The Male reproductive system

1. Penis
   a. Urination
   b. Sexual intercourse
      1. Corpus cavernosum- spongy tissue that fills with blood to make penis erect
      2. Glans- the head, end of penis
      3. Foreskin
         i. Covers glans,
         ii. May be removed surgically in an operation (circumcision)

2. Scrotum
   a. Located behind penis
   b. Contains two testes
   c. Temperature sensitive (Sperm must be made in cooler conditions i.e, 2-3°C lower than body temperature)

3. Testes
   a. Sperm is produced by the seminiferous tubules due to FSH
   b. Testosterone is produced by Leydig cells due to LH
      1. Causes the development of the male sex organs at ~8 weeks after conception.
      2. Responsible for facial, armpit, and pubic hair, bone growth and muscular development.
   c. Testes formed in the abdomen before birth. Descend through the "inguinal canal" during fetal or post-natal life. Sometimes it may take months/years to reach right place. Possible site for hernia.

4. Epididymis: Stores sperm until they have matured.

5. Vas deferens: Tube that leads from the epididymis to the urethra.
   Many sperm cells are stored here too.

6. Prostate gland: Provides an alkaline fluid that can protect sperm from harsh vaginal acids.

7. Seminal Vesicles: Produce food for sperm. Food "Fructose"

8. Cowper's gland: Produces clear lubricating fluid
The Female Reproductive System

Ovary:
  i) Each ovary contains immature ova (eggs) in follicles.
  ii) Females born with lifetime supply of eggs (250,000-400,000 in each ovary)
  iii) Ovaries release ovum - Almost all ova degenerate between birth and puberty.
  iv) Approx. 400 eggs will be ovulated over woman's life.
  v) Egg is the largest human cell.
  vi) Ovaries are located lower abdomen. 1 left and 1 on the right.

Fallopian tubes
  i) Two thin tubes attached to the upper sides of uterus
  ii) Tubes terminate near the ovaries but are not attached
  iii) "Fimbriae" are finger-like structures on the end of each tube
  iv) Tubes conduct egg to uterus by use of small hairs called "cilia"
  v) Fertilization of ovum takes place in the **ampullary-isthmic junction of the fallopian tubes**. Egg viable for only 24-48 hours after ovulation.

Uterus:
  i) Pear-shaped organ located in lower abdomen
  ii) Muscles (myometrium) stretch to allow baby to develop. Oxytocin starts labor contractions.
  iii) Lining of uterus (endometrium) thickens with blood-rich tissue due to progesterone
  iv) Endometrium supports embryo/fetus during growth
  v) Placenta It is the interface between baby and mother. If not pregnant, lining breaks down and is discharged from body through vagina. This is **menstruation** (period)
  vi) Cervix connects uterus to vagina. Like a door that opens during ovulation. Cervical mucous closes the door at all other times.

Vagina:

Birth canal:
  i) Menstrual blood leaves the body
  ii) Organ of intercourse
  iii) Muscular stretches to allow a baby to grow
iv) Vaginal opening partly remains closed by thin membrane of tissue called hymen. May be stretched or torn during any physical activity

**Cervix:**
i) Located at inner end of vagina  
ii) Opening of uterus into vagina  
iii) Mucous prevents bacteria and viruses from entering uterus  
iv) Lets sperm into uterus after ovulation  
v) Where baby also passes through during vaginal birth  

**Labia:**
2 layers of skin, which fold over the opening to vagina and urethra  
ii) Inner labia (labia minora)  
iii) Outer labia (labia majora)  
1. Two folds of skin, surround vaginal area  
2. Pubic hair grows on outer labia  

**Clitoris:**
i) Small organ, 5 to 10 millimeters long  
ii) Located at junction of inner labia near front of body  
iii) Contains erectile tissue & sexually sensitive  

