Separate Biology
Higher
Paper 2

Name: _____

Topic 5: Homeostasis and Response

Topic 6: Inheritance, Variation and Evolution

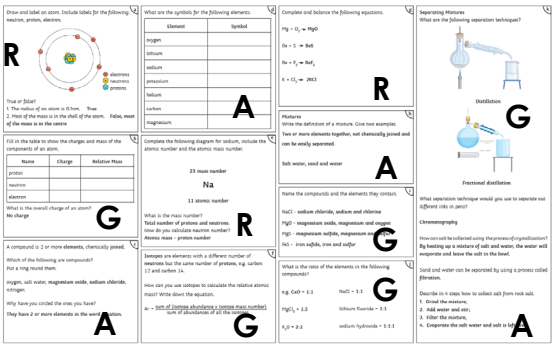
Topic 7: Ecology

Exam Date: Monday 9th June 2025

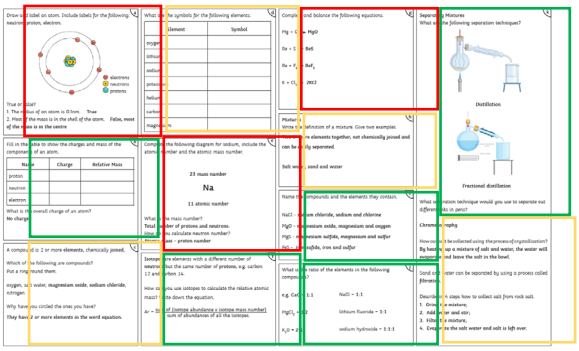
Instructions

This booklet has been separated according to the topic that will be covered in the exam.

1. Go through the revision mat for the topic and rate each box according to your understanding of that content. Use a typical RAG rating or 3 different colours of highlighter.
   For example:



OR



R = Red ☹ Low understanding

A = Amber 😐 Some Understanding

G = Green 😊 Good Understanding

2. Cut along the dotted lines of the question card template provided. Then produce a set of revision questions and answers for that topic – you should focus on those you have rated as red or amber on the revision mat. **For example:**

Front	**Back**
What is the mass number of an atom?	The total number of protons and neutrons found in the nucleus

3. Fold along the line indicated on the following page and glue where indicated to create a storage pocket for your question cards.
4. Regularly test yourself using your question cards or ask someone to test you and return them to your storage pocket for safekeeping after each use.

a

What is homeostasis?

The regulation of the internal conditions of a cell or organism to maintain optimum conditions for function. This is in response to internal and external changes.

b

Name three things that are controlled by homeostasis.

1. **blood glucose concentration**
2. **body temperature**
3. **water levels**

Choose the correct word and fill in the blanks:

Homeostasis is an **involuntary** control system that involves **nervous** or **chemical** responses.

All control systems include receptors, effectors and coordination centres. Describe what the role of each is and state the parts of the body that carry out the role.

Receptors: **detect stimuli - specialised cells.**

Coordination centres: **receive and process information - brain, spinal cord and pancreas.**

Effectors: **bring about responses to restore optimum levels - muscles or glands.**

c

What is the role of the nervous system?

To enable us to react to our surroundings and coordinate our behavior.

What does CNS stand for?

central nervous system

Which two organs make up the CNS?

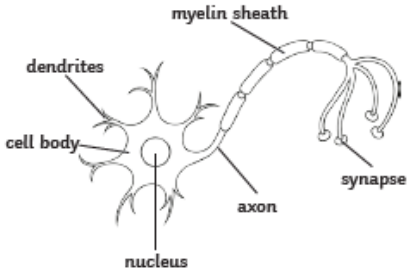
brain and spinal cord

d

What is the function of the nerve cell?

To carry electrical impulses rapidly around the body.

Label the nerve cell diagram with the nucleus, cell body, dendrites, axon, myelin sheath and synapse.



Explain how the nerve cell is adapted to its function.

- **It has lots of dendrites so that it can make lots of connections to other nerve cells.**
- **The axon is very long to carry the nerve impulse a long way.**
- **The axon is insulated so the impulses travel rapidly.**
- **The synapses have lots of mitochondria to transfer the energy needed to make transmitter chemicals.**

e

Put the following terms into a flow diagram to summarise how the nervous system works.

effector, stimulus, response, CNS, receptor

stimulus → receptor → CNS → effector → response

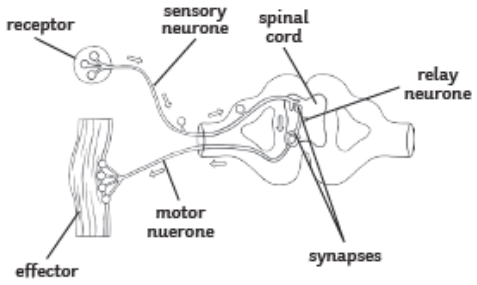
f

Why are reflexes important?

They happen automatically and rapidly so they help you to avoid harm. They take care of your body systems, like breathing and circulating blood, so you don't have to think about them all the time.

g

Label the diagram below with the following key parts of a reflex arc: receptor, spinal cord, motor neurone, sensory neurone, relay neurone, synapse, effector



Explain how the reflex arc works.

- **The receptor is stimulated.**
- **An electrical impulse travels along the sensory neurone to the CNS.**
- **At the synapse, a chemical is released. It diffuses across the synapse and triggers an electrical impulse in the relay neurone.**
- **When the impulse reaches the next synapse, a chemical is released which travels across the synapse and triggers an electrical impulse in the motor neurone.**
- **The impulse reaches the effector which is stimulated to respond.**

h

Which hormone is produced by the adrenal gland?

adrenaline

When is it produced?

If you are scared or stressed.

What are its effects?

- **Increases the heart rate.**
- **Increases the breathing rate.**
- **Prepares your body for flight or fight.**

i

Explain how the endocrine system produces a response to a stimulus.

The endocrine system produces a chemical response to a stimulus. The glands of the endocrine system secrete hormones into the blood stream.

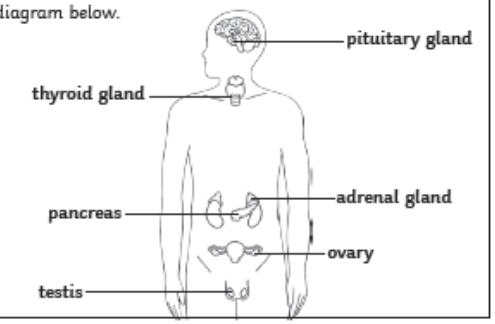
The blood carries hormones to target organs which have receptors to pick up the hormone, this causes them to respond.

