# Anatomy Notes Unit 6: Male and Female Reproductive Systems

The reproductive system allows for the reproduction of ourselves. It requires the union of the male sperm cell and the female egg cell. When these two cells unite to form **a fertilized egg cell**, also called a **zygote**, the process of reproduction begins.

## Overview of the Reproductive System

For both the male and female reproductive systems the **gonads** are the **primary reproductive structure**. Gonads are the **testes** (testicles) for men and the **ovaries** for women, see below.

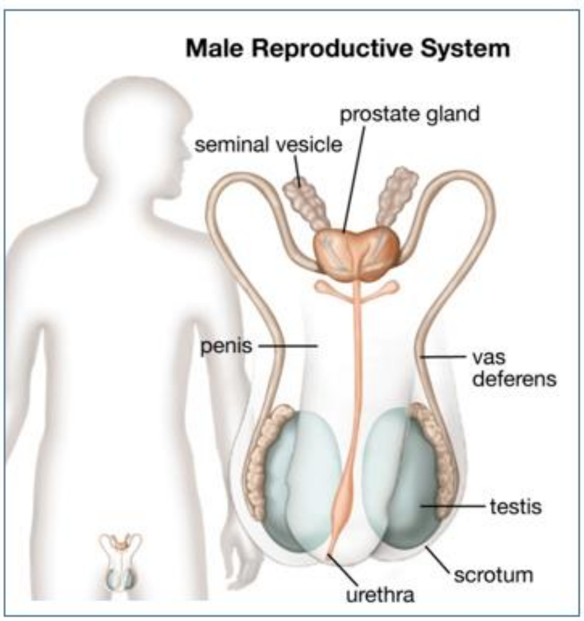
Both the male and female reproductive systems have these basic functions:

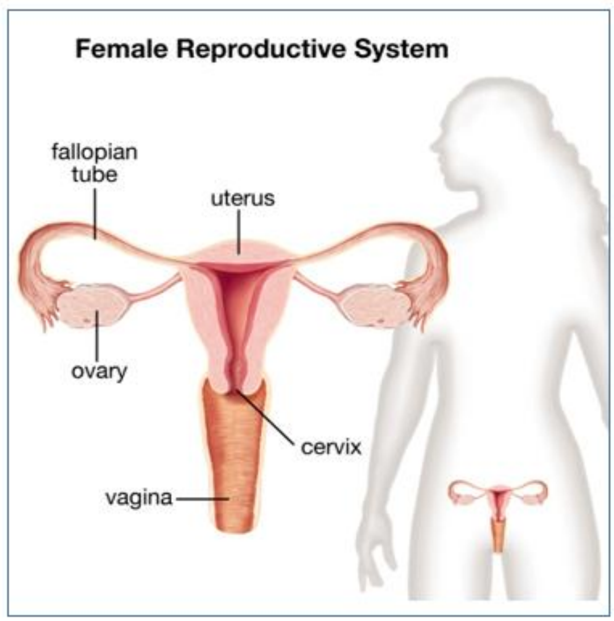
1) The **gonads** (ovaries and testes) produce the **gametes**, which are the sex cells (egg and sperm cells).
2) The gonads also produce the **sex hormones**, which support and assist with reproductive activity of the gametes and secondary sexual characteristics.
3) To develop, sustain and transport the sex cells these through the reproductive tract.
4) To nurture the developing offspring.

Gonads create two important things:

**1) Gametes**. These are the sex cells. They are the **sperm cell** or **spermatozoa** for males, and the egg cell, also called the mature **ovum** or the **primary ova** for females.

**2) Sex Hormones**. The male sex hormones are collectively referred to as **androgens**, principally they consist of **testosterone**, and some androstenedione. There are also other hormones but they are present in much lesser amounts. The female hormones consist of two principal groups: the **estrogens**, which are estradiol (E2) and estriol (E3), and **progesterone**. Females also have testosterone, but very small amounts.




**Functions of the Reproductive System**

The reproductive systems for males and females are for the production, storage, nourishment and transport of functional **gametes** made by the **gonads**. First, we will examine the primary reproductive structure, the gonads, for males and females, and describe the functions of the ducts and tracts of the reproductive systems that the gametes travel through. We will also discuss the **accessory organs** and **glands** of the reproductive systems that create the fluids and deliver the gametes to the external environment. The male and female **external genitalia** and other **secondary sexual characteristics** will be detailed.

The number of chromosomes in gametes (egg or sperm cells) is **haploid**, which means they contain only 23 chromosomes, or **half** of the 46 chromosomes that all other soma (body) cells have. This is because when the egg and sperm cells unite at conception, half of the chromosomes will be provided by the mother and the other half by the father to create the full **diploid** complement of 23 pairs (46) of chromosomes for the new, genetically unique individual being created!

These notes will cover the male reproductive system, which includes the **testes** (produce sperm), epididymis, vas deferens, ejaculatory ducts, urethra and penis. The female reproductive system consists of the **ovaries** (produce eggs or oocytes), fallopian tubes, uterus, cervix, vagina and vulva.

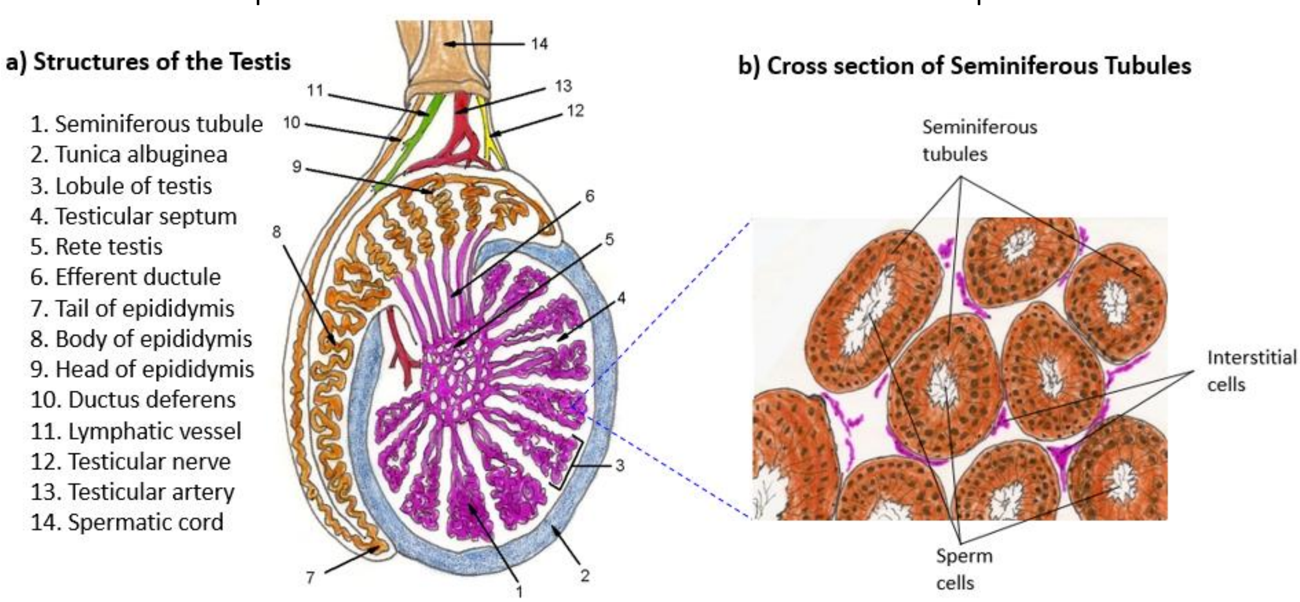
## The Male Reproductive System

The primary function of the male reproductive system is to produce **sperm cells** and **sex hormones**, and to transport semen, which contains millions of sperm cells, into the female reproductive tract. The approach of this discussion of the reproductive systems for both sexes will be to focus on the formation and journey of the **gametes**; from their starting point in the gonads, to their journey and expulsion from the body, and ultimately to their union at conception.

### The Testes

The male gonads are a pair of **testes** (singular = testis) housed in the **scrotum**, a bag-like structure to hold the testes outside of the body cavity, providing optimal thermoregulation of the testes. They produce both sperm cells and the androgen sex hormones (such as testosterone) and are active throughout the reproductive lifespan of the male.

As seen below, the lobules of the testes are created by tightly coiled **seminiferous tubules** that make up most of the testicle. This is where **spermatogenesis** occurs, that is, the origin and development of the sperm cells which are produced within the walls of the seminiferous tubules. Sperm exits the seminiferous



tubules into the rete testis, and via the efferent (leaving) ductule, both located at the hilum (opening and exit) of the testicle, allow the developing sperm cells to flow into the epididymis. The **epididymis** is an extremely coiled tube that sits on top and behind each testis, it's about 20 feet in length but takes up little very space. Sperm cells takes an average of about **two weeks** to travel through the epididymis, from the head region down the body and to the tail of the epididymis (see above). It can take longer (20 days) or occur very quickly (2 days), but the average is from **10** to **14** days. The sperm cells continue to mature and acquire mobility as they navigate the twisting and turning 20 feet of the epididymis. Any malformed sperm cells are culled (removed) in this region.

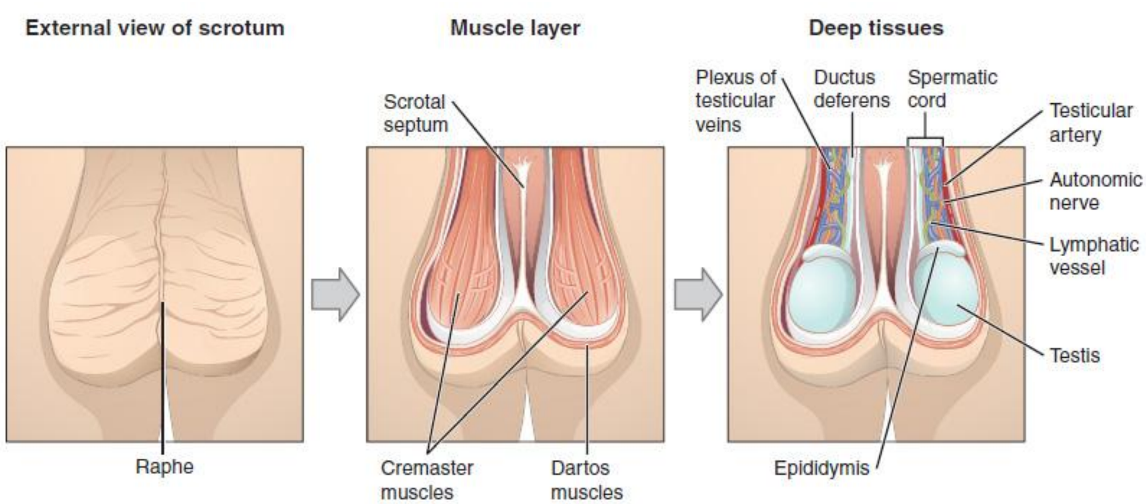
Once sperm cells have completed their development, they remain in the epididymis in readiness for deployment into the ductus deferens for the final leg of the journey. If the sperm is not ejaculated (released), the epididymis eventually breaks down and reabsorbs them.

During ejaculation, the smooth muscle in the walls of the epididymis contract and the sperm are pushed out of the tail of the epididymis into the **ductus deferens** (vas deferens). This thick, muscular tube also contracts as it travels through the spermatic cord which leads back into the body from the testes to connect with the three accessory glands that create the seminal fluid (described below). Once deposited inside the female reproductive tract, the sperm cells can move independently toward the unfertilized egg.

