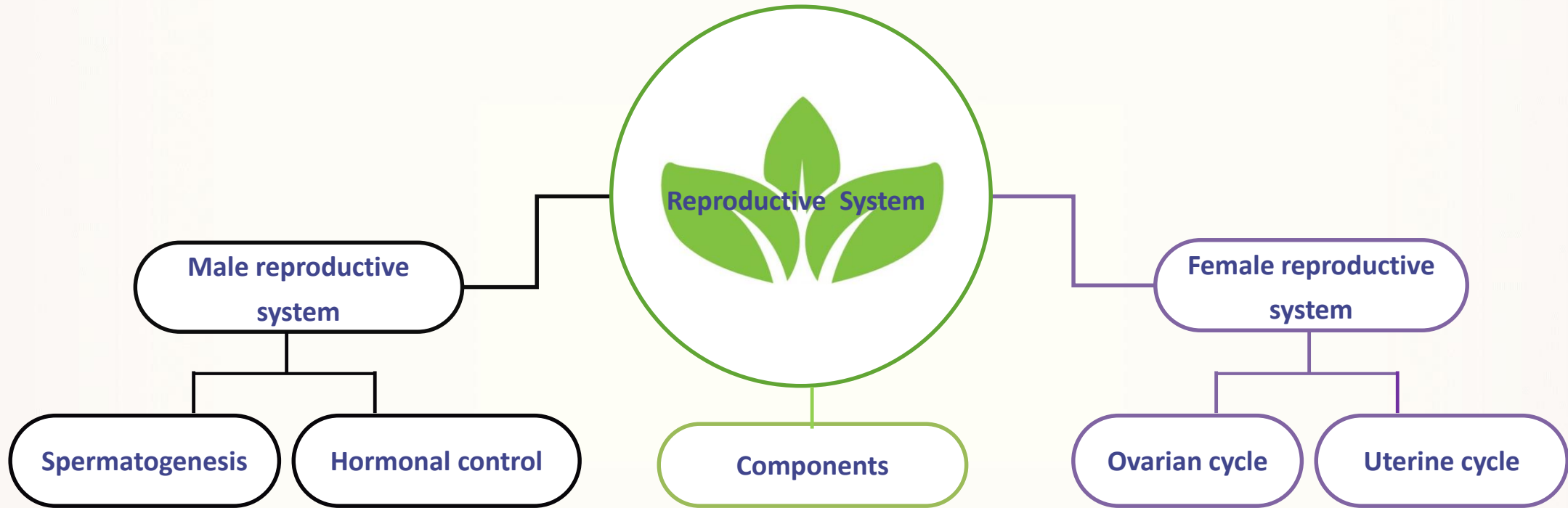


Mind Map



Preface

What makes up your reproductive system?
Why is reproduction Important to animals
and humans?



Index

1. Introduction
2. Objectives
3. First Activity
4. Male reproductive system
5. Components of male reproductive system
6. The accessory glands of the male reproductive system
7. Semen
8. Anatomy of testes
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15. Female Reproductive System
16. Components of female reproductive system
17. The oogenesis and ovarian Cycle
18. The utrine cycle (menstrual cycle)
19. Final Activity
20. Summary
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Introduction

- Reproduction is important for producing new individuals.
- Without a mechanism for reproduction, life would come to an end.
- reproduction is one of the most important concepts in biology.

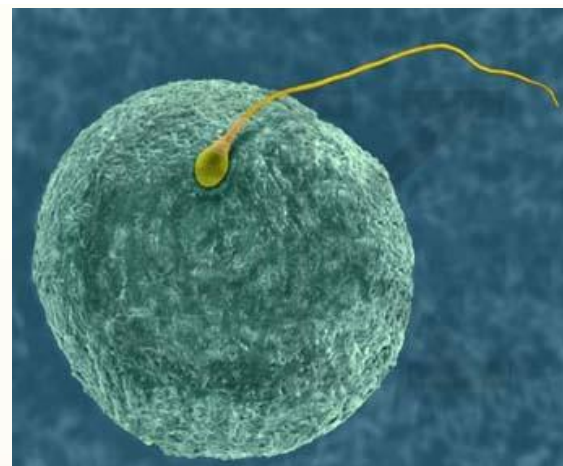
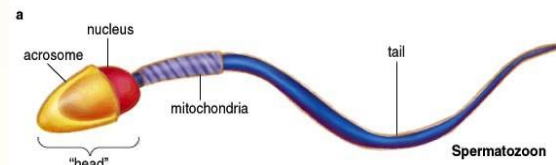


Introduction

The reproductive system becomes active after **puberty**. During puberty the reproductive organs mature to create a fertile individual capable of reproducing. The primary sex organs (**gonads**) produce the **sex cells** (egg/sperm) and **sex hormones**.

- Females produce eggs (**female gametes**)
- Males produce sperm (**male gametes**)

In sexual reproduction new individuals are produced by the fusion of egg and sperm (haploid gametes) to form a diploid **zygote**.



Objectives

- To review the components of the male and female reproductive systems.
- To characterize the general organization of the testis and the ovary.
- To understand the hormonal regulation and processes of spermatogenesis and oogenesis.



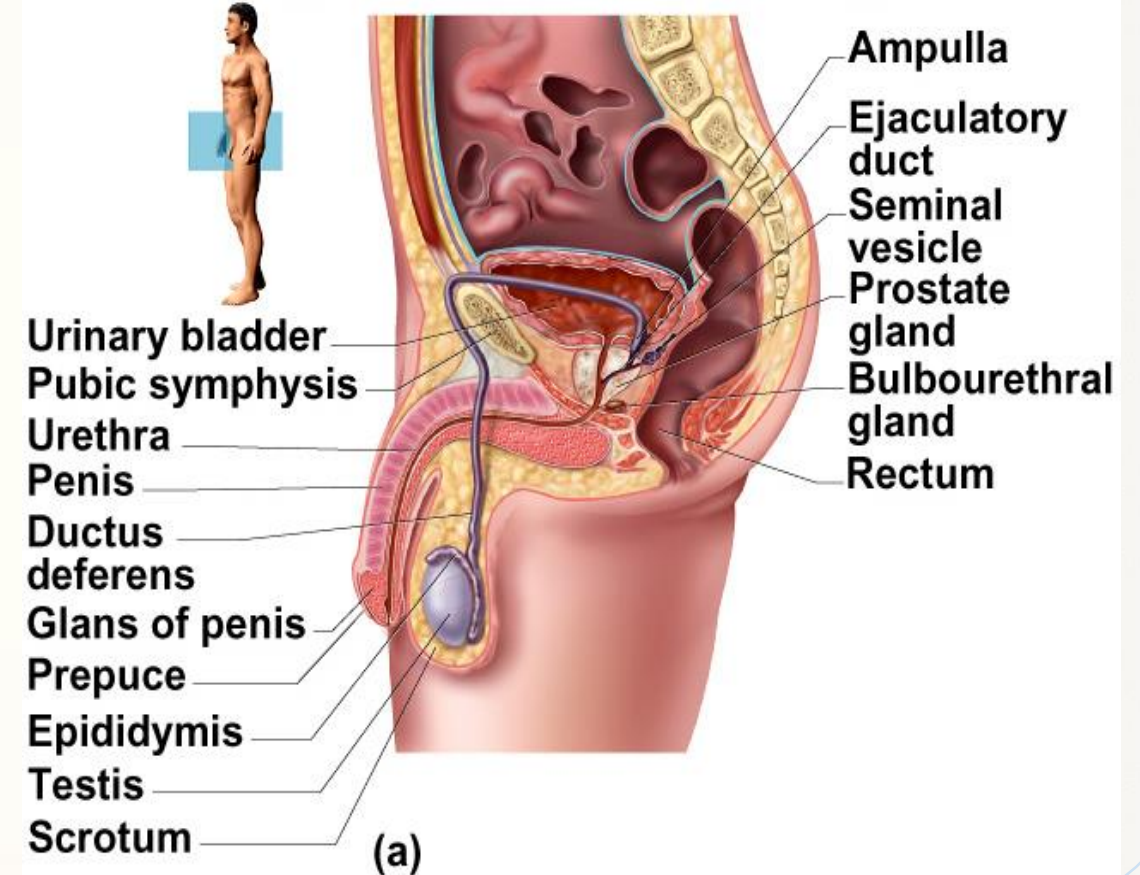
Male reproductive system

Testes (singular testis)

Testes are the male gonads. They produce sperm and secrete male hormones (testosterone).

The epididymis

- After leaving the testes, sperm enter the epididymis.
- The epididymis is a tubular structure located on one side of the testes. It is packed with a milky nutritive substance as well as spermatozoa from the testes.
- Site of sperm maturation – acquire motility and ability to fertilize
- Can store sperm for several months.



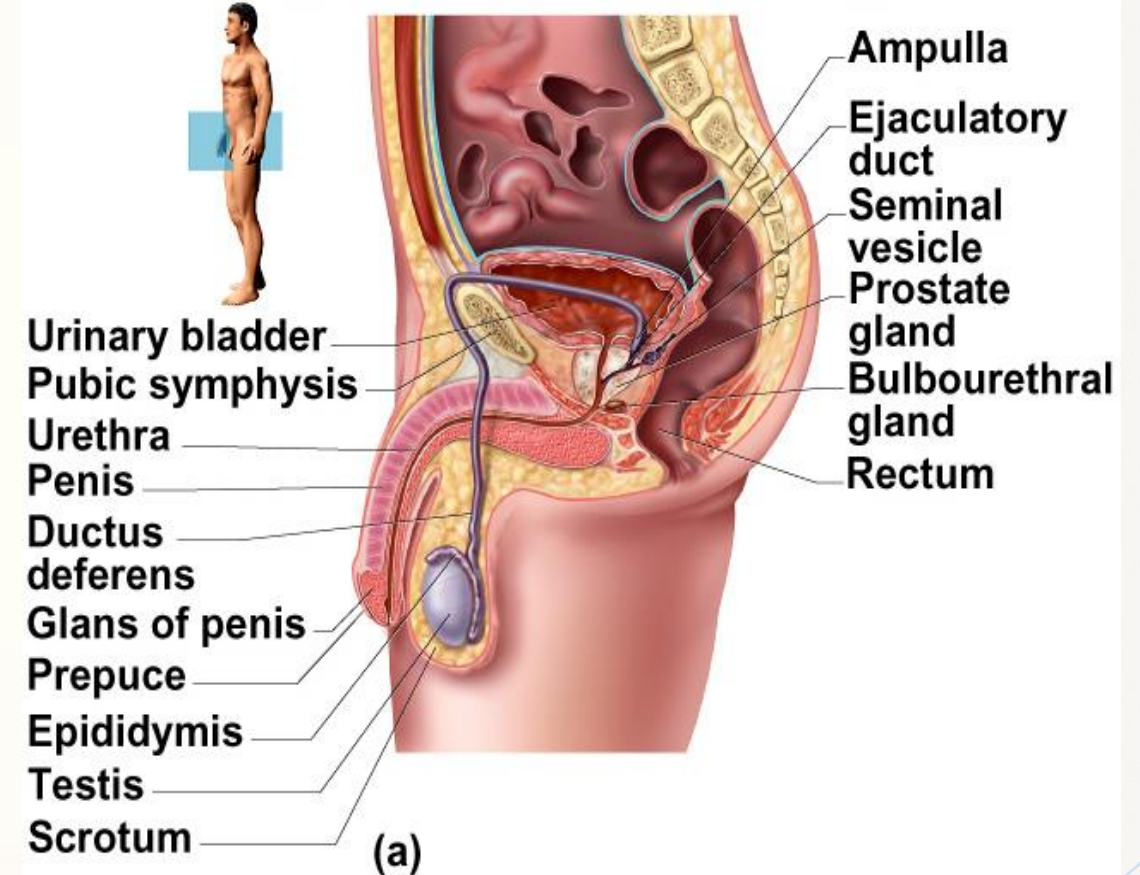
Male reproductive system

The vas (ductus) deferens

- From the epididymis, spermatozoa enter the vas deferens, towards the urethra.
- Can also store smaller numbers of sperm several months

The urethra

The urethra is the tube that drains both the excretory and reproductive systems.



