ARCHBISHOP ILSLEY CATHOLIC SCHOOL

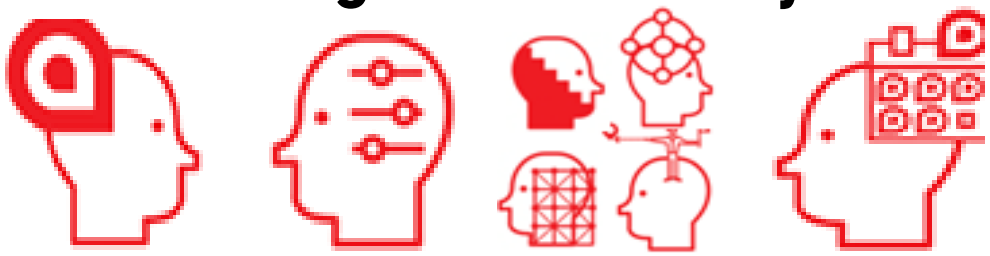
Justus et Tenax Propositi - Just and Firm of Purpose

AQA GCSE Combined/Triple Science

Year 11 Biology B6

Inheritance and Evolution

Knowledge and Mastery Book



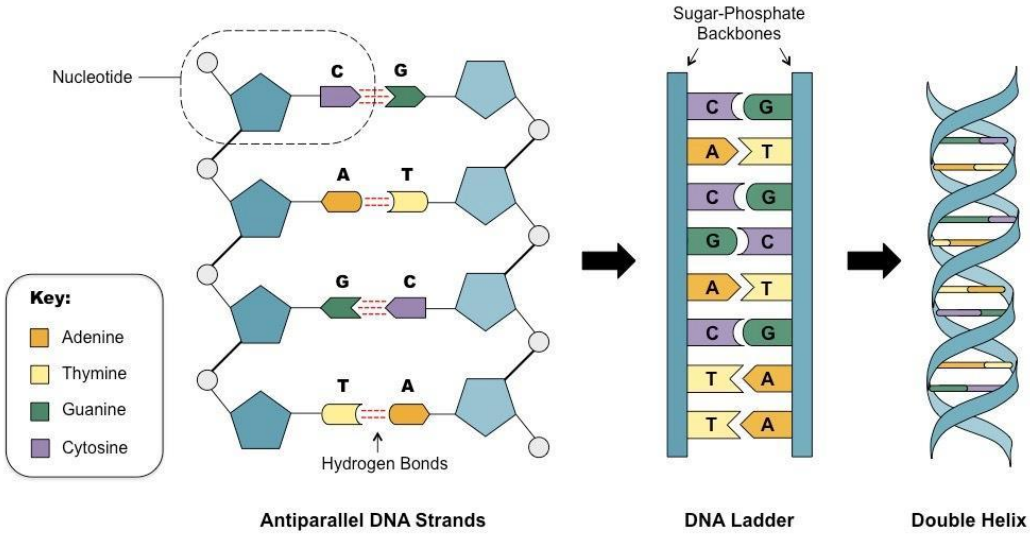
Do not write in this booklet

ALL answers to be written in your exercise book

Contents

Lesson 1: DNA and the Genome

DNA is often described as the molecule of life. It is responsible for the instructions to make proteins and therefore all of life's variation and complexity is coded in its' sequence..
A DNA strand is a polymer. A long chain molecule made of 4 similar repeating units. We call them A, T, C and G, also known as bases. It exists as a double helix, formed of two strands which twist round each other.
A DNA strand is a sequence of these 4 letters tells the ribosomes which order to place certain amino acids when making a protein. Remember proteins are long chains of amino acids and are made by ribosomes. By changing the order of amino acids, different proteins are made that have unique shapes and functions.



An organisms complete set of genetic material is called its genome. It is stored in the nucleus in eukaryotic cells but is free in the cytoplasm in prokaryotic cells.
In eukaryotes the DNA is organised as long, tightly wound strands called chromosomes. On each chromosome are 100's of genes.
A gene is a section of DNA, 50-1000 bases, which codes for a single protein.

We have now developed the technology to sequence an entire genome. This allows us to know the sequences of bases (letters) on each chromosome in an individual's nucleus. The human genome is over 3 billion base pairs long. So far we have used it to improve our understanding of certain diseases, to trace the movement of early humans across the globe from their starting point in Africa over 1 million years ago and there is hope that this technology will lead to even more medical diagnosis and treatments in the future. Although as we learn more about the human genome, we begin to realise how complex it is and how much more we need to learn.

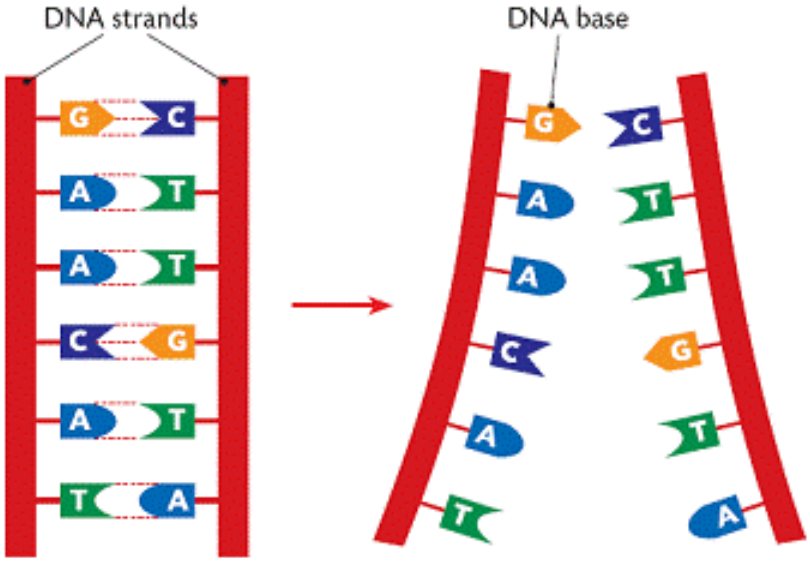
Changes in DNA can lead to **mutations.** These are changes in the DNA sequence of bases that means an individual might have a new characteristic, e.g., blue eyes or ginger hair.

These mutations are one source of **variation-** differences between organisms. If an organism has different DNA, then they nay have different characteristics. At the same time, if an organism lives in a different environment, this may lead to them having different characteristics. All of this means that even between organisms of the same species, there are differences.

Protein Synthesis (TRIPLE ONLY)

The two strands of the DNA molecule bond together in a specific way called complimentary base pairing.

C always bonds to G
T always bonds to A



Protein synthesis starts with a template being made of the desired gene. This template is called mRNA. The template travels out of the nucleus and into the cytoplasm. The template meets ribosomes. The ribosomes allow carrier molecules to bring in the specific amino acid that corresponds to the three bases in the template. As the ribosome moves along the template more amino acids are added, and the protein is formed with the correct sequence of amino acids. When the protein molecule is complete it folds up to form a unique 3D shape. This enables it to perform a specific task. It may be an enzyme, a hormone or form structural proteins like collagen.

Lesson 1 Mastery Questions

1. Name the genetic material enclosed in a nucleus of a eukaryotic cell.
2. Where is genetic material found in prokaryotic cells?
3. Describe the structure of double helix.
4. How is DNA organised in the cell?
5. Define ‘gene’.
6. Define ‘genome’.
7. Define ‘DNA’.
8. How many different bases are there?
9. Name 3 uses for the sequenced human genome?
10. How many base pairs make up the human genome?
11. What is a polymer?
12. What organelle makes proteins from amino acids?
13. Put the following structures in order of increasing size: **Organism, cell, nucleus, organ, tissue, chromosome, gene, organ system**
14. What is a mutation?
15. What is variation?
16. What two things lead to variation?

Triple Only

17. How does mRNA compare to DNA?
18. Where is mRNA read to make a protein?
19. What is the process where DNA is converted into mRNA?
20. What is the process where mRNA is converted into a protein?

Lesson 1 Exam Questions

Q1.

The genetic material in cells is made of DNA.

(a) Which **two** of the following describe the structure of DNA?
Pick **two.**
A double helix A monomer A polymer A protein A single strand

(2)

(b) Complete the sentences.
Choose answers from the box.

clone	**disorder**	**gene**
genome	**mutation**	

A small section of DNA which codes for one protein is called a _____ .
All the genetic material of an organism is called its _____ .

(2)

(c) Gametes (sex cells) contain half the amount of DNA compared to body cells.
Give the names of the **two** types of gametes in humans.

(1)

(d) What is the process called when the gametes join?

(1)

Q2.

Variation in individual organisms can be caused by:

- genes
- the environment
- a combination of both genes and the environment.

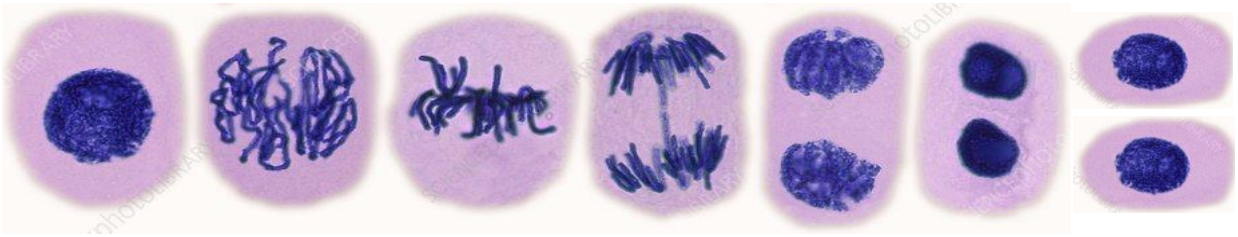
(a) What is the cause of each variation in the table below?
Copy and complete the table below:

Variation	**Cause of variation**		
	Genes only	**Environment only**	**Both genes and the environment**
Brown eyes			
Light brown skin colour			
Short hair			

(3)

Lesson 2: Cell Division and Reproduction

Mitosis

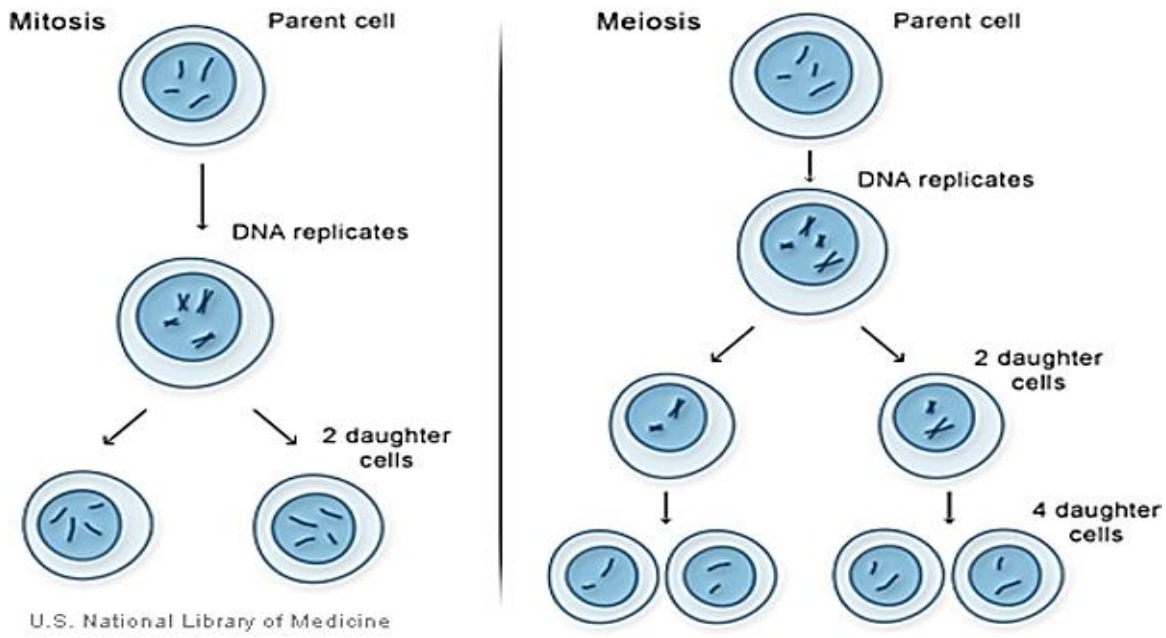


For an organism to reproduce asexually it must divide by mitosis. First the chromosomes and cell organelles are copied, then the chromosomes are pulled to opposite sides of the cell (**mitosis**) and the nucleus divides. Finally, the cytoplasm and cell membrane divides. Two identical 'daughter cells' are produced. Because they have identical genetic information to the parent cell, they are called clones. Mitosis happens in multicellular organisms, such as animals and plants, when they grow and when they repair damaged tissues, but we do not use it to reproduce.

Meiosis

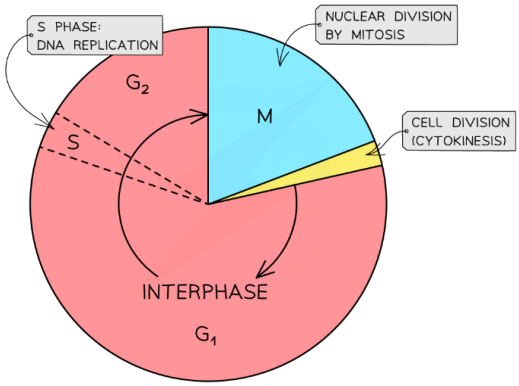
Sperm and egg cells are made by a process called ***meiosis***. Sexual reproduction is defined by the fusion of gametes. This means the offspring will have a unique combination of genes from both parents. This leads to variation (differences) within the population.

Meiosis is a special form of cell division that occurs in the sexual organs. Meiosis follows the same steps as mitosis to start (cell division 1), but once the daughter cells have formed, they undergo a second division. This results in 1 parent cell forming 4 gametes, each with **half** the number of chromosomes as an adult cell.



Cell Division and the Cell Cycle

Cells are the basic unit of life. All living things are either made of cells or require cells to survive. All cells undergo the cell cycle. To make a new cell, the original cell splits to form 2 cells. There are some important things the cell must do before this happens, these are described by the cell cycle. Each cycle ends with one cell dividing to form 2 identical cells.



- **Interphase**
  The cell grows, Mitochondria and ribosomes multiply, DNA replicates
- **Mitosis**
  Chromosomes pulled to opposite sides of the cell. Nucleus divides
- **Cell division (Cytokinesis)**
  Cytoplasm and cell membrane divide

To workout the length of each stage, you use the following equation:

$$Length\ of\ Stage = \frac{Number\ of\ cells\ in\ the\ stage}{Total\ number\ of\ cells\ counted}\ x\ Total\ length\ of\ the\ cycle$$

Reproduction

Reproduction is a vital process of all living things. It is the process of making new copies of themselves. Without this life would not be able to make new generations.
Reproduction comes in two main forms:

1) Asexual: Where **1 parent** provides all the genetic information. The offspring is an exact copy (clone) of the parent.
2) Sexual: Where **2 parents** provide the genetic information. A unique offspring is created

Humans only reproduce sexually. Bacteria only reproduce asexually. Most plants can reproduce both sexually and asexually.

