Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel
International Advanced Level

Centre Number | | | | | |

Candidate Number | | | | |

Wednesday 8 January 2020

Afternoon (Time: 1 hour 45 minutes) | Paper Reference **WBI14/01**

Biology

International Advanced Subsidiary / Advanced Level
Unit 4: Energy, Environment, Microbiology and Immunity

You must have:
Scientific calculator, ruler, HB pencil

Total Marks

Instructions

- Use **black** ink or **black** ball-point pen.
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*
- **Show all your working in calculations and include units 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.*
- 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 0 5 6 6 A 0 1 3 2

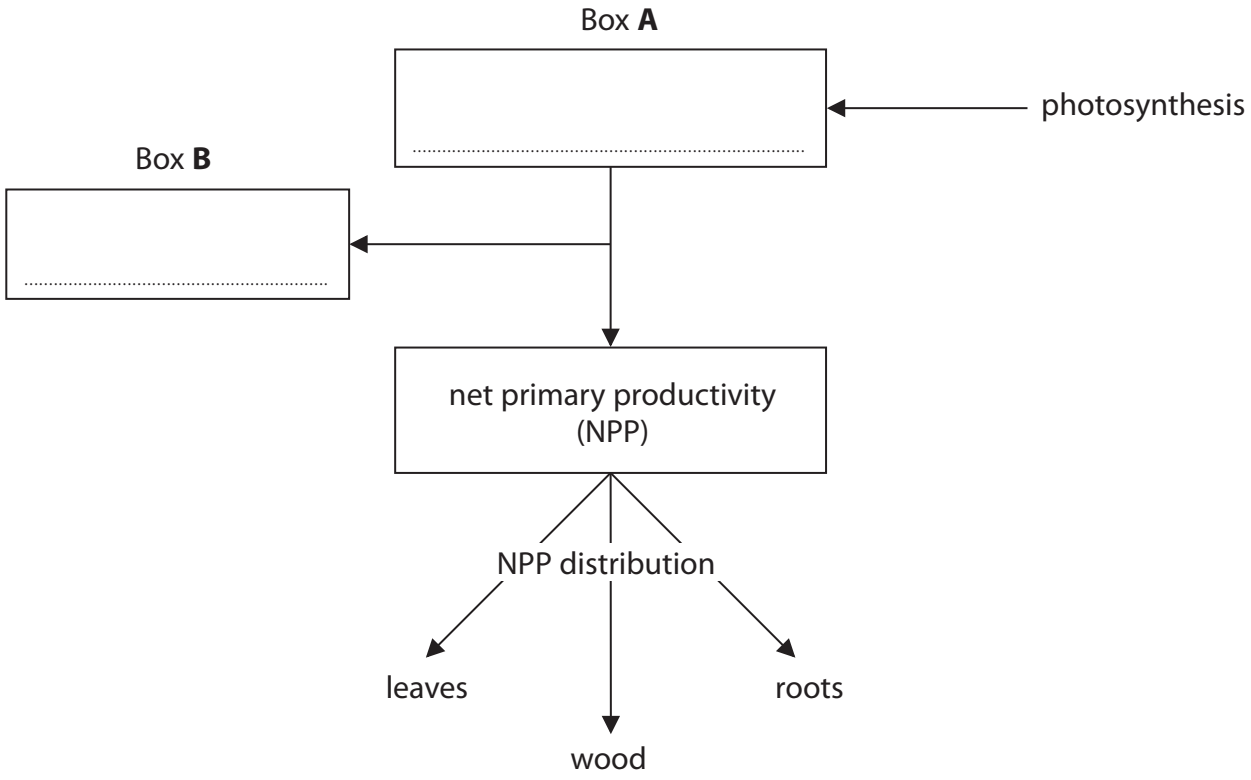
Pearson

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 diagram shows some processes linking photosynthesis to productivity and the distribution of biomass in the trees in a forest.



(a) Complete the diagram by writing the appropriate word or words in box **A** and in box **B**.

(1)

(b) In a healthy forest ecosystem, the NPP should be distributed equally to the leaves, wood and roots.

(i) State the meaning of the term **ecosystem**.

(1)

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(ii) Which of the following are the units for NPP?

(1)

☒ **A** $kg\,m^{-1}\,yr^{-1}$

☒ **B** $kg\,m^{-2}\,yr^{-2}$

☒ **C** $kJ\,m^{-1}\,yr^{-1}$

☒ **D** $kJ\,m^{-2}\,yr^{-1}$

(iii) In this forest, the total NPP was 11 700 units.

The leaves contained 34% of the NPP and the wood contained 39% of the NPP.

Calculate the NPP content in the roots.

(2)

Answer ..... units

(Total for Question 1 = 5 marks)

2 Plastics are carbon-based polymers made from repeating monomers.

Many plastics do not break down naturally and their disposal is causing a lot of damage to the environment.

(a) Plastics have been around for about 70 years.

Scientists think that microorganisms could evolve the ability to break down plastics to obtain nutrients.

(i) Explain why scientists think that plastics could be broken down by microorganisms.

