Outline

I. Male Reproduction
   A. Reproductive organs
   B. Sperm development

II. Female Reproduction
   A. Reproductive organs
   B. Egg development
   C. Uterine cycle

III. Fertilization

IV. Birth Control

V. Infertility
Terminology

- **Gonads** = testes or ovaries
  - Produce **gametes** = sperm or eggs
  - Produce hormones
    - Testes produce **testosterone**
    - Ovaries produce **estrogen** and **progesterone**
Terminology

- When sperm and egg fuse = **fertilization**
- The result of fertilization is a **zygote**
Male Reproduction Organs

1. Testes
2. Epididymis
3. Vas deferens
4. Urethra
5. Penis
6. Prostate
7. Seminal vesicles
8. Bulbourethral glands
# The Male Reproductive System

## 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>
Male Reproduction - Overview

- In males, the sperm begin their development in the **testes**.

- They undergo further development in the **epididymis**.

- The sperm will travel through the **vas deferens** then through the **urethra** and out of the body = **ejaculation**.

- Along the way from the testes to the urethra, fluid is secreted. The fluid and the sperm together is called **semen**.
1. **Testes** (testis, singular): Produce sperm and testosterone

- Sperm begin their development here

- The testes are contained in a sac, the **scrotum**, surrounded by muscle. Important in maintaining the correct temperature for sperm development.
Sperm production

- The testes are comprised of many tubes called **seminiferous tubules**.

- This is where the sperm begin to develop

- **Interstitial cells** are located between the seminiferous tubules, these cells produce testosterone
Figure 17.2
Seminiferous tubules
Male Reproduction Organs

2. **Epididymis**: Sperms mature and are stored here.

3. **Vas deferens** – conducts sperm from epididymis to the urethra.

4. **Urethra** – conducts sperm or urine out of the body through the penis

5. **Penis** – male organ for intercourse and urination
Male Reproduction Organs - Glands

6. **Prostate**: gland that secretes fluid that makes semen alkaline, activates the sperm and makes them motile

7. **Seminal vesicles**: gland that secretes fluid that makes up most of the volume of the semen. The fluid contains sugar, amino acids, and prostaglandins.

8. **Bulbourethral glands**: secretes fluid before ejaculation, this fluid lubricates the urethra, and rinse the acidic urine from the urethra
The Male Reproductive System

- **Vas deferens**
  - One of a pair of ducts that transport sperm from the epididymis to the urethra

- **Urethra**
  - A tube that transports semen during ejaculation, and urine at other times

- **Penis**
  - The organ of sexual intercourse that delivers sperm to the female reproductive tract

- **Testis**
  - One of a pair of primary reproductive organs (gonads) that produce sperm and testosterone

- **Epididymis**
  - One of a pair of ducts in which sperm are stored and mature

- **Prostate gland**
  - A gland that produces alkaline secretions that activate sperm and reduce the acidity of the male and female reproductive system

- **Seminal vesicle**
  - One of a pair of glands that produce a fluid that nourishes sperm, thickens sperm, and assists movement of sperm once in the female reproductive tract

- **Bulbourethral gland**
  - One of a pair of glands that produce a mucous secretion before ejaculation that neutralizes acidic urine in the urethra

- **Rectum**

- **Urinary bladder**
The sperm begin their development in the

1. Vas deferens
2. Testes
3. Epididymis
4. Urethra
They undergo further development in the

1. Vas deferens
2. Testes
3. Epididymis
4. Urethra
The gland that secretes fluid that makes up most of the volume of the semen is the:

1. Vas deferens
2. Testes
3. Seminal vesicles
4. Prostate
Diploid cells have this many chromosomes:

1. 23
2. 46
Spermatogenesis

- Spermatogenesis occurs in the outer layer of the seminiferous tubules.

- The process begins with diploid cells called **spermatogonia**.
When a diploid cell undergoes mitosis, the result is a:

1. Diploid cell
2. Haploid cell
When a diploid cell undergoes meiosis, the result is a:

1. Diploid cell
2. Haploid cell
Spermatogenesis

- Spermatogonia undergo mitosis to divide into two cells
- One of these cells will stay a spermatogonia, the other cell will become a primary spermatocyte.
Spermatogenesis

- The primary spermatocyte will undergo meiosis I to create two secondary spermatocytes.
- The secondary spermatocytes undergo meiosis II to create four spermatids.
- Structural changes take place to make spermatozoa.
Spermatogenesis

- Testis
- Uncoiled seminiferous tubule
- Cut end of seminiferous tubule
- Spermatogonium (two copies of each chromosome)
- Primary spermatocyte
- Secondary spermatocyte (one copy of each chromosome)
- Early spermatids
- Late spermatids
- Lumen
- Spermatozoan

Figure 17.3
The mature sperm cell has three regions:

1. Head – contains the DNA, coated with the acrosome
2. Midpiece – contains high concentration of mitochondria
3. Tail – flagella for movement
The Male Reproductive System

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.
Hormonal Regulation in Males

1. Gonadotropic-releasing hormone (GnRH)
2. Follicle-stimulating hormone (FSH)
3. Luteinizing hormone (LH)
4. Testosterone
5. Inhibin
# The Male Reproduction Hormones

## 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>
Gonadotropin-releasing hormone (GnRH)

- Produced in the hypothalamus
- Released by the hypothalamus
- Target: Stimulates the anterior pituitary to secrete LH and FSH
Luteinizing hormone (LH)

- Produced and released by the anterior pituitary
- Target: stimulates the interstitial cells of the testes to produce testosterone.
Follicle-stimulating hormone (FSH)

- Produced and released by the anterior pituitary
- Target: Stimulates cells in the seminiferous tubules to aid in the production of sperm.
Testosterone

- Testosterone – produced by the interstitial cells of the testes

- Function - essential for normal development and functioning of the male reproductive organs and sperm.
Regulation of Reproduction in Males

- Levels of testosterone is maintained by negative feedback

- Rising testosterone levels inhibit the release of GnRH, resulting in lower levels LH released, leading to lower levels of testosterone
Regulation of Reproduction in Males

- Levels of sperm is also maintained by negative feedback

- Rising sperm levels cause the seminiferous tubules to release inhibin.

- Inhibin inhibits the production of FSH, which lowers the production of sperm
Regulation of Male Reproduction

Inhibin inhibits the production of FSH and GnRH

Interstitial cells produce testosterone

Testosterone stimulates sperm production

LH stimulates testosterone production by testis

FSH (and testosterone) stimulates sperm production

Seminiferous tubules produce sperm and inhibin

High sperm count stimulates production of inhibin

Testosterone inhibits production of GnRH and LH

GnRH stimulates release of LH and FSH from anterior pituitary gland

Hypothalamus produces GnRH

Hypothalamus

Anterior pituitary gland
Female Reproductive System

1. Ovaries
2. Oviducts
3. Uterus
4. Cervix
5. Vagina
6. Breasts
# The Female Reproductive System

<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 egg (or embryo if fertilization occurred) from ovary to 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>
The Female Reproductive System

(b) Rear view

Ovary
Oviduct
Uterus
Uterine wall
Endometrium
Cervix
Vagina
Female Reproduction

- Why do females only produce one egg per month whereas males produce millions of sperm each day?

- Females not only produce the egg, they also carry the developing embryo.

- **Hormones** control the development of the egg and the preparation of uterus to support the embryo (ovarian and uterine cycles)
Oogenesis

- A woman is born with all the oocytes she will ever have (millions).
- As a fetus, diploid oogonia cells begin meiosis to form primary oocytes.
- The oocytes are suspended in Prophase I.
- Each month a few oocytes finish meiosis I and develop into a secondary oocyte.
- They stay at meiosis II in the metaphase stage until the sperm fertilizes the oocyte.
Female Reproductive System

1. **Ovaries** - produce eggs (ova) and female sex hormones estrogen and progesterone
Oogenesis

- The cells that will become ova (eggs) are called oocytes.

- The oocytes are contained in a female’s ovaries inside a follicle.

- Follicles are groups of cells that support the oocytes.
Follicles

- Follicle-stimulating hormone (FSH) is produced and secreted from the anterior pituitary.

- FSH travels to the ovaries where it promotes the development of the follicles.

- As the follicle develops it produces estrogen.
Corpus Luteum

- Approximately every 28 days an oocyte will leave the ovary = *ovulation*.

- The follicle stays in the ovary after ovulation, and is now the *corpus luteum*.
Corpus Luteum

- LH, produced by the anterior pituitary, promotes the development of the corpus luteum.

- The corpus luteum releases estrogen and progesterone to help support the uterus in preparation for the embryo.
Corpus Luteum

- If there is a pregnancy, then the corpus luteum will be maintained by a hormone secreted by the embryo = human chorionic gonadotropin

- If there is no pregnancy, corpus luteum will degenerate
Female Reproduction

2. **Oviducts** – Conducts egg, where fertilization usually occurs.

3. **Uterus** – the developing embryo implants in the endometrium, this is where fetus develops.

- Implantation usually occurs about 6 days after fertilization, pregnancy begins at implantation.
The Female Reproductive System

**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.

Uterus, Oviduct, Ovary
The Female Reproductive System

- **FSH stimulates the development of follicles in the ovary.**
- **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.**

**Blood levels of pituitary hormones**
- FSH
- LH

**Ovarian cycle**
- Follicular phase
- Luteal phase
- The corpus luteum in the ovary secretes estrogen and progesterone.

**Uterine cycle**
- Bleeding

**Figure 17.9**
Uterine Cycle

- As the follicle develops in the ovary there are also changes in the uterus.

