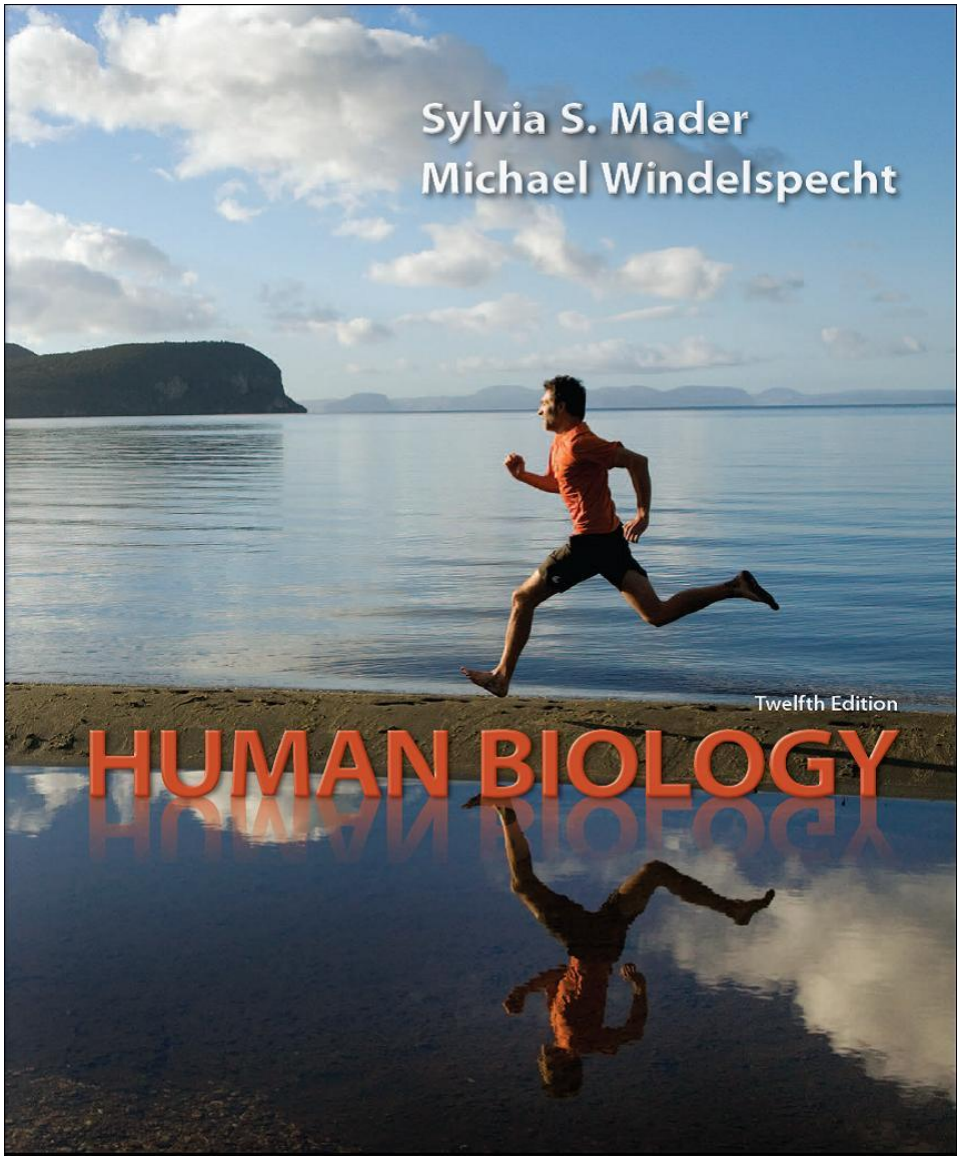
CHAPTER 15
Endocrine System

1. Endocrine glands
2. Hypothalamus and pituitary gland
3. Thyroid and parathyroid glands
4. Adrenal glands
5. Pancreas
6. Other endocrine glands
7. Homeostasis

Endocrine system
Nervous system
Immune system
} maintain homeostasis

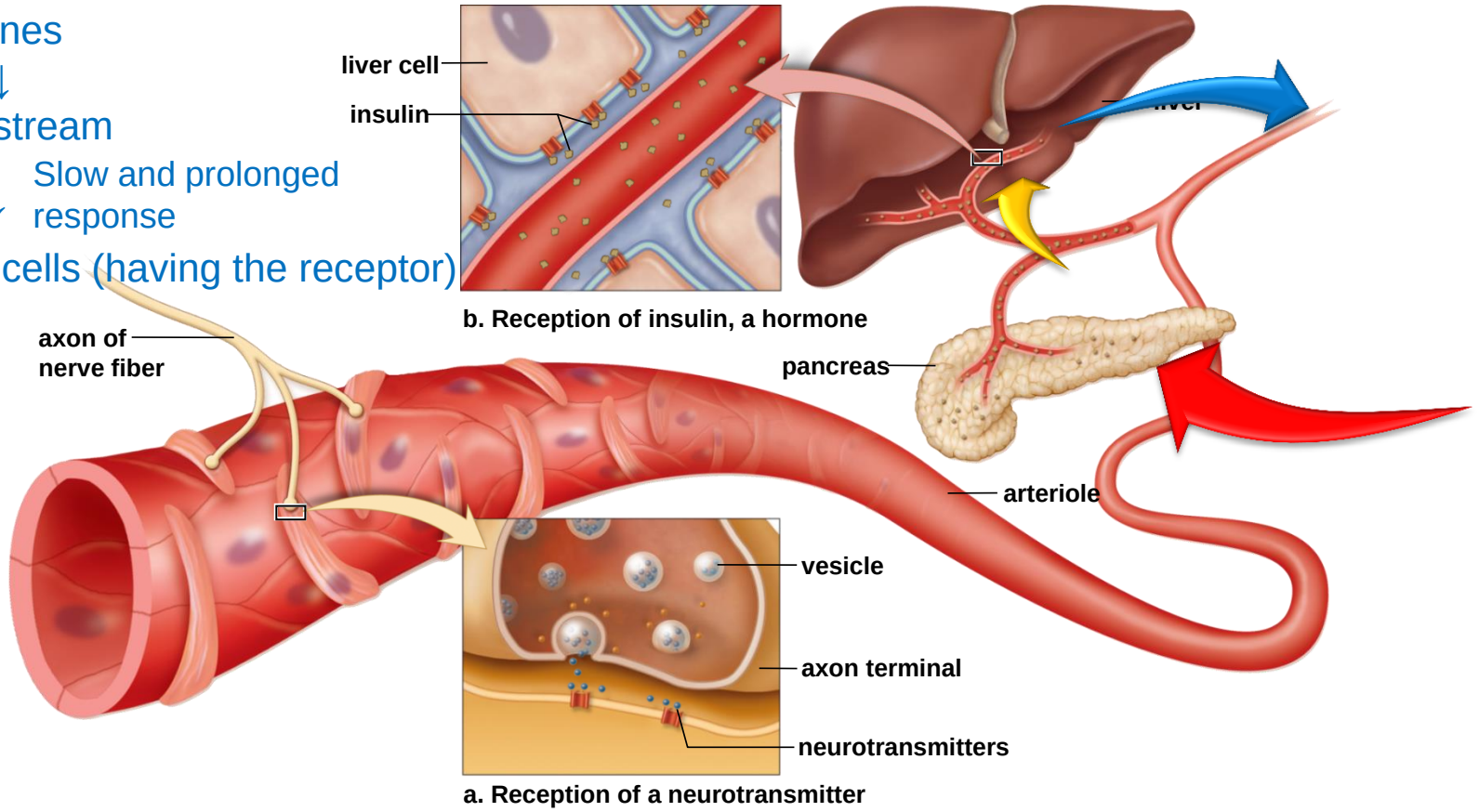


15.1 Endocrine glands

Fig. 15.1 The action of neurotransmitter differs from that of a hormone.

共通点：maintain homeostasis and use chemical signals

Hormones
↓
Blood stream
↓ Slow and prolonged response
Target cells (having the receptor)



心臓→大動脈→動脈→細動脈→毛細血管→静脈→大静脈→心臓

心臓→大動脈→動脈→細動脈→毛細血管→静脈→毛細血管→静脈→大静脈→心臓

門脈

腸管動脈→毛細血管→静脈→毛細血管→肝静脈→下大静脈

Fig. 15.2 The endocrine system (classical)

Recently identified endocrine systems
- vessels (artery) 血管
- heart 心臓
- fat tissue 脂肪組織
- stomach 胃

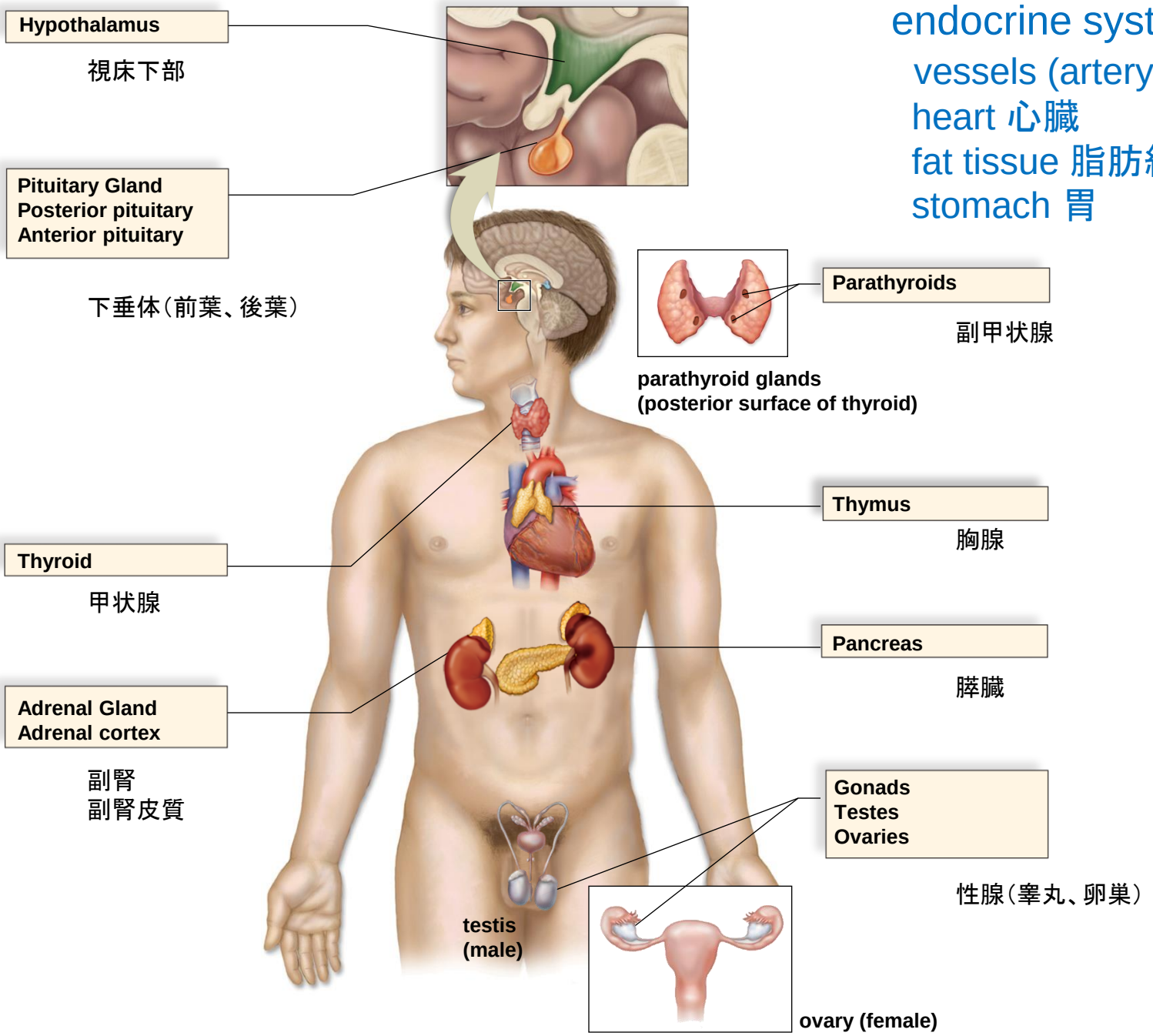


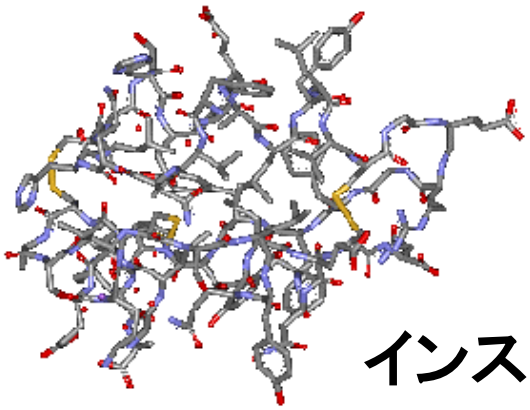
Table 15.1

Table 15.1 Principal Endocrine Glands and the Hormones They Produce

Endocrine Gland	Hormone Released	Target Tissues/Organs	Chief Functions of Hormone
Hypothalamus	Hypothalamic-releasing	Anterior pituitary	Regulate anterior pituitary hormones and inhibiting hormones
Pituitary gland			
Posterior pituitary	Antidiuretic (ADH)	Kidneys	Stimulates water reabsorption by kidneys
	Oxytocin	Uterus, mammary glands	Stimulates uterine muscle contraction, release of milk by mammary glands
Anterior pituitary	Thyroid-stimulating (TSH)	Thyroid	Stimulates thyroid
	Adrenocorticotropic (ACTH)	Adrenal cortex	Stimulates adrenal cortex
	Gonadotropic (FSH, LH)	Gonads	Egg and sperm production; sex hormone production
	Prolactin (PRL)	Mammary glands	Milk production
	Growth (GH)	Soft tissues, bones	Cell division, protein synthesis, and bone growth
	Melanocyte-stimulating (MSH)	Melanocytes in skin	Unknown function in humans; regulates skin color in lower vertebrates
Thyroid	Thyroxine (T_4) and triiodothyronine (T_3)	All tissues	Increases metabolic rate; regulates growth and development
	Calcitonin	Bones, kidneys, intestine	Lowers blood calcium level
Parathyroids	Parathyroid (PTH)	Bones, kidneys, intestine	Raises blood calcium level
Adrenal gland			
Adrenal cortex	Glucocorticoids (cortisol)	All tissues	Raise blood glucose level; stimulate breakdown of protein
	Mineralocorticoids (aldosterone)	Kidneys	Reabsorb sodium and excrete potassium
	Sex hormones	Gonads, skin, muscles, bones	Stimulate reproductive organs and bring about sex characteristics
Adrenal medulla	Epinephrine and norepinephrine	Cardiac and other muscles	Released in emergency situations; raise blood glucose level
Pancreas	Insulin	Liver, muscles, adipose tissue	Lowers blood glucose level; promotes formation of glycogen
	Glucagon	Liver, muscles, adipose tissue	Raises blood glucose level
Gonads			
Testes	Androgens (testosterone)	Gonads, skin, muscles, bones	Stimulate male sex characteristics
Ovaries	Estrogens and progesterone	Gonads, skin, muscles, bones	Stimulate female sex characteristics
Thymus	Thymosins	T lymphocytes	Stimulate production and maturation of T lymphocytes
Pineal gland	Melatonin	Brain	Controls circadian and circannual rhythms; possibly involved in maturation of sexual organs

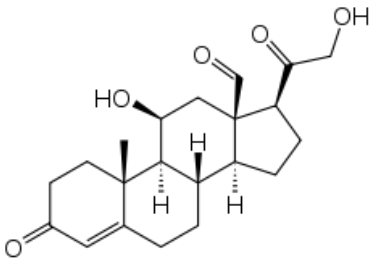
Types of hormones(p343)

