Medicines from microbes

Lucy Butler, Maria O'Hanlon and Dominic Gilchrist examine how the scientists of tomorrow are developing medicines of today

Figure 1 Lucy preparing samples that will be used to biosynthetically produce antibiotics within bacteria

Questions often heard echoing through classrooms are: '*Why do I need to know this?*' and '*When will I use this in real life?*'.

As three PhD students working at the National Horizons Centre (NHC), we were able to take these questions and answer them, using our own research as examples, with the help of CIEC (Centre for Industry Education Collaboration).

CIEC are involved in increasing children's and teachers' awareness of STEM careers through outreach activities with scientists in research or industry. They work between schools and industry to build links between science education and its application in STEM, with the aim to increase the number of local children considering a future in that area. We worked with CIEC to create a hands-on session for three local primary schools, talking all things science and research!

We all have different scientific backgrounds, with our research spanning across investigations into the antimicrobial resistance crisis, host pathogen interactions, and therapeutics for neurodegenerative diseases. Therefore, when we were asked if we would like to take part in an outreach programme with some local primary schools, we wanted to convey our own research interests to the classroom during the session. Working with CIEC, we decided to choose a curriculum segment that aligned with some of our research – microorganisms: how they can harm us, help us and how we can use them to our own advantage.

Our aim was to put this concept into a real-life context for the students to understand the application outside the classroom. We introduced the concepts of biotechnology and the development of new medicines, all within the classroom, whilst demonstrating the inclusivity and accessibility of science.

'We need your help'

Our session was based on CIEC's *Medicines from Microbes* resource (2003), where the overarching goal is to give insight to microorganisms and how they can produce beneficial medicines for us.

We brought the lab to the classroom using a fictitious newspaper article, requesting the help of young scientists to solve the NHC laboratories' question – how do you grow mould? We asked the children to help us, explaining that their findings were 'urgently required' by the lab to uncover the conditions that might encourage the mould to grow. We stated that this mould could then potentially be used to produce medicines in the lab.

Classroom to laboratory

As social media platforms are growing in popularity due to increased accessibility and, more recently, the COVID-19 pandemic, they have become more relied upon for child engagement. The sessions that we planned for this activity were originally intended to be in person; however, due to the pandemic and subsequent restrictions, the whole session moved to virtual presenting, with the question & answer (Q&A) taking place over Zoom. We decided to take full advantage of this to give the most attention-grabbing session that we could. Therefore, following training that we received from one of the CIEC team, we made three 'vlog'-style videos for the children

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News Post

Wednesday *48p*

Mouldy food produces new medicine!

Funding worries put breakthrough at risk

New discovery

A small local company at the cutting edge of new bio-technology has run into difficulties with the development of its latest discovery. The company, NewBioTech (NBT), has been working for some time with different plants and foods to try to extract ingredients which might make new medicines.

The Director of NBT, Dr. Smail, explained "Everyone knows that many common plants contain ingredients which can help us. If you are stung by a nettle, you can rub it with a dock leaf to take the itch away. Once upon a time, willow bark was boiled in water to make a drink which cured headaches. Even bread was used in poultices in some cases!"

In the latest discovery, NBT found that a mould growing on food seemed to stop other micro-organisms growing around the mould. "We wondered if this mould could be used as a medicine," said Dr. Smail. "If it stopped other micro-organisms growing, we wondered if it would stop bacteria, which are micro-organisms too. This could be a break-through in treating things like simple cuts, which so often get infected by bacteria in dirt. We think this mould might produce a new antibiotic."

Funding

However, NBT have run into difficulties. They only have a small research fund for developing new ideas, and have to rely on grants from other groups which are interested in their work. "If another firm thinks that our discovery might help their work, then they will give us some money to help develop the ideas," explained Dr. Smail. "Sometimes the government will help, too."

Unfortunately, this time no-one has come forward with offers to help with the development costs.

Appeal

The firm is looking for assistance from other groups. "We have been able to grow the mould, but we need to find the best conditions for growing it. We will need to produce large amounts to make antibiotics," said Dr. Smail.

One suggestion is that school research groups could help. Unlike small firms like NBT, who can spare just one or two people to experiment, school groups can gather lots of data very quickly. Dr. Smail was enthusiastic. "We would love to hear from a school, if they can help us find the best conditions for growing moulds. It does not matter what food is used either. Every piece of information is helpful! If the information gives us an idea of the actual amount of mould produced for each condition, that would be really useful."

Figure 2 Example of a CIEC fictitious newspaper article that is shown to the children

Figure 3 Dominic examining agar plates for bacterial colonies prior to performing a colony count

to watch during their classroom sessions, created as if speaking directly to them.

A series of practical activities took place over three sessions; the first two were teacher-led and included video guidance from us, in the lab, requesting the students' help, and the final one included a live Q&A session.

