Biology

Blueprint of Life

New Revised Edition

Kerri Humphreys

S
Science Press

First published 2003
Revised Edition 2016

Science Press
Bag 7023 Marrickville NSW 1475 Australia
Tel: (02) 9516 1122 Fax: (02) 9550 1915
sales@sciencepress.com.au
www.sciencepress.com.au

Contents

Use the table of contents to record your progress through this book. As you complete each topic, write the date completed, then tick one of the three remaining columns to guide your revision for later. The column headers use the following codes:

?? = Don't understand this very well at all. RR = Need to revise this. OK = Know this.

Introduction

Each book in the *Surfing* series contains a summary, with occasional more detailed sections, of all the mandatory parts of the syllabus, along with questions and answers.

All types of questions – multiple choice, short response, structured response and free response – are provided. Questions are written in exam style so that you will become familiar with the concepts of the topic and answering questions in the required way.

Answers to all questions are included.

A topic test at the end of the book contains an extensive set of summary questions. These cover every aspect of the topic, and are useful for revision and exam practice.

Words To Watch

account, account for State reasons for, report on, give an account of, narrate a series of events or transactions.

analyse Interpret data to reach conclusions.

annotate Add brief notes to a diagram or graph.

apply Put to use in a particular situation.

assess Make a judgement about the value of something.

calculate Find a numerical answer.

clarify Make clear or plain.

classify Arrange into classes, groups or categories.

comment Give a judgement based on a given statement or result of a calculation.

compare Estimate, measure or note how things are similar or different.

construct Represent or develop in graphical form.

contrast Show how things are different or opposite.

create Originate or bring into existence.

deduce Reach a conclusion from given information.

define Give the precise meaning of a word, phrase or physical quantity.

demonstrate Show by example.

derive Manipulate a mathematical relationship(s) to give a new equation or relationship.

describe Give a detailed account.

design Produce a plan, simulation or model.

determine Find the only possible answer.

discuss Talk or write about a topic, taking into account different issues or ideas.

distinguish Give differences between two or more different items.

draw Represent by means of pencil lines.

estimate Find an approximate value for an unknown quantity.

evaluate Assess the implications and limitations.

examine Inquire into.

explain Make something clear or easy to understand.

extract Choose relevant and/or appropriate details.

extrapolate Infer from what is known.

hypothesise Suggest an explanation for a group of facts or phenomena.

identify Recognise and name.

interpret Draw meaning from.

investigate Plan, inquire into and draw conclusions about.

justify Support an argument or conclusion.

label Add labels to a diagram.

list Give a sequence of names or other brief answers.

measure Find a value for a quantity.

outline Give a brief account or summary.

plan Use strategies to develop a series of steps or processes.

predict Give an expected result.

propose Put forward a plan or suggestion for consideration or action.

recall Present remembered ideas, facts or experiences.

relate Tell or report about happenings, events or circumstances.

represent Use words, images or symbols to convey meaning.

select Choose in preference to another or others.

sequence Arrange in order.

show Give the steps in a calculation or derivation.

sketch Make a quick, rough drawing of something.

solve Work out the answer to a problem.

state Give a specific name, value or other brief answer.

suggest Put forward an idea for consideration.

summarise Give a brief statement of the main points.

synthesise Combine various elements to make a whole.

1 Assumed Knowledge

1. Define evolution.
2. What is meant by the 'physical conditions' of the environment?
3. Many species compete for resources. What is meant by 'resources'?
4. Outline some feature of sclerophyll plants.
5. Define palaeontology.
6. Define biochemistry.
7. Draw a flow chart to show the evolution of the vertebrates from the ancestral fish.
8. Figure 1.1 shows adaptive radiation in Australian marsupials.
   Discuss how this diagram shows adaptive radiation in Australia.
9. Why is Gregor Mendel often referred to as the 'father of genetics'?
10. What is DNA?
11. What is the relationship between genes and DNA?
12. Explain the advantages of DNA replicating exactly.
13. What is a mutation?
14. Explain the advantages and disadvantages of DNA mutating.
15. How is information transferred when cells reproduce themselves?
16. Identify the factors that determine the features of an organism.
17. Use an example to show how environment influences the appearance of an organism.
18. Use an example to show how genes determine the features of an organism.
19. What is the 'Watson-Crick' model of DNA?
20. What is a pedigree?
21. The diagram shows the last division of meiosis in the anther of a flower.

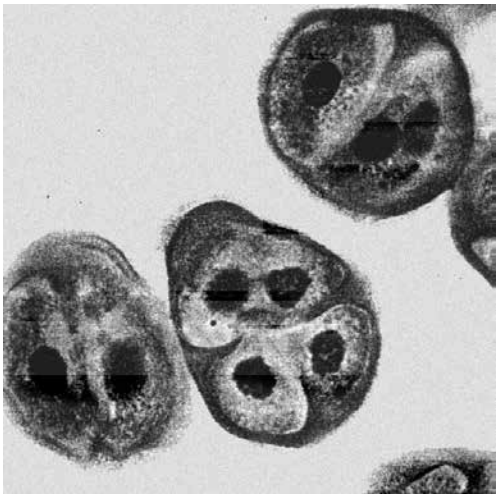

Figure 1.2 Meiosis in an anther.

