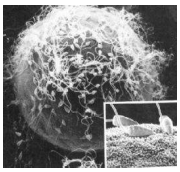
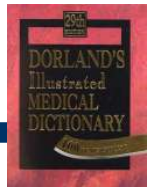
# Ch 26: Reproduction & Development

Keypoints:
Human Chromosomes
Gametogenesis
Fertilization
Fetal development
Maintenance of pregnancy
Parturition



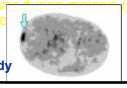
## Terminology




- Gonads (testes and ovaries)
  - Produce gametes(spermatozoa and ova)
    - Gametes are from germ cells
- External genitalia
- Internal genitalia
- Autosomes vs. sex chromosomes
- Meiosis

## *Human Chromosomes and Sex Determination*

- How many autosomes?
  - Sex chromosomes?
- X-linked disorders,
  - mechanism?
  - Examples
- Barr body = "extra" X-chromosome in female
- Nondisjunction during meiosis *(not in book)*
- Crossover during meiosis also not in book



Barr Body

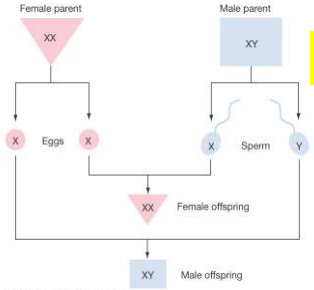
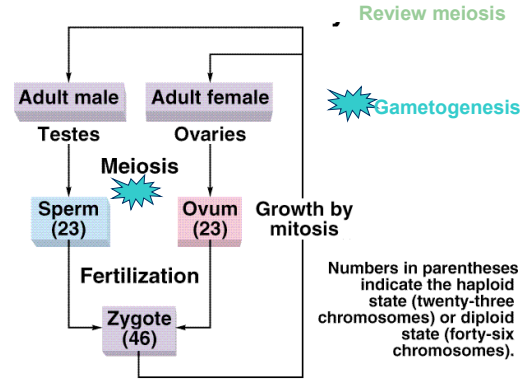
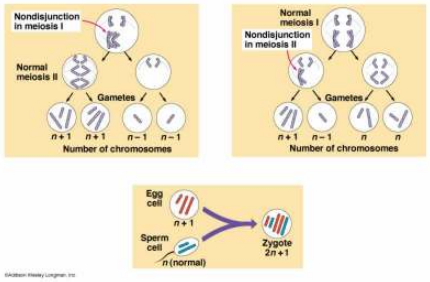
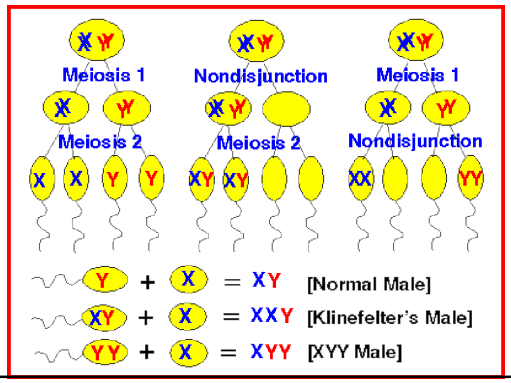



*Fig 26-2*



Nondisjunction

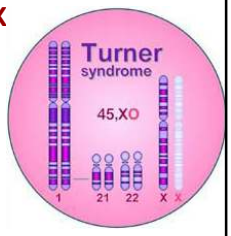



## *Abnormality Karyotype*

- Down Syndrome: Trisomy 21
- Turner Syndrome: X
- Triple-X Syndrome: XXX
- Klinefelter Syndrome: XXY
- Jacob Syndrome: XYY