During the first session, the children were able to read the fictitious newspaper article and were virtually introduced to the problem at hand via the first video. They then were asked to come up with a hypothesis about how/where they thought that the mould would grow best (on bread, cheese, fruit, etc.). Groups of children then planned and carried out their investigation, placing their food of choice in chosen conditions (hot, cold, room temperature, etc.) to discover how best to get mould to grow.

During the second session, the children went back to their food and location of choice and recorded the mould growth by describing, drawing pictures, and measuring the size of the mould. As a group, they took note of the conditions that had the most mould. The second video was shown to the students here, where we asked the children to 'send us their results' so that we could 'use their advice' and copy their conditions in our own lab to hopefully produce medicines.

During the final session, the children were informed that their experimental data had been sent to us and that we had used their results as a baseline to grow mould. Generally, their results showing where the mould grows best are very similar to how we do it in the lab, so we showed them the parallels. After this, the final video was shown, where we discussed their findings and optimal conditions for growing mould. This video also provided a great opportunity to share insights into life as a research scientist in a laboratory. We went on to explain that the techniques that we use to replicate their results might look different, but the principle remains the same. This showed the

children how their experimental data would be used in a 'real-life' situation to produce medicine and 'make a difference'.

This session culminated in a live Q&A opportunity with us, in order to ask any questions about the task. Before answering any of their questions, we explained that their results and methods of measuring their experimental variables had been very beneficial to us.

Why is this important?

Everything that scientists do relies on communication. To receive funding, we need to communicate to potential funders why our research is crucial. To expand our research horizons and ensure that people know about our work, we rely on well-articulated communication to identify specific, detailed areas for further exploration. Communication is an essential premise for science to move forward and one of the ways to do so is to share our knowledge with wider audiences.

Starting discussions with schoolchildren about science is an excellent way to engage them while at the same time breaking down some of the barriers and stigmas that surround science, such as: all scientists are stereotypical 'eccentric geniuses' or that that they work alone in a dark laboratory late at night!

Young children are naturally inquisitive. By asking them to 'solve' a task on an important, age-relevant topic, such as making medicines, we are engaging them with contextualised scientific research. Similarly, giving them the opportunity to ask real-life scientists questions about our work and our day-to-day activities captures their curiosity and further engages them in science. To develop this interest, our session combined critical thinking with fun. We utilised hands-on activities that were short and varied to ensure plenty of active involvement within the classroom.

Engaging children with key subjects

Sessions such as *Medicines from Microbes* enhance the classroom learning experience and bring the curriculum to life. By equipping children with other skills, such as problem-solving and creative thinking, these sessions provide transferable skills, a foundation for future prospects.

The session was challenging, but accessible, allowing the children to develop their understanding around some complex scientific concepts whilst thinking outside the box. They demonstrated clear understanding and scientific development by asking plenty of technical questions during their Q&A session. Their questions ranged from 'What's the purpose of the medicine ingredients?' and 'Does the viscosity of the medicine matter?' to more general questions including 'What is the best and worst parts of your job?' and 'What's that big machine behind you in the lab?'

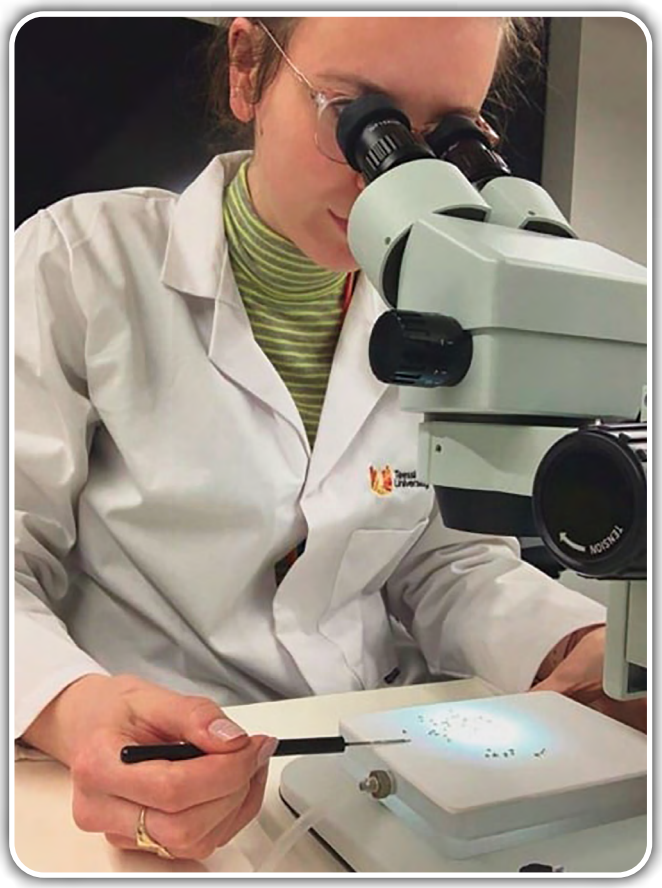

Figure 4 Maria using a microscope to examine fruit flies that have Parkinson's disease

The impact of scientific discussions

Real-life application sessions, such as those sessions run with the schools, are essential to contextualise science within education.

