AQA Separate Biology

Ecology

Revision Booklet

Name: _____

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4.7 Ecology Pupil Checklists

4.7.1 Adaptations, interdependence and competition	
4.7.1.1 Communities	**Review**
Describe: • different levels of organisation in an ecosystem from individual organisms to the whole ecosystem • the importance of interdependence and competition in a community.	☺ 😐 ☹
Be able to, when provided with appropriate information: suggest the factors for which organisms are competing in a given habitat suggest how organisms are adapted to the conditions in which they live.	☺ 😐 ☹
Recall that an ecosystem is the interaction of a community of living organisms (biotic) with the non-living (abiotic) parts of their environment.	☺ 😐 ☹
Understand that to survive and reproduce, organisms require a supply of materials from their surroundings and from the other living organisms there.	☺ 😐 ☹
Recall that plants in a community or habitat often compete with each other for light and space, and for water and mineral ions from the soil. Animals often compete with each other for food, mates and territory.	☺ 😐 ☹
Understand that within a community each species depends on other species for food, shelter, pollination, seed dispersal etc. If one species is removed it can affect the whole community. This is called interdependence. A stable community is one where all the species and environmental factors are in balance so that population sizes remain fairly constant.	☺ 😐 ☹
Extract and interpret information from charts, graphs and tables relating to the interaction of organisms within a community.	☺ 😐 ☹
4.7.1.2 Abiotic factors	**Review**
Explain how a change in an abiotic factor would affect a given community given appropriate data or context.	☺ 😐 ☹
Recall that the abiotic (non-living) factors which can affect a community are: • light intensity, temperature, moisture levels, soil pH and mineral content • wind intensity and direction, carbon dioxide levels for plants, oxygen levels for aquatic animals.	☺ 😐 ☹
Extract and interpret information from charts, graphs and tables relating to the effect of abiotic factors on organisms within a community.	☺ 😐 ☹

4.7.1.3 Biotic factors	**Review**
Explain how a change in a biotic factor might affect a given community given appropriate data or context.	☺ 😐 ☹
Recall that biotic (living) factors which can affect a community are; • availability of food • new predators arriving • new pathogens • one species outcompeting another so the numbers are no longer sufficient to breed.	☺ 😐 ☹
Extract and interpret information from charts, graphs and tables relating to the effect of biotic factors on organisms within a community.	☺ 😐 ☹
4.7.1.4 Adaptations	**Review**
Explain how organisms are adapted to live in their natural environment, given appropriate information.	☺ 😐 ☹
Understand that organisms have features (adaptations) that enable them to survive in the conditions in which they normally live. These adaptations may be structural, behavioural or functional.	☺ 😐 ☹
Understand that some organisms live in environments that are very extreme, such as at high temperature, pressure, or salt concentration. These organisms are called extremophiles. Bacteria living in deep sea vents are extremophiles.	☺ 😐 ☹

4.7.2 Organisation of an ecosystem	
4.7.2.1 Levels of organisation	**Review**
Understand that photosynthetic organisms are the producers of biomass for life on Earth.	☺ 😐 ☹
Understand that feeding relationships within a community can be represented by food chains. All food chains begin with a producer which synthesises molecules. This is usually a green plant or alga which makes glucose by photosynthesis.	☺ 😐 ☹
Understand that a range of experimental methods using transects and quadrats are used by ecologists to determine the distribution and abundance of species in an ecosystem.	☺ 😐 ☹
In relation to abundance of organisms you should be able to: • understand the terms mean, mode and median • calculate arithmetic means • plot and draw appropriate graphs selecting appropriate scales for the axes	☺ 😐 ☹
Recall that producers are eaten by primary consumers, which in turn may be eaten by secondary consumers and then tertiary consumers.	☺ 😐 ☹
Recall that consumers that kill and eat other animals are predators, and those eaten are prey. In a stable community the numbers of predators and prey rise and fall in cycles.	☺ 😐 ☹
Interpret graphs used to model the above cycles.	☺ 😐 ☹
4.7.2.2 How materials are cycled	**Review**
Recall that many different materials cycle through the abiotic and biotic components of an ecosystem	☺ 😐 ☹
Explain the importance of the carbon and water cycles to living organisms.	☺ 😐 ☹
Recall that all materials in the living world are recycled to provide the building blocks for future organisms.	☺ 😐 ☹
Recall that the carbon cycle returns carbon from organisms to the atmosphere as carbon dioxide to be used by plants in photosynthesis.	☺ 😐 ☹
Understand that the water cycle provides fresh water for plants and animals on land before draining into the seas. Water is continuously evaporated and precipitated.	☺ 😐 ☹
Explain the role of microorganisms in cycling materials through an ecosystem by returning carbon to the atmosphere as carbon dioxide and mineral ions to the soil.	☺ 😐 ☹
4.7.2.3 Decomposition (biology only)	**Review**
Explain how temperature, water and availability of oxygen affect the rate of decay of biological matter.	☺ 😐 ☹
• Calculate rate changes in the decay of biological material • Translate information between numerical and graphical form • Plot and draw appropriate graphs selecting appropriate scales for the axes	☺ 😐 ☹
Gardeners and farmers try to provide optimum conditions for rapid decay of waste biological material. The compost produced is used as a natural fertilizer for growing garden plants or crops.	☺ 😐 ☹
Aerobic decay produces methane gas. Biogas generators can be used to produce methane gas as a fuel.	☺ 😐 ☹

4.7.2.4 Impact of environmental change (biology only) (HT only)	**Review**
Evaluate the impact of environmental changes on the distribution of species in an ecosystem given appropriate information.	☺ 😐 ☹
Environmental changes affect the distribution of species in an ecosystem. These include: temperature, availability of water and composition of gases	☺ 😐 ☹
The changes may be seasonal, geographic or caused by human interaction	☺ 😐 ☹

4.7.3 Biodiversity and the effect of human interaction on ecosystems	
4.7.3.1 Biodiversity	**Review**
Recall that biodiversity is the variety of all the different species of organisms on earth, or within an ecosystem.	☺ 😐 ☹
Understand that a great biodiversity ensures the stability of ecosystems by reducing the dependence of one species on another for food, shelter and the maintenance of the physical environment.	☺ 😐 ☹
Understand that the future of the human species on Earth relies on us maintaining a good level of biodiversity. Many human activities are reducing biodiversity and only recently have measures been taken to try to stop this reduction.	☺ 😐 ☹
4.7.3.2 Waste management	**Review**
Understand that rapid growth in the human population and an increase in the standard of living mean that increasingly more resources are used and more waste is produced. Unless waste and chemical materials are properly handled, more pollution will be caused.	☺ 😐 ☹
Recall that pollution can occur: • in water, from sewage, fertiliser or toxic chemicals • in air, from smoke and acidic gases • on land, from landfill and from toxic chemicals.	☺ 😐 ☹
Recall that Pollution kills plants and animals, which can reduce biodiversity.	☺ 😐 ☹
4.7.3.3 Land use	**Review**
Recall that humans reduce the amount of land available for other animals and plants by building, quarrying, farming and dumping waste.	☺ 😐 ☹
Understand that the destruction of peat bogs, and other areas of peat to produce garden compost, reduces the area of this habitat and thus the variety of different plant, animal and microorganism species that live there (biodiversity).	☺ 😐 ☹
Recall that the decay or burning of the peat releases carbon dioxide into the atmosphere.	☺ 😐 ☹

4.7.3 Biodiversity and the effect of human interaction on ecosystems	
4.7.3.4 Deforestation	**Review**
Recall that large-scale deforestation in tropical areas has occurred to • provide land for cattle and rice fields • grow crops for biofuels	☺ 😐 ☹
4.7.3.5 Global warming	**Review**
Describe some of the biological consequences of global warming.	☺ 😐 ☹
Understand that levels of carbon dioxide and methane in the atmosphere are increasing, and contribute to 'global warming'.	☺ 😐 ☹

4.7.3.6 Maintaining biodiversity	**Review**
Describe both positive and negative human interactions in an ecosystem and explain their impact on biodiversity.	☺ 😐 ☹
Understand that scientists and concerned citizens have put in place programmes to reduce the negative effects of humans on ecosystems and biodiversity. These include: • breeding programmes for endangered species • protection and regeneration of rare habitats • reintroduction of field margins and hedgerows in agricultural areas where farmers grow only one type of crop • reduction of deforestation and carbon dioxide emissions by some governments • recycling resources rather than dumping waste in landfill.	☺ 😐 ☹

4.7.4 Trophic levels in an ecosystem (biology only)	
4.7.4.1 Trophic levels	**Review**
Describe the differences between trophic levels of organisms within an ecosystem.	☺ 😐 ☹
Trophic levels can be represented by numbers, starting at level 1 with plants and algae. Further trophic levels are numbered subsequently according to how far the organism is along the food chain. • Level 1: plants and algae make their own food and are called producers • Level 2: Herbivores eat plants/algae and are called primary consumers • Level 3: Carnivores that eat herbivores are called secondary consumers • Level 4: Carnivores that eat other carnivores are called tertiary consumers. Apex predators are carnivores with no predators	☺ 😐 ☹
Decomposers break down dead plant and animal matter by secreting enzymes into the environment. Small soluble food molecules then diffuse into the microorganism.	☺ 😐 ☹
4.7.4.2 Pyramids of biomass	**Review**
Pyramids of biomass can be constructed to represent the relative amount of biomass in each level of a food chain. Trophic level 1 is at the bottom of the pyramid.	☺ 😐 ☹
Construct accurate pyramids of biomass from appropriate data.	☺ 😐 ☹
4.7.4.3 Transfer of biomass	**Review**
Describe pyramids of biomass and explain how biomass is lost between the different trophic levels.	☺ 😐 ☹
Recall that producers are mostly plants and algae which transfer about 1% of the incident energy from light for photosynthesis.	☺ 😐 ☹
Only approximately 10% of the biomass from each trophic level is transferred to the level above it	☺ 😐 ☹
Losses of biomass are due to: • Not all the ingested material is absorbed, some is egested as faeces • Some absorbed material is lost as waste, such as carbon dioxide and water in respiration and water and urea in urine. Explain how this affects the number of organisms at each trophic level.	☺ 😐 ☹

4.7.5 Food production (biology only)	
4.7.5.1 Factors affecting food security	**Review**
Define food security as having enough food to feed a population Describe some of the biological factors affecting food security; • The increasing birth rate has threatened food security in some countries • Changing diets in developed countries means scarce food resources are transported around the world • New pests and pathogens affecting farming • Environmental changes that affect food production, such as widespread famine occurring in some countries if rains fall • The cost of agricultural inputs • Conflicts that have arisen in some parts of the world which affect the availability of food or water Recall that sustainable methods must be found to feed all people on Earth.	☺ 😐 ☹
4.7.5.2 Farming techniques	**Review**
The efficiency of food production can be improved by restricting energy transfer from food animals to the environment. This can be done by limiting their movement and by controlling the temperature of their surroundings.	☺ 😐 ☹
Some animals are fed high protein foods to increase growth.	☺ 😐 ☹
4.7.5.3 Sustainable fisheries	**Review**
Fish stocks in the oceans are declining. It is important to maintain fish stocks at a level where breeding continues or certain species may disappear altogether in some areas.	☺ 😐 ☹
Control of net size and the introduction of fishing quotas play important roles in conservation of fish stocks at a sustainable level.	☺ 😐 ☹
4.7.5.4 Role of biotechnology	**Review**
Describe and explain some possible biotechnical and agricultural solutions, including genetic modification, to the demands of the growing human population.	☺ 😐 ☹
Modern biotechnology techniques enable large quantities of microorganisms to be cultured for food	☺ 😐 ☹
The fungus *Fusarium* is useful for producing mycoprotein, a protein-rich food suitable for vegetarians. The fungus is grown on glucose syrup, in aerobic conditions, and the biomass is harvested and purified.	☺ 😐 ☹
A genetically modified bacterium produces human insulin. When harvested and purified this is used to treat people with diabetes.	☺ 😐 ☹
GM crops could provide more food or food with an improved nutritional value such as golden rice.	☺ 😐 ☹

4.7 Ecology Knowledge

4.7.1 Adaptations, interdependence and competition

4.7.1.1 Communities

These are important key terms:

- An **ecosystem** is the interaction between a **community** of living organisms and their environment.
- A community is two or more **populations** of organisms.
- An ecosystem is two or more populations of organisms (usually many more) in their environment.
- A population is all the organisms of the same or closely-related **species** in an area.

Levels of organisation within an ecosystem

Organisms within an ecosystem are organised into levels.

Producer	Producers are plants and algae, which photosynthesise.
Primary consumer	Primary consumers are herbivores, which eat producers.
Secondary consumer	Secondary consumers are carnivores, which eat primary consumers.
Tertiary consumer	Tertiary consumers are also carnivores. They eat secondary consumers.

Interdependence

All organisms in an ecosystem depend upon each other. If the population of one organism rises or falls, then this can affect the rest of the ecosystem.

A simple food chain is:

grass → rabbit → fox

If the foxes in the **food chain** above were killed, the population of rabbits would increase because they are no longer prey to the foxes. As a result the amount of grass would decrease because the increased population of rabbits would be eating it.

Often very small changes to ecosystems have large consequences, which can be difficult to predict. This means that all the organisms in an ecosystem are dependent upon each other. We call this **interdependence**.

Competition

All **photosynthesising** plants and algae in an ecosystem compete for light, space, water and minerals from the soil. Animals in an ecosystem compete for food, mates and their territory. Organisms which have more of these resources tend to grow more healthily and are more likely to have offspring. Competition can be interspecific or **intraspecific** depending on whether organisms from different species or the same species are competing for resources.

Stable communities

A stable community is one in which the size of the populations of all species remain relatively constant over time. In the example above the amount of grass, and the numbers of rabbits and foxes all remain relatively constant. The different populations are living in a healthy balance with their environment.

4.7.1.2 Abiotic factors

The abundance is the number of organisms in an **ecosystem** and their distribution is affected by **abiotic** factors. These are factors that are non-living.
They include:

Light intensity
Some plants have evolved for **optimum** growth in bright sunlight. An example of this is a cactus houseplant. Cacti originally come from deserts where they grow in bright sunlight. Other plants have evolved to grow in shade.
Many orchids, which are also kept as houseplants, grow on trees in the rainforest and have evolved for optimum growth in darker conditions. If you were to put an orchid on a bright windowsill and a cactus in a dark corner of your room neither plant would grow well.

Temperature
Both animals and plants have evolved to grow healthily at their optimum temperatures. If you planted either your cactus or orchid houseplants outside in cold temperatures, they would die. Similarly, animals that have evolved to live at the North Pole, such as the polar bear, could not survive in warmer conditions.

Moisture levels
More people kill houseplants by overwatering than by under-watering them. Many plants cannot survive in waterlogged soils. Their roots are unable to **respire**, they rot and the plant dies. Other plants, such as pitcher plants, grow best in bogs where the moisture levels are high. Soil moisture meters can accurately determine how wet an area is.

Soil pH content
The pH of soils can have a huge effect on the plants that are able to grow in them. Some plants, like azaleas, grow best in acidic soils and will quickly die if planted in alkaline soils. Others, like clematis, prefer alkaline soils. Some, like the hydrangea, can grow in both. These plants are unusual in that their flower colour changes in different soils. Just like universal indicator paper, hydrangea flowers are pink in acidic soils and blue in alkaline soils.

pH meters can accurately determine the pH of soils.
The pH of water can also affect the aquatic organisms that are found there. Different species have evolved to survive at different pH levels found within water.

Soil mineral content
Many plants require high levels of soil minerals to grow well. An example of this is magnesium, which is required to produce chlorophyll. Plants with unnaturally yellow leaves may have a magnesium **deficiency**. Carnivorous plants, such as pitcher plants, have evolved to catch insects to supplement the low levels of minerals found in the soils in which they grow.

Wind intensity and direction
The strength of the wind and its direction has a huge impact on where organisms are found within ecosystems. Many organisms prefer more sheltered locations. Plant seeds are more likely to settle and germinate there, and animals which depend upon these are more likely to live close to where they grow. The strength of the wind can also affect the growth of individual organisms.

Carbon dioxide levels for plants
Carbon dioxide is a reactant in **photosynthesis** which means plants need it to survive. Areas with higher levels of carbon dioxide are more likely to have healthy plants growing. Farmers often release carbon dioxide within their greenhouses to maximise their **crop yield**. Woodlands often

have higher carbon dioxide levels than open grassland, so many plants living in open areas have evolved mechanisms to overcome a shortage of carbon dioxide.

Oxygen levels for aquatic animals
Oxygen from the air and oxygen produced by aquatic plants dissolves in water. Without this, aquatic animals would suffocate and die. Healthy lakes and rivers have high levels of oxygen, and polluted waters often have low levels of oxygen. This pollution means that only certain **species** can survive there such as sludgeworms.

4.7.1.3 Biotic factors

The abundance and distribution of organisms are affected by **biotic** factors, which are factors that are living.
They include:

Availability of food
All animals require food to live. The availability of food is a major factor in how many animals live in an **ecosystem**. Areas like rainforests with rich food supplies have more **species** of life than other areas like deserts and the Polar Regions where there is less food.

New predators
The arrival of new **predators** in an ecosystem can have a devastating effect. In balanced ecosystems, predators and **prey** have evolved together. Predators can catch enough prey to survive, **but not so many that they kill all of their food**.
The arrival of a new predator can upset this balance. An example of this is the introduction of the red fox to Australia, which has caused concern over their effect on native birds and small mammals. Introducing new predators can cause a rapid decline in the numbers of prey, which then reduces the food supply for existing predators.

New pathogens
When organisms inhabit new ecosystems they often bring new **pathogens**. As an example, Europeans first colonised North America, and introduced new pathogens, like the influenza virus. Many Native Americans had not developed immunity to new diseases such as this, and so many were killed by them. There are many examples of new pathogens being introduced to the UK. Ash dieback is a disease caused by a fungus which has killed many ash trees since it was first found in the UK in 2012.
Pathogens have also been introduced on purpose. Myxomatosis is a disease that affects rabbits. It is caused by a virus and infected rabbits develop skin tumours and may go blind. In the 1950s it was purposefully released into the wild in the UK to reduce the **population** of rabbits. It did exactly this and some people estimate that more than 99 per cent of rabbits in the UK died. However, our rabbits developed immunity to it and the population has now returned to previous levels.

Out-competition
The introduction of a new species into an ecosystem can result in it out-competing another native species. Several hundred years ago grey squirrels were brought over from North America by wealthy people and let free in their grounds. Our smaller native red squirrel couldn't compete with the newer, larger grey squirrel. Because grey squirrels are larger they can store more fat and survive harsher winters. So the numbers of red squirrels and the places they live has reduced dramatically.
Other examples of out-competition of native species by newly introduced species include the Canada goose in Europe and the cane toad in Australia, Himalayan balsam in Cambodia and harlequin ladybirds are also current concerns.

4.7.1.4 Adaptations

Competition in plants

Light
All plants and algae need light to photosynthesise. Plants compete for light by growing quickly to reach it and often shade other plants with their leaves. When an old tree in a forest dies and falls to the ground, there is a race to fill in the gap in the canopy. It doesn't look like a race to us because it happens slowly.

Water from the soil
Water is a reactant in photosynthesis and it is essential that plants have a regular supply of water for the process to occur. Some fully grown trees, like the oak tree, lose a staggering 150 litres of water per day, which is used to transport materials through the plant to the leaves. Some plants have roots that are shallow but extend a long way from the tree to maximise the update of water after rainfall. Others have roots that are deep to find stores of underground water.

Minerals from the soil
Plants require minerals for healthy growth. These include nitrates and magnesium. Without sufficient minerals plants suffer deficiency diseases because they cannot grow healthily. Plants that grow in soils with few minerals, such as bogs, have evolved different ways of accessing nitrates. Some, like the Venus flytrap and pitcher plants, have evolved to be carnivorous and consume insects, enabling them to grow more successfully than their competitors on mineral poor soil.

Space
Plants also require space for healthy growth. This means their leaves are not shaded which maximises photosynthesis. Some gardeners have experimented by planting vegetables very close together. These result in much smaller vegetables being produced.
Competition can be intraspecific, for example competition between oak trees in a forest, or interspecific such as when another species of tree like birch or yew grew next to oak trees. When a woodland tree dies, other younger trees compete to replace it. This competition ensures the growth of the healthiest individuals, and maintains vigour in the population.

Individuals within a species that cannot compete effectively are unlikely to reproduce, and may die. This is known as survival of the fittest and is a driver for evolution. Whole species that are unable to effectively compete many become extinct.

Competition in animals

Food
All animals require food which provides them with energy and raw materials to complete life processes, without which they may die. Because of these, competition for food can be fierce. There are many birds which eat insects in our gardens, and some have evolved to only eat certain types of insect to reduce competition from other species. Others like the blue tit and great tit compete with other members of their own species and as well as others for different insects. Because food is so vital, many animals will fight for it.

Mates
Animals within a species also compete for mates. This is essential so they can pass on their genes to their offspring. Animals have evolved to have an innate or natural drive to reproduce, and this competition often results in fights. This is seen each year when animals like red deer group together at the start of the mating season. Large male deer fight with each other by

locking antlers and pushing hard, which is called a rut. In deer, and many others species, these fights competing for mates can often result in serious injury or death, but benefits the population as only the strongest pass on their genes to the next generation.

Territory
The territories of animals contain all of the resources and conditions they need to survive. These include abioticfactors such as light, temperature and water, and oxygen for aquatic animals. There are also biotic factors such as food and predators. Many animals, including the cats in back gardens, will fight for territory.
An example of intraspecific competition over territory would be between lions on the grass plains of Africa whereas interspecific competition would occur when another predator like leopards lived close to the lions.

Adaptations to the environment in plants
Plant adaptations can be structural, behavioural or physiological. Regardless of the type, all adaptations make organisms better suited to their ecosystem and provide them with a better chance of survival and reproduction, which are their ultimate aims. The adaptations that arise from competition are essential for the process of evolution. Survival of the fittest means survival of those best adapted.

Structural adaptations in plants
Structural adaptations of plants are the physical features, which allow them to compete. An example of this is the formation of spines, which are found on many species, such as cacti and roses, and can stop a plant being eaten by grazing animals. Other examples of structural adaptions include plants with wide-ranging, shallow roots to absorb lots of water after rain, large leaves to maximise photosynthesis and flowers, which attract insects to pollinate them.

Behavioural adaptations in plants
Behavioural adaptations of plants are behaviours which give them an advantage. All plant shoots grow quickly towards the light to maximise photosynthesis. Growth towards the light and other tropisms ensure that plants can respond to changes in their environment. Plant roots which grow downwards may be because of gravity or growing directly towards water to maximise photosynthesis. Other plants like the Venus flytrap have evolved structural and behavioural adaptations to catch insects. The flytrap itself is a structural adaptation and the closing of the trap to catch an insect is a behavioural adaptation.

Physiological adaptations in plants
Physiological adaptations of plants are processes which allow them to compete. An example of this is the formation of poisons for defence. The nettle plant stings us when we brush the tiny needles on its leaves, which contain poison. Other plants, like deadly nightshade, are so poisonous they can kill if consumed by humans.

Adaptations to the environment in animals
Not only are plants able to adapt to an ecosystem, so too can animals. Again, the adaptations can be structural, behavioural or physical to meet the aim of survival and reproduction. The competition that arises from adaptations is essential for the process of evolution.

Structural adaptations in animals
Structural adaptations of animals are the physical features which allow them to compete. Animals have a wide range of structural adaptations including sharp claws to catch prey, dig burrows or scratch trees to signal territories. The scratching of trees is a behavioural adaptation.

Predators and prey often have similar adaptations. Both are likely to have good vision and hearing. Prey often has eyes on the sides of their heads to easily spot predators. Predators often have their eyes on the front of their heads to judge distance to their prey.

Behavioural adaptations in animals
Behavioural adaptations of animals are behaviours which give them an advantage. Behavioural adaptations include mating rituals, like a male peacock bird showing his tail feathers to attract a female mate. They can also include working together in packs like wolves to hunt prey. Other animals have evolved the behavioural adaptation of using tools. For example, crocodiles use twigs to lure birds, who would pick them up to build nests.

Physiological adaptations in animals
Physiological adaptations of animals are processes which allow them to compete. The production of venom is an example of this. Many predators such as snakes and spiders produce venom both to defend themselves and kill their prey. When the cane toad was introduced into Australia, predators, such as native crocodiles and turtles, had not evolved to be resistant to its venom. Many ate cane toads and were killed.

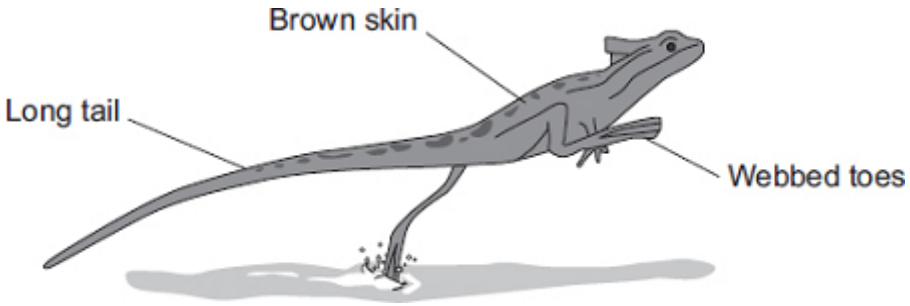
4.7.1 Adaptation, interdependence and competition PPQ's

Low demand

PPQ 1

Q1.

The picture shows a basilisk lizard. Some of the adaptations of the lizard are labelled.



Basilisk lizards are often found resting on branches of trees that grow next to water.
Basilisk lizards can run across the surface of the water.

(a) Draw **one** line from each adaptation of the lizard to the advantage of the adaptation.

Adaptation	Advantage
	For camouflage on branches of trees
Toes on the back feet are webbed	
	Helps the lizard to balance when running
Long tail	
	Warning colours to deter predators
Brown skin	
	Increases surface area in contact with the water

(3)

(b) Suggest **one** advantage to the basilisk lizard of being able to run across the surface of the water.

_____

_____

(1)

(c) Animals, such as lizards, compete with each other.

Give **two** factors that animals compete for.

Tick (✓) **two** boxes.

Oxygen	☐
Food	☐
Territory	☐
Light	☐

(2)

(Total 6 marks)

PPQ 2

Q2.

Many organisms are adapted to avoid being eaten.

(a) The photograph shows a gecko on a leafy branch.

The gecko is adapted to avoid being eaten by predators. Explain how.

_____

_____

_____

_____

(2)

(b) Ants can give a painful bite.

The photograph shows a type of ant living on acacia trees. Acacia trees have thorns on their branches. Branch of acacia tree.

(i) Predators are less likely to eat ants living on acacia trees than ants living on the ground. Suggest why.

_____

_____ **(1)**

(ii) Giraffes eat the leaves of acacia trees. Giraffes do **not** eat the leaves of acacia trees that have ants living on them. Suggest why.

_____

_____ **(1)**

(c) The photographs show a wasp and a hoverfly. The wasp and the hoverfly both have black and yellow stripes.

Wasp

© Alexandr Pakhnyushchyy/iStock

Hoverfly

© Richard Majlinder/iStock

Wasps have stings, but hoverflies do **not**. The stripes on the hoverfly help the hoverfly to avoid being eaten by predators. Explain why.

_____

_____

_____

_____ **(2)**

(Total 6 marks)

PPQ 3

Q3. Animals and plants are adapted in different ways in order to survive.

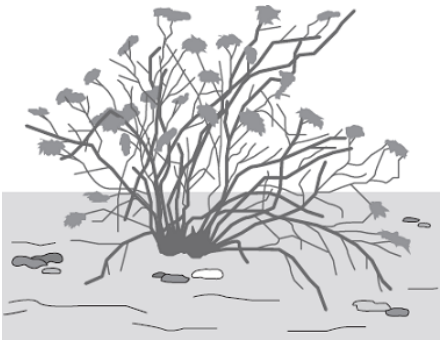
(a) Plants may have to compete with other plants.

(i) Name **two** things for which plants compete.

1. _____

2. _____ **(2)**

(ii) The drawing shows a creosote bush.



This bush lives in a desert. The creosote bush produces a poison that kills the roots of other plants. How does this poison help the creosote bush to survive in the desert?

_____

_____ **(1)**

(b) The photograph shows an insect called a katydid.

The katydid is preyed on by birds. How does the appearance of the katydid help it to survive?

_____

_____

_____

_____ **(1)**

(Total 4 marks)

Standard demand

PPQ 4

Q4. Animals and plants have features (adaptations) that allow them to survive in the conditions in which they normally live.

Describe how animals and plants are adapted to survive in dry conditions such as deserts.

For each adaptation that you give, describe how the adaptation helps the animal or plant to survive in dry conditions.

To obtain full marks you should refer to **both** animals and plants.

Extra space

(Total 6 marks)

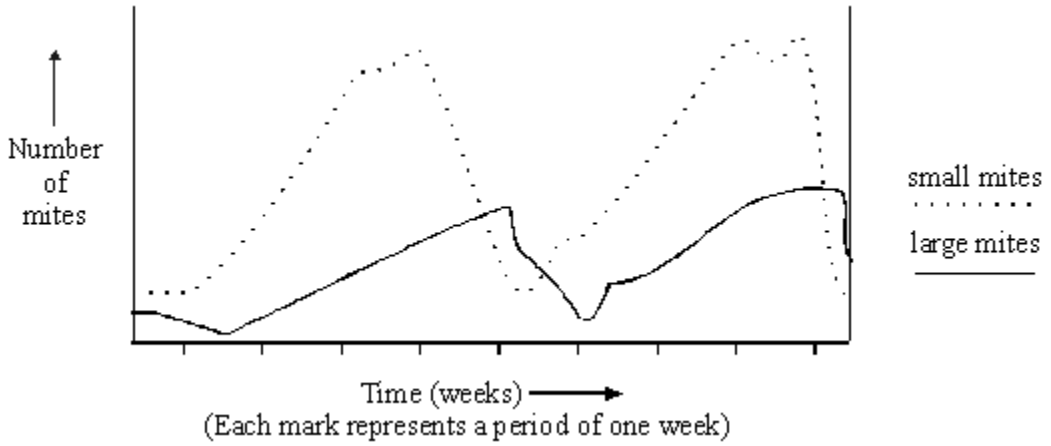
Q5.

Some small mites feed on the leaves of orange plants. Larger mites feed on the smaller mites.

(a) What do we call animals, like the large mite, which eat other animals, like the small mite?

_____

(1)



The graph shows how the number of these mites changes over a period of time.

(b) (i) What happens to the number of large mites one week after the number of small mites decreases?

_____

Suggest a reason for this.

_____

_____

_____

(3)

(ii) What happens to the number of small mites as the number of large mites increases?

_____

Suggest a reason for this.

