PEARSON EDEXCEL A-LEVEL BIOLOGY A · 9BN0

BIOLOGY



EXAM QUESTION PACK

TOPIC 3: VOICE OF THE GENOME

SCORE	PERCENTAGE
/485	%

STEMUP

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Q1.

Mineral ions are required for plant growth.

(i) Nitrate ions are required for the synthesis of

(1)

☒ **A** amino acids

☒ **B** cellulose

☒ **C** starch

☒ **D** sucrose

(ii) Phosphate ions are required for the synthesis of

(1)

☒ **A** cellulose

☒ **B** chlorophyll

☒ **C** nucleic acids

☒ **D** sucrose

(iii) Magnesium ions are present in the structure of

(1)

☒ **A** amino acids

☒ **B** cellulose

☒ **C** chlorophyll

☒ **D** starch

(Total for question = 3 marks)

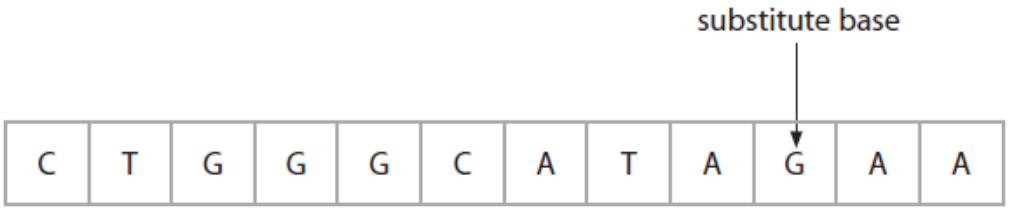
Q2.

Thalassaemia is a recessive genetic disorder that affects the production of haemoglobin. It is caused by a gene mutation.

Scientists are developing methods to repair gene mutations such as the one that causes

thalassaemia.

One of the most common mutations causing thalassaemia is the substitution of one adenine base with guanine. The diagram shows the location of the mutation in part of the DNA strand coding for four amino acids.



Explain why this mutation affects the function of the haemoglobin molecule.

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(Total for question = 3 marks)

Q3.

The consistency of the mucus is determined by the movement of water, by osmosis, from the cells lining the bronchi.

Explain how the partial permeability of the surface membrane of the cells lining the bronchi allows osmosis to take place.

(2)

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Q4.

All cells have a cell surface membrane.

Cell surface membranes regulate the movement of substances into and out of cells.

(i) Which of the following describes the movement of water by osmosis?

(1)

☒ **A**	against a solute concentration gradient	through a fully permeable membrane
☒ **B**	against a solute concentration gradient	through a partially permeable membrane
☒ **C**	down a solute concentration gradient	through a fully permeable membrane
☒ **D**	down a solute concentration gradient	through a partially permeable membrane

(ii) The concentration of potassium ions inside an animal cell is many times higher than the concentration of potassium ions in the extracellular fluid.

Which mechanism is responsible for the uptake of potassium ions by this animal cell?

(1)

☒ **A** active transport

☒ **B** exocytosis

☒ **C** osmosis

☒ **D** passive diffusion

(iii) Glucose enters cells by facilitated diffusion.

Which part of the cell surface membrane allows facilitated diffusion of glucose?

(1)

☒ **A** cholesterol

☒ **B** glycolipid

☒ **C** phospholipid

☒ **D** protein

(Total for question = 3 marks)

Q5.

Peat bogs are formed over millions of years from the remains of plants and animals.

Waterlogging and acidic conditions prevent the decomposition of plants and animals in peat bogs.

The photograph shows peat being cut from a peat bog.



(Source: © Reimar/Shutterstock)

(i) State how the age of the layers in a peat bog can be determined.

(1)

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(ii) Explain why the conditions in peat bogs prevent decomposition.

(3)

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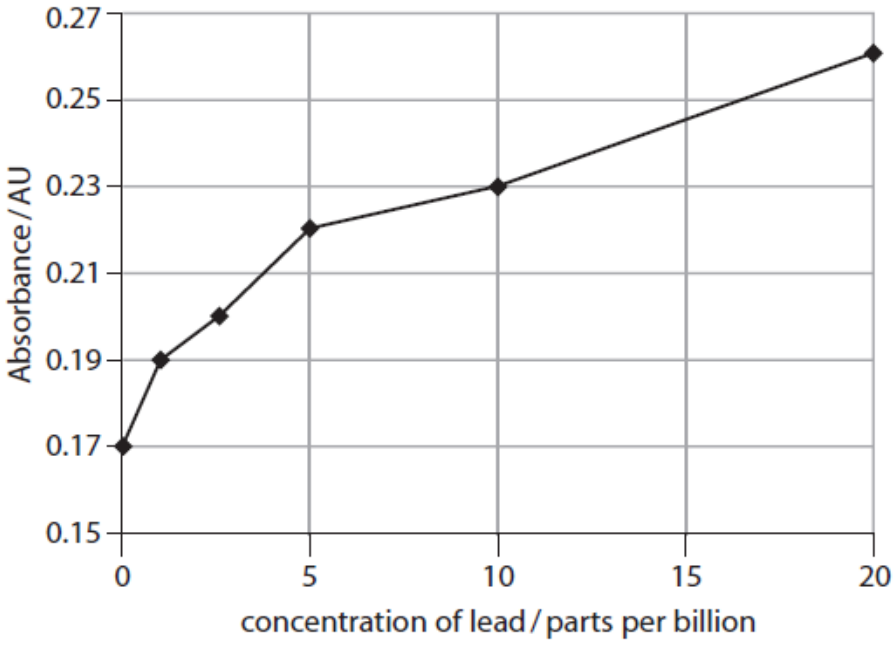
(Total for question = 4 marks)

Q6.

Lead is a toxic metal that can affect the structure of proteins. Lead affects protein in a similar way to changing pH.

Beetroot vacuoles contain a pigment. The absorbance of a solution is proportional to the concentration of the pigment in the solution.

The graph shows the results of a scientific investigation to study the effect of increasing lead concentration on the permeability of the membranes of beetroot cells.



(a) State the name of the membrane that surrounds the vacuole in beetroot cells.

(1)

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(b) Calculate the difference in percentage increase in absorbance between the lead concentration of 0-10 parts per billion and 10-20 parts per billion.

(3)

Answer ..... %

(c) (i) Explain the effect of lead on membrane permeability in beetroot cells.

(2)

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(ii) Devise an investigation to determine whether pH has a similar effect to lead on the permeability of the membranes of beetroot cells.

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(Total for question = 10 marks)

Q7.

Porphyria is a life-threatening genetic disease. It is caused by a mutation in the gene coding for an enzyme involved in the production of haem.

In people with porphyria, haem cannot be produced.

Explain why this mutation may prevent the enzyme involved in the production of haem from functioning correctly.

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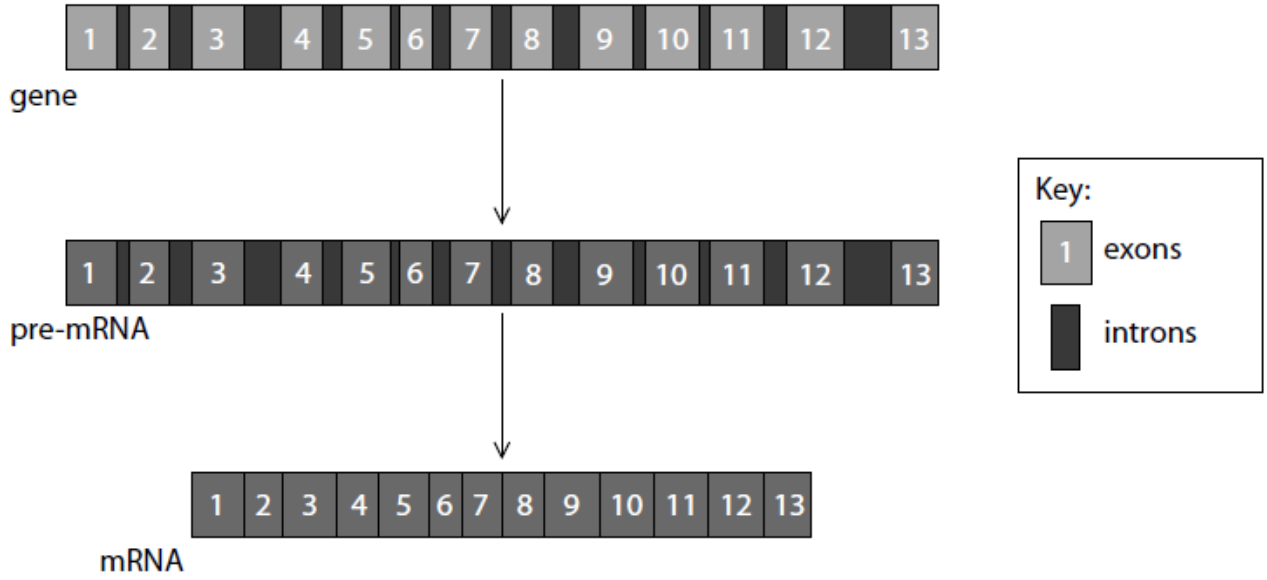
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(Total for question = 4 marks)

Q8.

A central idea in biology is that DNA codes for the synthesis of proteins from amino acids. The instructions for making proteins are in the form of mRNA.

The diagram shows two stages in the production of mRNA.



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(a) Explain how this molecule of mRNA is produced.

(4)

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(Total for question = 4 marks)

Q9.

The scientific article you have studied is adapted from 'How Performance-Enhancing Drugs Work.'

Use the information from the article and your own knowledge to answer the following questions.

(a) (i) The population of the UK is 63 182 000 of which 49 182 000 are adults (paragraph 13).

Calculate the number of adults who have asthma.

(2)

Answer .....

(ii) People with asthma sometimes have difficulty breathing (paragraph 13).

Explain how beta-2 agonists may help to relieve their symptoms.

(2)

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(iii) Explain how beta-2 agonists can increase the heart rate (paragraph 13).

(4)

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(b) Explain how human growth hormone (HGH) is able to stimulate cells to secrete IGF-1 (paragraphs 20 and 21).

(4)

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(c) Explain why it is difficult to identify athletes who are using banned substances such as HGH (paragraphs 17, 20 and 22).

(2)

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(d) Explain one benefit of using substances developed from perfluorocarbons (PFCs) to treat patients with breathing difficulties (paragraphs 30 and 31).

(2)

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(e) Local anaesthetics mask pain by binding to protein channels in the membranes of neurones (paragraph 38).

Explain how binding to protein channels will prevent pain being sensed by the pain centre of the brain.

(4)

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(f) Explain why diuretics are a prescribed drug for high blood pressure (paragraph 43).

(2)

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(g) A test for the T/E ratio can help to identify athletes who have injected testosterone into their body (paragraph 45).

Explain the limitation of this test.

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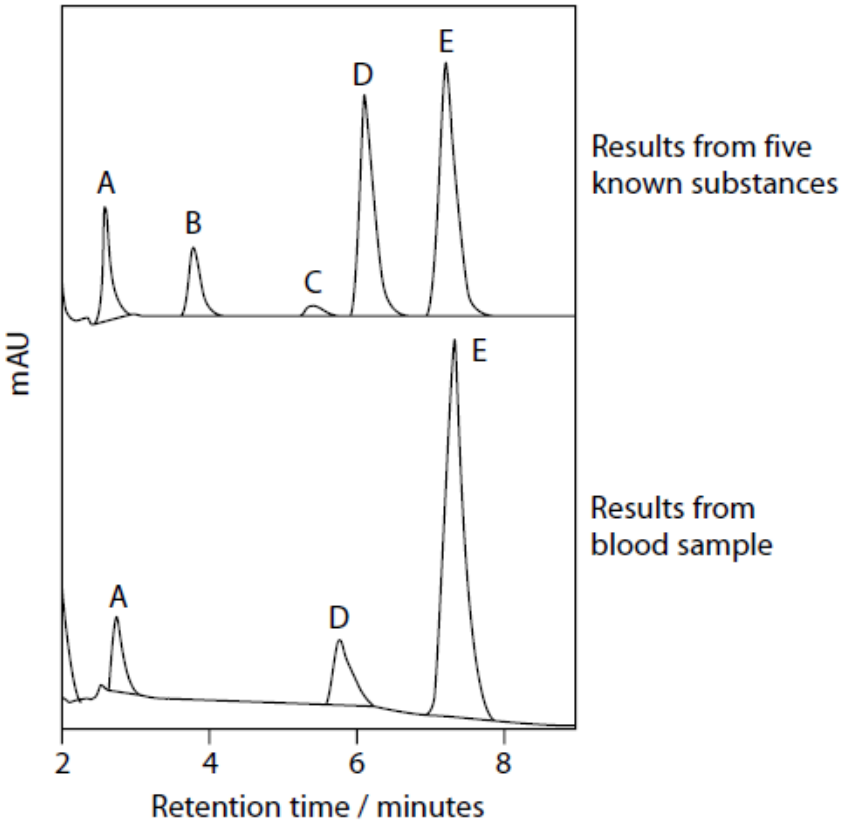
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(h) Gas chromatography (GC) can be used to detect athletes who have taken banned drugs (paragraph 48).

The chromatogram shows the GC results for five known banned substances, A, B, C, D and E.



Explain why the peak for drug E is different from the peak for drug A (paragraph 48).

(2)

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(i) Explain how the blood passport may result in more effective monitoring of athletes (paragraph 51).

(2)

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(j) Comment on the ethical viewpoints for and against the use of performance-enhancing drugs by athletes.

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(Total for question = 33 marks)

Q10.

Answer the questions with a cross in the boxes you think are correct ☒. If you change

your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

In the lungs, oxygen moves from the alveoli into red blood cells.

(i) How many times does an oxygen molecule cross a cell surface membrane to move from the centre of an alveolus to the centre of a red blood cell?

(1)

☒ **A** 2

☒ **B** 3

☒ **C** 4

☒ **D** 5

(ii) Oxygen enters the red blood cell by

(1)

☒ **A** active transport

☒ **B** diffusion

☒ **C** facilitated diffusion

☒ **D** osmosis

(Total for question = 2 marks)

Q11.

Penicillin is an antibiotic. It was discovered in 1928. Since then many antibiotics have been identified and are widely used in the treatment of bacterial infections.

Scientists have recently discovered a new class of antibiotics that bind to ribosomes.

(i) Explain why these antibiotics could affect the production of proteins in bacteria.

(3)

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(ii) These new antibiotics attach to a site on the ribosome not affected by any known antibiotics.

Deduce why these new antibiotics might be used to treat bacteria that are resistant to other antibiotics.

(2)

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* (iii) Scientists have isolated these new antibiotics and tested their effectiveness against bacteria that are resistant to other types of antibiotic.

Devise a laboratory procedure to compare the effectiveness of penicillin with one of the new antibiotics.

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(Total for question = 11 marks)

Q12.

(i) Many of the proteins synthesised become extracellular enzymes.

Describe what happens to these proteins following the process of translation until they are released from the cell.

(3)

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(ii) Cells in people with these diseases produce incorrectly folded enzyme molecules.

Explain why enzymes that are incorrectly folded cannot carry out their function.

