Science Spotlight

Issue 5 - Summer 2015

In this issue:

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Summer update

What's in this issue?

Welcome to the summer 2015 issue of Science Spotlight. We are close to submitting our new GCSE Science qualifications and we will be hosting free EXPO events around the country through June and July to tell you more about what we have developed. There will also be an opportunity to talk to colleagues from the University of York Science Education Group who have been working with us on our new Twenty First Century Science GCSEs and also time to explore what resources will be available (**cpdhub.ocr.org.uk/expo**).

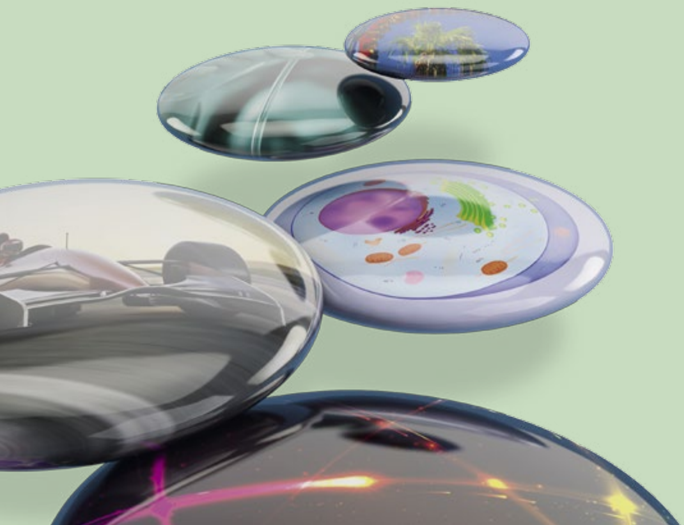
In this issue, amongst other items we have: Mary Whitehouse talking about the use of models in science, Sir John Holman looking at why we should encourage young people to study science, a summary of our recent Practical Endorsement launch event at the Royal Institution and an interview with Kirsten Evans, Head of Biology.

Continuing our theme of pull-out resources, in this issue to help your students understand what happens when a radioactive nucleus undergoes decay and why this is the key to grasping nuclear equations.

As always, if you have an idea for a future article please email us at **sciencespotlight@ocr.org.uk**

Good luck with the summer examinations and we look forward to meeting you at our summer EXPOs and helping to support you deliver the new qualifications starting from September 2015.

Steve Evans



Update

Steve Evans, Head of General Qualifications Reform, OCR

More details of our offer will be appearing on our web pages over the summer, **www.ocr.org.uk/science**

A Level Sciences

Our recent Practical Endorsement launch at the Royal Institution (see page 17 in this issue and **ocr.org.uk/positiveaboutpractical**) was a great opportunity to talk to teachers about what we have developed and hear their views on how the new approach to practical assessment might work and what support they might like. Following this event, a selection of our draft practical activities (PAGs) have been published along with draft Practical Skills Handbooks and a practical activity tracker. Examples are available from the new Science Coordinator pages on **interchange.ocr.org.uk**. If you do not currently have access to Interchange please email **positiveaboutpractical@ocr.org.uk** for the files (including a contact name and centre number). This summer there is also an article in School Science Review summarising our approach to the new Practical Endorsement (June 2015, volume 96, issue 357, p. 59, **www.ase.org.uk/journals/school-science-review**).

Later this term a cross-awarding body letter will be issued to all centres confirming the administrative arrangements for the Practical Endorsement. If you do not receive this letter we will also include a copy on our webpages, **ocr.org.uk/positiveaboutpractical**.

A Levels in Geology, and Health and Social Care

You will have seen from Ofqual's May announcement, that AS/A Level Geology has been given initial approval to start development work for first teaching from September 2017. Our Geology (Chae Cruickshank) and Health and Social Care (Zahra Amlani) Subject Specialists are currently working with other exam boards and wider stakeholders to draft updated criteria for these subjects. If you have any thoughts or would like to be involved with this work please email us at **science@ocr.org.uk**. Within the same Ofqual announcement you will see that Ofqual has not approved Environmental and Land Based Science (ELBS) for development for 2017. We are currently reviewing what we may be able to do in this area.

Engaging learners and supporting teachers in a world of STEM

With an increasing demand for innovation in UK industry, STEM is becoming more important. A holistic approach to teaching STEM subjects provides an opportunity for students to make informed decisions about their subject choices and the link to potential careers.

At OCR we provide a wide range of STEM qualifications that can be delivered through a project approach that suits the needs of all students and enabling young people to develop the necessary skills and knowledge in school to succeed at university and in employment.

The OCR STEM resources

Our web-based digital resource provides a project-based learning approach to STEM and supports the full ability range with exciting and challenging projects. The STEM project is not a qualification, but is a programme of study designed to:

- provide a structured transition from Key Stage 3 to Key Stage 4
- deploy a project-based learning approach to both engage students and encourage independent learning
- support the full ability range with a mixture of structured and open-ended activities
- support the introduction of the new GCSE STEM qualifications from September 2016, (and in particular support those who are starting delivery in year 9 from September 2015)
- develop 'soft' skills that are valued by employers and FE/HE alike
- map all content to OCR STEM qualifications enabling easy integration into GCSE and vocational schemes of work, signpost relevant high-quality third party resources from a range of sources including businesses, universities and the National STEM Centre.
  Want to know more? Contact **stem@ocr.org.uk**

New GCSE changes at a glance

(correct at time of press)

Aspect	
First teach	September 2016
First assessment	June 2018
Grading	9 to 1 for Biology, Chemistry, Physics 9-9 to 1-1 for Combined Science
Tiering	Higher (covering grade 3 to grade 9) Foundation (covering grade 1 to grade 5)
Proposed maths weightings	Minimum 10% Biology Minimum 15% Chemistry Minimum 20% Physics Minimum 15% for Combined Science
Assessment time	Minimum 3.5 hours (Biology, Chemistry, Physics) Minimum 7 hours (Combined Science)
Marks for assessment of practical within written exams	Minimum 15%
Practical assessment	Does not contribute to the grade. Assessment within the examinations plus a requirement to carry out a: • minimum of 8 practical activities covering a list of defined skills and techniques (Biology, Chemistry, Physics) • minimum of 16 practical activities covering a list of defined skills and techniques (Combined Science) • The coverage of practical skills mirrors the approach you will have seen in the A Level Sciences and we are developing our qualifications to ensure a good progression from our GCSEs to our A Levels

Why study science?

Professor Sir John Holman, University of York and Chair of the Salters' Institute Board

When a student asks you 'Why do we have to study science?', what do you answer? '

Jobs, jobs, jobs

'Because it's compulsory' won't do with today's savvy and independent-minded students.

Instead, how about 'Because it can get you a better job'? The facts are clear: people with qualifications in STEM (Science, Technology, Engineering and Maths) earn more and have more opportunities. The Social Market Foundation says the UK economy needs an additional 40,000 STEM graduates per year – and the need is even greater for people with technical skills. Over the next ten years nearly 500,000 extra job opportunities will be available for people with higher technical skills.

