Chapter 45

Hormones and the Endocrine System

PowerPoint® Lecture Presentations for

Biology

Eighth Edition

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Lectures by Chris Romero, updated by Erin Barley with contributions from Joan Sharp

Overview: The Body's Long-Distance Regulators

- Animal **hormones** are chemical signals that are secreted into the circulatory system and communicate regulatory messages within the body
- Hormones reach all parts of the body, but only target cells are equipped to respond
- Insect metamorphosis is regulated by hormones

- Two systems coordinate communication throughout the body: the endocrine system and the nervous system
- The **endocrine system** secretes hormones that coordinate slower but longer-acting responses including reproduction, development, energy metabolism, growth, and behavior
- The **nervous system** conveys high-speed electrical signals along specialized cells called neurons; these signals regulate other cells

Fig. 45-1

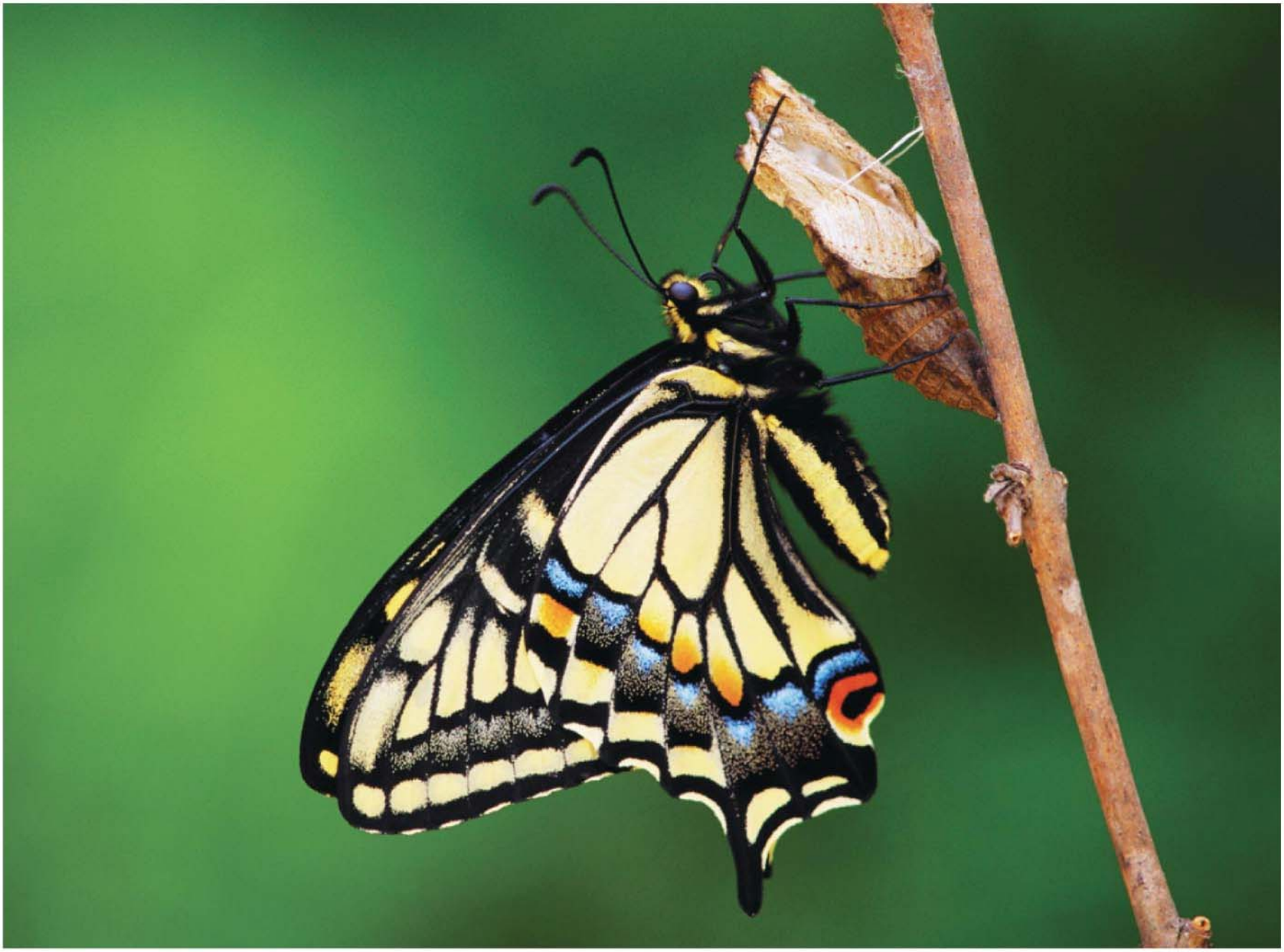


Fig. 45-UN1

Concept 45.1: Hormones and other signaling molecules bind to target receptors, triggering specific response pathways

- Chemical signals bind to receptor proteins on target cells
- Only target cells respond to the signal

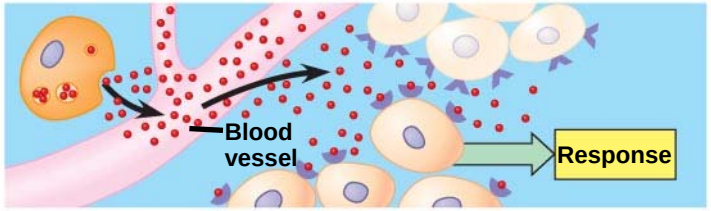
Types of Secreted Signaling Molecules

- Secreted chemical signals include
  - Hormones
  - Local regulators
  - Neurotransmitters
  - Neurohormones
  - Pheromones

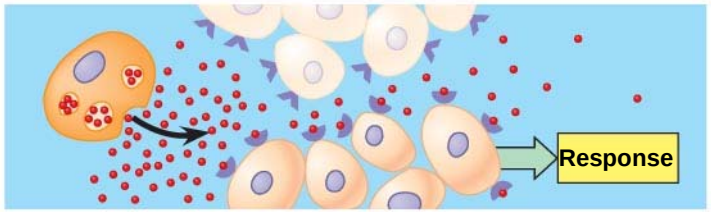
Hormones

- Endocrine signals (hormones) are secreted into extracellular fluids and travel via the bloodstream
- **Endocrine glands** are ductless and secrete hormones directly into surrounding fluid
- Hormones mediate responses to environmental stimuli and regulate growth, development, and reproduction

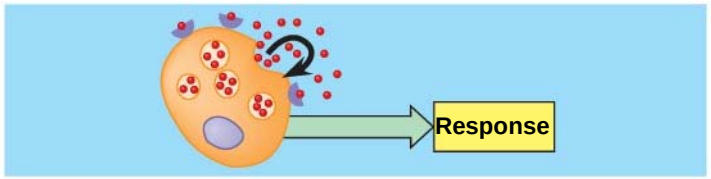
Fig. 45-2



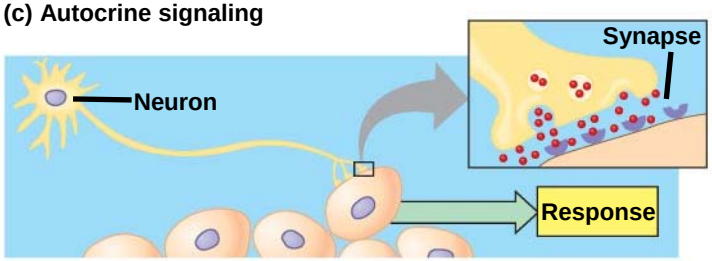
(a) Endocrine signaling



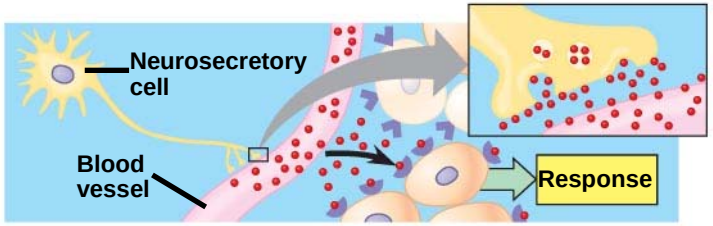
(b) Paracrine signaling



(c) Autocrine signaling



(d) Synaptic signaling



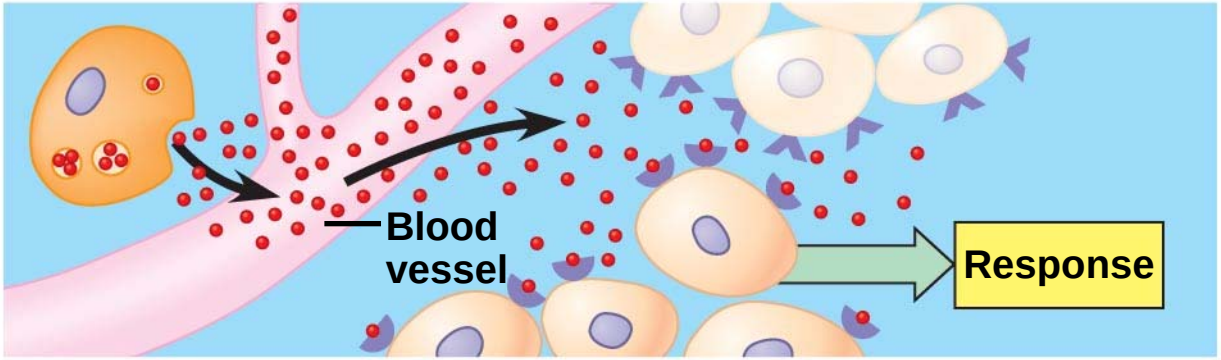
(e) Neuroendocrine signaling

- Exocrine glands have ducts and secrete substances onto body surfaces or into body cavities (for example, tear ducts)

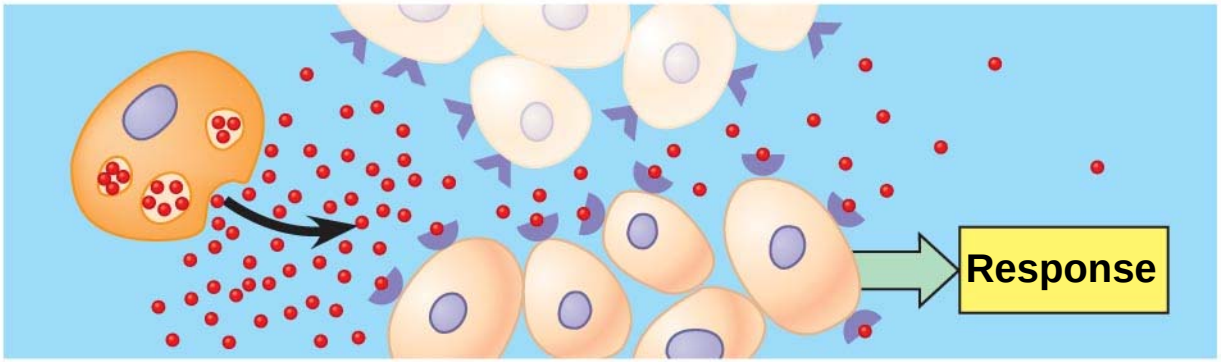
Local Regulators

- **Local regulators** are chemical signals that travel over short distances by diffusion
- Local regulators help regulate blood pressure, nervous system function, and reproduction
- Local regulators are divided into two types
  - **Paracrine** signals act on cells near the secreting cell
  - **Autocrine** signals act on the secreting cell itself

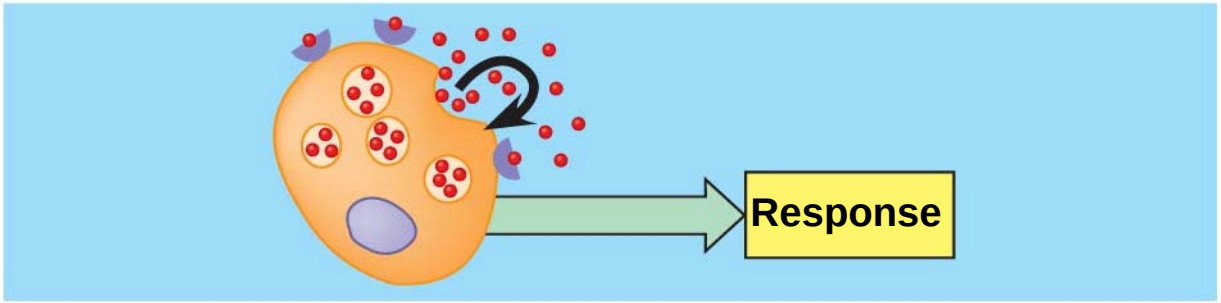
Fig. 45-2a



(a) Endocrine signaling



(b) Paracrine signaling

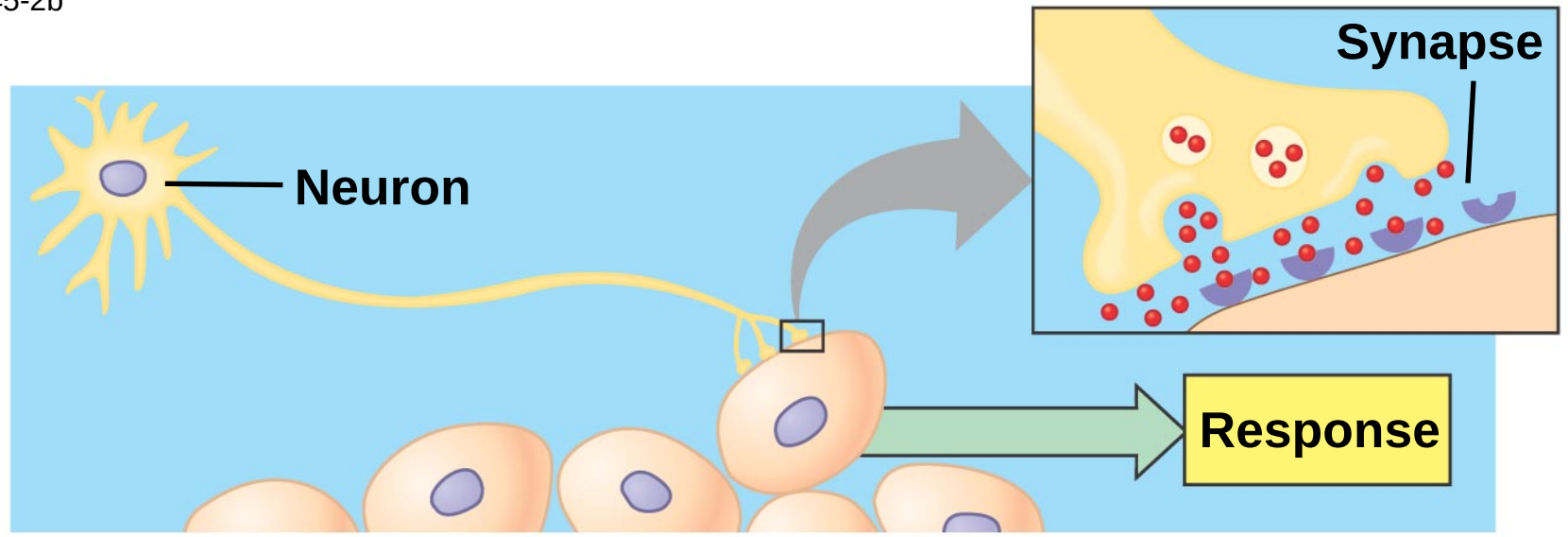


(c) Autocrine signaling

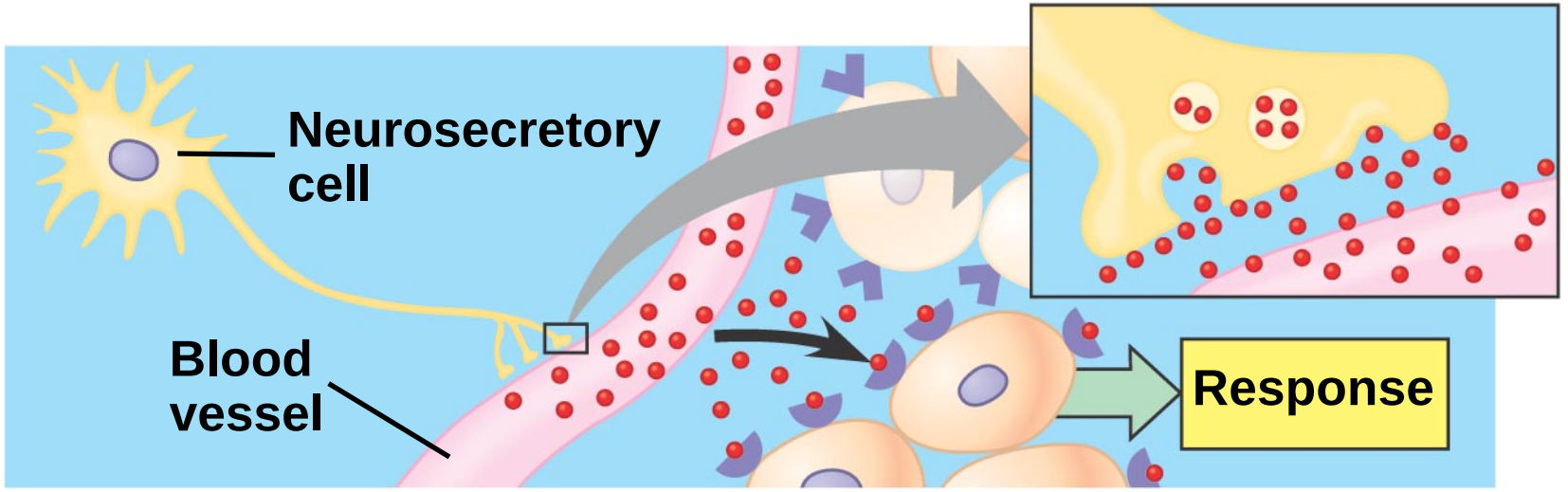
Neurotransmitters and Neurohormones

- Neurons (nerve cells) contact target cells at synapses
- At synapses, neurons often secrete chemical signals called neurotransmitters that diffuse a short distance to bind to receptors on the target cell
- Neurotransmitters play a role in sensation, memory, cognition, and movement

Fig. 45-2b



(d) Synaptic signaling



(e) Neuroendocrine signaling

- **Neurohormones** are a class of hormones that originate from neurons in the brain and diffuse through the bloodstream

Pheromones

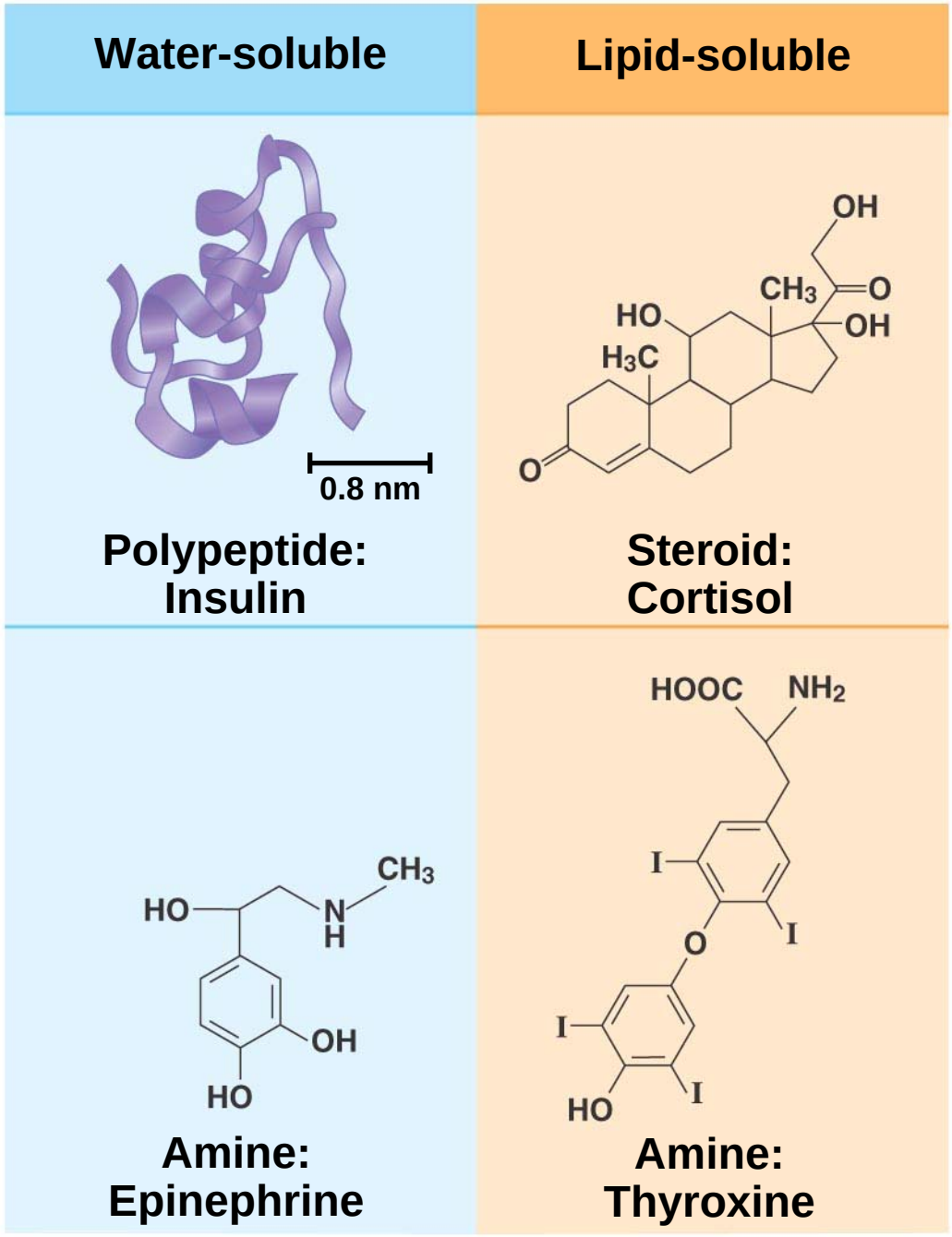
- **Pheromones** are chemical signals that are released from the body and used to communicate with other individuals in the species
- Pheromones mark trails to food sources, warn of predators, and attract potential mates

