Chapter 11 – Reproduction

1. Asexual Reproduction

Requires only one parent to produce offspring, offspring is the clone of the parent
Not very efficient for evolution, as only mutations can produce variations
Many organisms, usually simple ones, reproduce asexually

Prokaryotes – reproduce through binary fission (a simple type of cell division)
Single Celled Eukaryotes – Reproduce by mitotic cell division
Yeast and Hydras – reproduce through **budding**. (Buds grow on the body, then detach)
Flatworms – reproduce through fragmentation (breaks into pieces, each grows into new worm)
Certain Plants – growth of structures not specialized for reproduction
Grasses and strawberries grow new plants along "runner" stems
If you've grown a plant from a cutting, you've seen vegetative reproduction
Unfertilized Eggs – rarely, unfertilized eggs can develop into an organism
Unfertilized eggs from queen bees develop into male bees

2. Chromosome Numbers

Each species has a consistent number of chromosomes – humans (46) turkeys (82), etc
Prokaryotes generally have only 1. Chromosomes in eukaryotes are found in pairs
The two chromosomes in a pair are **homologous**, or similar in structure
The chromosome count from one generation to the next remains the same
In asexual reproduction, the chromosomes duplicate and each one gets one set
In sexual reproduction, two parents contribute chromosomes to the offspring
Gametes – reproductive cells (sperm/egg) **Fertilization** – uniting the nuclei of two gametes
Gametes have only half the number of normal chromosomes.
While normal cells have paired chromosomes, gametes don't.
Haploid – one chromosome per pair (no paired chromosomes, sex cells are haploid)
Diploid – two chromosomes per pair (paired chromosomes, normal cells are diploid)

3. **Meiosis** – a type of cell division that halves the number of chromosomes in gametes. Used to make sex cells
Meiosis turns the original cell, with 46 CHROMOSOMES into 4 cells with 23 CHROMATIDS
Chromatid – half a chromosome
1. Divides once, forming two cells 23 CHROMOSOMES each
2. Both cells divide again, forming four cells with 23 CHROMATIDS each
3. When the new cells mature, they will grow to have 23 CHROMOSOMES

Stages of Meiosis – similar to mitosis, but with a few important differences
Prophase 1 - chromosomes **cross over**
Crossing Over – DNA of one chromosome gets mixed with corresponding DNA of another chromosome. Also known as **Genetic Recombination**
Crossing over helps creates uniqueness and variations within species
Metaphase 1 – the pairs of chromosomes line up, similar to metaphase in Mitosis (Ch. 9)
Anaphase 1 – chromosomes separate, move to opposite end of the cell, similar to mitosis
Telophase 1 – cell divides, creating two cells with 23 chromosomes each
Prophase 2 – nothing significant happens, crossing over does NOT take place
Metahpase 2 – chromosomes line up at the center of the cell, but no pairs this time
The chromosomes line up single file down the equator of the cell
Anaphase 2 – centromeres divide, chromotids are pulled to opposite sides of the cell
Telophase 2 – both cells divide, forming 4 cells, each with 23 chromatids
Males produce 4 equal sized sperm. Females produce 1 egg, and 3 polar bodies, which die
In females, there isn't enough cytosol for 4 eggs; so 3 eggs give up cytosol and die

4. Non-flowering plants – these plants are weird, and rare, and usually simple (ie, moss)
In some plants, meosis produces haploid cells (spores) that grow into multicellular haploid plants
These plants produce male and female gametes through MITOSIS, which reproduce into diploid plants
The diploid plants will produce haploid **spores** by MEIOSIS, which grow into haploid plants
The cycle will continue. The first generation will be haploid, 2nd, diploid, 3rd haploid, etc
Known as the **Alternation of generations**.