## *r Syndrome*

**Monosomy X (45,X** Characteristically broad, "webbed" neck. Stature reduced, edema in ankles and wrists.



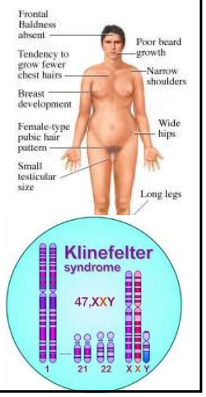

**Relatively normal lives – but no functional ovaries. 1 in 6,000 birth affected.**

## *Klinefelter Syndrome*

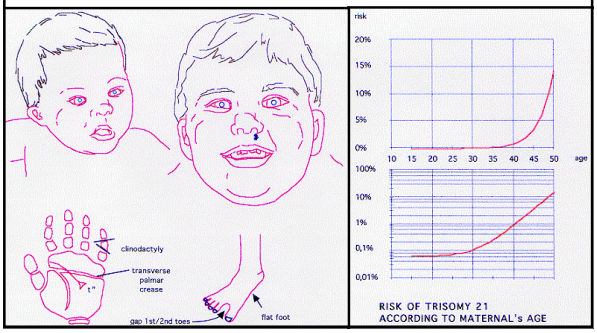
**XXY karyotype. Non-disjunction in meiosis (maternal or paternal) ⇒ ovum: XX; sperm: XY**

**Usually normal – may be tall and have small testes. Infertility due to absent sperm.**

**1 in 1,500 males affected.**




**TRISOMY 21:** Most frequent viable autosomal aneuploidy




## Sex Determination

- Early gonad (< 6 weeks) is bipotential (indifferent gonad)
  - SRY (Sex-determining Region of Y chromosome) gene on Y-chromosome codes for a protein that directs the gonad to become a testis
  - If no SRY, gonad becomes ovary.
  - Note that sex hormones are not yet produced!
- Testes produce Anti-Mullerian Hormone, Testosterone and DHT
  - Development of male accessory organs
- Ovaries develop due to absence of SRY and AMH
  - Estrogen directs development of female accessory organs

## *Intersex*

- **True hermaphrodite (both male and female gonads):** relatively rare and poorly understood
- **Pseudohermaphrodite** – external genitalia of one sex and internal sex organs of the other sex. Mostly no ambiguity in the sex of the external genitalia ⇒ no question about gender at birth
- **Male pseudohermaphroditism** due to **5 α-reductase deficiency** and ↓ DHT production. Born with female external genitalia
- Androgen Insensitivity Syndrome = XY genotype, but no receptors for androgens. Thus, the phenotype is female. (not in book)
- At puberty, ↑testosterone causes development of male characteristics

## *Gametogenesis*

**Starts *in utero* – resumes at puberty**

**General principle same for males and females**

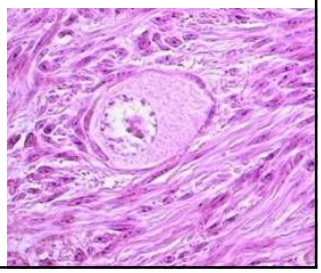
***Male*: continuous sperm manufacture. Meiosis produces 4 spermatozoa**

