Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel Level 3 GCE

Centre Number | | | | | |

Candidate Number | | | | |

Thursday 11 June 2020

Morning (Time: 2 hours) | Paper Reference **9BN0/02**

Biology A (Salters Nuffield)

Advanced

Paper 2: Energy, Exercise and Coordination

You must have:
Calculator, HB pencil, ruler

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Show your working in any calculation questions and include units in your answer where appropriate.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*

Information

- The total mark for this paper is 100.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*
- You may use a scientific calculator.
- In questions marked with an **asterisk** (*), marks will be awarded for your ability to structure your answer logically, showing how the points that you make are related or follow on from each other where appropriate.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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P 6 1 8 2 1 A 0 1 3 2

Pearson

Answer ALL questions.

Write your answers in the spaces provided.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 Genome sequencing and genetic modification (GM) can be used to develop proteins as personalised medicines.

(a) (i) Which of the following correctly describes the genome of an adult male?

(1)

☒ **A** all of his alleles plus all of his genes

☒ **B** all of his exons minus all of his introns

☒ **C** all of his introns minus all of his exons

☒ **D** all of his introns plus all of his exons

(ii) Which row correctly identifies all the types of organism that can be both genetically modified and be a source of a gene to be used in GM?

(1)

	Animal	Bacterium	Plant
☒ **A**	no	no	yes
☒ **B**	no	yes	yes
☒ **C**	yes	yes	no
☒ **D**	yes	yes	yes

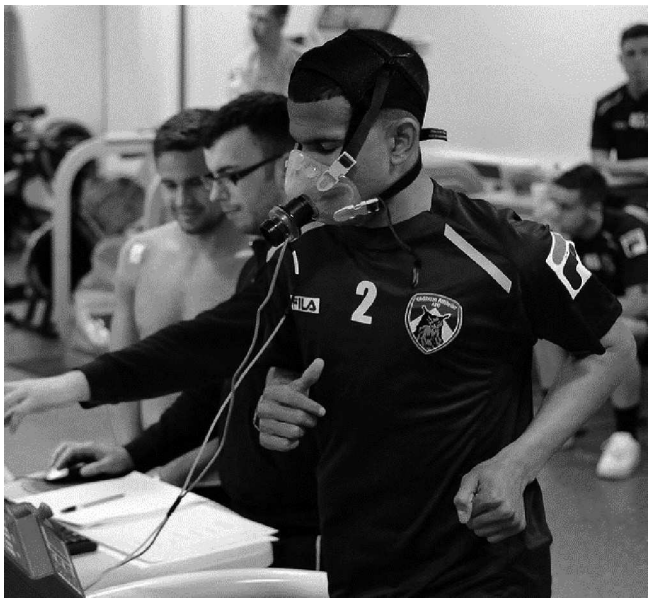
(b) Genetically modified organisms (GMOs) can synthesise personalised proteins for use as medicines.

Describe the role of enzymes involved in the synthesis of personalised proteins in GMOs.

(3)

(Total for Question 1 = 5 marks)

2 A spirometer can be used to study the performance of an athlete.



snabbiology.wordpress.com

The trace produced by a spirometer can be used to determine the respiratory minute ventilation and the oxygen consumption of an individual.

(a) Describe how a spirometer trace can be used to calculate the respiratory minute ventilation and the oxygen consumption per minute.

(4)

respiratory minute ventilation

oxygen consumption per minute

(b) A student compared the spirometer trace for a pair of healthy, genetically identical twins.

State two variables that would have to be controlled to make this a valid comparison.

