Candidate surname **Evans**

Other names **Alexander**

Pearson Edexcel
Level 3 GCE

Centre Number **1 2 4 1 6**

Candidate Number **3 1 5 4**

Thursday 6 June 2019

| Morning (Time: 2 hours) | Paper Reference **9BN0/01** |

Biology A (Salters Nuffield)
Advanced
Paper 1: The Natural Environment and Species Survival

You must have:
Calculator, HB pencil, ruler

Total Marks **63**

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 ▶

Pearson

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 Photosynthetic plants use light as a source of energy for the synthesis of organic molecules. Photosynthesis is a two-stage process.

(a) The light-dependent reactions take place in the chloroplast.

(i) Which of the following describes where, in the chloroplast, the light-dependent reactions take place?

(1) 1

☒ **A** cristae

☒ **B** matrix

☒ **C** stroma

☒ **D** thylakoids

(ii) Which of the following are the products of the light-dependent reactions?

(1) 1

☒ **A** carbon dioxide and reduced NADP

☒ **B** glucose and oxygen

☒ **C** reduced NAD, ATP and oxygen

☒ **D** reduced NADP, ATP and oxygen

(iii) Which of the following is the source of the hydrogen produced by the light-dependent reactions?

(1) 1

☒ **A** glucose

☒ **B** reduced NAD

☒ **C** reduced NADP

☒ **D** water

(b) In some commercial glasshouses, the concentration of carbon dioxide in the atmosphere is increased.

Explain why this increase in carbon dioxide concentration affects the growth of plants in glasshouses.
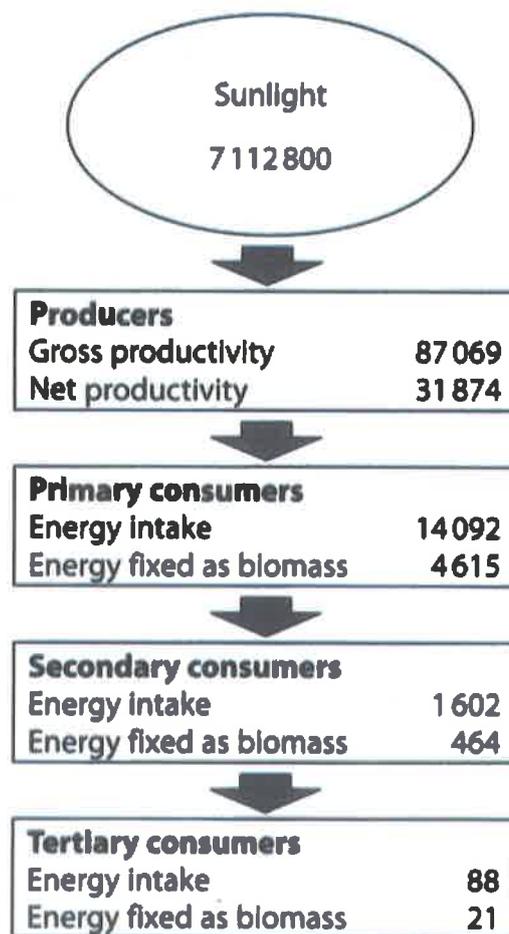
Carbon dioxide (CO₂) is needed for the calvin cycle, a light-independent stage of photosynthesis. CO_2 is take diffused into the plants leaf, down a concentration gradient. Due to fick's law, if you have a high cont concentration gradient, you will have a higher rate of diffusion. A higher rate of diffusion will result in more CO_2 entering the calvin cycle and more glucose being produced. This glucose can be used for the production of ATP in respiration, the production of starch which is a food store or the production of cellulose which is a building block for all plants. Aswell as the production of lignin.