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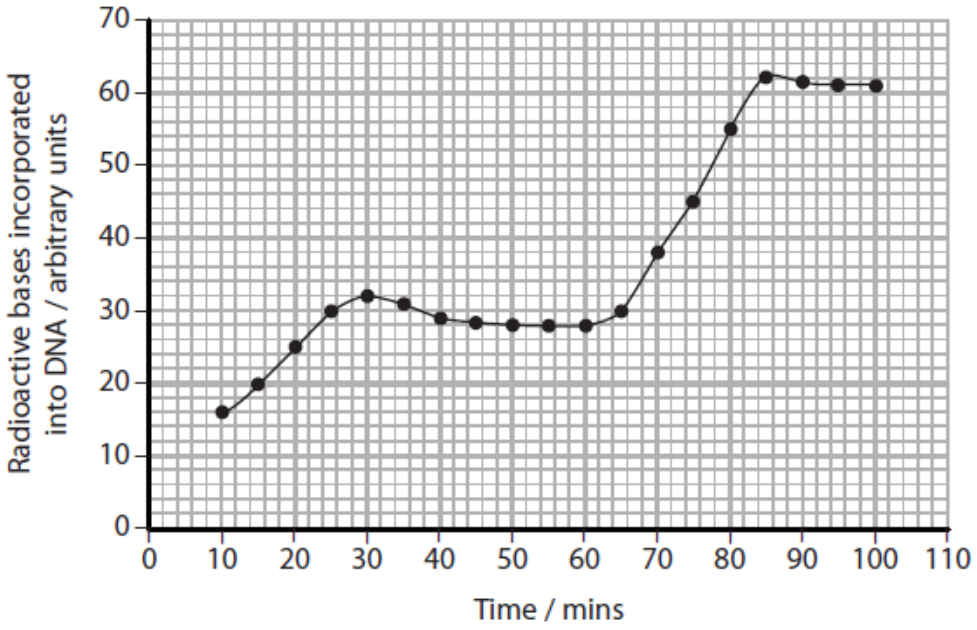
(Total for question = 6 marks)

Q13.

DNA synthesis in bacterial cell cultures has been investigated.

In an experiment, a mixture of radioactive bases was added to a culture of dividing bacteria.

The results are shown in the graph.



(i) Calculate the fastest rate of uptake of bases by these bacteria.

(2)

Answer .....

(ii) Deduce how many times the bacteria in the culture have divided during this experiment.

(2)

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(iii) Explain why the experiment would be improved if all the bases were provided but only the thymine was radioactive.

(2)

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(Total for question = 6 marks)

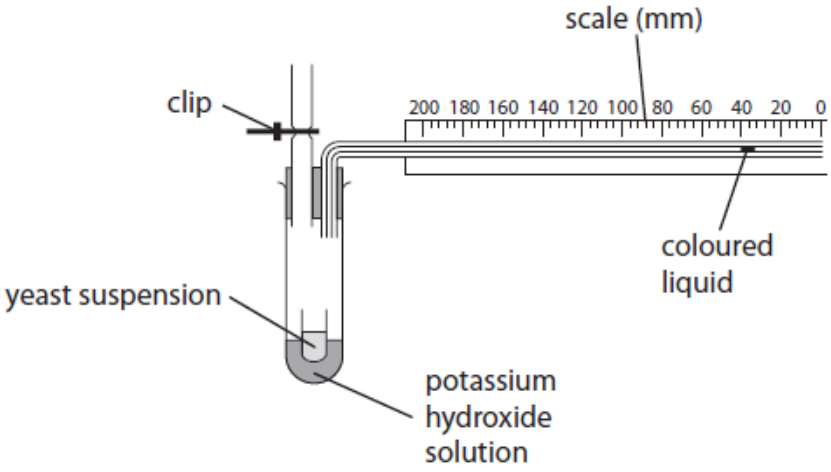
Q14.

Yeast is a single-celled organism that can respire aerobically.

Mitochondria are the sites of aerobic respiration in yeast cells.

It has been stated that if the temperature of yeast is raised by 10 °C, the rate of respiration will double.

The diagram shows some apparatus that can be used to measure the rate of respiration in yeast.



Devise an investigation using this apparatus to determine whether an increase of 10 °C doubles the rate of respiration in yeast.

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(Total for question = 4 marks)

Q15.

All cells have a cell surface membrane.

Some epithelial cells in the lungs secrete mucus. If the mucus is too 'sticky', it cannot be easily removed from the lungs.

Other epithelial cells in the lungs contain CFTR proteins in their cell surface membranes.

(i) Describe the role of the CFTR protein in ensuring that the mucus produced in the lungs has the right consistency.

(3)

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(ii) The table shows part of the gene that codes for the CFTR protein and the corresponding amino acid sequence. Each amino acid is represented by a single letter.

Part of the CFTR gene	ATTAAAGAAAATATCATCTTTGGTGTTTCCTAT										
Amino acid sequence	I	K	E	N	I	I	F	G	V	S	Y

Explain how the information in the table demonstrates the nature of the genetic code.

(3)

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(Total for question = 6 marks)

Q16.

There are a number of reactions that regularly occur in cells.

* Another reaction that regularly occurs in cells is phosphorylation.

Phosphorylation plays a significant role in a wide range of cellular processes. Over a quarter of a million scientific articles have been written on this subject.

Using your knowledge of biology, discuss the roles of phosphorylation in cells.

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Q17.

Trypsin is an enzyme found in many groups of living organisms.

Trypsin specifically acts on a polypeptide to form amino acids.

State the type of chemical reaction catalysed by trypsin.

(1)

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(Total for question = 1 mark)

Q18.

Enzymes control biochemical pathways.

Phosphofructokinase is an enzyme involved in controlling the rate of glycolysis.

State what is meant by the term enzyme.

(2)

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(Total for question = 2 marks)

Q19.

Collagen is a fibrous protein.

Explain how the structure of collagen is related to its function.

(4)

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Q20.

In birds and mammals, gas exchange takes place between the blood in the capillaries and the air in the alveoli.

There are three layers between the blood and the air in the alveoli: the capillary wall, a layer of extracellular matrix and the alveolar wall. This is called the blood-gas barrier.

The extracellular matrix contains collagen.

(i) Describe the structure of collagen.

(3)

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(ii) Give a function for collagen in the blood-gas barrier.

(1)

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(Total for question = 4 marks)

Q21.

Hereditary spherocytosis is a condition that affects red blood cells.

This inherited condition is caused by a gene mutation that affects the shape of the cell surface membrane.

Describe the structure of the cell surface membrane.

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(Total for question = 3 marks)

Q22.

Global warming can affect abiotic factors that determine the distribution of organisms.

The presence of sodium chloride in soil is an abiotic factor that affects the germination of seeds.

The effects of sodium chloride solution and gibberellin on the germination of rice seeds have been investigated.

Gibberellin regulates developmental processes in plants.

Gibberellins can activate the gene for amylase in rice seeds.

Amylase is an enzyme that hydrolyses starch in the rice seeds.

Devise an investigation to demonstrate the effect of gibberellin on amylase activity in rice seeds treated with sodium chloride.

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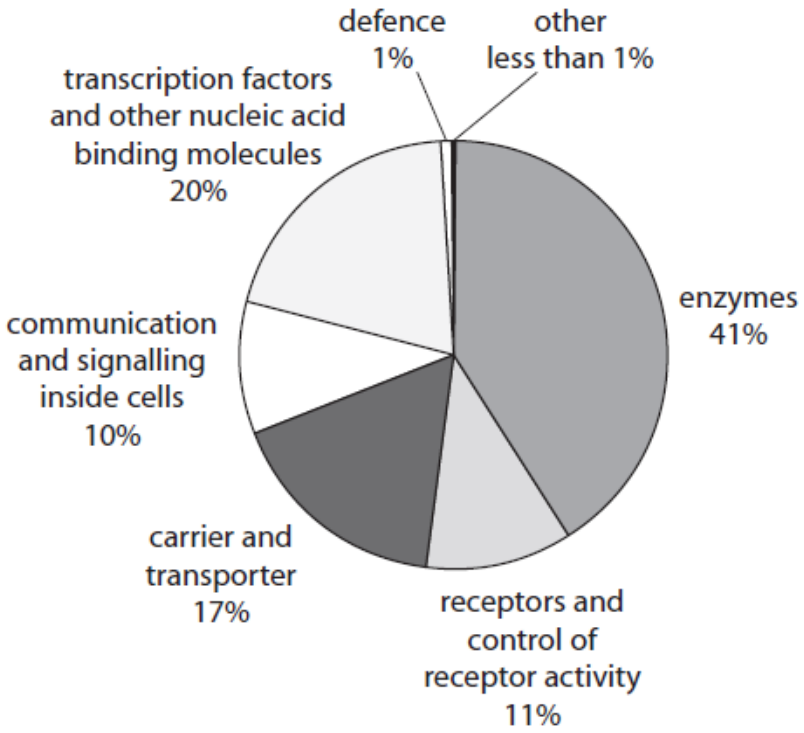
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(Total for question = 4 marks)

Q23.

* The human genome codes for approximately 20 000 different proteins.

The pie chart shows the proportion of proteins carrying out different functions.



The 20 amino acids used to make proteins can be classified according to the properties of their side chains (R groups).

Table 1 shows the number of amino acids with these properties.

Property of the side chain group	Number of amino acids with the property
Non-polar	9
Polar, uncharged	6
Negatively charged	3
Positively charged	2

Table 1

Table 2 shows three amino acids, used to synthesise proteins, that have unique properties.

Amino acid	Comment on structure
Cysteine	The side chain contains a thiol group (-S-H) that is chemically reactive.
Glycine	The side chain is a hydrogen atom which is much smaller than any other side chain. This allows tight coiling of polypeptide chains.
Proline	The side chain forms a peptide bond with the nitrogen in the amino group. This makes a polypeptide chain more rigid.

Table 2

Discuss the importance of the amino acid side chain to the structure, function and location of proteins.

(9)

(Total for question = 9 marks)

Q24.

The inheritance of coat colour in mice has been investigated.

Some scientists crossed mice that had yellow coats. The offspring had either yellow coats or non-yellow coats.

(i) Explain how the scientists knew which allele for coat colour was recessive.

(2)

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(ii) The crosses led to a total of 1599 offspring being produced.

Predict the number of yellow and non-yellow offspring produced.

(2)

Offspring with a yellow coat	Offspring with a non-yellow coat

(iii) The table shows the actual number of offspring with each coat colour.

Offspring with a yellow coat	Offspring with a non-yellow coat
1064	535

Explain why there are differences between the predicted and actual numbers of these mice.

(3)

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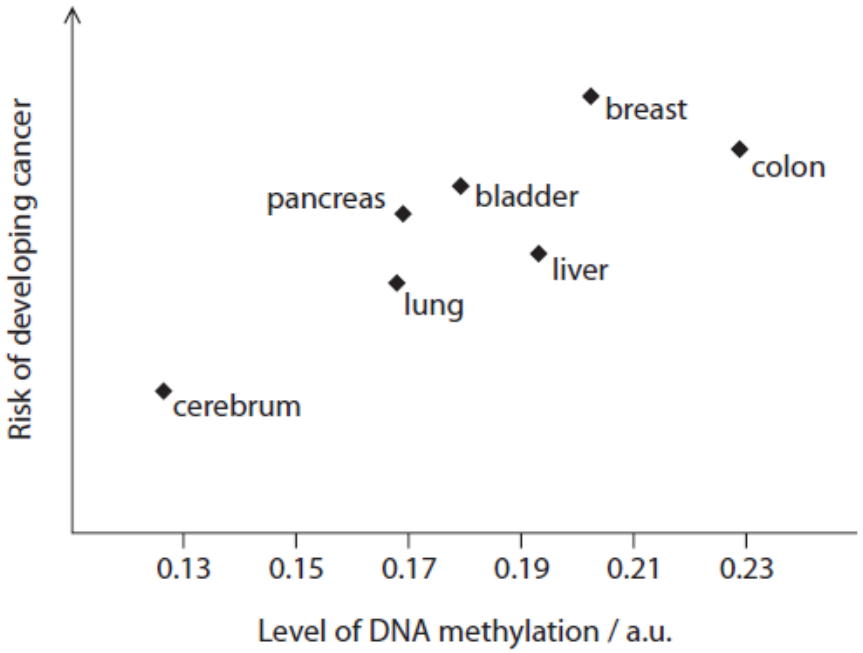
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(Total for question = 7 marks)

Q25.

There is a link between the methylation of certain regions of DNA and the risk of developing cancer.

The graph shows the relationship between the level of methylation of these regions of DNA and the risk of developing cancer in different parts of the body by the age of 70.



(i) Draw a line of best fit on the graph to identify any correlation between the

independent variable and the dependent variable.

(1)

(ii) An investigation studied the effect of age on the mean level of DNA methylation.

In this investigation, the null hypothesis was rejected at the 5% significance level.

Explain what is meant by the phrase: the null hypothesis was rejected at the 5% significance level for this investigation.

(2)

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*(iii) Scientists have found that a high level of succinate leads to the inhibition of an enzyme called TET.

The function of TET is to remove methyl groups from DNA.

Explain how a mutation in the gene for succinate dehydrogenase can increase the risk of developing cancer.

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(Total for question = 9 marks)

Q1.

At the start of fertilisation, many sperm cells will surround the ovum.

Fertilisation begins with the acrosome reaction.

(i) Which of the following describes the acrosome reaction?

(1)

☒ **A** the ovum releases enzymes that digest the egg cell membrane

☒ **B** the ovum releases enzymes that digest the zona pellucida

☒ **C** the sperm cell releases enzymes that digest the egg cell membrane

☒ **D** the sperm cell releases enzymes that digest the zona pellucida

(ii) Which of the following statements describes the genetic content of a sperm cell?

(1)

	Each sperm cell will contain	Different sperm cells will contain
☒ **A**	one copy of each gene	different alleles of some genes
☒ **B**	one copy of each gene	the same alleles for all genes
☒ **C**	two copies of each gene	different alleles of some genes
☒ **D**	two copies of each gene	the same alleles for all genes

(Total for question = 2 marks)

Q2.

Yeast is a single-celled organism that can respire aerobically.

Mitochondria are the sites of aerobic respiration in yeast cells.

(i) Name two molecules needed for aerobic respiration that can move into the mitochondria.

(2)

1 .....

2 .....

(ii) The outer mitochondrial membrane is not permeable to hydrogen ions (H^+).

Explain the importance of this feature of the membrane.

(4)

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(Total for question = 6 marks)

Q3.

The scientific article you have studied is adapted from *Scientific American*.

Use the information from the scientific article and your own knowledge to answer the following question.

"Why is aging, smoking or radiation exposure associated with cancer?" (paragraph 8).

Explain why "These things cause mutations".

(3)

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(Total for question = 3 marks)

Q4.

(i) Muscle contains actin and myosin protein fibres.

Which of the following describes the primary structure of a protein?

(1)

☒ **A** amino acids joined by hydrogen bonds

☒ **B** amino acids joined by ester bonds

☒ **C** amino acids joined by peptide bonds

☒ **D** amino acids joined by phosphodiester bonds

(ii) Describe the structure of an amino acid.

(3)

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Q5.

Answer the questions with a cross in the boxes you think are correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Moving a limb involves the interaction of muscles, tendons and ligaments.

Tendons and ligaments are important structures in elbow and knee joints.

(i) Which of the following identifies the structures that join bones to bones in an elbow joint?

(1)

☒ **A** ligaments only

☒ **B** ligaments and tendons

☒ **C** tendons only

☒ **D** neither ligaments nor tendons

(ii) One type of joint injury is a torn ligament. This may be treated by adding a piece of tendon to the ligament. This is because after a period of time, the tendon tissue changes and responds in the same way as a ligament.

Which of the rows in the table correctly describe the changes in this piece of tendon?

(1)

Row	Piece of tendon shows a change in its	The change is
1	genotype	an anatomical adaptation
2	genotype	a physiological adaptation
3	phenotype	an anatomical adaptation
4	phenotype	a physiological adaptation

☒ **A** row 1 only

☒ **B** row 3 only

☒ **C** rows 1 and 2

☒ **D** rows 3 and 4

*(iii) The photograph shows athletes competing in the modern triathlon.