Male reproductive system

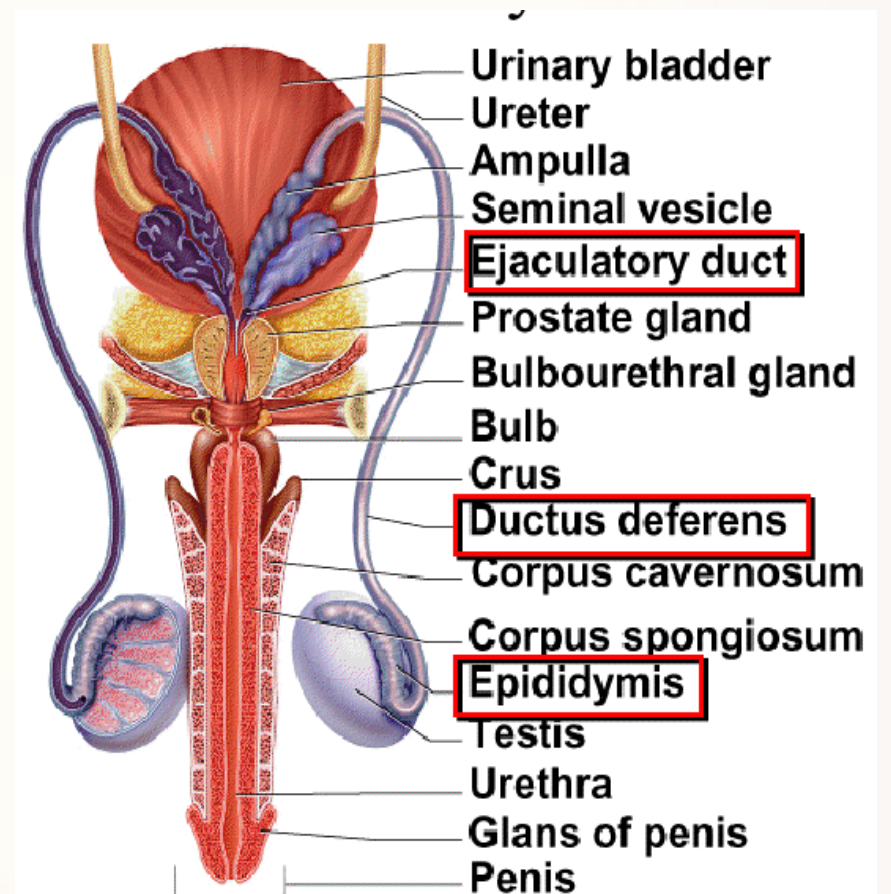
The accessory glands of the male reproductive system

There are three sets of accessory glands associated with the male system:

A pair of seminal vesicles

Their secretion is yellow and alkaline fluid containing:

- A coagulating enzyme (causes semen to coagulate after deposited in female reproductive tract)
- Fructose (provides energy for sperm)
- Prostaglandins (stimulates female uterine contractions to help move spermatozoa to the uterus.)



Male reproductive system

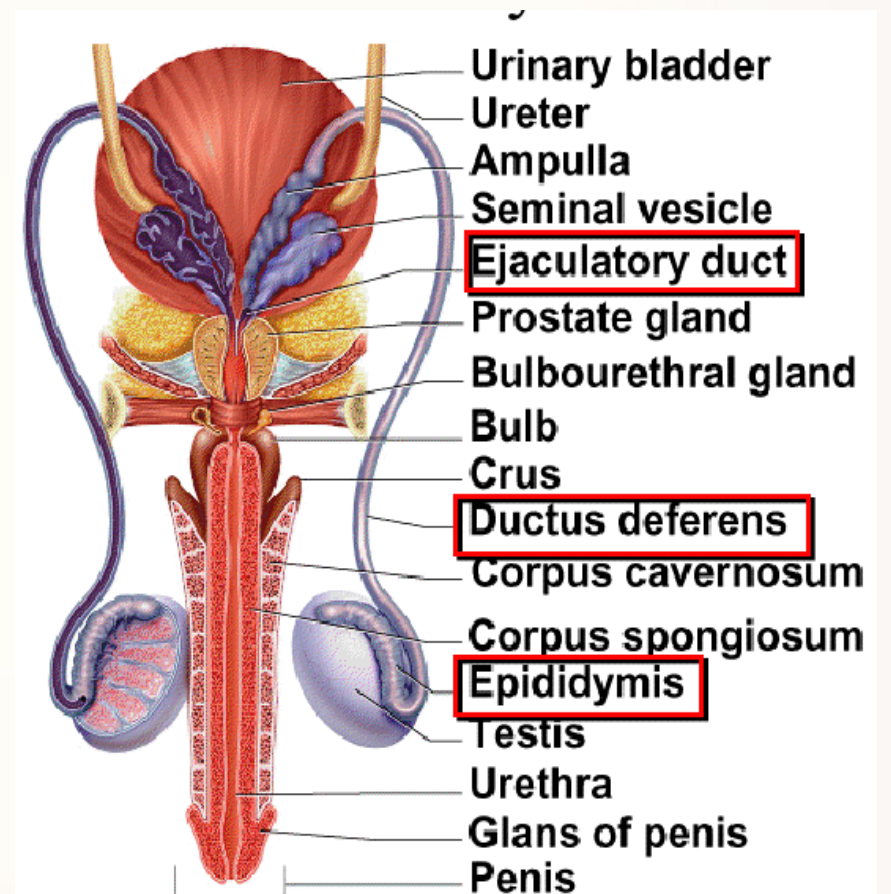
The accessory glands of the male reproductive system

The prostate gland

- It secretes a thin, milky fluid that contains citric acid, several proteolytic enzymes, acid phosphatase, seminal plasmin (antibiotic)
- Prostate secretion is about 25% of semen volume.

The bulbourethral (Cowper's) glands

- Are a pair of small glands below the prostate that empty into the urethra at the base of the penis.
- They secrete a clear mucous before ejaculation. The fluid neutralizes any acidic urine remaining in the urethra.



Male reproductive system

Semen

- The semen is a mixture of spermatozoa and seminal fluid: 60% from seminal vesicles, 30% from prostate. It's slightly alkaline, milky appearance and sticky
- Typical ejaculate in human male is 2.5 to 5 ml in volume
- Normal sperm count is 50 to 150 millions/mL and if less than 20 millions/mL sterile (or infertile).
- Contains nutrients:

Fructose: produced by the seminal vesicles and provides a source of energy for the sperm motility.

Clotting and anticoagulant factors: produced by seminal vesicles and prostate. When first ejaculated the semen due to the fibrinogen, making it easier for uterine contractions to move it along; then **anticoagulants** liquefy the semen and the sperm begins swimming through the female tract

Prostaglandins: produced by the prostate and seminal vesicles. They stimulate peristaltic contractions of the female reproductive tract which help move the sperm up the uterus.

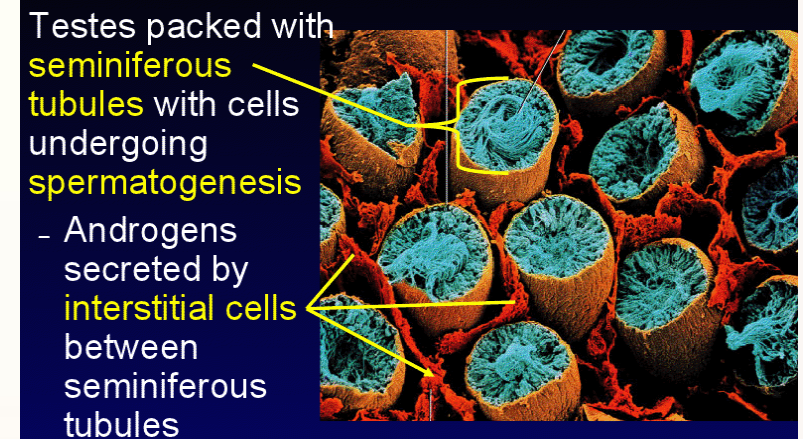
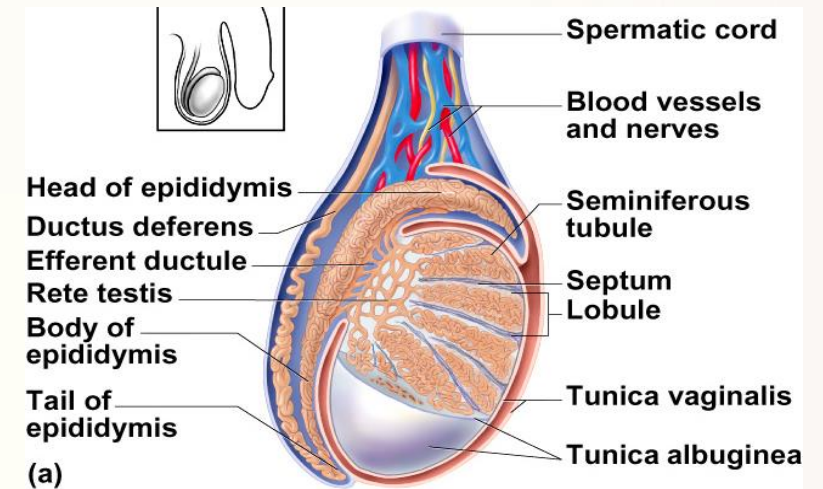
Spermin: The semen is slightly alkaline due to the presence of spermin. This neutralizes the acidic environment of the female vagina, protecting the sperm and increasing their motility.



Male reproductive system

Anatomy of testes

- Testes are composed of 200 - 300 compartments called **lobules** which are separated by **septa**.
- Each lobule is filled with 2 or 3 **seminiferous tubules** where sperm are formed in their walls (spermatogenic epithelium).
- The seminiferous tubules are separated by groups of Leydig cells (called also interstitial cells), blood vessels, lymphatics, and nerves.
- The seminiferous tubules are the site of sperm production.
- About 65-75 days are required in humans to go from a spermatogonium to a sperm (duration of spermatogenesis).



Male reproductive system

Spermatogenesis

A seminiferous tubule contains:

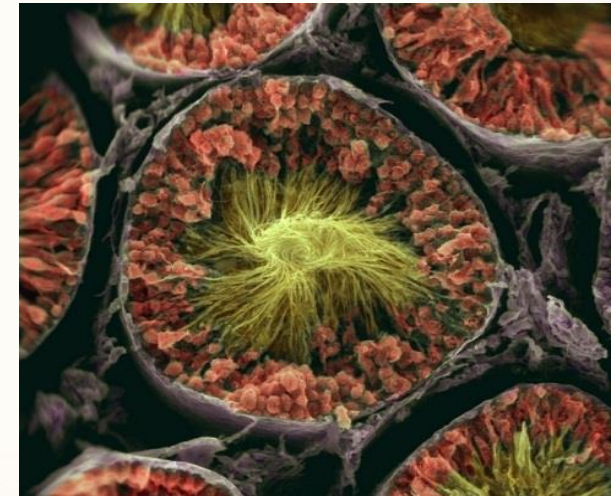
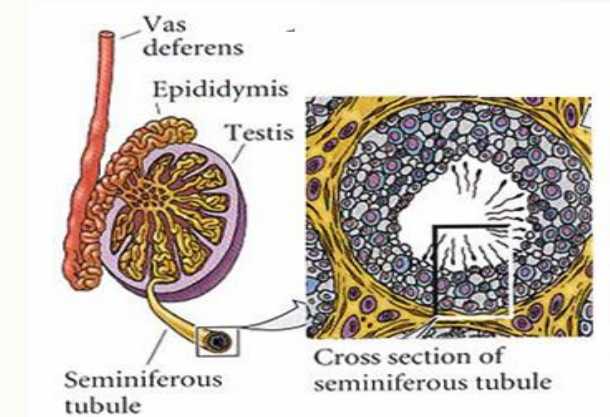
- Sperm forming cells (spermatogenic cells)
- Sertoli cells (supporting cells)

1. Spermatogenic cells

The spermatogenic cells represent the different stages of sperm formation or **spermatogenesis**.

Stage 1: Formation of primary spermatocytes

Spermatogonia divide by mitosis to produce two daughter cells, one remains in the germ line (to continue regeneration of more spermatogonia) and the other one give rise to **primary spermatocyte**, with larger nuclei. sperm.

