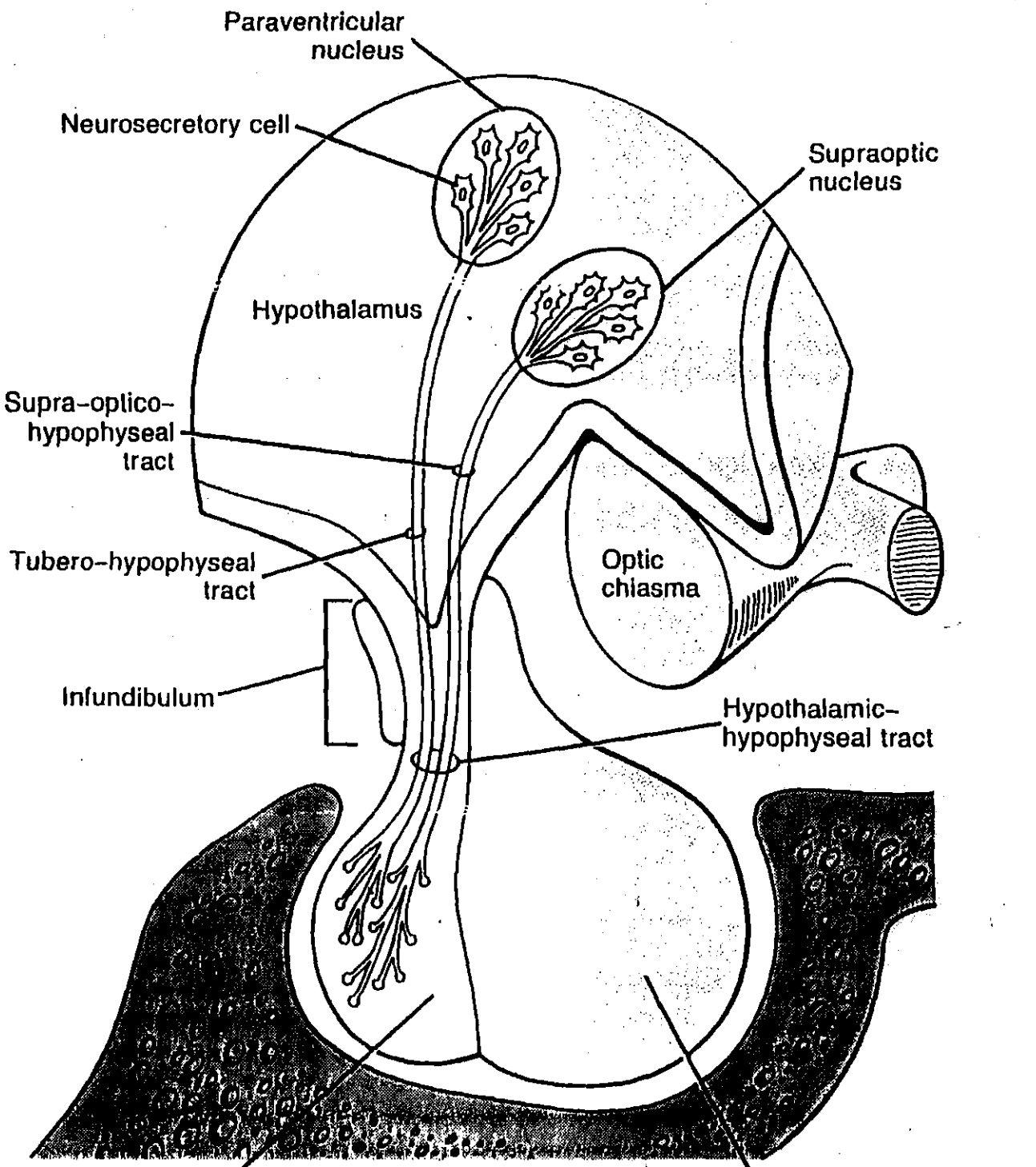


Figure 18-6
Tortora/Anagnostakos: Principles of Anatomy and Physiology, 5/e

The Pituitary

(hypophysis) GLAND

small gland—about 1 cm in diameter and 0.5 to 1 gram in weight—that lies in the sella turcica at the base of the brain.