Compare these hormonal effects with the response of the nervous system.

Hormonal effects are slower than the nervous system but last for longer.

j

Label the main endocrine glands shown in the diagram below.



k

Where is the hormone thyroxine produced?

thyroid gland

What is its role in the body?

It controls the basal metabolic rate.

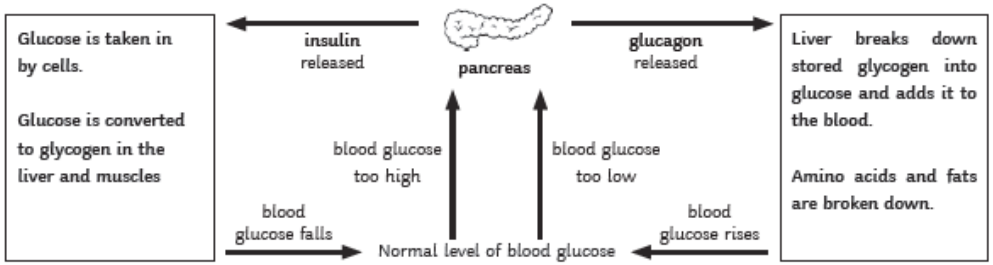
It is important in growth and development.

How is the level of thyroxine controlled?

A negative feedback loop involving the pituitary gland and the hormone TSH/thyroxine stimulating hormone.

a

Complete the boxes and fill in the blanks to show how blood glucose levels are controlled.



Control of blood sugar is an example of a **negative feedback** loop. What does this mean?

Negative feedback maintains a steady state by ensuring that any changes in the system are reversed and returned back to the normal level.

b

What causes type 1 diabetes? **The pancreas does not make enough insulin, so blood glucose isn't controlled and it gets very high after eating a meal.**

When does type 1 diabetes usually start?

In children and teenagers.

How is type 1 diabetes treated?

With insulin injections.

c

What causes type 2 diabetes?

The cells in the body no longer respond to the insulin that is produced by the pancreas.

What are the risk factors for type 2 diabetes?

Obesity and lack of exercise.

How is type 2 diabetes treated?

A carbohydrate-controlled diet and an exercise routine.

d

What is the main reproductive hormone in the female?

oestrogen

What is ovulation?

When a mature egg is released from an ovary.

What is the main reproductive hormone in the male?

testosterone

What does this hormone do?

Stimulates sperm production.

e

What is the role of each of the following hormones in the menstrual cycle?

Follicle stimulating hormone (FSH): **causes maturation of an egg in the ovary.**

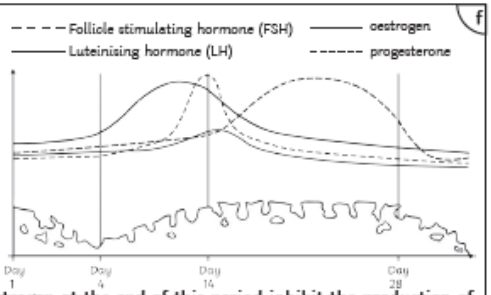
Luteinising hormone (LH): **stimulates the release of an egg.**

Oestrogen: **maintains the uterus lining.**

Progesterone: **maintains the uterus lining.**

f

Label the two remaining lines on the graph with the names of the hormones they represent.



Use the diagram to explain the stages of the menstrual cycle. Make links to the hormone interactions that happen at each stage.

Day 1-4: The uterine lining breaks down causing a period. Oestrogen and progesterone levels are at their lowest.

Day 4-14: Oestrogen increases and the uterine lining rebuilds. FSH increases and an egg in the ovary starts to mature. It also stimulates the ovaries to produce oestrogen. High levels of oestrogen at the end of this period inhibit the production of FSH and stimulate the release of LH.

Day 14: A peak in LH causes ovulation.

Day 14-28: Progesterone and oestrogen increase to maintain the uterine lining in preparation for fertilisation. Progesterone inhibits LH and FSH.

Day 28: The cycle restarts unless pregnancy has occurred.

g

Explain how each method of contraception works.

Oral contraceptives:
these contain hormones that inhibit FSH production so that eggs don't mature.

Injection, implant or skin patch of progesterone:
inhibits the maturation and release for a number of months or years.

Barrier methods, such as condoms and diaphragms:
these prevent the sperm reaching an egg.

Intrauterine devices:
prevents the implantation of the embryo or release a hormone.

Spermicidal agents:
these kill or disable sperm.

Abstinence:
avoiding intercourse when an egg might be in the oviduct.

Surgical methods:
sterilising the male or female by cutting, or tying, tubes to prevent the egg or sperm reaching their target area.

h

Some women are infertile because they do not ovulate. Explain how artificial hormones can be used to treat infertility.

Artificial FSH is given to stimulate the maturation of eggs and the production of oestrogen. Then artificial LH is given to trigger ovulation. The woman can then (possibly) become pregnant in the normal way.

Describe the process of in vitro fertilisation (IVF).

The mother is given artificial FSH and LH to stimulate the maturation of several eggs.

The eggs are collected and fertilised by the fathers sperm in the laboratory.

The fertilised eggs develop into embryos.

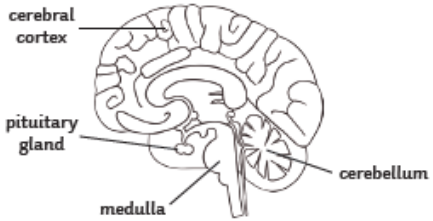
One or two embryos are inserted into the mothers uterus while they are still tiny balls of cells.

Give three disadvantages of IVF.

1. **It is emotionally and physically stressful.**
2. **The success rates are not high.**
3. **It can lead to multiple births which are a risk to both the babies and the mother.**

a

Label the parts of the brain.



Describe the functions of each part of the brain.

Medulla: **controls unconscious activities such as breathing, heartbeat and the movements of the gut.**

Cerebral cortex: **controls consciousness, intelligence, memory and language.**

Cerebellum: **coordinates muscular activity and balance.**

Pituitary gland: **produces hormones that control many body systems.**

b

Explain why it is difficult to...

investigate brain function.

The brain is very complex. Lots of neurones in different areas of the brain are involved in many processes. The brain is delicate and easily damaged.

treat brain damage and disease.

Drugs don't always reach the brain through the membranes that surround it. Surgery can cause damage to the brain and its difficult because we don't fully understand how the brain works.

c

Name two things that receptors in the eye are sensitive to.

