



Ingredients for success

by Guntram Bauer

HFSP Director of Scientific Affairs and Communications



I don't think we are boasting about HFSP when we say that our Program always tries to synchronize its procedures with the dynamics at the frontiers of science. This is particularly true for our peer review process. Over many years we have made more than just subtle changes to our procedures in response to feedback from the scientific community. We recognized that teams of young investigators should have a fair shot in applying for an HFSP Research Grant just like their more experienced neighbors along the department corridor. A bold change was to introduce new possibilities to encourage PhD holders from non-biological fields to enter into life sciences research allowing them to carry out their postdoctoral fellowship in the very best laboratories around the world. Researchers from physics, chemistry, material science, mathematics, engineering and many other areas that interface with biology now play an eminent role in our peer review process. To that end the physics-biology workshop organized in association with the 2017 Awardees Meeting in Lisbon covered the critical component of training concepts required to prepare the next generation of interdisciplinary scientists.

In 2018, we yet again embarked on a new era in the HFSP Fellowship program. After careful internal discussion and preparations, the review committee was presided over by a non-reviewing chair. Peter Koopman from the Institute of Molecular Bioscience of the University of Queensland took center stage as chair of this committee. Peter finished a four year tenure as a member of the fellowship review committee in 2016 and arrived back in Strasbourg after a three month sailing trip in the southern Pacific. Peer review at HFSP is not reading tea leaves but serious and demanding work for all involved. Thanks to Peter Koopman we successfully completed the first fellowship review committee run by a non-reviewing chair. We are still not sure what the magic ingredient was that made this fellowship committee stand out. Whether it was a truly committed international review panel, or the drive and oversight of its non-reviewing chair, or simply because of the HFSP Sauce which arrived in the chair's suitcase in Strasbourg. Probably all three, though be assured that we will get to the bottom of the HFSP Sauce!



18th HFSP Awardees Meeting

8 - 11 July 2018

The Peter Gilgan Centre for Research and Learning
at The Hospital for Sick Children (SickKids)
in Toronto, Canada

<http://www.hfsp.org/awardees/awardees-meeting>

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Impressum

The HFSP Newsletter is issued by the International Human Frontier Science Program Organization (HFSP). It contains announcements of HFSP-related matters and other information of interest to the support of young scientists and to interdisciplinary research in general. Please tell your friends, colleagues, students, etc. about this mailing list. They can subscribe via a link on the [HFSP home page](#).

Please address any suggestions or comments to:
communications@hfsp.org



HFSP members meet with Mr Yasuhiro Nakasone at the Nakasone Yasuhiro Peace Institute in Tokyo on 5 October 2017. From left to right: Mr Toichi Sakata (HFSP Board of Trustees), Dr Nobutaka Hirokawa (President of HFSP), Mr Yasuhiro Nakasone (former Prime Minister of Japan), Prof Warwick Anderson (Secretary General HFSP) and Mr Hideki Mizuma (Deputy Secretary General HFSP).



The call for nominations for the **2019 HFSP Nakasone Award** will open in March 2018.

You will find more information at

www.hfsp.org/awardees/hfsp-nakasone-award

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HUMAN FRONTIER SCIENCE PROGRAM

CALL FOR LETTERS OF INTENT FOR
RESEARCH GRANTS
AWARD YEAR 2019

HFSP supports **international** preferably **intercontinental** collaborations in **basic** life science research. Applications are invited for grants to support **innovative** approaches to understanding **complex mechanisms of living organisms**. Applicants are expected to develop **novel** lines of research distinct from their ongoing research. Preliminary results are not required.

Program Grants are for independent scientists at all stages of their careers while **Young Investigators' Grants** are for teams of scientists who are **all** within 5 years of establishing an independent laboratory and within 10 years of obtaining their PhDs. Both provide 3 years support for 2 – 4 member teams, with not more than one member from any one country, unless critical for the **innovative** nature of the project. Awards are dependent upon team size and successful teams will receive up to \$450,000 per year. The principal applicant must be located in one of the **HFSP** member countries but co-investigators may be located in any country.

