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Surname	Other names

Pearson Edexcel Level 3 GCE

Centre Number | Candidate Number

Biology B

Advanced

Paper 2: Advanced Physiology, Evolution and Ecology

Monday 11 June 2018 – Afternoon

Time: 1 hour 45 minutes

Paper Reference **9BI0/02**

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.*
- You may use a scientific calculator.
- In question(s) 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.

Information

- The total mark for this paper is 90.
- The marks for **each** question are shown in brackets – *use this as a guide as to how much time to spend on each question.*

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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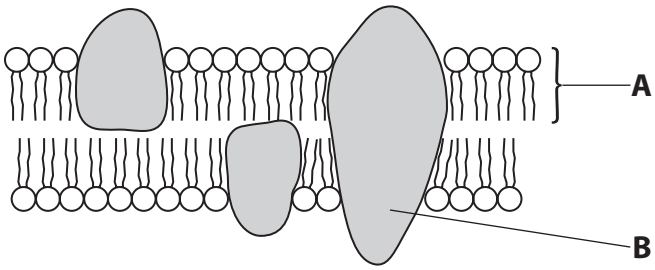
Answer ALL questions.

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 diagram shows the structure of a cell membrane.



(a) Name the parts labelled **A** and **B**.

(1)

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(b) Explain how the structure of the membrane controls the transport of polar molecules.

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(Total for Question 1 = 5 marks)

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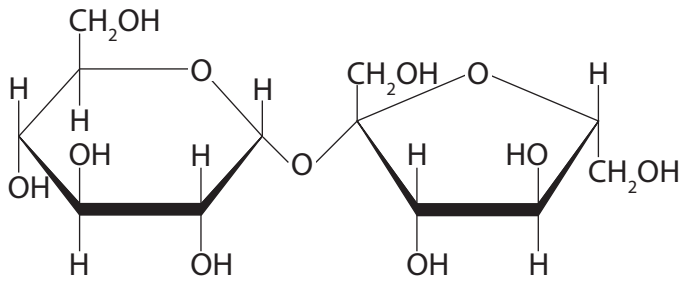
2 Enzymes are involved in the breakdown of carbohydrates.

(a) The diagram shows the structure of sucrose.



The enzyme sucrase breaks down sucrose into two monosaccharides.

(i) Which type of reaction does sucrase catalyse?

(1)

☒ **A** condensation

☒ **B** hydrolysis

☒ **C** phosphorylation

☒ **D** translocation

(ii) Name the monosaccharides produced from the breakdown of sucrose.

(1)

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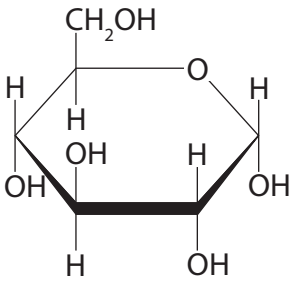
(iii) The diagram shows one of these monosaccharides.

Draw the structure of the other monosaccharide.

(1)



(b) The enzyme amylase breaks down the polysaccharide amylose into maltose.

How many of these statements are true for amylose?

(1)

- It contains 1,6 glycosidic bonds
- It contains 1,4 glycosidic bonds
- It has a helical structure
- It has a branched structure