(2)

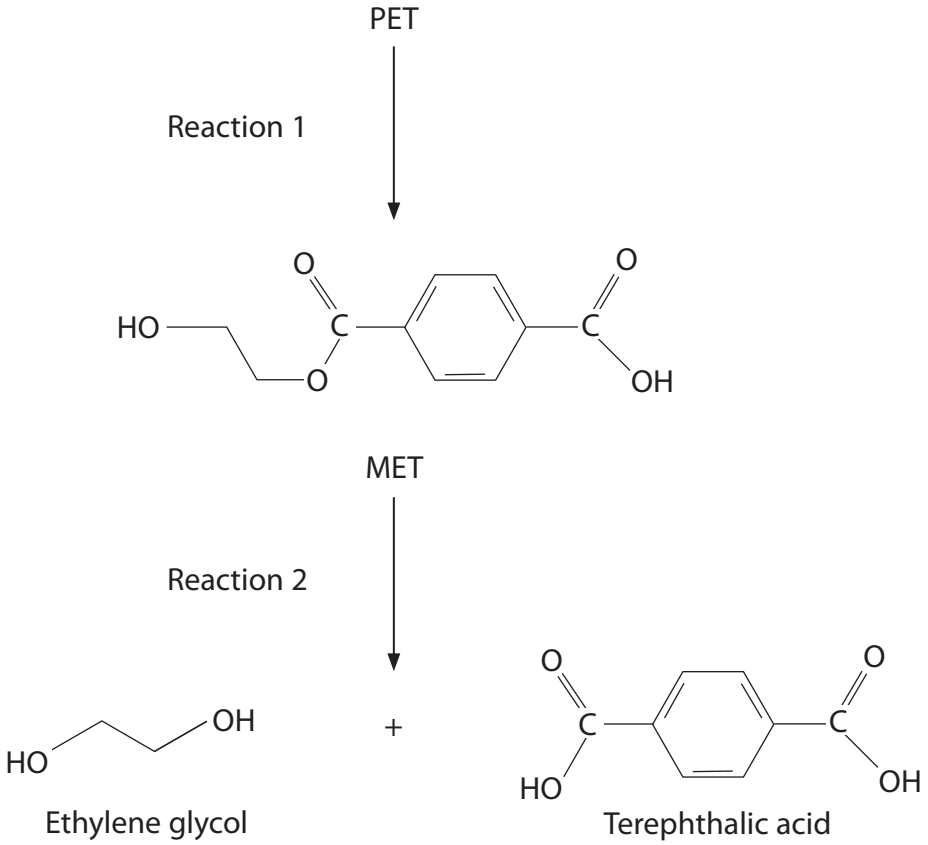
(ii) Explain how microorganisms could evolve to break down plastics.

(3)

(b) Some bacteria have been discovered that can break down one type of plastic, the polymer polyethylene terephthalate (PET).

This polymer is made from the monomer ethylene terephthalate (MET).

The diagram shows how PET can be broken down.



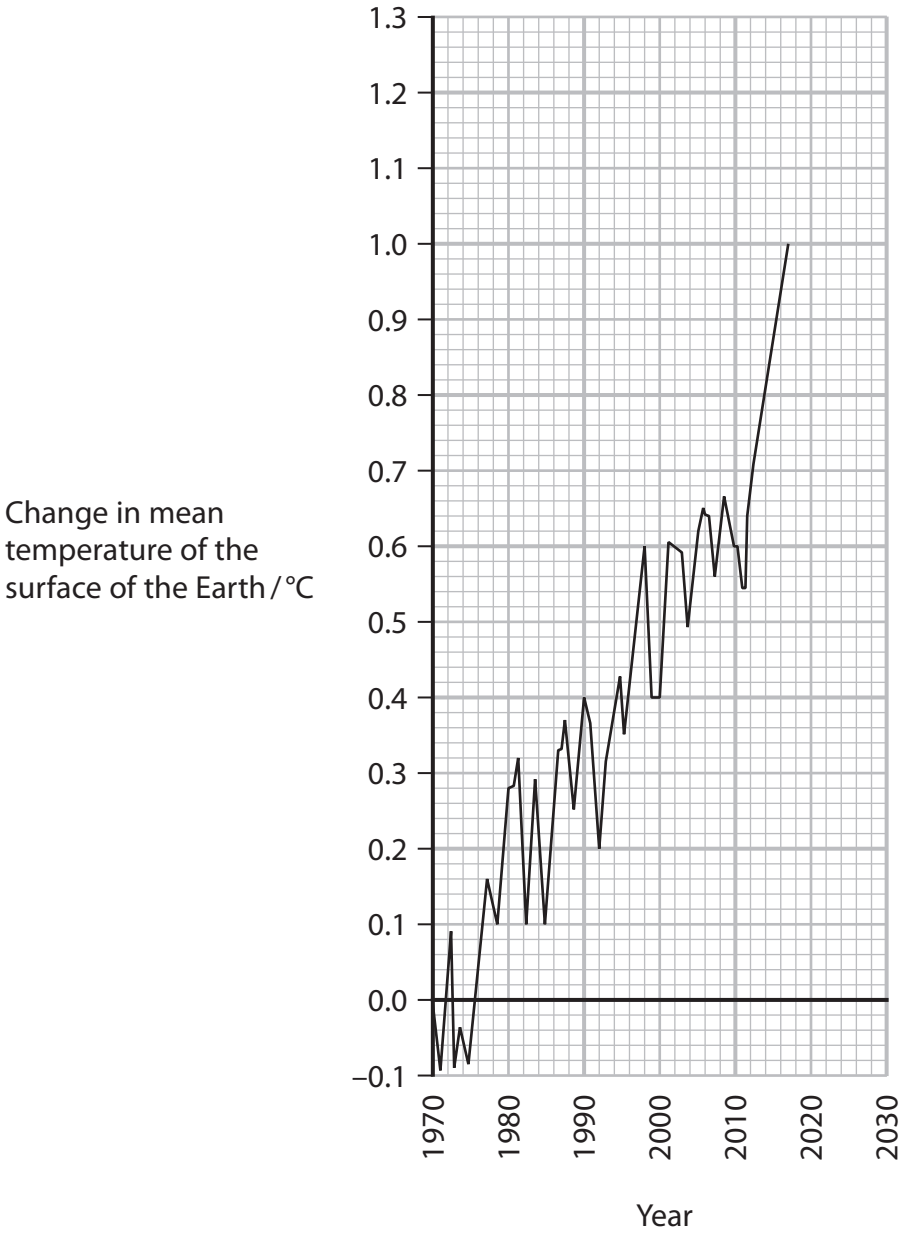
Which row of the table describes reaction 1 and reaction 2?

