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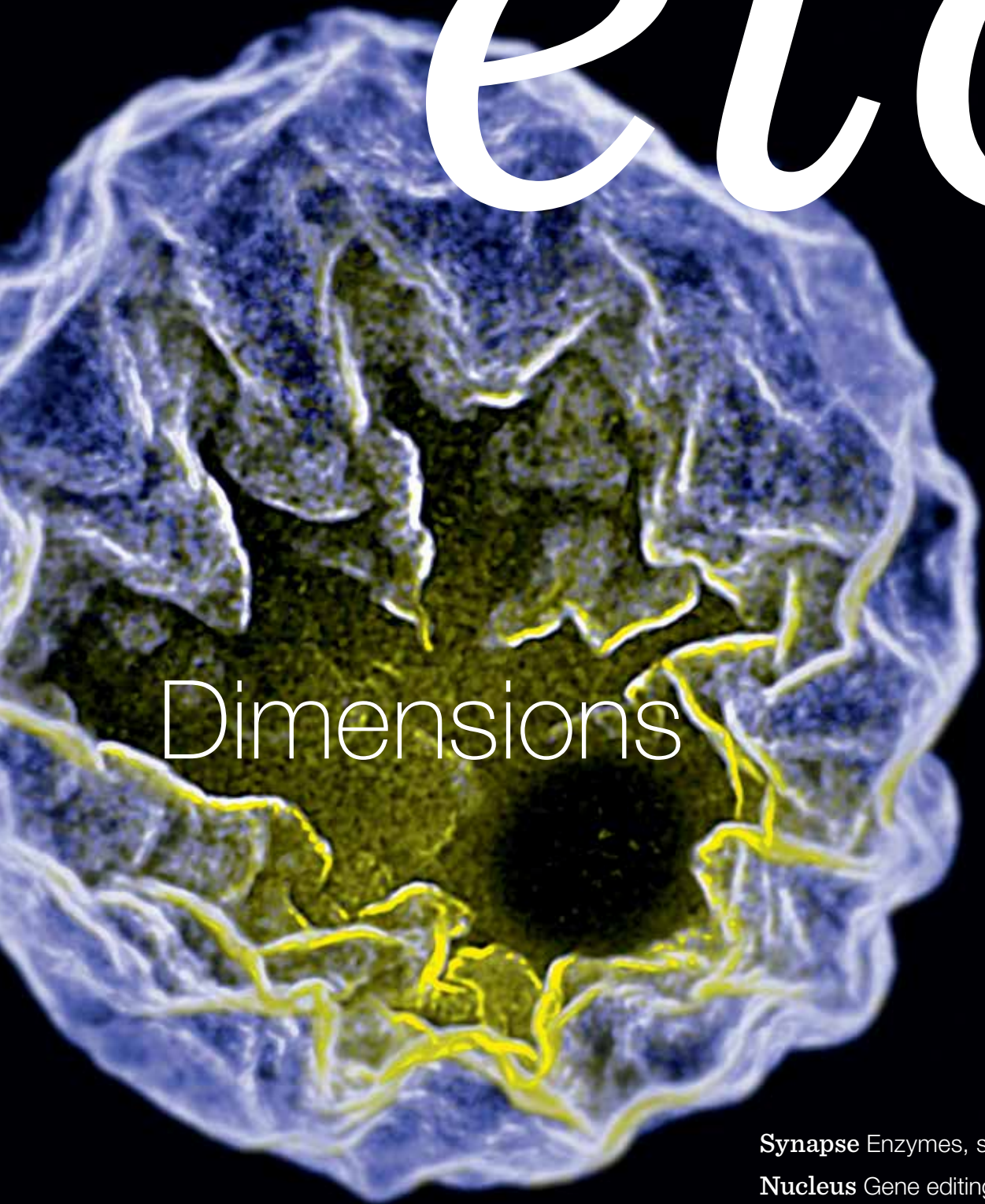
EMBL etc.



Dimensions

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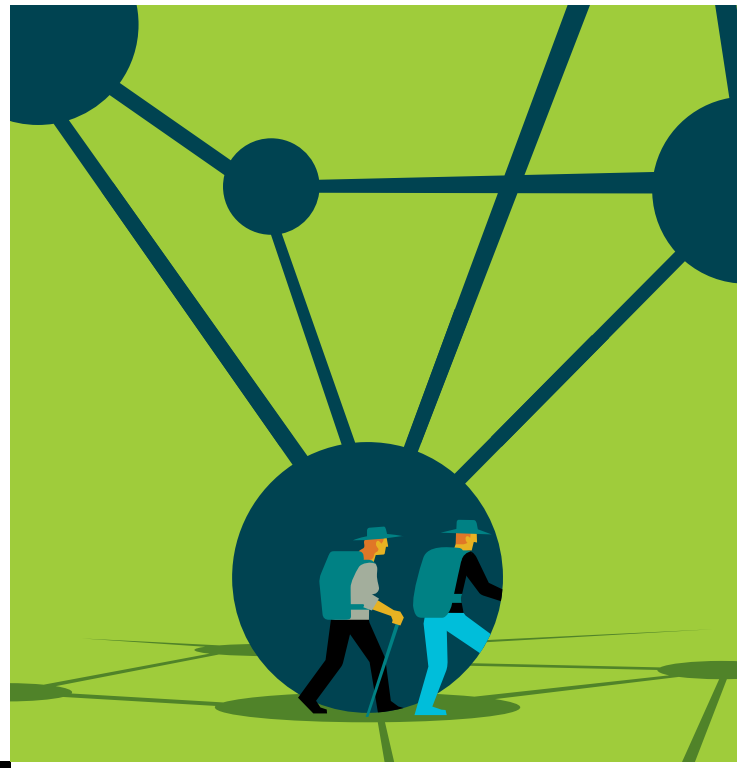

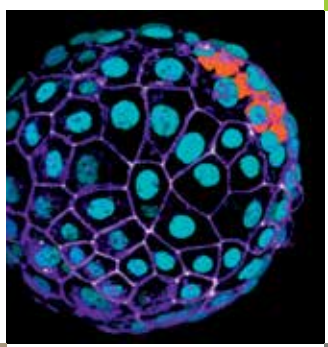

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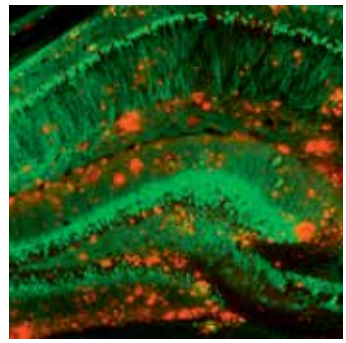

Cultures

Regulars

PHOTO: EMBL/MARIETTA SCHUPP

Editorial

Currently adorning the walls of the EMBL Advanced Training Centre is a striking lenticular print of a starfish nucleus, just about to divide. Recently, I stood staring at this picture in awe: it felt almost possible to dive deep into the mysterious centre of the nucleus. It is an astonishing work of art. But 3D visualisation technology – including 3D printing, virtual reality and computer games – is also helping EMBL researchers to better understand life under the microscope. We explore such innovative techniques in this edition which is themed on Dimensions (page 20). We also cover a range of other stories that illustrate the many dimensions of work and life at EMBL. We found structural biologists working in collaboration to develop the fourth dimension of time-resolved crystallography (page 11). We met EMBL service teams providing a bedrock for the study of the multifaceted universe of microbes (page 24). And we caught up with alumni volunteers who are helping to further the multidimensional impact of EMBL on the life-science community worldwide (page 44).

Adam Gristwood
Editor

Word to remember

Antennapedia

Noun, pronunciation:
/ænˈtenəpiːdiə/

A gene that handles leg development in fruit flies. A mutated version of this gene gives rise to legs, rather than antennae, growing from a fly's head

EMBL's early excitement (page 46).

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Stool transplants better understood

New study expands potential applications for stool transplants while emphasising need for personalised treatment

BY SONIA FURTADO NEVES

For the first time, scientists studying stool transplants can track which strains of bacteria from a donor take hold in a patient's gut after a transplant. A team led by EMBL, with collaborators at Wageningen University, the Academic Medical Centre in the Netherlands and the University of Helsinki, Finland, found that patient-donor compatibility likely plays a bigger role in these transplants than previously thought. The study was published in *Science*.

"Ultimately, the goal is to move from a stool transplant to something more manageable, such as a pill," says Simone Li, a PhD student in the Bork lab at EMBL. "Our work shows that this is likely going to be a personalised bacterial cocktail, rather than a one-size-fits-all solution."

Stool transplants involve taking microbes from the poo of a healthy donor and transferring them to a patient's gut. This procedure can help restore health to patients suffering from conditions that skew the balance of gut microbiota. The approach has been successful for treating recurrent *Clostridium difficile (C. diff)* infections, which can cause life-threatening cases of diarrhoea.

But for other gastrointestinal conditions, like ulcerative colitis, stool transplants have proven much less effective. The current study, led by Peer Bork and Shinichi Sunagawa at EMBL, could help improve those odds. The trick, they said, is to not only distinguish between species of gut microbes in a patient, but also to identify the strains of each species. Most people have *Escherichia coli (E. coli)* in their gut, but different strains of this species, some of which can cause health issues. By distinguishing between different strains, the team could ascertain whether the microbes in a patient's gut were their own or came from the donor.

They found that new strains of microbes from the donor were more likely to colonise a patient's gut if the patient already had that species. This implies that if doctors can match donors to patients, the chances of a successful treatment could improve considerably.

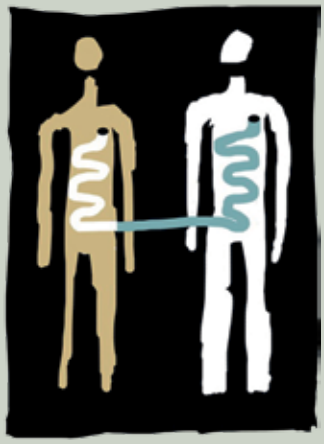


IMAGE: THE PLAIN DEALER/ANDREA LEVY

Compatibility between donor and patient in stool transplants is more important than previously thought

"With this method, we can really see if, for example, an antibiotic-resistant strain is replaced by a non-resistant one," says microbiologist Willem de Vos, who led the work at Wageningen University and the University of Helsinki, "so it could help to design stool transplants to work in other conditions beyond *C. diff*."

For more on the microbial universe see page 24

Li SS *et al. Science*, 28 April 2016.
DOI: 10.1126/science.aad8852

FULL REPORT ONLINE:
NEWS.EMBL.DE /?p=7012

Enzyme with a dual-purpose loop

BY ROSEMARY WILSON

A closer look at the 3D molecular structure of Death Associated Protein Kinases (DAPK) reveals an unexpected dual-purpose loop in the folded string of amino acids. Work by researchers in the Wilmanns group at EMBL's Hamburg site, published in *Structure*, suggests that the small loop is crucial for dimer formation and calmodulin binding. "What started as a small side project unearthed a complex and important signaling pathway within this group of kinases," says Matthias Wilmanns. "It goes to show, you can't always plan science!"

Simon B *et al. Structure*, 28 April 2016.
DOI: 10.1016/j.str.2016.03.020

FULL STORY ONLINE:
NEWS.EMBL.DE /?p=7037

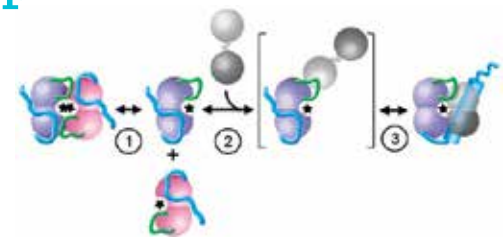


IMAGE: EMBL/PETRA RIEDINGER

A small loop (green) of the atomic structure of DAPK is shown to be crucial for dimer formation and binding with signaling partner calmodulin

Core connections

New professional association for core facilities in life sciences founded at EMBL

BY ISABELLE KLING

Access to complex and ever-evolving technologies is essential for biomedical researchers, but can be difficult for smaller laboratories to set up and manage. To ensure that scientists get access to the best equipment, therefore, many universities and life science research institutions now have specialised core facilities and infrastructures operated by dedicated staff, experts in those technologies. EMBL, for example, has core facilities covering a wide range of technologies used in molecular biology, including imaging technologies, genetic engineering, and database management.

The newly established Core Technologies in Life Sciences (CTLS) association aims to support the professionalisation of core facility and research infrastructure staff, as well as lobby for their recognition and represent their needs. The scope of the organisation is as wide as the membership, both geographically – its 100 founding members are from 21 countries worldwide – and in terms of expertise, covering all areas of life sciences from genomics and proteomics, through to biobanking, and clinical research.

"We want to be 'all-inclusive' and attract professionals from all the disciplines that can be useful for research in the life sciences, to identify common problems, find global solutions, and learn from each other," explains Rainer Pepperkok, who is Head of Core Facilities at EMBL .

The founding board was elected during the CTLS 2016 Conference at EMBL in June 2016, and the statutes were voted on and accepted. The goals of this new pan-European association are to offer a forum for the professionals in core facilities to meet and share information, as well as to help members with training. The association will organise regular conferences, workshops and networking events; it will also produce a database of all the existing core facilities available in Europe, as well as provide advice and support institutions that want to set up their own facilities.

Enzymes, sorted

A new method of searching for enzymes by function makes it easier to find the best match

BY MARY TODD BERGMAN

How would you find an enzyme that likes both cold water and digesting the dirt left on clothes? For biotechnology researchers, the first step would be to search the public data archives, which offer an overwhelming amount of information about enzymes. A new approach developed at EMBL-EBI makes it easier to find the best match by enabling search by function, rather than by gene sequence.

The functions of enzymes are the subject of intense interest in biotechnology. There is so much information available that it can be difficult to find what you need – particularly in the case of isomerases, whose substrates share the same atomic composition but are arranged differently in 3D space.

New approach

"Normally when scientists research enzymes they look at the sequence first – a gene sequence translates to an enzyme, which has a particular 3D shape and does certain jobs, or functions," explains Sergio Martínez Cuesta, formerly at EMBL-EBI and now at the Cancer Research UK – Cambridge Institute. "But what they're usually looking to find out is, how similar is the function of *this* enzyme to the chemical activity I'm looking for?"

Sorting by function is tricky, as enzyme families can catalyse multiple reactions, some very different from one another. Enzymes, and in fact all proteins, can be grouped according to their sequence, which implies function. But closely related members of an enzyme family pose a problem: their sequence may be similar, but their functions may differ.

The Thornton group resolved this problem by creating a new approach that puts function first, and applying it to a comprehensive study of isomerases.

"Our work gives researchers a way to see, for example, how broad a range of reactions an enzyme might be involved in – and that is very

PHOTO: EMBL

First administrative board of the new CTLS Association with, from left to right: Elena Trovesi, Patrick England, Josh Rappoport, Ralf Palmisano, Spencer Shorte, and Rainer Pepperkok

"The CTLS Association brings together institutions with high-level core facilities, like the Institut Pasteur and EMBL, with the aim to support and develop the same efficient and collaborative way to work across the whole of Europe," explains Spencer Shorte, head of Imagopole at the Institut Pasteur.

MORE INFORMATION ONLINE:
CTLS-ORG.EU

important to know if you only want that enzyme to do one thing, like digest dirt but not cotton," explains Martínez. "It's a method that lets you pinpoint how specific – or promiscuous – the function of an enzyme might be as its chemistry evolves."

Interdisciplinary

The group compared 250 isomerases reactions in enzymes from different classes, one at a time, to find similarities, then verified their findings using the EC-BLAST search tool. They showed how different isomerases can evolve to become enzymes with different functions – establishing a new way to describe functions while highlighting otherwise elusive relationships.

"Our method captures current knowledge, characterises the chemistry and catalytic function of isomerisation, and makes it easier to annotate their DNA sequences," says Janet Thornton, Senior Scientist at EMBL-EBI. "This is the first time that people can search enzyme classes to find proteins with similar function, drawing on a reliable knowledge base."

"The interdisciplinarity of this project is what makes it so special," she adds. "In the end we have something that allows us to explore the diversity of the chemistry of life more easily."

Martinez Cuesta S *et al. Proc Nat Acad Sci USA*, 12 January 2016. DOI: 10.1073/pnas.1509494113
Dönertas HM *et al. PLoS ONE*, 3 February 2016. DOI: 10.1371/journal.pone.0147952

Propelling cells towards the light

BY SONIA FURTADO NEVES

An airplane leaving a lit-up runway is not the image you'd expect to see on the cover of a scientific journal, but there it is on the May 2016 issue of *Cell Chemical Biology*. Inspired by a study from Carsten Schultz's lab, the image draws on the idea of using light to direct movement. The scientists developed a new way to switch on a lipid called LPA, which many cells – including cancer cells – are known to move towards. They manipulated this molecule so that it only becomes active when they shine a light on it. With this new method, researchers can make cells move towards a particular place by flipping a switch.