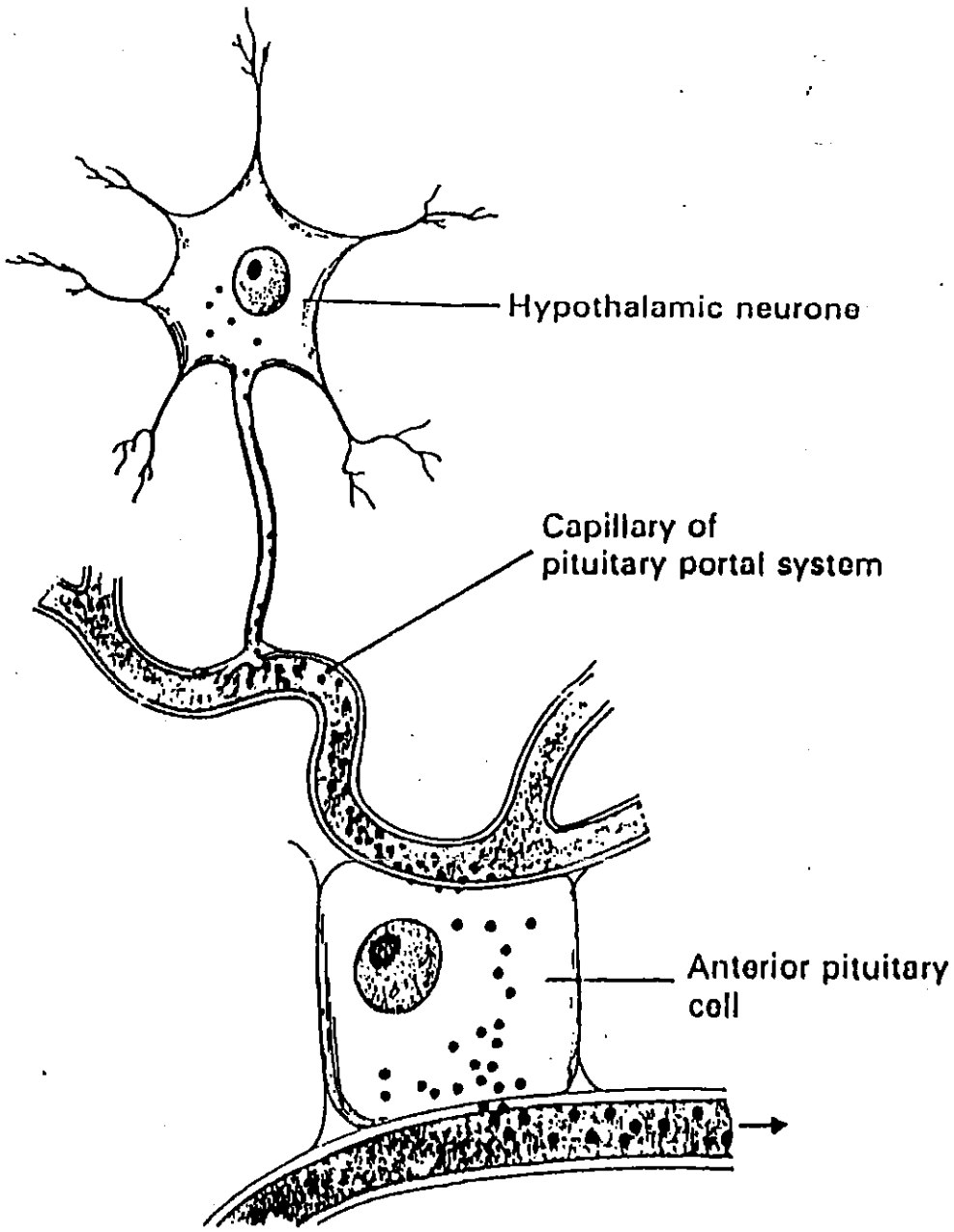


Fig. 28.5 Relationship between hypothalamic neurones and anterior pituitary cells. (*From* R. Guillemin & R. Burgus (1972) *Scientific American* 227 (5) 24–33.)

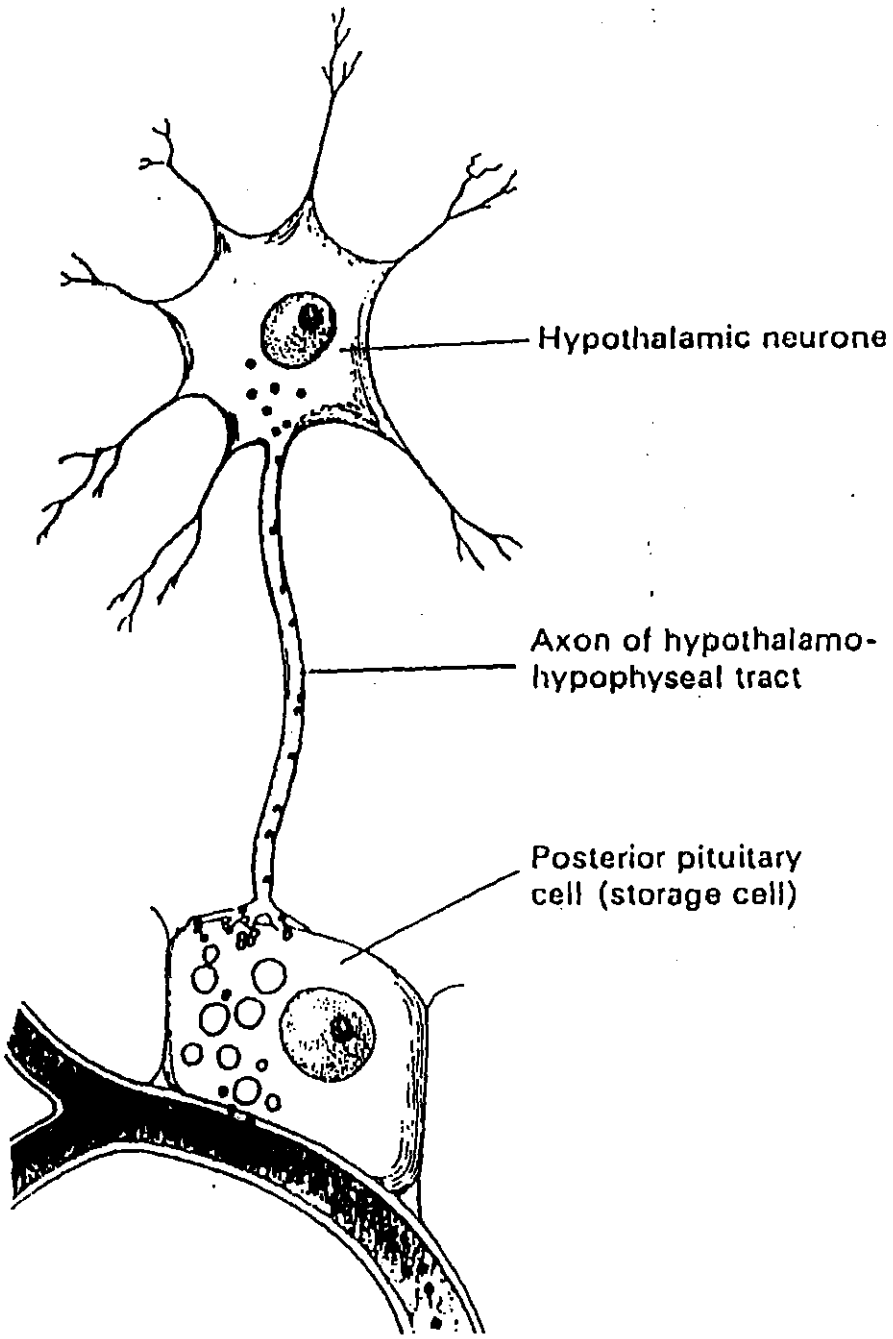


Fig. 28.8 Role of the posterior pituitary cells in the storage of the hormones oxytocin and ADH elaborated by hypothalamic neurones (*From* R. Guillemin & R. Burgus (1972) *Scientific American* 227 (5) 24–33).

