PHYSIOLOGY LECTURE

Endocrinology

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Anatomy

- The pituitary gland is suspended from hypothalamus by a stalk—**infundibulum**
- Location and size
  - Housed in **sella turcica of sphenoid bone**
  - Size and shape of kidney bean
- Composed of two structures with independent origins and separate functions
  - **Adenohypophysis** (anterior pituitary)
    - Arises from hypophyseal pouch (outgrowth of pharynx)
  - **Neurohypophysis** (posterior pituitary)
    - Downgrowth from brain

Embryonic Development

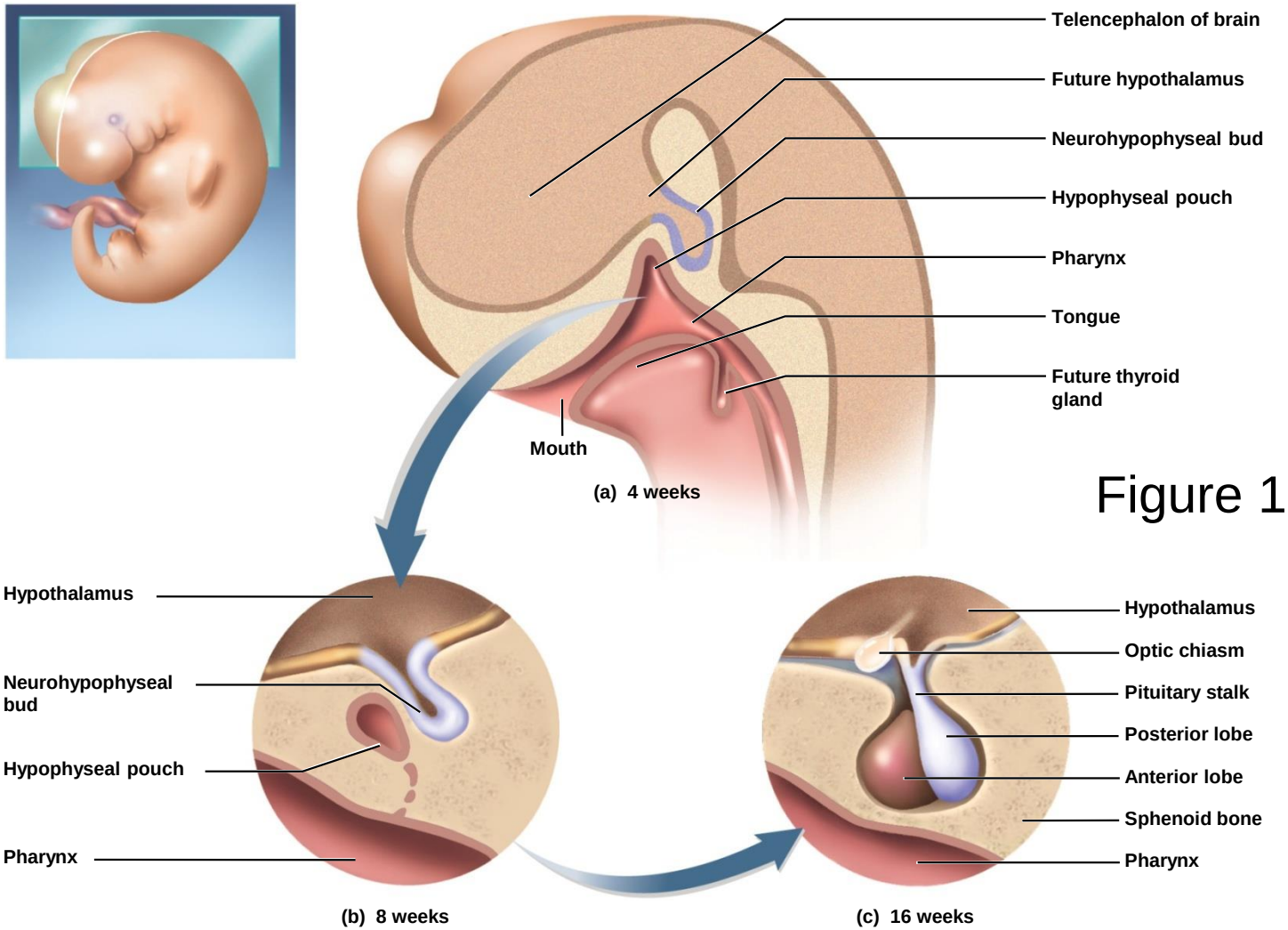

Figure 17.3a–c

Anatomy

- **Adenohypophysis** constitutes anterior three-quarters of pituitary
  - Has two segments
    - Anterior lobe (pars distalis)
    - Pars tuberalis—small mass of cells adhering to stalk
  - Linked to hypothalamus by **hypophyseal portal system**
    - Primary capillaries in hypothalamus connected to secondary capillaries in adenohypophysis by portal venules
    - Hypothalamic hormones regulate adenohypophysis cells