Hövelmann F, Kedziora KM, Nadler A *et al. Cell Chemical Biology,* 19 May 2016. DOI: 10.1016/j.chembiol.2015.11.019

FULL STORY ONLINE:
NEWS.EMBL.DE /?p=7145

IMAGE: CELL CHEMICAL BIOLOGY

Cell Chemical Biology cover image (cropped) shows an airplane approaching a runway – a metaphor for a new method developed by EMBL scientists

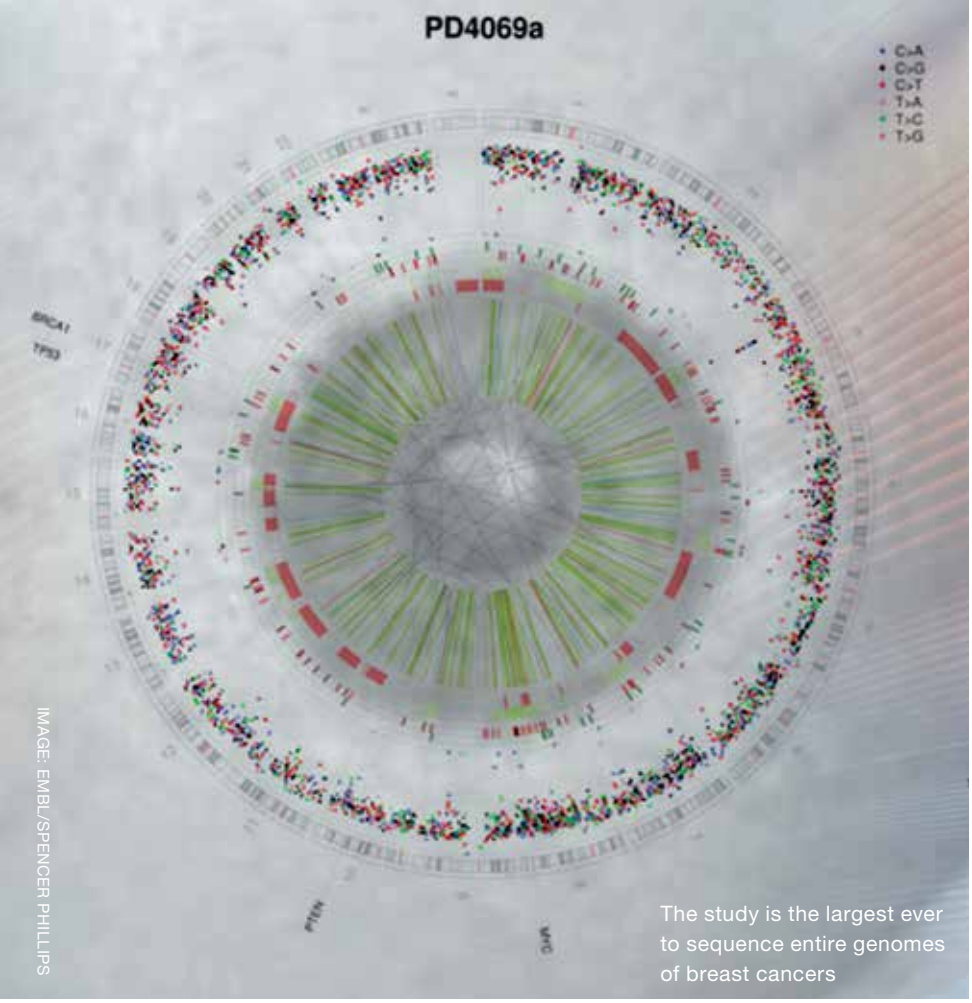


IMAGE: EMBL/SPENCER PHILLIPS

The study is the largest ever to sequence entire genomes of breast cancers

Towards personalised breast cancer treatment

Major study of breast cancer genomes by EMBL scientists and collaborators gives new directions for research into the disease

BY MARY TODD BERGMAN

Breast cancer genomes are highly individual, with each patient's cancer genome holding a complete historical account of the genetic changes that person has acquired throughout life. For cancer researchers, this poses a very real challenge for identifying the best possible treatment for a patient.

In the largest-ever study to sequence entire genomes of breast cancers, an international collaboration has uncovered five new genes associated with breast cancer and 13 new mutational signatures that influence tumour development. The group analysed 560 breast cancer genomes from cancer patients from the US, Europe and Asia, hunting for mutations that encourage cancers to grow and trying to recognise mutational signatures in each patient's tumour.

Unexpected technique

"We know that genetic changes and their position in the cancer genome influence how a person responds to a cancer therapy," explains Ewan Birney of EMBL-EBI, whose group used new computational techniques to analyse the sequence of genetic information held in each of the sample genomes. "This study uncovered some new reasons why breast cancer arises. It also gave us an unexpected way to characterise the types of mutations that happen in certain breast cancers."

The group found that women who carry mutations in the *BRCA1* or *BRCA2* gene, and therefore have increased risk of developing breast and ovarian cancer, had whole-cancer genome profiles that were very different to other breast cancers and highly distinctive from one other.

Towards personalisation

"In the future, we'd like to be able to profile individual cancer genomes so that we can identify the treatment most likely to be successful for a woman or man diagnosed with breast cancer," says Serena Nik-Zainal of the Sanger Institute. "It is a step closer to personalised healthcare for cancer."

Morganella S *et al. Nature*, 2 May 2016. DOI: 10.1038/NCOMMS11383
Nik-Zainal S *et al. Nature*, 2 May 2016. DOI: 10.1038/nature17676

FULL STORY ONLINE:
NEWS.EMBL.DE /?p=7020

Cancer cell lines predict drug response

EMBL researchers played a key role in the first systematic, large-scale study to combine molecular data from patients, laboratory cancer cell lines and drug sensitivity

Every cancer is different, and a major challenge in cancer research is predicting how a patient's tumour is likely to respond to a given drug. Now, thanks to a new study published in *Cell*, scientists know they can gain meaningful insights from cancer cells grown in the laboratory, as they harbour most of the same genetic changes found in patients' tumours.

The team looked at genetic mutations known to cause cancer in more than 11 000 patient samples of 29 different tumour types and mapped these alterations onto 1000 cancer cell lines. Next, they tested the cell lines for sensitivity to 265 different cancer drugs to understand which of these changes effect sensitivity.

They made two significant discoveries. First, the most frequent molecular abnormalities found in patient's cancers are also found in cancer cells in the laboratory. Second, they found that many of the molecular abnormalities detected in the patients can determine whether a particular drug affects a cancer cell's survival.

IMAGE: EMBL/SPENCER PHILLIPS

The study was based on rich, consistent, publicly available data gathered over the past six years by global scientific collaborations: the Cancer Genome Atlas and the International Cancer Genome Consortium

"If a cell line has the same genetic features as a patient's tumour, and that cell line responded to a specific drug, we can focus new research on this finding. This could ultimately help assign cancer patients into more precise groups based on how likely they are to respond to therapy," says Francesco Iorio, first author and a postdoc at EMBL-EBI and the Sanger Institute. "This resource can be used to create tools for doctors to select a clinical trial that is most promising for their cancer patient, even though it is still a way off."

"We could assess the value of different molecular data types for predicting drug efficacy, as a first step towards understanding which molecular characterisations clinicians should prioritise," says co-senior author Julio Saez-Rodriguez of EMBL-EBI and RWTH Aachen. "We hope others will use these datasets for different purposes, and so we have made them publicly available along with the tools needed to mine them."

Iorio F *et al. Cell*, 28 July 2016.
DOI: 10.1016/j.cell.2016.06.017

How new HIV drugs lock virus in immaturity

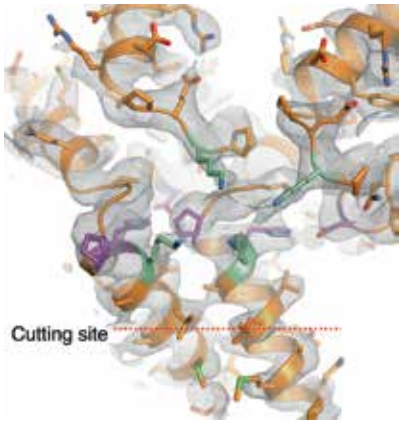


IMAGE: EMBL/FLORIAN SCHUR

BY SONIA FURTADO NEVES

A new type of HIV drug currently being tested works in an unusual way, scientists in the Molecular Medicine Partnership Unit, a collaboration between EMBL and Heidelberg University Hospital, have found. Led by John Briggs at EMBL and Hans-Georg Kräusslich at Heidelberg University Hospital, the team discovered that when the virus became resistant to early versions of HIV drugs, it did not do so by blocking or preventing their effects, but rather by circumventing them. The study, published online in *Science*, presents the most detailed view yet of part of the immature form of HIV.

For HIV to mature, a crucial cutting point has to be exposed

Schur FKM *et al. Science*, 14 July 2016.
DOI: 10.1126/science.aaf9620

FULL STORY ONLINE:
NEWS.EMBL.DE /?p=7307

IMAGE: EMBL/SPENCER PHILLIPS

Anatomy of a decision

Researchers at EMBL and the University of Cambridge ask: "How does a mouse embryo first begin to transform from a ball of unfocussed cells into a small, structured entity?"

BY MARY TODD BERGMAN

A new study – the first genome-scale experiment of its kind – provides a novel way to understand early development. Gastrulation is the point when an animal's body plan is set, just before organs start to develop. One of the biggest challenges in studying gastrulation is the very small number of cells that make up an embryo at this stage.

"How do you turn from an egg into an animal, with all sorts of tissues? Many of the things that go wrong, like birth defects, are caused by problems in early development," says Bertie Göttgens, Research Group Leader at the Wellcome Trust–MRC Cambridge Stem Cell Institute (CSCI).

Thanks to advances in single-cell sequencing, research led by EMBL-EBI and the CSCI were able to analyse over 1000 individual cells of gastrulating mouse embryos. The result is an atlas of gene expression during very early, healthy mammalian development.

"Single-cell technologies allow us to make direct observations, to see what's going on during the earliest stages of development," says John Marioni of EMBL-EBI, the Wellcome Trust Sanger Institute and the University of Cambridge. "We can look at individual cells and see the whole set of genes that are active at different stages of development, which until now have been very difficult to access."

Armed with that information, researchers can map cells from embryos in which some genetic factors are not working properly to healthy ones at the corresponding developmental stage in the atlas.

Next, the team studied what happened when they removed a genetic factor essential for the formation of blood cells from a mouse embryo. They were surprised by what they found: cells that would normally commit to becoming blood cells in healthy embryos became confused, effectively getting 'stuck'. "What's really exciting is that we can now look at the very small number of cells that are actually making the decision at the precise time point when the decision is being made," says Marioni.

"We can look at things that we know are important but were never able to see before – perhaps like people felt when they got hold of a microscope for the first time, suddenly seeing worlds they'd never thought of," adds Göttgens. "This is just the beginning of how single-cell genomics will transform our understanding of early development."

Scialdone *et al. Nature*, 6 July 2016. DOI: 10.1038/nature18633

FULL STORY ONLINE:
NEWS.EMBL.DE /?p=7294

How cells bag their rubbish

BY SONIA FURTADO NEVES

The build-up of protein deposits in cells is a hallmark of neurodegenerative diseases such as Alzheimer's and Parkinson's. "A protein accumulates in neurons, neurons die, and patients gradually lose brain functions," says Carsten Sachse from EMBL. "If the process by which the cell removes those proteins can be enhanced, then you might be able to prevent that disease progression." Before scientists can give the cell's rubbish collectors a boost, they must understand how the system works. In a paper recently published in *EMBO Reports*, Sachse and his lab drew on expertise from colleagues throughout EMBL to do just that.

Bertipaglia C *et al. EMBO Reports*, 6 June 2016. DOI: 10.15252/embr.201541960

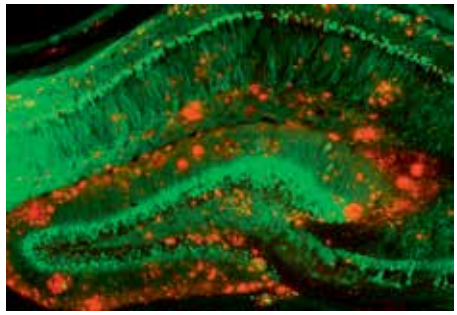


IMAGE: STRITTMATTER LABORATORY, YALE UNIVERSITY (CC BY)

Protein deposits (red) in the brain of a mouse used to study Alzheimer's disease

FULL REPORT ONLINE:
NEWS.EMBL.DE /?p=7205

We take a glimpse at the exciting future of structural biology, where developments in science and technology – powered by strong collaborations – are enabling EMBL researchers to see the molecules of life in ever greater detail

BY ROSEMARY WILSON

New dimensions

ILLUSTRATION: AAD GOUDAPPEL

Taking crystallography to the fourth dimension

Crystallography, but not as we know it

BY ROSEMARY WILSON

"Now we have the right people, in the right place, with the right technology!" exclaims EMBL group leader Thomas Schneider, who coordinates activities at the EMBL crystallography beamlines on DESY's light source PETRA III in Hamburg. Together with Arwen Pearson, Professor at the Centre for Ultrafast Imaging (CUI), Universität Hamburg, he and his team have been laying the groundwork to take crystallography – his structural biology method of choice – into a new time dimension.

Crystallography uses powerful X-ray beams to probe the 3D atomic structure of biological molecules such as proteins. As the X-rays bounce off the atoms in the protein, a distinctive pattern is produced that reveals information about its structure. This information can help scientists understand not only what a protein looks like, but also how it works and interacts with other molecules. "Crystallography gives us a single snapshot of a molecule in a single state," explains Pearson. "If you're lucky, your data will also allow you to see how it is bound to another molecule and you can begin to extrapolate how that molecule works." But sometimes one structure alone is not enough.

The whole of the protein can be involved in a binding event and any subsequent chemical reaction, and it changes shape as the molecules lock into place. "But just how the entire structure moves and changes shape is not really understood," says Pearson. "What we really want to do is to watch this process in motion." Instead of just

"What we really want to do is watch this process in motion"

Arwen Pearson

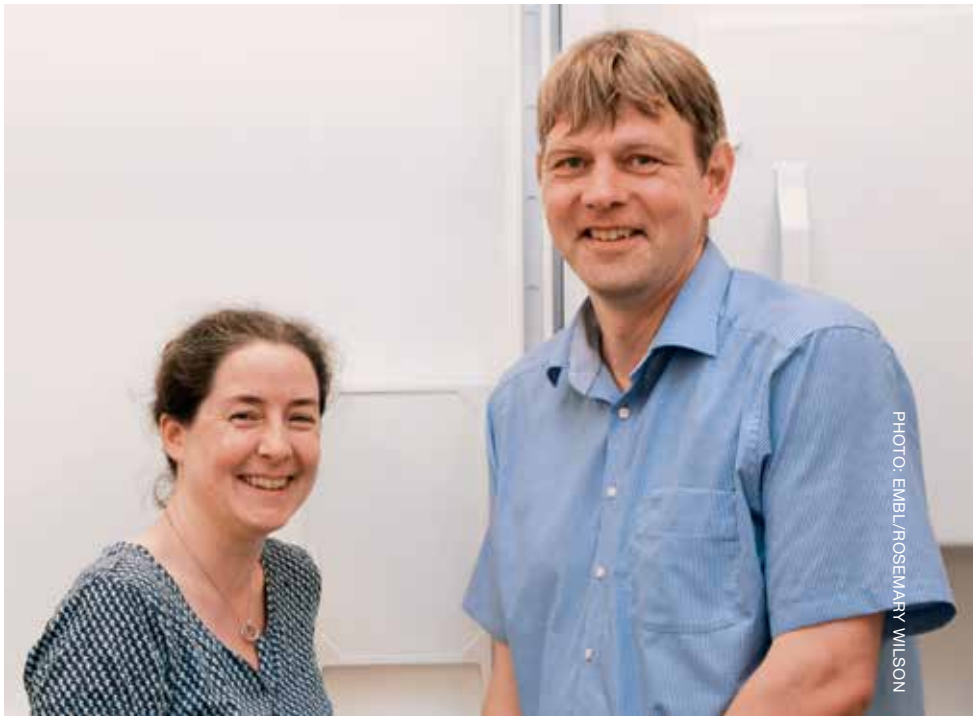


PHOTO: EMBL/ROSEMARY WILSON

Arwen Pearson and Thomas Schneider are laying groundwork to take crystallography to a new dimension

one snapshot, time-resolved crystallography involves taking many snapshots in quick succession to create a film of the molecule in motion, similar to running many photos together to make a movie.

Time-resolved crystallography is still very much a niche method, with complex requirements for both sample preparation and experimental set-up. Even defining when everything starts – Time Zero – is tricky. The reaction has to be triggered by a "pump" – a light pulse or a temperature jump for instance. "Just imagine me giving you a push," says Pearson. "The push, or pump, triggers you to start falling over, and we can watch what happens when you do. That push defines Time Zero." As the protein starts to move, the X-ray beam is used to probe the 3D structure of the protein at regular intervals thereafter, capturing information about the structure at different stages of the process.

"We are the gadget guys!"

