

Physiology 1 - PAP

With a minor introduction to
endocrine

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Objectives

By the end of this lecture, you should be able to:

1. Define hormones
2. Characterize hypothalamic pituitary relationship
3. Name the hypophysiotropic hormones and outline the effects that each has on anterior pituitary function
4. Name anterior pituitary gonadotropic hormones and outline the effects that each has on the gonads
5. Describe the negative and positive feedback mechanisms in the hypothalamic-pituitary-gonadal axis and their importance in the control of reproductive function

Keywords: hypophysiotropic hormones, gonadotropic hormones, androgens, estrogens

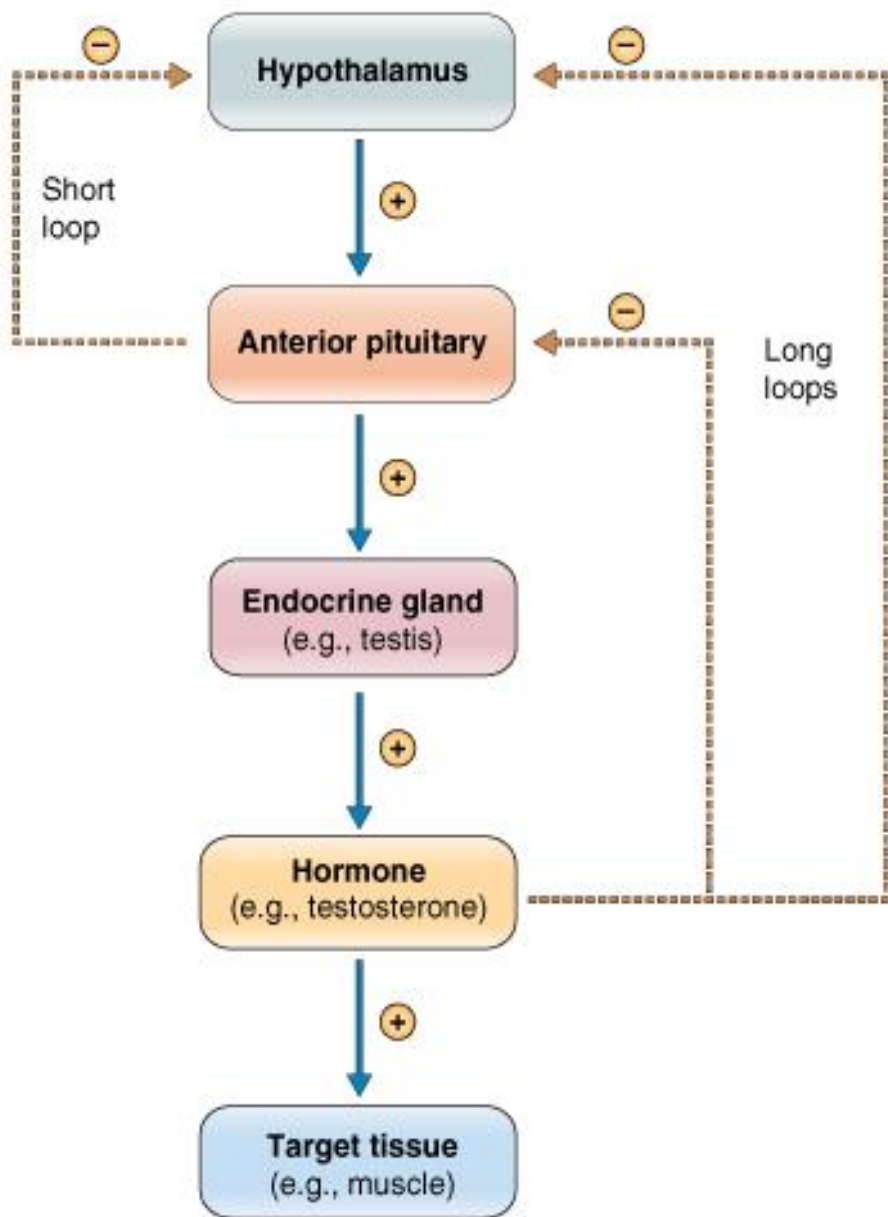
Define hormones

- chemical substance that is classified as a peptide, steroid, or amine.
- secreted into the circulation in small amounts and delivered to target tissues, where they produce physiologic responses