Peptide hormones
ペプチドホルモン



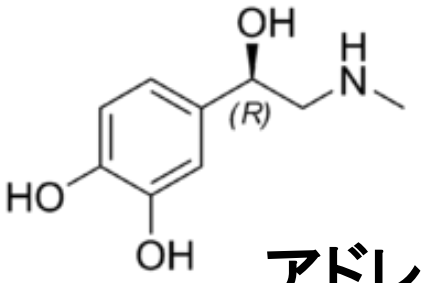
インスリン

Steroid hormones
ステロイドホルモン



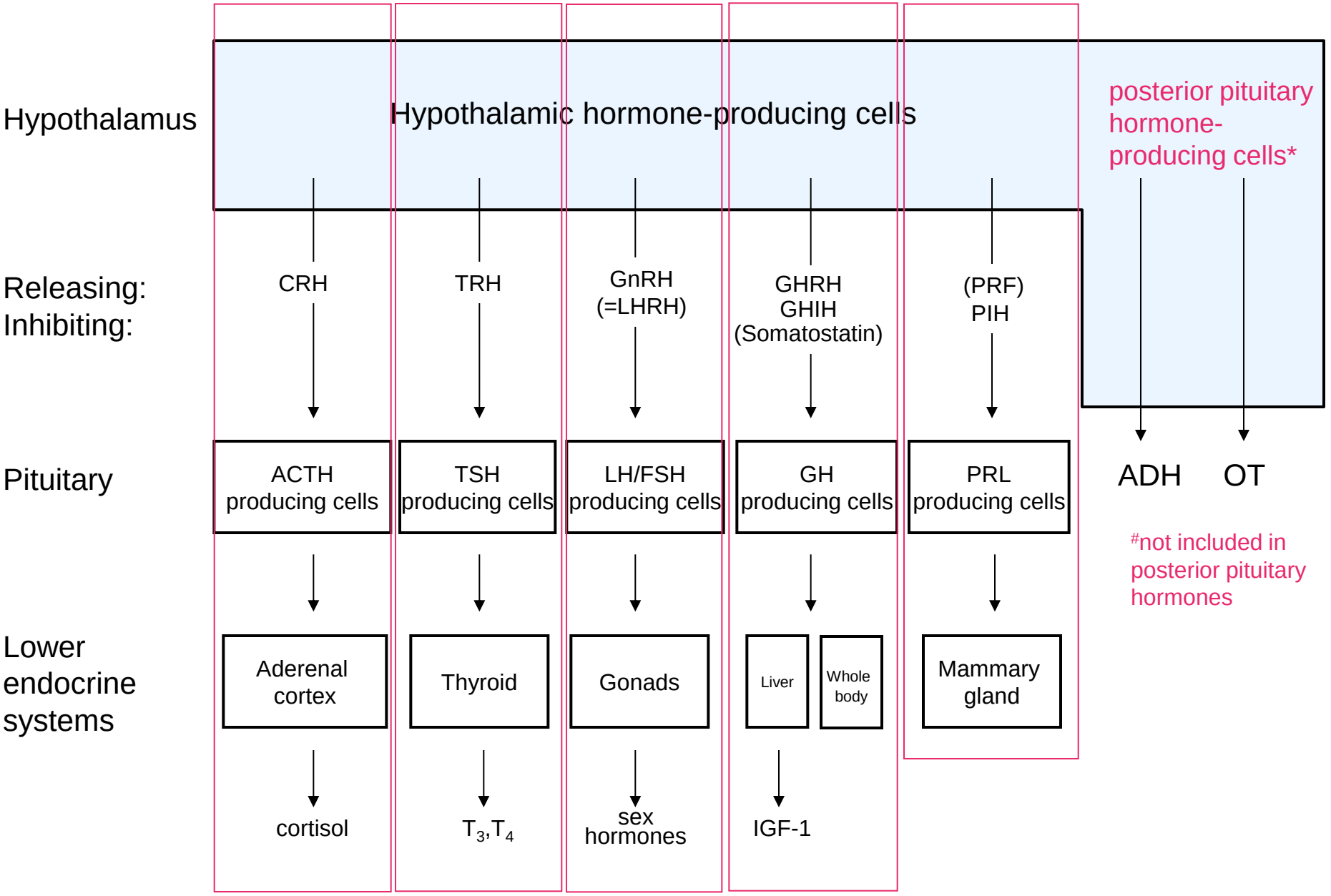
アルドステロン

Amino acid-derived hormones
アミノ酸誘導体ホルモン



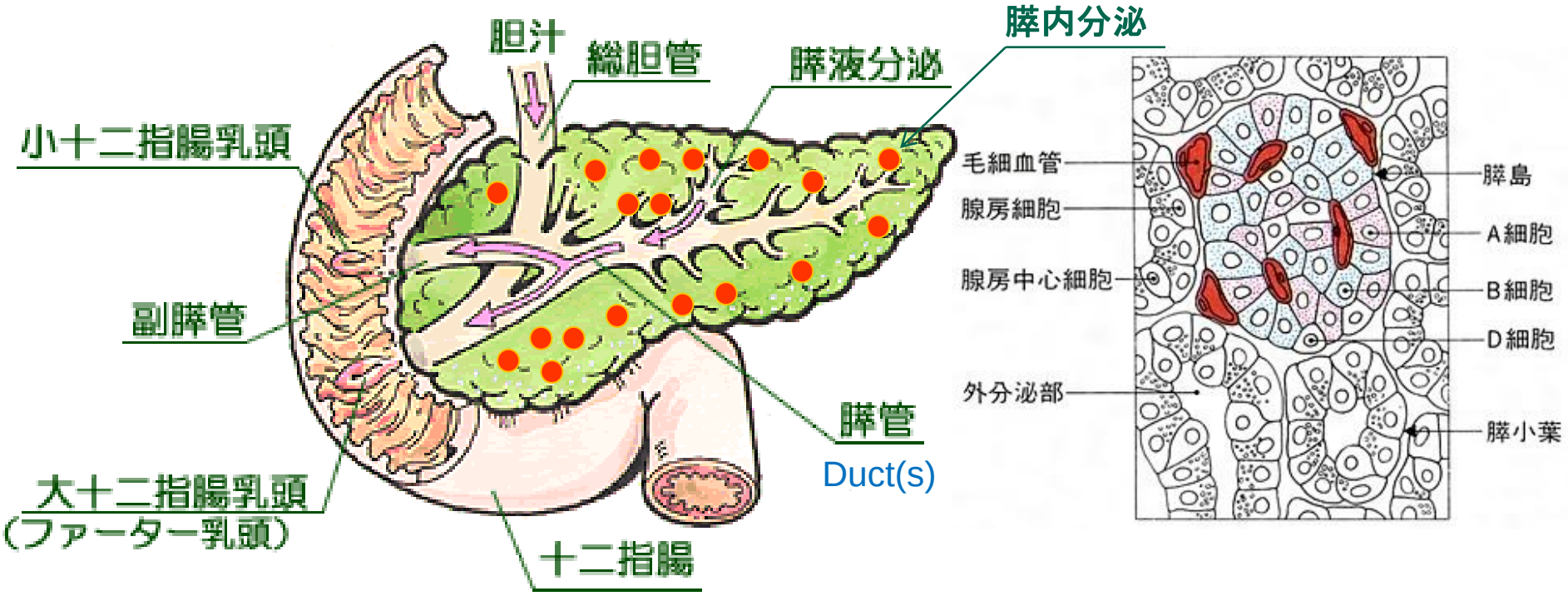
アドレナリン

Hypothalamus-pituitary-peripheral endocrine system



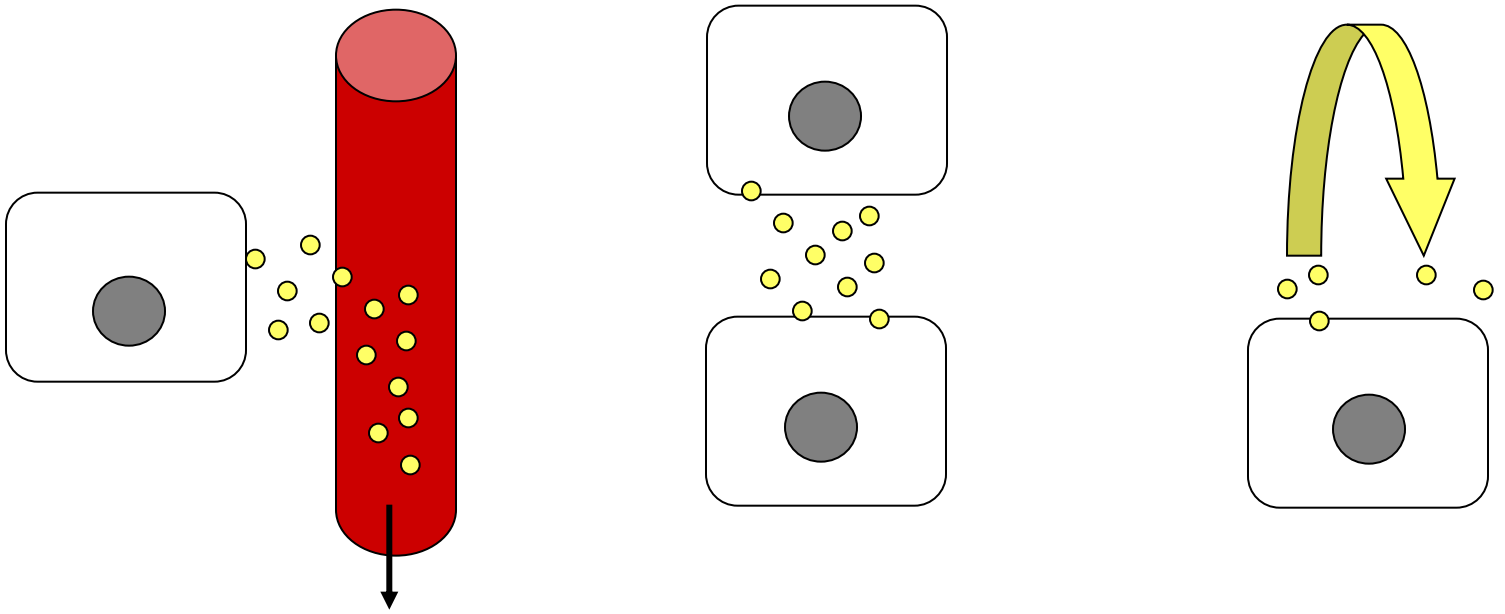
Exocrine *versus* Endocrine (p340)

違い：duct(s)の有無、細胞極性の有無



Local hormones (p342)

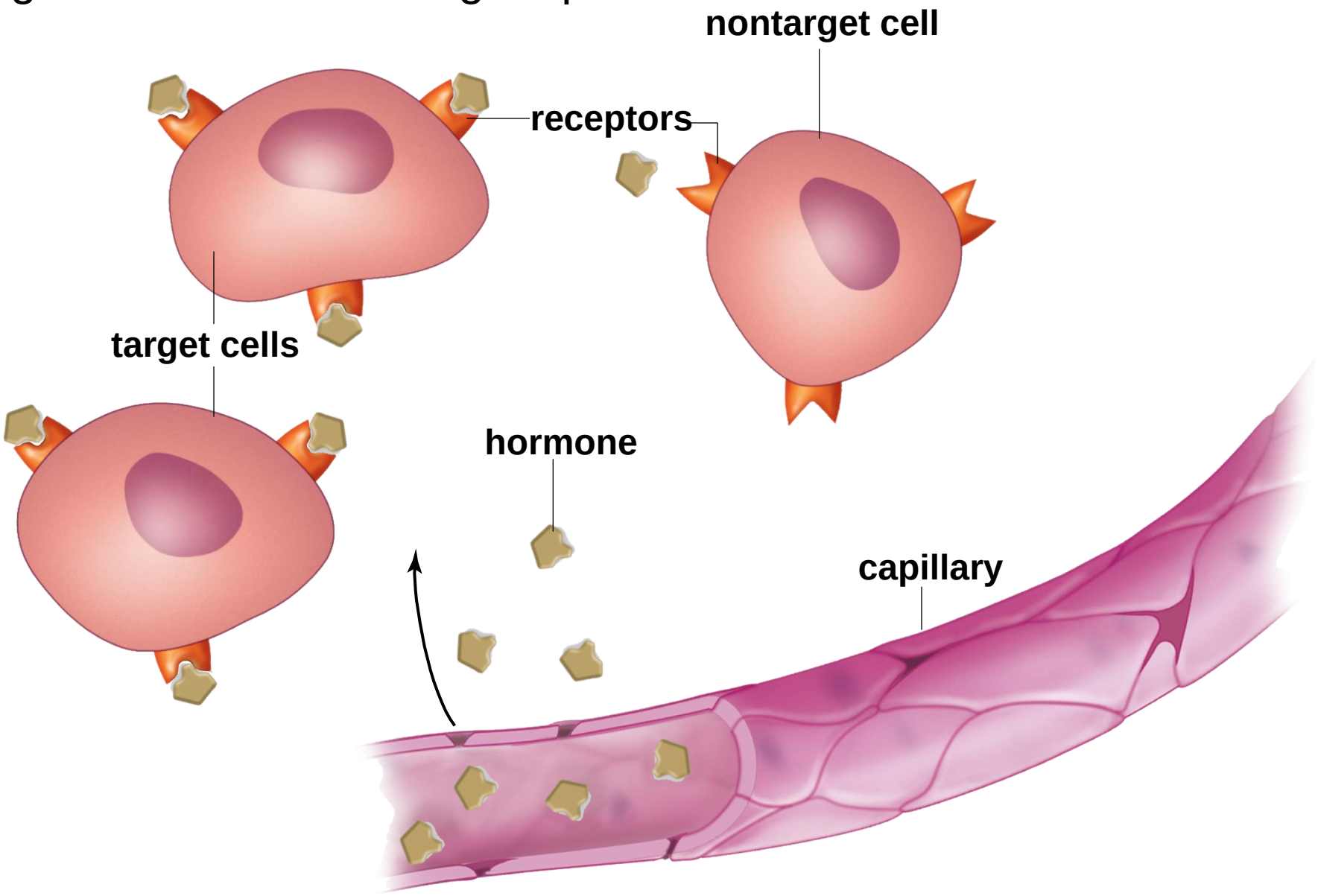
e.g., prostaglandins and growth factors.
Prostaglandins are produced, but not carried elsewhere in the bloodstream.



