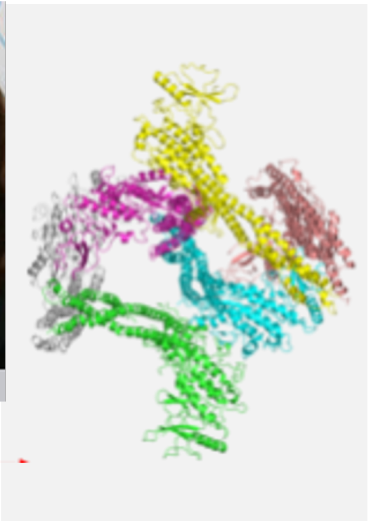
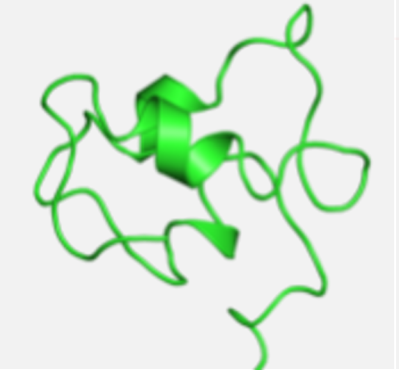
Clinical outcome: Monterotondo's mice and molecular medicine

Foteini Mourkioti, Nadia Rosenthal





1990s: EMBL's Mouse Biology Programme is founded in Monterotondo, Italy, first led by Klaus Rajewski and then by Nadia Rosenthal.

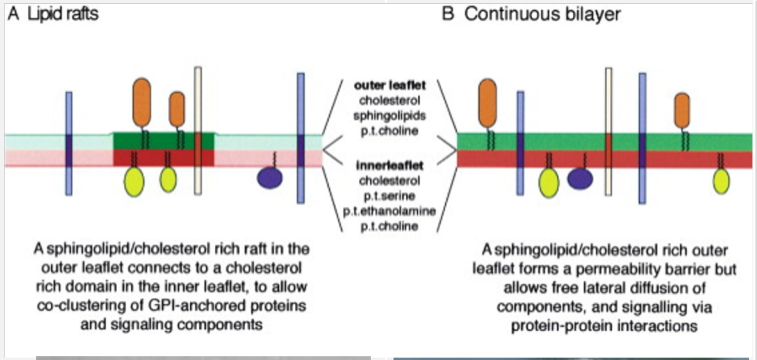
mid-2000s: Research by Rosenthal's team reveals that blocking a cellular signal protects muscle from wasting after injury and improves muscle regeneration.

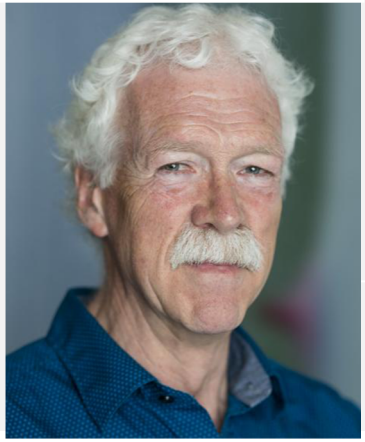
A research collaboration between Uni Heidelberg, Uni Ulm, and EMBL (Manolis Pasparakis' team) results in findings that shutting down a cellular signal can limit damage from strokes.

>10 years after the discoveries: therapies are being developed that target parts of the signaling pathway to treat stroke patients and muscle degeneration

EMBL

Clinical outcome:
The lipid “rafts” hypothesis and its biomedical applications





1988: EMBL scientists Kai Simons and Gerrit van Meer pioneer the concept of lipid “rafts” (LR).

2000s: - Research reveals LR can be entry sites for viruses, bacteria and toxins, and play a role in disease progression (HIV-1, Alzheimer’s, cancer, Hepatitis C).

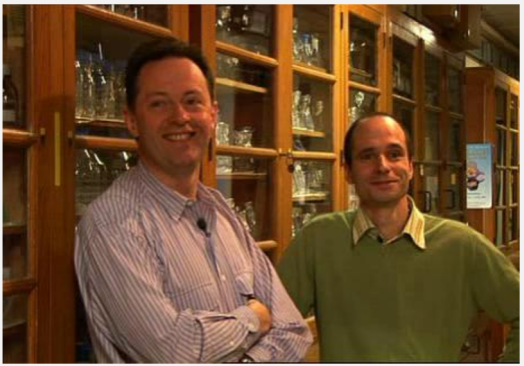
- New LR-targeted treatment strategies emerge.

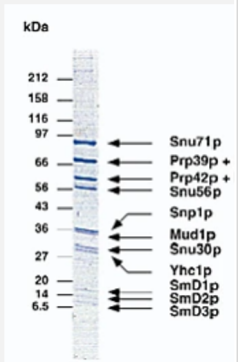
2010s – EU-funded research project Rafts4Biotech engineer bacterial lipid rafts; spin-off company Lipotype is founded by Kai Simons and Andrej Shevchenko.

>30 years after the discovery: greater understanding of virus entry, disease progression; new treatments and biopharmacological innovation

EMBL

Spin-off: Pioneering proteomics for drug discovery





cellzome
A GSK Company

1990s – The tandem affinity purification (TAP) technique is invented at EMBL by French scientists Bertrand Séraphin and Guillaume Rigaut.

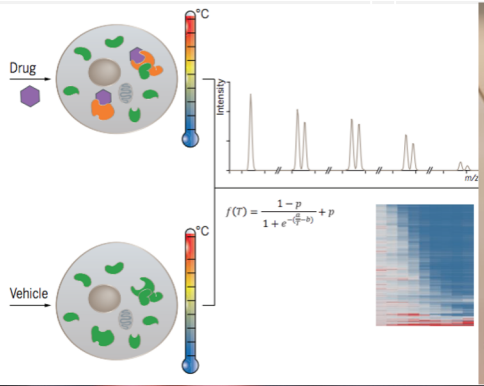
2000s – Based on TAP's success, Cellzome is founded as an EMBL spin-off. Cellzome pioneers protein purification technologies used to identify drug candidates to treat inflammatory diseases and cancer.

