

A bright future...



Providing new technology the bio-chemical way... hopefully without a sting!

CAREERS SPOT

There are lots of things that you could come across in the natural world that 'glow in the dark'. Some of these you may have seen

in the TV nature programmes, or some of you may have been lucky enough to see them up close! Glow in the dark in terms of chemical science means a whole lot more than just pretty colours...

One of the earliest mentions of luminescence in a scientific context was made by George Gabriel Stokes in 1852. He observed something he called 'fluorescence' when he was observing "a solution of sulphate of quinine and similar media". The molecule quinine is actually found in drinks such as tonic water and when under a UV-light this emits a purplish glow. Fluorescence is just

one of a number of types of luminescence, many of which have some amazing applications including bioluminescence (genetic engineering, bio-imaging); chemiluminescence (sensors, DNA sequencing); phosphorescence (glow sticks); and electroluminescence (lighting, information displays).

With the breadth of applications that luminescence touches upon, its not surprising that many people have gone on to have successful careers using this clever bit of science. There are still lots of fundamental research projects being done with luminescence at their centre. Many new therapeutic techniques rely heavily on spectral analysis to feedback inform about a range of conditions ranging from viral to cancerous. Without the continued efforts of young new scientist, lots of the therapies of tomorrow would just be an unachievable dream.

Welcome to issue 41



This month's edition focuses on the uses and applications of all things that 'glow in the dark'.

The phenomenon of 'luminescence' is the emission of photons (particles of light) by a material or chemical. There are many different types of luminescence – some of which you may have seen in things like glow sticks, special paints and other novelty items.

However, in the scientific community luminescence is no novelty – it has been used in many applications including mineralogy, chemical sensors and fluorescent labelling. It has even been responsible for a Nobel Prize or two with phosphorescent materials prompting the discovery of Radiation and more recently green fluorescent protein (GFP) has been used to study genes. I hope you all find it an 'enlightening' subject!



Mike Bonne – Editor

Dates for your diary

ChemNet Events:

► Meet the Universities 2010

Royal Horticultural Halls, London

Saturday 3rd July

Reserve the date in your diary now – it's a great opportunity to find out more about how chemistry can fit into your future!

Cool Chemistry

Over the last decade, scientists have developed a new technique called bioluminescence imaging (BLI). It allows the non-invasive study of ongoing biological processes in small laboratory animals. The DNA from a luminescent protein is incorporated into the animal either via a virus or by creating a transgenic animal. It can then be used to identify tumours and infections.

The results of this technique can lead to some rather odd looking animals – have a look at these mice for example...



A full list of ChemNet Events for 2010 will be coming soon. Keep checking the website for details.
www.rsc.org/chemnet



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

RSC Shire Prize 2009 the winners!



Last years winners - could this be you next year...?

Shire Pharmaceuticals Group is a global specialty biopharmaceutical company working together with the RSC to reward excellence in chemistry by post-16 students. For the second year running they have held a competition for those students who achieved the highest marks in their A-level and Scottish Higher examinations, the prize an all expenses paid trip to Boston, USA in December. Here is an example of one of the winning essays...

The Winners: **Rohan Sakhrani** (a student from Westminster School, London); **Sarah Gales** (Kings School, Macclesfield); **Jie Ming Yeo** (Abbey College, Cambridge); **Alison Davies** (The High School of Glasgow); **Sebastian Rex** (Kings School, Canterbury) and **Prateush Singh** (Loughborough Grammar School)

“Why is chemistry important in your everyday life?”

By Rohan Sakhrani, Westminster School, London

I never give much thought to the role Chemistry plays in my everyday life, but the true magnitude of its importance struck me on a Saturday evening some weeks ago. It was my friend's 18th birthday party that night. I was awoken by my alarm clock after my evening snooze. The ticking of the clock suddenly got me thinking about the importance of Chemistry. My clock itself was powered by the chemical interaction of the zinc and manganese dioxide electrodes with the alkaline electrolyte in the batteries!

My mind was wandering and I was running late. Lathering up in the shower cubicle, I realised how everyday phenomena such as the cleaning action of soap is taken for granted - chemically, soap is a sodium salt of fatty acids formed by the alkaline hydrolysis of a triglyceride. Soap has a dual hydrophobic and hydrophilic nature - the hydrophobic part is attracted to grease, while the hydrophilic part is attracted to water molecules. This effect loosens the grease particle from the surface medium resulting in a clean body (or clean clothes!).