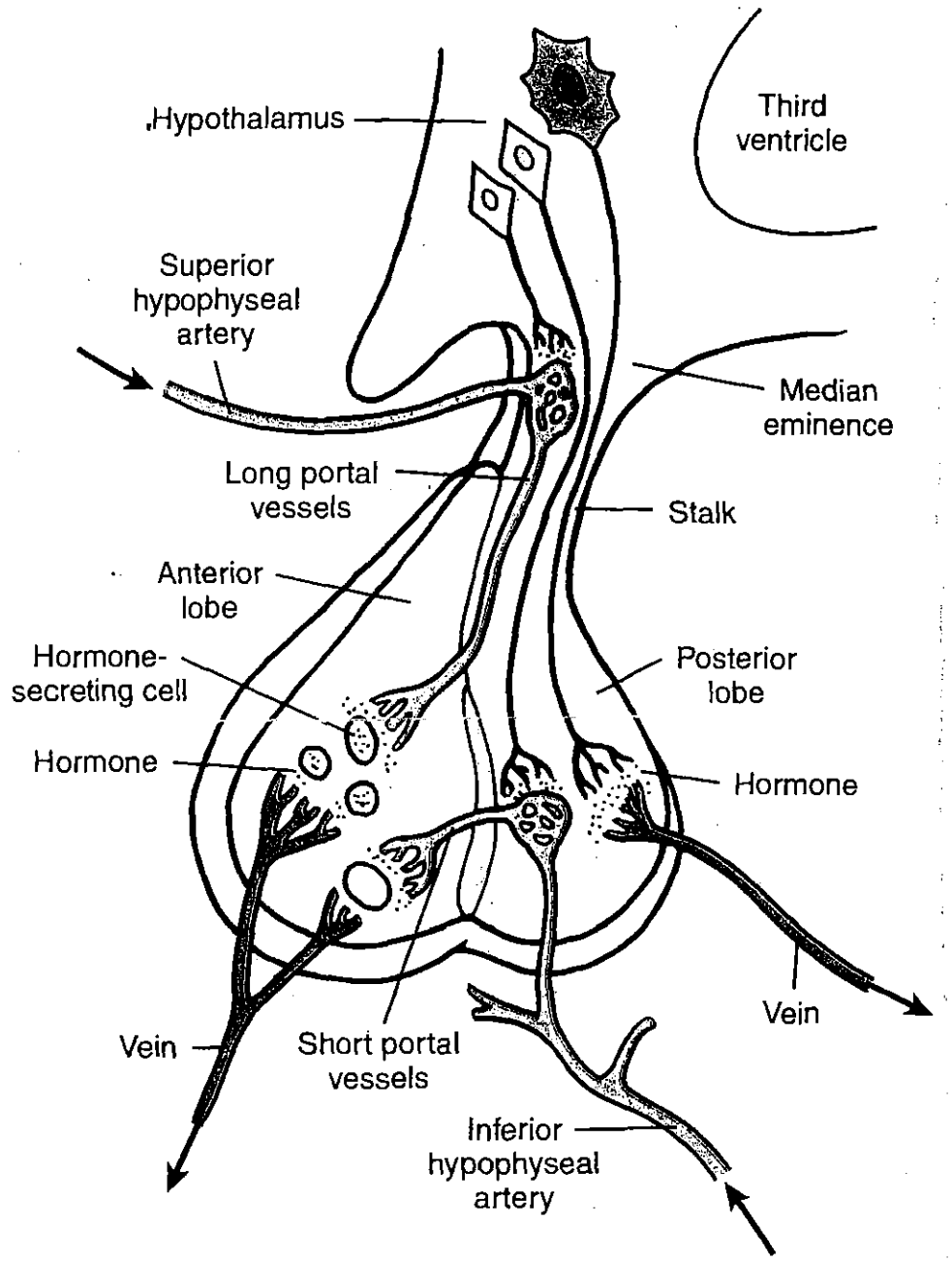


FIGURE 31.2 The blood supply to the anterior pituitary. This illustration shows the relationship of the pituitary blood supply to hypothalamic magnocellular neurons and to hypothalamic neurosecretory cells that produce releasing hormones. The magnocellular neuron (larger, dark blue cell body) releases AVP or oxytocin at its axon terminals into capillaries that give rise to the venous drainage of the posterior lobe. The neurons with smaller, light blue cell bodies are secreting releasing factors into capillary networks that give rise to the long and short hypophyseal portal vessels, respectively. Releasing hormones are shown reaching the hormone-secreting cells of the anterior lobe via the portal vessels.

