1 GENETICS

The contribution of Gregor Mendel to the science of genetics

1.1

In 1858, Gregor Mendel, an Austrian monk, began an eight year series of experiments on the common garden plea plant in his monastery garden. Although he published his results in 1865, little notice was taken of his work until 1900. Mendel summarised his results in a set of laws called 'Mendel's Laws of Heredity'.

Some reasons for Mendel's success

- Pea plant flowers are self-pollinating.
- Mendel cross-pollinated the pea plants by hand.
- Mendel started his breeding experiments with pure strains (pure-breeding) for each characteristic studied.
- Mendel was fortunate to have chosen a species of plant where each characteristic was determined by a single pair of genes — for example, plant height was determined by the 'T' and 't' gene.
- Independent genes for different characteristics are located on separate chromosomes in the pea plants.
- Mendel repeated his experiments many times and kept records of thousands of pea plant offspring.

1 Mendel's choice of the garden pea for these experiments was an extremely important factor in his success. How did each of the following pea plant features contribute to this success?
(a) the fact that the pea plant species was **self-pollinating**
(b) **a single pair of genes** determine each characteristic studied by Mendel

2 Some of Mendel's experimental methods were quite innovative for the time, adding reliability to his results and allowing him to notice inheritance patterns. How did each of the following contribute to his findings?
(a) artificially cross-pollinating the pea plants by hand
(b) the use of pure-breeding plants
(c) the use of a large number of crosses of each type, counting thousands of offspring
(d) the use of mathematics

Mendel's monohybrid cross results

Mendel's monohybrid cross results after crossing pea plants for two generations are shown in the table below.

Parental generation	F_1 plants	F_1 self-pollination	F_2 plants	F_2 ratio
(i) Tall × short stems	All tall stems	Tall × tall	787 tall stems 277 short stems	
(ii) Yellow × green seeds	All yellow seeds	Yellow × yellow	6022 yellow seeds 2001 green seeds	
(iii) Round × wrinkled seeds	All round seeds	Round × round	5474 round seeds 1850 wrinkled seeds	
(iv) Coloured × white seed coats	All coloured seed coats	Coloured × coloured	705 coloured seed coats 224 white seed coats	
(v) Axial × terminal flowers	All axial flowers	Axial × axial	651 axial flowers 207 terminal flowers	
(vi) Inflated × constricted pods	All inflated pods	Inflated × inflated	882 inflated pods 299 constricted pods	
(vii) Green × yellow pods	All green pods	Green × green	428 green pods 152 yellow pods	

The contribution of Gregor Mendel to the science of genetics *(continued)*

1.1

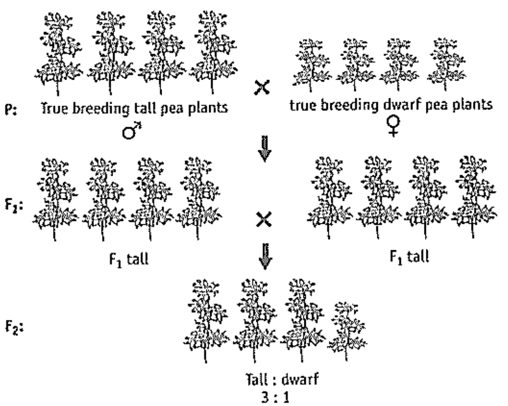
3 Mendel recognised that some 'particle' or 'factor' was being passed on from parents to offspring. Today, what do we call these discrete units of heredity first described by Mendel?

4 Study Mendel's data in the table above and answer the following questions.
(a) Circle the characteristic that appeared to Mendel as being the **dominant** character in each pea plant cross.
(b) How would Mendel have recognised the **dominant** and **recessive** characters in each cross?
(c) Calculate the F_2 **ratio** for each of Mendel's monohybrid crosses and write it in the space provided on the results table above.
(d) Mendel's famous F_2 **ratio** for a monohybrid cross is 3:1. How does **sample** size of F_2 plants affect this ratio?

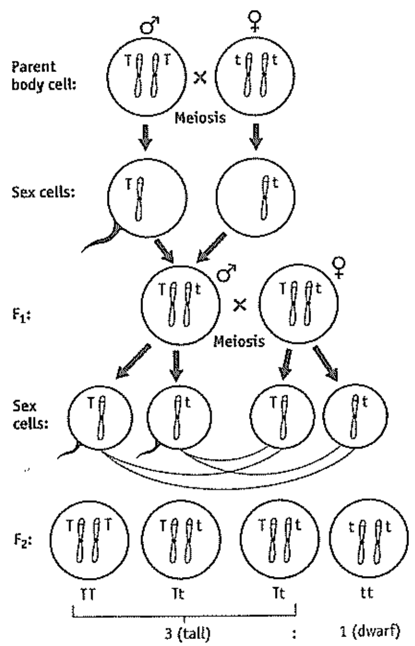
A modern interpretation of Mendel's results

We know today that pea plant genes for each characteristic (e.g. plant height) occur in pairs on separate homologous chromosomes.

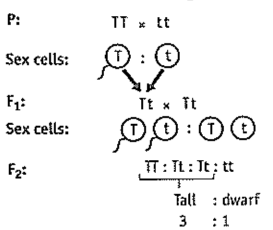
A. A simple Mendelian monohybrid cross



B. Applying our knowledge of meiosis, genes and chromosomes to Mendel's results



C. Quick shorthand working



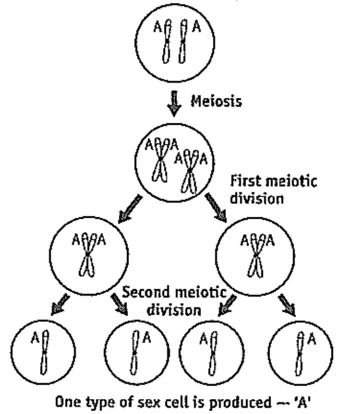
5 Choose *any two* of Mendel's other monohybrid crosses and, using the proper symbols, verify Mendel's F_1 and F_2 results by:
(a) using your knowledge of **meiosis**, **genes** and **chromosomes** (i.e. as in diagram B); and
(b) using the **shorthand working method** (i.e. as shown in diagram C).

