Key word

yield

describe and interpret the results shown in Fig 9.1 B and some of the conclusions that can be drawn before students work through Q3a and b on page 165.

- Draw together all the main points from the lesson.

9.1 Student Book answers

1. As food; as part of the water cycle: as medicines; any other sensible points.
2. Drawing like Fig 9.1.C with added flower and label to flower. Roots – anchor the plant and supply water and nutrients. Stem – supports plant. Leaves – capture energy from the Sun in photosynthesis. Flowers – reproduction.
3. **a.** The amount of every crop produced has increased over time.
   b. i. Potatoes
   ii. 1970: 14.35 tonnes per hectare; 2017 21.21 tonnes per hectare
   iii. 21 − 14 = 7 → 7/14 × 100 = 50%
   c. Cassava : 11.5 − 8.5 = 3 → 3/8.5 × 100 = 35.3%
   Rice: 4.5 − 2.5 = 2 → 2/4.5 × 100 = 44.4%
   Maize: 6 − 2.5 = 3.5 → 3.5/6 × 100 = 58.3%
   d. Scientists have investigated plant structures, plant breeding, plant genetic material, the nutrients plants need and the pests and diseases that attack them. It is important because it has allowed them to develop plants with useful characteristics that produce much more food than ever before.

s Worksheet 9.2.3.
ges them to remember
iation for aerobic
nd compare the
respiration and
sis – moving them
evel of understanding
GCSE Biology.

ork

on page 167 and/or
ge 69.

rd

9.2 Student Book answers

1. **a.** Photosynthesis is the process by which plants make their own biomass/food using carbon dioxide and water and light energy captured by chlorophyll.
   b.

$$\text{carbon dioxide + water} \xrightarrow[\text{chlorophyll}]{\text{light}} \text{glucose + oxygen}$$

   (reactants) (products)
2. Chloroplasts contain chlorophyll; the green colour/pigment that traps light energy for photosynthesis. Chloroplasts are also the site of most of the reactions of photosynthesis. Without chloroplasts there is no photosynthesis.
3. For aerobic respiration/as a starch store/to make other molecules such as proteins, etc.
4. Plants make their own biomass by photosynthesis and a lot of the biomass on the Earth is plants. Most other organisms depend on eating plants, or on eating animals that have eaten plants, to get their biomass – so directly or indirectly all of their biomass also comes from plants. The mass of decomposers also comes from breaking down plants or animals. So most of the biomass on Earth comes from photosynthesis.

9.3 Student Book answers

1. Take a leaf from a test plant → place it in boiling water for up to a minute (to remove waterproof covering/break open cells) → turn off heat → remove leaf from boiling water → place leaf in test tube of ethanol → place test tube of ethanol in beaker of hot water (ethanol boils/removes green colour from leaf) → remove pale, stiff leaf from ethanol → dip leaf into hot water (to soften) → spread leaf on white tile → add a few drops of iodine solution (to test for starch) → if starch is present, turns blue-black.

2. a. Plants turn some of the glucose they make during photosynthesis into starch in their leaves to use when they are in the dark. It takes two to three days to use up these starch stores. By using plants that have been kept in the dark, students know that any starch they find in their tests is the result of photosynthesis during their investigation.

b. Salma: **i.** Whether chlorophyll is needed for photosynthesis.

ii. Chlorophyll is needed for photosynthesis.

iii. Any two from these or any other sensible point: using a plant that has been kept in the dark, using a variegated leaf, leaving the plant in the light for 24 hours, using the iodine test for starch.

iv. Use more than one leaf of each type; use green and white leaves instead of green and pink leaves; try several different types of variegated leaves; any other sensible point.

Dina: **i.** Whether light is needed for photosynthesis.

ii. Light is needed for photosynthesis.

iii. Any two from these or any other sensible point: using a plant that has been kept in the dark, covering part of a leaf with foil/card so the light couldn't reach it, leaving the plant in the light for 24 hours, using the iodine test for starch.

iv. Partly cover more than one leaf; completely cover some leaves; use more than one plant; any other sensible point.

Abdul: **i.** Whether carbon dioxide is needed for photosynthesis.

ii. CO_2 is needed for photosynthesis.

iii. Any two from these or any other sensible point: using a plant that has been kept in the dark, removing the carbon dioxide from around one leaf, using the iodine test for starch.

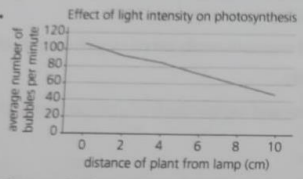
iv. Use more than one leaf of each type; use green and white leaves instead of green and pink leaves; try several different types of variegated leaves; any other sensible point.

Key word

light intensity

9.4 Student Book answers

1.



2. The graph shows that the numbers of bubbles produced per minute by the plant decreases as the plant is moved further away from the lamp.

3. That light intensity affects the rate of photosynthesis, and the rate of photosynthesis increases as the light intensity increases.

4. To measure the temperature of the water in the beaker around the test tube containing the experimental pond weed. It is important because temperature might affect the rate of photosynthesis so it is a variable which must be controlled.

5. a. Any two from: Giving the plant time to adjust to the changes in light intensity; measuring the distance from the lamp accurately; controlling the temperature of the water so it stays the same throughout; any other sensible points.

b. Keep the pondweed in the dark before starting the experiment; control the amount of carbon dioxide available to the plant in the water; repeat the investigation more times/with different pieces of pond weed; any other sensible suggestions.

Online resource

- Worksheet 9.5.1 The mineral needs of plants
- Interactive test

9.5 Student Book answers

1. Water-soluble substances that cells can absorb and need to grow well.
2. Magnesium to make chlorophyll, the green colour needed to capture light energy for photosynthesis.

   Nitrates to make the proteins that control reactions in plant cells and are part of the cell structure.
3. **a.** Each year the plants take minerals/nitrates from the soil so there is less for the next crop. This year the plants are deficient in nitrates. Know this because symptoms of nitrate deficiency are poor growth and yellowing of the older leaves.

   b. Peas and beans are legumes so they make their own nitrates in root nodules full of bacteria. So they are not deficient in nitrates and they grow well.

   c. Grow other plants where the peas and beans grew this year as they add nitrates to the soil. If students puts compost/manure/fertiliser, give 1 mark.

- Before the lesson, l
  several quiz questi
  importance of min
- Read through page
  Discuss the import
  students to recogn
  the need for magn
  page 173.
- Read through 'Min
  the images in the
  symptoms of defic
  lack.
- Give students **Wo**
  described. Studer
  lesson for the nex
  on **Worksheet 9.**
  lesson, demonstr
  experimental pro
  the different solu
  results and comp
  own investigatio
- Work through th
  from?' with stud
  demonstrate the
- Draw the lesson
  students that th
  lesson in the ne

Extension

Students research
potassium.

Homework

Workbook page 7

Key words

minerals, nitrates

9.6 Student Book answers

1.a. A substance that replaces minerals such as nitrates in the soil.

b. Naturally plants take minerals from the soil when they grow, and the minerals are replaced when they die and decompose. Crop plants take minerals from the soil and when we harvest them, no minerals are replaced. Fertilisers are needed to replace the minerals so the crops grow well.

2.a. Advantages: two from, are cheap/easily available/improve the soil structure. Disadvantages: release minerals slowly, limited supply.

b. Advantages: two from, are always available, release minerals fast, farmers control the amount of minerals applied. Disadvantages: expensive, don't improve soil quality.

3. Scientists understood the way plants need minerals, and they developed a method of making ammonia from nitrogen in the air. Industry developed a way to use that reaction to make ammonia on an enormous scale, so artificial fertilisers were available and farmers could increase their crop yields, feeding more people.

4.a. i. No fertiliser → 1300 kg/hectare; with 45 kg fertiliser, yield 2500 kg/hectare → 2500 − 1300 = 1200 increase. 1200/1300 × 100 = 92.3%

ii. No fertiliser → 1300 kg/hectare; with 90 kg fertiliser, yield 3700 kg/hectare → 3700 − 1300 = 2400 increase. 2400/1300 × 100 = 184.6%

b.

kg nitrate fertiliser/ hectare	% increase in yield canola	% increase in yield wheat
45 kg	92.3	60
90 kg	184.6	85

Objectives

Key words

transpiration stream, stomata

9.7 Student Book answers

1. Roots have root hair cells – microscopic hairs that increase the surface area for water to move in. Soil water moves into the root hair cells by diffusion into the xylem tubes in the root.

2. Mineral salts move into the roots dissolved in the soil water.

3. a. Holes found on the underside of leaves through which gas exchange takes place. They can be opened and closed by the guard cells.

b. Water evaporates from the cells in the leaf and moves out by diffusion through the stomata.

4. Plants lose water through their leaves by transpiration. Water is pulled up through the plant from the soil in the transpiration stream. On cool days, the plant transpires and there is enough water in the soil to replace it. On hot days, more evaporation takes place so more transpiration takes place; there is not enough water in the soil to replace it. The cells of the plant do not get enough water and so they cannot support the plant and it wilts.

