OXFORD

INTERNATIONAL AQA EXAMINATIONS

Topic Test: OxfordAQA International A level Biology

Populations and genes

Name: _____

Class: _____

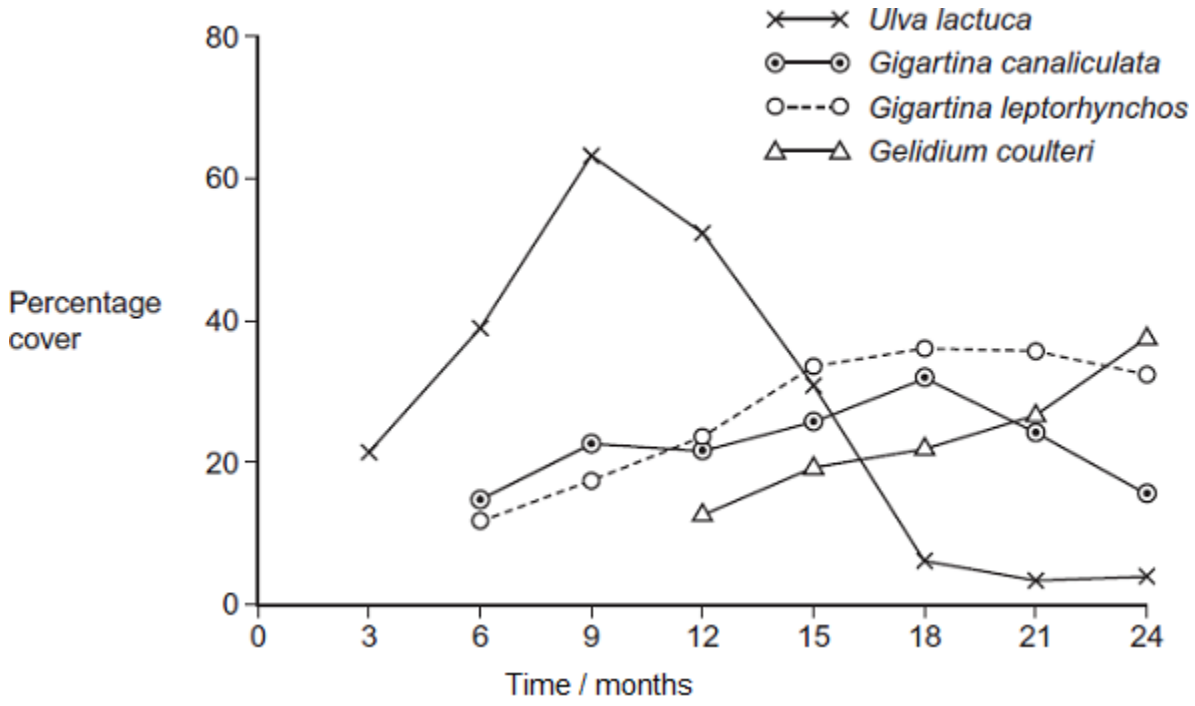
Date: _____

Time: **78 minutes**

Marks: **69 marks**

Comments:

1 Algae are photosynthesising organisms. Some algae grow on rocky shores. A scientist investigated succession involving different species of algae. He placed concrete blocks on a rocky shore. At regular intervals over 2 years, he recorded the percentage cover of algal species on the blocks. His results are shown in the graph.



(a) Name the pioneer species.

_____

(1)

(b) (i) The scientist used percentage cover rather than frequency to record the abundance of algae present. Suggest why.

_____

_____

_____

(1)

(ii) Some scientists reviewing this investigation were concerned about the validity of the results because of the use of concrete blocks.
Suggest **one** reason why these scientists were concerned about using concrete blocks for the growth of algae.

_____

_____

_____

(1)

(c) Use the results of this investigation to describe and explain the process of succession.

