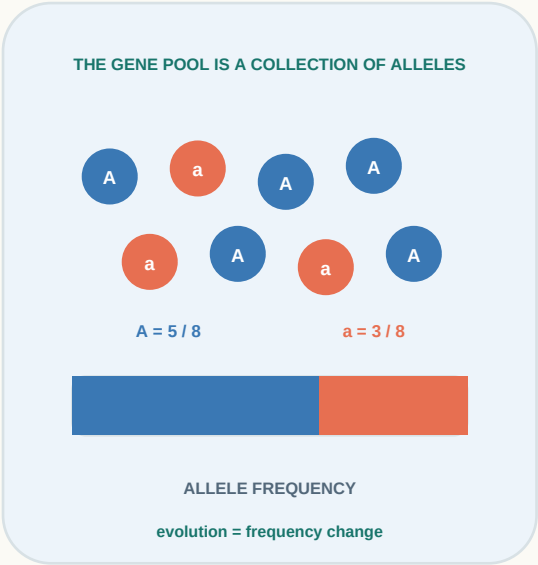
AP BIOLOGY | UNIT 7

TOPIC 7.4

Population Genetics

Population genetics tracks how common alleles are and explains how mutation, chance, and migration change the gene pool over time.



THE CORE CAUSAL CHAIN

GENE POOL
all alleles present

→

PROCESS
mutation, drift, flow

→

FREQUENCY
allele proportions shift

→

EVOLUTION
population changes

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

1. Calculate and interpret an allele frequency.
2. Distinguish mutation, genetic drift, and gene flow.
3. Explain bottleneck and founder effects in small populations.

CENTRAL IDEA

Evolution at the population level is a change in allele frequencies; the cause may be nonrandom selection or random demographic events.

1 Allele frequencies reveal population-level change

A frequency is a proportion of the gene pool. Tracking it across generations shows whether evolution has occurred.

A SIMPLE ALLELE-FREQUENCY CALCULATION

COUNT ALLELE COPIES, NOT JUST INDIVIDUALS

AA	Aa	aa	10 DIPLOID INDIVIDUALS
3 individuals	4 individuals	3 individuals	20 allele copies

A frequency = (2 x 3 + 1 x 4) / 20 = 10 / 20 = 0.50; therefore a = 0.50.

THREE WAYS TO CHANGE THE GENE POOL

MUTATION

MECHANISM	DNA sequence changes.
RESULT	A new allele can enter the population.

GENETIC DRIFT

MECHANISM	Random sampling changes reproduction.
RESULT	Alleles rise or fall by chance.

GENE FLOW

MECHANISM	Individuals or gametes migrate.
RESULT	Alleles enter or leave a population.

WHY POPULATION SIZE MATTERS

A chance event involving a few individuals is a large fraction of a small population but only a tiny fraction of a large population. Genetic drift is therefore strongest in small populations.

RANDOM DOES NOT MEAN DIRECTIONAL

Drift is unrelated to whether an allele is useful. Its frequency can rise, fall, or reach zero by chance.

Any change in allele frequency is population-level evolution, regardless of the mechanism.

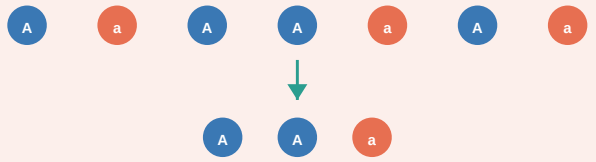
2 Demographic events can shift allele frequencies by chance

Bottlenecks and founder events sample only part of a gene pool; migration instead transfers alleles between populations.

TWO FORMS OF GENETIC DRIFT

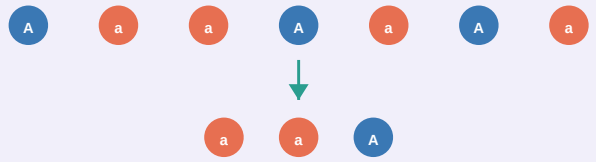
BOTTLENECK EFFECT

A sudden reduction leaves a random subset of survivors.



FOUNDER EFFECT

A few migrants establish a new, genetically sampled population.



GENE FLOW IS MOVEMENT, NOT RANDOM SAMPLING

GENE FLOW MOVES ALLELES BETWEEN POPULATIONS



Gene flow can add diversity within a population and often makes populations more genetically similar.

COMPARE THE PROCESSES

Drift changes frequencies through chance sampling. Gene flow changes frequencies through migration. Mutation creates new sequence variants that other processes can spread or remove.

DO NOT CONFUSE

Genetic drift is not natural selection. Drift is random with respect to fitness, while selection consistently favors phenotypes that reproduce better in that environment.

FINAL MAP

Mutation adds alleles; drift randomly samples them; gene flow moves them; every resulting frequency change is evolution.