Genetics Cheat Sheet

A comprehensive cheat sheet covering the fundamental concepts of genetics, including DNA structure, inheritance patterns, and genetic variation. This cheat sheet provides a quick reference for students and professionals in biology and related fields.

Basic Concepts

DNA Structure

Building Blocks	Nucleotides (Adenine, Guanine, Cytosine, Thymine) linked by phosphodiester bonds.
Double Helix	Two strands of DNA wound together; held by hydrogen bonds between complementary bases (A-T, G-C).
Backbone	Sugar-phosphate backbone provides structural support.
Base Pairing	Adenine (A) pairs with Thymine (T); Guanine (G) pairs with Cytosine (C).
Directionality	DNA strands run anti-parallel (5′ to 3′ and 3′ to 5′).
Major and Minor Grooves	Provide access points for proteins involved in DNA replication and transcription.

Genes and Chromosomes

Gene Definition	A segment of DNA that codes for a protein or functional RNA molecule.
Chromosome Structure	DNA molecule with associated proteins (histones), organized into a compact structure.
Chromatin	Complex of DNA and proteins (histones) that forms chromosomes.
Homologous Chromosomes	Pairs of chromosomes (one from each parent) that have the same genes but may have different alleles.
Locus	The specific location of a gene on a chromosome.
Allele	Different versions of a gene at a specific locus.

Central Dogma

DNA -> RNA -> Protein

Replication: DNA makes a copy of itself.
Transcription: DNA sequence is transcribed into RNA.
Translation: RNA sequence is translated into a protein.

Key Enzymes:

DNA Polymerase (Replication)
RNA Polymerase (Transcription)
Ribosome (Translation)

Inheritance Patterns

Mendelian Genetics

Dominant vs. Recessive	Dominant alleles mask the expression of recessive alleles in heterozygotes.
Genotype vs. Phenotype	Genotype is the genetic makeup (e.g., AA, Aa, aa); phenotype is the observable trait.
Homozygous vs. Heterozygous	Homozygous: having two identical alleles (AA or aa); Heterozygous: having two different alleles (Aa).
Punnett Square	A diagram used to predict the genotypes and phenotypes of offspring in a genetic cross.
Monohybrid Cross	Cross involving one gene (e.g., Aa x Aa).
Dihybrid Cross	Cross involving two genes (e.g., AaBb x AaBb).

Non-Mendelian Inheritance

Incomplete Dominance	Heterozygote phenotype is intermediate between the two homozygous phenotypes (e.g., pink flowers from red and white parents).
Codominance	Both alleles are equally expressed in the heterozygote (e.g., AB blood type).
Multiple Alleles	More than two alleles exist for a particular gene (e.g., ABO blood types).
Sex-Linked Traits	Genes located on sex chromosomes (X or Y); inheritance patterns differ between males and females.
Polygenic Inheritance	Traits controlled by multiple genes (e.g., height, skin color).
Epistasis	One gene affects the expression of another gene.

Linkage and Recombination

Linked Genes	Genes located close together on the same chromosome tend to be inherited together.
Recombination	Crossing over during meiosis can separate linked genes and create new combinations of alleles.
Genetic Mapping	Using recombination frequencies to determine the relative positions of genes on a chromosome.
Centimorgan (cM)	Unit of genetic distance; 1 cM = 1% recombination frequency.

Genetic Variation and Mutation

Sources of Genetic Variation

Mutation	Changes in the DNA sequence; can be spontaneous or induced by mutagens.
Recombination	Crossing over during meiosis creates new combinations of alleles.
Independent Assortment	Random distribution of chromosomes during meiosis.
Gene Flow	Movement of genes between populations.
Genetic Drift	Random changes in allele frequencies, especially in small populations.

Types of Mutations

Point Mutations	Changes in a single nucleotide base.
Base Substitutions	One base is replaced by another (e.g., A -> G).
Insertions	Addition of one or more nucleotide bases.
Deletions	Removal of one or more nucleotide bases.
Frameshift Mutations	Insertions or deletions that alter the reading frame of the mRNA.
Chromosomal Mutations	Large-scale changes in chromosome structure or number.

Effects of Mutations

Silent Mutations: No change in the amino acid sequence.
Missense Mutations: Change in the amino acid sequence.
Nonsense Mutations: Premature stop codon resulting in a truncated protein.

Beneficial Mutations: Increase fitness.
Harmful Mutations: Decrease fitness.
Neutral Mutations: Have no effect on fitness.

Molecular Genetics Techniques

DNA Sequencing

Sanger Sequencing	Method of DNA sequencing based on the incorporation of chain-terminating dideoxynucleotides.
Next-Generation Sequencing (NGS)	High-throughput sequencing technologies that allow for rapid sequencing of large amounts of DNA.

Polymerase Chain Reaction (PCR)

A technique used to amplify a specific DNA sequence.
Steps:

1. Denaturation: Separating DNA strands by heating.
2. Annealing: Primers bind to the DNA.
3. Extension: DNA polymerase synthesizes new DNA strands.

Key Components:
DNA template, DNA polymerase, primers, nucleotides.

Gel Electrophoresis

Purpose	Separates DNA fragments based on size; smaller fragments migrate faster.
Agarose Gel	Commonly used matrix for separating DNA fragments.
Applications	DNA fingerprinting, genotyping, analyzing PCR products.