

# ANNUAL REPORT 2022



[GULBENKIAN.PT/CIENCIA](https://gulbenkian.pt/ciencia)



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# DIRECTION STATEMENT

As we reflect on the past year, we are immensely proud of the remarkable achievements of the IGC community in advancing scientific knowledge and strengthening connections between science and society. Despite the challenges posed by the pandemic and a climate of global uncertainty, our community has demonstrated remarkable resilience and creativity. The year 2022 marked a significant milestone for IGC, with several initiatives launched within the last five years bearing fruit. These initiatives aimed to promote a trans-disciplinary international research agenda on understanding organisms in the context of their changing environment, while fostering closer ties with society. Breakthroughs were made in several areas, including understanding basic principles of life, the role of the environment in the physiology, behavior, and evolution of organisms, and mechanisms of disease. IGC scientists also launched a clinical trial on sepsis, one of the deadliest diseases globally, as part of our mission to tackle important challenges. Additionally, we forged new partnerships and strengthened existing national and international collaborations to promote more sustainable research with greater global impact.

## **Promoting Quantitative, Digital and Open Science**

To address the complexity of the questions we seek to answer, our research must be complemented by quantitative and digital biology approaches that are computational and theory-based. Our efforts to promote quantitative biology have yielded fruitful results, largely due to the creation of a Unit for Digital and Quantitative Science, led by Tiago Paixão. This unit has provided critical support to research groups pursuing quantitative research, including implementing electronic lab books and professionalized data management. Consistent with our mission, the PONTE fellows program is an innovative postdoc program in

which researchers from the exact sciences join the IGC without pre-assigned group and are expected to collaborate with at least two IGC PIs. In 2022 we welcomed the first two fellows, who are currently collaborating with diverse research groups on and beyond campus. We have also made significant strides towards promoting open science principles, which are now extended to all research groups. As a result, most of our publications are preprinted before publication, and many are accessible to the public.

## **Empowering and Recognizing Talent**

To achieve our ambitious research goals, it is crucial to attract and retain the best research talent, from PhD students to PIs. In 2022, we recruited two outstanding principal investigators (PIs), Moritz Treeck and Ilana Gabanyi, who will join seven other exceptional PIs recruited in the past five years. Their innovative research will focus on how organisms interact with bacteria, parasites, and their environment, advancing our understanding of fundamental biological processes. Several of our PIs completed their tenure at the IGC in 2022 and were recruited to prominent positions, including Colin Adrain at Queen's Mary University and Elena Baena at Oxford University, where they will continue to promote the IGC spirit. We are also proud of M<sup>a</sup> João Amorim, Raquel Oliveira, and Luís Teixeira, who became vice-directors of the new Biomedical Institute of the Catholic University, now incubated within the IGC. In addition, IGC scientists were recognized with prestigious grants, prizes, and fellowships, amongst many others an ERC grant awarded to Waldan Kwong, La Caixa grants awarded to Vera Martins and M<sup>a</sup> João Amorim, Alan Agar Award for Electron Microscopy to Erin Tranfield and membership in the American Academy of Microbiology awarded to Karina Xavier. Moreover, numerous scientists were selected for various EMBO programs, including EMBO fellows, EMBO



installation, EMBO YIP, and EMBO membership. At the end of 2022, the IGC hosted 26 research groups, nine active ERC grants, three active EMBO installation grants, and nine EMBO members, an important achievement of our scientists.

### Internationalization as an important priority

The Gulbenkian International Collaborative Center was established in partnership with the city council of Oeiras in 2019 with the aim of internationalizing Gulbenkian and Portuguese science, democratizing science, and maximizing the IGC's impact. This initiative is expected to increase the visibility of IGC in Europe and worldwide, making it easier to attract world-renowned researchers and companies to form partnerships with the institute. The center is already attracting exceptional scientists by hosting workshops, short-term visits, sabbaticals, and other collaborative events. In 2022, under the leadership of Luís Valente, we hosted three times more scientific events than the pre-pandemic period, including the IGC symposium, SymbNet events, the undergraduate summer school, and the host-microbe summer school. Sabbatical fellows Joe Howard (Yale University, US) and Jason Gigley (Wyoming University, US) also interacted with colleagues and provided career advice. We also established the Gulbenkian Senior Fellows Program to bring renowned scientists that complement ongoing research to the IGC. The program's first senior fellow is Pedro Beltrão from ETH Zurich, followed by Joe Howard from Yale. Towards internationalization, we also welcomed new António Coutinho fellows selected from Cabo Verde and Mozambique and held a ceremony and photograph exhibition to celebrate the global agenda for science democratization. We continued the ERC-Oeiras funding program, awarded to Luís Moita from IGC. This program aims at incentivizing and supporting ERC applications and has inspired a similar government program.

### Strengthening the future with strategic partnerships

As part of our commitment to promoting the scientific ecosystem in Portugal and Europe, we have continued investing in various initiatives. These include chairing the EU-LIFE alliance of institutes in 2021, starting the activities of the associated laboratory LS4F, and continuing activities of COLife, an alliance of life science institutes in Lisbon and Oeiras. We have established a timely and relevant initiative focused on the topic of one-health with the European Molecular Biology Laboratory (EMBL). The one-health initiative recognizes the interconnectedness between human, animal, and environmental health, and aims to address some of the most important health and environmental challenges of our time. By bringing together experts from multiple fields, including biology, medicine, physics, social sciences, and ecology, this partnership between the Gulbenkian Institute and EMBL will facilitate innovative research in the field of one-health. Through this collaboration, we are confident that we will make significant contributions to the global scientific community and to society at large.

### Innovation and science democratization

This year, we continued our commitment to democratizing science and connecting with society. IGC established a local joint innovation office with ITQB/NOVA in 2019, InnOValley, funded by the Oeiras municipality. This office serves as a platform for intellectual property assessment and management, building partnerships with companies and hospitals, funding and mentoring proof-of-concept activities, and increasing the technological readiness of IGC's findings. In 2022, InnOValley organized the first Proof of Concept scheme in Portugal to identify and fund projects in a translational stage that have shown promising and exciting results. Additionally, we initiated open days dedicated to

translational approaches in science, bringing our scientists and core facilities closer to industry. We believe that science should be fully embedded in society, promoting critical thinking, the full exercise of citizenship and social well-being. This year, we continued our commitment to democratizing science and connecting with society. We engaged directly with schools, universities, and the lay public, both in Oeiras and beyond. To achieve this, we developed and implemented programs such as Lab in a Box and Lab in a Suitcase, which aim to foster an interest in the scientific process and make science accessible. In addition to these programs, we also participated in a variety of public events, including concerts (such as NOS Alive and Gulbenkian Music), science festivals, and open days. All these initiatives combined allowed us to reach over 11,000 individuals, making science accessible and approachable for everyone.

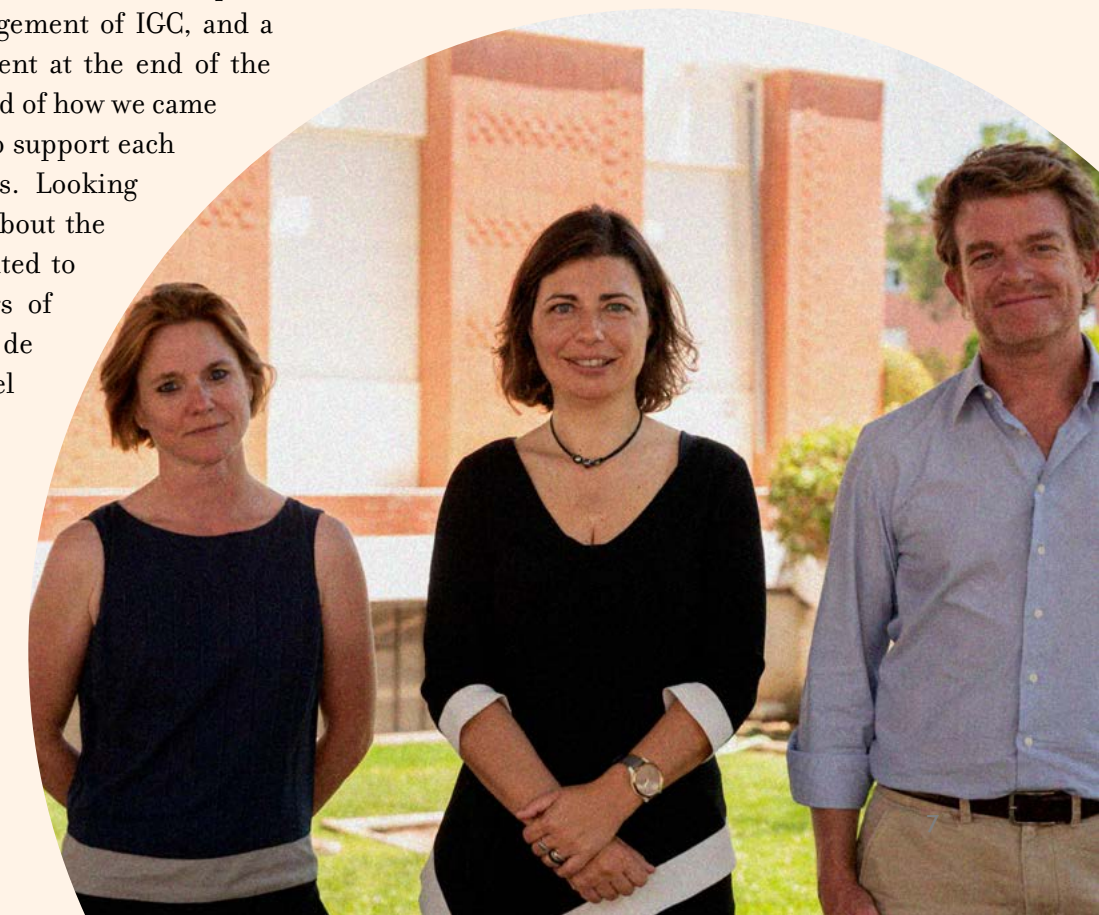
### Fostering Global challenges

As we close this annual report, we reflect on the challenges we faced in the past year, including the departure of a key member of our team, Manuel Schmidt, who introduced several positive changes in the management of IGC, and a devastating flooding incident at the end of the year. However, we are proud of how we came together as a community to support each other through these times. Looking ahead, we are optimistic about the future of the IGC and excited to welcome new coordinators of logistics and finances, João de Almeida Pedro and Gabriel Ramos, to our team.

In 2023, we celebrate two important milestones - the 10th anniversary of EU-LIFE, a successful

collaborative network of top European research institutes that we helped to found, and the 30th anniversary of our PhD programs, which have had a significant impact in Portugal and beyond. These milestones remind us of our past successes and inspire us to prepare for the challenges and opportunities ahead. As we continue to advance science, drive innovation, and empower our talented teams, we are grateful for the continued support of our community. We look forward to working together to define the new future of the IGC.

*Moira Botelho Dias*

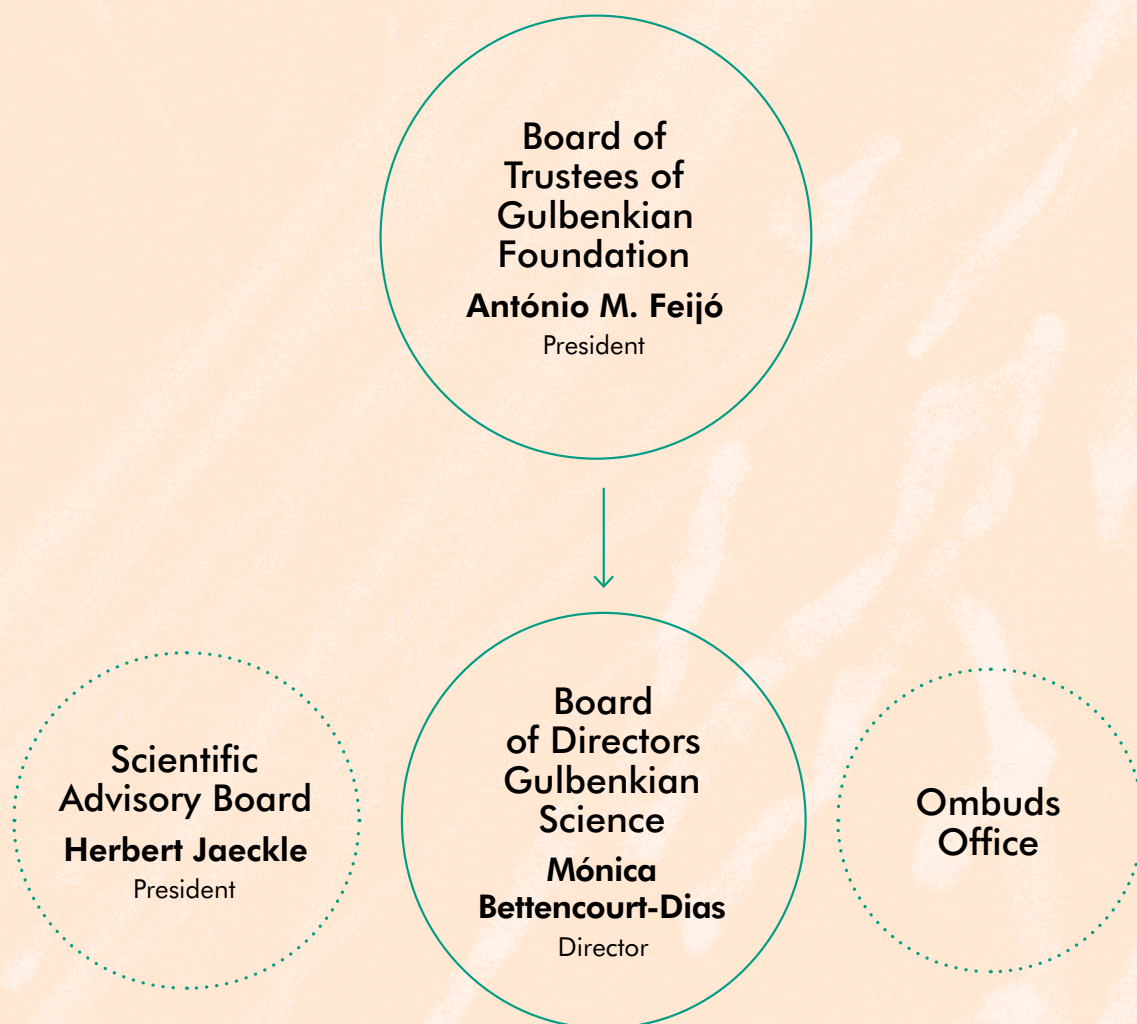




# ORGANISATION

Founded in 1961, the Instituto Gulbenkian de Ciência (IGC) is part of the Calouste Gulbenkian Foundation (FCG), a private charitable foundation promoting innovation in charity, arts, education, and science. Our Mission, Vision and Values are fully aligned with the FCG principles. The direct governance of the institute goes through the Director, an executive Director, and one Deputy Director for Science. The Director

is responsible to respond to the FCG Board of Trustees. An eminent external Scientific Advisory Board oversees the scientific activities of the IGC, whereas the Ethics Committee ensures the ethical conduct of the scientific activities related to vertebrate animals or humans. The Scientific Advisory Board and the Ethics Committee are appointed by FCG Board of Trustees.



# BOARD MEMBERS

## BOARD OF TRUSTEES GULBENKIAN FOUNDATION

**António M. Feijó**  
President

- António Cruz Serra
- Cristina Casalinho *(Non-executive)*
- Graça Andresen Guimarães *(Non-executive)*
- Guilherme d'Oliveira Martins
- Jorge Vasconcelos *(Non-executive)*
- José Neves Adelino
- Martin Essayan
- Pedro Norton *(Non-executive)*

## BOARD OF DIRECTORS GULBENKIAN SCIENCE

**Mónica Bettencourt-Dias**  
Director

- Manuel Schmidt  
Executive Director
- Caren Norden  
Deputy Director for Science

## SCIENTIFIC ADVISORY BOARD

The Scientific Advisory Board comments and consults on the scientific progress, graduate programmes, recruitment and overall performance of staff and research groups, advising the Board of the Gulbenkian Foundation on all matters related to the mission of the Institute.

