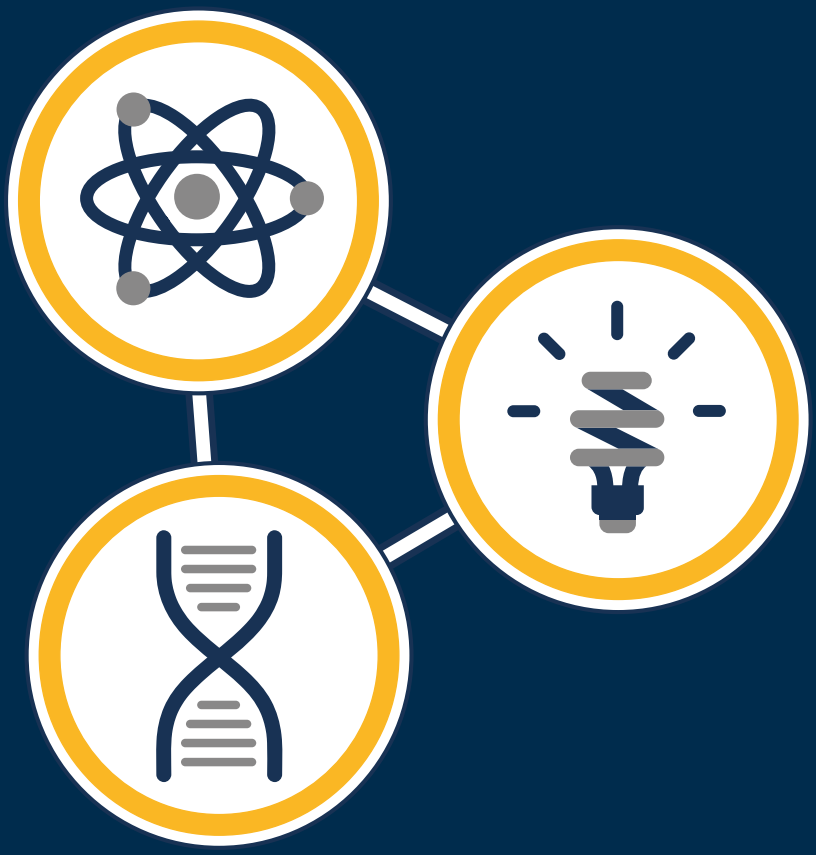
Pearson

Mastery in Science

Using big ideas to make cognitive links from year 7 to year 11



A2259 Version 1.1 • UKS • October 2020

Mastery in Science

Welcome to **Mastery in Science!**

We have worked with lots of teachers, examiners and subject experts to put together a comprehensive pathway to help you with planning your teaching from year 7 right up to year 11 and beyond.

Read through this guide to see how mastery can support you with broadening the science curriculum and diversity links in science, and how to use the short formative assessment grids to help support students' learning.

What is Mastery in Science?

Mastery in Science is a way to teach the KS3 and GCSE subject content that uses big ideas to encourage deep understanding of key concepts. It is designed to link content together in a logical and steady way from year 7 to year 11. The big ideas are introduced in year 7 where students secure their knowledge in each key theme.

Our Mastery pathways are structured to:

- consolidate previous knowledge
- add an extra layer of deeper understanding each time a big idea is visited
- include regular formative assessment points to identify areas to support learning.

A2259 Version 1.1 • UKS • October 2020

Why science matters

Learning about science and the world around us should be engaging, relevant and thought provoking. We have interwoven a range of links through our mastery pathways to help students engage with their learning, and broaden their understanding of science in everyday life:

- dedicated STEM careers videos to inspire learners and showcase the diverse applications of science based careers
- **STEM Careers poster** outlining a wide variety of future careers in science to serve as a reminder of all the opportunities available to students
- links to our **Future Skills for Employability framework** which is designed to equip today's learners with the future skills needed to flourish in tomorrow's world of work
- encouraging diversity in science by exploring our fantastic **'Scientist of the Month'** series, including special featured scientists such as Alan Turing in Pride month, and lots more exciting spotlights to complement learning in Black History Month.

What are the big ideas in Mastery?

There are three big ideas in each of biology, chemistry and physics. These are developed each year, and are always referred to in the content and details to show how the learning links to the bigger picture.