(2)

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(Total for Question 2 = 6 marks)

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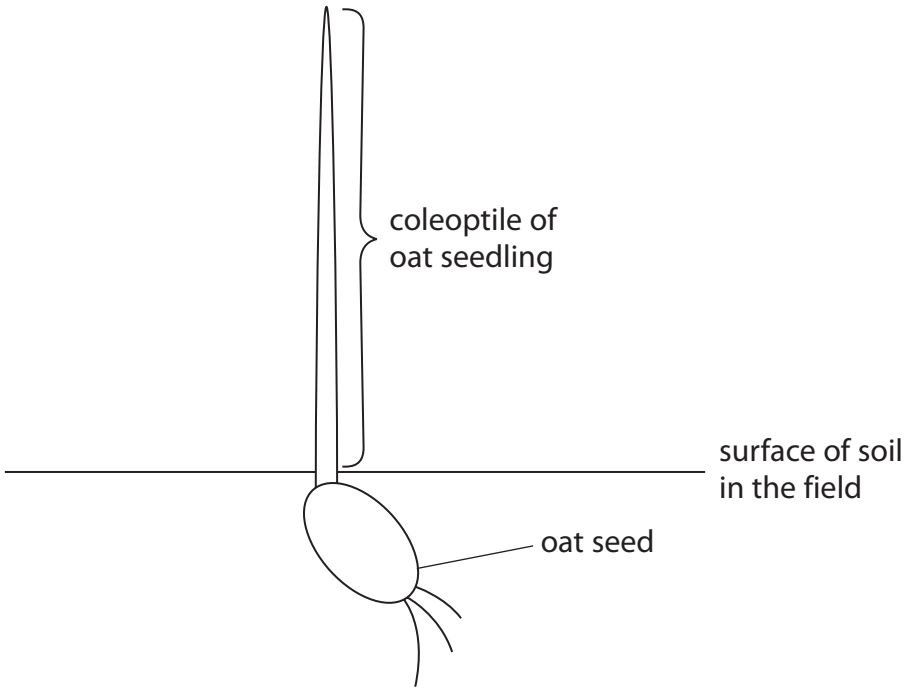
3 Phytochromes and IAA (indole acetic acid) are important substances that bring about growth responses in plants.

(a) The diagram shows an oat seedling in part of a field.



Cells in the tip of the oat coleoptile release IAA.

Explain how the IAA affects the growth of the coleoptile.

(4)

(b) Phytochrome is found in two different forms known as P_R (or P_{660}) and P_{FR} (or P_{730}).

(i) Which row correctly describes the effects of sunlight on phytochrome?

(1)

	Change in form of phytochrome	Speed of change
☒ **A**	P_{FR} to P_R	slow
☒ **B**	P_{FR} to P_R	rapid
☒ **C**	P_R to P_{FR}	slow
☒ **D**	P_R to P_{FR}	rapid

(ii) Phytochrome can be described as

(1)

☒ **A** a form of opsin

☒ **B** a photosensitive pigment

☒ **C** an isomer of retinal

☒ **D** a type of cytochrome

(iii) Give one example of a growth response of a plant that is affected by phytochrome.

(1)

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(Total for Question 3 = 7 marks)

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4 A number of seed banks have been set up around the world.

(a) When a seed bank receives new seeds, it processes them in several ways.
The processes can include the following stages:

- washing the seeds with disinfectant
- allowing the seeds to dry.

Explain the advantages of these two stages.

(3)

(b) The food store of many seeds is an organ called a cotyledon.

An organ can be defined as

(1)

☒ **A** a group of cells of one type that has a function

☒ **B** a group of several different cell types, each type working together

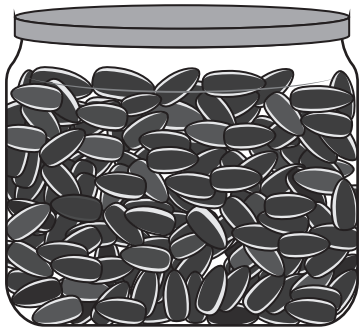
☒ **C** a group of tissues that are located together that have unrelated functions

☒ **D** part of a system and therefore does not have a function of its own

(c) The processed seeds are stored at minus 20 °C. At intervals, samples of seeds are removed from storage and tested for viability.

If at least 75% of the seeds in the sample germinate, the remaining seeds are described as viable.

The diagram shows a container with many seeds in it.



Sunflower Seeds
mass of 1000 seeds = 50 g

A sample of 3 g of seeds was removed from this container. These seeds were given optimum conditions for germination.