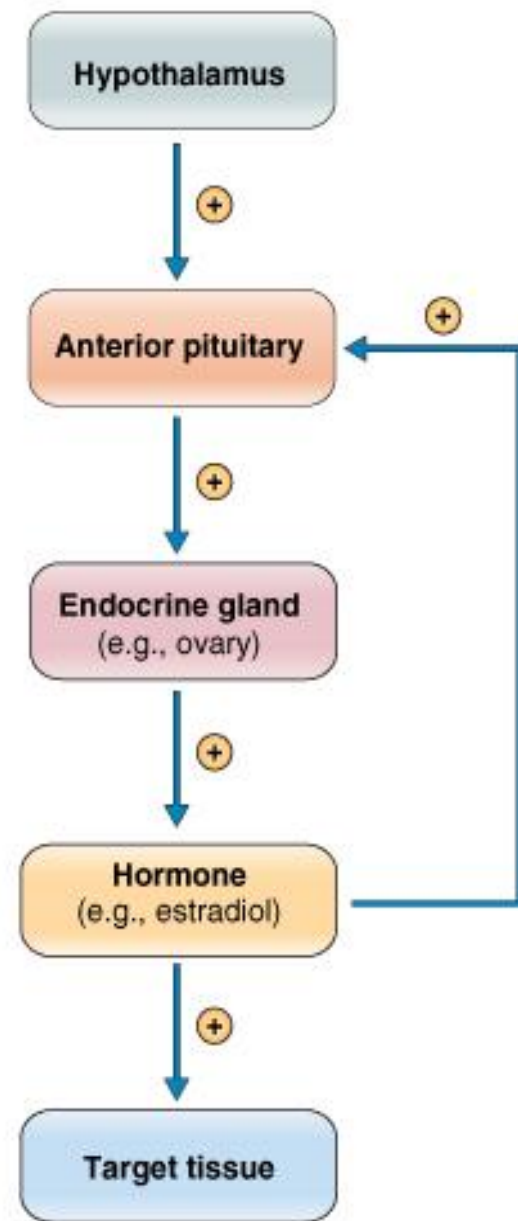
Regulation (- feedback)

- **Long-loop feedback** means that the hormone feeds back *all the way* to the hypothalamic-pituitary axis
- **Short-loop feedback** means that the anterior pituitary hormone feeds back on the hypothalamus to inhibit secretion of hypothalamic-releasing hormone

NEGATIVE FEEDBACK



POSITIVE FEEDBACK



+ feedback

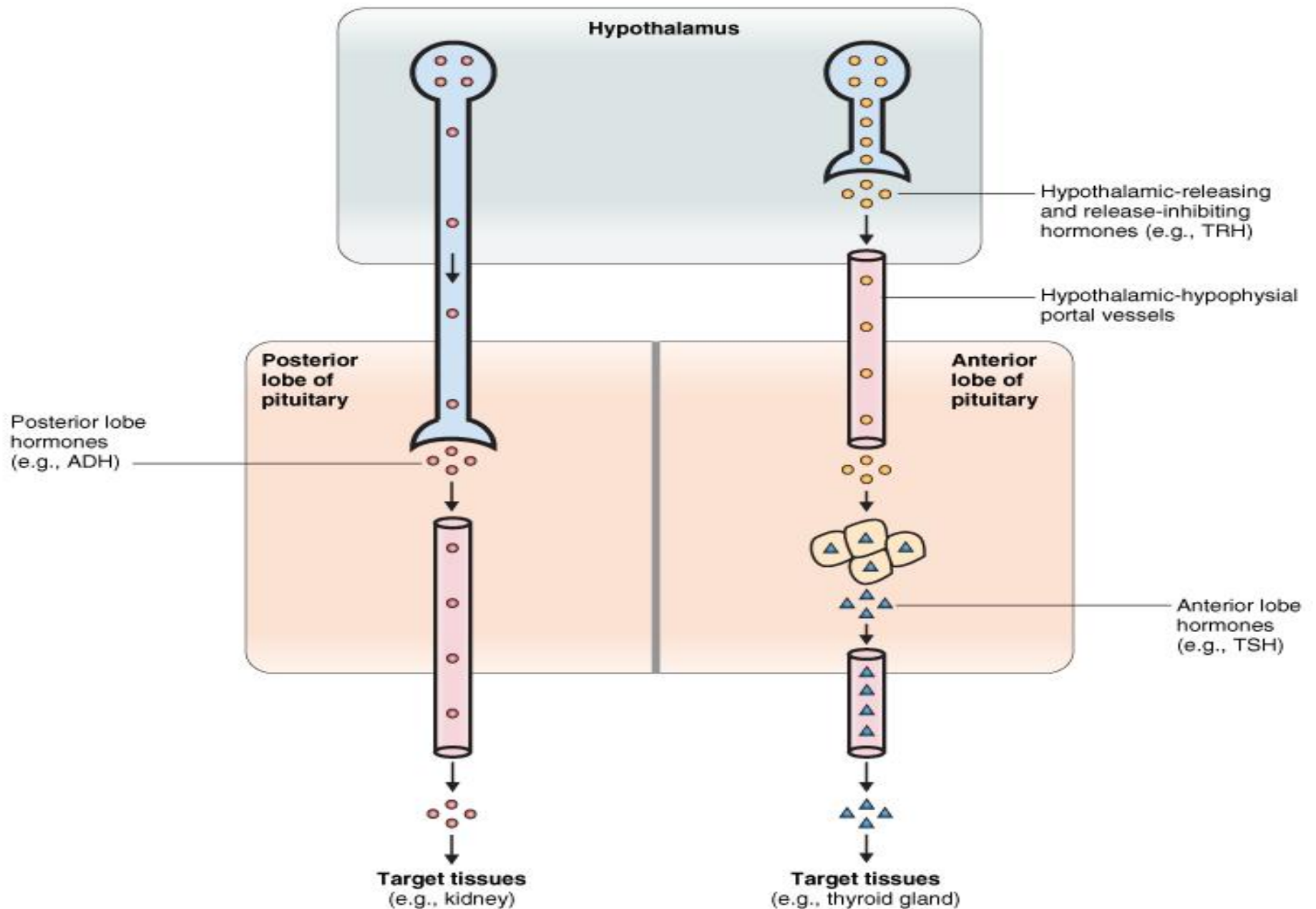
- E.g. LH surge
- effect of **estrogen** on the secretion of follicle-stimulating hormone (**FSH**) and luteinizing hormone (**LH**) by the anterior pituitary at the midpoint of the menstrual cycle
- Causing the release of more estrogen

