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# A2 Biology

LATEST SYLLABUS

## Unit 4: Topical Questions

## 2020 - 2026

## Examiner's Insights Edition

# Click the topic to access it quickly

## Unit 4 (WBI14/01) · Questions & Answers by Topic

Past-paper questions classified by topic · click a chapter to jump

Chapter 1

# Photosynthesis: light-dependent reactions



15 questions in this chapter

## Chloroplast structure

# Edexcel IAL Biology - Solved Past Paper

**June 2020 · Unit 4: Energy, Environment, Microbiology and Immunity (WBI14/01) · Question 1**
**The chloroplast, pigments & chromatography**

hard medium easy

## 1 (a)

Identify (multiple choice) · [1 mark]

Which row shows where the light-dependent and light-independent reactions take place?

**Model answer**

✓ C - the light-dependent reactions take place in the thylakoid membranes and the light-independent reactions in the stroma.

**Mark scheme** 1 mark

- ✓ C - thylakoid membranes / stroma (1)

**Do not accept:** rows A, B or D - the light-dependent reactions are in the thylakoid membranes and the light-independent reactions in the stroma

**Examiner's insight**

Scored well - the vast majority knew where each stage occurs.

## 1 (b)

Draw · [3 marks]

Draw three labelled features found in a chloroplast, other than the stroma and thylakoid membranes.

**Model answer**

✓ A DNA loop (circular / plasmid-like DNA), drawn and labelled. ✓ A starch grain (starch granule), drawn and labelled. ✓ The envelope (double / inner and outer membrane) - or alternatively grana / granum / lamellae, or ribosomes - drawn and labelled.

**Mark scheme** any 3 marks

- ✓ DNA (loop) drawn and labelled (1)
- ✓ starch grain drawn and labelled (1)
- ✓ envelope / inner / outer membrane drawn and labelled (1)
- ✓ grana / granum / lamellae (1)
- ✓ ribosomes drawn and labelled (1)

**Accept:** plasmid / plasmid-like DNA; starch granules; double membrane
**Ignore:** lipid droplets, stroma, thylakoid membranes, size references

**Examiner's insight**

A range of chloroplast diagrams was seen - label each feature clearly and avoid re-drawing the stroma or thylakoids that are already given.

## 1 (c)

Identify (multiple choice) · [1 mark]

Which wavelength of light is absorbed the least by chloroplasts?

**Model answer**

✓ B – 520 nm (green light), because green wavelengths are reflected rather than absorbed by chlorophyll.

**Mark scheme** 1 mark

✓ B - 520 nm (1)

**Do not accept:** rows A, C or D - green wavelengths (~520 nm) are reflected, so absorbed least

**Examiner's insight**

Scored well.

## 1 (d)

State · [1 mark]

State what is meant by the term action spectrum.

**Model answer**

✓ An action spectrum shows the rate of photosynthesis at different wavelengths of light.

**Mark scheme** 1 mark

✓ rate of photosynthesis at different wavelengths of light (1)

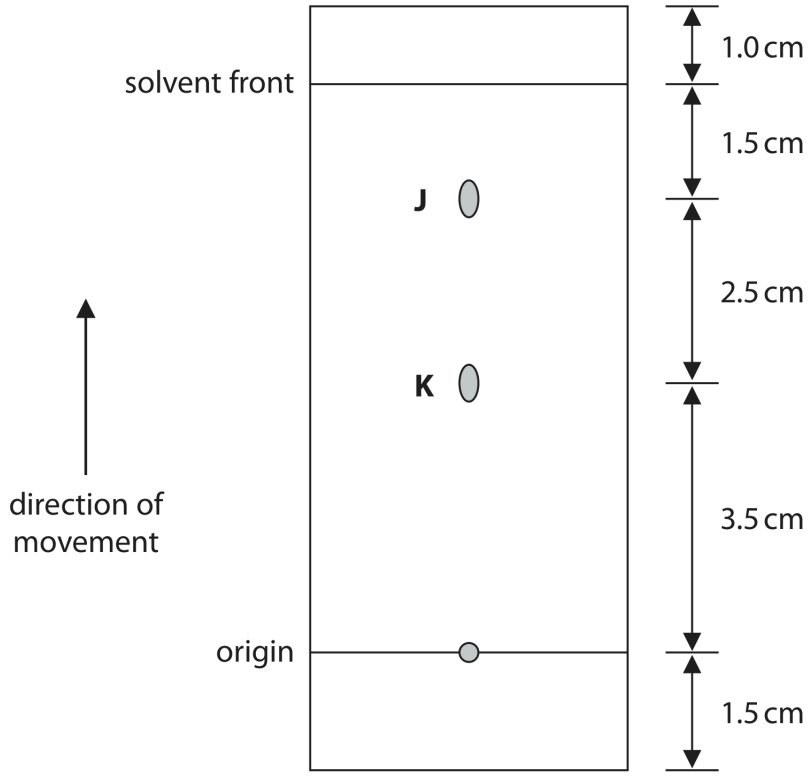
**Examiner's insight**

Candidates who did not confuse the action spectrum with the absorption spectrum generally gave acceptable definitions - keep the two clearly apart.

## 1 (e)(i)

Identify (multiple choice) · [1 mark]

Which process can be used to separate chloroplast pigments?




**Model answer**

✓ A – chromatography, which separates pigments by their differing solubility and movement up the paper.

**Mark scheme** 1 mark

✓ A - chromatography (1)

**Do not accept:** rows B, C or D - dendrochronology studies tree rings, osmosis moves water, PCR amplifies DNA

**Examiner's insight**

Scored very well.

## 1 (e)(ii)

Calculate · [1 mark]

What is the $R_f$ value for chloroplast pigment J?

**Model answer**

✓ B – 0.800, because $R_f$ = distance moved by J ÷ distance moved by solvent front = 6.0 ÷ 7.5 = 0.800.

**Mark scheme** 1 mark

✓ B - 0.800 (6.0 ÷ 7.5) (1)

**Accept:** $R_f$ = distance moved by pigment ÷ distance moved by solvent front

**Examiner's insight**

Most calculated the $R_f$ correctly as 0.800.

## Revise from your notes

- Chloroplast, action spectrum & chromatography: 2.1 The Chloroplast · 2.2 The Action Spectrum · 2.3 Separation Of Photosynthetic Pigments By Chromatography

# Edexcel IAL Biology - Solved Past Paper

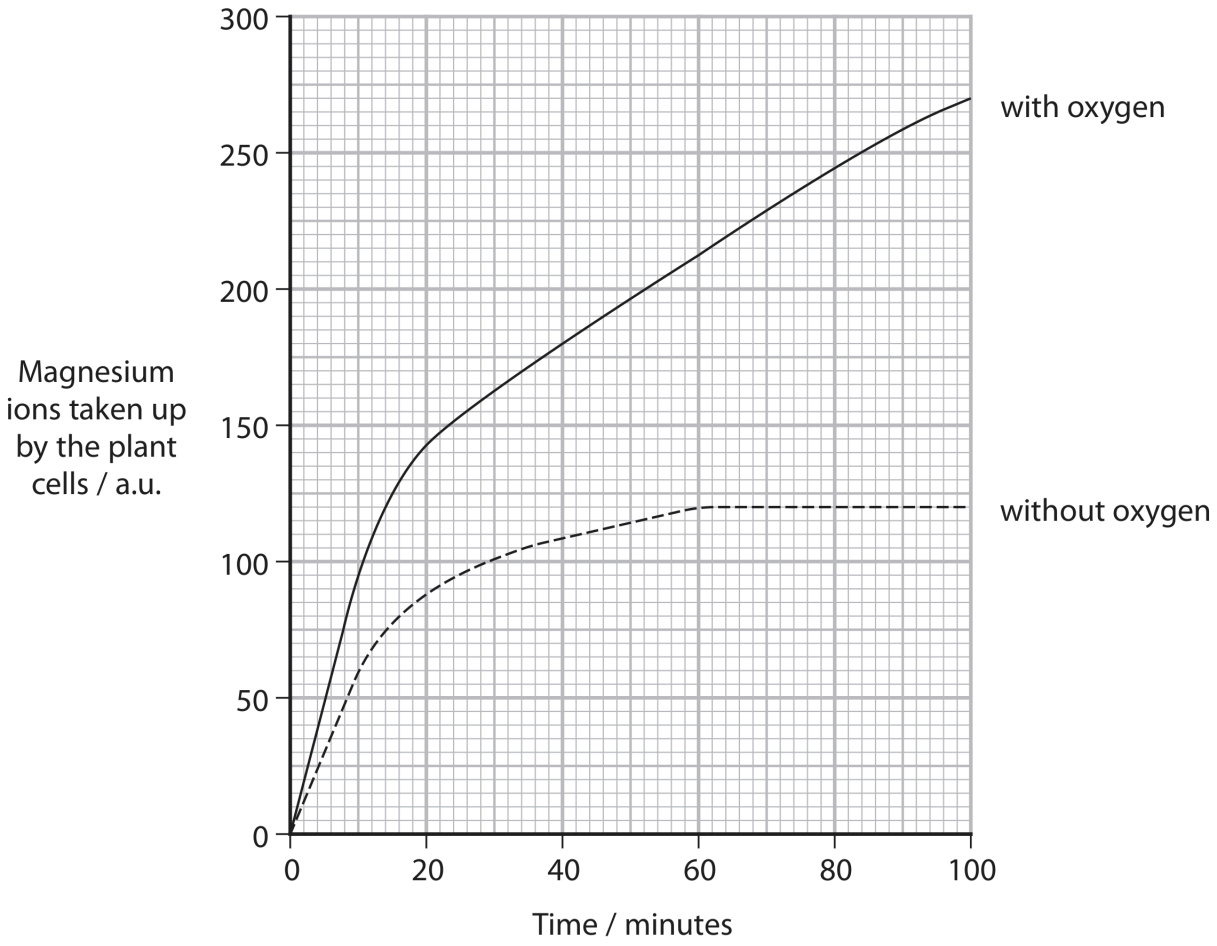
**June 2023 · Unit 4: Energy, Environment, Microbiology and Immunity (WBI14/01) · Question 1**
**Magnesium ions & active transport**

hard medium easy

## 1 (a)

Explain · [2 marks]

Explain the importance of magnesium ions to a plant.




**Model answer**

✓ Magnesium ions are a component of chlorophyll. ✓ Which absorbs light for photosynthesis.

**Mark scheme** 2 marks

- ✓ magnesium ions are components of chlorophyll (1)
- ✓ which absorbs light / photons (1)

**Accept:** other correct roles e.g. cofactor for RNA polymerase / ATP synthase, component of ribosomes

**Examiner's insight**

Most scored the chlorophyll mark; the second was often lost by writing that light is 'trapped' or 'captured' rather than 'absorbed'.

## 1 (b)

Explain · [4 marks]

Explain why the student concluded uptake is by active transport. Use the graph.

**Model answer**

✓ Uptake of magnesium ions levels off without oxygen but keeps increasing with oxygen. ✓ The ions are being taken up against their concentration gradient. ✓ This needs ATP (energy), and oxygen is used in aerobic respiration to produce that ATP. ✓ If uptake were passive, the rate would have been the same with and without oxygen.