(Total for Question 1 = 6 marks) 4

2 Silver Springs is a state park in Florida. The photograph shows one of the many waterways in this state park.

(a) Energy flow through this ecosystem has been studied. The results are shown in the flow chart. All values are given in $kJ\,m^{-2}\,yr^{-1}$.

```
          ┌─────────────────────┐
          │       Sunlight      │
          │      7 112 800      │
          └─────────────────────┘
                     │
                     ▼
┌──────────────────────────────────────┐
│ Producers                            │
│ Gross productivity           87 069  │
│ Net productivity             31 874  │
└──────────────────────────────────────┘
                     │
                     ▼
┌──────────────────────────────────────┐
│ Primary consumers                    │
│ Energy intake                14 092  │
│ Energy fixed as biomass       4 615  │
└──────────────────────────────────────┘
                     │
                     ▼
┌──────────────────────────────────────┐
│ Secondary consumers                  │
│ Energy intake                 1 602  │
│ Energy fixed as biomass         464  │
└──────────────────────────────────────┘
                     │
                     ▼
┌──────────────────────────────────────┐
│ Tertiary consumers                   │
│ Energy intake                    88  │
│ Energy fixed as biomass          21  │
└──────────────────────────────────────┘
```

4

(i) Calculate how much energy is lost through respiration by the primary consumers.

(1) Q02ai

$$14,092 - 4615 = 9477$$

Answer ......9477...... $kJ\,m^{-2}yr^{-1}$

(ii) The table gives details of energy transfers at the different trophic levels.

Trophic level	Energy fixed as biomass / $kJ\,m^{-2}yr^{-1}$	Transfer efficiency (%)
Producers	31874	
Primary consumers	4615	14.5
Secondary consumers	464	
Tertiary consumers	21	4.5

Calculate the efficiency of energy transfer between primary consumers and secondary consumers.

(1) Q02aii

$$\left(\frac{464}{4615}\right) \times 100 = 10.05$$

10.1
~~10.05~~ %

(iii) The efficiency of photosynthesis can be measured as the percentage of energy from sunlight that is converted to gross primary productivity (GPP).

Which of the following shows the percentage efficiency of photosynthesis in this ecosystem?

(1)

☒ A   1.2%

☒ B   12%

☒ C   36.6%

☒ D   55.8%

(b) Explain why the value for GPP is lower than the light energy available to the ecosystem.

Firstly, not all of the sunlight that shines on the ecosystem will hit a plant leaf. This will decrease the amount of actual light absorbed, compared to the possible amount of light to be absorbed. Secondly, the photostems in the thylakoid membrane of the chloroplast only absorb light within a very narrow wavelength. This means that only a fraction of the possible the light energy that is available will be taken in by the leaf and be turned into ~~energy~~ energy. Not all the light that hits the leaf hits the photostem.

(Total for Question 2 = 6 marks) 6

3 A study of the genetics of grass snakes has led to the identification of a new species of grass snake in the UK.

The barred grass snake was thought to be a variation of the common grass snake, *Natrix natrix*.

However, the barred grass snake, *Natrix helvetica*, has been found to be a different species.

Both types of grass snake are normally found in lowland regions in the south of England. The snakes can be more than a metre long, are found near water and eat mainly amphibians such as frogs and newts.

The common grass snake is olive green with a bright yellow collar.

The barred grass snake, shown in the photograph, is grey with black markings.

(a) State what is meant by the term species.

(1) Q03a

A group of organisms with the same behavioural, morphological, physiological and anatomical characteristics that can interbreed to produce fertile offspring.

(b) Describe how DNA profiling could be carried out to show that these snakes are different species.

(4) 1 Q03b

A sample of DNA will be taken and that DNA extracted by treaking with detergents. Then PCR will take place which increase the amount of DNA in the sample. Next gel of electrophoresis will be done to the sample. This is when you get an agarose plate and wells will be cut into it. Each sample of the DNA will placed in a separate well, and an electrical current will be passed through the gel plate. The positive electrode will be at the far end and the negative electrode will be at the near end. Because DNA is negatively charged, due to the phosphate groups, the DNA will be pulled towards the positive electrode, the shortest section of DNA will go the furthest and the largest the shortest

* The DNA will also be treated with restriction enzyme which specifically break up the DNA strand.