5. Reproduction in Flowering Plants – refer to the picture as needed
Carpel – the female organ in the plant, producing eggs
The ovaries are located at the base of the carpel, containing **ovules**, where eggs are produced
Egg Formation – special cell in ovule, undergoes meiosis, forms 4 haploid cells, only 1 survives
Surviving cell undergoes a series of mitotic divisions to form 7 cells, 1 of which is egg

Another is a large cell with 2 nuclei known as the **polar nuclei**

Stamen – the male organs. Pollen production occurs in the **anther**, or tip of the stamen

Specialized cells undergo meiosis, forming 4 haploid cells

Each haploid cell then divides mitotically to produce a grain of pollen

Each pollen grain consists of a tube cell and a cell with **two** haploid sperm nuclei

Pollination – the process of delivering the pollen from the stamen to the carpel

Occurs due to wind, water, insects, birds, etc.

Cross pollination – pollen from one plant comes in contact with carpel of another plant

Increases genetic variation among plants

Fertilization – occurs with the pollen is united with the egg cell in the ovule

When pollen lands on the tip of the **stigma** (tip of the carpel), it forms a tube going towards ovule

When it reaches the ovule, one sperm nucleus fuses with the egg, creating an **embryo**

The 2nd sperm nucleus fuses with the cell with the two polar nucleo, forming a triploid

Endosperm – the result of the 2nd sperm nucleus fusing with the cell w/ 2 polar nuclei

The endosperm serves as a food storing tissue for the growing embryo

A protective covering then covers the embryo and the endosperm, forming a **seed**

At about the same time, the ovary enlarges and develops into a fruit

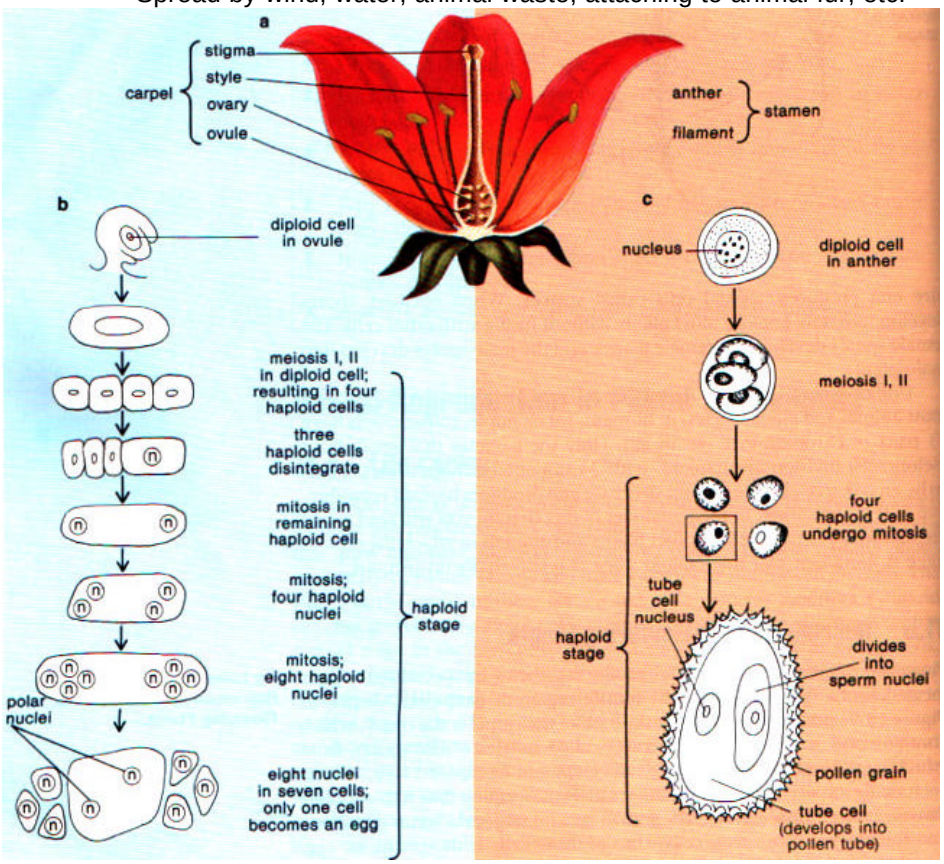
The endosperm contains energy, which animals can use as food

If the seed ever germinates, the endosperm serves as food for the new plant

Usually, seeds need to be carried long distances before they can germinate

The seed has little chance competing for resources with larger plants

Spread by wind, water, animal waste, attaching to animal fur, etc.