The demand for STEM qualifications means that they command higher salaries. The chart shows that the average annual earnings of STEM graduates is significantly higher than for non-STEM graduates (the figures are from 2008, but the pattern is the same in 2015).

And STEM qualifications are in demand in every sector of employment – not just in science and engineering. STEM qualifications open opportunities in retail, hospitality, finance and across the whole economy, with opportunities to travel, meet people and work outdoors, not just in labs.

We need to be telling young people about this wealth of opportunity from STEM qualifications. For students from well-off homes, they may be getting this message from family and friends, but if no-one in your family has ever had a skilled job, how would you know? This is why career guidance in schools is so important for social mobility, as I discovered in my international study of Good Career Guidance .

Making the world a better place

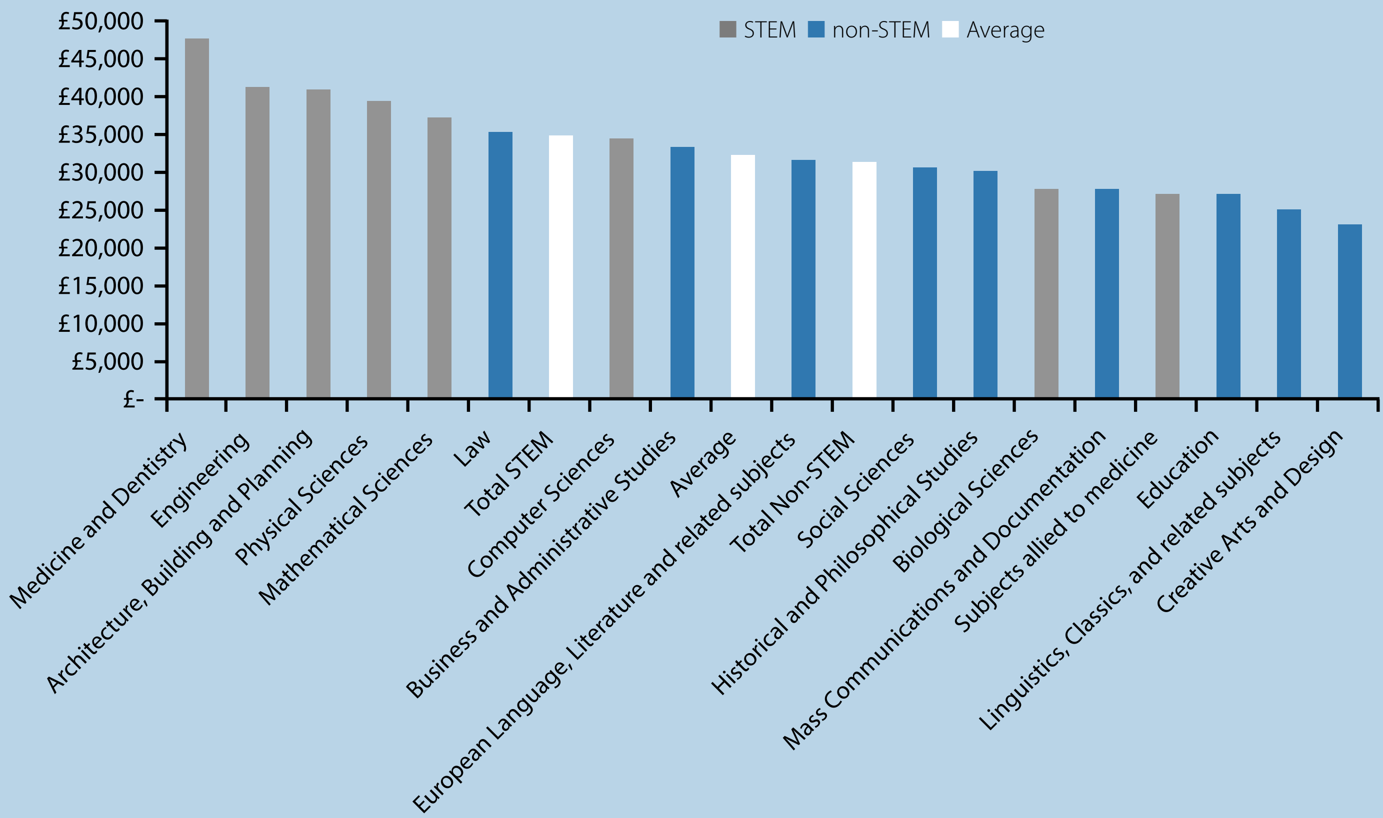
If the lure of a well-paid job doesn't work, you could try appealing to your students' higher principles. If they are anything like the undergraduates I teach, many of them have a strong motivation to make the world better. Tell them about the way science has fought Ebola and is winning and how it will make cheap solar power available to everyone (it's a matter of when, not if).

I realise all this is easier said than done, with headteachers wanting ever more from GCSE and A Level results, and Ofsted's shadow hanging over all. That's why I believe policymakers need to look very carefully at school accountability systems. We need to ask whether using exam results as the main way of holding schools to account is counterproductive, when we need so many youngsters to be inspired to study science, not just because it's compulsory, but because it shapes their future.

Sir John Holman teaches chemistry to undergraduates at the University of York

Good Career Guidance, the Gatsby Foundation 2014
www.gatsby.org.uk/GoodCareerGuidance

Average Annual First Degree Graduate Earnings by Subject



Source: Labour Force Survey, Q2 2008, 16-59/64 employees only, UK

Science and models

Mary Whitehouse, Project Director for Twenty First Century Science

Models are going to play an increasing role in the new GCSEs for science. Here, Mary Whitehouse looks at the importance of science models and how we can help students get to grips with them.

Getting back to basics

In the new Criteria for GCSEs in Science (from 2016) it states that students should:

- understand how scientific methods and theories develop over time
- use a variety of models such as representational, spatial, descriptive, computational and mathematical to solve problems, make predictions and to develop scientific explanations and understanding of familiar and unfamiliar facts.

So what does this mean for science teachers?

In these statements there are two implicit roles for modelling. Students should:

- understand that modelling is an essential part of the scientific process
- use models to help them understand scientific ideas.

Why we use scientific models

Models are essential to the production, dissemination, and acceptance of scientific knowledge; they help us to visualise, and so better understand, abstract ideas (Gilbert, 2004). Scientists use informal mental models as they develop explanations; by the time they share their ideas with a wider audience their model will have become more refined.

The story of scientific theories

For a scientific model to be accepted, it must fit the known observations and also correctly predict outcomes of new experiments. Often the accepted scientific model changes as more evidence is discovered (see box) and we can use these stories as examples of how (and why) scientific theories develop over time.