_____

_____

_____

(2)

(Total 6 marks)

PPQ 6 '

Q6. Swallows and swifts migrate between Britain and South Africa every year.

(a) **Photograph 1** shows a swallow.

Photograph 1

Swallows can fly very quickly. Use information from the photograph to give **one** way in which the swallow is adapted for flying very quickly.

_____

_____

(1)

(b) **Photograph 2** shows swifts.

Photograph 2

Swallows and swifts both feed on flying insects.
They both spend the summer in Britain and then migrate to South Africa in the autumn.

Suggest **one** reason why swallows and swifts do not stay in Britain in the winter.

_____

_____

(1)

(c) The table gives data about swallows and swifts.

	Swallows	**Swifts**
Arrival date in Britain	April	Early May
Leaving date from Britain	October	Early August
Food	Flying insects	Flying insects
Height at which the birds feed	Near ground level	Up to 350m above ground level
Times at which birds feed	Mainly when it is light	Almost 24 hours per day

(i) There is very little competition between swallows and swifts for food.

Use information from the table to suggest **two** reasons for this.

1. _____

_____

2. _____

_____

(2)

(ii) Swallows and swifts do compete for some factors.

Suggest **one** of these factors.

_____

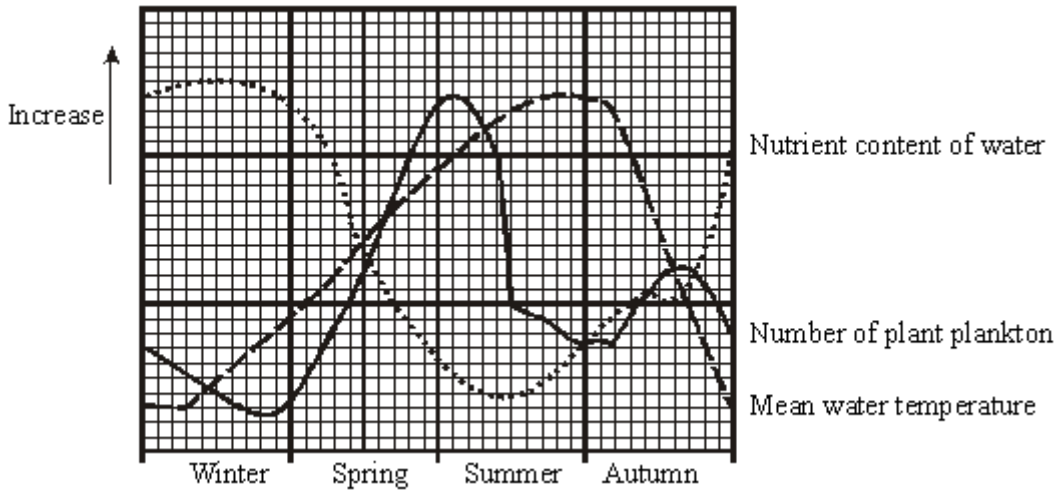
_____

(1)

(Total 5 marks)

Q7.

Plant plankton are aquatic microscopic organisms that photosynthesise. The graph shows the numbers of plant plankton in the North Sea at different times of the year.



Use the data and your knowledge of photosynthesis and growth to explain:

(a) why numbers of plant plankton were low in winter but increased rapidly during the spring,

_____

_____

_____

_____

_____

_____

(3)

(b) the reduction in numbers of plant plankton in the early summer.

_____

_____

_____

_____

(1)

(Total 4 marks)

PPQ 8

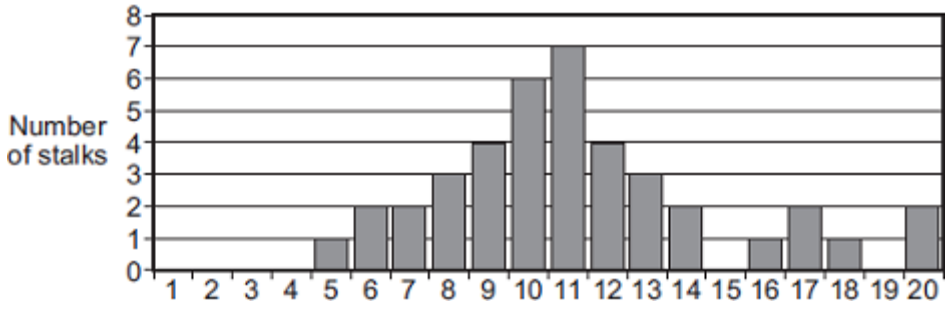
Q8.

Some students studied bluebell plants growing in two different habitats.

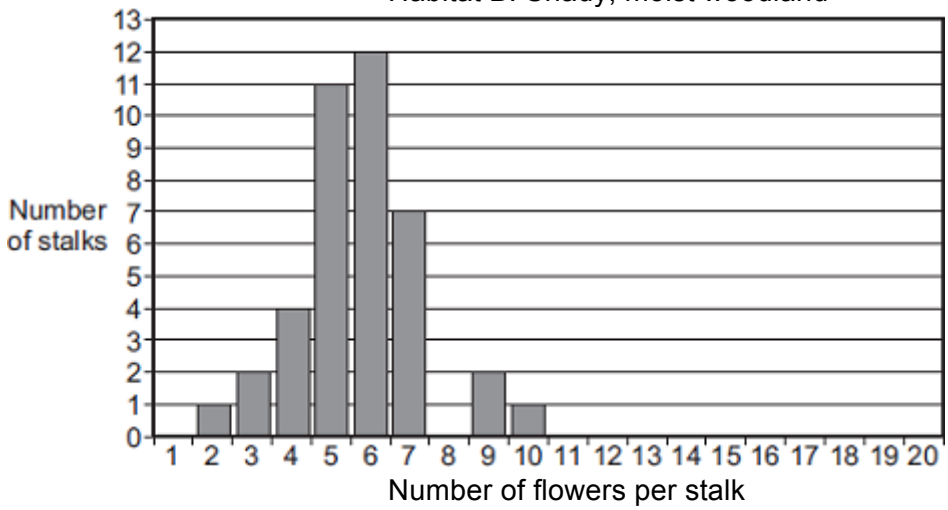
Habitat **A** was a sunny field next to woodland.
Habitat **B** was a shady, moist woodland.

A bluebell plant can have several flowers on one flower stalk. The students counted the number of flowers on each of 40 bluebell flower stalks growing in each habitat.
The bar charts show the results.

Habitat A: Sunny field next to woodland



Habitat B: Shady, moist woodland



(a) The students wanted to collect valid data.
Describe how the students should have sampled the bluebell plants at each habitat to collect valid data.

_____

_____

_____

_____

_____

(2)

(b) (i) The students used the bar charts to find the mode for the number of flowers per stalk in the two habitats.

The mode for the number of flowers per stalk in habitat **A** was 11.

What was the mode for the number of flowers per stalk in habitat **B**?

Mode = _____

(1)

(ii) The students suggested the following hypothesis:

'The difference in the modes is due to the plants receiving different amounts of sunlight.'

Suggest why.

_____

_____

_____

_____

(2)

(iii) Suggest how the students could test their hypothesis for the two habitats.

_____

_____

_____

_____

(2)

(c) Suggest how receiving more sunlight could result in the plants producing more flowers per stalk.

_____

_____

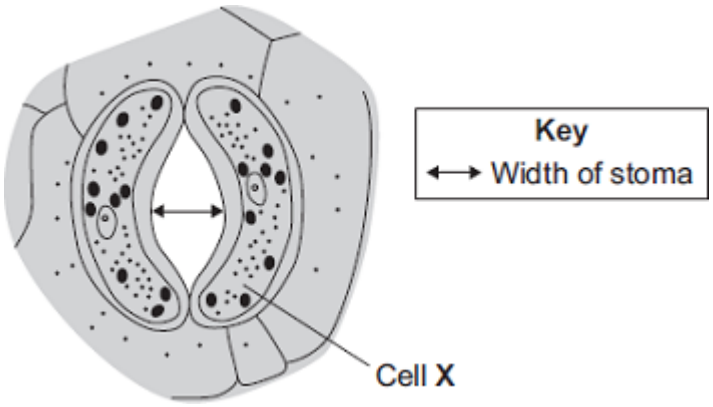
_____

_____

(2)

(Total 9 marks)

Q9. Plant leaves have many stomata.The diagram shows a stoma.



(a) Name cell **X** _____ **(1)**

(b) The table shows the mean widths of the stomata at different times of the day for two different species of plant.
Species **A** grows in hot, dry deserts.
Species **B** grows in the UK.

	Time of day in hours	Mean width of stomata as a percentage of their maximum width	
		Species A	Species B
Dark	0	95	5
	2	86	5
	4	52	6
Light	6	6	40
	8	4	92
	10	2	98
	12	1	100
	14	0	100
	16	1	96
	18	5	54
Dark	20	86	6
	22	93	5
	24	95	5

The data in the table show that species **A** is better adapted than species **B** to living in hot, dry deserts.

Explain how.

_____

_____

_____

_____

_____

_____

_____

_____

(4)

(Total 5 marks)

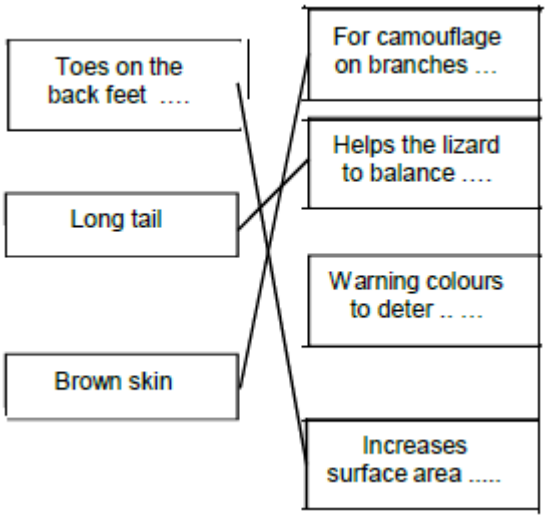
4.7.1 Adaptation, interdependence and competition PPQ answers

Low demand

PPQ MS1

Q1.

(a)



one mark for each line

*do **not** award mark for an adaptation if lines are drawn from it to more than one advantage*

3

(b) escape (predators)

accept faster than swimming

allow chase prey

allow it stops them from drowning

1

(c) food

1

territory

1

*deduct **one** mark for each tick in excess of two*

[6]

PPQ MS2

Q2.

(a) looks like a leaf

1

so predator less likely to / won't see it

allow 'camouflage' as alternative to either point

1

(b) (i) thorns (of acacia tree) hurt (predators)

*allow idea that fewer animals / predators live in trees **or** ground living animals can't reach them (in the trees)*

1

(ii) (giraffe) avoids being bitten by ants

allow ants are poisonous / have unpleasant taste

1

(c) looks like / mimics a wasp **or** has warning colouration

1

so predators think it has a sting

1

[6]

PPQ MS3

Q3.

(a) (i) any **two** from:

ignore oxygen / food / sun / carbon dioxide

- light
- water
- space
- nutrients / ions / minerals / named

*accept two named minerals / ions for **2** marks*

2

(ii) less competition for water

ignore space / light / food

or

more water / nutrients / minerals available

1

(b) camouflage / same shape as leaf / looks like a leaf

allow 'blends in'

ignore colour

1

[4]

Standard demand

PPQ MS4

Q4.

0 marks
No relevant content.

Level 1 (1 – 2 marks)
At least **one** way in which animals **and / or** plants are adapted to survive.

Level 2 (3 – 4 marks)
A description of ways in which animals **and / or** plants are adapted **and** an attempt to link at least **one** adaptation to how it increases the chance of survival.

Level 3 (5 – 6 marks)
A description of ways in which animals **and** plants are adapted **and** a description of how at least **one** adaptation increases the chance of survival.

examples of biology points made in the response:

(animals)

(A) change / decrease in surface area / example
(decrease in surface area which) reduces area from which sweat / water may be lost

(A) hump with fat / fat stores
(fat in hump) to convert to water (via respiration)

(A) long eyelashes
(long eyelashes) to keep (wind-blown) dust out of eyes

(A) nocturnal / 'keep out of the sun'
reduce sweat loss (in heat of the day)

extra information

allow adaptations of specific animals to living in specified dry conditions, eg a desert

(A) change / increase in surface area / example

(increase in surface area which) increases area heat may be lost from (by radiation)

(A) changes to thickness of insulating coat

(thicker coat on upper surface) increases insulation from sun's heat

(A) thin (layer) / reduced amount of body fat

(reduced amount of body fat which) reduces insulating layer

(A) wide feet

(wide feet) to reduce pressure / spread weight / prevent sinking

(plants)

(A) decrease in surface area

(A) leaves are spikes
(reduced area / leaves are spikes) reduces water loss / transpiration / evaporation

(A) long / wide spread / extensive roots
(long / wide spread /extensive roots) to absorb (more) water

(A) fleshy / thick stem
(fleshy / thick stem) to store water

extra information

allow adaptations of specific plants to living in specified dry conditions, eg a desert

(A) thick wax
(thick wax) to reduce evaporation / water loss / transpiration

(A) few(er) stomata
(few stomata) to reduce evaporation / water loss / transpiration

[6]

PPQ MS5

Q5.

(a) predator/carnivore

(not consumer/hunter)
for 1 mark

1

(b) (i) number decrease
not 'no' less food (for large mites)/less prey/fewer small mites to eat
(not 'fewer small mites' etc)
starve/cannot grow/cannot breed/die/die out

each for 1 mark

3

(ii) increase small mites breeding faster (than they are eaten)

each for 1 mark

(accept different food found)
decrease = O maths but 1 mark for possible reason can be awarded - more (small mites) eaten

each for 1 mark

2

[6]

PPQ MS6

Q6.

(a) streamlined / aerodynamic / swept-back / arrow-shaped / dart-shaped wings / tail

allow pointed / curved wings, ignore pointed tail / beak

OR

large / long wings

ignore large tail

1

(b) no / fewer insects / food (in winter)

*allow **too** cold*

ignore not adapted to cold ignore day length

1

(c) (i) any **two** from

- feed / hunt at different heights **or** swifts feed higher up
- feed / hunt at different times **or** swifts feed at night
- arrive / depart at different times

2

(ii) nesting sites / territory / habitat

allow homes / space

ignore food unqualified
allow well qualified food answers
eg insects / food near the ground

or

insects / food when it's light

or

insects / food between early May and early August

1

[5]

High demand

PPQ MS7

Q7.

(a) light and/or temperature too low in winter,
increasing light in spring leads to increase in photosynthesis
increasing temperature in spring leads to increasing metabolism/ growth/reproduction

for 1 mark each

3

(b) they run out of minerals

for 1 mark

1

[4]

PPQ MS8

Q8.

(a) use of quadrat / point frame

allow description

1

randomly placed / random sampling
ignore reference to transects

1

(b) (i) 6

1

(ii) more light in A / in field / where sunny
ignore sun

1

more / better / faster photosynthesis in A / with more light
allow converse

1

(iii) use light meter / measure light intensity in both habitats

1

take many measurements at same time of the day

1

or

laboratory / field investigation with 2 batches high light and low light (1)

count or number of flowers in each (1)
counting point is dependent on investigation point

(c) more glucose / energy available
allow other named product eg protein
allow if more energy produced

1

for growth
dependent on 1st mark

1

[9]

PPQ MS9

Q9.

(a) guard cell *ignore stoma / stomata*

1

(b) Species A : *allow converse points for species B*

stomata open in dark / at night **or** close in light / in day

1

stomata closed during warm(est) period **or** open when cool(er)

1

heat (energy) /warmth increases evaporation / transpiration

1

reduces water loss / evaporation / transpiration *ignore photosynthesis*

1

[5]

4.7.2 Organisation in an ecosystem

4.7.2.1 Levels of organisation

An ecosystem is the interaction between a community of living organisms and their environment. A community is two or more populations of organisms. An ecosystem is the interaction of two or more populations of organisms in their environment.

Producers and consumers

Feeding relationships show what organisms eat or are eaten by others and through this the levels of organisation in an ecosystem. These can be shown in food chains, which add together to make food webs for a habitat.

A simple example of a food chain is:

grass → rabbits → foxes

At the base of almost every food chain is a producer. These are plants or algae, which photosynthesise. This means they convert energy from the sun into glucose during photosynthesis producing biomass. It is this which feeds the rest of the food chain.

All animals above the producer are called consumers. The first is the primary consumer, the next is the secondary consumer. Animals that hunt and kill others are called predators, and those that are hunted and killed are called prey. The top animal in the feeding relationship is called the apex predator.

Decomposers

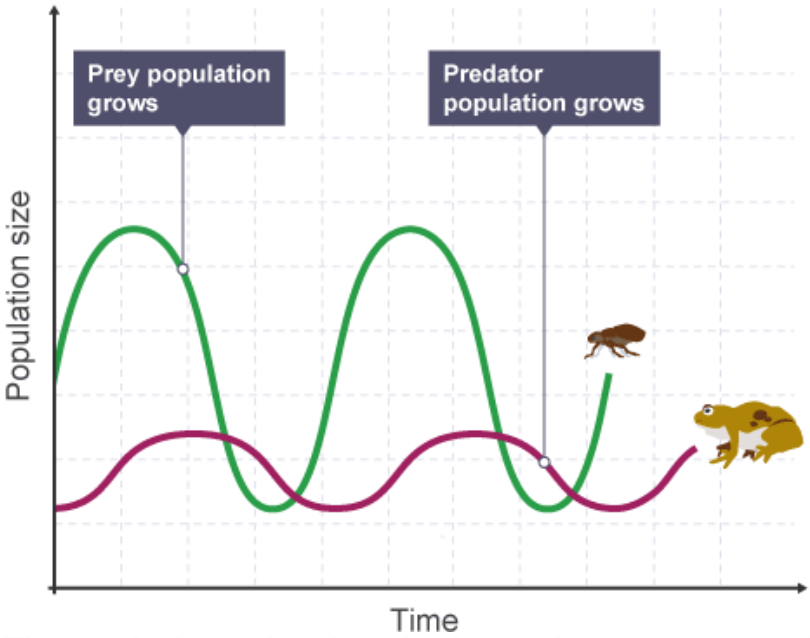
Decomposers are bacteria and fungi, which break down dead organisms in a process called decomposition or rotting. They do this by releasing enzymes onto the dead matter and afterwards, consume the broken down substances. They form a vital role in the recycling of matter. When organisms die and decompose plants absorb the broken down nutrients through their roots.

Predators and prey

In a healthy, balanced **ecosystem** the numbers of **predators** and **prey** remain fairly constant. They can go up and down during each year but generally over the years, these increases and decreases remain fairly constant.
If numbers of either predators or prey increase or decrease it could be due to a change in the **abiotic** factors, like water or sunlight, or **biotic** factors, like a new predator or **pathogen**. This would result in a less healthy, balanced ecosystem.

Predator-prey cycles

The numbers of predators and prey for certain ecosystems such as the Canadian Lynx (wild cat) and hare have been recorded over many years and found to change in a regular cycle. A similar example is shown in the graph below and shows characteristic repeating patterns called predator-prey cycles.



The graph shows that there is almost always more prey than predators. It also shows the following patterns:

- the number of predators increases because there is more prey
- the number of prey reduces because there are more predators

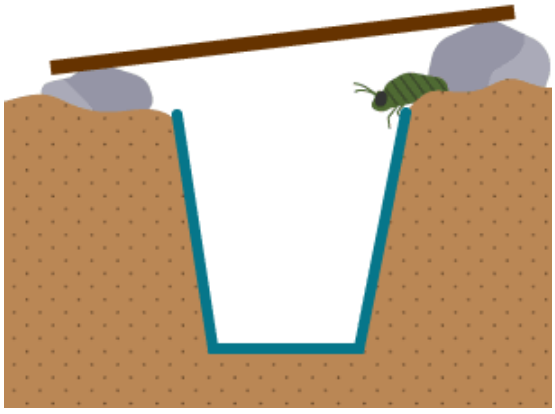
the number of predators reduces because there is less prey

Experimental methods using quadrats and transects

It is important to estimate the number of organisms in a population to better understand the relationships in a community. This information is useful for monitoring the impact of conservation projects that aim to conserve **endangered species** or **habitats** It is almost always impossible to count all of the organisms in a population. So we look at a small section of a population to draw conclusions about the rest. This process is called **sampling** and the area or part of population looked at is called a sample.

Sampling

When sampling a population, the numbers of organisms are counted within a sample site, and then the results multiplied to estimate the total number in the entire habitat. Large animals and plants can often simply be counted. However, many smaller animals like insects and smaller mammals need to be trapped first so they can be counted and then released afterwards. Pitfall traps are small traps dug into the ground, which often has food inside to attract small mammals. The sides of these traps are smooth to stop the mammals escaping.



Another method is to use large nets to sweep through grasses or leaves of trees in a process called sweep netting. To catch aquatic organism nets are often held downstream of an area of river bed which is then gently disturbed by the person doing the sampling. The small animals float into the net. This is called kick-sampling.
Pooters are small devices used when sampling to suck up small insects safely without them going into your mouth.

Using quadrats

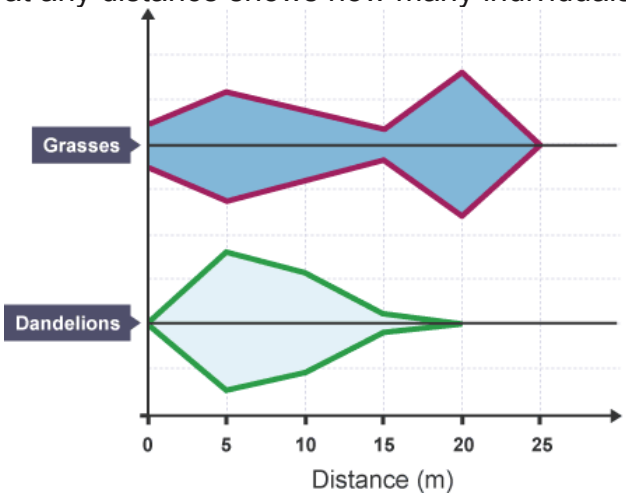
Quadrats are square frames of wire usually 0.25 m^2. These are placed on the ground to look at the plants or slow-moving animals within them. When looking at plants in a quadrat the following sampling can be used:

- Number of an individual species: the total number of individuals of one species (eg daisies) is recorded.
- Species richness: the number of different plant or animal species is recorded but not the number of individuals within a species.
- Percentage cover: the percentage of the quadrat area that is covered by one species (eg grass). This is easier to estimate if a quadrat has wires making smaller sections. Percentage cover rather than number of individuals is used when estimating plant frequencies if it is difficult to identify individual plants, such as grasses or moss.

Random or systematic
Random sampling using a quadrat involves the placing of quadrats at random coordinates. Regardless of whether you are investigating the number of individual species, the species diversity or the percentage cover in different areas you would use random sampling.

What are we sampling for?
Sometimes we want to see if the number of species or percentage cover changes within an area. This is often as a result of a change in an **abiotic** factor.

An example of this is an investigation into whether the growth of seaweed depends upon the distance it is found on the seashore from the tide. As we are looking to link a linear change (in this case the number of hours the seaweed is covered by the tide) we would use systematic sampling. A quadrat could be placed at regular distances, for example every five metres, along an imaginary line called a **transect**, which would run down the shore. Systematic sampling would be used along the transect to link changes in **species** to abiotic factors, such as immersion by water, temperature fluctuations, light intensity, all of which are influenced by the tide.
The results from transects can be drawn into kite diagrams. The width of the bar from the middle at any distance shows how many individuals were observed at that point.



Science calculationsThere are three different types of average which are all useful in science. They are called the mean, median and mode.

Mean

The mean is the most common type of average we use. To calculate the mean you add all the values together and divide by the total number of values. Two students completed an ecological investigation into the dandelions on the school field. They randomly placed ten quadrats in shaded and sunny areas, in order to count the dandelions in each. Their results are below.

Quadrat number	1	2	3	4	5	6	7	8	9	10
Number of dandelions per quadrat in shade	4	4	6	0	1	4	2	3	6	5
Number of dandelions per quadrat in sun	6	5	7	8	4	5	8	5	5	3

The students wanted to compare their results, thus they calculated the **mean** for each. They added up all the dandelions in the shade, which came to 36 and all those in the sun which came to 57. They divided each of these numbers by ten to calculate the two means, as there were ten numbers from the ten quadrats.

Quadrat number	1	2	3	4	5	6	7	8	9	10	Total	Average
Number of dandelions per quadrat in shade	4	4	6	0	1	4	2	3	6	5	36	3.6
Number of dandelions per quadrat in sun	6	5	7	8	4	5	8	5	5	3	57	5.7

The number of dandelions per quadrat is given to one significant figure. Usually the same number of significant figures would be used in the results of a calculation, but in this case when finding the mean of a series of integers, giving the answer to two significant figures is acceptable. Using three significant figures (eg 3.60) would be unacceptable as an inappropriate level of precision is implied.

Median

To calculate the median, a set of numbers are placed in increasing order of size. The median is the middle number in the list. The two students took an even number of readings, and they calculated the median as the mean of the two middle numbers. The median for shade is four because both middle numbers are four and the median for sun is 5.5 as it is halfway between five and six.

Number of dandelions per quadrat in shade	0	1	2	3	4	4	4	5	6	6
Number of dandelions per quadrat in sun	3	4	5	5	5	6	6	7	8	8

Mode

The mode is the value that appears the most often. In the shade, the mode is four because there are three values of four. In the sun, it is five because there are three values of five.

4.7.2.2 How materials are cycled

Atoms exist in different forms or compounds at different times in history and cycle between them. We can see this cycling in the element carbon and the compound water. Just as rocks can cycle between igneous, sedimentary and metamorphic, carbon and water can exist in different forms at different times.

Other elements and compounds also exist in cycles. Many humans eat protein in the form of meat from other animals. Our bodies break this down into its constituent parts called amino acids and then use these to make proteins within our own bodies for growth and repair. When we eventually die these building blocks are returned to the environment to be used by other living organisms.

Decomposing bacteria and fungi help dead organisms break down and rot. They help recycle minerals and nutrients to the environment, which can then be used by other organisms. As they decompose dead matter, the decomposers also respire and so release carbon dioxide to the environment, contributing to the carbon cycle.

The carbon cycle

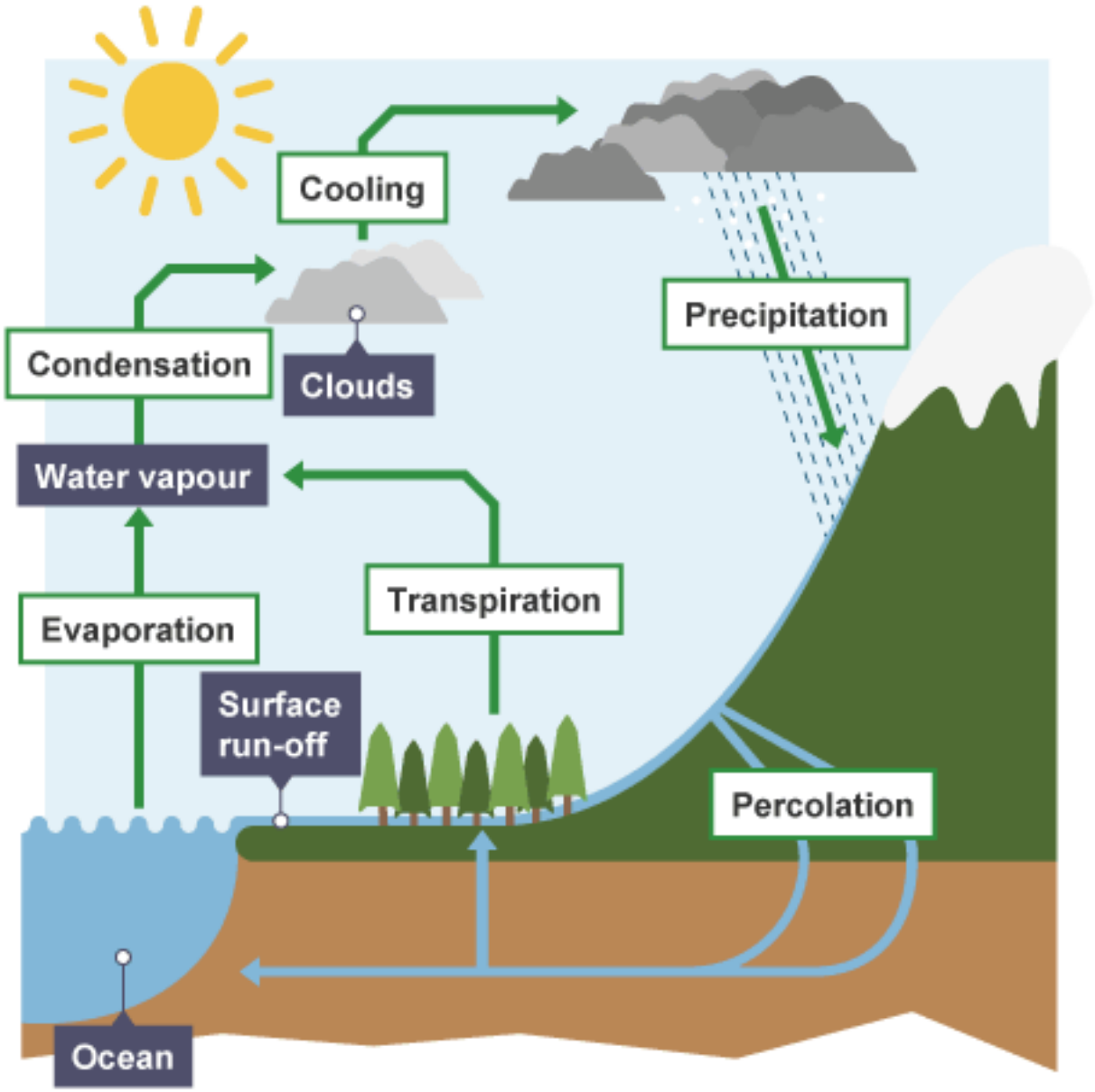
Carbon is an essential element for life on Earth and parts of each of the cells in our bodies are made from it. The carbon cycle shows how atoms of this element can exist within different compounds at different times.

The carbon cycle is easiest to understand in terms of its processes and the conversion of carbon that they undertake. The three key processes and their conversions are shown in the table below.

Process	Carbon starts as	Carbon ends as
Photosynthesis	Carbon dioxide	Glucose
Respiration	Glucose	Carbon dioxide
Combustion (burning)	Fuel (eg methane or wood)	Carbon dioxide

The water cycle

Water is a key compound for life on Earth. All living organisms need water. Some can survive in a dormant state without it for long periods of time, but all organisms will quickly or eventually die without it.



