

Introduction to Animal Genetics

Introduction to Animal Genetics – Study Notes

1. What Is Animal Genetics?

- **Definition:** The branch of biology that studies how traits are inherited and expressed in animals.
- **Key Focus Areas**
 - DNA structure and function
 - Gene expression and regulation
 - Inheritance patterns (Mendelian & non-Mendelian)
 - Genetic variation and evolution
 - Applications in breeding, conservation, and biotechnology

2. Basic Molecular Foundations

Concept	Description	Relevance to Animals
DNA	Double-helix polymer of nucleotides (A, T, C, G).	Stores the genetic blueprint for all animal species.
Gene	A functional DNA segment that encodes a protein or RNA molecule.	Determines specific traits (e.g., coat colour, milk production).
Chromosome	Thread-like structures of DNA packaged with proteins (histones).	Animals have species-specific chromosome numbers (e.g., cattle $2n=60$).
Allele	Alternative versions of a gene.	Heterozygous (Aa) vs. homozygous (AA or aa) genotypes affect phenotype.
Mutation	Permanent change in the DNA sequence.	Source of new genetic variation; can be beneficial, neutral, or deleterious.
Genome	Complete set of DNA (all chromosomes) in an organism.	Whole-genome sequencing enables marker-assisted selection.

3. Patterns of Inheritance

Pattern	Main Features	Example in Animals
1. Batesian Mimicry A harmless species evolves to imitate the warning signals of a harmful species to deter predators.	- Non-toxic species mimicking toxic species. - Warning coloration (bright colors, patterns). - Behavioral mimicry.	Butterflies: <i>Papilio polytes</i> (Morpho mimics) mimicking toxic <i>Papilio</i> species. Snakes: Non-venomous <i>Echis</i> mimicking the color and pattern of the venomous <i>Bitis</i>.
2. Müllerian Mimicry Two or more harmful species evolve similar warning signals to reinforce predator learning.	- Toxic species mimicking other toxic species. - Warning coloration (bright colors, patterns). - Behavioral mimicry.	Butterflies: <i>Papilio polytes</i> (Morpho mimics) mimicking toxic <i>Papilio</i> species. Snakes: Venomous <i>Echis</i> mimicking the color and pattern of the venomous <i>Bitis</i>.
3. Aggressive Mimicry A predator evolves to imitate a harmless or beneficial species to lure prey.	- Predator mimicking a harmless or beneficial species. - Warning coloration (bright colors, patterns). - Behavioral mimicry.	Fish: <i>Anguilla</i> (Eel) mimicking the harmless <i>Anguilla</i> to lure prey. Insects: <i>Andrena</i> (Bee) mimicking the harmless <i>Andrena</i> to lure prey.

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Mendelian (simple) inheritance	Single gene traits, dominant/recessive alleles, 3:1 phenotypic ratio in F ₂ .	Black coat (B) dominant over white (b) in mice.
Incomplete dominance	Heterozygote shows intermediate phenotype.	Red/white flower colour in snapdragons; analogous coat colour blends in some livestock.
Codominance	Both alleles expressed equally.	Blood type AB in cattle; Roan coat colour (both red & white hairs) in horses.
Sex-linked inheritance	Genes located on sex chromosomes (X or Z).	Color blindness in dogs (X-linked); plumage colour in birds (Z-linked).
Polygenic inheritance	Multiple genes contribute additively.	Body size, milk yield, growth rate.
Epistasis	One gene masks the effect of another.	White spotting (dominant) can mask underlying colour genes in horses.
Maternal / paternal effects	Phenotype influenced by the genotype of the mother or father (e.g., cytoplasmic inheritance).	Mitochondrial DNA diseases transmitted maternally.

4. Sources of Genetic Variation

1. **Mutations** – point mutations, insertions, deletions, copy number variations.
2. **Recombination** – crossing over during meiosis shuffles alleles.
3. **Gene flow** – migration of individuals introduces new alleles.
4. **Genetic drift** – random changes in allele frequencies, especially in small populations.
5. **Artificial selection** – human directed breeding alters allele frequencies for desired traits.

5. Tools & Techniques in Animal Genetics

Technique	Principle	Typical Use
PCR (Polymerase Chain Reaction)	Amplifies specific DNA fragments.	Genotyping, disease diagnostics.

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