Gametes is the name given to sex cells. These are specialised cells which contain half the number of chromosomes needed to make a healthy offspring. Sperm and Egg cells are human gametes. Pollen and Ovum are the names of the gametes in flowering plants. Gametes are produced by a process called meiosis.
Fertilisation occurs when two gametes fuse (join). At this stage the first cell of a new organisms has been formed, with unique characteristics and the correct number of chromosomes (a Diploid nucleus, 46 chromosomes). This one cell then divides (by mitosis) before differentiating into all the specialised cells that make up an organism.

Lesson 2 Mastery Questions

1. How many divisions are in mitosis?
2. How many divisions are in meiosis?
3. How many cells are produced in mitosis?
4. How many cells are produced in meiosis?
5. How many chromosomes are in each daughter cell in mitosis?
6. How many chromosomes are in each daughter cell in meiosis?
7. What is the function of mitosis?
8. What is the function of meiosis?
9. Compare mitosis and meiosis in a table
10. Why is cell division important?
11. A clone was made from one of your body cells. Suggest what that individual would be like. What would be the same as you and what might be different?
12. If there are 54 cells in cell growth, 90 cells total, and the total cycle length is 2.5 hours, how long does cell growth take? Use VESNU
13. If a cell takes 3 hours to completely form a new cell, 18 cells are splitting, 19 cells are in mitosis, and 140 cells are growing, how long does the growth stage take? Use VESNU
14. What are the three stages of the cell cycle?
15. State what happens during interphase, mitosis and cell division
16. What is asexual reproduction?
17. What is sexual reproduction?
18. Does asexual or sexual reproduction make identical organisms?
19. Does asexual or sexual reproduction need two organisms?

Lesson 2 Exam Questions

Q1.

(a) The body cells of a kangaroo have 16 chromosomes.
How many chromosomes will an egg cell of a kangaroo have?
Choose **one** number.

4 8 16 32

(1)

(b) Which sex chromosomes will be in the body cells of a male kangaroo?
Choose **one**.

XX XZ XY YZ

(1)

(c) Scientists have now studied the whole human genome.
Give **two** benefits of understanding the human genome.

(2)

Q2.

(a) Meiosis and mitosis are different types of division in human cells. Compare the two processes by referring to where each takes place and the kind of products that are made.

Lesson 3 Genetic Diagrams

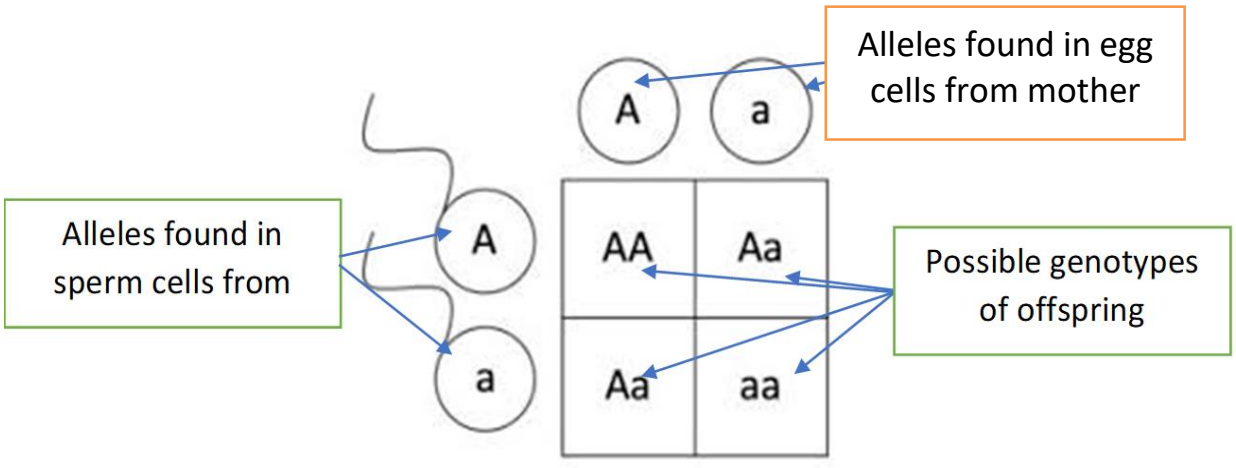
Individuals within a species all display variation, differences in characteristics. This is due to sexual reproduction. In sexual reproduction genes in gametes fuse to form unique offspring. They are unique because they have inherited half their chromosomes from their father and half from their mother. Each time a different combination of the chromosomes combines; this is why you will resemble your brother/sister but are not identical to them.
Different forms of the same gene are known as alleles.
There are 2 copies of every chromosome in a body cell nucleus (1 copy inherited from the mother the other copy inherited from the father). Therefore, there are 2 copies of every gene. These copies may be different alleles and the combination of the 2 alleles, known as the genotype, determines the characteristic, known as the phenotype.
If the 2 alleles for a gene are the same, we call this combination homozygous, whereas if the 2 alleles are different, we call this combination heterozygous. Homos is a Greek word meaning 'the same' whereas heteros means 'other'.

For most genes, one allele is dominant and the other recessive. If only one dominant allele is present, its phenotype is expressed. This means individuals that have 2 dominant alleles, homozygous dominant, OR one dominant and one recessive allele, heterozygous, will express the dominant phenotype. Both alleles need to be recessive (homozygous recessive) for the recessive phenotype to be expressed. Due to this relationship, we often refer to the alleles using the same letter, the dominant in UPPER case and the recessive in lower case e.g. "B" is dominant, "b" is recessive.

Punnett squares.

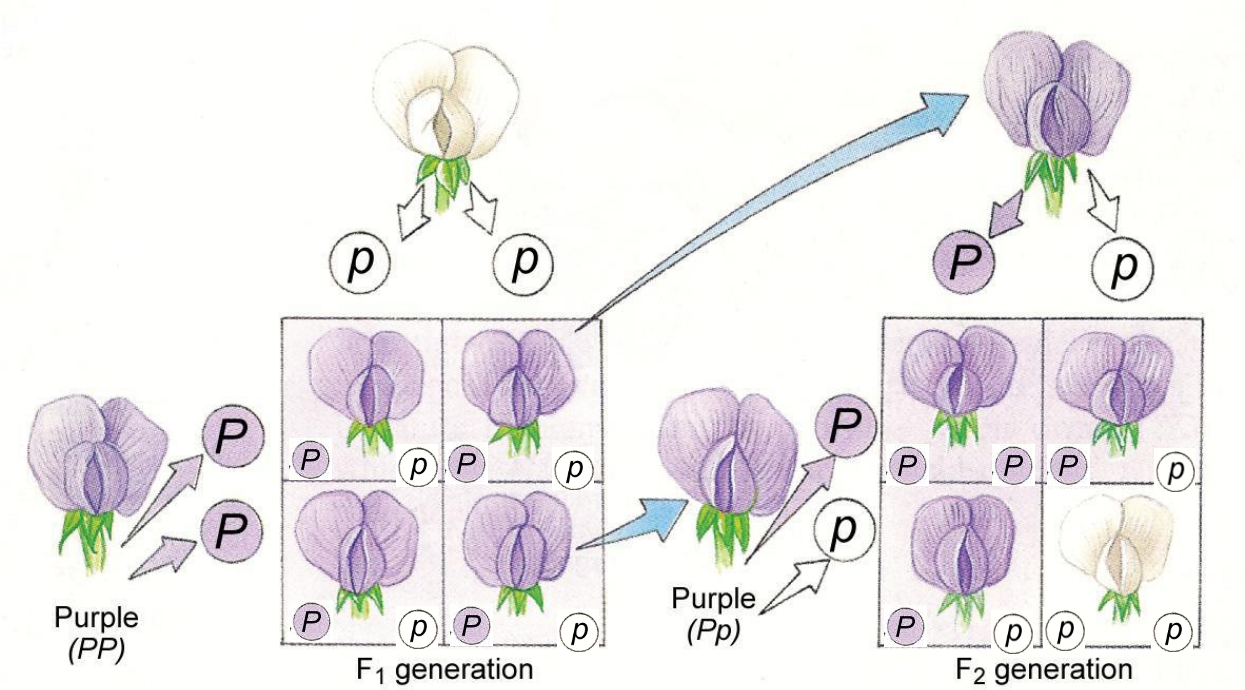
When examining the inheritance of alleles through multiple generations we use genetic cross diagrams or Punnett squares.

The diagram shows the Punnett square for the inheritance of recessive condition called Albinism.



For example:
Consider a flowering plant that can have purple or white petals. Purple is the dominant allele, so our code is P= purple and p=white

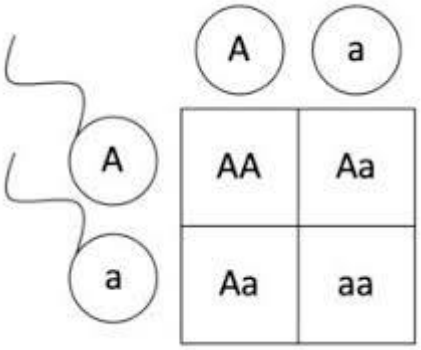
PP is the homozygous dominant, its phenotype is purple, **Pp** is heterozygous, its phenotype is also purple as purple is dominant to white, **pp** is homozygous recessive; its phenotype is white.



Lesson 3 Mastery Questions

1. Define allele.
2. Define genotype.
3. Define phenotype.
4. Define dominant.
5. Define recessive.
6. Define homozygous.
7. Define heterozygous
8. Define sexual reproduction
9. Define gamete
10. What happens during fertilisation?
11. Define chromosomes
12. The gene for flower colour in pea plants has 2 alleles, purple and white. The purple allele represented by "R" and the white allele by "r".
    a) What is the homozygous dominant genotype and phenotype?
    b) What is the homozygous dominant genotype and phenotype?
    c) What is the homozygous recessive genotype and phenotype?
13. Draw punnet squares from the following crosses
    a) RR and rr
    b) Yy and Yy
    c) Gene P - Homozygous dominant and homozygous recessive
    d) Gene P - Heterozygous and homozygous dominant

14. Copy the Punnett square.
    a) Add the following labels: alleles from father, alleles from mother, offspring genotypes
    b) What proportion of the possible genotypes is homozygous dominant?
    c) What proportion of the possible genotypes is heterozygous?
    d) What proportion of the possible genotypes is homozygous recessive?
    e) What proportion of the possible offspring will be healthy?
    f) What proportion of the possible offspring will have Albinism?



15. The gene for flower colour in pea plants has 2 alleles, purple and white. The purple allele is represented by "R" and the white allele by "r".
16. Two pea plants both with the genotype Rr breed.
    a) Draw a Punnett square to show the 4 possible offspring genotypes from this breeding.
    b) For each offspring, label the phenotype.
    c) For each offspring, describe the genotype using the words homozygous, heterozygous, dominant and recessive.
    d) Calculate the probability of each phenotype.
17. Rr x rr
    a) Draw a Punnett square to show the 4 possible offspring genotypes from this breeding.
    b) For each offspring, label the phenotype.
    c) For each offspring, describe the genotype using the words homozygous, heterozygous, dominant and recessive.
    d) Calculate the probability of each phenotype.
18. RR x rr
    a) Draw a Punnett square to show the 4 possible offspring genotypes from this breeding.
    b) For each offspring, label the phenotype.
    c) For each offspring, describe the genotype using the words homozygous, heterozygous, dominant, and recessive.
    d) Calculate the probability of each phenotype.
19. Rr x RR
    a) Draw a Punnett square to show the 4 possible offspring genotypes from this breeding.
    b) For each offspring, label the phenotype.
    c) For each offspring, describe the genotype using the words homozygous, heterozygous, dominant and recessive.
    d) Calculate the probability of each phenotype.

Lesson 3 Exam Questions

Q1.

The shape of a person's earlobes is controlled by a gene.
Figure 1 shows two types of earlobe.

A dominant allele codes for free earlobes.

(a) What is a dominant allele? Choose **one** box.

Free earlobe

Attached earlobe

An allele expressed even if a person only has one copy of the allele

An allele expressed only if a person has two copies of the allele

An allele expressed only if a person has no recessive allele

An allele expressed only if it is inherited from the male parent

(1)

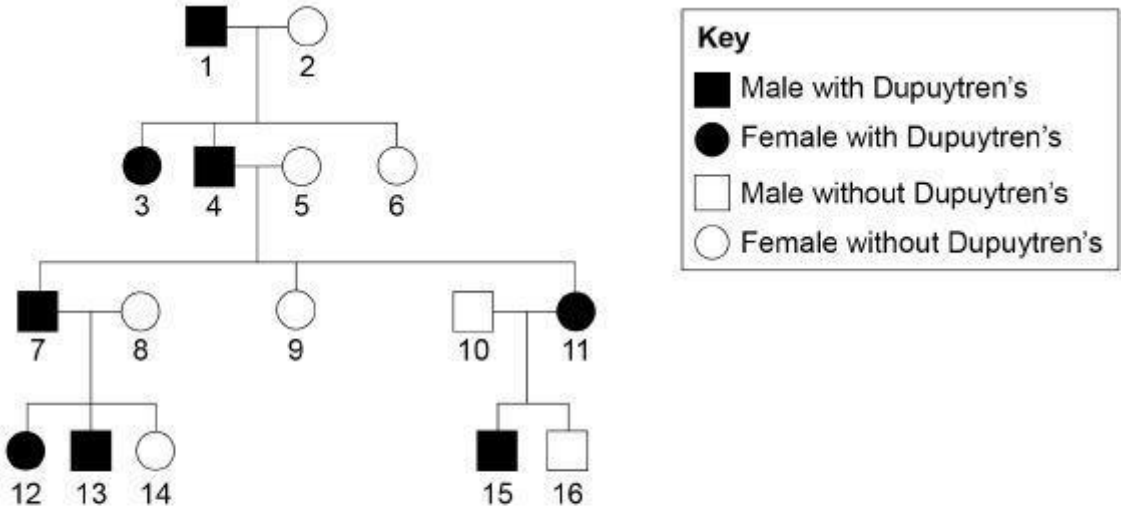
(b) A man with free earlobes and a woman with attached earlobes have children together.
Draw and complete **Figure 2** to show the possible genotypes of the children. **(2)**
Use the symbols:
E = allele for free earlobes
e = allele for attached earlobes

(c) What is the probability that one of the children would have attached earlobes? **(1)**
Use **Figure 2**.

		Woman	
		e	e
Man	E	Ee	
	e		

Q2.