**Herbert Jaeckle**  
Chair

Max Planck Institute for Multidisciplinary Sciences, Germany

Anthony Hyman  
Vice-President  
Max Planck Institute, Germany

Cassandra Extavour  
Harvard University, USA

Joe Bury  
VIB, Belgium

Luis Serrano  
Centre de Regulació Genòmica (CRG), Spain

Nancy Moran  
University of Texas, USA

Patrick Cramer  
Max Planck Institute for Biophysical Chemistry, Germany





**302**  
People



**40**  
Nationalities  
71% Portuguese  
29% International



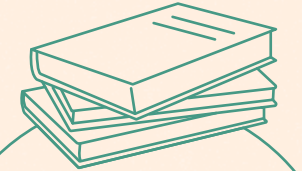
**48**  
Prizes  
and honours

**112**  
Seminars

**50**  
Events  
organised

**151**  
Projects

25 New projects in 2022



**109**  
Publications

89 open access  
1690 in the last 10 years

**16**  
Theses in 2022

2 BSc  
7 MSc  
7 PhD

**194**  
Researchers

♀ 60% ♂ 40%



**198**  
Collaborations with  
other institutions

79 National  
119 International

**25**  
Research groups

♀ 40% ♂ 60%

**9**  
Scientific  
support units

♀ 61% ♂ 39%

**12**  
Technical  
support units

♀ 52% ♂ 48%

**19.100K€**  
Funding 2022

126 Grants in the last 5 years

100 New research grant applications





## Jan

- Mónica Bettencourt-Dias appointed EU-LIFE chair
- 2<sup>nd</sup> GloMiNe by Symposium for Africa hosted the IGC
- Waldan Kwong awarded EMBO Installation Grant
- 170 applications in new group leader call

## Feb

- Karina Xavier elected member of the American Academy of Microbiology
- INFO-VAC: COVID-19 mRNA vaccines require two doses for population immunity

## Mar

- Science for Ukraine: open positions for Ukraine scientists
- Waldan Kwong receives ERC Grant
- First COLife Hackaton
- SymbNET Interim Meeting at the IGC
- First Gulbenkian Senior Fellow – Pedro Beltrão

## Apr

- Jamil Kitoko receives HFSP fellowship
- IGC Annual Retreat
- MERCK delegation visits the IGC

## May

- LS4FUTURE kickoff meeting at the IGC
- InnOValley Proof of Concept Fund's 1<sup>st</sup> edition
- SAB Meeting
- New Emerald call

## Jun

- IGC Director receives Gold Medal of Merit from Oeiras Municipality
- 1<sup>st</sup> edition of Medinfar/IGC Translational Open Day
- Estibaliz Gómez de Mariscal wins EMBO Postdoctoral Fellowship
- New Equity, Diversity and Inclusion policy

2

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2

2

## Jul

- Raquel Oliveira elected EMBO Member
- The IGC at NOS Alive 2022
- SymbNET PhD Summer school
- Luís Moita awarded ERC-Oeiras
- Nine IGC projects secure FCT funding
- SymbNET Open Session "Microbiota and Human Health" at FCG

## Aug

- 4<sup>th</sup> edition of the António Coutinho Science Awards (ACSA)
- Undergraduate Summer School internships

## Sep

- New cohort of IBB students
- EU-LIFE Science Communication workgroup training at the IGC
- COLife Community Meeting
- Vera Martins awarded in the CaixaResearch Health Call
- ACSA Ceremony and exhibition at FCG

## Oct

- EMBO Practical Course "Computational optical biology"
- COLife PhD Day at the IGC
- IGC Symposium – [3C] Cells, Computers & Clinics
- EU-LIFE's Community Meeting
- Launch of the Lab in a Box 2022/2023 training

## Nov

- COLife Postdoc Day at the IGC
- InnOValley Proof of Concept Fund's 2<sup>nd</sup> edition
- Elias Barriga elected EMBO Young Investigator
- IGC Open Day
- IGC project awarded by the Chan Zuckerberg Initiative (CZI)

## Dec

- Hannah Heil receives EMBO Scientific Exchange Grant
- IGC Alumni Reunion
- IBB Annual Workshop
- Two new NOS Alive-IGC fellowships



# SCIENCE STORIES

## New rare disease identified, caused by defects in cell division

A collaborative study between clinicians and researchers published in **Science Advances** described the first two patients known to have mutations in both copies of *BUB1*, a critical gene for cell division.

Contrary to previous thoughts, deleterious *BUB1* mutations are compatible with life albeit associated with developmental problems. The researchers, led by **Raquel Oliveira**, suggest that the mitotic errors stemming from these mutations cause the death of cells that are important for brain development, accounting for the clinical manifestations of this **novel inherited neurodevelopmental disorder**, namely microcephaly and intellectual disability.

The identification and characterization of such mutations could improve the diagnosis of this rare disorder and the understanding of syndromes with similar features.

Carvalho, S., Bader, I., Rooimans, M.A., *et al.* (2022). Biallelic BUB1 mutations cause microcephaly, developmental delay, and variable effects on cohesion and chromosome segregation. *Science Advances*, 8(3), eabk0114.

## Cells read the room before migrating to form tissues

The environment within a developing embryo is very dynamic, with cells traveling coordinately to get to places where they will perform specific functions. Moving alone or in clusters, through a process known as collective cell migration, cells eventually reach their destination to form the different tissues and organs of the body. But what exactly triggers and directs the motion of multiple cells in such a coordinated way?

Researchers led by **Elias Barriga** studied the interplay between cells that form several structures of the head and face and their native substrate in frog embryos. They found that cells sense the stiffness of their environment through a specific channel in their membrane. This, in turn, triggers the modification of the cells' skeleton, allowing them to **tune their mechanical properties** and **initiate collective migration** in the embryo regardless of whether the substrate is soft or not. "This is relevant as stiff substrates were typically described as permissive surfaces for migration", explains the principal investigator.

The findings, published in **Nature Materials**, could impact our understanding of embryogenesis, regeneration, and cancer invasion.

Marchant, C.L., Malmi-Kakkada, A.N., Espina, J.A. & Barriga, E.H. (2022). Cell clusters softening triggers collective cell migration *in vivo*. *Nature Materials*, 21(11), 1314–1323.





### Tell me what you eat, and I will tell you how your microbiota evolves

New research reveals that diet can change the evolutionary path of bacteria in the gut, within host-relevant timescales. Researchers observed that *Bacteroides thetaiotaomicron*, a prevalent bacterium in the human gut, accumulates diet-specific adaptive mutations within a couple of weeks. Bacteria in mice fed a low-fiber diet accumulated mutations that favored the degradation of the gut mucus, which could potentially increase susceptibility to infection and inflammation.

The study, published in *Cell Host & Microbe*, emphasizes that “the consequences of an unbalanced diet can be much more permanent than previously recognized because diet affects not only the composition of the microbiota, but also leaves permanent genetic alterations in the gut microbes”, explains **Karina Xavier** who led the research. Such information could improve our understanding of microbiota-dependent host responses to diet and to other perturbations, including the use of antibiotics.

Dapa, T., Ramiro, R. S., Pedro, M. F., Gordo, I., & Xavier, K. B. (2022). Diet leaves a genetic signature in a keystone member of the gut microbiota. *Cell Host & Microbe*, 30(2), 183-199.e10.

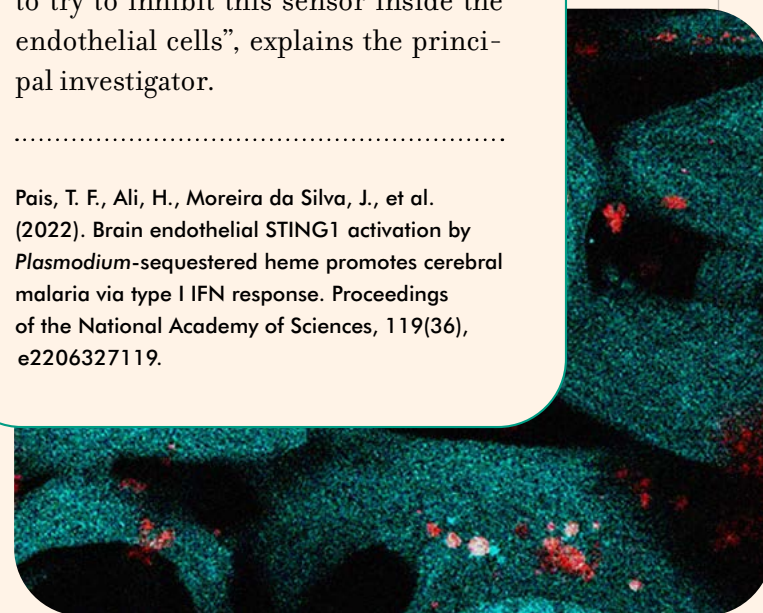
### The brain can detect infection with malaria

Researchers led by **Carlos Penha Gonçalves** discovered that endothelial brain cells can detect malaria parasites in the blood.

The study, published in the *PNAS* journal, revealed that these cells detect the infection through an internal sensor which triggers a cascade of events, starting with the production of interferon- $\beta$ . Next, they release a signalling molecule that attracts cells of the immune system to the brain, triggering the inflammation underlying cerebral malaria. What really surprised the researchers was the factor activating the sensor and triggering this cell response: nothing more nothing less than a byproduct of the activity of the parasite.

This discovery brought to light **new targets for adjuvant therapies** that could restrain brain damage in initial phases of the disease and avoid neurological sequelae. “The next step will be to try to inhibit this sensor inside the endothelial cells”, explains the principal investigator.

Pais, T. F., Ali, H., Moreira da Silva, J., et al. (2022). Brain endothelial STING1 activation by *Plasmodium*-sequestered heme promotes cerebral malaria via type I IFN response. *Proceedings of the National Academy of Sciences*, 119(36), e2206327119.



### How gut bacteria go from striving to thriving in days

Researchers led by **Isabel Gordo** described how the gut environment shapes bacteria and the relationship they establish with us.

This is the first time researchers show that the naturally fluctuating environment within a host is a key determinant of **within-species diversity**. “Sampling feces extensively throughout time allowed us to dissect subtle but functional differences occurring in this dynamic environment in the matter of days, in both healthy and diseased individuals”, the researchers explain. With this longitudinal approach, they noticed things they would not with a simple “before and after” picture.

The data, published in *Current Biology*, highlight how subtle the interactions between the **immune system**, the **microbiota**, and **antibiotics** can be in tempering the way evolution acts on bacterial regulation of iron, which is essential both for microbes and their host. Understanding the factors that shape the evolution of this process could contribute to the development of microbiome-based therapies, including the use of probiotics to control which bacteria proliferate in disease settings.

Barreto, H. C., Abreu, B., & Gordo, I. (2022). Fluctuating selection on bacterial iron regulation in the mammalian gut. *Current Biology*, 32(15), 3261-3275.e4.



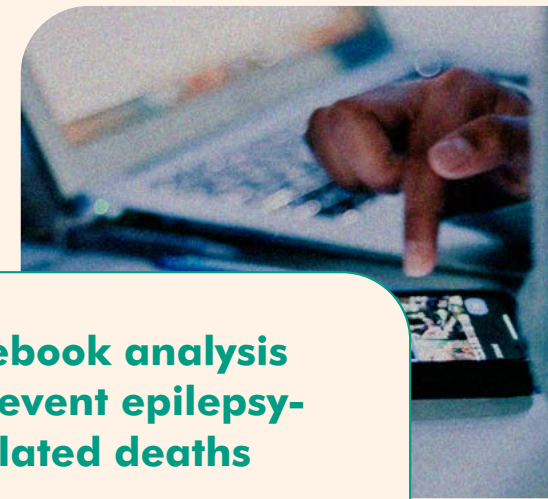
### Facebook analysis to prevent epilepsy-related deaths

A group led by **Luís Rocha** demonstrated that social media could be used to detect behaviors preceding Sudden Unexpected Death in Epilepsy (SUDEP), the leading cause of death in people with uncontrolled epileptic seizures.

The researchers went through the Facebook timelines of six epilepsy patients deceased due to SUDEP and used various tools to decipher human emotion and any stress markers hidden in their written posts. “For five subjects, the number of words written was significantly higher in their final days, in comparison to the rest of their timeline”, the researchers explain. In addition, the type of words used by the subjects changed and there were drastic sentiment shifts in their posts in the weeks preceding their death.

These changes in **digital behavior could be used as early-warning signals** to put preventive interventions for SUDEP into practice, possibly avoiding death.

Wood, I. B., Brattig Correia, R., Miller, W. R., & Rocha, L. M. (2022). Small cohort of patients with epilepsy showed increased activity on Facebook before sudden unexpected death. *Epilepsy & Behavior*, 128, 108580.





# MISSIONS

Conducting excellent  
curiosity-driven research  
in life sciences

20

Offering researchers the best  
state-of-the-art scientific  
and technical support units

38

Fostering innovative training  
and new ways of doing science

50

Bringing science closer to society

56

Promoting national and  
international partnerships

62



# CONDUCTING EXCELLENT CURIOSITY-DRIVEN RESEARCH IN LIFE SCIENCES

In 2022, the IGC continued to excel in biological and biomedical research. Driven by curiosity, researchers made discoveries that contributed to a deeper understanding of the processes that shape living systems, including cell division, embryonic development, evolution, interaction of organisms across scales, and much more.



**25**  
Group Leaders



**57**  
Running Grants  
27 National  
30 International



**5**  
New software  
developed

**194**  
Researchers

**24**  
New Grants  
in 2022



**37**  
Prizes and  
honours

**8**  
EMBO  
Members

**8**  
ERC Grants

**1**  
EMBO Young  
Investigator







## RESEARCH

Throughout the year, the IGC has made remarkable discoveries across its four main thematic lines of research revolving around how the organism forms and interacts with the environment. These research findings led to several high-impact publications in top-tier scientific journals.



## ORGANISATION AND COMMUNICATION OF CELLS AND TISSUES

Researchers at the IGC explore the fundamental principles that guide the development of healthy and functional organisms while uncovering alterations that lead to disease. Several groups complement each other to study different levels of biological organisation, ranging from molecular and subcellular to the complexities of tissues that form the body.

DNA is present in all forms of life. Functional chromosome organisation ensures the maintenance of genome integrity and the correct transmission of genetic material across generations. How chromosomal abnormalities ultimately impact cells, tissues, and organisms is an area of research of particular importance at the IGC.

The **Chromosome Dynamics** lab, led by **Raquel Oliveira**, investigates how chromosomes assemble and how their morphology influences the fidelity of cell division.

In 2022, the group was awarded with a grant from Fundação para a Ciência e a Tecnologia (FCT). This new project aims to identify novel players of DNA topology regulation uncovering potential novel causes of genomic instability which may underly several pathologies linked to chromosome mis-segregation, such as cancer, genetic disorders, and infertility. The group also studies how transcription is shut down in mitosis, and its influence on genome partitioning and transcriptional control. Under the scope of the Consolidator ERC Chromosilence project and in collaboration with Rui Martinho (University of Aveiro), the group identified a novel protein involved in this process. They uncovered that the shutting down of transcription before mitosis is an active process linked to sister chromatid resolution.

The correct propagation of the genetic material depends on critical subcellular structures. The **Cell Cycle Regulation** lab, led by **Mónica Betencourt-Dias**, studies the assembly and maintenance of complex subcellular structures and their variations during development, disease, and evolution.

To explore these general principles in biology, the group uses centrioles and cilia as study subjects. The presence of supernumerary centrosomes is a hallmark of cancer and is frequently observed in aggressive tumors. In 2022, this lab unveiled that:

- hematological malignancies are the most proficient in clustering centrosomes to survive and are sensitive to targeting clustering through inhibition of the spindle assembly checkpoint;
- high expression levels of Plk4 induce anoikis resistance of both mammary epithelial cells with p53KO background, as well as of breast cancer cells exposed to their secretome. These results reinforce the idea that Plk4, independently of its role in centrosome biogenesis, functions as an oncogene by impacting the tumor microenvironment to promote malignancy.



On the other hand, ciliary defects cause ciliopathies, some of which with late onset, suggesting cilia are actively maintained. The group has shown that IFT88 continues to move along fully formed sensory cilia and that these require an active maintenance programme which involves DmIFT88 and at least two of its signalling transmembrane cargoes, DmGucy2d and Inactive.

Several research groups at the IGC are dedicated to unraveling the complex mechanisms that govern the organisation and communication of cells and tissues during embryonic development. By zooming out from the microscopic world inside cells, these scientists aim to gain a deeper understanding of how tissues and organs form and function.

