

## **Reproductive Physiology**

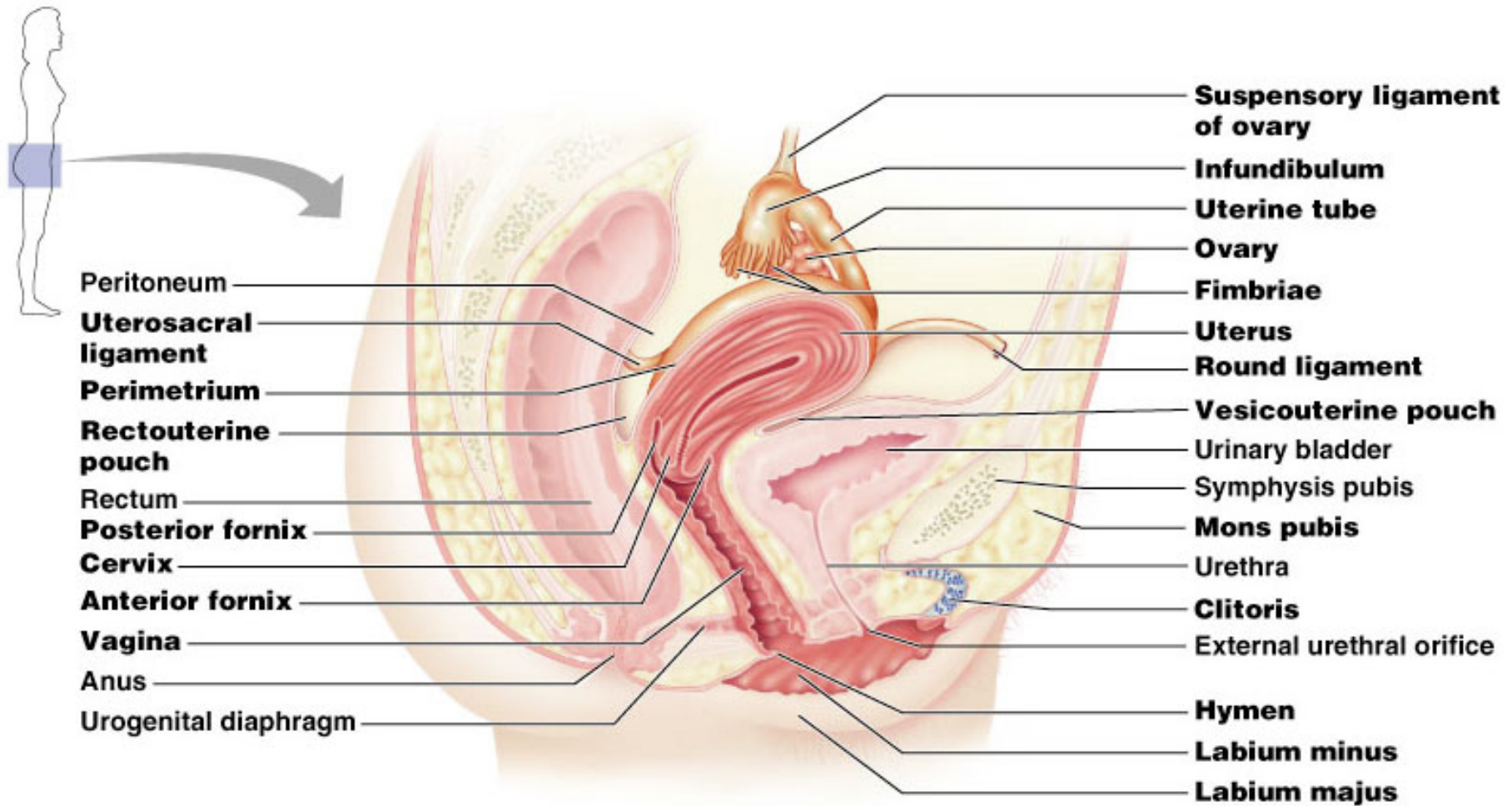
# **The Female Reproductive System**

# Female Reproductive Anatomy

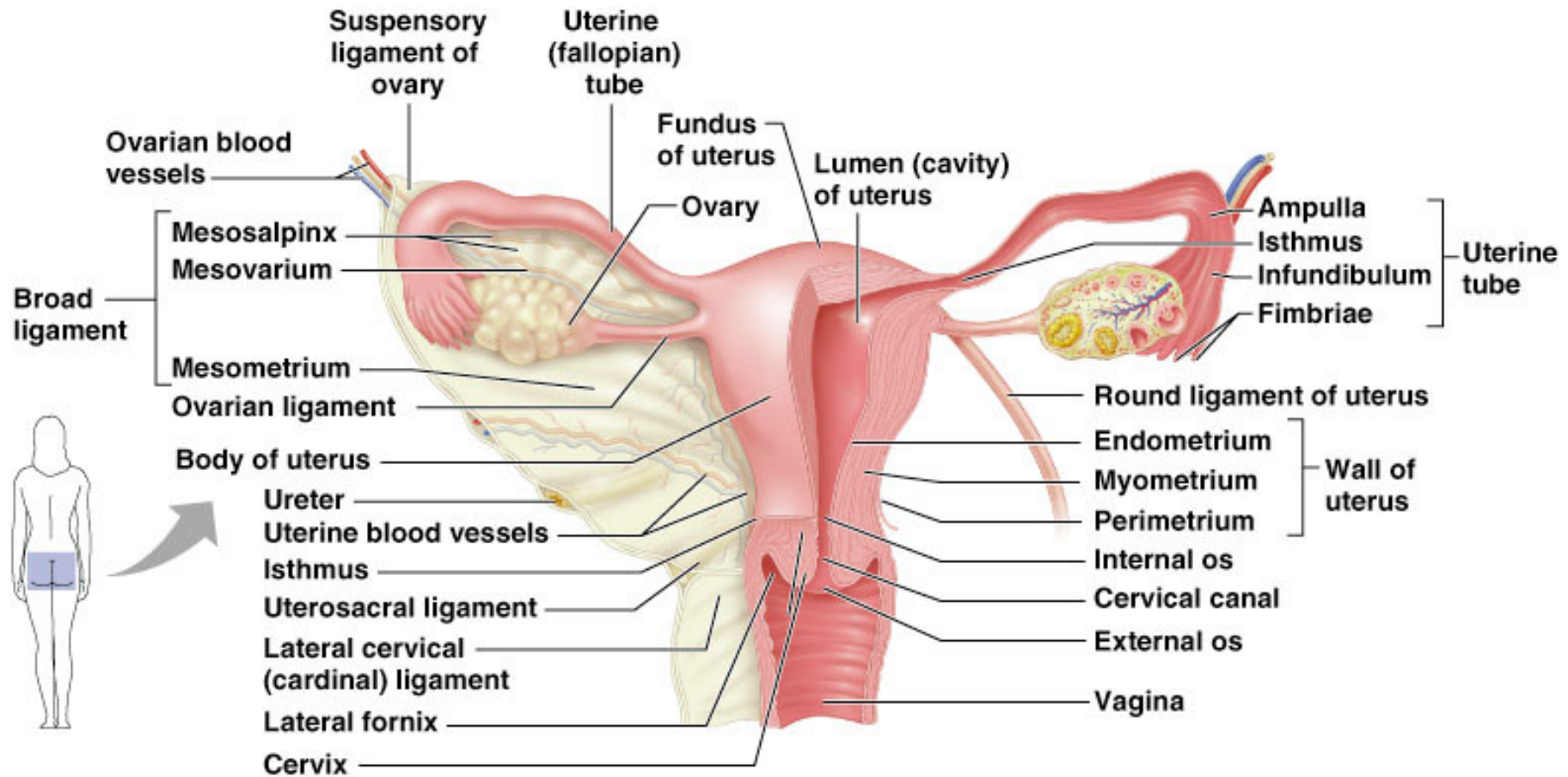
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- Ovaries are the primary female reproductive organs
  - Make female gametes (ova)
  - Secrete female sex hormones (estrogen and progesterone)
- Accessory ducts include uterine tubes, uterus, and vagina
- Internal genitalia – ovaries and the internal ducts
- External genitalia – external sex organs

