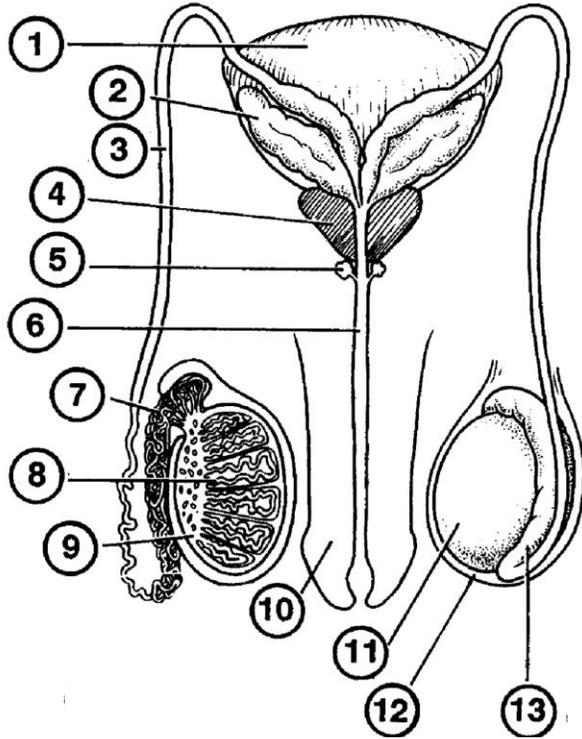


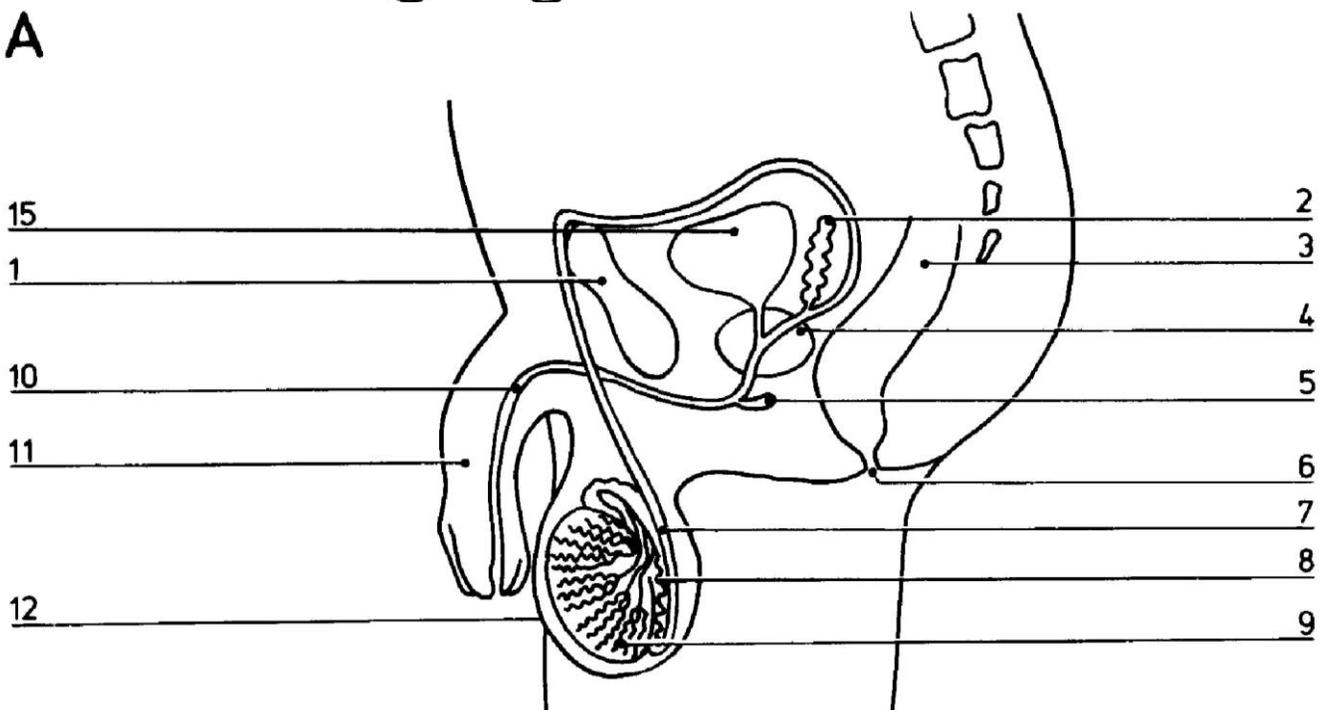
You started off, as did all humans (as does, indeed, all life on Earth) very small. You are the result of the chance meeting and fusing of two cells. The human reproductive system is the system which produces **specialized cells** capable of combining their genetic information to form a new individual. This requires **special organs** and structures for producing these special cells, for bringing the cells close enough together so that they can fuse, and for providing a place for the new individual to develop into a viable human being. The processes also require the coordination of various **hormones**. In this chapter, we will learn about the structures, processes and functions of the human reproductive system.

Male Reproductive System



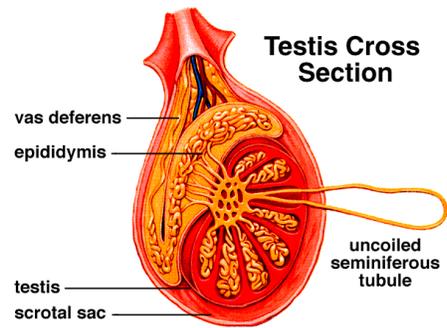
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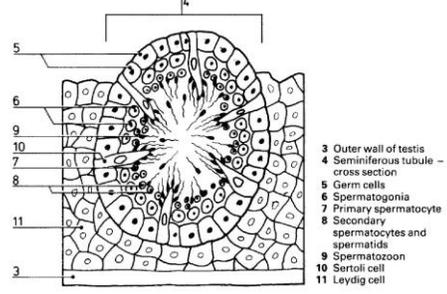
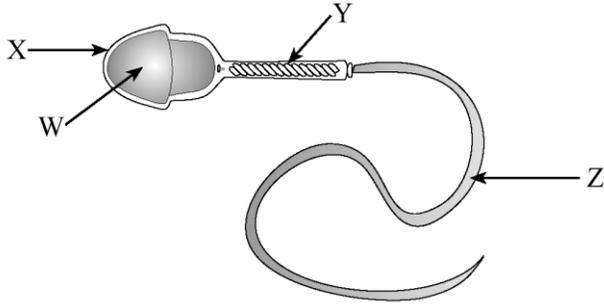
TESTES

The testes (sometimes still called "testicles" Testes actually comes from the latin word meaning "witness")
 Testes are paired organs that develop from _____ within abdomen of fetus. They subsequently descend through a canal into _____ (a pouch of skin located below the pelvic region) during the last 2 months of fetal development.
 _____ maintains testes at _____ than the abdominal cavity. This is necessary for producing viable sperm.
 _____, due to too high body temperature, results if testes fail to descend; can be corrected by surgery.