**Mark scheme** any 4 marks

- ✓ uptake levels off without oxygen but continues to increase with oxygen (1)
- ✓ ions taken up against the concentration gradient (1)
- ✓ ATP / energy is needed for active transport (1)
- ✓ oxygen used in aerobic respiration to produce this ATP (1)
- ✓ if uptake were passive, the rate would be the same in both groups (1)

**Accept:** more / faster uptake with oxygen; piece together

**Examiner's insight**

Many just described the graph for mark point 1. Mark point 2 (against the gradient) was least seen, as candidates only restated 'active transport' from the stem, and the final mark point was rarely awarded.

**Revise from your notes**

- The chloroplast & light-dependent reactions: 2.1 The Chloroplast · 3.2 The Light-Dependent Reactions Of Photosynthesis
- Active transport - revise from Unit 1: 7.12 Active Transport - (Unit 1)

# Edexcel IAL Biology - Solved Past Paper

**October 2021 · Unit 4: Energy, Environment, Microbiology and Immunity (WBI14/01)**
**Question 1 · Chloroplast structure & DNA replication**

hard medium easy

## 1 (a)(i)

Identify (multiple choice) · [1 mark]

Which row identifies structures P, Q and V?

| P | Q | V |
|---|---|---|
| DNA | starch grain | ribosome |
| starch grain | DNA | ribosome |
| starch grain | ribosome | DNA |
| ribosome | starch grain | DNA |

**Model answer**

✓ D – P is a ribosome (the smallest structure), Q is a starch grain (the largest) and V is DNA.

**Mark scheme** 1 mark

✓ D - ribosome / starch grain / DNA (1)

**Do not accept:** rows A, B or C - P is the smallest structure (ribosome) and Q the largest (starch grain)

**Examiner's insight**

Did not trouble many candidates.

## 1 (a)(ii)

Identify (multiple choice) · [1 mark]

Which structure contains GALP?

**Model answer**

✓ B – structure R, the stroma, where the light-independent reactions make GALP.

**Mark scheme** 1 mark

✓ B - R (the stroma) (1)

**Do not accept:** rows A, C or D - GALP is found in the stroma, structure R

**Examiner's insight**

Well answered.

## 1 (a)(iii)

Calculate · [1 mark]

The chloroplast is 7.5 µm long. Calculate the magnification of the diagram.

**Model answer**

✓ Magnification = image size ÷ actual size. Measuring the diagram (~107 mm = 107 000

μm) ÷ 7.5 μm ~ 14 267 (×).

**Mark scheme** 1 mark

- ✓ 14 267 / 14 270 / 14 300 / 14 400 / 14 000 (1)

**Accept:** standard form e.g. $1.4267 \times 10^4$

**Do not accept:** an answer with units

**Examiner's insight**

Some tried to give the answer in standard form but lost the mark by leaving more than one figure before the decimal point.

## 1 (a)(iv)

Compare and contrast · [3 marks]

Compare and contrast the structure of membranes T and U.

**Model answer**

✓ Similarity – both are made of a phospholipid bilayer. ✓ Difference – the thylakoid membrane T contains chlorophyll (photosystems PSI and PSII) whereas the envelope membrane U does not. ✓ Difference – T also contains ATP synthase and electron-carrier proteins, whereas U does not.

**Mark scheme** ·1 similarity and 1 difference

- ✓ both have a phospholipid bilayer (1)
- ✓ T has chlorophyll / photosystems / PSI / PSII but U does not (1)
- ✓ T contains ATP synthase but U does not (1)
- ✓ T contains electron carrier proteins but U does not (1)

**Accept:** made of phospholipids; electron carriers / ETC

**Do not accept:** do not piece together; penalise once if T/U called cells

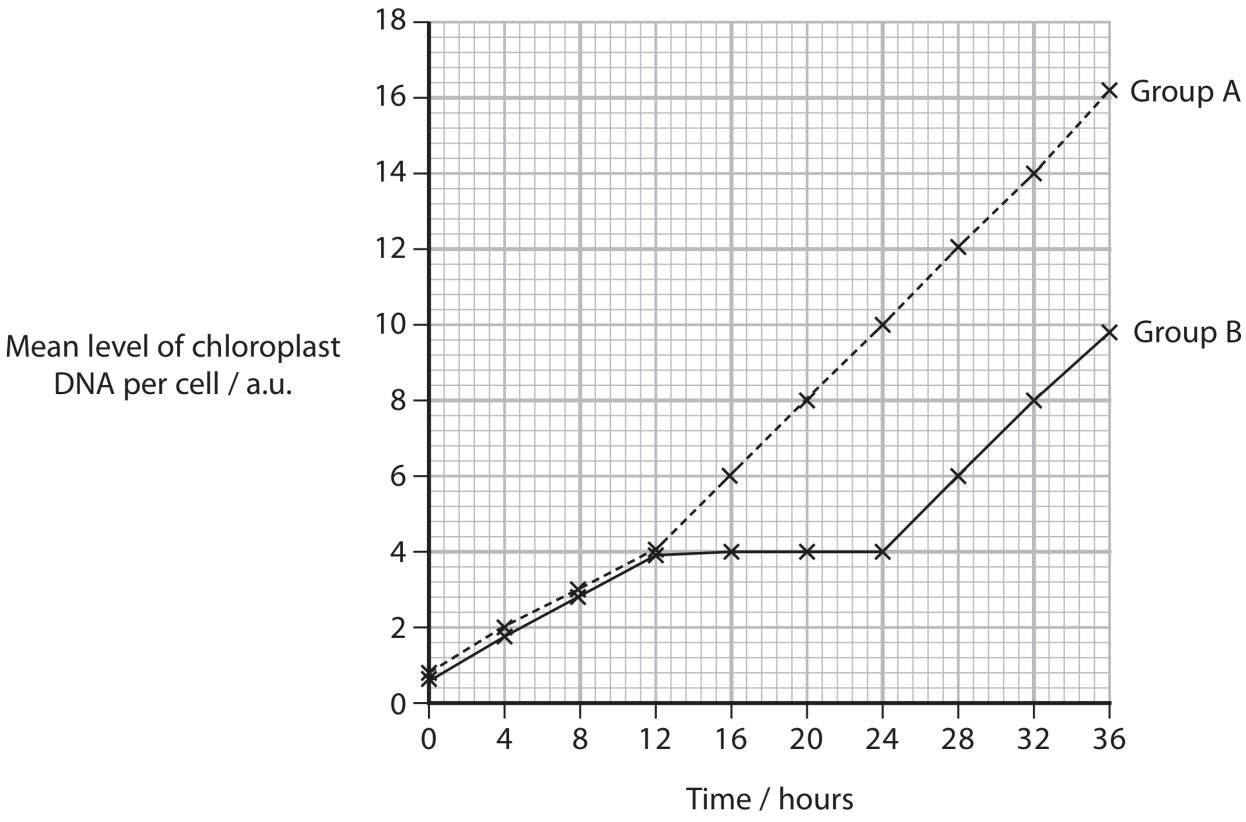
**Examiner's insight**

Good responses from those taught to answer compare-and-contrast questions and to focus on the structures of the two membranes.

## 1 (b)

Describe · [2 marks]

Describe two conclusions about the replication of chloroplast DNA.




**Model answer**

✓ Light is needed for the replication of chloroplast DNA (it does not replicate in the dark).

✓ Replication of chloroplast DNA is independent of mitosis / the cell cycle (which occurs in the dark).

**Mark scheme** 2 marks

- ✓ light is needed for replication of chloroplast DNA (1)
- ✓ replication is independent of mitosis / the cell cycle (1)

**Accept:** chloroplast DNA replication does not occur in the dark

**Ignore:** DNA increases; day / night

**Examiner's insight**

Virtually all said light was needed for replication, but very few concluded that it is independent of mitosis or the cell cycle.

**Revise from your notes**

- The chloroplast & light-dependent reactions: 2.1 The Chloroplast · 3.1 The Electron Transport Chain
- Membrane structure & mitosis - revise from Units 1 & 2: 6.2 Structure Of The Cell Membrane - (Unit 1) · Mitosis & the cell cycle - (Unit 2)

# Edexcel IAL Biology - Solved Past Paper

**October 2022 · Unit 4: Energy, Environment, Microbiology and Immunity (WBI14/01)**
**Question 3 · The chloroplast & its membranes**

hard medium easy

## 3 (a)

Identify (multiple choice) · [1 mark]

Which row is correct for the two reactions?

**Model answer**

✓ B - in the light-dependent reactions ADP is phosphorylated (requiring energy), and in the light-independent reactions ATP is hydrolysed (releasing energy).

**Mark scheme** 1 mark

✓ B - ADP phosphorylated / ATP hydrolysed (1)

**Do not accept:** rows A, C or D - phosphorylating ADP requires energy, and ADP is not hydrolysed in the light-dependent reactions

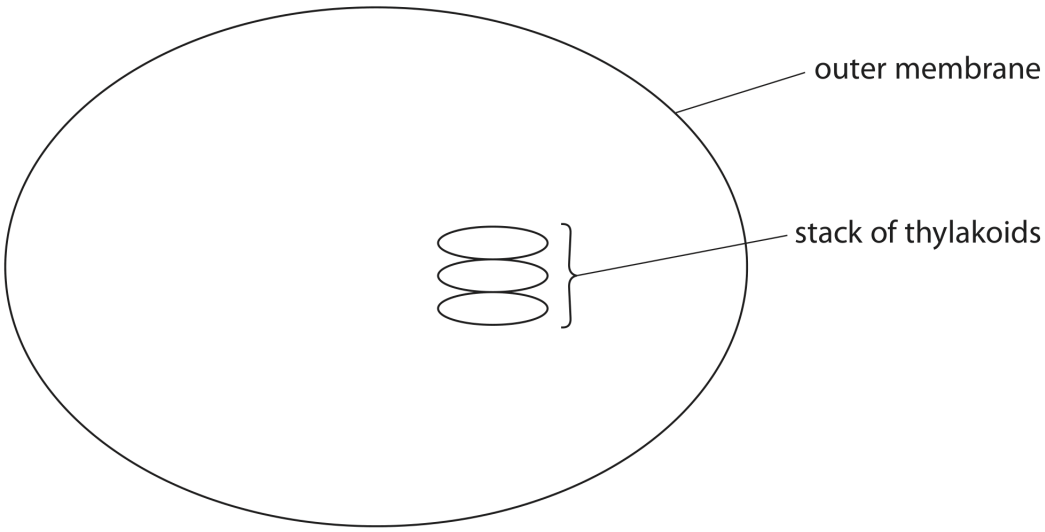
**Examiner's insight**

Generally answered correctly, with a mixture of distractors chosen by those who erred.

## 3 (b)(i)

Complete (diagram) · [3 marks]

Complete the diagram to show three other labelled structures in a chloroplast.