2010s – Cellzome is acquired by GlaxoSmithKline; it continues to develop drugs for respiratory, oncological, metabolic, cardiovascular, and infectious diseases, in continuous partnership with EMBL.

Bridging academia and industry enables cutting-edge technologies, drug research and development.

EMBL

Technological outcome:
Academia–industry symbiosis drives innovation in proteomics



2000s – Cellzome is founded as an EMBL spin-off company. Mikhail Savitski joins Cellzome.

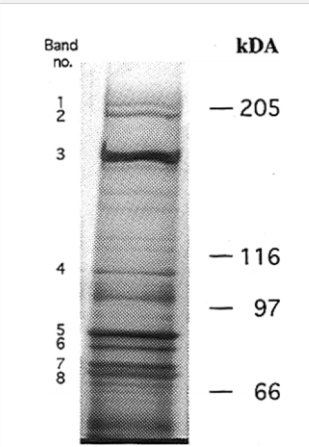
2010s – Savitski's team develops thermal proteome profiling (TPP), a technology that enables identification of drug targets on a proteome-wide scale.

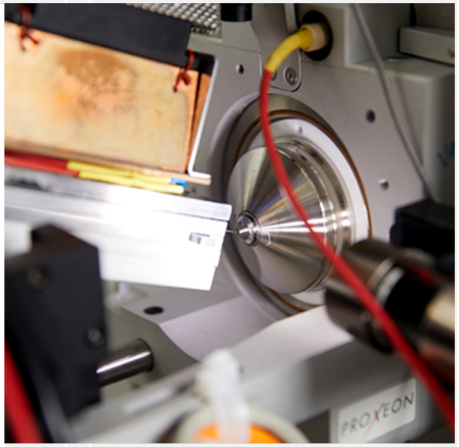
– Savitski moves to EMBL. TPP is offered as part of EMBL Proteomics Core Facility services.

6 years since development, TPP is being used to test potential COVID-19 drugs

EMBL

Creativity and collaboration at its best: Mapping proteins for disease prevention





1990s – ‘Peptide sequence tag’ and nanoelectrospray techniques are developed by Matthias Mann and Matthias Wilm. Mann’s postdoctoral student, Andrej Shevchenko, develops a silver-staining technique for nanoelectrospray sample preparation.

2000s – These techniques for rapidly mapping and identifying proteins become widely recognized and used in laboratories for research and clinical analysis.

2010s – PreOmics, a spin-off company founded by Matthias Mann based on nanoelectrospray, aids the diagnosis and prediction of human disease.

Today: Pioneering techniques enable direct work on proteins in food, pharma, and chemical industries and help clinicians better predict and diagnose illnesses.

EMBL

Educational outcome: *Science in School*
Inspiring young minds today, fostering European research tomorrow

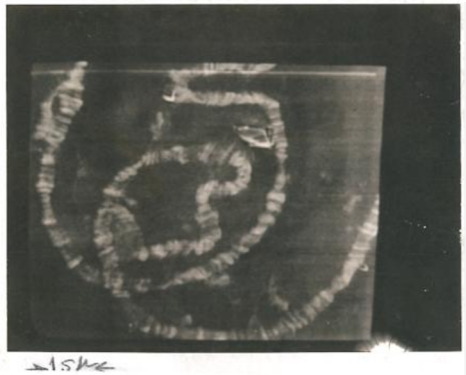
2006 – The first issue of *Science in School*, a European multidisciplinary science journal for teachers is published, first funded by the European Commission and then by EIROforum. Free print copies in English are distributed across Europe.

2010s – Thanks to volunteer translators (over 200 scientists and teachers), articles are made available in 31 European languages.

Today: *Science in School* print copies reach 5,000+ readers every quarter, and online articles attract around 80,000 readers from around the world, every month.

EMBL

Instrumentation outcome:
Inventing new ways to see – the Light Microscopy Group



1990s – EMBL scientists Stefan Hell and Ernst Stelzer develop the confocal 4Pi microscope.

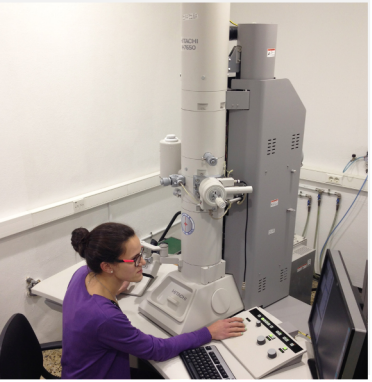
1990s to 2000s – The Light Microscopy Group at EMBL, led by Stelzer, develop and introduce various instruments and methods, patenting over ten inventions, among them light sheet fluorescence microscopy.

2010s – Improvements in microscopy allow scientists to see and study cells with more clarity, ease, and efficiency in laboratories across the world.

Today: It is possible to create super-resolution, three-dimensional images of living cells.

EMBL

Infrastructural outcomes:
Bolstering core scientific facilities in Portugal and Luxembourg



2000s to 2010s – EMBL's Advanced Light Microscopy Facility (ALMF) offers its services and training to many scientists, including postdocs Erin Tranfield and Hugo Botelho. Andreas Girod works at ALMF as a staff scientist.

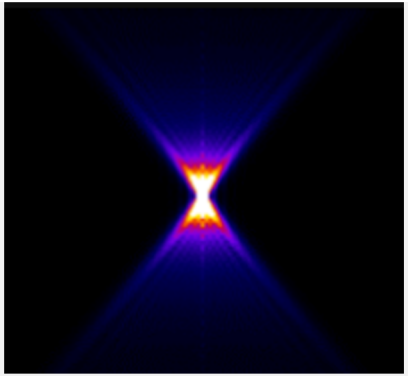
Portugal: Tranfield moves to Instituto Gulbenkian de Ciência to build its electron microscopy unit. Botelho joins BioISI/University of Lisboa and helps establish its high-throughput microscopy facility.