***Female*: born with all possible oocytes. Meiosis produces 1 ovum**

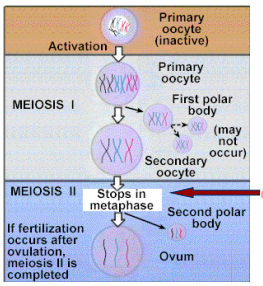
## *Oogenesis: Egg Cell Formation*

**Oogonia mitosis ceases before birth**

**At birth: only primary oocytes – suspended in prophase of meiosis I** *(= prophase I)*

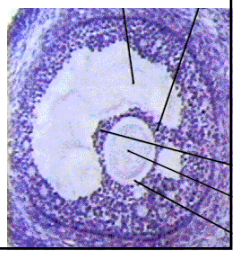


## *Oogenesis after Birth:*




ovulation

**At puberty: ↑ estrogen initiates ovarian cycle**



## *Male versus Female Gametogenesis*

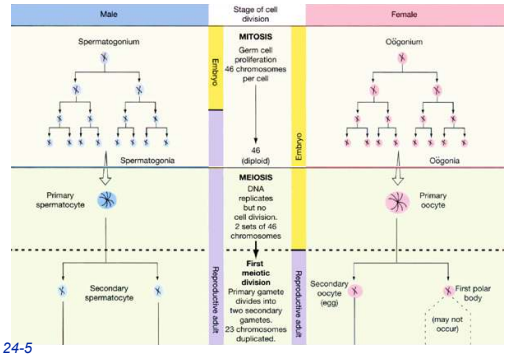



Fig 24-5

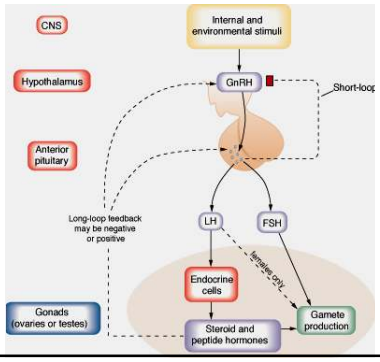
## *Hormonal Control of Reproduction*

- **Directed by brain (hypothalamus, etc.)**
- **Both sexes produce androgens & estrogens (progesterone only in female)**
- **Main androgen = testosterone and DHT**
- **Main estrogen = estradiol**
- **Testicular and ovarian enzyme (aromatase) converts testosterone into estradiol**
- **Mechanism of action of steroid hormones?**

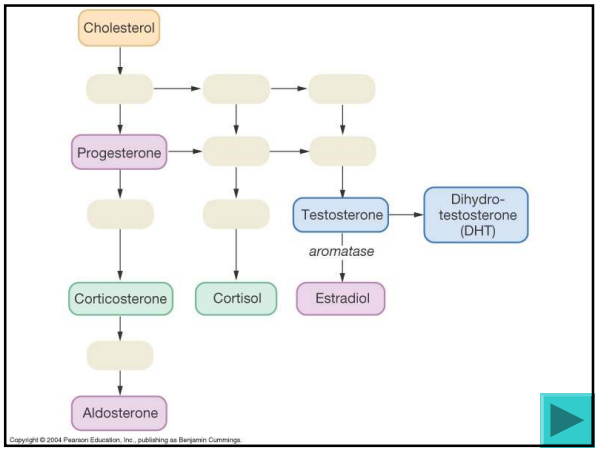
Fig 26-7

Fig 26-6

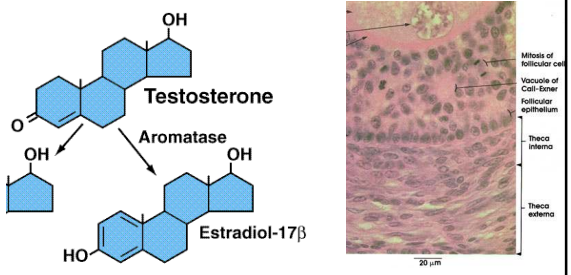
## *Interactions Between Hypothalamus, Anterior Pituitary, and Gonads*




**Special: High levels of estrogen ⇒ pos. feedback! ⇒ LH Peak**




## *Biosynthetic Pathway for Steroid Hormones*



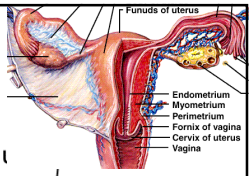


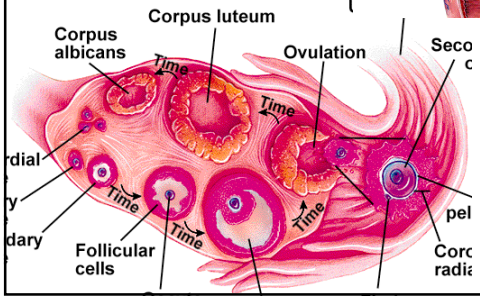


**Theca cells** Synthesize androgens → **diffusion** → **Granulosa cells** convert androgens to estrogen

## *Female Reproduction*

**Anatomy review: Ovaries and uterus**



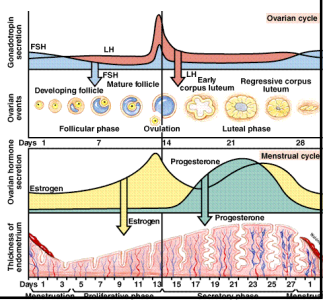




## *Menstrual Cycle lasts ~ 1 month*

**range 24-35 days**

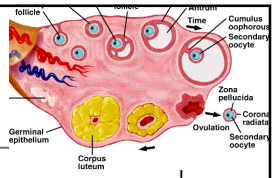
**Ovarian cycle**
**(changes in follicles)**
**function: monthly production of gametes**

