

Chapter 10

The Reproductive System

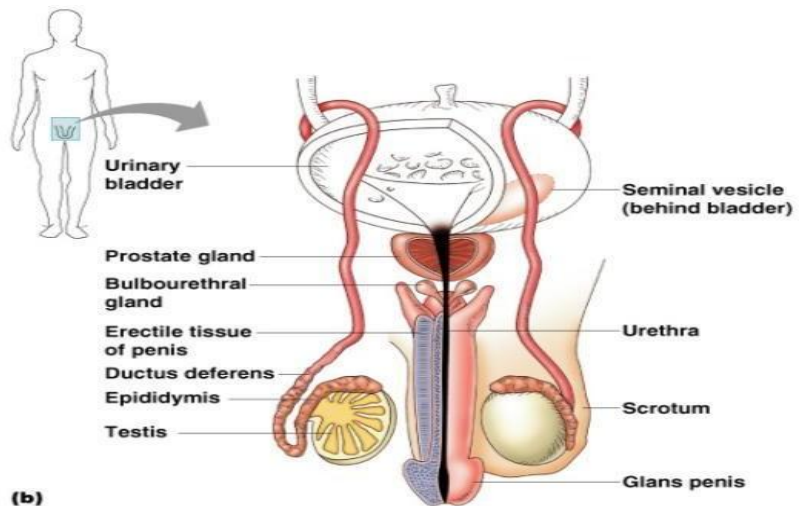
The Gonads are the primary sex organs (Testes in males and Ovaries in females). Gonads produce gametes (sex cells) and secrete hormones:

Sperm – male gametes

Ova (eggs) – female gametes

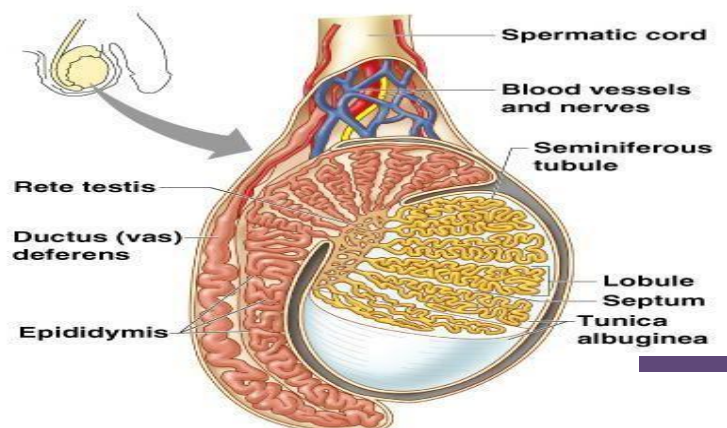
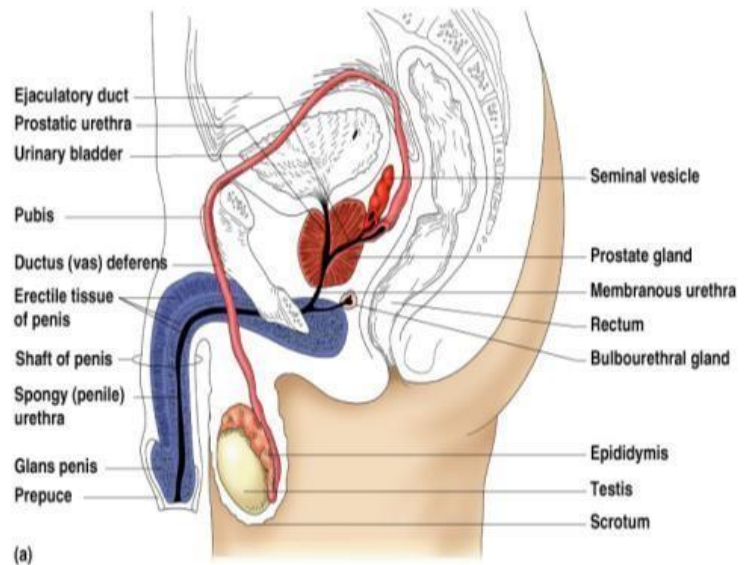
Male Reproductive System

- Consists of:
 - ✓ Testes
 - ✓ Duct system
 - Epididymis
 - Ductus deferens
 - Urethra
- Accessory organs
 - Seminal vesicle
 - Prostate gland
 - Bulbourethral gland
- External genitalia
 - Penis
 - Scrotum



Testes

- Each testis is approx. 4 cm long and 2.5 cm wide
- Coverings of testes
 - Tunica albuginea
 - Fibrous connective tissue capsule that surrounds each testis
 - Septa – extensions of the capsule that extend into the testis and divide it into lobules
 - Each lobule contains one to four seminiferous tubules
 - Tightly coiled structures
 - Function as sperm-forming factories



- Empty sperm into the rete testis (first part of the duct system)
- Sperm travels through the rete testis to the epididymis
- Interstitial cells in the seminiferous tubules produce androgens such as **testosterone**

Duct System

- Epididymis
- Ductus (vas) deferens
- Urethra

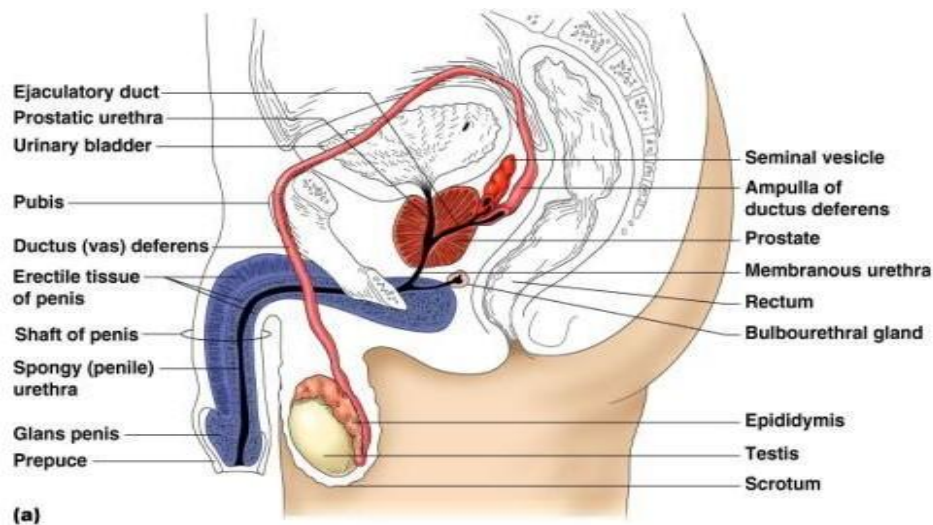
Epididymis

Comma-shaped, tightly coiled tube

- Location:
 - Found on the superior part of the testis and along the posterior lateral side
- Function
 - To mature and store sperm cells (at least 20 days)
 - Expels sperm with the contraction of muscles in the the epididymis walls to the Vas deferens

Ductus Deferens (Vas Deferens)

- Carries sperm from the epididymis to the ejaculatory duct
- Passes over the bladder
- Moves sperm by peristalsis
- Ends in the ejaculatory duct which unites with the urethra
- Expanded end is called the ampulla
- Vasectomy :
- cutting of the ductus deferens at the level of the testes to prevent transportation of sperm



Urethra

- Extends from the base of the urinary bladder to the tip of the penis
- Carries both urine and sperm
- Sperm enters from the ejaculatory duct
- Regions of the urethra
 - Prostatic urethra –surrounded by prostate
 - Membranous urethra – from prostatic urethra to penis
 - Spongy (penile) urethra – runs the length of the penis

Accessory Organs

1. Seminal vesicles
2. Prostate
3. Bulbourethral glands

1-Seminal Vesicles

- ❖ Located at the base of the bladder
- ❖ Produces a thick, yellowish secretion (60% of semen)
 - Fructose (sugar)
 - Vitamin C
 - Prostaglandins
 - Other substances that nourish and activate sperm

2-Prostate Gland

- ❖ Encircles the upper part of the urethra
- ❖ Secretes a milky fluid
 - Helps to activate sperm
 - Enters the urethra through several small ducts

3-Bulbourethral Glands

- ❖ Pea-sized gland inferior to the prostate
- ❖ Produces a thick, clear mucus
 - Cleanses the urethra of acidic urine
 - Serves as a lubricant during sexual intercourse
 - Secreted into the penile urethra

Semen;

