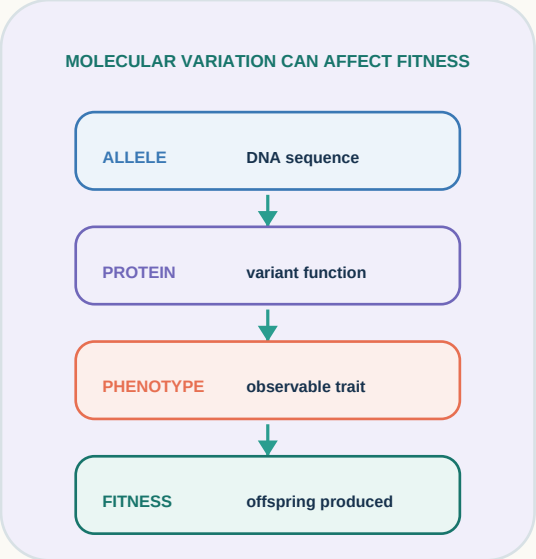
AP BIOLOGY | UNIT 7

TOPIC 7.2

Natural Selection

Natural selection connects heritable molecular and phenotypic variation to differential reproductive success, changing allele frequencies over time.



THE CORE CAUSAL CHAIN

VARIATION
alleles and traits

→

PRESSURE
environment acts

→

FITNESS
reproduction differs

→

FREQUENCY
alleles shift

BY THE END, YOU SHOULD BE ABLE TO...

1. Connect molecular variation to phenotype and fitness.
2. Predict how a selection pressure shifts allele frequency.
3. Explain why a trait's effect depends on the environment.

CENTRAL IDEA

Selection acts on phenotype, but when the phenotype is heritable, the underlying allele frequencies can change across generations.

1 Molecular differences can become fitness differences

An allele can change a protein or its expression, producing a phenotype that alters reproductive success under a specific pressure.

FROM GENOTYPE TO SELECTION

A/a — ALLELE

DNA sequence differs.

P — MOLECULE

Protein amount or function differs.

T — PHENOTYPE

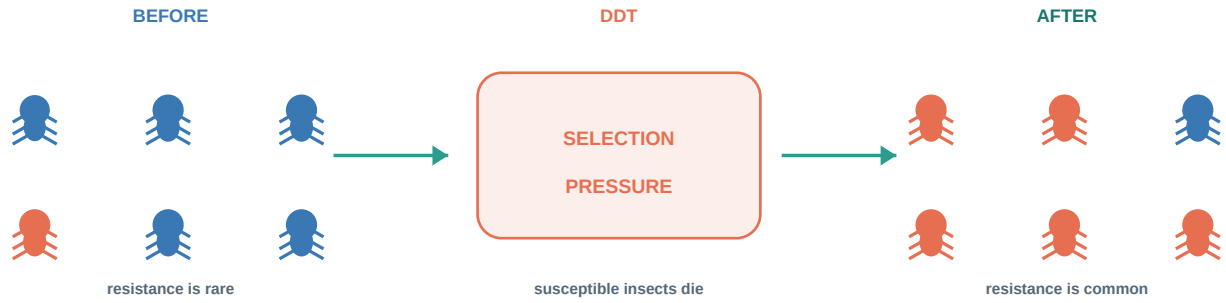
Observable performance differs.

W — FITNESS

Offspring contribution differs.

SELECTION CHANGES THE POPULATION

DDT RESISTANCE: A SELECTION EPISODE



DDT does not create resistance; it changes which inherited variants reproduce.

ALLELE FREQUENCY IS THE OUTPUT

If resistant insects leave more offspring during DDT exposure, resistance alleles become a larger fraction of the population's gene pool.

DIRECTION CHECK

Change the environment and the fitness advantage may weaken, disappear, or reverse. Selection is not a permanent ranking of traits.

2 Selection is always context-dependent

A phenotype can be beneficial, neutral, or harmful depending on genotype, competitors, climate, disease, and other conditions.

ONE ALLELE, MULTIPLE FITNESS EFFECTS

SICKLE-CELL ALLELE: FITNESS DEPENDS ON GENOTYPE AND ENVIRONMENT

HbA/HbA	HbA/HbS	HbS/HbS
normal hemoglobin	malaria protection in some regions	sickle-cell disease

Where malaria is common, heterozygote survival can help maintain both alleles in the population.

SELECTION CAN TARGET TIMING AS WELL AS STRUCTURE

EARLIER FLOWERING

dry season arrives sooner

Plants that reproduce before drought may leave more seeds, increasing alleles linked to earlier flowering.

LATER FLOWERING

long, cool growing season

When resources remain available, longer growth before flowering may increase reproductive output.

WHAT NATURAL SELECTION CAN CHANGE

Selection can shift trait frequencies, allele frequencies, and average molecular or physiological properties of a population across generations.

DO NOT CONFUSE

A beneficial allele is not always dominant, common, or helpful in every environment. Fitness describes reproductive success under particular conditions.

FINAL MAP

Allele -> molecular variation -> phenotype -> context-dependent fitness -> differential reproduction -> allele-frequency change.