Takeaway Science
Toxicology, more about life on Mars and children's author Philip Ardagh

Mike Bullivant
Welcome to takeaway science, another in the series of short podcasts produced by BLAST! at the Open University. This particular podcast comprises 3 more short audio sequences. Later in the podcast Susan Conway sets out to discover more about life on Mars and the Martian climate and we chat with OU Alumnus, Tony Diane of the Royal Society of Medicine about his work as a toxicologist but first we went to a very noisy Cheltenham Science Festival to talk with best selling children's author and science communicator Philip Ardagh about the subject of several of his books, inventions and discoveries. We first asked him to tell us what inspires his writing in this area.

Philip Ardagh
I've always enjoyed writing and when I was very little I would write short stories and a lot of the writing I do is fiction and therefore character based. But I've also always been fascinated with the whole world of inventions and discoveries, what got us to where we are today and I suppose I really came at it from the people perspective, looking at it from the point of view of what inspired people, what motivated people, what events happened that led to discoveries and inventions and improving and engineering so just really the world around us. How we come to be, how we are through the people who are living there and the inventions and discoveries they made.

David Smith
What do you see as the most important invention in the past 100,000 years?

Philip Ardagh
That's a tricky one, obviously Homo sapiens has been around for about 100,000 years so that's a good, good time to pick. Obviously farming was instrumental because it stopped us running around here, there and everywhere, got us in one place and, and changed the job description of people, not just being out to hunt and gather food. Er, for me, writing, obviously an enormous impact on things that the fact that you didn't actually have to be talking to somebody or to be next to somebody who'd experienced or to experience something yourself, you could read it or have it read to you and understand something from a different time period or from a different place and use that information to advance your own knowledge so I think, er, farming and writing are 2 pretty big ones. If I, if I can cheat a bit and make it just over 100 years, I'd say, um, obviously flight, I think, um, I think the aeroplane has made the world a much, much smaller place. But in, in another sense I think medical advances, um, penicillin, for example, something like that, the whole antibiotics, anaesthetics, all these things have just completely, er transformed the world we live in. When AIDS came along in the 1980s one of the shocks was, here was, um, an ailment that we didn't know how to deal with because we'd become very blasé about it, we've come to expect, with the possible exception of, um, cancer, that everything was curable. Um, certainly not true in the third world where, for want of sugar water, people are still dying of simple things like diarrhoea but, in, in, certainly, in the West, we really felt that medicine could do everything, whereas go back 100, 150 years and everyone and anyone was dying of what we see as the most simple ailments nowadays. So I think medicine has, has taken us into a whole different area. Now, of course with the whole embryology debate and everything, that is the heart of, of modern scientific thinking.

David Smith
How would you enthuse the younger generation to be more interested in science?

Philip Ardagh
Well I would say to older listeners enthuse, enthuse children, get them thinking, get them looking around them, looking at the world saying how we came to be where we are today and

also, er, thinking about just having fun. What solution would you like to solve? You might not come up with an answer but, um, you know, would it be useful if we could walk on water? Would that really change things? How, just take simple ideas, look at them, see how things have been come up with and the example I always like to give is with, with railways. Um, steam locomotion was invented, people could see that you could go at great speed but the problem was that no-one had invented railway tracks that could sustain it for any real length of time. The wood would break and iron in those days was brittle and it was only when cast iron was developed that it was strong enough for trains to travel on it so small inventions and changes and tweaks leading to bigger and bigger things as you go along. So it really is, it's a fantastic detective story. I think science is a detective story and you can get children really, really involved in that, something you can do together.

Mike Bullivant
Best selling children's author and science communicator Philip Ardagh there. If you've an interest in science there's bound to be an Open University science course for you. How about the introductory course, "Exploring Science" which amongst other things, explores a range of topics including the origin of life, genetics, evolution and bio-diversity, sources of energy and global warming, earthquakes and volcanoes, food and drugs, the structure of the atom and the quantum world and the solar system and the origin of the universe. "Exploring Science" provides a foundation for studying science at higher levels and students taking the course should have some previous knowledge of science and basic mathematical skills. To find out more about "Exploring Science" or any other OU course log on to ww3, that's the numeral 3, ww3.open.ac.uk/study and follow the links to "Exploring Science". The second sequence in this podcast features Open University research student, Susan Conway, continuing her chat from the second takeaway science podcast about life on Mars and the Martian climate with three of her fellow OU researchers, Charles Cockell who is Professor of Geo-microbiology in the Planetary and Space Sciences Research Institute, Matthew Balme from the Department of Earth and Environmental Sciences and from the Department of Physics and Astronomy, Stephen Lewis. Here's Susan Conway.