**Model answer**

✓ A DNA loop (drawn circular, not linear). ✓ A starch grain and the inner membrane. ✓ Plus any of: the stroma, intergranal (stromal) lamellae, a 70S ribosome, the intermembrane space or lipid droplets.

**Mark scheme** any 3 marks

✓ DNA (loop) (1)

- ✓ starch grain / granule (1)
- ✓ inner membrane (1)
- ✓ intergranal lamellae / (small) ribosome / stroma / intermembrane space / lipid droplets (1)

**Do not accept:** DNA drawn as linear; 'stoma'

**Examiner's insight**

Candidates know chloroplast structure and some very accurate diagrams were drawn.

## 3 (b)(ii)

Compare and contrast · [4 marks]

Compare and contrast the structure of the outer membrane with the thylakoid membrane.

**Model answer**

✓ Similarity - both consist of a phospholipid bilayer, and both contain proteins. ✓ Difference - the thylakoid membrane has ATP synthase whereas the outer membrane does not. ✓ Difference - the thylakoid membrane has chlorophyll and light-absorbing pigments (PSI and PSII), which the outer membrane does not. ✓ Difference - the thylakoid membrane has electron carriers, whereas the outer membrane does not.

**Mark scheme** any 4 marks

- ✓ both consist of a phospholipid bilayer (1)
- ✓ both have proteins (1)
- ✓ thylakoid has ATP synthase, outer membrane does not (1)
- ✓ thylakoid has chlorophyll / pigments / PSI / PSII, outer membrane does not (1)
- ✓ thylakoid has electron carriers, outer membrane does not (1)

**Do not accept:** do not piece together; ATPase accepted

**Examiner's insight**

Far more paired comparisons and fewer separate descriptions were seen. Marks were lost by describing processes or properties rather than structure.

**Revise from your notes**

- The chloroplast & the two stages of photosynthesis: 2.1 The Chloroplast · 3.2 The Light-Dependent Reactions Of Photosynthesis · 4.1 Light-Independent Reactions
- Membrane structure - revise from Unit 1: 6.2 Structure Of The Cell Membrane - (Unit 1)

# Edexcel IAL Biology - Solved Past Paper

**October 2023 · Unit 4: Energy, Environment, Microbiology and Immunity (WBI14/01)**

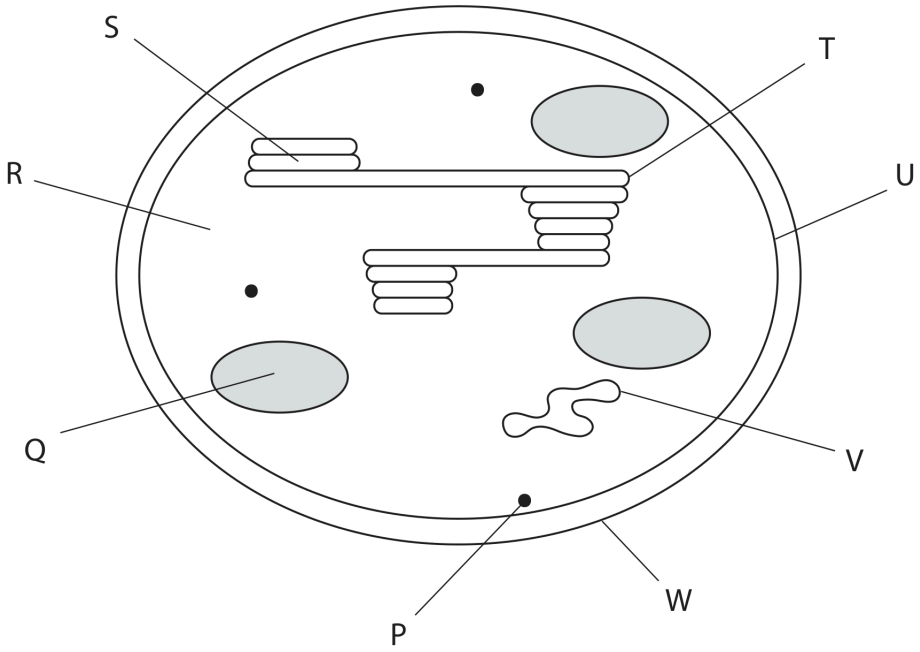
**Question 1 · Chloroplast structure & photosynthesis**

hard medium easy

## 1 (a)

Identify (multiple choice) · [1 mark]

Which is the site of photolysis?




**Model answer**

✓ C – T, the thylakoid membrane, where photolysis of water occurs.

**Mark scheme** 1 mark

✓ C - T (thylakoid membrane) (1)

**Do not accept:** rows A, B or D - photolysis takes place on the thylakoid membranes

**Examiner's insight**

Scored reasonably well.

## 1 (b)

Identify (multiple choice) · [1 mark]

Which contains a gene coding for RUBISCO?

**Model answer**

✓ D – V, the DNA (genes are on the chloroplast DNA).

**Mark scheme** 1 mark

✓ D - V (DNA) (1)

**Do not accept:** rows A, B or C - DNA contains the genes; P is a ribosome, Q a starch grain

**Examiner's insight**
One of the highest-scoring items.

## 1 (c)

Identify (multiple choice) · [1 mark]

Where do hydrogen ions accumulate for use in photosynthesis?

**Model answer**

✓ C – S, inside the thylakoid space, where $H^+$ accumulate for chemiosmosis.

**Mark scheme** 1 mark

✓ C - S (thylakoid) (1)

**Do not accept:** rows A, B or D - hydrogen ions accumulate in the thylakoids

**Examiner's insight**
Well answered.

## 1 (d)(i)

Identify (multiple choice) · [1 mark]

How many of P, T, U and W are made of phospholipids?

**Model answer**

✓ C – 3: the membranes T, U and W are made of phospholipids (P is a ribosome).

**Mark scheme** 1 mark

✓ C - 3 (1)

**Do not accept:** rows A, B or D - T, U and W are all phospholipid membranes

**Examiner's insight**
The most challenging of the five multiple-choice items.

## 1 (d)(ii)

Identify (multiple choice) · [1 mark]

Which describes a phospholipid?

**Model answer**

✓ A – glycerol attached to two fatty acids and one phosphate group.

**Mark scheme** 1 mark

✓ A - glycerol + two fatty acids + one phosphate (1)

**Do not accept:** rows B, C or D - a phospholipid has two fatty acids and one phosphate group

**Examiner's insight**
A phospholipid replaces one fatty acid of a triglyceride with a phosphate group.

## 1 (e)

Calculate · [2 marks]

A cell is 0.0085 cm long; the cell : chloroplast length ratio is 11.7 : 1. Calculate the chloroplast length (μm, 2 s.f.).

**Model answer**

✓ 0.0085 cm = 85 µm. ✓ Chloroplast = 85 ÷ 11.7 = 7.3 µm (2 s.f.).

**Mark scheme** 2 marks

- ✓ 0.0085 cm = 85 µm (1)
- ✓ 7.3 µm (1)

**Accept:** bald 7.3 = 2 marks; bald 85 = 1 mark

**Examiner's insight**

Most did the calculation but dropped a mark for not expressing the answer to two significant figures.

**Revise from your notes**

- The chloroplast & light-dependent reactions: 2.1 The Chloroplast · 3.2 The Light-Dependent Reactions Of Photosynthesis
- Phospholipids - revise from Unit 1: 6.1 Phospholipids - (Unit 1)

# Edexcel IAL Biology - Solved Past Paper

**May 2025 · Unit 4: Energy, Environment, Microbiology and Immunity (WBI14/01) · Question 6**
**Chloroplast DNA & its proteins**

hard medium easy

## 6 (a)(i)

Identify (multiple choice) · [1 mark]

Where in the chloroplast is the DNA located?

**Model answer**

✓ C - the stroma.

**Mark scheme** 1 mark

✓ C - stroma (1)

**Do not accept:** rows A, B or D - DNA is not in the membranes, the matrix is in mitochondria, and it is not in the thylakoid space

**Examiner's insight**

Chloroplast DNA is in the stroma.

## 6 (a)(ii)

Identify (multiple choice) · [1 mark]

Which other plant-cell structures contain DNA?

**Model answer**

✓ B - mitochondria and nucleus.

**Mark scheme** 1 mark

✓ B - mitochondria and nucleus (1)

**Do not accept:** rows A, C or D - amyloplasts and vacuoles do not contain DNA

**Examiner's insight**

Only the mitochondria and nucleus (besides chloroplasts) contain DNA.

## 6 (b)(i)

Identify (multiple choice) · [1 mark]

150 000 base pairs code for proteins in 105 regions. Mean bases in the template strand of one region?

**Model answer**

✓ D - 1429: 150 000 ÷ 105 = 1429 base pairs per region, so 1429 bases on the template strand.

**Mark scheme** 1 mark

✓ D - 1429 (1)

**Do not accept:** rows A, B or C - 150 000 ÷ 105 = 1429

**Examiner's insight**

Divide the base pairs by the number of coding regions.

## 6 (b)(ii)

Suggest · [2 marks]

Suggest two reasons why this DNA contains more than 150 000 base pairs.

**Model answer**

✓ There are non-coding regions (introns) and promoter / regulatory regions. ✓ Some regions code for non-protein products (e.g. tRNA, rRNA), and there are stop codons.

**Mark scheme** any 2 marks

- ✓ non-coding regions (1)
- ✓ promoter regions (1)
- ✓ some regions code for non-proteins (1)
- ✓ stop codons (1)

**Accept:** introns / telomeres / satellite DNA; enhancer / silencer regions; ncRNA / tRNA / rRNA (not mRNA)

**Examiner's insight**

The most common answers were non-coding regions and stop codons, as expected. A common error was muddling exons and introns.

## 6 (b)(iii)

Describe · [4 marks]

Describe the roles of RNA polymerase, ribosomal protein, RUBISCO and ATP synthetase.

**Model answer**

✓ RNA polymerase catalyses the synthesis of RNA (transcription), joining RNA nucleotides along a DNA strand. ✓ Ribosomal proteins are involved in translation - forming peptide bonds between amino acids (holding the mRNA and tRNAs in place). ✓ RUBISCO catalyses carbon fixation (the reaction of carbon dioxide with RuBP). ✓ ATP synthetase catalyses the synthesis of ATP by phosphorylating ADP, as hydrogen ions pass through it releasing energy.

**Mark scheme** 4 marks

- ✓ RNA polymerase - synthesis of RNA (transcription) (1)
- ✓ ribosomal proteins - translation / forming peptide bonds (1)
- ✓ RUBISCO - carbon fixation (1)
- ✓ ATP synthetase - ATP synthesis / phosphorylation of ADP (1)

**Accept:** phosphodiester bonds between RNA nucleotides; hold mRNA and tRNA in place; reaction of $CO_2$ with RuBP; $H^+$ pass through releasing energy

**Examiner's insight**

Good responses working down the list. Ribosomal protein was the least known. Marks were lost for insufficient A-level detail (e.g. RUBISCO 'used in photosynthesis', ATP synthetase 'makes ATP').