9.8 Student Book answers

1. Xylem is dead tissue, phloem is alive; xylem transports water and dissolved minerals, phloem transports water and dissolved food/sugars; xylem transports from the roots to the shoots/up the plant only, phloem transports all around the plant, transport in xylem doesn't use energy, transport in the phloem does.
2. **a.** An insect that feeds on the liquid in the phloem of living plants.
   b. Many aphids take a lot of the food from the plant by feeding on the contents of the phloem; the biting mouthparts of the aphids can carry pathogens into the plant, causing diseases.
3. Plants make sugars by photosynthesis and they are carried around the plant in the phloem. They are carried to the buds and provide the food needed to grow many healthy flowers. Aphids stick their stylets into the phloem and feed on the sugary liquid. A plant infected with many aphids will have less sugar reaching the buds, so it will have less food available and so will produce fewer, smaller flowers.
4. **a.** A tree carries out photosynthesis in the leaves. It needs a supply of water carried from the roots to the leaves in the xylem. The sugars made during photosynthesis are carried to all of the tissues of the tree, including the roots, in the phloem. If deer eat a complete ring of bark, both the xylem and the phloem are destroyed. Water cannot reach the leaves so they cannot photosynthesise and die. Sugars cannot reach the roots so the cells are starved and the roots die. These two things mean the whole tree dies.
   b. Covering the bark of young trees above the level that can be reached by deer, etc. – until the tree is older and the bark is too tough for the deer to eat it.

9.9 Review answers

Student Book pages 134–135

Student Book answers

1. **a.** Photosynthesis is the process by which plants make their own biomass/food using carbon dioxide and water and light energy captured by chlorophyll. [2]

   b.

   carbon dioxide + water (reactants) —light, chlorophyll→ glucose + oxygen (products) [3]

   c. Carbon dioxide gets into the leaf from respiration in the cells and diffusion from the air through the stomata.

   Water enters the root hair cells by diffusion from soil water and is transported up the plant in the xylem to the photosynthesising cells in the leaves.

   Oxygen is used by the plant cells for aerobic respiration and the rest is lost through the stomata in the leaves by diffusion.

   Some of the glucose is used directly by the cells for aerobic respiration, some is converted to starch to store energy, some is used to build other molecules such as proteins, and some is transported around the plant to all of the other cells to use. [10]

   d. i. No – root hair cells have no chloroplasts and they are not exposed to light. [3]

   ii. Yes – the light needed for photosynthesis is captured by chlorophyll in the chloroplasts when there is plenty of light. [2]

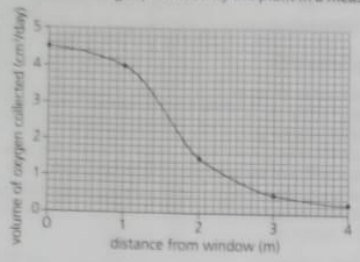
   iii. No – chloroplasts are still there but there is no light for them to capture. [2]

2. **a.** The pond weed photosynthesised in the light. It absorbed carbon dioxide from the water and used it in photosynthesis. The concentration of carbon dioxide in the water fell so the indicator turned purple. [3]

   b. The pondweed did not photosynthesise in the dark, so it did not remove any carbon dioxide from the water. It respires all the time, in the light and the dark, so in the dark it added carbon dioxide to the water from respiration and the indicator changed colour. [4]

3. a. He collects the gas produced by the plant in a measuring cylinder. **[1]**

b. **[5]**



c. The closer the plant is to the light of the window, the more oxygen is produced – indicating that more photosynthesis is happening. So the greater the light intensity, the more photosynthesis takes place. **[3]**

d. Any two sensible suggestions, e.g. temperature of water, amount of carbon dioxide in the water, the size of the piece of pondweed. **[2]**

4. a. Does a plant need carbon dioxide to photosynthesise? **[1]**

b. To use up any starch it has stored in its leaves, so the presence of starch can be used to indicate photosynthesis has taken place in the investigation. **[2]**

c.
- Take the two experimental leaves from the plant and drop them into boiling water to remove the waterproof layer and break open the cells.
- Turn off the heat. Take the leaves from the boiling water.
- Place the leaves in a test tube of ethanol and put the test tube into the hot water. The ethanol will boil and the green colour will come out of the leaves.
- Remove the white leaves from the ethanol and dip them into hot water to soften them.
- Spread the leaves on a white tile and add a few drops of iodine solution to each. **[6]**

d. Leaf B (from the bag containing lots of carbon dioxide) will turn the iodine blue–black. It has been photosynthesising and contains starch. Leaf A (from the bag with no carbon dioxide) cannot photosynthesise so it has no starch in its leaves and has no effect on the iodine which stays yellow–brown. **[5]**

5. a. The amount of minerals available to the plants. **[1]**

b. Minerals are absorbed into the roots of plants from the soil, dissolved in the soil water. They get into the plant through the root hair cells. They move into the xylem and are transported up the plant to all the cells in the transpiration stream. **[4]**

c. i. Magnesium is needed to make chlorophyll which is the green colour in plants. If a plant lacks magnesium, it can't make chlorophyll and this affects the colour of the leaves **[2]**

ii. Chlorophyll captures light energy for photosynthesis. If a plant lacks magnesium it cannot make the chlorophyll it needs, so it cannot capture as much light energy. Less photosynthesis takes place, so less food is made and so the plants do not grow as quickly as those that have plenty of magnesium. **[5]**

6. a. Xylem **[1]**

b. It is a dead tissue comprising tubes that go from the roots to the leaves and buds; it carries water (and dissolved minerals) up the plant from the roots to the leaves. **[3]**

c. It was put in plain water/it had the end sealed up, e.g. by wax, before it was put in the ink. **[2]**

Prior learning

- Use the scientific names for some major body organs
- Describe the main functions of major body organs

10.1 Student Book answers

1. Excretion means getting rid of/removing waste products made in the body.
2. Removing undigested food from the body.
3. Kidneys
4. Urea comes from the breakdown of excess proteins in the liver. It is toxic so it must be excreted so that it does not poison/cause damage to the organs of the body, e.g. the brain.
5. The kidneys do a very important job removing toxic urea, so it is important that they do not get damaged. The thick layer of fat which covers them is to protect them from damage.

understand tha

- Read on throug detail at the re so in this chapt In their work o carbohydrates obesity. Explai Part of the mol be removed, a
- Read 'What do importance of kidney from a t the tubes that cutting the kid
- Have some ure white and diss different colou and depend or
- Discuss the dif they read the f
- Students answ
- Give students e **10.1.1** is a wor give weaker stu an opportunity students' know well as buildin sentences befo

Extension

Students make a

Homewor

Workbook page

Key word

toxic, kidneys, u

s to
wo
ve to
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- Have a plenary session summarising what students have learned.

10.2 Student Book answers

1. Urine is the yellow liquid produced by your kidneys – it contains urea, water and other chemicals.
2. Your kidneys filter the blood – urea passes through the filters but blood cells and big, useful molecules stay in the blood. Small useful molecules may pass through the filter but they are taken back into the blood.
3. The ureter carries urine from the kidney to the bladder; the urethra carries urine from the bladder to the outside world.
4. Similarity: both contain urine. Difference: one from, kidneys make urine by filtering the blood; the bladder stores urine made by the kidneys.
5. After you have drunk a lot of water, the amount of urine produced by the kidneys increases over time until it reaches a peak. As the extra water is removed, the volume of urine produced falls back towards normal.

ey or answer Workbook
78.

10.3 Student Book answers

1. A physical model is something used by scientists to help explain something which is too small, too big or too difficult to see, such as the filtering system in the kidney.
2. Strengths e.g. it shows filtering in action/you can see how some things come through the filter and others don't/ you can see that the filtering depends on the size of the particles/it has substances in solution like the real thing/any sensible point.

   Weaknesses e.g. it looks as if all the water is filtered out of the blood through the model kidney– this doesn't happen/ looks as if some of the red blood passes through the filter which it doesn't/any other sensible point.
3. Strengths e.g. it shows how the kidney filter acts as a sieve/you can see how small particles come through the filter and larger ones don't/ you can see that the filtering depends on the size of the particles/any sensible point.

   Weaknesses e.g. There is nothing that is actually in solution so it is unrealistic/it looks as if all the water is filtered out through the sieve/ any other sensible point.
4. For example, Ejaz's model: don't add the red colouring because blood does not go through the filters in the kidney/Fatima's model: reduce the size of some of the holes so some of the water does not pass through the filter/any sensible ideas.
5. $22/40 \times 100 = 55\%$

Student Book pages 188–189

kerboodle

Online resource

- Worksheet 10.4.1 Kidney dialysis
- Interactive test

10.4 Student Book answers

1. Because urea is toxic and the body cannot get rid of urea, excess water and other waste products if the kidneys do not work. This affects all the other body systems and makes people very ill.
2. Depends on where student lives.
3. Dialysis: instant results, makes patients feel better and carry on with relatively normal life BUT has to be repeated often, takes a lot of time, expensive, not enough machines, eventually damages the blood, any other valid points.

   Transplants – permanent, relatively cheap, allows patient to live a normal life going forward BUT ethical decisions to be made about donors, e.g. should live donors be allowed to give away a kidney? Some people worry about the use of organs from deceased donors, etc.

to treat diseases that would
reinforces understanding that
and ethical considerations also
check out the laws and attitud
before using this lesson. In son
donation schemes; in others t
In some countries, organs are

**As always when dealing with
with this topic as some stude
by kidney failure.**

Activities

- Read the first paragraph wit
someone feels ill if their kid
confirm students' understa
- Read the section 'Life witho
of the size of the problem. M
caused by kidney failure or
- Students answer questions
- Read 'Life without kidneys:
the advantages and disadva
why Mohammed feels well
before the next one. Tell stu
eats and drinks most of the
the first hour or two he is o
- Give students **Worksheet 1**
blood in the dialysis machi
table to compare a dialysis
- Read through 'A new kidne
both living and deceased d
and rejection and explain t
twin, anyone who receives
their life to make sure thei
- Give students the opportu
around organ donation be

Extension

Students research the ways i
donation programmes.

