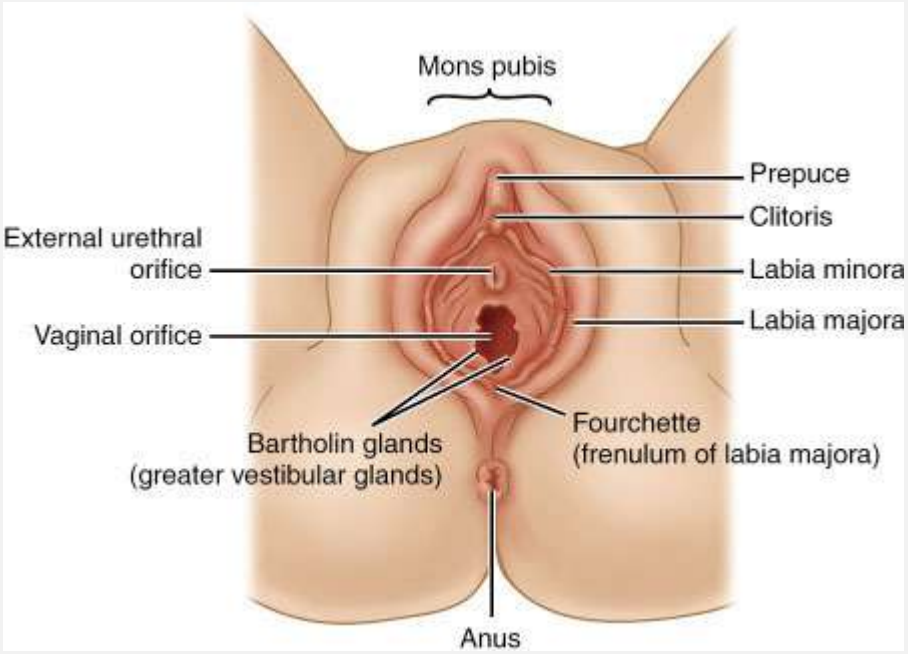
ANATOMY/PHYSIOLOGY

Kallah Teacher Certification

Bat-Sheva L. Maslow, MD

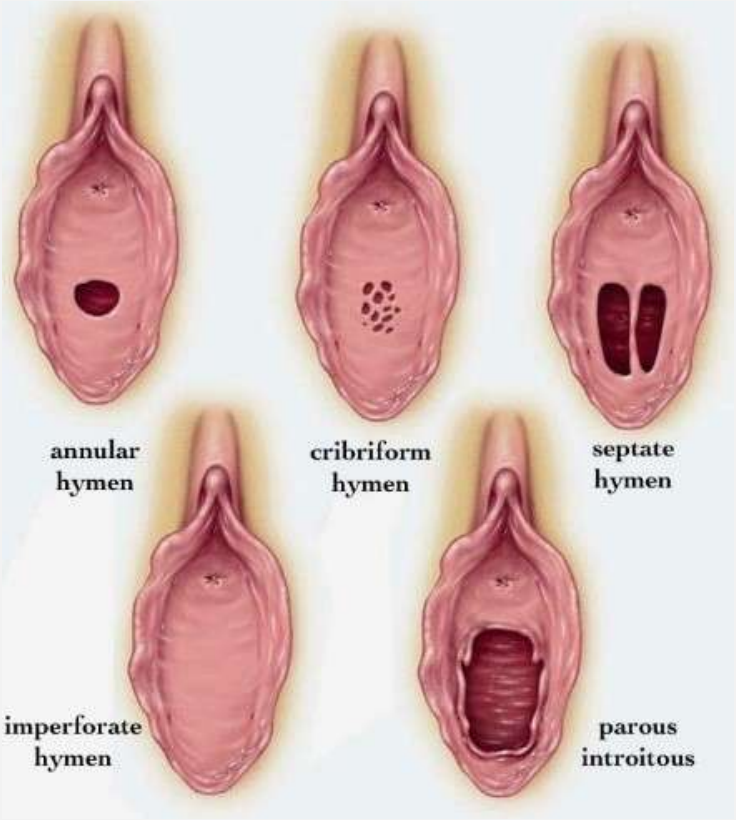
EXTERNAL GENITALIA

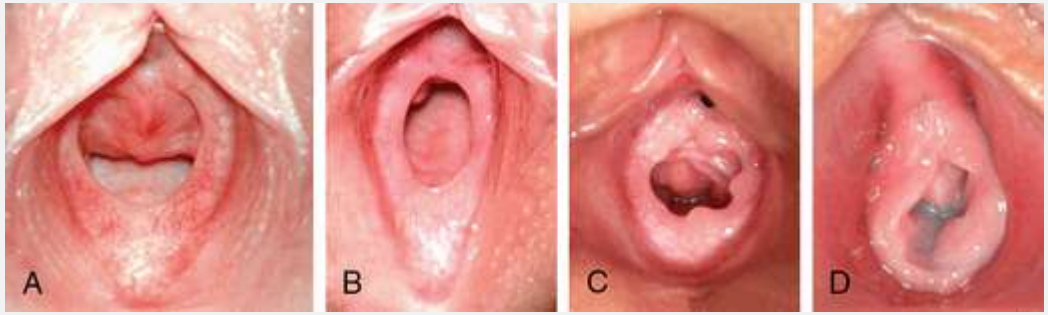
- Mons
- Clitoris
- Labia (Minora/Majora)
- Urethral meatus
- Vaginal meatus (introitus)
- Perineum
- Anus



THE HYMEN

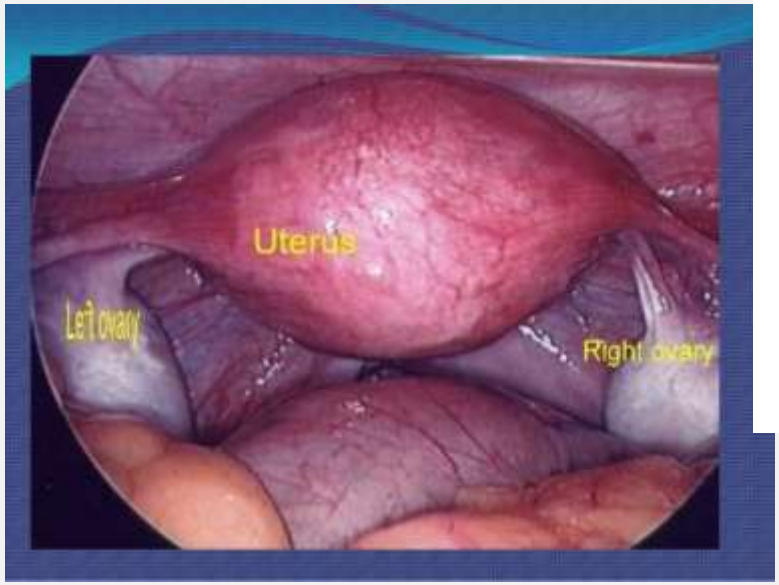
- Part of normal development
- Must have some opening for menstrual flow
- Imperforate/septate require surgical correction to allow for intercourse
- May or may not bleeding with first penetration