# Female Reproductive Anatomy

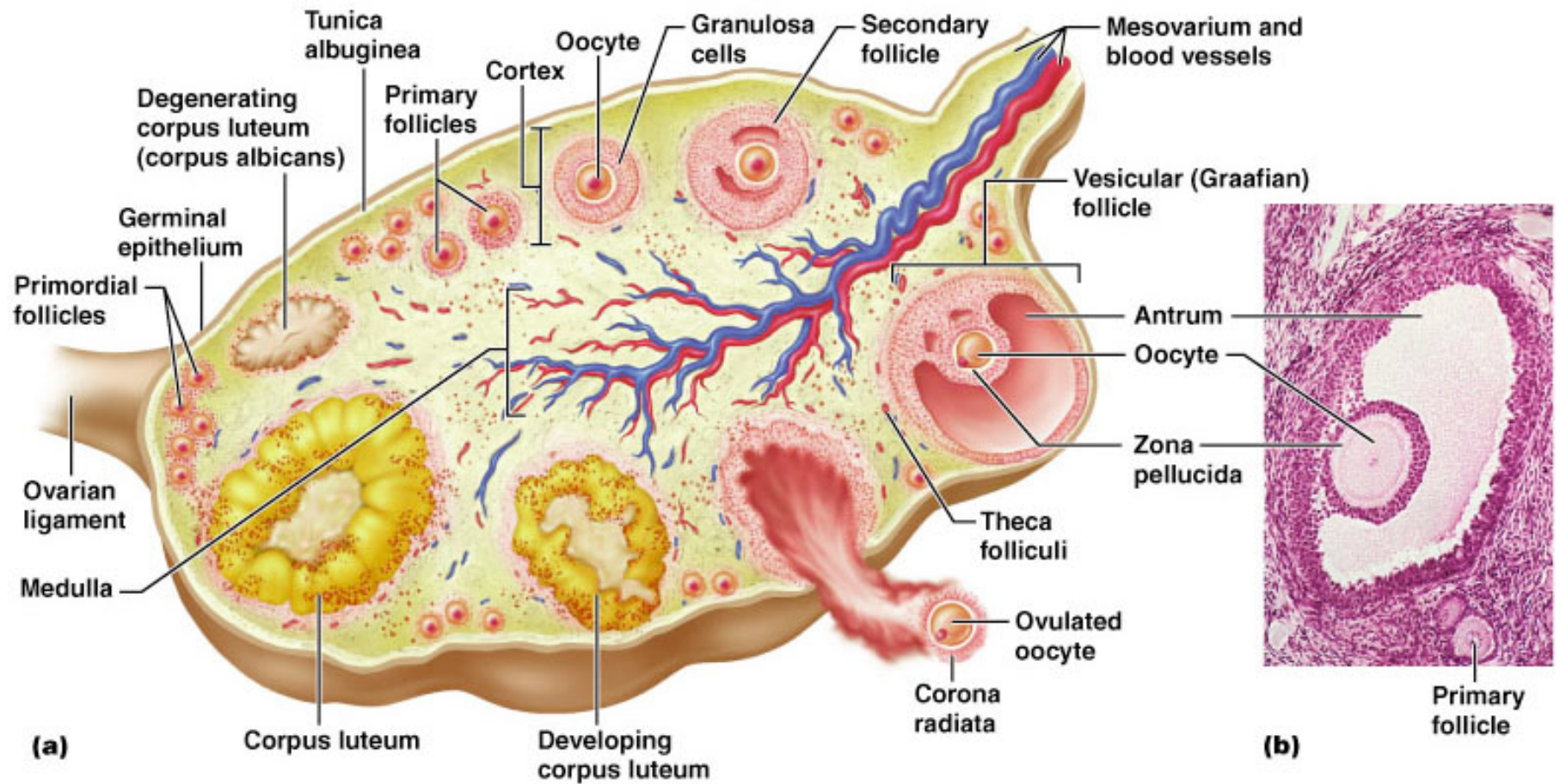


# The Ovaries



(a)

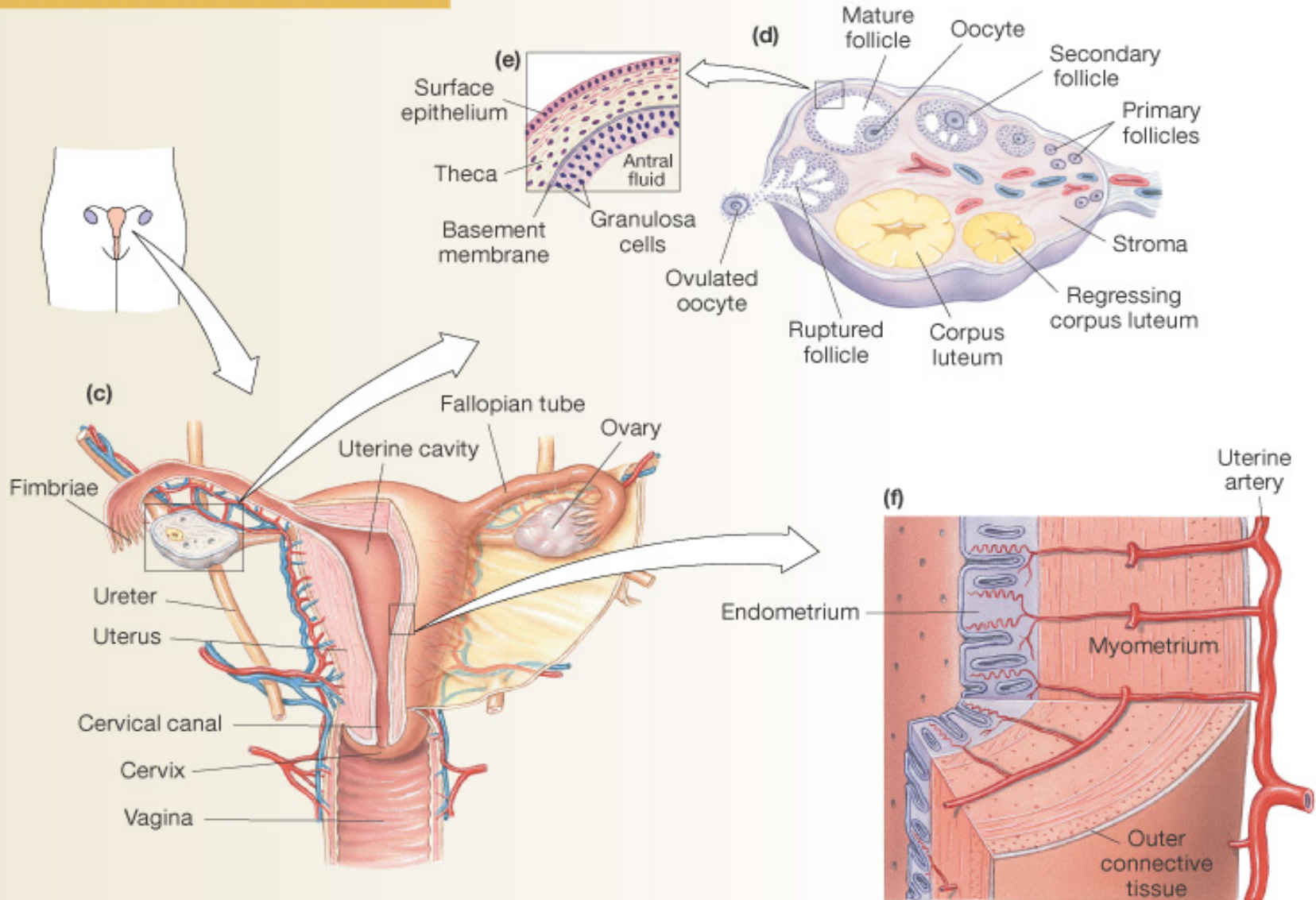
# Ovaries





# Ovary: histology

## STRUCTURE OF THE UTERUS AND OVARY



# Ovarian Cycle

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- Monthly series of events associated with the maturation of an egg
- Starts at puberty (beginning of the menstrual cycles is termed menarche)
- Average duration 28 days (20-45 days)
- Phases of ovarian cycle:
  - Follicular phase – period of follicle growth (days 1–14)
  - Luteal phase – period of corpus luteum activity (days 14–28)
  - Ovulation occurs midcycle (day 14)

# Follicular Phase

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- Upon FSH stimulation, (6-12) primordial follicles becomes a primary follicle (one layer of cells)
- Primary follicle then becomes a secondary follicle
  - The theca and granulosa cells cooperate to produce estrogens
  - The antrum is formed
- Before ovulation, only one follicle grows and the rest (5-11) becomes atretic