Homework

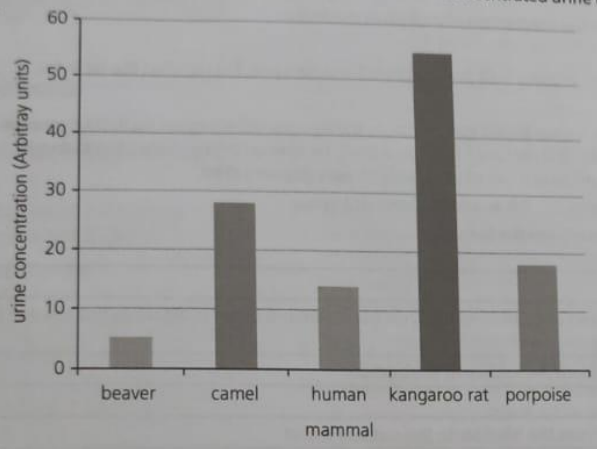
Workbook page 79

Key words

dialysis, kidney transplant,

10.5 Student Book answers

1. Camels are larger animals than humans but they produce less urine. Average human urine 1500 cm^3, average camel urine 500–1000 m^3.
2. Camels are large, kangaroo rats are small; camels need to drink, kangaroo rats do not need to drink as they can get enough water from the breakdown of their food; both have specially adapted kidneys which can produce very concentrated urine, but kangaroo rats can produce more concentrated urine than camels.
3. **a.**



   b. Advantage: It shows very clearly which animals produce the most concentrated urine. Disadvantage: some people might misread it and think it showed which animals produced the biggest volume of urine.

4. Kangaroo rats have little or no water available to them. Often the only water they get is from the breakdown of their food. They produce very small amounts of highly concentrated urine – approximately 4× as concentrated as human urine. Porpoises have limitless water available but it is salty. They have to get rid of the excess salt which uses a lot of water, so they produce large amounts of relatively concentrated urine – 1.3× the concentration of human urine.

10.6 Review answers

Student Book pages 192–193

Student Book answers

1. **a.** Excretion means getting rid of/removing waste products made in the body.
   b. Urea, carbon dioxide [2]
   c. Waste products like urea and carbon dioxide are toxic/poisonous so if they build up, they damage the tissues and cause illness or death. [2] [3]

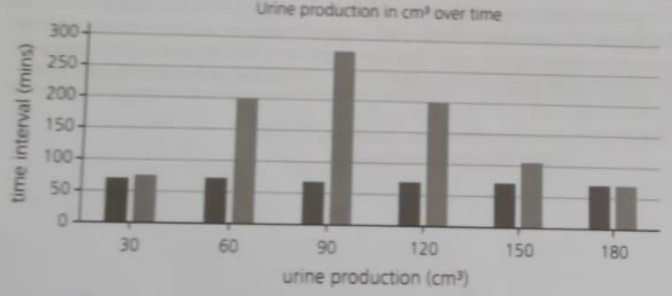
2. **a.** A toxic waste product formed from the breakdown of protein in the body.
   b. The liver **c.** The kidneys [2]
   d. They do a very important job so it is important to protect them from damage. This is what the fat is for. [1, 1]
   e. Poisonous/damages the body [2]

3. **Urea** is very toxic. If the concentration in your **blood** gets too high, it damages other organs including your brain. It can make you very ill and may lead to **death**. It is removed from your body by special organs called the **kidneys**. They **filter** the toxic molecules from your **blood** and pass it out of your body as part of your **urine**. [1]

4. **a.** Excretory system **b.** Renal system OR **a.** and **b.** given vice versa [7]
   c. To remove toxic urea and excess water from the blood. [1, 1]
   d. [2]

Part of the system	Function
Kidney	Filters the blood and removes urea, excess water and other substances not needed by the body
Ureter	Carries urine from the kidney to the bladder
Bladder	Stores urine
Urethra	Carries urine from the bladder to the outside world

5. **a.** Bar chart with volume of urine in cm^3 on vertical axis and time intervals 30 mins, 60 mins, etc. along the bottom. [7]



b. Normal volume of urine in 30 mins is 75 – 70 = 5 cm^3; 200 – 72 = 128 cm^3; 280 – 68 = 212 cm^3; 190 – 70 = 120 cm^3; 105 – 70 = 35 cm^3. The patient produced 5 + 128 + 212 + 120 + 35 = 500 cm^3 of extra urine. [7]

6. **a.** Your kidneys filter your blood. Toxic waste products such as urea pass through the filters and are removed from your blood. Blood cells and big molecules which your body needs stay in the blood.
   Some useful substances, like glucose, are also small enough to pass through the filters in the kidneys. They get taken back into your blood because your body needs them. The yellow liquid formed is called urine. [5
   b. Some water is filtered out of your blood, along with other substances which your body does not need, e.g. excess salt from your food. [2
   c. If the kidneys fail, then urea is not removed from the body. Urea is toxic so, if the levels build up, it can damage other organs and cause death. If the levels of salt and water in the blood are wrong, this can cause problems. [
   d. It can't be with you all the time/it is expensive/it is not as good at balancing the blood as kidneys/toxic substances build up between times on the machine. [

Homework

Workbook page 81

Key words

genetic material, DNA, chromosomes, genes, asexual reproduction, sexual reproduction, gametes

- Now read through the section headed 'Asexual reproduction' with students, looking at Fig 11.1 C. Give students **Worksheet 11.1.2** and let them carry out the procedure, giving them each an identical plantlet to take care of. You can use these later in Chapter 13 when looking at variation.
- Read through the final two sections on page 195 with students: 'Sexual reproduction' and 'What are gametes?' Use Fig 11.1 A to show students that the young geese are not identical to each other.
- Draw together all the main points from the lesson. Students answer questions 1–4 on page 195.

11.1 Student book answers

1. The process by which living things make more of themselves.
2. **a.** An enormous molecule which is the genetic material of cells. It contains the instructions for making a new life.
   b. Chromosomes
3. **a.** 46
   b. 23
4. Asexual: one parent/parent cell/ offspring identical to parent/same DNA.
   Sexual: two parents/parent cells/offspring get DNA from both parents/offspring differ from both parents.
5. **a.** $82/2 = 41$
   b. $21 \times 2 = 42$

- chromosomes contain genes, made of DNA
- Know that genes contribute to the characteristics of an organism
- Describe the fusion of gametes to produce a fertilised egg with a new combination of DNA

Overview

This lesson continues directly from Unit 11.1. Students should grasp the key facts about male and female gametes, including the fact that each gamete contains half the number of chromosomes as the normal body cells. This will help them to understand sex inheritance in CLSS and the genetics they will study in IGCSE Biology much more easily. You may explain how the sperm are introduced into the female, if this is appropriate for your students.

Activities

- Begin by firing a few questions at students, e.g. garlic cells have 8 pairs or 16 chromosomes – how many chromosomes will there be in the gametes? Elephant gametes each contain 28 chromosomes – how many chromosomes are there in an elephant body cell? How many pairs of chromosomes are there in an elephant body cell? Make sure students know that the gametes contain half the number of chromosomes as the body cells, and that the chromosomes in body cells come in pairs, one from the mother and one from the father.
- Read through page 196 with students and give them **Worksheet 11.2.1**. They label and annotate the diagrams to show how the different gametes are adapted to their functions. **OR** students can answer Q1 on page 197.
- Talk through the process of fertilisation with students, explaining how the egg and sperm fuse to form an embryo with a new combination of DNA. Then ask students to read page 197. They should copy Fig 11.2 C and answer Q2 on page 197.
- Tell students that although we now understand the process of fertilisation, it was unknown for many centuries. Give students **Worksheet 11.2.2** to work through either individually or in pairs. Bring the whole class together and go through the correct answers to the table – use a show of hands to see what students have answered and explain the correct conclusions as you go through. Students answer Q3 on page 197. Use this as the focus for a brief plenary session to make sure that students have grasped the key points of the lesson.

11.2 Student Book answers

1.

Eggs	Sperm
Relatively big	Small
Contain a store of food	No food store
Few	Many
Made in the ovaries	Made in the testes
Can't move themselves	Swim to the egg
No tail	Long tail

2. Many thousands of sperm swim to the egg → one sperm gets into the egg cell → the egg stops any more sperm cells getting in → the nucleus of the successful sperm fuses with the nucleus of the egg cell → the fertilised egg begins to divide to form an embryo.

3. a. Gametes have half the number of chromosomes as normal body cells.

b. At fertilisation, the nuclei of the two gametes fuse – so the new cell has twice the number of chromosomes as each gamete – which is the number of a normal cell.

complete ten 'fertilisation events' as described on the worksheet and collect the data from each student to see how many boys and girls have been produced. This allows you to illustrate two important points: Any particular student may have any number of boys and girls, from all girls to all boys. The bigger the data set, as you collect information from each student, the nearer the class average will come to a 1 : 1 ratio of boys to girls.

- Students answer questions 3 and 4 on page 199 to complete the lesson.

