VICTORIA UNIVERSITY PRESENTS THE...

2011 VCE LECTURE SERIES

HEALTH, ENGINEERING AND SCIENCE

VCE BIOLOGY
UNIT 4
AREA OF STUDY 2: CHANGE OVER TIME

REVISION NOTES

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VICTORIA UNIVERSITY
MELBOURNE AUSTRALIA

BACHELOR OF SCIENCE (BIOMEDICAL SCIENCES) VTAC code 40181

You could play an important role in the search for cures of life threatening diseases, be involved in the marketing of these discoveries, or be the link between scientists and the public.

This appropriately tailored course qualifies students for entry to a broad range of careers including:

medical and scientific research, sales and marketing of biomedical products and health promotion. This degree leads on to postgraduate programs in medicine, dentistry, nursing, physiotherapy, dietetics and other allied health courses. This degree also offers a fourth year (Honours) program, with the possibility of Masters and PhD.

The Biomedical Sciences course aims to produce highly flexible but well-trained graduates who will be adequately equipped to adapt to a changing workforce environment. This course offers a range of core and elective units from biomedical sciences, as well as electives from other courses within the university, such as languages, sport and exercise, creative arts, psychology, chemistry, mathematics.

The core program consists of modern and traditional biomedical sciences including units of study such as: anatomy, physiology, biochemistry, microbiology, cell and molecular biology, immunology, pharmacology, pathophysiology, wellness and health management.

The Biomedical Sciences degree satisfies all the undergraduate selection requirements for post graduate medicine at all Australian Universities including prerequisites in anatomy, physiology and biochemistry. However, entry into medicine or other allied health related courses at other universities may depend on other specific entry requirements at these institutions.

Prerequisites: Units 3 and 4 – English (any). Middle Band: A study score of at least 25 in one or more health and human development, mathematics (any), physical education or science (any) = an aggregate 3 points higher per study, to a maximum 9 points.

BACHELOR OF SCIENCE (NUTRITION, HEALTH AND FOOD SCIENCES) VTAC code 44251

Nutrition, Food and Health Science involves the study of human nutrition, functional foods and nutraceuticals, safety and quality of food, food processing and their role in health. It includes the application of cutting-edge technologies in nutrition and food sciences. The course is designed to develop the knowledge and skills in the science of food, its safety and quality as required by today's nutritionists and food scientists. Increasing consumer awareness in regard to food related health and safety issues and the role of nutrition in the development and evaluation of food products have generated a rapidly growing need for graduates with a good understanding of food science, nutrition and health. The course has been specifically designed to meet the demand for such graduates. When you graduate, you will be qualified to contribute to the development of new foods and, to ensure their safety and provide advice and information to consumers.

Employers of our past graduates include:

- Kraft Foods Ltd
- Nestlé Australia
- Food Science Australia
- Australian Quarantine Inspection Service (AQIS)
- CSL Ltd
- Cadbury Schweppes Aust Ltd
- Heinz – Watties Aust
- McCains Foods (Aust) Pty Ltd

Prerequisites: Units 3 and 4 – English (any) and mathematics (any).

SCHOLARSHIPS ENTER AT 70

Available for Nutrition, Health and Food Sciences course for students with an ATAR (Enter) of 70 and above who meet the requirements. See www.vu.edu.au/hes for more information and application form.

ALTERNATIVE ENTRY FOR SCIENCE (VTAC code 41451)

Alternative entry program to science courses for students who have:

- Successfully completed year 12 with the required prerequisites, but may not have achieved the required study score in all prerequisites; or
- Have not studied the required mathematics prerequisite.

All admissions are on an individual basis. All applicants offered a place would be required to enroll in one or more subjects from the Foundation Year.

Prerequisites: Units 3 and 4 – English (any) and mathematics (any). ATAR (ENTER) 50+

AREA OF STUDY 2

CHANGE OVER TIME

1. CHANGE IN POPULATIONS

A. VARIATION

The variations we see in the phenotypes of individuals of any single species or population can be quite spectacular. Look around a group of *Homo sapiens* and variation is evident immediately. Remember

PHENOTYPE = GENOTYPE + ENVIRONMENT

We can conclude that the genotype that is the DNA, of the individuals must be responsible for at least some of the variation we see.