Luxembourg: Girod is recruited to lead the Light Microscopy Facility at the University of Luxembourg in 2012. A state-of-the-art confocal microscope is installed a couple of years later.

Today: Research institutions in Portugal and Luxembourg offer state-of-the-art microscopy facilities, services, and expertise.

EMBL

Infrastructural outcome:
Building bioimaging facilities in Portugal



1997: A few EMBL scientists explore partnerships with microscopy companies, leading to the establishment of the Advanced Light Microscopy Facility (ALMF) at EMBL.

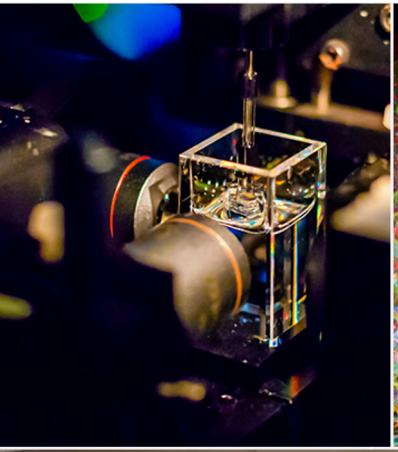
– Visiting scientist Paula Sampaio (1995-2002) is inspired during her time at EMBL to start a microscopy unit back home.
– Sampaio sets up the **Advanced Light Microscopy Facility at the Institute for Molecular and Cell Biology (IBMC)** in Porto, Portugal in 2004.

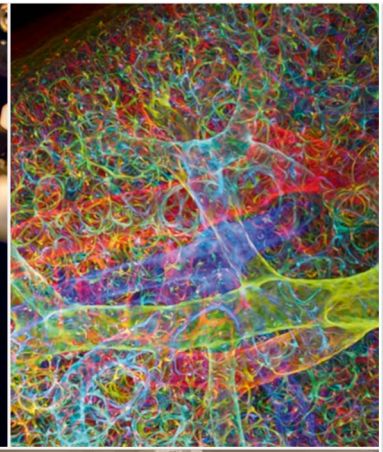
– Erin Tranfield, postdoc (2009-2013), hones her microscopy skills in the ALMF. Tranfield builds and leads the **Electron Microscopy Facility at the Instituto Gulbenkian de Ciência** in Oeiras, Portugal starting in 2013.

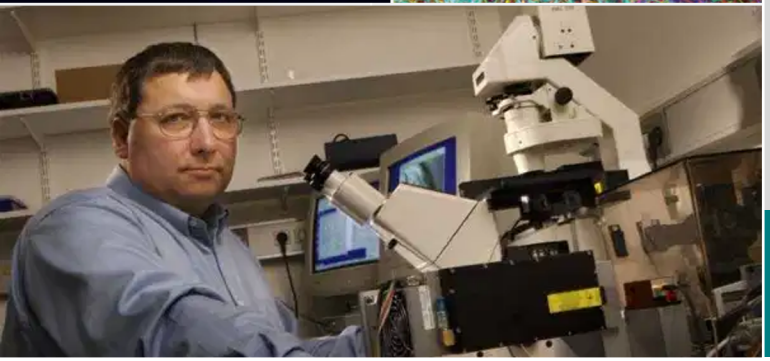
Today: State-of-the-art, open access facilities are available to the scientific community in Portugal.

EMBL

Infrastructural outcome:
Real-time, 3D imaging in Spain







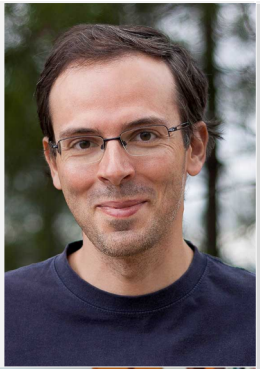
2000s – The Light Microscopy Group at EMBL, led by Ernst Stelzer, develop Selective/Single Plane Illumination Microscopy (SPIM).

2018 – The Mesoscopic Imaging Facility is set up in EMBL Barcelona to provide access to imaging technologies specifically designed for research in developmental biology and disease modeling.

Today: the Mesoscopic Imaging Facility enables 3D imaging of tissue over time.

EMBL

Infrastructural outcome:
Conducting cystic fibrosis research from home



2000s – The early phase of **ELIXIR**, a pan-European infrastructure for biological information, is coordinated by Janet Thornton at EMBL-EBI. ELIXIR is officially launched in 2013.

Euro-Bioimaging, the European infrastructure for biological and biomedical imaging, starts at EMBL with Jan Ellenberg as coordinator. It officially begins operation in 2016.

2010s – EMBL alumni Margarida Amaral and Hugo Botelho in Lisboa, Portugal use ELIXIR and Euro-Bioimaging to identify novel drug candidates for cystic fibrosis disease.

Today: Open access infrastructures, both physical and virtual, help scientists identify drug targets for cystic fibrosis.

EMBL

Infrastructural and technological outcome: From floppy disks to the Universal Protein resource (UniProt)

1980s – SWISS-PROT is created by Amos Bairoch. It soon becomes a collaborative project between the EMBL Data Library (precursor to EMBL-EBI) and the Univ. of Geneva.

1990s – TrEMBL, a computer-annotated protein sequence database is introduced in order to make new sequences available as soon as possible.

