Please check the examination details below before entering your candidate information

Candidate surname	Other names
Evans	Alexander

Pearson Edexcel Level 3 GCE

Centre Number	Candidate Number
1 2 4 1 6	3 1 5 4

Thursday 13 June 2019

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: 45

HA025964298

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 5 6 6 9 7 A 0 1 3 2

Pearson

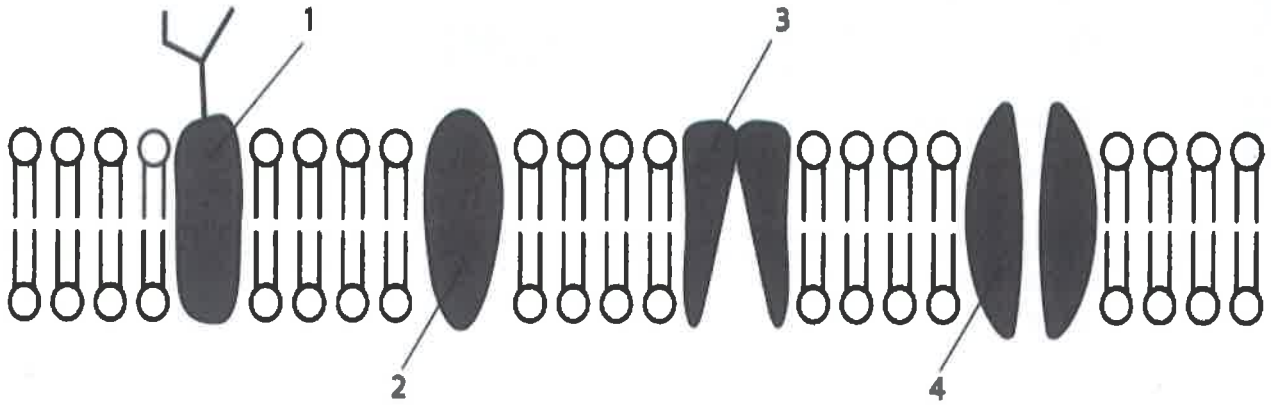
Answer ALL questions.

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

(a) 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) 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) 0

☒ **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)0

- ☒ A × 5000
- ☒ B × 50 000
- ☒ C × 500 000
- ☒ D × 5 000 000

J

A m

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

(3)2 Q01b

The heads have a phosphate group making it hydrophilic and the tails contain chains of hydrocarbons which are hydrophobic. They As the the hydophobic tails do not want to touch water, they create a bilayer which has the hydrophilic heads pointing out at the water and the hydrophobic tails pointing inwards.

(Total for Question 1 = 6 marks) 3

2 There are various ways to scan the brain.

(a) (i) Brain tumours are dense masses of cells. The presence of brain tumours can be detected using several types of scanning method.

The table shows two types of scan. Place a tick [✓] in the box if the scan can identify the size and location of a large brain tumour or a cross [✗] in the box if the scan cannot identify the size and location of a large brain tumour.

(2) 1 Q02ai

Type of scan	Can be used to identify the tumour
CT	✗
MRI	✓

(ii) Functional MRI (fMRI) measures brain activity by detecting changes in

(1) 1

- ☒ **A** blood flow
- ☒ **B** bone density
- ☒ **C** dopamine release
- ☒ **D** lactic acid production

(iii) Which of the following types of scanner uses X-rays?

(1) 1

- ☒ **A** CT
- ☒ **B** fMRI
- ☒ **C** MRI
- ☒ **D** PET

(b) Describe how positron emission tomography (PET) scans can be used to investigate brain structure.

(2) 2 Q02b

Radiotracers which are radioactive isotopes of Carbon, ~~and~~ nitrogen and oxygen are injected. These are the building blocks of many organic molecules and when needed, will be transfered to the area of the brain that is most use. They radiate gamma rays which are ~~picte~~ picked up by scanners.

(Total for Question 2 = 6 marks) 5

3 Cystic fibrosis is a genetically inherited condition.

A couple who are both carriers for the condition have a 25% chance of having a baby with cystic fibrosis. In the UK, 1 in 2500 babies born have cystic fibrosis.