☒ **A** 1

☒ **B** 2

☒ **C** 3

☒ **D** 4

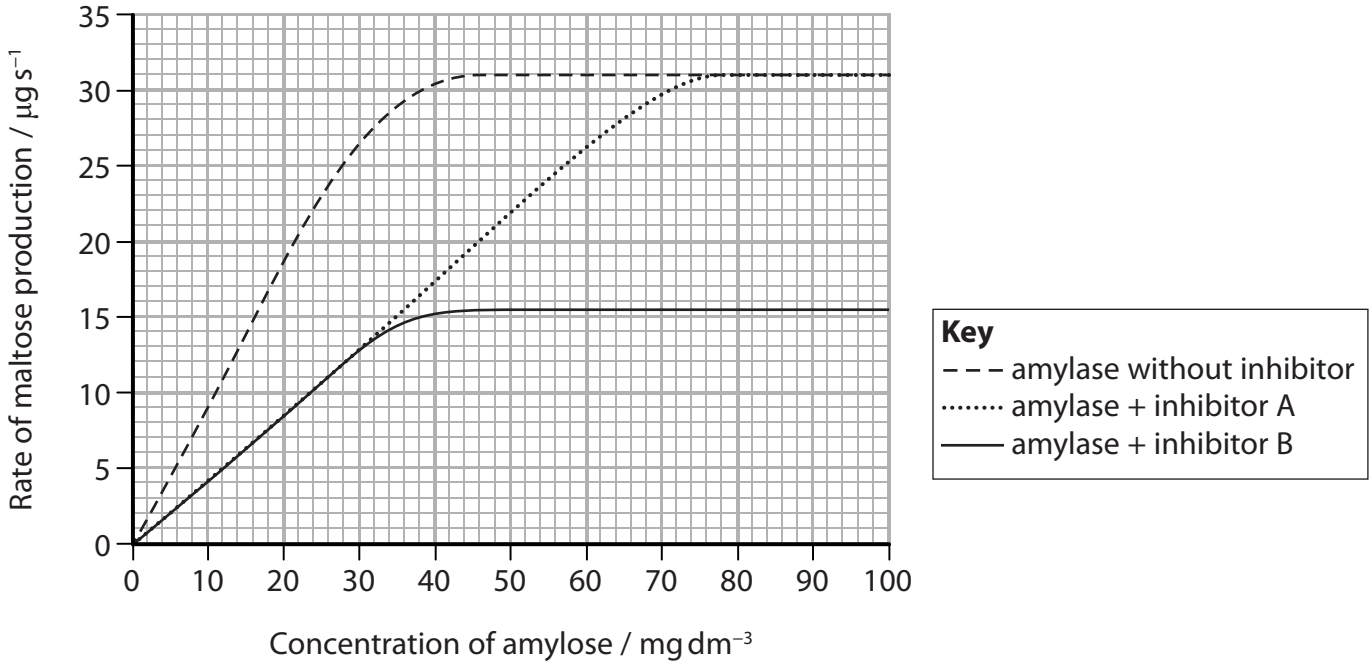
(c) Some plants produce amylase inhibitors.

A student investigated the effects of two inhibitors, A and B, on the activity of amylase.

The same concentration of amylase and the same concentrations of the inhibitors A and B were used.

The rate of maltose production was measured at different concentrations of amylose with each inhibitor and without an inhibitor.

The results are shown in the graph.



P 5 2 2 8 7 R A 0 4 3 2

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(i) Compare and contrast the effects of these two inhibitors on amylase activity.

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(ii) Explain which of the two inhibitors is non-competitive.

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(Total for Question 2 = 9 marks)

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3 The retina contains rod cells and bipolar neurones.

Rod cells contain large numbers of mitochondria.

(a) Explain the role of mitochondria in the functioning of rod cells.

(2)

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(b) Rod cells release glutamate, an inhibitory neurotransmitter.

Describe how light causes a change in the release of glutamate from rod cells.

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(Total for Question 3 = 6 marks)

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4 The photograph shows part of a bacterial cell surrounded by viruses, as seen using an electron microscope.

(a) (i) Which of these structures would be present in a bacterial cell but absent in a palisade mesophyll cell?

(1)

☒ **A** cellulose cell wall and nucleoid

☒ **B** cellulose cell wall and nucleolus

☒ **C** peptidoglycan cell wall and nucleoid

☒ **D** peptidoglycan cell wall and nucleolus

(ii) Which virus contains DNA?

(1)

☒ **A** Ebola

☒ **B** HIV

☒ **C** λ (lambda) phage

☒ **D** tobacco mosaic

(iii) Explain why an electron microscope, rather than a light microscope, was used to produce this photograph.

(2)

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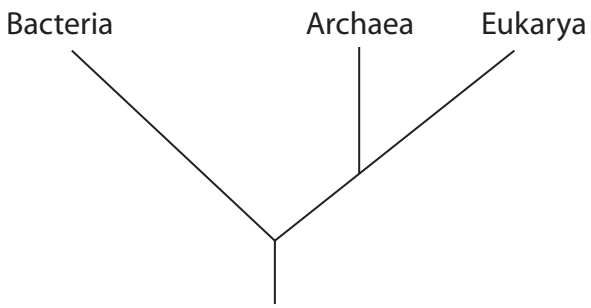
(b) The diagram shows the three-domain model of classification as suggested by Carl Woese.



This model was based on the comparison of many different characteristics.

Some of the characteristics used by Woese are shown in the table.

Characteristic	Archaea	Bacteria	Eukarya
Membrane lipids	branched carbon chains attached to glycerol by **ether** linkage	straight carbon chains attached to glycerol by **ester** linkage	straight carbon chains attached to glycerol by **ester** linkage
First amino acid in protein synthesis	methionine	formylmethionine	methionine
Antibiotic sensitivity	no	yes	no
rRNA loop sequence	absent	present	absent
Ribosome size	70 S	70 S	80 S

(i) Analyse the information to explain the evidence for the three-domain model of classification.

