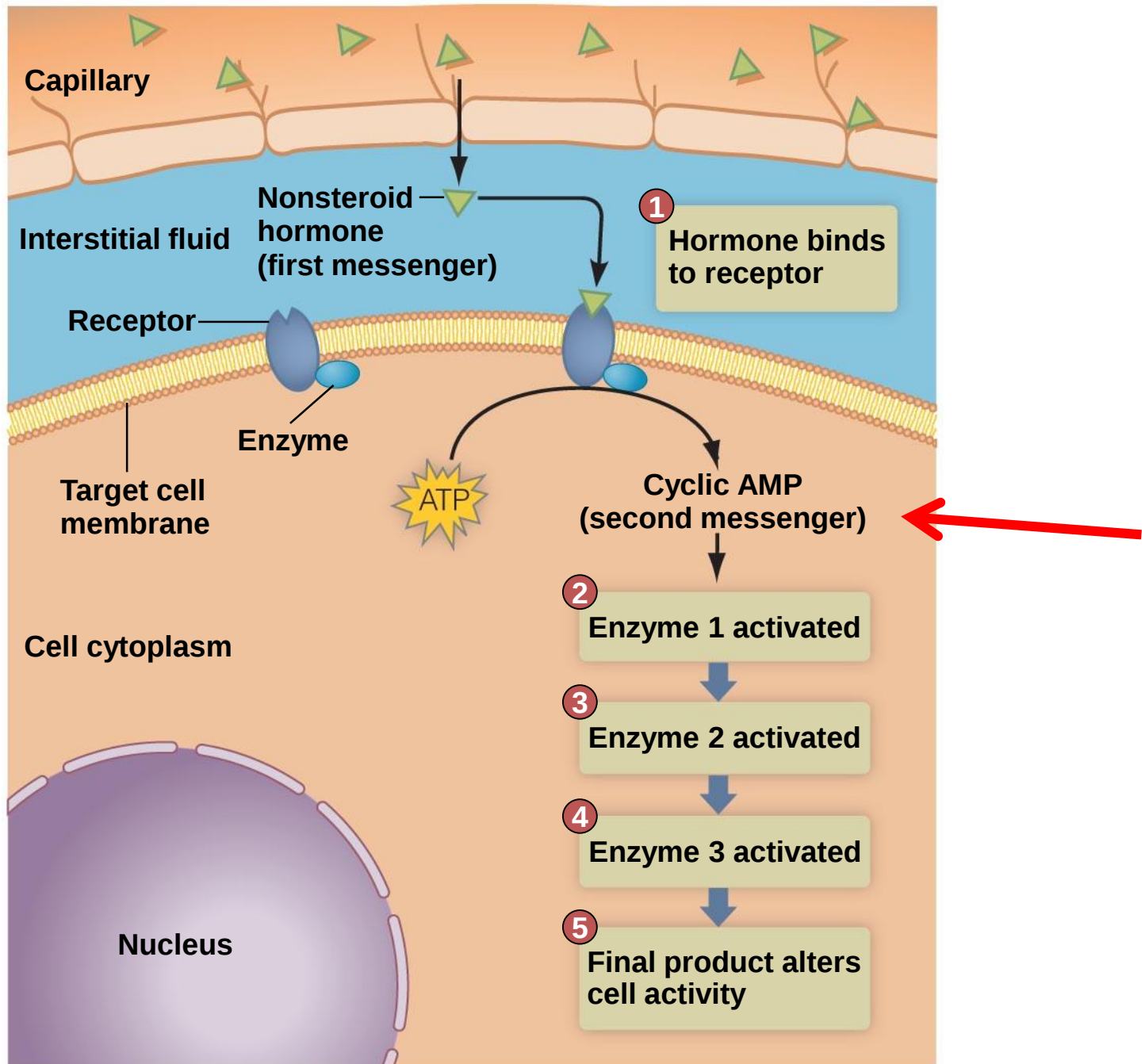
Classification of Hormones: Steroid

- Steroid hormones
 - Lipid soluble, chemically derived from cholesterol
 - Enter target cells
 - Activate specific genes to produce specific proteins
 - Slower acting than nonsteroid hormones; minutes to hours



