The Male Reproductive System

**Function:** To create and deliver sperm to an egg (ovum) for the purposes of fertilization.

*Structure of the Male Reproductive System*

**Functions of parts of Male Reproductive System**

1. **Scrotum:** Sac that holds the testicles. Testicles are held outside the body to maintain proper temperature for sperm production.

2. **Testis:** Two oval shaped structures that create sperm. Each sperm cell contains haploid (n) the chromosome number.

3. **Epididymis:** Oval shaped structure that lies on top of the testis. It stores sperm. Sperm become motile here.
NOTES

Topic: Human Reproduction

① Vas Deferens: Hollow tube leading from the testis to the urethra. It carries sperm from the testes to the penis.

⑤ Cowper’s Gland: A small gland that adds an alkaline (Basic) fluid to sperm to help neutralize the acidity of the female reproductive tract.

⑥ Prostate Gland: Adds fluid to sperm. This fluid helps to neutralize the acidity of the female reproductive tract.

⑦ Seminal Vesicles: Glands that secrete a mucus-like fluid with the sperm. The fluid contains fructose that provides energy for sperm.

⑧ Urethra: Opening through which sperm and urine exit the male body.

⑨ Penis: The reproductive organ of the male.

⑨ Semen: Male reproductive fluid containing sperm and other fluids.

Structure of a Human Sperm

The human sperm consists of 3 main parts.

A. The Head - contains a nucleus and an acrosome — small section at the top of the head that contains enzymes to digest the membrane of the egg.

B. Mid Section: Contains mitochondria that give the sperm energy.

C. Tail: consists of a long flagellum that propels the sperm forward.
Structure of a Male Testicle

A male testicle is comprised of the following structures.

a. **Seminiferous Tubules** → These are long coiled tubes within a testicle where sperm are produced.

b. **Sertoli Cells** → These are cells that surround the seminiferous tubules and help to nourish sperm as they are developing.

c. **Epididymis** → Oval shaped structure in the testicle that stores sperm after creation. Sperm mature here and become motile.

Formation of Sperm within a Male

Sperm are created within the testicles of males through a process known as **Spermatogenesis**. **Spermatogenesis is controlled by a series of hormones within the male.**

1. FSH (Follicle Stimulating Hormone)
   - Hormone released by the anterior pituitary that causes spermatogenesis to begin.

2. Inhibin
   - Hormone released by the seminiferous tubules. Works on the hypothalamus to slow the production of releasing factors that control release of FSH.

FSH and Inhibin work in a negative feedback loop to control sperm production in males.

Inhibin/FSH negative feedback loop

If sperm count is high, Inhibin is released by seminiferous tubules. This causes the hypothalamus to NOT produce releasing factors. If there are no releasing factors, then the pituitary does not release FSH. If FSH is not released from the pituitary, spermatogenesis does not begin and sperm production is slowed. Sperm count will fall.

The opposite happens if sperm count is low.
Other Male Reproductive Hormones

1. LH (Lutenizing Hormone)
   - Hormone released by the pituitary that causes the interstitial cells of the testicles to produce the hormone Testosterone.

2. Testosterone
   - Major male hormone. Responsible for the development of secondary sex characteristics in a male.
     - Secondary Sex characteristics of a male
       - Enlargement of pens and testicles
       - Facial hair
       - Lower voice
       - Increased muscle mass
The Female Reproductive System

**Function:** To create ova and after fertilization, provide a place of development for the fetus.

**Structure**

Functions of the parts of the female reproductive system

1. **Vagina:** Opening through which sperm enters on its way to fertilize an egg.

2. **Cervix:** Small opening at the top of the vagina and the base of the uterus. It supports the fetus and prevents foreign material from entering the uterus.

3. **Uterus:** Large muscular chamber where the embryo attaches and the fetus develops.
4. **Ovary:** Creates ova (eggs) for fertilization. Each egg contains the haploid \((n)\) chromosome number.

5. **Fallopian Tubes (Oviduct):** Tubes that lead from the ovaries (not attached) to the uterus. **Where fertilization occurs.** It conducts the eggs to the uterus.

6. **Fimbriae:** Finger-like projections on the opening of the oviduct that helps sweep eggs from the ovary into the oviduct.

7. **Endometrium:** The lining of the uterus. It contains a rich blood supply to provide nutrients for a developing embryo.
The Female Menstrual Cycle

The female menstrual cycle normally follows a 28 day pattern that functions in the release of a mature egg for the purposes of fertilization. The cycle can be from 20 – 45 days long.

