

GCSE (9–1)

Transition Guide

TWENTY FIRST CENTURY SCIENCE BIOLOGY B

J257

For first teaching in 2016

KS3–KS4 focus Photosynthesis

Version 1



GCSE (9–1)

TWENTY FIRST CENTURY SCIENCE BIOLOGY B

Key Stage 3 to 4 Transition guides focus on how a particular topic is covered at the different key stages and provide information on:

- Differences in the demand and approach at the different levels;
- Useful ways to think about the content at Key Stage 3 which will help prepare students for progression to Key Stage 4;
- Common student misconceptions in this topic.

Transition guides also contain links to a range of teaching activities that can be used to deliver the content at Key Stage 3 and 4 and are designed to be of use to teachers of both key stages. Central to the transition guide is a Checkpoint task which is specifically designed to help teachers determine whether students have developed deep conceptual understanding of the topic at Key Stage 3 and assess their 'readiness for progression' to Key Stage 4 content on this topic. This checkpoint task can be used as a summative assessment at the end of Key Stage 3 teaching of the topic or by Key Stage 4 teachers to establish their students' conceptual starting point.

Key Stage 3 to 4 Transition Guides are written by experts with experience of teaching at both key stages.

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**QUALIFICATION
AWAITING
ACCREDITATION**

'These draft qualifications have not yet been accredited by Ofqual. They are published (along with specimen assessment materials, summary brochures and sample resources) to enable teachers to have early sight of our proposed approach.'

'Further changes may be required and no assurance can be given at this time that the proposed qualifications will be made available in their current form, or that they will be accredited in time for first teaching in 2016 and first award in 2018 (2017 for AS Level qualifications).'

Key Stage 3 Content

Structure and function of living organisms

Nutrition and Digestion

- plants making carbohydrates in their leaves by photosynthesis and gaining mineral nutrients and water from the soil via their roots.

Material cycles and energy

Photosynthesis

- the reactants in, and products of, photosynthesis, and a word summary for photosynthesis
- the dependence of almost all life on Earth on the ability of photosynthetic organisms, such as plants and algae, to use sunlight in photosynthesis to build organic molecules that are an essential energy store and to maintain levels of oxygen and carbon dioxide in the atmosphere
- the adaptations of leaves for photosynthesis.

Cellular respiration

- aerobic and anaerobic respiration in living organisms, including the breakdown of organic molecules to enable all the other chemical processes necessary for life
- a word summary for aerobic respiration
- the process of anaerobic respiration in humans and micro-organisms, including fermentation, and a word summary for anaerobic respiration
- the differences between aerobic and anaerobic respiration in terms of the reactants, the products formed and the implications for the organism.

Key Stage 4 Content

B3.1.1 a) describe the process of photosynthesis, including the inputs and outputs of the two main stages and the requirement of light in the first stage, and describe photosynthesis as an endothermic process

b) describe practical investigations into the requirements and products of photosynthesis

B3.1.2 explain how chloroplasts in plant cells are related to photosynthesis

B3.1.4 a) explain the effect of temperature, light intensity and carbon dioxide concentration on the rate of photosynthesis

b) describe practical investigations into the effect of environmental factors on the rate of photosynthesis

B3.1.5 use the inverse square law to explain changes in the rate of photosynthesis with distance from a light source

B3.1.6 explain the interaction of temperature, light intensity and carbon dioxide concentration in limiting the rate of photosynthesis, and use graphs depicting the effects

B3.1.7 in the context of the rate of photosynthesis:

a) understand and use simple compound measures such as the rate of a reaction

M1a, M1c

b) translate information between graphical and numerical form

M4a

c) plot and draw appropriate graphs selecting appropriate scales for axes

M4a, M4c

d) extract and interpret information from graphs, charts and tables

M2c

Comment

Differences:

Learners build on basic knowledge of photosynthesis from Key Stage 3. All learners should already know the reaction for photosynthesis and be able to use the word equation successfully. Learners will know where the raw materials for photosynthesis come from, including water from the soil via the roots. At Key Stage 4 this is built on and split into the two stages of photosynthesis and learners are expected to know where the reactants are involved: water, chlorophyll and light in the first stage and carbon dioxide and hydrogen from the second stage. They will be able to give the products of each reaction.

