

PEARSON EDEXCEL A-LEVEL BIOLOGY B • 9B10

BIOLOGY



EXAM QUESTION PACK

TOPIC 5: ENERGY FOR BIOLOGICAL PROCESSES
PHOTOSYNTHETIC PIGMENTS

SCORE

/40

PERCENTAGE

%

STEMUP

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Q1.

Cadmium is an environmental pollutant that affects the synthesis of plant pigments.

A scientist investigated the effect of cadmium on the synthesis of chlorophyll and carotenoid pigments in plants.

The scientist used the following steps in the method.

Step 1: plants were grown in darkness for one week to produce yellow leaves

Step 2: leaf discs of the same diameter were taken from the first pair of these leaves

Step 3: a total of 25 discs was put into tubes containing different cadmium chloride concentrations

Step 4: these tubes were kept at 27 °C and exposed to the same source of light

The table shows information about the pigments chlorophyll a and chlorophyll b and the carotenoids present in the leaf discs after 48 hours.

Cadmium chloride concentration / a.u.	Mean concentration of chlorophyll / mg kg ⁻¹	Mean concentration of carotenoid / mg kg ⁻¹	Ratio of chlorophyll a : b	Ratio of carotenoid : chlorophyll
0.0	384 ± 4.2	444 ± 6.2	1.23	1.15
0.1	204 ± 4.9	270 ± 4.5	1.00	1.32
1.0	180 ± 3.6	207 ± 5.2	0.83	1.15
3.0	146 ± 4.1	140 ± 3.1	0.81	0.95
5.0	126 ± 2.7	91 ± 1.0	0.56	0.71
10.0	102 ± 1.9	64 ± 1.1	0.80	0.63

(i) Analyse the data to deduce the effect of cadmium on the synthesis of plant pigments.

(3)

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(ii) Justify the method used by the scientist.

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(Total for question = 8 marks)

Q2.

(a) A student investigated the effect of ethanol on plant cell membranes.

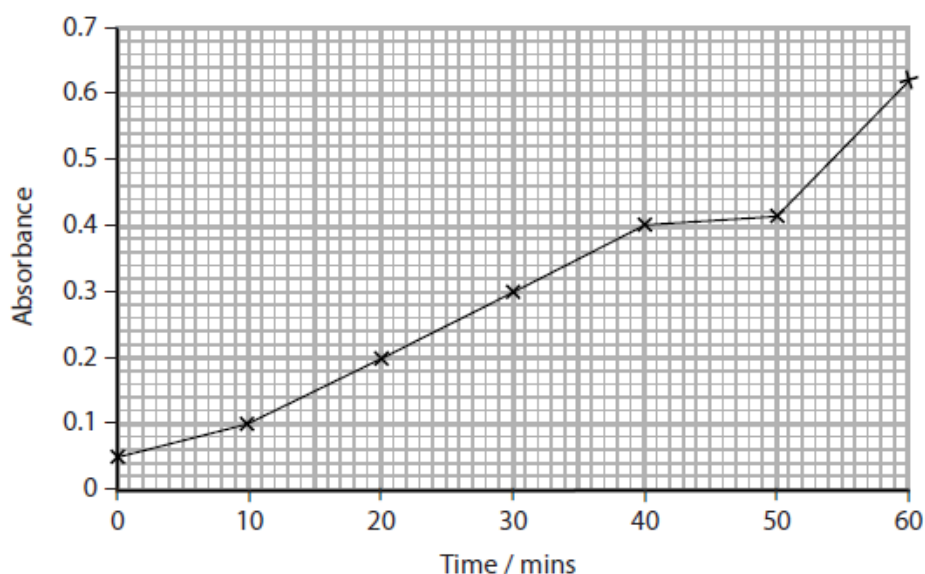
Step 1: The student cut leaf discs from leaves, using a cork borer.

Step 2: These leaf discs were then added to a boiling tube containing 10 cm³ of 40% ethanol solution. The pigments in the leaf discs dissolved in the ethanol, producing a green solution.

Step 3: The boiling tube was shaken and the amount of red light absorbed by this solution (absorbance) was measured at the start.

Step 4: The absorbance was measured every 10 minutes, for an hour.

The graph shows the results of this investigation.



(i) Explain why red light was used in this investigation.

(2)

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(ii) Explain the absorbance value at 0 minutes.

(2)

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(iii) Explain the effect of ethanol on plant cell membranes.