Thomas Schneider

This "pump-probe" concept won Ronald George Wreyford Norrish, George Porter and Manfred Eigen a Nobel Prize in Chemistry in 1967 and is widely used in time-resolved experiments. Some naturally light-sensitive proteins, like those involved in vision, can be easily triggered using bright laser pulses. Otherwise, a 'reaction initiation strategy' must be painstakingly worked out for each new protein. Once this has been established, the crystallographic experiment itself requires a very bright X-ray source and clever strategies to ensure data of sufficient quality are obtained. These issues are the current focus of Pearson's research at the CUI and will be central themes for the new Hamburg Advanced Research Centre for Bioorganic Chemistry (HARBOR), which is being coordinated by Pearson and is soon to be established at the Universität Hamburg.

New dimensions

The beamlines at EMBL Hamburg at DESY's light source PETRA III have precisely the right qualities for taking crystallography into this next time dimension. "In order to take many snapshots in quick succession, you need a really small, stable and brilliant beam," explains Schneider. "Here we really profit from the excellent properties of PETRA III, and the EMBL crystallography beamline P14 that translates the beam delivered by PETRA III into what we need for these types of experiments."

To catch a process in action, you also need to be able to work on the same timescale at which the reaction occurs. "With the new European X-ray Free Electron Laser being built here in Hamburg, we will be able to observe extremely fast chemical reactions," explains Pearson. "But we are also interested in watching mechanistic structural changes – these occur on timescales that are already accessible to us at the beamlines. Currently, we can see reactions that occur in the millisecond range, but plans are afoot to further optimise the beamline so we can start to look at fascinating events happening on nano- and microsecond timescales." With grant funding from the German Federal Ministry for Education and Research, the groups will be able to extend the EMBL beamline P14 to establish an additional endstation dedicated to time-resolved crystallography.

Coming together

It was a talk by Pearson at the European Crystallography Meeting held in Warwick, UK in 2013 that got Schneider thinking and made him realise that time-resolved experiments might actually be possible on the EMBL crystallography beamlines at PETRA III. Discussions then really kicked off a year later when Pearson took up her post as Professor at the CUI, just across the road from the EMBL beamlines on the DESY campus. "The facilities at PETRA III were the reason I came to Hamburg!" says Pearson with a smile. "Hamburg is currently the epicentre of time-resolved science, and is the place to do these types of experiments," she adds excitedly.

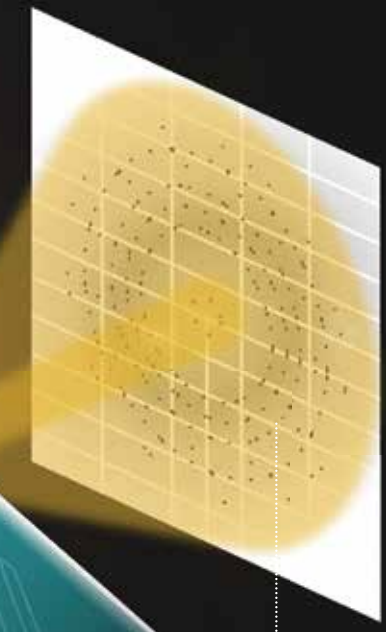
But the ongoing development and establishment of the technique in Hamburg wouldn't be possible without the dedication of many people behind the scenes, say Schneider and Pearson – from the EMBL beamline Project Evaluation Committee who recognised the unique opportunity, to the instrumentation teams based in both Hamburg and Grenoble who provide dedicated support to the project. "Time-resolved crystallography is by no means standard, and it is crucial to have the support and expertise of people like Gleb Bourenkov, a principle beamline scientist at P14 who has tested different set-ups on the beamline."

Pearson and Schneider are already working with several groups who are interested in studying the dynamics of their samples – but this is just the start. "We will be able to help scientists choose the right initiation switch for their system in preparation for experiments at the EMBL beamlines and ultimately the dedicated endstation," Pearson explains. "We want to provide the best beamline facilities and services so that scientists can study the dynamics of their proteins in detail," adds Schneider, grinning. "We are the gadget guys!"

Viewing proteins in motion with time-resolved crystallography

Time-resolved crystallography allows scientists to study how a protein's shape changes during a reaction. Scientists use a laser to trigger the reaction, and then an X-ray beam to capture a series of snapshots of the protein as the reaction unfolds. They can then put those snapshots together to create a movie of the molecule in action.

Protein crystal
A protein crystal consists of regularly arranged protein molecules. It also contains a lot of solvent, which gives the molecules space for a small amount of movement and changing shape.

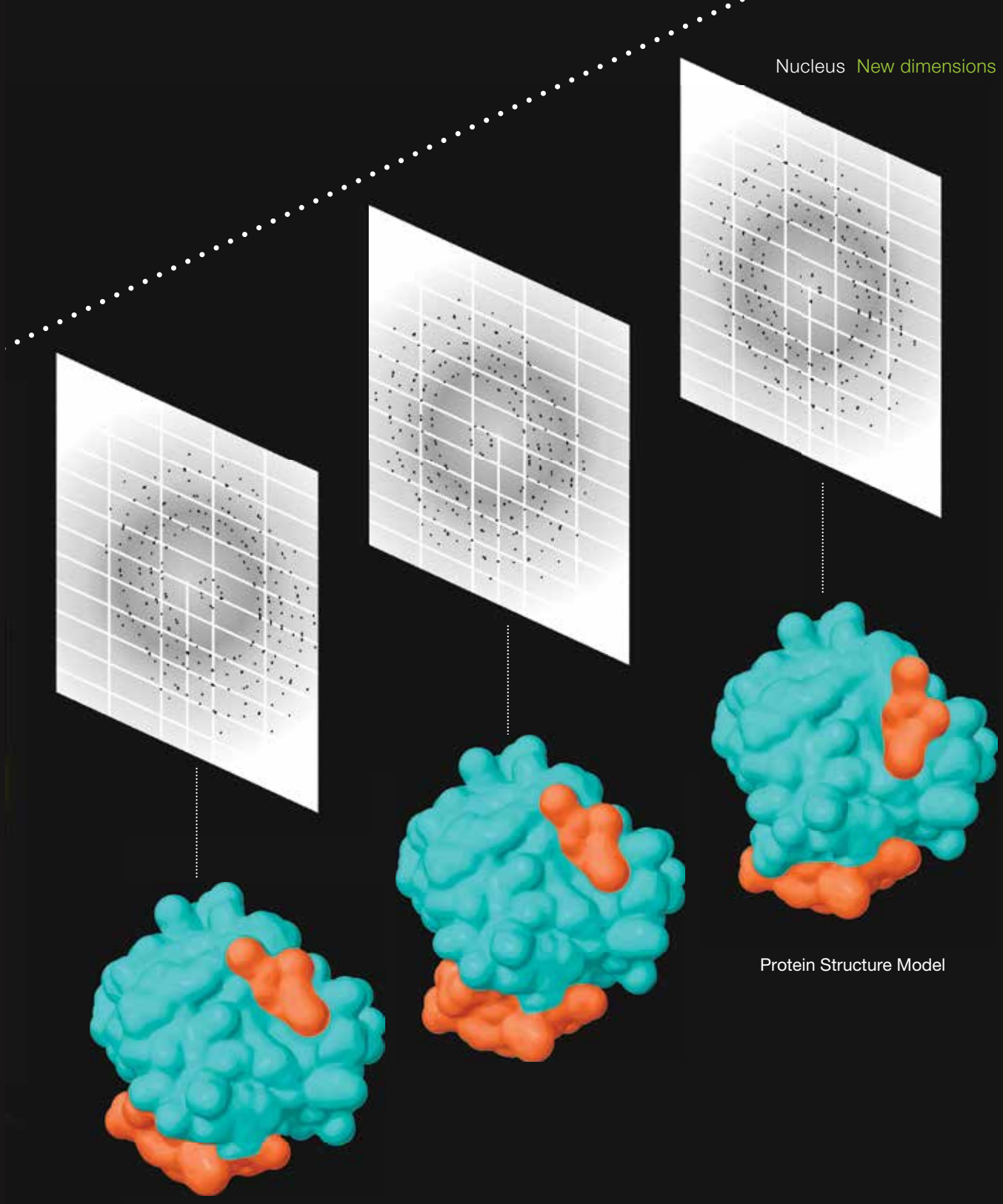


Crystal microjet

Laser
A trigger, such as a laser, is used to prompt the protein to change shape.

X-ray
At one or more time slots after the initial trigger, the X-ray beam is used to analyse the structure of the protein.

Diffraction pattern



Snapshots
When the X-ray beam passes through the protein crystal it is deflected off course by the atoms in the protein. This produces a distinct pattern which can be used to build a model of the protein structure. In time-resolved crystallography, a different pattern is produced at each time slot. This series of snapshots can be put together to show a movie of the protein in motion.

INFOGRAPHIC: GOBIUS.PT

Atomic proportions

PHOTO: ESRF/P. GINTER

How EMBL scientists and mechanics are working together with ESRF colleagues on an upgrade for one of Europe's big X-ray sources

BY ROSEMARY WILSON

Just as doctors use X-rays to study the hairline fracture of a bone in the hospital, scientists also use X-rays to explore structures that are invisible to the naked eye. But whereas the hospital's X-ray machine can only reveal details of the skeleton beneath our skin, the scientists' X-rays – which are produced by stadium-sized circular machines called synchrotrons – are able to delve far deeper and reveal minute details of the atomic world. They are enabling unprecedented insights into such worlds as the surface inaccuracies of metal, to the delicate fossils trapped in rocks, to the paintings hidden by their creator under famous masterpieces, to the molecular structures of proteins.

The European Synchrotron Radiation Facility (ESRF), situated at the foot of the French Alps on the European Photon and Neutron (EPN) campus in Grenoble, has been producing X-rays for scientific research for more than 20 years. EMBL's Grenoble site also forms part of the campus. Scientists there use this synchrotron radiation to explore the 3D atomic structure of biological molecules such as proteins and nucleic acids, shedding light on how we might prevent them causing disease or harness their unique qualities for new biotechnologies. As part of a collaboration that has been ongoing for over two decades, EMBL scientists work alongside ESRF colleagues to design and operate measuring stations – or beamlines – for structural biology experiments on the 844m synchrotron ring. Now, in an extensive modernisation programme structural biologists will be able to develop techniques such as time-resolved crystallography and serial crystallography to explore, in unprecedented detail, the molecules that make up our world.

An air of excitement

"There is definitely an air of excitement here at the moment," says Gordon Leonard, the Head of the Structural Biology Group at the ESRF. EMBL group leader Andrew McCarthy, who works closely with Leonard as part of the ESRF-EMBL Joint Structural Biology Group (JSBG) to improve the accuracy and speed of structural biology experiments, agrees. "Our users will be able to use the traditional crystallography set-ups they are used to, as well as being able to choose from a wider range of techniques such as serial and time-resolved crystallography and even being able to take high-resolution images of individual proteins inside the cell."

To study the structure of a protein using X-ray crystallography, scientists first need their protein samples to take on a crystalline form – much like the salt crystals produced from salt water. When put into the X-ray beam, the X-rays diffract off the atoms in the protein crystal, producing a distinct pattern that can be used to understand the molecular structure of the protein. But as scientists seek to explore the structure of larger and more complex proteins – and even multiple protein molecules bound together – the crystals that these samples produce

are, conversely, smaller and more fragile.

Traditionally, scientists remove protein crystals from the plates in which they grow before taking them to the beamlines. Many proteins, such as some membrane proteins, cannot be encouraged into forming large crystals but will often form very tiny crystals. Until recently these very fragile crystals were almost impossible to extract from where they were grown. To get around this problem, EMBL team leaders Florent Cipriani and Jose Marquez developed CrystalDirect™. "This technology allows you to automatically mount individual or multiple crystals from plates and subsequently move them directly into the X-ray beam for measurements," explains McCarthy. "We will implement this technology on the beamline for serial crystallography techniques, which will be a great help to our users."

Extreme brilliance

To be able to measure these tiny crystals, a smaller and more focused X-ray beam is also needed. "With bigger, less compact beams, most of the X-rays will pass by such a small crystal without touching it – that is a lot of lost energy," explains Leonard. "And the longer the crystal is exposed, the higher the risk of damage."

The 150 million euro ESRF Extremely Brilliant Source (ESRF-EBS) project aims to address this problem. "We will produce X-ray beams up to 100 times more brilliant and focused than is currently possible," says Leonard enthusiastically. "That's like the difference between trying to read a book by the light of a candle in the next room and holding a powerful head torch directly over the page."

This ambitious project entails replacing the current synchrotron storage ring with an upgraded version within the existing ESRF infrastructure, all the while recycling as many components as possible. "The old infrastructure will be re-used – this keeps costs and construction time to a minimum and allows us to keep the existing experimental stations fed by the storage ring," explains Leonard.

"It is opening our eyes even wider to an incredible molecular universe"

Andrew McCarthy

Key to the new design are 1000 custom made, high-performance magnets. They will be slotted precisely together in a lattice designed to reduce energy loss, while guiding electrons around the ring and producing some of the world's most compact and minute X-ray beams. To minimise disruption, much of this work will initially take place in specially constructed temporary buildings. Installation and commissioning is scheduled to begin in late 2018. "It's a fast turnaround, but we hope we can take the first users again in spring 2020," says McCarthy.

Smaller and smaller

But even before the ring upgrade begins, several of the beamlines themselves are being overhauled. One of these is ID23-2, the world's first microfocus beamline dedicated to macromolecular crystallography. "It has contributed nearly 900 depositions in the Protein Data Bank (PDB), including several relating to the structures of medically important membrane proteins, but it is now over 10 years old," McCarthy explains. "The optical configurations will get a major overhaul in order to provide an extremely high intensity beam with a micron-sized diameter. This also requires new high-precision instruments designed by Cipriani and his team for measurements, as well as new algorithms for analysing the data."

A bright future

Meanwhile, the JSBG are planning even further into the future. "With such an intense beam, it will be possible to do time-resolved experiments," says McCarthy. "More information will be captured in shorter time frames: we can start to 'watch' protein structural changes in real time by capturing multiple snapshots and putting them together to form a movie, opening our eyes even wider to an incredible molecular universe," he explains. "The future is very bright!"

MORE ONLINE:
WWW.ESRF.EU/about/upgrade

EMBL group leader Andrew McCarthy (left) and Gordon Leonard, Head of the Structural Biology Group at the ESRF

PHOTO: ESRF/CHANTAL ARGOUD

Form follows function

Structural biology at EMBL covers the full cycle of discovery: curiosity, training, research, instrumentation, experimentation, analysis, quality control, data deposition, data sharing and re-use, molecular design and back again

BY ROSEMARY WILSON

The Protein Data Bank in Europe (PDBe), in operation at EMBL-EBI for 20 years, is an essential resource for depositing, analysing and accessing new data. The PDBe team handles European and African depositions to the PDB and the Electron Microscopy Data Bank (EMDB) archives and works hard to provide an accurate, useful and flexible resource that keeps pace with a fast-growing field.

A new angle

"When the PDB was first established, it contained only data from X-ray crystallography experiments," says Gerard Kleywegt, team leader of PDBe at EMBL-EBI. "Over the past few decades, we have seen increasing amounts of data produced by new methods such as NMR, electron microscopy and solution scattering. This diversity is great for structural biologists, but we are not always able to handle diverse data types. Collaboration, dialogue and close ties with groups focused on different methods are absolutely essential to providing the best possible service to the entire community."

A case in point is small-angle scattering (SAS) data. In the past, SAS-based models were occasionally deposited in the PDB alongside X-ray crystallography data, but as SAS techniques improved and increased in popularity, the wwPDB partners recognised a need for new expertise to manage these data. A wwPDB task force was established and in 2014, the Small-Angle Scattering Biological Data Bank (SASBDB) was launched by Dmitri Svergun's group at EMBL Hamburg. From its inception, the SASBDB and PDBe teams have worked closely together, transferring knowledge and data between Hinxton and Hamburg.

"The PDBe team are very open," says Alexey Kikhney, Senior Technical Officer in the Svergun group. "Their expertise has been invaluable – they have been able to advise us on problems and issues we might run into in terms of infrastructure, policies, standards and programming."

The Hinxton and Hamburg teams have several joint projects. "We are working on creating an interface that makes it easier for users to move between the SASBDB and the PDB," says Kikhney.

Another technique on the rise is cryo-electron microscopy (cryo-EM). By firing beams of electrons at frozen samples, scientists obtain images that they can piece together to create atomic models and 3D representations, or 'volume maps', of the molecules in the sample. In 2002, the EMDB was established at EMBL-EBI as an archive for these volume maps. But it was not designed to handle the raw data.

"The raw data are crucial for scientists who want to understand and validate the structures, or develop new software tools for handling cryo-EM data," explains Ardan Patwardhan, who heads the EMDB at EMBL-EBI. In 2014, the Electron Microscopy Pilot Image Archive (EMPIAR) was established by the PDBe to fill this gap.

"Developing EMPIAR was very challenging in terms of storing and transferring huge amounts of data," says Patwardhan. "The largest entry is over 12 Terabytes, which would require thousands of DVDs if you were trying to store it yourself. The EM field is developing rapidly. We are working on tools for users to visualise 3D structures right from the atomic to the cellular level, opening up new avenues for knowledge dissemination and discovery."

