Chapter 19: Reproductive System

• Introduction
  o Sex cells are haploid. Haploid cells contain only one set of chromosomes. Sperm and egg are both haploid, and when they unite, they form a diploid cell, particularly called the zygote. The zygote will develop into a new individual. Diploid cells contain 2 sets of chromosomes (one set from each sex cell—one set from the sperm and one set from the egg cell).
  o The haploid cells are formed through a nuclear division called meiosis. Unlike mitosis, meiosis is a nuclear division that results in a reduction of genetic information. The reduction allows for genetic variability when two haploid cells unite to form a diploid cell. Examples of this genetic variability are the differences between siblings yet the siblings will share some similarities if the haploid cells uniting are coming from the same parents. Review: mitosis is a nuclear division that results in an exact replication of genetic information from “mother” cell to “daughter” cell.
  o Primary sex organs (gonads) produce the haploid cell and hormones.
  o Accessory sex organs provide a supportive function (transport, secretion of substances, and nurturing of the sex cells).

• Male Reproductive System

REFERENCE FIGURE 19.1
  o Primary Sex Organs: Testes

REFERENCE FIGURE 19.2
  ▪ Anatomy: The testes are ovoid structures suspended by a spermatic cord in the scrotum
  ▪ Structure of the testes
    • 250 lobules separated by connective tissue
    • Each lobule holds 1 to 4 seminiferous tubules which are the structures that contain the stem cell, spermatagonia, that give rise to sperm cells.
    • Interstitial cells are located between the seminiferous tubules and produce male hormones -- testosterone.
    • Channels and ducts lead from the seminiferous tubules and convey the sperm to the epididymus- lateral tube that holds the new sperm cells and allow for further maturation of the sperm cells.

  o Spermatogenesis

REFERENCE FIGURE 19.3 AND FIGURE 19.4
  ▪ Spermatogenesis is the sequence of forming sperm cells from the undifferentiated diploid cells, spermatagonia.
  ▪ Steps:
    • Spermatogonia enlarge and become primary spermatocytes via mitosis.
    • Primary spermatocytes begin as diploid, but soon divide by meiosis to form haploid secondary spermatocytes. Meiosis will create a reduction in the genetic information in the offspring cell but will allow genetic variability.
    • Secondary spermatocytes also divide by meiosis to form spermatids which will mature into sperm cells.
Sperm cells will be located in the lumen of the seminiferous tubules and wait to be transported to the epididymus.

- Sperm cell

**REFERENCE FIGURE 19.5**

- Structure of sperm:
  - Head = contains DNA of the male and possesses an enzymatic "capsule" called the acrosome that will aid the sperm to penetrate through a barrier
  - Midpiece = the "body" of the sperm that contains mitochondria to fuel the sperm with ATP to "swim" or travel
  - Tail = flagellum made up of microtubules that provide movement for the sperm cells

- Internal Accessory Organs

**REFERENCE TABLE 19.1**

- **Epididymus** = tightly coiled tube adjacent to each testis; site of sperm maturation
- **Vas Deferens** = muscular tube that leads from the epididymus; conveys sperm from epididymus and through the other accessory organs via peristalsis; will lead to the **ejaculatory duct** which will empty semen into urethra
- **Seminal Vesicles** = saclike structures attached to the vas deferens near the base of urinary bladder; secretes alkaline fluid with fructose to nourish sperm and prostaglandins to stimulate muscular contractions in the female tract to help propel sperm to the egg
- **Prostate gland** = chestnut-shaped structure at the base of urinary bladder; secretes alkaline fluid to enhance mobility of sperm and neutralizes acidity of female tract
- **Bulbourethral glands** = inferior to prostate gland; secrete mucus for lubrication of the penis during sexual arousal