Biology	Chemistry	Physics
Cells and Cellular processes	Materials and their properties	Energy
Biological systems for life	Chemical changes	Forces and fields
Organisms and their interactions with the environment	Our Earth and its atmosphere	Matter and materials

Mastery in Science

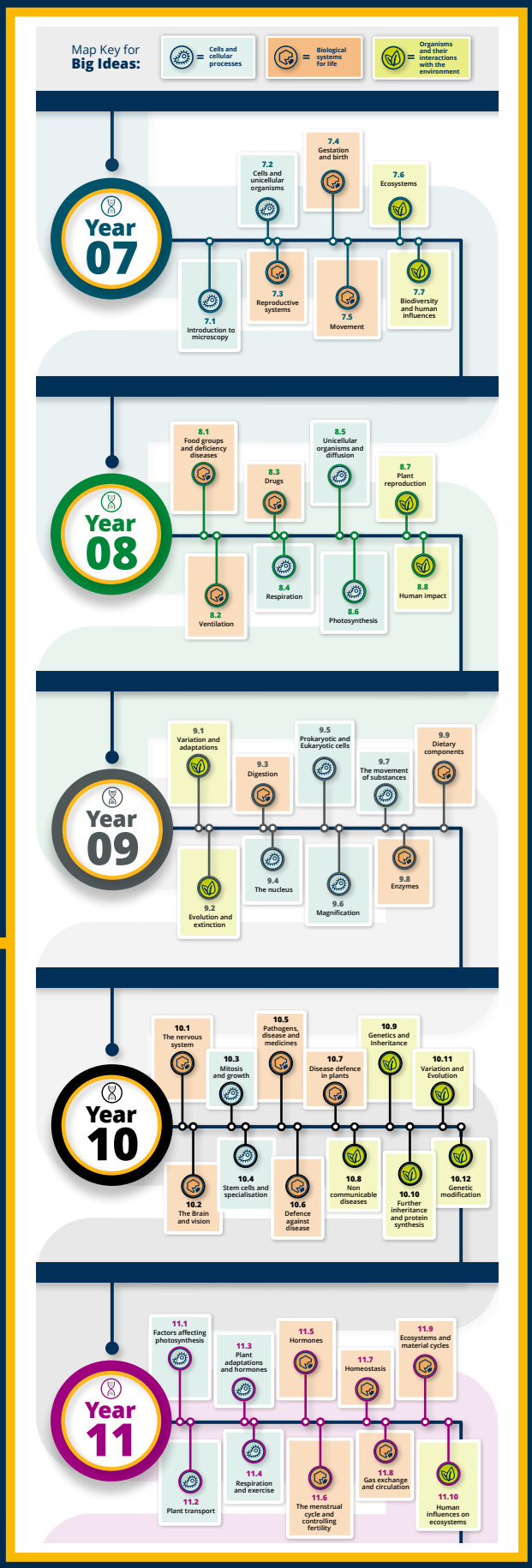
Pearson

Overview of content

This is an overview of one of the journeys for students from year 7 to year 11. There is one journey for each of biology, chemistry and physics (separate science version, and combined science versions).

You will be able to use these journeys to access the topics by clicking on the relevant ones. As you can see, the colours relate to each big idea in each subject.

Take me to the subject journeys!



A2259 Version 1.1 • UKS • October 2020

Formative assessment in Mastery

Formative assessment is a fundamental part of mastery in science. Students must show that they have mastered concepts before more complex applications and ideas are built into the big ideas each year.

We have developed two options for teachers to help with formative assessment in mastery. These are quick-response questions designed to determine whether students have mastered the main points before moving on to the next big idea. They are designed to draw on content they have just been taught, as well as link to content that would have been in a previous topic. This helps to ensure previous learning isn't forgotten, and is built upon every year.

1. **Rewind grids:** use the built-in question grids to quickly determine students' understanding of a topic each week.
2. **Tassomai:** buy in to the bespoke Tassomai quizzes, which have been tailored for our mastery course, to access the rich feedback from student responses and see you how well they have grasped prior learning, and mastered new content.

Delving into the detailed pathways

Each topic outlined in our overviews is designed to be the equivalent of approximately a week of teaching material. Here's a topic in miniature to show you what this looks like, and take you through some of the embedded features in the pathway.