Chemical Classes of Hormones

- Three major classes of molecules function as hormones in vertebrates:
  - Polypeptides (proteins and peptides)
  - Amines derived from amino acids
  - Steroid hormones

- Lipid-soluble hormones (steroid hormones) pass easily through cell membranes, while water-soluble hormones (polypeptides and amines) do not
- The solubility of a hormone correlates with the location of receptors inside or on the surface of target cells

Fig. 45-3



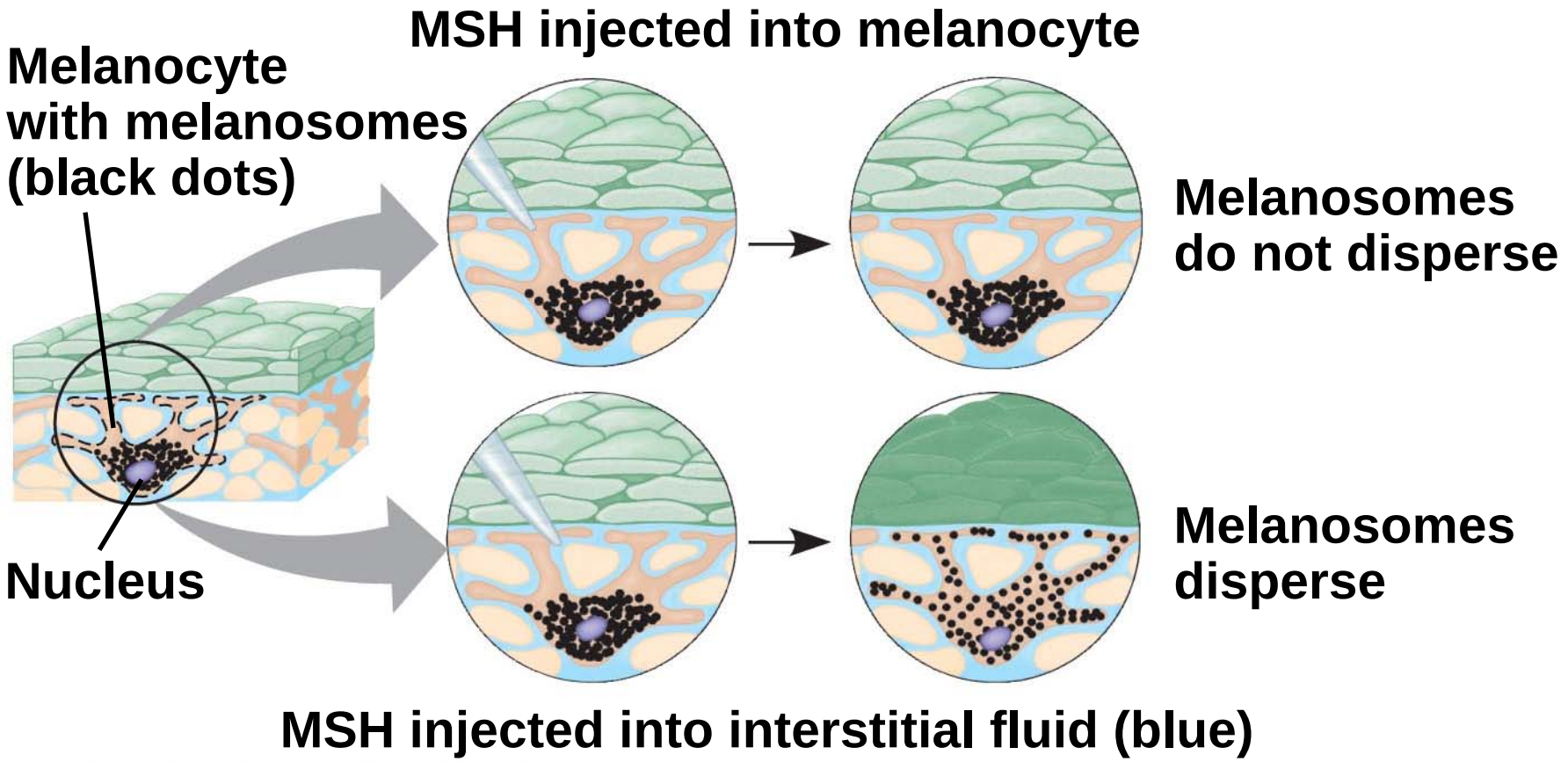
Hormone Receptor Location: *Scientific Inquiry*

- In the 1960s, researchers studied the accumulation of radioactive steroid hormones in rat tissue
- These hormones accumulated only in target cells that were responsive to the hormones
- These experiments led to the hypothesis that receptors for the steroid hormones are located inside the target cells
- Further studies have confirmed that receptors for lipid-soluble hormones such as steroids are located inside cells

- Researchers hypothesized that receptors for water-soluble hormones would be located on the cell surface
- They injected a water-soluble hormone into the tissues of frogs
- The hormone triggered a response only when it was allowed to bind to cell surface receptors
- This confirmed that water-soluble receptors were on the cell surface

Fig. 45-4

RESULTS



Cellular Response Pathways

- Water and lipid soluble hormones differ in their paths through a body
- Water-soluble hormones are secreted by exocytosis, travel freely in the bloodstream, and bind to cell-surface receptors
- Lipid-soluble hormones diffuse across cell membranes, travel in the bloodstream bound to transport proteins, and diffuse through the membrane of target cells

- Signaling by any of these hormones involves three key events:
  - Reception
  - Signal transduction
  - Response

Fig. 45-5-1

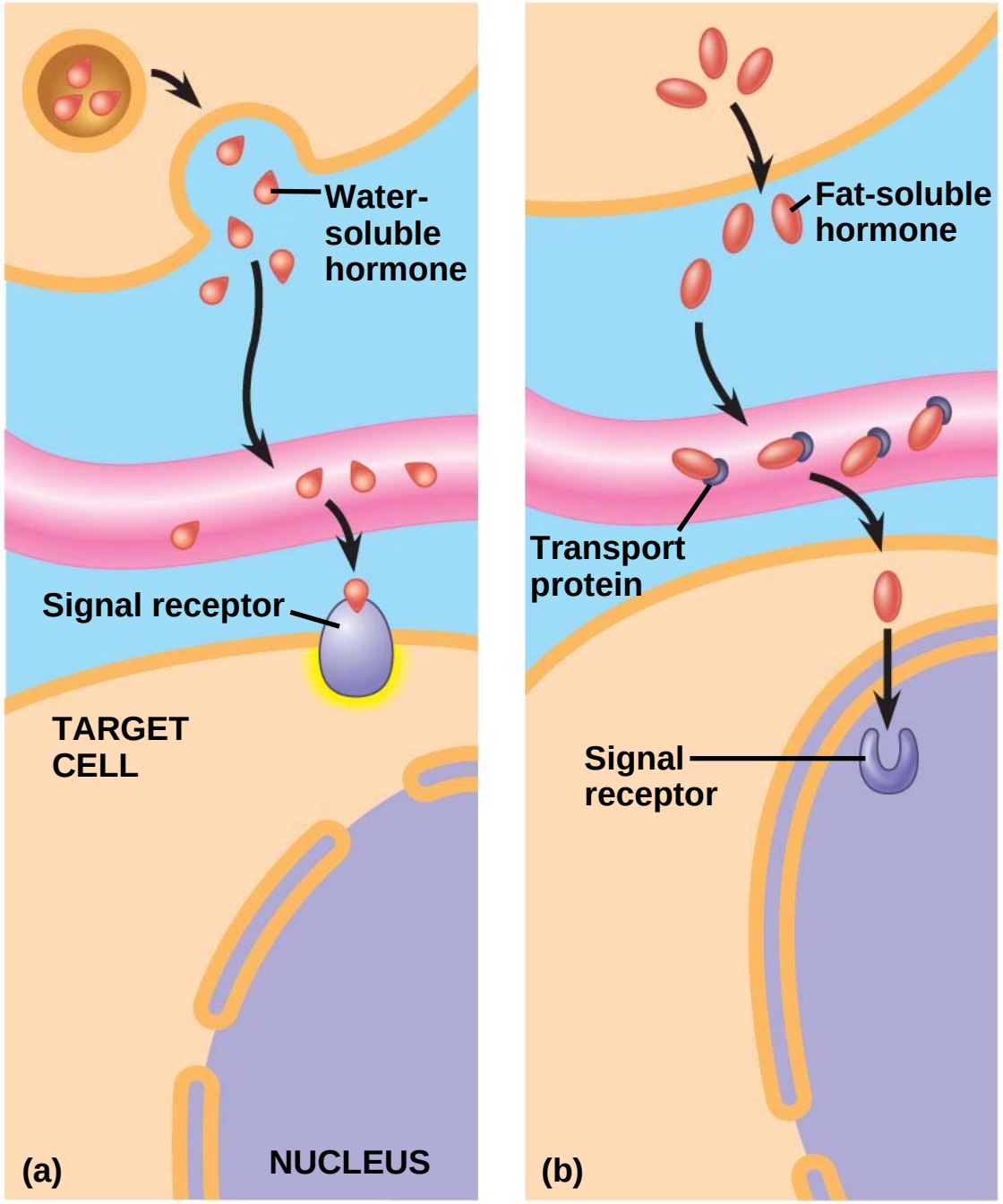
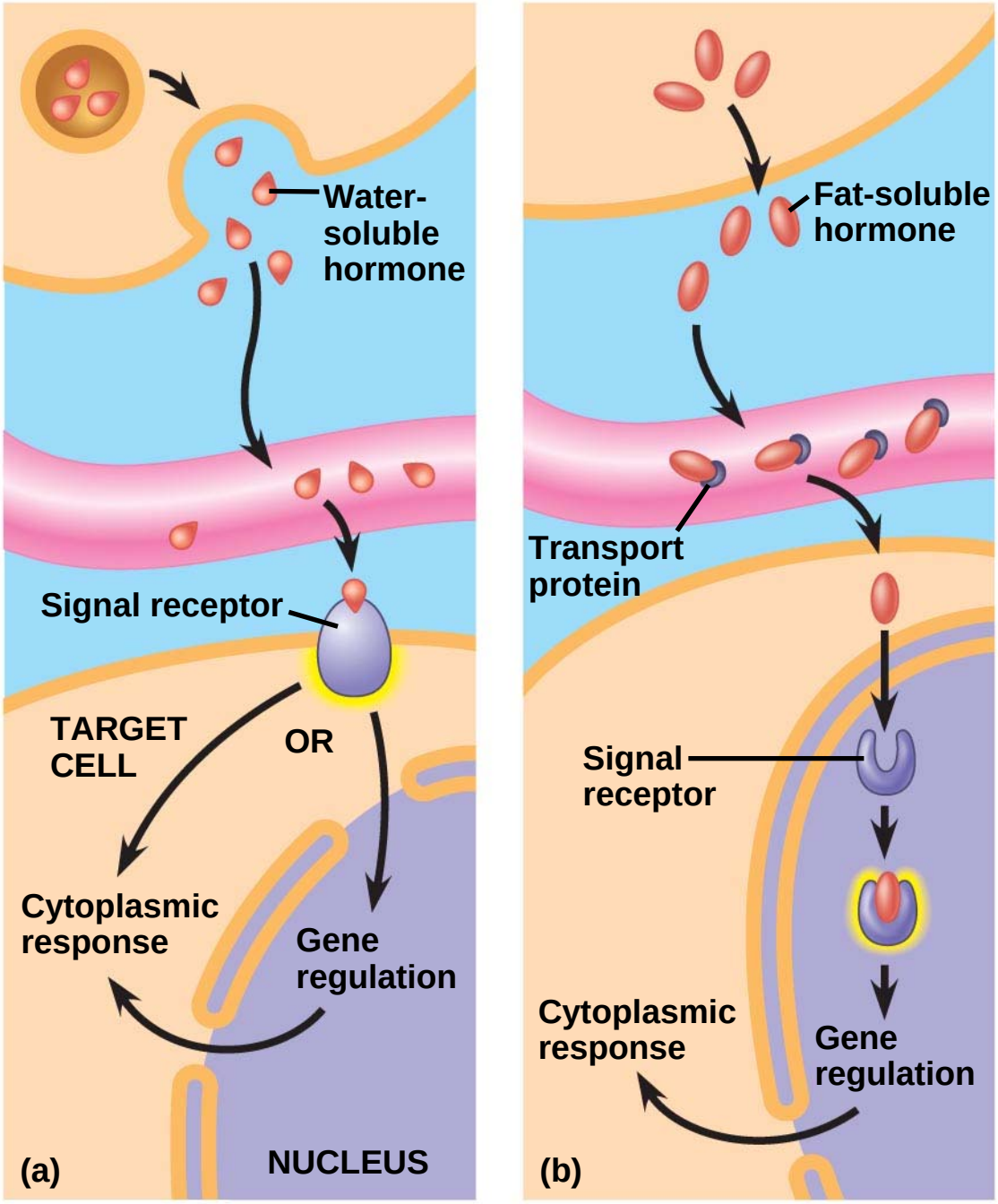


Fig. 45-5-2



Pathway for Water-Soluble Hormones

- Binding of a hormone to its receptor initiates a **signal transduction** pathway leading to responses in the cytoplasm, enzyme activation, or a change in gene expression

PLAY Animation: Water-Soluble Hormone

- The hormone **epinephrine** has multiple effects in mediating the body's response to short-term stress
- Epinephrine binds to receptors on the plasma membrane of liver cells
- This triggers the release of messenger molecules that activate enzymes and result in the release of glucose into the bloodstream

Fig. 45-6-1

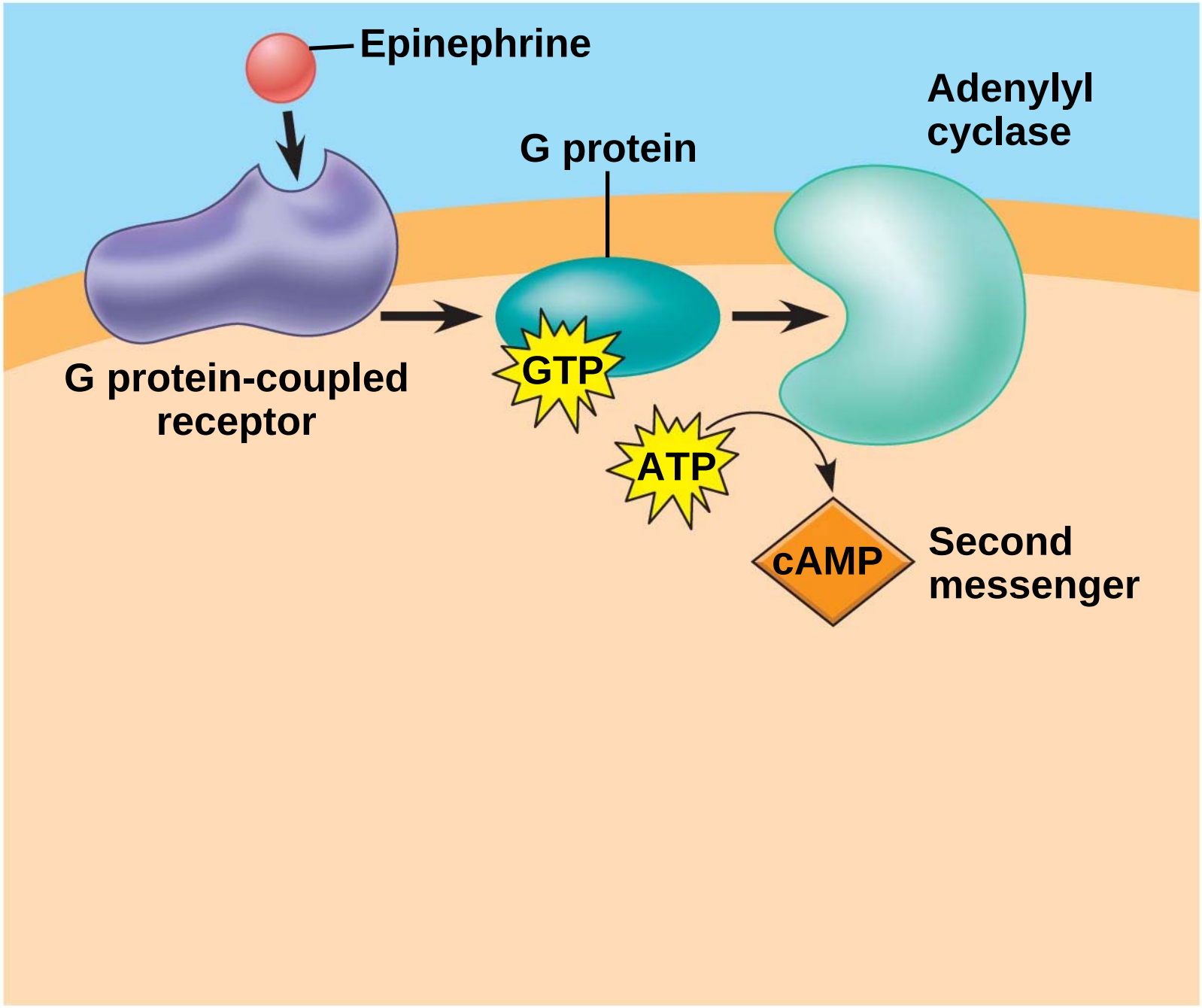
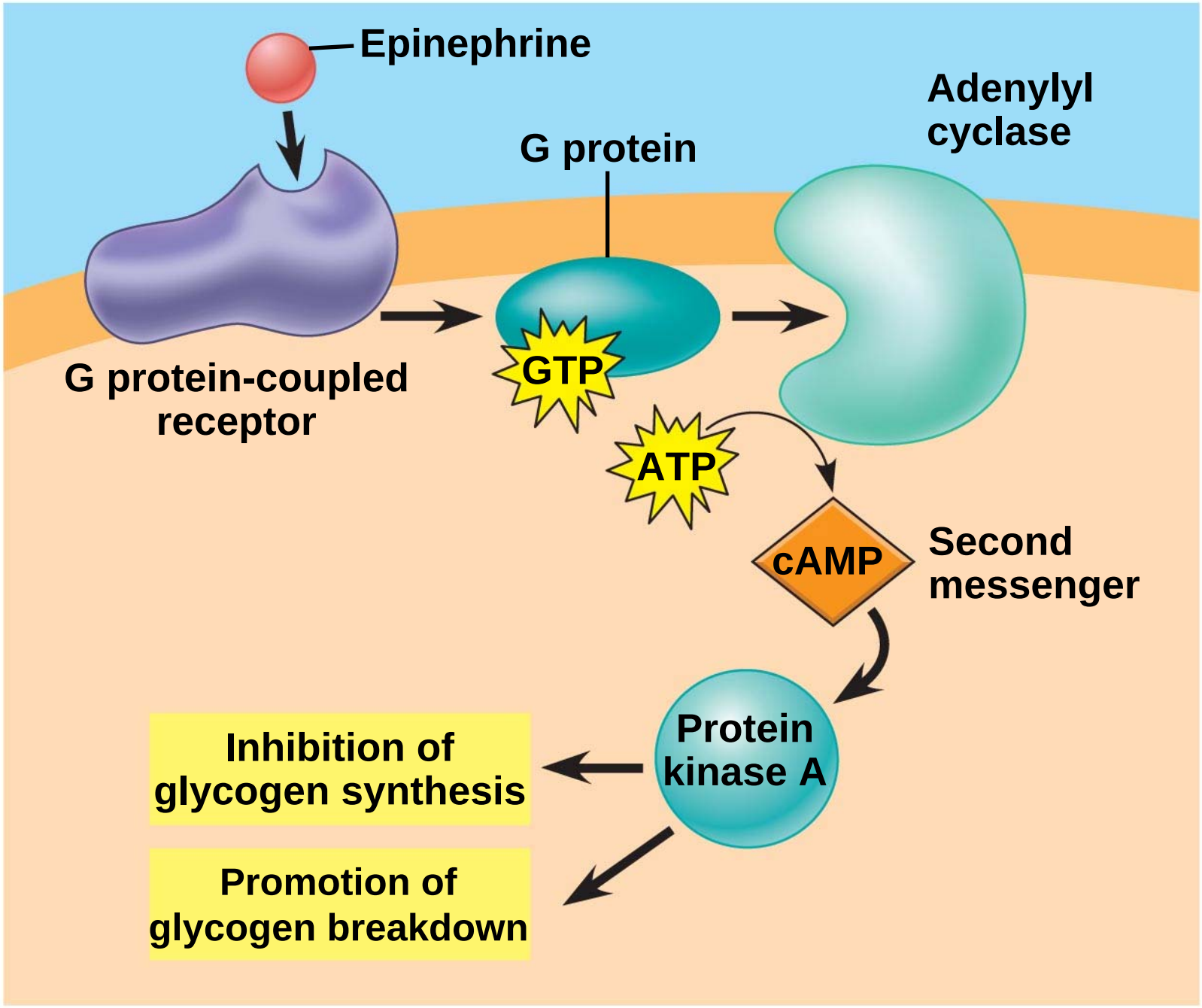


Fig. 45-6-2



Pathway for Lipid-Soluble Hormones

- The response to a lipid-soluble hormone is usually a change in gene expression
- Steroids, thyroid hormones, and the hormonal form of vitamin D enter target cells and bind to protein receptors in the cytoplasm or nucleus
- Protein-receptor complexes then act as transcription factors in the nucleus, regulating transcription of specific genes