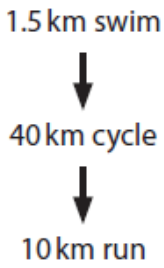
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The modern triathlon involves three sports: swimming, cycling and running.

An investigation was carried out to compare the level of demand on the body of these three sports during a triathlon.

The investigation involved 12 athletes who were all males of the same age.

Each athlete carried out the triathlon as shown in the flow diagram. There was no rest period between each sport.



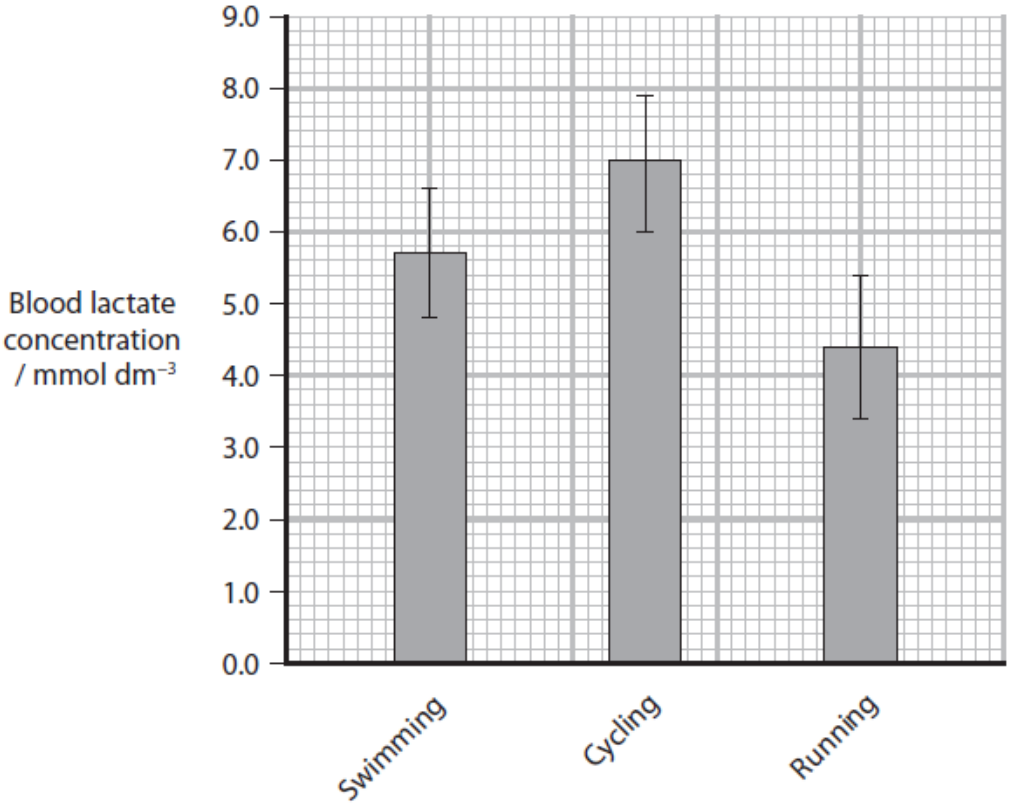
The heart rate for each athlete was measured as they completed each sport.

The mean heart rate for each sport was then calculated and is shown in the table.

Sport	Mean heart rate / bpm
Swimming	163
Cycling	165
Running	159

The blood lactate level for each athlete was also measured as they completed each sport. Means for lactate level after each sport were calculated.

The results are shown in the graph.



It was concluded that cycling was the most demanding of the three triathlon sports. This was followed by swimming and then running.

Evaluate the validity of this conclusion.

(6)

(Total for question = 8 marks)

Q6.

The structure of the cell surface membrane can be explained using the fluid mosaic model.

This model suggests that there are a variety of different proteins and glycoproteins present in a phospholipid bilayer.

* The ratio of lipid to protein in a cell surface membrane is approximately 1:1.

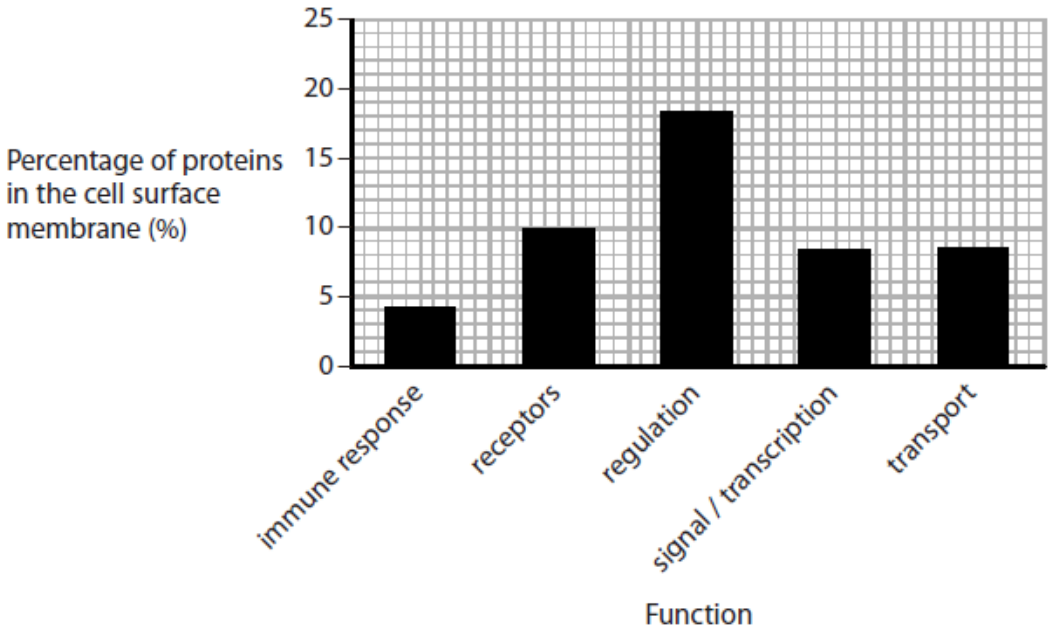
Scientists have studied the proteins present within human cells. Proteins in a cell are found in several locations.

The table shows the percentage of protein found in some locations in a cell.

Location within a cell	Percentage of total protein present (%)
cell surface membrane	68.2
cytoplasm	1.4
endoplasmic reticulum / Golgi apparatus	1.4
nucleus	14.5
other	14.5

The proteins within the cell surface membrane were further analysed for their function.

The graph shows some of the results of this analysis.



Analyse the data to evaluate the following statement.

'*The variety of different proteins present in the cell surface membrane makes them more important than the phospholipid bilayer to the functioning of that cell.*'

(9)

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(Total for question = 9 marks)

Q7.

Tuberculosis (TB) is an infectious disease caused by mycobacteria.

Individuals infected with M. tuberculosis can be treated with antibiotics.

Four of the antibiotics used to treat TB are shown in the table.

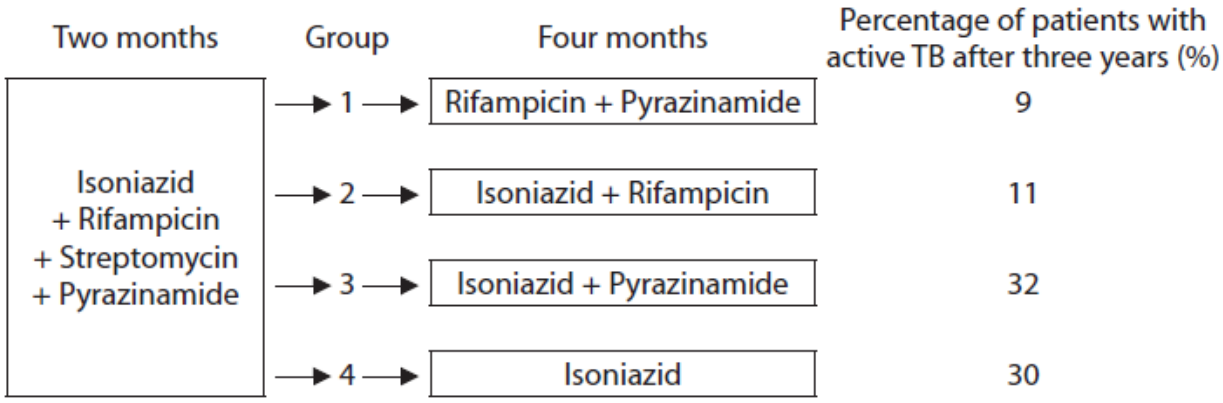
Antibiotic	Mechanism of action
Isoniazid	Inhibits the synthesis of a fatty acid needed to make bacterial cell walls
Rifampicin	Inhibits bacterial RNA polymerase
Streptomycin	Binds to bacterial ribosomes to prevent the binding of tRNA
Pyrazinamide	Not yet known, but not the same mechanisms as the other three antibiotics

In one clinical trial lasting six months, the effect of treating TB with these antibiotics was investigated.

All patients were treated with all four antibiotics for two months. Then they were treated with different pairs of antibiotics or isoniazid alone for a further four months.

All patients were free of any signs of active TB at the end of the clinical trial.

The design of the trial and the percentage of these patients with TB three years after the trial ended are shown in the diagram.



Analyse the data to comment on the effectiveness of these antibiotics for the treatment of TB.

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(Total for question = 6 marks)

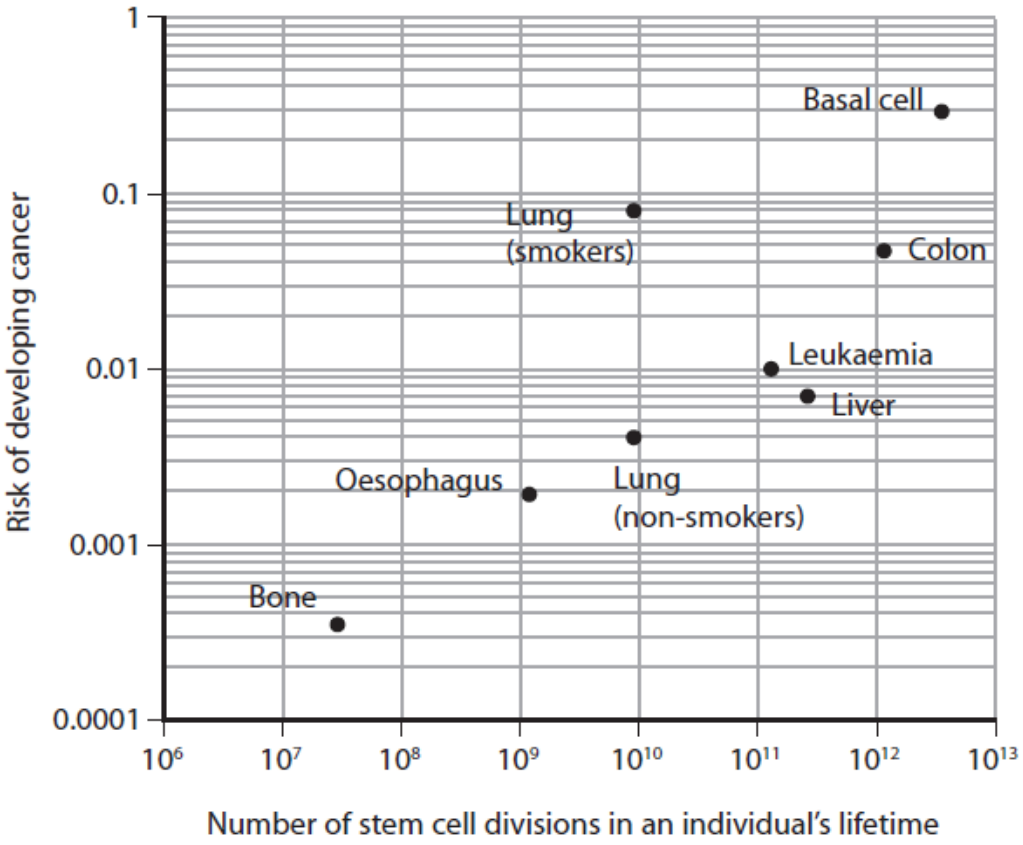
Q8.

Tissues of the human body have different stem cell populations.

These stem cells divide to replace and renew cells in these tissues.

Scientists have observed a relationship between the number of times a stem cell population divides in a tissue and the risk of developing cancer in that tissue.

This relationship is shown in the graph.



(i) The correlation coefficient for the data is 0.937.

The table shows some critical values for this correlation coefficient.

Critical values for the correlation coefficient	
n	**p = 0.05**
4	1.00
5	0.90
6	0.83
7	0.71
8	0.64
9	0.60
10	0.56

Which of the following correctly describes the correlation?

(1)

☒ **A** non-significant and positive

☒ **B** non-significant and negative

☒ **C** significant and positive

☒ **D** significant and negative

(ii) Explain the relationship between the number of stem cell divisions and the risk of developing cancer.

(2)

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(iii) The graph shows that the risk of developing lung cancer is greater in a cigarette smoker compared to a non-smoker.

Calculate how many times greater.

(2)

Answer .....

(iv) Explain why cigarette smokers have a higher risk of developing lung cancer than non-smokers.

(2)

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Q9.

*Genetic testing can be used to identify individuals who have genetic disorders such as Batten disease.

The table shows examples of some types of genetic screening and examples of where they may be used.

Type of screening	Method	Example
Blood test to identify risk of a disease	DNA from a blood sample is examined	Identifying presence of BRCA1 and BRCA2 mutations where there is a family history of breast cancer
Blood test to identify carriers of a genetic disease	DNA from a blood sample is examined	Establishing if a person is heterozygous for a recessive condition such as cystic fibrosis (CF)
Amniocentesis	Fetal DNA from amniotic fluid is tested	Identifying genetic disorders in the fetus
Chorionic villus sampling (CVS)	Fetal DNA from placental tissue is tested	Identifying genetic disorders in the fetus
Non-invasive prenatal diagnosis (NIPD)	Analysis of fetal DNA fragments from blood samples from the mother	Identification of chromosomal disorders and a small number of single gene disorders in the fetus
Pre-implantation genetic diagnosis (PGD)	Combined with IVF to test embryo at 8-cell stage	Ensures only embryos without a genetic disorder such as CF are implanted

Assess the advantages and disadvantages of these types of screening for genetic disorders.

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(Total for question = 6 marks)

Q10.

All known organisms can be placed into one of the three domains of life.

The table shows some information about the three different domains.

Feature	Archaea	Bacteria	Eukaryota
DNA is circular	Yes	Yes	No
DNA is single-stranded	No	.....	No
Growth inhibited by the antibiotic streptomycin	No	Yes	No
Name of the link between fatty acids and glycerol in lipids	Ether	Ester	Ester
Presence of cell wall	Some	Yes	.....
Methionine required for starting protein synthesis	Yes	No	Yes
Transcription factors required for transcription	Yes	No	Yes

Complete the table to show the features in Bacteria and in Eukaryota.

(2)

(Total for question = 2 marks)

Q11.

Scientists have studied behavioural, anatomical and genetic variation in elephants.

The table shows some information about two populations of African elephants.

Population	Location	Feeding behaviour	Anatomical differences
Forest elephant	tropical forest of central and West Africa	feeds on leaves and fruits of high-growing plants such as shrubs and trees	• lower jaw longer and narrower • tusks straighter and downward facing • overall a much smaller size
Savannah elephant	African savannah	feeds on grass and leaves of low-growing shrubs	• lower jaw shorter and wider • tusks more curved and upward facing • overall a larger size

The photographs show elephants from the two populations.



Forest elephant



Savannah elephant

DNA samples were collected from these two populations of elephants.