- Mixture of sperm and accessory gland secretions of
 1. Seminal vesicle
 2. Prostate gland
 3. Bulbourethral gland
- Advantages of accessory gland secretions
 1. Fructose provides energy for sperm cells
 - i. Alkalinity of semen helps neutralize the acidic environment of vagina
 - ii. Semen contains seminalplasmin, an antibiotic chemical that inhibits bacterial

iii. multiplication

2. Semen releases hormones and enzymes that enhance sperm motility

External Genitalia

➤ Scrotum

➤ Penis

➤ Scrotum

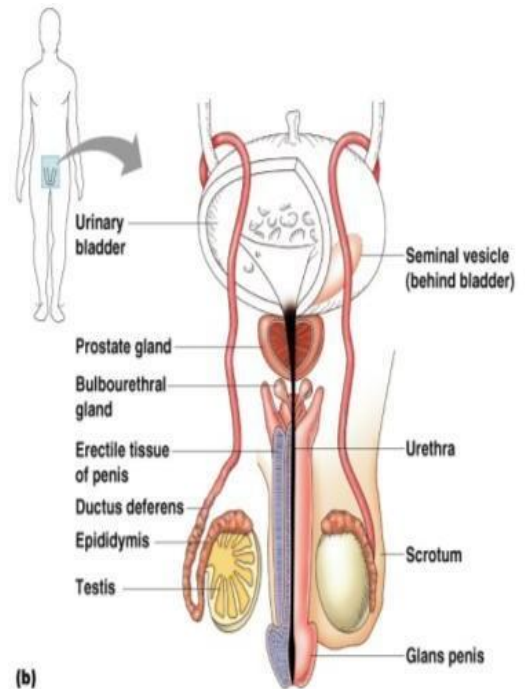
- Is a divided sac of skin hangs outside the abdomen between legs and at the root of the penis
- Maintains testes at 3°C lower than normal body temperature to protect sperm viability

➤ Penis

- Delivers sperm into the female reproductive tract

Regions of the penis

- Shaft
- Glans penis (enlarged tip)
- Prepuce (foreskin)
 - Folded cuff of skin around proximal end
 - Often removed by circumcision

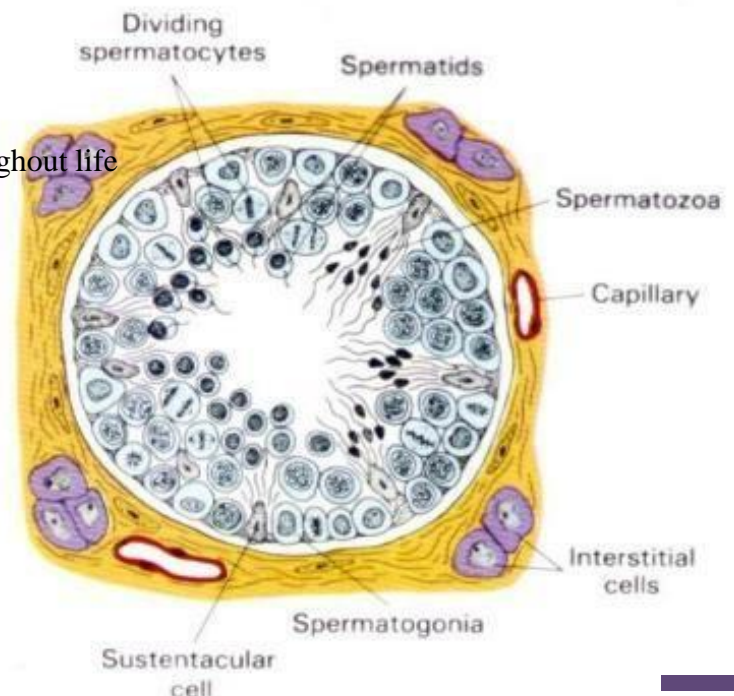


Male Reproductive Functions

- Produce sperm
- And Testosterone hormone

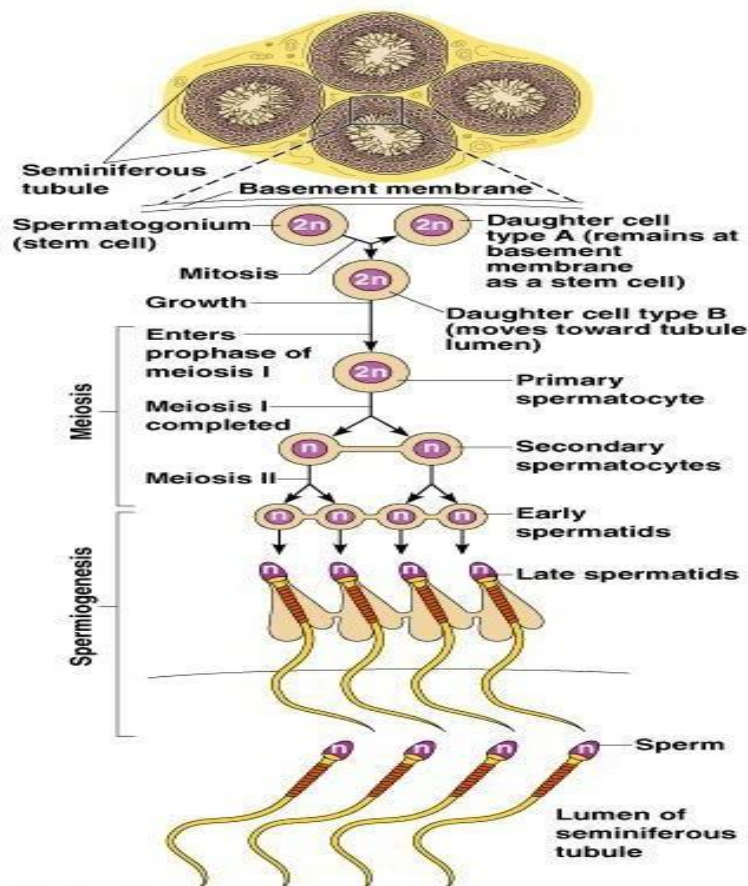
Spermatogenesis

- Production of sperm cells
- Begins at puberty and continues throughout life
- Occurs in the seminiferous tubules



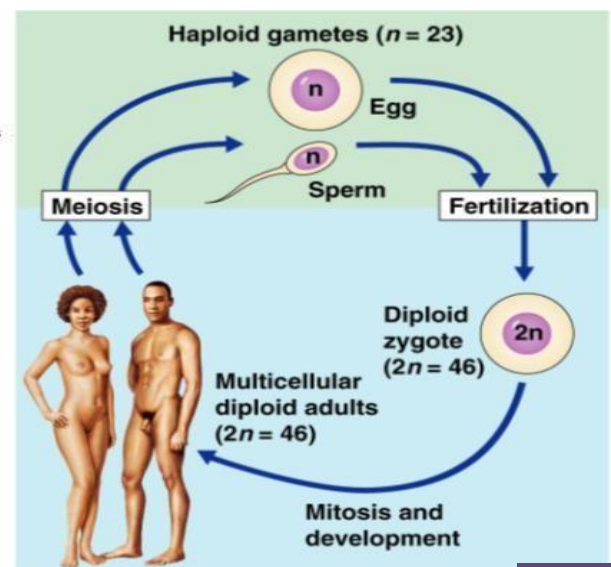
Processes of Spermatogenesis

- Spermatogonia (stem cells) in outer edge of seminiferous tubules of testes undergo rapid mitosis to produce more stem cells before puberty
- During puberty, Follicle stimulating hormone (FSH) modifies spermatogonia division
One cell produced is a stem cell, called a type A daughter cell, maintain the stem cell population
- The other cell produced becomes a primary spermatocyte, called a type B daughter cell
Primary spermatocytes undergo meiosis
- One primary spermatocyte produces four haploid spermatids Spermatids—
23 chromosomes (half as much material as other body cells)



Human Life Cycle

Union of a sperm (23 chromosomes) with an egg (23 chromosomes) creates a zygote ($2n$ or 46 chromosomes)