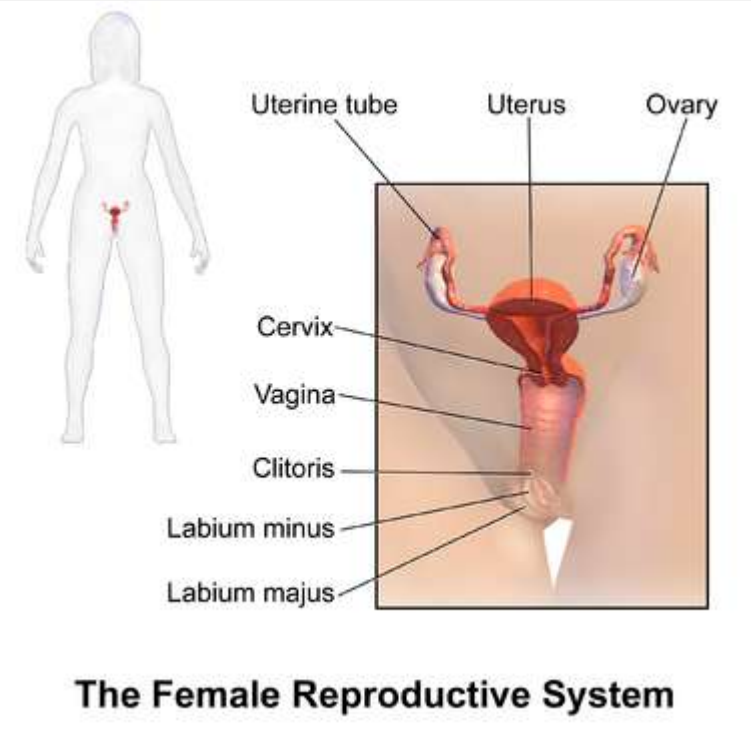




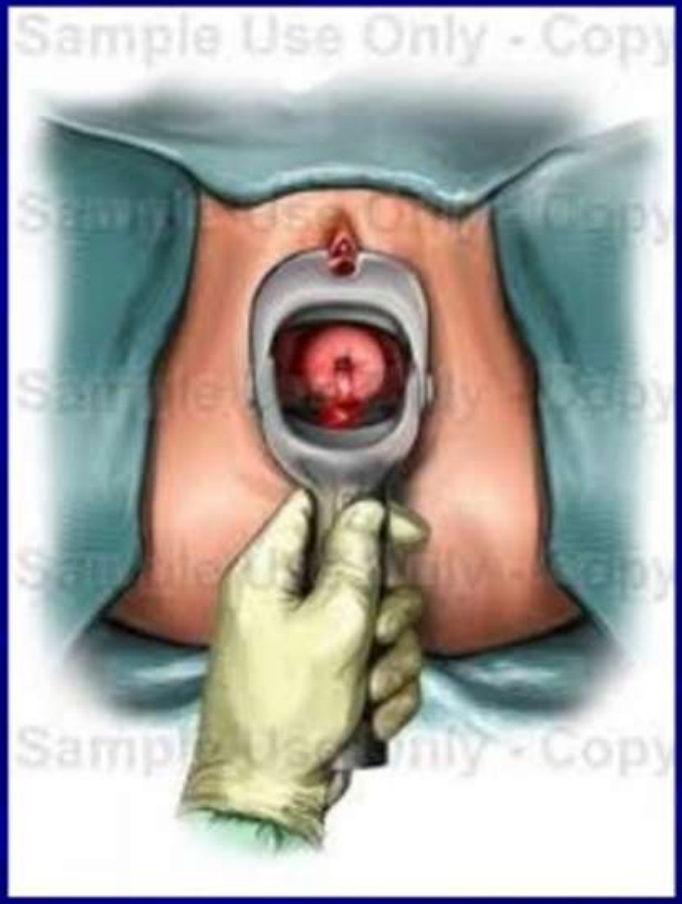
INTERNAL REPRODUCTIVE ORGANS

- Vagina
- Cervix
- Uterus
- Fallopian Tubes
- Ovaries



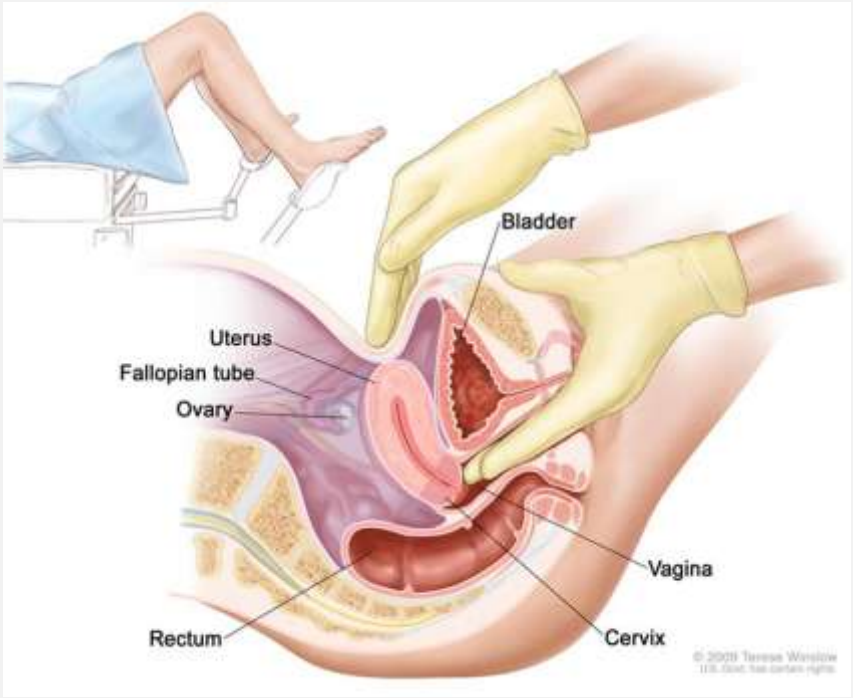


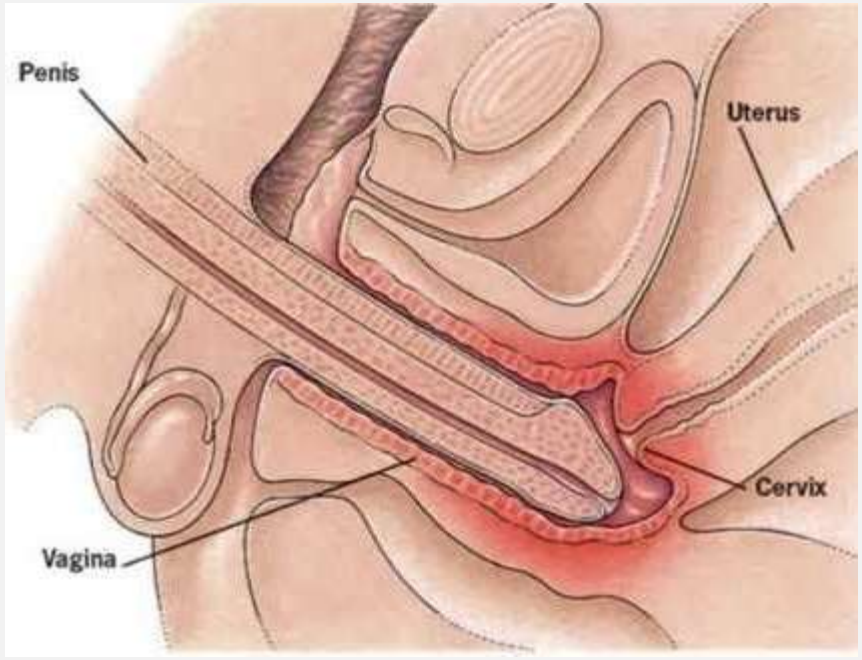
Speculum examination of the cervix



VAGINA

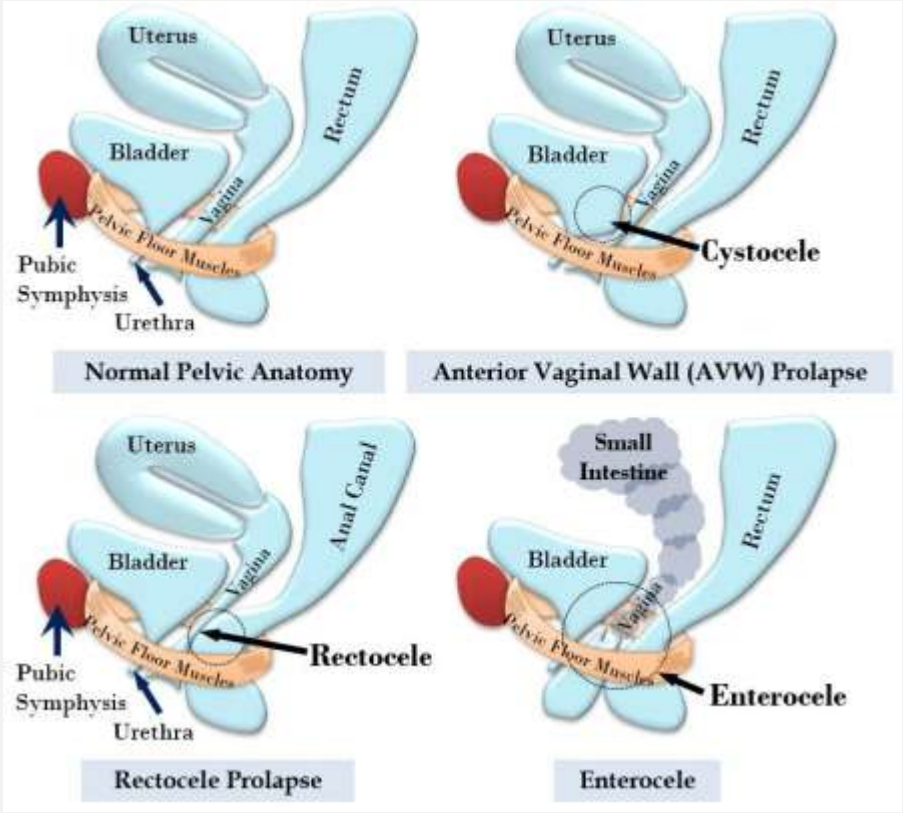
- 3D space to accommodate intercourse/delivery (exam)
- Cervix at the "top" although may be pointed toward back or front
- Bimanual exam allows palpation of surrounding organs





PELVIS

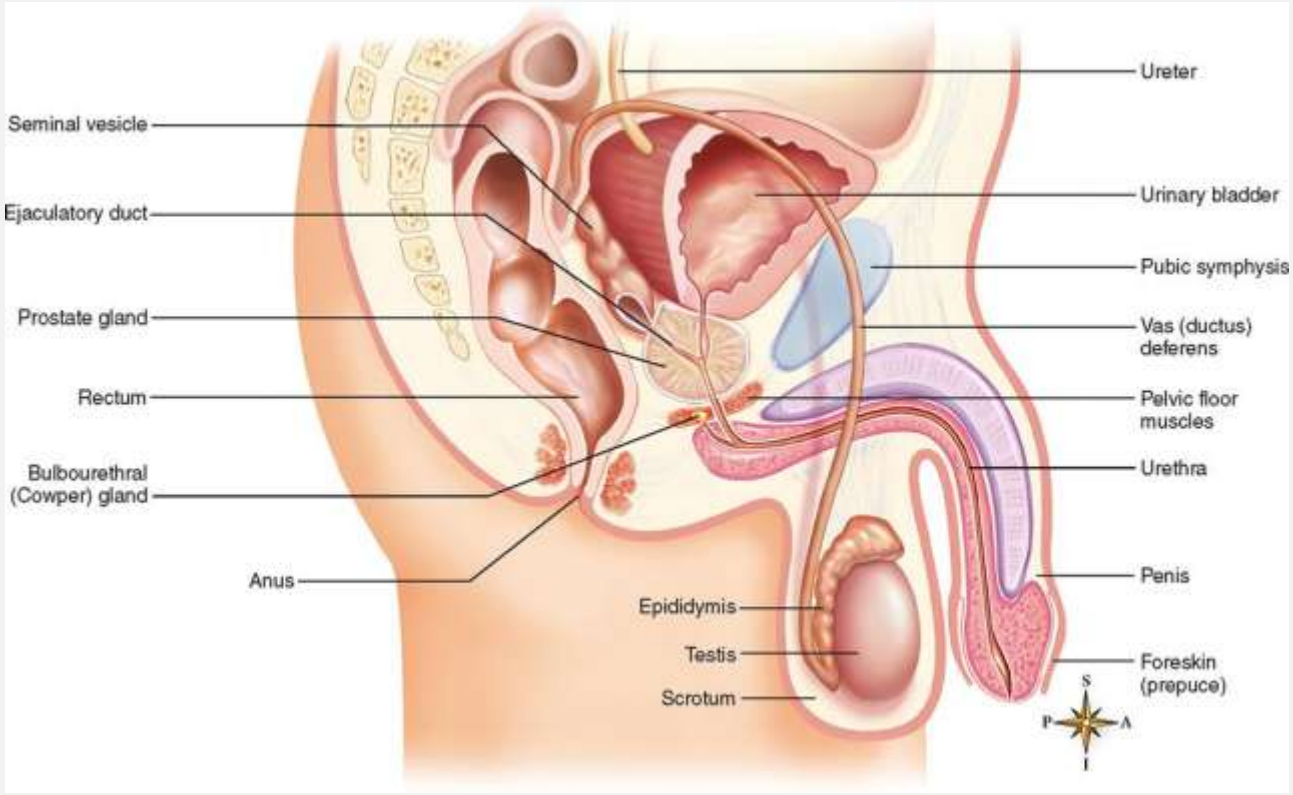
- Bladder/Bowel
- Ureters
- Pelvic floor
- https://vimeo.com/45379737