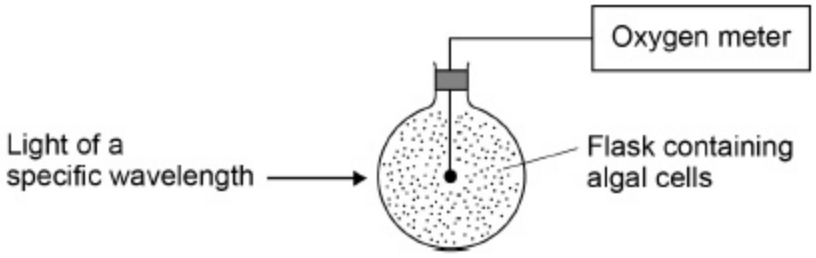
(4)

(Total 7 marks)

2 A student investigates the effect of different wavelengths of light on the rate of photosynthesis.

The student:

- uses photosynthesising algal cells
- sets up the apparatus shown in the diagram
- shines different wavelengths of light onto the flask
- takes measurements to determine the rate of photosynthesis.



(a) What **two** measurements should the student take to determine the rate of photosynthesis?

(1)

(b) The student controls the temperature, pH and carbon dioxide concentration.

Give **two** other factors that the student should keep constant during this investigation.

1. _____

_____

2. _____

_____

(2)

(c) The student adds a reagent to the suspension of photosynthesising algal cells.

The reagent is blue when oxidised and is colourless when reduced.

The blue colour disappears when the suspension of algal cells is exposed to light.

Explain why.

Use your knowledge of the light-dependent reaction of photosynthesis.

_____

_____

_____

_____

(2)

(d) Some purple bacteria can photosynthesise, but use hydrogen sulfide instead of water. The hydrogen sulfide has a similar role to water in photosynthesis.

Suggest how the bacteria use hydrogen sulfide.

_____

_____

_____

_____

_____

_____

(3)

(e) Suggest how the products of the light-dependent reaction in purple bacteria would be different from those in photosynthetic algae.

_____

_____

(1)

(Total 9 marks)

3 (a) Name the **two** substances produced by anaerobic respiration in humans.

1. _____

2. _____

(2)

(b) When an athlete runs in a 100 metre race, 90% of the energy needed is provided by anaerobic respiration.

(i) Explain why most of the energy is provided by anaerobic respiration rather than aerobic respiration.

_____

_____

_____

_____

(2)

(ii) The athlete continues to breathe deeply for several minutes after the race ends. Explain why this is necessary.