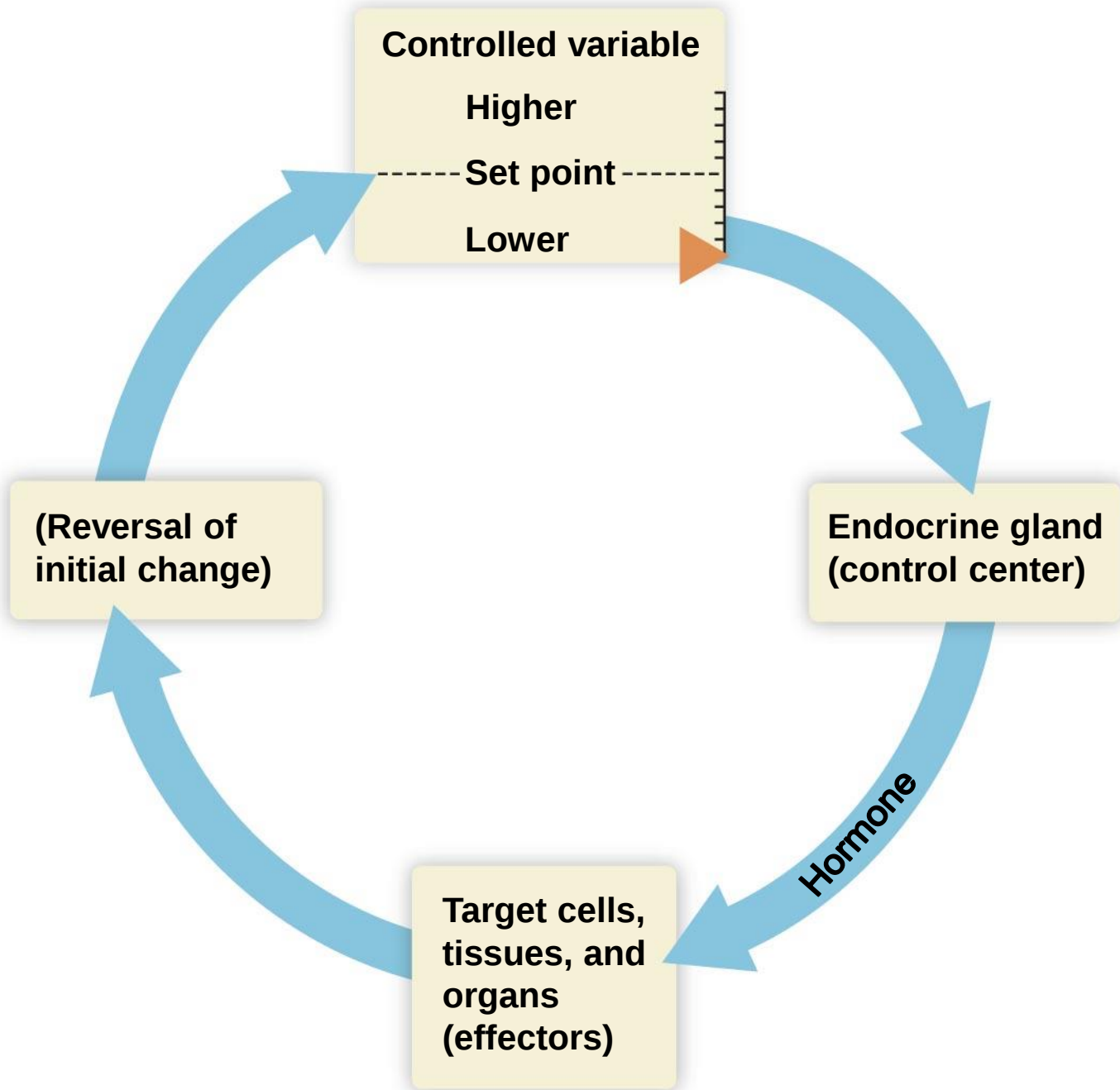
Classification of Hormones: Nonsteroid

- Nonsteroid hormones
 - Water soluble
 - Bind to receptors on target cell membranes
 - Work through intermediate mechanisms to activate existing enzymes
 - Faster action than steroid hormones; seconds to minutes



Hormones Participate in Negative Feedback Loops

- Many hormones participate in internal homeostatic control mechanisms
- Negative feedback loop involving hormones includes the following:
 - Endocrine gland serves as the control center
 - Hormone is the pathway between the control center and the effectors
 - Target tissues or organs are the effectors



Hypothalamus and the Pituitary Gland

- **Hypothalamus**

- Homeostatic control center of the brain
- Links nervous system and endocrine system
- Produces two hormones of its own
 - Antidiuretic hormone (ADH) and Oxytocin
- Monitors and controls hormone secretions of the pituitary gland

- **Pituitary gland**

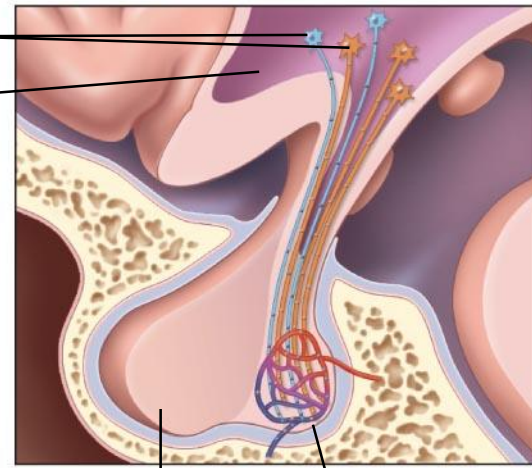
- “Master” gland
- Secretes eight different hormones that regulate other endocrine organs
- Two lobes: posterior and anterior

Posterior Pituitary Stores ADH and Oxytocin

- Posterior pituitary is connected to hypothalamus by neuroendocrine cells
 - Hormones (ADH and oxytocin) made in cell bodies in hypothalamus are transported down axons to posterior pituitary
- Posterior pituitary hormones: nonsteroidal
 - Antidiuretic hormone (ADH)
 - Conserves water in kidneys
 - Regulates water balance in body
 - Oxytocin
 - Causes uterine contractions during labor and milk ejection through neuroendocrine reflex