The **water cycle** is easiest to understand in terms of its processes and what happens to the water in each of these. These are the key processes

Process	What happens to water
Evaporation	Water turns from a liquid to a gas when it evaporates. Energy from the Sun can evaporate water from all places on the Earth's surface such as puddles, ponds, lakes and oceans.
Condensation	After evaporation water can cool and convert from gas to liquid, often forming clouds.
Precipitation	Precipitation occurs when rain, snow, hail and sleet fall from the sky.
Transpiration	Plants need to maintain a constant steam of water to their leaves for transport and support. So they allow some water to evaporate as water vapour from their leaves to mean that more is continually 'pulled' to their leaves from the soil.

4.7.2.3 Decomposition (biology only)

Decomposition is the breakdown of dead matter, which is often called rotting. Decomposing bacteria and fungi are organisms that help the process of decomposition. Decomposition is crucial to the cycling of elements, such as carbon from one living organism to another. You can learn more about the carbon and water cycles **here**.

The rate of decay is the speed at which dead matter is broken down by decomposers. The rate can be estimated by measuring changes in pH, (for example in milk), change in mass (decaying fruit and vegetables) or change in temperature (grass cuttings). Rates of decay are affected by a number of key factors.

Temperature

At colder temperatures decomposing organisms will be less active, thus the rate of decomposition remains low. This is why we keep food in a fridge. As the temperature increases, decomposers become more active and the rate increases. At extremely high temperatures decomposers will be killed and decomposition will stop.

Water

With little or no water there is less decomposition because decomposers cannot survive. As the volume of available water increases, the rate of decomposition also increases. Many decomposers secrete enzymes onto decaying matter and then absorb any dissolved molecules. Without water these reactions cannot occur.

Oxygen

Similar to water, decomposers need oxygen to survive and without it there is little or no decomposition. Oxygen is needed for many decomposers to respire, to enable them to grow and multiply. This is why we often seal food in bags or cling film before putting it in the fridge. As the volume of available oxygen increases, the rate of decomposition also increases. Some decomposers can survive without oxygen. **We use these in biogas generators**.

The Egyptians mummified their dead kings and queens. This process removed all water from the mummy and so stopped decomposers from breaking down the dead tissue.

Archaeologists have found very old remains of people who have fallen into peat bogs. A famous example of this was the Tollund Man. In peat bogs there is low oxygen, low temperature and acidic water which can naturally mummify dead remains, similar to the process that the Egyptians undertook.

The use of compost and manure by gardeners and farmers

Gardeners and farmers improve the quality of their soil by adding compost or manure. Compost is made from dead plants and manure is the waste from animals. Once spread on the soil, compost and manure are broken down into minerals by decomposing bacteria and fungi, as well as by other organisms, such as worms. Adding compost or manure helps recycle minerals so that they are absorbed by new plants and used in growth. Compost and manure also improve the quality of soil by increasing aeration and water retention.

Farmers can also use inorganic fertilisers on soil to overcome specific mineral deficiencies, although this does not require the involvement of decomposers.

One key element which is recycled is nitrogen. This element is needed by plants to make proteins in order to grow and repair themselves. Plants cannot absorb nitrogen gas, and need it to be provided as nitrate ions. These nitrate ions are produced as a result of a long series of reactions by decomposers breaking down proteins and urea in the soil. The nutrients and minerals are then passed along the food chain as the organisms are consumed by others.

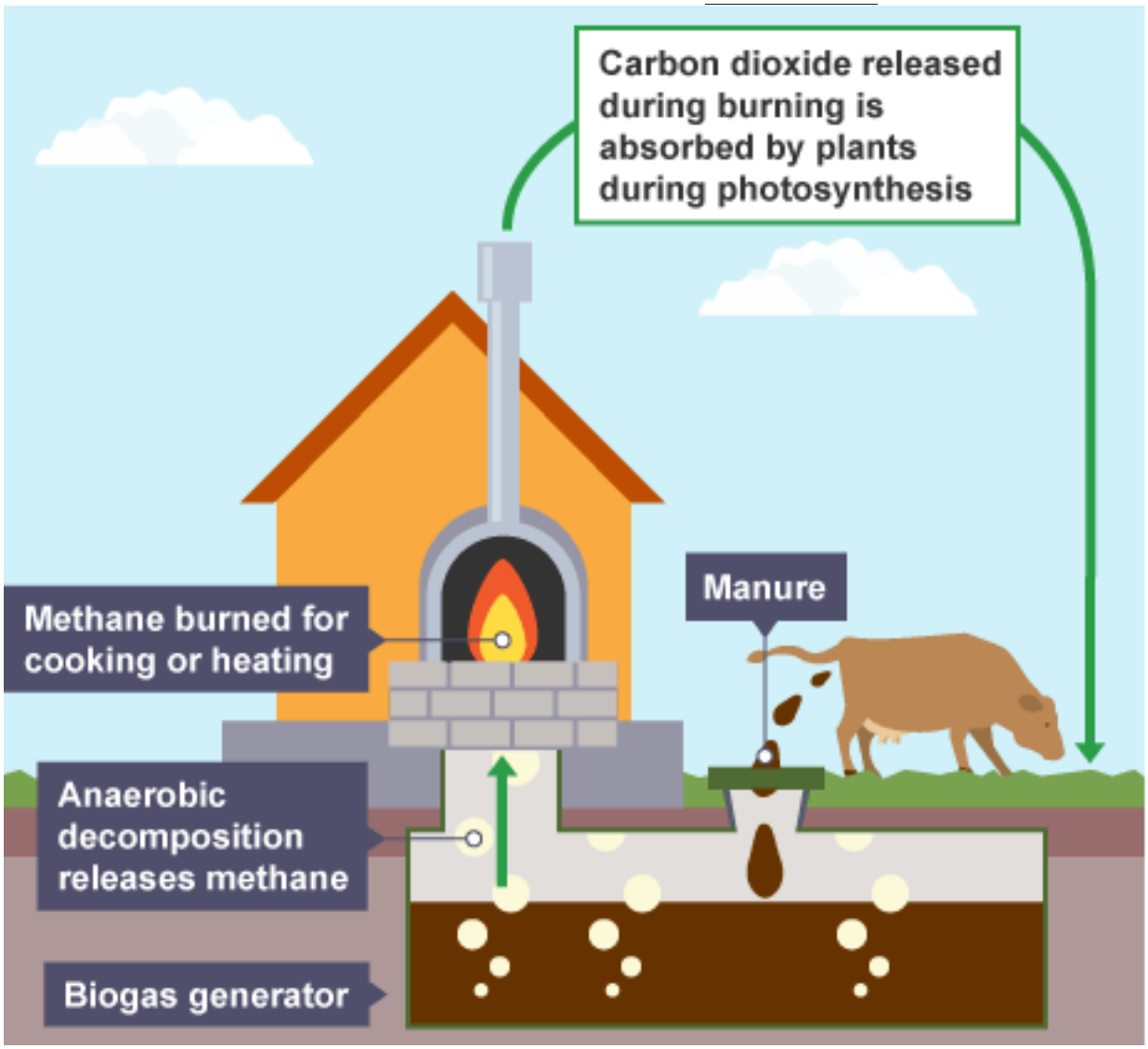
Anaerobic decay, methane gas and biogas generators

Anaerobicdecay occurs when bacteria and fungi break down dead matter without oxygen. This can happen naturally in some soils, particularly water logged soils, and in lakes and marshes. When people overwater their houseplants and flood the roots, anaerobic decay can occur, which can kill them.

The products of anaerobic decay are methane and carbon dioxide. We use methane as a fuel. Both gases are **greenhouse gases**, which contribute towards **global warming**.

Biogas

We can use the process of anaerobic decay or decomposition to provide us with fuel. Together the methane and carbon dioxide produced are called **biogas**. This is a source of **renewable energy**. Biogas generators are large vessels in which animal waste or specially grown crops such as maize are allowed to anaerobically digest. If domestic waste is used as a source of methane, this also reduces the volume of domestic waste added to **landfill sites**.



Required practical

Investigate the effect of temperature on the rate of decay of fresh milk by measuring pH change

As milk decays its pH reduces. This is because bacteria present in milk carry out a chemical process to provide them with energy. This process converts lactose sugar in the milk to lactic acid, and producing this acid reduces the pH of the milk.

Aim

To investigate the effect of temperature on the rate of decay of fresh milk by measuring pH change.

Method

1. Place 20 cm^3 of fresh milk into three beakers
2. Decide the three temperatures you will investigate. Write these onto the sides of the beakers. They may be 5, 20 and 35°C.
3. Use universal indicator paper or solution to determine the pH of the milk in the three beakers
4. Cover each beaker in cling film and incubate at the appropriate temperature
5. Use universal indicator paper or solution to determine the pH of the milk in the three beakers after 24, 48 and 72 hours

Results

	0 hours	24 hours	48 hours	72 hours
5°C	6.5	6.4	6.4	6.0
20°C	6.5	6.1	5.5	4.8
35°C	6.5	5.1	4.8	4.8

Science calculations

Rate changes show how quickly something is happening. The rate of change can be calculated using this equation:

curriculum-key-fact

$$rate\ of\ change = \frac{change\ in\ value}{change\ in\ time}$$

We can calculate the rate of change from the results of the experiment on the previous page. Milk was incubated at three different temperatures and the pH recorded every 24 hours.

□□0 hours□24 hours□48 hours□72

	0 hours	24 hours	48 hours	72 hours
5°C	6.5	6.4	6.4	6.0
20°C	6.5	6.1	5.5	4.8
35°C	6.5	5.1	4.8	4.8

To calculate the rate of change we first need to know the change, or difference, from the previous point for each value. These calculations and answers are shown in the table below.

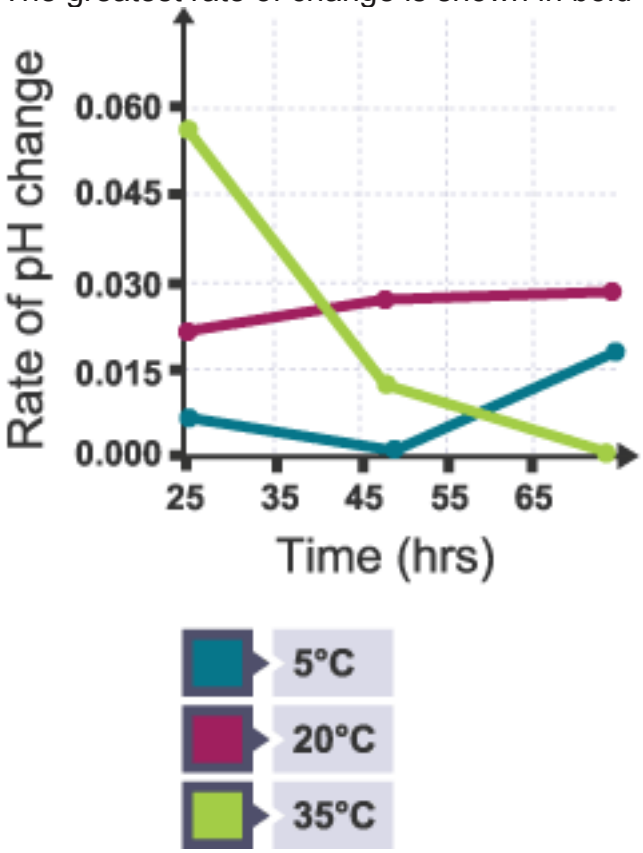
	0 hours	24 hours	48 hours	72 hours
5°C		6.5 - 6.4 = 0.1	6.4 - 6.4 = 0	6.4 - 6.0 = 0.4
20°C		6.5 - 6.1 = 0.4	6.1 - 5.5 = 0.6	5.5 - 4.8 = 0.7
35°C		6.5 - 5.1 = 1.4	5.1 - 4.8 = 0.3	4.8 - 4.8 = 0

Because we started at pH 6.5 at zero hours there is no rate change for this time. Similarly, because the milk did not change from pH 4.8 in the last 24 hours at 35°C there is no rate change here.

We now need to divide each change in value by the change in time (24 hours).

	24 hours	48 hours	72 hours
5°C	0.1 ÷ 24 = 0.0041	0 ÷ 24 = 0	0.4 ÷ 24 = 0.017
20°C	0.4 ÷ 24 = 0.017	0.6 ÷ 24 = 0.025	0.7 ÷ 24 = 0.029
35°C	**1.4 ÷ 24 = 0.058**	0.3 ÷ 24 = 0.013	0 ÷ 24 = 0

The greatest rate of change is shown in bold above.

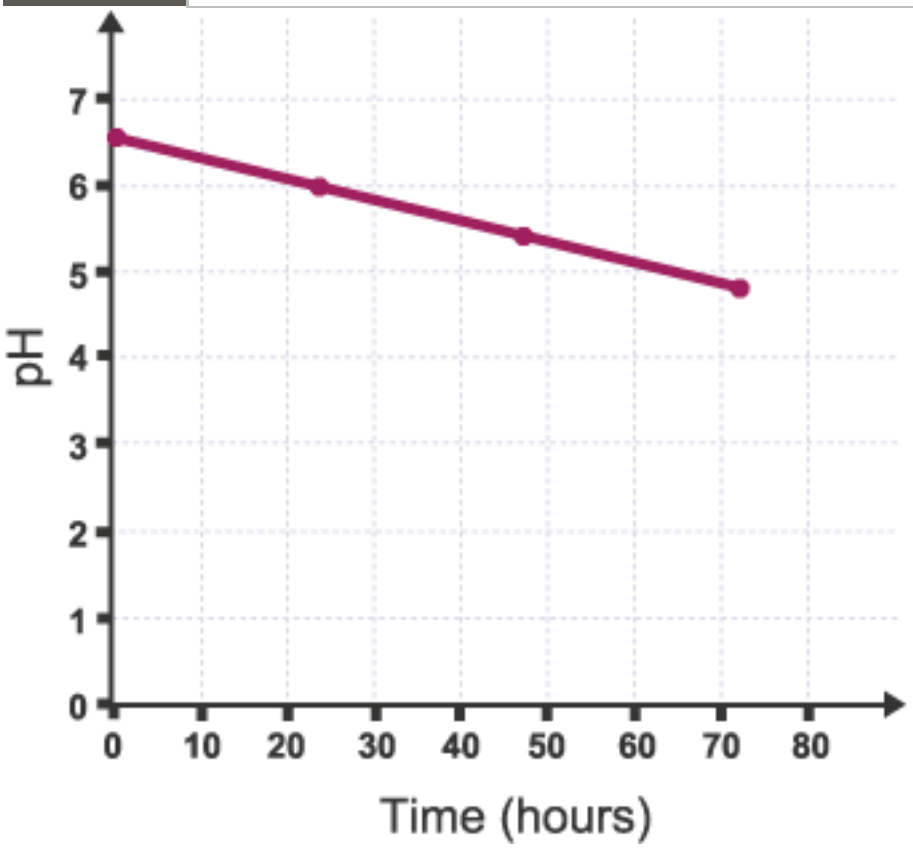


Graph showing rates of pH change at different times after incubation

Rate of change can also be calculated from graphs. Here we use this equation:

curriculum-key-fact

$$rate\ of\ change = \frac{vertical\ change}{horizontal\ change}$$



The rate of change can be calculated from the above graph by finding the gradient of the trendline, using the equation above.
For example after 0 hours in the above graph, the pH is 6.6; after 50 hours it is 5.4.

$$rate\ of\ change = \frac{vertical\ change}{horizontal\ change}$$

$$= \frac{5.4 - 6.6\ pH\ units}{50 - 0\ hours}$$

$$= \frac{-1.2\ pH\ units}{50\ hours}$$

$$= -0.024\ pH\ units/hour$$ (to 2 significant figures)

The '-' sign means that the pH went down and the milk became more acidic.
The calculated rate of -0.024 pH units/hour is the mean of the rates shown by the red line in the first graph.
Using the gradient of a graph to find a rate of change is easier than calculating rate when there is a lot of data, or when the data shows a great deal of variability.

4.7.2.4 Impact of environmental change (biology only) (HT only)

Changes in the environment affect the distribution of living organisms in a habitat. Such changes may be caused by living or non-living factors such as the arrival of a new competitor, or changes in the average temperature or rainfall. These changes have an effect on the organisms found in that habitat. Populations of the organisms that are better adapted to the environmental change will increase whilst poorly adapted ones will decrease. Organisms that are highly specialised can disappear entirely as a result of environmental changes.

It is for that reason that certain species can be used as 'indicator species' for pollution in air or water. Some forms of pollution, especially in water, are obvious, however, others, such as dissolved salts or low oxygen levels, are not so easy to see. To monitor those all the time would be costly and involve lots of time consuming analytical tests. Indicator species provide an easy to see and quick method of qualitatively checking air and water pollution.

Algae and lichens are sensitive to any air pollution, particularly sulfur dioxide. Observing these can tell environmental scientists whether or not the air is polluted. In water, the larvae of certain species are very sensitive to pollution. If they disappear from a stream or river, environmental scientists need to find out why and where the pollution is coming from. The opposite is true too, if they are found in places where they were not originally seen, then the water has become cleaner.

4.7.2 Organisation in an ecosystem PPQs

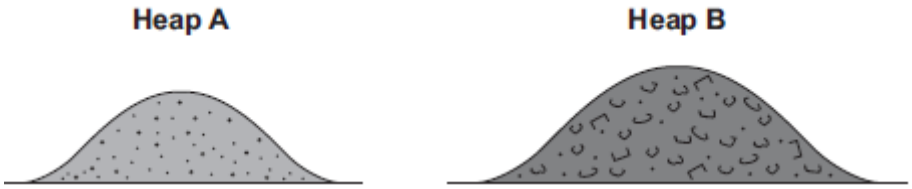
Low Demand

PPQ 1

Q1. A gardener investigates if turning over the waste in a compost heap makes the waste decay more quickly. The gardener:

- makes two separate heaps of garden waste, heap **A** and heap **B**
- turns over the material in heap **A** every 2 weeks
- does **not** turn over the material in heap **B**
- estimates the amount of decay in the two heaps after 6 months.

The diagram shows the two heaps of garden waste at the beginning of the investigation.



(a) Suggest **two** factors, other than time, the gardener should control to make the investigation fair.

1. _____

_____

2. _____

_____

(2)

(b) Name **one** type of living thing that causes decay.

_____

(1)

(c) The gardener's results are shown in the table.

Compost heap	Estimated amount of decay
A	A lot
B	Very little

(i) Why does turning over the material in heap **A** make the material decay more quickly?

_____

_____

(1)

(ii) The gardener puts decayed material around his plants to help them grow.

Suggest why the plants in a woodland grow well each year **without** material from compost heaps being added.

_____

_____

_____

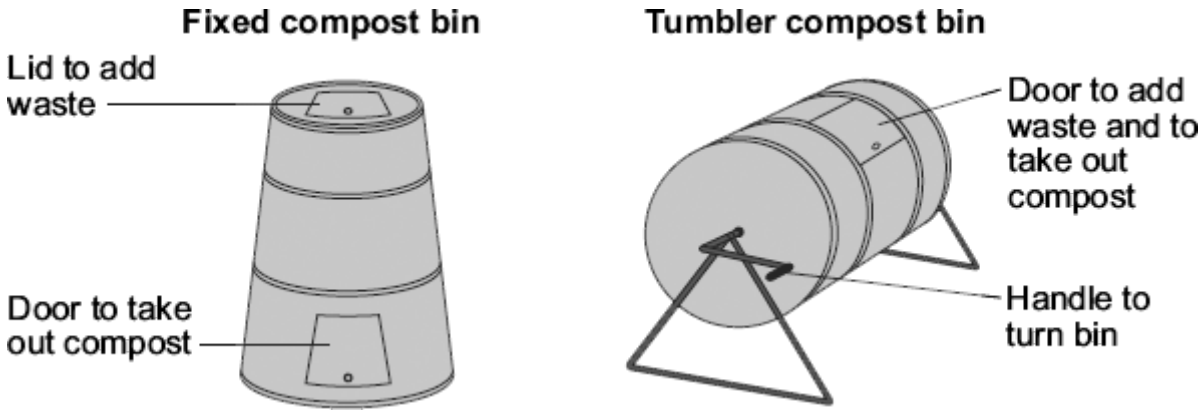
_____

(2)

(Total 6 marks)

PPQ 2

Q2. Garden waste can be recycled. One way of recycling garden waste is to use a compost bin. The diagram shows two types of compost bin.
Each bin can contain the same amount of waste.



Information about the compost bins is given below.

Fixed compost bin

- Compost can be taken out after two years.
- The bin costs about £40.
- The bin takes up an area of 1 m^2.

Tumbler compost bin

- The bin is turned twice a day using the handle.
- Six weeks later compost can be taken out.
- The bin costs about £80.
- The bin takes up an area of 2 m^2.

(a) A gardener is buying a compost bin.

(i) Give **one** advantage to the gardener of buying a tumbler compost bin and not a fixed compost bin.

_____

_____

(1)

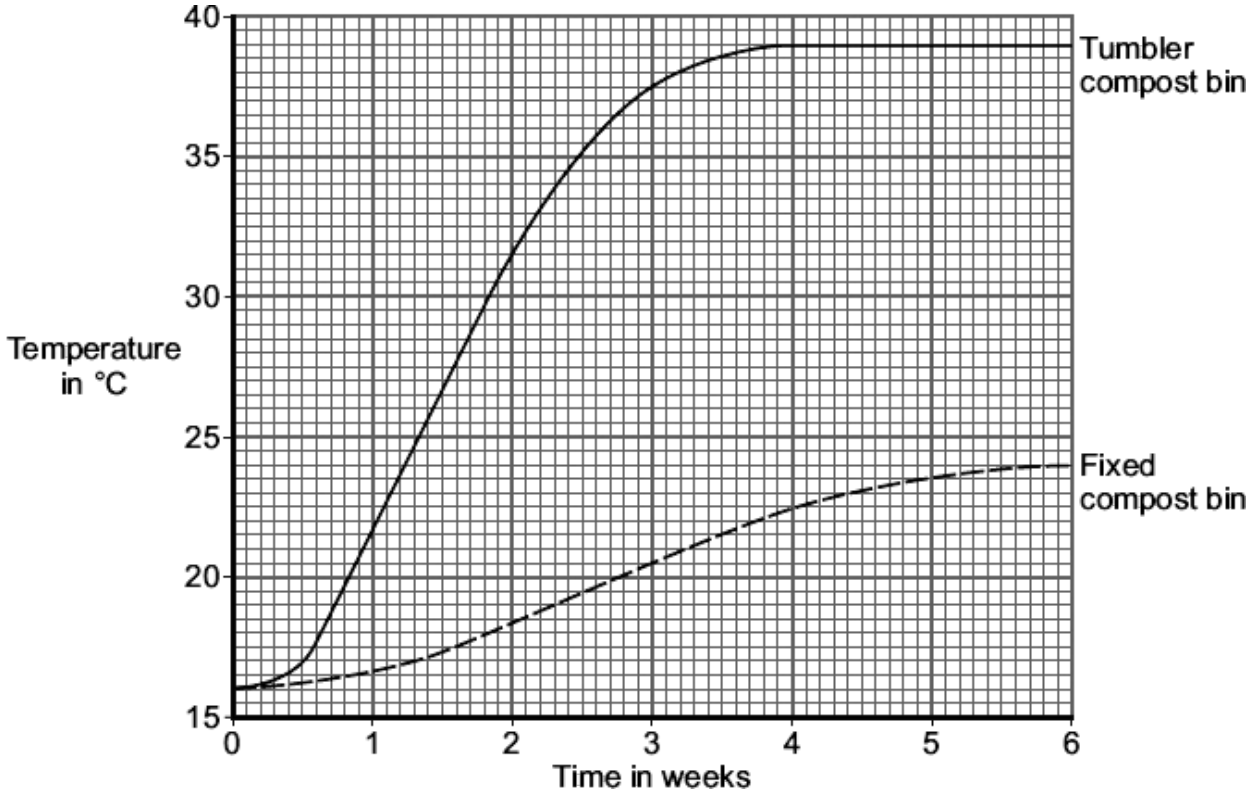
(ii) Give **two** advantages to the gardener of buying a fixed compost bin and not a tumbler compost bin.

1. _____

2. _____

(2)

(b) The same amounts of waste were added to the two types of bin.
The graph shows the temperature in the bins in the first six weeks after the waste was added.



(i) Give **two** differences between the results for the tumbler compost bin and the fixed compost bin.

1. _____

_____

2. _____

_____ **(2)**

(ii) Complete the sentences.

The waste is converted into compost by organisms

called _____

The conversion of waste into compost works best in warm, moist

and _____ conditions.

(2)

(iii) There was a big difference in the final temperatures in the two bins.

Suggest an explanation for this temperature difference.

_____

_____

_____ **(2)**

(Total 9 marks)

PPQ 3

Q3. A student was asked to estimate how many clover plants there are in the school field. The image below shows the equipment used.

Not drawn to scale

1. Throw a quadrat over your shoulder.
2. Count the number of clover plants inside the quadrat.
3. Repeat step **1** and step **2** four more times.
4. Estimate the number of clover plants in the whole field.

(a) What is the tape in the image above used for in this investigation?

_____

_____ **(1)**

(b) The teacher told the student that throwing the quadrat over his shoulder was **not** random. The method could be improved to make sure the quadrats were placed randomly. Suggest **one** change the student could make to ensure the quadrats were placed randomly.

_____

_____ **(1)**

(c) How could the student improve the investigation so that a valid estimate can be made?

Tick **two** boxes.

Weigh the clover plants	☐
Compare their results with another student's results	☐
Count the leaves of the clover plants	☐
Place more quadrats	☐
Place the quadrats in a line across the field	☐

(2)

(d) The table below shows the student's results.

Quadrat number	Number of clover plants counted
1	11
2	8
3	11
4	9
5	1
Total	40

The area of the school field was 500 m^2. The quadrat used in the table above had an area of 0.25 m^2. Calculate the estimated number of clover plants in the school field.

_____

_____

_____

Estimated number of clover plants = _____ **(3)**

(e) What was the mode for the results in the table above?

Tick **one** box.

1 ☐

8 ☐

11 ☐

40 ☐

(1)

(f) Suggest which quadrat could have been placed under the shade of a large tree. Give **one** reason for your answer.

Quadrat number _____

Reason _____

_____

(1)

(Total 9 marks)

Standard demand

PPQ 4

Q4.

A gardener wants to add compost to the soil to increase his yield of strawberries.

The gardener wants to make his own compost.

(a) An airtight compost heap causes anaerobic decay.

Explain why the gardener might be against producing compost using this method.

_____

_____

_____

_____

(2)

(b) The gardener finds this research on the Internet:

'A carbon to nitrogen ratio of 25:1 will produce fertile compost.'

Look at the table below.

Type of material to compost	Mass of carbon in sample in g	Mass of nitrogen in sample in g	Carbon:nitrogen ratio
Chicken manure	8.75	1.25	7:1
Horse manure	10.00	0.50	20:1
Peat moss	9.80	0.20	**X**

Determine the ratio **X** in the table above.

_____

Ratio _____

(1)

(c) Which type of material in the table above would be **best** for the gardener to use to make his compost?

Justify your answer.

_____

_____

(1)

(d) Some of the leaves from the gardener's strawberry plant die. The dead leaves fall off the strawberry plant onto the ground. The carbon in the dead leaves is recycled through the carbon cycle. Explain how the carbon is recycled into the growth of new leaves.

_____

_____

_____

_____

_____

_____

_____

_____

_____

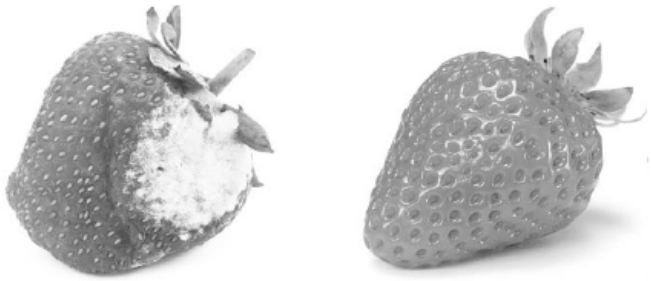
_____

(6)

(e) The diagram below shows two strawberries.

- Both strawberries were picked from the same strawberry plant.
- Both strawberries were picked 3 days ago.
- The strawberries were stored in different conditions.

Strawberry A **Strawberry B**



Give **three** possible reasons that may have caused strawberry **A** to decay.

1. _____

_____

2. _____

_____

3. _____

_____

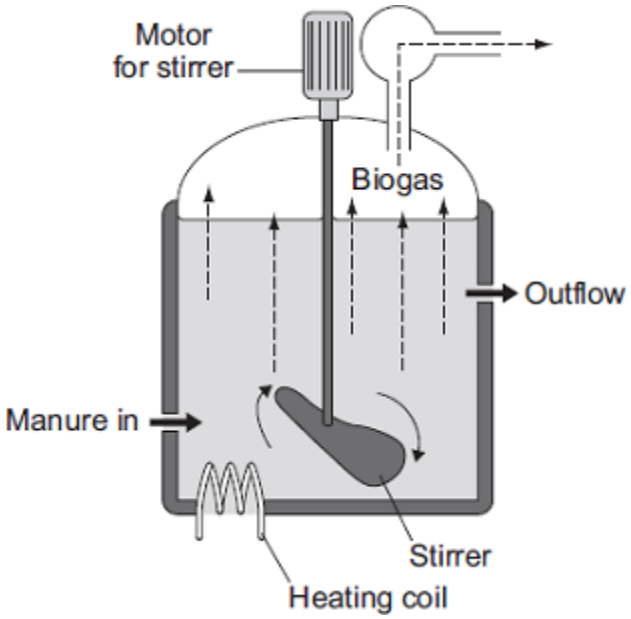
(3)

(Total 13 marks)

PPQ 5

Q5.

The diagram shows one type of *anaerobic* digester. The digester is used to produce biogas.



(a) (i) What does *anaerobic* mean?

_____

_____

(1)

(ii) The concentration of solids that are fed into this digester must be kept very low.

Suggest **one** reason why.

_____

_____

(1)

(iii) This digester is more expensive to run than some other simpler designs of biogas generator.