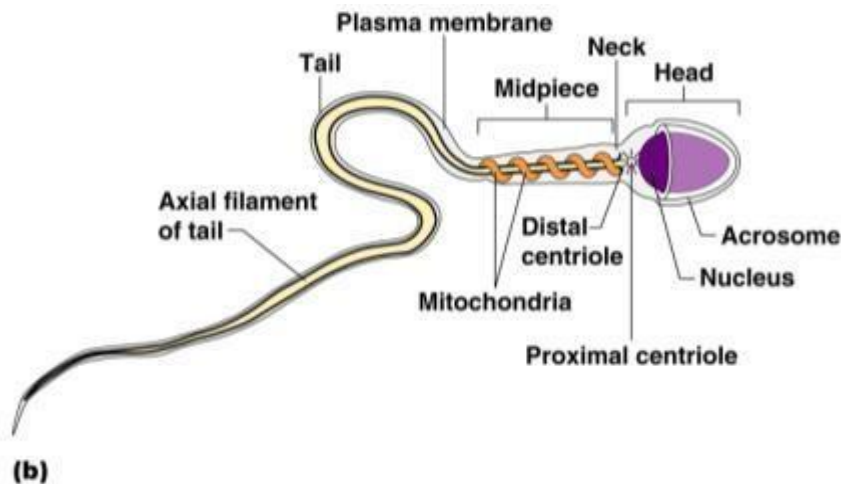
Spermiogenesis

- Spermiogenesis
 - Late spermatids are produced with distinct regions
 1. Head
 2. Midpiece
 3. Tail
 - Sperm cells result after maturing of spermatids
- Spermatogenesis takes 64 to 72 days

Anatomy of a Mature Sperm Cell

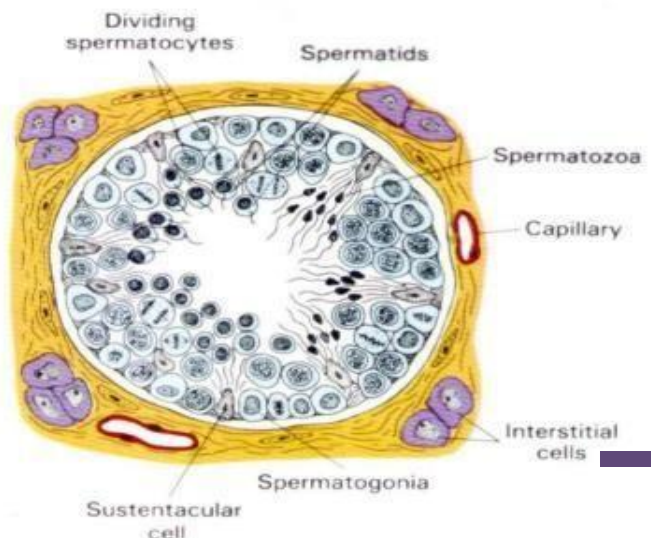
The only human flagellated cell

- Head
 - Contains DNA
 - Acrosome—“helmet” on the nucleus, similar to a large lysosome
 - Breaks down and releases enzymes to help the sperm penetrate an egg
- Midpiece
 - Wrapped by mitochondria for ATP generation needed for the movement of tail



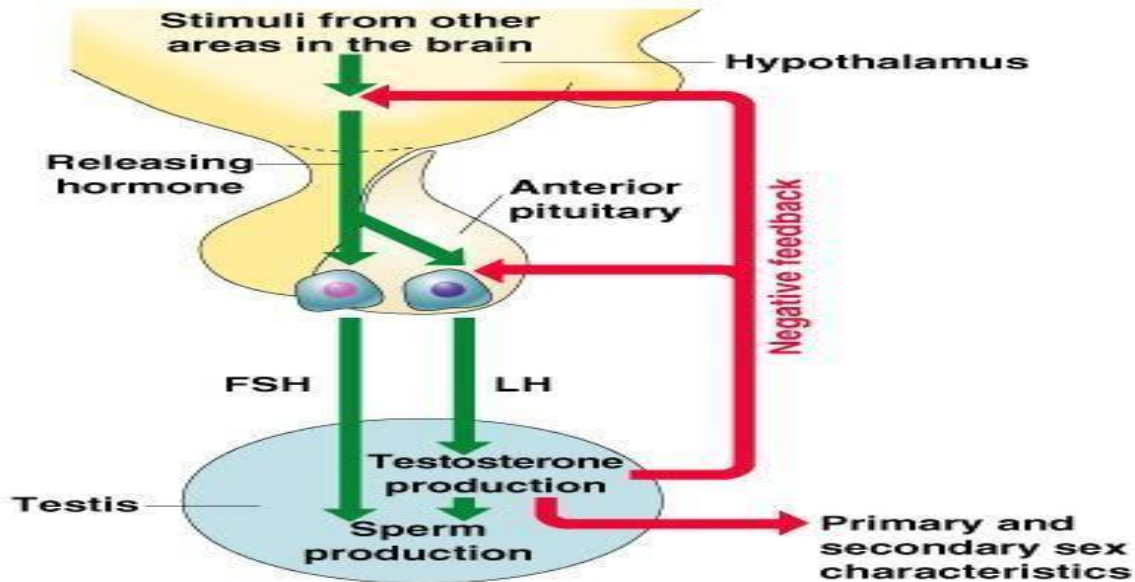
Testosterone Production

- The most important hormone of the testes
- During puberty, luteinizing hormone (LH) activate the interstitial cells
- And testosterone is produced in interstitial cells
- Functions of testosterone
 - Stimulates reproductive organ development
 - Underlies sex drive



- Causes secondary sex characteristics
 1. Deepening of voice
 2. Increased hair growth
 3. Enlargement of skeletal muscles
 4. Thickening of bones

Hormonal Control of the Testis

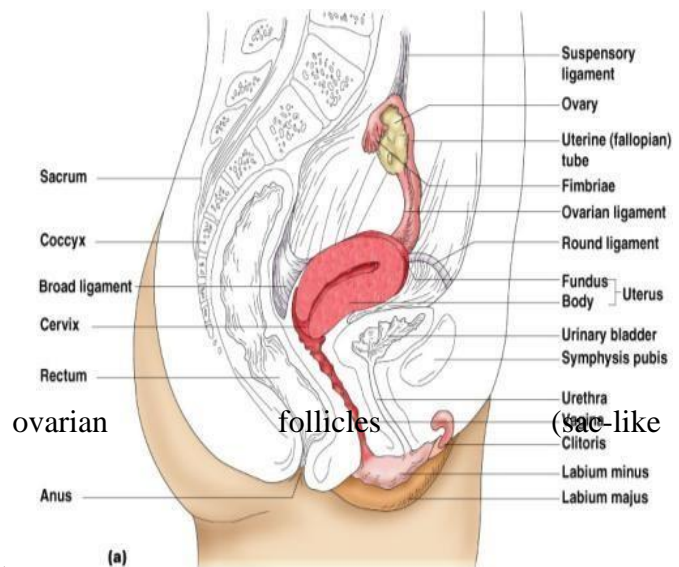


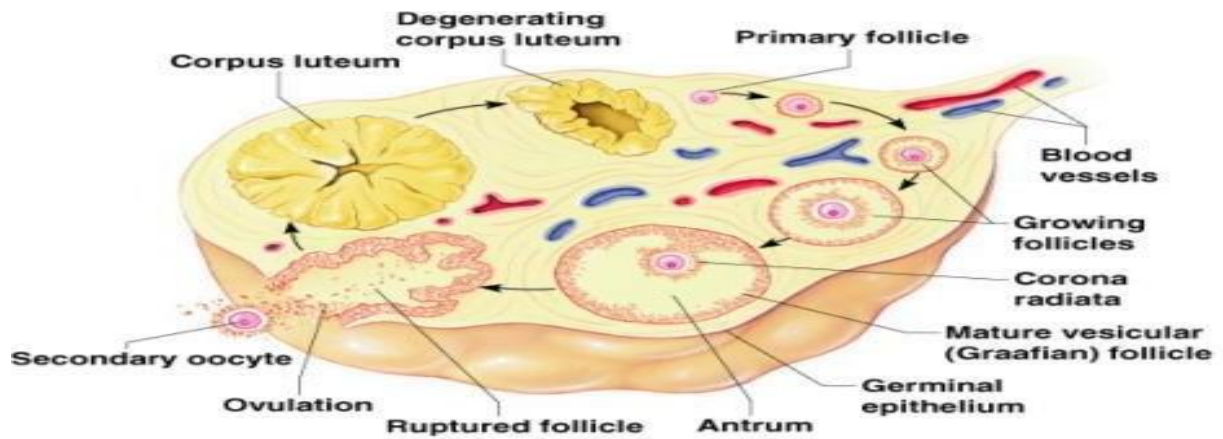
Female Reproductive System

- Ovaries
- Duct System
 - Uterine tubes (fallopian tubes)
 - Uterus
 - Vagina
- External genitalia