Types of Variation
Variation or diversity in a species increases the chances of a least some members of the species surviving environmental changes, natural disasters etc. The variation present in a population can be classified in several ways:

Structural -

Behavioural -

Biochemical -

Developmental -

Physiological -

Geographical – different phenotypes in different locations - this variation can be due to **environmental factors** such as climate etc or **genetic factors**.

When members of a population show variation, the population is said to be **polymorphic.**

CAUSES OF VARIATION BETWEEN INDIVIDUALS

The sources of variation between individuals in a species or population can be due to genetic or environmental factors. In some cases variation may be due to an interaction of both factors.

Inherited (genetic) factors

- Recombination in meiosis
  The random assortment of homologous chromosomes during meiosis creates great variation. Every time gametes are produced from a parent diploid cell new combinations of alleles are created. This is the greatest factor in variation.
  Crossing over and recombination of genetic material between homologous chromosomes also creates variation.
- Random fusion of gametes
  With the large variation in gametes produced by both parents the random fusion of two adds to variation. This explains why brothers and sisters are not alike.
- Mutations
  This is a process that produces new alleles of genes in various species.
  Point mutations occur when a nucleotide base and its pair are changed. This may cause the production of new and different proteins that affect the phenotype.
- Changes in chromosome number – each species has a set number of chromosomes. Gain or loss can cause variation.
- Variation due to one gene. Example ABO blood groups.
  Discontinuous variation – members of a population can be arranged into a few discreet groups with respect to variation.
- Variation due to polygenes. Example human height.
  Continuous variation – members of a population display a large amount of variation.

Environmental factors

- **External factors.**
  Nutrition
  Diseases
  Soil type
  Temperature
  Light
  Altitude

- **Internal factors**
  Hormones
  Developing foetus

B. POPULATION GENETICS

A **population** of organisms is all the individuals of a species that live in a particular area at a particular time. There will be variation in the phenotypes of individuals within a population.

Population genetics is the study of allele frequencies in populations and the factors that change these frequencies.

Gene Pool

The **gene pool** can be defined as **the total aggregate of genes, and all of their alleles, in a population at any one time.**

For a diploid individual, each gene locus is represented twice in the genome, and the two alleles may be the same (homozygous) or different (heterozygous).
There may, however, be more than two alleles for a gene within a population's gene pool (eg the ABO blood groups in humans), although each individual can only have two of those alleles.
Allele frequencies can vary from 0 (no one has the allele) to 1 (everyone has the allele).

The total of all allele frequencies at one gene locus in a population is always 1.

Populations in Equilibrium

If a population of a species is stable and non-evolving, the composition of that population's gene pool is constant, since it is in equilibrium. This is known as the **Hardy-Weinberg Theorem** and it can be demonstrated mathematically to be true.
It is stated as follows:

> **No matter how many generations' alleles are segregated by meiosis and combined by fertilization, the frequencies of the alleles in the gene pool will remain constant <u>unless acted on by other agents.</u>**

For this to be true, five conditions must be met:

1. The population must be very large.
2. The population must be isolated. There must be no migration of individuals into or out of the population.
3. There are no net changes to alleles due to mutations.
4. Mating is random.
5. All genotypes are equal in reproductive success.

Whilst these conditions can be approached in nature, they are never achieved for very long. Because the five conditions for Hardy-Weinberg equilibrium are seldom maintained for many generations, gene frequencies in gene pools do change. In other words the populations are **evolving.**

Factors affecting the gene pool equilibrium

Any factor, which upsets the equilibrium of a population, can cause variations in the predicted allele frequencies in later generations.

- **Genetic Drift**
  Refers to random changes in allele frequencies in a population.
  This is due to chance.
  Occurs more when populations are small. Unpredictable.

- **Founder effect**
  Occurs when a small population of individuals establishes in an area.
  The individuals in the new population are unlikely to have the same allele frequencies of the original parent population.
  The subsequent allele frequencies in the resulting new population can vary markedly from the original population provided they remain isolated.