**Mons pubis:** Cushion like fatty tissue covered by skin and pubic hair  

**GAMETOGENESIS & ITS HORMONAL REGULATION :**
Ref: Concept Map Page C 3  

**Differentiate between: Spermatogenesis and oogenesis:**

<table>
<thead>
<tr>
<th>Spermatogenesis</th>
<th>Oogenesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Produces male gametes (sperm)</td>
<td>produces female gametes (oocytes)</td>
</tr>
<tr>
<td>-- occurs in the seminiferous tubules (in testes)</td>
<td>-- occurs in the ovaries</td>
</tr>
<tr>
<td>-- involves meiosis</td>
<td>-- involves meiosis</td>
</tr>
<tr>
<td>-- occurs throughout life after puberty</td>
<td>occurs after puberty until menopause</td>
</tr>
<tr>
<td>may produce 400,000,000 per day</td>
<td>-- humans normally produce one oocyte during each ovarian cycle</td>
</tr>
<tr>
<td>Primary spermatocyte divide equally to form two similar secondary spermatocytes</td>
<td>Primary otocyte divide unequally to form one large secondary oocyte and a small polar body</td>
</tr>
<tr>
<td>One spermatogonium produces 4 functional spermatozoa</td>
<td>An oogonium produces one functional ovum and 3 non functional polar bodies</td>
</tr>
</tbody>
</table>
2) Follicular phase (Proliferative phase) and Luteal phase (Secretory Phase)

<table>
<thead>
<tr>
<th>Proliferative phase</th>
<th>Secretory Phase</th>
</tr>
</thead>
<tbody>
<tr>
<td>Follicular phase</td>
<td>Luteal phase</td>
</tr>
<tr>
<td>Stage of repair and proliferation</td>
<td>Prepares endometrium for implantation</td>
</tr>
<tr>
<td>It extends from the end of menstruation to ovulation</td>
<td>It extends after ovulation to menstruation</td>
</tr>
<tr>
<td>LH and FSH increases</td>
<td>LH is high (LH surge)</td>
</tr>
<tr>
<td>Estrogen level increases</td>
<td>Progesterone level increases</td>
</tr>
<tr>
<td>Estrogen is secreted by Graffian follicle</td>
<td>Progesterone secreted by corpus luteum</td>
</tr>
</tbody>
</table>

Menstrual Cycle

<table>
<thead>
<tr>
<th>Menstruation</th>
<th>Repair of the endometrium</th>
<th>Ovulation</th>
<th>Thickening of the endometrium</th>
<th>Breaking down</th>
</tr>
</thead>
<tbody>
<tr>
<td>Follicular Phase</td>
<td>FSH/Estrogen</td>
<td>Due to LH</td>
<td>Luteal Phase</td>
<td>LH/Progesterone</td>
</tr>
</tbody>
</table>

MENSTRUAL CYCLE: Ref. Concept Map Page C 4
Endometrial changes following fertilization

Functional Activities of FSH and LH

THE MENSTRUAL CYCLE

A typical menstrual cycle. It is usual to regard the first day of the cycle as the day when bleeding begins.
FSH and LH from the pituitary:

<table>
<thead>
<tr>
<th>Hormone</th>
<th>In Females</th>
<th>In Males</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FSH</strong> Controls →</td>
<td>Eggs + Estrogen</td>
<td>Spermatogenesis</td>
</tr>
<tr>
<td><strong>LH</strong> Controls →</td>
<td>Ovulation + Corpus Luteum</td>
<td>Testosterone</td>
</tr>
</tbody>
</table>

**STAGES OF MATURATION OF OVA**

- **Primordial follicle**: The surviving primary oocytes, at birth, are surrounded by thin, single layers cells of so-called follicular epithelial cells.
- **Primary follicle**: The primordial follicles while developing into primary follicles the follicular epithelium that surrounds the oocyte becomes iso- to highly prismatic.

**From Primordial Follicle to Tertiary Follicle**

- **Primordial follicle**
- **Primary follicle**
- **Secondary follicle**
- **Graafian follicle**
- **Tertiary follicle**

A  Primordial follicle
B  Primary follicle
1  Oocyte
2  Follicular epithelium
3  Pellucid zone
4  Stratum granulosum
5  Theca folliculi cells
6  Theca interna
7  Theca externa
8  Antrum
9  Liquor folliculi

- **Corona radiata**
- **Zona pellucida**
- **Ovulation**

**Primordial follicle**: The surviving primary oocytes, at birth, are surrounded by thin, single layers cells of so-called follicular epithelial cells.