endocrine paracrine autocrine

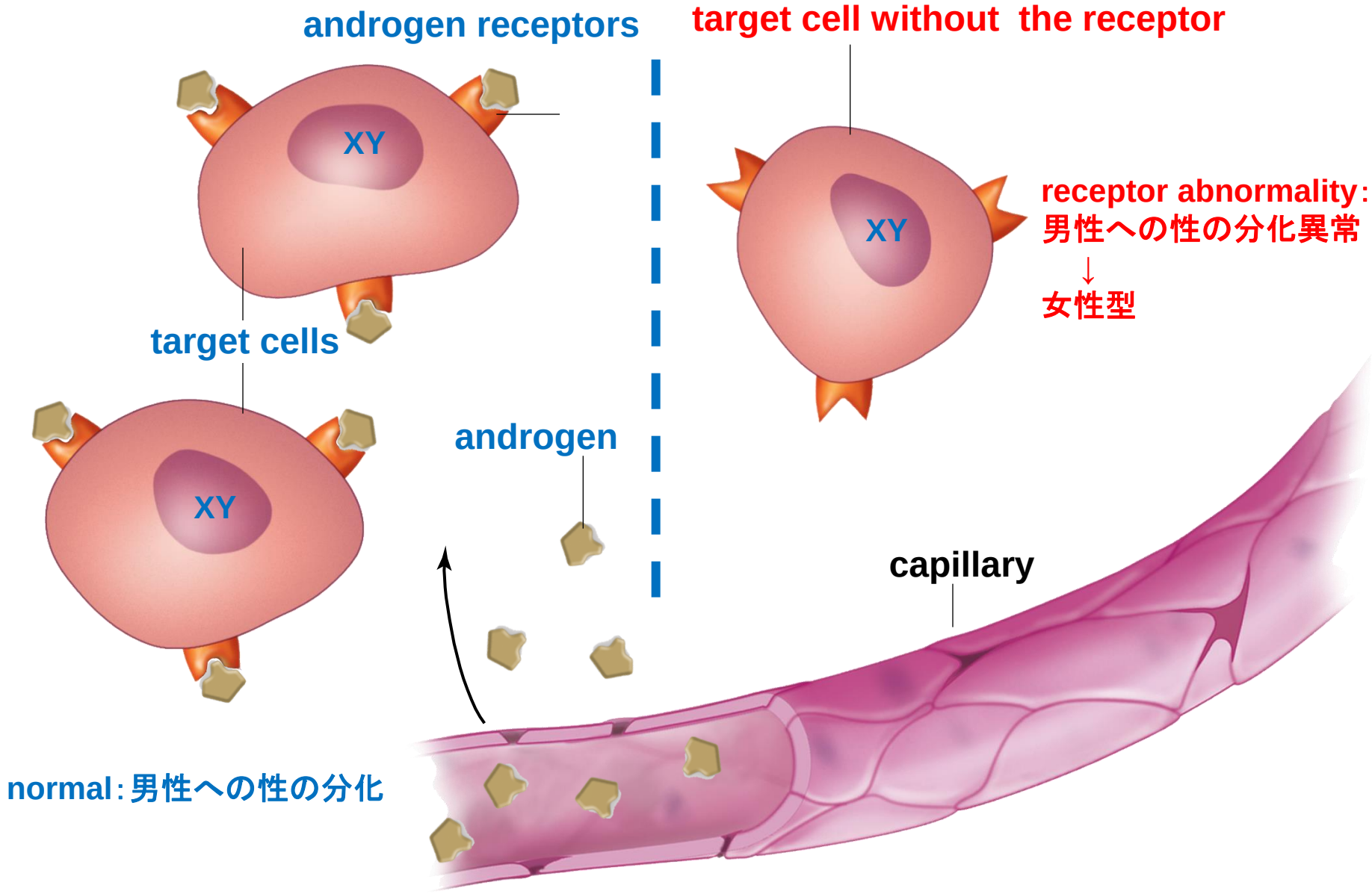
Receptors (p341)

Fig. 15.3 Hormones target specific cells.



Androgen insensitivity (p342)

Fig. 15.3 Hormones target specific cells.



Negative feedback (p341)

Fig. 15.7 Negative feedback mechanism in the endocrine system.

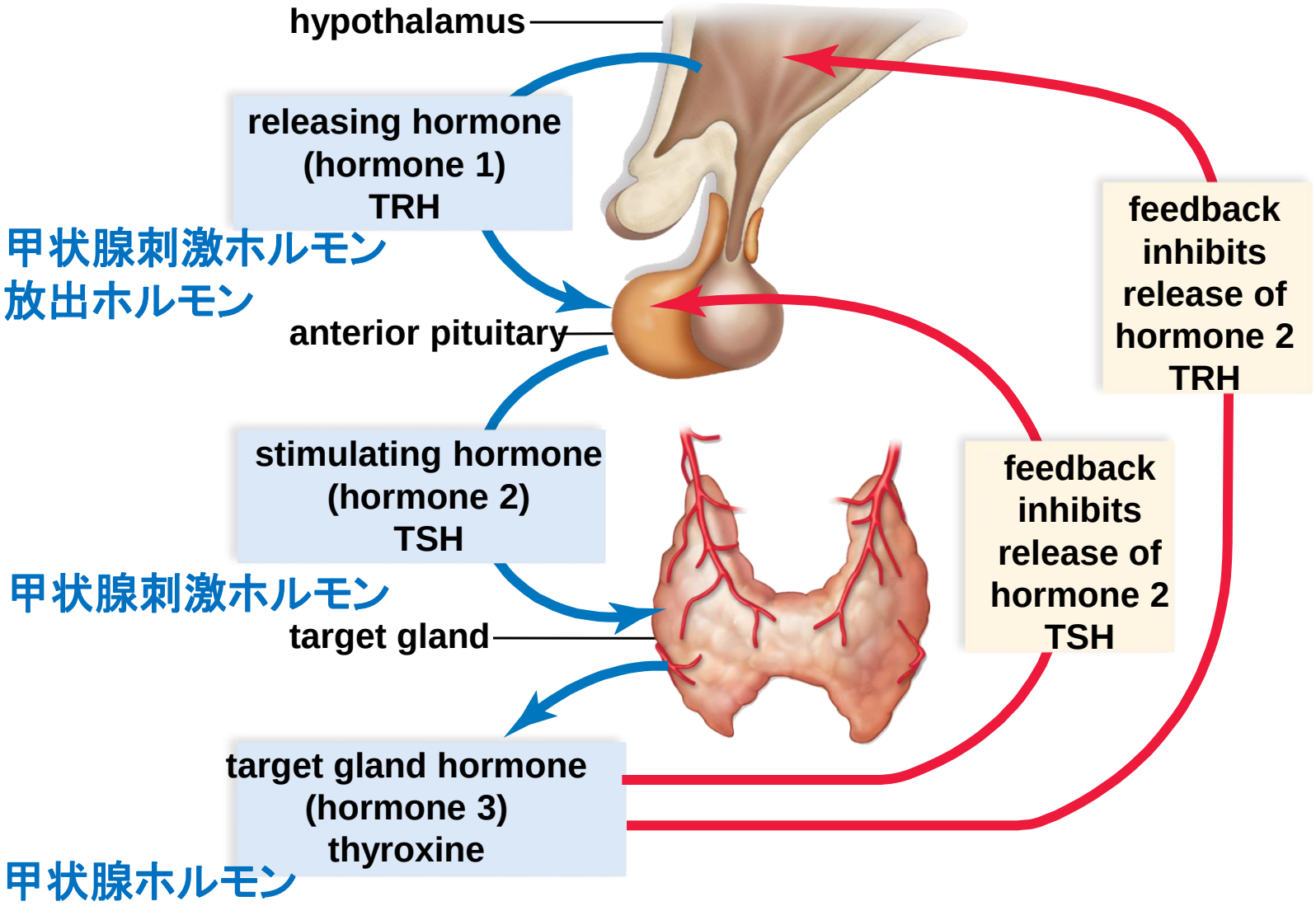
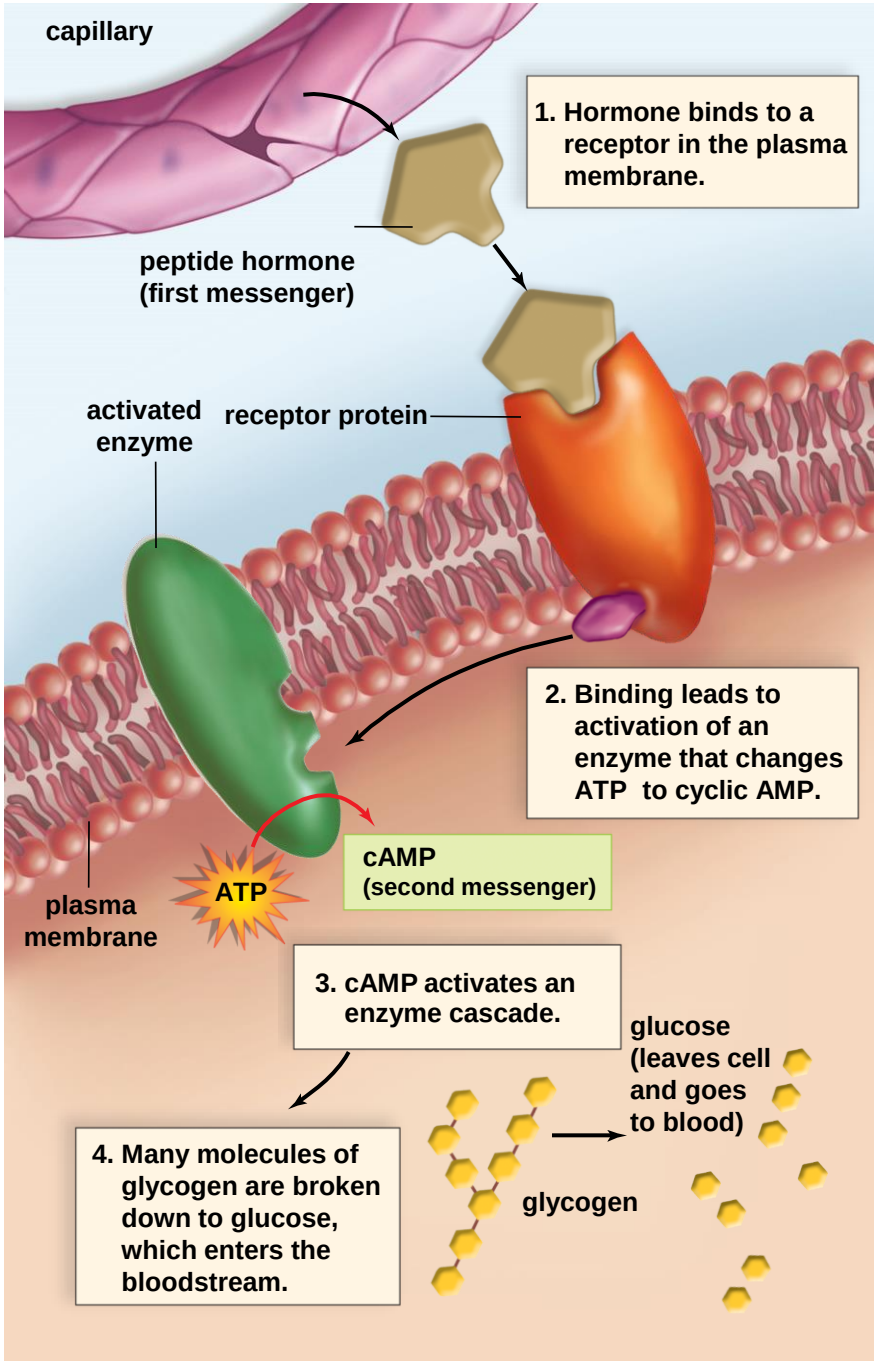
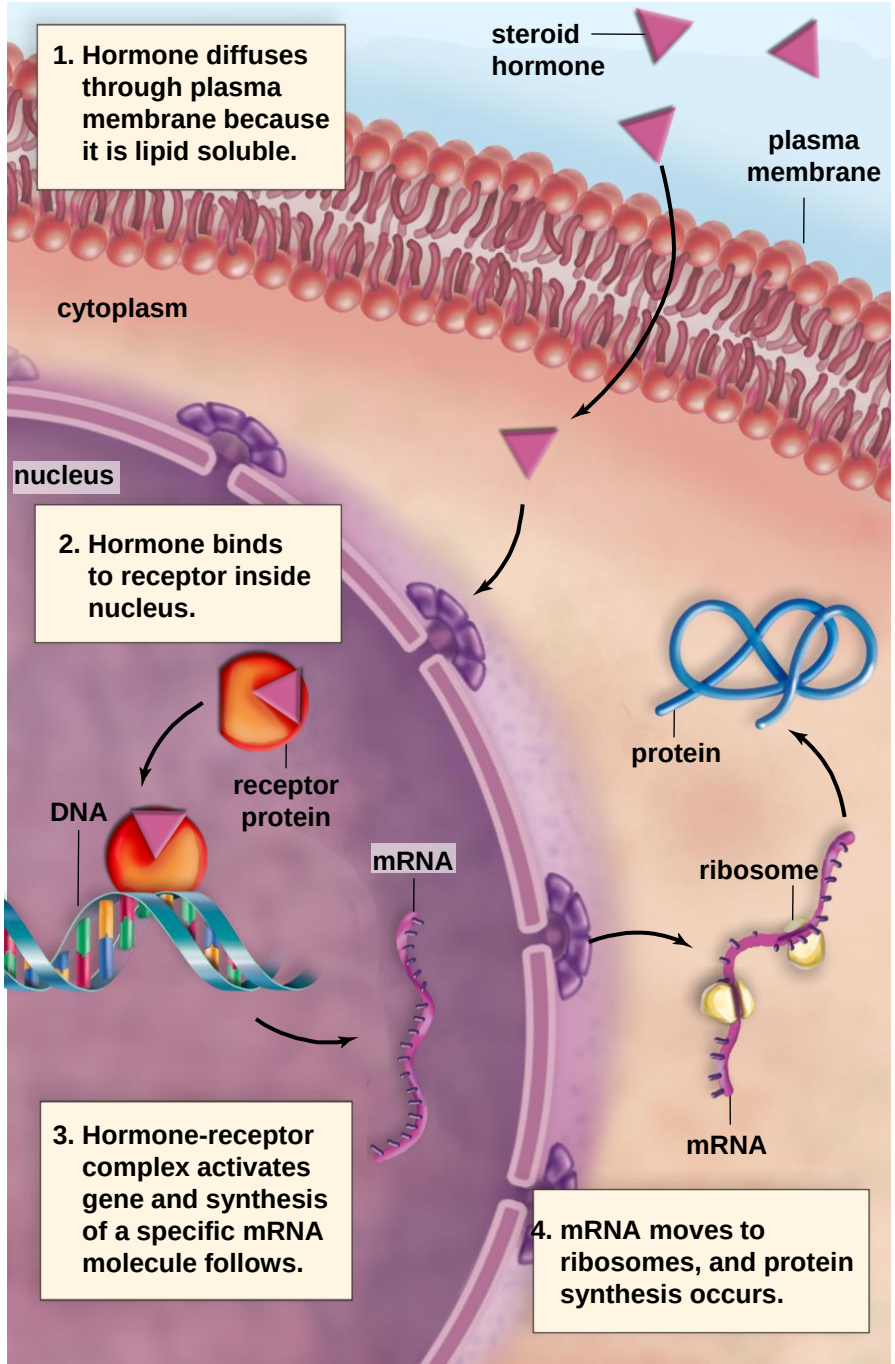


Fig. 15.4 Action of a peptide hormone.



親水性ホルモン→膜受容体

Fig. 15.5 Action of a steroid hormone and amino acid-derived hormones.