Dupuytren's is a disorder that affects the hands.
The diagram below shows the inheritance of Dupuytren's in one family.



Dupuytren's is caused by a dominant allele in this family.

D = dominant allele

d = recessive allele

(c) Give the genotype of person **1**.
Explain your answer.

(2)

(d) Person **7** and person **8** in the diagram above are expecting a fourth child.
What is the probability of the child having Dupuytren's? **(5)**
You should:

- draw a Punnett square diagram
- identify which offspring have Dupuytren's

(e) Explain how the diagram above shows the allele for Dupuytren's is **not** on the Y chromosome.

(2)

Lesson 4 Inherited Disorders

Sometimes a mutation happens in the chromosomes of a gamete. In this case the faulty gene will be present in every cell of the body. In some very rare cases this can cause an inherited disorder. The disorder is inherited because there is a chance it can be passed down to the next generation. Some inherited disorders are dominant and other are recessive, we will look at an example of both.

Polydactyly

Polydactyly is an inherited disorder that results in the child growing extra fingers or toes. It does not have any significant long term health problems. It is caused by a dominant allele, so only one parent needs to have it. So a homozygous dominant parent is guaranteed to have a polydactyly child and a heterozygous parents will have a chance of having one.

Picture 1
Normal Hand

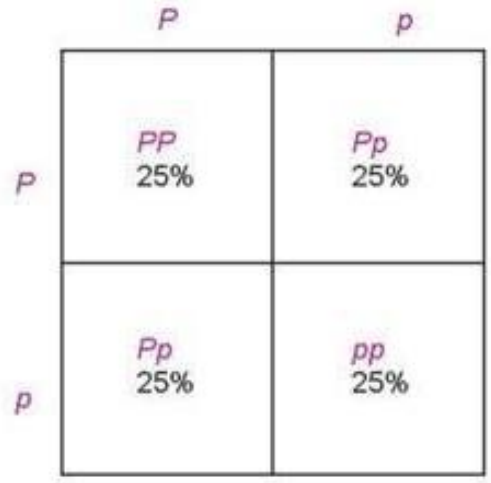
Picture 2
Hand with Polydactyly

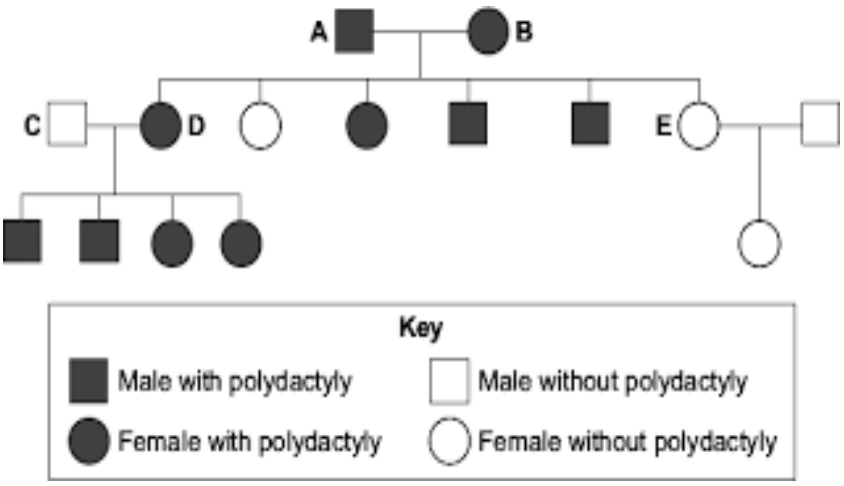
Genotypes – combination of alleles

- 25% chance of the homozygous dominant PP
- 50% chance of the heterozygous Pp
- 25% chance of the homozygous recessive

Phenotypes - characteristic

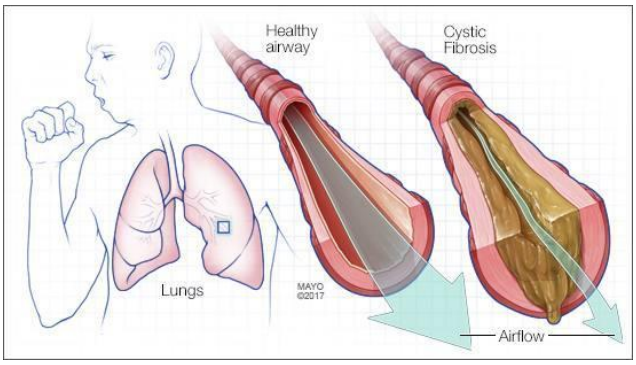
- 75% chance of having polydactyly (as it is dominant)
- 25% chance of being unaffected





Another way of determining the dominant nature of polydactyly is through a family tree diagram. The clue to its dominant nature is the breeding between D and C. As their children all suffer from the disease there is a very strong chance the condition is dominant.

Cystic Fibrosis



Cystic fibrosis is an inherited disorder which affects the mucus that lines the respiratory and digestive tract.

Cystic fibrosis sufferers have much thicker mucus than normal which makes breathing harder and increases their chance of chest infections. It can also reduce the amount of nutrients gained from food due to issues with the digestive system.

Currently the disorder is managed using a combination of physical therapy (to remove the mucus) and drugs (to improve the digestion). A more long-term solution is for a heart and lung transplant.

Cystic fibrosis is caused by a recessive allele. This means that only homozygous recessive people are suffering from the disorder and heterozygous people are not, **but** they can pass it on to children (carriers). In the UK it is estimated that 1 in 25 people is a heterozygous carrier. Currently there are approximately 10,500 people with cystic fibrosis in the UK. This is about 1 in every 2500 babies born.

In this example there is a cross between two heterozygous carriers. C= healthy, c= cystic fibrosis. We see the following probabilities

Genotypes

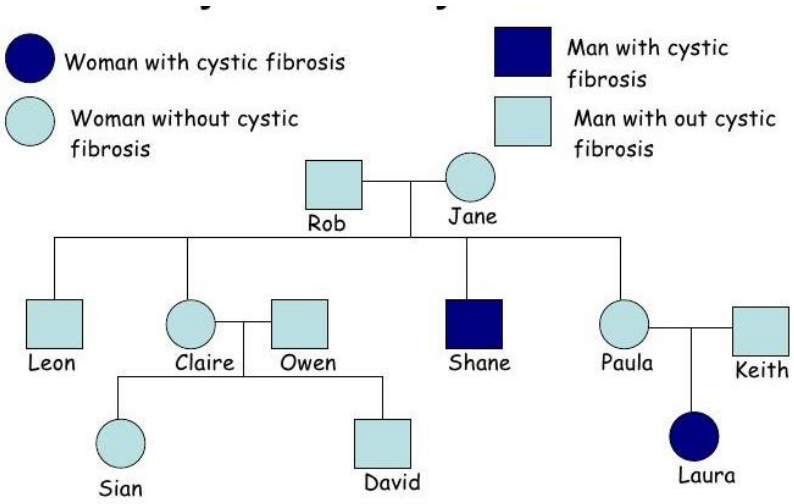
- 25% chance of the homozygous dominant CC
- 50% chance of the heterozygous Cc
- 25% chance of the homozygous recessive cc

	C	c
C	CC	Cc
c	Cc	cc

Phenotypes

- 25% of being unaffected CC
- 50% of having no symptoms but being a carrier Cc
- 25% chance of suffering from cystic fibrosis cc

If we look at the family tree a key clue to it being a recessive condition can be seen. Recessive inherited conditions have the ability to **skip generations**. Consider Rob and Jane. Both did not suffer from CF, but had a child (Shane) who did. This pattern is also repeated with Paula and Keith. In both cases it must be that they were both heterozygous carriers, a key defining factor of a recessive inherited condition.



Genetic tests

Genetic testing involves analysis of a person's DNA to see if they carry alleles that cause genetic disorders. It can be done at any stage in a person's life.

Antenatal testing is before they are born. This testing is offered to couples who may have an increased risk of producing a baby with an inherited disorder.

Neonatal testing known as the new born blood spot test involves analysing a sample of blood that is taken from pricking a new born baby's heel. It detects genetic disorders in order to treat them early.

Pre-implantation genetic diagnosis (PGD) is a part of IVF treatment. Embryos are tested before implantation. Once the embryos have reached the eight-cell stage, one cell is removed. The cells are tested for the disorder causing alleles. Embryos that don't contain the disorder allele are implanted into the uterus.

Limits of genetic testing

Genetic tests are not available for every possible inherited disorder and are not completely reliable. They may produce false positive or false negative results, which can have serious consequences for the parents involved.

On top of the technical problems, people can be against these tests for moral and spiritual reasons. Most of these stems from a strong belief that it is wrong to tamper with the natural process of reproduction. With embryo screening techniques some of the embryos are destroyed. Some people believe that this is the same as murder and so are against this process.

Lesson 4 Mastery Questions

1. Draw a Punnett square to show the outcomes of the following crosses:
    a. Pp x Pp
    b. Using Pp, a heterozygous father and a homozygous recessive mother
2. Suggest why polydactyly is not considered a serious inherited disorder
3. Draw a Punnett square to show the outcomes of the following crosses:
    c. CC x cc
    d. A heterozygous father and a homozygous recessive mother
4. If 1 in 25 people are carriers suggest why so few babies are born with cystic fibrosis?
5. If the population of the UK is 6.6 x 106 people how many people are carriers? Give your answer in standard form.
6. What is the meaning of 'inherited disorder'?
7. Mariana says "Measles is an inherited condition because my dad had it when he was young and now I've had it!" Explain why she is wrong.
8. What medical treatment could Mariana's parents have given her when she was young to prevent her catching measles?
9. Explain the difference between a dominant and recessive inherited disorder.
10. What are the symptoms of polydactyly?
11. What are the symptoms of cystic fibrosis?
12. What can you not be a carrier of polydactyly?
13. What three ways are inherited disorders tested for?
14. Why is every baby born given the heel prick test (neonatal), but only high risk pregnancies given antenatal testing?
15. Why would a person who is against abortion refuse PGD?
16. What is the difference between a false positive and a false negative? Which do you think is worse?
17. Huntington's disease is a dominant inherited condition. It causes problems in a persons' ability to use their muscles, including breathing and swallowing. There is no cure. Symptoms begin to show during a person's 30's and 40's.
18. Can you be a carrier for Huntington's?
19. Will the Huntington's allele be H or h?
20. Draw a Punnett square for a heterozygous and homozygous recessive breeding. Give the proportions of each genotype and phenotype.

Lesson 4 Exam Questions

Q1.

Humans reproduce sexually.

(a) Copy and select the correct answer to complete each sentence. **(2)**

(i) At fertilisation

chromosomes
genes
gametes

join together.

(ii) At fertilisation a single cell forms. The cell has new pairs of

chromosomes.
nuclei.
gametes.

(b) A child inherits cystic fibrosis. The child's parents do **not** have cystic fibrosis.

(i) What does this information tell us about the cystic fibrosis allele? **(1)**
Choose **one**.

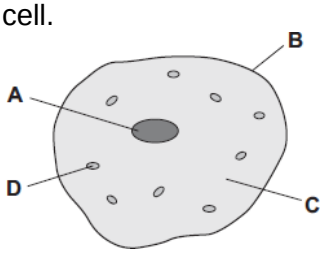
The allele is dominant.

The allele is recessive.

The allele is strong.

(ii) How many copies of the cystic fibrosis allele does the child have? **(1)**

(c) The diagram shows a human body cell.



Which part of the cell, **A**, **B**, **C** or **D**:

(i) contains the allele for cystic fibrosis? **(1)**

Q2.

Cystic fibrosis and Huntington's disease are inherited disorders.

(a) Someone can be a carrier of cystic fibrosis. Explain how.
You may include a genetic diagram in your answer.

(2)

(b) Why does only one parent need to have the Huntington's disease allele for a child to inherit Huntington's disease?

(1)

Q3.

(a) Mr and Mrs Smith both have a history of cystic fibrosis in their families.
Neither of them has cystic fibrosis.
Mr and Mrs Smith are concerned that they may have a child with cystic fibrosis.
Use a genetic diagram to show how they could have a child with cystic fibrosis.
Use the symbol **A** for the dominant allele and the symbol **a** for the recessive allele.

(3)

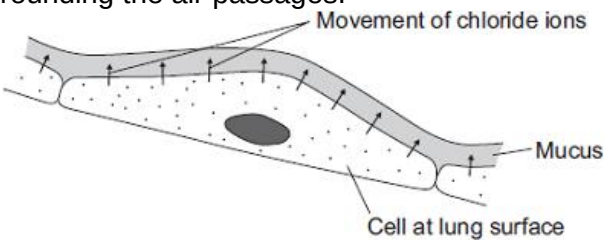
(b) Mr and Mrs Smith decided to visit a genetic counsellor who discussed embryo screening.
Read the information which they received from the genetic counsellor.

- Five eggs will be removed from Mrs Smith's ovary while she is under an anaesthetic.
- The eggs will be fertilised in a dish using Mr Smith's sperm cells.
- The embryos will be grown in the dish until each embryo has about thirty cells.
- One cell will be removed from each embryo and tested for cystic fibrosis.
- A suitable embryo will be placed into Mrs Smith's uterus and she may become pregnant.
- Any unsuitable embryos will be destroyed.

(i) Suggest why it is helpful to take five eggs from the ovary and not just one egg. **(1)**

(ii) Evaluate the use of embryo screening in this case. **(4)**
Remember to give a conclusion to your evaluation.

(c) In someone who has cystic fibrosis the person's mucus becomes thick.
The diagram shows how, in a healthy person, cells at the lung surface move chloride ions into the mucus surrounding the air passages.



The movement of chloride ions causes water to pass out of the cells into the mucus.
Explain why.