PLAY Animation: Lipid-Soluble Hormone

Fig. 45-7-1

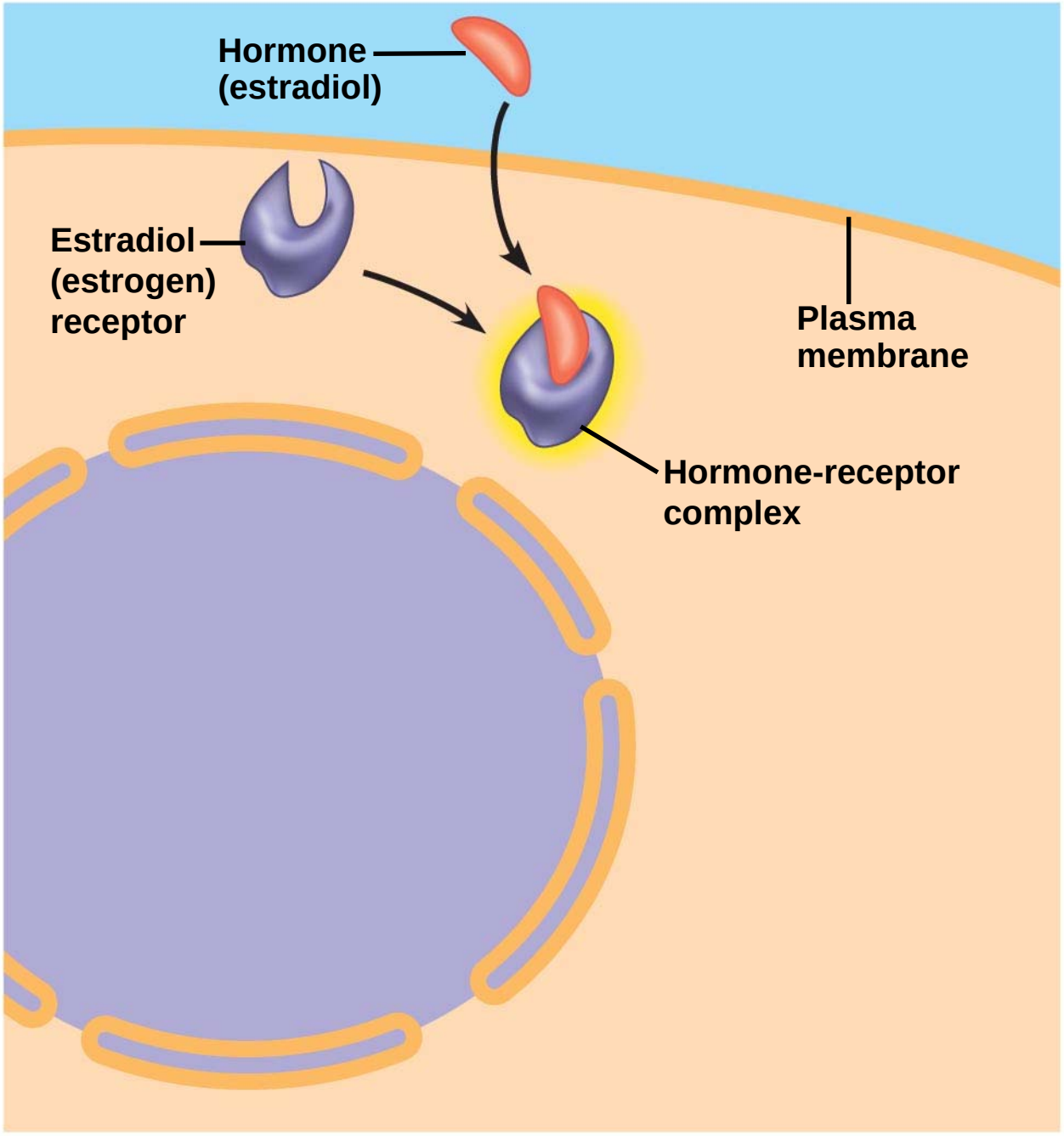
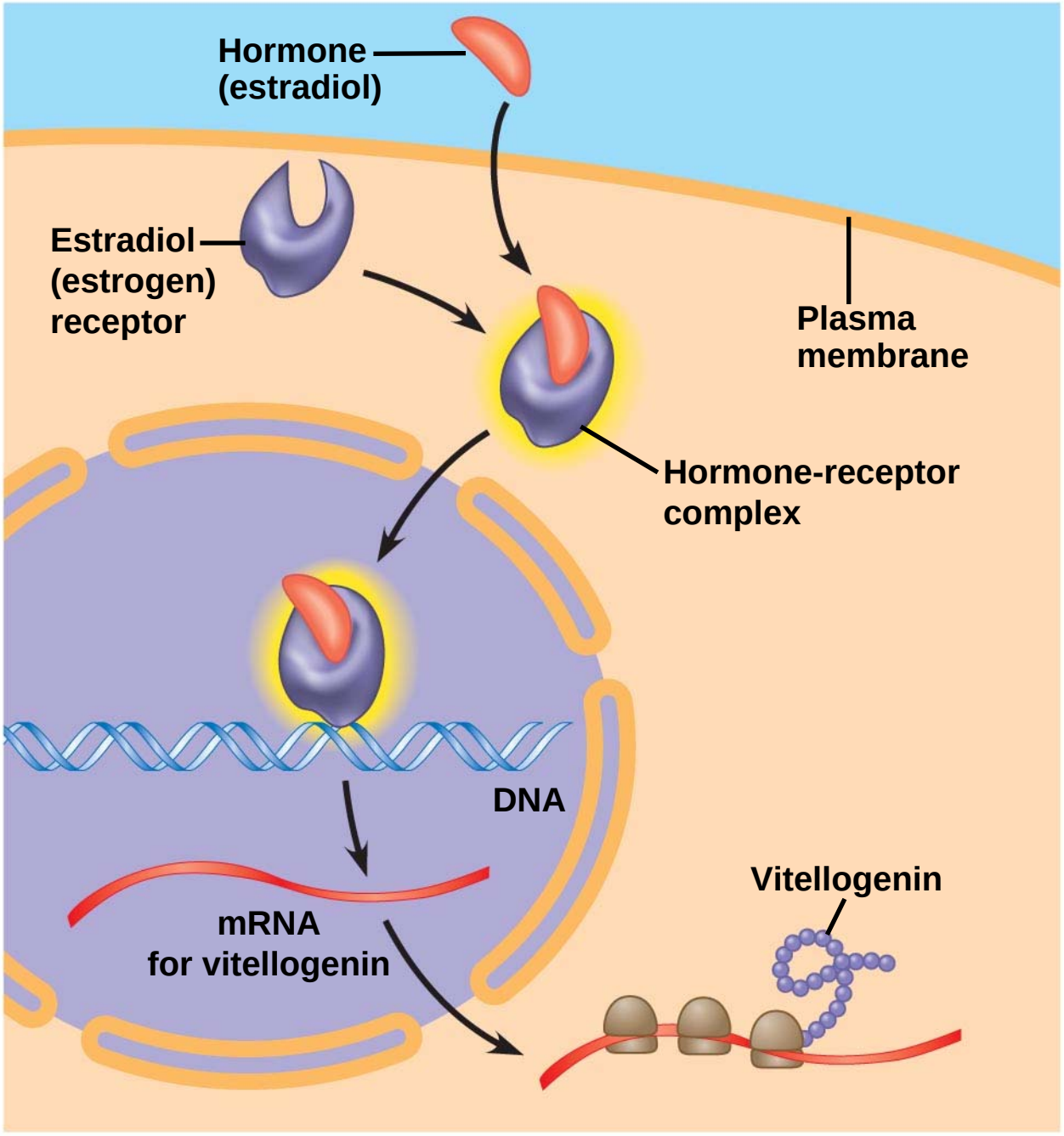


Fig. 45-7-2



Multiple Effects of Hormones

- The same hormone may have different effects on target cells that have
  - Different receptors for the hormone
  - Different signal transduction pathways
  - Different proteins for carrying out the response
- A hormone can also have different effects in different species

Fig. 45-8-1

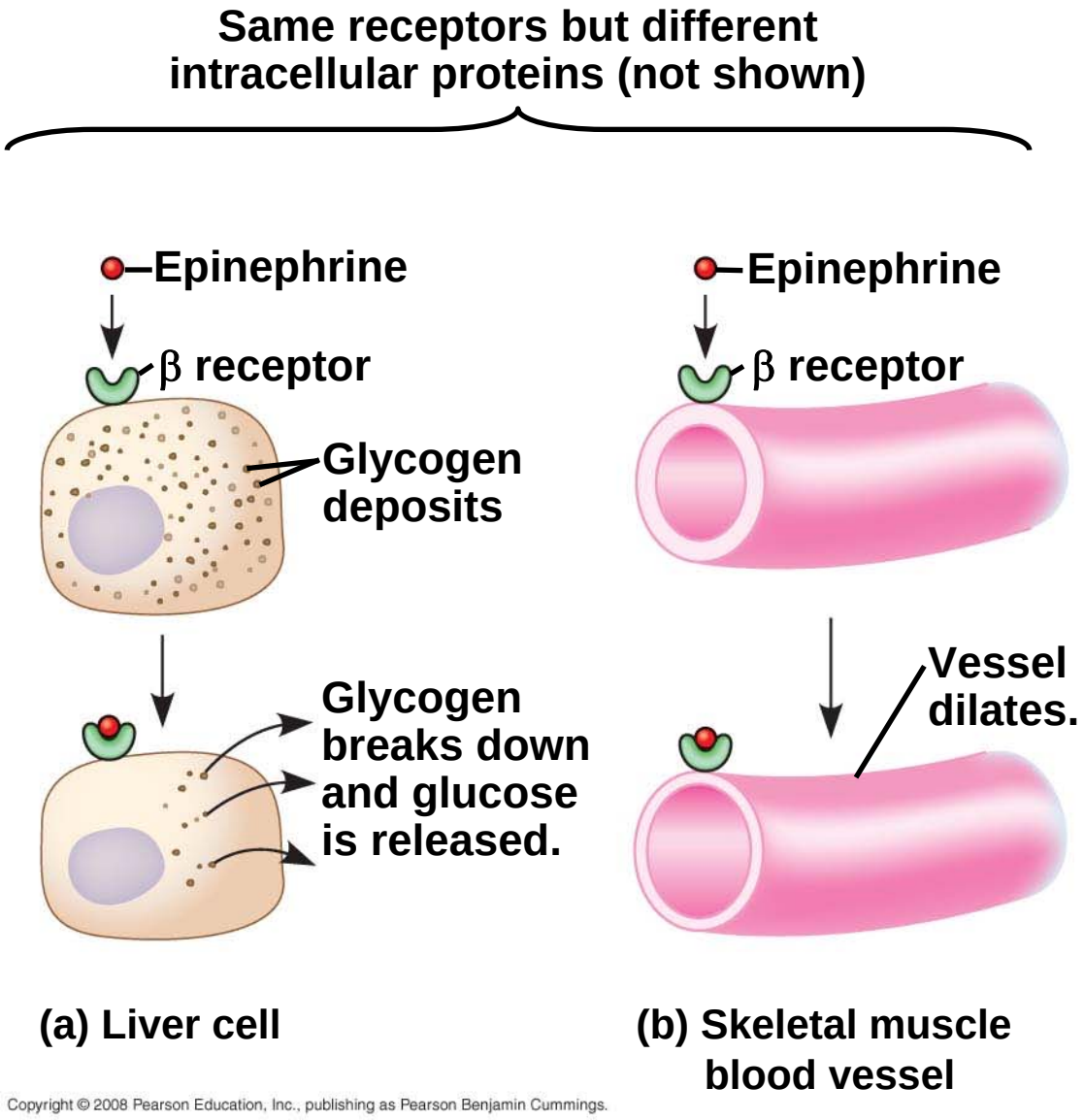


Fig. 45-8-2

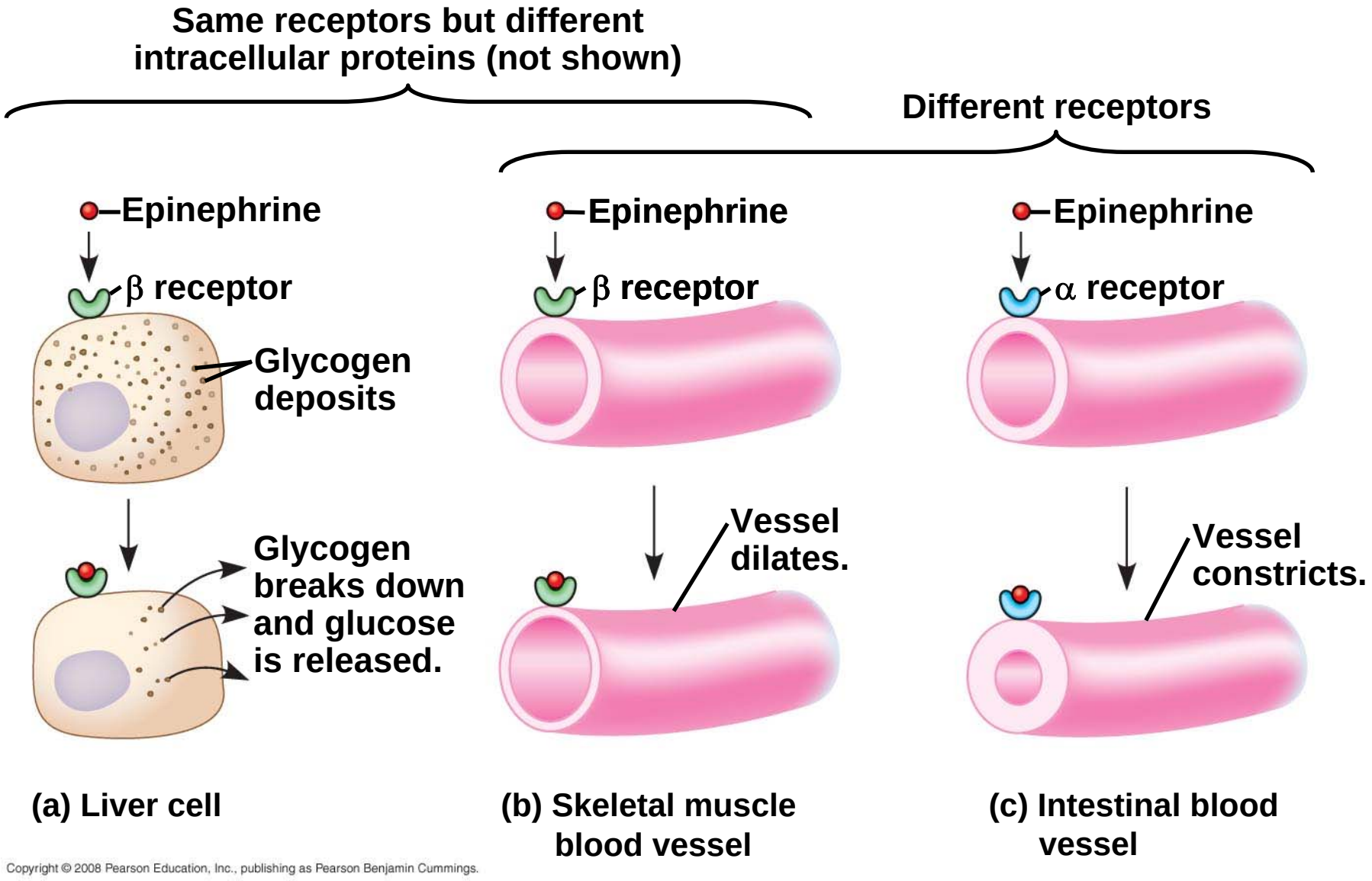


Fig. 45-9

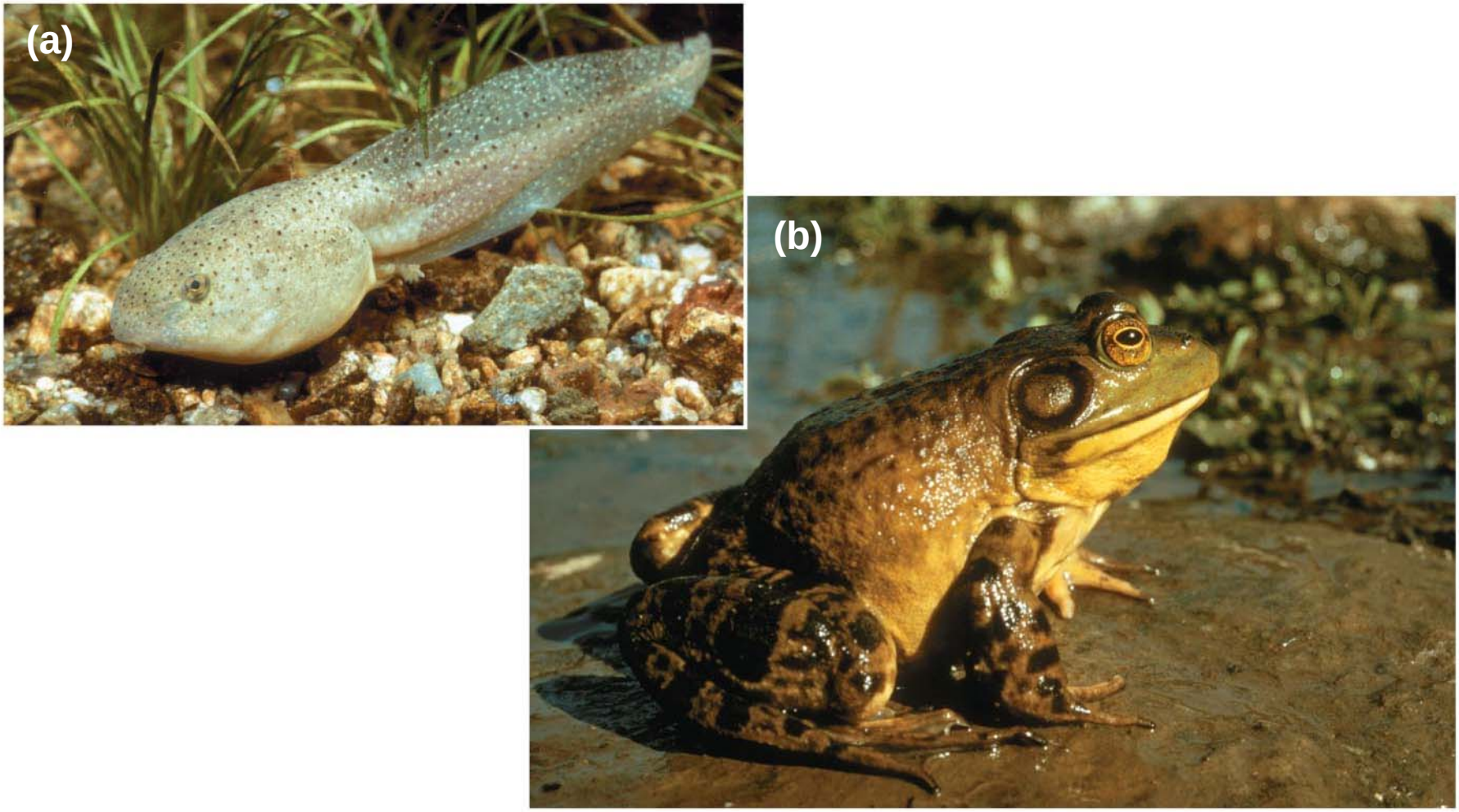


Fig. 45-9a

Fig. 45-9b

Signaling by Local Regulators

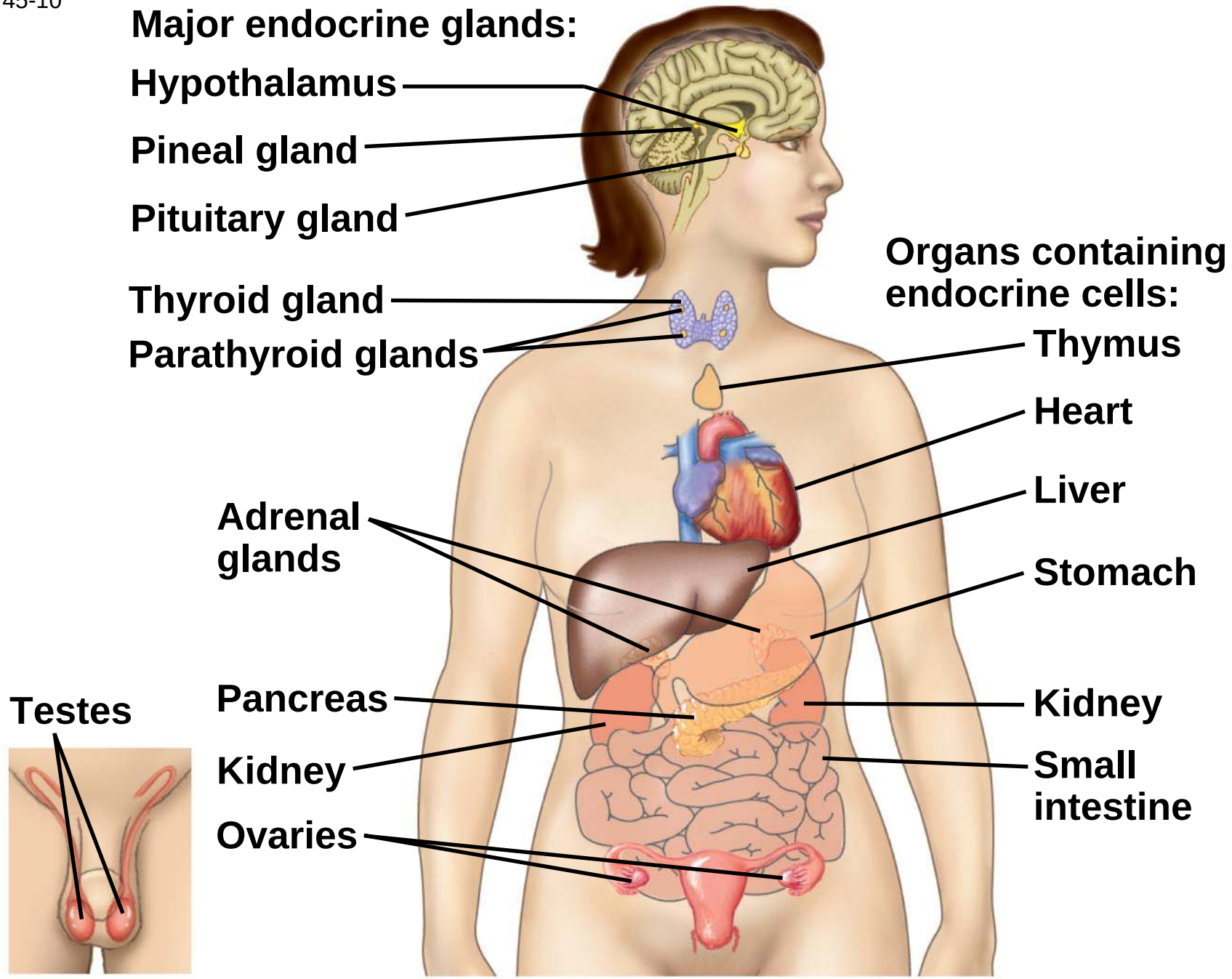
- In paracrine signaling, nonhormonal chemical signals called local regulators elicit responses in nearby target cells
- Types of local regulators:
  - **Cytokines** and **growth factors**
  - **Nitric oxide (NO)**
  - **Prostaglandins**