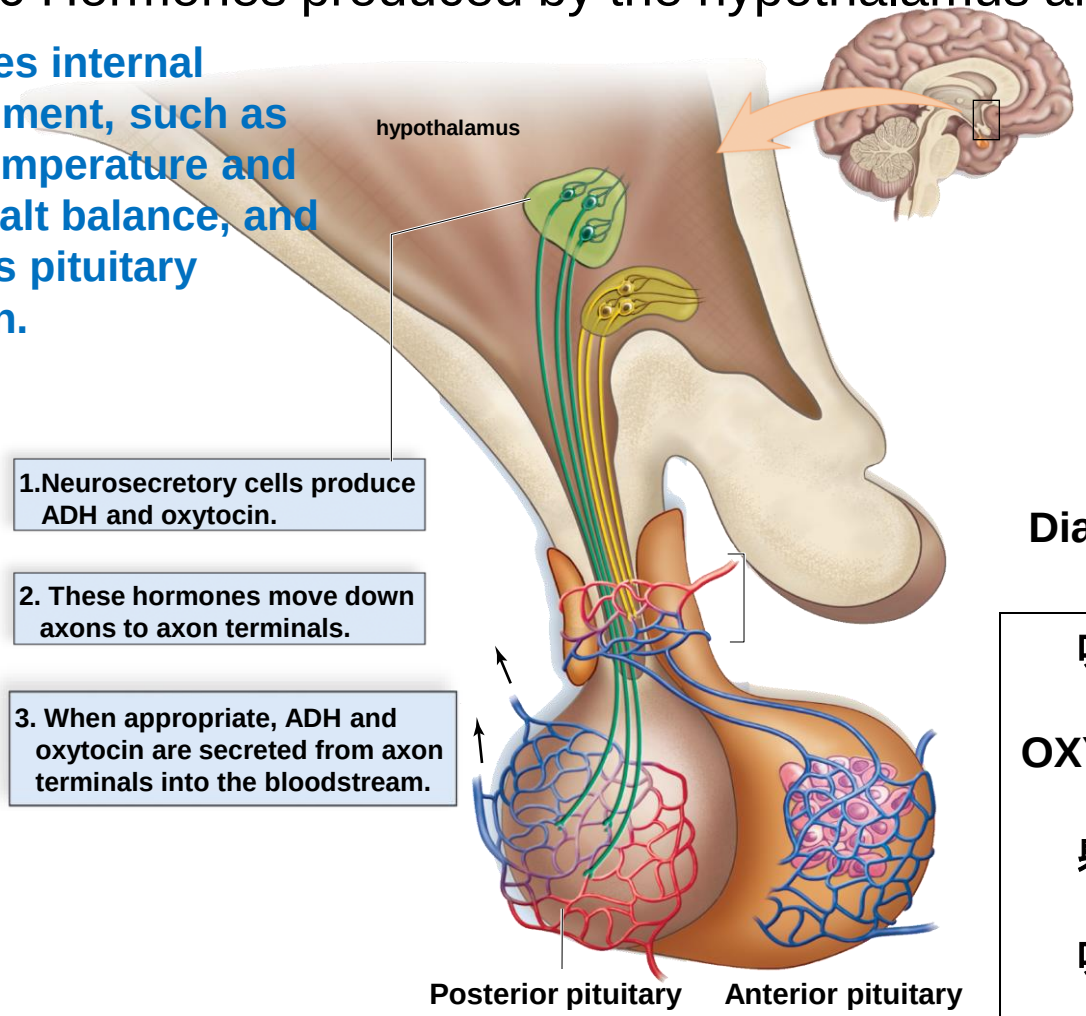


脂溶性ホルモン→
核（細胞質）受容体
＝転写因子

15.2 Hypothalamus and pituitary gland

Fig. 15.6 Hormones produced by the hypothalamus and pituitary.

regulates internal environment, such as body temperature and water-salt balance, and controls pituitary function.



浸透圧上昇
↓
ADH分泌↑
↓
尿量減少
↓
浸透圧低下
↓
ADH分泌↓

Diabetes insipidus ADH↓ 尿崩症

吸乳
↓
OXY分泌↑
↓
射乳
↓
吸乳
↓
OXY分泌↑

出産
↓
子宮頸部拡張
↓
OXY分泌↑
↓
子宮体部収縮
↓
分娩進行
↓
子宮頸部拡張
↓
OXY分泌↑

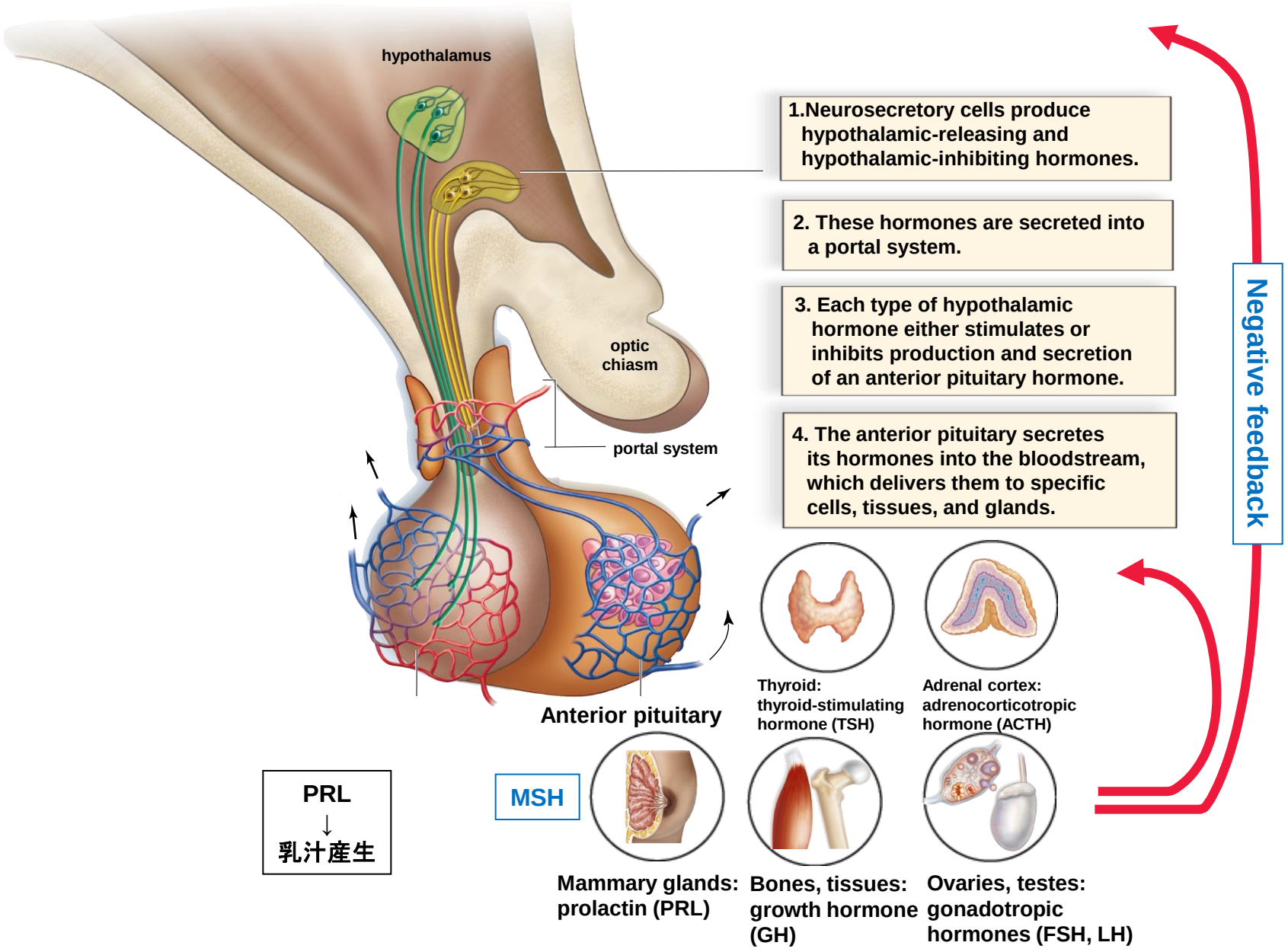
Kidney tubules: antidiuretic hormone (ADH)

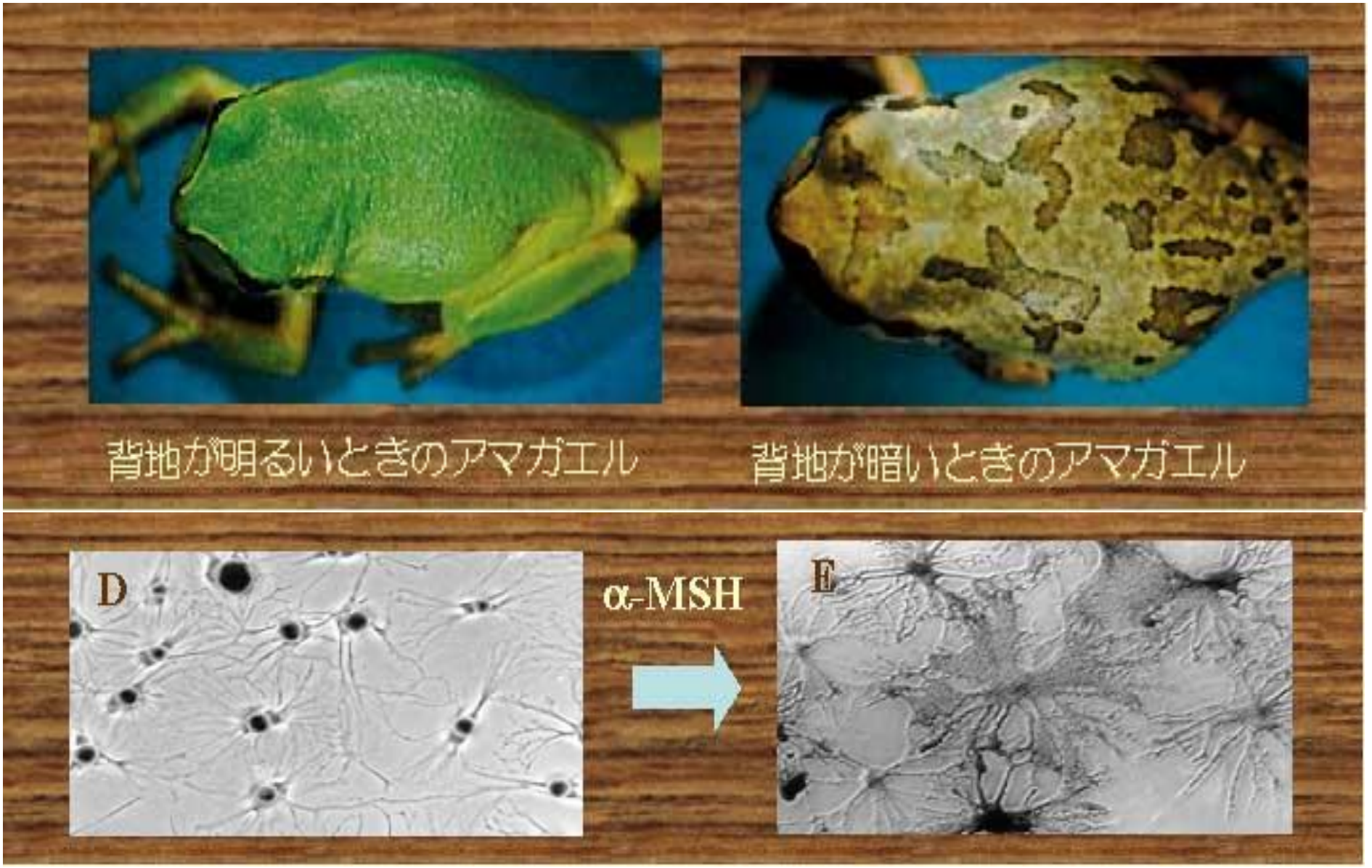
Smooth muscle in uterus: oxytocin

Mammary glands: oxytocin

15.2 Hypothalamus and pituitary gland

Fig. 15.6 Hormones produced by the hypothalamus and pituitary.

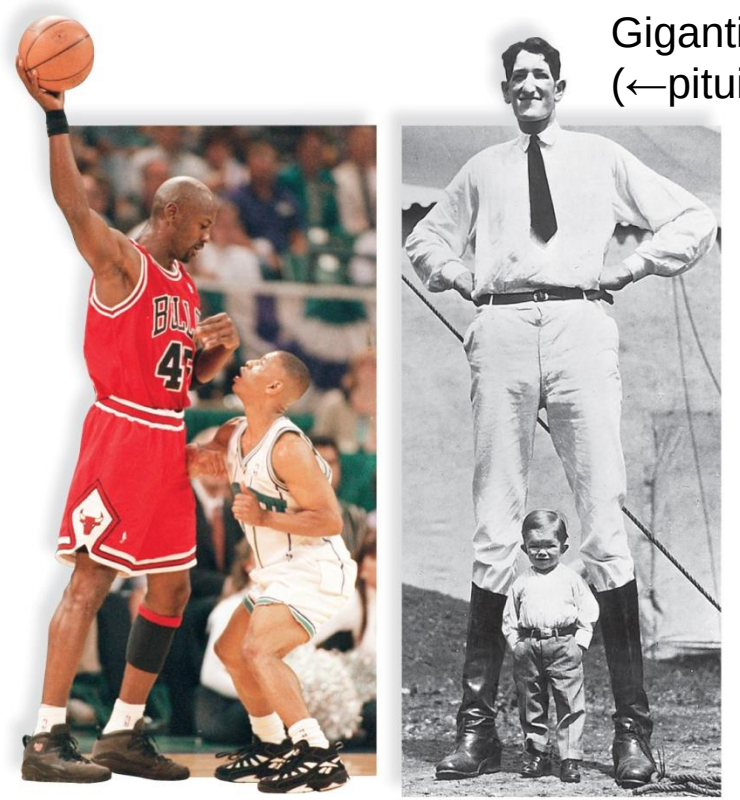




メラノフォア

Effect of growth Hormone

Fig. 15.8 Growth hormone influences height.



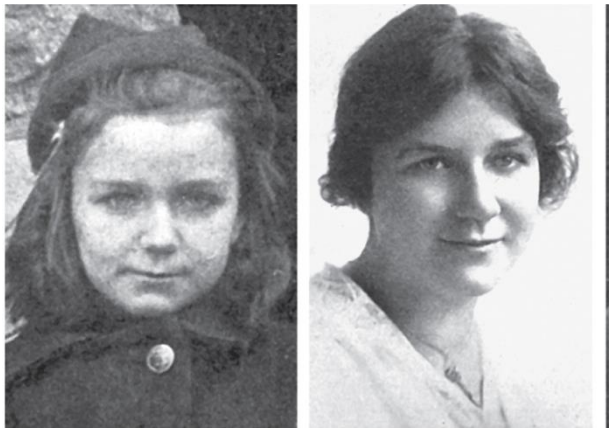
a. b.

a: © AP/Wide World Photos; b: © General Photographic Agency/Getty Images

Gigantism
(←pituitary tumors)

Pituitary
dwarfism

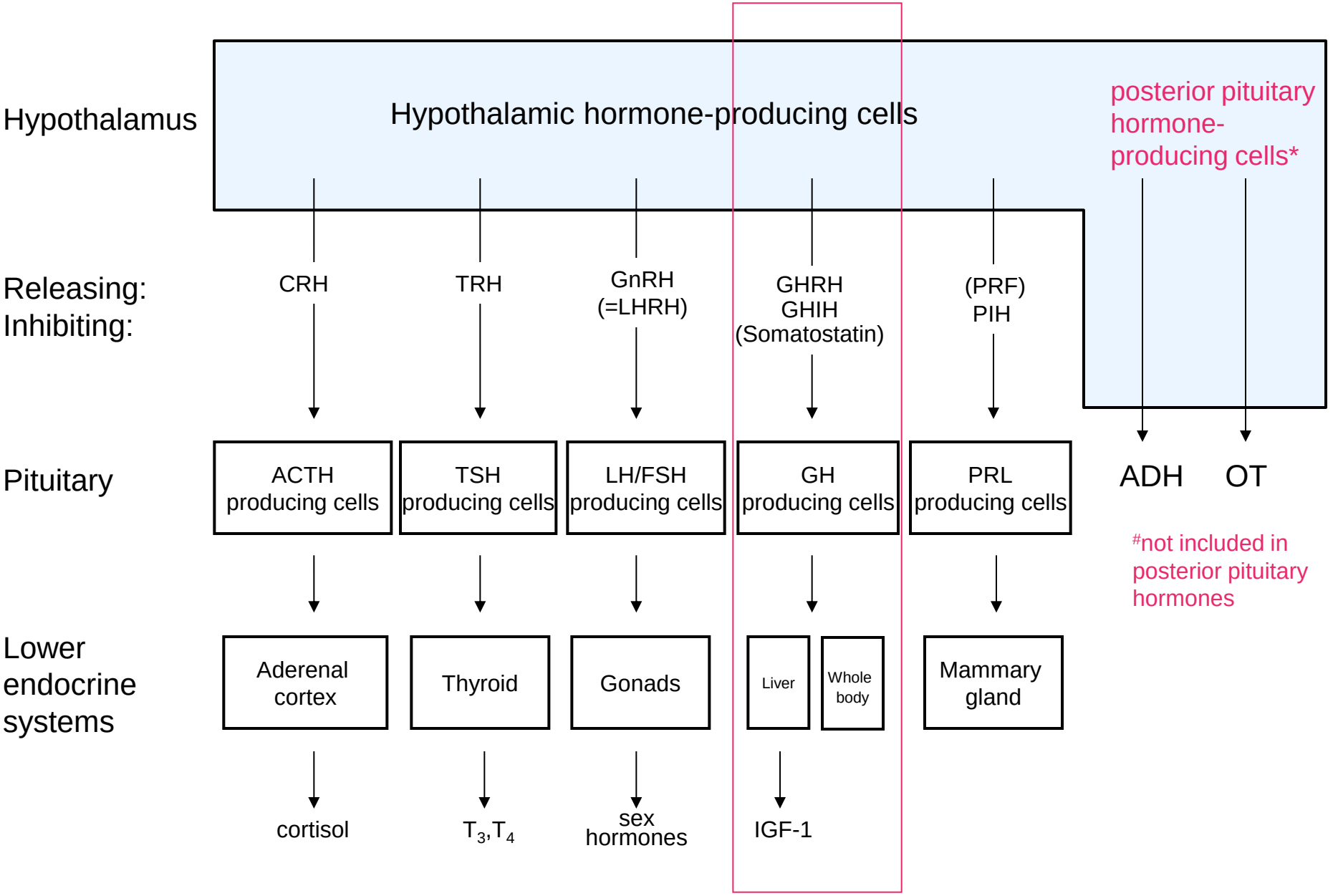
Fig. 15.9 Overproduction of growth hormone in adults leads to acromegaly.



