17

Reproductive Systems
Reproductive Systems

OUTLINE:

- Gonads
- Male and Female Reproductive Roles
- Form and Function of the Male Reproductive System
- Form and Function of the Female Reproductive System
- Disorders of the Female Reproductive System
- Stages of the Human Sexual Response
- Birth Control
Gonads

- Two important functions:
  1. They produce the gametes, meaning the eggs and sperm—the cells that will fuse and develop into a new individual
  2. They produce the sex hormones

- Testes
  - Produce sperm and testosterone

- Ovaries
  - Produce eggs and estrogen and progesterone
Male and Female Reproductive Roles

- Males and females make an equal genetic contribution by contributing one copy of each chromosome to their offspring

- Reproductive strategies
  - Male
    - Produce millions of sperm and deliver them to the female reproductive system
  - Female
    - Produce one egg each month and nourish and protect developing offspring
Male and Female Reproductive Roles

- Each gamete contains one-half the number of chromosomes (23; haploid)

- When an egg and sperm fuse at fertilization, they form a zygote with a full set of chromosomes (46; diploid)
Form and Function of the Male Reproductive System

- Testes
- Duct system (epididymis, vas deferens, urethra)
- Accessory glands
  - Prostate gland
  - Seminal vesicles
  - Bulbourethral glands
- Penis
Figure 17.1 The male reproductive system.
Testes

- Held outside the abdominal cavity in the scrotum: allows for temperature regulation
- Sperm develop in the seminiferous tubules
- Interstitial cells produce androgens, including testosterone
Testes

- **Testicular cancer**
  - Most common form of cancer among men 15–35 years of age
  - Does not usually cause pain, so monthly self-examinations are important
  - High cure rate when caught in early stages
Figure 17.2 The internal structure of the testis and epididymis.
Duct System

- Epididymis
  - Receives sperm from seminiferous tubules
  - Site of sperm maturation and storage
- Vas deferens
  - Conducts sperm from epididymis to urethra
- Urethra
  - Conducts urine from urinary bladder
  - Conducts sperm from vas deferens
Accessory Glands

- **Semen**
  - Fluid containing sperm and secretions of the accessory glands
  - Released through the urethra at sexual climax

- **Accessory glands**
  - Prostate gland
    - Surrounds upper portion of urethra
    - Produces alkaline secretions that activate sperm and reduce acidity of male and female reproductive tracts
Accessory Glands

- Two conditions of the prostate gland
  - Age-related enlargement: begins at middle age and may restrict flow of urine
  - Cancer: can be detected through rectal exam or blood test that measures prostate-specific antigen (PSA)

- Seminal vesicles
  - Paired glands
  - Secretions nourish sperm (fructose), thicken semen (amino acids), and assist movement of sperm in the female reproductive tract (prostaglandins)
Accessory Glands

- Bulbourethral glands
  - Paired glands
  - Release clear, slippery liquid before ejaculation that may rinse acidic urine from the urethra
Accessory Glands

- **Penis**
  - Delivers sperm to the female reproductive tract
  - **Glans penis**
    - Tip of the penis with many sensory nerve endings
    - Covered by the foreskin, which is sometimes surgically removed (circumcision)
  - Contains three columns of spongy erectile tissue that fill with blood during an erection
Penis

- Erectile dysfunction (ED; impotence)
  - Inability to achieve or maintain an erection
  - Causes range from psychological issues to damaged nerves or blood vessels
  - Medications (Viagra, Levitra, and Cialis) prolong effects of nitric oxide, which promotes widening of arteries in the penis
## Table 17.1 Review of Male Reproductive System

