Inheritance, Variation & Evolution - Revision materials

Content will be tested on Biology Paper 2

ChecklistKey Point	☺	☹
Inheritance, Variation & Evolution		
Explain what is meant by the terms 'sexual' and 'asexual' reproduction and the differences between them		
Describe the main stages of the production of gametes by meiosis		
Explain the differences between mitosis and meiosis in terms of daughter cells		
Describe the structure of DNA and define the term genome		
Describe the importance of understanding the genome		
Define key genetic terms – allele, heterozygous, homozygous, dominant, recessive, genotype and phenotype		
Complete punnett squares to show the possibilities for offspring of a genetic cross and interpret them using direct proportion and ratios		
Describe the chromosome make up of men and women and use genetic crosses to show how gender is inherited		
Use and interpret family tree diagrams		
Construct genetic diagrams and use theory of probability to interpret results		
Describe the inheritance of the diseases polydactyly and cystic fibrosis		
Evaluate the use of embryo screening to prevent these and other inherited diseases		
Explain why Darwin's theory of natural selection was not well accepted at first and contrast his theory with that of Lamarck		
Define the reasons for variation within a species and across species		
Explain the role of mutations in variation		
Describe the theory of evolution		
Apply the theory of natural selection to explain how organisms have changed over time		
Explain how different species arise over time		
Describe 'selective breeding' and give examples of where it is used		
Give the disadvantages of selective breeding in terms of the gene pool		
Describe how plants, animals and bacteria can be genetically engineered and evaluate this – e.g +/- of genetically modified foods, production of insulin by GM bacteria		
Describe the main steps in genetic engineering of crops and bacteria (HT)		
Describe the evidence for evolution – fossils, antibiotic resistant bacteria etc		
Explain what fossils show u, how they were formed and why the fossil record is incomplete		
Interpret evolutionary trees and explain why organisms may go extinct		
Explain how antibiotic resistant bacteria form and how we can try to prevent this		
Describe Linnaeus' classification system		
Describe the more recent 'three-domain' system		

4.6.1.1 Sexual and Asexual Reproduction

Meiosis is the formation of four non-identical cells from one cell.

Mitosis is the formation of two identical cells from one cell. (This is covered in detail in Paper 1: cell biology)

There are two types of reproduction:

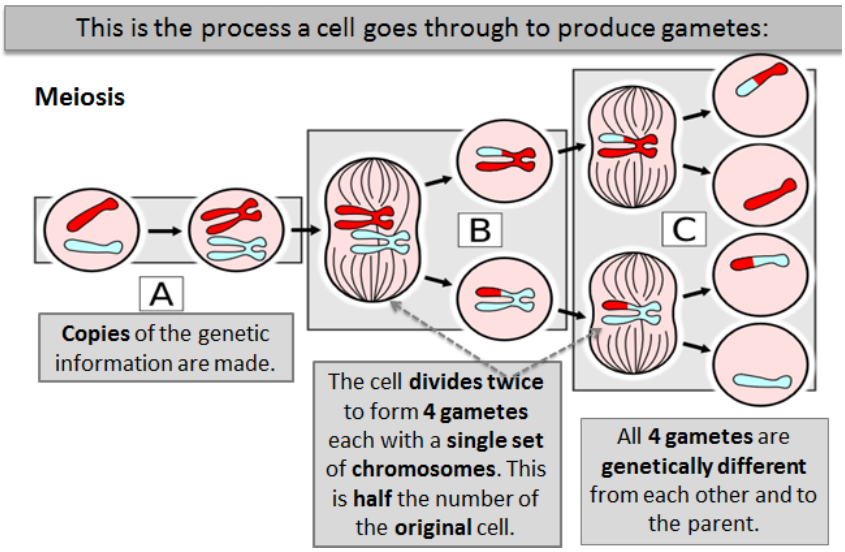
Sexual reproduction	Asexual reproduction
Involves the **joining of male and female gametes**, each containing genetic information from the mother or father.	Involves **one parent** with **no gametes joining**.
Gametes: ● Sperm and egg cells in animals ● Pollen and egg cells in flowering plants	Examples of organisms that reproduce this way are bacteria, some plants and some animals.
Gametes are formed by **meiosis**, as they are non identical. • A normal cell has 46 chromosomes. There are two sets of chromosomes (i.e. 23 pairs). In each pair, one chromosome is from the father and the second set are from the mother. • Each gamete has 23 chromosomes and they fuse in fertilisation. • The genetic information from each parent is mixed, producing variation in the offspring.	It happens using the process of **mitosis**, where **two identical cells are formed from one cell.** • There is no mixing of genetic information. • It leads to **clones**, which are **genetically identical** to each other and the parent.

4.6.1.2 Meiosis

Meiosis is the formation of four non-identical cells from one cell. Cells in the reproductive organs divide by meiosis to form gametes. Gametes only have one copy of each chromosome.

The cell makes copies of its chromosomes, so it has double the amount of genetic information.

- The cell divides into two cells, each with half the amount of chromosomes (46).
- The cell divides again producing four cells, each with a quarter the amount of chromosomes (23).
- These cells are called gametes and they are all genetically different from each other because the chromosomes are shuffled during the process, resulting in random chromosomes ending up in each of the four cells.

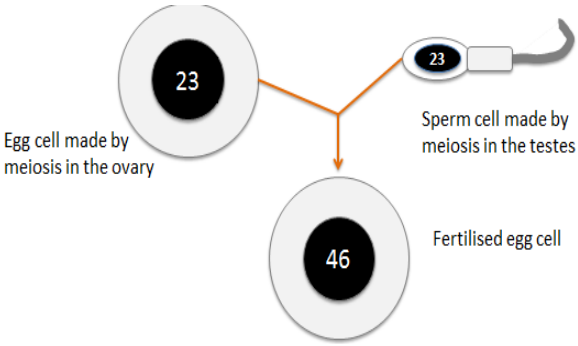


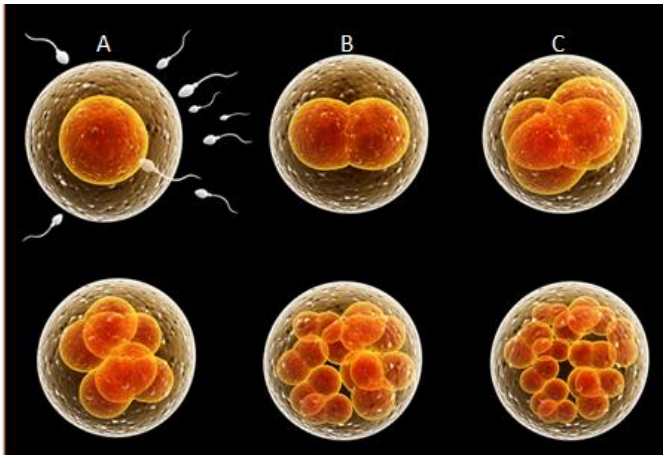
These gametes with 23 chromosomes join at fertilisation to produce a cell with 46 chromosomes, the normal number.

- This cell divides by mitosis to produce many copies.
- More and more cells are produced, and an embryo forms.
- The cells begin to take on different roles after this stage (differentiation).

Fertilisation:

- When gametes join at fertilisation, a single body cell with new pairs of chromosomes is formed. **This is now called an embryo.**
- **Cells now begin to differentiate into different types of cell.**





Variation:

Asexual reproduction leads to very little variation:

- Organisms that reproduce asexually create new individuals by mitosis.
- They are genetically identical to the parent.
- They may develop differently due to differences in their environment.

Sexual reproduction leads to much more variation:

- Meiosis ensures that all gametes contain the same genes, but have a different selection of alleles. It is random which sperm fertilises which egg.
- Therefore all individuals (except for identical twins) produced sexually are genetically different.

Examples of organisms that use both methods to reproduce are below:

1. Malarial parasites: causes malaria, spread by mosquitoes and transferred to humans through a bite
    - They reproduce sexually in the mosquito.
    - They reproduce asexually in the human host (in the liver and blood cells).

2. Some fungi: many species can undergo both types of reproduction, releasing spores which land and become new fungi
    - Spores produced asexually are genetically identical.
    - Spores are produced sexually when the conditions change, in order to increase variation and avoid extinction.

3. Some plants
    - Many reproduce sexually using pollen, which must reach the egg cells in the female parts of another flower. This is called pollination, and it forms seeds.
    - Strawberry plants reproduce asexually, as they produce runners. New identical plants grow off the runner.
    - Daffodils reproduce asexually. They grow from bulbs. New bulbs can grow from the main one, producing a new identical plant.
    - It is advantageous in plants as it means they can reproduce even if the flowers have been destroyed by frost or other animals.

