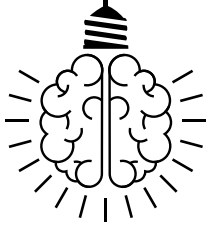
Learning notes

- explore three of the key stories



Discover ideas, activities and opportunities to learn more about the science and technology covered in this edition of Catalyst magazine.

Contents

Curriculum links

The articles in this issue of Catalyst are relevant to the curriculum for students aged 14 to 19.

Article - Death, destruction and...pollen?

Jessica McCoy

GCSE or equivalent

Biology

- Sexual and asexual reproduction – pollen and egg cells in flowering plants

Geography

- The living world – ecosytems

History

- Shaping the nation – thematic studies, Britain: Health and the people c1000 to the present day

Article - My journey into engineering

Lorcan Smith

GCSE or equivalent

Careers

- Supports Gatsby Benchmark 4

A-Level or equivalent

Careers

- Supports Gatsby Benchmark 4

T' Level Science

Careers

- Supports Gatsby Benchmark 4

Article - Do dolphins like a noisy environment?

Ashleigh Kitchiner

GCSE or equivalent

Physics

Waves in air, fluids and solids

- Sound waves
- Waves for detection and exploration

A-Level or equivalent

Physics

- Sound waves, wave amplitude and intensity
- Progressive waves
- Longitudinal and transverse waves

Article - What are teeth made up of and how does this make you smile?

Diya Ashaq

T' Level Health and Science

- Dental nursing

Article - What do your favourite superheroes or characters have to do with studying science at school?

Amy Smith

GCSE or equivalent

Computer Science

- Programming
- Programming skills
- Representing images
- Algorithms

A level or equivalent

Computer Science

- Fundamentals of programming
- Fundamentals of algorithms
- Theory of computation
- Fundamentals of data representation
- Fundamentals of computer systems
- Consequences of uses of computing
- Fundamentals of communication and networking
- Fundamentals of functional programming

Article - Vaccines, biotherapeutics and... cellular meat?!

Emma Colbeck

GCSE or equivalent and A-Level or equivalent

Biology

- Extension on drug development ideas that are found in GCSE/biology and combined science and post-16 science
- Example of the use of monoclonal antibodies (GCSE Biology, Higher tier only)
- Immune response – post 16 Applied science and biology
- WJEC/EDUQAS resource GCSE Biology Higher tier Monoclonal antibodies. resource.download.wjec.co.uk/vtc/2015-16/15-16_27/pdf/unit05/activities/market-place-cards.pdf

Further reading on RNA vaccines can be found in:

- Compound interest infographic www.compoundchem.com/2020/12/02/rna-vaccines
- The Vaccine Knowledge Project pages including a video animation here: vk.ovg.ox.ac.uk/vk/covid-19-vaccines
- Genomics Education Programme, 'Why mRNA vaccines aren't gene therapies' www.genomicseducation.hee.nhs.uk/blog/why-mrna-vaccines-arent-gene-therapies
- ecdc video www.ecdc.europa.eu/en/publications-data/video-how-do-covid-19-mrna-vaccines-work

A level or equivalent

Biology

- cell recognition and the immune system
- ethical issues associated with the use of vaccines

T' Level Science

Science Core Component

- The diversity of work undertaken in different job roles within the Science sector (including research and clinical testing/trials)
- Links between sample size and effective statistical analysis
- Immunology: the nature of infection including viruses

Specific links Core:

B1.25 Causative agents of infection and examples of resulting diseases

B2.2 The role of DNA bases in the production of amino acid chains, which form proteins

B1.24-1.32 Immunology

Lab sciences:

K1.3 The principles of the 'Universal Ethical Code for Scientists 2007' and how it affects ethical practices in a laboratory setting

Article - The engineer of tomorrow, today

George Fryer

GCSE or equivalent

Careers

- Supports Gatsby Benchmark 4

A level or equivalent

Careers

- Supports Gatsby Benchmark 4

T' Level Science

Careers

- Supports Gatsby Benchmark 4

Article - Zero Emission: Energy from the heat beneath our feet

John Clegg

GCSE or equivalent

Physics

Energy:

- Energy changes in systems
- Energy transfers in a system
- National and global energy resources

Energy Transfers

- Internal energy and energy transfers
- Temperature changes in a system and specific heat capacity
- Changes of state and specific latent heat

A level or equivalent

Physics

Thermal physics

- Thermal energy transfer

Learning notes

Death, destruction and... pollen?!

