

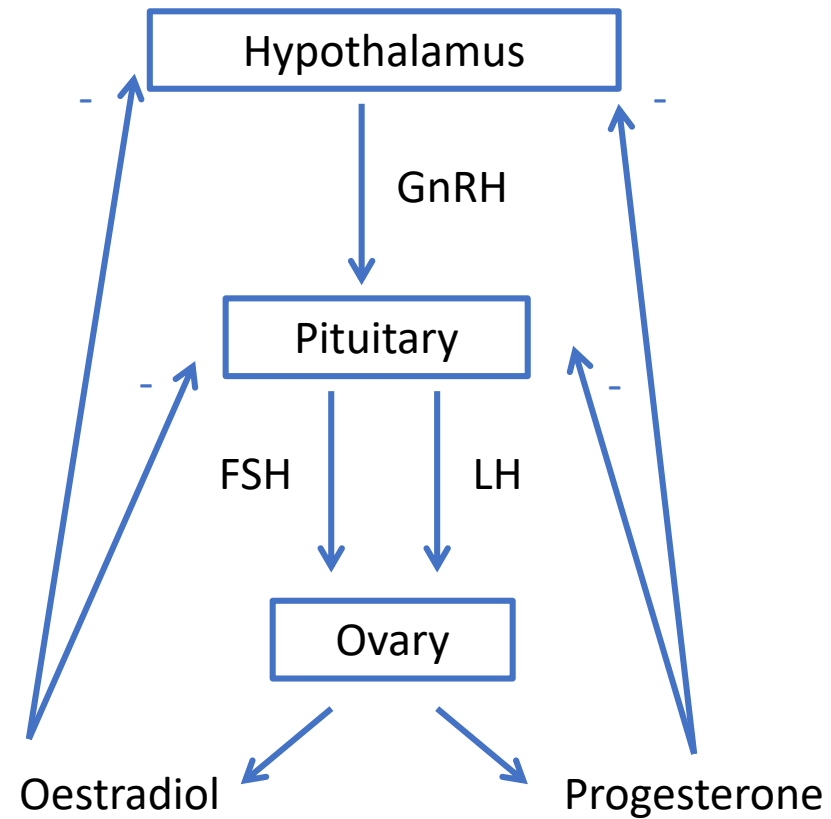
Establishing the Ovarian Cycle

- During childhood, ovaries grow and secrete small amounts of estrogens that inhibit hypothalamic release of GnRH
- As puberty nears, GnRH is released; FSH and LH released by pituitary, and act on ovaries
- These events continue until an adult cyclic pattern achieved and menarche occurs (first menstrual period)

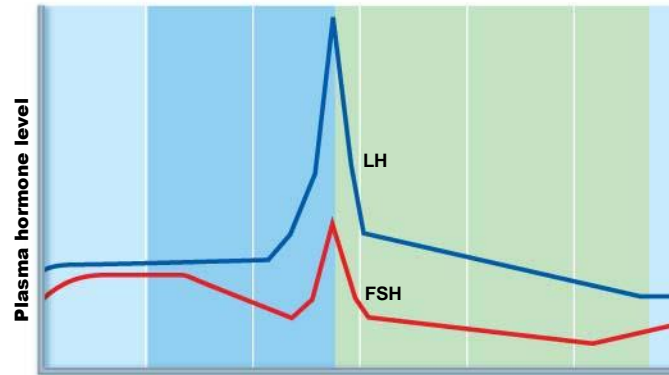
Hormonal Regulation of the Ovarian Cycle

- Hormone interaction produces cyclic events in ovaries
 - Gonadotropin-releasing hormone (GnRH)
 - Pituitary gonadotropins
 - Ovarian estrogen
 - Ovarian progesterone

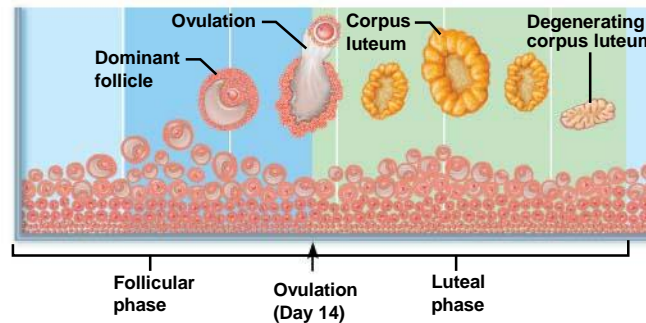
Female reproductive axis



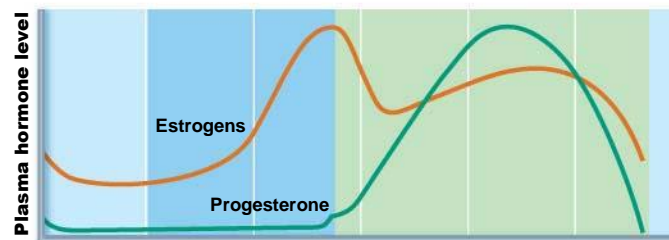
Correlation of anterior pituitary and ovarian hormones with structural changes of the ovary



(a) **Fluctuation of gonadotropin levels:** levels of pituitary gonadotropins (follicle-stimulating hormone and luteinizing hormone) in the blood regulate the events of the ovarian cycle.

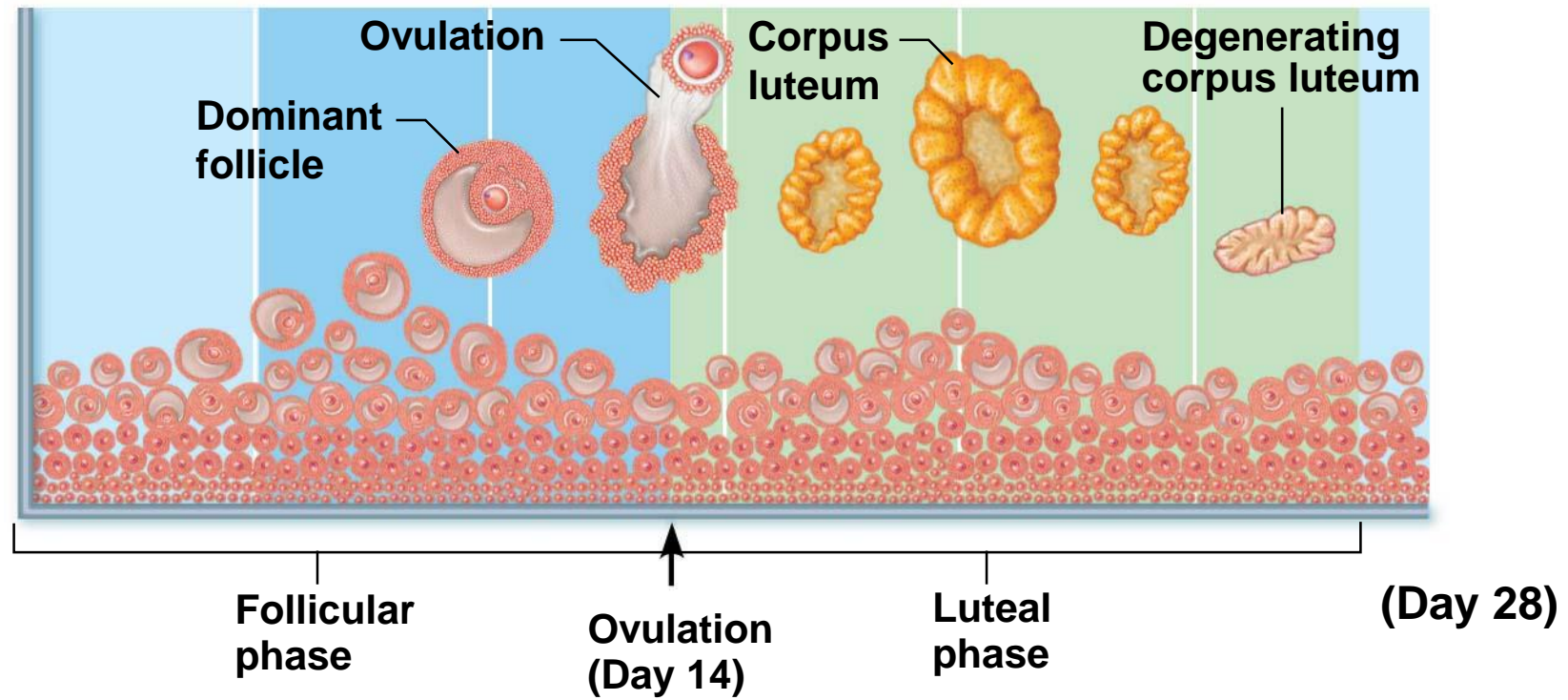


(b) **Ovarian cycle:** Structural changes in ovarian follicles and the corpus luteum. Recall that only follicles in their antral phase are hormone dependent —primary and secondary follicles are not.