This is your main reference point. Topic titles here will match the subject journeys, and the numbering reflects teaching order.

Use this section to see what the prior knowledge of the topic is, and what's going to be covered in this topic.

See how the content in this topic links to Programme of Study, and Working Scientifically skills.

This section highlights any misconceptions, and links lesson content to our Future Ready framework, getting students ready for the world of work!

Mastery in Science

Pearson

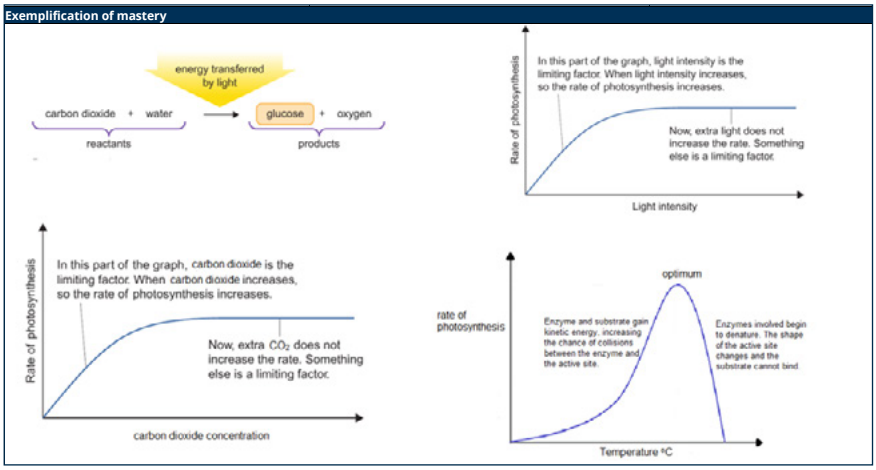
Literacy ideas and terminology	Broadening curriculum
Ideas: Research historical investigation on photosynthesis such as Helmont, Woodward and Priestley. ***Diversity Debate:*** Percy Julian (see scientist of the month) attended De Pauw and Harvard University. He was names Chicago's Man of the Year in a Chicago Sun-Times poll, but his home was bombed and burned when he moved to the all -white suburb of Oak Park (ref: Britannica). Was this right? How would be have felt? How do you think the residents of Oak Park felt? ***Key words:*** *Tier 1*: light, temperature, carbon dioxi[illegible], plants, glucose *Tier 2*: optimum [illegible]cer, biomass, photosynthesis, chloroplasts, chlorophyll, palisade cells, [illegible] proportional, inverse square law, hydrogencarbonate indicator, heat shield.	***Scientist:*** *Katherine Esau:* German-American botanist who received the National Medal of Science for her work on plant anatomy. ***Scientist of the month*** *Percy Julian* (Chemist, Male, African-American) used his knowledge of plants to synthesis drugs. He led research that resulted in quantity production of hormones: progesterone and testosterone. He was also active as a fund-raiser for the National Association for the Advancement of Coloured People. ***STEM careers:*** *botanist, conservationist.*

Make sure you check out these sections, all about literacy idea, key terms, and lots of broadening curriculum and diversity links.

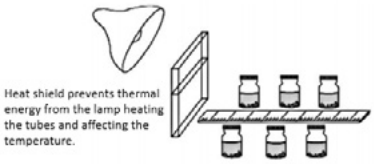
Learning objectives	Teaching ideas / links to resources	Indicative success criteria
Photosynthesis *(Spec points: 6.1 – 6.6)* • Know that photosynthetic organisms are producers. • Know the photosynthesis reaction. • Understand how factors affect photosynthesis. • Core practical: Investigate the effect of light intensity on the rate of photosynthesis.	• Show images of the different types of photosynthetic organisms. • Test leaves left in the light or dark for starch. • Investigate the rate of photosynthesis using pondweed measuring pH change with sodium hydrogencarbonate indicator or measure rate of oxygen production. • Show data on the effect of different factors on the rate of photosynthesis • Use algal balls to investigate the effect of light intensity. • Use web-based simulators to collect data on factors affecting the rate of photosynthesis. • Plot graphs to show that rate of photosynthesis is directly proportional to light intensity and indirectly proportional to distance from the lamp ***Opportunities for extension:*** Investigate the effect of different coloured light on the rate of photosynthesis.	• Write the word equation for photosynthesis (AO1). • Write a method to investigate the effect of light intensity on the rate of photosynthesis (AO3). • Identify variables that need to be controlled (AO2). • Evaluate data on the effect of light intensity and distance from the lamp on the rate of photosynthesis (AO3). • Explain the effect of light, temperature and carbon dioxide concentration on the rate of photosynthesis (AO1).

