

Diagnosis Chemistry



CAREERS SPOT

Chemistry is often associated with helping to treat diseases through the development of new drugs, but did you know that it can

also play a vital role in diagnosing these diseases in the first place?

Many major diseases that affect the world's population today, such as cancer and HIV, can be treated more effectively if they are diagnosed in patients early on. For example, detecting breast cancer early on can significantly reduce the number of people who die as a result of this illness; worldwide there are over 13 million people living with HIV, but very few of these people know that they carry the virus and, until they are aware that they are ill, they can continue to spread the disease.

Conditions that might affect us in old age, such as Alzheimer's disease, could also be treated more effectively if they were diagnosed earlier.

Diseases like these can be detected and diagnosed in a number of ways using chemistry. Some diseases cause patients to have high protein levels in their blood - these can be detected using antibodies attached to indicator molecules such as fluorescent dyes or radioactive nuclei.

Some diseases are coded for by certain genes, which can be detected using matching strands of DNA attached to indicator molecules. Other diseases can be diagnosed using medical imaging techniques, such as MRI scans, which work using the same principles that are used in NMR spectroscopy. Scientists are continually trying to find new imaging and detection methods to help medicine treat diseases more effectively.

As you can see, chemistry is important in all these areas of medical science. Analytical chemistry in particular plays an important role in diagnostics, so if that's something you particularly enjoy then a career in diagnostics research could be for you.

Welcome
to issue 43



It's all about diagnostics this month.

With the world's population ever increasing, there is a growing need to be able to diagnose diseases early on, when they can be treated more effectively - so research by chemists into diagnostics is vital.

A lot of the methods used for disease diagnosis involve spectroscopy. You can find out how you can get your hands on some real-life spectroscopic equipment at your school, and use it to take part in a forensic investigation, on page 2.

This month we'd also like to hear what you think of **ChemNet News**. Is there anything you'd like to see more (or less!) of in future issues? Are there any particular areas of chemistry careers you'd like us to feature?

Let us know your thoughts and opinions by emailing chemnet@rsc.org

Victoria Steven

Victoria Steven – Editor

Dates for your diary

ChemNet Events:

► Kent Local Section Crystal Growing Competition

April 2010

Calling all Kent Schools
and Science Clubs...

Contact Dr A Hardy:

phdtutor@hotmail.com

(using the subject line:

RSC Kent Section Crystal

Competition 2010)

► The Bayesian's Burden: Or Why Physicists Shrug and Statisticians Scoff

National Science Learning
Centre, University of York

9 April 2010

Controversial views on
climate change from
Professor Lenny Smith

► Viral Glycobiology: Chemistry of Infection and Therapeutics

University of Oxford

13-14 April 2010

The role of carbohydrates
in the transmission of viral
disease and their therapeutic
potential

► Analytical Division Midlands Schools Analyst Competition - Heat 1 of 2 Nottingham Trent University

14 April 2010

National competition run by
the RSC's Analytical Division
for 1st year sixth form
students studying AS level
Chemistry or equivalent.

To register contact

Natasha Neale:

natasha.neale@ntu.ac.uk

► Look What Chemistry Has Done For Me – Belfast Queen's University, Belfast

20 April 2010

Gain an insight into careers
from chemistry and talk to a
number of chemists working
in the Belfast area



To book a place on a
ChemNet event:
E: chemnetevents@rsc.org
T: 01223 432340
or book online and find more
info about all the events at:
www.rsc.org/chemnet

Spectroscopy in a Suitcase

To be able to diagnose a patient as having a certain disease, we need a detection method to determine whether or not that disease is present in a biological sample from the patient. Often, spectroscopy techniques are used as detection methods.

If you are interested in learning more about spectroscopy, the RSC offers an interactive activity for post-16 chemistry students called Spectroscopy in a Suitcase. This involves a postgraduate chemistry student from a local university, or a chemistry teacher, coming along to your school with state-of-the-art portable spectroscopy equipment and giving you the chance to take part in some really exciting and challenging hands-on investigations using the equipment.

Spectroscopy in a Suitcase covers three different types of spectroscopy: UV-visible (UV), infra-red (IR) and mass spectrometry (MS).

One of the activities you could take part in is a crime scene investigation using all three of these spectroscopy techniques.



Students who have taken part in Spectroscopy in a Suitcase told us what they liked about the activity:

'Being able to use the different equipment that's not available to us at school.'

'Getting to actually see and do the stuff you only see in the text books or on videos. I also liked the brightly coloured chemicals!'

'Being able to use the IR equipment and analyse our spectra.'