One of the genes showing variation was the GBA gene. The table shows the frequency of the alleles of the GBA gene in the two populations.

GBA allele	Frequency of allele in the elephant population	
	Savannah elephant	Forest elephant
J	0.05	0.43
K	0.00	0.57
L	0.95	0.00

(i) State what is meant by the term **allele**.

(1)

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(ii) Use the Hardy-Weinberg equation to show that more than 50% of the forest elephant population are homozygous for the GBA gene.

(3)

Answer .....

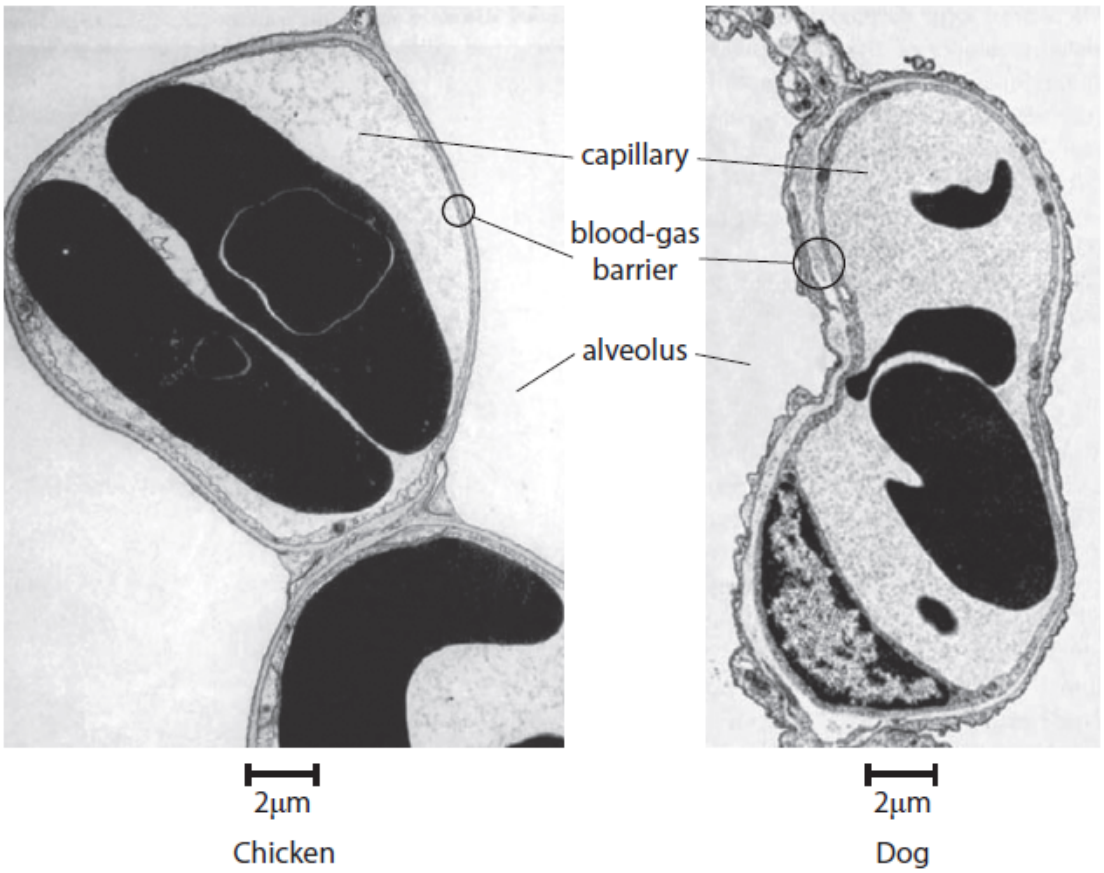
(Total for question = 4 marks)

Q12.

In birds and mammals, gas exchange takes place between the blood in the capillaries and the air in the alveoli.

There are three layers between the blood and the air in the alveoli: the capillary wall, a layer of extracellular matrix and the alveolar wall. This is called the blood-gas barrier.

The electron micrographs show the blood-gas barriers for a chicken and a dog.



Explain how the blood-gas barrier of the chicken is adapted to give more efficient gas exchange than the blood-gas barrier of the dog.

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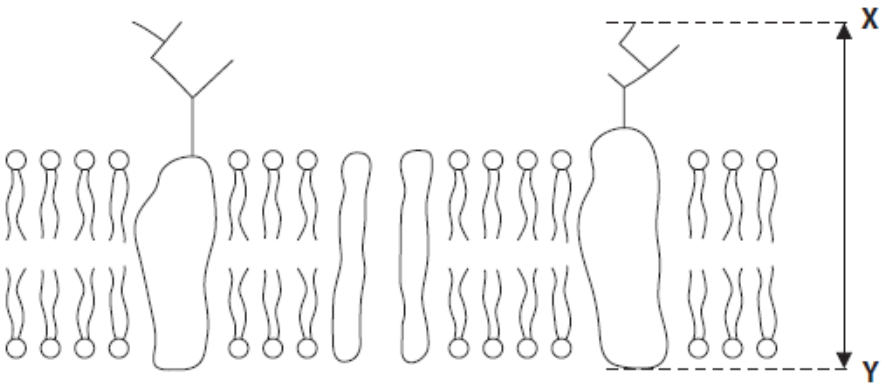
(Total for question = 3 marks)

Q13.

The structure of the cell surface membrane can be explained using the fluid mosaic model.

This model suggests that there are a variety of different proteins and glycoproteins present in a phospholipid bilayer.

The drawing shows the cell surface membrane of a liver cell. The drawing has a magnification of 5×10^6.



Calculate the actual length of the glycoprotein between points **X** and **Y**.
Give your answer with an appropriate unit.

(2)

Answer .....

(Total for question = 2 marks)

Q14.

During the development of the mammalian heart, there is a hole between the left ventricle and the right ventricle.

This hole usually becomes sealed before the mammal is born. If it is not sealed, the mammal will become easily tired due to a lack of energy.

Explain why a mammal born with a hole between the two ventricles will have these symptoms.

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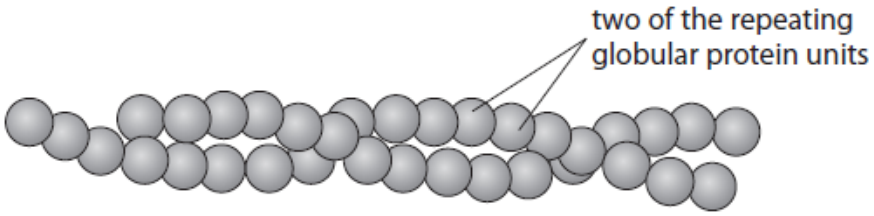
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(Total for question = 3 marks)

Q15.

Actin and collagen are both proteins.

The diagram shows two filaments of actin from a muscle fibre. Each filament is a polymer of repeating globular protein units.



Compare and contrast the structures of an actin filament and collagen.

(3)

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(Total for question = 3 marks)

Q16.

Glucosaminoglycans (GAGs) are the by-products of chemical reactions inside cells. GAGs are broken down by enzymes inside lysosomes in cells.

Mucopolysaccharidosis type I (MPS I) is a genetic condition that results in the build-up of GAGs inside cells.

MPS I affects the production of enzyme G that breaks down GAGs inside lysosomes.

Enzymes work by

(1)

☒ **A** increasing the activation energy of a reaction

☒ **B** lowering the activation energy of a reaction

☒ **C** providing energy to the reactants

☒ **D** removing energy from the products

(Total for question = 1 mark)

Q17.

Beetroot cells contain the pigment betalain.

When beetroot cells are placed in alcohol, the concentration of betalain in the cells changes.

Explain why alcohol affects the concentration of betalain in these cells.

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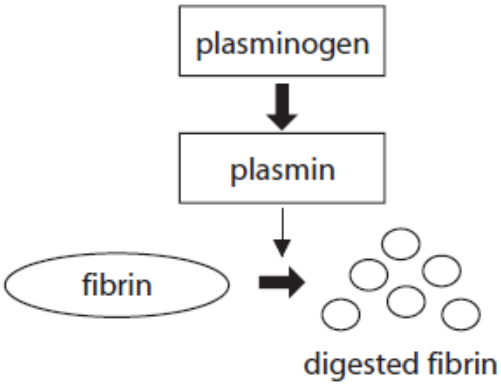
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(Total for question = 3 marks)

Q18.

Plasmin is an enzyme that digests fibrin.

Plasmin is produced, in the blood, from an inactive form of the enzyme called plasminogen.

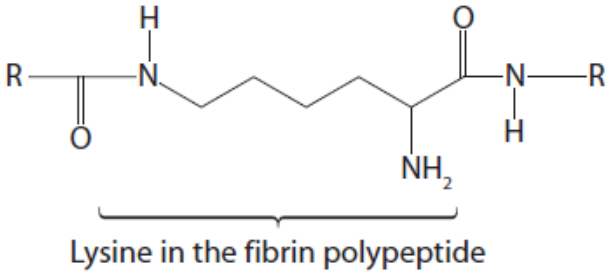


Pharmaceutical companies have developed drugs that inhibit the activity of plasmin.

One of these drugs, tranexamic acid, is used in surgery to reduce blood loss.

The active site of the plasmin enzyme binds to the amino acid lysine on the fibrin protein molecule.

Plasmin binds to part of the fibrin molecule in order to break down the fibrin. The diagrams show the structure of lysine in the fibrin polypeptide and the structure of tranexamic acid.



Lysine in the fibrin polypeptide



tranexamic acid

Deduce why tranexamic acid prevents plasmin breaking down fibrin.

(3)

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(Total for question = 3 marks)

Q19.

Leptin is a protein hormone with a role in the control of appetite in humans.

The leptin gene is located on chromosome 17.

(i) State what is meant by the term gene.

(2)

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(ii) Describe the role of tRNA in the production of leptin.

(3)

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(iii) Describe how the primary structure of leptin enables it to be soluble in water.

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(Total for question = 8 marks)

Q20.

Leptin is a protein hormone with a role in the control of appetite in humans.

Several mutations of the leptin gene have been identified. All these mutations are frameshift mutations that result in shortened primary structures.

A frameshift mutation involves the insertion or removal of one or two nucleotides from a gene.

Describe how a frameshift mutation could result in the production of leptin with a variety of shorter primary structures.

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(Total for question = 2 marks)

Q21.

Some species of bacteria have developed resistance to antibiotics.

This has led scientists to investigate many molecules for antimicrobial properties.

Peptides extracted from broad bean plants and cowpea plants have been studied.

Describe how a peptide bond is formed.

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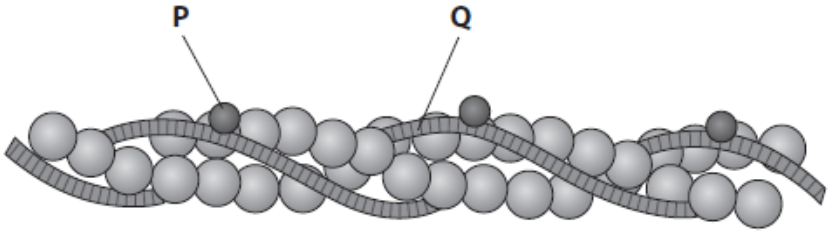
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(Total for question = 2 marks)

Q22.

The diagram shows actin and other components (P and Q) of a thin filament in a myofibril.



(i) Describe the interaction between P and Q that allows muscle contraction.

(2)

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(ii) The thick filament in a myofibril contains myosin. The myosin head contains the enzyme ATPase.

Explain the importance of the primary structure for the functioning of this enzyme.

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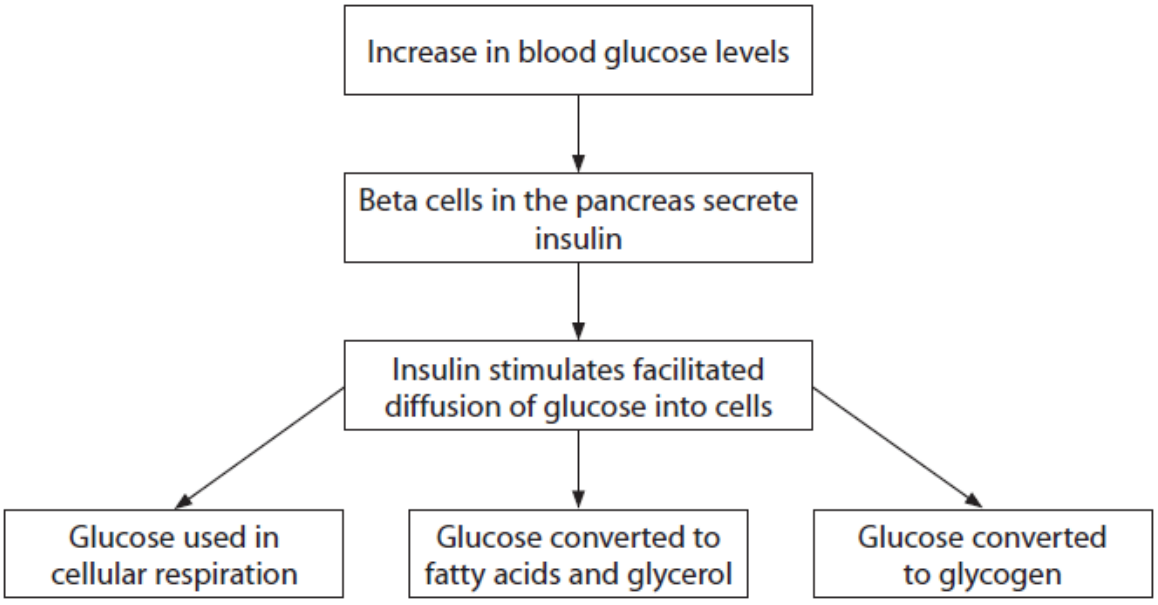
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(Total for question = 5 marks)

Q23.

The internal conditions within the body are maintained by homeostatic mechanisms. The regulation of blood glucose involves homeostatic mechanisms.

The diagram shows part of the sequence of events when there is an increase in blood glucose levels.



(i) Describe how glucose moves into cells by facilitated diffusion.

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(ii) Explain how the structure of glycogen allows it to be an energy store.

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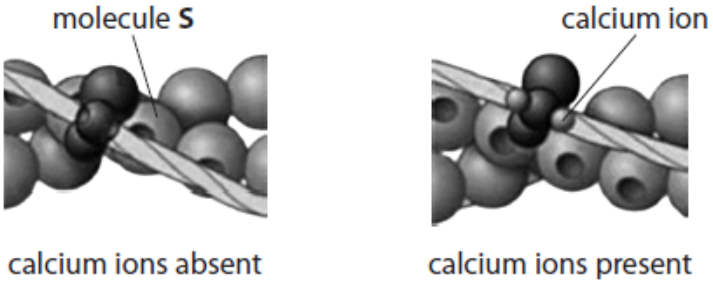
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(Total for question = 5 marks)

Q24.

Muscle cells contain myofibrils. The diagrams show the arrangement of some of the molecules present in a myofibril when calcium ions are absent and when they are present.



Describe how the concentration of calcium ions around the myofibrils is controlled.

(3)

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(Total for question = 3 marks)

Q25.

The scientific article you have studied is adapted from several sources.

Use the information from the scientific article and your own knowledge to answer the following questions.

'The hunger system is mediated by hormones from the gut and from fat cells' (paragraph 6).

Describe how these fat cells could release hormones.

(2)

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(Total for question = 2 marks)

Q1.

The scientific article you have studied is adapted from several sources.

Use the information from the scientific article and your own knowledge to answer the following questions.

'The hunger system is mediated by hormones from the gut and from fat cells' (paragraph 6).

Describe how these fat cells could release hormones.