Neuroendocrine cells

Hypothalamus

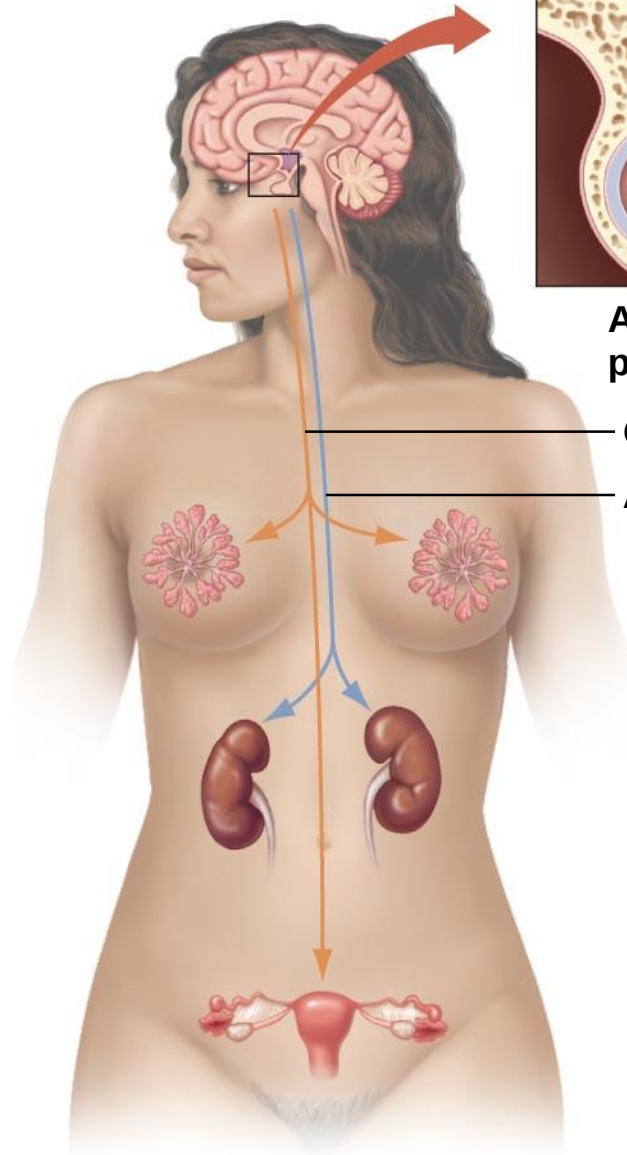


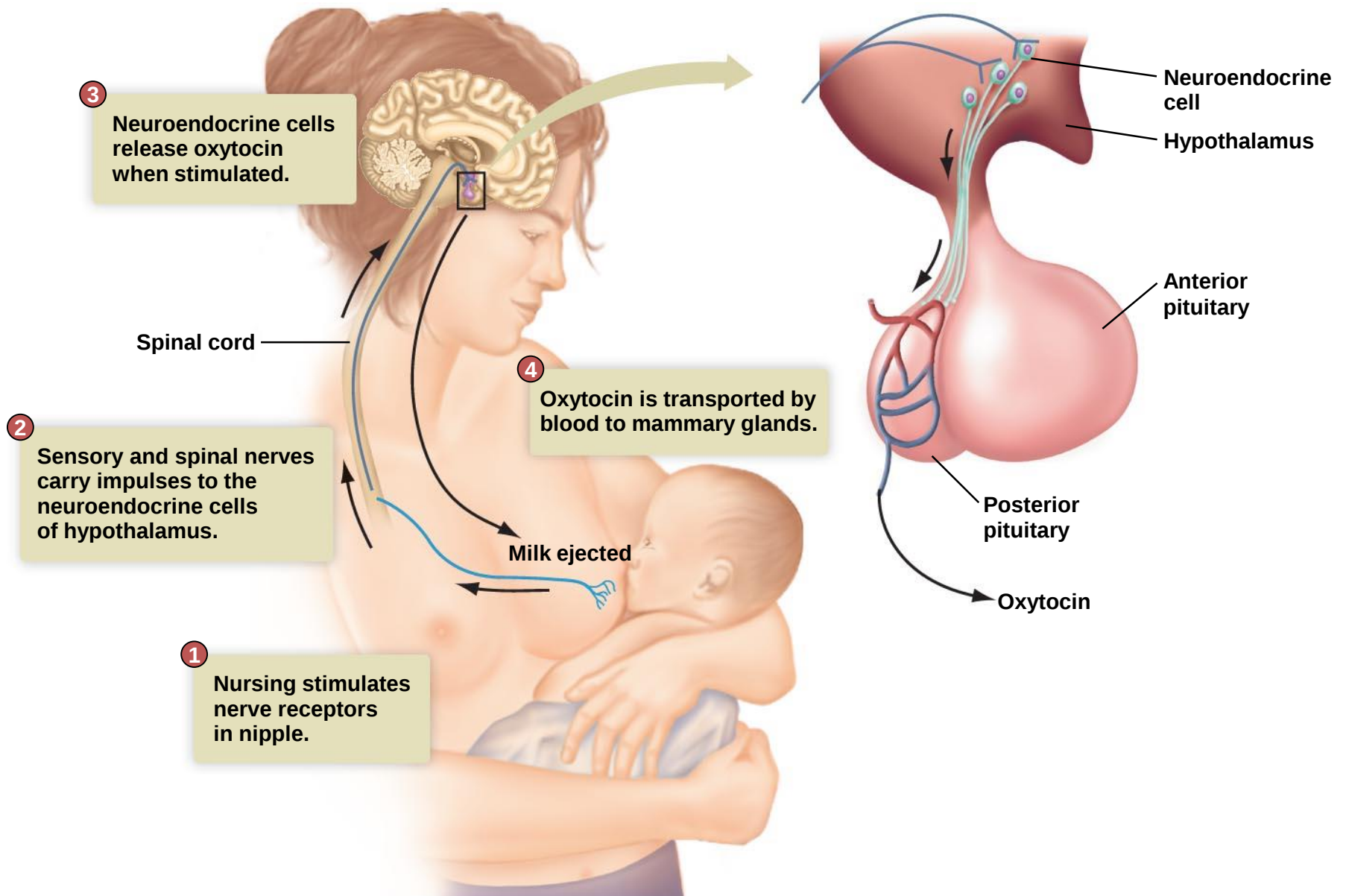
Anterior
pituitary

Posterior
pituitary

Oxytocin

ADH





The Anterior Pituitary Produces Six Key Hormones

- Anterior pituitary
 - Controlled by hypothalamus
 - Releasing and inhibiting hormones from hypothalamus travel to pituitary through pituitary portal system