Meiosis (sex cell formation) and genetics

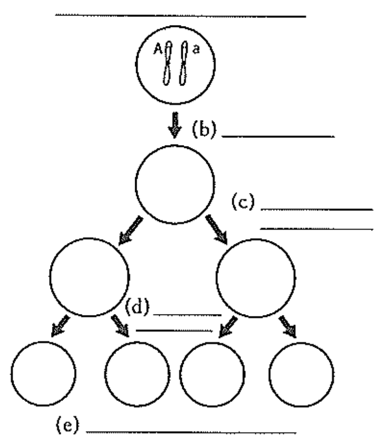
1.2

Single-gene inheritance

A. Body cell from individual with genetic make-up 'AA'



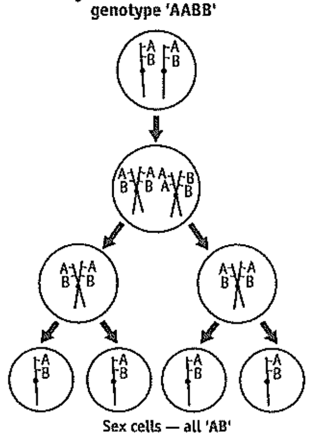
B. (a) ____________



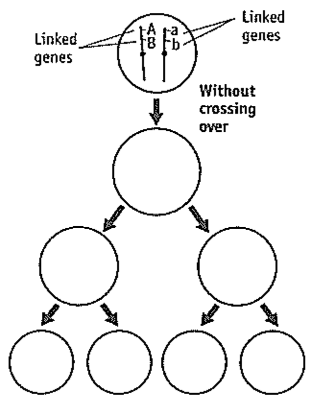
1 Using diagram A as a guide, complete diagram B above showing the sex cells produced from an individual of genotype 'Aa'.

Two-gene inheritance

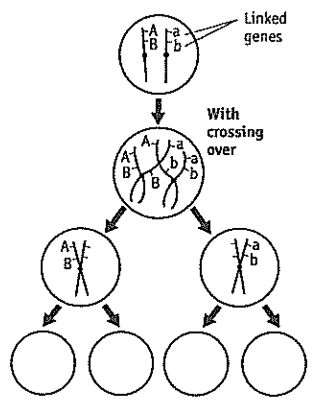
A. Body cell from individual with genotype 'AABB'



B. Individual genotype 'AaBb'



C. Individual genotype 'AaBb'



2 Using diagram A as a guide, complete diagram B to show the variety of sex cells produced by individual 'AaBb', assuming linked genes **without** crossing over.

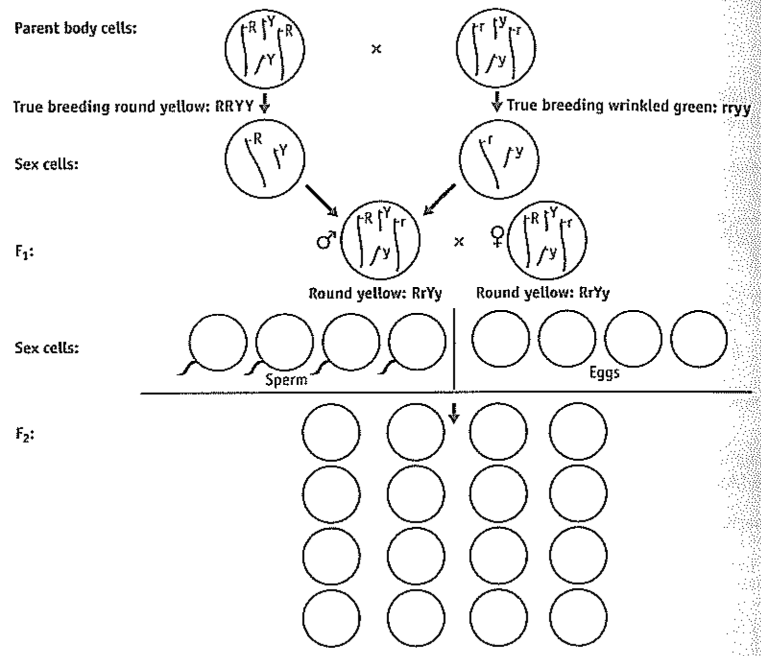
3 Complete diagram C to show the variety of sex cells produced from the same individual 'AaBb' — this time assuming **linked** genes **with** crossing over taking place.

Meiosis (sex cell formation) and genetics *(continued)*

1.2

Two-gene inheritance in Mendel's pea plants

In the pea plant the genes for each characteristic are located on separate chromosomes. Consider the following typical Mendelian dihybrid cross:



4 Complete the diagram and count up the numbers of different phenotypes (plants with different physical appearance). Express this as a **Mendelian ratio.**

5 Show by chromosomal diagrams (or by using gene symbols — for example, 'R') how many types of sex cells are produced by the organisms with the following genetic make-up (genotypes):
(a) Tt (a hybrid tall pea plant)
(b) TT (a pure breeding tall pea plant)
(c) UUBb (assume linked genes — no crossing over)
(d) UuBb (assume linked genes — with crossing over)
(e) TtYY (assume genes are located on separate chromosomes, i.e. independently assorting chromosomes)

6 Show the possible union of sex cells between the following organisms:
(a) Aa × aa
(b) RrYy × rrYy

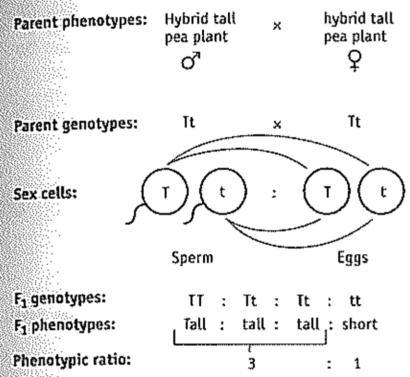
7 What effect does crossing over have on the genetic variety in a set of sex cells?