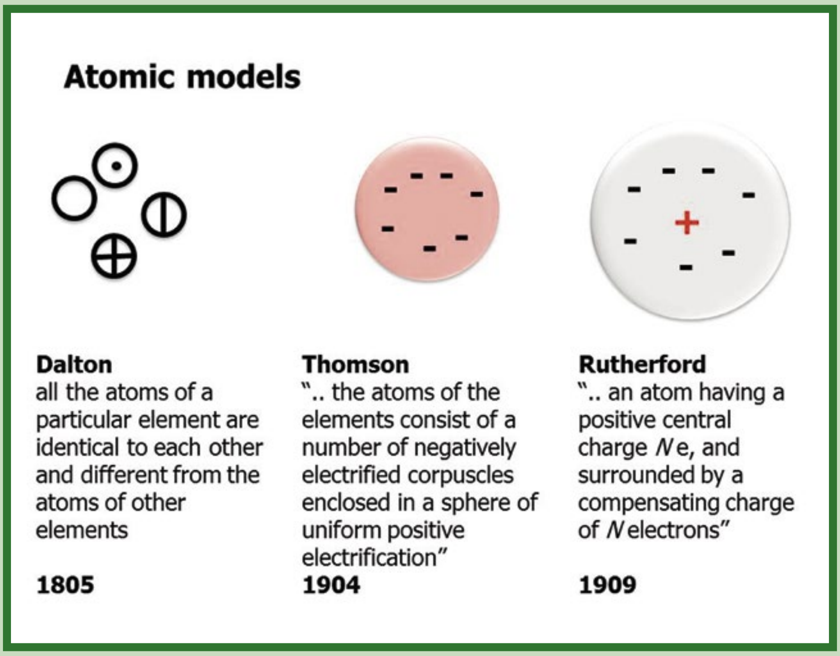
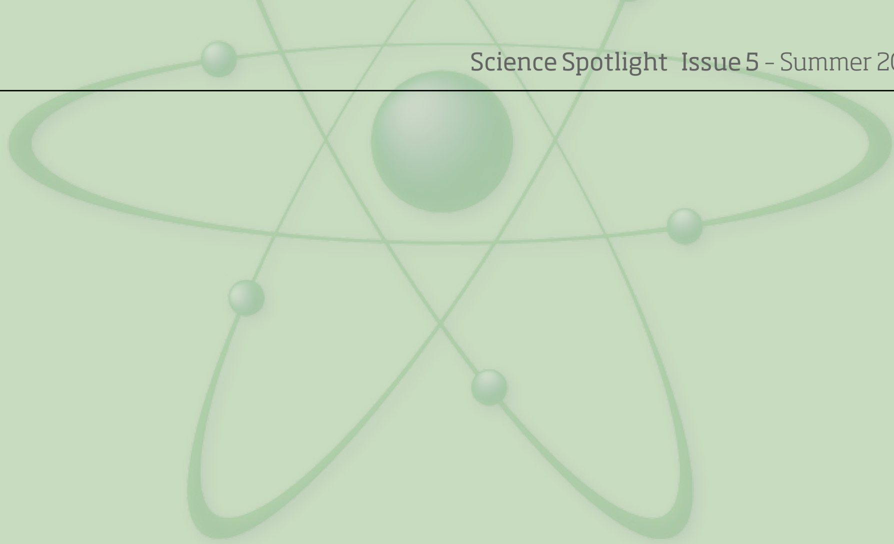


Figure: Atomic models



The art (and science) of simplicity

A key feature of accepted scientific models is that they are parsimonious; scientists prefer the simplest explanation that covers all the observations (this is known as Occam's Razor). This requirement is a good reason for accepting Copernicus' heliocentric model of the solar system over the complex system of epicycles that were needed to explain the observations of the planets if the Earth was at the centre.

Perhaps the ultimate paring down of a model is the representation of a scientific explanation by a series of mathematical equations. In the process of developing his theory about electromagnetic waves, James Clerk Maxwell hypothesised that electromagnetic waves travelled in an aether. By the time he had completed his theory and described the behaviour of electromagnetic radiation with four equations, the aether was no longer needed; it had been part of his mental model to visualise the problem, but the four equations summarised the relationships completely (Morrison, 2014).

Part of our toolkit

So mathematical models are an important part of the scientist's toolkit. But sometimes the mathematics gets complex – so many variables, so many boundary conditions to be defined; carrying out calculations to test the model becomes too complex to be done by hand. An example of this is using supercomputers to model climate change, which has enabled meteorologists to test their climate models in a way that would have been impossible in earlier times.

Using models in teaching science

Teachers use models in teaching science all the time, but we don't always make this explicit to the students.

We use representational models to help a student visualise an idea, a system, or a process. Sometimes these representations are analogies – making links between an abstract idea and a real-world situation that is familiar to students.

Take, for example, an electric circuit…

A common use of analogies is to describe what is happening in an electric circuit. In the rope model for an electric circuit, a loop of rope represents the charge and a person pulling the rope represents the battery. In the scientific model, electric charge exists all round the circuit; when the circuit's closed all the charge begins to move at the same time. A student who can explain the analogy and its weaknesses will show some understanding of electric circuits.

We also use historical models – at Key Stage 3, Dalton's model of an atom is sufficient to explain a simple particle model of matter. The model needs to become more sophisticated as students progress, and we should make it clear that the reason we're moving from a solid sphere atom to a nuclear atom model is that a more detailed model is needed to explain more complex ideas.

So what about at GCSE level?

There are opportunities in GCSE science to introduce mathematical and computational models; there are the equations of motion in physics, and in chemistry, students can make simple models to predict what happens when rates of reaction change. In biology, simple spreadsheets can be used to model what happens to populations of predators and prey when conditions change (Carson, 1996).

Of course, models are also part of everyday language including Lego® models, role models and fashion models. If we talk about models in science from the beginning and make explicit links between these different uses of the word, we might help students understand what we mean by a model.

References

Carson, S.R. (1996). Foxes and rabbits – a spreadsheet School Science Review 78(283), 21-27

Gilbert, J.K. (2004). Models and Modelling: Routes to More Authentic Science Education. International Journal of Science and Mathematics Education, 2(2), 115–130

Morrison, M. (2014). Fictional models in science, Physics World, February 2014, (29-31)

Cluster together

Chae Cruickshank & Crawford Kingsnorth

OCR Subject Specialists

What is a cluster?

A cluster is a group of local schools all doing the same OCR science specification (Gateway or Twenty First Century). They meet together as often as they feel they need to. They are a mutually supportive group. They are managed at the local level by cluster coordinators. They rely on the wisdom of crowds or collective wisdom. If you have a question that you cannot answer within your school science team, it is very likely that someone from your cluster can.

OCR has been using science cluster groups to support and share information and advice since 2006. We believe it is an invaluable resource that we would like to expand further to include all schools that wish to.

Are you a member of a cluster?

If you are not sure whether your school is a member of a cluster, please contact us and we will check our database **sciencegcse@ocr.org.uk**. Most schools that ask find they are already attached to a cluster, but have lost contact, typically with changes in staff.

How can you join a cluster meeting?

If we find that your centre is not a member of a cluster then we will give you the name of you closest cluster coordinator. Please feel free to contact them and ask to join.

