

Annual Report 2021



Index

4 | Direction Statement

6 | Organization

10 | In numbers

12 | Timeline

16 | Missions

72 | COVID-19 Efforts

76 | Directory

Direction Statement

2021, sharpening IGC's agenda towards a more sustainable and healthier future



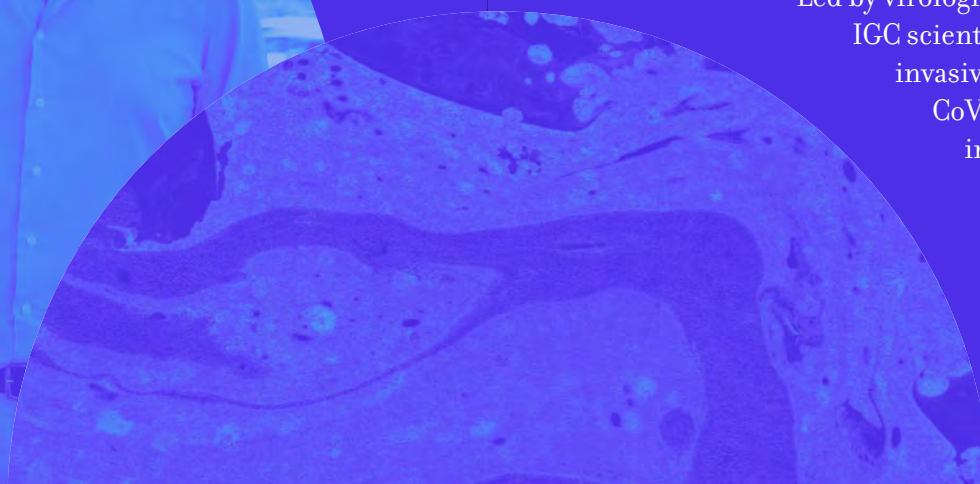
2021 was another year of challenges as the world continued to face disruptions related to the COVID-19 pandemic. At IGC, we remained determined to continue pursuing a healthier and more sustainable tomorrow through frontier science, while at the same time embracing the challenges and make the most out of our expertise and knowledge to help society fighting the pandemics for a healthier today. 2021 ended on a high note with a new project for IGC's future, through sharpening its scientific agenda and spreading its installations to the river front, with other institutions and hospitals, creating a leading international life-sciences and biomedical research campus.

Focused on a healthier today, the IGC COVID-19 task force headed by immunologists and geneticists Jocelyne Demengeot and Carlos Penha Gonçalves worked in several fronts, in work that included the genomics team and members from several groups at the IGC. Within Portugal, with Lisbon (CHLO) and Fernando Fonseca hospitals, and with Oeiras and Almeirim councils, IGC scientists monitored the efficacy of different vaccines and their impact in health care workers, teachers, elderly communities and cancer patients, addressing vaccine immediate and long-term effects. Together with the national institutes of health, INSA, hospitals and other research institutions, our scientists monitored existing and emerging SARS-CoV-2 variants, as well as investigated others that may arise through experimental evolution, while addressing their potential to evade the immune system.

Led by virologist M João Amorim, IGC scientists developed a less invasive and cheaper Sars-CoV-2 diagnostic test, implementing a saliva surveillance program within FCG to

ensure safety within the work environment. The results of IGC studies were highlighted in several national and international newspapers and scientific outlets, and played an important role in advocating the urgency for a booster dose in Portugal, which was given in the fall 2021. For their work, IGC's scientists received the Grand Prize from the Portuguese Society of Pediatrics, as well as the Gilead Sciences 2021 Program Prize. This work was only possible due to the combination of scientific expertise covering different disciplines at IGC, as well as the availability of multiple technologies and equipment within IGC. Moreover, 2020 efforts in the serology4covid consortium led by IGC culminated in the development of a marketable ELISA assay with IBET and the Group Medinfar in 2021. The prototype of this assay was used by many Portuguese research institutions in efforts that have led to the publication of more than 12 papers so far.

In 2021, IGC scientists fought for a healthier and more sustainable tomorrow by pursuing frontier science, bridging between different disciplines but all converging into a common scientific vision of the 'organism in its environment', excellently supported by our state-of-the-art technological infrastructures. Aligned with today's planetary challenges, IGC sharpened its research agenda, giving heightened attention to the role of the environment for organismal wellbeing and survival. In this context we investigate the shaping and functioning of cells, organisms and their communities, with an important emphasis on the role microbes, within and surrounding us, friends or foe, play in those processes. In pursuing this line of knowledge, IGC has and will continue to strengthen its cross-disciplinary approaches, in particular regarding complex data analysis, promoting computational, quantitative and theoretical life-sciences. In 2021, IGC scientists elevated our understanding of both the



biology and physics underlying cell and organism development, homeostasis and interactions with microbes. Through the work of different teams, IGC scientists uncovered major forces that shape fitness, variation and evolution of microbial populations, in particular the ones in our gut, including the role of temperature, nutrients and other microbes. Severe sepsis remains a poorly understood systemic inflammatory condition with high mortality rates and limited therapeutic options outside of infection control and organ support measures. Based on their discovery in mice, Luis Moita's team started a clinical trial in the context of severe sepsis, to test the protective effect of epirubicin.

Excitingly, three new group leaders started at the IGC in 2021, strengthening our agenda to look at the cell biology, ecology and evolution of microbial populations: Marco Fumasoni, studying the interplay between genome maintenance mechanisms and evolutionary forces in shaping cell biology; Waldan Kwong, focusing on understanding how microorganisms live in their environment, evolve, and interact with each other within the gut microbiome of bees and Giulia Ghedini, investigating the mechanisms regulating the functioning of ecological communities within sea microorganisms. It is very thrilling and gratifying to see how well they have adapted to IGC, as well their influence in shaping IGC's science and *modus operandi*.

Besides pursuing excellent research another strong pillar of IGC strategy is collaboration and internationalization, with a view to strengthen our ability to address complex problems, as well as attracting outstanding talent. We recently renovated part of the IGC building for the Collaborative Center where we now can provide laboratory space, where research groups from all over the world can work together to do ground breaking research, thinking out of the box in an open, col-

laborative space. In the same spirit we continued to host sabbaticals, courses, workshops, small, summer schools as well as postgraduate education. The Covid crisis also made us explore virtual and hybrid formats for seminars, meetings and conferences, which have now been integrated into our program to reach new and more inclusive audiences and make science as accessible as possible.

We continued to explore local synergies, continuing activities within COLife, hosting a workshop with Instituto Superior Técnico, and signing protocols for common activities with: i) the national health institutes (INSA), ii) the Católica Biomedical Research Institute, which is now being incubated on our campus, and iii) obtaining funding from the government for LS4F, an associated Laboratory of life sciences with IGC, ITQB, iBET, CEDOC and IPO, working towards a healthier and more sustainable planet. Internationally, we further advanced our collaboration with: i) EMBL, through the start of the twinning- SymbNET activities, as well as the signing of an MoU, ii) the Pasteur Institute, through a workshop involving most faculty from both places and iii) several Institutes within EU-LIFE through a shared first international MD-PhD program, which will explore new forms of training MDs in science. With these activities we will expose more national and international audiences to the IGC, a proven critical element for IGC's reputation and attraction. This will increase the critical mass, in particular of people and Institutions that complement our expertise.

To build a sustainable tomorrow, it is essential to democratize science, making science more affordable and accessible and engaging lay audiences. IGC, together with its partners, the MERCK family foundation and Oeiras city council, have a long-standing program to stim-

ulate "science from all 4 all" and to promote an agenda for diversity, equity and inclusion. This year, the first experimental kits from the lab in a suitcase (portable labs built at the IGC) arrived to their destination, with the first ever PCR test being performed at the University of São Tomé e Príncipe. This activity won the Prize for Social responsibility from a national magazine *Visão*. IGC continued its activities in schools reaching more than 500 students and was present in the first ever international science festival held in Portugal (FICA), with the venue in the gardens of the Palace, behind the IGC. These and many other science outreach activities organized through 2021 consolidated IGC's position as a leading institution in science democratization.

Finally, the year ended with an important event where the Gulbenkian Foundation signed the concession protocol for IGC new building to be located in the Ocean Campus at the river mouth of Tagus. The new research campus aim is to bring together several actors and promote and make it possible to take advantage of synergies and deepen new opportunities for collaboration with neighbouring research institutions. The importance of studying the organism within their environment brings immediate synergies with the Champalimaud Foundation's cancer and neuroscience programs and with the study of marine organisms and their food safety by the Portuguese Institute of the Sea and Atmosphere, two institutions that also occupy the same campus. This new location, enhanced by robust technical infrastructures in a shared campus, will be a magnet attracting scientists, research institutions, companies and entrepreneurs, national and international grants and philanthropic donors. Clustering more Institutions leads to more critical mass, collaborations, lower costs and creates vital R&D hubs as has been the case in places like Boston, Cambridge, Munich, Vienna, or San Francisco.

At IGC, our commitment to science, to our community and society helped us persevere during complex times, and take lessons from that process towards a more collaborative, inclusive and sustainable future. At the IGC board of directors we are very grateful and proud of the IGC community for their motivation and dedication and look forward to exciting years ahead.

Sincerely,

Moïrice Bettencourt Dias

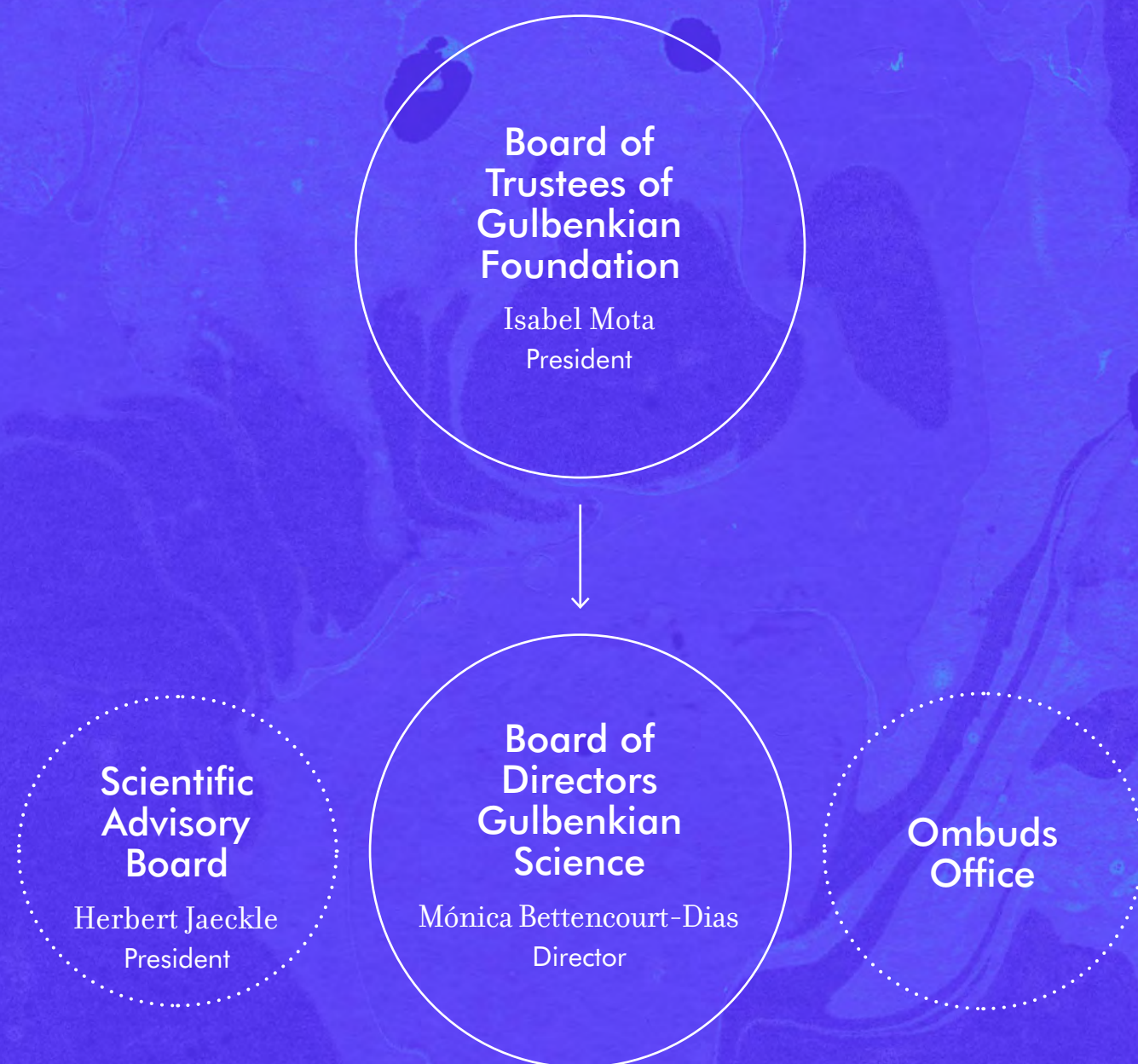
Organization

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 Calouste Gulbenkian Foundation principles.

The direct governance of the Institute goes through the Director, a managing Director, one Deputy Director for Science and one People Management Director for Research. The Director is responsible to respond to the FCG Board of Trustees. An eminent external Scientific Advisory Board, appointed by FCG Board of Trustees, oversees the scientific activities of the IGC.