- In the early days (1 - 5) of the cycle, estrogen and progesterone are low. This causes the endometrium to break down, the tissue and blood flows out = menstruation.
Uterine Cycle

- Then (days 6 – 13) the increased estrogen produced by the follicle, causes the endometrium to thicken.

- Midway though the cycle (day 14) ovulation occurs.
Then (days 15 – 28) the progesterone from the corpus luteum causes the endometrium to continue to develop. This thick endometrium is ready to receive the developing embryo.

If there is no embryo then the corpus luteum will regress and stop producing progesterone and estrogen, causing the endometrium to break down.
Hormones Controlling Female Reproduction

1. Gonadotropic-releasing hormone (GnRH)
2. Follicle-stimulating hormone (FSH)
3. Luteinizing hormone (LH)
4. Estrogen
5. Progesterone
# The Female Reproductive System

## Table 17.4 Hormones Involved in Regulating Female Reproductive Processes

<table>
<thead>
<tr>
<th>Hormone</th>
<th>Source</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Estrogen</td>
<td>Ovaries (follicle cells and corpus luteum)</td>
<td>Maturation of the egg; development and maintenance of female reproductive structures, secondary sex characteristics; thickens endometrium of uterus in preparation for implantation of embryo; cell division in breast tissue</td>
</tr>
<tr>
<td>Progesterone</td>
<td>Ovaries (corpus luteum)</td>
<td>Further prepares uterus for implantation of embryo; maintains endometrium</td>
</tr>
<tr>
<td>Follicle-stimulating hormone (FSH)</td>
<td>Anterior pituitary gland (in brain)</td>
<td>Stimulates development of a follicle in the ovary</td>
</tr>
<tr>
<td>Luteinizing hormone (LH)</td>
<td>Anterior pituitary gland (in brain)</td>
<td>Triggers ovulation; causes formation of the corpus luteum</td>
</tr>
</tbody>
</table>
Gonadotropic-releasing hormone (GnRH)

- Produced in the hypothalamus

- Target: Stimulates the anterior pituitary to secrete LH and FSH
Follicle-stimulating hormone (FSH) is produced and secreted from the anterior pituitary.

FSH travels to the ovaries where it promotes the development of the follicles.
Luteinizing hormone (LH) is produced and secreted from the anterior pituitary.

LH travels to the ovaries where it triggers ovulation and it promotes the development of the corpus luteum.
Regulation of Reproduction in Females

- Levels of estrogen and progesterone is maintained by negative feedback.

- Rising levels of estrogen and progesterone (except at very high levels) inhibits the anterior pituitary, resulting in lower levels of LH and FSH released.
### TABLE 17.5 Ovarian and Uterine Cycles

<table>
<thead>
<tr>
<th>Ovarian Cycle</th>
<th>Uterine Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Approximate Timing in 28-Day Cycle</strong></td>
<td><strong>Approximate Timing in 28-Day Cycle</strong></td>
</tr>
<tr>
<td>Events</td>
<td>Events</td>
</tr>
<tr>
<td>Days 1–13</td>
<td>Follicle develops, caused by FSH Follicle cells produce estrogen</td>
</tr>
<tr>
<td>Day 14</td>
<td>Ovulation is triggered by LH surge</td>
</tr>
<tr>
<td>Days 15–21</td>
<td>Corpus luteum forms and secretes estrogen and progesterone</td>
</tr>
<tr>
<td>Days 22–28</td>
<td>Corpus luteum degenerates, causing estrogen and progesterone level to decline</td>
</tr>
</tbody>
</table>
What reproductive organ conducts the egg from the ovary to the uterus?

1. Cervix
2. Oviducts
3. Vagina
4. Vas deferens
Where does fertilization usually occur?

1. Ovaries
2. Oviducts
3. Vagina
4. Uterus
LH promotes the development of the

1. endometrium
2. follicle
3. corpus luteum
4. oocyte
The layers of cells that surround and support the oocytes are

1. Oogonia
2. Spermatocytes
3. Follicles
4. Cervix
Fertilization Overview

- Females release one oocyte per month
- Males release an average of 200 million sperm ejaculation.
- When the first sperm enters the egg, it triggers the egg to put up a protective barrier to prevent other sperm from entering the egg.
Fertilization and Pregnancy

- **Fertilization** - occurs when the sperm enters the oocyte.

- **Pregnancy** - begins when implantation occurs usually on the sixth day after fertilization.

- **Embryo develops into a fetus**
Female Reproductive System

4. **Cervix** – opening to uterus, dilates to let the fetus pass through.

5. **Vagina** - birth canal and intercourse organ of the female.