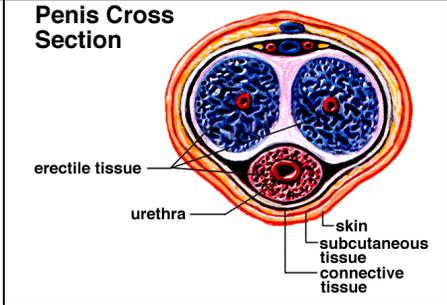
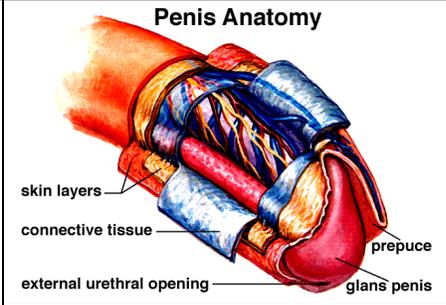
_____ are coiled tubules packed into lobes of the testes that _____. Inside the seminiferous tubules are other cells called _____ that nourish the developing sperm cells.
 _____ (also known as **Leydig cells**) in the testes surround the seminiferous tubules and **produce** the male hormone _____.
 _____ – the male gamete

- Men can produce up to 1,000,000,000 sperm per day. The whole *process* of spermatogenesis takes about 9 or 10 weeks.
- Produced inside _____ in testes. Testes contains sections called _____, each with one to three coiled seminiferous tubules with total length of _____.
- sperm _____ and are stored in the tubular _____ (singular = _____) behind each testes.
- Once mature, sperm propelled into _____ by muscle contractions.
- Sperm moves from storage in vas deferens to _____ for ejaculation.



- Sperm is composed of **three parts**: _____, and _____.
- In the _____ are numerous _____ which **provide energy for sperm movement**.
- Middle piece and tail have _____ with _____ pattern of cilia and flagella.
- On the tip of the head is the _____. The acrosome cap contains _____ 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.
- _____ is **development of sperm**; involves meiosis (cell division that reduces the number of chromosomes by half).

 _____ are other cells inside the seminiferous tubules that support, nourish and regulate the cells that generate sperm cells.

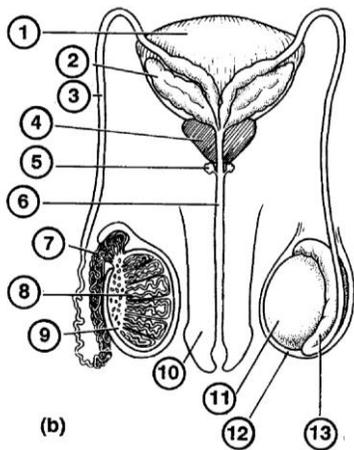




PENIS

- the penis is a cylindrical-shaped organ in that hangs in front of scrotum.
- **Spongy tissue** inside shaft of penis is flaccid (soft) with normal blood flow in the penis.
- _____ occurs from _____ filling spongy tissue.
- **IMPOTENCY** is failure to become erect.

SEMEN



- Semen is a thick, whitish fluid containing **SPERM** and **SECRETIONS FROM THREE ORGANS.**
- **i)** _____: Two seminal vesicles join two vas deferens; secrete _____ at time of ejaculation.
- _____ is single duct leading from two vas deferens; carries semen to urethra.
- **ii)** _____ surrounds urethra below bladder; secretes _____ that aids sperm motility and survival (helps to **neutralize the acidic environment in the vagina**).
- Prostate gland **enlargement** is common in older men; constricts urethra and makes urination difficult. (Prostate cancer is 3rd largest cancer killer of men.)
- **iii)** _____ (often called _____ Glands) have **mucous secretions** with _____.
- note that the **urethra also carries** _____ from the bladder during urination.

EJACULATION

- a process in which semen is forced from the penis
- sexual arousal can cause an erection, and ejaculation occurs when sexual arousal reaches its peak.
- after sperm enters the ejaculatory duct, the seminal vesicles, prostate gland, and Cowper's gland release their secretions.
- Rhythmical contractions of the ejaculatory duct and urethra expels semen from the penis. This (and accompanying physiological and psychological sensations) is known as male orgasm.
- "Refractory period" is typical time following ejaculation during which erection cannot occur. This time tends to increase as a man ages.

TESTES ALSO PRODUCE HORMONES

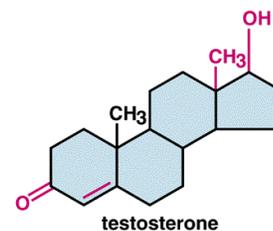
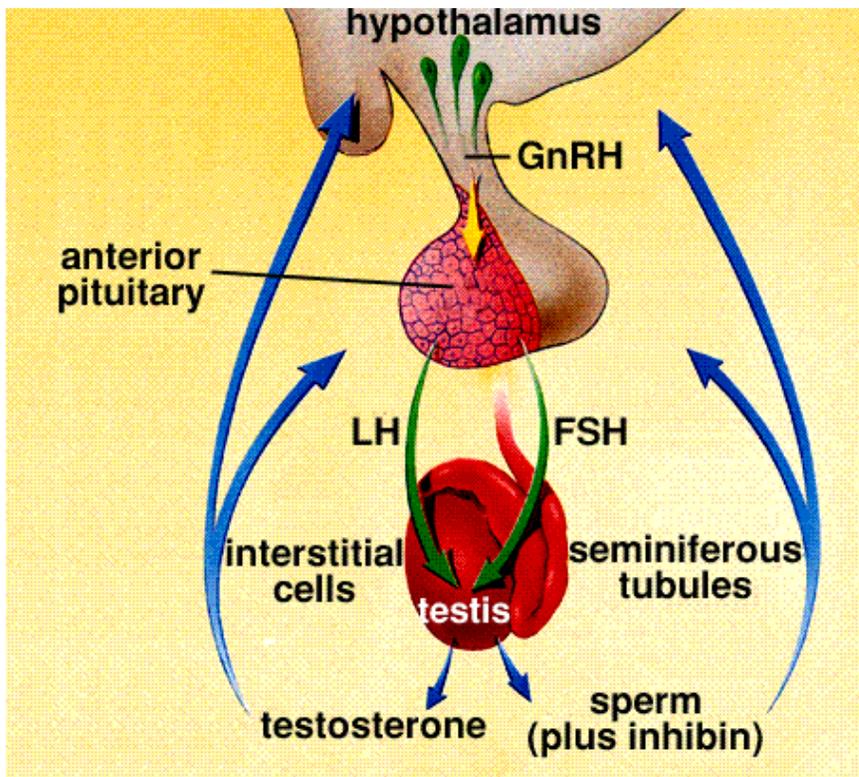
- _____ and _____ **feedback cycles** control the development and maintenance of the male reproductive system. After puberty, a man maintains a relatively constant level of testosterone and sperm production. *Let's look at the feedback loops involved.* There are four hormones involved: _____, _____, _____ (also called _____), and _____.