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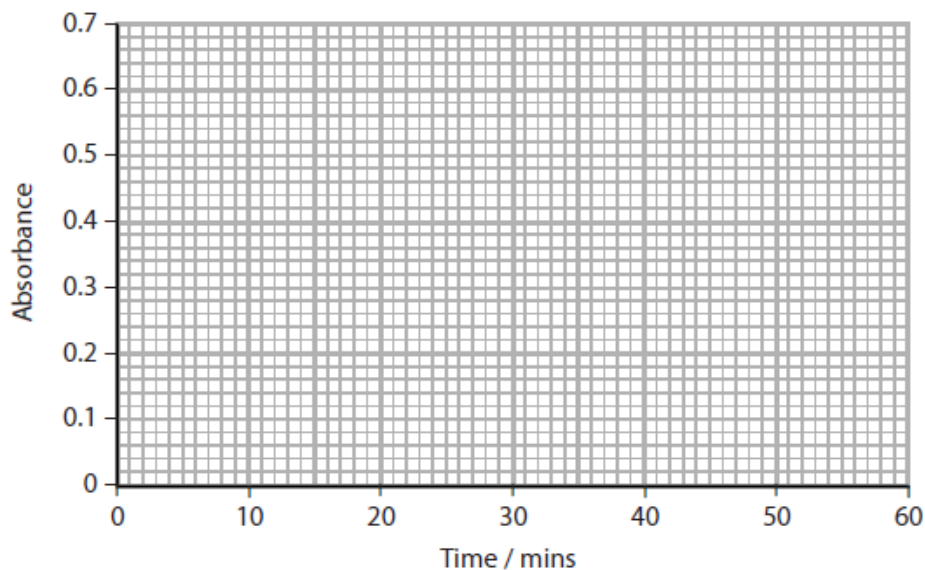
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(b) The student also carried out a control, using water instead of 40% ethanol.

Draw a line on the graph to show the results for this control.

(2)



(c) The student then investigated the effect of ethanol concentration on leaves from different plant species.

Justify the modifications to the procedure in part (a) that will be required to obtain valid data.

(5)

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(Total for question = 13 marks)

Q3.

Plant pigments are involved in photosynthesis.

The action spectrum of chloroplasts and the absorption spectrum of the pigments can be determined.

(i) State the difference between an action spectrum and an absorption spectrum.

(1)

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(ii) State how an action spectrum and an absorption spectrum show that chlorophyll is used in photosynthesis.

(1)

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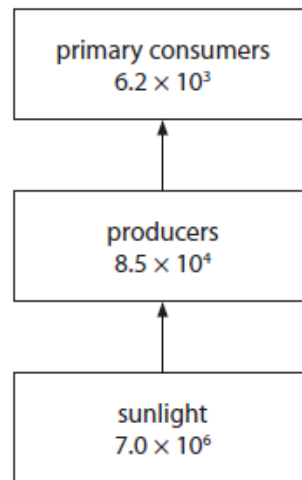
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Q4.

The diagram shows the flow of energy in an ecosystem.

The numbers represent the energy in $\text{kJ m}^{-2} \text{yr}^{-1}$ in each category.



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

(2)

Answer %

(ii) Give one reason why the energy transfer from sunlight to the producers is less than 100% efficient.

(1)

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(iii) Explain the energy difference between the producers and the primary consumers.

(2)

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(Total for question = 5 marks)

Q5.

Fritillaria delavayi is a small plant (height 7 cm), that grows on rocky slopes on mountains in China.

The image shows *Fritillaria delavayi*.



For at least 2 000 years, this plant has been collected and used in Chinese medicine. It is not known to be eaten by animals.

In less accessible regions, where few humans go, the plants are bright green with bright yellow flowers.

In locations where bulbs are collected in high numbers, most plants have greyish-brown leaves and flowers.

Scientists believe that the greyish-brown plants are the same species as the brightly-coloured plants.

(i) Describe how scientists can use gel electrophoresis to show that these plants belong to the same species.

(4)

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(ii) Explain why the features of the brightly-coloured plants enable them to grow successfully in the areas where they are not collected by humans.

(2)

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(Total for question = 6 marks)

Q6.

Macroalgae and microalgae are photosynthetic organisms.

Seaweeds are macroalgae that live attached to rock in coastal areas.

Some seaweeds are green, some are brown and some are red.

The colour of seaweeds depends on the photosynthetic pigments contained in their cells.

Green seaweeds contain chlorophyll, brown seaweeds contain chlorophyll and fucoxanthin and red seaweeds contain chlorophyll and phycoerythrin.