The **Patterning & Morphogenesis** lab, led by **Moises Mallo**, studies the mechanisms governing the early steps of vertebrate development, when the main layout of the body is first established. The group's current research is mostly focused on the regulation of developmental transitions and their impact in the anatomical diversity observed among vertebrate species.

In 2022, the group showed that head and trunk development in mouse embryos are controlled by distinct gene regulatory networks. One of the most important differences was related to Wnt signalling dependence on Porcupine-mediated modification of the Wnt molecules, essential during gastrulation, but only required for a subset of Wnt-regulated processes during trunk formation. The researchers uncovered a high degree of developmental plasticity of the pericloacal mesoderm of the mouse embryo, which is under the control of Tgfb $\beta$ 1 signalling. In normal embryos, this mesoderm generates the external genitalia but in the absence of Tgfb $\beta$ 1 this tissue is recon-

verted into an extra set of hindlimbs. Tgfb $\beta$ 1 controls this process by modulating the regulatory landscape in the genome that eventually defines how the pericloacal mesoderm responds to patterning signals from the cloacal endoderm.

After the main vertebrate body axis are defined, cells organise to build a functional organism. The **Cell Biology of Tissue Morphogenesis** lab, led by **Caren Norden**, studies the events that reproducibly lead to the development of organs from cells to tissue using the vertebrate retina as a model. The group combines cell and developmental biology approaches with advanced quantitative imaging, image analysis, mechanobiology and, in collaboration, theoretical modeling. Its researchers use mainly zebrafish, but they also use retinal 3D cultures and organoids from human iPSC cells to compare findings across species.

In 2022, the group revealed a new model of neuronal migration not previously described in the central nervous system: ameboid-like migration. The group showed that horizontal cells, retinal cells that modulate information flow in the retina, fulfill all tested criteria for this type of migration and that changing mechanical tissue properties impedes this migration mode. Further, they showed that cell migration during optic cup formation, important for retinal shape, equals active collective cell migration. The efficiency of rim migration is coupled to the topology of the underlying extracellular matrix, showing that the matrix does not always merely serve as a passive scaffold but can influence cell migration behavior. Throughout the year, the lab's work was presented at important national and international conferences.

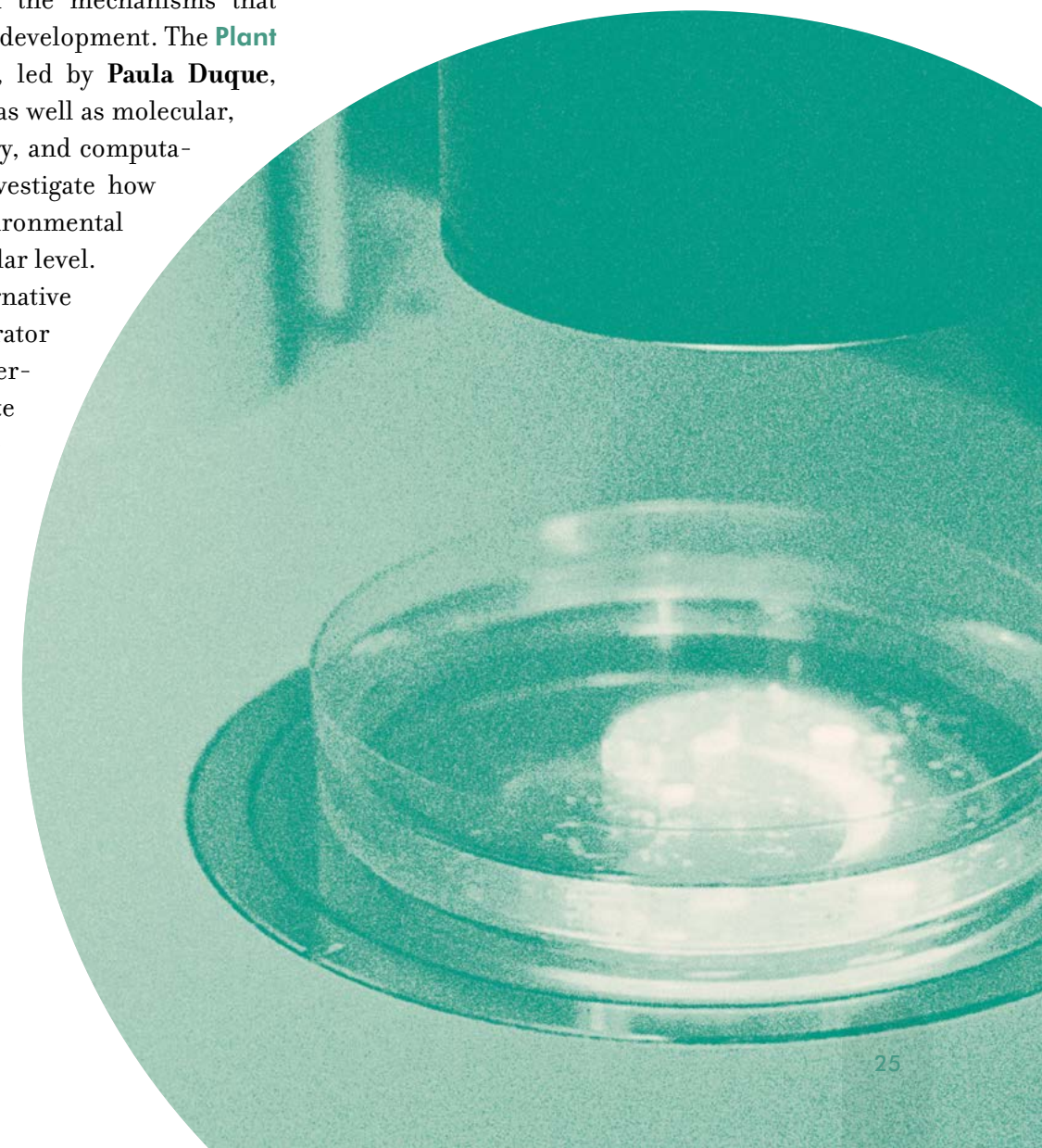
Also interested in the mechanisms underlying collective cell migration in embryogenesis is the

group led by **Elias Barriga**, the **Mechanisms of Morphogenesis** lab. His group studies how biochemical and biophysical inputs from the environment contribute to tissue morphogenesis. For this, they investigate how the interplay of these molecular and physical signals influences the onset and guidance of collective cell migration as well as cell fate decisions in both embryo development and regeneration. In 2022, the principal investigator was elected a member of EMBO's Young Investigator programme. During the year, the group published a paper revealing how cell clusters transit from non-to-migratory states in embryos, which made the cover of Nature Materials. Four other papers were published, including one that was resubmitted to Nature.

This thematic line of research extends to plants, with a strong focus on the mechanisms that govern plant growth and development. The **Plant Molecular Biology** lab, led by **Paula Duque**, uses *Arabidopsis thaliana* as well as molecular, cell biology, biochemistry, and computational approaches to investigate how plants respond to environmental challenges at the molecular level. The lab focuses on alternative splicing, a potent generator of transcriptomic diversity likely to contribute to plant stress tolerance, and on the role of membrane transport in plant responses to abiotic stress. In 2022, the researchers pursued the analysis of the biological functions of SR proteins, which are key alternative splicing modula-

tors, and the Major Facilitator Superfamily (MFS) of membrane transporters. Significant progress included:

- the identification of the direct RNA targets and binding motif of the SR34a splicing factor;
- the discovery that a natural variant of *Arabidopsis* with reduced ABA sensitivity elicits a weaker splicing response to the hormone;
- finding that an MFS transporter detoxifies toxic metals under iron deprivation;
- the development of new methods to accurately assess stomatal movements, plant cell expansion or cotyledon greening under stress.







## PUBLICATION HIGHLIGHTS

### ORGANISATION AND COMMUNICATION OF CELLS AND TISSUES



- Albuquerque-Martins, R., Díez, A. R., Szakonyi, D., & Duque, P. (2022). Assessing postgermination development in *Arabidopsis thaliana* under abiotic stress. In P. Duque & D. Szakonyi (Eds.), *Environmental Responses in Plants: Methods and Protocols* (pp. 207–215). Springer US.
- Albuquerque-Martins, R., Szakonyi, D., Rowe, J., Jones, A. M., & Duque, P. (2022). ABA signaling prevents phosphodegradation of the SR45 splicing factor to alleviate inhibition of early seedling development in *Arabidopsis*. *Plant Communications*, 100495.
- Amini, R., Bhatnagar, A., Schlüßler, R., Möllmert, S., Guck, J., & Norden, C. (2022). Amoeboid-like migration ensures correct horizontal cell layer formation in the developing vertebrate retina. *ELife*, 11, e76408.
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## HOST-MICROBE INTERACTIONS

The complex relationship between hosts and microbes is a field that is thoroughly explored at the IGC. Besides addressing the emerging role of interactions with important implications for human health and the environment, researchers strive to reach a deeper understanding of the biology of immunity and inflammation. By exploring these interrelated areas, the IGC is advancing our knowledge of the intricate mechanisms that govern health and disease.

Multicellular organisms establish stable associations with microbes during their lifetime. A major challenge is to understand how these interactions, that can range from parasitic to mutualistic, are specified and regulated, and how the host and microbes influence each other (e.g., physiology, evolution).

The **Host-Microorganism Interactions lab**, led by **Luís Teixeira**, addresses these problems using *Drosophila melanogaster* and its symbionts as a model system. In 2022, the group analyzed how genetic variation in *Wolbachia* impacts the endosymbiont titers and antiviral protection. Using genomic data for these *Wolbachia* variants and a genome wide association study, researchers identified candidate *Wolbachia* genes modulating these phenotypes. During the year, the group has also organised a global meeting on the microbiome focused on Africa, a scientific meeting of the SymbNET network, and an international two-week PhD Summer School on host-microbe symbioses.

The **Microbial Genomics and Symbiosis lab**, led by **Waldan Kwong**, also uses genomic techniques to understand how microorganisms live in their environment, evolve, and interact with each other. By revealing these fundamental mechanisms of microbial communities, we can better understand and ultimately manipulate these

systems for beneficial purposes in global ecology, agriculture, and animal health. The group uses the microbiome of the honeybee as their main model system. In 2022, the lab acquired an ERC starting grant, securing funding for the next five years. During this year, they optimized and acquired a first set of transcriptomic data from the bee gut, providing insight into the genes involved in bee-bacteria interactions, and published two papers from previously established collaborations. The team also started collaborating with IGC members Isabel Gordo and Pablo Sartori (3D modeling of bacterial effector proteins).

Successful bacterial-host relationships depend on the ability of microorganisms to communicate with one another and regulate their behavior. The **Bacterial Signalling lab**, led by **Karina Xavier**, focuses on interspecies cell-cell chemical signalling in bacteria and its role in beneficial and hostile interactions with the host. The group aims to decipher the molecular basis of signalling processes such as quorum sensing, determine their role in assembly, maintenance, and recovery of gut microbiota communities, and understand the consequences of these processes in symbioses and pathogenesis. In 2022, the group followed the emergence of mutations in *Bacteroides thetaiotaomicron*, a very prevalent fiber-degrading member of the microbiota, upon colonization of





the mouse gut under different dietary regimens. Through the integration of mutational, metabolomics and microbiota composition data, the group showed that diet leaves a genetic signature in *B. thetaiotaomicron*, and mutations arising under Western-style diet favor consumption of host mucus. This work on ecology and evolution in the mammalian gut contributed to consolidate the work that the group has been developing together with Isabel Gordo and Jocelyne Demengeot, showing how evolution within host-relevant time scales is affected by the gut metabolomic environment, which is shaped by the interplay between diet and members of the microbiota.

Besides bacteria, the interaction of hosts with viral pathogens is a topic of major interest at the IGC. The **Cell Biology of Viral Infection** lab, led by **Maria João Amorim**, seeks to understand how viruses replicate inside their hosts and how organisms respond to infections with the overarching goal of better controlling viral challenges. The group pioneered research on the viral usage of compartments formed by liquid-liquid phase separation, which is emerging as a widespread mechanism to facilitate viral reactions and may provide novel antiviral strategies.

The Influenza A virus builds biomolecular condensates with liquid properties for viral assembly. In 2022, the group found that targeting the formation and/or material properties of condensates impacts viral replication and may constitute a novel antiviral strategy. Modulating condensates is emerging as the next generation therapy against infection, many cancers, and neurodegeneration. The lab also contributed with novel approaches to control the SARS-CoV-2 pandemic, having established a spike-pseudotyped virus-based neutralization assay. Using this method, the group 1) identified synergetic mutations allowing reinfection; 2) is studying the population immune status; 3) is identifying drugs against SARS-CoV-2 (in collaboration) and 4) assessed the immune maternal

protection of the growing fetus (in collaboration). In addition, they developed a saliva molecular test for SARS-CoV-2 and demonstrated its efficiency in newborns.

Besides exploring the intracellular events stimulated by infection, IGC researchers also pay close attention to relevant processes occurring at the intercellular and organismal levels.

The **Inflammation lab**, led by **Miguel Soares**, aims at understanding, at an organismal level, the cellular and molecular mechanisms regulating inflammation and immunity and how these can be targeted therapeutically to overcome the pathologic outcome of major immune mediated inflammatory diseases. In 2022, the group:

- discovered that labile heme, an alarmin generated as a byproduct of hemolysis during *Plasmodium* infection, orchestrates a non-canonical resistance mechanism that restricts asexual stages of the parasite from accessing glucose. In response, *Plasmodium* reduces its virulence and undergoes sexual differentiation to promote transmission. This hypometabolic-based defense strategy underlies the pathogenesis of malaria-associated hypoglycemia, an independent risk factor for malaria mortality;
- found out that reprogramming of organismal iron metabolism by the kidneys is a central component of the host metabolic response regulating the pathogenesis of life-threatening malarial anemia;
- contributed to the discovery of a new mechanism of action for anthracyclines.

This last study was led by **Luís Moita**, the principal investigator of the **Innate Immunity and Inflammation** group. Severe sepsis remains a poorly understood systemic inflammatory condition with high mortality rates and limited ther-

apeutic options outside of infection control and organ support measures. Based on their recent discovery showing that anthracycline drugs prevent organ failure without affecting the bacterial burden in a model of severe sepsis, the group proposes that strategies aimed at target organ protection have extraordinary potential for the treatment of sepsis and possibly for other inflammation-driven conditions. However, the mechanisms of organ protection and disease tolerance are either unknown or poorly characterized. The central goal of their research is to identify and characterize novel cytoprotective mechanisms, as a window into stress-induced genetic programmes leading to tissue protection.

In 2022, the group discovered:

- a novel mechanism of action for the anticancer anthracycline drugs that work independently from their DNA damage properties;
- a major risk factor for postoperative bleeding risk, in cardiac surgery;
- an ICU predictor of long-term survival after cardiac surgery.

Disease and organ dysfunction are, in many cases, controlled by genetic factors. The **Disease Genetics** lab, led by **Carlos Penha Gonçalves**, is interested in uncovering how genetic factors work in specific cell types to drive organ inflammation trajectories and infectious disease outcomes, namely placental and cerebral malaria, and liver damage.

In 2022, the group investigated the role of brain endothelial cells (BECs) in cerebral malaria development as sensors and initiators of brain inflammatory responses. The researchers found that Type I IFN response in BECs during malaria infection is linked to activation of immunoproteasome, enhancement of presentation of *Plasmo-*



*dium* antigens, and endothelium disruption. They also found that this Type I IFN response requires increased glucose uptake leading to cellular metabolic adaptations. The group was also involved in longitudinal studies to evaluate the immune response to COVID-19 vaccines, having characterized responses to boosts administered during 2022 in the Portuguese population.

Since March 2020, the efforts of the **Lymphocyte Physiology** lab, led by **Jocelyne Demengeot**, have precisely focused on addressing societal and health needs imposed by the COVID-19 pandemic. The group aims at understanding immune regulation in health and disease, combining mouse and human studies, and addressing infections, autoimmune diseases, cancer, and their therapies.

In 2022, the group maintained the INFO-VAC programme that monitored the humoral immune response to COVID-19 vaccines over time in approximately 3000 participants. This project ran since the start of the COVID-19 vaccination campaign in Portugal (December 2020). The cohort's composition allowed the comparison between vaccine types and regimens, across age, sex, and health conditions. Among the key findings are that severe immunosuppression and age are the main factors explaining the heterogeneity of antibody levels. However, repeated injections serve to homogenize positivity for vaccine-specific antibody.