Susan Conway
So we're talking, we're talking about life today, that's all we're talking about now but, I, I've heard that life could have been present on Mars in the past. Now Stephen could you give us an insight into what the past climate on Mars would be like, how, how it would be different to today?

Stephen Lewis
Right, well, on short timescale, what we, what we think of as a short timescale geologically of 10,000-100,000 million years, then, then the Martian climate certainly does change. There's lots of evidence in deposits near the poles that the Martian climate has changed almost periodically between a cold, clear atmosphere and a warmer, dustier atmosphere. Um, however, that, those changes are relatively small, um, they wouldn't lead to a, to a planet anything like the Earth. There, there wouldn't be an atmosphere as thick as the Earth and there wouldn't be rain and water on the surface. This, these are changes, um, perhaps a factor of 2 in pressure, that, that kind of magnitude. To actually look for a planet where you might imagine life existing on the surface, you probably have to go back very many more years, perhaps, um, more than 3½ billion years, um, to, to very near the start of the solar system, perhaps the planets are 4½ billion years old. So in the first billion years of Mars and back then things are very uncertain, um, I certainly wouldn't claim that we are able to model the atmosphere of a planet that long ago and there are many, many holes in our understanding.

Susan Conway
Okay. Thank you for that. Now Matt is there any clues in the landscape on Mars about the, the, the climate, how the climate was in the past?

Matthew Balme
Well as, er, Stephen has said, um, in the very ancient Martian history there's a possibility that the atmosphere was thicker and warmer and we an see this because we see channels on the surface that appear to be very much like rivers and as Charles pointed out you cannot have liquid water stable at the Martian surface under today's atmosphere for very long because it moves very quickly from water to gas, it sort of bubbles and boils away in the thin atmosphere. So for there to have been, er, rivers and streams and you know, these do show a sort of a, a branching stream like pattern, so they seem to er, demonstrate that there was, um, perhaps rain and perhaps catchment areas that create basins that sort of turn into small streams then feed into rivers. So it seems there's, um, evidence from the geological record of there being a period in Martian history where it was a lot more like Earth, where you may even have, you might even have had rain, er, rivers and, er, and, and possibly lakes. And we know that these are very old because these deposits, these river valleys are covered in impact craters so as, er, a surface is exposed, um, over time, more and more impact craters, er, impacts from space, meteorites hit the surface and form impact craters and by counting the number of impact craters we can get an idea of the age of these deposits and these ages turn out to be of the order of 2-4 billion years so these are very, very old. They are not recent.

Susan Conway
Very old yeah. Okay. Now, following on from that, I remember hearing that, er, um, life could have started way back in the history, as you were saying life could have been, the conditions for life could have been more, much more favourable in the ancient, er, Martian past. Now Matt was talking about impact craters so how would life survive these impact craters happening in the early history of Mars?

Charles Cockell
It depends on how large and how frequent they are. Some people have said that there were impacts in the very early history of the solar system that could have sterilised, er, the oceans of the Earth and, and sterilised life, um, from the surface of the planet. Um, generally though impact craters can be beneficial to life because they create hydrothermal systems, hot water systems that are good for bacteria that like to live in, in hot water systems like the microbes that live in the hot springs of Yellowstone National Park, for example. Er, they could also fracture rocks and create new habitat bases for microbes. So it's not always the case that impacts are bad for life and it could be that, er, as Mars began to cool down and, and freeze that impacts may have created transient hot water bodies, er, for life to hold on, if it had ever been there in the first place.

Susan Conway
Okay. Um, now I've also heard that, that maybe life could have started on Mars and then been transported to Earth but I have a problem with this because how would life survive through space, I mean, do you have an answer to this?

Charles Cockell
A lot of people have been doing a lot of experiments recently looking at, um, the survival of microbes in impacts so subjecting them to simulated impact pressures to see whether they could survive and we now know that microbes can survive the impact pressures associated with being launched from a planetary surface to escape velocity which means they can escape into space. The real problem for life is surviving for hundreds of thousands of millions of years in outer space as it makes the journey from one planet to another, er, but in fact people have now found, um, microbes in permafrost having survived for hundreds of thousands of years frozen in ice in Siberia and in the polar regions. And as more and more data is gathered it does seem that microbes are very resilient.