Anatomy

- **Neurohypophysis** constitutes the posterior one-quarter of the pituitary
- Three parts
  - Median eminence, infundibulum, and the posterior lobe (pars nervosa)
- Nerve tissue, not a true gland
  - Nerve cell bodies in hypothalamus pass down the stalk as **hypothalamo–hypophyseal tract** and end in posterior lobe
  - Hypothalamic neurons secrete hormones that are stored in neurohypophysis until released into blood

Anatomy

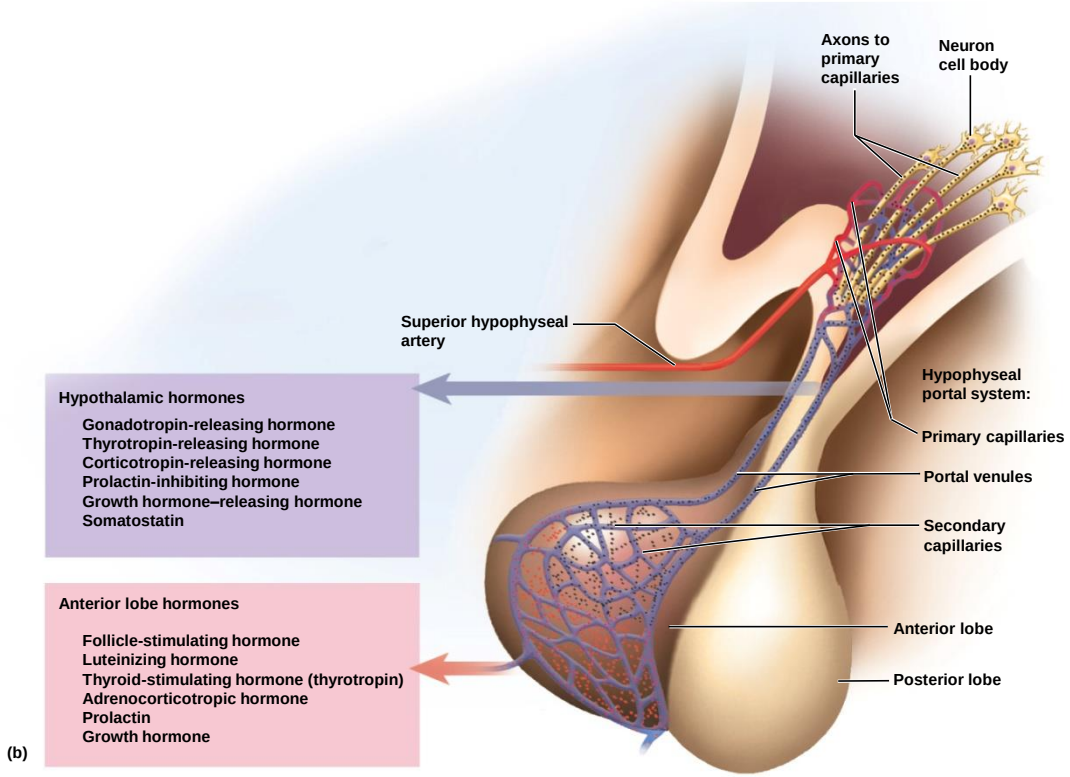

Figure 17.4b

- Hypothalamic-releasing and -inhibiting hormones travel in hypophyseal portal system from hypothalamus to anterior pituitary
- Hormones secreted by anterior pituitary

Hypothalamic Hormones

- Eight hormones produced in hypothalamus
  - Six regulate the anterior pituitary
  - Two are released into capillaries in the posterior pituitary when hypothalamic neurons are stimulated (oxytocin and antidiuretic hormone)
- **Six releasing** and **inhibiting hormones** stimulate or inhibit the anterior pituitary
  - TRH, CRH, GnRH, and GHRH are releasing hormones that affect anterior pituitary secretion of TSH, PRL, ACTH, FSH, LH, and GH
  - PIH inhibits secretion of prolactin, and somatostatin inhibits secretion growth hormone and thyroid-stimulating hormone by the anterior pituitary