_____

_____

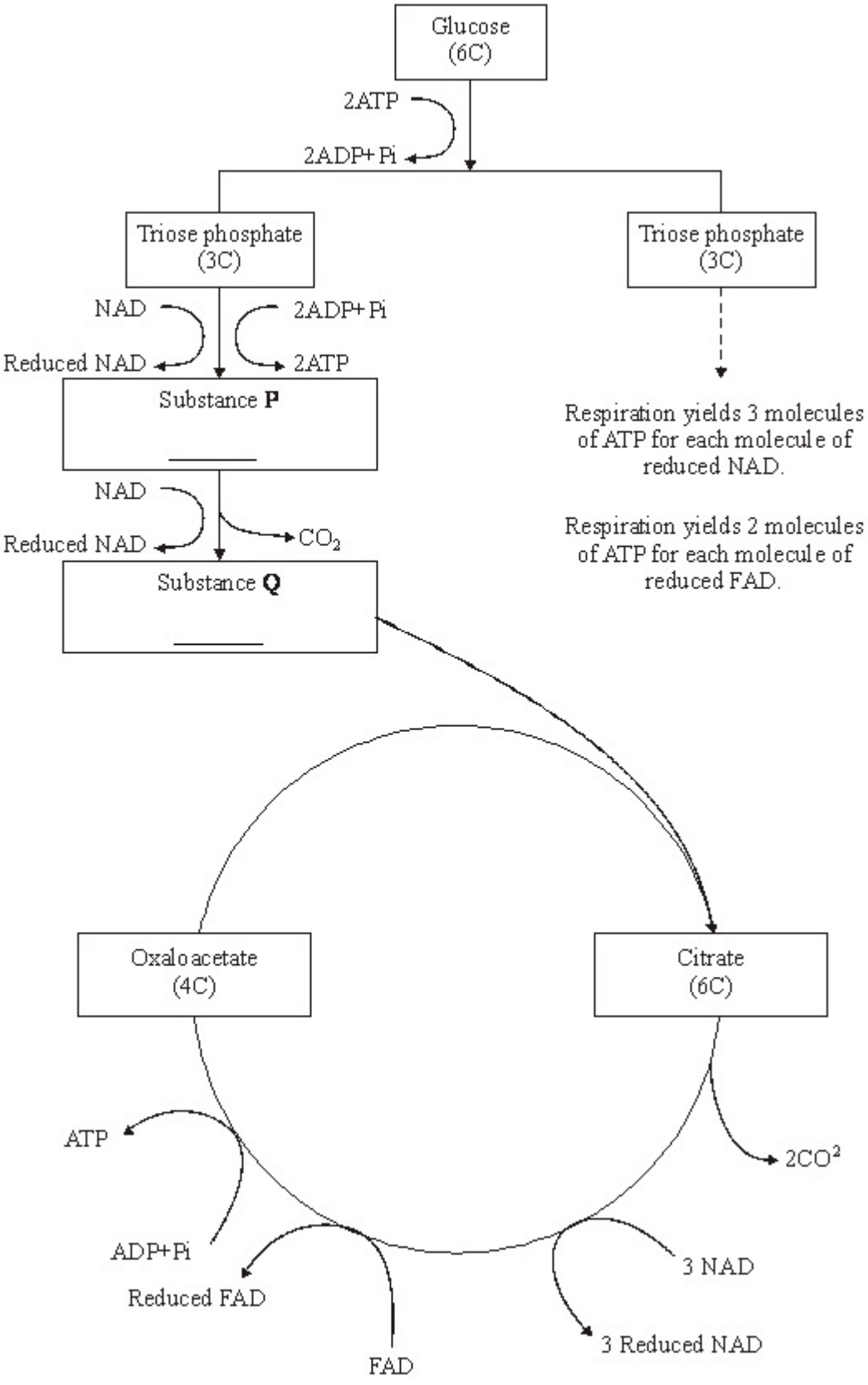
_____

_____

(2)

(Total 6 marks)

4 (a) The flow chart shows the main stages in aerobic respiration.



(i) Complete the flow chart by writing, in the appropriate boxes, the number of carbon atoms in substance **P** and the name of substance **Q**.

(2)

(ii) Some ATP is formed in the cytoplasm and some in the mitochondria. Use the information given to calculate the number of molecules of ATP formed in a mitochondrion from one molecule of glucose in aerobic respiration. Show how you arrived at your answer.

Answer_____

(2)

(iii) In the presence of oxygen, respiration yields more ATP per molecule of glucose than it does in the absence of oxygen. Explain why.