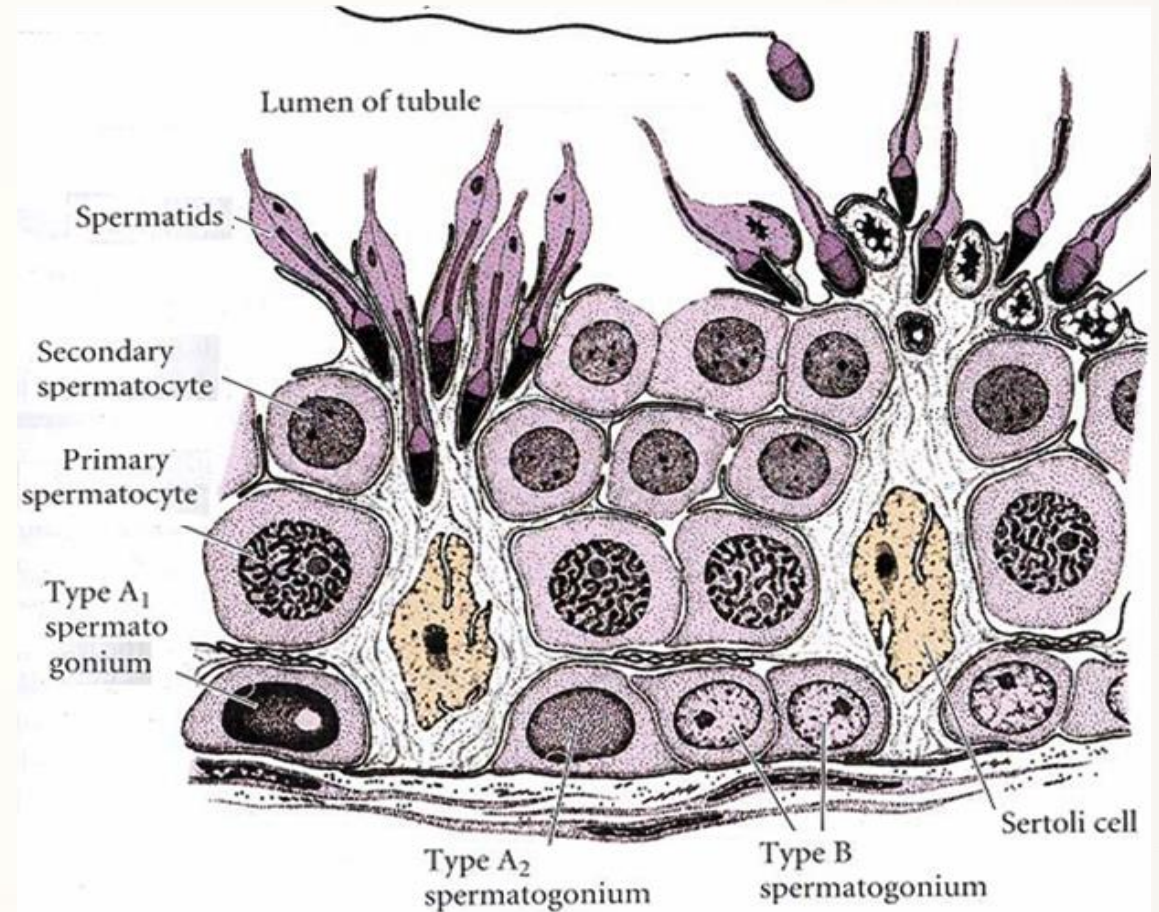


Male reproductive system

Spermatogenesis

Stage 2: Meiosis

The primary spermatocytes undergoes meiosis I to produce two haploid **secondary spermatocytes**. At the end of meiosis ii four genetically distinctive cells (**spermatids**) are created which will each mature (or differentiated) into a sperm.



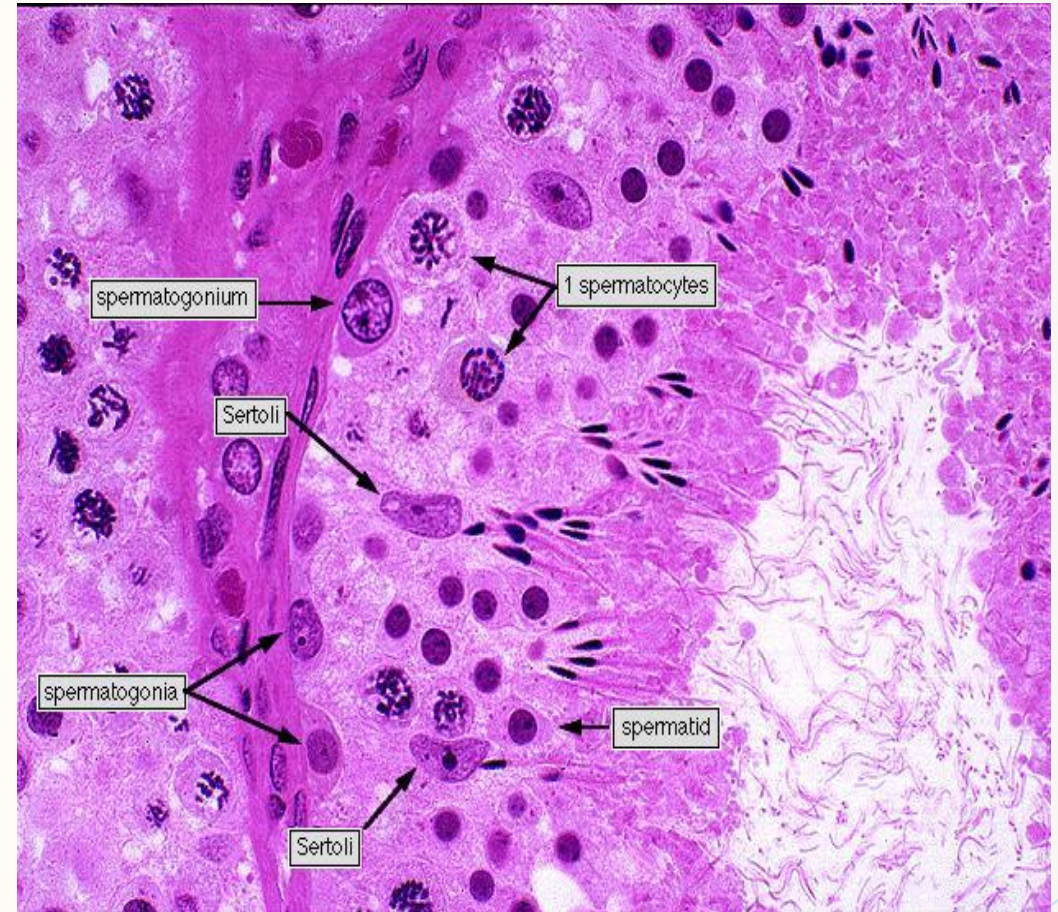
Male reproductive system

2. Sertoli cells

- Nourish spermatocytes, spermatids and recently formed sperm.
- Phagocytize excess spermatid cytoplasm during spermiogenesis (Transformation from spermatid to sperm).
- Control movements of spermatogenic cells and release of sperm into lumen.
- Produce fluid for sperm transport to the duct, secrete inhibin, regulate effects of testosterone and follicle-stimulating hormone (FSH) (**negative feedback**).

3. Leydig (interstitial) cells

- They are found in spaces between seminiferous tubules.
- Secrete testosterone (under the influence of LH).

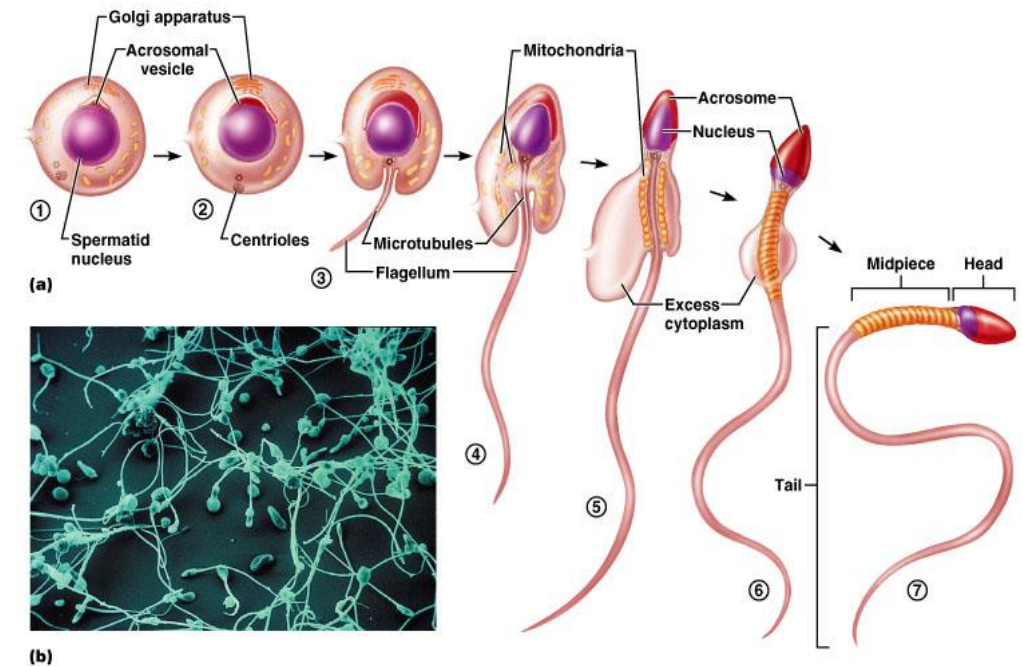


Male reproductive system

Spermiogenesis

Spermiogenesis is the process by which spermatids become mature spermatozoa. The changes include:

- Golgi apparatus forms the **acrosome**: cap-**proteolytic enzymes**.
- Nucleus is condensed
- Microtubules form **flagellum**.
- Mitochondria arrange as spiral around the **neck**.
- Excess cytoplasm cast off as residual body.
- Cytoplasmic bridges break and sperms release from Sertoli cells to lie free in lumen of seminiferous tubules (**Spermiation**).



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Male reproductive system

Structure of the spermatozoon

The spermatozoon is adapted for reaching and **fertilizing** the egg. It is composed of:

- **Head**

Contains DNA and the **acrosome** with enzymes for penetrating the egg

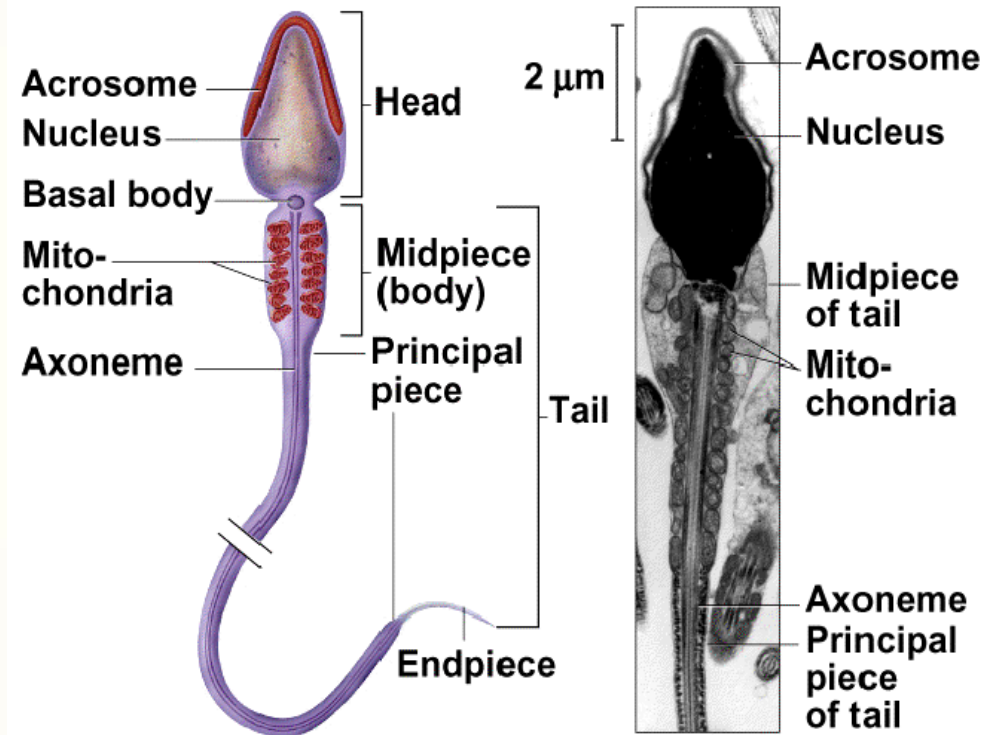
- **Midpiece**

Contains mitochondria to form ATP for energy.