FEMALE PELVIS

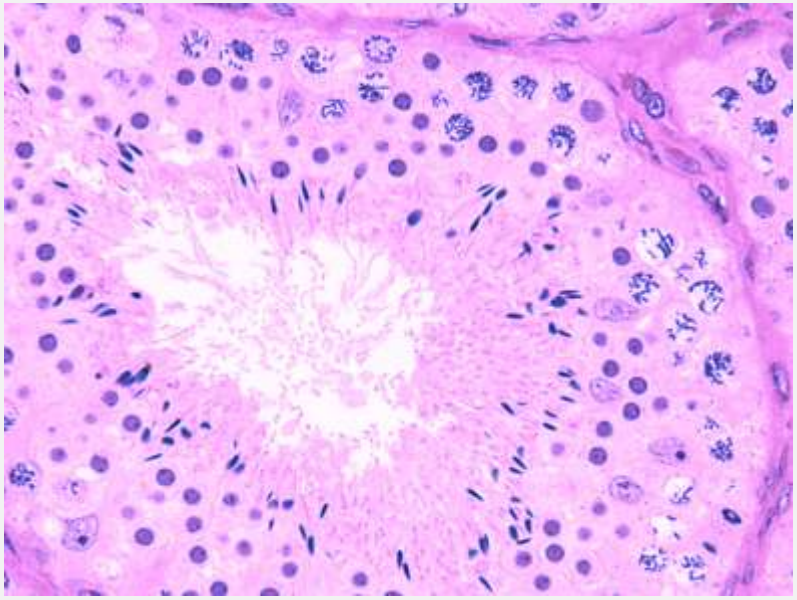
MALE REPRODUCTIVE SYSTEM

- Testicle
- Epididymis
- Spermatic Cord
- Vas Deferens
- Prostate
- Bladder
- Urethra
- Penis
- Urethral meatus



SPERMATOGENESIS

- Very different than oogenesis
  - Continuous production
  - Millions per milliliter of ejaculate
  - Affected by environment
  - ~90 day production period

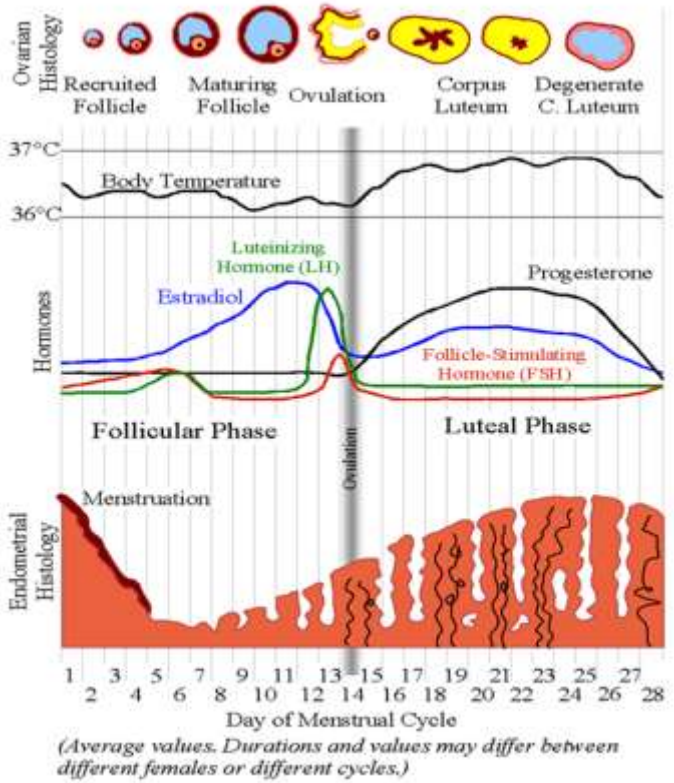


ONLINE "CRASH COURSE"

- Review/Prep for the first few lectures "Crash Course"
- https://www.youtube.com/watch?v=RFDatCchpus
- https://www.youtube.com/watch?v=-XQcnO4iX_U
- https://www.youtube.com/watch?v=SUdAEGXLO-8&t=54s
- https://www.youtube.com/watch?v=BtsSbZ85yiQ&t=13s

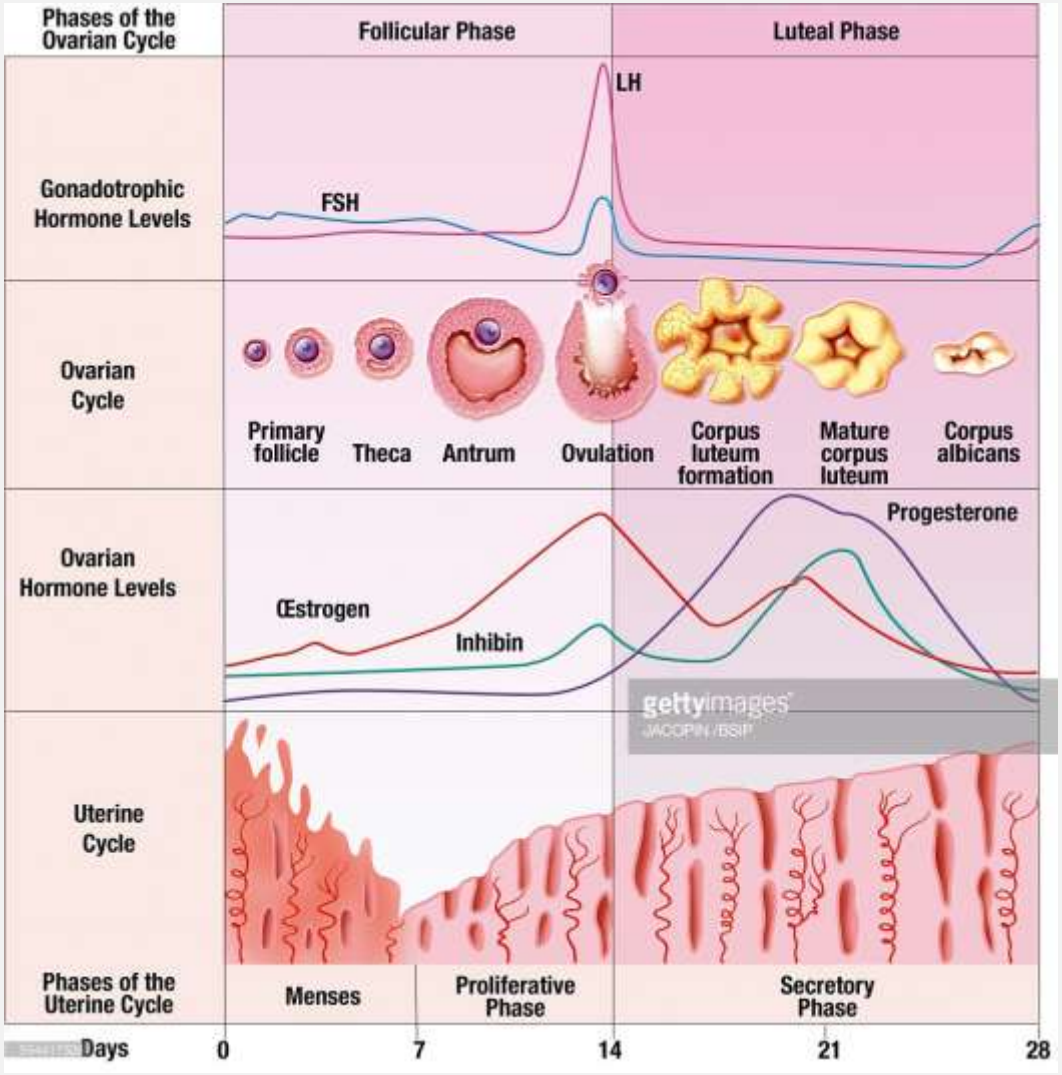
MENSTRUAL CYCLE BASICS

- Four "phases" in time
  - Follicular/Proliferative Phase
  - Ovulation
  - Luteal/Secretory Phase
  - Menstrual