Ovaries

- Composed of ovarian structures)
- Structure of an ovarian follicle
 - Oocyte (immature egg)
 - Follicular cells —surround the oocyte



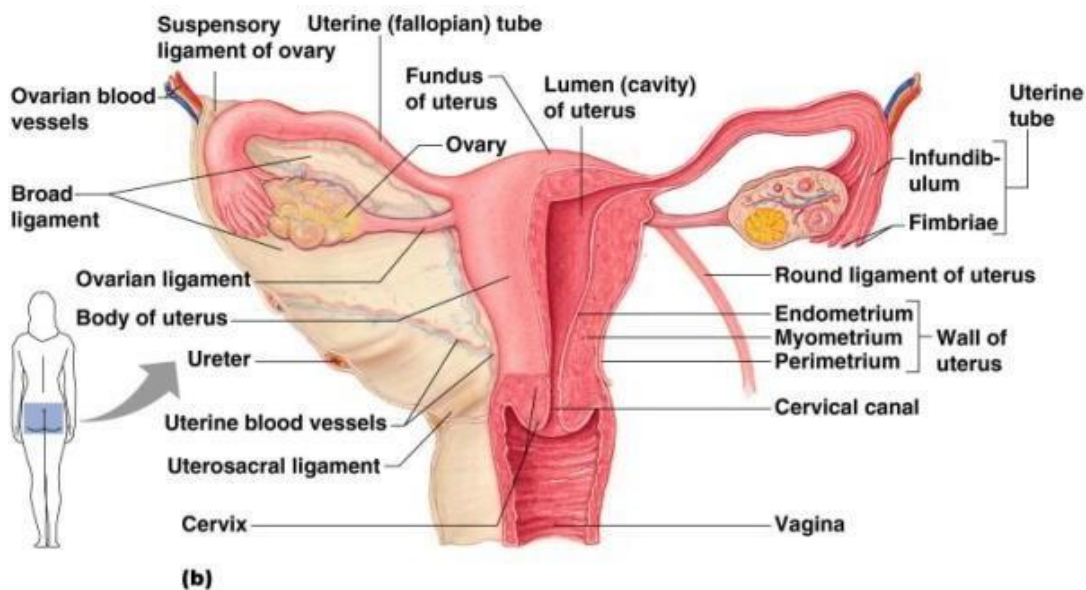


Ovarian Follicle Stages

- Primary follicle – contains an immature oocyte
- Graafian (vesicular) follicle – growing follicle with a maturing oocyte
- Ovulation –
 - when the egg is mature the follicle ruptures
 - Occurs about every 28 days
- The ruptured follicle is transformed into a corpus luteum which eventually degenerates

Support for Ovaries

- Suspensory ligaments – secure ovary to lateral walls of the pelvis
- Ovarian ligaments – attach to uterus
- Broad ligament – a fold of the peritoneum, encloses suspensory ligament



Uterine (Fallopian) Tubes

- Receive the ovulated oocyte
- Provide a site for fertilization
- Attaches to the uterus
- Does not physically attach to the ovary
- Supported by the broad ligament

Uterine Tube Function

- Fimbriae
 - Finger-like projections at the distal end of the uterine tube
 - Receive the oocyte from the ovary
- Cilia
 - Located inside the uterine tube
 - Slowly move the oocyte towards the uterus (takes 3–4 days)
- Fertilization occurs inside the uterine tube since oocyte lives about 24 hours

Uterus

- Located between the urinary bladder and rectum
- Hollow organ
- Functions of the uterus
 - Receives a fertilized egg
 - Retains the fertilized egg
 - Nourishes the fertilized egg

Support for the Uterus

- Broad ligament – attached to the pelvis
- Round ligament – anchored anteriorly
- Uterosacral ligaments – anchored posteriorly

Regions of the Uterus

- Body – main portion
- Fundus – area where uterine tube enters
- Cervix – narrow outlet that protrudes into the vagina

Walls of the Uterus

- Endometrium: Inner layer
 - Allows for implantation of a fertilized egg
 - Sloughs off if no pregnancy occurs (menses)
- Myometrium – middle layer of smooth muscle
- Serous layer – outer visceral peritoneum

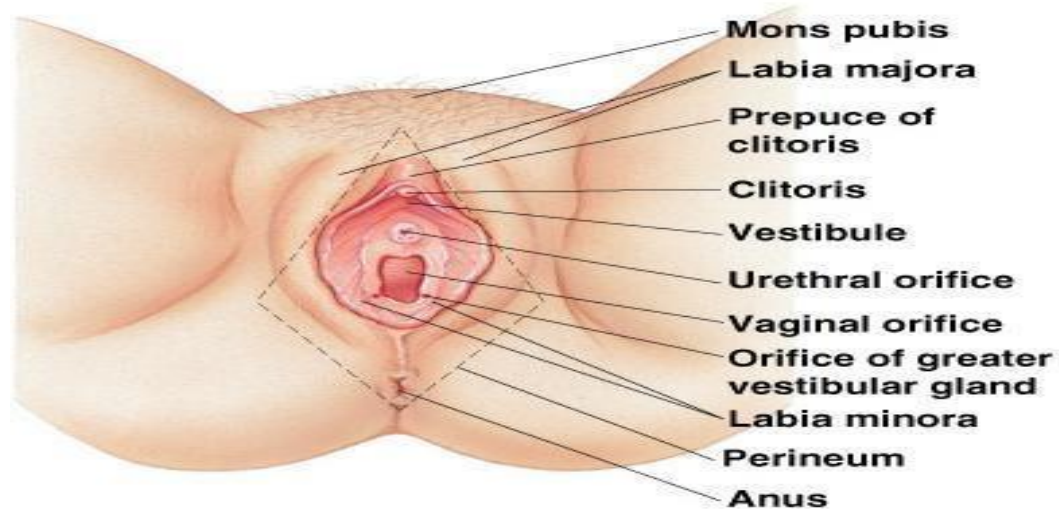
Vagina

- Extends from cervix to exterior of body
- Behind bladder and in front of rectum
- Serves as the birth canal
- Receives the penis during sexual intercourse

- Hymen – partially closes the vagina until it is ruptured

External Genitalia (Vulva)

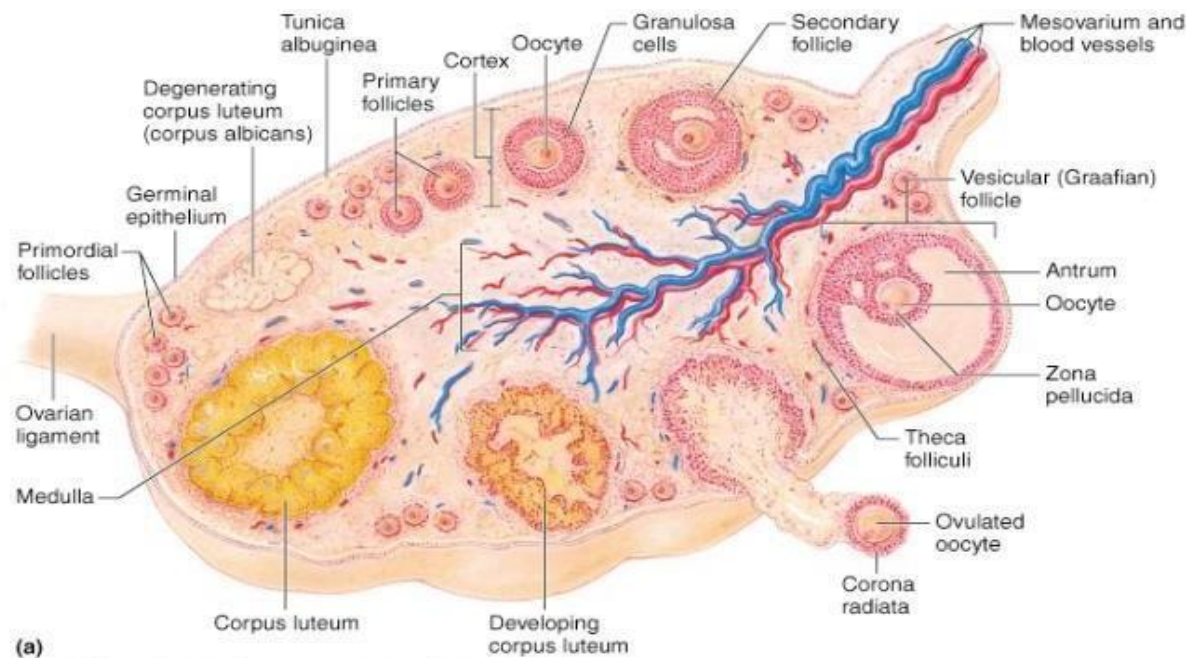
- Mons Pubis
 - Fatty area overlying the pubic symphysis
 - Covered with pubic hair after puberty
- Labia – skin folds
 - Labia majora— hair-covered skin folds
 - Labia minora— delicate, hair-free folds of skin