- **Tail**

Is a **flagellum** used for locomotion

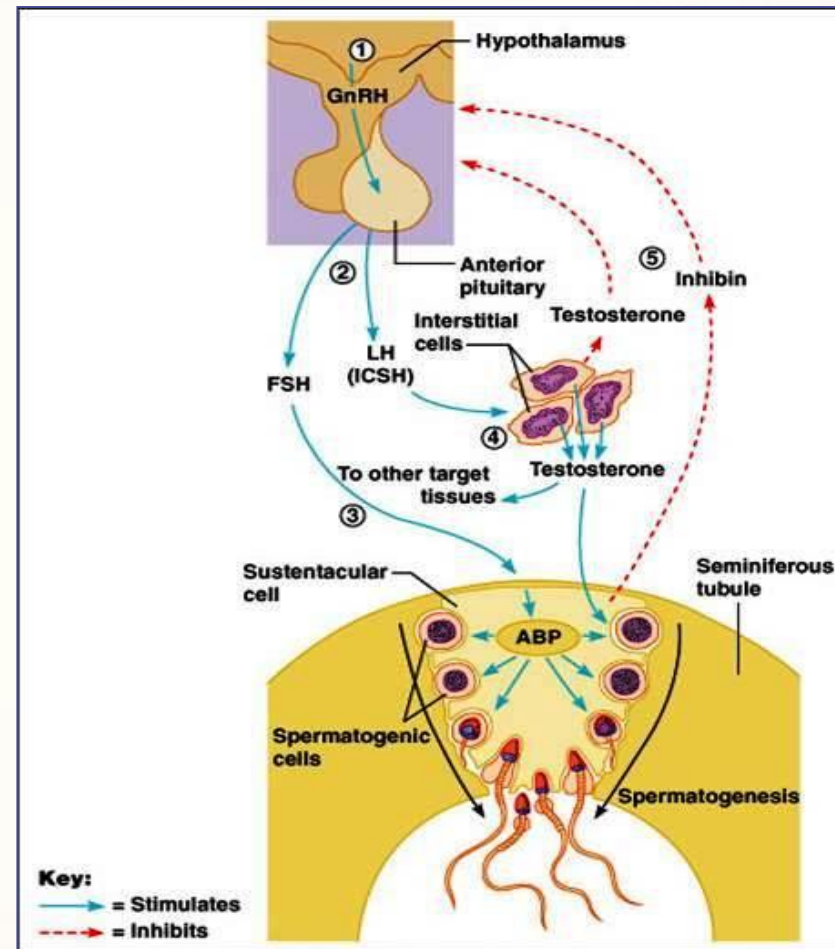
Spermatozoon



Male reproductive system

Hormonal control of testes

- At **puberty**, secretion of gonadotropin-releasing hormone (**GnRH**) from hypothalamus increases.
- GnRH stimulates anterior pituitary to increase secretion of luteinizing hormone (**LH**) and follicle-stimulating hormone (**FSH**). Both together are called gonadotropin)
- LH stimulates Leydig cells to secrete **testosterone**.
- FSH and testosterone act on Sertoli cells to stimulate secretion of androgen-binding protein (**ABP**)
- ABP binds testosterone keeping concentration high.
- Testosterone stimulates spermatogenesis
- Feedback: Sertoli cells release **inhibin** which inhibits FSH



Male reproductive system

Reproductive System Disorders

The prostate tumour

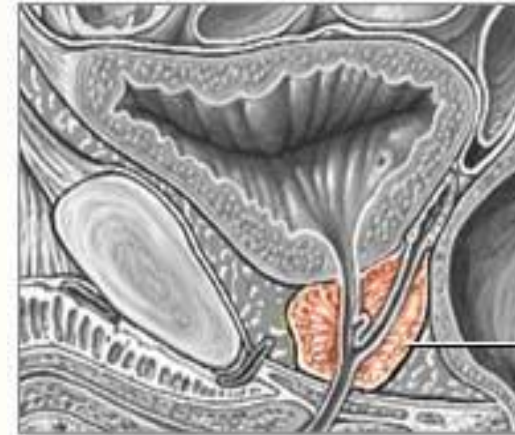
- Very common in blacks and whites but rare in asians.

Incidence increases with age.

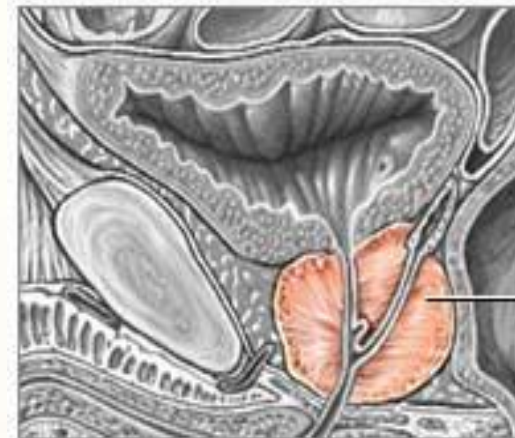
- *Benign (noncancerous)* enlargement of the prostate occurs in more than half of all men over the age of 40 and in virtually all men over 70.
- *Prostate cancer* is one of the most common cancer in men, it is treated surgically or with drugs that inhibit gonadotropins, resulting in reduced prostate activity and size.

Seminoma

Common tumor of the testicles



Normal prostate



Benign prostatic hypertrophy (BPH)



Male reproductive system

Reproductive System Disorders

Male Infertility

- Infertility is the **inability to fertilize** an egg. It can be genetic or can be caused by environmental conditions such as heat & trauma to the testes.
- Considered infertile after one year of unprotected intercourse fails to produce a pregnancy.

Male problems include

- **Changes in sperm or semen**
- **Hormonal abnormalities:** pituitary disorders or testicular problems
- **Physical obstruction of sperm passageways:** congenital or scar tissue from injury
- **Semen analysis:** number, motility, normality



Male reproductive system

Reproductive System Disorders

The main origin of male infertility are:

- Varicocele (35-40%)
- Idiopathic (25%)
- Infection (~10%)
- Genetic (~10%)
- Endocrine (<5%)
- Immunologic (<5%)
- Obstruction (<5%)
- Cryptorchidism (<5%)

Infections

Caused by Chlamydia or Gonorrhea bacterial invasion originates in the bloodstream or from a descending infection from the kidney.

- **Epididymitis:** inflammation of the epididymis.
- **Prostatitis:** Inflammation of the prostate
- **Sexually Transmitted Diseases:** Syphilis, Chlamydia

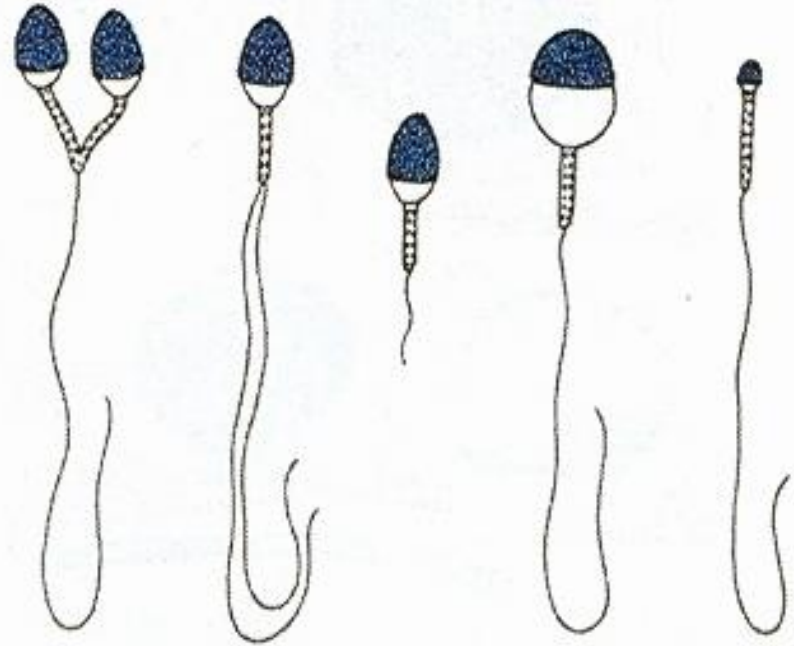


Male reproductive system

Reproductive System Disorders

Environmental gonadotoxins

- Smoking
- Alcohol
- Radiation, chemicals, pesticides, chemotherapy
- Heat exposure (short order cook, tanning booths, hot tub/bath)
- Medications (steroids, herbal supplements, hair growth products)



Male Reproductive System

Reproductive System Disorders

- Decline in testosterone secretion
 - peak secretion at 7 mg/day at age 20
 - declines to 1/5 of that by age 80
- Rise in FSH and LH secretion after age 50 produces male climacteric (menopause)
 - mood changes, hot flashes & “illusions of suffocation”
- Impotence (erectile dysfunction)
 - 20% of those in 60s and 50% of those in 80s
 - Over 90% of impotent men remain able to ejaculate

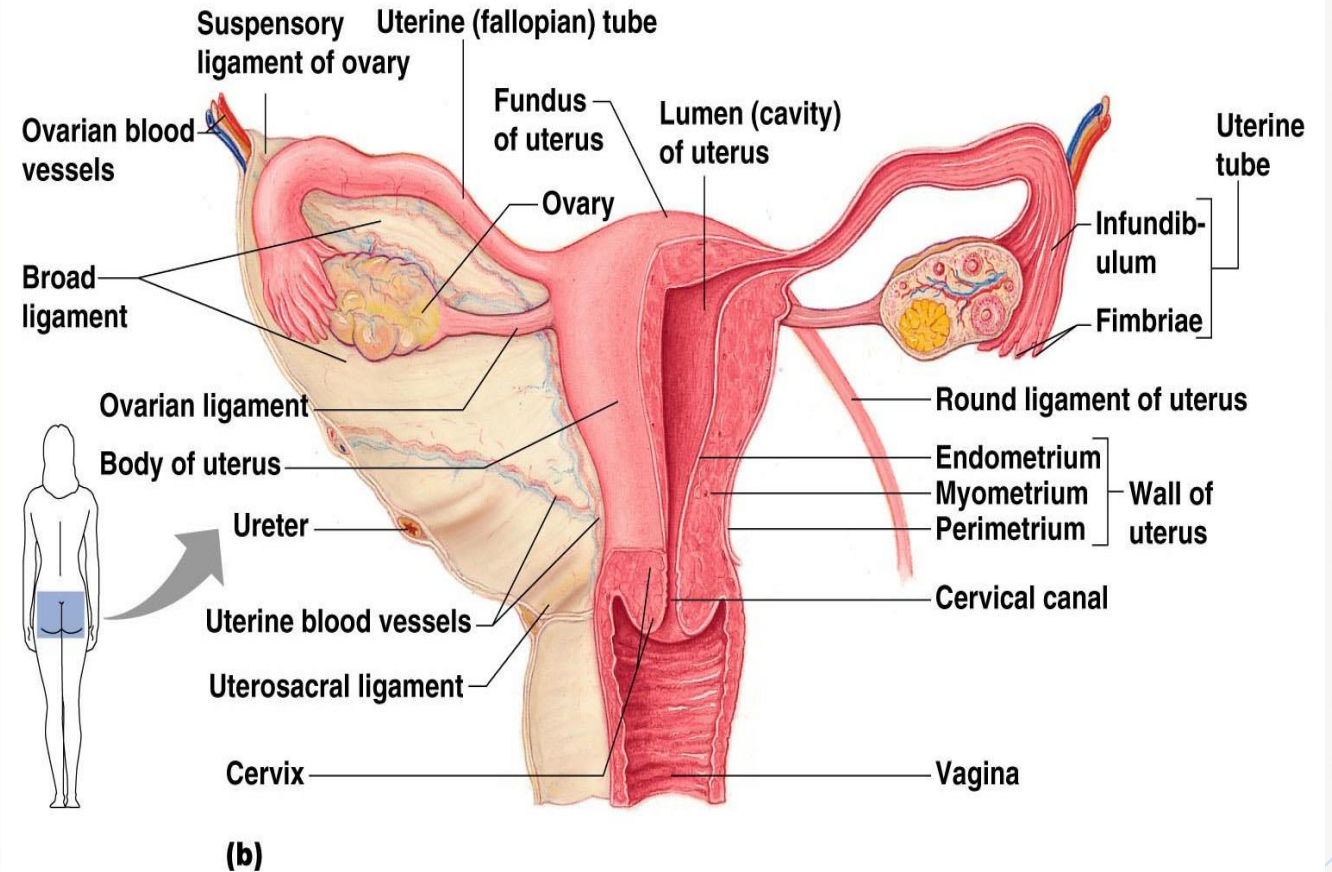


Female Reproductive System

The organs of the female reproductive system produce the ova (eggs), sex hormones, and provide an environment for internal fertilization and development of the fetus.