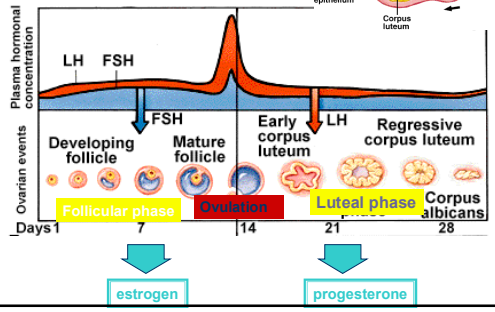
**Uterine cycle**
**(changes in endometrial lining)**
**function: receive developing embryo**



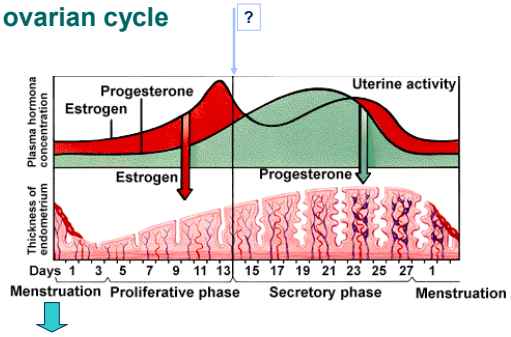

*Compare to Fig. 26-13*

## Ovarian Cycle



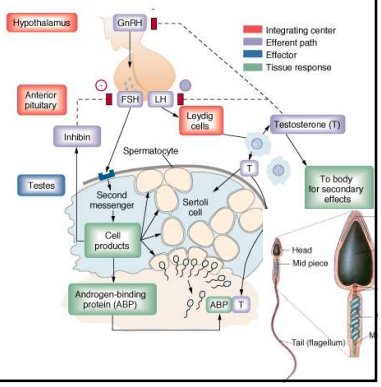



## Uterine Cycle: regulated by hormones of ovarian cycle




## *Spermatogenesis*

- Seminiferous tubules
- Sertoli cells:
  androgen binding protein
  blood testes barrier etc.
- Leydig cells
  testosterone vs. DHT




## Chapter 26 Repro, Part 2

## *Procreation*

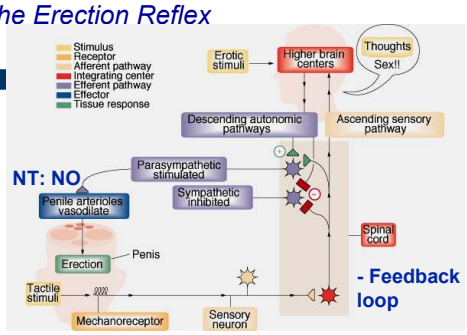
success

- Terrestrial vertebrates require adapted genitalia
- Male sex act:
  - Erection
    - Parasympathetic activation
    - Sympathetic inhibition
  - Ejaculation
    - Sympathetic activation of duct system smooth muscle

Fig 26-15

Arterial smooth muscle relaxes

## *The Erection Reflex*



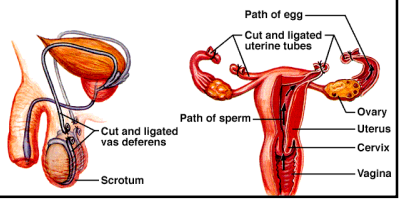

**- Feedback loop**

**Viagra prolongs the effect of NO**

## *Birth Control = Contraception*

**& when**

- **List methods of contraception from most effective to least effective**
- **Infertility**




