IB BIOLOGY | D4.1 | SL AND HL

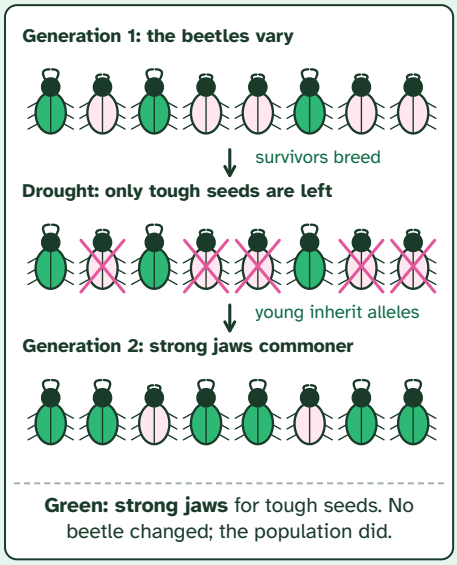
REVISION ON TWO PAGES

Who survives, who *breeds*

What to know, what to draw and what to say. Nothing else.

THE ONE IDEA

Individuals vary and more are born than survive. Those best suited leave more offspring, so their heritable traits become commoner.



Green: strong jaws for tough seeds. No beetle changed; the population did.

D4.1.1 START HERE

The mechanism of *evolution*

- **Natural selection** drives evolution: individuals whose traits suit the conditions **leave more offspring**, so those traits become commoner.
- It never stops: it sorts every generation **over billions of years**, giving the **biodiversity of life**. Nothing tries and nothing is planned.
- **Nature of science:** Darwin's theory **replaced Lamarckism** (changes from use and disuse passed on): a **paradigm shift**, one explanation replaced by a better one.

THE LOGIC, IN ORDER (A TEACHING AID) *Icy Cubs Eat Anything Growing Enormous*

I Inherited variation heritable differences	**C** Competition more young than resources	**E** Environment pressures sort them
A Adaptations helpful traits selected	**G** Genes allele frequencies shift	**E** Evolution the population changed

D4.1.2

Sources of *variation*

- Selection can only choose between individuals that **differ in their alleles**.
- Mutations arise **by chance**, never because they are needed.

Mutation new alleles
A change in the base sequence: the **only source of new alleles**. In animals, only in cells that make gametes.

Sexual reproduction new mixes
Crossing over, independent assortment and fertilisation **shuffle existing alleles**.

D4.1.3, D4.1.4

Competition and *pressures*

- **Overproduction**: far more offspring than survive (a frog lays hundreds or thousands of eggs).
- **Carrying capacity** is set by what runs short: **food, water, shelter, space**; for plants, light and minerals.
- So they **compete**, and the winners leave more offspring.
- **Abiotic:** heat, frost or drought is **density-independent**: a frost kills about the same share of a sparse or crowded patch.

D4.1.5, D4.1.6

Fitness and heredity

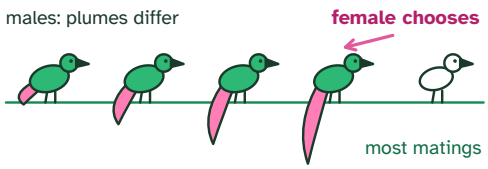
- In **intraspecific competition** for limited food, the better adapted are more likely to survive and breed.
- **Fitness**: a genotype's **survival value** (living to breed) and **reproductive potential** (offspring left).
- **Acquired traits are not heritable**: a body-builder's muscles are not in the base sequence of the genes in gametes.

0
fitness of a cat that lives 15 years but raises no kittens

D4.1.7

Sexual selection

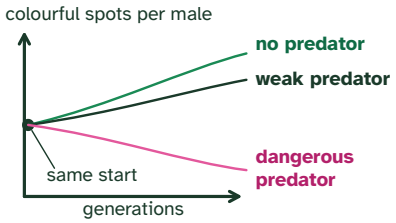
- Selection for **success in getting mates**: one sex (usually males) competes (**intrasexual**), or one (usually females) chooses (**intersexual**).
- A trait that wins mates is often a **sign of overall fitness**.
- **Birds of paradise:** males with the finest **plumage** and displays leave most young.
- **Cost:** long feathers hinder flight; bright colour draws predators.