## Revise from your notes

- The chloroplast, light reactions & the Calvin cycle: 2.1 The Chloroplast · 3.2 The Light-Dependent Reactions Of Photosynthesis · 4.2 Reactions Of The Calvin Cycle
- Gene structure & transcription - revise from Unit 2: 8.6 The Genetic Code · 9.2 Transcription Of DNA - (Unit 2)

## Photosynthetic pigments & spectra

# Edexcel IAL Biology - Solved Past Paper

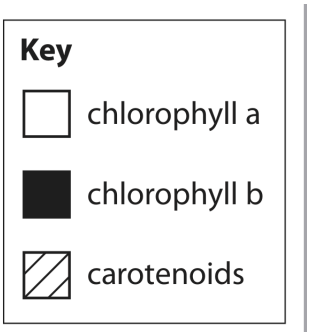
**January 2020 · Unit 4: Energy, Environment, Microbiology and Immunity (WBI14/01)**
**Question 7 · Photosynthetic pigments & evaluating a food source**

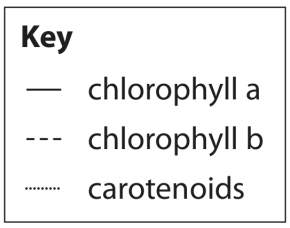
hard medium easy

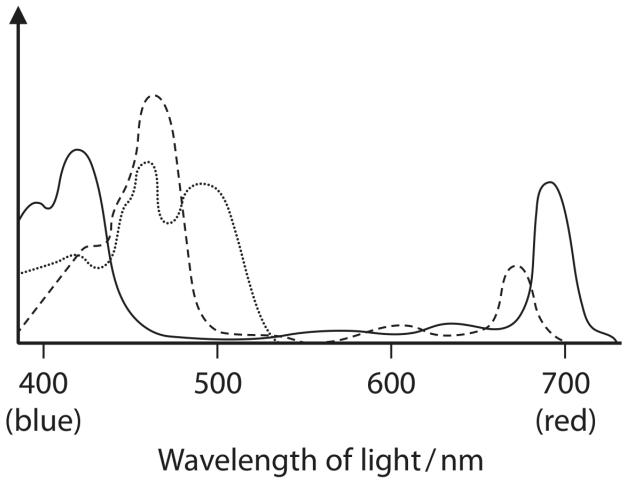
## 7 (a)(i)

Identify (multiple choice) · [1 mark]

Which row shows the colour of each seaweed?




**Model answer**

✓ A – U. fasciata green, S. linifolium brown, C. officinalis red, because U. fasciata is rich in chlorophylls a and b while C. officinalis has a high carotenoid content.

**Mark scheme** 1 mark

✓ A - green, brown, red (1)

**Do not accept:** U. fasciata is rich in chlorophyll a and b; C. officinalis is rich in carotenoids

**Examiner's insight**

Probably the hardest multiple choice on the paper, but a fair number still read the pigment data correctly.

## 7 (a)(ii)

Explain · [2 marks]

Explain the role of chloroplast pigments in the light-dependent reactions.

**Model answer**

✓ The pigments absorb light so that electrons in the photosystems are excited and released. ✓ This energy allows reduced NADP and ATP to be synthesised in photophosphorylation.

**Mark scheme** 2 marks

✓ absorb light so electrons are excited / released from photosystems (1)

✓ so reduced NADP and ATP can be synthesised (1)

**Accept:** NADPH; photophosphorylation

**Examiner's insight**

Reports on earlier papers had clearly been taken on board - there were many more correct references to light being "absorbed".

## 7 (b)(i)

Describe · [3 marks]

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

**Model answer**

✓ GALP is first converted into hexose sugar (glucose). ✓ Amino acids are then built from this sugar combined with nitrates (a nitrogen source). ✓ The amino acids are joined by peptide bonds in condensation reactions, using ATP from respiration of the glucose.

**Mark scheme** any 3 marks

✓ GALP converted into hexose / glucose / sugar (1)

✓ amino acids made from sugar and nitrates (1)

✓ amino acids joined by peptide bonds / condensation (1)

✓ glucose respired to make ATP for protein synthesis (1)

**Ignore:** other nitrogenous compounds

**Examiner's insight**

Better answers showed a clear route from sugar to protein; weaker ones knew peptide bonds join amino acids but forgot that nitrate is needed as the nitrogen source.

## *7 (b)(ii)

Comment (levels) · [6 marks]

Comment on the claim that these seaweeds are a healthy, environmentally-friendly and economic food source, using the table and your own knowledge.

**Model answer**

✓ Healthy – the seaweeds are a good protein source for growth and repair and provide carbohydrate for energy, while their low lipid content and antioxidants (carotenoids, phenols, flavonoids) reduce the risk of heart disease. ✓ Environmentally-friendly – they are sustainable and grow naturally, so no habitats are destroyed; they photosynthesise and remove carbon dioxide, and unlike cattle they produce no methane, so fewer greenhouse gases. ✓ Economic – they can be grown in situ with no need for fertilisers, buildings or heating, keeping costs very low. On balance the claim is justified, though harvesting vehicles do release some carbon dioxide.

**Mark scheme** 6 marks (levels)

- ✓ Healthy: protein for growth/repair, carbohydrate for energy, low lipid & antioxidants reduce heart-disease risk
- ✓ Environmentally-friendly: sustainable, grows naturally, photosynthesises (removes CO2), no methane like cattle
- ✓ Economic: grown in situ, no fertilisers / buildings / heating needed
- ✓ Level 3 (5-6): points from all three aspects including 1-2 justifications

**Accept:** vehicles to harvest seaweed produce CO2 as a balancing point

**How to reach full marks**

This is a levels-of-response question - aim for Level 3 (5-6 marks) by making points across all three aspects (healthy, environmentally-friendly, economic) and justifying them. Healthy: high protein for growth and repair, carbohydrate for energy, low lipid and antioxidants reduce the risk of heart disease. Environmentally-friendly: sustainable, grows naturally so no habitats destroyed, photosynthesises to remove CO2, and unlike cattle produces no methane. Economic: grown in situ with no fertilisers, buildings or heating needed. Give a judgement with reasons, not just a list.

**Examiner's insight**

The higher-scoring of the two levels questions. The command word demanded a justified judgement across all three aspects - concise, relevant detail scores better than length.

**Revise from your notes**

- Chloroplast pigments & light-dependent reactions: 2.1 The Chloroplast · 2.2 The Action Spectrum · 3.2 The Light-Dependent Reactions Of Photosynthesis
- Protein synthesis / translation - revise from Unit 2: Protein synthesis (transcription & translation) - (Unit 2)

# Edexcel IAL Biology - Solved Past Paper

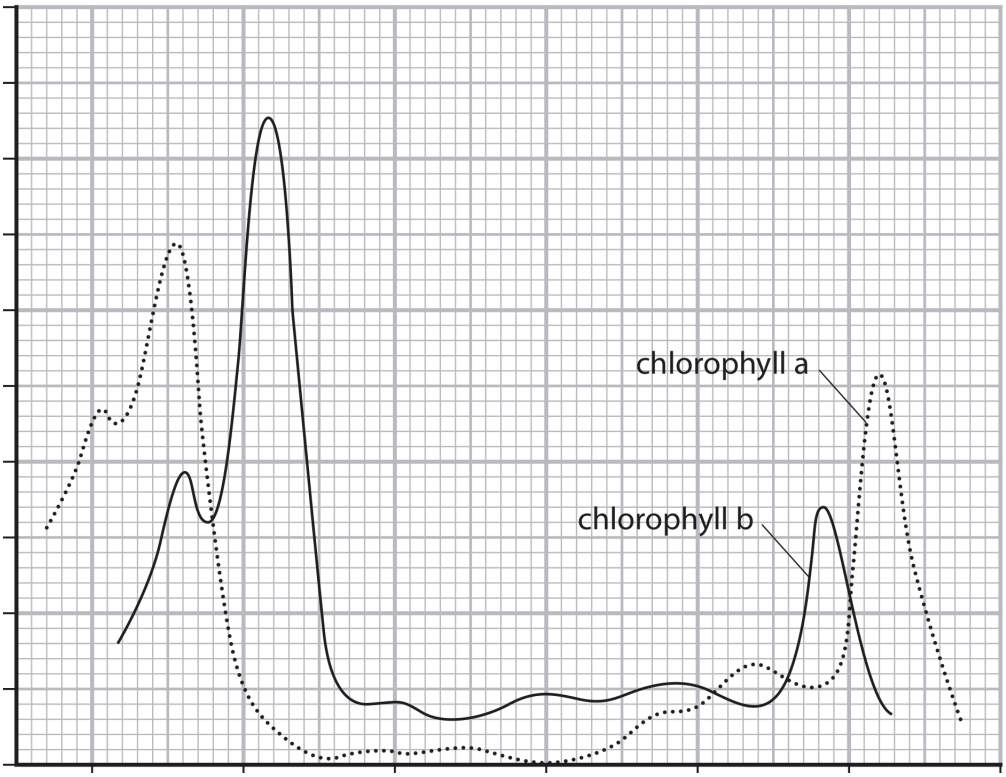
**January 2022 · Unit 4: Energy, Environment, Microbiology and Immunity (WBI14/01)**
**Question 2 · Action spectrum, pigments & amino acids**

hard medium easy

## 2 (a)(i)

Draw · [2 marks]

Draw the action spectrum for this plant.




**Model answer**

✓ Draw a line that roughly follows the contours of the two absorption-spectrum curves and does not drop to zero. ✓ Make the left-hand peak (around 460 nm) higher than the right-hand peak.

**Mark scheme** 2 marks

- ✓ line roughly follows the absorption spectrum and does not drop to zero (1)
- ✓ the left-hand / 460 nm peak is higher than the right-hand peak (1)

**Ignore:** extrapolation back to the y-axis, unless it hits zero (which negates mp1)

**Examiner's insight**

Some carefully drawn graphs easily scored both marks; drawing the action spectrum only troubled those who had not fully understood the topic.

## 2 (a)(ii)

Calculate · [1 mark]

Calculate how many times greater the maximum absorption of chlorophyll b is than that of chlorophyll a.

**Model answer**

✓ Read the two peak percentages and divide the larger by the smaller: ~ 1.2 times greater.

**Mark scheme** 1 mark

✓ 1.2 / 1.23 / 1.24 / 1.25 (1)

**Do not accept:** an answer expressed as a percentage

**Examiner's insight**

Generally well done, except by those who tried to express the answer as a percentage.

## 2 (a)(iii)

Explain · [2 marks]

Explain the advantage of having different types of chlorophyll pigment.

**Model answer**

✓ So that light can be absorbed at each of the different wavelengths. ✓ So the rate of photosynthesis is maximised.

**Mark scheme** 2 marks

✓ light can be absorbed at different wavelengths (1)

✓ so the rate of photosynthesis is maximised (1)

**Accept:** faster / more

**Ignore:** colours of light

**Examiner's insight**

Pleasingly, far more candidates referred to the 'absorbance' of light - but keep answers concise when only two marks are on offer.

## 2 (b)(i)

Identify (multiple choice) · [1 mark]

Which row describes the bonds between amino acids in a protein?