Digging deep

Thanks to these efforts behind the scenes, scientists now have a wealth of data at their fingertips.

"I look for common patterns in biology, and for that the PDBe is a very important resource," says Alejandro Panjkovich, an EMBL Interdisciplinary Postdoc (EIPOD) supervised jointly by Svergun in Hamburg and Kleywegt at EMBL-EBI. "When we develop new computational approaches, we need to know if they will work on existing structures. The PDB represents a huge source of data we can search for reoccurring patterns, test new methods on, collect statistics and use as benchmarks."

"The PDB plays a crucial role in structural biology research and development"

Sameer Velankar

"The PDB is really essential to the work we do," adds Joana Pereira, a PhD student in Victor Lamzin's group at EMBL Hamburg that develops methods for determining the quality of information about how small molecules interact with proteins. "The PDB is a very well maintained archive, but even the 'bad' entries are useful for us. We can test our methods to improve these entries and find new methods for validating them."

Bringing it together

Structural biology at EMBL covers the full spectrum of discovery: curiosity, training, research, analysis, quality control, data deposition, data sharing and molecule design. As part of research infrastructure networks such as ELIXIR, EMBL's services are well placed to grow, continuing to enable research and discovery as technologies change. Through ELIXIR, the PDBe team recently teamed up with scientists in the Czech Republic to train researchers from Masaryk University in enriching structure data with value added information. If successful, the project will broaden the European base for structure annotation and bolster data expertise in the Czech Republic's life-science community.

"The PDB plays a crucial role in structural biology research and development," says Sameer Velankar, who leads PDBe content and integration at EMBL-EBI. "What started as a central repository for predominantly X-ray crystallography structures has evolved and diversified through constant dialogue with the community it serves. We are very much looking forward to another 20 years of helping scientists bring 'structure to biology'."

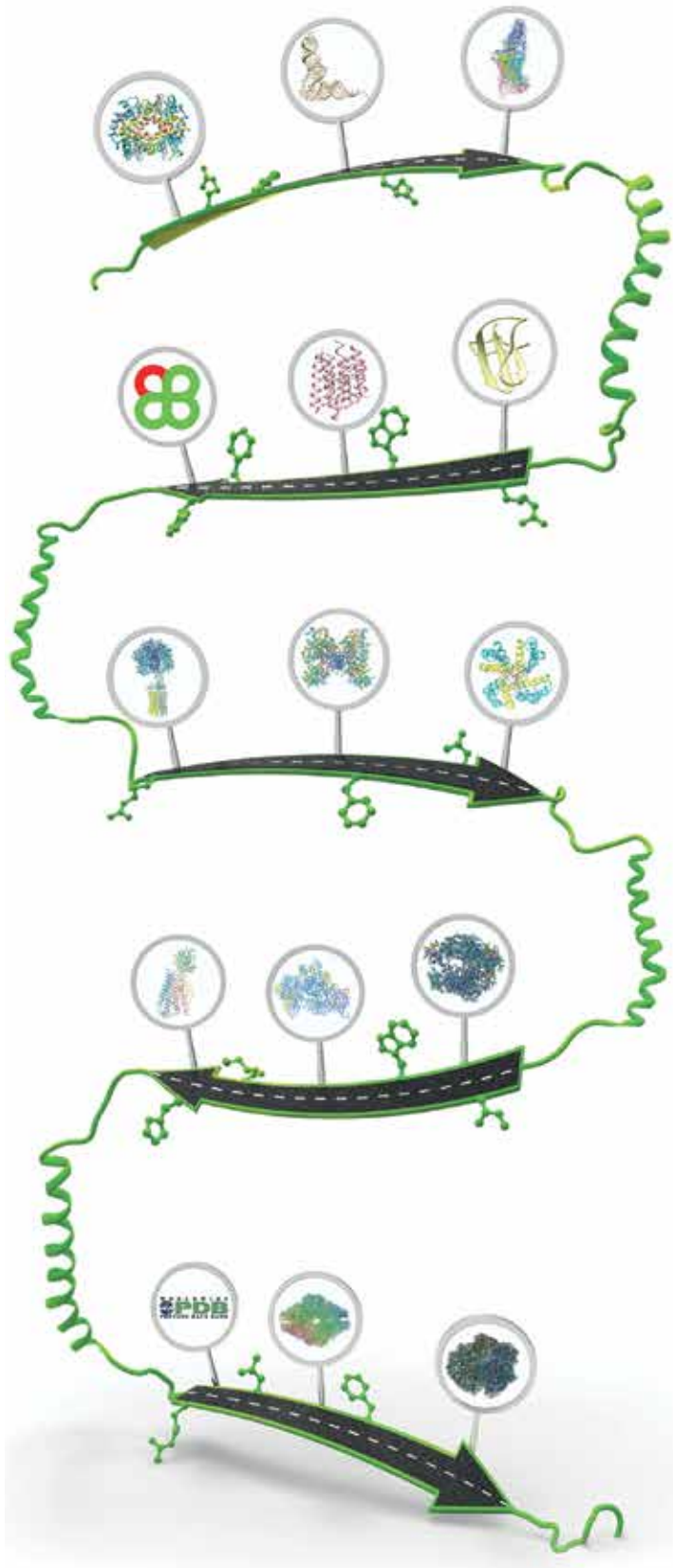


IMAGE: EMBL/SPENCER PHILLIPS

Tilt your head

BY MARGAUX PHARES

When it comes to lenticular posters, shifting your perspective is as simple as moving your head: What you see standing at one end of the poster may not be the same at the other end. But for several labs at EMBL, converting microscopic data into a 3D poster allows biologists to see what they never knew about before – from where proteins interact with a folding tissue, to how a Drosophila embryo develops. "We almost never see just a sharp surface," EMBL scientist Stefan Günther points out. "We see reflections, we see shadings, we see noise." For these reasons, visualising data in 3D can paint a more striking picture of the science. "When you go back and forth on the computer screen and rotate a structure in 2D, you have to have the first structure in your head," EMBL scientist Gustavo de Medeiros says. "But on a lenticular poster, if you just move your head to a different angle instead, the data is much clearer." Life in Perspective, an exhibit to be showcased at the Heidelberg City Library in October and November 2016, will explore this medium by bringing small structures to larger scales. "The nucleus of the cell looks like a mountain, which is familiar to us," Günther says. "That is one of the things scientists and society as a whole can benefit from – by showing real data as it is."

MORE ONLINE:
LIFEINPERSPECTIVE.DE

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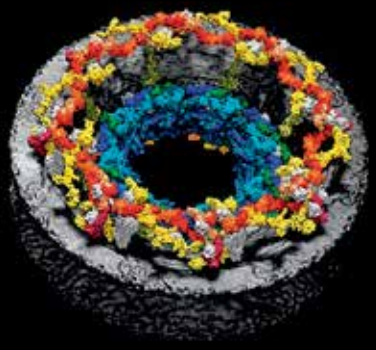
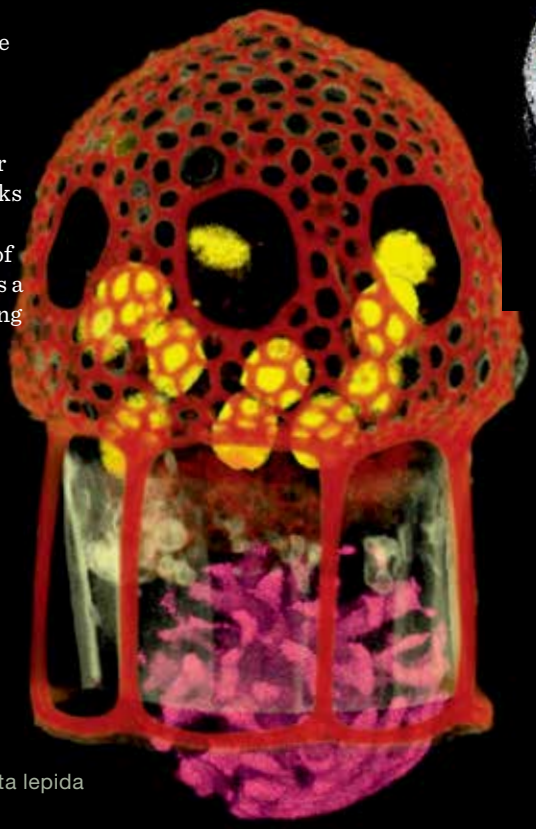
Starfish nucleus

IMAGE: EMBL/NATALIA WESOLOWSKA



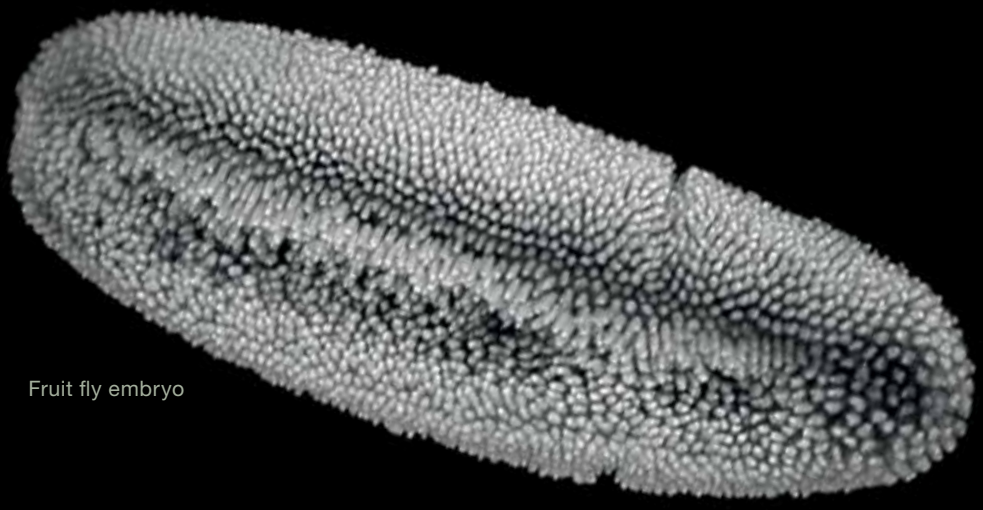
Nuclear pore complex

IMAGE: EMBL/JAN KOSINSKI



Dictyosysta lepida

IMAGE: EMBL/SEBASTIEN COLIN



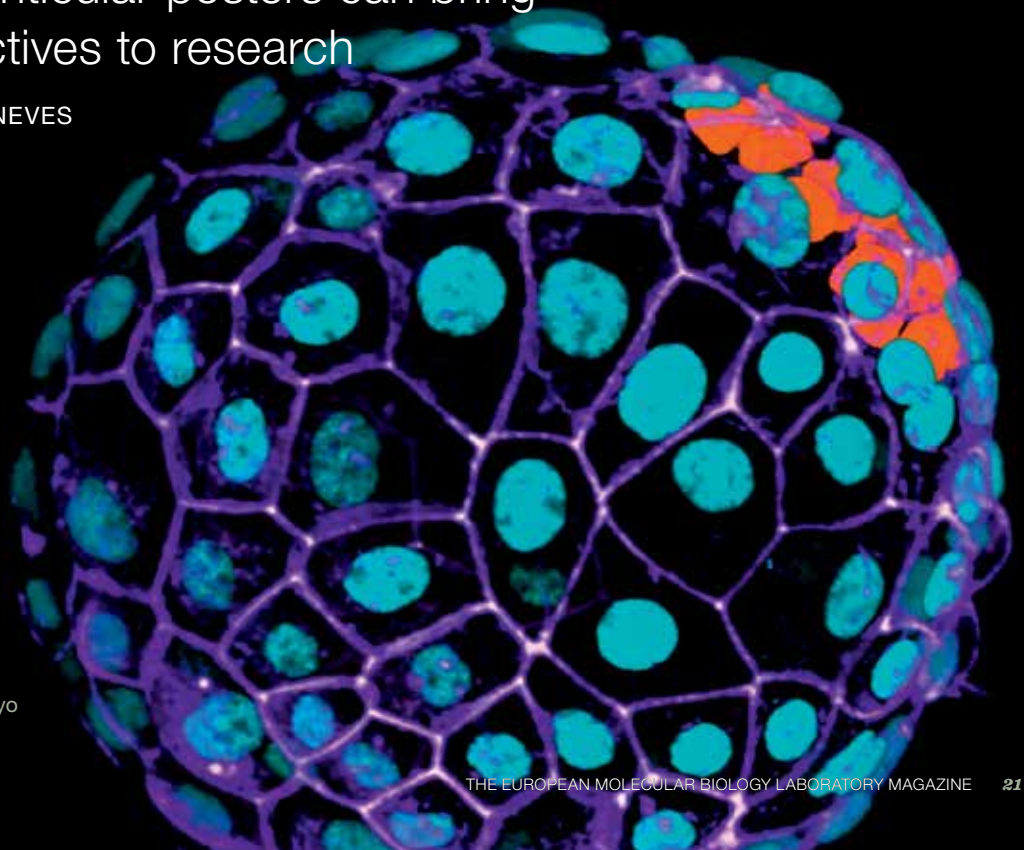
Fruit fly embryo

IMAGE: EMBL/STEFAN GÜNTHER

See your data in new light

How 3D printing, gaming, virtual reality and lenticular posters can bring new perspectives to research

BY SONIA FURTADO NEVES



Mouse embryo

IMAGE: EMBL/LAURA PANAVAITE

CONCEPT & VISUALISATION OF IMAGES: MANUELA BECK/GUSTAVO DE MEDEIROS/JORAN DESCHAMPS/STEFAN GÜNTHER

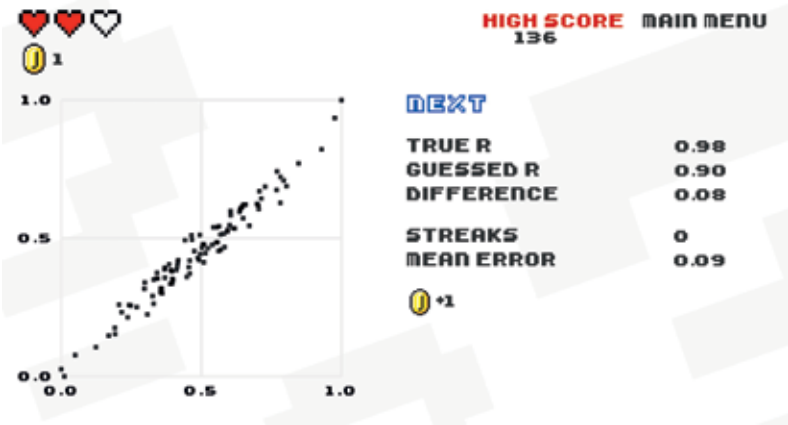
>>

Play a video game

Games are a powerful teaching tool, and scientists have turned to video games to gather data and crowdsource solutions to biological questions. But it turns out gaming can also be a way for scientists to improve their skills.

Omar Wagih, a PhD student in the Beltrão group at EMBL-EBI, created a game called *Guess the Correlation*, which challenges players to do something that scientists often must do: look at a graph showing dots plotted on two axes, and estimate how tightly linked – how correlated – the variables represented by those two axes are. Even seasoned scientists can get caught out, he says. "Sometimes people are so confident in their answer that they believe that the chart is wrong," he says. "I've had people emailing me saying 'there's no way this is right, something's wrong with your game,' and I'll send them the data so they can check for themselves, because the game was right." Besides alerting colleagues to how poorly human intuition can do at this task – and collecting data he hopes will help to reveal what kinds of graph people are most likely to guess wrong – Wagih says he has anecdotal evidence that players improve after playing repeatedly, implying this could be a way for scientists to hone an important skill. "I'm so much better at it now," he says. "When I play it alongside friends, they'll say 'that's a .6,' or something, and I'll say 'no, it looks more like a .43' – and my guess will be closer."

GUESSTHECORRELATION.COM



Put on a headset

The idea of putting on a headset and stepping into your data may sound like science fiction, but some scientists say virtual reality could help us understand data better. EMBL group leader Theodore Alexandrov wishes he'd had access to the technology a few years ago, when he was working with collaborators studying the different molecules on the surface of lichens. "Lichens are such curly and intricate structures with parts sticking out at all possible angles, that it's really difficult to recognise its shape on a photo or a 2D map. Does this part face sunlight or shade? Are these two parts touching each other?" he says. Even with something as familiar as the human body, seeing things in 3D can make it more intuitive to generate hypotheses, Alexandrov argues: "It was way easier to understand data looking at even a simple 3D visualisation than when you're looking at a spreadsheet!" Virtual reality could also help biologists engage with colleagues from other disciplines, says Alexandrov: "A black and white image might mean a lot to experts, but for computer scientists it's like something from the stone age. If you can show them something in VR, that'll grab their attention!" Ivan Protsyuk, a bioinformatician in Alexandrov's team who is exploring how virtual reality could be used in

"With new technologies like this, you never know what you can do until you actually start playing around"

Theodore Alexandrov

PHOTO: EMBL/THEODORE ALEXANDROV

the lab's own research, is aware that to become truly useful for scientific research, the technology will have to become more practical. "It would need plug-ins for programmes that scientists already use, and it would have to become simple enough to just put on the headset, look at something, then put down the headset and carry on working," he says. "But with new technologies like this, you never know what you can do until you actually start playing around," adds Alexandrov.