6. **External Fertilization in Animals** – relatively low chance of fertilization compared to internal fert.

Ovaries – the female sex organ, producing ova, or eggs

Testes – the male sex organ, producing sperm

Some animals can produce both, but not at the same time

The large size of the egg allows it to store food and organelles for early development

However, its size prevents it from moving on its own, unlike the sperm

Spawning – depositing of eggs into water. Sperm needs a liquid environment to reach the eggs

Usually leave a large number of eggs, since chance of fertilization is rather low

Males usually go great lengths to attract the females. Sperm cells must be deposited close to eggs

Amphibians and water dwellers commonly use external fertilization

7. **Internal Fertilization in Animals** – relatively high chances for fertilization

Sperm is released into the female, and the female's body protects the embryo from the environment

Only a few eggs are needed, but large number of sperm, for several reasons
Sperm have a short lifetime, and they have to "swim" quite a distance to the egg
The female's body is usually highly acidic, which is hazardous to the sperm
Out of 200,000,000 sperm released by human males, only 50 ever reach the egg
Also, many sperm are needed to break down the protective layer of the egg
Some insects, such as bees, store sperm in the female's body and release them as necessary….
For many vertebrates, there are many ways to signal to others that they're about to release gametes

8. Reproduction in Humans

Females

Ovaries – females have 2 ovaries, each releasing an **ova** (egg) every other month
The ovaries are also responsible for releasing **estrogen** (a female sex hormone)
Ovarian follicles – a pouch surrounding the egg, ruptures when the egg is released
Corpus Luteum – forms from tissues of ruptured ovarian follicle, secretes hormones
Progesterone – another female sex hormone, secreted by the corpus luteum

Oviducts/fallopian tubes – after the egg is released, it travels through this tube to the uterus
Cilia – small "tails" in the fallopian tubes that "sweep" the egg towards the uterus
Fertilization – the fusing of a sperm with an egg, occurs in the fallopian tubes
Peristalsis – involuntary muscle contractions that move the egg towards the uterus
Tubel ligation – tying of the fallopian tubes, permanent birth control

Uterus – a muscular, pear shaped organ where the fertilized egg grows and develops
At birth, the uterus contracts, pushing the baby out of the uterus through the vagina
Corpus – the top portion of the uterus
Cervix – the lower neck of the uterus that opens to the vagina
Endometrium – the lining of the uterus, builds throughout the menstrual cycle

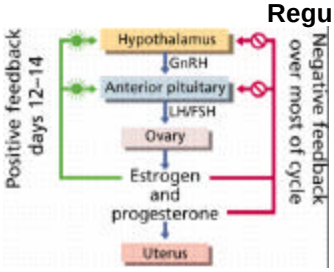
Vagina – the passageway through which the baby passes through during birth
It also serves as the location for males to deposit sperm
Bartholin's Gland – secretes mucus to lubricate the vagina during intercourse
Volvovaginal gland – same as the Bartholin's Gland
Rugae – folds in the walls of the vagina, allows it to expand for child birth

Vulva – the external genitals
Vaginal opening – opens to the vagina
Labium Majus – the major lining around the vagina, protects it
Labium minus – the thinner lining around the vagina, protects it
Urethral meatus – a tube that leads to the bladder
Clitoris – a "organ" that fills with blood on arousal

Menstrual Cycle – the process of releasing an egg once every 28 days
During the cycle, the **endometrium**, or inner lining, of the uterus builds up
If the egg is not fertilized, then the endometrium is broken down and flows out the body
If the egg is fertilized, it plants itself in the thick endometrium, and a baby develops
The first day of menstrual flow marks day 1, the egg is released on day 14
The exact days of the menstrual cycle varies