(i) Explain why these seaweeds have different absorption spectra and action spectra.

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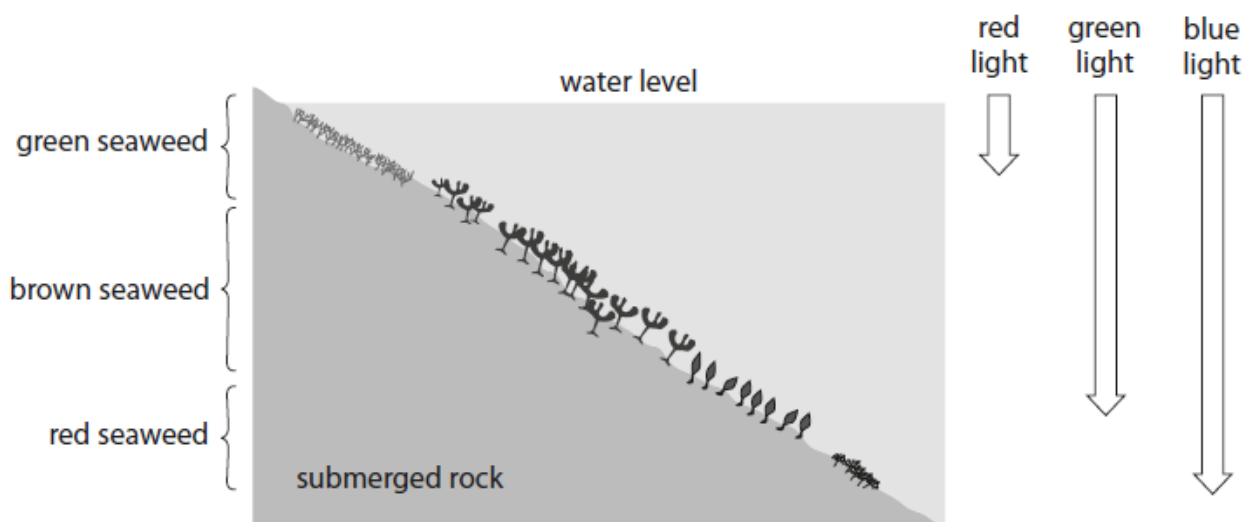
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(ii) The diagram shows the position that these seaweeds occupy on submerged rock and the depth to which different wavelengths of light penetrate into the water.



Explain why the seaweeds occupy different positions on the submerged rock.

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(Total for question = 6 marks)

Mark Scheme

Q1.

Question Number	Answer	Mark
(i)	An answer that makes reference to the following: • decreases chlorophyll and carotenoid / plant pigment (synthesis) (1) • chlorophyll a (synthesis) is less than chlorophyll b (synthesis) / chlorophyll a more inhibited / chlorophyll b less inhibited (1) • carotenoid (synthesis) is less than chlorophyll (synthesis) / carotenoid more inhibited than chlorophyll / chlorophyll less inhibited than carotenoid (1) • SD show difference is significant (1)	(3)

Question Number	Answer	Mark
(ii)	An answer that makes reference to five of the following: - grown in darkness for a week so leaves big enough to obtain discs / so leaves contain {less / no pigment} (1) - discs same {diameter / leaves / leaf age} because affects pigment {amount / content / concentration} (1) 25 discs used so that sufficient pigment obtained / calculate SD (1) {control / 0.0} solution allows comparison (1) - same temperature as it affects enzymes (1) - same light {wavelength / source / intensity} as light affects synthesis of pigments (1) 48 hours allows time for pigment synthesis (1)	(5)

Q2.

Question Number	Acceptable Answers	Additional Guidance	Mark
(a)(i)	An explanation that makes reference to the following: - red is absorbed (1) - because of the presence of chlorophyll (1)		(2)

Question Number	Acceptable Answers	Additional Guidance	Mark
(a)(ii)	An explanation that makes reference to the following: {chlorophyll / leaf pigment} was present (1) - because some cells are damaged / discs not washed (1)		(2)

Question Number	Answer	Additional Guidance	Mark
(a)(iii)	An explanation that makes reference to the following: - ethanol {disrupts / damages / dissolves / affects} the phospholipid (1) - therefore the membrane {becomes more permeable / allows pigment out} (1)		(2)

Question Number	Answer	Additional Guidance	Mark
(b)	An answer that makes reference to the following: - starts at 0.05 absorbance value (1) - flat line along 0.05 absorbance value (1)		(2)