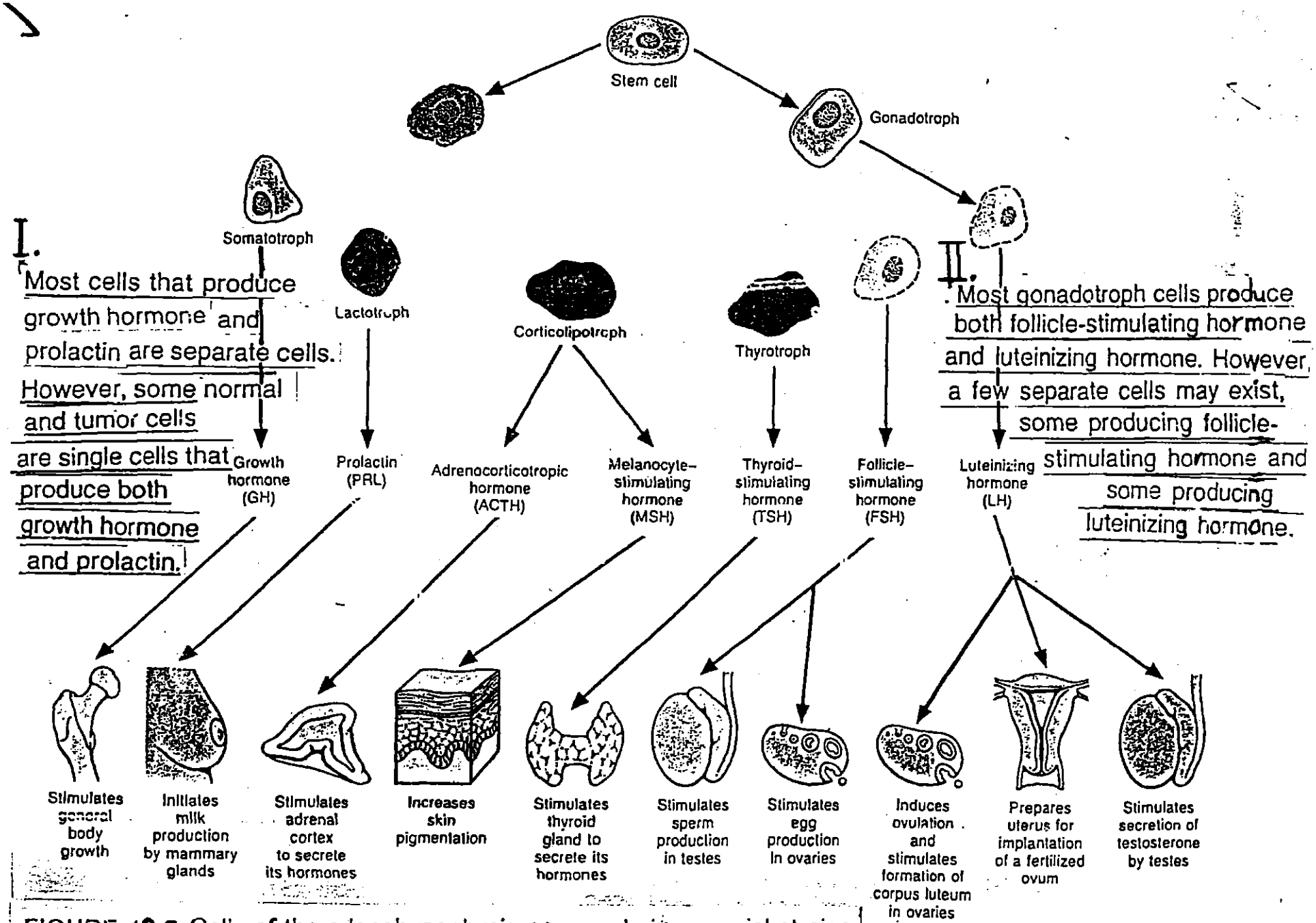


FIGURE 18-6 Cells of the adenohypophysis as revealed by special strains.

Anterior Pituitary Gland Contains Several Different Cell Types That Synthesize and Secrete Hormones. Usually, there is one cell type for each major hormone formed in the anterior pituitary gland. With special stains attached to high-affinity antibodies that bind with the distinctive hormones, at least five cell types can be differentiated.

Table 75-1 Cells and Hormones of the Anterior Pituitary Gland and Their Physiological Functions

Cell	Hormone	Chemistry	Physiological Action
Somatotropes	Growth hormone (GH; somatotropin)	Single chain of 191 amino acids	Stimulates body growth; stimulates secretion of IGF-1; stimulates lipolysis; inhibits actions of insulin on carbohydrate and lipid metabolism
Corticotropes	Adrenocorticotropic hormone (ACTH; corticotropin)	Single chain of 39 amino acids	Stimulates production of glucocorticoids and androgens by the adrenal cortex; maintains size of zona fasciculata and zona reticularis of cortex
Thyrotropes	Thyroid-stimulating hormone (TSH; thyrotropin)	Glycoprotein of two subunits, α (89 amino acids) and β (112 amino acids)	Stimulates production of thyroid hormones by thyroid follicular cells; maintains size of follicular cells
Gonadotropes	Follicle-stimulating hormone (FSH)	Glycoprotein of two subunits, α (89 amino acids) and β (112 amino acids)	Stimulates development of ovarian follicles; regulates spermatogenesis in the testis
	Luteinizing hormone (LH)	Glycoprotein of two subunits, α (89 amino acids) and β (115 amino acids)	Causes ovulation and formation of the corpus luteum in the ovary; stimulates production of estrogen and progesterone by the ovary; stimulates testosterone production by the testis
Lactotropes Mammotropes	Prolactin (PRL)	Single chain of 198 amino acids	Stimulates milk secretion and production

IGF, insulin-like growth factor.

About 30 to 40 percent of the anterior pituitary cells are somatotropes that secrete growth hormone, and about 20 percent are corticotropes that secrete ACTH. Each of the other cell types accounts for only 3 to 5 percent of the total; nevertheless, they secrete powerful hormones for controlling thyroid function, sexual functions, and milk secretion by the breasts.

Specific Areas in the Hypothalamus Control Secretion of Specific Hypothalamic Releasing and Inhibitory Hormones. All or most of the hypothalamic hormones are secreted at nerve endings in the median eminence before being transported to the anterior pituitary gland. Electrical stimulation of this region excites these nerve endings and, therefore, causes release of essentially all the hypothalamic hormones. However, the neuronal cell bodies that give rise to these median eminence nerve endings are located in other discrete areas of the hypothalamus or in closely related areas of the basal brain.

Table 75-2 Hypothalamic Releasing and Inhibitory Hormones That Control Secretion of the Anterior Pituitary Gland

Hormone	Structure	Primary Action on Anterior Pituitary
Thyrotropin-releasing hormone (TRH)	Peptide of 3 amino acids	Stimulates secretion of TSH by thyrotropes
Gonadotropin-releasing hormone (GnRH)	Single chain of 10 amino acids	Stimulates secretion of FSH and LH by gonadotropes
Corticotropin-releasing hormone (CRH)	Single chain of 41 amino acids	Stimulates secretion of ACTH by corticotropes
Growth hormone-releasing hormone (GHRH)	Single chain of 44 amino acids	Stimulates secretion of growth hormone by somatotropes
Growth hormone inhibitory hormone (somatostatin)	Single chain of 14 amino acids	Inhibits secretion of growth hormone by somatotropes
Prolactin-inhibiting hormone (PIH)	Dopamine (a catecholamine)	Inhibits synthesis and secretion of prolactin by lactotropes

ACTH, adrenocorticotropic hormone; FSH, follicle-stimulating hormone; LH, luteinizing hormone; TSH, thyroid-stimulating hormone.

For most of the anterior pituitary hormones, it is the releasing hormones that are important, but for prolactin, a hypothalamic inhibitory hormone probably exerts more control.

