



SCIENCE@HKU

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HIGHLIGHTS

The Power and Impact of STATISTICS

Dr P L H Yu, Department of Statistics and Actuarial Science



www.statistics2013.org

2013 INTERNATIONAL YEAR OF STATISTICS RECOGNIZING THE CONTRIBUTIONS OF STATISTICS TO SOCIETY WORLDWIDE

Do you know that the analysis of big data helped Obama win swing voters and get re-elected last year? Do you know that an accurate estimate of the number of marchers does not just make use of the simple head counting technique but also a sample survey and a statistical estimation method? Do you know that statistics was used to protect astronauts on their preparation of journey to Mars?



Source: <http://datamine.bstro.com/varonis/files/2011/03/obama-family-winner.png>

Let's take a look on how the data crunchers helped Obama win. At the beginning, the Obama campaign's data crunchers collected data on millions of voters from pollsters, fundraisers, field workers, consumer databases, social media and private companies. Using the big data, they ran computer simulations every day to estimate Obama's odds of winning each state. They also built statistical models to generate scores to all potential swing voters, on a range from 0 to 100. The two important scores measured an individual's likelihood of supporting Mr Obama and of casting a ballot. Using the data on 2008 voters, Obama's data

From The Editor

Dear readers,

Statistics is around us, affecting our lives in visible and not so visible ways. In this issue of Science@HKU, Dr P L H Yu will tell us the power and impact of statistics in our daily lives.

We encourage communications and feedbacks from readers. Here we publish a reader's feedback on our recent article "Pepper spray, how does it work?" together with our response. Please write us an e-mail if you have any comments and suggestions about our Newsletter in general or any article published here in particular.

Yours sincerely,

Professor H F Chau
Chief Editor

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crunchers identified that the past vote history was most useful to predict the turnout. As early as 2007, they conducted randomized experiments to determine the most effective combination of media and buttons. Among the four buttons: “join us now”, “sign up now”, “learn more”, and “sign up”, “Learn more” did the best. In six media considered, the one with the picture of Obama and his family did the best. Although inside knowledge about the statistical methods used in the Obama team is not known to us, the recent work by Drew Linzer who successfully predicted Obama’s win in his website Votamatic may be referred, which accurately predicted US presidential election outcomes at the state level by building a dynamic Bayesian forecasting model (see Linzer, 2013).

For the details on how statistics are applied in crowd counting and in reducing risk to astronauts, please refer to Goodier (2011) and Ploutz-Snyder (2012). In fact, statistics affects nearly every aspect of our life. Statisticians, the scientists who collect and analyze data, actually work in many areas, including environmental and medical studies, business, economics and social research, weather forecasting and so much more. However, you may not be aware of statistics.

To increase the visibility of statistics and to encourage young people to pursue statistics careers, this year is the **International Year of Statistics**, initiated by the American Statistical Association, Institute of Mathematical Statistics, International Biometric Society, International Statistical Institute (and the Bernoulli Society), and Royal Statistical Society. More than 1,800 organizations in over 120 countries — professional statistical societies, colleges and universities, secondary schools, government entities and businesses — are banding together to celebrate this worldwide event. The goals of the event are:



- To increase public awareness of the power and impact of statistics on all aspects of society;
- To nurture statistics as a profession, especially among young people; and
- To promote creativity and development in the sciences of probability and statistics.

2013 is a very special year for statistical profession not only because the International Year of Statistics will be celebrated by thousands of organizations all over the world but also it is the 300th Anniversary of Jacob Bernoulli’s *Ars Conjectandi* and the 250th Anniversary of Bayes’ theorem. The former one is a work of the greatest significance in the theory of probability and the latter one is a simple statistical formula used in a wide variety of areas that vitally affects our world.