Exam practice 1

Q1. There are two types of reproduction, asexual and sexual. Use the words in the box to complete the sentences about reproduction.

You may use each word once or not at all.

asexual	eggs	gametes	fertilisation	inheritance
ovaries	sexual	sperms	testes	variation

The genetic information from the mother is carried in the _____ which are made in the _____ .

The genetic information from the father is carried in the _____ which are made in the _____ .

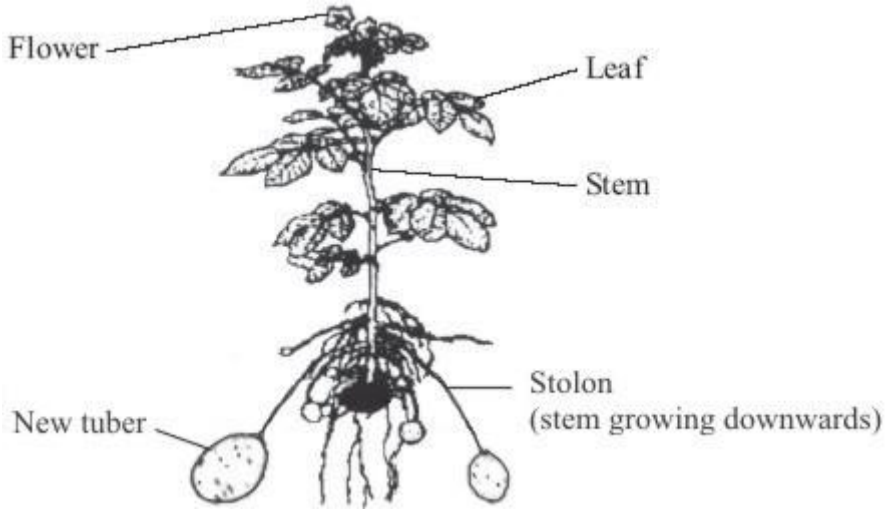
In _____ reproduction, offspring are produced that are genetically different from either parent.

This happens because genetic information from each parent is carried in the _____ and joined together during _____ to develop into a fetus.

In _____ reproduction, genetically identical offspring are produced because no mixing of genetic material takes place.

(Total 8 marks)

Q2. The drawing shows a potato plant producing new tubers (potatoes). Buds on the stem of the parent plant produce stolons. The new tubers are formed at the ends of the stolons (stems that grow downwards).



(a) Explain why the new tubers are genetically identical to each other.

_____

_____

_____

_____ **(2)**

(b) Some of the tubers are used to produce potato plants. These new potato plants will not all grow to the same height.

Give **one** reason why.

_____

_____

(1)

(Total 3 marks)

Q3. (a) Use words from the list to complete the sentences.

alleles chromosomes gametes genes mutations

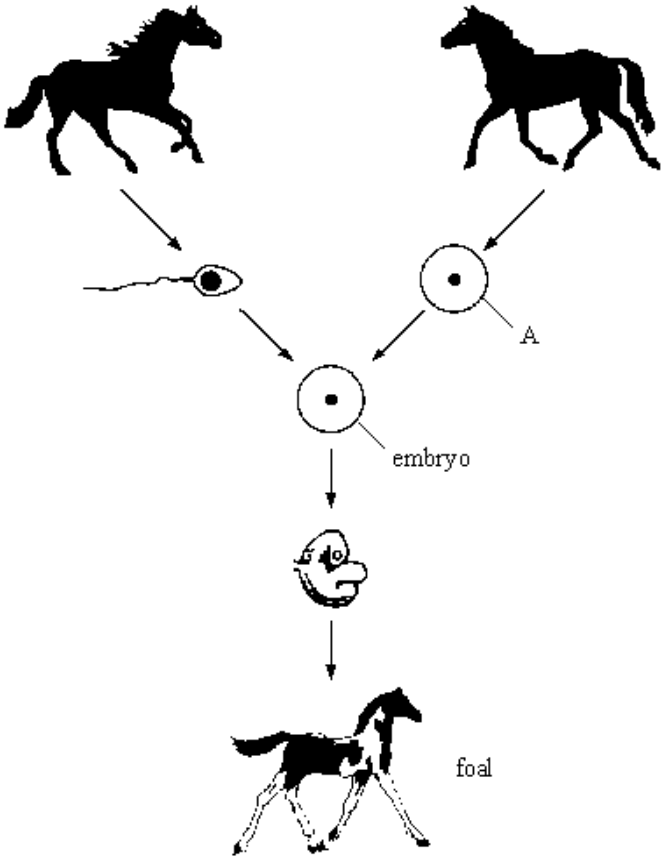
The nucleus of a cell contains thread-like structures called _____ .

The characteristics of a person are controlled by _____

which may exist in different forms called _____ .

(3)

(b) The drawing shows some of the stages of reproduction in horses.



(i) Name this type of reproduction

_____

(1)

(i) Name the type of cell labelled **A**

_____

(1)

(c) When the foal grows up it will look similar to its parents but it will **not** be identical to either parent.

(i) Explain why it will look similar to its parents.

_____

_____

_____

(1)

(ii) Explain why it will **not** be identical to either of its parents.

_____

_____

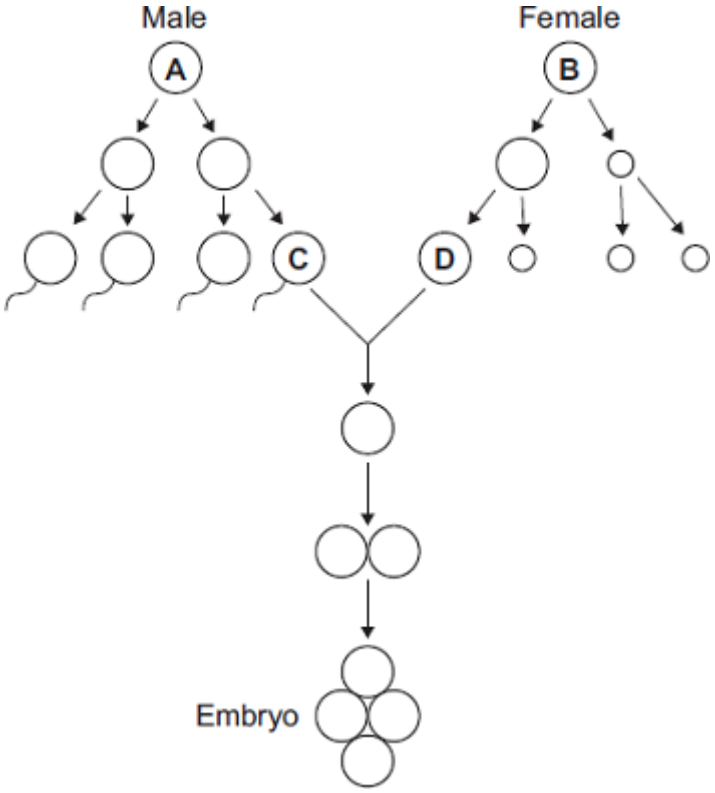
_____

_____

(2)

(Total 8 marks)

Q4. The diagram shows some of the cell divisions that occur during human reproduction.



(a) (i) Name the type of cell division that produces cell **D** from cell **B**.

_____

(1)

(ii) Which organ in the male body produces cell **C** from cell **A**?

_____

(1)

(b) (i) Cells **A** and **B** each contain 46 chromosomes.

How many chromosomes would there be in the nucleus of cell **C**? ☐

(1)

(ii) Why is it important that cell **C** has this number of chromosomes?

_____

_____

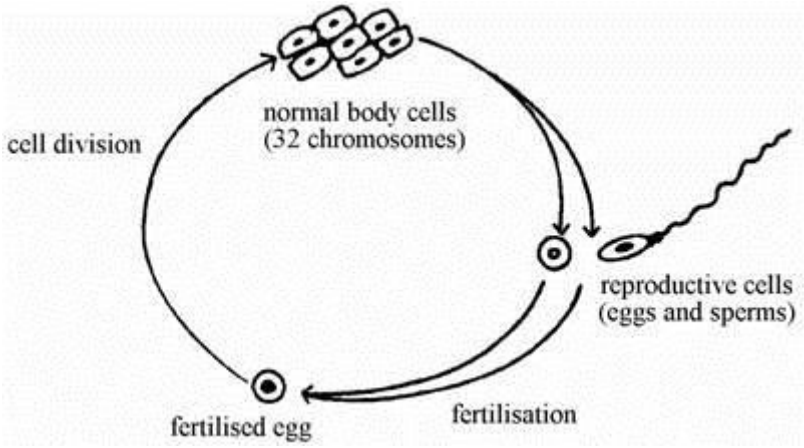
_____

_____

(2)

(Total 5 marks)

Q5. The diagram shows three types of cells in a life history of a simple animal.