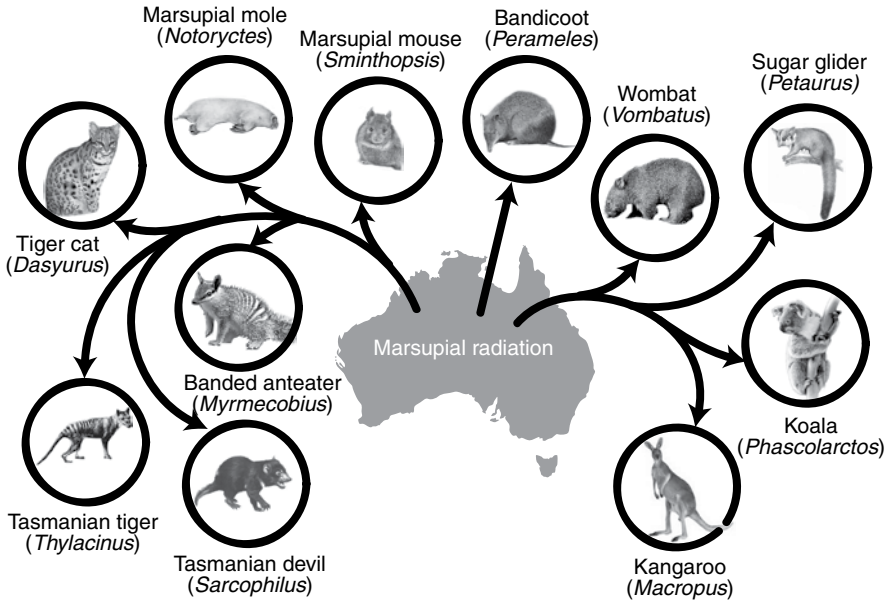

Figure 1.1 Adaptive radiation in Australian marsupials.

(a) What is meiosis?
(b) What would be produced, according to this diagram?

22. Define fertilisation.
23. Why is it important for gametes to have half the number of chromosomes of the species?
24. What is biotechnology?
25. Describe some benefits of using biotechnology.
26. Describe some social and ethical issues of using biotechnology.
27. What is biodiversity?
28. The diagram shows the structure of a buttercup.

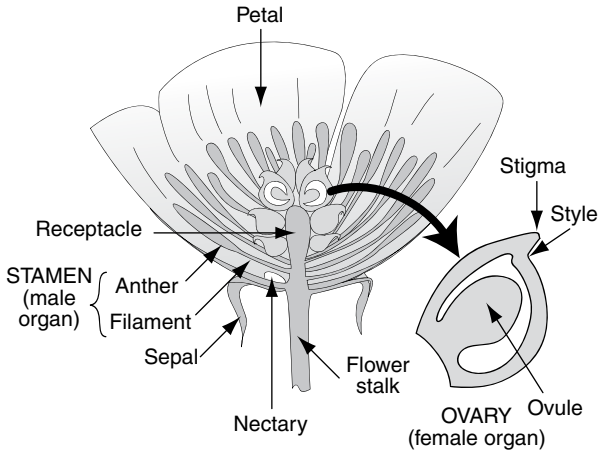

Figure 1.3 Half-flower of buttercup.

(a) Identify the male part of the flower and the female part of the flower.
(b) What is pollination?
(c) Name some of the agents of pollination.
(d) What is artificial pollination?

2 Evolution

Evolution is the change in a population over time. **Biological evolution** occurs when there is a natural selection pressure for a particular characteristic that increases the chances of survival in a changing environment. In humans, biological evolution is slowing down while cultural evolution is rapidly advancing and changing our way of life.

The mechanism for evolution is **natural selection**. Within a population individuals are characterised by a variety of inherited traits. In a changing environment, some of those traits will provide an advantage. Individuals with these traits will survive, breed and pass these traits on to their offspring so that, over time, these traits will become more common in the population. The population will evolve.

Changes in the physical conditions. A change in the physical conditions, e.g. temperature or rainfall, will act as a selection pressure for evolution. For example, in the past 25 million years the physical conditions in Australia have changed, with increased aridity causing a decrease in rainforests and an increase in open woodlands and grasslands with poor-quality grasses. These changes have altered the selecting pressure on the kangaroo so that the ancient kangaroo, which was much smaller with generalised molars, has evolved into the modern-day red kangaroo, which is much larger in size and eats grasses using its high-crested molar teeth. In the red kangaroos there has been a reduction in the number of toes, the disappearance of a 'big' toe and an increase in toe length, which all assist in increasing the speed of the red kangaroo and changing to a hopping gait. The musky rat kangaroo, found only in rainforest in north Queensland, has several primitive features and is believed to resemble the early kangaroo. For example, it still has five toes on its hind foot, doesn't hop but gallops like a horse when moving fast, it has no specialised teeth and its stomach is a simple sac.

