Outline
I. Male Reproduction
   A. Reproductive organs
   B. Sperm development
II. Female Reproduction
   A. Reproductive organs
   B. Egg development
   C. Uterine cycle
III. Fertilization

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

Table 17.1

Male Reproduction Organs
1. Testes
2. Epididymis
3. Vas deferens
4. Urethra
5. Penis
6. Prostate
7. Seminal vesicles
8. Bulbourethral glands

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.

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

Male Reproduction Organs - Testes
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.
Semeniferous tubules

Male Reproduction Organs

2. Epididymis: Sperm 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

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 it 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.

Vas deferens
Testes
Seminal vesicles
Prostate

25%
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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.

Sperm

- 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

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>
<thead>
<tr>
<th>Hormone</th>
<th>Source</th>
<th>Effects</th>
</tr>
</thead>
<tbody>
<tr>
<td>Testosterone</td>
<td>Intestine cells in testes</td>
<td>Spontaneous production and maintenance of secondary sex characteristics, androplasia</td>
</tr>
<tr>
<td>Gonadotropin-releasing hormone (GnRH)</td>
<td>Hypothalamus (in brain)</td>
<td>Stimulates the anterior pituitary gland to release FSH, LH</td>
</tr>
<tr>
<td>Follicle-stimulating hormone (FSH)</td>
<td>Anterior pituitary gland (in brain)</td>
<td>Stimulates the testes to produce testosterone</td>
</tr>
<tr>
<td>Luteinizing hormone (LH)</td>
<td>Anterior pituitary gland (in brain)</td>
<td>Enhances sperm formation</td>
</tr>
<tr>
<td>Inhibin</td>
<td>Intestine cells in intestine</td>
<td>Inhibits FSH secretion</td>
</tr>
</tbody>
</table>

Table 17.2
Gonadotropic-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.

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

The Female Reproductive System

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

- 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.

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.

- 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

- 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
- 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

- Approximately every 28 days an oocyte will leave the ovary = ovulation.
- The follicle stays in the ovary after ovulation, and is now called the corpus luteum.

Figure 17.8 The Female Reproductive System

Figure 17.9 The Female Reproductive System

Figure 17.14 The Female Reproductive System
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.
- 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

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.

LH
- 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.

The Female Reproductive System

Gonadotropic-releasing hormone (GnRH)
- Produced in the hypothalamus.
- Target: Stimulates the anterior pituitary to secrete LH and FSH.

Table 17.4: Gonadotropic-releasing hormone (GnRH)
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<td>Ovary (follicles)</td>
<td>Stimulation of follicle development</td>
</tr>
<tr>
<td>Luteinizing hormone (LH)</td>
<td>Ovary (corpus luteum)</td>
<td>Trigger ovulation and further development of corpus luteum</td>
</tr>
</tbody>
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Table 17.5: The Female Reproductive System
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<th>Cycle Stage</th>
<th>Menstrual Cycle</th>
<th>Fertility Cycle</th>
</tr>
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<tr>
<td>Menstrual Cycle</td>
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<td>Day 15 - 28</td>
<td>Corpus luteum begins producing estrogen and progesterone</td>
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Table 17.6: Uterine Cycle
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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 per 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.
6. Breasts – produce milk to feed infant
### Important concepts

- 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?
- 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?
- 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?

### 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.