The role of the cluster coordinator

Cluster coordinators arrange the meetings and typically provide the venue. This means that they have some work to do in contacting centres and booking rooms (often with refreshments). The advantage is that they have the least distance to travel to the meeting.
Many cluster coordinators are junior members of science departments with the time and energy to devote to networking and peer support between schools.

What is done at cluster meetings?

We have had groups helping each other with:

- 6 mark questions
- Scientific language
- Controlled assessment moderation.

Once a year you can request a visit from a Science Subject Specialist from OCR to answer any of the questions the cluster cannot.

Clusters have also been used by teachers to feed back comments directly to OCR. We do listen; comments from OCR science teachers have led to a number of different research projects: they have influenced the design of our new GCSEs to give pupils a more positive "I can do science" exam experience and the need for a Y9 transition to GCSE has led to the STEM resource project.

Who should attend?

Anyone is welcome to attend. We do not restrict the numbers to one per school. It has always been the case that generally the head of science or a departmental head attends. You might consider sending a younger member of the team, possibly even an NQT, who can report back at a departmental meeting. An Inner London cluster arranged for one of our subject specialists to run a CPD on delivery of practicals which brought together teachers, science technicians and support staff from seven schools.

Can we set up a new cluster?

Of course. For example if you are part of an academy chain, then why not set up a chain for your academy? If your cluster is becoming too big then feel free to split into smaller, more local clusters.

Alternatives

With the advent of social media you can get many of your questions answered by our Twitter feed **@OCR_Science**. We are developing a Facebook cluster that you will be able to join up to. Here we will be able to provide many of the advantages of the cluster group.

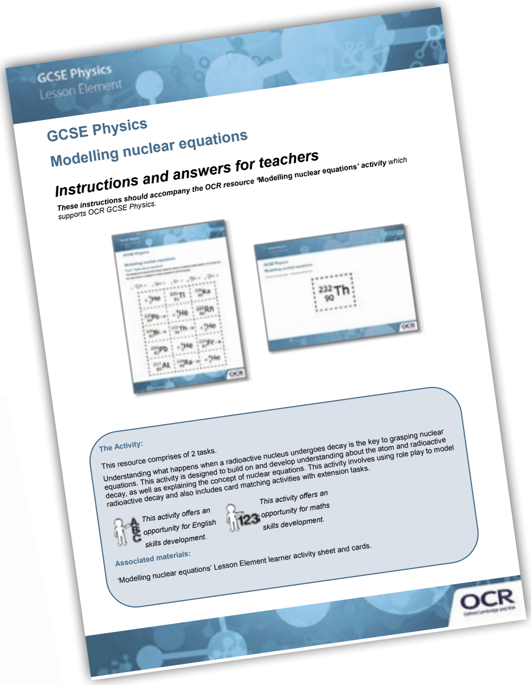
Pull-out Resource Extract

Modelling nuclear equations

This is a sample of the GCSE Physics lesson element 'Modelling Nuclear equations'. To download the full lesson element visit the GCSE Chemistry qualification page at **www.ocr.org.uk/qualifications/gcse-twenty-first-century-science-suite-physics-a-j245-from-2012**

Understanding what happens when a radioactive nucleus undergoes decay is the key to grasping nuclear equations. This activity is designed to build on and develop understanding about the atom and radioactive decay, as well as explaining the concept of nuclear equations.

These are essentially card matching activities designed to assess learners' understanding of how to construct nuclear equations. They can be completed individually, in pairs or larger groups; as a race or completed within a set time. Assessment can be formal via the board or peer assessed by encouraging learners to evaluate each other's work.


GCSE Physics
Lesson Element

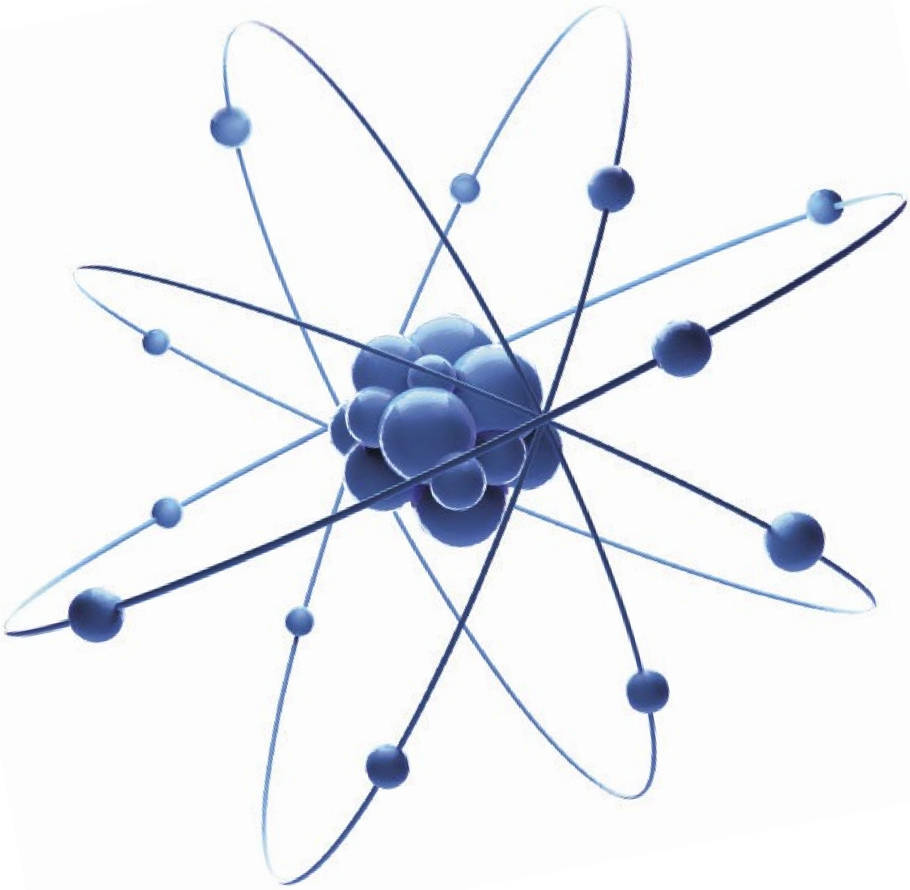
GCSE Physics
Modelling nuclear equations
Instructions and answers for teachers
These instructions should accompany the OCR resource 'Modelling nuclear equations' activity which supports OCR GCSE Physics.

The Activity:
This resource comprises of 2 tasks.
Understanding what happens when a radioactive nucleus undergoes decay is the key to grasping nuclear equations. This activity is designed to build on and develop understanding about the atom and radioactive decay, as well as explaining the concept of nuclear equations. This activity involves using role play to model radioactive decay and also includes card matching activities with extension tasks.

This activity offers an opportunity for English skills development.
This activity offers an opportunity for maths skills development.

Associated materials:
'Modelling nuclear equations' Lesson Element learner activity sheet and cards.