**Sperm Production Needs to keep Cool!**

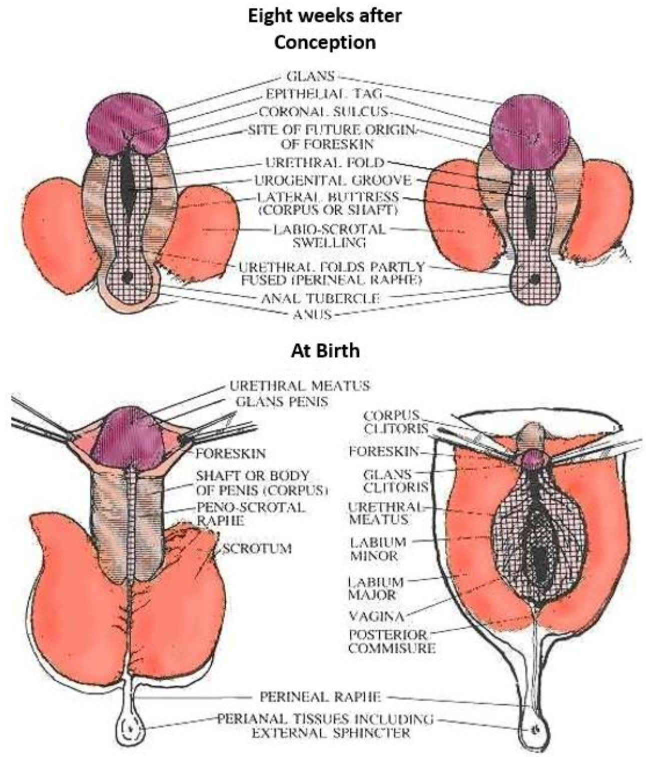
There is a reason the testes are kept outside of the body cavity, this is because sperm production occurs more efficiently when the surrounding temperature is about **3** to **5°F** cooler than core body temperature. This is why testes sit in the **scrotum**, which is an outside bag for each testicle. The skin of the scrotum contains the subcutaneous **dartos muscle** which gives the scrotum their wrinkled appearance. The dartos muscle contracts and relaxes automatically to alter its surface area in response to temperature changes. In this way it helps to constantly regulate the temperature inside the scrotum to ensure they remain cooler. See below for the arrangement within the scrotum.

Another thermoregulation safeguard for the testes are the two **cremaster muscles** which descending from the abdominal muscles and encircle each testis like a muscular suspender. In fact, the word cremaster means 'suspender'. In cold weather (or water), the cremaster muscles contract and elevate the testes closer to the body to retain heat.  If the temperature increases, the cremaster muscles relax and drop the testes further away from the body to allowing for heat loss. The cremaster muscle also protects the testes from extrinsic trauma, as they act as a type of slender muscular shield.



## Testosterone

The predominant male sex hormone is **testosterone**, a steroid hormone derived from **cholesterol** and produced by the **interstitial cells**, which are located in between the seminiferous tubules of the testes (see page 2). The word *interstitial* means in between. These are also called the **cells of Leydig**, or can be called the **interstitial cells of Leydig** as a happy mixture between an eponym (named after a person) and a descriptive name (describing the function or location) of a structure.




During embryological development it is by the seventh week of development in the male that testosterone is secreted by the interstitial cells of Leydig, with concentrations peaking in the second trimester. This critical release of testosterone at this developmental stage denotes the start of the **anatomical** and **physiological differentiation** of the male and female sexual organs (see right) and much more.

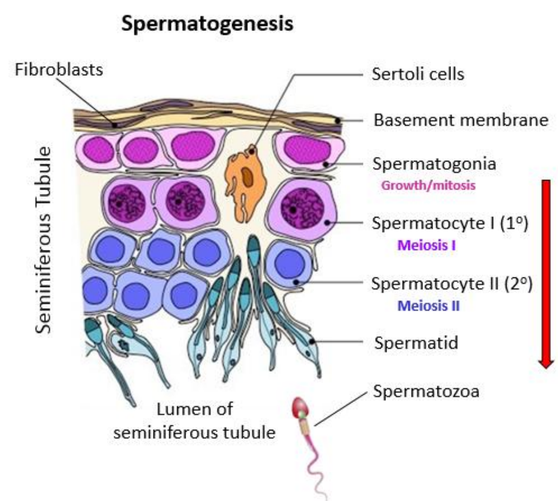
Testosterone concentrations are low until male puberty hits, when it dramatically increases. This activates the physical changes promoting the secondary sexual characteristics, and also initiates spermatogenesis.

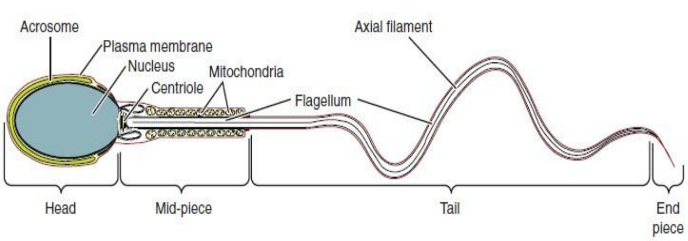
## Spermatogenesis

Spermatogenesis is the process of the production of sperms from the immature male germ cells and this begins at puberty and continues throughout a man's life.

### Cell Types in Seminiferous Tubules

Inside the seminiferous tubules there is stratified epithelium that lines the lumen and there are two distinct populations of cells there: **1) spermatogenic cells** that develop into spermatozoa; and **2) Sertoli cells** which are support cells that provide nutrients for the developing perm cells. These distinctions can be nicely seen in image at right which depicts spermatogenesis. Note the mature sperm cell below.



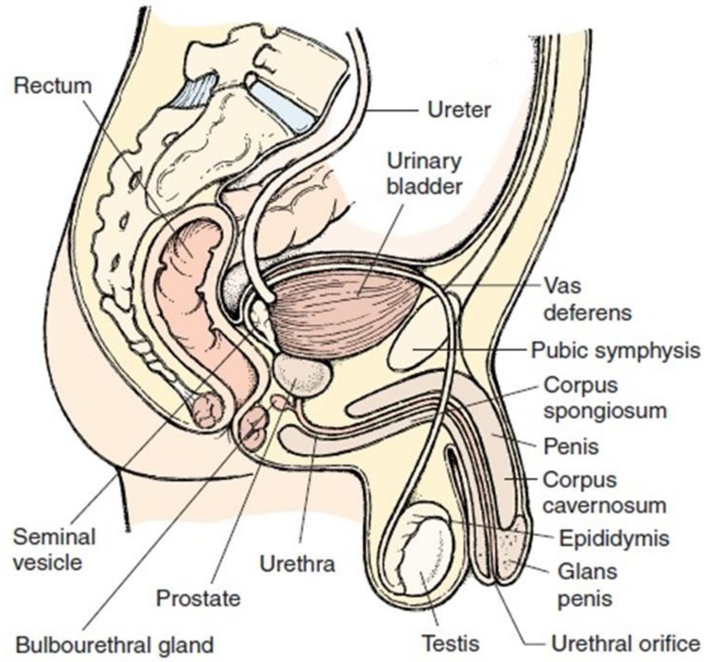




## The Accessory Structures and Semen

Until this point we have only discussed the development of sperm cells, but sperm requires a mixture of substances to join it in its journey outside of the body. Sperm only make ups about 5%t of the total volume of **semen** - the thick, opaque fluid that the male ejaculates. The vast majority of semen is produced by three accessory glands of the male reproductive system, they are: **1)** the seminal vesicles, **2)** the prostate, and **3)** the bulbourethral glands.

**1) Seminal Vesicles**

We described sperm cells going back into the body cavity via the ductus or vas deference (within the spermatic cord through the inguinal canal). The sperm cells are now ready to connect with the accessory structures that are within the pelvic cavity. The sperm cells enter the dilated ampulla of the two ductus deferens (one form each testicle) during ejaculation where they mix with fluid from the paired **seminal vesicles**. The paired seminal vesicles are glands that make up about **60%** of the total semen volume.




The seminal vesicle fluid contains large amounts of the simple sugar **fructose**, used by the sperm mitochondria to generate ATP to propel their flagella promoting movement through the female reproductive tract. This fluid also contains proteins, enzymes, mucus, citric acid, fibrinogen and prostaglandins.

The **fibrinogen** facilitates **seminal clotting** after ejaculation, this helps to keep the ejaculated sperms in the female reproductive tract. **Prostaglandins** may assist by softening mucous of the cervix, and by causing reverse contractions of parts of the female reproductive tract such as the fallopian tubes, to ensure that sperm are less likely to be expelled. All of these elements help support sperm until fertilization occurs. The fluid, now containing both sperm and seminal vesicle fluid continues to move forward into the paired **ejaculatory ducts** just beyond the ampulla and transport the seminal fluid into the prostate gland.

**2) Prostate Gland**

The single **prostate gland** sits adjacent to the rectum, above the anal canal and at the base of the bladder (see above). The prostate gland is about the size of a walnut, and is both glandular and muscular tissue. It contributes about **30%** of the total volume of semen and it surrounds the prostatic urethra (which also carries urine through the prostate). The constituents of its secretions are mainly citric acid, ions and **fibrolysin**, an enzyme that dissolves the clot in semen produced by the fibrinogen contributed by the seminal vesicles. It is critical to first **coagulate** and then **de-coagulate** the semen following ejaculation.

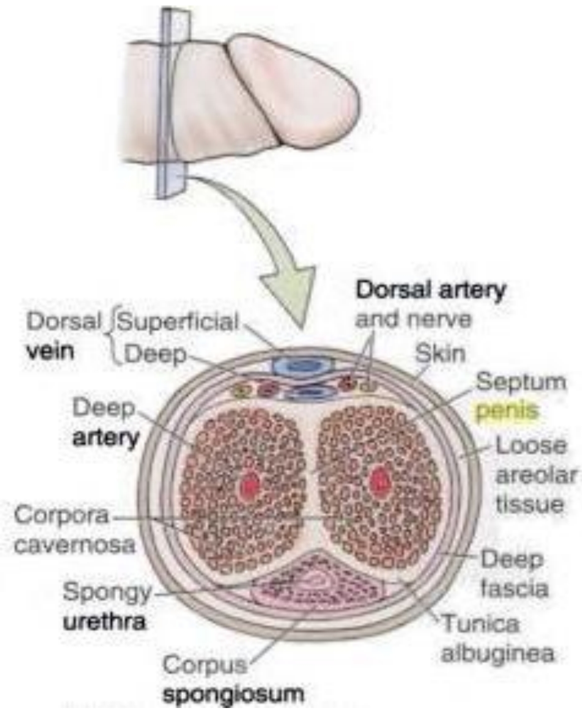
The temporary thickening of semen helps retain it within the female reproductive tract, providing time for sperm to utilize the fructose provided by seminal vesicle secretions. When the semen regains its fluid state, sperm can then pass farther into the female reproductive tract. The prostate also excretes an alkaline (basic) fluid into semen that acts to neutralize the acidic conditions (pH 3.8 to 4.5) in the vaginal canal.

