Male Reproductive System
1. Know that the testis is the male gonad where spermatogenesis (meiosis) occurs to make haploid (N) flagellated sperm cells
2. Know that the interstitial (Leydig) cells are found in the testes between the seminiferous tubules. The interstitial cells secrete the masculinizing steroid hormone testosterone.
3. The seminiferous tubules are lined by 2N (diploid) spermatogonia that divide by mitosis. One of the daughter cells becomes a spermatogonium to maintain their population throughout adult life and the other daughter cell becomes a 2N primary spermatocyte that divides by meiosis (spermatogenesis) to become flagellated sperm cells
4. Sperm and egg cells are also known as gametes (sex cells). They are haploid (N) cells with 23 unpaired chromosomes. Diploid cells (2N) possess 46 (23 pairs) of chromosomes.
5. The “tail” of a sperm cell is its flagellum. The flagellum whips back and forth allowing sperm cells to swim through vaginal and uterine fluids.
6. Know that the testes form during embryogenesis in the abdominal cavity. A cord-like structure called the gubernaculum “pulls” them through the inguinal canal in the pelvic wall into the scrotum 1-2 months prior to birth. This is referred to as the descent of the testes.
7. Know that the failure of the testes to descend prior to birth is called cryptorchidism.
8. Know that the testes descend into the scrotal sac to keep the testes in a place where the temperatures are cooler which favor sperm production. The testicular temperature is around 95 F (several degrees lower than body temperature)
9. Know that the cremaster muscle is embedded in the scrotal sac. It contracts or relaxes in response to the ambient (surrounding) temperature. The cremaster muscle contracts when cold (e.g., swim in cold water) to retract the testes closer to the body to keep them warm. The cremaster muscle relaxes when warm (e.g., exercise) and the scrotal sac elongates and droops away from the core temperature to prevent the testes from getting to warm.
10. Know that the epididymis is a highly coiled tube where sperm are stored. Sperm can stay in the epididymis for around 20 days if they aren’t ejaculated. Old sperm that aren’t ejaculated are phagocytized in the epididymis by macrophages.
11. Know that the epididymis gives rise to the ductus deferens (vas deferens). Sperm only go into the vas deferens if male is going to ejaculate semen. The vas deferens leaves the scrotal sac through the inguinal canal and goes into the abdominopelvic cavity.
12. The vas deferens fuses with the seminal vesicle duct to form a short ejaculatory duct. The ejaculatory duct goes through the prostate gland and opens into the urethra (drains the urinary bladder).
14. Know that semen is a thick, milky white secretion with an alkaline pH of around 7.4 that contains the secretions of the semen-forming glands as well as 100’s of millions of flagellated haploid sperm cells. Semen plays no functional role within a male’s body. It is a
solution designed to nourish sperm and allow them to travel out of the penis at ejaculation and into the vagina. Semen is a solution that transfers sperm from the male body to the female body so that the sperm can unite with an ovulated egg to form a zygote that ultimately becomes a newborn child.

15. Know that there are a pair of seminal vesicles on either side of the urinary bladder. They secrete an alkaline fluid with a pH of around 7.4. The seminal vesicles fluid accounts for around 70% of the volume of semen.

16. Know that the seminal vesicle fluid is high in fructose which sperm cells take up and use for ATP synthesis. Lots of ATP is needed to power the swimming motion of flagella when sperm swim.

17. Know that there is only one prostate gland just below the urinary bladder. The urethra goes through the middle of the prostate gland. The fluid from the prostate gland has a pH of around 6.5. It mixes with the alkaline fluid (pH of 7.4) of the seminal vesicle to give semen a slightly alkaline pH of around 7.4.

18. Know that vaginal fluids have an acidic pH of around 4.5.

19. Know that sperm cells do not swim very well in the vaginal fluids at a pH of 4.5. The alkaline pH of semen (around 7.4) mixes with the vaginal fluids which raises the vaginal fluid pH to around 7 which is within the optimal pH range for sperm motility (movement). In other words, semen helps to neutralize the acidity of the vaginal fluids and adjust the pH of the vaginal fluids to 7 so that sperm will swim vigorously in the vagina.

20. Know that the 2 bulbourethral glands secrete a mucus-containing solution that lubricates the urethra (makes its walls slippery) so that semen moves through it with greater ease during ejaculation.

21. Know that penis contains 3 erectile columns (corpus spongiosum and corpora cavernosa) that engorge with blood when a male has an erection. Stimulation to the glans of the penis can trigger the vascular changes that lead to an erection. The penis must become erect (hard and rod-like) An erect penis is necessary to penetrate into the vagina during sexual intercourse. A flaccid (limp) penis will not go into the vagina.