(a) Use the Hardy-Weinberg equation to calculate the probability of babies born in the UK being carriers for cystic fibrosis.

(3) 0 Q03a

$\sqrt{4 \times 10^{-4}} + p = 1$

$p = 0.9996 \quad q = 4 \times 10^{-4}$

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

Homozygous recessive = 1.6×10^{-7}

$(2pq) \times 100 = 0.079968\%$

or

7%

Answer 0.08%

(b) 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.

50% C & G

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.

CFTR

(2) Q03bii

The CFTR gene is responsible for producing the CFTR channel protein which is responsible for the regulation of water in the mucus around the body. Some mutations will result in the CFTR protein not being present at all, therefore very severe cystic fibrosis, or it just being faulty, therefore being less severe.

(Total for Question 3 = 6 marks) 1

4 A moderate amount of exercise is considered good for the human body.

(a) A student carried out 20 minutes of physical exercise. During this time, her heart rate and level of sweating increased.

Shortly after completing the exercise, the student noted that her heart rate and level of sweating decreased.

(i) Explain the role of the brain in reducing the student's heart rate after the exercise.

(2) 0 Q04ai

Once ~~sweating~~ exercise stops, the body's core temperature decreases therefore sweating is no longer needed and the glucose and oxygen need for the muscles is less so the heart does not need to pump blood around as much. The medulla oblongata recognises this and uses the parasympathetic system to stop and slow these actions e.g. the use of the vegus nerve to slow heartrate.

(ii) Describe how the brain reduces the activity of the sweat glands after the exercise.

(2) 0 Q04aii

The medulla recognises a drop in the body temperature which is too low, ~~It the~~ from the ~~brain~~ thermoreceptors in the skin. ~~This signals~~ The medulla then uses the parasympathetic system to close sweat pores which stops sweat being released. This will stop the body from cooling down further.

(b) Explain why too much exercise could be harmful to the human body.

(3) Q04b

Too much exercise can be harmful to the joints. For example, excessive exercise will result in the fast wearing away of the cartilage which stops bones rubbing together. Without this, it can become painful as the bones are now wearing away. Ligaments also do not grow back. Too much exercise can cause damage and without these ligaments, the joint will simply fall apart.

(Total for Question 4 = 7 marks) 2

5 Muscle fibres contain a number of proteins, including actin, myosin and collagen.

(a) The myosin binding site is found on

(1) 1

- ☒ **A** actin
- ☒ **B** sarcoplasmic reticulum
- ☒ **C** tropomyosin
- ☒ **D** troponin

(b) 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) 0 Q05b

The actin filament is made up of a repeating unit of ~~two~~ more than one protein. It has folded in on itself and is held together by hydrogen bonds, ionic bonds and disulphide bridges. Collagen is a fibrous protein that is ~~mde~~ made up of more than one protein also. It ~~has~~ has not folded in on itself but instead it has twisted into a long fibre. It ~~also~~ is held together by hydrogen bonds and disulphide bridges.

(c) 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) Q05ci

The troponin (Q) blocks the actin's binding site for the myosin head. When Ca^{2+} ions come from the sarcoplasmic reticulum they bind to the trop myosin (P) and make the two molecules move and reveal the myosin head binding site. Then muscle contraction can occur.

(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.

(3) Q05cii

Each peptide has a specific R group. This specific R group will interact with different R group, by using intermolecular forces e.g. hydrogen bonds. This will allow the enzyme to form a specific shape with the ~~active site~~ specific active site that is complementary in shape to ATP. to This will allow the breakdown of ATP → ADP + Pi releasing energy which is what is needed for the myosin head to pivot an move the sarcomeres closer together.

(Total for Question 5 = 9 marks) 4

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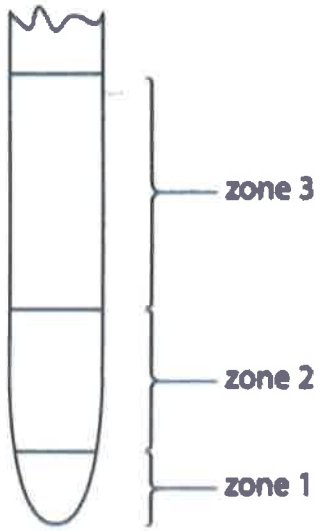
6 The diagram shows three different zones found in a plant root.



