Voice of the Genome -3

Name: _____

Class: _____

Date: _____

Time:

Total Marks Available:

Total Marks Archived:

Level: Edexcel A level Biology

Subject: Biology

Exam Board: Pearson Edexcel Level 3 GCE AS and A level Biology A (Salters-Nuffield) and also Pearsons Edexcel AS and A Level Biology B (9BI0) - Is however suitable for use by AS and A level Biology Students of other Boards

Topic: Voice of the Genome -3

Type: Topic Questions

To be used by all students preparing for Edexcel AS and A level Biology A and Biology B - Students of other Boards may also find this useful

Questions

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.

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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.

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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)

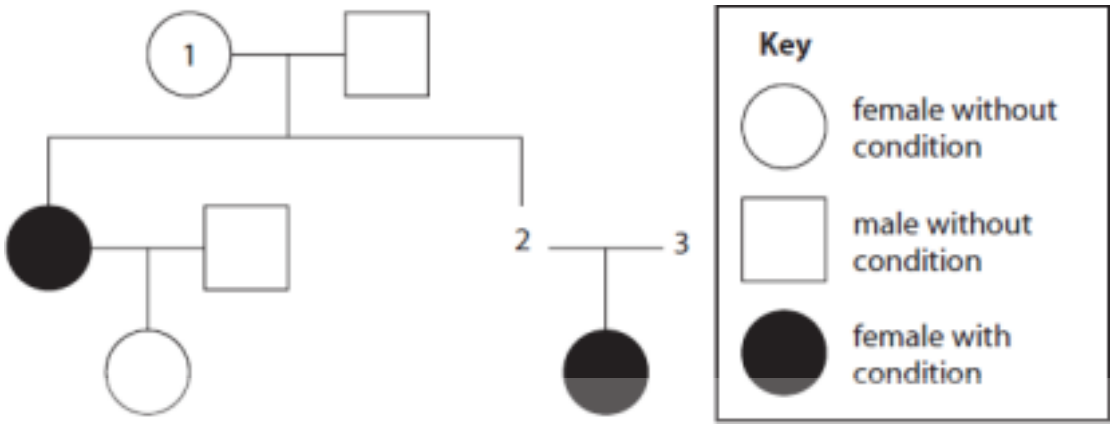
Q4.

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.

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

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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.

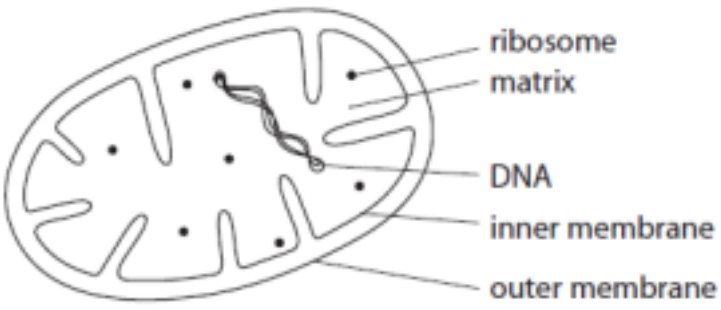
(2)

(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.

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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.

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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.

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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.

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(Total for question = 12 marks)

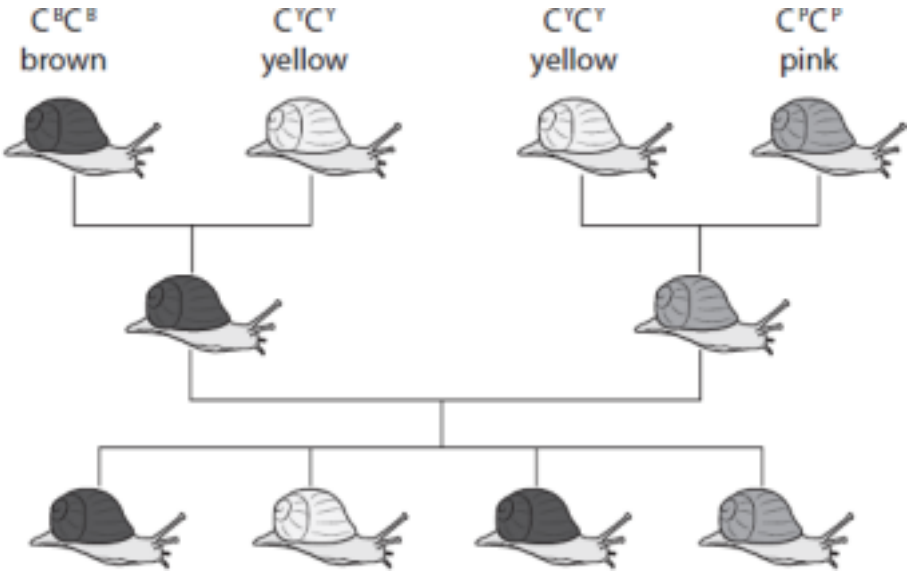
Q10.

