

HSC Biology

Core 2 - Blueprint of Life

Focus 1

- ✚ Evidence of evolution suggests that the mechanisms of inheritance, accompanied by selection, allow change over many generations

Outline the impact on the evolution of plants and animals of:

- changes in physical conditions in the environment
- changes in chemical conditions in the environment
- competition for resources

Changes in physical conditions in the environment:

- Include natural conditions (eg. Temperature, availability of water).
- Australian landmass has become drier over time.
 - Led to changes in species of kangaroos present today.
- Approx. 25 million years ago, Aust wetter.
 - Large areas of rainforest.
 - Kangaroos small, omnivorous, unspecialised teeth.
 - Ate variety of foods from forest floor.
 - Food nutritious, abundant.
 - No need for specialised grinding teeth.
- As Aust became more arid, grass more dominant vegetation in some areas.
 - Environmental selective pressure resulted in larger kangaroos favouring teeth suited to grass.
 - High crested molars, efficiently grind low-nutrition grass into digestible paste.
 - Slicing pre molars no use, became reduced from ancestral kangaroos.

Changes in chemical conditions in the environment:

- Chemicals can affect evolution.
 - Eg. Salt, elements such as Fe (iron).
- Parts of Aust have high salinity in soils.
 - Range of salt tolerant plants evolved to inhabit these areas.
 - Animals feeding on these plants also evolved to handle conditions.
- Sheep blowfly, major problem in Aust sheep industry.
 - Stresses, weakens, lethal to sheep when larvae burrows into wounds & wet wools.
 - Chemicals such as dieldrin & organophosphates used to extensively used to control blowfly.
 - Genetic resistance occurred within fly population, chemicals ineffective.
 - Withholding particular insecticide for a time allowed resistance blowfly population to drop.
 - Continued use of insecticide resulted in mutation of modifier gene, increases, maintains resistance.
 - Insecticides never effective again on this species, regardless of number of generations passed.

Competition for resources:

- Occurs within a species & between species.
 - If new species introduced into an area, competition may lead to different species using different resources.
- Resources include;
 - Food.
 - Shelter.
 - Space.
 - Mates.
 - If species could specialise on different resources or breed at different times they could avoid direct competition.
- Some **fruit fly** species evolved into different species confined to different type of fruit tree.
 - Possible if flowering/fruited times on each tree type suited to breeding cycles in fruit flies.
 - Eventually, two separate species can result.

Describe, using specific examples, how the theory of evolution is supported by the following areas of study:

- palaeontology, including transitional forms
 - biogeography
 - comparative embryology
 - comparative anatomy
 - biochemistry
- Palaeontology is the study of fossils.
 - Fossils are preserved traces of life on Earth.
 - Most are found in sedimentary rocks. Also found in ice or amber.
 - Include preserved body parts, moulds, casts of decayed organisms.
 - Imprints left in mud (eg. Footprints).
 - Preserved material <10,000 years old or hand made objects (eg. Arrowheads) considered artefacts, not fossils.

Palaeontology:

- Fossil record provides time line of evolution of life engraved in order in which they appear in rock layers.
 - Transitional fossils show gradual change in life forms over millions of years.
 - Provide further evidence for evolutionary change.
- Transitional fossils, with characteristics belonging to ancestral groups of interest.
 - Demonstrate development of one group of organisms from another form or common ancestor.
 - Help understand how evolutionary changes come about.
 - Fossils record suggests modern vertebrates appeared in following order;
 - Jawless fish 500m.y.a.
 - Bony fish 400m.y.a.
 - Amphibians 360m.y.a.
 - Reptiles 300m.y.a.
 - Birds 190m.y.a.
 - Mammals 150m.y.a.
 - Theory that they developed from common ancestor supported by fossil evidence
 - Intermediate types found, show transition.

Eg.

- Most famous transitional form is **Archaeopteryx**.
- Fossil first thought to be a therapsid reptile.
- Reptilian features include;
 - Teeth.
 - Reptilian-like skeleton.
 - Long, jointed tail.
- Bird like features include;
 - Feathers.
 - Wishbone sternum, to attach flight muscles. - Wings.
- Provides evolutionary pathway between dinosaurs/reptiles & birds.

Eg.

- Lung fish.
 - Absorb O₂ from air.
 - Appeared 400m.y.a.
 - End of Devonian age.
 - Thought amphibians developed from this line.
 - Had bones in fins.
 - May be able to walk/drag itself on land.

