

In conversation with... People in chemistry

What kinds of jobs are there in chemistry? Who works in chemistry? Through bringing together the experiences of seven different chemists, Ali Eley illustrates the diversity found in jobs that are based in chemistry, as well as in the people that do chemistry

What is chemistry and why is it important?

Chemistry is the study of the composition, properties and behaviour of matter. It is concerned with understanding the structure of atoms and how they react, as well as substances and how they can be

changed and new ones synthesised. It involves creative thinking and innovation. New substances are constantly being created, usually for a particular purpose.

Chemistry has wide-ranging applications and is central to many industries, as well as to research in

key areas such as healthcare, food production and climate change. It also underpins understanding of other scientific disciplines, such as biochemistry, pharmacology, forensics and meteorology.

The nature of chemistry and its wide applications is evident in these stories from the chemists who have contributed to this article. Each of them describes what they would say now to their 10-year-old selves, and what they wish their primary school teachers had known about them. Their responses offer support to teachers with understanding their children better, and with recognising and nurturing particular interests, attributes, ambitions and worries that the children might have, but that might not be immediately obvious.

Haydn Francis is a researcher at the University of Cambridge. He develops new ways of measuring how and why batteries degrade over their lifetime.



What would you say now to your 10-year-old self?

Studying science is the best way to keep as many doors open in your career as possible. You enjoy all subjects at school, and it will be difficult to choose

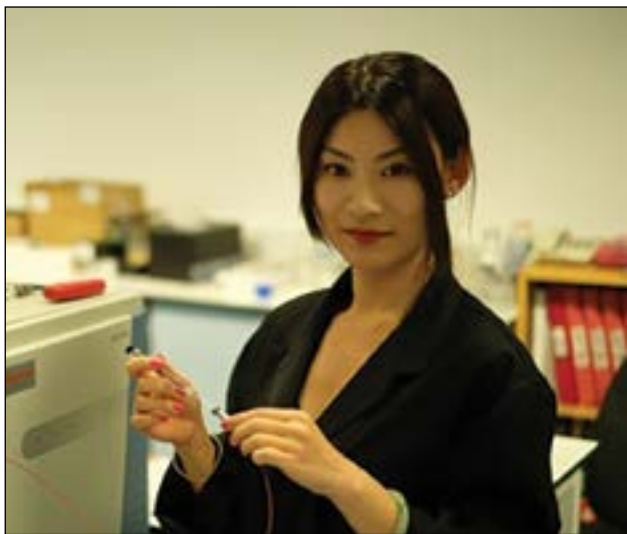
what to study when you are older. You worry you will be closing doors to certain careers when picking what to study for GCSE, A-level or as a degree. But you will be very happy to find that studying science is considered a great platform for going into almost any career you could imagine. So don't worry too much, because studying science will provide you with skills that mean you're ready for jobs in business, law and government as well as science and engineering.

Things you wish your primary school teachers had known about you

Although I had some really great teachers in primary school, I do wish they'd known that I didn't actually know anyone at all who worked in science or who had studied science to a high level in my home and family life. I think it would have added a lot of value to lessons if we were able to speak directly to people working in science or at least see examples of people like ourselves who have ended up studying and working in science.

Key words: ■ Chemistry careers ■ Case studies

Candy Jiang is a postgraduate researcher in analytical chemistry at Bristol University. She focuses on analysing chemicals using various scientific instruments.



What would you say now to your 10-year-old self?

Don't let anyone dissuade you from pursuing your passion. You might think you are more of a 'maths' person, but your love lies with chemistry. Although you might not be very good at it now, through hard

work and persistence you will get to be a chemist. It is OK to doubt yourself, and sometimes you might think, 'Perhaps my family is right, chemistry isn't for a girl like me', but these doubts and fears will not last long. You will sometimes feel like you are walking down an unknown path by yourself, which might be scary, but it will all be worth it when you reach the end, and you are exactly where you need to be.