Finally, the **Lymphocyte Development and Leukemogenesis** lab, led by **Vera Martins**, studies T lymphocyte development at steady-state and in conditions that are permissive to leukemia. Normal T lymphocyte development occurs mostly in the thymus from progenitors of bone marrow origin in a process that involves high cellular

turnover. The group seeks to identify and understand the cellular and molecular mechanisms governing cell competition in normal thymus turnover, as well as during thymus autonomy and leukemia initiation.

In 2022, the group found that IL-7 and IL-7R are essential following thymus seeding by promoting proliferation and survival of the most immature thymocytes. Mice lacking IL-7 or IL-7R have a marked loss of early T lineage progenitors (ETPs) resulting mostly from a cell-autonomous defect in proliferation and survival, although no changes were detected in Bcl2 protein levels. A fraction of ETPs responded to IL-7 stimulation *ex vivo* by phosphorylating Stat5, and IL-7R was enriched in the most immature Flt3(+)Ccr9(+) ETPs. Consistently, IL-7 promoted the expansion of Flt3(+) but not Flt3(-) ETPs on OP9-DLL4 cocultures, without affecting differentiation at either stage.

Moreover, throughout the year:

- the lab published a peer-reviewed paper in the *Journal of Immunology*;
- Vera Martins was granted a *La Caixa* grant for the T-ALLOREL project;
- Camila Ramos, a PhD student, won the best oral presentation award at the IGC Symposium and submitted her thesis;
- Sónia Santos, an Erasmus student, defended her MSc thesis;
- Vera Martins represented the Portuguese Society of Immunology at the retreat of the European Federation of Immunological Societies, in Italy, and was one of the organisers of the IGC's principal investigators' retreat.



## PUBLICATION HIGHLIGHTS

### HOST-MICROBE INTERACTIONS



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## ORGANISM EVOLUTION AND ECOLOGY

Researchers at the IGC work collaboratively to understand how organisms evolve and adapt to their environment. This field of research is not only advancing our understanding of the biological processes that shape life, but also has important applications for addressing societal challenges such as disease prevention and biodiversity conservation.

The **Evolutionary Biology** lab, led by **Isabel Gordo**, combines theoretical and experimental models to study bacterial evolution at micro-evolutionary time scales. The group performs experiments in mice to understand how bacteria evolve in the mammalian gut – a currently pressing question in ecology and evolution but also in medicine, since the gut microbiome is an important ecosystem for host health and many diseases are modulated by it. In 2022, the group:

- found that two modes of natural selection shape the evolution of a focal strain colonizing the mouse gut after antibiotic treatment;
- developed new theoretical models that help understand the patterns of natural selection found in the gut;
- developed summary statistics of the trajectories of mutations that spread to detectable frequencies in bacteria colonizing the gut microbiome;
- found the first empirical evidence for strong fluctuating selection acting on mutations of a gene related with iron metabolism and showed that such fluctuating selection is modulated by the composition of the microbiota, the level of gut inflammation and the host adaptive immune system.

Overall, these findings gave rise to a key new

question: what are the dominant modes of natural selection occurring in the mammalian gut in health and disease?

The **Population and Conservation Genetics** lab, led by **Lounès Chikhi**, on the other hand, is interested in the patterns of genetic diversity observed in present-day species due to their recent evolutionary history (collapses, expansions, periods of connectivity or disconnection, including introgression or lack thereof). The group's work involves interdisciplinary research, fieldwork in Madagascar, Borneo, and Portugal, data analysis and simulations, and theory to understand the limits of genetic data as inferential tools. In 2022, the group:

- published an article showing how different forms of selection along the genome can generate spurious signals of population size change, simply because selection influences the local level of genetic diversity which can be interpreted as variation in effective size along the genome and through time;
- carried out a comparative analysis using two groups of species of colobine monkeys from West Africa (fragmented habitats from Guinea Bissau and Tai National

Park from Ivory Coast). They showed that the populations that maintain the highest levels of genetic diversity are those still living in the Tai National Park. These results provide clear evidence that large continuous forested areas are necessary for the conservation of these species' genetic diversity;

- published a study using statistical associations along the genome to detect and quantify recent bottlenecks. Rémi Tournebize and colleagues managed to quantify the intensity of bottleneck in many human populations and tested the method on dog breeds;
- finalized genetic analyses, carried out by Gabriele Sgarlata, suggesting that the group identified a new species of *Eliurus*, an endemic rodent in Madagascar. The study is currently under review but freely available on bioRxiv.

This plasticity favors the emergence of novel functions, shaping organisms over time. However, how complex traits are originated and modified remains an active area of research. The following groups share an interest in understanding the mechanisms that shape organisms over time, each approaching the question from a unique perspective:

The **Evolution and Development** lab, led by **Élio Sucena**, focuses on the evolution of the immune response in insects, the mechanistic basis of disease tolerance, and resistance and immune cell function diversity and hematopoiesis in *Drosophila*.

In 2022, the group has established a robust protocol to measure disease tolerance in *Drosophila* and quantify its components, namely immunopathology and tolerance to virulence-induced damage. To explore the mechanisms underlying the variation in host response to immunopathology,

the researchers measured fitness traits (i.e., survival and reproduction) in ~200 *Drosophila melanogaster* isogenic lines (DGRP) after oral exposure to an inactivated form of the entomopathogen bacterium *Pseudomonas entomophila*. They observed considerable host genetic variation in immunopathology, that is highly sexually dimorphic and variable according to the level of pathogenicity of the bacterium species. Furthermore, they report that survival and fecundity are not necessarily correlated. The group is currently carrying out a genome-wide association study to determine the genetic basis for this variation in immunopathology.

Meanwhile, the **Genome Maintenance and Evolution** lab, led by **Marco Fumasoni**, studies the interplay between genome maintenance mechanisms and evolutionary forces in shaping cell biology. The group is interested in understanding how cells evolutionary recover from perturbations in the molecular mechanisms which replicate, repair, and segregate the genetic material. They are also interested in studying how these processes affect karyotype evolution and cellular aging. In 2022, the group:

- published a protocol paper on expansion microscopy with *S. cerevisiae* and a review preprint highlighting the lab's approach to evolutionary cell biology;
- was awarded a FCT exploratory research project (PeX) grant and an EMBO Installation grant;
- successfully hired a postdoc.

Finally, the **Functional Ecology** lab, led by **Giulia Ghedini**, is interested in understanding how species interactions shape the traits of species and the functioning of their communities. The group focuses on competition for resources and how it influences the plasticity and evolution of metabolic traits, using marine phytoplankton as a model system to investigate these eco-evo-





## PUBLICATION HIGHLIGHTS

### ORGANISM EVOLUTION AND ECOLOGY



→ Amicone, M., Borges, V., Alves, M. J., Isidro, J., Zé-Zé, L., Duarte, S., Vieira, L., Guiomar, R., Gomes, J. P., & Gordo, I. (2022). Mutation rate of SARS-CoV-2 and emergence of mutators during experimental evolution. *Evolution, Medicine, and Public Health*, 10(1), 142–155.

→ Barreto, H. C., Abreu, B., & Gordo, I. (2022). Fluctuating selection on bacterial iron regulation in the mammalian gut. *Current Biology*, 32(15), 3261–3275.e4.

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→ Teles, M. C., Faustino, F., Chanfana, C., Cunha, A., Esteves, M., & Oliveira, R. F. (2023). Social Enhancement of Adult Neurogenesis in Zebrafish is Not Regulated by Cortisol. *Neuroscience*, 509, 51–62.

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→ Tournebize, R., Chu, G., & Moorjani, P. (2022). Reconstructing the history of founder events using genome-wide patterns of allele sharing across individuals. *PLOS Genetics*, 18(6), e1010243.

lutionary dynamics because of their diversity and rapid life cycles.

In 2022, the group applied for an ERC Starting Grant and finished an experiment that tested the evolutionary consequences of competition on phytoplankton metabolism. This work showed that phytoplankton metabolism evolves rapidly (within ten weeks) in response to competition to maximize carrying capacity, providing a first demonstration of metabolic evolution in communities. The lab also established procedures for sorting phytoplankton species from mixtures which are required to progress the study of evolution in communities, and sequenced phytoplankton-associated bacteria to determine the nature of these interactions.

The social environment plays an important role in shaping the evolution and ecology of living organisms. How social behavior evolved is a matter of interest at the IGC, particularly for the **Integrative Behavioral Biology** lab, led by Rui

Oliveira. The group is interested on 1) the evolution of social behavior and its neural and genetic mechanisms; 2) the genomic and epigenomic mechanisms of social plasticity; 3) the effects of the social environment (i.e., social interactions, social isolation) on susceptibility/resilience to disease; and 4) cognitive bias and susceptibility/resilience to disease.

In 2022, the group continued their work on the neural and genetic mechanisms underlying social behavior both in zebrafish and fruit flies. Main findings include: 1) characterizing the genetic architecture of social behavior in zebrafish; 2) showing that adult neurogenesis in zebrafish is regulated by the social environment independently from stress, and 3) establishing a judgment bias test for zebrafish and using it to assess the association between judgment bias and fitness. During this year, the group published eight papers in peer-reviewed journals and completed three MSc theses.

## QUANTITATIVE AND SYSTEMS BIOLOGY

The IGC leverages its interdisciplinary expertise by integrating experimental and computational approaches to fully understand the complexity and dynamics of biological systems.

The **Optical Cell Biology** lab, led by **Ricardo Henriques**, develops analytical, optical, and biochemical approaches to tackle biological problems that cannot be addressed with current imaging technology. The group is particularly interested in the dynamics of viral infection at the nanoscale, having published numerous nanoscale studies on immunological NK cell activation and inhibition by its receptors in 2022. Although

the developed technology is designed to answer questions of interest in the lab, it has broad applications in cell biology research.

This lab is at the forefront of the development of open-source next-generation quantitative technologies for super-resolution imaging and machine-learning. In 2022, it established the enhanced Super-Resolution Radial Fluctuations (eSRRF) method, which can use real-time data-



driven machine learning to enhance super-resolution microscopy imaging. In addition, the group established partnerships with Roche and Abbelight, maintaining its commitment to translational research, and initiated the AI4Life network to provide life-scientists with easy access to high-performance machine-learning tools. The lab is also committed to training the next generation of researchers in this field. In 2022, they co-directed the Wellcome Trust UCL Optical Biology PhD programme and contributed towards the organisation of the IGC's PhD programme.

Accounting for biological function requires a new kind of physics. Both the Living Physics and the Physics of Intracellular Organization labs share a common focus on applying the principles of physics to understand biological systems.

Led by **Pablo Sartori**, the **Living Physics** lab studies the interplay between functionality and material properties of biological systems. A recurring question is how thermodynamics constrains biological function. The group addresses this at multiple scales: mechanical transduction in the structure of a motor protein, evolutionary conservation of ATP synthase function, thermodynamic phases of heterogeneous mixtures, and energetics of microbial metabolism. In 2022, the group:

- published a manuscript on the biomechanics of cilia, the first paper to which the principal investigator is a senior author;
- submitted manuscripts on evolutionary conservation of mechanical deformations of the ATP synthase structure and dynamics of neural networks;
- finished a manuscript concerning how multi-component mixtures assemble specific phases encoded in their interactions;
- began to write manuscripts on how protein

mechanics can bridge between conformational variability of structural data and the energy transduction cycle of AAA ATPases, in collaboration with CSSB (Hamburg), and on the energetics of microbial metabolism across species, in collaboration with MPI-CBG (Dresden);

- established unexpected collaborations on the topics of disease modeling and replisome dynamics through the PONTE programme.

On the other hand, the **Physics of Intracellular Organization** lab, led by **Ivo A. Telley** studies physical aspects of intracellular organization and uses *Drosophila melanogaster* oogenesis and early embryogenesis as model systems. The group works on three research tracks: how minimal chemical and physical cues determine oocyte polarity, the unbiased subcellular mapping of genome-wide RNA expression in the oocyte, and nuclear positioning during syncytial divisions in the one-cell stage embryo.

In 2022, the group reports three main lines of progress. Firstly, it made substantial progress in their FCT project aiming at identifying and resolving on a subcellular level novel mRNA essential for oogenesis and early embryogenesis in *Drosophila*, with full validation and new candidate genes. Secondly, it finished its studies and published a paper on the mechanical interplay between the oocyte and the somatic cells, maintaining oocyte polarization. Thirdly, in an in-house collaboration, the group finished a PhD project looking at the contribution of endoplasmic reticulum membranes on mitosis and published this work.

Besides identifying general principles and patterns of living systems, IGC researchers aim to integrate this knowledge to advance the prediction and control of complex networks. The **Complex Adaptive Systems and Computational Biology** lab, led by **Luís Rocha**, focuses on tackling multi-level complexity involved in

human health, via three main threads: complex networks & systems, computational & systems biology, and computational intelligence. Ongoing research ranges from understanding redundancy, robustness, modularity, spreading dynamics, and control in complex biological networks, to studying human health from biomedical literature, social media, and electronic health record data. The lab is also committed to interdisciplinary research, teaching, and graduate training, having hosted three students from the IGC's summer school programme, one of which in a collaboration with Miguel Soares' lab.

In 2022, the group was awarded a new FCT grant and published its work on redundancy in networks in excellent venues. They have also continued to develop two main software packages (with associated publications) that were shared with the systems biology and complex network communities. The principal investigator received many invitations to speak as a keynote at conferences and seminars, such as the European Conference on Mathematical and Theoretical Biology and the Northwestern University Complex Systems colloquium series, as well as many other workshops, university, and institute colloquia. He was also the program chair of Complex Networks 2022.



## PUBLICATION HIGHLIGHTS QUANTITATIVE AND SYSTEMS BIOLOGY



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# OFFERING RESEARCHERS THE BEST STATE-OF-THE-ART FACILITIES AND SERVICES

Research at the IGC is supported by a large array of scientific and technical support units that accelerate original and high-impact discoveries. In 2022, the IGC furthered its commitment to house state-of-the-art facilities and services by creating the Single Cell Hub, the first of its kind in Portugal.





## NEW SERVICES

In 2022, the Single Cell Hub and Microfabrication (BE $\mu$ FAB) were added to the list of IGC services offering the latest technology to support research.



### SINGLE CELL HUB

The Single Cell Hub was created with the aim of offering the latest technology to support scientific research in the single cell field. Researchers and technicians from IGC's Genomics Unit, strongly supported by the Histopathology, Flow Cytometry and Bioinformatics Units, support single cell and spatial transcriptomics projects from an embryonic stage until completion, providing technical and scientific support in the planning, design, execution, and sequencing of projects.

Training partners and companies is one of the hub's objectives, through events, courses, and collaborations. In 2022, the hub made itself known at the COLife and Paralab BAT – “From Smart to Spatial – RNA-Seq” meetings and promoted four events and training courses.

Since its creation, several research centers have already interacted with the hub, namely Instituto de Medicina Molecular (IMM), Instituto de Investigação e Inovação em Saúde (i3S), Nova Research, Champalimaud Foundation, Instituto de Biologia Experimental e Tecnológica (iBET), and the Cardiovascular Center of the University of Lisbon (CCUL).

