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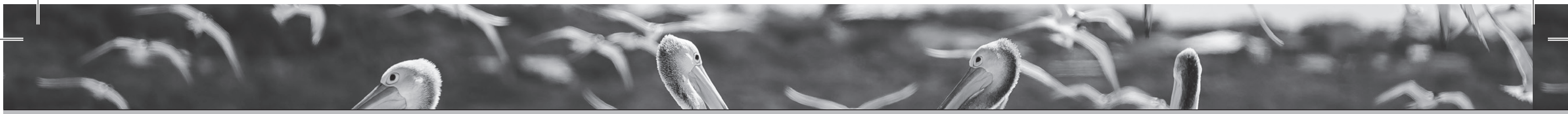
QCE BIOLOGY UNITS 3 AND 4

• Kerri Humphreys •

Science Press



Unit 3 Biodiversity and the Interconnectedness Of Life

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Topic 3.1 Describing Biodiversity and Populations

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Unit 3 Biodiversity and the Interconnectedness Of Life

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Unit 4 Heredity and Continuity Of Life

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Unit 3

Biodiversity and the Interconnectedness Of Life

In this unit you will:

- **Explore the ways biology is used to describe and explain the biodiversity within ecosystems, a range of biotic and abiotic components, species interactions, adaptations of organisms to their environment and principles of population dynamics.**
- **Understand how classification systems are used to identify organisms and aid scientific communication.**
- **Understand the structure of ecosystems, the processes involved in the movement of energy and matter in ecosystems and how environmental factors limit populations.**
- **Measure abiotic factors, population numbers and species diversity.**
- **Interpret interactions between species making spatial and temporal comparisons between ecosystems.**
- **Carry out field work to understand the interconnectedness of organisms, the physical environment and the impact of human activity.**
- **Apply scientific knowledge and understanding to offer valid explanations and reliable predictions.**
- **Analyse data and develop ecological models to describe and explain the diversity and interconnectedness of life on Earth.**

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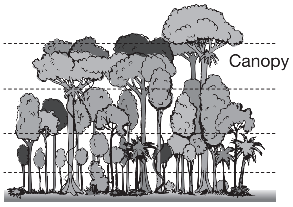
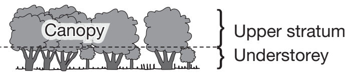
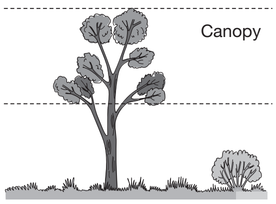
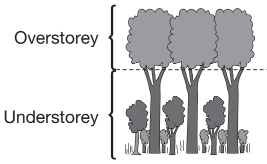
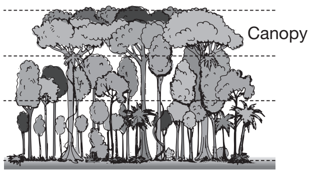
3.1.1.2 Complete the table to summarise the three levels of biodiversity.

Level of biodiversity	Description
Genetic diversity	
Species diversity	
Ecosystem diversity	

3.1.1.3 Use the data in the table to link environmental factors to global distribution of ecosystems.

Ecosystem	Diagram	Rainfall and temperature	Global distribution
Tropical rainforest		High rainfall > 1500 mm/year constant and can have two seasons: wet and dry. Hot temperature range usually 20°C to 35°C with average 25°C to 29°C.	
Desert		Low, highly variable, erratic rainfall usually < 300 mm/year. High temperature ranges from –18°C (winter night) to 50°C (summer day) varying daily and seasonally.	
Grassland (savanna)		Low, seasonal rainfall ranging 500 to 900 mm/year, averaging 300 to 500 mm/year. The dry season can last 8 to 9 months. Temperate or tropical temperature range is –30°C to 30°C, averaging 24°C to 29°C.	
Shrubland		Low rainfall ranging 200 to 1000 mm/year. Hot summer and cool winter temperatures.	
Open woodland		High rainfall in tropical areas with wet and dry seasons, 500 to 750 mm/year in southern areas. Moderate temperature ranges from 0°C to 30°C or tropical.	
Sclerophyll forest		750 to 950 mm/year with no distinct rainfall season. Warm temperate temperatures.	
Temperate rainforest		High rainfall > 900 mm/year. Temperate temperatures with cold winters and hot summers; from 0°C to 30°C.	

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3.1.1.4 Why is there a wide range of ecosystems in Australia?

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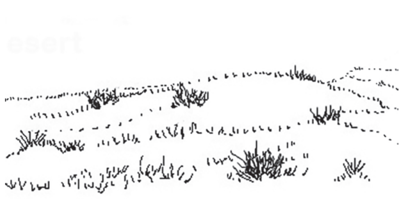
3.1.1.5 Classify each of the following ecosystems.

Ecosystem 1	Ecosystem 2	Ecosystem 3
		
Classification is	Classification is	Classification is

3.1.1.6 Australia can be divided into several major ecosystems. Create your own key and on the map identify these ecosystems.

☐ Tropical rainforest

☐ Desert or arid zone

☐ Grassland

☐ Shrubland

☐ Open woodland

☐ Sclerophyll forest

☐ Temperate rainforest

3.1.1.7 List some of the habitats found in the Munga-Thirri National Park, also known as the Simpson Desert.

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3.1.6.8 Discuss the possibility of Simpson's diversity index being a negative number.

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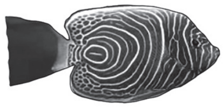
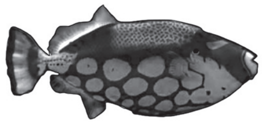
3.1.6.9 On a field trip some students counted the number of fish in a large enclosed area.

Species 1	Species 2	Species 3	Species 4	Species 5
				
8 individuals	19 individuals	5 individuals	3 individuals	1 individual

(a) Determine Simpson's diversity index for this area.

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(b) Some of the students suggested the value of Simpson's diversity index showed there was insufficient biodiversity and to improve evenness more individuals from species 4 and 5 should be introduced into the area. Suggest some other factors that need to be considered before following this suggestion.

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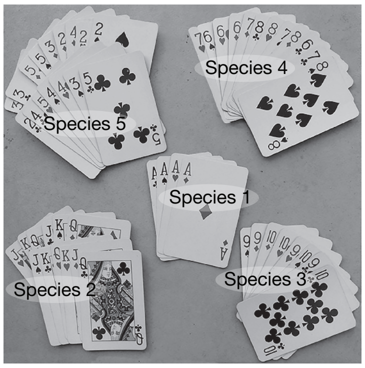
3.1.6.10 Two groups of students used some playing cards to represent a community of organisms.



They divided the cards into five species:

Species 1 – all aces

Species 2 – all court cards (jack, queen, king)

Species 3 – all 9s and 10s

Species 4 – all 6s, 7s, 8s

Species 5 – all 2s, 3s, 4s and 5s

Each group shuffled their pack of cards and dealt out 30 cards. This was their total number of individuals in their community (*N*).