**Primary follicle**

The primordial follicles while developing into primary follicles the follicular epithelium that surrounds the oocyte becomes ISO- to highly prismatic.
Secondary follicle
Secondary follicles with follicular epitheliums encompassing multiple rows are formed called the stratum granulosum. Pellucid zone, between the oocyte and follicular epithelium becomes visible.

Tertiary follicle
A well-developed net of capillaries in the theca internal.
Antrum – a fluid filled cavity develops
The theca layer organized in to Theca internal & Theca external

1 Oocyte
2 Pellucid zone
3 Stratum granulosum
4 Theca internal
5 Theca external
6 Antral follicle
7 Cumulus oophorus (Granulosa cells, together with the oocyte)
8 Basal lamina between theca and stratum granulosum

Conception to Birth
The following shows some of the many stages of human development:

Zygote
The single cell that results from fertilization of an ovum by a sperm.

Morula
*The morula (little mulberry)*
- Solid ball (16 → 64 cells).
- Morula arises from mitotic (cleavage) divisions.
<table>
<thead>
<tr>
<th>Blastocyst</th>
<th>The blastocyst is a liquid-filled ball of cells. Occurs around 5 – 8 days after conception. Implantation in the endometrium occurs at this stage.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Embryo</td>
<td>Human considered an embryo from implantation until about 8 weeks after conception.</td>
</tr>
<tr>
<td>Foetus</td>
<td>8 weeks after conception until birth.</td>
</tr>
</tbody>
</table>
**Fate of three germ layers**

<table>
<thead>
<tr>
<th>Ectoderm</th>
<th>Mesoderm</th>
<th>Endoderm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nervous system</td>
<td>Skeleton</td>
<td>Digestive tract</td>
</tr>
<tr>
<td>Epidermis of skin</td>
<td>Muscles</td>
<td>Respiratory system</td>
</tr>
<tr>
<td>Circulatory system</td>
<td></td>
<td>Liver, pancreas</td>
</tr>
<tr>
<td></td>
<td>Gonads</td>
<td>Bladder</td>
</tr>
</tbody>
</table>

**Mnemonics**

*Tubules in male reproductive system*  
“SEVEN UP”

- Seminiferous tubules
- Epididymis
- Vas deferens,
- Ejaculatory duct  
  *(Nothing)*
- Urethra
- Penis

*Menstrual Cycle*  
“FOL(d) M(a)PS”

- Ovarian cycle:
  - Follicular phase
  - Ovulatory phase
  - Luteal phase

- Menstrual cycle:
  - Menstrual flow,
  - Proliferative phase
  - Secretory phase
TERMS TO REMEMBER

**Acrosome** - the part of a sperm cell that contains an enzyme – (This enables a sperm cell to penetrate an egg.)
**Afterbirth** - placenta and fetal membrane expelled from the uterus after the birth of a baby
**Amniotic sac** - fluid-filled membrane or sac that surrounds the developing embryo while in the uterus. (protects baby from hard shocks, keeps it at a constant temperature.)
**Birth** - the process of being born. process by which baby moves from the uterus into the outside world.
**Parturition**

**Blastocyst** = blastula = early stage of an embryo; a liquid-filled sphere whose wall is composed of a single layer of cells; during this stage (about eight days after fertilization) implantation in the wall of the uterus occurs.

**Cervix** - lower part, or neck, of uterus. (Opening to the uterus.)
**Clitoris** - small, sensitive organ in front of the vagina
**Coitus** - synonym for sexual intercourse

**Conception** - fertilization of an egg cell by a sperm cell

**Corpus Luteum** - After ovulation, this crater-like structure produces progesterone and estrogen. The corpus luteum is the old RUPTURED GRAFFIAN follicle. It means “yellow body”.

**Cowper's glands** - 2 glands that secrete an oily liquid, which cleans and lubricates the urethra of the male

**Egg cell** - a female sex cell (female gamete or ovum or secondary oocyte)
**Ejaculation** - the discharge of semen from the penis
**Embryo** - the unborn child developing in the uterus between the second and eighth weeks of life
**Endometrium** - the lining for the uterus – site for blastocyst implants and develops.
Epididymis - the tightly coiled tube at the back at each testis that holds newly created sperm – (each epididymis is like a nursery where sperm mature and learn to swim.)