- Vestibule
 - Enclosed by labia majora
 - Contains external openings of the urethra, followed by vagina
- Greater vestibular glands
 - One is found on each side of the vagina
 - Secretes lubricant during intercourse
- Clitoris
 - Contains erectile tissue
 - Corresponds to the male penis

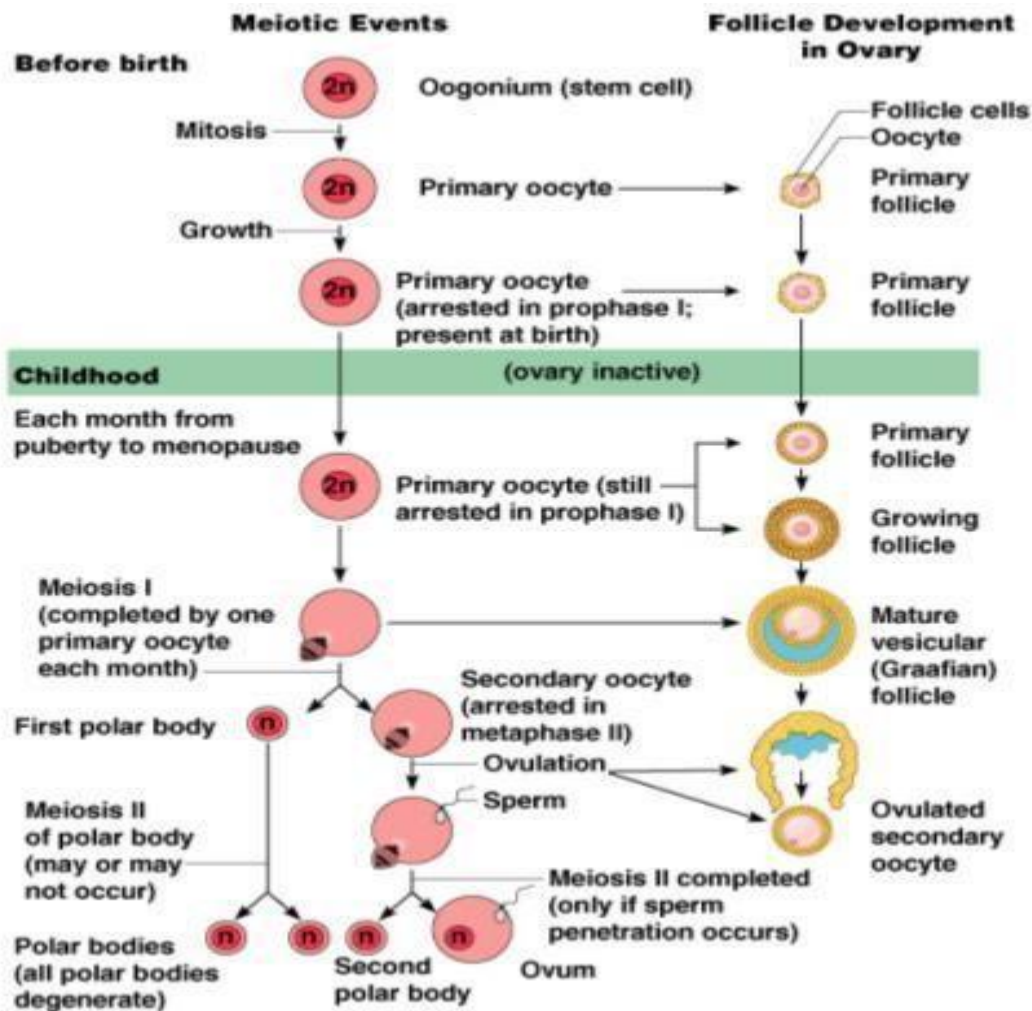
Oogenesis

- The total supply of eggs are present at birth
- Ability to release eggs begins at puberty
- Reproductive ability ends at menopause
- Oocytes are matured in developing ovarian follicles
- Oogonia – female stem cells found in a developing fetus
 - Oogonia undergo mitosis to produce primary oocytes
 - Primary oocytes are surrounded by cells that form primary follicles in the ovary
 - Oogonia no longer exist by the time of birth



(a)
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- Primary oocytes are inactive until puberty
- Follicle stimulating hormone (FSH) causes some primary follicles to mature each month
 - Meiosis starts inside maturing follicle
 - ✚ Produces a secondary oocyte and the first polar body
 - Meiosis is completed after ovulation only
 - ✚ if sperm penetrates
 - ✚ ovum is produced
 - ✚ Two additional polar bodies are produced
- Once ovum is formed, the 23 chromosomes can be combined with those of the sperm to form the fertilized egg (zygote)
- If the secondary oocyte is not penetrated by a sperm, it dies and does not complete meiosis to form an ovum



Male and Female Differences

- Meiosis
 - Males— produces four functional sperm
 - Females— produces one functional ovum and three polar bodies
- Sex cell size and structure
 - Sperm are tiny, motile, and equipped with nutrients in seminal fluid
 - Egg is large, non-motile, and has nutrient reserves to nourish the embryo until Implantation

Uterine (Menstrual) Cycle

- Cyclic changes of the endometrium
- Regulated by cyclic production of estrogens and progesterone
- FSH and LH regulate the production of estrogens and progesterone
- Both female cycles are about 28 days in length
- Ovulation typically occurs about midway through cycle on day 14

- Stages of the menstrual cycle
 1. Menstrual phase
 2. Proliferative stage
 3. Secretory stage

Menstrual phase

- Days 1–5
- Functional layer of the endometrium is sloughed
- Bleeding occurs for 3–5 days
- By day 5, growing ovarian follicles are producing more estrogen

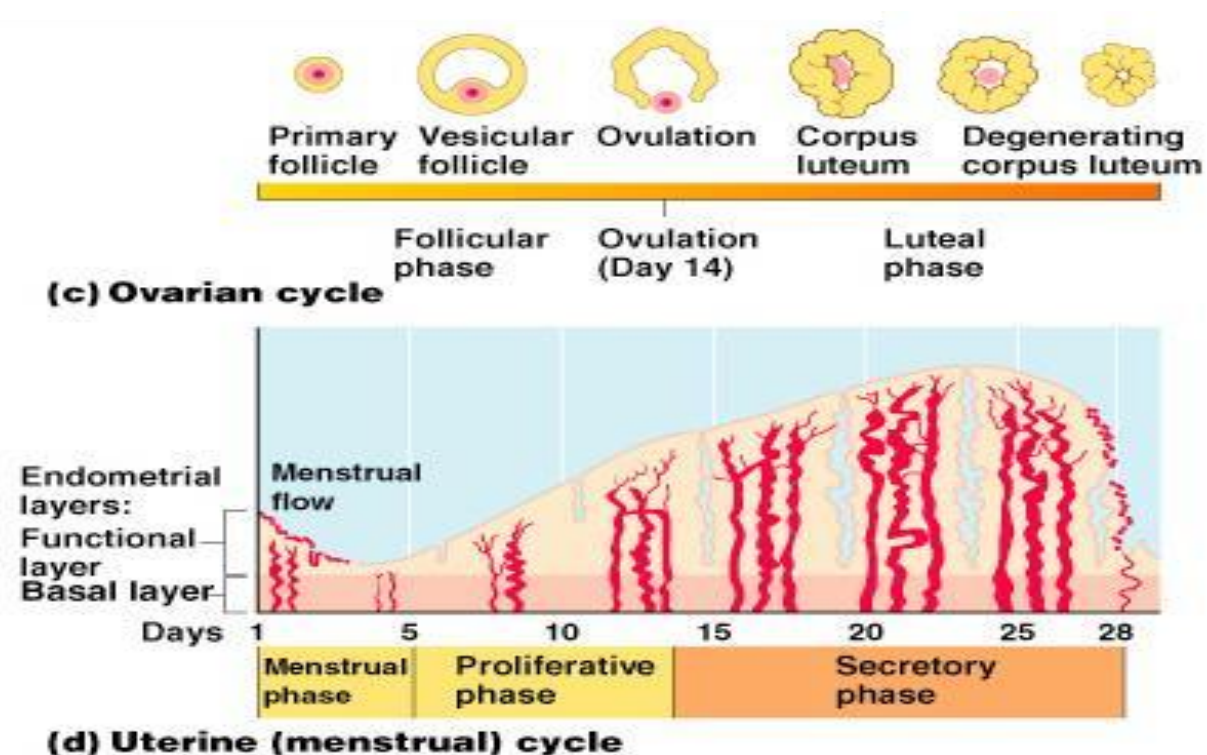
Proliferative stage

- Days 6–14
- Regeneration of functional layer of the endometrium
- Estrogen levels rise
- Ovulation occurs in the ovary at the end of this stage