Characterize hypothalamic pituitary relationship

The connection between the hypothalamus and pituitary gland via:

- Hypothalamohypophysial tract between the posterior pituitary gland, supraoptic and paraventricular nuclei (neural connection)
- **the hypophyseal portal system** which contains vessels that connect the anterior pituitary gland and the hypothalamus

HYPOTHALAMIC-PITUITARY RELATIONSHIPS



Hypothalamohypophysial tract

- posterior pituitary is a collection of nerve axons whose cell bodies are located in the hypothalamus.
- hormones secreted by the posterior lobe are actually **neuropeptides**; in other words, they are peptides released from neurons.
 - ADH and oxytocin
 - cell bodies of **ADH** primarily in the **supraoptic nuclei**
 - The cell bodies of **oxytocin** neurons are contained primarily in the **paraventricular nuclei**

the hypophyseal portal system

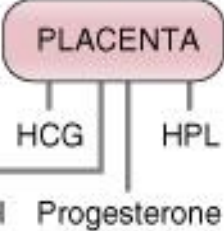
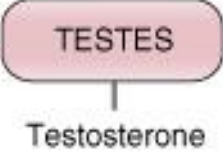
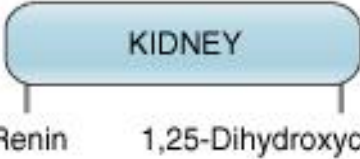
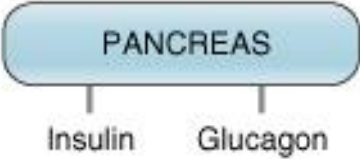
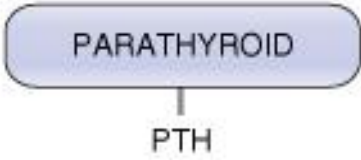
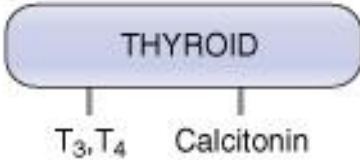
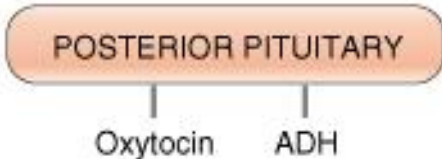
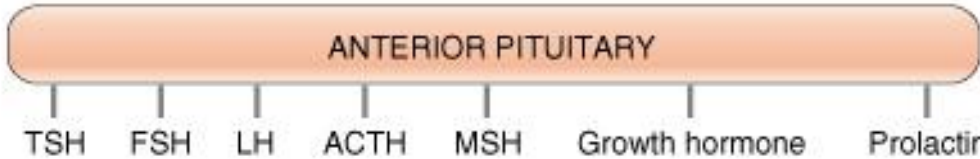
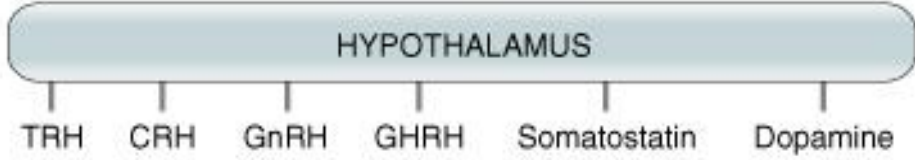
- Unlike the posterior lobe, which is neural tissue, the anterior lobe is primarily a collection of endocrine cells.
- hypothalamus and anterior pituitary are linked directly by the **hypothalamic-hypophysial portal blood vessels**

Regulation of Reproduction: General Pathways

- Hypothalamus: pulse generator
 - Gonadotropin releasing H (GnRH)
- Anterior Pituitary
 - Lutenizing H (LH)
 - Follicle stimulating H (FSH)
- Ovary:
 - Estrogen, progesterone, inhibin
- Testis:
 - Testosterone, inhibin

GNRH

- GnRH peptide is secreted by the arcuate nuclei of the hypothalamus through the hypothalamic-hypophysial portal system to the anterior pituitary gland and stimulates the release of gonadotropins (LH and FSH)
- **GnRH**
 - is secreted intermittently for few minutes every 1 to 3 hrs.
 - The secretion of LH by the anterior pituitary is also cyclical following the pulsatile release of GnRH