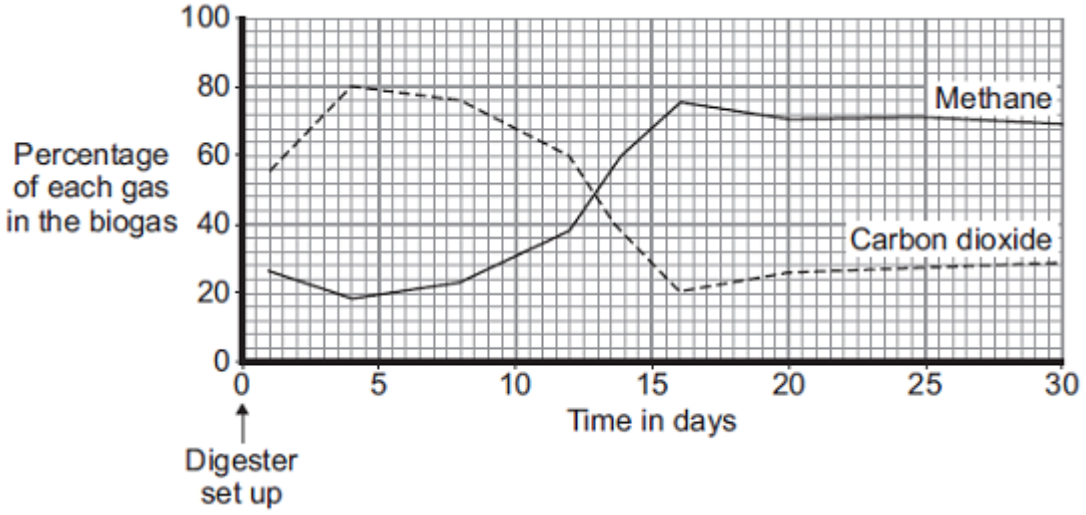
Suggest **one** reason why.

_____

_____

(1)

(b) The graph shows how the composition of the biogas produced by the digester changed over the first 30 days after the digester was set up.



Use information from the graph to answer the following questions.

(i) Describe how the percentage of carbon dioxide changed over the 30 days.

_____

_____

_____

_____

_____

_____

(3)

(ii) On which day was the best quality biogas produced? _____

(1)

(c) Four days after the digester was first set up, the biogas contained a high percentage of carbon dioxide.

Suggest an explanation for this.

_____

_____

_____

_____

(2)

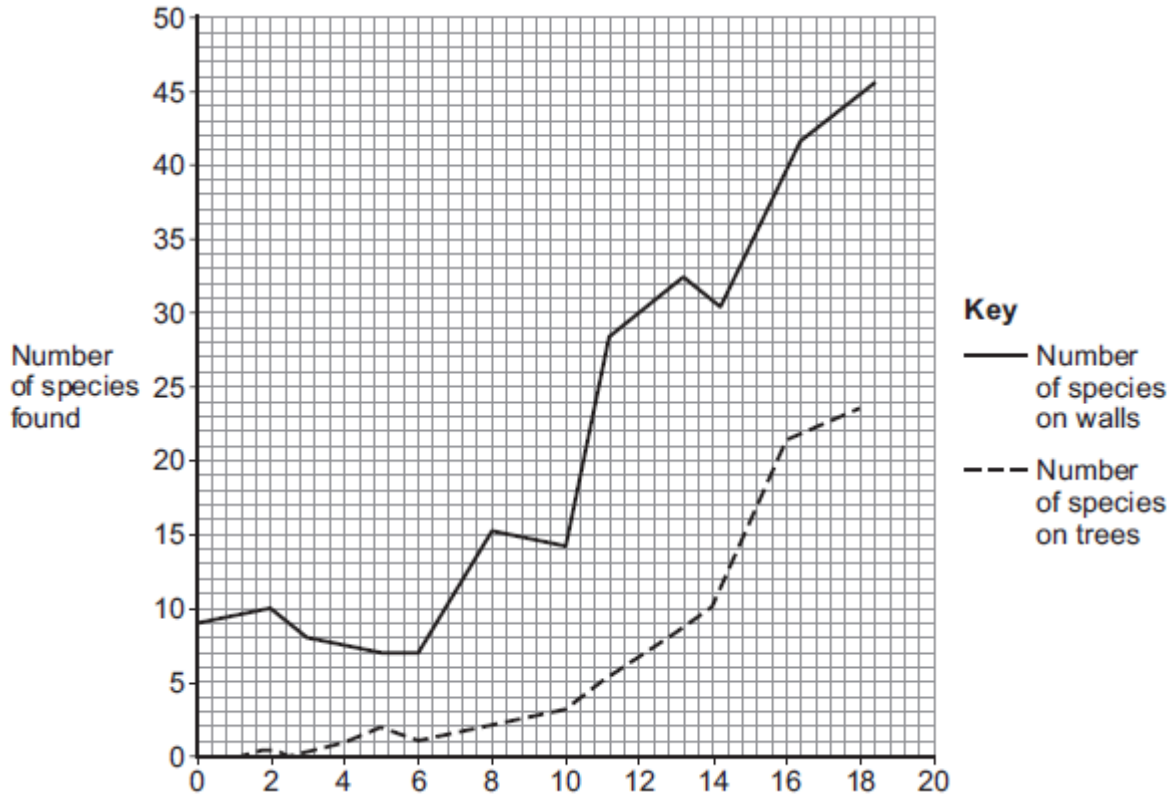
(Total 9 marks)

PPQ 6

Q6.

Lichens can be used as air pollution indicators.

The graph below shows the number of lichen species found growing on walls and trees at increasing distances from a city centre.



Distance from city centre in km

(a) (i) How many species of lichen are found on walls 2 km from the city centre?

_____

(1)

(ii) Describe the patterns in the data.

_____

_____

_____

_____

_____

_____

(3)

(b) The table below shows the concentration of sulfur dioxide (SO_2) in the air at different distances from the same city centre.

Distance from city centre in km	SO_2 concentration in g per m^3
0	200
3	160
8	110
13	85
18	65

Suggest how the data in the table could explain the patterns in the graph above.

_____

_____

_____

_____

(2)

(c) Nitrogen oxides are also air pollutants.

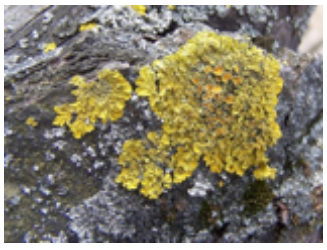
The main source of nitrogen oxide pollution comes from road vehicles.

Different lichen species vary in their tolerance of the levels of nitrogen oxides in the air.

Some lichens can only grow in very clean air where there are low levels of nitrogen oxides. They are nitrogen-sensitive.

Some lichens grow very well in high levels of nitrogen oxides. They are nitrogen-loving.

The table below shows one lichen species which is nitrogen-sensitive and one lichen species which is nitrogen-loving.

Nitrogen-sensitive	Nitrogen-loving
Usnea 	*Xanthoria* 

(i) Describe how you would investigate the distribution of the two lichens at different distances into a wood from a main road.

_____

_____

_____

_____

_____

_____

_____

(3)

(ii) Predict the results from the experiment you described in your answer to part **(c)(i)**. Explain why you made this prediction.

_____

_____

_____

_____

_____

_____

_____

_____

(3)

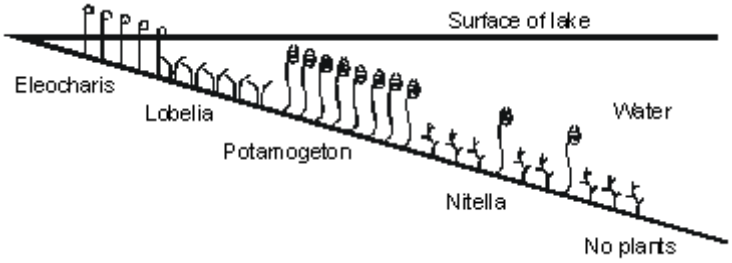
(Total 12 marks)

High demand

PPQ 7

Q7.

This is a diagram of a belt transect showing the major types of plants growing on the bottom of a lake.



(a) Suggest, and explain, **two** reasons why a much smaller population of Nitella plants is found amongst the Potamogeton plants than further down in the lake.

1. _____

_____

_____

_____

2. _____

_____

_____

_____

(4)

(b) Describe how you would use the belt transect technique to measure the abundance and distribution of plants which live on the bottom of a shallow lake.

_____

_____

_____

_____

_____

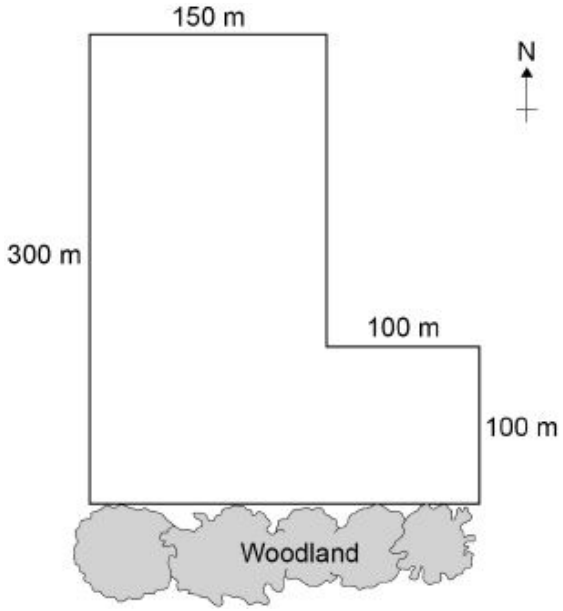
_____

(3)

(Total 7 marks)

PPQ 8

Q8. Some students investigated the size of a population of dandelion plants in a field. The diagram below shows the field.



The students:

- placed a 1 m × 1 m square quadrat at 10 random positions in the field
- counted the number of dandelion plants in each quadrat.

The table below shows the students' results.

Quadrat number	Number of dandelion plants
1	6
2	9
3	5
4	8
5	0
6	10
7	2
8	1
9	8
10	11

(a) Why did the students place the quadrats at random positions?

_____

_____ **(1)**

(b) Estimate the total number of dandelion plants in the field.

Calculate your answer using information from the diagram and the table above.

Give your answer in standard form.

Total number of dandelion plants = _____

(5)

Quadrats **5**, **7** and **8** were each placed less than 10 metres from the woodland.

These quadrats contained low numbers of dandelion plants.

The students made the hypothesis:

'Light intensity affects the number of dandelion plants that grow in an area.'

(c) Plan an investigation to test this hypothesis.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(6)

(d) Light is an environmental factor that affects the growth of dandelion plants.

Give **two** other environmental factors that affect the growth of dandelion plants.

1. _____

2. _____

(2)

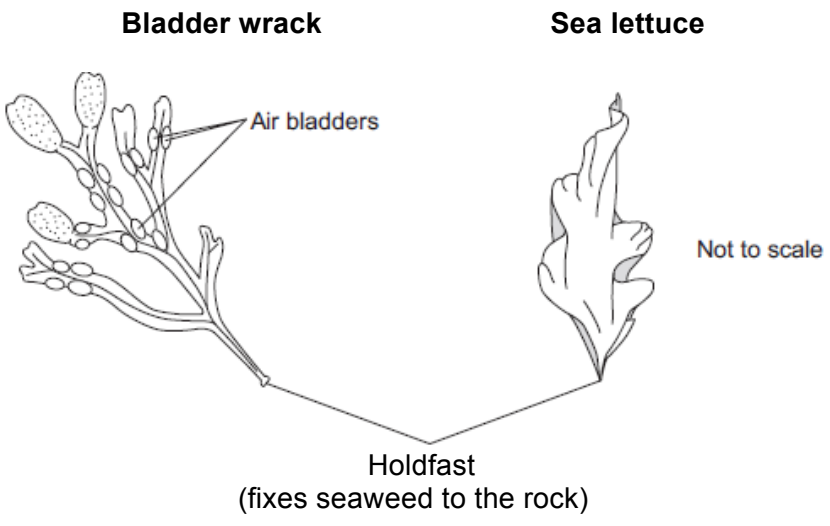
(Total 14 marks)

PPQ 9

Q9.

At the seashore, the tide comes in and goes out twice each day. Some students investigated whether two different species of seaweed could live only at certain positions on a rocky shore. Seaweeds are plant-like organisms that make their food by photosynthesis. **Figure 1** shows the two species of seaweed that the students investigated.

Figure 1



(a) The students:

1 placed a 50-metre tape measure on the rocks at right angles to the sea

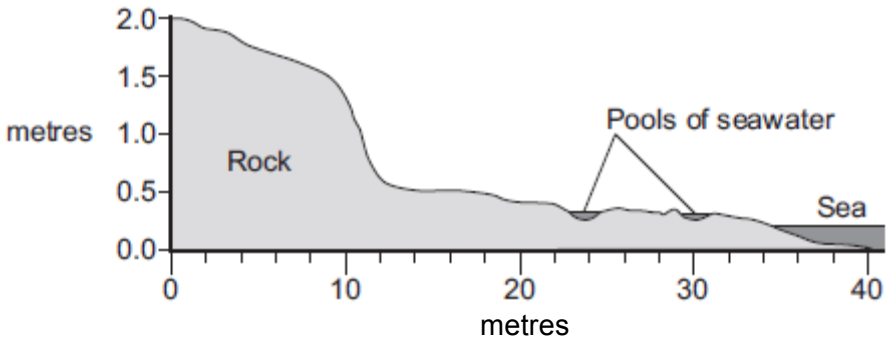
2 placed a quadrat next to the tape measure

3 recorded whether each species was present or not.

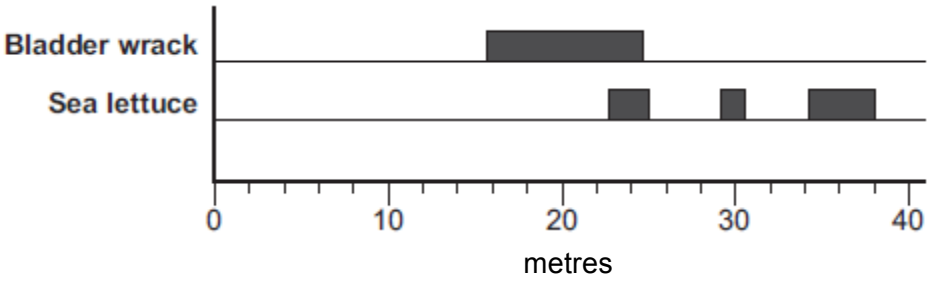
The students repeated steps 2 and 3 every metre down the shore. **Figure 2** shows a section of the seashore and the students' results.

Figure 2

Section of the seashore



Students' results



(i) The students placed the quadrat at regular intervals along a transect line rather than placing the quadrat at random positions anywhere on the rocky shore. Explain why.

_____

_____

_____

_____ **(2)**

(ii) How could the students have improved their investigation to ensure that they produced valid data?

_____

_____

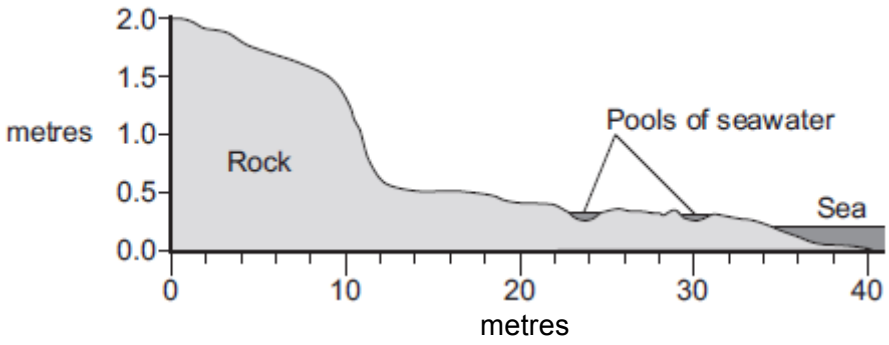
_____

_____ **(2)**

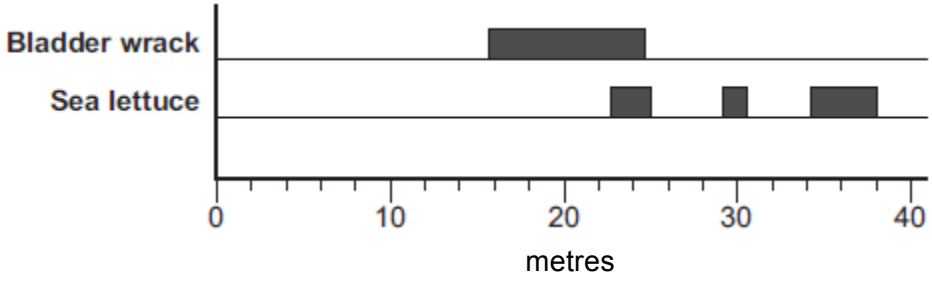
(iii) **Figure 2** is repeated here to help you answer this question.

Figure 2

Section of the seashore



Students' results



The students concluded that bladder wrack is better adapted than sea lettuce to survive in dry conditions.

What is the evidence for this conclusion?

Use information from **Figure 2**.

_____

_____

_____

_____ **(2)**

(b) The bladder wrack has many air bladders.
The air bladders help the bladder wrack to float upwards when the sea covers it.

Suggest how this helps the bladder wrack to survive.

_____

_____

_____

_____

(2)

(Total 8 marks)

4.7.2 Organisation in an ecosystem PPQ answers

Low Demand

PPQ MS1

Q1.

(a) any **two** from:

- amount of waste on each heap

  allow size of heap
- (type of) materials on each heap

  *if neither marking points one or two awarded, allow **1** mark for same waste*
- put heaps in same (environmental) conditions.

  e.g. keep at same (outside) temperature

  allow put in same place

2

(b) microorganisms / microbes / bacteria / fungi / decomposers

ignore detritivores / examples (such as worms, maggots, insects)

ignore pathogens / germs

*do **not** allow viruses*

1

(c) (i) oxygen / air added (when turning over)

allow idea that decay will be aerobic

allow bacteria / microorganisms need oxygen / air

allow (microorganisms) respire faster

1

(ii) any **two** from:

- dead leaves / fruit / plants (fall off / onto the ground)
- (fallen dead leaves / fruit / plants) decay
- minerals / ions / nutrients are recycled / released.

ignore references to carbon dioxide

*allow animal waste **or** dead animals*

2

[6]

PPQ MS2

Q2.

(a) (i) (compost produced) quicker / faster / takes less time

it = tumbler bin

*answers should be comparative eg **only** 6 weeks = 1 mark*

6 weeks = 0 marks

1

(ii) any **two** from:

- takes less space
- cheaper (to buy)
- don't need to turn / rotate it

it = fixed bin

references to space and cost should be comparative
*do **not** accept unqualified data*

2

(b) (i) any **two** from:

- faster rise (in tumbler)
- higher (in tumbler) **or** 2 correct number readings
- levels off (in tumbler) **or** continues to rise in fixed

it = tumbler bin
ignore eg faster compost

2

(ii) microorganisms / microbes / decomposers

allow bacteria / fungi / detritus feeders / worms / other named examples of detritus feeders / mould

1

aerobic

allow air(y)
allow oxygen(ated)

1

(iii) faster respiration / decay / **or** microorganisms / microbes / decomposers work faster (in tumbler)

allow converse
allow bacteria / fungi / mould

1

so more heat produced (in tumbler)

ignore heat produced by friction

OR

more air / more oxygen(ation) (in tumbler) (1)

so more respiration / faster decay / bacteria work faster (in tumbler) (1)

1

[9]

PPQ MS3

Q3.

(a) measure the length / area of the field

1

(b) use (a) random number(s) (generator)
or
use coordinates method explained

1

(c) compare their results with another student's results

1

place more quadrats

1

(d) 0.25 × 5 = 1.25

1

500 / 1.25 = 400

1

(40 × 400 =) 16 000

*allow 16 000 with no working shown for **3** marks*

1

(e) 11

1

(f) (quadrat) 5

*both quadrat number and correct reason must be given for **1** mark*

1

very few or only 2 growing (here)

[9]

Standard demand

PPQ MS4

Q4.

(a) methane is produced

ignore bad smell

1

which is a greenhouse gas / causes global warming

1

(b) (9.80 / 0.20 = 49 therefore) 49:1

1

(c) horse (manure)

*allow ecf from **11.2***

closest to 25:1 (ratio)

1

(d) **Level 3 (5–6 marks):**
A detailed and coherent explanation is given, which logically links how carbon is released from dead leaves and how carbon is taken up by a plant then used in growth.

Level 2 (3–4 marks):
A description of how carbon is released from dead leaves and how carbon is taken up by a plant, with attempts at relevant explanation, but linking is not clear.

Level 1 (1–2 marks):
Simple statements are made, but no attempt to link to explanations.

0 marks:
No relevant content.

Indicative content

statements:

- (carbon compounds in) dead leaves are broken down by microorganisms / decomposers / bacteria / fungi

- photosynthesis uses carbon dioxide

explanations:
- (microorganisms) respire
- (and) release the carbon from the leaves as carbon dioxide
- plants take in the carbon dioxide released to use in photosynthesis to produce glucose

use of carbon in growth:
- glucose produced in photosynthesis is used to make amino acids / proteins / cellulose
- (which are) required for the growth of new leaves

6

(e) any **three** from:
(storage conditions)
- (at) higher temperature / hotter
- (had) more oxygen
- (had) more water / moisture
- (contained) more microorganisms (that cause decay)

allow reference to bacteria / fungi / mould

3

[13]

PPQ MS5

Q5.

(a) (i) without oxygen

ignore reference to 'air'

1

(ii) otherwise difficult to stir / to pump / to transfer

allow prevent 'clogging' owtte

1

(iii) need to stir / pump / heat

1

(b) (i) rises then falls

1

then levels / slight rise

1

quantitative descriptor
- e.g. to 80% / max. on day 4 / min. on day 16

accept other valid quantitative descriptor

allow accuracy ± ½ small square

1

(ii) 16 (15.5 to 16.4)

1

(c) any **two** from:

- oxygen present
- (CO_2 produced) by aerobic respiration

or not much anaerobic respiration

- **not** much methane / CH_4 produced

2

[9]

PPQ MS6

Q6.

(a) (i) 10

1

(ii) any **three** from:

- both increase with distance
- more spp on walls than on trees
- no lichen spp on trees for first 1 km from city
- more steady / less erratic increase on trees than walls (or converse)
- rate of increase increases with distance

3

(b) SO_2 decreases with distance from centre

accept converse, Ignore pollution

1

high SO_2 reduces survival or kills lichen *accept converse*

1

(c) (i) any **three** from:

- (line) transect
- quadrat / reference to specific area
- count number of lichens or coverage on trees
- at regular intervals / set distances

3

(ii) (more) Xanthoria nearest road

allow 'nitrogen-loving' for Xanthoria

1

(more) Usnea further from the road

allow 'nitrogen-sensitive' for Usnea

1

because most nitrogen oxide from vehicles (near road)

OR because nitrogen oxide levels will be falling / less further away (from road)

accept converse

1

[12]

High demand

PPQ MS7

Q7.

(a) e.g.:
competition for light because potamogeton plants taller
competition for nutrients taller plants may have longer roots

each for 1 mark

4

(b) descriptions of:
measuring tape or similar quadrat, method of estimating cover (inside quadrat)

each for 1 mark

3

[7]

PPQ MS8

Q8.

(a) there is an uneven distribution of dandelions
or
(more) representative / valid
or
avoid bias
or
more accurate / precise mean

ignore accurate / precise unqualified
ignore repeatability / reproducibility / reliability / fair test

1

(b) (correct mean per m^2 =) 6 or 6.0

1

(correct field area =) 55 000 (m^2)

1

mean × area − e.g. 6(.0) × 55 000

allow incorrect calculated values for mean and / or field area

1

330 000

allow correct calculation from previous calculation

1

3.3×10^5

allow calculated value in standard form

1

*an answer of 3.3×10^5 scores **5** marks*
*an answer of 330 000 scores **4** marks*

(c) **Level 3:** The method would lead to the production of a valid outcome. All key steps are identified and logically sequenced.

5–6

Level 2: The method would not necessarily lead to a valid outcome. Most steps are identified, but the method is not fully logically sequenced.

3–4

Level 1: The method would not lead to a valid outcome. Some relevant steps are identified, but links are not made clear.

1–2

No relevant content

0

Indicative content

- placing of quadrat
- large number of quadrats used
- how randomness achieved − e.g. table of random numbers **or** random number button on calculator **or** along transect
- quadrats placed at coordinates **or** regular intervals along transect
- in each of two areas of different light intensities **or** transect running through areas of different light intensity
- for each quadrat count number of dandelions
- for each quadrat measure light intensity
- compare data from different light intensity

to access **level 3** the key ideas of using a large number of quadrats randomly, or along a transect, and counting the number of dandelions in areas of differing light intensity need to be given to produce a valid outcome

(d) any **two** from:

- temperature

  allow heat

- water

  allow moisture / rain

- (soil) pH

  allow acidity

- minerals / ions

  *allow e.g. magnesium ions **or** nitrate allow salts / nutrients*

- winds
- herbivores

  allow trampling ignore carbon dioxide, ignore space
  ignore competition unqualified
  *do **not** accept oxygen*

2

[14]

PPQ MS9

Q9.

(a) (i) to get data re position of seaweed / of organism

1

in relation to distance from sea / distance down shore / how long each seaweed was exposed

1

(ii) repeat several times *minimum = 2 repeats*

1

elsewhere along the shore

1

(iii) bladder wrack is further up the shore (than the sea lettuce) / exposed for longer *ignore found in dry areas / on bare rock*

1

sea lettuce (only) in rock pools / in the sea / (only) in water

1

(b) gets more light / closer to light *allow better access to CO_2*

1

(so) more photosynthesis

allow 1 mark for light for photosynthesis, allow 1 mark for CO_2 for photosynthesis, ignore reference to oxygen for respiration 'more' only needed once for 2 marks

1

[8]

4.7.3 Biodiversity and the effect of human interaction on ecosystems

Areas like tropical rainforests have millions of different species and are very biodiverse. Other areas like the Polar Regions have far fewer species and are less biodiverse.

Biodiversity is specifically the number of different species. An area with large populations of few species is not biodiverse.

Interdependence

If the numbers of one species are affected, there are almost always knock-on consequences. A simple food chain is:

algae → zooplankton → sand eel → puffin → arctic skua

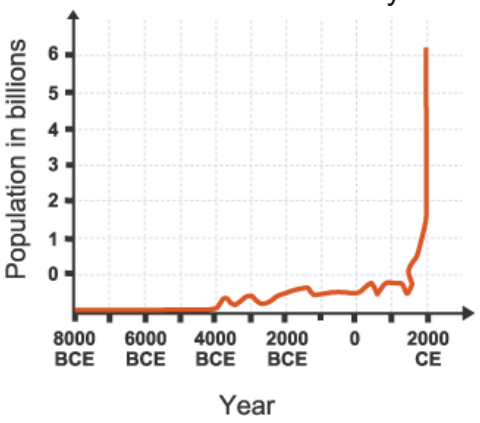
If the numbers of zooplankton are reduced by pollution, such as plastic waste, then more algae will grow and the population of other consumers will fall.

Ecosystems with higher biodiversity have fewer species that depend on just one other for food, shelter and maintaining their environment. With the example above, puffins could also eat molluscs and worms. Ecosystems with higher biodiversity are more stable as they can easily adjust to changes.

We are slowly realising that the future of our species on Earth depends on maintaining high biodiversity. Activities that create air and water pollution, are reducing biodiversity in many ecosystems. Conservation of species and habitats by charities, governments and individuals helps to maintain the range of biodiversity.

Human population growth

The number of people alive now is at a record level and is increasing. In 2012, the human **population** exceeded seven billion for the first time. Each year about 75 million more people are born than die. This is known as the net increase.
This increase can be clearly seen in a graph of human population.



Graphs of this shape are called **exponential**. Interestingly, we see the same pattern of growth in many populations of living organisms with sufficient resources. There are many reasons why our population increases:

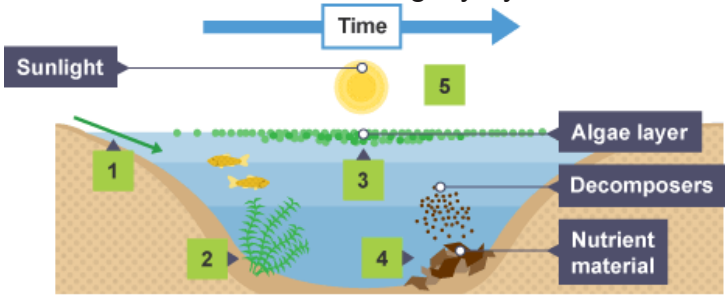
- better health care so people are living longer
- new medicines are being developed so people don't die of previously fatal diseases
- farmers are able to produce more food using new breeds and equipment
- some religions do not permit the use of **contraception**

Scientists are unsure whether this population increase will continue for ever. Some think that the human population will continue to increase and humans will be able to solve any problems that come their way.

Others think that humans will run out of food, fresh water or other resources and the earth's population will stop increasing, but remain high. Whereas, other scientists think that the population will reduce significantly, this is called a crash. In the past, plagues have caused a rapid decline in the population (note the dips in the graph at 600 CE and 1200 CE), and this could be a possible explanation for a rapid decline in the population in the future.
As the population grows, the pollution we produce also increases, which may cause significant issues.

Waste management
As the human **population** increases, the volume of waste and **pollution** that is produced also increases. Polluting an **ecosystem** harms or kills the organisms that live within it.
Modern society is more consumable, which means humans manufacture more products and replace them more often. This consumption is not **sustainable**. Many natural materials, including fossil fuels, will soon run out and scientists argue that there is already too much waste.

Water pollution
In some parts of the world, open sewers can lead into water courses, such as streams and rivers, which can cause serious illness in humans that may drink the contaminated water.
Some farmers use too many fertilisers, which can run off fields during heavy rain. This can pollute nearby streams and rivers leading to **eutrophication**. Some water pollution even comes from **toxic** chemicals released illegally by factories.



1	Nutrient load up: excessive nutrients from fertilisers are flushed from the land into rivers or lakes by rainwater.
2	Plants flourish: these pollutants cause aquatic plant growth of algae, duckweed and other plants.
3	Algae blooms, oxygen is depleted: algae blooms prevent sunlight reaching other plants. The plants die and oxygen in the water is depleted.
4	Decomposition further depletes oxygen: dead plants are broken down by bacteria decomposers, using up even more oxygen in the water.
5	Death of the ecosystem: oxygen levels reach a point where no life is possible. Fish and other organisms die.

Air pollution
Combustion of fossil fuels and other fuels releases carbon dioxide. This contributes to the **greenhouse effect** and leads to **global warming**. It also releases sulfur dioxide and nitrogen oxides which can cause acid rain. Air pollution can also be caused by tiny particulates from smoke which can cause **smog**. Some of the world's major cities like Delhi in India and Karachi in Pakistan have dangerously high levels of air pollution.
Land pollution
The rubbish we throw out that is not **recycled** goes into a land fill. These are huge holes in the ground into which our rubbish is dumped. Some things like batteries cannot be put into **landfill sites** because of the toxic chemicals they contain. They must be recycled. Other land pollution comes when some people dump rubbish in public or other private places, often to avoid paying for it to be disposed of. This is called fly tipping and is illegal.
Land use
The larger the human population gets, the more land we require. More houses must be built, more resources found, more food must be grown and more waste is produced. This often means less space and fewer resources for other animals and plants.
Often **biodiversity** is significantly reduced when land is cleared for human uses, such as building, quarrying, farming and waste disposal. Think about the reduction in biodiversity, which occurs when an area of rainforest is cut down to grow crops.