Stages of the female menstrual cycle

*The Follicle Stage — days 1 to 14(approximately)*

During this stage a hormone called FSH (follicle stimulating hormone) from the pituitary causes a follicle in the ovary to release the hormone estrogen.

**Estrogen** causes the lining of the uterus to build up in blood supply and to thicken in preparation for a pregnancy.

*Ovulation — Day 14*

During this stage, a hormone called LH (luteinizing hormone) is released from the pituitary gland that causes the follicle to break open and release the egg.

*Luteal Stage — Day 15 - Day 28*

During this stage, the left over follicle (now called the corpus luteum) releases Progesterone which keeps the uterine lining prepared for pregnancy.

*Menstruation — Day 28 – Day 1*

If no egg is fertilized, then estrogen and progesterone levels begin to drop. This causes the uterine lining to be “shed” and it passes out through the vagina along with blood. As this is happening, FSH is being released and this causes another follicle to mature. The cycle begins to repeat itself.
Female Hormones

1. FSH (Follicle Stimulating Hormone)
   - Hormone released from pituitary (under hypothalamus control) that causes follicles within the ovary to release estrogen.

2. Estrogen
   - Hormone released from a follicle that causes the endometrium to thicken and increase blood supply in preparation for pregnancy.

3. Luteinizing Hormone (LH)
   - Hormone released by the pituitary (under control of hypothalamus) that causes ovulation (release of egg from the follicle).

4. Progesterone
   - Hormone created and released from the Corpus Luteum that maintains the uterus during pregnancy.

Female Hormone Treatments

As females get older there is a reduction in the amount of estrogen and progesterone they produce. This causes menopause.

Menopause ⇒ The stopping of the menstrual cycle in women.

Menopause is characterized by the following
- Stopping of the menstrual cycle
- Temperature changes - “hot flashes”
- Loss of bone density
Hormone Replacement Therapy and Contraception

Hormone Replacement Therapy

Hormone replacement therapy is a treatment for women who have entered menopause. It is done to counteract the declining amounts of progesterone and estrogen in females.

The hormones estrogen and progesterone are given to women in low amounts (usually by pill or injection) to alleviate some of the symptoms of menopause.

<table>
<thead>
<tr>
<th>Benefits of Hormone Replacement Therapy</th>
<th>Risks of Hormone Replacement Therapy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. reduces bone loss (osteoporosis)</td>
<td>1. increased risk of cancer</td>
</tr>
<tr>
<td>2. decreased rate of macular degeneration</td>
<td>2. headaches</td>
</tr>
<tr>
<td>3. improved memory</td>
<td>3. blood clots</td>
</tr>
<tr>
<td>4. decreased chances of urinary infections</td>
<td>4. stomach upset</td>
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Contraception – The Pill

The “pill” or “oral” contraceptive is a combination of synthetic portions of estrogen and progesterone.

The pill works because the estrogen and progesterone causes the inhibition of FSH and LH. When this happens, ovulation is inhibited. This results in no egg being present to be fertilized.
**Sexually Transmitted Infections (STI’s)**

These are diseases transmitted mainly through sexual contact.

**Causes:** Most STI’s are caused by either a bacteria or virus.

**Note:** Bacterial STI’s are curable whereas viral STI’s are NOT curable, but *treatable* (symptoms)

**List of Sexually Transmitted Infections**

1. **HIV and AIDS**

   **Cause:** AIDS (Acquired Immune Deficiency Syndrome) is caused by HIV (Human Immuno Virus).

   **Action:** HIV attacks and takes over the helper T-cells of a person’s immune system. As the level of helper T cells increases in the blood, the person becomes susceptible to many infections.

   Full Blown AID occurs when many T cells are destroyed by the virus and the body is not able to make enough replacement T cells to fight infections.

   **Transmission:**
   - Sexual contact with an infected person.
   - Sharing needles with infected person.
   - Breast feeding

   **Cure:** None known. Many drugs used to help fight various infections.
2. **Chlamydia**

   **Cause:** Caused by the bacterium called *Chlamydia trachomatis*

   **Symptoms:**
   - Pain when urinating
   - Discharge from penis
   - Vaginal discharge
   - Fever

   **NOTE:** Some people have no symptoms at all. This is dangerous as damage is occurring without symptoms.

   **Transmission:**
   - Sexual contact with an infected person.

   **Cure:** Antibiotics

3. **Hepatitis**

   Hepatitis occurs in three different forms – Hepatitis A, B or C.

   Hepatitis B is considered to be a sexually transmitted Infection.