- **Gene flow**
  The movement of individuals into or out of a population can change allele frequencies. Migration refers to movement of individuals between populations.
  Since most populations are not entirely reproductively isolated, the population may gain or lose alleles by **gene flow**, the migration of fertile individuals or the transfer of gametes, between populations

- **Non - random mating**
  The selection of mates is not random.
  Non-random matings are more common that one might first expect. In many populations, family groups stay within loose geographical boundaries within the larger group. This can lead to localised **inbreeding** and pockets of very different allele frequencies within the larger group.

- **Selection Pressures**
  Allele frequencies can be changed by **natural selection.** Some phenotypes are better suited to particular environments so organisms that have the alleles for these phenotypes are better able to survive.
  Artificial selection in which organisms with particular traits are selected for breeding and others prevented from breeding changes allele frequencies.

2. NATURAL SELECTION

The genetic basis for natural selection is variation within population.
Without variation within a population, there could be no natural selection - the population would either survive or die as minor environmental changes were encountered, since all members of the population would be genetically identical and all would be equally well or badly equipped to deal with the changes.

The frequency of an allele in a population can change as a result of a change in the environment. This is called natural selection.
Darwin first proposed this and he stated that those organisms, which are best able to survive and breed, are most likely to pass on their characteristics to the next generation. This is often referred to as **Survival of the fittest.**

Natural selection is the differential success in reproduction of different phenotypes resulting from interaction of organisms with their environment. With time, natural selection causes changes in relative frequencies of alleles in the gene pool.

For Natural Selection to occur there must be

- **Variation in the population**
- **A selecting Factor**
- **Survival of some individuals which are better suited i.e. survival of the fittest**
- **Reproduction to pass on the characteristics to the next generation**

STRUGGLE FOR SURVIVAL

All species have such great potential fertility that their population size would increase exponentially if all individuals born would eventually reproduce at their full potential. The fact is that populations are generally relatively stable in size, except for seasonal variation. A notable exception to this is the human population. We have all heard of the dire predictions facing *Homo sapiens* if population growth continues at the current world rate!

What keeps populations constant? Why do some individuals survive? Why do many individuals die? The answers to these questions all help explain the struggle for survival, which occurs constantly in all populations of all species, including our own.

SELECTIVE PRESSURES

Selective pressures are those biotic and abiotic factors of the environment, which can influence the survival and reproduction of individuals, and ultimately of populations and species. They include:

- **Competition** for food, water, shelter, mates. The competition may be within the species or between species. The result is that not all individuals obtain equal shares of the resources, some survive, and some do not.

- **Migration.** If populations outgrow or exhaust their resources, one solution for all or part of the group may be migration to a new location. This in itself may lead to many deaths during the journey, and may have a significant effect on population gene pools as previously discussed.

- **Geographical features.** If natural events such as floods or earthquakes split a population, with or without killing many, the remaining population sub-groups may never recombine. This is a form of **reproductive isolation**. Over time, changes in the gene pools of each sub-group will occur, as described earlier. This can eventually lead to the evolution of new species.

ADAPTATION

Individuals with **structural, functional or behavioural ADAPTATIONS, which** give them a better chance of survival to adulthood and/or give them a reproductive advantage, are more likely to pass their genes on to the next generation of the population.

> **Adaptations are acquired by an individual as a set of genetic information - the chance combination of alleles obtained at fertilization.**

Individuals can only express in their phenotype the characteristics for which their genotype codes. This can include many variants of phenotype, within the one individual. For example a weight lifter changes his body shape over time with a great deal of training, but his children will not be born as mini-Schwarzeneggers because he did so! What the weight lifter has done is manipulate his own environment to realise all of his genetic potential in his phenotype.
Similarly, some people, with all the iron pumping they could possibly do, would still be the skinny "Mr Universe" type. No amount of environmental pressure can give them the genes they don't possess.

"FITNESS"

The phrases ***"struggle for survival"*** and ***"survival of the fittest"*** can be misleading if taken literally. They are not meant to mean that <u>only</u> the strongest, physiologically fittest individuals will survive and reproduce. Rather they mean that species will acquire favourable characteristics (become "fitter"), which enable viable populations of that species to survive over much generation.