(c) Explain how these two species of snake could have arisen from a common ancestor.

(4) Q03c

Due to allopatric speciation. This is when there is a geological barrier and the two populations of the common ancestor are split. This The genetic variation in each population may give rise to favourable characteristics, spec specific to that their population's environment. This will make them more likely to survive, and therefore reproduce. Over time their entire population will have that favourable characteristic and their DNA will have changed. Once this happens many times, the populations may be so genetically different that they can no longer reproduce to maker fertile offspring.

Total for Question 3 = 9 marks

4 Vitamin C has antioxidant properties. The human body cannot make or store vitamin C.
   A healthy diet must contain vitamin C.

   The graph shows the concentration of vitamin C in a variety of cooked and
   uncooked vegetables.
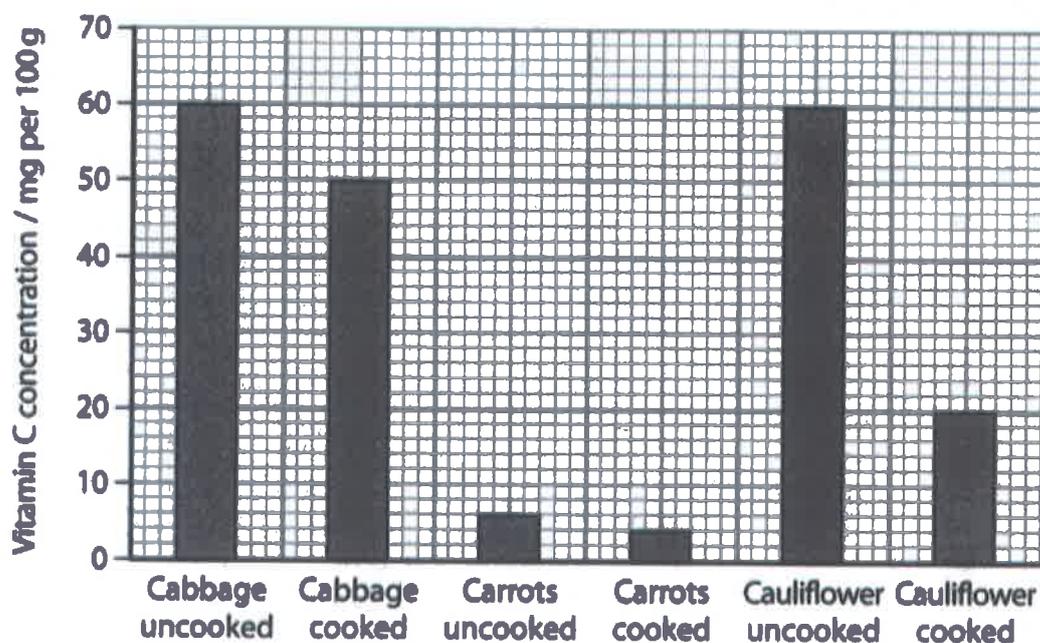
(a) (i) How many of the following conclusions are valid for these results?

   • cooking destroys all of the vitamin C
   • each vegetable contains less vitamin C when it is cooked than when it is uncooked
   • cabbage contains the most vitamin C

(1) 0

☒ A 0

☒ B 1

☒ C 2

☒ D 3

(ii) The recommended daily value (DV) of vitamin C for men is 90 mg.

Calculate the mass of cooked cauliflower that would provide 90 mg of vitamin C.

$$\frac{90}{20} = 4.5$$

$$100 \times 4.5 = 450g$$

Answer ....450g........

(b) Devise a procedure that can be used to investigate the effect of cooking on the vitamin C content of cauliflower.