Hold it in your hand

As 3D printing technology becomes more mainstream, it is making its way into the lab, too. "At first I wanted to have 3D printed things for how cool this technology is," Hernando Martinez Vergara, a PhD student in the Arendt group at EMBL, admits. "But I was highly surprised to see that having a volume in your hand is way more telling than having it on a screen. I have spent dozens of hours looking at *Platynereis*' body plan on screens, but just a few seconds of playing around with a 3D printed model revealed so many details I could not believe it!"

Christoph Müller, Joint Head of the Structural and Computational Biology Unit, says the same is true of his work in structural biology. "It really gives you a different perspective – you can literally 'get to grips' with things," he says. "I sometimes take the model of a molecule and try to see where the active site would be, where things fit."

IMAGE: EMBL/STEFAN GÜNTHER

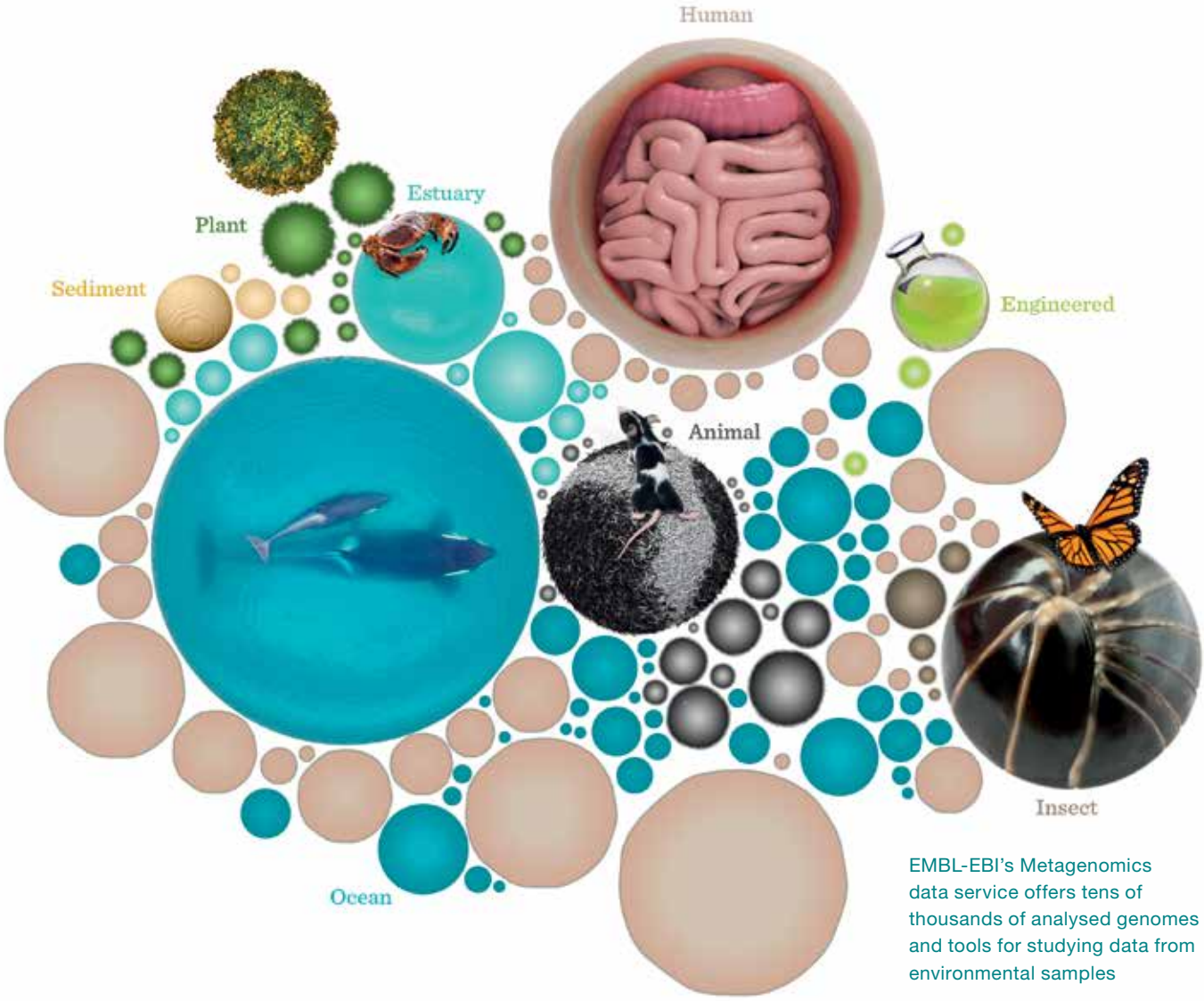


IMAGE: EMBL/SPENCER PHILLIPS

EMBL-EBI's Metagenomics data service offers tens of thousands of analysed genomes and tools for studying data from environmental samples

Microbiomes: our humble overlords

In the seas, in the soil, on our skin, in our gut – even in sewage treatment plants – microbes play pivotal roles in health and disease. To decipher how they work and how they influence each other, their hosts and the environment, scientists throughout the world are sharing and comparing vast amounts of information, and EMBL-EBI's data services help researchers to explore it

BY MARY TODD BERGMAN

A microbiome is an ecosystem of microbes: bacteria, viruses and other creatures invisible to the naked eye. Microbes are masters of their environment, growing everywhere from icy permafrost to boiling deep-sea vents, and influencing more of the living world than you might imagine.

Microbes are the great nitrogen fixers of our soil – in fact, with the right balance of them you can reduce the need for fertiliser to grow crops. They play a crucial role in our digestive systems – as anyone who has suffered an upset stomach after taking antibiotics knows from personal experience. They rule the seven seas, too – the microorganisms in our oceans play a vital role in absorbing carbon dioxide, helping to sustain a healthy atmosphere.

Every one of us depends on these ecosystems to stay alive, so we have a lot to gain from understanding how they function, fall apart and recover. For example, if you spray detergent to clean up an oil spill, you might break up the oil nicely but the detergent will stick around in the environment, potentially affecting marine life forms – effectively, you would be solving one problem only to create another.

Alternatively, you could use the right combination of microbes to remove that oil by breaking it down into harmless compounds like sugar. That would make it much easier to restore the microenvironment to its original state.

But how do you do that?

The microbiome challenge

The tricky thing is that most microbes are very difficult to study outside the context of their communities. This means scientists can't grow the microbes in a Petri dish and analyse them in isolation. Instead, they must study the whole environment, look at all the genetic material in a sample and try to tease out what organisms it came from.

Describing microbiomes in detail – making a community directory – is really difficult, as the individuals aren't easy to pinpoint.

So how do you find out who's who, what they're eating, and how they function? How can you pin down a beneficial chain of events in a given microbiome, such that you can manipulate it – returning it to health after the chain has been interrupted – or turn it to some new use, like sewage treatment or biofuel production?

Who's who?

Humans are pretty good at sequencing DNA these days – everything from whole genomes of people and plants to pathogens lurking in a hospital environment, identified on-the-fly.

But DNA sequences are pretty meaningless unless you can compare them to a reference. That can tell you whether it's a known sequence (which is pretty important) and, if so, what it is and what's special about it. Then again, you might discover that a sequence is novel, because there is no reference in the public archive.

So far, so good. But what if you want to sequence a spoonful of soil, a bucket of seawater, a stool sample, a scraping of skin, a little patch of the forest floor – each of which has millions of microbes and an untold number of DNA sequences? You'll end up with a huge amount of new information, all of which you want to compare to a reference archive at one go.

Does that even work?

Genomes within genomes

Yes, it does work. Studying the DNA sequences of a whole environmental sample, whether it's from the sea or your skin, is called metagenomics – literally, the study of genomes within genomes. "You can take a mixture of microbes from an environment and use computational approaches to identify what's in there, skipping the part where you separate out and culture individual viruses and bacteria," explains Guy Cochrane, who runs the European Nucleotide Archive – a major source of reference sequences and, as part of the International Nucleotide Sequencing Consortium (INSDC), the engine driving much of genomics research today. "Collecting, sequencing and comparing samples is something scientists are pretty good at, so we can provide a strong start towards understanding what these communities are doing biochemically," he adds.

> *"We can provide a start towards understanding what these communities are doing biochemically"*
>
> **Guy Cochrane**

"With environmental samples, you have to sequence so much stuff!" says Rob Finn, who runs EMBL-EBI's Metagenomics data service, which contains tens of thousands of analysed datasets representing genetic material from environmental samples. "Comparing the sequences found in one microbiome might be the equivalent to analysing a few thousand human genomes – that is simply a staggering amount of information. Our Metagenomics service helps people discover what is actually in their samples, and classify things that are being described for the first time." >>

>> "You can compare the DNA in a sample of contaminated soil to a clean sample from roughly the same place, or healthy gut to a diseased one, look for the differences and make some reasonable assumptions about what those genes are doing," adds Finn. "We need to look beyond that, so we can start to see what makes one microbiome thrive and another languish. If we can manipulate these environments, we can start to solve some serious problems."

Trending bugs

Anticipating disease outbreaks is an incredibly important application for metagenomics. The COMPARE project, an international pathogen-surveillance network, uses genome sequencing technology and rapid data sharing to speed up the detection of infectious disease outbreaks.

COMPARE is working to set up monitoring of sewage treatment plants in cities throughout the world, looking at which bacteria are circulating in a population, and what infectious diseases may be brewing.

"In COMPARE, our colleagues are using advanced methods, including some developed in Rob's team, sharing data as it is generated and using our cloud compute for some of the analyses. So they don't have to worry about the infrastructure – they can get on with figuring out how these things are moving from place to place and evolving," says Cochrane.

The microbiome as an organ

Microbiome research, like cancer research, is very, very broad and endlessly complex. It's a poster child for 'interdisciplinary research', demanding expertise in many areas of science. "Studying the microbiome covers so many different areas that it brings together a hugely diverse community," says Finn. "The people involved in international microbiome projects bring a lot of different knowledge to the table: microbiology, ecology, genetics, metabolomics, clinical research, healthcare, ecology, biodiversity... They're specialists, bioinformaticians, citizen scientists, participants at all levels, and they need the right tools to get on with their part of the work."

The human microbiome can be considered akin to the brain or another organ. After all, our bodies contain a substantial number of both parasites (the agents of disease) and symbionts (providing essential functions). At EMBL, several research groups are collaborating to understand the human microbiome and its role in our lives.

"Microbiomes are the focus of intense research at EMBL," says Peer Bork, whose research group explores how the environment in the human gut influences how a person responds to a drug. "My group has been exploring microbial functions in the gut since 2004, and thanks to the Tara Oceans expeditions, we've also had the opportunity to compare these communities inside humans with those on the surface of the sea. It is endlessly fascinating – and useful – to see how life processes are connected and influence one another."

Tara Oceans: marine microbiomes

The importance of plankton in maintaining the Earth's climate cannot be understated – their communities absorb a staggering volume of carbon dioxide from the atmosphere and release oxygen in exchange. Yet only a small fraction of these life forms have been classified and analysed.

To address this gap, EMBL scientists initiated and led the Tara Oceans

The rosetta that captures plankton samples is lifted onboard Tara

PHOTO: TARA EXHIBITIONS/FRANCOIS AURAT

expeditions: an unprecedented effort that resulted in 35,000 samples of seawater, each of which contained millions of small organisms. The samples, studied using advanced microscopy from EMBL, were sequenced at Genoscope in France, generating over 7000 datasets. Teams of researchers all over the world delved into this richly described collection, bringing to light 40 million novel genes and a raft of discoveries about life in the world's oceans.

Where can you find Tara Oceans data, and other marine datasets? At EMBL-EBI, of course. "We've worked with sequencing experts at Genoscope in France, our research colleagues at EMBL Heidelberg, data providers at Pangaea in Germany and many, many others to make Tara Oceans data available to everyone," says Cochrane. "This was an extensive sampling programme that was well organised from the start, so we have rich information about their chemistry and environmental context. That makes these datasets incredibly valuable over the very long term, because people can use them over and over again, in new ways, well into the future."

"Our job is to normalise the data – no matter what technology was used"

Rob Finn

Comparing Tara Oceans, Ocean Sampling Day and Malaspina marine datasets has already provided insights into the profound differences between the microbiomes of deep, shallow and coastal marine waters.

Big, smart data

Genome technology is advancing so quickly that it can be difficult to keep pace. EMBL-EBI teams work with researchers, data providers, technology companies and even biotech start-ups to make sure the right machinery is in place to keep science moving.

"Our goal is building knowledge, not just gathering data," says Paul Kersey, who leads the Ensembl Genomes project at EMBL-EBI. "If you want to understand something as complex as a microbiome, you've got to have the best possible data on every level, and provide intelligent ways to cross-link and query them. It only works if you can present new information in the context of what is already known.

"This is precisely what the Ensembl Genomes service does. We bring together all the knowledge gained about the genomes of microbial life forms – linking historically well-studied species with those only recently discovered."

"It's all very exciting, and scientists are easily tempted to jump in and gather data very quickly, using the latest kit, and upload it into an archive as an afterthought," says Cochrane.

"Our job is to normalise the data – no matter what technology was used – and connect it all up so that people can slice across it in interesting ways. That's how you get researchers finding novel genes that influence diseases like Crohn's, or discovering cold-loving enzymes that can take the place of detergents," adds Finn.

What's next?

Microbiome research is very new, and changing rapidly as new technologies and approaches widen the range of questions we can address. At EMBL-EBI, the Finn team is collaborating with a company called BioCatalysts, using metagenomics to discover novel enzymes that could have industrial applications. Discovering these enzymes using a data-driven approach rather than carrying out chemical synthesis experiments would curb the generation of chemical waste.

Get involved

Want to know more about life in the seas? On 21 June, every year, the Micro B3 project invites sailors, skippers and anyone working in marine research to participate in Ocean Sampling Day (OSD), a simultaneous sampling campaign of the world's oceans, from the subtropical waters around Hawaii to the rather brisk rapids of the Fram Strait in the Arctic. By taking samples at the same time every year, the hundreds of scientists taking part in OSD are describing microbial diversity and function, which at present is very poorly understood, and identifying trends over time. Not working on a boat or in marine science? The OSD Citizen Science campaign welcomes everyone to collect marine microbes and environmental data to help scientists piece together a better understanding of the world's oceans.

Want to know more about the human gut microbiome? The my.microbes project (initiated by EMBL scientists), the British Gut Project and the American Gut project all welcome citizen scientists to provide samples and information about diet and lifestyle. These projects, taken together, will help map the gut microbes of human populations throughout the world, building an understanding of how lifestyle choices and diet influence our microbiomes, and therefore our health.

Gene editing 3.0

Emmanuelle Charpentier, an alumna of the Nordic EMBL Partnership for Molecular Medicine, sheds light on how CRISPR-Cas9 turned from a side project into a worldwide revolution

BY ISABELLE KLING AND MARGAUX PHARES

PHOTO: EMBL/ADAM GRISTWOOD

Three molecules are enough to alter a genome. And three years is how long it took microbiologist Emmanuelle Charpentier to discover not only how these molecules work together, but also how they can be used in a revolutionary gene-editing technique (published in *Nature* in 2011 and *Science* in 2012). This system, called CRISPR-Cas9, is a naturally occurring defence mechanism that enables bacteria to fight viral infections. As Charpentier and her collaborator Jennifer Doudna at the University of California, Berkeley found, though, it can also be easily manipulated to add or mutate genes. Like a set of microscopic scissors, the nuclease Cas9 can be programmed to find and cut any sequence of DNA.

Their findings have led to a rapid expansion in applications of cut-and-paste genome-editing techniques. In particular, CRISPR-Cas9 holds immense potential for combating diseases – from altering the genomes of mosquitoes carrying the Zika virus to staving off infections by the human immunodeficiency virus (HIV). Human clinical trials to assess the effectiveness of CRISPR-Cas9 against three different types of cancer are due to begin in 2017.

Charpentier's career has advanced rapidly in the past four years: one of the two seminal publications on CRISPR-Cas9 (published in *Science*) is in the top 5% of all research outputs scored by Altmetric, an alternative to traditional citation impact metrics to measure the impact of a publication. She is currently a Visiting Professor at the Laboratory for Molecular Infection Medicine Sweden (MIMS), Umeå University, which is part of the Nordic EMBL Partnership for Molecular Medicine, and she has recently been appointed as Director of the Max Planck Institute for Infection Biology in Berlin. She has also co-founded two biotechnology companies (CRISPR Therapeutics and ERS Genomics) and has received numerous awards, including the Gottfried Wilhelm Leibniz Prize, the Breakthrough Prize in Life Sciences and, most recently, the Tang Prize in Biopharmaceutical Science.

EMBL got the opportunity to speak with Charpentier during this year's EMBL Partnership Conference – Perspectives in Translational Medicine – in Heidelberg. She discussed with us her time at the Umeå University, the importance of basic research, and the far-reaching implications of CRISPR-Cas9 in our day-to-day lives.