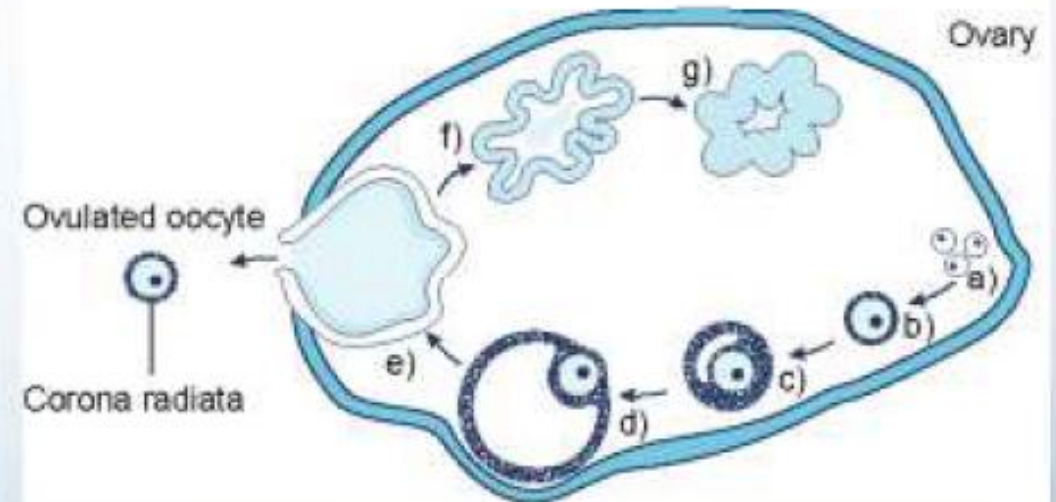
(c) **Fluctuation of ovarian hormone levels:** Fluctuating levels of ovarian hormones (estrogens and progesterone) during the ovarian cycle. The high estrogen levels are also responsible for the LH surge in (a).

Ovarian Cycle



Ovarian Cycle

- Follicular Phase (preovulatory):
 - Recruitment
 - Selection of the dominant follicle
 - Increasing levels of estradiol and inhibin
- Ovulatory Phase:
 - Luteinizing hormone (LH) surge
 - Rupture of preovulatory follicle wall
 - Release of a viable oocyte
- Luteal Phase (postovulatory):
 - Formation of corpus luteum
 - Increasing levels of progesterone
 - Secretory changes in endometrium



Schematic diagram of an ovary.

- a) Primordial follicles
- b) Primary follicle
- c) Secondary follicle
- d) Vesicular (Graafian) follicle
- e) Ovulation
- f) Corpus luteum
- g) Corpus albicans

Ovarian Cycle

• Follicular Phase (preovulatory):

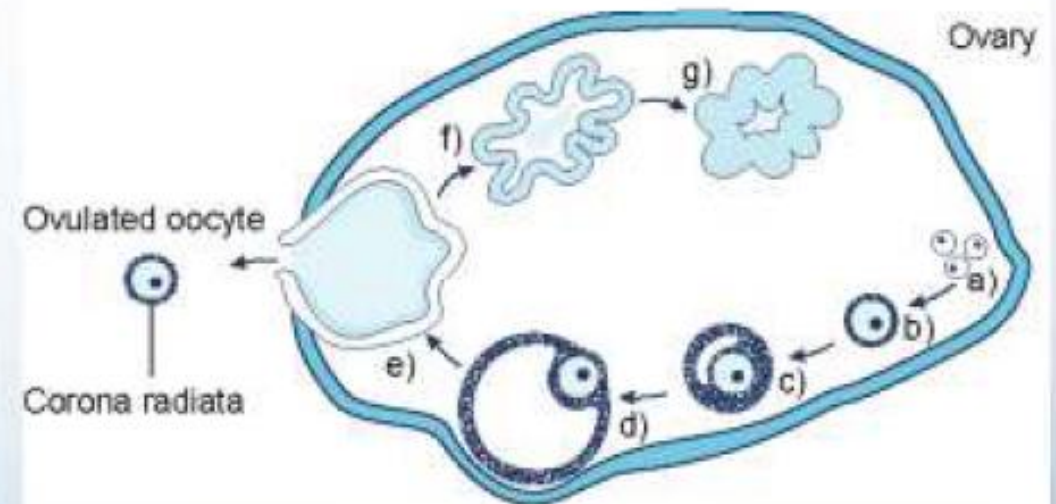
- Recruitment
- Selection of the dominant follicle
- Increasing levels of estradiol and inhibin B

• Ovulatory Phase:

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Ovarian Cycle

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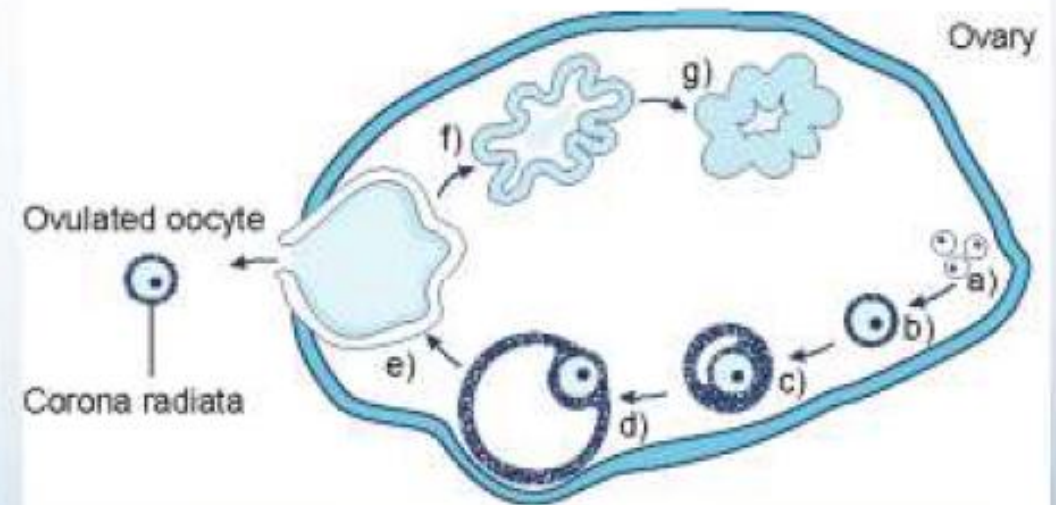
- Recruitment
- Selection of the dominant follicle
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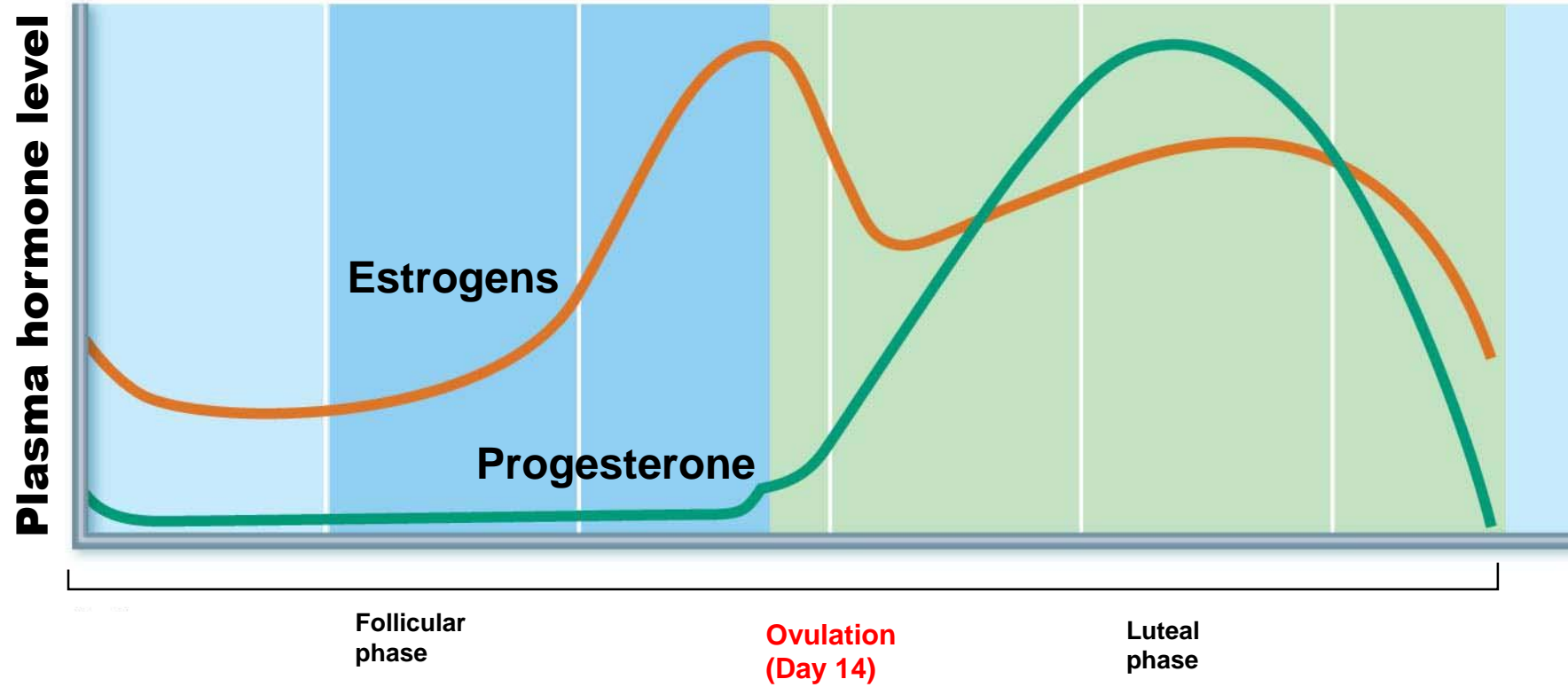
- Formation of corpus luteum
- Increasing levels of progesterone
- Secretory changes in endometrium



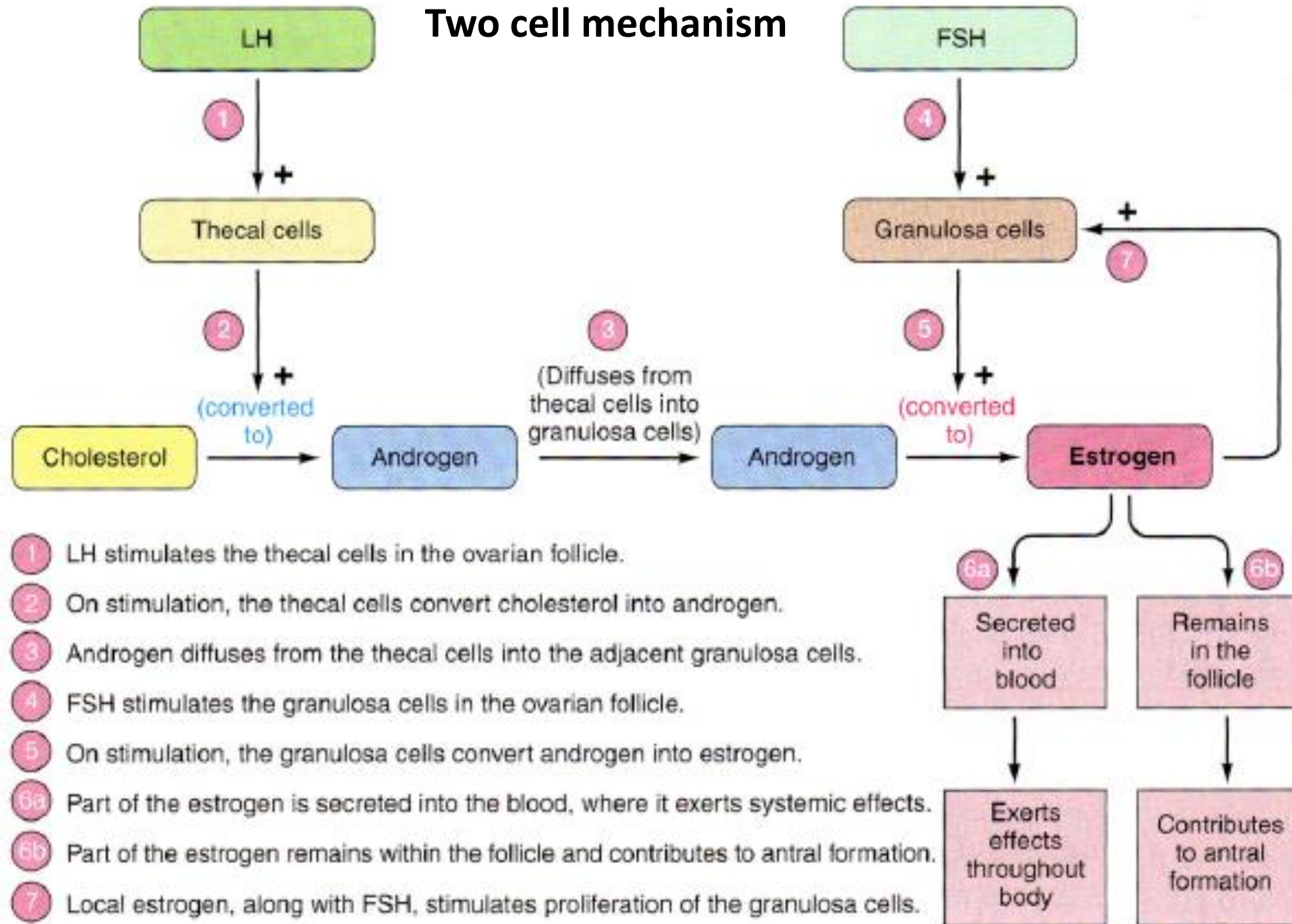
Schematic diagram of an ovary.