Figure 2.1 Red kangaroo and musky rat kangaroo.

Changes in the chemical conditions. A change in the chemical conditions in the environment can have a marked effect on plant life. Many plants prefer a specific soil type and the introduction of mining has led to the evolution of plant varieties especially tolerant to mineral wastes, e.g. plants near copper mines. The use by humans of insecticides and antibiotics has led to the evolution of resistant varieties, e.g. strains of staphylococcus bacteria that are resistant to penicillin. In Australia, the change in the physical conditions, with increasing temperatures and lower rainfall as Australia drifts north, has also led to a change in the chemical composition of the soil. Increased erosion and leeching have helped to alter the soil type and have influenced the evolutionary path of Australian flora, e.g. eucalypts.

Competition for resources. Competition can occur between individuals of the same species or between different species. The resources can be for the food supply, for access to water, for a nesting site, for nesting materials, etc. In Australia, the introduction of many species, e.g. rabbits, foxes and feral cats, has caused serious competition for resources with native species. This competition has led to the extinction of several species and many other species are on the endangered list. As Australia drifted north and the climate became drier and hotter, competition for resources also influenced which kangaroo survived to reproduce.

QUESTIONS

1. (a) Define evolution.
   (b) Distinguish between biological evolution and cultural evolution.
2. Explain how natural selection leads to evolution.
3. (a) Use an Australian case study to show how changes in the physical or chemical conditions have led to changes in a species.
   (b) The introduction of the rabbit has increased competition for resources, leading to changes in several other species. Choose one native Australian species and explain how the introduction of the rabbit has led to changes.
4. Explain how mining can influence the evolution of the plants in the area.
5. Use an Australian example to show how changes in physical and chemical conditions and increased competition for resources have led to changes in a species.
6. As Australia has drifted north, the continent has become drier and the soils poorer. There has been a change from the Antarctic beech forests to sclerophyllous plants. Fossils of eucalypts, with their 'capped' fruit, appear about 25 million years ago.

Fire became frequent from about 100 000 years ago and acted as a selecting agent. Discuss why fires assisted the evolution of some of the sclerophyllous plants, such as eucalypts, but led to the extinction of other species.

7. When scientists refer to a 'change in the physical conditions in the environment' what do they mean?
   (A) The climate has altered in some way.
   (B) A predator has migrated into the area.
   (C) Disease has wiped out a large number of organisms.
   (D) The food source has become scarce.
8. When is natural selection *least* likely to occur?
   (A) During changes in the chemical conditions in the environment.
   (B) During static and unchanging conditions.
   (C) During introduction of a competitive species.
   (D) At the beginning of an ice age.
9. Since European settlement in 1788, many native species are either threatened or have become extinct. Although extinction is a natural process, what has caused the rapid decline of many native Australian species?
   (A) Competition with introduced species.
   (B) Loss of habitat from farming and logging.
   (C) Urban development.
   (D) All of the above.
10. The native burrowing bettong, *Bettongia lesueur*, is the only rat kangaroo to live in a burrow.

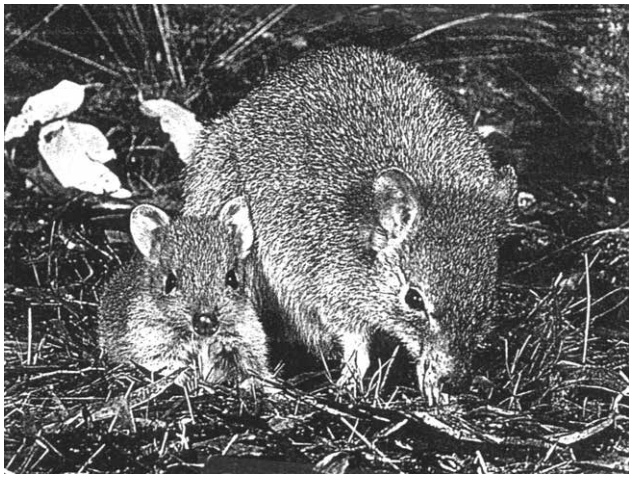

Figure 2.2 The native burrowing bettong, *Bettongia lesueur.*

When rabbits and foxes were introduced, this native became extinct on the mainland. Once it had been found across inland Australia in shrublands and semi-desert, but now it exists only on four islands off the coast of Western Australia. It has been suggested that we should reintroduce the burrowing bettong into fox-free areas on the mainland. Which of the following shows the result of such an action?