<table>
<thead>
<tr>
<th>Structure</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Testes</td>
<td>Produce sperm and testosterone</td>
</tr>
<tr>
<td>Epididymis</td>
<td>Location of sperm storage and maturation</td>
</tr>
<tr>
<td>Vas deferens</td>
<td>Conducts sperm from epididymis to urethra</td>
</tr>
<tr>
<td>Urethra</td>
<td>Tube through which sperm or urine leaves the body</td>
</tr>
<tr>
<td>Prostate gland</td>
<td>Produces secretions that make sperm mobile and that counteract the acidity of the female reproductive tract</td>
</tr>
<tr>
<td>Seminal vesicles</td>
<td>Produce secretions that make up most of the volume of semen</td>
</tr>
<tr>
<td>Bulbourethral glands</td>
<td>Produce secretions just before ejaculation; may lubricate; may rinse urine from urethra</td>
</tr>
<tr>
<td>Penis</td>
<td>Delivers sperm to female reproductive tract</td>
</tr>
</tbody>
</table>
Sperm Development

- Sperm development—spermatogenesis
  - Occurs within seminiferous tubules
  - Reduces number of chromosomes to one member of each pair
  - Changes shape of sperm so they can deliver chromosomes
Sperm Development

- Spermatogonia (undifferentiated diploid cells)
- Primary spermatocyte (diploid cell that undergoes two divisions of meiosis)
  - Secondary spermatocytes (after meiosis I)
  - Spermatids (after meiosis II; haploid)
Sperm Development

- Spermatozoa (exhibit structural changes necessary for reaching egg and fertilizing it)

- The mature sperm cell has three regions
  1. Head
  2. Midpiece
  3. Tail
Figure 17.3 The stages of spermatogenesis.
Figure 17.4 The structure of a mature sperm (spermatozoon).

- The whiplike movements of the tail propel the sperm.
- The midpiece contains mitochondria that will provide metabolic energy to fuel the trip to the egg.
- The head contains the father’s chromosomes, his genetic contribution to the next generation.
- The acrosome, a sac that covers the head of the sperm, contains enzymes that will assist in fertilization.
Hormones

- Testosterone, secreted by the interstitial cells of the testes, is important for sperm production and development of male characteristics

  - Production is regulated by a negative feedback loop:
    - Hypothalamus releases gonadotropin-releasing hormone (GnRH)
    - GnRH stimulates anterior pituitary to secrete luteinizing hormone (LH)
    - LH stimulates production of testosterone by interstitial cells of testes
    - Rising testosterone levels then inhibit release of GnRH from hypothalamus, which decreases LH, which decreases testosterone secretion
Hormones

- Sperm production is also controlled by a negative feedback loop
  - Follicle-stimulating hormone (FSH) produced by the anterior pituitary makes the cells that will become sperm more sensitive to testosterone
    - This stimulates sperm production
  - High sperm numbers then prompt the seminiferous tubules to produce inhibin, which inhibits production of GnRH and FSH
The Male Reproductive System

The male reproductive system is responsible for the production and storage of sperm, synthesis of accessory fluids, and the transport and delivery of semen that can then fertilize an egg. This tutorial explores the structure and function of the male reproductive system and describes how the process of fertilization takes place.

Press "PLAY" to begin Animation.
Figure 17.5 Feedback control of the production of sperm and testosterone.
Table 17.2 Hormones Important in Regulating Male Reproductive Processes

<table>
<thead>
<tr>
<th>Hormone</th>
<th>Source</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Testosterone</td>
<td>Interstitial cells in testes</td>
<td>Sperm production; development and maintenance of male reproductive structures, male secondary sex characteristics; sex drive</td>
</tr>
<tr>
<td>Gonadotropin-releasing hormone (GnRH)</td>
<td>Hypothalamus (in brain)</td>
<td>Stimulates the anterior pituitary gland to release LH</td>
</tr>
<tr>
<td>Luteinizing hormone (LH)</td>
<td>Anterior pituitary gland (in brain)</td>
<td>Stimulates interstitial cells of testis to produce testosterone</td>
</tr>
<tr>
<td>Follicle-stimulating hormone (FSH)</td>
<td>Anterior pituitary gland (in brain)</td>
<td>Enhances sperm formation</td>
</tr>
<tr>
<td>Inhibin</td>
<td>Seminiferous tubules in testes</td>
<td>Inhibits FSH secretion by anterior pituitary gland, causing a decrease in sperm production and testosterone production</td>
</tr>
</tbody>
</table>
Form and Function of the Female Reproductive System