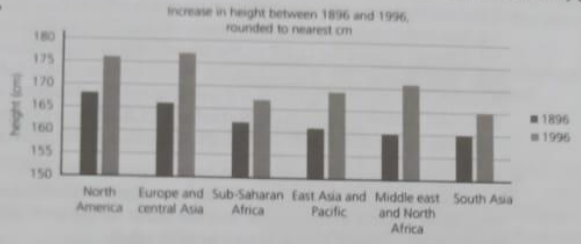
11.3 Student Book answers

1. Cell – nucleus – chromosome – DNA – gene
2. You inherit two sets of chromosomes, one from your mother, one from your father. They make pairs of chromosomes. Genes on the paired chromosomes control the same features. The gene that controls a feature may be from your mother or father.
3. **a.** 23 chromosome pairs
   b. 22 chromosome pairs are exactly the same size. The sex chromosomes may be exactly the same – XX (female) or one may be much smaller than the other – XY (male).
4. Each child is produced when an egg and a sperm fuse. Each egg contains an X chromosome. A sperm may contain an X chromosome or a Y chromosome. There is a 50 : 50 chance that the egg will be fertilised by an X or a Y sperm to make a girl or a boy. This is the same for every child – the sex of any other children does not affect this. (Diagram acceptable).

11.4 Student Book answers

1. Each child has a random selection of genes from each parent, so they will have some in common and some that are different.
2. They are genetically identical and so all of the features controlled by their genes will be the same. The environment will not have had time to make many changes. The older twins get, the more different environmental factors will have an impact on some of their characteristics, e.g. height and body mass are affected by eating habits and exercise, etc. Features entirely controlled by genes remain the same.

3.a.



b. i. Percentage increase = (1996 reading −1896 reading)/1896 reading × 100 SA = 3.1%, MENA = 6.9%, EAP = 5.0%, SSA = 3.1%, ECA = 6.6%, NA = 4.8%. Biggest increase is the Middle East and North Africa; smallest is both South Asia and East Asia and Pacific.

ii. Possible reasons: The countries with the biggest increases may have seen the biggest improvements in living standards/food availability, countries with small increases relatively little improvement; countries with relatively little improvement may have had a higher standard of living in 1896 and so been nearer to their genetic height potential, so less scope for getting taller; any other sensible suggestions.

c. i. 1996 reading − 1896 reading for tallest area: (168 − 160) cm so difference in height = 8 cm
1996 reading − 1896 reading for shortest area: (177 − 165) cm so difference in height = 12 cm

ii. In 1896 neither population reached full genetic height potential as both had relatively poor levels of nutrition. NA taller as genetically taller population. By 1996 NA population reaching full genetic height potential as plenty of food available. Bigger difference between tallest and shortest – full genetic height difference showing. It might be that shortest population are genetically much shorter OR, although food levels have improved everywhere, lack of food may still mean full genetic potential not reached in shortest population.

11.5 The development of a fetus

Student Book, pages 202–203

Objective

- Describe healthy fetal development

Overview

This lesson takes students from reproduction at the level of chromosomes and gametes to the development of a fetus in the uterus. This is important both as part of their CLSS course, as preparation for considering factors that have an adverse effect on fetal development in Units 11.6–11.8 and for them as biologically literate citizens understanding their own bodies.

Be very sensitive dealing with this topic as students may have family members who are pregnant, trying to become pregnant, have just had or have even lost a baby.

fed'. Discuss the cell division that follows fertilisation and the movement of the ball of cells into the uterus to continue development. Look at Fig 11.5 A with students and get them to use their rulers to measure the size of the embryo at the stages shown. Students answer Q1 on page 203.

- Point out that the embryo needs increasing amounts of food and oxygen as it grows and its cells produce more waste products. How does it acquire/get rid of these? Project Fig 11.5 B on the whiteboard or display it in some other way. Read through the section headed 'Protected, warm and fed' with students, referencing Fig 11.5 B and pointing out the structures as they are described. **Either** give students **Worksheet 11.5.1** to work through and complete as a record of this content **OR** students answer Q4 on page 203.
- Read through the final paragraph on page 203 describing how a baby is born. Be prepared to answer questions from students on this process and emphasise the role of the mother and the father AFTER birth in caring for the baby and helping it grow to be a healthy adult.
- Students answer Q3, page 203 – ask them to illustrate their flow diagram with drawings of the fetus at different stages to help them to remember it.
- Have a plenary session quizzing students to make sure they have understood the key elements of this lesson.

Extension

Ask students to carry out some research into the structure of the placenta. They should write an illustrated piece about the placenta, explaining how substances pass from mother to fetus and from fetus to mother, and why it is so important that the blood of the mother and the fetus do not mix.

Homework

Workbook page 85

Key words

uterus, gestation period, pregnancy, fetus, placenta, umbilical cord, fluid sac

11.5 Student Book answers

1. **a.** Some of the cells specialise to form particular tissues and organs.
   b. 4 weeks
2. It supports the baby as it grows and moves. It acts as a shock absorber to protect the developing baby from bumps and knocks.
3. Egg and sperm meet and fuse = fertilisation → cells divide to form a ball → 1 week – cells begin to specialise → 4 weeks spine and brain forming, heart beating → 9 weeks eyes and ears forming, movements start → 12 weeks fetus has most organs and moves – very tiny → remaining 28 weeks – fetus grows and matures → around 40 weeks baby is born.
4. The uterus provides the developing fetus with a warm, protected space to grow. It produces the placenta because the developing fetus needs a good supply of dissolved food and oxygen which is supplied by the placenta through the umbilical cord. It also needs its waste products to be removed through the placenta, and to be protected from infections and harmful substances. It needs to be supported and protected from physical harm by the fluid sac.

11.6 Student Book answers

1. The fetus gets the nutrients its needs from its mother, through the placenta. Their blood supplies pass very close but do not mix.
2. She needs iron to make red blood cells to carry the oxygen she and her fetus both need, and she needs iron so her fetus can make its own red blood cells.
3. **a.** Medicinal drugs make you feel better when you are ill, recreational drugs do not; medical drugs are legal, many recreational drugs are not; people take recreational drugs because they enjoy them, they only take medical drugs when they are ill.
   b. Some medicines cross the placenta and reach the fetus. Some medicines stop the fetus from developing properly and may harm it. So doctors must be sure that any medicines they give to a pregnant woman are also safe for her baby.
   c. Fig 11.6 D shows that the more caffeine the mother takes in, the higher the risk of her having a low birthweight baby. Low birthweight babies are more likely to have problems or die. Every cup of coffee contains around 95 mg of caffeine, so by cutting back to just one or two cups of coffee a day your mother's friend could reduce her caffeine intake and reduce the risk to her baby. Best of all, cut out the coffee completely.

Extension

Students produce an information leaflet aimed at young men and women that explains the importance of folic acid in the prevention of spina bifida and the value of managing your diet and taking vitamin supplements before starting a family.

Homework

Workbook page 87

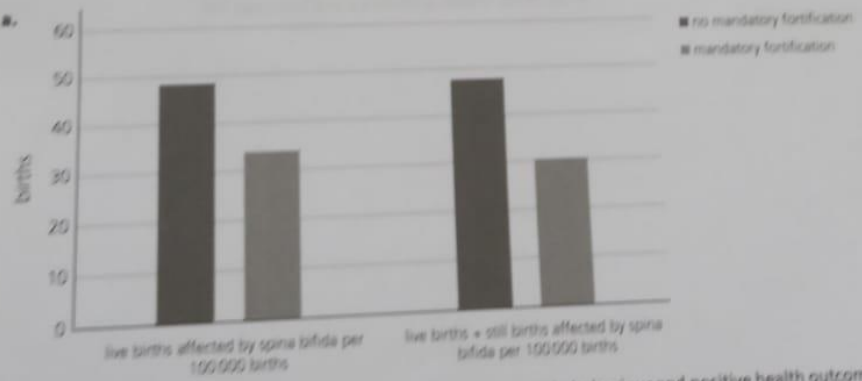
- Explain that for centuries people had no idea of the causes of spina bifida and we still do not know everything. Read the first paragraph headed 'Folic acid deficiencies' on page 206 with students. Ask what a peer reviewed paper means – make sure they all understand this.
- Discuss the ways in which scientific knowledge can be used by individuals, by medical professionals and by societies. Raise the issue of access – women cannot choose to eat folic acid-rich foods or take supplements if they do not know it is important or if they cannot afford/have access to the right foods. Students read the three bullet points – and then answer questions 1 and 2 on page 207.
- Give students **Worksheet 11.7.1**. Students then complete Q4 on page 207.
- Bring students together for a plenary session emphasising the importance of scientific understanding in decision making for both individuals and societies.

11.7 Student Book answers

1. **a.** A condition where the spine and spinal cord do not form properly in the fetus. It may be mild or very serious, causing paralysis.
   b. Scientists have discovered that women who lack folic acid in their diet have a higher risk of having a baby affected by spina bifida, and that if women take folic acid before and during pregnancy, the risk of having an affected baby is greatly reduced. So it is important for women to have folic acid to reduce the risk of having a baby affected by spina bifida.
2. Individual women can choose to eat folic acid-rich food or take folic acid supplements before they become pregnant and while they are pregnant, to reduce the risk of having a baby affected by spina bifida.
   Societies can choose to give all young women/pregnant women folic acid supplements OR to fortify staple foods such as bread and cereals so everyone has a good level of folic acid. This makes sure all women have plenty of folic acid whenever they get pregnant.
3.