Age 9 Age 16

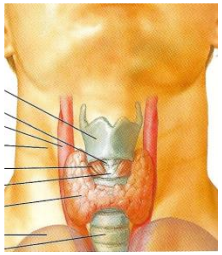
Age 33 Age 52

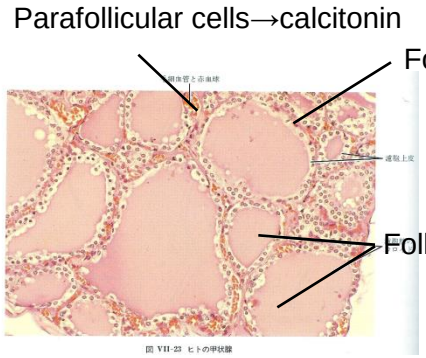
Hypothalamus-pituitary-peripheral endocrine system

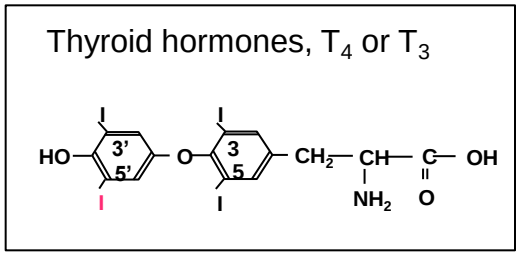


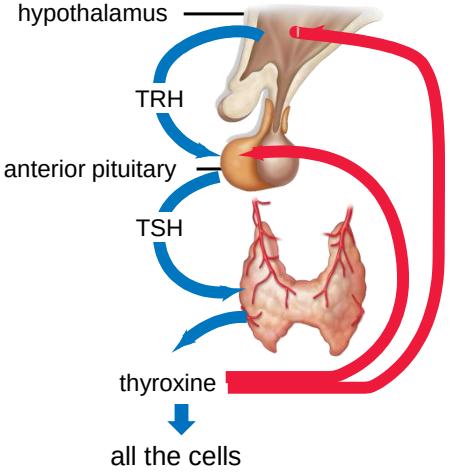
15.3 Thyroid and Parathyroid glands

Fig. 15.10 Effects of insufficient dietary iodine, hypothyroidism, and hyperthyroidism.



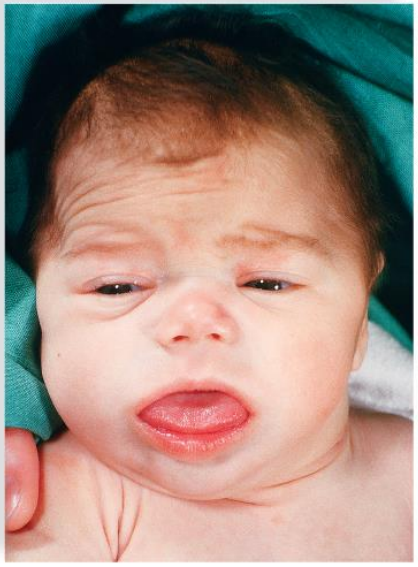




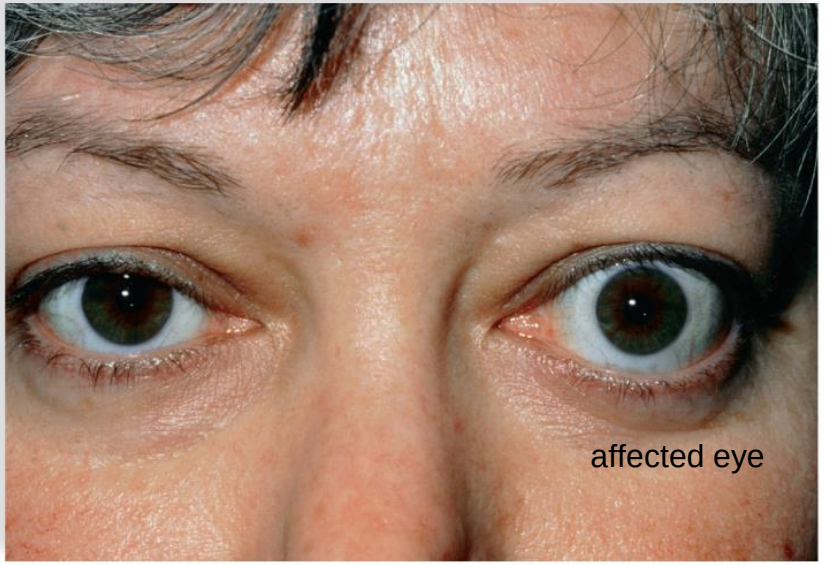


Hypothyroidism (←Hashimoto' disease)
vs.
Hyperthyroidism (←Graves' disease, Basedow disease)

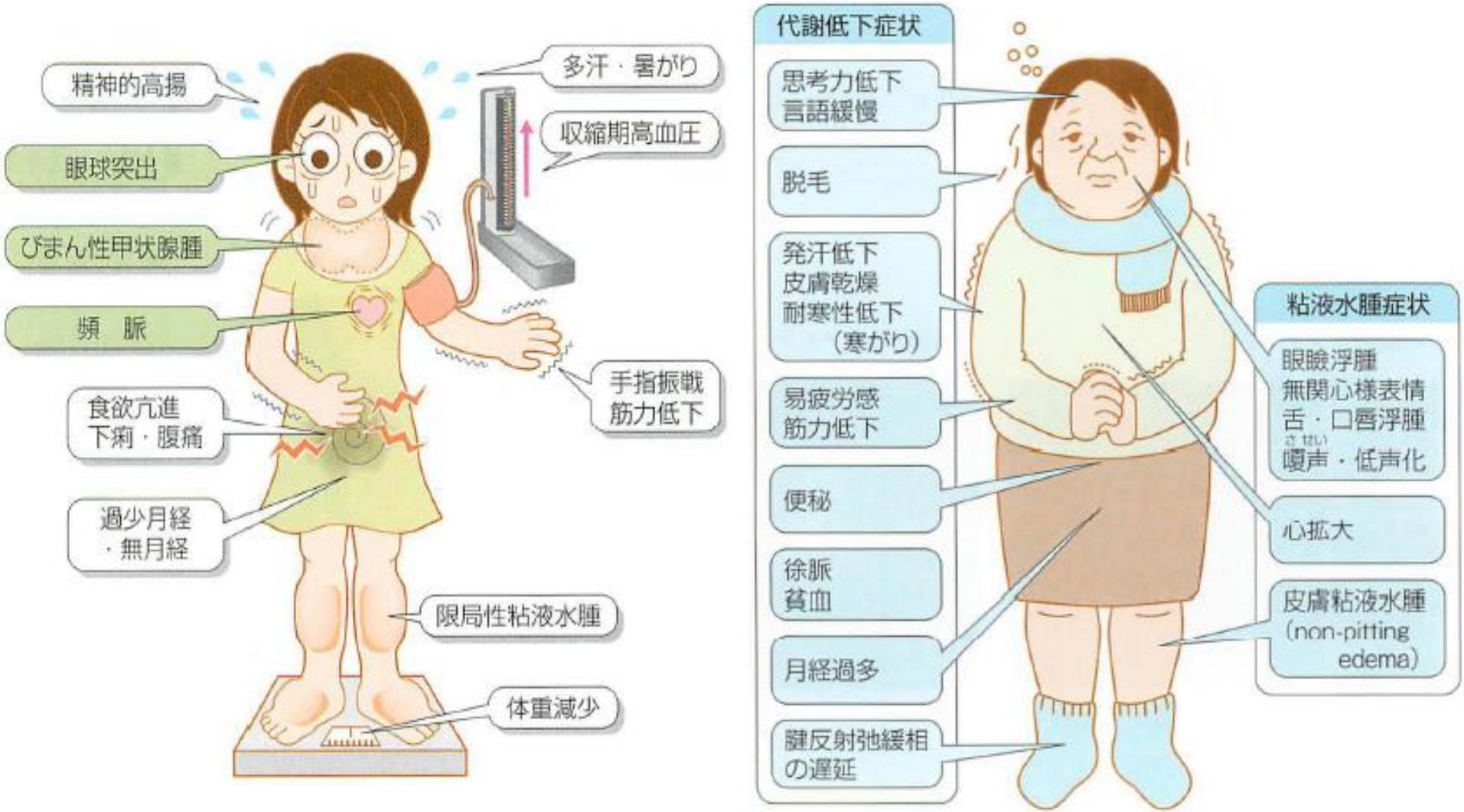
a. Simple goiter



b. Congenital Hypothyroidism (cretinism)



c. Graves' or Basedow disease; Exophthalmic goiter


精神的高揚
多汗・暑がり
収縮期高血圧
眼球突出
びまん性甲状腺腫
頻　脈
手指振戦
筋力低下
食欲亢進
下痢・腹痛
過少月経
・無月経
限局性粘液水腫
体重減少
代謝低下症状
思考力低下
言語緩慢
脱毛
発汗低下
皮膚乾燥
耐寒性低下
（寒がり）
易疲労感
筋力低下
便秘
徐脈
貧血
月経過多
腱反射弛緩相
の遅延
粘液水腫症状
眼瞼浮腫
無関心様表情
舌・口唇浮腫
嗄声（させい）・低声化
心拡大
皮膚粘液水腫
(non-pitting
edema)

Hypothalamus-pituitary-peripheral endocrine system

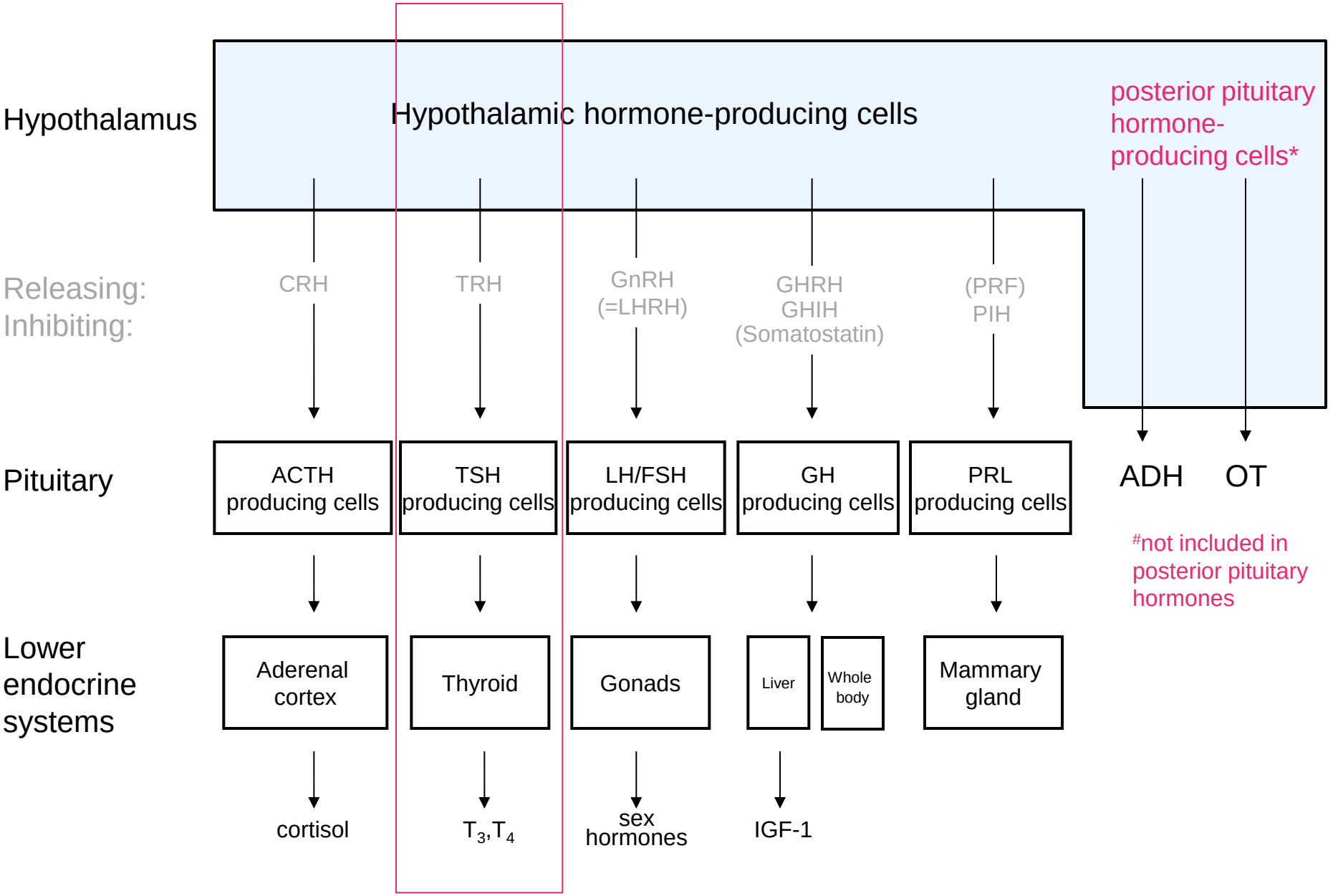
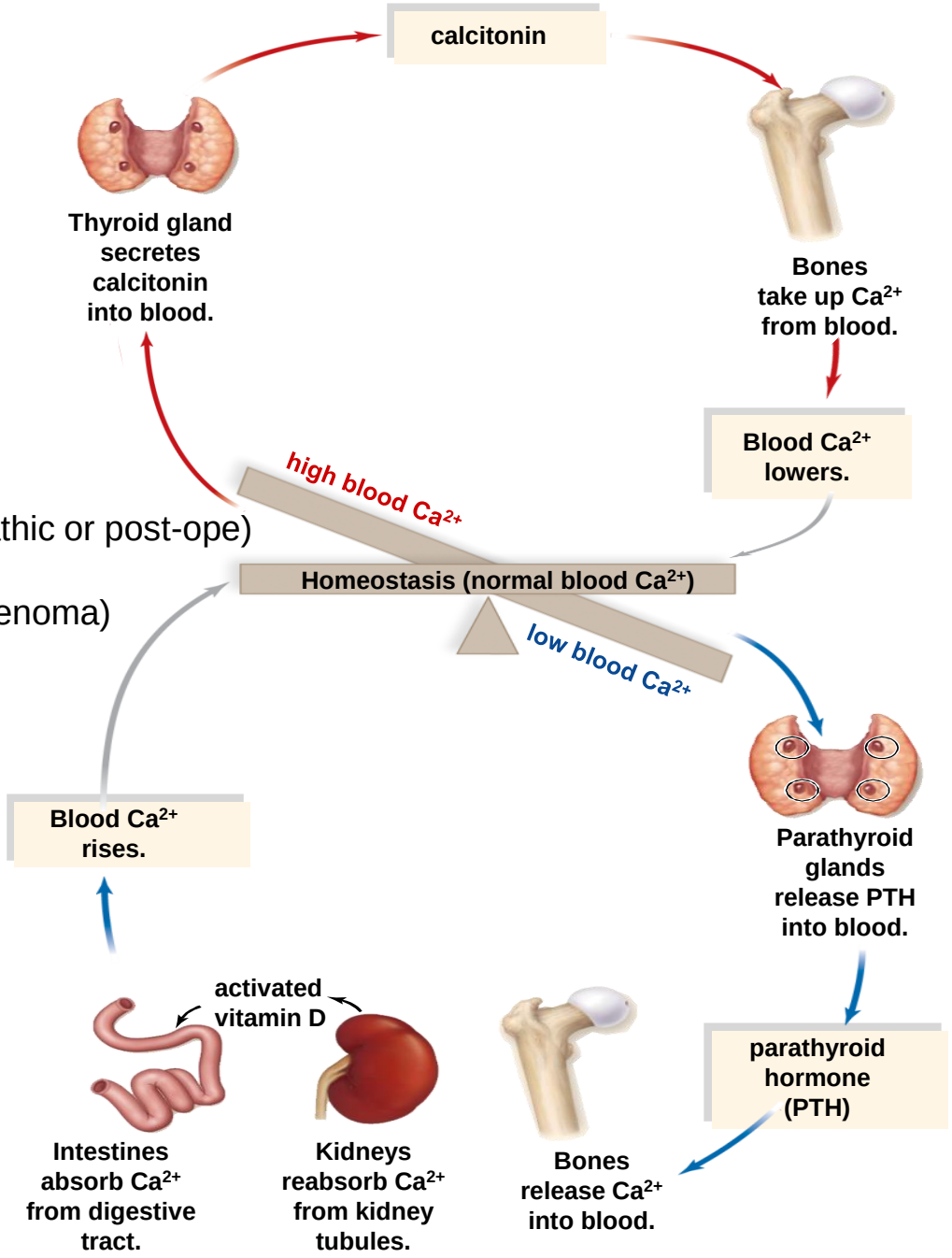