Anterior Pituitary Hormones

- **ACTH** (adrenocorticotrophic hormone)
 - Stimulates adrenal cortex to release glucocorticoids (cortisol)
- **TSH** (thyroid-stimulating hormone)
 - Acts on thyroid gland, promoting release of thyroid hormones
- **FSH and LH** (gonadotropins)
 - Stimulate growth, development, and function of ovaries and testes
 - Not produced until about age 10–13 (puberty)
 - Increase in production initiates sexual maturation and development at puberty

Anterior Pituitary Hormones

- **Prolactin**

- Stimulates development of mammary glands and milk production

- **Growth hormone**

- Has widespread effects on body
- Major effects on bone, muscle
- Most of its growth-promoting effects occur during childhood and adolescence

1

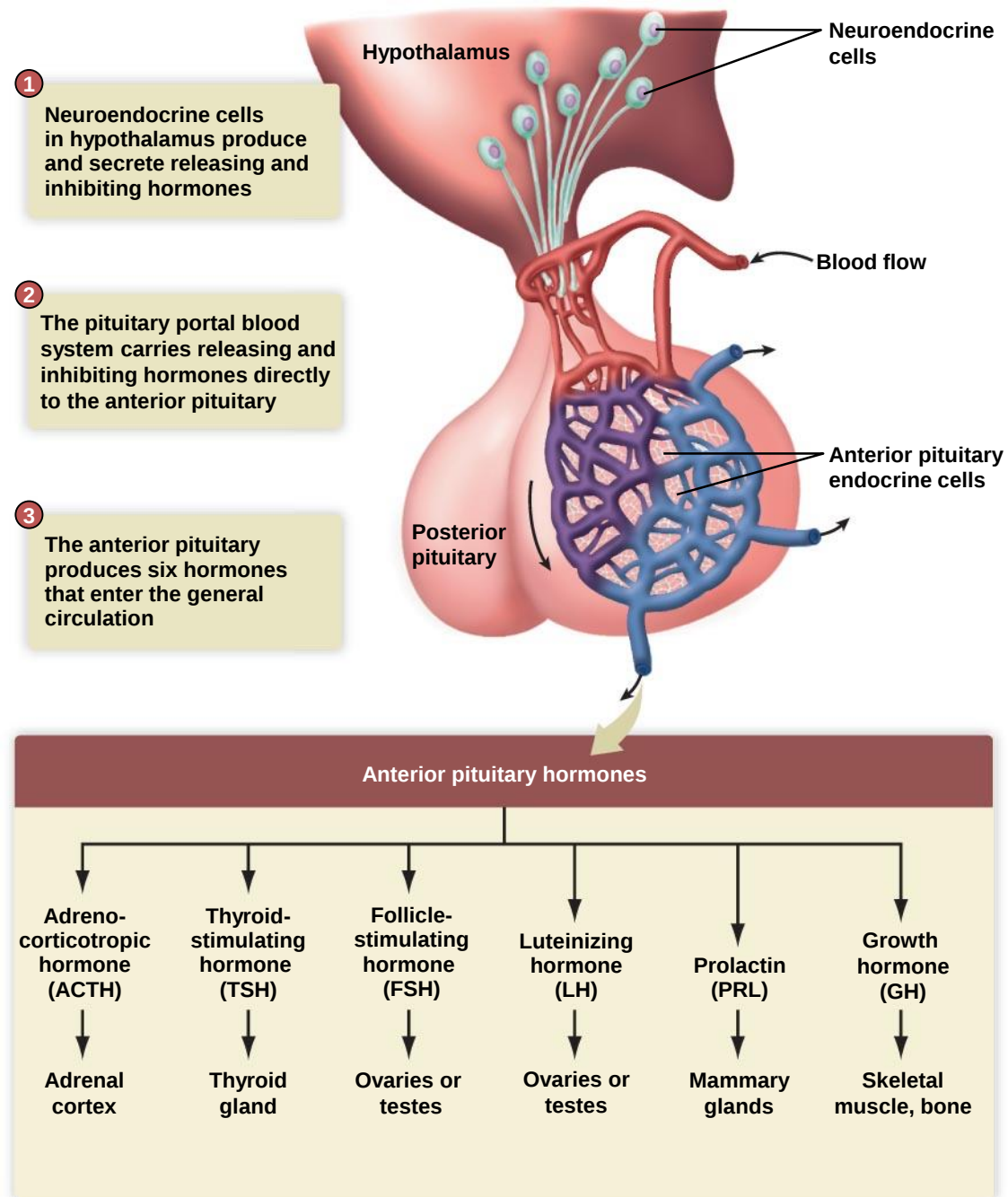
Neuroendocrine cells in hypothalamus produce and secrete releasing and inhibiting hormones

2

The pituitary portal blood system carries releasing and inhibiting hormones directly to the anterior pituitary