(a) How do the chromosomes of the body cells compare with the chromosomes in the fertilised egg from which they came?

_____

_____

(1)

(b) Describe what happens to chromosomes in the nucleus of a body cell when it forms reproductive cells.

_____

_____

_____

_____

_____

(4)

(Total 5 marks)

Q6. A child saved apple seeds from an apple she ate. She planted the seeds in the garden. A few years later the apple trees she had grown produced apples.

(a) The apples from the new trees did **not** taste like the original apple.

Explain why.

_____

_____

_____

_____

_____

(2)

(b) (i) Apple trees can be reproduced so that the apples from the new trees will taste the same as the apples from the parent trees.

Give **one** method used to reproduce apple trees in this way.

_____

_____

(1)

(ii) Explain why the method you have suggested in part **(b)(i)** will produce apples that taste the same as the apples from the parent trees.

_____

_____

_____

_____

_____

(2)

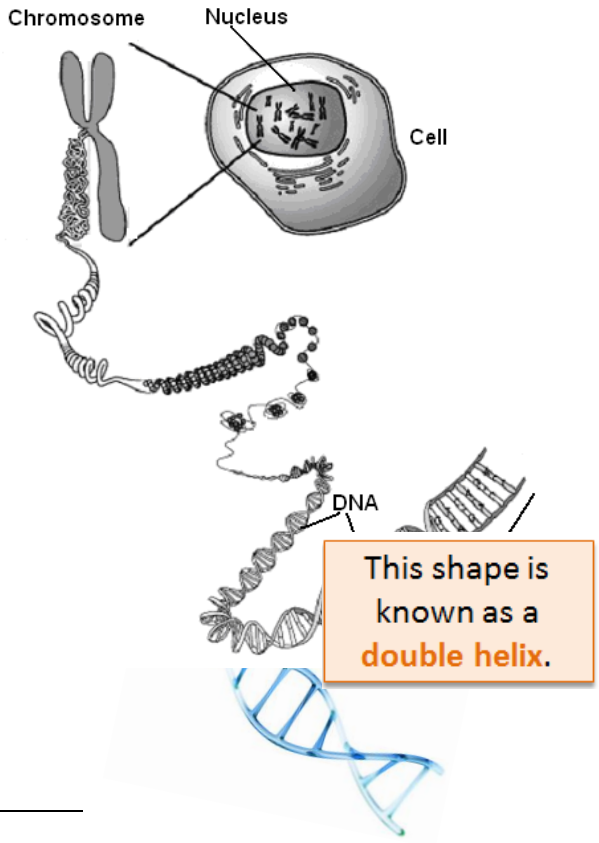
(Total 5 marks)

4.6.1.4 DNA and the genome

The genetic material in the nucleus of most cells is made from a chemical called DNA.

A polymer is a large molecule made from many smaller molecules called monomers.

- DNA: is a polymer, consists of two strands coiled into a double helix structure.
  - DNA has 2 main roles:
    1. It can replicate prior to cell division (mitosis or meiosis).
    2. Its code is used to synthesise proteins.
- Gene: is a small section of DNA.
  - Each gene codes for a particular combination of amino acids which make a specific protein.
    - These proteins determine our characteristics.
  - Some characteristics are controlled by a single gene.
  - **Each gene may have different forms called alleles**



Proteins have many different vital functions in our body.

- **Enzymes** – all made from protein.
- **Hormones** – all made from protein
- **Antibodies** – all made from protein
- **Structural** components such as muscle, hair and nail tissue.

Chromosomes are structures made up of long molecules of DNA.

The word genome describes all the genetic information of that organism. The human genome has been studied, which has improved our understanding of the genes linked to different types of disease, the treatment of inherited disorders and has helped in tracing human migration patterns from the past

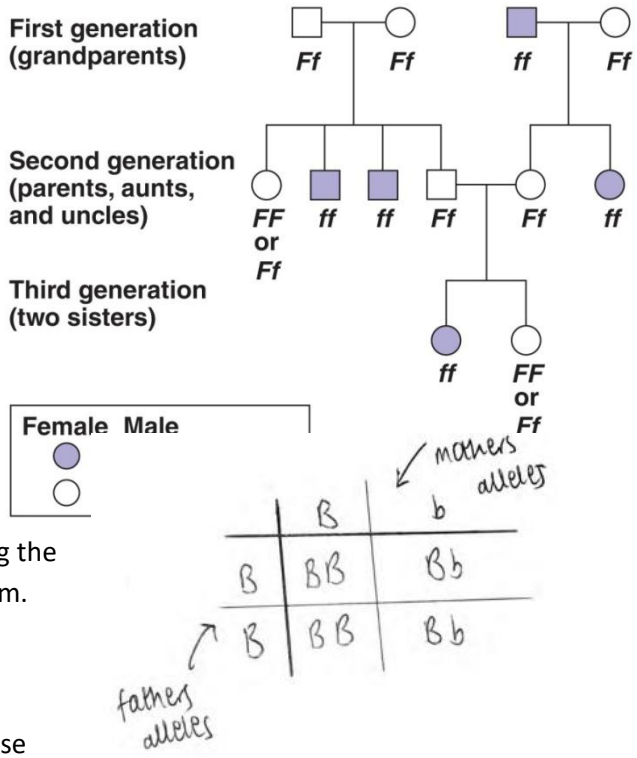
4.6.1.6 Genetic inheritance

You need to know the definitions for a number of terms.

Gamete	An organism's reproductive cell (egg in female and sperm in males), which has half the number of chromosomes (23).
Chromosome	A structure found in the nucleus which is made up of a long strand of DNA.
Gene	A short section of DNA that codes for a protein, and therefore contribute to a characteristic. Some characteristics are controlled by a single gene, such as fur colour in mice and red-green colour blindness in humans. However, most characteristics are the result of many different genes interacting.
Alleles	The different forms of the gene - humans have two alleles for each gene as they inherit one from each parent.
Dominant allele	Only one (out of the two alleles) is needed for it to be expressed and for the corresponding phenotype to be observed.
Recessive allele	Two copies are needed for it to be expressed and for the corresponding the phenotype to be observed.
Homozygous	When both inherited alleles are the same (i.e. two dominant alleles or two recessive alleles).
Heterozygous	When one of the inherited alleles is dominant and the other is recessive.
Genotype	The combination of alleles an individual has, e.g. Aa
Phenotype	The physical characteristics that are observed in the individual, e.g. eye colour

Family Trees: show the inheritance of different phenotypes over generations in the same family.

- The inheritance of traits in families can be illustrated using a family tree
- In this example, the allele for attached earlobes is recessive.
- F = allele for detached earlobes
- f = allele for attached earlobes
- FF and Ff = genotypes for detached earlobes
- ff = genotype for attached earlobes



Genetic crosses / drawing punnet squares:

A single gene cross looks at the probability of the offspring of two parents having certain genotypes and phenotypes. This is done using the alleles the two parents have for a gene and a Punnett square diagram.
You should be able to draw and use a Punnett square diagram

Uppercase letters are used to represent **dominant characteristics**. **Lowercase** letters represent **recessive characteristics**. You can choose any letter but usually either A or B is used for simplicity.

When working out genetic crosses ALWAYs identify the genotype and state the phenotype that will be shown. Work out the probability/ratio – this will depend on what the question is asking.

Inherited Conditions in Humans:

Polydactyly: People that inherit this condition have extra fingers or toes.

- It is caused by a dominant allele of a gene.
- If someone inherits one copy of this allele, they will develop the disorder.
- It can therefore be passed on by only one parent who has the disorder.

Cystic fibrosis:

- A disorder of cell membranes.
- It causes thick, sticky mucus to accumulate in the lungs and the digestive system.
- This causes:
    - Lung infections
    - Problems with breathing
    - Problems with digestion and absorption.
- It is caused by a recessive allele of a gene.
- The parents may be carriers of the disorder (Cc) without actually having the disorder themselves.
- It can therefore be passed on by parents, neither of whom has the disorder.
- To develop the disease, the allele must be inherited from both parents.

