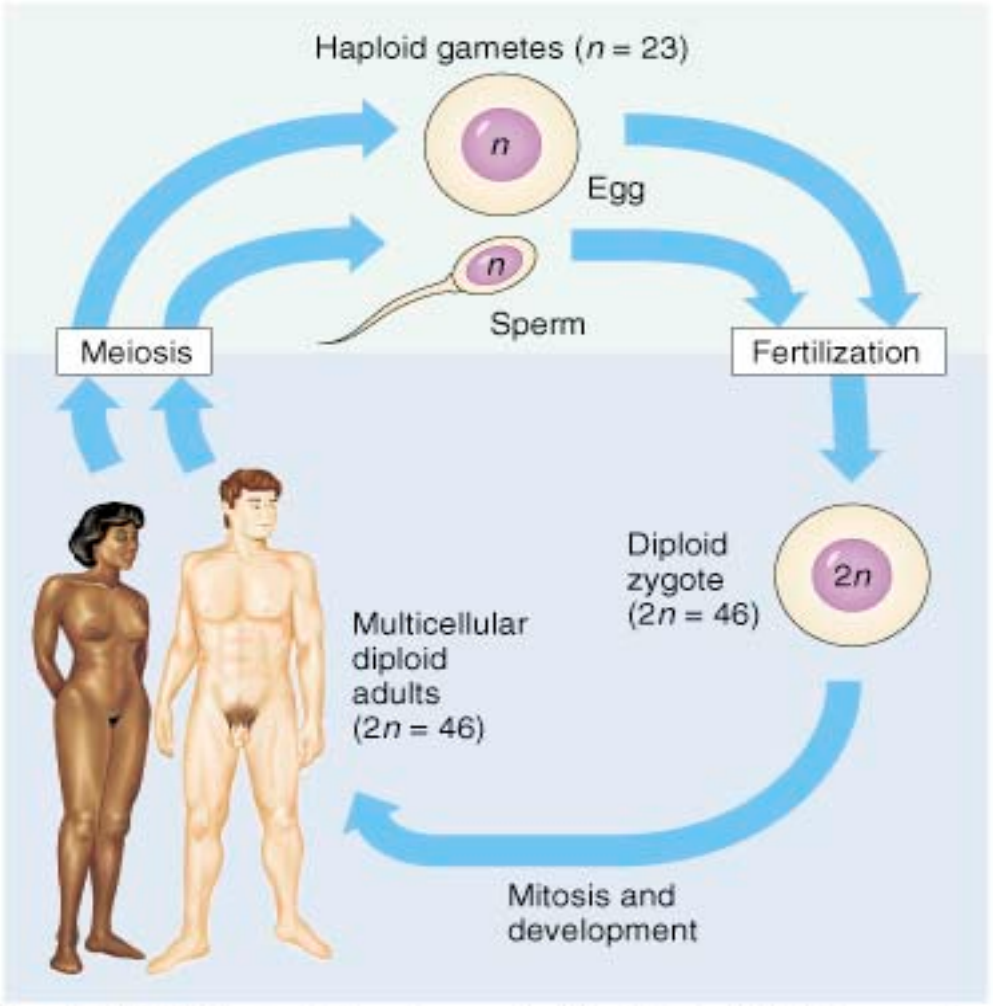
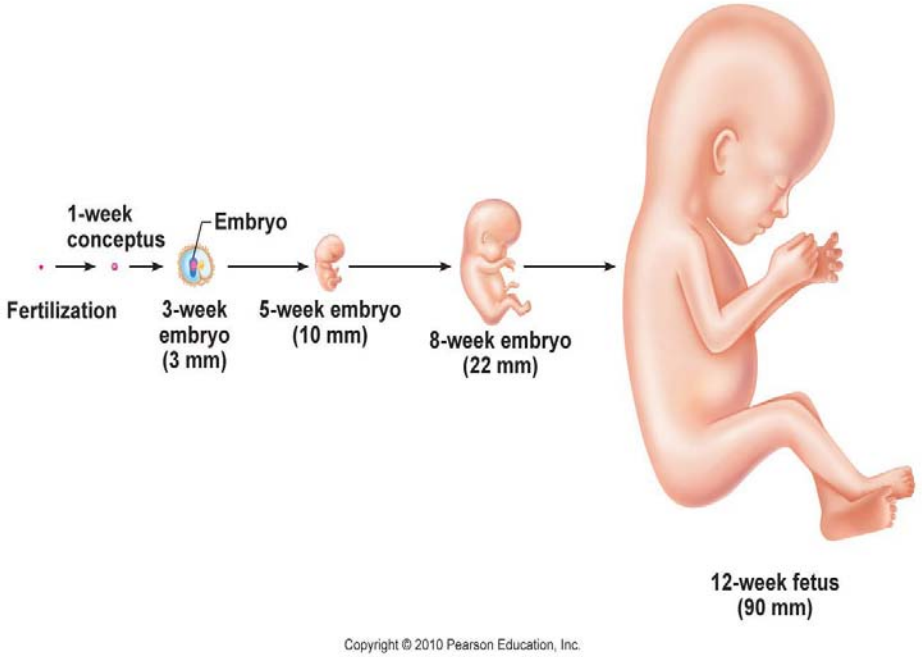
Reprod. Phys



Reproduction

= again + to make (human organism)

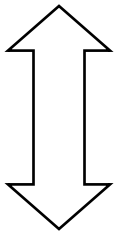
prior:
fertility
->meiosis
->gamete
->fertilize



