

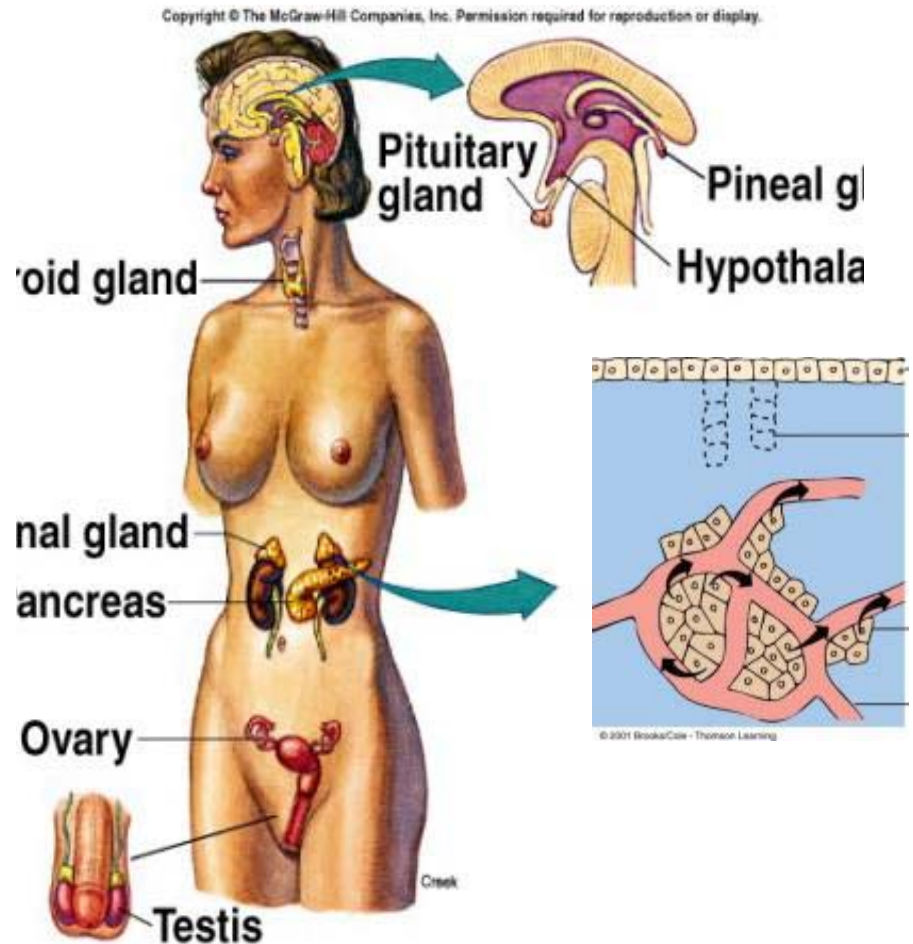
BS2001 Lecture 3 Endocrine System (I)

1. What is the endocrine system?
2. Mechanisms of hormone action
3. Regulation of endocrine function
4. The central endocrine glands
 - Pituitary gland
 - Hypothalamus
 - Pineal gland

1. What is the endocrine system?

Consists of ductless endocrine glands that secrete hormones

- Specialized glands: thyroid gland, adrenal glands, etc.
- Endocrine cells in tissues: hypothalamus, adipose tissue (leptin), gastrointestinal tract (Glucose-dependent Insulinotrophic Peptide) etc.



1. What is endocrine system?

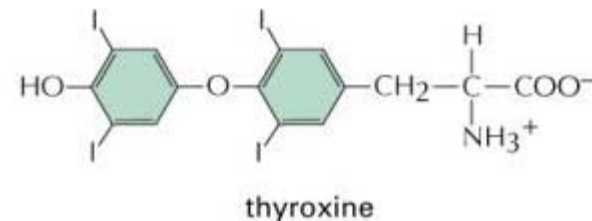
Chemical Classification of Hormones

- **Peptides**

- Small peptides: TRH (**GluHisPro**), vasopressin (nonapeptide)
- Proteins: insulin, growth hormone
- Glycoproteins - Long polypeptides (>100 KD) bound to 1 or more carbohydrate groups (FSH and LH).