22. Impotence (erectile dysfunction) – failure of a male to have or sustain an erection.

23. Know the 3 phases of the male sexual response: erection, emission, and ejaculation.

24. Know that stimulation of fine touch receptors in the glans of the penis triggers vascular changes that lead to an erection.

25. Know that the semen-forming accessory glands secrete their solutions during emission. Know that smooth muscle contractions in the walls of the epididymis and vas deferens move sperm into the urethra during emission. The sperm mixes with the secretions to create semen in the urethra.

26. Know that semen forms in the urethra during emission. A male is not aware that this is occurring.

27. Know that ejaculation occurs as a skeletal muscle contracts several times and presses down on the urethra to pump semen out of the penis.

28. Know about the withdrawal method for preventing a pregnancy during unprotected sex. Know that withdrawal is not very effective and often results in an unwanted pregnancy because a male who is not wearing a condom doesn’t withdraw in time to prevent some semen from entering the vagina. Know that males feel the contraction of the skeletal
muscles that occur during ejaculation and use that feeling to “withdraw” the penis quickly from the vagina in order to ejaculate outside the vagina. Sometimes semen is ejaculated into the vagina before a male withdraws. If the female is not using any form of birth control (e.g., pill or IUD), then the sperm in the semen can find and fertilize an ovulated egg in the fallopian tubes.

29. Know that **FSH and LH are gonadotropins** secreted from the anterior pituitary gland in the brain. They are secreted for the **first time at puberty** when males are around **12 years** of age (7th grade).

30. Know that FSH stimulates spermatogenesis in the seminiferous tubules. LH stimulates the Leydig cells to secrete testosterone. Males continue to **secrete FSH and LH for the rest of their life**. As a result, males secrete testosterone and make sperm cells from puberty until death.

31. Know the **effects of testosterone in males**: hair growth, deepen the voice, increase RBC production through EPO, increase oil gland activity that leads to acne, increase skeletal muscle strength, promote sex drive and increase basal metabolic rate. Testosterone is known as a masculinizing hormone since it is responsible for features of males that differ from females:: deeper voice, more problems with acne, stronger skeletal muscles, and greater oxygen carrying capacity.

32. Know that a **vasectomy** is the male sterilization procedure. A sterile male cannot get a female pregnant. Know that the vas deference is cut and the cut ends sealed shut. Sperm cannot incorporate into semen. Males who have had a vasectomy still secrete testosterone and ejaculate semen (without sperm).

**Female Reproductive System**

1. Know that the ovary is the **female gonad where oogenesis** (meiosis) produces **haploid egg** cells (singular: ovum, plural ova)

2. Know that “**immature eggs**” form during **fetal development** and are found in the cortex (outer) region of the ovary surrounded by follicle cells. The egg surrounded by a layer of follicle cells is known as an **ovarian follicle** (OF). Females are born with all of their ovarian follicles in the cortex.

3. Menopause is a time in a female’s life when they stop having menstrual cycles. This occurs around the ages of 45 to 55 (average age is 51 in U.S.). Postmenopausal women do not have menstrual cycles and their ovaries no longer secrete estrogen and progesterone.

4. Know that the **uterine tubes** are also called **fallopian tubes or oviducts**. The fallopian tube is the **site of fertilization**. Fertilization is when the N sperm and N egg (unfertilized egg) fuse together into a single 2N cell called the **zygote**. The zygote is also called the **fertilized egg**. Once the fertilized egg (zygote) forms it divides by mitosis into a ball of cells known as the developing **embryo**.