Things you wish your primary school teachers had known about you

I wish my primary school teachers had given me more chance to express my curiosity and ask questions. I wish they had known that I was quiet due to shyness, not lack of interest. When I was growing up, my family was very traditional, with boys' education being valued more highly than that of girls. Being a girl meant finishing university, getting a non-challenging job, marrying and starting a family. It was a good life, but not for me. My parents never believed that I could pursue anything in science. Balancing my family's expectations and chasing my own goal was difficult. I think my interest in chemistry was started by my grandad – he did chemistry at university and he told me that the process of making Tofu involves chemistry.

Amy Packer is a pharmaceutical scientist who works in the NHS, focusing on the manufacture of medicines.



What would you say now to your 10-year-old self?

Try not to compare yourself to other people in the class or care so much about what other people think. And don't worry so much

about exam results as no one will ever ask you at any job interview for your year 6 SATs results! Exam results are stepping stones, but not the goal. You might not find it easy to work out what you want to do, but you

have been interested in STEM from a young age, and it doesn't matter now if you have no definite aspirations about what job to do. You are keen to get a job that involves helping other people so the NHS might be a good fit as you can work in healthcare and be a scientist!

Things you wish your primary school teachers had known about you

As a Christian who was interested in science, I often felt like I was told that I couldn't believe in God and be a scientist. I wish my teachers had been more understanding of different faith backgrounds and recognised that I was being taught seemingly contrasting things like creation and evolution. As it is, I now believe that science and religion do not have to be mutually exclusive and can complement each other, but at the time I found it confusing. It's really exciting to see more women in science now. I am grateful to my teachers and my family for encouraging me to see a future in science, without discrimination based on my gender. This isn't true for everyone though, so female scientist role models are really important.

James Mortimer is a photochemist at Bristol University, working with LEDs to form new molecules purely from photochemical excitation and reactivity.



What would you say now to your 10-year-old self?

Whatever you want to achieve, you can. Sometimes the idea of a career in advanced sciences can seem scary and you will think you

aren't good enough many times, but you have to ignore those doubts and just work hard to achieve your goals. You may feel overly inquisitive, and like you don't fit in

with certain expectations, like a scientist being an older straight man, but you can carve your own path in the world of science by just being yourself. Even if teachers imply that you aren't 'good enough' or 'clever enough' to be a scientist, do your best to prove them wrong.

Things you wish your primary school teachers had known about you

I identify as a gay man and I often didn't feel included in many school discussions as a student where heteronormativity was rife. I think I wish my teachers had realised that everyone is an individual and unique in many ways and they should adapt their teaching to suit individual students' needs. In the context of promoting a science career, I wish my teachers had known how to ease my fears about not being good enough or thinking I didn't fit the mould of a scientist. I think this lack of engaging with students' individuality led me to dislike my school years and become isolated in my mission to be a scientist. I didn't have science interests outside of school but was an avid reader and consumed most of my information and knowledge from books of various sorts!

Dr Kirsty Anderson is a medicinal chemist who designs and plans synthetic routes to make new small-molecule targets for biological testing for the treatment of neuroinflammation, in particular Alzheimer's disease.



What would you say now to your 10-year-old self?

Allow yourself to enjoy the subjects that actually interest you, no matter how many people tell you that

they're 'too difficult' or not usually what a girl would like – i.e. STEM subjects. It's OK to be unsure which subject you enjoy; make sure you give all opportunities your best, since you never know what you might end up enjoying and excelling at! And remember that a scientist doesn't have to have crazy hair, be doing maths on a chalkboard, or be a man!

Things you wish your primary school teachers had known about you

I mostly felt that there was a disconnect with what was being taught and what you could do with that. I didn't have any interactions with scientists until I was leaving high school and starting university. The opportunity to have scientists visit (or Zoom!) into classrooms to share their jobs would be beneficial to show kids what they can do, as they may not have had the chance to learn about this at home or in their family. I was the first in my family to go to university and I know I would have benefited from more exposure to the science careers that exist; I also missed out on later opportunities by simply not being aware they existed, such as work placements in labs, rather than in retail.

Dr Magdalena Wajrak is a chemistry lecturer at Edith Cowan University in Perth, Western Australia, where she teaches general, physical and inorganic chemistry units and carries out research in electrochemistry.



