IB Biology C1.3 Photosynthesis - Worksheet 3

Absorption spectra and action spectra | SL core | Total: 44 marks | Suggested time: 60 min

Name: _____ **Class:** _____ **Date:** _____

Assessment instructions: Answer all sections. Show calculations and units where relevant. HL questions are marked [HL]. The answer key and marking guidance are included at the end for teacher review or self-assessment.
Learning focus: wavelengths and pigments; electron excitation; absorption spectrum; action spectrum from oxygen data

Section A - Multiple choice (5 marks)

1. An absorption spectrum shows (1)
   A. rate of glucose formation only.
   B. amount of light absorbed at different wavelengths.
   C. carbon dioxide concentration over time.
   D. the number of chloroplasts in a leaf.

2. An action spectrum for photosynthesis can be produced by measuring (1)
   A. leaf colour only.
   B. oxygen production or carbon dioxide consumption at different wavelengths.
   C. Rf values of pigments.
   D. temperature change in a water bath.

3. Green light is usually less effective for photosynthesis because it is (1)
   A. mostly reflected or transmitted by chlorophyll pigments.
   B. too energetic for any pigment to absorb.
   C. not part of the visible spectrum.
   D. absorbed only by water.

4. When a pigment absorbs a photon, an electron in the pigment may be (1)
   A. converted into a proton.
   B. excited to a higher energy level.
   C. destroyed to form oxygen.
   D. fixed into RuBP.

5. Blue light has a shorter wavelength than red light, so blue photons generally have (1)
   A. less energy.
   B. the same energy as all visible photons.
   C. more energy.
   D. no ability to excite electrons.

Section B - Short answer

6. Compare an absorption spectrum with an action spectrum. (4)

7. Explain why different pigments absorb different wavelengths of light. (3)

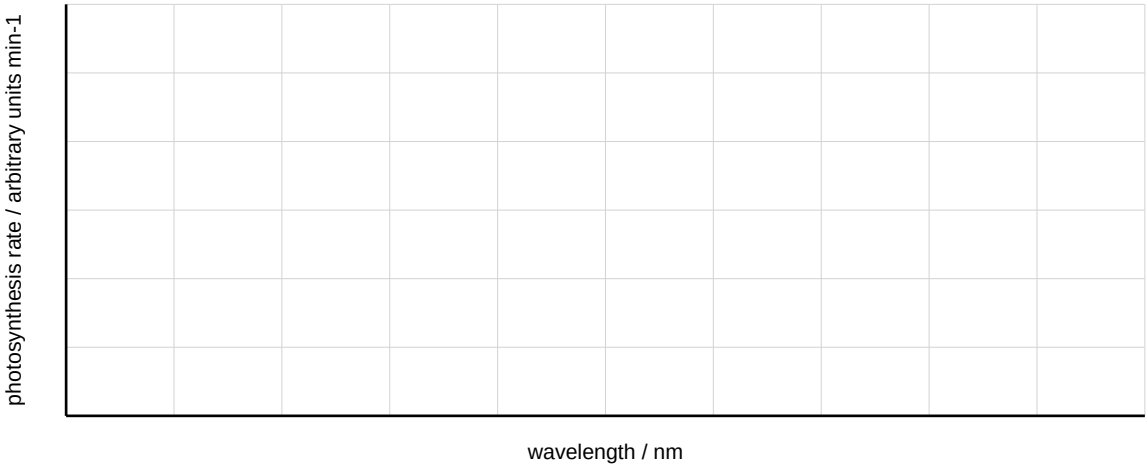
8. State the approximate visible wavelength ranges for blue, green and red light as used in photosynthesis graphs. (3)

9. Explain why an action spectrum is often similar to, but not identical to, the absorption spectra of individual pigments. (4)

Section C - Data response / case study

A student measured the rate of photosynthesis in algal cells under equal light intensity but different wavelengths. Oxygen production was used as the measure of photosynthesis.

Wavelength / nm	Colour region	O2 produced / arbitrary units min-1
420	blue	84
460	blue	92
520	green	28
560	green	18
620	red	63
680	red	88
730	near infrared	6



10a. Plot the data on the grid to produce an action spectrum. (4)

10b. Identify the wavelength with the highest photosynthetic rate. (1)

10c. Calculate the percentage decrease in oxygen production from 460 nm to 560 nm. (3)

10d. Use the data to explain why green light is less effective than blue or red light. (3)

10e. Suggest one reason why photosynthesis is not zero at 520 nm. (2)

Section D - Extended response

11. Explain how light absorption by pigments is linked to chemical energy production in photosynthesis. Refer to wavelengths, electron excitation and action spectra. (8)

Answer key and marking guidance

Award credit for equivalent wording. Marks should be awarded for valid biological reasoning, correct use of data, and clear links to photosynthesis. Do not require exact phrasing unless a term is specified.

Section A - Multiple choice

Question	Answer	Guidance
1	B	Absorption spectra show absorption across wavelengths.
2	B	Action spectra use photosynthesis rate, such as oxygen production.
3	A	Chlorophyll reflects/transmits much green light.
4	B	Photon energy raises an electron to a higher energy level.
5	C	Shorter wavelength photons have more energy.

Section B - Short answer

6. Up to 4 marks: absorption spectrum shows light absorbed by pigment(s) at wavelengths; action spectrum shows rate/effectiveness of photosynthesis at wavelengths; both are plotted against wavelength/colour; both depend on pigments present.

7. Up to 3 marks: pigments have different molecular structures; electron energy level gaps differ; only photons with suitable energy/wavelength excite electrons; therefore absorption peaks differ.

8. Accept approximate ranges: blue about 400-500 nm; green about 500-600 nm; red about 600-700 nm. Award 1 each.

9. Up to 4 marks: action spectrum reflects combined effect of all pigments; accessory pigments transfer energy to reaction centres; non-pigment factors can affect measured photosynthesis; not all absorbed energy is used with equal efficiency.

Section C - Data response / case study

10a. Award up to 4 marks: axes labelled with units; suitable scale; all seven points plotted accurately; points joined with a smooth line or appropriate line segments.

10b. 460 nm gives the highest rate (92 arbitrary units min-1).

10c. Decrease = 92 - 18 = 74. Percentage decrease = 74/92 x 100 = 80.4%, about 80%. Award 1 for difference, 1 for correct denominator, 1 for answer.

10d. At 520 and 560 nm rates are 28 and 18, much lower than blue 84-92 and red 63-88. This suggests green wavelengths are absorbed less and/or reflected more by pigments.

10e. Accessory pigments may absorb some green light; chlorophyll absorbs a small amount in the green range; scattered light/experimental limitations may contribute.

Section D - Extended response

11. Mark out of 8. Award up to 2 for wavelength/colour detail: blue and red absorbed strongly, green weakly. Up to 2 for pigment function: chlorophylls and carotenoids absorb specific photons. Up to 2 for electron excitation and transfer of energy to chemical reactions. Up to 1 for action spectrum evidence from O2/CO2 rate. Up to 1 for chemical energy in ATP/reduced NADP/glucose or carbon compounds.