The female reproductive system is made up of:

- Ovaries
- Uterine tubes
- Uterus
- Vagina
- External genitalia

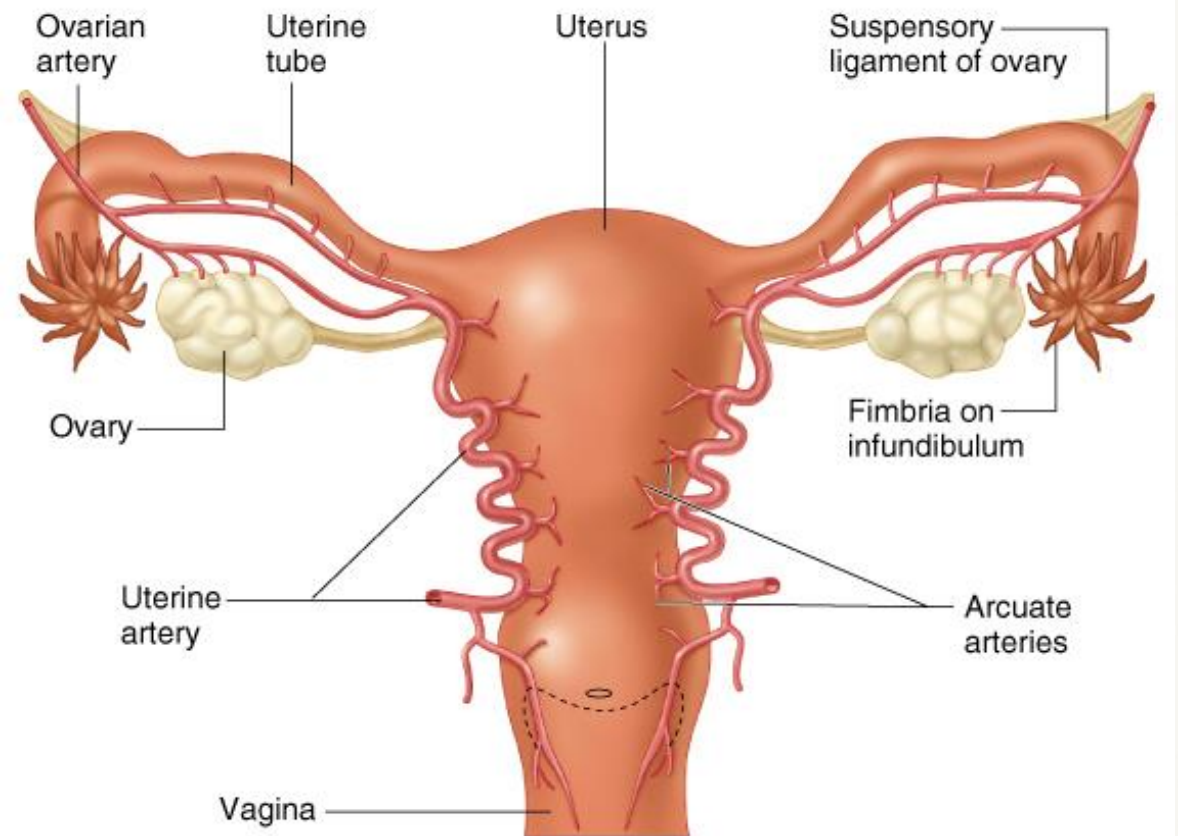


Female Reproductive System

The ovary

The ovary has the size of an almond and is the site of **oogenesis** and female **sex hormone production**. This paired organ is suspended by mesenteries and **ligaments**.

Typically, only one egg is released from an ovary every month, the ovaries alternate in releasing the egg.



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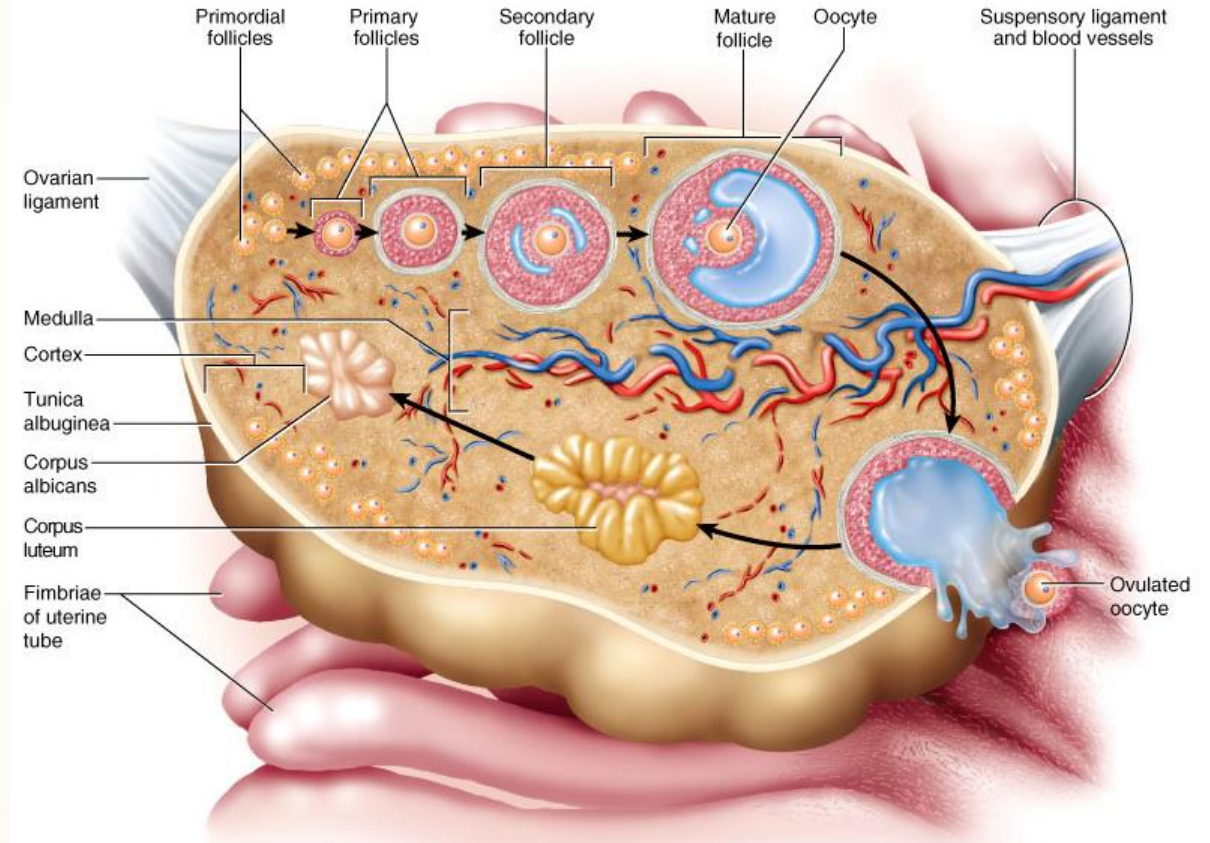


Female Reproductive System

The ovary

The ovary is composed of two parts:

- **The cortex** that houses the developing egg cells.
- **The medulla:** is the middle region composed of connective tissue, blood vessels and lymphatics.
- **Germinal epithelium** is a peritoneal membrane covering the ovary. A layer of flattened epithelial cells.



Female Reproductive System

Uterine Tubes (Fallopian tubes) or oviducts

The uterine tubes are hollow, muscular tubes composed of:

- Fimbriae

The **finger-like projections** at the distal end of the uterine tube that receives the oocyte from the ovary.

- Infundibulum:

An expanded funnel near ovary.

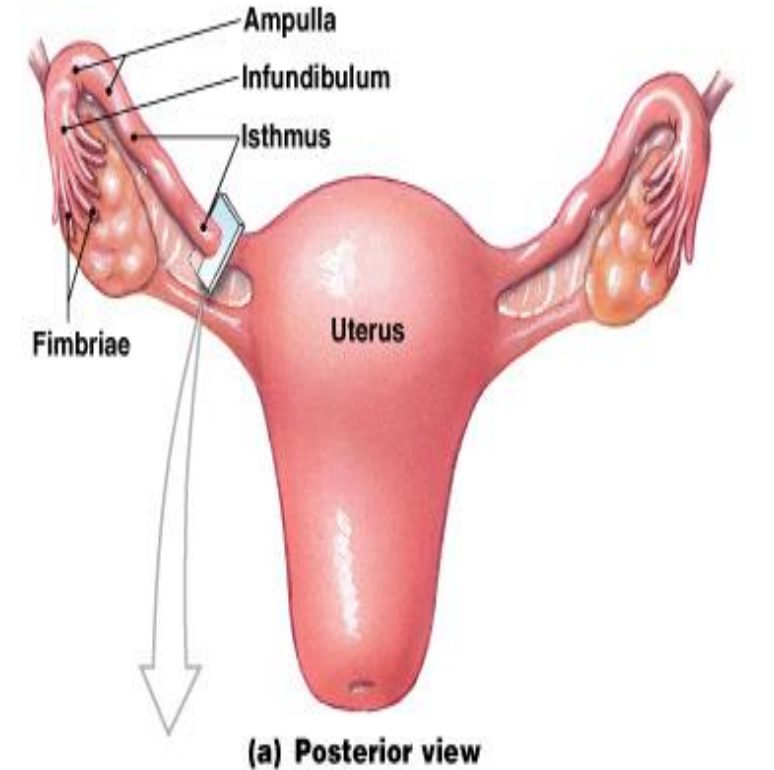
- Ampulla

Middle segment near Infundibulum with larger diameter. It is the site of fertilization.

- Isthmus:

A short segment near uterus

The uterine tube is lined by a ciliated epithelium. The cilia slowly move (pull) the oocyte (or fertilized oocyte which begins cleavage towards the uterus (takes 3–4 days)).