Throughout 2013, participating organizations plan conferences, competitions, media outreach and other educational and promotional activities in their countries. For example, all six issues of **Significance**, an outreach magazine showing how statistics benefits our society in an entertaining way, are free to be read via the Significance IOS and Android apps in 2013. Don’t miss this chance of reading such a high quality magazine free of charge. For a complete list of updated news and activities that will be organized by the participating organizations, visit the website www.statistics2013.org.

Being one of the largest statistics departments in the Far East region, the Department of Statistics and Actuarial Science of The University of Hong Kong (hereafter, the Department) is going to take a leading role in organizing a series of activities to promote the importance of statistics to the general public. First of all, the Department takes part in organizing the 59th World Statistics Congress (WSC) of the International Statistical Institute (ISI) to be held in Hong Kong during 25-30 August 2013. Such biennial meeting is regarded as an important event of the international statistical community and it is expected to attract more than 2,000 participants this time. This is the first time Hong Kong hosts such a large-scale statistical conference.



Established in 1885, the ISI is one of the oldest scientific associations operating in the modern world. It is our honor that the Department has 14 teaching staff being an elected member of the ISI. This is really a remarkable record in Far East region.

The ISI WSC in 2013 will be held under a special theme “Youth”. As such, there will be many theme-related sessions for young statisticians and also various activities including the Young Statisticians Satellite Meeting (YSI 2013) to be organized by the Department. Taking place in the campus of the University of Hong Kong, the YSI meeting will give an opportunity for young statisticians to present their work in an encouraging and heartening environment, and provide them with a forum where they can build scientific bonds with other participants in their respective fields.



The ISI and its Associations will partner with the Department to arrange some short courses before the WSC during 22-25 August 2013. All the Congress delegates are welcome to participate in the courses. There are totally 9 short courses on various topics of statistics, including Analysis of complex sample survey data, Wavelet methods for environmental time series, Actuarial and statistical aspects of reinsurance, etc.

With a vision to promote the importance of the proper use of statistical concepts in various aspects, I brought up an idea of establishing a new statistics competition with an aim at encouraging students to creatively express in words the daily application of statistical concepts or put statistical concepts into a story in a scientific and objective manner. With the full support from Hong Kong Statistical Society and Education Bureau, the first Statistics Creative-Writing Competition (SCC) for Secondary School Students was organized in 2009. Since then, the Department has been the sole sponsor of the prizes of each round of the Competition. The prize presentation ceremony of the current round is scheduled to be held on 28 August 2013 in the venue of the 59th WSC. The winning teams will present their work in the ceremony and have a chance to experience in an international statistical meeting.



Photo of officiating guests and the organizing committee in the SCC in 2009:(From the left) Dr K C Cheung, Dr Philip L H Yu, Dr K W Cheung, Professor W K Li, Mr H W Fung, JP, Mr Leslie W K Tang.

The International Year of Statistics in 2013 is not only for statistical professionals but also for every person in the world. Let us experience how statistics shape our lives.

References:

Goodier, R. (2011). The curious science of counting a crowd. *Popular Mechanics*, <http://www.popularmechanics.com/science/the-curious-science-of-counting-a-crowd>.
Linzer, D.A. (2013). Dynamic Bayesian forecasting of presidential elections in the States. *Journal of the American Statistical Association*. 108(501), 124-134.
Ploutz-Snyder, R. (2012). To boldly and safely go: Biostatistics in space. *Significance*, 9(1), 4-7.

LETTER TO THE EDITOR

Re: “Pepper SPRAY I , How Does It Work?”

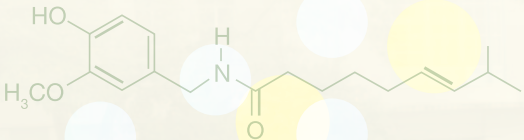
Article of “Behind the News” Section, 2012 October Issue

“I think sharing the chemistry behind is just “part A” of the story, it was too short in my opinion. Given the HKSAR police force tends to excessively use this capsaicin during non-violent protests, I wonder if the Chemistry Department can share any academic knowledge about any other chemicals (even house hold chemicals like soaps or vinegar) that can serve as quick antidote to this Capsaicin compound? The perspective of expanding that article (or rationale) is not about counter-acting the enforcement; from a pure academic perspective, I think sharing the knowledge of antidote of capsaicin is actually enabling the “weapon-less” civilian in HK for a better awareness of self-defense when being ill-treated by those having weapon?”

