

Fertilization

- **Acrosome reaction:** enzymes allow sperm to penetrate granulosa cells, and the zona pellucida
- A single sperm & headpiece enter the egg
- Nuclei from egg and sperm fuse (fertilization)
- Egg prevents polyspermy:
Fast Block: binding of sperm to egg opens Na⁺ channels depolarizing egg – this inhibits binding more sperm
Slow Block: When the sperm enters the oocyte, Ca²⁺ is released by the sperm and there is an inflow of Ca²⁺
- Stimulates cortical reaction where cortical granules released and cause zona pellucida to be impenetrable (Fertilization Membrane)

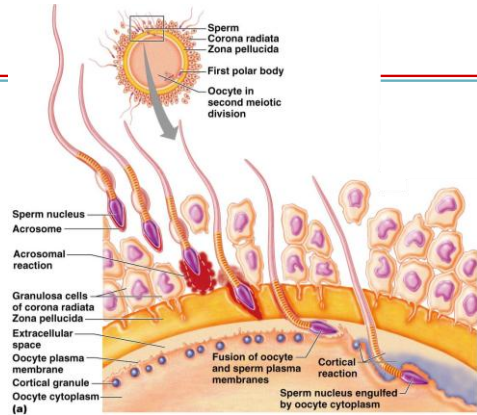
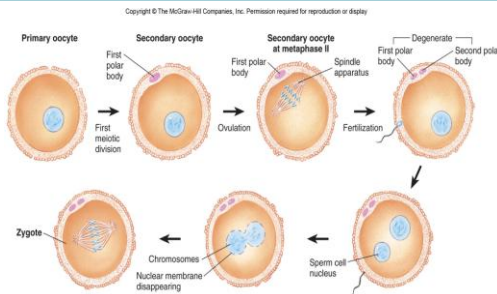


Figure 28.2a

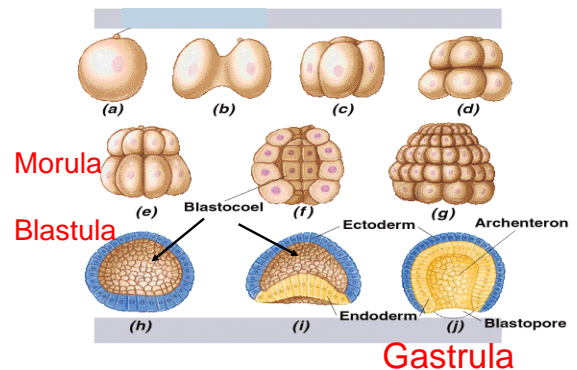
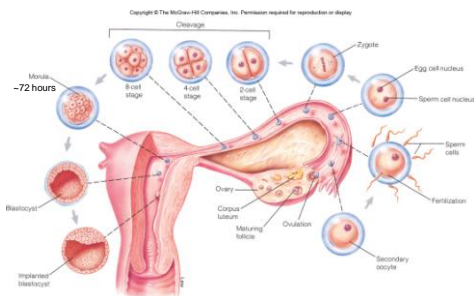
Fertilization



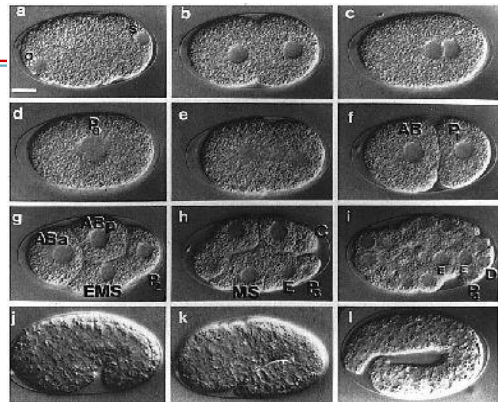
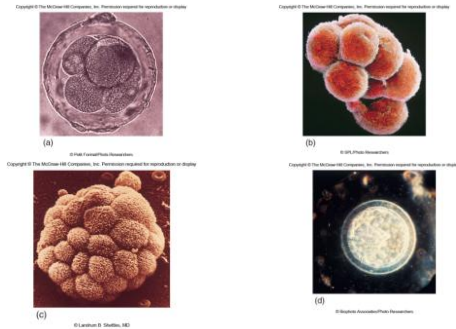
Cleavage and Blastocyst Formation