1. **light intensity**
2. **colour**

d

Describe the techniques that neuroscientists have used to map some areas of the brain to their functions.

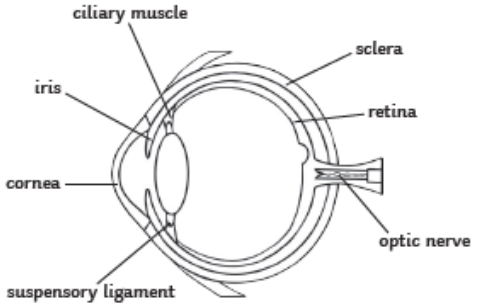
By studying people with brain damage, they can link the damaged areas of the brain to changes in behaviour or memory of the patient.

They can electrically stimulate different parts of the brain of a conscious person by removing the top of their skull. The patient can describe how they feel when different areas of the brain are stimulated.

MRI scans can show which areas of the brain are affected by tumours or strokes. They can then link this damage to symptoms or changes in behaviour.

e

Label the diagram with the structures of the eye.



f

Explain the difference in pupil size between bright light and dim light.

In bright light, the circular muscles of the iris contract to reduce the size of the pupil. This means less light enters the eye and protects it from damage.

In dim light, the radial muscles of the iris contract to enlarge the pupil. This allows as much light as possible to enter the eye.

g

Explain how each of the structures below is related to its function.

Optic nerve: **contains sensory neurones to send impulses to the brain.**

Cornea: **transparent to let light into the eye and curved to help focus the light on the retina.**

Iris: **made of muscles that contract or relax to change the size of the pupil and control how much light enters the eye.**

Retina: **contains light-sensitive cells that are stimulated when light hits the retina.**

Sclera: **tough and strong so the eyeball is not easily damaged.**

Ciliary muscles: **contracts or relaxes to change the shape of the lens and focus the light from short or long distances.**

Suspensory ligaments: **hold the lens in place and help the lens to focus on near or distant objects.**

h

What is the name of the process that changes the shape of the lens to focus on near or distant objects?

accommodation

Explain how the eye focuses on...

a near object:

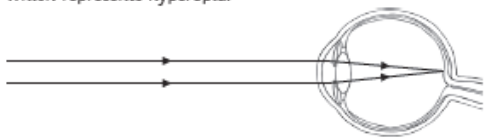
- **the ciliary muscles contract;**
- **the suspensory ligaments loosen;**
- **the lens is thicker and refracts rays strongly.**

a distant object:

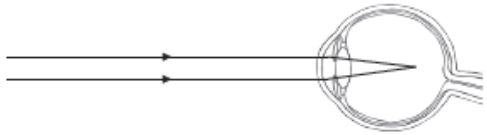
- **the ciliary muscles relax;**
- **the suspensory ligaments are pulled tight;**
- **the lens is pulled thin and only slightly refracts light rays.**

i

Label each diagram below to show which represents an eye with normal focus, which represents myopia and which represents hyperopia.



normal focus



myopia

hyperopia

j

Explain how these defects in eyesight are treated.

Spectacle lenses refract the light to focus it on the retina. Contact lenses do the same job, but are placed on the surface of the eye.

Laser eye surgery is available to adults with stable vision. It changes the thickness or the curve of the cornea to refract light onto the retina.

Replacement lenses are added inside the eye to permanently correct the defect.

a

Describe how the temperature of the body is monitored.

Receptors in the thermoregulatory centre are sensitive to the temperature of the blood.

Temperature receptors in the skin send nervous impulses to the thermoregulatory centre.

b

Explain how the body responds if the body temperature becomes too high.

Vasodilation occurs (blood vessels dilate) and sweat is produced from the sweat glands. This causes heat energy to be transferred from the skin to the environment.

Explain how the body responds if the body temperature becomes too low.

Vasoconstriction occurs (blood vessels constrict) and sweating stops which reduces the transfer of energy from the skin to the environment. Skeletal muscles contract to cause shivering. This means the muscles need lots of respiration to occur which transfers energy and raises the body temperature.

c

Explain what happens to excess protein in the diet.

The protein is broken down into amino acids. In the liver, these amino acids are deaminated to form ammonia. Ammonia is toxic, so it is immediately converted into urea for safe excretion.

d

The body cannot control the loss of waste products from some organs.

Water is lost from the **lungs** during **exhalation**.

Water, mineral ions and urea are lost from the **skin** in **sweat**.

e

The illustration shows a kidney.

Describe how the kidneys function to maintain the water balance of the body.

Glucose, water, urea and mineral ions are filtered out of the blood and into the kidneys. All of the glucose is reabsorbed into the blood stream. Urine is moved to the bladder. Water and mineral ions undergo selective reabsorption. The amount of water reabsorbed into the blood depends on what is needed by your body and is controlled by the hormone ADH.

f

Describe two ways that kidney failure can be treated.

Dialysis – the function of the kidney is carried out artificially. The dialysis fluid has the same concentration of glucose and mineral ions as a healthy person. This means that there is no net loss of glucose from the blood. The dialysis fluid contains no urea, so urea moves out of the blood and into the dialysis fluid.

Kidney transplant – the diseased kidney is replaced with a healthy donor kidney.

g

The response of plants to light is called **phototropism**.

The response of plants to gravity is called **gravitropism** or **geotropism**.

These responses are controlled by the hormone **auxin**.

Explain how the hormone works.

It causes an unequal growth rate in plant roots and shoots. When cells on one side of the plant grow faster than the other, the root or shoot bends in the right direction.

h

Give three ways that auxins are used in agriculture and horticulture.

1. **weed killers**
2. **rooting powders**
3. **promoting growth in tissue culture**

i

Describe the role of ethene in plants.

Ethene controls cell division and the ripening of fruits.

How is ethene used in the food industry?

Ethene is used to control the ripening of fruit during storage and transport.

j

Describe the role of gibberellins in plants.