(a) Cells in zone 1 carry out interphase, mitosis and cytokinesis.

A student stated the hypothesis that:

In zone 1, the percentage of cells carrying out mitosis decreases from the tip to the start of zone 2.

(i) Which one of the following would be the correct null hypothesis?

(1)

☒ A the percentage of cells carrying out mitosis increases from the tip to the start of zone 2

☒ B the percentage of cells in interphase decreases from the tip to the start of zone 2

☒ C there is no change in the percentage of cells carrying out mitosis from the tip to the start of zone 2

☒ D there is no change in the percentage of cells in interphase from the tip to the start of zone 2

cormu

(ii) Devise an investigation to test this hypothesis.

(5) 2 Q06ai

Grow 15 basil ~~pl~~ plants from a seed a wait 20 days for roots 2~~6~~ to form. Take 2 samples from ~~each~~ root from every plant. One sample will be the root tip and the other is from the start of zone # 2. Next prepare a slide for a microscope from each sample. This will be done by treating with ethanol first, then adding a dye e.g. Trypan blue and the squashing firmly another ~~pie~~ slide of glass over the top. Making sure not to roll or put fingerprints on the glass. Next, view every slide. Count each visible cell and each cell you can see the chromosomes. The cells that you can see the chromosomes in will be in the ~~metaphase~~ prophase of mitosis. Then calculate the percentage of cells undergoing mitosis by doing $\left(\frac{\text{number of cells in metaphase}}{\text{Total number of cells}}\right) \times 100$. Now you can compare the results.

(b) In zone 2, the plant cells elongate due to a change in their cellulose cell walls.

(i) Cellulose and amylopectin are polymers of hexose sugars.

State one difference between the hexose in cellulose and the hexose in amylopectin.

(1) 1 Q06bi

Cellulose is made from B-glucose whilst amylopectin is not made from α-glucose.

(ii) The cellulose molecules form microfibrils.

Name the bond between adjacent cellulose molecules in a cellulose microfibril.

(1) 0 Q06bii

glycosidic bond

(c) In zone 3, some of the cells differentiate to give rise to phloem sieve tube elements and others differentiate into phloem companion cells.

(i) Explain how genetically identical cells in zone 3 can differentiate to give rise to different tissues.

(3) Q06ci

The cells in cell 3 are stem cells. Stem cells are undifferentiated cells that can differentiate to make any sort of cell in the plant (if totipotent). This allows the root tip to grow down towards water, while the cells above it differentiate to make phloem companion cells aswell as other transport systems. These will feed the root tip and allow it to grow further.

(ii) The student also hypothesised that the cells in zone 1 would be smaller in size than the cells that had differentiated into xylem vessels in zone 3.

The student prepared microscope slides of sections from zones 1 and 3.

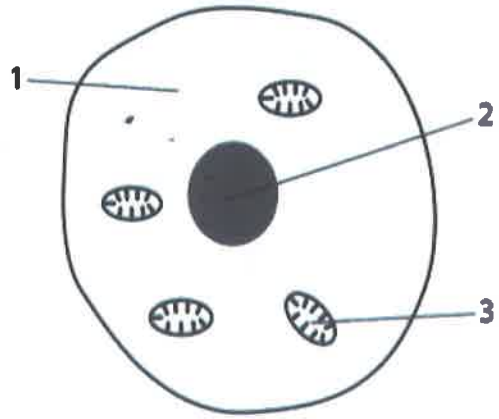
Explain how the student could compare the sizes of cells in zone 1 with the sizes of xylem vessels in zone 3.

(3) Q06cii

Use a graduated measuring square. A clear piece of plastic that you can add on top of the slide that has specific measurements. The student can now look at the specific cells and measure their length. They can then compare the lengths to other cells and see whether the zone 3 cells are larger than the zone 1 cells.