Erection - condition of penis when it fills with blood and becomes firm, enlarged, and erect.

Fallopian tubes - tubes leading from each ovary to the uterus. Tubes carry the egg from ovary to the uterus. Fertilization occurs here. (Also known as the oviducts.)

Fimbria - A fimbria (plural fimbriae) Latin word, literally means "fringe." a fringe of tissue near the ovary leading to the fallopian tube

Fertile - able to conceive a child

Fertilization union of sperm and egg. Conception.

Fertilized egg - egg after sperm has united with it. Zygote

Fetus - unborn child developing in the uterus after the first eight weeks of life


Foreskin – A sheath of skin that surrounds the penis.

Follicle Stimulating Hormone - secreted from pituitary gland in both men and women. In women, FSH promotes the development of eggs and estrogen. In men, FSH promotes the development of sperm cells.

Fraternal twins - babies that develop from two eggs, each fertilized by a sperm cell; may or may not be of the same sex

Gamete – a sex cell. Sperm cells and egg cells are gametes.

Genitals - the reproductive or sex organs, especially the external organs

Germ Cell - egg or sperm cell. Gamete. In humans, germ cell contains 23 chromosomes

Hormones - chemical substances produced by the endocrine glands; they act in other parts of the body and affect maturation, growth, and behavior; LH, FSH, GH, Testosterone, Estrogen, Progesterone are all hormones.

Hymen - a thin bit of tissue, or membrane that may partially cover the opening of the vagina

Identical twins - babies that develop from a single fertilized egg that separates into two halves; identical twins are always of the same sex

Labia - two folds of skin surrounding the entrance of vagina

Labor - the muscular contractions that expel a baby from uterus during childbirth

Leydig Cells – when prompted by LH, Leydig cells create testosterone.

LH - Luteinizing Hormone - Secreted from pituitary gland, causes ovulation and formation of corpus Luteum in women. In men, LH causes Leydig cells to produce testosterone.

Menstrual cycle - periodic building up and sloughing off of lining of uterus approximately every twenty-eight days

Menstruation - the periodic discharge of blood and waste material (unfertilized secondary oocyte / ova and the degenerating endometrium lining) from the uterus

Miscarriage - expulsion from the uterus of a fetus before it is developed sufficiently to live. Also called spontaneous abortion

Myometrium - muscles of the uterus that stretch to accommodate the growth of the baby. These muscles contract during labor and push baby out...

Orgasm - the peak of sexual excitement when the male ejaculates semen,

Ovary - female sex glands; they produce egg cells, estrogen and progesterone.

Ovulation - the discharge, or release, of an egg cell / secondary oocyte from the ovary