D4.1.8 APPLICATION OF SKILLS

Endler's *guppies*

- Females prefer colourful males (**sexual selection**); predators see them (**natural selection**).
- Ponds **the same except the predator**: none, weak or dangerous; a model of the streams.
- **Result:** a dangerous predator gave **fewer, duller spots**; none or a weak one, more colour.
- **Interpret: differences between ponds** show selection.



Selection in the *gene pool*

D4.1.9 to D4.1.11 HIGHER LEVEL

The *gene pool* and neo-Darwinism

- A **gene pool** is all the genes, and their different alleles, in a population.
- **Allele frequency**: copies of one allele ÷ all alleles of the gene.
- **Database skill: isolated populations** differ. The sickle-cell allele (rs334) is very rare in northern Europe, common in parts of West Africa.
- **Neo-Darwinism:** selection joined to genetics. Evolution is a **change in allele frequencies**.

0.5 → 0.625
J after a drought kills the 4 jj of 20 beetles (20 J of 32 left)

D4.1.15 HIGHER LEVEL

Artificial selection

- Breeders **deliberately choose** which crops or domestic animals breed; the alleles for the chosen traits become commoner.
- The mechanism is the same as natural selection: **heritable variation** sorted by who breeds.

Artificial deliberate
A person chooses the parents; the change is the aim.

Antibiotic resistance natural selection
An **unintended consequence**: the drug kills susceptible bacteria and spares the resistant ones, which already existed.

D4.1.12 HIGHER LEVEL

Directional, stabilising, disruptive



- **Directional:** antibiotic resistance in bacteria.
- **Stabilising:** human birth weight.
- All three **change allele frequencies**, even stabilising: alleles for the extremes become rarer.

Remember: *Drive, Squeeze, Divide*

D4.1.13, D4.1.14 HIGHER LEVEL

The *Hardy-Weinberg* equation

- **p + q = 1**; random mating gives **$p^2 + 2pq + q^2 = 1$** (AA, Aa, aa).
- **Working back:** 18 of 200 beetles are recessive: $q^2 = 0.09$, q = 0.3, p = 0.7, 2pq = 0.42 (84 carriers).
- **Not a fit?** A condition fails, such as **non-random mating** or survival differing between genotypes.

CONDITIONS FOR EQUILIBRIUM

Large Rats Make Most Spaghetti

L Large population	**R** Random mating	**M** Migration none	**M** Mutation none	**S** Selection none

eggs \ sperm	A p = 0.6	a q = 0.4
A p	AA p^2 0.36	Aa pq 0.24
a q	Aa pq 0.24	aa q^2 0.16

WATCH OUT

Six mistakes that *cost marks*

- ✕ **Individuals do not evolve.** Populations do, over generations.
- ✕ **Mutations are not a response to need.** They arise by chance.
- ✕ **Fittest is not strongest.** It means most offspring that breed.
- ✕ **Acquired traits are not inherited.** Training changes muscles, not the genes in gametes.
- ✕ **Stabilising selection still changes allele frequencies.** The mean stays; the extremes go.
- ✕ **Antibiotic resistance is not artificial selection.** Nobody chose which bacteria bred.

COVER THE SHEET

Can you *answer these?*

1. Explain why replacing Lamarckism was a paradigm shift.
2. Distinguish the roles of mutation and sexual reproduction.
3. Outline how overproduction and frost act in selection.
4. Explain why an acquired trait cannot evolve.
5. Describe sexual selection in birds of paradise.
6. Deduce why dangerous-predator ponds had duller guppies.
7. Outline what a gene pool is. HL
8. Distinguish stabilising from disruptive selection. HL
9. Calculate p if 16% show a recessive trait. HL
10. Explain why resistance is natural selection. HL

IN THE EXAM

Explain in ICE AGE order: variation, competition, a named pressure, **the better adapted leave more offspring**, then **allele frequencies change** in the population.

GO FURTHER

Animated figures, a dry lab and a marked Check are in the full guide online.