   (A) It will never lead to their survival on the mainland as rabbits will always take over the burrows.
   (B) It will never lead to their survival on the mainland as all necessary habitats have been destroyed.
   (C) It will succeed if predators and competitors are controlled.
   (D) It will succeed if they are immunised against such diseases as myxomatosis.
11. When *must* competition occur between two species of birds?
   (A) When they are found in the same area at the same time and season.
   (B) When they use the same limited resources for their nests.
   (C) When both are the food source of the wedge-tailed eagle.
   (D) When both are susceptible to the same bacterial infection.
12. Over the past 25 million years Australia has moved northwards due to plate tectonics and the climate has become more arid. Kangaroos have diversified. The most primitive living kangaroo is the musky rat kangaroo, *Hypsiprymnodon moschatus,* which lives in rainforests and eats fruits and small invertebrates. By 10 million years ago there were five main groups of kangaroos — the carnivorous kangaroos (*Propleopus*), the musky rat kangaroos (*Hypsiprymnodon*), the rat kangaroos (*Caloprymnus*), the sthenurine kangaroos (*Sthenurus*) and the macropodine kangaroos (*Macropus*).

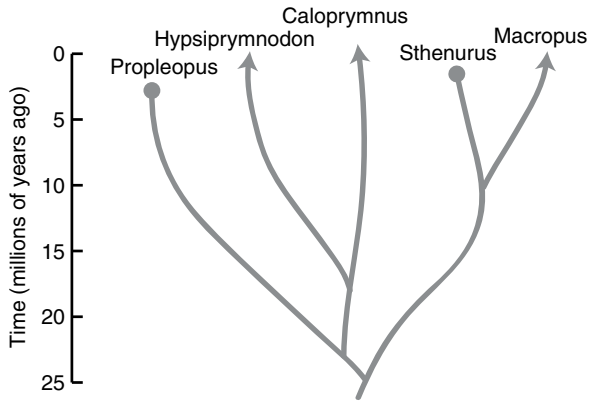

Figure 2.3 Evolution of kangaroos

What is this is an example of?
(A) Convergent evolution.
(B) Evolution through inheritance of acquired characteristics.
(C) Adaptive radiation from a common ancestor.
(D) Homologous structures.

3 Evidence for Evolution

There are many areas of study that provide evidence for evolution. Darwin supported his theory of natural selection using fossil records and the geographical distribution of species.

A **fossil** is any trace or remain of pre-existing life. Fossils show the history of life on Earth and when different groups first appeared. Fossil records show the evolution of the vertebrates.

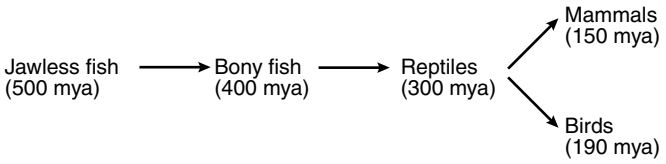

Figure 3.1 Evolution of the vertebrates.

Fossils can provide case histories for some organisms. Numerous fossils of the horse have shown its evolution from a small animal, *Hyracotherium*, about the size of a fox terrier which lived about 55 million years ago, to the modern horse, *Equus*. *Hyracotherium* browsed on trees and bushes with smaller teeth, and had four toes on each front foot and three on each rear foot. *Equus* is much larger, has larger teeth and only one toe on each foot. These changes were probably due to a change in environment with a reduction in rainfall and swampy areas becoming dry grasslands.

A **transitional form** is a missing link that shows characteristics of two different groups. Transitional forms suggest a possible pathway of evolution when one group evolves from another group. *Archaeopteryx* is a transitional form that has teeth like a reptile and feathers like a bird, showing the evolution of birds from reptiles.

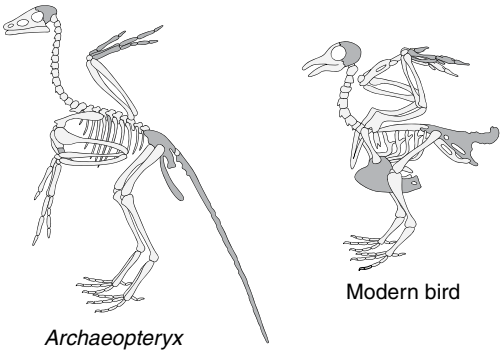

Figure 3.2 *Archaeopteryx* and modern bird.

Comparative embryology studies the embryo development of different species. For example, the early stage embryos of many vertebrates appear very similar, showing that the different groups evolved from a common ancestor.

QUESTIONS

1. (a) What is a fossil?
   (b) Suggest two reasons why fossils are important in the study of biology.
   (c) Trace the fossil record of one group of organisms to show how it has evolved over time. Suggest a possible reason for the changes.
2. (a) Define the term 'transitional form'.
   (b) Explain how transitional forms provide evidence for the theory of biological evolution.
   (c) Name one transitional form you have studied and explain why it is important to the theory of evolution.
   (d) Describe one other area of evidence used to support the theory of evolution.
3. The diagram shows three stratigraphic columns from nearby areas.