The Details...

- _____ ultimately controls testes by secreting _____ (_____).
- GnRH triggers _____ to produce two hormones: _____ and _____.
- _____ (_____) is released by the anterior pituitary. _____ 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 _____. 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 _____ and _____**, which in turn reduces the amount of sperm and inhibin being released. This is a classic _____.
- _____ (_____) (called **luteinizing hormone (LH)** in females), _____ **by interstitial cells**. LH thus causes increased testosterone levels in the blood. High levels of LH is detected by the hypothalamus, which then reduces its release of _____ – **another negative feedback loop!**
- Interaction of hormones maintains **fairly constant production** of sperm and testosterone.

TESTOSTERONE is the Male Sex Hormone

- Promotes normal _____ and _____ of _____ of male. (e.g. high levels of testosterone in puberty stimulate the maturation of the penis & testes). Causes _____ during puberty (beard growth, axillary & pubic hair), deepens voice, greater muscle growth)
- Testosterone is necessary for the _____ (_____ **causes spermatogenic cells in testes to take up testosterone** -- testosterone causes these cells to produce sperm).
- Testosterone _____ from **oil** and _____ (contributes to acne and body odor).
- Side effect of _____ (which is also controlled by genetic factors).
- _____ and aggressive behavior is testosterone related.
- _____ is also related to testosterone levels. Indeed, testosterone is administered to people (male or female!) who complain of a low sex drive.
- Since testosterone causes an increase in muscle mass, athletes have used testosterone and other "anabolic steroids" to artificially boost their body's natural male hormone levels. However, anabolic steroids have **serious negative side effects:**



Summary of Male Reproductive System Parts

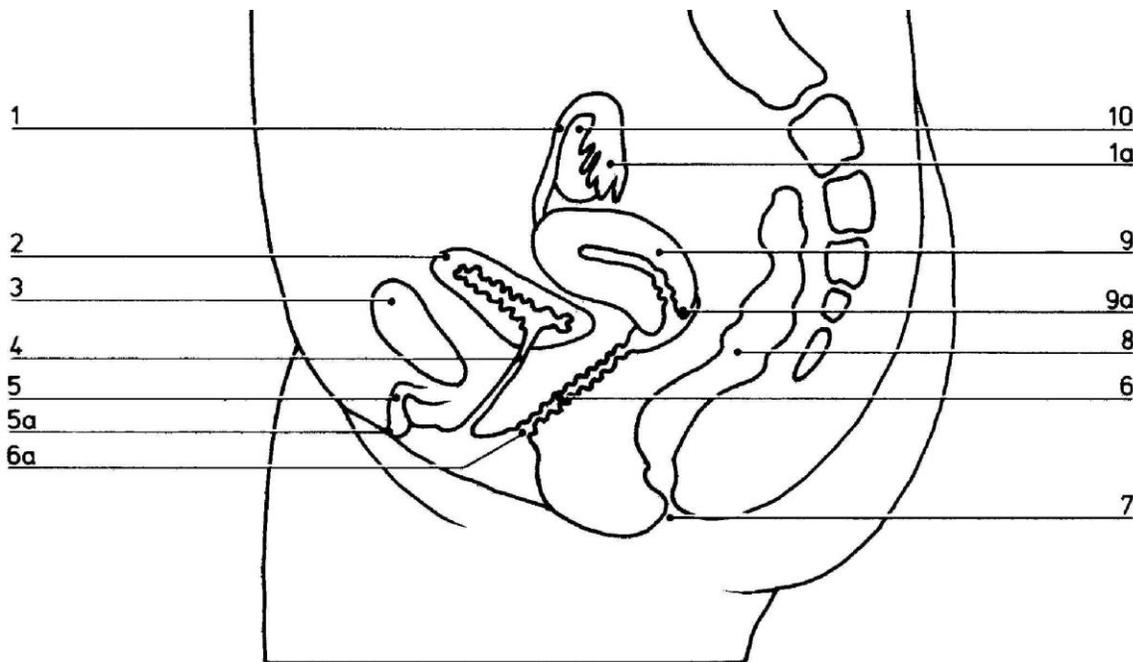
Structure	Function
_____	Produce sperm cells and male sex hormones (i.e. testosterone)
_____	Produce immature sperm cells.
_____	Matures and stores sperm cells in coiled tubules.
_____	Carries sperm from the epididymis to its junction with the urethra.
_____	Secretes fructose into the semen which provides energy for the sperm. Also, secretes prostaglandins that aid in the stimulation of uterine contractions.
_____	Secretes an alkaline buffer into the semen to protect the sperm from the acidic environment of the vagina.
(Bulbourethral glands)	Secretes mucus-rich fluids into the semen that protect the sperm from acids in the urethra
_____	Deposits sperm into the vagina during ejaculation.

You should be able to **trace the path of a sperm cell through all the structures of the male reproductive system.**

FEMALE REPRODUCTIVE SYSTEM

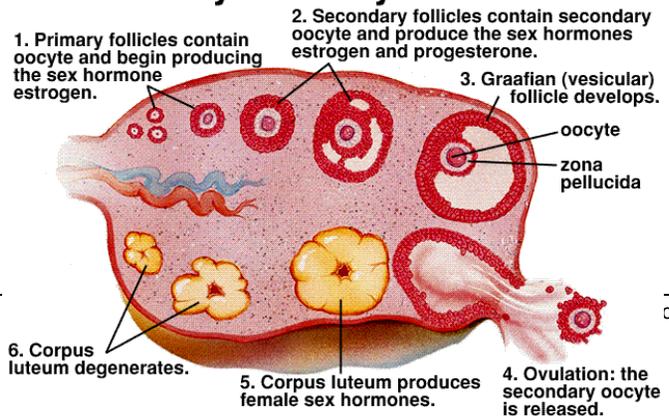
Overview

- The female reproductive system is designed for the production of the female gamete (the ovum) as well as for receiving the male gamete, and for providing a suitable environment for the development of a new human life. Over the course of 28 days each month after puberty, the body of a female undergoes a regular cycle of events, known as the **menstrual cycle**, that accomplishes these goals.