Stages of the menstrual cycle
Menstruation – discharge of endometrium/egg. Days 1 – 5
Follicle State – egg matures, Days 5 – 14
Ovulation – egg released, Day 14
Corpus Luteum Stage, The building up of the endometrium. Day 14 – 28

Regulating the menstrual cycle – The Feedback Mechanism



Hypothalamus – a gland near the base of the brain, secretes the hormone **GnRH**
Pituitary gland – secretes hormones **FSH** and **LH**
GnRH controls the secretion of FSH and LH, which stimulate the egg to mature
Rising levels of FSH and LH also stimulates production of more estrogen
Rising levels of estrogen trigger the production of more LH, which triggers ovulation
LH causes formation of corpus luteum, which secretes estrogen and progesterone
The estrogen and progesterone triggers buildup of the endometrium
If no egg is fertilized, the drop in LH and FSH cause the endometrium to dissolve
If the egg is fertilized, the placenta produces HCG, which stimulates corpus luteum to produce estrogen and progesterone. Pregnancy tests check for this hormone in urine

Males

Testes – males have 2 testes, consisting of **seminiferous tubules**, which produce sperm
The testes also secrete testosterone

Scrotum – the pouch surrounding and protecting the testes
Vas Deferens – sperm travels through this tube, similar to the woman's fallopian tubes
Epididymis– holds and stores sperm, allows them to mature
Vasectomy – tying of the vas deferens, permanent form of birth control
Seminal vesicles – produces the majority of the fluid in semen. Adds fructose
Semen – the sperm + seminal fluid, or the fluid that leaves the body
Ejaculatory ducts – connects the Vas Deferens to the Urethra
Prostate Gland – secretes an "activator" into the sperm that excites it
Ejaculation – the contracting of muscles to push semen out the body
Urethra – the tube that leads to the penis and out the body
Penis – the external organ that is responsible for directing semen and urine out the body
Cavernous bodies – blood vessels in the penis that fill with blood upon arousal
Cowper's/Bulbourethral Gland – produces mucus that provides lubrication during intercourse
Regulation of sperm production
GnRH stimulates pituitary glands to release FSH and LH
LH stimulates testes to secrete **androgens**, a group of male hormones
The most common hormone is testosterone
FSH regulates sperm production

9. Puberty and secondary sex characteristics
Puberty – a stage where males and females undergo many changes
Females – occurs in North America around ages 10 - 12
Begins at the 1st menstrual period, caused by rising estrogen levels
Cause changes in breasts, bone structure, and fat deposits under the skin
Males – occurs in North America around the age of 12
Caused by production of androgens, changes in voice and body hair distribution

10. Pregnancy and Birth
Gestation – period of pregnancy – 180 days
Parturition – the process of giving birth
Stages of Parturition
Labor - the uterus starts contracting, pushing the baby out, usually lasts 8 – 12 hours
Birth – the baby is pushed through the birth canal out the body
Afterbirth – the placenta, which was attached to the walls of the uterus, is pushed out the body
The umbilical cord, which provided the baby with oxygen, is pushed out
Types of Multiple Births
Identical Twins – 1 egg, 1 sperm, split, two are clones, at least genetically
Non Identical Twins – 2 eggs, 2 sperm, the two have different genes/traits
Siamese Twins – 1 egg, 1 sperm, split, but didn't split all the way, joined babies

11. Other Information
Reproduction is a basic function of living things, but is not needed for that single organism to survive
Reproduction is concerned with the preservation of a species rather than the survival of a single organism
The more offspring a species can produce, the better its chances for survival
1/6 of the human population could face fertility problems in the future
In Vitro Fertilization – egg is removed from female, fertilized outside body, and replanted in her uterus
Maternal – coming from the female **Paternal** – coming from the male
Contraception – birth control

Chapter 11 Important Concepts

1. **Explain how asexual reproduction is similar/different to sexual reproduction. Describe several methods of asexual reproduction.**

   The main difference between sexual and asexual reproduction is that asexual reproduction requires only one parent, and the offspring is a genetically a clone of the parent. Sexual reproduction requires two parents, and the offspring is a mix of the two parents, possessing traits from both sides. Asexual reproduction includes binary fission (cell division, prokaryotes), Mitosis (cell division, eukaryotes), budding (small "buds" grow, then separate from main body), fragmentation (a piece of part of the body grows into a new organism), and unfertilized eggs that grow into new organisms that are a clone of the female parent.

