# Hypothalamus & pituitary gland

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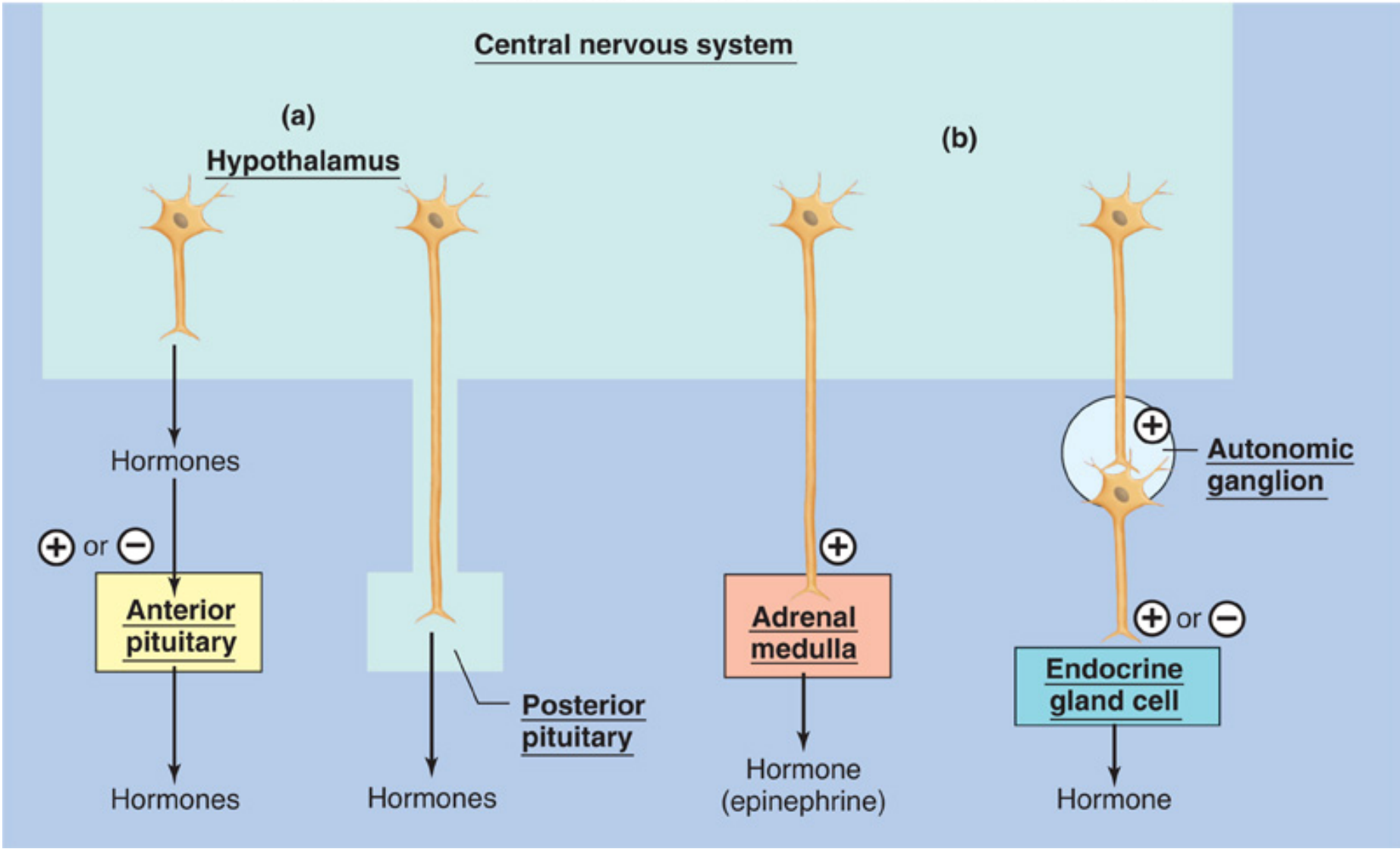