Relative fitness is the contribution of a genotype to the next generation compared to the contribution of alternative genotypes at the same locus. From this it can be seen that the phenotype corresponding to a high frequency genotype is probably advantageous in the environment of the species at the time - or at least it is not disadvantageous.
There are three common ways that natural selection can act:

Stabilising selection removes the extreme variants from a population, reducing the trend towards phenotypic variation and maintaining the status quo. This is most likely to be the case where an environment is itself stable.

Directional selection shifts the overall makeup of the population by favouring one extreme phenotype. This is likely to occur when the environment undergoes a marked change. The case study of the *Biston betularia* (peppered moth) illustrates this.

Diversifying selection favours the extremes over intermediates. If the environment of the species contains two different features (eg. in background colour - light/shade) two different phenotypes have a selective advantage, depending on location.

Another form of natural selection occurs in species where the males and females are very different in appearances or behaviour, apart from the physiological differences due to gender. This is called **sexual dimorphism**, an example of which is size differences in male/female gorillas. This can itself, be an agent of natural selection, with the biggest male gorillas, or the best-plumed male birds gaining the largest number of matings within their population. This ensures that the genes for the "desirable" traits are passed on to the next generation and those genes from the "less desirable" males are reduced or eliminated.

Some special cases of selection in action include:

- **Heterozygote advantage**
  Heterozygotes are more likely to survive than either of the homozygotes
- **Co-evolution**
  Evolution in two interdependent species. Sometimes two species provide the selection pressures or selecting agent for each other. Common in plant/browser, predator/prey, parasite/host and other relationships.
- **Clines**
  Continuous variation in the phenotype of a species over its range due to differences in selection pressures in different environments. An example is plants growing over a range of areas from plains to tops of mountains.

SPECIATION

Species = A particular kind of organism; members of a species possess similar anatomical characteristics and have the ability to interbreed, producing vigorous (= healthy), virile (= able to reproduce sexually) offspring.

Two patterns of speciation can occur:

- **Phyletic evolution** in which one population gradually changes over time to become a new species.

- **Branching evolution** is when a population of one species splits, and one part of the population evolves separately to form a new species distinct from the original population. This usually involves **geographical isolation and** the populations may become **reproductively isolated** from each other.

Different selection pressures lead to different phenotypes being selected for and over time the two populations evolve different adaptations to these environments.
As described earlier, this will almost certainly, over many generations, lead to changes in the gene pool of each sub-group. As these changes progress, random chance makes it highly likely that significant differences in phenotypes will develop in each group. For a while, breeding between groups will remain theoretically possible, if individuals were to meet and mate. Eventually, however, the accumulated changes in each group's gene pool would lead to a significant lack of homology at a number of gene loci. Viable offspring between the groups would now be impossible - the groups are no longer members of the same species and **speciation** has occurred.

When speciation occurs as a result of geographical isolation it is termed **allopatric speciation.**

Reproductive isolation can be due to

- Differences in breeding seasons
- Differences in structure of genitalia
- Incompatible mating behaviours
- Gamete isolation

Speciation has been, and still is, occurring constantly since life began on Earth. We can see evidence of it in nature, for example, Australian magpies, species *Gymnorhina tibicen*, show phenotypic variation in different populations on the East Coast, from Tasmania to Cape York. In some of these sub-groups (sometimes termed **races**), interbreeding is still possible, especially if their home ranges overlap. Where large distances or high mountains geographically separate the populations, the populations may no longer be able to successfully interbreed. Deciding exactly where one species stops and another starts can be very difficult in cases such as this.

Human activity has recently hastened this process by manipulating selection criteria in many species. Many cultivated plants, bred originally from natural "wild" species bear little resemblance to the originals and are now infertile, being reproduced asexually (e.g. by cuttings) for commercial purposes.