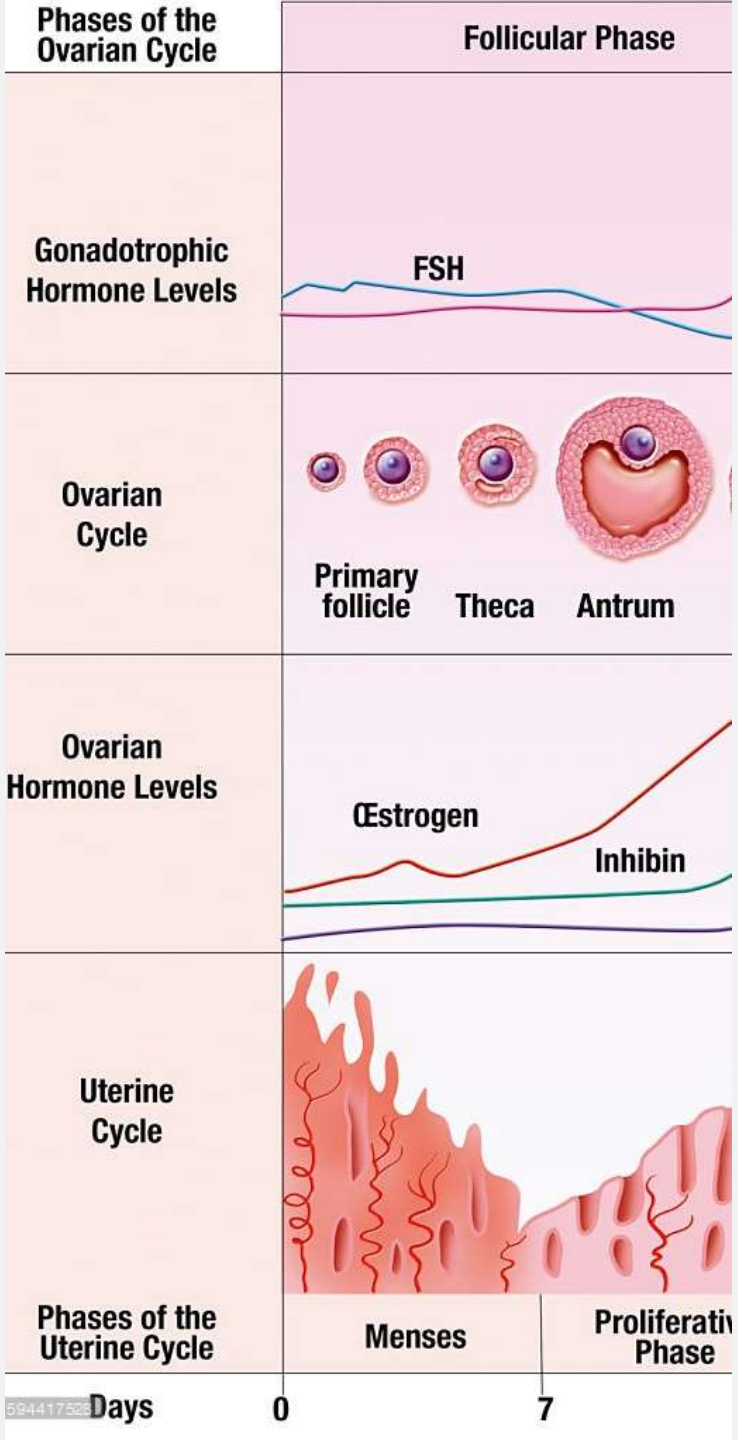
MENSTRUAL CYCLE BASICS

- Three cycle "levels"
  - Endocrine
    - Communication between brain and ovary
    - Main driver of the cycle
  - Follicle
    - Selection of the dominant follicle and atresia of the remaining cohort
  - Uterus
    - Development of the uterine lining and ultimate shedding of the lining



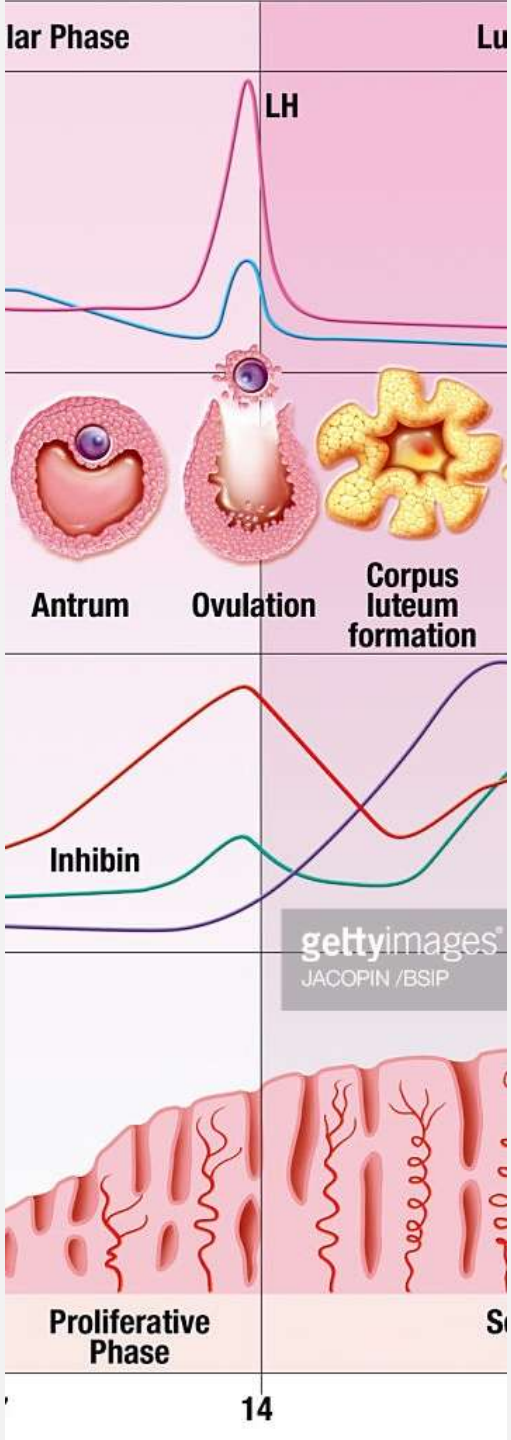
FOLLICULAR/PROLIFERATIVE PHASE

- Endocrine:
  - Brain → Ovary = FSH (follicle stimulating hormone)
  - Ovary → Brain = Estradiol (estrogen)
- Ovary:
  - Follicle/s grow
  - The dominant follicle is selected
- Uterus:
  - Estrogen causes proliferation (thickening) of the endometrium (lining of the uterus)



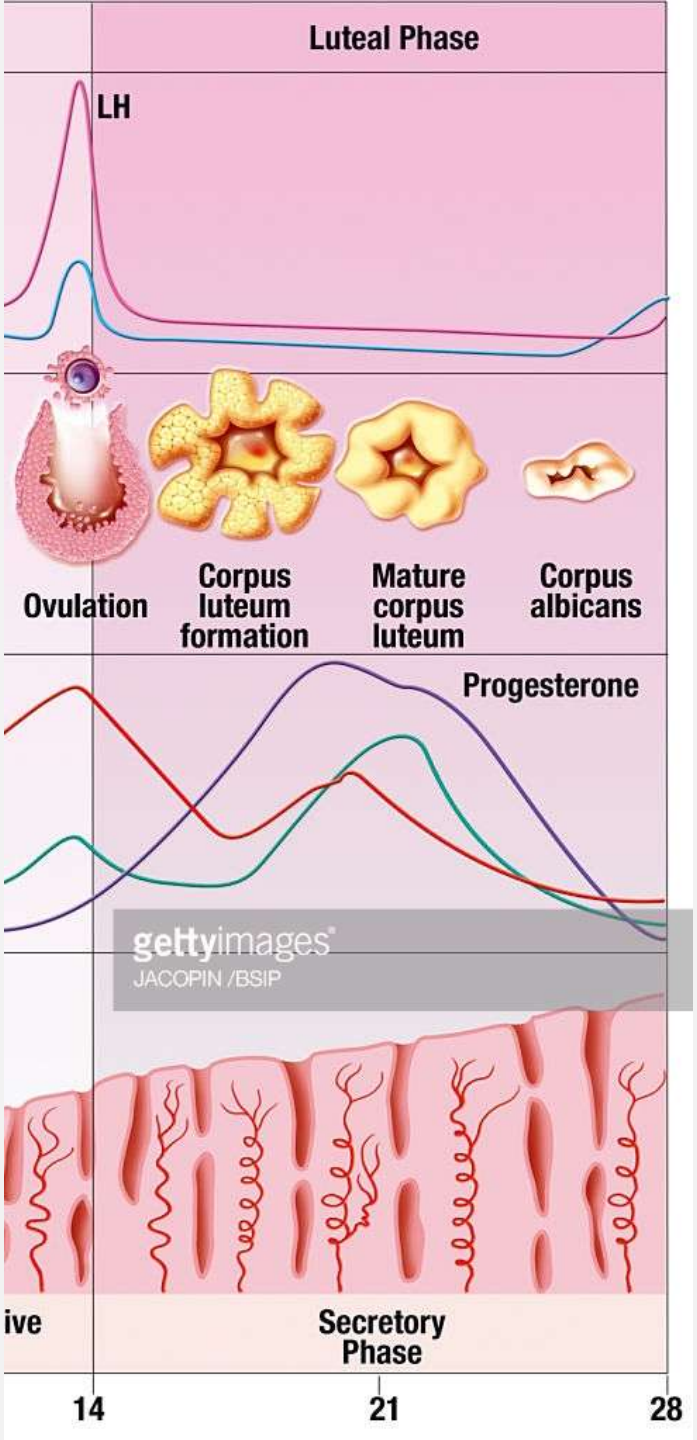
OVULATION PHASE

- Endocrine:
  - Brain→ Ovary = LH (Luteinizing Hormone) surge from brain
  - Ovary → Brain = ↓Estradiol ↑Progesterone
- Ovary:
  - Dominant follicle releases oocyte (egg)
- Uterus
  - Endometrium thickness becomes fixed
  - Secretory changes begin



