### Male Reproductive System

<table>
<thead>
<tr>
<th>Structure</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Testes:</strong></td>
<td></td>
</tr>
<tr>
<td>Seminiferous Tubules</td>
<td>- produce sperm cells</td>
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<tr>
<td></td>
<td>- contain Sertoli cells, which support, nourish, and regulate the sperm cells.</td>
</tr>
<tr>
<td><strong>Testes:</strong></td>
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<tr>
<td>Interstitial cells</td>
<td>- cells that lie between the seminiferous tubules &amp; secrete the male sex hormone (testosterone)</td>
</tr>
<tr>
<td><strong>Epididymis</strong></td>
<td>- matures and stores sperm cells</td>
</tr>
<tr>
<td><strong>Vas deferens</strong></td>
<td>- carries sperm from epididymis to its junction with the urethra</td>
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<tr>
<td><strong>Seminal vesicles</strong></td>
<td>- secretes fructose into the seminal fluid which provides energy for the sperm</td>
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<tr>
<td></td>
<td>- it also secretes the chemical prostaglandins, which causes the uterus to contract</td>
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<tr>
<td><strong>Prostate Gland</strong></td>
<td>- secretes an alkaline buffer into the seminal fluid to protect the sperm from the acidic environment of vagina</td>
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<tr>
<td><strong>Cowper's Glands</strong></td>
<td>- secretes mucus-rich fluids into the seminal fluid that protect the sperm &amp; provide them with a medium to swim in</td>
</tr>
<tr>
<td>(Bulbourethral glands)</td>
<td></td>
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<tr>
<td><strong>Urethra</strong></td>
<td>- transports semen (seminal fluid + sperm) or urine out of the body</td>
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</tbody>
</table>

**Penis**
- deposits semen into vagina during ejaculation

**Sperm** – the male gamete
- **SPERMATOGENESIS**: development of sperm; involves meiosis (cell division that reduces the number of chromosomes by half)
  - takes about 9-10 weeks
- Sperm:
  1. produced in **SEMINIFEROUS TUBULES** in testes (total length of coiled tubules is ~ 250 meters)
  2. mature & stored in **EPIDIDYMIS**
  3. moved into the **VAS DEFERENS** by muscle contractions and then to URETHRA for ejaculation
  4. move out of penis through the **URETHRA** for ejaculation
• Sperm is composed of three parts: **HEAD**, **MIDDLE PIECE**, and **TAIL**

• **HEAD** contains the 23 chromosomes within a nucleus

• In the **middle piece** are numerous **MITOCHONDRIA** which **provide energy** for sperm movement.

• On the tip of the head is the **ACROSOME CAP**
  - contains **ENZYMES** needed to **penetrate** the outer barriers of the egg.

• Normal male releases over 100 million sperm per ejaculation; usually, fewer than 100 reach vicinity of egg; one penetrates
• an egg is actually **100,000 times larger** than a sperm

**TESTES ALSO PRODUCE HORMONES**

• **Hormones** and **negative feedback cycles** control the development and maintenance of the male reproductive system. After puberty, a man maintains a relatively constant level of testosterone and sperm production.

**The Details…**

• **HYPOTHALAMUS** ultimately controls testes by secreting **GONADOTROPIC-RELEASING HORMONE** (GnRH).

• GnRH triggers **ANTERIOR PITUITARY** to produce two hormones: **FSH** and **LH**

• **FOLLICLE-STIMULATING HORMONE (FSH)** is released by the anterior pituitary. **FSH promotes spermatogenesis** in seminiferous tubules. It does this by entering the Sertoli cells and causing them to take up more testosterone. This in, turn, enhances sperm production.
• As sperm is made, Sertoli cells in the seminiferous tubules also release hormone **INHIBIN**. The more sperm that is made, the more inhibin is released. Since inhibin is a hormone that travels in the blood and can be detected by the brain, inhibin levels in the blood are the body's way of keeping track of sperm levels. As inhibin (and therefore sperm) levels rise, this is detected by the hypothalamus and anterior pituitary gland. The hypothalamus and anterior pituitary in turn, reduce the release of GnRH and **FSH**, which in turn reduces the amount of sperm and inhibin being released. This is a classic **negative feedback cycle**.

