Textbook and Workbook Assignments

Textbook: p. 538-570
Workbook: 325-345

Crash Course Videos:
Reproductive System part 1 – Female System
https://www.youtube.com/watch?v=RFDatCchpus&t=66s
Reproductive System part 2 – Male System
https://www.youtube.com/watch?v=-XQcnO4iX_U&t=1s
Reproductive System part 3 – Sex and Fertilization
https://www.youtube.com/watch?v=SUdAEGXLO-8&t=295s
Reproductive System part 4 – Pregnancy and Development
https://www.youtube.com/watch?v=BtsSbZ85yiQ&t=167s
Reproductive System Function

To produce offspring

Male and female reproductive systems work together

Gonads – primary sex organs
- Testes in males
- Ovaries in females
- Produce gametes (sex cells)
  - Sperm – male gametes
  - Ova (eggs) – female gametes
- Secrete hormones
Male Reproductive System
Anatomy

Reproductive Function:
Spermatogenesis

Text p. 539-547
WB 325-331
Male Reproductive System

Role in producing offspring: to make sperm and deliver them to the woman’s reproductive tract.
Male Reproductive System

Testes – primary organ

Duct system
- Epididymis
- Ductus (vas) deferens
- Urethra

Function:
Make and deliver sperm
Male Reproductive System

Accessory organs
- Seminal glands (vesicles)
- Prostate
- Bulbourethral glands

External genitalia
- Penis
- Scrotum
Male Reproductive System

Additional Tissue / Ducts

- Ejaculatory duct
- Erectile tissue
- Prepuce (foreskin)
Testes – Internal Structures

Lobules of seminiferous tubules
- Tightly coiled structures
- Sperm-forming factories
- Produce testosterone
  - Interstitial cells in seminiferous tubules

Rete testis

Epididymis
- first part of the duct system
Duct System

Transports sperm out of the body

- Epididymis
- Ductus deferens (vas deferens)
- Urethra
Epididymis

Comma-shaped, tightly coiled tube

Site where sperm cells mature

- 20 days
- Gain the ability to swim

Smooth muscle contraction

- Move sperm to ductus deferens
Ductus deferens (Vas deferens)

Transports sperm by peristalsis

Epididymis → ejaculatory duct
- Passes through inguinal canal
- Passes over the urinary bladder

Ejaculation
- smooth muscles of vas deferens contract to move sperm forward

Spermatic cord is a connective tissue sheath that wraps:
- ductus deferens
- blood vessels
- nerves
Vasectomy

Cutting of the vas deferens at the level of the testes

- prevents transportation of sperm
- form of birth control
Urethra

Base of the urinary bladder to the tip of the penis
- Carries both urine and sperm (Never at the same time)
- Sperm enters from the ejaculatory duct
Accessory Glands Producing Semen

- Seminal glands (vesicles)
- Prostate
- Bulbo-urethral glands
Seminal vesicles

Located at the base of the bladder
Produce a thick, yellowish secretion (60% of semen)
Seminal fluid is alkaline
Seminal fluid includes:
  - Fructose (sugar)
  - Vitamin C
  - Prostaglandins
  - Other substances that nourish and activate sperm

Purpose: secretions provide sperm with vitamins and energy to sustain journey to egg
Prostate

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

Health Conditions:
  - Prostatitis—inflammation of the prostate
  - Prostate cancer—third most common cancer in males
Bulbourethral glands

Pea-sized glands inferior to the prostate

Produce a thick, alkaline, clear mucus

- Is released into the urethra
- Cleanses the urethra of acidic urine prior to ejaculation
- Serves as a lubricant during sexual intercourse
Semen

Mixture of sperm and accessory gland secretions

- Sperm = male sex cell
- Fluids dilute sperm to increase their motility
- Fructose → provides energy for sperm cells
- Alkalinity of semen
  - Helps neutralize the acidic environment of vagina
  - Inhibits bacterial growth
Semen Analysis for Male Infertility

Factors considered:

- Sperm count
- Sperm motility
- Sperm morphology
External Genitalia - Scrotum

Sac of skin outside the abdomen that houses testes

- Maintains testes at 3°C lower than normal body temp
  - Lower temperature protects sperm viability
- Muscles contract / relax
  - Regulate proximity to body heat