- Structures of the female reproductive system
  - Ovaries
  - Oviducts
  - Uterus
  - Vagina
  - External genitalia
  - Breasts
Figure 17.6 The female reproductive system.
Ovaries and Oviducts

- Ovaries
  - Produce eggs through oogenesis
  - Produce estrogen and progesterone

- Oviducts
  - Also known as fallopian or uterine tubes
  - Transport immature egg from the ovaries to the uterus
  - Most commonly the site of fertilization
Uterus

- **Uterus**: hollow, muscular organ that receives and nourishes developing embryo
  - Wall has two layers
    - Smooth muscle
    - Endometrium
      - Site of implantation of the embryo (if outside uterus, then ectopic pregnancy)
      - If no embryo, then shed as menstrual flow

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Uterus

- **Cervix**: narrow neck of the uterus that extends into the vagina
- **Vagina**: receives the penis during intercourse and serves as the birth canal during delivery
External Genitalia

- External genitalia (vulva)
  - Female reproductive structures that lie outside the vagina
  - Include
    - Labia majora
    - Labia minora
    - Clitoris
      - Contains erectile tissue and many nerve endings
Breasts

- Mammary glands
  - Present in both sexes, but only in females produce milk to nourish newborn
    - Contain milk-secreting glands and ducts, which drain through the nipple
    - Connective tissue supports breasts, which are mostly fatty tissue
Breasts

The Female Reproductive System

The female reproductive cycle runs on an approximate 28-day cycle and results in the release of an egg that, if fertilized by sperm, will develop into a zygote. If the egg is not fertilized, menstruation will ensue and the cycle begins anew. This tutorial explores the structure and function of the human female reproductive system and the sex hormones that control the menstrual cycle.

Press "PLAY" to begin Animation.
Figure 17.7 Breast structure.
<table>
<thead>
<tr>
<th>Structure</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ovary</td>
<td>Produces eggs and the hormones estrogen and progesterone</td>
</tr>
<tr>
<td>Oviducts</td>
<td>Transport ovulated oocyte (or embryo if fertilization occurred) to the uterus; the usual site of fertilization</td>
</tr>
<tr>
<td>Uterus</td>
<td>Receives and nourishes embryo</td>
</tr>
<tr>
<td>Vagina</td>
<td>Receives penis during intercourse; serves as birth canal</td>
</tr>
<tr>
<td>Clitoris</td>
<td>Contributes to sexual arousal</td>
</tr>
<tr>
<td>Breasts</td>
<td>Produce milk</td>
</tr>
</tbody>
</table>
Ovarian Cycle

- Events leading to the release of an egg
- About one month in length
Ovarian Cycle

- Timing of egg development across a female's lifetime
  - Before birth, all of a woman's primary oocytes (immature eggs) have formed
    - Primary oocyte plus surrounding flattened cells—primary follicle
  - Eggs remain in immature state until puberty
  - At puberty, one primary follicle each month resumes development
Ovarian Cycle

- Steps of the ovarian cycle
  - Follicle maturation
    - Primary follicle matures into secondary (Graafian) follicle
    - Primary oocyte completes its first meiotic division, forming a secondary oocyte and first polar body
  - Ovulation
    - Secondary oocyte released from ovary
    - If fertilization occurs, then the second round of meiosis occurs, forming an ovum (mature egg) and second polar body
Ovarian Cycle

Steps of the ovarian cycle (cont’d)

- Formation of the corpus luteum
  - Luteinizing hormone (LH) transforms cells of the Graafian follicle into the corpus luteum
    - Endocrine structure that secretes estrogen and progesterone
    - Degenerates unless pregnancy occurs
**Figure 17.8 The ovarian cycle.**

- **Step 1:** The primary follicle contains the primary oocyte. The follicle cells secrete the sex hormone estrogen.
- **Step 2:** The layer of follicle cells thickens. Estrogen-containing fluid accumulates, resulting in the formation of a cavity.
- **Step 3:** The mature (Graafian) follicle results from rapid growth. Meiosis I forms a secondary oocyte and a polar body.
- **Step 4:** At ovulation, the mature follicle ruptures, releasing the secondary oocyte.
- **Step 5:** The corpus luteum forms from the follicle cells that remain in the ovary. It secretes the sex hormones estrogen and progesterone.
- **Step 6:** If pregnancy does not occur, the corpus luteum degenerates.