8 Consider an individual with genotype AaBb. When genes for the different characteristics are located on separate chromosomes (as in Mendel's pea plants), is the genetic variety in the resulting sex cells *less*, the *same* or *greater than* those produced where:
(a) the same genes are linked **without crossing over;**
(b) the same genes are linked **with crossing over?**

Monohybrid cross genetics: single-gene inheritance

1.3

Worked example



Genetics terms
Allele various forms of the one gene (e.g. 'T' and 't' are the alleles for plant height)
F_1 represents the '**first filial generation**'
Phenotype the physical appearance of a genetic character (e.g. tall)
Genotype the gene make-up of an individual with respect to a characteristic (e.g. Tt)
Homozygous the genes in a genotype are identical (e.g. TT, tt)
Heterozygous the genes in a genotype are different (e.g. Tt)
Hybrid see *heterozygous*

1 In pea plants, tall (T) is dominant over the dwarf condition (t). Work out the genotypes and phenotypes of the offspring of the following crosses:
(a) heterozygous tall pea plant × homozygous tall pea plant
(b) a cross between a hybrid tall and a dwarf pea plant
(c) a cross between two heterozygous tall pea plants

2 The lack of body pigmentation (albinism) in humans is due to a recessive allele (a) and normal pigmentation is the result of its dominant allele (A). Work out the chances (as a percentage) of the following couples producing an albino child:
(a) normal heterozygous ♀ × normal homozygous ♂
(b) albino ♂ × normal (carrier) ♀
(c) normal heterozygous ♀ × normal heterozygous ♂
(d) albino ♂ × albino ♀

3 Assume that in the families below the allele for brown eye colour is dominant over the allele for blue eye colour.
(a) A brown-eyed man marries a blue-eyed woman. All their children are brown-eyed. What are the genotypes of all the individuals in this family?
(b) A blue-eyed man, both of whose parents were brown-eyed, marries a brown-eyed woman. They have one child, who is blue-eyed. What are the genotypes of all the individuals mentioned?
(c) A blue-eyed man marries a brown-eyed woman whose father was blue-eyed. What proportion of their children would you predict to have blue eyes?

4 In fruit flies, long wing (L) is dominant to short wing (l). Two long-wing flies produced 49 short-wing and 148 long-wing offspring.
(a) What were the probable genotypes of the parents?
(b) What proportion of the long-wing offspring should be heterozygous?

5 Heterozygous black (Bb) guinea pigs are mated to homozygous recessive (bb) whites. Predict the phenotypic ratios expected from backcrossing the black F_1 progeny to:
(a) the black parent;
(b) the white parent.

Dihybrid cross genetics

1.4

Worked example: a typical Mendelian dihybrid cross

	♂		♀
Parent (P_1) phenotype:	True breeding round, yellow pea plant	×	true breeding wrinkled green pea plant
P_1 genotypes:	RRYY	×	rryy
Sex cells:	RY		ry
F_1 genotype:	All RrYy		
F_1 phenotype:	All round yellow pea plants		
P_2 phenotypes:	F_1 round yellow plants	×	F_1 round yellow plants
P_2 genotypes:	RrYy	×	RrYy
Sex cells:	RY Ry rY ry (Sperm)	:	RY Ry rY ry (Eggs)

F2 genotypes take into account all possible combinations of sperm and eggs. You may find a **Punnett Square** useful here (below right).

Sperm \ Eggs	RY	Ry	rY	ry
RY	RRYY	RRYy	RrYY	RrYy
Ry	RRYy	RRyy	RrYy	Rryy
rY	RrYY	RrYy	rrYY	rrYy
ry	RrYy	Rryy	rrYy	rryy

F_2 phenotypes and phenotypic ratios
Round yellow : round green : wrinkled yellow : wrinkled green
9 : 3 : 3 : 1

1 In Mendel's pea plants, the gene for tallness (T) is dominant over its allele for dwarf plants (t). The gene for round peas (R) is dominant over its allele for wrinkled peas (r). Calculate the phenotypes and phenotypic ratios of the following crosses:
(a) TtRr × TtRr
(b) Ttrr × ttrr
(c) ttRr × Ttrr
(d) TTrr × ttRR

2 In guinea pigs rough coat is dominant over smooth coat and black coat is dominant over white coat. (Assume that the genes are independent.) If a homozygous rough black animal is crossed with a smooth white one, what will be the appearance and **phenotypic** ratios of:
(a) the F_1;
(b) the F_2;
(c) the offspring of a cross of the F_1 back with the rough, black parent;
(d) the offspring of the F_1 crossed with the smooth white parent.

3 In the fruit fly ***Drosophila melanogaster***, long wing (L) is dominant over vestigial wing (l), and hairless body (H) is dominant over hairy body (h). Work out the phenotypic ratios of the following matings:
(a) a hairy female, heterozygous for vestigial wing × vestigial wing male which is heterozygous for the hairy character
(b) vestigial winged, hairy male × homozygous normal female
(c) LlHh × LlHh
(d) llHh × LLhh

4 For each cross in question 3, work out the percentage chance of producing **long-winged, hairless fruit fly**.

5 In watermelons, the genes for green colour (G) and short shape (S) are dominant over the alleles for striped colour (g) and long shape (s). Work out the appearance of the offspring if a plant with long, striped fruit is crossed with a double heterozygote plant for these characteristics.

Incomplete dominance

1.5

Incomplete dominance is a type of heredity where Mendel's Law of Dominance does not operate. In this type of heredity, the hybrid (or heterozygous individual) is different from both pure-bred parents.

Worked example
In snapdragons, the gene for red flower colour (R) is incompletely dominant over the gene for white flower colour (r). Heterozygous individuals (Rr) produce pink flowers.

P_1 phenotypes:	Red-flowered snapdragon		×		white-flowered snapdragon		
P_1 genotypes:	RR		×		rr		
Sex cells:	R				r		
F_1 genotypes:	All Rr						
F_1 phenotypes:	All pink						
P_2 phenotypes:	F_1 pink snapdragon		×		F_1 pink snapdragon		
P_2 genotypes:	Rr		×		Rr		
Sex cells:	R	r	:	R	r		
F_2 genotypes:	RR	:	Rr	:	Rr	:	rr
F_2 phenotypes:	Red	:	pink	:	pink	:	white
Phenotypic ratio:	1	:	2	:			1
Phenotype %:	25%		50%				25%

1 In snapdragons where red flower colour (R) is incompletely dominant over white flower colour (r), what will be the flower colour of the offspring and genotypic ratios for each of the following crosses?
(a) pink-flowered plant × red-flowered plant
(b) white × pink
(c) red × white
(d) pink × pink

2 How would you produce snapdragon seeds that would all yield pink-flowered plants when sown?

3 In Andalusian fowls, black plumage (B) is incompletely dominant over white plumage (b). The heterozygous fowls are blue. Calculate the percentage chance of producing blue Andalusian fowls in each of the following crosses:
(a) black cock × white hen
(b) blue hen × black cock
(c) blue hen × blue cock
(d) blue cock × white hen