![Diagram of scrotum](image.png)
External Genitalia - Penis

Delivers sperm into the female reproductive tract

Regions of the penis

1. Shaft
   - Contains spongy erectile tissue
2. Glans penis (enlarged tip)
3. Prepuce (foreskin)
   - Folded skin at tip
   - Often removed by circumcision

Erections occur when erectile tissue fills with blood

- during sexual excitement
Spermatogenesis

Process of making sperm cells

- Begins at puberty and continues throughout life
- Sperm are formed in the seminiferous tubules
- 64 to 72 days (start to finish)

Sperm maturation

- In epididymis
  - 20 days

Seminiferous tubule
Spermatogenesis

Before puberty

- **Spermatogonia** undergo rapid mitosis
  - produce more stem cells (Type A)

During puberty

- **FSH** (follicle-stimulating hormone) and **testosterone** are secreted in increasing amounts
  - Promotes sperm development and maturation
- **Spermatogonia** undergo rapid mitosis
  - produce stem cells (Type A and B)
    - Type A remains → mitosis
    - Type B moves toward lumen → meiosis

During puberty and after

- Millions of sperm produced daily
Primary Spermatocytes

Type B cells

Undergo meiosis

- produces four haploid spermatids
  - Spermatids have 23 chromosomes (half as much as body cells)

Undergo spermiogenesis

- Streaming process
  - strips excess cytoplasm from spermatid
  - modifies it into a sperm
- Mature sperm is compacted
  - three regions: head, midpiece, tail
Sperm Structure and Function
Sperm Structure and Function

Three regions:

- Tail
- Midpiece
- Head
Sperm Structure and Function

- **Tail**
  - Provides mobility

- **Mitochondria rich**
  - Provides energy for mobility

- **Midpiece**

- **Head**
  - **Nucleus** – Provides DNA for future offspring
  - **Acrosome** – Provides enzymes used to breakdown follicle cell capsule and oocyte membrane
Testosterone

Produced by interstitial cells in the testes

**In embryo**
- Causes development of male reproductive organs

**During puberty**
- Increased testosterone production
  - Anterior pituitary secretes LH (luteinizing hormone)
    - activates the interstitial cells

Stimulates reproductive organ development

Causes secondary sex characteristics
- Deepening of voice
- Increased hair growth
- Enlargement of skeletal muscles
- Increased bone growth and density

Underlies sex drive
Female Reproductive System
Anatomy
Reproductive Functions
Oogenesis

Text p. 547-553
WB 331-335
Female Reproductive System

Ovaries – primary organ

Duct system

- Uterine (fallopian) tubes
- Uterus
- Vagina
Ligaments Hold Ovaries in Place

Suspensory ligaments
  ▪ secure the ovaries to the lateral walls of the pelvis

Ovarian ligaments
  ▪ anchor the ovaries to the uterus
Ovaries

House many ovarian follicles (sac-like structures)

Inside each follicle:
- Oocyte (immature egg)
- Follicle cells
  - layers of different cells that surround the oocyte
Ovaries

House many ovarian follicles (sac-like structures)

Inside each follicle:

- Oocyte (immature egg)
- Follicle cells
  - layers of different cells that surround the oocyte
Oocytes and Ovulation

Follicles change name as oocyte matures in ovary.

Primary follicle
- contains an immature oocyte

Vesicular (Graafian) follicle
- growing follicle with a maturing oocyte

Ovulation
- follicle ruptures when the egg is mature
- occurs about every 28 days

Ruptured follicle
- transformed into a corpus luteum
Ovulation and Corpus Luteum Develops

- Corpus luteum
- Developing corpus luteum
- Ruptured follicle
- Ovulation
Duct System

Uterine (fallopian) tubes

Uterus

Vagina

Body of uterus

Ureter

Cervix

Lumen (cavity) of uterus

Uterine tube (Fallopian tube)

Endometrium

Myometrium

Perimetrium

Wall of uterus

Vagina

Uterine tube

Perimetrium
Uterine tube (Fallopian tube)

Receive the ovulated oocyte from the ovaries
- Provide a site for fertilization
- Empty into the uterus
- Little or no contact between ovaries and uterine tubes
- Supported and enclosed by the broad ligament

Structures
- Fimbriae
  - Fingerlike projections
  - Receive the oocyte from the ovary
- Cilia
  - Inside the uterine tube
  - Move the oocyte to uterus (takes 3 to 4 days)
Uterus