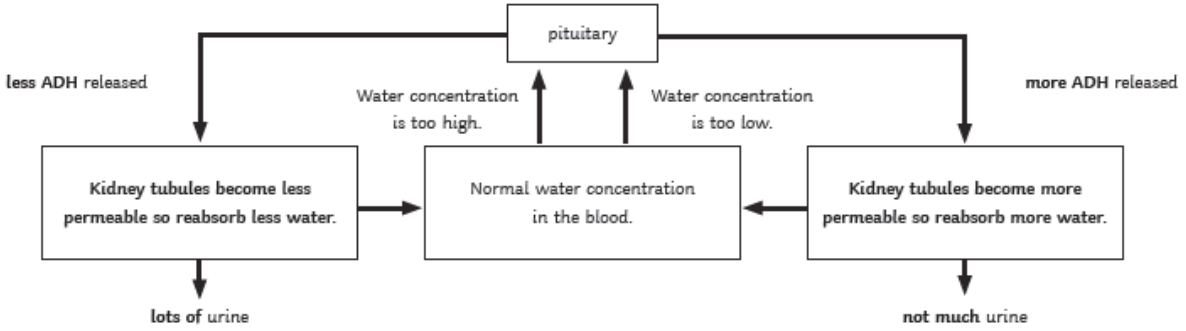
Gibberellins initiate seed germination.

Give three ways that gibberellins are used in agriculture and horticulture.

1. **end seed dormancy**
2. **promote flowering**
3. **increase fruit size**

k

Complete the boxes and fill in the blanks to show how water concentration in the blood is controlled via negative feedback.



a

Compare meiosis and mitosis.

Meiosis includes two nuclear divisions which produce four non-identical daughter cells. Each daughter cell contains one set of chromosomes.

Mitosis includes one nuclear division that produces two identical daughter cells. Each daughter cell contains two full sets of chromosomes.

b

What are the names of the male and female gametes...

in plants? **pollen cells and egg cells**

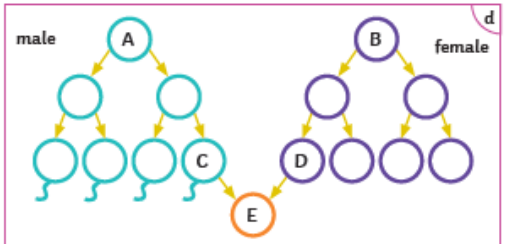
in animals? **sperm cells and egg cells**

c

What is asexual reproduction?

When there is only one parent and no fusion of gametes. Only mitosis is involved, so there is no mixing of genetic information. The offspring are genetically identical (clones).

d



How many chromosomes are in cell B? **46**

What is the process called that produces cell C from cell A? **meiosis**

How many chromosomes are in cell C? **23**

How many chromosomes are in cell E? **46**

What is the process that produces cell E called? **fertilisation**

What happens to cell E next?

It divides by mitosis and the number of cells increases. These differentiate as the embryo develops.

e

Give three advantages of sexual reproduction.

1. **It produces variation in the offspring.**
2. **Natural selection gives a survival advantage if the environment changes.**
3. **Selective breeding allows humans to speed up natural selection to increase food production.**

f

Give four advantages of asexual reproduction.

1. **Only one parent is needed.**
2. **It's more time and energy efficient as there is no need to find a mate.**
3. **It's faster than sexual reproduction.**
4. **Many identical offspring can be produced when conditions are favourable.**

g

Describe how three different organisms reproduce both sexually and asexually.

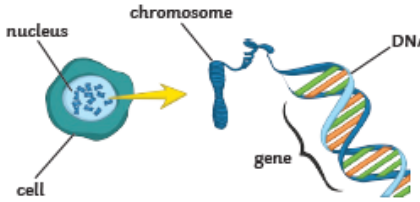
1. **Malarial parasites reproduce asexually in the human host and sexually in the mosquito.**
2. **Fungi reproduce asexually by spores, but also reproduce sexually to give variation.**
3. **Plants reproduce sexually, but some also reproduce asexually. Strawberry plants reproduce asexually via runners; daffodils reproduce asexually via bulb division.**

h

Describe the structure of DNA.

DNA is a polymer made up of two strands of nucleotides that are twisted to form a double helix.

Label the diagram below with the following keywords: cell, nucleus, chromosome, gene, DNA.



How many pairs of chromosomes does an ordinary human body cell contain? **23**

i

Complete the complementary strand to show which bases pair up.

How many amino acids does this strand code for? **5**

Explain how a change in this DNA sequence could result in a change in the protein that this gene codes for.

If the DNA sequence changes, then it may code for a different amino acid. If the amino acid sequence changes, then a different shaped protein may be produced.

j

Describe how protein synthesis occurs.

A template is made of the DNA. The template moves from the nucleus to the cytoplasm of the cell where it attaches to a ribosome. A carrier molecule attaches to every three bases of the template. The carrier molecule is attached to an amino acid. The amino acids are joined together to form a chain. The chain folds into the final shape of the protein.

k

Label the parts the make up a nucleotide.

l

What effect might a mutation in a non-coding region of DNA have?

It might change the expression of a gene.

m

Define the following terms.

genome: **The entire genetic material of an organism.**

gamete: **The sex cells (sperm and egg cells) which contain one set of genetic information.**

chromosome: **Found in the nucleus, they are made from long DNA molecules and passed from parent to offspring.**

gene: **A section of DNA that codes for a particular sequence of amino acids which makes a specific protein.**

allele: **A different form or variant of a gene.**

dominant: **Controls the characteristic, even if it is only present on one chromosome.**

recessive: **Only controls the physical characteristic if it is present on both chromosomes.**

homozygous: **Two identical alleles for a characteristic.**

heterozygous: **Different alleles for a characteristic.**

genotype: **The alleles present in an individual for a particular characteristic.**

phenotype: **The physical appearance of an individual for a particular characteristic.**

a

Explain why it's important for us to study the human genome.

It helps us to search for genes that are linked to different types of diseases. Understanding inherited disorders gives us more chance of repairing the genes or producing successful medicines. It also helps us to trace the migration patterns of humans from the past and develop a greater understanding of human evolution.

b

Give an example of variation between individuals that is affected by genetics (genetic variation).

Some examples: eye colour, dimples, inherited disease, natural hair colour, earlobes, natural skin colour, gender.

Give an example of variation between individuals that is affected by the environment (environmental variation).

Some examples: language, religion, scars, fillings, ability to play an instrument.

Give an example of variation between individuals that is affected by a combination of genetic and environmental variation.

Some examples: height, weight, IQ.

c

What causes new variants in the genes of a species?

Mutations/changes to the DNA code.

Explain what effects this could have on the phenotype of an organism.

It might have no effect at all and this is most common. It might be harmful and mean the individual is less likely to survive.

It might produce a phenotype that is beneficial, making the individual better suited to the environment - this is rare.

d

Give an example of a characteristic caused by a single gene.

Some examples: eye colour, red-green colour blindness, polydactyly, cystic fibrosis, tongue rolling, attached earlobes, freckles, dimples, fur colour in mice.