- Prostaglandins help regulate aggregation of platelets, an early step in formation of blood clots

Concept 45.2: Negative feedback and antagonistic hormone pairs are common features of the endocrine system

- Hormones are assembled into regulatory pathways

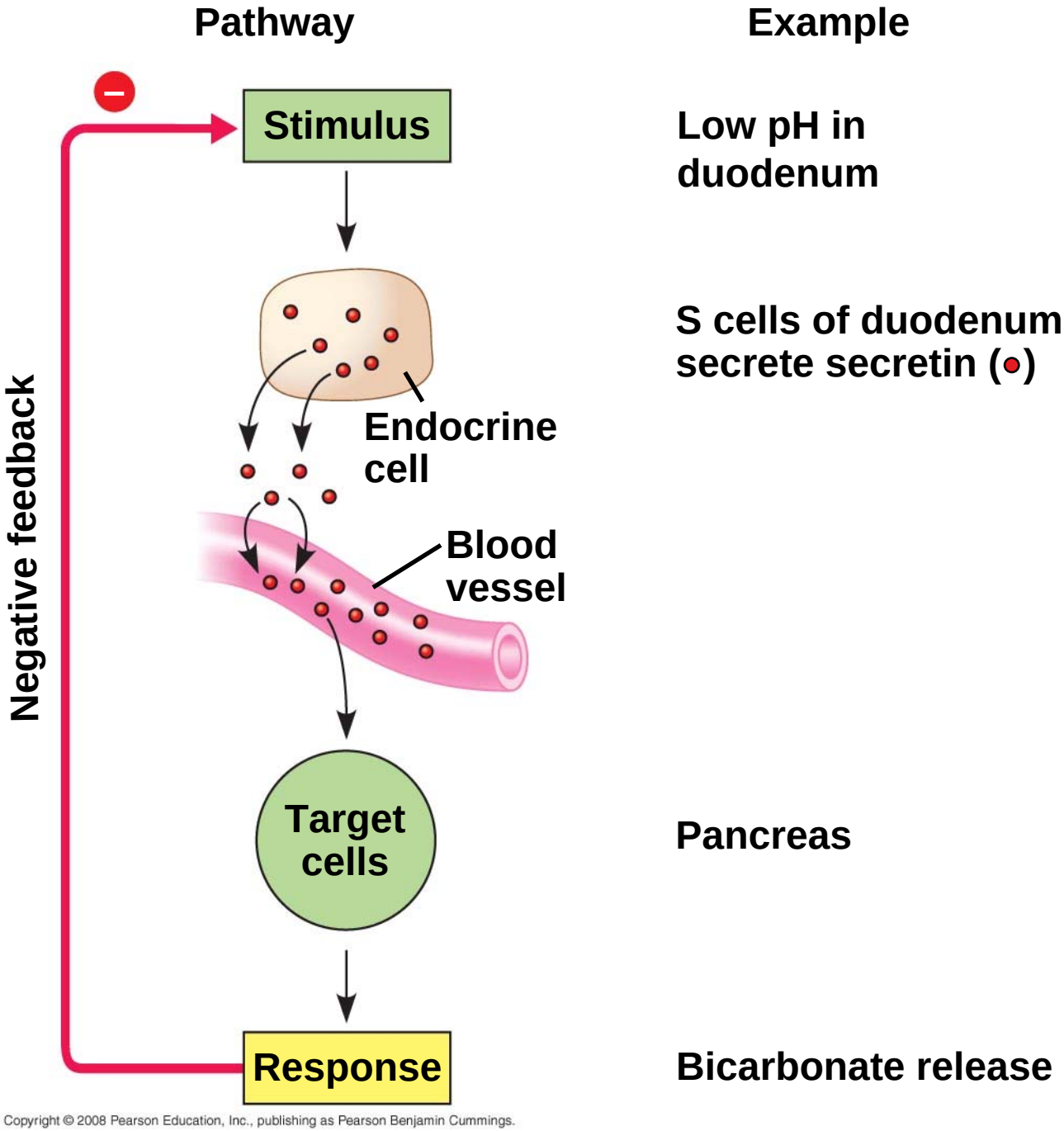
Fig. 45-10



Simple Hormone Pathways

- Hormones are released from an endocrine cell, travel through the bloodstream, and interact with the receptor or a target cell to cause a physiological response

Fig. 45-11


Pathway
Example
Stimulus
Low pH in duodenum
S cells of duodenum secrete secretin (•)
Endocrine cell
Blood vessel
Target cells
Pancreas
Response
Bicarbonate release
Negative feedback
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- A **negative feedback** loop inhibits a response by reducing the initial stimulus
- Negative feedback regulates many hormonal pathways involved in homeostasis

Insulin and Glucagon: Control of Blood Glucose

- **Insulin** and **glucagon** are antagonistic hormones that help maintain glucose homeostasis
- The **pancreas** has clusters of endocrine cells called **islets of Langerhans** with alpha cells that produce glucagon and beta cells that produce insulin

Fig. 45-12-1

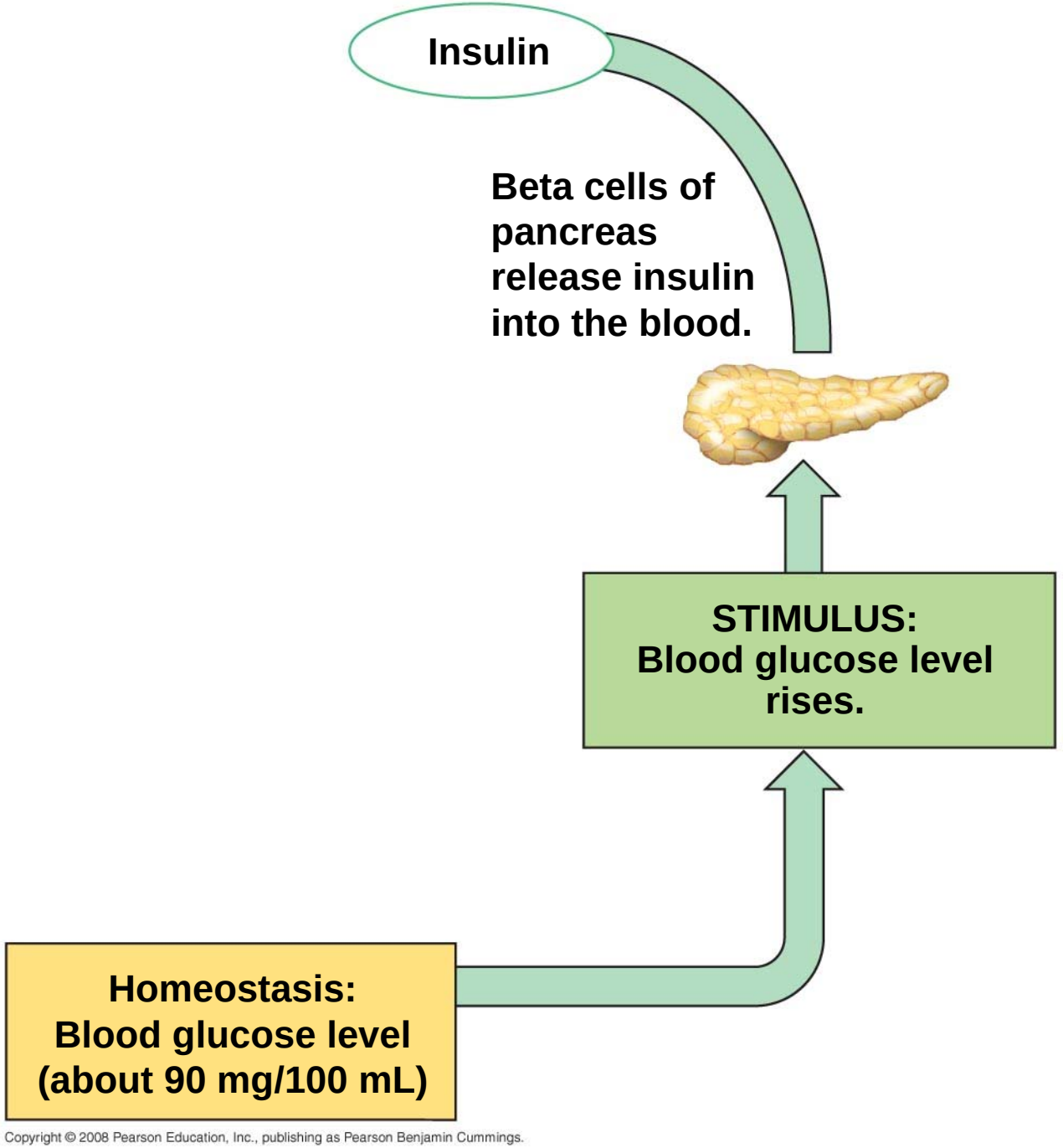


Fig. 45-12-2

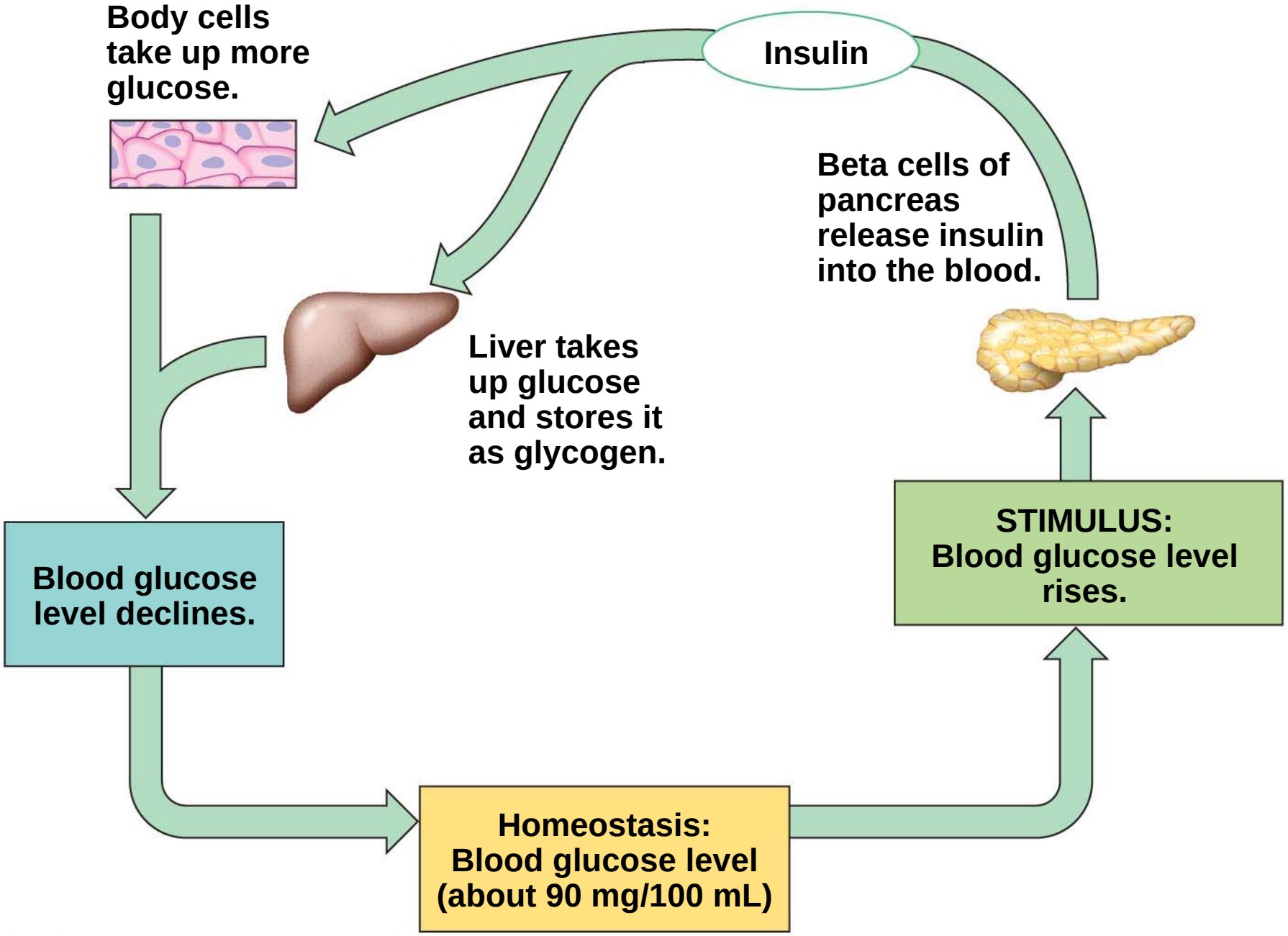
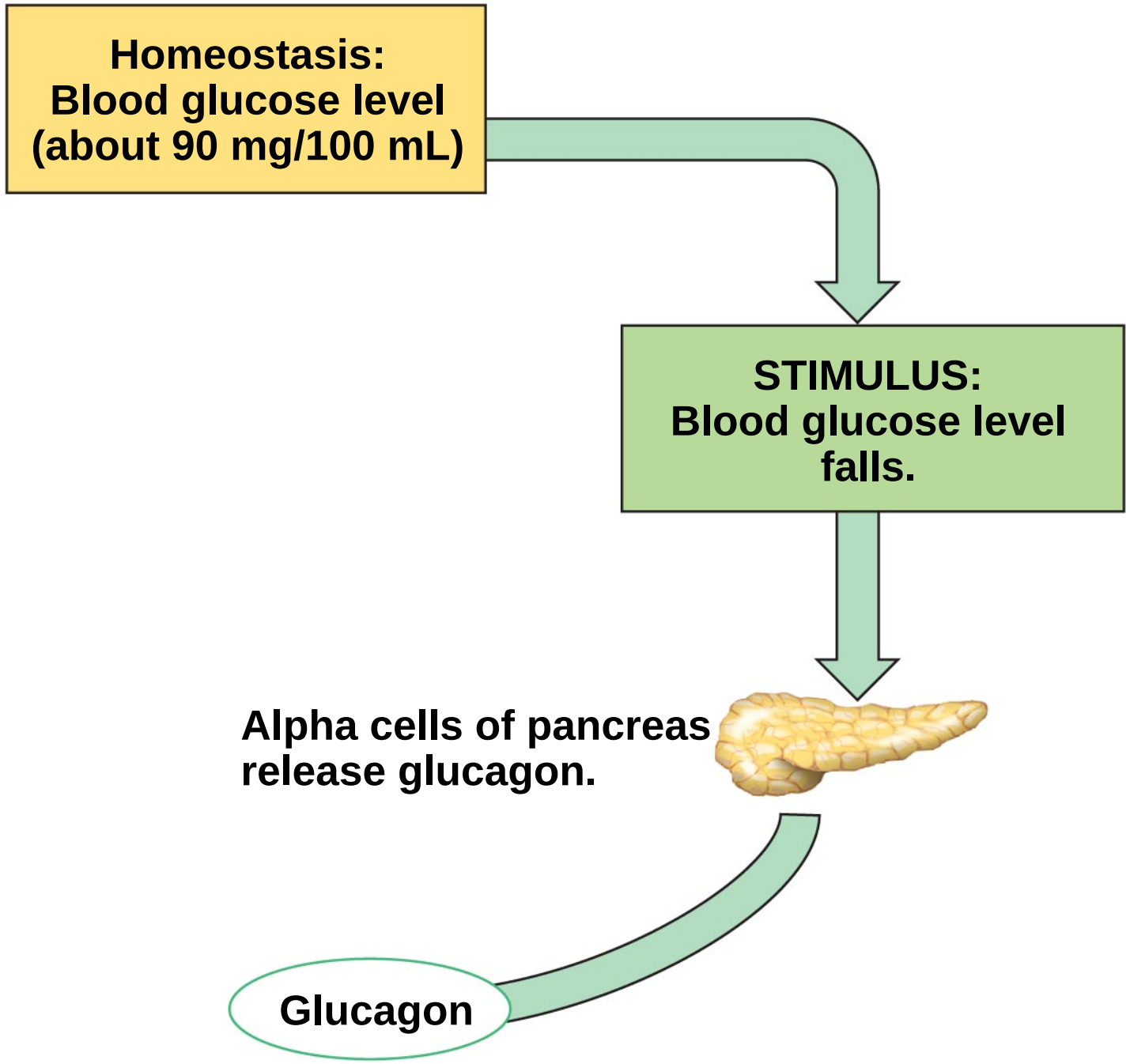


Fig. 45-12-3



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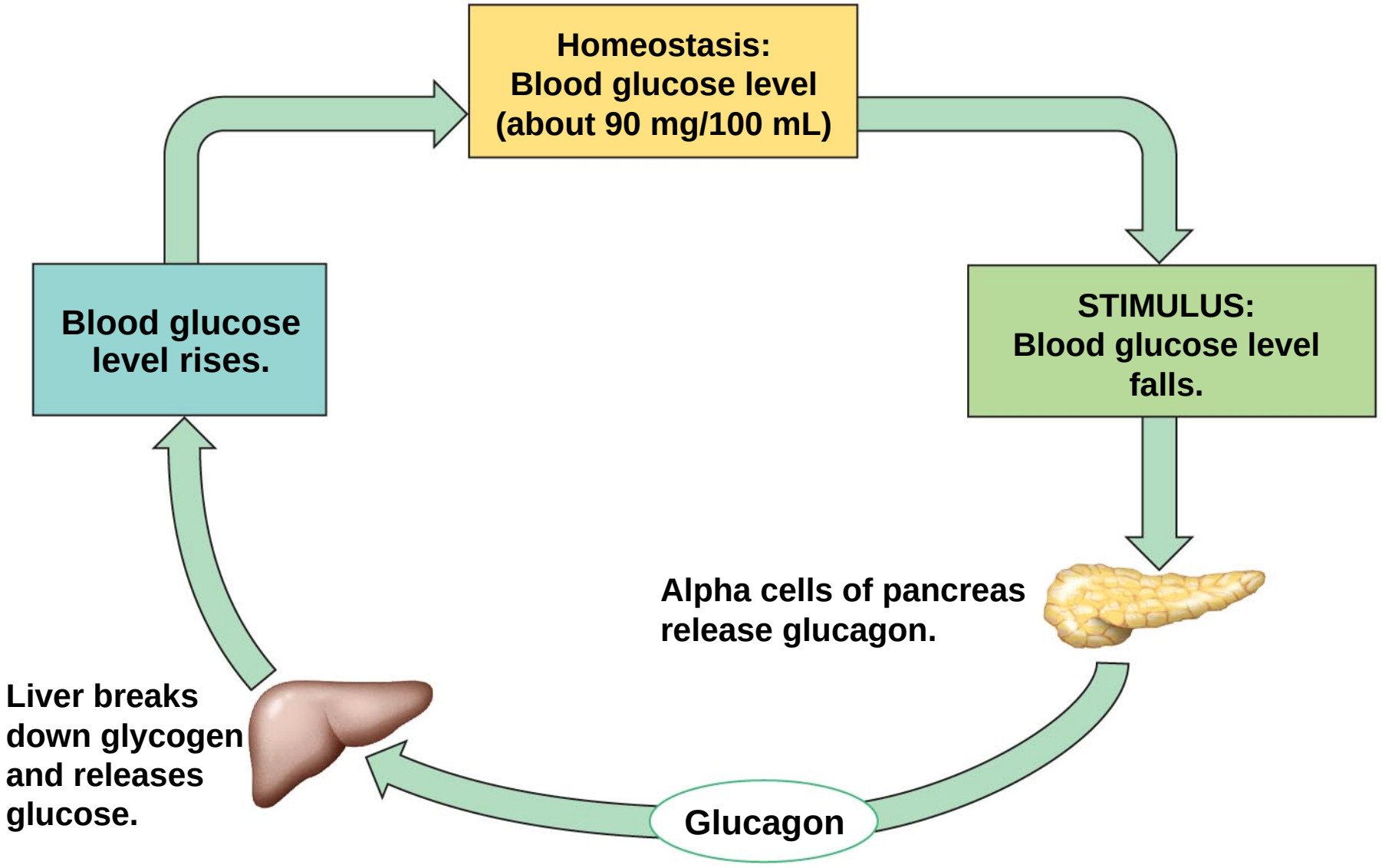
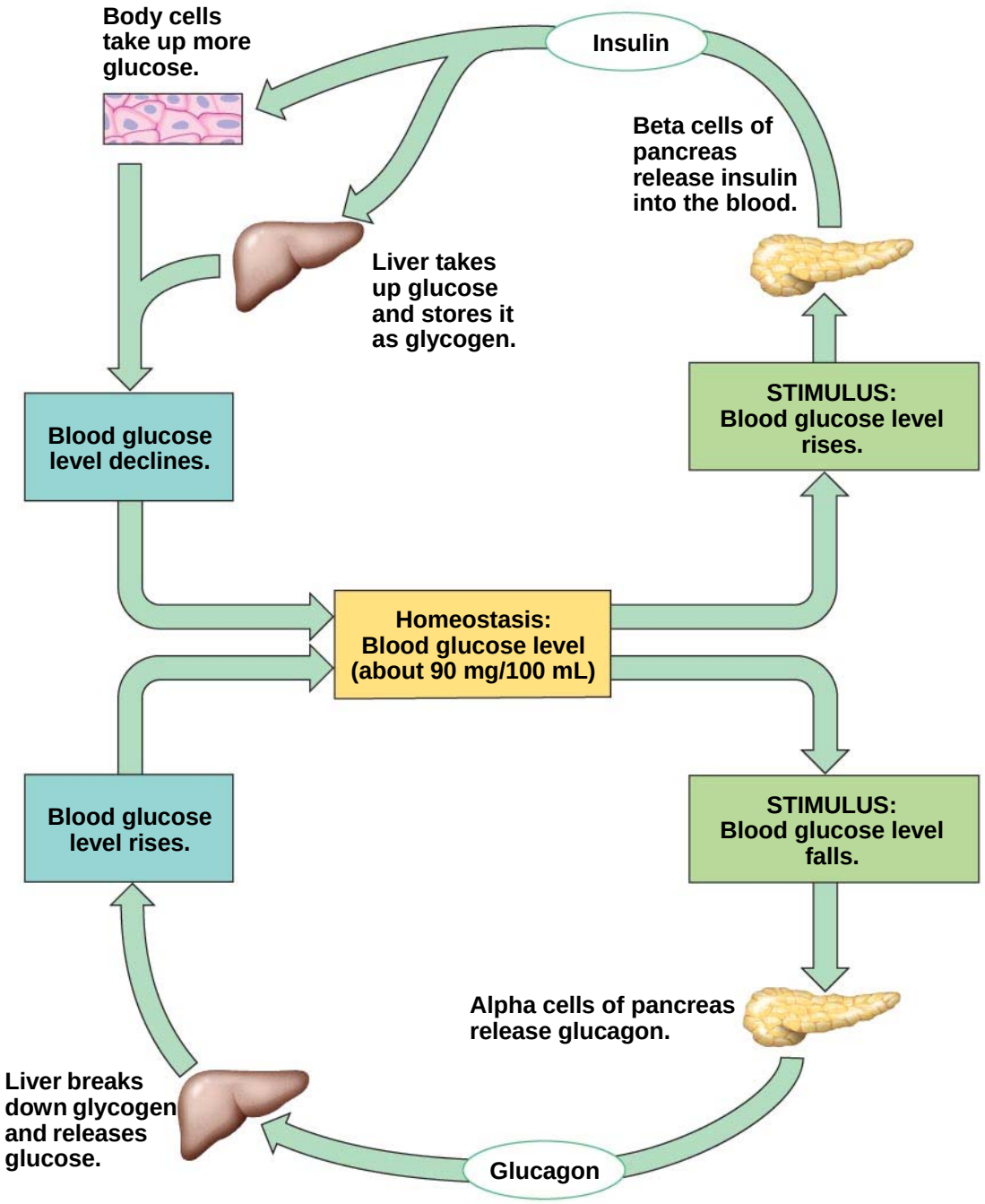