Partnership perspectives in Heidelberg

Nearly 200 participants from EMBL and select partner institutes gathered in Heidelberg from 6–8 June 2016 for the Perspectives in Translational Medicine conference. The second event of its kind, and the first hosted at EMBL, took place in the context of the EMBL Partnership Programme and brought together EMBL's partner institutes operating in the field of molecular medicine. From PhD students to institute directors, participants exchanged expertise in connecting basic science with medical research, intent on strengthening networks and building new collaborations.

How does CRISPR-Cas9 work, and what makes it such a powerful technique to edit DNA?

Although it might seem strange, bacteria can also suffer from infections – by viruses called phages – and have developed an adaptive immune system as a result. This means that they can 'remember' phages that have infected them in the past and can fight more efficiently against them if they strike again. At a molecular level, this 'memory' is made up of a small piece of phage DNA that is inserted into the bacteria's genome and stored in a location called 'clustered regularly interspaced short palindromic repeats', or CRISPR. Think of it like the wall of a sheriff's office in a western movie, with mug shots of outlaws to catch. When the outlaws come back to town, the sheriff goes after them armed with a copy of their mug shots and a weapon. Similarly, when a phage strikes again, the immune system of the bacteria goes after it armed with a molecular mug shot – a single short piece of RNA that matches the viral DNA stored in its genome – and a pair of molecular scissors called Cas9. Another RNA, called tracrRNA, triggers the maturation of this viral RNA sequence. The complex formed by these three molecules – viral RNA, tracrRNA, and the DNA-cutting enzyme Cas9 – recognises the invading DNA and snips it, thus disabling the phage and preventing infection.

CRISPR-Cas9 is easy to engineer: by modifying the sequence of the viral RNA, scientists can redirect the complex to another location on the DNA that will then be cut – like if someone gives the sheriff another mug shot of someone to catch. Our experiments showed that we could adapt this tool and use it to manipulate the DNA of any cell. We studied CRISPR-Cas9 initially in >>

>> *Streptococcus* bacteria, but we now know a similar adaptive immune system exists in approximately 40 percent of bacteria.

What made you realise that you had discovered something big?

When I accepted my new position in Umeå in 2008, it took me almost a year to convince people to look at the connection of two systems – CRISPR and tracrRNA – that now defines the unique feature of the CRISPR-Cas9 mechanism. The CRISPR project was carried out with limited manpower and everyone else was very busy with other projects, which were more interesting than CRISPR-Cas9 at first sight. Above all: who is interested in an adaptive immune system in bacteria, anyway?!

"I had a hunch that something interesting could be there"

I cared, because I started my career in the field of bacterial genetics and I had a hunch that something interesting could be there. So, I kept pushing the idea. When my student from my former position at the University of Vienna set her mind to some experiments, the results were exciting, unexpected, yet breathtakingly simple – and it became clear to me that we were potentially studying a totally unknown and unique mechanism. The environment within the Nordic EMBL Partnership for Molecular Medicine was instrumental in helping us to achieve these results. Like scientists at EMBL, young researchers there receive the resources and space needed to pursue fundamental questions.

Like every scientist, I was in love with the mechanism I was studying. When you focus on the same mechanism and molecules every day, the moment when you finally understand how it functions always seems like a breakthrough. But the rest of the world might see it with different eyes, depending on whether or not it has useful applications right away. In the case of researching CRISPR-Cas9, my focus was on the science. I was really excited about what we had observed and I wanted to dig deeper into the workings of the mechanisms. The research projects in my laboratory have always had a focus on the understanding of basic mechanisms in bacteria that could lead to novel gene targeting technologies or novel anti-infective strategies. It was only when the technique attracted a number of high-profile awards, I then realised its global scope beyond the range of versatile applications.

The CRISPR-Cas9 system is now being used in almost every molecular biology lab in the world – how do you feel about that?

When it became clear that we could tweak this mechanism into a powerful gene-editing technology, I followed my initial interest in seeing the technology applied to the field of human medicine. It is quite rare in science to see the development of so many applications for one technology, and so quickly. Exactly how the different applications will develop in future is still hard to define, but I am very pleased to see that many medical geneticists are embracing it. In the long-term, it would be tremendous if CRISPR could directly treat human genetic disorders. I have co-founded, together with Rodger Novak and Shaun Foy, a biotech company called CRISPR Therapeutics with the goal of pushing forward this endeavour.

However, it is also important that society and politicians understand and be mindful of the complex implications of this simple yet sophisticated and versatile technology. Further down the line some research or resulting applications, for example in relation to genetically modified organisms in agriculture, could require widespread societal discussion and debate. Ultimately, decisions will need to be made. It is important and very good that groups are forming at different levels to discuss the opportunities and potential consequences of the CRISPR-Cas9 technology.

Do you think that being a woman has influenced your career? How could we improve the situation of women in science?

When it comes to my work, I want to be considered for my scientific expertise first and foremost. This is something that I've always fought for. I have always had reservations about politics based on quotas. I consider them plasters on a wound that will not make the wound disappear: only a change in mentality will end discriminations, like those against women. Ideally, you would hire people for their qualifications, research projects and whether they fit well in your work environment – not whether they are male or female. Strong education programmes focusing on these issues, from an early age, have the potential to change mentalities and thereby make progress on discrimination issues. But that will take some time. It's not a question of being politically correct – it is one of observing a certain reality and questioning it.

Note from the Editors: Quotas are a matter of heated debate in science. We will be publishing interviews with people who offer different perspectives on the issue, so watch this space

Cultures

Postdocs of EMBL

Continuing our 'Humans of EMBL' series, we turn the spotlight on the diverse universe of EMBL's 200-strong postdoc community

BY ADAM GRISTWOOD AND ROSEMARY WILSON

For me, science is a way of life. I grew up in a family of doctors and was very used to hearing scientific discussions at the dinner table. My mum encouraged my interest by giving me books to read like *100 Important Discoveries*. But I actually thought I would be a detective! In my mother tongue "detective" translates as "the one who is searching for the truth", and in effect that is what we do as scientists. Every day we follow the principles observe, analyse, understand. There is a powerful expression: "to understand is to transform what is!" and the people who inspire me most are not only great scientists, but those who also manage to bring their science to people. There is no rule that all science has to have an application, but if there is scope to do so I think it's our responsibility to facilitate that. A few years ago, a friend and I set up a biotechnology company: by understanding how proteins are built, we wanted to see if it was possible to build a collection of 'molecular Lego bricks' and design a smart, functional material. In the beginning this was basic scientific exploration, but then we wondered if it was feasible to use our method as 'ink' for 3D printing of human tissues. Indeed it was, and using living cells we printed part of a functional liver. The great hope is that this research could one day lead to alternatives for full-scale liver transplants. There is still a lot to figure out, but it's been an exciting journey so far. Entrepreneurship really complements my academic work here in Hamburg and in the end – even if things don't work out – it has been an enjoyable and fulfilling journey!

PHOTO: EMBL/ROSEMARY WILSON

Tuhin Bhowmick

EMBL Interdisciplinary Postdoc, Meijers & Peri groups

PHOTO: EMBL/MARIETTA SCHUPP

In the unusual setting of a brewery, I was tasked with introducing yeast's other face to participants of the Friends of EMBL Frühschoppen – a traditional Sunday morning social gathering. Rather than using yeast to make beer or bread, I study the effects of genetic variation and how this propagates across multiple molecular levels to affect the cell. By understanding the basic principles of variation in this very simple organism, it is possible to also gain insights into human biology, health and disease. I was involved in planning the event at a very early stage and it forced me to think about my project in a completely different way – participants were thirsty to learn more! What I really like about being a postdoc at EMBL is the level of interactivity: we are encouraged to mingle and take part in activities with other people. This is good for the science because you learn about the activities of other groups and how that can be relevant to your research.

Sibylle Vonesch

Postdoc, Steinmetz group

My daughter is six months old now. After her birth it was difficult because my girlfriend was very ill and I took time off work to look after them both. Luckily, things got better and have settled down now and we have a daily routine going – as much as possible! One of the biggest challenges is striking the right balance between work and family. I feel a lot more focused at work, trying to plan ahead and be more organised to make sure I finish on time and can get back home to spend time with my family. You also have to switch your subject quickly – from changing dirty nappies to pipetting in the wet lab – after a rough night that can really be quite a challenge! Being busy at work and busy at home, I've evolved into an early bird, getting up to have some quiet time for myself before everyone else gets up. Having a child has also changed my outlook on life. I think, and worry, more about the future. Priorities change, and when things don't go so well at work, having a family at home puts things into perspective. Yet despite the challenges and sleepless nights, it's very fulfilling!

Jan Strauss

EMBL Interdisciplinary Postdoc, Löw and Thornton groups

PHOTO: JAN STRAUSS

PHOTO: ROBERT SLOWLEY

I always had an inquisitive mind and was fascinated by chemistry, wanting to know the answers to questions such as: what is matter? What is an atom? What is a protein? And what is the role of chemistry in the life sciences? As a high school student in Zimbabwe, where very few girls joined science classes, a question of a very different nature got in the way: I am a woman – how can I be good in science and inspire other women? An inspiring teacher and mentors shone a light on opportunities for me to become one. I managed to see past the male-scientist stereotype and proceeded to do a PhD in Chemistry, in Cape Town, South Africa. Through collaborations and the desire to participate in interdisciplinary research in an international atmosphere a door was opened for me at EMBL-EBI. Here, I have the freedom to satisfy my curiosity in drug discovery and life sciences, working on target identification and validation of anti-tuberculosis compounds, aiming to help tackle a killer disease that affects millions worldwide. Having support from the EMBL community, opportunities to work with renowned scientists like John Overington, participating at local and international conferences and establishing collaborations helped me to excel. The exposure, the experiences and the inspiration from female leaders such as Janet Thornton, former EMBL-EBI director, continue to shine the light on massive opportunities. Indeed, there are no limits, no boundaries and our potential is limitless – it is all about how you see yourself.

Grace Mugumbate

EMBL Interdisciplinary Postdoc (until April 2016) Now a research scientist and data curator at EMBL-EBI

I recently gave a talk at an EMBL Science Movie Night, themed 'the truth about X-men'. In the film, X-men are feared and hated by humans because they are different: heroic mutants, each born with special powers. Of course people realise that X-men is not reality, but giving a talk with the movie gave me a chance to present to a large public audience what mutants are away from the world of Hollywood. We are all a little bit different and in some respects everyone is a 'mutant' because we all carry mutations in our genes – it is very normal to have mutants sitting next to you! My key message mirrored that of the film: don't be afraid if something or someone looks different, it's just a natural part of life.

Falk Hildebrand

Postdoc, Bork group

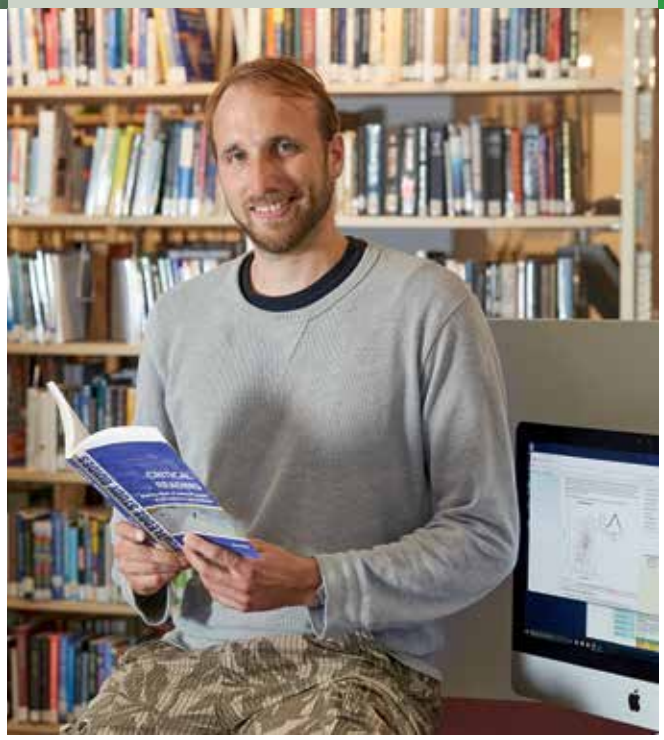


PHOTO: EMBL/MARIETTA SCHUPP

PHOTO: ROBERT SLOWLEY

When I was nine years old my parents gave me a Commodore 64. This computer ran on cassettes and I wrote my first lines of code with it: a simple animation of a centipede. I was amazed because I realised it was possible to be very creative with computers. What people appreciate the most about me is my creativity, and while I am interested in literature, art and – naturally as an Italian – singing, my career as a computer scientist has enabled me to be involved in creative collaborations with people in many different fields [see page 8]. EMBL is a great place because it nurtures creativity: I have had the opportunity to be free, independent and tackle problems with a lateral-thinking approach. It is also very family friendly. This is my first experience living abroad, and I came here to EMBL-EBI together with my family. There is a lot of support, an onsite nursery and I have even brought my kids into the office on occasions – they have been very welcome! This is important to me as I want to be a great dad, as well as a great researcher.

Francesco Iorio

EMBL-EBI/Sanger Interdisciplinary Postdoc (until April 2016) Now a senior bioinformatician at EMBL-EBI

PHOTO: EMBL/ROSEMARY WILSON

One of the things I love most about science is connecting with many different people. I've been on Twitter since about 2009 and have become part of a whole community that I wouldn't otherwise come into contact with. You can 'follow' scientists you wouldn't otherwise meet at conferences, and you can see what they are up to and interact with them on a virtual level, as well as being amongst the first to hear about new papers. I seem to be interacting with users based in Australia – who knows; maybe I'll get the opportunity to move there next! I also participate in science outreach – I got in touch with a college near my hometown, and volunteered to talk to students about my experiences of what it's like being a scientist. For students deciding what to study at university, it's really hard to get a feeling for what a scientist actually does, so I aimed to give them an insight into my daily work in the wet lab. One key message is that scientific career paths are not set in stone and not to get too worried about making the 'wrong' decision. I have moved from one topic to another and all science is interlinked. There are also great possibilities to travel and work abroad – something I think also impressed them! After I had given one talk, teachers at the school asked me to speak to the other science classes – I think it really makes a difference for scientists to share their world in schools and it felt great to be there. I would definitely do it again.

Kate Beckham

EMBL Interdisciplinary Postdoc, Wilmanns and Sachse groups

Inspire change in science

Bruce Alberts on fixing the broken academic career pipeline

PHOTO: THE UNIVERSITY OF CALIFORNIA/TOM KOCHEL

Bruce Alberts is a former President of the National Academy of Sciences, former Editor-in-Chief of *Science* and a former United States Science Envoy. He is now the Chancellor's Leadership Chair in Biochemistry and Biophysics for Science and Education at the University of California, San Francisco

"We are producing more research scientists than academia can handle and doing nothing is not an option". Renowned biochemist Bruce Alberts delivered this stark warning at EMBL's Lifelong Learning in the Biomedical Sciences conference in Heidelberg on 6 July, pointing to the need to change the way science is funded, staffed and organised. EMBL postdoc Julia Roberti spoke to him to find out more.

What are the main challenges for young researchers?

By many measures we are currently in a golden age of the life sciences. Yet this disguises the fact that the training pipeline produces more scientists than relevant positions in academia or industry are capable of absorbing. This oversupply of scientists – and a scramble for limited resources – threatens to reduce scientific productivity, undermines career development and diminishes the attractiveness of our profession. Young researchers should be encouraged to carefully consider what they want for their future, focus much earlier on their career options, explore alternative paths and get trained if they find them attractive. We don't want to discourage people from becoming scientists in academia, but they should go in with open eyes about the challenges of doing so. Alternative roles such as in education, policy, media, business and law can be hugely rewarding, and spreading scientists throughout these fields means they also become interpreters and connectors between the vibrant scientific community and other important enterprises with distinct cultures.

If you could add a new chapter to your book, *Molecular Biology of the Cell*, what would it be about?

It would be great to have a chapter about *what we don't know*. Often the public read that we have sequenced every human gene, but most never hear about what we do not understand about those genes. We fail to emphasise enough to funders how little we know and how important it is to solve the large number of present mysteries.

What drew you to science in the first place?

My favourite class in high school was chemistry, and I thought I could use chemistry and be a doctor – at the time I didn't know it was possible to be a professional scientist. As a pre-med at Harvard, we had to take a lot of science courses: the course laboratories were basically like cooking, and after two years of such labs, I asked to drop the practical part of my physical chemistry course. As an alternative I was invited to join a research lab. But in those days they didn't tell you about that possibility until you asked! This was a great experience for me – finally discovering how science gets done – and I decided to follow a path in research. I am a big advocate for two things: getting rid of all those "cooking classes", and giving every first year college student the opportunity to work in a research lab. We are losing a lot of potential scientists because they think science is boring – it's not!

Fundraising dimensions

EMBL's Heidelberg site hosts the inaugural European Conference of Life Science Funders and Foundations BY CAROLINE HADLEY

In this 'Century of the Life Sciences', researchers are increasingly supported by governments, funders and private citizens to address some of humankind's most pressing challenges: preventing famine, mitigating global warming, protecting biodiversity, sourcing safe and renewable energy and meeting the biomedical needs of an ageing population.