However, only 48 seeds germinated.

Determine whether the remaining seeds in the container are viable or not.

(3)

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(d) Glycolysis occurs during germination. One of the products is adenosine triphosphate (ATP).

Which of the following is another product of glycolysis?

(1)

☒ **A** carbon dioxide

☒ **B** glucose

☒ **C** oxygen

☒ **D** pyruvate

(Total for Question 4 = 8 marks)

5 An investigation was carried out to study the effect of alcohol concentration on heart rate in *Daphnia*.

(a) Give one reason why some people believe that there are fewer ethical issues when using *Daphnia* for this investigation rather than using a species of mammal.

(1)

(b) In this investigation, *Daphnia* were placed into three groups of 10. Each group was placed in alcohol of a different concentration for five minutes.

After five minutes, each *Daphnia* was removed from the alcohol and its heart rate recorded every 15 seconds for one minute. A mean for each concentration was calculated.

The results are shown in the table.

Alcohol concentration / mol dm^{-3}	Mean *Daphnia* heart rate / beats per minute
0.00	221
0.17	176
0.34	97

(i) Give one reason why 10 *Daphnia* were used for each alcohol concentration.

(1)

(ii) Explain why the *Daphnia* were left for five minutes in the alcohol before the heart rate was recorded.

(2)

(c) Devise an investigation to find the lowest concentration of alcohol that has an effect on the heart rate of *Daphnia*.

(5)

(Total for Question 5 = 9 marks)

6 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

(a) Complete the table by giving the name of the type of adaptation.

(2)

Description of adaptation	Type of adaptation shown by the wasp
knocking its body to signal food	
the stinger	

(b) 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.

(4)

(c) Phospholipase in the venom of wasps can cause allergic reactions.
Phospholipase can affect the Golgi apparatus in cells.

Phospholipase inhibitors are being investigated as possible drugs to treat the allergic reactions.

(i) Give two functions of the Golgi apparatus.

(2)

(ii) A three-phase protocol will be used when developing the phospholipase inhibitor as a new drug.

Explain the purpose of each phase of this protocol for a phospholipase inhibitor.

(3)

(Total for Question 6 = 11 marks)

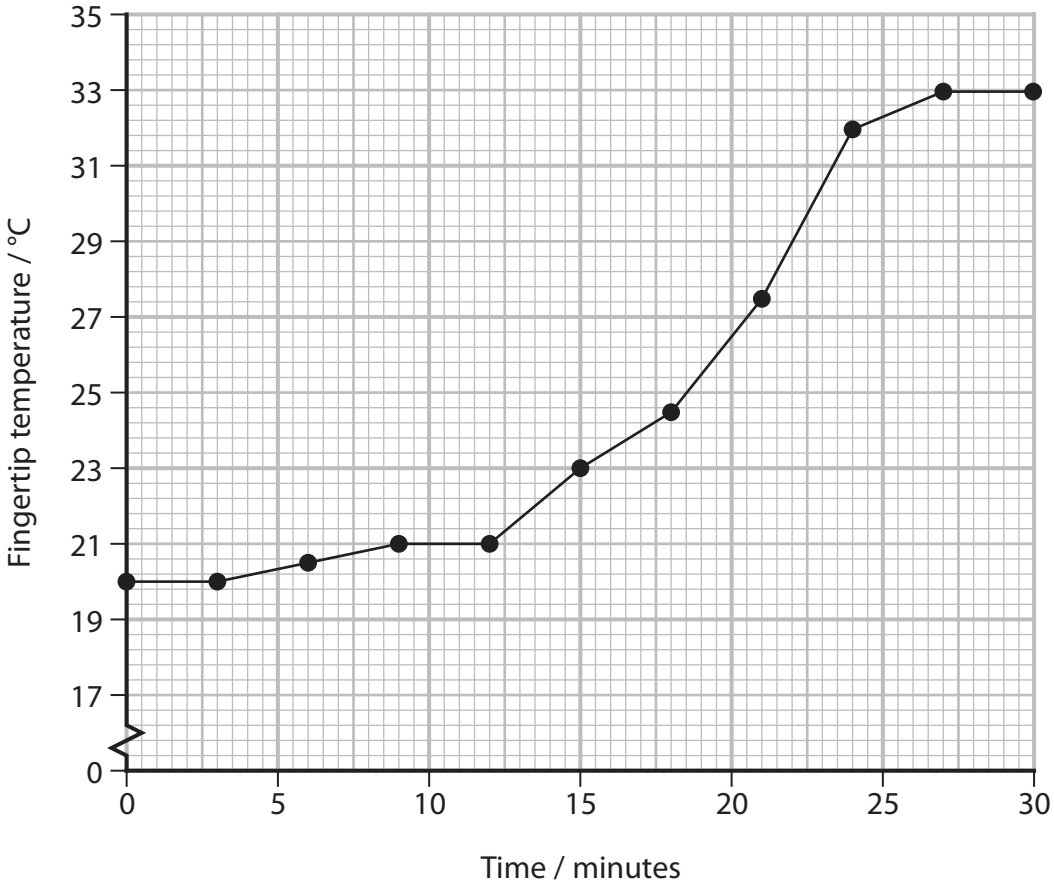
7 When scientists visit Antarctica, they need appropriate clothing to help with thermoregulation.

