YOUR MENTOR GURU

CSIR NET Life Sciences & Biotechnology — Unit 8

Inheritance Biology

Study & revision companion | Topic explanations, core facts, and active-recall questions

How to use this guide

Read each topic, explain the key mechanism in your own words, then answer the self-check prompts without looking at the notes. Use your detailed textbook or class notes for full derivations and additional examples.

Topic overview

1. 1. Mendelian Inheritance and Probability
2. 2. Linkage and Genetic Mapping
3. 3. Chromosomal Changes and Aneuploidy
4. 4. Quantitative Genetics and Heritability
5. 5. Population Genetics and Hardy–Weinberg
6. 6. Microbial and Molecular Genetics
7. 7. Pedigrees and Human Genetics

1. Mendelian Inheritance and Probability

Segregation separates alleles into gametes; independent assortment applies to unlinked loci or loci behaving as independent.

A testcross can reveal genotype when the phenotype is dominant.

The product rule multiplies independent probabilities; the sum rule adds mutually exclusive alternatives.

Incomplete dominance, codominance, epistasis and penetrance modify simple phenotypic ratios.

Allele segregation and independent assortment explain many genetic ratios; dominance relationships and epistasis modify outcomes.

When solving a question, distinguish the underlying mechanism from its observable outcome. Compare the normal situation with the altered condition, and check whether the evidence supports a direct effect or only an association. The central distinction to retain is: a 9:3:3:1 ratio requires independent assortment and particular dominance assumptions.

Self-check: Explain the mechanism or relationship above; identify one common misconception; predict the effect of changing a key variable.

2. Linkage and Genetic Mapping

Recombination frequency = recombinant offspring / total offspring × 100%.

One centimorgan corresponds to approximately 1% recombination for short genetic intervals.

Three-point testcrosses identify gene order using the rarest double-crossover classes.

Interference = 1 − coefficient of coincidence, where coincidence = observed/expected double crossovers.

Linked genes recombine less often than unlinked genes; three-point crosses help infer order and distance.

When solving a question, distinguish the underlying mechanism from its observable outcome. Compare the normal situation with the altered condition, and check whether the evidence supports a direct effect or only an association. The central distinction to retain is: double crossovers can make distances appear shorter.

Self-check: Explain the mechanism or relationship above; identify one common misconception; predict the effect of changing a key variable.

3. Chromosomal Changes and Aneuploidy

Nondisjunction causes unequal chromosome segregation and may yield aneuploid gametes.

Deletion removes, duplication repeats, inversion reverses and translocation relocates chromosomal segments.

Reciprocal translocation heterozygotes can generate unbalanced gametes during meiosis.

Polyploidy increases whole chromosome sets and is important in plant evolution.

Mutations can cause loss-of-function, gain-of-function or dominant-negative effects. Complementation tests compare recessive mutations.

When solving a question, distinguish the underlying mechanism from its observable outcome. Compare the normal situation with the altered condition, and check whether the evidence supports a direct effect or only an association. The central distinction to retain is: dominant-negative effects interfere with normal gene-product function.

Self-check: Explain the mechanism or relationship above; identify one common misconception; predict the effect of changing a key variable.

4. Quantitative Genetics and Heritability

Phenotypic variance can be partitioned conceptually into genetic, environmental and interaction components.

Broad-sense heritability $H^2 = VG/VP$; narrow-sense $h^2 = VA/VP$ under the specified population and environment.

Response to selection $R = h^2S$ in the breeder's equation under relevant assumptions.

Polygenic traits often show continuous distributions influenced by environment.

Transformation uses environmental DNA; conjugation involves contact; transduction uses bacteriophages.

When solving a question, distinguish the underlying mechanism from its observable outcome. Compare the normal situation with the altered condition, and check whether the evidence supports a direct effect or only an association. The central distinction to retain is: horizontal transfer can spread resistance genes.