Second, as rightly said in the article, “severe over-exposure” to the chemicals can result in death, can the Department establish a baseline dosage for that particular brand that was adopted by the police force to provide a safe application of this capsaicin. If you recall from a few live footages, policemen actually tear off

the glasses/mask from protestors and then apply the spray directly to the eyes of protestors. I am suspecting that’s an over-exposure already, assuming some of them are regular protestors. Also, I doubt the actual product used by the police force is NOT a natural extract, and thus the MSDS from sciencelab.com cannot be a good reference towards the daily life situation. From an academic angle contributing to the well-being of the society, I am appealing to HKU Chemistry Department can take a lead as the first academic institution in HK to pick up that subject to explore further. I think it could be a very well-structured focus article for next discussion in the newsletter.”

Kenneth Wong
BSc (FNS) 2001



EDITORIAL REPLY



“Thanks for your comments and suggestions. The focus of our article is the scientific aspect of the chemical involved. Perhaps, we could go further.

However, we have to be very careful. For instance, the problem with your second suggestion is that it is not legal to possess the spray in Hong Kong. So, even if we know the brand, we cannot do any test on it without the

permission of the relevant government body. Moreover, it is not wise simply quoting the tests and reports from another source. We know all too well that there is a general tendency of over-estimating the safety and effectiveness in reports provided by companies selling and promoting almost any product. And on the other hand, there is a general tendency of under-estimating the safety and other issues in quite a number of NGO’s. Also, it is a grey area to say what is safe and what is unsafe. Water is not safe if one drinks too much at a short time. Essentially all chemotherapy drugs are downright toxic and unsafe if injected into an ordinary health person. Quantifying safety is not something that can be said in one paragraph or two, not to mention that

it requires an expert to do it after a thorough and professional research. Similarly, for your first suggestion, without knowing the detail chemical involved, it is not wise to give any advice on how to clean it up. Furthermore, those with sensitive skin probably require additional care.

With all the above in mind, we decided not to say more than what has been said in the article. Yes, it is a bit disappointing. But we have to be responsible and put forward our views based on established and independently verifiable (better still verified) facts for we know all too well that there are so many irresponsible views around, intended or otherwise, from governments, politicians, pressure groups and so on, both local and abroad. We should stand firm on the above principle for we believe in what Abraham Lincoln had said ‘You can fool some of the people all the time, and all of the people some of the time, but you can’t fool all of the people all of the time.’”

Professor H F Chau and Professor W K Chan
Editorial Board

BRAINTEASER

Question

While celebrating the Year of Snake, let’s see how much you know about snakes!

The species shown in the photos on the right are common snakes found in Hong Kong. Can you identify them and tell which is / are venomous?



Photo courtesy: School of Biological Sciences



“Adrift – Tales of Ocean Fragility”

by Professor Y J Sadovy and co-authors

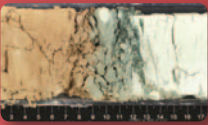
Deadline: June 30, 2013

Please email your answer together with your name and school (for students), to scinews@hku.hk. FIVE winners will be drawn randomly from the contestants who give the correct answer.



Questions of last issue

The Earth’s history can be divided into a few geological periods. The boundaries between these periods (epochs) are often associated with notable changes in sediment color and grain size that can be easily identified in field. The following photo is a section retrieved by the recent IODP Expedition 342 from the Newfoundland region. A layer of coarse-grain sediments can be clearly observed at a boundary associated with a mass extinction event. Identify the boundary and the animal most often associated with this mass extinction.



Answer: K/Pg (Cretaceous/ Paleogene) boundary, formerly known as K/T (Cretaceous/ Tertiary) boundary, associated with an impact event and the extinction of dinosaurs.