www.aa.com

(a) An investigation was carried out to study thermoregulation in humans.

A woman was wrapped in blankets and her feet were put in hot water for 30 minutes. During this time, the temperature of the skin at the end of one of her fingertips was recorded.

The graph shows the results of this investigation.



(i) Explain why there was no change in fingertip temperature between 0 and 3 minutes.

(2)

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(ii) Calculate the greatest rate of increase in fingertip temperature.

(2)

Answer .....

(iii) Explain the role of the nervous system in bringing about the increase in temperature of the fingertip as shown in this investigation.

(5)

(b) Sweating is a thermoregulatory mechanism.

A student stated that loss of heat when sweating is related to the dipole nature of water molecules.

Justify this statement.

(3)

(Total for Question 7 = 12 marks)

8 There are many reasons why humans may lose muscle mass.

Two known causes are hip replacement surgery and some genetically inherited conditions.

(a) A muscle fibre is a specialised body cell.

Explain how the structure of a muscle fibre is related to its specialised function.

(3)

(b) Muscles can be scanned using magnetic resonance imaging (MRI) to investigate the loss of muscle mass.

It is safer to use MRI than computed tomography (CT) because

(1)

☒ **A** CT uses X-rays that can cause mutations in the DNA of muscle fibres

☒ **B** CT uses X-rays that can cause mutations in the protein in the muscle fibres

☒ **C** CT uses magnets that can cause mutations in the DNA of muscle fibres

☒ **D** CT uses magnets that can cause mutations in the protein in the muscle fibres

(c) Muscular dystrophy (MD) is a range of genetically inherited conditions in which a loss of muscle mass can occur.

Limb-girdle muscular dystrophy (LGMD2A) is a rare type of MD. Only six people per million have this recessive condition.

In 2018 there were 66.5 million people in the UK.

(i) Calculate the number of people in the UK who are carriers of LGMD2A using the Hardy-Weinberg equation.

(3)

$$p^2 + 2pq + q^2 = 1$$

Answer .....

(ii) In the human population, the frequency of the allele for LGMD2A may change from one generation to the next.

Explain why the frequency of this allele may change from one generation to the next.

(3)

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(d) Duchenne muscular dystrophy (DMD) is the most common inherited type of MD. DMD is caused by a recessive allele.

The table shows some data on DMD from 1993 to 1999.

Year	Number of deaths due to DMD per year in England and Wales		Median age of death / years
	males	females	
1993	75	0	19
1994	37	2	19
1995	41	0	20
1996	53	0	19
1997	43	1	20
1998	51	0	21
1999	51	1	20

Analyse the data to explain why DMD causes more deaths in males than in females.