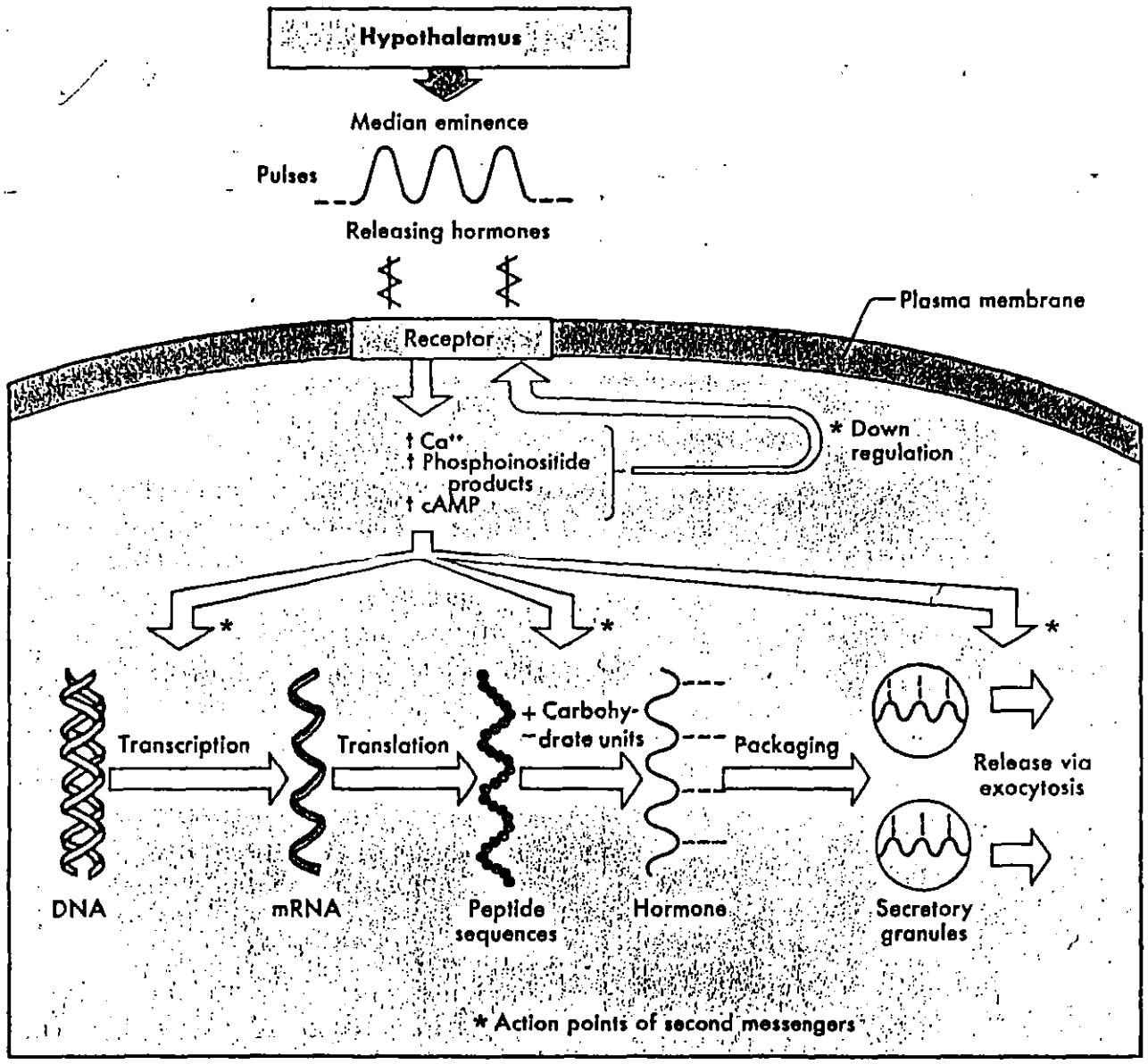


FIGURE 39-3 The action of hypothalamic releasing or inhibiting hormones on anterior pituitary cells. Characteristically the neurohormones are released in pulses, bind to plasma membrane receptors, and act through calcium ions *(Ca^{++})* and other second messengers. They regulate gene expression, posttranslational processes, and secretion of anterior pituitary tropic hormones. cAMP, Cyclic adenosine monophate; *DNA,* deoxyribonucleic acid; mRNA, messenger ribonucleic acid.

Vasopressin & Oxytocin

In most mammals, the hormones secreted by the posterior pituitary gland are **arginine vasopressin (AVP)** and **oxytocin.** In hippopotami and most pigs, arginine in the vasopressin molecule is replaced by lysine to form **lysine vasopressin.** The posterior pituitaries of some species of pigs and marsupials contain a mixture of arginine and lysine vasopressin. The posterior lobe hormones are nonapeptides with a disulfide ring at one end (Figure 14–10).