Embryonic screening allows scientists to observe whether the child will have a genetic condition or not.

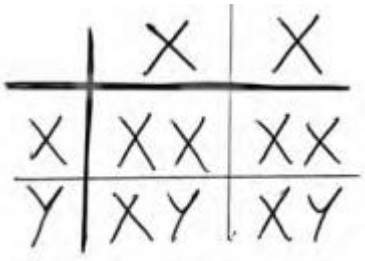
- If the embryo is developed in the lab, cells can be taken from it and analysed
- DNA from embryos in the womb can also be extracted

There are many economic, social and ethical issues surrounding embryonic screening.

Arguments for embryonic screening	Arguments against embryonic screening
Reduces the number of people suffering (ethical).	Could encourage people to pick characteristics - creating designer babies (ethical).
Treating disorders is very expensive (economic).	It is expensive to carry out screening (economic).
There are many regulations in place to stop it getting out of hand (social).	May promote prejudice as it suggests that those with genetic disorders will not live a full life or are unwanted (social).
	Decisions about terminating a pregnancy have to be made (social).
	The procedure can lead to a miscarriage (social).

Sex determination: In human body cells, one of the 23 pairs of chromosomes carries the genes which determine sex. 22 control characteristics, and the chromosomes in each pair look very similar. The 23rd pair carries sex determining genes, and the two chromosomes can look different to each other (Y chromosomes are much smaller than X chromosomes)

- In females the sex chromosomes are the same (XX).
- In males the sex chromosomes are different (XY).
- There is a 50% possibility of being a girl or a boy.
- As a foetus, we all start off with female characteristics.
- Presence of Y chromosome causes male development.
- Absence of Y chromosome continues female development.
- The sex of the baby is determined by the sex chromosome inherited from the father.



Exam practice 2

Q1. When humans reproduce, chromosomes and genes are passed on to the next generation.

In each of the following questions, draw a ring around the correct answer to complete the sentence.

(a) A gene is a small section of

- cellulose.
- DNA.
- protein.

(1)

(b) The sex chromosomes in the human male are

- X and X.
- X and Y.
- Y and Y.

(1)

(c) (i) Most human body cells contain

- 23 chromosomes.
- 46 chromosomes.
- 92 chromosomes.

(1)

(ii) The number of chromosomes in a human gamete (sex cell)

is

- the same number as
- half the number
- twice the number

in body cells.

(1)

(d) Gametes are produced by

- fertilisation.
- meiosis.
- mitosis.

(1)

(Total 5 marks)

Q2. In humans, hair colour is an inherited characteristic.

Red hair is caused by a recessive allele.

(a) When does a recessive allele control the development of a characteristic?

Tick (✔) **one** box.

When the allele is present on only one of the chromosomes. ☐

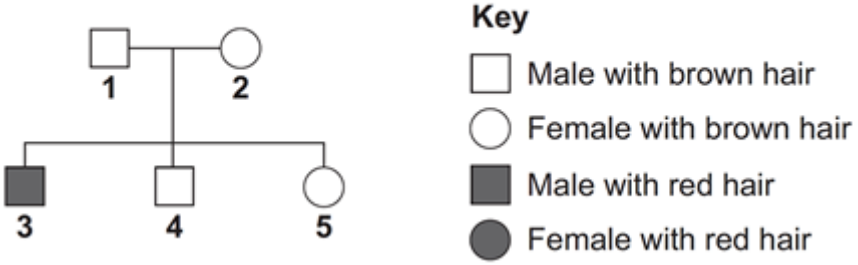
When the dominant allele is not present. ☐

When the allele is inherited from the female parent. ☐

(1)

(b) **Figure 1** shows the inheritance of hair colour in one family.

Figure 1



(i) Brown hair is caused by a dominant allele, **B**.

Red hair is caused by the recessive allele, **b**.

What combination of alleles does person **1** have?

Tick (✔) **one** box.

BB ☐

Bb ☐

bb ☐

(1)

(ii) Person **3** married a woman with brown hair.

Figure 2 shows how hair colour could be inherited by their children.

Figure 2

Complete **Figure 2** to show the combination of alleles that the children would inherit.

One has been done for you.

(2)

Person 3 Red hair \ Woman Brown hair	B	b
b	Bb	
b		

(iii) What is the probability that one of the children would have red hair?

Tick (✔) **one** box.

1 in 2 ☐

1 in 3 ☐

1 in 4 ☐

(1)

(Total 5 marks)

Q3. In humans, the sex chromosomes **X** and **Y** determine whether the baby will be male or female (its gender).

(a) (i) Draw a genetic diagram to show how gender is inherited. The male has **XY** chromosomes and the female has **XX.**

(2)

(ii) What is the likelihood of obtaining a male child?

_____

(1)

(b) In the 16th century Henry VIII was the King of England. He blamed some of his wives for giving birth to daughters instead of sons. With our present day knowledge of genetics this mistake could not be made today. Explain why Henry VIII was wrong.

_____

_____

_____

(2)

(Total 5 marks)

Q4. Some genetic disorders are caused by alleles inherited from the parents.

(a) What are **alleles**?

_____

_____

(1)

(c) Polydactyly is a genetic disorder that leads to extra fingers or toes.

Polydactyly is caused by a dominant allele, **D**.

The photograph shows the hand of a person with polydactyly.

A man has polydactyly. His wife does not have polydactyly.

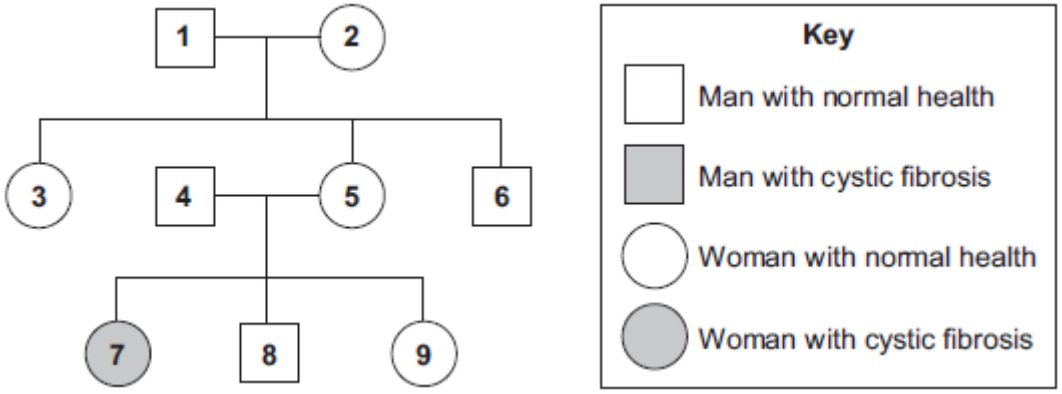
This couple's children have a 50% chance of having polydactyly.

Draw a genetic diagram to explain why.

(3)

(d) Cystic fibrosis is another genetic disorder. It is caused by a recessive allele.

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



Woman **5** is pregnant with her fourth child.

What is the probability that this child will have cystic fibrosis?

Draw a genetic diagram to explain your answer.

Use the following symbols.

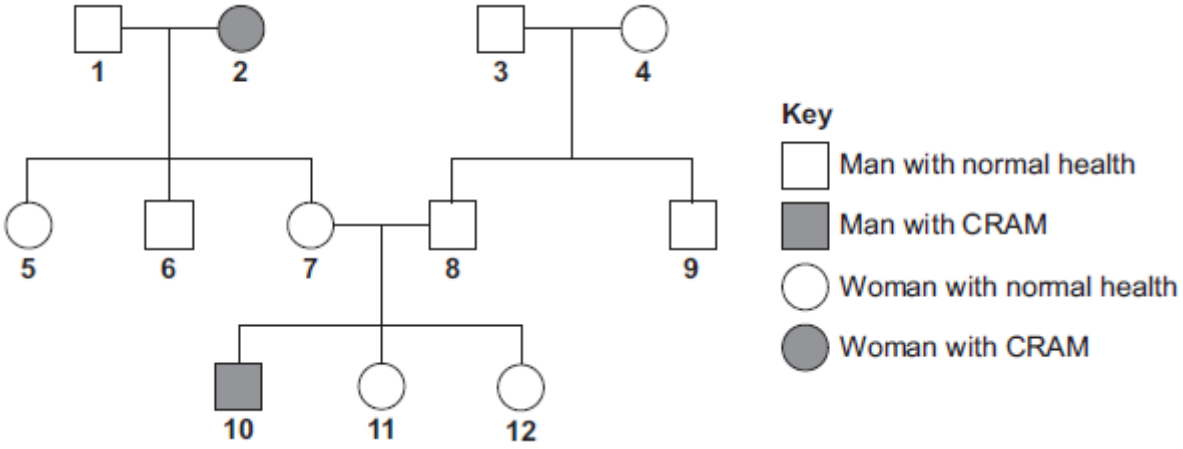
N = allele for normal health
n = allele for cystic fibrosis

(4)
(Total 12 marks)

Q5. CRAM is an inherited condition which causes muscle breakdown.