(2)

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(Total for question = 2 marks)

Q2.

The movement of materials into and out of a cell needs to be controlled.

Describe what is meant by the term **fluid mosaic** with reference to cell membranes.

(2)

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Q3.

Hereditary spherocytosis is a condition that affects red blood cells.

Most cases of hereditary spherocytosis are caused by a dominant allele.

Use a genetic diagram to determine the probability of a child inheriting this condition if one parent is heterozygous and the other parent does not have the condition.

(2)

Answer .....

(Total for question = 2 marks)

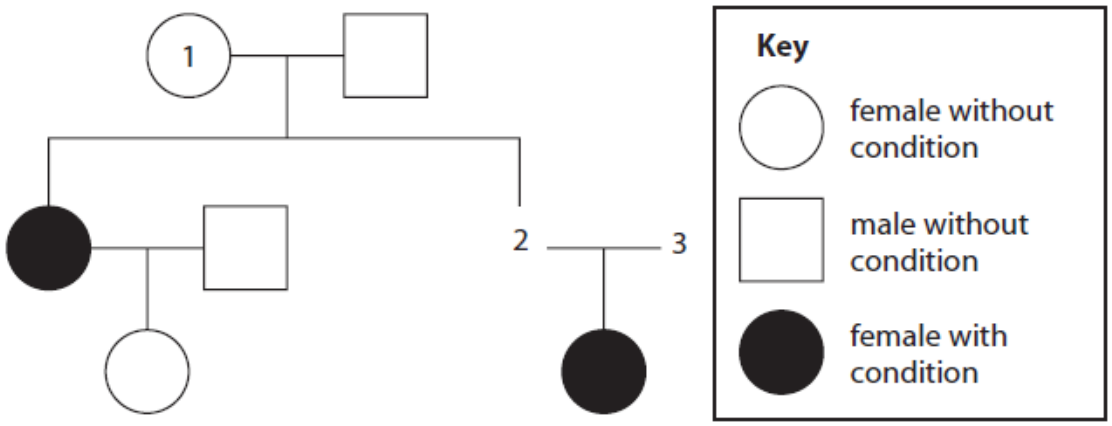
Q4.

Mucopolysaccharides are complex molecules found in the human body.

Mucopolysaccharidosis type 1 (MPS 1) is a recessive genetic condition.

People with MPS 1 cannot break down mucopolysaccharides.

The pedigree diagram shows the inheritance of MPS 1 in a family.



Determine the probability that person 2 has the same sex and MPS 1 phenotype as person 1.

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(Total for question = 4 marks)

Q5.

* The inheritance of coat colour in mice has been investigated.

There is a gene in humans similar to the mouse coat colour gene.

This human gene comprises 74 775 base pairs. The mRNA produced from this gene codes for a protein made up of 132 amino acids.

Explain the differences in the gene coding for this protein and the mRNA produced from it.

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(Total for question = 6 marks)

Q6.

An experiment was carried out to determine the effect of temperature on the activity of the enzyme catalase in yeast cells.

The substrate was hydrogen peroxide. A suspension of yeast cells was added to hydrogen peroxide.

The volume of oxygen produced during the initial two minutes was recorded. This was repeated at a range of temperatures.

The results are shown in the table.

Temperature / °C	Mean volume of oxygen / mm^3
20	80
30	240
40	540
50	320
60	120

(i) Calculate the temperature coefficient (Q_{10}) for this reaction between 20 °C and 30 °C.

(1)

Answer .....

(ii) Explain the effects of a temperature increase from 20 °C to 30 °C on the initial

rate of activity of catalase in the yeast cells.

(3)

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(iii) Explain what happens to the Q_{10} value between 40 °C and 50 °C.

(2)

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(Total for question = 6 marks)

Q7.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Batten disease is a rare, inherited disorder of the nervous system. It usually begins in childhood. It is a recessive disorder.

(i) Parents without Batten disease have a child with Batten disease.

Which of the following describes the genotype of the parents?

(1)

☒ **A** bb and Bb

☒ **B** Bb and Bb

☒ **C** BB and BB

☒ **D** BB and bb

(ii) Draw a genetic diagram to show the probability of their future children developing Batten disease.

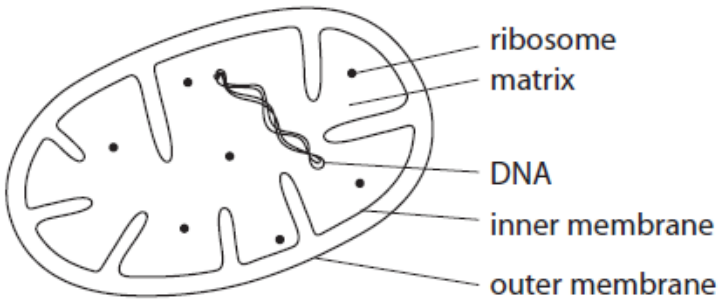
(2)

(Total for question = 3 marks)

Q8.

Mitochondria are organelles found in eukaryotic cells.

The diagram shows a mitochondrion.



Mitochondrial diseases are caused by mutations in the DNA of the mitochondria.

One type of mitochondrial disease is caused by the production of defective ATP synthase.

(i) Explain how a mutation in the mitochondrial DNA could result in defective ATP synthase being produced.

(3)

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(ii) Mitochondrial myopathy is a mitochondrial disease. The symptoms of this disease vary in severity.

The table shows the relationship between the percentage of mitochondria with mutated DNA in parents and the severity of the symptoms in their child.

Percentage of mitochondria with mutated DNA in the mother (%)	Percentage of mitochondria with mutated DNA in the father (%)			
	0	20	50	80
0	No symptoms	No symptoms	No symptoms	No symptoms
20	No symptoms	No symptoms	No symptoms	No symptoms
50	Mild symptoms	Mild symptoms	Mild symptoms	Mild symptoms
80	Severe symptoms	Severe symptoms	Severe symptoms	Severe symptoms

Explain the effects that the percentage of mitochondria with mutated DNA in the parents has on the severity of symptoms in their child.

(3)

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Q9.

The Atlantic tomcod is a fish found in the rivers of North America.

The photograph below shows an Atlantic tomcod.



Magnification ×1

Atlantic tomcod in the Hudson River are able to survive high levels of polychlorinated biphenyls (PCBs). PCBs enter the water from industrial processes.

One group of scientists identified a mutation in the DNA of these fish. They found that the AHR2 gene had six bases missing. This mutation was rarely found in Atlantic tomcod in the unpolluted St. Lawrence River.

(a) Suggest how scientists in other countries learnt of these findings.

(2)

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*(b) (i) Describe how the DNA and protein of Atlantic tomcod from the Hudson River could be compared with the DNA and protein of Atlantic tomcod from the St. Lawrence River.

(6)

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(ii) Suggest **one** similarity in the DNA of the Atlantic tomcod from these two rivers.

Give an explanation for your answer.

(2)

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(iii) Suggest **one** difference in the protein of the Atlantic tomcod from these two rivers.

Give an explanation for your answer.

(2)

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(Total for question = 12 marks)

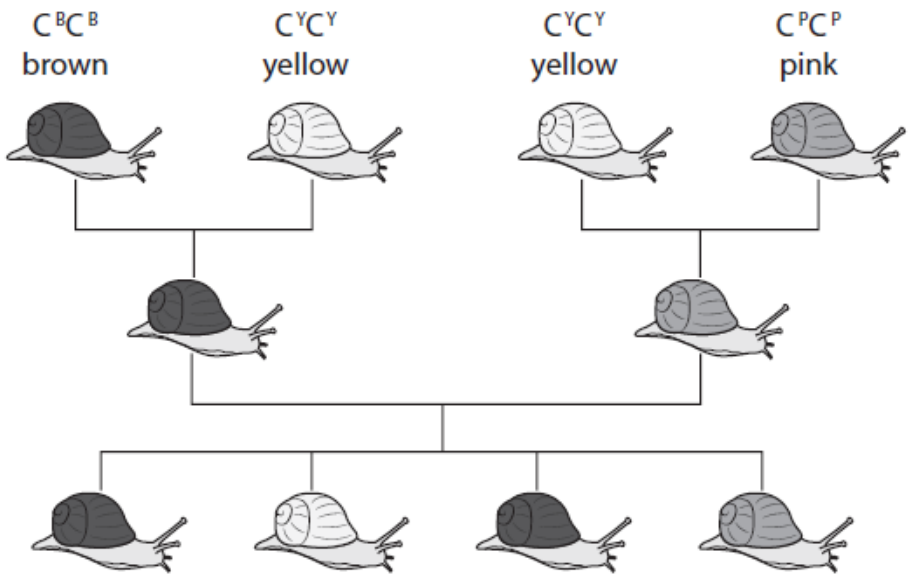
Q10.

The shell colour of the banded snail can be yellow, pink or brown.

A single gene controls shell colour in the banded snail.

There are three alleles for this gene, C^Y, C^P, and C^B.

The effects of these alleles on shell colour is shown in the genetic pedigree diagram.



Deduce the dominance of the alleles for shell colour.

(2)

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(Total for question = 2 marks)

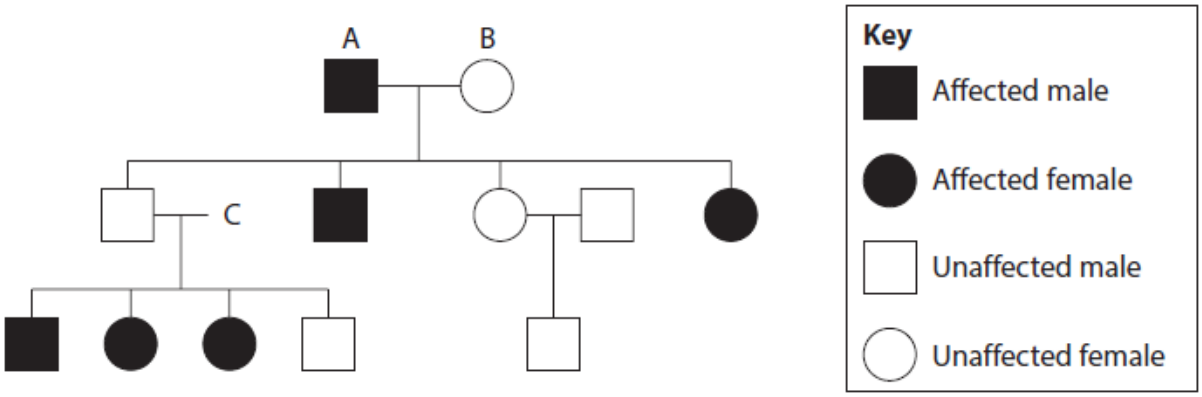
Q11.

Porphyria is a life-threatening genetic disease. It is caused by a mutation in the gene coding for an enzyme involved in the production of haem.

In people with porphyria, haem cannot be produced.

Porphyria is caused by a dominant allele and may not develop until later in life.

The pedigree diagram shows a family in which some individuals have porphyria.



(i) State the genotype and phenotype of person C.

(1)

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(ii) Person A and Person B have one son with porphyria. What was the probability of them having a child that was male and had porphyria?

(1)

☒ **A** 0.00

☒ **B** 0.25

☒ **C** 0.50

☒ **D** 1.00

(Total for question = 2 marks)

Q12.

The phenotype of an organism can be influenced by a variety of factors.

Phenotypic plasticity is the mechanism that many organisms use to phenotypically alter due to a change in environmental conditions.

An investigation to study phenotypic plasticity was carried out using a species of freshwater snail.

Newly hatched freshwater snails were used. These snails were divided into three groups and each group was placed in a tank with a different set of conditions.

Three different conditions were used. One was a control and the other two are described in the table.

Condition	Description
A	In water taken from a tank containing predator fish that had eaten some of the snails
B	In water in a tank exposed to ultraviolet light (UV)

(a) Describe a suitable control to be used with the third group of snails.

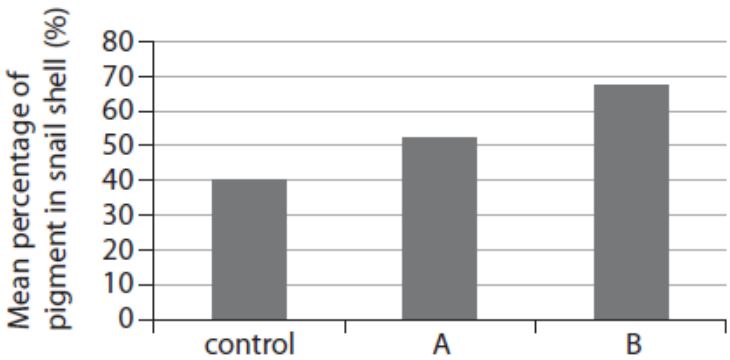
(2)

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(b) The snails were allowed to grow for eight weeks and then the mean percentage of pigment in the snail shells was assessed for each group. The results are shown in the graph.



(i) Scientists predicted that the snails exposed to both UV light and water from a tank of predator fish would have 80% shell pigmentation.

Explain how this prediction was made.

(2)

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(ii) It is thought that an increase in shell pigmentation levels provides protection against UV light. UV is a form of radiation that can damage DNA.

Explain how the DNA of the snail could be damaged.

(2)

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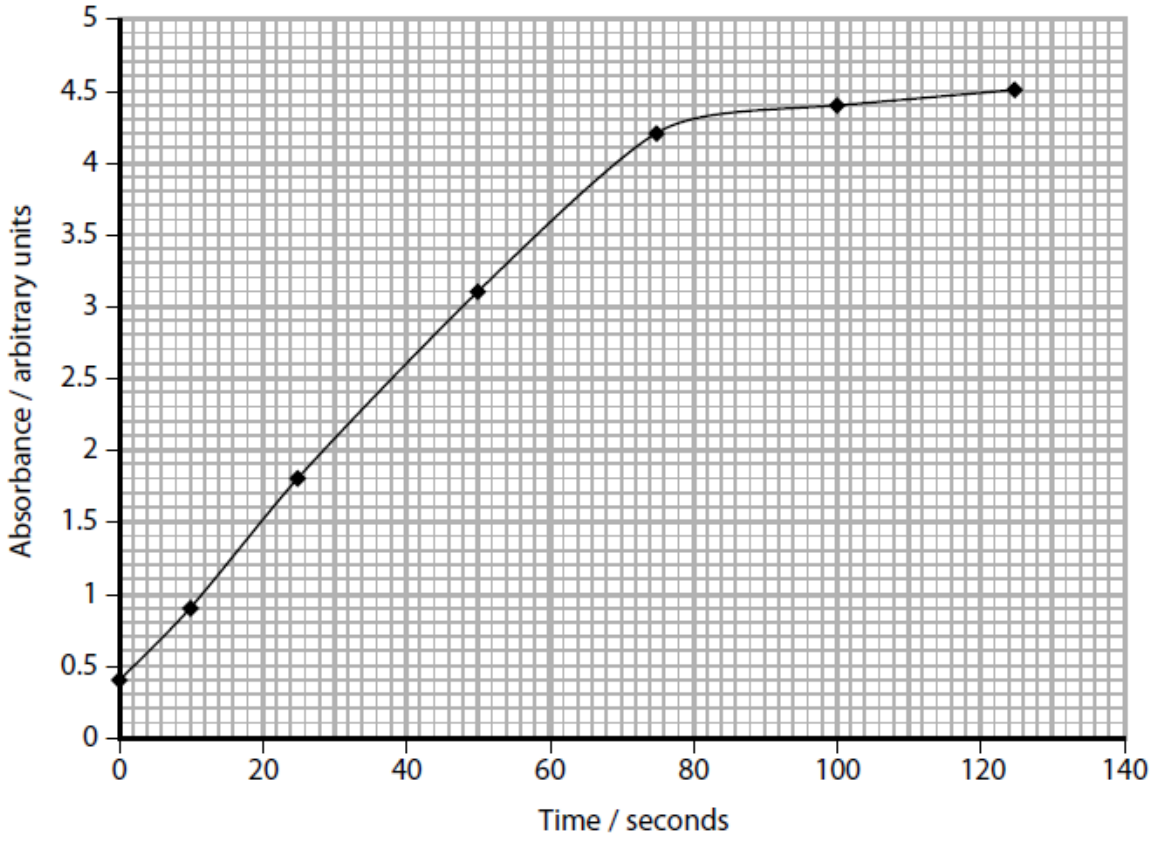
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Q13.