Organigram



Board members

Board of Trustees of Gulbenkian Foundation

Isabel Mota
President

Martin Essayan

José Neves Adelino

Carlos Moedas *(Left in February 2021)*

Guilherme d'Oliveira Martins

Emílio Rui Vilar *(Non-executive)*

Graça Andresen Guimarães *(Non-executive)*

António Feijó *(Non-executive)*

Pedro Norton *(Non-executive)*

Board of Directors Gulbenkian Science

Mónica Bettencourt-Dias
Director

Manuel Schmidt
Executive Director

Caren Norden
Deputy Director for Science

Susana Miranda
People Management Director for Research

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
President

Max Planck Institute, Göttingen, Germany

Anthony Hyman
Vice-President

Max Planck Institute, Dresden, Germany

Joe Bury
VIB, Flandres, Belgium

Leslie Vosshall
Rockefeller University, New York, USA

Luis Serrano
Centre for Genomic Regulation, Barcelona, Spain

Nancy Moran
University of Texas, Austin, USA

Akiko Iwasaki
Yale University, New Haven, USA

Patrick Cramer
Max Planck Institute for Biophysical Chemistry, Göttingen, Germany



414

People

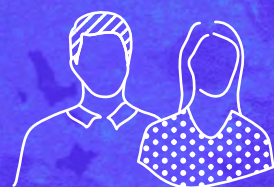
♀ 256 ♂ 158



283

Researchers

♀ 176 ♂ 107



27

Group Leaders

♀ 11 ♂ 16



45

Nationalities

71% Portuguese
29% International

20
Master
Students
♀ 11 ♂ 9

90
PhD
Students
♀ 56 ♂ 34

97
Postdocs
♀ 61 ♂ 36

52
Visitors
♀ 29 ♂ 23

12 Technical Support Units

9 Scientific Support Units

175

Collaborations with other institutions

58 National | 117 International



133

Publications

91 Open Access Publications

1664 Publications in the last
10 years

23 Thesis in 2021
1 BSc | 10 MSc | 12 PhD



36

Events Organized

397 Talks

304 Event Speakers

186 Seminars and Meetings
66 National | 120 International

18.570K€

Funding 2021

52% Core funding
48% External funding

41
Prizes and
Honours

118
Grants
in the last
5 years

130

Projects

17% EU funding
47% FCT funding
20% International funding
16% Other

27
New Projects in 2021

01

JAN

IV Graduate Science
for Development
Postgraduate
Programme (PGCD)
Meeting

Elias Barriga and
Ricardo Henriques
receive **EMBO
Installation Grants**

Start of the Twinning
project on host-
-microbe symbiosis –
SymbNET

02

FEB

Supra-institutional
organization
LS4FUTURE
granted the **Status
of Associated
Laboratory by FCT**

INFO-VAC: First
results on vaccine
effectiveness in
health professionals

**Open Session to
University Students**

03

MAR

Miguel Soares wins
the 1st **ERC-Oeiras
Award**

Three IGC
researchers receive
Marie Curie grants

**COVID-19 Vaccines
in the PALOP:** open
session seminar
promoted by PGCD

04

APR

**Launch of
COVID-19 saliva
surveillance tests** for
the IGC community

05

MAY

**Marco Fumasoni
starts his lab** at the
IGC

06

JUN

Karina Xavier
elected new EMBO
Member

Ricardo Henriques
receives **Chan
Zuckerberg
Initiative (CZI)
award**

Lab in a Suitcase
Open Science
Webinars

First bilateral workshop
between the IGC and
Institut Pasteur

07

JUL

PhD Summer School on Host-Microbe Symbiosis – Alumni Meeting

The IGC hosts its **first EU-LIFE Visiting Postdoctoral Seminar**

Gulbenkian and INSA establish a cooperation protocol

Release of the **“Parece Impossível!”** Podcast

08

AUG

Summer School launch

First Lab in a Suitcase kits delivered in Guinea Bissau, Mozambique, Angola, Cape Verde and São Tomé e Príncipe

09

SEP

Core Technologies for Life Sciences – CTLS 2021 conference gathers almost 300 people working in scientific core facilities in the five continents

The IGC joins the European-wide Emerald project to train medical doctors in biomedical research

SAB Meeting

The IGC at the 1st edition of the European Researchers' Night in Oeiras

10

OCT

INFO-VAC receives Gilead Award

The IGC at the 1st edition of the International Science Festival in Oeiras – FIC.A

EMBO Workshop: Target of Rapamycin (TOR) Signaling in Photosynthetic Organisms

IGC's COVID-19 saliva test awarded the **Grand Prize from the Portuguese Society of Pediatrics**

8th Edition of Maratona da Saúde dedicated to infectious diseases broadcast live from the IGC

11

NOV

Lab in a Box presentation session

Lab in a Suitcase receives the Social Responsibility Award by VISÃO and Exame Informática

SymbNET Host-Microbe Symbiosis Course

12

DEC

Giulia Ghedini and Waldan Kwong start their labs at the IGC

António Coutinho Science Awards go to students from Cape Verde & Mozambique

Gulbenkian signs contract for the creation of IGC's new hub

The IGC and EMBL sign a collaborative agreement to strengthen their scientific collaboration

Missions

.....

Conducting excellent
curiosity-driven research
in life sciences

.....

18

.....

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

.....

38

.....

Fostering innovative training
and further innovating on
how science is done

.....

48

.....

Bringing science closer
to society

.....

54

.....

Promoting national and
international partnerships

.....

62

MISSION

Conducting excellent curiosity-driven research in life sciences

The IGC is devoted to excelling in biological and biomedical research. Eager to reach a deep understanding of the processes that shape living systems, scientists invest in curiosity-driven research with the potential to make groundbreaking discoveries, promote knowledge and the overall benefit of humankind.

IN NUMBERS



Research

IGC's research focuses on the organism, ranging from how it forms to how it interacts with the environment and can be affected by it, over multiple scales of space and time. In 2021, the IGC continued to contribute with significant discoveries in the life sciences in its main thematic lines of research: 1) organization and communication of cells and tissues; 2) host-microbe interactions; 3) organism evolution and ecology, and 4) quantitative and systems biology. Below are some of the research highlights from this year.

ORGANIZATION AND COMMUNICATION OF CELLS AND TISSUES

At the IGC, biological organization is studied at different levels, from single cells to whole organisms. Here, researchers explore the fundamental principles that ultimately guide the development of healthy and functional organisms, while they unveil alterations underlying disease.

The **Cell Cycle Regulation** lab, led by Mónica Bettencourt-Dias, is one of IGC's groups dedicated to studying general principles in biology. The group studies the assembly and maintenance of complex subcellular structures and their

variations during development, disease, and evolution, using centrioles and cilia as their study subjects. In 2021, their work on *de novo* centriole biogenesis and centriole maintenance highlighted that the pericentriolar material plays an important role in those processes that goes much beyond microtubule nucleation. Moreover, it showed that centriole components are more dynamic than previously thought. It is possible that the pericentriolar material serves as a concentrator, recruiting and retaining centriole components. With this data, the team provided a new perspective on the regulation of centriole birth, function and homeostasis. In addition, their work with cancer cells highlighted the importance of how cells adapt to centrosome number dysregulation to allow for normal proliferation. Cancer cells show different processes of adaptation, some of which are more common to certain tumor types. The fact that adaptation processes

are regulated in a tumor specific manner suggests new diagnostic and therapeutic opportunities.

The **Chromosome Dynamics** group, on the other hand, investigates how chromosomes assemble and how their morphology influences the fidelity of cell division. The group, led by Raquel Oliveira, also studies how transcription is shut down in mitosis, and its influence on genome partitioning and transcriptional control. The aim is to uncover novel routes for chromosome mis-segregation, which impact on various human pathologies, such as cancer, genetic disorders, and infertility. In 2021, the lab initiated the ERC Consolidator grant – ChromoSilence – awarded in 2020, a new research line aimed at understanding the unknown process of transcription shutdown at mitotic entry. In a fruitful collaboration with Diogo Castro (i3S), they uncovered the importance of differential binding of transcription factors to mitotic chromosomes in defining transcriptional reactivation upon mitotic exit (Soares *et al* Gen&Dev). In a collaborative work with clinicians and geneticists they have also uncovered a new genetic condition associated with biallelic mutations in a key mitotic player (*BUB1*), that was accepted for publication (Carvalho *et al* Sci Adv). Collectively, their work has established novel hypothesis for how chromosome mis-segregation may compromise accurate genome partitioning, maintenance of cell identity and organism development.

The IGC is world class in developmental biology, with several groups focusing on the mech-

anisms that regulate the organization of cells and tissues during this complex process, and how their alteration leads to disease. In particular, the **Patterning and Morphogenesis** group, led by Moises Mallo, is interested in understanding the mechanisms of vertebrate axial extension.

The group studies the regulation of the head to trunk transition and how Tgfb β 1 signaling controls the trunk to tail transition, the principles governing body plan diversity among vertebrates, and the coordinated development of the legs and the external genitalia. In 2021, the group found that:

- > the Myf5 gene of turtles plays an important role in the formation of the carapace by modulating the characteristics of the dermomyotome during the initial phases of somite development;
- > EphA1 positive cells from the mouse embryo tail bud have the potential to generate neural and mesodermal derivatives characteristic of the neuromesodermal progenitors;
- > during the head to trunk transition many enhancers change their accessibility, some of them dependent on the activity of retinoic acid;
- > enhancer deletion experiments reveal strong redundancy in gene regulatory mechanisms;
- > the cell composition of embryos mutant for Raldh2 is very similar to that of their wild type littermates, although their development is strongly compromised during the head to trunk transition;

The mechanisms that regulate the organization of cells and tissues during development, and how their alteration leads to disease, is an area of focus at the IGC

- > Tgfbri signaling modulates the response of the pericloacal mesoderm to patterning signals.

After the main vertebrate body axis are defined, progenitor cells form tissues and organs to build a functional organism. The **Cell Biology of Tissue Morphogenesis** group aims to untangle the events that lead to the development of organs. In this context, the lab studies the formation of the vertebrate retina from cells to tissue and takes the interactions between scales into account. The research group, led by Caren Norden, further assesses how mechanics influence tissue formation. Importantly, only when developmental programs occur coordinately from one stage to the next can tissues form correctly in time and space. The lab combines methods of cell and developmental biology with advanced quantitative imaging, image analysis tools and, in collaboration, theoretical modeling. In 2021, the group published an important review on the role of the extracellular matrix in development and disease that got great recognition in the field, as well as a collaborative study on image segmentation. The group further deposited two manuscripts on preprint servers that elucidate how neurons in the retina, in particular photoreceptor cells and horizontal cells, find the correct location where they will later function and how cells and tissues interact during this process. The principal investigator and other lab members presented their work at numerous conferences and at international institutions, mostly in virtual mode. These included two EMBO conferences as invited speaker. During the year, new collaborations were started with Anna Erzberger, a theorist at EMBL Heidelberg, and in-house with Pablo Sartori and Elias Barriga.

The group led by Elias Barriga, **Mechanisms of Morphogenesis**, studies the cellular, molecular, and biophysical mechanisms underlying collective cell migration in embryogenesis, regeneration and, more recently, in cancer. In 2021, the group has revealed the mechano-molecular nature of neural crest relaxation and its requirement for the onset of collective motion, and the mechano-electrical mechanisms guiding collective cell motion. In addition, they provided a toolbox to study mechanics *in vivo* and *in vitro*.

Besides studying the organization and communication of cells and tissues in animals, IGC researchers also have a keen interest on how these processes are coordinated to allow the proper growth and development of plants. In this sense, the **Plant Molecular Biology** group uses *Arabidopsis thaliana* to investigate how plants respond to their environment at the molecular level. Their main focus is on alternative splicing, a potent generator of transcriptomic diversity likely to contribute to plant stress tolerance, but they also study the role of membrane transporters of the Major Facilitator Superfamily (MFS) in plant responses to abiotic stress. The lab, led by Paula Duque, is analyzing the functions of SR proteins, which are key alternative splicing modulators, and of MFS transporters. In 2021, they discovered that:

- > the abscisic acid (ABA) stress hormone prevents phosphodegradation of the SR45 splicing factor to autoregulate inhibition of seedling development;
- > loss of SR45 function leads to ABA hyposensitivity during seed germination but ABA hypersensitivity during seedling development and has opposing transcriptomic effects at these two developmental stages;

- > loss of function of the SR34a protein results in enhanced sensitivity to ABA during early plant development;
- > two *Arabidopsis* natural variants show distinct sensitivity to ABA and differential transcriptional and posttranscriptional regulation of ABA-related gene expression;
- > a novel MFS transporter, NLM1, regulates plant development in response to gibberellin (GA) hormone signaling.

On the other hand, the interests of the **Plant Stress Signaling** group include plant carbon management, mechanisms underlying carbon sensing and downstream signaling, regulation of carbon signaling pathways by hormonal and other stress signals, and the role of these pathways on plant central metabolism, stress responses and development. The lab, led by Elena Baena Gonzalez, focuses on one particular carbon signaling pathway mediated by the SnRK1/AMPK protein kinase. In 2021, the team found that besides being activated by low energy, as in animals, the plant kinase evolved to sense the phytohormone ABA. Upon its activation by ABA, SnRK1 exits the nucleus in meristematic cells of the root to repress TOR activity and growth. This allows plants to repress growth in response to water scarcity by promoting the presence of SnRK1 in the cytosol and its interaction with TOR. In addition, the group found that SnRK1 is constantly shuttling between the cytosol and the nucleus and its entry to the nucleus requires components of the outer nuclear pore ring, HOS1 and SAR1 and that SnRK1 is part of the Suc-T6P system (analogous to the glucose-insulin system in mammals), required to maintain Suc homeostasis. SnRK1 influences the Suc-T6P relationship and modulates the flux of carbon to the TCA cycle.