Winners of the last issue have been informed individually.

The Gutter Oil Scare

by Dr E T S Li, School of Biological Sciences

In December 2012, the unfounded rumor that restaurants in Hong Kong were using the so called “gutter oil” had led to societal havoc and a series of investigation was launched by the Centre for Food Safety (CFS). The culprit in this saga was a chemical called Benzo[a]pyrene (BaP) with the formula $C_{20}H_{12}$. It belongs to the chemical class of polycyclic aromatic hydrocarbons (PAH). Benzopyrenes and in particular BaP are health hazards because they intercalate into DNA and can cause cancer in humans. Hence it is listed as a Group 1 carcinogen by the International Agency for Research on Cancer. As the story unfolds, it now appears that the BaP risk is relatively minimal. However, the public should not ignore other potential health risks related to cooking oil. The following questions and answers will provide readers a proper perspective on food safety, nutrition and health.

Gutter oil

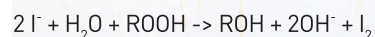
It is definitely wrong to equate gutter oil with BaP. BaP needs not be present in gutter oil. There is no clear definition for gutter oil and not any established scientific method to test and identify “gutter oil”. A potential approach in identifying the source of oil is on the basis of their fatty acid profile. Because cooking oils are primarily plant based and each has a typical profile, careful analyses may provide clues as to the origin. One would expect gutter oil to contain mixture of fatty acids from plant and animal sources.

Is BaP the “gold standard” in assessing oil quality?

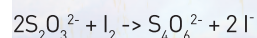
PAHs are ubiquitous in the environment and BaP can be found in car exhaust fumes (especially from diesel engines) and in cigarette smoke and charbroiled foods. Normally, BaP level in cooking oil is very low. CFS only found 4 samples with BaP level exceeding the European Union’s limit of 2 microgram/kg. In fact, consumers who frequently eat siu mei and BBQ products would be at higher risk than through consumption of BaP tinted cooking oil. The concern of BaP’s carcinogenicity has overshadowed other indicators of oil quality. On a day-to-day basis, we should be more concerned with the peroxide content and fatty acid composition of household as well as restaurant cooking oil.

Peroxide Value

Fats and oils consist of saturated and unsaturated fatty acids. Unsaturated fatty acids are susceptible to autoxidation (free radical reaction involving oxygen) leading to the formation of peroxides (ROOH). When this happens, the oil is rancid indicating structural changes had occurred. The amount of peroxide can be easily determined by the amount of iodine formed upon reacting peroxides with iodide ion.



The iodine liberated is then titrated with sodium thiosulphate.



Heating and re-heating speed up peroxidation and fats with a high degree of unsaturation are more susceptible to free radical attacks. Once peroxides are formed they can undergo secondary oxidation leading to a variety of degrading lipid structures known to exert negative health impacts in laboratory animals including hypertension, thickening of arterial wall and reduce capillary elasticity. Thus, it is advisable not to consume re-use oil at home and decrease the consumption of food fried in “million-year-oil” when eating out.

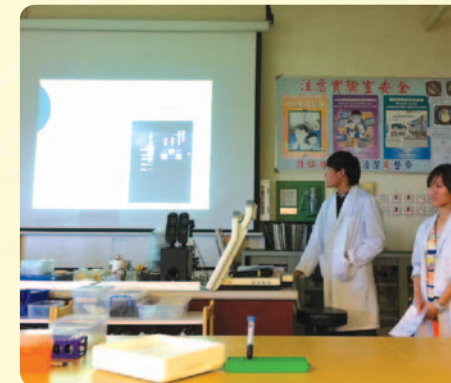


Exchanging Knowledge on DNA technologies to Secondary Schools

In the new DSE Biology curriculum, DNA technologies, including polymerase chain reaction (PCR) and genetic fingerprinting, are important elements of the Biotechnology module. Secondary school students studying this module are required to have hands-on experience on these techniques. Noticing not every secondary school has the resources and equipment to plan or conduct such experiments, the School of Biological Sciences with the support of the Faculty, partnered with Caritas Chan Chun Ha Field Studies Centre to set up DNA technology workshops, with the use of simple equipment, reagents and plant materials near the Field Studies Centre.