The breakdown products enter the urine, making it dark-coloured.

The diagram below shows the inheritance of CRAM in one family.



CRAM is caused by a recessive allele, **n**.

The allele for normal health is **N**.

(a) (i) What is an **allele**?

_____

_____

(1)

(ii) What does **recessive** mean?

_____

_____

(1)

(iii) Give evidence from the diagram that CRAM is caused by a **recessive** allele.

_____

_____

(1)

(b) (i) Person **2** is homozygous for CRAM.

What does **homozygous** mean?

_____

_____

(1)

(ii) None of person **2**'s children have CRAM.

Explain why.

_____

_____

_____

(2)

(c) Persons **7** and **8** want to have another child.

(i) What is the probability that this child will have CRAM?

Draw a genetic diagram to explain your answer.

Probability = _____

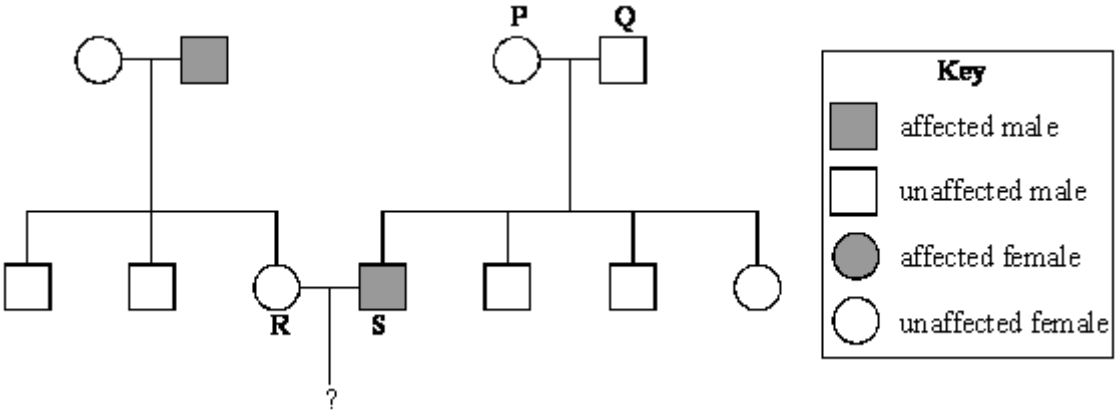
(4)

Q6. The black pigment in human skin and eyes is called melanin.

A single gene controls the production of melanin.

A person who is homozygous for the recessive allele of the gene has no melanin and is said to be albino.

The diagram shows the inheritance of albinism in a family.



(a) Use a genetic diagram to explain the inheritance of the albino allele by children of parents **P** and **Q**.

(3)

(b) **R** and **S** decide to have a child.

What is the chance that this child will be an albino? _____

Use a genetic diagram to explain your answer.

(3)

(Total 6 marks)

4.6.2 Variation and evolution

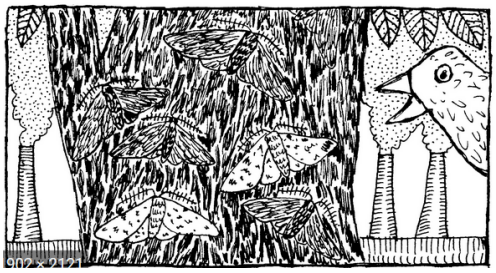
Variation means that individuals in a population show **differences** in characteristics (phenotype). Population is the number of one species in a habitat.

The **genome** and its **interaction** with **the environment** influence the development of a **phenotype** in an organism.

The phenotype an organism has **depends on two things**:

1. Genotype: the genes it inherited
   - Genes are passed on from the parent in sex cells.
   - The combining of genes from the mother and father creates genetic variation.
   - Only identical twins have the same genotype.
   - There is lots of genetic variation in a population.

2. Environment: the place it lives in
   - The conditions the organism grows and develops in also affects its appearance.
   - Examples include scars in animals, or smaller and yellow leaves in plants.



Sometimes characteristics can result from a combination of genetics and the environment, such as weight. Weight depends on the food you eat but also how quickly your body breaks it down and how much it stores as fat depends on your genes.

Genetic variation is introduced by **mutations** in the sequence of DNA.

Mutations:

How do mutations occur?

- Errors occur when the DNA is replicated prior to cell division.
- Errors may occur when chromosomes are separated during cell division.

What do mutations do?

- Genes control the synthesis of proteins.
- Therefore a change in a gene or a new sequence of genes can result in different proteins being synthesised.
- This can change a characteristic i.e. bring about a **new** phenotype

- Most mutations are harmful or fatal.
- Occasionally, some mutations are useful.
  - If the mutation does determine the phenotype and it is advantageous, natural selection will mean it becomes the common phenotype relatively quickly.

4.6.2.2 Evolution

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

Theory of Evolution: All species have evolved from simple life forms that first developed more than three billion years ago.

- These first organisms were very simple single-celled organisms, similar to bacteria.
- The theory of evolution by natural selection **was only gradually accepted** because:
  1) the theory **challenged the idea that God** made all the animals and plants that live on Earth
  2) there was **insufficient evidence** at the time the theory was published to convince many scientists
  3) the **mechanism of inheritance** and variation was **not known** until 50 years after the theory was published

Evolution occurs because of natural selection.

- Mutations occur which provide variation between organisms.
- If a mutation provides a survival advantage the organism is more likely to survive to breeding age.
- The mutation/alleles will then be passed onto offspring.
- Over many generations, the frequency of the mutation/alleles will increase within the population.

MRSA is a strain of bacteria which is **resistant** to several **antibiotics**.

The development of new antibiotics is very expensive and slow. It can take up to 10 years, once an antibiotic has been found, to bring it to market.

4.6.3.4 Evidence for Evolution

Evidence for evolution is seen in:

1. Fossils: the remains of organisms from many years ago, which are found in rocks
2. Antibiotic resistance in bacteria: the selection pressure of antibiotics leads to advantageous mutations being selected for in bacteria populations so they are no longer killed when exposed to antibiotics.

4.6.3.5 Fossils:

Fossils are the remains of organisms from millions of years ago, which are found in rocks

We can learn from fossils how much or how little different organisms have changed as life developed on Earth. However, The **fossil record** is **incomplete** for many reasons:

1. **Early life forms** were often **soft bodied** and so **few traces** remain.
2. Most organisms **do not** become **fossilised** as **conditions** are **rare**.
3. We are **still discovering fossils** which give us more information.
4. **Traces** are often **destroyed** by **geological activity** like earthquakes, volcanic eruptions, formation of mountain ranges and erosion.

Fossils may be formed in various ways:

- from the hard parts of animals that do not decay easily
- from parts of organisms that have not decayed because one or more of the conditions needed for decay are absent
- when parts of the organism are replaced by other materials as they decay
- as preserved traces of organisms, e.g. footprints, burrows and rootlet traces

Fossils are used to show how the anatomy of organisms has changed over time. They can be used to **compare how closely related two organism**s are, through looking at the number of similarities they have. This information is used to create evolutionary trees.

4.6.3.6 Extinctions:

- Various events can make it difficult for individuals to survive:
  - changes to the environment over geological time
  - new predators may arise
  - new diseases may arise
  - new, more successful, competitors may arise
  - a single catastrophic event, eg massive volcanic eruptions or collisions with asteroids.
- If the organisms cannot evolve quick enough to become better adapted to the change they may become extinct. If they do evolve, they are likely to develop into new species.

Q1. (c) Mutation may also give rise to variation.

(i) What is meant by mutation?

_____

_____

(1)

(ii) Are all mutations harmful? Explain the reason for your answer.

_____

_____

_____

_____

(2)

(Total 7 marks)

Q2. Darwin's theory of natural selection states that all living things have evolved from simple life forms.