### BIOENGINEERING MICROFABRICATION (BE $\mu$ FAB)

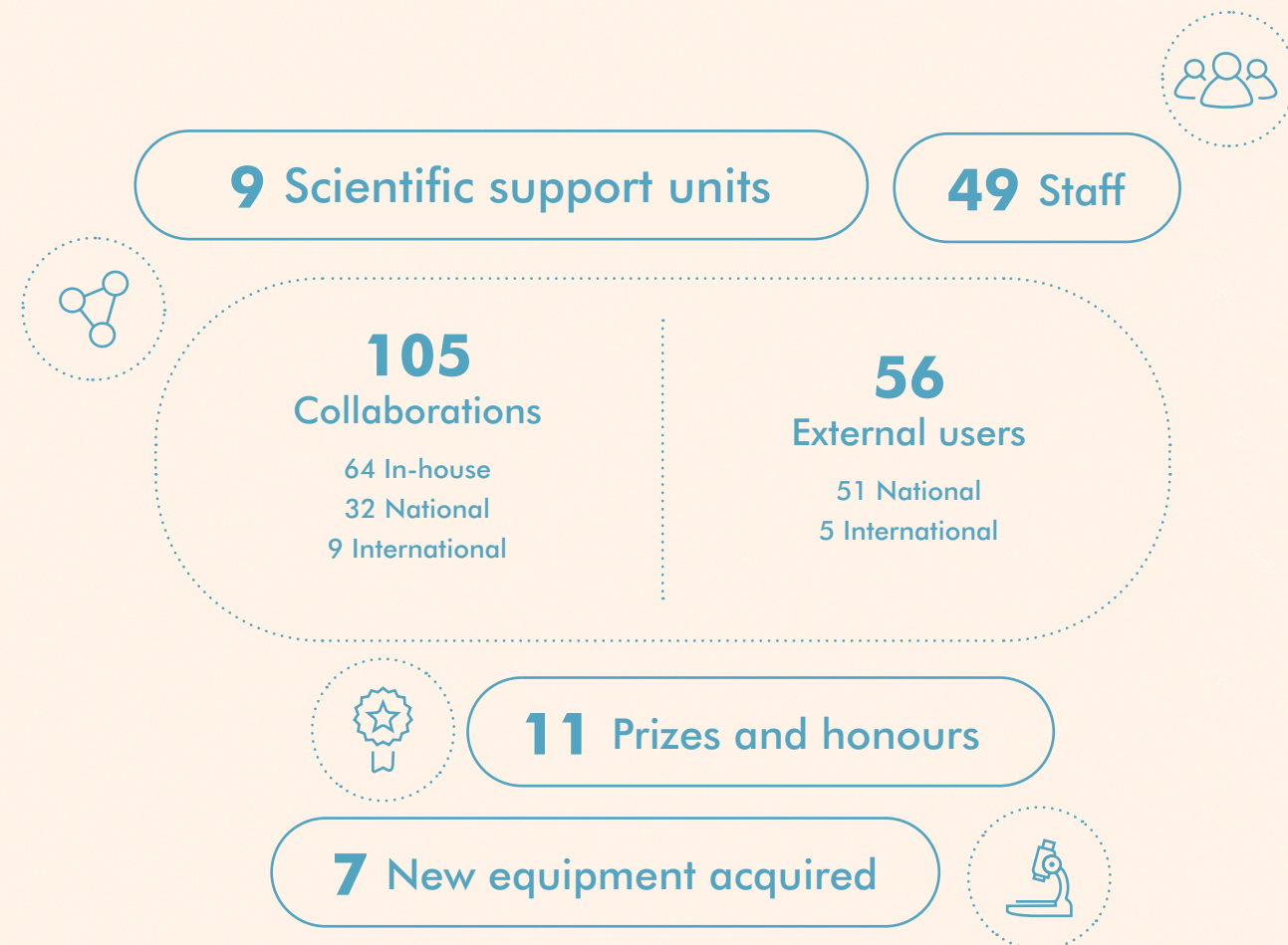
As part of the Single Cell Hub, the Bioengineering Microfabrication service aims to provide services of conceptualization and multi-scale fabrication of new devices and tools for applications in life sciences, so researchers can answer complex biological questions and accelerate their scientific findings. Creative and customised solutions are delivered for investigation – with a special focus on microfluidics and micropatterning technologies.

In 2022, the service's portfolio expanded with new microfluidics chips for diverse operations (size sorting, mixing, screening, cell trapping) and surface micropatterning protocols involving artificial lipid bilayers and oriented immobilisation of proteins. The operational opening of the new ISO7 cleanroom in April was a great contribution for such progress. Regarding lab tools and equipment, the service manufactured Arduino-based syringe pumps for precise flow-control on chips and mini-incubators with temperature and LED illumination control, holders for microscopy coverslips and chips handling, racks for beehives frames manipulation, micro-drilled filters for organoids among several miscellaneous parts – from optics to molecular and cell biology applications. The service was also particularly active in consultancy activities, supporting researchers in the preparation of their funding proposals. These contributed to the successful application to four grants (one local, two national and one international). These projects include the development of an open science super-resolution microscope, a microfluidics chip for lifespan studies in *S. cerevisiae*, a 3D micropatterning method to identify surface topology effects on T-cell activation, and a microbioreactor for fungi growth studies in solid media.



# SCIENTIFIC SUPPORT UNITS

Scientific support units at the IGC provide cutting-edge equipment as well as technology-driven expertise and services to support research. From training and technical consultation to the implementation of new applications and protocols, these units catalyze the production of original and high-impact scientific discoveries at the IGC, the Lisbon area, and beyond.



## ADVANCED IMAGING UNIT

The Advanced Imaging Unit, headed by **Gabriel Martins**, provides open access and support for light microscopy and is a reference unit housing more than 20 systems (confocal, 2photon, HTM widefield, SR, light-sheet & optical tomography). Users are trained for sample prep, instrument usage, and bioimage analysis, on-site or via regular internal and international workshops. Campus-wide support for optics maintenance and data analysis is provided.

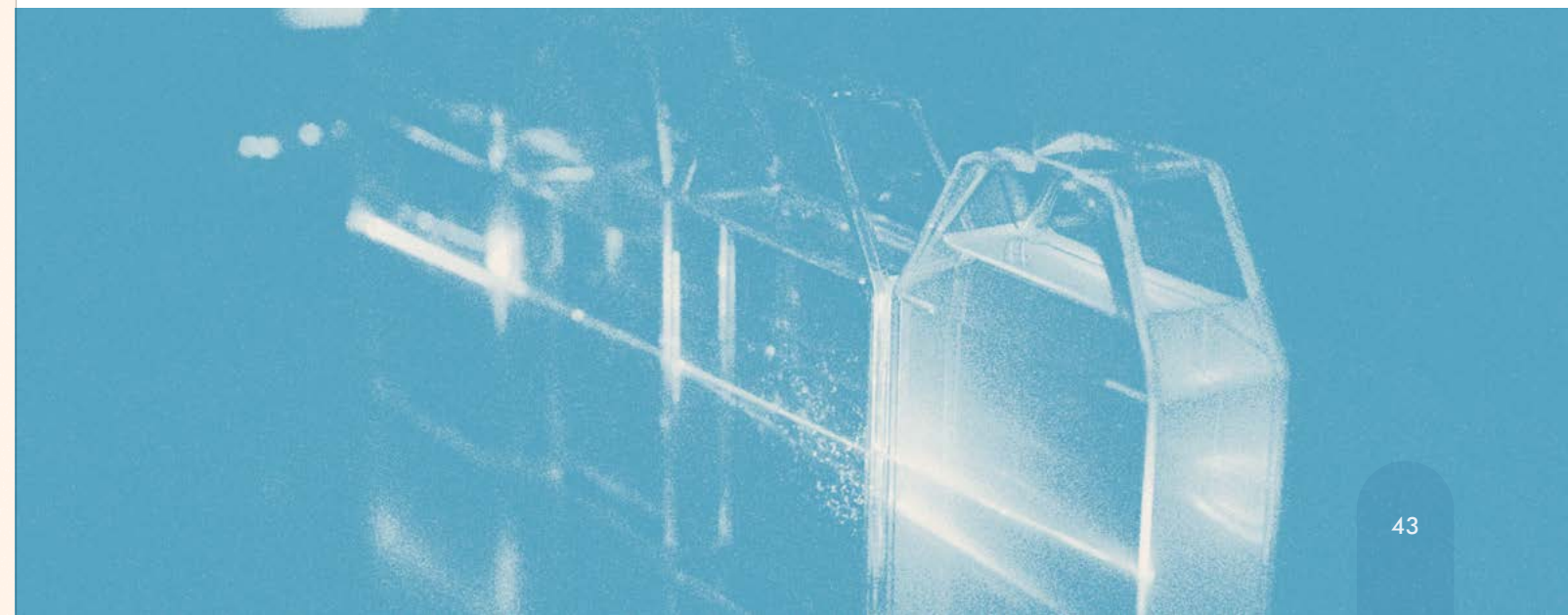
### In 2022, the unit:

- installed a new advanced system (LSM900);
- organised two international practical courses (EMBO) and three internal workshops on bioimage analysis;
- contributed to twenty publications, one of which with co-authorship;
- participated in the training of the Huygens Deconvolution and Cell Profiler software;
- presented two posters at the SPAOM2022 meeting in Spain;
- concluded and submitted the report of the FCT project "OPenT Mesoscope".

## BIOINFORMATICS UNIT

The Bioinformatics Unit, led by **Jingtao Lilue**, is running a core facility, which supports scientific research at the IGC, and multiple universities and research centers around the world. The unit provides a broad range of bioinformatic services, a one-stop service from experimental design to final publications. The group is also interested in population genetics, evolutionary genetics, mammalian genomes, transcriptomes, and genome assembly algorithms.

**In 2022, the unit** received 18 requests from research groups. It also provided and maintained high-performance computer virtual machines for six research groups on campus, including a Chipster and a Metagenomics server. The unit works closely with the Genomics and Quantitative Biology & Digital Science units on providing consultants for experimental design and data analysis. During the year, the unit successfully built a pipeline on single-cell RNA analysis and started testing the special single-cell transcriptome. The group co-authored two publications throughout the year and an additional one that is under revision.





## ELECTRON MICROSCOPY UNIT

Led by **Erin Tranfield**, the Electron Microscopy (EM) Unit is specialized in transmission electron microscopy for biological samples but is open to all scientific disciplines. The aim is to provide high-quality EM services, training, and access to specialized equipment for all the IGC, as well as external academic or corporate users. The EM unit tailors, optimizes, and develops methods adapted to the scientific questions of the Portuguese research community.

**In 2022, the unit** continued to provide EM services for research groups and collaborated with colleagues in the COLife community to build an EM Infrastructure in the Lisbon area. The unit also expanded its technical tools with the installation of a new ultramicrotome. Throughout the year, the TechEM Seminars continued to attract a large audience of international scientists interested in advancing EM and have fueled a growing international recognition of the IGC, including an Alan Agar Award. The unit also piloted a new intern programme for the Escola Superior de Tecnologia da Saúde de Lisboa (Degree in Biomedical Sciences) to continue in 2023.

## FLOW CYTOMETRY & ANTIBODIES UNIT

The Flow Cytometry & Antibodies Unit, headed by **Marta Monteiro**, offers flow cytometry and antibodies-related services and expertise to the scientific community. Staff is trained in instrument operation, providing support to cell sorting, cell acquisition, and data analysis. Full service is provided for antibodies-related requests and includes the production of monoclonal antibodies, antibody purification, and fluorescent labeling of antibodies and proteins. Training is available for all analytical instruments and SOP are implemented to comply with the highest quality standards required to ensure reproducibility in science.

**In 2022, the unit** was involved in the organisation of several events of flow cytometry education in collaboration with other Lisbon biomedical institutions belonging to the FLxFlow network. Of note, the technical webinar on Autofluorescence and Fluorescence Resolution in Conventional and Spectral Cytometry, by Dr. Alexis Perez Gonzalez, and the Best Practices in Panel Design Workshop, were two outstanding events that received unanimous excellent feedback from the community.

## GENOMICS UNIT

Led by **Ricardo Leite**, the Genomics Unit provides short (Illumina NexSeq 2000 and Illumina MiSeq) and long read Nanopore sequencing, as well as library preparation, and fragment-analyzer/TapeStation sample QC services. The unit provides a range of services: RNA-Seq, Whole Genome Sequencing, Spatial transcriptomics, and Metagenomics (bacterial 16S rRNA, ITS). For single-cell sequencing, the unit operates a 10X Genomics Chromium controller and the new Chromium X capable of high-throughput experiments. The group is equipped with the most recent liquid handling technology (Biomek i7; Hamilton Starlet and Formulatrix Mantis).

### **In 2022, the unit:**

- continued their effort to survey the FCG/IGC community for SARS-CoV-2, using saliva PCR tests and sequencing, as well as genomes in the context of the collaboration signed between FCG/IGC and Instituto Nacional de Saúde Doutor Ricardo Jorge (INSA) within a project coordinated by João Paulo Gomes;
- implemented a new 10x Genomics Visium Spatial Gene expression, this time with Fresh Frozen to map the whole transcriptome with morphological context (in close collaboration with the Histopathology Unit);
- participated in the “Malango project” to determine the bases of genetic resistance to antimalarial drugs in Angola, supported by FCT, Aga Khan, and FCG;
- provided services and support to 20 groups at the IGC;

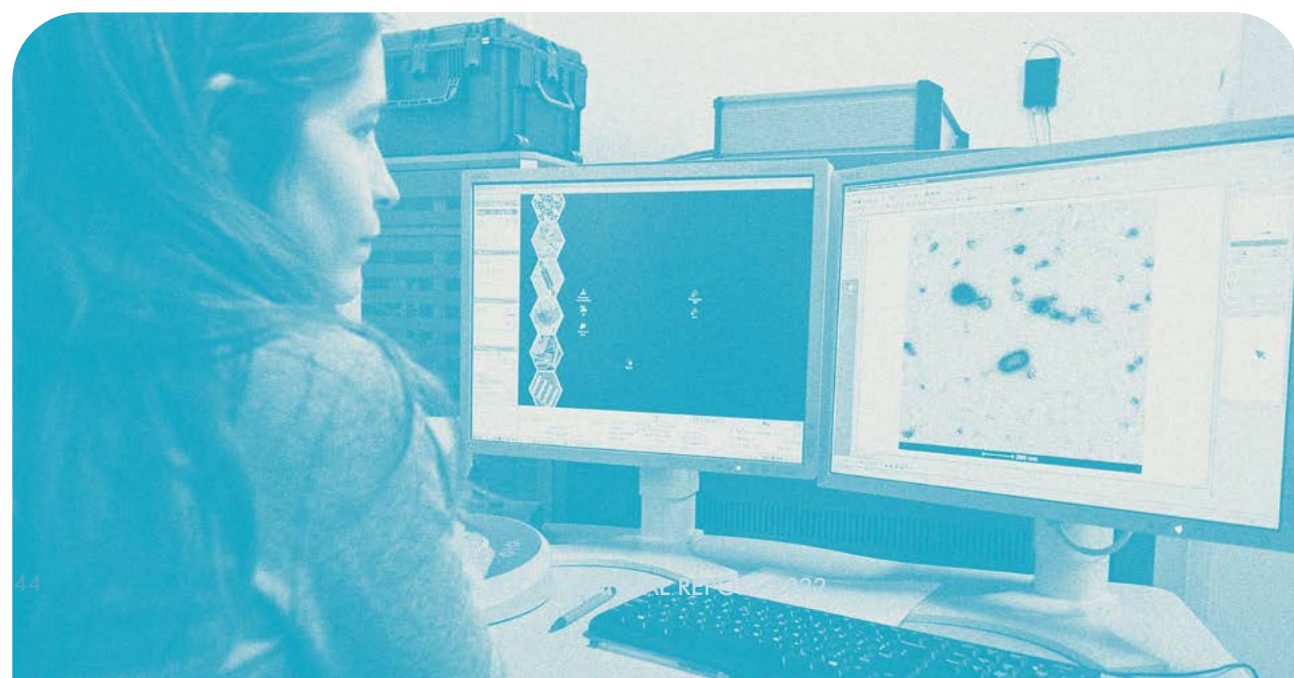
2022 was also the year of the commercial availability of the new NextSeq 2000 sequencer and the Chromium X from 10x genomics for Single Cell and the installation of the new Genomic robot Biomek i7.

## HISTOPATHOLOGY UNIT

The Histopathology Unit, headed by **Pedro Faisca**, is a user-oriented, fully equipped laboratory that provides high-quality histopathological services and pathology support to the IGC scientific community and external groups. The staff is highly qualified, with extensive experience working with a diverse range of samples, from humans to model organisms.

### **In 2022, the unit highlights:**

- ESTeSL internships protocol implementation;
- Visium Spatial Gene Expression for formalin fixed Paraffin embedded samples implementation and Visium Spatial Gene Expression in Fresh Frozen samples training;
- customized mold creation with the Microfabrication service;
- biobank implementation;
- resin protocol implementation (plants, lung stereology);
- protocol with Instituto de Medicina Molecular to perform pathology assessment for their groups.