→ After the main vertebrate body axis are defined, progenitor cells form tissues and organs to build a functional organism

Publication highlights

Organization and communication of cells and tissues

- Amini, R., Schlüßler, R., Möllmert, S., Bhatnagar, A., Guck, J., & Norden, C. (2021). Amoeboid-like neuronal migration ensures correct horizontal cell layer formation in the developing vertebrate retina. *BioRxiv*, 2021.10.15.464510.
- Belda-Palazón, B., Costa, M., Beeckman, T., Rolland, F., & Baena-González, E. (2021). ABA represses TOR and root meristem activity through nuclear exit of the SnRK1 kinase. *BioRxiv*, 2021.12.27.474243.
- de Lemos, L., Dias, A., Nóvoa, A., Mallo M. (2021) Epha1 is a cell-surface marker for the neuromesodermal competent population. *Development*. 149(6), dev198812.
- Dias Louro, M. A., Bettencourt-Dias, M., & Carneiro, J. (2021). A first-takes-all model of centriole copy number control based on cartwheel elongation. *PLOS Computational Biology*, 17(5), e1008359.
- Dias, A., Martins, G. G., Lopes, A., & Mallo, M. (2021). Three and Four-Dimensional Visualization and Analysis Approaches to Study Vertebrate Axial Elongation and Segmentation. *JoVE*, 168, e62086.
- Ferreira, F., Moreira, S., & Barriga, E. H. (2021). Stretch-induced endogenous electric fields drive neural crest directed collective cell migration in vivo. *BioRxiv*, 2021.10.11.463916.
- Gomes Pereira, S., Sousa, A. L., Nabais, C., Paixão, T., Holmes, A. J., Schorb, M., Goshima, G., Tranfield, E. M., Becker, J. D., & Bettencourt-Dias, M. (2021). The 3D architecture and molecular foundations of de novo centriole assembly via bicentrioles. *Current Biology*, 31(19), 4340-4353.e7.
- Marchant, C. L., Malmi-Kakka, A. N., Espina, J. A., & Barriga, E. H. (2021). Microtubule deacetylation reduces cell stiffness to allow the onset of collective cell migration in vivo. *BioRxiv*, 2021.08.12.456059.
- Martín, G., & Duque, P. (2021). Tailoring photomorphogenic markers to organ growth dynamics. *Plant Physiology*, 186(1), 239–249.
- Martín, G., Márquez, Y., Mantica, F., Duque, P., & Irimia, M. (2021). Alternative splicing landscapes in *Arabidopsis thaliana* across tissues and stress conditions highlight major functional differences with animals. *Genome Biology*, 22(1), 35.
- Nabais, C., Pessoa, D., de-Carvalho, J., van Zanten, T., Duarte, P., Mayor, S., Carneiro, J., Telley, I. A., & Bettencourt-Dias, M. (2021). Plk4 triggers autonomous de novo centriole biogenesis and maturation. *Journal of Cell Biology*, 220(5), e202008090.
- Peixoto, B., Moraes, T. A., Mengin, V., Margalha, L., Vicente, R., Feil, R., Höhne, M., Sousa, A. G. G., Lilue, J., Stitt, M., Lunn, J. E., & Baena-González, E. (2021). Impact of the SnRK1 protein kinase on sucrose homeostasis and the transcriptome during the diel cycle. *Plant Physiology*, 187(3), 1357–1373.
- Serrazina, S., Machado, H., Costa, R. L., Duque, P., & Malhó, R. (2021). Expression of *Castanea crenata* Allene Oxide Synthase in *Arabidopsis* Improves the Defense to *Phytophthora cinnamomi*. *Frontiers in Plant Science*, 12.
- Soans, K. G., & Norden, C. (2021). Shining a light on extra-cellular matrix dynamics in vivo. *Seminars in Cell & Developmental Biology*, 120, 85–93.
- Soares, M. A. F., Soares, D. S., Teixeira, V., Heskol, A., Bressan, R. B., Pollard, S. M., Oliveira, R. A., & Castro, D. S. (2021). Hierarchical reactivation of transcription during mitosis-to-G1 transition by Brn2 and Ascl1 in neural stem cells. *Genes & Development*, 35(13–14), 1020–1034.
- Solomatina, A., Kalaidzidis, Y., Cezanne, A., Soans, K., Norden, C., Zerial, M., & Sbalzarini, I. F. (2021). Particle-Based Segmentation Of Extended Objects On Curved Biological Membranes. 2021 IEEE 18th International Symposium on Biomedical Imaging (ISBI), 1150–1154.

HOST-MICROBE INTERACTIONS

At the IGC researchers do not only study organisms, but also the interactions they establish with one another. Besides addressing the emerging role of host-microbe interactions in health and disease, they integrate knowledge and methodologies from several scientific fields to reach a deeper understanding of the biology of inflammation and immunity.

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. They found that turnover is partly regulated by cell competition. 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 2021, they identified the thymocytes that can self-renew to maintain thymopoiesis autonomously, independently of bone marrow contribution: the double negative 3 early. Besides maintaining a typical differentiation program, thymus autonomy also covered an alternative novel path, whereby an atypical new cell population emerged. This population had an aberrant gene expression profile but found a way to survive despite the failure to express a pre-T cell receptor, a key event required to overcome the first checkpoint in T

cell differentiation. The data suggests that these cells might be the earliest precursors of acute lymphoblastic leukemia (T-ALL), setting up the stage to address the earliest events that trigger neoplastic transformation in thymocytes. The team also found that thymocytes undergoing cell competition in the thymus have a gene expression signature, with peptidyl-prolyl cis-trans isomerase C (Ppic) being one of the genes that is dispensable to thymic cell competition. Nevertheless, its genetic ablation caused a defect in invariant NKT (iNKT) cell differentiation. iNKT cells were reduced in percentage and absolute cell numbers in the Ppic-deficient thymus, which affected the most mature stages in the thymus, and the phenotype was maintained at the periphery (Paiva RS et al). During this year, Rafael Paiva received his PhD and Sara Azenha completed her MSc thesis (graded 20/20) and was recognized by her university for the best thesis with an award. The group published two peer-reviewed papers and was invited to write a review on Cell competition in the hematopoietic system as a recognition for all their contributions to the field. The PI also integrated the organizing committee of the IGC Summer School.

Also focused on understanding immune regulation in health and disease is the **Lymphocyte Physiology** group, which combines mouse and human studies, and addresses infections, autoimmune diseases, cancer, and their therapies. The lab is led by Jocelyne Demengeot and, since March 2020, their efforts have focused on addressing societal and health needs imposed by the COVID-19 pandemic. In 2021, the group scrutinized the variance of the immune response to SARS-CoV-2 vaccines. They implemented and maintained the INFO-VAC program that monitors the humoral immune response to

COVID-19 vaccines along time in approximately 3000 participants. This project runs since the initiation of the COVID-19 vaccination campaign in Portugal, in December 2020, and the cohort's composition allows comparison between vaccine types and regimen, across age, sex and health conditions. Amongst the key findings are that severe immunosuppression and age are main factors explaining the heterogeneity of antibody levels. However, repeated injections serve to homogenize positivity for vaccine specific antibody. Over the year, the group has collaborated with the other research groups and scientific support units at the IGC who participated to the COVID-19 efforts. In collaboration with IGC's Genomic Unit and the FCG occupational clinical center, the group implemented and maintained a COVID-19 surveillance program targeted at IGC and FCG workers, based on weekly molecular testing of saliva samples. The laboratory has also developed a marketable ELISA assay with IBET and the Group Medinfar, PT which allows assessing COVID-19 prevalence and vaccine immunogenicity in populations.

The interaction of hosts with pathogens, as is the case of SARS-CoV-2, is a topic of major interest at the IGC. Within this line of research, our scientists explore the complex intracellular events that are stimulated by infection. The main interest of the **Cell Biology of Viral Infection** group is to understand viral-host interactions, identifying host factors and pathways essential for viral replication, virulence factors that impact disease severity and therapeutic strategies that target evolving and zoonotic viruses. In 2021, the group led by Maria João Amorim has found how the *influenza A* virus modulates the complement system leading to increased immunopathology and discovered innovative therapeutic strategies

targeting structures formed exclusively during influenza infection – viral inclusions – whose function relies on their liquid behavior. Regarding the SARS-CoV-2 virus, the group developed alternative methods for identifying infected people, with special focus on using saliva samples to detect infected children. They found that molecular detection of SARS-CoV-2 in saliva is sensitive and specific for monitoring, for example, school settings, being advantageous in terms of collection, logistics and price. The group also produced suitable spike-pseudotyped viral systems to test how SARS-CoV-2 spike mutations escape neutralizing antibodies upon natural infection and vaccination, to predict hotspots for immune evasion and for assessing that breast-milk contains non-neutralizing secretory IgA antibodies.

The **Host-Pathogen Co-evolution** group, on the other hand, focuses on *Toxoplasma gondii*. Led by Jonathan Howard, the lab studies the resistance of mice to this ubiquitous intracellular protozoan parasite, which infects about 40% of humans. Mouse immunity against *T. gondii* is based on a mechanism absent in humans: inducible GTPases (IRG proteins) that cooperatively destroy the vacuole in which the parasite lives. This mechanism has in turn been targeted by the parasite, via a family of kinases that inactivate IRG proteins. Both the IRG proteins and the kinases are massively polymorphic, consistent with a complex co-evolutionary dynamic. The research group's work stretches from ecological studies on wild mice to cell biological, biochemical and structural studies. 2021 started with a collaborative work with the lab of Etienne Joly, from Toulouse, who developed a fast and inexpensive method to detect SARS-CoV-2 antibodies in human serum. The Host-Pathogen Co-Evolution lab tested this experimental approach to

detect SARS-CoV-2 antibodies in mouse serum samples, provided by Isabel Gordo's group, and participated in the validation of the assay in human samples provided by Jocelyne Demengeot's laboratory at the IGC. Besides this, the group pinpointed the morphological sperm defects underlying a fertility defect present in the *Irgc* mutant mice generated at the IGC. This was achieved through a collaborative work in the lab of Genetic, Epigenetic and Therapies of Infertility in Grenoble (Christophe Arnoult) and with the support of IGC's Electron Microscopy unit. The team was also able to determine that the IRG gene *Irgb2-b1* from Wild derived mice from Brazil is necessary for resistance against local Brazilian *Toxoplasma gondii* strains.

The research conducted by these groups is largely complementary to other immunity and inflammation-oriented groups at the IGC that focus on intercellular and organismal level processes. These are particularly interested in understanding how the engagement of the immune system can lead to organ dysfunction and finding ways to prevent this.

The **Inflammation** group, led by Miguel Soares, for instance, 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 2021, the team discovered that the loss of α -gal glycan expression during primate evolution enhanced antibody-effector function while shaping the gut microbiota towards an overall reduction of its pathogenicity. They also found that the

→ Our scientists explore the complex intracellular events that result from infection, aiming at identifying the factors that control the host's response.

labile heme, an alarmin generated as a byproduct of hemolysis during Plasmodium infection, orchestrates a host hypometabolic response that restricts asexual stages of the parasite from accessing glucose. As a trade-off the infected host develops hypoglycemia, a major cause of mortality from malaria. Through fruitful collaborations, the group contributed to discoveries made by Antonio Sica's lab of a cancer-induced myeloid cell population that can be targeted therapeutically to repress metastasis, by Sebastian Weis' lab on innate immune training by labile heme, and Alain Le Moine's lab of a myeloid cell population that regulates T-cell alloreactivity and acute graft versus host disease severity, highlighting a potential therapeutic target for the engraftment of stem cell transplants patients. Finally, the team co-authored a book on Metals in Host-Microbe Interactions, describing how transition metal ions can be targeted therapeutically to treat infectious diseases, caused by bacteria, fungi, viruses, or protozoan parasites.

Severe sepsis remains a poorly understood systemic inflammatory condition with high mortality rates and limited therapeutic options outside of infection control and organ support measures. Based on their recent discovery in mice showing that anthracycline drugs prevent organ failure without affecting the bacterial burden in a model of severe sepsis, the **Innate**

Immunity and Inflammation group, led by Luís Moita, 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 program is to identify and characterize novel cytoprotective mechanisms, as a window into stress-induced genetic programs leading to tissue protection. In 2021, the group unraveled the activation of the hypothalamic-pituitary-adrenal axis by exogenous and endogenous GDF15 and discovered that combined glucocorticoid resistance and hyperlactatemia contributes to lethal shock in sepsis.

Disease and organ dysfunction are, in many cases, controlled by genetic factors. The **Disease Genetics** group is interested in uncovering how genetic factors work in specific cell types to drive organ inflammation trajectories and infectious disease outcomes namely placental malaria, cerebral malaria and liver damage. In 2021,

the group, led by Carlos Penha Gonçalves has investigated the role of brain endothelial cells (BECs) in cerebral malaria development as sensors and initiators of brain inflammatory responses. They identified STING1 as the key innate immune sensor that activates type I IFN pathway in BECs to initiate type I IFN-driven inflammation in the brain. The team has shown that extracellular particles derived from plasmodium-infected erythrocytes and containing parasite digestive vacuoles trigger a STING1-dependent IFN β response in BECs. This response increases with heme content in digestive vacuoles within extracellular particles derived from plasmodium-infected erythrocytes. Throughout the year, the group was also involved in studies to evaluate the immune response to COVID-19 vaccines in the Portuguese population. Their longitudinal studies of antibody responses show increased decay with age and in hemodialyzed patients.