What causes most characteristics?

multiple genes interacting

e

A woman with polydactyly is heterozygous for the polydactyly allele. The woman marries a man who does not have polydactyly. Draw a punnet square diagram to help you explain what the probability of their first child having polydactyly is.

Use the symbol **A** for the dominant allele and the symbol **a** for the recessive allele.

dad \ mum	A	a
a	Aa	aa
a	Aa	aa

50% or $\frac{1}{2}$ offspring have polydactyly

1 mark for correct parental genotypes. 1 for complete punnet square. 1 for highlighting the offspring with polydactyly. 1 for the correct probability.

f

Which sex chromosomes do human females carry?

XX

Which sex chromosomes do human males carry?

XY

g

Use a punnet square to show the inheritance of sex.

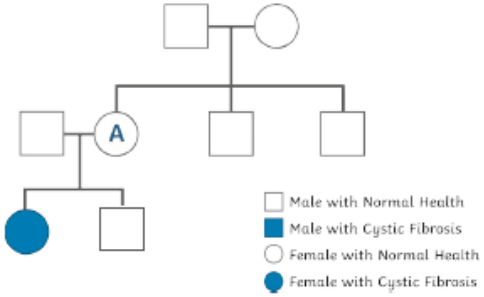
dad \ mum	X	X
X	XX	XX
Y	XY	XY

What is the chance that a pregnancy produces a boy?

50% / $\frac{1}{2}$

h

The diagram shows the inheritance of cystic fibrosis in one family.



Use the symbol **N** for the allele for normal health and the symbol **n** for the allele for cystic fibrosis.

What is the genotype for person A? **Nn**

How do you know?

They don't have cystic fibrosis, but they have passed on a cystic fibrosis allele to their daughter. This means they must carry the allele. They don't suffer from the disease themselves, so they must carry the normal, dominant allele. They are therefore heterozygous.

Person A is pregnant with their third child. Use a genetic diagram to explain the probability that their child will have cystic fibrosis.

dad \ mum	N	n
N	NN	Nn
n	Nn	nn

25% / $\frac{1}{4}$ / 0.25 / 1 in 4 offspring have cystic fibrosis

1 mark for correct parental genotypes. 1 for complete punnet square. 1 for highlighting the offspring with cystic fibrosis. 1 for the correct probability.

i

What is selective breeding?

The process by which humans breed plants and animals for particular genetic characteristics.

j

Evaluate the process of embryo screening.

Student responses may cover the following:

- **The process used to collect cells has a risk of miscarriage, so sometimes a healthy foetus will be miscarried.**
- **Sometimes the tests can give a false-positive or false-negative result.**
- **Screening allows people to make choices about whether they have a family or not.**
- **The decision to terminate a pregnancy is a very difficult one that will vary based on the individual's views and religious beliefs.**
- **Some people decide not to have the screening to avoid making these decisions.**
- **Screening can allow a family to prepare for a child with an inherited disorder.**
- **Screening is expensive, so is not currently offered to everyone.**
- **However, if a child is born with a genetic disorder, it can be expensive for society to provide the healthcare and support needed.**
- **Some people worry that genetic screening may lead to 'designer babies'.**

k

Explain the benefits and risks of selective breeding.

Selective breeding produces organisms that are useful to us and has improved our food production.

It reduces the number of alleles in a population which reduces the variation of a species. If the environment then changes the organisms may not be able to cope with the change and may die out.

It can lead to inbreeding which can make a breed particularly prone to disease or inherited defects. This could cause a whole herd or crop to be affected by a disease all at once.

a

Describe the process that farmers use to ensure they have varieties of cow that produce lots of milk.

Parents that have the desired characteristic/produce lots of milk are chosen from the herd.

Only these parents are bred together.

From their offspring, only those that produce the most milk will be bred together.

This is repeated over many generations, until all of the offspring show the desired characteristic.

Give four other examples of characteristics that might be chosen for selective breeding in plants or animals.

1. **Disease resistance in plants.**
2. **Animals that produce more meat.**
3. **Domestic animals with a gentle nature.**
4. **Large or unusual flowers.**

b

What are GM crops?

Crops that have had their genes modified by genetic engineering.

What are the benefits of GM crops?

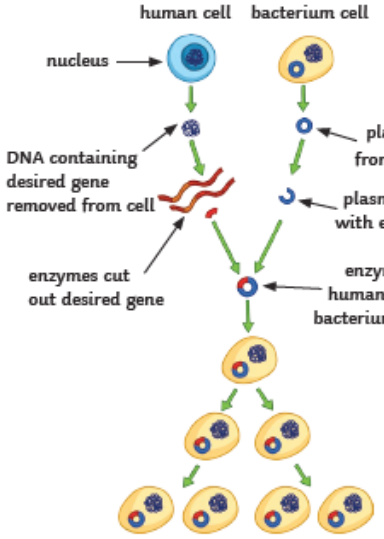
They can be resistant to insect attack, herbicides or disease.

They have increased yields.

They can be engineered to grow in more difficult climates.

c

Annotate the diagram to describe the process of genetic engineering.



Bacteria reproduce rapidly.
This creates bacteria with the new characteristic.

d

Name two ways that cloning is carried out in plants.

Tissue culture: uses small groups of cells from part of a plant to grow identical new plants.

Cuttings: uses a small piece of a plant to produce an identical plant to the parent plant.

e

What are the concerns about genetic engineering?

We can't be sure what effects GM crops will have on populations of wild flowers and insects.

Some people are concerned that we don't know what affects they may have on human health.

Some worry that it may lead to people wanting to manipulate the genes of humans to produce 'designer babies'.

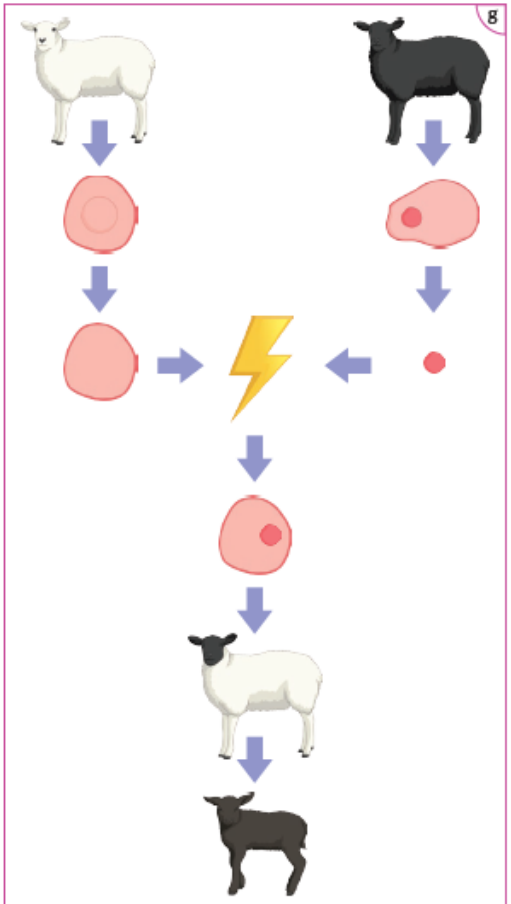
f

Describe how embryo transplants are used to clone animals.