Each group counted the number of individuals for each species in their community and then used Simpson's diversity index to determine the species diversity of their community.

The two groups tabulated their results as shown.

Calculate Simpson's diversity index (SDI) for the two groups and compare their biodiversity.

Species	Group 1	Group 2
1	2	4
2	5	12
3	5	1
4	6	0
5	12	13
N	30	30

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TOPIC 3.2

Functioning Ecosystems and Succession

In this topic you will:

- Explain energy transfer and transformations in ecosystems.
- Analyse energy flow diagrams.
- Investigate ecological niche requirements.
- Understand the competitive exclusion principle.
- Explore keystone species and predict outcomes if they are removed from an ecosystem.
- Analyse graphs for carrying capacity.
- Discuss population limiting factors.
- Explain ecological succession.
- Predict successional changes and the impact of human activities on ecosystems.

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Topic 3.2 Functioning Ecosystems and Succession.

3.2.1 Explain the transfer and transformation of energy as it flows through the biotic components of an ecosystem, including the:

- **Conversion of light into chemical energy.**
- **Production of biomass and its interactions with components of the carbon cycle.**
- **Loss of energy as heat.**

3.2.1.1 Outline the role of photosynthesis in energy transformation and production of biomass.

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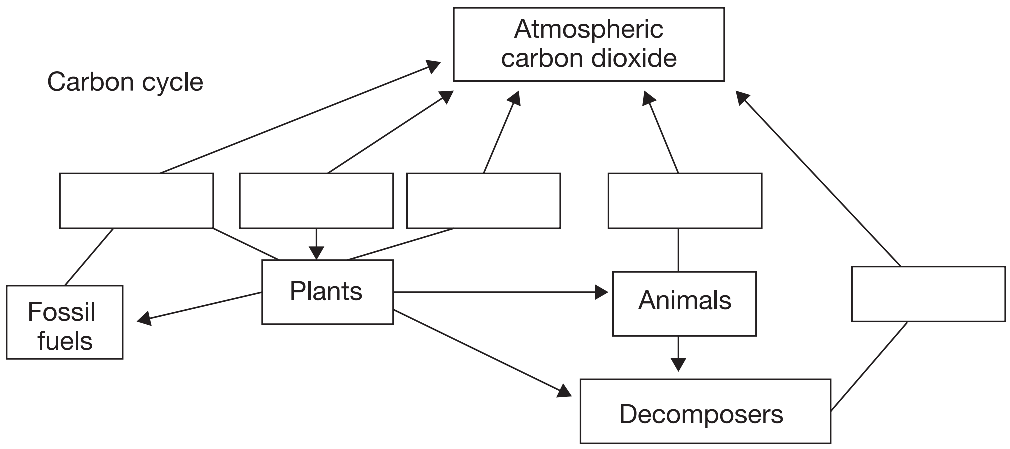
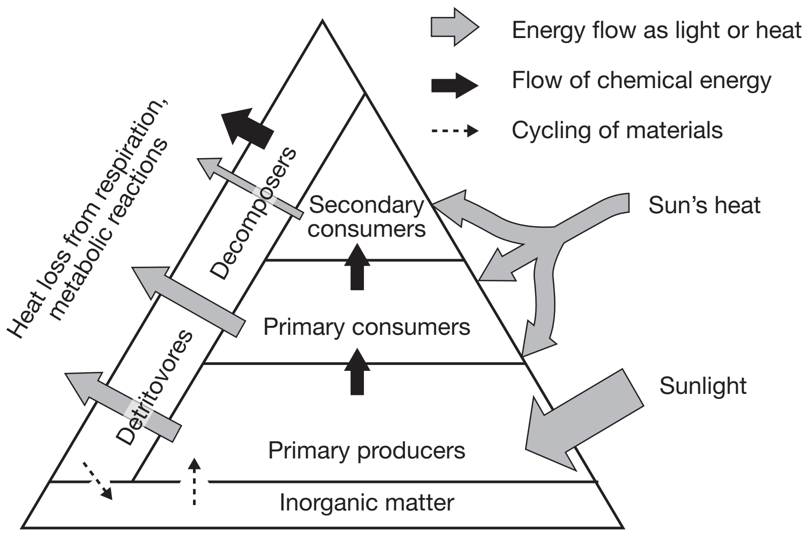
3.2.1.2 Fill in the boxes to label the arrows in the carbon cycle.



3.2.1.3 The diagram shows a pyramid of biomass with some arrows showing the flow of energy and the flow of materials. Complete the diagram by drawing in the rest of the arrows to show material transfers.



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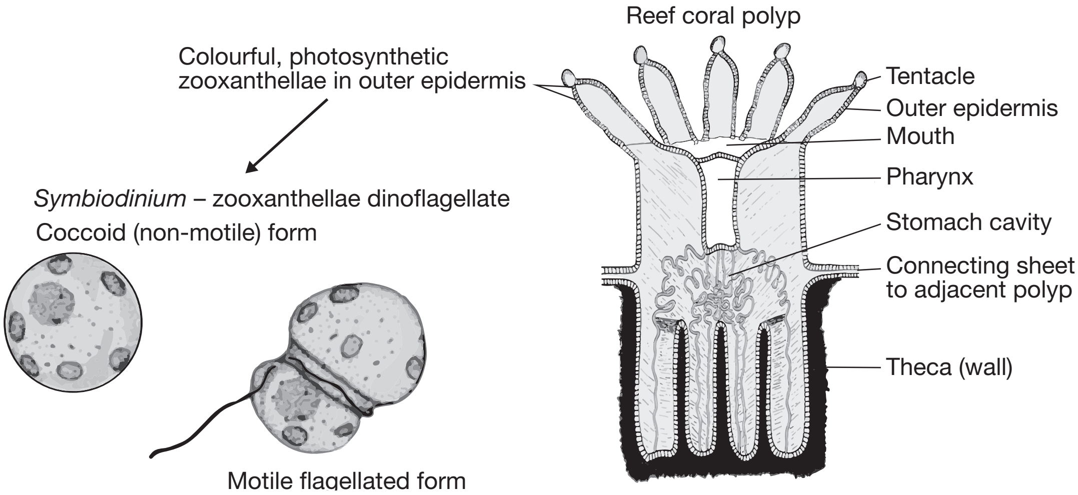
3.2.5.3 Why can it be advantageous for an organism to have a very specialised niche?

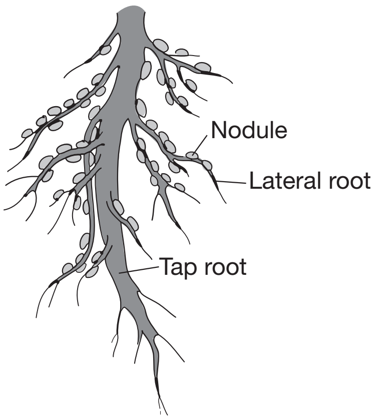
3.2.5.4 The diagram shows a reef coral polyp containing zooxanthellae.