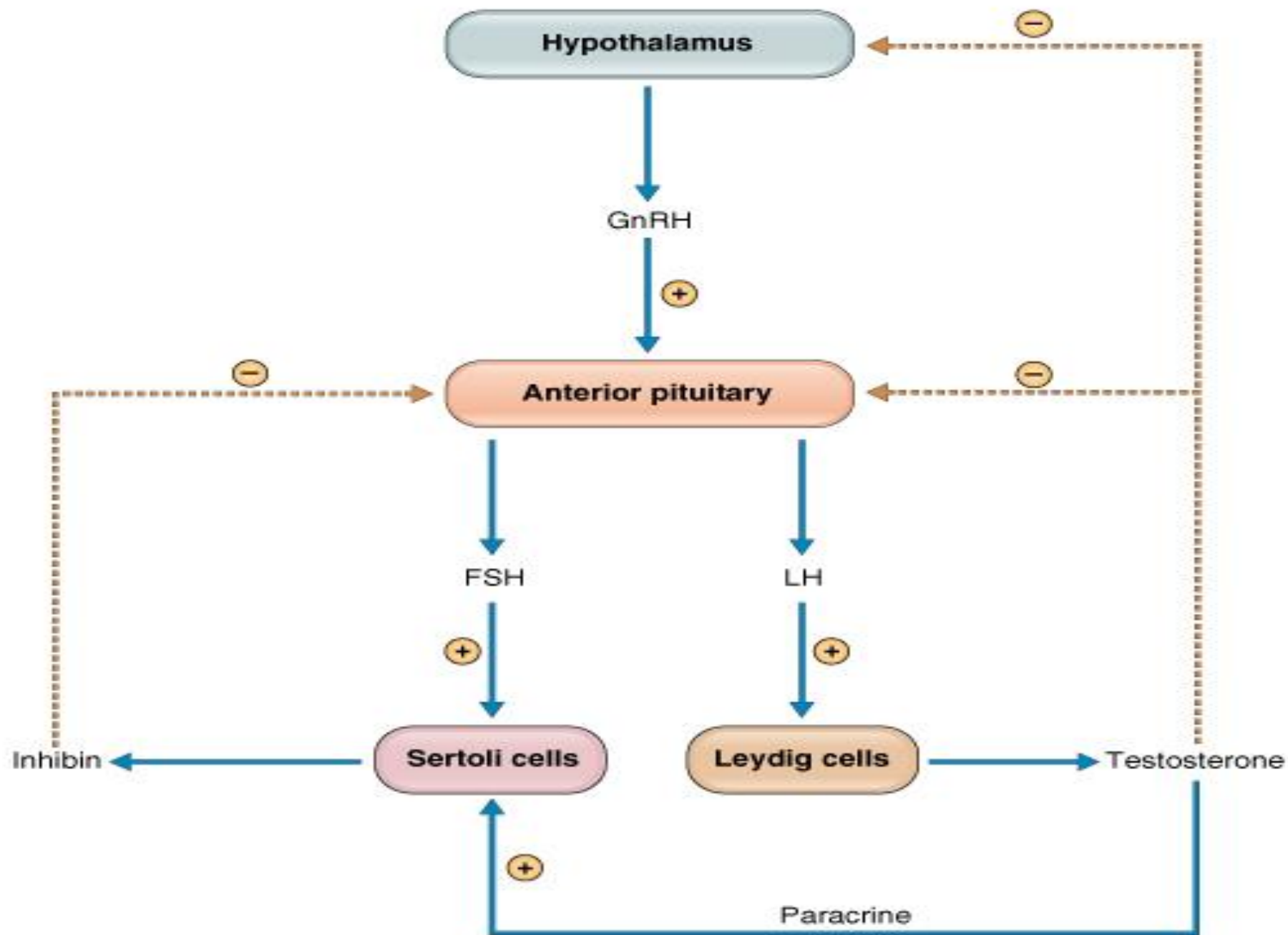
Anterior Pituitary Hormones

The anterior pituitary secretes six hormones:

1. Adrenocorticotrophic hormone (corticotrophin, ACTH)
2. Thyroid-stimulating hormone (thyrotropin, TSH)
3. Growth hormone (GH)
4. Follicle-stimulating hormone (FSH)
5. Luteinizing hormone (LH)
6. Prolactin (PRL)

Male

- **seminiferous tubules produce sperm**
- **Leydig cells**
 - The function of the Leydig cells is synthesis and secretion of testosterone
 - local (paracrine) effects that support spermatogenesis in the testicular Sertoli cells
 - Endocrine effects on other organs
- **Sertoli cells** lining the seminiferous tubule
 - provide nutrients to the sperm
 - **blood-testes barrier**
 - secrete an aqueous fluid



- **FSH** stimulates spermatogenesis and **S**ertoli cell function. Sertoli cells then release:
 - aromatase
 - Inhibin
 - ABP (androgen binding protein)
- **LH** stimulates the **L**eydig cells to synthesize testosterone.
 - its release is directly proportional to the amount of LH.