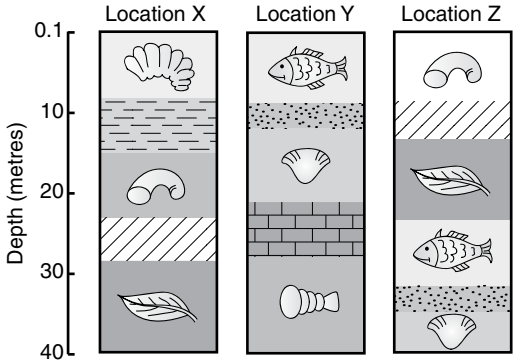

Figure 3.3 Three stratigraphic columns.

   (a) Which locality has the oldest stratum? Explain your answer.
   (b) Explain how index fossils are used to date rock layers.
4. The diagram shows the present and past distribution of the camel family.

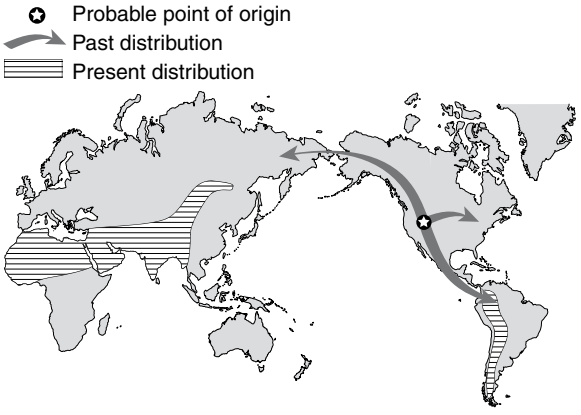

Figure 3.4 Camel family distribution.

Wild herds of camels are now found only in North Africa, Asia, South America and Australia. Yet camel fossils 20 000 years old are found in Alaska. Use the diagram to explain the current distribution of camels.

5. (a) What is biogeography?
   (b) Use an example to explain why biogeography exists.
   (c) Figure 3.5 shows a series of events.

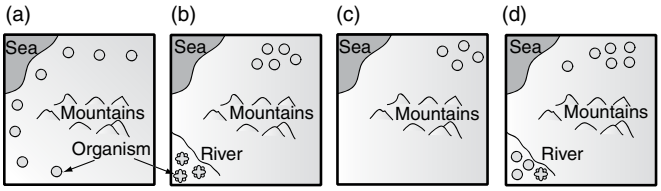

Figure 3.5 Formation of a new species.

   (i) Place them in their correct order and explain how the new species evolved.
   (ii) Relate these diagrams to biogeography.

6. (a) The following diagram shows a series of diagrams collected by a biology student.

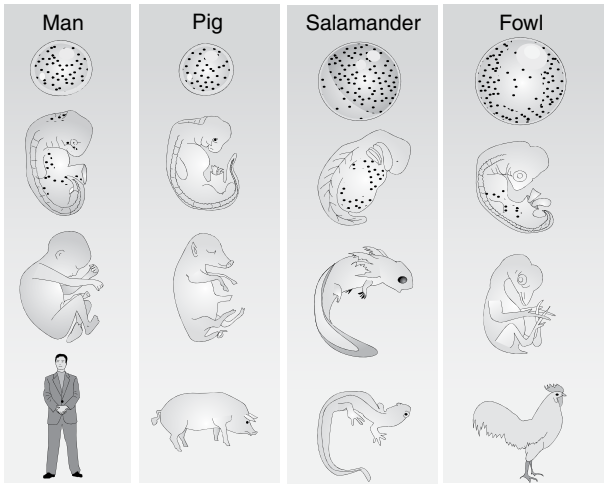

Figure 3.6 Series of diagrams for evolution.

What area of evidence was this student investigating?
   (b) Explain how this area of evidence supports the theory of evolution.

7. The following diagram shows a Devonian lobe-finned fish and a Carboniferous amphibian.

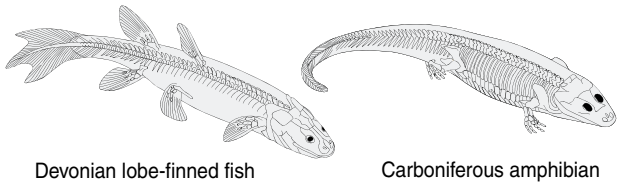

Figure 3.7 Lungfish and amphibian.

   (a) What evidence suggests that a lungfish with lobed fins is the ancestor of early amphibians?
   (b) Choose one feature that has developed from the lungfish and explain the importance of this development.

8. The dodo bird has been extinct since 1681. It was flightless and lived on the island of Mauritius before European sailors began their voyages of discovery.

Figure 3.8 Dodo bird.

When the shipping companies reached the island, the men killed the birds and took the eggs to replenish food supplies. They also introduced pigs and rats, which ate the dodo eggs. Outline how the extinction of the dodo bird could be used to support evolution.

9. In Western and eastern Australia, there are underground orchids of the genus *Rhizanthella*, which obtain all nutrients from mycorrhizal fungi. What is shown by the evolution of orchids with no leaves and no chlorophyll?
   (A) Two species can form a unique symbiotic relationship.
   (B) Natural selection will lead to leafless plants in Australia.
   (C) Orchid mycorrhizae inhibit chlorophyll production in orchids.
   (D) Geographic isolation in Australia favours underground plants.