- **Amines**

- derived from tyrosine (thyroxine)



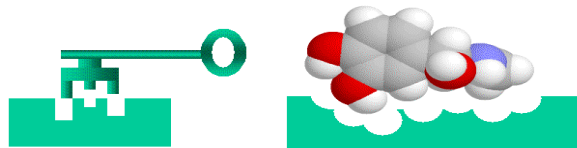
- **Steroids**

- hydrophobic hormones derived from cholesterol



2. Mechanisms of hormone action

- The effects of hormones are mediated by specific hormone receptors in the cell
- The **location** of the hormone receptor depends on the chemical nature of the hormone
 - Receptors for hydrophilic hormones are on cell surface membrane.
 - Receptors for hydrophobic hormones are intracellular (nuclear or cytoplasmic)



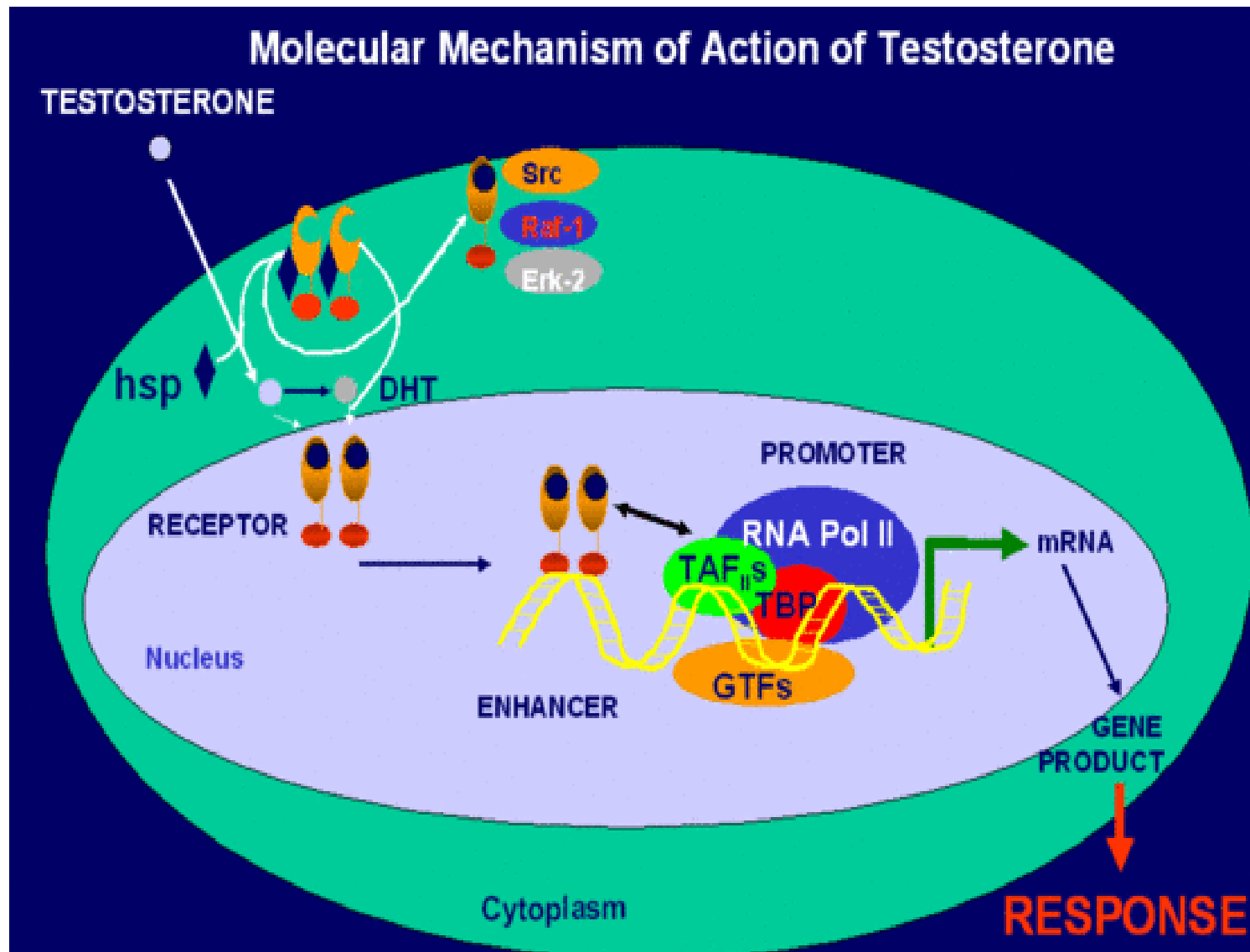
2. Mechanisms of hormone action

The action of hydrophilic hormones is mediated by receptors on cell surface (I)