Deforestation

For thousands of years humans have been deforesting small areas of woodland to build their own houses or grow crops to feed their families. However, in recent years the increase in the human population and development of industrial machinery has meant that much larger areas have been cleared. This is often by large companies who deforest to provide land for cattle, rice fields and growing crops for biofuels.

In the last 75 years we have cut down over half of the world's rainforests. Scientists estimate that 32 000 hectares of rainforest are destroyed each day.
Deforestation destroys the habitats of the organisms that live there and through this kills individuals of many species. Scientists estimate that several hundred species of plant, animal and insect are lost each day partly as a result of deforestation. This means that deforestation is causing extinctions and dramatically reducing biodiversity.

Peat bog destruction

Bogs are very wet areas of land without trees in which many types of moss grow. They are acidic and often have very low levels of nutrients. Here decomposition is very slow and peat is formed from partially decayed plants.

For many years peat was removed from bogs for gardeners to add to their soil or to burn as fuel. This dramatically reduced biodiversity. Because peat takes such a long time to form, it is a non-renewable energy resource like fossil fuels.

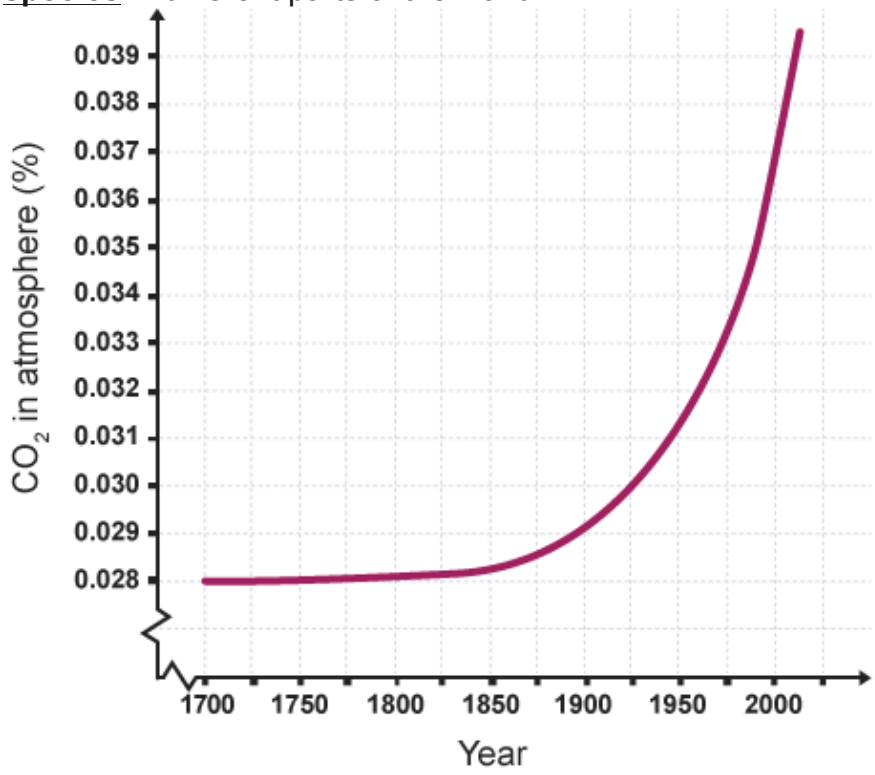
Peat bogs are a very important store of carbon. We call them carbon sinks. If all the peat was removed and burned this would quickly release a huge volume of carbon dioxide into the atmosphere and contribute to the greenhouse effect.

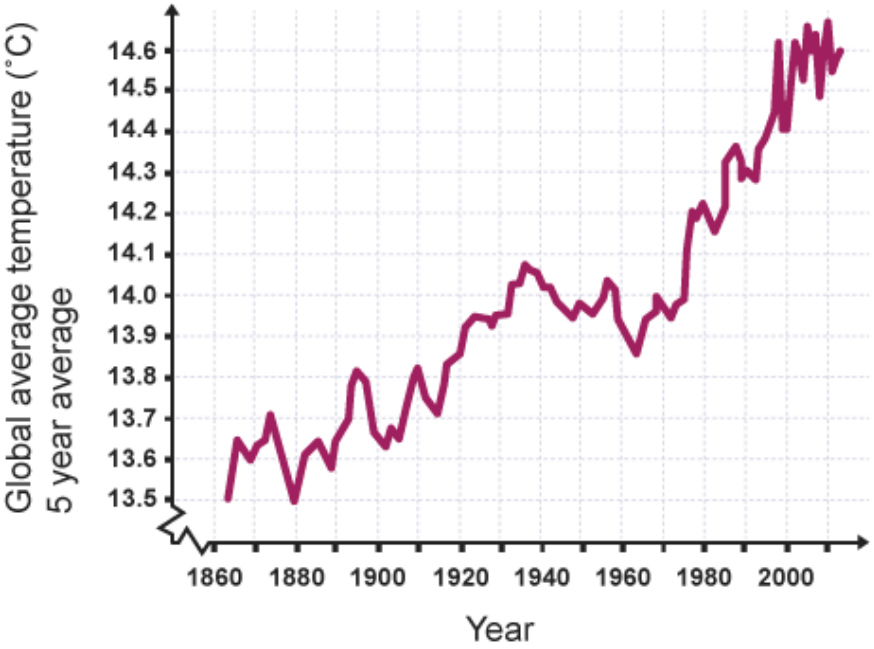
Greenhouse effect and evidence of enhanced greenhouse effect
The greenhouse effect
Without the **greenhouse effect** the **mean** temperature on Earth would be -18°C and there would be very little or no life. So the greenhouse effect itself is a good thing. The greenhouse effect traps some of the energy from the Sun, which keeps our planet at a suitable temperature for life.

The problem is that our increased release of **greenhouse gases** is causing an increase in the greenhouse effect called the enhanced greenhouse effect. This is leading to **global warming**. Carbon dioxide, water vapour and methane are amongst the most common greenhouse gases. Since the start of the **Industrial Revolution** in about 1750 the levels of carbon dioxide have increased by 40%.

Global warming

Global warming is the increase in the mean temperature of the Earth. The ten hottest years since records began have been in the last 30 years. The mean increase in the last 100 years has been less than 1°C. This might seem small, but is enough to have devastating consequences on many **species** in different parts of the world.





As the percentage of carbon dioxide in our atmosphere has increased so has the Earth's mean temperature. Note that the shape of the first graph showing the amount of carbon dioxide in the atmosphere is 'exponential' and is a similar shape to graphs showing human population change over the same time period. When comparing graphs such as changes to carbon dioxide levels and

temperature against time, note that the axes are drawn to different scales, and do not start at '0'.

The consequences of global warming are:

- melting of the polar ice caps
- the rise in sea level may one day threaten many cities such as London, New York and Amsterdam
- weather patterns will change with more unusual weather
- animals will migrate towards the poles to find habitats with suitable temperatures
- tropical diseases may become more common in other regions, such as the Europe many species will become **extinct**

Evidence for global warming

For many years the evidence that linked increased carbon dioxide levels to the greenhouse effect and global warming was not enough to convince everyone. In recent years more and more evidence has been collected and many scientists believe that this is the case. The evidence used by scientists is 'peer reviewed' by other scientists, which is the method used by the science community to ensure that research findings are valid. Peer review ensures that the science community are confident in the accuracy of data and any conclusions made.

Maintaining biodiversity

The increase in the human population and waste it produces, deforestation, peat bog destruction and global warming are all reducing biodiversity. Conservation helps reverse this. Conservation is the preservation of ecosystems and the organisms that live within them.

Scientists and concerned members of the public help maintain biodiversity by:

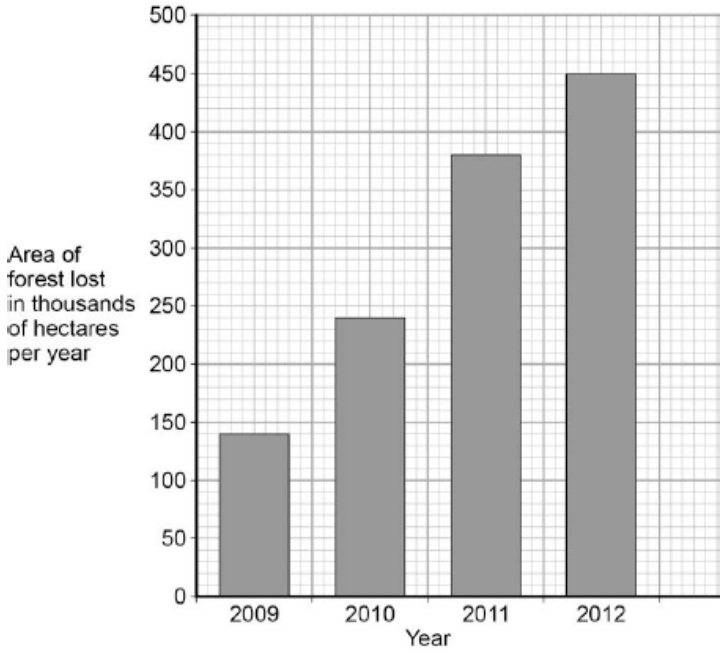
- breeding programs to help preserve endangered species, like the panda
- protection and development of new endangered habitats, often by making National Parks
- replanting hedgerows because there is higher biodiversity in them than the fields they surround
- reducing deforestation and the release of greenhouse gases
- recycling rather than dumping waste in landfill sites
-

4.7.3 Biodiversity and the effect of human interaction on ecosystems PPQs

Low Demand

PPQ 1

Q1. The graph below shows the area of forest lost in Madagascar from 2009 to 2012.



(a) The area of forest lost each year in Madagascar increased between 2009 and 2012. Determine the total area of forest lost from the start of 2009 to the end of 2012.

_____

_____

Total area of forest lost = _____ thousand hectares **(1)**

(b) What are the possible reasons for the change in the area of forest lost per year between 2009 and 2012?

Tick **two** boxes.

The local people stop growing rice	☐
Fewer new houses are needed for the population	☐
The local people decided to farm cattle	☐
More trees have been planted	☐
A company starts growing plants for biofuels	☐

(2)

(c) More forest was lost in 2012 than in 2009.

Use words from the box to complete the sentences.

carbon dioxide	**excretion**	**nitrogen**
oxygen	**photosynthesis**	**respiration**

The increase in the area of forest lost has caused an increase in the gas

_____

The increase of this gas has been caused because less of the gas is being

absorbed by plants for the process of _____ .

(2)

(d) Deforestation can have negative effects on our ecosystems.

What are the negative effects of deforestation?

Tick **two** boxes.

Animals and birds migrate because there is less food	☐
More habitats are destroyed	☐
There is less acid rain	☐
There is more biodiversity	☐
The global temperature decreases	☐

(2)

(e) Scientists try to reduce the negative effects of human activity on our ecosystems.

One way is to protect rare habitats.

Give **one other** way of reducing the negative effects of human activity on our ecosystems.

_____

_____

(1)

(Total 8 marks)

PPQ 2

Q2.

The human population is increasing and more household waste is being produced.

(a) Give **one** way in which an increase in household waste affects our environment.

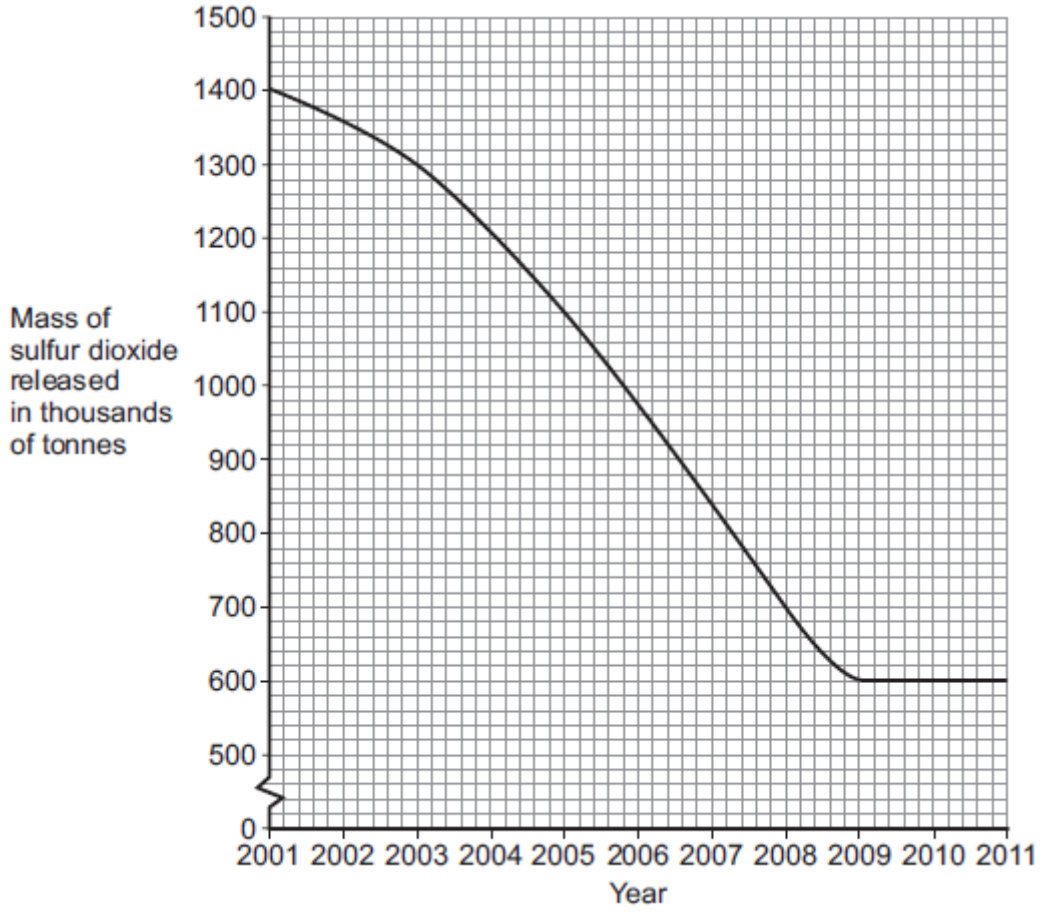
_____

_____

(1)

(b) The release of sulfur dioxide affects our environment.

The graph shows how the mass of sulfur dioxide released in the UK has changed from 2001 to 2011.



(i) Describe the pattern shown in the graph.

_____

_____

_____

_____

(2)

(ii) In 2001, 1400 thousand tonnes of sulfur dioxide were released.

By which year had the amount of sulfur dioxide released reduced to half of this amount?

_____

_____

_____

Year = _____

(2)

(iii) Give **one** problem caused when sulfur dioxide gas is in the air.

_____

_____

(1)

(c) Carbon dioxide is another gas that affects the environment.

Which **two** of the following help to reduce the levels of carbon dioxide in the atmosphere by storing carbon dioxide?

Tick (✓) **two** boxes.

Animals respiring	☐
Carbon dioxide being absorbed in oceans and lakes	☐
Photosynthesis by trees	☐
The production of biogas	☐

(2)

(Total 8 marks)

PPQ 3

Q3. Human activities affect the environment.

(a) **List A** gives four human activities. **List B** gives the effect of the activities on the environment. Draw **one** line from each human activity in **List A** to its effect on the environment in **List B**.

List A **Human activity**	**List B** **Effect on the environment**
	Adds methane to the atmosphere
Digging a new quarry	
	Pollutes hedges around fields
Spraying pesticides on crops	
	Reduces the land available for wild animals
Growing rice	
	Produces lots of litter
Driving cars that release sulfur dioxide	
	Produces acid rain

(4)

(b) Human activities are increasing *global warming* . Give **two** effects of *global warming* on the environment.

1. _____

_____

2. _____

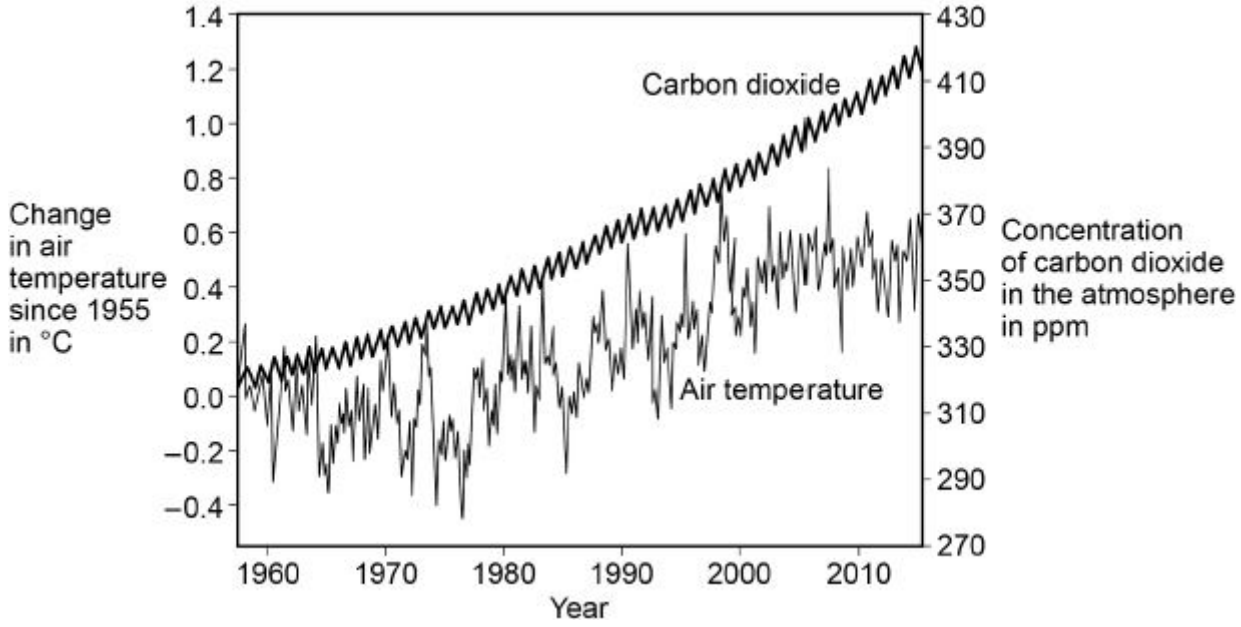
_____**(2)**

(Total 6 marks)

Standard demand

PPQ 4

Q4. Many scientists think that global air temperature is related to the concentration of carbon dioxide in the atmosphere. The graph below shows changes in global air temperature and changes in the concentration of carbon dioxide in the atmosphere.



(a) Complete the table below. Use information from the graph above. Choose answers from the box. You may use each answer once, more than once or not at all.

constant	decreasing	increasing

	1960 – 1977	1977 – 2003	2003 – 2015
Trend in carbon dioxide concentration	Increasing		
Trend in air temperature			

(2)

Many scientists think that an increase in carbon dioxide concentration in the atmosphere causes an increase in air temperature.

(b) How would an increase in the concentration of carbon dioxide in the atmosphere cause an increase in air temperature?

_____

_____

(1)

(c) Evaluate evidence for and against the theory that an increase in the concentration of carbon dioxide in the atmosphere causes an increase in air temperature. Use data from the graph above and your own knowledge.

(4)

In each year, the concentration of carbon dioxide in the atmosphere is higher in the winter than in the summer.

(d) Give **one** human activity that could cause the higher concentration of carbon dioxide in the winter.

(1)

(e) Give **one** biological process that could cause the lower concentration of carbon dioxide in the summer.

(1)

(f) Give **two** possible effects of an increase in global air temperature on living organisms.

1.

2.

(2)

(Total 11 marks)

PPQ 5

Q5.

(a) Describe **three** ways in which large-scale deforestation in tropical areas has **increased** the concentration of carbon dioxide in the atmosphere.

1. _____

_____

2. _____

_____

3 _____

_____

(3)

(b) Suggest **two** reasons why deforestation also causes a reduction in biodiversity.

_____

_____

_____

_____

(2)

(c) Scientists are thinking of new ways to try to repair the damage done by deforestation.

One way is by carbon sequestration.

(i) What is **carbon sequestration**?

_____

_____

(1)

(ii) Suggest **one** way in which carbon can be sequestered.

_____

_____

(1)

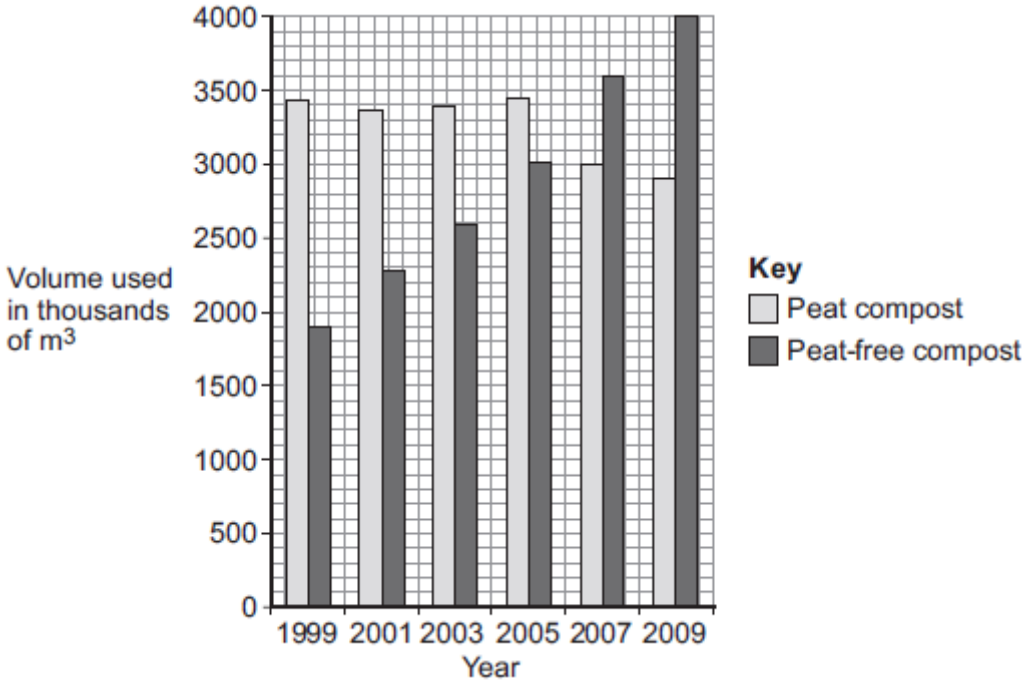
(Total 7 marks)

PPQ 6

Q6.

Human activities have many effects on our ecosystem.

The graph shows the volume of peat compost and peat-free compost used in gardening from 1999 to 2009.



(a) Describe the trends shown in the graph.

_____

_____

_____

_____

_____

(2)

(b) What effect does the destruction of peat bogs have on the gases in the atmosphere?

_____

_____

(1)

(c) Deforestation is also damaging ecosystems.

Describe **one** effect of deforestation on ecosystems.

_____

_____ **(1)**

(Total 4 marks)

High demand

PPQ 7

Q7.

In tropical areas of the world, forests are being cut down at the rate of 150 hectares every minute of every day.

(a) Give **two** reasons why forests in tropical areas are being cut down at a high rate.

1. _____

_____

2. _____

_____

(2)

(b) Explain how this deforestation is affecting the composition of the atmosphere.

_____

_____

_____

_____

_____

_____

(5)

(Total 7 marks)

PPQ 8

Q8. The figures below show the levels of carbon dioxide in air from 150 000 years ago.

TIME	CARBON DIOXIDE CONCENTRATION
1500 years ago	270 parts per million
1800 AD	290 parts per million
1957	315 parts per million
1983	340 parts per million

(a) Explain why carbon dioxide levels in the atmosphere are changing.

_____

_____

_____

_____ **(3)**

(b) It is suggested that the increased level of carbon dioxide in the air is causing the atmosphere to warm up (the "Greenhouse Effect").

Describe, as fully as you can, **two** major effects of global warming and how these may affect the human population.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

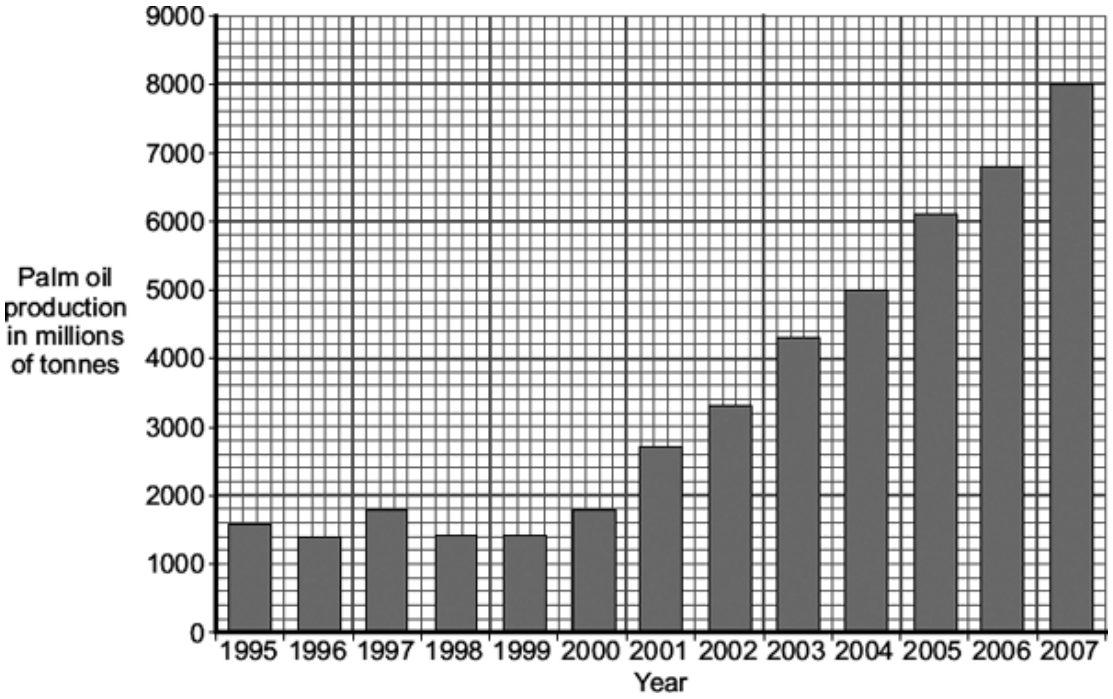
(6)

(Total 9 marks)

PPQ 9

Q9.

In South Asia, forests are being cleared to grow palm oil trees. The palm oil is mainly used to produce fuel for motor vehicles. The graph shows the production of palm oil in one South Asian country.



(a) Calculate the mean increase in palm oil production per year for the five year period 2000 to 2005.

Show clearly how you work out your answer.

_____

_____

Mean increase = _____ millions of tonnes per year

(2)

(b) Clearing forests and replacing the forests with palm oil trees to produce fuel for motor vehicles will affect the composition of the atmosphere.

Explain how.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(5)

(Total 7 marks)

4.7.3 Biodiversity and the effect of human interaction on ecosystems PPQ answers

Low Demand

PPQ MS1

Q1.

(a) (140 + 240 + 380 + 450 =) 1210

1

(b) the local people decided to farm cattle

1

a company starts growing plants for biofuels

1

(c) carbon dioxide

in this order only

1

photosynthesis

1

(d) animals and birds migrate because there is less food

1

more habitats are destroyed

1

(e) any **one** from:

- breeding programmes (for endangered species)
- regeneration (programmes)
- reintroduction of field margins / hedgerows
- awareness raising with politicians / public
- recycling

1

[8]

PPQ MS2

Q2.

(a) any **one** from:

- increased pollution
- dumping waste

allow described consequence e.g. vermin

accept (increased) landfill

accept (increased) fly tipping.

1

(b) (i) (mass of SO_2) decreases

1

and then levels off / plateaus

1

(ii) 2008

clear evidence of calculating 700 (000) = 1 mark

2

(iii) any **one** from:

- acid rain

- erosion of statues / buildings
- destruction of habitats
- reduction in biodiversity
- damage to lichen
- breathing problems

ignore reference to ozone layer

allow damage to plants.

1

(c) Carbon dioxide being absorbed in oceans and lakes

1

Photosynthesis by trees

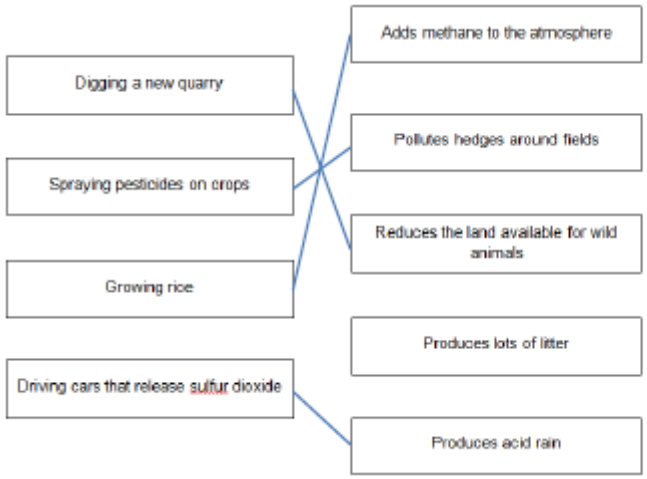
1

[8]

PPQ MS3

Q3.

(a)



1 mark for each correct line

extra line from box in left hand column cancels mark

4

(b) any **two** from:

- climate change

  ignore 'Earth warmer'

- more extreme weather / changes to weather (patterns) / described
- rise in sea level
- melting of ice caps
- reduced biodiversity
- changes to migration patterns
- changes in distribution of species

  accept faster plant growth / tropical species can be grown in UK

  accept tropical diseases / example spread to temperate regions

2

[6]

Standard demand

PPQ MS4

Q4.

(a)

	1960 – 1977	1977 – 2003	2003 – 2015	
trend in carbon dioxide concentration		increasing	increasing	**1**
trend in air temperature	decreasing	increasing	constant / decreasing	**1**

allow synonyms e.g. level / goes up / goes down

(b) traps heat / energy or (long-wavelength / IR) radiation

*do **not** accept light / UV*

or

less loss of heat

allow stops (some) heat escaping
*do **not** accept stops all heat escaping*

or

insulates

ignore greenhouse effect
ignore reference to ozone layer

1

(c) **Level 2:** Some logically linked reasons are given. There may also be a simple judgement.

3–4

Level 1: Relevant points are made. They are not logically linked.