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.

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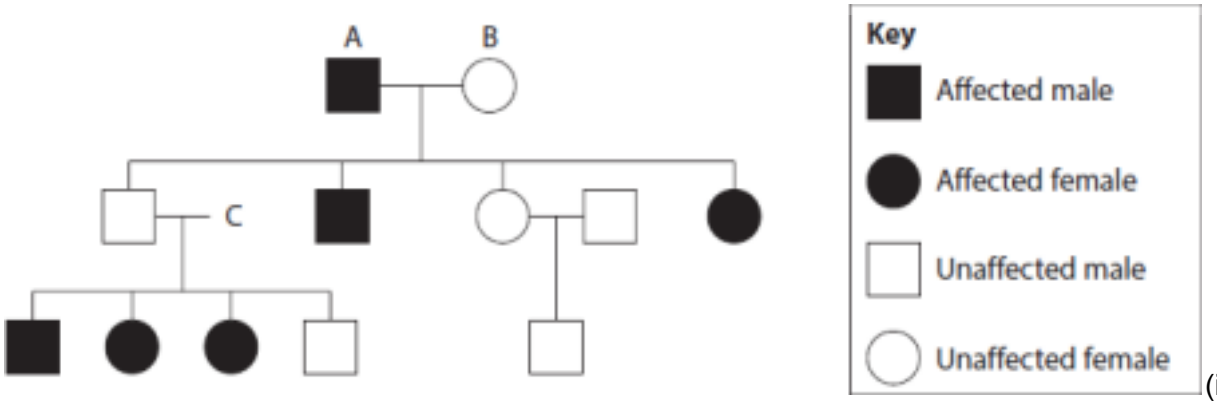
(Total for question = 2 marks)

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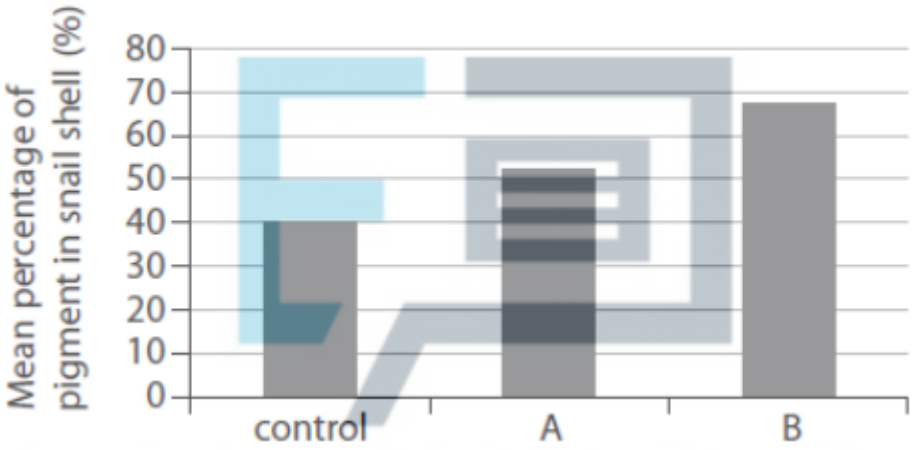
(b) The snails were allowed to grow for eight weeks and then the mean percentage of pigment in the snail shells was assessed for each group. The results are shown in the graph.