- Testosterone inhibits FSH and LH by negative feedback effects on?
 - Hypothalamus (most)
 - decrease secretion of GnRH so it stops
 - LH
 - FSH
 - Anterior pituitary
 - LH

Spermatogenesis

- After FSH is secreted it binds to receptors on sertoli cells causing these cells to grow and secrete spermatogenic substances.
- Also testosterone & dihydrotestosterone diffuses into the seminiferous tubules from the leydig cells and BIND TO ABP effecting the spermatogenesis (the paracrine effect)
- So spermatogenesis is regulated by ?
 - FSH
 - Testosterone

- What happens When the seminiferous tubules fail to produce sperm?

Failure to produce sperm

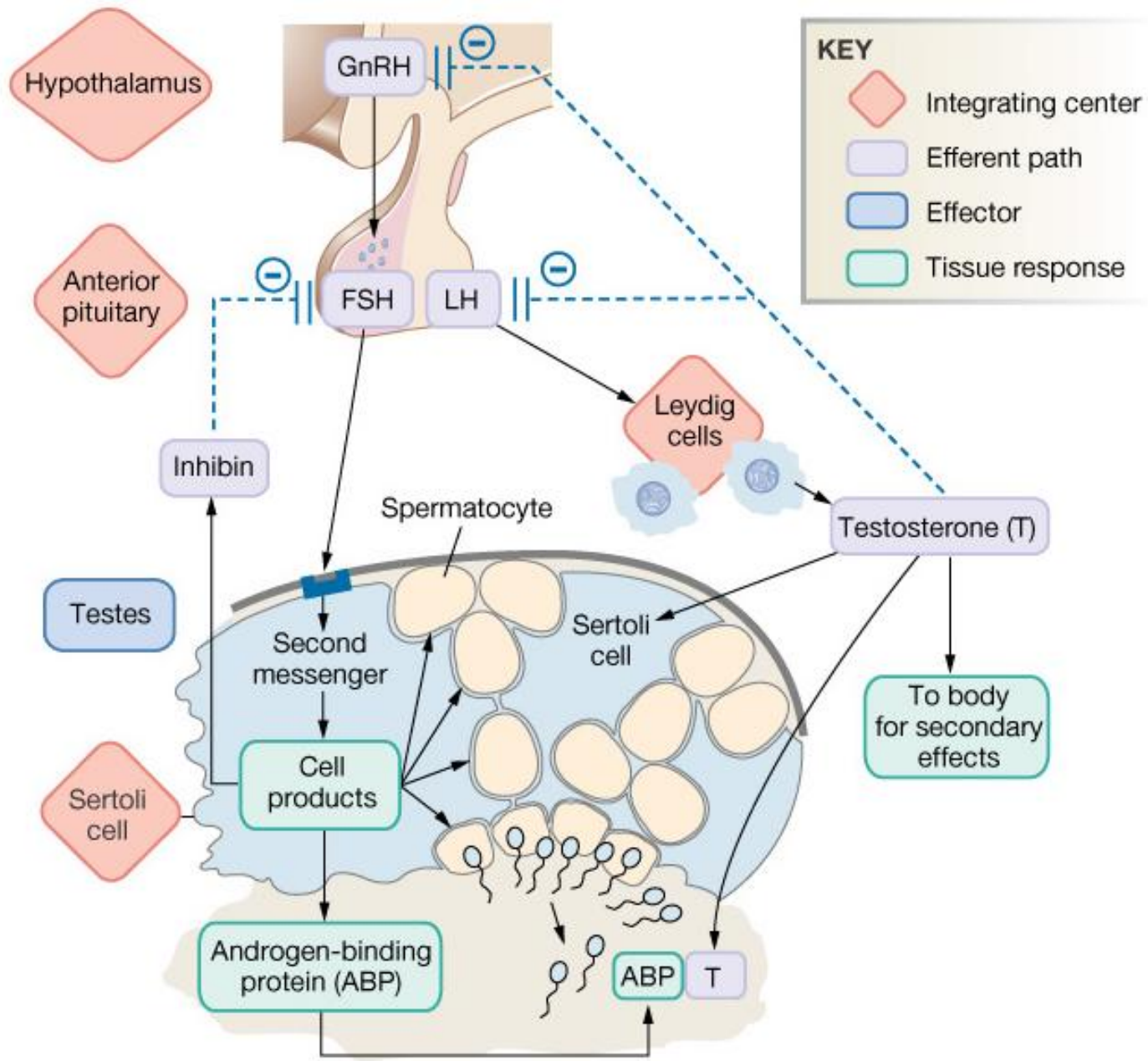
No inhibin

↑↑ of FSH from anterior P.