The inaugural European Conference of Life Science Funders and Foundations, which took place in April, included talks from Leroy Hood, Tim Hunt and Mark Walport, and brought together life science researchers with representatives from business, foundations and research funding across Europe. The programme covered not only how research is changing, but also how funding is adapting in response – and what needs to change for Europe to remain competitive.

The scale and complexity of these challenges demands a long-term view, and participants at the event heard a wide range of perspectives on the issue. Delegates at the conference discussed emerging schemes and explored how new models of financial support – underpinned by entrepreneurship, philanthropy and private investment – could be used to greatest advantage, transforming discoveries into meaningful applications.

Marc Zabeau: Europe needs more entrepreneurship

PHOTO: EMBL

"In Europe, we have great ideas and excellent scientists," says EMBL alumnus Marc Zabeau, who moderated a session of experts from venture capital and investment firms on 'Coping with complexity and keeping European biotech competitive'. "But we're missing the financial strength that the US ecosystem has. We're also short on entrepreneurship.

"You need an ecosystem to build a biotech industry, and this takes more than one generation," continues Zabeau. "You need a critical mass of talent with young graduates who are excited in this field, you need entrepreneurs, and you need to learn from success stories."

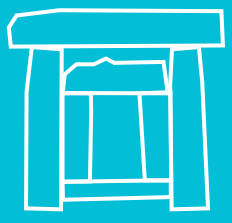
Private investment and innovation can be risky – something that Zabeau has experienced first-hand. Within five years of leaving his position as an EMBL group leader in Cell Biology & Biophysics (1978–1983), he had built his own biotech services company. He soon realised that interest in his products did not match people's willingness to pay for them, and the company went bankrupt. "I didn't see this as a failure," Zabeau says. "You have to make this kind of mistake once in your life to understand what entrepreneurship is all about."

Serial entrepreneur

Rather than letting it stop him, Zabeau's experience pushed him to become a serial entrepreneur. In 2012, he founded Qbic, a venture capital fund that aims to transform technological discoveries in universities and research institutes into sustainable business – and he is optimistic European science can rise to funding and investment challenges. "The future is bright," he says. "The generation of my kids is more entrepreneurial than their parents. There are now more opportunities at universities. The number of companies created by young people now is amazing. Hence, I believe we can be competitive with the rest of the world."

Maltese science: From Stone Age temples to the Maltese genome

As we welcome Malta as EMBL's most recent member state, Maltese science writer Edward Duca looks back at the nation's rich history of scientific contributions



Science and research holds an important place in Maltese history. In the early 20th century, archeologist Sir Temi Zammit unearthed the remains of a hypogeum as well as megalithic temples, amongst the oldest freestanding structures on Earth – and now **UNESCO World Heritage Sites**.

But this just scratches the surface of Zammit's contributions. A polymath who was rector of the University of Malta, Zammit also discovered the cause of Malta fever (*Brucellosis melitensis*), a disease that had afflicted the Island's population and the British Navy. A few decades later, Censu Tabone, who would go on to be Malta's president, led the efforts that eliminated **trachoma** – a common disease that can lead to blindness – from the Maltese island of Gozo, and campaigned for its treatment in Taiwan, Indonesia and Iraq.

When Malta joined the EU in 2004, large-scale competitive funds became accessible to the nation's scientists, transforming the country's research landscape. In the twelve years since, the number of **research publications** by scientists based in Malta **quadrupled**. Even Zammit's work is being upgraded. In an EU-Funded project to study the fragility and sustainability of Malta's environment, geologists and archeologists are trying to figure out why the Temple people mysteriously disappeared around 2500 BC.

Biologists have also contributed to the knowledge of the country's history, with the recent discovery that the Maltese population originates from 12th century Sicily. The finding, which settles a long-standing debate, stems from

the ambitious **Maltese Genome Project**, which aims to sequence the DNA of 4,000 Maltese people. The reference genome from the project will be used in numerous biomedical studies, from cancer to heart attacks.

Maltese scientists are not only analysing the population's genes but also their brains. The newly established **Malta Neuroscience Network** covers research including whether specific nutrients in the Mediterranean diet can mitigate Alzheimer's disease, how marijuana could be used to treat epilepsy, using fruit flies to test new therapies for spinal muscular atrophy, and more.

The work underscores an exciting future for Maltese science, with its ties to the life science research community in Europe further strengthened by becoming a member state of EMBL and EMBO.

From potential to policy

Integrated initiatives, creative collaboration and open objectives topped the agenda as EMBL and EMBO hosted a visit from Carlos Moedas, European Commissioner for Research, Science and Innovation in April. We spoke to Commissioner Moedas to find out more

BY ADAM GRISTWOOD

PHOTO: EUROPEAN COMMISSION

What were your main goals during your visit of EMBL and EMBO?

The meeting in Heidelberg was a great chance to discuss some of the many common goals of the European Commission, EMBO and EMBL – I feel that the Commission should always be involved in discussions on the molecular life sciences at the European level. I also wanted to show support for both EMBL and EMBO signing the San Francisco Declaration on Research Assessment (DORA), and highlight our viewpoint that, although the Impact Factor is an easy and well-known indicator of research performance, others should also be considered, which is why we have set up an expert group on Alternative Metrics.

This visit was also the ideal platform to discuss progress, successes and areas for potential improvement for the newly-signed EC-EMBL Work Plan 2016-2017; this outlines common objectives in areas such as research infrastructures and e-infrastructures, personalised medicine, research data sharing, mobility and training of excellent researchers.

I was also interested in engaging in active discussion on how we could work together to fulfil the common goals of open science and open innovation.

How might the scientific community work more effectively on such issues?

In our Horizon 2020 projects, open access to results and publications is already the norm and we have been running a pilot initiative on open research data generated by Horizon 2020 projects. But policies are not enough and, to gain leadership, we must also invest in the necessary infrastructure. For Europe's 1.7 million researchers and 70 million science and technology professionals, we will create a new European Open Science Cloud: a virtual environment to store, share and re-use their data across disciplines and borders. Researchers and innovators will be able to access and re-use data, while reducing the cost of data storage and high-performance analysis.

We have the full support of the European Member States on this: in late May, the Competitiveness Council adopted the concusions of the European Council on "Open, data-intensive and networked research as a driver for faster and wider innovation" which states that Member States "look forward to the possible development of action plans or strategies for open science". Member States have also expressed interest in the development of a European Open Science Agenda.

We need to work together to make sure that open science develops in the right way to make the EU more competitive and maintain excellence in science. This requires the involvement of all key stakeholders involved, including publishers, research performing organisations, research funding organisations, and businesses, and will imply a review of how science is evaluated, the creation of new research funding mechanisms and alternative ways of publishing.

FULL INTERVIEW ONLINE:
NEWS.EMBL.DE /?p=7416

The pheromones behind romance

Takefumi Kikusui, a researcher from Azabu University, Japan, visited EMBL in Monterotondo to understand the molecular basis of our sense of connection

BY ISABELLE KLING

From finding an ideal partner to the curious relationship we share with our canine friends, bonding behaviour is guided by some very complex – some might say "unromantic" – biochemistry. Takefumi Kikusui, from the School of Veterinary Medicine, Azabu University, Japan, is hoping the inspiring environment of EMBL Monterotondo, just a stone's throw from romantic Rome, could help him in his quest to explore the hormones and pheromones that interact with the 'social brains' of animals – including humans – and affect behaviour.

Kikusui spent 10 days this March in the Gross lab at EMBL exploring the neural mechanisms of social behaviour

PHOTO: CORNELIUS GROSS

Kikusui was invited by EMBL's Cornelius Gross, a neurobiologist who focuses on fear and anxiety, to mobilise the chemistry between their fields of research, which both seek to understand why we do what we do. We caught up with Kikusui to find out more.

What are your research interests?

I am a behavioural neurobiologist with a specific focus on what we call the 'social brain' and the neural processes that control bonding in different ways. I am also interested in how these behaviours change depending on the environment in which one grows up. Oxytocin, for example, seems to work very similarly between mice and humans to foster social interactions. Its level rises in both mothers and their pups when they are together; this is very similar to what we observe when dogs and their human masters look at each other. However its reputation as the "cuddle hormone" is a huge over-simplification: its effects are very complex and we need to study them more. Another example are the stress hormones called glucocorticoids: pups separated from their mothers early in life secrete such hormones, and tend to show more fearful and aggressive behaviour later in life. Interestingly, the same seems to be true in humans where children exposed to psychological or physical abuse are themselves more abusing and violent in adulthood. Understanding these mechanisms could have medical implications.

What is your impression of EMBL?

It is my second visit to EMBL's campus in Monterotondo: coming back now is very interesting to see firsthand how Cornelius's lab and his research have moved forward, but also to get another taste of the fantastic Italian coffee. Last time I came was also during the football World Cup and Italy had qualified. There was a great atmosphere and the football fan in me was obviously enthusiastic!

Are you formally collaborating with EMBL already?

Not yet, but one of the postdocs in Cornelius' lab is starting to use a behavioral test we developed and we will be collaborating to carry out the study. I would also be interested to host researchers from EMBL in my lab in Japan for several months to help us set up the equipment and the procedures necessary to work with transgenic mice.

FULL STORY ONLINE:
NEWS.EMBL.DE/science/1605-kikusui

PHOTO: HEIDELBERG CEMENT

Teachers and teacher trainers visited a quarry as part of an EMBL LearningLAB

Bioinformatics with a bang

Unexpected adventures at EMBL LearningLAB focused on biodiversity

BY ADAM GRISTWOOD

"You might want to cover your ears," smiles Philipp Gebhardt, head of EMBL's European Learning Laboratory for the Life Sciences (ELLS), looking out over the meadows that roll up to the rocky cliff face of Nußloch Quarry in the distance. Two dozen schoolteachers and teacher trainers are stood behind a safety barrier, here as part of a LearningLAB focussed on bringing bioinformatics into the classroom. It is an unlikely location for a lesson in computer science, and the group has carefully collected plant samples for analysis in the teaching labs at EMBL's Heidelberg site 12 kilometers away. But before that there is a surprise in store.

Suddenly, a loud explosion rings out across the quarry, sending tonnes of sediment tumbling to the foot of the mine. It's an intimidating sight: plumes of dust are thrown into the air and a brigade of diggers wait impatiently to snap up the haul, which will be used by building materials company HeidelbergCement. But while quarries are destructive by reputation, when carefully managed and restored they provide important habitats for a wide range of flora and fauna – including rare birds, amphibians and plants such as wild orchids. Participants are here to learn how modern molecular methods can be used to study this rich biodiversity.

Real insights

"Our goal is to provide training for accessible, hands-on lessons that convey the excitement of real science," says Gebhardt. In the training lab, teachers adorn lab coats and start getting to grips with an array of pipettes, solutions, centrifuges, water baths and rubber gloves. Under the guidance of EMBL scientists and ELLS educators, they extract DNA from samples, amplify the barcode regions using the polymerase chain reaction and prepare them for sequencing.

"It's challenging, but there has been lots of support from experts," says Niti Dhingra, a secondary school biology teacher from Berlin, pleased with her progression during the three-day LearningLAB. When the sequences are returned the following day, the group analyses and compares the data from their samples, making use of EMBL-EBI's European Nucleotide Archive, to evaluate the diversity of plants collected. "Each course is supported by specialised education resources developed by the ELLS team," explains Eva Haas, an ELLS education officer. "We want to inspire teachers by providing a direct connection between classroom exercises and science in practice."

Modernising methods

The course is packed out with seminars, lab tours and social activities, and is part of a wider programme that delivers several courses each year, with the ultimate goal of modernising science teaching. "We can immediately pass on what we have learnt," says Marinke van der Velde of the Institute for Teacher Training in Rotterdam as the LearningLAB reaches its conclusion, the bioinformatics analysis of the DNA barcodes underscoring the high diversity of plant life in the quarry environment. "It's one of the best courses I have been on," she adds.

Pathways
Community management

Scientific community manager and EMBL alumnus Aidan Budd explains the challenges and rewards of bringing together researchers with shared interests, values and goals

PHOTO: COURTESY OF AIDAN BUDD

Senior Project Manager Aidan Budd said farewell to EMBL in June with a scientific speed-dating event that reflected the mission of his role: to bring together people.

I look back at photographs from nearly 20 years ago and I barely recognise myself – and not just because the hair on my head now sprouts out of my chin! I was somewhat shy when I joined EMBL in Heidelberg as a summer student in 1998. But while my network was small, I found EMBL and the science happening on site incredible. I was hooked.

I returned to EMBL to do my PhD in Toby Gibson's group, and after trying my hand as a commissioning editor I returned for a second time to work on training, service and research initiatives in bioinformatics. The role required substantial networking with colleagues from many different fields. And the more I networked, the more I discovered I love community-focused work. These experiences provided a bridge to my ultimate role at EMBL, as a project manager focused on scientific community building.

Community management

Communities come in all shapes and sizes, but one common goal of scientific community managers is to help people with shared interests, values and goals find ideas for collaboration – and then make it as easy as possible to put these ideas into practice together.

EMBL has a very special culture of collaboration – there is great openness and many opportunities for interaction between people and teams. The first major community initiative I worked on was the Bio-IT Project at EMBL's Heidelberg site, supporting EMBL staff working with computers to analyse biological data. This involved developing an interactive web platform, training events, surveys, meetings, and more. I have also helped build other communities in and beyond EMBL, including a long-running series of events called the Heidelberg Unseminars in Bioinformatics (HUB) and unconference sessions and collaborations at various conferences and other events.

Most of the projects I have worked on are mainly driven by the work of volunteers. For example, HUB turns the standard meeting format on its head, uniting people from many different disciplines for participant-driven workshops. Identifying people who want to get involved lies at the heart of community-building work.

People person

My expertise in community building has been largely self-taught, and it has been a steep learning curve at times – something unexpected can happen at any moment, and it often does! One challenge comes in balancing the desire to make exciting things happen quickly with more strategic long-term objectives. But if you like working with people and are well organised you could be well suited to a community management role. I have connected with truly inspiring colleagues, many who have become friends, built valuable and enjoyable professional relationships, and am happy to work in a role that my younger-self might not have dared imagine.

Awards & honours

EMBL scientists were awarded the 2016 Felix Burda Award

PHOTO: © FELIX BURDA STIFTUNG

Sharing the stage with government ministers, business and TV personalities, EMBL scientists **Peer Bork, Georg Zeller, Anita Voigt** and **Jessica Oberheim** collected the Felix Burda Award 2016 recently for their contribution to the field of colorectal cancer screening. A trophy and 5 000 Euro prize is awarded annually at a gala event that also rewards workplace initiatives and awareness raising campaigns in the fight against colorectal cancer. The team was recognised for their innovative work in identifying gut bacteria constellations that serve as warning signs for colon cancer.

Darren Gilmour and **Jan Korbel**, Group leaders at EMBL Heidelberg, have been named in EMBO's list of new members, elected in recognition of their contributions to scientific excellence. In total, EMBO membership now comprises more than 1700 of the best researchers in Europe and around the world, whose input has helped to promote excellence in life sciences since 1964. With emphasis always on scientific merit, EMBO Members apply their expertise and insight to guide the execution of the EMBO initiatives and collectively serve the research community.

Group leader **Christian Häring** has been awarded a prestigious 2 milion Euro Consolidator Grant from the European Research Council to reveal the elusive mechanisms behind the functions of the condensin protein complex. Condensin plays a fundamental role in changes in the structure of chromosomes, but its mechanisms are not currently understood. By combining structural biology with biochemical and cell biological methods, Häring seeks to change that. He aims to unravel how condensin coordinates with DNA to influence chromosome architecture, which could shed light on how genomic integrity is affected in various diseases.

EMBL Director **Matthias Hentze** has been elected as a Corresponding Member of the Australian Academy of Science in recognition of his pioneering RNA research. The Academy is a not-for-profit organisation of individuals elected for their outstanding contributions to science and research. Corresponding members are a special category within the Academy's Fellowship that comprises eminent international scientists with strong ties to Australia.

The Miklós Bodanszky Award, presented in commemoration of the chemist's outstanding contributions to peptide science, was this year awarded to group leader **Maja Köhn**. The award acknowledges scientists who make significant contributions to peptide-based drug research within 10 years of obtaining their PhD degree. Maja Köhn is recognised for her critical contributions to the design of peptides targeting protein phosphatases that are involved in diseases such as cancer and diabetes.

EMBL Director-General **Iain Mattaj** has been elected as a Fellow of the Academy of Medical Sciences. The Academy of Medical Sciences is an independent organisation that campaigns to ensure advances in medical science are translated into benefits for patients – its Fellows represent the UK's leading medical scientists. Iain Mattaj was elected alongside more than 40 new fellows in recognition of contributions to medical research and healthcare, the generation of new knowledge in medical sciences and its translation into benefits to society.

Kjetil Taskén, Director of the Centre for Molecular Medicine Norway (NCMM) and recently renewed as speaker of the Nordic EMBL Partnership for Molecular Medicine, has received the King Olav V's Cancer Research Prize. Awarded by the Norwegian Cancer Society, the 1 million NOK (105 000 Euro) prize is presented annually to researchers who have advanced Norwegian cancer research. Taskén is recognised for his "major contribution to the understanding of immuno-oncology, work that will become even more relevant in the development of next-generation immunotherapy".