(3)

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(ii) Many scientists agree with this three-domain model.

State how these scientists would have reached agreement about this model.

(1)

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(Total for Question 4 = 8 marks)

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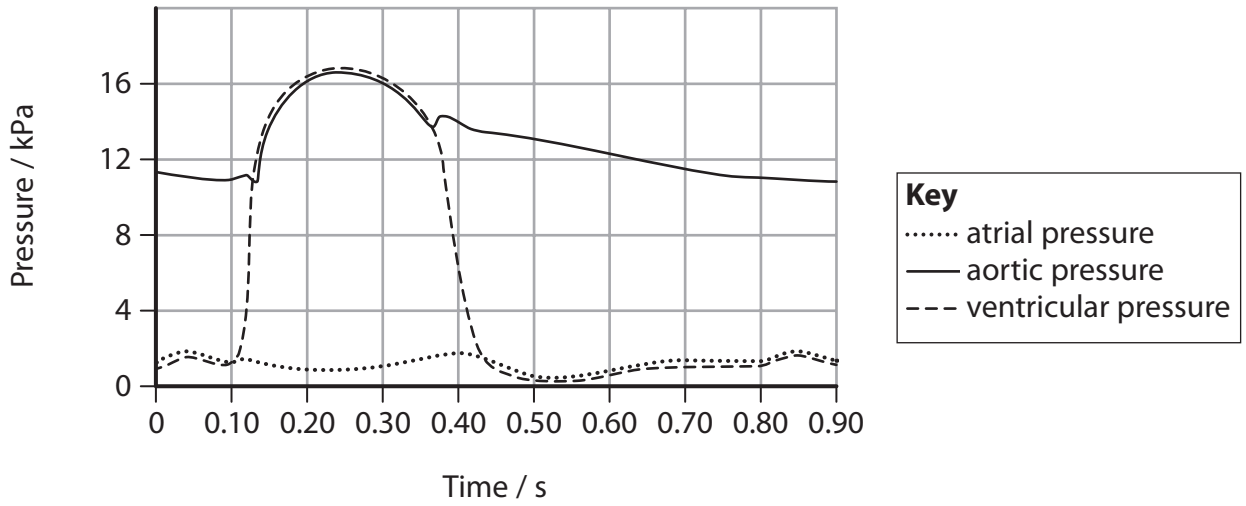
5 The graph shows the pressure changes in the left side of the heart during one cardiac cycle.



(a) (i) Calculate the heart rate.

(1)

Answer .....

(ii) During which time period does blood leave the left ventricle?

(1)

☒ **A** 0.10 s to 0.13 s

☒ **B** 0.10 s to 0.37 s

☒ **C** 0.13 s to 0.37 s

☒ **D** 0.13 s to 0.43 s

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(iii) At which time does the valve between the atrium and the ventricle close?

(1)

☒ **A** 0.10 s

☒ **B** 0.13 s

☒ **C** 0.37 s

☒ **D** 0.43 s

(b) Describe how myogenic stimulation brings about contraction of the atria and the ventricles.

(5)

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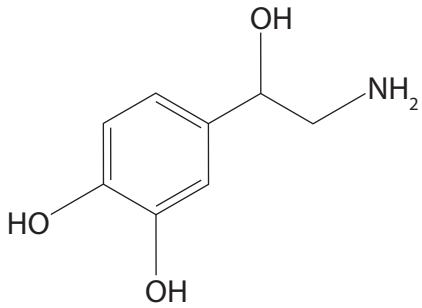
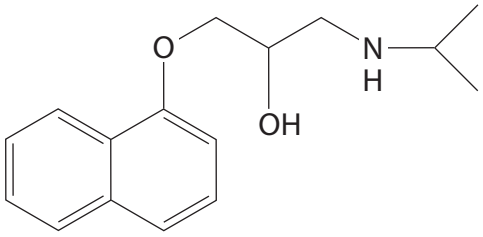
(c) The diagram shows two chemicals that affect the human heart rate.