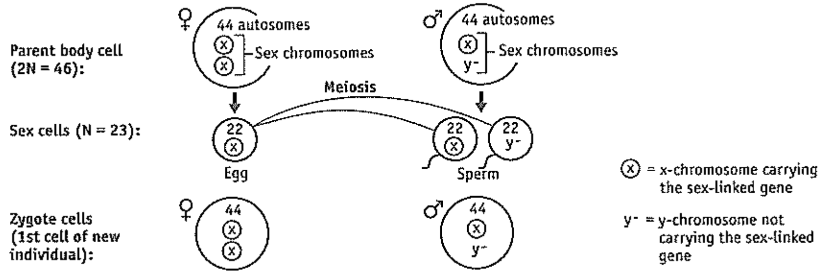
4 After several matings of tan-coloured birds, a breeder noted the following average offspring numbers: 23 white, 26 brown, 53 tan birds. Work out a cross that would produce the following results:
(a) 50% of all offspring are *brown*
(b) 100% of all offspring are *tan*
(c) 50% of all offspring are *tan*
(d) 25% of all offspring are *white*

Sex-linked inheritance

1.6

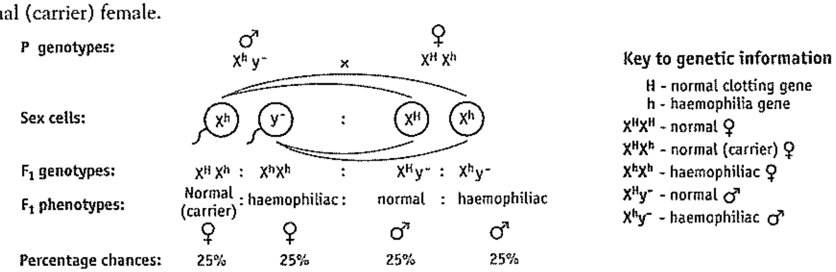
In mammals, genes for some characteristics are carried on the X-chromosome only. The **Y-chromosome**, while carrying some genes, is always **'blank'** with respect to the gene for this particular sex-linked characteristic.

Background



Worked example

In humans, haemophilia is a rare condition where the blood fails to clot. It is inherited as a sex-linked recessive gene — that is, the genes for the condition are carried on the X-chromosome. Consider a haemophiliac man who marries a normal (carrier) female.



1 Work out the percentage chances of the following marriages producing a haemophiliac child:
  (a) $X^H Y^- \times X^H X^H$
  (b) $X^h y^- \times X^H X^H$
  (c) a normal male × carrier female
  (d) a haemophiliac male × carrier female

2 In humans red–green colour blindness is an inherited condition which is sex-linked and recessive.
  (a) If a colour-blind man marries a woman who is homozygous for normal vision, work out the expected phenotypes of their children.
  (b) A woman with normal sight whose father is colour-blind marries a man with normal vision. What are the chances of their first child being colour-blind?

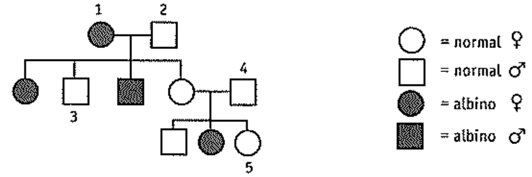
3 'X-linked mental retardation' is the most common form of mental retardation in males. The gene responsible (m) is sex-linked and recessive. If a normal male marries a heterozygous female, what would be the risk of producing an affected child?

4 In cats, black coat colour (B) is incompletely dominant over the gene for orange coat colour (b). All heterozygous cats (Bb) have a tortoiseshell coat colour. The condition is also sex-linked.
  (a) Write down the genotype of a:
    (i) black ♂ cat;
    (ii) orange ♂ cat;
    (iii) black ♀;
    (iv) orange ♀;
    (v) tortoiseshell ♀.
  (b) Can tortoiseshell male cats exist? Explain.
  (c) Work out the percentage chances of each of the following matings producing tortoiseshell cat offspring.
    (i) black ♂ × orange ♀
    (ii) orange ♂ × black ♀
    (iii) black ♂ × tortoiseshell ♀
    (iv) orange ♂ × tortoiseshell ♀

Genetics and pedigree charts

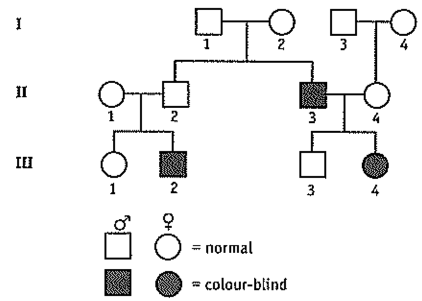
1.7

1 Albinism is an autosomal condition (i.e. the gene is carried on chromosomes other than the sex chromosomes) and it is recessive. Albino individuals have the **genotype 'aa'** and lack any body pigmentation of hair, skin or iris. A family pedigree for the condition is shown below.



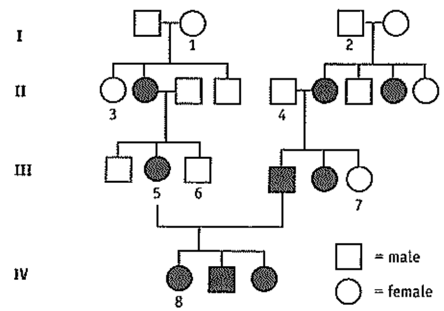
  (a) Work out the genotype of all individuals (1 to 5).
  (b) What evidence is there in the pedigree that albinism is:
    (i) a **recessive trait**;
    (ii) **not sex-linked**?

2 Study the pedigree chart showing the incidence of **colour blindness** in a family over three generations (I, II and III). Colour blindness is due to a recessive, sex-linked gene (c).



  (a) Write down the genotypes of all individuals shown in the pedigree.
  (b) Work out the phenotypes of all possible offspring that could be produced by the following marriages:
    (i) I3 × I4
    (ii) II3 × II4
    (iii) III2 × III4
  (c) What family relationship exists between individuals III2 and III4?

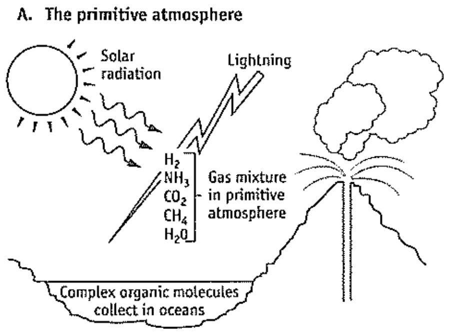
3 Myopia (**near-sightedness**) is an inherited eye condition traced in the following family pedigree chart.