EXTINCTION

Sometimes environments change relatively rapidly. If the species, which live in those changing environments, are not lucky enough to already possess genes, which enable the species to survive in the face of such change, or if random mutations do not accumulate sufficiently quickly, all members of the unlucky species may die. This is **extinction.** Extinction may be localised to one species in an ecosystem, often due to destruction of that species' habitat or it may widespread. The fossil record (see later) indicates that there have been at least twelve periods during the history of life on Earth where **mass extinctions** occurred. The two most extreme of these occurred about 250 million years ago (>90% of marine species died) and 65 million years ago (>50% of marine species, and many terrestrial species, including the dinosaurs died). Paleobiologists are still divided as to the explanations for these; asteroid collisions and global climate changes are currently the two leaders in the explanation stakes.

3. EVIDENCE FOR EVOLUTION

EVOLUTION = All the changes that have transformed life on Earth from its earliest beginnings to the diversity that exists today.

The currently accepted theories of evolution have been developed and refined by biologists as evidence has become available to support and extend the mechanisms first proposed by **Alfred Wallace** and **Charles Darwin**. Earlier explanations, especially those of Lamarck are not well supported by the current evidence and are generally not accepted by current scientists.

The evidence upon which the current theories of evolution are based is varied in its origins, and it is this multi-faceted approach which, taken together provides the strength of the theory.

(a) FOSSIL RECORD

FOSSIL = A relic or impression of an organism from the past, usually preserved in rock.

Fossils can take many forms

- **Hard parts** of animals, teeth and bones, are often fossilised
- Thin tissues such as leaves may be preserved as **films**
- Entire organisms may be preserved e.g. frozen or in **amber**
- Plant tissue is sometimes found **"petrified"**
- **Imprints** such as footprints of dinosaurs occur, but rarely.

For fossilisation to occur the following conditions must be met:
- Rapid burial
- Prevention of decomposition
- The organism is undisturbed

Fossils are most often found in **sedimentary rocks** such as sandstone, mudstone, shale and limestone. The layers of silt or other debris, which accumulate over time, exert pressure on plant and animal remains, or settles into the imprints left by passing animals, minerals are exchanged, and fossils are formed.

Fossil dating
The age of fossils can be determined in two ways; comparative age (sedimentary layers – see below) or absolute age using radiometric dating.

Radiometric dating

This method relies on the properties of naturally occurring **radioactive isotopes** to determine the age in years of rocks and the fossils within them. These isotopes are present in constant amounts in living organisms.
Since radioactive isotopes have known **half lives** (the time taken for the radioactivity to decay to half its initial value), measurement of the radioactivity in a sample can easily be calculated as a function of number of years since death occurred.

Carbon-14 dating is most useful for relatively recent fossils, that is fossils up to about 50 000 years old.

Isotopes of other elements, such as potassium**-40** are used to date rocks which are hundreds of millions of years old and so infer the age of fossils embedded in them.

Radioactive dating has an error of approximately ± 10%.

(b) STRATIFICATION

Over thousands and millions of years sedimentary rocks form in **strata**, or layers. As a consequence of this, the layers reflect the order in which the fossils were deposited; the oldest fossils are in the lowest layers, with progressively "younger" fossils in each higher layer.

This **stratification** of the sedimentary rock enables palaeobiologists to assign relative ages to fossils. Where similar fossils are discovered at different, separated locations, these **index fossils** can be used to correlate evolutionary events at the different locations, by comparing and contrasting the fossils in the strata above and below them.

Analysis of fossils in strata does not give dates in terms of years, it only gives the **relative age** of a fossil in terms such as *before* or *after* and *early* or *late*.

Because of the constant, slow movement of the Earth's crustal plates (**plate tectonics**), the strata in some locations have been buckled and broken. This causes some difficulty in the interpretation of the fossil record in these places but a combination of geology and biology can be used to infer what has happened.

(c) BIOGEOGRAPHY

BIOGEOGRAPHY = the study of past and present distribution of species.

Studying and comparing similarities and differences in present species environments and their global distribution can make inferences about the likely environments of similar species, which are now only known from the fossil record. The presence or absence of types of life forms can often be explained by the movement of the continental masses (**continental drift or plate tectonics**)

Study of the biogeography of islands is also instructive in the study of evolution, as initially barren locations (such as the island remaining after the eruption of Krakatoa) have given valuable information about **succession** in such environments.