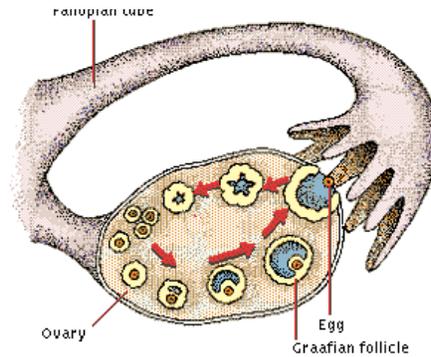


- First, let's review the parts of the female system.
- _____ are two egg-shaped are to each side of uterus in pelvic abdominal cavity. The ovaries **produce eggs** (ova) and the _____ & _____.
- each ovary measures about 3 cm by 1 cm in size. Are held in place by ligaments to oviduct and uterus.
- Each month, an ovary produces an egg that bursts from ovary during *ovulation*. Release of _____ (egg) is called _____.
- Ovaries contain _____ containing _____ plus surrounding _____.

Anatomy of Ovary and Follicle

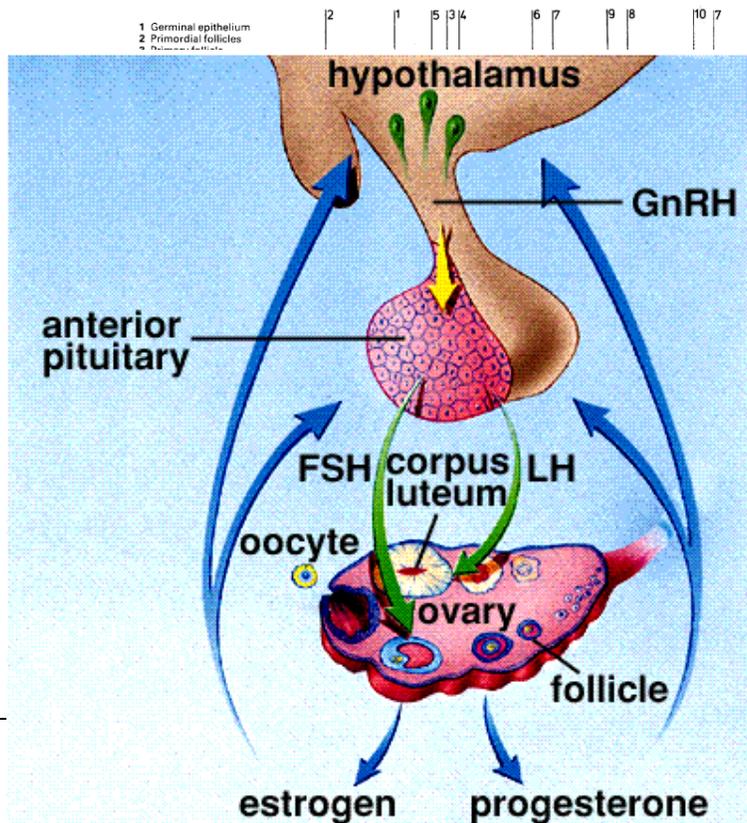


- Female is born with up to **2 million follicles**; reduced to about **350,000 - 400,000** at puberty; _____
_____ at about one egg per month in reproductive life of average woman.
- _____ are tubes to the uterus, and extend from near ovaries into uterus. Oviducts sweep up eggs from ovary using _____ lining and wafting _____ at end of oviducts.
- _____ are fingerlike ends of the oviducts. _____ and _____ lining the oviducts waft the egg toward uterus.
- The **oviducts** _____. They are also the _____. Sperm usually meet and fertilize an ovum in the upper oviduct. **Mark this on your diagram.** ("Tubular pregnancies" occur when embryo implants in oviduct. *Ectopic pregnancy* is any implantation outside central body of uterus).
_____ is **thick-walled muscular, hollow, pear-shaped organ** for nurturing embryo (fetus develops here); opening in cervix leads to vagina.
- The uterus is about the size and shape of inverted, flattened pear. It lies above and slants forward over the bladder. It can stretch from **5 cm wide** to over **30 cm** with growing baby.
- The lining of the uterus is called the _____. The endometrium is composed of connective tissue, glands, and blood vessels. The _____ lines the uterus and, if pregnancy occurs, forms the _____. The endometrium has a *basal layer* and a *functional layer* that varies with the "uterine cycle."
- A "_____" is the name for the surgical removal of the uterus.
- _____ is located at back of vaginal canal. The cervix contains opening to uterus.
_____ is a muscular tube with **mucosa lining**; It makes 45° degree angle with small of back. The vagina serves in intercourse (receives penis during sexual intercourse) and serves as the _____ during childbirth.
- The external genitals are collectively known as the **vulva**. **Mons pubis** is fatty prominence under pubic hair. There are two sets of skin folds called **labia**. Outermost are a pair of fat-padded skin folds called the **labia majora**, which enclose a smaller pair of skin folds called the **labia minora**. The **labia minora** extend from vaginal opening to encircle clitoris at front.
- _____ is an erectile organ, partly enclosed by the labia minora, that is sensitive to stimulation. The clitoris is homologous to the male's penis, and has a shaft of **erectile tissue** capped by a pea-shaped gland. It has many sensory nerve receptors which makes it sexually sensitive and is prominent in the processes of female orgasm.
- The **hymen** is a ring of tissue that may partially close the vaginal opening. If unbroken as a child it is broken by the first sexual intercourse.



FEMALE HORMONES & THE MENSTRUAL CYCLE

- First of all, in order to understand the 28 day menstrual cycle, you need to keep track of what is going on with hormone secretion, the uterus, and the ovaries *simultaneously*. We will look at the cycle from a **locational** point of view by studying the **uterine cycle** and the **ovarian cycle**. We will look at the cycle from a **temporal** point of view (i.e. the timing of events) by keeping track of what happens before ovulation (called the **follicular phase** and what happens after ovulation (called the **luteal phase**).
- You can look at the menstrual cycle like a symphony, with all the players doing their part as part of a highly choreographed "dance" involving hormones and feedback cycles. It's customary to **number the days** of the menstrual cycle, which lasts on average 28 days. **Day 1** is the first day that menstruation starts.



- During menstruation, some of the uterine lining, plus a small amount of blood, is shed. However, menstruation is only one event in the menstrual cycle. Let's look first at the ovarian cycle.
- The menstrual cycle can be divided into _____: the _____ (when a follicle is developing in an ovary), and the _____ (when a follicle has release its egg and is called the corpus luteum).
- In both phases, we need to keep track of hormones, and what is going on in **both** the ovaries and the uterus. **It's quite a production!**

THE FOLLICULAR PHASE: DAYS 1 - 14

The Highlights!