_____

_____

_____

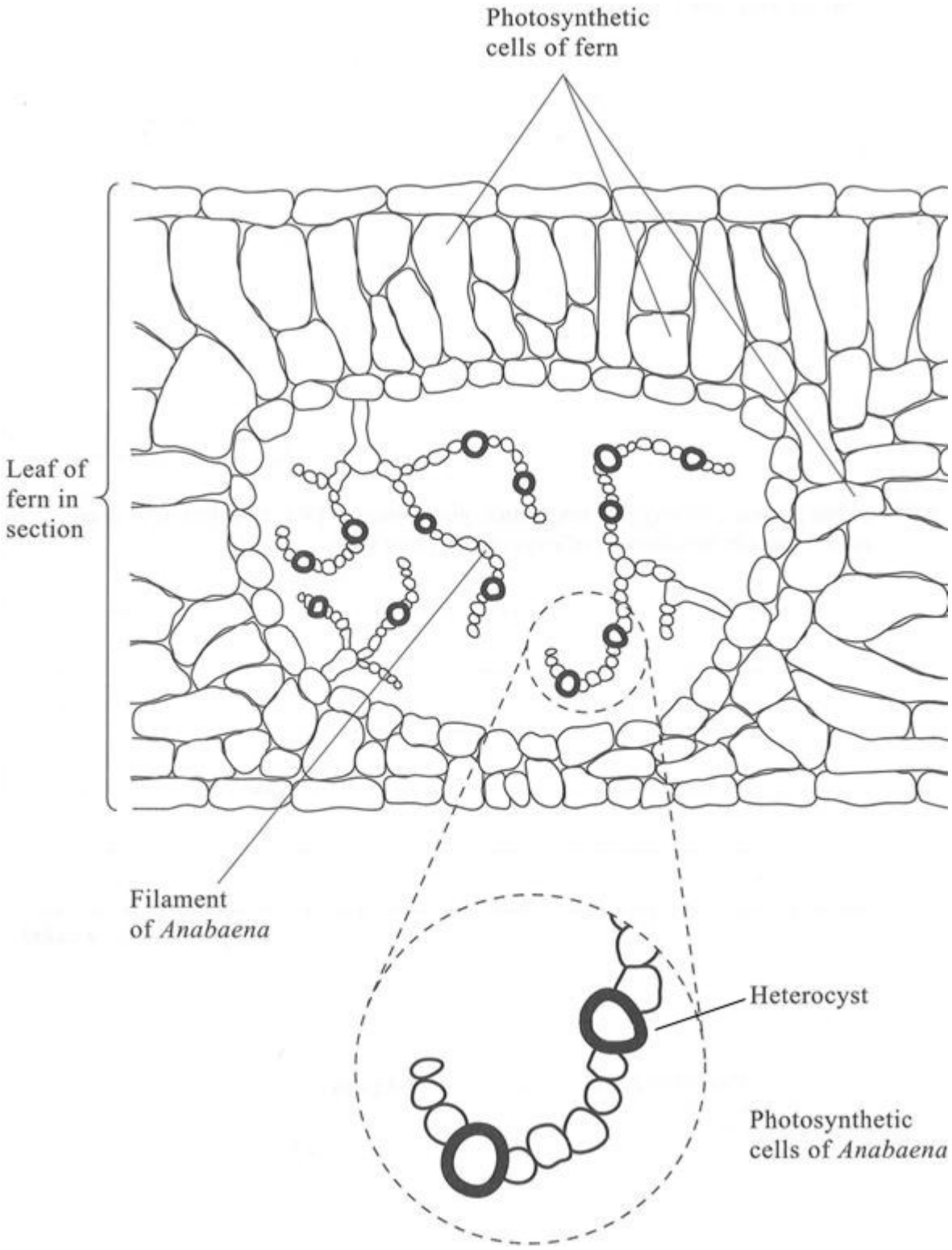
_____

_____

_____

(3)

(b) Anabaena is a prokaryote found inside the leaves of a small fern. Anabaena can produce ammonia from nitrogen (nitrogen fixation). This reaction only takes place in the anaerobic conditions found in cells called heterocysts. Heterocysts are thick-walled cells that do not contain chlorophyll. The drawing shows the relationship between *Anabaena* and the fern.



(i) Suggest how the features of the heterocysts improve the efficiency of the process of nitrogen fixation.

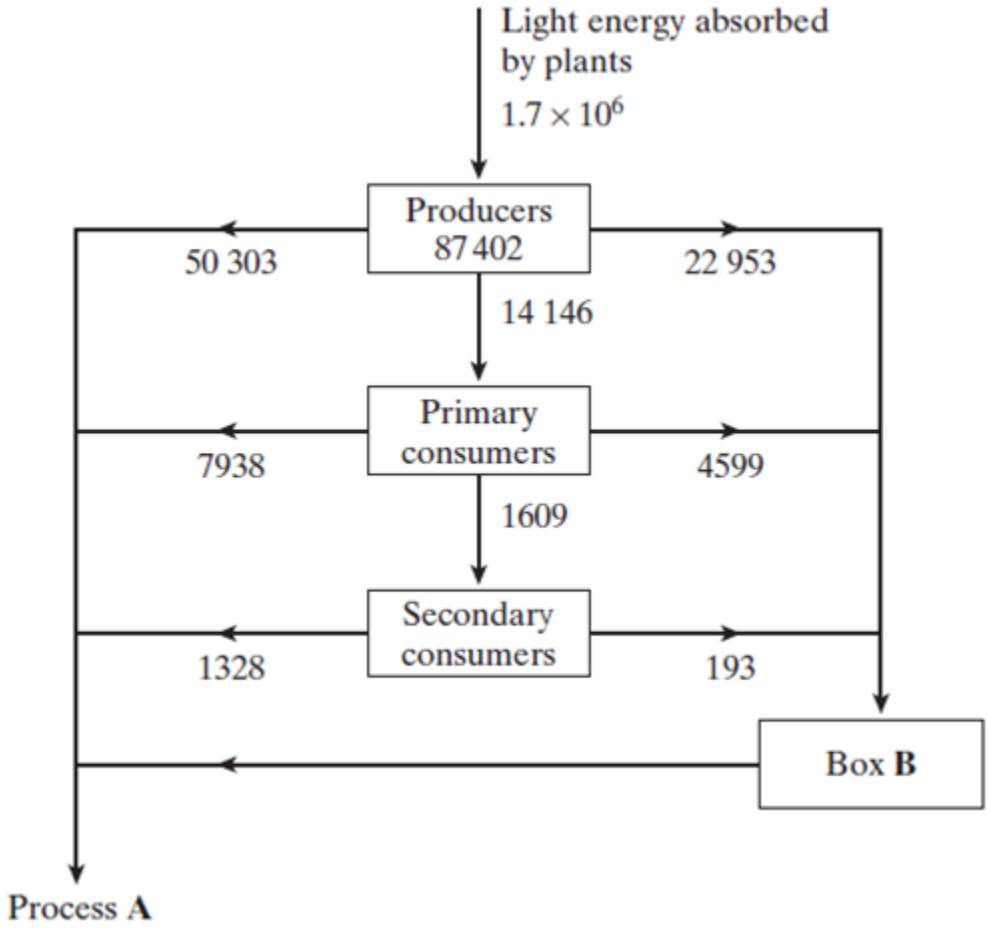
(3)