10. By the end of the Palaeozoic era, many of the modern orders of Insecta had appeared. Some modern insect species appear very similar to their ancestral form. What is this lack of change most likely due to?
   (A) Their strong exoskeleton made of chitin.
   (B) Living in a relatively unchanging habitat.
   (C) Their small size making them hard to catch by most predators.
   (D) Presence of specialised digestive, circulatory, respiratory and excretory systems.

11. Which of the following would *not* support the theory of evolution?
   (A) Transitional forms of molluscs in successive layers of rocks.
   (B) Similarities in hindlimbs of cats, lizards, frogs and humans.
   (C) Similarities in the embryos of fish, tortoise, chicken and pig.
   (D) Similarities in the diet between cows, kangaroo, sheep and deer.

4 Activity – Vertebrate Forelimbs

Some biology students wished to analyse and compare the structure of a range of vertebrate forelimbs as part of their study of comparative anatomy. Comparative anatomy is the study of the structures, e.g. organs or bones, found in different groups.

They decided to study the pentadactyl limb. The **pentadactyl limb** is the five-digit limb found in some amphibians and reptiles, birds and mammals. The pentadactyl limb is an example of an homologous structure. An homologous structure is a similar structure found in different organisms due to common ancestry but used for different purposes.

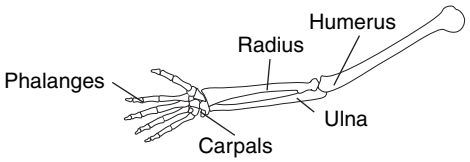

Figure 4.1 Parts of the human forelimb (arm).

The students collected diagrams and/or prepared specimens of vertebrate forelimbs and drew an outline of the limb of each animal.

The students decided that there are many underlying similarities between the forelimbs of these groups, showing that these groups had a common ancestor, and since that time natural selection has led to different modifications of the limb.

QUESTIONS

1. (a) What is comparative anatomy?
   (b) Choose one feature studied in comparative anatomy and explain how it provides evidence for the theory of evolution.
2. The diagram shows the forelimb of several different animals.

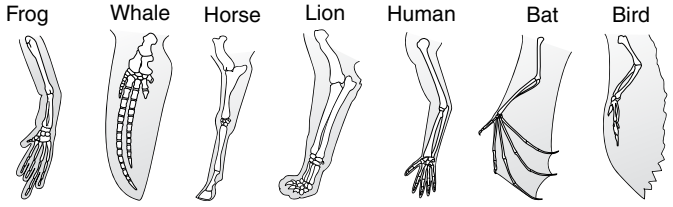

Figure 4.2 Forelimb of several different animals.

   (a) What is an homologous structure?
   (b) Describe how each of these animals has adapted the structure for its own purpose.
   (c) Explain how homologous structures are used to support the theory of evolution.
3. The diagram shows the skeleton of a horse and the skeleton of a whale.

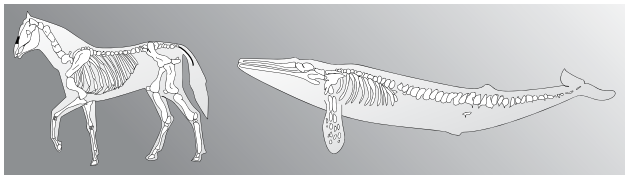

Figure 4.3 Skeletons of a horse and whale.

What does a comparison of their anatomy show?
   (A) Differences can be explained by convergent evolution from a common ancestor.
   (B) Differences can be explained by inheritance of acquired characteristics.
   (C) Similarities can be explained by adaptive radiation from a common ancestor.
   (D) Similarities can be explained by convergent evolution.
4. The diagram shows the forefeet of four different ancestors of the modern horse, *Equus*.

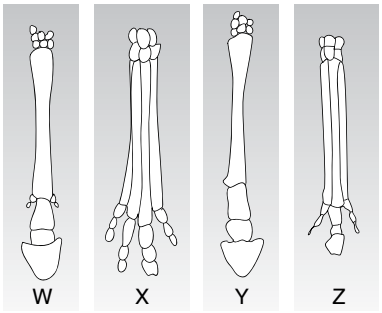

Figure 4.4 Forefeet of four ancestors of modern horse.

What is the correct order in which they occurred?
   (A) Y, W, Z, X (B) W, Y, X, Z
   (C) X, Z, W, Y (D) X, Z, Y, W
5. The diagram shows the forelimbs of four different vertebrates.

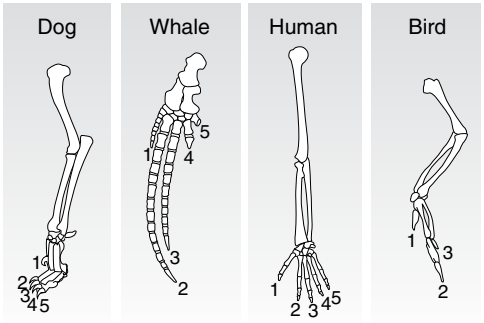

Figure 4.5 Forelimb of four different vertebrates

An analysis of these forelimbs shows that they:
   (A) Evolved from a common ancestor.
   (B) Adapted to similar environments.
   (C) All belong to the same class.
   (D) Use the pentadactyl limb for the same function.