**3) Bulbourethral Glands**

The final contribution to semen is made by the very tiny paired **bulbourethral** (**Cowper's**) **glands** (see above). These glands release a thick, salty mucus alkaline fluid that lubricates the end of the urethra, the glans penis and the vagina, and helps to clear out any residual acidic urine from the penile urethra. This fluid usually represents about **5%** of the total volume of semen. The fluid from the bulbourethral gland is released after the male becomes sexually aroused, and shortly prior to the release of the semen. It is therefore sometimes called pre-ejaculate.

## The Penis

The **penis** is the male organ of copulation (sexual intercourse). It is flaccid for non-sexual actions, such as urination, and turgid (rod-like) with sexual arousal. When erect, the stiffness of the organ allows it to penetrate into the vagina and deposit semen into the female reproductive tract.

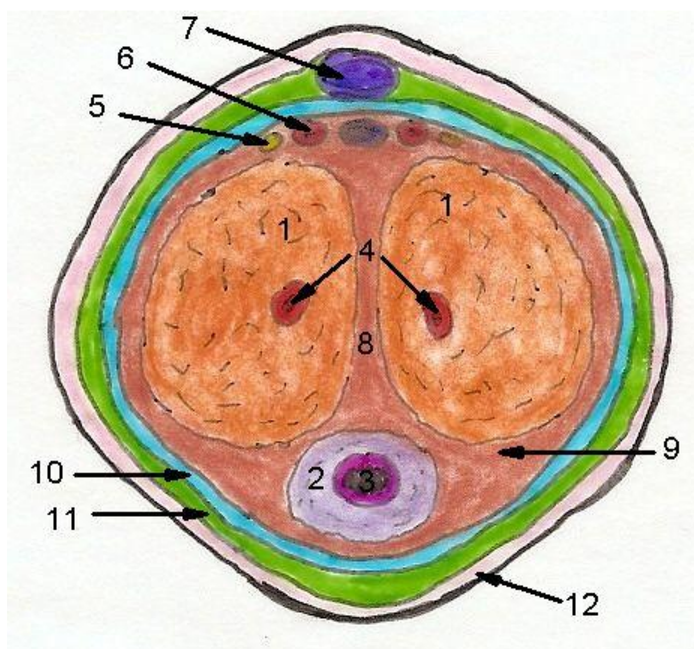



The shaft of the penis surrounds the urethra. The shaft is composed of three column-like chambers of erectile tissue that span the length of the shaft. Each of the two larger lateral chambers is called a **corpus cavernosum** (plural = corpora cavernosa). Together, these make up the bulk of the penis. The **corpus spongiosum**, which can be felt as a raised ridge on the erect penis, is a smaller chamber that surrounds the spongy, or **penile urethra**.

The end of the penis, called the **glans penis**, has a high concentration of nerve endings, resulting in very sensitive skin that influences the likelihood of ejaculation. The skin from the shaft extends down over the glans and forms a collar called the **prepuce** (or **foreskin**). The foreskin also contains a dense concentration of nerve endings, and both lubricate and protect the sensitive skin of the glans penis. A surgical procedure called circumcision, often performed for religious or social reasons, removes the prepuce, typically within days of birth. That process is extremely painful and has no role in protection or health.

**Structures**

1 Corpora cavernosa
2 Corpus spongiosum
3 Penile urethra
4 Deep artery
5 Doral nerve
6 Doral artery
7 Superficial dorsal vein
8 Septum of penis
9 Tunica albuginea
10 Deep fascia
11 Loose areolar CT
12 Skin of penis



## Glossary of Terms for Male Reproductive System

**Blood-testis barrier:** tight junctions between Sertoli cells that prevent bloodborne pathogens from gaining access to later stages of spermatogenesis and prevent the potential for an autoimmune reaction to haploid sperm.

**Bulbourethral glands:** (also, Cowper's glands) glands that secrete a lubricating mucus that cleans and lubricates the urethra prior to and during ejaculation.

**Corpus cavernosum:** either of two columns of erectile tissue in the penis that fill with blood during an erection.

**Corpus spongiosum:** (plural = corpora cavernosa) column of erectile tissue in the penis that fills with blood during an erection and surrounds the penile urethra on the ventral portion of the penis

**Ductus deferens:** (also, vas deferens) duct that transports sperm from the epididymis through the spermatic cord and into the ejaculatory duct; also referred as the vas deferens.

**Ejaculatory duct:** duct that connects the ampulla of the ductus deferens with the duct of the seminal vesicle at the prostatic urethra.

**Epididymis:** (plural = epididymides) coiled tubular structure in which sperm start to mature and are stored until ejaculation.

**Gamete:** haploid reproductive cell that contributes genetic material to form an offspring.

**Glans penis:** bulbous end of the penis that contains a large number of nerve endings.

**Gonadotropin-releasing hormone (gnrh):** hormone released by the hypothalamus that regulates the production of follicle-stimulating hormone and luteinizing hormone from the pituitary gland.

**Gonads:** reproductive organs (testes in men and ovaries in women) that produce gametes and reproductive hormones.

**Inguinal canal:** opening in abdominal wall that connects the testes to the abdominal cavity.

**Leydig cells:** also called interstitial cells, as they are located between the seminiferous tubules of the testes, and produce testosterone.

**Penis:** male organ of copulation, contains erectile tissues.

**Prepuce:** (also, foreskin) flap of skin that forms a collar around, and thus protects and lubricates, the glans penis; also referred as the foreskin.

**Prostate gland:** walnut-shaped gland at the base of the bladder surrounding the urethra and contributing fluid to semen during ejaculation.

**Scrotum:** pouch of skin and muscle that houses the testes, located external to the abdominal cavity.

**Semen:** ejaculatory fluid composed of sperm and secretions from the seminal vesicles, prostate, and bulbourethral glands.

**Seminal vesicle:** gland that produces seminal fluid, which contributes to semen.

**Seminiferous tubules:** tube structures within the testes where spermatogenesis occurs.

**Sertoli cells:** cells that support germ cells through the process of spermatogenesis; a type of sustentacular cell.

**Sperm:** this is the male gamete (sex cell), it can also be called spermatozoon.

**Spermatic cord:** bundle of nerves and blood vessels that supplies the testes; contains ductus deferens.

**Spermatid:** immature sperm cells produced by meiosis ii of secondary spermatocytes.

**Spermatocyte:** cell that results from the division of spermatogonium and undergoes meiosis i and meiosis ii to form spermatids.

**Spermatogenesis:** formation of new sperm, occurs in the seminiferous tubules of the testes.

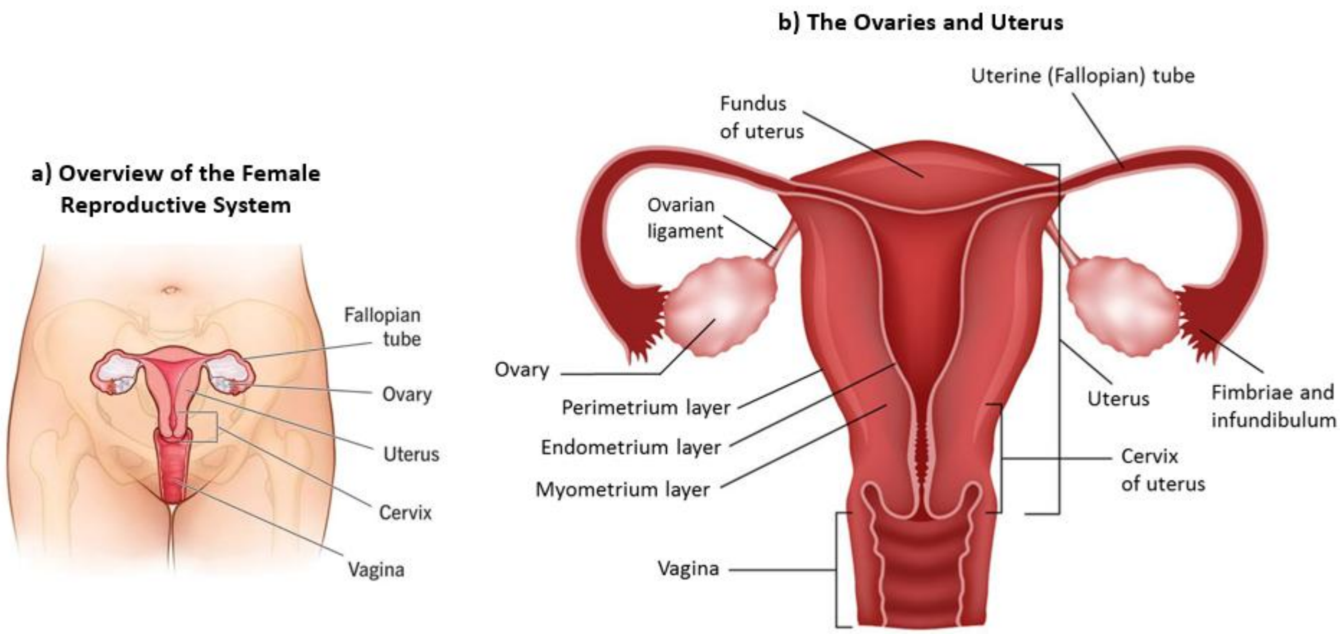
**Spermatogonia:** (singular = spermatogonium) diploid precursor cells that become sperm.

**Spermiogenesis:** transformation of spermatids to spermatozoa during spermatogenesis.

**Testes:** (singular = testis) male gonads.

## The Female Reproductive System

The gonads of the female reproductive system are the **ovaries** and they function to produce **gametes** (**oocytes** or **egg cells**) in addition to the reproductive hormones, including estrogens and progesterone, as is the same concept for the male reproductive system. The female body has the additional role of supporting the developing embryo and fetus in the womb and delivering at birth a genetically unique baby into the world.



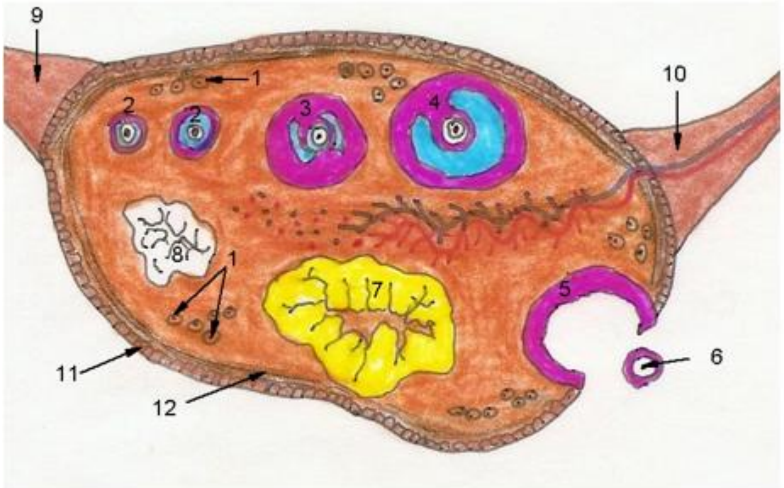

### The Ovaries

The entire female reproductive system is snuggly nestled within the protection of the boney pelvic cavity, as seen above. The **ovaries** are the primary reproductive structure of the female as these are the gonads that make the gametes and sex hormones. The paired oval-shaped ovaries are often remarkably small for all the things they do. The size can vary, but on average have the dimensions of 3.5 cm x 2 cm x 1 cm, in other words they are about the size and shape of a large **almond**. The size of a woman's ovary can have an impact, as women with larger ovaries have a greater egg reservoir which may mean they will have an easier time conceiving and also be able to conceive at older ages.