**INTERSTITIAL CELL-STIMULATING HORMONE (ICSH)** (called **luteinizing hormone** (LH) in females and on the Provincial), controls production of **testosterone** by interstitial cells. LH thus causes increased testosterone levels in the blood. High levels of LH are detected by the hypothalamus, which then reduces its release of GnRH – another **negative feedback loop**!

• Interaction of hormones maintains fairly constant **production** of sperm and testosterone.

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**TESTOSTERONE is the Male Sex Hormone**

• Promotes normal **development** and **function** of **primary sexual organs** of male. (e.g. high levels of testosterone in puberty stimulate the maturation of the penis & testes).

• Causes **development of secondary sexual characteristics** during puberty (beard growth, auxiliary & pubic hair), deepens voice, greater muscle growth). **Aggressiveness** and aggressive behavior is testosterone related.

• Testosterone is necessary for the **development of sperm** (FSH causes spermatogenic cells in testes to take up testosterone -- testosterone causes these cells to produce sperm).
FEMALE REPRODUCTIVE SYSTEM

1. **OVARIES**: produce eggs (ova) and sex hormones estrogen & progesterone

2. **OVIDUCTS/FALLOPIAN TUBES**: tubes to uterus & extend from near the ovaries in to the uterus
   - conducts an egg to the uterus
   - site of fertilization (sperm usually meet and fertilize an ovum in the upper oviduct)
   (tubular pregnancy occur when embryo implants in oviduct; ectopic pregnancy is any implantation outside the central body of the uterus)

3. **Fimbriae**: fingerlike projections at the ends of the oviducts
   - muscular contractions and cilia lining the oviducts waft the egg toward the uterus

4. **Uterus**: thick-walled muscular, hollow, pear-shaped organ for housing a developing fetus
   - about size and shape of inverted, flattened pear
   - lies above and slants forward over the bladder
   - can stretch from 5cm wide to over 30 cm with a growing baby

5. **Endometrium**: lining of the uterus
   - composed of connective tissue, glands, & blood vessels
   - if pregnancy occurs, it forms the placenta

6. **Cervix**: located at back of vaginal canal
   - contains the opening to uterus and is found between the vagina and uterus

7. **Vagina**: muscular tube with *mucosa lining*
   - serves in intercourse (receives penis during sexual intercourse) and serves as the *birth canal* during childbirth.

- ovaries contain **FOLLICLES**, which are the sacs containing the eggs in the cortex of the ovary
- each month, an ovary produces an egg (oocyte) and releases it in a process called **OVULATION**
- a female is born with up to 2 million follicles; reduced to about 350,000 - 400,000 at puberty; **only about 400 mature** at about one egg per month in reproductive life of average woman.
**Estrogen and Progesterone: Female Sex Hormones**

**ESTROGEN:** at puberty, stimulates the growth of the uterus and vagina  
- is necessary for egg maturation  
- causes and maintains secondary sex characteristics  
  - growth of body, underarm, and pubic hair  
  - stimulates fat deposit under skin for more rounded body  
  - stimulates wider pelvic development and female proportions  
  - stimulates breast development  
  - involved in regulation of uterine cycle

**PROGESTERONE:**  
- required for breast development  
- involved in regulation of uterine cycle

**Oogenesis**  
The follicle is the sac in the cortex of the ovary that contains the oocyte (egg):  

The primary (1°) follicle contains the immature egg with the 46 chromosomes.

The egg divides by meiosis to produce 2 cells with 23 chromosomes. One of them, the polar body which has little cytoplasm, is shed from the follicle. It is now called the secondary (2°) follicle.

The follicle fills with fluid & enlarges. It is now called the Graafian follicle. When the pressure of this fluid builds up it causes the follicle to burst and release the egg “ovulation”.

