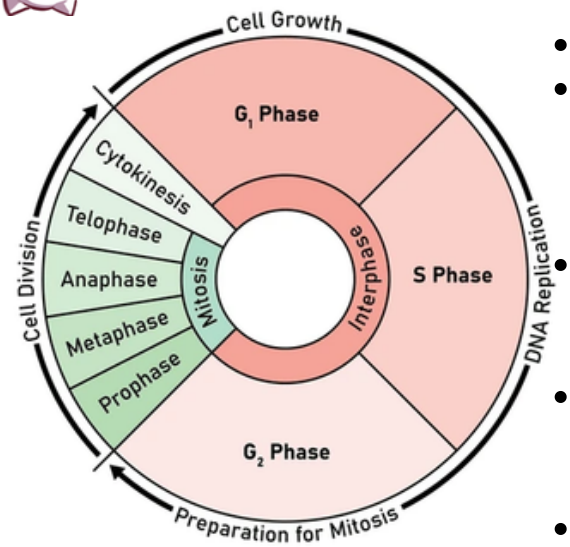


Info On The Cell Cycle:

- 90% of time in the cell cycle is spent in Interphase.
- **G0 (Resting Phase):** A temporary or permanent phase where the cell exits the cycle. It is used for repairs if DNA synthesis has issues or if the cell does not need to divide. Some cells, like nerve and muscle cells, stay in G0 indefinitely.
- **G1 (Gap 1):** The cell grows in size, produces proteins and organelles, and ensures it has enough resources for DNA replication. It also checks for damage before proceeding.
- **S (Synthesis):** The cell duplicates its entire DNA, creating two identical copies for future daughter cells. Histone proteins are also produced to help package the DNA.
- **G2 (Gap 2):** The cell continues growing, produces proteins needed for mitosis, and performs a final quality check to fix DNA errors. It also begins forming structures like spindle fibers for division.

DNA/RNA Info:

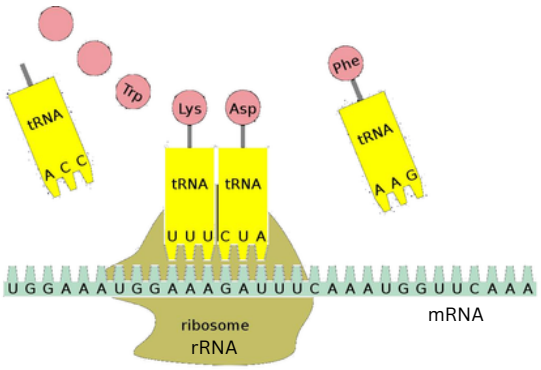
Pairings:

DNA: A-T, A-Adenine, T-Thymine, 2 Hydrogen bonds. **RNA:** A-U, A-Adenine, U-Uracil, 2 hydrogen bonds.
DNA: C-G, C-Cytosine, G-Guanine, 3 Hydrogen bonds. **RNA:** Exactly the same as DNA pairings.

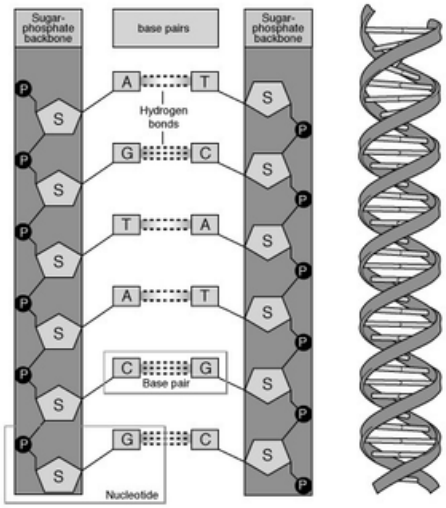
DNA	RNA
Deoxyribonucleic Acid Uses Thymine Stays in the nucleus Double Helix 1 type (Just DNA) Deoxyribose sugar Stores genetic information and is the template for replication	Ribonucleic Acid Uses Uracil Can leave the nucleus Single strand 3 types ((m, t, r)RNA) Ribose sugar Carries genetic information from DNA to ribosomes for protein synthesis