This article tells the story of the Black Death in medieval times and the use of pollen forensics to track its impact on people and the environment. The story telling approach would make it a suitable text to read aloud in class. The history of medicine context could be used to work collaboratively with a GCSE history teacher and the environmental sampling may tie in with ideas your geography colleagues are tackling. After reading you could do a hands-on pollen investigation to practice using light microscopes and to compare with the electron microscope images in the article.

Learning Task:

If you are confident reading aloud, you could read the article or an adapted version to the class. You might want to pre-teach some of the ideas in the article with help from images in this Science and Plants for Schools (SAPS) powerpoint

The article gives an interesting context for the use of different types of microscopes and to environmental sampling, which you could discuss briefly before looking at some pollen from fresh flowers and comparing what pupils see with the images in the article.

Looking at pollen with a light microscope.

You will need:

- Flowers with large pollen – tulip, daffodil, sunflower, alstroemeria
- Microscope slides
- Cover slips or Sellotape
- Paintbrush or cocktail stick
- Water
- A dropper

Method:

1. Dust some pollen onto the microscope slide using the paintbrush or cocktail stick – you should see a yellow or pale brown dust on the slide.
2. Stick a small piece of Sellotape over the pollen or add a drop of water and cover with a cover slip. Take care not to wash the pollen off.
3. Place the pollen slide on the microscope and look at it with the lowest magnification. When you have a clear view of the pollen try the higher magnification.
4. Try taking a photo of the pollen with the camera of your phone or tablet.
5. Tidy away and wash up the slides, check the stage of the microscope is clean and dry and put it away.

Take your learning further:

You can find additional downloadable, printable pollen electron micrographs and a graphic of how a scanning electron microscope works in 'A close look at pollen grains' here. The article also has more examples of uses of pollen.

Science and Plants for Schools (SAPS) have a student activity that simulates pollen bog core analysis, with a power point of pollen images and information about the techniques described in the article. The power point would be useful for pre-teaching some ideas in the article before reading it.

BBC Bitesize history revision – summaries of Black Death. This one is for AQA, but adding the relevant board to an internet search for 'GCSE history Black Death' brings up the other boards

Take your learning further still:

Find more things to look at with a light microscope in the experiments tab on the Microscopes 4 Schools site. The microscopes tab has a guide to how to use a microscope effectively.

Science and Plants for Schools (SAPS) have a more detailed guide to looking at pollen and air-borne particles here

Explore a pollen library of images at SAPS

To find out more:

CLEAPSS using smart phones in microscopy

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Learning notes

What do your favourite superheroes or characters have to do with studying science at school?

To be convincing, CGI effects must follow 'real world' rules. Objects fall and (sometimes) bounce, light reflects at the same angle it is incident, muscles work in antagonistic pairs, sound and light reduce in intensity over distance...

This activity examines your favourite superhero and abstracts the key rules and information relating to their universe. VFX artists would then use this to programme behaviours of CGI artefacts.

Learning Task:

Choose your favourite superhero and watch them in action. Note down the physical properties they display, such as strength, flight, laser eyes... Now consider any scientific principles that apply to these properties. Newton's Laws of Motion are the ideal place to start. You may need to simplify your abstracted model of the world, in order to apply your knowledge of science... for instance, whether an object bounces elastically, or encounters drag as it moves through the air.

Does your superhero observe these scientific principles when you see them in action? For instance, can you estimate the force required to accelerate a flying superhero, reaching great speed in the blink of an eye?

Take your learning further:

Once you've defined the physical principles and relationships, use a suitable programming environment (such as Scratch, Greenfoot or Kodu Game Lab) and apply them to an 'object'. This might be something simple like a ball (circle), or more complex like an articulated arm. You could make the object move, or act on another object in some way.

Adjust variables until the object behaves similarly to your chosen superhero.

Take your learning further still:

Define a superhero 'object' and define its properties (such as speed, or laser-eye-power) and its behaviours (such as 'punch', 'lift', 'telekinesis'). Use an object oriented programming (OOP) language to simulate the superhero, perhaps building a game.

To find out more:

This collection of free resources provides a good grounding in OOP – see what you can achieve!

Learning notes

Enhance your careers awareness

Linked Article: **All articles**

This edition of Catalyst introduces you to a variety of STEM subject topics and the careers and roles of the contributors, helping to open up the world of potential STEM led careers you could do.

Whether working towards being an engineer or a dentist, creating new vaccines, designing sustainable energy solutions, or monitoring the environment and wildlife, all the contributors had to make decisions about how they would achieve their career goal. Whether that was a career path through university, further education or apprenticeships.