Animal embryos are divided into several single cells before they have specialised. These are grown into embryos in a laboratory.

The identical embryos are then transplanted into host mothers.

g



Use the diagram to describe the process of adult cell cloning.

The nucleus is removed from an unfertilised egg cell and the nucleus from an adult body cell (such as a skin cell) is inserted into it as a replacement.

An electric shock is used to stimulate the egg cell to divide to form an embryo. The embryo cells will contain the same genetic information as the adult skin cell.

When the embryo has developed into a ball of cells, it is inserted into the womb of an adult female to continue developing.

h

Chemical analysis led Carl Woese to adapt the system we used for classification.

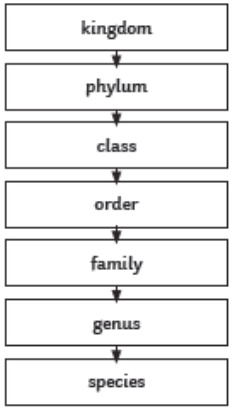
Describe how his system divides organisms.

Into three domains:

- **archaea - primitive bacteria which live in extreme environments;**
- **bacteria (true bacteria);**
- **eukaryote - these includes protists, fungi, plants and animals.**

i

Complete the boxes to show the way Linnaeus classified living things.



How are organisms named?

By the binomial system of genus and species.

j

What is evolution?

A change in the inherited characteristics of a population over time through a process of natural selection. This may result in the formation of a new species.

When did the first simple life forms develop?

3 billion years ago

What evidence do we have for evolution?

1. **fossils**
2. **antibiotic resistance in bacteria**

a

This is a fossil of the prehistoric bird Archaeopteryx.

Archaeopteryx is now extinct.

Give some factors that could contribute to a species extinction.

New predators, better competitors, a catastrophic event (e.g. volcanic eruption, meteor), changes to the environment over time, lack of food, new diseases.

b

What are fossils?

The remains of organisms from millions of years ago. They are now found in rocks.

Give three ways fossils may be formed.

1. **From parts of organisms that have not decayed because one or more of the conditions for decay were absent.**
2. **When parts of the organism are replaced by minerals as they decay.**
3. **As preserved traces of organisms, such as footprints, burrows and rootlet traces.**

c

What can we learn from fossils?

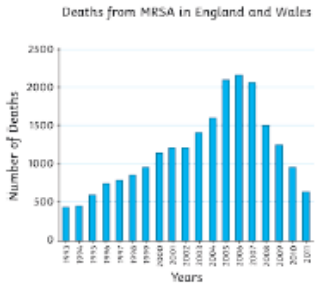
How organisms have changed over a long period of time.

Why can scientists not be certain about how life began on earth?

Many early life forms were soft bodied so left few traces behind. Most traces have been destroyed by geographical activity.

d

MRSA is resistant to antibiotics. The graph shows how the number of MRSA infections has changed over the last 15 years.



Describe the trend in the data.

From 1993 to 2006, the number of deaths due to MRSA increases from ~450 to ~2150. After 2006, the number of deaths from MRSA starts to decrease and reaches ~650 by 2011.

Explain what measures were put in place in England and Wales in 2006 that caused the trend in the data shown on the graph.

Doctors only prescribed antibiotics when they were really needed, not for treating non-serious or viral infections.

Information was given to patients telling them to complete their course of antibiotics, so all bacteria are killed and none survive to mutate and form resistant strains.

Patients with antibiotic resistant bacteria were isolated from other patients.

Increased information about handwashing was provided for staff and visitors to hospitals and care homes. Alcohol gel was provided throughout hospitals.

e

Why can bacteria evolve rapidly?

They reproduce at a fast rate.

Explain how bacteria can become resistant to antibiotics.

Mutations arise that produce new strains.

Some mutations may cause the strain to become resistant to antibiotics.

Bacteria are no longer killed by antibiotics, so they survive and reproduce. This increases the population of antibiotic resistant bacteria.

The resistant strain is spread between people because they are not immune to it and there is no effective treatment.

f

Use Darwin's theory of natural selection to explain how the length of giraffe necks has increased over time.

The population of giraffes will have had lots of variation in neck length. They will have competed for food and resources. Those with the longest necks are more able to reach food and are therefore most likely to survive and reproduce. They then pass the alleles for the long necks onto the next generation.

g

Give three reasons that it took a while before Darwin's theory of natural selection was accepted?

1. **The theory challenged the idea that God made all the animals and plants that live on earth.**
2. **There wasn't enough evidence at the time to convince a lot of scientists.**
3. **The mechanism of inheritance was not understood until 50 years after the theory was published.**

h

How did Lamarck's theory differ from Darwin's?

He thought that changes that occur to the organism during its lifetime are inherited by the offspring.

i

Explain how the work of Mendel contributed to our understanding of genetics.

Mendel carried out breeding experiments with peas. He bred pea plants with different characteristics and counted the number of offspring of each type. He was able to predict how traits would be inherited.

He thought that each characteristic was determined by separate 'units' that are passed on to offspring unchanged. These units were later called genes.

j

Why was the importance of Mendel's discovery not recognised until after his death?

At the time, nobody knew about genes or chromosomes and people didn't understand his theories. When scientists observed chromosomes and how they move during cell division, they finally accepted his work.

k

Explain the role that Alfred Russel Wallace played in the publication of the theory of evolution by natural selection.

He worked worldwide gathering evidence for evolution. He worked on warning colouration in animals. He independently proposed the theory of evolution by natural selection and published joint writings with Darwin in 1858. This prompted Darwin to publish On the Origin of Species a year later. He did a lot of pioneering work on a theory for speciation.

l

The anole lizards are found on the Caribbean islands. There are around 150 species of the lizard which evolved from a single species that colonised the islands. Explain how two species of the anole lizard, found on different Caribbean islands, could have evolved from a common ancestor.