Noradrenaline



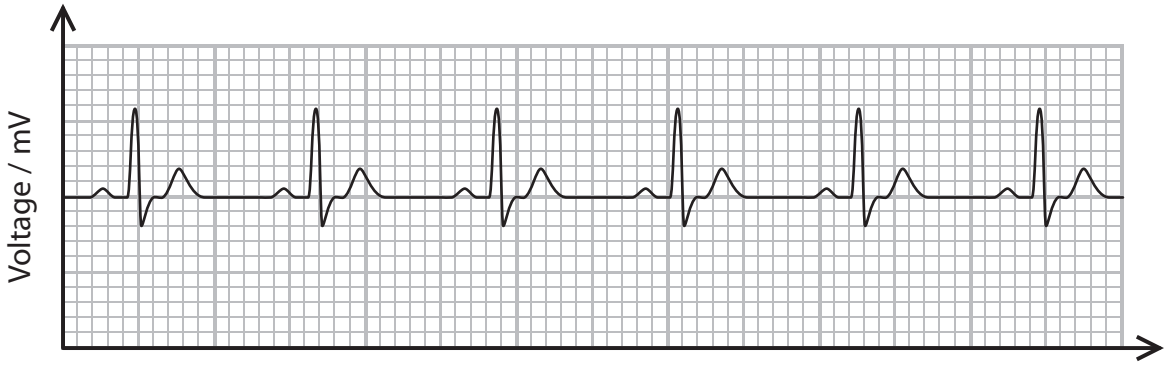
Beta blocker

Beta blockers are drugs used to regulate the heart rate of some patients.

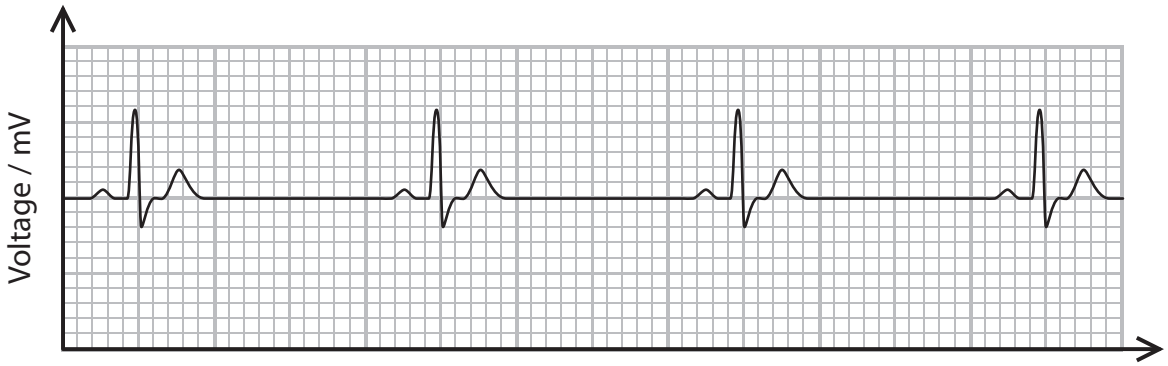
The effect of beta blockers on the heart rate during exercise was investigated.

The ECG traces show the heart rate of a person exercising before and after taking a beta blocker.

Exercise with no beta blocker



Exercise with a beta blocker



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Analyse the information to explain the results of this investigation.

(3)

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(Total for Question 5 = 11 marks)

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6 (a) Mosquitoes have cells with a diploid number (2n) of six.

The diagram shows two cells from a male mosquito at different stages of meiosis.

P **Q**

(i) Which row of the table shows the stages of meiosis of cells P and Q?

(1)

		P	Q
☒	**A**	anaphase II	anaphase I
☒	**B**	metaphase I	prophase I
☒	**C**	prophase I	anaphase II
☒	**D**	prophase II	metaphase II

(ii) Non-disjunction occurred during meiosis I.

Which of the following shows the number of chromosomes in each of the four sperm cells produced?

(1)

☒ **A** 4, 3, 3, 2

☒ **B** 4, 4, 2, 2

☒ **C** 6, 6, 7, 5

☒ **D** 7, 7, 5, 5

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(b) Down's syndrome in humans is caused by non-disjunction.

The chance of having a baby with Down's syndrome increases as the age of the mother increases.

At age 40, the probability of having a baby with Down's syndrome is 0.018.

In 2016 the number of women aged 40 in the UK was estimated to be 500 000.

The pregnancy rate for women in the UK aged 40 is 14 pregnancies per 1000 women per year.

Calculate the number of babies with Down's syndrome that were expected in 2016 in the UK.

(2)

Answer .....

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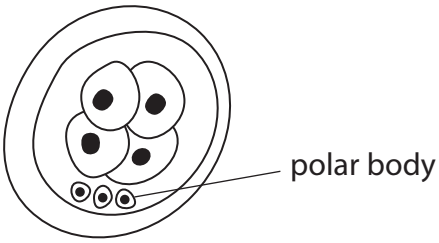
(c) *In vitro* fertilisation (IVF) is a technique in which eggs are taken from the ovaries and fertilised with sperm in a laboratory.

The resulting embryos are cultured until the four-cell stage, as shown in the diagram.