**Model answer**

✓ A – a peptide bond, forming between the amino group of one amino acid and the carboxyl group of the next.

**Mark scheme** 1 mark

✓ A - peptide / amino group and carboxyl group (1)

**Do not accept:** rows B, C or D - the peptide bond forms between the amino and carboxyl groups, not the R group, and it is not phosphodiester

**Examiner's insight**

A surprising number opted for distractor B.

## 2 (b)(ii)

Describe · [2 marks]

Describe how plants synthesise amino acids.

**Model answer**

✓ They use GALP (glucose) as the carbon skeleton to build the amino acids. ✓ Combined

with nitrates taken up from the soil (the nitrogen source).

**Mark scheme** 2 marks

- ✓ use GALP / glucose (1)
- ✓ use nitrates (taken up from the soil) (1)

**Accept:** nitrogen from nitrates

**Do not accept:** wrong sugars; wrong ions e.g. magnesium

**Ignore:** nitrogen / sulfates alone

**Examiner's insight**

Many knew GALP and nitrates, but wrote lengthy accounts of the Calvin cycle that were not needed.

**Revise from your notes**

- Action spectrum & using the products of photosynthesis: 2.2 The Action Spectrum · 5.1 Using Products Of Photosynthesis
- Peptide bonds & protein structure - revise from Unit 1: 4.2 The Primary Structure Of Proteins - (Unit 1)

# Edexcel IAL Biology - Solved Past Paper

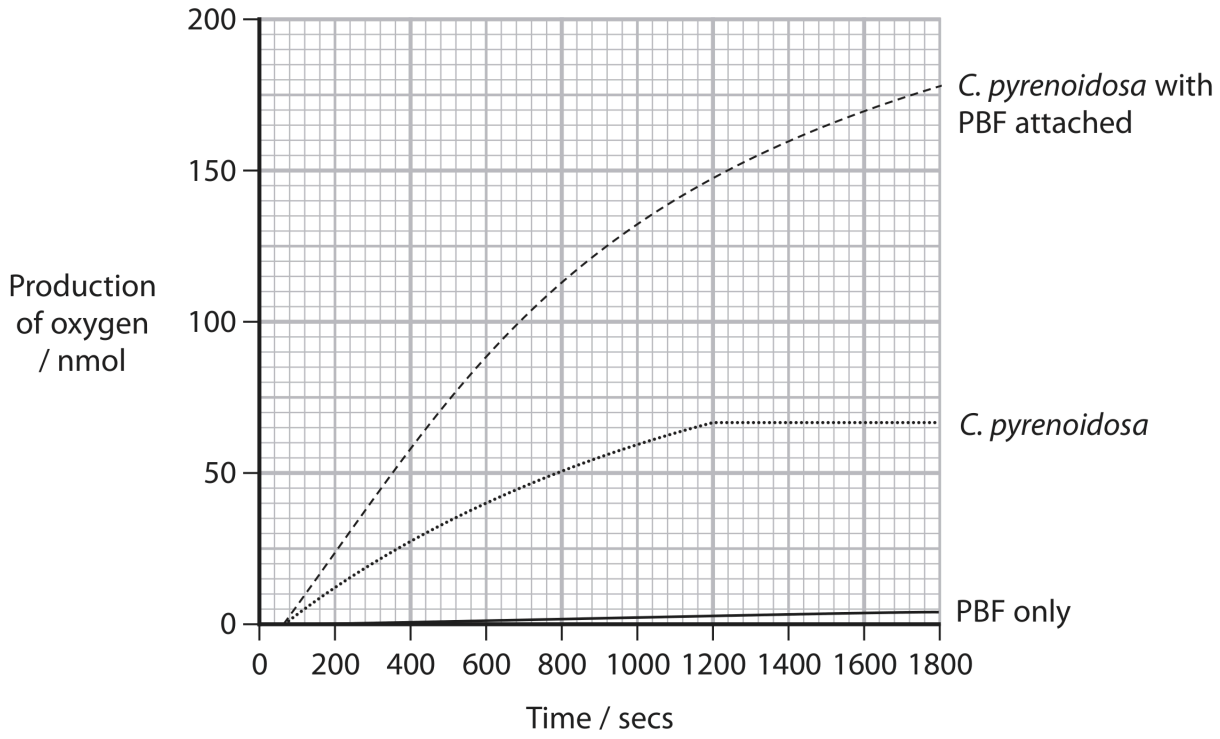
**June 2023 · Unit 4: Energy, Environment, Microbiology and Immunity (WBI14/01) · Question 5**
**Photosynthesis in algae & light absorption**

hard medium easy

## 5 (a)(i)

Calculate · [3 marks]

Calculate the rate of oxygen production at 1200 s for C. pyrenoidosa with PBF.




**Model answer**

✓ Draw a tangent to the curve at 1200 s (touching the outside of the curve). ✓ Find the gradient - e.g. rise ÷ run = 65 ÷ 880. ✓ Rate ~ 0.074 nmol $s^{-1}$ (a value between 0.060 and 0.090, to 3 d.p. max).

**Mark scheme** 3 marks

- ✓ tangent correctly drawn at 1200 s (1)
- ✓ rate calculated (rise ÷ run) (1)
- ✓ value between 0.060 and 0.090, to <=3 d.p. (1)

**Accept:** ecf 2 marks if no tangent but the line does not start at the origin

**Examiner's insight**

Well answered by those who used a tangent touching the curve at 1200 s and gave an appropriate number of decimal places - some were limited to 2 marks for over-rounding.

## 5 (a)(ii)

Explain · [3 marks]

Explain the effect PBF has on oxygen production.

**Model answer**

✓ Oxygen is produced by photolysis in photosynthesis. ✓ With PBF attached, C. pyrenoidosa produces oxygen faster (more oxygen) than without it, whereas PBF alone produces almost none. ✓ PBF alone produces no oxygen because it is only a molecule and cannot photosynthesise; the extra oxygen comes because PBF absorbs green light too, so a wider range of wavelengths is absorbed.

**Mark scheme** any 3 marks

- ✓ oxygen is produced by photolysis (1)
- ✓ PBF on the algae produces more / faster oxygen; PBF alone produces very little (1)
- ✓ PBF alone produces none as it is only a molecule / cannot photosynthesise (1)
- ✓ more oxygen because PBF absorbs green light / a wider range of wavelengths (1)

**Accept:** PBF means light is not rate-limiting; converse for algae alone

**Examiner's insight**

Many stated the effect on oxygen and gave a reason (more light / green light absorbed), but few mentioned photolysis, and hardly any said PBF alone produced no oxygen because it is not photosynthetic. Do not just repeat the stem that 'PBF absorbs green light'.

## 5 (b)

Explain · [3 marks]

Explain why C. pyrenoidosa with PBF gained more mass over 20 days.

**Model answer**

✓ Because the light-dependent reactions are faster, producing more ATP and reduced NADP. ✓ So more GALP (glucose) is produced in the light-independent reactions (Calvin cycle). ✓ So more large organic molecules (biomass / NPP) are made – for example starch, protein or cellulose.

**Mark scheme** 3 marks

- ✓ faster light-dependent reaction / more ATP / more reduced NADP (1)
- ✓ more GALP / glucose in the light-independent reactions (1)
- ✓ so more large organic molecules / biomass / NPP produced (1)

**Accept:** NADPH; named polymer e.g. starch, protein, cellulose

**Do not accept:** NAD

**Examiner's insight**

Good understanding - many stated more ATP / faster light-dependent reactions and more GALP, then more organic molecules. Some slipped and wrote 'reduced NAD'.

**Revise from your notes**

- Light-dependent reactions, products & limiting factors: 3.2 The Light-Dependent Reactions Of Photosynthesis · 5.1 Using Products Of Photosynthesis · 5.2 Limiting Factors Of Photosynthesis

# Edexcel IAL Biology - Solved Past Paper

**October 2021 · Unit 4: Energy, Environment, Microbiology and Immunity (WBI14/01)**
**Question 6 · Biodiversity, chlorophyll & pigment extraction**

hard medium easy

## 6 (a)

State · [2 marks]

State the meaning of the term biodiversity.

**Model answer**

✓ The number of different species present (species richness). ✓ Together with the genetic diversity within each species.

**Mark scheme** 2 marks

- ✓ number of (different) species (1)
- ✓ genetic diversity within a species (1)

**Accept:** species richness; variation in genotypes / alleles

**Examiner's insight**

Disappointing, given biodiversity is a specification term that has been asked before.

## 6 (b)

Explain · [2 marks]

Explain the role of chlorophyll in the light-dependent reactions.

**Model answer**

✓ Chlorophyll absorbs light energy so that electrons are excited and released. ✓ This allows ATP and reduced NADP to be synthesised.

**Mark scheme** any 2 marks

- ✓ absorb light energy so electrons are excited / released (1)
- ✓ to synthesise ATP and reduced NADP (1)