The empty follicle, now called the Corpus Luteum, degenerates if there is no pregnancy. If pregnancy occurs, it exists for ~6 months & secretes progesterone. After the egg is fertilized, it release the 2nd polar body which is there because the egg has divided by mitosis.
**Fertilization**

- several hundred sperm might make it to the egg, only one will fertilize the egg
- **acrosome releases its enzymes** which break through the outer layer of the egg
- plasma membranes of the egg and sperm fuse, and the nucleus from the sperm enters the egg
- finally, the sperm nucleus fuses with the egg nucleus
  - this could correctly be viewed as the moment of conception
  - now called a **zygote**

<table>
<thead>
<tr>
<th>The Ovarian Cycle</th>
<th>The Uterine Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Low levels of female hormones</strong> in blood from <strong>days 1 - 5</strong>.</td>
<td><strong>Low levels of female hormones</strong> cause <strong>Menstruation (days 1-5)</strong> - endometrium breaks down and is shed.</td>
</tr>
<tr>
<td><strong>FSH levels increase</strong> from days during <strong>days 6 - 13</strong>.</td>
<td><strong>Days 6 - 13</strong>: the rising levels of estrogen make the <strong>endometrium thicken</strong> and become <strong>vascular &amp; glandular</strong> (= <strong>proliferative phase</strong>).</td>
</tr>
<tr>
<td>This causes a <strong>follicle to mature</strong>. As follicle matures, it makes more and more <strong>estrogen</strong>, so <strong>estrogen levels rise</strong>.</td>
<td><strong>The endometrium rebuilds</strong> itself.</td>
</tr>
<tr>
<td>High levels of estrogen in blood causes hypothalamus to secrete a large amount of <strong>GnRH</strong>, which leads to a <strong>surge of LH</strong> at day 13 which causes:</td>
<td></td>
</tr>
<tr>
<td><strong>Ovulation at day 14</strong>.</td>
<td></td>
</tr>
<tr>
<td><strong>Negative feedback</strong> by <strong>estrogen</strong> on <strong>FSH</strong> ends follicular phase.</td>
<td></td>
</tr>
<tr>
<td><strong>(days 15 - 28) Corpus Luteum makes</strong> increasing amounts of <strong>progesterone</strong>.</td>
<td><strong>(days 15 - 28)</strong> <strong>Progesterone makes endometrium double in thickness.</strong></td>
</tr>
<tr>
<td><strong>Progesterone</strong> causes <strong>negative feedback control</strong> over anterior pituitary secretions of LH, causing <strong>corpus luteum</strong> to <strong>degenerate</strong>.</td>
<td><strong>Uterine glands mature and release thick mucoid secretions.</strong></td>
</tr>
<tr>
<td><strong>As luteal phase ends, menstruation occurs.</strong></td>
<td><strong>As corpus luteum degenerates, progesterone secretion decreases.</strong> This causes menstruation to occur again.</td>
</tr>
</tbody>
</table>
PREGNANCY Follows Fertilization

• fertilized egg develops as it travels down the oviduct to uterus
• embryo embeds in the endometrial lining (implantation) several days after fertilization

If Implantation Occurs…

• The uterus is undisturbed; the usual menstrual cycle must be interrupted for 9 months
• Placenta:
forms from both maternal and fetal tissues: provides exchange of molecules between fetal and maternal blood

produces Human Chorionic Gonadotropin (HCG), which temporarily maintains the corpus luteum (pregnancy tests test for HCG in the blood)

as it develops, the placenta begins to make its own progesterone and estrogen.

Progesterone and estrogen, from the placenta, do two things:
1) shut down the release of FSH & LH from the anterior pituitary (so that no new follicles mature)
2) maintain the lining of the uterus so that the corpus luteum is not needed

This means no menstruation during pregnancy

Labour and Childbirth

Fetus rotates with head pointed toward cervix.
If not in position, breech birth (bum first) may require Cesarean section.

End of ninth month, fetus averages 525 mm (20 inches) and 3,380 grams (7.5 pounds).

Birth occurs in Stages

Mild, indiscernible contractions occur throughout pregnancy; become stronger and more frequent near end of pregnancy

True LABOUR involves contractions lasting over 40 seconds occurring every 15 - 20 minutes.