Secretory stage

- Days 15–28
- Levels of progesterone rise and increase the blood supply to the endometrium
- Endometrium increases in size and begin secreting nutrients into the uterine cavity and sustain a developing embryo
- If fertilization does occur
 - Embryo produces a hormone that causes the corpus luteum to continue producing its hormones
- If fertilization does NOT occur
 - Corpus luteum degenerates as LH blood levels decline
 - Endometrial cells die
 - Sets the stage for menses again on day 28

Hormonal Control of the Ovarian and Uterine Cycles



Hormone Production by the Ovaries

Estrogens

- Produced by follicle cells
- Cause secondary sex characteristics
 - Enlargement of accessory organs
 - Development of breasts
 - Appearance of pubic hair
 - Increase in fat beneath the skin
 - Widening and lightening of the pelvis
 - Onset of menses

Progesterone

- Produced by the corpus luteum
- Production continues until LH diminishes in the blood
- Does not contribute to the appearance of secondary sex characteristics
- Other major effects
 - Helps maintain pregnancy
 - Prepare the breasts for milk production

Mammary Glands

- Present in both sexes, but only function in females
 - Modified sweat glands
- Function is to produce milk
- Stimulated by sex hormones (mostly estrogens) to increase in size

Anatomy of Mammary Glands

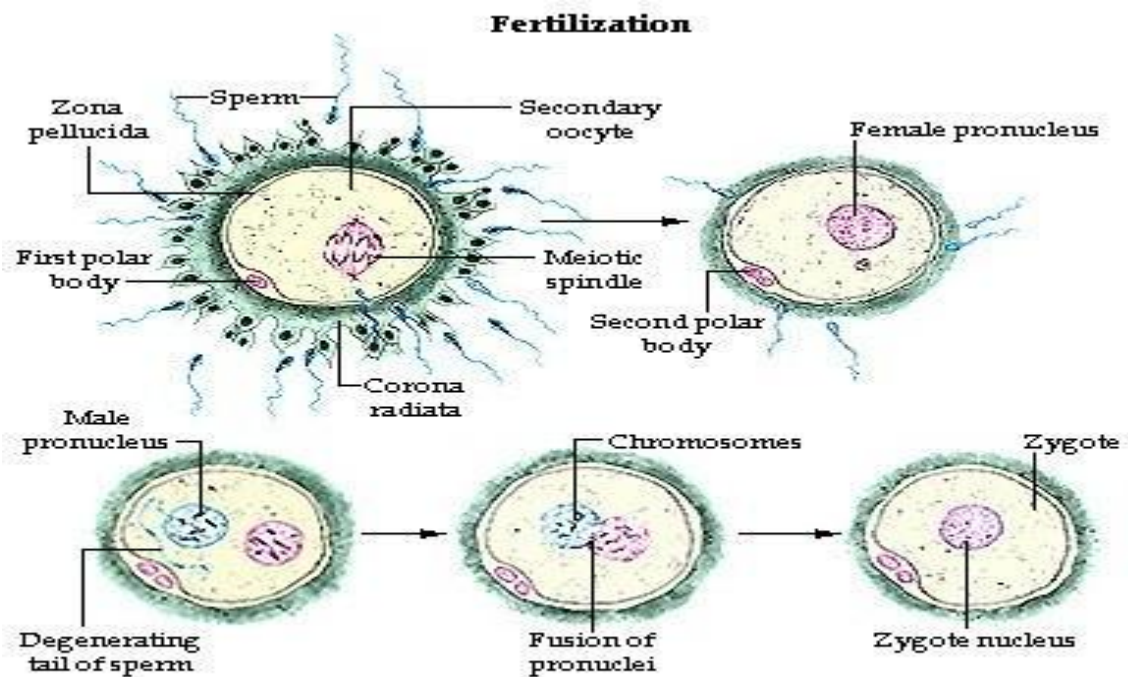
- Areola – central pigmented area
- Nipple – protruding central area of areola
- Lobes – internal structures that radiate around nipple
- Alveolar glands – clusters of milk producing glands within lobules
- Lactiferous ducts – connect alveolar glands to nipple

Stages of Pregnancy and Development

- Fertilization
- Embryonic development
- Fetal development
- Childbirth

Fertilization

- The oocyte is viable for 12 to 24 hours after ovulation
- Sperm are viable for 12 to 48 hours after ejaculation
- Sperm cells must make their way to the uterine tube for fertilization to be possible



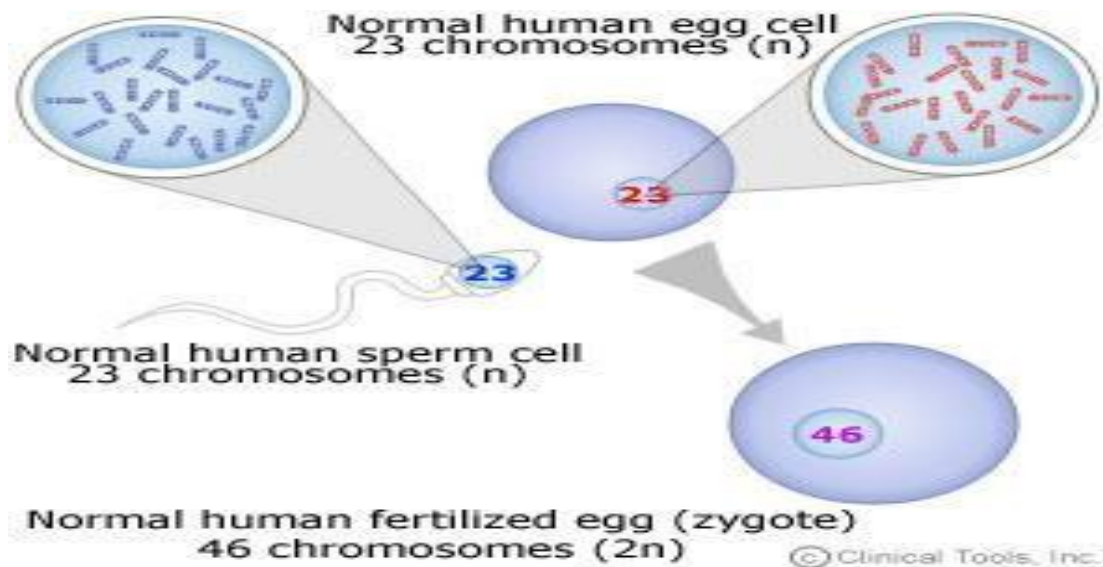
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Mechanisms of Fertilization

- Membrane receptors on an oocyte pulls the
 - head of the first sperm cell to make contact
 - The membrane of the oocyte does not permit a second sperm head to enter
 - The oocyte then undergoes its second meiotic division
 - Fertilization occurs
- when the genetic material of a sperm combines with that of an oocyte to form a zygote