Learners will know that carbohydrates are made in the leaf and at Key Stage 3 learners should know about the various adaptations that the leaf has, to include the role of the stomata in gas exchange in plants. Learners will know from cell structure about the function of chloroplasts and be able to identify these in a plant cell. This will assist when discussing the two reactions of photosynthesis and learners will learn specific details about the involvement of the chloroplasts at Key Stage 4.

Learners' knowledge of enzymes at Key Stage 3 is basic and limited to their role as biological catalysts in the digestive system. At Key Stage 4, enzyme knowledge is linked to the reactions of photosynthesis and learners are expected to be able to explain how factors affect the rate of photosynthesis. At Key Stage 4, learners should be able to utilise the basic knowledge of the reactions of photosynthesis to explain practical investigations and interpret data from graphs, charts and tables. Learners should be able to explain in detail, using graphs, the limiting factors. There is also a greater mathematical element at Key Stage 4, as in addition to graphs and charts, learners will be able to use the inverse square law to explain changes in the rate of photosynthesis.

Challenges learners face when tackling this topic at GCSE:

Learners are generally able to recall the equation for photosynthesis well, although lower ability learners sometimes get confused between this and respiration, particularly with the idea that plants use both processes. It is important to distinguish between these two processes.

There are lots of data related questions and learners struggle with the interpretation of these. Sometimes, there are large amounts of data to process. Quite often questions are based around graphs and learners frequently find it difficult to distinguish between describe and explain questions. It is important to embed activities into lessons that allow learners to recognise the difference in these. One idea is to create a table before describing/explaining a graph that has columns with the headings: describe, connective, explain. This allows learners to link ideas together and clearly see the difference between the two command words.

Learners often forget in answers to questions to make direct comparisons, so although they show understanding of concepts, they lose marks in examinations. This could include missing off "-er" at the end of descriptive words. For example, "high" changes to "higher" – providing a direct comparison of two pieces of data. In order to prepare learners for the mathematical demands at GCSE, it is important to include activities when teaching Key Stage 3 photosynthesis that allow these skills to be developed.

Activities

Biology animations – transport of water and sugar, respiration and photosynthesis and cell growth in plants: Science & Plants for Schools (SAPS)

Resources: <http://www.saps.org.uk/secondary/teaching-resources/1299-biology-animations-plant-transport-photosynthesis-and-cell-growth>

This interactive animation could be used to recap the structure of the leaf and introduce key ideas about photosynthesis, assessing what learners remember from Key Stage 3. Use the 'Photosynthesis and Respiration' animation. There are accompanying resources that can be used alongside this.

Illuminating Photosynthesis: NOVA

Resources: <http://www.pbs.org/wgbh/nova/nature/photosynthesis.html>

An animation that looks at the interaction of oxygen, carbon dioxide and water in photosynthesis. It starts off quite basic and then looks at the molecules. There are three puzzlers at the end to discuss different aspects of photosynthesis, which should stimulate thinking.

Why...?

Resources: [Teacher resource 1](#) or [Learner resource 1](#)

This could be used as a starter activity to gauge knowledge. It is a selection of questions that should stimulate thinking about various aspects of plants, that link onto photosynthesis concepts.

Photosynthesis – A Survival Guide for Teachers: SAPS

Resources: <http://www.saps.org.uk/secondary/teaching-resources/134-photosynthesis-a-survival-guide-teaching-resources>

There are a huge amount of resources on this link in the form of PowerPoints, learner worksheets and practical activities. There are accompanying teacher notes to help support. Lots of activities promote thinking skills and developing basic knowledge, to move onto GCSE level.

Photolab

Resources: <http://www.kscience.co.uk/animations/photolab.swf>

This is quite a basic simulation visually that allows learners to manipulate different factors that affect the rate of photosynthesis. It could be used as an introduction to limiting factors and investigations could be planned using this as a stimulus.