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Estrogens and Progesterone

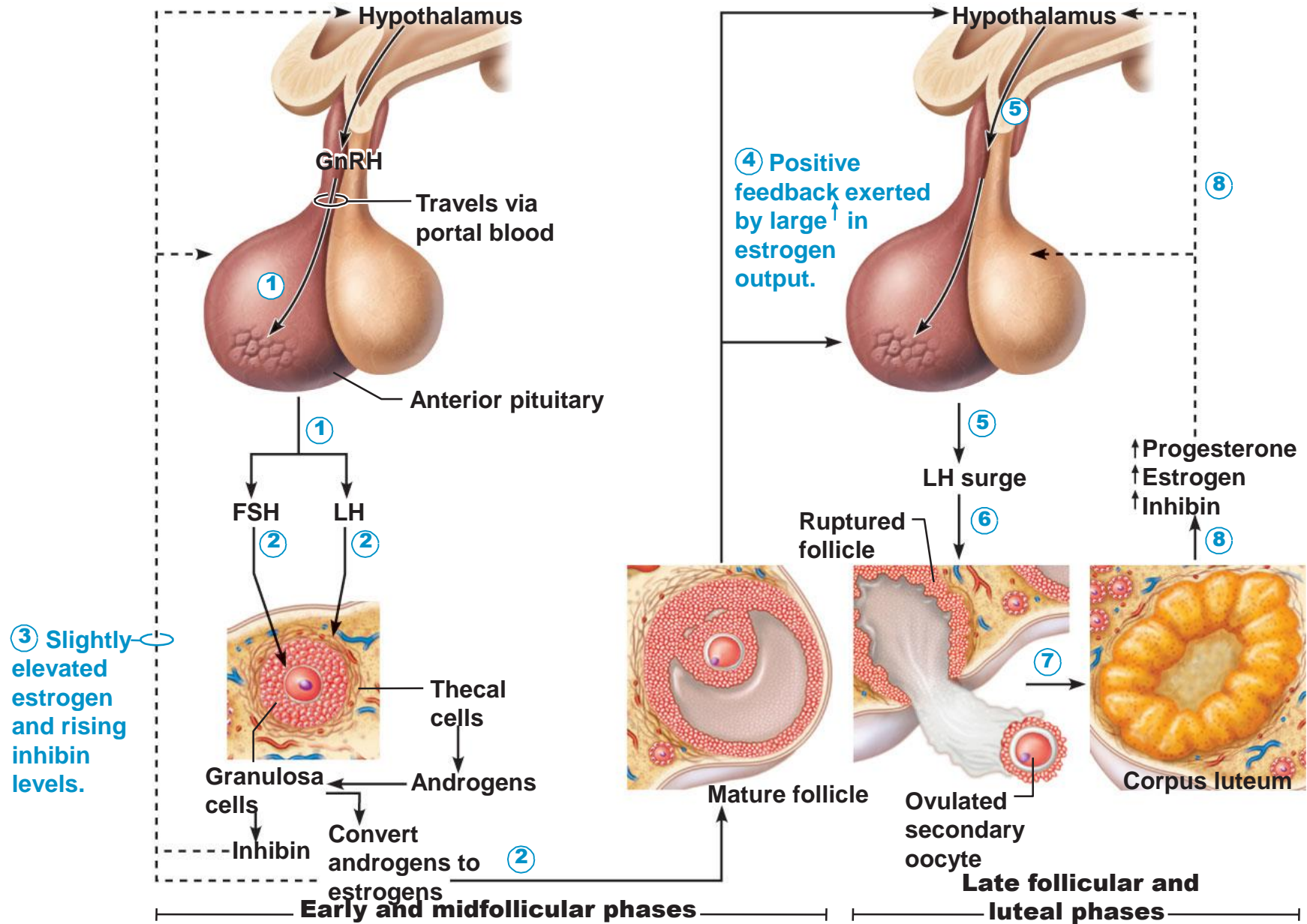


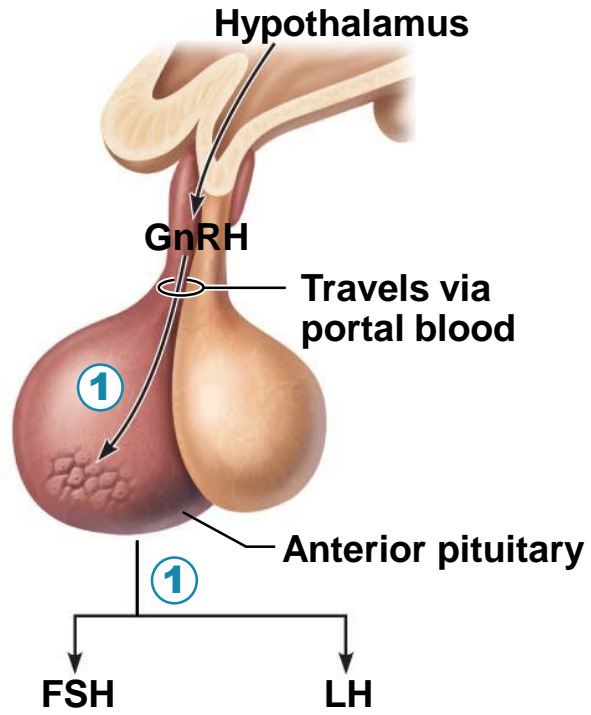
Two cell mechanism



- 1 LH stimulates the thecal cells in the ovarian follicle.
- 2 On stimulation, the thecal cells convert cholesterol into androgen.
- 3 Androgen diffuses from the thecal cells into the adjacent granulosa cells.
- 4 FSH stimulates the granulosa cells in the ovarian follicle.
- 5 On stimulation, the granulosa cells convert androgen into estrogen.
- 6a Part of the estrogen is secreted into the blood, where it exerts systemic effects.
- 6b Part of the estrogen remains within the follicle and contributes to antral formation.
- 7 Local estrogen, along with FSH, stimulates proliferation of the granulosa cells.