(ii) In China, the fern is cultivated and ploughed into fields to act as an organic fertiliser. Explain how ploughing the fern plants into the soil results in an improvement in the growth of the rice crop grown in these fields.

(5)

(Total 15 marks)

5 The diagram shows the energy flow through a freshwater ecosystem.
All units are kJ $m^{-2}year^{-1}$.



(a) Name

(i) process **A**;

_____

(1)

(ii) the group of organisms represented by box **B**.

_____

(1)

(b) Calculate the percentage efficiency with which light energy is transferred to energy in producers. Show your working.

Answer _____

(2)

(c) Describe the effect of light energy in the light-dependent reaction of photosynthesis.

_____

_____

_____

_____

(2)

(d) If a plant is kept in the dark it is still able to produce carbohydrates, as long as it is provided with two products of the light-dependent reaction of photosynthesis. Give the name of these products and explain their function in the light-independent reaction of photosynthesis.

Name _____

Function _____

_____

Name _____

Function _____

_____

(4)

(Total 10 marks)

6 A breeder crossed a black male cat with a black female cat on a number of occasions. The female cat produced 8 black kittens and 4 white kittens.

(a) (i) Explain the evidence that the allele for white fur is recessive.

_____

_____

(1)

(ii) Predict the likely ratio of colours of kittens born to a cross between **this** black male and a white female.

_____

(1)

(b) The gene controlling coat colour has three alleles. The allele **B** gives black fur, the allele **b** gives chocolate fur and the allele **b^i** gives cinnamon fur.

- Allele **B** is dominant to both allele **b** and **b^i**.
- Allele **b** is dominant to allele **b^i**.

(i) Complete the table to show the phenotypes of cats with each of the genotypes shown.

Genotype	Phenotype
Bb^i	
bb^i	
Bb	

(1)

(ii) A chocolate male was crossed several times with a black female.

They produced

- 11 black kittens
- 2 chocolate kittens
- 5 cinnamon kittens.

Using the symbols in part (b), complete the genetic diagram to show the results of this cross.

Parental phenotypes Chocolate male Black female

Parental genotypes _____ _____

Gametes _____ _____

Offspring genotypes _____ _____ _____

Offspring phenotypes Black Chocolate Cinnamon

(3)

(iii) The breeder had expected equal numbers of chocolate and cinnamon kittens from the cross between the chocolate male and black female. Explain why the actual numbers were different from those expected.

_____

_____

_____

(1)

(iv) The breeder wanted to produce a population of cats that would all have chocolate fur. Is this possible? Explain your answer.

_____

_____

_____

_____

_____

(2)

(Total 9 marks)

7 Sea otters were close to extinction at the start of the 20th century. Following a ban on hunting sea otters, the sizes of their populations began to increase. Scientists studied the frequencies of two alleles of a gene in one population of sea otters. The dominant allele, **T**, codes for an enzyme. The other allele, **t**, is recessive and does not produce a functional enzyme.

In a population of sea otters, the allele frequency for the recessive allele, **t**, was found to be 0.2.