Alumni

Alumni in action

This edition highlights ways in which alumni volunteers support EMBL and the life science community worldwide as speakers, moderators, mentors and teachers. The success of the EMBL alumni programme relies on the voluntary work of alumni as advisors, advocates, event organisers, speakers, participants, collaborators, facilitators and Alumni Association board members. To see how you can get involved, visit: embl.org/alumni/makeadifference.

Mehrnoosh Rayner
Head of Alumni Relations

PHOTO: EMBL

Science: a training ground for entrepreneurs

Abel Ureta-Vidal

Then: Project leader EMBL-EBI (2001–07)
Now: Co-founder, Eagle Genomics

PHOTO: ROBERT SLOWLEY

"The skills you develop as a scientist – patience, persistence and resilience in the face of setbacks and failures – are fundamental to entrepreneurship," says Abel Ureta-Vidal, co-founder of Eagle Genomics

"My aim was to join a big company for a change of scene, but I ended up starting my own," says Ureta-Vidal, who moved on from EMBL-EBI to industry by way of the Judge Business School at the University of Cambridge.

"Starting your own business is about mindset: believing you can do it, seeing it like a job and jumping into it. When I started I knew nothing about business. I'd done my PhD and worked in bioinformatics, a trendy field, but I didn't have the tools to start a company."

Location, location, location

Location played no small part in Ureta-Vidal's career change. "Here in Cambridge, you can do both academic and commercial research, and you get a lot of exposure to entrepreneurs, start-ups, role models," he says. "That is so valuable – if you don't have this kind of environment, you won't see the possibilities that may be open to you."

Ureta-Vidal worked on the Ensembl genomic data resource for six years before acting as a consultant. He then joined forces with Eagle Genomics co-founder Will Spooner and grew the company from there. Eagle Genomics brings profound domain knowledge to big-data projects, not just solving problems for companies by creating technologies to prepare data for machine-learning, but empowering them to find their own way. "We work on the premise that our clients are not looking for a drill, but they're trying to make a hole," he explains. "They don't want to 'do big data,' or machine learning, but they want to reposition drugs, or identify the neutral microbiome so they can create a winning product."

Hard graft pays off

Collaborations between start-ups and academia can be tricky because the legal environment is complex, but there is a lot to be gained from informal interactions, says Ureta-Vidal whose company moved to the

Making business in Britain

More than 70 UK-resident alumni and their networks connected on 23 May at Cambridge University's Trinity Hall College, where inspiring projects were presented by a cross-section of EMBL alumni speakers. We caught up with two of them to find out more.

BY MARY TODD BERGMAN

Wellcome Genome Campus this summer.

"You shouldn't worry too much about giving your ideas away," he says. "There is so much more to making something profitable – you should worry more about whether you're up for a lot of hard work, and learning some very hard lessons about risk, collaborations and IP." Ureta-Vidal believes all scientists should receive basic business education and gain hands on experience. His top advice to budding entrepreneurs? "Start earlier than I did, when it's not so hard to take risks, and don't ever get too comfortable. You've got to prepare for the next step."

So what's the next step for Ureta-Vidal? "After eight years, I am looking into new possibilities," he smiles. "I'm finally able to step back and watch the company function on its own. That is something I'm really proud of."

Connecting ideas and discovery

PHOTO: ROBERT SLOWLEY

Louise Modis

Then: EMBL PhD student (1995–9)
Now: Scientific Director, Immunology Network, GSK

EMBL alumna Louise Modis is a driving force in GSK's Immunology Network, a fresh take on commercial-academic collaboration.

"Bridging the gap between ideas and discovery is what we're trying to do, and that takes challenging one another more," says Modis, whose experience as an EMBL PhD student brought home the importance of defending questions rigorously. "We can't do it without an interdisciplinary community because there's only so much any one of us can know."

Creative communities

Modis is actively involved in the GSK Immunology Network, which provides a new way for researchers working in companies and academic settings to collaborate.

"After leaving EMBL I assumed I'd only be able to find the kind of collaborative, questioning environment I'd enjoyed so much at EMBL at an academic institute. But I have found such an environment throughout my experience in the sector – first at Millennium Pharmaceuticals, then at Boehringer Ingelheim Pharmaceuticals, and now at GSK," she says.

At the May 2016 EMBL Alumni event in Cambridge, Modis stressed the importance of gaining experience in both commercial and academic sectors. For example, the Immunology Network features a sabbatical programme (the Immunology Catalyst) at GSK where researchers with big ideas can spend a percentage of their time, benefiting from GSK's science, resources and technologies to pursue interesting questions in ways they couldn't easily achieve in their academic labs.

"Being co-located makes a huge difference because it's so much easier for people to keep asking each other tough questions, which makes the research better," says Modis. "At EMBL it was easy to ask, 'Why not?' We were working together constantly in this creative and collaborative environment, and it was taken as read that we were working towards a common goal."

Making a difference

Industry needs more 'constructive disruptors', says Modis, to achieve breakthroughs. "The immunology network is pre-competitive, and provides a way for researchers with very different styles and approaches to work on innovative ideas in the same physical space," she adds. "That's how we're going to achieve breakthroughs that lead to better-designed medicines, and solutions that make a difference in people's lives."

Italian interconnections

Rome was the destination for 80 alumni and people from their networks to participate in an 'EMBL in Italy' event on 27 May to learn about the focus of researchers at EMBL's Monterotondo site. The event brought participants together to share their research directions and spread the word about EMBL's opportunities and resources.

EMBL's early excitement

Marco Tripodi

Then: EMBL Postdoc (1981–4)
Cortese group, Heidelberg
Now: Professor, La Sapienza University, Rome

PHOTO: EMBL/ISABELLE KLING

EMBL was already an exciting place in the early 80s: both the institute and the gene expression programme were very young, powered by a small but vibrant community of around 200 scientists. We all had the feeling of being part of something new and exciting, which would allow us to open new 'boxes' of knowledge without the pressure to deliver specific applications.

Breaking boundaries

Strong in my memory are "wow!" conferences covering the discovery of the first oncogenes, as well as Walter Gehring's landmark talk on *Antennapedia*. This spirit of going beyond current knowledge and always preparing for the next steps has shaped my approach to science. During my EMBL years, I studied transcription mediated by polymerase 2 and 3, mostly in liver cells. Like most alumni, I specialised after leaving EMBL – but I also kept one eye on the 'bigger picture'. I still work on the same tissue, but new technologies and 'big data' are allowing us to dig much deeper into the complexity of the processes.

Next-generation scientists

Many of the talks at the event were focused on networks of molecules: I find this topic absolutely fascinating! As a professor, I want to convey this fascination for learning to my students and in turn make a strong contribution to training the next generation of motivated young scientists.

Postdoc: platform for success

Valeria Carola

Then: EMBL Postdoc (2003–9)
Gross group, Monterotondo
Now: Team leader, Santa Lucia Foundation, Rome

PHOTO: EMBL/ISABELLE KLING

Five years as a postdoc in Cornelius Gross' group have proven crucial to my career as a researcher. They were also extremely enjoyable from a personal perspective: EMBL really is a place that cares for its staff and where you are certain to meet great people.

Creative connections

Before my postdoc, my research focus was on behaviour and I used very little molecular biology. Studying gene expression and its links to the environment with Cornelius Gross allowed me to bridge that gap and make contributions to understanding the connections between experiences animals have as youngsters and their behaviour later in life. Cornelius is a great inspiration and a very important colleague.

Bringing light to behaviour

My current work focuses on the impact of the environment on young animals and the onset of mental health disorders later in their lives. We proved that mice pups who grow up in an aggressive environment tend to be more prone to cocaine addiction as adults; on the other hand, pups who grow alone, with little social interactions, tend to be more prone to depression in their adulthood. In both cases we are able to link the behaviours to specific gene expression patterns, and that could give us clues to understanding similar patterns in humans.

Angela Relogio at the event together with Matyas Gorjanacz, group leader at Bayer

EMBL/MEHRNOOSH RAYNER

Taking science to new dimensions

Angela Relogio was one of 15 former EMBLers who participated at the Max Delbrück Center (MDC) Career Day in Berlin, representing the EMBL alumni community as speaker and advocate at the EMBL careers stand. Here she tells us about her passion for science, communication and mentoring

BY CAROLINE HADLEY

"There is a certain thrill about doing science which is contagious, communicable – one gets it and passes it on." For EMBL alumna Angela Relogio, embarking on groundbreaking research is not enough. She is passionate about sharing her knowledge by teaching, mentoring and encouraging others. Originally from Portugal, Relogio joined EMBL's International PhD Programme in 1999. After completing her PhD and a postdoc, she moved to Berlin's Humboldt University to become a research scientist at the Institute for Theoretical Biology. Relogio then moved to the Charité Medical University in Berlin, where she has been a research group leader in the Molecular Cancer Research Centre since 2014.

When leaving EMBL in Heidelberg, Relogio took with her what she calls "the EMBL spirit." "The EMBL spirit embodies an incredible thirst for knowledge and an infinite curiosity," she explains. This feeds not only her ongoing activities with the EMBL alumni programme, but also her research, studying the mammalian circadian clock and its role in cancer. But in addition to running her lab, Relogio is active in promoting, communicating and teaching science to students of all ages. "I want to lift the 'curtain of mystery' that surrounds scientific work, and encourage young girls in particular to get involved," she explains. "At almost all stages of a scientific career, one can be of great support to other scientists or scientists-to-be."

Relogio also applies her diverse experiences to mentoring others. "I advise and discuss problems and uncertainties with colleagues that I also experienced at the same career stage," she says. "Honesty is crucial: most scientists have had misunderstandings with supervisors, grants that failed, experiments that didn't work, and papers that just couldn't get accepted. It is important to talk with others who have also gone through the same situations and to realise that there are many ways to be successful in science."

But it's not just science that moves Relogio to inspire others: away from the lab, she is a qualified diving instructor, practices karate and runs half-marathons – all while raising a young family. "It's quite an adventure, but achievable ... using some imagination!"

PHOTO: UNIVERSITY OF HEIDELBERG

Alumni Profile Swimming

Give EMBL alumnus Jochen Wittbrodt ten minutes of your time, and he'll convince you just how much biologists have to gain from embracing the impossible, pursuing outlandish ideas, and living on the edge

BY SONIA FURTADO NEVES

Wittbrodt clashed with the impossible in his very first position as group leader, at the Max Planck Institute for Biophysical Chemistry in Göttingen. He decided to run genetic screens on Medaka fish. In a genetic screen, scientists introduce mutations into an organism's genes, and systematically look at the effects of those mutations on aspects like physical traits, physiology and behaviour. This is a laborious process – and was even more so back in the early 1990s, when gene sequencing was in its infancy – so the labs carrying out such studies tended to rely on a large workforce, and focus on established model organisms such as zebrafish. So Wittbrodt's proposal to tackle a species for which no-one had yet developed specific tools, with a lab of 6 people, was met with scepticism. "But we just did it, and it worked," he chuckles.

Birth of SPIM

A decade later, he had set up a lab at EMBL, and a presentation at a conference sparked another daring idea. "Pete Curry was showing an image of a whole fish in 3D imaged by a new method called OPT," he recalls. "When I came back to Heidelberg,

against the tide

I met Ernst Stelzer in the EMBL cafeteria, and I said: 'We need that, but we need it in live fish!'" Wittbrodt eventually convinced Stelzer to put a student on the job, and single-plane illumination microscopy (SPIM) was born. The basic idea of SPIM sounded like science fiction, says Wittbrodt: having a living organism under the microscope, shining a sheet of light on one layer of cells at a time, and putting that information back together to get a picture of the whole animal. The technique enabled Wittbrodt's lab to see a fish embryo's beating heart, and to trace its optic nerve from eye to brain. But he saw an opportunity to probe deeper – another 'wild idea': tracking each cell in an embryo, as they divide and move throughout the first day of its life. "Textbooks said you couldn't do this in a vertebrate," he says, "until Philipp Keller, who was then a PhD student in the Stelzer group, developed Digital Scanned Laser Light Sheet Microscopy (DSLM), and we saw how long we could image embryos for – and then we went for it!" The result, which they dubbed the Digital Embryo, earned them recognition from *Science* as one of the breakthroughs of the year for 2008.

Since leaving EMBL, Wittbrodt has continued to work on further developments to the technology, collaborating with Lars Hufnagel in particular. He has another wild idea up his sleeve. "You'd have the fish swimming freely, and passing through a laser scanner, being imaged as it goes." Such a naturalistic setting would allow scientists to probe questions that are currently out of bounds, but so far, this particular idea has proven too 'sci-fi' for even Wittbrodt to get anyone to bite on.

How does he keep up his own drive in such situations, and keep swimming against the current? "Some people see the problems along the way, but forget what we're aiming at. I think I can worry about a problem, but if I have an aim, I'll find a solution, a way around it," he replies.

Radical vision

Fostering and developing this type of unconventional approach is something that Wittbrodt has built into the workings of his lab at the University of Heidelberg. "I always give some 'crazy vision' talk once a year, at one of our lab meetings," he says. One of the ideas he presented at this year's talk was a new way to probe what conditions stem cells need in order to grow. His vision: to print an unconventional 3D scanner. "This scanner would not be a scanner in the sense that it scans your material; instead, your material – in our case stem cells – would scan the scanner," he explains. The idea would be to use 3D printing technology to create a habitat for cells; hundreds of thousands of alcoves with different properties – some spongier, some harder, some with one type of food, others with another... Wittbrodt and colleagues would place their stem cells on this habitat, and let the cells choose their niche. "And we could just read out the properties and know what the stem cell needs," he says, noting that he already has engineers, chemists and physicists, as well as specialists in 3D printing, on board.

Biologists have to be conversant in other fields in order to dream up – and implement – these approaches, he emphasises. "Specialisation gives you more details, and will keep some people happy," he concedes. "But there are others who like to maybe bridge the boundaries and live in the interface, and try to get new ideas at the edges – this is much more the way I see myself. I wouldn't say that I'm a zoologist, or a geneticist, or a cell biologist; I need a little bit of everything."

To anyone who feels similarly, and has an 'impossible' idea that just might work, he says: "follow your heart; trust your gut!"

"If I have an aim, I'll find a solution"

PHOTO: MARIA ESTEBAN MASFERRER/SENTHILKUMAR DEIVASIGAMANI

Fun in the sun at a summer party in Monterotondo

EMBL in pictures

Snapshots of life at EMBL this Summer

Behind the scenes at this year's Lab Day in Heidelberg on 21 July

PHOTO: TOBY GIBSON

Staff band La Brat go out with a bang in their final performance at EMBL's summer party in Heidelberg

PHOTO: EMBL/HUGO NEVES

27 former lab members joined EMBL Heidelberg's Peer Bork for a lab reunion on 24 June

PHOTO: COURTESY OF THE BORK GROUP

PHOTO: MARY TODD BERGMAN

Fun on the fairground rides at the EMBL-EBI summer spectacular

PHOTO: ANGELA NIETO

Safety first at EMBL Grenoble as delegates visit for the Summer Council Meeting. From left to right: Claudio Sunkel (ex-Chair of EMBL Council), Angela Nieto (Vice Chair of EMBL Council), Paul Nurse (Chair of the Scientific Advisory Council), Patrick Cramer (Chair of EMBL Council)

PHOTO: COURTESY OF NCT

EMBLers came out in force for the National Centre for Tumour Disease (NCT) run in July

PHOTO: MARY TODD BERGMAN

In July, EMBL-EBI welcomed a group of 45 pupils from Saarland, Germany who were visiting England to explore a new culture and learn about different career options

Events

September
10-13

Rosengarten, Mannheim
The 7th EMBO Meeting


IMAGE: EMBL/PETRA RIEDINGER

September
14-17

EMBL Heidelberg
EMBL–Wellcome Genome Campus Conference: Proteomics in Cell Biology and Disease Mechanisms

September
19-20

EMBL Heidelberg
EMBL/DFG Women in Science Network Conference: From Genes, Cells and the Immune System towards Therapies


IMAGE: EMBL/PETRA RIEDINGER

September
23

EMBL Monterotondo
EMBL Distinguished Visitor Lecture: Deciphering the physiology of hematopoiesis by fate mapping and endogenous barcoding – Hans-Reimer Rodewald, German Cancer Research Center (DKFZ)

September
25-27

EMBL Heidelberg
EMBL–Wellcome Genome Campus Conference: Big Data in Biology and Health


IMAGE: EMBL/PETRA RIEDINGER

October
13

EMBL-EBI
Open Day

November
3-4

EMBL Heidelberg
Science and Society: The Past in the Present – The Making of Memories


IMAGE: EMBL/MARIETTA SCHUPP

Upcoming meetings
Alumni

12 September: **Drinks Reception, EMBO Meeting, Mannheim**
5 October: **EMBL in Spain, CRG, Barcelona**
26 November: **EMBL in Greece, Ioannina**

VIEW THE COMPLETE LIST OF EVENTS ONLINE
EMBL.ORG/EVENTS