- **G-protein-linked:** activate second messenger pathway (cAMP or Ca^{++}) or ion channels
- **Ion-channel-linked:** mostly for neuropeptide hormones
- **Enzyme-linked:** Most are protein kinases (e.g. insulin receptor is a receptor tyrosine kinase)

2. Mechanisms of hormone action

The action of hydrophobic hormones is mediated mainly by nuclear receptors



3. Regulation of endocrine function

1) Hormone secretion

- Respond to changes in the internal and external environment
- Negative and positive feedback and feed forward
- Neuroendocrine reflexes (the secretion of epinephrine by adrenal medulla is under the control of sympathetic nervous system)
- Diurnal rhythms (cortisol secretion)

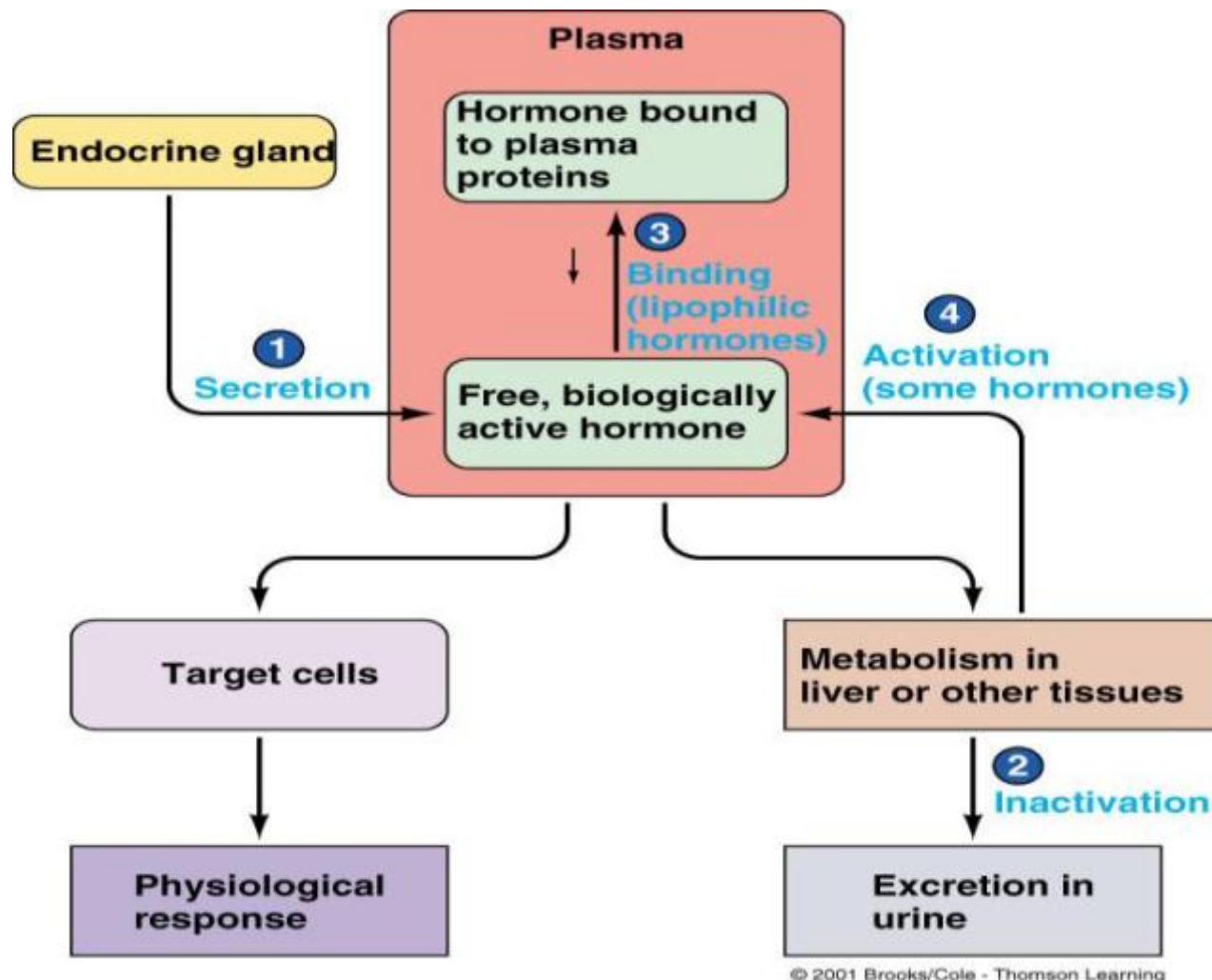
2) Tissue sensitivity

- Tissue receptors
- transcription cofactors (co-repressors and co-activators)

3) Hormone binding to plasma proteins, metabolism and excretion (next slide)

3. Regulation of endocrine function

Binding to plasma proteins, hormone metabolism and excretion regulates concentration of active hormones