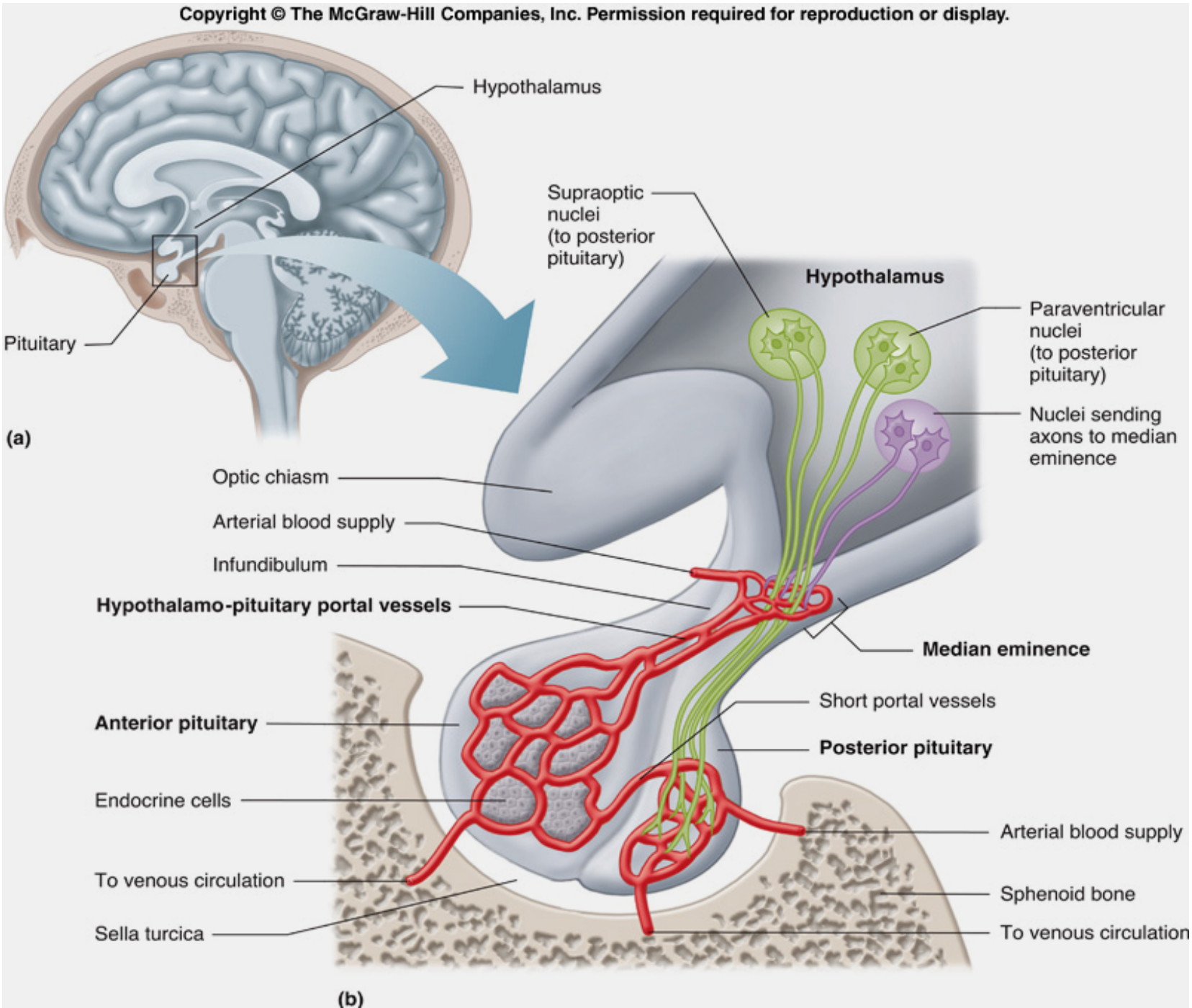
# Hypothalamus

- **Contains neural centers for hunger, thirst, and body temperature.**
- **Contributes to the regulation of sleep, wakefulness, emotions, etc**
- **Stimulates hormonal release from anterior pituitary.**
- **Produces anti-diuretic hormone (ADH) and oxytocin.**
- **Coordinates sympathetic and parasympathetic reflexes.**

# Hypothalamus

- **Secretes releasing & inhibiting hormones that regulate release of hormones from anterior pituitary**
- **Function as tropic* hormones to either stimulate or inhibit release of anterior pituitary hormones**
- ***5 releasing hormones and 2 inhibiting hormones* that regulate the glandular cells in the anterior pituitary**

***hormone that stimulates the secretion of another hormone, and often the growth of hormone-secreting gland**



# Structure of the Pituitary Gland

- **Two distinct lobes**
  - **Anterior pituitary**
    **(adenohypophysis; pars distalis)**
    - **true endocrine tissue**
    - **secretes classic hormones**
  - **Posterior pituitary**
    **(neurohypophysis; pars nervosa)**
    - **neural tissue**
    - **secretes neurohormones**

# Relationship between the hypothalamus and the pituitary

- **The cells in the anterior pituitary are the target cells of the neurotransmitters secreted by the hypothalamic neurons (neuroendocrine) which have a stimulatory or inhibitory effect on the anterior pituitary cells.**

# Cont'd

- **This *Hypothalamic – pituitary portal system (or* hypophyseal portal system) acts as a one way chemical messenger system between the hypothalamus and anterior pituitary gland**
- **The anterior pituitary then reacts to these chemical signals by either *increasing* or *decreasing* the release of hormones that affect other cells in the body**

# Hypophyseal portal system:

- **A network of blood vessels that delivers hormones to anterior pituitary from hypothalamus**

# Anterior versus Posterior

- **Structural difference:**

- **the anterior pituitary is made up of secretory cells within a glandular epithelium.**
- **the posterior pituitary consists largely of nerve fibers and neuroglial* cells**

*** Specialised cells that surround neurons, providing mechanical and physical support and electrical insulation between neurons**

# HYPOTHALMUS/PITUITARY.

1. **Control of anterior pituitary.**

**(Humoral)**

**neurons in hypothalamus**

↓

**release of releasing/inhibiting hormones**
**(at median eminence)**

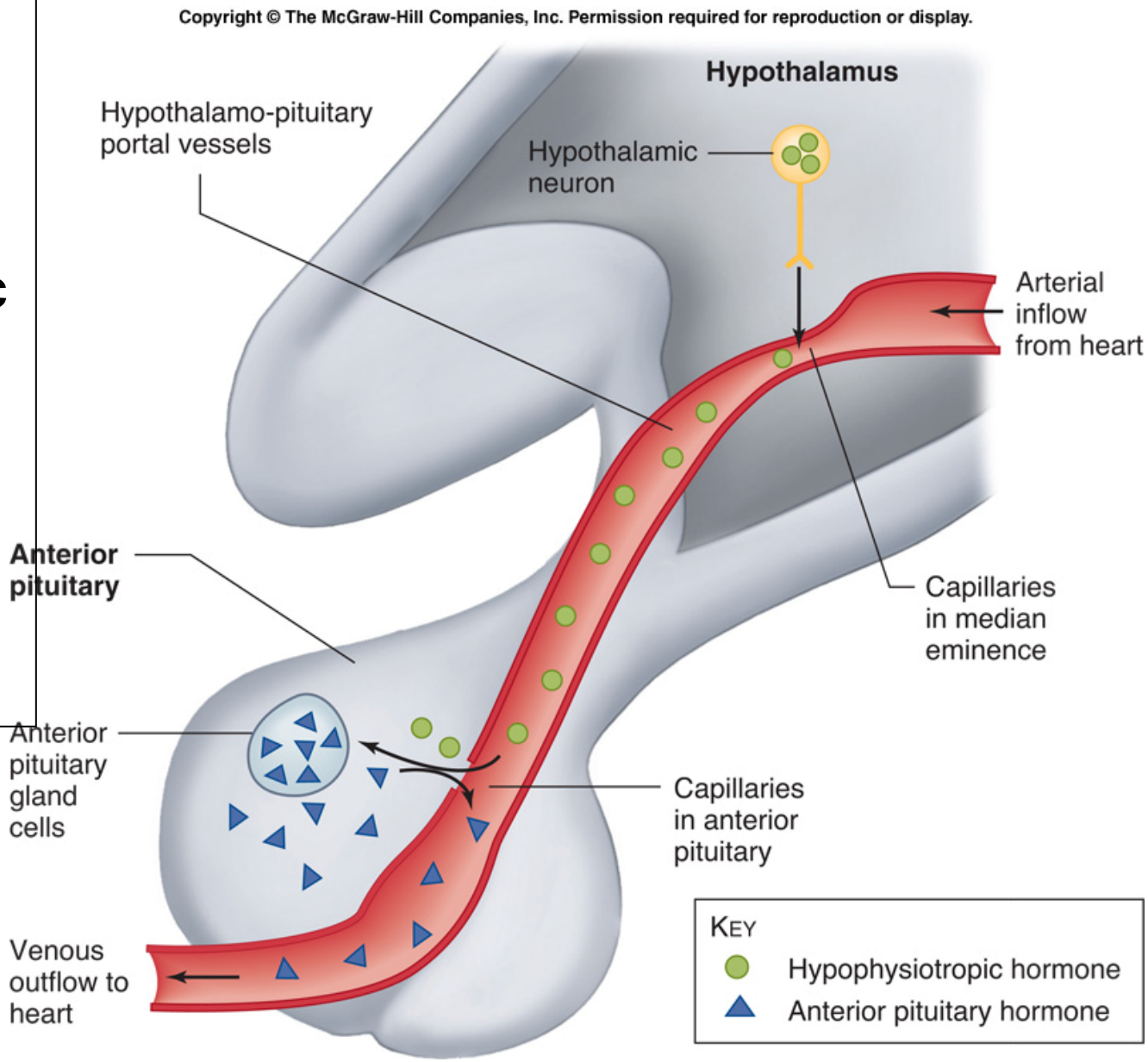
↓

**Portal Blood**

↓

**Anterior pituitary**
**(true endocrine)**

**Hormone from the anterior pituitary is controlled by the hypophysiotropic hormone (from the hypothalamic neurons) and reaching the ant. pituitary by the portal systems**