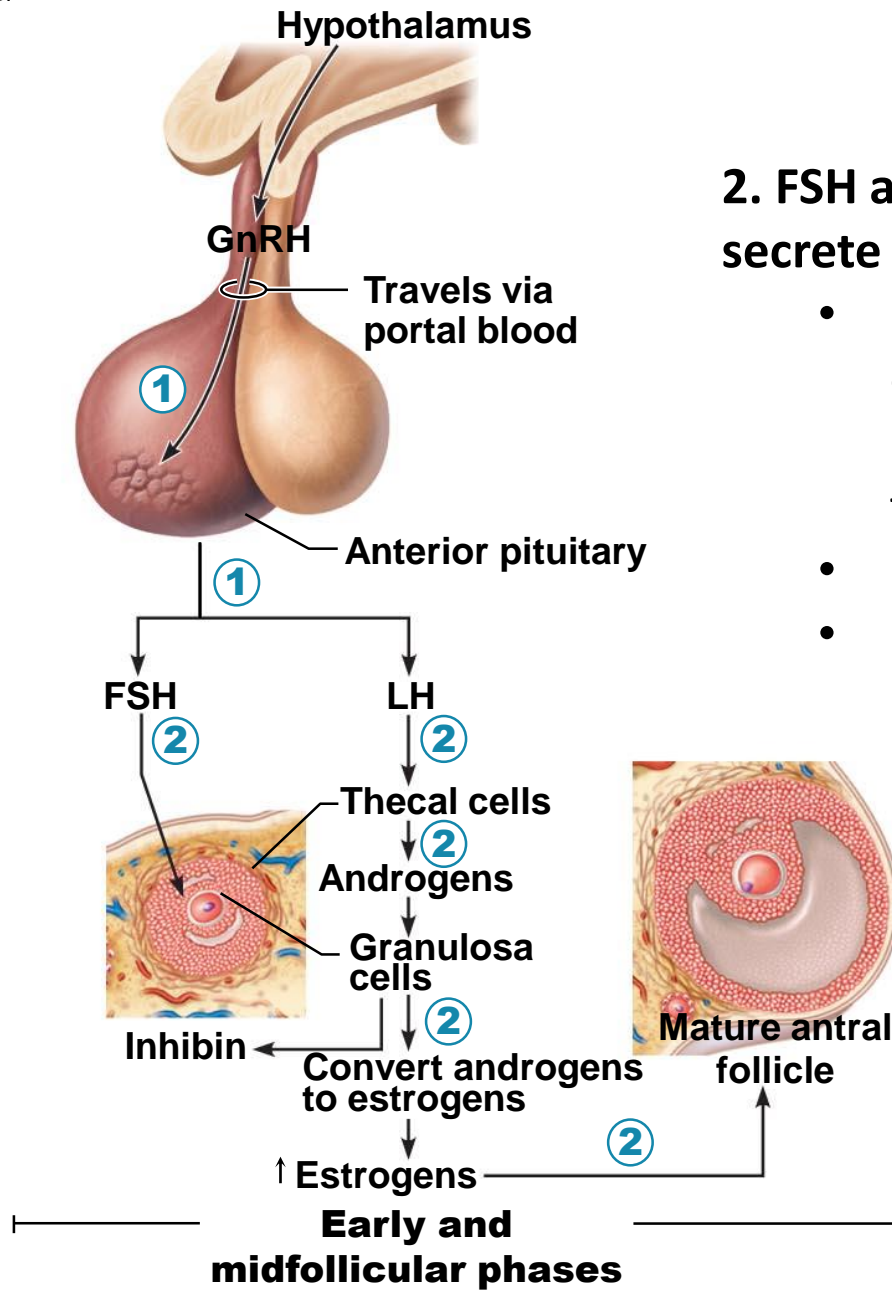
Hormonal regulation of ovarian activity





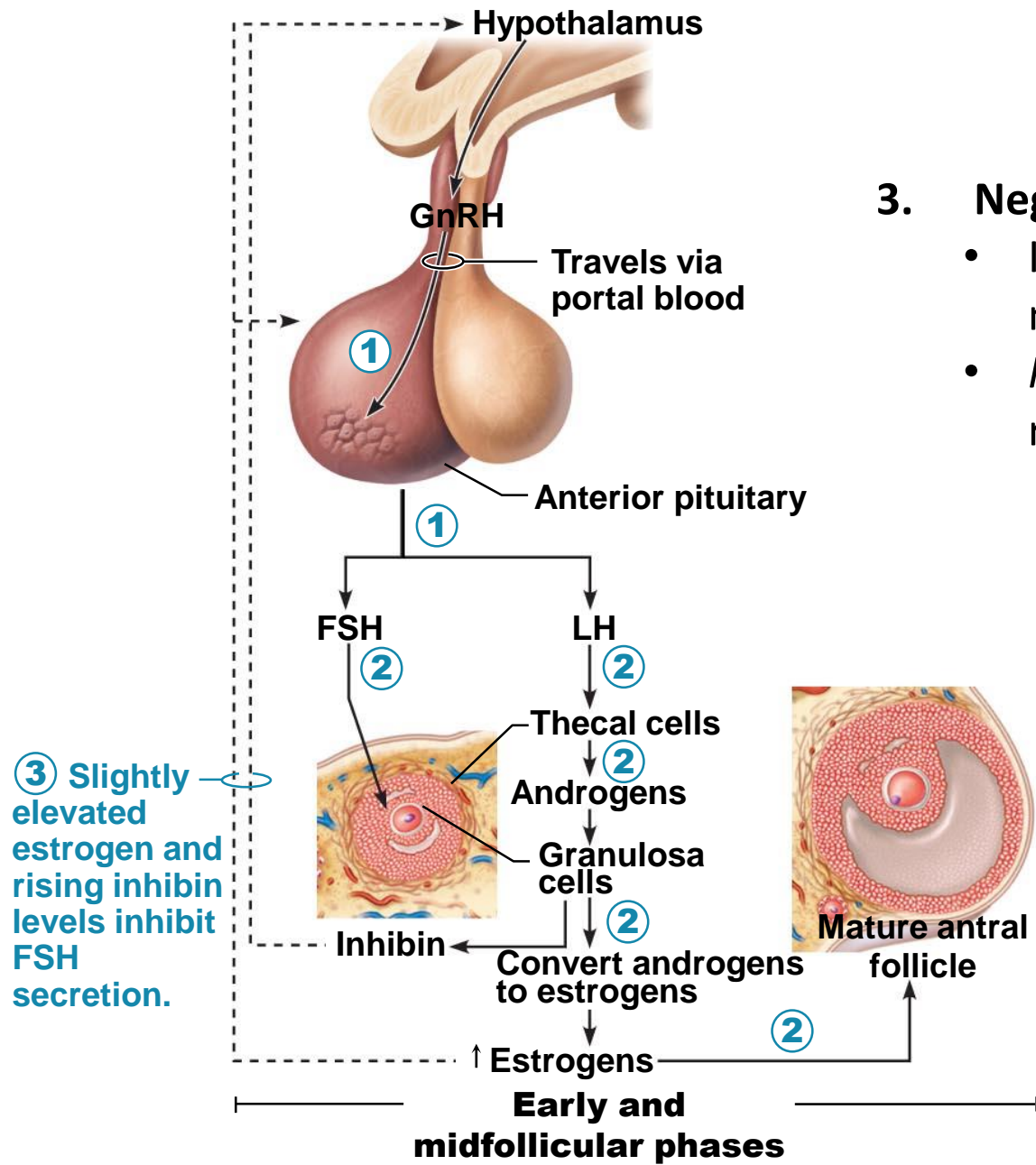
1. GnRH stimulates FSH and LH secretion

Early and midfollicular phases



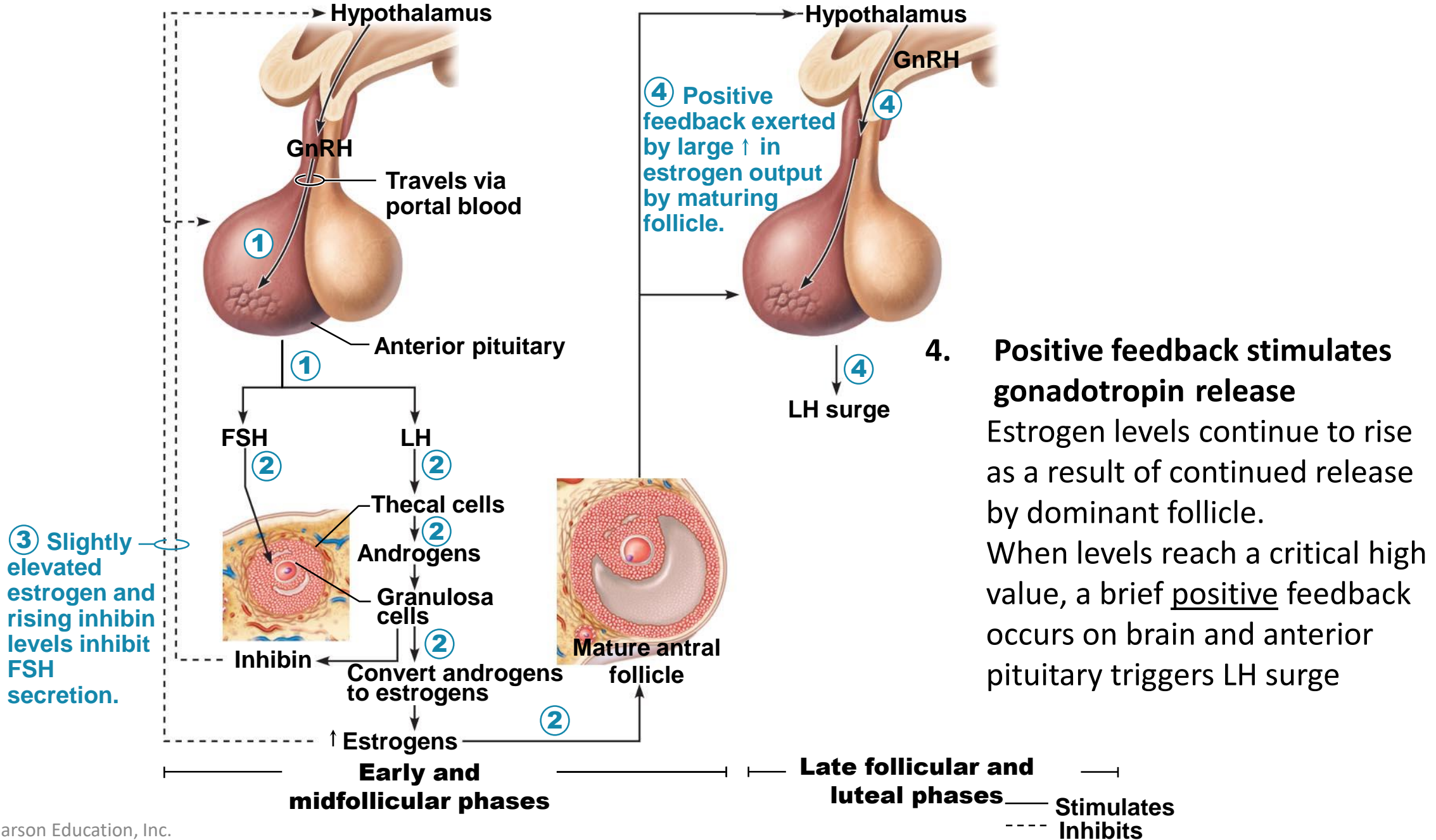
2. FSH and LH stimulate follicles to grow, mature, and secrete sex hormones