**Accept:** NADPH; 'absorb light so it can be converted into ATP energy' = 1 mark

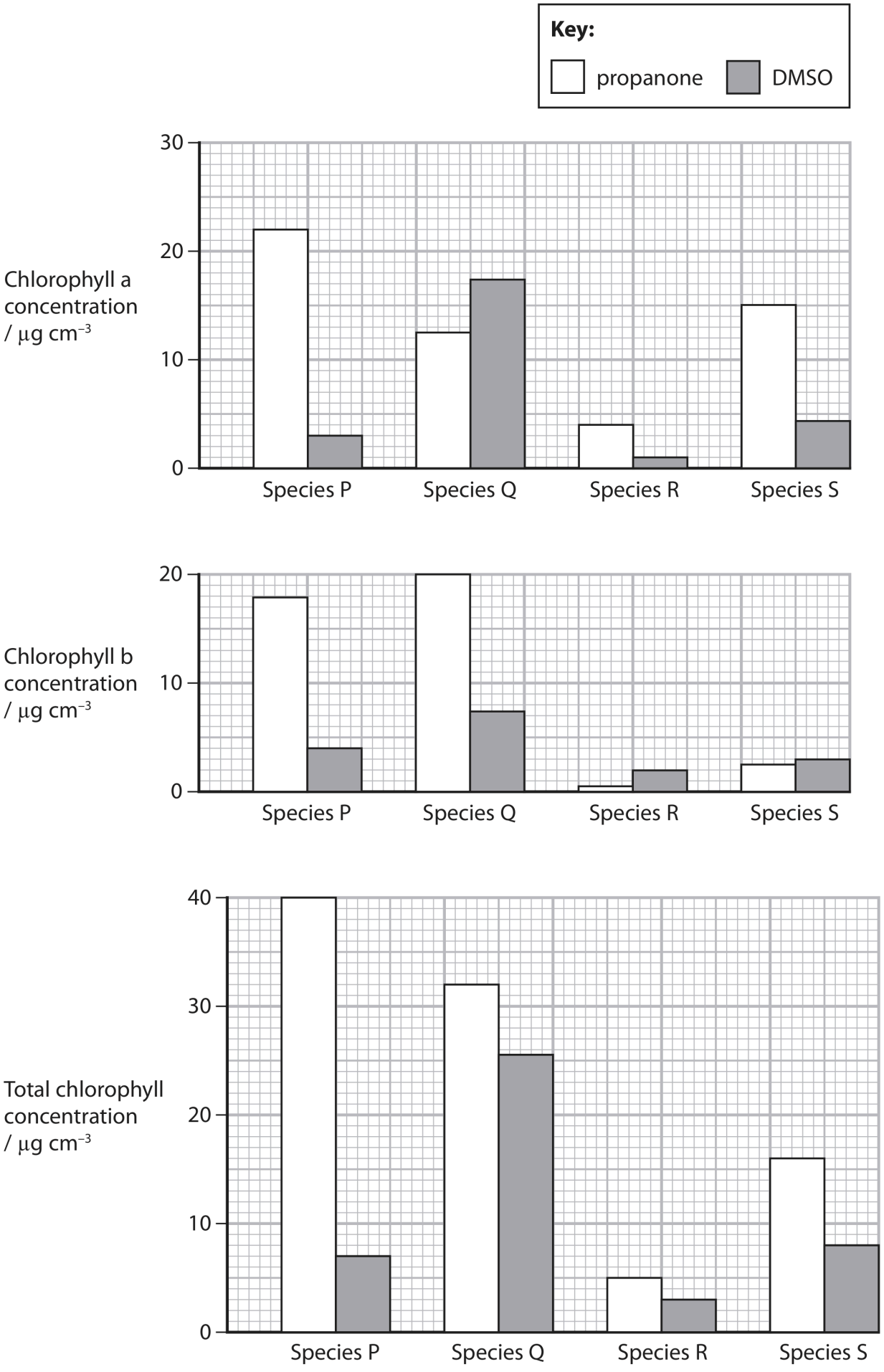
**Examiner's insight**

Many wrote about chlorophyll 'catching' or 'trapping' the light - say that it absorbs the light energy.

## *6 (c)(i)

Discuss (levels) · [6 marks]

Discuss the effectiveness of these extraction methods in identifying the species. Use the graphs.




**Model answer**

✓ Propanone extracts more chlorophyll a from species P and R and more chlorophyll b from species P and Q, whereas DMSO extracts more chlorophyll a from species Q. ✓ So overall propanone is the more effective solvent (and species P yields the most chlorophyll with it), DMSO being less effective except for chlorophyll a from Q. ✓ The total chlorophyll is sometimes less than the sum of a and b (some is lost in extraction) and sometimes more (other pigments are also extracted), so a single solvent gives an incomplete profile. ✓ Because pigments differ in solubility and in how solvents permeate the membranes, more than one solvent – with a comparison table or calibration profile – is needed to identify a species reliably by its pigments.

**Mark scheme** 6 marks (levels)

- ✓ comparisons: propanone extracts more from P and R; DMSO more chlorophyll a from Q
- ✓ generalisation: propanone is generally the most effective solvent
- ✓ implication: total · sum of components - some pigment lost or other pigments extracted
- ✓ implication: choice of solvent depends on pigment/species (solubility, membrane permeability)
- ✓ implication: more than one solvent / a comparison profile needed to identify species

**How to reach full marks**

Levels question - for Level 3 (5-6 marks) make comparisons, then discuss the implications for identifying species. Comparisons: propanone extracts more chlorophyll a from P and R and more chlorophyll b from P and Q, while DMSO extracts more chlorophyll a from Q; so propanone is generally the more effective solvent (except chlorophyll a from Q). Implications: total chlorophyll is sometimes less than the sum of a + b (some lost) and sometimes more (other pigments extracted); the best solvent depends on the pigment/species because of differences in solubility and membrane permeability; so more than one solvent is needed to identify species reliably, and a comparison table/calibration profile is required. Level 3 needs implications discussed, not just data described.

**Examiner's insight**

Candidates readily described the extractions, but only the more able read the question carefully and discussed the use of the solvents in identifying the species.

## 6 (c)(ii)

Suggest · [2 marks]

Suggest why different concentrations of chlorophyll were obtained with the two solvents.

**Model answer**

✓ The chlorophylls have different solubilities in the two solvents, because the chlorophylls have different structures. ✓ And the two solvents permeate or disrupt the cell/chloroplast membranes differently.

**Mark scheme** any 2 marks

- ✓ chlorophylls have different solubility in different solvents (1)

- ✓ because the chlorophylls have different structures (1)
- ✓ solvents permeate / dissolve / disrupt membranes differently (1)

**Accept:** more / less will dissolve

**Ignore:** $R_f$ values; 'reacted with solvent'

**Examiner's insight**

Most picked up one of the three points but very few scored both marks.

**Revise from your notes**

- Biodiversity, chlorophyll & light-dependent reactions: 6.1 Essential Definitions · 2.2 The Action Spectrum · 3.2 The Light-Dependent Reactions Of Photosynthesis
- Membrane permeability & solubility - revise from Unit 1: 6.4 Investigating Membrane Permeability - (Unit 1)

# Edexcel IAL Biology - Solved Past Paper

**October 2025 · Unit 4: Energy, Environment, Microbiology and Immunity (WBI14/01)**
**Question 2 · Chloroplast membranes & the action spectrum**

hard medium easy

## 2 (a)

Identify (multiple choice) · [1 mark]

Which statements about chloroplasts are correct?

**Model answer**

✓ C – statements 2 and 3: there is DNA in the stroma and they contain ribosomes (they are not in every cell type – e.g. phloem cells have none).

**Mark scheme** 1 mark

- ✓ C - 2 and 3 only (1)

**Do not accept:** rows A, B or D - not all cells contain chloroplasts (e.g. phloem cells)

**Examiner's insight**

Scored well.

## 2 (b)(i)

Complete (diagram) · [3 marks]

Complete the diagram to show and label the other membrane structures inside a chloroplast.

**Model answer**

✓ Draw a granum (a stack of thylakoids) and an intergranal lamella connecting them. ✓ Label the thylakoid membrane and the granum. ✓ Label the (stromal) lamella (intergranal membrane).

**Mark scheme** 3 marks

- ✓ drawings of a granum / thylakoid AND lamellae (1)
- ✓ one labelled membrane (granum / thylakoid) (1)
- ✓ second labelled membrane (lamellae) (1)

**Do not accept:** non-chloroplast structures e.g. mitochondria, ER; labelling the inner / outer envelope

**Examiner's insight**

Those who read the question scored all three marks. Many drew (and labelled) other structures - even nuclei and mitochondria in the chloroplast - which could not be ignored once labelled.

## 2 (b)(ii)

Identify (multiple choice) · [1 mark]

Which are found in chloroplast membranes?

**Model answer**

✓ A – ATP synthase and chlorophyll (RUBISCO is in the stroma, not the membrane).

**Mark scheme** 1 mark

✓ A - ATP synthase and chlorophyll (1)

**Do not accept:** rows B, C or D - RUBISCO is found in the stroma, not the membranes

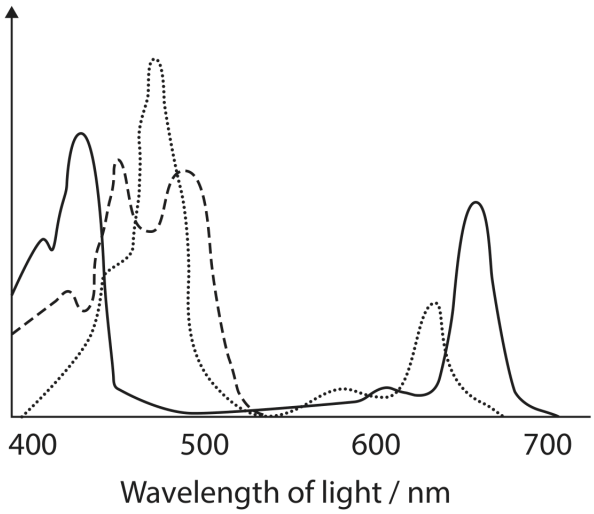
**Examiner's insight**

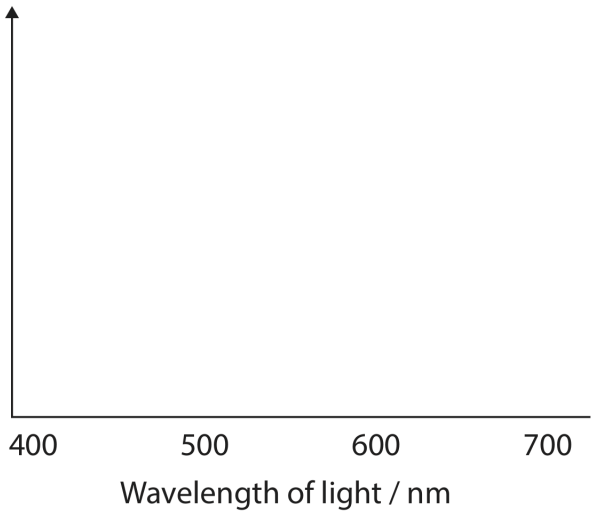
Scored well - RUBISCO is a stromal enzyme, not membrane-bound.

## 2 (c)

Complete (graph) · [2 marks]

Complete the graph to show the action spectrum of this chloroplast.




**Model answer**

✓ Draw a single line that rises and falls to peaks in the blue (400–500 nm) and red (600–700 nm) regions, following the absorption spectrum. ✓ The rate line should not touch the x-axis except at 700 nm (there is still some photosynthesis at green wavelengths).

**Mark scheme** 2 marks

✓ a single line rising and falling with peaks in 400-500 and 600-700 (1)

✓ a line that does not touch the x-axis except at 700 (1)

**Do not accept:** peaks outside these ranges (except a small one just left of 600)

**Examiner's insight**

A range of responses. Graphs that did not score were generally due to a lack of attention to detail - peaks in the wrong wavelength range, or the line touching the x-axis where it should not.

**Revise from your notes**

- The chloroplast, action spectrum & light reactions: 2.1 The Chloroplast · 2.2 The Action Spectrum · 3.2 The Light-Dependent Reactions Of Photosynthesis

Chromatography of pigments

# Edexcel IAL Biology - Solved Past Paper

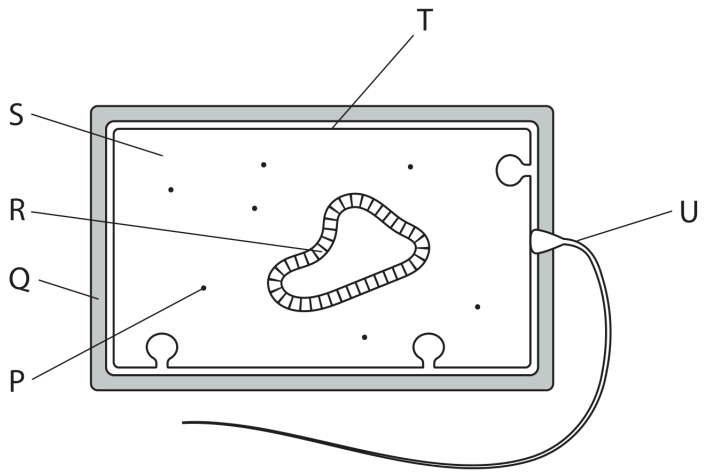
**January 2023 · Unit 4: Energy, Environment, Microbiology and Immunity (WBI14/01)**
**Question 2 · Photosynthetic bacteria, spectra & chromatography**

hard medium easy

## 2 (a)(i)

Identify (multiple choice) · [1 mark]

Which structure contains the genes coding for the photosynthesis enzymes?