(1)

	Reaction 1	Reaction 2
☒ **A**	condensation	condensation
☒ **B**	condensation	hydrolysis
☒ **C**	hydrolysis	condensation
☒ **D**	hydrolysis	hydrolysis

(Total for Question 2 = 6 marks)

3 The graph shows the changes in mean temperature of the surface of the Earth from 1970 to 2017.



(a) Which of the following gases could be responsible for these temperature changes?

(1)

☒ **A** carbon dioxide and methane

☒ **B** carbon dioxide and oxygen

☒ **C** carbon dioxide, methane and oxygen

☒ **D** methane and oxygen

(b) What is the estimated change in the mean temperature of the surface of the Earth in 2030?

(1)

☒ **A** 1.3

☒ **B** 1.1

☒ **C** 0.8

☒ **D** 0.2

(c) Ultraviolet light has a shorter wavelength than infrared radiation.

Which row of the table describes the passage of ultraviolet light and infrared radiation, reflected from the surface of the Earth, through gases in the atmosphere?

(1)

	Ultraviolet light	Infrared radiation
☒ **A**	passes through	passes through
☒ **B**	passes through	does not pass through
☒ **C**	does not pass through	passes through
☒ **D**	does not pass through	does not pass through

(d) Studying the width of tree rings provides evidence for climate change.

(i) Which of the following involves the study of tree rings?

(1)

☒ **A** dendrochronology

☒ **B** entomology

☒ **C** epigenetics

☒ **D** proteomics

(ii) Explain why the width of tree rings produced in 1970 would be different from the width of tree rings produced in 2010.

(3)

(Total for Question 3 = 7 marks)

4 Malaysia is covered by large areas of rainforest. These rainforests have one of the highest biodiversities in the world.

However, the rate of loss of rainforest in Malaysia is one of the highest in the world.

(a) (i) From 2000 to 2012, Malaysia lost 14.4% of its rainforest. This is equivalent to 47 278 km^2.

Calculate the area of Malaysia covered by rainforest in 2000.

Give your answer in standard form.

(3)

Answer ..... km^2

(ii) A decrease in the area covered by rainforest results in both a decrease in biodiversity and a decrease in populations.

Explain why a decrease in the area covered by rainforest reduces both biodiversity and populations within the rainforest.

(2)

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(b) The diagram shows an Oriental blue clearwing, a species of moth found in the rainforests of Malaysia.

Magnification × 5

The Oriental blue clearwing has blue bands on its body. It resembles a bee by having transparent wings and fur on its body. It drinks in puddles of water where a number of species of bee also drink.

(i) Explain which examples of adaptation are illustrated by this moth.

(2)

(ii) Suggest **two** advantages to the Oriental blue clearwing of resembling bees.

(2)

(iii) This moth was seen and a specimen collected in 1887. It was not seen again in the rainforests of Malaysia until 2017.

The DNA of these recently rediscovered Oriental blue clearwings was compared with the DNA of the moth collected in 1887.