Pear-shaped muscular organ
Located between the urinary bladder and rectum
Receives, retains, nourishes a fertilized egg

Round ligament anchors the uterus anteriorly
Uterosacral ligament anchors the uterus posteriorly
Uterus – 3 regions

Body – main portion
- Endometrium
- Myometrium
- Perimetrium

Fundus
- top rounded region

Cervix
- narrow outlet that protrudes into the vagina
Vagina

- Passageway from cervix to body exterior
- Located between urinary bladder and rectum
- Serves as the canal that allows a baby or menstrual flow to leave the body
- Receives the penis during sexual intercourse
- Hymen – partially closes the vagina until it is ruptured
The female external genitalia, or vulva, includes:

- Mons pubis
- Labia majora
- Clitoris
- Urethral orifice
- Vaginal orifice
- Greater vestibular glands
- Labia minora
- Prepuce of clitoris
Vulva

Mons pubis
- Fatty area overlying the pubic symphysis
- Covered with pubic hair after puberty

Labia—skin folds

Labia majora
- Hair-covered skin folds
- Enclose the labia minora
- Encloses the vestibule

Labia minora
- Delicate, hair-free folds of skin
Vulva

Vestibule
- Enclosed by labia majora
- Contains external openings of the urethra and vagina

Greater vestibular glands
- One is found on each side of the vagina
- Secretes mucus lubricant during intercourse
Vulva

Clitoris
- Contains erectile tissue
- Corresponds to the male penis

Similarities of clitoris and penis:
- Hooded by a prepuce
- Has erectile tissue
- Swollen with blood during sexual excitement
Perineum

Diamond-shaped region
Oogenesis

The process of producing ova (eggs) in a female
- The total supply of eggs is determined by the time a female is born
- Ability to release eggs begins at puberty
- Reproductive ability ends at menopause
- Oocytes are matured in developing ovarian follicles
Oogenesis

Oogonia

- Female stem cells found in a developing fetus
- Undergo mitosis
  - produce primary oocytes
  - surrounding cells form primary follicles in the ovary
Oogenesis and the Ovarian Cycle

Primary oocytes

- inactive until puberty

- Follicle stimulating hormone (FSH) causes some primary follicles to mature each month

- Cyclic monthly changes constitute the ovarian cycle
The Ovarian Cycle

Mammary Glands
The Ovarian Cycle

Meiosis

- Starts inside maturing follicle
- Produces a secondary oocyte and the first polar body

Follicle development

- To the stage of a vesicular follicle takes about 14 days

Ovulation of a secondary oocyte

- Occurs with the release of luteinizing hormone (LH)
- Secondary oocyte is released
- Surrounded by a corona radiata
- Oocyte → fallopian tube
Male and Female Differences in Gametes

Meiosis
- Males produce
  - four functional sperm
- Females produce
  - one functional ovum
  - three tiny polar bodies

Sex cell size and structure
- Sperm are tiny and motile
- Equipped with nutrients in seminal fluid
- Egg is large and nonmotile
- Has nutrient in cytoplasm to nourish the embryo
Cyclic changes in endometrium ~28 days
Regulated by estrogens and progesterone

- FSH and LH
  - regulate ovary production of estrogens and progesterone

Ovulation typically occurs about midway through cycle
- Day 14
The Menstrual Cycle

The three phases of the uterine cycle:

• Menstrual: Shedding of the functional layer of the endometrium.
• Proliferative: Rebuilding of the functional layer of the endometrium.
• Secretory: Begins immediately after ovulation. Enrichment of the blood supply and glandular secretion of nutrients prepare the endometrium to receive an embryo.
The Menstrual Phase (Day 1-5)

- Functional layer of the endometrium is sloughed
- Bleeding occurs for 3-5 days
- Ovarian hormones are at their lowest levels
- By day 5, growing ovarian follicles are producing more estrogen
The Proliferative Stage (Day 6-14)

- Regeneration of functional layer of the endometrium
  - Endometrium is repaired
  - Thickens
  - Becomes well vascularized
- Estrogen levels rise
- Ovulation occurs in ovary at the end of this stage
Fluctuation of ovarian hormone levels:
Fluctuating levels of estrogens and progesterone cause the endometrial changes of the uterine cycle.