(a) (i) Use the Hardy-Weinberg equation to calculate the percentage of homozygous recessive sea otters in this population. Show your working.

Answer _____ %

(2)

(ii) What does the Hardy-Weinberg principle predict about the frequency of the **t** allele after another 10 generations?

_____

_____

(1)

(b) Several years later, scientists repeated their study on this population. They found that the frequency of the recessive allele had decreased.

(i) A statistical test showed that the difference between the two frequencies of the **t** allele was significant at the P = 0.05 level.

Use the terms **probability** and **chance** to help explain what this means.

_____

_____

_____

_____

_____

(2)

(ii) What type of natural selection appears to have occurred in this population of sea otters? Explain how this type of selection led to a decrease in the frequency of the recessive allele.

Type of selection _____

Explanation _____

_____

_____

_____

(2)

(Total 7 marks)

8 The Amazonian forest today contains a very high diversity of bird species.

- Over the last 2 000 000 years, long periods of dry climate caused this forest to separate into a number of smaller forests.
- Different plant communities developed in each of these smaller forests.
- Each time the climate became wetter again, the smaller forests grew in size and merged to reform the Amazonian forest.

(a) Use the information provided to explain how a very high diversity of bird species has developed in the Amazonian forest.

(5)

(b) Speciation is far less frequent in the reformed Amazonian forest. Suggest one reason for this.

(1)

(Total 6 marks)

1

(a) *Ulva lactuca*;

Reject: Ulva on its own

Accept: lactuca on its own

Accept: Incorrect spelling

1

(b) (i) Difficult / too many / too many to count / individual organisms not identifiable / too small to identify / grows in clumps;

Neutral: easier / quicker / representative / more accurate, unless qualified

1

(ii) Any described feature of concrete eg texture / flat / composition chemicals / nutrients etc;

Neutral: not natural / man made / are different, without further qualification

1

(c) 1. Pioneer species / *Ulva* increases then decreases;

1 and 4. Growth / reproduces = increases. Dies = decrease

2. Principle of a species changing the conditions / a species makes the conditions less hostile;

2. Accept description of change in conditions eg soil / humus forms, nutrients increased

3. New / named species better competitor / previous / named / pioneer species outcompeted;

Pioneer species grows, dies and forms humus = 2 marks

G. coulteri / Gelidium outcompetes other / named species = 2 marks

4. *G. coulteri / Gelidium* increases <u>and</u> other / named species decreases;

4

[7]

2

(a) oxygen concentration/reading on oxygen meter <u>and</u> time;

Accept 'amount' of oxygen in a given time

1

(b) Light intensity/distance between light and flask;

1

Mass/volume/number of algae/photosynthesising cells;

1

(c) Electrons/e^- (from chlorophyll) excited/reduced NADP formed;
Reject NAD
1

hydrogen/electrons (from water/chlorophyll) change dye colour;
1

(d) Any **three** from four

1. (hydrogen sulfide is) source of hydrogen/protons/H^+ and electrons/e^-;
1

2. (hydrogen/protons/H^+ used for) reduction of NADP/electron carrier;
Reject NAD
Accept production of NADPH/$NADPH_2$/reduced NADP
1

3. (electrons) replace electrons lost from chlorophyll/pigment;
1

4. (protons) generate ATP;
1
3 max

(e) Sulphur/S produced (instead of oxygen);
Reject SO_2 / SO_3
1
[9]

3 (a) lactate / lactic acid / pyruvate; ATP;
2

(b) (i) energy demand is very high / high respiration rate;
unable to supply enough oxygen to muscles / tissues / cells /
insufficient time for oxygen to reach muscles / tissues / cells /
insufficient oxygen in muscles / tissues / cells;
2

(ii) break down with oxygen / oxidise lactate into pyruvate / glucose / glycogen /
CO_2 + water;
by aerobic respiration;
2
[6]

4 (a) (i) **P** = 3;
Q = acetylcoenzyme A;
2

(ii) 36 ATP, however derived = 2 marks
30 ATP, however derived = 1 mark
2

(iii) *Correct statement in the context of aerobic respiration or anaerobic respiration concerning*:
Oxygen as terminal hydrogen / electron acceptor allowing operation of electron transport chain / oxidative phosphorylation;
Fate of pyruvate;
Significance of ATP formed in glycolysis;