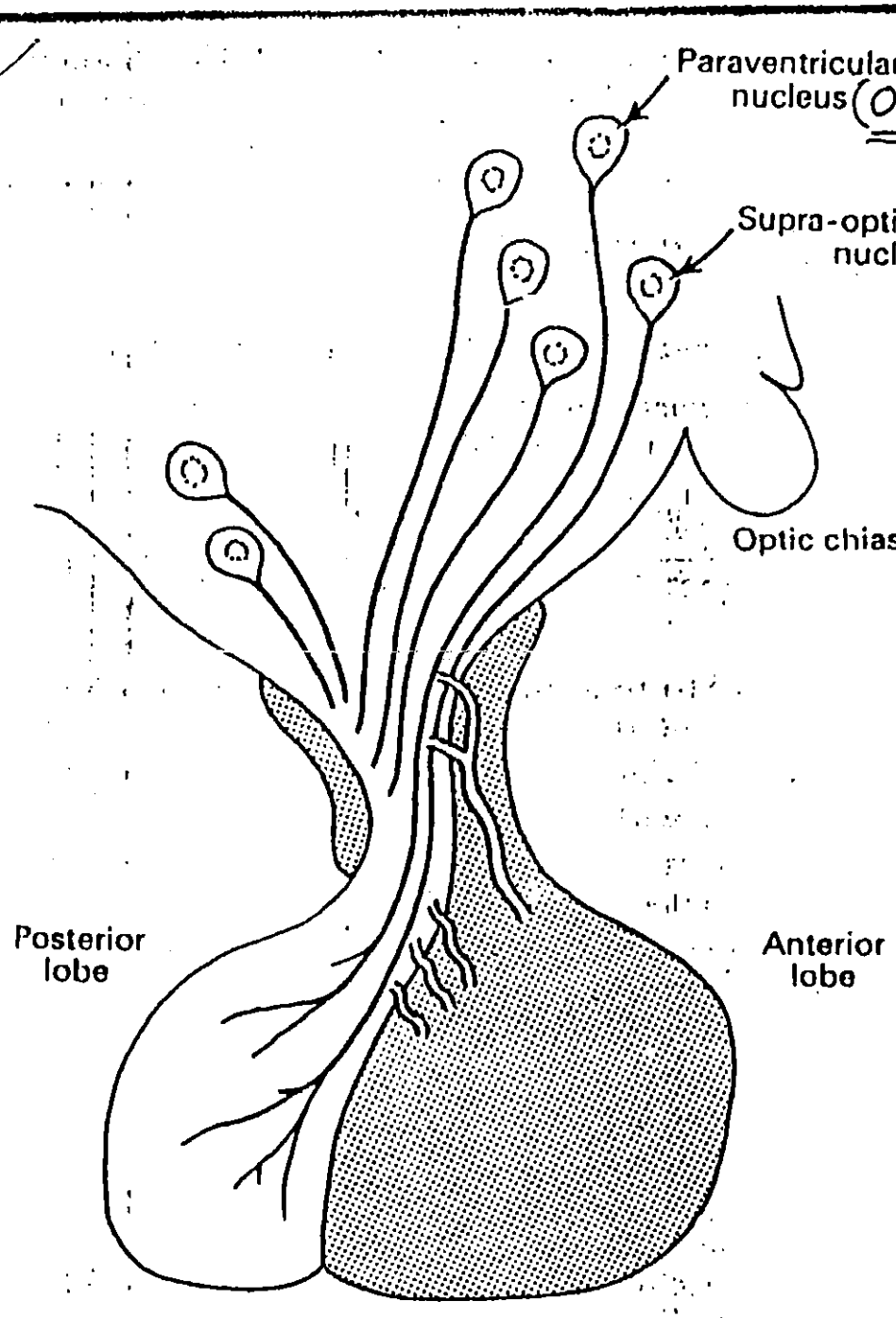


Fig. 28.7 The tracts from the hypothalamus to the pituitary. The paraventricular nucleus and the supra-optic nucleus are thought to be responsible for the elaboration of oxytocin and ADH respectively. The other tracts terminate in the capillary plexus shown in Figure 28.4 and carry the hypothalamic hormones which control the release of the hormones of the anterior pituitary.

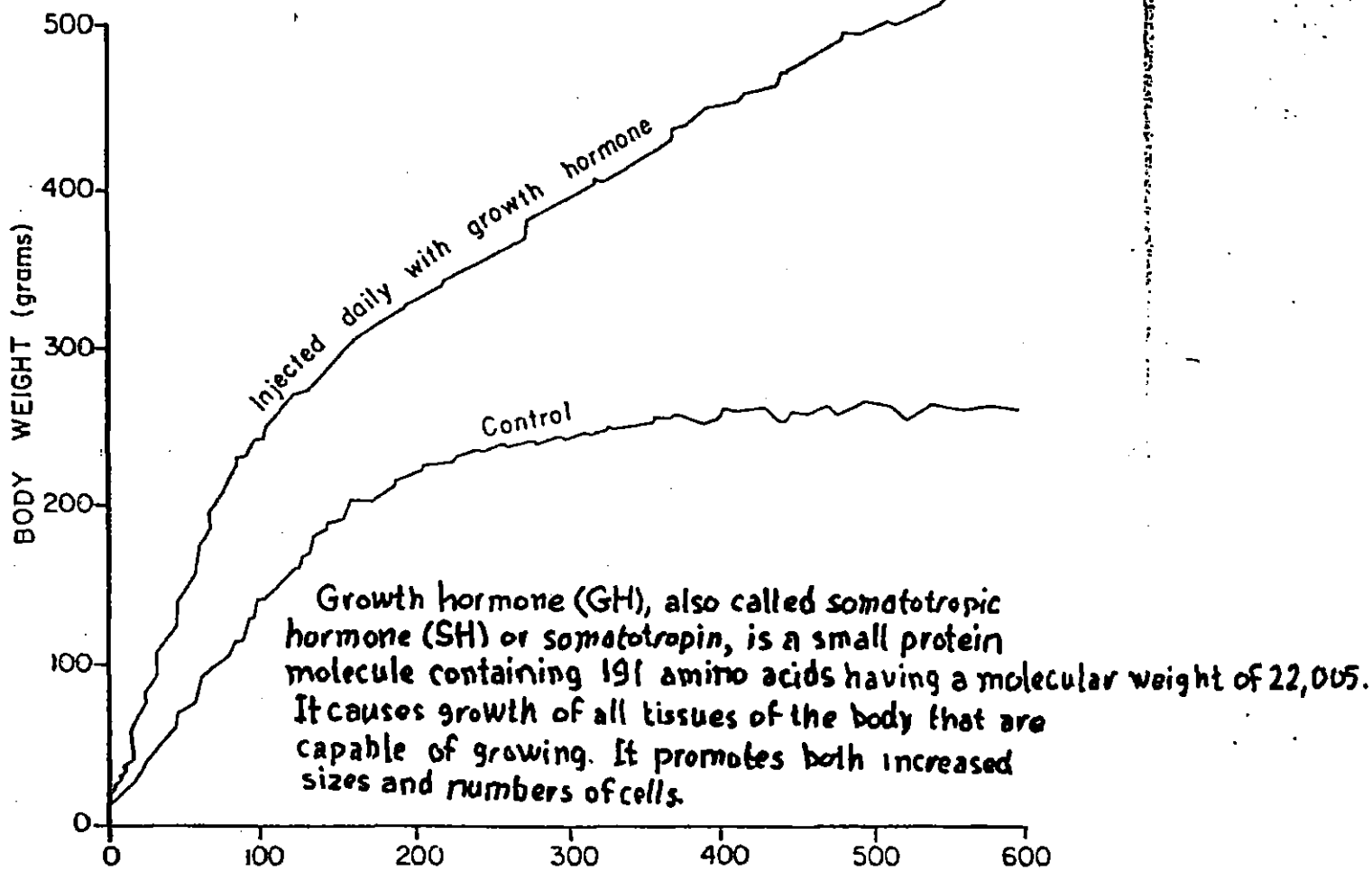
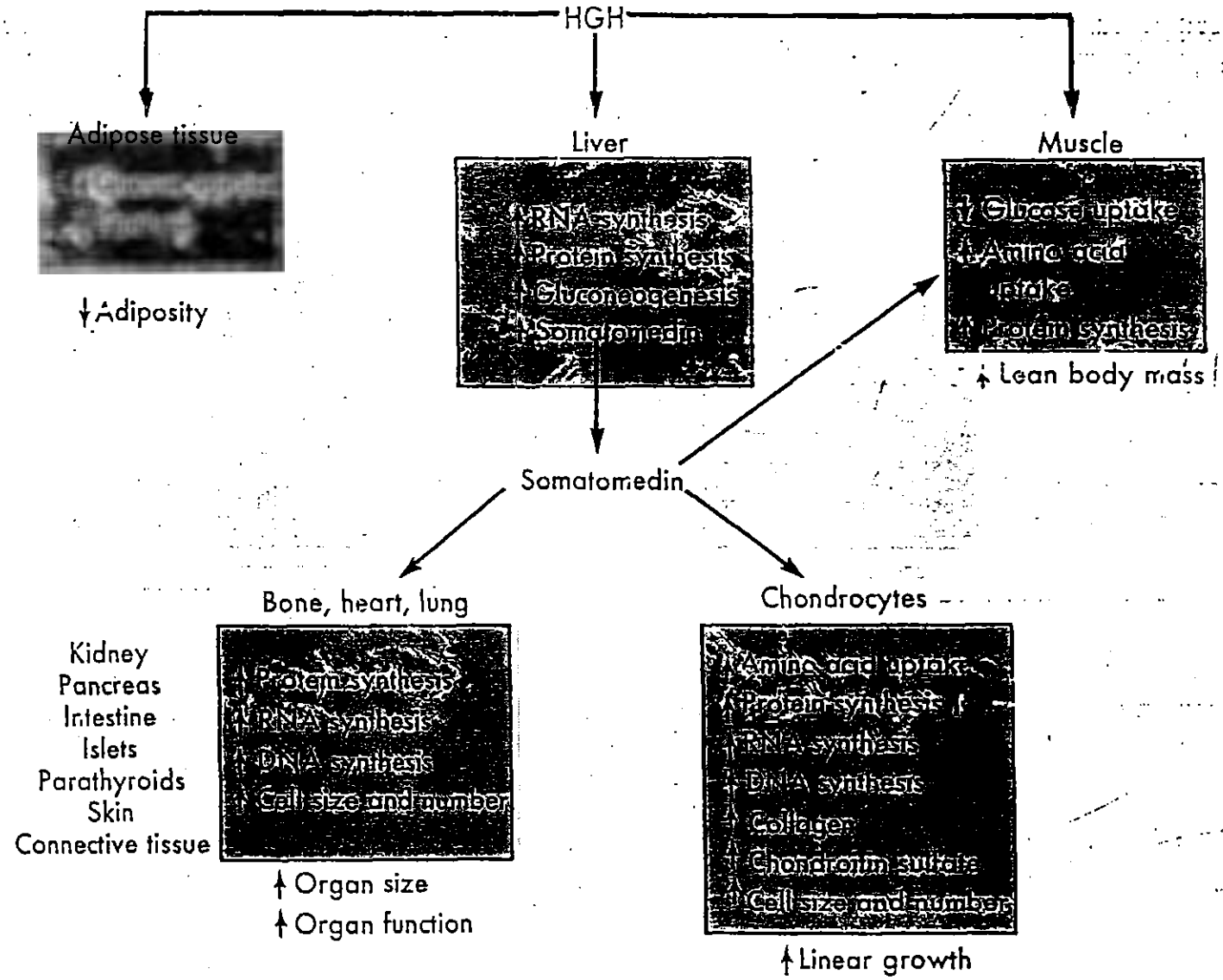