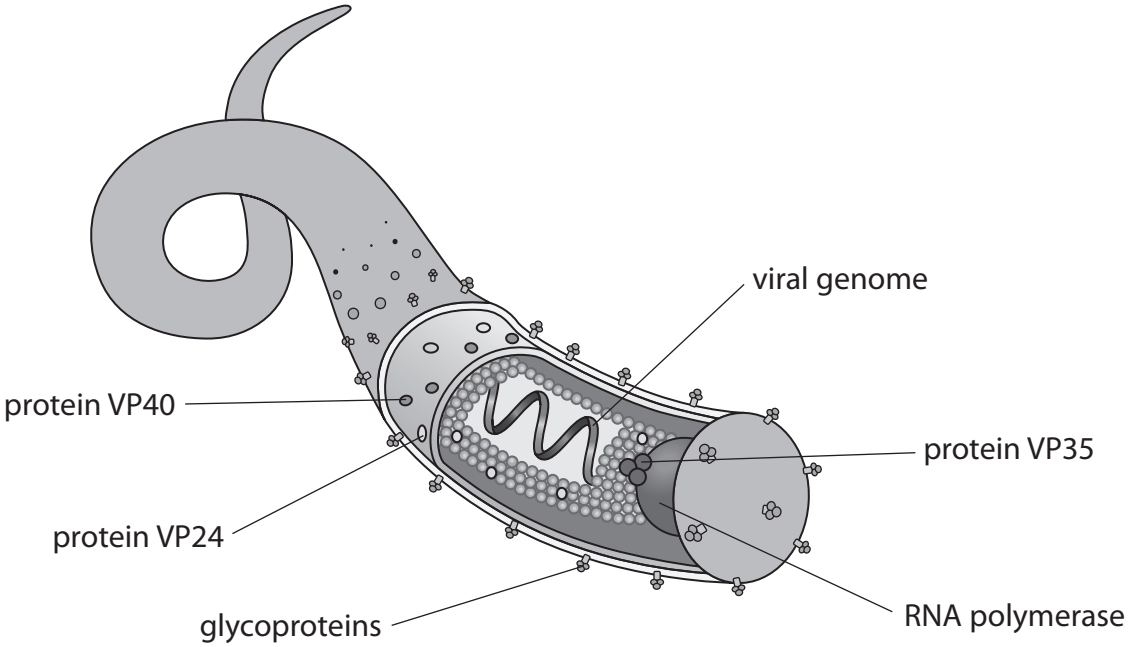
Describe how this comparison could be made.

(3)

(Total for Question 4 = 12 marks)

5 In December 2018 there was an outbreak of Ebola, with 500 cases being reported.

The diagram shows the structure of an Ebola virus.



(a) Describe the role of each of the following.

(i) The viral genome

(2)

(ii) The glycoproteins

(2)

(b) The enzyme RNA polymerase is involved in RNA transcription.

Explain why the structure of the Ebola virus includes RNA polymerase.

(2)

(c) The proteins VP24 and VP40 are involved in virus assembly.

State what is meant by the term virus assembly, using Ebola as an example.

(2)

(d) The protein VP35 inhibits the production of interferon by host cells.

Explain why the structure of the Ebola virus includes VP35.

(2)

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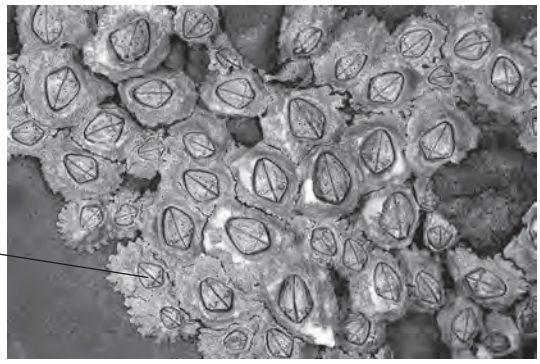
(Total for Question 5 = 10 marks)

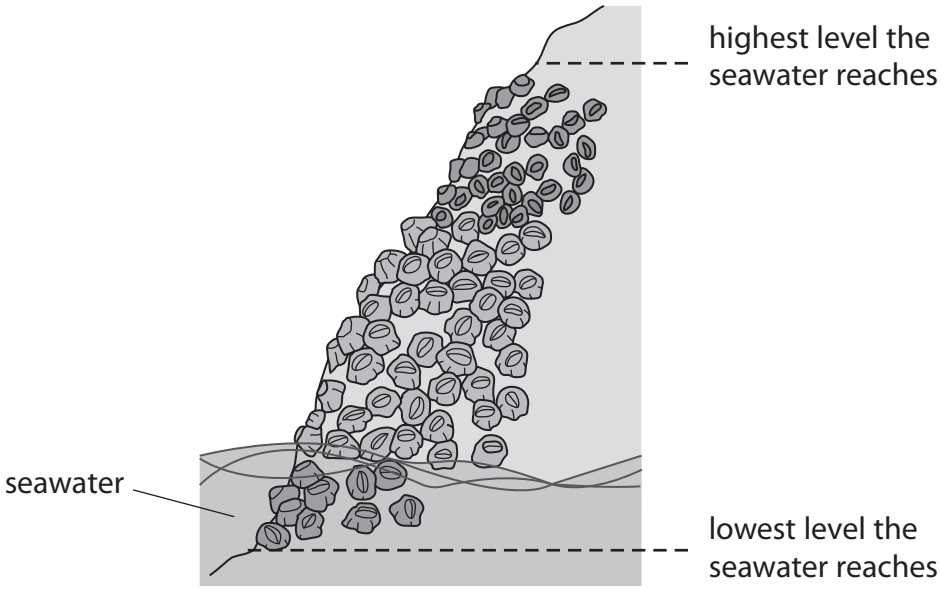
6 The photograph shows barnacles attached to a rock on a seashore.



The list gives some facts about barnacles:

- barnacles are marine animals that live inside their shells
- the shells are permanently attached to a solid surface
- barnacles feed on food particles that they filter from the water
- barnacles reproduce sexually and produce larvae that swim in the seawater
- larvae settle on suitable surfaces such as rocks.

(a) The diagram shows the distribution of two types of barnacle, *Chthamalus* and *Balanus*, on a rock.