- Cleavage begins 30–36 hours after fertilization
 - Characterized by rapid mitosis, which forms a hollow ball of cells called the blastocyst
- The blastocyst has two parts:
 - Embryoblast becomes the fetus.
 - Trophoblast will become the chorion → placenta.

Cleavage and Blastocyst Formation



Cleavage and Blastocyst Formation



Sexual Reproduction

- Germ cells become gametes (sperm and ova) in gonads via meiosis.
- Ova and sperm are fused in fertilization.
- The new individual progresses from zygote → embryo → fetus.

Chromosomes

- Each zygote gets 23 chromosomes from mom and 23 from dad.
 - Produces **23 pairs of homologous chromosomes**
 - **22 pairs are autosomal chromosomes = have the same (but not identical) genes on them.**
 - **The last pair are the sex chromosomes.**

Sex Chromosomes

- Females have two X chromosomes.
 - Mom always passes on an X chromosome.
- Males have an X and a Y chromosome.
 - Dad can pass on *either* an X or a Y chromosome.
 - i.e sex is determined by sperm.

Sex Chromosomes

- X and Y look different and have different genes.
 - X has 1,090 genes while Y has only 80 genes.
 - The Y chromosome has many testis-specific genes.

Formation of Gonads

- Embryonic gonads/associated structures are identical in males and females.
 - can become *either* testes or ovaries.
 - Become testis if there is **testis-determining factor (TDF)**.
- TDF is coded for by a gene on the Y chromosome.
- SYR gene (sex determining gene)

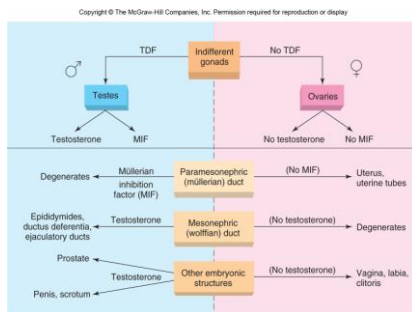
Formation of Testes

- Soon after the production of TDF in XY embryos - testis and seminiferous tubules form.

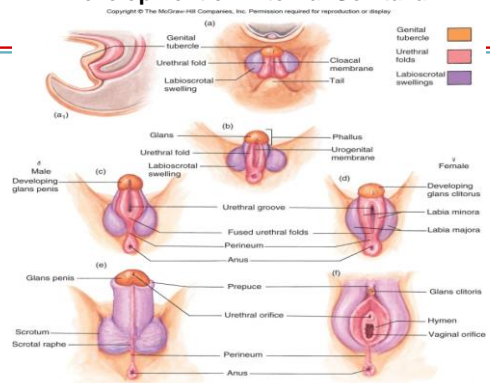
Testis have:

- Sertoli cells of seminiferous tubules make Mullerian Inhibiting Factor (Mullerian duct regresses)
- Leydig cells (make testosterone) promotes development of Wolffian duct into accessory structures, penis, & scrotum

Regulation of Sexual Development (internal)



Development of External Genitalia



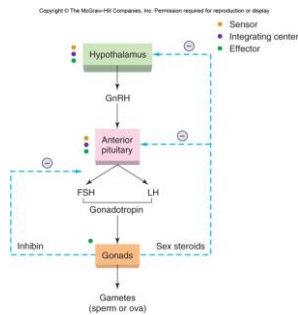
Sex Hormone Secretion

- Testes stop making testosterone by 3rd trimester
- Embryonic ovaries don't make embryonic sex hormones
- Sex hormone secretion doesn't occur again until puberty.
 - At this time, anterior pituitary begins releasing gonadotropic hormones.

