Importance of Puberty

- Humans reproduce sexually, and are usually born with the either male or female sex organs\(^1\). These organs do not function sexually until our bodies get the sign to produce mature gametes.
- When the body is ready it undergoes **puberty** – a time where hormones cause the body to change and produce mature gametes. For males these are mature sperm. For females these are mature eggs.
- Puberty generally starts for males around the ages of 13-16, while for females they usually reach menstruation (one of the last stages of puberty) at around 12-13 years.
- The hormone FSH (follicle-stimulating hormone) is produced in the brain and reaches the gonads (reproductive organs) to produce gametes. Male gonads are testes. Female gonads are ovaries.

Male Reproductive System

- When FSH travels to the testes, the testes produce a hormone called testosterone. This produces secondary male characteristics, such as:
  - Broader shoulders
  - Deeper voice
  - Growth of body hair
- Males begin producing sperm during puberty, and continue producing sperm throughout their lives.
- Sperm have short life spans – die within a few days if not released and are reabsorbed into the body. Males produce, on average, about 200 million sperm per day.
- Anatomy:
  - Testes are found in a sac called the scrotum. Located outside of body to keep it cool, which allows for better sperm production.
  - Testes are made up of **seminiferous tubules** where cells divide by mitosis to produce diploid cells. Eventually, the cells progress to meiosis where haploid cells are produced, which are the start of sperm.
  - Immature sperm move to the **epididymis** to finish maturing. It takes approximately 70 days for sperm to mature in a human male.
  - The **penis** delivers the sperm to the female during reproduction. Before sperm leaves the epididymis and travels to the penis, it travels through the **vas deferens** (a tube connecting the epididymis to the urethra), through the prostate gland (where a thick milky seminal fluid is added to the sperm to make semen), and to the urethra (the tube that exits the penis).
  - One drop of semen contains about 5 million sperm.

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\(^1\) Some humans are born with both female and male physical characteristics. These individuals are not necessarily considered hermaphrodites. Instead, they are said to be in an intersex state – meaning they have both male and female physical characteristics.
Female Reproductive System

- FSH travels from the brain to stimulate the female gonads (ovaries).
- Ovaries produce two main hormones – estrogen and progesterone. These hormones produce secondary female characteristics:
  - Growth of body hair
  - Fat deposits in hips and breasts
- Before a female baby is born, her ovary cells begin meiosis which will produce haploid cells (eggs) – but this meiosis is suspended before the baby is born. At the time a female is born she has all the egg cells she will ever have. Human female starts with about 1-2 million eggs cells at birth, but only about 400,000 remain by the time a female reaches puberty.
- Once a female reaches puberty, meiosis resumes and mature egg cells are produced.
- Anatomy:
  - Each egg cell surrounded by a structure in the ovary called a follicle, which nourishes and protects the egg until it matures and is released during ovulation.
  - During ovulation, the follicle ruptures and a mature egg is released. One egg is typically released every 28 days.
  - When the egg leaves the follicle, the empty follicle turns into the corpus luteum and produces progesterone.
  - When egg is released, it gets swept into the fallopian tubes – sometimes also called the oviduct (tubes that connect ovaries and the uterus).
  - Eggs need to be fertilized by a sperm within 24-48 hours or else it will die.
  - The uterus is a hollow pear-shaped organ that protects a developing baby.
  - The cervix connects the uterus to the vagina
  - The vagina is a long muscular tube that leads to the outside of the body. Sometimes called the birth canal.

Hormones in Female Reproductive Cycle

- In females, hormone production is a precisely timed event. The cycle of hormones is called the menstrual cycle.
- Menstrual cycle continues every 28 days unless an egg has been fertilized.
- The hormones in the brain signal the ovaries, which signal the uterus. There are four main hormones involved in this cycle:
  - Follicle-stimulating hormone (FSH)
  - Luteinizing hormone (LH)
  - Estrogen
  - Progesterone
- The cycle happens as follows:
  - Brain releases FSH to bloodstream. FSH reaches the ovaries and signals it to start developing follicles. Many start developing, but only one will mature and release and egg, while the others will disintegrate.
  - Developing follicle produces estrogen and releases it to the bloodstream.
  - Estrogen reaches uterus and brain. Lining of uterus begins to thicken (to prepare for a baby). Lining is called endometrium. Brain produces and releases LH.
  - LH reaches ovary and causes mature follicle to release and egg.
  - Once egg is released, LH signals empty follicle to develop into corpus luteum.
  - Corpus luteum produces progesterone.
Corpus luteum produces progesterone and some estrogen and releases it to bloodstream. Produces these for about two weeks until it disintegrates.