Fig. 45-12-5



Target Tissues for Insulin and Glucagon

- Insulin reduces blood glucose levels by
  - Promoting the cellular uptake of glucose
  - Slowing glycogen breakdown in the liver
  - Promoting fat storage

- Glucagon increases blood glucose levels by
  - Stimulating conversion of glycogen to glucose in the liver
  - Stimulating breakdown of fat and protein into glucose

Diabetes Mellitus

- **Diabetes mellitus** is perhaps the best-known endocrine disorder
- It is caused by a deficiency of insulin or a decreased response to insulin in target tissues
- It is marked by elevated blood glucose levels

- *Type I diabetes mellitus* (insulin-dependent) is an autoimmune disorder in which the immune system destroys pancreatic beta cells
- *Type II diabetes mellitus* (non-insulin-dependent) involves insulin deficiency or reduced response of target cells due to change in insulin receptors

Concept 45.3: The endocrine and nervous systems act individually and together in regulating animal physiology

- Signals from the nervous system initiate and regulate endocrine signals

Coordination of Endocrine and Nervous Systems in Invertebrates

- In insects, molting and development are controlled by a combination of hormones:
  - A brain hormone stimulates release of **ecdysone** from the prothoracic glands
  - **Juvenile hormone** promotes retention of larval characteristics
  - Ecdysone promotes molting (in the presence of juvenile hormone) and development (in the absence of juvenile hormone) of adult characteristics

Fig. 45-13-1

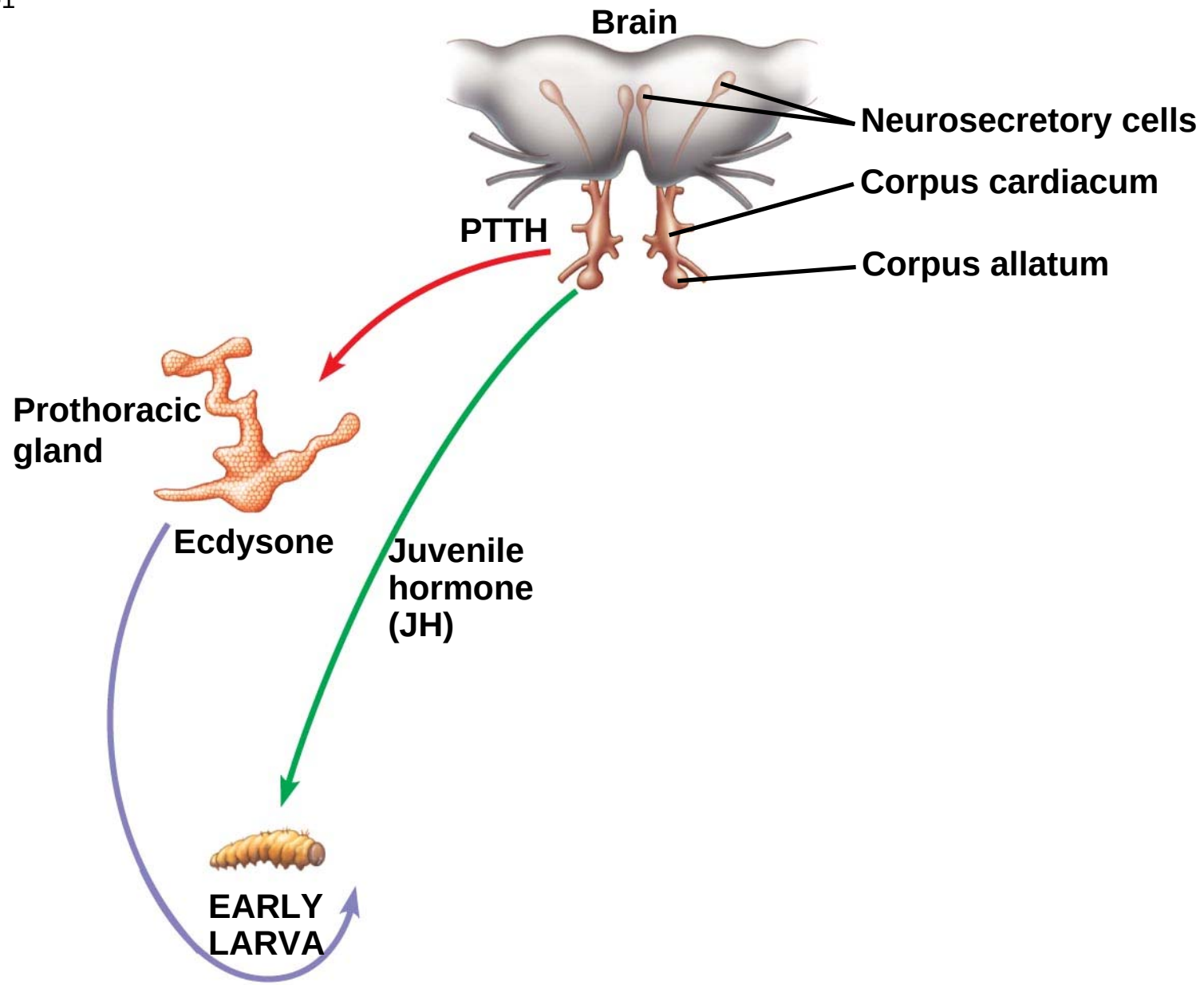


Fig. 45-13-2

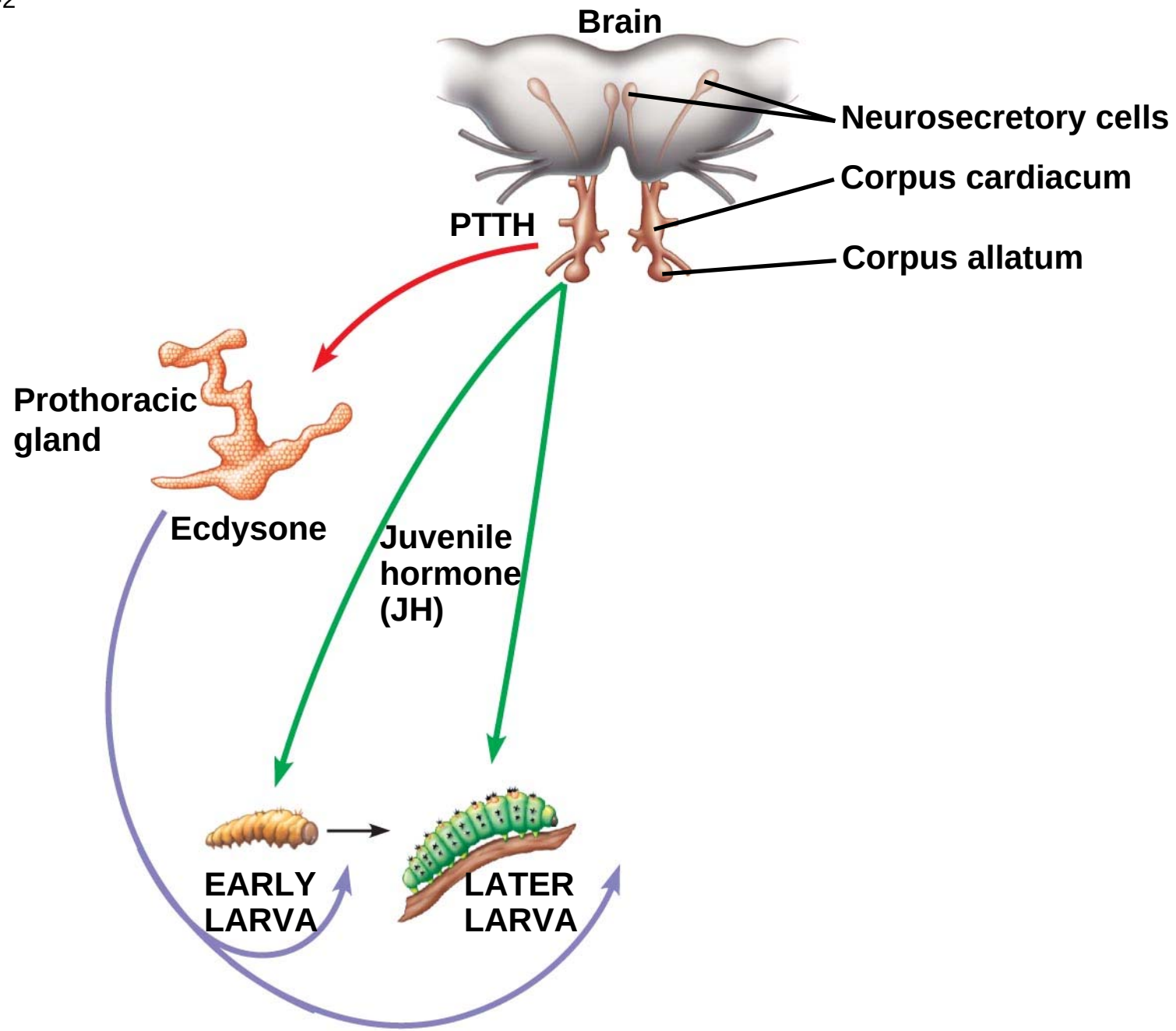
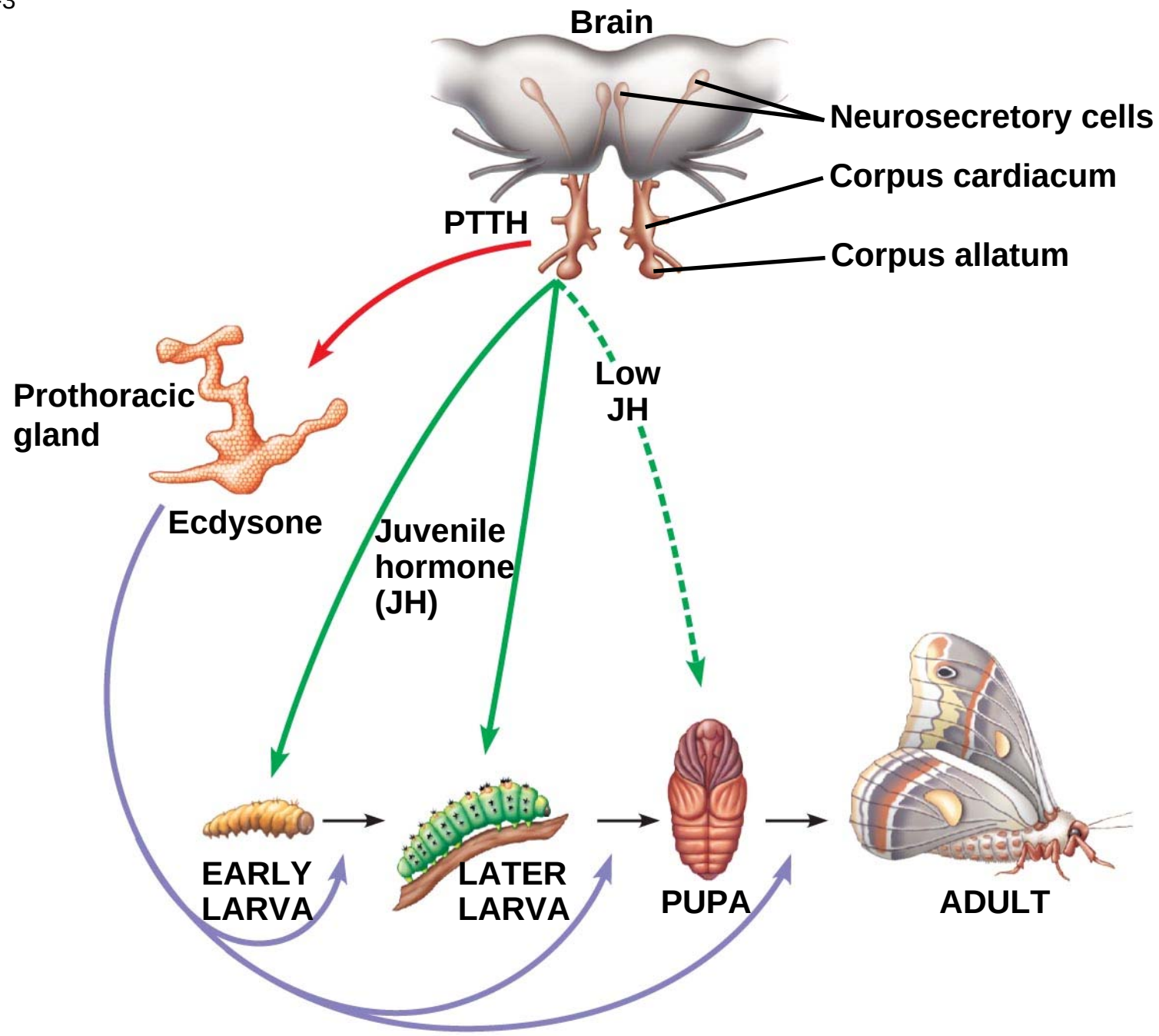


Fig. 45-13-3



Coordination of Endocrine and Nervous Systems in Vertebrates

- The **hypothalamus** receives information from the nervous system and initiates responses through the endocrine system
- Attached to the hypothalamus is the **pituitary gland** composed of the posterior pituitary and anterior pituitary

- The **posterior pituitary** stores and secretes hormones that are made in the hypothalamus
- The **anterior pituitary** makes and releases hormones under regulation of the hypothalamus

Fig. 45-14

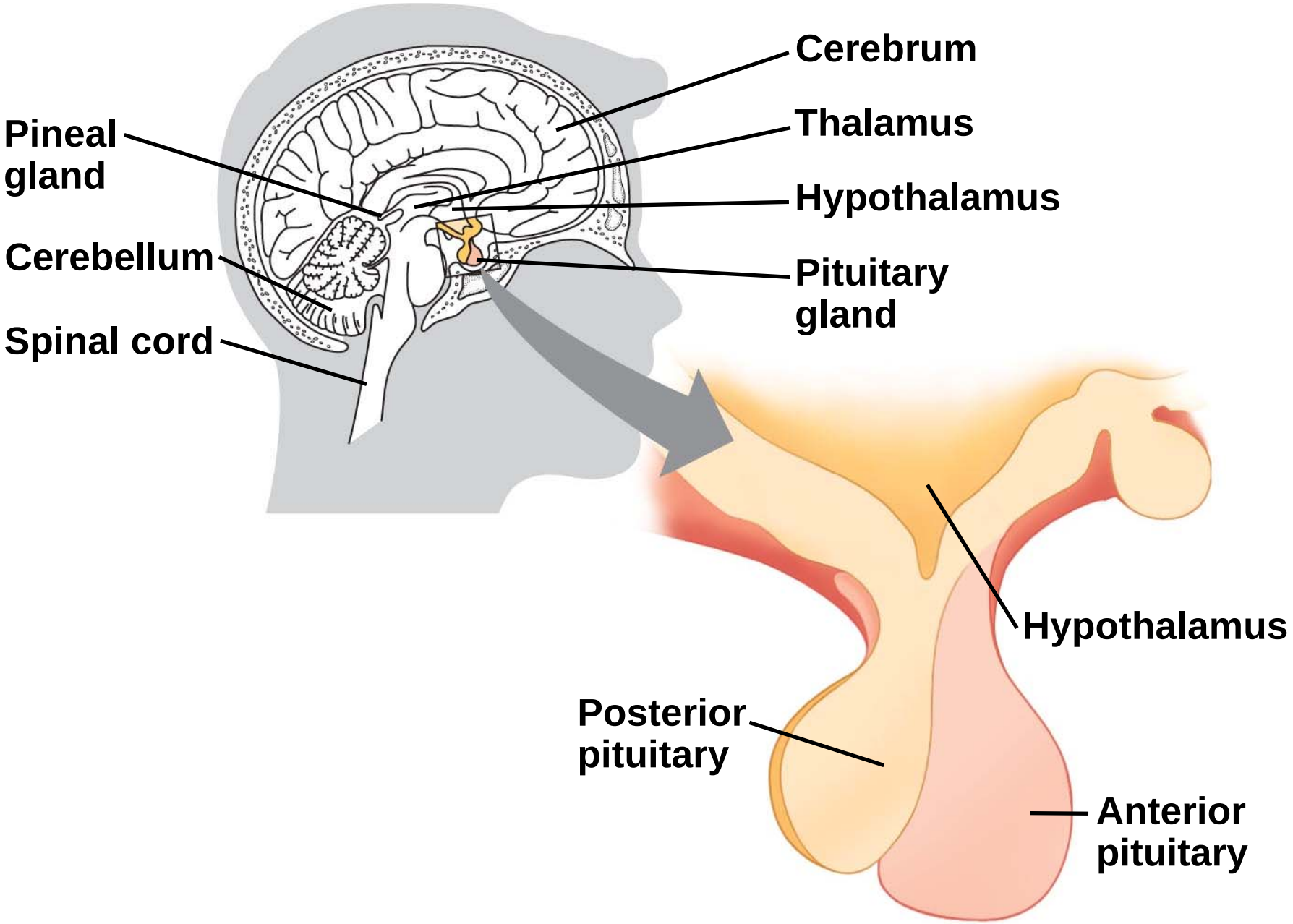


Table 45-1

Table 45.1 Major Human Endocrine Glands and Some of Their Hormones

Gland		Hormone	Chemical Class	Representative Actions	Regulated By
Hypothalamus		Hormones released from the posterior pituitary and hormones that regulate the anterior pituitary (see below)			
Posterior pituitary gland (releases neurohormones made in hypothalamus)		Oxytocin	Peptide	Stimulates contraction of uterus and mammary gland cells	Nervous system
		Antidiuretic hormone (ADH)	Peptide	Promotes retention of water by kidneys	Water/salt balance
Anterior pituitary gland		Growth hormone (GH)	Protein	Stimulates growth (especially bones) and metabolic functions	Hypothalamic hormones
		Prolactin (PRL)	Protein	Stimulates milk production and secretion	Hypothalamic hormones
		Follicle-stimulating hormone (FSH)	Glycoprotein	Stimulates production of ova and sperm	Hypothalamic hormones
		Luteinizing hormone (LH)	Glycoprotein	Stimulates ovaries and testes	Hypothalamic hormones
		Thyroid-stimulating hormone (TSH)	Glycoprotein	Stimulates thyroid gland	Hypothalamic hormones
		Adrenocorticotropic hormone (ACTH)	Peptide	Stimulates adrenal cortex to secrete glucocorticoids	Hypothalamic hormones
Thyroid gland		Triiodothyronine (T_3) and thyroxine (T_4)	Amine	Stimulate and maintain metabolic processes	TSH
		Calcitonin	Peptide	Lowers blood calcium level	Calcium in blood
Parathyroid glands		Parathyroid hormone (PTH)	Peptide	Raises blood calcium level	Calcium in blood

Table 45-1a

Table 45.1 Major Human Endocrine Glands and Some of Their Hormones

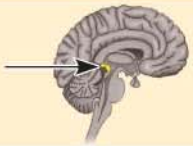
Gland		Hormone	Chemical Class	Representative Actions	Regulated By
Pancreas		Insulin	Protein	Lowers blood glucose level	Glucose in blood
		Glucagon	Protein	Raises blood glucose level	Glucose in blood
Adrenal glands					
Adrenal medulla		Epinephrine and norepinephrine	Amines	Raise blood glucose level; increase metabolic activities; constrict certain blood vessels	Nervous system
Adrenal cortex		Glucocorticoids	Steroid	Raise blood glucose level	ACTH
		Mineralocorticoids	Steroid	Promote reabsorption of Na^+ and excretion of K^+ in kidneys	K^+ in blood; angiotensin II
Gonads					
Testes		Androgens	Steroid	Support sperm formation; promote development and maintenance of male secondary sex characteristics	FSH and LH
Ovaries		Estrogens	Steroid	Stimulate uterine lining growth; promote development and maintenance of female secondary sex characteristics	FSH and LH
		Progestins	Steroid	Promote uterine lining growth	FSH and LH
Pineal gland		Melatonin	Amine	Involved in biological rhythms	Light/dark cycles