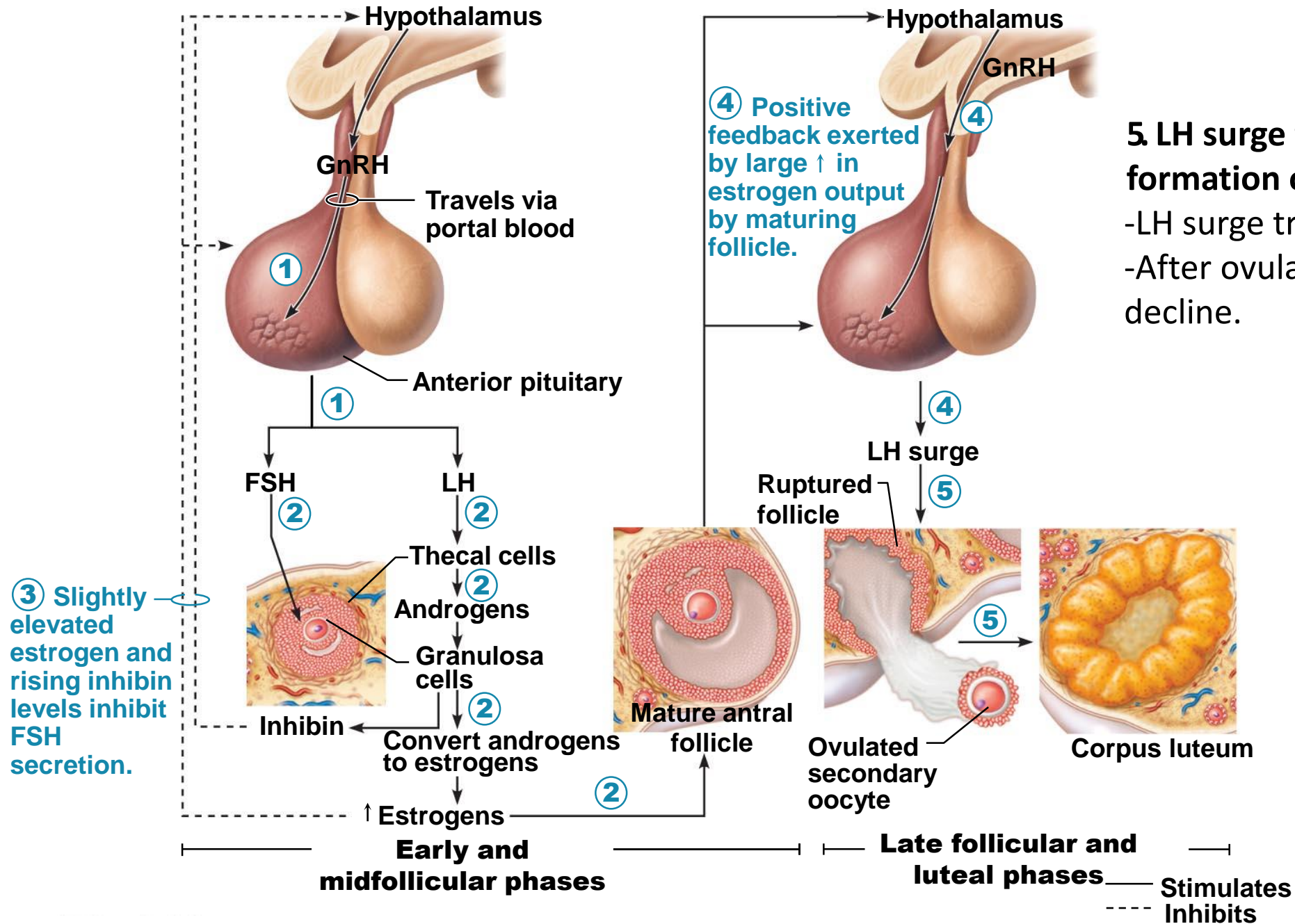
- FSH stimulates granulosa cells to release estrogen, and LH induces thecal cells to produce androgens, which granulosa converts to estrogens.
- Dominant follicle is recruited.
- Other developing follicles deteriorate

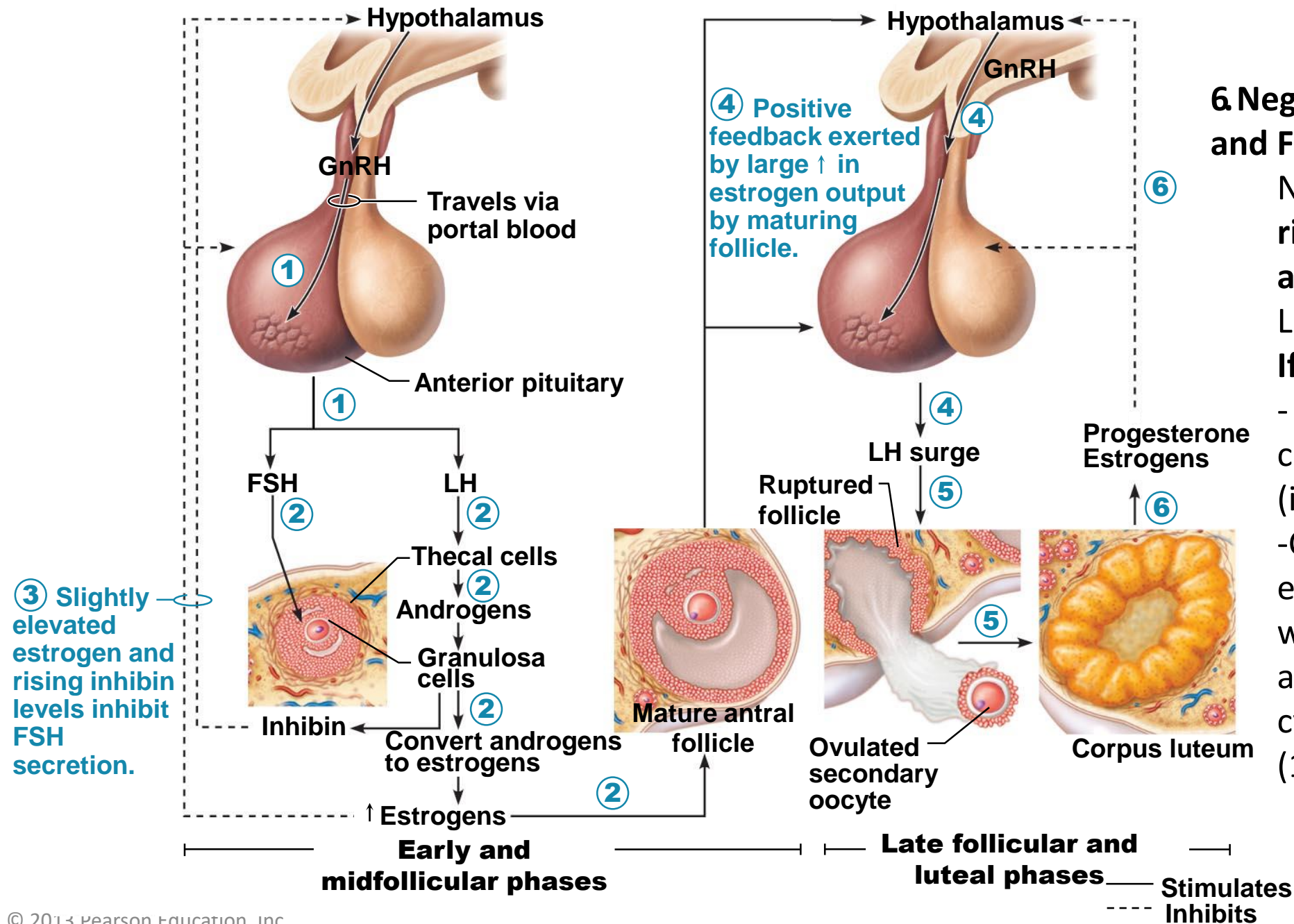


3. Negative feedback inhibits gonadotropin release

- Increasing levels of plasma estrogen exert negative feedback inhibition on FSH release.
- *Inhibin* from granulosa cells also inhibits FSH release.