- **The ancestral populations of anole lizards were separated (geographical isolation) because they were on different islands.**
- **There was genetic variation in each population, each environment would have had different environmental conditions.**
- **The individuals in each population that were better adapted to those conditions would survive and reproduce/natural selection occurs.**
- **The alleles for the beneficial phenotypes were passed to their offspring, eventually.**
- **The two populations would be so different they could not successfully interbreed.**

a

Define the following terms.

community: **All the populations of different organisms that live together in a habitat.**

stable community: **Where all the species and environmental factors are in balance so that population sizes remain stable.**

ecosystem: **A community and its habitat.**

population: **All the members of a single species that live in a habitat.**

interdependence:: **A network of relationships between different organisms in a community.**

biotic factor: **A living thing that affects the ecosystem.**

abiotic factor: **A non-living part of the environment that affects living organisms.**

b

Give three ways that animals and plants are interdependent.

Any three of the following:

- **Plants produce food by photosynthesis.**
- **Animals eat plants.**
- **Animals eat other animals.**
- **Animals pollinate plants.**
- **Plants use animal waste for nutrients.**
- **Animals use plant and animal materials for building nests or shelters.**
- **Plants use animals for seed dispersal.**

c

When young male lions reach maturity, the older males kick them out of the pride. Explain which factors cause them to do this.

If the males remain in the pride, they will compete for food, territory and mates with the older lions. The older males will be more likely to survive and reproduce without this competition.

d

Plants may have to compete with other plants.

Explain why plants may not grow as well on the forest floor when compared to a meadow.

The plants will receive less light because the tree canopy will block most of it from reaching the floor. Light is needed to provide energy for photosynthesis; reduction of light will reduce photosynthesis and therefore the glucose needed for growth.

The plants will have to compete for space from the bigger trees and plants. The plant may not have enough space to grow, or enough space for a big root system to get water and nutrients. This means growth would be reduced.

The bigger trees would be better at getting water and mineral ions because they have large root systems. Water is needed for photosynthesis. The plants will get less water which will reduce photosynthesis and therefore the glucose required for growth.

Mineral ions are needed to produce larger molecules for growth. If the plant gets less of these, its growth will be reduced.

e

List the factors that can affect a community under the correct headings below.

abiotic	biotic
light intensity	availability of food
temperature	new predators arriving
moisture levels	new pathogens
soil pH	one species outcompeting another
soil mineral content	
wind intensity and direction	
carbon dioxide levels for plants	
oxygen levels (for aquatic animals)	

f

Red squirrels are the native squirrel species in European woodlands. Grey squirrels were introduced to the UK in the late 19th century. Grey squirrels feed more often at ground level than red squirrels and are able to digest acorns, which the reds can't. Grey squirrels carry a deadly pox virus which does not affect them.

Explain why grey squirrels are now the dominant species of squirrel across much of England and Wales.

Grey squirrels outcompete the red squirrels for food because they eat more often on the ground. This means they are able to eat food that has fallen from the trees. They are also able to eat acorns as a food supply so they have more food available. This means that they are more likely to survive and reproduce than the red squirrel.

The grey squirrels brought the pox virus to the habitats when they were introduced. The red squirrels are not immune so the disease will have spread through the population and resulted in the loss of many red squirrels.

g

In 2010, an oil spill off the coast of Mexico polluted 1100 miles of coastline. Explain how this will have affected the marine plants that live on the floor of the ocean.

The sunlight cannot pass through the oil on the surface of the water. The sunlight won't reach the plants so they won't be able to photosynthesise. This means they won't be able to grow.

h

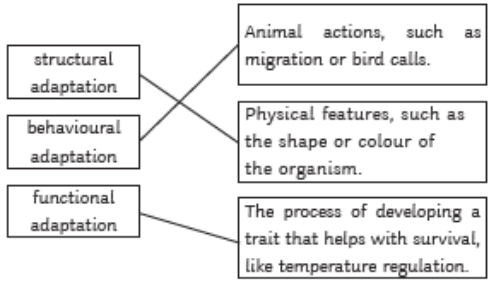
Organisms that live in extreme environments are called **extremophiles.**

Give three examples of extreme environments.

1. **high temperature**
2. **high pressure**
3. **high salt concentration**

i

Link the type of adaptation to the correct example.



j

Explain why most desert animals have a large surface area to volume ratio and large, thin ears.

To increase energy transfer through their skin to the surroundings to help them cool down.

k

Explain how animals that live in cold climates are adapted to survive.

They have a small surface area to volume ratio and small ears to reduce energy transfer to the surroundings.

They have thick layers of fat and fur for insulation.

l

A student uses a 1m^2 quadrat to take 10 random readings of dandelions in the school field. The results are shown below.

1	4	3	1	2	3	1	5	3	3

What is the range of their data? **1-5 dandelions per m^2**

What is the median of their data? **3 dandelions per m^2**

What is the mode of their data? **3 dandelions per m^2**

What is the mean of their data? **2.6 dandelions per m^2**

a

The illustration shows an ocean food chain.

Label each organism with their position in the chain and what type of diet they eat (if any).

tertiary consumer, carnivore

secondary consumer, carnivore

primary consumer, herbivore

producer

Name a predator from the food chain.

Either the whale or seal.

Name an organism from the food chain that is prey.

Either the seal or crab.

Explain the role of producers in food chains.

Producers use energy from sunlight to make glucose during photosynthesis. The glucose is used to synthesise molecules that add to the biomass of the organism.

b

Define biodiversity.

The variety of all the different species of organisms within an ecosystem.

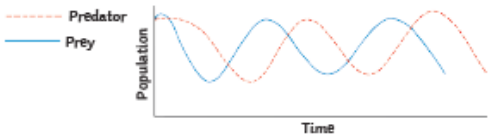
Why is it important to maintain a good level of biodiversity?

It reduces the dependence of one species on another for food, shelter and the maintenance of the physical environment.

What programmes are scientists putting into place to maintain biodiversity?

1. **Breeding programmes for endangered species.**
2. **Protection and regeneration of rare habitats.**
3. **Reintroduction of field margins and hedgerows.**
4. **Reduction of deforestation and carbon dioxide emissions.**
5. **Recycling resources.**

The numbers of predators and prey fall and rise in cycles. Use the graph to explain why.



When there is plenty of food available, the prey animals are able to grow and reproduce successfully. As a result, their numbers rise.

This means there is plenty of food available for the predators, so they can grow and reproduce successfully. Their numbers increase shortly afterwards.

The large number of predators around to eat the prey cause the prey numbers to fall.

The reduced number of prey means there is less food for the predators, so their numbers begin to fall too.