## 2. Control of posterior pituitary. (neural)

**Action potential in the hypothalamus**

↓

**nerve fibres (Nerve Tract)**

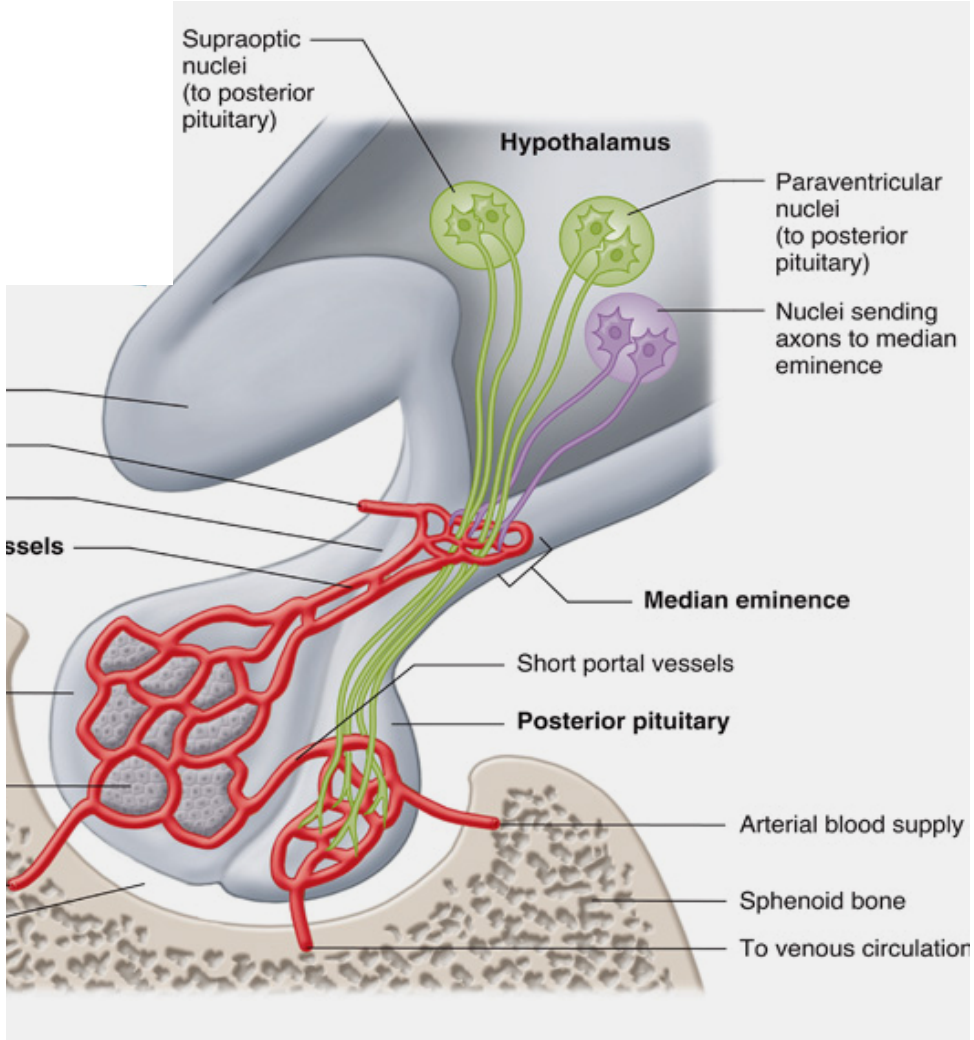
↓

**posterior pituitary (store and secrete)**

**Enclosed in small vesicles, the hormone moves down the neural axons to accumulate at the axon terminals in the posterior pituitary**

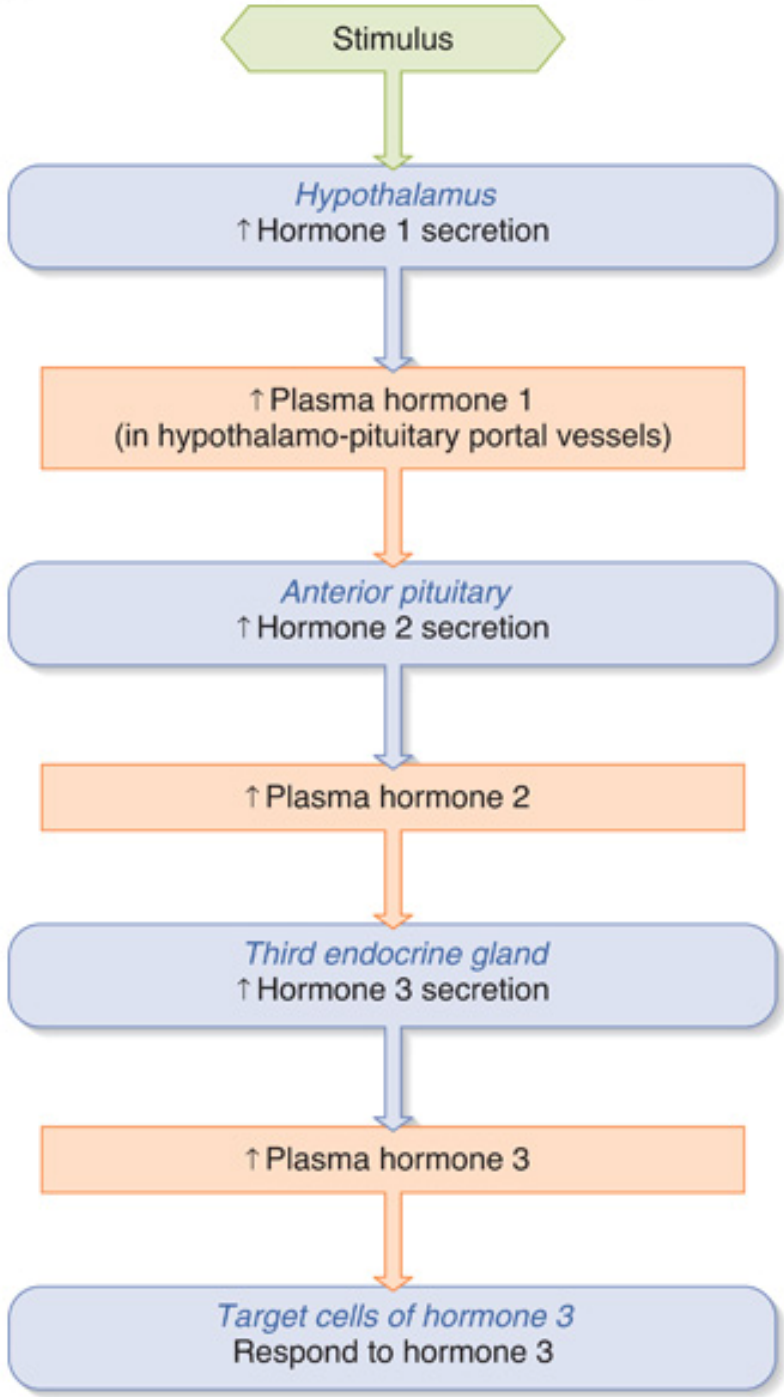
**Stimuli (e.g. neurotransmitters) generate action potential in the neurons**

