The War of the Worlds and antibiotic resistance: a case study for science teaching

Elena Riva (Warwick University, UK)

What is the web with which Spiderman swings, slides and jumps through the streets of New York City if not a long-chain polymer molecule, similar to nylon, that in contact with air knits and forms an extremely tough, flexible fibre with extraordinary adhesive properties?
Did you know that the ultrafast lasers utilized for 'capturing' the temporal behaviour of chemical and biological reactions are similar to the ones with which every spaceship involved in *Star Wars* was equipped?
Have you ever thought that Superman's 'X-ray eyesight' that allows him to see through solid objects works on the same principle of the X-ray crystallography that allows chemists, physicists and biologists to 'see' molecules and proteins?

Starting from these simple considerations, we decided to explore how popular scientific and 'superpowers' films and radio plays from the twentieth and twenty-first centuries can be the starting point to explain the scientific principles behind them and their applications in our real world. In order to develop this idea, the Institute for Advanced Teaching and Learning (IATL) and the Institute of Advanced Study (IAS) at Warwick University supported us to create 'Science on Screen',[1] a pilot workshop dedicated to 20 first year undergraduates with diverse scientific backgrounds (chemistry, life sciences, medicine, physics and mathematics). Every movie screened during the workshop led to an interactive lecture and discussion about the scientific phenomena presented in the film. Through these activities we were able to introduce the principles of chemistry, biology and physics which have great importance for our everyday life and to explain the relevant scientific research that is developed in these fields.

Introducing *The War of the Worlds* and antibiotics

As an example to illustrate this idea, we decided to utilize H.G. Wells' masterpiece *The War of the Worlds* to motivate a discussion and to lock-in concepts regarding the discovery and importance of antibiotics as well as the threat of antibiotic resistance. We presented parts of two artistic adaptations of this novel to students, the radio play by Orson Welles – aired over the Columbia Broadcasting System radio network in 1938 – and the Hollywood film directed by Steven Spielberg and distributed in 2005. H.G. Wells' original novel tells the story of an alien invasion of Earth. We decided to screen and play the final parts of the movie and radio drama when the narrator, walking in a silent and deserted London, witnesses the destruction generated by the aliens and then suddenly discovers that all the Martians have been killed by an attack of earthly microbial infections to which they had no immunity: "slain, after all man's devices had failed, by the humblest things that God, in his wisdom, has put upon this Earth". The fascinating and engaging view of the movie and the dramatic experience of listening to the news bulletins of the radio play were the starting point for a lecture about microbes, antibiotics and antibiotic resistance. In fact, stimulated by a question regarding a feasible method of alien survival, the students identified antibiotics as the most potent weapon for fighting bacterial infections and the only possible cure for the Martians.

Subsequently we had an interactive lecture about the history of antibiotics, from the Nubian use of beer (a source of bacteria able to produce active

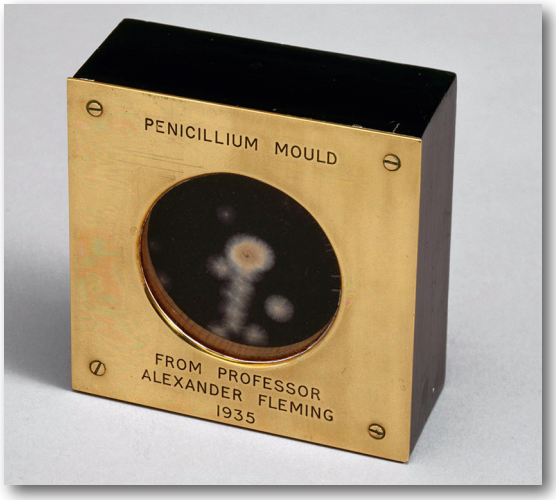
The War of the Worlds by Tom Kidd, 2001, via Tom Simpson, FLICKR (CC BY-NC-ND 2.0)

compounds) for treating infections in 350–550 AD[2] to Fleming and his discovery of penicillin, the first antibiotic. We then studied the mass production of antibiotics in the 1940s and how their ability to fight and kill bacteria revolutionized medicine and profoundly impacted everything in modern history, from agriculture to war[3].