(4)

(Total for Question 8 = 14 marks)

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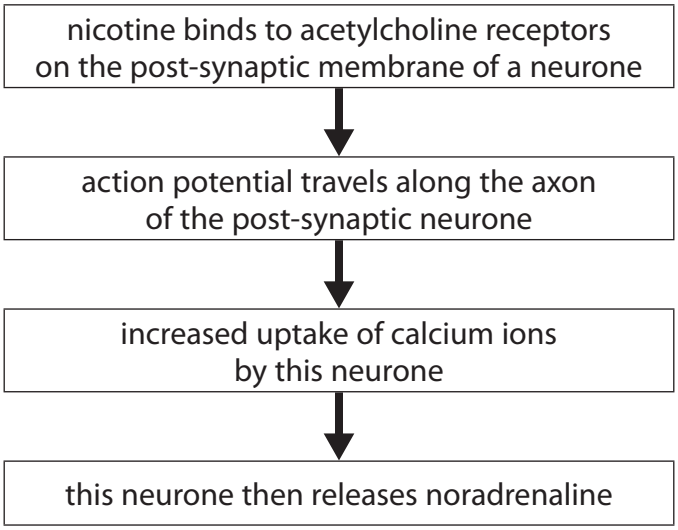
9 Nicotine is a drug found in the smoke of cigarettes.

(a) The flow diagram shows how the presence of nicotine can cause the release of noradrenaline.



(i) Explain how nicotine causes an action potential in the post-synaptic neurone that releases noradrenaline.

(3)

(ii) State how an increase in calcium ion uptake by the neurone leads to the release of noradrenaline.

(1)

(b) The effect of inhaling nicotine on the circulatory system of rats was investigated.

In this investigation, three variables were considered:

- the concentration of nicotine in blood plasma
- the diameter of the lumen of one artery
- blood pressure

Two groups of rats were treated as shown in the table.

Group	Number of rats in group	Nicotine dose / mg
A	6	1.0
B	6	0.1

(i) The concentration of nicotine in the blood plasma of the group A rats was recorded at different times and the means calculated.

The means are shown in the table along with the range of data for each mean.

Time of sampling / minutes	Mean concentration of nicotine in blood plasma / ng cm^{-3}
0 (immediately after inhalation)	35.0 ± 9.3
30 (after inhalation)	24.1 ± 5.6

Determine the maximum rate of decrease in the concentration of nicotine in the blood plasma per minute after being given the nicotine.

(2)

Answer ..... ng cm^{-3} min^{-1}

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(ii) The diameter of the lumen of one artery, in each of the 12 rats, was measured when the rats were resting. The blood pressure of each rat was also measured and the mean blood pressure calculated.

The diameter of the lumen of the artery and the blood pressure of each rat were then recorded at intervals, for a total of 30 minutes. The rats inhaled nicotine for the first minute (0.0 to 1.0).

The table shows the results for the mean diameter of the lumen of the artery.

Time / minutes	Mean diameter of lumen / μm	
	Group A (1.0 mg nicotine)	Group B (0.1 mg nicotine)
0.0	48	48
0.5	44	44
1.0	49	45
2.0	52	48
5.0	57	52
10.0	55	48
15.0	49	48
30.0	49	48

Determine the effect of nicotine concentration on the percentage change in lumen diameter in the first minute.

(2)