Discuss the importance of the ecological niche of microscopic zooxanthellae such as *Symbiodinium*.

3.2.5.5 The diagram shows root nodules containing *Rhizobium* bacteria.

Describe the ecological niche of *Rhizobium* bacteria.



3.2.5.6 Bettongs are rat kangaroos belonging to the Potoroidae family with *Bettongia penicillata,* the brush tailed bettong once widely distributed across southern Australia, NSW and southern Queensland. Discuss the changes in the ecological niche of the brush tailed bettong that caused it to become extinct over much of this area by the 1970s.

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Unit 4

Heredity and Continuity Of Life

In this unit you will:

- **Explore the ways biology is used to describe and explain the cellular processes and mechanisms that ensure the continuity of life.**
- **Understand the processes and mechanisms of how life on Earth has persisted, changed and diversified over the last 3.5 billion years.**
- **Investigate different factors that influence cellular processes and gene pools.**
- **Examine different patterns of inheritance and the genetic basis of the theory of evolution through natural selection to analyse the use of predictive models in decision making.**
- **Research DNA profiling, gene therapy and genetically modified organisms and their impact on future society.**
- **Carry out a range of experiments and investigations to develop science inquiry skills and participate in collaborative experimental work to develop communication, interaction, character and management skills.**

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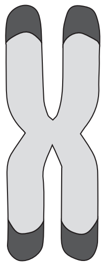
4.1.1.13

(a) Distinguish between introns and exons.

(b) When are introns removed from a sequence of nucleotides?

4.1.1.14 On the diagram of a duplicated chromosome consisting of two sister chromatids:

- Identify the location and define telomeres.
- Identify the location and define the centromere.



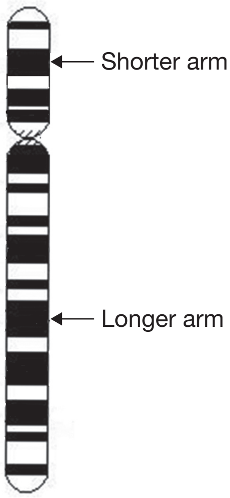
4.1.1.15

(a) Elizabeth Blackburn, Jack Szostak and Carol Greider received the 2009 Nobel Prize for Medicine or Physiology.

What did they discover?

(b) Explain why eukaryotic chromosomes need telomeres.

4.1.1.16 Each chromosome is divided into two sections (arms) based on the location of the centromere.



(a) Using the diagram outline how you would name a gene on the shorter arm compared to a gene on the longer arm.

(b) Where would you expect to find the locus of the gene 6q33?

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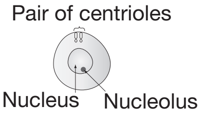
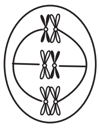
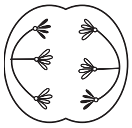
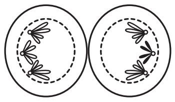
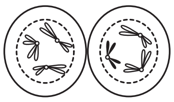
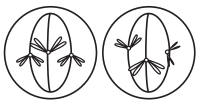
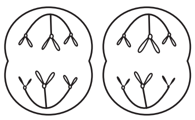
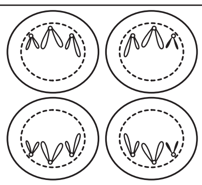
4.1.4.5 Complete the table to summarise the stages of meiosis.

Stage of meiosis	Diagram of stage	What is happening
Interphase		
Prophase I		
Metaphase I		
Anaphase I		
Telophase I and cytokinesis		
Prophase II		
Metaphase II		
Anaphase II		
Telophase II and cytokinesis		
Four new haploid daughter cells are formed from the original cell.		

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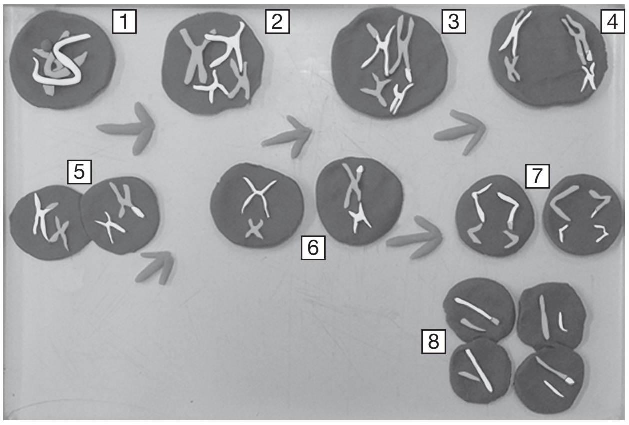
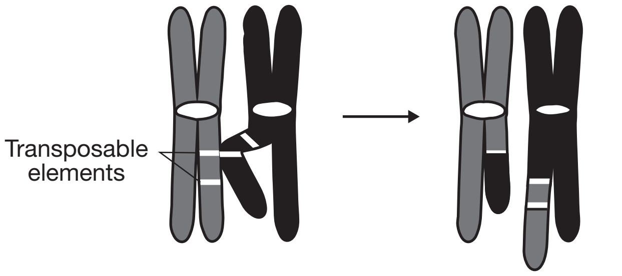
4.1.4.13 A biology student constructed the model shown out of plasticine to show meiosis and crossing over.

(a) Mark on the model the step at which crossing over occurs.

(b) Assess this model and discuss why the student was told some aspects of the model were good but some aspects needed to be improved.

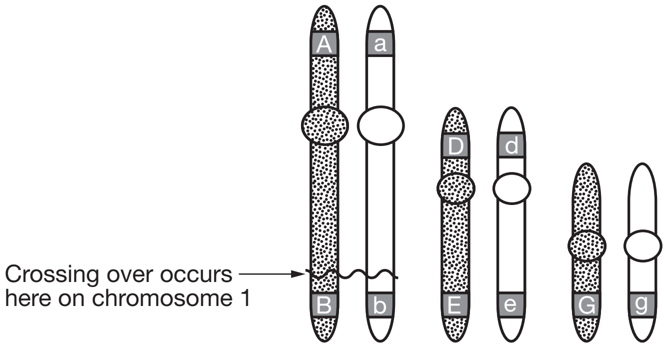


4.1.4.14 The diagram shows unequal crossing over in meiosis. Explain what is happening in this situation and why it causes chromosomal abnormalities.



4.1.4.15 The diagram shows a diploid cell (2n = 6) with genotype.

(a) How many chromosomes will be present in daughter cells after meiosis?



(b) What is the genotype of the parent cell?

(c) Write the possible genotypes of possible daughter cells of meiosis if *no* crossing over occurs.

(d) Write the possible genotypes of possible daughter cells of meiosis if crossing over occurs at the indicated point on chromosome 1.

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4.1.5 Compare spermatogenesis and oogenesis.

4.1.5.1

(a) Distinguish between spermatogenesis and oogenesis.