(3)

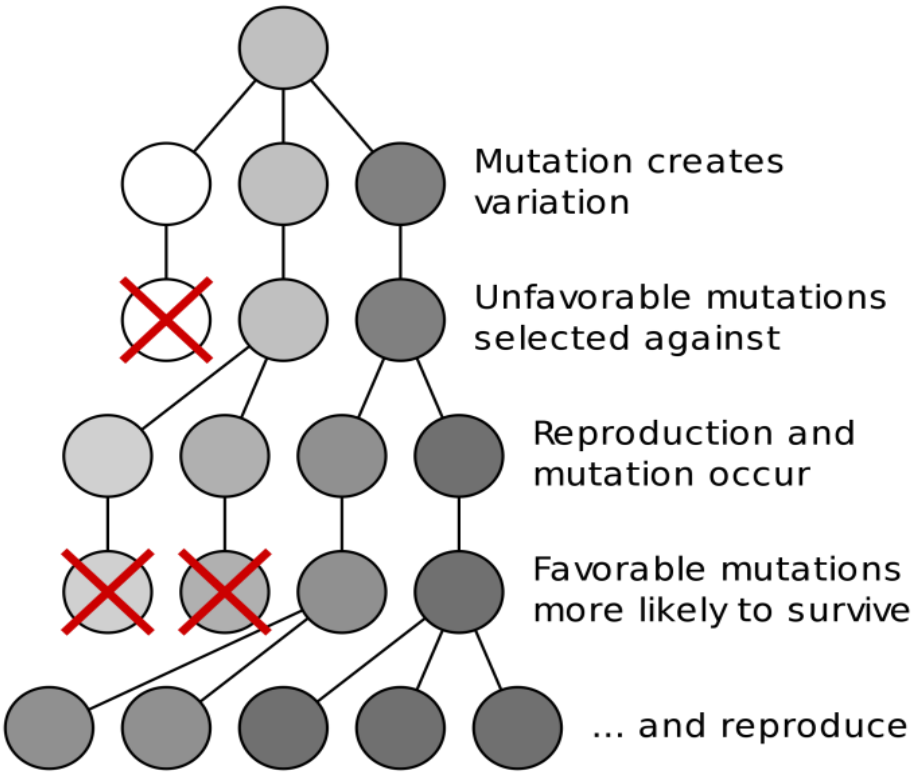
Lesson 5 Evolution by Natural Selection

The organisms that exist nowadays are very different from those billions of years ago. Over time it appears that organisms have become more complex. This is due to evolution by natural selection.

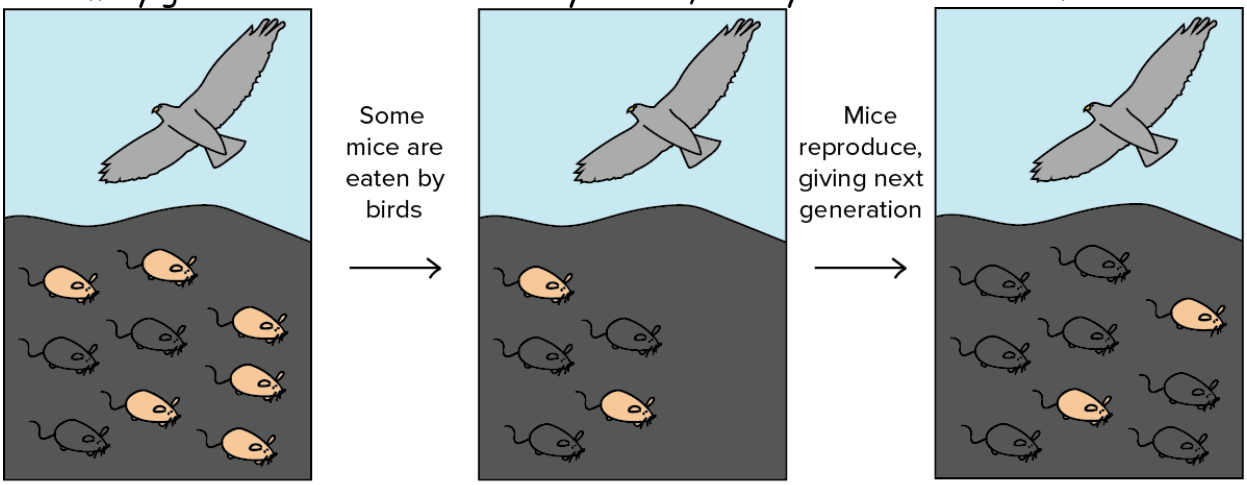
Natural selection is the process where nature selects what characteristics (controlled by genes) are best for organisms to survival in that specific environment and hence allows it to reproduce. In simple terms, this is the survival of the fittest, where "fittest" refers to those best adapted to their environment, but not necessarily the strongest. **Evolution** occurs after natural selection occurs over many generations. This is the process:

- Individual organisms in a species have a range of pre-existing genetic variation due to random mutation.

- Certain individuals have favourable mutations. These alleles that give them a survival advantage are called adaptations.
- They're more likely to survive and reproduce, passing on the favourable alleles.
- Overtime, these variations accumulate,
- They may eventually evolve into a new species (speciation), where they can no longer interbreed to form fertile offspring.



Be careful: Avoid saying "organisms adapt to their environment" in your answer. Organisms cannot (choose to) adapt to a certain environment within their lifetime. Evolution must happen over many generations! And it is not by choice, but by natural selection.



A population of mice has moved into a new area where the rocks are very dark. Due to natural genetic variation, some mice are black, while others are tan.

Tan mice are more visible to predatory birds than black mice. Thus, tan mice are eaten at higher frequency than black mice. Only the surviving mice reach reproductive age and leave offspring.

Because black mice had a higher chance of leaving offspring than tan mice, the next generation contains a higher fraction of black mice than the previous generation.

Students find it hard to write answers to evolution question as there is a lot to remember. To help you, always remember the mnemonic…

My Very Angry Sister Really Annoys Grandad

- **Variation** which might result in …
- **Advantageous characteristic** which could help an organism…
- **Survive** and…
- **Reproduce** which means advantageous…
- **Alleles** are passed on to the next …
- **Generation**

Lesson 5 Mastery Questions

1. What causes genetic variation?
2. Explain how the cause above can lead to variation in phenotype.
3. State the theory of evolution by natural selection.
4. What is a 'species'?
5. Define 'natural selection'.
6. What is evolution?
7. Why can genetic mutation be beneficial to organisms in a changing environment?
8. Which would be the most successful organism within a species and why?
9. The strongest?
10. The one which reproduces the fastest?
11. The one which is best adapted to the environment?
12. List 3 things organisms compete for.
13. A lion is living in the dense jungle, the climate change and the jungle starts to become a desert. What adaptations could help the lion survive in order to pass on its genes?
14. A disease wipes out 75% of all male wildebeest. What kind of adaptations could ensure the surviving male wildebeest will be able to mate and pass on their genes?
15. Cacti live in the desert and are able to store water in their thick waxy leaves. Describe the process of evolution that lead to this species.
16. Suggest how giraffes having long necks may be a result from evolution by natural selection.

My Very Angry Sister Really Annoys Grandad

M...
V...
A...
S...
R...
A...
G...

Lesson 5 Exam Questions

Q1.

The figure to the right shows flamingos. Flamingos are birds. They have long legs.
They can walk in deep water and use their long necks to reach food in the mud.

How would Darwin have explained the evolution of the flamingo's long neck?
Use the correct answer from the box to **copy and** complete each sentence.

mutation	**natural selection**	**sexual reproduction**	**variation**

In a population of flamingos there are birds with different lengths of neck.
This range of differences in neck length is called _____ .
The flamingos with longer necks are better adapted to feed in deeper waters.
They are more likely to survive than flamingos with shorter necks.
This is an example of _____ .
The surviving flamingos pass on their genes for a longer neck to their offspring during _____ .

(Total 3 marks)

Q2.

A particular species of snail has a shell which may be pink, yellow or brown. It may also be plain or have bands running round it.
The snails are eaten by song thrushes.
Explain why snails with plain brown shells are the most common in hedgerows.

(Total 4 marks)

Q3.

Moose are animals that eat grass.
Figure 1 shows a moose.

Figure 1

Moose have distinct characteristics such as antlers.
Describe how moose may have evolved to have large antlers.

(5)

Lesson 6 Developing the Theory of Natural Selection (Triple Only)

Charles Darwin, because of observations on a round-the-world expedition, backed by years of experimentation and discussion and linked to developing knowledge of geology and fossils, proposed the theory of evolution by natural selection.

• Individual organisms within a particular species show a wide range of variation for a characteristic.
• Individuals with characteristics most suited to the environment are more likely to survive and breed successfully.
• The characteristics that have enabled these individuals to survive are then passed on to the next generation.
Darwin published his ideas in On the Origin of Species (1859). There was much controversy surrounding these revolutionary new ideas. The theory of evolution by natural selection was only gradually accepted because:

• The theory challenged the idea that God made all the animals and plants that live on Earth
• There was insufficient evidence at the time the theory was published to convince many scientists
• The mechanism of inheritance and variation was not known until 50 years after the theory was published.
Other theories, including that of Jean-Baptiste Lamarck, are based mainly on the idea that changes that occur in an organism during its lifetime can be inherited. We now know that in the vast majority of cases this type of inheritance cannot occur.

Mendel

In the mid-19th century Gregor Mendel carried out breeding experiments on different variations in peas (smooth vs. wrinkled; green vs. yellow).
One of his observations was that the inheritance of each characteristic is determined by 'units' that are passed on to descendants unchanged. We later came to know of these units as genes.
People did not recognise how important Mendel's discovery was, as they did not understand his theory as they had no evidence for genes or chromosomes.
Another of his observations was that you could predict the expected ratio of the **phenotypes** based on what was present in the initial population. This was not always perfect, as the expected ratios may differ due to chance e.g., biological sex is 50-50- there are only two options. However, in the world there are slightly more girls than boys.

Seed form	Seed color	Pod form	Pod color	Flower color	Flower position	Stem length
Round	Yellow	Inflated	Green	Purple	Axial	Tall
Wrinkled	Green	Constricted	Yellow	White	Terminal	Short

In the late 19th century, the behaviour of chromosomes during cell division was observed for the first time.

In the early 20th century, Walter Fleming reflected that chromosomes and Mendel's 'units' behaved in similar ways. This led to the idea that the 'units', now called genes, were located on chromosomes.

In the mid-20th century, the structure of DNA was determined, and the mechanism of gene function worked out. The double helix structure was found by Watson and Crick, using X-ray results from Franklin and Wilkins but without Franklin's permission. This scientific work by many scientists led to the gene theory being developed.

Lesson 6 Mastery Questions (TRIPLE ONLY)

1. What did Darwin find that led him to propose the theory of evolution?
2. Where did Darwin go?
3. What was the name of Darwin's book?
4. Why was his theory controversial?
5. What is the name of another person who suggested the theory of evolution?
6. What was his theory?
7. Was his theory proven correct?
8. Why were Mendel's ideas of inheritance not accepted during his time?
9. What were some of the ideas Mendel came up with?
10. What did Mendel do his experiments on?
11. Who published the double helix structure of DNA?
12. Watson and Crick used whose work to find out the structure of DNA?
13. What is the name for the structure of DNA?
14. Name the 4 bases in DNA
15. (HT) What is complimentary base pairing
16. How many bases code for an amino acid
17. What is the name for a long polymer of amino acids
18. How many chromosomes are in a human gamete?
19. Name the person who proposed the theory of evolution.
20. Name the person who suggested changes that occur in an organism during its lifetime can be inherited.
21. On what mechanism is Darwin's theory of evolution based on?
22. What is Darwin's theory of evolution by natural selection?
23. State three reasons why Darwin's ideas were only slowly accepted.

Lesson 6 Exam Questions (TRIPLE ONLY)

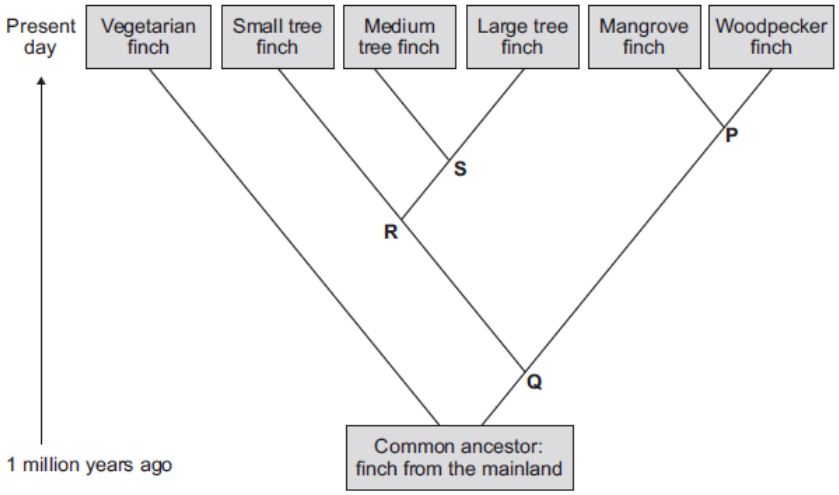
Q1.

Darwin's theory of evolution states that all species of living things have evolved from simple life forms.
Darwin's theory was published in 1859.

(a) Give **two** reasons why Darwin's theory was only slowly accepted. **(2)**

(b) **Darwin observed birds called finches on the Galapagos Islands, 1000 km from the coast of South America. He saw that the birds were similar to, but not the same as, birds he had seen on the mainland of South America. Recent evidence suggests that 13 different species of finch on the islands evolved from 1 species of finch that arrived from the mainland about 1 million years ago.**
Describe how a new finch species may have evolved from the original species of finch that arrived from the mainland. **(4)**

(c) The diagram to the right shows the evolutionary tree for some Galapagos finches.



(i) Which type of present-day finch is **least** closely related to all the others? **(1)**

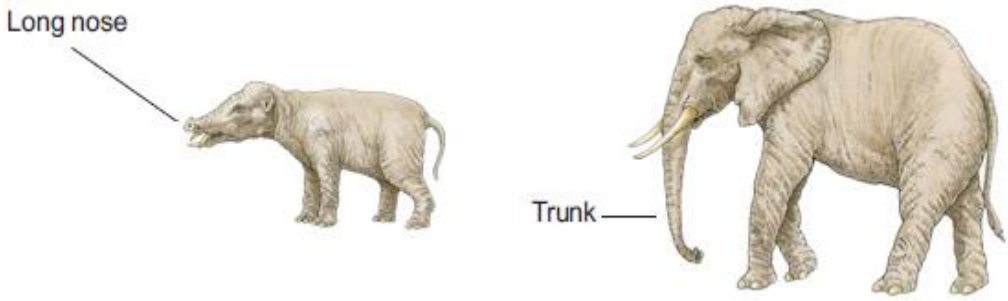
(ii) Which branching point, **P, Q, R** or **S**, on the diagram above shows the most recent common ancestor of all the **tree finches**? **(1)**

(iii) Which **two** finches have the most recent common ancestor? **(1)**

Q2.

The image below shows:
- *Phiomia*, an ancestor of elephants
- a modern African elephant.

Phiomia lived about 35 million years ago.



Phiomia **African elephant**

Both *Phiomia* and the African elephant reach up into trees to get leaves.
In the 1800s, Darwin and Lamarck had different theories about how the long nose of *Phiomia* evolved into the trunk of the African elephant.