Science is the study of the natural world through observation and experiment. Within this are many different specialities and disciplines. By talking to scientists from different fields, children get to experience the vast diversity and inclusivity of their curiosity. Therefore, students develop and discuss their own ideas while contributing to and developing a scientific method. Science also incorporates several subjects, allowing this session to improve on multidisciplinary knowledge: for example, the use of mathematics during dilutions; or the role of chemistry and physics in microbiology, by the use of a spectrophotometer to determine the level of bacterial or 'mould' growth.

The underlying foundation of these activities allows children to draw comparisons and experience the similarities in their own work to that carried out in a professional setting.

Could this influence future career choices?

When deciding on a career, it is daunting to think about what opportunities may be available, especially for young people who may have limited understanding of the workplace. However, providing children with opportunities to meet with people working in different fields allows for some common misconceptions surrounding gender bias and age range in the field, or even personality stereotypes, to be broken down and aspirations to be nurtured from an early age.

This outreach experience allowed us to show how three local-to-the-area people have been able to develop careers as scientists with a range of previous experience, highlighting that science can be accessed by all, regardless of background: one scientist joined their PhD programme from a Master's degree, one from an undergraduate degree, and another who came back into education, later in life, from a completely different career. This is beneficial to the children, as science is not often presented as an attainable career path.

We also have a responsibility at the National Horizons Centre to showcase our world-class facility to the local community and the opportunities that it offers to the Tees Valley. Currently, the National Horizons Centre is playing a major role in developing the scientific skill capacity of the region to prepare scientists with the knowledge and skillset for the production of 60 million COVID-19 vaccines, through a bespoke training course.

Therefore, one of our motivations to participate in this programme was to open the lab doors of the NHC and allow local people to see inside, to instil career aspirations into potential scientists and to prove to local people that they can be employed locally in this field of work.

Providing educational scientific material to classrooms

Resources such as *Medicines from Microbes* provide a full support package of educational material and guidance to allow teachers to deliver a series of hands-on science lessons. With the industrial involvement, the activities can be easily adapted and developed around varying areas of expertise to emphasise the link between lessons and industry and to take place either in person or virtually.

The incorporation of the Q&A activity allowed the children to discuss, gain feedback on their work and ask any questions of professionals in the field. Personally, we were all happy to receive many questions covering topics ranging from our own work and what it's like being a scientist, to what the machine was behind us on the video call!

Overall, the aim of our session was to encourage the children to see science as interesting and accessible. We intended to provide an insightful and memorable experience for all, showing the importance of the scientific topics and how these can be utilised in a research laboratory.

National Horizons Centre

We all work at the National Horizons Centre (NHC) in Darlington, which was established by Teesside University to address the growth needs of the bio-based industries that are set to transform the UK economy, including biologics, industrial biotechnology and biopharmaceuticals. It brings industry and academia together, to provide the sector with knowledge, skills, talent and facilities to support its development and growth.
www.nationalhorizonscentre.co.uk

Reference

Chemical Industry Education Centre (2003) *Medicines from Microbes: A science investigation pack for teachers of 9-11 year olds* (First edition). York: Chemical Industry Education Centre

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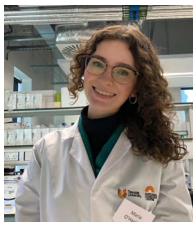
Biographies



'My name is Maria, and I am researching what causes Parkinson's disease, using fruit flies as a model organism. I thoroughly enjoyed the sessions with CIEC and the primary schools, not only because it was fantastic seeing the children being so engaged with science, but also because it was nice to talk to people about my own research too. I am very passionate about what I do, but it makes me even more excited when other people show an interest, so having children ask me about the brain and working with flies was really amazing. After our experience, I'd definitely encourage teachers and schools to get involved in this kind of activity.'

'My name is Lucy, and I am investigating how to overcome the antibiotic resistance crisis. I really enjoyed partaking in the 'Medicines from Microbes' sessions as it outlines my research area very well! It was brilliant to see the children engage with this real-life scientific research. It was also interesting to be questioned on specific details that we wouldn't normally focus on.'

'My name is Dom, and I am involved in the study of how pathogens and their hosts interact. I'm from Middlesbrough and came to science in my mid 30s, having always had an inquisitive mind. Having had many different careers including a car painter, bartender, pub manager and retail management, I decided to follow my passion and retrain as a scientist, joining Teesside University and completing my undergraduate degree in biological science before going on to studying my PhD at the NHC with Lucy and Maria. I really enjoyed taking part in the outreach with the primary schools, particularly the Q&A sessions, where the children asked us lots of questions about our own research and careers.'