Country	% change in the incidence of spina bifida since fortification of food
Canada	−54
Chile	−50
Costa Rica	−85
Oman	−80
South Africa	−30
US	−35

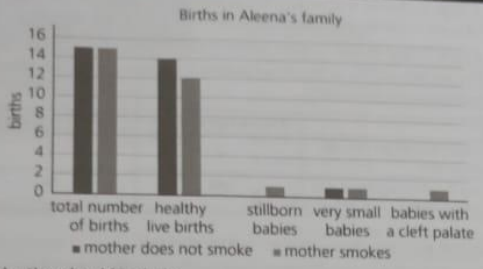
4. **a.**



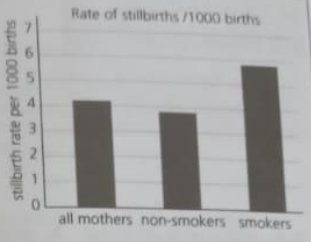
b. Look for students linking scientific understanding with changes in behaviour and positive health outcomes.

11.8 Student Book answers

1. a.



b.



2. Evaluation should include:

Aleena: Negatives: very personal, very small sample, based only on what people tell her. Positives: very personal; two similar sized samples; results reflect those from larger studies; displayed data clearly; any other sensible points.

Yousuf: Negatives: Doesn't tell us where the information comes from; limited data. Positives: has used big, peer reviewed studies; looked for data based on samples of many thousands of women; found more detailed information about the risk of stillbirths; compared two studies; displayed data clearly; any other sensible points.

3. Main points:

- Smoking during pregnancy risks harming the fetus.
- Smoking during pregnancy increases the risk of low birthweight babies.
- Smoking during pregnancy increases the risk of the baby being born dead, both because it dies before it is born or because it dies during the delivery.
- Smoking during pregnancy increases the risk of the baby failing to develop properly e.g. it increases the risk of cleft palate and heart defects.
- Even if the mother does not smoke, if her husband smokes or she spends a lot of time in a smoky atmosphere, the baby is also at increased risk of low birthweight, early birth, stillbirth, cleft palate, etc.
- Any other sensible, thoughtful points.

11.9 Review answers

Student Book pages 36–37

Student book answers

1. a. A large molecule that acts as the genetic material in the nucleus of a cell. It carries the instructions to make a new cell/new life. [2]

b. A long thread of DNA formed before a cell divides. [2]

c. The section of DNA in the chromosome carrying information about particular characteristics. [2]

d.

	Asexual reproduction	Sexual reproduction
How many parent cells are involved?	1	2
Are the offspring identical to their parents?	yes	no

2. a. cell X = sperm, cell Y = egg **b.** Gamete has half as many chromosomes as a normal cell. [2, 1]

c. Tail = A; Cytoplasm with fat stores = B; Nucleus on both = C; Head/streamlined head = D; Jelly layer = E [5]

d. A Tail = lets sperm swim to the egg; B Cytoplasm with fat stores = allows fertilised egg to grow and divide/produce an embryo; C Nucleus = contains the genetic material from the mother/father/ half the chromosomes; D Head/streamlined head = helps swimming/ breaks into egg; E Jelly layer = protects egg cell/attracts sperm. [6]

e. Similarity – both contain half the number of chromosomes of normal body cells. Differences – any two from: egg much bigger than sperm; sperm can swim, egg can't move itself; egg female, sperm male; [3]

3. a. Fertilisation **b.** C E B D A **c. i.** 23 **ii.** 23 [1, 5, 2]

4. a. Your blood group is directly inherited from your parents – nothing environmental can change it. The graph shows there are 4 distinct possibilities with no overlap. [3]

b. Identical twins are genetically identical so characteristics that are completely inherited, e.g. the shape of the earlobes and the blood group, will be identical whatever environment the twins grow up in. Height and body mass are partly inherited but they are affected by the environment the boys grew up in. If one twin had more and better food than the other, he will be taller and heavier. [5]

5. a. The pair of chromosomes that determine if you are female or male. [1]

b. See Figure 11.3D page 199. [8]

6. a. i. = B **ii.** = C **iii.** = D **iv.** = A [4]

b. Transports waste products from fetus to placenta/transports food and oxygen from placenta to fetus. [2]

c. Supports the fetus as it grows and moves and protects it from external knocks and bumps. [2]

7. a. A **b.** B **c.** B **d.** A [4]

8. a. Nutrients pass from the mother to her growing fetus through the placenta. During the whole pregnancy, the fetus needs a balance of nutrients for its tissues and organs to develop properly. The mother must eat a healthy diet to provide her fetus with everything it needs. If the mother is deficient in a nutrient, her fetus will be also and this can affect its development. [4]

b. During the last three months of pregnancy the baby grows and gains the weight it needs to survive after birth. It gets a layer of fat under the skin. The mother needs to eat a bit more to supply the baby with what it needs and maintain her own body. [3]

c. Some medicines can cross the placenta and reach the developing fetus. Some medicines can harm the fetus and stop it developing properly especially in the first twelve weeks of pregnancy. Doctors need to choose medicines which will make the mother better but will not harm her fetus. [3]

d. i. The mass of a baby increases as the pregnancy goes on. [1]

ii. The evidence does support the idea that cigarette smoking can harm a growing baby. It shows clearly that the mass of a baby in the last few weeks of pregnancy is lower when mothers smoke than when they don't. Babies with lower birthweight are more likely to have health problems or die. [3]

iii. Cigarette smoke contains many different chemicals which go into the blood of the mother. Carbon monoxide joins with the haemoglobin/red blood cells instead of oxygen, so a mother who smokes provides her developing baby with less oxygen for the developing cells. Many of the other chemicals in tobacco smoke cross the placenta from the mother to the baby. Many of them are toxins, so they slow down or affect the growth and development of the fetus. [5]

opportunities for students to read and manipulate data. It also covers content which is important for success in both CLSS, and IGCSE and which will help your students become informed and scientifically aware global citizens.

Activities

- Ask students to sketch the water cycle they learned in Chapter 4. Then introduce the idea that water is not the only substance that cycles in nature. Read the first two paragraphs on page 212 with students, which explain the carbon cycle and why it is so important to living organisms.
- **EITHER** read through the paragraphs on respiration, photosynthesis, feeding, decomposition and combustion on pages 212 and 213 with students **OR** ask groups of students to make a brief presentation about each of these processes based on the content of the Student Book pages and anything else they know.
- Look at Fig 12.1 C showing the carbon cycle. Look at the interactions between different organisms and the atmosphere and discuss them with students, asking for examples of the different types of organisms involved.
- Give each student a large sheet of paper on which to create a poster using **Worksheet 12.1.1**.
- Students answer questions 1 and 2 on page 213. If they have not used the worksheet, they also answer Q3.
- Summarise the carbon cycle with students, making sure that they know the five main processes involved.

12.1 Student Book answers

1. a. A series of processes that move carbon between living things and the physical environment.

b. Molecules that make up living organisms contain carbon; plants need carbon dioxide for photosynthesis – important that there is always enough carbon.

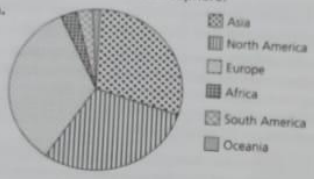
2. a. Photosynthesis, respiration, combustion, decomposition, feeding.

b. Respiration: takes place in all living organisms. Glucose molecules are broken down using oxygen, producing carbon dioxide (CO_2) and water. This releases energy to be used by cells. The carbon dioxide is released into the atmosphere.
Photosynthesis: takes place in the green parts of plants, and in algae. Uses energy from light, trapped by chlorophyll in the chloroplasts. Carbon dioxide is taken in from the air and combined with water to produce glucose and oxygen. Takes carbon dioxide out of the atmosphere.
Feeding: Animals eat plants or other animals. Carbon is passed from organism to organism.
Decomposition: Microorganisms such as bacteria and fungi feed on the waste materials produced by animals, the dead leaves produced by plants and the dead bodies of animals and plants. They break them down, releasing carbon dioxide back into the atmosphere.
Combustion: Many fuels e.g. wood, coal, oil and gas, are carbon compounds. When they burn, they react with oxygen in the air, producing carbon dioxide and water which are released into the atmosphere.

3. Any diagram based on Fig 12.1 C.

12.2 Student Book answers

1. a. The greenhouse effect: Light from the sun reaches the Earth. Lots is reflected back into space. Greenhouse gases like carbon dioxide trap energy from the sun, keeping the surface of the Earth warm enough for life.
   b. Increase in carbon dioxide = increase in the energy trapped in the atmosphere = increase in temperature at the surface of the Earth.
2. Human transport systems: based on engines which burn fossil fuels like petrol; when fossil fuels burn they produce carbon dioxide which goes into the atmosphere. Humans use a lot of transport so a lot of carbon dioxide produced; fossil fuels like gas, coal and oil burned to generate electricity; carbon dioxide produced when they burn increasing carbon dioxide in the atmosphere.
   Deforestation: Removes trees that take carbon dioxide out of the atmosphere. The trees are burnt which adds carbon dioxide to the atmosphere.
3. a.



   b. Europe produces much more of the global carbon dioxide emissions, and Asia a lot less than in modern times; no data for international aviation and shipping.
   c. During most of the time period 1751–2017 there was no international aviation and shipping used wind power, not combustion of fossil fuels.
   d. Asia has grown more powerful/carries out many of the industrial processes/people everywhere travel more using vehicles/people everywhere want electricity, refrigeration, etc. so usage and thus generation and carbon dioxide production goes up – any other sensible points.

impact of climate change on sea levels and why this is likely to have an effect on people around the world.