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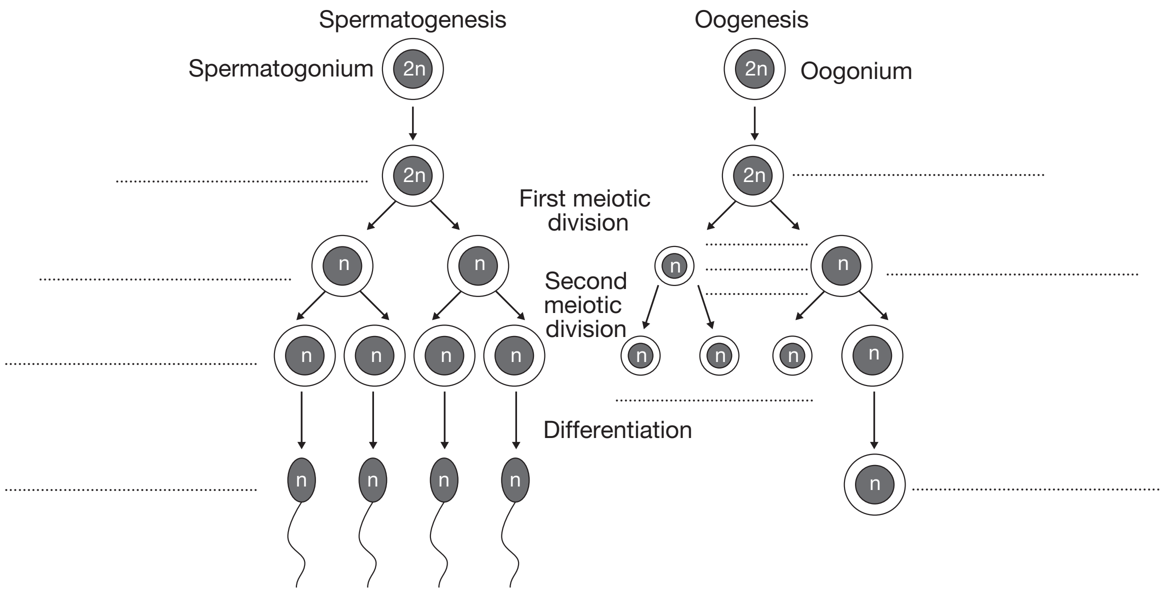
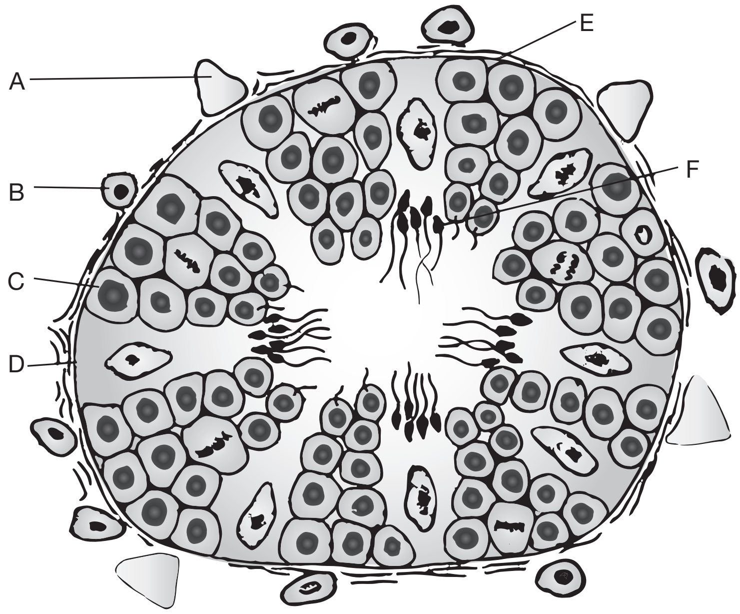
(b) Label the cells to compare spermatogenesis and oogenesis.



4.1.5.2 Label the diagram of the cross-section of a mammalian seminiferous tubule to identify each part the diagram.



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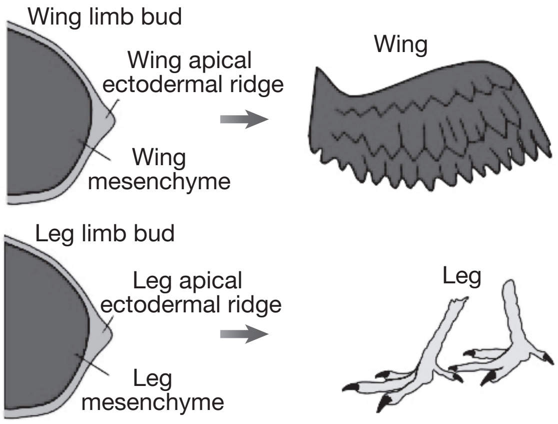
4.1.11.5 Research into limb development in chickens has involved determining the embryonic regions for limb development and altering individual genes changing a chicken leg into a wing and a chicken wing into a drumstick.

In what way are transcription factors involved in gene cascades and limb development?



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4.1.11.6 The diagram shows Edward Lewis (left), Christiane Nusslein-Volhard (middle) and Eric Wieschaus (right). In 1995, they shared the Nobel Prize for Physiology or Medicine for their work on the genetic control of early embryonic development.

(a) What did Edward Lewis discover?

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(b) What is mutagenesis?

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(c) Outline the collaboration between Christiane Nusslein-Volhard and Eric Wieschaus.

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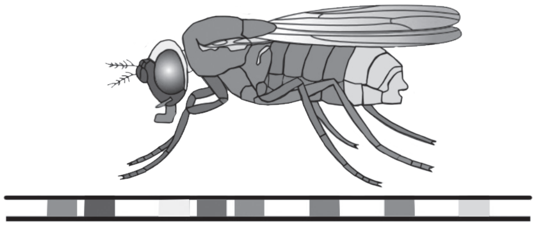
(d) How does the diagram of the insect body segments relate to the order of genes on the chromosome?



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4.1.13.4 Some senior biology students carried out a series of experiments using two particular garden pea plants counting the number of round and wrinkled seeds produced from each cross.

Seed type	1	2	3	4	5	6	7	8	9	10
Round	24	19	15	31	24	22	28	44	26	26
Wrinkled	8	6	4	11	10	7	6	12	8	7

Discuss these results, identifying the proportions of round and wrinkled seeds and how this enables you to identify the genotype of the two parent plants.

4.1.13.5 Thomas Hunt Morgan studied inheritance in the fruit fly *Drosophila melanogaster* and was the first person to determine sex linkage placing eye colour gene on the X chromosome.

White eyes is a recessive X sex linked trait in *Drosophila*, fruit flies. Normal eye colour is red. In *Drosophila*, males are XY and females are XX.

What phenotype would you predict if a white eyed female was mated with a red eyed male? Show your working.

White eyed mutant fly

Red eyed wild type fly

4.1.13.6

(a) What is codominance?

(b) What is an allele dominance hierarchy?

(c) In humans there are three alleles for blood group – I^A and I^B are codominant while i is recessive. If a man has blood group A and a woman has blood group AB, what is the probability of blood groups of their children?