throughout: male & female hormones

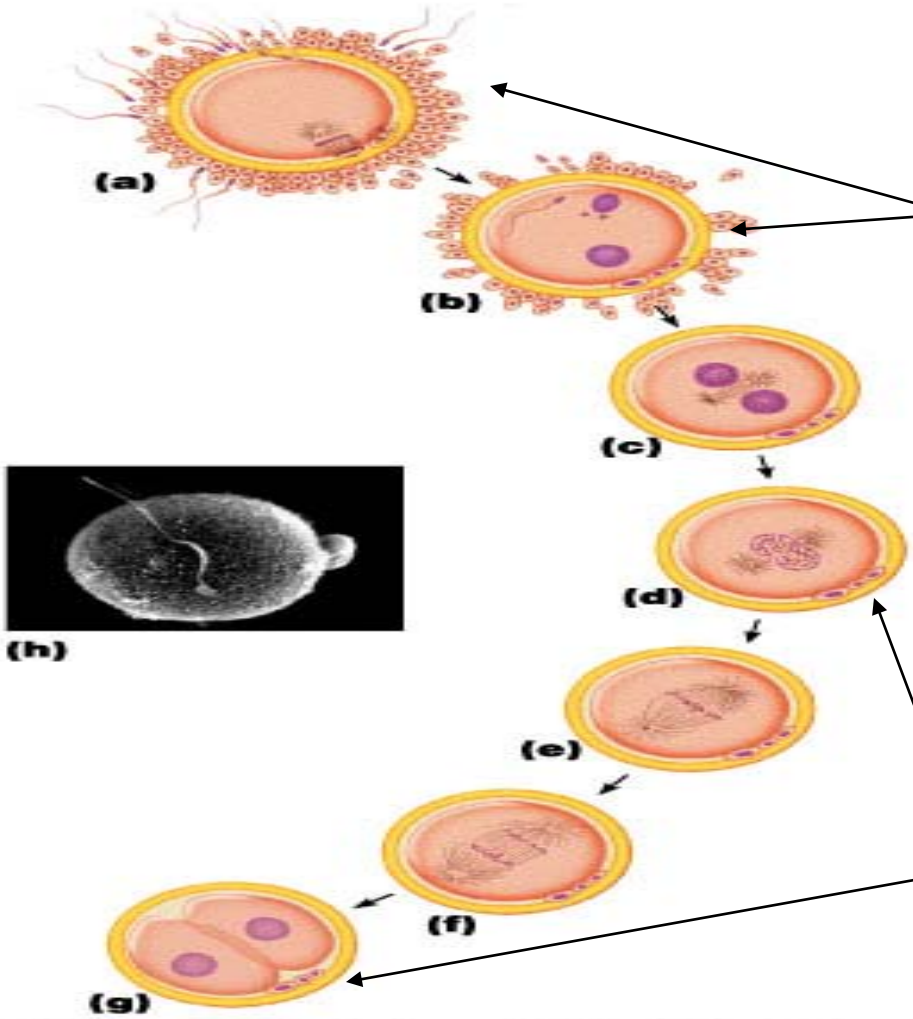
Growth & Division

cell growth phase (interphase)
- orig. cell grows larger
(46 chrom. -> 92 chrom.)



cell division phase
- enlarged cell divides into 2 or 4 cells
a) somatic cell - mitosis (2 x 46, 2n)
b) reproductive cell - meiosis (4 x 23, 1n)

Meiosis & Mitosis



meiosis
2° oocyte (M_2) divides into 4 haploid cells (ovum & 3 polar bodies

mitosis
fertilized egg divides into 2 daughter cells

Meiosis

= cell div. of reproductive cells

reprod. cell cycle:

1) **interphase (46 → 92)**
   → **meiosis (4 x 23), 4 haploid (1n) cells**
2) **8 meiosis phases:**
   - **meiosis I : P_1 + M_1 + A_1 + T_1**
   - **meiosis II: P_2 + M_2 + A_2 + T_2**

reprod. cell makeup:

1) **haploid (1n)**
2) **23 chromosomes**
   - **22 autosomes**
   - **1 sex chromosome**

Meiosis Functions

= nuclear division to form haploid (1n) cells

function:

1) book keeping

- correct # chromosomes per cell

2) genetic diversity

- new individuals due to

a) sexual reproduction - new gene combinations

b) crossover - new chromosomes

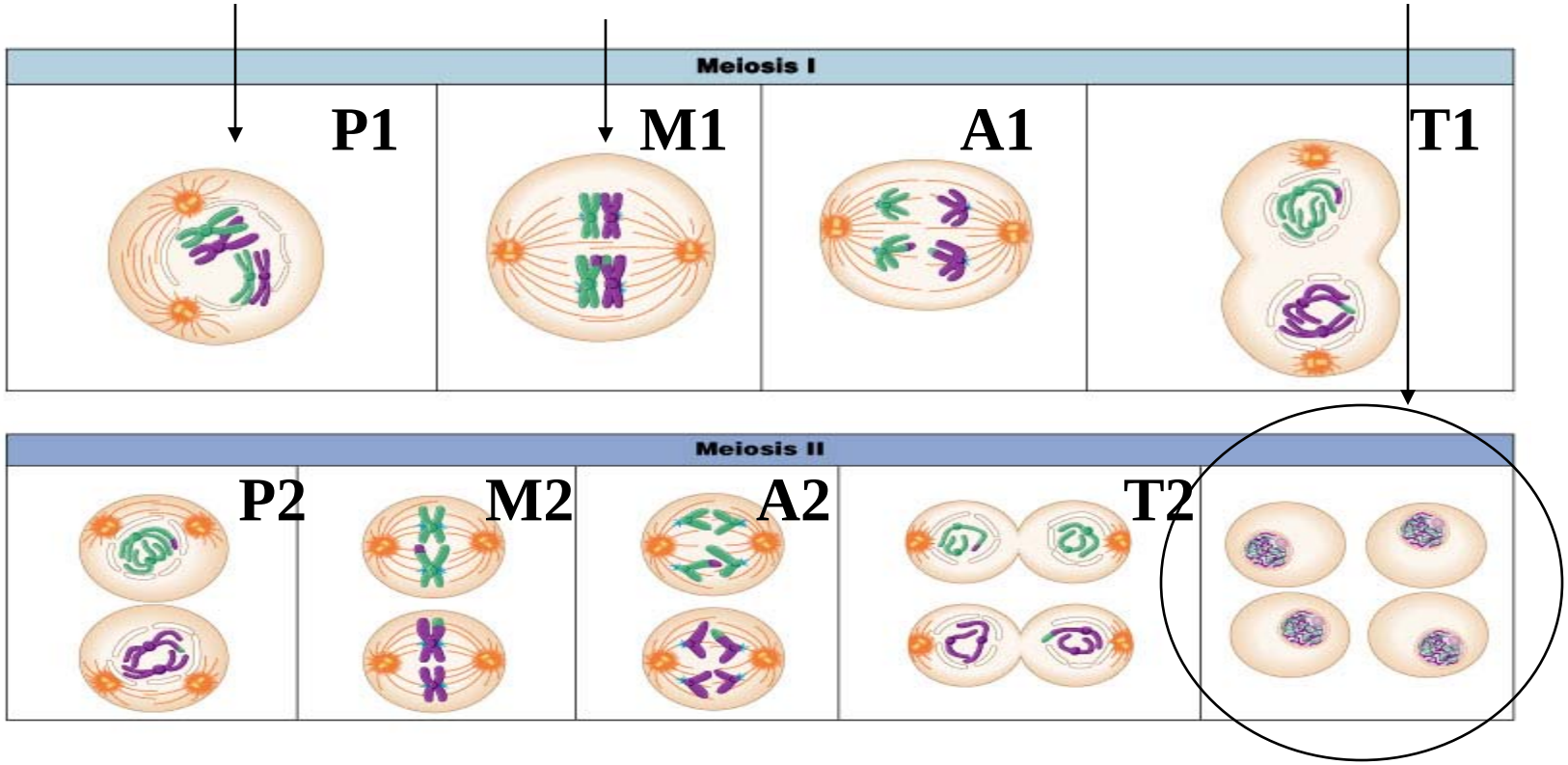
(allele exchanges bet. parental homolog. chrom.)

c) independent assortment - new chrom. combination

(random grouping of parental homolog. chrom.)