'The uni students talked about their university course in chemistry during the practicals, which was useful for someone like me that wants to study chemistry.'

'It gave me a better visual representation of what I have been learning in my chemistry lessons.'

'It was very informative, and has helped me make a clear decision on what I wish to study at university.'

Murder in the lab

A body has been found in the lab. Was it an accident or was it foul play? Using spectroscopy you can carry out a forensic investigation to find out what happened.

Was it an overdose? Using UV-Vis you can analyse a blood plasma sample from the victim to see if there is a high concentration of the drug in his body.

Was it the chemicals in the lab? Using IR spectroscopy you can find out which functional groups are present in the chemical samples collected, then decide if any of these are likely to be toxic and could be linked to the victim's death.

Or was it something else? An unknown chemical was found in a urine sample from the victim... using mass spectrometry results you could pick up something the other techniques missed.

Digest the data and find out who, or what, was the culprit!

If you think Spectroscopy in a Suitcase is an activity that you would like to visit your school, please let your teacher know. For more information, or to request a spectroscopy visit, contact the RSC: hstem@rsc.org

Careers: finding answers in blood

Dana Spence discusses with Jane Hordern the function of red blood cells and the importance of a foundation in chemistry



Dana Spence is an associate professor at Michigan State University, East Lansing, USA, specialising in quantitative biological chemistry.

His current research looks into the role of red blood cells in diseases such as diabetes and multiple sclerosis.

When he's not in the lab, he is a big sports fan, following American Football and his favourite hockey team - the Detroit Red Wings.

'We are getting a better understanding of pharmacological sciences and physiological sciences because of our background in chemistry.

You can take that chemistry background and truly do a lot of neat things with it - it's all chemistry! Chemistry provides a great foundation for all the sciences.'

What inspired you to become a scientist?

The real reason is because not many people do, and I like a challenge! I thought that if this university is taking in 10 000 new students this year and only 10 were going to do chemistry - I want to be one of those 10. I like being off the beaten track.

What motivated you to specialise in biological chemistry?

I always liked medicine and I thought I wanted to be a doctor when I was at high school. But at 17 years old, the thought of going to school for another 10-12 years was just unacceptable! I always liked the medical and biological aspects of science but I wasn't sure I had what it takes to be a medical physician. Fortunately I have been able to stay with these interests in my chemistry career.

What benefits to you hope to provide for diseases?

In some cases we hope to offer them some help. There is currently only one proven therapy for sickle cell disease (a drug called Hydroxyurea). But the exact mechanism as to how it works is not known. We think that we may have possibly found out how this mechanism works, which could help design new improved drugs.

The work we have done with C-peptide and insulin could change the way in which insulin is administered to diabetics and may eliminate the complications that diabetes patients suffer.

Also, now that cystic fibrosis sufferers live longer, many develop diabetes, which I believe is due to the red blood cells not disposing of the amount of glucose that they should. It is difficult to convince people of this, as most people don't believe red blood cells play a role in glucose levels in the blood stream. But we are going to keep at it - as I think it is really exciting. Our main hope is to just try to help people!

What advice would you give to a young scientist about to pursue a career in chemistry?

There are many biological questions that have been out there for quite some time and progress is starting to be made, but in our group a lot of the questions we are beginning to answer are based on our chemical knowledge - which we learn through our general chemistry courses. When you have that root in the chemical sciences and you understand how things work at the molecular level, it helps explain things at many other different levels. We are getting a better understanding of pharmacological sciences and physiological sciences because of our background in chemistry. You can take that chemistry background and truly do a lot of neat things with it - it's all chemistry! Chemistry provides a great foundation for all the sciences.

Which scientist do you most admire and why?

Linus Pauling - considered one of the greatest chemists in the world and he did a lot of biological work too. I like people that have hypotheses that are so far off-the-wall that people think their ideas are impossible or crazy. Another is Otto Heinrich Warburg, who won a Nobel Prize, and towards the end of his career he tried to pitch to people that a lot of cancers were caused by dysfunctional mitochondria. They thought he was crazy at the time, but in the last few years there has been work to show that he wasn't totally far off base. I like stories about people who proposed ideas fifty or sixty years ago and now it is being found that their ideas were right.