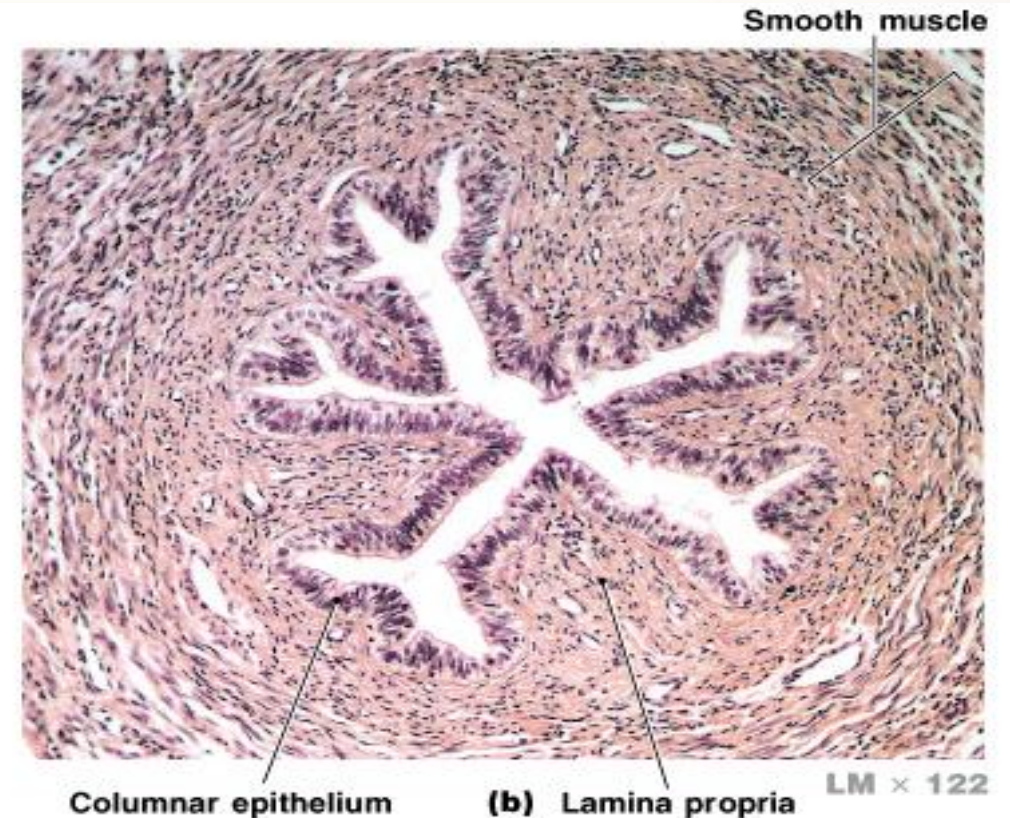


Female Reproductive System

Uterine Tubes (Fallopian tubes)

Functions

- **Receive** the ovulated oocyte and moves toward uterus
- **Provide a site for fertilization**: Fertilization occurs inside the uterine tube between ampulla and isthmus. Secondary oocyte must meet spermatozoon during first **12–24** hours after ovulation since oocyte lives about 24 hours. Whereas sperm can remain viable up to 48 hrs.
- **Attach** to the uterus
- **Transport** oocyte from ovary to uterus involves ciliary movement and peristaltic contractions
- The site of early embryonic development.



Female Reproductive System

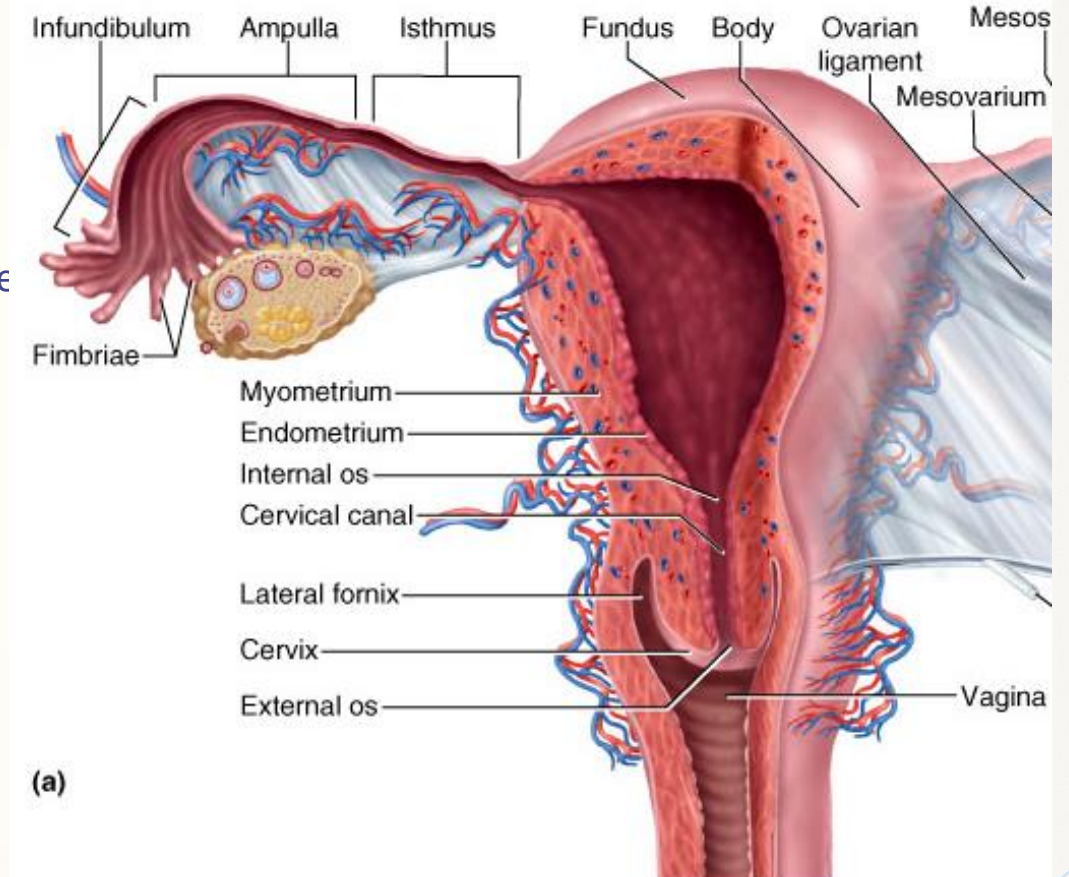
Uterus

There are 3 anatomical regions in the uterus:

- **Cervix:** Arrow neck which connects to the vagina inferiorly
- **Body:** Large middle portion of the uterus.
- **Fundus:** Rounded superior region that connects to the 2 uterine (fallopian) tubes.

The wall of the uterus is composed of:

- **Endometrium**
 - Inner layer
 - Allows for implantation of a fertilized egg
 - Sloughs off if no pregnancy occurs (menses)
- **Myometrium:** Middle layer of smooth muscle
- **Perimetrium:** Utermost serous layer of the uterus



Female Reproductive System

Uterus

Functions

- Receives a fertilized egg
- Retains the fertilized egg
- Provides protection, nourishment and waste removal for the developing embryo and fetus.
- Contractions of muscle walls expel fetus at birth.



Female Reproductive System

Vagina

- Composed of smooth muscle
- Extends from **cervix** to exterior of body
- Located between bladder and rectum
- Serves as the birth canal
- Receives the penis during sexual intercourse (site of semen deposition)
- Hymen—partially closes the vagina until it is ruptured

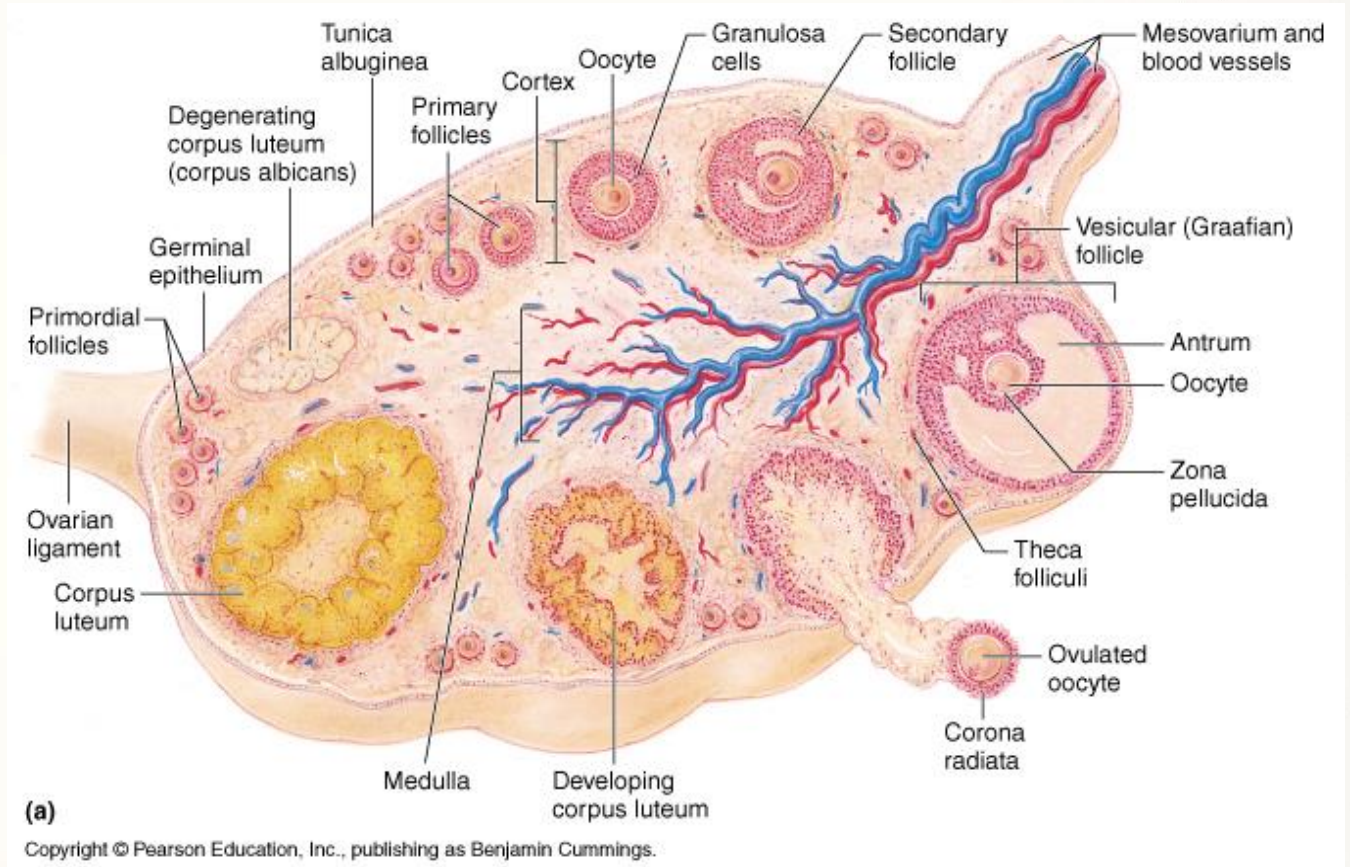


Female Reproductive System

The oogenesis and ovarian Cycle

Every 28 days in humans the pituitary hormones FSH and LH stimulate the growth of follicles called the **ovarian cycle**. By looking at the ovary, we conclude various stages of the development of the ovum and follicle.

During the first two weeks of the menstrual cycle, several follicles begin to grow and become **multilayered**, but only one will continue to mature while others degenerate.

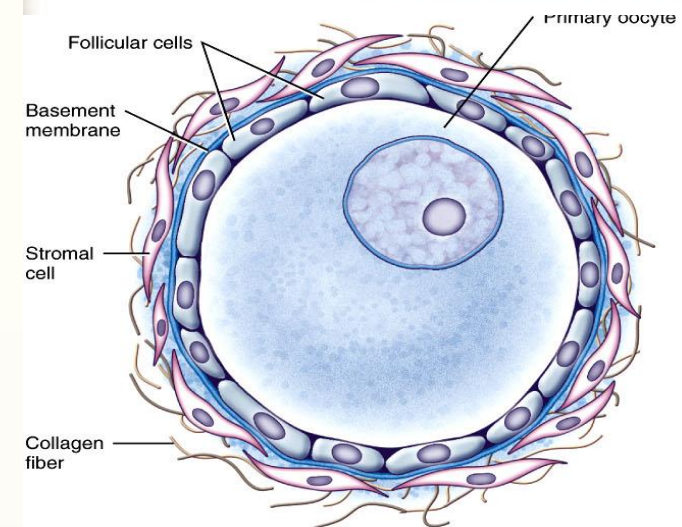
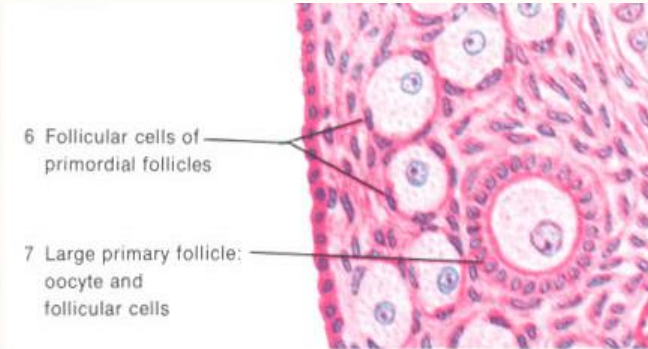


The oogenesis and ovarian Cycle

The process of making egg cells is called **oogenesis**. It begins in the female embryo when primordial germ cells undergo mitotic division to produce diploid oogonia surrounded by a layer of flattened follicular cells. These are called the **primordial follicles**.