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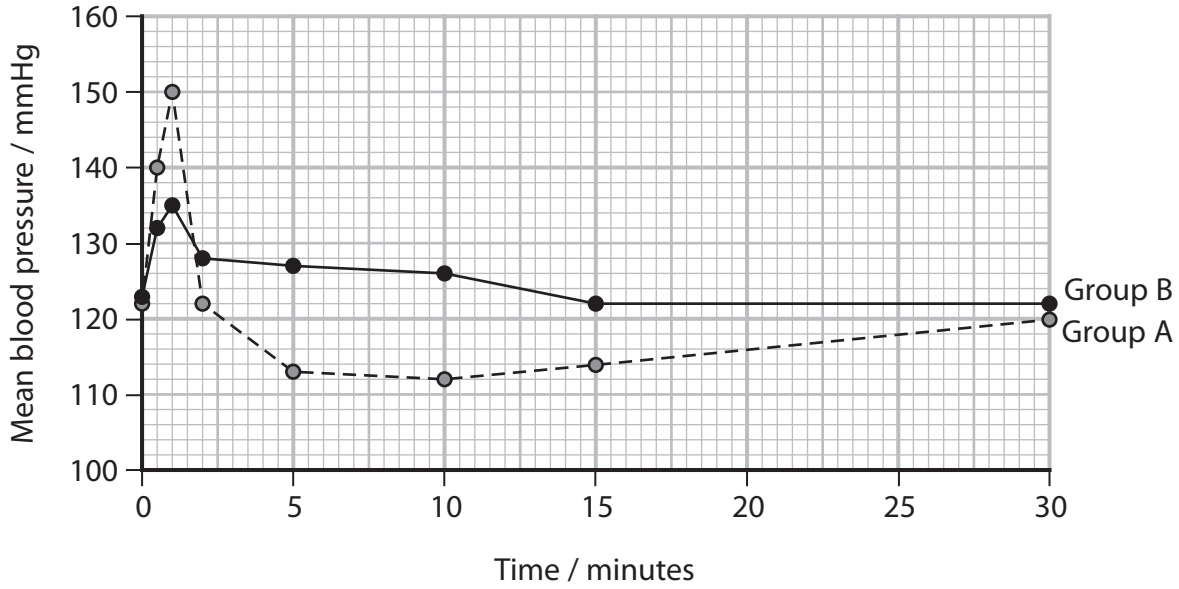
*(iii) The graph shows the results for the mean blood pressure for the two groups of rats. Nicotine was inhaled for the first minute.



It has been stated that:

'Nicotine gained from smoking cigarettes in humans causes an increase in blood pressure and a decrease in the lumen of arteries.'

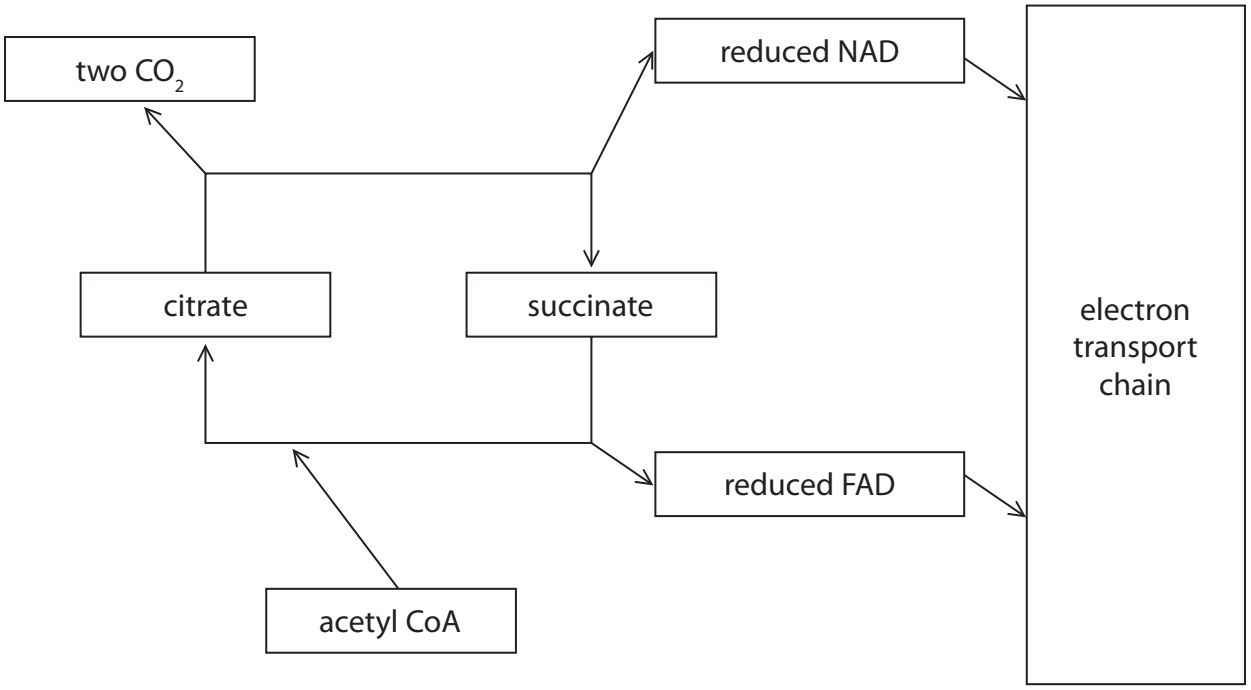
Analyse all the data from this investigation using rats to evaluate the validity of this statement.