Please read the guidelines on the HFSP web site (www.hfsp.org). Teams must initiate an application via the web site by **March 19, 2018** so as to submit a letter of intent online by the **March 28, 2018** deadline.

Specific enquiries: grant@hfsp.org

The 2018 HFSP Nakasone Award winner

Svante Pääbo of the Max Planck Institute for Evolutionary Anthropology in Leipzig, Germany, was awarded the 2018 HFSP Nakasone Award for his discovery of the extent to which hybridization with Neanderthals and Denisovans has shaped the evolution of modern humans, and for his development of techniques for sequencing DNA from fossils.

Svante Pääbo is the founder of molecular archeology which involves the recovery, sequencing and analysis of DNA sequences from ancient remains found by paleontologists and archaeologists.

In 1985, while studying in Sweden, he showed that DNA can survive in Egyptian mummies. He continued to develop methods of increasing sophistication to determine DNA sequences from ancient remains. These techniques permitted Pääbo to recover mitochondrial DNA sequences from a Neanderthal bone in 1997. It was the first time that molecular genetics data were extracted from a fossil hominin. His meticulous analysis of this sample of DNA sequences showed that the Neanderthals did not contribute to the mitochondrial DNA of all contemporary human genes. On the contrary, the human and Neanderthal mitochondrial DNA only share a common ancestor from which we diverged more than 500,000 years ago. Although these results were sometimes interpreted wrongly as excluding any genetic contribution of Neanderthals to anatomically modern humans, Pääbo defended a balanced interpretation that places these results in the context of population genetics and variations between humans and contemporary apes.

Pääbo has adapted and applied high-throughput DNA sequencing techniques to ancient DNA, opening the possibility for analysis of whole genomes of extinct organisms. He launched the ambitious project to sequence the entire Neanderthal genome, which resulted in a first draft of the genome and its direct comparison to present-day human genomes. One of the key findings is that about 2% of the genomes of all humans whose roots are outside Africa come from Neanderthals. This solves a long-standing debate on a possible mixture of Neanderthals with modern humans and demonstrates that interbreeding did take place. The work of several groups has subsequently shown that this genetic contribution

has functional consequences, for example, for the immune system, for aspects of metabolism, and a susceptibility to type 2 diabetes.

Pääbo has continued his research with the genome sequencing of a small bone found in a cave in southern Siberia. Analysis of this genome showed that it came from a group of previously unknown hominins, related to Neanderthals, but with a long independent history. This group, which he named "Denisovans" after the site where the bone was found, is the first group of extinct hominins described exclusively from genetic data. Pääbo has also shown that Denisovans contributed to about 5% of the genomes of inhabitants of Papua New Guinea, Australia and other parts of Oceania. Other groups have used the Denisovan genome to show that a significant adjustment to life at high altitude in Tibet is derived from it.

Recently Pääbo developed a new method for efficient sequencing from small amounts of degraded DNA and derived the complete genome sequences of a Denisovan and two Neanderthals with an accuracy comparable to that of the genome of modern humans. The analysis of these genomes has helped, in particular, to reveal almost all the changes that have occurred in the genome of modern humans since their separation from their closest relatives - Neanderthals and Denisovans. This catalogue includes thirty thousand modifications and will be the working basis for anthropological research of human specificity for years to come.



In summary, Pääbo has systematically developed techniques to isolate and sequence DNA that is tens and hundreds of thousands of years old. This is not an easy task since ancient DNA is heavily degraded, modified by chemical processes, and present in a vast excess of microbial DNA. In addition, old samples often contain traces of modern DNA which can confuse the analysis. Besides being the founder of the field of molecular paleontology, Pääbo is a leading researcher in the fields of comparative genomics and history of human populations. Pääbo has pioneered the comparison between humans and apes to better understand the genetic history of humans. His studies showed that humans differ from apes in having low genetic variation in their nuclear genome, but carry a signal of a population expansion in their recent evolutionary past. Svante Pääbo has pioneered the functional genomics approach to human evolution by comparing genomes and gene expression in humans and great apes. In particular, he has studied genes that changed during recent human evolution, for example FOXP2, which is involved in language and speech.