Figure 75–4. Comparison of weight gain of a rat injected daily with growth hormone with that of a normal rat.



■ **Fig. 48-21** Biological actions of GH. The effects on linear growth, organ size, and lean body mass are mediated by somatomedin produced in the liver.

EFFECT OF GH IN ENHANCING FAT UTILISATION, FOR ENERGY:

1) INCREASES THE RELEASE OF FATTY ACIDS FROM THE ADIPOSE TISSUE.

2) FATTY ACIDS CONCENTRATION INCREASES IN BODY FLUIDS.

3) IT ENHANCES THE CONVERSION OF FATTY ACIDS INTO ACETYL- C O A., WITH THE SUBSEQUENT UTILISATION FOR ENERGY.

4) IN THIS CASE SPARE THE PROTEIN

5) UNDER THE EFFECT OF GH THE MOBILISATION OF FAT REQUIRES MINUTES TO HOURS, WHERE AS PROTEIN SYNTHESIS CAN BEGIN IN MINUTES.

6) UNDER THE EXCESSIVE OF GH GREAT AMOUNT OF FAT MOBILISED, THEREFORE A LOT OF ACETOACETIC ACIDS ARE FORMED BY THE LIVER AND RELEASED INTO THE BODY FLUIDS, THUS CAUSING (KETOSIS). WHICH IS CALLED "KETOGENIC EFFECT" OF GH.

⊛ DIABETOGENIC EFFECT OF GH.

1) WE HAVE ALREADY MENTIONED THAT GH INCREASES BLOOD GLUCOSE CONCENTRATION.

2) IN ADDITION GH MAY HAVE A DIRECT EFFECT ON BETA-CELLS.

3) IN THESE CASES PANCREAS OVER STIMULATED AND THE CELLS FINALLY, BURN OUT.

4) WHEN THIS OCCURS THE PERSON DEVELOPS DIABETES MELLITUS.

5) THEREFORE IS SAID GH HAS DIABETOGENIC EFFECT.

Diabetogenic Effects of Other Anterior Pituitary Hormones. Growth hormone is not the only anterior pituitary hormone that increases the blood glucose concentration. At least three others can do the same: adrenocorticotropin, thyroid-stimulating hormone, and prolactin. Especially important is adrenocorticotropin, which increases the rate of cortisol secretion by the adrenal cortex. Cortisol then increases the blood glucose concentration by increasing the rate of gluconeogenesis. This effect, quantitatively, is probably equally as diabetogenic as the effect of growth hormone.