Primordial follicle

- Consists of **primary oocyte** surrounded by a single layer of squamous (flat) **follicular cells** that have begun proliferation.
- Each month a population of primordial follicles develop under the influence of FSH.
- No change in primary oocyte which still arrested at **prophase I** at birth.
- Most primordial follicles undergo a process of degeneration called **atresia**. Only 2 million remain at the time of birth, and by puberty, only 400,000 remain. From the 400,000 oocytes; release about 400-500 (at ovulation) in a lifetime.



(a) Primordial follicle



The oogenesis and ovarian Cycle

The ovarian cycle is divided into **follicular phase** and **luteal phase**. The first day of the cycle is the first day of blood flow (day 0) known as menstruation.

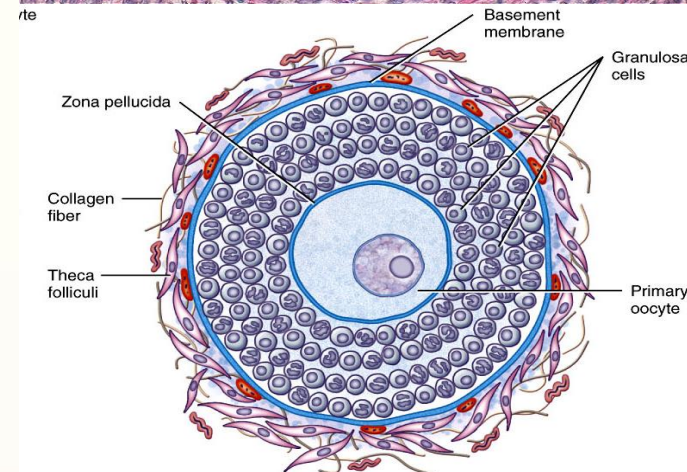
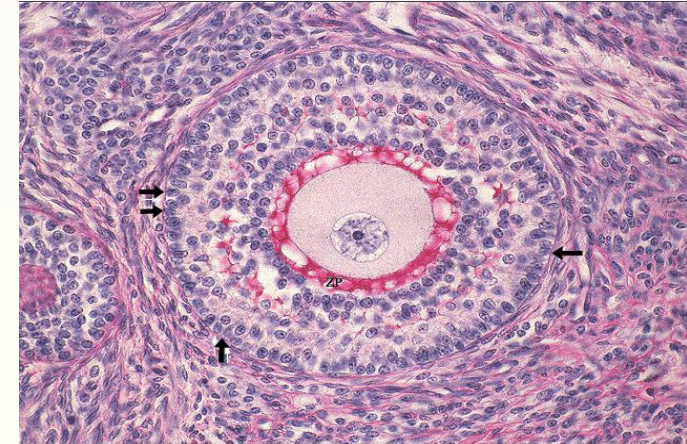
Follicular phase (preovulatory phase)

Day 1-14

The follicular phase extends from the beginning of menstruation until ovulation. It averages 14 days, but is also the most variable portion of the cycle.

Primary follicle

- FSH causes the follicular cells surrounding the oocyte to proliferate and form many layers of cuboidal granulosa cells, and the follicle is now a primary follicle.
- The follicular cells secrete a layer of glycoprotein around the ova called the **zona pellucida** (acellular coat).
- Stromal cells begin to form **theca folliculi** (**theca interna & theca externa**).



(b) Late primary follicle

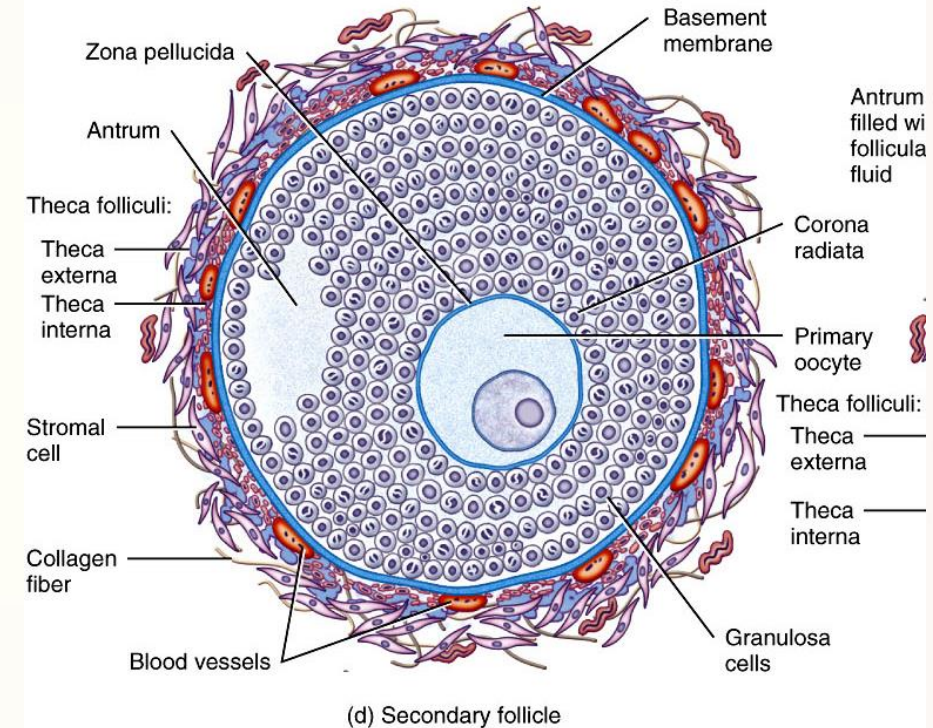


The oogenesis and ovarian Cycle

Secondary follicle

- A follicular fluid secreted by granulosa cells accumulates between inner and outer layers of follicle. This fluid is rich in estrogen.
- Few of the primary follicles progress to this stage each cycle.
- Thecal cells are formed from cells that surround follicle. They produce estrogens. (by combined action of both granulosa and theca interna cells).

Primary and secondary follicles are microscopic.



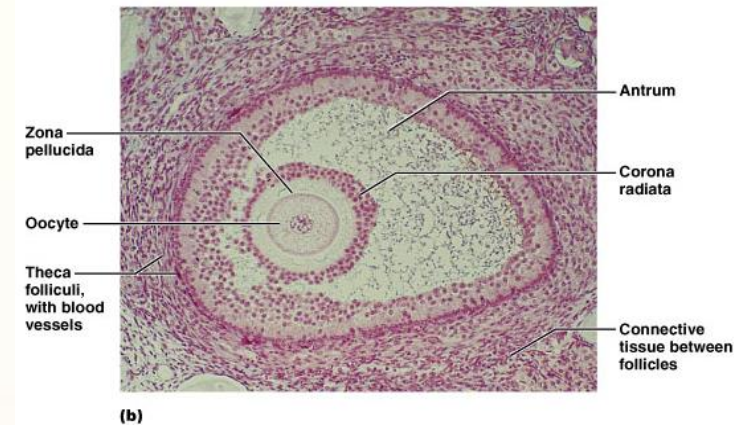
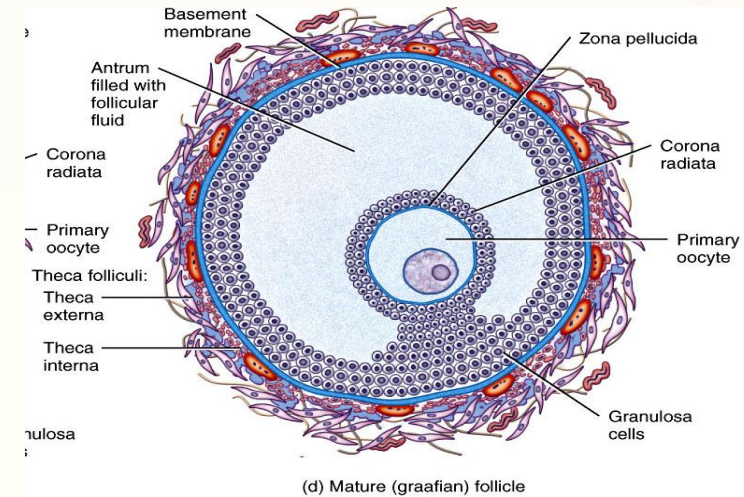
(d) Secondary follicle
Figure 28.14abcd Tortora - PAP 12/e
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The oogenesis and ovarian Cycle

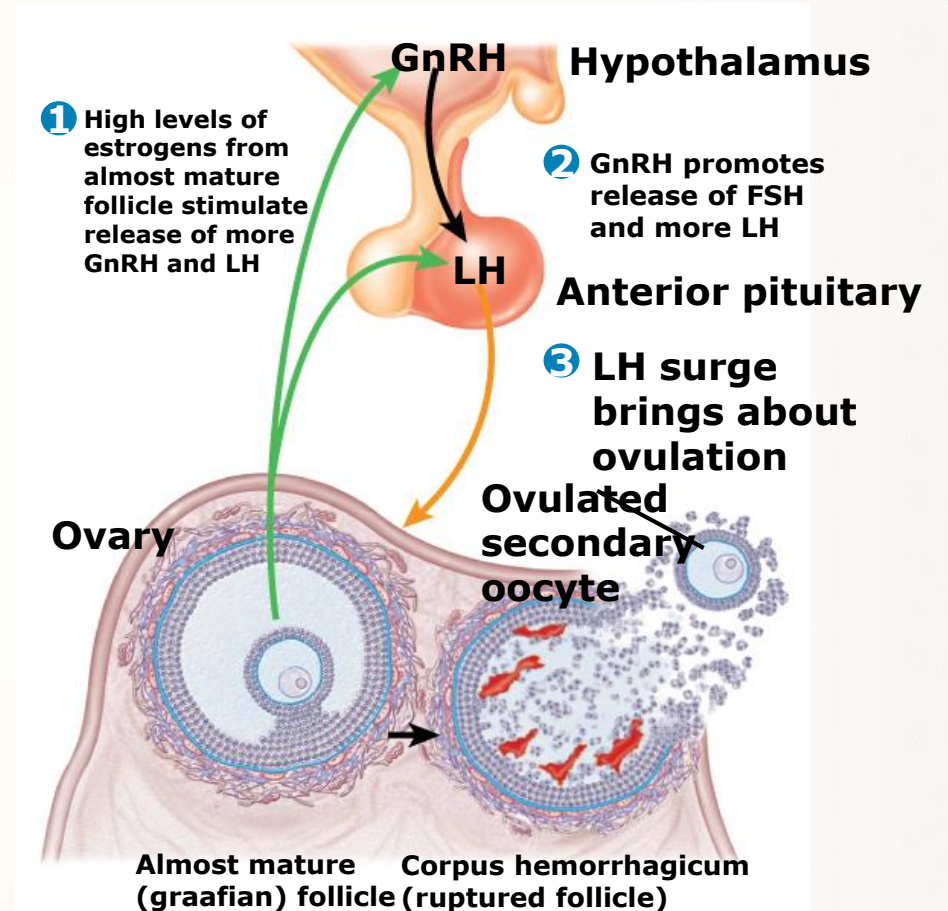
Mature follicle or Graafian follicle

- One follicle of secondary follicles rapidly outpaces the others and becomes the dominant follicle. The follicle is now called the Graafian follicle (can be seen by naked eyes on the surface of the ovary).
- The follicle size has increased and becomes very large. Many layers of cells surrounding fluid-filled center called **antrum**.
- Primary oocyte completes meiosis, produces **secondary oocyte** and polar body.
- Secondary oocyte covered with thick, clear membrane called **zona pellucida**; pushed to one side in follicle and surrounded by mass of follicular cells called **cumulus oophorus**.



The oogenesis and ovarian Cycle

- The rising levels of estrogen secreted from the Graafian follicle causes a surge (release) of LH (and FSH) from the pituitary gland.
- The LH surge stimulates a rapid production of antral (follicular) fluid which fills the follicle beyond capacity causing it to **rupture**.
- When the follicle ruptures, the secondary oocyte surrounded by the zona pellucida and cumulus oophorus, is released from the surface of the ovary, and move into the uterine tube (ovulation process). The cumulus oophorus now is called the corona radiata.
- Only the oocyte in the dominant follicle is released in each ovarian cycle. Oocytes in other follicles degenerate.