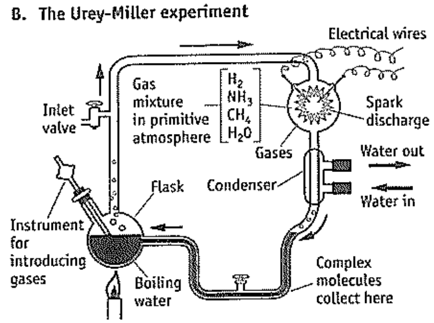


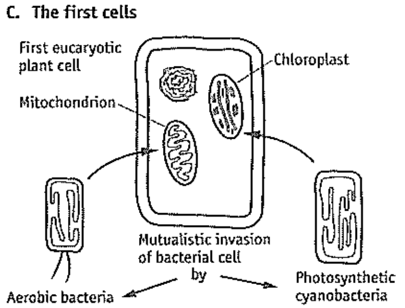
  (a) What evidence in the pedigree suggests that:
    (i) the disorder is **recessive**;
    (ii) the disorder is **not sex-linked**?
  (b) Determine the genotypes of all individuals (1 to 8).
  (c) Calculate the percentage chance of myopia affecting a child produced in the following marriages:
    (i) III6 × III7
    (ii) II4 × III5

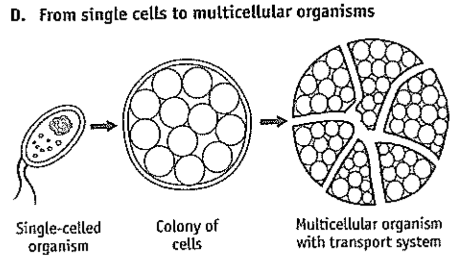
2 EVOLUTION
The origin of life on earth

2.1









1 What do you think was the aim of the Urey-Miller experiment (see diagram B)?

2 The following are all features of the Urey-Miller experiment. What does each one represent on primitive earth?
(a) the gas mixture (hydrogen, ammonia, methane, water vapour)
(b) the electrical discharge through the gas mixture
(c) the collection of organic molecules in the apparatus

3 Which **chemical elements,** present in the primitive atmosphere gases, were used to form the first simple amino acid and protein molecules?

4 In which part of the primitive earth environment did the first **organic compounds** collect and interact?

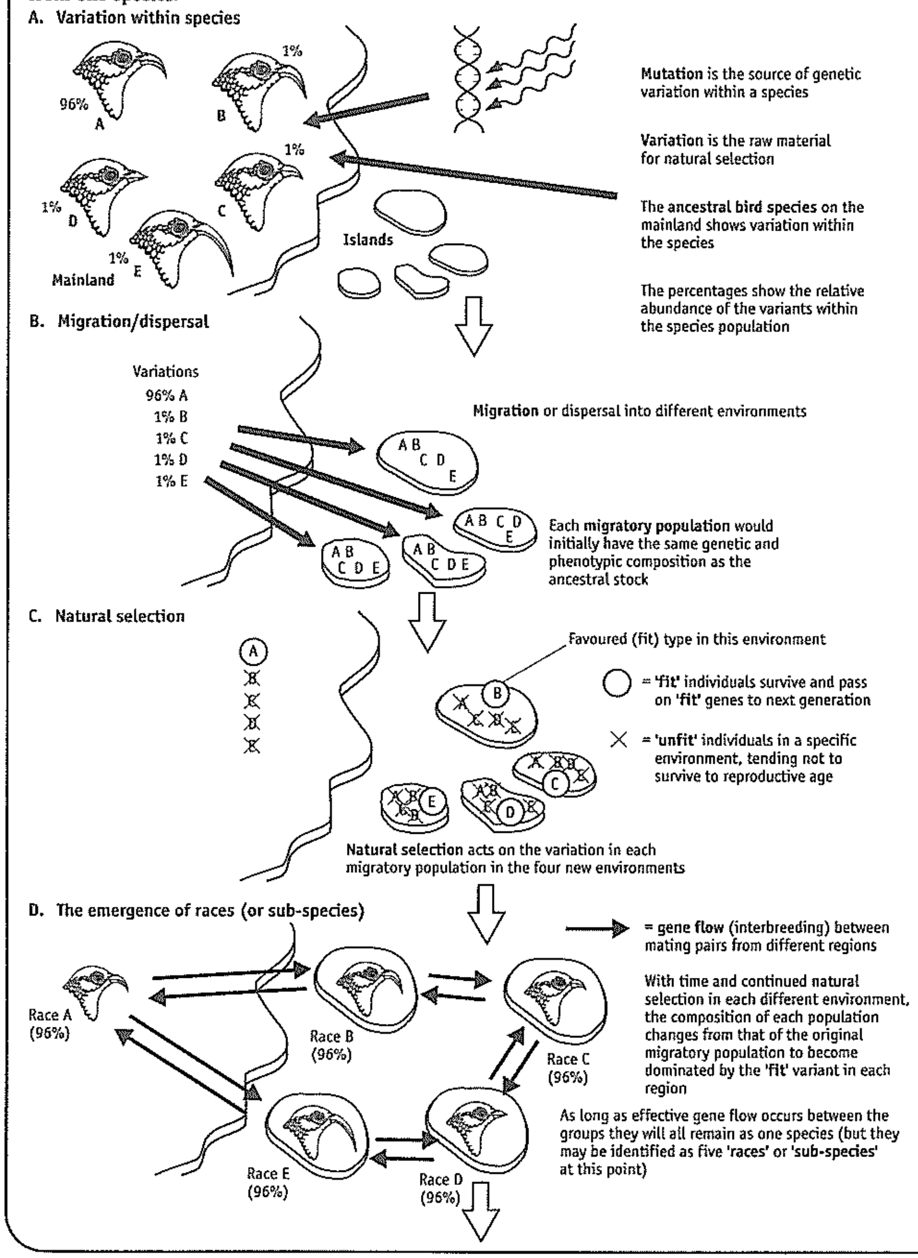
5 One theory suggests that the first simple cells (procaryotes) may have been mutualistic and invaded other simple cell types in order to form the first eucaryotic cells. Study diagram C. According to this theory, which modern organelle developed from the mutualistic association of a cell with:
(a) an ancestral **cyanobacteria** (colour these components in diagram C *green* to represent chlorophyll);
(b) an ancestral **aerobic** (oxygen-loving) bacteria (colour these components in diagram C *blue* to represent oxygen consumption and ATP production)?

6 (a) Study diagram D and suggest two advantages of being multicelled over being single-celled.
(b) As **multicellular organisms** became larger groups of cells, suggest a reason for their close association with the development of canals and transport systems.