Hypothalamic Hormones

- **Two** other hypothalamic hormones are **oxytocin (OT)** and **antidiuretic hormone (ADH)**
  - Both stored and released by posterior pituitary
  - Right and left **paraventricular nuclei** produce OT
  - **Supraoptic nuclei** produce ADH
  - Posterior pituitary does not synthesize them

Anterior Pituitary Hormones

- Anterior lobe of the pituitary synthesizes and secretes **six principal hormones**

- **Two gonadotropin hormones** that target gonads
  - **Follicle-stimulating hormone (FSH)**
    - Stimulates secretion of ovarian sex hormones, development of ovarian follicles, and sperm production
  - **Luteinizing hormone (LH)**
    - Stimulates ovulation, stimulates corpus luteum to secrete progesterone, stimulates testes to secrete testosterone

- **Thyroid-stimulating hormone (TSH)**
  - Stimulates secretion of thyroid hormone

Anterior Pituitary Hormones

Cont.

- **Adrenocorticotropic hormone (ACTH)**
  - Stimulates adrenal cortex to secrete glucocorticoids
- **Prolactin (PRL)**
  - After birth, stimulates mammary glands to synthesize milk; enhances secretion of testosterone by testes
- **Growth hormone (GH)**
  - Stimulates mitosis and cellular differentiation