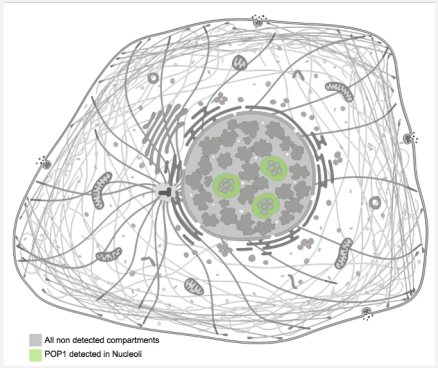
–SWISS-PROT and TrEMBL grow rapidly thanks to the work of the EBI group led by Rolf Apweiler.

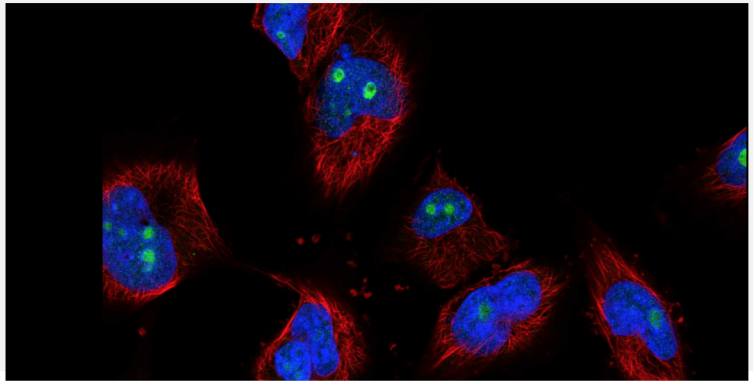
2000s – EBI, the Swiss Institute of Bioinformatics (SIB), and the Protein Information Resource (PIR) join forces as the UniProt consortium.

Today: UniProt is a foundation for biological and molecular medicine research. It can cut research time in half.

EMBL

Clinical outcome:
On the frontiers of genetic research





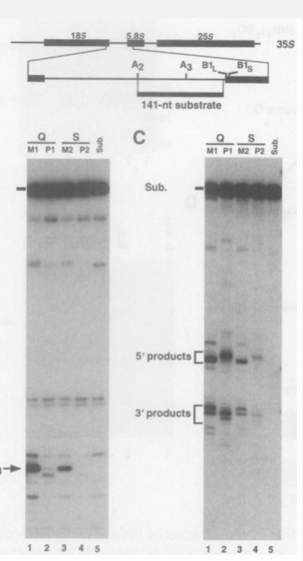
1990s – Zoi Lygerou at EMBL and Helma Pluk at Uni Nijmegen identify the first protein subunit from human RNase P and MRP RNAs, called POP1.

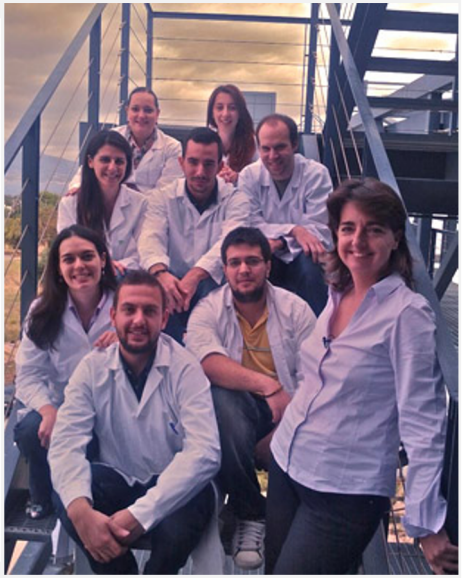
2010s – POP1 mutations are identified as the cause of a novel skeletal dysplasia. POP1 was also identified as a potential biomarker for prostate cancer.

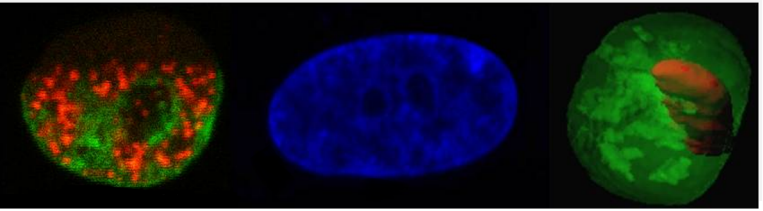
20+ years later, genetic screening and analyses can diagnose genetic growth disorders

EMBL

Infrastructural/clinical outcome:
Facilities, funding and fundamental research in Patras, Greece







1990s – Zoi Lygerou researches RNA processing and cell cycle control mechanisms at EMBL Heidelberg under Iain Mattaj and Bertrand Seraphin.

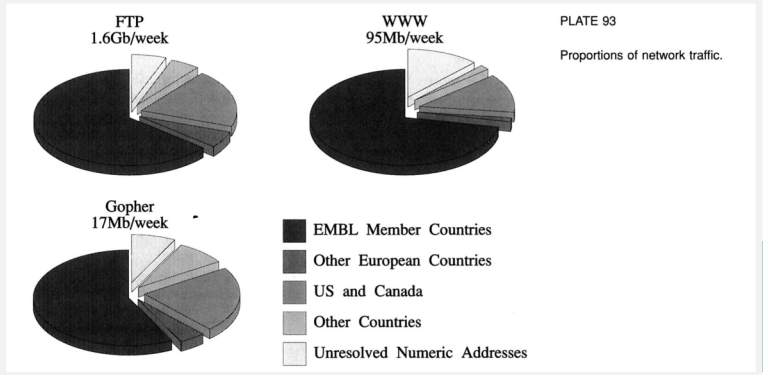
2000s – Z. Lygerou becomes a faculty member at the University of Patras School of Medicine, helps establish imaging facilities there, and later co-heads the Advanced Light Microscopy Facility at the School of Medicine.

2010s – Lygerou's group, the Cell Cycle Laboratory, receives 5-year ERC funding to research the mechanisms underlying cancer development and progression.

Today: Cutting-edge molecular & genetic research at the University of Patras enhances our understanding of cancer.