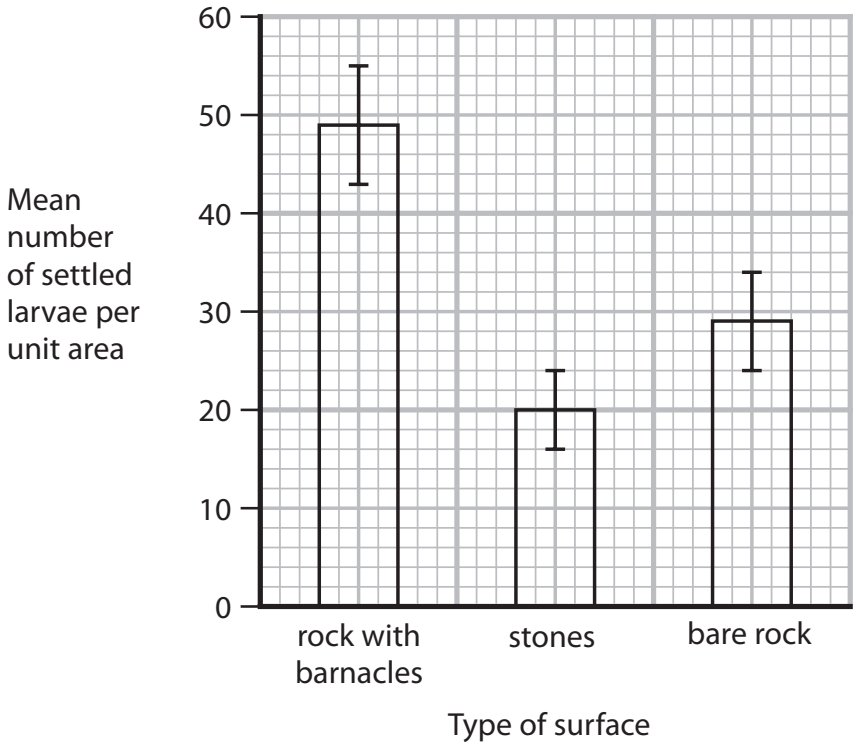
These two types of barnacle occupy different niches.

Explain how the distribution and abundance of these two types of barnacle on this rock show that these barnacles occupy different niches.

(3)

(b) The types of surface that the larvae settled on were studied.

The graph shows the results of this study.



(i) Comment on the reliability of the conclusions that can be drawn from this study.

(4)

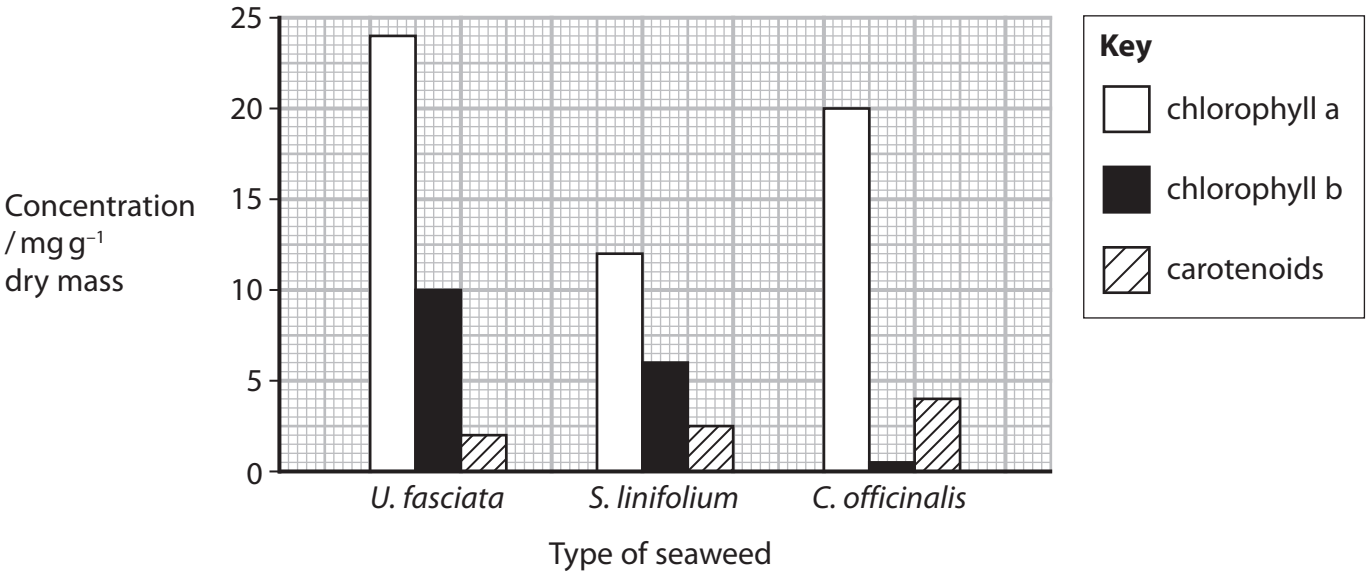
(ii) Describe how this study could be carried out in a laboratory.