Mike Bullivant
Susan Conway there, talking matters Martian with Open University Researchers, Charles Cockell, Matthew Balme and Stephen Lewis. Do you want to know more about the planets in our solar system? Well if you do the Open University short course, “Planets, an Introduction” will tell you a great deal more about those planets and planet size objects in orbit around our own star the Sun. The course also delves into our rapidly expanding knowledge of the planets around other stars. In “Planets, an Introduction” students examine some of the amazingly detailed images of planetary surfaces that have become available thanks to the space programme and modern telescopes. For more details of this introductory course and other Open University courses log on to ww3, remember that’s the numeral 3 again, ww3.open.ac.uk/study.

Mike Bullivant
And now to OU alumnus Tony Diane of The Royal Society of Medicine. Tony used to study law with the Open University and here he talks with David Smith about his work as a toxicologist and, a subject close to his heart, biological medicines.

David Smith
Can you explain a bit about, um, what is a biological medicine?

Tony Diane
A biological medicine is something that is derived directly from a living biological system, might be an animal cell, might be a plant cell, might be a whole animal, or it may be, er, or cells in culture or sometimes from extracts of cells including extracts of organisms like bacteria, or fungi, or parasites which are used to make vaccines. So it covers a wide variety of complex chemical substances which cannot really be defined strictly by conventional chemical analytical procedures and that’s the key point, inability to define by conventional chemical analysis. You have to define them partly by their chemistry, partly by their biological activities and partly by the way that they are made because changes in the method of manufacture may greatly affect their activity.

David Smith
So are these normally directly taken from, say, a plant or can they be synthesised in the lab?

Tony Diane
They would not be taken directly any longer from an animal, or from a plant because of all the other material that you will inevitably get coming in with them, plant proteins, plant cell walls, animal proteins which may have untoward actions. They might be toxic or they might immunise somebody and cause side effects, adverse effects which you don’t want. So the simplest example would be something, say if you were making smallpox vaccine, these days, originally made by infecting the skin of a calf and scraping the cowpox or, sorry the vaccinia pox, um, crusts off the calf, cleaning by coarse filtration and that was the basis of a very successful vaccine for 200 years. Nowadays you would grow the virus in a selected strain of cells in a rigidly controlled tissue culture system and then using perhaps centrifugation or other physical chemical techniques you would separate just the viral particles that you want, if they are to be given as a live vaccine, you would then store them perhaps by freeze drying, another difficult procedure but very good for stability or you might have to kill them with an appropriate cydal chemical which depends on the organism that you are killing and then again you would freeze dry or make some other stable preparation suitable for administration to people or to animals.

David Smith
Is there any risks which are more prevalent than in conventional medicines?

Tony Diane
An interesting question. All medicines carry risks, carry adverse effects. Biological medicines have some that are common to all medicines and some that are specific to them. The common one, very briefly, of course, are getting the dose wrong, either too much or too little and both of those may be harmful, or giving a medicine that isn’t appropriate for the disease

but that's dealing with a different matter. The particular ones of biological therapies, first of all many of, most of them are high molecular weight substances, often, though not always, protein in nature so there is the risk of antigenicity. That they may stimulate the immune system of the patient or worse still of immunogenicity, they not only stimulate the immune system but they lead to the production of antibodies and sensitized cells which may rapidly destroy the medicine, if the medicine is much the same as a naturally existing, a naturally occurring protein then you may lose whatever residual effect the amount of the normal protein in the body has and it may sometimes even destroy the cells that are producing it. So the consequences of antibody formation are rapid, potentially rapid loss of effect of the medicine; it's cleared from the body too rapidly and the problems of immune complex formation which may damage the kidneys or the lungs or even cause anaphylactic shock.

Mike Bullivant
David Smith there talking with Tony Diane of the Royal Society of Medicine. Well if you found that interesting check out the Open University course, "Molecules, Medicine and Disease". This short course tells the fascinating story of the development of a variety of commonplace drugs and explores the chemical strategies that have been adopted from Hippocrates to the modern day in order to minimise the risk of infection and disease. You can find out more about "Molecules, Medicine and Disease" by visiting ww3.open.ac.uk/study. Well that's the end of this particular podcast, brought to you by BLAST! at the Open University. For other podcasts in this takeaway science series revisit the Open University science faculty website at www.open.ac.uk/science. If you want to find out more about some of the science outreach work carried out by OU visit the BLAST! web pages at blast.open.ac.uk. Anyway that's all for now so from me, Mike Bullivant adios amigos.