Meiosis (1)

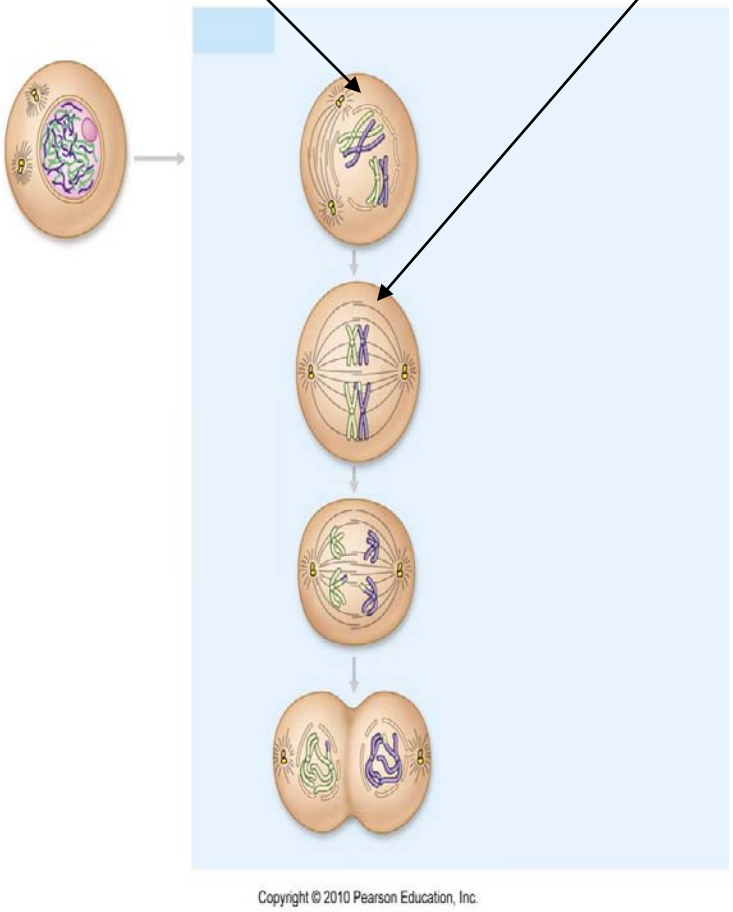
Genetic Diversity from:
crossover independent assortment sex. reprod.

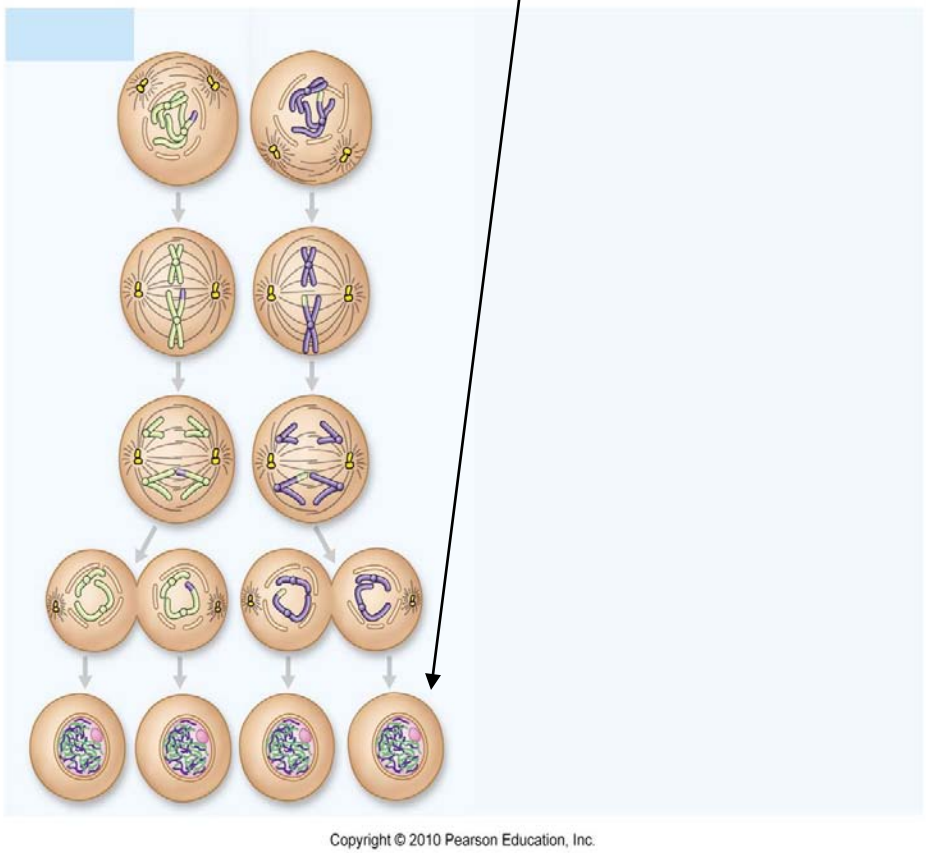


4 - 1n cells

Meiosis (2)

Genetic Diversity from:
crossover independent assortment sex. reprod.





Meiosis Review

Define these terms:

1) **homologous chrom.**
2) **synapsis**
3) **tetrad**
4) **dyad**
5) **chiasmata**
6) **crossover**
7) **independent assort.**
8) **gametes**
9) **1° oocyte**
10) **2° oocyte**

Diagram meiosis (8 steps):

- meiosis I: show the tetrad in P1, crossover in M1, and results in A1 & T1

- meiosis II: show the dyad in P2, and results in T2

Gametogenesis

gametes = reprod. cells, sperm & egg

<u>oogenesis</u>

- begun 1st trimester, ends @ 50's

- egg cells last 10-40 years (≅ 400k/lifetime)

- 1 egg dev/mon., completed in 28 days

- coord. with uterus prep. & hormone prod.