Major investments in the last years have successfully strengthened IGC's position in the field of host-microbe interactions. While host interactions with pathogens have been of major interest for a long time, host-mutualist relationships, and their impact on the outcome of infectious diseases and other aspects of host physiology have recently gained particular attention in the scientific community.

The **Host-microorganism Interactions** group, led by Luís Teixeira, studies the interaction of *Drosophila melanogaster* with different microorganisms, in particular intracellular ones. The research group found that the intracellular bacteria *Wolbachia* confers resistance to RNA viruses in the fruit fly and now seeks to understand the molecular basis of this induced resistance. They are also interested in the interplay between *Drosoph-*

ila and *Wolbachia* itself. These endosymbionts are one of the most widespread intracellular bacteria in the world, but little is known about how the hosts control *Wolbachia* or vice-versa, at the molecular level. In 2021, the lab reported for the first time a forward genetic screen in *Wolbachia* and the isolation and identification of new over-proliferating, mutant variants of this intracellular bacteria. They also published a paper describing how *Wolbachia* protection to viruses is strongly modulated by host developmental temperature. This year, the group participated in the organization of the Portuguese Fly Meeting 2021 and the principal investigator was a founding board member of the European Drosophila Society, a new initiative to promote this model organism. They also started SymbNET, a network on host-microbe symbiosis, and organized a meeting with the alumni of previous PhD Summer Schools on this field. Finally, the lab participated in the International Science Festival (FIC.A) and explained their research to a general audience at music concerts at FCG.

Successful bacterial-host relationships depend on the ability of microorganisms to communicate with one another and to regulate their behaviour. The main focus of the **Bacterial Signalling** group, led by Karina Xavier, is interspecies cell-cell chemical signaling in bacteria and its role in beneficial and hostile interactions with the host. The group aims to decipher the molecular basis of signaling 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 pathogene-

→ Major intellectual and technical investments in the last years have successfully strengthened the position of the IGC in the field of host-microbe interactions.

sis. It is well-accepted that environmental perturbations, such as diet or antibiotics, can affect microbiota functions through changes in microbiota composition or changes in bacterial gene expression with negative consequences for the host. In 2021, the team studied the evolution of *Bacteroides thetaio-taomicron* in the mouse gut under different dietary regimens. Their results show that this keystone microbiota member evolves rapidly in the mouse gut, and that diet can shape its evolution. In additions, they revealed that environmental driven perturbations in microbiota functions can be explained by selection for mutations in the microbiota members. This study suggests that intra-species genetic diversity within microbiota members is an overlooked biomarker for dietary differences among individuals and microbial evolution can be the cause for microbiota-mediated functional effects of diet, beyond microbiota composition.

In December 2021, the principal investigator Waldan Kwong joined the IGC to further strengthen the institute's position in the field of host-microbe interactions. His lab, **Microbial Genomics and Symbiosis**, will unveil important information regarding how stable microbial communities form and persist and uncover new ways to improve microbiome resilience in the face of pathogenic invaders and environmental perturbations. The research will have a broad implication in agriculture, medicine and biotechnology.

Publication highlights *Host-microbe interactions*

- Alenquer, M., Ferreira, F., Lousa, D., Valério, M., Medina-Lopes, M., Bergman, M.-L., Gonçalves, J., Demengeot, J., Leite, R. B., Lilue, J., Ning, Z., Penha-Gonçalves, C., Soares, H., Soares, C. M., & Amorim, M. J. (2021). Signatures in SARS-CoV-2 spike protein conferring escape to neutralizing antibodies. *PLOS Pathogens*, 17(8), e1009772.
- Alenquer, M., Silva, T. M., Akpogheneta, O., Ferreira, F., Vale-Costa, S., Medina-Lopes, M., Batista, F., Garcia, A. M., Barreto, V. M., Paulino, C., Costa, J., Sobral, J., Diniz-da-Costa, M., Ladeiro, S., Delgado Alves, J., Leite, R. B., Demengeot, J., João Rocha Brito, M., & João Amorim, M. (2021). Saliva molecular testing bypassing RNA extraction is suitable for monitoring and diagnosing SARS-CoV-2 infection in children. *MedRxiv*, 2021.08.11.21261899.
- Almeida-Santos, J., Bergman, M.-L., Cabral, I. A., & Demengeot, J. (2021). Interruption of Thymic Activity in Adult Mice Improves Responses to Tumor Immunotherapy. *The Journal of Immunology*, j2000626.
- Almeida, L., Dhillon-LaBrooy, A., Castro, C. N., Adossa, N., Carriche, G. M., Guderian, M., Lippens, S., Dennerlein, S., Hesse, C., Lambrecht, B. N., Berod, L., Schausser, L., Blazar, B. R., Kalesse, M., Müller, R., Moita, L. F., & Sparwasser, T. (2021). Ribosome-Targeting Antibiotics Impair T Cell Effector Function and Ameliorate Autoimmunity by Blocking Mitochondrial Protein Synthesis. *Immunity*, 54(1), 68-83.e6.
- Chrostek, E., Martins, N., Mari-alva, M. S., & Teixeira, L. (2021). Wolbachia-Conferred Antiviral Protection Is Determined by Developmental Temperature. *MBio*, 12(5), e0292320–e0292320.
- Colaço, H. G., Barros, A., Neves-Costa, A., Seixas, E., Pedroso, D., Velho, T., Willmann, K. L., Faisca, P., Grabmann, G., Yi, H.-S., Shong, M., Benes, V., Weis, S., Köcher, T., & Moita, L. F. (2021). Tetracycline Antibiotics Induce Host-Dependent Disease Tolerance to Infection. *Immunity*, 54(1), 53-67.e7.
- Duarte, E. H., Carvalho, A., López-Madrigal, S., Costa, J., & Teixeira, L. (2021). Forward genetics in Wolbachia: Regulation of Wolbachia proliferation by the amplification and deletion of an additive genomic island. *PLOS Genetics*, 17(6), e1009612.
- Landum, M., Silva, M. S., Martins, N., & Teixeira, L. (2021). Viral route of infection determines the *Drosophila melanogaster* gut bacteria on host resistance and tolerance to disease. *BioRxiv*, 2021.02.18.431843.
- Oliveira, R. A., Cabral, V., & Xavier, K. B. (2021). Microbiome-diet interactions drive antibiotic efficacy. *Nature Microbiology*, 6(7), 824–825.
- Paiva, R. A., Sousa, A. G. G., Ramos, C. v., Ávila, M., Lilue, J., Paixão, T., & Martins, V. C. (2021). Self-renewal of double-negative 3 early thymocytes enables thymus autonomy but compromises the β -selection checkpoint. *Cell Reports*, 35(2).
- Paiva, R. S., Ramos, C. v., Azenha, S. R., Alves, C., Basto, A. P., Graca, L., & Martins, V. C. (2021). Peptidylprolyl isomerase C (Ppic) regulates invariant Natural Killer T cell (iNKT) differentiation in mice. *European Journal of Immunology*, 51(8), 1968–1979.
- Ramos, C. v., & Martins, V. C. (2021). Cell competition in hematopoietic cells: Quality control in homeostasis and its role in leukemia. *Developmental Biology*, 475, 1–9.
- Ramos, S., Ademolue, T. W., Jenth, E., Wu, Q., Guerra, J., Martins, R., Pires, G., Weis, S., Carlos, A. R., Mahú, I., Seixas, E., Duarte, D., Rajas, F., Cardoso, S., Sousa, A. G. G., Lilue, J., Mithieux, G., Nogueira, F., & Soares, M. P. (2021). A Hypometabolic Defense Strategy Against Plasmodium Infection. *Biorxiv*, 2021.09.08.459402.
- Santos, N. B., Vaz da Silva, Z. E., Gomes, C., Reis, C. A., & Amorim, M. J. (2021). Complement Decay-Accelerating Factor is a modulator of influenza A virus lung immunopathology. *PLOS Pathogens*, 17(7), e1009381.
- Singh, S., Bastos-Amador, P., Thompson, J. A., Truglio, M., Yilmaz, B., Cardoso, S., Sobral, D., & Soares, M. P. (2021). Glycan-based shaping of the microbiota during primate evolution. *ELife*, 10, e67450.
- Singh, S., Thompson, J. A., Yilmaz, B., Li, H., Weis, S., Sobral, D., Truglio, M., Aires da Silva, F., Aguiar, S., Carlos, A. R., Rebelo, S., Cardoso, S., Gjini, E., Nuñez, G., & Soares, M. P. (2021). Loss of α -gal during primate evolution enhanced antibody-effector function and resistance to bacterial sepsis. *Cell Host & Microbe*, 29(3), 347-361.e12.
- Vandewalle, J., Timmermans, S., Paakinaho, V., Vancraeynest, L., Dewyse, L., Vanderhaeghen, T., Wallaey, C., van Wyngene, L., van Looveren, K., Nuytens, L., Eggermont, M., Dewaele, S., Velho, T. R., Moita, L. F., Weis, S., Sponholz, C., van Grunsven, L. A., Dewerchin, M., Carmeliet, P., ... Libert, C. (2021). Combined glucocorticoid resistance and hyperlactatemia contributes to lethal shock in sepsis. *Cell Metabolism*, 33(9), 1763-1776.e5.
- Vasquez, K. S., Willis, L., Cira, N. J., Ng, K. M., Pedro, M. F., Aranda-Díaz, A., Rajendram, M., Yu, F. B., Higginbottom, S. K., Neff, N., Sherlock, G., Xavier, K. B., Quake, S. R., Sonnenburg, J. L., Good, B. H., & Huang, K. C. (2021). Quantifying rapid bacterial evolution and transmission within the mouse intestine. *Cell Host & Microbe*, 29(9), 1454-1468.e4.
- Weigert, A., Bergman, M.-L., Gonçalves, L. A., Godinho, I., Duarte, N., Abrantes, R., Borges, P., Brennand, A., Malheiro, V., Matoso, P., Akpogheneta, O., Kosack, L., Cruz, P., Nogueira, E., Pereira, M., Ferreira, A., Marques, M., Nunes, T., Faro-Viana, J., ... Penha-Gonçalves, C. (2021). Longitudinal Analysis of Antibody Responses to the mRNA BNT162b2 Vaccine in Patients Undergoing Maintenance Hemodialysis: A 6-Month Follow-Up. *Frontiers in Medicine*, 8.

ORGANISM EVOLUTION AND ECOLOGY

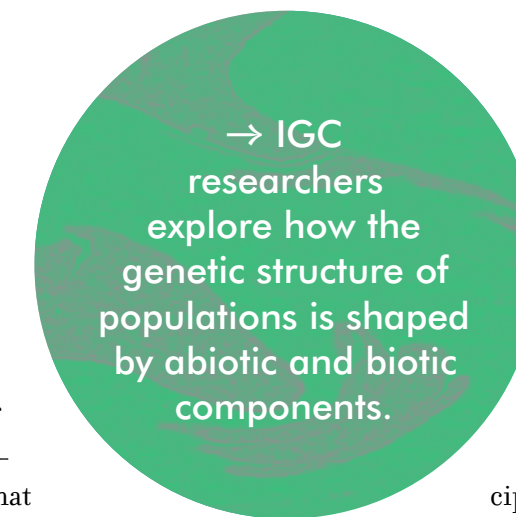
Researchers at the IGC work collaboratively to unveil how the interactions maintained between organisms and their environment shapes their evolution. This knowledge, in turn, sheds light on the impact of adaptive changes in the organism's physiology and the overall functioning of ecosystems.

Combining lab and theory approaches of eco-evolutionary processes, IGC researchers explore how the genetic structure of populations is shaped by abiotic and biotic components. The **Evolutionary Biology** group, led by Isabel Gordo, combines theoretical and empirical work aiming at a better understanding of the major forces that shape variation in bacterial populations. The lab studies the tempo and mode of adaptation of commensal bacteria in their natural environment. They use different strains of mice and *E. coli* to unravel the dynamics of adaptation in the complex ecosystem of the mammalian gut in health and in certain disease conditions. The gut is a very rich system to study ecological interactions and microbial evolution. These processes are key to microbe-microbe and host-microbe homeostasis. In 2021, the group combined *in vivo* experimental evolution, whole-genome sequencing and mathematical modeling to gain a better understanding of the eco-evolutionary mechanisms structuring microbiome diversity. They developed a new modeling framework, where they expand the classical MacArthur model of competition for resources to incorporate

evolution by *de novo* mutation. The team started by considering the dynamics of a single clonal lineage evolving to consume a set of different substitutable resources that are constantly replenished in a well-mixed environment which mimics some basic features that occur in the gut (Amicone and Gordo 2021). This model can predict some of the essential modes of evolution that the group has discovered to take place when a new lineage colonizes the mouse gut (Frazão *et al.* under review).

On the other hand, the **Population and Conservation Genetics**, led by Lounes Chikhi, is interested in the patterns of genetic and genomic diversity observed in present-day species as a consequence of their recent evolutionary history (collapses, expansions, periods of connectivity or disconnection). They perform fieldwork in Madagascar, Borneo, West Africa and Portugal, data analysis and simulations. The team collaborates with theoreticians and develops new approaches to understand the information content and the limits of genetic data as inferential tools. In 2021, the group developed a new inferential method **SNIF, Structured Non-Stationary Inference Framework** and applied it to human genomic data. They showed that (under simplifying assumptions) it is possible to use the genome of a single individual sampled in a particular population and infer the number of populations to which that population was connected, and the periods at which connectivity between these populations changed. For humans the group suggest that current models of evolution are unlikely to explain the patterns we observe, and that models of population structure are necessary to study human evolution.