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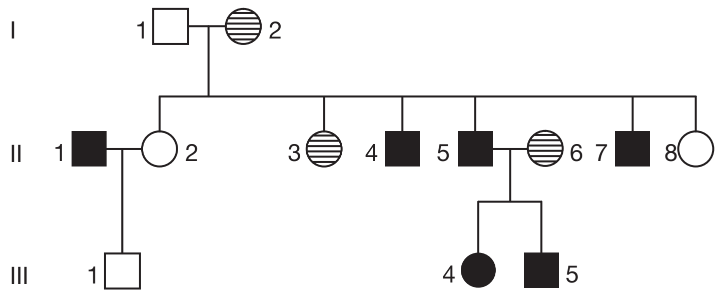
4.1.13.10 In cats male cats can be yellow or black. Female cats can be yellow, black or tortoiseshell (has both yellow hair and black hair).

Female tortoiseshell cat

(a) Explain the extra colour possibility in cats.

(b) Suggest a reason why male cats only show two colours while female cats show three colours.

(c) The diagram shows a family tree for cats. Solid shaded areas are cats with black colouring, the striped shaded areas are tortoiseshell and unshaded are cats with yellow colouring.



(i) Offspring (II,3) mated with a black male and produced two kittens – a yellow male and a black female. Fill in the family tree to show this extension of the cat family.

(ii) Outline a coding system you could use to represent the genotypes in this family tree.

(iii) Identify the phenotypes and genotypes of parents (I,1) and (I,2) and construct a Punnett grid to show the probability of genotypes and phenotypes of their offspring.

(iv) Compare the predicted ratios of the offspring of parents (I,1) and (I,2) with their actual offspring. Explain any differences.

(v) If offspring (II,4) fathered a litter of 18 kittens that only produced tortoiseshell females and yellow males, what was the most likely genotype of the mother of these kittens? Show your reasoning.

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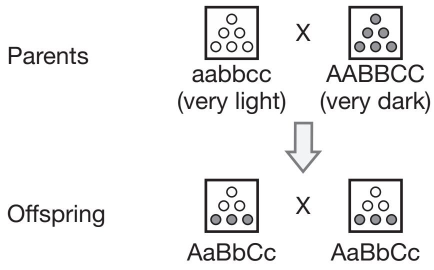
4.1.13.13 In humans skin colour is determined by at least three genes. If these genes are designated A, B, C (dominant allele) and a, b, c (respective recessive allele), then skin colour will range from AABBCC (very dark) to aabbcc (very light).

The diagram shows a cross between AABBCC and aabbcc.



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(a) List the possible genotypes for gametes produced by the offspring.

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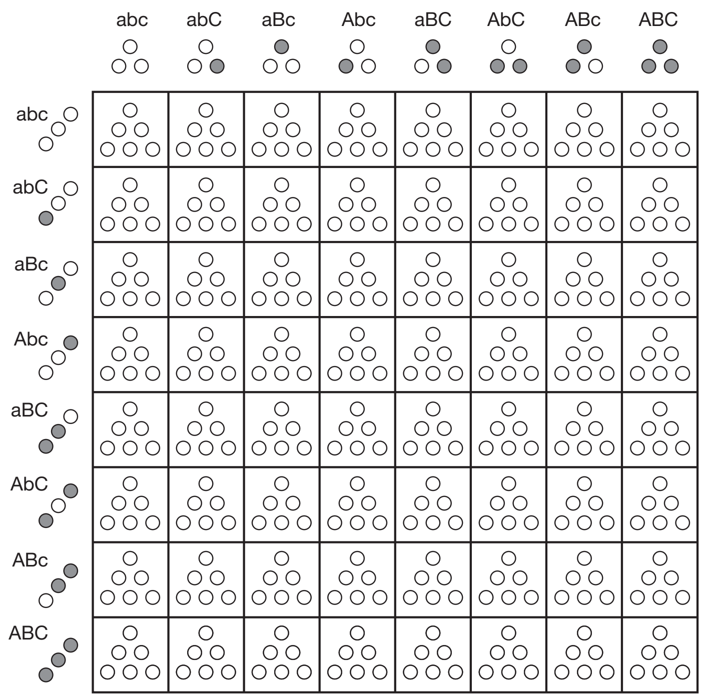
(b) If one of the offspring married a person with a similar genotype, complete the following grid by colouring in the circles to show the probability of a child having a particular skin colour.



(c) Using the results from part (b), a graph was constructed to show the distribution of skin colour for a heterozygous cross between individuals with the genotypes AaBbCc and AaBbCc.

Describe the shape of this curve and discuss why it is typical of polygenic inheritance and different to Mendelian inheritance.

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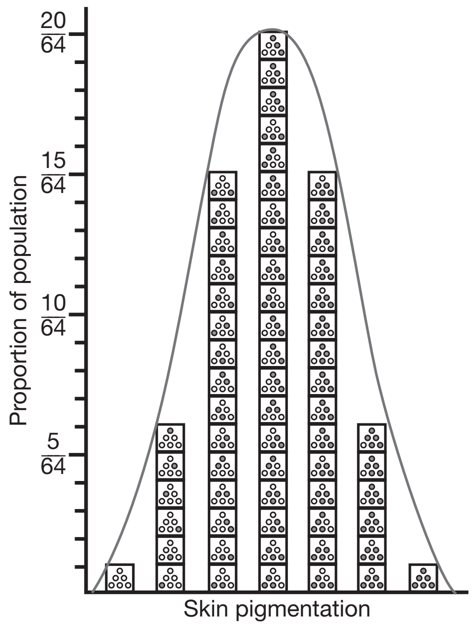

(d) Identify some factors that would cause the 'smoothing' out of the shape of the curve.