EMBL

Infrastructural outcome
EMBL: a key player in the birth of European bioinformatics



1980s – The world's first nucleotide sequence database, the EMBL Nucleotide Sequence Data Library, is established. The EMBL Biocomputing Programme is set up. SWISS-PROT is co-developed by EMBL. EMBnet is established to facilitate data communication across Europe.

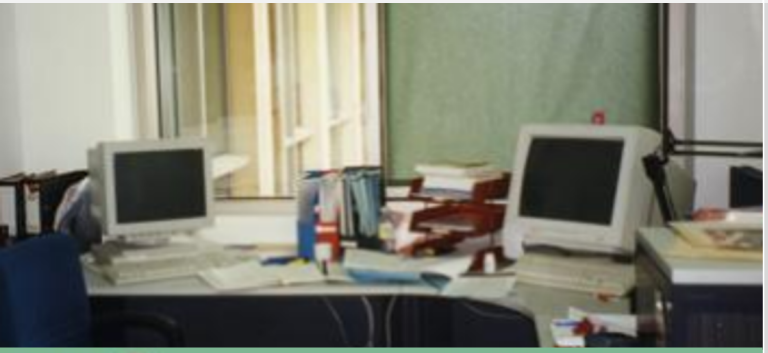
1990s – The EMBL Data Library becomes EMBL-EBI. TrEMBL, a complementary database to SWISS-PROT, is developed at EMBL.

2000s – UniProt is launched. The ChEMBL database is acquired and launched.

Today: EMBL-EBI provides free and open access to the world's most comprehensive and up-to-date biomolecular data.

EMBL

What's in your cereal?
Ensembl, cereal genomics and sustainable agriculture



e! EnsemblPlants

1980s – The world's first nucleotide sequence database, the EMBL Nucleotide Sequence Data Library, is established.

1990s – The EMBL Data Library becomes EMBL-EBI. The Ensembl genome database project is launched by EMBL-EBI and the Wellcome Trust Sanger Institute.

2000s – Ensembl incorporates genome data for non-vertebrates.

2010s – EBI and Ensembl participate in various int'l projects to capture genome sequences of major food crops.

Today: Cereal genomics helps researchers develop solutions for sustainable agriculture.

EMBL

Infrastructural outcome
SESAME: The first synchrotron in the Middle East

1975 – The EMBL site at the DESY synchrotron ring in Hamburg is established.

1980s to 1990s – Biophysicist Zehra Sayers works as a staff scientist at EMBL Hamburg using synchrotron radiation for structural studies of cytoskeletal proteins and chromatin.

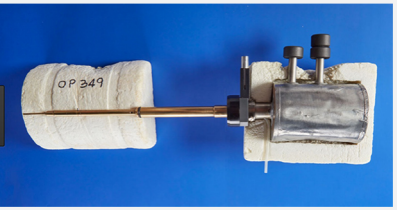
2000s – Z. Sayers chairs the scientific advisory committee of Synchrotron light source for Experimental Science and Applications in the Middle East (SESAME) and is a key driver of SESAME's development.

2017 – SESAME officially opens in Allan, Jordan.

After 20+ years in the making, SESAME's user community numbers nearly 1000 scientists in the region today.

EMBL

Clinical outcome: from basic research to antiviral therapies



1980s – EMBL scientists Jacques Dubochet and Alasdair McDowall developed the cryo-EM technique.

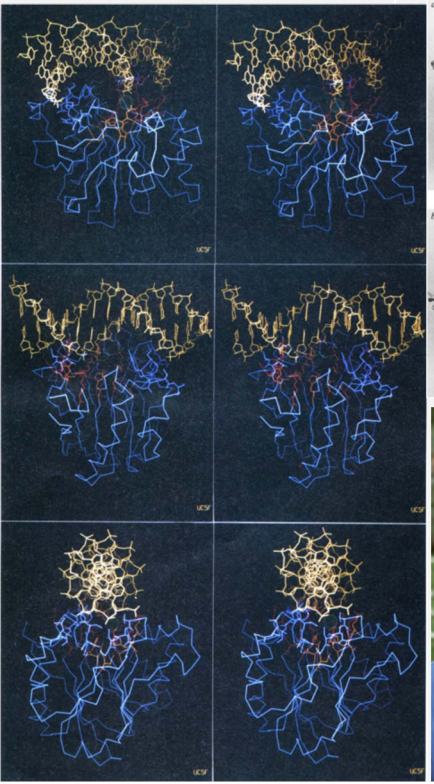
2000s – EMBL PhD student Tanmay Bharat and his lab group, led by John Briggs, developed novel cryo-EM techniques.

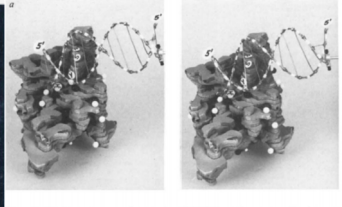
2010s – Tanmay Bharat and his lab group, led by John Briggs, applied cryo-EM to solve the structures of Ebola and Marburg viruses, as well as HIV.

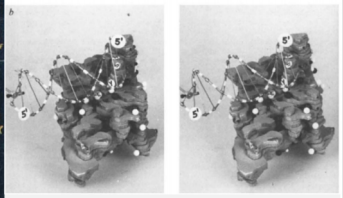
30+ years later, structures of viruses are used to develop drugs and therapeutic strategies.

EMBL

Taking the long view on basic research: Solving protein structure unlocks therapeutic possibilities







1980s – EMBL scientists Dietrich Suck and Christian Oefner solve the crystal structures of bovine DNase I and the actin–DNase I complex in collaboration with researchers at the Max Planck Institute in the early days of structural biology.