Organism plasticity favors the emergence of novel functions, shaping organisms across



evolutionary time. Despite being a universal property of biological systems, how complex traits, including those that determine disease susceptibility, are originated and modified is still a matter of research. This is the question driving the **Evolution and Development** group. Élio Sucena's lab focuses on the evolution of the immune response in insects, the mechanistic basis of disease tolerance and resistance in *Drosophila* and the origins of transcriptional novelty. In 2021, the group has shown that, in *Drosophila*, concomitantly with the initiation of the metamorphic moult and the dramatic remodelling of larval tissues including the bacteria-containing gut, ecdysone triggers a pulse-dependent peak of antimicrobial peptide expression. This anticipatory immune response is vital for the control of bacterial numbers in the pupal case, is deployed both locally and systemically and involves mainly three anti-microbial peptides, *Drosomycin*, *Drosomycin-like 2* and *Drosomycin-like 5*. The team established a new role for ecdysone in the co-option of immunity by the metamorphosis programme and speculates that it may constitute an important element in the evolution of this developmental novelty. Additionally, they established a robust protocol to measure disease tolerance in *Drosophila* and quantify its components, namely immunopathology and tolerance to virulence-induced damage, upon bacterial pathogen oral infection.

To strengthen this research field, Marco Fumasoni joined the IGC in May 2021. His lab, **Genome Maintenance and Evolution**, is particularly interested in how cells evolutionarily adapt to perturbations in complex processes, including DNA replication, DNA repair, cell cycle regulation and chromosome segregation, how the mechanisms of adaptation are influenced by the environment, and what are the physiological and

evolutionary consequences of the adaptive changes on organisms. In 2021, the principal investigator finished the revision of a paper demonstrating how the evolutionary adaptation to DNA replication stress targets the same cellular modules in cells with different ploidy or recombination proficiency. Nevertheless, the specific nature of the mutation selected is dictated by the different genomic features.

Later in the year, Giulia Ghedini also joined the IGC, establishing the **Functional Ecology** group aiming to identify evolutionary responses to competition and their effects on biodiversity and biological production. The aim of this work is to clarify whether changes in energy use in response to ecological interactions are predictable across species and whether they can inform on the functioning of biological systems.

Living organisms can also be shaped by their social environment, which cannot be neglected in the study of organism's evolution and ecology. How social behavior evolved is a matter of interest at the IGC, particularly for the **Integrative Behavioral Biology** group, led by Rui Oliveira. The main interests of this group are the evolution of social behavior and its neural and genetic mechanisms, the genomic and epigenomic mechanisms of social plasticity, and the effects of the social environment (i.e. social interactions, social isolation) on susceptibility/resilience to disease and cognitive bias. In 2021, the lab continued the work on the neural and genetic mechanisms underlying social behavior both in zebrafish and in fruit-flies, 1) demonstrating a developmental effect of oxytocin neurons on the differentiation of a neural circuit needed for sociality in zebrafish; 2) showing that social and asocial learning share neural networks but have specific patterns

of network activation, and 3) identifying genetic polymorphisms associated with sociality in zebrafish. During this year, six papers were pub-

lished in peer-reviewed journals, and three MSc and one PhD theses were completed.

Publication highlights

Organism evolution and ecology

- Amicone, M., Gordo, I. (2021) Molecular signatures of resource competition: Clonal interference favors ecological diversification and can lead to incipient speciation. *Evolution*, 75(11), 2641-2657.
- Antunes, D. F., Teles, M. C., Zueling, M., Friesen, C. N., Oliveira, R. F., Aubin-Horth, N., & Taborsky, B. (2021). Early social deprivation shapes neuronal programming of the social decision-making network in a cooperatively breeding fish. *Molecular Ecology*, 30(16), 4118-4132.
- Arredondo, A., Mourato, B., Nguyen, K., Boitard, S., Rodríguez, W., Noûs, C., Mazet, O., & Chikhi, L. (2020). Inferring number of populations and changes in connectivity under the n-island model. *BioRxiv*, 2020.09.03.282251.
- Balbontín, R., Frazão, N., & Gordo, I. (2021). DNA Breaks-Mediated Fitness Cost Reveals RNase HI as a New Target for Selectively Eliminating Antibiotic-Resistant Bacteria. *Molecular Biology and Evolution*, 38(8), 3220-3234.
- Cruz, M.A., Magalhães, S., Sucena, É., Flore, Z. (2021) Wolbachia and host intrinsic reproductive barriers contribute additively to postmating isolation in spider mites *Evolution* 75(8), 2085-2101 2021.
- Nunes, A. R., Gliksberg, M., Varela, S. A. M., Teles, M., Wircer, E., Blechman, J., Petri, G., Levkowitz, G., & Oliveira, R. F. (2021). Developmental Effects of Oxytocin Neurons on Social Affiliation and Processing of Social Information. *The Journal of Neuroscience*, 41(42), 8742.
- Nunes, C., Koyama, T., & Sucena, É. (2021). Co-option of immune effectors by the hormonal signaling system triggering metamorphosis in *Drosophila melanogaster*. *PLOS Genetics*, 17(11), e1009916.
- Nunes, C., Sucena, É., & Koyama, T. (2021). Endocrine regulation of immunity in insects. *The FEBS Journal*, 288(13), 3928-3947.
- Poelstra, J. W., Salmons, J., Tiley, G. P., Schüßler, D., Blanco, M. B., Andriambeloson, J.B., Bouchez, O., Campbell, C. R., Etter, P. D., Hohenlohe, P. A., Hunnicutt, K. E., Iribar, A., Johnson, E. A., Kappeler, P. M., Larsen, P. A., Manzi, S., Ralison, J. M., Randrianambinina,

B., Rasoloarison, R. M., Rasolofson, D. W., Stahlke, A. R., Weisrock, D. W., Williams, R. C., Chikhi, L., Louis, E. E., Radespiel, U., Yoder, A. D. (2021). Cryptic Patterns of Speciation in Cryptic Primates: Microendemic Mouse Lemurs and the Multispecies Coalescent. *Systematic Biology*, 70(2), 203-218.

- Schlebusch, C. M., Loog, L., Groucutt, H. S., King, T., Rutherford, A., Barbieri, C., Barbuani, G., Chikhi, L., Stringer, C., Jakobsson, M., Eriksson, A., Manica, A., Tishkoff, S. A., Scerri, E. M. L., Scally, A., Brierley, C., & Thomas, M. G. (2021). Human origins in Southern African palaeo-wetlands? Strong claims from weak evidence. *Journal of Archaeological Science*, 130, 105374.

QUANTITATIVE AND SYSTEMS BIOLOGY

To decipher the whole complexity and the dynamics of biological systems, IGC researchers integrate approaches from various scientific areas ranging from biophysics to computational biology.

The **Optical Cell Biology** group, led by Ricardo Henriques, focuses on biological problems that cannot be addressed with current imaging technology and thus develops analytical, optical and biochemical approaches to address these questions. They particularly study the dynamics of viral infection at the nanoscale. Although the developed technology is designed to answer questions of interest in the lab, it also has broad applications in cell biology research. The Optical Cell Biology lab continues to take a leading role in the development of open-source next-generation quantitative technologies for super-resolution imaging and machine-learning. As a follow up to these developments, in 2021 they have released the ZeroCostDL4Mic, DeepBacs and BioImage Model Zoo platforms, providing high-quality deep-learning based data-mining computational approaches for life sciences. The laboratory was founded at the IGC in late 2020, initiating new research lines and transferring resources from their previous UCL and Crick Institute laboratories. The group established translational research in partnership with Roche and Abbelight, generating €650K of industrial funding for research being carried in the laboratory and securing an industrial funded PhD fellowship for a student. In line with IGC's mission of incubating new talent, two alumni laboratory members secured independent positions – Siân Culley (now prin-

cipal investigator at KCL) and Pedro Pereira (now principal investigator at ITQB). Finally, the group continued to co-direct the Wellcome Trust UCL Optical Biology PhD programme and coordinated the IGC Summer School.

Accounting for biological function requires a new kind of physics. Pablo Sartori's group, **Living Physics**, explains biological phenomena by exploring new regimes of statistical physics, mechanics, and thermodynamics. The research group addresses how the functions are embedded in biological matter, for instance, how proteins find correct partners in the heterogeneous cellular environment, what determines the characteristics that organisms evolve, why some organisms evolve sensory response, whereas others evolve stochastic response, and what the main constraints to biological functionality are. In 2021, the lab collaborated with researchers from Yale University, King's College, and the Center for Structural Systems Biology (CSSB) Hamburg, participated in two international meetings and seminars and co-authored a paper on ciliary beating patterns.

The **Physics of Intracellular Organization** group, led by Ivo A. Telley, on the other hand, studies the 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 1-cell stage embryo. The lab reports three lines of progress in 2021. First, they have started a new FCT project aiming at the subcellular transcriptomics analysis of the oocyte and developed

a single oocyte extraction assay (using microscopy-assisted micromanipulation). A MSc student in the group is working on the experimental validation and precision of this novel assay. Second, they have finalized the experimental analysis of late-stage oocyte polarization, the process determining the future body axes of the fly and present an exciting new perspective on the mechanical interplay between the oocyte and the somatic cells, maintaining oocyte polarization. Third, they have published two peer-reviewed papers that highlight the molecular and mechanical requirements defining nuclear positioning in the multinucleated embryo cell of *Drosophila*. This project line is coming to an end.



Publication highlights

Quantitative and Systems Biology

- Deshpande, O., & Telley, I. A. (2021). Nuclear positioning during development: Pushing, pulling and flowing. *Seminars in Cell & Developmental Biology*, 120, 10–21.
- Deshpande, O., de-Carvalho, J., Vieira, D. v., & Telley, I. A. (2021). Astral microtubule cross-linking safeguards uniform nuclear distribution in the *Drosophila* syncytium. *Journal of Cell Biology*, 221(1), e202007209.
- Lv, Z., de-Carvalho, J., Telley, I. A., & Großhans, J. (2021). Cytoskeletal mechanics and dynamics in the *Drosophila* syncytial embryo. *Journal of Cell Science*, 134(4), jcs246496.
- Spahn, C., Laine, R. F., Pereira, P. M., Gómez-de-Mariscal, E., von Chamier, L., Conduit, M., de Pinho, M. G., Jacquemet, G., Holden, S., Heilemann, M., & Henriques, R. (2021). DeepBacs: Bacterial image analysis using open-source deep learning approaches. *BioRxiv*, 2021.11.03.467152.
- von Chamier, L., Laine, R. F., Jukkala, J., Spahn, C., Krentzel, D., Nehme, E., Lerche, M., Hernández-Pérez, S., Mattila, P. K., Karinou, E., Holden, S., Solak, A. C., Krull, A., Buchholz, T.-O., Jones, M. L., Royer, L. A., Leterrier, C., Shechtman, Y., Jug, F., ... Henriques, R. (2021). Democratizing deep learning for microscopy with ZeroCostDL4Mic. *Nature Communications*, 12(1), 2276.
- Yuan, Y., Jacobs, C.A., Llorente Garcia, I., Pereira, P.M., Lawrence, S.P., Laine, R.F., Marsh, M., Henriques, R. (2021) Single-Molecule Super-Resolution Imaging of T-Cell Plasma Membrane CD4 Redistribution upon HIV-1 Binding. *Viruses* 13(1), 142.

New Research Groups

Giulia Ghedini, Marco Fumasoni and Waldan Kwong joined the IGC to strengthen the study of metabolism in ecosystems, evolutionary genetics, and host-microbe symbiosis.



Genome Maintenance and Evolution

Marco Fumasoni

“I am a biologist, broadly interested in cell biology and evolution. I graduated in biological sciences (B.Sc., 2006) and Molecular biology of the cell (M.Sc., 2008) at the University of Milan. I obtained a PhD in Molecular Medicine (2014) working at the FIRC Institute in Milan and received postdoctoral training at Harvard University (2015–2021). My lab studies the interplay between genome maintenance mechanisms and evolutionary forces in shaping cell biology. We are interested in understanding how cells evolutionary recover from perturbations in the molecular mechanisms which replicate, repair, and segregate the genetic material. We are also interested in studying how these processes affect karyotype evolution and cellular aging.”



Microbial Genomics and Symbiosis

Waldan Kwong

“I obtained my PhD in December 2015 from Yale University and did postdoctoral work at the University of Texas Austin and the University of British Columbia. I started my research group at the IGC in December 2021. My lab focuses on using 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.”



Functional Ecology

Giulia Ghedini

“I received my Ph.D. in ecology from the University of Adelaide in 2016. I then started a two-year postdoctoral position with Professor Dustin Marshall at Monash University, where I continued my work until 2021 with the support of an Australian Research Council fellowship. I joined the IGC in December 2021 with a “la Caixa” fellowship. I am broadly interested in the mechanisms that regulate the functioning of ecological communities. Specifically, I study how species interactions affect the energy use of species and its consequences for the stability and productivity of communities.”

MISSION

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

Research at the IGC is supported by a large array of scientific and technical support units, contributing to an open, stimulating, and collaborative environment that catalyzes the production of original and groundbreaking scientific discoveries.

Scientific Support Units

Scientific Support Units at the IGC provide the research groups with cutting-edge equipment and infrastructures as well as technology-driven expertise and services, including training, technical consultation, and implementation of new techniques and protocols in a wide range of scientific disciplines. These resources are also made available to external researchers from the Lisbon area and beyond.