With nothing but chemistry on my mind, I got dressed. There was chemistry in my fancy dress too - my orange nylon outfit. We had recently completed a laboratory practical where we had made a few strings of 6,6 nylon via a polycondensation reaction of hexamethylene diamine and 1,6-hexanedioic acid! The absolute pervasiveness of the subject is astounding, something which most of us remain oblivious of.

I then rushed to the dinner table to be greeted by a plate of salad. The Chemistry all around me was mind boggling. I stared at the tomatoes - brightly coloured due to the presence of carotenoids (lycopene) in the chromoplasts. The conjugated pi systems in the structures of the carotenoids lead to the formation of chromophore regions. Electrons in the ground state in these regions absorb light in the blue end of the spectrum to move to an excited state, resulting in red wavelengths being reflected. At the other end of the table, my grandmother was taking her statin tablets, which aim to slow atherosclerosis by inhibiting cholesterol synthesis and increasing the synthesis of LDL receptors in the liver.

All these musings about Chemistry had made me late, and I demanded that my mother drive me to the party. The car had been refuelled with a new high-octane fuel ensuring a smoother and more efficient drive by reducing the knocking characteristics of the fuel. Such technological advances are only possible due to chemists spending hours in laboratories to determine the composition of the most practical and commercially viable high performance fuel. I then looked at the airbags, which offer protection by inflating with high pressure nitrogen gas in a crash, produced via another chemical reaction - that of sodium azide with potassium nitrate.

I expected the rest of the evening to be different. However, once at the party and with alcohol in my bloodstream, yet again, I lapsed into the wonderful world of Chemistry...

Careers: A glowing career

From jellyfish to cancer diagnostics, **Roger Tsien** discusses the challenges of looking into a cell with Harp Minhas. Interview reported by Leanne Marle



Curriculum vitae

Work experience

1989-present : Professor, Dept. of Pharmacology and Chemistry, Univ. of California, San Diego; Investigator, Howard Hughes Medical Institute

1987-1989: Professor, Dept. of Physiology-Anatomy, Univ. of California, Berkeley

1985-1987: Associate Professor, Dept. of Physiology-Anatomy, Univ. of California, Berkeley

1981-1985: Assistant Professor, Dept. of Physiology-Anatomy, Univ. of California, Berkeley

1978-1981: Postdoctoral research with Dr. T.J. Rink, Physiological Laboratory, Cambridge, England

1975-1978: Research assistant to Prof. R.D. Keynes, Physiological Laboratory, Univ. of Cambridge, England

Education

1977 – Harvard College, A.B. summa cum laude in Chemistry and Physics, University of Cambridge, Ph.D. in Physiology

'...you have to follow your own gut and do what you find interesting yourself and that's the best chance you have that it will turn out to be good enough and make an impact.'

Roger Tsien is an Investigator at the Howard Hughes Medical Institute and a professor at the University of California, San Diego, US. In 2008 he was co-awarded the Nobel Prize for Chemistry for the discovery and development of the green fluorescent protein (GFP)

What motivated you to specialise in cellular imaging?

My interest in imaging actually started as an interest in neurobiology. I wanted to see lots of neurons interacting and essentially neurons are a large number of cells interacting. They couldn't be measured just by sticking in an electrode them as I wanted to actually see the neural populations firing away and that proved too hard to begin with. In the meantime we looked at calcium which was just a poor man's way of getting a big chemical signal. Once we could define how to measure calcium then we could do it on lots of cells, not just neurons.

Since being awarded the Nobel Prize for Chemistry what, if anything, has changed in an unexpected way?

Well, I guess most things were expected. There was one particular case though, where I had written to a company to ask for an anticancer agent that wasn't commercially available and I got no response to my email. I wrote again a month later saying that we still hadn't had a response and asked for an answer, even if it was just to say no. There was still no reply. Then, a few days after the Nobel prize, I got a letter saying they hadn't opened my previous email and that they were contacting their legal department to discuss a Material Transfer Agreement to give me the agent - so that was an unexpected bonus.

Douglas Prasher sent you the gene that created GFP in the Aequorea victoria jellyfish. If he hadn't, things could have been very different - could you comment on the importance of collaboration with other scientists and disciplines for scientific development?

Absolutely, things could have been very different - I think that GFP wouldn't have escaped from just being a curiosity of the jellyfish without Douglas Prasher. Collaboration is absolutely crucial. We're lucky as scientists that we can work together. Artists or authors can't really team up or pass their work to somebody else to continue - it's not quite the same.