Chemistry on the web

Exam time is getting ever closer so this month we've got some revision websites to help you along with your studying:

► Doc Brown's Chemistry Clinic

Loads of useful information if you're studying for A-levels, including revision notes, quizzes and helpful links.
<http://www.docbrown.info/>

► BBC Higher Bitesize

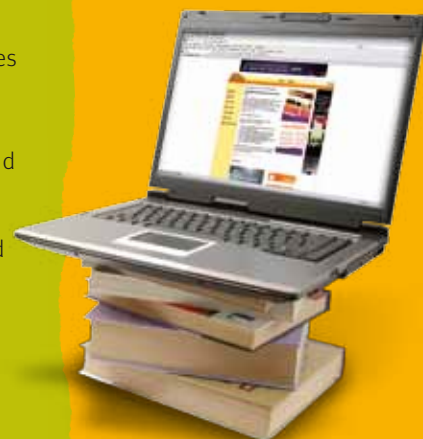
Information on each of the Scottish Higher Chemistry topics, including revision tests and access to past papers.
<http://www.bbc.co.uk/scotland/learning/bitesize/higher/chemistry/>

► S-cool Revision

Free A-level revision sources as well as information on careers and universities.
<http://www.s-cool.co.uk/index.html>

► Stephen Fry talks tiny

Fancy a bit of light relief from all that revision? Do you want to know more about nanoscience and nanotechnology? The University of Cambridge Nanoscience Centre and the EU NanoYou network have produced a 15 minute film about nanoscience, narrated by Stephen Fry.
<http://tinyurl.com/yb96zsh>



Win stuff

Since it's coming up for Easter, in honour of all those Easter eggs you'll be eating, this month's competition is all about chocolate.

Everyone knows that a little bit of chocolate is good for you! This is because chocolate contains anti-oxidants – but do you know what these anti-oxidants are called?

Send your answer by email to chemnet@rsc.org, along with your name and your ChemNet membership number.

Closing date 15th April. Two winners will receive a molymod[®] molecular modelling kit, ideal for all that looming chemistry revision. www.molymod.com



Last month's winners were **Elly Boshell** from Wantage and **Rasan Burhan** from Croydon, who correctly answered that Alexandre-Edmond Becquerel discovered the photovoltaic effect – well done!

For a chance to **WIN**, email us at: chemnet@rsc.org

Did you know?



Triglycerides are the main constituent of the fat in chocolate, cocoa butter. This is solid at room temperature but molten at body temperature, which is why chocolate melts in your mouth!

Cutting-edge Chemistry

Detecting disease with a little TLC

US scientists have developed a simple, low cost method to detect toxins from the organism that causes the wasting disease Buruli ulcer.

Buruli ulcer is a wasting disease caused by organisms called *Mycobacterium Ulcerans*, which are in the same group as the organisms that cause leprosy and tuberculosis. Early diagnosis and treatment are vital as delayed treatment may lead to irreversible deformity, long-term functional disability such as restriction of joint movement, extensive skin lesions and sometimes life-threatening secondary infections.

Polymerase chain reaction of *M. Ulcerans* DNA is commonly used to detect the infection, but is expensive and difficult to maintain reliably, say Yoshito Kishi and Thomas Spangenberg from Harvard University, Cambridge. They have created a simple but highly sensitive fluorescent detector for mycolactones – the toxins secreted by *M. Ulcerans* and distributed within the infected tissue.

Buruli ulcer toxins are detected using thin layer chromatography.

Mycolactones are known to behave well in thin layer chromatography, producing a distinct spot on silica gel, say Kishi and Spangenberg, but the sensitivity is low. The pair used boronic acids to selectively bind to the mycolactone enhancing the fluorescent emission and allowing detection of levels as low as two nanograms of mycolactones.

'This is an exciting prospect which will be received with great interest,' says Mark Wansbrough Jones, chair of the World Health Organisation technical advisory group for Buruli ulcer. 'It has potential use as a diagnostic tool which is important because clinical diagnosis is only 70% likely to be correct and a simple test such as microscopy for the bacteria is less than 50% sensitive.'

This simple and cost effective method would be particularly useful in the remote areas known to suffer from this disease, say Kishi and Spangenberg. And they are now investigating whether the technique can be developed into an effective way to diagnose Buruli ulcer in its early stages.

Rachel Cooper

For more stories like this featuring the latest research from RSC journals, visit Chemical Biology on the web: www.rsc.org/highlightschembiol



Buruli ulcer toxins are detected using thin layer chromatography

Easter Chemistry

You will probably have heard of the C₆₀ Buckyball but did you know that scientists have also made a Buckyegg? Chemists in the USA made the 'uneggpected' discovery after trying to make mixtures of carbon structures under special conditions.

Buckyballs are made up from hexagons and pentagons of carbon atoms, like a football. In normal Buckyballs, no two pentagons ever touch – they are always surrounded by hexagons. However, scientists found that in the Buckyegg, two pentagons lie next to each other to make the pointy end of the egg. They also discovered the egg-shaped structure contains a molecule of tritertium nitride inside it.