3. How the function of endocrine system is regulated?

Endocrine disorders result **mostly** from the hyposecretion or hypersecretion of a hormone



➤ **Hyposecretion**

- Due to heredity, dietary deficiency, immunologic factors etc.
- Causes can be primary, or secondary (due to the deficiency of another hormone).
- Can be treated by Hormone Replacement Therapy in most cases.

➤ **Hypersecretion**

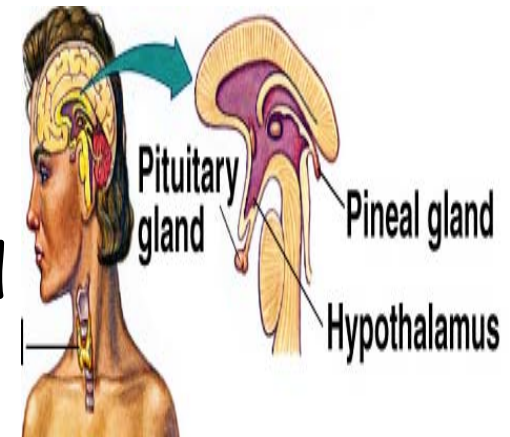
- Due to tumors of the endocrine gland, immunologic factors etc.
- Causes can also be primary or secondary.

➤ **Lack of Tissues response**

- Endocrine dysfunction can also arise from the unresponsiveness of target cells to a hormone (Testicular feminization syndrome, type II diabetes).

4. The central endocrine glands

- The hypothalamus
- The anterior pituitary gland
- The posterior pituitary gland
- The pineal gland



4. The central endocrine glands

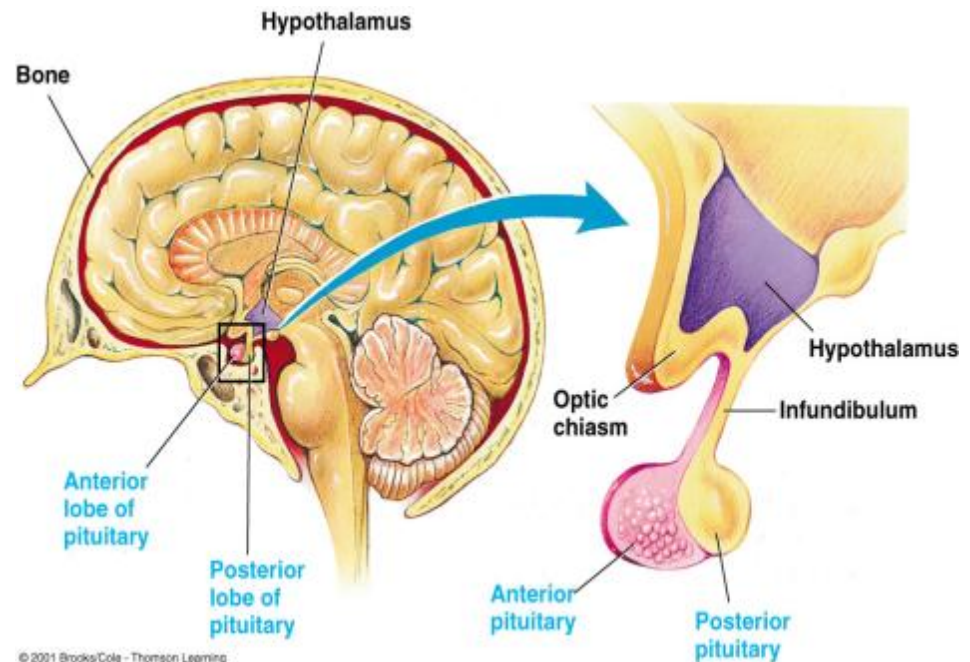
Anatomy of the hypothalamus and Pituitary

