

Introduction to Genetics

Introduction to Genetics – Study Notes

1. What Is Genetics?

- **Definition:** The branch of biology that studies how traits are inherited from one generation to the next.
 - **Key Question:** *How do organisms transmit biological information to their offspring?*
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2. Historical Milestones

Year	Scientist	Contribution
1859	Charles Darwin	Proposed natural selection; hinted at variation mechanisms.
1865	Gregor Mendel	Formulated the laws of inheritance using pea plants.
1902	Walter Sutton & Theodor Boveri	Chromosome theory of inheritance.
1910	Thomas Hunt Morgan	Demonstrated genes are located on chromosomes (fruit fly experiments).
1953	James Watson & Francis Crick	Described the double helix structure of DNA.
1970s	Frederick Sanger	Developed DNA sequencing methods.
2003	Human Genome Project	Completed the first reference sequence of the human genome.

3. Core Concepts

3.1. Genes & Alleles

- **Gene:** A discrete unit of hereditary information (a DNA segment) that codes for a functional product (RNA or protein).
- **Allele:** Different versions of the same gene that arise by mutation.

3.2. DNA Structure

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- Double helix composed of **nucleotides** (A?T, C?G base pairs).
- **Coding strand** ? mRNA ? protein (via transcription & translation).

3.3. Chromosomes

- Linear DNA molecules packaged with proteins (histones).
- Humans: 46 chromosomes (23 pairs); one set from each parent.

3.4. Genotype vs. Phenotype

- **Genotype**: Genetic makeup (e.g., AA, Aa, aa).
 - **Phenotype**: Observable trait (e.g., flower color, blood type).
 - Environment can modify phenotype without changing genotype.
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4. Mendelian Inheritance

Law	Description	Typical Ratio (Monohybrid Cross)
Law of Segregation	Two alleles for a trait separate during gamete formation.	3?:?1 (dominant : recessive)
Law of Independent Assortment	Genes for different traits assort independently (if on different chromosomes).	9?:?3?:?3?:?1 (dihybrid cross)
Law of Dominance	Dominant allele masks the effect of a recessive allele in heterozygotes.	—

Note: Linked genes, incomplete dominance, codominance, and polygenic traits are **non-Mendelian** exceptions.

5. Types of Inheritance Patterns

Pattern	Key Features	Example
Autosomal Dominant	One copy of mutant allele ? phenotype.	Huntington disease
Autosomal Recessive	Two copies required for phenotype.	Cystic fibrosis

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Pattern	Key Features	Example
X?Linked Dominant	Affects both sexes; males often more severe.	Rett syndrome
X?Linked Recessive	Mostly males affected; females carriers.	Hemophilia A
Mitochondrial	Maternal inheritance only (mtDNA).	Leber's hereditary optic neuropathy
Polygenic	Many genes contribute additively.	Height, skin color
Multifactorial	Genes + environment.	Type