(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.

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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.

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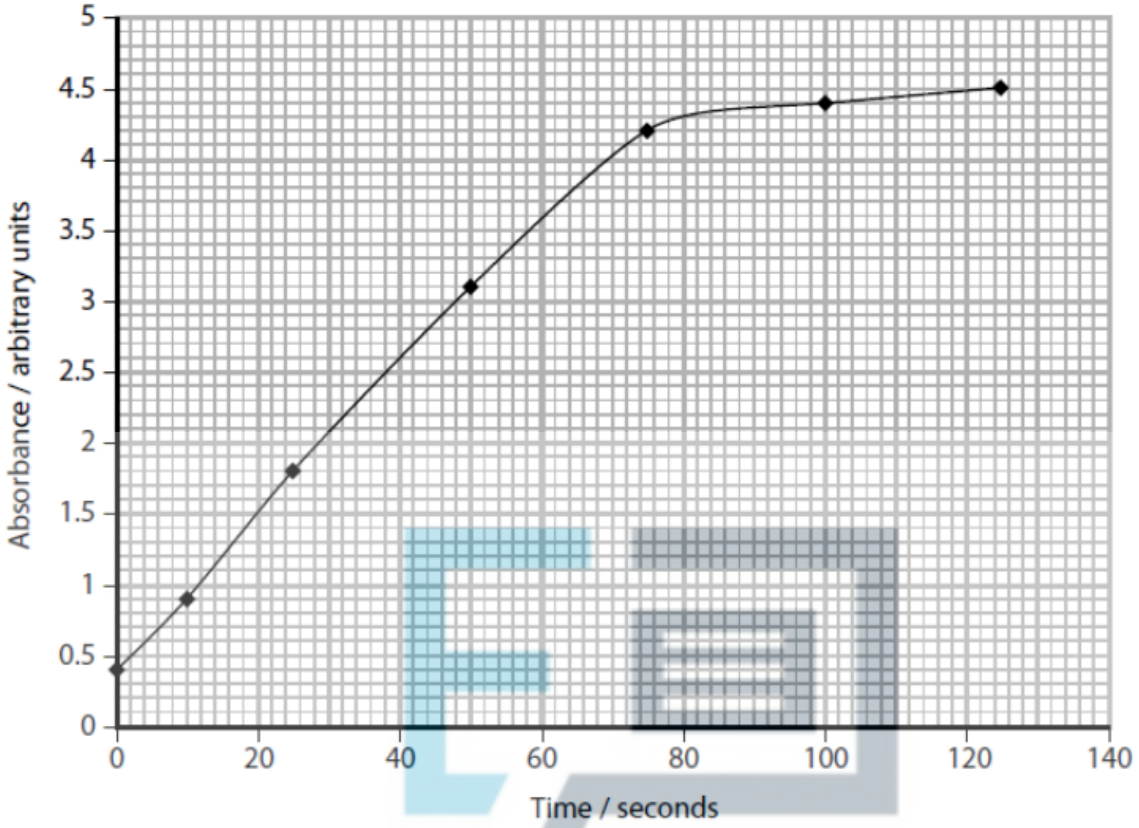
Q13.