The hypothalamus forms the lower lateral walls and floor of the third ventricle.

The pituitary gland attaches to the hypothalamus by the infundibulum. It is structurally and functionally divided into anterior lobe and posterior lobe.

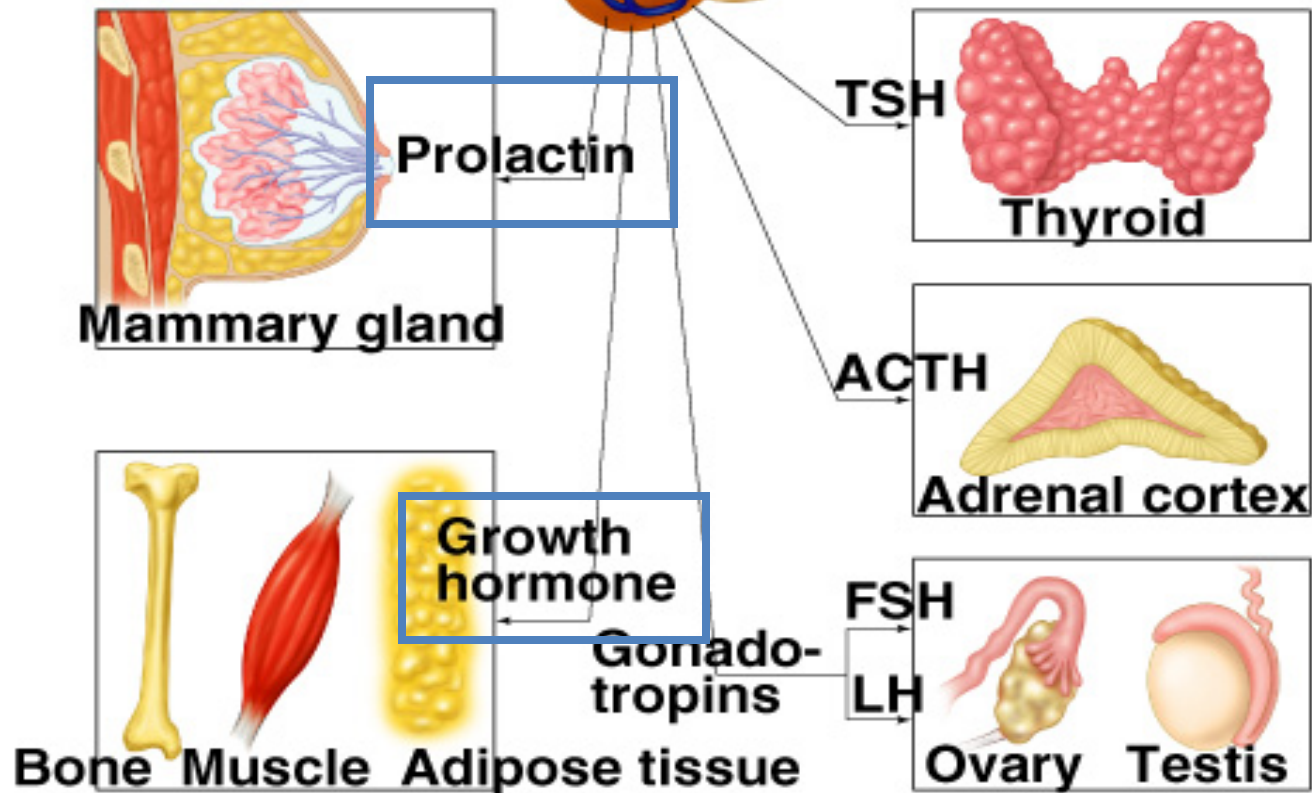
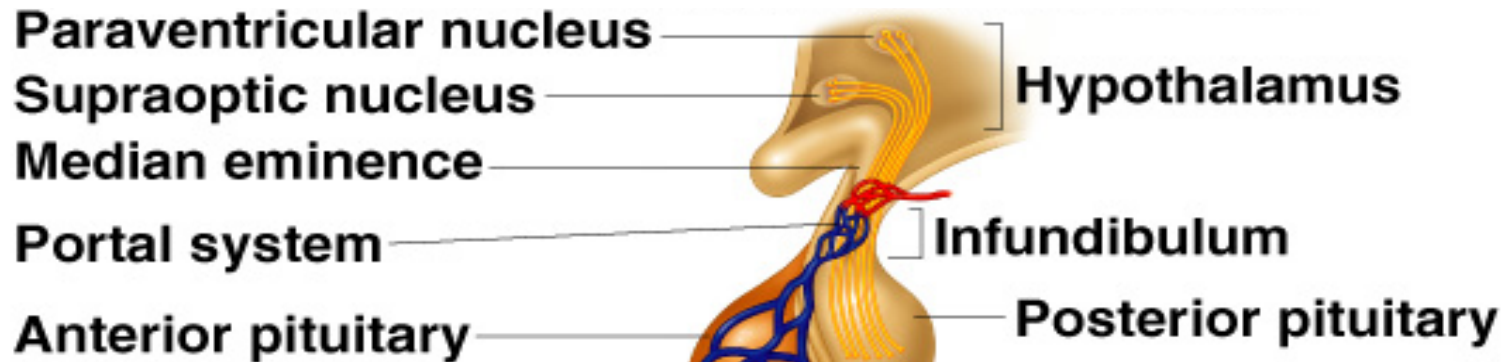
The anterior lobe, or adenohypophysis, consists of glandular tissue.