3

The anterior pituitary produces six hormones that enter the general circulation



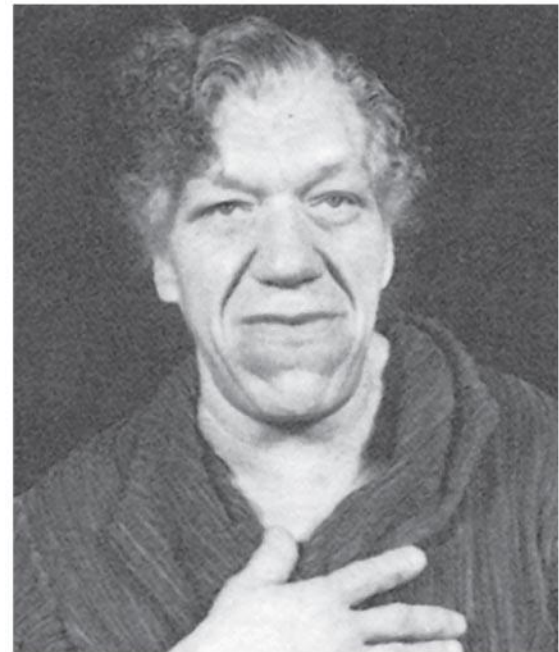
Pituitary Disorders: Hypersecretion and Hyposecretion

- **Diabetes insipidus**
 - Hyposecretion of ADH results in inability to conserve water appropriately
 - Causes excessive urination, dehydration, thirst
- **Gigantism**
 - Hypersecretion of growth hormone in childhood
- **Acromegaly**
 - Excessive growth hormone over a long period in adults
- **Pituitary dwarfism**
 - Hyposecretion of growth hormone
 - Treated by administration of GH throughout childhood

Gigantism and Dwarfism



Acromegaly



Pancreas Secretes Glucagon, Insulin, and Somatostatin

- Pancreas
 - has both exocrine and endocrine functions
- Pancreatic hormones are involved in regulating blood glucose levels
- Endocrine cells in Islets of Langerhans within the pancreas secrete the following hormones:
 - **Alpha cells**
 - secrete glucagon
 - **Beta cells**
 - secrete insulin

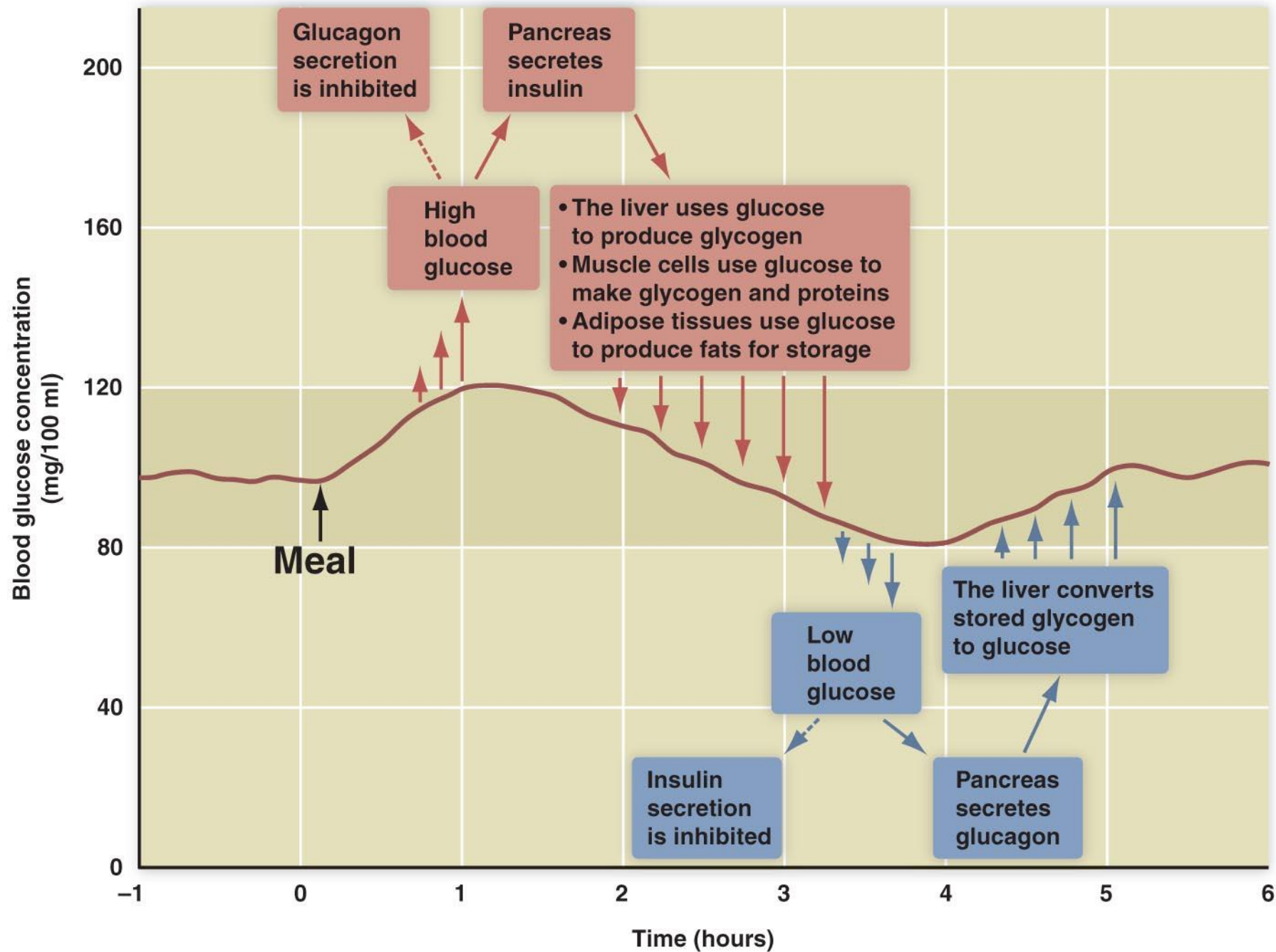
Pancreas Secretes Glucagon, Insulin, and Somatostatin