**Model answer**

✓ C – R (the DNA / nucleoid): P is a ribosome, Q the cell wall, T the membrane.

**Mark scheme** 1 mark

✓ C - R (1)

**Do not accept:** rows A, B or D - P is a ribosome, Q the cell wall, T the membrane

**Examiner's insight**

Scored well.

## 2 (a)(ii)

Identify (multiple choice) · [1 mark]

Where do the light-dependent reactions take place?

**Model answer**

✓ C – T (the membrane): in bacteria the light-dependent reactions occur on membranes, not in a chloroplast.

**Mark scheme** 1 mark

✓ C - T (the membrane) (1)

**Do not accept:** rows A, B or D - the light-dependent reactions take place on membranes

**Examiner's insight**

Answered least well - many do not appreciate that the light-dependent reactions take place on membranes.

## 2 (a)(iii)

Identify (multiple choice) · [1 mark]

Where do the light-independent reactions take place?

**Model answer**

✓ B - S (the cytoplasm): with no chloroplast, the light-independent reactions occur in the cytoplasm.

**Mark scheme** 1 mark

✓ B - S (the cytoplasm) (1)

**Do not accept:** rows A, C or D - the light-independent reactions take place in the cytoplasm

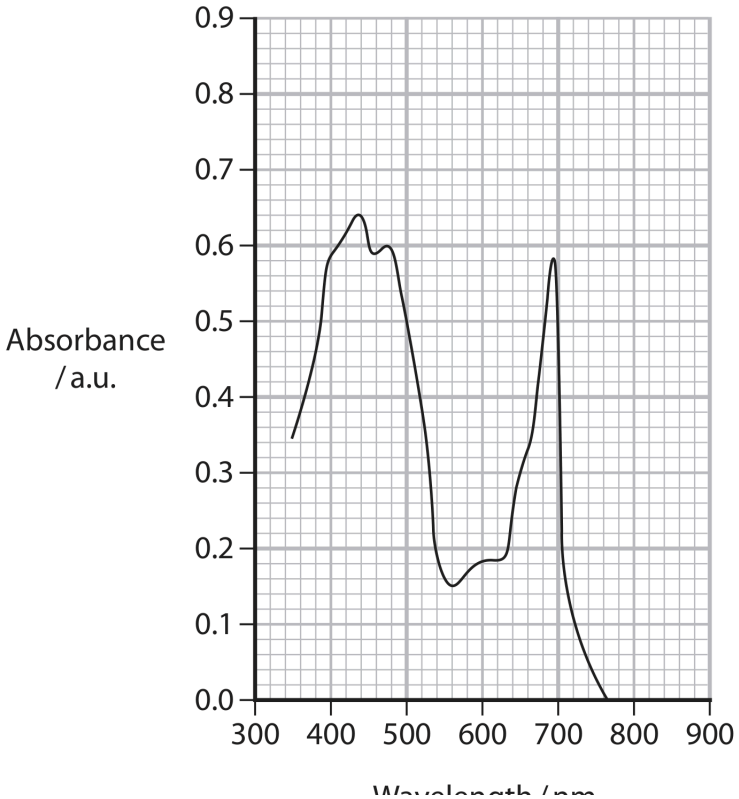
**Examiner's insight**

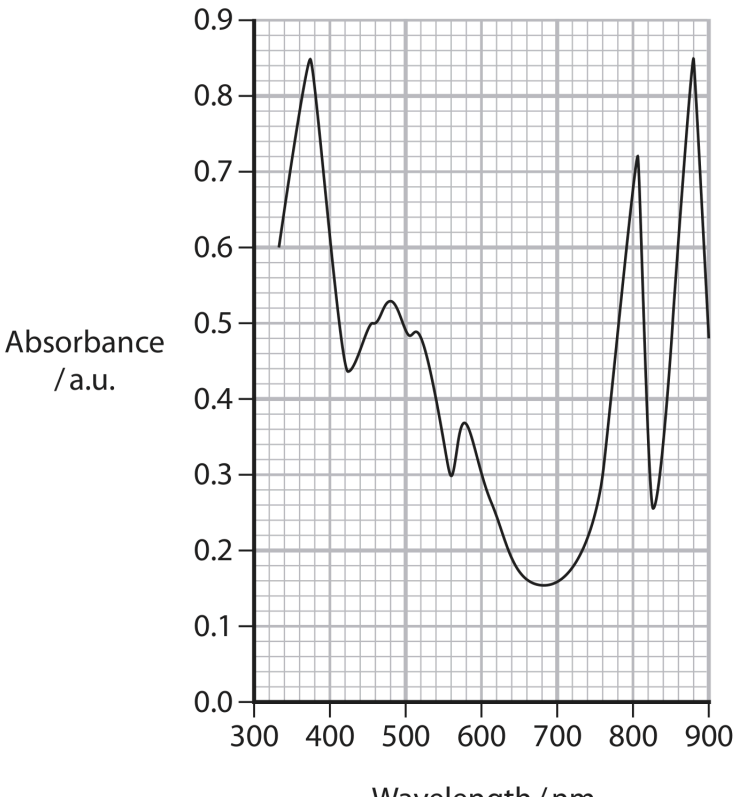
The Calvin cycle occurs in the cytoplasm of a photosynthetic bacterium.

## 2 (b)

Describe · [2 marks]

Describe two conclusions about the differences in the two absorption spectra.






**Model answer**

✓ The bacterial pigments absorb light over a greater range of wavelengths (and absorb more at most wavelengths). ✓ The bacterial pigments have maximum absorption at 380 nm and 880 nm, whereas the plant pigments peak at about 440 nm.

**Mark scheme** any 2 marks

- ✓ bacterial pigments absorb over a greater range of wavelengths (1)
- ✓ bacterial pigments absorb more at most wavelengths (1)
- ✓ bacterial max absorption at 380 nm and 880 nm, plant at 440 nm (1)

**Accept:** bacteria absorb at the ends of the spectrum too; more peaks; ±10

**Examiner's insight**

Those who read the question gave conclusions; those who saw 'describe' merely described the profiles. A mark was often lost by not spotting that the bacteria have two absorption maxima.

## 2 (c)

Describe · [3 marks]

Describe the measurements taken and how the $R_f$ value is calculated.

**Model answer**

✓ Measure the distance the solvent front moved from the origin. ✓ Measure the distance the pigment moved from the origin (to the centre of the spot). ✓ Then $R_f$ = distance moved by the pigment ÷ distance moved by the solvent.

**Mark scheme** 3 marks

- ✓ distance the solvent moved from the origin measured (1)
- ✓ distance the pigment moved from the origin measured (1)
- ✓ equation given: $R_f$ = distance moved by pigment ÷ distance moved by solvent (1)

**Accept:** measure from the centre / leading edge of the pigment

**Examiner's insight**

Answered very well - this specification point is clearly well understood.

**Revise from your notes**

- Action spectrum, chromatography & prokaryotes: 2.2 The Action Spectrum · 2.3 Separation Of Photosynthetic Pigments By Chromatography · 18.2 Differences Between Viruses And Bacteria

# Edexcel IAL Biology - Solved Past Paper

**May 2024 · Unit 4: Energy, Environment, Microbiology and Immunity (WBI14/01) · Question 1**
**Seaweed pigments, chromatography & light**

hard medium easy

## 1 (a)

Identify (multiple choice) · [1 mark]

Which process separates pigments according to their solubility?

**Model answer**

✓ A - chromatography, which separates pigments by their differing solubility.

**Mark scheme** 1 mark

✓ A - chromatography (1)

**Do not accept:** rows B, C or D - dendrochronology counts tree rings, gel electrophoresis separates by size, PCR amplifies DNA

**Examiner's insight**

Chromatography separates by solubility.

## 1 (b)(i)

Compare and contrast · [3 marks]

Compare and contrast the pigments in the seaweeds with those in spinach.

**Model answer**

✓ Similarity - all have beta-carotene and chlorophyll a, and each has at least one xanthophyll. ✓ Difference - spinach has chlorophyll b, which the seaweeds do not. ✓ Difference - the brown seaweed has pigments P and Q that spinach lacks, and spinach has a wider range (more types) of xanthophylls / pigments overall.

**Mark scheme** 3 marks (·1 similarity + 1 difference)

✓ all have beta-carotene / chlorophyll a / a xanthophyll (1)
✓ only spinach has chlorophyll b (1)
✓ brown seaweed has pigments P and Q that spinach does not (1)
✓ spinach has more types / a wider range of pigments (1)

**Accept:** spinach has chl a and b, seaweed only a = 2 marks; do not piece together
**Ignore:** bands; explanations of pigment function

**Examiner's insight**

Candidates are now very familiar with 'compare and contrast' - most gave both similarities and differences and accessed all the marks.

## 1 (b)(ii)

Describe · [3 marks]

Describe how the student could identify pigment P using this method.

**Model answer**

✓ Measure the distance pigment P moved from the origin and the distance the solvent

front moved. ✓ Calculate the $R_f$ value (distance moved by P ÷ distance moved by the solvent). ✓ Then look up the pigment name using known $R_f$ values – obtained with the same solvent (or by running known pigments in the same tank).

**Mark scheme** 3 marks

- ✓ measure distance of pigment P and the solvent front from the origin (1)
- ✓ calculate / use the $R_f$ value (1)
- ✓ look up the name using $R_f$ values for the same solvent (1)

**Accept:** retention / retardation factor; run with known pigments in the same solvent

**Examiner's insight**

Fewer candidates appreciated the need to use the SAME solvent when comparing $R_f$ values - as it is so important, there is very likely a mark for it. Some wrongly described setting up the chromatogram.

## 1 (c)(i)

Identify (multiple choice) · [1 mark]

Which row shows the light that green seaweed can absorb?

| Green light | Red light |
|---|---|
| can absorb | can absorb |
| can absorb | cannot absorb |
| cannot absorb | can absorb |
| cannot absorb | cannot absorb |

**Model answer**

✓ C – cannot absorb green light (it reflects it) but can absorb red light.

**Mark scheme** 1 mark

- ✓ C - cannot absorb green / can absorb red (1)

**Do not accept:** rows A, B or D - green seaweed reflects green light and absorbs red light

**Examiner's insight**

Green seaweed reflects green light (hence its colour) and absorbs red.

## 1 (c)(ii)

Explain · [2 marks]

Explain the positions of the brown and red seaweeds on the rock.

**Model answer**

✓ They are positioned to maximise the absorption of light for photosynthesis. ✓ And located separately from the green seaweed (and each other) to avoid competition for the blue/green light that penetrates deeper, and for space.