Liquify Homogenise the two sets of cauliflower. One will be the control (uncooked) and the other will be the independent variable (cooked). Once the are homogenised obtain DCPIP which has a known concentration. Place 10 cm³ of the DCPIP in a tasty test tube and have a white background. Add the control to the DCPIP until there is a constant decolourisation of blue → colourless note the volume down and do it again only this time before you get to the noted value, stop, and add dropwise until constant colour change. Repeat 5 more times. Do the same with the independent and repeat 5 times also. Find the average titre of each variable which have concordant results (0.1 difference) cm³

(Total for Question 4 = 7 marks)

5 The extent of decomposition is important in helping to determine the time of death of a mammal.

Body farms are outdoor laboratories where experiments take place to investigate the changes that take place after death in a range of conditions. Body farms use the bodies of pigs or donated human bodies.

The effects of factors such as temperature, moisture and position of the body on the rate of decomposition can be studied.

(a) Explain the effect of ambient temperature on the rate of decomposition.

(3) 2 Q05a

An increase in ambient temperature will increase the rate of decomposition. This is because an increase in temperature increases the rate a which enzyme work. This is because they have more kinetic energy and so do the substrate so there is an increase of enzyme-substrate complexes being made. These enzymes are hydrolytic enzymes produced by bacteria and fungi which decompose your the soft tissue into mono saccharides which can be used for respiration of the bacterium or fungus.

(b) Describe the changes that occur inside a body in the first week after death.

(3) 2 Q05b

Rigor martis sets in as there is no longer the production of ATP so the PH drops and fuses muscles together. The body will become stiff. Bacteria in the gut will grow, releasing CO₂ which will bloat the body. There will also be a greenish colour in the lower abdomen that spreads. Flys flies will start to enter orifices which and lay eggs. There will be maggots in the body eating the tissue and growing into to the flies

(c) Body farms use the bodies of pigs to study the changes in insect species on a body after death.

(i) Describe how this study could be carried out.

Have a constant temperature and release known numbers of different species of flies. Have a known number of bodies. At set times, sample the bodies and count the average number of maggots of each species. These set times will be 1, 2, 5, 10, and 15 days. Record the number of each species & this will help indicate the preference of the age of the body the maggots with have. Record the average length of each maggot species also.

(ii) Explain how the results of this study could be used to help to establish the time of death of a human.

The size and species of the maggots could help indicate how long the body has been dead. Supposing, you know that an 8mm maggot has be growing for 36 hours, for example, will help the entymologists identify the bodies approximate time of death. This can help investigators find out what happened to the person at that time.

BLANK PAGE

6 Electron microscopes have enabled scientists to view the ultrastructure of cells.

(a) (i) Which of the following structures is found in animal cells?

(1)

☒ **A** amyloplast

☒ **B** chloroplast

☒ **C** mesosome

☒ **D** ribosome

(ii) Which of the following structures is found only in plant cells?

(1)

☒ **A** amyloplast

☒ **B** Golgi apparatus

☒ **C** mesosome

☒ **D** vacuole

(iii) Which of the following structures is found in both animal and plant cells?

(1)

☒ **A** amyloplast

☒ **B** cell wall

☒ **C** pili

☒ **D** smooth endoplasmic reticulum

(b) The photograph shows an electron micrograph of a mitochondrion from a liver cell.

Magnification ×20 000

Calculate the maximum actual length of this mitochondrion.

$$\frac{I}{A \quad M}$$

$$\frac{11.5\,cm}{20,000} = 5.75 \times 10^{-4}\,cm$$

No units specified?

(2) 1 Q06b

Answer ....