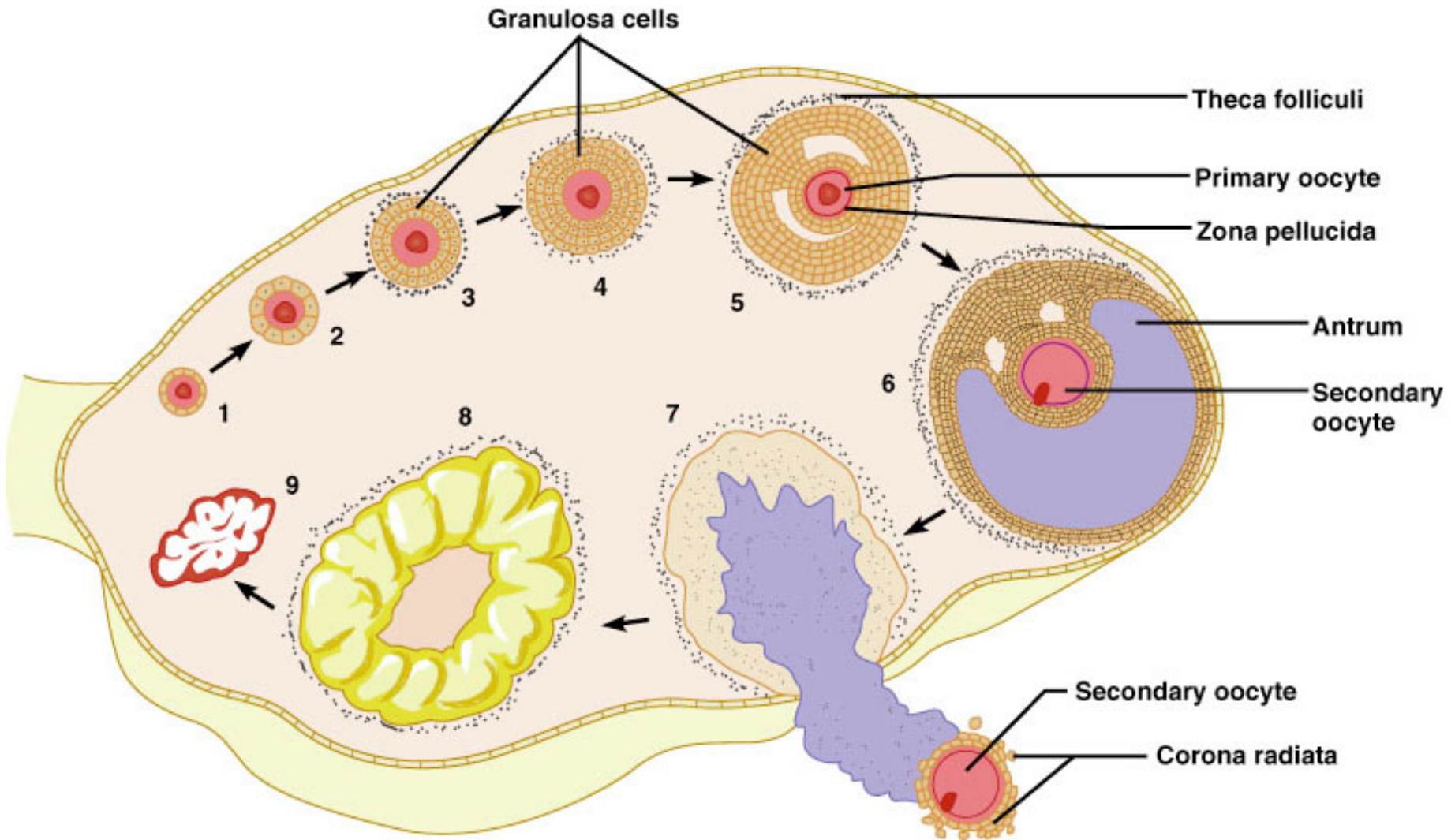


# Follicular Phase (hormonal regulation)

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- GnRH rises in response to a decline in inhibin and sex steroids
- GnRH stimulates rise in pituitary FSH & LH secretion.
- FSH stimulates new follicle growth
- LH induces thecal cell growth, vascularization & androgen synthesis
- FSH stimulates granulosa cell production of E2 & LH receptor

# Ovarian Cycle



# Ovulation

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- Rapidly rising estrogen levels stimulate LH surge (positive feedback-GnRH sensitization) about 2 days before ovulation
- LH surge triggers ovulation
- Ovulation occurs when the ovary wall ruptures and expels the secondary oocyte
- Mittelschmerz – a twinge of pain sometimes felt at ovulation

# Luteal Phase

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- After ovulation, the ruptured follicle collapses, granulosa cells enlarge, and along with internal thecal cells, form the corpus luteum (LH action)
- The corpus luteum secretes progesterone and estrogen
- If pregnancy does not occur, the corpus luteum degenerates in 12 days after ovulation, leaving a scar (corpus albicans)
- If pregnancy does occur, the corpus luteum produces hormones until the placenta takes over that role (at about 3 months)