While developing the PCR and fingerprinting protocols, two undergraduates were involved and worked as interns under the supervision of Dr A S T Wong and Dr K W Y Yuen last summer. The workshops the team ran for secondary school teachers and technicians could be potentially run in other secondary school laboratories of similar settings, fostering knowledge exchange on DNA technologies to local schools.

Let's hear from our students on their experience of developing the project.



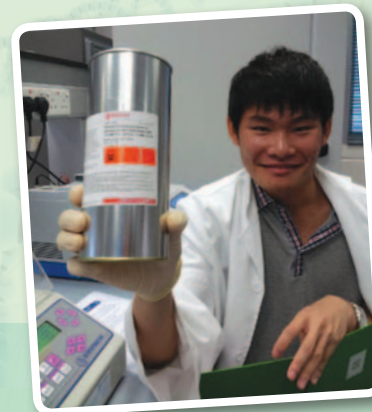
Charmaine Wong

Year3, BSc (major in Biotechnology)

“This project had both theoretical and practical sides. We planned our own experiments with great flexibility. The process involved lots of techniques which we have learnt in classes. In addition to knowledge acquisition, repeated attempts of designing experiments inspired me a lot on learning methods, scientific analysis and idea deliveries. I would say it was indeed a very unique learning experience.

The task we were given was challenging yet meaningful. Passion of scientists always begins with just a tiny spark. We hope that can arouse their interest and enhance their understanding of the subject by encouraging students to participate in some up-to-date experiments. As a student majoring in Biotechnology, PCR is undoubtedly a well-acquainted topic for me. However, this is the first time I and my teammates took the initiative to design the workshop, which was very different from just attending laboratory sessions. Guidance from supervisors and their team helped us a lot when we were stuck in the bottleneck. Also, passionate teachers at Field Studies Center gave us feedback and support, and their Biotechnology-theme day camp allowed us to put forward the DNA extraction protocol into practice.

Frankly, I feel cool to be teachers' teacher, though only for a single laboratory session! I wish the programme can benefit more undergraduates as well as secondary school students in the future.”



Lao Ka Long Leo

Year3, BSc

(major in Biotechnology, double minors in Biology and Biochemistry)

“Literally, in the very beginning, I thought this internship could be done within a short period since the principle of polymerase chain reaction had already been taught for several times in different courses. Nevertheless, reality was totally different from my expectation. It took me nearly three months, but everything is just so meaningful and worthwhile.

The most impressive moment in this internship is definitely when we were presenting our protocol to the teachers at Caritas Chan Chun Ha Field Studies Centre on behalf of HKU & the School. After two months of hard work, my “baby” finally came to the world. Although it might not be perfect and there were rooms for improvement, I was greatly satisfied for I had done my best already.

This internship allowed me to have a taste of research life – I had to read scientific journals and worked in the lab day and night. It is absolutely an unforgettable and memorable experience to me as I can work with two nice supervisors, their team and my fellow classmate on the project. Without the internship, I would not have the chance to know more about them and experience the research life. Thanks to you all!”

ACHIEVEMENTS

Teachers

University and Faculty Awards



Professor G K Y Chan, Department of Chemistry received the **University Outstanding Researcher Award 2011-12** for his exceptional research achievements of international merit.



Professor J J J Jiao of Department of Earth Sciences received the **Faculty of Science Award for Teaching Excellence 2011-12** for his outstanding teaching performance and the continuous efforts he has put in arousing students' learning interests.



Dr M Wang, School of Biological Sciences, received the **University Outstanding Young Researcher Award 2011-12** for his outstanding research accomplishments and involvement in high-impact applied research work.