- _____, following by a rebuilding of the uterine lining.
- **Increased levels of female hormones follow menstruation.**
- _____.
- An "_____" causes _____ on day _____.

The Details!

- In the uterus between **days 1 and 5**, the **low levels of female hormones** (estrogen, progesterone, FSH, LH, GnRH) **cause** _____. In menstruation, part of the **lining of the uterus**, plus a small amount of blood, is released through the vagina. The lining of the uterus (also called the _____) is at its **thinnest** at this point.
- While this is going on, the female reproductive system is getting ready to repeat the whole cycle once more. The **low levels of female hormones is detected by the** _____, causing it to _____. GnRH is sent to the _____. Remember that GnRH acts on the anterior pituitary gland, making it _____.
- During **days 6 to 13**, we see _____. Follow along carefully, because FSH and LH cause different things to happen!
- _____ in the **ovary**, so as the anterior pituitary gland releases increasing amounts of FSH, this makes _____.
- **Follicles produce the hormone** _____, so as the follicle matures and gets bigger, it makes **more and more estrogen**.
- There is a _____ involving _____, _____ and _____. As estrogen levels rise, this causes the release of _____, which causes the release of _____. This is going on between about **days 7 to 13**. Finally, **high levels of estrogen** cause the hypothalamus to **release a large amount of GnRH**, which cause the release of a _____ from the pituitary on day 13. This so-called "_____" _____ on **day** _____. In ovulation, the mature _____, **releasing the egg** from the ovary. The follicle cells stay behind. These remaining follicle cells are called the _____.
- Meanwhile, the **high levels of estrogen** _____ **cause** _____ on the pituitary to **reduce the release of** _____, ending the follicular phase.
- In the **ovary**, the **rising levels of estrogen** during days 6 - 13 make the **uterus lining** get _____. There is a **proliferation** in the _____ in the lining during days 6 -13. That's why, in the uterine cycle, this is called the "_____."

THE LUTEAL PHASE: DAYS 15 - 28

The Highlights!

- _____ predominates. It is released by _____
- Progesterone makes the endometrium _____ and _____
- Around about day 25, negative feedback by progesterone on LH causes _____, which in turn reduces secretions of progesterone and female hormones, which in turn causes endometrium lining to start to degenerate by about day 28.
- As luteal phase ends, menstruation begins, and we're back to day 1.

The Details!

- The _____ (the cells left over from the follicle after the egg has been released) produces **increasing amounts of progesterone** (and some estrogen). It is **progesterone that predominates** in the luteal phase.
- Progesterone makes the endometrium get **thicker**. It will _____. As the uterine lining is thickening, those _____ we mentioned earlier have **matured**, and -----

_____ That's why this part of the uterine cycle is called the

"_____".

- **Progesterone levels** are controlled by a _____. When progesterone levels reach their highest levels, **negative feedback to the anterior pituitary gland** causes the anterior pituitary gland to _____. This happens at around the day 24 or 25 stage.
- Since the **corpus luteum requires high levels of LH** to maintain itself, _____, the _____.
- Since it is the corpus luteum that makes progesterone (it also is producing estrogen), as the corpus luteum degenerates, it _____ (and estrogen).
- Without high levels of progesterone, the _____. It will therefore _____ by about **day 28**, and _____ on day 1.
- *The whole cycle will continue to repeat itself until pregnancy occurs or the woman goes through menopause. And now, for a one page summary!*

Follicular Phase

The Ovarian Cycle	The Uterine Cycle
<ul style="list-style-type: none"> • Low levels of female hormones in blood from days 1 - 5. 	<ul style="list-style-type: none"> • Low levels of female hormones causes Menstruation (days 1-5) - endometrium breaks down
<ul style="list-style-type: none"> • FSH levels increase from days during days 6 - 13. • This causes a follicle to mature. As follicle matures, it makes more and more estrogen, so estrogen levels rise. • High levels of estrogen in blood causes hypothalamus to secrete a large amount of GnRH, which leads to a LH surge at day 13 which causes ovulation at day 14. • Negative feedback by estrogen on FSH ends follicular phase. 	<ul style="list-style-type: none"> • Days 6 - 13: the rising levels of estrogen make the endometrium thicken and become vascular & glandular (=proliferative phase). • the endometrium rebuilds itself.
<ul style="list-style-type: none"> • (days 15 - 28) Corpus Luteum makes increasing amounts of progesterone (and some estrogen). • High progesterone causes negative feedback control 	<ul style="list-style-type: none"> • (days 15 - 28) Progesterone makes endometrium double in thickness. • Uterine glands mature and release thick mucoid