Different kinds of RNA:

- **mRNA (Messenger RNA):** Carries genetic instructions from DNA to the ribosome for protein synthesis.
- **tRNA (Transfer RNA):** Delivers amino acids to the ribosome by matching its anticodon to the mRNA codon.
- **rRNA (Ribosomal RNA):** Forms part of the ribosome and helps assemble proteins by linking amino acids together.



Cell Processes:
Photosynthesis:
Cells that do this process: Plant Cell
Light Energy + Carbon Dioxide + Water -> Oxygen + Glucose
Cellular Respiration:
Cells that do this process: Animal Cells and some Plant Cells
Glucose + Oxygen -> Energy (ATP) + Carbon Dioxide + Water (H2O)



Parts of DNA and RNA:

- **Base Pairs:** Pairs of nitrogenous bases in DNA or RNA that bond together, forming the "rungs" of the nucleic acid ladder. A-T, C-G, U-A.
- **Hydrogen Bonds:** Holds the complementary base pairs together.
- **Nucleotide:** The basic building block of both DNA and RNA. Each nucleotide consists of three parts: Phosphate Group, Sugar Molecule, and a Nitrogenous Base.
- **Sugar-Phosphate Backbone:** The structural framework of DNA and RNA. It is made up of alternating sugar (deoxyribose in DNA, ribose in RNA) and phosphate groups that are covalently bonded together.
- **Codons:** Sequences of three nucleotides in mRNA that correspond to specific amino acids or signal the start/stop of protein synthesis. eg. AUG

Definition of important terms:

- **Chromatin:** Proteins that attach to DNA which condenses long DNA to help them fit in the nucleus. (unwound form of chromosome).
- **Chromatid:** One of two identical parts of sister chromosomes. The two chromatids are joined by a centromere and the chromatids are made of many chromatins.
- **Chromosomes:** Contain all DNA instructions necessary for cell function. The chromosome is made of one or two chromatids with one centromere. They are stored in the nucleus.
- **Centriole:** A cylindrical organelle made of microtubules that helps organize the mitotic spindle and aids in chromosome movement during cell division.
- **Centrosome:** An organelle found in animal cells that serves as the main microtubule-organizing center, playing a key role in cell division by helping to form the mitotic spindle. It contains a pair of centrioles, which assist in chromosome movement during mitosis and meiosis.
- **Centromere:** The region of a chromosome that holds two sister chromatids together and is the attachment site for spindle fibers during cell division.
- **Nucleus:** The organelle in eukaryotic cells that contains the cell's genetic material in the form of DNA. It serves as the control center of the cell, regulating activities like growth, metabolism, protein synthesis, and cell division.
- **Spindle Fibers:** Microtubule structures that form during mitosis and meiosis. They attach to the centromeres of chromosomes and pull the chromatids (in mitosis) or homologous chromosomes (in meiosis) apart during cell division.

Karyotypes:

A karyotype is the general appearance of the complete set of chromosomes in the cells of a species or in an individual organism, mainly including their sizes, numbers, and shapes. Karyotyping is the process by which a karyotype is discerned by determining the chromosome complement of an individual, including the number of chromosomes and any abnormalities.

Mitosis and Meiosis:

Mitosis and meiosis are both types of cell division. Mitosis produces two identical daughter cells, used for growth and repair, while meiosis creates four genetically unique gametes (sperm or egg cells). Mitosis has one division, whereas meiosis has two. In meiosis, crossing over occurs in prophase I, increasing genetic variation. Mitosis maintains the chromosome number (diploid to diploid), while meiosis halves it (diploid to haploid). Meiosis is essential for sexual reproduction, while mitosis supports asexual reproduction and tissue maintenance. Both processes share similar stages (prophase, metaphase, anaphase, telophase), but meiosis includes additional steps for genetic diversity.