Dr A S T Wong of School of Biological Sciences received the **Faculty of Science Award for Service Contribution 2011-12** for her untiring efforts in servicing the University, the Faculty and the Department in past years.



Professor K W Ng, Patrick S C Poon Professor in Statistics and Actuarial Science, received the **Research Output Prize (Faculty of Science) 2012**. Professor Ng has co-authored a book with Dr Gary G L Tian entitled 'Dirichlet and Related Distributions: Theory, Methods and Applications', published by John Wiley & Sons Ltd, New York in June, 2011.



The Junior Science Institute teaching team received the **University Knowledge Exchange Award for Faculty of Science 2012** for their efforts in promoting science literacy and fostering knowledge exchange with secondary schools. Instructors of the team include Dr B C H Hau, Dr Z Liu, Professor L S Chan, Dr H C Chiu, Dr T W Ng, Dr S P Yung, Professor K M Tsang, Dr C W Wang, Professor W Zang, Dr W K Ching, Dr A P L Tong, Dr E L M Wong, Professor W K Chan, Dr C S C Lo, Dr K F Lam, Dr A B Djurišić, Dr S Bevan and Mr S L Cheung.

Others



Professor V V W Yam was conferred a **Doctorat Honoris Causa** by the Universite de Rennes 1 in France on March 8, 2013. Previous recipients include Nobel Laureates and top chemists.



Dr K M Y Leung of School of Biological sciences received the **VTC Outstanding Alumni Award** from Vocational Training Council, in recognition of his professional achievements and community services.

Students

Mr Andy Yi and Mr Edward Lau, PhD students under the supervision of Dr Kenneth Leung in School of Biological Sciences, won the **Best Oral Presentation Award** and the **Best Poster Presentation Award** respectively at the SETAC (Society of Environmental Toxicology and Chemistry) Asia-Pacific Annual Meeting held in Kumamoto, Japan during 24-27 September 2012. There were over 420 participants, with over 400 abstracts being presented in this international meeting. SETAC currently has over 5500 professional members from 100 different countries.



Mr Andy Yi

Mr Edward Lau has also received the **Faculty of Science Award of Excellence by Teaching Assistant 2011-12** for his outstanding performance in providing teaching support and interaction with students.



Mr Edward Lau

Mr Ambrose Lo, PhD Candidate of Department of Statistics and Actuarial Science was granted the Faculty of Science **Award of Excellence by Teaching Assistant 2011-12** for his outstanding performance in providing teaching support and interaction with students.



FACULTY NEWS



Science and Art Crossover Programme – Visualizing Science via Creative Lens & Interactive Art for Secondary School Students

by Dr B C H Ng, Director of Science and Art Crossover Programme

Science and art, intertwined yet pole apart, were the twin dynamic components in the cultural development of any civilizations. However, people often merely consider their polarity, which leads to the partitioning of curiosity, inquiry and knowledge into specialized compartments. To promote science literacy and enhance students' appreciation of science in an artistic sense, the Faculty organized a one-day programme on January 26, 2013, attracting up to 80 junior secondary school students to join us.

The programme consisted of a series of lectures and workshops, and responses from the participants were overwhelmingly positive. Here are some of them:

Geometry and Origami by Dr Patrick TW Ng, Department of Mathematics

"It gives us a chance to try to solve these problems (angle trisection) that we normally use tools to solve them."



Right: Dr Patrick TW Ng from the Department of Mathematics was teaching the participants how to trisect a right angle by folding paper.

Lotus Effect by Dr Tony SP Feng, Department of Mechanical Engineering

Lotus effect refers to the very high water repellence exhibited by leaves of the lotus flower. Participants "get to know more about how the superhydrophobic surfaces work" and found that "it's amazing and practical in real life."

Science of Painting by Dr A Djurišić, Department of Physics

Paintings are two dimensional representations of three dimensional objects. Students found that "it's a fun and interesting topic and I can know more about both physics and arts."