Proliferative Phase

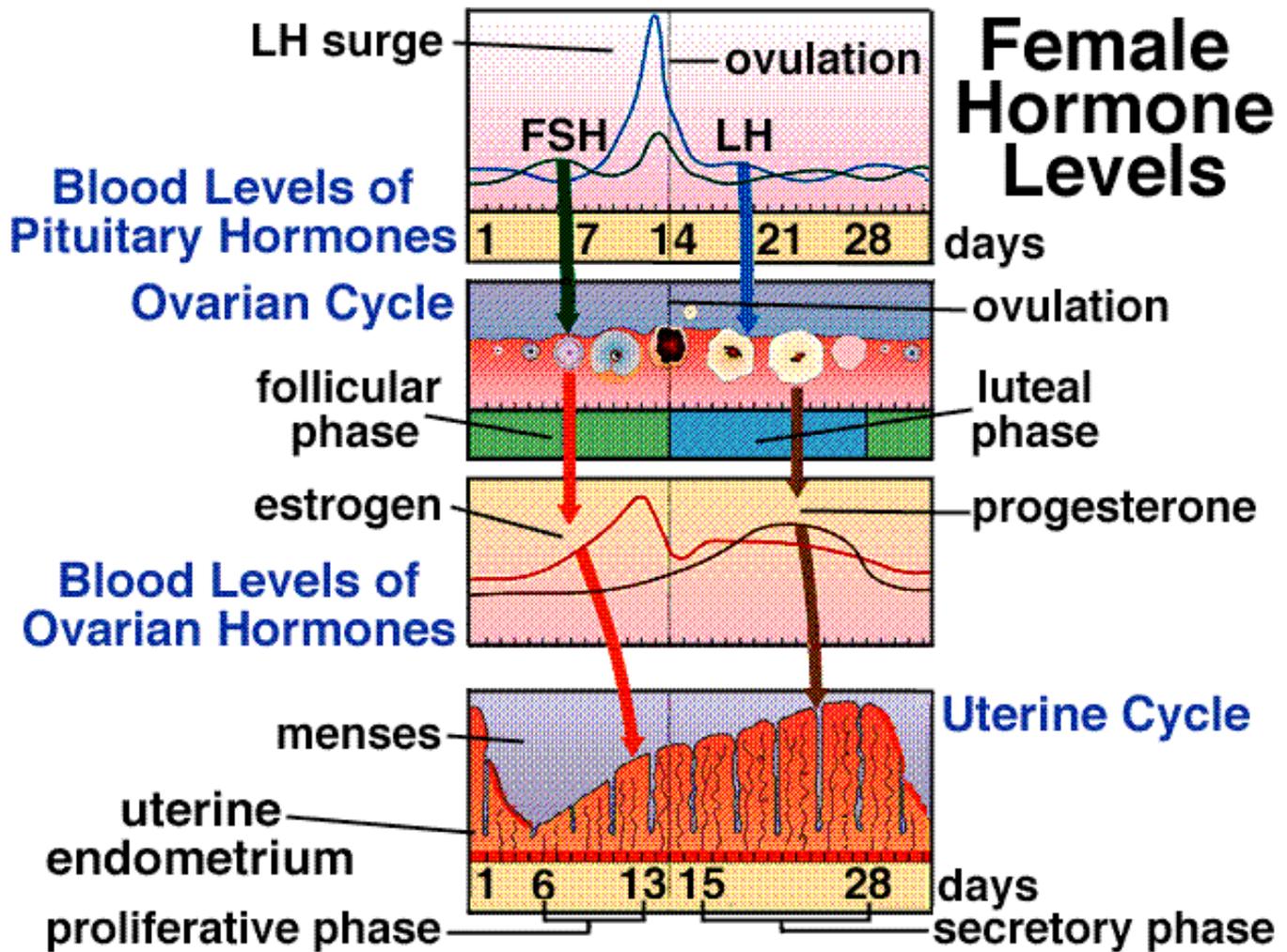
Secretory Phase

over anterior pituitary secretions of **LH**, causing **corpus luteum to degenerate**.

- *As luteal phase ends, menstruation occurs.*

secretions.

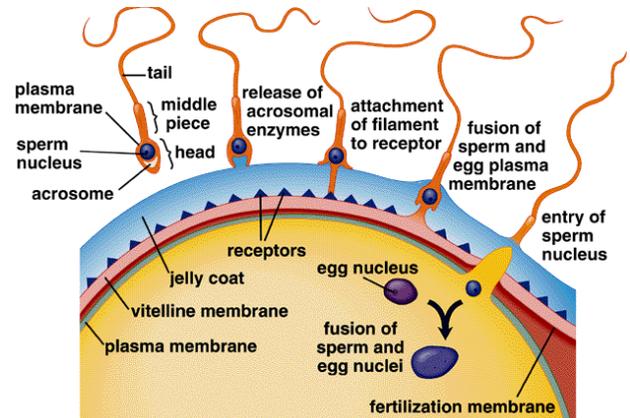
- As corpus luteum degenerates, **progesterone secretion decreases**. This causes **menstruation to occur again**.



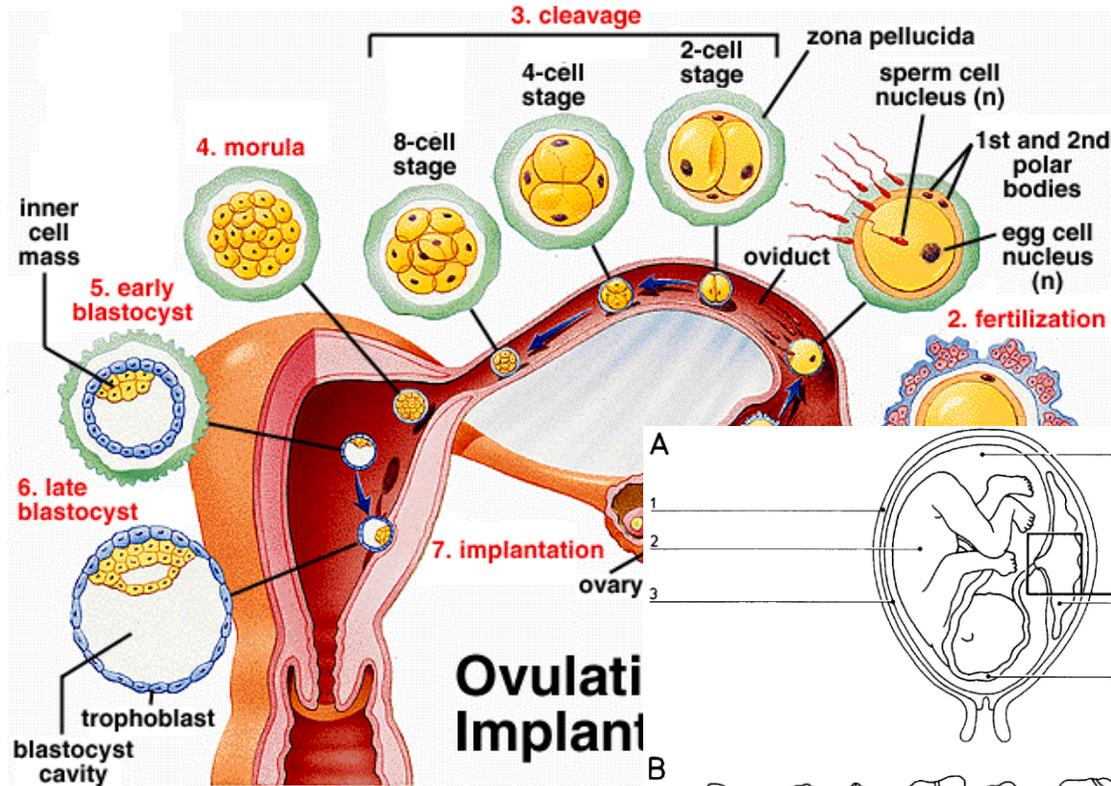
- _____; _____ cause _____ to _____, blood vessels (**menses**) rupture and flow out of vagina during _____.
- _____; endometrium becomes **thicker** and more **vascular** due to _____; called *proliferative phase*.
- _____ usually occurs on _____ of 28-day cycle.
- _____; **endometrium doubles in thickness**, **uterine glands mature** and **secrete mucus** due to **production of progesterone** by **corpus luteum**; readies uterus to receive developing embryo.
- If not pregnant, **corpus luteum degenerates**; lower **hormone levels** cause **uterine lining to break down**.