The high estrogen levels are also responsible for LH/FSH surge.
The Secretory Stage (Day 15-28)

- Progesterone is produced by the corpus luteum
  - Hormone productions lasts 10-14 days after ovulation
- Levels of progesterone rise
  - Increases blood supply
- Endometrium
  - becomes more vascular
  - increases in size
  - readies for implantation
Fertilization?

If fertilization occurs:

- Embryo produces hormone
  - causes the corpus luteum to continue producing its hormones (progesterone)

If fertilization does NOT occur:

- Corpus luteum degenerates as LH blood levels decline
How Does LH and FSH Impact Development?
Estrogens Production by the Ovaries

Produced by follicle cells

- Cause secondary sex characteristics
  - Enlargement of accessory organs of the female reproductive system
  - Breast development
  - Axillary and pubic hair growth
  - Increase in fat beneath the skin
    - Especially in hips and breasts
  - Widening and lightening of the pelvis
  - Onset of menses (menstrual cycle)
Progesterone Production by the Corpus Luteum

Production continues until LH diminishes in the blood

- Does *not* contribute to the appearance of secondary sex characteristics
- Major effects include
  - Helps to maintain pregnancy
  - Prepares the breasts for milk production
Mammary Glands

Present in both sexes, but function only in females
  - Modified sweat glands

Function: produce milk
  - Nourishes newborn child

Stimulated by sex hormones (mostly estrogens)
  - Size increase
Mammary Glands

- **Areola** - central pigmented area
- **Nipple** - protruding central area of areola
- **Lobes** - internal structures radiate around nipple
- **Lobules** - located in each lobe and contain clusters of **alveolar glands**
- **Alveolar glands** - produce milk when a woman is lactating (producing milk)
- **Lactiferous ducts** - connect alveolar glands to nipple
Mammography

- X-ray examination
  - detects breast cancers too small to feel
- Recommended every 2 years for women 40-49 yrs.
  - Annually after 50 yrs old
- Breast cancer
  - Symptoms include a change in skin texture, puckering, or leakage from the nipple
Pregnancy and Embryonic Development

Childbirth

Development of the Reproductive System

Text p. 557-567
WB 338-345
Pregnancy—and Embryonic Development

Pregnancy—time from fertilization until infant is born

Conceptus—developing offspring
  - Embryo—period of time from fertilization until week 8
  - Fetus—week 9 until birth

Gestation period—from date of last period until birth (approximately 280 days)
Accomplishing Fertilization – Timing

- An oocyte is viable up to 24 hours after ovulation
- Sperm are viable up to 48 hours after ejaculation
- For fertilization to occur, sexual intercourse must occur no more than 2 days before ovulation and no later than 24 hours after (Days 12-15)
- Sperm cells travel to uterine tube to fertilize the oocyte
Accomplishing Fertilization

- Sperm reaches the oocyte
- Enzymes break down follicle cells
- Acrosomal reaction occurs
  - enzymes digest holes in the oocyte membrane
- Membrane receptors on an oocyte pull in the head of the first sperm cell to make contact
Accomplishing Fertilization

- Oocyte membrane does not permit a second sperm head to enter
- Oocyte undergoes its second meiotic division
  - Forms the ovum and a polar body
- Fertilization occurs when the genetic material of a sperm combines with that of an oocyte to form a zygote
Events of Embryonic & Fetal Development

- Zygote formation
- Cleavage
- Blastocyst
- Implantation
Zygote

- First cell of a new individual
- Result of the fusion of DNA from sperm and egg
- Begins rapid mitotic cell divisions, **cleavage**
  - 24 hours after fertilization
- Journeys down the uterine tube toward the uterus
Cleavage, Blastocyst, Implantation

- Rapid series of mitotic divisions
  - begins with the **zygote**
  - ends with the **blastocyst**
- the preembryo reaches the uterus
  - 3 to 4 days after ovulation
  - floats freely for 2 to 3 days

Late blastocyst stage

- embryo attaches to the endometrium (day 7 after ovulation)

Implantation

- by day 14 after ovulation
- placenta is forming
Human Embryonic Development

- Fertilized egg
- 2-cell stage
- 4-cell stage
- 8-cell stage
- 16-cell stage
- Blastocyst
The Placenta