Effective spermatogenesis

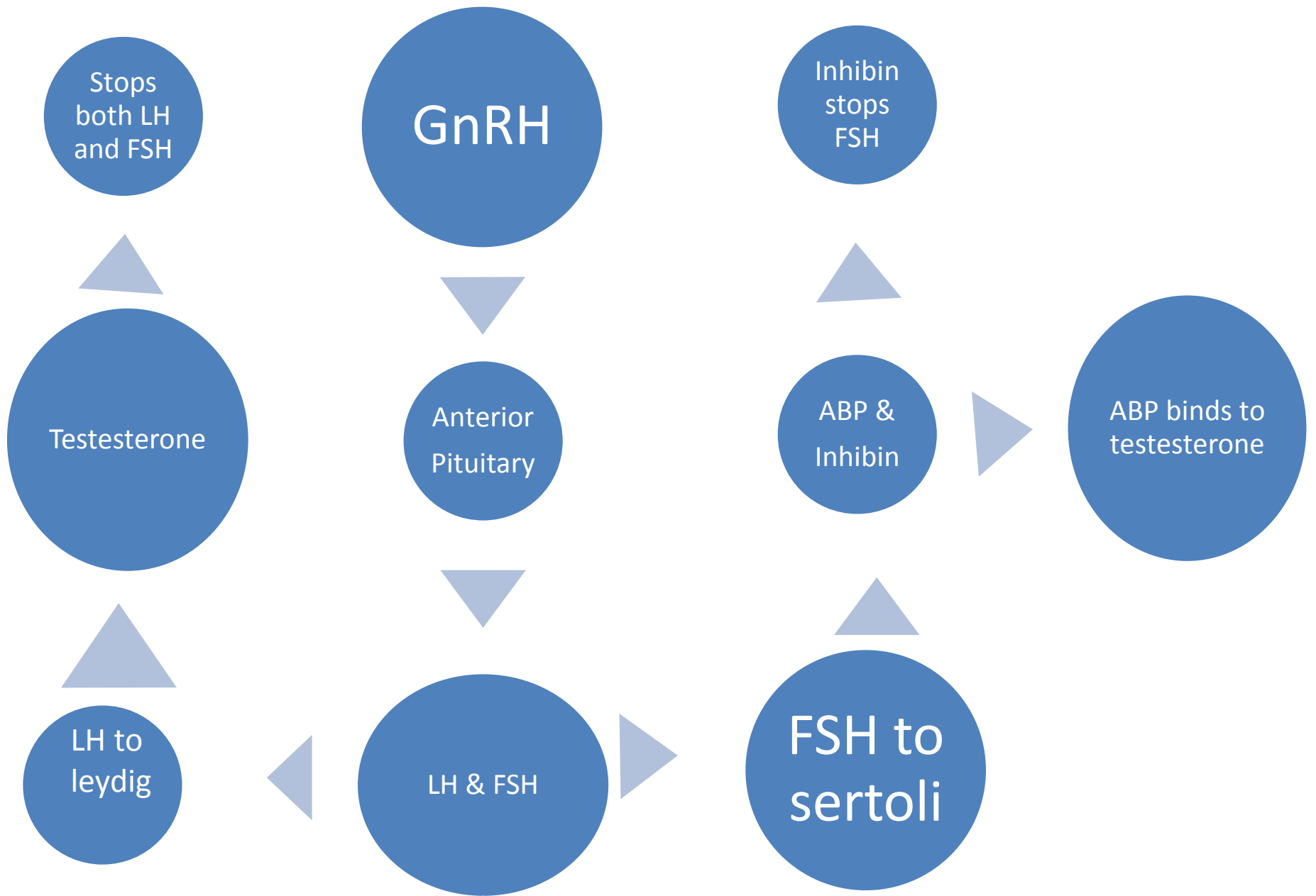
↑ inhibin from sertoli cells

↓↓ FSH from anterior P.