- Semen
  - Semen is deposited into female reproductive tract. Sperm cells will swim in search for the egg to fertilize. The acrosome will aid in breaking down the membrane of the egg.
  - Contents
    - Sperm cells (120 million per milliliter)
    - Secretion from prostate gland
    - Secretions from seminal vesicles
    - Secretions from bulbourethral glands

- External Accessory Organs

**REFERENCE TABLE 19.1**

- **Scrotum** = pouch of skin and tissue that houses the testes; suspends the testes to maintain optimal temperature for the maturing sperm cells
- **Penis** = cylindrical organ made up of erectile tissues (corpus cavernosa and corpus spongiosum); conveys both urine and semen to the outside
- **Glans penis** = enlarged area at the distal end of the penis made up of erectile tissue called corpus spongiosum. This region contains sensory sexual receptors for sexual arousal
  - Erection and Orgasm
    - Erection
      - Parasympathetic impulses triggers arteries within the penis to dilate and constrict the veins to accumulate blood to produce erection
    - Orgasm
      - Orgasm is the culmination of sexual stimulation (consists of emission and ejaculation)
        - Emission = moving sperm and secretions into the urethra
        - Ejaculation = forcing semen to the outside
      - After ejaculation, sympathetic impulses constrict arteries and allow blood flow, penis returns to flaccid state
  - Hormonal Control of Male Reproductive Functions
    - **REFERENCE FIGURE 19.6**
      - During puberty, the hypothalamus directs changes that will lead to the development of a reproductively functional adult
      - Gonadotropin Releasing Hormone (GnRH) = released from the hypothalamus and is sent to the anterior pituitary to stimulate the release of specific anterior pituitary hormones
        - Anterior pituitary hormones
          - LH = aid in the development of interstitial cells in the testes which will secrete testosterone
          - FSH = stimulates supporting cells of the seminiferous tubules
          - Both hormones stimulate spermatogenesis
    - Regulation of Male Sex Hormones
      - Androgens = male type sex hormones
      - Most abundant androgen: testosterone
      - Testosterone
        - Effects of testosterone
          - Development of reproductive organs
          - Testes descend prior to birth
          - Secondary sexual characteristics (examples):
            - Deepen of the voice
            - Increase body hair
            - Muscular development
            - Thickening of the skin

- Female Reproductive System
  - **REFERENCE FIGURE 19.7**
    - Primary Sex Organs: Ovaries
      - Anatomy of the ovaries: solid, ovoid structures within the pelvic cavity
      - Ovary structure:
• Medulla: Middle region consisting of connective tissue, blood and lymphatic vessels, nerves
• Cortex: Outer region made up of follicles covered by cuboidal epithelium
• During prenatal development, primordial follicles are formed which consists of a primary oocyte surrounded by follicular cells, and the primary oocyte will undergo meiosis incompletely. It will halt the meiosis process and will resume at puberty

  o Oogenesis
  **REFERENCE FIGURE 19.8**
  - Beginning puberty, some oocytes will continue meiosis
  - Steps:
    • Primary oocyte undergoes meiosis and give rise to a large haploid secondary oocyte (the egg) and a polar body
    • The polar body disintegrates and contains the excess genetic material.
    • The secondary oocyte will undergo the second meiotic division if a sperm fertilizes it to give rise to the zygote and a second polar body
    • If the secondary oocyte does not get fertilized by a sperm, then the secondary oocyte will degenerate

  o Follicle Maturation
  **REFERENCE FIGURE 19.9 AND FIGURE 19.10**
  - FSH stimulates follicular maturation
  - A mature follicle will contain the secondary oocyte which is surrounded by the zona pellucida and the corona radiata
    • Corona radiate is made up of stratified cuboidal epithelial tissue that surround the secondary oocyte
    • Zona pellucida is a glycoprotein membrane that covers the secondary oocyte. The acrosome of the sperm will attempt to penetrate through the membrane to unite and fertilize the “egg.”
  - Ovulation = process that responds to LH and releases the secondary oocyte