## MODEL ORGANISM UNIT

The Model Organism Unit, led by **Manuel Rebelo**, provides infrastructure and services for model organism-based research at the IGC. It includes mouse, aquatic (zebrafish and frog), insect (fly, butterfly, and bees), and plant facilities. Services include husbandry procedures, general maintenance of facilities and equipment, advanced services such as rederivation, revitalization, cryopreservation, production of germ-free animals, gnotobiology, metabolism, conditions for infection studies with biological agents of biosafety level 2 (ABSL-2) and level 3 (ABSL-3), assistance to researchers, colony maintenance, animal importation and exportation, organisation of Laboratory Animal Science (LAS) courses, and support on legal issues.

**In 2022**, the ServCancer/INFRAFRONTIER project, funded by HORIZON EUROPE and involving the IGC's Mouse Facility/Germ-Free, was accepted. The project's primary aim is to offer cutting-edge and customized research services to the cancer research community EU-wide, enable innovative R&D projects, and foster precision medicine for patients' benefit across Europe. By connecting, coordinating, and aligning existing oncology and complementary research infrastructures (RIs) and synergistically providing services transnationally, canSERV will capitalize on the critical mass of experts and cutting-edge services offered by its RIs and their extended network. The European RI for disease models, INFRAFRONTIER, provides various services for cancer researchers and leads the efforts concerning *in vivo* models in canSERV. The IGC is the responsible partner for the cancer and microbiota interaction pipeline within INFRAFRONTIER.

## QUANTITATIVE & DIGITAL SCIENCE UNIT

Headed by **Tiago Paixão**, the Quantitative & Digital Science Unit is specialized in mathematical modeling, statistical inference, and research data management. The unit develops custom statistical inference tools, mechanistic models, and machine learning solutions for data analysis. It also provides consulting services on experimental design and data management.

**In 2022**, the unit instituted and hired an institutional data steward and developed new inference methods for Pooled Seq data, applied to evolve and resequence experiments (to be published).

## TRANSGENICS UNIT

The Transgenics Unit provides services that include the introduction of a wide spectrum of genetic modifications into the mouse and *Drosophila* genomes. These services are led by **Ana Nóvoa**, who assumed leadership at the start of the year, and **Leonardo Gaston Guilgur**, respectively.

The mouse transgenesis and genome editing services provides mouse models to internal and external researchers, both in Portugal and abroad. Using state-of-the-art technologies in the field, the staff performs microinjections of DNA into oocytes to generate transgenic mice, microinjections of gene-targeted ES cells into host blastocysts to generate gene knock-out or knock-in mice, and CRISPR/Cas9 reagents for gene editing projects.

Meanwhile, the fly transgenesis and genome editing service is equipped not only to supply embryonic microinjection but also to perform all the steps to generate customized construct cloning, on demand, offering an all-inclusive service to deliver transgenic and gene-edited flies.

Besides the technical assistance to produce the desired genetic tools, the transgenics unit provides consultancy and support to all issues regarding working with these models and state-of-the-art genome engineering techniques. This solid and personalized service has proven to be equal in time and far more cost-effective than external commercial companies.

**In 2022**, the unit started a new collaboration with the Axenic/Gnotobiology Facility, from the Model Organisms Unit, to provide transgenic and gene targeted mice in Germ free/Gnotobiotic conditions, both in FVB/N and C57Bl/6 backgrounds. Throughout the year, the unit worked on 44 different projects, for internal and external international researchers, producing 142 mouse transgenic embryos and 53 founder mice, in FVB/N and C57Bl/6 backgrounds, and 24 fly transgenic original lines relying on transgenesis methodologies as well as genome editing techniques like CRISPR/Cas9 induced modifications.





## PUBLICATION HIGHLIGHTS



## SCIENTIFIC SUPPORT UNITS

- Borges, V., Isidro, J., Trovão, N. S., Duarte, S., Cortes-Martins, H., Martiniano, H., Gordo, I., Leite, R., Vieira, L., Lira, A. J. S., Sousa Fernandes, A. M., Estrada, A., Nunes, A., Rodrigues, A., Caldas, A., Constança, A., Henriques, A. M., Matos, A. M., Oliveira, A. (2022). SARS-CoV-2 introductions and early dynamics of the epidemic in Portugal. *Communications Medicine*, 2(1), 10.
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- Smolle, M. A., Goetz, C., Maurer, D., Vielgut, I., Novak, M., Zier, G., Leithner, A., Nehrer, S., Paixao, T., Ljuhar, R., & Sadoghi, P. (2023). Artificial intelligence-based computer-aided system for knee osteoarthritis assessment increases experienced orthopaedic surgeons' agreement rate and accuracy. *Knee Surgery, Sports Traumatology, Arthroscopy*, 31(3), 1053–1062.
- Spruce, T., Plass, M., Gohr, A., Ray, D., Martínez de Lagrán, M., Rot, G., Nóvoa, A., Burguera, D., Permanyer, J., Miret, M., Zheng, H., Swanson, M. S., Morris, Q., Mallo, M., Dierssen, M., Hughes, T. R., Pernaute, B., Irimia, M. (2022). The X-linked splicing regulator MBNL3 has been co-opted to restrict placental growth in eutherians. *PLoS Biology*, 20(4), e3001615–e3001615.
- Tranfield, E. (2022). 'Just': the most deceptive word in science (and maybe life). *Microscopy & Analysis*.
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# TECHNICAL SUPPORT UNITS

Technical support units provide a wide range of services that support IGC science. Different teams work closely with the research groups, leading innovation actions, funding support, organising events, or managing projects, contributing to all IGC missions, and upholding the institute's standards of excellence.

12 Technical support units



59 Staff



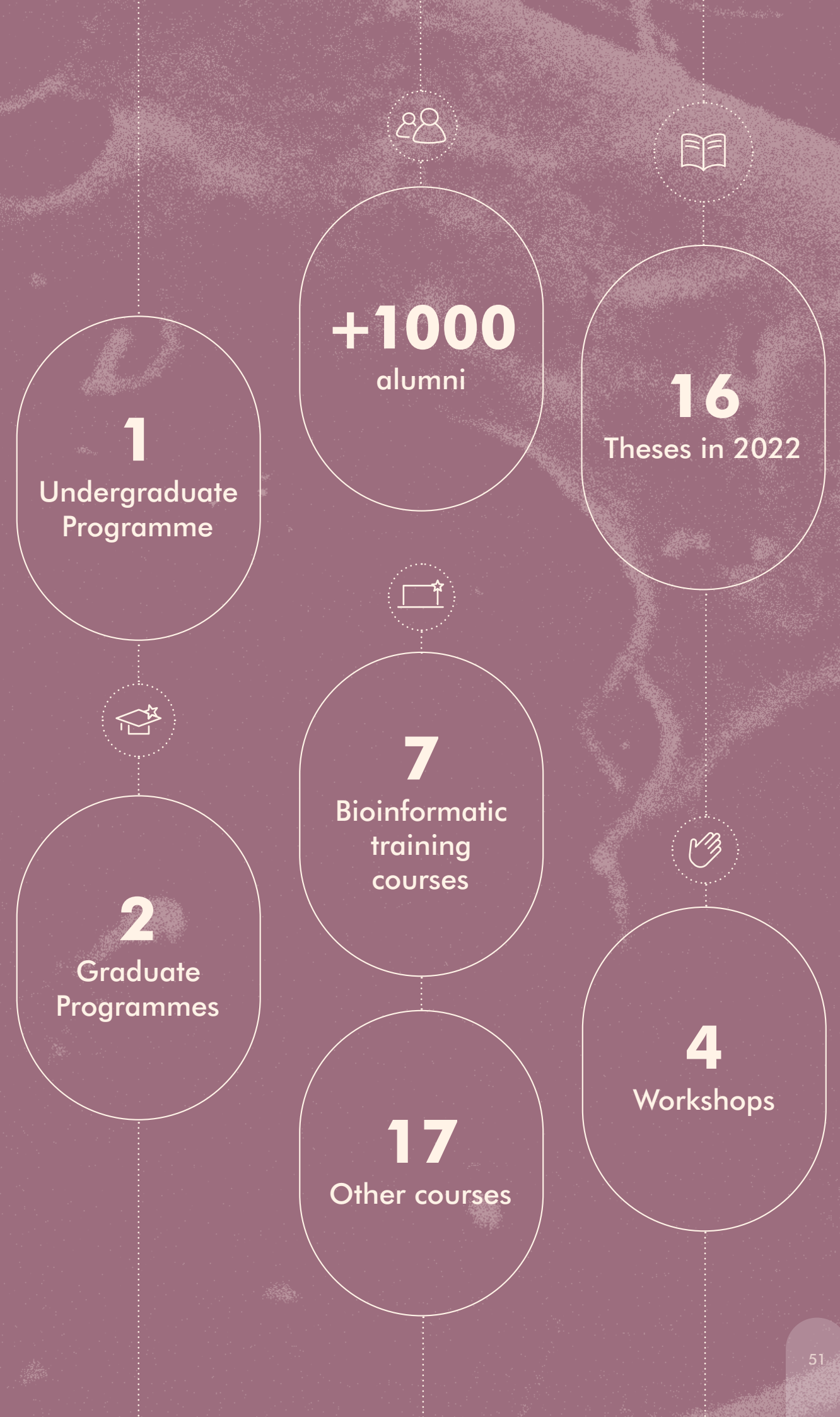
- Advanced Training
- Biosafety\*
- Information Technology Infrastructure
- Innovation\*
- Institutional Communication\*
- Lab Operations
- Maintenance
- People Management\*
- Procurement
- Project Management & Accounting
- Research Funding Affairs
- Science & Society
- Scientific Equipment & Infrastructures
- Scientific Events

\*These units were integrated in the headquarters' Communication (in October) and Human Resources (in September) services, respectively.



# FOSTERING INNOVATIVE TRAINING AND FURTHER INNOVATING ON HOW SCIENCE IS DONE

The IGC provides innovative training at all levels, from undergrads to postdocs, in a true commitment to incubate future talent. Apart from its well-known education programmes, including a PhD programme with 30 years of history, the IGC provides several training and career development opportunities to help scientists unlock their full potential.





## UNDERGRADUATE SUMMER SCHOOL

 177 Applications

 31 Students admitted

 18 Internships

 12 Nationalities

In 2014, the IGC and the University of Oxford ran a programme aiming to bring young science undergraduates to the IGC for a lab experience. This programme expanded to accommodate undergraduates studying in Portuguese universities, then in other European universities, and, recently, it started including students from all over the world.

In 2022, the programme ran in a hybrid format offering one week of in-person hands-on activities at IGC facilities for the 18 students selected for internships, in the morning, and afternoon seminars covering a wide breadth of themes related to science for all the students (including 13 participating via zoom). The programme included a field trip, organised in partnership with Cascais City Council, to the Avencas Marine Protected Area, where students collected samples, a science communication session held by the IGC's Institutional Communication Unit, and talks by Professor Mike Bruford and Professor António Coutinho. The lab internships were hosted in ten laboratories and three scientific support units of the IGC.

## IBB PHD PROGRAMME – INTEGRATIVE BIOLOGY AND BIOMEDICINE

 95 Applications

 10 New students

 6 Nationalities

 72 PhD students in the programme

 23 Nationalities

 7 Theses defended in 2022

The IGC's PhD programme offers the opportunity to learn biology from a combination of resident institute researchers and invited faculty from many of the world's most prestigious scientific institutions to a highly selected group of students. Students benefit from an intensive semester of coursework before creating their own research project and choosing the research groups to join. Candidates hail from all over the globe and have diverse academic backgrounds.

The class of 2022 maintains its international collaborations with the University of Cologne and the Max Planck Institute for Plant Breeding Research for the plant biology course, the University of Kiel and EMBL for the host-microbe interaction course (in the scope of SymbNET), and the University Paul Sabatier in Toulouse for ecology courses. Students also benefit from many educational courses and workshops throughout their PhD, including our popular bioinformatics training programme, weekly seminars, and an annual retreat. Graduate students drive social life at the institute, organising cultural events all year round. The IBB programme is supported by FCT and FCG, in partnership with the degree-award-

ing universities Instituto de Tecnologia Química e Biológica (ITQB) and Instituto Universitário de Ciências Psicológicas, Sociais e da Vida (ISPA).

In 2022, the following events took place:

- the **annual meeting of Gulbenkian PhD Students** was resumed after being postponed due to COVID-19. Students from the ITQB NOVA host-microbe Interface PhD programme were also present;
- the **IBB PI retreat**, a one-day workshop in which all the group leaders presented their research lines to the student cohort of 2021;
- the **IBB2021 Annual Workshop**: first-year students presented their projects to the IGC community.

During this year, the programme's accreditation was renewed for the next six years by the Agency for Assessment and Accreditation of Higher Education (A3ES).



## PHD THESES

DEFENDED IN 2022

→ André Dias (IBB 2017). Axial progenitors and the making of the vertebrate body plan: Understanding the process of axial extension in vertebrates. Defended in June.

→ Abdulbasit Amin (IBB 2017). Role of metalloprotease ADAM17 in metabolic regulation. ADAM17 in obesity and adipose tissue thermogenesis. Defended in June.

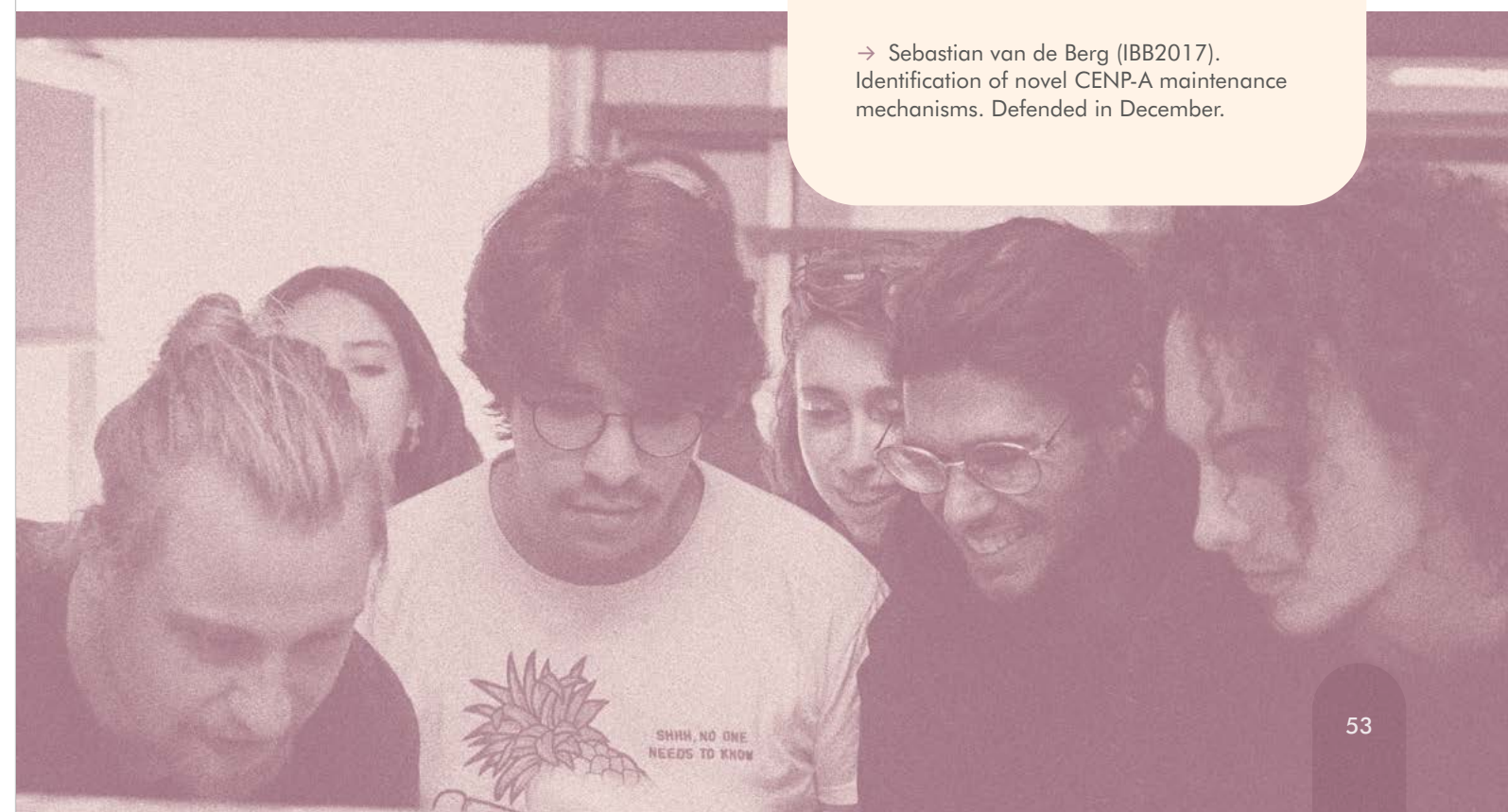
→ Mayra Martinez Lopez (IBB 2018). Zebrafish avatars as a model for immunotherapy response in bladder cancer. Defended in July.