L-dopa forms a colourless solution in water. Dopa oxidase is an enzyme that converts L-dopa into dopachrome, which is red.

A colorimeter can be used to study this reaction. As the red colour appears, the amount of light absorbed by the solution increases.

(a) The graph shows the course of a reaction in which there was an enzyme concentration of 20 (arbitrary units) of reaction mixture.



Calculate the initial rate of reaction for this concentration of enzyme.

(3)

Answer .....

(b) In another study, a student used this procedure with a range of enzyme concentrations. The results are shown in the table below.

Enzyme concentration / arbitrary units	Initial rate of reaction / absorbance s^{-1}
0	0.0
10	2.5
30	6.1
50	9.0
70	11.0
90	11.0

Explain the effect of enzyme concentration on the initial rate of this reaction.

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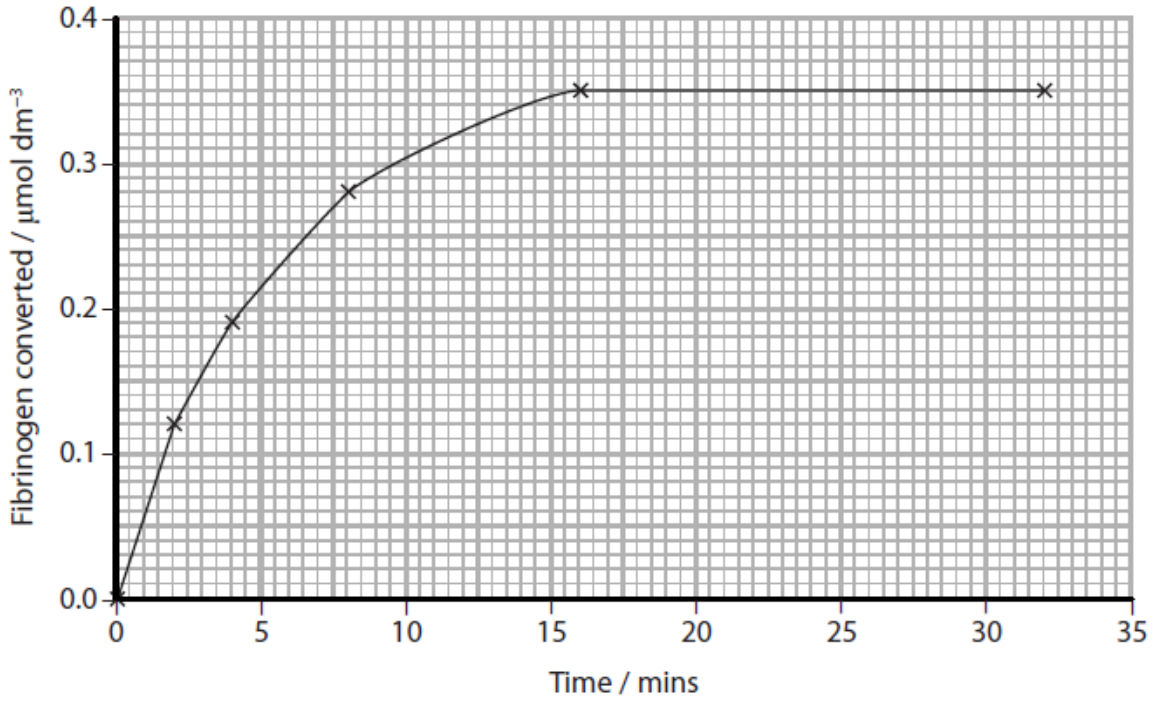
(Total for question = 6 marks)

Q14.

Fibrin is involved in the formation of blood clots.

Thrombin is an enzyme that converts fibrinogen to fibrin.

The graph shows the effect of one concentration of thrombin on the conversion of fibrinogen to fibrin.



(i) Calculate the initial rate of reaction.

(2)

Answer .....

(ii) On the graph, draw a line to show the effect of halving the concentration of thrombin.

(1)

(iii) Explain the effect of changes in the initial rate of reaction on the time taken for a blood clot to form.

(2)

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(Total for question = 5 marks)

Q15.

Emphysema is a condition that causes changes to the tissues in the lungs.

In an investigation, the surface area for gas exchange and the volume of the lungs of three groups of individuals were determined. The results are shown in the table.

Measurement	Individuals without emphysema	Individuals with mild emphysema	Individuals with severe emphysema
Mean surface area for gas exchange / m^2	118 ± 11	97 ± 8	30 ± 5
Mean total lung volume / cm^3	4772 ± 223	6232 ± 410	6725 ± 384
Mean surface area for gas exchange : volume ratio	247.3 : 1		44.6 : 1

(i) Calculate the mean surface area for gas exchange : volume ratio for individuals with mild emphysema.

(2)

Answer .....

(ii) There appears to be a difference in the lung volume of individuals with mild emphysema and those with severe emphysema.

Which of the following would be a relevant statistical test to determine whether this difference is significant?

(1)

☒ **A** chi-squared

☒ **B** correlation coefficient

☒ **C** standard deviation

☒ **D** Student's t-test

(iii) Give reasons for the variation in the lung volumes of healthy individuals.

(2)

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(iv) Give a reason for calculating the surface area for gas exchange to volume ratio in this investigation.

(1)

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(Total for question = 6 marks)

Q16.

The scientific article you have studied is adapted from an article from '*The Scientist*'.

Use the information from the scientific article and your own knowledge to answer the following questions.

Explain how cyanobacteria evolved to 'handle high temperatures' (paragraphs 14 and 15).

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(Total for question = 5 marks)

Q17.

The scientific article you have studied is adapted from *The Biologist*.

Use the information from the scientific article and your own knowledge to answer the following question.

Mice used in research have a number of limitations (paragraph 6). Mice that are homozygous for a recessive trait are rare in the population, but can be produced in genetic crosses.

Explain how genetic crosses could be used to generate a mouse line expressing a recessive trait.

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(Total for question = 3 marks)

Q18.

Goblet cells lining the bronchi produce mucus. This mucus is released by exocytosis.

Explain how goblet cells release mucus by exocytosis.

(2)

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Q19.

All cells have a cell surface membrane.

Explain how phospholipids form a cell surface membrane.

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(Total for question = 3 marks)

Q20.

Glucosaminoglycans (GAGs) are the by-products of chemical reactions inside cells. GAGs are broken down by enzymes inside lysosomes in cells.

Mucopolysaccharidosis type I (MPS I) is a genetic condition that results in the build-up of GAGs inside cells.

MPS I affects the production of enzyme G that breaks down GAGs inside lysosomes.

More than 50 different mutations in the gene for enzyme G have been found to result in MPS I. Most of these mutations involve changing a single base in the gene.

(i) Explain how a single base mutation can lead to an altered primary structure of enzyme G.

(3)

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(ii) Explain how human genome sequencing can be used to identify the mutations associated with MPS I.

(3)

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(Total for question = 6 marks)

Q21.

Batten disease is a rare, inherited disorder of the nervous system. It usually begins in childhood. It is a recessive disorder.

Explain what is meant by an inherited recessive disorder.

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(Total for question = 2 marks)

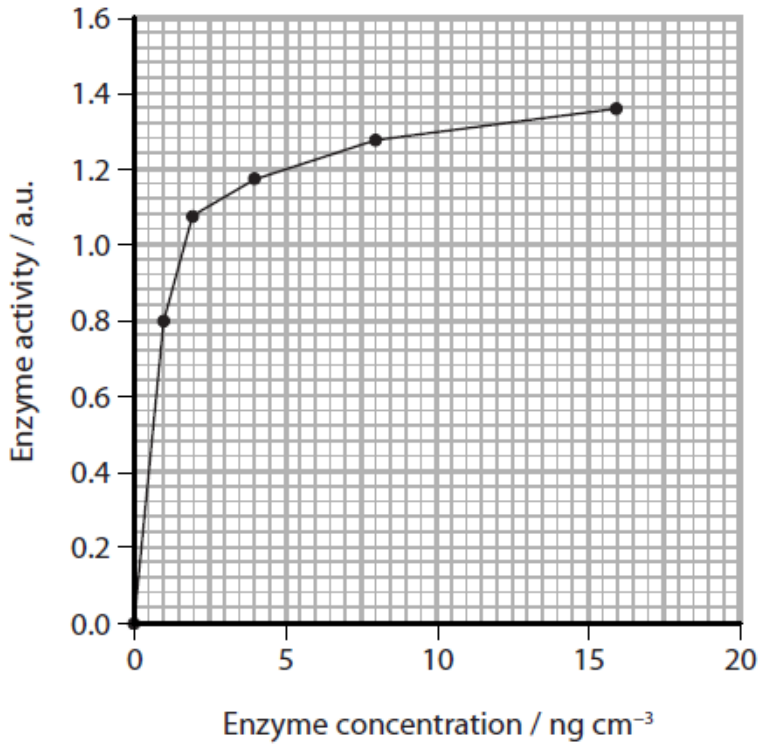
Q22.

Trypsin is an enzyme found in many groups of living organisms.

Trypsin specifically acts on a polypeptide to form amino acids.

In an experiment, the effect of enzyme concentration on the activity of human trypsin was measured.

The results are shown in the graph.



Explain which range of enzyme concentrations should be used to compare the activity of trypsin from different species.

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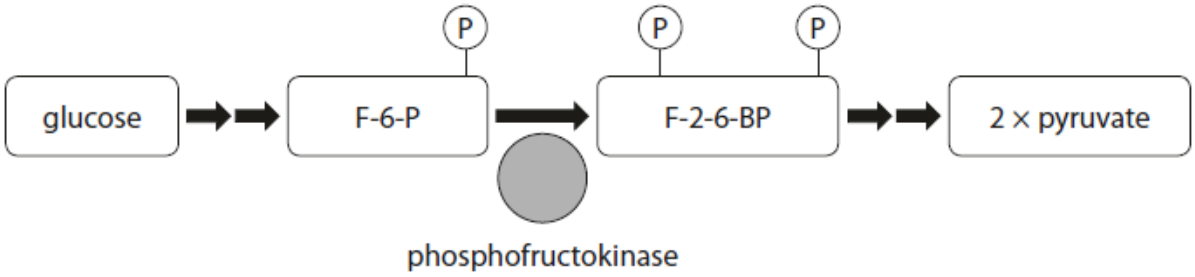
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(Total for question = 2 marks)

Q23.

Phosphofructokinase is an enzyme that uses ATP to convert fructose-6-phosphate (F-6-P) into fructose-2,6-bisphosphate (F-2,6-BP).

The conversion of F-6-P by this enzyme is a rate-determining step in glycolysis. This is shown in the diagram.



(i) Explain why ATP is required for this reaction.

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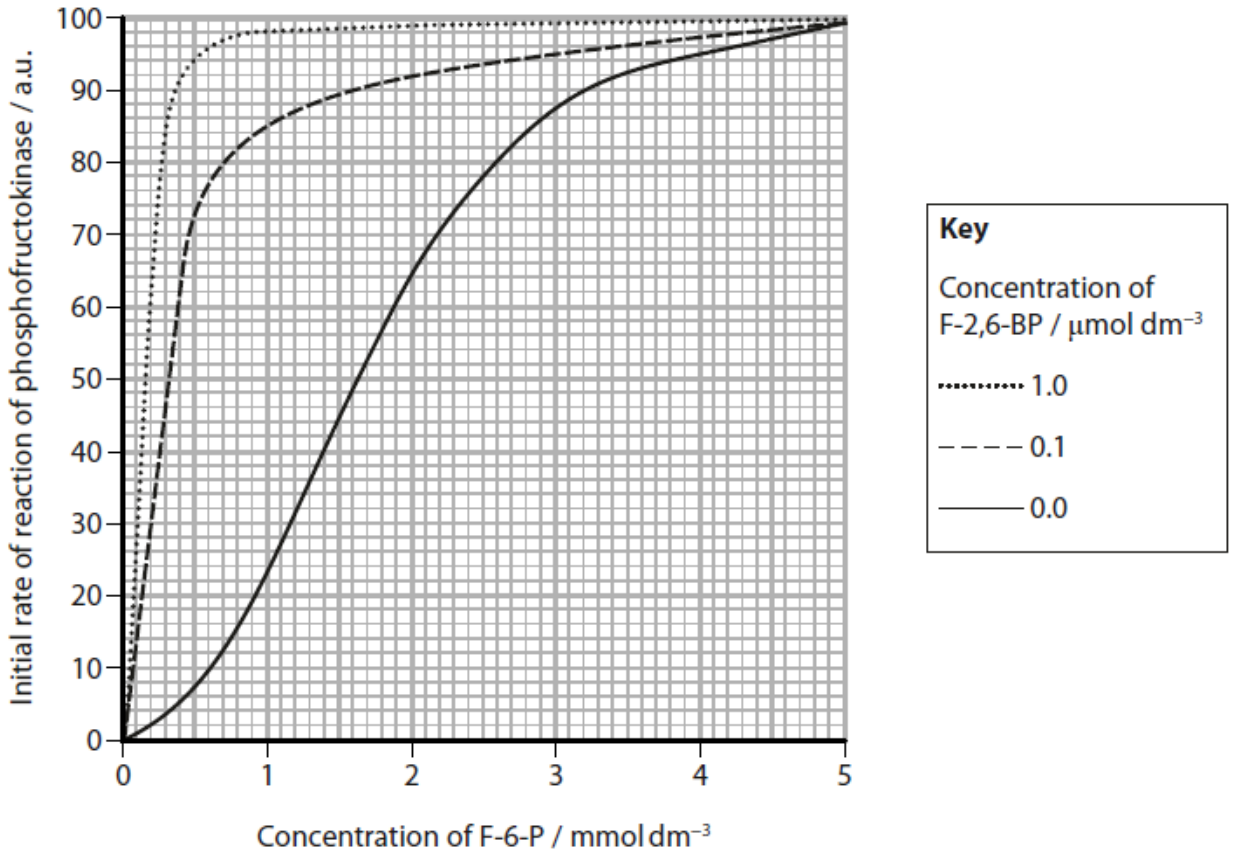
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The effect of substrate concentration on the initial rate of reaction of phosphofructokinase was investigated.

This investigation was repeated with the addition of two concentrations of F-2,6-BP.

The graph shows the results of this investigation.



Comment on the effects of F-6-P and F-2,6-BP concentrations on the rate of glycolysis.

(3)

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(Total for question = 6 marks)

Q24.

Cystic fibrosis is a condition that affects breathing.

Explain why cystic fibrosis affects the rate of oxygen uptake in the lungs.

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(Total for question = 3 marks)

Q25.

Emphysema is a condition that causes changes to the tissues in the lungs.

In an investigation, the surface area for gas exchange and the volume of the lungs of three groups of individuals were determined. The results are shown in the table.

Measurement	Individuals without emphysema	Individuals with mild emphysema	Individuals with severe emphysema
Mean surface area for gas exchange / m^2	118 ± 11	97 ± 8	30 ± 5
Mean total lung volume / cm^3	4772 ± 223	6232 ± 410	6725 ± 384
Mean surface area for gas exchange : volume ratio	247.3 : 1		44.6 : 1

Explain why individuals with severe emphysema will tire more easily than healthy individuals.