(c) The diagram shows part of a molecule of chitin, a modified polysaccharide found in fungal cell walls.
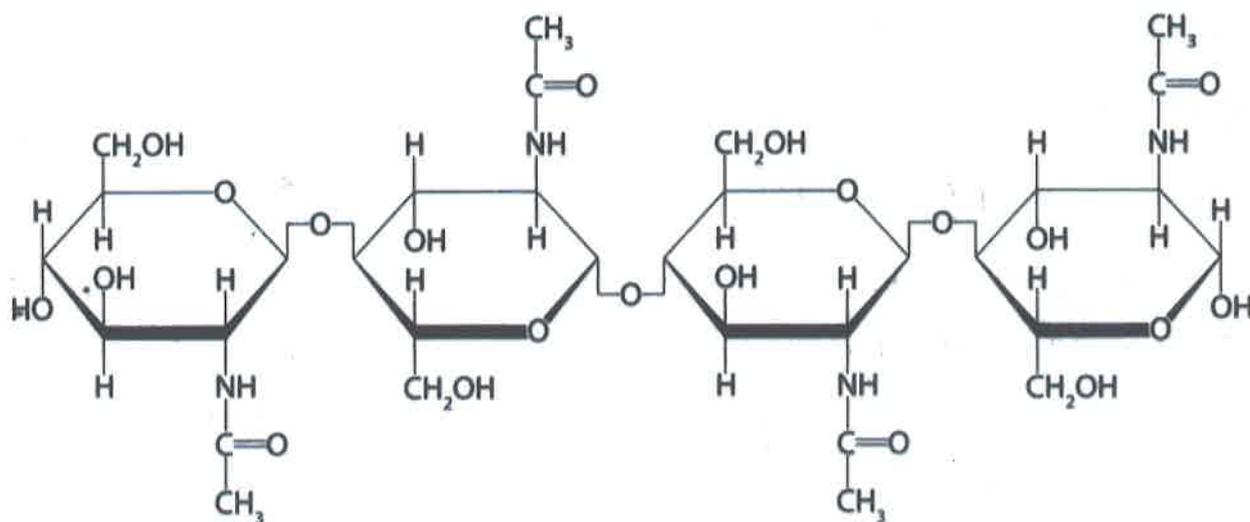
Compare and contrast the structure of chitin with that of a cellulose molecule.

(3) Q06c

The monosaccharide are still bonded together by glycosidic bonds, still making a polysaccharide. However, the poly monosaccharide is different to that of cellulose. A Cellulose uses β-glucose. The struct is very similar, however what is an -OH on carbon 2 on β-glucose is instead a methylamide group. The monosaccharides still flip like the do in cellulose though.

(Total for Question 6 = 8 marks)

7 Some species of bacteria have developed resistance to antibiotics.

This has led scientists to investigate many molecules for antimicrobial properties.

Peptides extracted from broad bean plants and cowpea plants have been studied.

(a) Describe how a peptide bond is formed.

(2) 2 Q07a

When two tRNA molecules have arrived at the ribosome, their anticodon hydrogen bonds to the codon on the mRNA this lines up the two specific amino acids that each tRNA molecule is carrying. A peptide bond then forms between the H₂N group of one amino acid and the -COOH group of the other, in a condensation reaction.

(b) The effects of these plant extracts were tested on pathogenic bacteria. It was found that each extract had an effect on its own, but the effect was greater when used together.

Devise a procedure that scientists may have used to measure the effects of these extracts on pathogenic bacteria.

(4) 2 Q07b

Have 4 agar plates all within petri dishes and there must all be contaminated with a pathogenic bacteria. Have 2 samples of each extract on a paper disc and one other paper disc soaked in ethanol. Then Place the ethanol paper disc in the centre of the the first petri dish. The have using aseptic technique. Next place one of each of the extracts in the next petri dish and the third 4 petri dish. place both next to each other & seal. The bacteria that have been killed will turn transparent. After 5 days in a warm environment, measure the diameter of each of clear spot and calculate the area. The petri dish with the largest area will be the best antibacterial microbial

(c) A bacteriostatic antibiotic works by

(1)1

☒ A destroying bacteria

☒ B destroying viruses

☒ C preventing the multiplication of bacteria

☒ D preventing the development of antibiotic resistance

(d) Hospitals have developed practices in response to the increase in hospital acquired infections.