Link to the [Department of Svante Pääbo](#)

Some reflections on the mirrored eyes of scallops

by Benjamin Palmer

Most people are surprised to hear that scallops see with up to 200 majestic iridescent eyes peering out from between their two valves (Fig. 1A,B). We too were ignorant of this hidden treasure until reading the work of Professor Michael Land while preparing a review article on natural photonics in 2016^[1]. Land performed pioneering research on vision from the 1960s to the 80s, including uncovering the optical secrets of the mirrored eyes of animals.

Most terrestrial animals, including humans, use lenses to form images by refracting light at an interface between two media with different refractive indexes. Conventional lens-based eyes work well in terrestrial environments, but things start to get more complicated under water, where the contrast in the refractive index between the outside medium (water) and the cornea is much smaller. This limitation, together with other selective pressures associated with seeing under water (e.g. low light intensities and the preferential attenuation of red light by water), has resulted in numerous ‘ingenious’ solutions to the problem of vision in aquatic animals. One of these solutions is to use mirrors instead of lenses to form images.

A spectacular example of a mirrored eye is in the scallop. Land found that scallops form images by reflecting light from a concave mirror lining the back of their eyes onto a double-layered retina residing above it^[2]. He determined that this mirror was made from guanine crystals which are responsible for its beautiful iridescent appearance.

Despite their beauty, scallop eyes remained a curiosity for us until Ben Palmer had a serendipitous conversation with a local fisherman whilst holidaying at home in South Wales. The fisherman reported observing thousands of ‘diamonds’ shining out of the darkness when diving under torchlight over a scallop bed off the Pembrokeshire coast... and so having inadvertently been presented with a source for our scallops, our journey with their eyes began...

Our research focuses on the way in which animals use crystalline materials to manipulate light, for example, to produce structural colors used in camouflage and display^[1,3]. However, we had never looked at eyes before and we were intrigued to understand how an image-forming mirror is constructed from biological materials and what its optical performance is.



Benjamin Palmer is an HFSP Fellow at the Weizmann Institute of Science in Israel. He studied chemistry in his home city of Cardiff and continued there for his PhD in solid state organic chemistry under the supervision of Prof. Kenneth Harris. His PhD research on the interaction of polarized X-rays with materials led to the development of the X-ray Birefringence Imaging (XBI) technique. In 2014, he joined the group of Profs. Lia Addadi and Steve Weiner at Weizmann as a Dean of Faculty and Koshland Prize Fellow. Since 2015, he has been funded by an HFSP Cross-Disciplinary Fellowship. His research is in the field of ‘organic biomineralization’ and he is particularly interested in how organisms make and use organic crystals to manipulate light for different optical functions. Ben has a special interest in visual systems in animals which utilize reflective rather than refractive optics.

Lia Addadi is a Professor at the Weizmann Institute of Science in Israel. Her research (much of which is conducted in collaboration with Prof. Steve Weiner) spans the mechanisms of biomineralization, cell adhesion, and antibody recognition of organized materials, and has implications in areas as diverse as materials research, optics and medicine. Of particular interest is currently the research on how organisms manipulate light through complex crystalline architectures in plant leaves, fish scales, crustacean cuticles and invertebrate eyes. Lia currently holds an HFSP Program Grant to investigate the role of extracellular vesicles in breast cancer bone metastasis. Addadi’s work has been recognized with the award of the Prelog Medal in Stereochemistry (1998), the 2009 Prize for Excellence from the Israel Chemical Society, the 2011 Aminoff Prize for Crystallography by the Swedish Royal Academy of Sciences, and in 2017 with her election to the US Academy of Sciences.