What projects are you working on at the moment?

We've had a big push in attempting to find synthetic molecules that will home in on cancers and will be of clinical relevance. We're not working as much on fluorescent proteins as most people think we are. They assume that just because of the Nobel Prize I have to do that for the rest of my life and that is everything I do - if ever I show a cancer cell that's glowing they assume it's because I stuck GFP in it, which is not true. That's just one of many projects.

What would you ultimately like to achieve from your research?

I would like to achieve something that could be clinically beneficial. My father and PhD supervisor both died from cancer and it would be very nice to do something in their memory if nothing else.

What do you see in the future for cellular imaging?

A lot of the difficulties arise when doing cellular imaging inside a living organism. And not a zebrafish or a worm that is very small and transparent, but inside mice or humans. Humans are the most difficult because you can't put genes into humans.

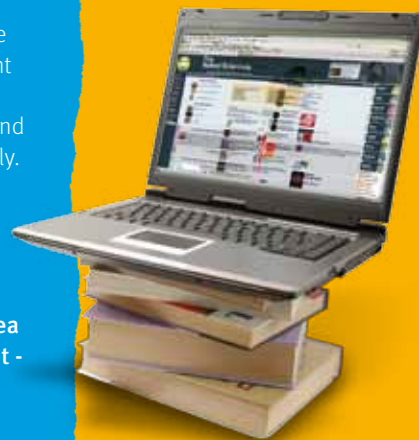
Chemistry on the web

► There aren't many ways you can listen to or watch things about science. What makes this group of people special is that they love to talk about science and in very interesting ways too!

<http://www.thenakedscientists.com/>

"The naked scientists"

details the exploits of a group of researchers in Cambridge. It has lots of pod-casts and details of shows that are conducted on BBC radio on a weekly basis. It also looks to go further afield and see what science is happening around the world. Why don't you have a look and listen?



► Something for you all to look out for on **iPlayer** this month is the BBC Four series, **Chemistry: A Volatile History**. If you don't manage to catch it first time around on the television then have a look on the web at the BBC iPlayer page.

<http://www.bbc.co.uk/iplayer>

This programme looks at the explosive story of chemistry and the building blocks that make up our entire world - the elements. From fiery phosphorous to the pure untarnished lustre of gold and the dazzle of violent, violet potassium, everything is made of elements - the earth we walk on, the air we breathe, even us.

Win stuff

Many of you will have seen glowsticks before – they exhibit a type of luminescence called ‘chemiluminescence’. This is where a chemical reaction occurs which releases a photon – but what is the name of the chemical that causes this in glow-sticks called?

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

Closing date 15 February. Two winning entries will each receive a copy of *Elegant Solutions*, showcasing 10 of the best chemical experiments of all time. Last month’s winners were Seehan Tang from Enfield and Ben May from Woodbridge.

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

Chemistry facts

Did you know that you can do your own triboluminescence experiment at home? All you need is a something made out of crystals and something to crack it with... I usually use a sugar cube.



If you take the cube, turn off the lights and split it you will see what look like sparks! This is the emission of photons caused by the breaking of chemical bonds in the sugar. You can also try this with most adhesive tapes when you remove them from a surface. Why don't you give it a go?

Cutting-edge Chemistry

Two techniques are better than one

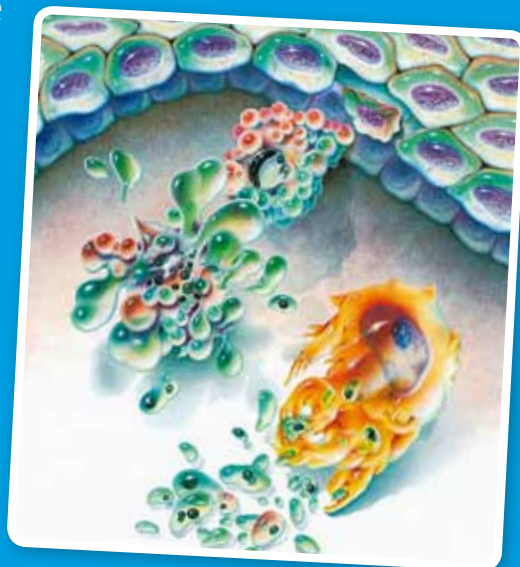
Using inorganic dyes to label cells allows imaging by fluorescence and resonance Raman spectroscopy at the same time, which could help understand cell death caused by cancer and strokes, say scientists in Ireland.