Hypothalamo–Pituitary–Target Organ Relationships

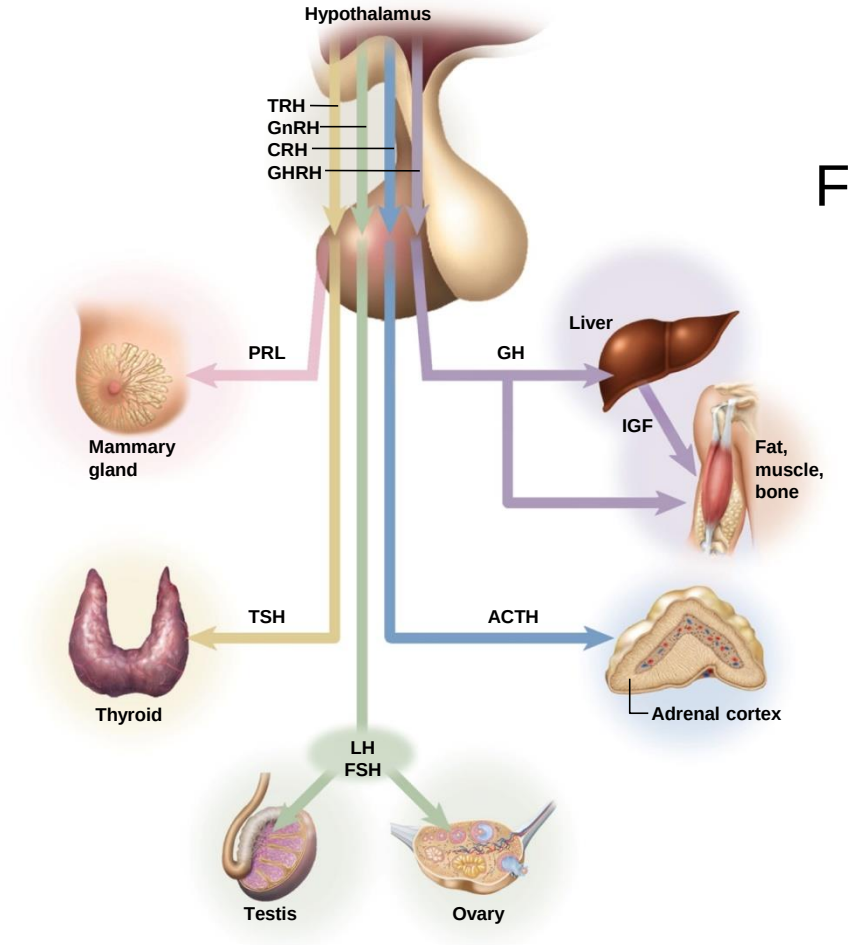

Figure 17.6

- Principle hormones and target organs

Posterior Pituitary Hormones

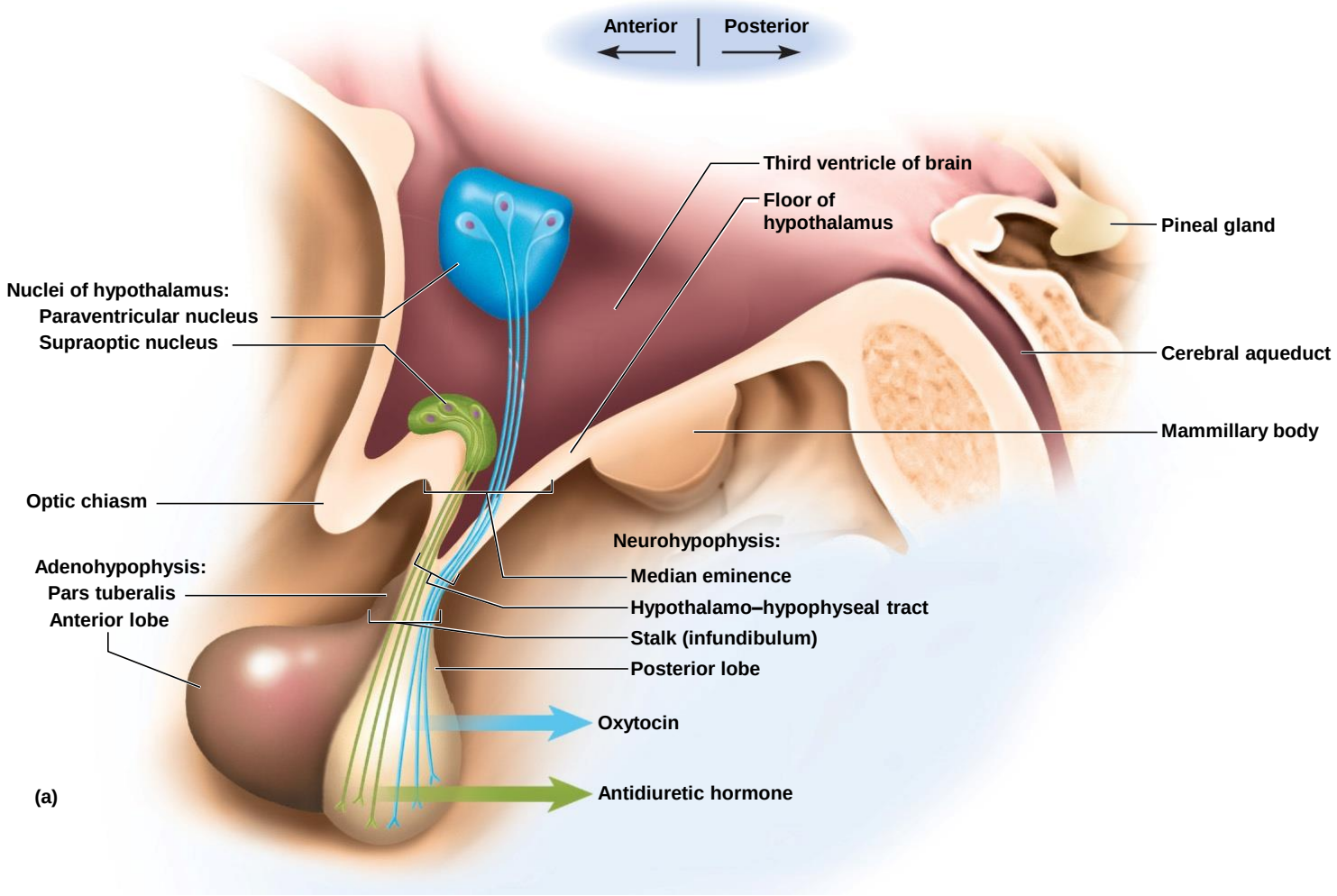

Figure 17.4a

Posterior Pituitary Hormones

- Produced in hypothalamus
  - Transported by **hypothalamo–hypophyseal tract** to posterior lobe
  - Releases hormones when hypothalamic neurons are stimulated

- **ADH** (antidiuretic hormone)
  - Increases water retention, thus reducing urine volume, and prevents dehydration
  - Also called vasopressin because it can cause vasoconstriction

Posterior Pituitary Hormones

- **Oxytocin (OT)**
  - Surge of hormone released during sexual arousal and orgasm
    - Stimulate uterine contractions and propulsion of semen
  - Promotes feelings of sexual satisfaction and emotional bonding between partners
  - Stimulates labor contractions during childbirth
  - Stimulates flow of milk during lactation
  - Promotes emotional bonding between lactating mother and infant

Control of Pituitary Secretion

- Rates of secretion are not constant
  - Regulated by hypothalamus, other brain centers, and feedback from target organs

Control of Pituitary Secretion

- **Hypothalamic and cerebral control:**
  - **Anterior lobe control:** releasing hormones and inhibiting hormones from hypothalamus
    - In cold weather, pituitary stimulated by hypothalamus to release TSH, leads to generation of body heat

Control of Pituitary Secretion

Cont.