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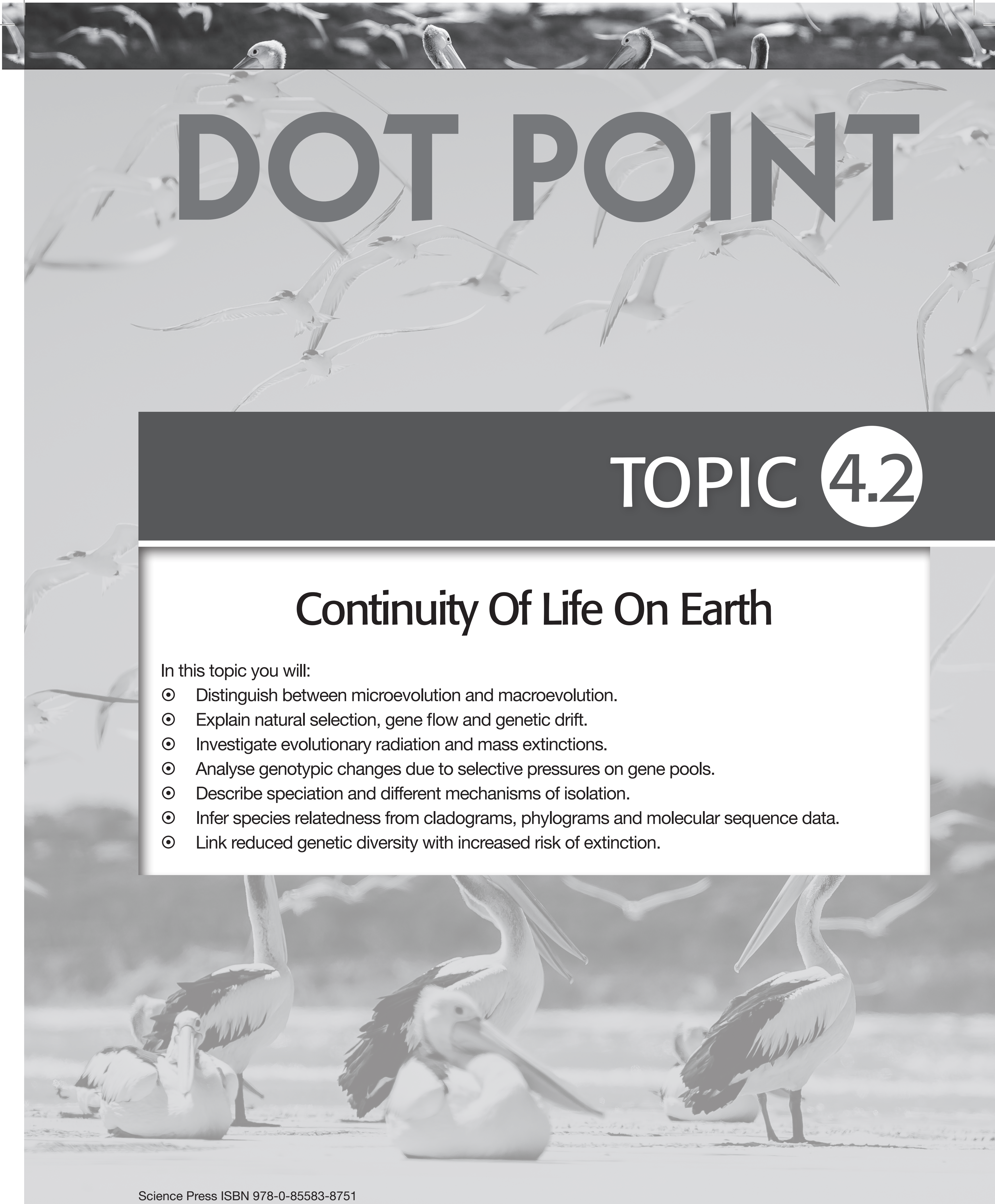

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TOPIC 4.2

Continuity Of Life On Earth

In this topic you will:

- Distinguish between microevolution and macroevolution.
- Explain natural selection, gene flow and genetic drift.
- Investigate evolutionary radiation and mass extinctions.
- Analyse genotypic changes due to selective pressures on gene pools.
- Describe speciation and different mechanisms of isolation.
- Infer species relatedness from cladograms, phylograms and molecular sequence data.
- Link reduced genetic diversity with increased risk of extinction.

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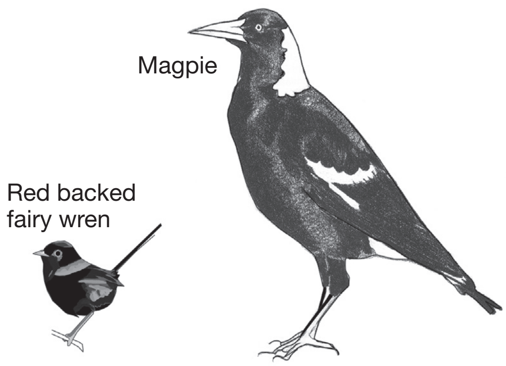
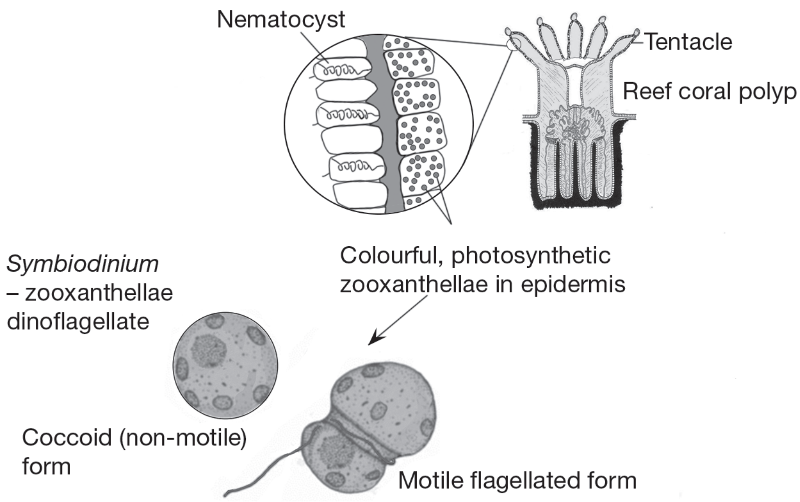
4.2.5.3 Studies of bird species across different landscape types in Brisbane have linked the decline in many bird species, especially the small and colourful species with melodious songs, e.g. the scarlet honeyeater, red backed fairy wren, the golden whistler and the white throated gerygone, to the loss of green spaces and competition from aggressive birds, e.g. noisy miners, magpies and butcherbirds.



What change in human activities is needed to change the selective pressures that are causing the decline of small bird populations in urban areas?

4.2.5.4 Zooxanthellae are unicellular dinoflagellates that can live inside coral, jellyfish, and nudibranchs. DNA sequencing has shown there are at least nine species and many subspecies classified into eight clades (clades A, B, C, D, E, F, G and H) each with varying tolerances, e.g. to high light intensity, higher temperatures, lower salinity, pollution levels. Clade D is relatively resistant to bleaching, compared to many clade C phylotypes.



(a) What is coral bleaching?

(b) Identify some human activities that can cause coral bleaching.

(c) From the given information about zooxanthellae clades, what is the likely change in zooxanthellae biodiversity with the change in selection pressures you described in part (b)?

4.2.5.5 Many respiratory viruses mutate relatively frequently. How does this show negative selection?

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4.2.9.3 The diagram shows a fossil of *Archaeopteryx* which was long considered to be a transitional form between reptiles and birds.

(a) Define paleontology.

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(b) Discuss how this fossil supports the theory of evolution.