- **Glucagon**

- Raises blood sugar
- Causes breakdown of glycogen to glucose in liver

- **Insulin**

- Lowers blood sugar
- Promotes uptake of sugar by cells in liver, muscle, and adipose tissue
- Promotes conversion of glucose into glycogen, proteins, fat,



Adrenal Glands

- Adrenal cortex
 - outer layer
- Adrenal medulla
 - inner layer

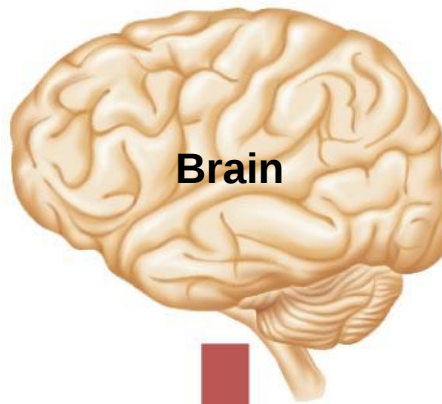
Adrenal Cortex

- Glucocorticoids (**Cortisol** is an example)
 - Secretion mediated through hypothalamus-pituitary secretions
 - Maintain blood glucose levels during prolonged fasting
- Mineralocorticoids (**Aldosterone** is an example)
 - Regulate sodium, potassium, water balance
 - Act on kidneys, promoting sodium reabsorption and potassium excretion

Adrenal Medulla

- Adrenal medulla
 - Neuroendocrine organ
 - Secretion stimulated by
 - Sympathetic nervous system
 - Hormones
 - Epinephrine and norepinephrine
 - enhance function of sympathetic nervous system (fight-or-flight response)