2 EVOLUTION
Natural selection, evolution and speciation

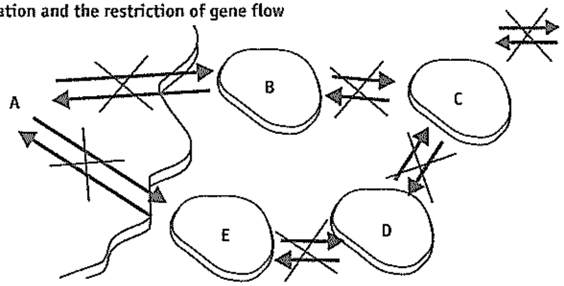
2.2

Shown below is an account of the processes involved in the **evolution** of several species from one species.



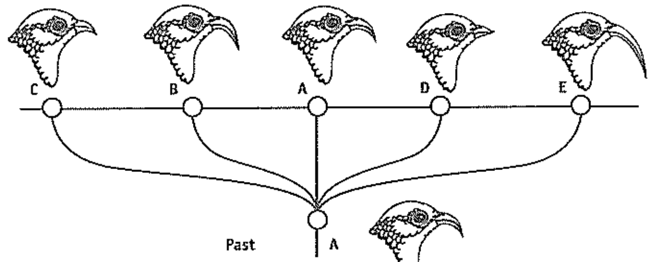
Natural selection, evolution and speciation *(continued)*

E. Isolation and the restriction of gene flow



If, due to **isolation**, the gene flow is restricted or stopped between the groups over many generations, then it is possible that the races (sub-species) could become five separate species

F. Overall



Study the situations above, which represent the main steps in the evolution of several species from one species.

Diagram A

1 How does **variation** first appear in the original species?
2 Which variation is at a **selective advantage** (i.e. favoured by the environment) on the mainland?
3 Describe in your own words what is meant by: 'Variation is the raw material for natural selection'.

Diagram B

4 While birds can migrate into different environments, what type of living thing undergoes **'dispersal'**?
5 List some factors that can force a bird species to migrate into new environments.

Diagram C

6 On the different islands, why might one beak shape be more advantageous than another?
7 Compare the fate of the 'fit' and 'unfit' individuals in a given environment.

Diagrams D and E

8 Under what conditions will these birds remain as the same **species**?
9 What is required for the bird groups (races or sub-species) to become five **different** species?
10 Suggest one type of isolation that may prevent interbreeding between the groups of birds.
11 How does **isolation** help to accelerate the evolution process and lead to the formation of separate species?

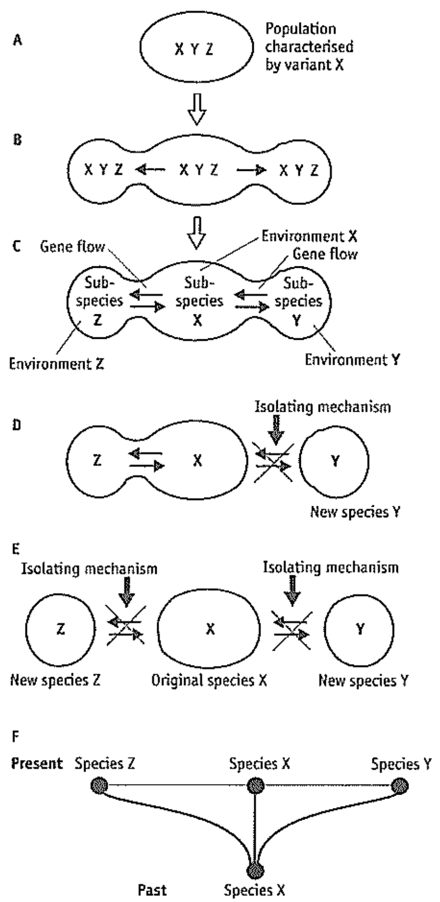
Diagram F

This is a **summary diagram** where the overall outcome of the evolutionary process is illustrated.

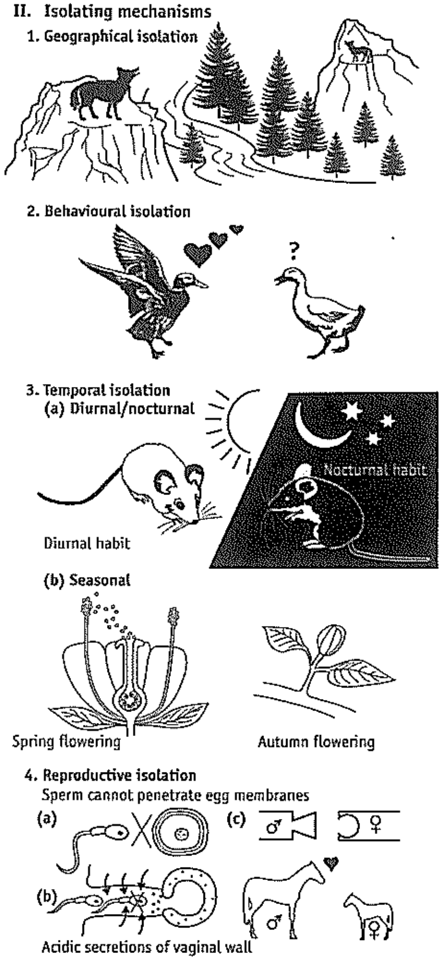
12 Write a single sentence to describe the meaning of this diagram.
13 In the process, each bird group (A, B, C, D and E) becomes suited (**adapted**) to a particular environment and flourishes in that environment.
(a) Explain in point form how **adaptations** arise through the evolutionary process.
(b) Study diagram F and suggest a meaning for the following terms:
(i) divergent evolution; (ii) adaptive radiation.