(Total for Question 6 = 14 marks) 4

7 (a) 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) 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) 0 Q07aii

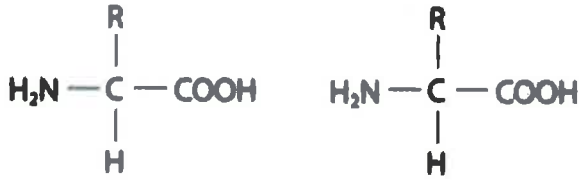
Lactate will be broken down by the hydrolytic enzymes ~~in the~~ (lysozymes) in the cytoplasm of the liver cell. The products of this reaction will then ~~can~~ be reused ~~in the~~ in the the body.

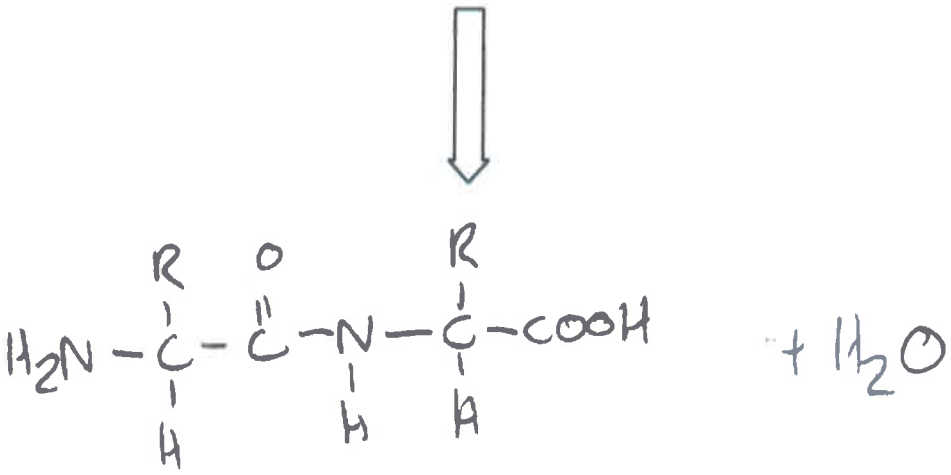
(iii) During protein synthesis, two amino acids are joined together to form a dipeptide.

The diagram shows two identical amino acids.

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

(2) Q7aiii





(b) Explain why the liver is an organ and not a tissue.

(2) Q07b

The liver is a group of cells that has a specific role in the organism. That is taking harmful toxins out of the blood. A tissue does not have a specific function other than to support other tissues.

(c) Each liver cell carries out respiration.

During respiration, ATP is formed and broken down.

(i) During which of the following processes is ATP formed?

(1) 1

☒ A glycolysis and the electron transport chain only

☒ B glycolysis and the Krebs cycle only

■ C glycolysis, the Krebs cycle and the electron transport chain only

☒ D glycolysis, the link reaction, the Krebs cycle and the electron transport chain

(ii) Explain why some ATP is broken down during glycolysis.

(2) 2 Q07cii

Energy is needed to break the 6 carbon glucose ~~is~~ down into ~~2~~, two, 3 carbon glyceraldehyde 3 phosphate molecules.

(iii) The electron transport chain occurs in the cristae of mitochondria. The electron transport chain involves a number of carrier molecules.

Explain the role of these carrier molecules in the electron transport chain.

(3) 2 Q7ciii

The carrier molecules e.g. NADH and $FADH_2$ are used ~~in the~~ to transport H^+ ions and electrons. The electrons move down the electron transport chain which pumps the H^+ ions into the ~~matrix~~ ~~intermembrane~~ mitochondrias inter-membrane space which, due to the high concentration of H^+, can diffuse back through the stalked particle, catalysing the reaction of $ADP + Pi \rightarrow ATP$.