1) TSH
2) Prolactin
3) ACTH^{+++}
↓
Cortisol
↓
gluconeogenesis

Growth hormone is secreted in a pulsatile pattern, increasing and decreasing. The precise mechanisms that control secretion of growth hormone are not fully understood, but several factors related to a person's state of nutrition or stress are known to stimulate secretion:

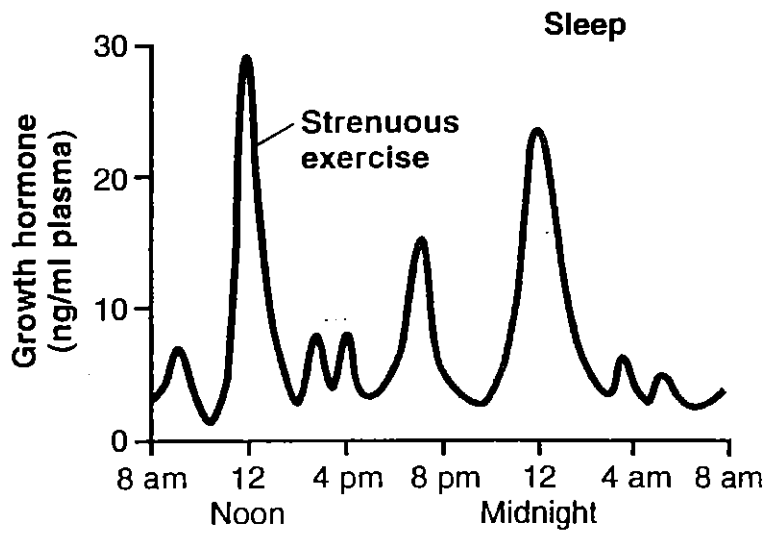


Figure 75-6 Typical variations in growth hormone secretion throughout the day, demonstrating the especially powerful effect of strenuous exercise and also the high rate of growth hormone secretion that occurs during the first few hours of deep sleep.

Table 75-3 Factors That Stimulate or Inhibit Secretion of Growth Hormone

Stimulate Growth Hormone Secretion	Inhibit Growth Hormone Secretion
Decreased blood glucose	Increased blood glucose
Decreased blood free fatty acids	Increased blood free fatty acids
Increased blood amino acids (arginine)	Aging
Starvation or fasting, protein deficiency	Obesity
Trauma, stress, excitement	Growth hormone inhibitory hormone (somatostatin)
Exercise	Growth hormone (exogenous)
Testosterone, estrogen	Somatomedins (insulin-like growth factors)
Deep sleep (stages II and IV)	
Growth hormone–releasing hormone	
Ghrelin	

● *ghrelin,* a hormone secreted by the stomach before meals.

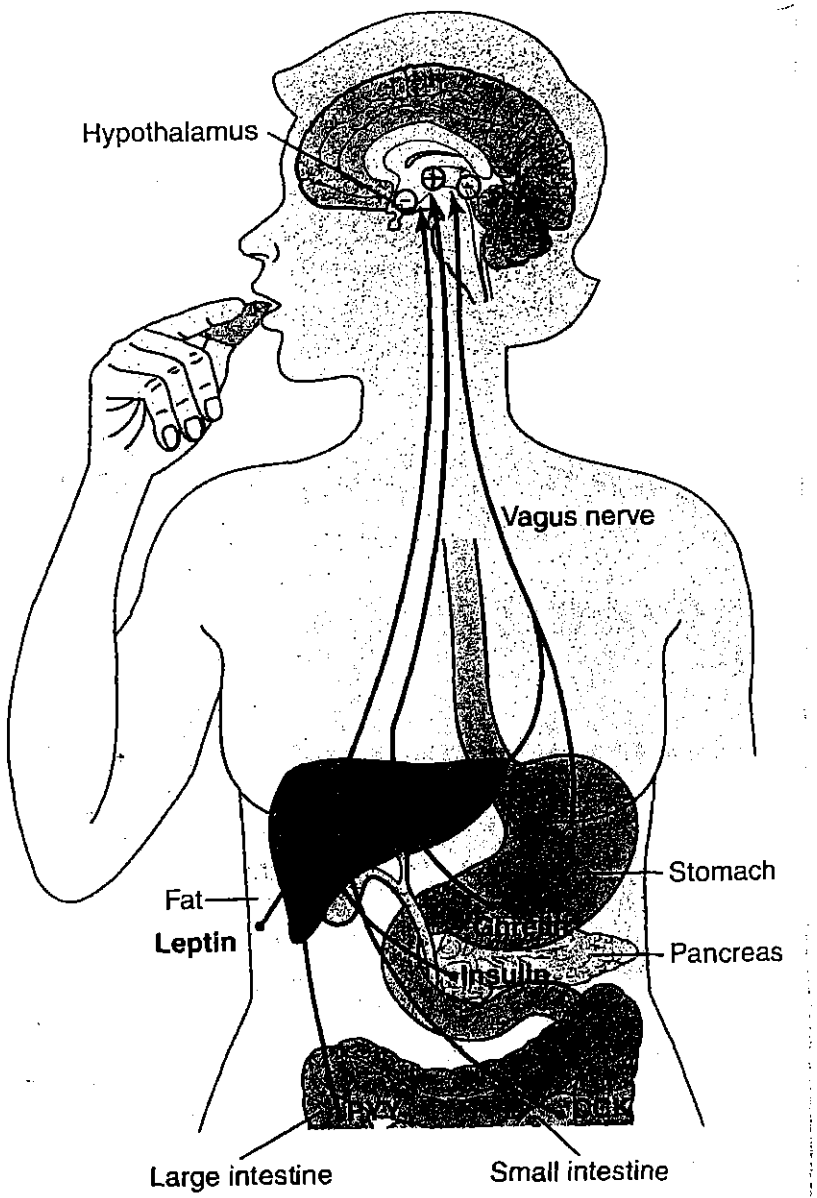


Figure 71-1 Feedback mechanisms for control of food intake. Stretch receptors in the stomach activate sensory afferent pathways in the vagus nerve and inhibit food intake. Peptide YY (*PYY*), cholecystokinin (*CCK*), and insulin are gastrointestinal hormones that are released by the ingestion of food and suppress further feeding. Ghrelin is released by the stomach, especially during fasting, and stimulates appetite. Leptin is a hormone produced in increasing amounts by fat cells as they increase in size; it inhibits food intake.

Ghrelin—a Gastrointestinal Hormone—Increases Feeding. *Ghrelin* is a hormone released mainly by the oxyntic cells of the stomach but also, to a much less extent, by the intestine. Blood levels of ghrelin rise during fasting, peak just before eating, and then fall rapidly after a meal, suggesting a possible role in stimulating feeding. Also, administration of ghrelin increases food intake in experimental animals, further supporting the possibility that it may be an orexigenic hormone. However, its physiologic role in humans is still uncertain.