9

Scientific Support
Units Groups

58

Staff

89

Collaborations

51 In-house
20 National
18 International

13

New Equipment
Acquired

4

New Software
Developed

8

Prizes and Honours

71

External Users

63 National
8 International

ADVANCED IMAGING UNIT

The Advanced Imaging Unit, headed by Gabriel Martins, provides open-access and support for light microscopy and is a reference lab 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 2021, five new advanced systems were installed, and two older systems were decommissioned. Feedback microscopy workflow for the OMX-SIM SR and several macros for analysis were also implemented. Throughout the year the unit organized several events, namely SPAOM2021 – Spanish & Portuguese Advanced Optical Microscopy Meeting (online, with approximately 220 participants), two internal workshops on bioimage analysis (32 participants), and co-organized 6 webinars on microscopy (>100 international participants) with CO-Life. During this year, the unit head was elected the PPBI representative for the EuroBioimaging “Panel of Nodes”. Finally, the unit contributed to the publication of 15 papers, five of which with co-authorship.

ELECTRON MICROSCOPY UNIT

The Electron Microscopy Unit, headed by Erin Tranfield, is specialized in transmission electron microscopy (EM) for biological samples, albeit open to all scientific disciplines. The unit’s aim is to provide high-quality EM services, training, and access to specialized equipment for all the IGC, and external academic or corporate users. They tailor, optimize, and develop methods adapted to the scientific questions of the Portuguese research community.

In 2021, the unit supported a huge array of science within Portugal, working on more than 65 electron microscopy projects from 12 different institutes in the country. Furthermore, after years of advocacy and effort, the IGC was part of the scientific community that received funding for the first Cryo-electron microscope in Portugal. The unit also worked with the Histopathology Unit and was supported by the Advanced Imaging Unit from the IGC to develop two separate workflows: (1) the Histo-CLEM – a workflow which aims to provide a range of techniques that help bridge the imaging scales between light microscopy and EM –, and (2) the Stereology of Lungs collaboration – a workflow that aims to provide detailed stereology and ultrastructural analysis of lung tissue.

HISTOPATHOLOGY UNIT

The Histopathology Unit, headed by Pedro Faísca, 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 in working with a diverse range of samples: from humans to model organisms. In 2021, the unit was involved in several in-house collaborations with other support units, including the Electron Microscopy Unit – acute lung injury protocol for light and EM quantification –, the Genomics Unit – Spatial transcriptomics in Formalin Fixed, Paraffin Embedded (FFPE) samples –, the Advanced Imaging Unit – Macros for image analysis and quantification – and Making Lab – Tissue microarrays.

The year of 2021 was also marked by the publishing of a chapter in *Methods in Cell Biology* entitled “Chapter 2 – The Histo-CLEM Workflow for tissues of model organisms”, the implementation of the open Swiss-roll Technique for Intestine Necropsy, the approval for the IGC Biobank implementation for FFPE samples and COLife’s Histopathology focus group first meeting.

FLOW CYTOMETRY AND ANTIBODIES UNIT

The Flow Cytometry & Antibodies Unit, headed by Marta Monteiro, offers flow cytometry and antibody-related services and expertise to the scientific community.

Unit staff is trained in instrument operation, providing support to cell sorting, cell acquisition and data analysis. Full service is provided for antibody-related requests and include 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.

Being the first in Portugal to acquire a full spectrum cytometer, in 2021 the unit implemented new procedures and protocols that opened novel possibilities for project development. This new technology provides high sensitivity, facilitates the simultaneous analysis of a high number of parameters and allows the management of cell autofluorescence. To further support this, the unit has also increased the data analysis capacity. Importantly, more than 250 fluorescent antibodies from its private collection, which is used by IGC researchers, were validated. Finally, the Flow Cytometry & Antibodies Unit was involved in the organization of two important events: the 3rd FLxFlow Course, an international Flow Cytometry course attended by around 180 scientists, and the CTLS2021 Virtual Conference, which gathered almost 300 people working in scientific core facilities in the five continents.

MODEL ORGANISM UNIT

The Model Organism Unit, headed by Manuel Rebelo, provides infrastructure and services for model organism-based research at the IGC. It includes mouse, aquatic (zebrafish and frog), fly, and plant units.

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, organization of Laboratory Animal Science (LAS) courses, and support on legal issues.

In 2021, a new ABSL-3 unit for mouse studies became available and the capacity of the Aquatic Unit was increased through the acquisition of recirculation life support systems for zebrafish and *Xenopus*. In addition, new user committees were put into place for all the Model Organism Units and the import/export processes of fly stocks were centralized. The unit also contributed to a chapter on Mouse Germ-Free technology in a book of the Spanish Society of Laboratory Animal Science (SECAL).



TRANSGENICS UNIT

The Transgenics Unit, headed by Moises Mallo, generates genetically modified mouse and *Drosophila* strains for research groups at the IGC.

The services include the production of transgenic mice by pronuclear DNA microinjection, targeted modifications of the mouse genome by embryonic stem cell-mediated approaches and by CRISPR/Cas9 techniques, and generation of transgenic or mutant flies, via p-element, Φ C31, RNAi or CRISPR/Cas9 methods. Below are some of the unit's numbers from 2021:

- > Mouse transgenic embryos: 445 from 50 different constructs;
- > Mouse mutants through CRISPR/Cas9-mediated gene edition: 54 founder lines involving 15 different targetings in both FBV/N and C57BL/6 backgrounds;
- > *Drosophila* transgenic lines generated: 26 through Φ C31 insertion, from which 7 were for RNAi-mediated inactivation, and 4 through random p-element insertion;
- > Number of constructs built for *Drosophila* transgenesis: 7;
- > *Drosophila* CRISPR/Cas9 targeted lines: 1.

BIOINFORMATICS UNIT

The Bioinformatics Unit, headed by Jingtao Lilue, is a core unit that supports research projects both internal and external to the IGC. The unit provides a broad range of bioinformatic services, a one-stop-service from experimental design to final publications, and is interested in population genetics, evolutionary genetics, mammalian genomes, transcriptomes, and genome assembly algorithms.

In 2021, the bioinformatics unit has received 18 requests from internal and external research groups. At the same time, it is providing and maintaining high performance computer virtual machines for four research groups on campus, including a Chipster server and a Metagenomics server. The unit is working closely with the Genomics and the Quantitative Biology & Digital Science Units on providing consultants for experimental design and data analysis. In 2021, the Bioinformatics unit has developed an analysis pipeline on single cell RNA analysis. Many research groups on campus have benefited from these new techniques. Throughout the year the unit has coauthored three publications, and an additional one that is under revision.

QUANTITATIVE & DIGITAL SCIENCE UNIT

The Quantitative & Digital Science Unit, headed by Tiago Paixão, provides advanced data analysis services, statistical consulting, and scientific computing to the research community.

In 2021, the unit developed a publication and an eLabBook monitoring dashboard for the IGC community and contributed to publications in the fields of cell cycle regulation and lymphocyte development, as well as gene regulatory networks and collective intelligence for science, research, and technology development.

GENOMICS UNIT

The Genomics Unit, headed by Ricardo Leite, offers short read (Illumina NexSeq 2000 and Illumina MiSeq) and long read (Nanopore MinION) sequencing and Library prep, and Fragment-analyzer/TapeStation sample QC service.

The unit provides a range of services: RNA-Seq, Whole Genome Sequencing, Spatial transcriptomics and metagenomics (16S rRNA). For Single Cell sequencing the unit operates a 10X Genomics Chromium controller. In 2021, the unit participated in the national effort of SARS-CoV-2 sequencing. More than 2000 genomes were sequenced in the context of this project coordinated by João Paulo Gomes/INSA. In addition, the unit was also involved in the development of a saliva test for monitoring and diagnosing SARS-CoV-2 infection in children and adults, a project coordinated by Maria João Amorim (IGC). These tests were used as a surveillance method at the FCG/IGC, with approximately 4000 tests performed throughout the year.

Still in 2021, the 10x Genomics Visium Spatial Gene expression FFPE was implemented, allowing to map the whole transcriptome with morphological context, in close collaboration with the Histopathology Unit.

The unit also participated in the Malango project – Malaria drug resistance in Angola, supported by FCT, Aga Khan and FCG. Throughout the year, the unit has provided services and support to more than 20 groups at the IGC.



Publication highlights

- Auger, J., Fletcher, L., Frankowiak, S., Grills, G., Lemas, M. V., Mische, S., Monteiro, M., Peláez, F., Tabarini, D., Vinard, A., & White, A. N. (2021). SRLs in a Global Pandemic: An Administrative Perspective. *Cytometry Part A*, 99(1), 19–21.
- Bom, J., Rebelo, M., Pereira, M., Ribeiro, A., Leocádio, A. S., & Demengeot, J. (2021). Chapter E.01.05 - Types of models depending on their microbiological condition. Germ-free technology and insulation systems / Tipos de modelos dependiendo de su condición microbiológica. In *Science and Technology in Animal Research / Ciencia Y Tecnología En La Investigación Animal*. SECAL/UAH.
- Borges, V., Isidro, J., Trovão, N. S., Duarte, S., Cortes-Martins, H., Martiniano, H., Gordo, I., Leite, R., Vieira, L., (Consortium), P. network for S.-C.-2 genomics, Guiomar, R., & Gomes, J. P. (2021). The early dynamics of the SARS-CoV-2 epidemic in Portugal. *MedRxiv*, 2021.02.22.21252216.
- Casanova, M., Branco, S., Veiga, I. B., Barros, A., & Faísca, P. (2021). Stereology in Grading and Prognosis of Canine Cutaneous Mast Cell Tumors. *Veterinary Pathology*, 58(3), 483–490.
- Ducrée, J., Etzrodt, M., Bartling, S., Walshe, R., Harrington, T., Wittek, N., Posth, S., Wittek, K., Ionita, A., Prinz, W., Kogias, D., Paixão, T., Peterfi, I., & Lawton, J. (2021). Unchaining Collective Intelligence for Science, Research, and Technology Development by Blockchain-Boosted Community Participation. *Frontiers in Blockchain*, 4.
- Gonçalves, C., Kareklas, K., Teles, M. C., Varela, S. A. M., Costa, J., Leite, R. B., Paixão, T., & Oliveira, R. F. (2021). Phenotypic architecture of sociality and its associated genetic polymorphisms in zebrafish. *BioRxiv*, 2021.07.29.454277.
- Martins, G. G., Lopes, A., Pereira, H., Martins, N. P., Munck, S., & Swoger, J. (2021). Optical projection tomography. In A. Walter, J. Mannheim, & C. Caruana (Eds.), *Imaging Modalities for Biological and Preclinical Research: A Compendium* (Vol. 1, p. I.2.f'1-I.2.f.11). IOP Publishing.
- Nagy-Staron, A., Tomasek, K., Caruso Carter, C., Sonnleitner, E., Kavčič, B., Paixão, T., & Guet, C. C. (2021). Local genetic context shapes the function of a gene regulatory network. *ELife*, 10, e65993.
- Sarkans, U., Chiu, W., Collinson, L., Darrow, M. C., Ellenberg, J., Grunwald, D., Hériché, J.-K., Iudin, A., Martins, G. G., Meehan, T., Narayan, K., Patwardhan, A., Russell, M. R. G., Saibil, H. R., Strambio-De-Castillia, C., Swedlow, J. R., Tischer, C., Uhlmann, V., Verkade, P., ... Brazma, A. (2021). REMBI: Recommended Metadata for Biological Images - enabling reuse of microscopy data in biology. *Nature Methods*, 18(12), 1418–1422.
- Saumya, K., R, F. V., Filipa, R., P. B. A., Ana, Á.-D., Marta, M., Dikélélé, E., J. M. R., Tomás, G., Eliane, P., Elodie, S., Margarida, G.-C., A, T.

- S., & Luis, G. (2021). Developmental bifurcation of human T follicular regulatory cells. *Science Immunology*, 6(59), eabd8411.
- Sousa, A. L., Rodrigues Lóios, J., Faísca, P., & Tranfield, E. M. (2021). Chapter 2 - The Histo-CLEM Workflow for tissues of model organisms. In T. Müller-Reichert & P. Verkade (Eds.), *Methods in Cell Biology* (Vol. 162, pp. 13–37). Academic Press.
- Tranfield, E. M., & Lemgruber, L. (2021). Transmission electron microscopy. In A. Walter, Julia G Mannheim, & C. J. Caruana (Eds.), *Imaging Modalities for Biological and Preclinical Research: A Compendium* (Vol. 1, p. I.5.a'1-I.5.a – 16). IOP Publishing.

Technical Support Units

IGC's technical support units provide the foundations for the excellence and quality standards of the research conducted in the institute. Working closely with the research groups and scientific support units, these ensure core functions such as project management, funding and the organization of events.

IN NUMBERS

12

Technical Support Units

58

Staff

BIOSAFETY

EVENTS & WELCOME TEAM

INFORMATICS

INNOVATION

INSTITUTIONAL COMMUNICATION

MAINTENANCE

PEOPLE MANAGEMENT

PROCUREMENT

PROJECT MANAGEMENT & ACCOUNTING

PUBLIC ENGAGEMENT

RESEARCH FUNDING AFFAIRS

SCIENTIFIC EQUIPMENT & INFRASTRUCTURES

MISSION

Fostering innovative training and further innovating on how science is done

The IGC fosters innovative training at all levels, from undergrads to postdocs, contributing to shape future scientific leaders in academia and beyond. As a commitment to maximize the potential of the scientific community, graduate education programmes, career development support, as well as diverse courses and workshops, are available to scientists who wish to grow and boost their career perspectives.