Fig. 15.11 Blood Ca homeostasis

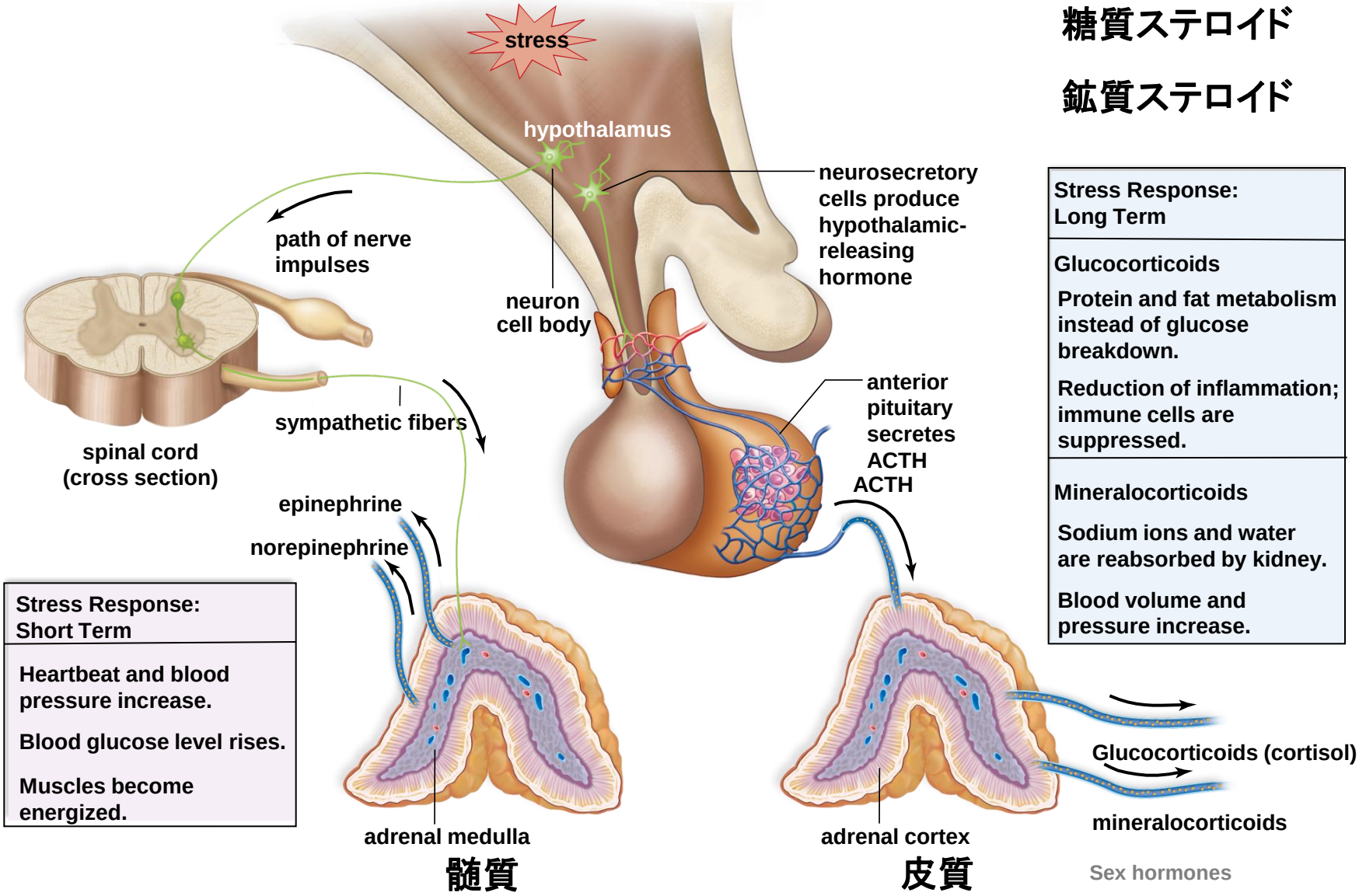


Hypoparathyroidism (idiopathic or post-ope)
vs.
Hyperparathyroidism (←adenoma)

PTH
↓
Ca++

15.4 Adrenal Glands

Fig. 15.12 Response of the adrenal medulla and the adrenal cortex to stress.



Hypothalamus-pituitary-peripheral endocrine system

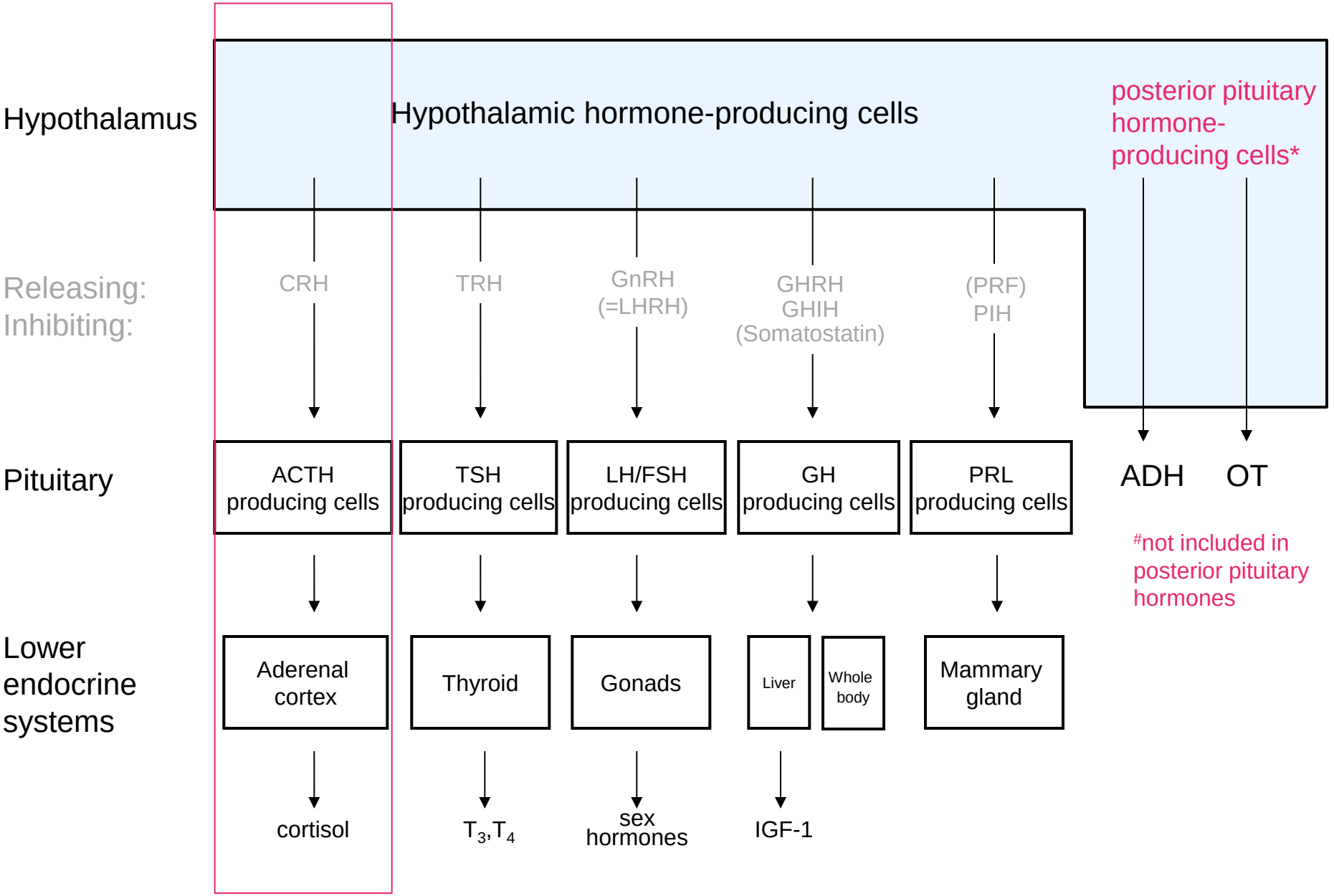
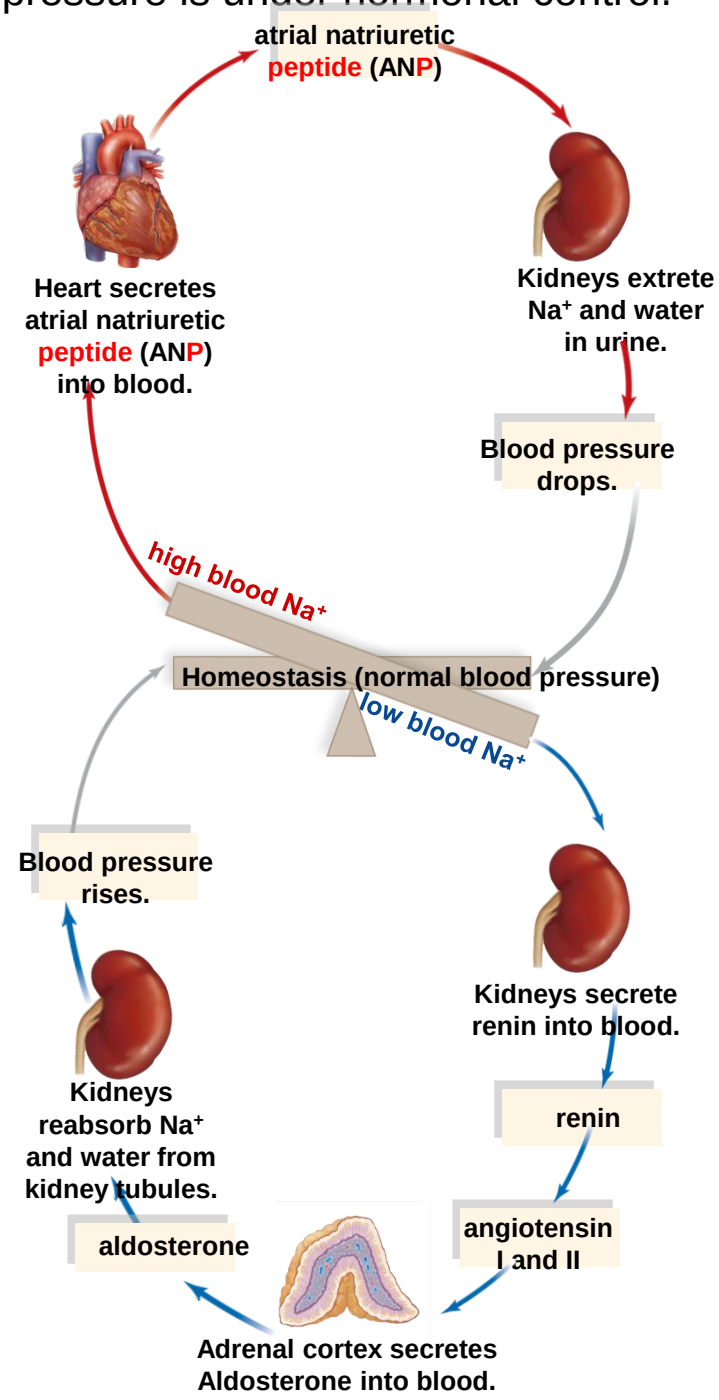


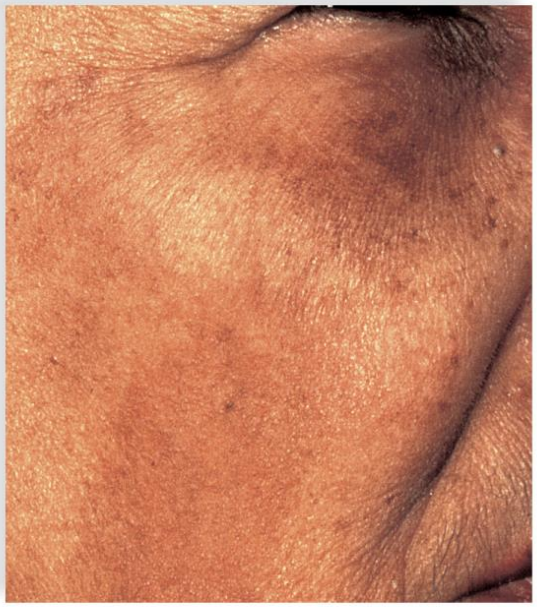
Fig. 15.13 Regulation of blood pressure is under hormonal control.