The processes that occur within the ovary have intricate timing interwoven into a complex series of cycles. It is the hypothalamus that directs the ovarian cycle, and this then dictates the uterine cycle. Therefore, elements both upstream and downstream of the ovaries must be meticulously synchronized. The position of the ovaries are tethered and supported within the pelvic cavity by three important ligaments, the **ovarian ligament**, the **suspensory ligament** and the **broad ligament**.

The drawing below is a representation of the histology of an ovary under microscopic examination. The figure is best read by going through the structures in order, from 1 to 12, flowing around the ovary in a clock-wise direction. This is how the clock-work elements of the ovary can be most appreciated. The central functional aspect of the ovary is to release a mature egg and then prepare the body for possible implantation of a zygote and pregnancy.

If implantation does not occur, then the ovarian cycle moves on from ovulation to the end of the cycle, and repeats itself every other month. Since there are two ovaries, each takes a turn releasing a mature egg cell; one releases an egg one month, the other releases an egg the next month, and so on.




**Structures of the Ovary**

1. Primordial follicles (with oogonium)
2. Primary follicles
3. Secondary follicles with oocyte
4. Mature (Graafian) follicle with oocyte
5. Follicle at ovulation
6. Release of egg at ovulation
7. Corpus luteum
8. Corpus albicans
9. Suspensory ligaments
10. Ovarian ligament
11. Germinal epithelium
12. Tunica albuginea

As seen above, the ovary has a smooth outer covering of cuboidal epithelium called the **germinal epithelium**, it was so named because it was once (inaccurately) believed that the egg cells germinated from this layer of cells. Just deep to this is the **tunica albuginea**, which is a dense fibrous connective tissue that holds and protects the tissue organ.

Deep to the tunica albuginea is the **ovarian cortex**, which is the large outer portion of the ovary, and is where all the action takes place! For instance, this is where the **oocytes** develop inside of **ovarian follicles**. Ovarian follicles are like a house that the egg cell (oocyte) matures in, becoming more developed as it cycles around the ovarian cortex in a very precise manner. In the deepest central region is the inner **ovarian medulla**, where blood and lymph vessels, the nerves supplying the ovary.

Once the mature cell is released from the mature ovarian follicle at **ovulation** (number 6 above), the ovarian follicle become the **corpus luteum** (number 7 above) a name meaning 'yellow body'. This readies the body for pregnancy, should fertilization occur.

If the egg is unfertilized, the corpus luteum becomes the **corpus albicans** (number 8 above) a name meaning 'white body'. This structures is degraded by resident macrophages and the cycle begins again.

### The Ovarian Cycle

Cycles are extremely meaningful and important in the body, and particularly in the reproductive system. The **ovarian cycle** is created by gonadotropic hormones form the anterior pituitary gland, and orchestrate the events that occur in the ovary. In healthy ovulating women these events are extremely predictable.

During a woman's reproductive years, the ovarian cycle is usually 28 days. Yes, exactly like the cycles of the moon! To be clear, this is <u>not</u> the **uterine cycle** (what most know as the **menstrual cycle**), but the two are correlated because as we will see, it is the ovarian cycle that dictates the uterine cycle.

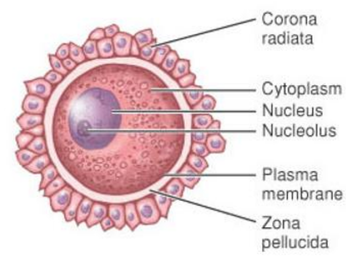
The ovarian cycle may be divided into three stages: **1)** the follicular phase, **2)** ovulation, and **3)** the luteal phase. Distilled into the simplest terms the sequence of events can be described as this:

- **Follicular Phase** – the follicles (with the oocyte inside) facilitate **oogenesis**, which is the growth and development of the primary ova into a mature ovum.
- **Ovulation** – triggers the release of the mature egg cell from the follicle and the ovary.
- **Luteal Phase** – the follicle becomes the corpus luteum, secreting estrogens and progesterone levels for potential implantation of a fertilized egg cell within the endometrium of the uterus.

### The Female Egg Cell

The female egg cell is small, but it may be bigger than you realize! This cell is the largest cell in the human body and can be seen without a microscope. Thus, comparatively, the egg cells are huge. They measure between about 100 to 200 µm (microns) in diameter. On the small side of the scale that size is similar to the width of a strand of hair, and larger eggs can be about the size of a single grain of reined granular sea salt.

**Oocyte - The Female Egg Cell**




**The Hormones Involved in the Ovarian Cycle**

The **gonadotropic releasing hormones** (GnRH) from the hypothalamus signal the anterior pituitary to release the gonadotropins **follicle stimulating hormone** (**FSH)** and **luteinizing hormone** (**LH**) that bind to receptors on granulosa and theca cells of ovarian follicles.

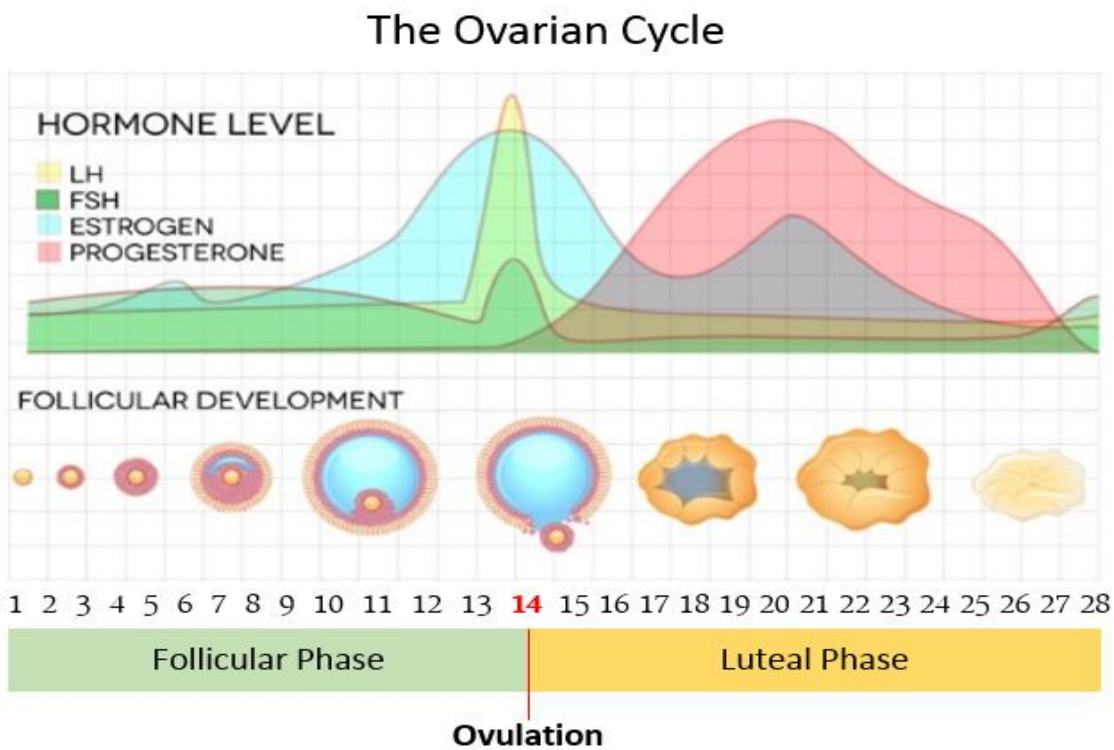
As its name implies, follicle stimulating hormone (FSH) stimulates the growth and development of the ovarian follicles in females, including the development of the egg cell inside the follicle. It is the luteinizing hormone (LH) that binds to receptors on granulosa and theca cells of ovarian follicles to produce the sex steroid hormone estradiol, a type of estrogen, at ovulation. The LH also causes the release of progesterone by the corpus luteum after ovulation.

### Ovulation

Ovulation occurs approximately once every 28 days. In the very last portion of follicular development, the cells of the follicle start to produce more **estrogen** than all the follicles previously, such massive amounts that raise plasma estrogen enough to trigger the anterior pituitary to secret more **LH** and **FSH**, and this makes more estrogen, a positive feedback loop ensues that releases more LH and FSH, etc. It is the large **surge in LH** leads to **ovulation of the dominant follicle**. It also induces the dominant follicle to resume meiosis of a primary oocyte to a secondary oocyte.

This spike in LH triggers proteases that break down structural proteins in the ovary wall on the surface of the bulging dominant follicle. This degradation of the wall, combined with pressure from the large, fluid-filled antrum, results in the expulsion of the oocyte surrounded by granulosa cells into the peritoneal cavity, that is it triggers ovulation occur.

Interestingly, meiosis (the reduction division) of a released egg cell (oocyte) is only completed if a sperm cell penetrates its barriers. This action will trigger meiosis II to resume, producing a haploid (1n) genome and the cell is now called an **ovum**. It is not really necessary to be pedantic about the specific names of the egg cell, the best practice is to know that the mature egg cell is an oocyte that can become an ovum. Technically, the moment the haploid ovum is fertilized by a haploid sperm, it becomes the **fertilized egg cell** or a **zygote**. That union is the first diploid cell of the new offspring.



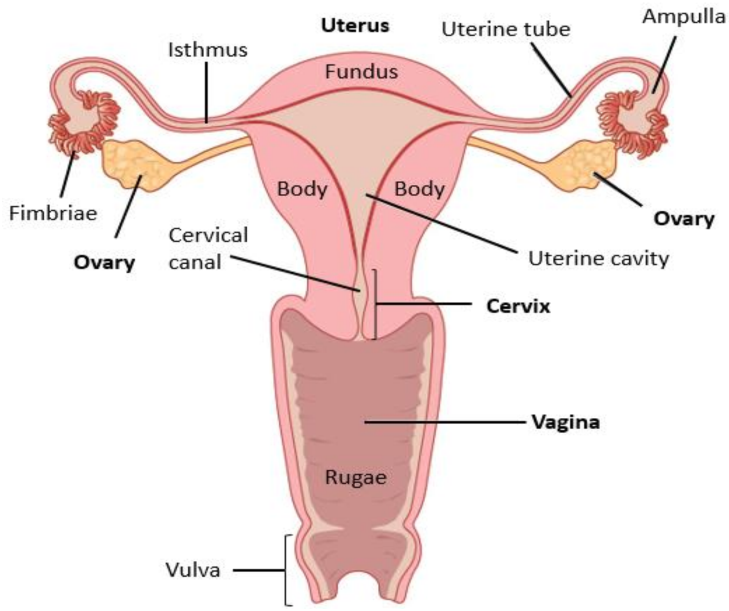

**The Luteal Phase**
The surge of luteinizing hormone (LH) that triggers ovulation also converts the now empty follicle into the **corpus luteum** (yellow body) which is actually now acts as a secondary endocrine gland.

The granulosa and theca cells of the corpus luteum start to produce **progesterone** in very large amounts in preparation for the possibility of pregnancy. This occurs in order to support and maintain that condition, if it occurs. This high level of progesterone triggers a negative feedback of the hypothalamus and pituitary gland, which keeps GnRH, LH, and FSH release low in order to prevent any new dominant follicles to develop until the end of the luteal phase. This is sort of a failsafe mechanism so that no other egg cells are maturing in readiness for ovulation until the next cycle begins.