The idea of the first checkpoint task is to identify understanding of the key words in relation to photosynthesis. All of these key words should be familiar to learners from Key Stage 3 and they will be used constantly in the teaching of this topic at GCSE level, so it is essential that learners are able to use them effectively. It is important before moving onto data interpretation and practical investigations that learners have a good understanding of the photosynthesis basics.

The second activity is used to develop this further, using concepts relating to limiting factors and respiration. Learners have the opportunity to explain ideas and this will determine the level of their understanding.

Quite often learners get muddled up between respiration and photosynthesis when learning about plants, as they do both reactions. The third checkpoint activity is based on identifying the key differences between the two processes and make it clear that plants carry out both processes.

Checkpoint Task:

<http://www.ocr.org.uk/Images/289146-photosynthesis-checkpoint-task.doc>

Activities

Limiting Factors on Photosynthesis Worksheet: TES website

<https://www.tes.com/teaching-resource/limiting-factors-6049709>

This worksheet allows learners to develop their graph drawing skills. It is more complex for data interpretation as it involves two independent variables. There are a series of questions that can be used to analyse and explain the data.

Video clip – plant adaptations to overcome environmental limitations: BBC video clip, from SAPS website.

<http://www.saps.org.uk/secondary/teaching-resources/827-plant-adaptations>

This video clip could be used to introduce limiting factors. Learners could think of the different factors that affect the rate of photosynthesis and this could lead to discussions on how the rate could be measured or practical activities.

Measuring the rate of photosynthesis of Elodea: Syngenta

http://www3.syngenta.com/country/uk/en/about/learning-zone/KS345/biology/Pages/Photosynthesis_in_Action_Large.aspx

This interactive simulation allows the light source to be adjusted to change the rate of photosynthesis. Learners are able to collect raw data using this animation and this provides a graph drawing opportunity. Experiments with Elodea are often unsuccessful. There are challenge questions at the bottom to analyse the results.

Describing and explaining graphs (OCR lesson element)

[Learner resource 2](#)

This activity is to develop learners' ability to describe and explain data. The table could be prepared in advance or it could be an active part of the lesson where learners suggest words that could go in the table. The example given specifically links to temperature.

Annotating Graphs Activity (OCR lesson element)

[Learner resource 3](#)

Learners could be shown the three graphs and asked to annotate what they think is happening at each point and why it is happening. This is useful in establishing if they understand the difference between describe and explain. Specific graphs with data could be used alternatively.

Measuring photosynthesis with Cabomba: STEM

<https://www.stem.org.uk/elibrary/resource/28215/measuring-photosynthesis-with-cabomba>

Cabomba is a more reliable plant for investigating photosynthesis. There is a practical sheet with accompanying questions on this resource.

Activities

Greenhouse activity: TES

<https://www.tes.com/teaching-resource/greenhouses-and-photosynthesis-11013188>

The main activity is based around explaining the different ways that photosynthesis can be enhanced in greenhouses. This allows learners to be creative and lead a pitch in an apprentice style activity to persuade people to purchase items for their greenhouse.

Biosphere: STEM

<https://www.stem.org.uk/elibrary/resource/34427/biosphere>

This resource allows the linking of various different topics based around the idea of people living in space. There are opportunities for practical investigations and creative thinking.

Virtual Labs: Glencoe

http://www.glencoe.com/sites/common_assets/science/virtual_labs/LS12/LS12.html

This virtual laboratory extends learners to consider how different wavelengths of light affect the rate of photosynthesis. There are videos to accompany the experiment which provide explanations and questions that could be answered in the 'journal' section. An electronic table of results can be made and from this a graph.

How commercial growers improve crop yield

<http://www.bbc.co.uk/education/clips/z7snvcw>

A video clip that discusses how the crop yield of plants can be increased. This provides links to how the rate of photosynthesis can be manipulated in real life situations.

Resources, links and support

Science Spotlight – Our termly update Science Spotlight provides useful information and helps to support our Science teaching community. Science Spotlight is designed to keep you up-to-date with Science here at OCR, as well as to share information, news and resources. Each issue is packed full with a series of exciting articles across the whole range of our Science qualifications: www.ocr.org.uk/qualifications/by-subject/science/science-spotlight/

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