6. Negative feedback inhibits LH and FSH release

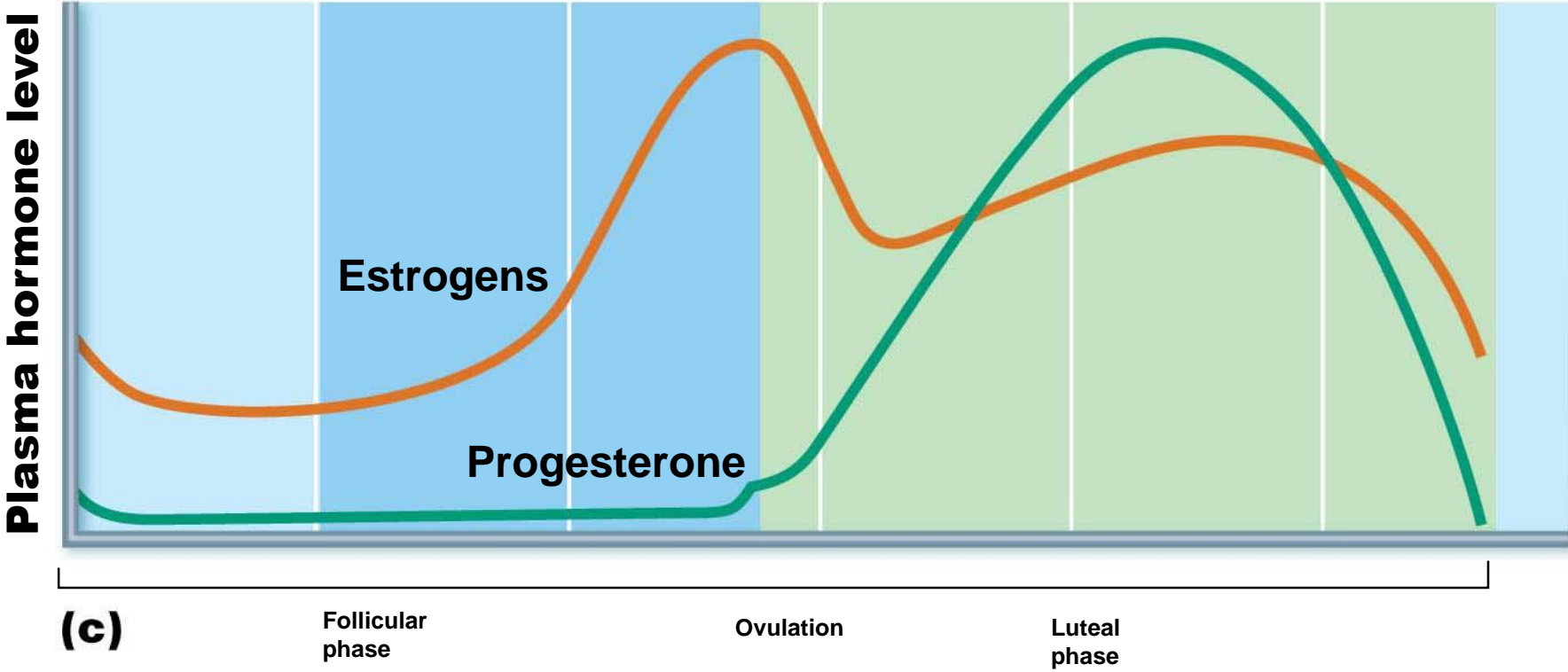
Negative feedback from rising plasma progesterone and estrogen levels inhibits LH and FSH release.

If no fertilization occurs:

- when LH levels start to fall corpus luteum degenerates (in humans).

- Causes a sharp decrease in estrogen and progesterone, which ends blockage of FSH and LH secretion, causing cycle to start all over again (1)

Estrus cycle in domestic animals



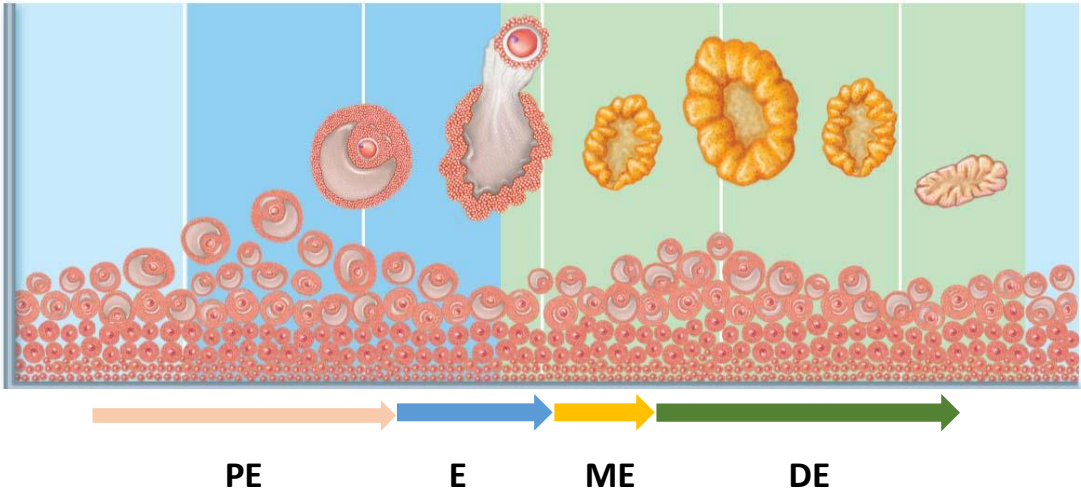
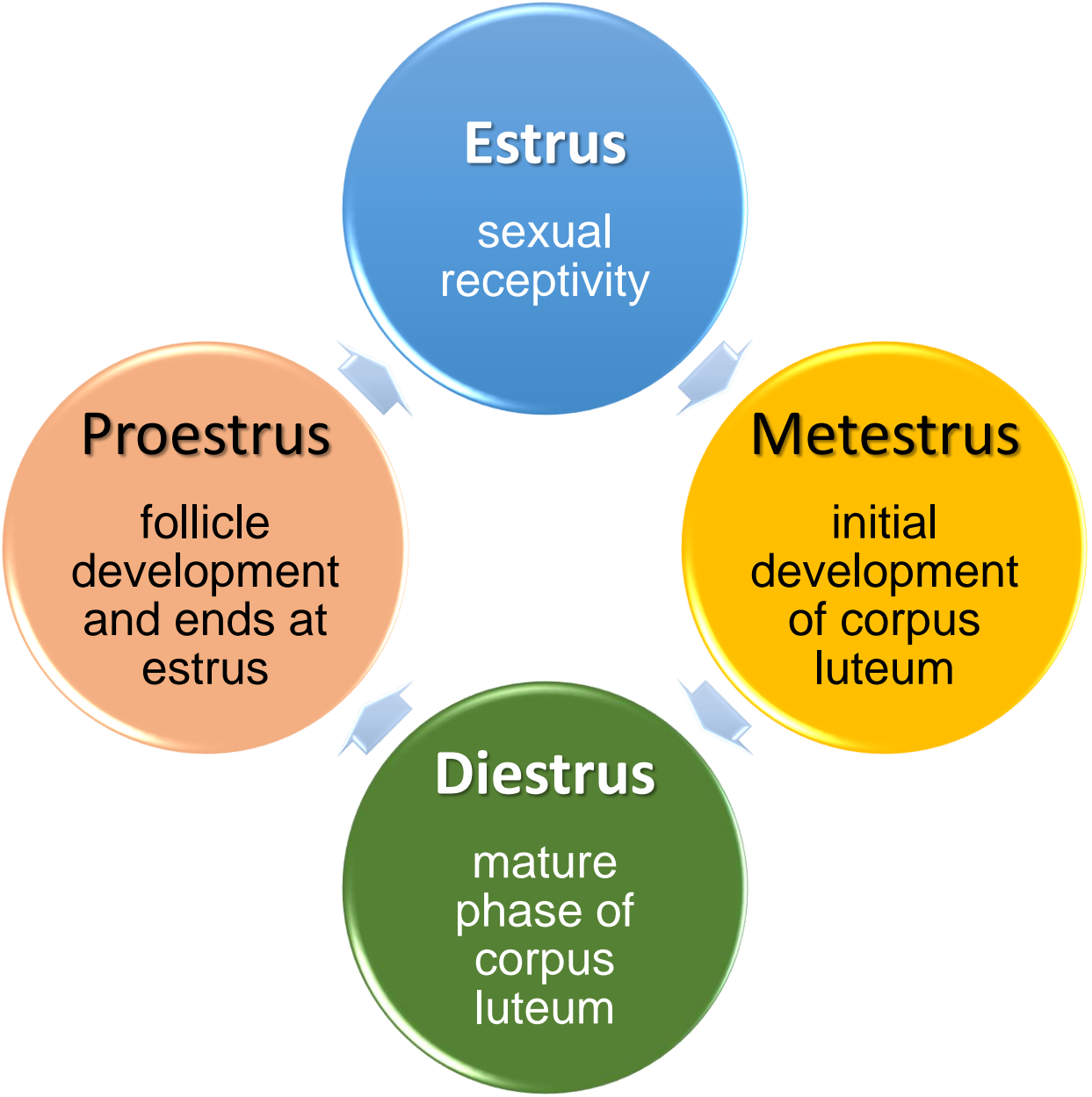
(c)