OCR



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Task 1 Alpha decay equations

The following five isotopes will undergo radioactive decay by emitting an alpha particle. Cut out and use the cards below to complete the nuclear equations for all five isotopes.

1. $^{232}_{90}Th \rightarrow$ 2. $^{224}_{88}Ra \rightarrow$ 3. $^{221}_{87}Fr \rightarrow$ 4. $^{209}_{83}Bi \rightarrow$ 5. $^{210}_{84}Po \rightarrow$

$+^{4}_{2}He$	$^{205}_{81}Tl$	$^{228}_{88}Ra$
$^{210}_{84}Po \rightarrow$	$+^{4}_{2}He$	$^{220}_{86}Rn$
$^{209}_{83}Bi \rightarrow$	$^{232}_{90}Th \rightarrow$	$+^{4}_{2}He$
$^{206}_{82}Pb$	$+^{4}_{2}He$	$^{221}_{87}Fr \rightarrow$
$^{217}_{85}At$	$^{224}_{88}Ra \rightarrow$	$+^{4}_{2}He$

Task 2 Beta decay equations

The following five isotopes will undergo radioactive decay by emitting a beta particle. Cut out and use the cards below to complete the nuclear equations for all five isotopes.

1. $^{210}_{82}Pb \rightarrow$ 2. $^{206}_{80}Hg \rightarrow$ 3. $^{14}_{6}C \rightarrow$ 4. $^{210}_{83}Bi \rightarrow$ 5. $^{209}_{82}Pb \rightarrow$

$+\ ^{0}_{-1}e$	$^{14}_{6}C \rightarrow$	$^{210}_{84}Po$
$+\ ^{0}_{-1}e$	$^{206}_{81}Tl$	$+\ ^{0}_{-1}e$
$^{210}_{83}Bi \rightarrow$	$+\ ^{0}_{-1}e$	$^{210}_{82}Pb \rightarrow$
$^{210}_{83}Bi$	$^{14}_{7}N$	$^{209}_{82}Pb \rightarrow$
$^{209}_{83}Bi$	$^{206}_{80}Hg \rightarrow$	$+\ ^{0}_{-1}e$

Extension activities

Task 1 Thorium-232 decay chain

Most radioactive nuclei undergo a series of radioactive decay transformations before finally becoming a stable nucleus. Such a series of transformations is called a decay chain. Thorium-232 is just a radioactive element that experiences several before becoming a stable nucleus. Below is the incomplete decay chain for thorium-232. Using your knowledge of alpha and beta decay and a periodic table of the elements, complete this decay chain identifying the final and stable isotope.

$$^{232}_{90}\mathrm{Th} \longrightarrow {}^{228}_{88}\mathrm{Ra} + {}^{4}_{2}\mathrm{He}$$

$$^{228}_{88}\mathrm{Ra} + \longrightarrow \boxed{\quad\quad} + {}^{0}_{-1}\mathrm{e}$$

$$\boxed{\quad\quad} \longrightarrow \boxed{\quad\quad} + {}^{0}_{-1}\mathrm{e}$$

$$\boxed{\quad\quad} \longrightarrow \boxed{\quad\quad} + {}^{4}_{2}\mathrm{He}$$

$$\boxed{\quad\quad} \longrightarrow \boxed{\quad\quad} + {}^{4}_{2}\mathrm{He}$$

$$\boxed{\quad\quad} \longrightarrow \boxed{\quad\quad} + {}^{4}_{2}\mathrm{He}$$

$$\boxed{\quad\quad} \longrightarrow \boxed{\quad\quad} + {}^{4}_{2}\mathrm{He}$$

$$\boxed{\quad\quad} \longrightarrow \boxed{\quad\quad} + {}^{0}_{-1}\mathrm{e}$$

$$\boxed{\quad\quad} \longrightarrow \boxed{\quad\quad} + {}^{0}_{-1}\mathrm{e}$$

$$\boxed{\quad\quad} \longrightarrow \boxed{{}^{208}_{82}\mathrm{Pb}} + {}^{4}_{2}\mathrm{He}$$

Task 2 Uranium-235 decay chain

The isotope ^{235}U decays into another element, emitting an alpha particle. What is the element?

This element decays, and the next, and so on until a stable element is reached. The complete list of particles emitted in this chain is:

$$^{235}_{92}\mathrm{U} \rightarrow [\alpha, \beta, \alpha, \beta, \alpha, \alpha, \alpha, \alpha, \beta, \alpha, \beta] \rightarrow \mathrm{X}$$

What is the stable element X? You could write down each element in the series, but there is a quicker way; can you work it out?

To give us feedback on, or ideas about the OCR resources you have used, email resourcesfeedback@ocr.org.uk

Q & A: meet the Head of Biology

We caught up with Kirsten Evans, the newly appointed Head of Biology, and asked her about her role.

Q: Can you remember how you felt when you were offered the position?

A: I was surprised and excited to receive the call to offer me the job as Head of Biology. When I submitted my application, I knew that having only been a teacher for a few years meant that I might not be able to compete against those with greater teaching experience. I had decided that this was the next step I wanted to take with my career and at the very least, the interview would provide me with a good opportunity to find out how to progress.

When I met the other candidates, I was the most inexperienced but I was given the opportunity to discuss how I might deal with the challenges of managing teachers with far greater experience when I was interviewed. I still thought that my inexperience would prevent me being offered the job, hence my surprise at the offer. You have to put yourself forward for these opportunities if you want your drive and determination to be recognised.

Q: Have you enjoyed your new role?

A: I have enjoyed making the transition to this new role. I have relished the opportunities to shape the Biology department and to have input into the running of the Science department as a whole too. It hasn't been without its challenges and difficult decisions but it is very satisfying to see progress being made, particularly if this is reflected in examination results. I feel very fortunate to be managing a team of passionate, progressive teachers and working alongside them continues to be a great experience.

Q: What is the most rewarding part of your job?

A: Overall, I would say that the most rewarding part of my job has remained the same throughout my career so far and that is to see students making progress and achieving their goals. To hear how much students enjoy a subject is always rewarding but I am now in the privileged position to hear about this across the department.

Alongside this, it is great to see a new initiative being implemented successfully. For example, at A Level, we have created student lab books. These are in part like a hand book but also contain a set of core practical tasks that the students will complete throughout the year. We based these tasks on the practical tasks outlined in the specification (HSW5) and tried to ensure that we built in opportunities for students to practise and develop the skills that are needed to be successful in the practical modules. It is really rewarding to see a project that you have worked on receive positive student feedback and also make a valuable impact on student learning and progress.

Q: How did you choose the GCSE controlled assessment for this year?

A: We started by trialling the controlled assessment options that were available to help us see how students might interpret and carry out the different tasks. It is important that they are able to collect data that is repeatable so that they have confidence in the experiments they are planning. We also took into consideration where the tasks link in to the specification as the students must have covered sufficient theory in lessons so that they have an adequate grounding in the principles that underpin the task. It is also vital that the controlled assessment is accessible to all but offers opportunities for stretch and challenge as well. It is something that we discuss in departmental meetings to ensure that we make the right decision for each cohort of students.