Hypoaldosteronism
vs.
(Primary) aldosteronism

Aldosterone, ANP
↓
血圧、体液量

Fig. 15.14 Addison disease

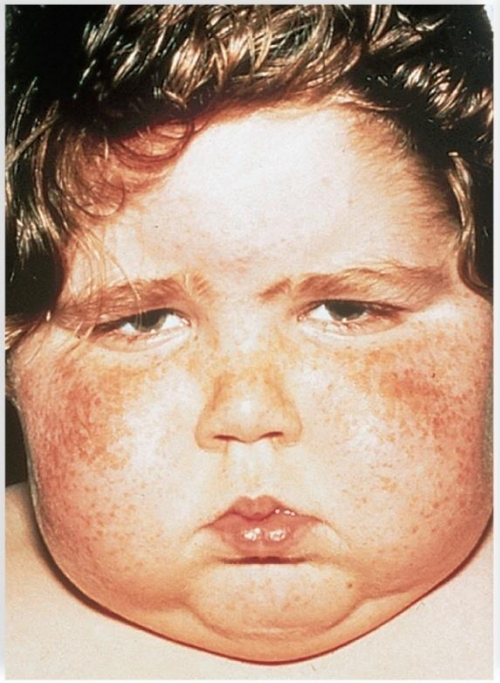


a.

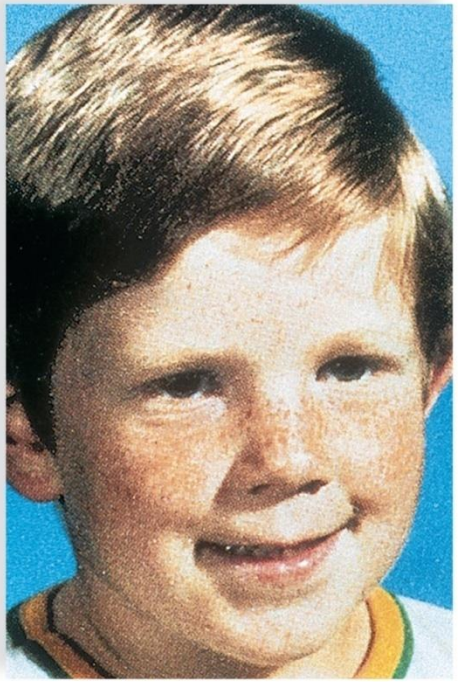
b.

a: © Custom Medical Stock Photos; b: © NMSB/Custom Medical Stock Photos

Fig. 15.15 Cushing syndrome



a.



b.

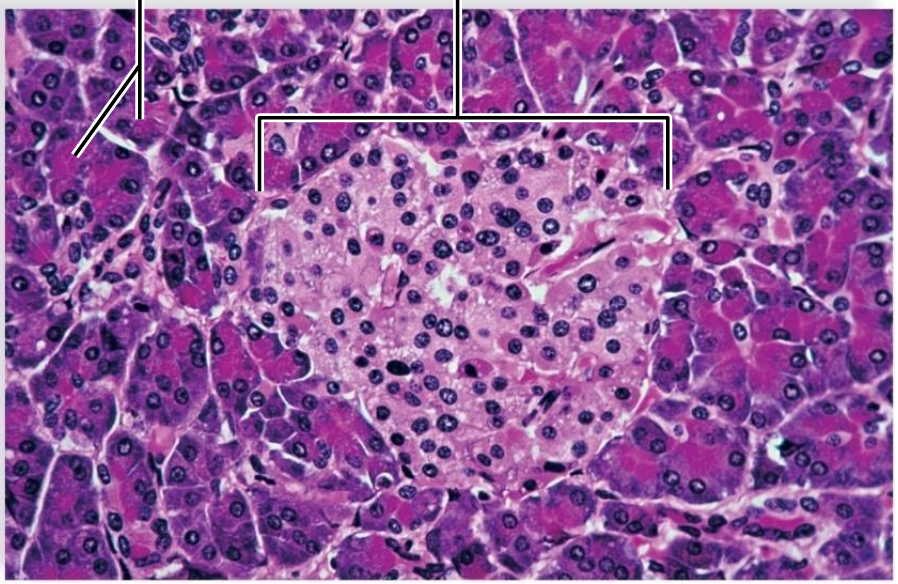
Atlas of Pediatric Physical Diagnosis, Second Edition by Zitelli & Davis, 1992. Mosby-Wolfe Europe Limited, London, UK

15.5 Pancreas

Fig. 15.16 The pancreas is both an endocrine and exocrine gland.

Exocrine tissue produces digestive juice.

Pancreatic islet (islet of **Langerhans**)
Endocrine tissue produces insulin, glucagon etc.



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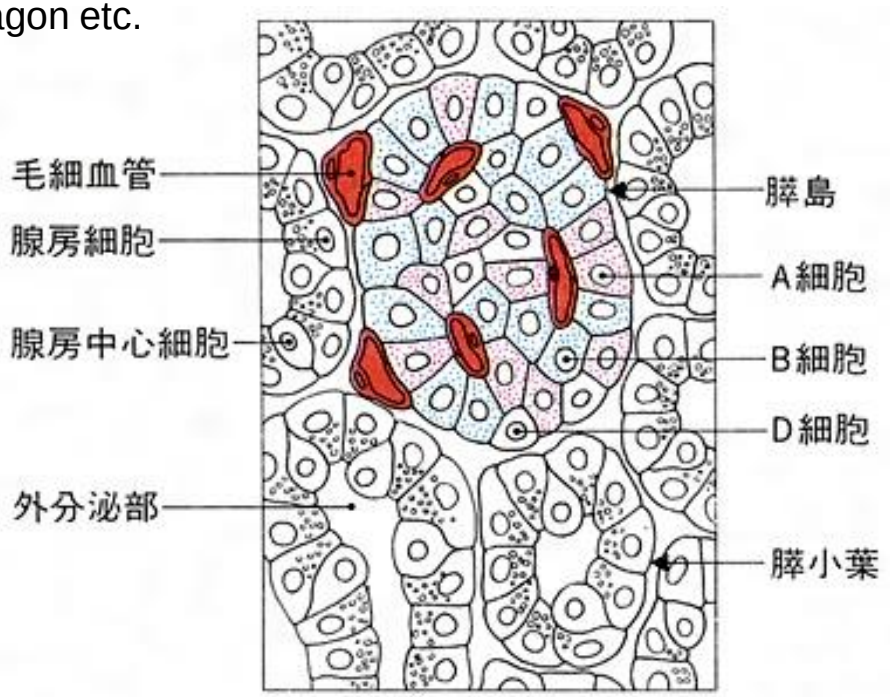
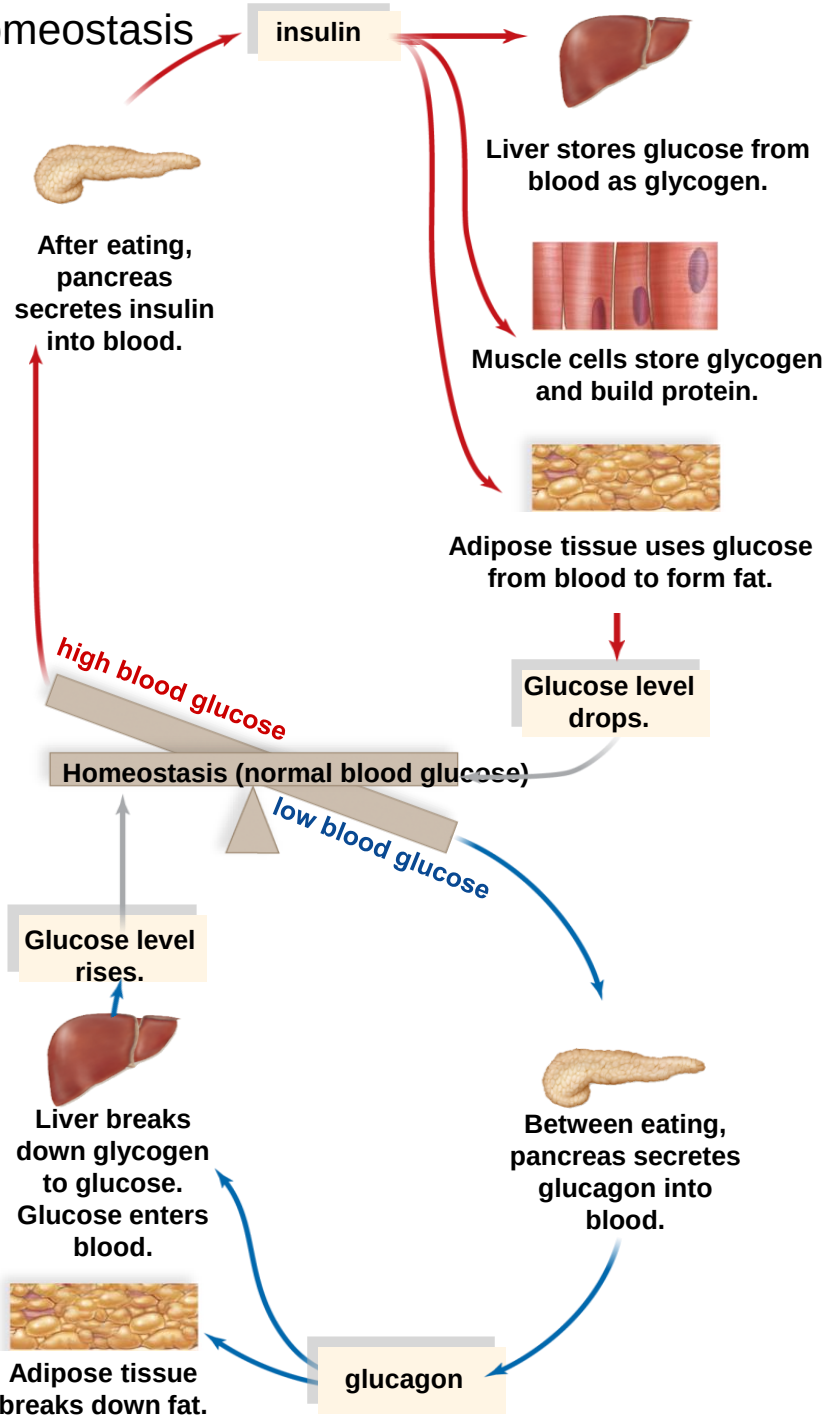


Fig. 15.17 Blood glucose homeostasis

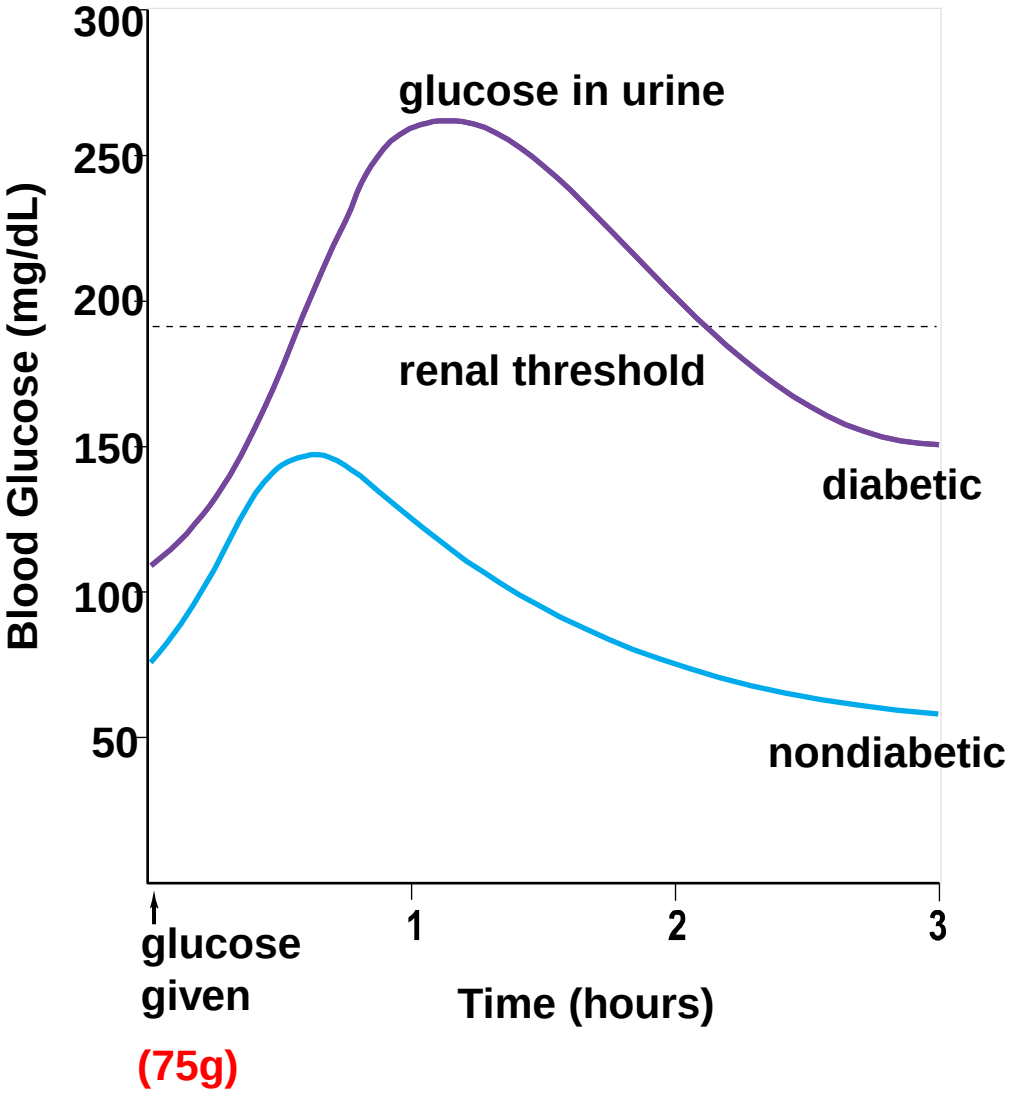


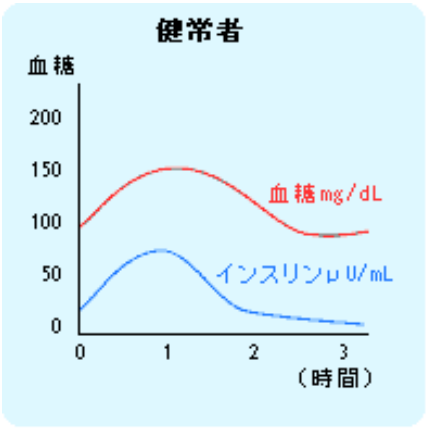
Diabetes
vs.
Insulinoma
(insulin-producing tumor)

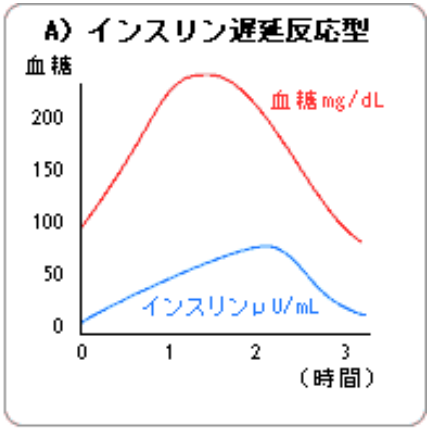
Classification of diabetes
Type 1; autoimmune
Type 2; related to obesity

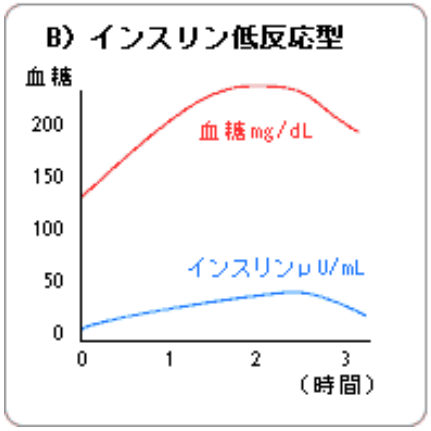
Insulin, glucagon
↓
glucose

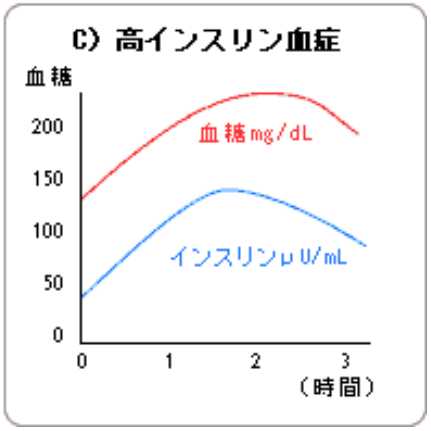
Fig. 15.18 The results of a glucose tolerance test for diabetes.