This is the main teaching content. Remember that at the bottom of these sections, there are links to our GCSE published resources if you have purchased these.

Exemplification of mastery



Core practical investigating the effect of light intensity on the rate of photosynthesis using algal balls and hydrogen carbonate indicator.



Variables to control

Mass of/number of algal balls
Volume of indicator in the vials
Temperature
Size of the vials
Same stock solution of hydrogencarbonate indictor

Control tube
A tube containing indicator and no algal balls to compare th[illegible] colour of the indictor with.

The control tube is red.

Distance from the lamp (m)	Relative light intensity ($1/d^2$)	Colour of the indicator after 2 hours	Interpretation
0.2	25.00	purple	There is a net decrease in the concentration of carbon [illegible] in pH. The rate of photosynthesis is greater than the rat[illegible] to removal of carbon dioxide from the solution.
0.4	6.25	red	There is no change in the pH of the indicator meaning there is no change in the concentration of carbon dioxide. The rate of photosynthesis is equal to the rate of respiration
0.8	1.56	yellow	There is a net increase in the concentration of carbon dioxide and a decrease in pH. The rate of photosynthesis is lower than the rate of respiration leading to more carbon dioxide in the solution.

Exemplifying Mastery! This section has lots of images that you can use to see how well your students have grasped the content. A visual way to represent the learning that is taking place!

Rewind grid

This topic	Enzymes (Y9)	Photosynthesis (Year 8)
Give the equation for photosynthesis **1 point**	Give the term used to describe the molecules that binds to an enzyme. **1 point**	State where in a plant cell photosynthesis occurs. **1 point**
Describe the effect of rate limiting factors on the rate of photosynthesis. **3 points**	Describe the effect of high temperature on enzymes. **3 points**	Describe the features of palisade cells. **3 points**
Explain how hydrogencarbonate indicator can be used as a quantitative measure of photosynthesis. **5 points**	Explain the effect of temperatures below the optimum on enzyme activity. **5 points**	Explain the similarities and differences between flowering plants and conifers. **5 points**

Rewind grids are designed to have three columns. The first one is questions from the current topic, and the second and third one are questions from previous topics to help support core knowledge retention from prior learning

Rewind grid answers

Carbon dioxide + water ® glucose + oxygen	Substrate	In the chloroplast
Rate limiting factors prevent the rate of photosynthesis increasing beyond a point causing the rate to plateau. Rate limiting factors include light intensity, carbon dioxide concentration and temperature.	High temperatures denature enzymes, changing the shape of the active site.	Palisade cells are in the upper part of the leaf, they have a large surface area to absorb sunlight and contain a lot of chloroplasts for photosynthesis.
Hydrogencarbonate indicator is sensitive to small changes in pH. If the rate of photosynthesis is high then carbon dioxide is used in the reaction, the pH increases (less acidic) and the indicator changes to a purple colour. If the rate of photosynthesis is low the net level of carbon dioxide increases as it is released through respiration. The pH decreases (becomes more acidic) and the indictor turns yellow.	Below the optimum temperature for the enzyme particles have less kinetic energy. There is less chance of a collision between the enzyme and the active site. Less enzyme-substrate complexes are formed and the rate of reaction is lower.	Both have roots and xylem as well as the general features of plants including cellulose cell walls, multicellular and autotrophic (synthesis their own food) Flowering plants reproduce using flowers and have large flat leaves. Conifers reproduce using cones and have needle-like leaves.

Register for a network event

- Sign up to our Mastery networks in the Autumn term to learn about how you can use the mastery course to help your planning.
- Register on the website to receive all the details you need to get started with Mastery in Science, and also to speak to our curriculum consultants.

Sign up to find out more