(Total for Question 7 = 13 marks) 8

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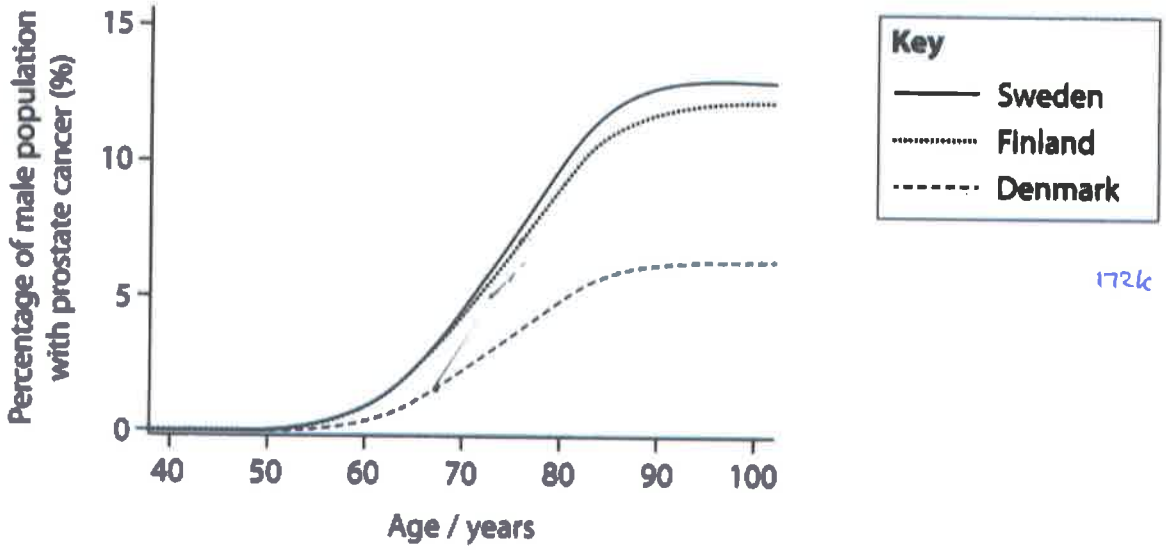
8 Prostate cancer is one of the most common forms of cancer in adult men.

A number of investigations have been carried out to study prostate cancer in a large number of men in Denmark, Finland and Sweden.

(a) In one of these investigations, the effect of age on developing prostate cancer was studied.

The graph shows the results.



1726

Comment on the effect of age on the development of prostate cancer.

(3) 3 Q08a

Between 40 and 50, 0% of people have prostate cancer, but from 50 the percentage of people with prostate cancer starts to increase. Between 70 and 80 has the largest number of increase of people with prostate cancer. At around 90 years of age, it levels off with the same number of people with prostate cancer and no increase.

(b) In another investigation, the effect of diet on the development of prostate cancer was studied.

Data were collected on prostate cancer death rates and the intake of sugar. Some of the data are shown in the table.

Daily sugar intake per person / kJ	Prostate cancer death rate / 100 000 of the male population
420	5.0
840	8.5
1260	12.0
1680	16.0
2100	20.0

343

The male population size of Denmark is 2.86 million.

Calculate the number of men likely to die from prostate cancer if their daily sugar intake was 1260 kJ.

(2) Q08b

$\frac{2,860,000}{100,000} = 28.6$

$28.6 \times 20 = 572$

Answer 572.

(c) In a third investigation, prostate cancer in identical and non-identical male twins was studied.

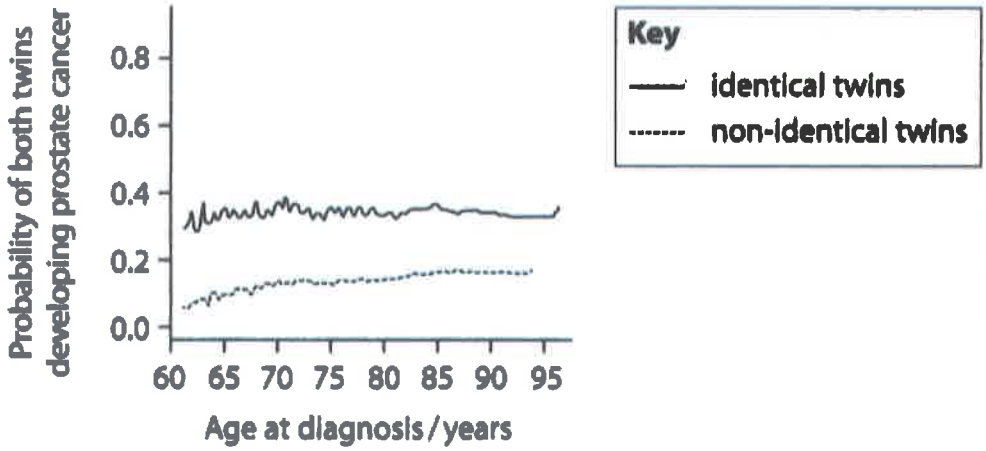
Data were collected on the probability of one male twin developing prostate cancer if his twin brother had prostate cancer.