**How do birth control pills work?**

**TABLE 26-5 Efficacy of Various Contraceptive Methods**

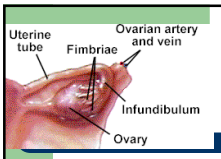
| METHOD | PREGNANCY RATE WITH TYPICAL USE* |
|---|---|
| No contraception | 85% |
| Spermicides | 29% |
| Abstinence during times of predicted fertility | 25% |
| Diaphragm, cervical cap, or sponge | 16–32%† |
| Oral contraceptive pills | 8% |
| Intrauterine devices (IUDs) | < 1% |
| Implanted hormonal contraceptives (Norplant™) | < 1% |
| Male condom | 15% |
| Female condom | 21% |
| Sterilization | < 1% |

*Rates reflect unintentional pregnancies in the first year of using the method. Data are from www.contraceptivetechnology.org/table.htm/ (Accessed 6/14/05).
†Lower rates are in women who have never delivered a child.



## ***Pregnancy and Parturition*** *p 848*

1. Transport of spermatozoa and ova
2. Fertilization
3. Blastogenesis
4. Implantation
5. Maintenance
6. Parturition
7. Lactation




## *2. Fertilization*

***Where? /Uterine Tube***

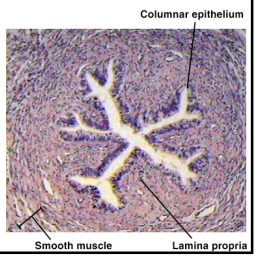
**~ 100 sperm needed**

***When? After ovulation***

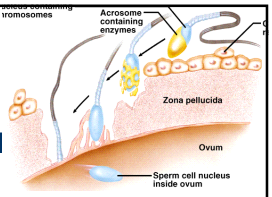
**Egg: 12-24 h post ovulation**

**Sperm: viable for up to 72 h**

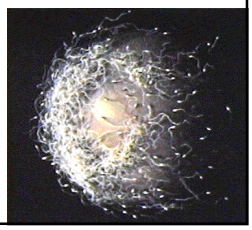
**Then: 3-4 day journey to uterus**




## *Fertilization* **cont.**




- **Sperm must penetrate several layers**
- **Acrosomal reaction allows sperm penetration**
- **1st sperm reaching egg binds to sperm-binding receptors on oocyte membrane & enters**
- **Cortical reaction prevents polyspermy**
- **Resulting structure = ?**

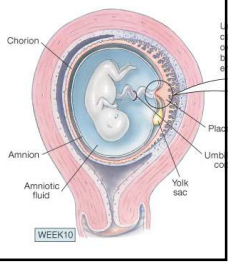


## 3. Developing Zygote Implants in Secretory Endometrium

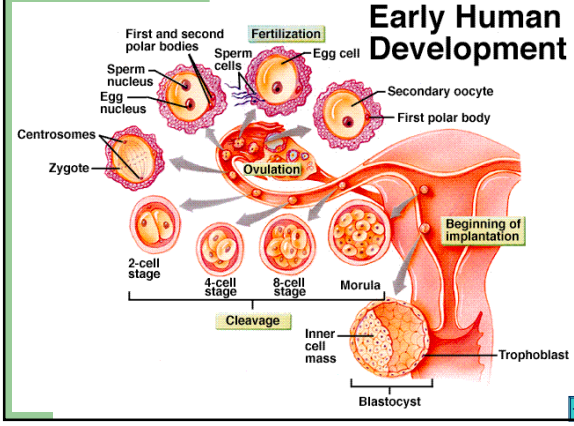
tube to uterine cavity over period of 3-4 days

Fig 26-18

- Implantation of the blastocyst into the endometrium~ 7 days after fertilization