Born in Pretoria, South Africa, in 1948, Prof. Weiner attained a BSc in geology and chemistry from the University of Cape Town in 1969; that same year, he made aliyah to Israel. He went on to receive a MSc in geochemistry from the Hebrew University of Jerusalem and a PhD in biomineralization from the California Institute of Technology. He joined the Weizmann Institute in 1977. Prof. Weiner carries out research in two fields: biomineralization, the processes by which organisms produce minerals, and microarchaeology, revealing the microscopic archaeological record with the help of instruments.

Prof. Weiner received the Israel Chemistry Society Prize for Scientific Excellence in 2009 and the Aminoff Prize for Crystallography from the Royal Swedish Academy of Sciences in 2011. In 2013, he received the Pomerance Award for Scientific Contributions to Archaeology. Together with the late Prof. Heinz Lowenstam, Prof. Weiner wrote the book *On Biomineralization* (Oxford University Press, 1989), a widely used text book in this field, and the book *Microarchaeology: Beyond the Visible Archaeological Record* (Cambridge University Press, 2010).

One novel aspect of our research was to use cryogenic scanning electron microscopy to observe the nano to microscale organization of the scallop eye mirror in close-to-life conditions^[4]. The scallop mirror is constructed from millions of micron-sized square guanine crystals (Fig. 1C) which are arranged into a multilayer formed from 20-30 layers of crystals separated by cytoplasm (Fig. 1D). This is an example of a multilayer interference mirror whereby light is reflected from the interfaces between the high refractive index guanine crystals and the low refractive index cytoplasm. We also obtained high resolution 3D images of the fresh hydrated eye using X-ray microCT. This too enabled us to resolve the detailed anatomy under almost *in vivo* conditions.

The square-plate morphology of the crystals is extremely unusual, being observed nowhere else in the animal kingdom, and is a clear indication of the control which the organism exerts over the crystallization process. Each square ‘single crystal’ is in fact constructed from a sandwich of smaller sub-crystals called crystal-twins. Control over the orientational relationship between these twin components is used as a strategy for controlling the crystal morphology^[5].

The entire surface of the scallop’s mirror is tessellated with an ordered mosaic of square crystal tiles – closely resembling the segmented mirror of reflecting telescopes (Fig. 1E). Crystal tiling appears to be functionally important, since tiling the crystals together minimizes defects in the mirror’s surface, which in turn minimizes optical diffraction aberrations and optical loss due to transmission of light through the mirror.

Other properties of the multilayer mirror also appear to be well-suited to the visual needs of the scallop. Reflectivity simulations demonstrated that the crystal thicknesses and cytoplasm spacings of the mirror are ‘optimized’ to efficiently reflect the blue green light that penetrates the scallop marine habitat.

At a higher level of organization the scallop mirror has a concave shape. X-ray micro computed tomography showed that it does not have a simple hemispherical shape as was previously thought. Rather, the central portion of the mirror is flattened with respect to the periphery. Optical ray tracing simulations indicated that this has an important consequence for the visual performance of the eye. The unusual shape of the mirror means that it has two focal points at different heights above the surface depending on the angle of incidence of the light. This may be the key to understanding why the scallop has an unusual double-tiered retina.

Light impinging on the eye from on-axis sources is focused predominantly on the upper (distal retina), whereas light hitting the periphery of the mirror is focused predominantly on the lower (proximal) retina. Previous studies had shown that the distal retina responds to dark, moving features, triggering defense or escape reflexes but the role of the underlying proximal retina was not known. Ray tracing showed that dim, peripheral light forms well resolved images on the highly sensitive proximal retina, which we suggest may be specialized to observe static features of its habitat in poorly illuminated conditions.