(a) (i) Use Darwin's theory of natural selection to explain how the elephant's trunk evolved. **(4)**

(ii) Lamarck's theory is different from Darwin's theory.
Use Lamarck's theory to explain how the elephant's trunk evolved. **(2)**

(b) (i) In the 1800s, many scientists could **not** decide whether Lamarck's theory or Darwin's theory was the right one.
Give **two** reasons why. **(2)**

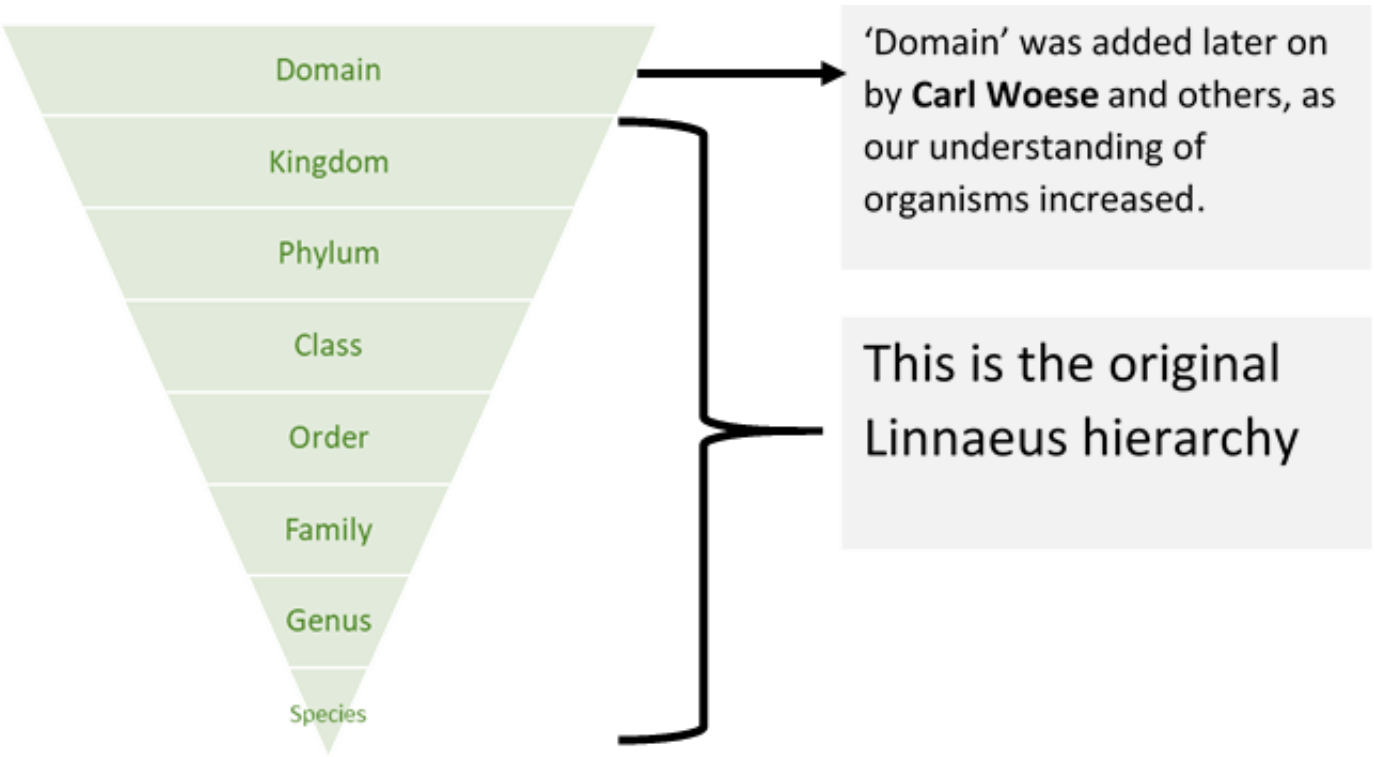
(ii) Before the 1800s, many people had a different idea to explain where all the living things on Earth came from. What was this idea?

Lesson 7 Classification

Classification is the organisation of living organisms into groups according to similarities. Organisms are classified based on their structure and characteristics into a specific hierarchy. Originally there were five kingdoms, but with more understanding there are distinct enough differences within the prokaryote kingdom that it was split into two kingdoms: archaebacterial and eubacteria. You need to know the three domains, six kingdoms and what a species is.

The "updated" Linnaeus hierarchy

Classification	Human
Domain	Eukaryota
Kingdom	Animals
Phylum	Chordates
Class	Mammals
Order	Primates
Family	Hominids
Genus	Homo
Species	Sapiens



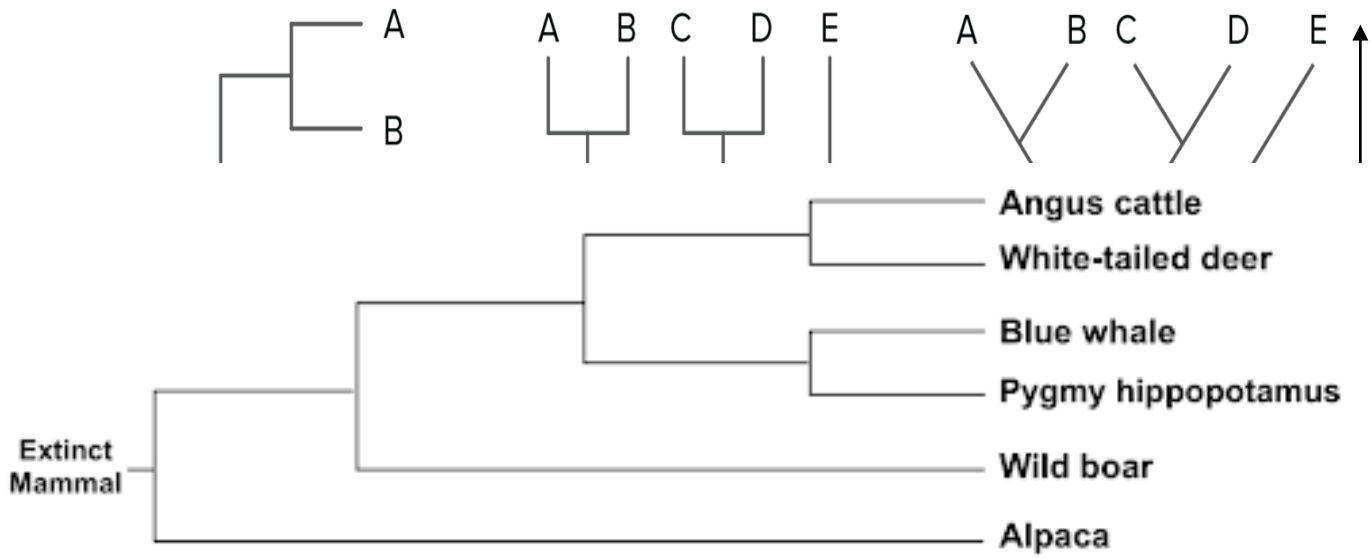
Species refers to a group of organisms that can interbreed to produce fertile offspring. When talking about classification, we refer to humans as Homo sapiens. This type of naming is called binary naming. It is "binary", as the name is made up of two words – the genus and species names. It is in Latin, as it is considered as the universal scientific language, so this helps scientists of different countries who speak different languages to understand each other better.

Rules of binary naming

1. When typed, it needs to be in italics; when handwritten, it needs to be underlined
2. The first letter of 'genus' must be in capital
3. The first letter of 'species' must be in small letter

Evolutionary Trees

We can use models like evolutionary trees to show relationships between organisms. Although the above three trees look slightly different, they suggest the same relationships between organisms A-E. From the trees, we can tell that A is closely related to B, C is closely related to D, whereas E is not. However, they all originated from the same common ancestor.



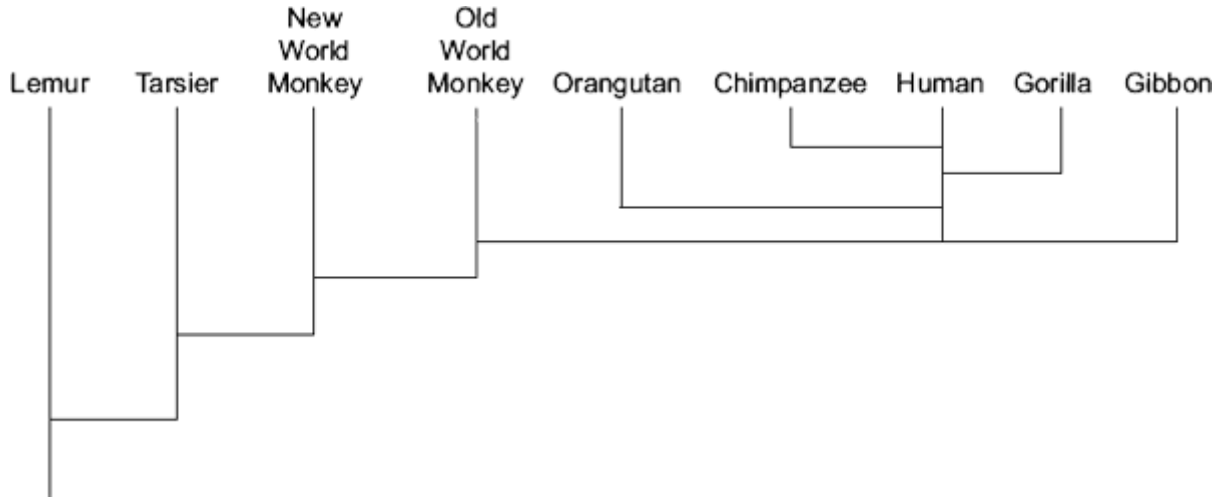
Lesson 7 Mastery Questions

1. What does classification of organisms mean?
2. Name the person who first developed the classification system.
3. State the 7 hierarchical levels of the Linnaean classification system.
4. Every organism has a scientific name using a binomial system. What does binomial mean?
5. Which language does the binomial naming system use?
6. The binomial name of an organism is made up of two words. What does each word represent of that organism?
7. What are the three rules of writing a binomial scientific name of a species?
8. Why do we use the binomial naming system?
9. How many domains and kingdoms do scientists now consider in classification?
10. Based on what knowledge were the three domains set?
11. Who developed the three-domain system?
12. What are the three domains?
13. What are the six kingdoms?
14. How is classification helpful?
15. Name the type of models that are used to show how different organisms are related.
16. How are evolutionary trees made?
17. What aspects of knowledge would be considered when suggesting evolutionary relationships?
18. The binomial name for an artic fox is *Vulpes lagopus*. What is the genus?
19. The red fox is called *Vulpes vulpes*. The gray fox is called *Urocyon cinereoargenteus*. Is the red or gray fox most closely related to the artic fox and why?
20. The great white sharks binomial name is *Carcharodon carcharias*. Identify the genus and species?
21. The white oak tree's binomial name is *Quercus alba*. Identify its genus and species?
22. Look at the evolutionary tree on the previous page.
    1. Who is the blue whale most closely related to?

Lesson 7 Exam Questions

Q1.

The diagram shows the evolution of a group called the primates.



(a) Which primate evolved first? **(1)**

(b) Name **two** primates that developed most recently from the same common ancestor as humans. **(2)**

(c) (i) The theory of evolution by natural selection was suggested in the 1800s.

Which scientist suggested this theory? **(1)**

(ii) Use words from the box to copy and complete the passage about natural selection.

evolution	**environment**	**generation**
mutate	**survive**	**variation**

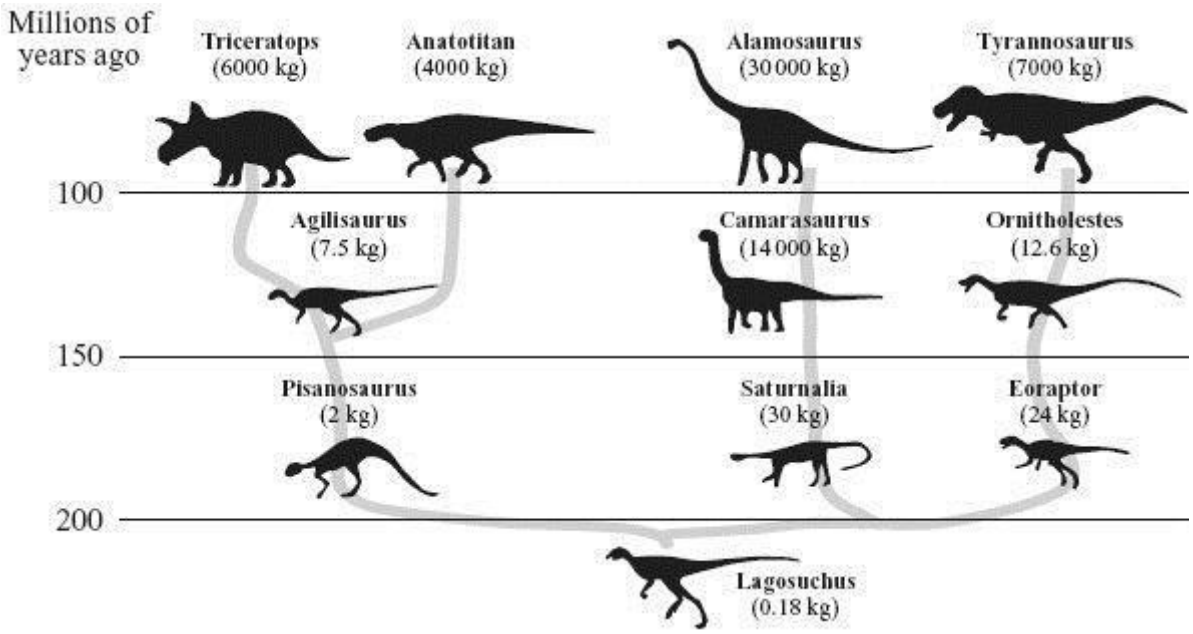
Individual organisms of a species may show a wide range of _____ because of differences in their genes. Individuals with characteristics most suited to the _____ are more likely to _____ and breed successfully. The genes that have helped these individuals to survive are then passed on to the next _____.

(4)

Q2.

The diagram shows a timeline for the evolution of some dinosaurs.

The mass of each dinosaur is shown in the brackets by its name.



(a) Name **one** dinosaur which lived between 100 and 150 million years ago.

(1)

(b) Which dinosaur did Ornitholestes evolve from?

(1)

(c) Apart from body size and mass, give **one other** difference between Lagosuchus and Alamosaurus.

(1)

(d) (i) Which dinosaur had the largest mass?

(1)

(ii) What happened to the mass of dinosaurs during evolution?