Question Number	Answer	Additional Guidance	Mark
(c)	An answer that makes reference to five of the following: - use leaves of {same age / same position on plant} because this affects concentration of pigment (1) - obtain leaf discs from the same part of the leaf because this affects concentration of pigment (1) - use same {cork borer / size of leaf disc / diameter of leaf disc} because this affects concentration of pigment (1) - use same temperature because temperature affects the rate of diffusion (1) - use same volume of ethanol so chlorophyll is diluted the same (1) - replicate each ethanol concentration to {see if results are consistent / identify anomaly / to calculate standard deviation / allow statistical test} (1) - wash discs to remove pigment (1)		(5)

Question Number	Answer	Additional Guidance	Mark
(i)	absorption spectrum shows absorption of light of different wavelengths and action spectrum shows rate of photosynthesis at each wavelength	ACCEPT absorption spectrum involves wavelengths only and action spectrum involves photosynthesis / oxygen production only	(1)

Question Number	Answer	Additional Guidance	Mark
(ii)	spectra are similar / spectra overlap / peaks and troughs follow similar pattern	ACCEPT similar peak at blue / similar peak at red / similar trough at green	(1)

Q4.

Question Number	Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to the following: divide energy in producers by energy in sunlight (1) multiply by 100 (1)	$85\,000 \div 7\,000\,000$ $\times 100 = 1.21$ Correct answer gains full marks, with no working shown.	(2)

Question Number	Answer	Additional Guidance	Mark
(ii)	An answer that makes reference to one of the following: - light reflected (from leaf) (1) - light misses {chloroplast / chlorophyll} (1) - only certain wavelengths absorbed (1)	Accept transmitted / not absorbed by {chloroplast / chlorophyll} Accept limiting factors eg lack of CO ₂ , water etc may reduce rate	(1)

Question Number	Answer	Additional Guidance	Mark
(iii)	An explanation that makes reference to two of the following: - because some of the energy is lost through {respiration / heat / movement} (1) - some of the producers not eaten (1) - some of the producers not digested (1)		(2)

Q5.

Question Number	Answer	Additional Guidance	Mark
(i)	An answer that includes four of the following: - obtain DNA (from the two types of plants) (1) {use of restriction enzymes to cut DNA into fragments / use of PCR to amplify DNA} (1) {DNA / fragments} (loaded) on (agarose) gel with {current passed through / voltage or potential difference applied} (1) - fragments of DNA are separated (1) {same / similar} (banding) pattern suggests they are the same species (1)	Accept movement of (negatively charged) DNA moves to positive electrode Accept description / diagram of banding pattern Accept shorter fragments travel further Accept converse	Exp (4)

Question Number	Answer	Additional Guidance	Mark
(ii)	An answer that includes two of the following: • (if leaf is green it contains) chlorophyll / photosynthetic pigments (1) • so more {light / more wavelengths of light} absorbed for photosynthesis (1) • so more glucose produced for growth (1) OR • (if flower is brightly coloured) it attracts {pollinators / insects} (1) • so (more likely to) reproduce successfully (1) • to produce seeds / pass trait on (1)	Accept more light / wavelengths of light leads to higher rate of photosynthesis Accept more GALP / TP / GP for growth Accept so increased genetic variation (as less self- pollination) Accept asexual reproduction (through bulb) still possible if pollination does not occur	Exp (2)

Q6.

Question Number	Answer	Additional Guidance	Mark
(i)	An explanation that makes reference to three of the following: • each pigment will absorb different wavelengths (of light) (1) • each pigment will absorb different amounts of light at each wavelength (1) • action spectrum is different because the seaweeds are absorbing different wavelengths of light (1) • the rate of photosynthesis will therefore be different at each wavelength (1)	ACCEPT each pigment will reflect different wavelength (of light) description of which colour light is {reflected / absorbed}	(3)

Question Number	Answer	Additional Guidance	Mark
(ii)	An explanation that makes reference to three of the following: • green seaweeds found in shallow water as they {cannot absorb the green light / can absorb the red light} (1) • {brown / red} seaweeds can absorb {green / blue / other} wavelengths of light so are positioned further down as these wavelengths can penetrate further (1) • seaweeds positioned so that they can absorb light for {photosynthesis / light-dependent reactions / photolysis} (1) • seaweeds positioned to avoid competition with the other types of seaweed (1)	ALLOW plants for seaweeds	(3)