2015 King Faisal International Prize for Science and Medicine

The King Faisal Foundation in Riyadh, Saudi Arabia has awarded the 2015 King Faisal International Prize (KFIP) for Science in the field of chemistry to Michael Grätzel of Switzerland and Omar Mwannes Yaghi of USA. Grätzel is recognized for his foundational and practical discoveries in the development of photoelectrochemical systems for solar energy conversion. Yaghi has made seminal contributions in the field of metal organic frameworks. The Prize for Medicine has been awarded to Jeffrey Ivan Gordon of USA for his work on intestinal microflora and human health. The Prize consists of a certificate, hand-written in Diwani calligraphy, summarizing the laureate's work; a commemorative 24 carat, 200 g gold medal, uniquely cast for each Prize; and a cash endowment of Saudi Riyal 750,000 (about US$ 200,000). The winners received their awards on 1 March 2015 in a ceremony in Riyadh under the auspices of the King of Saudi Arabia.

Michael Grätzel was born in 1944 in Dorfchemnitz, Saxony, Germany. At present, he is a Director of the Laboratory of Photonics and Interfaces (Institute of Physical Chemistry), Swiss Federal Institute of Technology, Switzerland. The Prize committee has stated that 'Michael Grätzel is recognized for his foundational and practical discoveries in the development of photo-electrochemical systems for solar energy conversion. His world-famous Grätzel solar cells are simple and relatively inexpensive to manufacture, and they possess unique practical properties including flexibility and transparency. Grätzel's work has had and will continue to have a major impact on the practical realization of solar-energy conversion'. Grätzel solar cells are dye-sensitized solar cells that provide a technically and economically credible alternative concept to the conventional p–n junction photovoltaic devices. In contrast to the conventional systems where the semiconductor assumes both the task of light absorption and charge carrier transport, the two functions are separated here. Light is absorbed by a sensitizer, which is anchored to the surface of a wide-band semiconductor. Charge separation takes place at the interface via photo-induced electron injection from the dye into the conduction band of the solid. Carriers are transported in the conduction band of the semiconductor to the charge collector. The use of sensitizers having a broad absorption band in conjunction with oxide films of nanocrystalline morphology permit the harvesting of a large fraction of sunlight. Nearly quantitative conversion of incident photon into electric current is achieved over a large spectral range extending from the UV to the near-IR region[1,2]. Grätzel solar cells have high efficiency and are being mass produced. Grätzel's recent awards include the 2012 Albert Einstein World Award of Science, 2011 Gutenberg Research Award, 2011 Paul Karrer Gold Medal and the 2010 Millenium Technology Grand Prize. It is interesting to note here that this piece of work is optics-related. It is an additional boost to the on-going activities of the International Year of Light and Light-based Technologies[3]. It is to be recalled that by another remarkable coincidence both the Physics and Chemistry Nobel Prizes of 2014 are related to optics.

Omar Mwannes Yaghi was born in 1965 in Jordan and moved to USA at the age of fifteen. At present, he is a Professor of Chemistry and Biochemistry at the University of California, Berkeley, USA. The Prize committee has stated that 'Omar Yaghi has made seminal contributions in the field of metal organic frameworks (MOFs). MOFs possess a wide array of potential applications including materials for gas storage, gas/vapour separation, catalysis, luminescence and drug delivery. In the last two decades, he developed MOFs through innovative approaches to construct novel materials and explored their applications in various fields, including encapsulation of bio-molecules, and capturing of gases such as carbon dioxide and hydrogen'. MOFs are extended porous structures composed of transition metal ions (or clusters) that are linked by organic bridges. They are prepared as crystalline solids by solution reactions of metal ion salts with organic linkers. MOFs represent a new class of network solids that have great potential in specific applications such as separation, storage, heterogeneous catalysis and controlled drug delivery. Extensive research has been performed on MOFs as these materials are excellent for storing hydrogen and carbon dioxide[4]. Yaghi's work was recognized by numerous awards, including the US Department of Energy Hydrogen Program Award for outstanding contributions to hydrogen storage (2007).

The Prize for Medicine has been awarded to Jeffrey Ivan Gordon, as mentioned earlier. The intestines of humans contain 100 trillion viable bacteria. These live bacteria, which make up 30% of the faecal mass, are known as the intestinal microflora. There are two kinds of bacteria in the intestinal flora, beneficial and harmful[5]. In healthy subjects, they are well balanced and beneficial bacteria dominate. These bacteria in the gut (alimentary canal or gastrointestinal tract) fulfil a host of useful functions for humans, including digestion of unutilized energy substrates, stimulating cell growth, repressing the growth of harmful microorganisms, training the immune system to respond only to pathogens, and defending against some diseases. Gordon is a Dr Robert Glaser Distinguished University Professor, and Director of the Centre of Genome Sciences and Systems Biology at the Washington University, St Louis, USA. He is recognized for his seminal work on defining the genomic and metabolic role of microbiomes in human health. Gordon's pioneering work and interdisciplinary studies of the human microbiome (microorganisms in the gastrointestinal tracts) has provided fascinating insights into the metabolic processes and the genetic basis of mutually beneficial relationships between the host and microorganisms in the human gut. His innovative research has provided major breakthroughs regarding the influence of intestinal microbiota on postnatal development, physiology and illness susceptibility in humans and has thus enhanced our understanding of the pathogenesis of complex diseases such as obesity. His research has opened opportunities for novel gut microbiome-directed treatments to improve human health. So far, a total of 63 scholars from 12 countries have been awarded the King Faisal International Prize for Medicine.