→ Sahar Tehrani (IBB 2017). Determining the role of STAT1 and STAT3 transcription factors in transcriptional memory. Defended in October.

→ Gabriele Maria Sgarlata (IBB 2016). Habitat loss and fragmentation: effects on genetic diversity and differentiation. Defended in November.

→ Massimo Amicone (IBB2018). The role of competition in microbial evolution. Defended in November.

→ Sebastian van de Berg (IBB2017). Identification of novel CENP-A maintenance mechanisms. Defended in December.





## PONTE POSTDOCTORAL PROGRAMME IN THEORETICAL QUANTITATIVE BIOLOGY

 20 Applications

 2 New International postdoctoral fellows

PONTE is a programme for graduates in physics, mathematics, engineering, or a related field to perform research in theoretical quantitative biology hand in hand with experimentalists.

In 2022, the IGC welcomed two new fellows who established interdisciplinary collaborations and interacted with experimental groups on topics that include population genetics, systems medicine, and genome evolution.

## GTPB – GULBENKIAN TRAINING PROGRAMME IN BIOINFORMATICS

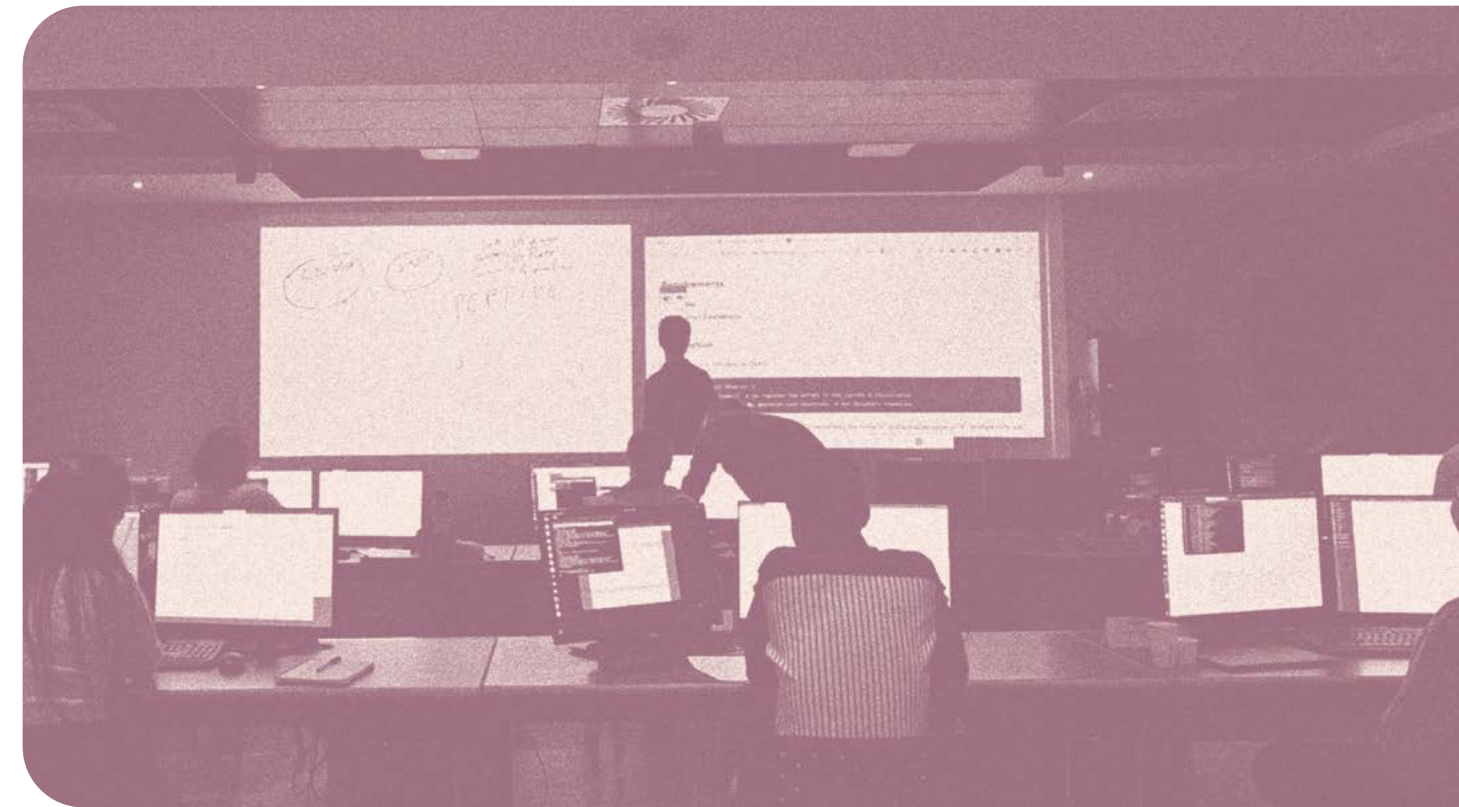
 7 Courses

 75 Participants

The GTPB runs face-to-face bioinformatics training courses regularly at the IGC since 1999. Up to now, more than 6250 course participants have acquired practical skills that they can use with a **high degree of independence**. The programme consists of a series of short intensive hands-on courses. The design of the courses is based on sets of carefully chosen exercises, flanked by short lectures and participative interaction sessions. Critical thinking, group discussions and self-assessment are key ingredients to build confidence in the independent use of the newly acquired skills.

### Modules held in 2022

- **Practical Statistics for the Life Sciences**  
(28 Mar – 1 Apr) – 11 participants
- **Precision Oncology**  
(9-13 May) – 7 participants
- **Computational Pangenomics**  
(23-27 May) – 19 participants
- **Integrative Biological Interpretation using Proteomics** (20-24 Jun) – 4 participants
- **Proteomics Data Analysis**  
(12-16 Sep) – 10 participants
- **Applied Metagenomics**  
(11-14 Oct) – 12 participants
- **3C-data Analysis and 3D Chromatin Folding**  
(22-25 Nov) – 12 participants





## MISSION

# BRINGING SCIENCE CLOSER TO SOCIETY

The IGC promotes science from all to all, with an agenda for diversity, equity, and inclusion. The institute achieves this through several initiatives, including programs and outreach activities that foster better science education and scientific literacy. By maintaining industry relations and promoting technology transfer, the IGC translates its discoveries into tangible benefits for humankind.



## INNOVATION AND TECH TRANSFER

 **54** Protocols with academia, industry and hospitals

 **1** Research licensing agreement

 **1** New provisory patent registration

InnOValley is the joint innovation unit of the IGC and ITQB NOVA created in 2019 with the support of the Municipality of Oeiras. The unit aims to boost the transfer of knowledge and technology from the scientific institutes to the society by establishing industrial partnerships, providing services, licensing technology, and creating new spin-offs, while empowering researchers with the knowledge and tools necessary to develop their projects.

One example that perfectly illustrates the InnOValley strategy is the first InnOValley Proof-of-Concept (IOV PoC) Fund. Launched at the end of 2021, the IOV PoC is a pioneer €200K Proof of Concept mechanism in Portugal, designed and implemented by the unit to leverage the potential of scientific research projects generated at the IGC and ITQB labs into viable economic products and services. From the 14 applications in the first edition, four projects were awarded €50K for a 12-month project that will further increase both institutes' innovation capacity. The second edition was launched in December 2022.

During that year, the unit was the leading party in the consortium application “Innovative Diagnostics and Therapeutic Solutions Within a One-Health Excellence Hub Ecosystem” to the 2022 European Excellence Hub call. The InnOValley Unit participated in the 2022 ASTP European TTO Meeting and one of its members, Pedro Pedrosa, received a fellowship for the LifeArc-North American Association of University Technology Managers 2022-2023 junior cohort.

## GULBENKIAN COLLABORATIVE CENTRE

 **50** Events organised

 **2** Sabbaticals hosted

 **2** Gulbenkian Senior Fellows hosted

The Collaborative Centre aims to promote the development of life sciences, enhancing interdisciplinary and collaborative research. More specifically, the centre intends to establish the IGC as an international hub that a) attracts talent and provides advanced training for scientists, b) enables researchers, clinicians, and entrepreneurs to collaboratively develop innovative projects, and c) develops initiatives that bring collaborative science to society and that contribute to reducing inequalities in the access to science and scientific knowledge. Currently, the Collaborative Centre administers a sabbatical programme and organises lectures, courses, conferences, and postgraduate training events. The centre also runs fellowships and awards, coordinates the selection of the corresponding awardees and, together with the Making Lab, runs a project that assembles portable, personalized, and easy-to-maintain mini-laboratories called Lab in a Suitcase.

**In 2022**, the Collaborative Centre:

- Organised around **40 face-to-face, virtual or hybrid scientific meetings** that involved many distinguished researchers;
- **Hosted excellent scientists**, including Dr. Jonathon Howard from Yale University and Dr. Jason Gigley from the University of Wisconsin, who performed their sabbaticals at the IGC;
- **Coordinated the second edition of the ERC-Oeiras Research Incentive Awards**,

which recognized the work of the IGC researcher Luís Moita;

- Took steps to **expand the scope of the agreement with the European Molecular Biology Laboratory (EMBL)**;
- **Produced 12 new suitcases** in the scope of the Lab in a Suitcase project and started a regional suitcase loan system in Oeiras;
- Launched a **new call for the António Coutinho Science Awards (ACSA)**, organised an award ceremony for the second and third editions, and hosted the first ACSA Alumni Meeting. The centre also inaugurated the “Ciência para o Mundo” exhibition, which was displayed in the FCG Gardens, in Lisbon, and in the Palácio Marquês de Pombal Gardens, in Oeiras.

## COMMUNICATION & PUBLIC ENGAGEMENT

Communication and public engagement initiatives play a vital role in promoting IGC's discoveries and increasing society's engagement with science.

 **326** News on national media

 **21** Press releases

 **2** Journal covers

 **10.594** followers (+14%)

 **41 135** followers (+31%)

 **2610** followers (+47%)

 **43 881** followers (+2%)

 **528 029** page views

### Events with science

 **+10k** People reached

The IGC promotes several actions to spread the values of science in society, increasing knowledge and critical thinking. In 2022, the Institutional Communication team organised several events, reaching over ten thousand people in a wide range of ages.

- **3 Concerts** – Music and Science at the Gulbenkian Foundation, presented by Isabel Gordo, Moises Mallo and Paula Duque | 6000 people
- **First COLife Hackaton** | 48 participants
- **Immunology Day** | 25 students
- **NOS Alive Music Festival 2022** | 1500 visitors
- **2nd edition of the International Festival of Science – FIC.A** | 2000 visitors
- **IGC Open Day** | 1000 visitors



## SCIENCE & SOCIETY

The IGC seeks to ensure the participation of society in the innovation and knowledge-creation processes, promoting critical reasoning and science as part of active citizenship. The Science in Society unit establishes dynamic bridges between researchers and citizens, making science accessible to all. It promotes education activities and life-long learning and encourages interdisciplinary approaches and citizen participation in the research and innovation processes.

### Education

The IGC develops science education programmes that target teachers and students at all levels, from preschool to higher education, aiming a greater involvement of the school community in science and its methodologies. The goal is not only to facilitate the transmission of knowledge but mainly to awaken curiosity and to promote the understanding and the assimilation of the scientific method.

### Lab in a Box

 18 Schools

 1625 Students

 40 Teachers

Lab in a Box (LiB) is a pioneering pedagogical project focused on experimental science. It is designed to develop a fascination for the environment, critical thinking skills and scientific curiosity. The LiB kit contains the materials and curriculum-linked protocols necessary for performing experimental science activities in the classroom. The project also provides training workshops to fully enable teachers to use the kit and implement hands-on activities in the classroom, while learning how to plan a scientific

experiment step by step. LiB also aims to promote the connection between science and society by showcasing its scientific experiments to different audiences and the public.

This project is supported by the Oeiras Municipality and Merck Family Foundation.

Below are some of the highlights from 2022:

#### LIB OEIRAS

- Production and delivery of **30 LiB Oeiras kits**;
- **Teacher training sessions** (two for the first and second cycles each);
- **New LiB activity** about antibiotic resistance and two new digital resources;
- **Workshop** for ten teachers from the project's first edition;
- **Workshop** at the Senior Academy Oficina de Saberes;
- **Science fairs**: FIC.A, European Researchers Night, Ciência Viva Clubs Meeting, IGC Open Day.

#### LIB PALOP

- **LiB experimental teaching methods workshop** for 34 teachers in Guinea-Bissau (impact on approximately 4,500 students);
- **LiB experimental teaching methods workshop** for 32 teachers in Benguela, Angola [seven local schools and the Institute of Educational Sciences (ISCED). Expected impact on a community of around 6,000 students].

### IGC Programme with schools

 761 Students

 2 School visits to the IGC

 7 IGC scientists' visits to schools

 3 Lab Chats

 2 Job shadowing

The school community – teachers, students, parent associations, and families – and its involvement in science is essential in the construction of a more participatory and knowledgeable society, with a greater critical spirit deeply grounded on scientific reasoning. The IGC develops science education programmes that target teachers and students at all levels of education, from preschool to higher education, aiming for greater involvement of the school community in science and research. The goal is not only to facilitate the transmission of knowledge but mainly to awaken curiosity and to promote the understanding and the assimilation of the scientific method.

In 2022, the programme was relaunched, with activities reaching over 800 students across 15 schools, encompassing diverse education levels.

### Citizen Science

 450 Citizens

 100 Students

 20 Teachers

 9 Invited artists

 12 Collaborators

 Partners: ITQB NOVA and Oeiras Municipality

The Active Citizenship Programme (Ciência + Cidadã) is an innovative collaborative project

between the IGC, ITQB NOVA, and Oeiras Municipality, promoting:

- **citizen science projects**: engaging citizens in real research projects in collaboration with researchers;
- **co-creation**: re-thinking science with citizens, combining education, art, and sport;
- **public consultation**: science-based decision-making, through citizen assemblies and other initiatives, in an open dialogue between citizens, scientists, and political representatives.

Below are some of the highlights from 2022:

- Citizen Science projects**: “Oeiras Experimenta” at Quinta do Marquês, “Human Gut Microbiome characterization - a pilot study in Oeiras” and “Tackling antibiotic micro-pollution”;
- **Citizen consultation** with seniors and disadvantaged people in Oeiras;
- **Art & Science**: participatory art mural at FIC.A; video animation and co-creation of two art panels made from laboratory plastic waste at the IGC Open Day (IGC Green Team and *Plasticus laboratorius*);
- **Theatre**: participatory playback theatre performance and sketch-noting at FIC.A;
- **Partnership with CAIS** non-profit association;
- Participation in the programme **IMPETUS/ Citizen Panel**;
- **Interactive online quiz** about the microbiome.



## MISSION

# PROMOTING NATIONAL AND INTERNATIONAL PARTNERSHIPS

The IGC collaborates with leading research institutes from all around the world to promote joint research projects, publications, and the exchange of knowledge and resources. This highly collaborative and multidisciplinary mindset, starting in-house, brings together the diverse expertise needed to tackle complex scientific questions and push the boundaries of scientific understanding.



**290**

Collaborations

92 In-house  
119 International  
79 National



**2**

International sabbatical visitors

**209**

Talks from IGC staff



**64**

External speakers at IGC seminars  
83% international  
17% national





# NATIONAL COLLABORATIONS

As part of a vast network of scientific institutions in Portugal, the IGC collaborates with a range of partners that share complementary expertise, infrastructures, and services. In 2022, the IGC focused on building new partnerships and strengthening existing ones, leveraging impactful research in the life sciences to the global stage.