- Forms a barrier between mother and embryo
  - (blood is not exchanged)
- Delivers nutrients and oxygen
- Removes wastes from embryonic blood
- Becomes an endocrine organ
  - takes over for the corpus luteum (by week 10)
  - produces estrogen, progesterone, and other hormones that maintain pregnancy
Embryonic Development (Week 2-8)

All organ systems are formed by the end of week 8
Week 3

- uterine cavity
- uterine lining
- blastocyst
- yolk sac
- embryo
- amniotic sac
- placental cells
- fallopian tube
- ovary
- uterus
- cervix
- bladder
- colon
- vagina
Week 4

- Uterine lining
- Uterine cavity
- Yolk sac
- Embryo
- Amniotic sac
- Primitive placenta
- Uterus
- Uterine cavity
- Cervix
- Bladder
- Colon
- Vagina
Week 5
Week 6

- upper jaw
- eye spot
- lower jaw
- arm bud
- placenta
- yolk sac
- umbilical cord
- heart bulge
- tail
- leg bud
- uterus
- cervix
- vagina
Week 7

- amniotic sac
- eyelid
- yolk sac
- placenta
- umbilical cord
- tailbone
- heart bulge
- fingers
- elbow joint
- uterus
- cervix
- bladder
- vagina
Week 8
Fetal Development

Fetus activities: growth and organ specialization

Fetal stage is one of tremendous growth and change
Anatomical Changes of Pregnancy for the Mother

- Uterus grows
- Accentuated lumbar curvature (lordosis)
- Production of relaxin hormone
  - Pelvic ligaments relax
  - Pubic symphysis ligament relaxes
- Breasts grow – develop milk production
Impact of Pregnancy on Respiratory and Digestive Systems
Physiological Changes of Pregnancy for the Mother

Gastrointestinal system

- Morning sickness
  - Due to elevated progesterone and estrogens
- Heartburn
  - Caused by organ crowding by the fetus
- Constipation
  - Due to declining motility of the digestive tract

Urinary system

- Kidneys produce more urine
- Uterus compresses the bladder
  - stress incontinence
Physiological Changes of Pregnancy for the Mother

Respiratory system

- Nasal mucosa
  - becomes congested and swollen
- Vital capacity and respiratory rate increase
- Dyspnea (difficult breathing)
  - during later stages of pregnancy

Cardiovascular system

- Blood volume increases by 25% to 40%
- Blood pressure and pulse increase
- Varicose veins are common
Childbirth (Parturition)

- **Labor**
  - Series of events that expel the infant from the uterus
  - Rhythmic, expulsive contractions
  - Positive feedback mechanism
  - 3 stages
    - Dilation (of cervix)
    - Expulsion (delivery of infant)
    - Placental (delivery)

- **False labor**
  - Braxton Hicks contractions
  - Weak, irregular uterine contractions
Dilation stage

Longest stage at 6 to 12 hours

Cervix becomes dilated
  - Full dilation is 10 cm
  - Cervix softens and effaces (thins)

Uterine contractions begin and increase

The amnion ruptures
  - “breaking the water”
Expulsion stage

Infant passes through the cervix and vagina

- Can last as long as 2 hours
- ~50 minutes (1st birth)
- ~20 minutes other births

Normal delivery is head-first

- Breech presentation is buttocks-first
Placental stage

Delivery of the placenta
- ~15 minutes after birth of infant
- Afterbirth
  - placenta and attached fetal membranes

All placental fragments should be removed
- avoids postpartum bleeding
Developmental Aspects of the Reproductive System

- Reproductive system structures of males and females are identical during early development
- Gonads do not begin to form until the eighth week
- Presence/absence of testosterone determines whether male or female accessory reproductive organs will form
- The reproductive system is inactive during childhood
- Reproductive system organs do not function for childbearing until puberty
- Puberty usually begins between ages 10 and 15
Signs of Puberty

Males
- ~13 yr
- Enlargement of testes and scrotum

Females
- ~11 yr
- Budding breasts
- Menarche—first menstrual period
Menopause

Females

- a whole year has passed without menstruation
  - Ovaries stop functioning as endocrine organs
    - Changes in hormone production
  - Childbearing ability ends
  - Hot flashes and mood changes may occur

Males – no equivalent to menopause

- steady decline in testosterone