The posterior lobe, or neurohypophysis, consists of neural tissue.



4. The central endocrine glands

The anterior pituitary hormones-Trophic hormones



4. The central endocrine glands

The anterior pituitary hormones-Trophic hormones

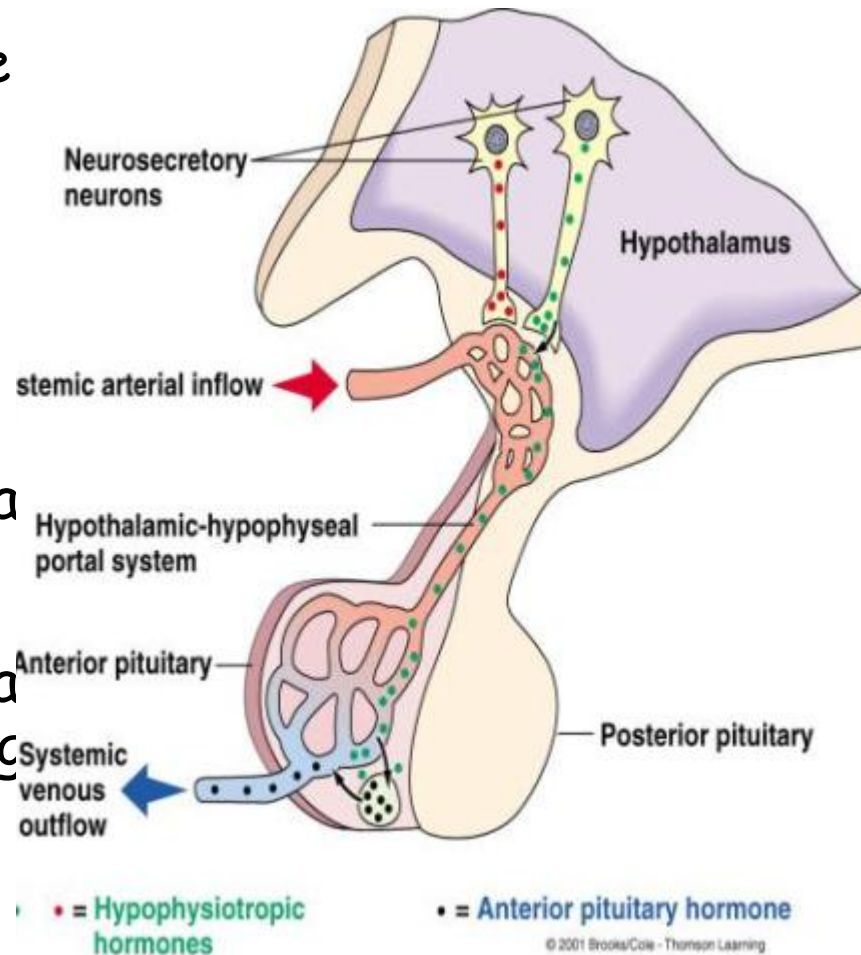
- Adrenocorticotrophic hormone (ACTH or corticotropin) - stimulate adrenal cortex to produce corticosteroids
- Thyroid-stimulating hormone (TSH or thyrotropin) - Stimulates thyroid to produce thyroxine
- Luteinizing hormone (LH) - Needed for ovulation, formation of corpus luteum in females; Stimulates testes to produce testosterone in males
- Follicle-stimulating hormone (FSH) - Required for development of ovarian follicles in females (estrogen) and for sperm development in males
- Prolactin - Induces lobulo-alveolar growth of the mammary gland and stimulates lactogenesis (milk production);
- Growth hormone (GH or somatotropin) - promote growth of tissues and essential for metabolic regulation