**Mark scheme** 2 marks

- ✓ to maximise light (energy) absorption (1)
- ✓ located separately to avoid competition for light / space (1)

**Accept:** brown outcompeted red for light / space; red/brown below green to avoid competition for blue light

### Examiner's insight

Very low scoring - many just put the diagram into words describing the depths the light reached. The key idea, that separation lets them absorb as much light as possible, was often missed.

### Revise from your notes

- Action spectrum & chromatography: 2.2 The Action Spectrum · 2.3 Separation Of Photosynthetic Pigments By Chromatography

## The light-dependent reactions & photophosphorylation

# Edexcel IAL Biology - Solved Past Paper

**January 2021 · Unit 4: Energy, Environment, Microbiology and Immunity (WBI14/01)**
**Question 5 · The light-dependent reactions & ATP**

hard medium easy

## 5 (a)(i)

Explain · [2 marks]

Explain why light energy is converted into energy stored in ATP.

**Model answer**

✓ ATP is the usable source of energy (the energy currency) for the plant, because light energy cannot be used directly. ✓ ATP is then needed in the light-independent reactions (Calvin cycle) to convert GP into GALP.

**Mark scheme** any 2 marks

- ✓ ATP is the source of energy for plants / living organisms (1)
- ✓ light energy cannot be used directly (1)
- ✓ ATP needed in the light-independent reactions to convert GP -> GALP (1)

**Accept:** ATP is the usable source / energy currency

**Examiner's insight**

Some misread this as 'how' light is converted and repeated it in part (iii). The third mark point was the one most often earned.

## 5 (a)(ii)

Complete · [2 marks]

Complete the ATP equation with the substrates and the type of reaction.

**Model answer**

✓ ADP + inorganic phosphate ($P_i$) -> ATP by phosphorylation. ✓ The reverse breakdown of ATP is hydrolysis (dephosphorylation).

**Mark scheme** 2 marks

- ✓ ADP and inorganic phosphate ($P_i$ / $PO4^{3-}$) (1)
- ✓ hydrolysis (1)

**Accept:** adp; dephosphorylation

**Do not accept:** P / phosphorus

**Examiner's insight**

A range of answers - note that $P_i$ is acceptable but 'P' is not. If unsure of a formula, write the full name.

## 5 (a)(iii)

Explain · [3 marks]

Explain the role of light energy in the light-dependent reactions.

**Model answer**

✓ Light is absorbed to excite and release electrons from chlorophyll. ✓ So the electrons can be used in chemiosmosis / photophosphorylation. ✓ Light also drives photolysis, replacing the electrons lost by chlorophyll and providing protons to form reduced NADP - producing ATP and reduced NADP for the Calvin cycle.

**Mark scheme** any 3 marks

- ✓ to release / excite electrons from chlorophyll (1)
- ✓ so electrons are used in chemiosmosis / photophosphorylation (1)
- ✓ photolysis replaces electrons / provides protons for reduced NADP (1)
- ✓ to produce ATP and reduced NADP for the light-independent reactions (1)

**Examiner's insight**

Excellent responses - but say light is 'absorbed' by chlorophyll, not that it 'hits' it.

## 5 (b)(i)

Identify (multiple choice) · [1 mark]

Which row shows the products of the light-dependent reactions used in the light-independent reactions?

| ATP produced by | NADP |
|---|---|
| cyclic photophosphorylation | oxidised |
| cyclic photophosphorylation | reduced |
| non-cyclic photophosphorylation | oxidised |

| New biological molecule | Nitrates | Phosphates | Both nitrates and phosphates | Neither nitrates nor phosphates |
|---|---|---|---|---|
| protein | ☒ | ☒ | ☒ | ☒ |
| RNA | ☒ | ☒ | ☒ | ☒ |
| triglyceride | ☒ | ☒ | ☒ | ☒ |

**Model answer**

✓ D - ATP from non-cyclic photophosphorylation and reduced NADP.

**Mark scheme** 1 mark

- ✓ D - non-cyclic photophosphorylation / reduced NADP (1)

**Do not accept:** rows A, B or C - cyclic photophosphorylation ATP is not passed on, and NADP is reduced, not oxidised

**Examiner's insight**

The confusion here lay between cyclic and non-cyclic photophosphorylation.

## 5 (b)(ii)

Name · [2 marks]

Name the inorganic molecule from which each element (C, H, O) in a simple sugar originated.

**Model answer**

✓ The carbon and the oxygen come from carbon dioxide ($CO_2$). ✓ The hydrogen comes from water ($H_2O$).

**Mark scheme** 2 marks

- ✓ C and O from carbon dioxide (1)
- ✓ H from water (1)

**Accept:** $CO_2$; $H_2O$

**Do not accept:** O from water

**Examiner's insight**

Very poorly answered - many read it as asking for chemicals named C, H and O, and many wrongly said oxygen comes from water.

## 5 (b)(iii)

Identify (table) · [3 marks]

Which inorganic ions are needed to synthesise each new biological molecule?

**Model answer**

✓ Protein needs nitrates (nitrogen for the amino acids). ✓ RNA needs both nitrates and phosphates (bases and the sugar-phosphate backbone). ✓ Triglyceride needs neither nitrates nor phosphates.

**Mark scheme** 3 marks

- ✓ protein - nitrates (1)
- ✓ RNA - both nitrates and phosphates (1)
- ✓ triglyceride - neither (1)

**Examiner's insight**

Marks depended on knowing which elements each molecule contains - nitrogen for protein, nitrogen and phosphorus for RNA, neither for a triglyceride.

**Revise from your notes**

- ATP & the light-dependent reactions: 1.2 About ATP · 3.2 The Light-Dependent Reactions Of Photosynthesis · 3.4 Non-Cyclic Phosphorylation · 4.1 Light-Independent Reactions

# Edexcel IAL Biology - Solved Past Paper

**June 2020 · Unit 4: Energy, Environment, Microbiology and Immunity (WBI14/01) · Question 3**
**Bond energies, photophosphorylation & amino acids**

hard medium easy

## 3 (a)(i)

Calculate · [1 mark]

In photolysis one bond in each water molecule is broken. Using the equation, calculate the energy released by photolysis to make one glucose molecule.

| Type of bond | Bond energy / kJ per bond |
|---|---|
| C═O | 785 |
| O—H | 462 |
| O═O | 487 |

**Model answer**

✓ Six water molecules are split, so six O-H bonds are broken: 6 × 462 = 2772 kJ.

**Mark scheme** 1 mark

✓ 2772 (1)

**Ignore:** any other units given

**Examiner's insight**

Candidates who used the information that one bond is broken in each of the six water molecules calculated the energy correctly.

## 3 (a)(ii)

Explain · [4 marks]

Explain how light energy is converted into chemical energy in the form of ATP.

**Model answer**

✓ Light is absorbed by the photosystems (chlorophyll). ✓ This excites electrons, releasing them to a higher energy level. ✓ The electrons are passed along a series of electron carriers, releasing energy as they go. ✓ That energy phosphorylates ADP into ATP - in cyclic photophosphorylation, and in non-cyclic photophosphorylation via the proton gradient through ATP synthase.

**Mark scheme** any 4 marks

✓ light absorbed by photosystems / chlorophyll (1)
✓ excites / releases high-energy electrons (1)
✓ electrons passed along a series of electron carriers (1)
✓ energy released phosphorylates ADP -> ATP (cyclic) (1)
✓ phosphorylation via the proton gradient -> ATP (non-cyclic) (1)

**Accept:** $H^+$ pass through ATP synthase releasing energy for phosphorylation of ADP

**Examiner's insight**

Candidates know the events well, but very few covered ATP synthesis in BOTH cyclic and non-cyclic photophosphorylation. Say light is "absorbed by" chlorophyll, not just "hitting" it.

## 3 (b)(i)

State · [1 mark]

State what other information is needed in the table of bond energies for the glucose figure to be calculated.

**Model answer**

✓ The bond energies for two of: C-H, C-O and C-C (the bonds within glucose).

**Mark scheme** 1 mark

✓ two from: C-H, C-O and C-C (1)

**Accept:** bond between carbon and hydrogen / carbon and oxygen / carbon and carbon

**Ignore:** O-H

**Examiner's insight**

There were three possible bond types to list; very few gave all three, but two out of three was enough.

## 3 (b)(ii)

Identify (multiple choice) · [1 mark]

Where in the chloroplasts are these bonds formed?

**Model answer**

✓ C - the stroma, where glucose is synthesised in the light-independent reactions.

**Mark scheme** 1 mark

✓ C - stroma (1)

**Do not accept:** rows A, B or D - there is no cytoplasm or matrix inside a chloroplast; glucose is made in the stroma

**Examiner's insight**

Well answered, though a few chose the matrix.

## 3 (c)(i)

Identify (multiple choice) · [1 mark]

Which row describes how two amino acids join together?

| Bond formed between | Type of reaction |
|---|---|
| carbon and nitrogen | condensation |
| carbon and nitrogen | hydrolysis |
| oxygen and nitrogen | condensation |
| oxygen and nitrogen | hydrolysis |

**Model answer**

✓ A - a bond forms between carbon and nitrogen (the peptide bond) by a condensation

reaction.

**Mark scheme** 1 mark

- ✓ A - carbon and nitrogen / condensation (1)

**Do not accept:** rows B, C or D - the peptide bond joins the C of one amino acid to the N of the other and forms by condensation, not hydrolysis

**Examiner's insight**

Many chose correctly, though some confused hydrolysis with condensation.

## 3 (c)(ii)

Explain · [2 marks]

Explain why amino acids cannot be produced from glucose alone.

**Model answer**

✓ Amino acids contain nitrogen, which glucose does not – the nitrogen must be obtained from nitrates. ✓ Some amino acids (their R groups) also contain sulfur, obtained from sulfates.

**Mark scheme** any 2 marks

- ✓ amino acids contain nitrogen (1)
- ✓ some amino acids / R groups contain sulfur (1)
- ✓ nitrogen from nitrates / sulfur from sulfates (1)

**Accept:** glucose does not contain nitrogen / sulfur; nitrates / sulfates needed

**Examiner's insight**

Many had the gist but wrote vaguely about an "amino group"; at this level state precisely that nitrogen (and sulfur) are needed.

**Revise from your notes**

- Light-dependent reactions & using the products: 3.2 The Light-Dependent Reactions Of Photosynthesis · 3.3 Cyclic Phosphorylation · 3.4 Non-Cyclic Phosphorylation · 5.1 Using Products Of Photosynthesis
- Amino acid & protein structure - revise from Unit 1: 4.1 Amino Acids · 4.2 Primary Structure Of Proteins - (Unit 1)

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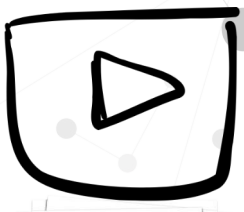

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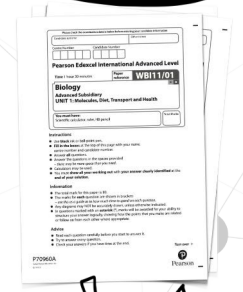

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