Take every opportunity to research careers and jobs that interest you, ask around and seek advice. The more you find out, the easier it will be to choose the right path for you. And remember, it's ok to change your mind about a career and try something different.

Learning Task:

Green careers and green skills are increasing in importance across every industry and with every employer. Here are four questions to consider and discuss with friends, teachers, and family.

1. What are green careers and green skills?
2. Why are green careers important and how could the jobs or roles of the adults you talk to be more supportive of climate change?
3. Which of the contributors in this edition of Catalyst would you consider to have a green career, how could those not immediately seen as green be more sustainable or be supportive of net zero?
4. Whose career would you most like to have and why?

Take your learning further:

Select one of the articles in this edition of Catalyst and plot a career path that would enable you to achieve a similar career. Consider the knowledge, skills and experience you will need.

Think about:

- What subjects do you need to study or improve?
- What skills does the role need, how could you improve your own skill set?
- How could you make yourself stand out to future employers so they choose you and not someone else?
- How could you gain experience to show you are serious about this career?
- How could this role be more sustainable?

Take your learning further still:

Improve your skill sets, gain experience and increase your knowledge so that you are a candidate that an employer, apprenticeship, further or higher education will want to engage.

Whether you seek opportunities to improve your skill sets or gain valuable experience, keep a record of what you do, when you did it and what you earned from it. This kind of evidence can really help you when completing applications and further demonstrates your commitment and work ethic.

Explore your skill sets:

We asked some of the contributors to think about the key skills they use in their work:

- Amy: Creativity, digital skills, teamwork and problem solving
- Ashleigh: Project management, reading and writing skills, organisation, passion, patience, flexibility and adaptability.

- Emma: Creativity, digital skills, teamwork and problem solving.
- Jess: Aiming high, interdisciplinary research, fieldwork, organisation, writing to publishable standards, team work, delegation of work
- John: Problem solving, creativity, staying positive and aiming high

Consider which skills you use in your school studies, how could you help develop these key transferable skills that employers, further and higher education value? You could try the Skills Builder essential skills as a tool to assess your current skills and identify ways to improve them.

Gain experience:

Consider ways to gain experience of the career or job you want, choose one or two opportunities, and be proactive, gain experience and enhance your knowledge. Here are some suggestions:

- Work experience
- Job shadowing
- Online courses
- Read articles
- Talk to company's and individuals
- Attend lectures or seminars
- Site visits

Demonstrating your commitment, interest and abilities helps you to stand out from the crowd and shows your willingness to go that bit further to achieve your goal. These are traits that all employers will look for whichever career path

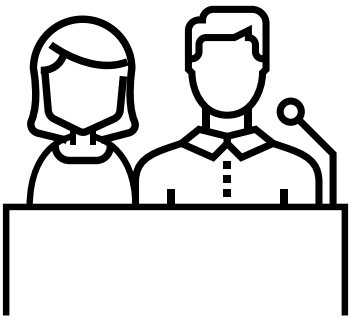
Meet our authors and 1000's of inspiring STEM role models like them!

Many of the Catalyst authors are volunteers in the STEM Ambassadors programme.

STEM Ambassadors are inspiring volunteers from industry and university, situated across the UK who can support young people and educators by providing talks, mentoring and engaging STEM activities.

For example, you could request a STEM Ambassador to:

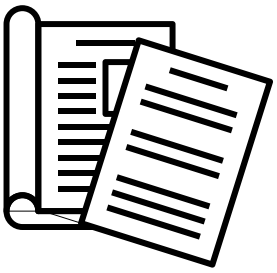
- provide an online talk for your class
- judge a STEM competition in your school or college
- attend a parents evening and talk about careers linked to STEM subjects
- run a practical activity for a STEM subject club



Bring the power and inspiration of STEM Ambassadors to your classroom, free of charge:

- visit the STEM Ambassador website (**www.stem.org.uk/stem-ambassadors**)
- use the STEM Ambassador app (search STEM Teacher on your app store).

If you need help getting started, contact your local STEM Ambassador Hub: **www.stem.org.uk/stem-ambassadors/local-stem-ambassador-hubs**



Thank you

We hope you enjoyed Catalyst, and matching learning notes. If you have any feedback, or ideas for topics you'd like to see covered in future editions, please email:

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Join us on Twitter **@STEMLearningUK**

Visit our website **www.stem.org.uk/catalyst**