5 Transitional Forms

There are many areas of study that provide evidence for evolution. Fossils can provide case histories for some organisms with transitional forms showing the 'missing links' from one group to another.

Transitional or intermediate forms show the characteristics of two different groups. Transitional forms suggest a possible evolutionary pathway of evolution when one group evolves from another group.

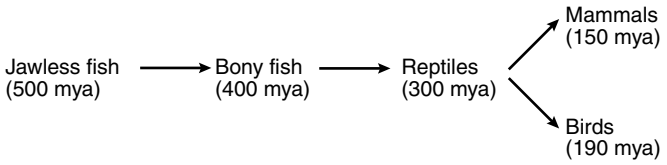

Figure 5.1 Evolution of the vertebrates.

Evolution of the horse

Numerous fossils of the horse have shown its evolution from a small animal, *Hyracotherium*, about the size of a fox terrier which lived about 55 million years ago, to the modern horse, *Equus*. *Hyracotherium* browsed on trees and bushes with smaller teeth, and had four toes on each front foot and three on each rear foot. *Equus* is much larger, has larger teeth and only one toe on each foot. The intermediate forms are extinct. These changes were probably due to a change in environment with a reduction in rainfall and swampy areas becoming dry grasslands.

Archaeopteryx

Archaeopteryx is a transitional form that has teeth like a reptile and feathers like a bird, showing the evolution of birds from reptiles.

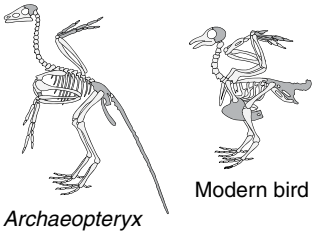

Figure 5.2 *Archaeopteryx* and modern bird

Evolution of whales

Whales evolved from land animals that had long skulls, large carnivorous teeth, arms and legs. Transitional forms of whales have been found that show the change from a terrestrial lifestyle to an aquatic lifestyle. The nostrils became further back along the snout, the pelvis is reduced in size and the hindlimbs reduced in size. The ancient whale *Basilosauris* is a transitional form that had hindlimbs and a tailfin.

QUESTIONS

1. (a) Define the term 'transitional form'.
   (b) Explain how transitional forms provide evidence for the theory of biological evolution.
   (c) Name one transitional form you have studied and explain why it is important to the theory of evolution.
2. Trace the fossil record of one group of organisms to show how it has evolved over time. Suggest a possible reason for the changes.
3. The diagram shows the present and past distribution of the camel family.

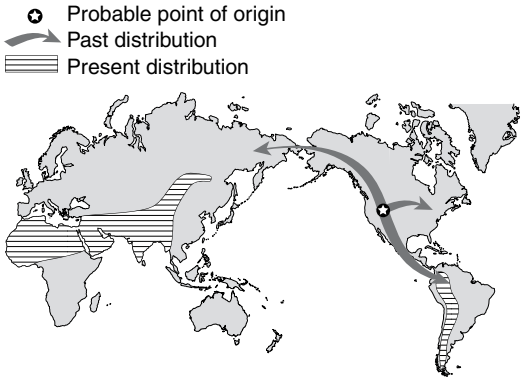

Figure 5.3 Camel family distribution.

Wild herds of camels are now found only in North Africa, Asia, South America and Australia. Yet camel fossils 20 000 years old are found in Alaska. Use the diagram to explain the current distribution of camels.

4. The following diagram shows a Devonian lobe-finned fish and a Carboniferous amphibian.

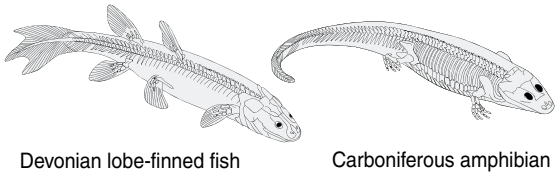

Figure 5.4 Lungfish and amphibian.

   (a) What evidence suggests that a lungfish with lobed fins is the ancestor of early amphibians?
   (b) Choose one feature that has developed from the lungfish and explain the importance of this development.
5. Which of the following would *not* support the theory of evolution?
   (A) Transitional forms of molluscs in successive layers of rocks.
   (B) Similarities in hindlimbs of cats, lizards and frogs.
   (C) Similarities in the embryos of fish, snakes and pigs.
   (D) Similarities in the diet between cows, kangaroos, and deer.