3

(b) (i) Thick walls exclude oxygen;
Produced by photosynthetic cells (of fern and *Anabaena*);
Contain no chlorophyll so do not photosynthesise;
Do not produce oxygen;
Oxygen would inhibit nitrogen fixation process;

max. 3

(ii) Decomposers / bacteria / fungi / saprobionts (in fields);

Convert protein / organic nitrogen (in cells of fern) into ammonium ions (*allow ammonia*);
Ammonium ions (ammonia) converted to nitrite, then converted to nitrate;

Allow 1 mark for NH_3 / $NH_4^+ \rightarrow NO_3^-$
By nitrifying bacteria / correctly named;
Nitrate used to form protein / amino acids in rice;

5

[15]

5 (a) (i) respiration;

1

(ii) decomposers;
(*accept bacteria / fungi*)

1

(b) $\frac{87402}{1.7 \times 10^6} \times 100 = 5.14 / 5.1\%$;

(correct answer = 2 marks)
(principle: energy in producers ÷ energy of light absorbed = 1 mark)

2

(c) excites chlorophyll / electrons;
release electron(s);

2 max

(d) reduced NADP;
reduces GP / to change GP to TP;
ATP;
provides the energy to reduce GP / convert GP to TP / TP to RuBP /
provides phosphate to convert TP to RuBP;

4

[10]

6

(a) (i) 1. Parents are heterozygous;

Accept carriers / carries white allele

2. Kittens receive white allele from parents / black cat;

1 max

(ii) 1:1;

Answer must be expressed as a ratio that could be reduced to 1 : 1

1

(b) (i) Black,
Chocolate,
Black;

All three correct for the mark

1

(ii) Parental phenotypes Chocolate male Black female

1. Parental genotypes bb^i Bb^i;

Both genotypes needed for the mark.

1

2. Parental gametes b b^i B b^i;

Allow credit if gametes are correctly derived from candidate's incorrect parental genotypes.

1

3. Offspring genotypes Bb, Bb^i bb^i b^ib^i;

Genotype(s) must be with correct phenotype.

Allow credit if symbols other than B / b / b^i have been used correctly.

Ignore genetic diagrams unless clearly annotated.

1

Offspring phenotypes Black Chocolate cinnamon;

(iii) 1. Offspring ratios are a probability / not fixed / arise by chance /

2. gametes may not be produced in equal numbers /

3. fertilisation / fusion of gametes is random /

4. small sample;

1

(iv) 1. Possible if parents homozygous / bb;

2. Don't know genotype of chocolate cat / chocolate cat could be homo- or heterozygous / chocolate cat could be bb or bb^{i};

3. Two chocolate cats could give cinnamon kittens;

2 max

[9]

7 (a) (i) Two marks for correct answer of 4;;

One mark for calculation involving 0.2 × 0.2 or 0.04;

2

(ii) 0.2 / the frequency remains the same;

Reject if wrong frequency is quoted

1

(b) (i) 1. There is a <u>probability</u> of 5% / 0.05;

2. That difference in frequencies / difference in results are due to <u>chance</u>;

Accept 95% probability changes in frequencies not different as a result of chance

2

(ii) 1. Directional;

2. The recessive allele confers disadvantage / the dominant allele confers advantage / more likely to survive / reproduce;

Assume "it" to refer to the recessive allele

2. References to selection do not gain credit as the term is in the question. Allow reference to phenotype / enzyme functionality (instead of allele) when describing advantage / disadvantage.

2

[7]

8

(a) 1. No interbreeding / gene pools are separate / geographic(al) isolation;

Accept: all marks if answer written in context of producing increased diversity of plants

1 Do not award this mark in context of new species being formed and then not interbreeding

1 Accept reproductive isolation as an alternative to no interbreeding

2. Mutation;

2 Accept: genetic variation

3. Different selection pressures / different foods / niches / habitats;

3 Accept: different environment / biotic / abiotic conditions or named condition

3 Neutral: different climates

4. Adapted organisms survive and breed / differential reproductive success;

5. Change / increase in allele frequency / frequencies;

5

(b) Similar / same environmental / abiotic / biotic factors / similar / same selection pressures / no isolation / gene flow can occur (within a species);

Accept: same environment

1

[6]