Regulation of Spermatogenesis

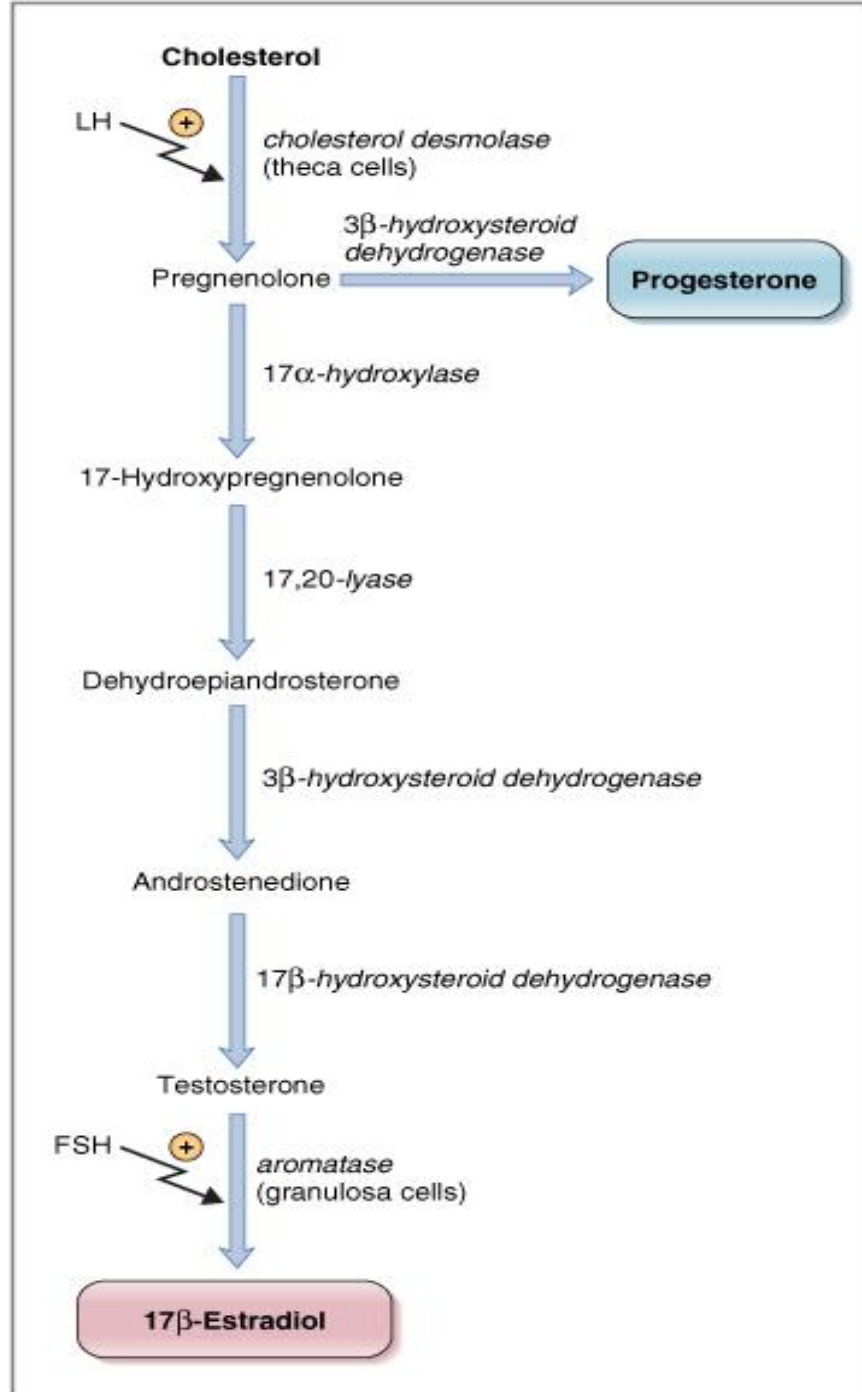
- GnRH → LH → Leydig cells → testosterone → growth and division of germ cells
- GnRH → FSH → Sertoli cells → spermatocyte maturation
- Inhibin feedback – FSH, testosterone – short & long loops



- Does LH produce gametes in males ?
 - Yes but not directly
 - Answer : FSH and testosterone
 - LH not direct !!!

Female

- LH :
 - Ovulation is initiated by LH
 - LH surge
 - stimulates cholesterol desmolase in the theca cells
- FSH :
 - granulosa cells are the only ovarian cells with FSH receptors
 - FSH stimulate the growth of granulosa cells in primary follicles and stimulate estradiaol
 - stimulates aromatase in the granulosa cells



- Theca cells:
 - Synthesize and secrete progesterone and testosterone (diffuses from the theca cells to the nearby granulosa cells)
- granulosa cells :
 - Contains aromatase
 - Converts testosterone to 17β -estradiol
 - Releases inhibin (corpus luteum)

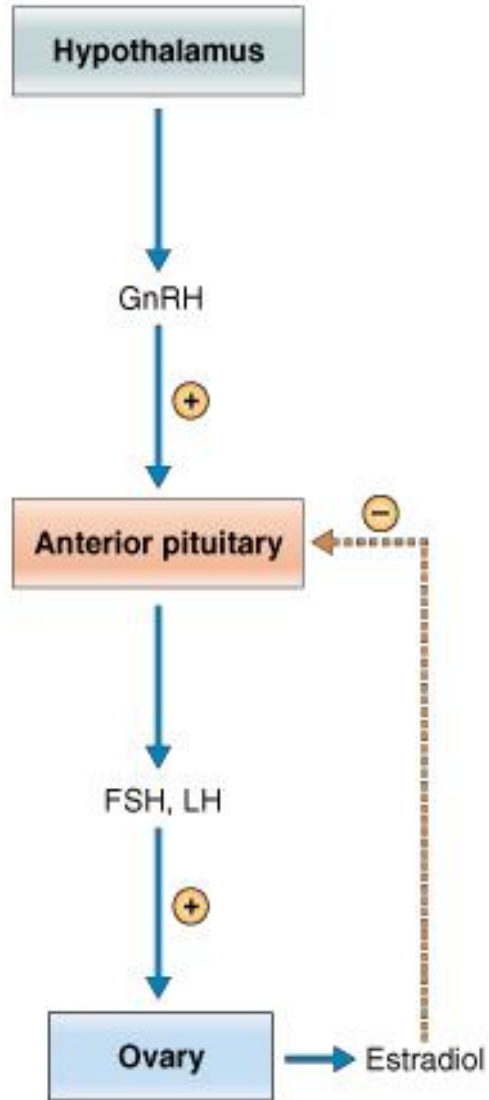
Regulation

- Estrogen in small amounts has strong effect to inhibit the production of LH & FSH. This inhibitory effect of estrogen is increased when progesterone is available
- The hormone inhibin secreted by the granulosa cells of the ovarian corpus luteum inhibit the secretion of FSH & to a lesser extent LH. (same as male)