Mutations

Basics:

Mutations: Any change in the sequence of base pairs of a gene is called a mutation
Causes: Any errors caused during replication or by environmental factors (called mutagens)
Mutagen examples: *Radiation:* X-Rays, UV Rays, etc.
Chemicals: Asbestos, Urethane, etc.
Heavy Metals: Lead, Mercury, etc.
Viruses: HPV, Hepatitis B, etc.

Single Gene Mutation:

Affects only a single gene on a chromosome (Ex: Cystic Fibrosis, Color Blindness, Haemophilia, etc.)

Two Types of Single Gene Mutations:

- *Point Mutation:* A single nucleotide base is substituted for another (Ex. ATCCGA -> AT*G*CGA)
- *Frameshift Mutation:* Caused by the addition or deletion of one or more nucleotide bases (this shifts all the future nucleotide bases and changes the amino acids)
  (Ex: ATCCGA -> AT*A*CCGA and ATCCGA -> ATCGA)

Results of point mutations:

- *Silent mutations:* Does not produce a change in amino acids on the protein.
- *Missense mutations:* Produces change in amino acids in proteins. This may or may not change the function of the protein.
- *Nonsense mutation:* Produces a stop codon in the middle of the mRNA. This can produce a non-functional protein.

Chromosomal Mutations:

Affects multiple genes on a chromosome or an entire chromosome
Some examples include: *Down's Syndrome:* One gamete receives 2 copies of chromosome 21 resulting in the newborn having a total of 3 copies.
Turner Syndrome: One of two x chromosomes in females is either missing or incomplete.
How chromosomal mutations can occur: Change the structure of whole chromosomes as they alter multiple genes on the same chromosome or the entire chromosomal structure.
4 kinds of mutations: *Deletion:* This removes a chromosome segment
Translocations: A segment from a chromosome is transferred to another chromosome
Duplications: A segment from one chromosome is transferred to its homologous chromosome giving it a duplicate of some genes.
Inversions: A segment of a chromosome is inverted.

Mutation Effects:

Concept: Gene mutations may produce proteins that are beneficial or harmful to the organism or may have no effect at all.
Positive Mutation: When a gene mutation benefits the individual (Some plants have resistance to bacterial and fungal infections)
Negative Mutation: When a gene mutation harms the individual (Ex. Some humans have Sickle Cell Mutation which makes it so your cells are abnormally shaped causing blood issues)
Neutral Mutation: When a gene mutation has no effects on the individual (Ex. The white Kermode bear)

Punnett Squares (Mendelian Genetics):

Punnett Square: A diagram that predicts the possible outcomes of a genetic cross between two individuals. It's a grid of 4 “offspring” boxes that shows the probability of different genotypes and phenotypes in the offspring.

Traits: All organisms have different traits. Some of these traits are dominant (called dominant traits characterized by an uppercase letter) and some are recessive (called recessive traits characterized by a lowercase letter). The dominant traits overrule the recessive (eg. Bb would not show b) and to get a recessive trait you need two recessive genotypes (eg. bb)

Punnett Square (Example)

	B	b
B	BB	Bb
b	Bb	bb

How to make a Punnett Square: First find the parents genotypes (For the provided Punnett square there are two heterozygous parents (Bb)) and list them in the way shown on the example (Female horizontal and male vertical (if not defined it doesn’t matter)). Then cross the letters and write the 2 letters in the square that they meet with the uppercase one first.