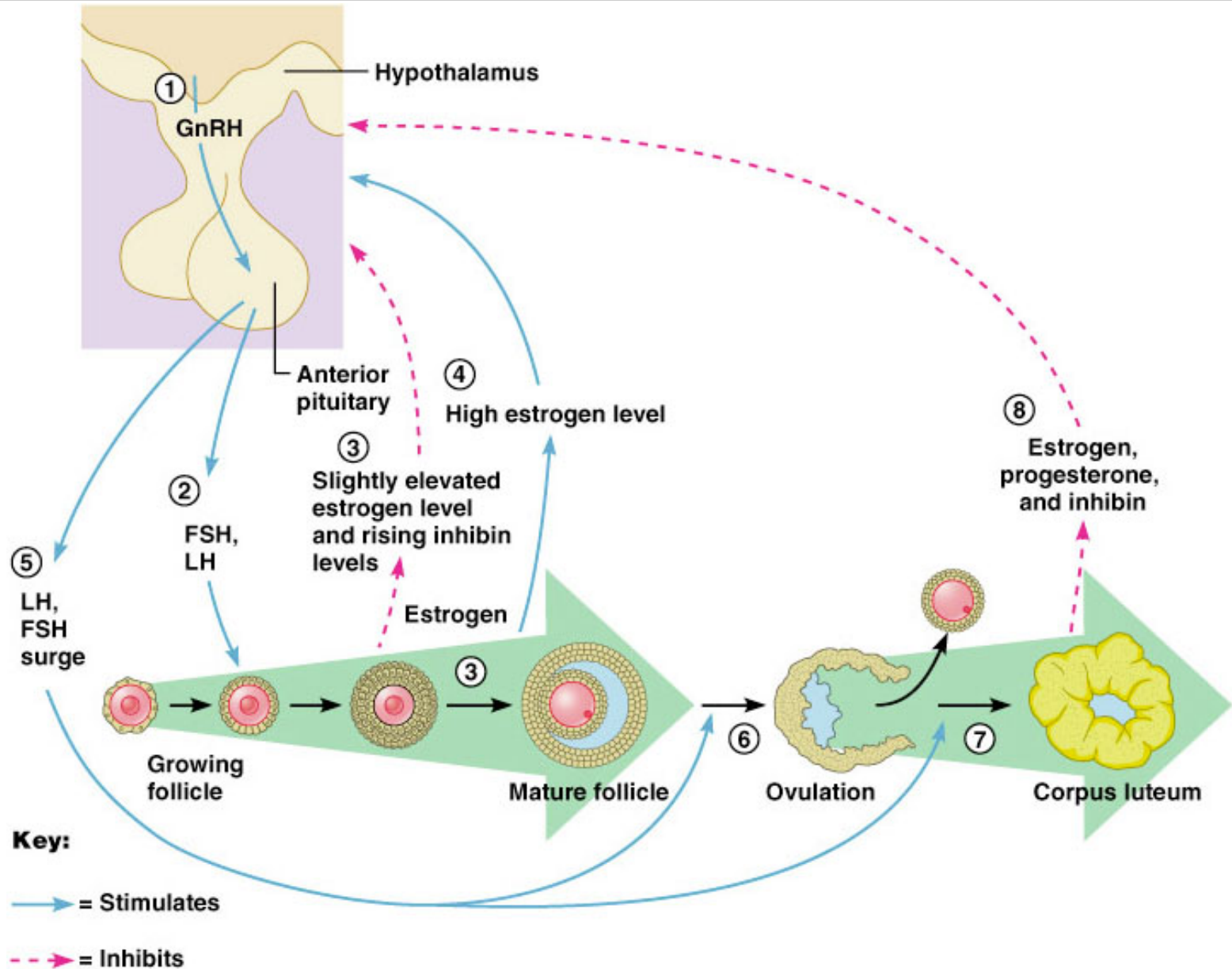
# Luteal Phase (cont.)

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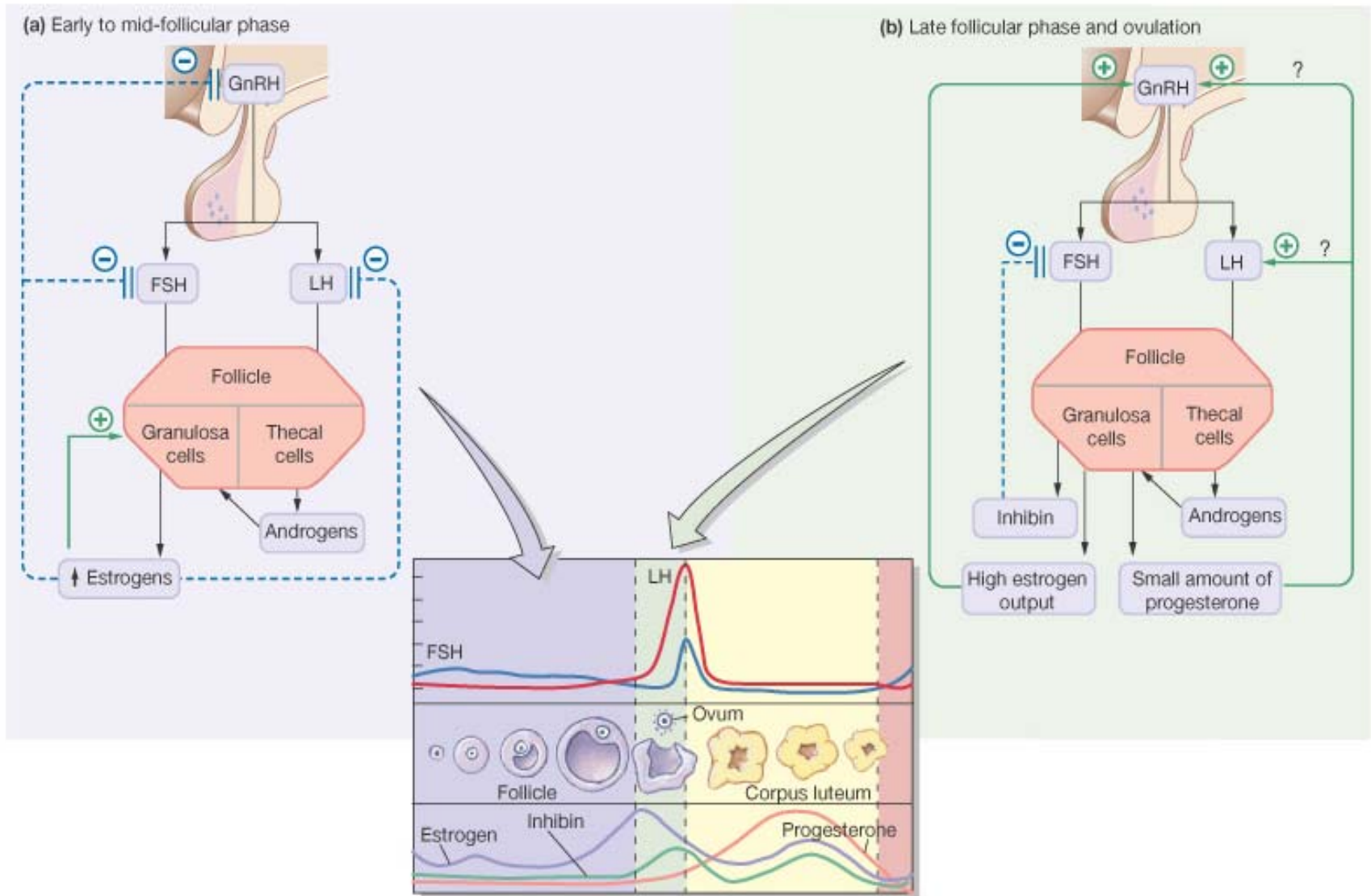
- Estrogens and progesterones shut off FSH and LH release
- Days 26-28 – decline of the ovarian hormones
  - Ends the blockade of FSH and LH
  - The cycle starts anew