LUTEAL/SECRETORY PHASE

- Endocrine:
  - Ovary → → Progesterone
  - Ovary → Brain = Inhibin B (Inhibits FSH)
- Ovary:
  - Corpus Luteum (ruptured follicle) produces lots of progesterone
  - If no hCG (pregnancy hormone), the CL will start to involute and Progesterone will decline
- Uterus
  - Progesterone stabilizes lining
  - Lining becomes secretory (mucous) in preparation for implantation

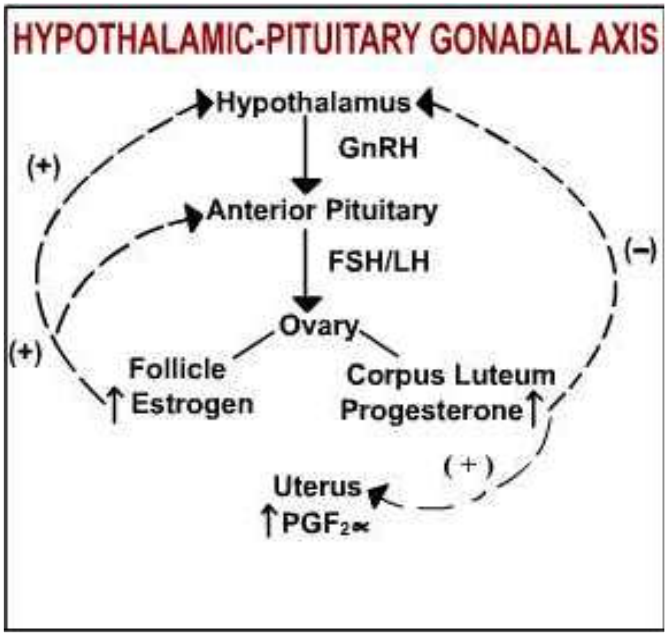


MENSTRUAL PHASE

- Endocrine:
  - ↓Progesterone from ovary triggers ↑FSH from brain
- Ovary
  - CL involutes completely
  - New cohort of follicles recruited
- Uterus
  - ↓Progesterone = no more support for lining → shedding

ENDOCRINE CYCLE

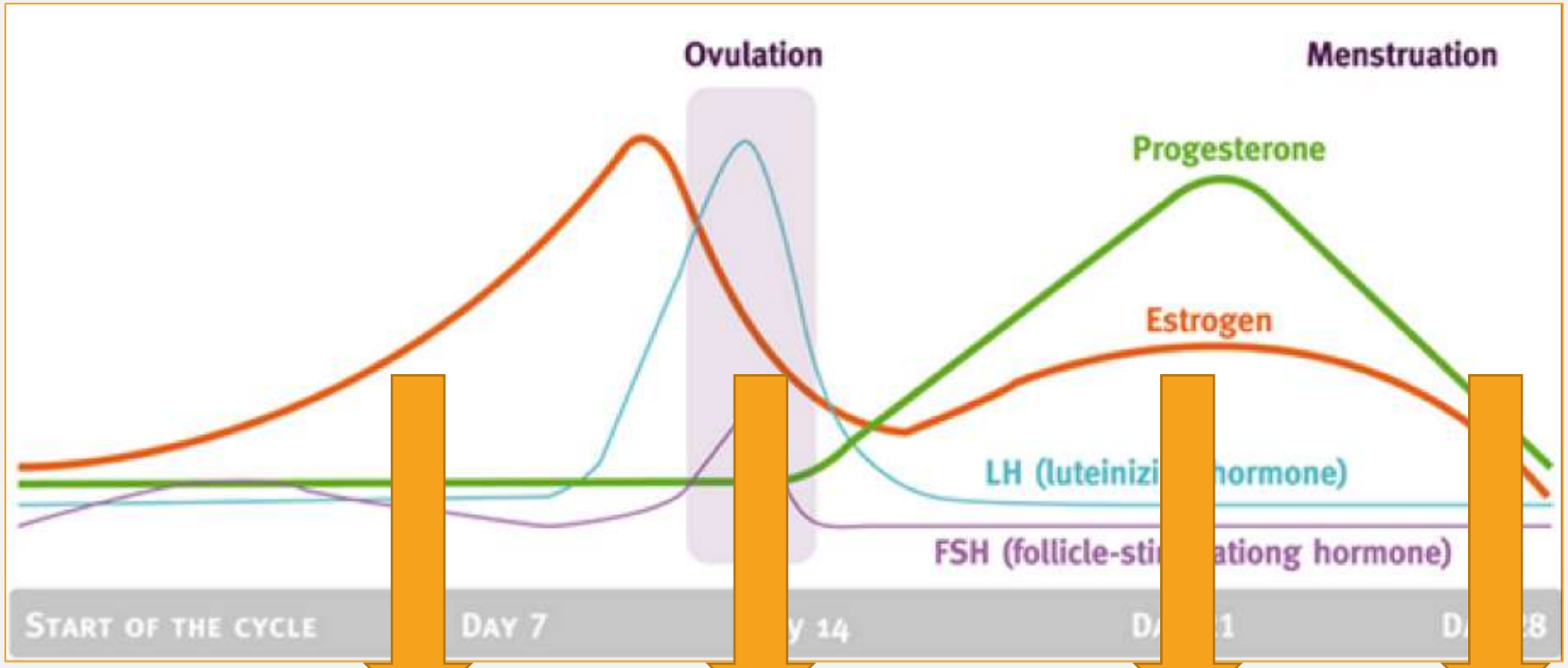
- The Hypothalamic-Pituitary Axis
- Four major hormones - under the control of GnRH from the hypothalamus
  - Two from the brain (gonadotropins)
    - FSH – Follicle Stimulating Hormone
    - LH – Luteinizing Hormone
  - Two from the ovary (sex steroids)
    - E2 – Estradiol (estrogen)
    - P4 – Progesterone
- *The levels of these 4 hormones on any given day will identify where a woman is in the menstrual cycle*



ENDOCRINE CYCLE

- Follicular Phase
  - FSH → E2
  - Symptoms of pre-ovulation are due to increase in E2
- Ovulation
  - Peak E2 triggers "LH Surge"
  - LH Surge leads to ovulation cascade
- Proliferative Phase
  - Dominated by P4 production from Corpus Luteum
  - Supports lining of uterus
- Menstrual
  - If no "rescue" of the CL by hCG, P4 declines
  - Drop in P4 causes lining to shed
    - Also causes rise in FSH → cycle starts again!