(4)

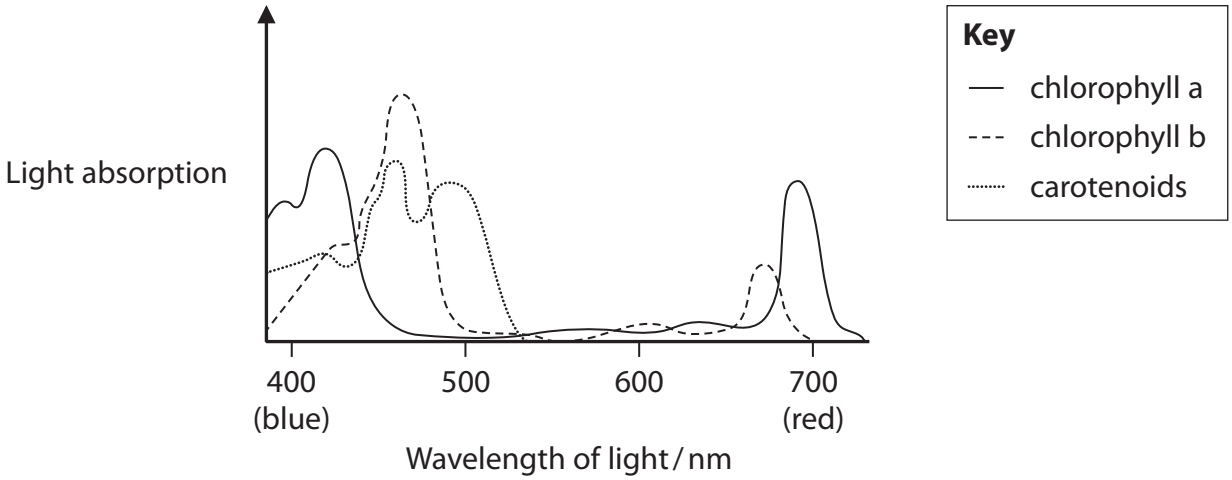
(Total for Question 6 = 11 marks)

7 The composition of three seaweeds, *U. fasciata*, *S. linifolium* and *C. officinalis*, collected from a beach in Egypt, was determined.

(a) The graph shows the chloroplast pigments extracted from these seaweeds.



The graph shows the absorption spectrum for these three chloroplast pigments.



(i) Which row of the table shows the colour of each of these seaweeds?

(1)

	U. fasciata	*S. linifolium*	*C. officinalis*
☒ **A**	green	brown	red
☒ **B**	green	red	green
☒ **C**	red	brown	red
☒ **D**	red	green	green

(ii) Explain the role of chloroplast pigments in the light-dependent reactions of photosynthesis.

(2)

(b) The table shows some of the compounds found in two of these seaweeds.

Compound		*U. fasciata*	*S. linifolium*
*carotenoids	/ mg g^{-1} dry mass	2.00	3.00
*phenols	/ a.u. g^{-1} dry mass	11.95	10.35
*flavonoids	/ a.u. g^{-1} dry mass	7.04	4.53
carbohydrates	/ percentage of dry mass	23.70	25.03
proteins	/ percentage of dry mass	9.56	14.89
lipids	/ percentage of dry mass	2.96	2.16

* antioxidants

(i) Describe how GALP, produced in chloroplasts, is converted into protein.

(3)

*(ii) These seaweeds are considered to be a healthy, environmentally-friendly and economic food source.

Comment on this statement.

Use the information in the table and your own knowledge to support your answer.

(6)

(Total for Question 7 = 12 marks)

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8 The immune response to cancer involves both T helper and T killer cells.

(a) Which row of the table shows the cells that present antigens to each of these T cells?

(1)

	T helper cells	T killer cells
☒ **A**	host-infected cells	host-infected cells
☒ **B**	host-infected cells	macrophages
☒ **C**	macrophages	host-infected cells
☒ **D**	macrophages	macrophages