(6)

(Total for Question 9 = 14 marks)

10 Respiration occurs in all healthy living cells.

(a) The diagram shows part of the Krebs cycle and the electron transport chain.



(i) Which row shows the number of carbon atoms in citrate and succinate?

(1)

		Number of carbon atoms in	
		citrate	**succinate**
☒	**A**	2	4
☒	**B**	5	4
☒	**C**	6	4
☒	**D**	6	8

(ii) Which of the following is transferred to a molecule of FAD to form reduced FAD?

(1)

☒ **A** two oxygen atoms

☒ **B** two hydrogen atoms

☒ **C** one oxygen atom and one hydrogen atom

☒ **D** one water molecule

(iii) Explain the need for reduced NAD to be oxidised in a mitochondrion.

(2)

(iv) A mutation in the gene that codes for the enzyme succinate dehydrogenase stops the conversion of succinate into citrate.

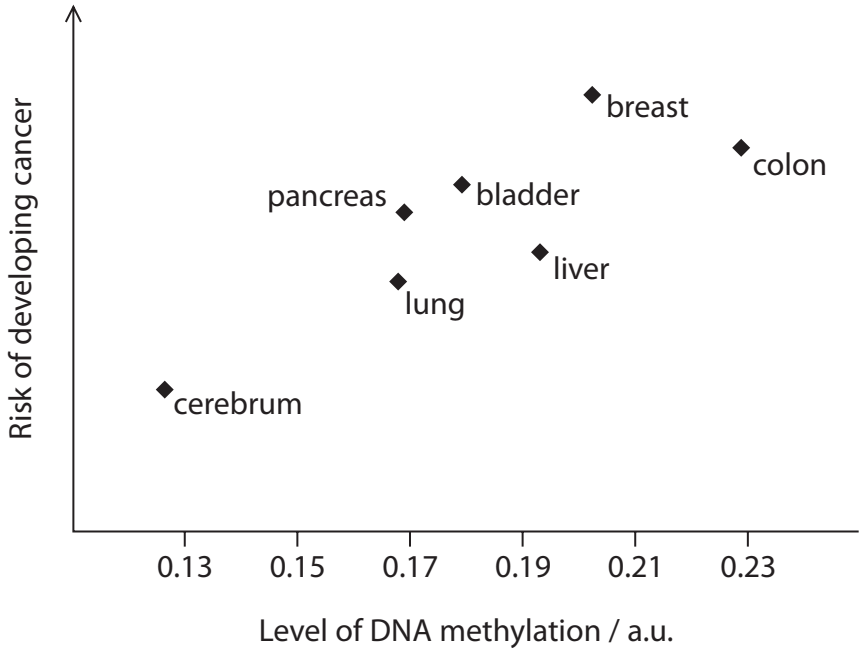
Which row states the change in concentration of citrate and reduced FAD as a result of this mutation?

(1)

	Concentration of citrate	Concentration of reduced FAD
☒ **A**	decreases	decreases
☒ **B**	decreases	increases
☒ **C**	increases	decreases
☒ **D**	increases	increases

(b) 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.

(6)

(Total for Question 10 = 14 marks)

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