MENSTRUAL CYCLE HORMONES



↑E2, FSH
↓P4, LH

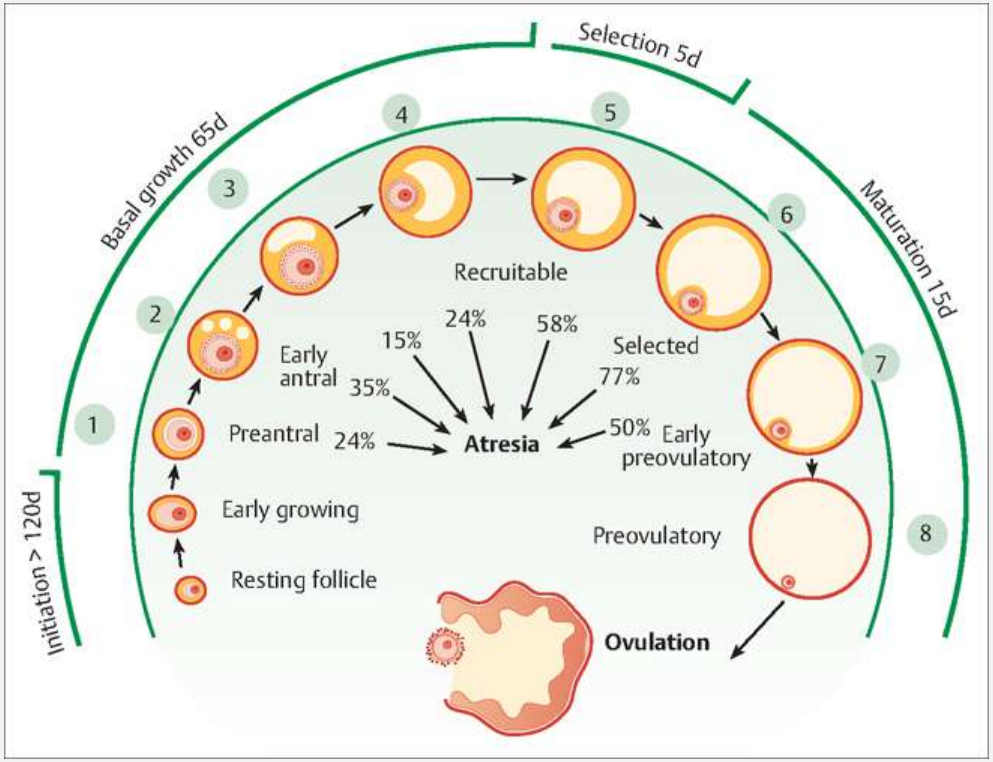
↑E2, FSH
↑↑LH
~P4

↑P4 ~E2
↓FSH, LH

↓E2, FSH
↓P4

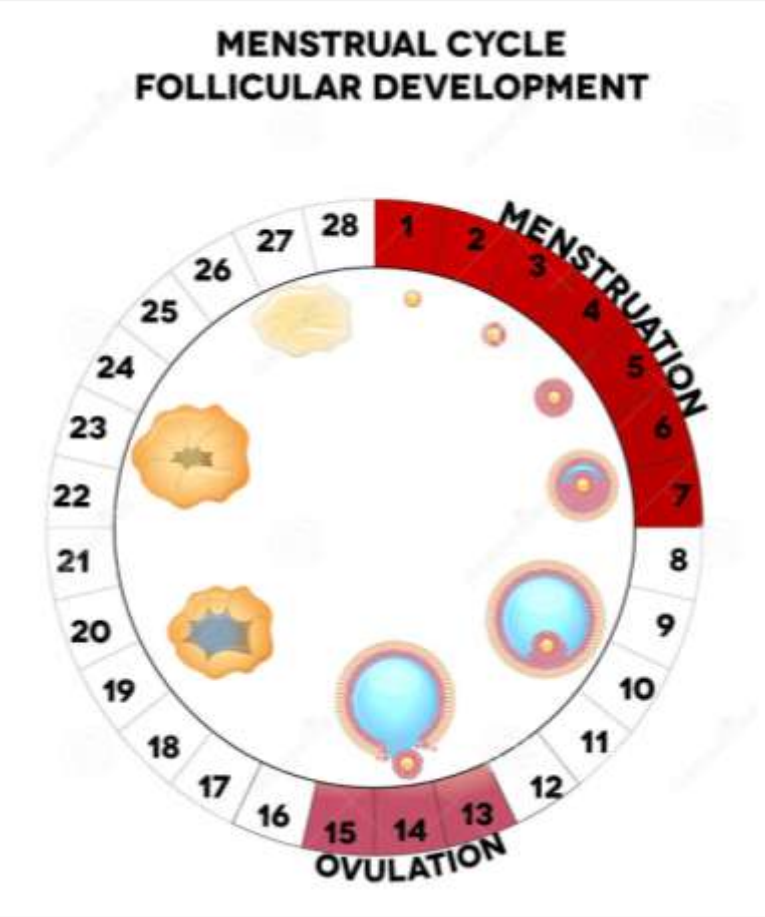
OVARIAN CYCLE: FOLLICULAR RECRUITMENT

- Follicles are in constant state of growth and atresia (resolution)
- resting → antral phase → atresia
- Whichever follicles are at the antral phase at the time that FSH starts to rise will become the "cohort" of recruited follicles for the upcoming cycle
- FSH starts to rise *AT THE END* of the luteal phase (before menstruation)

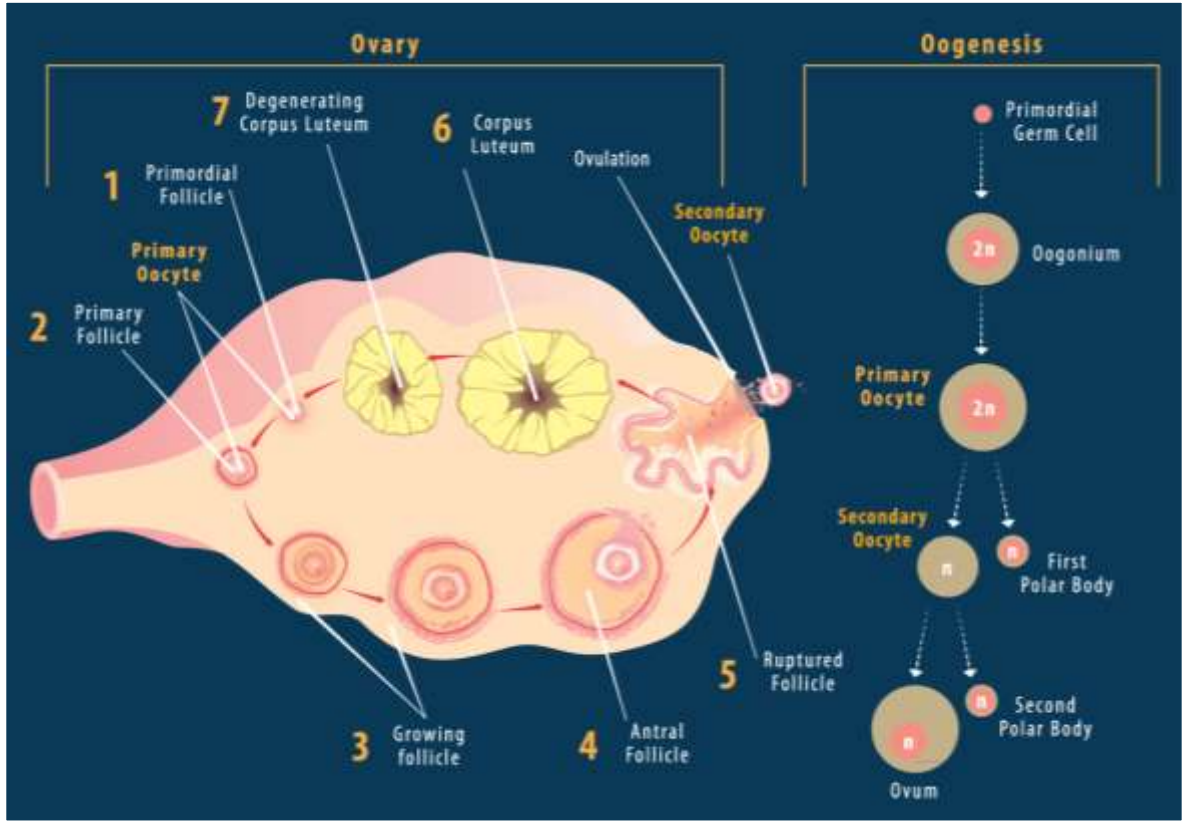


OVARIAN CYCLE: DOMINANT FOLLICLE

- Dominant follicle selected from cohort of recruited follicles
- Follicle grows and takes on fluid which supports the oocyte
- Visible on ultrasound by Day 8-10



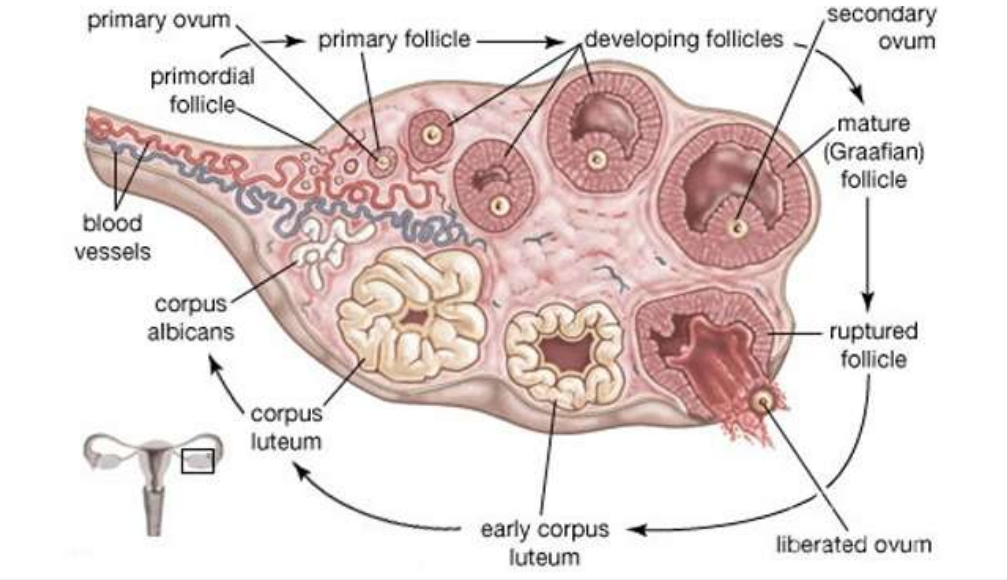
OVARIAN CYCLE: LH SURGE



- LH surge from the brain triggers breakdown of the follicle's basement membrane and release of the oocyte ("egg")
- The LH surge also triggers the "maturity" of the oocyte
  - Completes Meiosis I

OVARIAN CYCLE: CORPUS LUTEUM

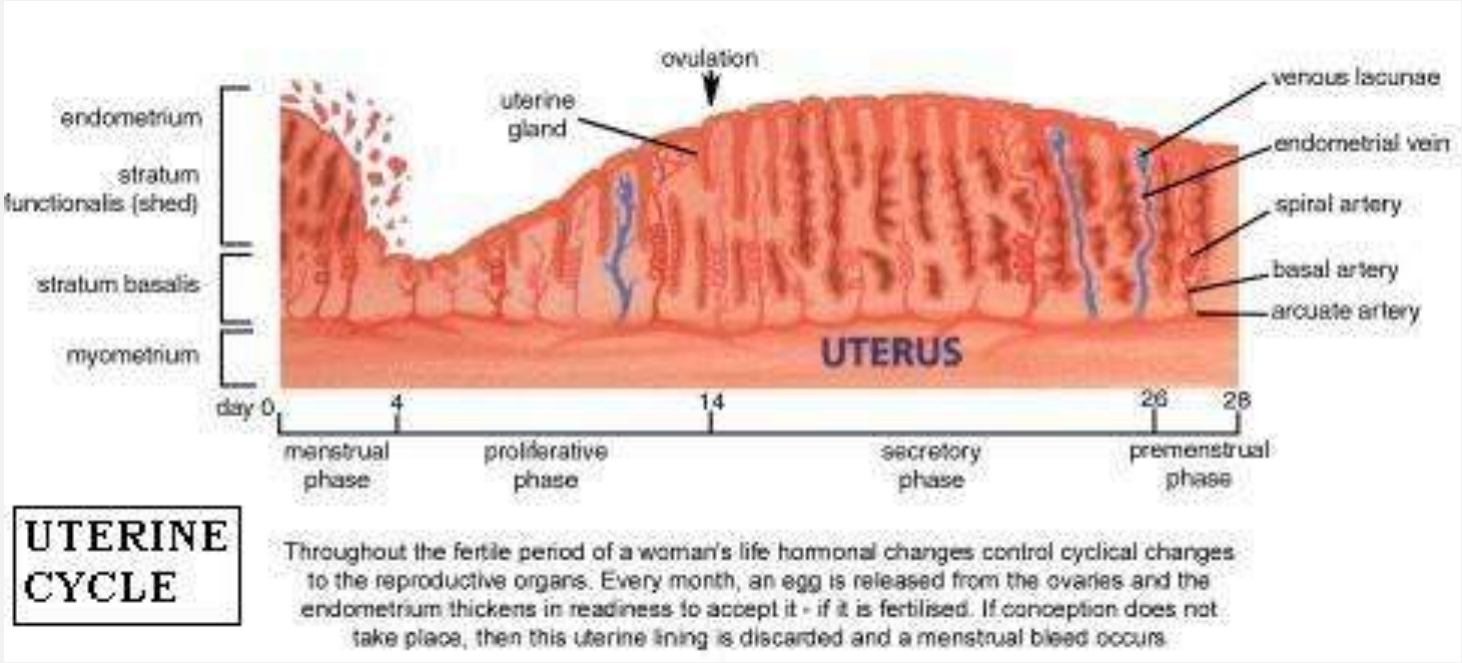
- The remaining follicle becomes a "Corpus Luteum"
- The CL's role is to produce P4 to support the lining of the uterus
- hCG from an implanted pregnancy will "rescue" the CL