(a) Use the correct answer from the box to complete the sentence.

three billion	**three million**	**three thousand**

Darwin's theory states that life began on Earth _____ years ago.

(1)

(b) Life evolved due to changes in genes. Changes in genes cause variation.

Complete the sentences.

Changes in genes are called _____ .

Individuals with characteristics most suited to the environment are more likely

to survive and _____ .

(2)

(Total 3 marks)

Q3. Fossils give evidence about organisms that lived a long time ago.

(a) Scientists have found very few fossils of the earliest life forms.

Give **one** reason why.

_____

_____

(1)

Below is a photograph of a fossilised fish.

(b) Suggest how the fossil in the photograph above was formed.

_____

_____

_____

_____

(2)

(c) The species of fish shown in the photograph above is now extinct.

Give **two** possible causes of extinction.

1. _____

_____

2. _____

_____

(2)

Modern fish species have evolved from fish that lived a long time ago.

Evolution is caused by mutation and natural selection.

(d) What is a mutation?

Tick **one** box.

A change in a gene	☐
Accidental damage to an organism	☐
An organism with a new characteristic	☐
The loss of a species	☐

(1)

(e) Describe the process of natural selection.

_____

_____

_____

_____

_____

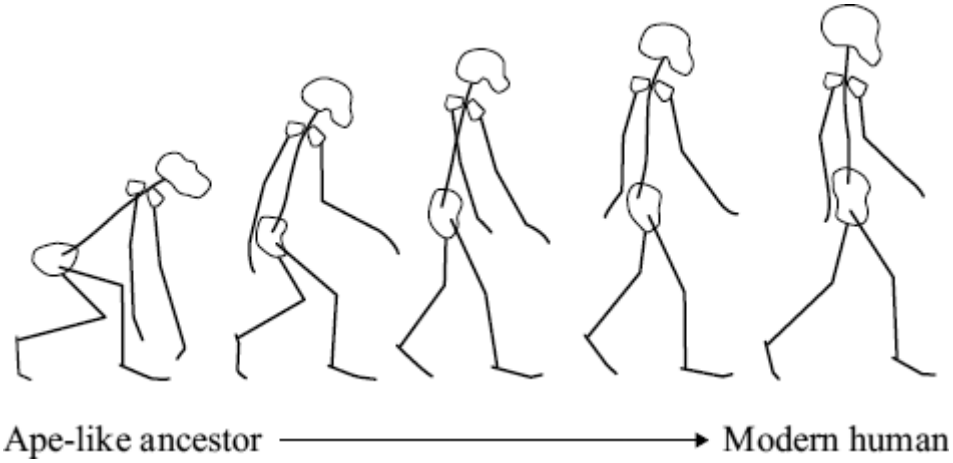
_____

(3)

(Total 9 marks)

Q4. (b) The drawings show stages in the evolution of the human skeleton.

All the drawings are to the same scale.



Use information from the drawings to describe **two** trends in the evolution of the human skeleton.

1. _____

_____

2. _____

_____

(2)

(c) Darwin said that humans had evolved from ape-like ancestors.

Many people disagreed with him at the time.

Give **two** reasons why.

1. _____

_____

2. _____

_____

(2)

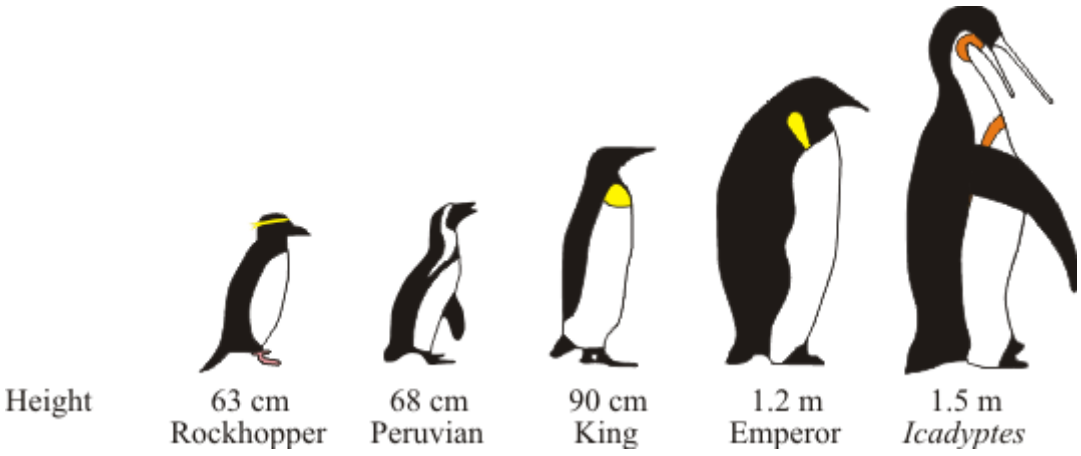
Q5.(a) Explain, as fully as you can, how natural selection leads to evolution.

(3)

(b) Most penguins live in cold climates. The modern penguin best adapted for cold conditions is the emperor penguin.

Scientists have found fossils of a 'giant' penguin which they have called *Icadyptes*.

The diagram shows how the size of modern penguins compares with *Icadyptes*.



The scientists were surprised to discover that *Icadyptes* lived in warm seas at a time when the Earth's climate was much warmer than it is now.

Explain why the scientists were surprised that *Icadyptes* lived in warm seas.

(2)

(Total 5 marks)

Q6.

Penicillin is an antibiotic which stops bacteria from reproducing. It was used a lot in the past to treat bacterial infections in humans and other animals. In many hospitals there are now strains of penicillin resistant bacteria.

Explain how natural selection could have produced these strains of penicillin resistant bacteria.

_____

_____

_____

_____

_____

_____

_____

_____

(Total 5 marks)

4.6.2.3 Selective Breeding

Selective breeding is when humans choose which organisms to breed in order to produce offspring with a certain desirable characteristic (e.g animals with more meat, plants with disease resistance or big flowers).

This has been happening for many years since animals were domesticated and plants were grown for food.

- Parents with desired characteristics are chosen.
- They are bred together.
- rom the offspring those with desired characteristics are bred together.
- The process is repeated many times until all the offspring have the desired characteristic.

The problem is that it can lead to inbreeding.

- Breeding those with similar desirable characteristics means it is likely you are breeding closely related individuals.
- This results in the reduction of the gene pool, as the number of different alleles reduce (as they mostly have the same alleles).
- This means if the environment changes or there is a new disease, the species could become extinct as they all have the same genetic make-up (so the chance of a few organisms having a survival advantage and not dying is reduced).
- Another problem is that the small gene pool leads to a greater chance of genetic defects being present in offspring, as recessive characteristics are more likely to present.

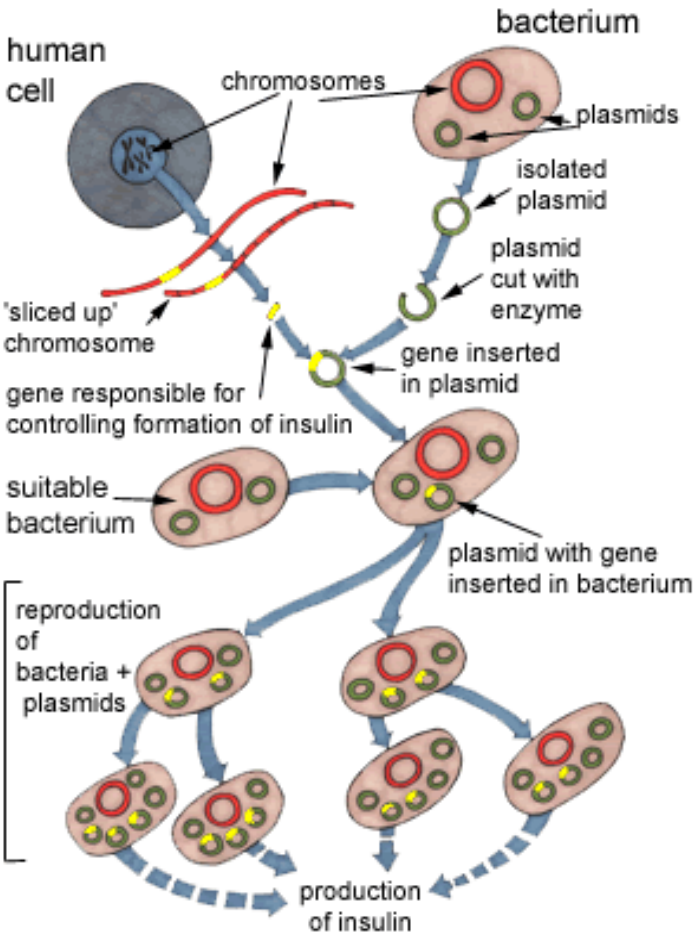
4.6.2.4 Genetic Engineering

Genetic engineering: Modifying the genome of an organism by introducing a gene from another organism to give a desired characteristic.