5. Know that the finger-like projections of the fallopian tubes are called fimbriae. They embrace the ovary.

6. Know that a **tubal ligation** (tubes tied) is a female sterilization procedure. The fallopian tubes are sealed shut so that the egg and sperm cannot meet at fertilization so a female cannot get pregnant. Females with a tubal ligation still undergo menstrual cycles, ovulate eggs and secrete estrogen and progesterone from their ovaries.
7. Know the **structure of the uterus**: fundus, body and cervix.
8. Know the 3 layers of the uterine wall: **endometrium** (inner lining), **myometrium** (smooth muscle layer) and **perimetrium** (outer). Cervical cancer is a form of cancer associated with the cervix of the uterus.
9. Know that the **endometrium** in a female who is experiencing menstrual cycles consists of 2 layers: **stratum basale** and **stratum functionalis**. The s. basale is the layer of the endometrium that grows the functional layer when stimulated by estrogen. It is the s. functionalis that is shed into the uterine cavity during mensis (period) along with blood.
10. Know that the **uterus** is also known as the **womb**. During a pregnancy, the embryo and fetus develop in the uterus.
11. Know that the **vagina** is also known as the **birth canal**. The baby develops in the uterus (womb) and then comes through the vagina (birth canal) during childbirth into the world.
12. Know that the **vaginal fluids have an acidic pH of 4.5** that inhibit sperm motility.
13. Know the 3 **major functions of the vagina**: (1) carry menstrual discharge from uterus to outside of body (or to a tampon inserted into the vagina); (2) receive penis during copulation (sexual intercourse); (3) birth canal
14. Know that the external genitalia are collectively found in the **vulva**: mons pubis, labial folds (minor and majora), and the vestibule where one finds the clitoris as well as the urethral and vaginal orifices.
15. Know that the **clitoris contains two columns of erectile tissue**. The erectile columns engorge with blood when the glans of the clitoris is physically stimulated. This results in a clitoral erection.
16. Know that the **mammary glands** (breast) contain epithelial cells that line ducts that **make breast milk (lactational fluid) after childbirth**. The milk ducts open at the nipple. There are around 10 milk duct openings in each nipple.
17. Know the 2 pituitary hormones that regulate milk production: **PRL** and **OXT**. They are both released from the pituitary gland into the blood when an infant suckles on the nipple of the breast. **Prolactin** (PRL) stimulates the epithelial cells of the breast to produce milk (lactational fluid) inside of them. **Oxytocin** (OXT) causes the epithelial cells in the breast to release their milk into the ducts where it flows into the mouth of a suckling infant.
18. Know that the pigmented area around the **nipple** of the breast is the **areola**.
19. Know all of the details about the events associated with the **reproductive cycle of females** that occur in the **ovaries** and the **uterine lining (endometrium)**.
20. Know that **puberty** is the time in a female’s life when she starts her menstrual cycles. Puberty in females occurs around the age of 10-12 (6th and 7th grade).
21. Know the following changes that occur in **females at puberty**: breast buds form, pubic and armpit hair appears, menstrual cycles begin, regular periods (mensis) start occurring.
22. Know that the **pituitary gland** secretes the gonadotropins, **FSH and LH** in females that regulate their menstrual cycles.
23. Know that **FSH** (follicle stimulating hormone) stimulates an ovarian follicle (OF) in the right or left ovary each month to develop.
24. Know that **LH** (luteinizing hormone) causes ovulation to occur around the midpoint of a menstrual cycle. **At ovulation, the OF splits open and releases the egg onto the surface of**
the ovary where it eventually makes its way into the fallopian tube. The OF without the egg is now called the corpus luteum (CL).

25. Know the effects of the ovarian steroids: **estrogen and progesterone**
26. Know that **estrogen** is a feminizing hormone that is responsible for the “female” look (as compared to males): stimulates fat deposition beneath the skin that makes the breasts, hips and thighs larger than in females as compared to males (hourglass shape), widens the hip (coxal) bones and rotates the acetabulum laterally that creates a “wiggle” when females walk that is not seen in males, softer skin. Estrogen also causes the growth (epiphyseal) plates in long bones to close earlier than they would in males. This makes females shorter on average than males. Girls usually reach their adult height by 10\textsuperscript{th} grade when they are 16 whereas males continue to gain height for several more years (up to 21 years of age). Estrogen stimulates osteoblasts to increase the density of calcium salts with the walls of bones (strengthen bones).

27. During each menstrual cycle, know that **estrogen stimulates** the stratum basale of the endometrium to thicken as it grows a stratum functionalis layer.
28. Know that **estrogen is secreted by the OF (ovarian follicle) and the CL (corpus luteum).**
29. **Progesterone** is known as the hormone of pregnancy and its secretion is essential to maintaining a pregnancy. Know that progesterone is **only secreted by the CL after ovulation** (release of egg from OF) occurs.
30. **Progesterone** stimulates glandular cells in the endometrium to release nutrients that nourish the developing embryo during the early stages of a pregnancy. Progesterone also **prevents the smooth muscle of the myometrium from contracting** during a pregnancy. This is called progesterone’s quieting effect and it prevents the contractions from starting labor contractions prematurely.
31. Know that the **abortion pill** blocks the effects of progesterone early on in a pregnancy (within the first 10 weeks) and that causes the uterus to abort the pregnancy. This is called a medication abortion.