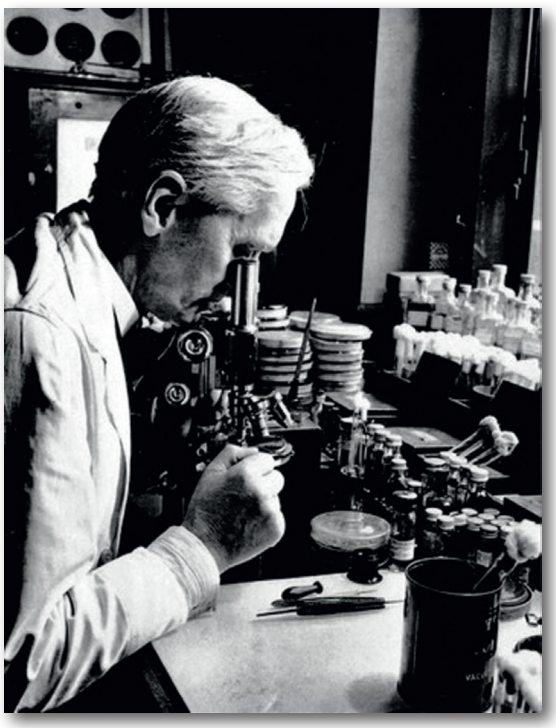
Using *The War of the Worlds* to highlight antibiotic resistance

Students then had the opportunity to identify and draw parallels between what they had learned in the overview of the history of medicine and *The War of the Worlds*. They were able to realize that without this scientific progress and the production of potent medicines we could die of bacterial infections exactly as the aliens did in Wells' novel. Also clear and immediate for the students was the link between the horrific death of the Martians and the dreadful risk for humankind associated with the threat of antibiotic resistance[4], resulting from microbes exhibiting resistance to one or more antimicrobial agents. In fact, after less than 80 years from the beginning of the mass use of antibiotics, these miracle drugs are failing. Resistant infections kill hundreds of thousands of people around the world each year and there are now dozens of so-called superbugs. We therefore analysed the different processes that led to the phenomenon of resistance and how most of them find their roots in the misuse of antibiotics[5]. Among those we concentrated our attention on was the increasing global availability of these drugs over time since the 1950s, their uncontrolled sale resulting in broad-spectrum antibiotics being prescribed when not indicated, as well as antibiotic use in livestock feed at low doses for growth promotion and the releasing of large quantities of these medicines into the environment during pharmaceutical manufacturing. Students underlined the necessity of supporting an action for identifying which opportunities exist for the discovery, research and development of new antibiotics as well as promoting a better use of these powerful medicines.

The visionary novel of H.G. Wells and the powerful adaptations in Orson Welles' masterpiece and Spielberg's movie made all the students realize that it is vital to the health of all nations that antibiotics remain the mainstay of modern medicine and are available to all who need them.



Sample of penicillin mould presented by Alexander Fleming to Douglas Macleod, 1935, via Science Museum London, FLICKR (CC BY-SA 2.0)



Old Photograph Sir Alexander Fleming Scotland, via FLICKR (CC BY-NC-ND 2.0)

An interdisciplinary approach to public engagement

This is just one example of how this interdisciplinary approach has been helpful to undergraduates, from very diverse scientific backgrounds, for learning state-of-the-art scientific concepts across different disciplines in a new and exciting way. Students were stimulated to 'think out of the box' and to observe how what they study is related to everyday reality and how it can influence even science fiction and popular art.

This project was run as a Warwick University pilot workshop but our mission is to expand our audience and to reach primary and secondary school students as well as the wider public with similar activities. In fact, this way of communicating science, which utilizes popular art as a starting point for learning scientific topics and introducing global scientific issues, can be applied at any level of public engagement. The use of films to which the wider public can relate enhances teaching and learning, and complements more traditional approaches for the communication and acquisition of scientific information[6]. As demonstrated by our workshop 'Science on Screen', movies, radio plays and modern media engage people, aid retention of knowledge, motivate interest in the subject matter, illustrate the relevance of many concepts and therefore can be utilized as powerful tools for scientific teaching and learning. ■

Dr Elena Riva is a Chemical Biologist and Teaching Fellow at the Institute for Advanced Teaching and Learning (IATL) at Warwick University (UK). She develops modules for undergraduates and postgraduates that explore complex and global scientific topics and issues creating connections between scientific disciplines and humanities. Elena also has a great passion for communicating science to primary and secondary school students. Her research is dedicated to the generation of novel 'unnatural' polyketide products with medicinal (e.g. antibiotic, antifungal, anticancer) and commercial value by combining small-molecule organic synthesis, microbiology, microbial genetic manipulation and new chemistry technologies.

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