Q: How did you choose the A Level controlled assessments this year?

A: I think that it is vital to keep all options open with controlled assessment at A Level. As there are three different tasks available for each skill, it is realistic to expect that some students will want to complete all three opportunities to maximise their chances of success within each module. As with the GCSE controlled assessment, trialling the tasks is important. It helped us to identify the skills that students would need to develop within their biology lessons and also meant that we could collect exemplar teacher data that we could submit alongside the moderation sample.

Q: How did you manage the delivery of the controlled assessment this year?

A: As I started the role as head of department, I began teaching the OCR specification at A Level and the controlled assessment was quite different to the controlled assessment that I had prepared students for previously. Reading through all of the guidance and documentation from OCR was essential to ensure that all procedures were followed correctly. At the end of the last academic year, we sat down as a department and planned our route through the specification alongside the controlled assessment task titles.

Q: Name one thing that has given you a sleepless night and how did you resolve it?

A: Preparing the sample of controlled assessment for moderation was something that I worried about a lot. You feel a lot of responsibility as controlled assessment has the potential to have a big impact on a student's final grades. The department had worked hard throughout the year to ensure that the work was moderated and that we were confident in our marking. Asking for help from other members of the team to double check and verify all of the annotations and paperwork really helped.

Q: Do you feel that your teaching has improved or suffered this year?

A: At times, I feel that my teaching has suffered as a consequence of taking on this new role. Even though as a head of department you have a slight reduction in timetable, you can face new challenges including setting cover, dealing with behavioural issues, supporting other members of staff and the students that take your subject. This does mean that planning and preparation time is rarely your own! I have tried to ensure that I have taken opportunities to continue developing and improving my teaching. Getting involved with teaching and learning communities is a good way to meet other teachers outside of those in your department and share ideas. Attending CPD and sharing good practice in departmental meetings helps to develop skills and provide inspiration for new teaching ideas. Observing other members of the department has been an excellent opportunity to see the different ways in which teachers deliver the GCSE and A Level syllabus and reminds you to reflect on your own lessons.

Q: How is your department going to deal with the GCE/GCSE changes?

A: We have started by looking at the similarities between the courses that we run and the new specifications. We want to make sure that the great lesson ideas and resources that we already have are not lost with the upcoming course changes. We can then use future planning and preparation time to work on new areas of the course. In the summer term, we will create a new teaching overview and plan in time for controlled assessments. When planning for the new AS qualification, we will plan in the opportunities students will need to achieve the Practical Endorsement.

I have also been along to the training sessions run by OCR to find out first-hand about the changes being made to courses. It is a great opportunity to ask questions and to find out how other schools are dealing with the changes.

Q: In your first year did you ever feel that you have been 'over-promoted'?

A: There were definitely times within my first year of the job when I felt overwhelmed by the volume of work and the new responsibility of decision making. The realisation that the choices you make impact a much greater percentage of the student population can feel daunting. I think that it is important to remember that you were selected on the interview day for a reason and that when you are newly promoted, you aren't expected to know everything straight away. Taking time to evaluate and seeking feedback from the department helps to identify areas to improve on in the future.

Q: If you had a magic wand, what would you change about your job?

A: I would ask to have more hours in the day! It can be difficult to balance a teaching timetable with the administration, coordination and responsibilities that come with a head of department role.

Q: What one golden nugget piece of advice would you give to a newly promoted teacher?

A: Communication is key. Don't be afraid to ask questions and seek advice, especially with the parts of the job that are new to you. Also, be sure to listen. Listening to the opinions and expertise within your department is vital for team cohesion and will help you to make balanced and informed decisions.

Practical science lives on at the Royal Institution

Neil Wade, Subject Specialist, OCR

Consider our new Science 'B' specifications for all these reasons…

On Friday 6 February, we launched our Practical Endorsement at the Royal Institution.

This prestigious venue boasts that "Science Lives Here", having been home to Humphrey Davy, Michael Faraday and numerous other key scientific figures.

The overwhelming response from guest speakers and the audience was that practical work is an essential element in teaching and learning and that our Endorsement provides an opportunity to increase the amount and variety of practical work undertaken at A Level. As Steve Jones, Director of CLEAPSS, said, "We have to be honest about previous attempts to assess practical aspects of science and reconnect with the real reasons for doing practical work with pupils."

Here are some of the key points we heard from our speakers on this fascinating day.

The scene was set by Mark Dawe, Chief Executive of OCR, who said that we're intent on making our new Practical Endorsement a success. He also commented that while OCR's an assessment organisation, we're also committed to meeting the requirements to support practical science in the classroom, linking our assessments to teaching and learning.

Tim Oates CBE, Group Director of Assessment Research and Development with Cambridge Assessment, outlined the role of practical activity in pedagogy and how the current system of assessment has fallen into disrepute. He concluded that our newly accredited A Levels in the sciences provide a solution for our time, and our set of circumstances.

Dr Rachael Sharpe of the University of Lincoln spelled out the different approaches of direct and indirect assessment of practical skills in the new specifications, where 15% of the examination marks are the indirect assessment of practical skills, while the practical skills are directly assessed and separately reported. Rachael commented that it was amazing to see these ideas finally coming to fruition, releasing teachers to be free to carry out more practical science than many schools currently do.

Steve Jones provided a very entertaining take on the value of practical activity in learning, while continuing the challenge to define why practical work's being used. He reminded us that the intention of practical work isn't to amuse students or fill time, but to provide cognitive challenge or to develop skills and techniques.

This challenge was addressed almost immediately as Neil Wade, one of our Physics Subject Specialists, detailed reasons why we use practical work in science and linked these to typical activities in the sciences. He then detailed the links between pedagogy and our Endorsement before Rachael Tomkins, one of our Chemistry Subject Specialists, spelled out the detail of how our Practical Endorsement works.

Frances Evans of the ASE, detailed experience and ideas of moderation, verification and the transition to monitoring. Her opinion was that with practical workload spread across the whole school year rather than in assessment windows, the technician workload would be reduced. Teachers would also see changes, particularly removing the defined practical tasks that are separated from the teaching and learning.

Finally, Sarah Old, one of our Biology Subject Specialists, explained how the Practical Activity Group Tracker works. This automated spreadsheet's designed to assist teachers to monitor their students and provide the detail they need to fulfil their requirements for the Practical Endorsement.

Talking at the launch with the representatives of professional institutions, educational charities and teachers, who were overwhelmingly positive about the Practical Endorsement, the only question remaining is why the press continue to only report the negative?

Find out more - **ocr.org.uk/positiveaboutpractical**

Mark Dawe addressing the Audience at The Royal Institution

Research notes

Dr Frances Wilson, Principal Researcher, OCR

Ten key aims for practical work

Practical work is central to teaching and learning in science and may serve many different purposes.