Workshops

Workshops were offered in the afternoon. Students found that the workshops were fun. "I think it's a great opportunity for me to learn more about both arts and science. It triggers me to further learn more on the topics."

Create the Impossibility by LEGO - Learn Escher, Go On!

Participants learned how to use LEGO to make the impossible constructions illustrated by the Dutch painter MC Escher. In building relativity, one participant said, "I like the LEGO most as I cannot touch this topic in school and I am quite curious about the relation of directions."



"Creating my own building [Escher's Belvedere] and cooperate with others," said a participant.

Painting on Canvas

"I could observe the scientific objects more closely."



Dr N K Tsing from Department of Mathematics was instructing in our painting workshop.

String Arts

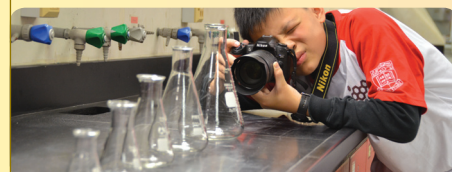
Mathematical equations were visualized by strings. "It was fun to do hands-on things and produce something you feel pride."



A participant experienced the synergy of science and art tied together through our String Art workshop. Right: Mr Andy K L Kong from the Department of Mathematics

Capture the moment in a Laboratory

Participants were guided to a laboratory. Some found that they "know more about a laboratory in universities" and "have learnt to look at the laboratory in a different way."



A participant demonstrated his creativity, immersed his personal interest and identify where the unique angle lied.

Final Thought

After the workshop, some participants expressed their view on science and art. "I can know about the relationship between art and science, and I found that art is actually based on science and I am much more interested in science now." They enjoyed the programme very much and "hoped there will be summer programmes available."



A participant reflected her experience "I feel so happy!" on her palm-sized T-shirt.

Completed students' artworks have been scheduled to showcase at the Science & Art Crossover Exhibition at HKU Chi Wah Learning Commons and other venues starting from the beginning of March. For programme details, please visit: <http://www.scifac.hku.hk/community/projects/scienceXart>

Public Lectures

October 18, 2012: "There is no integer between 0 and 1" by Professor William Chen, Y C Wong Visiting Lecturer in Mathematics, HKU and Emeritus Professor of Mathematics, Macquarie University.



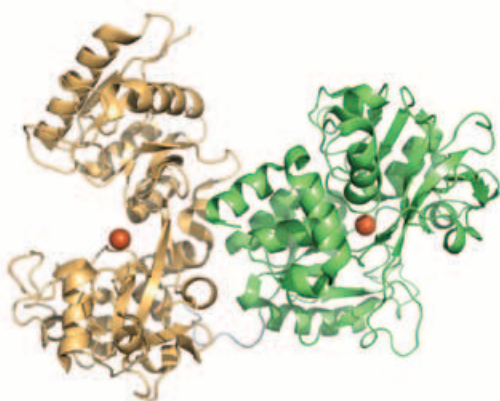
February 25, 2013: "The Elements of Life and Medicines" by Professor Peter Sadler, Fellow of the Royal Society of Edinburgh (FRSE) and the Royal Society of London (FRS), and the Mok Hing Yiu Distinguished Visiting Professor, Department of Chemistry, HKU.

For details: please visit <http://www.scifac.hku.hk/>

The *Secret* of Iron Transport Protein-Transferrin in Our Body

by the research team of Professor H Sun, Department of Chemistry

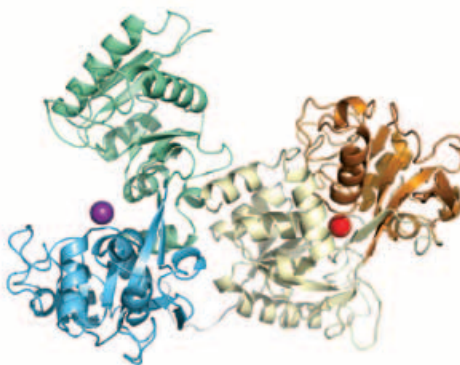
Iron is indispensable to the functioning of our body. A healthy human body consists of 4 grams of iron in total. More than 60% of the iron is associated with hemoglobin in red blood cells for oxygen transport, with the remaining distributed throughout our body for normal cellular metabolism. Have you ever wondered how our body transports iron from the site of uptake to the designated body tissues? This is achieved by the iron-carrier protein human transferrin.