A reduced number of predators, and lots of food available because there are fewer animals around, means the prey are able to grow and reproduce so their numbers rise again.

d

Label the illustrations with the method being used to determine the **abundance** and **distribution** of organisms.

quadrat

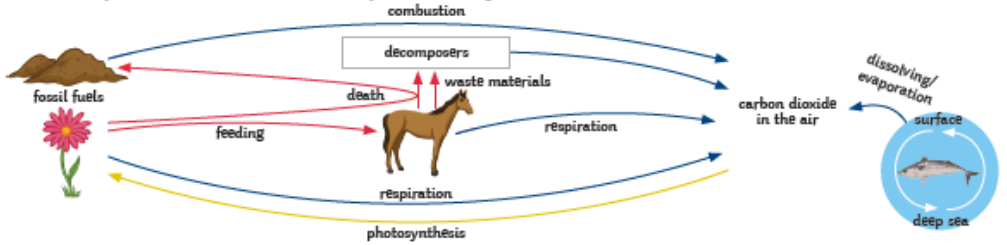
transect

The abundance is... **the number of species in an area.**

The distribution is... **how the number of species changes from one area to another.**

e

Label each of the arrows in the illustration of the carbon cycle with the process that the arrow represents.



f

Explain the role of decomposers in the recycling of materials through an ecosystem.

Decomposers break down dead bodies and waste materials. They release mineral ions as waste products back into the soil and carbon dioxide back into the air. These can then be used by producers in the food chain.

g

Explain the importance of the water cycle to living organisms. Include the following keywords: condensation, transpiration, precipitation, evaporation, respiration.

Water vapour is lost from organisms to the atmosphere via transpiration and respiration. Other water drains into the oceans and evaporates.

The warm water vapour in the atmosphere condenses as it cools and forms clouds of water droplets. As these get heavier, they fall onto the land as rain, hail or snow. This is called precipitation. The water cycle therefore provides fresh water for plants and animals on land.

h

How does pollution occur...

in water? **From sewage, fertiliser or toxic chemicals that are washed or dumped into water.**

in the air? **From smoke and acidic gases (sulfur dioxide and nitrogen oxides) which cause acid rain.**

on land? **From landfill and toxic chemicals from farming.**

i

How have humans affected the use of land?

Reduced the amount of land available to other organisms by building, quarrying, farming and putting waste into landfill.

Destroyed peat bogs which reduces biodiversity in those areas.

Large scale deforestation to provide land for cattle and rice fields, and growing crops for biofuels, reduces biodiversity.

j

Explain why global warming is occurring.

Deforestation reduces the rate at which carbon dioxide is removed from the atmosphere by photosynthesis. Burning the trees also releases carbon dioxide via combustion.

The land that has been cleared is often used for rice fields or cattle, both of these release methane into the atmosphere.

When peat is burnt as a fuel or used in gardens, carbon dioxide is released.

When fossil fuels are burnt in power stations, factories or vehicles, carbon dioxide is released into the atmosphere.

k

What are the biological consequences of global warming?

Loss of habitat by flooding reduces biodiversity.

Climate changes will affect the distribution of organisms and may cause the migration patterns of animals to change.

Climate changes may mean some organisms are no longer able to survive and will become extinct. This reduces biodiversity.

a

What is a decomposer?

A decomposer is a microorganism that breaks down dead plant and animal matter by secreting enzymes into the environment. Small food molecules then diffuse into the microorganism.

b

For each of the conditions below, explain why it affects the rate of decay of dead plants and animals.

temperature

Chemical reactions in the microorganisms responsible for decay happen faster in warmer conditions. However, in hot conditions the enzymes in the microorganisms may become denatured which will stop decay.

moisture

Microorganisms grow faster in moist conditions because they won't dry out. It's also easier for them to digest food. This means that decay will happen faster.

oxygen

Most decomposers respire aerobically so they need oxygen available for growth, reproduction and food digestion. Decay will therefore happen more rapidly when there is a lot of oxygen present.

c

What is compost used for?

natural fertiliser

How do gardeners and farmers ensure the rapid production of compost?

They try and provide optimum conditions for the rapid decay of waste biological material.

d

How is one of the products from anaerobic decay useful?

It produces methane which can be used as a fuel. It can be produced using biogas generators to use up waste and produce a renewable energy supply.

e

Write the following keywords next to the correct trophic levels below. There should be at least two key terms for each level.

herbivores, secondary consumers, plants, algae, tertiary consumers, primary consumers, carnivores, producers

Level 1: **plants, algae, producers**

Level 2: **herbivores, primary consumers**

Level 3: **carnivores, secondary consumers**

Level 4: **carnivores, tertiary consumers**

f

What is an apex predator?

A carnivore with no predators.

g

Draw a pyramid of biomass for the data shown.

Organism	Number	Biomass (g)
oak tree	1	5000
aphid	10 000	1000
ladybird	200	50

h

Explain how biomass can be lost between trophic levels.

Not all material that is eaten is absorbed, some is egested as faeces.

Some material is lost as waste such as carbon dioxide and water in respiration, and urea in urine.

Glucose is used in respiration.

i

How much of the energy that plants and algae take in from light is transferred to the next trophic level?

1%

How much biomass from each trophic level is transferred to the level above it?

10%

j

Explain how the loss of biomass at each trophic level affects the number of organisms at each level.

At each trophic level, less of the original biomass is passed on. This means a smaller amount of biomass can be supported at each level, so the numbers of organisms usually decreases at each level.

k

How can farming techniques improve the efficiency of food production?

Limiting the movement of animals and controlling the temperature of their surroundings restricts the amount of energy that is transferred from the animals to the environment.

Some animals are fed high-protein diets to increase growth.

l

Give three biological factors that are threatening food security.

Three from:

- **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 affect farming.**
- **Environmental changes that affect food production, such as widespread famine occurring in some countries during droughts.**
- **The cost of agricultural inputs.**
- **Conflicts that have arisen in some parts of the world that affect the availability of water or food.**

m

How can we use fishing techniques to promote the recovery of fish stocks?

Introduce fishing quotas on the amount and type of fish that can be caught.

Controlling the size of holes in the nets so that only the biggest fish are caught. This means the younger, smaller fish can continue to grow and breed.

n

Explain the role that biotechnology can play in achieving food security.

Genetically modified crops can give bigger yields or improved nutrition. An example is golden rice which has extra vitamin A.

Microorganisms can be cultured on a large scale for food. The fungus Fusarium is useful for producing mycoprotein, which is 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 insulin which is used to treat people with diabetes.