(3)

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(Total for question = 3 marks)

Q1.

Explain why the phospholipids are arranged in two layers in a cell surface membrane.

(3)

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(Total for question = 3 marks)

Q2.

Describe how thicker mucus would affect gas exchange across the walls of the alveoli.

(2)

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Q3.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Farmers use fertilisers to increase the growth of crops such as wheat.

(i) Fertilisers contain phosphate ion compounds.

Plants need phosphate in order to synthesise

(1)

☒ **A** both cellulose and phospholipids

☒ **B** both phospholipids and polysaccharides

☒ **C** both polynucleotides and phospholipids

☒ **D** both polynucleotides and polysaccharides

(ii) After the grain is harvested, farmers plough the stems (straw) from wheat plants into the soil.

This improves the quality of the soil. These stems contain polysaccharides.

Explain how microorganisms in the soil break down the stems.

(3)

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(Total for question = 4 marks)

Q4.

Emphysema is a condition that causes changes to the tissues in the lungs.

In an investigation, the surface area for gas exchange and the volume of the lungs of three groups of individuals were determined. The results are shown in the table.

Measurement	Individuals without emphysema	Individuals with mild emphysema	Individuals with severe emphysema
Mean surface area for gas exchange / m^2	118 ± 11	97 ± 8	30 ± 5
Mean total lung volume / cm^3	4772 ± 223	6232 ± 410	6725 ± 384
Mean surface area for gas exchange : volume ratio	247.3 : 1		44.6 : 1

Fick's law of diffusion can be used to calculate a value for the effectiveness of the uptake of oxygen by the lungs.

This value can be calculated using the equation

$$\text{value} = \frac{\text{surface area} \times \text{concentration difference}}{\text{diffusion distance}}$$

The diffusion distance in alveoli is 0.5 µm.

The mean oxygen concentration in alveoli is 14 kPa and in the capillaries is 5 kPa.

The calculated value for healthy individuals is 2124.

(i) Calculate the value for individuals with severe emphysema.

(2)

Answer .....

(ii) Calculate the percentage difference between the value for individuals with severe emphysema and the value for individuals without emphysema.

(2)

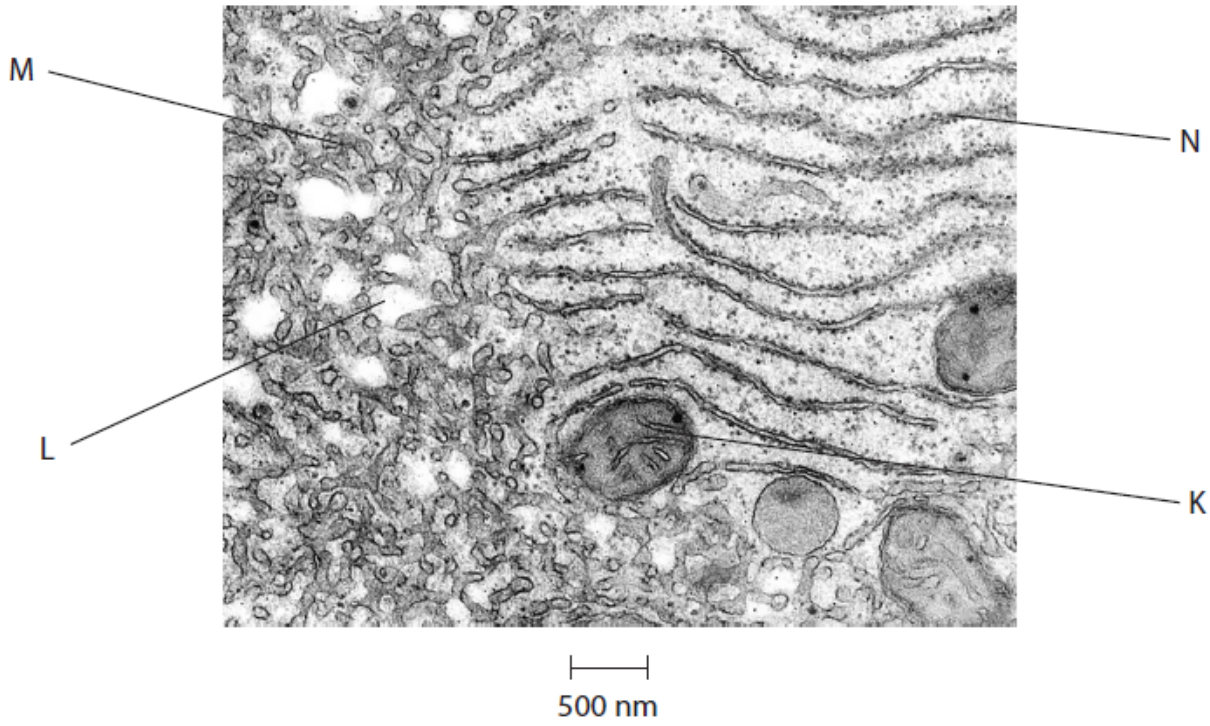
Answer .....

(Total for question = 4 marks)

Q5.

Liver cells synthesise and export a variety of proteins.

The image is a transmission electron micrograph of part of a liver cell.



(i) Which of the following structures is involved in respiration?

(1)

☒ **A** K

☒ **B** L

☒ **C** M

☒ **D** N

(ii) Which of the following structures is involved in synthesising lipids?

(1)

☒ **A** K

☒ **B** L

☒ **C** M

☒ **D** N

(iii) The site of synthesis of proteins to be released by exocytosis is

(1)

☒ **A** K

☒ **B** L

☒ **C** M

☒ **D** N

(iv) Calculate the maximum width of the structure labelled **K**.

(2)

Maximum length ..... nm

Q6.

Hereditary spherocytosis is a condition that affects red blood cells.

The red blood cells of individuals with spherocytosis are spherical instead of having a biconcave disc shape.

Explain the effect of spherocytosis on the uptake of oxygen by red blood cells.

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(Total for question = 3 marks)

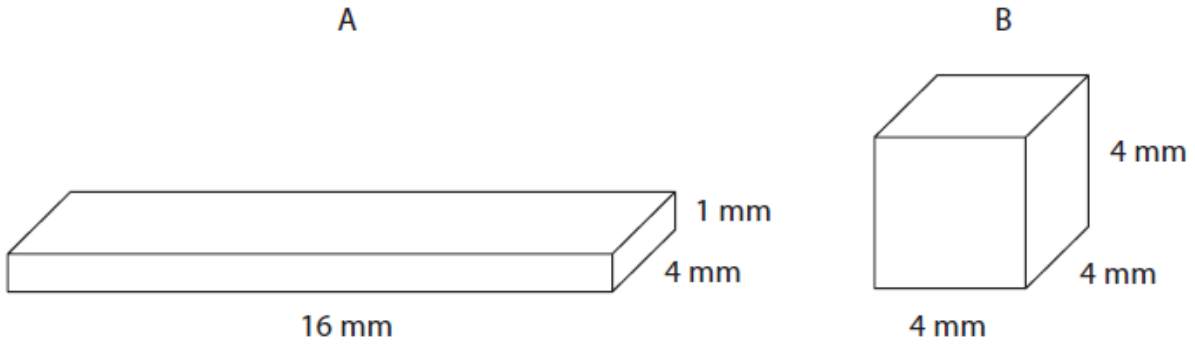
Q7.

Scientists can use models to explain the need for a circulation system in animals.

The shapes in the diagram represent two different animals that live in water.
The figures represent the height, width and breadth of the animals.

Determine why animal A does not need a circulation system but animal B does.

(4)



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(Total for question = 4 marks)

Q8.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Thalassaemia is a recessive genetic disorder that affects the production of haemoglobin. It is caused by a gene mutation.

Scientists are developing methods to repair gene mutations such as the one that causes thalassaemia.

A gene mutation can be a change in a single base in the

(1)

- ☒ **A** DNA that codes for a different amino acid
- ☒ **B** DNA that codes for a different monosaccharide
- ☒ **C** RNA that codes for a different amino acid
- ☒ **D** RNA that codes for a different monosaccharide

(Total for question = 1 mark)

Q9.

Porphyria is a life-threatening genetic disease. It is caused by a mutation in the gene coding for an enzyme involved in the production of haem.

In people with porphyria, haem cannot be produced.

A new technique known as gene silencing has been developed to treat this disease.

Molecules known as small interfering RNA (siRNA) combine with mRNA to prevent translation.

Deduce how siRNA may be used to prevent the development of porphyria.

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(Total for question = 4 marks)

Q10. The sequence of bases in DNA determines the sequence of amino acids in a polypeptide.

The table below shows the genetic code for each amino acid.

TTT	Phe	TCT	Ser	TAT	Tyr	TGT	Cys
TTC		TCC		TAC		TGC	
TTA	Leu	TCA		TAA	Stop	TGA	Stop
TTG		TCG		TAG		TGG	Trp
CTT	Ieu	CCT	Pro	CAT	His	CGT	Arg
CTC		CCC		CAC		CGC	
CTA		CCA		CAA	Gln	CGA	
CTG		CCG		CAG		CGG	
ATT	Ile	ACT	Thr	AAT	Asn	AGT	Ser
ATC		ACC		AAC		AGC	
ATA		ACA		AAA	Lys	AGA	Arg
ATG	Met	ACG		AAG		AGG	
GTT	Val	GCT	Ala	GAT	Asp	GGT	Gly
GTC		GCC		GAC		GGC	
GTA		GCA		GAA	Glu	GGA	
GTG		GCG		GAG		GGG	

(a) The diagram below shows the DNA base sequence coding for part of a polypeptide.

A	T	G	G	G	C	A	T	T

(i) Using the information in the table, state the order of amino acids for this part of the polypeptide.

(1)

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(ii) Explain what is meant by the term **non-overlapping genetic code**.

(1)

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(b) (i) Explain why there are **three** bases in each of the codes shown in the table.

(2)

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(ii) Suggest an advantage for most amino acids having more than one code. Give an explanation for your answer.

(2)

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(c) Explain the role of the base sequences TAA, TAG and TGA.

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(d) Explain how the amino acids are joined together in a polypeptide.

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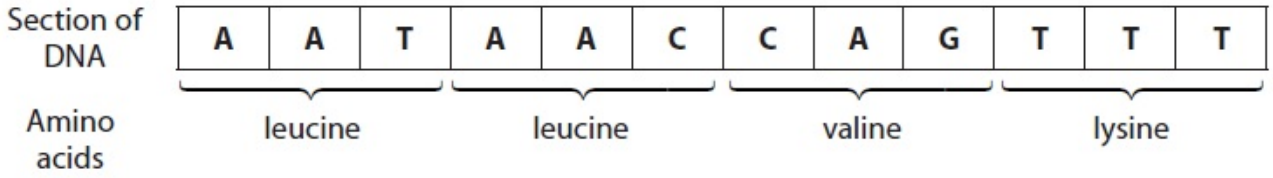
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(Total for Question = 13 marks)

Q11. The diagram below shows the base sequence on a short section of DNA consisting of 12 mononucleotides. This base sequence contains the genetic code for a short section in the primary structure of a polypeptide.



(a) Name each of the bases represented by the letters, **A**, **C**, **G** and **T** in the diagram.

(1)

A.....

C.....

G.....

T.....

(b) Using the sequence shown in the diagram, explain the meaning of each of the following terms.

(i) Triplet code

(2)

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(ii) Non-overlapping

(2)

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(iii) Degenerate

(2)

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(c) Place a cross ☒ in the box next to the names of the two components, other than the bases, that form part of each mononucleotide in this sequence.

(1)

☒ **A** deoxyribose and nitrate

☒ **B** deoxyribose and phosphate

☒ **C** ribose and nitrate

☒ **D** ribose and phosphate

*(d) Transcription of this section of DNA forms a complementary strand of mRNA.

Describe how translation of this mRNA synthesises part of a polypeptide molecule.

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(Total for Question = 13 marks)

Q12.

Some people have a disorder that reduces their ability to produce an enzyme required to break down glycogen. This enzyme is glycogen phosphorylase.

The symptoms of this disorder include muscle weakness and lack of stamina when exercising.

(i) Explain why a low concentration of this enzyme would cause the symptoms described.

(3)

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(ii) Devise an experiment to investigate the effect of glycogen phosphorylase concentration on the breakdown of glycogen.

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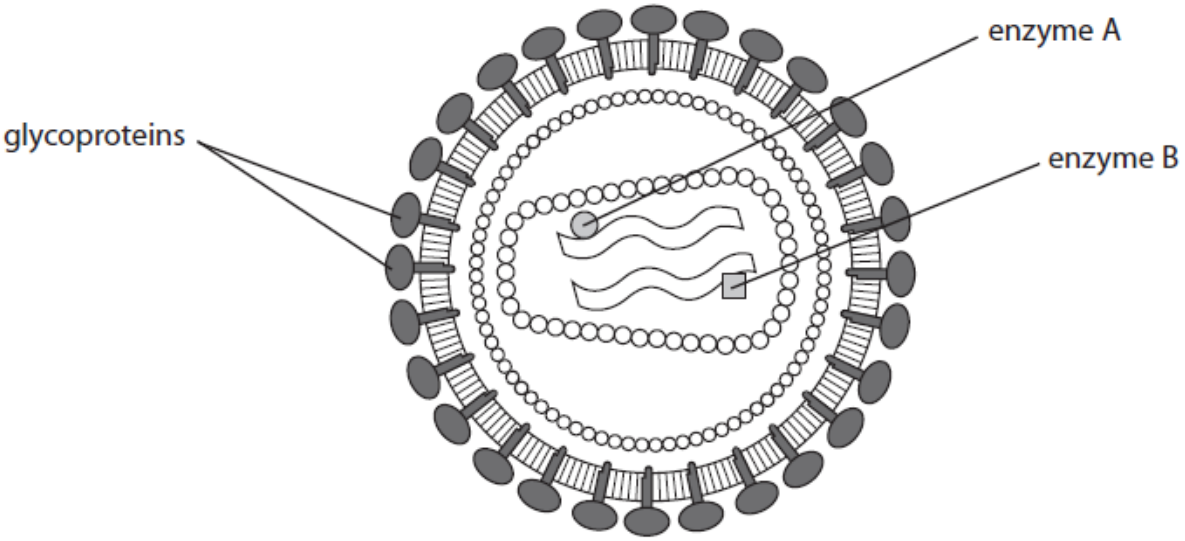
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Q13.

Anti-viral drugs have been developed to treat patients infected with Human Immunodeficiency Virus (HIV).

The diagram below shows the structure of HIV.



(a) A glycoprotein has a carbohydrate attached to a protein molecule.
Describe the three-dimensional structure of a glycoprotein.

(3)

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(b) Some anti-viral drugs prevent HIV entering the host cells.

Suggest how these anti-viral drugs could prevent HIV entering the host cells.

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*(c) Describe how the enzymes shown in the diagram are involved in HIV infection.