- Progesterone reaches the uterus and brain – signals uterus to continue thickening. Signals brain to stop producing FSH and LH to prevent another egg from being released.

- Once the corpus luteum disintegrates (takes about 10 days), the progesterone level decreases. This signals endometrium to break down and body to get rid of it, in a process called menstruation. Usually lasts 4 to 7 days.
- After menstruation, progesterone levels are low, which causes body to release FSH and the cycle starts over.
- Pregnancy interrupts this cycle. Keeps progesterone levels high.

Human Development

- In order for an egg to be fertilized a sperm must find it. When sperm enters the vagina, it must travel through the cervix, uterus, and into the fallopian tubes. Hundreds of millions of sperm will search for the egg (attracted by compounds released by the egg), but most will die looking for the egg.
- So, a haploid egg and a haploid sperm join to form a diploid zygote in a process called fertilization.
- About 24 hours after fertilization, the cell has undergone mitosis and will continue to do this. By 7 days the embryo (the fertilized diploid cell) will have traveled to the uterus and is called a blastocyst.
- The embryo is connected to the mother’s uterus by a placenta – an organ that allows for the exchange of nutrients, oxygen, and carbon dioxide with the mother. Embryo is connected to the placenta by the umbilical cord.
- After approximately 8 or 9 weeks the embryo is referred to as a fetus. The pregnancy starts with two cells (sperm and egg) and undergoes enough mitotic divisions to produce a baby that survive outside the mother’s body.

Contraceptive Technology

- When couples try to prevent pregnancy this is known as contraception. Abstinence (refraining from having sex) is the only form of contraception that is 100% effective.
- Other forms of contraception include:
  - Condoms
    - Most common is the male condom: typically a latex bag designed to catch the sperm so that it does not enter into the female.
    - There are female condoms, as well as diaphragms (barrier inserted into vagina that covers the cervix).
  - Oral Contraceptive Pill
    - Commonly called the birth control pill.
    - Contains a combination of estrogen and progesterone. Works to suppress normal ovulation. Because these hormone levels are high, it suppresses ovulation (tricks body into not releasing an egg) and keeps endometrium from thickening.
    - These pills are taken for 21 days, then menstruation occurs for the other 7 days.
Contraceptive Injections
- Administered between once every 1-3 months. Injections are done into muscles.
- Works similar to oral contraceptives where they a form of progesterone (called progestin) tricks the body into not releasing an egg.

Intrauterine Device (IUD)
- Devices inserted into the uterus. Two types of IUDs:
  - One contains a hormone that thins the endometrium and thickens mucous in uterus, which stops sperm from entering.
  - Second type is made of copper and changes the internal chemistry so that sperm cannot survive.

Sterilization
- Both men and women can elect to have this done.
- For women it is called tubal ligation
  - Fallopian tubes are disconnected from the uterus.
- For men it is called a vasectomy
  - The vas deferens are surgically disconnected.

Reproductive Technology
- Some couples have difficulty (about 10%) trying to conceive a child. Typically this happens in women because of a blockage in one or both fallopian tubes, irregular or non-ovulation, or problems with ovaries not producing mature eggs. In men, most infertility is because of low sperm count.
- Fertility drugs are often used to correct hormone levels or enhance/inhibit other hormones.
- Two common assistive technology are:
  - Artificial Insemination
    - In this case, sperm is inserted directly into the cervix or into the uterus in an attempt to get the sperm closer to the egg. This helps when there either isn’t enough sperm or the sperm cannot swim or survive in the vagina.
  - In Vitro Fertilization (IVF)
    - In vitro means “in glass.” It is called in glass because the fertilization occurs in a glass test tube or dish.
    - Powerful drugs are given to the female to produce more than one egg. The mature eggs and sperm are collected and put into a dish where fertilization takes place.
    - Sperm and egg are fertilized and incubated for about 18 hours. If the cells show signs of fertilization, they are inserted into the mother’s uterus. Once inserted, hopefully the cells implant on the uterus and the pregnancy continues as normal.
    - In most cases more than one embryo is inserted in the hopes that at least one will implant. For this reason it is normal to have multiple births when attempting IVF.