Self-check: Explain the mechanism or relationship above; identify one common misconception; predict the effect of changing a key variable.

5. Population Genetics and Hardy–Weinberg

For two alleles, $p + q = 1$ and expected genotype frequencies are p^2, $2pq$ and q^2 under Hardy–Weinberg assumptions.

Mutation, selection, migration, genetic drift and nonrandom mating can alter genotype or allele frequencies.

Inbreeding increases homozygosity without necessarily changing allele frequencies by itself.

Small effective population size strengthens drift.

Pedigrees reveal patterns of autosomal, sex-linked and mitochondrial inheritance; karyotypes detect large changes.

When solving a question, distinguish the underlying mechanism from its observable outcome. Compare the normal situation with the altered condition, and check whether the evidence supports a direct effect or only an association. The central distinction to retain is: a LOD score of +3 conventionally favors linkage.

Self-check: Explain the mechanism or relationship above; identify one common misconception; predict the effect of changing a key variable.

6. Microbial and Molecular Genetics

Bacterial transformation takes up DNA; transduction uses bacteriophages; conjugation involves cell-to-cell DNA transfer.

Complementation tests can distinguish mutations in different genes under appropriate conditions.

Loss-of-function, gain-of-function and dominant-negative alleles have distinct functional consequences.

CRISPR-based gene editing creates targeted changes, but repair outcomes depend on the cell and edit design.

For two alleles, $p + q = 1$ and genotype frequencies are p^2, $2pq$ and q^2 under equilibrium assumptions.

When solving a question, distinguish the underlying mechanism from its observable outcome. Compare the normal situation with the altered condition, and check whether the evidence supports a direct effect or only an association. The central distinction to retain is: hardy–Weinberg is a null model with assumptions.

Self-check: Explain the mechanism or relationship above; identify one common misconception; predict the effect of changing a key variable.

7. Pedigrees and Human Genetics

Autosomal dominant traits can show vertical transmission, but penetrance and de novo mutation complicate patterns.

X-linked recessive traits often affect hemizygous males more frequently.

Mitochondrial inheritance typically follows maternal transmission.

LOD scores compare linkage and no-linkage likelihoods; a score of 3 corresponds to 1000:1 odds in favor under the model.

Polygenic traits reflect genetic and environmental contributions; heritability measures variance within a population and environment.

When solving a question, distinguish the underlying mechanism from its observable outcome. Compare the normal situation with the altered condition, and check whether the evidence supports a direct effect or only an association. The central distinction to retain is: high heritability does not imply environmental immutability.

Self-check: Explain the mechanism or relationship above; identify one common misconception; predict the effect of changing a key variable.

Active-recall practice

1. Explain the essential principles of 1. Mendelian Inheritance and Probability and give one experimental or real-world application.

2. Explain the essential principles of 2. Linkage and Genetic Mapping and give one experimental or real-world application.

3. Explain the essential principles of 3. Chromosomal Changes and Aneuploidy and give one experimental or real-world application.

4. Explain the essential principles of 4. Quantitative Genetics and Heritability and give one experimental or real-world application.

5. Explain the essential principles of 5. Population Genetics and Hardy–Weinberg and give one experimental or real-world application.

6. Explain the essential principles of 6. Microbial and Molecular Genetics and give one experimental or real-world application.

7. Explain the essential principles of 7. Pedigrees and Human Genetics and give one experimental or real-world application.

Final revision checklist

- 1. Mendelian Inheritance and Probability
- 2. Linkage and Genetic Mapping
- 3. Chromosomal Changes and Aneuploidy
- 4. Quantitative Genetics and Heritability
- 5. Population Genetics and Hardy–Weinberg
- 6. Microbial and Molecular Genetics
- 7. Pedigrees and Human Genetics

Further study

Use the corresponding unit notes, topic-wise detailed lessons, MCQs, practice tests and full-length mock tests on yourmentorguru.com. This compact PDF is a revision companion, not a replacement for full syllabus textbooks.