Fertilization

- While several hundred sperm might make it to the egg, only one will fertilize the egg.
- The **acrosome releases its enzymes** which break through the outer layer of the egg. The 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**. The new individual at this point is called a **zygote**.



PREGNANCY Follows Fertilization

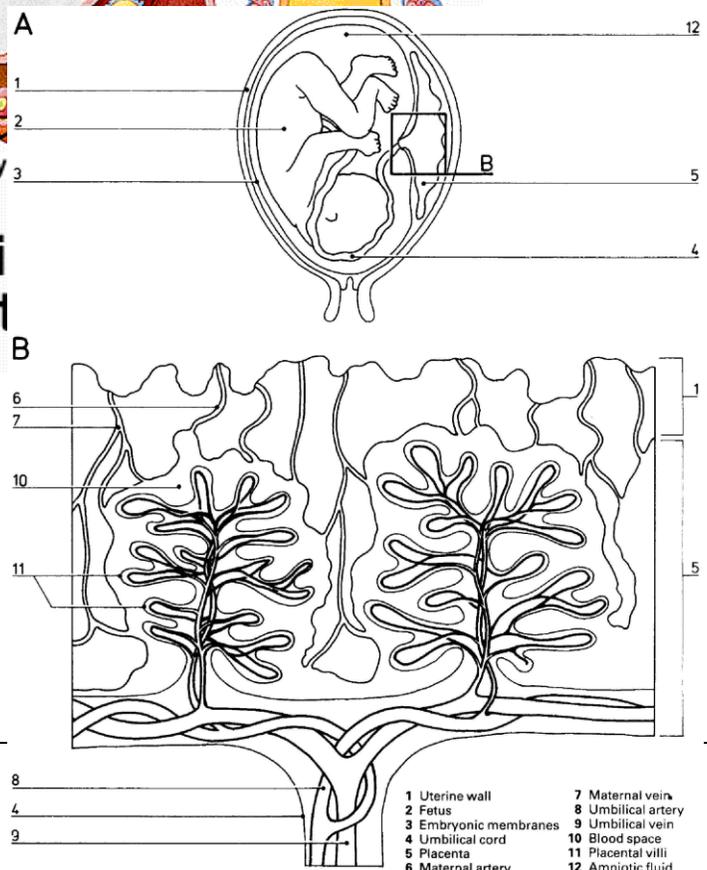


Ovulation and Implantation

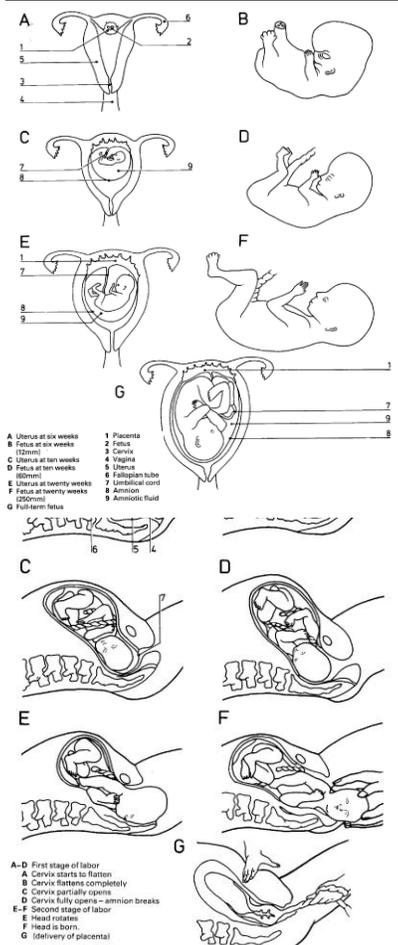
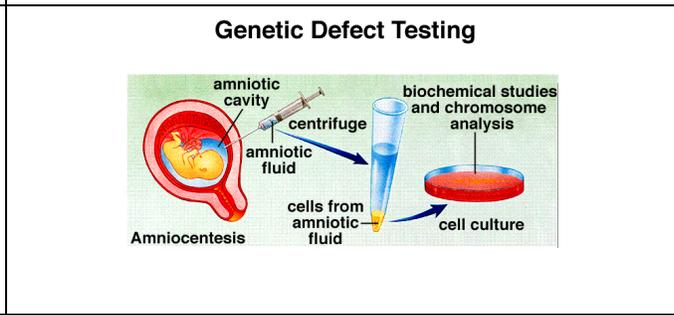
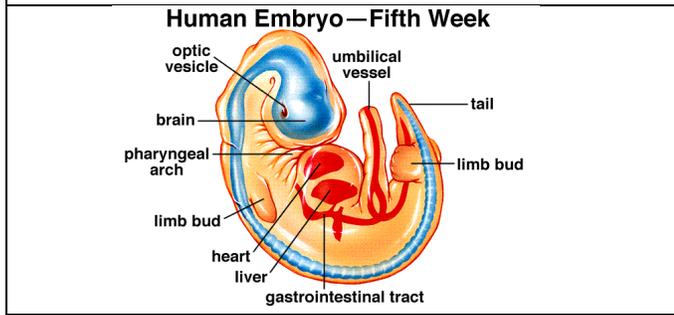
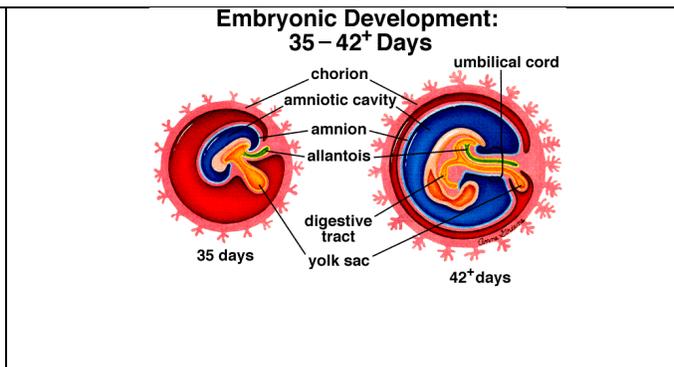
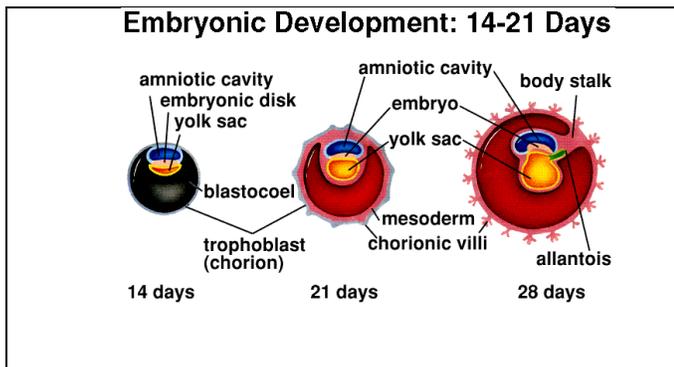
- Fertilized egg develops as it travels down oviduct to uterus.
- Embryo embeds in endometrial lining (implantation) several days after fertilization.