(d) COMPARATIVE ANATOMY

By comparing the anatomy of species, gradual progressions in structural characteristics can be observed. For example, comparison of skulls of gorillas, chimpanzees, orang-utans, humans and many now extinct arthropods has made it possible to suggest pathways of evolutionary progression from **common ancestor** to the existing species. When combined with radioactive dating of the fossils, the timing of this evolution can also be estimated.

(e) HOMOLOGOUS & ANALOGOUS STRUCTURES

When comparisons are made of the anatomy of structures, which seem to have evolved very different functions, it can be seen that the process of natural selection has led to these differences. **Homologous structures** such as the forelimbs of a variety of mammals (e.g. human, cat, whale and bat) can be shown to possess the same skeletal elements, suggesting that a common ancestral forelimb has been modified for many different functions.
Homologous structures such as those described above should not be confused with **analogous structures** (e.g. bat wing and insect wing), where evolution has given rise to anatomically very different structures which have similar function (aid in flying) where this function provides a survival advantage in a particular environment.

(f) EMBRYOLOGY

Closely related organisms go through similar stages in their embryonic development. In fact, the similarities between early embryos of fish, frogs, snakes, birds, cats and humans are much more evident than are the subtle differences.
By following the progression of development of embryos, and studying the paths of differentiation of tissues in different species, many similarities between species, which are difficult to detect in adults, become increasingly clear.

(g) BIOCHEMISTRY

With recent technological advances in the analysis of the molecular composition of biological molecules, some of the most compelling evidence for evolution has been discovered.
Evidence of shared ancestry can be found in similarities between the DNA and its protein products, of related species.

It is also important to note:

- Every species on earth shares the same genetic code.
- Some genes are present in almost every species.
- Some other genes and their protein products are found in all members of particular animal and plant families, indicating descent from a common ancestor.
- The structure of chromosomes show common chromosomal regions between related species. Evident from karyotyping.

Since the hereditary information of an individual is located in its genes, we would expect that closely related individuals (e.g. siblings) would have a large amount of very similar DNA and proteins. This is found to be true. For the same reason, we would expect that members of the same species would also possess much common DNA and many common amino acid sequences in their proteins.
This is also found to be true.

Some biochemical techniques used to determine the evolutionary relationship between species.

- **DNA - DNA hydridisation**

  Separating the strands of DNA from two different species
  The separated strands of DNA are mixed, one from each species
  The strands pair up by complementary base pairing
  Organisms that are genetically similar will show a large degree of hybridisation.
  The similarity of genomes gives an estimate of the genetic distance between them, i.e. the time elapsed since the two species shared a common ancestor.

- **DNA sequencing**

  Comparing the sequence of nucleotides in related genes in different species can indicate an evolutionary relationship. Mutations cause changes in base sequences in the same gene.
  The more mutations there are, the longer the species have been separated.
  Humans and chimps have the greatest similarity in the sequences of a haemoglobin gene.

- **Amino acid sequencing of matching proteins**

  Amino acid sequences of proteins can be determined.
  Similar sequences indicate similar DNA sequences and indicate an evolutionary relationship.
  Differences are due to mutations. The number of different amino acids is an indicator of the number of mutations and hence the degree of separation of species.

- **Mitochondrial DNA**

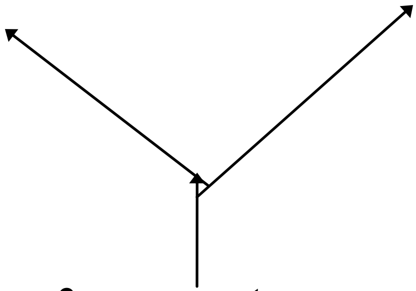
  Mitochondria contain their own DNA separate from the DNA found in the nucleus.
  Mitochondrial DNA is only inherited from the mother via the egg cell.
  mtDNA mutates at a faster rate than nuclear DNA, so comparison can be made between closely related species or different populations of the same species.
  The more mutations a population has accumulated over time the longer its time of evolutionary change.