Describe the infection control practices hospitals have introduced.

(3)1 Q07d

Aseptic technique. Wash hands and wear a new set of sterlised gloves when seeing every new patient. Isolate highly infectious patients as to not spread disease unnecessarily. Where masks and sterile overalls when operating. Clean wounds with antiseptic. Do not overprescribe antibiotics.

(Total for Question 7 = 10 marks)6

8 Thrombophilia is a condition that increases the risk of blood clots forming.

This condition increases the risk of venous thromboembolism (VTE), a condition where a blood clot forms in a vein. Thrombophilia due to the production of overactive factor V can be inherited.

Factor V is involved in the conversion of prothrombin to thrombin.

(a) (i) Describe the role of thrombin in blood clotting.

(3) 1 Q08ai

When a blood vessel is damaged, platelets burst releasing thromboplastin. Vitamin k and calcium are also in the blood which catalyses prothrombin to thrombin. Thrombin will will then be co' catalyse ~~too~~ soluble fibrinogen to insoluble fibrin which wraps around the ~~blood~~ vessel burst and prevent more blood loss

(ii) Explain why a mutation in the gene coding for the protein factor V may increase the risk of VTE.

(3) 1 Q08aii

If more prothrombin is converted then necessary then ~~the~~ more ~~soluble fibrigen~~ fibrinogen will be converted into fibrin an ~~more~~ clots will form. These clots many be unnecessary or too large.

9   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 / mm³
20	80
30	240
40	540
50	320
60	120

(a) (i) Calculate the temperature coefficient (Q_{10}) for this reaction between 20 °C and 30 °C.

(1) 0   Q09ai

Answer ....

(b) A study was carried out to determine the incidence of VTE in people of different ages. Those who developed VTE were then tested for the factor V gene mutation.

The results of this study are shown in the table.

Age range	Percentage incidence of VTE in the study group (%)	Percentage of VTE patients with factor V mutation in the study group (%)
less than 20 years of age	1.3	49.3
over 70 years of age	34.0	20.9

Deduce the relative impact of the genotype and environmental factors on the development of VTE.

(4) 2 Q08b

As age increase, so does the percentage incidence. There is an ~~ire~~ increase of 32.7%. for people over 70 compare to people under 20. However, younger people are more likely to have the factor V mutation in the study group (40%) under 20 compared to 20.9% for people over 70. Environmental factors appear like to have a larger impact than the genotype does.

(Total for Question 8 = 10 marks) 4

(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.

(3) Q09aii

An increase in temperature will increase the kinetic energy of the enzyme and substrates forming. This increases the chances of successful collisions between the enzyme and substrate forming more enzyme - substrate complexes. The volume increases because the enzymes became more active by catalysing the breakdown of H_2O_2. Enzymes are have a specific, complentary active site for the H_2O_2.

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

(2) Q9aiii

The Q_{10} value decreases because the enzymes are becoming denatured. This means that the active site will change shape, meaning that the H_2O_2 will no longer be able to bind to the active site of the enzyme and the mean volume of oxygen will decrease.

(b) Leaf rust is a disease caused by a species of fungus. Leaf rust affects cereal crops such as wheat.

Leaf rust yeast spreads through cereal crops when the humidity is high.

Discuss the possible impact of climate change on the effects of leaf rust on the yield of wheat crops.

(4) 3 Q09b

Climate change will result in a global average rise in temperature. This rise in temperature will increase the evaporations of water from lakes aswell as the rate of of transpiration, the exiting of water from the leaves leaves of plants. This will increase the humidity as there is a higher concentration of water in the atmosphere. As the humidity rises, so will the ~~poputat~~ population of cereal crops being affected by ~~a~~ leaf rust as leaf rust can is transfered by a fungus which spreads when the humidity is high. This will kill plants and decrease the yield. This means that there is a potential of for food shortage around the ~~your~~ world.

(Total for Question 9 = 10 marks) **8**