**These action potential propagate to the axon terminals and trigger the release of the hormone by exocytosis**

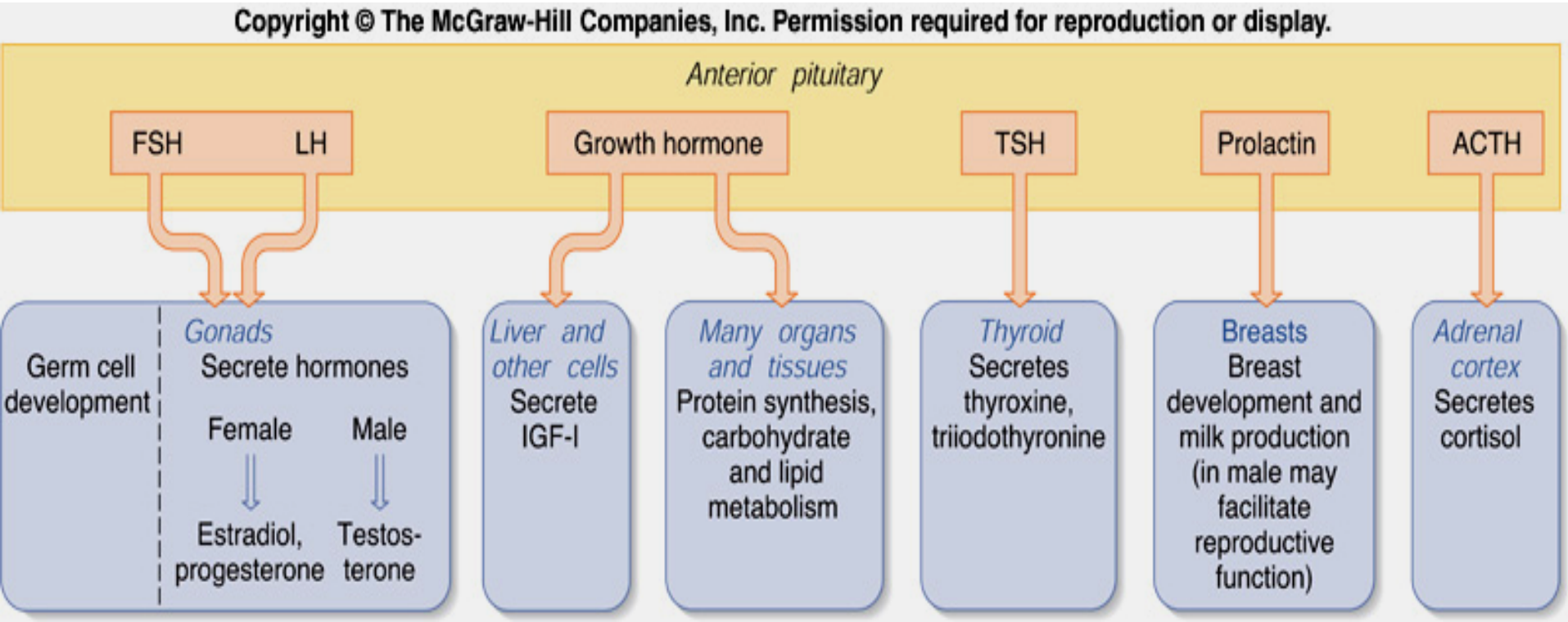


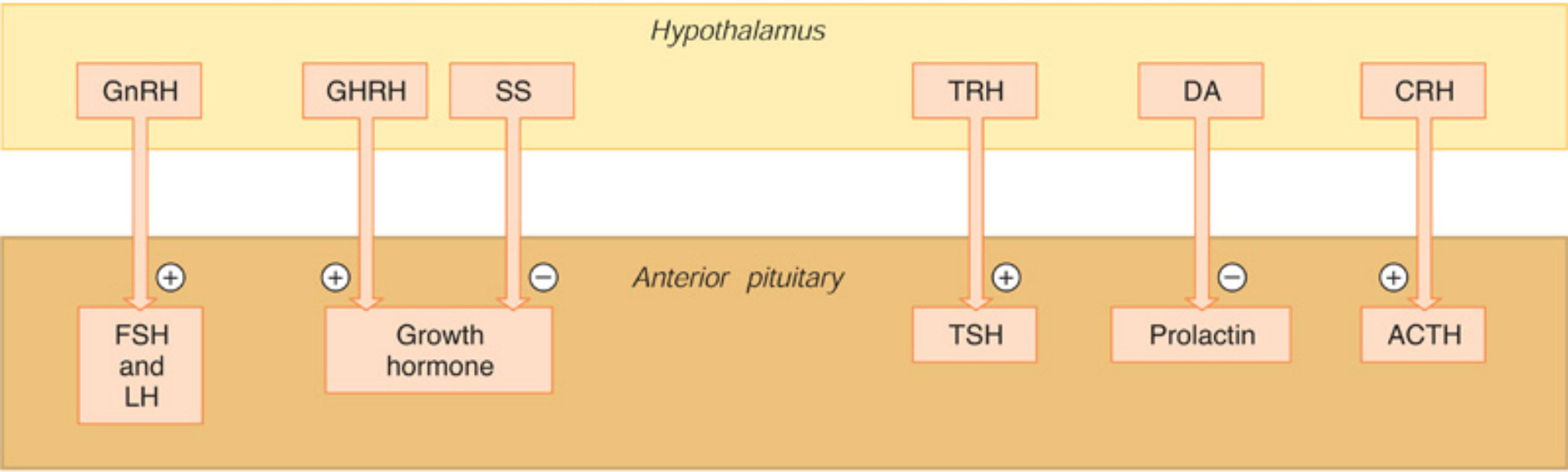
**Typical sequence of events leading from the hypophysiotropic hormone (hormone 1) controls the secretion of hormone 2, which in turn affects the secretion of a hormone by a third endocrine gland (hormone 3).**