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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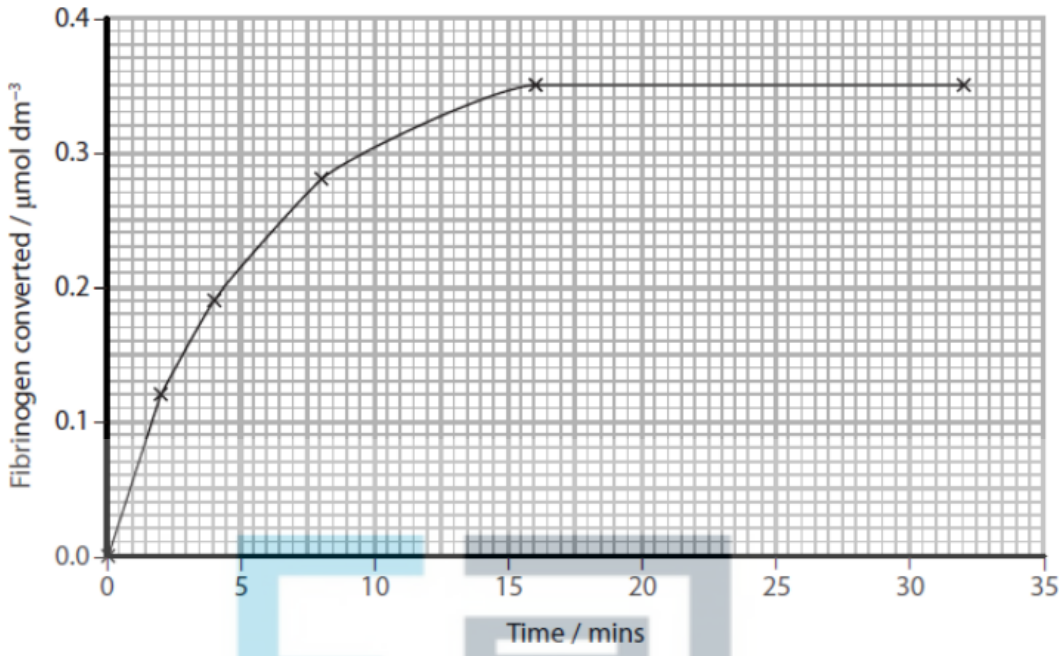
(Total for question = 6 marks)

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.

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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. **(3)**

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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.

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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.

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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)

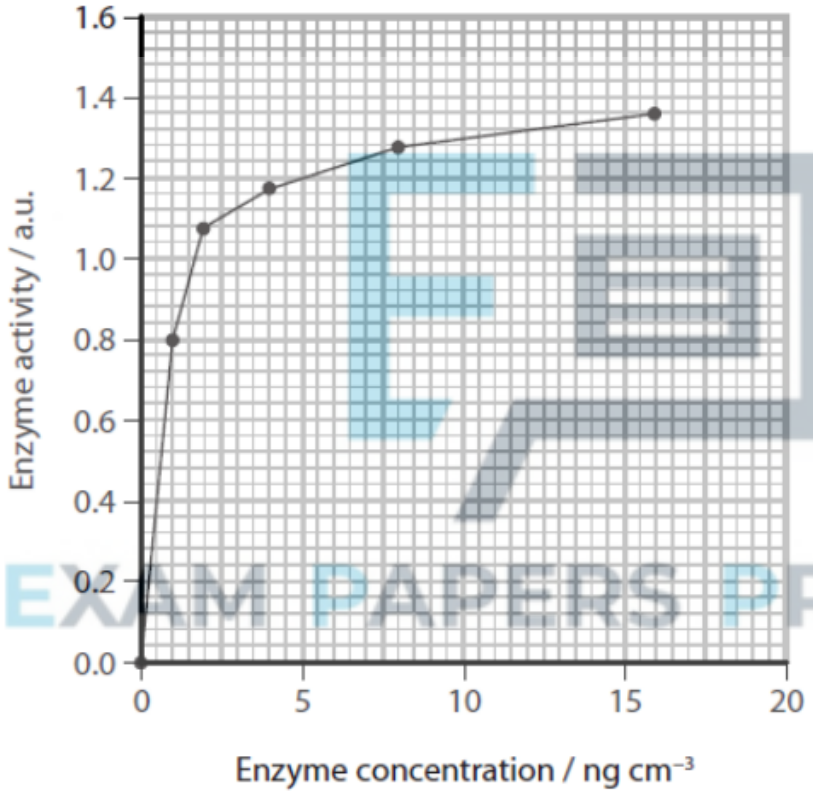
Q22.