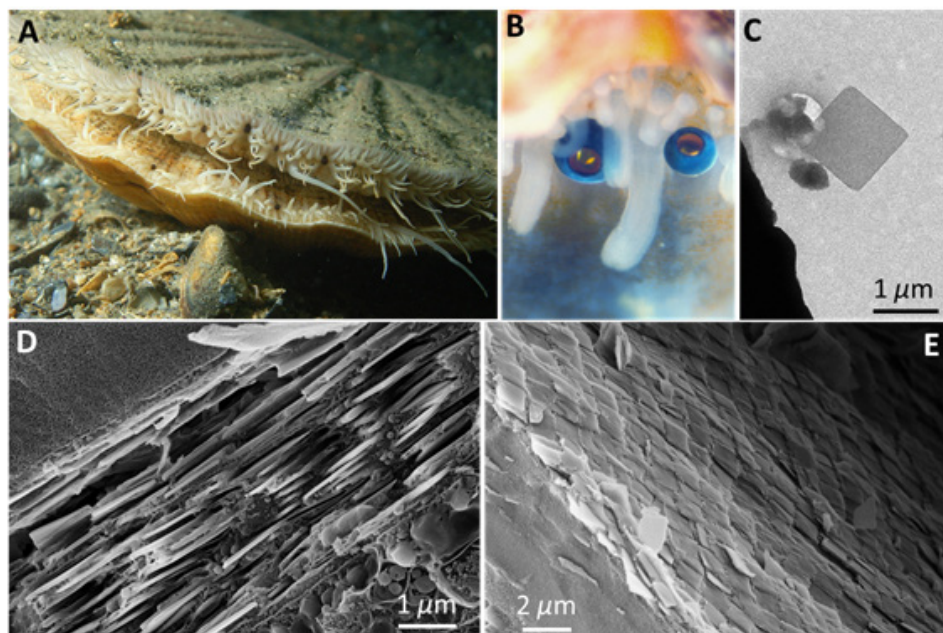


Figure 1. (A) The scallop *Pecten maximus* with numerous eyes (appearing black in this image) dotted along the mantle tissue (photograph courtesy of Mr. Ceri Jones of Haven Diving Services). (B) A higher magnification view of two scallop eyes (photograph courtesy of Prof. Dan-Eric Nilsson of Lund University). (C) A TEM of a single square guanine crystal extracted from the scallop eye mirror. (D) and (E) Cryo-SEM images of the mirror viewed (D) perpendicular to the mirror showing the multilayer structure and viewed (E) above the mirror showing the crystal tiling.

Scallop eyes provide another example of the extraordinary control which organisms exert over both the morphology and organization of crystals to produce different optical phenomena. One of the key goals in this emerging field of organic biomineralization is to understand how organisms control crystallization and to determine if these strategies could be harnessed in the development of new materials, bearing in mind that many biological optical devices display functionalities beyond the state of the art in artificial optics.

We are also interested to explore what other functional organic crystals, besides guanine, exist in nature. In comparison to inorganic bio-minerals very few types of functional organic crystals are known to exist. Isoxanthopterin, a pteridine analogue of guanine, was recently found to be the reflective material in the mirrored eyes of decapod crustaceans, and it may well be that many other types of functional organic crystals remain to be discovered^[6]. Exploring the fascinating biological functions that these organic biogenic crystals perform will no doubt provide fruitful ground for future research.

[1] D. Gur, B.A. Palmer, S. Weiner, L. Addadi, *Adv. Func. Mater.* 2017, 1603514.

[2] M. F. Land, *J. Physiol.* 1965, 179, 138-153.

[3] (a) D. Gur, B.A. Palmer, B. Leshem, D. Oron, P. Fratzl, S. Weiner, L. Addadi, *Angew. Chem. Int. Edit.* 2015, 54, 12426-12430; (b) D. Gur, B. Leshem, M. Pierantoni, V. Farstey, D. Oron, S. Weiner, L. Addadi, *J. Am. Chem. Soc.* 2015, 137, 8408-8411; (c) N. Funt, B.A. Palmer, S. Weiner, L. Addadi, *Chem.Plus.Chem.* 2017, 82, 914-923.