Table 45-1b

Table 45.1 Major Human Endocrine Glands and Some of Their Hormones

Gland	Hormone	Chemical Class	Representative Actions	Regulated By
Hypothalamus 	Hormones released from the posterior pituitary and hormones that regulate the anterior pituitary (see below)			
Posterior pituitary gland (releases neurohormones made in hypothalamus) 	Oxytocin	Peptide	Stimulates contraction of uterus and mammary gland cells	Nervous system
	Antidiuretic hormone (ADH)	Peptide	Promotes retention of water by kidneys	Water/salt balance
Anterior pituitary gland 	Growth hormone (GH)	Protein	Stimulates growth (especially bones) and metabolic functions	Hypothalamic hormones
	Prolactin (PRL)	Protein	Stimulates milk production and secretion	Hypothalamic hormones
	Follicle-stimulating hormone (FSH)	Glycoprotein	Stimulates production of ova and sperm	Hypothalamic hormones
	Luteinizing hormone (LH)	Glycoprotein	Stimulates ovaries and testes	Hypothalamic hormones
	Thyroid-stimulating hormone (TSH)	Glycoprotein	Stimulates thyroid gland	Hypothalamic hormones
	Adrenocorticotropic hormone (ACTH)	Peptide	Stimulates adrenal cortex to secrete glucocorticoids	Hypothalamic hormones

Table 45-1c

Table 45.1 Major Human Endocrine Glands and Some of Their Hormones

Gland		Hormone	Chemical Class	Representative Actions	Regulated By
Thyroid gland		Triiodothyronine (T_3) and thyroxine (T_4)	Amine	Stimulate and maintain metabolic processes	TSH
		Calcitonin	Peptide	Lowers blood calcium level	Calcium in blood
Parathyroid glands		Parathyroid hormone (PTH)	Peptide	Raises blood calcium level	Calcium in blood
Pancreas		Insulin	Protein	Lowers blood glucose level	Glucose in blood
		Glucagon	Protein	Raises blood glucose level	Glucose in blood
Adrenal glands					
Adrenal medulla		Epinephrine and norepinephrine	Amines	Raise blood glucose level; increase metabolic activities; constrict certain blood vessels	Nervous system
Adrenal cortex		Glucocorticoids	Steroid	Raise blood glucose level	ACTH
		Mineralocorticoids	Steroid	Promote reabsorption of Na^+ and excretion of K^+ in kidneys	K^+ in blood; angiotensin II

Table 45-1d

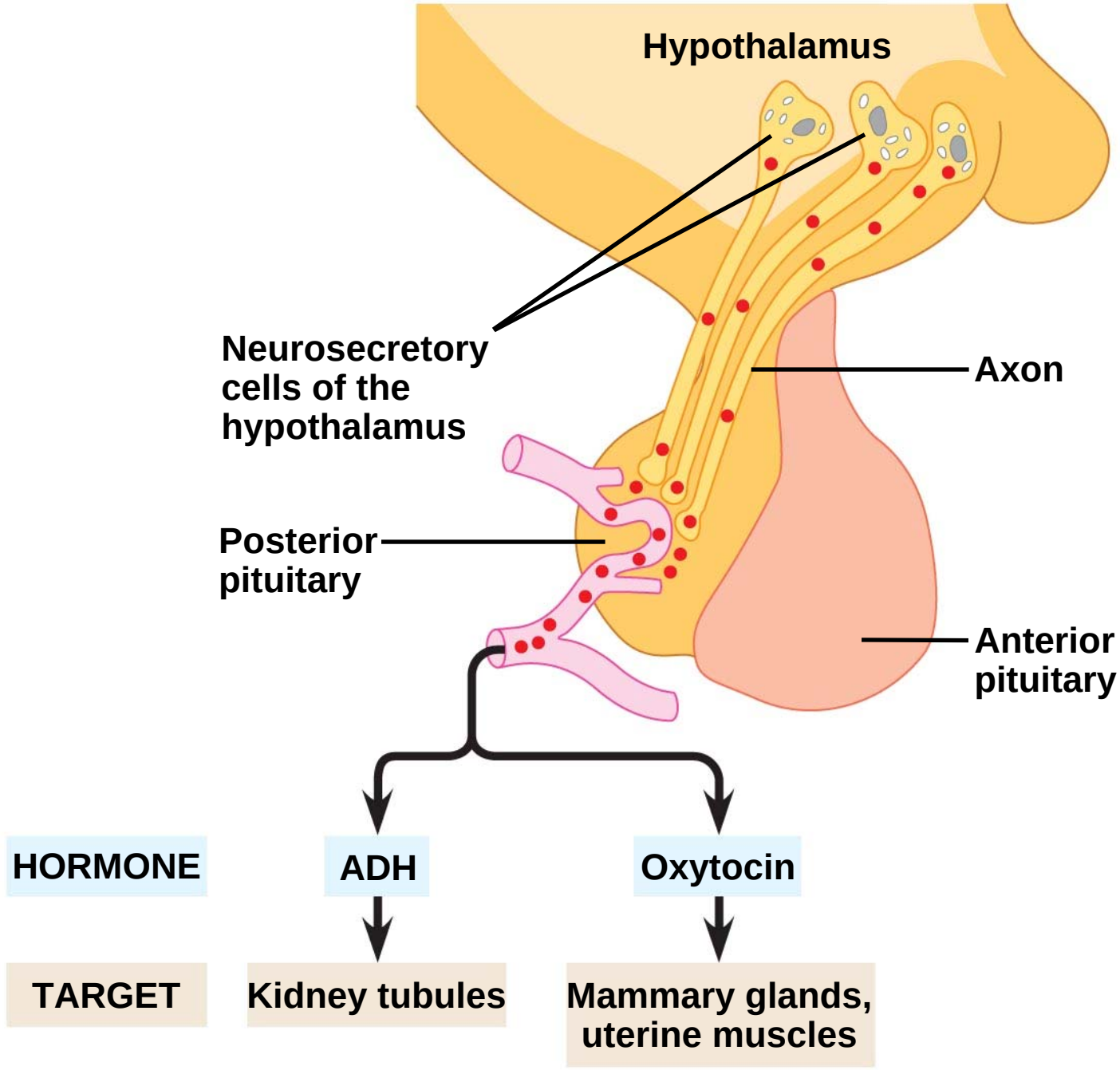
Table 45.1 Major Human Endocrine Glands and Some of Their Hormones

Gland	Hormone	Chemical Class	Representative Actions	Regulated By
Gonads				
Testes 	Androgens	Steroid	Support sperm formation; promote development and maintenance of male secondary sex characteristics	FSH and LH
Ovaries 	Estrogens	Steroid	Stimulate uterine lining growth; promote development and maintenance of female secondary sex characteristics	FSH and LH
	Progestins	Steroid	Promote uterine lining growth	FSH and LH
Pineal gland 	Melatonin	Amine	Involved in biological rhythms	Light/dark cycles

Posterior Pituitary Hormones

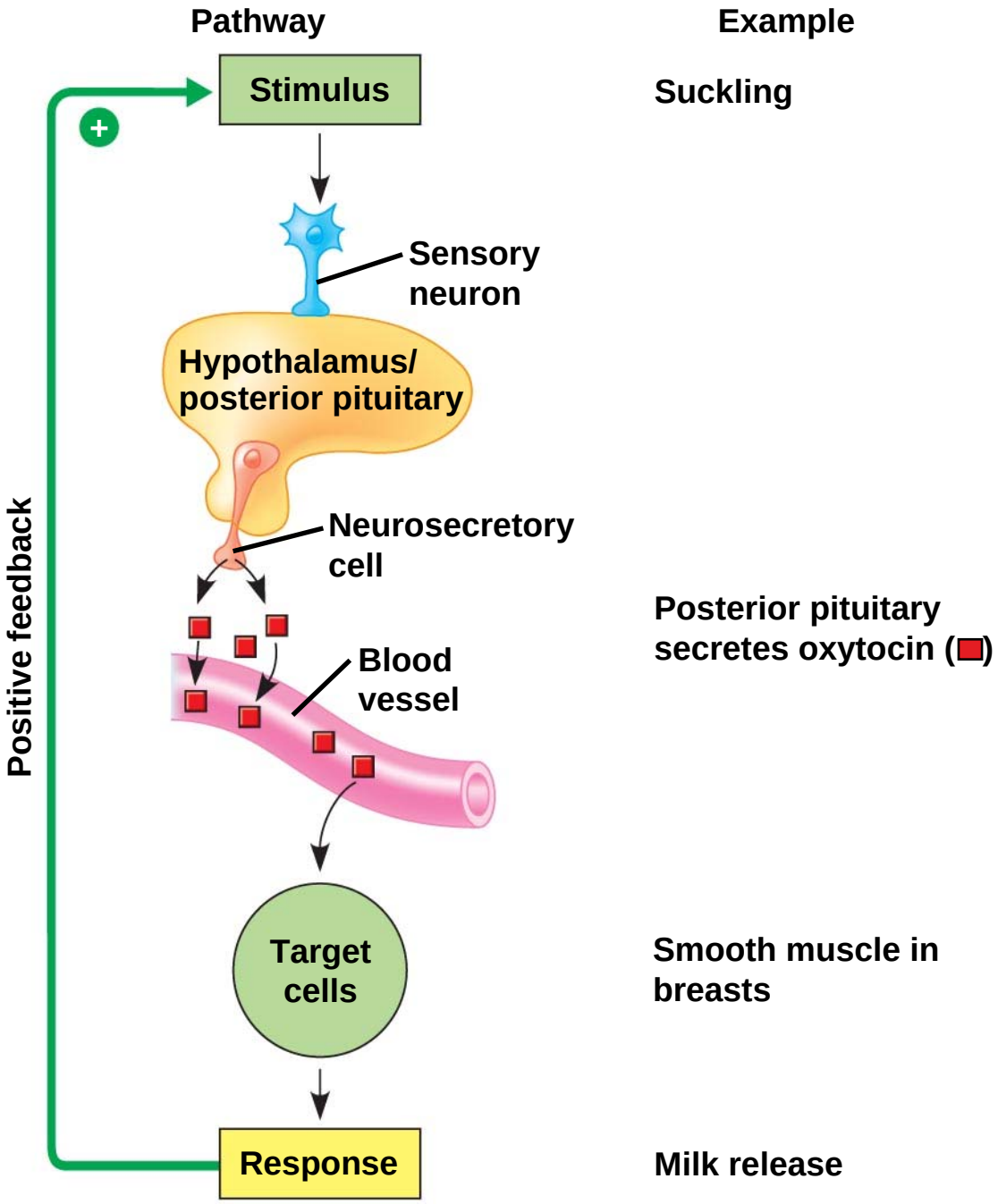
- The two hormones released from the posterior pituitary act directly on nonendocrine tissues

Fig. 45-15



- **Oxytocin** induces uterine contractions and the release of milk
- Suckling sends a message to the hypothalamus via the nervous system to release oxytocin, which further stimulates the milk glands
- This is an example of **positive feedback**, where the stimulus leads to an even greater response
- **Antidiuretic hormone (ADH)** enhances water reabsorption in the kidneys

Fig. 45-16



Anterior Pituitary Hormones

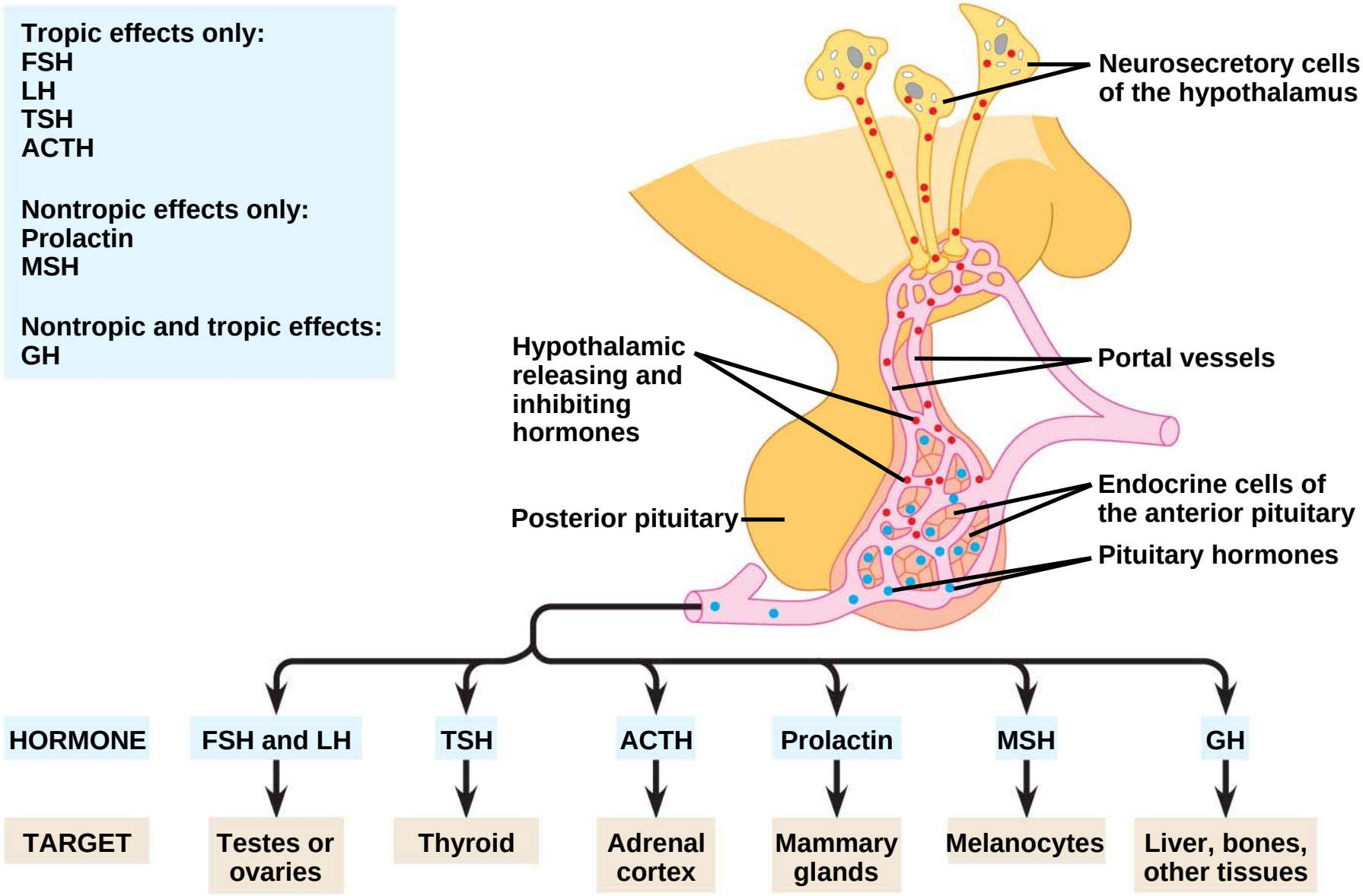
- Hormone production in the anterior pituitary is controlled by releasing and inhibiting hormones from the hypothalamus
- For example, the production of *thyrotropin releasing hormone* (*TRH*) in the hypothalamus stimulates secretion of the *thyroid stimulating hormone* (*TSH*) from the anterior pituitary

Fig. 45-17

Tropic effects only:
FSH
LH
TSH
ACTH

Nontropic effects only:
Prolactin
MSH

Nontropic and tropic effects:
GH



Hormone Cascade Pathways

- A hormone can stimulate the release of a series of other hormones, the last of which activates a nonendocrine target cell; this is called a hormone cascade pathway
- The release of thyroid hormone results from a hormone cascade pathway involving the hypothalamus, anterior pituitary, and thyroid gland
- Hormone cascade pathways are usually regulated by negative feedback

Fig. 45-18-1

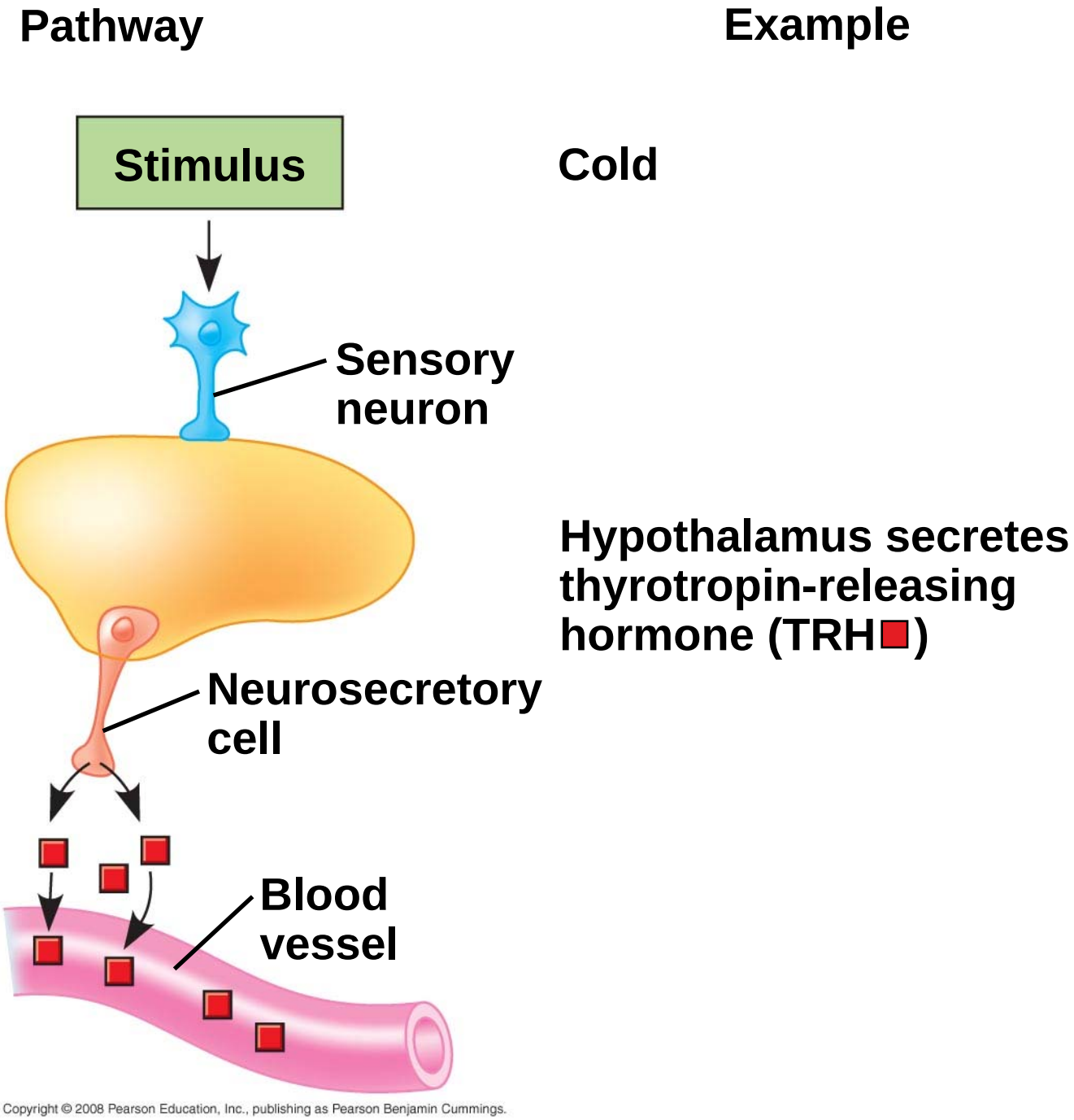

Pathway
Example
Stimulus
Cold
Sensory neuron
Hypothalamus secretes thyrotropin-releasing hormone (TRH■)
Neurosecretory cell
Blood vessel
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Fig. 45-18-2