## COLIFE – NATIONAL ALLIANCE OF 6 RESEARCH INSTITUTIONS IN LISBON AND OEIRAS

With the motto “Stronger Together”, the COLife alliance includes IMM, IGC, ITQB-NOVA, Champalimaud, iBET, and CEDOC-NMS and was built with three main aims: 1) maximizing critical mass and resources by sharing scientific facilities, services, and scientific expertise; 2) promoting national and international visibility and attract talent to COLife institutes, and 3) having an active participation in the development and implementation of science policies.

In 2022, Mariana Silva, the COLife coordinator, embarked on one-month rotations at partner institutes to rekindle the alliance's spirit, strengthen relationships within the institutes, explore new project opportunities, understand the needs of research communities, and enhance the visibility of research and facilities within the community.

With the beginning of the crisis in Ukraine, since March, COLife institutes have welcomed a few students from that country. During that month, in partnership with Ciência Viva and with the support of the Oeiras Municipality and Portugal Bugs, COLife organized the “Future Food Challenge” Hackaton. With the help of eight COLife scientists, 48 university students designed and

discussed scientific solutions for problems associated with world feeding.

To celebrate the National Scientist Day, COLife released a presentation video, providing a glimpse of its extensive scientific community and excellent research and technical facilities.

In September, COLife organized its second Community Meeting, bringing together 260 participants from all institutes and career stages. It featured scientific talks, technological pitch sessions, and round table discussions on topics of interest to all COLife institutes.

In October, COLife held its first PhD day, enabling 75 students from the different COLife institutes to network, learn about the science conducted at other institutions, and explore potential future collaborations. The first COLife postdoc day was held in November at the IGC, with the participation of 90 postdocs. The event was designed to promote interaction, strengthen communities, and encourage discussion on common interests.

Throughout the year, COLife organized several courses and workshops in collaboration with the COLife Bioimaging, Histopathology, and FlxFlow working groups.

## LS4FUTURE – LIFE SCIENCES FOR A HEALTHY AND SUSTAINABLE FUTURE

The Associate Laboratory LS4FUTURE is a unique infrastructure in Portugal that brings together five Portuguese research institutes – the IGC, ITQB NOVA, iBET, NOVA Medical School (NMS - Universidade Nova de Lisboa), and Instituto Português de Oncologia Francisco Gentil –, and four research units – MOSTMICRO-ITQB, GREEN-IT, the IGC, and iNOVA4Health.

LS4FUTURE is based on the concept of “One Health,” aimed at human and environmental health for a sustainable future. By bringing together diverse and complementary knowledge, LS4FUTURE addresses problems in an interdisciplinary and comprehensive way, offering effective solutions to current and emerging social challenges.

The Associate Laboratory status was granted by FCT in 2021 for a period of ten years, and its funding was awarded for five years, with the contract signed in February 2022.

In 2022, the activity of this associate laboratory focused on two areas. First, on strategic planning to ensure the achievement of the goals defined for each of LS4FUTURE's pillars, and secondly, on appointing LS4FUTURE's coordination team, responsible for implementing the action plan at the level of careers, internationalization, translation, and communication.

In May 2022, a kickoff session was held at the IGC, bringing together all partners involved. In October 2022, the “Research Management Staff Meeting” was launched to promote interaction



between the members of the Scientific Projects Management Offices of the various institutes. The LS<sub>4</sub>FUTURE also marked the "Science and Technology Week" with an online meeting to bring science and society closer.

## CATÓLICA BIOMEDICAL RESEARCH CENTRE

In 2022, FCG and Universidade Católica Portuguesa signed a memorandum of understanding to establish the Católica Biomedical Research Centre on IGC premises. For four years, this agreement foresees the sharing of available resources, highly specialized infrastructures, and equipment, including access to the IGC's scientific support units.

This partnership is in line with the IGC's history of incubating scientific projects in life sciences that later became prestigious research centers in Portugal; examples of this are the Champalimaud Foundation, ITQB NOVA, and CEDOC (currently Nova Medical School Research).

## BRIDGING SCIENCE AND HEALTH

The IGC maintains strong partnerships with hospitals, public health agencies, and industry leaders to advance innovative research and development in healthcare.

In 2022, the IGC continued its collaboration with Centro Hospitalar Lisboa Ocidental and Centro Hospitalar Lisboa Central, EPE, to study COVID-19 vaccine effectiveness (through the INFO-VAC project) and further explore the potential of the award-winning saliva test developed for diagnosing the disease in children. Through its partnership with INSA, the institute continued to study SARS-CoV-2 and immune responses, having published a paper on the virus mutation rate during experimental evolution.

Beyond COVID-19, the IGC collaborated with Centro Hospitalar Universitário Lisboa Norte, EPE (Hospital de Santa Maria) on a study regarding postoperative bleeding in heart surgery. The IGC also maintains a partnership with CUF for the exchange of knowledge, training, and research, and the Hospital Lusíadas Lisboa in the scope of the EMERALD PhD programme.

IGC's partnerships extend to leading, technology and pharmaceutical companies to establish strategic partnerships and commercialize intellectual property assets. In 2022, the IGC and Medinfar gathered for the first edition of the Translational Open Day, an initiative that aims to reinforce synergies by identifying innovative and mutually beneficial collaboration projects. A delegation from MERCK also visited the IGC to assess the impact achieved with projects such as Lab in a Box, Lab in a Suitcase, and the António Coutinho Science Awards, identify new opportunities and align strategies.

## PARTNERSHIP WITH OEIRAS CITY COUNCIL

Oeiras has a set of unique conditions that position the municipality as a benchmark ecosystem in the development of R&D activities, entrepreneurship, the attraction of companies and promotion of science. IGC's partnership with the Oeiras Municipality aims to take science closer to the society, through initiatives including Ciência Aberta a Oeiras, Oeiras Educa, Ciência + Cidadã, and the Lab in a Box and Lab in a Suitcase projects.

In the scope of the Oeiras Science & Technology strategy, in 2022, the IGC collaborated with the Municipality in three main axes:

- 1) **education:** by coordinating several activities with students, from elementary school to university, and various public engagement, citizen and open science initiatives aimed at different audiences;
- 2) **innovation:** with the aim to advance life sciences research in Oeiras towards the translational pathway, the Oeiras Municipality, the IGC, and ITQB NOVA awarded €50K to four innovation projects in the first edition of IOV PoC;
- 3) **internationalization:** the Oeiras Municipality supported research activities through the António Coutinho Science Awards, in partnership with IGC's Collaborative Center and the Merck Family Foundation, as well as the Oeiras ERC Frontier Research Incentive Awards.







# RESEARCH STRUCTURES

Four research structures of the IGC are included in the National Roadmap of Research Infrastructures.

## BIODATA.PT: PORTUGUESE BIOLOGICAL DATA NETWORK

Executive Director: Ana Portugal Melo

BioData.pt is the Portuguese distributed infrastructure for biological data and the Portuguese ELIXIR node. It is a not-for-profit private association of 13 R&I organisations. BioData.pt supports the national scientific system through best practices in data management and state-of-the-art data analysis. It interfaces with both academia and industry, making research available for innovation, namely in sectors such as agro-food and forestry, sea, and health. BioData.pt services include ELIXIR services such as its training programme and computing facilities, as well as consulting services in data analysis and management, and several community services.

In 2022, BioData.pt:

- trained the first cohort of data stewards for life sciences in Portugal in collaboration with ELIXIR and several Portuguese organisations;
- hired the first data steward for life sciences in Portugal to support the implementation of data management policies and best practices at the IGC, and welcomed a new project manager that took over the role of Node Coordinator;
- participated in international projects (ELIXIR Converge, AgroServ and GDI) and in ELIXIR implementation studies (Beacon, Federated Human Data, Increasing, Training Platform, Impact evaluation at Node-level - getting it done);

- held a technical meeting, the national All Hands and the node SAB assessment, and a monthly webinar (the BioData.pt Talks);
- participated in several ELIXIR communities, platforms and focus groups;
- contributed with expertise and resources to the publication of 13 papers;
- initiated two staff exchange programmes: OAT-EN - Open access tools for effective management of ELIXIR nodes (12 nodes), and ELIXIR PT as a case study for the deployment of Local EGA/Beacon v2 instances (3 Nodes);
- gained a new associate, UCIBIO.

## PPBI: PORTUGUESE PLATFORM OF BIOIMAGE

South Region Co-coordinator: Gabriel Martins (IGC)

PPBI is a common functional platform dedicated to promoting the technical integration and centralized management of shared resources in bioimaging. Organised as a consortium of top research universities and institutes in Portugal, the PPBI services focus on advanced microscopy and processing/analysis of images in the life sciences, from cell & developmental biology, neurosciences, oncobiology, immunology, infection, and regenerative medicine.

The PPBI Euro-BioImaging Node integrates the European research infrastructure as a Biological Node of Euro-BioImaging ERIC. PPBI nodes provide a wide variety of services in bioimaging, including access to imaging equipment, wet lab, and sample preparation equipment, cluster access for computation and data storage, image analysis, and training (courses and workshops, online tools). This infrastructure also offers support for animal facilities (model and non-model organisms) and equipment operation, consulting and project planning, technology development, and outreach activities.





## GENOMEPT: NATIONAL FACILITY FOR GENOME SEQUENCING AND ANALYSIS

IGC Coordinator: Ricardo Leite

GenomePT is a distributed genome sequencing and analysis infrastructure for basic and applied genome research and advanced services. Its main objectives are: 1) to potentiate participation in national and international genome projects, and 2) to develop clinical, environmental, biotechnology and green chemistry. GenomePT congregates more than 90% of national centers involved in genomic, brings over 5M€ of investment in genome sequencing, over 40 researchers and technical personnel, and bioinformatics expertise that are dispersed across Portugal.

The priority of GenomePT is to resolve existing fragilities at the consortium node level, including HR, sequencing capability, data reproducibility, computational power, bioinformatics tools and advanced training.

## CONGENTO: CONSORTIUM OF GENETICALLY TRACTABLE ORGANISMS

Steering Committee member at the IGC:  
Jocelyne Demengeot

CONGENTO is a research infrastructure (RI) with partners at the IGC, Fundação Champalimaud, iMM, and CEDOC. This RI synergizes technology development across mouse, zebrafish, and *Drosophila*, providing state-of-the-art services in these organisms, integrating the expertise of all partners. Training and education on laboratory animal sciences and technologies are cornerstones of CONGENTO. Regular and ad-hoc events are organised by the consortium and provide frequent opportunities for continuous learning, aiming to address the specific needs of the scientific community.

In 2022, the animal Welfare Body/ORBEA-related issues working group, aimed at improving standards of animal welfare and harmonizing procedures amongst partners, met several times, and directly interacted with the state institution DGAV, e.g., to improve documents and forms that reach the end users.

The education and training working group organised harmonized courses on Laboratory Animal Sciences (LAS) available throughout the year at the four CONGENTO institutions. These courses cover FELASA contents for Functions A+C+D and upgrade to Function B. In addition, several workshops were organised: Severity Assessment; Statistics; Anesthesia and Surgery in rodents; Necropsy, Zebrafish Xenografts, and "hands-on molecular tools".

Finally, the steering committee worked out the expansion of the infrastructure, formally engaging additional partners for the North and South of Portugal, to enrich the portfolio of services and prepare for eventual funding opportunities.

# INTERNATIONAL COLLABORATIONS

The IGC teams up with leading institutions worldwide to address complex questions in the life sciences and push the frontiers of science and technology.

## EU-LIFE: ALLIANCE OF RESEARCH INSTITUTES ADVOCATING FOR EXCELLENT RESEARCH IN EUROPE

EU-LIFE is an alliance of 15 independent European research institutes in the life sciences. It contributes to the improvement of research by influencing European science policies and developing, implementing and disseminating best practices in the organisation and management of research institutes. EU-LIFE institutes share the view that scientific excellence in life sciences can only be achieved through strong adherence to principles of quality, scientific integrity, ethical responsibility, societal accountability, ecological sustainability, gender equality and cultural diversity while promoting a strong dialogue with society.

In 2022, the IGC Director Mónica Bettencourt-Dias was appointed as Chair of the alliance and Giulio Superti-Furga, from CeeM, Austria, co-Chair. During the year, EU-LIFE has contributed to drafting the Reform Research Assessment Agreement as a member of the Core Group. EU-LIFE has also launched several policy papers and contributed to the European Commission's Consultation on the Health Cluster's programme impact.

## COLLABORATIVE AGREEMENT WITH EMBL

The IGC and EMBL have a memorandum of understanding (MoU) to promote scientific cooperation and unite complementary strengths. Such strengths lie in promoting scientific collaborations, developing training opportunities, and increasing technical expertise, particularly in electron and advanced light microscopy, genomics, and bioinformatics, as well as in technology transfer activities. In 2023, the partnership with EMBL will allow the IGC to establish a programme to leverage the national scientific landscape.

The IGC and EMBL share a common vision for research in the life sciences and have a history of several joint actions, including the twinning project on host-microbiome symbiosis research – SymbNET.





# COLLABORATIVE INITIATIVES

## SYMBNET TWINNING

SymbNET is a European network for host-microbe symbiosis research funded by the EU's H2020 Programme (900K€), running from 2021 to 2023. The project is coordinated by the IGC and involves four other institutes: ITQB NOVA in Portugal, the University of Lausanne (UNIL) in Switzerland, EMBL and Kiel University (CAU) in Germany.

The project aims to promote the transfer of knowledge and collaborations through programmes of researchers and staff visits exchanges, collaborative projects, sponsoring the use of new technologies, organising scientific meetings, workshops, PhD Summer Schools, and a European meeting on host-microbe symbiosis. Specific actions targeted at early-stage researchers are planned, to promote research, training, mentoring, and networking, ensuring gender equality in participation.

SymbNET also aims to develop the IGC management and administrative capacity in collaborative grants (applying and managing), in the organisation of international scientific events, and in career development. This impacts the following

IGC Units: Research Funding Affairs, Collaborative Centre, Institutional Communication, People Management, and Project Management.

In 2022, several in-person events were organised, potentiating all the interactions this network can provide. Below are some highlights:

- the first in-person SymbNET Interim Meeting gathered over 60 team members for two days at the IGC to share their work, design future interactions and establish/strengthen collaborations;
- the first edition of the SymbNET PhD Summer school at the IGC, with 20 lecturers and 35 students from 13 different countries;
- the Research Managers and Administrators capacity building one-day event with 40 participants at the IGC and 80 online;
- SymbNET seminars with six talks in person at the IGC (in 19), streamed online and opened to the entire community;
- the first experts and staff exchange visits among partners;

- participation in three outreach events (open session on microbiota and human health at FCG; FIC.A and IGC Open Day);
- organisation of two career development events and co-organisation of two symposiums (GloMiNe and Microbiome Metabolomics);
- €28,000 in SymbNET Funding for collaborative projects (two PhD awards; five Research Grants).

## MICROBIOTA VAULT

The Microbiota Vault initiative sets out to preserve the biodiversity of the human microbiota by supporting collection efforts and constructing an infrastructure for the safe preservation of samples. The goal is to conserve long-term health for humanity.

The project is supported by a team of international experts, including IGC researchers who have decisive roles on two fronts: contributing with scientific knowledge and enhancing the networks developed over the years by IGC's Science for Development Programme, an advanced training programme for researchers from Portuguese-Speaking Countries in Africa and Brazil.

To expand sample collection and attract partnerships in Africa, in 2022, the IGC hosted the second Global Microbiome Network – GloMiNe – Symposium for Africa. The event brought together scientists from African academic institutions and other countries to discuss the importance of conservation efforts on microbial diversity.

## EMERALD PROJECT

Emerald, the first European-wide physician-scientist training programme, provides medical doctors with state-of-the-art biomedicine skills and helps bridge the gap between laboratory research and clinical practice. Funded by the EU's Horizon 2020 programme, Emerald provides medical doctors with unique opportunities to move to a different country to conduct their PhD research project, participate in tailored summer schools, benefit from peer-mentoring, and explore new collaborations.

Aligned with its strategy to promote scientific partnerships with different sectors to generate new knowledge with impact, the IGC is one of the eight cutting-edge European biomedical research institutes to train the next generation of physician-scientists. In 2022, the IGC welcomed one MD-PhD Emerald student who joined the IBB – PhD Programme and will enroll at a partner medical university. A new Emerald call was also open.







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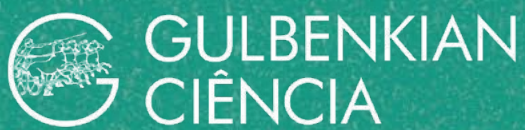
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