Biogeography:

- Study of; distribution of organisms over Earth.
 - Distribution patterns provide evidence of species originating from common ancestors, when isolated become new species.
- Earth has a number of biogeographical zones.
 - **Eg.** Arctic zone.
 - Each with specific enviro features.
 - Therefore, contain organisms with specific adaptive features.
- Charles Darwin, Alfred Russel observed distribution of species into different biographic regions.
 - Saw as major evidence to support theory of evolution.
 - Argued that animals in different regions come from ancestors in that region, adapted to conditions overtime.

- Darwin suggested line (Wallace's Line) separate distribution of organisms of Asia & Aust.
- **Special Creation**, prevailing religious based explanation of the time.
 - Didn't explain why islands with similar conditions didn't contain same flora & fauna.
 - Darwin proposed migration & evolution much more satisfactory explanations for unique flora & fauna in places such as Aust.

Comparative Embryology:

- Study of embryos of different organisms.
 - Looking for similarities, differences.
 - Similarities suggest common ancestry.
- Obvious similarities between embryos of fish, amphibians, reptiles, birds, mammals.
 - Comparison of vertebrate embryos show all have gill slits, even though they don't remain later in life, except in fish.
 - Indicates fundamental step common to all vertebrates.
 - Supports idea of a common ancestor.
- All chordates possess pharyngeal gill pouches at some stage in development.

Comparative Anatomy:

- Study of similarities, differences in structure between different organisms.
 - Similar structures evidence of common ancestry.
 - Anatomical structures on different organisms that have same plan but different functions called; **homologous structures**.
 - Homologous structures evidence for evolution.
 - Structures shared by related species because inherited some way from a common ancestor.
-
- **Eg.** of homologous structure;
 - Pentadactyl limb found in amphibians, reptiles, birds, mammals.
 - Basic plan consists of 1 bone in upper limb, 2 in lower limb, leading 5 fingers/toes.
 - In bats, limb modified to form a wing with fingers extended, skin stretched between each finger.
 - Whales have fully formed pentadactyl limb within their single, paddle like fin.
 - Limbs are modified adaptations to different enviros.
 - Suggests animals descended from common ancestors with pentadactyl limbs.
 - **Eg.** Xylem;
 - Ferns, conifers, flowering plants have vascular tissue.

Biochemistry:

- Some biochemical processes same for all living cells.
 - Certain proteins common in a large number of organisms.
- Recent technology advances allowed comparison of organisms on molecular basis, rather than structural.
 - Previously impossible between distantly related species such as an orchid & a mouse.
- Study of amino acid sequences shows that related species share more common sequences than unrelated species.
 - Particular evidence derived from haemoglobin sequences, showing humans & rhesus monkey share all but 8 amino acid sequences (1.0%). There are 125 amino acid differences between humans & lampreys.
 - Supports fossil, embryological, anatomical evidence that humans are more closely related to rhesus monkeys than lampreys.

Explain how Darwin/Wallace's theory of evolution by natural selection and isolation accounts for adaptive radiation leading to divergent evolution and convergent evolution.

- Darwin/Wallace theory outlines characteristics favourable to reproduction & survival of organisms in their environment will be selected for, and over time, new species will appear in response to environmental changes.
- Adaptive radiation;
 - Refers to variety of different species evolved from ancestral lines as a result of migration & isolation.
 - Darwin/Wallace theory of natural selection & isolation provides mechanism for adaptive radiation.
 - If groups of a population become isolated, chances are high that they will encounter differing selective pressure as each environment evolves independently.
 - Eventually, 2 populations may change enough to become 2 separate species.

- **Eg.** Biodiversity of flora, fauna unique to Aust result of adaptive radiation.
 - When Aust separated from Gondwana, organisms evolved due to selective pressure from changing environment.
 - Supports Darwin/Wallace theory of evolution.
- Adaptive radiation can lead to divergent evolution, convergent evolution.

- Divergent evolution;

- Occurs when closely related species experience different environments.
- Vastly different characteristics will be selected.
- Overtime, species evolve differently, appear quite differently.
 - **Eg.** Elephants large animals, closely related to the hyrax, small guinea pig like creature.
 - Live amongst rocky outcrops on mountains.
 - Comparison of skeletons indicates close relationship.

- Convergent evolution;

- Occurs when relatively unrelated species develop similar structures, physiology, behaviours in response to similar selective pressures from similar environments.
 - **Eg.** Dolphins (mammals), sharks (cartilaginous fish) evolved streamlined body shape & fins, enabling efficient movement in water.
 - Only remotely related as vertebrates.
 - Communal social behaviour developed independently in ants, bees, termites.