[4] B.A. Palmer, G.J. Taylor, V. Brumfeld, D. Gur, M. Shemesh, N. Elad, A. Osherov, D. Oron, S. Weiner, L. Addadi, *Science* 2017, 358, 1172-1175.

[5] A. Hirsch, B.A. Palmer, N. Elad, D. Gur, S. Weiner, L. Addadi, L. Kronik, L. Leiserowitz, *Angew. Chem. Int. Ed.* 2017, 56, 9420-9424.

[6] B.A. Palmer, A. Hirsch, V. Brumfeld, E. D. Aflalo, I. Pinkas, A. Sagi, S. Rozenne, D. Oron, L. Leiserowitz, L. Kronik, S. Weiner, L. Addadi, accepted PNAS 2018.

Au revoir to HFSP's longest serving staff member

At the end of February, Sarah Naett, a member of the HFSP Finance team, will retire from the Secretariat after 28 years. Sarah plans to spend this next chapter of her life in Strasbourg with frequent visits to her native New Zealand.

Reflecting on her time with the Organization, she reminisces about highlights over the years and colleagues, past and present.

In a couple of weeks, it will be my last day. I remember the first, 28 years ago now, as if it was yesterday. I had arrived from Phnom Penh and Peking and settled in Strasbourg with my family. If my travelling around the world was curtailed by professional and family responsibilities, HFSP allowed me to continue to wander the globe – through our many awardees, review committee members, Council and Board members located all over the world.

It was fun in accounts. I must have made thousands of payments over the years. The work was complex, keeping me on my toes, but it is the touch of the exceptional that stands out – parties at the Cuénod's¹ beautiful flat by the Cathedral, family gatherings at the end of the year when children gathered around the Christmas tree, the Buddha kindly donated by Prof. Winnacker², which found its way to my office to catch the light of the morning sun, and the arrival, so unexpectedly, of a Secretary General from Australia, not so far from my own home. 'Down under' comes up top – for once! HFSP always had style, but exceptional again were Sir James Gowans³, the perfect English gentleman, and the Wiesel⁴ art collection that graced the Secretariat for a number of years.

¹Michel Cuénod, Secretary General HFSP (1993-2000); ²Ernst-Ludwig Winnacker, Secretary General HFSP (2009-2015); ³Sir James Gowans, first Secretary General of HFSP (1989-1993); ⁴Torsten Wiesel, Secretary General HFSP (2000-2009).



I have served under five Generals and a dozen or so 'Dir's' (dears) and enjoyed the company of innumerable 'spice of life' AO's (Japanese Administrative officers). I have been present at Board meetings when a Maori welcome made me tremble to my toes and when the infectious laughter of another made it fun to grow grey together. We, the rank and file, were generally happy, so strong is the sense of community, foibles and all. I have special memories, special friends, and a special sense of loyalty to this exceptional scientific organisation, incarnate in one small Strasbourg street yet open to the world.

HFSP fellows and alumni get-together on the East Coast

by HFSP alumnus Miguel Coelho



After a roundtable discussion at the Awardees Meeting in Lisbon in 2017, a group of postdoctoral fellows decided to strengthen the HFSP community on the East Coast of the USA by organizing a dinner at a Portuguese restaurant in Cambridge on the 8th of December, bringing together more than 20 HFSP fellows.

After a first email, a doodle calendar was filled, the restaurant was booked and a menu of codfish, pot roast meat and vegetarian omelet was served. Good food, original Portuguese wine and table soccer matches brought the friendly crowd closer together.

The meeting was an opportunity to introduce the most recent awardees to our community, and bring current fellows and alumni together. It is also a way to keep in touch between the annual HFSP Awardees Meetings.