Terms:

Genes: Parts of DNA that define traits.
Alleles: Different forms of genes. Ex. Eye color (Blue, Brown, etc.), Hair color (Blonde, Brown).
Genotype: The genes of an organism. Not all genes could be shown (Bb would only show the B trait instead of the B and b trait). The genotype is important as some traits that weren’t expressed can be passed down to the offspring.
Phenotype: The physical characteristics of an organism. This is governed by the dominant trait and isn’t the letter but an explanation of physical characteristics (eg. Long legs).
Homozygous: Homozygous has two forms (Dominant and Recessive) Heterozygous refers to having two of the same genes that form the genotype (BB or bb).
Heterozygous: Heterozygous refers to having both of the genes (Bb).
Carriers: Heterozygous organisms that don’t show their recessive trait (Phenotype doesn’t express the recessive genotype) but the recessive trait they have can be passed down to offspring.

Law of Segregation: Traits occur in pairs and these pairs are separated during gamete formation and are recombined during feralization. Sperm and egg cells each contribute one allele.

Dihybrid Cross (Non-Mendelian Genetics):

Dihybrid Crosses: A diagram that predicts the possible outcomes of a genetic cross between two individuals. Instead of comparing only one trait like a Punnett square it compares 2. It's a grid of 16 “offspring” boxes that shows the probability of different genotypes and phenotypes in the offspring.

How to make a dihybrid cross: First find the parents genotypes (For the provided dihybrid cross homozygous recessive and heterozygous). (Using NnBb as the example) the order matters and you use F.O.I.L to connect them. The order is NB, Nb, nB, and nb. Then intersect the genotypes and put them together (you should have 4 letters now, 2 of each).

Dihybrid Cross (Example)

Parents: NnBb and nnbb

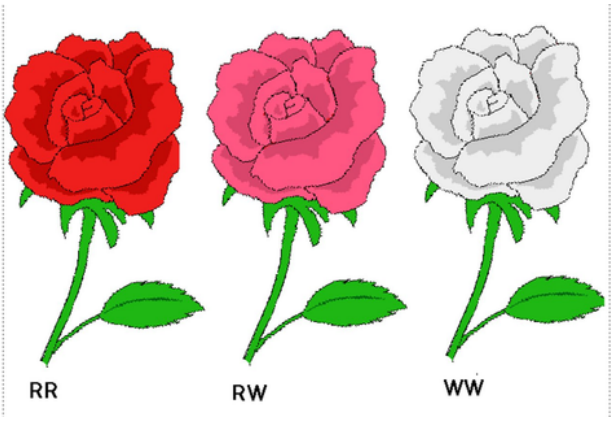
	NB	Nb	nB	nb
nb	NnBb	Nnbb	nnBb	nnbb
nb	NnBb	Nnbb	nnBb	nnbb
nb	NnBb	Nnbb	nnBb	nnbb
nb	NnBb	Nnbb	nnBb	nnbb

Incomplete Dominance and Codominance:

Incomplete Dominance: Instead of having one dominant trait they blend. With just two alleles 3 phenotypes can be produced. (Red and white could have red, white, or a blend of both (pink)).

Codominance: Both alleles contribute to the phenotype. Instead of blending it has speckles/dots. With 2 alleles 3 phenotypes can be produced (Red and white could have red, white, red with black dots, or white with red dots).

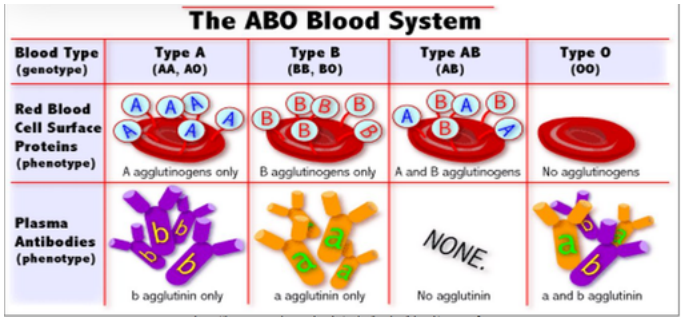
Incomplete Dominance



Codominance:

Blood Types:

Overview:



Types: There are 3 types of blood alleles: A, B, and O. These are sometimes written as I^A (A), I^B (B), and i (O). Of these i/O is recessive and A and B are codominant. Using these 3 alleles there are 4 blood types: AB, A, B, and O. These 4 blood types produce different antigens and antibodies. The antigens are the blood's identifier and will not be attacked and the antibodies make sure that there are no incorrect blood that enter the blood stream (if the blood isn't recognized by the antibodies it is attacked)the antibodies are stored in the plasma. Type "AB" blood is the "universal receiver" as it has no antibodies making it so any blood with any antigens can enter the blood stream. Type "O" blood is the universal donor as their blood has no antigens which means it isn't recognized as an issue.

RH factors: RH factors are a positive or negative trait of blood and if someone is RH positive they will have the "D" antigen and an RH negative person will not have the "D" antigen. This was first seen in the Rhesus Monkeys who have many similarities to humans. The D antigen causes more variation in blood with positive blood (even of the same type) to not be compatible with negative blood.

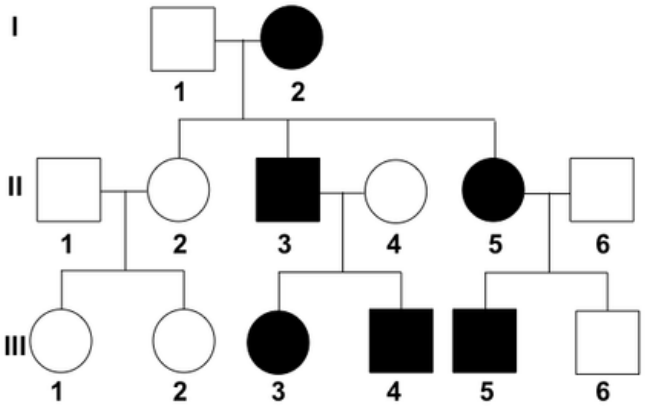
Pedigrees:

Overview:

What: A pedigree is a recorded lineage or ancestry, often used to trace traits for a living organism.

How to read a pedigree: Shaded means a carrier, half shaded means carrier, circle means female, square means male.

How to show person on pedigree: First list the generation as a roman numeral. Then the number than they are in the row. Then list if they are a carrier, affected, or unaffected. Then list their gender. (eg. II 3 affected male, and III 2 unaffected female).



Blood types, X-linked traits, Pedigrees

Sex linked traits:

Compared	Sex linked traits	Autosomal traits
Location	Found on sex chromosomes (x and y)	Found on autosomes (chromosomes)
Inheritance Pattern	Males and females inherit the traits at different points (x linked chromosomes will mostly go to males)	Inherited equally by both genders
Carriers	X linked traits: Carriers are only females (females can still get the trait but it is much rarer)	Both genders can be carriers

How to tell if a trait is dominant, recessive, X -linked, or autosomal:

First glance: are more males affected? Probably X-linked recessive

Can 2 unaffected parents have an affected child?: Recessive

Does the father transmit the disease to the son?: Cannot be X-linked

More ways to check info on traits:

If the trait is x linked dominant:

- Fathers cannot pass onto sons
- Affects sons and daughters (but usually females less severe) (fragile X syndrome)
- One parent must be affected, or it's a mutation
- Cannot skip generations

If the trait is x linked recessive:

- Fathers cannot pass onto sons
- Affects mostly sons, as daughters would need both copies of altered gene. (Hemophilia)
- Can skip generations

If the trait is autosomal dominant:

- **Affected offspring must have at least one affected parent**
- Only need one altered copy of the gene to be affected (Huntington disease, Marfan syndrome, Dwarfism)
- Affects sons and daughters

If the trait is autosomal recessive:

- **Traits can skip generations**
- Each parent carries one copy of the altered gene, but usually are carriers.
- Typically not seen in every generation of an affected family. (cystic fibrosis, sickle-cell disease)
- Affects sons and daughters