Isolating mechanisms and evolution

I. Evolution of several species from one species



II. Isolating mechanisms



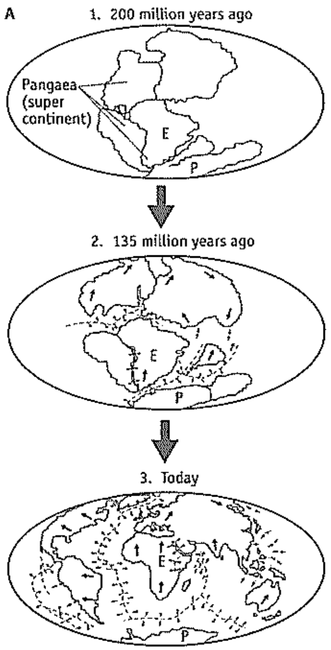
4. (a), (b) = gametic reproductive isolation
4. (c) = mechanical reproductive isolation

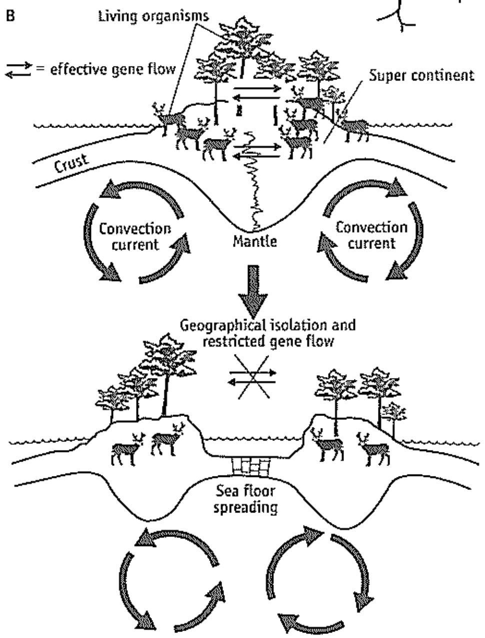
1 Diagrams A to F summarise the evolutionary steps in simple terms. For each symbolic diagram, write a sentence (or short paragraph) to show that you understand what is happening at each step in the evolutionary process.

2 Diagrams 1 to 4 show some important isolating mechanisms.
(a) What role do isolating mechanisms play in the evolutionary process?
(b) For each type of isolating mechanism shown (1, 2, 3(a), 3(b), 4(a), 4(b) and 4(c)), interpret each of the symbolic diagrams and describe in your own words how each might prevent interbreeding between closely related groups.

Evolution and continental drift as an isolating mechanism

2.4





1 Describe two changes in the earth's continents over the last 200 million years.

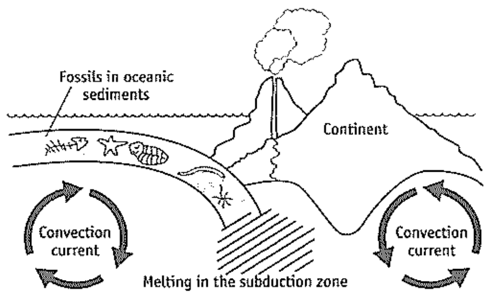
2 What is the main driving force causing sections of the earth's crust (continents) to **'drift'**?

3 What type of **isolating mechanism** has affected living things as a result of continental drift?

4 Describe the role played by continental drift in the evolution of plants and animals on earth.

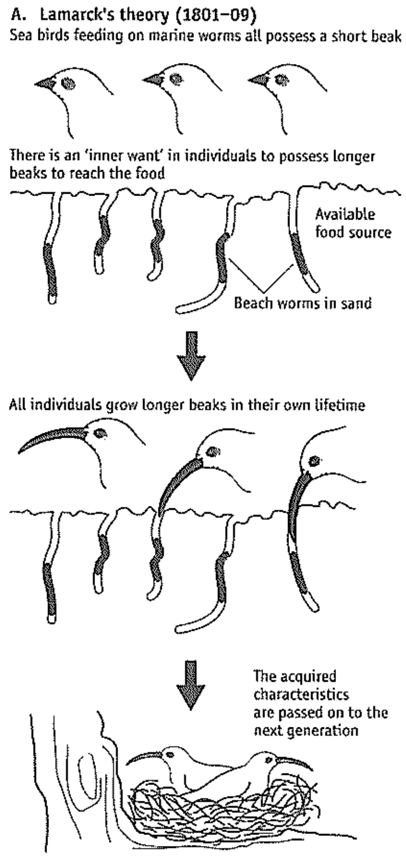
5 Study diagram A to appreciate the evolution of equatorial (E) and polar (P) adaptations in plant and animal species. Plant and animal groups have been dispersed into very different environments as a result of continental drift. Adaptations to these new environments have arisen through the evolutionary process.
(a) Name one **animal adaptation** that is favoured in:
  (i) the **polar** (P) environment; (ii) the **equatorial** (E) environment.
(b) Name one **plant adaptation** that has evolved in:
  (i) the **polar** environment; (ii) the **equatorial** environment.

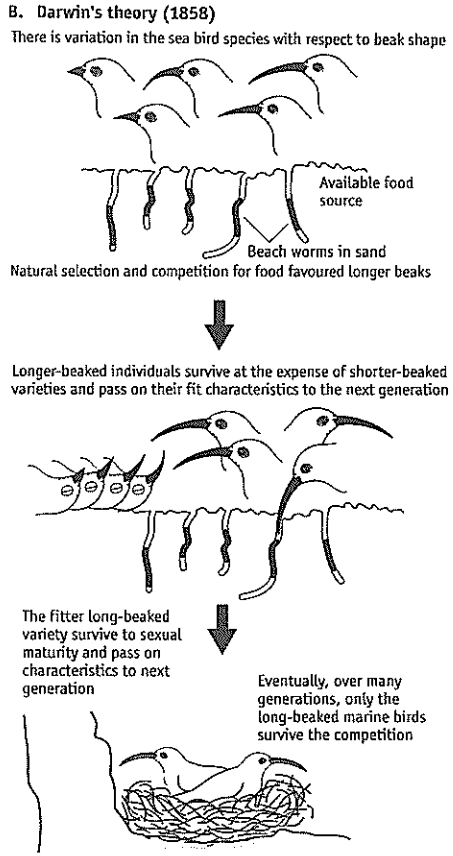
6 Study this diagram and suggest how continental drift mechanisms can contribute to an incomplete fossil record of life on earth.



A comparison of Lamarckian, Darwinian and modern theories of evolution

2.5





1 The **Australian Rabbit-eared Bandicoot** possesses large ears which act as large vascularised radiation surfaces for losing excess body heat to the environment. These help prevent the animal from overheating in hot environments.
Using the illustrated Lamarckian and Darwinian models to guide you, discuss in point form how:
(a) Lamarck; and
(b) Darwin
would have explained the evolution of the bandicoot's large ears.