4. The central endocrine glands

Regulation of anterior pituitary secretion by hypothalamus

- Hypothalamus neurons secrete releasing and inhibiting hormones that regulate the secretions of the anterior pituitary (AP) hormones.
- The hypothalamic hormones are transported to AP through the Hypothalamic-hypophyseal portal system.
- Hypothalamic-hypophyseal portal system: blood vessels connecting capillaries in the hypothalamus with capillaries in the anterior pituitary.



Regulation of anterior pituitary secretion by hypothalamus

Hypothalamic releasing and inhibiting hormones

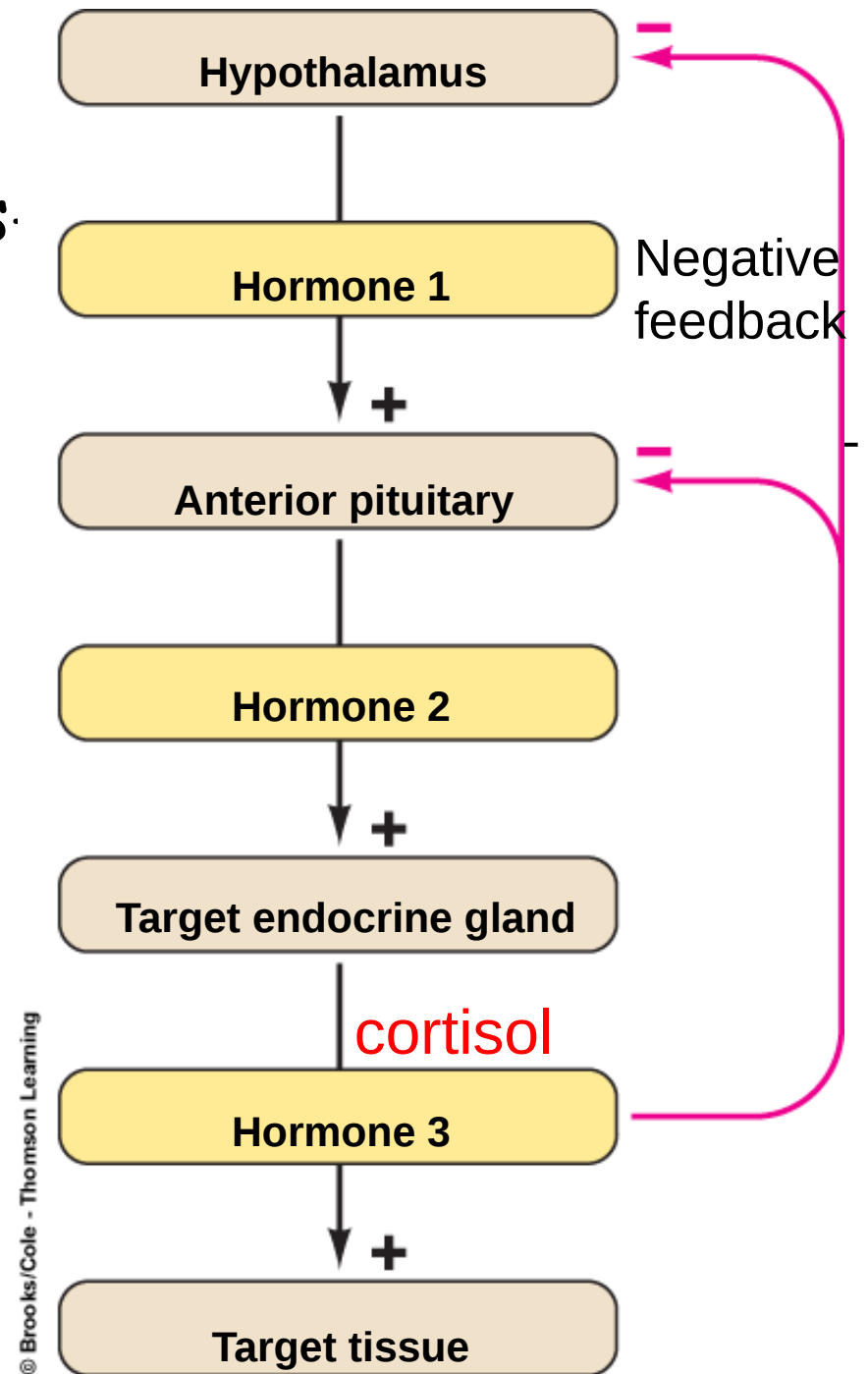
- Thyrotropin-releasing hormone (TRH) - stimulate TSH release
- Corticotropin-releasing hormone (CRH) - stimulate ACTH release
- Gonadotropin-releasing hormone (GnRH) - stimulate FSH and LH
- Growth hormone-releasing hormone (GHRH) - stimulate GH release