Two screening techniques used to identify embryos with chromosomal abnormalities are:

- polar body biopsy in which the polar bodies are removed and the chromosomes analysed
- pre-implantation genetic diagnosis (PGD) in which one cell from the four-cell stage embryo is removed and the chromosomes analysed.

Embryos without chromosome abnormalities are placed into the mother's uterus.

The success rates of both techniques are shown in the table.

Technique	Percentage of embryos that survive screening (%)	Percentage of embryos transferred to the uterus that lead to the birth of baby (%)
Polar body biopsy	87	21
PGD	74	29
Control	IVF with no screening	16

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Analyse the data to comment on the effectiveness of the two techniques.

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(Total for Question 6 = 8 marks)

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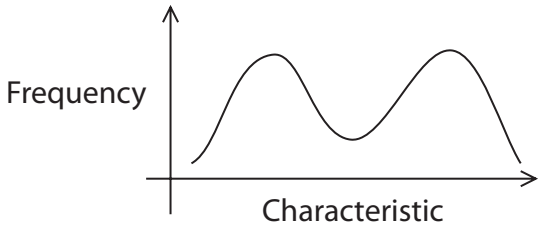
7 (a) The graph shows the frequency of a characteristic found in a population of animals.



Which type of selection would create this pattern?

(1)

☒ **A** allopatric selection

☒ **B** directional selection

☒ **C** disruptive selection

☒ **D** stabilising selection

(b) The Eurasian lynx is the largest native European cat species.

It was once widespread across Europe but is now restricted to small areas of national parks.

Ex-situ and *in-situ* conservation measures were used in the 1970s to increase biodiversity.

- Lynx were bred in zoos and 10 were reintroduced into an area of protected forest where the lynx had become extinct.
- Existing wild lynx were protected in an area of forest where they had not become extinct.

In 2016 scientists estimated the population sizes and genetic biodiversity of the lynx in these two areas of forest.

They found that the population and genetic biodiversity of the lynx in the area where they had been reintroduced were much lower than in the protected area.

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

(1)

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(ii) Explain why, in 2016, the genetic biodiversity of the lynx population in the area where they had been reintroduced was much lower than in the protected area.

(2)

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(c) Explain the principles and issues associated with *ex-situ* conservation methods.

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(Total for Question 7 = 8 marks)

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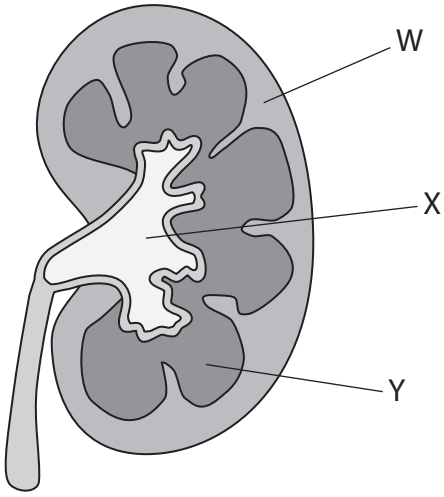
8 The diagram shows a section through a mammalian kidney.



(a) Which row of the table names the parts of the kidney labelled in the diagram?

(1)

	W	X	Y
☒ **A**	cortex	medulla	pelvis
☒ **B**	cortex	pelvis	medulla
☒ **C**	medulla	pelvis	cortex
☒ **D**	medulla	cortex	pelvis

(b) The table shows information about substances found in the blood and in the filtrate in the renal (Bowman's) capsule.

Substance	Relative molecular mass	Ratio of concentration in the filtrate in the renal (Bowman's) capsule : concentration in blood
sodium ions	23	1.00
water	18	1.00
urea	60	1.00
glucose	180	1.00
myoglobin	17 000	0.75
plasma proteins	69 000	<0.01

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Analyse the data to explain the ratios of these substances.