Gonadotropic Hormones

- Follicle-stimulating hormone (FSH) and luteinizing hormone (LH) are produced in both males and females with three effects:
 1. Stimulation of spermatogenesis & oogenesis
 2. Stimulation of gonadal hormone secretion

Regulation of Hormones



Regulation of FSH and LH

- **Inhibin.**
 - Secreted by Sertoli (sustentacular) cells in testes
 - Secreted by granulosa cells of ovarian follicles
 - Specifically inhibits release of FSH (no effect on LH)

Testes

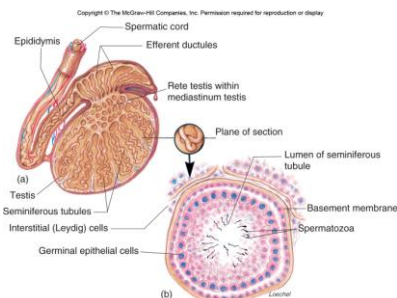
- **Two compartments:**
 - **Seminiferous tubules:** where spermatogenesis occurs
 - FSH receptors are here, on Sertoli cells.
 - FSH influences spermatogenesis.
 - **Interstitial tissue:** where Leydig cells make testosterone; also filled with blood and lymphatic capillaries
 - LH receptors found here on Leydig cells
 - Testosterone secreted in response to LH

Action of Testosterone

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Category	Action
Sex Determination	Growth and development of Wolffian ducts into epididymis, ductus deferens, seminal vesicles, and ejaculatory ducts Development of urogenital sinus into prostate Development of male external genitalia (penis and scrotum)
Spermatogenesis	At puberty: Completion of meiotic division and early maturation of spermatids After puberty: Maintenance of spermatogenesis
Secondary Sex Characteristics	Growth and maintenance of accessory sex organs Growth of penis Growth of facial and axillary hair Body growth
Anabolic Effects	Protein synthesis and muscle growth Growth of bones Growth of other organs (including larynx) Erythropoiesis (red blood cell formation)

Testis Structure



Spermatogenesis

- Diploid spermatogonia first go through **mitosis**.

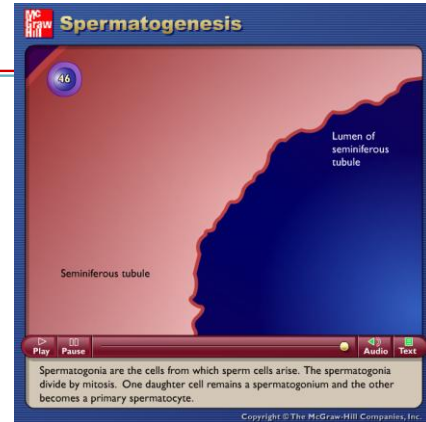
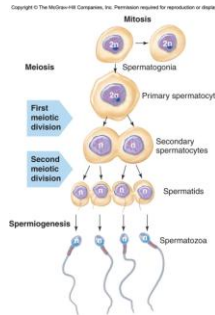
2 Daughter cells:

1. Primary spermatocyte continues through meiosis
2. Spermatogonia

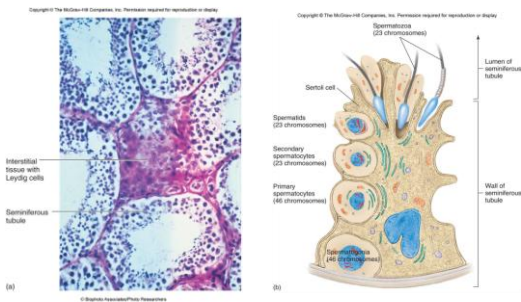
- After meiosis I → 2 secondary spermatocytes.