Ovulation
Coordination of the Ovarian and Uterine Cycles

- At monthly intervals
  - An egg matures and is released from the ovary (ovarian cycle)
  - The uterus is readied to receive and nurture the embryo (uterine or menstrual cycle)
    - If fertilization does not occur, then uterine provisions are discarded as menstrual flow
    - If fertilization occurs, human chorionic gonadotropin (HCG) produced by the embryo maintains the corpus luteum
      - Hormones of the corpus luteum maintain the endometrium (keep it from shedding)
Coordination of the Ovarian and Uterine Cycles

- Hormones that control female fertility
  - Anterior pituitary gland
    - Follicle-stimulating hormone (FSH)
      - Stimulates follicle development
    - Luteinizing hormone (LH)
      - Triggers ovulation
Hormones that control female fertility (cont’d)

- Ovary
  - Estrogen
    - Development of endometrium and female reproductive structures
  - Progesterone
    - Maintains the endometrium
Figure 17.9 The ovarian and uterine cycles.

The LH surge triggers ovulation, and then LH causes the transformation of the follicle cells remaining in the ovary into the corpus luteum.

The follicle cells in the ovary secrete estrogen.

Estrogen and progesterone stimulate the development of the uterine lining (endometrium) in preparation for pregnancy.
Preparation of the Endometrium for Implantation

The hormones released from the ovary during the ovarian cycle stimulate the uterus in preparation for pregnancy. In this tutorial, you will see the connection between ovulation, the formation of a structure called the corpus luteum in the ovary, and the state of the uterine lining. Press "PLAY" to begin Animation.
Menopause

- Cessation of ovulation and menstruation
- Usually occurs between 45 and 55 years of age
Menopause

- Physiological effects caused by drop in estrogen associated with menopause
  - Loss of fat layer leads to wrinkles
  - Disruption of thermostat causes hot flashes
  - Vaginal dryness
  - Growth of facial hair
  - Increased risk of heart and blood vessels diseases
  - Osteoporosis
Disorders of the Female Reproductive System

- **Premenstrual syndrome (PMS)**
  - Symptoms appear 7–10 days before period
    - Include depression, irritability, fatigue, headaches
  - Possibly caused by progesterone deficiency
- **Treatments**
  - Medications that raise serotonin
  - Changes in diet
  - Aerobic exercise
Disorders of the Female Reproductive System

- Menstrual cramps
  - Caused by high levels of prostaglandins produced by endometrial cells
  - Prostaglandins cause smooth muscle cells of uterus to contract
  - Muscle spasms may cause pain by reducing blood supply to uterine muscles
Disorders of the Female Reproductive System

- **Endometriosis**
  - Condition in which tissue from the uterine lining is found outside the uterine cavity
    - Often on oviducts, ovaries, outside surface of uterus, or bladder
  - Endometrial tissue grows and breaks down in response to hormones, which may cause severe pain
Disorders of the Female Reproductive System

- Breast cancer
  - May begin in cells lining milk ducts or in milk glands
  - Detection
    - Monthly breast self-exam
    - Mammograms
  - Risk factors (increased exposure to estrogen)
    - Young age at first menstruation
    - Menopause after age 55
    - Childlessness and late age at first pregnancy
    - Obesity
- Breast-feeding may reduce risk
Figure 17.A A monthly breast self-exam.

**Step 1:** Stand in front of the mirror and look at each breast to see if there is a lump, a depression, a difference in texture, or any other change in appearance.

**Step 2:** Get to know how your breasts look. Be especially alert for any changes in the nipples’ appearance.

**Step 3:** Raise both arms and check for any swelling or dimpling in the skin of your breasts.

**Step 4:** Lie down with a pillow under your shoulder and put your arm behind your head. Perform a manual breast examination. With the nipple as the center, divide your breast into imaginary quadrants.