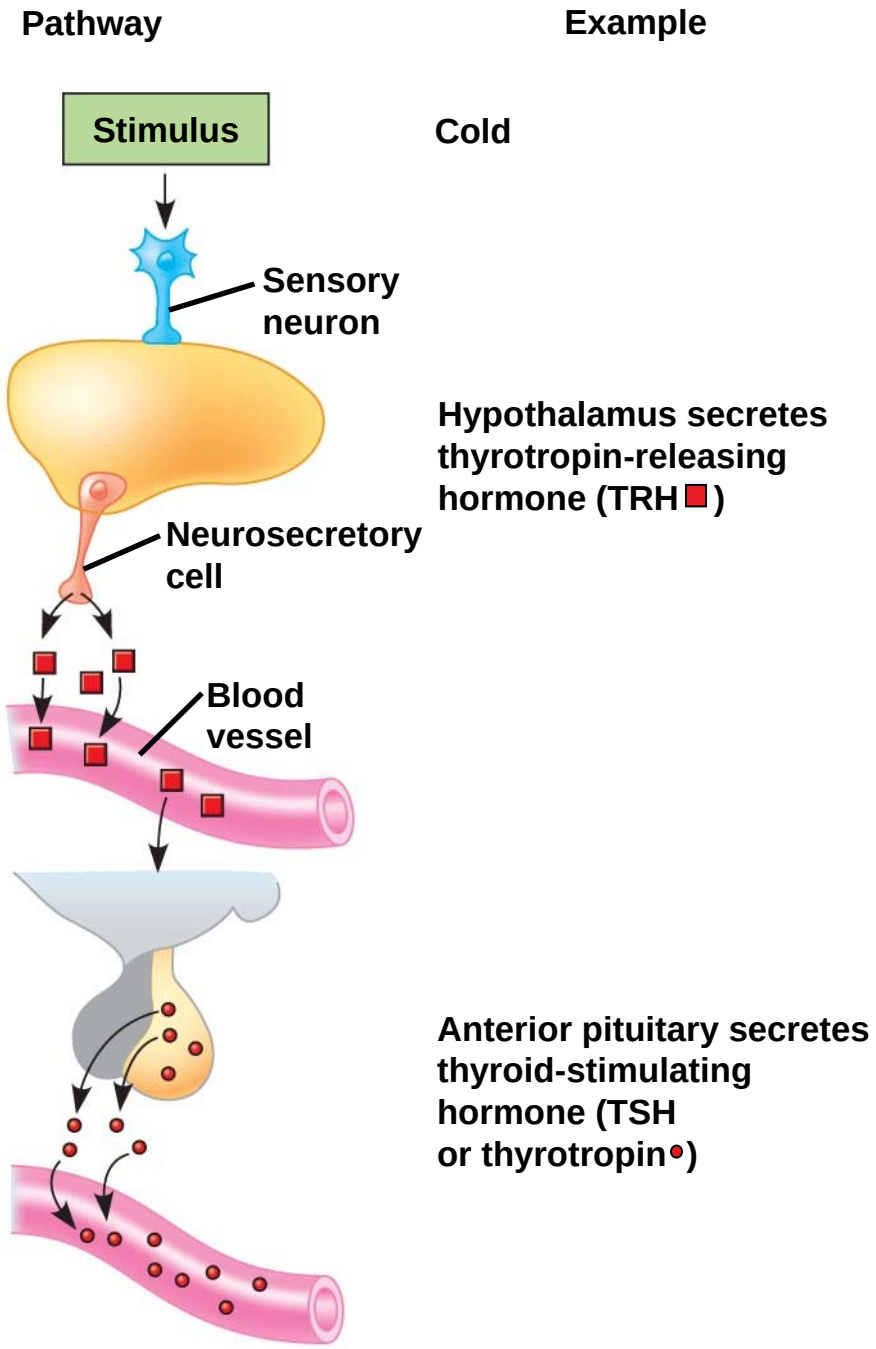
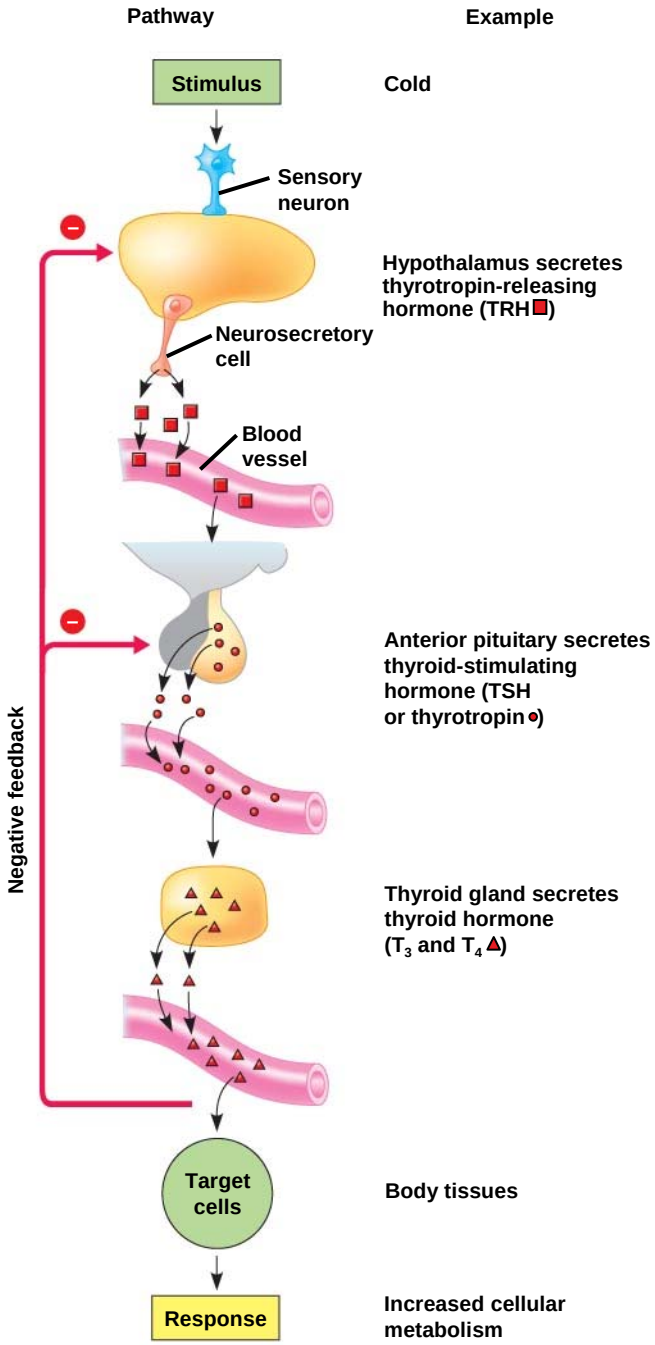


Fig. 45-18-3



Tropic Hormones

- A **tropic hormone** regulates the function of endocrine cells or glands
- The four strictly tropic hormones are
  - Thyroid-stimulating hormone (TSH)
  - **Follicle-stimulating hormone (FSH)**
  - **Luteinizing hormone (LH)**
  - **Adrenocorticotropic hormone (ACTH)**

Nontropic Hormones

- Nontropic hormones target nonendocrine tissues
- Nontropic hormones produced by the anterior pituitary are
  - **Prolactin (PRL)**
  - **Melanocyte-stimulating hormone (MSH)**

- Prolactin stimulates lactation in mammals but has diverse effects in different vertebrates
- MSH influences skin pigmentation in some vertebrates and fat metabolism in mammals

Growth Hormone

- **Growth hormone (GH)** is secreted by the anterior pituitary gland and has tropic and nontropic actions
- It promotes growth directly and has diverse metabolic effects
- It stimulates production of growth factors
- An excess of GH can cause gigantism, while a lack of GH can cause dwarfism

Concept 45.4: Endocrine glands respond to diverse stimuli in regulating metabolism, homeostasis, development, and behavior

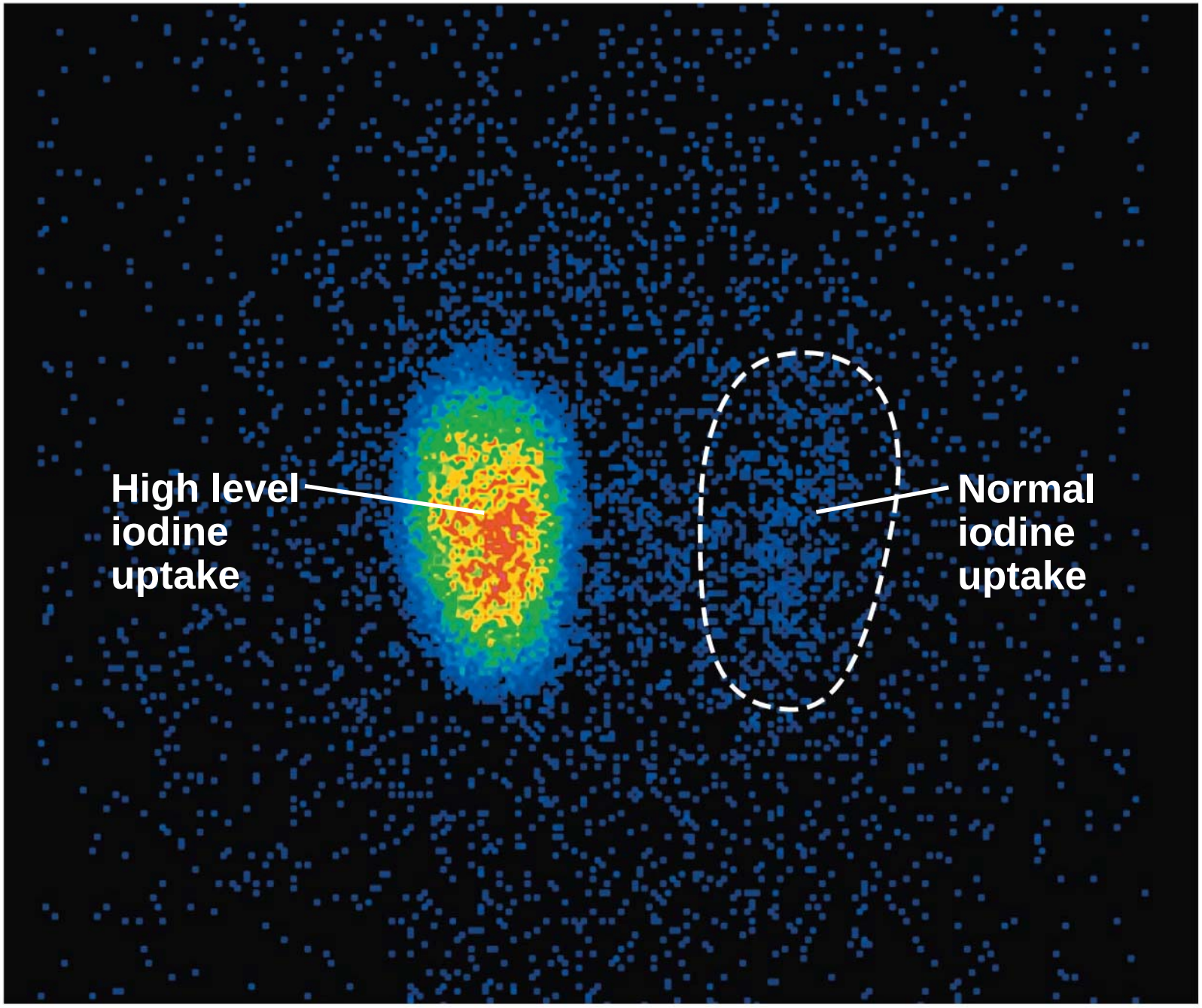
- Endocrine signaling regulates metabolism, homeostasis, development, and behavior

Thyroid Hormone: Control of Metabolism and Development

- The **thyroid gland** consists of two lobes on the ventral surface of the trachea
- It produces two iodine-containing hormones: **triiodothyronine (T_3)** and **thyroxine (T_4)**

- Thyroid hormones stimulate metabolism and influence development and maturation
- Hyperthyroidism, excessive secretion of thyroid hormones, causes high body temperature, weight loss, irritability, and high blood pressure
- Graves' disease is a form of hyperthyroidism in humans
- Hypothyroidism, low secretion of thyroid hormones, causes weight gain, lethargy, and intolerance to cold

Fig. 45-19



- Proper thyroid function requires dietary iodine for hormone production

Parathyroid Hormone and Vitamin D: Control of Blood Calcium

- Two antagonistic hormones regulate the homeostasis of calcium (Ca^{2+}) in the blood of mammals
  - **Parathyroid hormone (PTH)** is released by the **parathyroid glands**
  - **Calcitonin** is released by the thyroid gland

Fig. 45-20-1

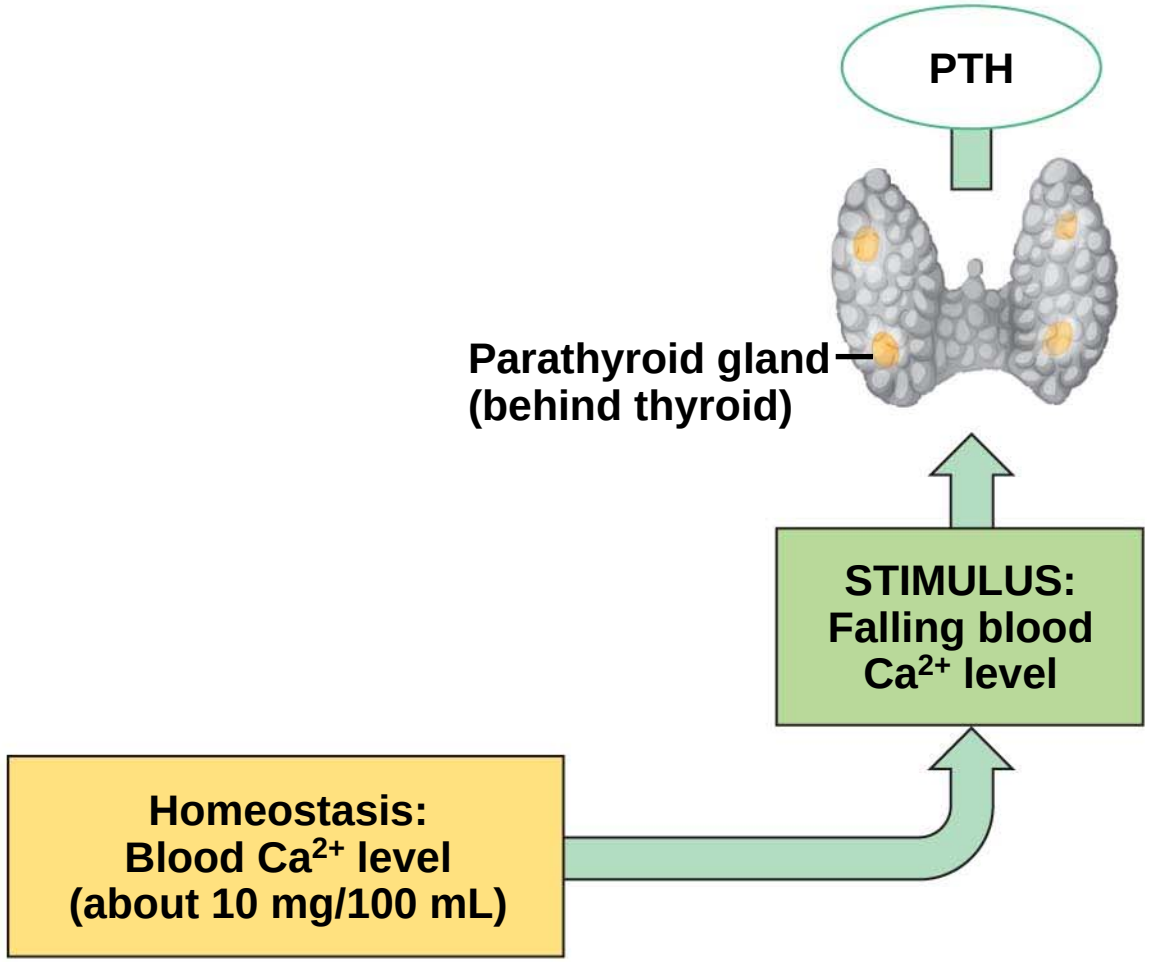
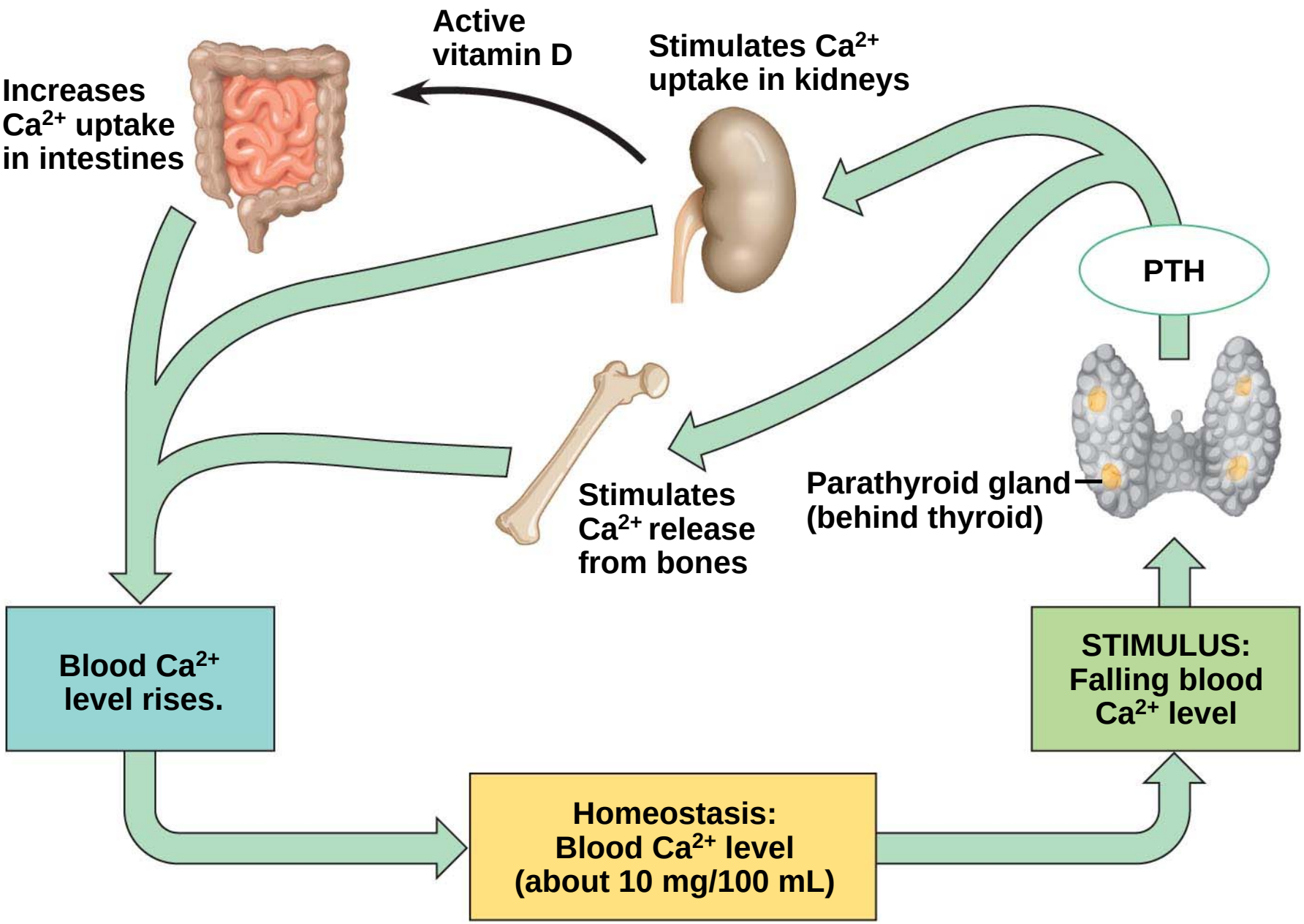


Fig. 45-20-2



- PTH increases the level of blood Ca^{2+}
  - It releases Ca^{2+} from bone and stimulates reabsorption of Ca^{2+} in the kidneys
  - It also has an indirect effect, stimulating the kidneys to activate vitamin D, which promotes intestinal uptake of Ca^{2+} from food
- Calcitonin decreases the level of blood Ca^{2+}
  - It stimulates Ca^{2+} deposition in bones and secretion by kidneys

Adrenal Hormones: Response to Stress

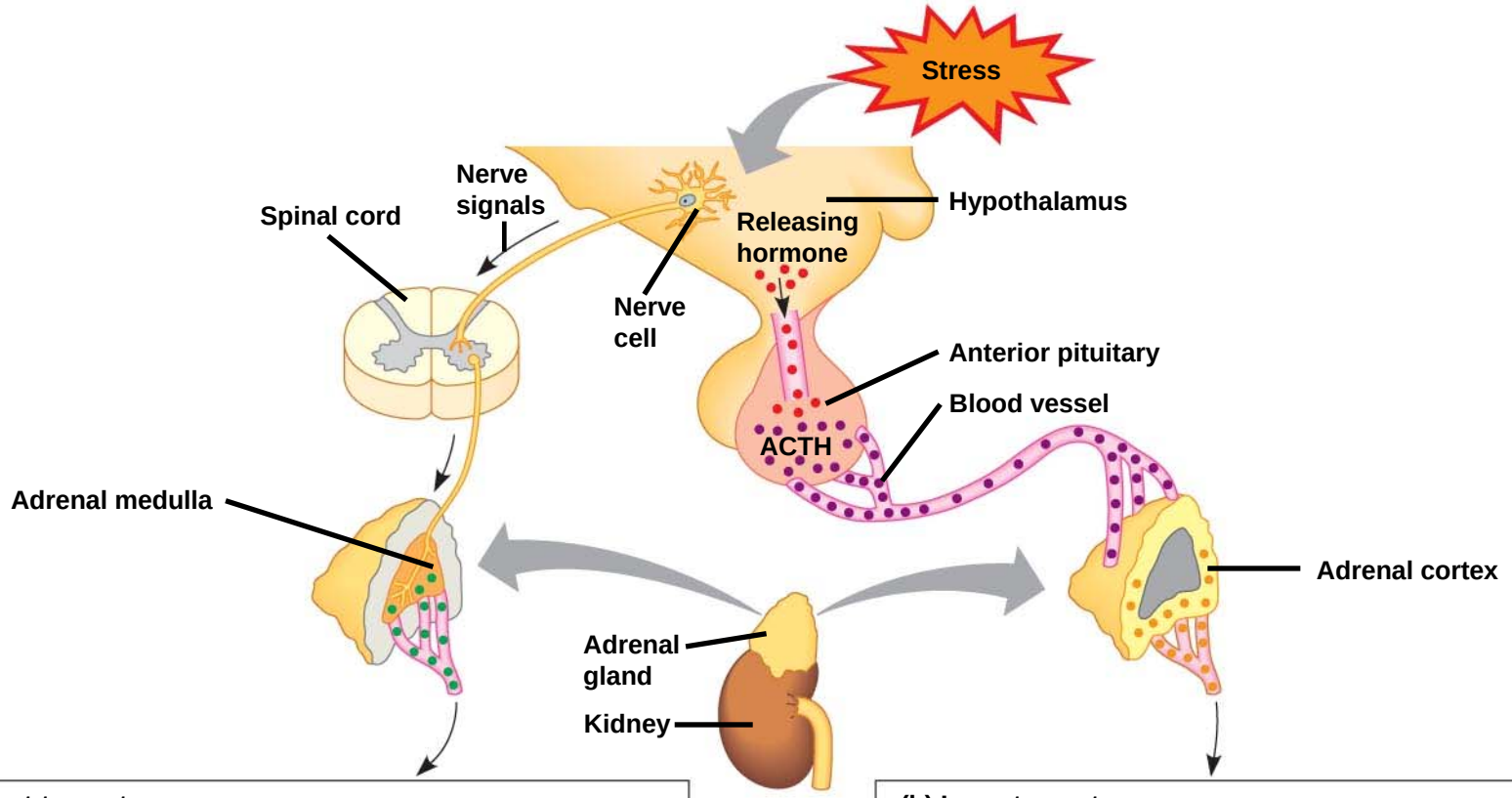
- The adrenal glands are adjacent to the kidneys
- Each adrenal gland actually consists of two glands: the *adrenal medulla* (inner portion) and *adrenal cortex* (outer portion)

Catecholamines from the Adrenal Medulla

- The adrenal medulla secretes epinephrine (adrenaline) and **norepinephrine** (noradrenaline)
- These hormones are members of a class of compounds called **catecholamines**
- They are secreted in response to stress-activated impulses from the nervous system
- They mediate various fight-or-flight responses

- Epinephrine and norepinephrine
  - Trigger the release of glucose and fatty acids into the blood
  - Increase oxygen delivery to body cells
  - Direct blood toward heart, brain, and skeletal muscles, and away from skin, digestive system, and kidneys
- The release of epinephrine and norepinephrine occurs in response to nerve signals from the hypothalamus