Another meeting is planned for spring 2018 and will hopefully include Career Development and Research Grant awardees as well! We definitely recommend that fellows in other cities organize similar events. It is a way to celebrate HFSP support and to extend the spirit of the annual meeting to those unable to attend.

Participants at the meeting were Pietro Artoni, Uri Ben-David, Inbal Benhar, Moshe Biton, Ana Boskovic, Miguel Coelho, Marco Fumasoni, Lior Golomb, Mor Grinstein, Mathilde Guzzo, Kristina Haslinger, Tackhoon Kim, Elisha Krieg, Nils Krietenstein, Gabriel Leventhal, Aya Ludin, Akankshi Munjal, Pedro Saavedra, Sinem Saka, Hong-Wen Tang, Steffen Wolf, Chengchao Xu and Jian Xue.

A push for science at the World Economic Forum

by Diego Oyarzún, HFSP Young Investigator Grant awardee

In 2016, the World Economic Forum created a network of thirty-five *Global Future Councils* to “challenge conventional thinking and develop new insights on the key global systems”. Each council runs for two years and comprises 20-30 members from different walks of academia, civil society, government and industry. Several councils focus on emerging technologies and their impact on various aspects of human life. There is a particular emphasis on technologies that fuel the Fourth Industrial Revolution, a concept that aims to describe the technological fusion of physical, biological, and digital domains. I had the privilege to be appointed to the Global Future Council on Biotechnologies together with colleagues from life sciences, social sciences and the private sector. As Council we made it our mission to assess the role of biotechnology on sustainable development.

The Sustainable Development Goals, officially known as “Transforming our world: the 2030 agenda for Sustainable Development” is a set of goals defined by the United Nations that draw an all-encompassing guideline for improving the state of the world. Key themes include eradication of hunger, climate responsibility and improved health and well-being. The last decades have witnessed a dramatic progress in our ability to engineer biological systems across many scales. These advances will lead to a suite of disruptive biotechnologies with applications in areas as diverse as healthcare, the environment and agriculture, all of which will help us get closer to the Sustainable Development Goals.

The Council work took place during the 2016 and 2017 Annual Meetings for the Global Future Councils in Dubai, in addition to discussions via email and video link. Our sessions in Dubai featured lively discussions on the role of biotechnology on health and the environment, two pillars where biological solutions can make a transformational impact. We discussed the potential of cutting-edge biotechnologies in health (e.g. gene editing, personalized medicine) and the environment (e.g. metabolic



WEF Annual Meeting for the Global Future Councils, Dubai



Diego Oyarzún is a Research Fellow in Biomathematics at Imperial College London. He leads the Biomolecular Control Group, focused on analysis of molecular networks for Systems Biology, Synthetic Biology and Biotechnology. He holds a Global Future Council Fellowship from the World Economic Forum.

www.imperial.ac.uk/people/d.oyarzun

engineering, synthetic biology), and identified a number of challenges ahead. Thanks to the diverse backgrounds of Council members, our discussions not only covered the technical aspects, but also touched upon key governance issues that need to be addressed for effective and responsible deployment of biotechnology across various sectors.

A summary of the ideas discussed by the Council will be published in the “Handbook of the Fourth Industrial Revolution”, a flagship initiative of the World Economic Forum to inform world leaders and policy makers on the landscape of emerging technologies. A crosscutting issue that arose in discussions is the crucial role of basic science as a driver for innovation. CRISPR, for example, is a technology whose origins go all the way back to fundamental research on bacterial genomes decades ago. This and other success stories make the mission of HFSP all the more relevant and a much-needed engine for fundamental science. The Council will publish an upcoming paper on the role of biotechnology on environmental sustainability in EMBO reports.

¹Victor de Lorenzo, Kristala L. J. Prather, Guo-Qiang Chen, Elizabeth O’Day, Conrad von Kameke, Diego A. Oyarzún, Leticia Hosta-Rigau, Habiba Alsafar, Cong Cao, Weizhi Ji, Hideyuki Okano, Richard J. Roberts, Mostafa Ronaghi, Karen Yeung, Feng Zhang, Sang Yup Lee (2018). How synthetic biology will empower bioproduction, environmental remediation and pollution control. EMBO reports, in press.