   **Cause:** Viral infection

   **Symptoms:**
   - Flu like symptoms
   - Jaundice
   - Liver failure
   - Liver disease

   **Transmission:**
   - Sexual contact with an infected person.

   **Cure:** vaccine

   **NOTE:** Hepatitis is able to cross the placenta and infect an unborn child!!!
4. **Genital Herpes**

**Cause:** Caused by Herpes Simplex Virus II.

**Symptoms:**
- Tingling or itching in genital area
- Blisters on genitals, buttocks, thighs or internal tissues
- Painful sores occur when blisters break open.

**NOTE:** Some people have no symptoms at all.

**Transmission:**
- Sexual contact with an infected person.

**Cure:** No cure. Treatment with antiviral medications for symptoms.

**Note:** If a newborn comes in contact with the herpes during birth, the infection may cause blindness, neurological disorders or even death.

5. **Syphilis**

**Cause:** Caused by the bacterium *Treponema pallidum*

**Symptoms/Action:**
The infection proceeds through three stages.

- **Stage 1:** Sores appear at infection site.
- **Stage 2:** Rash appears on skin (usually soles of feet and palms of hands)
  
  **Note:** During this stage the infection can be passed to another person.

- **Stage 3:** Cardiovascular and nervous system becomes damaged resulting in mental disorders and/or heart disease.

**Transmission:**
- Sexual contact with an infected person.

**Cure:** Antibiotics

**Note:** syphilis can infect a developing embryo resulting in birth defects and/or still birth.
6. **Gonorrhea**

**Cause:** Caused by the bacterium called *Neisseria gonorrhoeae*.

**Symptoms:**
- Pain when urinating
- Discharge from penis (greenish-yellow)
- Vaginal discharge

**NOTE:** In females, if not treated, the disease can cause the oviducts to become blocked.

**Transmission:**
- Sexual contact with an infected person.

**Cure:** Antibiotics
Reproductive Technologies

Reproductive technologies are mechanisms used to either:
- Enhance reproductive potential (fertility)
- Reduce reproductive potential

Human Infertility vs. Human Sterility

Infertility ➔ Term describing couples not having the ability to have more children than wished. Couples are considered to be infertile if they have been unsuccessful for one year in becoming pregnant.

Sterility ➔ Term used to describe couples unable to have any children.

Causes of Human Infertility/Sterility

a. **Blocked oviducts** – The oviducts become blocked usually as the result of an STI not allowing for fertilization of the egg.
b. **Failure to Ovulate** – Usually caused by hormonal imbalances (FSH/LH estrogen etc.)
c. **Endometriosis** – Painful condition where the endometrium grows outside the uterus. Result is non implantation of fertilized egg.
d. **Obstruction in Vas Deferens or Epididymis** – STI’s, varicose veins etc, may cause obstructions in the vas deferens causing sperm to not be released from the male and into the female. No fertilization results.
e. **Low sperm count** – Caused by numerous factors including overheated testicles, smoking, and alcohol.
f. **Abnormal sperm** – Caused by STI’s, overheated testicles, toxins
Technological Solutions to Infertility

These are technological advances that help overcome the barriers/causes of infertility.

1. *Artificial Insemination (AI) ➔* Sperm is placed in the vagina by a physician.

2. *In vitro Fertilization (IVF) ➔* Fertilization of an egg occurs outside the body. The fertilized egg is implanted in the uterus.

3. *In Vitro Maturation (IVM) ➔* Follicles are removed from a woman and caused to mature. Several oocytes are used for *in vitro* fertilization.

4. *Superovulation ➔* Injections of drugs (Fertility drugs) causes several follicles within the ovaries to mature. Several eggs are released with hopes of fertilization.

5. *Surrogate Motherhood ➔* A fertilized egg is placed into the uterus of another woman or sperm from a male is used to fertilize the egg of another female.

6. *Embryo Storage(Cryopreservation) ➔* Fertilized eggs or embryos are preserved by freezing them. Can be used at a later date etc.
Birth Control Technologies

These are technologies aimed at controlling reproduction/birth.

These can be classified on the basis of how they control birth.

1. **Barrier methods** ➔ Technologies aimed at keeping conception from happening.
   - They include:
     - Condoms (Stops sperm from entering female)
     - Diaphragm (Blocks the cervix)
     - Spermicidal Jellies and foams (contain chemicals that help kill sperm)
     - IUD – Intrauterine Device (Blocks implantation in the uterus)

2. **Hormonal methods** ➔ The use of hormones to stop conception.
   - They include:
     - Birth Control Pill – A pill containing progesterone/estrogen hormones that blocks the release of an egg.
     - Norplant -- Slow release hormones are implanted under the skin. They block the release of the egg.
     - Depo Provera -- Injections of hormones are given every few months. These hormones block the release of eggs.
     - Morning After Pill -- This is a pill taken after intercourse. If an egg is fertilized, it is kept from implanting in the uterus.