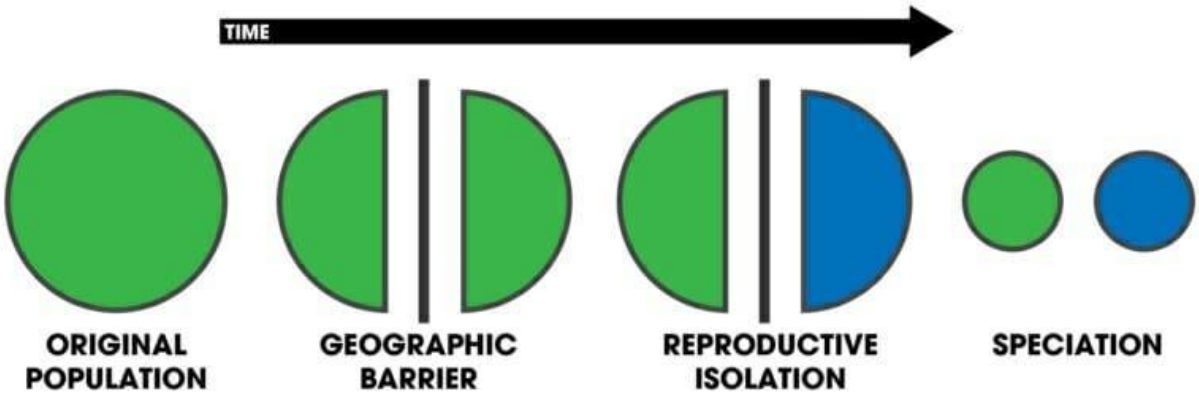
(1)

Lesson 8 Evolution and Speciation

Alfred Russel **Wallace** independently proposed the theory of evolution by natural selection. He published joint writings with Darwin in 1858 which prompted Darwin to publish *On the Origin of Species* (1859) the following year. Wallace worked worldwide gathering evidence for evolutionary theory. He is best known for his work on **warning colouration** in animals and his theory of **speciation**.
Alfred Wallace did much pioneering work on speciation but more evidence over time has led to our current understanding of the theory of speciation.

Process of speciation:

1. **Isolation** occurs – when a species becomes separated into two populations
- **Geographical** (e.g., new river/island) – caused by natural phenomenon (e.g., earthquakes, volcanic eruption)
- Environmental (e.g., climate change)
2. **Natural selection** occurs:
- There is **genetic variation** within one species between individuals
- Alleles for characteristics favourable for survival and successful breeding in the new conditions will be selected
- Those with **favourable alleles** can **survive and reproduce** and pass on favourable alleles (genetic variation increases)
3. **Speciation** occurs – eventually, the organisms change so much that they can no longer interbreed with the original organisms to produce fertile offspring



Lesson 8 Mastery Questions

1. Who worked with Darwin to develop the theory of evolution?
2. Apart from evolution, what are two other studies Wallace worked on?
3. What is speciation?
4. What needs to happen to a population of species for speciation to occur?
5. Why is isolation a key step to creating a new species?
6. Identify six steps in the process of speciation.

Lesson 8 Exam Questions

Q1.

Figure 1 is a map showing a group of islands in the Pacific Ocean, near the coast of California, USA.

Figure 1

A species of fox, called the Island Fox, lives on each of the six islands shown in **Figure 1**.

The foxes on each island are slightly different from those on the other islands.

The Island Foxes are similar to another species of fox, called the Grey Fox.

The Grey Fox lives in mainland California.

(a) Suggest how scientists could prove that the six types of Island Fox belong to the same species.

(2)

(b) Scientists believe that ancestors of the modern Island Fox first colonised what is now Santa Cruz Island during the last Ice Age, approximately 16 000 years ago. At that time, lowered sea levels made the three northernmost islands into a single island and the distance between this island and the mainland was reduced to about 8 km.

(i) How could the Island Fox have developed into a completely different species from the mainland Grey Fox?

(5)

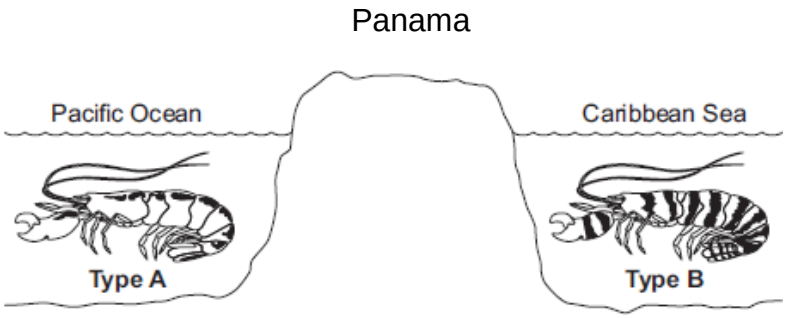
(ii) Suggest why the Island Foxes have developed into different varieties of the same species instead of six different species.

(1)

Q2.

(a) The illustration below shows two types of pistol shrimp.

The shrimps live in shallow, tropical seas on opposite sides of Panama.



Not to scale

Scientists put one **Type A** shrimp and one **Type B** shrimp together in a tank of seawater.
The two types of shrimp snapped their claws aggressively at each other.
They did not mate.

The scientists said that this was evidence for the **Type A** and **Type B** shrimps being classified as two different species.

(i) Give **one** reason why the scientists' opinion may be correct.

(1)

(ii) Suggest **two** reasons why the scientists' opinion may **not** be correct.

(2)

(b) Panama is a narrow strip of land which today joins North America and South America.
It was formed by land moving up from beneath the sea. Panama has separated the Pacific Ocean and the Caribbean Sea for the past 3 million years.

Explain how two different species of pistol shrimp could have developed from an ancestral species of shrimp.

(6)

Lesson 9 Evidence for Evolution

The process of evolution is only a theory. It needs to be supported by evidence – fossils. **Fossils are the remains of organisms from millions of years ago, preserved in the environment (e.g. rock, ice).** Through looking at fossil records, we can see how organisms are structurally adapted in the past. It also helps scientists to understand how they have changed since life developed on Earth, which can act as evidence for evolution by natural selection.

There are different forms of fossils, depending on how they are formed. A lack of decay is key to forming fossils. This means conditions are needed so decomposers, such as bacteria can survive.

- Oxygen (for aerobic respiration of bacteria)
- Correct temperature (too hot – enzymes in bacteria denature, leading to their death; too cold – enzymes are inactive, leading to a lack of respiration)
- Water (so cells can function properly)

Organisms do not decay after death due to lack of decay conditions

Situation A: Organism drowned in water which froze relatively quickly
A whole baby mammoth (with muscles, blood, fur intact) was found frozen in ice

Situation B: Organisms (e.g., flies, ants) trapped in tree sap

There may be very few decomposers within the tree sap. Even though the temperature may be appropriate, the lack of oxygen means decay cannot occur as bacteria cannot respire aerobically.

Overtime the tree sap hardens to become amber with insects trapped inside

Preserved traces of organisms left behind

- Organisms left a particular imprint on wet mud, like a mould. Overtime, it dried out with the traces formed and hardened into rocks.
- E.g., Footprints, burrows, rootlet traces, droppings

Harder parts of organisms (e.g., Bones) replaced by minerals

- This is the most common form of fossils, like the ones you can see in museums

Process of fossilisation of skeletons

It is important to remember that bone tissues can still decay as they are organic, but just takes a longer time to do so. If they get replaced by the minerals before they decay, meaning the minerals can form a mould of their shapes, then the fossil can be made.

Even though fossils are a great way to support the theory of evolution, it is not enough as we do not have a complete fossil record. The reasons for this are as follows:

- Many early life forms are **soft-bodied**, which means they decay quickly and cannot be mineralised to form fossils
- Geological activity **destroyed** some fossils, such as earthquakes
- Most organisms **did not become fossilised** – the conditions for fossilisation are very rare, and any imprints made are washed away easily.
- Many **undiscovered** fossils – we do not know exactly how many fossils they are still buried, hence we may be missing parts of the record

Extinction is the **permanent loss** of **all** members of **one** species.

Mass extinction, on the other hand, is the loss of **many or most** species on Earth, and it usually happens over several million years. So far, there have been five mass extinction events, as seen on the five major peaks in the graph.

Extinctions can be caused by different factors.

Biotic (living) causes of extinction

- New **predators** – organisms could not adapt quickly enough to survive the new predators and were all killed before they could reproduce and pass on favourable alleles
- Successful interspecific **competition** – the species that got outcompeted for food, territory/shelter etc. may become extinct overtime
- New **diseases/pathogens** – if the majority of the species could not (adapt to) survive the new disease then they may become extinct

Abiotic (non-living) causes of extinction

- Climate change
- Single catastrophic event – e.g., volcanic eruption, asteroid collision, etc.

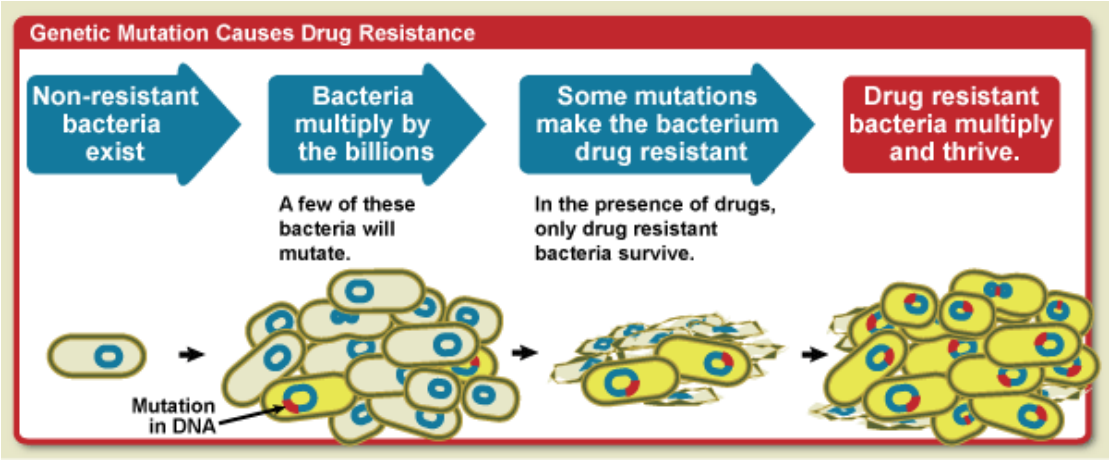
An example of a catastrophic event leading to a mass extinction

I. Asteroid collision caused tectonic plates to shift
II. This triggered earthquakes and tsunamis, which then subsequently triggered volcanic eruptions
III. The lava itself could kill many organisms already. On top of that, the eruption(s) could produce a massive ash cloud which may cover a large portion (if not all) of the earth
IV. The ash cloud blocked out sunlight, preventing them from reaching the surface. This could then have two effects:
A.) Plants (producers) don't get sunlight and cannot do photosynthesis. They then die out, which then affects the food chain

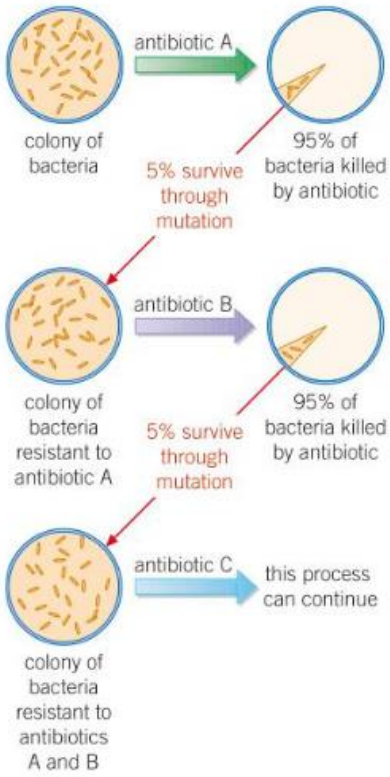
B.) Global temperature drops, eventually leading to the ice age

More evidence: Antibiotic resistant bacteria

Bacteria becoming resistant to certain antibiotics is an example of evolution, which happens at a comparatively much faster pace than evolution of multicellular organisms like animals and plants. The reason for this is because **mutations** occur much quicker in bacteria due to their rapid reproduction by binary fission, compared to how long it takes for animals/plants to reproduce. Mutation is a change in DNA (specifically alleles). It would need to be a mutation that favours survival that lead to successful evolution.



This is of particular concern in the current medical world, as more and more bacteria are becoming resistant to various antibiotics. This ultimately may lead to the rise of "superbugs", which are bacteria strains that are resistant to almost all antibiotics. They pose a massive threat as it is a slow and expensive process to develop new antibiotics to counteract them. MRSA (methicillin-resistant *Staphylococcus aureus*) is the most classic example of superbugs. Therefore, it is important that we know how to prevent more bacteria from developing antibiotic resistance and to prevent their spread:



- Don't overuse antibiotics – restrict its use only for severe bacterial infections
- Finish the course of antibiotics – ensure all bacteria strain are killed, none survive and reproduce (as seen in the diagram)
- Regulate agricultural use of antibiotics – some bacteria may affect both animals and humans
- Only use specific antibiotics for specific bacteria – limit exposure of unnecessary antibiotics to bacteria

- Maintain hygiene – personal and large-scale (hospital) level
- Isolation – isolate patients infected with antibiotic-resistant bacteria

Lesson 9 Mastery Questions

1. What are fossils?
2. What are the three criteria for decay to occur?
3. Describe the five steps of fossilisation by mineralisation.
4. Why is it harder for bones to decay?
5. What are the three different types of fossils that can be formed?
6. Fossils which are older often appear to be simpler organisms. What theory does this provided evidence to support?
7. How is the fossil record helpful?
8. Define 'extinction'.
9. State three causes of extinction.
10. What causes mass extinction? Suggest two examples of this cause.
11. What is the difference between extinction and mass extinction?
12. What is antibiotic resistance?
13. What causes antibiotic resistance?
14. Describe the steps in which a bacteria strain develops resistance to an antibiotic.
15. Why can bacteria evolve quicker than other organisms?
16. Suggest 3 methods to prevent and slow down the development of antibiotic-resistance
17. Why must patients finish their course of antibiotics every time?
18. Suggest 3 ways in which a hospital can reduce the spread of antibiotic-resistant strains.
19. Why is it difficult to develop new antibiotics to combat the appearance of new antibiotic-resistant strains of bacteria?
20. Why are bacteria prokaryotic organisms?
21. Is binary fission sexual or asexual reproduction?
22. What is the role of the DNA plasmid for bacteria?
23. What type of cell in your blood fights infection?
24. Define 'pathogen'
25. How does your body fight a bacterial infection?
26. Define 'allele'

27. Sue says 'antibiotic resistance isn't a big deal, we can just make more antibiotics' Do you agree? **Explain your answer.**

28. Why will your doctor not prescribe antibiotics for a cold?

Lesson 9 Exam Questions

Q1.

Choose words from this list to copy and complete the sentences below.

bones	extinct	fossils
muscles	rocks	

In the past some types of animals and plants have died out.

They have become _____ .

We know about these animals and plants because we find them as _____ .

Sometimes the hard parts of animals such as _____ did not decay.

In other cases the bodies of animals and plants were replaced by minerals.

You can still see their shape in _____ .

(Total 4 marks)

Q2.

Figure 1 shows a fossil of a sea animal called a Plesiosaur.
The Plesiosaur was alive about 135 million years ago.

(a) How can fossils give evidence for evolution? **(1)**

Choose **one**.