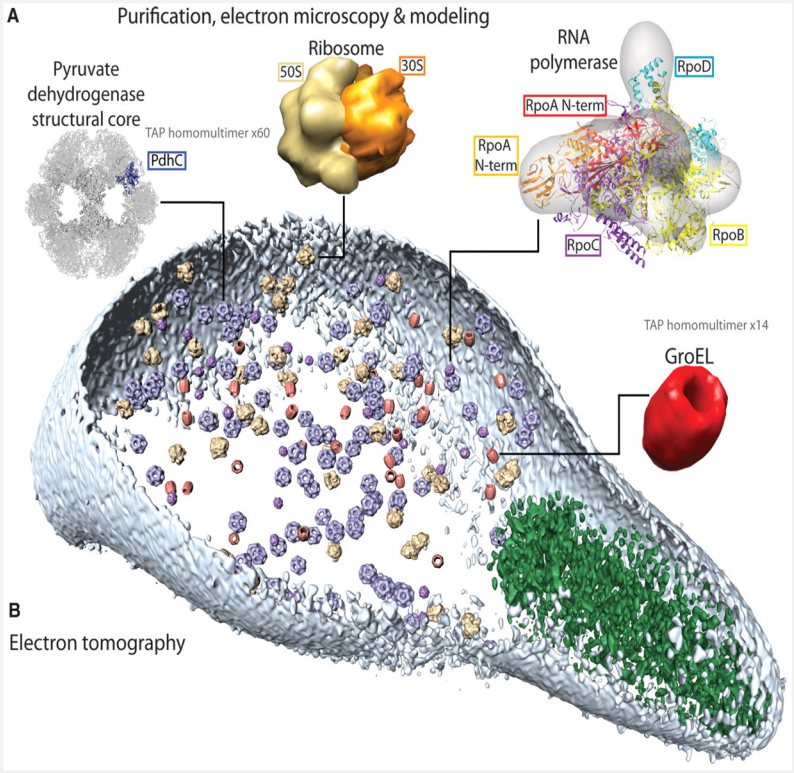
1990 – The structure and function of recombinant human DNase I (rhDNase) is modeled after the DNase I structure solved by D. Suck and his group. rhDNase is found to effectively treat cystic fibrosis (CF).

Post-1990 – Drugs with rhDNase are developed for CF patients, simplifying the process of clearing their lungs.

30+ years later, DNase I not only offers a simple therapy for CF but may also help treat COVID-19.

EMBL

The EMBL-CRG synergy:
Elegant approaches to unraveling complexity



2006 – A partnership between EMBL and the Centre for Genomic Regulation (CRG) in Barcelona, Spain is established. The *Mycoplasma pneumoniae* project is undertaken jointly.

2009 – The project reveals the sophisticated functions of the molecular components of the *Mycoplasma pneumoniae* bacterium.

2012 – EMBL, CRG and other collaborators find that *M. pneumoniae* can tweak proteins to perform a variety of tasks, which is likely an ancient evolutionary strategy.

10+ years later: Comprehensive molecular studies of bacteria increase our understanding of the building blocks of life and may help drug targeting and design.

EMBL

Training outcome
CABANA: Spreading the bioinformatics bug across the world

2007 – EMBL-EBI's training programme is officially launched and a state-of-the-art training facility is opened, offering bioinformatics courses for free.

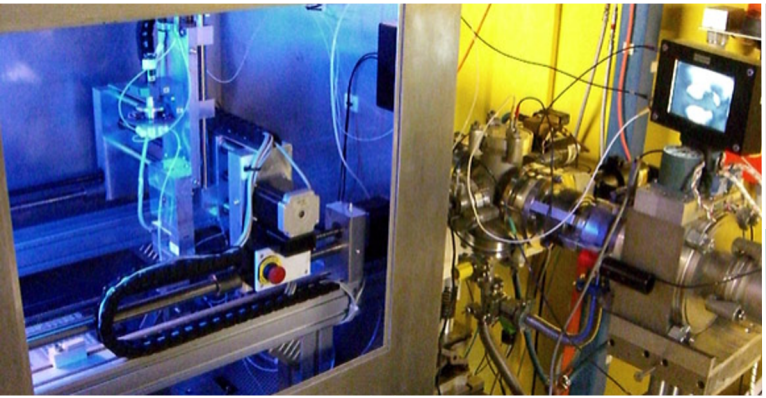
2012 – The Train-the-Trainer (TtT) programme is initiated for both external and internal trainers to develop their training skills.

2017 – EMBL-EBI coordinates CABANA, a sustainable capacity-building project in Latin America. It offers its own TtT programme, workshops, and online resources.

CABANA has influenced 4 policy instances in Latin America, and has forged collaboration between leading scientists in 9 regional institutions.

EMBL

Technological/infrastructural outcome
The SAXS superpower: Applying X-ray vision to biomolecules



1990s – Dmitri Svergun at EMBL Hamburg develops novel small-angle X-ray scattering (SAXS) methods and software.

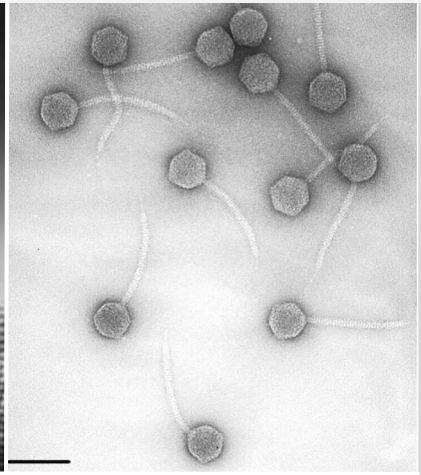
2003 – A software package called ATSAS, one of the most popular and comprehensive SAXS data analysis and modelling platforms for biological macromolecules and nanoparticles, is released by D. Svergun and team.