Ovum - scientific name for an egg cell / secondary oocyte

Oxytocin - hormone, released from the pituitary gland, stimulates contraction of the myometrium of the uterus during labor and facilitates ejection of milk from the breast during nursing.
<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Penis</td>
<td>the male sex organ through which sperm cells leave the body; it also discharges urine</td>
</tr>
<tr>
<td>Placenta</td>
<td>network of blood vessels and other tissues by which the unborn child is attached to the wall of the uterus. grows out of the endometrium The umbilical cord is attached to it. It is the interface between mother and developing fetus.</td>
</tr>
<tr>
<td>Pregnancy</td>
<td>the process in a woman from conception to birth</td>
</tr>
<tr>
<td>Pregnant</td>
<td>the condition of a woman with an embryo or fetus in her uterus</td>
</tr>
<tr>
<td>Progesterone</td>
<td>pregnancy hormone, which is first produced by the corpus luteum and then by the placenta.</td>
</tr>
<tr>
<td></td>
<td>* increases lining of endometrium.</td>
</tr>
<tr>
<td></td>
<td>* maintains pregnancy</td>
</tr>
<tr>
<td></td>
<td>* helps develop mammary glands.</td>
</tr>
<tr>
<td>Prostate gland</td>
<td>surrounds the upper end of male urethra and produces part of the fluid that mixes with the sperm to form semen. Prostate fluid alkaline helps to protect sperm from vaginal acids.</td>
</tr>
<tr>
<td>Scrotum</td>
<td>pouch of loose skin containing the testes. Houses and air-conditions the testicles by moving and sweating.</td>
</tr>
<tr>
<td>Semen</td>
<td>the mixture of sperm and fluids released during ejaculation. Semen comprised of sperm, fructose, prostate fluid and oil from Cowper’s gland.</td>
</tr>
<tr>
<td>Seminal vesicles</td>
<td>small saclike organs opening into each vas deferens near the upper end of the urethra; produce part of the fluid that mixes with the sperm to form semen; provide food (fructose) for the sperm.</td>
</tr>
<tr>
<td>Seminiferous tubules</td>
<td>tubes in testes that produce sperm</td>
</tr>
<tr>
<td>Sexual intercourse</td>
<td>entry of penis into vagina and subsequent release of semen; also called coitus</td>
</tr>
<tr>
<td>Sperm</td>
<td>the male sex cell (male gamete or spermatozoon), which contains 23 chromosomes in human.</td>
</tr>
<tr>
<td>Spermatozoon</td>
<td>scientific name for sperm</td>
</tr>
<tr>
<td>Spontaneous abortion</td>
<td>synonym for miscarriage</td>
</tr>
<tr>
<td>Testes</td>
<td>male sex glands; produce sperm cells and testosterone;</td>
</tr>
<tr>
<td>Testicles</td>
<td>synonym for testes</td>
</tr>
<tr>
<td>Testosterone</td>
<td>male hormone that regulates development of penis, muscles, body hair, etc...</td>
</tr>
<tr>
<td>Umbilical cord</td>
<td>ropelike structure connecting embryo or fetus to placenta within the uterus.</td>
</tr>
<tr>
<td>Urethra</td>
<td>the tube through which urine is expelled from the bladder in both males and females and through which semen leaves the male body</td>
</tr>
<tr>
<td>Uterus = womb</td>
<td>the hollow pear-shaped organ in which a baby develops before it is born;</td>
</tr>
<tr>
<td>Vagina</td>
<td>passage from the uterus to the outside of the body, accepts the penis during intercourse. It is the birth canal &amp; menstrual fluids leave through it</td>
</tr>
<tr>
<td>Vas deferens</td>
<td>tube extending from each epididymis to the urethra in males</td>
</tr>
<tr>
<td>Womb</td>
<td>synonym for uterus</td>
</tr>
<tr>
<td>Yolk sac</td>
<td>a structure that develops for the nutrition of embryo during early embryonic life and then ceases to function</td>
</tr>
<tr>
<td>Zygote</td>
<td>The cell formed by the union of two gametes. [fertilized ovum before cleavage.]</td>
</tr>
</tbody>
</table>
IMPORTANT NOTES

- An adult male produces over $10^{12}$ to $10^{13}$ sperms each day.
- Human female oogonial development by mitosis is completed by 25 weeks of foetus and no oogonia are formed after birth.
- Sperm entry into the ovum stimulates MPF (M phase promoting factor) & APC (Anaphase promoting complex) for completion of Meiosis II.
- During Spermatogenesis, spermatogonium produces four sperms while in oogenesis, oogonium produces one ovum and two polar bodies.
- Human Sperm contains Clupein proteins.
- Yolk nucleus: A mass of mitochondria and golgi bodies near nucleus is called as yolk nucleus and controls vitellogenesis.
- Maximum level of estrogen – 12th day, LH-13th day, Progestrone – 21st day, Corpus luteum formation – 19th day of menstrual cycle.
- Menstrual cycle is absent during pregnancy, lactation periods and permanently during menopose.
- Two ovaries alternate in ovulation.
- 13 mature eggs are released per year, so about 416 eggs (13x32 years) are ovulated during whole reproductive period of human female.
- Menstruation is also called “Weeping of uterus for the lost ovum” or ”Funeral of unfertilized eggs”.
- In human embryo, yolk sac degenerates since eggs is microlecithal, which shows evolutionary significance.
- Placenta acts as a physiological barriers and an ultra-filter between foetal and maternal blood.
- Progesterone is also called pregnancy hormone since its secretions controls pregnancy.
- Teratogens are physical, chemical, biological agents which may cause malformation in developing embryo.
- Period between fertilization and parturition is called gestation periods. Varies between 266 days up to 280 days (49 weeks).