- Now give students **Worksheet 12.3.2**. They design a poster to warn of the potential problems that may arise as a result of global warming. Bring students together to summarise the learning points of the lesson.

Homework

Workbook page 91

Key words

glaciers

12.3 Student Book answers

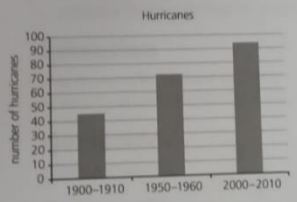
1. a. e.g. glaciation/global warming.

b. Ash from volcanoes or dust from meteorite hits blocking the Sun; changes in orbit of Earth or activity of the Sun/increased carbon dioxide levels in the atmosphere.

2. Any four from: sea levels rising, flooding, drought, extreme weather events; Earth's surface temperature rising; ice melting.

3. a. Trend has been a steady increase in the number of major storms.

b.



c. The trend is similar – the numbers of major storms and the numbers of hurricanes increase steadily over time.

Percentage increase in storms = 81/89 × 100 = 91%

Percentage increase in hurricanes = 49/45 × 100 = 109%

Rate of increase of hurricanes greater than the increase in tropical storms.

Climate change is causing an increase in extreme weather.

Workbook page 92

Key words

Intergovernmental Panel on Climate Change (IPCC), extinct

interpreting and analysing data. It also provides a further activity which considers the difficulties of using evidence such as this to make predictions.

- Draw together the work so far on the difficulties of changing carbon dioxide levels or predicting climate change and global warming.

12.4 Student Book answers

1. a. Intergovernmental Panel on Climate Change.

b. It studies evidence from thousands of scentists all over the world and advises governments globally.

c. 1.3–1.8 °C

2. a. Sea levels will continue to rise: (26–82) cm by the end of the century.

b. Low lying countries will disappear, loss of coastal land (breeding grounds etc), etc.

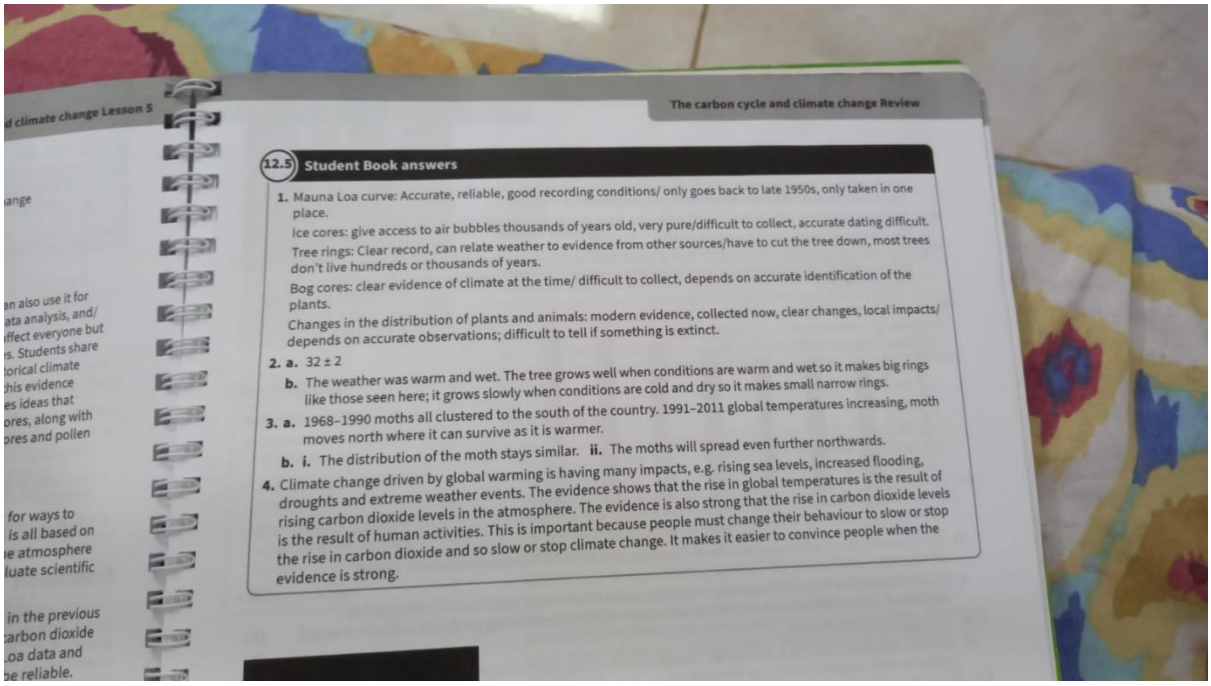
3. a. 415 – 370 = 45 (allow ±2 ppm)

b. 0.6 °C

c. i. Carbon dioxide: between 2000 and 2020 (20 years) increase was 415 – 370 = 45 ppm. If rate continues the same for the next 80 years will be 45 × 4 = 180 ppm more than current level. 415 + 180 = 595 ppm in 2100.

ii. Surface temperature: between 2000 and 2020 (20 years) there was a 0.6 °C rise in temperature. If that continues for the next 80 years, the temperature increase will be 0.6 × 4 = 2.4 °C.

Allow appropriate calculations based on student's answer in **3a**.



d climate change Lesson 5

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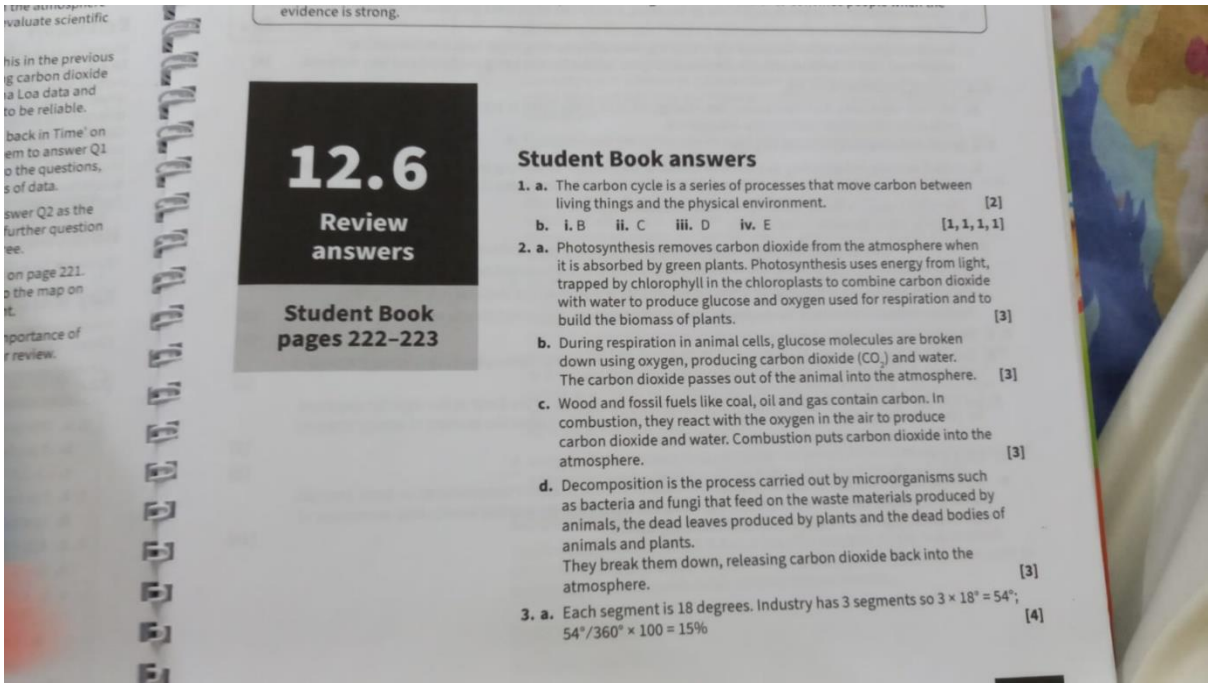
12.5 Student Book answers

1. Mauna Loa curve: Accurate, reliable, good recording conditions/ only goes back to late 1950s, only taken in one place.
   Ice cores: give access to air bubbles thousands of years old, very pure/difficult to collect, accurate dating difficult.
   Tree rings: Clear record, can relate weather to evidence from other sources/have to cut the tree down, most trees don't live hundreds or thousands of years.
   Bog cores: clear evidence of climate at the time/ difficult to collect, depends on accurate identification of the plants.
   Changes in the distribution of plants and animals: modern evidence, collected now, clear changes, local impacts/ depends on accurate observations; difficult to tell if something is extinct.
2. **a.** 32 ± 2
   b. The weather was warm and wet. The tree grows well when conditions are warm and wet so it makes big rings like those seen here; it grows slowly when conditions are cold and dry so it makes small narrow rings.
3. **a.** 1968–1990 moths all clustered to the south of the country. 1991–2011 global temperatures increasing, moth moves north where it can survive as it is warmer.
   b. i. The distribution of the moth stays similar. **ii.** The moths will spread even further northwards.
4. Climate change driven by global warming is having many impacts, e.g. rising sea levels, increased flooding, droughts and extreme weather events. The evidence shows that the rise in global temperatures is the result of rising carbon dioxide levels in the atmosphere. The evidence is also strong that the rise in carbon dioxide levels is the result of human activities. This is important because people must change their behaviour to slow or stop the rise in carbon dioxide and so slow or stop climate change. It makes it easier to convince people when the evidence is strong.