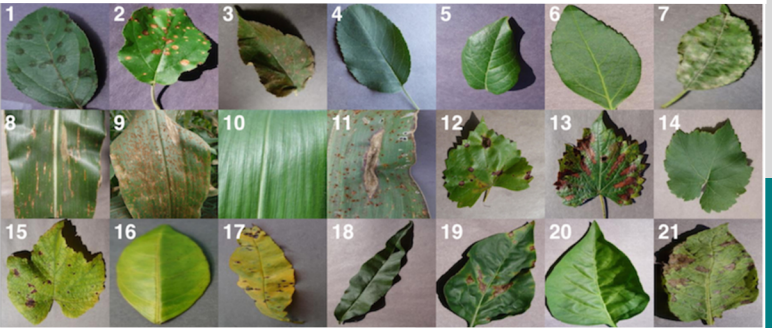
2005 to 2009 – SAXIER, a unified European SAXS infrastructure initiative, is coordinated by D. Svergun.

Nearly 30 years of innovation has made SAXS a fundamental technique in academia, medicine and materials sciences.

EMBL

Agricultural outcome
EMBL vectors: A genetic tool for creating disease-resistant plants





1980s – At EMBL, Noreen Murray, in collaboration with Hans Lehrach's group, creates the "EMBL (aka. "lambda") vectors".

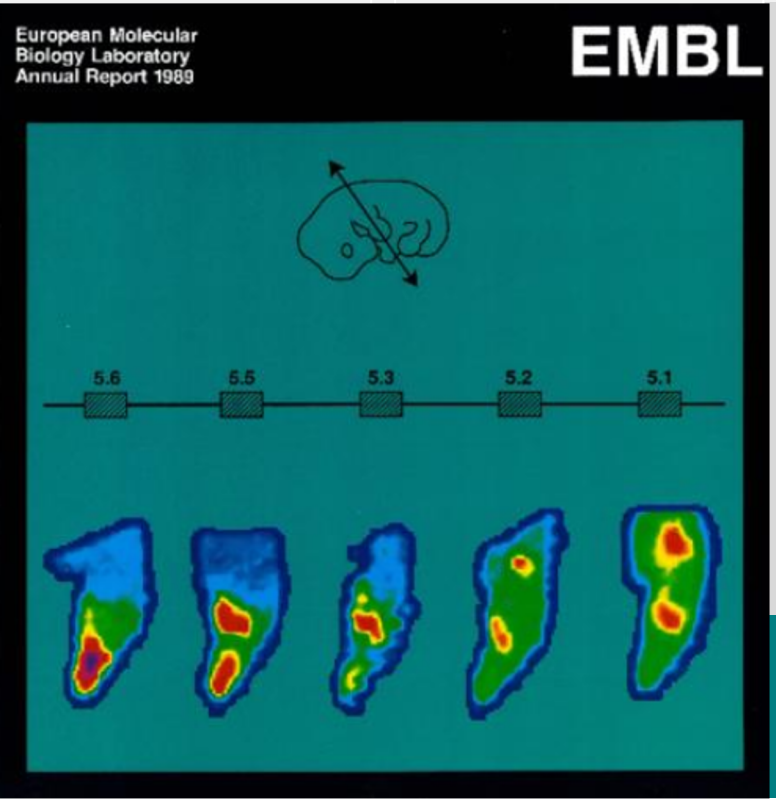
1990 – Scientists use EMBL vectors to transfer the stilbene synthase (STS) gene from grapevine to tobacco, demonstrating for the first time that the STS gene can help plants fight infection.

2000s – The STS gene is transferred to many different plants to test for disease resistance.

Today: EMBL vectors continue to be used for genetic engineering. Ongoing research may transform future crops.

EMBL

Clinical outcome
Hox genes: Directing the body in space and time



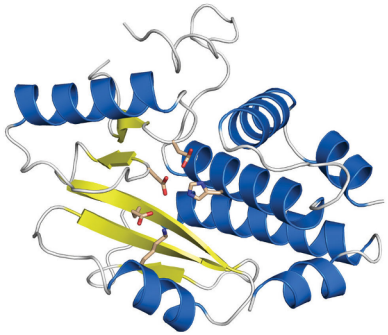
1980 – Ed Lewis, Christiane Nüsslein-Volhard and Eric Wieschaus identified 15 genes of key importance in determining the body plan and formation of body segments of the fruit fly.

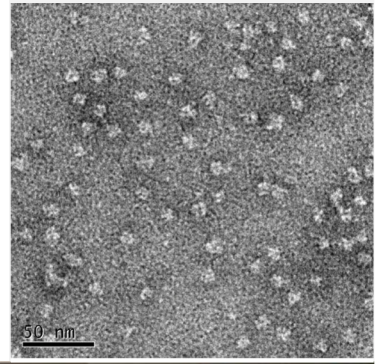
1980s – Denis Duboule's group found that vertebrates use similar genetic networks ("Hox" genes) to fruit flies in order to develop. They described how Hox genes organise not only the body axis but also limb patterning and timing during embryonic development.

Over 30 years after Hox gene clusters are first described, research into developmental disorders and cancer continue to draw from this foundational genetic knowledge.

EMBL

Clinical outcome
How do influenza viruses replicate?





2007: The Unit of Virus Host Cell Interactions (UVHCI) is created in Grenoble, France to foster collaboration between EMBL Grenoble, the Joseph Fourier University and the CNRS.

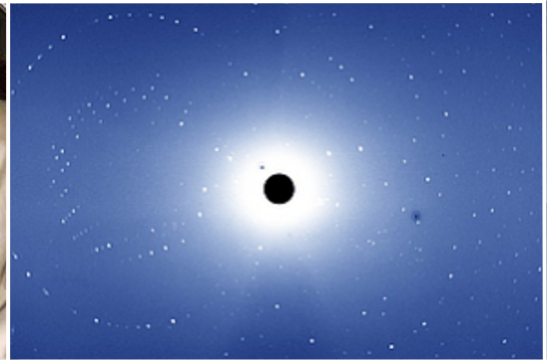
2008-9: Using X-ray crystallography, the UVHCI determine the atomic structure and mechanism responsible for replication in the influenza virus.