The prizes are named after the third king of Saudi Arabia, to recognize dedicated men and women whose contributions make a positive difference, including to scientists and scholars whose research result in significant advances in specific areas that benefit humanity. The King Faisal Foundation awards International Prizes each year for Service to Islam, Islamic Studies, Arabic Literature, Medicine and Science. The Prize for Science rotates among the fields of physics, mathematics, chemistry and biology[6]. Within three decades the KFIP are ranked among the most prestigious awards. To date there are 17 KFIP laureates who have also received Nobel Prizes (mostly after the KFIP). A total of 52 scholars from 12 countries have been awarded the King Faisal International Prize for Science. Mudumbai Seshachalu Narasimhan is the only Indian to have won the KFIP for science (in mathematics)[7,8].

The Science Prize for the year 2016 will be awarded in the field of biology. The topic for the Medicine prize is 'Clinical application of next-generation genetics'. The deadline for all nominations is 1 May 2015 and the details are at http://www.kff.com/ and http://www.kfip.org/

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Sameen Ahmed Khan, Engineering Department, Salalah College of Technology, Salalah, Sultanate of Oman.
e-mail: rohelakhan@yahoo.com

A close look at Darwin's finches

The key gene responsible for varying beak shapes in Darwin's finches has been finally identified and sequenced.

A team of scientists[1], that includes the well-known evolutionary biologists Rosemary and Peter Grant, have identified the gene responsible for the diversity in beak shapes and sizes in Darwin's finches.

Charles Darwin observed these finches on the Galapagos Islands, which though looked similar to one another, had beaks of different shapes and in varying sizes, to accommodate specialized diets. His observation of these finches is believed to be the key inspiration on his formulating the theory of natural selection.

Presently, there are 15 recognized species of Darwin's finches that have evolved from a common ancestor (Figure 1). They are the best model species to showcase the process of speciation and adaptive radiation. Adaptive radiation is a process where a species rapidly undergoes morphological changes in order to cope or to exploit the sudden changes in its environment. The process of adaptive radiation in case of Darwin's finches was accelerated due to strong geographical isolation on the islands that were created from volcanic activity. As a result, each of the 15 species has evolved a different shaped beak to accommodate a specific diet. Here the adaptation was driven by the availability of different food resources.

Genetic samples from 120 individuals including all of Darwin's finched were collected from the Galapagos archipelago and Cocos Island. Phylogenetic analyses of the genomic sequences reveal a few critical deviations from traditional taxonomy, which is based on the morphological features or the appearances of species. For example, it was found that the ground finch (*Geospiza difficilis*) whose range is spread across six islands in the Galapagos, actually comprises of three species. The study also revealed the mixed ancestry of these finches as a result of hybridization throughout their evolutionary period.

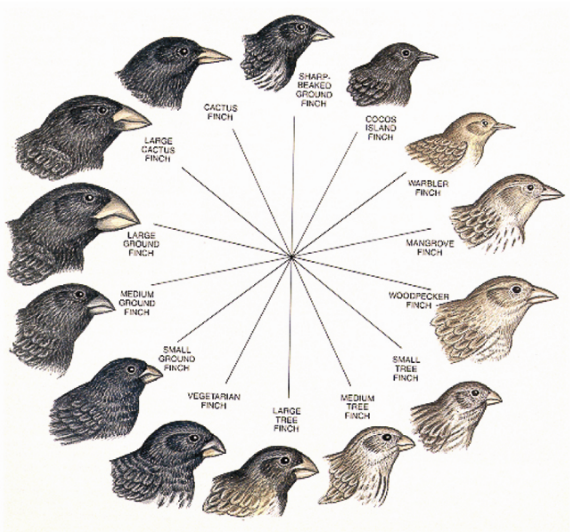

Figure 1. The 14 species of Darwin's finches found on the Galapagos archipelago. All the 14 species evolved from a common ancestor, but have undergone rapid adaptive radiation, modifying their beaks for specific food resources. Photo: http://cmuems.com/2014a/maj/09/21/generating-darwins-galapagos-finches/

Further, genomic sequencing has helped scientists to identify the gene *ALX1*, to be the key driver of beak adaptation in the finches. During a series of droughts in the 1980s, that resulted in scarcity of food resources for the medium ground finch. Peter and Rosemary Grant observed that, the beak of the finch grew more pointed to enable it to adapt to a new diet. The *ALX1* gene exhibited two distinct variations that fitted neatly with the pointed and blunt beak adaptations in the finches. The genome of the medium ground finch, has a mixture of both pointed and blunt beak gene variants. The scientists thus believe that *ALX1* which is also found in other vertebrates including humans where it is associated with the development of facial structures, plays a major role in development of beak morphology in Darwin's finches.

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Ipsita Herlekar (*S. Ramaseshan Fellow*)
e-mail: iherlekar@gmail.com