# Targets and major functions of the 6 classical anterior pituitary hormones

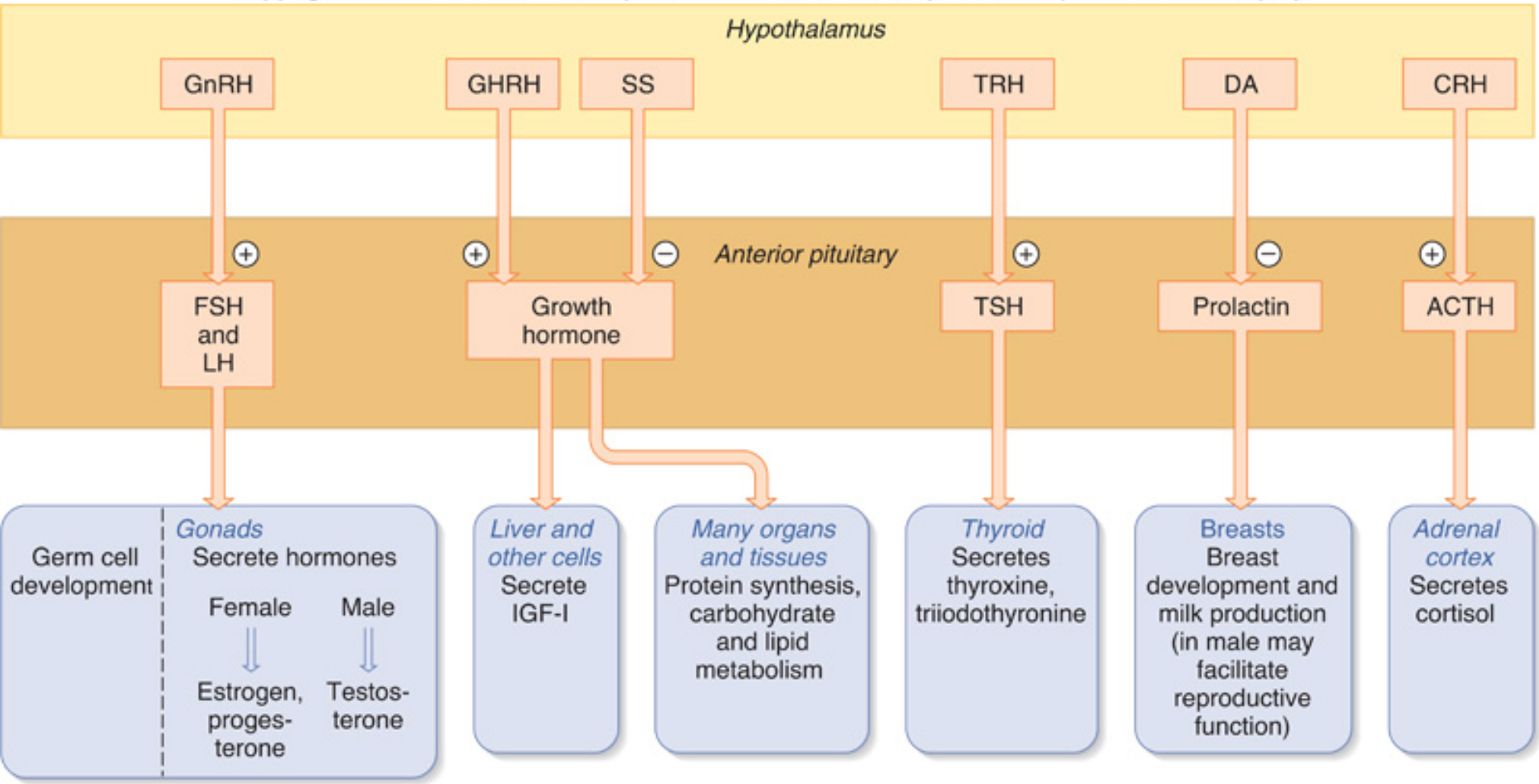





| Major known hypophysiotropic hormones | Major effect on anterior pituitary |
|---|---|
| Corticotropin-releasing hormone (CRH) | Stimulates secretion of ACTH |
| Thyrotropin-releasing hormone (TRH)* | Stimulates secretion of TSH |
| Growth hormone-releasing hormone (GHRH) | Stimulates secretion of GH |
| Somatostatin (SS) | Inhibits secretion of GH |
| Gonadotropin-releasing hormone (GnRH) | Stimulates secretion of LH and FSH |
| Dopamine (DA)‡ | Inhibits secretion of prolactin |

*TRH can also stimulate the release of prolactin, but whether this occurs physiologically is unclear.

‡Dopamine is a catecholamine; all the other hypophysiotropic hormones are peptides.



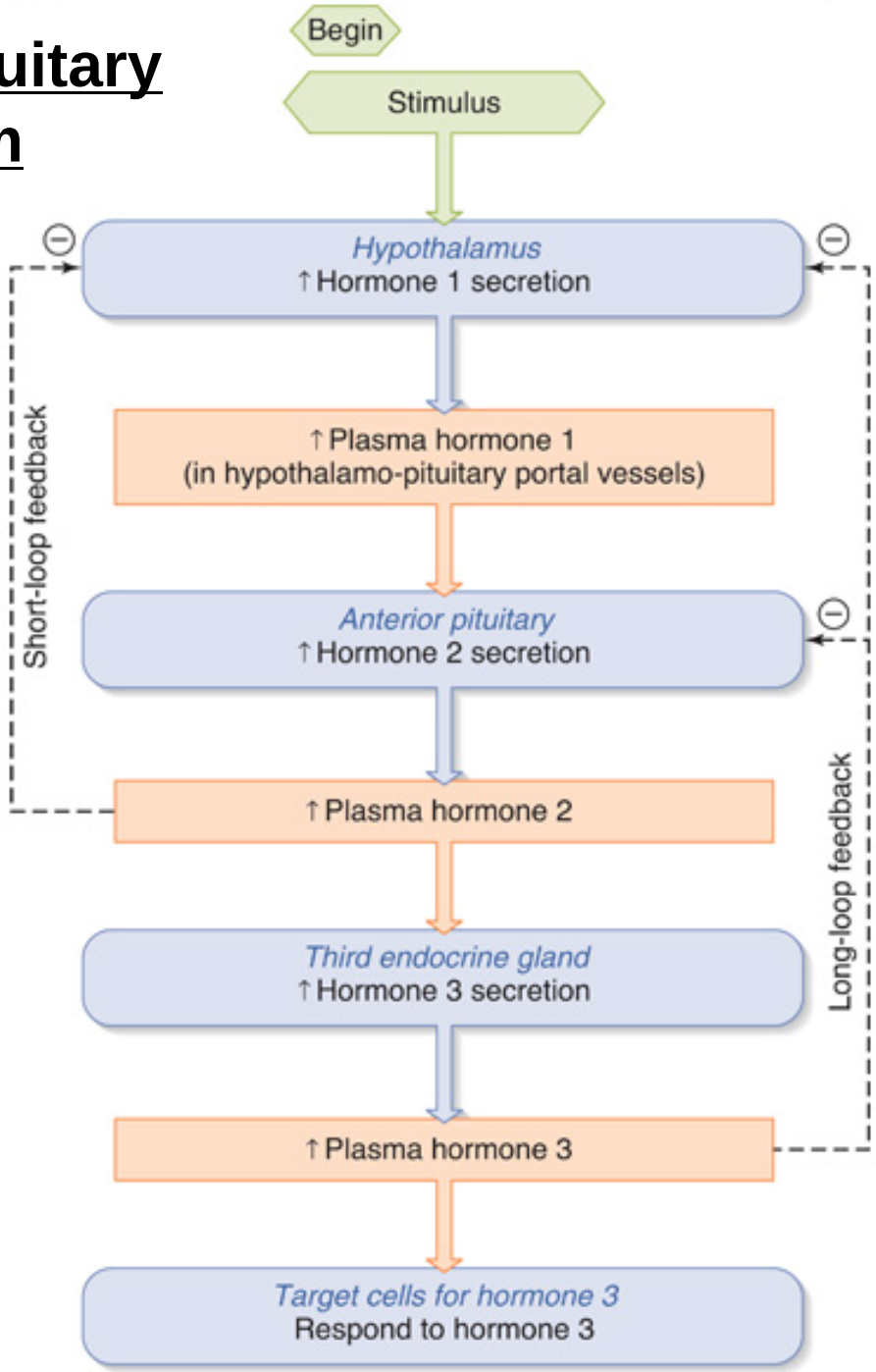
# Regulation of hypothalamic and pituitary hormones