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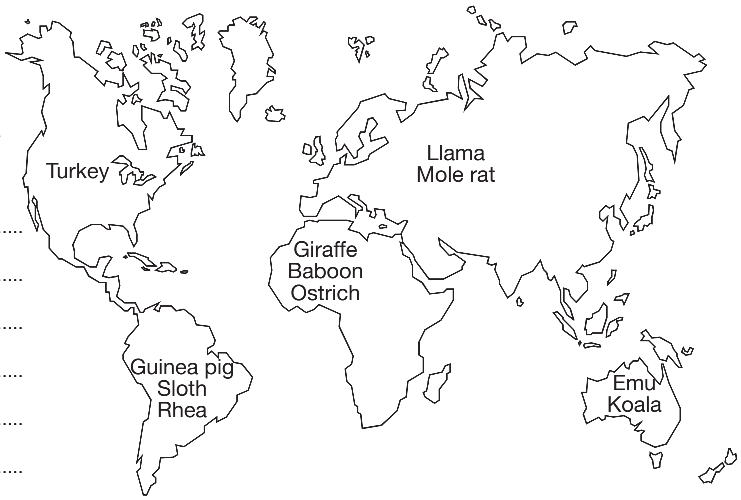
4.2.9.4 The map of the world shows some organisms that are unique to particular continents.

Discuss how biogeography supports the theory of evolution.



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4.2.9.5

(a) What is morphology?

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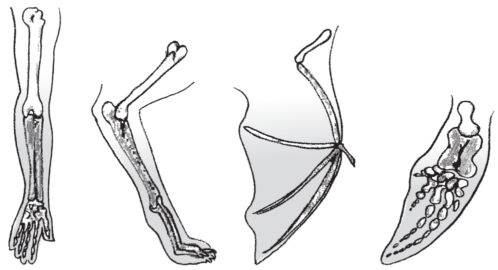

(b) Discuss how comparative anatomy supports the theory of evolution.

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4.2.9.6

(a) What is developmental biology?

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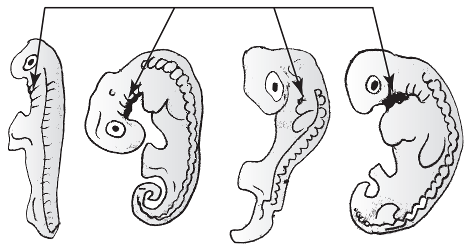

(b) What is embryology?

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(c) Discuss how comparative embryology supports the theory of evolution.

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DOT POINT

Answers

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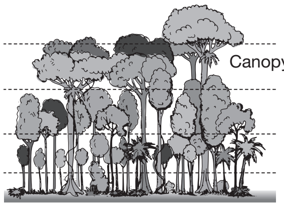
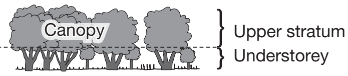
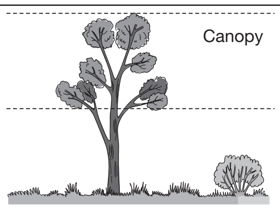
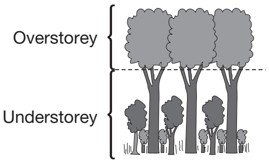
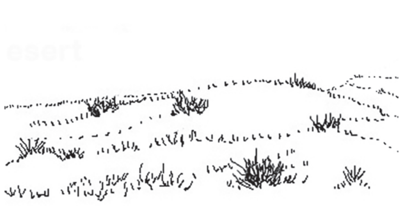
3.1.1.3

Ecosystem	Diagram	Rainfall and Temperature	Global distribution
Tropical rainforest		High rainfall > 1500 mm/year constant and can have two seasons: wet and dry. Hot temperature range usually 20°C to 35°C with average 25°C to 29°C.	Mainly located between the Tropic of Cancer and the Tropic of Capricorn.
Desert		Low, highly variable, erratic rainfall usually < 300 mm/year. High temperature ranges from –18°C (winter night) to 50°C (summer day) varying daily and seasonally.	Most deserts found in a belt between 30° north and 30° south latitude lines.
Grassland (savanna)		Low, seasonal rainfall ranging 500 to 900 mm/year, averaging 300 to 500 mm/year. The dry season can last 8 to 9 months. Temperate or tropical temperature range is –30°C to 30°C, averaging 24°C to 29°C.	Grassland is a major ecosystem covering approximately 20% to 40% terrestrial surface depending on classification criteria.
Shrubland		Low rainfall ranging 200 to 1000 mm/year. Hot summer and cool winter temperatures.	Most shrubland found in a belt between 30° north and 40° south latitude lines with wet winters and long, dry summers.
Open woodland		High rainfall in tropical areas with wet and dry seasons, 500 to 750 mm/year in southern areas. Moderate temperature ranges from 0°C to 30°C or tropical.	Open woodland found in many zones, e.g. tropical, subtropical and temperate areas.
Sclerophyll forest		750 to 950 mm/year with no distinct rainfall season. Warm temperate temperatures.	Most sclerophyll forests found in a belt between 30° north and 40° south latitude lines between subtropics and temperate zone.
Temperate rainforest		High rainfall > 900 mm/year. Temperate temperatures with cold winters and hot summers; from 0°C to 30°C.	Found on coasts of oceanic moist regions with high rainfall.

3.1.1.4 Australia covers a large area with a large range of terrestrial ecosystems from tropical rainforest to cool temperate forest to arid desert to subalpine grasslands. The distribution of most vegetation types and ecosystems is determined by rainfall.

3.1.1.5

Ecosystem 1	Ecosystem 2	Ecosystem 3
		
Classification is – desert	Classification is – grassland	Classification is – shrubland

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3.1.3.4

Feature	Bacteria	Archaea	Eukarya
Membrane bound organelles	No	No	Yes
Cell membrane	Glycerol ester lipids; unbranched fatty acid chains, chains attached to glycerol by ester linkages; D form of glycerol.	Glycerol ether lipids; membranes are branched hydrocarbon chains; chains attached to glycerol by ether linkages; L form of glycerol.	Glycerol ester lipids; unbranched fatty acid chains; chains linked to glycerol by ester linkages; D form of glycerol.
Cell wall	Present and made of peptidoglycan.	Present but not made of peptidoglycan.	Not always present and not made of peptidoglycan.
Histones, DNA and rRNA	No histones associated with DNA. Introns are rare or absent. rRNA unique to bacteria with molecular regions different from rRNA of Archaea and Eukarya.	Proteins, like histones are bound to DNA. Some introns present in some genes. rRNA is unique to Archaea with molecular regions different from rRNA of bacteria and Eukarya.	Histones associated with DNA. Introns often present in genes. rRNA is unique to Eukarya with molecular regions different from rRNA of archaea and bacteria.
Environment	Most widespread prokaryote. Abundant in moderate environments.	Often live in extreme environments, e.g. high temperatures, stronger acid or salt concentration, high sulfur.	Widespread. Forms are found in most environments.

3.1.3.5 Bacteria include the gram negative bacteria, gram positive bacteria and cyanobacteria. Archaea include the thermoacidophiles, methanogens and halophiles and the Eukarya include animals, plants, protists and fungi.