Kirschner and Meester (1988), for example, drew up a list of 120 different specific objectives for practical work. More recently, Abrahams and Saglam (2010) drew up a list of 10 aims for practical work (adapted from Kerr, 1963):

- To promote accurate observation and careful recording
- To promote simple, common-sense, scientific methods of thought
- To develop manipulative skills
- To give training in problem solving
- To fit the requirements of practical examination regulations
- To elucidate the theoretical work so as to aid comprehension
- To verify facts and principles already taught
- To be an integral part of the process of finding facts by investigation and arriving at principle
- To arouse and maintain an interest in the subject
- To make physical phenomena more real through actual experience.

Why do we use different types of practical activity?

While all these different aims for practical work might be considered more or less important, it's clear that not every practical activity can meet all of them. Domin (1999) classified practical activities into four broad categories (Table 1), according to three factors: the outcome, approach and procedure. For example, a practical activity may have a 'right' or predetermined outcome, or may have a range of possible satisfactory outcomes. It may require students to derive rules and principles on the basis of their observations (inductive), or draw on pre-taught knowledge.

The inductive approach was a key feature of Nuffield Science (Duggan & Gott, 1995), and is also known as an enquiry approach. Additionally, the procedure that students follow may be given to them to follow, or devised (in part) by the students themselves.

These different types of practical activity may serve different purposes: an expository practical allows students to practise a technique, and apply knowledge that they've already been taught, potentially reducing working memory demands, which may support learning. At the other extreme, an inquiry practical allows students to develop their own procedure, and discover principles and rules for themselves. An investigation into the types of practical work most commonly undertaken by first-year chemistry undergraduates found that the most frequently used type of practical work in timetabled classes was expository (Mewis, 2011).

Table 1: Categorisation of practical activities according to Domin (1999).

Style	Outcome	Descriptor	Procedure
Expository	Predetermined	Deductive	Given
Inquiry	Undetermined	Inductive	Student generated
Discovery	Predetermined	Inductive	Given
Problem-based	Undetermined	Deductive	Student generated

The impact of assessment

The assessment of practical work in science has a big impact on the types of practical work that students undertake in class, and the extent to which the aims for practical work are met. It's become clear that the current assessment models for practical work at both GCSE and A Level aren't working: teachers state that their practical activities are distorted by controlled assessments, and reduce time for other practical work, so that students may not have the opportunity to undertake a wide range of practical activities (Abrahams, Reiss, & Sharpe, 2013).

The findings from the cross-awarding body trial of the new model of practical assessment at A Level indicated that the new model will allow teachers more flexibility in the types of practical work they do, and support the inclusion of a wider range of practical activities. It may also help to prepare students for university study, by encouraging the use of a lab book. You'll find a summary of the trial findings, including a video and summary report on our Positive about Practical website: (**ocr.org.uk/positiveaboutpractical**).

Get involved

Despite our optimism about the new model for practical assessment, we think it will be crucial to gather some robust evidence about whether it's working, and where it could be improved, so we've set up a long-term research project to investigate. The first step is to gather some baseline data: we won't know what effect the changes are having if we don't have a firm basis for comparison.

We've developed a questionnaire to survey teachers' views on practical work at GCSE and A Level, to find out what types of practical work teachers are doing, why they're doing these, and what challenges they face. We'll repeat this questionnaire annually as the reforms are introduced, and compare the findings from year to year. Your views, and your colleagues' views are vital to this study. If you can spare 15 minutes to contribute to the research, please visit:
www.surveymonkey.com/s/pracsci

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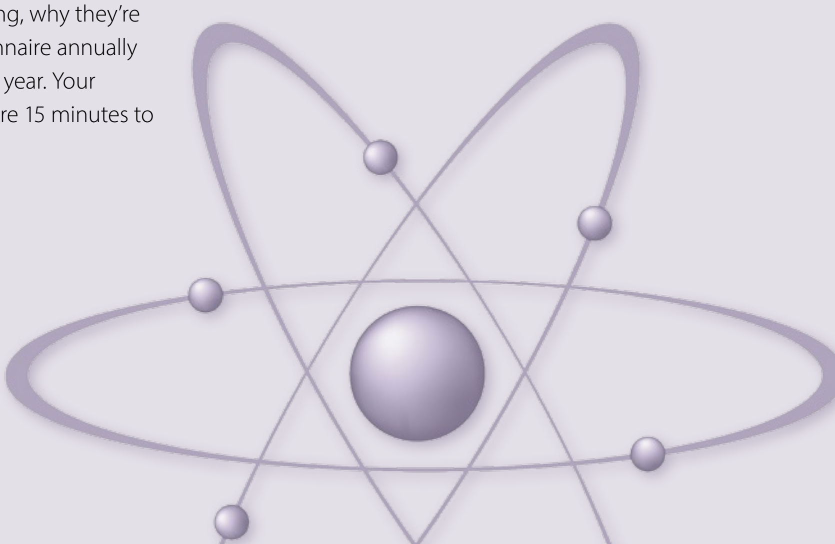
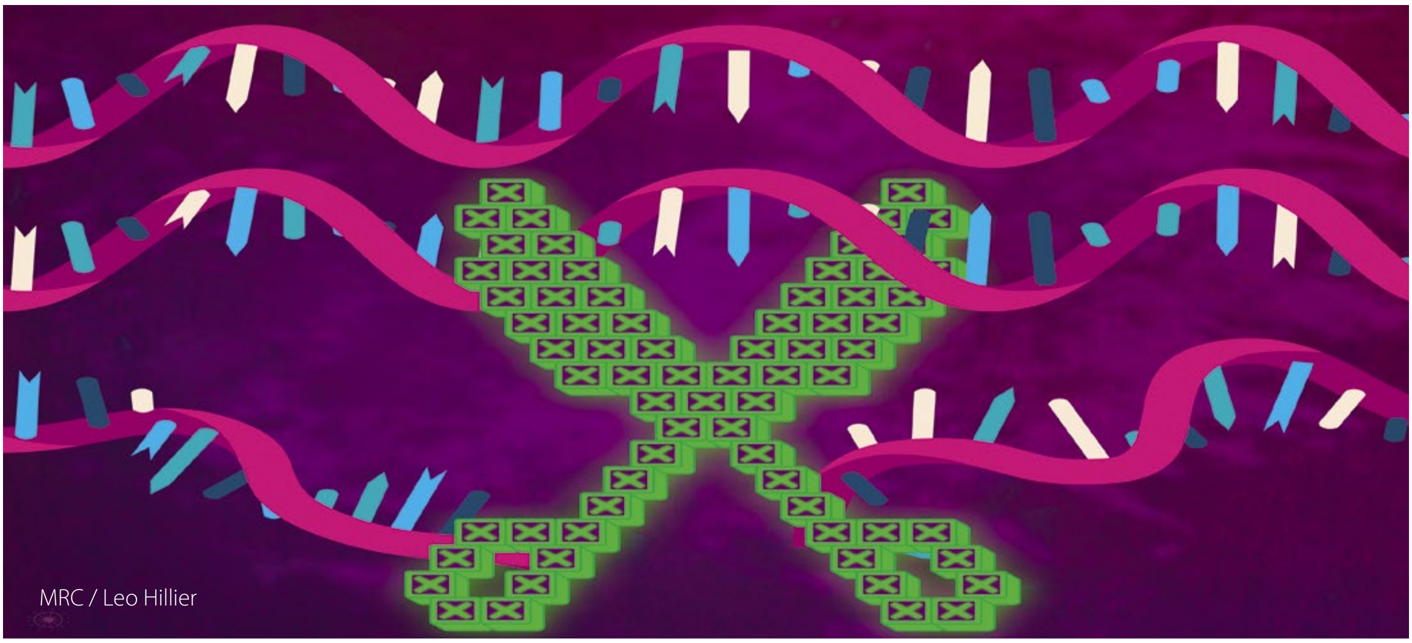


XNAzymes: Artificial enzymes suggest that synthetic life could be built from alternative molecules.