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12.6 Review answers

Student Book pages 222–223

Student Book answers

1. **a.** The carbon cycle is a series of processes that move carbon between living things and the physical environment. [2]
   b. i. B **ii.** C **iii.** D **iv.** E [1, 1, 1, 1]
2. **a.** Photosynthesis removes carbon dioxide from the atmosphere when it is absorbed by green plants. Photosynthesis uses energy from light, trapped by chlorophyll in the chloroplasts to combine carbon dioxide with water to produce glucose and oxygen used for respiration and to build the biomass of plants. [3]
   b. During respiration in animal cells, glucose molecules are broken down using oxygen, producing carbon dioxide (CO_2) and water. The carbon dioxide passes out of the animal into the atmosphere. [3]
   c. Wood and fossil fuels like coal, oil and gas contain carbon. In combustion, they react with the oxygen in the air to produce carbon dioxide and water. Combustion puts carbon dioxide into the atmosphere. [3]
   d. Decomposition is the process carried out by microorganisms such as bacteria and fungi that feed on the waste materials produced by animals, the dead leaves produced by plants and the dead bodies of animals and plants.
   They break them down, releasing carbon dioxide back into the atmosphere. [3]
3. **a.** Each segment is 18 degrees. Industry has 3 segments so 3 × 18° = 54°; 54°/360° × 100 = 15% [4]

b. Deforestation

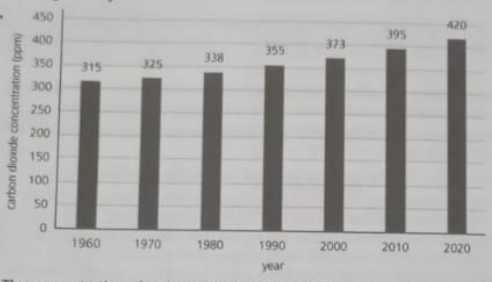
c. It reduces the numbers of trees and other plants. Plants remove carbon dioxide from the atmosphere in photosynthesis. Removing plants leaves more carbon dioxide in the air. Trees are often burned. Combustion of wood produces carbon dioxide raising the levels in the air. [1]

4. a. The concentration of carbon dioxide in the atmosphere in ppm (parts per million). [4]

b. Near the top of Mauna Loa volcano in Hawai'i. **c.** 1958 [2]

d. The trend increases from 1958 to 2020. The rise in concentration is steady from 1958 to the 1990s. Then the rate at which the carbon dioxide levels go up increases. Any other sensible points, e.g. variations through each year. [2, 1]

5. a.



[3]

b. The concentration of carbon dioxide in the air increases, and the rate of increase gets faster in the last 30–40 years. [3]

c. Use of transport has increased, more electricity is generated by burning fossil fuels and the rate has accelerated, rate of deforestation has increased so more carbon dioxide being produced and less removed. [4]

6. a. Cooling; glaciation/warming. [2]

b. Ash from volcanoes, dust from meteorites, changes in orbit of the Earth or activity of the sun/ increased carbon dioxide concentration in the atmosphere. [2]

7. a. International Panel for Climate Change. [1]

b. Global warming is happening as a result of human activities such as burning fossil fuels and deforestation – these are causing an increase in carbon dioxide and other greenhouse gases in the atmosphere. [2]

c. Sea levels rising, increased flooding, increased heatwaves and droughts, more severe weather events. [4]

d. Sea levels rising: losing land, coastal erosion which can remove breeding areas for animals, loss of countries.

Increased flooding: loss of lives, loss of homes, loss of crops, topsoil washed away.

Increased heatwaves and droughts: crops failing, people and animals starving, extinctions, big fires.

More severe weather events: direct deaths, loss of infrastructure, associated floods, etc. [8]

8. a. Diagram similar to Fig 12.2.A. [5]

b. Greenhouse gases trap some of the energy from the Sun in the Earth's atmosphere. This keeps the surface of the Earth relatively warm so it is the right temperature for life. [2]

c. Current level of carbon dioxide in the atmosphere keeps the surface of the Earth at the right temperature for life. Increasing levels of carbon dioxide in the atmosphere will increase the amount of energy trapped and so increase the temperature at the Earth's surface. [3]

d. 1.3–1.8 °C [2]

e. Any selection of valid points based on different impacts of a rise in global temperatures on land, animals, plants and people. Look for descriptions, e.g. rising sea level, extreme weather events AND awareness of their impacts, e.g. loss of countries/land/breeding grounds. [10]

13.1 Student Book answers

1. **a.** Genetic/inherited.
   b. Genetic/inherited; environmental.
2. **a.** Black and white/birds/with big colourful beaks/orange feet/live on rocky cliffs/have dark eyes and an eye stripe/beaks have red/blue/yellow stripes.
   b. Different sized beaks/different patterns of stripes on the beak/different depth of orange colour feet.
3. **a.** Genetic.
   b. There are four possible choices only/must be one of those types.
4. **a.** Three from: size of bulge at the bottom/size of flower/size of petals/shape of petals/depth of colour/shape of blue pattern.
   b. Some features are genetic: overall shape of the flower, pattern on the petals, colours.

   Environment only: lack of colour due to lack of minerals, any bits eaten by insects, any aspects of size or shape damaged by frost or heat.

   Combination: maximum size of plant/flower will be genetic BUT the size it reaches will be affected by the amount of photosynthesis that takes place which depends on amount of light and temperature. Appearance depends on the amount of water available.

selection.

Homework

Workbook page 95

Key words

natural selection

- Summarise the main points of the lesson. Introduce the idea that environment drives natural selection and ask students to think about examples of this and how it links to their work on the carbon cycle and climate change, before the next lesson.

13.2 Student Book answers

1. The parent organisms die, not all of the offspring survive.
2. **a.** A natural process by which the organisms best able to survive are the ones which live and reproduce, passing on advantageous characteristics to their offspring.
   b. Each individual inherits genetic variation from their parents and is different from all other members of their species. Individuals with characteristics that give them an advantage are the ones most likely to survive. The successful individuals survive long enough to reproduce and pass on their useful characteristics. This process is repeated many times until these characteristics become more common in the population. Over a long period of time, it may lead to the development of a new species.
3. Look for two local examples with clear understanding of how natural selection has led to particular characteristics, e.g. butterflies with long tongues to access nectar or similar.
4. Look for two local examples with clear understanding of how natural selection has led to particular characteristics, e.g. plants with deep roots to access water/flower at night for bat pollinators.

13.3 Student Book answers

1. If the environment changes, many organisms are no longer well adapted to their environment. Every population contains genetic variation. Some of the variants will be better adapted to the new conditions. They will breed successfully. As a result of natural selection most of the population will become this new form, adapted to the changed environment.
2. **a.** Best adapted; make the most seeds – 28 per plant.
   b. Both the 5-flowered plants and the 3-flowered plants cope better with the dry conditions than the 7-flowered plants. The 5-flowered plants make 15 seeds but the 3-flowered plants only make 6 seeds. The 5-flowered plants make more seeds so they reproduce more successfully/and become the most common form by natural selection.
   c. It would depend how the climate changes but one of the other variants might be better adapted to the new conditions. If it reproduces successfully it will become the main form by natural selection, e.g. if it gets wetter, the 7-flowered plant might become more common again by natural selection/if it gets even drier, the 3-flowered plants may cope better and be selected; even though they don't make many seeds they become the main form.
3. **a.** In normal years, whatever the temperature, kestrels raise an average of almost 3.3 young birds per nesting pair. When there is a drought, fewer young kestrels survive – on average fewer than 2.9 per nest.
   b. The data shows fractions of birds – but in any one nest it would be whole birds that survived. So must be the average of several or many nests in each case.
   c. As the temperature of the environment increases, those kestrels which are best adapted to the warmer conditions/e.g. eat a wider range of prey, regulate internal temperature better/will be more successful at raising chicks. Those less well adapted will raise fewer chicks – the overall effect will be that population numbers remain the same. In a severe drought it will be chance which birds find water or food –,so population numbers fall and natural selection has little effect.

Key words

extinct

13.4 Student Book answers

1. **a.** Extinction is when there are no more individuals of a particular species alive either in an area (local extinction) or anywhere on Earth (global extinction).
   b. Species become extinct because new species which are better adapted to the changed environmental conditions take their place. Extinction means there are not enough resources to go round.
2. **a.** Any four from: climate change; temperature of an area increasing; temperature decreasing; new disease; new predators; new competitors; changes in land use; catastrophic events; hunting; habitat destruction; pollution; any other sensible point.
   b. Extinction happens because there are no longer enough organisms left to breed and maintain a population so that when the final organisms die out the species becomes extinct.
3. **a.** 1800
   b. Amphibians. Global warming/loss of habitat; new fungal disease.
   c. Data shows that extinction rates have increased rapidly over the last 200 years for all types of vertebrates. This is the period of time when we know the environment has been warming much more quickly. Suggests that the increase in extinctions is linked to the increase in global temperatures. Numbers increased particularly during 20th century when measured global warming also increased. Data show the percentage of all the species of each type of vertebrate that have gone extinct. There are thousands of species, so 2% of that is many species. If vertebrates are going extinct, invertebrates and plants will also be affected. There are many more species of invertebrates and plants than vertebrates so the numbers of extinctions linked to climate change is very large.

Student Book answers

1. a. If natural selection causes changes in moth populations, clean woodlands will contain mainly pale moths. Pale moths are more likely to survive and reproduce, because they are camouflaged against the tree trunks where they rest. Darker moths produced by natural variation will be seen and eaten by birds. In polluted woodlands, he predicted that dark trees would make it easy for birds to find pale moths, so moths with genes for lighter colours would be eaten. As a result, in polluted woodlands there would be many more dark moths than light ones in the population.