Newer fossils are simpler than older fossils.

Fossils show change over time.

All fossils show the bones of animals.

(b) Plesiosaurs lived in the sea. There was mud at the bottom of the sea.

Suggest how the fossil shown in **Figure 1** may have been formed after the animal died.
(3)

(c) Scientists think that the Plesiosaur had smooth skin, with no scales.

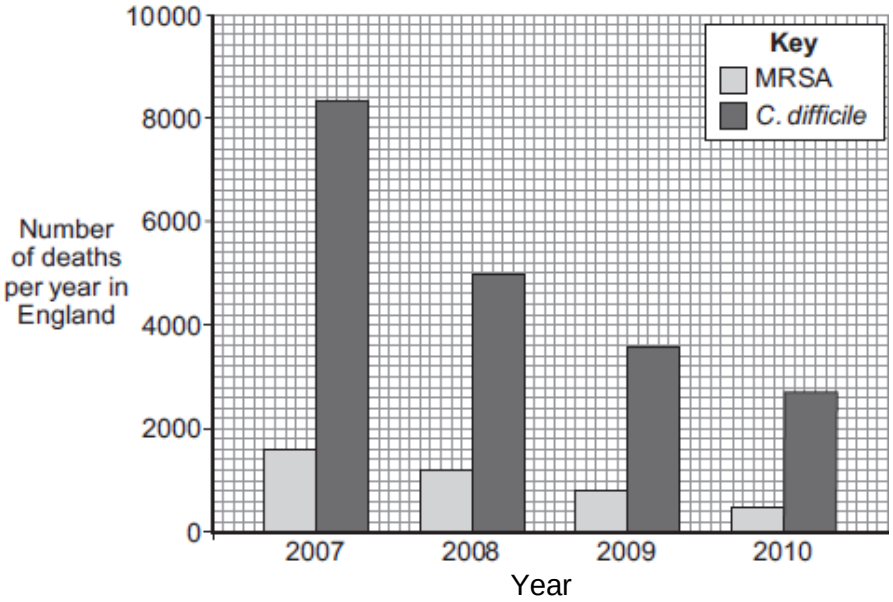
The scientists **cannot** be certain what the skin of a Plesiosaur was like.
Suggest why. **(1)**

(d) Plesiosaurs are now extinct.

Give **two** possible reasons why. **(2)**

Q3.

Infections by antibiotic resistant bacteria cause many deaths.
The bar chart below shows information about the number of deaths per year in England from *Methicillin-resistant Staphylococcus aureus* (MRSA) and from *Clostridium difficile* (*C.difficile*) over 4 years.



(a) (i) Describe the trend for deaths caused by *C. difficile*.

(2)

(ii) Suggest a reason for the trend you have described in part **(a)(i)**.
Explain your answer.

(2)

(iii) Numbers have not yet been published for 2011.
When the numbers are published, scientists do **not** expect to see such a large percentage change from 2010 to 2011 as the one you have calculated for 2009 to 2010.
Suggest **one** reason why.

(1)

(b) Before 2007 there was a rapid increase in the number of deaths caused by MRSA.
Describe how the overuse of the antibiotic methicillin led to this increase. **(3)**

Lesson 10 Selective Breeding

Humans can speed up evolution by doing **selective breeding** (artificial selection). It is the process by which humans breed plants and animals for desired characteristics. Here is a list of desired characteristics (and quite often *the* advantages to selective breeding):

- Disease resistance
- Increased food production/crop yield
- Gentle nature of domestic animals (e.g. Dogs)
- Heavily scented flowers

It is especially useful in agriculture, where farmers want all or most of their animals or plants to be resistant to diseases and can grow in size quickly, so they could farm and harvest as efficiently as possible for profit. This is the **process of selective breeding:**

1. Choose two individuals with the desired characteristic(s) from a mixed population.
2. Allow them to breed, which produces offspring with a range of characteristics.
3. Choose the few offspring with the (most) desired trait(s) and allow them to breed.
4. Repeat this crossbreeding process over many generations until **all** the offspring show the desired characteristic.

There are pros and cons to selective breeding.

Advantages	Disadvantages
Disease resistance in food crops	Reduces genetic variation, less able to cope with change to environment because of reduced allele types
Animals which produce more meat or milk	More prone to disease because more likely to inherit recessive alleles

Genetic engineering is the process where a gene from an organism is transferred to the genome of another organism to give it a desired characteristic. Many organisms have been genetically modified (GM) for the benefits of humans, for example, GM crops becoming disease/pest-resistant and make bigger, better fruits; GM bacteria producing human insulin to treat diabetes.

Advantages	Disadvantages
Can mass produce desired proteins/products	Resistant genes could be transferred to natural populations (wild type) this affects biodiversity
Can modify crops to be resistant to pests/diseases this increases crop yield	Expensive

The process of genetic engineering for making insulin (HT ONLY)

1. Extract human DNA from human cell and the **plasmid** (**vector**) from bacteria
2. Cut out **desired gene** (e.g. Insulin gene) from human DNA using **restriction enzyme**
3. Using the same restriction enzyme, cut the plasmid
4. Insert desired gene into plasmid, becoming **recombinant DNA**
5. Put recombinant DNA into bacteria, becoming a **transgenic bacteria/organism**
6. Allow transgenic bacteria to multiply by mitosis. All GM bacteria make human insulin

7. Extract human insulin to treat diabetes

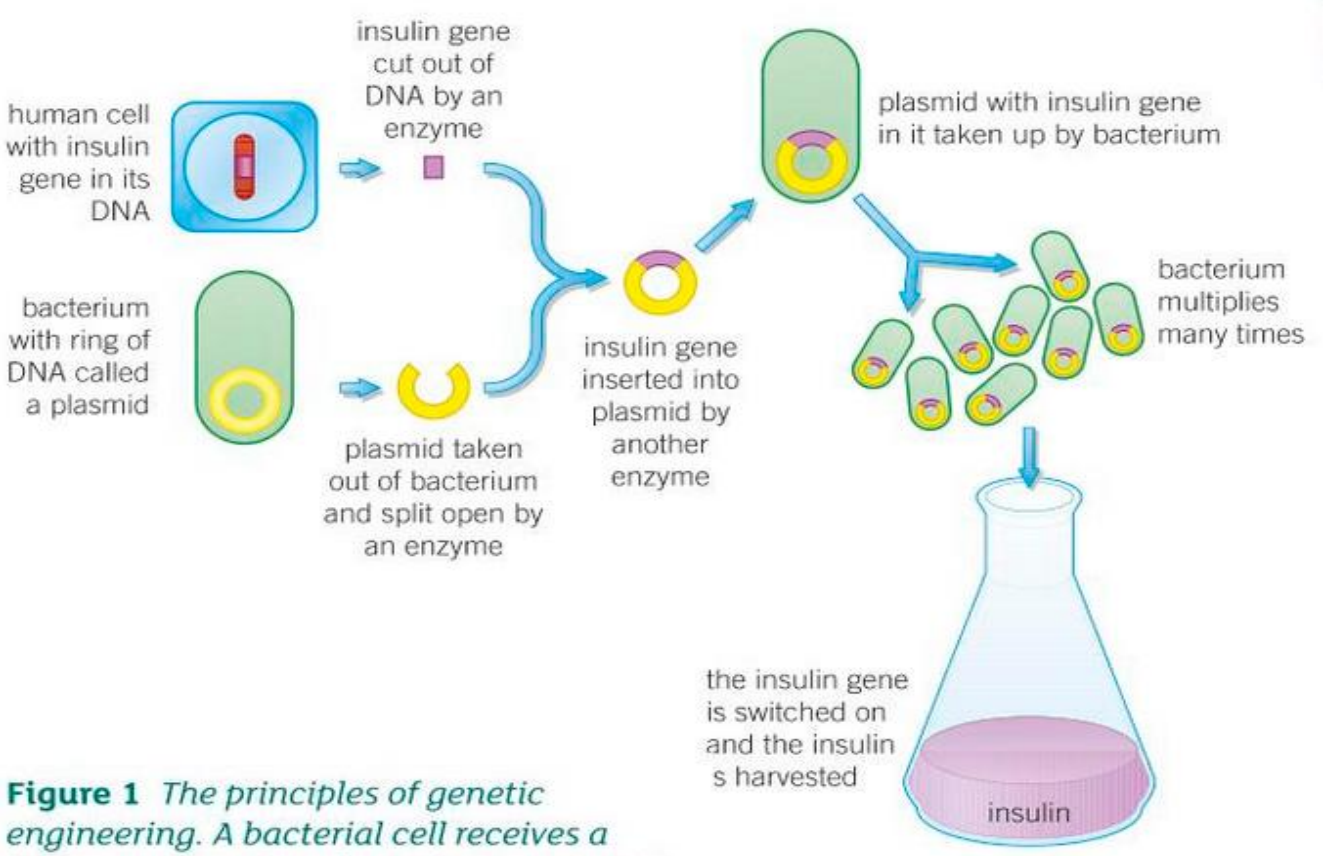


Figure 1 *The principles of genetic engineering. A bacterial cell receives a human gene so it makes a human protein –*

Lesson 10 Mastery Questions

1. Define 'selective breeding'.
2. What are the desired characteristics in farm animals? Explain.
3. Describe the process of selective breeding.
4. Name two historic examples of selective breeding.
5. State four modern examples of selective breeding.
6. How do breeders of domestic pets use selective breeding to produce many pets?
7. Give two desirable characteristics in crops.
8. Explain how selective breeding reduces genetic variation.
9. Explain how selective breeding can lead to extinction of a species.
10. State another problem with selective breeding and explain why that is a problem.
11. Name the gametes of a cow
12. Name the gametes of a maize plant
13. A cow body cell has 60 chromosomes. How many will its gametes have?
14. Calculate the percentage increase in chromosome number from human gametes to cow gametes.
15. Selective breeding has increased milk production by 40%. If a modern cow produces approximately 23 litres of milk, how much milk did early cows produce?
16. Many different types of animals are produced using selective breeding.
17. What is genetic engineering?
18. What is the term used to describe organisms that are genetically modified?
19. Why is genetic engineering useful?
20. Give two examples of vectors used in genetic engineering.
21. Give two ways in which genetic engineering is useful in agriculture.
22. Explain how genetic engineering is useful in treating diabetes.
23. Suggest what genes could be engineered into crops to make them pest-resistant.
24. How can genetically modified (GM) crops affect the growth and survival of natural (wild type) crops/plants?

25. HT ONLY Describe the process of genetic engineering. You may draw a diagram to help illustrate.
26. Complete the sentences below:
27. Genetic engineering is useful for society because….
28. Genetic engineering is useful for society but….
29. Genetic engineering is useful for society so….

Lesson 10 Exam Questions

Q1.

Many different types of animals are produced using selective breeding.
Some cats are selectively bred so that they do not cause allergies in people.

(a) Suggest **two other** reasons why people might selectively breed cats.

(2)

(b) Selective breeding could cause problems of inbreeding in cats. Describe **one** problem inbreeding causes.

(1)

(c) Many people have breathing problems because they are allergic to cats. The allergy is caused by a chemical called Fel D1.
Different cats produce different amounts of Fel D1. A cat has been bred so that it does not produce Fel D1. The cat does **not** cause an allergic reaction.
Explain how the cat has been produced using selective breeding.

(4)

Q2.

Read the information.

> Insects can be both useful and harmful to crop plants.
> Insects such as bees pollinate the flowers of some crop plants. Pollination is needed for successful sexual reproduction of crop plants.
> Some insects eat crops and other insects eat the insects that eat crops.
>
> Corn borers are insects that eat maize plants.
> A toxin produced by the bacterium *Bacillus thuringiensis* kills insects.
> Scientists grow *Bacillus thuringiensis* in large containers. The toxin is collected from the containers and is sprayed over maize crops to kill corn borers.
>
> A company has developed genetically modified (GM) maize plants. GM maize plants contain a gene from *Bacillus thuringiensis*. This gene changes the GM maize plants so that they produce the toxin.

(a) Describe how scientists can transfer the gene from *Bacillus thuringiensis* to maize plants. (**HT Only)**

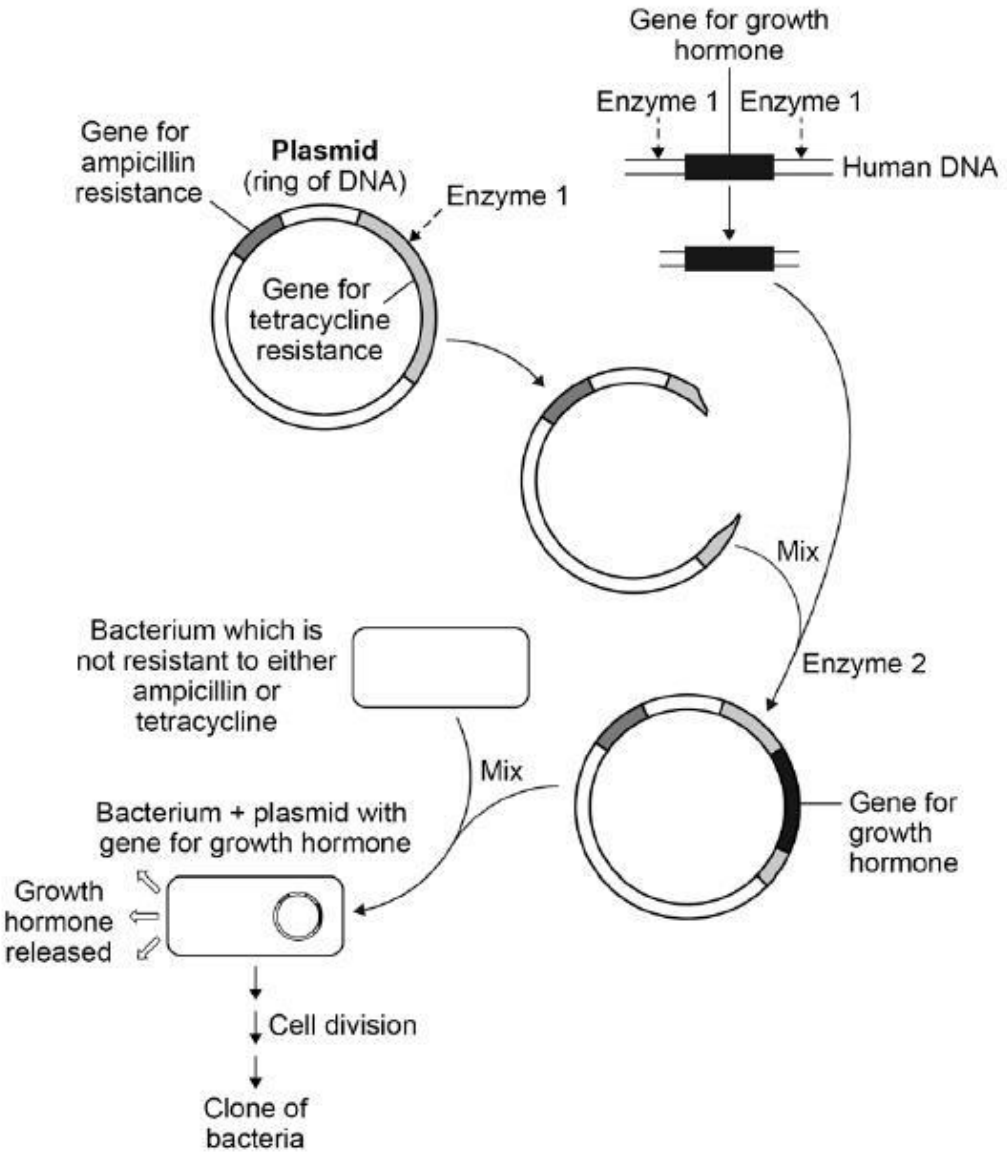
(3)

(b) Would you advise farmers to grow GM maize plants? Justify your answer by giving advantages and disadvantages of growing GM maize plants.
Use the information from the box and your own knowledge to help you.