3. **Surgical Methods** ➔ The use of surgery to help prevent conception.
   - They include:
     - Tubal Ligation -- The oviducts (fallopian tubes) are cut and tied.
     - Vasectomy -- The vas deferens in males is cut and tied.

4. **Other Methods**
   - These include:
     - Abstinence
     - Rhythm Method – using timing and temperature to determine time when woman is ovulating. Intercourse is avoided during this time.
Fertilization and Implantation

**Fertilization:** This is the process whereby the sperm meets the egg and genetic material (chromosomes) is mixed. $\frac{1}{2} + \frac{1}{2} = 1$ complete set.

**Implantation:** This is the process whereby an embryo becomes embedded within the uterine lining.

The process of Fertilization

Fertilization occurs when sperm/semen from the testis of a male pass through the vas deferens and out through the urethra (picking up fluid as it moves along) and is deposited into the vagina of a female. The sperm then swim up through the cervix of a female and into the uterus. Sperm continue to swim up into the oviduct where an egg is supposed to be waiting.

An egg is released from the ovary (ovulation) and it passes to the oviduct. While in the oviduct it unites with sperm to become fertilized.

The moment of conception

When a sperm meets an egg, the acrosome of the sperm releases a powerful enzyme (hyaluronidase) that digests a portion of the egg membrane. The sperm’s nucleus is deposited inside the egg and it releases its chromosomes which are united with the chromosomes of the egg.
Embryonic Development

After fertilization, the zygote (fertilized egg), now called an *embryo* undergoes a series of distinct stages as it continues to develop.

1. **Cleavage** – This is a series of cell divisions without growth in an embryo. The cells become smaller and smaller. This occurs immediately after fertilization.

2. **Morula** – The embryo exists as a solid mass of identical cells. Created from the continued division of cells in the embryo.

3. **Blastocyst** – The embryo now exists as a hollow ball of identical cells. This is created from the repeated cell divisions.

   The blastocyst is made up of an *inner mass* of cells and an *outer mass* of cells. The inner mass of cells will develop into the *baby*, while the outer mass – called the *trophoblast* gives rise to the germ layers.

4. **Gastrula** -- The embryo now exists as a ball of cells with distinct cell layers known as *germ layers*. During this stage, the cells of the embryo begin to grow and rearrange themselves into 3 distinct layers. This process is known as *gastrulation*.

   The three germ layers are known as *ectoderm, mesoderm, endoderm*.

   **Ectoderm – The outside layer.** Forms the skin and nervous system of the baby.

   **Mesoderm – The middle layer.** Forms the muscles, bones and many organs.

   **Endoderm – The inner layer.** Forms the digestive and respiratory tract.
**Summary of Embryonic Development**

- **Fertilization**
  - Cleavage begins
  - Implantation into uterus occurs here
  - Embryo located in Oviduct

- **Morula**
  - Cleavage continues

- **Blastocyst**
  - Cleavage continues

- **Gastrula**
  - Gastrulation begins
  - Contains
    - Ectoderm
    - Mesoderm
    - Endoderm
The Embryonic Membranes

These are a series of membranes that surround, nourish and protect the developing embryo. They are known as the primary membranes.

**NOTE:** These membranes are NOT part of the embryo!!!

They develop from the germ layers.

**Chorion:** This is the outermost layer of cells of the embryo. They become the *placenta*.

*Placenta:* Structure that exchanges nutrients and wastes between the embryo and mother.

**Allantois and Yolk Sac:** These parts develop into the *umbilical chord*.

*Umbilical chord:* Structure connecting fetus to the placenta.

**Amnion:** This membrane develops into the *Amniotic membrane*.

*Amniotic membrane:* A thin membrane sac that surrounds the fetus. It contains *amniotic fluid* that serves to protect the fetus and absorb shocks.
Twins

Twins are identified as babies that are born at approximately the same time or at least during the same pregnancy. There are two types of Twins.

**Fraternal Twins** → These are twins created when **TWO SEPARATE** eggs are fertilized in a female.

Fraternal twins can be of the same or opposite sex.

Fraternal twins are no more alike than any other set of siblings.

**Identical Twins** → These are twins created when one sperm fertilizes one egg.

The blastocyst splits into two separate bodies early in development.

This results in **TWO embryos with EXACTLY the same DNA**!

These twins MUST be of the same sex because their DNA is identical.
The Effects of Teratogens on Development

As the baby grows, various substances and factors can affect its normal development.