インスリンの発見（p357)

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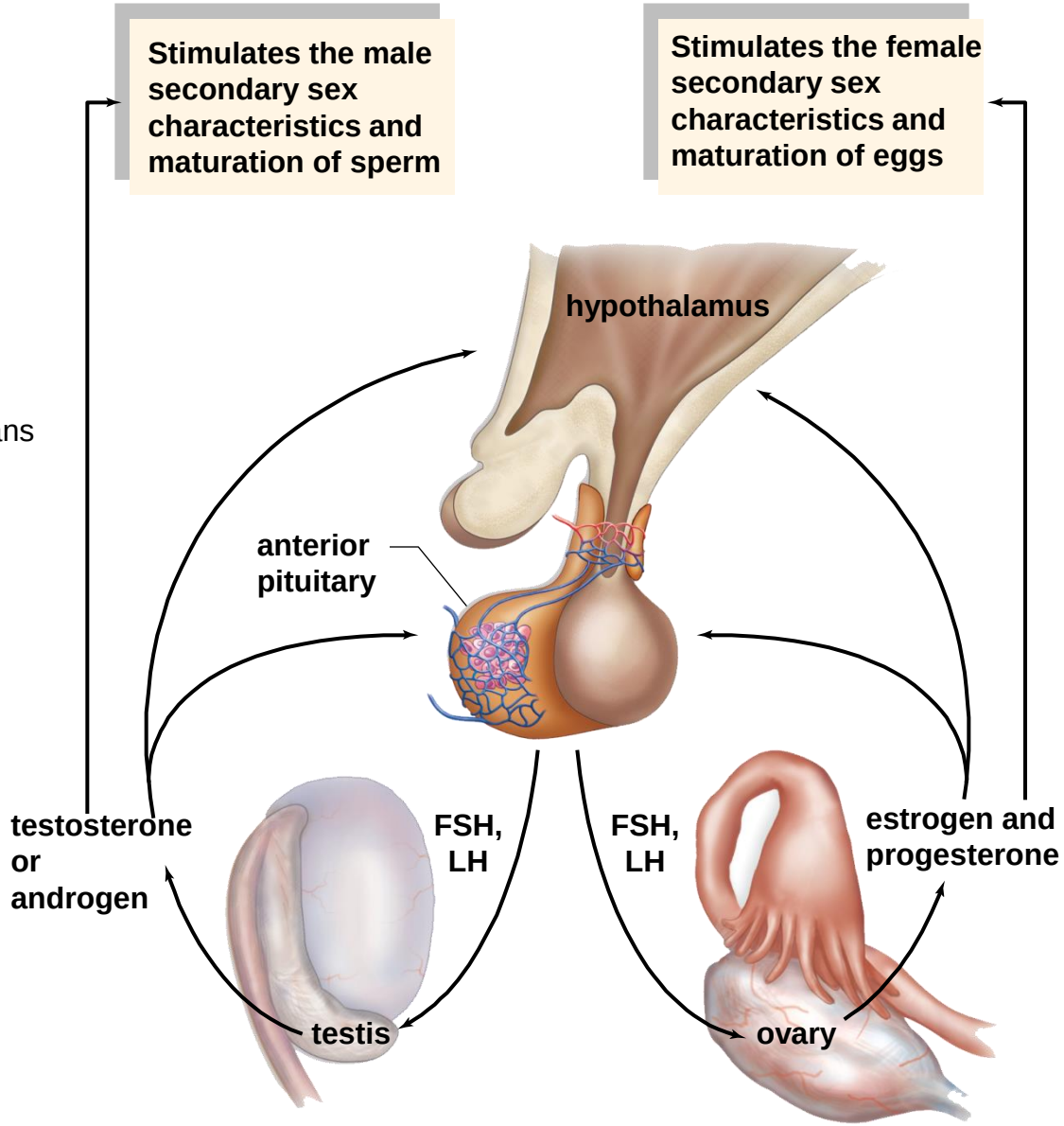
1921年　トロント大学生理学教室（マクラウド教授）にて、バンティング（外科医）とベスト（医学部学生）インスリンを発見。

1922年　糖尿病の患者へのインスリンの治療投与開始。その結果をバンティングとベストが発表。

1923年　ノーベル医学賞が、バンティングとマクラウドに贈られる。

15.6 Other Endocrine Glands

Fig. 15.19 The hormones produced by the testes and the ovaries



Puberty:

Growth of sex organs
Hair growth
Voice change
Acne

(Baldness)

etc

Puberty:

Growth of sex organs
Hair growth

etc

Hypothalamus-pituitary-peripheral endocrine system

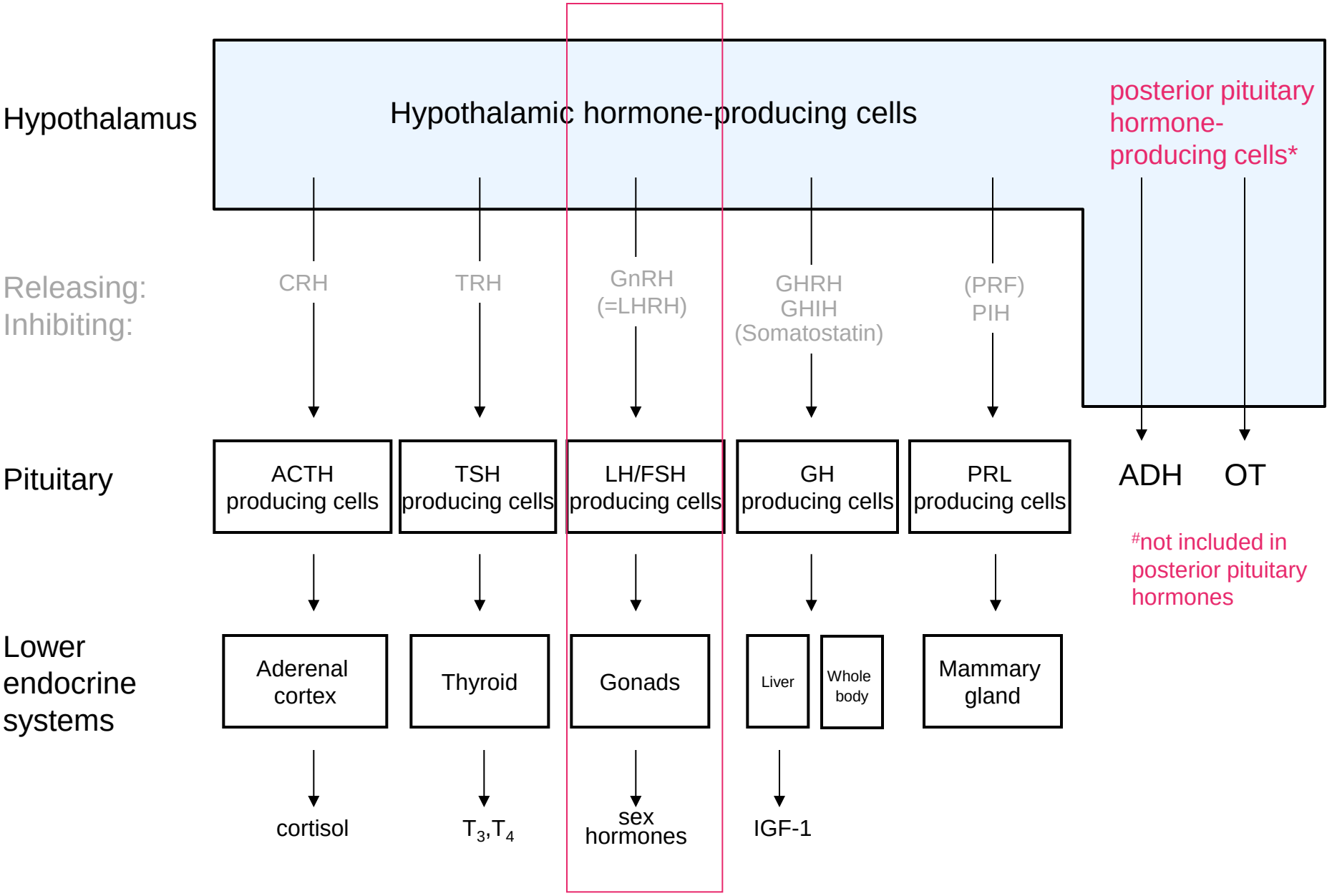
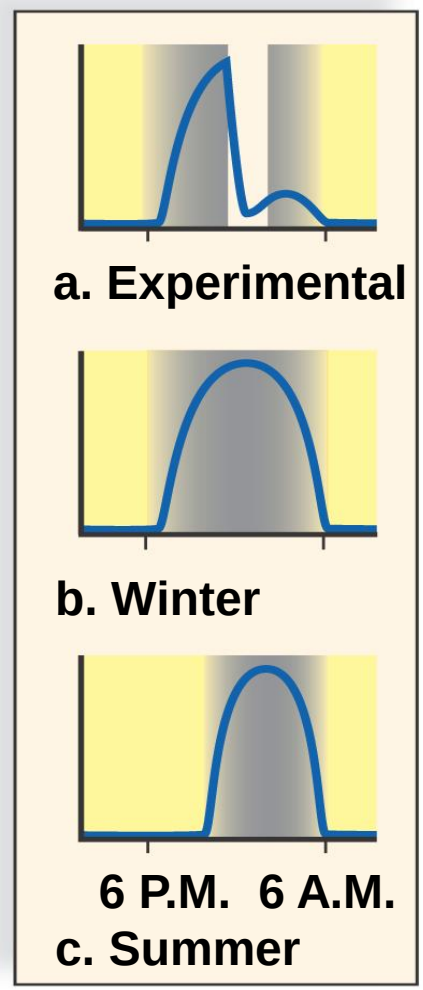
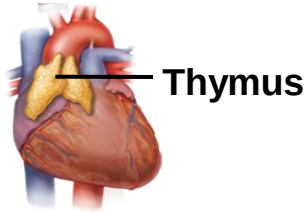


Fig. 15.20 melatonin production changes by season.

Pineal gland→Melatonin→Circadian rhythm （概日リズム）



Other hormones



Thymus; Thymosin→differentiation of T lymphocytes

Kidney; Hypoxia→Erythropoetin→an increase in red blood cells

Fat tissue; Leptin→satiety, fullness (appetite suppression)

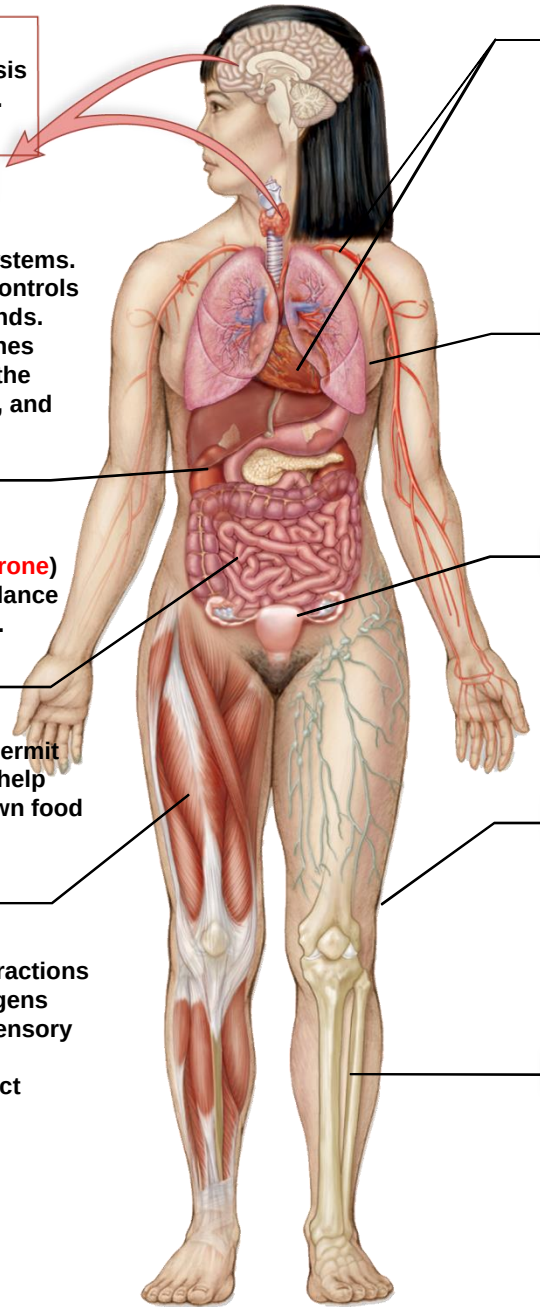
Prostaglandins


皮下脂肪型肥満


内臓型肥満

15.7 Homeostasis

Fig. 15.21 Homeostasis is maintained through cooperation of multiple organ systems.



The nervous and endocrine systems work together to maintain homeostasis The systems listed here in particular. also work with these two systems.

Nervous and Endocrine Systems

The nervous and endocrine systems coordinate the activities of the other systems. The brain receives sensory input and controls the activity of muscles and various glands. The endocrine system secretes hormones that influence the metabolism of cells, the growth and development of body parts, and homeostasis.

Urinary System

Nerves stimulate muscles that permit urination. Hormones (ADH and aldosterone) help kidneys regulate the water-salt balance and the acid-base balance of the blood.

Digestive System

Nerves stimulate smooth muscle and permit digestive tract movements. Hormones help regulate digestive juices that break down food to nutrients for neurons and glands.

Gastro-intestinal hormones

Muscular System

Nerves stimulate muscles, whose contractions allow us to move out of danger. Androgens promote growth of skeletal muscles. Sensory receptors in muscles and joints send information to the brain. Muscles protect neurons and glands.

Secretin
Ghrelin

Cardiovascular System

Nerves and epinephrine regulate contraction of the heart and constriction/dilation of blood vessels. Hormones regulate blood glucose and ion levels. Growth factors promote blood cell formation. Blood vessels transport hormones to target cells.

ANP
Endothelin (from vessels)

Respiratory System

The respiratory center in the brain regulates the breathing rate. The lungs carry on gas exchange for the benefit of all systems, including the nervous and endocrine systems.

Reproductive System

Nerves stimulate contractions that move gametes in ducts, and uterine contraction that occurs during childbirth. Sex hormones influence the development of the secondary sex characteristics.

Integumentary System

Nerves activate sweat glands and arrector pili muscles. Sensory receptors in skin send information to the brain about the external environment. Skin protects neurons and glands.

Skeletal System

Growth hormone and sex hormones regulate the size of the bones; parathyroid hormone and calcitonin regulate their Ca^{2+} content and therefore bone strength. Bones protect nerves and glands.