Trigger of childbirth involves prostaglandins and OXYTOCIN from mother's pituitary; both hormones can induce birth.

Oxytocin: made in the hypothalamus and stored in the posterior pituitary

- causes the uterus to contract and is used to artificially induce labour
- also stimulates the release of milk from the mammary glands for nursing
- involves a POSITIVE FEEDBACK LOOP
- Just before birth, the growing baby's head exerts pressure against the cervix
pressure triggers sensory nerves in the cervix to send a nerve signal to the posterior pituitary to release oxytocin.

oxytocin is released into the blood when it gets to the uterus, it causes stronger uterine contractions.

greater stimulation of the sensory nerves

more oxytocin to be released, which causes stronger uterine contractions, and so on.

cycle ends when the baby is pushed out of the uterus, stopping the stimulation of sensory nerves to the pituitary.

Childbirth (called Parturition) includes labor and expulsion of fetus; involves three stages:

**Stage 1: Cervix dilates.** Mucus plug from cervical canal is expelled; amniotic membrane ruptures to release amniotic fluid (i.e. "water" breaks); stage ends when cervix is fully dilated.

**Stage 2: Baby emerges.** Uterine contractions that occur every 1 - 2 minutes, lasting one minute each; if vagina cannot expand enough, an episiotomy is performed and baby is born. Umbilical cord is cut, shriveling and leaving scar that becomes navel.

**Stage 3: Placenta (afterbirth) is expelled** from uterus about 15 minutes after delivery of baby.
After Menopause the Ovaries Don't Respond

- Between ages 45 and 55, the ovarian and uterine cycles cease.
- Ovaries no longer respond to FSH and LH and stop producing estrogen and progesterone.
- Menstruation becomes irregular; menopause completed after one year of no menstrual cycle.
- Highly variable symptoms include: "hot flashes" from irregular circulation, dizziness, headaches, depression, either insomnia or sleepiness...or no symptoms at all.
- Increased sex drive after menopause may be due to androgens produced by adrenal cortex.

BIRTH CONTROL

- Most reliable method of birth control is ABSTINENCE.
- Birth control methods have variable effectiveness. The table below summarizes current birth control methods, risks and effectiveness.

<table>
<thead>
<tr>
<th>Name</th>
<th>Procedure</th>
<th>Methodology</th>
<th>Effectiveness</th>
<th>Risk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Abstinence</td>
<td>Refrain from sexual intercourse</td>
<td>No sperm in vagina</td>
<td>100%</td>
<td>None</td>
</tr>
<tr>
<td>Contraceptive implants</td>
<td>Six tubes of progesterone (form of progesatone) are implanted under skin.</td>
<td>Anterior pituitary does not release FSH and LH</td>
<td>&gt; 99%</td>
<td>Presently none known</td>
</tr>
<tr>
<td>Depo-Provera injection</td>
<td>Four injections of progestrone-like steroid are given per year</td>
<td>Anterior pituitary does not release FSH and LH</td>
<td>About 99%</td>
<td>Breast Cancer?</td>
</tr>
<tr>
<td>Intrauterine Device (IUD)</td>
<td>Plastic coil is inserted into uterine by physician</td>
<td>Prevents implantation</td>
<td>&gt; 90%</td>
<td>Presently none known</td>
</tr>
<tr>
<td>Diaphragm</td>
<td>Latex cup is inserted into vagina to cover cervix before intercourse</td>
<td>Blocks entrance of sperm to uterus</td>
<td>About 70%</td>
<td>Presently none known</td>
</tr>
<tr>
<td>Contraceptive implants</td>
<td>Six tubes of progesterone (form of progesatone) are implanted under skin.</td>
<td>Anterior pituitary does not release FSH and LH</td>
<td>About 99%</td>
<td>Presently none known</td>
</tr>
<tr>
<td>douche</td>
<td>Vagina and uterus are cleansed after intercourse</td>
<td>Washes out sperm</td>
<td>Less than 70%</td>
<td>Presently none known</td>
</tr>
</tbody>
</table>

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