**Perceived or
real threat**



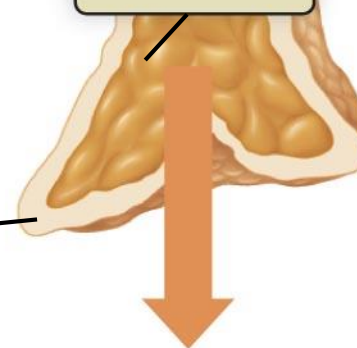
Brain

**Activation of
sympathetic
nerves**



**Adrenal
medulla**

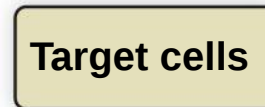
**Adrenal
cortex**



**Norepinephrine
and epinephrine**



Target cells

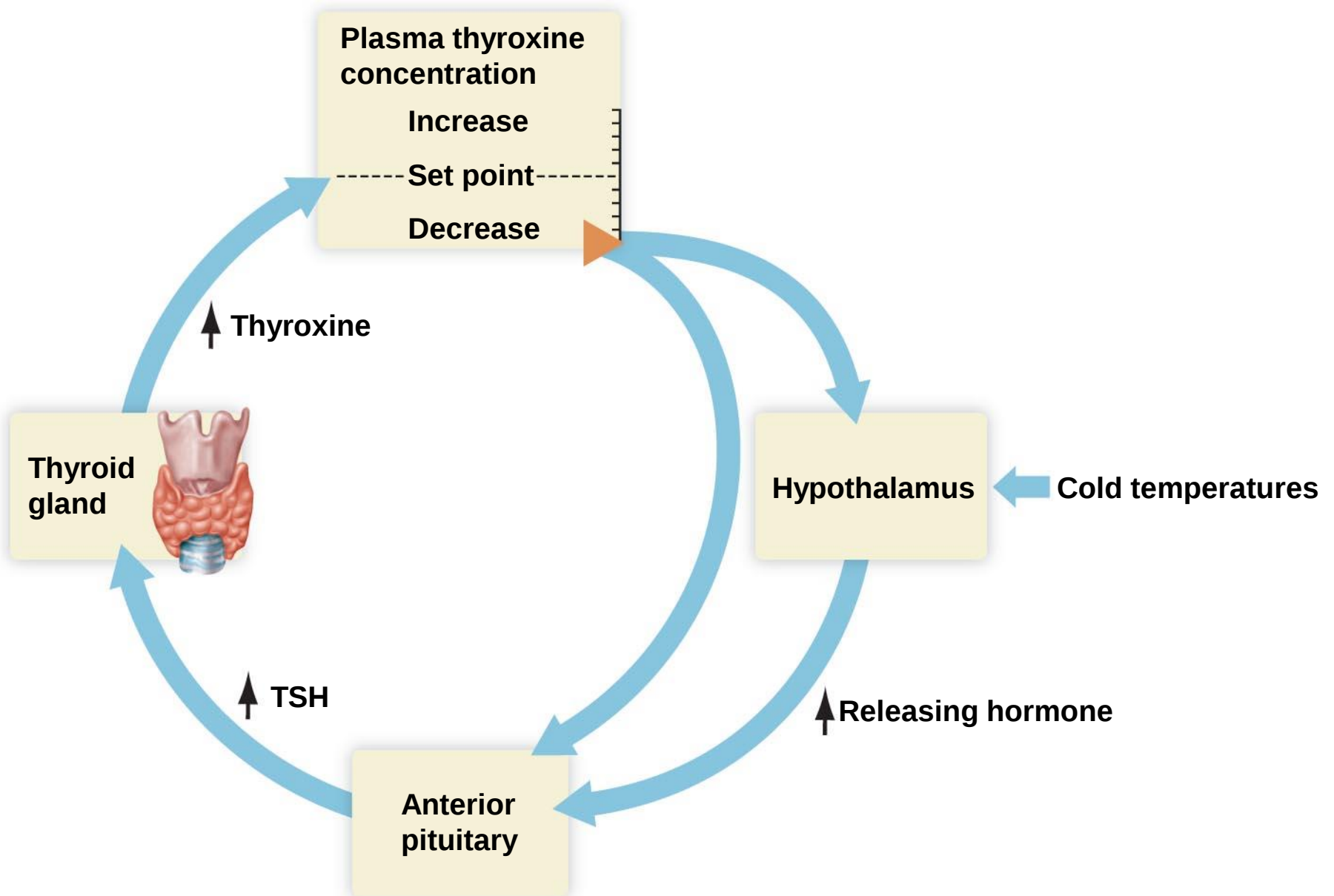


Thyroid and Parathyroid Glands

- Thyroid located just below larynx in neck
- Parathyroid glands embedded in back of thyroid
- Both thyroid and parathyroid involved in calcium balance
- Thyroid also involved in regulating metabolism

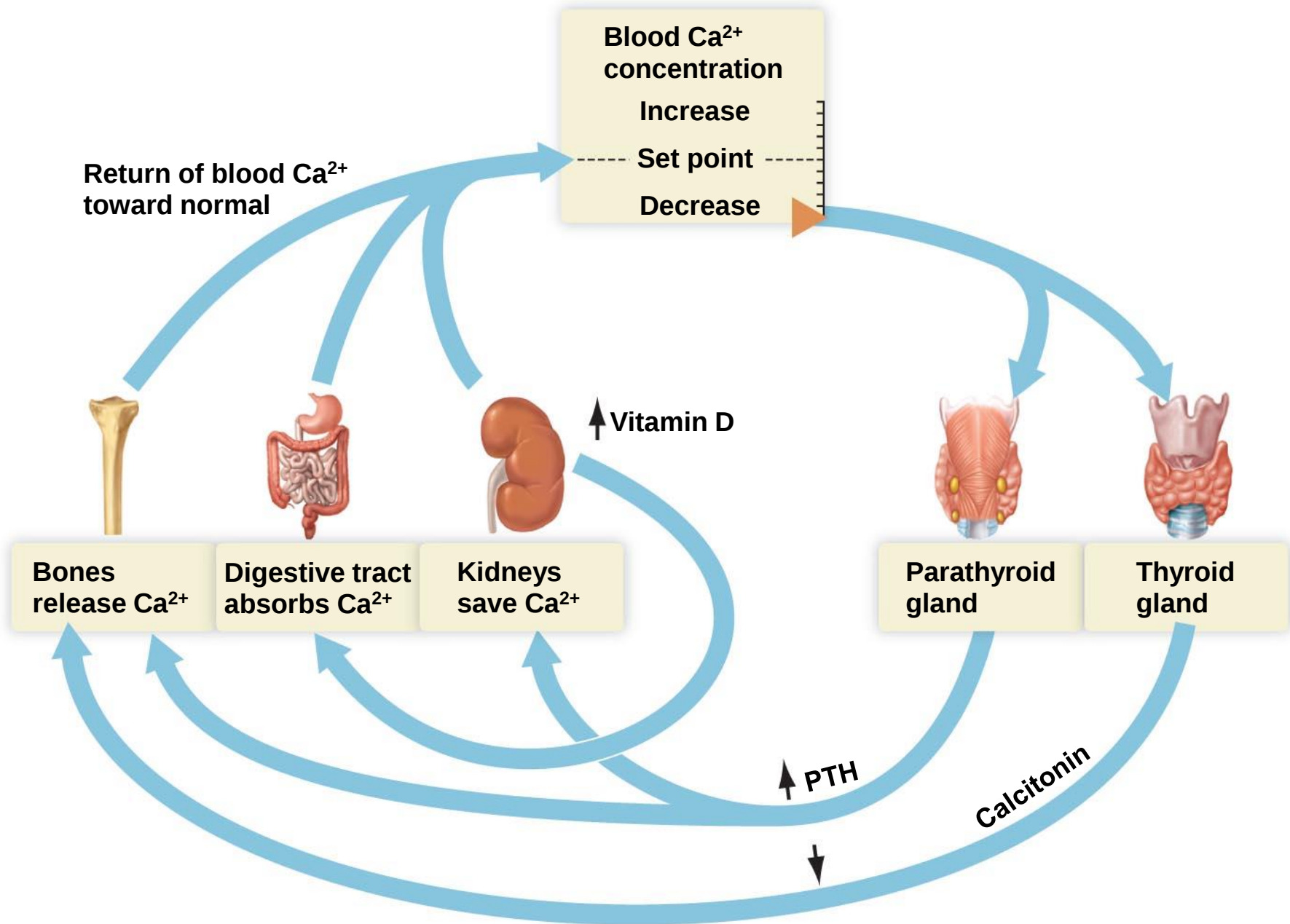
Thyroid Gland: Thyroxine Speeds Cellular Metabolism

- Secretion: mediated through hypothalamus-pituitary secretions
- Steroidal hormones
 - Thyroxine (T_4) and Triiodothyronine (T_3)
 - Both regulate production of ATP from glucose, affect metabolic rate
 - Calcitonin
 - Lowers blood calcium levels
 - Decreases rate of bone resorption by inhibiting osteoclasts
 - Stimulates uptake of calcium by bones