4. PATTERNS OF EVOLUTION

1. DIVERGENT EVOLUTION (ADAPTIVE RADIATION)

In DIVERGENT EVOLUTION one species (a **common ancestor**) splits into two, which become less and less alike over time due to different selection pressures. Evidence of descent from a common ancestor is often seen in homologous structures.

SPECIES A **SPECIES B**

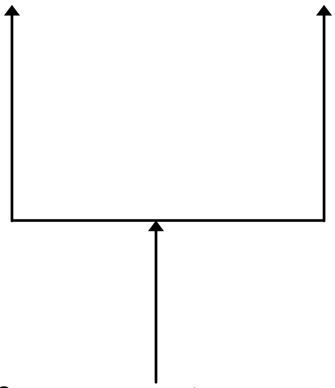


Common ancestor

2. PARALLEL EVOLUTION

In PARALLEL EVOLUTION two related species arise from a common
ancestor. The two species then evolve in much the same way over time, probably in response to similar environmental selection pressures.

SPECIES A **SPECIES B**

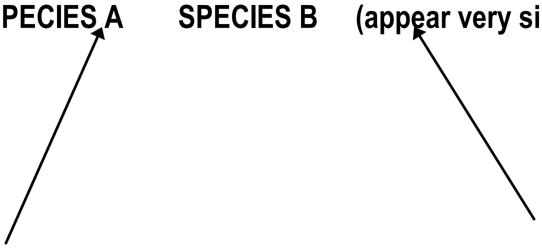


Common ancestor

3. CONVERGENT EVOLUTION

CONVERGENT EVOLUTION occurs when two groups that are not closely related come to resemble each other more and more as time passes. This is usually the result of occupation of similar habitats and similar environmental selection pressures.

SPECIES A SPECIES B (appear very similar)



Ancestor A **Ancestor B**

5. HUMAN EVOLUTION

The mechanisms that led to the evolution of the huge diversity of species living today are believed to be identical to those that led to the evolution of our own species (*Homo sapiens*).
It is generally accepted that humans share a common ancestor with the other primates, and many lines of evidence support this. Most textbooks will have a diagram showing the most likely relationships between primates. Some of the animals on this diagram survive today; others have long been extinct.

Features of primates:

- Rounded faces with reduced snouts
- Eyes protected by bony ridges
- Relatively large brains and a larger brain case
- Eyes pointing forward
- Variation in tooth size and shape
- Collar bones for swinging by the arms
- Five digits on hands and feet
- Opposable thumbs
- Some bipedal, many quadrupedal
- Internal fertilisation, long gestation, long period of parental care
- Social groups with hierarchies

At least 4 million years ago the first **hominid ancestor** appears in the fossil record in **Africa**.

> Family Hominidae are humans and their (now extinct) close relatives.

Hominids changed over time from the first ancestor:
- Body size tended to increase
- Thick skeletons- some robust, others fine boned
- Skull capacity increased and therefore brain size
- Skull bones and teeth were more like apes than modern humans
- Pelvis and thigh bones indicated bipedal gait
- Ability to use tools

Extinct hominids include many species, including those in the following genera:
- Ardipithecus
- Australopithecus

The **Australopitheclines** include species such as A. ramindus, A. afarensis, A. africanus and A. robustus. These fossils have only been found in Africa.

The **Homo** genus includes many extinct species: for example H. erectus, H. neanderthalensis and H. heidelbergensis.

Eventually one species of hominid remained. Perhaps ***Homo sapiens*** was better adapted to survive a major environmental change. Perhaps 'he' was merely smarter and he directly or indirectly caused the extinction of other Homo species, which were already beginning to migrate out of Africa.

The evidence does seem strong that the origin of our species is somewhere in Africa, but the details will probably never be known for sure. However, there is a great deal of evidence to show that many groups of early *Homo sapiens* migrated out of Africa about 200 000 years ago. The pressures of selection and adaptation that we have described for other species have acted on these population founding groups over the succeeding years and produced the sub-groups of the human species that we know as **races**. Since interbreeding between members of different human races can and does occur, these groups must still be classified, according to the rules of taxonomy, as members of the same species.