(i) Explain why identical twins were included in this investigation.

(2) 0 Q08ci

B Identical twins share 100% of their DNA, therefore if a higher percentage of identical twins had prostate cancer and a low percentage of non-identical twins had prostate cancer, then prostate cancer is more likely to be genetically inherited.

*(ii) The graph shows the results of this investigation.



Analyse the data from these three investigations to evaluate the likely causes of prostate cancer.

(6) Q08cii

Diet is the most important factor when it comes to developing prostate cancer. With age, there is a minimum of 5% increase of developing prostate cancer, between 50 and 100. But with the sugar intake, there is a 200% increase in the likelihood of developing prostate cancer when you increase your sugar intake from 420kJ to 2100kJ. The environment has the greatest effect on developing prostate cancer but genetics also play a role. Identical twin are more likely to both develop prostate cancer than non identical twins. This means that genes may predispose you to be more likely to develop prostate cancer.

(Total for Question 8 = 13 marks) 4

9 Changes in diet are affecting the health of people in the UK.

(a) The table shows mean data for adult males in the UK in 1967 and 50 years later in 2017.

Year	Mean mass / kg	Mean height / cm	Mean BMI
1967	73	172	24.7
2017	84	178	26.5

The National Health Service (NHS) states that BMI can be used to assess the weight category of an adult male. The table shows these categories.

Category	BMI range
Underweight	⩽18.4
Healthy weight	18.5 – 24.9
Overweight	25.0 – 29.9
Obese	⩾30.0

The mean BMI for adult males in 1967 indicates that they were in the healthy weight category.

Use the BMI formula to determine the mean weight category for adult males in 2017.

$$\text{BMI} = \frac{\text{mass in kilograms}}{(\text{height in metres})^2}$$

(2) 2 Q09a

$\frac{84}{(1.78)^2} = 26.5$

This classes most adult males as overweight.

(b) The effect of being shown a cheeseburger on saliva production in a child was studied.

The mass of saliva produced by this child was measured.

The child was then shown a cheeseburger and the new mass of saliva produced was measured. The change in the mass of saliva produced was recorded.

This was repeated with the child being shown a cheeseburger on eight occasions, at five minute intervals.

The results in the table show the change in mass of saliva produced compared with the mass of saliva produced before the child being shown a cheeseburger.

Occasion	Change in mass of saliva produced / g
1	+ 0.30
2	+ 0.18
3	+ 0.05
4	+ 0.02
5	+ 0.02
6	– 0.08
7	– 0.18
8	– 0.19

(i) Describe the effect on saliva production shown by these results.

(2) Q09bi

This is Over time, the amount of saliva produced reduced after every time the cheeseburger was shown. If the first time there was an increase of 0.3g of saliva but the 8th time, there was a decrease of 0.19.

(ii) Name the type of learning behaviour shown by the child as they were repeatedly shown a cheeseburger.

(1) 1 Q09bii

Habituation.

(iii) Explain what happens at the synapse to cause a decrease in saliva production when the child was shown a cheeseburger on more than six occasions.

(4) 0 Q9biii

When the same stimulus is given multiple times, the calcium channels close. This stops calcium from diffusing in into the presynaptic bulb. The usually a the ~~stimulus~~ calcium ions mobilise the vesicle containing neurotransmitters and allow them to be released by exocytosis into the synapse. The After habituation, calcium ions cannot diffuse in, therefore the neurotransmitters aren't release and an action potential does not form at the next neurones so na saliva is produced

(c) When the child was shown the cheeseburger, information would have been sent from the eye to the brain.

Describe the role of sodium ions in the functioning of a mammalian rod cell.

(3) 0 Q09c

Sodium ions diffuse into the rod cell at one end and and then pumped out using targeted pumps that the middle of the cell. This depolarises the rod cell and and allows the inhibitory synapsy to fire, making the image of black.

(Total for Question 9 = 12 marks) 5