Follicular phase

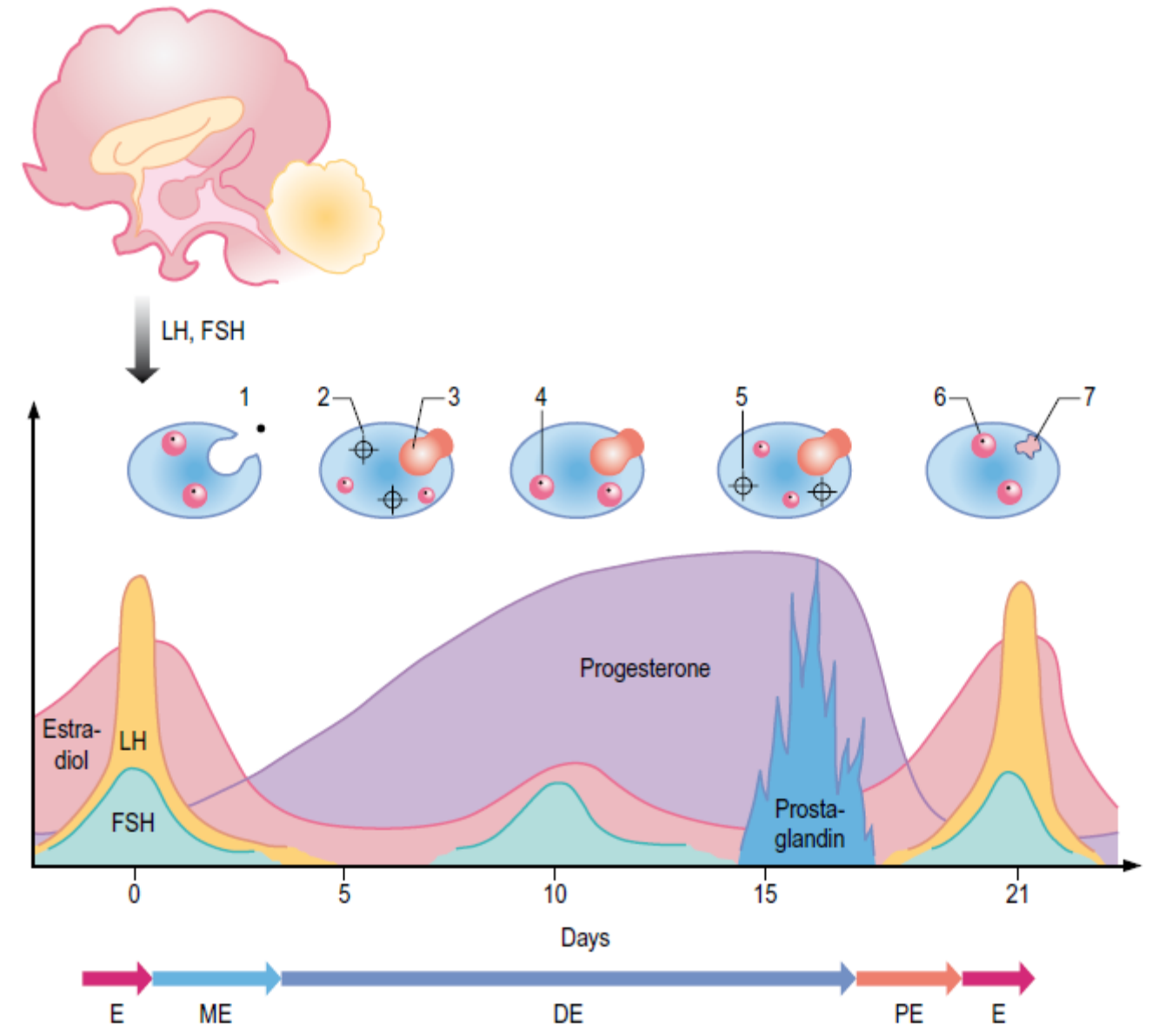
Ovulation

Luteal phase

The estrous cycle is subdivided into 4 stages:



Estrous cycle



The estrus cycle and time of ovulation in domestic animal species

Species	Cycle length	Duration of oestrus	Time of ovulation
Cattle	21 (18–24) days ¹	4–24 hours	12 (10–15) hours after end of oestrus
Horse	21 (18–24) days ²	3–9 days	24–48 hours before end of oestrus
Swine	21 (18–24) days ¹	2–3 days	38–48 hours after onset of oestrus
Sheep	17 (14–19) days ²	18–72 hours	18–20 hours after onset of oestrus
Goat	19–21 days ²	22–60 hours	Near the end of oestrus
Dog	Monocyclic (up to 2 months)	9 days	1–2 days after onset of oestrus
Cat	14–21 days ²	4–10 days ³	Induced ovulation

¹Non-seasonal polycyclic; ²seasonally polycyclic; ³4 days if ovulation is induced.

Nonseasonal continuously polycyclic (polyestrus) animals (throughout the year):

- Sow
- Cow

Seasonally polycyclic (polyestrus) (cyclicity is profoundly influenced by the timing of light):

- Mare (cyclic activity only from spring to autumn)
- Ewe (cyclic activity during autumn and early winter)
- Queen (cyclic activity with increasing daylight)

Monocyclic (monoestrus) animals (one or two estrous periods per year):

- Bitch

In seasonal polycyclic and monocyclic species, the cyclicity is interrupted by longer periods of **anoestrus**.

Phase ¹	Characteristics
Prooestrus	The phase immediately preceding oestrus. The main hormones being produced in the ovary are oestrogens.
Oestrus	The period (under natural conditions) of acceptance of the male. Ovulation occurs during this phase in all domestic species, with the exception of the cow where it occurs shortly afterwards. The main hormones being produced in the ovary, in response to FSH and LH, are oestrogens.
Metoestrus	The phase succeeding oestrus when the male is no longer accepted. Period of corpus luteum formation. The main hormone being produced in the ovary is progesterone.
Dioestrus	The period of the mature, functional corpus luteum. The main hormone being produced in the ovary is progesterone.
Anoestrus	The prolonged phase of sexual rest interrupting oestrous cyclicity in some species. The reproductive system is mainly quiescent.

Estrous cycle