OVARIAN CYCLE: MENSTRUATION

- Without hCG rescue the CL involutes approximately 14 days after ovulation
- Drop in P4 causes lining to shed *AND* FSH to rise again, leading to recruitment of next cohort

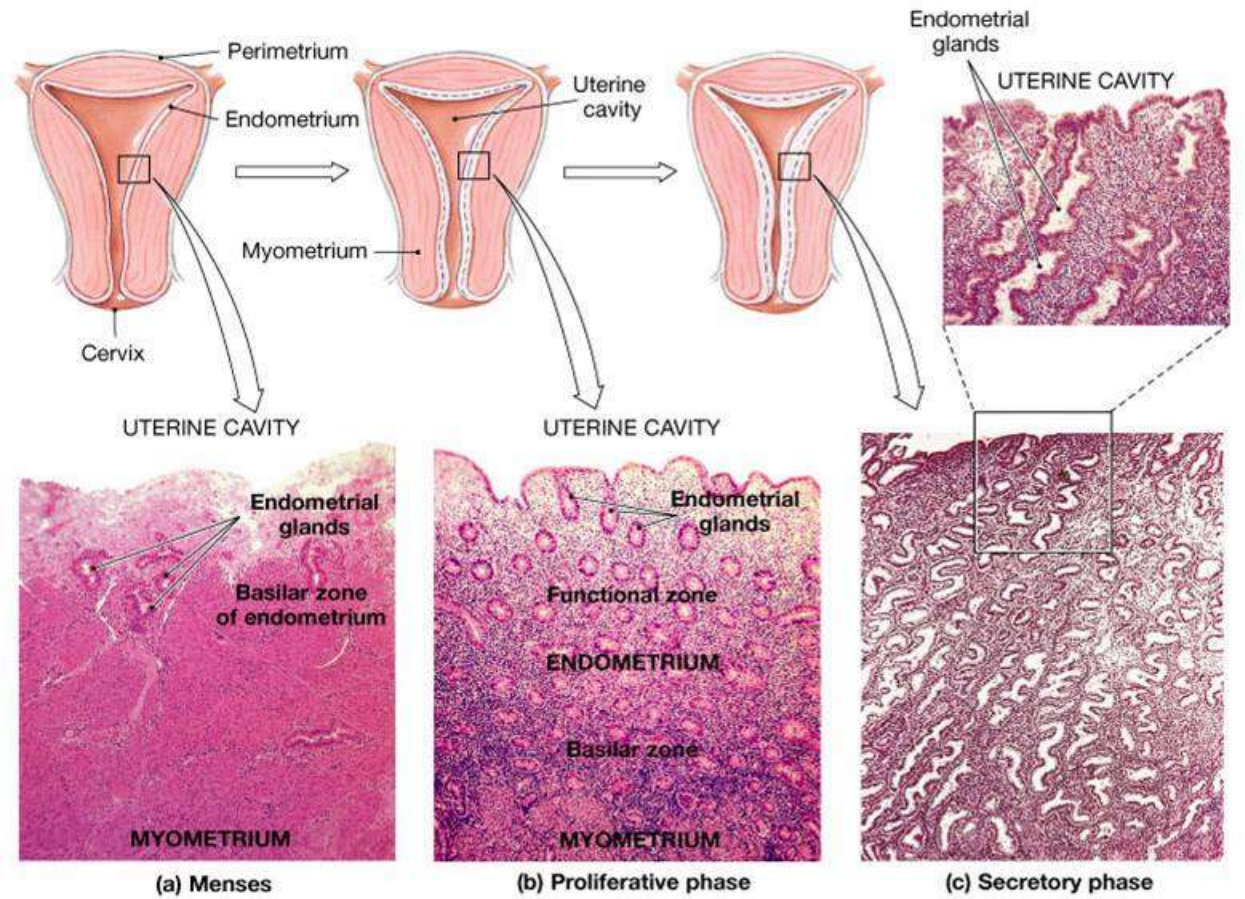
UTERINE CYCLE



UTERINE CYCLE

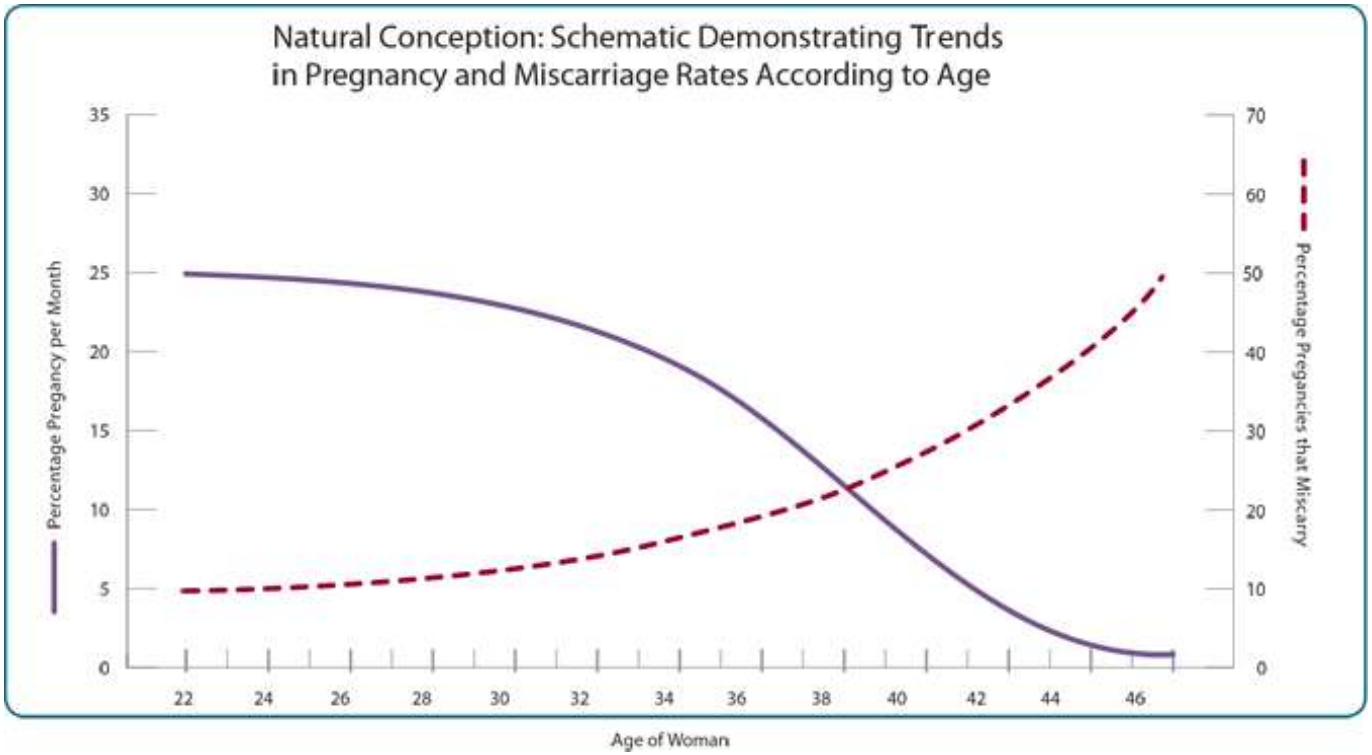
- Following completion of menses (Day 3-5) lining is very thin (3-5mm) with no glands and few blood vessels
- E2 from ovary "proliferates" the different layers of the uterine lining (7-12mm, trilaminar)
- P4 from CL arrests the growth, triggers glad and spiral artery formation in preparation for implantation
- Drop in P4 leads to breakdown of the lining