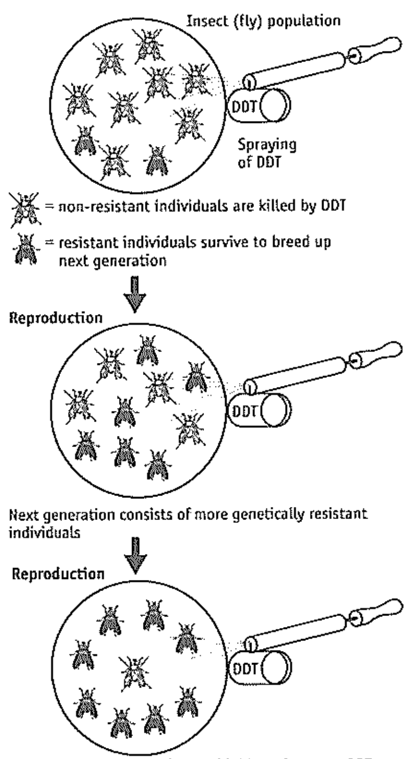

Rabbit-eared Bandicoot

2 Modern science has revealed the source or cause of Darwin's variations and the means by which characteristics are 'passed on' to the next generation. This provides us with a modernised Darwinian Theory of Evolution.
(a) What is the source of variation within a species?
(b) What are the factors that transmit characteristics from one generation to the next?
(c) Explain the evolution of the bandicoot's large ears in terms of the Modern Theory of Evolution.

Natural selection and rapid, observable evolution

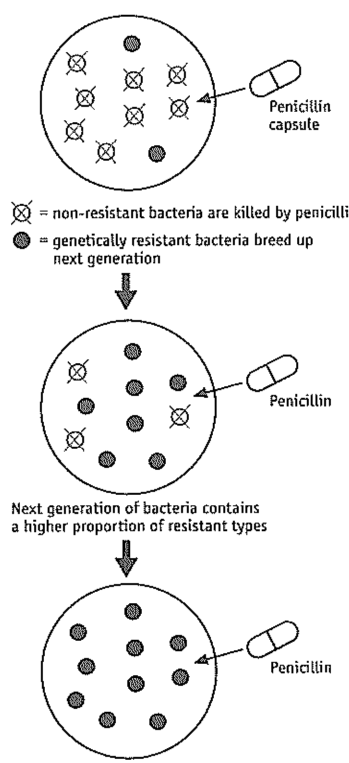
2.7

A. Insect resistance and DDT



Today many insect species are highly resistant to DDT

B. Bacteria resistance and antibiotics



Today some species of bacteria are highly resistant to penicillin and other antibiotics

1 The myxomatosis virus was widely used in Australia to control the numbers of the introduced European rabbit. The rabbits quickly developed a resistance to the virus. Draw a series of diagrams (like those above) to represent the development of resistance to the myxomatosis virus in the European rabbit.

2 (a) For each of the three case studies (insects, bacteria, rabbits), name the **environmental selection agent**.
(b) In each case describe the **type of environment** to which each organism becomes adapted.
(c) What term would you use to describe the process by which these organisms develop their resistance?

3 (a) How important to the process is the **variation** in the initial populations of the species in question? Explain.
(b) How does the initial variation arise in each of the insect, bacteria and rabbit populations?

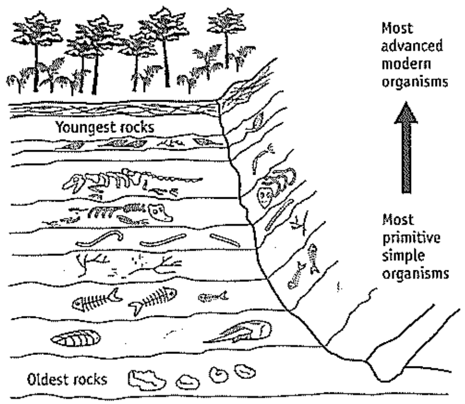
4 How would **Charles Darwin** have interpreted the development of resistance of bacteria to antibiotics?

5 Normally, these kinds of evolutionary changes take a long time to emerge in a species. What **biological feature** of insects, bacteria and rabbits allows us to readily observe such changes in a species over a relatively short period of time?

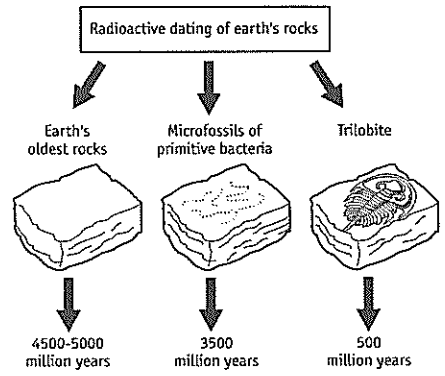
Evidence supporting the theory of evolution — the fossil evidence

2.8

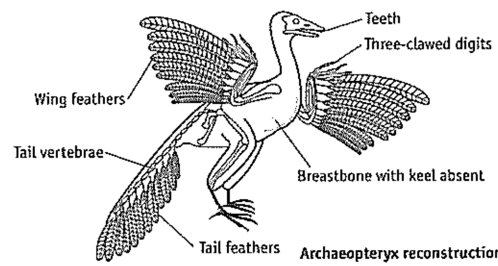
A. A comparison of fossils in old and young strata



B. The age of the earth and dating fossils

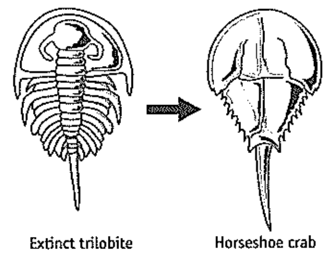


C. Archaeopteryx: evidence of a transitional life form (from archaeopteryx fossil in Jurassic limestone)



Archaeopteryx reconstruction

D. A comparison of fossil life forms with present day species



1 Study diagram A, which represents a site where the oldest rocks contain fossils of simple, primitive organisms and relatively younger rocks contain fossils of more advanced life forms. Write down two conclusions that an evolutionist (like Darwin) might make after observing such a site.

2 Study diagram B. By accurately determining the age of rocks and fossils (using radioactive dating techniques), list two things that scientists can learn about the history of life on earth.

3 Study the reconstruction of archaeopteryx in diagram C.
(a) Which features of archaeopteryx are:
(i) reptilian;
(ii) avian (bird-like)?
(b) Modern birds have a breastbone with a keel to which the flight muscles are attached. In archaeopteryx this is absent, yet feathers are present. From this fossil evidence make a conclusion about the lifestyle habit of archaeopteryx.
(c) In your own words explain how these fossils of **transitional life forms** provide strong evidence in support of the theory of evolution.

4 Study diagram D and provide an evolutionist's interpretation of the fact that many present day life forms are regarded as **living fossils**, resembling extinct, fossilised life forms.