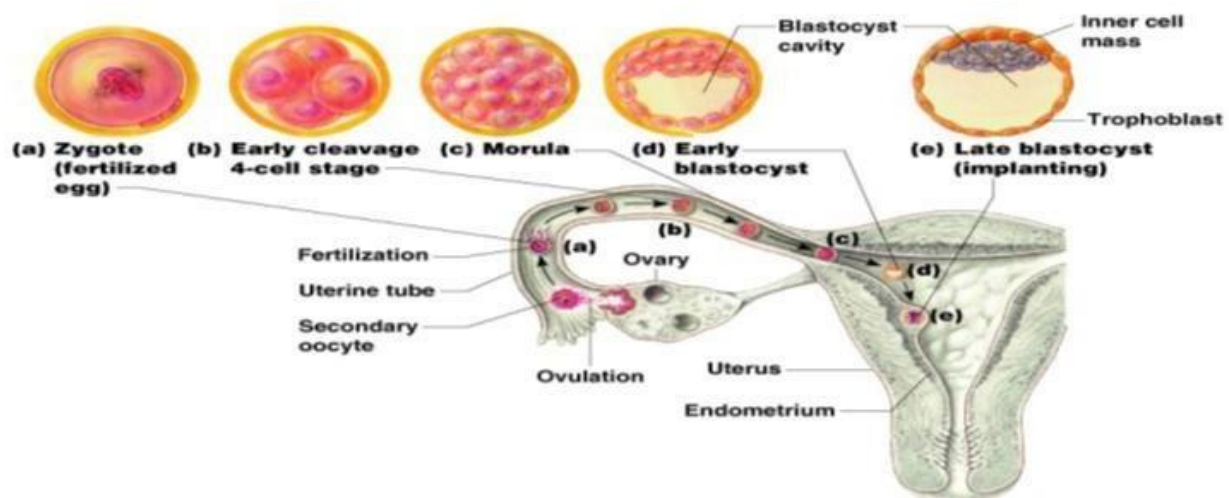
The Zygote

- First cell of a new individual
- The result of the fusion of DNA from sperm and egg
- The zygote begins rapid mitotic cell divisions
- The zygote stage is in the uterine tube, moving toward the uterus



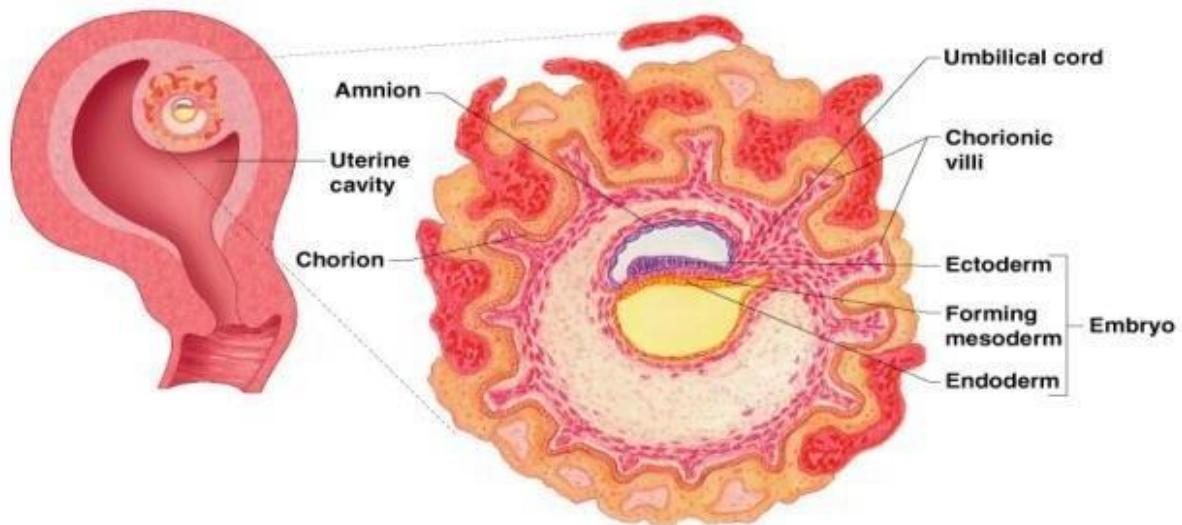
The Embryo

- Developmental stage from the start of cleavage until the ninth week
- The embryo first undergoes division without growth
- The embryo enters the uterus at the 16-cell state (called morula)
- The embryo floats free in the uterus temporarily
- Uterine secretions are used for nourishment



The Blastocyst

- Ball-like circle of cells
- Begins at about the 100 cell stage
- Secretes human chorionic gonadotropin (hCG) to
 - produce the corpus luteum to continue producing
 - Hormones progesterone and estrogen
- Functional areas of the blastocyst
 - Trophoblast – large fluid-filled sphere
 - Inner cell mass
- Primary germ layers are eventually formed
 - Ectoderm – outside layer
 - Mesoderm – middle layer
 - Endoderm – inside layer
- The late blastocyst implants in the wall of the uterus (by day 14)



Derivatives of Germ Layers;

- Ectoderm
 - Nervous system
 - Epidermis of the skin
- Endoderm
 - Mucosae
 - Glands
- Mesoderm
 - Everything else

Development after Implantation

- Chorionic villi (projections of the blastocyst) develop
- Cooperate with cells of the uterus to form the placenta

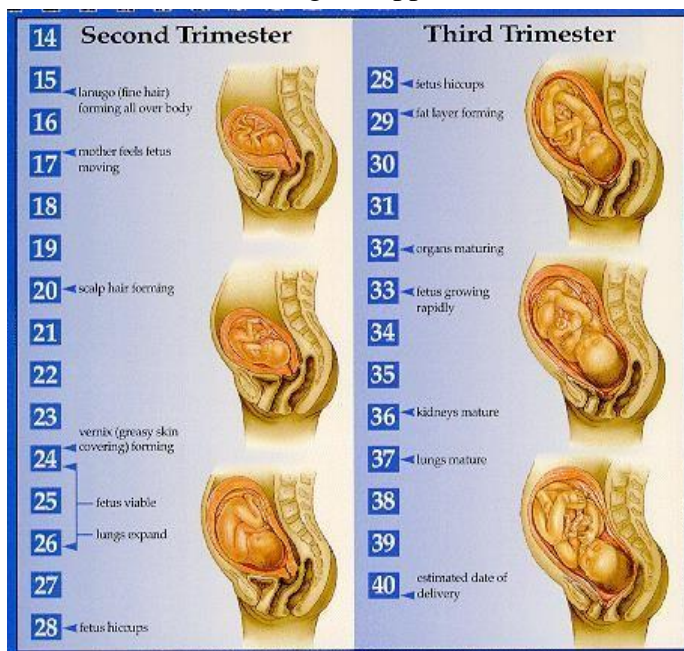
- The embryo is surrounded by the amnion (a fluid filled sac)
- An umbilical cord forms to attach the embryo to the placenta

Functions of the Placenta

- Forms a barrier between mother and embryo (blood is not exchanged)
- Delivers nutrients and oxygen
- Removes waste from embryonic blood
- Becomes an endocrine organ (produces hormones) and takes over for the corpus luteum by producing
 - Estrogen
 - Progesterone
 - Other hormones that maintain pregnancy

The Fetus (Beginning of the Ninth Week)

- All organ systems are formed by the end of the eighth week
- Activities of the fetus are
 - growth and organ specialization
 - change in appearance

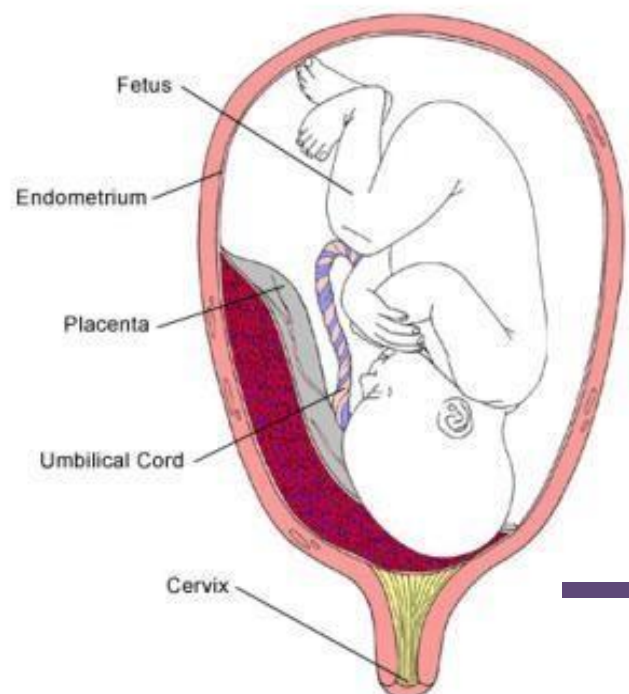


Early Stages of Pregnancy

Actual Size	Weeks	Length*	Weight*
	3	1/8" CR	
	4	5/32" CR	
	6	1/2" CR	
	8	1" CR	.07 oz
	12	3" CR	.6 oz