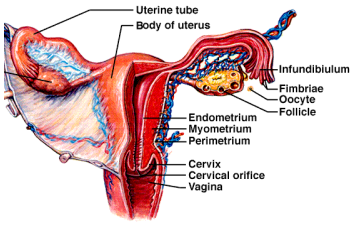

## Early Human Development




## 4. Implantation

### Uterine functions:

- Protection of embryo/fetus
- Nutritional support
- Ejection of fetus at birth

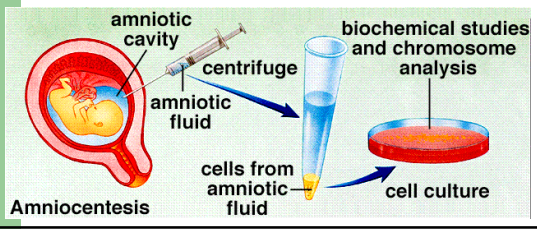



## Prenatal Genetic Testing

*Not in textbook*

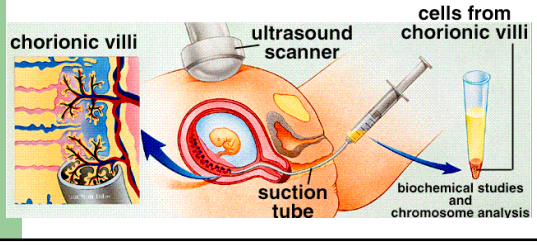
### Amniocentesis:

- Cell culture can take several weeks ⇒ Karyotyping and D




## Chorionic Villi Sampling

- Placental chorionic villi can be analyzed for genetic abnormalities
- Can be done at 8 weeks (recommendation: 10 weeks)
- No cell culture necessary



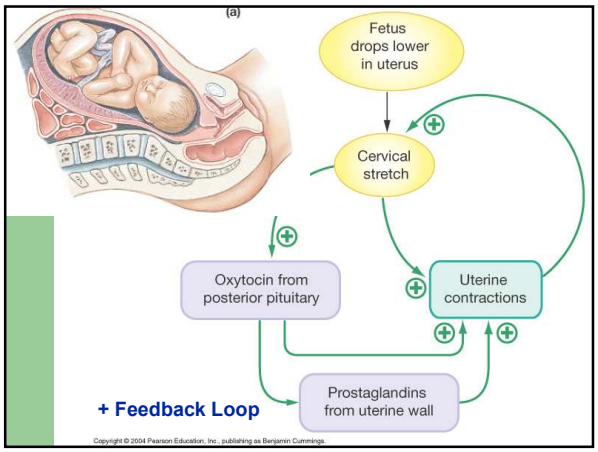

## 5. Maintenance of Pregnancy

- Progesterone is generally the hormone that maintains pregnancy
  - Quiescent uterus, no contractions
- hCG secreted by developing placenta (related to LH) ⇒ Prevents CL from degenerating and stimulates it to continue to produce progesterone
- Week 7: placenta takes over progesterone production; CL degenerates
- hCG also important in pregnancy testing (and for male sexual development)
- hCG used for pregnancy testing

## 6. Labor and Delivery

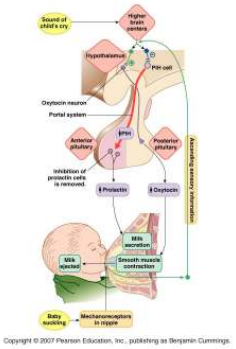
- Parturition = Birthing process
- At 38 - 40 weeks of gestation
- Initiation poorly – sequence of events well understood
  - (Placental CRH?)
- Relaxin
  - From ovaries and placenta
- The positive feedback loop of parturition
  - Stopped after cervical stretch is gone

Fig 26-21




## 7. Lactation

- Milk production: prolactin
  - Anterior Pituitary
  - Prolactin Inhibiting Hormone (PIH)
    - From hypothalamus
    - ↓ during late pregnancy
- hPL: Human Placental Lactogen
  - May aid breast development
  - May be associated with Gestational Diabetes?
- "Let-down" due to oxytocin
- Colostrum
  - Earliest milk after parturition
  - Lots of Ab for newborn




## Growth and Aging

- Puberty (↑GnRH)
  - in girls = menarche
    - Average 12 y
  - In boys, later (harder to pinpoint a time)
- Menopause
  - Irregular menstrual periods and cessation
- Andropause
  - Similar drop in androgens