1–2

No relevant content

0

Indicative content

for the theory:

- (overall increased CO_2 parallels) overall increased temperature (e.g. by 0.4 (°C))
- CO_2 traps (long-wave) radiation / IR / heat

against the theory:

- in some years (e.g. 1960–1977) temperature falls (while CO_2 is rising)
- many (large and small) erratic rises and falls in temperature
- overall correlation does not necessarily mean a causal link
- other (unknown) factors may be involved in temperature change

to access level 2 there must be evidence both for and against the theory **and** use of data from the graph

(d) burning of (fossil) fuels

allow e.g. coal / oil / gas
allow driving cars
allow any activity which leads to burning fuels − e.g. using central heating

ignore power stations unqualified
ignore burning / fires unqualified
ignore deforestation

1

(e) photosynthesis

allow full description or full equation
allow a symbol equation which is not balanced

1

(f) any **two** from:

- (some) plants grow faster / higher yield
- loss of habitat
- migration **or** change in distribution*
- extinction*

if neither is given allow alters biodiversity for **1 mark*

allow (in terms of extinction) death due to e.g. lack of water / food or increased disease

ignore death unqualified

2

allow points made using examples

[11]

PPQ MS5

Q5.

(a) decrease in photosynthesis (as fewer trees) causes less removal of CO_2

accept forest cleared for livestock which respire and give out CO_2

ignore 'Carbon sink'

1

burning / combustion releases CO_2

1

decay of wood (by microorganisms) releases CO_2

1

(b) any **two** from:

- loss of habitat / shelter
- loss of food source
- smaller populations more vulnerable / less likely to survive
- fewer plant species due to clearing

2

(c) (i) removing carbon dioxide from the air

1

(ii) any **one** from:

- growth of plants (to trap CO_2 in photosynthesis)

allow afforestation

- CCS (carbon capture and storage)
- separate / store CO_2 from waste gases in industry
- make new peat bogs
- absorbed / dissolved in oceans / lakes / ponds
- used as calcium carbonate to form shells / bones

1

[7]

PPQ MS6

Q6.

(a) any **two** from:

- (volume of) peat compost has been steady and then declined **or** volume of peat compost has declined since 2005

  allow 2007 instead of 2005
- (volume of) peat-free compost has increased (since 1999)
- (volume of) peat is higher than peat-free until 2005, then peat-free compost is higher (than peat)

  allow 2007
- total volume of peat and peat-free compost has increased.

2

(b) increases carbon dioxide (in the atmosphere)

ignore methane

1

(c) any **one** from:

- reduces biodiversity
- destruction of habitats
- disruption of food chains.

1

[4]

High demand

PPQ MS7

Q7.

(a) e.g.
timber
agriculture
roads / urban development / buildings **2**

(b) *ideas that (accept reverse arguments)*
increased carbon dioxide content since less during photosynthesis
and locked-up as wood burning increases carbon dioxide content
increased activity of microbes increases carbon dioxide content
oxygen content reduced water vapour content reduced

5

[7]

PPQ MS8

Q8.

(a) *idea:*
more (fossil) fuel burned (do not credit simply more people/cars/industry)
deforestation = less photosynthesis
deforestation = more respiration/burning *each for 1 mark*

3

(b) *idea*:
climate change *for 1 mark*

warmer/colder/drier/wetter
food production affected/starvation
mayor ecosystems destroyed/damaged *any two for 1 mark each*

6

sea level rise *for 1 mark*

low land flooded
less food grown/starvation
homes/factories flooded *any two for 1 mark each*

Allow
polar ice caps melt, sea water expands

[9]

PPQ MS9

Q9.

(a) 860

*correct answer gains **2** marks*
if answer incorrect evidence of (6100 - 1800) ÷ 5
***or** 4300 ÷ 5*
***or** (900 + 600 + 1000 + 700 + 1100) ÷ 5 gains **1** mark*
allow ecf from 1 incorrect graph reading

2

(b) *ignore references to oxygen / sulfur dioxide / nitrogen oxides / acid rain*
ignore global warming

Effects of deforestation

deforestation increases the amount of carbon dioxide in the atmosphere
award this point only if linked to deforestation

1

any **two** from:

- due to less photosynthesis **or** less carbon dioxide taken in **or** carbon dioxide not locked up in (forest) trees
- due to burning of forest / from machinery
- due to activity of microorganisms / decay

2

Effects of growing palm for fuel

carbon dioxide released when palm oil used as fuel

1

(eventually) CO_2 intake and output might balance out **or** burning palm oil carbon neutral
accept less carbon dioxide than from burning fossil fuels

1

[7]

4.7.4 Trophic levels in an ecosystem (biology only)

A simple food chain is:

algae → mosquito larvae → dragon fly larvae → perch

All other food chains in an ecosystem can be added together to make a food web. These stages in a food chain or web are called trophic levels. The arrows show the transfer of biomass from one trophic level to another.

At the bottom of all food chains is a producer. This is almost always a plant or alga which can photosynthesise to convert carbon dioxide and water into glucose. This provides all the biomass for the food chain. Algae are the producers in the food chain above.

The second trophic level in all food chains is an herbivore or omnivore called a primary consumer. Mosquito larvae are the primary consumers in the above food chain. The third stage is a carnivore or omnivore which eats the primary consumer. This is called the secondary consumerand is dragonfly larvae in the above food chain. There may be additional carnivorous consumers here which would be called tertiary and quaternary. The final level is perch, also a carnivore and is often called the top or apex predator. Organisms at the tops of food chains have no predators.

Decomposers are bacteria and fungi which breakdown dead plant and animal matter. They secrete enzymes on the surface of the dead organisms to break the down and then absorb the digested, smaller food molecules.

Common words used with food chains and their meaning

Word	Meaning
Producers	Green plants - they make glucose during photosynthesis.
Primary consumers	Usually eat plant material - they are herbivores. For example rabbits, caterpillars, cows and sheep.
Secondary consumers	Usually eat animal material - they are carnivores. For example cats, dogs and lions.
Predators	Kill for food. They are either secondary or tertiary consumers.
Prey	The animals that predators feed on.
Scavengers	Feed on dead animals. For example, crows, vultures and hyenas are scavengers.
Decomposers	Feed on dead and decaying organisms, and on the undigested parts of plant and animal matter in faeces.

Pyramids of biomass

Biomass is living or recently dead tissues. The mass of your body is biomass because you are alive. Wood is considered biomass because it was recently a plant. Fossil fuels are not considered biomass because they are the remains of organisms that died millions of years ago and have been chemically changed from the original living tissue.

Pyramids of biomass

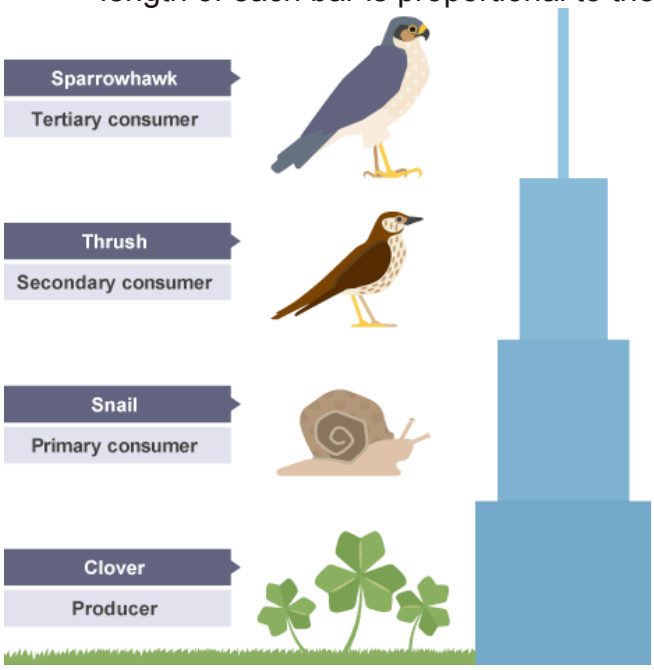
We can measure the amount of biomass at different **trophic levels** in a food chain. The total biomass of each trophic level is often represented as a modified bar chart called a pyramid of biomass. In a **food chain** from a healthy **ecosystem** the biomass at each trophic level must reduce. An example of a food chain is:

clover → snail → thrush → sparrowhawks

So in an ecosystem the clover has more biomass than all the snails, which have more biomas than all the thrushes and so on. We say that pyramids of biomass are always perfectly shaped. If this is not the case, then the ecosystem is likely to be unhealthy and in danger.

Pyramids of biomass must be drawn with the:

- bars equally spaced around the midpoint
- bars touching
- bar for the **producer** at the bottom
- length of each bar is proportional to the amount of biomass available at each trophic level



Transfer of biomass

The arrows in a **food chain** show the transfer of **biomass** from one organism to another. An example of a food chain is:

maize → locust → lizard → snake

Some of the energy from the Sun absorbed by maize when it **photosynthesises** is transferred to the locusts when they eat the plant. So biomass is transferred. Then some of the biomass in the locust is transferred to the lizards when they are eaten and so on.

Energy transfer

Not all of the biomass is passed from the maize plants to the locusts. In fact, only about ten per cent of the biomass is transferred from each **trophic level** to the next. The remaining 90 per cent is used by the trophic level to complete **life processes**. Biomass can be lost between stages

because not all of the matter eaten by an organism is digested. Some of it is excreted as waste such as solid **faeces**, carbon dioxide and water in **respiration** and water and **urea** in urine.
Because only around 10% of the biomass at each trophic level is passed to the next, the total amount becomes very small after only a few levels. So food chains are rarely longer than six trophic levels.
In fact, only about one percent of the energy from the Sun that reaches the plant's leaves is used by the plant during photosynthesis. This sounds small but is still enough to power almost all food chains on our planet.

Calculating efficiency of biomass transfers

The efficiency of **biomass** transfer is a measure of the proportion of biomass transferred from a lower **trophic level** to a higher one. Usually around ten per cent of biomass is transferred between trophic levels in a healthy **ecosystem** and the remaining ninety per cent is used by the organisms during **life processes**.
This is an example of a food chain:
phytoplankton → zooplankton → herring → sea lion

curriculum-key-fact	**The total biomass within the phytoplankton is 14.6 kg. The total biomass within the zooplankton is 1.3 kg. What is the efficiency of this transfer?**

To complete this calculation, we divide the amount from the higher trophic level by the amount from the lower trophic level and multiply by one hundred. That is, we divide the smaller number by the bigger one (and multiply by one hundred).

$$Percentage\ efficiency\ transfer = \frac{biomass\ in\ higher\ trophic\ level}{biomass\ in\ lower\ trophic\ level} \times 100$$

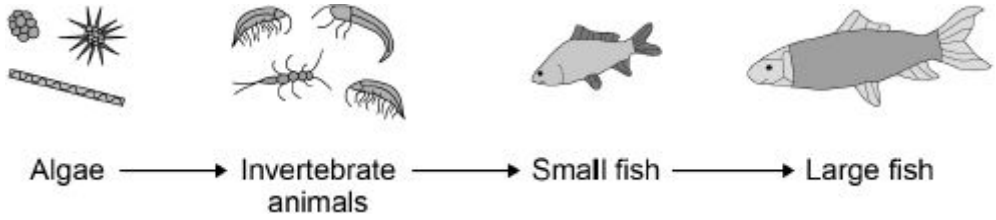
$$Percentage\ efficiency\ transfer = \frac{1.3\ kg}{14.6\ kg} \times 100 = 8.9\%$$

4.7.4 Trophic levels in an ecosystem (biology only) PPQs

Low Demand

PPQ 1

Q1. The diagram below shows a food chain in a river.



(a) Draw **one** line from each scientific term to the correct organism in the food chain.

Scientific term	Organism in the food chain
	Algae
Apex predator	
	Invertebrate animals
Primary consumer	
	Large fish
Producer	
	Small fish

(3)

(b) The table below shows the biomass of the organisms at each stage in the food chain.

Organism	Biomass in arbitrary units
Algae	840
Invertebrate animals	200
Small fish	40
Large fish	10

Calculate the percentage of the biomass of the invertebrate animals that is transferred to the large fish.

Use the equation:

$$\text{percentage} = \frac{\text{biomass of large fish}}{\text{biomass of invertebrate animals}} \times 100$$

_____

_____

_____

_____

Percentage = _____

(2)

(c) A large amount of biomass is lost from the food chain.

Complete the sentences.

Choose answers from the box.

coordination	**digestion**	**excretion**
filtration	**ingestion**	**respiration**

When the small fish eat the invertebrate animals, not all of this material is

broken down during _____ .

Materials absorbed from the gut may enter the body cells of the small fish.

These materials are broken down into carbon dioxide and

water by _____ .

The carbon dioxide and other waste materials from the body cells are removed

from the small fish by _____ .

(3)

(d) A disease kills many of the small fish.

Why does the number of invertebrate animals increase?

_____

_____

(1)

(Total 9 marks)

PPQ 2

Q2. There are two forms of peppered moth, dark and pale. Birds eat the moths when the moths are resting on tree bark. Pollution in the atmosphere may:

- kill lichens living on tree bark
- make the bark of trees go black.

(a) Draw a ring around the correct answer to complete the sentence.

Lichens are very sensitive to air pollution caused by

carbon dioxide.
nitrogen.
sulfur dioxide.

(1)

(b) The photographs show the two forms of peppered moth, on tree bark.

Tree bark covered with lichens Tree bark made black by pollution

(i) The dark form of the peppered moth was produced by a change in the genetic material of a pale moth.

Use **one** word from the box to complete the sentence.

characteristic	**clone**	**mutation**

A change in genetic material is called a _____

(1)

(ii) In the 19th century, pollution made the bark of many trees go black. Explain why:

- the population of the pale form of the moth in forests decreased
- the population of the dark form of the moth in forests increased.

_____

_____

_____

_____

_____

_____

_____

(3)

(c) (i) The larvae (young) of the peppered moths eat the leaves of birch trees. The diagram shows the food chain: birch trees → peppered moth larvae → birds

Draw a pyramid of biomass for this food chain. Label the pyramid.

(2)

(ii) Which **two** reasons explain the shape of the pyramid you drew in part (c)(i)? Tick (✓) **two** boxes.

Some material is lost in waste from the birds	☐
The trees are much larger than peppered moth larvae	☐
Peppered moth larvae do not eat all the leaves from the trees	☐
The trees do not use all of the Sun's energy	☐

(2)

(Total 9 marks)

PPQ 3

Q3.

Figure 1 shows a food chain containing three organisms.

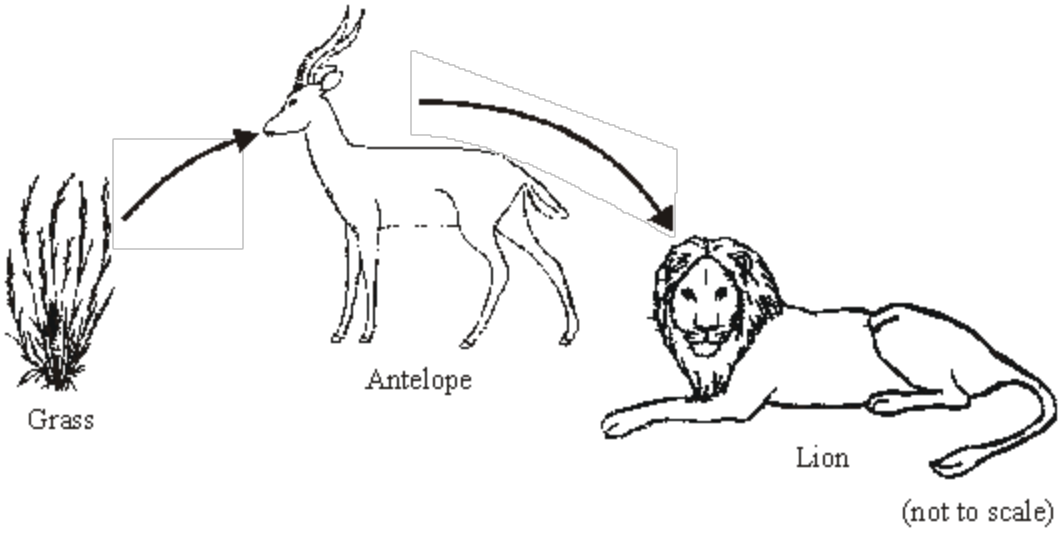


Figure 1

(a) (i) In this food chain, name:

the predator; _____

the prey. _____ **(2)**

(ii) What is the source of energy for the grass?

Draw a ring around **one** answer.

carbon dioxide **light** **nitrates** **water**

(1)

(iii) **Figure 2** shows a pyramid of biomass for the organisms in **Figure 1.**

Write the names of the organisms on the correct lines in **Figure 2.**

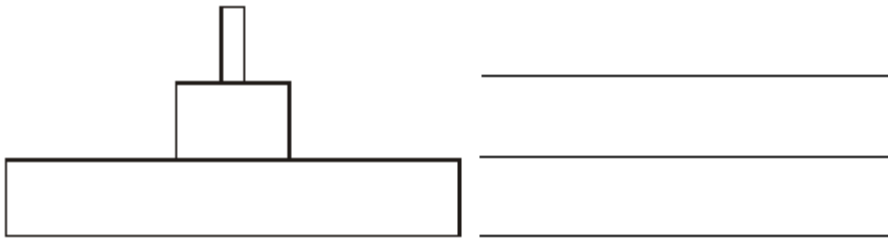


Figure 2

(1)

(b) Waste materials, like faeces from the animals, will decay,

(i) What sort of organisms cause decay?

_____ **(1)**

(ii) **Three** of the following conditions help decay to occur rapidly.

Which conditions do this?

Draw a ring around each of the **three** answers.

aerobic **anaerobic** **cold** **dry** **moist** **warm**

(3)

(iii) The list below gives four substances. Two of these substances are produced by decay and can be used by the grass.

Which **two** substances are these?

Tick (✓) **two** boxes.

Carbon dioxide ☐

Mineral salts ☐

Oxygen ☐

Protein ☐

(2)

(Total 10 marks)

Standard demand

PPQ 4

Q4. A group of students investigated populations in a food chain in a garden. The table shows the estimates of the number and biomass of some of the organisms the students found.

Organism	Number in the garden	Mean mass of each one in grams	Biomass of population in grams
Hedgehog	1	200	200
Slug	600	2	1200
Lettuce	60	100	

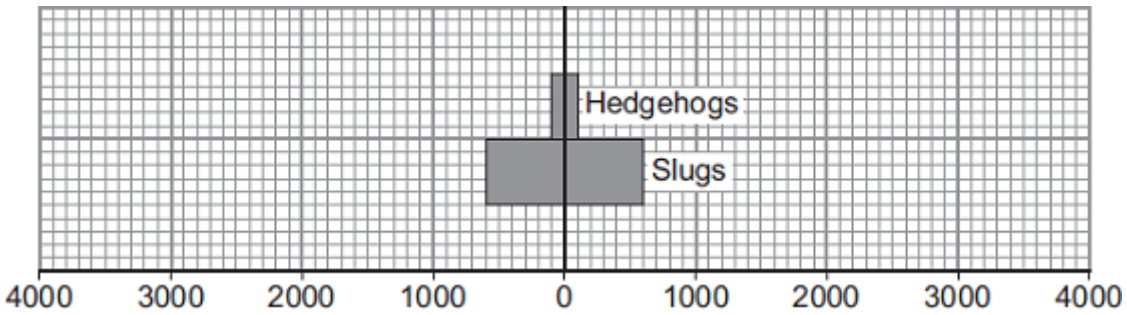
(a) (i) Calculate the biomass of the lettuce population. Show clearly how you work out your answer.

_____

_____

Biomass = _____ grams **(2)**

(ii) Use your answer to part (a)(i) to complete the pyramid of biomass. Show the biomass of the lettuce population in the garden.



Biomass of population in grams

(2)

(b) The energy in the hedgehog population is much less than the energy in the slug population. Explain why as fully as you can.

_____

_____

_____

_____

_____

_____ **(3)**

(Total 7 marks)

PPQ 5

Q5. There are many ways to increase the efficiency of food production.

(a) The table shows the energy available to humans from two different food chains.

Food chain	Energy transferred to humans in kJ per hectare of crop
Wheat → humans	900 000
Wheat → pigs → humans	90 000

(i) Compare the amount of energy the two food chains transfer to humans.

_____

_____ **(1)**

(ii) Give **one** reason for the difference in the amount of energy the two food chains transfer to humans.

_____

_____ **(1)**

(b) Give methods used in the factory farming of animals. Explain the advantages and disadvantages of these methods.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

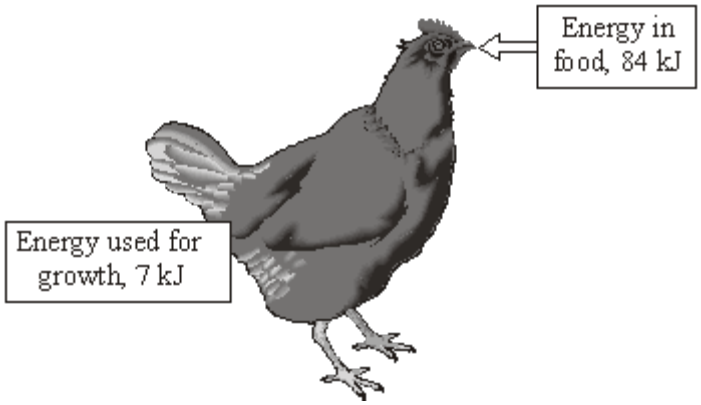
_____

_____ **(6)**

(Total 8 marks)

PPQ 6

Q6. The diagram shows what happens to some of the energy in the food that a chicken eats.



(a) Calculate the percentage of energy used for growth. Show clearly how you work out your answer.

_____

_____

Energy used for growth = _____ % **(2)**

(b) The energy that is not transferred into growth is lost. Give **three** ways in which this energy is lost.

1. _____

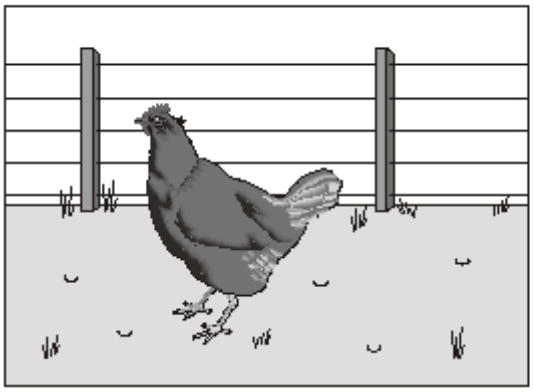
2. _____

3. _____

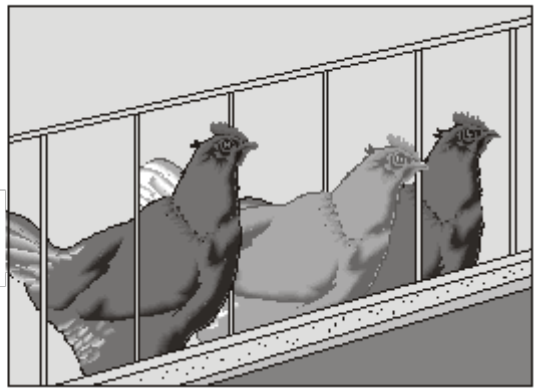
(3)

(c) The pictures show two ways of keeping chickens to produce eggs.

Chickens kept outdoors (free-range)



Chickens kept in cages (battery chickens)



Battery chickens produce more eggs per year than free-range chickens. Suggest **one** reason why.

_____

_____ **(1)**

(d) The animals that we raise for food are usually herbivores (plant eaters) rather than carnivores (flesh eaters).

Explain why.

_____

_____

_____

_____

_____

(2)

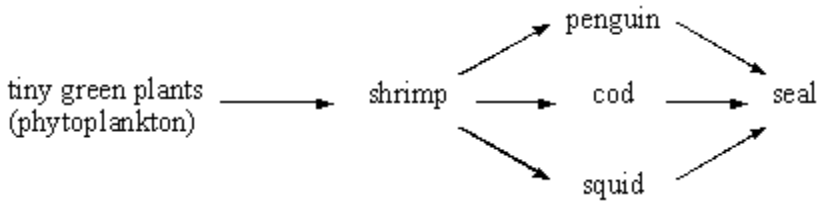
(Total 8 marks)

High demand

PPQ 7

Q7.

Scientists have found the following food web in the cold Antarctic Ocean.



(a) Humans are removing large numbers of the cod.

Some scientists argue that this could lead to a decrease in the numbers of squid and penguins.

Others argue that the numbers of squid and penguins will stay the same.

Carefully explain each argument.

Why they might decrease.

_____

_____

_____

(1)

Why they might stay the same.

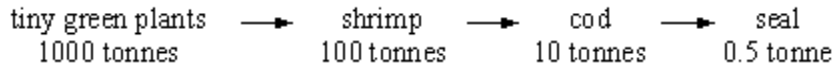
_____

_____

_____

(2)

(b) The following information is about the biomass of the organisms in one of the food chains in the web.



Draw and label a pyramid of biomass for this chain.

(2)

(c) Explain, as fully as you can, why the conversion of shrimp biomass into cod biomass is more efficient than that of cod biomass into seal biomass in the cold Antarctic Ocean.

_____

_____

_____

_____

(3)

(d) Boats from many countries fish the Antarctic Ocean. The cod are being overfished. If the numbers of cod are to increase, the population must be carefully managed.

(i) Suggest **two** control measures which would prevent a further drop in numbers,

_____

_____

(2)

(ii) Suggest why **one** of your control measures would be difficult to put into practice.

_____

_____

(1)

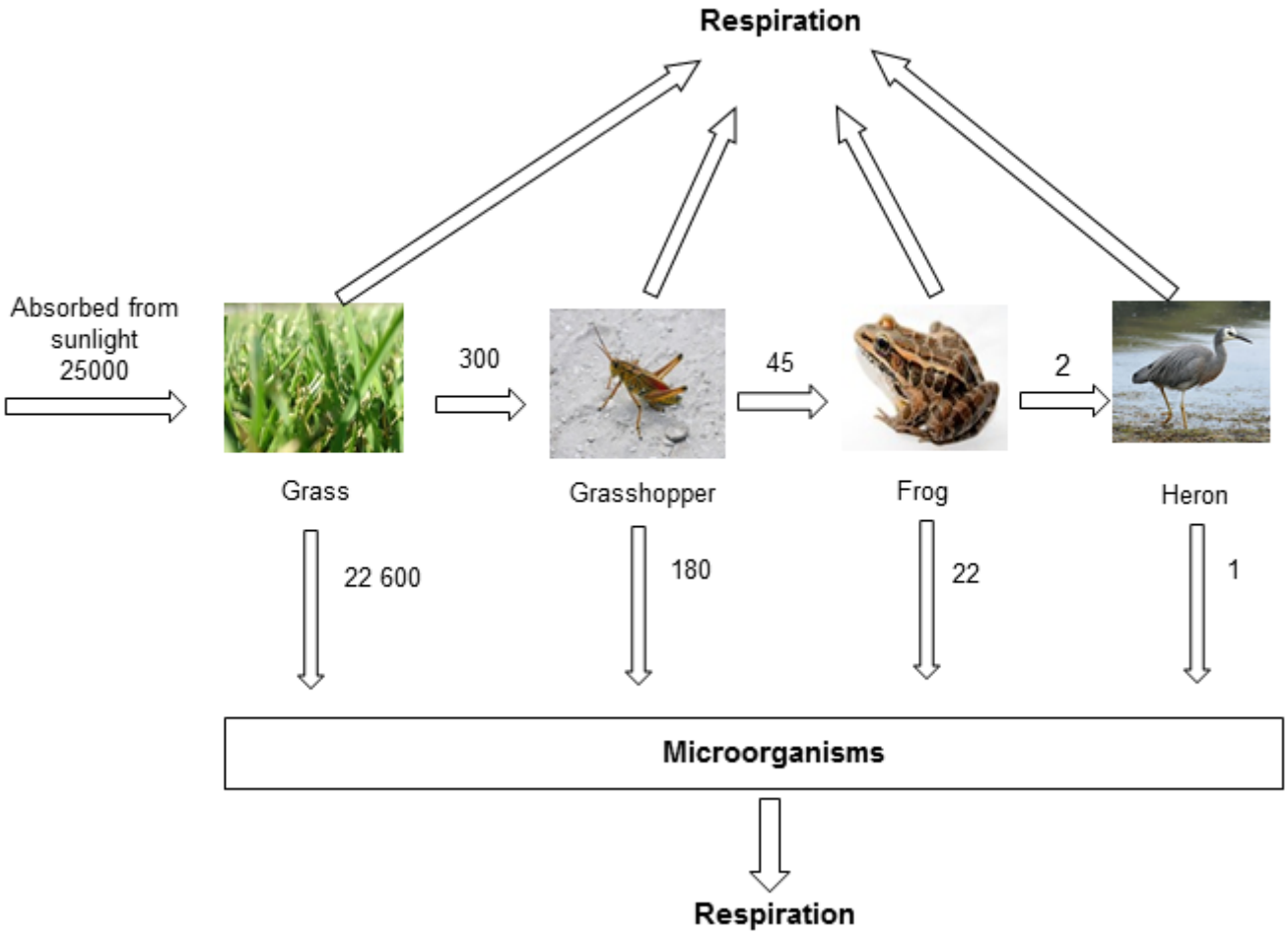
(Total 11 marks)

PPQ 8

Q8.

The diagram shows the annual energy flow through 1 m^2 of a habitat.

The unit, in each case, is kJ per m^2 per year.



(a) Calculate the percentage of the energy absorbed by the grass from sunlight that is transferred to the frog.

Show clearly how you work out your answer.

_____

_____

Answer _____ %

(2)

(b) All of the energy the grass absorbs from the sun is eventually lost to the surroundings.

In what form is this energy lost?

_____

(1)

(c) Food chains are usually **not** more than five organisms long.

Explain why.

To gain full marks you must use data from the diagram.

_____

_____

_____

_____

(2)

(d) In this habitat microorganisms help to recycle materials.

Explain how.

_____

_____

_____

_____

_____

_____

(3)

(Total 8 marks)

PPQ 9

Q9. **Figure 1** shows:

- a food chain for organisms in a river and the biomass of the organisms at each trophic level.