**Menstrual Cycle**

1. Know the events that occur during the following stages of the menstrual cycle: **mensis (period), preovulatory, ovulation and postovulatory**
2. Know that mensis is the stage when a female is on her period and using an absorbent tampon inserted into the vagina. Mensis lasts for around 5 days and is the stage when there is a bloody discharge from the uterus as the stratum functionalis layer is shed and blood vessels within it break. The bloody discharge includes dead endometrial cells, blood and an anticoagulant called **heparin**. Heparin prevents the blood in the menstrual discharge from clotting so that it will remain fluid and flow out of the uterus into the vagina.
3. Know that the **preovulatory phase** lasts about 9 days and it is when FSH from the anterior pituitary gland causes an OF (ovarian follicle) in the right or left ovary to develop. The number of follicle cells around the immature egg increase in number and secrete increasing amounts of estrogen. The estrogen causes the endometrium to thicken.
4. Know that **ovulation** only lasts for a few minutes. Ovulation occurs as LH from the anterior pituitary gland causes the enlarged OF to rupture (split open) and release the egg onto the surface of the ovary. This event is called **ovulation**. The egg then moves into the fallopian
tube where fertilization may occur if a sperm is present. Once the OF releases the egg it becomes the CL (corpus luteum).

5. Know that ovulation occurs around day 14 (midpoint) of a typical 28 day long menstrual cycle.

6. Know that the postovulatory phase which lasts around 14 days involves the secretion of estrogen and progesterone from the CL. Progesterone prepares the uterus for the possibility that an embryo might form and implant into the uterine lining (endometrium).

7. Know that if fertilization occurs it will happen sometime within the middle of the postovulatory phase.

8. Know that if fertilization does not occur, then the CL dies within 14 days of forming. Estrogen and progesterone are no longer secreted from the ovaries and the stratum functionalis layer of the endometrium starts to slough off as mensis begins.

**Fertilization and multiple ovulations**

1. Know that fertilization is the union of a N sperm with an unfertilized N egg to form the 2N zygote (fertilized egg). This occurs in the fallopian tube. Once the zygote forms it starts to divide by mitosis into a growing ball of cells called the embryo. The embryo then travels down the fallopian tube into the uterus where it implants into the endometrium.

2. FSH normally stimulates only 1 OF to develop in either the right or left ovary. This results in the ovulation of 1 egg. If the 1 egg is fertilized then a woman becomes pregnant with 1 child. Occasionally the one embryo that forms splits into two embryos to form identical twins.

3. FSH sometimes stimulates 2 or more OF’s to develop and that results in multiple eggs being ovulated. If all of the ovulated eggs are fertilized by sperm cells then a women can become pregnant with multiple births (e.g., twins, triplets, quadruplets).

**hCG from an implanted embryo**

1. Know that if a pregnancy occurs that the embryo implants into the uterus during the postovulatory phase and secretes a hormone called hCG that enters mom’s blood.

2. hCG is secreted by embryonic cells and it prevents the CL from dying.

3. As a result, the CL continues to secrete E and P to prevent the endometrium from shedding and to simulate glandular cells in the uterus to secrete nutrients that the embryo needs to thrive.

**Fertilization always occurs around the time of ovulation**

1. Sperm can live for 2 to 5 days in the uterus

2. The ovulated egg is only viable (capable of being fertilized) for 12 to 24 hours after ovulation before it dies. As a result, the ovulated egg must be fertilized within 1 day of ovulation.

3. A woman could receive semen from a male several days prior to ovulation and the sperm cells would be able to fertilize the egg on the day of ovulation.

4. A woman can only get pregnant within a 2 to 5 day period of time each month.
**Birth Control Pills**
1. Know that birth control pills are usually combination pills that contain estrogen and progesterone that prevent ovulation from occurring. Some birth control pills only contain progesterone.
2. If ovulation does not occur, then it is not possible to get pregnant since no egg was ovulated.

**Intrauterine Device (IUD)**
1. Know that an IUD is a small T-shaped device that is placed in the uterus
2. An IUD prevents a pregnancy from occurring for several years

**Morning After Pill** (also called Plan B One Step or Next Choice)
1. Know that the morning after pill can be bought at drug stores like CVS without a prescription
2. The morning after pill is taken by a female if she had unprotected sex and thinks there is a possibility that she might be pregnant. Unprotected sex usually means that the guy was not using a condom and ejaculated semen into the vagina of a female who wasn’t using birth control pills (or using an IUD).
3. if taken within 72 hours of unprotected sex, then the morning after pill reduces the chance of a pregnancy by 85-90%.