

Natural selection What is the mechanism driving evolutionary change?	Natural selection Paradigm shift
Natural selection Why must traits be heritable for evolution to occur?	Natural selection Role of mutation in variation
Natural selection Role of sexual reproduction in variation	Natural selection Carrying capacity
Natural selection Give an example of an abiotic, density-independent selection pressure.	Natural selection Fitness

A fundamental change in the accepted theory of a field, e.g. Darwin's natural selection replacing Lamarckism.

Natural selection, operating continuously over billions of years and producing the biodiversity of life on Earth.

Mutation generates new alleles by changing the base sequence of a gene.

Only traits encoded in the base sequence of genes pass to offspring. Acquired characteristics are not encoded in genes, so are not heritable.

The maximum population size an environment can support sustainably. Limited by resources such as food, water, nest sites, light and minerals.

Generates new combinations of alleles: crossing over and random orientation in meiosis, plus random fertilisation.

The survival value and reproductive potential of a genotype compared with others.

Very high or very low temperatures, e.g. a hard frost; also drought or flooding.

Natural selection Sexual selection	Natural selection Endler's guppies: effect of a strong predator (Crenicichla)
Natural selection Endler's guppies: effect of no predator or Rivulus	Stability and change Give evidence that ecosystems can be stable.
Stability and change Four requirements for ecosystem stability	Stability and change Tipping point
Stability and change Why does the Amazon need a large area of forest?	Stability and change Percentage change formula

Males evolved fewer spots: conspicuous males were eaten, so natural selection outweighed female preference.

Selection for traits that increase success in attracting a mate, e.g. plumage of male birds of paradise, which signals overall fitness.

Some have persisted for tens of millions of years, e.g. rainforest in the Daintree region of Australia and the Namib Desert (arid for at least 55 million years).

Males evolved more spots, because sexual selection by female choice for colourful males dominated.

A critical threshold beyond which a small change causes a large, often irreversible, shift to a different state.

Supply of energy, recycling of nutrients, genetic diversity, climatic variables within tolerance levels.

$(\text{final} - \text{original}) \div \text{original} \times 100.$

Transpiration generates water vapour, causing cooling, air flows and rainfall inland. The minimum area needed is uncertain.

Stability and change Mesocosm	Stability and change Keystone species
Stability and change Condition for sustainable harvesting	Stability and change How is the sustainability of cod fishing assessed?
Stability and change Factors affecting sustainability of agriculture	Stability and change Biochemical oxygen demand (BOD)
Stability and change Why do fish die in eutrophication?	Stability and change Which fertilizers cause eutrophication by leaching?

A species with a disproportionate impact on community structure; removing it risks ecosystem collapse, e.g. sea otters in kelp forests.

A small experimental ecosystem used as a model; best in sealed glass vessels so matter cannot enter or leave but energy can.

Stock assessments of breeding adults from catches and surveys; age structure of the catch; quotas and mesh sizes set accordingly.

The rate of harvesting is lower than the rate of replacement.

Oxygen used by microorganisms in a water sample over a set time to break down organic matter.

Soil erosion, leaching of nutrients, supply of fertilizers and other inputs, pollution by agrochemicals, carbon footprint.

Nitrogen (nitrate) and phosphate fertilizers.

Dead algae and plants are decomposed by aerobic bacteria; BOD rises, dissolved oxygen falls.

Stability and change

Biomagnification

Stability and change

Effect of DDT on birds of prey

Stability and change

Mercury biomagnification

Stability and change

Why are plastics persistent?

Stability and change

Macroplastic vs microplastic effects

Stability and change

Three methods of rewilding

Stability and change

Hinewai Reserve

Climate change

Anthropogenic causes of climate change

Thin eggshells that broke, so populations of ospreys and peregrine falcons crashed.

Increase in concentration of a toxin in the tissues of consumers at each higher trophic level.

They are non-biodegradable: decomposers lack enzymes to break them down.

From coal burning and mining; bacteria make methylmercury; highest in large predatory fish such as tuna; damages the nervous system.

Reintroduce apex predators and keystone species; reconnect habitats over large areas; minimise human impact.

Macroplastic: entanglement and swallowing (blocked guts). Microplastic (under 5 mm): eaten by plankton and filter feeders, passes along food chains.

Human increases in atmospheric CO₂ (fossil fuels, deforestation) and methane (livestock, rice fields, landfill).

Former farmland in New Zealand where, with grazing removed and minimal interference, native forest regenerates through gorse.

Climate change

Five positive feedback cycles in global warming

Climate change

How does loss of snow and ice cause further warming?

Climate change

Legacy carbon

Climate change

Why could boreal forests become a net carbon source?

Climate change

Threat to emperor penguins

Climate change

Threat to walruses

Climate change

Effect of warmer surface water on upwelling

Climate change

Ocean acidification and corals

Darker land and sea absorb more solar radiation than reflective ice.

CO₂ from deep ocean; loss of reflective ice; decomposition of peat and permafrost; methane from permafrost; droughts and forest fires.

Warmer, less snowy winters cause drought, lower primary production, forest browning and more intense fires.

Old organic carbon in deep boreal forest soils that survived earlier fires; burned by more intense fires.

Loss of Arctic sea ice used for resting and nursing between feeding dives.

Early breakout of landfast ice before chicks fledge destroys breeding grounds.

More dissolved CO₂ lowers pH and carbonate availability, suppressing calcification.

Prevents nutrient upwelling, decreasing ocean primary production and energy flow through marine food chains.

Climate change

Coral bleaching

Climate change

Upslope range shift example

Climate change

Range shifts in North American trees

Climate change

Why are mountain-top species at risk?

Climate change

Three approaches to carbon sequestration

Climate change

Why does peat store carbon?

Climate change

The debate over tree planting for carbon

Tropical-zone montane bird species in New Guinea now live higher up mountains.

Higher water temperature makes corals expel symbiotic algae; prolonged bleaching kills corals and the reef ecosystem collapses.

As ranges shift upslope they have nowhere higher to move.

Range contraction at the warm southern edge and northward spread at the cool edge.

Waterlogged soil is anaerobic, so dead plant matter decomposes very slowly and accumulates.

Afforestation, forest regeneration, restoration of peat-forming wetlands.

Non-native plantations absorb CO₂ fast but have low biodiversity; native rewilding is more biodiverse and resilient.