Figure 1

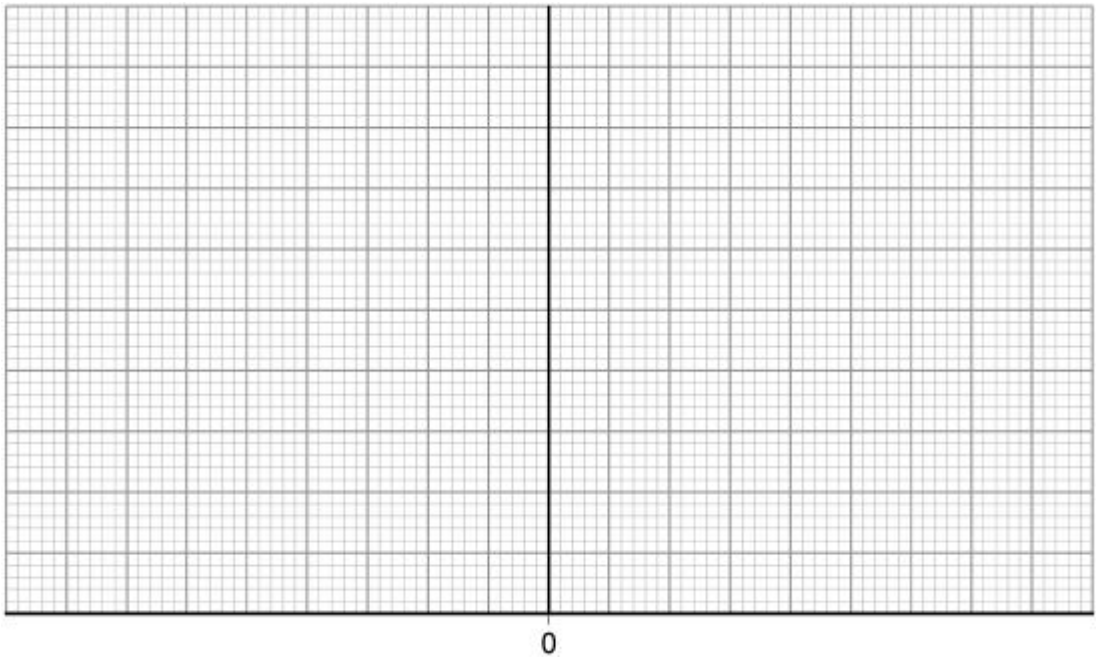
Algae → Invertebrate animals → Small fish → Large fish

	Algae	Invertebrate animals	Small fish	Large fish
Biomass in g/m^2:	840	200	40	10

(a) Draw a pyramid of biomass for the food chain in **Figure 1** on **Figure 2**. You should:

- use a suitable scale
- label the x-axis
- label each trophic level.

Figure 2



(4)

(b) Calculate the percentage of the biomass lost between the algae and the large fish. Give your answer to 2 significant figures.

_____

_____

_____

_____

Percentage loss = _____ **(3)**

(c) Give **one** way that biomass is lost between trophic levels.

_____

_____

(1)

(d) A large amount of untreated sewage entered the river. Many fish died.

Untreated sewage contains organic matter and bacteria.

Explain why many fish died.

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

_____

(5)

(Total 13 marks)

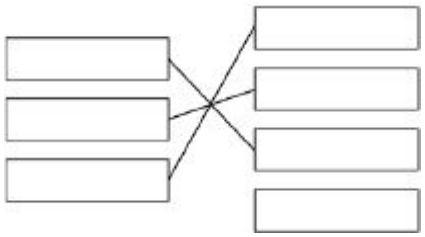
4.7.4 Trophic levels in an ecosystem (biology only) PPQ answers

Low Demand

PPQ MS1

Q1.

(a)



extra line from a scientific term cancels the mark

1
1
1

(b) $\frac{10}{200} \times 100$

1

5 / 5.0

1

*an answer of 5 / 5.0 scores **2** marks*

(c) digestion

1

respiration

1

excretion

1

in this order only

(d) fewer are eaten (by small fish)

allow there are fewer (small) fish eating them

*do **not** accept none are eaten*

1

[9]

PPQ MS2

Q2.

(a) sulfur dioxide

1

(b) (i) mutation

1

(ii) pale form now (more) easily seen (by predators) **or** dark form now less easily seen (by predators)

accept ref to camouflage

1

so pale form (more) likely to be eaten **or** dark form less likely to be eaten

1

so dark form (more likely to) breed / pass on genes

or pale form less likely to breed / pass on genes

1

(c) (i) pyramid of three layers of diminishing size

either way up

1

three labels in food chain order

award 2 marks only if the pyramid is correctly labelled

accept trees / birch, accept (peppered) moth(s) / larvae

1

(ii) some material is lost in waste from the birds

1

peppered moth larvae do not eat all the leaves from the trees

1

[9]

PPQ MS3

Q3.

(a) (i) (predator) lion

1

(prey) antelope

1

(ii) light

1

(iii) in sequence (top to bottom):

lion
antelope
grass

1

(b) (i) bacteria / fungi / saprotrophs

accept moulds / decomposers / microorganisms / microbes / saprophytes / saprobionts

1

(ii) aerobic

1

moist

1

warm

1

(iii) carbon dioxide

1

mineral salts

1

[10]

Standard demand

PPQ MS4

Q4.

(a) (i) 6000

*award **2** marks for correct answer irrespective of working*
*allow **1** mark for 60 × 100 with incorrect or no answer*
allow answer in table if answer line blank

2

(ii) bar width 6000 **or** to match answer to (a)(i)

anywhere on scale ignore depth / height of bar

1

drawn below slugs

label not required

1

(b) any **three** from:

ignore references to number / size / mass of organisms
assume reference is to / of hedgehog unless stated otherwise

- respiration (by hedgehog)

  *do **not** accept idea that respiration uses / produces energy*

- faeces (of hedgehog) **or** (slug) not absorbed (by hedgehog) **or** (slug) not digested (by hedgehog) /
- excreted / urine / urea (by hedgehog)

  *accept waste for **1** mark if neither faeces nor excretion point made*

- not all slug (s) eaten (by hedgehogs) **or** some slugs eaten by other things **or** not all parts (of slug) eaten

  ignore (some) slugs die

- movement (by hedgehog)

- heat (from hedgehog)

  allow appropriate references to biomass lost by these methods, rather than energy losses

3

[7]

PPQ MS5

Q5.

(a) (i) wheat → humans chain transfers 10 times more energy than wheat → pigs → humans chain

allow 10% if given as a comparison e.g. one is 10% of the other

or

wheat → pigs → humans chain transfers 810 000 (kJ per hectare) less

ignore less unqualified

1

(ii) any **one** reason for energy loss from pigs e.g :

ignore respiration, growth
ignore heat unqualified

- movement
- (maintaining) body temperature
- waste materials
  allow named examples
- not all parts of pig eaten by human
- because there is an extra stage (pigs) in the food chain and energy is lost at each stage
  allow longer food chain so more energy lost

1

(b) Marks awarded for this answer will be determined by the Quality of Written Communication (QWC) as well as the standard of the scientific response. Examiners should also refer to the information in the Marking guidance, and apply a 'best-fit' approach to the marking.

0 marks
No relevant content.

Level 1 (1-2 marks)
There is a basic description of at least one factory farming method
or
identification of an advantage or disadvantage of factory farming.

Level 2 (3-4 marks)
There is a description of at least one factory farming method
and
an advantage or disadvantage is explained.

Level 3 (5-6 marks)
There is a description of factory farming methods
and
advantage(s) and disadvantage(s) are explained.

Examples of Biology points made in the response:

factory farming methods e.g.:

- Kept in cramped conditions / battery hens / calf crates / pig barns / fish tanks
- Controlled temperature / heating
- Controlled feeding / modified food given / growth hormones
- Controlled lighting
- Treated with prophylactic antibiotics

Advantages e.g.:

- Increased efficiency / profit / greater food production / cheaper food / faster growth

- Farmer can have more livestock
- Less energy is lost through movement
- Less energy is used keeping warm
- (Food is high in calories / protein) so animals will grow faster / lay more eggs
- Easier to vaccinate all the animals
- Easier to protect animals from predators
- Antibiotic treatment stops infections in animals

Disadvantages e.g.:

- Stress / cruelty / inhumane / unethical
- Restricted movement / overcrowding
- Faster spread of diseases
- Antibiotics in the food chain / residual chemicals in the food chain
- Wasting fossil fuels / increasing global warming
- Increased pollution from animal waste and from additional transport

6

[8]

PPQ MS6

Q6.

(a) 8.3 **or** 8.3 recurring **or** 8

*award **both** marks for correct answer, irrespective of working*
*7 / 84 × 100 or equivalent for **1** mark*

2

(b) any **three** from:

- heat
  allow keeping warm
- respiration
  ***not** for respiration*
- movement **or** example of movement eg exercise / kinetic
- faeces / waste / urine / excretion / urea
  ignore eggs / sound

3

(c) any **one** from:

- less / no movement
  allow examples of movement
- less / no heat loss

- reference to selective breeding
- reference to controlled / better / more feeding

1

(d) any **two** from:

- less steps in food chain
- less losses of biomass / energy / examples of losses
- cheaper to feed herbivores

allow dangerous to keep carnivores
herbivores contain more energy is insufficient

2

[8]

High demand

PPQ MS7

Q7.

(a) Decrease: seals will eat more squid and penguins

for 1 mark

1

Stay the same:

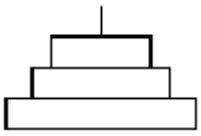
- more shrimp/food for squid and penguins

ideas that

- increase in squid and penguins balances the extra eaten by seals
- seals find other prey (allow start to eat shrimps)

any two for one mark each

2

(b) 

credit  *for seal*

allow

- correct shape (doesn't need to be to scale)
- correctly with organisms

(if wholly correct but inverted then credit 1 mark)

each for 1 mark

2

(c) • seals are mammals

- *idea that* seals have (to maintain) a constant body temperature
  [allow warm blooded]
- heat losses to cold seas
- more of food eaten used to replace heat loss

(credit use of figures i.e. 95% loss compared to 90%
or 5% efficient compared to 10%
or 20 : 1 conversion ratio compared to 10 : 1
with 1 mark)

any three for 1 mark each

3

(d) (i) *ideas that*

- reduce number of fishing boats allowed
- breed in captivity and then release
- agree quotas [not an unqualified 'ban']
- avoid breeding areas
- avoid breeding seasons
- increase size of net mesh/don't catch small fish
- limit catches of shrimps
- cull seals

any two for 1 mark each
[allow any other reasonable answer]

2

(ii)
- breeding areas closer to some countries than others
- difficult to police/easy to cheat/'poach'
- difficult to agree quotas
- some countries eat more fish than others
- best weather for fishing maybe in breeding seasons
- fisherman/trawlers need employment
- big demand for cod

any one for 1 mark
[allow any other sensible response]

1

[11]

PPQ MS8

Q8.

(a) 0.18

award both marks for correct answer irrespective of working
if no answer or incorrect answer

*allow **1** mark for 45 × 100 / 25000*

2

(b) heat / thermal

allow heat <u>from</u> respiration

1

(c) energy / mass / biomass lost / not passed on **or** energy / mass / biomass is used **or** not enough energy / mass / biomass left

ignore reference to losses via eg respiration / excretion / movement / heat

1

a sensible / appropriate use of figures including heron

*eg <u>only</u> **2** from frog / to heron*

ignore units

1

(d) any **three** from:

accept marking points if candidate uses other terms for microorganisms

- (microorganisms) decay / decompose / digest / breakdown / rot

  ignore eat

- (breakdown) releases minerals / nutrients / ions / salts / named

  ignore food

- (microorganisms) respiration

  ignore other organisms respiring

- (microorganisms / respiration) release of carbon dioxide

3

[8]

PPQ MS9

Q9.

(a) *x*-axis: scale + labelled, including units

scale ≥ ½ width of graph paper label: biomass in g/m^2

1

bar widths correct

± ½-square each side
allow 1 mark if 3 correct

2

all 4 bars correctly labelled

large fish + small fish + invertebrate (animals) + algae
or
(trophic level) 4 + 3 + 2 + 1
or
tertiary consumer + secondary consumer + primary consumer + producer

ignore bar heights

1

(b) $\frac{840-10}{840} \times 100$

allow equivalent calculation

1

98.809523... / 98.810 / 98.81 / 98.8

1

99

allow answer given to two significant figures from an incorrect calculation in step 2

1

*an answer of 99 scores **3** marks*

(c) inedible parts / example

*allow eaten by other animals **or** not all organisms eaten*

or

egested / faeces

allow not digested
allow excretion / urine
ignore waste

or

respiration / as CO_2

ignore energy losses
ignore movement

1

(d) bacteria decay organic matter / sewage / algae / dead plants

1

(by) digestion

allow example such as starch broken down to sugar
or
protein broken down to amino acids

1

(and) bacteria respire aerobically
or
respire using oxygen

1

(which) lowers oxygen concentration (in water)
or
fish have less oxygen *allow reduced respiration of fish*

1

(so) reduced energy supply causes death of fish

allow toxins in the sewage kill fish

ignore pathogens or (pathogenic) bacteria cause disease in fish and kills them

1

[13]

4.7.5 Food production (biology only)

Food security is a measure of the availability of food required to support people of a household, region, country or any specified area. It is a measure of how much food there is, if it is of suitable quality and whether people can access it.

Having fully stocked supermarket shelves is something that perhaps some of us might take for granted. However, this high level of food security is not experienced by all people. In some parts of the world there is a shortage of food, which can result in starvation and death. The United Nations estimates that over 20 000 people die each day from hunger or hunger-related causes.

Food security is reduced by:

- the increase in human population, as birth rates are increasing and many people have better access to medical care
- changing diets mean scarce food resources are transported to be sold to other areas from areas which need them
- new pests and pathogens that attack crops and farm animals
- environmental changes such as global warming
- increased costs of farming
- armed conflicts

Finding sustainable ways to feed people is an important problem for scientists.

In 2008 the prices of many foods increased. Wheat and rice were two key examples and increased by 130% and 75% respectively. This caused riots in over thirty countries. Similar riots are still occurring. In 2016 over 400 people were arrested in Venezuela after rioting and looting over food shortages.
The United Nations Food and Agriculture Organisation (FAO) records the **mean** prices of five key products: cereals, vegetable oils, dairy, meat and sugar. They compare this with different factors and produce an annual report called 'The state of food insecurity in the world'.

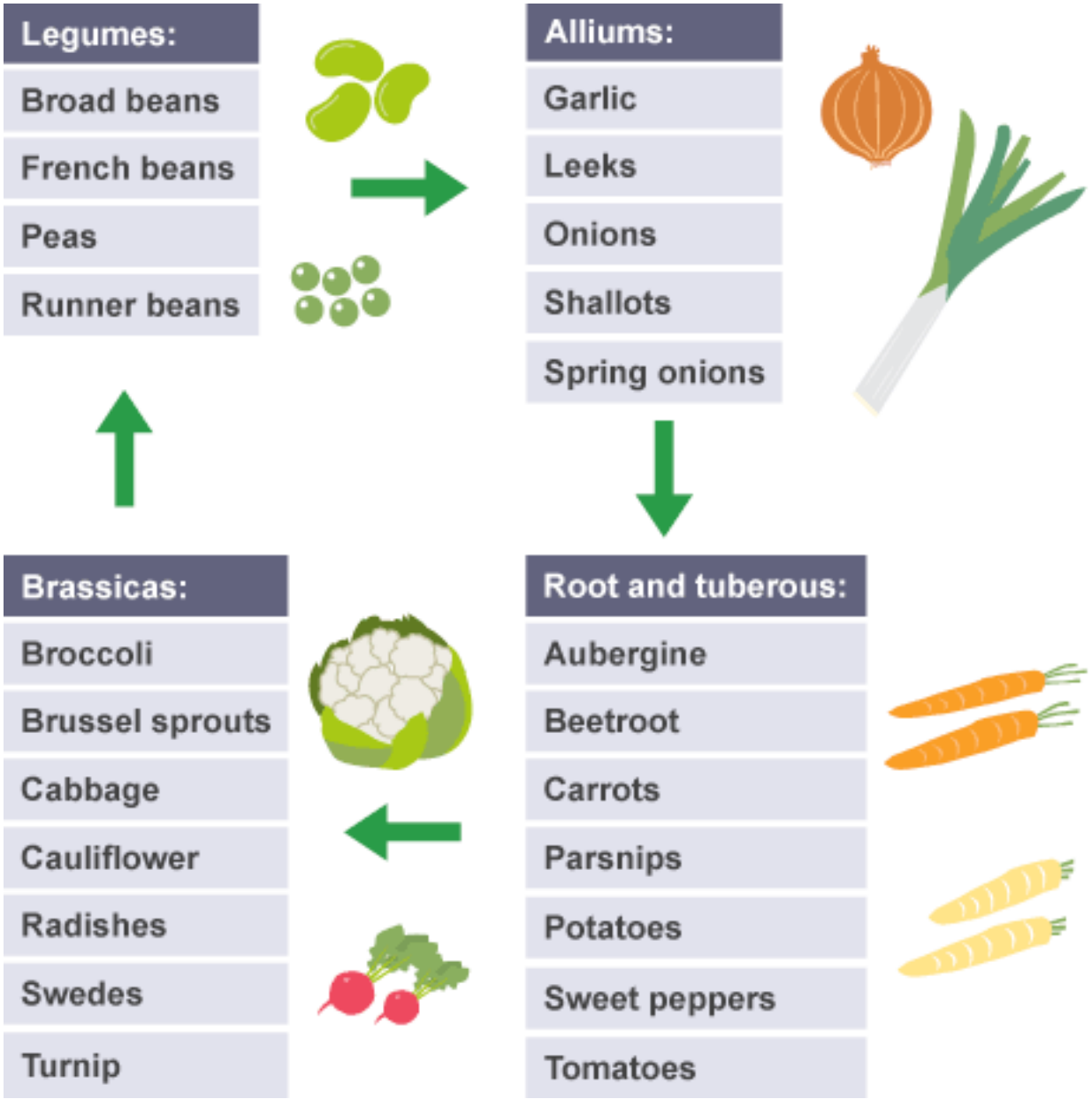
Farming techniques
Thousands of years ago many people grew small amounts of crops and raised small numbers of livestock to feed their families. As we have moved from small villages into larger towns and cities farming has become modernised to meet the demands of a larger and more urban lifestyle.
Intensive farming
Intensive farming uses machines, fertilisers, man-power and **high-yield** crops to maximise the amount of food produced. Farmers growing **arable** crops often specialise in growing only one crop to maximise their profits. This is called **monoculture**. It can quickly reduce key nutrients in the soil and lowers **biodiversity**.
Hedgerows have been removed from many fields to make them bigger and easier to tend to by big machines. This also reduces biodiversity. Crops are often sown, treated and harvested by machines which create pollution, and fertilisers are added to fields in larger amounts which can cause **eutrophication**.
Intensive farming can also mean keeping livestock in smaller pens with regulated temperatures. This reduces the energy they need for movement and temperature regulation and so maximises their size and yield. Some animals are fed high protein foods to increase their growth. They are often fed **antibiotics** in their food to prevent diseases. Many scientists think this is leading to antibiotic resistance in bacteria.

Advantages and disadvantages of intensive farming practices:

Advantage	Disadvantage
Higher yields	Costly additives needed
More efficient use of food	Risk of antibiotic resistance
Quality control easier	Considered unethical by some people

Organic farming

Many people object to intensive farming because it reduces biodiversity and increases pollution. More recently some farms have become **organic** to address this. Organic farmers do not use machines to the same extent as intensive farming. They do not apply **pesticides** to their crops and use natural fertilisers such as **compost** and **manure**. They rotate their crops to avoid monoculture.



This image shows how crops planted in a field are rotated each year. This increases yield, promotes biodiversity and helps keep the soil heathy.

Because of this organic food is often more expensive than intensively farmed food, and many people are willing to pay more for the perceived benefits.

Sustainable fisheries

Sustainable fisheries do not reduce the overall number of fish, because the number of fish that are caught and killed does not ever exceed the birth of new fish.

At one point we thought that we could remove as many fish as we wanted from the oceans without any consequence. During this period, we drastically overfishedsome of our oceans and seas and reduced some populations to critically low numbers.

Some scientists think that as much as 85% of the world's fish populations have been overfished. Common examples are cod in the North Sea and sole in the Irish Sea and English Channel. Overfishing can cause a critical point in populations that means certain species cannot ever recover and will become extinct.

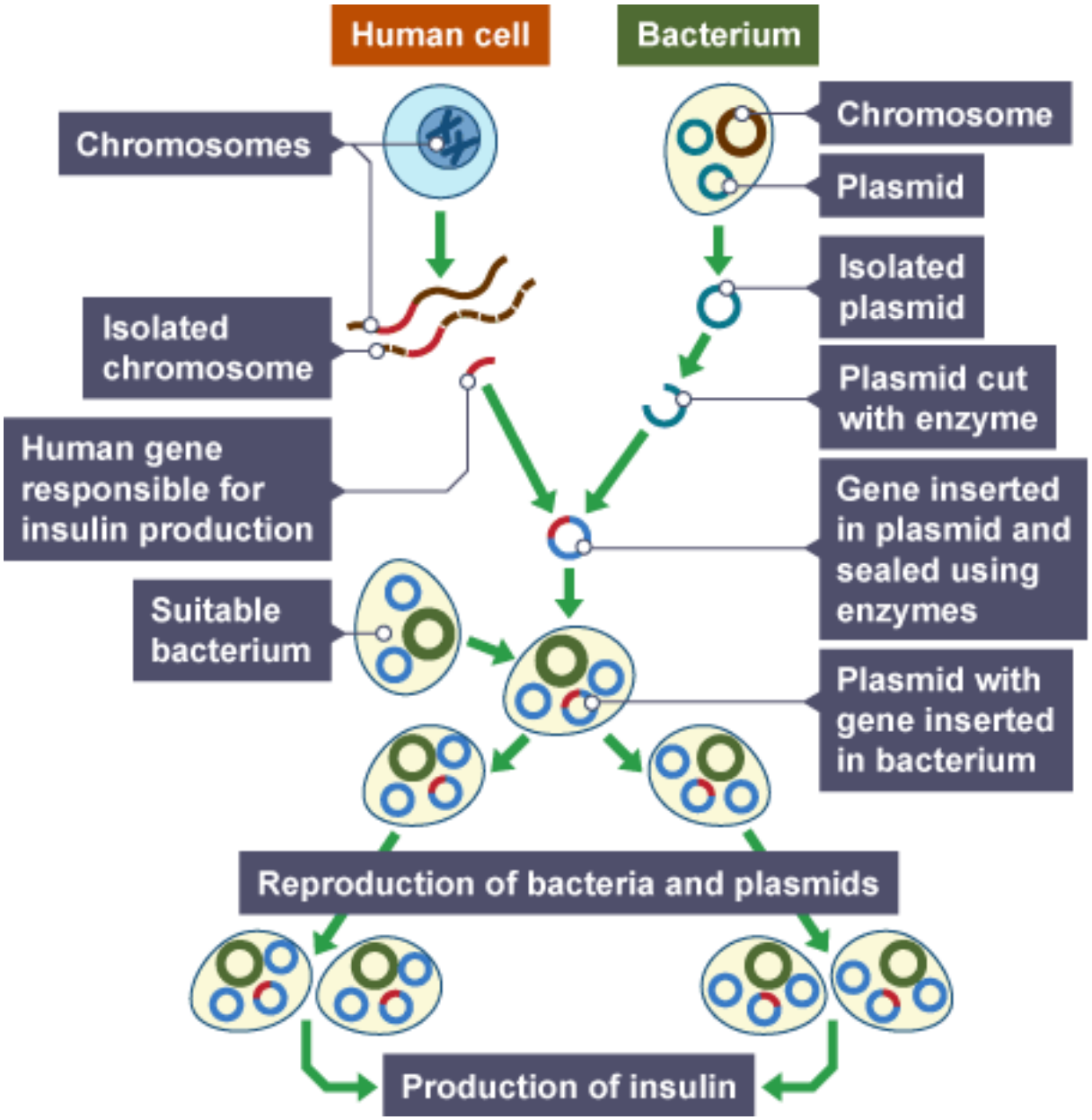
To address overfishing many countries are adopting a more sustainable strategy for fishing. These include Iceland and New Zealand. Many countries have introduced fishing quotas which limit the amount of fish that can be caught and killed from specific species. The size of the gaps in fishing nets has also been increased to ensure that juvenile fish can reach reproductive maturity and have offspring before being killed.

Role of biotechnology – Crop modification

Biotechnology is the alteration of living organisms to develop or make products that help us. This is quite a broad definition and so many different organisms or processes are involved. Humans have used biotechnology for thousands of years in **agriculture** and used selective breeding to produce better foods and medicines. More recent examples of biotechnology include **cloning** and **genetic modification**. Biotechnology can help us meet the food demands of our ever increasing **population**.

Crops directly feed us or animals we keep for food. They are commonly cereals, fruit and vegetables. We can change (or modify) crops in two key ways - selective breeding and genetic modification.

Genetic modification
Scientists can now identify the **genes** in some species that control some characteristics. These genes can be removed using **enzymes** and inserted into the genome of other species. This is genetic modification (or engineering). The organism that has been modified is called **transgenic**.
A common example of genetic modification involves the transfer of the glow-in-the-dark gene from jellyfish into mammals such as mice or rabbits. This gene is inserted into the embryo of the mammal so only a small number of cells need to be altered. As the embryo develops, all of its newly grown cells will contain the transferred gene.
We have genetically modified bacteria to contain the human gene for insulin. These bacteria therefore produce human insulin which is used by diabetics to manage their diabetes.



The process of genetically modifying bacteria to produce insulin

Golden rice is a variety of rice that has been genetically modified to contain **beta-carotene** which helps people who do not get enough vitamin A in their diet. This **deficiency** disease kills over half a million children each year. We have also genetically modified soybeans, cotton and corn to also include beta-carotene.

Other crops have been genetically modified to be resistant to insects. A bacterium called *Bacillus thuringiensis* naturally produces a toxin which kills many insects. The gene responsible for this has been identified, removed and inserted into crop plants.

Other crops have also been genetically modified to be resistant to pesticides. The genes that occurs naturally in some plants will be identified, removed and inserted into crop plants. This means that farmers can spray whole fields with **pesticides** and kill the pests, not the crops.
It is likely that all crops have been selectively bred to have greater **yields**.

Selective breeding
For thousands of years farmers have instinctively known to breed together - a big bull and a big cow to have big calves. This is selective breeding. It occurs when animals or plants with a desirable characteristic are selected to breed with each other. Because of inheritance, their

offspring are likely to have the desired characteristic. Over generations these characteristics have become enhanced.
All breeds of dog belong to the same **species**. They were all originally bred from wolves. Dogs have been bred for a variety of reasons including protecting livestock, hunting, providing company and for their different shapes, sizes and colours. They have all been selectively bred for these different characteristics.

Specific examples include:
- Friesian cows to produce large volumes of milk and Jersey cows to produce creamy milk
- Wheat that is resistant to some diseases

Unlike selective breeding, genetic modification is an **ethical** issue which means some people disagree with it for religious or other personal reasons. Some people believe scientists are playing God and others worry that the genes might spread to other species.

	Natural selection	Selective breeding	Genetic engineering
Number of generations needed for change	Very many	Many	One
Human intervention	Not needed	Needed	Needed
Desired outcome known?	No	Yes	Yes
New species formed?	Yes	No	No
Notes	This is the mechanism of change in Darwin's theory of evolution	This is how new varieties or breeds are usually produced	Genetic information can come from the same species or from a different one

Role of biotechnology – Novel foods

A novel food is a food that does not have a significant history of consumption in a region. It includes foods that are recently introduced, or foods that are produced using a new process. A good example of this is the fungus *Fusarium* which is used to produce mycoprotein. This is protein produced from a fungus. The fungus is grown in large containers called **fermenters**. The conditions inside are maintained to promote maximum growth:
- The pH and temperature are maintained at the **optimum**
- The temperature is controlled by a water jacket that surrounds the whole fermenter
- Sterile oxygen is added to make sure that aerobic **respiration** occurs
- A food source like glucose syrup is added
- The mixture inside is stirred to make sure all the oxygen and nutrients are equally distributed

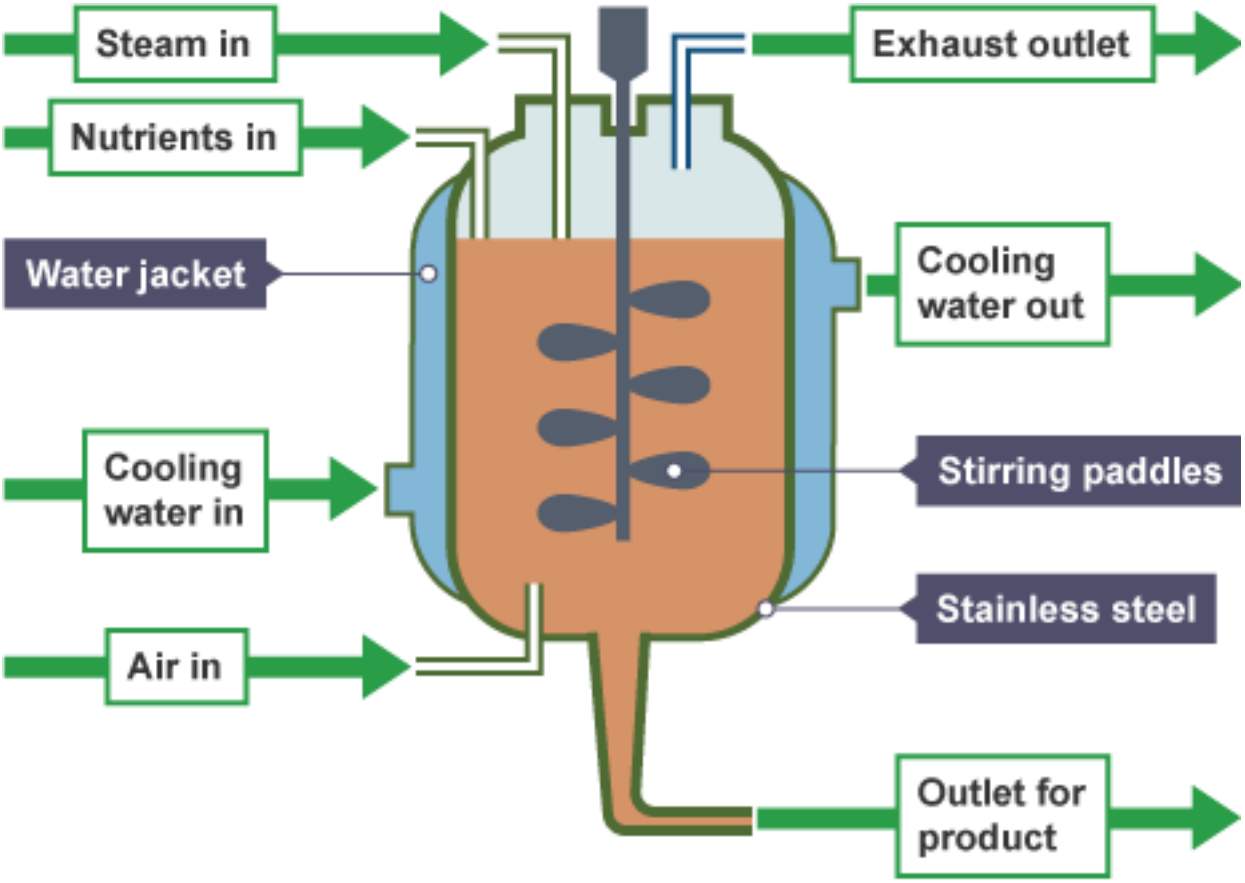


Diagram of a fermenter

After the fungus has fully grown in the fermenter, it is harvested and purified and the process is then repeated with a new batch of ingredients.