- **Control over the hypothalamic and pituitary hormones is achieved by *positive* and *negative feedback loops*.**

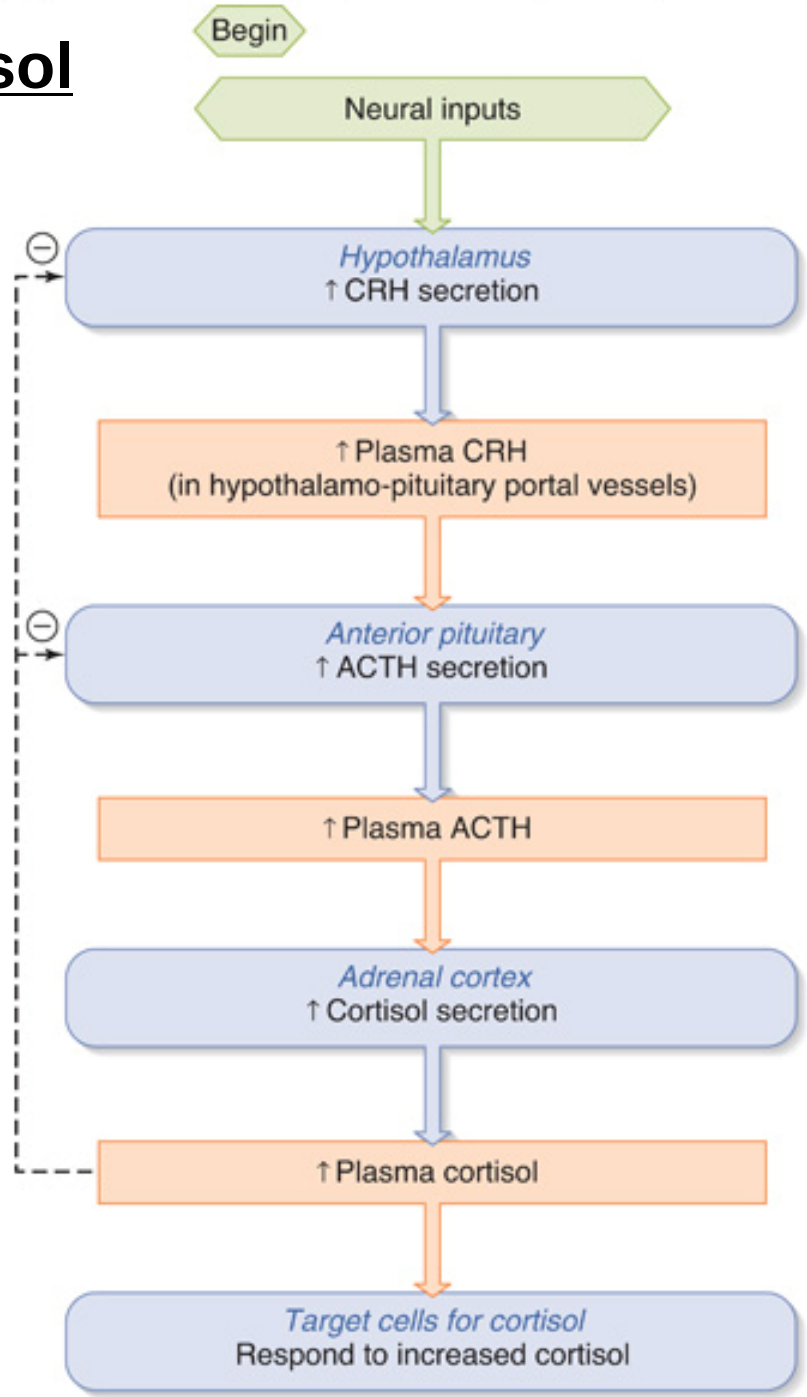
# Long loop *versus* short loop feedback

- ***Short loop*** **– influence of hypothalamus by an anterior pituitary hormone**
- ***Long loop*** **– inhibition of anterior pituitary and/or hypothalamus by hormone secreted by third endocrine gland**