Answers

1 Assumed Knowledge

1. Evolution is the change in a population over time.
2. Physical conditions of the environment refer to features such as temperature, rainfall, humidity, topography and wind speed and direction.
3. Resources refers to anything that is used by the organisms, e.g. nesting material, food supply, water source.
4. Sclerophyll plants have tough leaves, thick waxy cuticle, e.g. eucalypts.
5. Palaeontology is the study of life from the past based on fossil remains.
6. Biochemistry is the study of molecules and how they react in organisms.
7. Fish → Amphibian → Reptile → Bird / Mammal
8. The diagram shows three branches of an evolutionary tree representing the ancestral lines for the different groups. One of these ancestors was the common ancestor of the Tasmanian devil, Tasmanian tiger, banded anteater, marsupial mole, tiger cat and marsupial mouse. Since the marsupial mouse was the first to diverge from the lineage, the common ancestor was probably small and mouse-like. Natural selection occurred so that different features were favoured and the survivors were more adapted to their environment. Over time the different species evolved adapted to a wide variety of environments, i.e. adaptive radiation from a common ancestor occurred.
9. Gregor Mendel experimented with pea plants and worked out the basic laws of inheritance. His work led to the study of genetics and hence he is often referred to as the 'father of genetics'.
10. DNA stands for deoxyribose nucleic acid. DNA is the chemical that carries hereditary information.
11. A gene is a certain length of DNA that has the code for one characteristic.
12. DNA needs to be able to replicate itself exactly so that cell division can form identical new cells for growth, repair and maintenance of the body of a multicellular organism. Exact replication is also needed to maintain the genetic code for a species and hence keep its integrity as a distinct unit in nature.
13. A mutation is a change in the chemical structure of the DNA.
14. An advantage of DNA mutating is that it can lead to different phenotypes, individuals with different forms of characteristics which can be beneficial in a changing environment for natural selection and the survival of the species. A disadvantage is that mutations are often harmful and reduce the normal lifespan of the individual, e.g. mutation causing cancer.
15. Information is transferred as DNA on chromosomes when cells reproduce themselves.
16. Both genes and environmental factors determine the features of an organism.
17. In plants, e.g. pea plants, the environment can have a great influence on the appearance of an organism. If the plant has the genetic code to be tall, but is grown in poor soil which has few nutrients, then the plant will not reach its full height potential and may appear to be a dwarf plant.
18. In pea plants there are two alleles for plant height – tall (T) and dwarf (t). Given that all other environmental factors are the same, a plant with the genetic code TT or Tt will be tall, while a plant with the code tt will be dwarf.
19. Watson and Crick discovered that DNA had a double helix structure.
20. A pedigree is a graphical way of picturing the ancestry of living things. It shows genetic history.
21. (a) Meiosis is cell division to produce haploid daughter cells.
    (b) Meiosis produces four daughter cells and in the anther will produce four pollen grains.
22. Fertilisation is the union of two gametes.
23. Gametes fuse to form a zygote. It is essential that gametes contain only half the number of chromosomes to maintain the chromosome number of the species. Otherwise the number of chromosomes would double every generation.
24. Biotechnology is the use of biological processes by industry and agriculture.
25. Biotechnology has helped humans develop new food sources, e.g. baking bread, making cheese, brewing beer, breeding certain strains of cereal crops to get a higher yield. This has increased food supply and hence allowed population growth.
26. Social issues arising from the use of biotechnology can involve human safety and confidentiality. For example, the production of genetically modified food is a recent development in biotechnology. Some people call them 'frankenfoods' and are worried about the effect on human health if there is long-term consumption of these foods. Biotechnology has also developed new diagnostic tests using genetic engineering. A social issue arising from these diagnostic tests involves confidentiality of the results and whether insurance companies have the right to personal genetic information about an individual. Ethical issues involving biotechnology have arisen with the recent experiments with animal cloning and whether the creation of human clones should be allowed. Another ethical issue is animal welfare. Animals are involved in many ways in genetic research and although there are guidelines (minimum number of animals to be used, the experiments are to be carried out humanely) some activists would like to ban all animal experimentation.
27. Biodiversity refers to the genetic variety found in the different life forms on Earth.
28. (a) The male part of the flower is the stamen and it consists of the anther and the filament. The female part of the flower is the carpel and it consists of the ovary, with ovules, the style and the stigma.
    (b) Pollination is the transfer of pollen from the anthers to the stigma.
    (c) Agents of pollination include the wind, insects and birds.
    (d) Artificial pollination is when humans transfer the pollen from a plant with desired characteristics onto the stigma of another plant so they can breed plants with certain features.

2 Evolution

1. (a) Evolution is the change in a population over time.
   (b) Biological evolution occurs when there is a natural selection pressure for a particular characteristic that increases the chances of survival in a changing environment. Cultural evolution is a change in lifestyle, e.g. music, clothing, speech, dance patterns, beliefs.
2. Within a population individuals are characterised by a variety of inherited traits. In a changing environment some of those traits will provide an advantage. Individuals with these traits will survive, breed and pass these traits on to their offspring so that, over time, these traits will become more common in the population. The population will evolve and this mechanism is called natural selection.