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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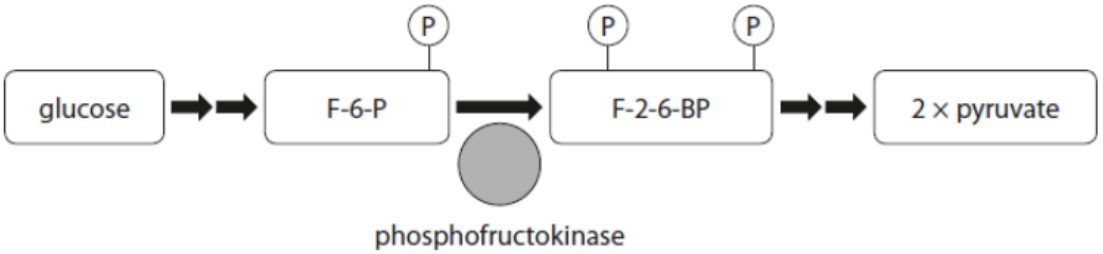
(Total for question = 2 marks)

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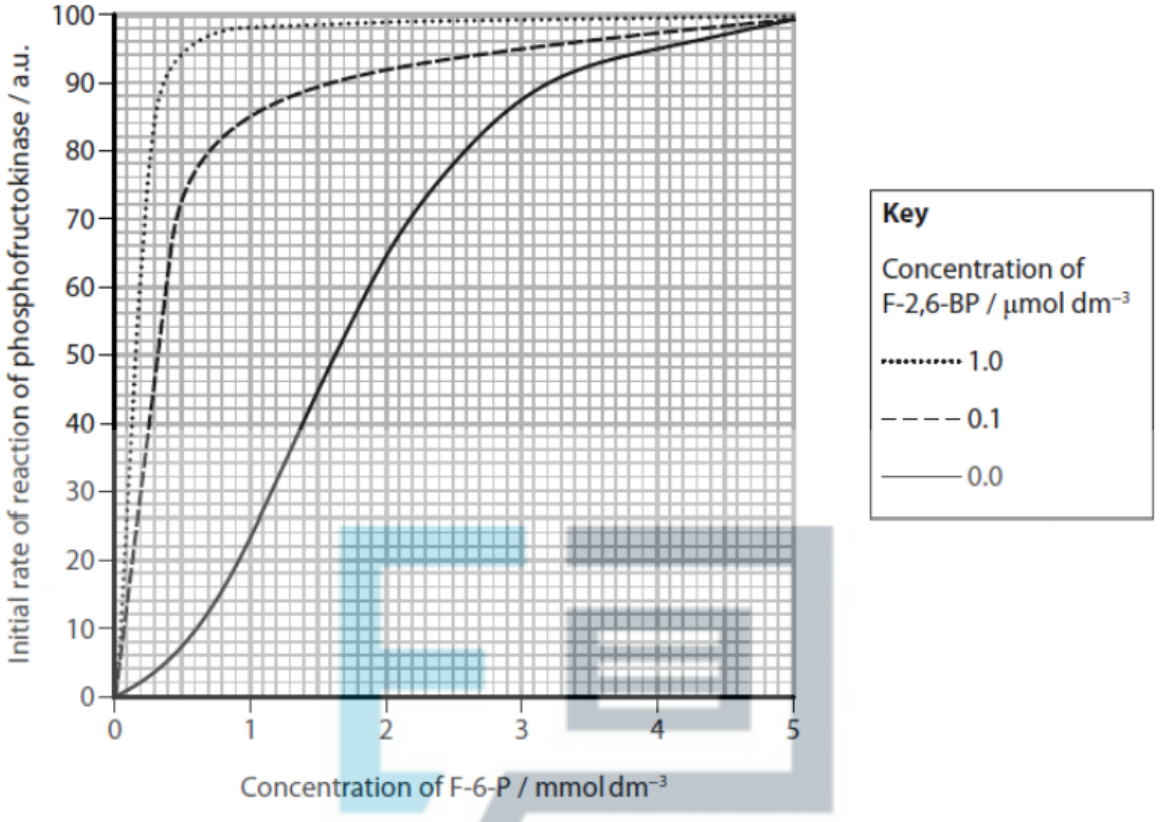
The effect of substrate concentration on the initial rate of reaction of phosphofructokinase was investigated.

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. **(3)**

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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.

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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.

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(Total for question = 3 marks)