# Hypothalmic-pituitary feedback system



# CRH-ACTH-Cortisol System



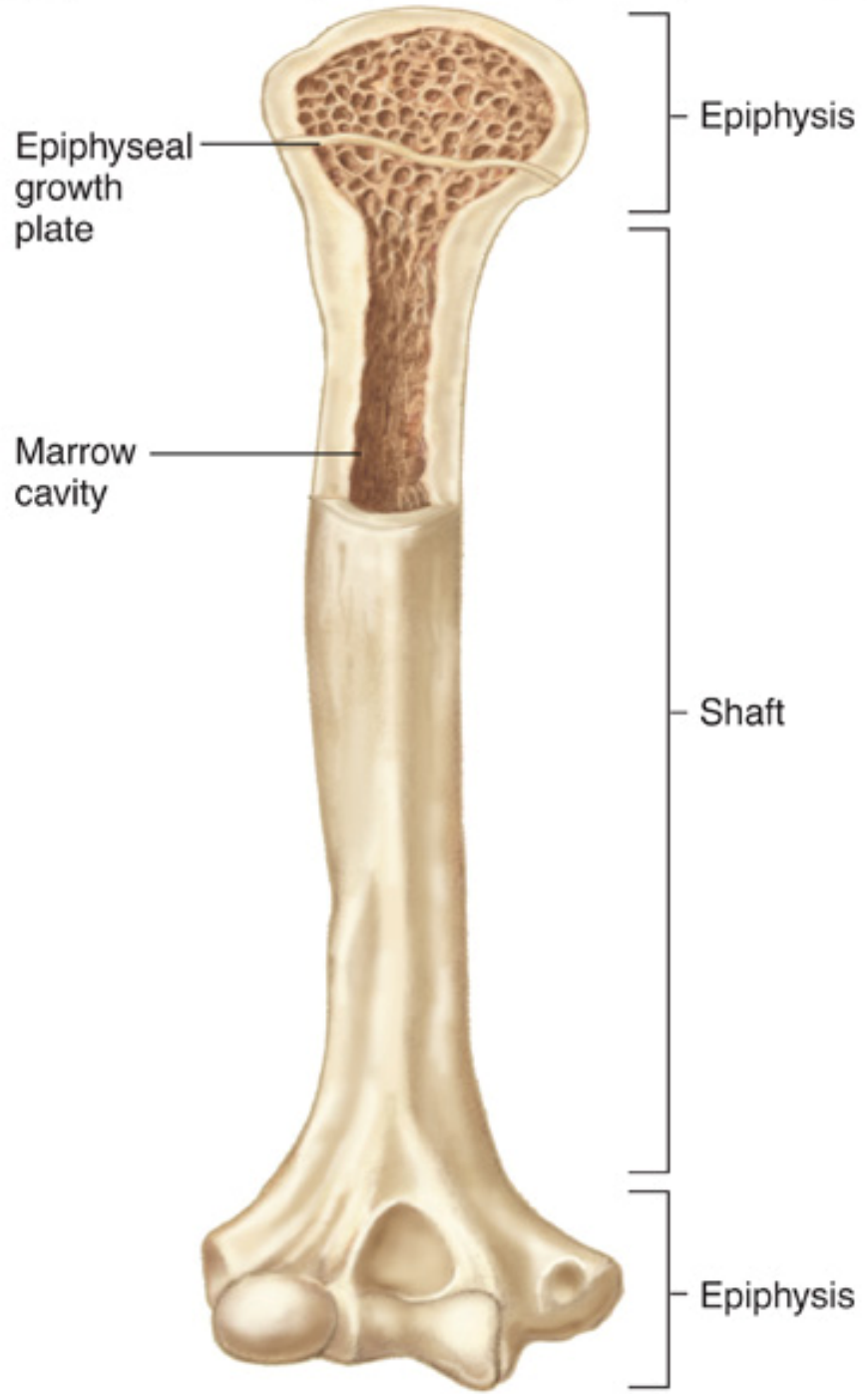
# Growth hormone

- The primary physiological effects of GH are to stimulate bone growth and protein anabolism
- Has little or no effect on fetal growth (embryo and fetus)
- Most important for postnatal growth
- Major growth promoting effect via stimulation of cell division in many target tissues

e.g. promotes bone lengthening by stimulating maturation and cell division of the chondrocytes in the epiphyseal plate

- A plate of actively proliferating cartilage
- Osteoblast, the bone-building cells at the shaft edge of the plate, convert the cartilage tissue at this edge to bone
- Chondrocytes lay down new cartilage in the interior of the plate
- Therefore, the epiphyseal plate is gradually pushed away from the centre of the bony shaft as the shaft lengthens





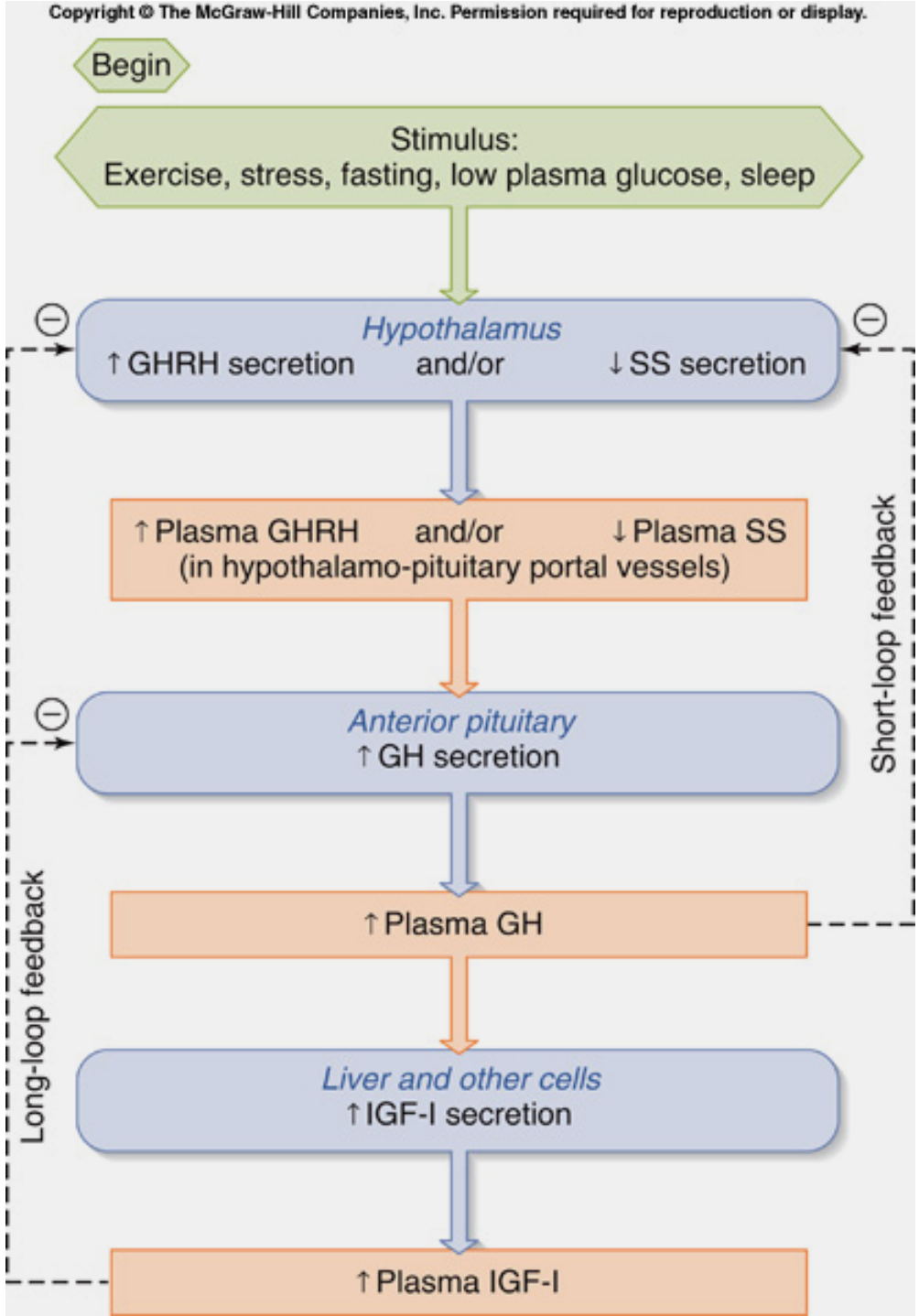
# Diurnal rhythm

- GH secretion occurs in episodic bursts and exhibits diurnal rhythm
- During most of the day, little or no GH is secreted, although bursts can be elicited by certain stimuli such as stress, hypoglycaemia, and exercise
- In 1 to 2 hours after a person falls asleep, one or larger, prolonged bursts of secretion may occur