<u>spermatogenesis</u>

- begun after puberty, ends @ 60's

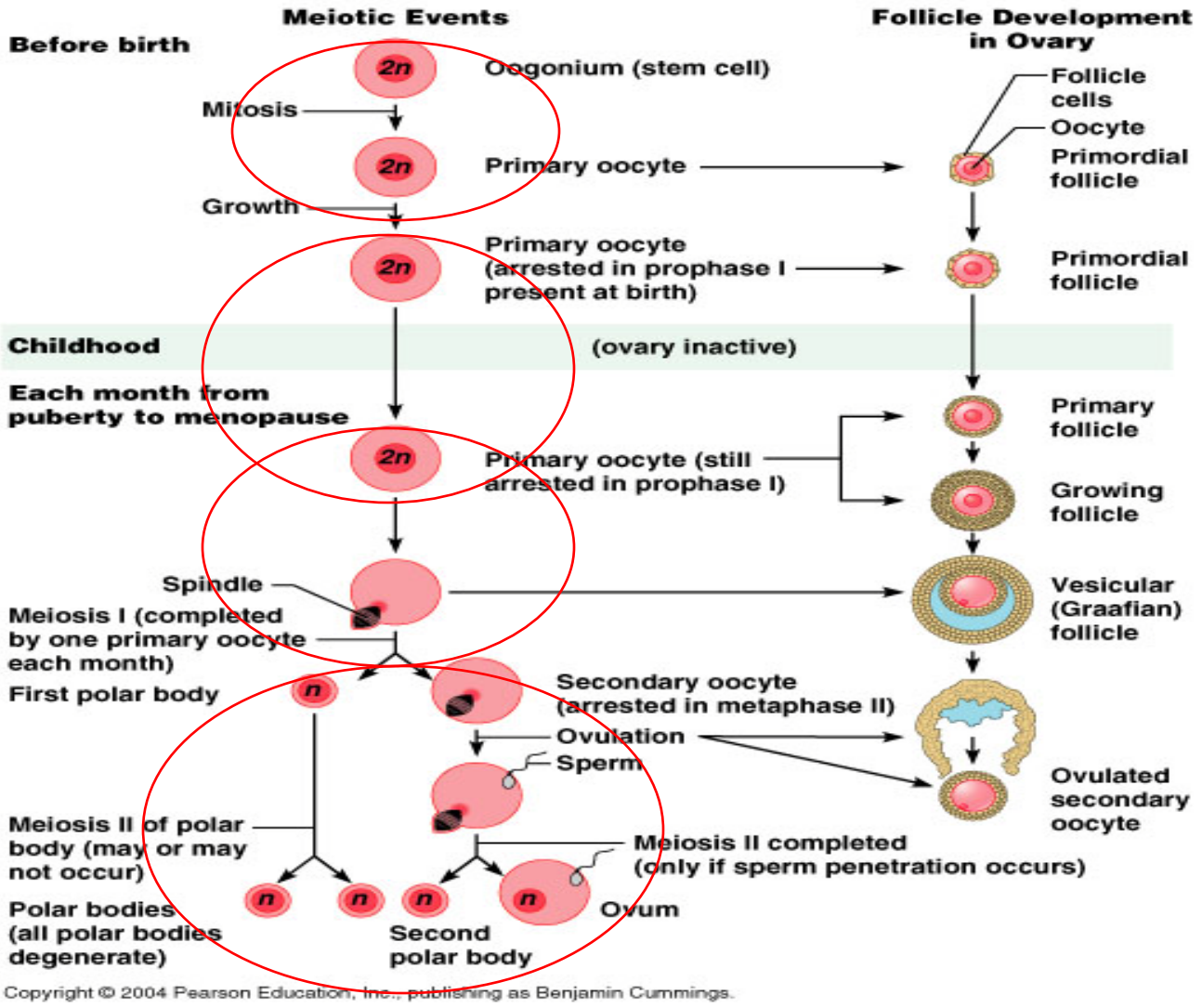
- sperm cells last days (≅ 400 million/day)

- million sperms dev/day, completed in 10 days

Oogenesis

4 stages:

1) **mitosis**
2) **meiosis I**
3) **meiosis IIa**
4) **meiosis IIb**



Egg Meiosis - 4 stages

- meiosis begins prenatal, completes 50+ yrs later

1) mitosis (embryo, 1st trimester)

- oogonia (2n) -> 1°oocyte (2n), ≅ 400k

2) meiosis I (1st trimester - puberty)

- pause @ P_1: 1°oocyte (2n) -> 1°oocyte (2n)

- storage: 10-40+ years

3) meiosis IIa (puberty-menopause)

- one egg dev. per month

- pause again, @ M_2: 1° oocyte, P_1->2° oocyte, M_2)

4) meiosis IIb

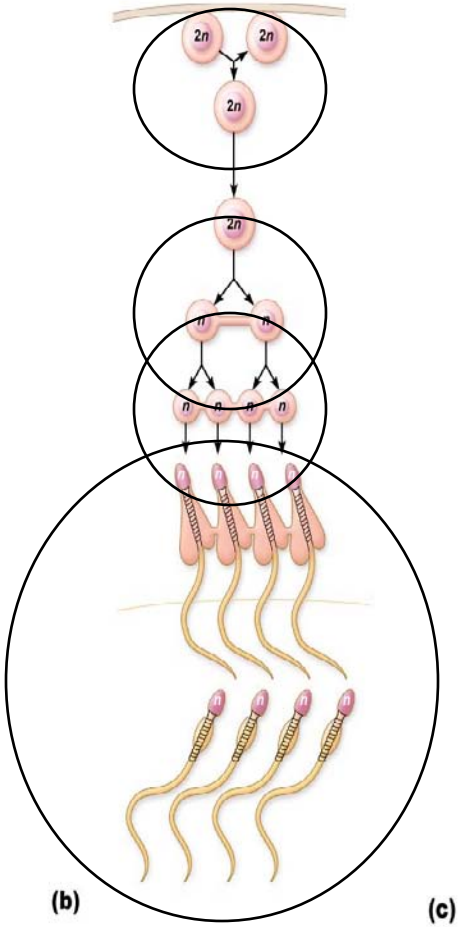
- preg, meiosis ends (oocyte -> ovum+3 polar bodies)

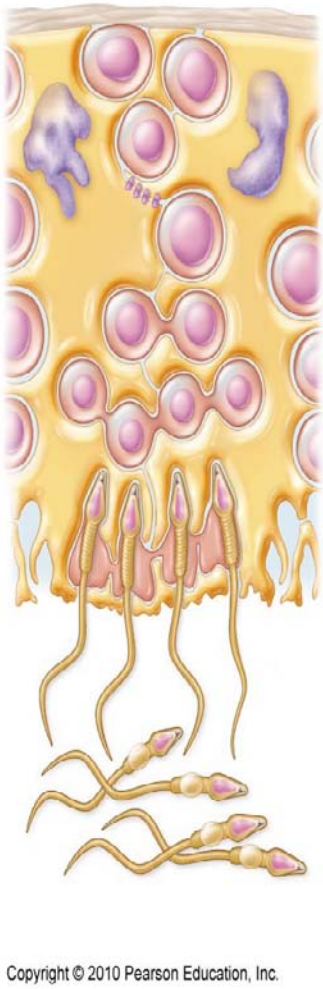
- w/o preg - oocyte never finishes meiosis

Spermatogenesis

4 stages:

1) **mitosis**
2) **meiosis I**
3) **meiosis II**
4) **spermio-genesis**





Sperm Meiosis - 4 stages

- meiosis begins @ puberty, completed in days

1) mitosis:

- stem cell (2n) -> spermatogonia (2n)

2) meiosis I:

- 1° spermatocyte (2n) -> 2° spermatocyte (1n)

3) meiosis II:

- 2° spermatocyte(1n) ->spermatids (1n)

4) spermigenesis:

- spermatids->spermatozoa->sperm

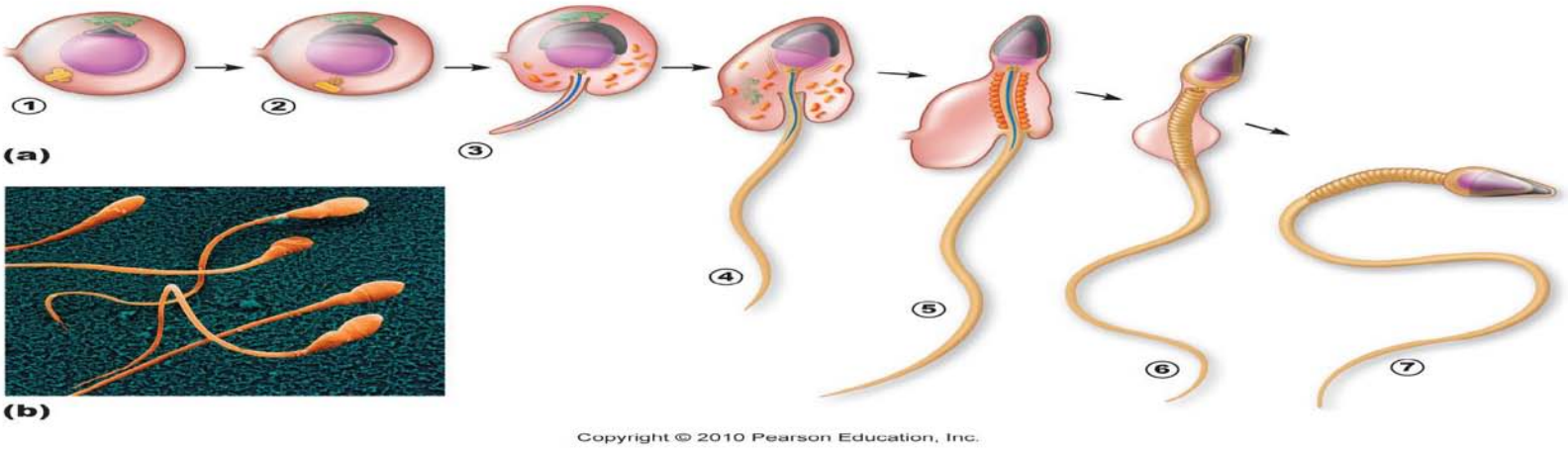
(no head or tail) (head) (head & tail)

Spermiogenesis

= maturation of spermatids, not spermatogenesis

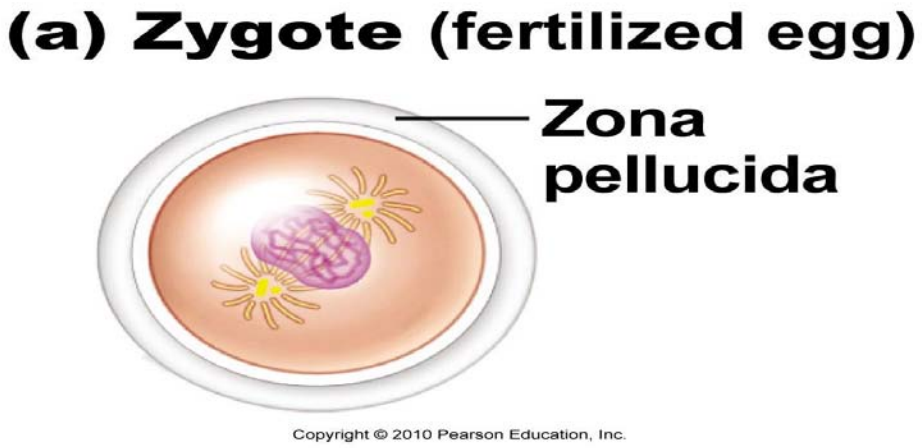
spermatids (1n)
- immature (no tails)
- attached to walls of seminiferous tubules

sperm (1n)
- mature (with tails)
- swim away thru central opening of seminiferous tubules



Fertilization

= successful alignment & combination of maternal and paternal chromosomes
= sperm fuses with egg -> fertilized egg
= 2 gametes -> zygote (“yoked together”)
= 2 haploid cells (23) -> 1 diploid cell (46)



Ideal Fertilization

best time: sexual inter. 2 days before to 1 day after ovul.

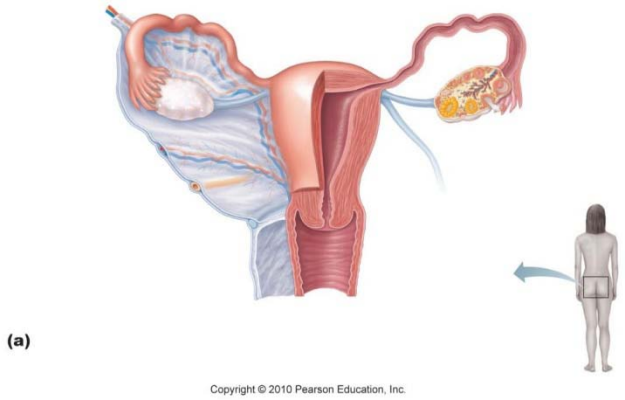
egg: viable 12-24 hrs after ovulation
- 24 hrs to move 1/3 length of oviduct
- female age: younger -> more eggs & capable of gestation
- 20's (150k eggs), 30's (100k eggs)
- 40's (50k eggs), 50's (few eggs)

sperm: viable 24-48 hrs after ejaculation
- during sexual intercourse, high sperm loss (millions)
- male age: younger -> travel faster to oviduct
- 20's: 6 hours
- 75: 2-1/2 days

Female Fertility

fertility: sexual attraction & reprod. capacity

1) **attract a partner: sexual attraction**
2) **oogenesis: creating new eggs (prenatal)**
3) **3 cycles (monthly)**
4) **receive & fertilize the egg & sperm**
5) **gestation, labor, & delivery**
6) **care of the young**



Egg Life Cycle

1) **prenatal, 1st trimester of preg.,**
   - **eggs begun & stored* (400K in stasis)**

2) **reproductive years - puberty on* (10-50 yrs old)**
   - **1 egg/mo. developed & released**
   - **↑hormones → ↑ female 2° sex. char**

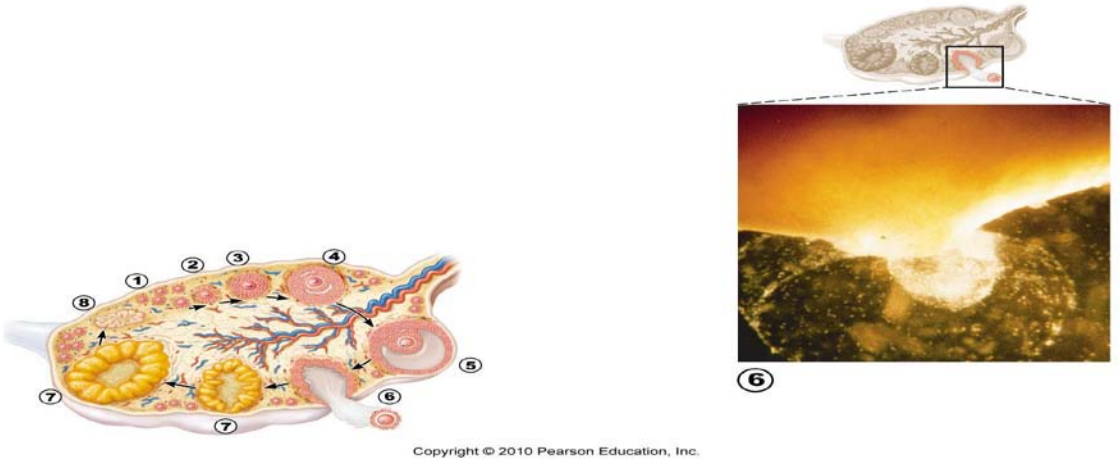
3) **reprod. free years - menopause, about 50 yrs**
   - **eggs deteriorate, menstruation ends**
   - **↓hormones → ↓female 2° sex. char.**