- After meiosis II → 4 spermatids → Sperm

Spermatogenesis



Spermatogenesis Within the Seminiferous Tubules



Spermiogenesis and Sertoli Cells

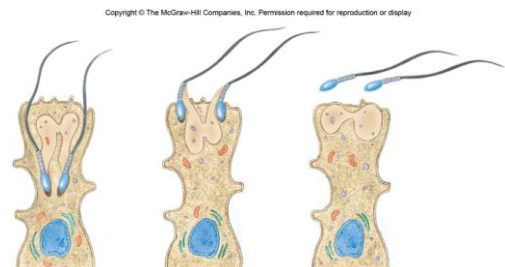
Part of seminiferous tubule

1. Regulate sperm development
 - Molecules from blood pass through cytoplasm of **Sertoli cells** before entering germinal cells
2. creates a blood-testis barrier
 - control what enters seminiferous tubules
 - prevents immune system from developing antibodies (for antigens on sperm)

Spermiogenesis and Sertoli Cells

3. - Phagocytize some of the spermatid cytoplasm
4. Secrete **androgen-binding protein (ABP)** into the seminiferous tubule lumen.
 - ABP binds to testosterone and concentrates it in the tubule.
 - Testosterone stimulates spermatogenesis
 - ABP production is stimulated by FSH.
5. Also secrete FAS ligand
 - binds to an FAS receptor on T cells, stimulating apoptosis.
 - creates an immunologically privileged site.
6. Sertoli cells also release other hormones, enzymes

Spermiogenesis and Sertoli Cells



Hormonal Control of Spermatogenesis

- **Testosterone is required to stimulate meiosis and early spermatid maturation.**
 - LH stimulates **Leydig cells** to release **testosterone**.
 - Promotes spermatogenesis
 - FSH targets **Sertoli cells**
 - Stimulates production of **ABP**, which **concentrates testosterone levels (facilitates spermatogenesis)**
 - Makes it **lipophilic (can't leave the lumen)**
 - FSH ensures **optimal fertility**

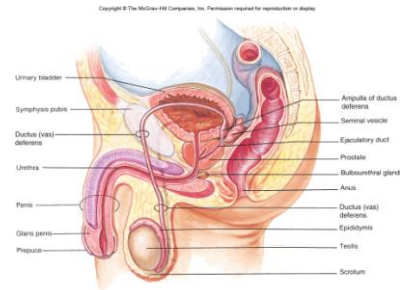
Male Accessory Sex Organs

- The seminal vesicle and prostate gland add fluid to the sperm to form semen.
- Seminal fluid: contains fructose (energy for sperm)
 - **prostaglandins stimulate sperm motility & viability**
 - **clotting proteins -coagulation**
- Prostate fluid: contains citric acid, calcium, and **enzymes for seminal liquefaction**

Male Accessory Sex Organs

- Spermatids move from the seminiferous tubules → rete testis → efferent ductules → epididymis.
- The epididymis is the site of sperm maturation and storage.
- In ejaculation, spermatozoa move from the epididymis → ductus deferens → ejaculatory duct → urethra.

Male Accessory Sex Organs



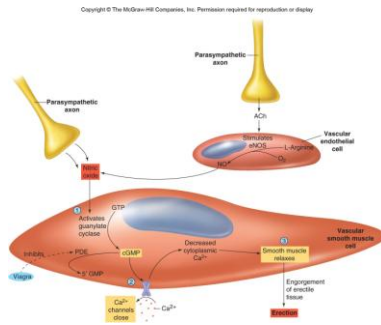
Erection

- **Results from blood flow into erectile tissues of the penis:**
 - **Corpora cavernosa and corpus spongiosum**
- **Parasympathetic or Sympathetic?**
 - **induced vasodilation of arterioles leading to the corpora cavernosa**

Erection

- Nitric oxide serves as the neurotransmitter.
 - Activates guanylate cyclase to produce cGMP → Closes Ca^{2+} channels → Decreases cytoplasmic Ca^{2+} levels → Relaxes muscles

Nitric Oxide and Erection



Control of the Erection

- Controlled by the hypothalamus and the sacral region of the spinal cord
- Can occur due to conscious sexual thought (hypothalamus → spinal cord → penis) or sensory stimulation (penis → spinal cord → penis)

Vasectomy