Evolution of the genus **Homo** has involved biological changes, for example

- Enlargement of the brain and cranium
- Reduction of tooth size
- Shortening of face

Cultural Evolution is also typical of the genus Homo. This is the term used to refer to changes in the human way of life since the evolution of biologically modern humans. This is a powerful agent of change that operates through the transmission of learned behaviours. It occurs very rapidly in contrast to **biological evolution.**

Examples include:

- Using tools
- The development of societies in which knowledge is passed down
- The controlled use of fire
- The development of language
- The use of symbols and ceremonies.

Technological Evolution:

- Refers to changes over time in technology that gave humans increased control over their environment

Examples include:

- The change from stone tools to metal tools
- Domestication of plants and animals.
- Change from steam power to electrical power
- Modern medical technology

6. HUMAN INTERVENTION IN EVOLUTIONARY PROCESSES

Humans can change the course of evolution through:

(A) Selective breeding

For many years, humans have been manipulating the process of evolution to suit their own ends. By choosing plants and animals with desired phenotypes as breeding stock, humans are practicing artificial selection.
There is value in this practice when desirable characteristics such as disease resistance in crop plants are achieved. But sometimes-undesirable results are obtained; such is the case with the development of antibiotic resistance in some pathogenic organisms.
As a result of human activity, rapid environmental changes have occurred in some locations. These, in turn, have changed ecosystems and habitats. As we have discussed earlier, mutations occur very slowly and are not necessarily favourable. It is, therefore, not surprising that many species are now endangered and many others have recently become extinct.

(B) Reproduction technologies

Examples include:

Artificial insemination is where the genetic material from one male can be passed onto thousands of offspring around the world.
Cloning of organisms is the production of a new individual from a cell, nucleus or asexual offshoot of another organism

(C) Medical intervention and transgenic organisms

Medical intervention includes:

- Recent advances in **medical technology** that has reduced the incidence of death from human genetic disease; with affected individuals now remaining in the population long enough to reproduce.
- **Genetic screening** of individuals to assess whether they are carriers of a recessive condition or likely to develop genetic conditions in later life. Screening of embryos for chromosomal abnormalities and/or inherited conditions.
- **Gene therapy** involves the insertion of genes into individuals who have genetic disorders in order to induce the production of a faulty or missing protein
- **Stem cell research.** Stem cells are cells that are undifferentiated. They are able to divide to produce new cells, which have the potential to be other stem cells, or to differentiate to become specific tissue cells such as a nerve cell, a blood cell or a bone cell. Embryo stem cells have the potential to differentiate into any type of body tissue. With research these cells could be used to replace neurons that are damaged, replace joint tissue, grow new livers, replace pancreatic tissue and replace tissues lost due to accidents such as burns

Transgenic organisms:

- Foreign genes have been introduced into selected organisms
- Examples include transgenic plants that are resistant to herbicides and transgenic mammals that produce human protein.

SUMMARY:

DNA

MUTATION

CHANGES IN GENOTYPE

CHANGES IN PHENOTYPE

VARIABILITY IN POPULATIONS

Selection pressures

CHANGES IN ALLELE FREQUENCIES IN GENE POOL
(Adaptations)

Many generations

Selection pressures

NEW SPECIES

EVOLUTION

EXTINCTIONS

VICTORIA UNIVERSITY 2011

CHANGE OF PREFERENCE 16-21 DECEMBER

DROP INTO VUHQ - CITY FLINDERS CAMPUS, ONLINE CHAT SERVICE & COURSE HOTLINE: 1300 VIC UNI

Friday 16	8:30AM - 5:30PM
Saturday 17	11:00AM - 4:00PM
Sunday 18	11:00AM - 4:00PM
Monday 19	8:30AM - 5:30PM
Tuesday 20	8:30AM - 5:30PM

GENERAL INFORMATION SESSIONS

Monday 19	4:00PM - 7:00PM
Tuesday 20	4:00PM - 7:00PM

Footscray Park Campus
Ballarat Road, Footscray
Melways Ref. Map 42 C2

CAMPUS TOURS

Footscray Park tours will operate after each information session.

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