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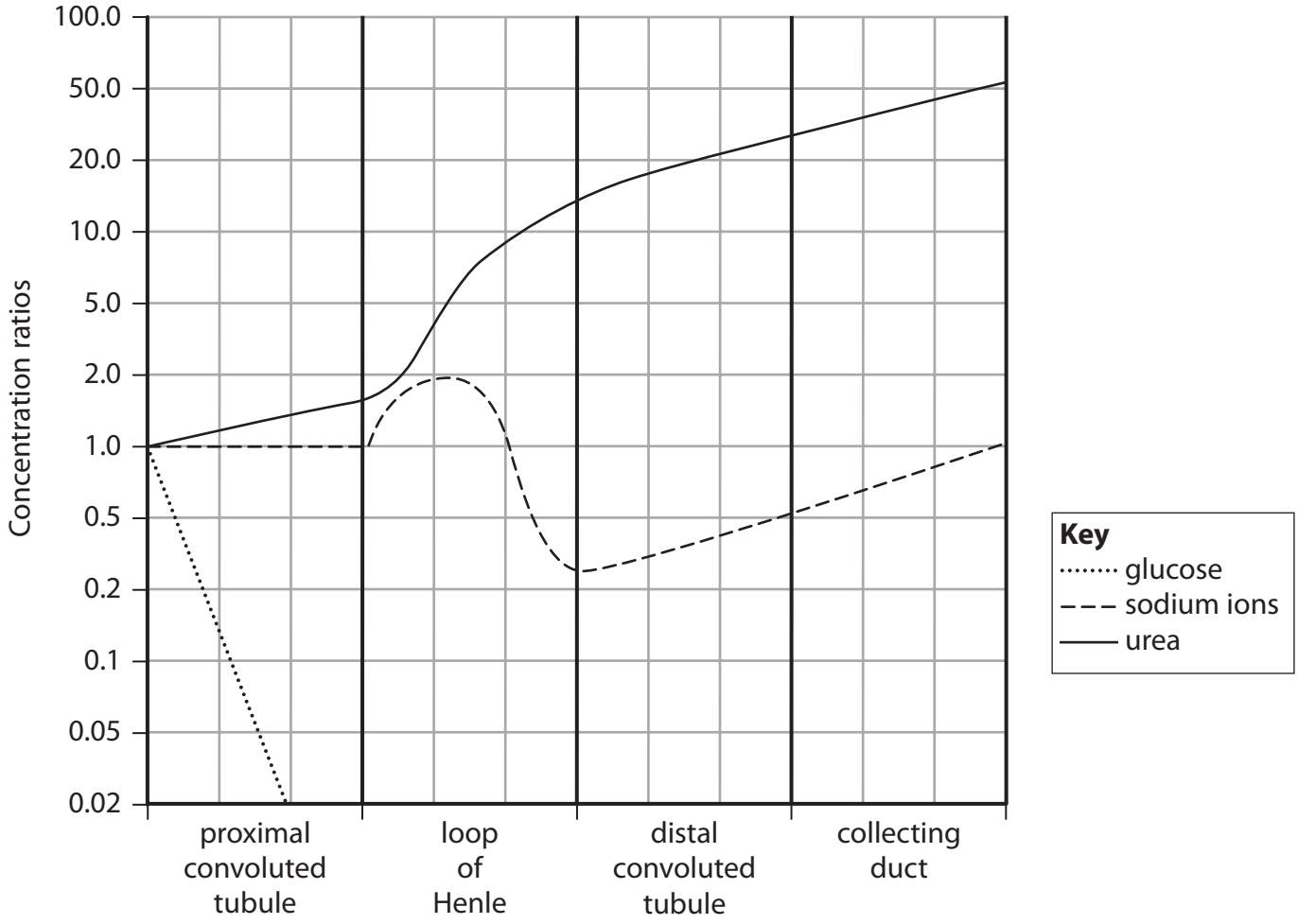
*(c) The renal (Bowman's) capsule is part of each nephron found in the kidney.

The graph shows the concentration ratios of three solutes in different parts of the nephron compared with their concentrations in the renal capsule.



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Explain the changes in the concentration ratios of these solutes in the different parts of the nephron.

(6)

(Total for Question 8 = 10 marks)

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9 The table shows information about one area of the North Atlantic Ocean.

Month	Mean hours of daylight / hr	Mean monthly temperature / °C	Net primary productivity (NPP) / g carbon m^{-2} day^{-1}
January	9.0	2.8	−1.0
February	10.0	3.1	−1.2
March	11.0	6.7	−0.5
April	13.0	9.4	+3.0
May	14.0	15.5	+4.0
June	15.0	20.6	+8.0
July	14.0	23.9	+7.0
August	13.5	23.3	+7.0
September	12.0	21.1	+5.0
October	11.0	16.1	+4.0
November	10.0	11.1	+3.0
December	9.0	4.0	−1.2

(a) (i) State what is meant by the term **net primary productivity** (NPP).

(1)

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(ii) Analyse the data to explain the effect of daylight and temperature on NPP.