IN NUMBERS

- **1**
Undergraduate Programme
- **2**
Graduate Programmes
- **5**
GTPB courses
- **97**
Participants
- **19**
Talks in other PhD Programmes

Undergraduate Summer School

232 applications
27 students admitted
4 nationalities

In 2014, the IGC and University of Oxford ran a Programme aiming to bring young science undergraduates to the IGC for a lab experience. This Programme then expanded to accommodate undergraduates studying in Portuguese Universities, then included other European universities and recently has also included students from all around the world.

In 2021, the Programme began in July with a week of online seminars that showcased the science done at the IGC in its multiple facets. A session about science communication was also offered as part of the programme, in collaboration with the Institutional Communication team. With the easing of Government health guidelines regarding the COVID-19 pandemic, it was possible to hold lab internships again. Seminars ran in an online format for 27 selected students and a total of eight students were then placed on internships at six IGC scientific support unit groups and labs: the Advanced Imaging Unit, and the Cell Cycle Regulation, Chromosome Dynamics, Evolution and Development, Mechanisms of Morphogenesis, and Optical Cell Biology research groups. The Summer School was seen as a meaningful milestone in the student's life and 17 out of 18 participants said that they would consider doing an MSc or PhD at the IGC as a result.

In addition, two public talks, from Dr. Richard Sever, founder of bioRxiv MedRxiv, and Prof. Maria Leptin, EMBO director, were broadcast online and attended by more than 70 people.

PhD Programme in Integrative Biology and Biomedicine (IBB)

120 applications
12 PhD students in 2021 (6 nationalities)
88 PhD Students in the Programme
(23 Nationalities)
11 Thesis defended

The IGC PhD programme offers to a highly selected group of students 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. Students benefit from an intensive semester of course work before creating their own research project and choosing the research groups to join. Candidates hail from all over the globe, and diverse academic backgrounds. The class of 2021 maintains its international collaboration with the University of Cologne, and the Max Planck Institute for Plant Breeding Research, as well as local partnerships with the Champalimaud Research (Champalimaud Foundation) and the Instituto de Tecnologia Química e Biológica (ITQB-UNL). These collaborations have been extended to the University Paul Sabatier of Toulouse and the EMBL. 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, organizing cultural events all year round. The IBB programme is supported by the Fundação para Ciência e a Tecnologia and the Calouste Gulbenkian Foundation and its students are awarded their degrees from the Universidade

NOVA de Lisboa.

In 2021, IBB PhD Programme's agenda started with the IBB2019 Annual Workshop. The annual workshop is a special occasion in the life cycle of the first-year students, who present their consolidate projects to the whole IGC community. The edition for the IBB2019 students was postponed to early 2021 due to the pandemic, being held by video conferencing. The coordinators took this as an opportunity to invite the former graduates of several IGC PhD programmes and to celebrate the former IBB Director Élio Sucena who was succeeded by Jorge Carneiro in 2020. One of the most participated events of the IGC in 2021, the workshop was a tremendous success gathering the extend family of alumni and present students. Later, from March to April, the international call for the IBB PhD Programme took place. There were 120 applicants, from which 40 were interviewed to reach the final selection of 12 students of the IBB2021 cohort. In October, the IBB2020 Annual Workshop was held in a hybrid manner. It was a vibrant event with students presenting their projects on zoom and the whole IGC scientific community participating on zoom or in presence in IGC's patio. The discussions of each presentation continued during the coffee break and happy hour held in the patio. In 2021, the IBB PhD Programme, whose degree conferring institutions are the Universidade NOVA and ISPA, submitted its accreditation for the next six years to the Agency for Evaluation and Accreditation of the High Education (A3ES). Throughout the year the PhD students contributed to a total of 32 publications.



PhD Thesis

Defended in 2021

- > **Ana Lina Rodrigues (PGCD2015)** - Early events of cell autonomous immunity against *Toxoplasma gondii* in the mouse – defended on 20/09/2021
- > **Bruno Alexandre Teixeira Peixoto** - The SnRK1 kinase: novel regulatory mechanisms and its role in metabolic homeostasis – defended on 27/07/2021
- > **Catarina Sofia Duarte Nunes (IBB2016)** - Co-operation of immune response mechanisms by the metamorphosis hormonal signalling system – defended on 06/04/2021
- > **Chandra Shekhar Misra (Plants4Life2016)** - Transcriptome dynamics in the *Arabidopsis thaliana* male germ unit: From mature pollen grain to pollen tube – defended on 29/07/2021
- > **Cláudia Cristiana da Cruz Gonçalves (PGCD2016)** - Phenotypic architecture and genetic polymorphisms associated with social behaviour in zebrafish – defended on 23/11/2021
- > **Filipe José Dias Vieira (MolBIOS2016)** - Regulation of virulence in the vector borne plant pathogen *Erwinia carotovora* – defended on 18/02/2021
- > **Gonçalo Santos Matos** - Regulation of the microbiota in the gut of *Drosophila melanogaster* – defended on 23/07/2021
- > **Martha Catalina Alvarez-Meneses (IBB2015)** - Immunity-related GTPases (IRGs) in the house mouse and the parasite *Toxoplasma gondii* in South America – defended 11/02/2021
- > **Nuno Filipe Brito Pais Dos Santos (PGCD2016)** - Interplay between DAF and viral proteins HA and NA modulates viral pathogenesis – defended on 02/06/2021
- > **Rafael de Almeida Paim (IBB2016)** - Thymus autonomy – defended on 07/12/2021
- > **Sónia Alexandra Gomes Pereira (IBB2016)** - De novo centriole biogenesis during spermatogenesis in the model bryophyte *Physcomitrium patens* – defended on 25/06/2021

PONTE Postdoctoral Programme in Theoretical Quantitative Biology

23 applications
2 international postdoctoral fellows admitted

The Postdoctoral Programme Biology by Numbers transitioned into the PONTE Postdoctoral Programme in Theoretical Quantitative Biology, a multidisciplinary program for PhD holders from Exact Sciences. This program bridges exact sciences with biology, awarding postdoctoral fellowships for up to three years to highly independent graduates in physics, mathematic, engineering or a related discipline. PONTE Fellows perform research in theoretical quantitative biology in collaboration with local experimental groups.

In 2021, Biology by Numbers Postdoctoral fellow Estefanía Muñoz left for another Postdoctoral Position at the Theoretical Ecosystem Ecology Group at Max Planck Institute for Biogeochemistry in Germany. She published a paper under IGC affiliation and is currently working on another publication with Jorge Carneiro, coordinator of the Education Unit and former principal investigator at the IGC.

Gulbenkian Training Programme in Bioinformatics – GTPB

58 participants
5 courses

The GTPB provides practical hands-on training in bioinformatics and related disciplines, regularly since 1999. It covers a wide variety of thematically focused subjects, while providing foundations type courses to support young research practitioners with helpful practical knowledge in statistics, for example. In all courses, participants learn about reproducibility. Participants get acquainted with open science principles applied to data science, curation, sharing and publishing as insiders, as they directly witness what we do with the materials that were developed and used in each course, collecting them into open access repositories. In 2021, the course design methodology was consolidated, and the delivery of the training courses was compressed in two months, preserving quality.

The following modules/courses were held in 2021:

- > **3DAROC 3C-Data Analysis and 3D Chromatin Folding** (Oct 4-6) – 11 participants
- > **PO21 Precision Oncology** (Oct 25-29) – 7 participants
- > **AM21 Applied Metagenomics** (Nov 2-5) – 17 participants
- > **PSLS21 Practical Statistics for the Life Sciences** (Nov 8-12) – 15 participants
- > **IBIP21 Integrative Biological Interpretation using Proteomics** (Nov 22-26) – 8 participants

MISSION

Bringing science closer to society

The IGC promotes science from all to all. With the aim to increase the global impact of its research, the IGC engages actively in technology transfer and industry relations, develops programmes that foster better science education and research in the developing world, and promotes initiatives to disseminate the values of science in society.

IN NUMBERS

- **50**
Innovation Agreements
- **1**
Product Introduced into the Market
- **23**
Events Organized
- **26**
Press Releases
- **934**
News on National Media

Innovation and Tech Transfer

IN NUMBERS

50

innovation
agreements

19

protocols with
academia

24

protocols with
industry and
hospitals

1

product
introduced into
the market

The Innovation Unit increases the impact of the science produced at the IGC by bringing it closer to clinical practice, the industry and society, while contributing to the institute's visibility and international reputation. The unit provides support to researchers regarding innovation projects, protection and exploitation of intellectual property, as well as the translation of discoveries into impactful resources through collaborations with strategic partners. The relevance of this growing area in the institute was reaffirmed in 2021, as revealed by a high activity in all offered services and the launch of the Proof of Concept's first edition. The Innovation Unit remained very focused on initiatives related with the study of COVID-19, particularly, the immune response, vaccination, and new treatments, while also resuming innovation activities in other scientific areas. Partnerships with hospitals and municipalities were strengthened, as well as the connection between researchers and the public.

Throughout the year, more than 50 innovation agreements, five of which with industry, were reviewed and negotiated. A brand related

with the "Lab in a Box" project was registered. Following the licensing agreement for the ELISA serological test for SARS-CoV-2 to Medinfar in 2020, the IGC collaborated actively in the scale-up process, which resulted in the regulatory approval and market introduction of the Sero-COVMed® product in 2021. Close to the end of the year, the first edition of InnOValley Proof of Concept (PoC) was launched. Co-funded by the IGC, Oeiras Municipality and ITQB NOVA, the PoC fund is one of the first initiatives in Portugal to identify and fund scientific research projects that have shown promising results and seek to move forward to create prototypes or proofs of concept, with a clear focus on translation and future applications.

Gulbenkian Collaborative Centre

IN NUMBERS

23

Events
Organized

120

IGC Seminars

4

Sabbatical
Visitors

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 organizes lectures, courses, conferences and postgraduate training events. The Centre also runs fellowships and awards, coordinates the selection of the corresponding awardees and runs a project that assembles portable, personalized and easy-to-maintain mini-laboratories called Lab in a Suitcase.

In 2021, the Collaborative Centre organized more than 15 virtual or face-to-face events, including the IGC-Institut Pasteur symposium, and an EMBO conference in energy signaling

pathways in photosynthetic organisms. The 1st edition of the ERC-Oeiras, a prize financed by the Municipality of Oeiras (CMO), was also organized. Throughout the year, the Collaborative Centre hosted several renowned researchers who took their sabbatical at the institute. The negotiation that led to a Memorandum of Understanding with EMBL, and discussions with Institut Pasteur aiming to establish a partnership agreement, were also supported by the centre.

As part of the efforts to promote the democratization of science, in 2021, 10 Lab in a Suitcase kits were produced and delivered to Portuguese-speaking African countries (PALOP) partner researchers, with the support from MERCK and CMO. These portable laboratories were awarded the Social Responsibility prize by Exame Informática magazine. Three PALOP researchers were also supported through the António Coutinho Awards, which offered them opportunities for training, collaboration and networking in Portuguese scientific institutions, also with the support from MERCK and CMO.

Science & Society

Several public engagement, active citizenship and communication initiatives promote IGC's discoveries and contribute to society's engagement in science.

IN NUMBERS

26

Press Releases

934

News on National Media

5

Editorial illustrations
1 published on National Media

2

Journal Covers

2

Infographics

9260
followers
+ 13%30 894
followers
+ 28%1740
followers
+43%843 116
followers
+2%530 000
page views

PUBLIC ENGAGEMENT

The public engagement unit's goal is to bring citizens closer to science through innovative approaches, and to promote a more critical, collaborative and participatory society. The IGC promotes science communication activities aimed at diverse audiences and stakeholders, including educational initiatives with schools and public events. Throughout the year, the public engagement programme at the IGC was adjusted to cope with the COVID-19 pandemic restrictions. Despite the return of some face-to-face activities, many were still held digitally.

IGC's educational activities, including scientists visits to schools, online school visits to the IGC, open sessions, job shadowing, and support to experimental activities, reached over 764 students. In addition, 5 multimedia resources were produced, receiving more than 1669 views.

In 2021, a new Podcast called "Parece Impossível!" was created in collaboration with ITQB

NOVA and Oeiras Municipality, with the aim to discuss how science is shaping our future. Eight episodes aimed at all ages and covering various topics, from research in bacteria to the democratization of science, were produced and made available on several streaming platforms, reaching more than 1300 listeners.

To bring science closer to society, the Institutional Communication team organized several events, including four face-to-face that reached over 6900 people. More than 80 volunteers from the IGC attended these events, promoting a vast program of didactic activities, including games, storytelling, demonstrations, debates, workshops, talks and others. These events with science reached over 30 schools and more than 2900 participants of various ages who had the opportunity to interact with IGC researchers and to learn more about science.

PUBLIC EVENTS

- > 1st edition of the European Researcher's Night of Oeiras | 1000 participants
- > 1st edition of FIC.A | 1900 participants
- > 2 Concerts – Music and Science at the Gulbenkian Foundation | 4000 participants
- > Maratona da Saúde Live Broadcast from the IGC | 55K€ raised for research

WEBINARS

- > "Conversas com Cientistas – Décadas de Ciência para Dias de Vacinas" – More than 400 online sessions to explain the importance of COVID-19 vaccines to the general public organized by Ciência Viva, COLife, Sociedade Portuguesa de Imunologia, and i3S.
- > "Apresentação INFO-VAC: Estudo de eficácia da vacina em idosos nos lares de Almeirim" – presentation of INFO-VAC results in partnership with the Almeirim Municipality and the Group of Lezíria Health Centers.