Structure of human transferrin in the iron-bound form, with the two bound iron indicated by red spheres.

Human transferrin is abundantly found in blood plasma and is responsible for iron delivery from the absorption centre (i.e. gastric system) to various tissues, playing an essential role in supplying iron to various body cells. The malfunction of transferrin will cause iron imbalance in human body and hence many serious health effects such as heart failure, anemia or protein malnutrition will occur. Recently, our team, in collaboration with Professor Quan Hao's team (Department of Physiology), resolved some key structures of transferrin, with the use of protein X-ray crystallography. The results have been published earlier in *Scientific Reports* in December 2012.

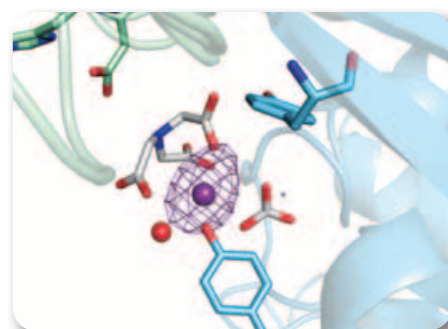
Human transferrin binds iron tightly but reversibly, and delivers iron with high efficiency. For the specific recognition by human cells, it was predicted to undergo significant structural changes during the iron binding and release process. However, the structural evidence of this was absent over a long time. In our first structure determined, we successfully captured the 'intermediate state' of transferrin during the iron release process, which is in between the known 'iron fully-loaded' and 'iron fully-released' states. We can thus draw the conclusion that the release of iron from transferrin in normal cells is a continuous and dynamic process, resembling an opening clamp that is 'loosening what has been gripped'.



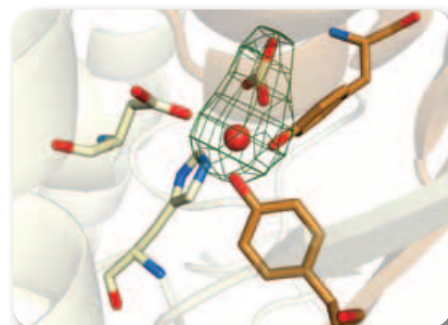
Structure of human transferrin in the bismuth-bound form, with the bound bismuth (magenta sphere) and iron (red sphere) indicated

Though transferrin is responsible for iron delivery, only 30% in total is iron-saturated. This leaves the remaining 70% the capability of binding and delivering other metals with chemical properties similar to iron, while some of them are essential for our life and some are not. Some scientists were also considering of exploiting such availability for metallodrug (a new class of drugs utilizing

metals that are key to their pharmacological effects) delivery. Another achievement of our research is the structural snapshot of transferrin in the bismuth-binding form. This provides the first structural evidence of transferrin's capability of being a 'vehicle' of metallodrug in human body, since bismuth-containing drugs have long been applied clinically to gastrointestinal infections and cancers.



The close-up of the bismuth-binding site of transferrin, bismuth is shown in magenta.



The close-up of the iron-binding site of transferrin, iron is shown in red.

We hope that our new findings can stimulate relevant researches on other metallodrugs in the near future. Hopefully, our work will make contribution to the design or improvement in current metallodrugs by enhancing their delivery efficiency in the human body.

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FACULTY OF SCIENCE

G12 Chong Yuet Ming Physics Building, Pokfulam Road, Hong Kong

Tel: 2859 2683

Email: science@hku.hk

Fax: 2858 4620

Website: <http://www.scifac.hku.hk/>

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