- Growth hormone-inhibiting hormone (GHIH-Somatostatin) - inhibit GH release
- Prolactin-releasing hormone (PRH)
- Prolactin-inhibiting hormone (PIH) = dopamine



4. The central endocrine glands

Regulation of the hypothalamus- pituitary- adrenal/gonadal/thyroid axis

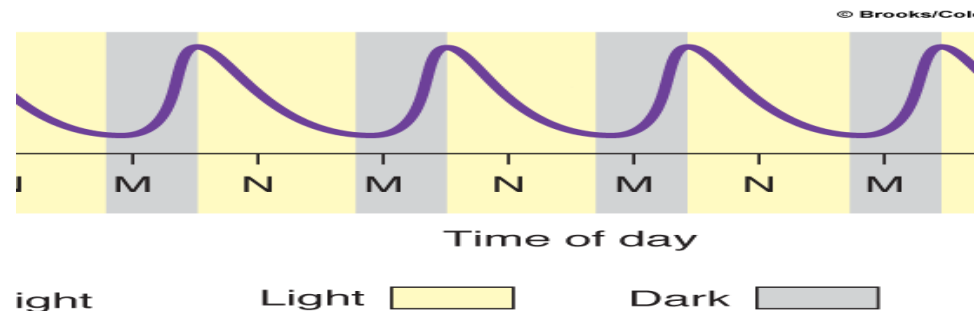
- Negative feedback
 - The hormone from target gland can act on the hypothalamus and the anterior pituitary to inhibit the secretion of releasing and stimulating hormones.



4. The central endocrine glands

Regulation of the hypothalamus-pituitary Adrenal/gonadal axis by the higher brain

- Stress affects the timing of menstruation
- 'Dormitory effect' may be due to pheromones
- Stress - $CRH \uparrow$ - $ACTH \uparrow$ - corticosteroid $\uparrow$
- Circadian rhythms:
 - Secretion of cortisol is highest during sleep and decrease during wakefulness



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