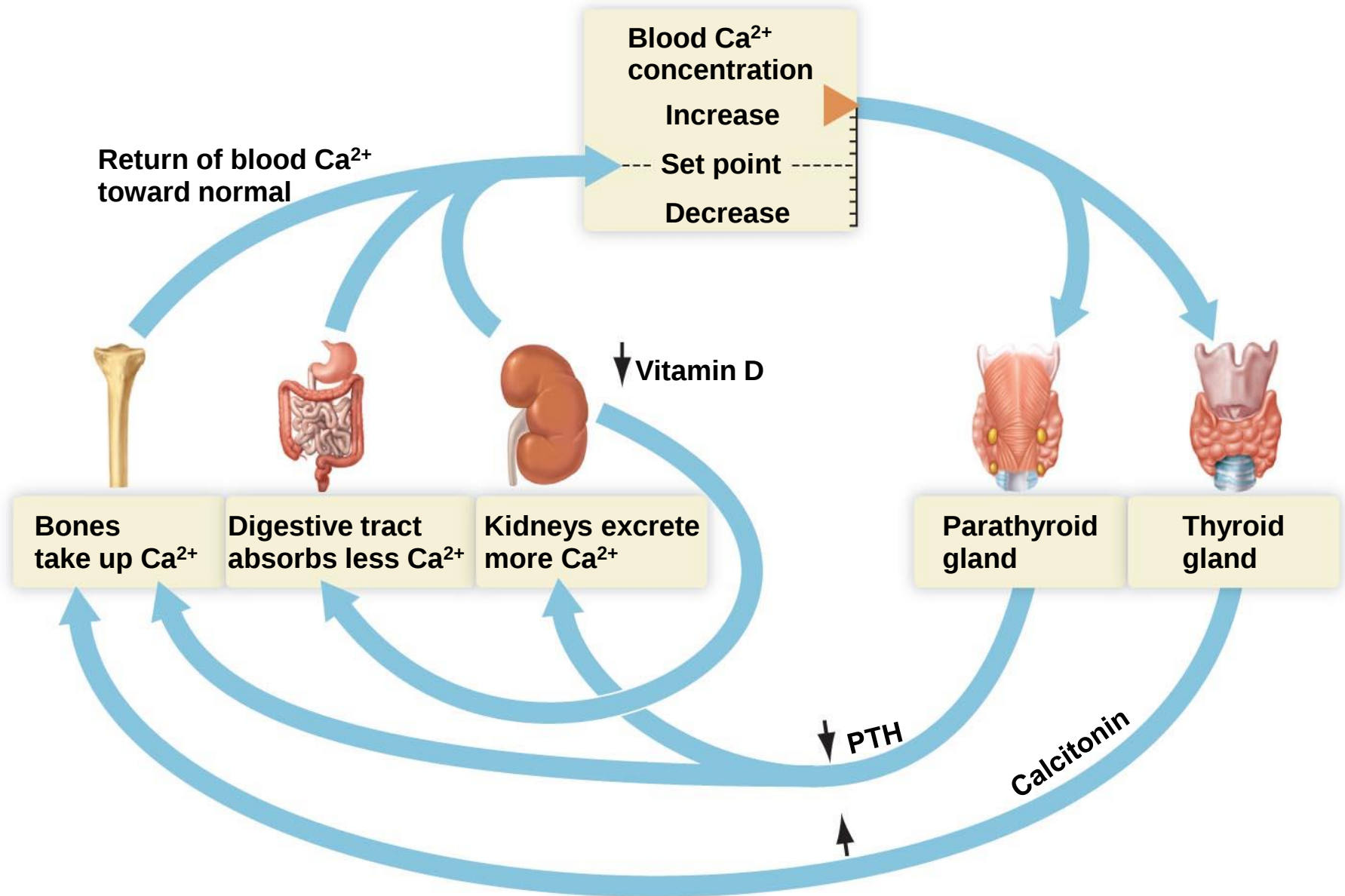


Parathyroid Hormone (PTH) Controls Blood Calcium Levels

- Secretion
 - Response to lowered blood calcium levels
- Action
 - Removes calcium and phosphate from bone
 - Increases absorption of calcium by the digestive tract
 - Causes kidneys to retain calcium and excrete phosphate
- Major regulator of blood calcium concentration in adults



a) Responses to a fall in blood calcium.



b) Responses to a rise in blood calcium. The importance of calcitonin is greatest in children, declining once adulthood is reached.

Thyroid Disorder

- **Goiter**
 - Iodine deficiency increases growth of thyroid gland



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Testes Produce Testosterone

- Functions of testosterone and other androgens
 - Before birth – responsible for development of external male genitalia
 - At onset of puberty
 - Regulates development and normal functioning of sperm, male reproductive organs, and male sex drive
 - Regulates development of male secondary sex characteristics
- Small amounts of androgens produced by adrenal glands in both sexes

Ovaries Produce Estrogen and Progesterone

- Hormones: steroidal
 - **Estrogen**
 - Initiates development of secondary sex characteristics
 - Regulates menstrual cycle
 - **Progesterone**
 - Regulates menstrual cycle

Disorders of the Endocrine System

- **Diabetes mellitus**
 - **Type 1:** insulin-dependent diabetes
 - 5–10% of all cases
 - Inadequate insulin
 - Treated with insulin injections
 - **Type 2:** non-insulin-dependent diabetes
 - 90–95% of all cases
 - Insulin resistance

Disorders of the Endocrine System

- **Thyroid**
 - **Hypothyroidism**: underactive thyroid gland
 - Children: cretinism
 - slowed body growth, altered brain development, delayed puberty
 - Adults: myxedema
 - edema, lethargy, weight gain, low BMR
 - **Hyperthyroidism**: overactive thyroid gland
 - Increased BMR, hyperactivity, nervousness, agitation, weight loss
 - Graves' disease: autoimmune form of hyperthyroidism