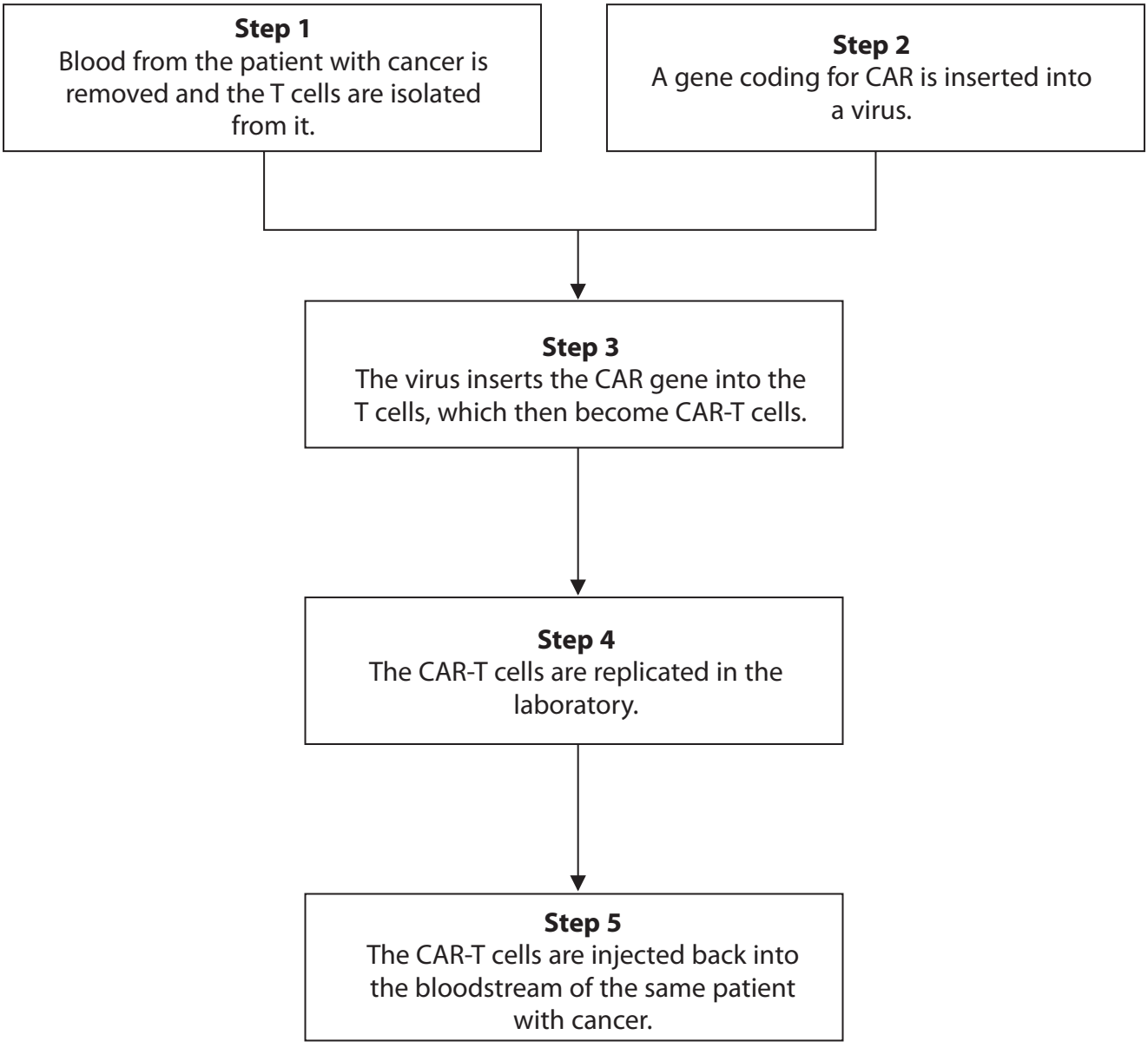
(b) Immunotherapy, using genetically-modified T cells, is being developed to treat blood cell cancers.

Cancer cells have a specific antigen on their surface.

The T cells have to possess a receptor (CAR) on their surface that binds to this antigen.

A gene coding for CAR has to be inserted into the T cells. These genetically-modified T cells are called CAR-T cells.

The diagram shows some steps in this procedure.



(i) The virus used in this procedure is modified so that it is not pathogenic.

Which virus would be suitable to use in **Step 2**?

(1)

- ☒ **A** Ebola virus
- ☒ **B** human immunodeficiency virus (HIV)
- ☒ **C** lambda phage (λ phage)
- ☒ **D** tobacco mosaic virus (TMV)

(ii) Explain why the CAR gene is inserted into the T cells in **Step 3**.

(2)

(iii) Explain the importance of mitosis in the replication of the CAR-T cells in **Step 4**.

(3)

(iv) In **Step 1**, T cells are removed from a patient with cancer.

Explain the advantages of injecting CAR-T cells into the same patient in **Step 5**.

(3)

(v) Currently, the use of CAR-T cells has been effective against blood cell cancers only.

Suggest why CAR-T cells are not effective against cancer cells in solid tumours growing in other tissues in the body.

(2)

(Total for Question 8 = 12 marks)

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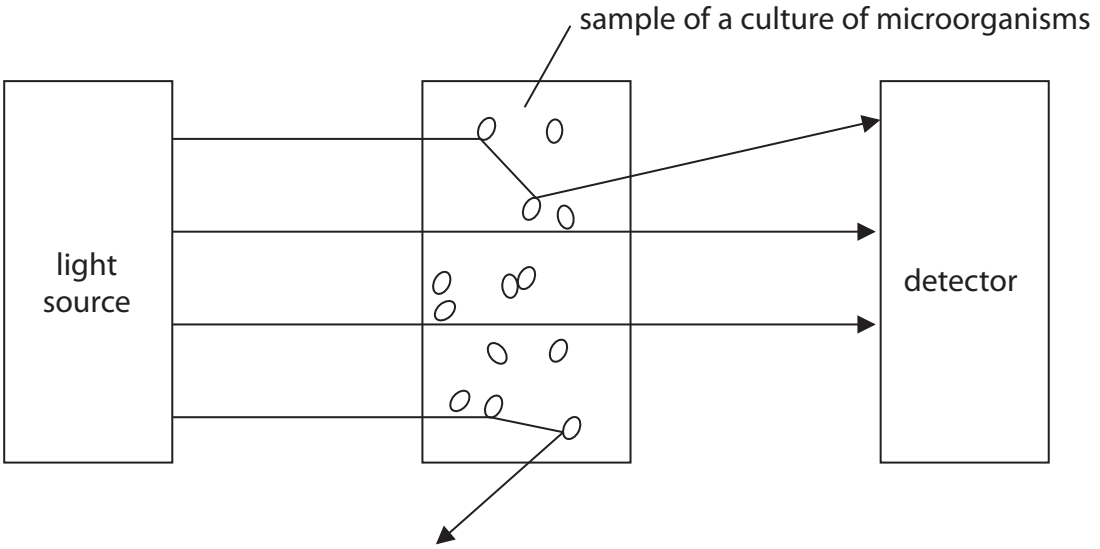
9 The growth of microorganisms can be studied using optical methods (turbidity).