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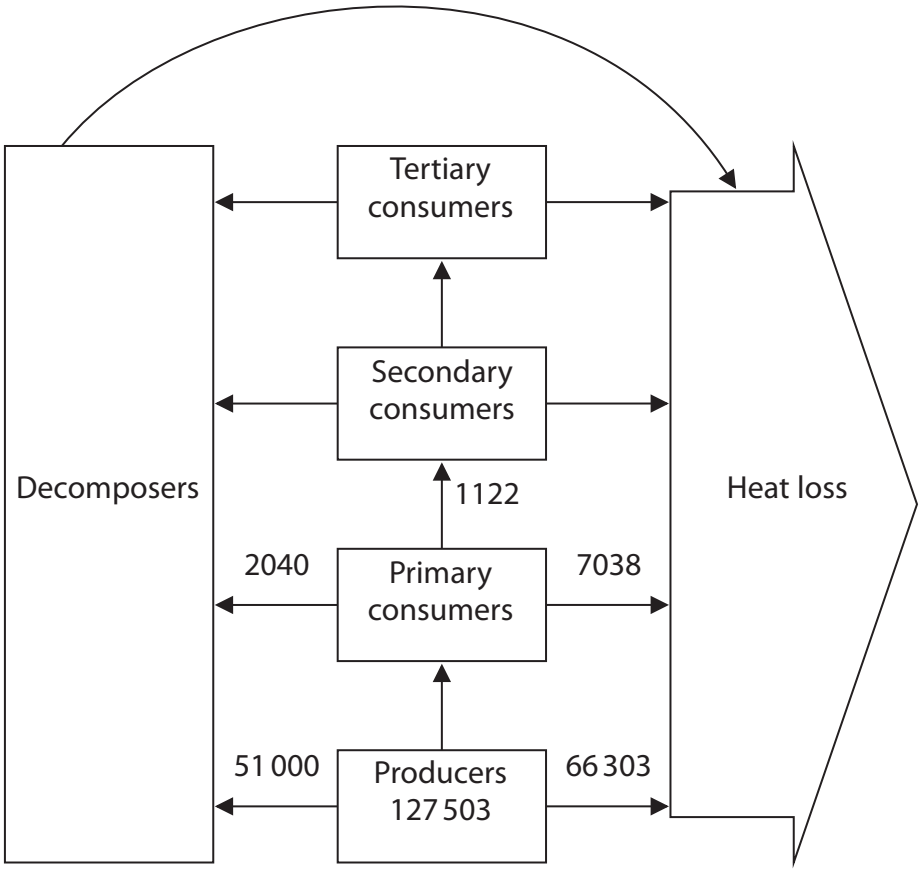
(b) The diagram shows some of the energy transfers through a food chain from this area.

The figures show the energy transfer in kJ m^{-2} yr^{-1}.



(i) Calculate the percentage efficiency of energy transfer from the producers to the primary consumers.

(2)

Answer .....

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(ii) Explain why the efficiency of energy transfer differs between different trophic levels.

(3)

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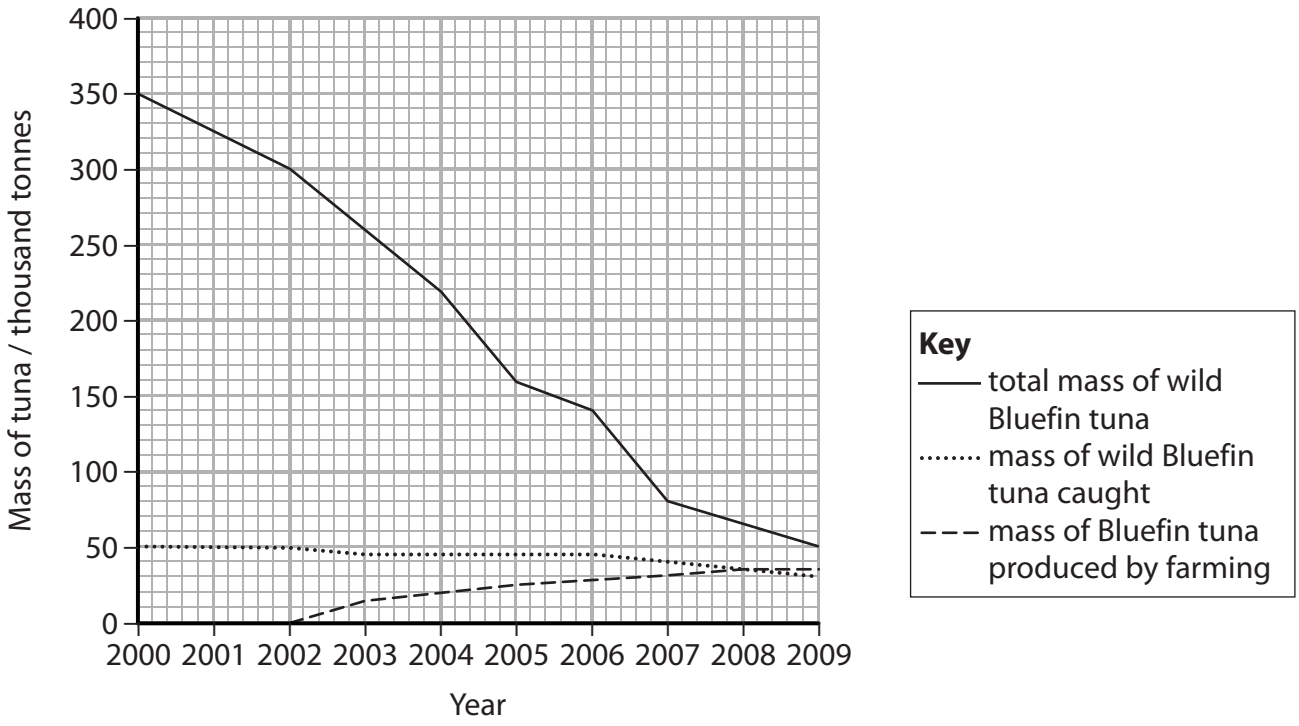
(c) Bluefin tuna are the top predators in this ocean.