***life cycle - 10 to 40 yrs!**

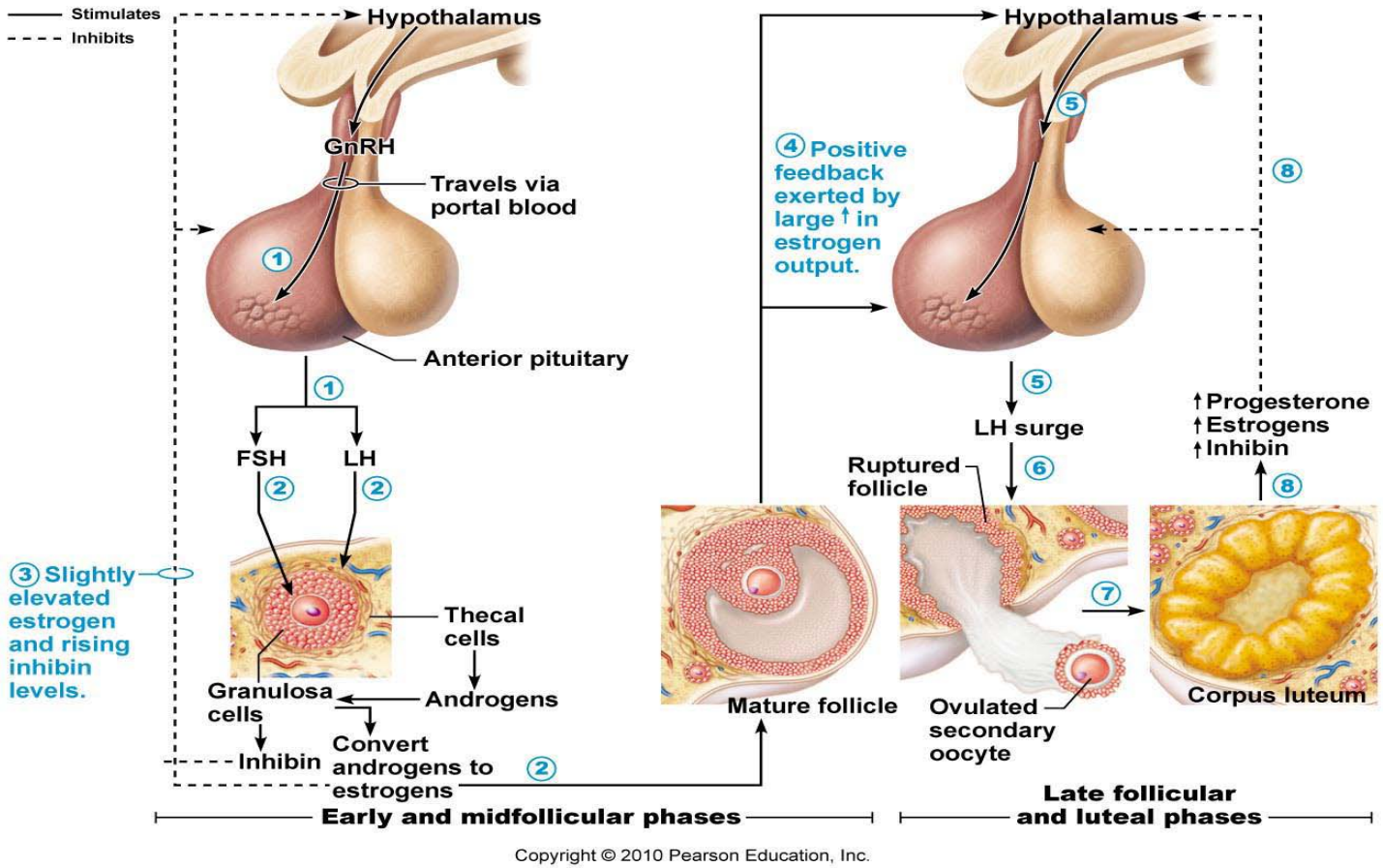
Optimal Female Fertility

each month @ day 14 of 28 day cycle:

1) **egg ovulates (egg cycle)**
2) **uterine lining is thickest (uterus cycle)**
3) **ovary release sex hormones (ovarian cycle)**



Brain-Ovary Reg.

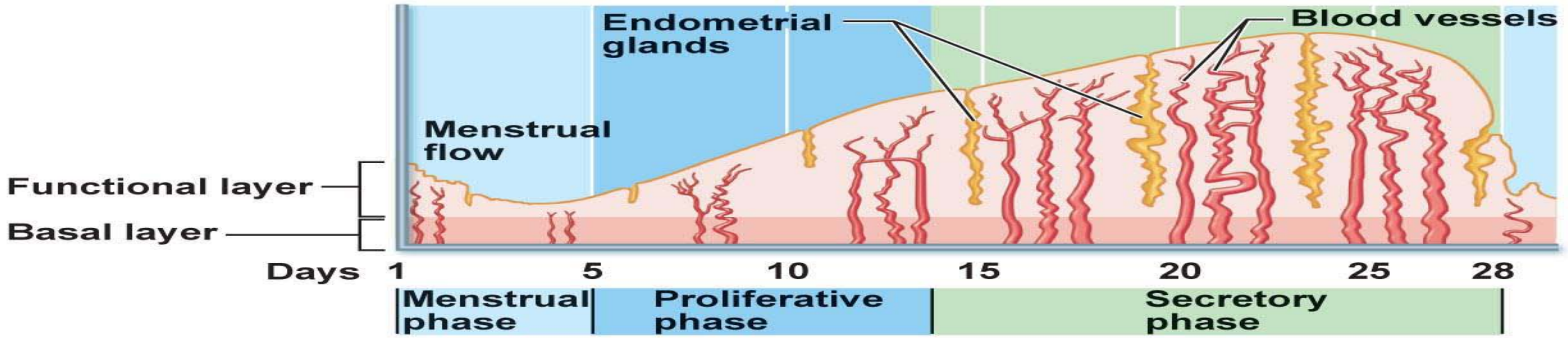


Timing Table

Day #	Uterine Cycle	Ovarian Cycle	Egg Cycle
1	menstrual	follicular	1° oocyte (P_1)
5	"	"	"
10	proliferative	"	"
14	"	ovulatory	2° oocyte (M_2)
20	secretory	luteal	no preg - stop preg - ovum
25	"	"	"
28	"	"	"