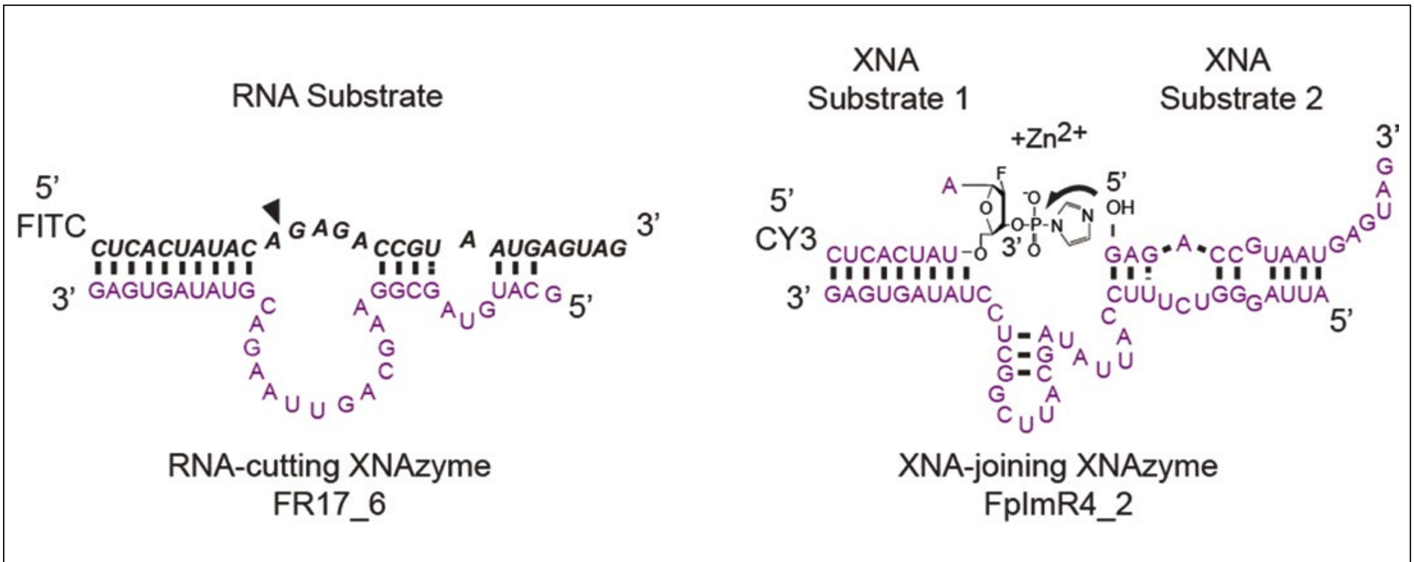
Dr Alexander Taylor, MRC Laboratory of Molecular Biology, Cambridge

Life is chemistry showing off

There are a dizzying number of chemical reactions in order to build and maintain living cells, which must be kicked off or sped up by sophisticated catalytic molecules – enzymes. For much of the 20th century, it was believed that enzymes were exclusively proteins, occasionally decorated with other biomolecules. It came as quite a surprise in the 1970s-80s when Thomas Cech and Sidney Altman demonstrated that life also uses molecules normally associated with carrying the DNA code 'message' to the cell's protein manufacturing machinery, RNA, for several crucial reactions – a finding which earned them the 1989 Nobel Prize for chemistry. We now know that there are many such RNA enzymes ("ribozymes") in biology, including at the heart of the very machine that translates the genome's code into proteins – the "ribosome" (now say: "the ribosome is a ribozyme" five times quickly!). Indeed, life on Earth may have begun when ribozymes capable of catalysing their own replication emerged.



MRC / Leo Hillier



Synthetic genetics and artificial enzymes

But are these natural 'biomolecules' the only options? Could an alternative life be built on different molecular foundations? In the Holliger group at MRC-LMB, Cambridge, we have sought answers to these questions by adopting the "synthetic biology" philosophy – attempting to recapitulate the hallmarks of life in the test tube. In 2012, we reported the construction of "synthetic genetic systems", based on "xeno nucleic acids" (XNA), chemical cousins of DNA, strung together from building blocks that do not occur in nature using polymerases (the enzymes that copy DNA), engineered in the lab[1]. Heredity and Darwinian evolution could now be performed by entirely artificial molecules: we challenged several XNAs to evolve catalytic activity (cutting or sticking strands of RNA or XNA). As we now report in *Nature*, we were able to discover a range of XNA-based artificial enzymes ('XNAzymes')[2], implying that 'our' chemistry, of DNA, RNA and proteins is not 'special', there may be many other chemicals that could make life possible – perhaps "alternative biologies" existed at the origin of life, or exist now, elsewhere in the cosmos.

Novel medicines and devices

The ability to perform Darwinian evolution using an expanded chemistry set offers new avenues to diagnostic or clinical applications. Whereas naked DNA and RNA are rapidly destroyed in the body, some XNAs may be able to resist destruction long enough to have useful therapeutic effects, such as targeting and destroying cancer-related RNA molecules within cells.

1. Pinheiro, V.B., Taylor, A.I., *et al.* (2012) Synthetic genetic polymers capable of heredity and Evolution, Science 336, 341-344.

2. Taylor, A.I., *et al.* (2015) Catalysts from synthetic genetic polymers, Nature. 518, 427-430.

Out and about …

17th Horners Ralph Anderson Lecture

Held at the Royal Society of Medicine, London

In the opulent setting of the Royal Society of Medicine, Professor Sir John Holman (University of York and Chair of the Salters' Institute Board) delivered the 17th Horners Ralph Anderson Lecture.

The topic was "The Livery Companies and Education – a Scientific Perspective". The lecture looked into the work the 110 Livery companies do in support of education, paying particular attention to those that work more closely with science. This included the links supporting examinations (e.g. the OCR Salters Chemistry A Level). The talk also included the often-asked question as to why education in science is so important (£257 billion turnover in science and engineering, 450,000 extra job opportunities by 2020 and more besides).

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