The oogenesis and ovarian Cycle

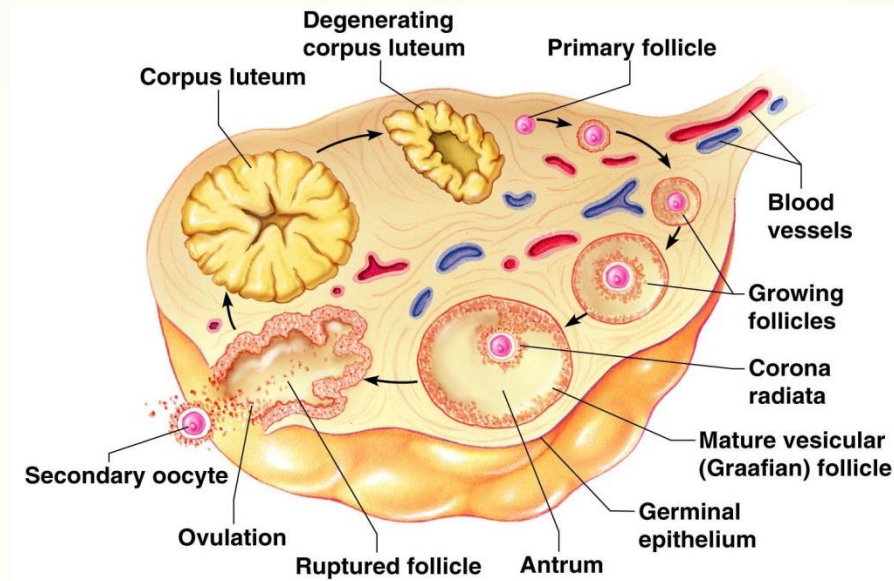
Ovulation



The oogenesis and ovarian Cycle

Luteal Phase (postovulatory phase) (Day 15-28)

- When the follicle expels the oocyte, most of the follicular cells of the ruptured Graafian follicle remain in the ovary and organize into a glandular **corpus luteum** that secretes progesterone and some estrogen.
- If oocyte not fertilized, the corpus luteum lasts 2 weeks and degenerates into a **corpus albicans** (a fibrous tissue). This causes a reduction in progesterone and estrogens and, by a negative feedback, causes the secretion of FSH and a new ovarian cycle begins.

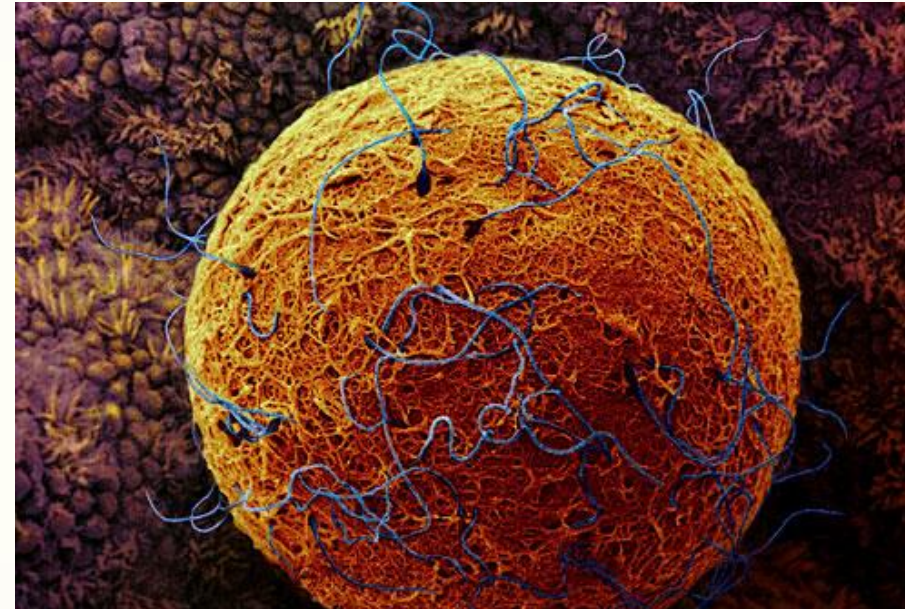


● The oogenesis and ovarian Cycle ●

Luteal Phase (postovulatory phase) (Day 15-28)

- If oocyte become fertilized, it secretes a hormone called Human chorionic gonadotropin (hCG) produced by chorion of embryo about 8 days after fertilization.

The hCG stimulates the anterior pituitary gland for continued secretion of LH which prevents the degeneration of the corpus luteum and progesterone-hormone of pregnancy- is maintained.



The Uterine Cycle

The utrine cycle (menstrual cycle)

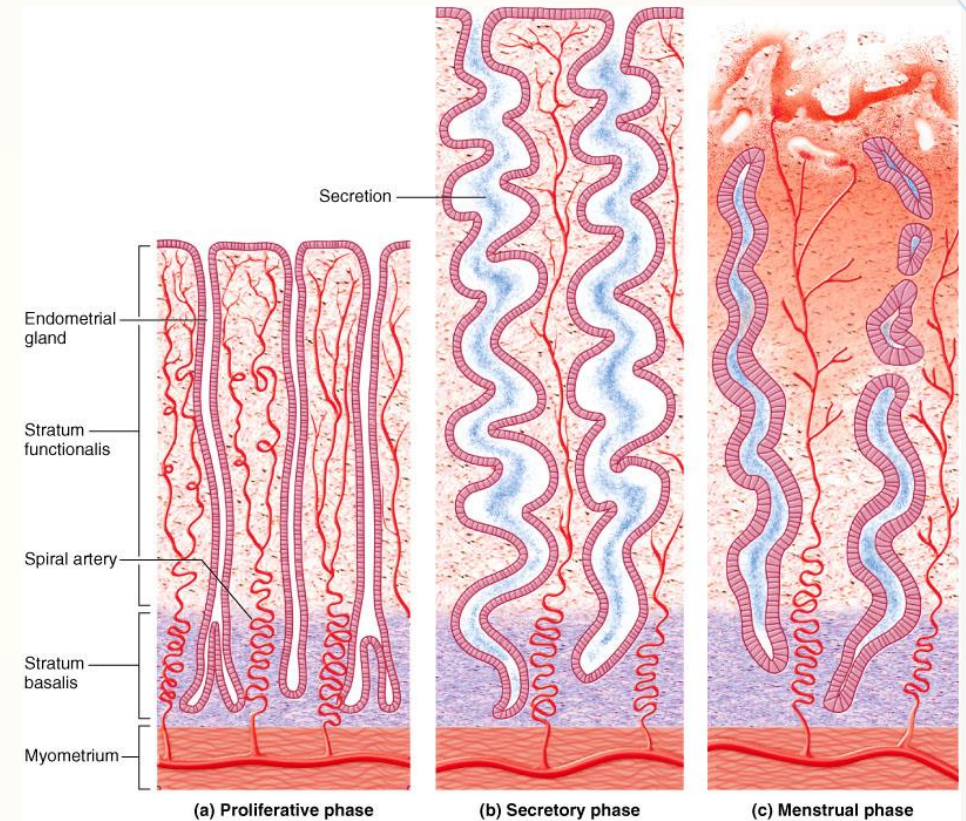
Occurs in primates.

- An utrine cycle is parallel to the ovarian cycle. It varies from one woman to another; usually 28 days, but can be 20 to 40 days.
- First utrine cycle, called **menarche** begins at puberty (age 11–12) and cessation of menstruation occurs at **menopause** (age 45–55).

The phases of utrine cycle are:

Menstrual phase (days 1 – 5)

If the corpus luteum degenerate the estrogen level decrease and causes the **endometrium** to shed (decrease thickness) and the blood flows out of the vagina.



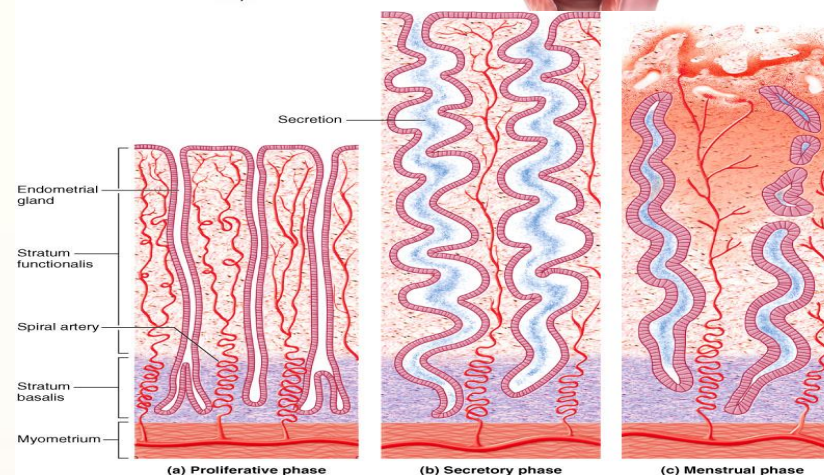
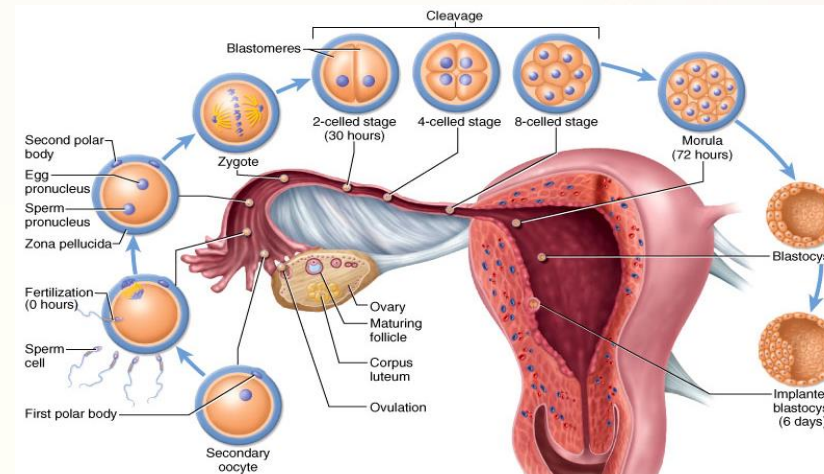
The Uterine Cycle

Proliferative phase (days 6 – 14)

- In uterine cycle, preovulatory phase is the proliferative phase because endometrium is proliferating.
- With greater amounts of estrogen secreted from the ovary, the endometrium lining thickens and prepares for the eventual embryo.

Secretory phase (days 14 – 28)

- After ovulation and during the **luteal phase** progesterone and estrogens produced by corpus luteum promote growth of endometrium because of the secretory activity of **endometrial glands**.
- Endometrium continues to thicken, or vascularize, and develops glands which secrete a **glycogen fluid**.



The Uterine Cycle

An increase in vascular supply (arteries grow) and develops exocrine secreting uterine glands make the thickness of endometrium double.

- At the end of the cycle, the endometrial glands secrete **uterine milk** that nourish a developing fertilized egg.
- If fertilization does not occur and therefore no embryo implant by the end of this phase, levels of progesterone and estrogens decline due to the degeneration of corpus luteum.

The endometrium breaks down and passes out with the **menstrual flow**. A new cycle begins.



Summary

The Male Reproductive System

- It consists of **primary sex organs (testes)**, a system of ducts that transport and stores sperm and accessory sex glands that adds secretions (**seminal plasma**) to semen.
- The sex cells (spermatozoa) or sperm are produced in the male gonads or **testes** (in the wall of seminiferous tubules).
- Scrotum is a sac located outside the body that houses the two testes.
- **Testosterone** is the main male hormone required for spermatogenesis and sexual desire.
- The spermatogenesis produces a microscopic sex cell (male gamete) consisting of a head, neck and tail (flagellum). The genetic material (chromosomes) are located in the head whereas motility occurs by means of the flagellum.



Summary

The Female Reproductive System

- It consists of the organs that produce and transport the ova (eggs), sex hormones, and provide an environment for internal fertilization and development of the fetus.
- They undergo changes according to the menstrual cycle.
- Each month from puberty to menopause, FSH and LH stimulate the development of several primordial follicles.
- Usually, only one reaches ovulation which occurs at the middle of the cycle (Day 14).
- At ovulation, secondary oocyte expelled with first polar body and corona radiata.
- If fertilization does not occur, cells degenerate.