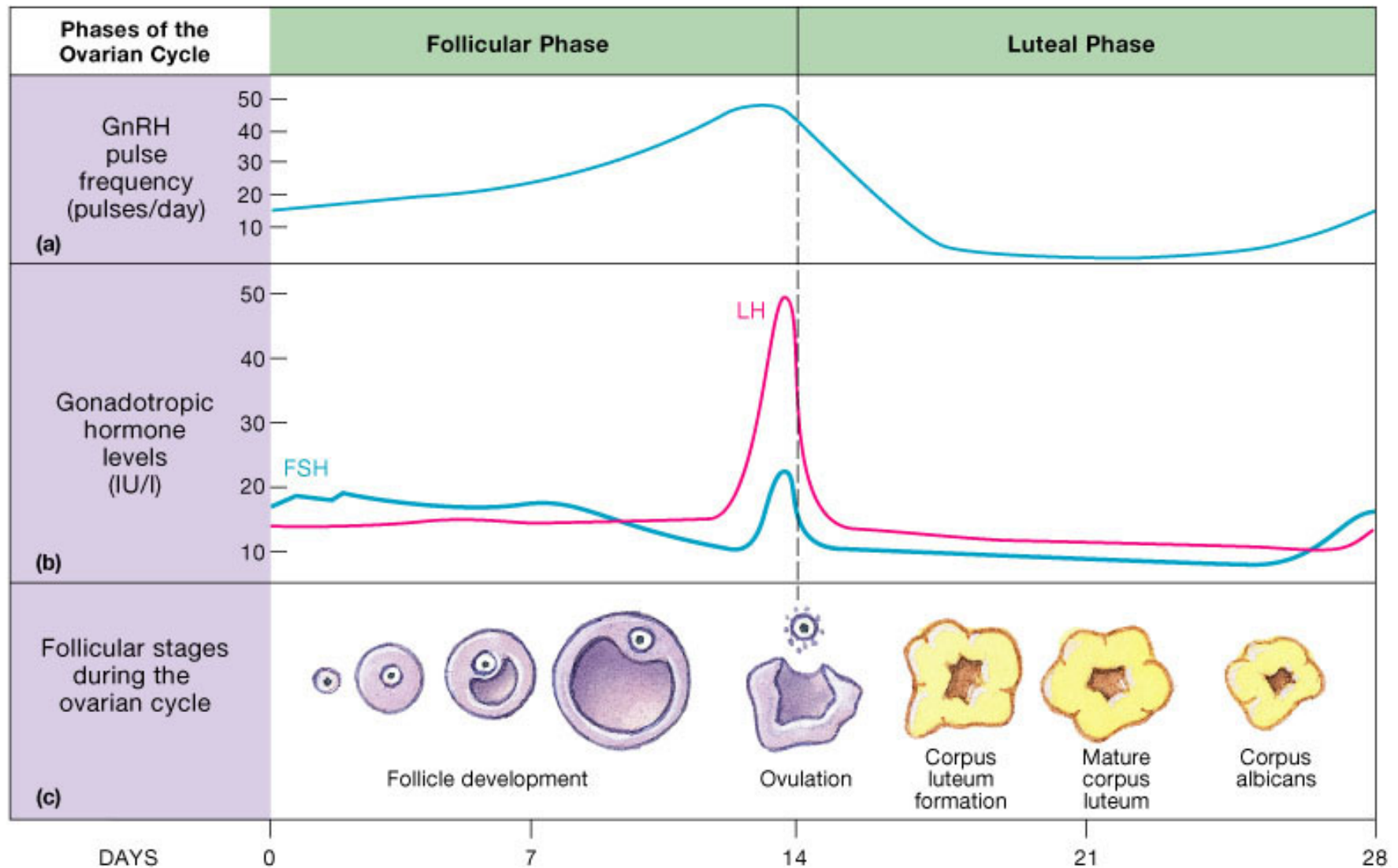
# Feedback Mechanisms in Ovarian Function