Plan, choose equipment or resources and perform a first-hand investigation to model natural selection.

- 'Stick bird', a simple game using red & green toothpicks.
 - Red, green toothpicks scattered over area on ground with a green background.
 - One person in group given task of picking up as many toothpicks in given time.
 - Count red toothpicks collected, count green toothpicks collected.
 - Repeat game on a neutral background.
 - Collate results.
- More red toothpicks collected on green background because;
 - Green toothpicks have physiological adaptation, camouflage.
 - Allows them to blend into background, escaping predator.
 - Natural selection has allowed green toothpicks to survive under selective pressure of predator.
 - Red toothpicks will die out, leaving green species to survive & reproduce.
- Enviro selected better adapted 'worms' to reproduce & become greater in number.
 - Green worms will become greater in number.
 - Become prevalent phenotype within worm population.

Analyse information from secondary sources to prepare a case study to show how an environmental change can lead changes in a species.

The Kangaroo:

- Kangaroos offer a unique opportunity to study evolutionary changes within a group of Australian mammals.
 - Have best known fossil record, most extensively studied of all Aust mammals.
 - Have undergone rapid evolutionary change.
 - Commonly good indicators of restricted enviros.

- Middle of Miocene (10-12 million y.a.)
 - Aust became warmer.
 - Aust moved north.
 - Aridity (dryness) increased.
 - Rainfall became seasonal.
 - Forests changed.
 - Dominated by eucalypts.
 - Some pockets of open forests
 - Grassland thriving in drier conditions.

- Kangaroos became abundant.
 - Evolving to take advantage of variety of new environments emerging from changes.
 - Dominated grasslands.
 - Increased in size.
 - Rapidly diversified.
 - Kangaroos of this age show hopping.
 - 5th toe, adaptation to arboreal (live in trees) life lost.
 - Fossils show adaptations to grazing life.

- Pliocene (5-2 million y.a.)
 - Continent continued to dry out at faster rate.
 - Rainforest restricted to east coastal regions.
 - Woodlands / grasslands replaced rainforests in central Aust.

- End of Pliocene
 - Evolved bounding strides.
 - Take advantage of vast grasslands in arid areas.
 - Important adaptation.

- Pleistocene (1.6 million y.a.) to present
 - Kangaroos at most diverse.
 - Varied from giant kangaroos to small types.
 - Adapted to variety of enviros.

- Grasslands led to development of specialised teeth.
- Increased temp^oC led to larger kangaroos.

Use available evidence to Analyse, using a named example, how advances in technology have changed scientific thinking about evolutionary relationships.

- Technological changes;
 - Up until 1950's, relationships between organisms worked out by;
 - Anatomical similarities.
 - Became possible to analyse protein sequence data & DNA sequence data.
 - Proteins (**Eg.** Haemoglobin) compared & similarities discovered based on biochemical similarities.
 - Rate of change estimated;
 - Possible to work out molecular clock.
 - Estimates when 2 organisms shared common ancestors.

Eg. Similarities between humans, chimpanzees worked out by comparing amino acid sequences in DNA.

Analyse information from secondary sources on the historical development of theories of evolution and use available evidence to assess social and political influences on these developments.

- **1735:**
 - Linnaeus;
 - Published classification system.
 - Humans, apes classified together.
 - No idea of evolution in classification, though strongly contested.
- **Late 1700s:**
 - Erasmus Darwin (grandpa Darwin);
 - Suggested life came from single source.
- **1809:**
 - Lamarck;
 - 1st theory of evolution.
 - Variation developed due to 'use' & 'disuse'.
 - Changes passed onto offspring.
 - Theory proved incorrect.
 - Challenged creationism.
 - Helped Darwin's ideas be recognised.
- **1859:**
 - Darwin;
 - Published 'On the Origins of Species by Means of Natural Selection.
 - In 1871, applied theory to humans in 'Descent of Man'.
- **Early 1900s:**
 - Scientists refined Darwin's theory.
- **Social, political influences:**
 - Up until Darwin's theory;
 - Predominant Western view **creationism**.
 - Diversity of living things created for enviro at same time by God in 6 days, remain unchanged, unrelated.
 - Despite mounting evidence, Darwin's theory still rejected by religious groups.
 - Darwin's theory of descendants from apes caused political, social outrage.