What would you say now to your 10-year-old self?

Be more confident in yourself and believe in your abilities. Don't let anyone put you down. Follow your passion in science, because you will succeed in having a

career that you will love. Stay focused and work hard

towards your goals and you will definitely achieve them. Also, it is OK to be ambitious as a female; don't feel pressured into following society's view that you need to be married and have a family if you feel that is not your path. Not having a family or being married does not make you less important or less valuable.

Things you wish your primary school teachers had known about you

I wish that my primary school teachers knew that, despite coming to Australia without any English when I was 12 years old, I did have a good understanding of science concepts and I was very good at mathematics. Unfortunately, because my English was very limited, I was placed in the lowest science and maths classes. That made me start to doubt my knowledge of science and maths subjects and, despite completing a Bachelor of Science majoring in chemistry and applied physics and a PhD in quantum chemistry, to this day I still doubt myself and lack confidence. Primary school teachers are so important for students' growth in confidence and to set them up for lifelong learning.

Dr Zoë Ayres is a chemist in the food and drink industry. She conducts experiments to identify contaminants and changes to ensure food and drinks are fresh and safe to consume.



What would you say now to your 10-year-old self?

There are lots of jobs you want to have – archaeologist, lawyer, doctor, scientist – and you don't know yet what you will end up doing. But

you don't need to worry that you are not sure what you want to do; it is perfectly fine to be unsure or change your mind depending on what you are finding exciting

and interesting. The most important thing is doing something you enjoy! Sometimes life takes unexpected turns too – you will one day become a doctor, but a doctor of science rather than the medical doctor you are thinking about now!

Things you wish your primary school teachers had known about you

I was interested in a lot of different things in science, so having more idea of the possible careers I could have had, would have been really useful. I struggled with my confidence at school a lot, so someone saying, 'You could do that', would have helped improve my self-esteem. I thought getting good grades was the most important thing in science, and a few bad test scores could mean that being a scientist would not be possible. I have also found out later in life that I am probably neurodivergent, and one of the things I really struggled with is doing school work just for the sake of doing school work; I always wanted to know why I was doing the work I was doing and what the bigger picture was and I think I still do. Being taught the practical reasons behind learning and why it is useful was essential to keep me engaged.

Themes emerging from these chemists' stories and experiences

The life paths and careers of these chemists are all different, but some

common themes that are relevant to the primary classroom emerge from the thoughts and experiences that they have shared here. Many of them speak about a lack of self-belief

and the importance of choosing something that you really enjoy as a career. Some have highlighted that studying science offers later opportunities, not just in science

but in many other jobs that are not directly related to science. This is something that might not be obvious to children, but that teachers could explain. The views expressed about tests at primary school are also interesting. The emphasis on how much the results matter seems disproportionate, and there is a conviction that poor results, even at this early age, will rule out future opportunities. Another useful point is that children actively want to understand the purpose of what they are doing in science lessons.

Stereotypes around who does science clearly persist, and teachers continue to be an important part of challenging these. Some of these accounts illustrate how personal characteristics, cultural backgrounds and specific difficulties experienced can all be direct barriers to children developing an identity with, or even accessing, science. Again, the primary teacher has a key role to play: effective science teaching is not just about delivering the science curriculum, but also encompasses good pastoral care, empathy and knowledge about children as individuals.

Perhaps one way of highlighting different science careers to children is to consider first the personal qualities and skills they have and in which jobs and industries they would be valuable. Table 1 gives an outline of a range of jobs that are based on chemistry, alongside some of the personal qualities and skills that people who do these jobs typically have. Children in your class who love science may already demonstrate these qualities and skills, and therefore might be interested to find out more about the chemistry careers where these attributes are valued.