# Hormonal Interactions During the Ovarian Cycle



# The Hormonal Regulation of the Female Reproductive Cycle



# Uterine (Menstrual) Cycle

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- Series of cyclic changes that the uterine endometrium goes through each month in response to ovarian hormones in the blood
- Days 1-5: Menstrual phase – uterus sheds all but the deepest part of the endometrium
- Days 6-14: Proliferative (preovulatory) phase – endometrium rebuilds itself
- Days 15-28: Secretory (postovulatory) phase – endometrium prepares for implantation of the embryo

# Menses

- If fertilization does not occur, progesterone levels fall, depriving the endometrium of hormonal support
- Spiral arteries kink and go into spasms and endometrial cells begin to die (prostaglandin effect)
- The functional layer begins to digest itself
- Spiral arteries constrict one final time then suddenly relax and open wide
- The rush of blood fragments weakened capillary beds and the functional layer sloughs
- Fibrinolysin is produced to prevent clotting



# Proliferative Phase (estrogen phase)

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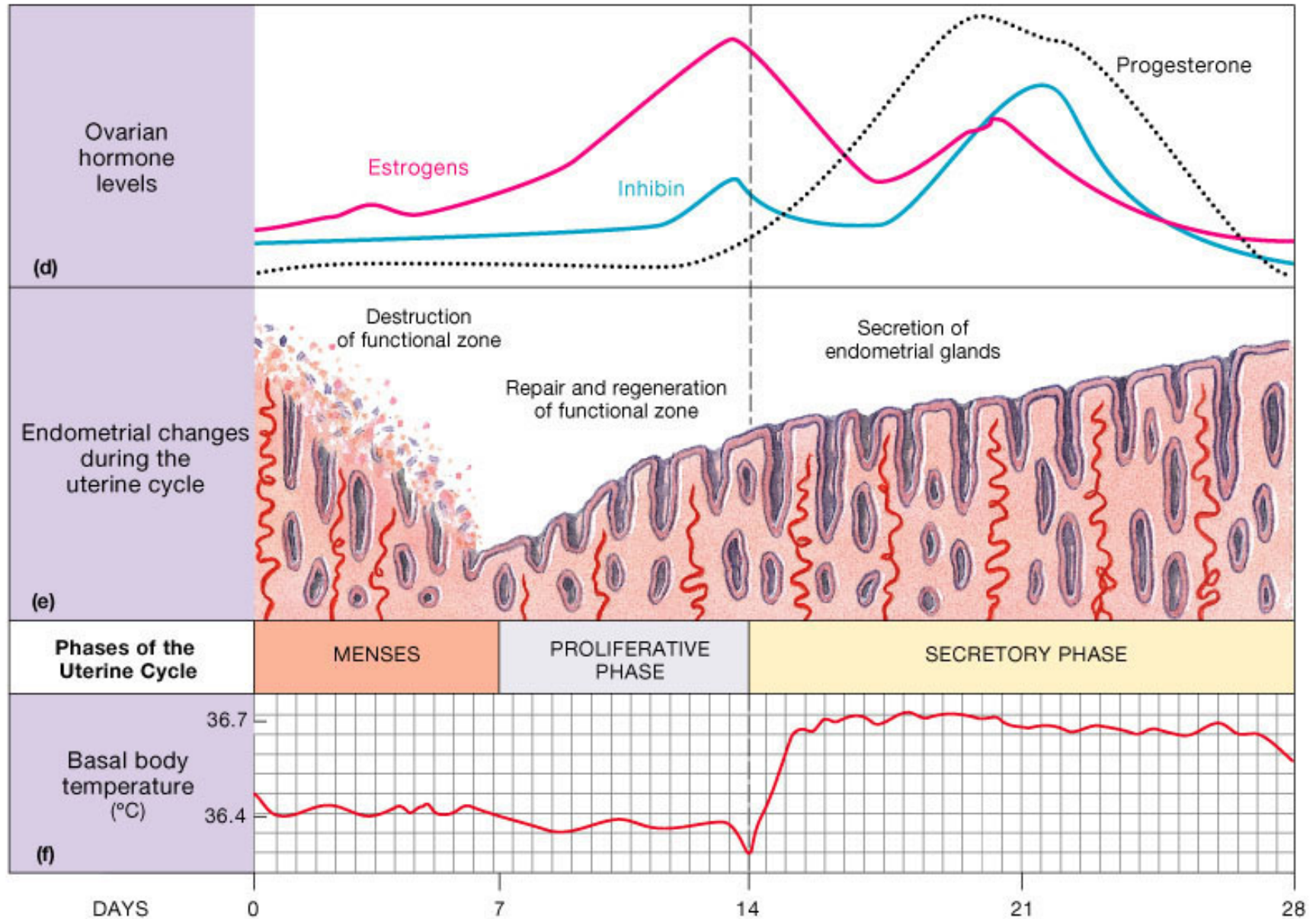
- preovulation
- Rising levels of estrogens cause re-epithelialization of the endometrium, vascularization, and growth of endometrial glands
- At the time of ovulation, the endometrium is 3-5 mm thick