**Step 5:** With the pads of the fingers, make firm circular movements over each quadrant, feeling for unusual lumps or areas of tenderness. When you reach the upper, outer quadrant of your breast, continue toward your armpit. Press down in all directions.

**Step 6:** Feel your nipple for any change in size and shape. Squeeze your nipple to see if there is any discharge. Repeat from step 4 on the other breast.
Stages of the Human Sexual Response

- In both men and women, sexual arousal and sexual intercourse involve two physiological changes
  - Vasocongestion: certain tissues fill with blood
  - Myotonia: certain muscles show sustained or rhythmic contractions

- Four stages of the sexual response cycle
  1. Excitement
  2. Plateau
  3. Orgasm
  4. Resolution
Birth Control

- Prevents pregnancy
- In some cases can reduce the risk of spreading sexually transmitted diseases (STDs)
- Abstinence: refraining from sexual contact
  - Reliably avoids both pregnancy and spread of STDs
Birth Control

- Sterilization: cutting and sealing gamete transport tubes to permanently prevent fertilization
  - Offers no protection against STDs
  - Vasectomy in males: vas deferens cut to prevent sperm from leaving the body (reversible soon after)
  - Tubal ligation in females: oviducts cut to prevent egg and sperm from meeting (irreversible)
Hormonal Contraception

- Currently available only to females
- Does not protect against STDs, and may even increase risk of transmission

- Two basic approaches
  - Combination estrogen and progesterone
  - Progesterone only
Combination Estrogen and Progesterone Contraception

- Uses synthetic forms of estrogen and progesterone to suppress release of FSH and LH
- Prevents maturation of egg and its release from the ovary
- Examples: “the pill,” skin patch, vaginal ring
Progesterone-Only Contraception

- Uses synthetic progesterone
- May prevent ovulation, thicken cervical mucus (making it difficult for sperm to reach egg), and keep endometrium unprepared for implantation
- Examples: injection every 3 months, “minipill,” rod-shaped implants
Progesterone-Only Contraception

Ovulation and Hormonal Birth Control Methods

The hormones progesterone and estrogen regulate ovulation and the menstrual cycle, and some methods of contraception alter this cycle to prevent pregnancy. This tutorial explores hormonal control of the menstrual cycle and the ways in which this cycle can be modified by various hormonal birth control methods.

Press "PLAY" to begin Animation.
Intrauterine Devices

- Small device inserted into the uterus by a physician
- Prevent the union of sperm and egg and/or implantation
- Do not protect against STDs
Barrier Methods

- Prevent fertilization
- Examples
  - Diaphragm
  - Cervical cap
  - Contraceptive sponge
  - Male and female condoms
- Vary in degree of protection offered against STDs
  - No protection (cervical cap) to good protection (latex condom)
Figure 17.10 Selected methods of birth control.

(a) Hormone-containing skin patch
(b) Vaginal contraceptive ring
(c) Intrauterine device (IUD)
(d) Diaphragm and spermicidal cream or jelly
(e) Male latex condom
(f) Female polyurethane condom
Spermicidal Preparations

- Kill sperm and therefore prevent fertilization
  - Effective for only about one hour once activated
- Forms include foam, cream, jelly, or tablet
- Also kill organisms responsible for STDs but may damage cells of vagina and increase susceptibility
Fertility Awareness

- The avoidance of intercourse when fertilization is likely to occur

- Also called “natural family planning” or “rhythm method”

- Challenging to determine the four days in each cycle when fertilization might occur
  - Methods include calendar, body temperature, cervical mucus
Emergency Contraception

- Morning-after pills
  - Hormones taken within the first few days after unprotected intercourse
- Two types
  - Preven combines estrogen and progesterone
  - Plan B contains only progesterone
You Should Now Be Able To:

- Define and describe gonads
- Understand male and female reproductive roles
- Know the form and function of both male and female reproductive systems
- Understand the possible disorders of the female reproductive system
- Understand the stages of the human sexual response
- Know the choices available regarding birth control