Uterine Cycle

1) **menstrual - uterine lining sheds (thinnest)**
2) **proliferative - uterine lining rebuilds**
3) **secretory - lining secretes nutrients (thickest)**



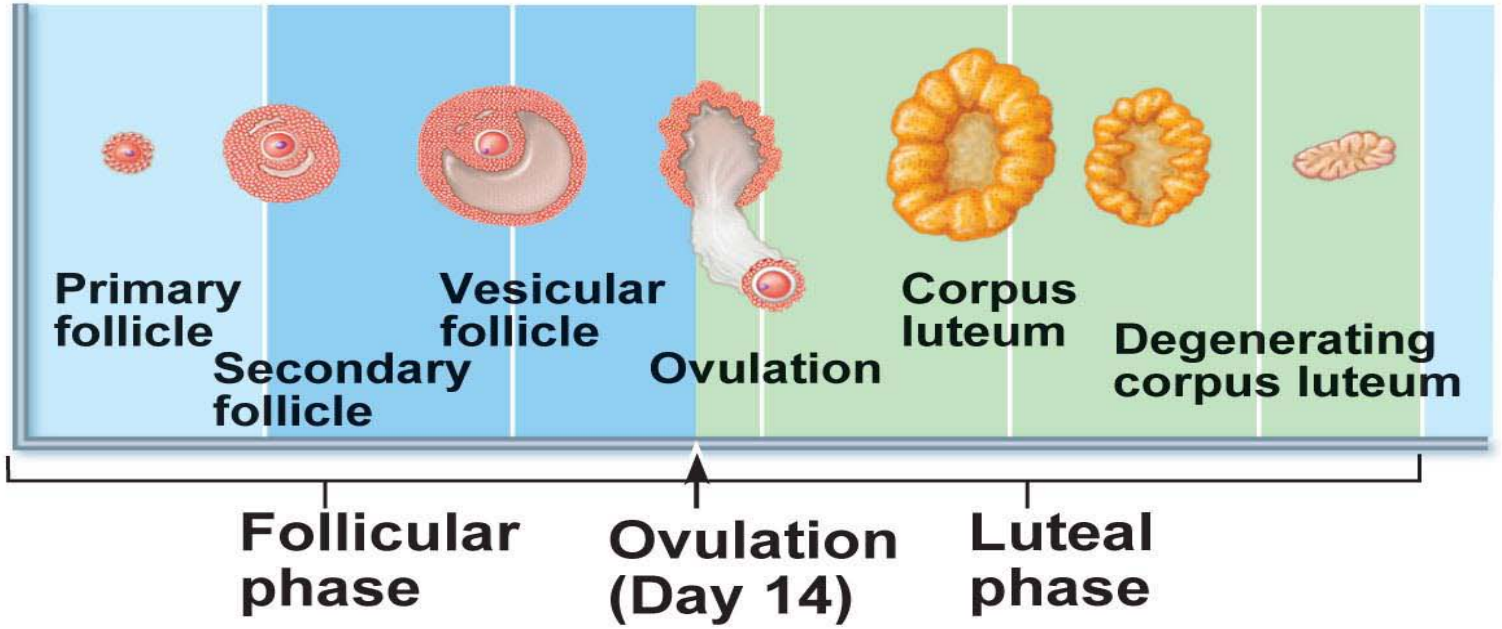
(d) The three phases of the uterine cycle:

- **Menstrual: Shedding of the functional layer of the endometrium.**
- **Proliferative: Rebuilding of the functional layer of the endometrium.**
- **Secretory: Begins immediately after ovulation. Enrichment of the blood supply and glandular secretion of nutrients prepare the endometrium to receive an embryo.**

Both the menstrual and proliferative phases occur before ovulation, and together they correspond to the follicular phase of the ovarian cycle. The secretory phase corresponds in time to the luteal phase of the ovarian cycle.

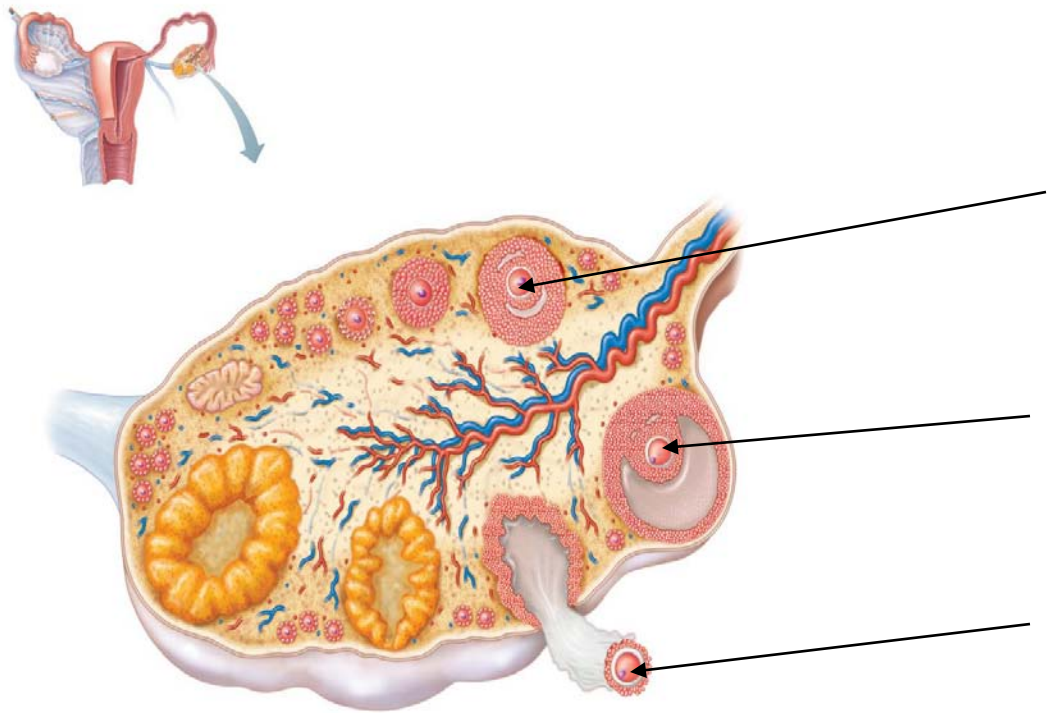
Ovarian Cycle

3 phases: follicular, ovulatory, luteal
days: 1 14 28



(b) Ovarian cycle: Structural changes in the ovarian follicles during the ovarian cycle are correlated with (d) changes in the endometrium of the uterus during the uterine cycle.