After ovulation, if pregnancy does not occur within about 10 to 12 days, the corpus luteum stops releasing progesterone and begins to transform into the **corpus albicans** (white body). This structure is then naturally degraded by resident ovarian macrophages. This change causes a reduction of progesterone, which then allows the release of FSH and LH to re-commence, and the ovary is now cycled back to the starting follicular phase.

The term ***mittelschmerz*** is a German word meaning "middle pain" and it is used to describe abdominal pain women have that is associated with ovulation, which of course occurs in the middle of both the ovarian and menstrual cycles. Some women can feel ovulation and this is accompanied by pelvic pain at about the 14 day of the typical 28 day cycle.

## The Uterine Tubes




The **uterine** (**Fallopian**) **tubes** serve as a passageway for the oocyte as it departs the ovary and makes its way to the uterus. Each of the two uterine tubes is close to, but not directly connected to, the ovary and divided into sections. At right it shows the close physical proximity of the ovary and the fimbriae at the entrance of the uterine tube.

The egg cell is released into the abdominopelvic cavity and it is the billowing **fimbriae** of the **infundibulum** of the uterine tube hat guide the egg into the uterine tube. It is the inner mucosal lining of this tube that has ciliated columnar epithelial cells which rhythmically beat their cilia to create a current that pulls the oocyte in the direction of the uterus.

## Hormonal Actions help Transport Gamete

The elevated **estrogen** levels around the time of ovulation cause the **smooth muscle** within the uterine tube to contract which helps the finger-like structures called fimbriae to sweep the egg into the uterine tube. The egg travels through the uterine tube, propelled in part by contractions in the tubes walls. All of this contributes to the slow and steady movement of the oocyte toward the uterus, which typically takes about **3 days** if no fertilization occurs. Since the egg cell must be fertilized within the first 24 hours of being released, it is in the uterine tube that the egg cell is fertilized by a sperm.

If fertilization occurs, the sperm usually makes contact with the egg while it is moving through the ampulla of the uterine tube (see image on next page). An **ectopic pregnancy** occurs when a fertilized egg tries to implant and grow outside of the uterus. It can occur if the egg cell travels into the abdominal cavity instead of the uterus. However, the vast majority of ectopic pregnancies (over 90%) occur in the uterine tube.

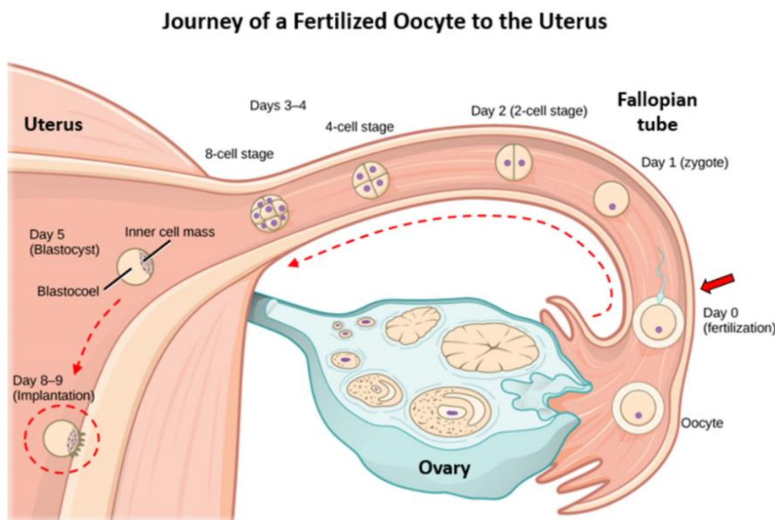
## The Uterus

The **uterus**, also known as the **womb**, is the organ where the **embryo** becomes the **fetus** as it grows and develops. As we will see as we look more closely, the uterus is a very muscular organ, with about 90% of it being composed of smooth muscle. This component is an important structure that provides the very effective contractions during childbirth.

In females who are not pregnant, the uterus is surprisingly small, with an average size of 2 inches wide by 3 inches long (5 cm by 7 cm). The actual dimensions vary greatly, as all women are different, but this gives an idea of the relative size and how impressive it is that the uterus can dramatically change in order to accommodate a growing baby.

The superior portion that meets the uterine tubes of the uterus is called the **fundus** (a term which means ‘opposite of the open end’, like when a coin purse is tipped upside down, the top part in that position would be the fundus).

The bulk of the uterus is the middle section called the **body of uterus** (or corpus). The lowest region is called the **cervix** (meaning neck) which contains the extremely narrow **cervical canal** that merges into the **vagina**. The cervix produces **mucus secretions** that become thin and stringy under the influence of high systemic plasma **estrogen** concentrations, and these secretions more effectively facilitate the movement of sperm through the female reproductive tract.




### The Layers of the Uterine Wall

There are three layers of the uterine wall. From outermost to innermost they are the:
**1) Perimetrium; 2) Myometrium;** and **3) Endometrium.**

### 1) Perimetrium

The perimetrium is the most superficial exterior layer of the uterus that is in contact with the other organs and structures in the pelvic cavity. It is a slippery **serous membrane** that functions to protect the uterus and to reduce friction between it and the structures moving around.

### 2) Myometrium

The middle layer of the uterus is the myometrium and it is the thickest layer, making up about **90%** of the uterine wall. It is composed of **smooth muscle** and this is the layer responsible for uterine contractions during childbirth.

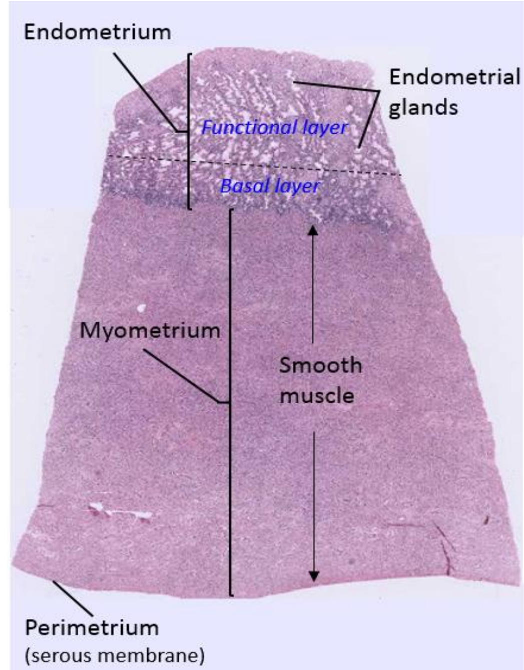
The arrangement of the muscle fibers in the myometrial tissue is complicated and effective. The muscle fibers run horizontally, vertically, and diagonally, enabling for powerful and extremely effective contractions during childbirth or labor. The myometrial layer of the uterus may also contract in a much more moderate way during menstruation or menstrual cycle. When prostaglandins are released they stimulate uterine contractions and this can cause discomfort and pain which are often experienced as cramps during the first two days of menses (menstruation) in order to facilitate menstrual blood flow from the endometrium. In addition, myometrial contractions around the phase ovulation are thought to be a contributing factor in the transport of sperm cells from the cervix toward the uterine tubes of the female reproductive tract.

### 3) Endometrium

The innermost layer of the uterus is called the **endometrium**, this is the layer the fertilized egg cell would implant into. It consists of two layers: **a)** the **functional layer**, or stratum functionalis (the exposed surface), and **b)** the **basal layer**, or stratum basalis (on the bottom),

The thicker functional layer is the portion of the endometrial wall that is shed each month during **menses** (a Greek term for month), also called **menstruation**. The basal layer creates the lamina propria which connects to the myometrium below it. This bottom layer always remains and does not shed during menstruation or menses.

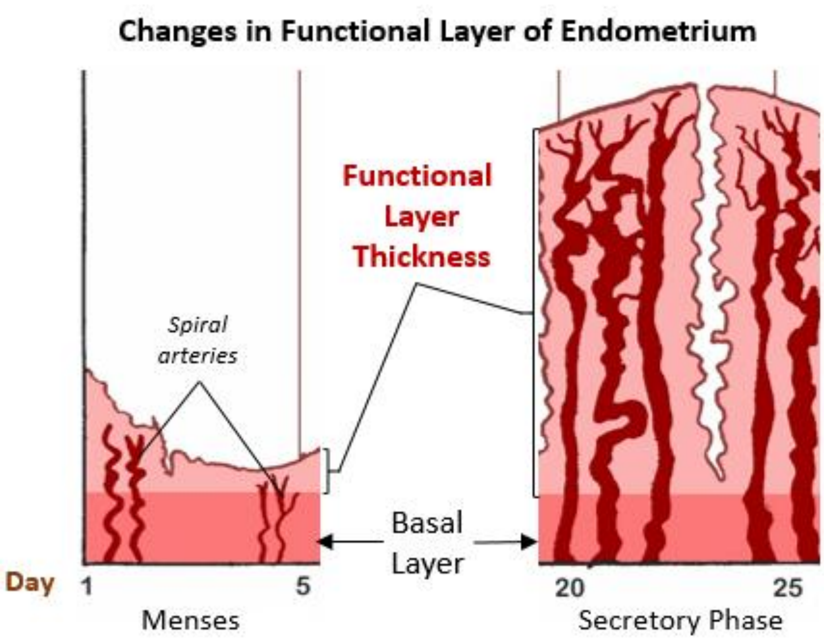
The condition of **endometriosis** can occur when tissue that is similar to the endometrial lining of the uterus grows outside the uterus, for example in the uterine tube or in the abdominal cavity. This tissue can thicken, break down, and bleed with each period, but is not able to be released the same way. It can lead to painful periods, heavy bleeding, pain during sexual intercourse or when having a bowel movement or urinating. Treatments can vary but the most fundamental issue is to determine the cause of this (or any) condition and address that directly, rather than suppress symptoms related to the issue.




**The Shedding of the Functional Layer**

The most superficial exposed layer of the uterus is the stratum functionalis, or the functional layer. It is the ***functional layer*** that grows and thickens in response to increased levels of **estrogen** and **progesterone**. In the luteal phase of the ovarian cycle (and secretory phase of menstrual cycle) there are special branches coming off of the uterine artery called **spiral arteries** and these supply the thickened functional layer (below). This inner functional layer provides the perfect site for implantation of a fertilized egg cell. Should fertilization *not* occur, it is then this functional layer *only* of the endometrium that sheds during **menstruation** (or the **menstrual period**). Distal vessels are sloughed off, while the spiral arteries (named for their helical shape) retract into the stratum basalis and constrict to limit blood loss during menstruation. The uterine lining does not receive the progesterone, causing the spiral arteries constrict and the endometrial tissue to become ischemic. This causes cell death and the sloughing of the functional layer. This layer is of course re-built every month.

The deeper stratum basalis or basal layer (meaning bottom layer) is the deepest tissue of the endometrium it sits atop the muscular myometrium and does not undergo any removal or structural changes during the uterine cycle. Its purpose is to assist in the replacement of tissue that is loss during the menstruation.




At the start of the ovarian cycle, estrogen release stimulates ovarian follicles (in follicular phase) and the functional layer of the endometrium also starts to rebuild from menses. It is the increase in progesterone after ovulation during the luteal phase which maintains the thick functional layer that steadily thickens in preparation for a potential implantation of a fertilized egg cell. If the corpus luteum in the ovary is still present and functioning, then the endometrial lining continues to prepare for implantation.

If no embryo implants into the endometrium, the corpus luteum will degrade and progesterone production will stop, ending the luteal phase of the ovarian cycle. In the uterus, the lack of progesterone, coupled with the impact of prostaglandins, will signal the onset of **menstruation**.