If Implantation Occurs...

- **Implantation** (embryo embedding itself into the endometrium) occurs within a few days of fertilization. Since the developing offspring needs to grow in the uterus undisturbed, the usual menstrual cycle must be interrupted for 9 months.

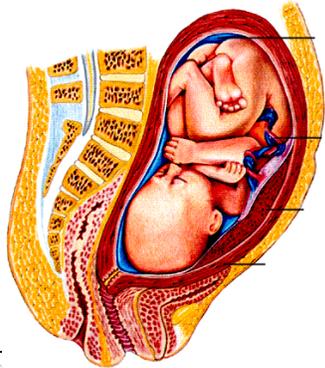
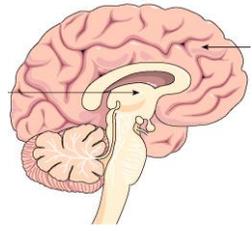


- Placenta forms from both maternal and fetal tissues: provides exchange of molecules between fetal and maternal blood.
- Placenta produces _____ (_____), which **temporarily** _____.
- As placenta develops, it begins to _____.
- Progesterone and estrogen do two things:
 - a) **shut down the release of _____ & _____ from the anterior pituitary** (so that *no new follicles mature*)
 - b) **maintain the lining of the uterus** so that the corpus luteum is not needed.
- There is, of course, _____.



Labour and Childbirth

- Fetus rotates with head pointed toward cervix.
- If not in position, breech birth (*rump 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 _____ involves **contractions** lasting over 40 seconds occurring every 15 - 20 minutes.
- Trigger of childbirth involves **prostaglandins** and _____ (though we don't have all the details worked out yet) from mother's pituitary; both hormones can **induce birth**.
- Oxytocin is _____ and _____. It causes the uterus to contract and is used to artificially induce labour. It also **stimulates the release of milk** from the mammary glands for nursing. Oxytocin involves a _____.
- Just before birth, the growing baby's head exerts pressure against the cervix. This pressure triggers sensory nerves in the cervix to send a nerve signal

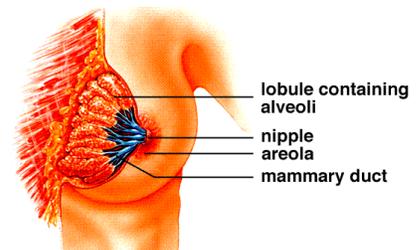


to the posterior pituitary to release oxytocin. The oxytocin is released into the blood. When it gets to the uterus, it causes **stronger** uterine contractions, which causes greater stimulation of the sensory nerves, which causes more oxytocin to be released, which causes stronger uterine contractions, and so on. The cycle ends when the baby is pushed out of the uterus, stopping the stimulation of sensory nerves to the pituitary.

- Oxytocin also stimulates the mammary glands to produce milk.
 - Childbirth (called _____) includes labor and expulsion of fetus; involves three stages:
 - **Stage 1:** _____; mucus plug from cervical canal is expelled; amniotic membrane ruptures to release _____ (i.e. "water" breaks); stage ends when cervix is fully dilated.
 - **Stage 2:** _____ from 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:** _____ from uterus about 15 minutes after delivery of baby.

Estrogen and Progesterone: Female Sex Hormones

- At puberty, **estrogen stimulates the growth of the uterus and vagina** and is **necessary for egg maturation**. Estrogen also **causes and maintains _____ at puberty:**
 - Growth of **body, underarm, and pubic hair** in female pattern.
 - Stimulates **fat deposit** under skin for more rounded body.
 - Stimulates **wider pelvic development** and female proportions.
 - **Stimulates breast development.**
- **Breasts Produce Milk** Breasts contains one to two dozen **lobules**, each with many **mammary ducts** that end in blind sacs called **alveoli**.
- **Areola** (pigmented area of nipple) lacks hair and sweat glands but has saliva-resistant lubricant.
- **Prolactin** hormone stimulates alveoli to produce milk; feedback inhibition suppresses milk production during pregnancy.
- During couple of days after childbirth and before milk production is underway, a watery, yellowish- white fluid termed **colostrum** is secreted; contains more protein, less fat.



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 _____.
- Birth control methods have **variable effectiveness**. The table below summarizes current birth control methods, risks and effectiveness.

Name	Procedure	Methodology	Effectiveness	Risk
Abstinence	Refrain from sexual intercourse	No sperm in vagina	100%	None
Vasectomy	Vasa deferentia are cut and tied	No sperm in seminal fluid	almost 100%	Irreversible sterility
Tubal ligation	Oviducts are cut and tied	No eggs in oviduct	Almost 100%	Irreversible sterility
Oral Contraception	Hormone medication is taken daily	Anterior pituitary does not release FSH and LH	Almost 100%	Thromboembolism, especially in smokers
Depo-Provera injection	Four injections of progesterone-like steroid are given per year	Anterior pituitary does not release FSH and LH	About 99%	Breast Cancer? Osteoporosis?
Contraceptive implants	Six tubes of progestin (form of progesterone) are implanted under skin.	Anterior pituitary does not release FSH and LH	> 90%	Presently none known
Intrauterine Device (IUD)	Plastic coil is inserted into uterus by physician	Prevents implantation	> 90%	Infection (Pelvic Inflammatory disease, PID)
Diaphragm	Latex cup is inserted into vagina to cover cervix before intercourse	Blocks entrance of sperm to uterus.	With jelly, about 90%	Presently none known
Cervical Cap	Latex cap is held by suction over cervix	Barrier method, delivers spermicide near cervix	Almost 85%	Cancer of cervix?
Male Condom	Latex sheath is fitted over erect penis	Traps sperm and prevents STD's	About 85%	Presently none known
Female Condom	Polyurethane tubing is fitted inside vagina	Blocks entrance of sperm to uterus and prevents STD's	About 85%	Presently none known
Coitus interruptus	Male withdraws penis before ejaculation	Prevents sperm from entering vagina	75%	Presently none known
Jellies, creams, foams	Spermicidal products which are inserted before intercourse	Kills a large number of sperm	about 75%	Presently none known
Natural family planning	Day of ovulation is determined by record keeping: various methods of testing	Intercourse avoided on certain days of the month.	About 70%	Presently none known
Douche	Vagina and uterus are cleansed after intercourse	Washes out sperm	Less than 70%	Presently none known