- GH exerts its cell division-stimulating (mitogenic) effect indirectly through insulin-like growth factor I(IGF-I)
- Under the influence of GH, IGF-I is secreted by the liver, enters the blood and acts as a hormone

# TABLE 11–5 *Major Effects of Growth Hormone*

1. Promotes growth: Induces precursor cells in bone and other tissues to differentiate and secrete insulin-like growth factor I (IGF-I), which stimulates cell division. Also stimulates liver to secrete IGF-I.
2. Stimulates protein synthesis, predominantly in muscle.
3. Anti-insulin effects:
   a. Renders adipocytes more responsive to lipolytic stimuli.
   b. Stimulates gluconeogenesis.
   c. Reduces the ability of insulin to stimulate glucose uptake by cells.



- In addition to the hypothalamus, a number of hormones (sex hormones, insulin and TH) influence the secretion of GH
- **Net effect is:** GH secretion is highest during adolescence, next highest in children and lowest in adults
- The decreased GH secretion associated with aging is responsible, in part, for the decrease in lean body and bone mass, the expansion of adipose tissue, and the thinning of the skin that occur as people age

| HORMONE | PRINCIPAL ACTIONS |
|---|---|
| Growth hormone | Major stimulus of postnatal growth: Induces precursor cells to differentiate and secrete insulin-like growth factor I (IGF-I), which stimulates cell division |
| | Stimulates liver to secrete IGF-I |
| | Stimulates protein synthesis |
| Insulin | Stimulates fetal growth |
| | Stimulates postnatal growth by stimulating secretion of IGF-I |
| | Stimulates protein synthesis |
| Thyroid hormones | Permissive for growth hormone's secretion and actions |
| | Permissive for development of the central nervous system |
| Testosterone | Stimulates growth at puberty, in large part by stimulating the secretion of growth hormone |
| | Causes eventual epiphyseal closure |
| | Stimulates protein synthesis in male |
| Estrogen | Stimulates the secretion of growth hormone at puberty |
| | Causes eventual epiphyseal closure |
| Cortisol | Inhibits growth |
| | Stimulates protein catabolism |

**Epiphseal- a part of a *long bone* where bone growth occurs from**

# Acromegaly and gigantism

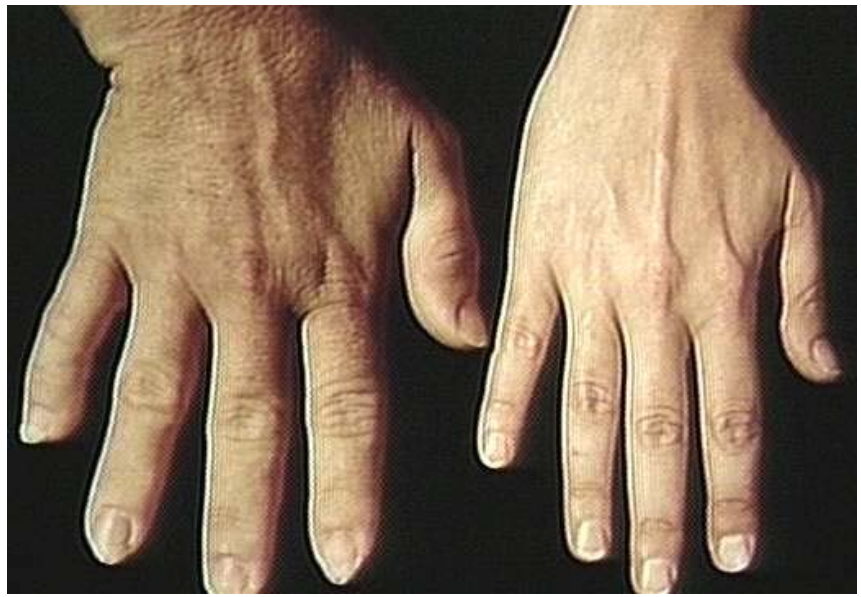
- Happens when there is an excessive GH secretion
- Usually caused by tumors in the ant. Pituitary gland
- If the tumor arises before puberty when the epiphyseal plates are still open, then the individual will develop gigantism (“pituitary giant”)
- If it arises after puberty when linear growth is no longer possible, this is called acromegaly

# In childhood leads to GIGANTISM

**Gigantism is a condition where there is over-production of growth hormone by the pituitary gland in a child before the bone growth plates close, resulting in excessive long bone growth**

# In adulthood leads to ACROMEGALY

GH results in thickening of many bones in the body, most noticeably in the hands, feet and head and metabolic derangement



The jaw enlarges to give the characteristic facial appearance (prognathism)

Many internal organs notably the heart also become enlarged and this can interfere with their ability to function normally

(a)

(b)

(c)

- Because of the metabolic functions (↑glucose and FA level) of GH, in acromegaly, GH levels are always elevated
- Thus acromegaly is also associated with elevated plasma levels of glucose and fatty acids, similar to the level of diabetes

- Treatment of gigantism and acromegaly usually requires surgical removal of the pituitary tumor
- Alternatively, treatment with long-acting analogs of somatostatin (inhibits GH secretion) is necessary

# Posterior pituitary (Neurohypophysis)

Receives & stores hormones from hypothalamus for later release

1. Oxytocin: produced by paraventricular nucleus of hypothalamus; stimulates uterine contraction during childbirth & milk ejection during nursing

2. Antidiuretic hormone (ADH): produced by supraoptic nucleus of hypothalamus; stimulates kidney tubules to retain water

# Posterior pituitary hormones.

1. **ADH (vasopressin)**

   **Actions:- anti-diuretic (kidney)**
   **increase blood pressure**
   **(vasoconstriction)**

   **Regulation:-**

   **↑ osmolality → ↑ secretion**
   **↑ blood volume → ↓secretion**
   **(atrial receptors)**

# Oxytocin.

**Actions:- milk ejection**
**uterine contraction**

**Regulation:-**

**Neuroendocrine reflex**
**e.g. suckling**

**Positive feed-back**