Bluefin tuna are caught by the fishing industry for human consumption. The demand is very high.

One method to help meet the demand for Bluefin tuna is tuna farming.

This method traps young sexually immature fish from the wild. They are placed in submerged cages and fed on a diet of prey species captured from the ocean.

The graph shows the masses of wild Bluefin tuna caught and Bluefin tuna produced by farming. It also shows the total mass of wild Bluefin tuna in an area of the North Atlantic Ocean.



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Comment on the impact of Bluefin tuna farming.

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(Total for Question 9 = 13 marks)

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10 In the fruit fly, *Drosophila*, the allele for normal wings (**N**) is dominant to the allele for vestigial (small) wings (**n**).

The allele for red eyes (**R**) is dominant to the allele for sepia eyes (**r**).

In an investigation, students crossed homozygous parent flies. Flies with normal wings and red eyes were crossed with flies with vestigial wings and sepia eyes.

All the F_1 offspring of this cross had normal wings and red eyes.

Flies from this F_1 generation were crossed and the phenotypes of their offspring (F_2 generation) were counted.

The results for the F_2 generation are shown in the table.

***Drosophila* phenotype**	**Number of *Drosophila* with each phenotype**
normal wings and red eyes	885
normal wings and sepia eyes	322
vestigial wings and red eyes	286
vestigial wings and sepia eyes	107

The students thought that the genes for wing length and eye colour were on different chromosomes.

(a) (i) State a null hypothesis for this investigation.

(1)

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(ii) A Chi squared test was carried out to test this hypothesis.

Complete the table.

(1)

Phenotype	**Expected ratio**	**Observed results (O)**	**Expected results (E)**	**(O – E)**	**$(O - E)^2$**	**$\frac{(O - E)^2}{E}$**
normal wings and red eyes	9	885	900			
normal wings and sepia eyes	3	322	300	22	484	1.61
vestigial wings and red eyes	3	286	300	–14	196	0.65
vestigial wings and sepia eyes	1	107	100	7	49	0.49

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(iii) Calculate the value of Chi squared using the formula

(1)

$$\chi^2 = \sum \frac{(O - E)^2}{E}$$

Answer .....

(iv) The table shows some critical values of Chi squared at different degrees of freedom.

Degrees of freedom	***p* value**				
	0.900	**0.500**	**0.100**	**0.050**	**0.010**
1	0.016	0.455	2.706	3.841	6.635
2	0.211	1.386	4.605	5.991	9.210
3	0.584	2.366	6.251	7.815	11.345
4	1.064	3.357	7.779	9.488	13.277

Use this table to comment on the results of the investigation.

(3)

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*(b) In *Drosophila*, the allele for grey bodies (**G**) is dominant to the allele for black bodies (**g**).

In a second investigation, students crossed homozygous parent flies. Flies with normal wings and grey bodies were crossed with flies with vestigial wings and black bodies.

All the F_1 offspring had normal wings and grey bodies.

Flies from this F_1 generation were crossed and the phenotypes of their offspring (F_2 generation) were counted.

The results are shown in the table.

***Drosophila* phenotype**	**Number of *Drosophila* with each phenotype**
normal wings and grey body	1105
normal wings and black body	85
vestigial wings and grey body	72
vestigial wings and black body	338

Explain the results of this second investigation.

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TOTAL FOR PAPER = 90 MARKS

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