(4)
(Total 7 marks)

Q3.

The diagram shows how scientists can use genetic engineering to produce human growth hormone.



(a) Human growth hormone is made by the pituitary gland. The human DNA containing the gene for growth hormone can be taken from a white blood cell.
Give the reason why the gene does **not** have to be taken from cells in the pituitary gland.
(1)

The figure above shows that the plasmid contains two genes for antibiotic resistance:

- a gene for resistance to the antibiotic ampicillin
- a gene for resistance to the antibiotic tetracycline.

(b) Explain how the structure of **Enzyme 1** allows it to cut the gene for tetracycline resistance, but **not** the gene for ampicillin resistance.

(3)

(c) In the final step of the diagram above, very few bacteria take up a plasmid containing the gene for growth hormone.
Some bacteria take up an unmodified plasmid.
Most bacteria do **not** take up a plasmid.
Complete the table below.

- Put a tick in the box if the bacterium **can** multiply in the presence of the given antibiotic.
- Put a cross in the box if the bacterium **cannot** multiply in the presence of the given antibiotic.

	Bacterium can multiply in the

	presence of	
	Ampicillin	**Tetracycline**
A. Bacterium + plasmid with growth hormone gene		
B. Bacterium without a plasmid		
C. Bacterium with an unmodified plasmid		

(d) The figure above shows that the bacterium containing the gene for human growth hormone multiplies by cell division.
This produces a clone of bacteria.
Explain why **all** the bacteria in this clone are able to produce growth hormone. **(3)**

Lesson 11 Cloning and Adult Cell Cloning TRIPLE ONLY

A **clone** is an individual that has been produced through **asexual reproduction** and is **genetically identical** to the parent. Clones can be made by different methods, also dependent on if you are trying to clone plants or animals.

Plant cloning

Plant cuttings + **Tissue culture**:

1. Part of the plant is cut out from parent plant
2. The plant tissue is placed in growth medium with nutrients and plant hormones (e.g. Auxins)
3. It eventually grows into plantlets
4. Plantlets are transferred to be planted in compost

Animal cloning

Method 1 – Embryo splitting:

1. An embryo is made either by letting two individuals mate and wash out the embryo, or by artificial insemination/fertilisation in the lab
2. Split the embryo into several individual cells
3. Allow each cell to grow individually into identical embryos
4. Transfer these embryos into host mothers and allow them to grow naturally into foetuses
5. The cloned offspring are born and are **genetically identical to each other**, but not related to their host mothers

Method 2 – Adult cell cloning:

1. Extract an adult body cell and an unfertilised egg cell (from different individuals)
2. Remove the nucleus in the egg cell
3. Extract the nucleus from the adult body cell and insert it into the empty egg cell
4. Pass a small **electric shock** through to the egg cell, stimulating it to start dividing to form an embryo
5. Insert the embryo into an adult female to continue its development into a fetus
6. The offspring is **genetically identical to the nucleus donor** (i.e. The donor of the adult body cell)

Some pros and cons of cloning:

Advantages	**Disadvantages**

Combine with genetic engineering to increase crop yield	Reduce genetic variety/Smaller gene pool less likely to survive in changing environment
Save animals from extinction	Potential use in engineering human babies (ethical concerns)

When it comes to evaluating genetic technologies, we need to consider them in terms of four aspects: scientific, economic, social and ethical aspects.

Benefits	**Concerns**
Increase growth rate of plants and animals	Unsure of long-term effects
Increase food value (e.g. Higher yield)	Unsure of effect of eating GM food on human health
Designed to be resistant to poor environments (e.g. Dry, cold)	Affect wild type organisms' chances of survival
Designed to be pest/herbicide-resistant	Ethical concerns of potential human engineering

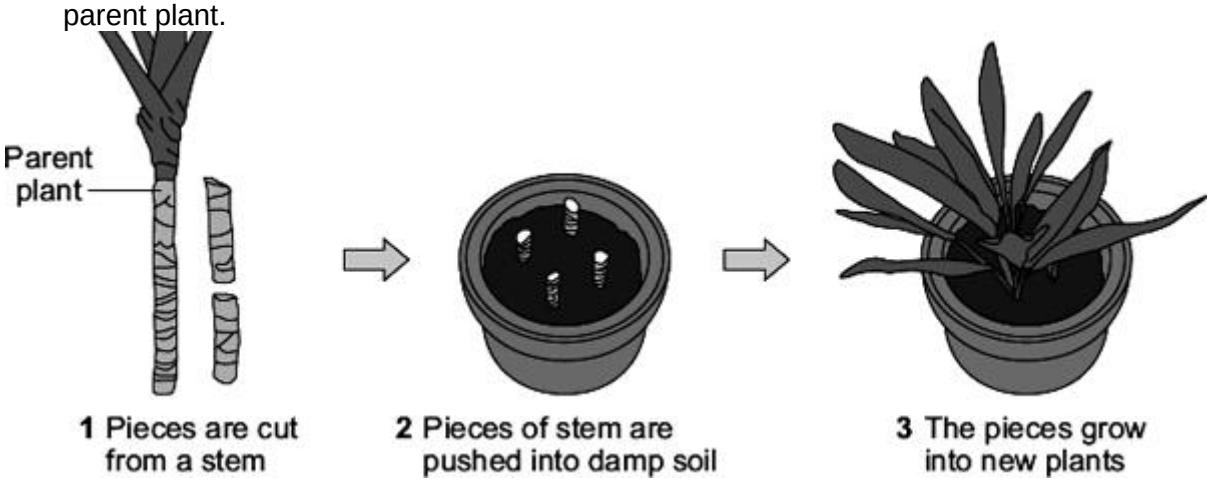
Lesson 11 Mastery Questions

1. Define ‘clone’.
2. Name the traditional method of artificial plant cloning.
3. Name the modern method of artificial plant cloning.
4. What are “plant cuttings”?
5. Describe the process of modern artificial plant cloning.
6. Compare the offspring from embryo transplants with each other and with the parents.
7. Explain why artificial plant cloning is useful.
8.
9. Suggest how genetic engineering and artificial plant cloning can be combined for agricultural benefits.
10. Suggest a hormone that would be used in tissue culture.
11. Among a batch of plants grown using the cloning method, one of them was checked to be genetically different from its parent and sibling plants. Suggest why.
12. Describe in detail how a batch of top-quality cows can be produced by embryo cloning/transplants.
13. In adult cell cloning, what is removed from the cloning target's cell, in order to create its clone?
14. What type of cell is taken from the target clone in adult cell cloning?
15. What has to be done to the egg cell in adult cell cloning?
16. What is needed to stimulate the new egg cell to divide in adult cell cloning?
17. Describe in detail how adult cell cloning is done.
18. Compare the offspring in adult cell cloning to both its parents.
19. Describe the two benefits and two risks of adult cell cloning.
20. Compare the offspring from embryo cloning and adult cell cloning. Explain their difference. You could use a Venn diagram to help
21. State two ways in which genetic engineering can be used in medicine.
22. State two ways in which genetic engineering can be used in agriculture.
23. Give one benefit of growing GM crops to humans.
24. What are the two concerns people have on GM crops?
25. Explain why people have ethical concerns about animal genetic engineering.

Lesson 11 Exam Questions

Q1.

(a) The drawings show one way of producing new plants. The new plants are identical to the parent plant.



Use words from the box to copy and complete the sentences.

asexual	characteristics	clones	engineering	genes	sexual

The colour and shape of the leaves are known as _____

The information for leaf colour is stored in parts of chromosomes called _____

The new plants are known as _____

The new plants have been produced by _____ reproduction.

(4)

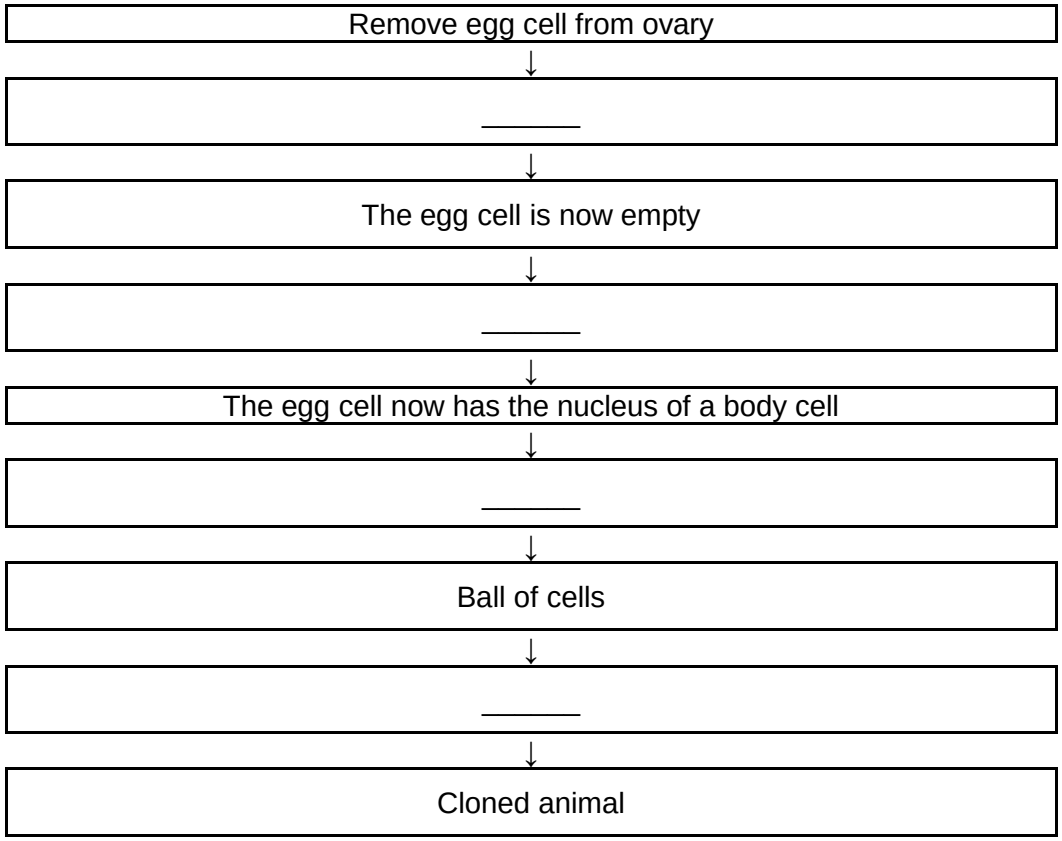
(b) (i) Name **one** other way of producing plants that are identical to their parents. **(1)**

(ii) Name **one** way of producing animals that are identical to each other. **(1)**

Q2.

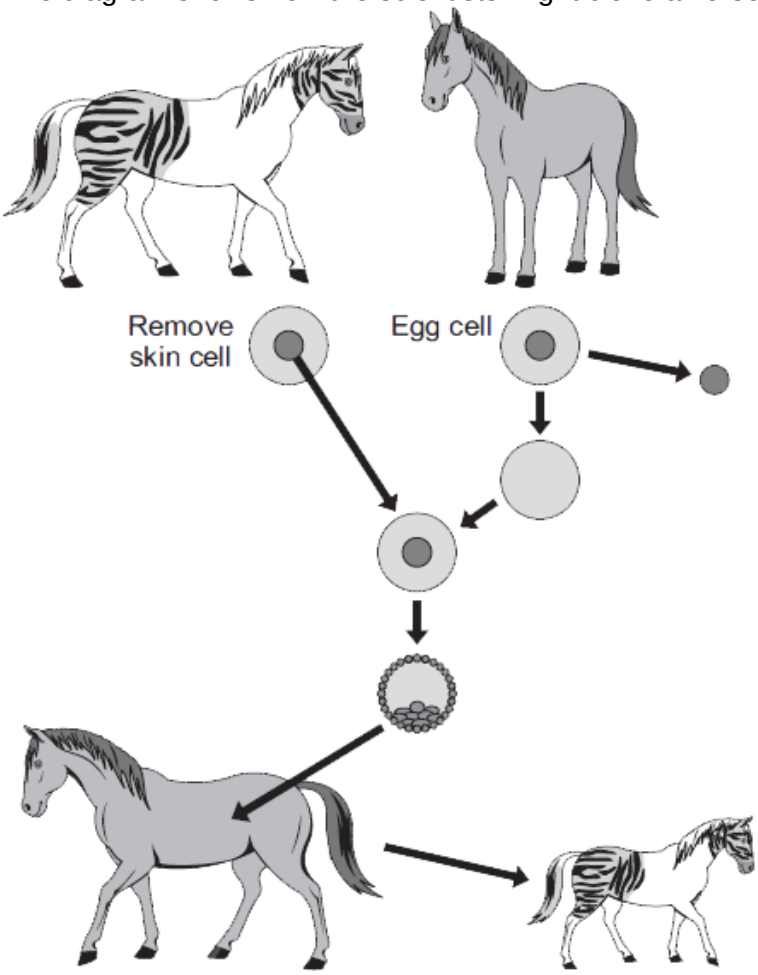
(a) Cloning is one way of making sure that endangered species do not die out. The flowchart below shows one way of cloning an animal.
Copy and complete the flow chart by writing the correct statement in the empty box. **(3)**

- Give a small electric shock
- Transfer nucleus from body cell
- Remove nucleus from egg cell
- Insert embryo into womb of female



Q3.

(a) Zorses are **not** able to breed.
Scientists could produce more zorses from this zorse by adult cell cloning.
The diagram shows how the scientists might clone a zorse.



In this question you will be assessed on using good English, organising information clearly and using specialist terms where appropriate.
Use information from the diagram and your own knowledge to describe how adult cell cloning could be used to clone a zorse.

(6)