Fluorescence imaging and Raman mapping are two common techniques used to study live cells and understand the processes occurring in diseased cells such as tumours. But Raman microscopy can suffer from low sensitivity and background fluorescence interference limiting its usefulness. Tia Keyes and colleagues at Dublin City University have shown that using ruthenium complexes to label cells allows both techniques to be carried out independently without changing the conditions. This allows consecutive or simultaneous imaging by both techniques.

This multi-modal imaging would not be possible with traditional organic dyes, explains Keyes. But unlike organic dyes, the inorganic metal complexes have large Stokes shifts, so when Raman imaging is carried out, there is no background fluorescence interfering with the Raman signal.

Ruthenium complexes allow simultaneous fluorescence and resonance Raman cell imaging

‘The advantage of Raman mapping is that you can get structural information on the dye, which can reflect on the environment,’ says Keyes. The ruthenium dye shows that the Raman signal validates the fluorescence results, but other dyes can sense oxygen and pH levels, she says.

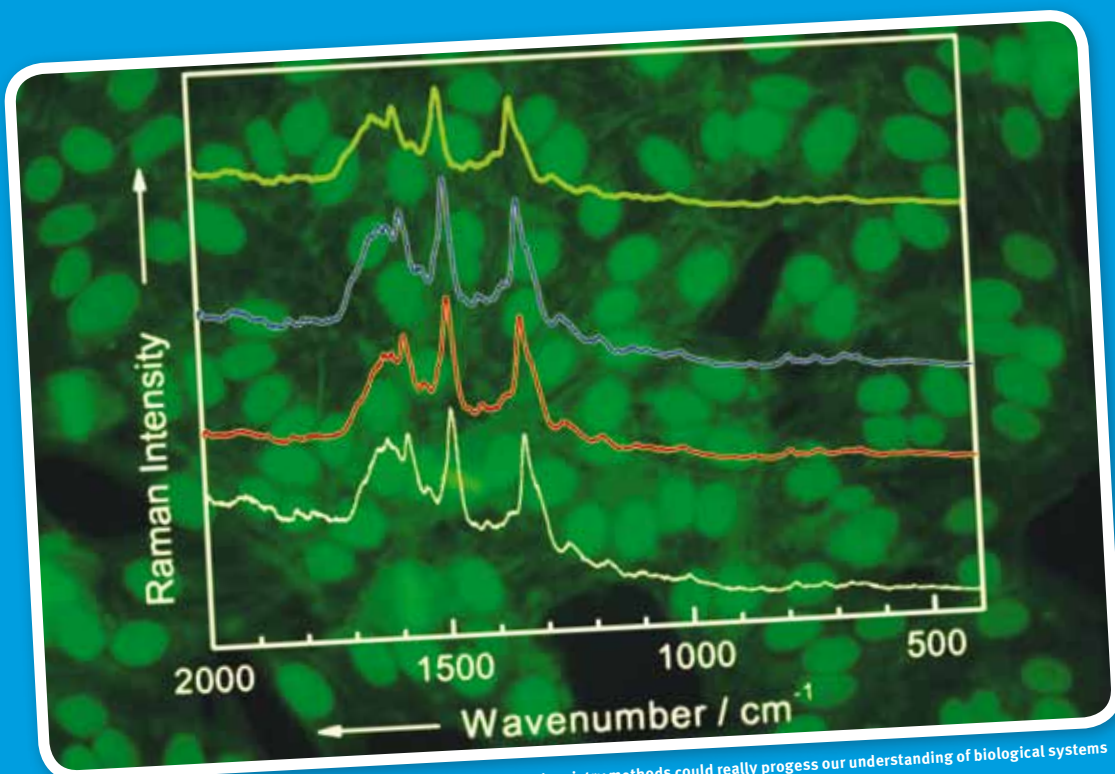


Where chemistry and biology collide ...

The group are now creating a library of dyes using ruthenium, iridium, osmium and copper to make the complexes. *‘We’d like to see some of these dyes used in understanding the biochemical processes in cells and for mapping the concentrations of chemicals,’* says Keyes.

The work has attracted interest already, Yunhua Yu, who also works on cell imaging at Georgia Institute of Technology, Atlanta, US, says that *‘with such sophisticated functionalisation, resonance Raman imaging will be a powerful tool for biological studies.’*

Article by Laura Howes



The use of analytical chemistry methods could really progress our understanding of biological systems