When an embryo does implant into the functional layer of the endometrium, a hormone called **human chorionic gonadotropin** (**hCG**) begins to be produced in the uterus. This hormone signals the corpus luteum to *continue* secreting progesterone in order to maintain the full state of the endometrium, and thus maintain the pregnancy. This is what prevents the uterine lining from being shed and this is why a woman does not have a period when she becomes pregnant. It is the levels of the hCG that a pregnancy test measures. Once hCG reaches a high enough level in the blood, usually 10 to 12 days after conception (after becoming pregnant), it can be detected in the urine with a pregnancy test.

### The Uterine (Menstrual) Cycle

The ovarian cycle is determined by the hypothalamic and pituitary gonadotropic hormones, and the uterine cycle is dictated by the ovarian hormones. The **uterine** or **menstrual cycle** also has three phases: **1) Menses; 2) Proliferative phase**; and **3) Secretory phase**

#### Menses or Menstruation

As discussed earlier, **menses** means 'month' in Greek and it is the monthly shedding of the functional layer of the endometrium, which is also called the **menstrual period**, or **menstruation**. This phases typically goes from day 1 to day 5 of the 28 day cycle (see below), though it can be as short as 2 days or longer than 7. The time of menses coordinates with the early stages of the follicular phase of the ovarian cycle. The sloughing off of the functional layer occurs particularly significantly when progesterone (plus FSH and LH) hormone levels are low. It is important to note that menstrual flow is not composed of just blood but also contains remnants of the cellular debris from the functional layer of the endometrium. The first menses at the onset of puberty is called **menarche** and can occur before or after the first ovulation.

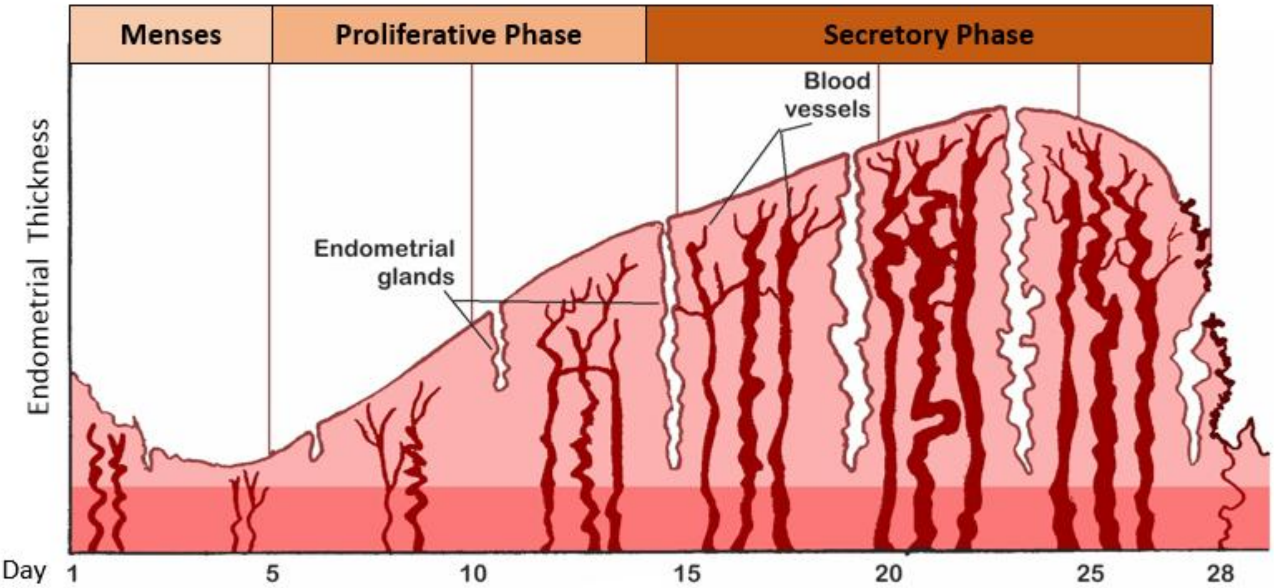
#### Proliferative Phase

Once menstrual flow ceases, the re-building of the endometrium commences making it the start of the **proliferative phase** of the uterine cycle. The increasing levels of estrogen from the granulosa and theca cells of the ovarian follicles stimulate the endometrial lining to increase and thicken. Ovulation on day 14 marks the end of the proliferative phase in the uterus (and the end of the follicular phase in the ovary).

#### Secretory Phase

The last phase on the uterine cycle starts with elevated **progesterone** that is produced by the corpus luteum, as the **secretory phase** centers on preparing the endometrial lining for possible implantation of a fertilized egg cell. The second peak of elevated estrogen levels is what facilitates the contractions of the uterine tube in order to conduct the oocyte to the uterus after ovulation. The corpus luteum within the ovary now pivots its activity into the *luteal phase* of the ovarian cycle, which, toward the end of it coincides with the start of the secretory phase of the uterine cycle.

During the secretory phase, the endometrial glands become long and twisted, and the secretion of a fluid rich in **glycogen** starts to occur. The uterine epithelial cells express the enzymes necessary to make and catabolize glycogen (glucose-6-phosphotase) that is necessary to liberate the glucose stored as glycogen. If an **embryo** does implant in the endometrium this nutrient rich fluid is perfect to nourish it. The **spiral arteries** develop in order to provide plenty of blood to the thickened functional layer. The estrogen levels during this phase also tend to lower the acidity of the vagina, making it more hospitable to sperm.




If no pregnancy occurs after about 10 to 12 days from the start of this phase, no signal will be sent for the corpus luteum to continue on, and thus it will degrade into the **corpus albicans**. The estrogen and progesterone levels fall and the endometrium will not get any thinker but will start to thin.

This is combined with **prostaglandins** being secreted which causes constriction of the spiral arteries, reducing oxygen supply which causes the endometrial tissue in the functional layer to die, signaling the onset of menses, which will be the first day of the next cycle.

Most women can predict their menstrual cycle due to its regularity, however, there are a few common problems that can affect the cycle: **Amenorrhea** – lack of menstrual cycle; **dysmenorrhea** – painful periods; and abnormal uterine bleeding.

**Amenorrhea**
Amenorrhea is a term used to describe the condition of women who haven't gotten their period by age 15 or women who haven't had a period for more than 90 days. The most common cause of amenorrhea is pregnancy.
Some other causes of amenorrhea are:

- Breastfeeding.
- Extreme weight loss.
- Obesity.
- Eating disorders.
- Excessive exercise.
- Stress.
- Medical conditions in need of treatment.

**Dysmenorrhea**
Dysmenorrhea is a condition in which a woman experiences painful menses, usually in the form of abdominal cramps during her period. It is most often caused by an excess of the chemical prostaglandin, a hormone that helps the body heal after injury. The symptoms of pain and discomfort caused by dysmenorrhea can be relieved by over-the-counter medication, such as ibuprofen, Advil, Motrin or Midol. If pain persists and interrupts a normal routine, treatment from a doctor is recommended.

**Abnormal uterine bleeding**

Abnormal uterine bleeding occurs when a woman experiences bleeding in the middle of her menstrual cycle or experiences excessive bleeding during her period. Abnormal bleeding can happen:

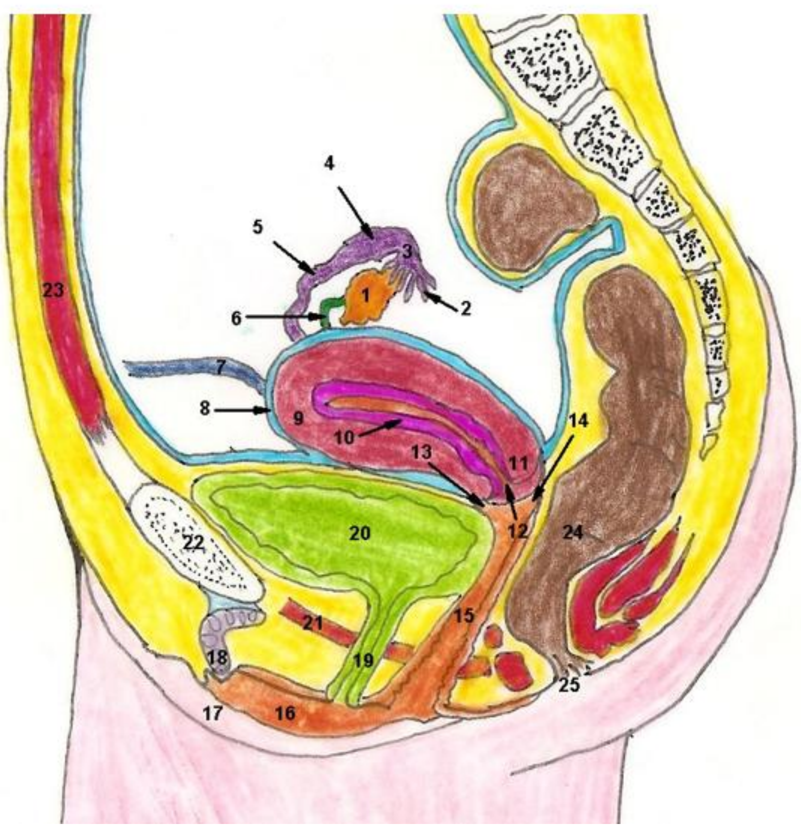
- After sex.
- Between periods.
- After menopause.

Abnormal uterine bleeding by itself may not indicate a serious medical condition. Many times, women can bleed from ovulation or birth control medication and devices. However, abnormal bleeding may also indicate an underlying condition that could be causing infertility.

## External Female Genitals

The external female reproductive structures are referred to collectively as the **vulva**. The **mons pubis** is a pad of fat that is located at the anterior over the pubic bone. After puberty, it becomes covered in pubic hair. The **labia majora** (labia = "lips"; majora = "larger") are folds of hair-covered skin that begin just posterior to the mons pubis. The thinner and more pigmented **labia minora** (labia = "lips"; minora = "smaller") extend medially to the labia majora. Although they naturally vary in shape and size from woman to woman, the labia minora serve to protect the female urethra and the entrance to the female reproductive tract.

The superior anterior portions of the labia minora come together to encircle the **clitoris** (or glans clitoris), an organ that originates from the same tissue as the glans penis and has an abundance of nerves that make it important in sexual sensation and orgasm. The **hymen** is a thin membrane that sometimes partially covers the entrance to the vagina. An intact hymen cannot be used as an indication of "virginity"; even at birth, this is only a partial membrane, as menstrual fluid and other secretions must be able to exit the




**The Female Reproductive Structures**

1. Ovary
2. Fimbriae
3. Uterine (Fallopian) tube
4. Infundibulum
5. Ampulla
6. Ovarian ligament
7. Round ligament
8. Perimetrium layer (serous membrane)
9. Myometrium layer (of Fundus)
10. Endometrium layer
11. Cervix
12. External os (opening) of cervix
13. Anterior fornix
14. Posterior fornix
15. Vagina
16. Labia majora
17. Labia minora
18. Clitoris
19. Urethral orifice
20. Bladder
21. Urogenital diaphragm
22. Pubic symphysis
23. Rectus abdominis
24. Rectum
25. Anus

body, regardless of penile-vaginal intercourse. The vaginal opening is located between the opening of the urethra from the bladder and the anus. It is flanked by outlets to the **Bartholin's glands** (or greater vestibular glands) and the lesser vestibular glands (located near the clitoris) which secrete mucus to keep the vestibular area moist.