Prizes & Awards

We would like to congratulate the following awardees and alumni:

* Two time grant awardee **Jeffrey C. Hall**, who together with Michael Rosbash and Michael W. Young, received the [2017 Nobel Prize in Physiology or Medicine](#) "for their discoveries of molecular mechanisms controlling the circadian rhythm". This brings the total number of Nobel Prizes received by HFSP alumni to 27.

* **David Julius** was among the winners of the [2017 Canada Gairdner International Award](#), which he received "for determining the molecular basis of somatosensation - how we sense heat, cold and pain". In 2017, David Julius received the HFSP Nakasone Award.

* Research Grant alumni, **Joanne Chory**, **Kim Nasmyth** and **Peter Walter**, were among the winners of the [2018 Breakthrough Prize in Life Sciences](#). Dr Chory received the award "for discovering how plants optimize their growth, development, and cellular structure to transform sunlight into chemical energy". Dr Nasmyth was rewarded "for elucidating the sophisticated mechanism that mediates the perilous separation of duplicated chromosomes during cell division and thereby prevents genetic diseases such as cancer", and Dr Walter "for elucidating the unfolded protein response, a cellular quality-control system that detects disease-causing unfolded proteins and directs cells to take corrective measures".

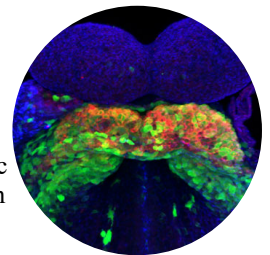
You will find more prizes and awards in [HFSP's Annual Reports](#) on the HFSP website.

Awardees' Articles

[Live 3D imaging highlights cellular activity during embryonic heart development](#)

by HFSP Long-Term Fellow Kenzo Ivanovitch and colleagues

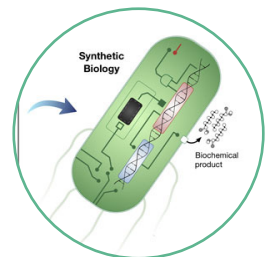
Live 3D imaging analysis reveals the coordination that occurs between cardiac progenitor cells - cells that, similar to stem cells, can change into another specific type of cell - during heart development. We found that progenitor cells go through alternate phases of changing into cardiac muscle (differentiation) to help initiate early heart function, and assisting the heart tube to take on its shape (morphogenesis).



[Precision engineering of metabolite biosensors](#)

by HFSP Young Investigator Grant holders Diego Oyarzún and Fuzhong Zhang and colleagues

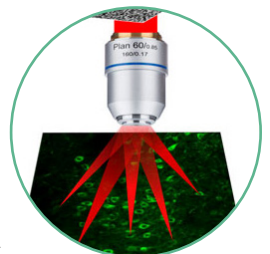
Mathematical modeling and wet-lab engineering revealed how genetic tuning shapes biosensor function. Our findings enable precision engineering of gene circuits for basic science and microbial cell factories.



[Optogenetic neuronal control with sub-millisecond temporal precision and cellular resolution](#)

by HFSP Program Grant holders Valentina Emiliani and Ed Boyden and colleagues

A new approach that allows the spatial and temporal control of neuronal activation at a single cell level with a resolution of the order of milliseconds has been developed in the labs of HFSP grant holders Valentina Emiliani and Ed Boyden. This approach combines the development of a new type of light-sensitive protein that can be embedded in neuron cell bodies, combined with an innovative holographic light shaping approach that can focus light on a single cell using low light levels. These advances open up the possibility of probing the connectivity between each neuron in a neural network and understanding how neurons contribute together to the processing of information.



Read more in the [Awardees' Articles section](#) of the HFSP website.