UTERINE CYCLE

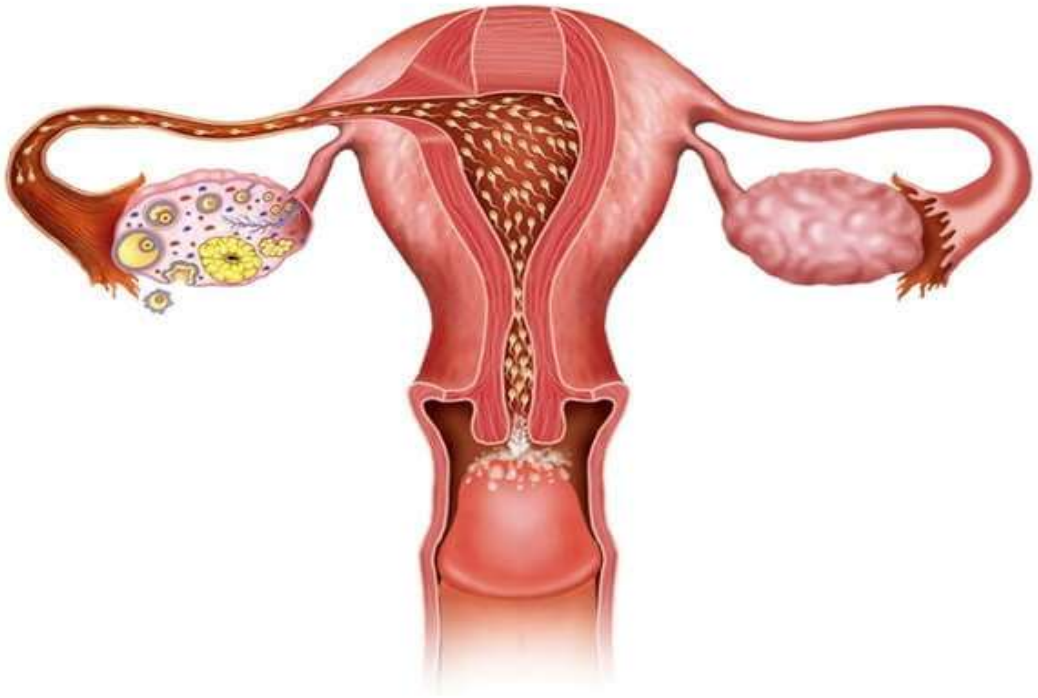


MENSTRUAL CYCLE AND AGE

- Adolescence
  - Puberty is directed by GnRH pulses from the hypothalamus (everything else is just following "marching orders")
  - GnRH secretion matures with time so normal to have irregular cycles up to age 20
- Fertile "window" age 20-40 but not stagnant
  - As number of eggs declines, ovary becomes less responsive to message from the brain
  - Requires higher "doses" of FSH to catch an antral follicles and move the cycle forward
  - "Day 3 FSH" testing
- When egg supply decreases entirely, ovary no longer responds, no E2 from ovary means FSH continues to rise → menopause
  - Menopausal symptoms are due to lack of estrogen



EGGS AND AGING

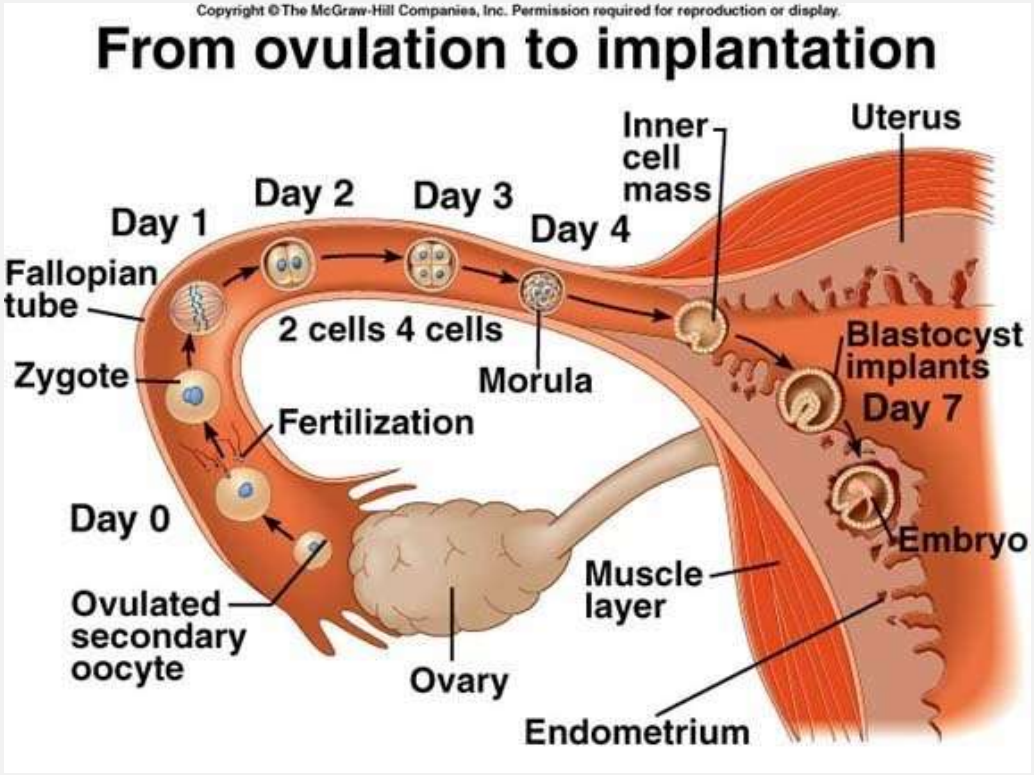


EARLY PREGNANCY

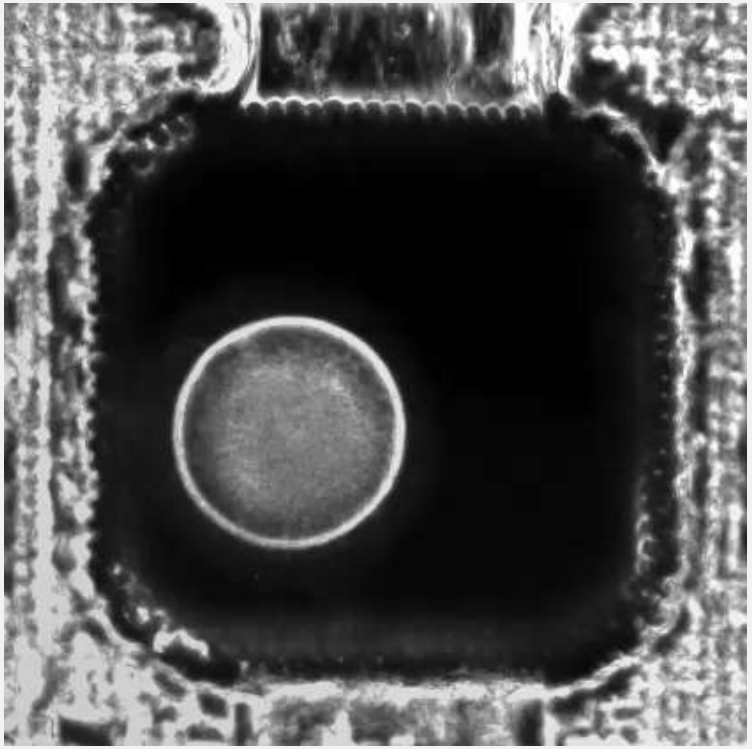
What happens when the Corpus Luteum *is* rescued?

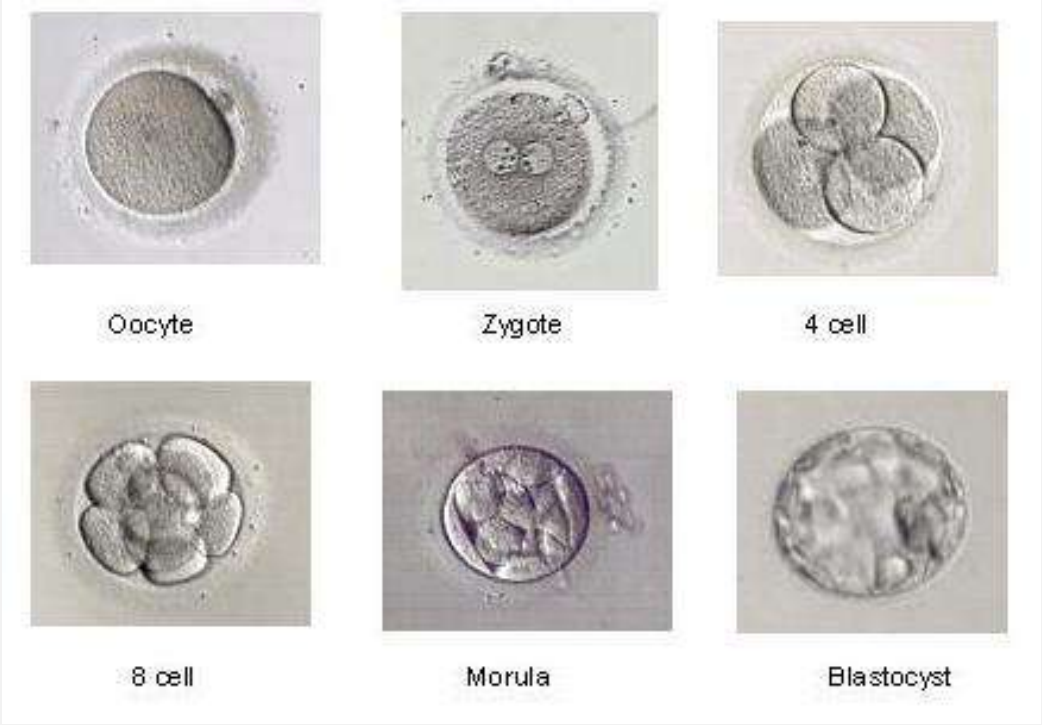
FERTILIZATION

- Egg fertilized in the tube within 24-48hrs of ovulation
- Embryo develops for 5-7 days before it develops to a blastocyst
- Only the blastocyst is capable of implantation
- The rest of the body is unaware of the pregnancy until implantation!



EMBRYO DEVELOPMENT





IMPLANTATION

- Triggers massive cascade of hormonal and immunologic events
- Invading "trophoblast" starts to produce hCG
- hCG "rescues" the corpus luteum → continues to produce progesterone → supports uterine lining
- At ~10wks the placenta produces enough P4 to overcome the CL