### The Vagina

The **vaginal canal** or **vagina** is a muscular canal that invaginates from the external usually about 3 to 6 inches (6.5 to 15 cm) in length, see the mid-sagittal diagram below. This passageway serves as the entrance to the female reproductive tract. It also serves as the exit from the uterus of blood and cellular debris during menses, and as the exit for the baby during childbirth. The vaginal canal leads directly into the most inferior portion of the uterus, the **cervix**.

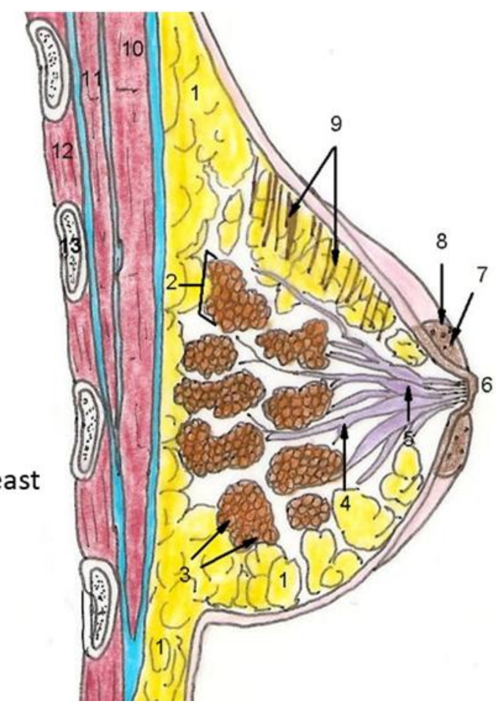
The outer walls of the anterior and posterior vagina are formed into longitudinal columns or ridges, and the superior portion of the vagina creates a series of arches called the **vaginal fornices** (plural of fornix) where the canal meets the protruding uterine cervix. The tissue of the walls of the vagina are lined with an outer fibrous adventitia; a middle layer of smooth muscle; and an inner mucous membrane with transverse folds called **rugae**. Together, the middle and inner layers allow the expansion of the vagina to accommodate intercourse and childbirth.

### The Breasts and Mammary Glands

The breasts and mammary glands are considered accessory organs of the female reproductive system. The fully developed mammary glands have a distinct role in nourishment and bonding between the mother and the baby. They are located on the chest in very close proximity to the beating heart and also close to the mother's face. The function of the breasts is to supply nutrient rich milk to an infant in a process called **lactation**. The external features of the breast include a nipple surrounded by a pigmented **areola**, whose coloration may deepen during pregnancy. The areola is typically circular and can vary in size from 25 to 100 mm in diameter.

**Breast and Mammary Glands**

1. Adipose tissue
2. Mammary lobes
3. Mammary lobules
4. Lactiferous duct
5. Lactiferous sinus
6. Nipple
7. Areola
8. Areolar glands
9. Suspensory ligaments of breast
10. Pectoralis major muscle
11. Pectoralis minor muscle
12. Intercostal muscle
13. Rib



The areolar region is characterized by small, raised areolar glands that secrete lubricating fluid during lactation to protect the nipple from chafing and becoming sore. When a baby nurses, or draws milk from the breast, the entire areolar region is taken into the mouth.

In terms of navigating through the breast, the milk itself exits the breast through the nipple via 15 to 20 **lactiferous ducts** that open on the surface of the nipple, see above. These lactiferous ducts each extend to a **lactiferous sinus (ampulla)** that connects to a glandular lobe within the breast itself that contains groups of milk-secreting cells in clusters called **alveoli**. The clusters can change in size depending on the amount of milk in the alveolar lumen. Once milk is made in the alveoli, stimulated myoepithelial cells that surround the alveoli contract to push the milk to the lactiferous sinuses. From here, the baby can draw milk through the lactiferous ducts by suckling. The lobes themselves are surrounded by fat tissue, which determines the size of the breast; breast size differs between individuals and does not affect the amount of milk produced. Supporting the breasts are multiple bands of connective tissue called **suspensory ligaments** that connect the breast tissue to the dermis of the overlying skin.

During the normal hormonal fluctuations in the menstrual cycle, breast tissue responds to changing levels of **estrogen** and **progesterone**, which can lead to swelling and breast tenderness in some individuals, especially during the secretory phase. If pregnancy occurs, the increase in hormones leads to further development of the mammary tissue and enlargement of the breasts.

**Breast Feeding and Breastmilk**

During breastfeeding, the **letdown reflex** is a trigger which causes the release of breastmilk and allows it to flow. This reflex occurs when tactile stimulation of the nipple-areolar complex occurs as the baby begins to suckle. Nerves send afferent signals to the **hypothalamus**, triggering the release of **oxytocin**, which stimulates the milk ejection, or letdown reflex.

Breastmilk is produced by the **mammary glands**, which are modified apocrine sweat glands. This milk from a healthy mother is the best possible source of nutrients for a developing baby. Though there are numerous scientific experiments that prove breast milk is far superior for babies than any formula, should we really need 'proof' of this? Hopefully, as we understand more about the human body, issues like knowing breast milk is always better for babies will become obvious and self-evident.

As the breast starts to empty, the fat globules begin to dislodge and move down the ducts (let-down facilitates this process). So the further into the feed, the higher the fat content of the milk, as more and more fat globules are forced out. The end result is that the milk gradually <u>increases in fat</u> as the feeding progresses, as described below in the difference between foremilk and hindmilk.


Breast milk is complex, containing many subtle elements such as hormones and a perfect ratio of proteins, sugars (mostly from lactose), lipids (fats), plus the vitamins and mineral needed to help your baby grow and develop. Breast milk also contains many other substances that protect your baby from many illnesses.

**Colostrum** is a type of breastmilk that the breast begins to produce during pregnancy, and is the first breastmilk released by the mammary glands after birth. Its composition is very think and nutrient-rich to ensure the newborn baby has everything it needs, see above for a compassion of the different stages of breastmilk. The colostrum changes to breastmilk within about two to four days after birth. There are then two types of breastmilk, foremilk and hindmilk, but more accurately these terms describe the variations in the milk at the beginning and end of a breastfeeding session. **Foremilk** is what the baby drinks at the beginning of a feeding and is usually more watery, though it still contains many fatty nutrients and is slightly higher in lactose (milk sugar) levels. This is followed by a gradual transition to **hindmilk**, which also has lactose but is much higher in fats and other growth promoting nutrients, including vitamins A and E. It is the hindmilk that satiates the baby's hunger.

**Here are the main benefits of breastfeeding for both the baby and mother:**

- Breastmilk is the perfect nutrition for a baby.
- Creates the best digestion for baby
- Provides immense health protection for both baby and mother.
- Stimulates brain and nervous systems development.
- This food sources is almost always ready and portable.
- Numerous health and wellness benefits for mothers.
- This practice builds a special bond between mother and child.
- The advantages continue as the baby grows.

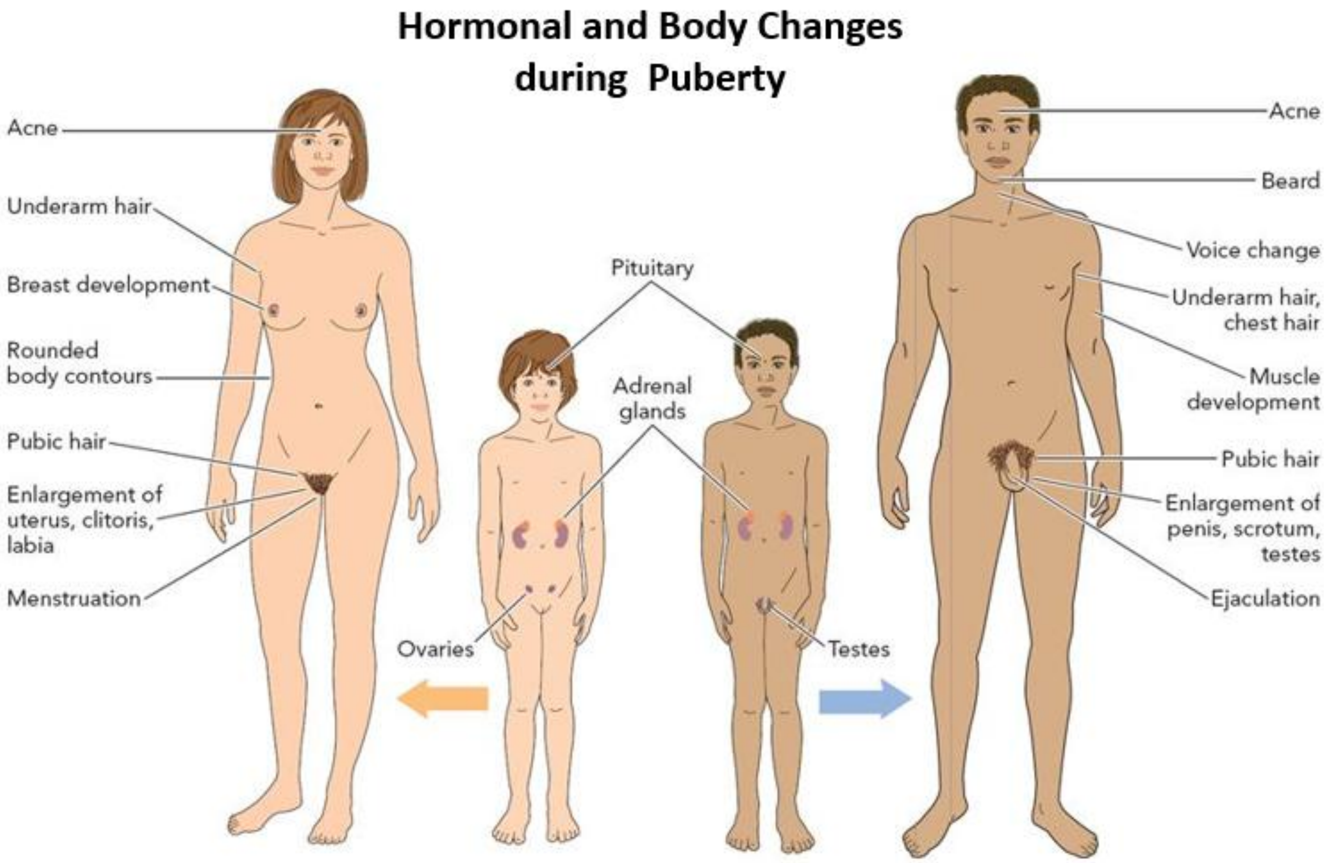
Succinctly, breast milk is the best milk. The nutrients in breast milk are unmatched by any other first food your baby can receive and the practice yields enormous benefits all around.

### Further Sexual Development Occurs at Puberty

Puberty is the stage of development at which individuals become **sexually mature**, ultimately what this means is that they are now able to reproduce. Regardless of the sex, either male or female, the general outcomes of puberty are similar in terms of the hormonal control of the process, in that the central issue is preparing the sex cells or gametes, the oocyte and the sperm. The onset of puberty may vary in terms of age, however the sequence of events and the changes that occur are very predictable for male and female adolescents.

It is quite a symphony of hormones that facilitates this stage of development. The concerted release of hormones from the hypothalamus **gonadotropic releasing hormone** (**GnRH**), the anterior pituitary **luteinizing hormone** (**LH**) and follicular stimulating hormone (**FSH**), and the gonads (either testosterone or estrogen) are responsible for the maturation of the reproductive systems and the development of **secondary sexual characteristics**, which are the often visible physical changes that occur which serve auxiliary roles in reproduction.