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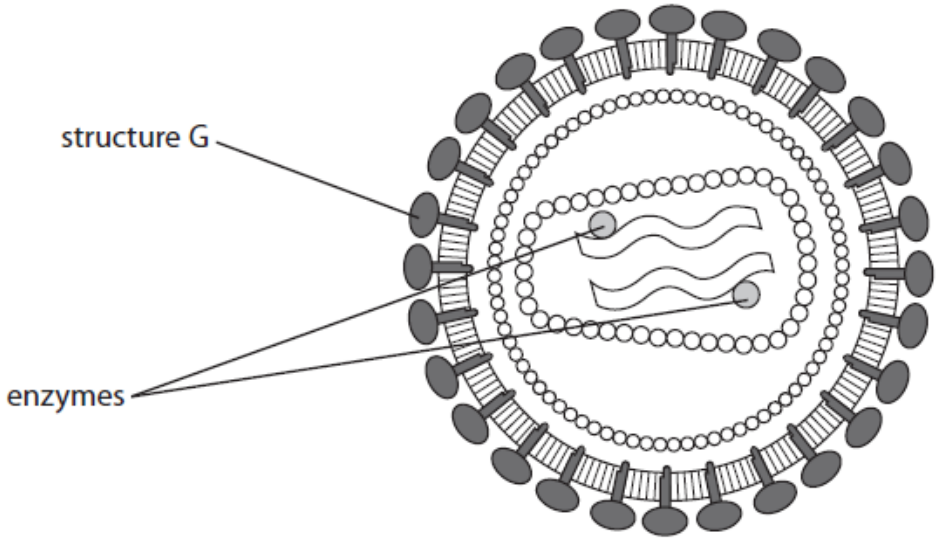
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(Total for question = 11 marks)

Q14.

Anti-viral drugs have been developed to treat patients infected with Human Immunodeficiency Virus (HIV).

The diagram below shows the structure of HIV.



(a) Explain how **structure G** enables HIV to infect human cells.

(3)

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(b) Some anti-viral drugs used to treat patients infected with HIV are inhibitors of enzymes found within HIV.

(i) Describe the structure of an enzyme.

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*(ii) Suggest how these anti-viral drugs would work in the treatment of patients infected with HIV.

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(Total for question = 11 marks)

Q15.

Wasps are insects that live in groups.

One species of wasp (*Vespula germanica*) has been shown to knock its body repeatedly against a hard surface. This signals the presence and quality of food to other wasps.

When threatened by another animal, it may use its stinger to inject a venom to protect itself.



bugguide.net

The stinger injects a venom that contains the enzyme phospholipase.
This enzyme hydrolyses phospholipids, releasing fatty acids.

Describe how the structure of phospholipase allows it to hydrolyse phospholipids.

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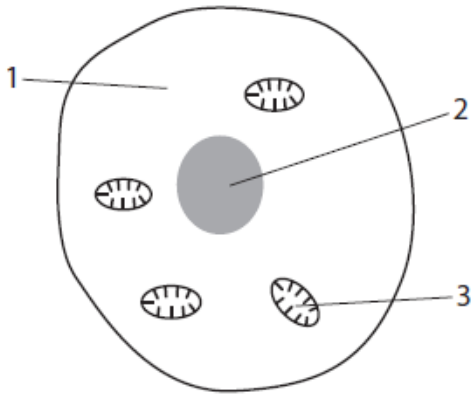
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(Total for question = 4 marks)

Q16.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

The diagram shows some of the features of a human liver cell.



(i) Which of the labelled features in the liver cell contain RNA?

(1)

☒ **A** 1 only

☒ **B** 1 and 3 only

☒ **C** 2 and 3 only

☒ **D** 1, 2 and 3

(ii) Cells produce lactate during anaerobic respiration. Lactate travels in the blood to the liver.

Liver cells can absorb lactate from the blood.

Deduce what happens to the lactate in these cells.

(2)

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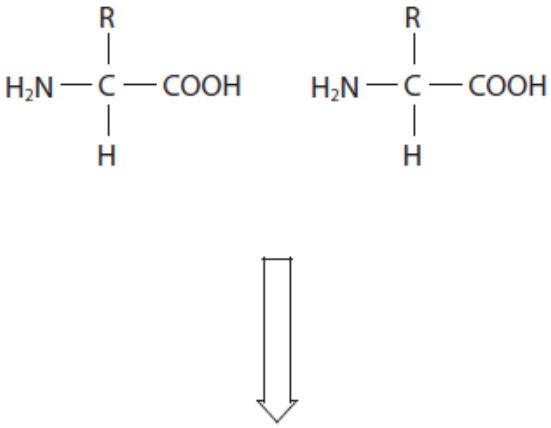
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(iii) During protein synthesis, two amino acids are joined together to form a dipeptide.

The diagram shows two identical amino acids.

Complete the diagram to show how the dipeptide is formed from these two amino acids.

(2)



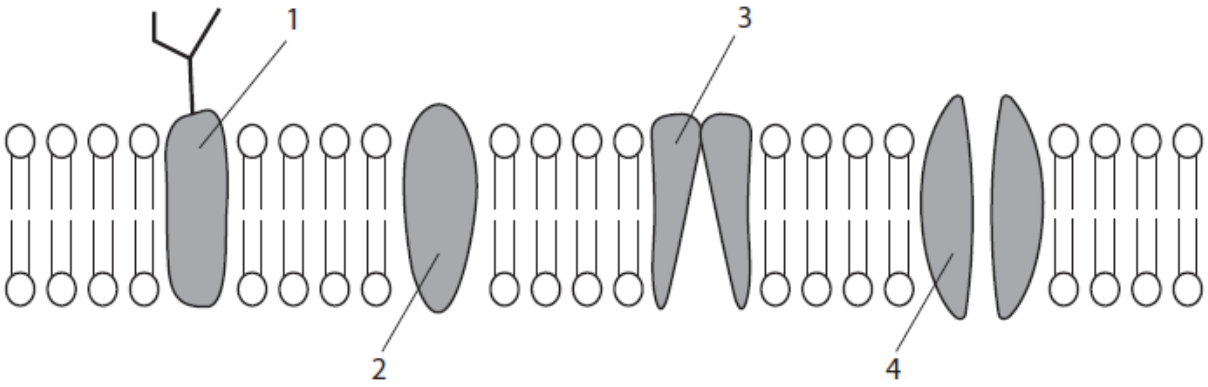
(Total for question = 5 marks)

Q17.

Answer the questions with a cross in the boxes you think are correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

The structure of the cell surface membrane can be described by the fluid mosaic model.

The diagram shows the fluid mosaic model of the cell surface membrane.



(i) Which of the shaded structures transport charged molecules or ions across the membrane?

(1)

☒ **A** 1 and 2 only

☒ **B** 3 and 4 only

☒ **C** 1, 2 and 3 only

☒ **D** 1, 2, 3 and 4

(ii) Which of the shaded structures contain both hydrophilic regions and hydrophobic regions?

(1)

☒ **A** 1 and 2 only

☒ **B** 3 and 4 only

☒ **C** 1, 2 and 3 only

☒ **D** 1, 2, 3 and 4

(iii) A student measured the width of the phospholipid bilayer shown on the

diagram as 2.5 cm. The actual size of this bilayer is 5 nm.

What is the approximate magnification of the diagram?

(1)

☒ **A** × 5000

☒ **B** × 50 000

☒ **C** × 500 000

☒ **D** × 5 000 000

(Total for question = 3 marks)

Q18.

Answer the question with a cross in the box you think is correct ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

Cystic fibrosis can be caused by a number of different mutations in the CFTR gene.

(i) A gene contains a number of base pairs. Of the base pairs in this gene, 50% are adenine and thymine.

Q = the number of base pairs in this gene.

Which of the following shows the total number of hydrogen bonds (H bonds) present in this gene?

(1)

☒ **A** 2.0 × Q

☒ **B** 2.5 × Q

☒ **C** 4.0 × Q

☒ **D** 5.0 × Q

(ii) Explain why different mutations in the CFTR gene can lead to differences in the severity of the symptoms of cystic fibrosis.

(2)

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(Total for question = 3 marks)

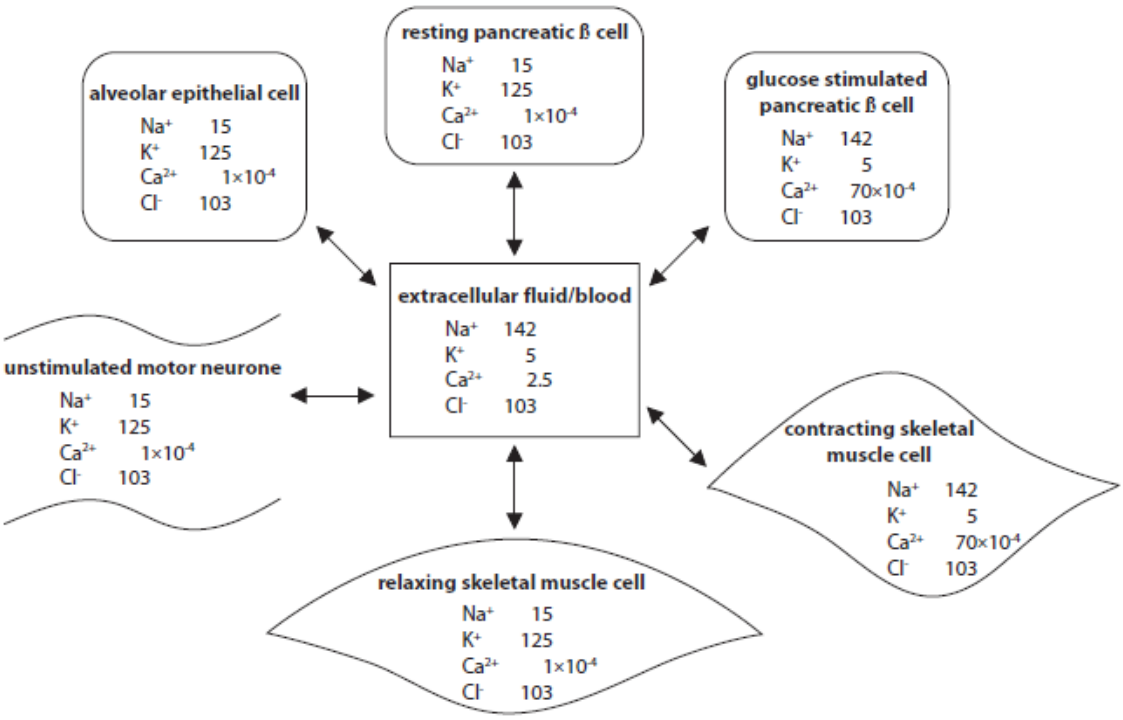
Q19.

*Cells use ions in many different processes.

Ion transport across cell membranes is a fundamental property of all living cells.

The diagram shows some typical ion concentrations in healthy human cells and in the extracellular fluid.

All values are in mmol dm^{-3}.



The tables show information about the human genome and types of transport channel in humans.

Some information about the human genome	
Number of genes in the human genome	approximately 20 000
Number of genes coding for membrane proteins	approximately 5 400
Number of genes coding for proteins involved in the transport of ions across cell membranes	more than 350
Number of diseases associated with mutations in genes involved in the transport of ions across cell membranes	more than 28
Organs and systems in which ion channel mutations cause disease	central nervous system, heart, lungs, pancreas and skeletal muscle

Type of transport channel	Number of each type of transport channel
Voltage gated ion channels	147
Chloride channels	17
Active transport	81

Discuss the importance of ion transport across membranes in human health and disease.

(Total for question = 9 marks)

Q20.

Glycolysis is inhibited by acidic conditions.

Devise an investigation to determine the effect of acidic conditions on the initial rate of reaction of phosphofructokinase.

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(Total for question = 4 marks)

Q21.

Lettuce plants usually grow upright. This is the 'upright' phenotype.

In one variety of lettuce the stem of the lettuce grows along the ground. This is the 'weary' phenotype.

These two phenotypes are shown in the diagram.



Upright



Weary

Inheritance of the weary phenotype has been investigated.

Scientists crossed weary lettuce plants with upright lettuce plants.
The F_1 generation produced from this cross were all upright.

In the second cross, two of the F_1 lettuce plants were crossed with each other to produce the F_2 generation.

The phenotypes of the F_2 generation and the results of a statistical test are shown in the table.

Number of offspring with weary phenotype	Number of offspring with upright phenotype	Chi-squared (χ^2)
159	414	2.31

Degrees of freedom	Probability		
	0.01	0.05	0.1
1	2.71	3.84	6.64
2	4.61	5.99	9.21
3	6.25	7.82	11.35
4	7.78	9.49	13.28

Justify the conclusion that the weary phenotype was inherited as a recessive trait.

(3)

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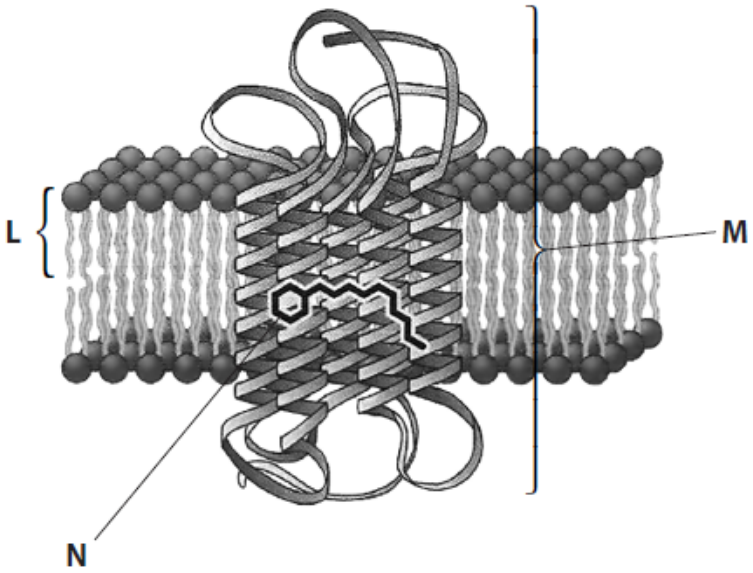
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(Total for question = 3 marks)

Q22.

The diagram shows part of the membrane of the outer segment of a rod cell.



(a) Which of the following is the part labelled **L**?

(1)

☒ **A** fatty acid tail

☒ **B** phosphate head

☒ **C** phospholipid

☒ **D** phospholipid bilayer

(b) (i) Give the name of the visual pigment labelled **M**.

(1)

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(ii) Give the name of the light-absorbing part of the visual pigment labelled **N**.

(1)

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(c) Describe how the absorption of light by the part labelled **N** results in an action potential in the optic nerve.

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(Total for question = 6 marks)

Q23.

Malaria is a disease that kills more than 400 000 people every year.

It is caused by *Plasmodium*, a single-celled organism that lives in the blood.

Plasmodium is transmitted by mosquitoes.

Malaria can be controlled by killing the mosquitoes that transmit the disease.

Scientists are genetically modifying *Metarhizium pingshaense*, a fungus that infects mosquitoes.

The genetically modified (GM) fungus contains a gene from a species of spider. This gene codes for a protein that kills mosquitoes.

(i) The GM fungus transcribes and translates the gene for this protein.

Describe the primary structure of a protein.

(2)

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(ii) The primary structure of this protein is then converted into a tertiary structure and modified by organelles in the cell.

Describe the role of the organelles involved in these processes.

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(Total for question = 7 marks)

Q24.

Mineral ions are required for plant growth.

Mineral ions enter the plant through the roots.

Mineral ions in the soil are in lower concentrations than in the vacuoles of root hair cells.

Describe how mineral ions are taken up by root hair cells.

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(Total for question = 3 marks)

Q25.

Mineral ions are required for plant growth.

(i) Nitrate ions are required for the synthesis of

(1)

☒ **A** amino acids

☒ **B** cellulose

☒ **C** starch

☒ **D** sucrose

(ii) Phosphate ions are required for the synthesis of

(1)

☒ **A** cellulose

☒ **B** chlorophyll

☒ **C** nucleic acids

☒ **D** sucrose

(iii) Magnesium ions are present in the structure of

(1)

☒ **A** amino acids

☒ **B** cellulose

☒ **C** chlorophyll

☒ **D** starch

(Total for question = 3 marks)