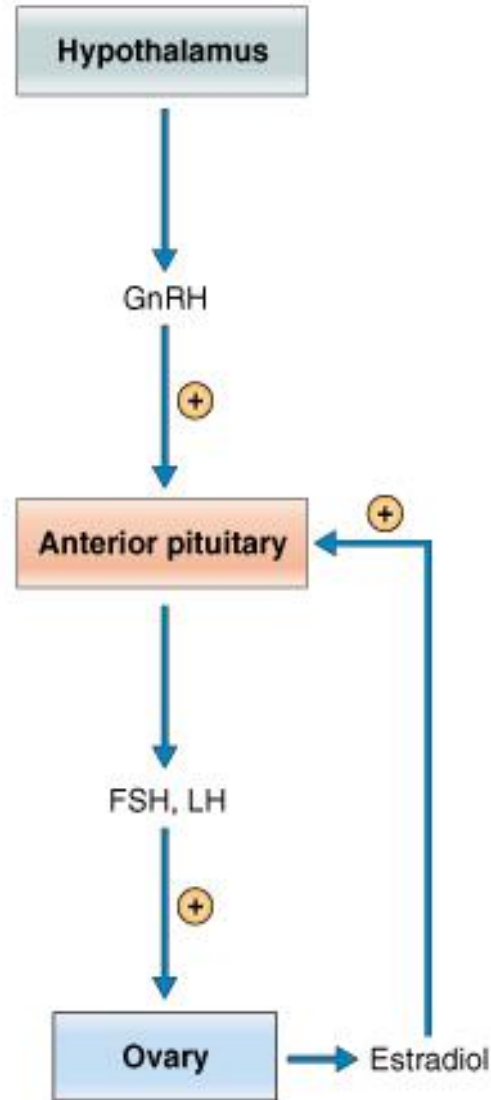
Ovulatory cycle hormones

- Post ovulatory (between ovulation & beginning of menstruation) :
 - Corpus luteum secretes progesterone & estrogen & inhibin
 - ↓ in levels of FSH and LH
 - lowest level 3-4 days before the onset of menstruation

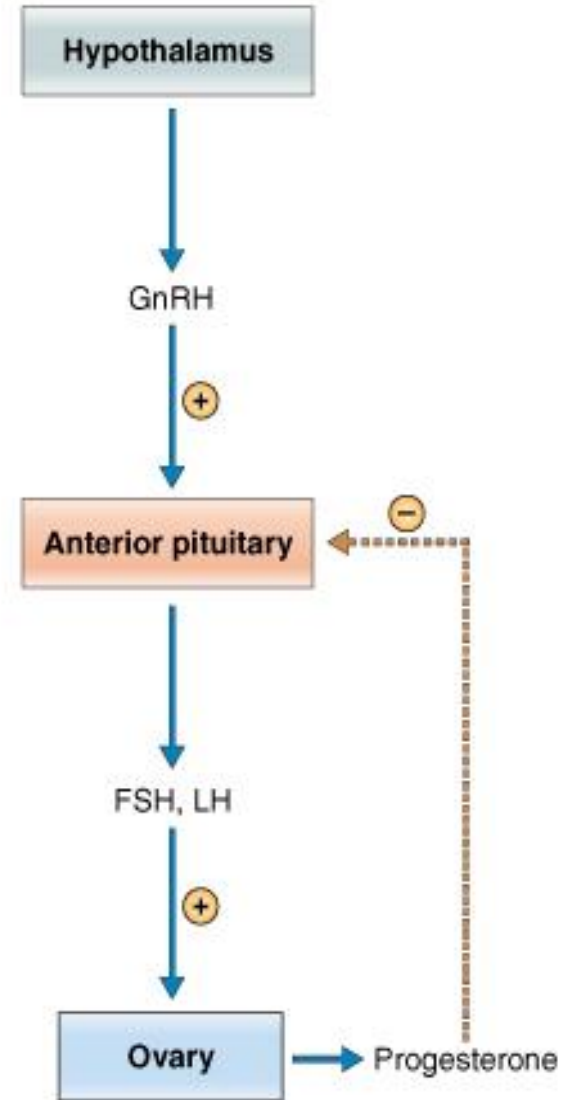
FOLLICULAR PHASE



MIDCYCLE



LUTEAL PHASE



- Follicular growth
 - 2 to 3 days before menstruation, corpus luteum regress & secretion of estrogen, progesterone & inhibin decrease
 - No negative feedback >> ↑↑ FSH 2 folds / LH slight
 - Then will start to level or decrease due to negative feedback
 - growth of the follicle. During the first 11 to 12 days

- Preovulation
- LH surge & FSH surge
- Causes ovulation

- Questions ?