- Plant cells have been engineered for disease resistance or to have larger fruits
- Bacterial cells have been engineered to produce substances useful to humans, such as human insulin to treat diabetes.

<u>The process:</u>

1) Cut out the insulin gene from the DNA of a human cell using an enzyme.
2) Remove a ring of DNA / plasmid from a bacterium and open it up using the same enzyme.
3) Insert the insulin gene into the plasmid using another enzyme. Enable a bacterium to take up the altered DNA.
4) Put the bacterium in a fermenter, and it multiplies many times. Each new bacterium contains the insulin gene.
5) The bacteria produce insulin which can be extracted.



Genetically modified crops

- They are engineered to be resistant to insects and to herbicides.
- This will result in increased yields as less crops will die.

Genetic modification in medicine

- It may be possible to use genetic engineering to cure inherited disorders.

- It is called gene therapy and involves transferring normal genes (not faulty) into patients so the correct proteins are produced.

Other uses of genetic engineering:

- Genes can also be transferred to the cells of animals or plants at an early stage in their development so that they develop with desired characteristics:
    - This could be used to insert 'healthy' genes into an embryo that has a genetic disease.
- New genes can also be transferred to crop plants:
    - Crops that have had their genes modified in this way are called genetically modified crops (GM crops).
    - Examples of genetically modified crops include ones that are resistant to insect attack or to herbicides.
    - GM crops generally show increased yields.

Concerns:

- Long-term, unpredicted effects of consuming GM plants on human health.
- Genes for pesticide resistance may spread from GM plants to their wild relatives, creating pesticide resistant weeds.
- People may want to manipulate the genes of their future children.

Exam practice 4

Q1. Genetic engineering is being used to help sufferers of cystic fibrosis.

In the sentence below, cross out the **two** lines which are wrong in each box.

In genetic engineering, genes are cut out of	cell membranes chromosomes cytoplasm	using	drugs enzymes hormones	

(Total 2 marks)

Q2. Insecticides are chemicals which kill insects.
Insecticides may be sprayed onto crops to increase crop yield.

(a) Killing insects on crops increases crop yield.

Suggest why.

_____

_____

(1)

(b) A microorganism contains a gene which causes the production of an insect poison.

Scientists transferred the gene for production of the insect poison into wheat plants.
This makes genetically modified (GM) wheat.

The scientists:

- grew wheat plants with the insect poison gene in fields and in greenhouses
- grew wheat plants without the insect poison gene in fields and in greenhouses

- measured the crop yield of the wheat plants.

The bar chart shows the results.

(i) What was the yield of the wheat with the insect poison gene grown in greenhouses?

_____ arbitrary units

(1)

(ii) The yield from wheat without the insect poison gene grown in greenhouses was different from the yield you gave in (b)(i).

Describe this difference in yield.

_____

_____

_____

_____

(2)

(iii) Look again at the bar chart.

What advice would you give to a farmer about the type of wheat to grow in fields?

Give a reason for your answer.

_____

_____

_____

_____

(2)

(c) Some people are concerned about the use of GM crops.

Why?

_____

_____

_____

_____

_____

(2)

(Total 8 marks)

Q3.

Scientists have produced many different types of GM (genetically modified) food crops.

(a) Use words from the box to complete the sentence about genetic engineering.

clones	**chromosomes**	**embryos**	**genes**

GM crops are produced by cutting _____ out of the _____ of one plant and inserting them into the cells of a crop plant.

(2)

(b) Read the information about GM food crops.

- Herbicide-resistant GM crops produce higher yields.
- Scientists are uncertain about how eating GM food affects our health.
- Insect-resistant GM crops reduce the total use of pesticides.
- GM crops might breed naturally with wild plants.
- Seeds for GM crops can be bought from only one manufacturer.
- The numbers of bees will fall in areas where GM crops are grown.

Use this information to answer these questions.

(i) Give **two** reasons why some farmers are in favour of growing GM crops.

1. _____

_____

2. _____

_____

(2)

(ii) Give **two** reasons why many people are against the growing of GM crops.

1. _____

_____

2. _____

_____

(2)

(Total 6 marks)

Q4.

Insulin is now made by a biotechnological process. A description of the process is given below. Complete the gaps in the sentences.

(a) The first step in the biotechnological process is that a special enzyme is used to cut the insulin _____ out from a human _____ .

In a separate operation, a ring of bacterial _____ is cut open using a special enzyme.

These two pieces of genetic material are combined together to form a new plasmid ring which is inserted into a bacterium.

(3)

(b) Explain why large quantities of insulin are produced when this bacterium is put into a culture medium.

_____

_____

_____

(2)

(c) Before insulin was made in this way, it could only be obtained from sheep and pigs. Suggest **two** reasons, other than preventing the exploitation of animals, why it is better to obtain insulin by genetic engineering than from animals.

1. _____

_____

2. _____

_____

(2)

(Total 7 marks)

Q5.

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.

1. _____

_____

2. _____

_____

(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.

_____

_____

_____

_____

_____

_____

_____

_____

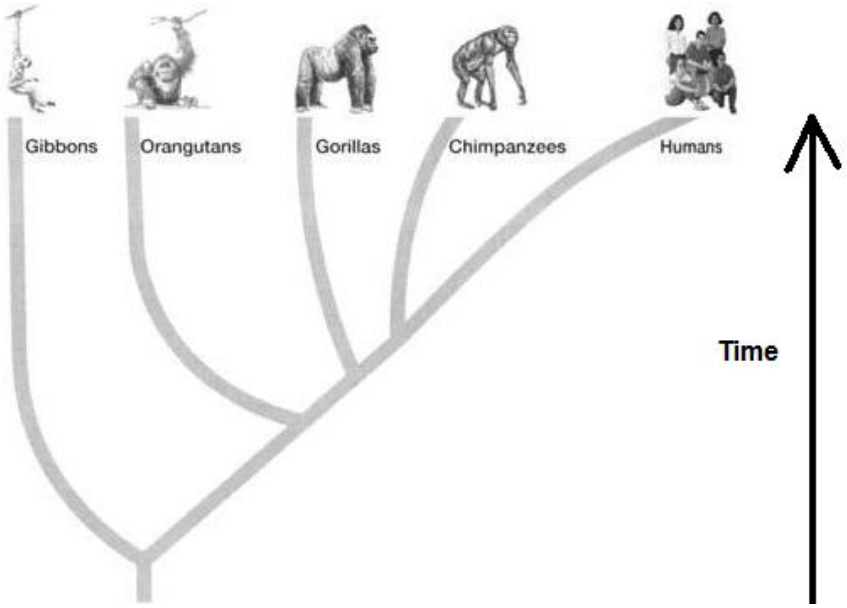
(4)

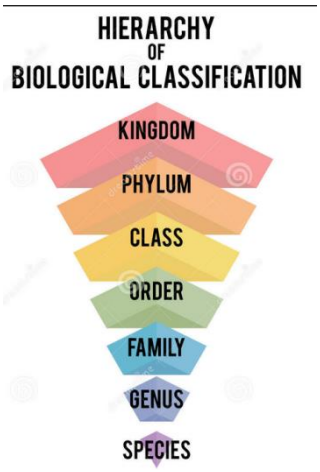
(Total 7 marks)

4.6.4 Classification of living organisms

Studying the similarities and differences between organisms allows us to classify living organisms into animals, plants and microorganisms.

- This helps us to understand evolutionary and ecological relationships.
- Models allow us to suggest relationships between organisms.
- Evolutionary trees (models): used to show how closely related organisms are.
    - This tree indicates how long ago the ancestors of ape species diverged from each other.
    - It indicates that humans share a common ancestor with chimpanzees more recently than with any other ape species.





The Linnaean system

- Carl Linnaeus put this forward in the 1700s
- Living things were divided into kingdoms, phylum, class, order, family, genus, species.

The binomial system gives each organism a name which is used worldwide (overcomes language barriers). The first part is their genus and the second part is their species. An example is the ladybug, which has the name Harmonia (genus) axyridis (species).