# Secretory Phase (progesterone phase)

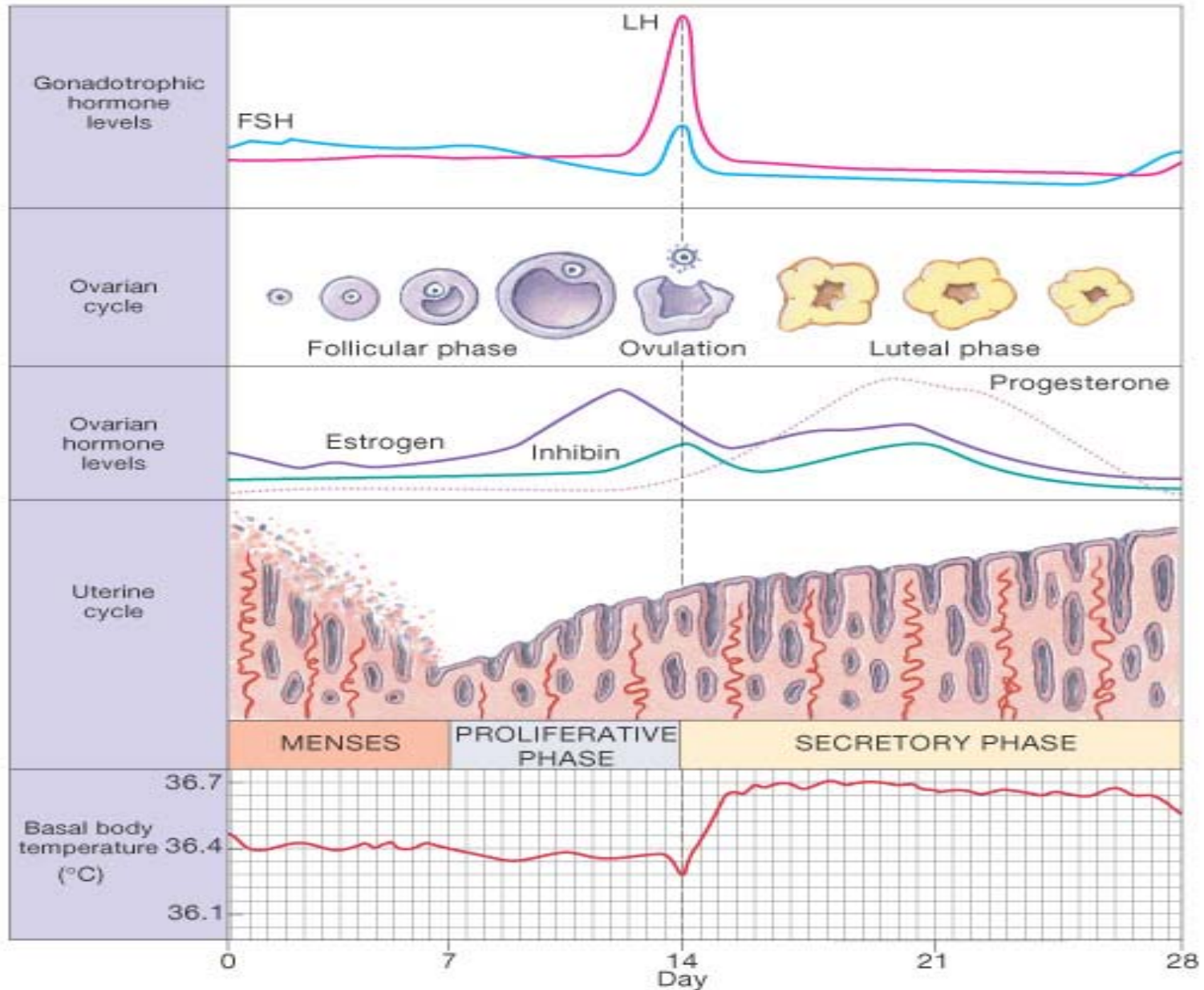
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- After ovulation
- Estrogen and progesterone levels are high
- More growth, progesterone causes swelling and secretory development of the endometrium
- One week after ovulation, the endometrium is 5-6 mm thick
- Provide appropriate conditions for fertilized ovum

# Overview of the Menstrual Cycle



# The Hormonal Regulation of the Female Reproductive Cycle



# Effects of Estrogens

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- Estrogen levels rise during puberty
- Change of vaginal epithelium from stratified cuboidal to.....
- Promote oogenesis and follicle growth in the ovary
- Exert anabolic effects on the female reproductive tract
  - Uterine tubes, uterus, and vagina grow larger and become functional
  - Uterine tubes and uterus exhibit enhanced motility
  - Vaginal mucosa thickens and external genitalia mature
  - In breast, estrogen causes development of stromal cells, ductile system, and fat deposition



# Effects of Estrogens (cont.)

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- Estrogens cause increased osteoblastic activity as well as closure of epiphyseal plates
- The skin is thicker, smoother, and more vascular

# Estrogen-Induced Secondary Sex Characteristics

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- Growth of the breasts
- Increased deposition of subcutaneous fat, especially in the hips and breasts
- Widening and lightening of the pelvis

# Effects of Progesterone

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- Promote secretory changes in the uterus
- Increased secretion of fallopian tubes
- Promote development of ducts and alveoli of the breast

# Female Sexual Response

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- Like in male, depends on psychic and local stimulation
- The clitoris, vaginal mucosa, and breasts engorge with blood
- Activity of vestibular glands lubricates the vestibule and facilitates entry of the penis
- Orgasm – accompanied by muscle tension, increase in pulse rate and blood pressure, and rhythmical contractions of the uterus
- Females do not have a refractory period after orgasm and can experience multiple orgasms in a single sexual experience
- Orgasm is not essential for conception

# Menopause

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- At age 40-50 years
- Ovulation and menses cease entirely
- Without sufficient estrogen, reproductive organs and breasts atrophy
  - Irritability and depression result
  - Skin blood vessels undergo intense vasodilation (hot flushes occur)
  - Gradual thinning of the skin and bone loss