**Teratogen:** Any chemical or agent that causes a structural abnormality due to fetal exposure during pregnancy.

**Examples of teratogens:**
1. Cigarette Smoke
2. Alcohol
3. Prescription drugs (some)

1. **Effects of Cigarette Smoke on a fetus**

   Cigarette smoke constricts fetal blood vessels preventing it from getting oxygen.

   Babies are usually:
   - Underweight
   - Can suffer from convulsions

2. **Effects of Alcohol on a fetus**

   Alcohol affects the fetus’ brain, central nervous system and physical development.

   Babies are usually:
   - Born with FAS – Fetal alcohol syndrome
     - These babies usually display the following:
       - Mental delays/retardation
       - Decreased height/weight and head size
       - Malformed face
       - Have aggression and/or personality changes
3. **Effects of Prescription drugs on a fetus**

Various prescription and over the counter drugs may have impacts on the developing fetus.

**Thalidomide**

A prescription drug given to women during the 1950’s to reduce morning sickness.

*Effect of Thalidomide on a fetus:* Babies were born with either *missing* or *deformed* limbs.

4. **Other Teratogens**

Things such as X-rays, PCB’s, heavy metals are all teratogens that can cause birth defects and/or abnormalities within an fetus.
Childbirth

When gestation (period of pregnancy) is reached, childbirth begins. Childbirth occurs under the influence of hormones in three distinct stages.

**Dilation Stage**

The following events occur during this stage.

- Pituitary releases *oxytocin*. Oxytocin causes uterine muscles to contract. This is the beginning of *labour*.
- The cervix opens and dilates (gets larger).
- The amniotic membranes rupture (water breaks) and amniotic fluid is released.

Dilation stage usually lasts anywhere from 2 to 20 hours.

**Expulsion Stage**

- Contractions by the uterus, forces the baby out through the cervix and into the birth canal (vagina).
- The baby’s head rotates making it easier for the baby to be delivered.

This stage usually lasts from 0.5 to 2 hours.

**Placental Stage**

- About 15 minutes after birth, the placenta and umbilical cord are forced out through the vagina by contractions of the uterine muscles.
- The placenta is now called the “*afterbirth*”
Hormones and Pregnancy

The following hormones are involved either during or after pregnancy in a female.

1. **Progesterone** → Hormone secreted by the *corpus luteum* that *maintains the uterus during pregnancy*.

2. **Human Chorionic Gonadotropin Hormone (HCG)** →

   Hormone released by the developing embryo that maintains the corpus luteum for the first three months of pregnancy. This helps to maintain the endometrium.

   **Note:** Pregnancy tests given to women test for the presence of this hormone. If found, it confirms a pregnancy.

3. **Estrogen** → Hormone that works with progesterone to maintain the uterus during pregnancy.

4. **Prolactin** → This is a hormone released by the pituitary that causes milk to be produced in the mammary glands (breasts) **AFTER PREGNANCY**. This allows a suckling baby to have milk.
Monitoring Pregnancy/Fetal Development

Monitoring the fetus/mother as the baby develops is crucial to ensure both the health of the baby and the mother. There are several technologies used to monitor pregnancy and/or fetal development.

They include:

1. **Ultrasound**
   
   Sound waves generated by an ultrasound machine penetrate the abdomen of a woman. They are “bounced” off the baby and other uterine structures. A computer turns the sound waves into pictures for the technician to view etc.

2. **Amniocentesis**
   
   A procedure performed around week 14 where a needle is inserted into the abdomen of the mother. The needle penetrates the uterus and a small amount of amniotic fluid is removed. Within the amniotic fluid are cells from the baby. These cells are examined and/or tested for irregularities such as Down Syndrome (3 copies of chromosome 21) etc. If defects are found parents are counseled on their options to terminate the pregnancy and/or continue.

3. **Fetoscopy**
   
   A procedure that allows for direct observation of the fetus using a special camera known as an endoscope. In this procedure the endoscope is placed inside the uterus through a small cut in the mother’s abdomen. The camera is able to view the fetus in real time and enables doctors to look for defects. If defects are found, doctors are able to use the camera to guide them when doing operations on the fetus **WHILE INSIDE** the uterus.

   For example: operations that drain fluid from a baby’s head or obtaining blood samples from the baby can be done this way.

4. **Chorionic Villus Sampling (CVS)**
   
   A procedure performed around week 9 where fetal cells are removed from the chorion layer. (The chorion helps to make up the placental). A karyotype (picture of the arrangement of chromosomes) is done to see if any abnormalities exist. If they do, once again the parents receive counseling.