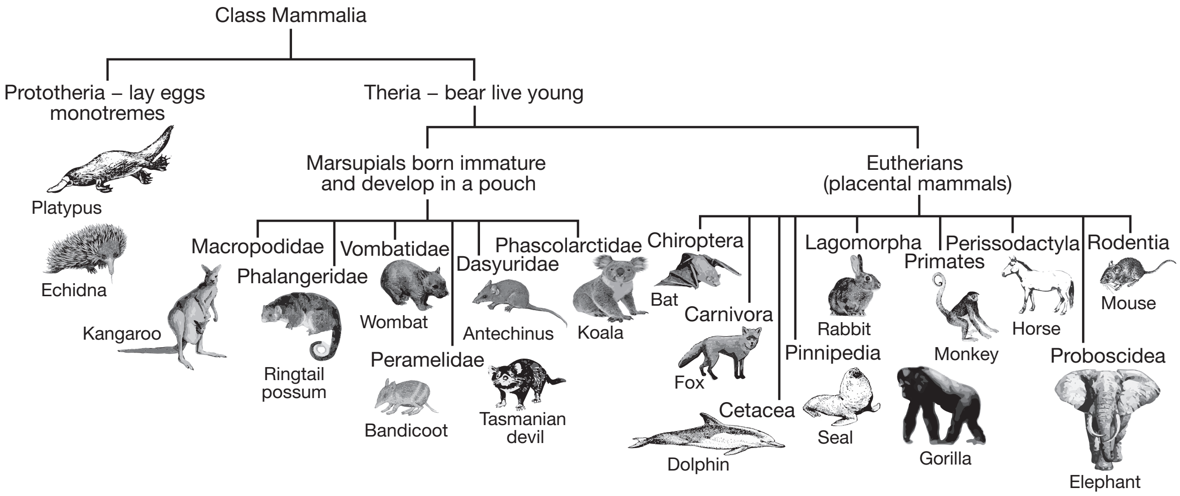
3.1.3.6 Classification features include physical features, methods of reproduction and molecular sequences.

3.1.3.7 (a) After domain, the levels are: kingdom, phylum, class, order, family, genus, species.

(b) More levels can be made by using super-, sub- or infra-, e.g. humans are in the subphylum 'Vertebrata'.

3.1.3.8 Blue-green algae were named as they turn the water a blue-green colour. The electron microscope showed the internal structure of the cells leading to the reclassification to blue-green bacteria (cyanobacteria) – they do not have any membrane bound organelles and have lamella with bacteriochlorophylls for photosynthesis.

3.1.3.9 (a) and (b)



3.1.3.10 (a) The diagram shows that the bandicoot is family Peramelidae, order Peramelemorphia. The bilby is also in order Peramelemorphia and thus the bandicoot and the bilby will have many common features. The cucus is also a marsupial but is in the order Diprotodontia and will thus have fewer similar features to the bandicoot than to the bilby.

(b) The delicate mouse is not a marsupial and is infraclass Eutheria (order Rodentia) and thus not in the diagram.

3.1.3.11 (a) A clade is a group of organisms that consists of a common ancestor and all its lineal descendants.

(b) A single homologous characteristic is usually considered when constructing a clade, e.g. base sequences of a gene or the corresponding amino acid sequences of a protein.

(c) A node is a branch point indicating the evolution of shared derived characteristics.

(d) A cladogram appears as a straight line with branching points showing divergence along the single sequence whereas a phylogenetic tree has many branches with additional groupings.

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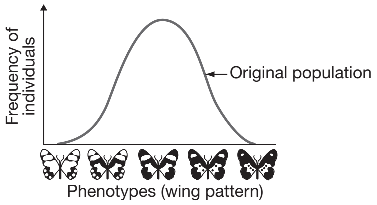
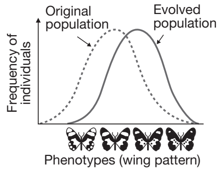
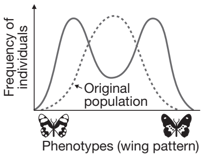
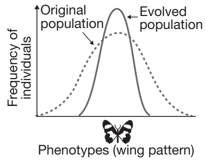
4.2.3.2

Original population			
Type of natural selection	**Directional selection**	**Disruptive selection**	**Stabilising selection**
Diagram			
Description	Directional natural selection shifts the population in one direction favouring a phenotype at one end of the variation. It usually occurs when some individuals migrate to new habitats with different environmental conditions.	Disruptive natural selection shifts the population to both extremes of the phenotypic range. The intermediate form is less favoured. It is important in speciation.	Stabilising natural selection shifts the population to the intermediate form with the extreme variants less favoured. This does not promote evolutionary change and maintains the most common phenotype.

4.2.4.1 (a) The frequency of an allele in a population refers to the proportion of the population that have that allele.

(b) The frequency of allele *A* is 75% or 0.75 and the frequency of allele *a* is 25% or 0.25.

(c) A kennel of 12 dogs means 24 alleles in kennel (total)

4 curly coat dogs (K^CK^C) = 8 K^C alleles

3 straight hair dogs (K^+K^+) = 6 K^+ alleles

5 wavy coat dogs (K^+K^C) = 5 K^+ and 5 K^C alleles

In the kennel there are 13 K^C alleles and 11 K^+ alleles

Frequency of K^C alleles = $\frac{13}{24}$ = 0.5417 = 0.54 (54%)

4.2.4.2 (a) Phenotype is the observable physical and physiological traits of an organism and the outward appearance of an organism. Allele frequency of particular traits will then show the frequency of particular phenotypes in a population.

(b) Not all alleles are observable in the phenotype and thus there can be difficulties in quantifying some allele frequencies within the gene pool. Allele frequencies are usually calculated from genotype frequencies.

4.2.4.3 Frequency allele A = $\frac{(2 \times 61) + 187}{800}$ = 0.39

Frequency allele a = $\frac{(2 \times 152) + 187}{800}$ = 0.61

4.2.4.4 (a) The Hardy-Weinberg principle gives the mathematical formula to show how the frequencies of two alleles (A and a) represented by symbols *p* and *q* maintains constant gene frequencies if the following conditions exist. 1. The population is large. 2. There is no mutation or the rate of mutation of a specific allele equals the reverse mutation. 3. There is no selective mating and reproduction is purely random. 4. There is no migration of individuals into or out of the population. The Hardy-Weinberg equation:

$p^2 + 2pq + q^2 = 1$ or 100%

This means that there is 100% probability that the offspring are AA (p^2), Aa ($2pq$), aa (q^2).

(b) The equilibrium proposes that frequencies of alleles and genotypes remain constant from generation to generation provided that only Mendelian segregation and recombination of alleles occur.

(c) The Hardy-Weinberg principle cannot be applied to haploid pathogens and if there is non-random mating, migration, natural selection or mutation.

(d) The graph shows that as the frequency of p increases, the frequency of q decreases, and a large proportion of the recessive alleles are in the heterozygotes.

(e) Sheep that are able to grow thicker wool in cold areas will survive and pass this trait to their offspring changing the allele frequency for wool type.

4.2.4.5 The allele W frequency for both populations was relatively similar A = 0.77 and B = 0.69. After gene flow the frequencies changed to A = 0.85 and B = 0.35. This shows genetic divergence and speciation occurring.

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