Egg Cycle



(a)

primary oocyte (P1)

secondary oocyte (M2)

ovulated oocyte

Male Fertility

fertility: sexual attraction & reprod. capacity

1) **attract a partner: sexual attraction**
2) **spermatogenesis: making new sperm**
3) **semen prod.: sperm & male reprod. fluid**
4) **erection: enlarged & stiff penis (blood engorgement)**
5) **ejaculation: propulsion of semen thru urethra**
6) **care of the young**

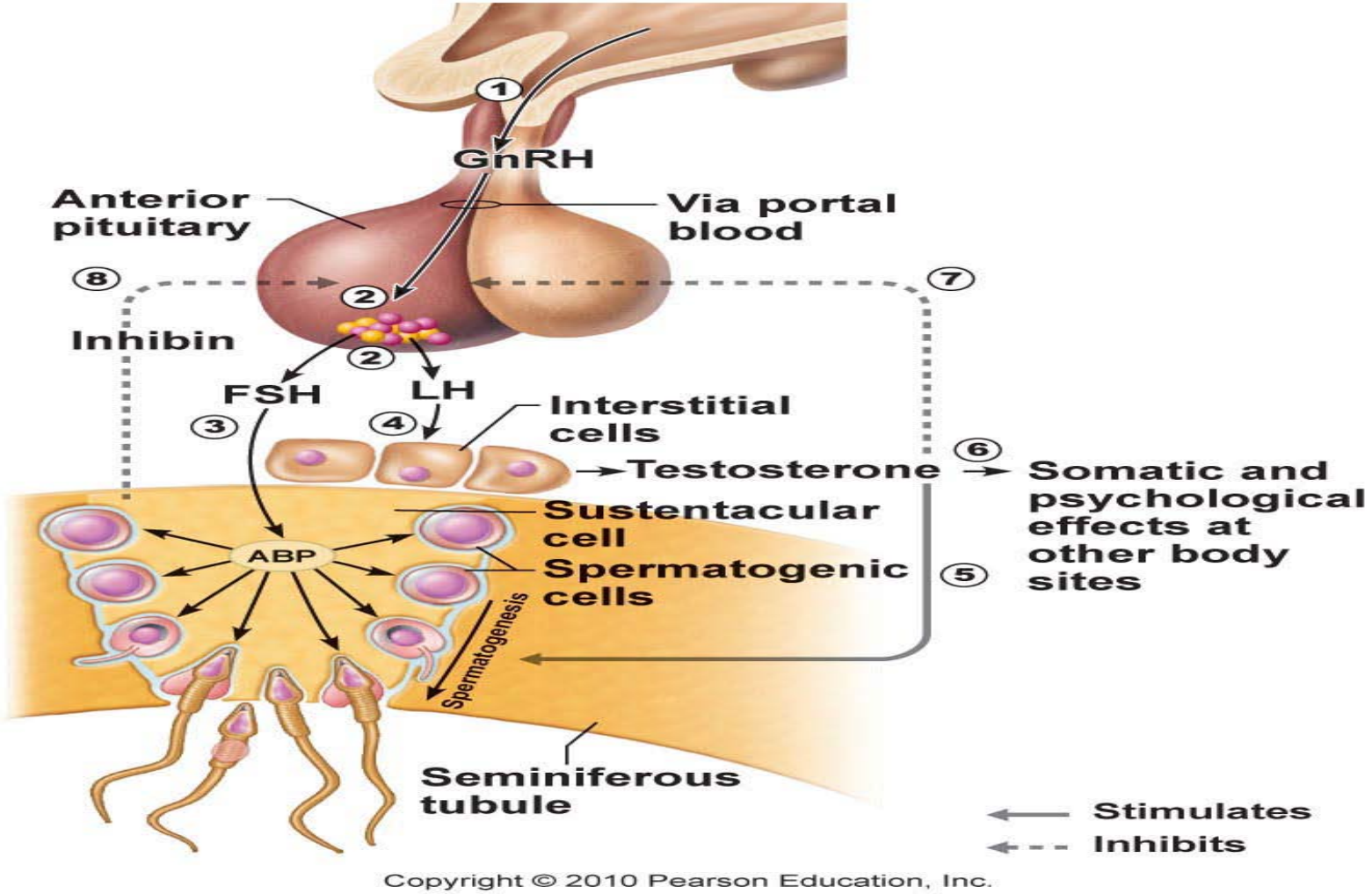
High Sperm Loss

- during sexual intercourse, high sperm loss (millions)

causes:

1) **leak from vagina**
2) **destroyed by acidic vagina**
3) **blocked by thick cervical mucous (thinned by estrogen)**
4) **spun by uterine "washing machine" contractions**
5) **eaten by uterine resident phagocytes**
6) **needs capacitation: ↑mobility & acrosome thinning**
   - occurs 6-8 hr after sex
7) **must "sniff" path to the released oocyte**

Brain-Testicular Axis (1)



Sex Hormones

function:

1) **reproduction (fertility)**
2) **sex. dev. (feminity & masculinity)**
3) **maturation (whole body growth & dev.)**

review female & male (not collected):

1) 1° & 2° sex. char

2) **hormones: GnRH, FSH, LH, inhibin, estrogen, progesterone, & testosterone**

Sex Hormone Levels

levels α (proportional) reproductive readiness

life stages:

1) prenatal: ↓ levels affect the brain (feminize & masulinize)

2) adolescent: ↓ levels α not reproductive (androgenous)

3) puberty: ↑ levels α pre-reproductive
(begin whole body and sex. dev.)

4) adulthood: ↑↑ levels α reproductive
(prime body & sex. dev.)

5) post-adult.: ↓ levels α post-reproductive
(declining body & sex. dev.)

Estrogen - Feminity & Fertility

function:

1) sexual attraction (femininity)

- whole body dev.

- 1°sex. char (breast, ovary, uterus)
- 2°sex. char (whole body)

2) gestation & oogenesis (fertility)
- female organs; 3 monthly cycles
- coord. dev. of uterus, ovary, & egg
- produce estrogen

Estrogen - Life Stages

1) prenatal: feminizes brain
2) adolescence: androgenous body
3) puberty: a) GnRH released rhythmically
   b) FSH & LH released to dev. ovaries
   c) estrogen & progesterone prod. & released
   d) body dev. & feminize; 3 monthly cycles
   e) inhibin & estrogen inhibits GnRH
4) adulthood: ↑ GnRH, FSH, LH, estrogen
   → ↑ feminine & fertile
5) post-adult.: ↓GnRH, FSH, LH, estrogen
   → ↓ feminine & fertile

Testosterone - Masculinity & Fertility

function:

1) sexual attraction (masculinity)

- whole body dev.

- 1°sex. char (penis)

- 2°sex. char (whole body)

2) spermatogenesis (fertility)

- testes dev.

- produce testosterone

Testosterone - Life Stages

1) **prenatal: masculinizes brain**
2) **adolescence: androgenous body**
3) **puberty: a) GnRH released rhythmically**
   - **b) FSH & LH released to dev. testes**
   - **c) ABP & testosterone prod. & released**
   - **d) body dev. & masculinize; spermatogenesis**
   - **e) inhibin & testosterone inhibits GnRH**
4) **adulthood: ↑ GnRH, FSH, LH, testosterone**
   → ↑ masculine & fertile
5) **post-adult.: ↓GnRH, FSH, LH, testosterone**
   → ↓ masculine & fertile