- **Neuroendocrine reflex—**hormone release in response to nervous system signals
- Suckling infant→ stimulates nerve endings → hypothalamus → posterior lobe → oxytocin → milk ejection
- Hormone release in response to higher brain centers
- Milk ejection reflex can be triggered by a baby's cry
- Emotional stress can affect secretion of gonadotropins, disrupting ovulation, menstruation, and fertility

Control of Pituitary Secretion

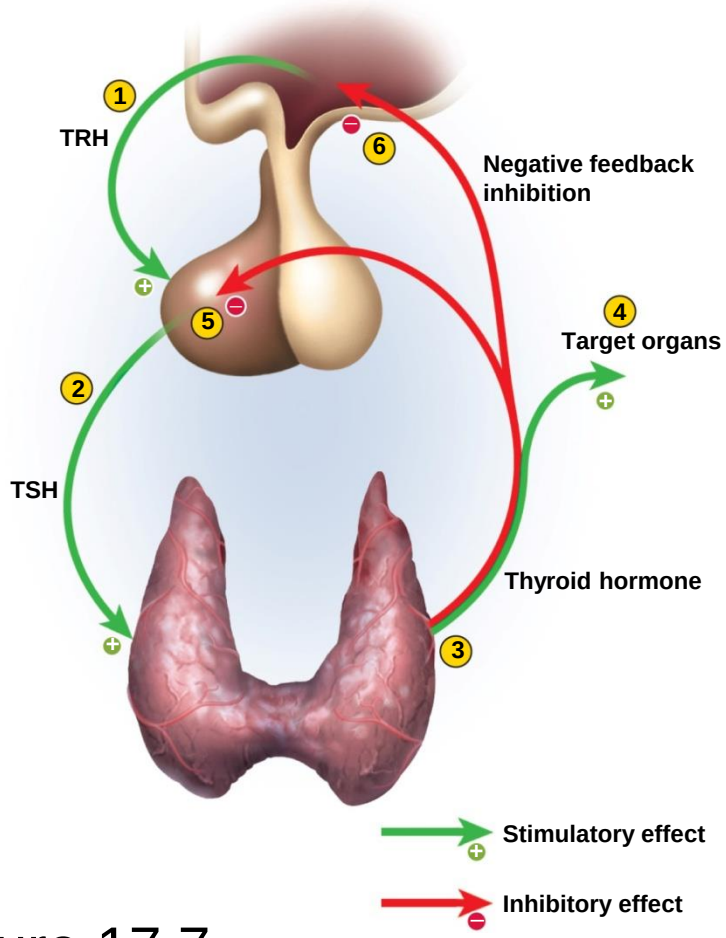

Figure 17.7

- **Negative feedback**—increased target organ hormone levels inhibit release of hormones
- **Positive feedback**—stretching of uterus increases OT release, causes contractions, causing more stretching of uterus, etc. until delivery

A Further Look at Growth Hormone

- GH has widespread effects on the body tissues
  - Especially cartilage, bone, muscle, and fat

- Induces liver to produce growth stimulants
  - **Insulin-like growth factors (IGF-I)** or **somatomedins (IGF-II)**
    - Stimulate target cells in diverse tissues
    - IGF-I prolongs the action of GH
    - **Hormone half-life—**the time required for 50% of the hormone to be cleared from the blood
      - **GH half-life:** 6 to 20 minutes
      - **IGF-I half-life:** about 20 hours

A Further Look at Growth Hormone

- Induces liver to produce growth stimulants (cont.)
  - **Protein synthesis increases:** boosts transcription of DNA, production of mRNA, amino acid uptake into cells, suppresses protein catabolism
  - **Lipid metabolism increased:** fat catabolized by adipocytes (protein-sparing effect), which provides energy for growing tissues

A Further Look at Growth Hormone

Cont.

- **Carbohydrate metabolism: glucose-sparing effect,** mobilizes fatty acids, reduces the dependence of most cells on glucose. Will not compete with the brain and makes these electrolytes available to the growing tissues.

- **Electrolyte balance:** promotes Na^+, K^+, and Cl^- retention by kidneys, enhances Ca^{2+} absorption in intestine

A Further Look at Growth Hormone

- Bone growth, thickening, and remodeling influenced, especially during childhood and adolescence
- Secretion high during first 2 hours of sleep
- Can peak in response to vigorous exercise
- GH levels decline gradually with age
- Average 6 ng/mL during adolescence, 1.5 ng/mg in old age
  - Lack of protein synthesis contributes to aging of tissues and wrinkling of the skin
  - Age 30, average adult body is 10% bone, 30% muscle, 20% fat
  - Age 75, average adult body is 8% bone, 15% muscle, 40% fat