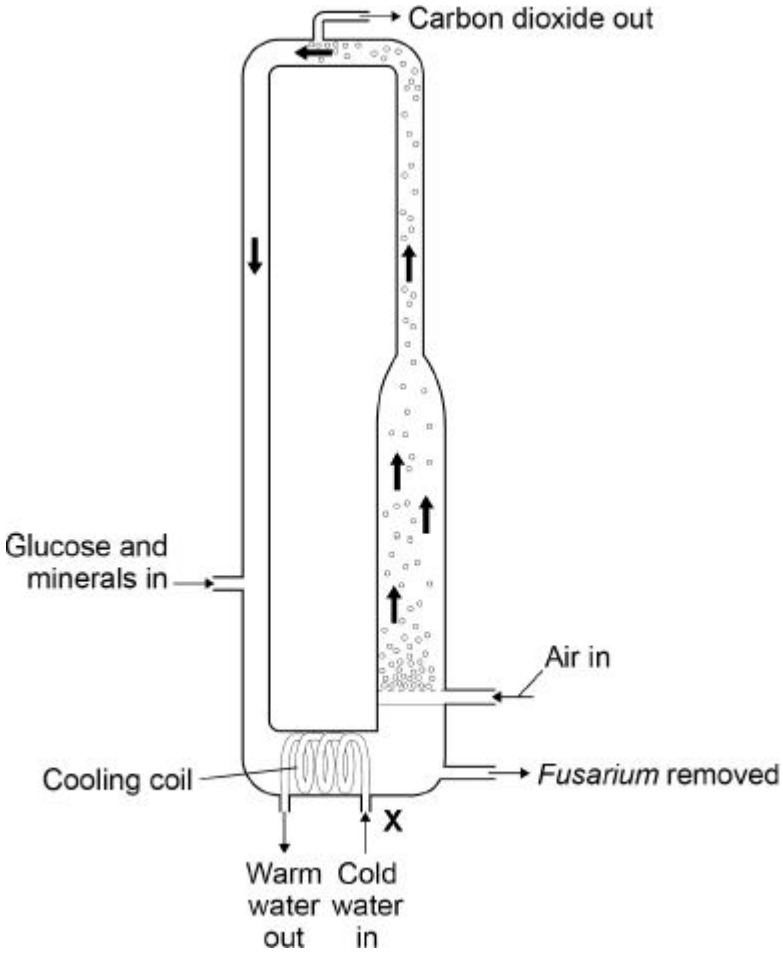
Producing protein from fungus is much more efficient than from meat from livestock. Only about 10% of the energy found in grass is transferred to the animals like cows that eat it. 1000 g of plant carbohydrate can produce up to 14 g of beef, 49 g of chicken or 136 g of mycoprotein. Additionally, fermenters can be used to produce protein in places where grass and livestock cannot grow.

4.7.5 Food production (biology only) PPQs

Low Demand

PPQ 1

Q1. Mycoprotein is a protein-rich food. Mycoprotein is made from the fungus *Fusarium*. The diagram below shows a fermenter used for growing *Fusarium*.



(a) Explain why the fermenter is sterilised before use.

_____

_____

_____

_____ **(2)**

(b) Cold water is pumped through the cooling coil at point **X**. This maintains a constant temperature inside the fermenter. Suggest the temperature at which *Fusarium* grows fastest.

Tick **one** box.

5 °C ☐

20 °C ☐

30 °C ☐

85 °C ☐

(1)

(c) Glucose and bubbles of air enter the fermenter. The bubbles of air supply oxygen. Explain why *Fusarium* needs glucose and oxygen.

_____

_____

_____

_____ **(2)**

(d) The bubbles of air also move materials around the fermenter.

Suggest why it is useful for bubbles of air and materials to move around inside the fermenter.

_____

_____

_____

_____ **(2)**

(e) 100 grams of chicken meat contains 22 grams of protein. 100 grams of mycoprotein contains 11 grams of protein. A man ate 100 grams of chicken in one meal.

How many grams of mycoprotein would the man need to eat to get the same mass of protein as in 100 grams of chicken?

Tick **one** box.

100 grams ☐

110 grams ☐

200 grams ☐

220 grams ☐

(1)

(Total 8 marks)

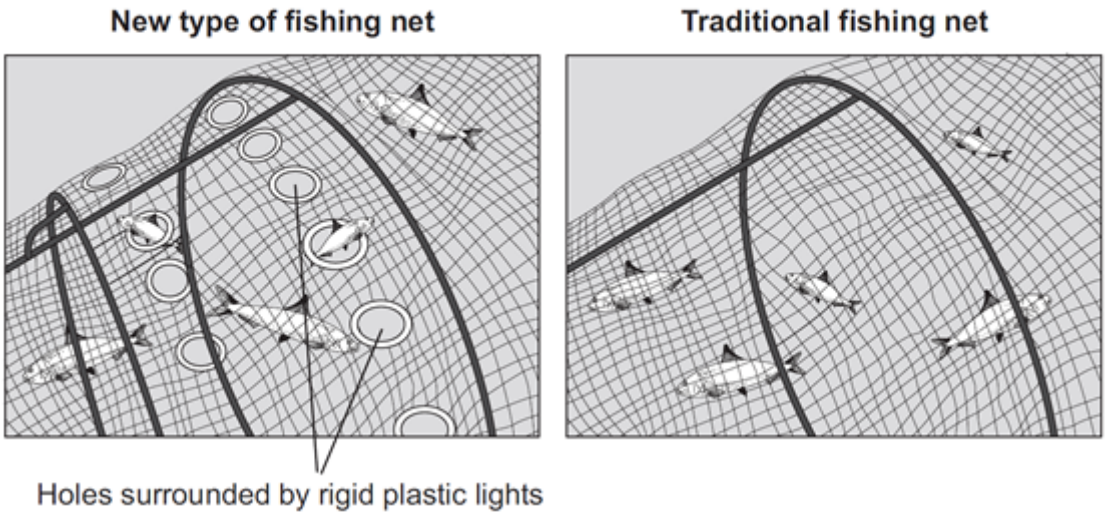
PPQ 2

Q2.

It is important to conserve fish stocks.

Figure 1 shows a new type of fishing net and a traditional fishing net.

Figure 1



(a) (i) Describe how the new type of fishing net helps to conserve fish stocks.

_____

_____

_____

_____

_____

(3)

(ii) Give **one** way, other than controlling nets, to reduce overfishing.

_____

_____

(1)

(b) Another way to make sure there is food for an increasing human population is to make food production more efficient.

Figure 2 shows how some cows are farmed.

Figure 2

© Dageldog/iStock

(i) Use information from **Figure 2** to suggest **two** ways in which this type of farming reduces energy loss from the cows.

1. _____

_____

2. _____

_____

(2)

(ii) Give **two** reasons why some people disagree with farming cows in this way.

1. _____

_____

2. _____

_____

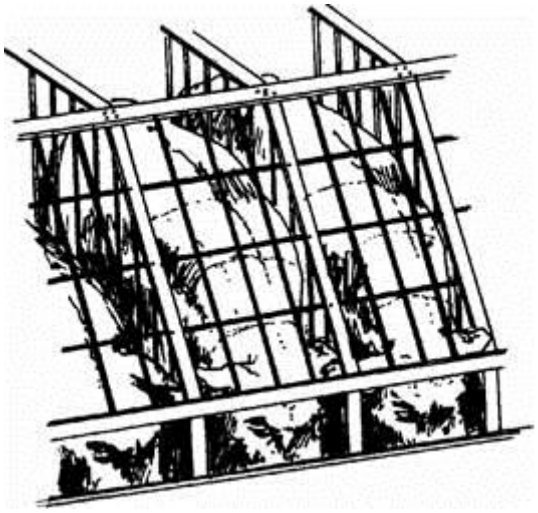
(2)

(Total 8 marks)

PPQ 3

Q3.

To produce cheap meat, animals must be grown (reared) efficiently. When pigs are reared intensively they are kept indoors. Their surroundings are closely monitored to make sure they have even ventilation and the correct temperature. The risk of infection is high but is reduced by feeding them antibiotics and removing their faeces. The pigs live in cages and cannot move around much.



(a) Explain why farmers control the temperature.

_____

_____

_____

(2)

(b) Explain why farmers want to stop the pigs moving about.

_____

_____

_____

(2)

(c) Give two arguments **against** rearing pigs indoors instead of rearing them outdoors.

1. _____

2. _____

(2)

(Total 6 marks)

Standard demand

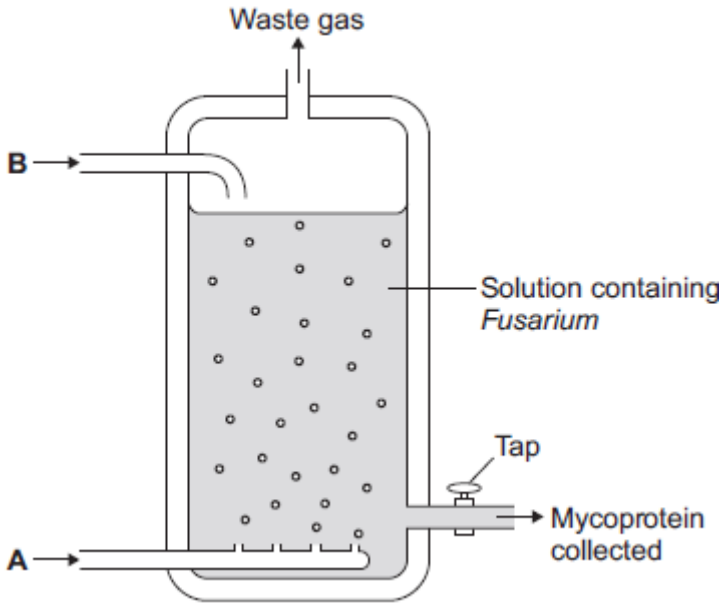
PPQ 4

Q4. The world population is increasing and the need for food is increasing. Mycoprotein is a high-protein food made in fermenters using the organism *Fusarium*. The process takes only a few weeks to produce a large amount of food.

(a) (i) What type of organism is *Fusarium*? Draw a ring around the correct answer.

bacterium **fungus** **virus**

The diagram below shows a fermenter used in mycoprotein production.



(1)

(ii) *Fusarium* makes mycoprotein. *Fusarium* respires aerobically. Suggest which gas is added to the fermenter at point **A**.

_____ **(1)**

(iii) Another substance is added to the fermenter at point **B**. This substance is used in aerobic respiration. Name this substance.

_____ **(1)**

(b) People need to eat protein to grow and to be healthy. Some people think that it would be an advantage to get more food from mycoprotein and less from farming animals. Suggest **two** possible advantages of getting more food from mycoprotein.

1. _____

_____

2. _____

_____

(2)

(Total 5 marks)

PPQ 5

Q5.

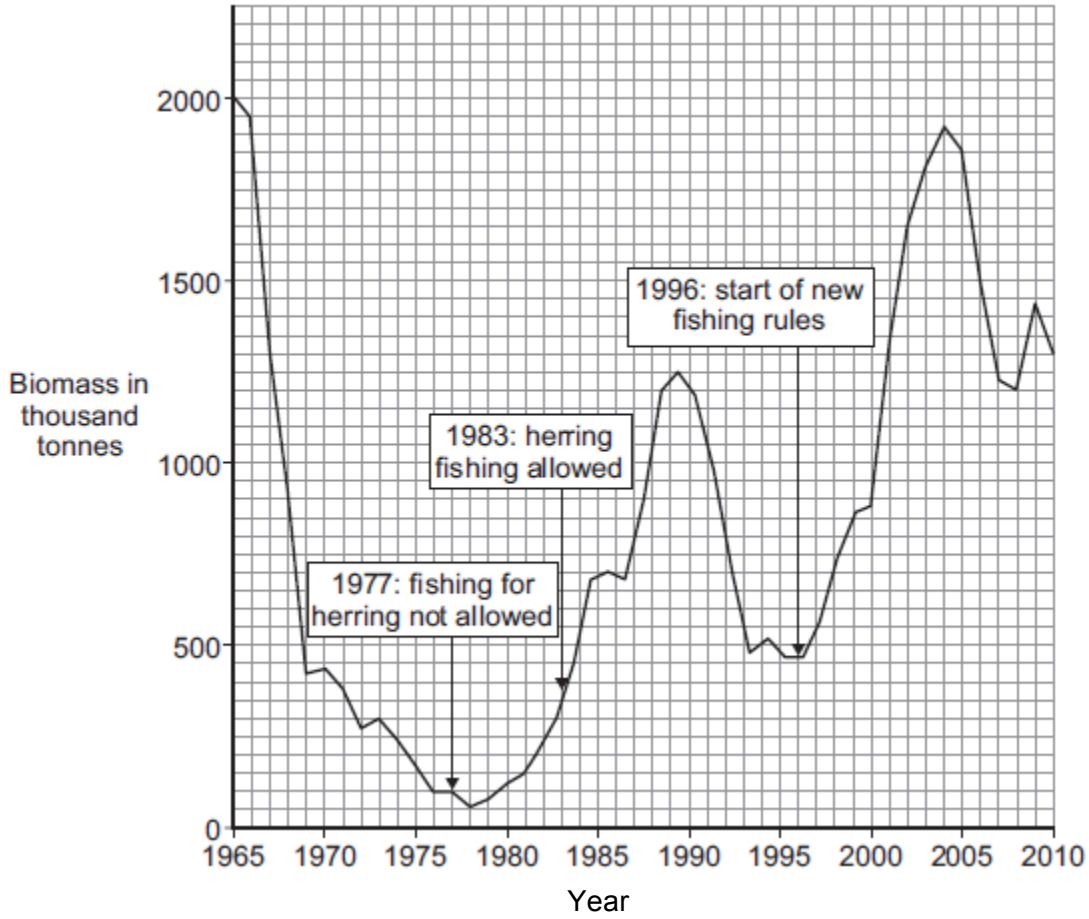
Herring are a type of fish found in the North Sea. Herring are caught using nets which are pulled by large boats.

The photographs show a fishing boat and some herring.

By Atle Grimsby from Utsira, Norway (Herring Catch at Utsira) [CC-BY-2.0 (http://creativecommons.org/licenses/by/2.0)], via Wikimedia Commons.

The herring population in the North Sea has changed a lot in recent years.

The graph shows the estimated biomass of herring in the North Sea between 1965 and 2010.



(a) Suggest why the biomass can only be estimated.

Tick (✓) **one** box.

Scientists are not properly trained. ☐

There are too many different types of fish in the sea. ☐

It is impossible to weigh all the herring in the sea. ☐

(1)

(b) (i) Describe the pattern shown in the graph from 1978 to 1983.

_____

_____

(1)

(ii) Suggest a reason for the pattern you have described in part **(b) (i)**.

_____

_____ **(1)**

(c) In 1996 the Government brought in strict rules to help to conserve fish stocks.

(i) State **two** rules that would help to conserve fish stocks.

1. _____

_____

2. _____

_____ **(2)**

(ii) Were the Government's rules effective?

Use data from the graph to support your answer.

_____

_____

_____

_____ **(2)**

(iii) Why should fish stocks be kept above a certain minimum level

_____

_____ **(1)**

(iv) The Government did not introduce rules about the amount of herring caught until 1977.

This was in response to a dramatic decrease in herring stocks.

What was the percentage decrease in herring stocks between 1965 and 1977?

_____

_____

Percentage decrease = _____

(2)

(d) Herring migrate to feed and spawn (lay eggs).

The eggs normally take about 3 weeks to hatch at 12 °C.

If the temperature of the water is higher the eggs will hatch more quickly.

But, if the temperature of the water is above 19 °C, the eggs will die.

Other fish, such as cod, feed on herring.

Suggest how climate change could affect North Sea fish.

_____

_____

_____

_____

_____

_____

_____

_____

_____

(4)

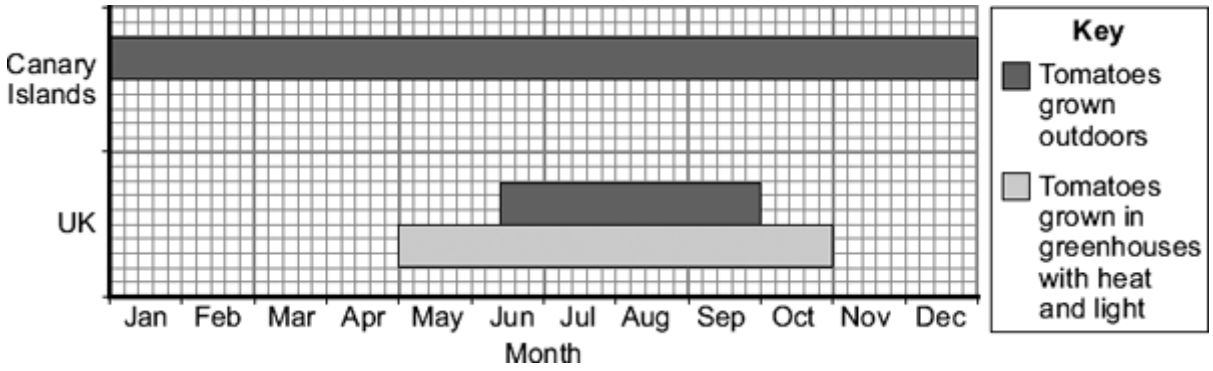
(Total 14 marks)

PPQ 6

Q6.

Tomatoes are grown in greenhouses in the UK and outdoors in the UK and the Canary Islands.

The chart shows in which months these tomatoes can be bought in shops in the UK.



The Canary Islands are about 3000 km from the UK.

Some people prefer to buy tomatoes grown in the UK.

What are the **advantages** and **disadvantages** of buying tomatoes grown in the UK, instead of buying tomatoes grown in the Canary Islands?

Advantages of buying tomatoes grown in the UK

_____

_____

_____

_____

Disadvantages of buying tomatoes grown in the UK

_____

_____

_____

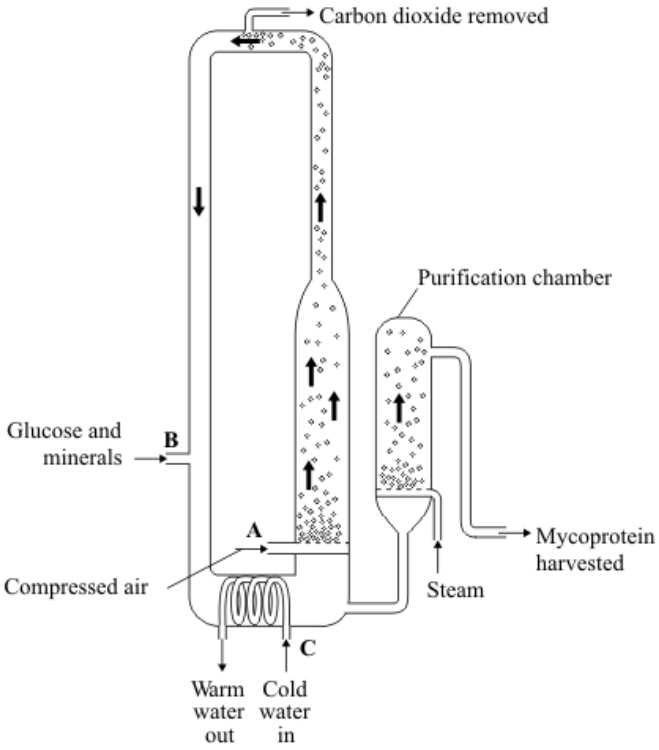
_____

(Total 3 marks)

High demand

PPQ 7

Q7. The diagram shows a fermenter. This fermenter is used for growing the fungus *Fusarium* which is used to make mycoprotein.



(a) Bubbles of air enter the fermenter at **A.**

Give **two** functions of the air bubbles.

1. _____

_____

2. _____

_____ **(2)**

(b) Glucose is added to the fermenter at **B.**

Explain why glucose is added.

_____

_____ **(1)**

(c) The fermenter is prevented from overheating by the cold water flowing in through the heat exchanger coils at **C.**

Explain what causes the fermenter to heat up.

_____

_____

(1)

(d) It is important to prevent microorganisms other than *Fusarium* from growing in the fermenter.

(i) Why is this important?

_____

_____ **(1)**

(ii) Suggest **two** ways in which contamination of the fermenter by microorganisms could be prevented.

1. _____

_____

2. _____

_____ **(2)**

(e) Human cells cannot make some of the amino acids which we need. We must obtain these amino acids from our diet.

The table shows the amounts of four of these amino acids present in mycoprotein, in beef and in wheat.

Name of amino acid	Amount of amino acid per 100 g in mg			Daily amount needed by a 70 kg human in mg
	Mycoprotein	Beef	Wheat	
Lysine	910	1600	300	840
Methionine	230	500	220	910
Phenylalanine	540	760	680	980
Threonine	610	840	370	490

A diet book states that mycoprotein is the best source of amino acids for the human diet. Evaluate this statement. Remember to include a conclusion in your evaluation.

_____

_____

_____

_____

_____

_____

_____ **(4)**

(Total 11 marks)

PPQ 8

Q8.

Figure 1 shows some information about 'stem cell burgers'.

Figure 1

The first laboratory burger has now been cooked

In July 2013 the first burger grown from cow stem cells was cooked.

Muscle stem cells from cows were grown into strands of beef in a laboratory. About 20000 strands of beef were then made into a burger. The burger can be cooked and eaten by humans. This type of meat is called cultured meat.

The cultured meat is exactly the same as normal cow muscle tissue and the cells are not genetically modified.

(a) (i) Some scientists think using cultured meat instead of traditionally-produced meat will help reduce global warming.

Suggest **two** reasons why using cultured meat may slow down the rate of global warming.

1. _____

_____

2. _____

_____

(2)

(ii) Suggest **two** other possible advantages of producing cultured meat instead of farmed meat.

Do **not** refer to cost in your answer.

1. _____

_____

2. _____

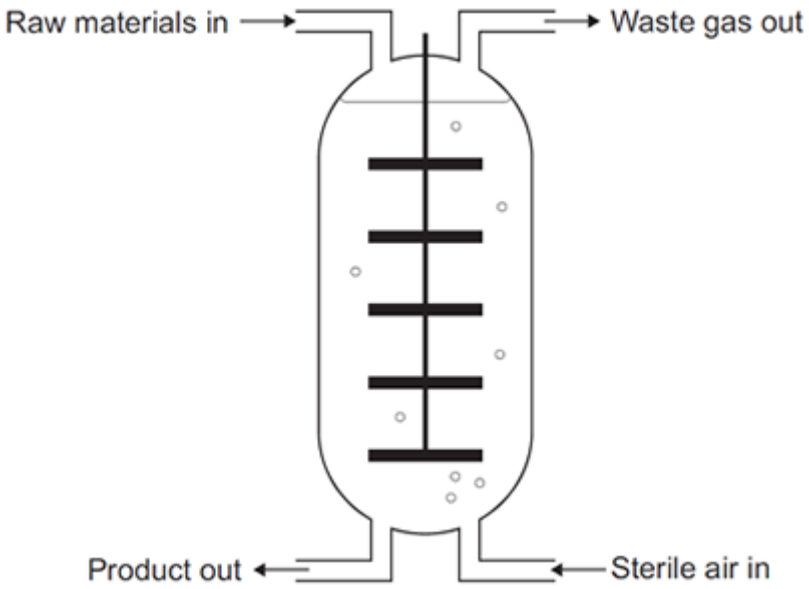
_____

(2)

(b) Mycoprotein is one type of food that is mass-produced.

Figure 2 shows a fermenter used to produce mycoprotein.

Figure 2



Describe how mycoprotein is produced.

(4)

(Total 8 marks)

4.7.5 Food production (biology only) PPQ answers

Low Demand

PPQ MS1

Q1.

(a) kills microorganisms / bacteria / fungi / viruses / microbes

allow to remove microorganisms / bacteria / fungi / viruses / microbes ignore germs

allow so mycoprotein is not contaminated

1

(which) compete for food / oxygen
or
which make toxins

allow so mycoprotein is safe to eat

or
which are pathogens
or which might kill the fungus / *Fusarium*

1

(b) 30 °C

1

(c) for (aerobic) respiration

*do **not** accept anaerobic*

1

(which) releases energy (for growth)

*do **not** accept produces energy*

allow glucose is used to make other organic substances e.g. protein

1

(d) any **two** from:

so *Fusarium* can

- grow faster / better
- get sufficient food / glucose / minerals

  allow more / enough

- get sufficient oxygen

  allow more / enough

- get rid of sufficient carbon dioxide

  allow more / enough
  allow waste

- be kept at a (suitable) temperature *allow to avoid 'clumping'*

2

(e) 200 grams

1

[8]

PPQ MS2

Q2.

(a) (i) any **three** from:
- lights to help guide / attract fish (to the holes)
- (rigid so) holes stay open
- (holes) allow small / young fish to escape
- (so that) they can breed

3

(ii) (fishing) quotas / legislation

1

(b) (i) movement is restricted

1

(in a building **or** close together so) heat is conserved

allow in heated buildings to reduce heat loss

1

(ii) any **two** from:
- it is cruel
  allow descriptions of 'cruelty'
- disease spreads faster
- (meat) often has antibiotics in it

2

[8]

PPQ MS3

Q3.

(a) *idea that*

- so they don't get too hot / cold
  for high temperatures
- don't lose condition / weight **or** don't become ill
- don't lose too much water / become dehydrated
  (*allow* don't sweat too much)
  for low temperatures
- reduce heat loss from pigs
- less energy wasted in maintaining body temperature
  for 1 mark each

2

(b)
- reduce energy loss by movement
- so more is available for growth*
  *(*credit this point if given in (a) but only credit once)*
- don't use body mass to provide energy
- easier to handle / monitor
  for 1 mark each

2

(c) *idea that*

- less humane / not natural / cruel / no room to exercise / stressful
- more intensive labour
- increased risk of disease / (often) in contact with faeces
- antibiotic residues in meat

any two for 1 mark each

2

[6]

Standard demand

PPQ MS4

Q4.

(a) (i) fungus

1

(ii) oxygen / O_2

accept air

accept O_2

*do **not** allow O^2 / O / O2*

1

(iii) glucose (syrup)

allow carbohydrate / sugar

ignore food / starch

allow oxygen if oxygen / air not given in (a)(ii)

1

(b) any **two** from:

- quicker
- suitable for vegetarians
- cheaper
- more efficient **or** less land / methane

ignore high in protein

ignore sustainability unqualified

ignore less pollution unqualified

allow less animals harmed / killed

*allow food chain is shorter **or** has less trophic levels*

allow less energy lost (from the food chain)

*do **not** allow no energy lost*

allow low(er) in calories (than some meat)

allow low(er) in fat / healthier (than some meat)

allow source of fibre / prevent constipation

2

[5]

Q5.

(a) it is impossible to weigh all the fish in the sea

1

(b) (i) increase / from 50 to 350 / by 300 thousand tonnes

1

(ii) due to fishing ban / not allowed

1

(c) (i) fishing quotas / limits

1

changes to net size

1

(ii) yes, biomass increases

1

use of figures from graph eg approx 4- times **or** (was effective at first) but numbers decline again after 2004

must use two comparative figures for 2nd marking point

1

(iii) so that breeding continues

alllow prevent extinction / limit impact of fishing on food chain / web

1

(iv) 95%

*correct answer gains **2** marks*

*2000-100=1900 award **1** mark*

2

(d) any **four** from:

- increase in sea / water temperature

  accept ref to lower sea / water temp if shift in Gulf Stream is referred to
- changes in migration patterns / distribution of species
- more eggs may survive (up to 19 °C) and could lead to an increase in herring pop
- reduction in herring pop (because eggs die if >19 °C)

  accept change in other populations of fish which are alternative prey for cod
- (appropriate) change in cod population as a result

4

[14]

PPQ MS6

Q6.

any **three** from:

*maximum **2** marks if only advantages **or** only disadvantages given*
ignore references to cost unqualified

advantages: (max 2)

ignore reference to fresher

- less transport / example of transport **or** less fuel used
  accept implication eg less food miles
  allow no transport / fuel costs
- less pollution / example
  accept eg less carbon dioxide / smaller carbon footprint
  allow no pollution / example
- support of local / UK economy / farmers

disadvantages: (max 2)

- not available all year
- may require use of heat / light
- (production of) heat / light causes pollution

[3]

High demand

PPQ MS7

Q7.

(a) circulation / mixing / described

1

or

temperature maintenance

supply oxygen

*do **not** allow oxygen for anaerobic respiration*

or

for aerobic conditions

or

for faster respiration

1

(b) any **one** from:

- energy supply / fuel
  or use in respiration

*do **not** allow just food / growth*
ignore reference to aerobic / anaerobic

- material for growth
  or to make mycoprotein

1

(c) (heat / energy) from respiration
allow exothermic reactions
allow description eg breakdown of glucose / catabolism
ignore metabolism
ignore aerobic / anaerobic

1

(d) (i) any **one** from:

- compete (with Fusarium) for food / oxygen
  or reduce yield of Fusarium
- make toxic waste products
  or they might cause disease / pathogenic
  or harmful to people / Fusarium
  *do **not** allow harmful unqualified*

1

(ii) any **two** from:

- steam / heat treat / sterilise fermenter (before use)
  ***not** just clean*
  *allow sterilisation unqualified for **1** mark*
- steam / heat treat / sterilise glucose / minerals / nutrients / water (before use)
  ***not** just use pure glucose*
- filter / sterilise air intake
- check there are no leaks

2

(e) any **three** from:

- beef is best **or** beef is better than mycoprotein(*)
- mycoprotein mainly better than wheat(*)
- more phenylalanine in wheat than in mycoprotein(*)
  allow equivalent numerical statements(*)
- but no information given on other amino acids / costs / foods

3

overall conclusion:

statement is incorrect

or

it would be the best source for vegetarians

or

for given amino acids, beef is the best source

or

three foods provide insufficient data to draw a valid conclusion

1

[11]

PPQ MS8

Q8.

(a) (i) fewer cows

1

any **one** from:

- less methane

  *do **not** allow CH^4*
- less CO_2 in the atmosphere because of less deforestation **or** less plants consumed.

  *allow less CO_2 released into the atmosphere because less fuel used e.g. to heat cowsheds **or** to transport meat*

  *do **not** allow CO^2*

1

(ii) any **two** from:

- could be mass produced to feed an increasing population
- disease free meat
- no / low fat
- no harm to animals or less intensive farming

  allow (may be) suitable for vegetarians
- antibiotic free meat
- more land available for farming crops

  allow no energy loss along a food chain

2

(b) fungus / Fusarium

1

with glucose (syrup)

1

in aerobic conditions **or** in presence of oxygen

ignore air

1

mycoprotein is harvested / purified

allow ammonia added (as source of nitrogen)

ignore stirring / mixing and temperature

1

[8]