2010s: Therapies targeting this influenza virus subunit that inhibit its replication are developed.

10+ years after findings, drug for acute influenza is made available and others are undergoing trial.

EMBL

Instrumentation and infrastructural outcome
Neutron beams and biology: The LADI-III in Grenoble



1990s – The first neutron LAue DIffractometer (LADI) is developed at the Institut Laue Langevin (ILL) in collaboration with EMBL Grenoble.

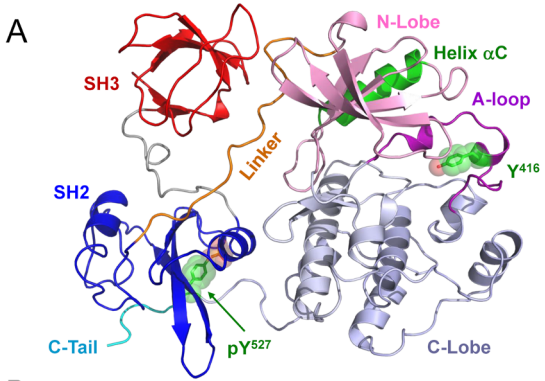
2000s – VIVALDI (LADI-II) and LADI-III are developed. The ILL–EMBL Deuteration Laboratory is set up, run by the Neutron Team.

2010s – Research using LADI-III and deuteration facility provide insights into disease-causing proteins.

Today: Neutron-based research guides drug discovery for HIV-1, amyloidosis, cancer, and possibly COVID-19.

EMBL

Clinical outcome
Regulation and dysregulation in cells: Src and cancer therapy



1990s – Sara Courtneidge's group at EMBL reveal crucial mechanisms of the Src protein which are required for the normal control of cellular growth.

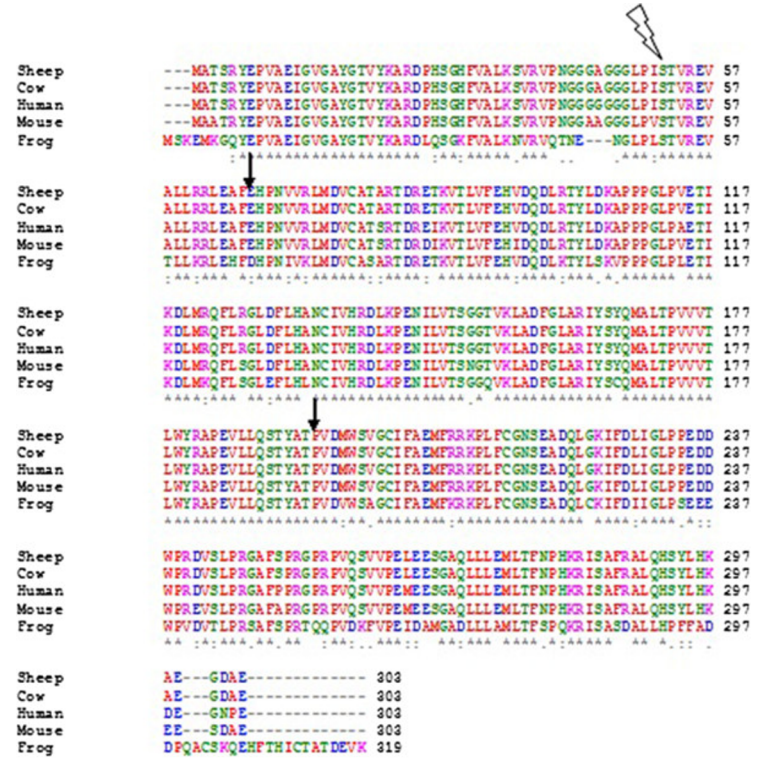
2000s onwards – Inhibitors of Src's kinase activity are studied as therapeutic agents in cancer treatment.

– Kinase inhibitor drugs for various types of cancers are developed and made available.

Today: Cancer therapies targeting Src continue to be developed and undergo clinical trials.

EMBL

Clinical and methodological outcomes
Clustal W: The genome sequence alignment tool that went viral



1990s – Clustal W is developed by Toby Gibson, Julie Thompson and collaborators at EMBL.

2000s – Clustal W is used for protein sequence alignment and analysis of the 2003 SARS-CoV.

2010s – Sequence analysis of 2012 MERS-CoV is performed to help determine origins of virus.

– Twenty years later after its publication, the article on Clustal W becomes one of the top ten most cited scientific articles of all time.

Today: Sequence analysis of SARS-CoV-2 using CLUSTAL helps track origin/evolution of virus and develop a vaccine.

EMBL

Infrastructural outcomes
Give and take: the mutual benefits of scientific exchange

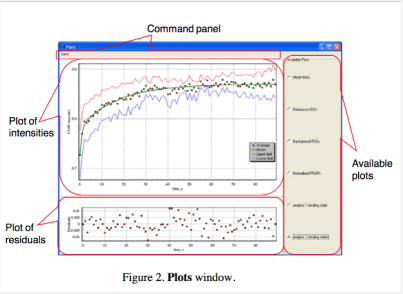


Figure 2. **Plots** window.

2000s – Professor E. Friederich, former EMBL postdoc, becomes head of the Life Sciences Research Unit at Luxembourg University.

– Aliaksandr Halavatyi, under Friederich's supervision, develops FRAPAnalyser, an open-source data analysis software for scientists. Halavatyi is later recruited to EMBL's Advanced Light Microscopy Facility (ALMF).

2010s – Andreas Girod from EMBL is recruited by E. Friederich to head the Light Microscopy Facility of the Life Sciences Research Unit in Luxembourg.

Today: Luxembourg has advanced microscopy facility & expertise; open-source data analysis software is available to researchers.

EMBL