Three-domain system

- Developments in science such as the improvement of the microscope and increased knowledge of biochemistry (for example, RNA sequence analysis) found that some species were more distantly related than first thought
- Carl Woese added three large groups called **domains above kingdoms**
    - **Archaea**: primitive bacteria which live in extreme environments such as hot springs
    - **Bacteria**: true bacteria (despite having similar features to archaea)
    - **Eukaryota**: organisms who have a nucleus enclosed in membranes, includes the kingdoms protists, fungi, plants and animals

Exam practice 5

Q1.(a) Complete the sentences about evolution.

Draw a ring around the correct answer to complete each sentence.

(i) Darwin suggested the theory of evolution by

artificial
natural
asexual

selection.

(1)

(ii) Darwin's theory of evolution says that all species of living things have evolved from

artificial
complex
simple

life forms.

(1)

(iii) Most scientists believe that life first developed about

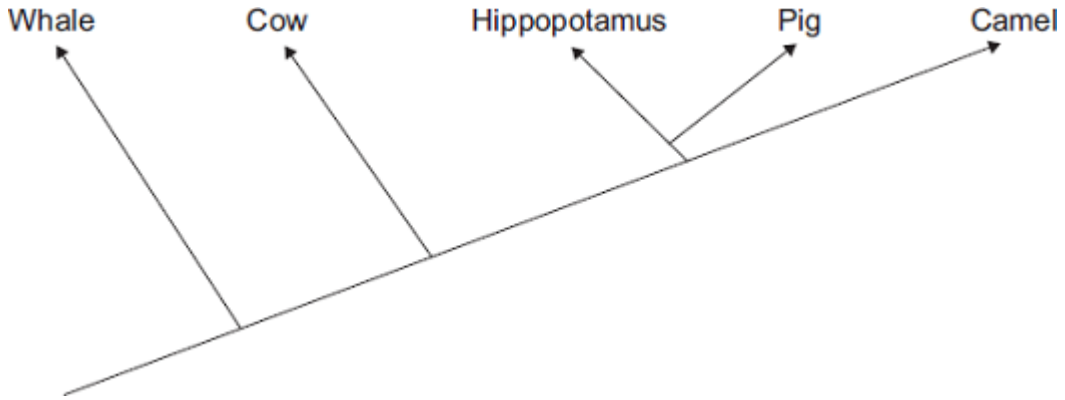
three billion
three million
three thousand

years ago.

(1)

(c) **Diagram 1** shows one model of the relationship between some animals.

Diagram 1



(i) Complete the sentence.

The model shown in **Diagram 1** is an evolutionary _____ .

(1)

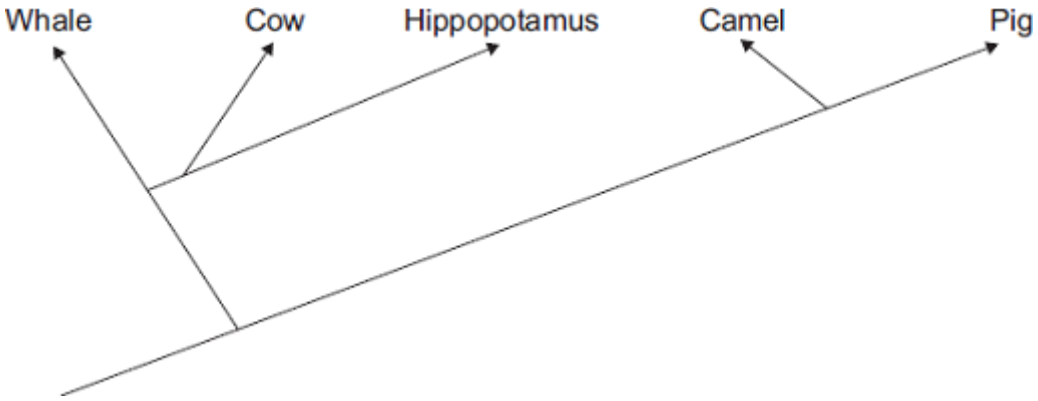
(ii) Which **two** of the animals in **Diagram 1** are most closely related?

_____ and _____

(1)

(iii) Diagram **2** shows a more recent model of the relationship between the animals.

Diagram 2



Suggest **one** reason why scientists have changed the model of the relationships between the animals shown in the diagram.

Draw a ring around the correct answer.

more powerful computers	**new evidence from fossils**	**new species discovered**

(1)

(Total 8 marks)

Q2. Living organisms are classified into the following groups:

- Kingdom
- Phylum
- Class
- Order
- Family
- Genus
- Species

(a) Which scientist first suggested this type of classification system?

Tick **one** box.

Alfred Russel Wallace	☐
Carl Linnaeus	☐
Charles Darwin	☐
Gregor Mendel	☐

(1)

The stone plant, *Lithops bromfieldi*, is adapted to live in very dry deserts.

Figure 1 shows several stone plants.

Figure 1

(b) Give the genus to which the stone plant belongs.

_____

(1)

Q3. **Figure 1** shows a ring-tailed lemur.

Figure 1

The table below shows part of the classification of the ring-tailed lemur.

Classification group	**Name**
Kingdom	*Animalia*
Phylum	*Chordata*
	Mammalia
	Primates
	Lemuroidea
Genus	*Lemur*
	catta

(a) Complete the table above to give the names of the missing classification groups.

(2)

(b) Give the binomial name of the ring-tailed lemur.

Use information from the table above.

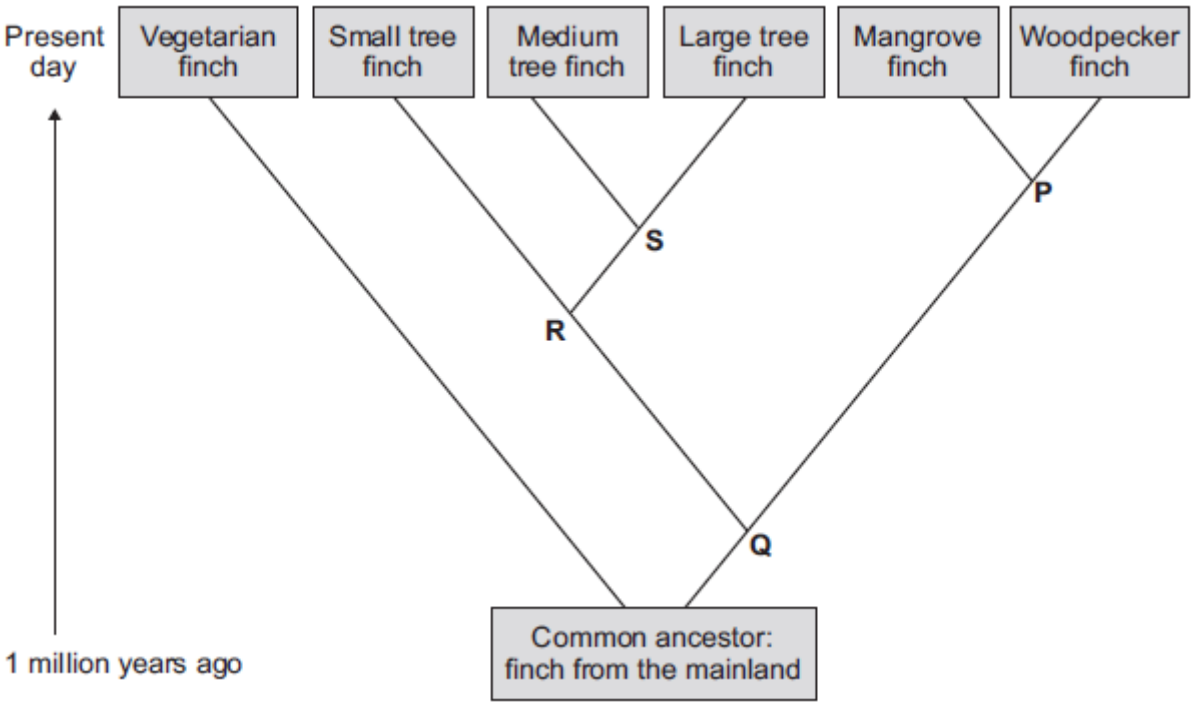
_____

(1)

Q4. 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.

(c) The diagram below 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**?

Write the correct answer in the box. ☐

(1)

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

1. _____

2. _____

(1)

(Total 9 marks)