6. **Breasts** – produce milk to feed infant
Menopause

- Menopause (begins at age 45-55) - when ovarian & uterine cycles cease.
Fraternal Twins

- Normally many follicles begin to develop, but only one oocyte will develop completely and be released from the ovary.

- But, occasionally more than one follicle will mature, and therefore more than one oocyte will be released. These two (or more) oocytes will travel into the uterine tubes where they can meet sperm, different sperm will fertilize the oocytes.
Birth Control Methods

- Birth control pills—block FSH and LH release and prevent follicle development & ovulation.
- IUD—small piece of plastic inserted into the uterus preventing implantation.
- Diaphragm—soft latex cup covering the cervix to block the movement of sperm into the uterus.
- Condom—(male and female) blocks fertilization.
- Contraceptive implants—synthetic progesterone to prevent ovulation.
- See page 358-361 for more info
Morning After Pills

- Preven - 4 synthetic progesterone and estrogen pills.

- 2 are taken up to 72 hours after intercourse and 2 more are taken 12 hours later.

- Prevents ovulation, fertilization and may prevent implantation.

- Will not cause the loss of an implanted embryo.
Morning After Pills

- RU-486 – (mifepristone) a pill that causes the loss of an implanted embryo.
- It is 95% effective, must be taken within 49 days of pregnancy.
- The mifepristone alone is about 60-80% effective in causing an abortion, it is followed with a dose of misoprostol.
- Mifepristone interferes with the action of progesterone.
- The misoprostol is known as a prostaglandin. It is a hormone that contracts the uterus - effectively inducing labor and forcing the fetal tissue out of the uterus.
Infertility

- Failure to achieve pregnancy after one year of regular, unprotected intercourse. Causes:
  - Low sperm count
  - Blocked uterine tubes (often from an infection)
  - Endometriosis
Assisted Reproductive Technologies

- **Fertility Drugs** – stimulate follicles to develop and ovulate
- **Artificial Insemination by Donor**—sperm are placed in the vagina by a physician.
- **In Vitro Fertilization**—conception occurs in laboratory glassware.
- **Gamete Intrafallopian Transfer**—eggs and sperm are placed in the oviducts immediately after they have been brought together.
- **Surrogate mothers**—women are contracted and paid to have babies.
- **Intracytoplasmic Sperm Injection**—a single sperm is injected into an egg.
Disorders of the Reproductive System

- Prostate cancer in men
  - Detected by an exam and blood test for PSA
  - Treatment: surgery, chemotherapy and radiation

- Breast cancer in women
  - Detected by exam and mammography
  - Treatment: surgery, chemotherapy and radiation
Disorders of the Reproductive System

- **Endometriosis**
  - The condition when tissue from the lining of the uterus is found outside the uterine cavity

- **Vaginitis**
  - An inflammation of the vagina

- **Pelvic inflammatory disease (PID)**
  - An infection of the pelvic organs
STDs Caused by Bacteria

- Chlamydia, gonorrhea, and syphilis
  - Caused by bacteria
  - Can be cured with antibiotics
STDs Caused by Viruses

- Genital herpes
  - Caused by herpes simplex viruses (HSV)
  - Can enter the body through mucous membranes or breaks in the skin
  - Can not be treated with antibiotics

- Human Papillomaviruses (HPVs) – can lead to cervical cancer. There are vaccines available

- Human immunodeficiency virus (HIV) leads to AIDS
Important concepts

- Read Chapter 18 for next lecture

- What are the organs, their location and their functions of the male reproductive system, including glands?

- What is the function of and location of the seminiferous tubules?

- What cells in the testes secrete testosterone?
Important concepts

- How are sperm formed, where it takes place, what is the path of the sperm as they leave the body, What are the important components of a sperm?

- How is the male reproduction regulated, what hormones are involved in male reproduction, where are they produced, what is their target and what is their function. How are these hormones regulated, be able to discuss this in detail.

- What are all the parts and organs of the female reproductive system, their function and location?
Important concepts

- How does an egg develop, where is the oocyte fertilized, when and where does a fertilized egg implant.

- Know the overview of the ovarian and uterine cycles.

- What are the hormones important in female reproduction and what are their functions.

- How are reproductive hormones regulated in male and females?
Important concepts

 How does RU-486 and preven works, which will cause the loss of an implanted embryo.

 What are all the forms of birth control discussed in class and in the book, be able to discuss the pros and cons of each type?

 Be able to discuss the disorders of the reproductive system and STDs, including causes, detection and treatment.
Definitions

- gonads, gametes, zygote, fertilization, scrotum, seminiferous tubules, semen, ejaculation, spermatogonia, interstitial cells spermatogenesis, primary spermatocyte, secondary spermatocyte, spermatids, spermatozoa, menstruation, corpus luteum, oocytes, ovaries, follicles, ovulation, pregnancy, oogenesis, oogonia, primary oocytes, secondary oocytes, menopause.