Table 1 Personal qualities and skills that could be useful in different careers in chemistry

Job	What do they do?	Some of the personal qualities and skills valuable in this field of work
Chemical engineer	Develop new substances and products, and design new production facilities able to make them	Enjoy practical work using equipment Good at thinking logically Good communication
Environmental chemist	Conduct research into the impact of human activity on quality of air, water and soil, and design systems for waste disposal and to minimise pollution	Cares about the natural world Interested in human behaviour Good at seeing the big picture
Meteorologist	Study the Earth's atmosphere by analysing data from weather stations and satellites, and make predictions about weather and climate	Interested in the weather Good problem-solver Good communication
Pharmacist	Administer a medication service for the public and complement healthcare provided by doctors	Enjoy interacting with people Strong physical stamina Good attention to detail
Pharmacologist	Investigate the effects of drugs on living systems and design new drugs to prevent illness and disease	Enjoy finding out new things Good at thinking logically Good attention to detail
Doctor	Diagnose, treat and prevent medical disorders, diseases and injuries	Caring about other people Good memory Good at solving puzzles Strong physical and emotional stamina
Dentist	Diagnose, treat and prevent diseases of the mouth and teeth	Caring about other people Good manual dexterity Strong emotional stamina
Veterinarian	Diagnose and treat diseases and injuries in animals	Love of animals Good memory Strong physical and emotional stamina
Pathologist	Study tissues or fluids taken from the human body to determine the cause of disease or death	High attention to detail Good emotional strength Good at practical, hands-on work

Forensic scientist	Analyse crime scene evidence to determine the composition and nature of material samples	Interested in law and justice Good manual dexterity Good communication
Nanotechnologist	Perform research and analysis of structures at the sub-atomic level to develop new applications and processes	Good hand-eye coordination Good imagination and visualisation Patience and persistence
Toxicologist	Study the harmful effects that substances such as drugs, food additives, pesticides and industrial chemicals have on living things	Care about the natural world Enjoy finding out new things Patience and perseverance
Colour technologist	Develop dyes and pigments for use in the manufacturing industry	Interested in art and colour Creative and flexible Good communication
Cosmetic scientist	Test and evaluate aromas of new toiletries and perfumes, and develop efficient production processes for new cosmetics	Well-developed sense of smell Patience and persistence Good communication
Food scientist	Improve the quality of foods and ensure that they are safe to eat by studying the properties of food ingredients	Interested in food and flavour Methodical Good at working in a team
New food developer	Design, manufacture, and test new foods and plan for their sales and marketing	Interested in people and marketing Good at working in a team Creative and original
Flavour technologist	Study the interaction of food ingredients with human sensory systems, and develop new flavours to improve the taste of food and drinks	Interested in food and flavour Resilient – happy to keep trying new ideas and approaches Good communication
Textile chemist	Apply chemical understanding to the development of functionally and aesthetically pleasing new textiles and materials	Interested in fashion or furnishings Resilient Good at working in a team
Analytical chemist	Support understanding of new and existing substances across many industries and in research	Good manipulation of number High attention to detail Good communicator
Nuclear chemist	Research and development in radioactivity and nuclear processes, including their application in medicine and in disposal of waste	High attention to detail Very good levels of concentration Good at working in a team
And then there is teaching science – the best career of them all of course!		

Further support for careers in chemistry

● **A Scientist Just Like Me**

(<https://psstt.org.uk/resources/curriculum-materials/ASJLM>).

A series of free-to-download slideshows and videos, each telling the story of someone working in a science-related job. The slideshows focus on what the people like about their jobs, challenges they have faced and how their work makes the world a better place. The focus is on the habits of mind and personal qualities needed

to do the particular job, rather than on the science knowledge needed. There is a slideshow about each of the chemists who contributed to this article, and there are videos featuring both James and Candy.

● **Steps into Science – Meet the Scientists**

(<https://edu.rsc.org/primary-science/find-resources/meet-the-scientists>).

The Royal Society of Chemistry’s new collection of resources to introduce primary children to STEM careers and historical and modern-day scientists. These include *Faces of Chemistry*

– *Women in Chemistry*, a set of stories about the achievements and inspirations of a diverse range of women in the chemical sciences.

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Alison Eley is Outreach Director for the Primary Science Teaching Trust. Email: ali.eley@psstt.org.uk

