Overview of the Reproductive System

We can sum up the reproductive system in just a few words...

Lecture Overview

- Function of the male reproductive system
- Overview of the anatomy of the male reproductive system
- Descent of the testes
- Structure of the testes
- Formation of sperm cells
- Structure of sperm cells
- Male internal accessory organs
- Male external accessory organs
- Erection, orgasm, and ejaculation
- Hormonal control of the male reproductive system
Male Reproductive System

- There are three main functions of the male reproductive system
  - Produce and maintain sex cells (sperm)
  - Transport sperm and supplemental fluids to the female reproductive tract
  - Secrete male sex hormones
- Sex organs can be divided into
  - Primary sex organs (gonads) = testes (sperm, hormones)
  - Accessory (secondary) sex organs = internal and external reproductive organs
**Descent of Testes**

Descent begins 1-2 months before birth under the influence of testosterone. Descent is necessary for sperm production.

Failure of testes to descend = cryptorchidism

**Structure of the Testis**

Surrounded by the tunica albuginea – a tough, white, fibrous capsule that encloses each testicle. Septa divide each testicle into about 250 lobules. Each lobule contains 1-4 highly coiled seminiferous tubules that give rise to sperm. Interstitial cells (of Leydig) lie in between seminiferous tubules and secrete male sex hormones.

**Review of Mitosis and Meiosis**

Mitosis – production of two identical diploid daughter cells.

Meiosis – production of four genetically varied, haploid gametes.
Chromosome Crossing Over

- mixes up traits
- different colors represent the fact that one homologous chromosome comes from the individual’s father (paternal) and one from the mother (maternal)
- the genetic information in sperm cells and egg cells varies from cell to cell

Figure from: Hole’s Human A&P, 12th edition, 2010

Seminiferous Tubules and Sperm Maturation

Figures from: Martini, Anatomy & Physiology, Prentice Hall, 2001

Spermatogonium = stem cell

Spermatogenesis

Know the order of events below!

Spermatogonium (2n) →
Primary spermatocyte (2n) →
Meiosis I →
Secondary spermatocyte (n) →
Meiosis II →
Spermatid (n) →
Spermiogenesis →
Spermatozoan (n)
Formation of Sperm Cells

Supporting cells are sustentacular cells. They:
1. Are important in regulating and supporting spermatogenesis.
2. Help maintain the blood-testis barrier.

Structure of a Sperm Cell

Enzymes used to penetrate the egg during fertilization.

Male Internal Accessory Organs
### Epididymis
- Maintains fluid produced in the seminiferous tubules
- Recycles damaged sperm and cellular debris
- Store and protects sperm, and aids in their maturation

### Ductus (Vas) Deferens
- Muscular tube about 45 cm long; transports sperm (can store sperm for several months)
- Extends from epididymis to ejaculatory duct

### Seminal Vesicles
- Attached to ductus deferens near base of bladder
- Secreses alkaline fluid (60% of the volume of semen)
- Secreses fructose, prostaglandins, and prosemminogelin
- Begins capacitation of sperm
- Contents empty into ejaculatory duct
Prostate Gland

- surrounds beginning of urethra
- ducts of gland open into urethra
- secretes a thin, milky, slightly acidic fluid (20-30% of semen volume)
- secretion enhances fluid mobility
- contains seminalplasmin
- composed of tubular glands in connective tissue
- also contains smooth muscle

Bulbourethral (Cowper's) Gland

- inferior to the prostate gland
- secretes thick, alkaline mucus - helps lubricate the tip of the penis (glands) and neutralize any urinary acids in urethra
- fluid released in response to sexual stimulation

Semen

- sperm cells
- secretions of seminal vesicles, prostate gland, and bulbourethral glands (seminal fluid)
- slightly alkaline (offsets acidity of female reproductive tract)
- prostaglandins (stimulates contraction in female reproductive tract)
- nutrients
- enzymes (protease, seminalplasmin, fibrinolysin)
- 20-100 million sperm cells per milliliter
- usually about 2-5 ml of fluid per ejaculate
Male External Reproductive Organs

Scrotum
- Pouch of skin and subcutaneous tissue
- Dartos muscle – smooth muscle in dermis; contracts to cause wrinkling of the scrotum (traps heat)
- Medial septum divides scrotum into two chambers
- Each chamber lined with a serous membrane
- Each chamber houses a testis and epididymis

Cremaster muscle can retract testes

Penis
Connection of penis to body wall (root)
Preputial glands in the prepuce (foreskin) produce a waxy material called smegma. This can be a source of bacterial growth if hygiene is poor. Circumcision is the surgical removal of the prepuce.