2. **Compare and contrast the processes of mitosis and meiosis**

   Mitosis is the process of cell division in most eukaryotic cells, where the number of chromosomes in the parent and the offspring cells remain constant. Meiosis, however, is the process of cell division to produce gametes, which reduce the number of chromosomes to ½ the original number. Also, meiosis produces 4 offspring cells, while mitosis only produces two. Also, during meiosis, the centromeres do not divide in anaphase 1. Instead, the centromeres don't divide until anaphase 2.

3. **Describe how flowering plants reproduce**

   Pollen, produced by the anther of the stamen, is transported to the stigma through insects, wind, water, etc. The pollen sticks to the sticky surface of the stigma, travels down the style, and fertilizes the egg in the ovary. One sperm nucleus fuses with the egg, forming the embryo, the other fuses with the polar nuclei, forming the endosperm. An outer layer develops, and the embryo/endosperm become a seed. When the seed germinates, it can grow into a new plant

4. **Describe how pollination and fertilization are similar and different.**

   Pollination and fertilization are similar because they are both forms of sexual reproduction, where a sperm nucleus and an egg nucleus combine to form an embryo with mixed traits. However, the double fertilization that occurs in plants (the egg and the endosperm) doesn't occur in animals.

5. **Identify reproductive strategies that are unique to each of the 5 classes of vertebrates**

   Fish – they spawn in the water, leaving large number of gametes, then leave, male leaves sperm, leaves
   Amphibians – they can live on land, but lay their eggs in water. Eggs have no shell
   Reptiles – lays eggs on land
   Birds – eggs, they guard their eggs, and nurse their young
   Mammals – internal fertilization, carry their offspring, takes care of their young

6. **Discuss how the human reproductive system is different from all of the other systems of the body. Explain why the process of reproduction is considered to be the "central theme of life"**

   The reproductive system isn't necessary for the survival of the organism. However, it is needed for the continuity of the species as a whole. Also, in many animals, and not as much in humans, the goal of an organism is to live to reproduce.

7. **Trace the pathway of a sperm cell through the male's reproductive system.**

   The sperm cells are produced in the seminiferous tubules in the testes. They travel to the epididymis, which allows them to mature. When they are mature, and when the male is sexually aroused, the sperm travel through the vas deferens, fluid and other nutrients are added by the seminal vesicles and prostate glands, and the sperm are pushed out of the body through the ejaculatory ducts

8. **Trace the pathway of an egg through the female's reproductive system**

   The egg is enclosed in ovarian follicles so it can mature. When the egg matures, the follicle ruptures, and the egg travels down the fallopian tubes towards the uterus. If it's fertilized, it implants itself in the wall of the uterus and a baby develops. If it isn't, the egg, along with the endometrium, is discharged

9. **Summarize the four major events of the female's menstrual cycle. Describe the hormonal feedback loop that regulates this cycle**

   Menstruation – the discharge of the egg and the built up endometrium – days 1 – 5
   Follicle stage – the egg matures in the ovaries – days 5 – 14
   Ovulation – the ovarian follicle ruptures, the egg enters the fallopian tubes – day 14
   Corpus Luteum stage – the build up of the endometrium – days 14 – 28

10. **Describe the structure and function of the important organs involved in the pregnancy, birth, and development of a child.**

    The embryo implants itself in the walls of the uterus, and the placenta joins the walls of the uterus and the outer membrane of the embryo, providing it with nourishment and nutrients. When the baby is ready to be born, the uterus contracts, pushing the baby through the cervix, through the birth canal, and out the body.