  o Internal Accessory Organs
  **REFERENCE FIGURE 19.11 AND TABLE 19.2**
  - Uterine tubes (Fallopian tubes) = leads to the uterus
    • Infundibulum = expanded region of the uterine tube near each ovary; contains cilia that beats in unison to draw the egg into the uterine tube
    • Fimbriae = projections from the infundibulum and “holds” the ovaries
  - Uterus = dome-shaped structure with the base of the uterus as the cervix which extends into the vagina
    • Lining of the uterus
      **REFERENCE 19.12**
      o Endometrium = glandular inner layer
      o Myometrium = muscular middle layer
      o Perimetrium = outer layer
  - Vagina = muscular tube that extends from the uterus to the outside; similar 3 wall layers of the uterus; receives the penis
o External Accessory Organs

REFERENCE FIGURE 19.11 AND TABLE 19.2

- **Labia Majora** = encloses and protects the other external reproductive organs; corresponds to the scrotum of the male
- **Labia Minora** = flattened longitudinal folds between labia majora; contains many blood vessels
- **Clitoris** = mass of erectile tissue at the anterior end of the labia minora; corresponds to the penis of the male
- **Vestibule** = space enclosed by the labia minor into which the vagina opens posterior
- **Vestibular glands** are located on either side of the vaginal opening and secretes mucous to provide lubrication; corresponds to the bulbourethral glands of the male

o Erection, Lubrication, and Orgasm

- **Erection**
  - Sexual stimulation causes erectile tissue of the clitoris to be engorged with blood
- **Lubrication**
  - Vestibular glands secrete mucus into the vestibule and vagina
- **Orgasm**
  - Muscle of the uterus and uterine tubes contract rhythmically

o Hormonal Control of Female Reproductive Functions

- At puberty, the hypothalamus begins to secrete GnRH to direct the anterior pituitary to produce LH and FSH
- The ovaries are stimulated to produce estrogens in response to FSH
- Main female sex hormones: Estrogens and progesterone
- Effects of estrogen
  - Encourages the thicken of the endometrium during the female reproductive cycle
  - Female secondary sexual characteristics:
    - Breast development
    - Vascularization of the skin
    - Adipose tissue deposition
- **Progesterone**
  - Secreted by the ovaries to promote uterine changes during the menstrual cycle
  - Aids estrogen in maintaining the thicken of the endometrium during the female reproductive cycle

o Female Reproductive Cycle: Regular changing of the lining of the uterus (endometrium) which results in menses (menstrual bleeding)***

REFERENCE FIGURE 19.13 AND TABLE 19.3

- **Steps:**
  1. Anterior pituitary releases FSH to stimulate follicle maturation
2. Granulosa cells surrounding the oocyte secrete estrogens
3. Estrogens cause uterine lining to thicken (during the first week of the cycle)
4. LH surge release and stimulates ovulation (about the 14th day)
5. Follicular cells turn into corpus luteum to continue secreting estrogens and progesterone to maintain the thicken of the uterine lining
6. Negative feedback: Estrogens and progesterone inhibit FSH and LH secretion
7. Corpus luteum degenerates and no longer secretes estrogens and progesterone (about the 24th day and no fertilization)
8. Uterine lining disintegrates and sloughs off (about the 28th day; disintegration of the endometrium breaks capillaries; menstrual flow of blood and cellular debris for about 3-5 days)
9. Anterior pituitary is no longer inhibited and cycle repeats
   o Menopause
     ▪ Menstrual cycles continue on a regular cycle until late 40’s to early 50’s.
     ▪ Onset of menopause: irregular female reproductive cycles until cycles cease
     ▪ The cause of menopause: the aging of the ovaries and follicles no longer mature and estrogen levels decline
     ▪ Symptoms:
       ● Fatigue
       ● “hot flashes" sometimes followed by chills
       ● Headaches
       ● Thinning of hair
       ● Thinning of the lining of the reproductive organs