Erection, Orgasm, and Ejaculation

Erection
• parasympathetic nerve impulses
• blood accumulates in erectile tissues

Orgasm
• culmination of sexual stimulation
• accompanied by emission and ejaculation

Emission and Ejaculation
• emission is the movement of semen into urethra
• ejaculation is the movement of semen out of the urethra
• largely dependent on sympathetic nerve impulses
Mechanism of Penile Erection

Sexual stimulation → Bulbospongiosus m. and Ischiocavernosus m.

Parasympathetic neurons release nitric oxide, causing dilation of small arteries to penis → Veins are compressed, reducing blood flow away from penis → Blood accumulates in the vascular spaces within erectile tissues of penis → Penis swells and becomes erect.

How Does Viagra™ (Sildenafil) Work?

Erotic stimuli → Nitric Oxide (NO) → Parasympathetic stimulation (required to start cascade) → GTP → Guanyl cyclase → cGMP → Smooth muscle relaxation, dilation of blood vessels → Interior of smooth muscle cell → Phosphodiesterase 5 (PDE5) → VIAGRA (Also Cialis, Levitra) → GMP.

Mechanism of Emission and Ejaculation

Culmination of intense sexual stimulation → Sympathetic impulses contract smooth muscle → Rhythmic contractions in testicular ducts, epididymides, vasa deferentia, and ejaculatory ducts → Rhythmic contractions in erectile columns of penis → Rhythmic contractions in bulbourethral glands, prostate gland, and seminal vesicles → Emission—semen moves into urethra → Ejaculation—semen is forcefully expelled from urethra.
Hormonal Control of Male Reproductive Functions

- hypothalamus controls maturation of sperm cells and development of male secondary sex characteristics
- negative feedback controls concentration of testosterone

Actions of Testosterone

- increased growth of body hair
- sometimes decreased growth of scalp hair
- enlargement of larynx and thickening of vocal cords
- thickening of skin
- increased muscular growth
- thickening and strengthening of the bones

Know these actions

Review

- Spermatogenesis
  - Spermatogonia, 1st spermatocyte, 2nd spermatocyte, spermatid, spermatozoan
  - Is a result of meiotic division
  - Under the control of FSH
  - Is guided and regulated by sustentacular cells
  - Produces 4 haploid gametes (spermatozoa)
- Spermatozoa
  - Head, midpiece, and tail
  - Acrosomal cap – enzymes use for fertilization
  - Non-motile when produced – must undergo capacitation
**Review**

- **Male Accessory Organs**
  - Epididymis
    - Maintains fluid produced in the seminiferous tubules
    - Recycles damaged sperm and cellular debris
    - Store and protects sperm, and aids in their maturation
  - Vas (ductus) deferens – muscular tube for sperm transport and storage
  - Seminal vesicle
    - Alkaline fluid with fructose, prostaglandin, and fibrinogen
    - About 60% of semen volume in ejaculate

- **Male Accessory Organs (cont’d)**
  - Prostate gland
    - Thin, milky fluid
    - 20-30% of semen volume in ejaculate
    - Seminalplasmin
  - Bulbourethral glands
    - Cowper’s glands
    - Thick, mucus-like substance
    - Lubricates glans of penis
    - Neutralizes acids in urethra

- **Semen**
  - Sperm + seminal fluid
  - 20-100 million sperm per ml in ejaculate (2-5 ml)
  - Contains enzymes

- **External Reproductive Organs**
  - Scrotum
    - Contains and separates testes
    - cremaster and dartos muscles regulate temperature of testes
  - Penis
    - Root, body (shaft), and glans; prepuce (foreskin)
    - Erectile tissues (c. cavernosum, c. spongiosum)
    - Urethra (common pathway for urine and sperm)
    - Prepuce
### Review

**Erection, orgasm, emission, and ejaculation**
- **Erection**
  - Filling of erectile tissues with blood; venous drainage is blocked
  - Controlled by parasympathetic NS (nitric oxide)
- **Orgasm** - highly pleasurable culmination of the sexual experience, accompanied by emission and ejaculation
- **Emission** - movement of semen into urethra
- **Ejaculation** - movement of semen out of urethra
- Orgasm, emission, and ejaculation are controlled by the sympathetic NS

### Review

**Hormonal control of male reproductive system**
- **FSH**
  - Meiosis in primary spermatocytes
  - Secretion of inhibin by sustentacular cells
- **LH (ICSH)**
  - Secretion of androgens (testosterone) by interstitial cells
- Levels of FSH and LH inhibit release of GnRH and FSH/LH
- Effects of androgens