Fig. 45-21



(a) Short-term stress response

Effects of epinephrine and norepinephrine:

1. Glycogen broken down to glucose; increased blood glucose
2. Increased blood pressure
3. Increased breathing rate
4. Increased metabolic rate
5. Change in blood flow patterns, leading to increased alertness and decreased digestive, excretory, and reproductive system activity

(b) Long-term stress response

Effects of mineralocorticoids:

1. Retention of sodium ions and water by kidneys
2. Increased blood volume and blood pressure

Effects of glucocorticoids:

1. Proteins and fats broken down and converted to glucose, leading to increased blood glucose
2. Possible suppression of immune system

Fig. 45-21a

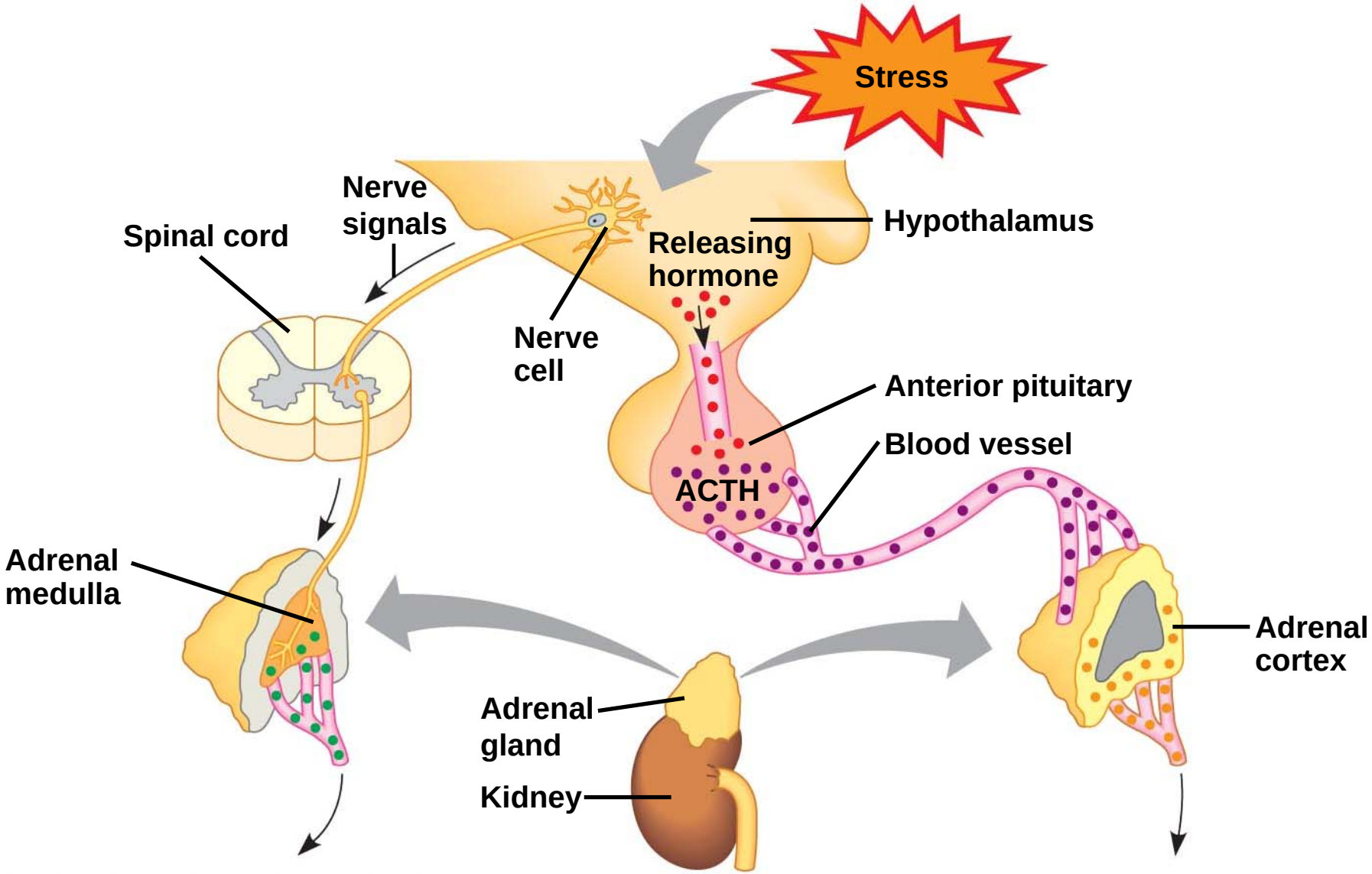
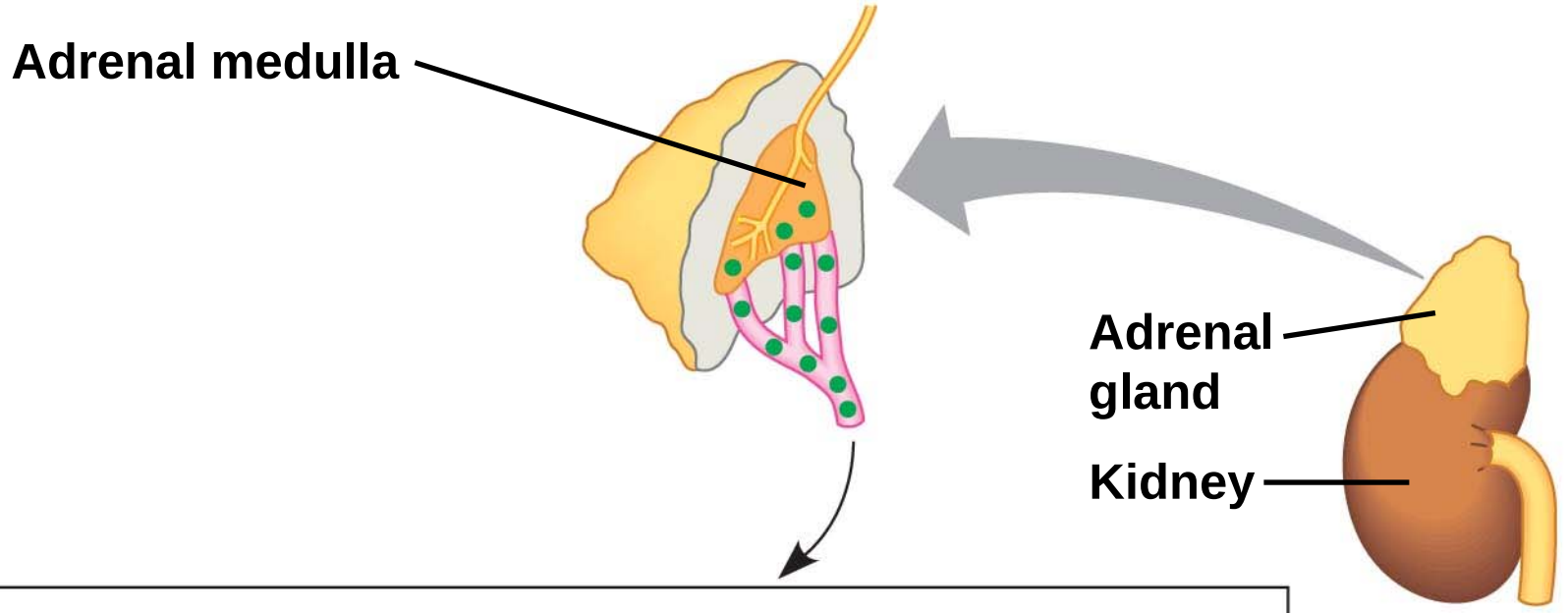


Fig. 45-21b



(a) Short-term stress response

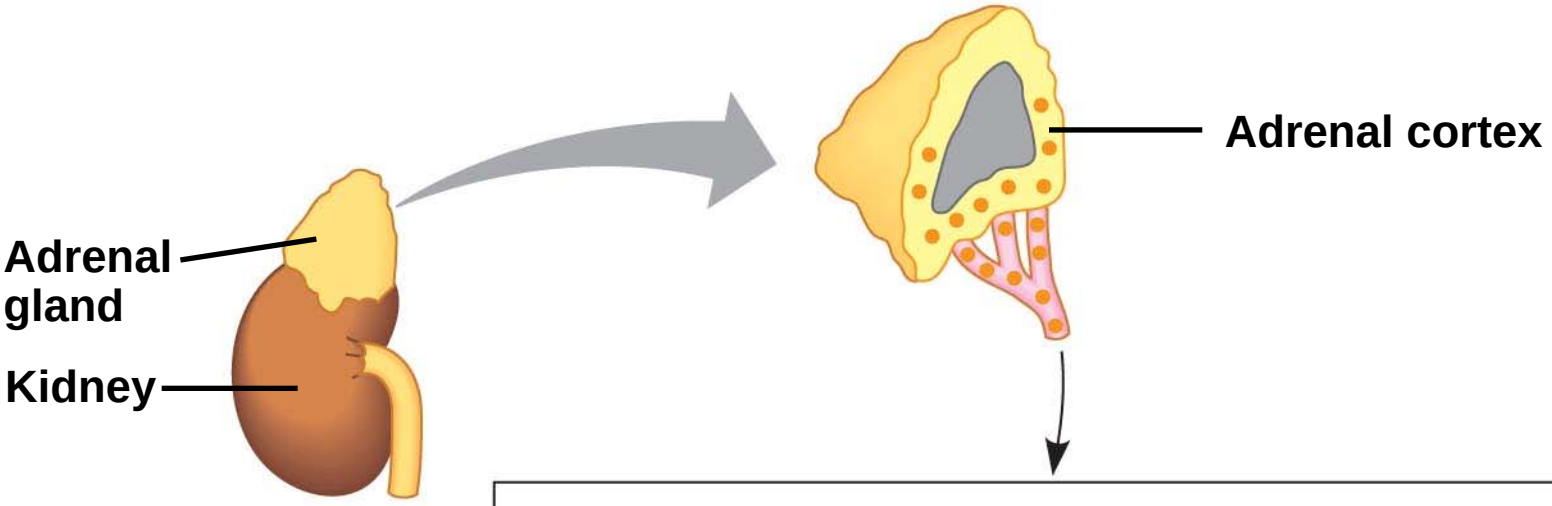
Effects of epinephrine and norepinephrine:

1. Glycogen broken down to glucose; increased blood glucose
2. Increased blood pressure
3. Increased breathing rate
4. Increased metabolic rate
5. Change in blood flow patterns, leading to increased alertness and decreased digestive, excretory, and reproductive system activity

Steroid Hormones from the Adrenal Cortex

- The adrenal cortex releases a family of steroids called **corticosteroids** in response to stress
- These hormones are triggered by a hormone cascade pathway via the hypothalamus and anterior pituitary
- Humans produce two types of corticosteroids: glucocorticoids and mineralocorticoids

Fig. 45-21c



(b) Long-term stress response

Effects of mineralocorticoids:	Effects of glucocorticoids:
1. Retention of sodium ions and water by kidneys	1. Proteins and fats broken down and converted to glucose, leading to increased blood glucose
2. Increased blood volume and blood pressure	2. Possible suppression of immune system

- **Glucocorticoids**, such as cortisol, influence glucose metabolism and the immune system
- **Mineralocorticoids**, such as aldosterone, affect salt and water balance
- The adrenal cortex also produces small amounts of steroid hormones that function as sex hormones

Gonadal Sex Hormones

- The gonads, testes and ovaries, produce most of the sex hormones: androgens, estrogens, and progestins
- All three sex hormones are found in both males and females, but in different amounts

- The testes primarily synthesize **androgens**, mainly **testosterone**, which stimulate development and maintenance of the male reproductive system
- Testosterone causes an increase in muscle and bone mass and is often taken as a supplement to cause muscle growth, which carries health risks

Fig. 45-22

RESULTS

Chromosome Set	Appearance of Genitals	
	No surgery	Embryonic gonad removed
XY (male)	Male	Female
XX (female)	Female	Female

- **Estrogens**, most importantly **estradiol**, are responsible for maintenance of the female reproductive system and the development of female secondary sex characteristics
- In mammals, progestins, which include **progesterone**, are primarily involved in preparing and maintaining the uterus
- Synthesis of the sex hormones is controlled by FSH and LH from the anterior pituitary

Melatonin and Biorhythms

- The **pineal gland**, located in the brain, secretes **melatonin**
- Light/dark cycles control release of melatonin
- Primary functions of melatonin appear to relate to biological rhythms associated with reproduction

Fig. 45-UN2

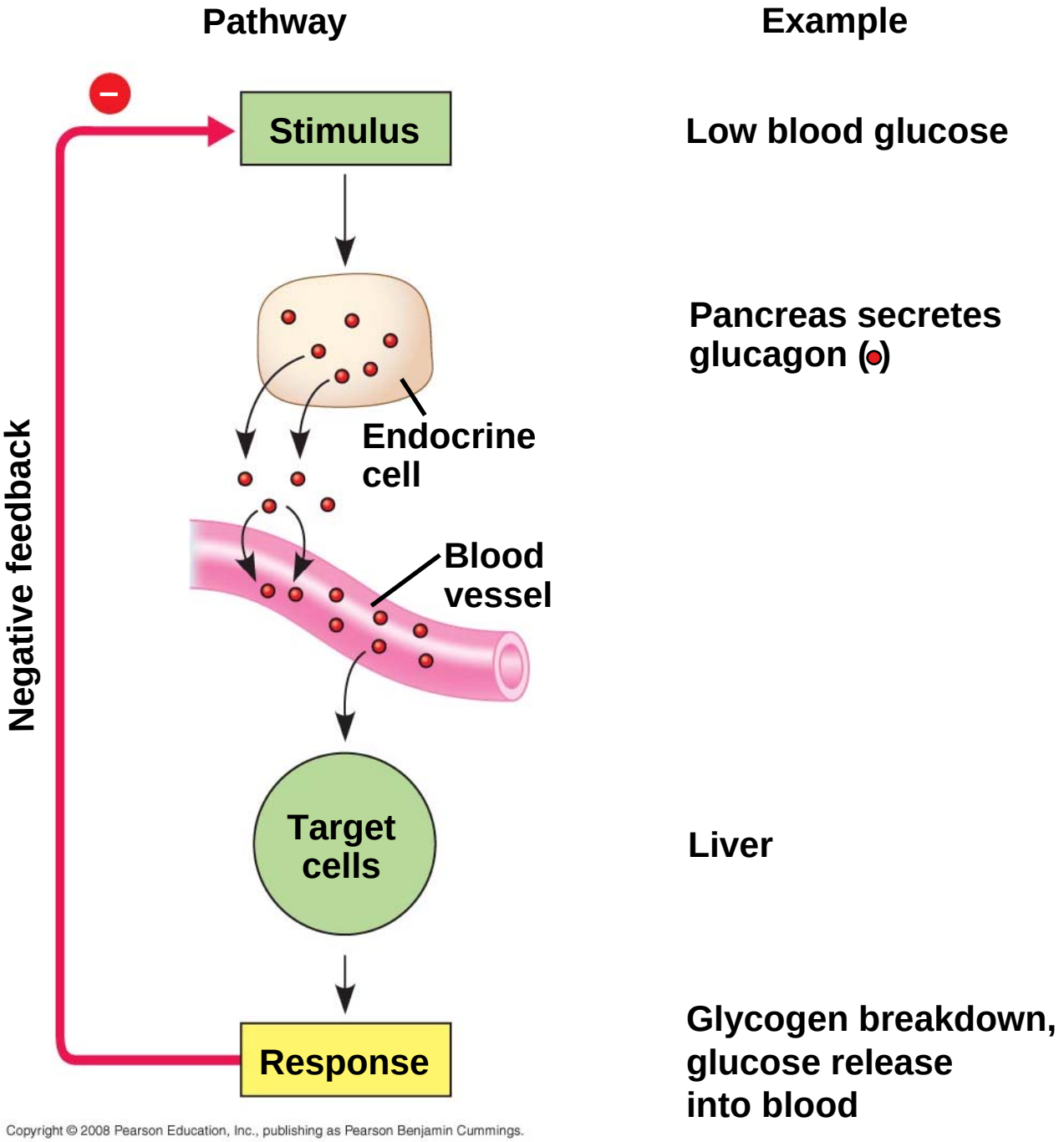


Fig. 45-UN3

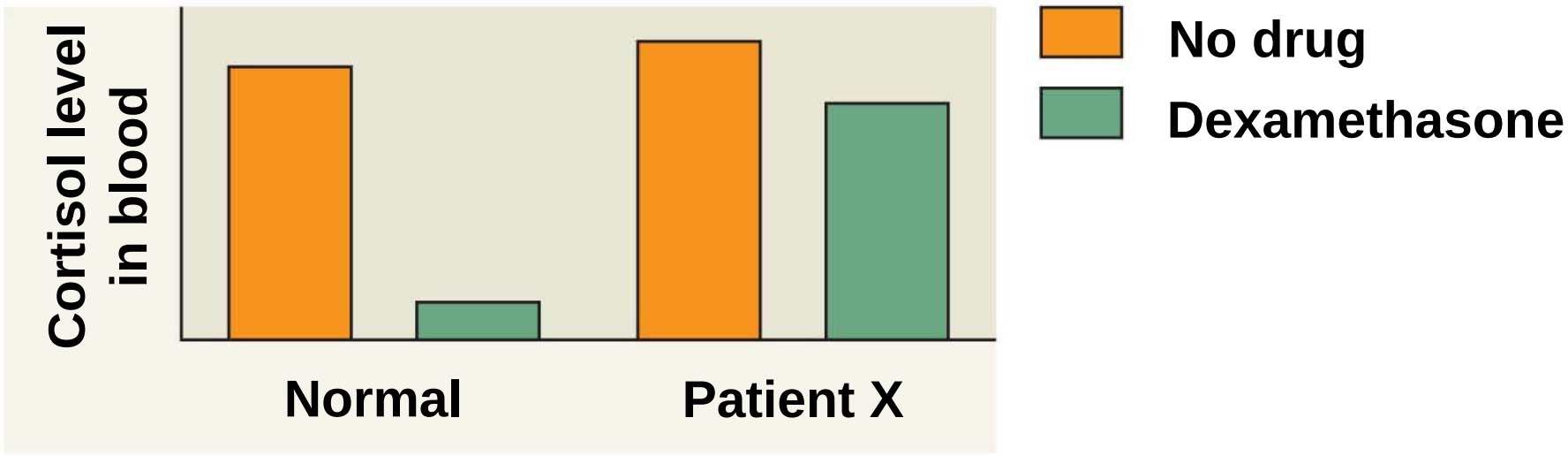
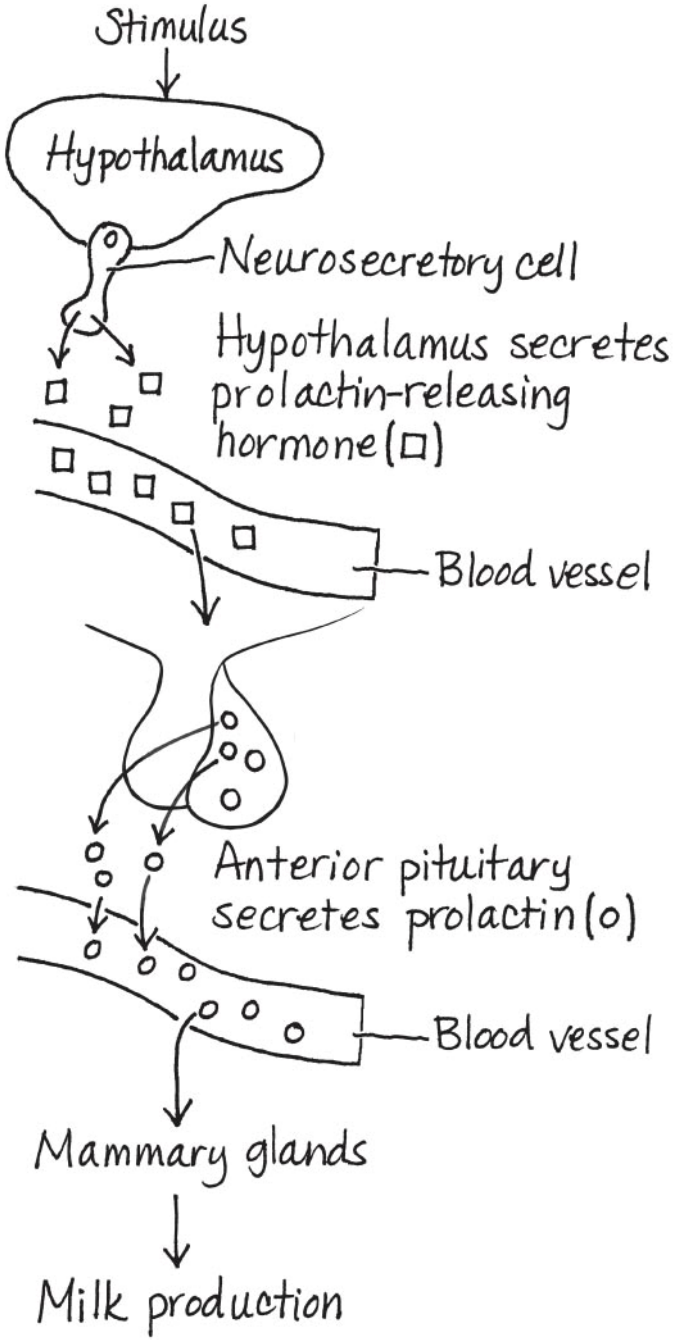


Fig. 45-UN4



You should now be able to:

1. Distinguish between the following pairs of terms: hormones and local regulators, paracrine and autocrine signals
2. Describe the evidence that steroid hormones have intracellular receptors, while water-soluble hormones have cell-surface receptors
3. Explain how the antagonistic hormones insulin and glucagon regulate carbohydrate metabolism
4. Distinguish between type 1 and type 2 diabetes

5. Explain how the hypothalamus and the pituitary glands interact and how they coordinate the endocrine system

6. Explain the role of tropic hormones in coordinating endocrine signaling throughout the body

7. List and describe the functions of hormones released by the following: anterior and posterior pituitary lobes, thyroid glands, parathyroid glands, adrenal medulla, adrenal cortex, gonads, pineal gland