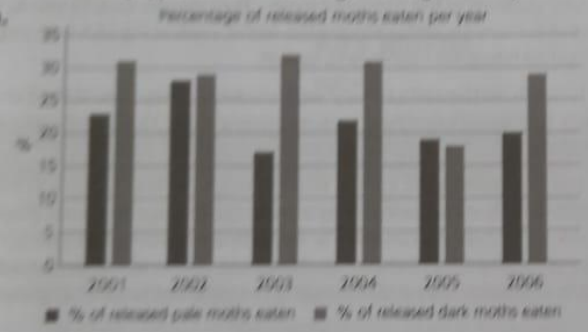
   b. Looked at colours of old collections/took data from amateur moth collectors all over the country/did field experiments on birds eating different coloured moths.

   c. Old collections were a way of looking back at moths that had lived before the industrial revolution. Taking data from moth collectors gave him evidence about colours of peppered moths in many populations and many different environments; field experiments allowed him to see if birds find more of one colour of moth than another on different coloured tree trunks.

2. a. Shows that the population of pale moths was very high until 1850. It fell until, by 1900, it was very low. Remained low until around 1970s when it increased again until, by around 2000, most moths are again the pale form. Shows that the population of dark moths was very low until 1850. It rose until, by 1900, it was very high. Remained high until around 1970s when it fell rapidly until, by around 2000, very few moths were the dark form.

   b. Until 1850, most peppered moths in clean woodlands were pale because dark form shows up clearly and those moths were eaten by birds so remain rare. From 1850s, woodlands became polluted as a result of industry. Became harder to see dark moths but easier to see pale moths so the proportions eaten by birds changed. After 50 years, mainly dark moths with just a few pale by natural selection. Around 1970s, pollution levels fell and woodlands became cleaner. Dark form became easier to see and were eaten; light form harder to see, so by the 2000s most peppered moths were again the light form by natural selection.

3. a.



b. Majerus carried out an investigation over many years. He observed peppered moths in their natural habitat to see where they rested and what ate them. He released 4864 moths over 6 years and observed where they rested, what ate them and the colours that were eaten. He built up a large data set which showed that, as Kettlewell observed, peppered moths do rest on tree trunks, they are eaten by birds and that, in a clean woodland, birds see the dark form more easily than the light and a greater proportion of the dark moth population is eaten. Thus natural selection will result in a larger number of pale moths as more of them live to reproduce. His findings confirmed the work of Kettlewell 50 years earlier.

13.6 Student Book answers

1. a.

Advantages of hydroelectric power	Disadvantages of hydroelectric power
Relatively cheap	[No disadvantages are mentioned]
Doesn't burn fossil fuels so doesn't add carbon dioxide to the atmosphere	
Clean	
Plenty of rivers and water in many parts of the world	
Helps prevent global warming and climate change	

b.

Advantages of hydroelectric power	Disadvantages of hydroelectric power
Generates electricity	Drains water from areas
	Floods areas
	Prevents fish moving up and down river to reproduce
	Remove indigenous peoples
	Destroys ecosystems

c. Nearly one third of all freshwater fish species are threatened by extinction/16 freshwater fish species became globally extinct in one year in 2020/populations of migratory fish like salmon and eels have fallen by 75% in the last 50 years/megafish – enormous freshwater fish that weigh over 30 kg and live for many years are seriously threatened/Their populations have reduced by around by 94% since 1970.

2. a. Global warming and climate change are the result of increased greenhouse gases in the atmosphere. Generating electricity by burning fossil fuels adds carbon dioxide to the atmosphere/which increases global warming and climate change. BUT everyone wants access to electricity for all the benefits it brings. Hydroelectric power uses a natural renewable resource to produce electricity/and does not add greenhouse gases to the atmosphere/so helps reduce/prevent global warming and climate change./However, building dams traps water in huge reservoir./These flood the land./This may displace indigenous people/and destroys ecosystems./Changing the river flow can cause drought in other places./It stops fish from moving up- or down-river to breed.

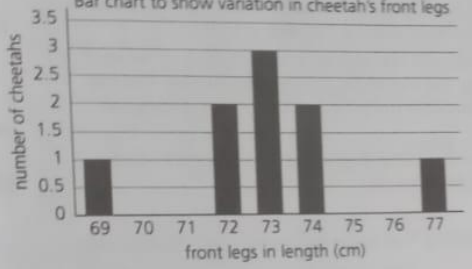
b. To have the benefits without the problems means careful planning/and looking for both the advantages and disadvantages before starting./Make sure other areas or countries are not deprived of water./Build the dam where it will have least effect on indigenous people or ecosystems./Build ways for fish to make their way up and down stream around the dam./Any other sensible points.

13.7 Review answers

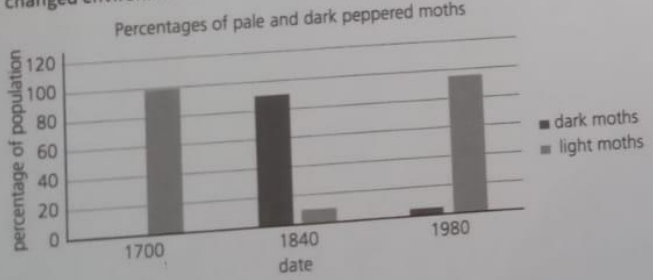
Student Book pages 236–237

Student Book answers

1. **a.** Differences between organisms of the same species. [1]
   b. Bar chart/graph [1]
   c. Inherited/genetic variation; environmental variation, e.g. different amounts of food given or found. [2]
2. **a.** O [1]
   b. AB [1]
   c. Body mass is decided by a combination of genetics and your environment. The amount you eat affects it. Blood groups are inherited/genetic variation. Nothing in the environment will change them. [6]
3. **a.** Natural selection is the process by which the organisms with the characteristics best adapted to their environment live and reproduce, passing on the useful characteristics to their offspring. [2]
   b. [5]



   c. A combination of genetic and environmental variation. [2]
   d. Cheetahs with the best leg length will be most able to run fast enough to capture prey without breaking their bones. These are the cheetahs that are most likely to survive to reproduce and pass on their genes for long legs. As a result of this natural selection, most female cheetahs have legs that are (72–74) cm long. A few cheetahs have short legs or particularly long legs as a result of natural variation. [6]
   e. Until the environment changed and a new plant-eater arrived, cheetahs with shorter legs were at a disadvantage, even though they used less energy. When a slower moving prey that reproduces quickly appears, shorter legged and slower cheetahs can catch them easily. As they also use less energy, they will be at an advantage, do well and become more likely to survive and pass on their genes. The population will change; most animals will have shorter legs and use less energy, as a result of natural selection. [6]
4. **a.** Organisms in a species show genetic variation → The organisms with the characteristics best adapted to the environment survive and reproduce. Less well adapted organisms die. → Genes from the successful organism are passed on to the offspring. They are likely to have the useful characteristics that made their parents successful → The process is repeated until most of the population have the useful characteristics. [6]
   b. A population or species is adapted to its environment. If the environment changes, e.g. warms due to climate change, the organisms will not be as well adapted. Some individuals in the population will be different as a result of natural variation. If some of the population cope better with the changed environment, they will be more likely to breed successfully and pass on their advantageous characteristics until most of the species have these characteristics and are adapted to the changed environment. [6] [5]
5. **a.**



b. The population was almost entirely pale moths in 1700. By 1840, 90% of the population were dark moths. **[2]**

c. Pale moths would be more visible. **[1]**

d. Light moths became the most common form again, changing from 10% of the population to 95% of the population. The dark moths did the opposite and became rare again. **[3]**

e. In 1700, trees and buildings were clean. The pale form of the moth was hard to see. Dark moths were easy for birds to see and eat. Mainly pale moths survived to reproduce and so by natural selection most of the population was pale.

By 1840 the industrial revolution had resulted in a lot of smoke and many trees were blackened. Now the pale moths were easy for the birds to see and eat. Dark moths were camouflaged. They survived to reproduce and pass on the dark colour genes. The population became largely dark in colour by natural selection.

In the 1970s, the air was cleaned up. Trees became pale again. The paler moths had the advantage and survived to breed. Dark moths were seen and eaten. So natural selection drove the population back to being mainly pale moths with a few dark variations. **[12]**

6. a. Extinction is when there are no more individuals of a species left alive. It may be local or global, when an organism no longer exists anywhere on Earth. Any correct example, e.g. dinosaurs, dodo. **[4]**

b. The graph shows the human population growing steadily until the middle of the 20th century, when it starts to grow much faster. The rate of extinctions is very low and stable until around the time that the human population grows rapidly. Shortly after this, the numbers of extinctions rises very steeply and continues to do so. **[4]**

c. Once the human population starts to grow rapidly, human activities begin to change the environment and so drive organisms to extinction/any other sensible explanation. **[3]**

d. Any four sensible suggestions with reasons, e.g.:

Change the environment of an organism, e.g. global warming. Some species cannot cope with change in temperature and become extinct.

Change the environment so new diseases can take hold, wiping out species.

Introduce new organisms to an environment – may be new predators and wipe out species/or better competitors and wipe out species.

Loss of habitat causes extinction as species have nowhere to live or breed.

Hunting – guns and vehicles enable people to kill large numbers of animals and drive them to extinction/ overfishing making fish species extinct. **[8]**