The number of cells in 1 cm^3 of a culture can be estimated by using a photometer to measure the optical density of the culture.

Light is shone through a sample of the culture and a detector records the optical density.

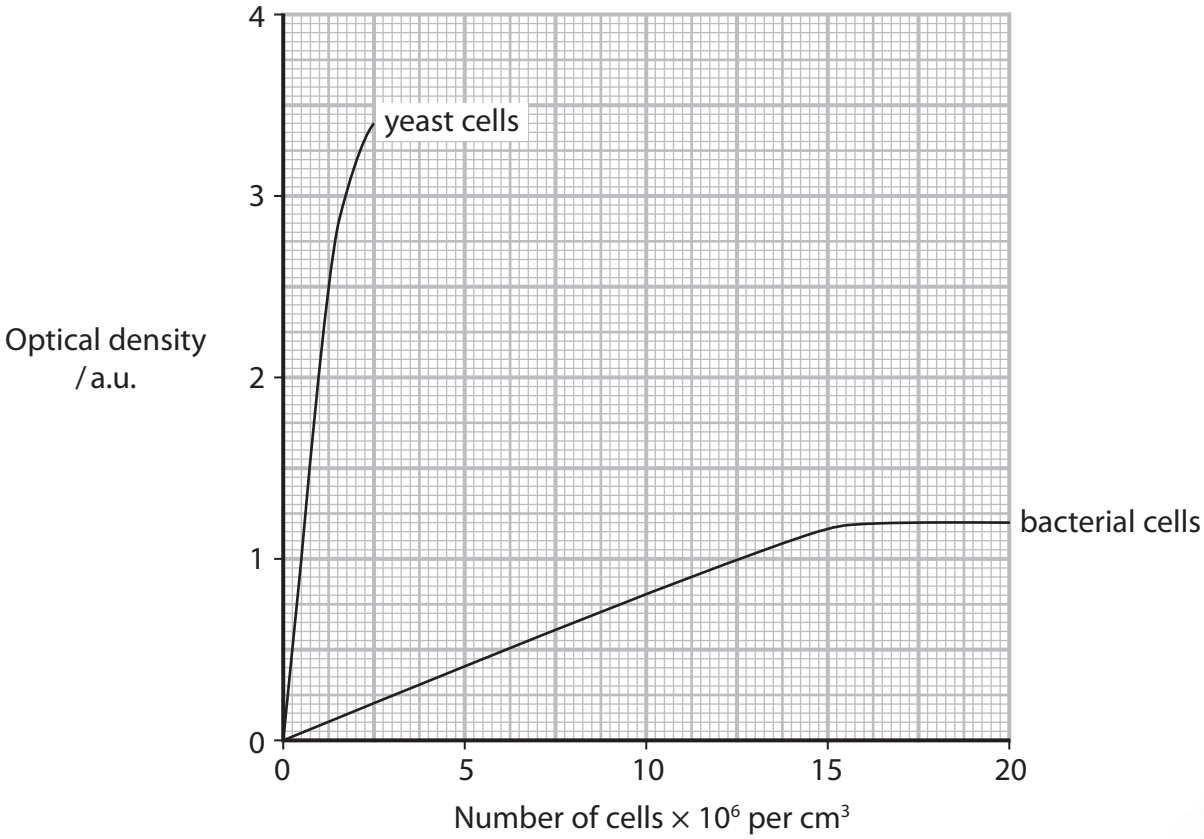
The more light absorbed by the culture, the higher the optical density.

The diagram shows what happens to light shone at a culture of microorganisms.

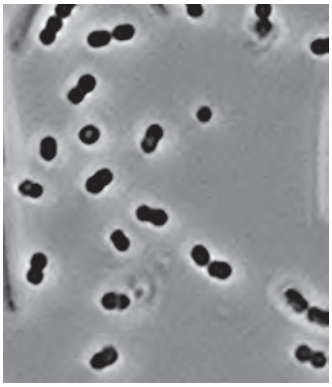


The number of cells in the sample is determined using a calibration curve.

The graph shows a calibration curve for bacterial cells and yeast cells.



The photographs show bacterial cells and yeast cells, as seen using a light microscope.



bacterial cells

yeast cells

scale: 5 µm

(a) State the relationship between optical density and the size of the microorganisms.

(1)

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.....

(b) Calculate how many times more bacterial cells there are than yeast cells if both samples have an optical density of 1.0 a.u.

(2)

Answer .....

(c) (i) State the relationship between the number of bacterial cells and optical density.

(1)

(ii) Suggest why using optical density to measure the concentration of microorganisms is more accurate at lower concentrations of cells.

Use the information in the diagram to support your answer.

(2)

(d) A liquid medium was inoculated with 6×10^3 bacterial cells and the culture was incubated for a period of time.

At the end of this incubation period, there were 1.2×10^7 bacterial cells.

Calculate the time (t) of this incubation period.

Use a value of 0.963 for the growth rate constant (k) and the equation

$$k = \frac{\log_{10} N_t - \log_{10} N_0}{0.301 \times t}$$

(3)

Answer .....

*(e) Explain why one calibration curve cannot be used to determine the growth of all microorganisms.

Use all the information in this question and your own knowledge to support your answer.

(6)

(Total for Question 9 = 15 marks)

TOTAL FOR PAPER = 90 MARKS

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