The first changes begin sooner than some may realize. At around the age of eight or nine the production of LH becomes detectable. The release of LH occurs primarily at night during sleep and precedes the physical changes of puberty by several years. In pre-pubertal children, the sensitivity of the negative feedback system in the hypothalamus and pituitary is very high. This means that very low concentrations of androgens or estrogens will negatively feed back onto the hypothalamus and pituitary, keeping the production of GnRH, LH, and FSH low.




Two important changes in sensitivity occur as an individual approaches puberty. First, there is a decrease of sensitivity in the hypothalamus and the anterior pituitary to the usual negative feedback mechanism, such that it takes increasingly larger concentrations of sex steroid hormones to stop the production of LH and FSH. The second change is an increased sensitivity of the gonads to the FSH and LH signals, meaning the gonads of adults are more responsive to gonadotropins than are the gonads of children. Due to these two changes, the levels of LH and FSH steadily, slowly increase and lead to the enlargement and maturation of the gonads, which in turn leads to secretion of higher levels of sex hormones and the initiation of **spermatogenesis** (development of sperm) and **folliculogenesis** (development of eggs).

**Males**

The physical changes of puberty for a boy usually start with enlargement of the testicles and sprouting of pubic hair, followed by a growth spurt between ages 10 and 16, this is typically 1 to 2 years later than when girls start puberty. A male's arms, legs, hands, and feet also grow faster than the rest of his body (see above as a reference).

The first real physical sign of the beginning of puberty for boys is the growth of the testes, which is followed by growth and pigmentation of the scrotum and growth of the penis. The next step is the growth of hair, including armpit, pubic, chest, and facial hair. Testosterone stimulates the growth of the **larynx** (Adam's apple) and thickening and lengthening of the vocal folds, which causes the voice to drop in pitch.

The first fertile ejaculations typically appear at approximately 15 years of age, but this age can vary widely across individual boys. Unlike the early growth spurt observed in females, the male growth spurt occurs toward the end of puberty, at approximately age 11 to 13, and a boy's height can increase as much as 4 inches a year. In some males, pubertal development can continue through the early 20s.

**Females**

Girls usually begin puberty between the ages of 8 and 13 years old. Typically the first change that is visible is the development of the breast tissue. This is followed by the growth of axillary and pubic hair. A growth spurt normally starts at approximately age 9 to 11, and may last two years or more. During this time, a girl's height can increase 3 inches a year.

The next step in puberty is menarche, the start of menstruation.

There are continued changes including vaginal discharge and expansion and further development of the pelvis, creating wider hips for childbearing, and also the female fat distribution patterns, especially on the hips, thighs (see above as a reference).

**Factors Effecting the Onset of Puberty**

Multiple factors can affect the age of onset of puberty, including genetics, environment, and psychological stress. One of the more important influences may be nutrition; historical data demonstrates the effect of better and more consistent nutrition on the age of menarche in girls in the United States, which decreased from an average age of approximately 17 years of age in 1860 to the current age of approximately 12.75 years in 1960, as it remains today. Some studies indicate a link between puberty onset and the amount of stored fat in an individual. This effect is more pronounced in girls, but has been documented in both sexes. Body fat, corresponding with secretion of the hormone leptin by adipose cells, appears to have a strong role in determining menarche (the first period for girls), occurring earlier with higher body fat. This may reflect to some extent the high metabolic costs of gestation and lactation. In girls who are lean and highly active, such as gymnasts, there is often a delay in the onset of puberty.

**Secondary Sexual Characteristics**

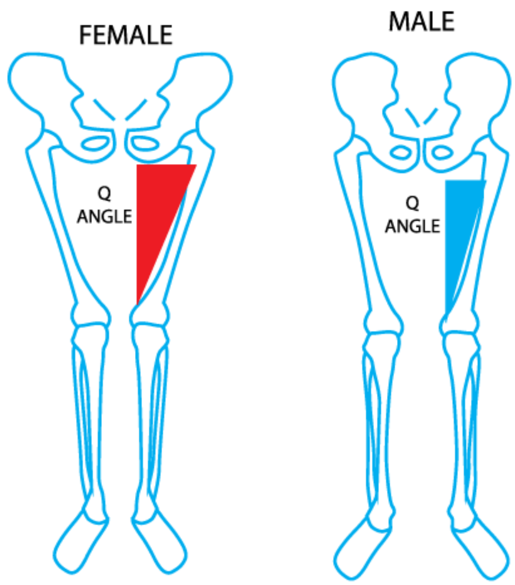
Men and women are physically different this is clearly obvious and can be seen in anatomy. One of the most obvious systems that exemplify how very different men and women are is the reproductive system. The key to the physical differences that exist and can be defined and measured between men and women are the sex hormone concentrations differences between the sexes. An important aspect of these hormone differences is that they contribute to the development and function of **secondary sexual characteristics**, seen in the table below.

Comparison of Male and Female Secondary Sexual Characteristics.

| **Development of the Secondary Sexual Characteristics** | |
|---|---|
| **Male** | **Female** |
| Increased larynx size (Adam's apple) and deepening of the voice. | Deposition of fat, predominantly in breasts, hips and thighs. |
| Broader Shoulder to Hip ratio (Triangle) | Broader Hip to Shoulder to ratio (Pare) |
| Increased muscular development. | Breast development. |
| Growth of facial, axillary, and pubic hair, and increased growth of body hair. | Broadening of the pelvis and growth of axillary and pubic hair. |

The **Q angle**, also known as quadriceps angle, is defined as **the angle formed between the quadriceps muscles and the patella tendon**. The Q angle has become accepted as an important factor in assessing knee joint function and determining knee health in individuals suffering from an anterior knee pain

Refer to the image below:
* The female pelvis is larger and broader than the male pelvis, which is taller (owing to a higher iliac crest), narrower, and more compact.




* The distance between the ischium bones is small in males. This causes the sides of the male pelvis to converge from the inlet to the outlet, whereas the sides of the female pelvis are wider apart.
* This results in the female inlet being large and oval in shape, while the male inlet is more heart shaped.
* The angle between the inferior pubic rami is acute (70 degrees) in men, but obtuse (90–100 degrees) in women. Accordingly, the angle is called the subpubic angle in men and pubic arch in women.
* The greater sciatic notch is wider in females.
* The ischial spines and tuberosities are heavier and project farther into the pelvic cavity in males.
* The male sacrum is long, narrow, straighter, and has a pronounced sacral promontory.
* The female sacrum is shorter, wider, more curved posteriorly, and has a less pronounced promontory.
* The acetabula are wider apart and face more medially in females than in males. This change in the angle of the femoral head gives the female gait its characteristic swinging of hips.

## Birth Control

Birth control is how to prevent pregnancy before it begins. There are several different methods and it is extremely important for anyone considering these to know all of the consequences involved, as many options can irreparably harm the health of the person using it.

The most obvious and fail-proof method of birth control is abstinence from sexual intercourse. In terms of birth control methods that involve sexual intercourse, these can be broadly classified into three different methods. Firstly is the **barrier methods**, this prevents the sperm cells from reaching the egg. Condoms and diaphragms are examples of barrier birth control methods. Secondly are methods that **prevent ovulation** such as the birth control pill, because it prevents ovulation from occurring. Thirdly are methods that allow fertilization of the egg but **prevent implantation of zygote** (the fertilized egg) inside the uterus (womb). An example of this is the intrauterine device (IUD). No method of birth control is 100% effective in preventing pregnancy, nor do they have any real impact on sexually transmitted diseases (STDs). A woman should carefully weigh the short and long term risks and side effects with the benefits.

### How Birth Control Pills Work

Birth control pills prevent pregnancy through several mechanisms, primarily by **stopping ovulation**. If no egg is released, there is nothing to be fertilized by the sperm and the woman cannot get pregnant. Most birth control pills contain **synthetic forms of estrogen and progestin**. These synthetic hormones are more potent and harsh, thus not really like the natural female hormones, and they alter a woman's normal hormone levels and prevent estrogen from peaking mid-cycle. Without the estrogen bump, the pituitary gland does not release the other hormones that normally cause the ovaries to release mature eggs.

Synthetic estrogen in the pill works to:

- Stop the pituitary gland from producing follicle stimulating hormone (FSH) and luteinizing hormone (LH) in order to prevent ovulation.
- Support the uterine lining (endometrium) to prevent breakthrough bleeding mid-cycle.

Synthetic progestin works to:

- Stop the pituitary gland from producing LH in order to prevent egg release.
- Make the uterine lining inhospitable to a fertilized egg.
- Partially limit the sperm's ability to fertilize the egg.
- Thicken the cervical mucus to hinder sperm movement.

## Glossary of Terms for Female Reproductive System

**Ampulla:** middle region of the uterine tube where fertilization often occurs

**Body of the uterus:** the middle section of the uterus, also called the corpus.

**Cervix:** is the narrow inferior portion of the uterus that projects into the vagina.

**Clitoris** (or glans clitoris), an organ that originates from the same cells as the glans penis and has abundant nerves that make it important in sexual sensation and orgasm.

**Ectopic pregnancy:** A pregnancy occurring in the fallopian tube or outside of the uterine lining.

**Egg:** An ovum produced by the woman's ovary. It turns into an embryo when fertilized by a man's sperm.

**Embryo:** An egg that has been fertilized and has started the process of cell division.

**Endometrium:** the innermost layer of uterus with a connective tissue epithelial tissue lining. It provides the site of implantation for a fertilized egg. The functional layer sheds during menstruation.

**Estrogen:** A hormone that is primary for women. It causes the uterine wall to thicken monthly, helping spur ovulation. There are different forms of estrogen hormones. The main form is called Estradiol.

**Fallopian tubes:** Found in the woman's reproductive system. They are a pair of tubes, attached on either side of the top of the uterus. Normal conception occurs in this area.

**Follicle:** a round sac, found in the ovary, containing an egg and cells that produce hormones.

**Fundus:** the portion of the uterus superior the opening of the uterine tubes.

**Hymen** is a thin membrane that partially covers the entrance to the **vagina**.

**Infundibulum** flares out with slender, finger-like projections called **fimbriae**.

**Isthmus** is the narrow medial end of each fallopian tube that is connected to the uterus.

**Labia majora** (labia = “lips”; majora = “larger”), folds of hair-covered skin that begin just posterior to the mons pubis.

**Labia minora** (labia = “lips”; minora = “smaller”), which is thinner and more pigmented and extends medially to the labia majora.

**Mons pubis:** a pad of fat that is located at the anterior, over the pubic bone. After puberty, it becomes covered in pubic hair.

**Myometrium:** the thick smooth muscle layer of uterus, responsible for uterine contractions.

**Oocyte:** The official medical term for an egg.

**Ovary:** Part of the female reproductive system. There are two ovaries, located on either side of the uterus. They contain and produce eggs and hormones.

**Ovulation:** When an ovary releases an egg into the fallopian tube.

**Perimetrium:** the most superficial layer of the  uterus, a serous membrane.

**Uterus:** Part of the female reproductive system. It is a muscular organ where the embryo implants and grows during pregnancy.

**Vagina:** Part of the female reproductive system. It is the canal that goes into to the cervix.

**Zygote:** A fertilized egg that has not begun the process of cell division.