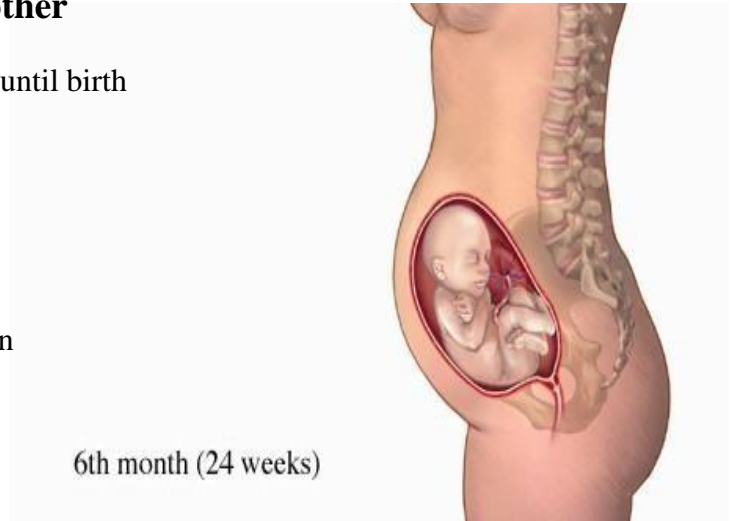
*This indicates approximate length and weight. Varies with each individual. CR-Crown to Rump

Total Placenta Previa



The Effects of Pregnancy on the Mother

- Pregnancy – period from conception until birth
- Anatomical changes
 - Enlargements of the uterus
 - Accentuated lumbar curvature
 - Relaxation of
 - ✓ the pelvic ligaments
 - ✓ and pubic symphysis
 - ✓ due to production of relaxin

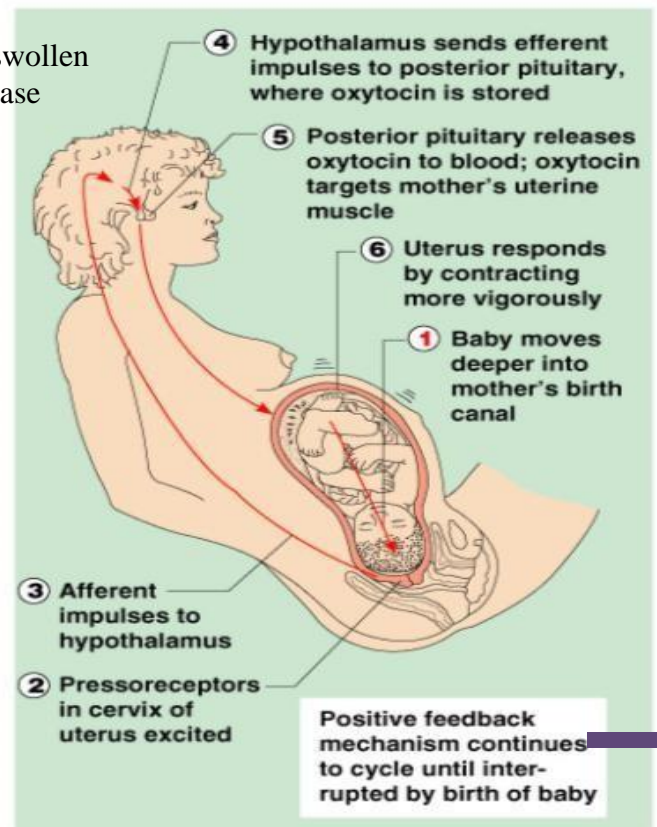


Effects of Pregnancy on the Mother

- Physiological changes
 - Gastrointestinal system
 - Morning sickness is common due to elevated progesterone
 - Heartburn is common because of organ crowding by the fetus
 - Constipation is caused by declining motility of the digestive tract
- Urinary System
 - Kidneys have additional burden and produce more urine
 - The uterus compresses the bladder
- Respiratory System
 - Nasal mucosa becomes congested and swollen
 - Vital capacity and respiratory rate increase
- Cardiovascular system
 - Body water rises
 - Blood volume increases by 25 to 40%
 - Blood pressure and pulse increase
 - Varicose veins are common

Childbirth (Parturition)

- Labor – the series of events that expel the infant from the uterus
- Initiation of labor
 - Estrogen levels rise
 - Uterine contractions begin
 - The placenta releases prostaglandins
 - Oxytocin is released by the pituitary
 - Combination of these hormones produces contractions

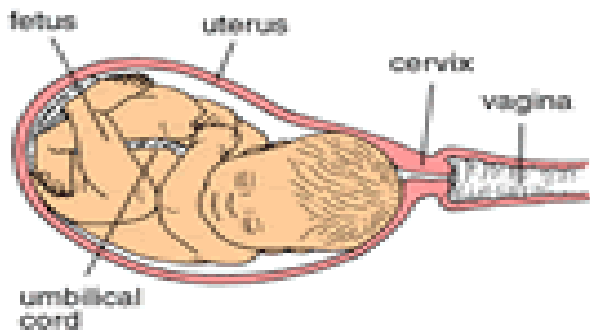


Stages of Labor

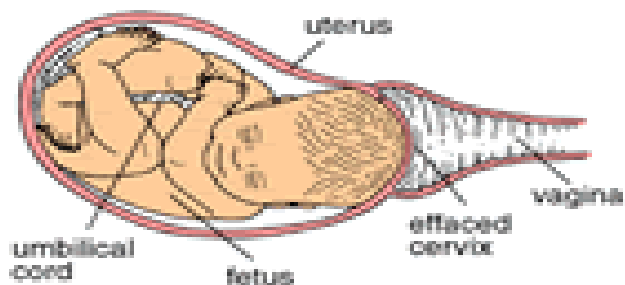
- Dilation
 - Cervix becomes dilated
 - Uterine contractions begin and increase
 - The amnion ruptures (breaking the water)
- Expulsion
 - Infant passes through the cervix and vagina
 - Normal delivery is head first
- Placental stage
 - Delivery of the placenta

Stage 1

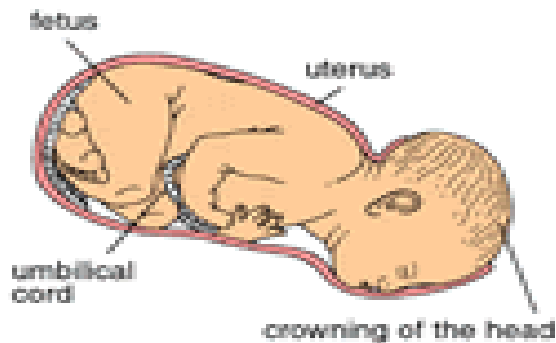
initial (latent) phase



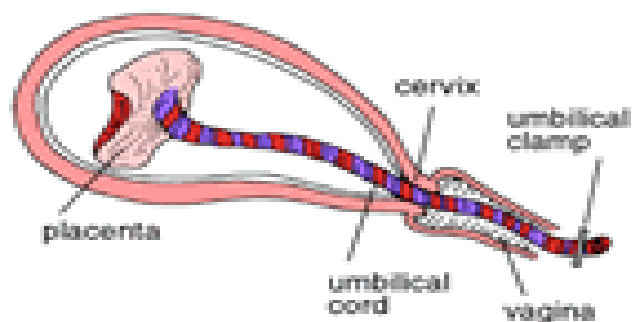
active phase



Stage 2



Stage 3



Developmental Aspects of the Reproductive System

- Gender is determined at fertilization
 - Males have XY sex chromosomes
 - Females have XX sex chromosomes
- Gonads do not begin to form until the eighth week
- Testosterone determines whether male or female structures will form
- Reproductive system organs do not function until puberty
- Puberty usually begins between ages 10 and 15

Males

- Enlargement of testes and scrotum signals onset of puberty (often around age 13)

Females

- Budding breasts signal puberty (often around age 11)
- The first menses usually occurs about two years after the start of puberty
- Most women reach peak reproductive ability in their late 20s
- Menopause occurs when ovulation and menses cease entirely
 - Ovaries stop functioning as endocrine organs
- There is a no equivalent of menopause in males, but there is a steady decline in testosterone.