LAB IN A BOX

22 teachers | 850 students | 7 partners

Lab in a Box is a pioneering pedagogical project, designed to develop students' scientific curiosity and critical thinking skills. Focused on making the teaching of experimental science and the scientific method a common practice, it aims to foster the creation of a community of future "citizen scientists" in Portugal and PALOP. Lab in a Box develops, produces, and implements in school communities of different Portuguese-speaking countries and regions, an educational kit of scientific experiments that is portable and modular, with simple, appealing and curriculum-integrated experimental protocols, made with low-cost materials of everyday use. The project also includes and strongly invests in accredited teacher training, classroom follow-up and online resources for teachers and a constant sharing of experiences between teachers and the Lab in a Box scientists.

The training of Oeiras' teachers (Estudo do Meio and Natural Sciences) for the 2020/2021 school year continued throughout 2021, as well as the pilot training of teachers from Vila Verde, in an online format. During this year, the team developed and produced 50 new Lab in a Box – Oeiras kits for the school year of 2021/2022, which are expected to reach from 2000 to 3000 children. New experimental activities were developed and included, allowing the expansion of the Lab in a Box kits previously aimed at the 4th grade to all primary school. With the support from the project's partners Oeiras Municipality and the Merck Family Foundation (MFF), as well as from several local supporters in Benguela, Angola, the kits were adapted and customized into Lab

in a Box – Angola kits, which will be distributed among 30 teachers in several schools in this region.

The project participated in several conferences and meeting throughout the year, including Native Scientist's Online Symposium, "Encontros de Comunicação de Ciência(s)", ScicomPt Congress, International Conference on Hands-on Science (HSCI 2021), European Researcher's Night of Oeiras, and FIC.A. The year closed with the 2020/2021 Pilot year's Presentation/Closing Ceremony.

CITIZEN SCIENCE PROGRAM

Ciência + Cidadã (C+C) is a partnership between the IGC, ITQB NOVA and Oeiras Municipality with the mission to promote science as the starting point for well-informed and participative citizens, able to make changes in their communities, towards a more healthy and sustainable future. It aims to do this by nurturing (i) an open dialogue between citizens, scientists and political representatives, through citizen assemblies and other participatory initiatives; (ii) an active citizenship, through citizen science projects that engage citizens in the discovery of the science in their municipality and in the protection and preservation of its natural resources and biological heritage.

In 2021, various initiatives were put in place to share C+C's program with local, national, and

international communities. For this purpose, four resources were produced, reaching more than 1347 views, including an episode of the Podcast "Parece Impossível!" and a promotional video for the Carbon Tree project. Participants of the Carbon Tree project presented it at the international conferences CitSciVirtual and TCCF 2021 and participated in the competition Jovens Cientistas 2021. Throughout the year, C+C presented its projects in several other national and international conferences, including the Fórum Nacional dos Clubes Ciência Viva, ScicomPT 2021 and Encontro Nacional de Ciência Cidadã 2021. In addition, the programme coordinated and participated in several activities, workshops and debates at the European Researcher's Night and the FIC.A Festival in Oeiras. For the first time, C+C collaborated with EU-Life institutes in a publication in EMBO Reports (Garrison et al), sharing the know-how and experience of public involvement.

MISSION

Promoting national and international partnerships

The IGC is multidisciplinary, international and highly collaborative. Apart from its in-house cooperation, promoted by IGC's open environment and interdisciplinarity, the IGC community engages in several national and international collaborations that contribute to research excellence and support scientific breakthroughs.

IN NUMBERS

- **243**
Collaborations
*68 in-house
58 National
117 International*
- **4**
Sabbatical Visitors
- **60**
Seminars from invited external speakers
88% from international institutions | 12% from national institutions
- **1**
MoU with EMBL

National Collaborations

The IGC is part of a vast network of Portuguese scientific institutes that share complementary expertise and skills, as well as infrastructures and services, to maximize and leverage national research in the life sciences. 2021 was a year that enhanced interdisciplinary and collaborative research and strengthened research partnerships, helping to establish the IGC, Oeiras and the greater Lisbon region, as a hub for Science and Innovation of international relevance.

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

With the motto “Stronger Together”, the CO-Life 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 attracting talent to COLife institutes, and 3) having an active participation in the development and implementation of Science Policies. COLife activities in 2021 started with a Scientific COLife Seminar by Jürgen Knoblich, from IMBA at Vienna Biocenter. Later, to celebrate Women’s International Day, COLife organized an online event that combined the screening of the

documentary “Picture a Scientist” with a panel discussion about the importance of Diversity and Equality in Science.

One year after the COVID-19 pandemic started, COLife joined forces with Ciência Viva, Sociedade Portuguesa de Imunologia, and i3S to organize and launch the vaccination awareness campaign “Conversas com Cientistas – Décadas de Ciência para Dias de Vacinas”. In this outreach effort, 120 scientists led more than 400 online sessions to explain the importance of COVID-19 vaccines and the science behind it to Portuguese citizens nationwide. In addition, COLife participated in the 1st edition of FIC.A with two outreach sessions on the science behind the vaccines and the importance of fundamental research.

Throughout 2021, Webinars were organized to showcase and promote the services provided by the research facilities of the COLife institutes. Courses and workshops in collaboration with the

COLife Bioimaging and FlxFlow working groups on Bioimaging, Flow Cytometry and Image Analysis were also organized. Finally, during the Postdoc Appreciation week in September, COLife joined forces with i3S and organized several career development events for COLife and i3S Postdocs.

ASSOCIATE LABORATORY LS4FUTURE – LIFE SCIENCES FOR A HEALTHY AND SUSTAINABLE FUTURE

In 2021, LS4FUTURE, that brings together four research units – MOSTMICRO-ITQB, INOVA-4HEALTH, IGC and GREEN-IT –, and five institutions – ITQB NOVA, IBET, IGC, CEDOC and IPO-Lisboa Francisco Gentil –, was granted the Status of Associated Laboratory by Fundação para a Ciência e Tecnologia (FCT). These research units and institutions offer complementary skills in fundamental, clinical and applied science, allowing an integrated and multidisciplinary approach to societal challenges related to health and sustainability.

LS4FUTURE covers subjects that are relevant to support and promote public policies and is committed to the translation of knowledge to application, supported by strong links to health units and hospitals. Moreover, it holds great potential to attract international talent to improve diversity and performance of research in the life sciences, goals that are fully aligned with IGC’s strategy.

BRIDGING SCIENCE AND HEALTH – COOPERATION PROTOCOLS WITH PUBLIC HEALTH AGENCIES AND HOSPITALS

Cooperation between researchers, clinicians and health authorities has become particularly urgent since the start of the COVID-19 pandemic. In 2021, the IGC reinforced its association with clinical research institutions, hospitals and public health agencies. These associations bridge health and science, promoting groundbreaking discoveries in biomedicine and a quicker translation of IGC findings with a direct impact on human health and public policies.

In July, the IGC and the Instituto Nacional de Saúde Doutor Ricardo Jorge (INSA) signed a cooperation protocol to reinforce their collaborative efforts. This new protocol comprises the study of SARS-CoV-2 genetic diversity, something that the institutions have been closely monitoring since 2020. Through this joint effort, the institutions have sequenced millions of samples of the new coronavirus, which has been and will continue to be pivotal to support strategies to tackle the current pandemic. Under this new protocol, the institutions will also cooperate to better understand COVID-19 immune responses. Data collected by the IGC, which has monitored vaccine effectiveness in more than 3000 people, is shared with INSA, which speeds up, with European Agencies (ECDC), the extended national monitoring, providing information for possible updates of the global policy recommendations. Beyond the pandemic, the link between the IGC and INSA also supports innovative scientific and technological initiatives, stimulates post-graduate training, and boosts scientific publications.

The IGC also maintains partnerships with several hospital units, promoting a close dialogue between researchers and clinicians. The IGC engaged with many hospitals throughout 2021, including Centro Hospitalar Lisboa Ocidental, which comprises the Egas Moniz, Santa Cruz and São Francisco Xavier Hospitals, and Centro Hospitalar Universitário de Lisboa Central, comprising Dona Estefânia and Professor Doutor Fernando da Fonseca Hospitals, with whom we collaborated on SARS-CoV-2 virus surveillance projects and on the development of saliva tests for COVID-19, respectively. The IGC also maintains a partnership with CUF for the exchange of knowledge, training and research.

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 City Council aims to take science closer to the society, through initiatives including the Ciência Aberta a Oeiras, Oeiras Educa, the Ciência + Cidadã, and the Lab in a Box and Lab in a Suitcase projects. Within the scope of these projects, in 2021, the IGC coordinated several activities with students, from elementary to high school, and various public engagement, citizen and open science initiatives aimed at different audiences. Besides these projects, the Oeiras City Council supports research activities through the António Coutinho Science Awards, in partnership with IGC's Collaborative Center and the Merck Family Foundation, and the Oeiras ERC Frontier Research Incentive Awards, aimed to attract and retain top scientists.

The first edition of this initiative was held this year, with a prize of 24,0K€ being attributed to a principal investigator at the IGC. Other initiatives supported by Oeiras Municipality include the INFO-VAC project and Serology4COVID.



Research Structures

IGC's scientific support units, resources and related services are used to develop cutting-edge research and innovation. The IGC is part of four consortiums that integrate FCT's National Roadmap of Research Infrastructures, providing services to national and international scientific and educational communities, as well as to businesses and industry.

BIODATA.PT: PORTUGUESE BIOLOGICAL DATA NETWORK

EXECUTIVE DIRECTOR:

Ana Portugal Melo (IGC)

BioData.pt is the Portuguese Distributed Infrastructure of Biological Data and the Portuguese Node of ELIXIR. To support the transformation of Portugal in a country with the ability to conduct research and innovation with large volumes of biological data and enable Portuguese organizations to translate this data into innovation for new research, products and services, BioData.pt organizes and adds value to the biological data generated by Portuguese R&I organizations, enhancing investment and value creation, through a National Platform of Biological Information. To capacitate platform users, BioData.pt provides training and services in computing, bioinformatics and data management.

In 2021, 12 Portuguese R&I organizations gathered to establish the BioData.pt Association to strengthen the governance and expedite the operations of the Portuguese Infrastructure of Biological Data bringing excellence in data management and advanced analysis to research in Portugal. To increase capacity in impact evaluation across national ELIXIR Nodes, the ELIXIR study "Impact evaluation at Node-level - getting it done" was started. Finally, in order to facilitate the management of research data according to the FAIR data principles and open science, in the context of the ELIXIR CONVERGE project, the RDMKit was released.

PPBI: PORTUGUESE PLATFORM OF BIOIMAGING

SOUTH REGION CO-COORDINATOR:

Gabriel Martins (IGC)

PPBI, the Portuguese Platform of Bioimage, is a common functional and centralized platform dedicated to the management of shared resources in bioimaging.

Organized 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 and 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 of animal facilities (model and non-model organisms) and equipment operation, consulting and project planning, technology development, and outreach activities.

2021 was the year of the official integration of PPBI in the EuroBioimaging research infrastructure, presented publicly to the Nodes in February 2021. During this year, Gabriel Martins (IGC) was also elected the PPBI representative in the EuBI “Panel of Nodes” and one of the representatives of the EuBI biological-imaging “tech expert” group. PPBI funding was concluded in September and the final report was submitted in October.

The Expression of Interest for continuing PPBI funding by FCT was prepared in December.

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: i) to potentiate participation in national and international genome projects, and ii) 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. During 2021, GenomePT sequenced more than 27000 SARS-CoV-2 genomes through a network of hospitals distributed throughout Portugal, under the coordination of INSA. The 2021 Annual meeting was attended by 350 participants, with high profile international speakers.

CONGENTO: CONSORTIUM OF GENETICALLY TRACTABLE ORGANISMS

IGC COORDINATOR:

Jocelyne Demengeot

CONGENTO is a distributed Portuguese Research Infrastructure synergizing four prominent biomedical research institutions in the Lisbon area (IGC, CCU, IMM, and CEDOC). It serves the needs of the academic and non-academic, public and private R&D+I communities requiring the three main non-human animal models – rodents, zebrafish and fruit fly – to generate knowledge and value in the biomedical field. In 2021 video tutorials on fruit fly as a model organism were developed by Gastón Guilguir from IGC’s Fly Transgenic Unit for the CONGENTO Course “Landing in the Drosophila World”. The videos were made freely available at CONGENTO website and YouTube. The year was also marked by the CONGENTALKS – presentations by CONGENTO working-groups, showcasing the innovative services provided by the infrastructure – and the organization of Laboratory Animal Sciences Courses covering competences for Functions A + D (former FELASA Category B), as defined in Directive 2010/63/EU.



International Collaborations

The IGC collaborates with exceptional institutions around the world to address complex questions in the life sciences and push science forward.

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

The IGC is one of the fifteen independent European research institutes in the life sciences that are part of EU-LIFE. This alliance contributes to the improvement of research by influencing European science policies and by developing, implementing, and disseminating best practices in the organization 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 2021, IGC Director Mónica Bettencourt-Dias was co-Chair of the alliance. During this year, IGC members participated in several working groups and tasks forces, organizing a Tech Transfer Pitching Event with participation of Venture Capital organizations, an ERC Masterclass for ERC Starting and Consolidator candidates, and a series of Policy Seminars on

Research Careers and Research Assessment. A Core Facilities Benchmarking Report was also issued. In addition, during this year the IGC joined six other biomedical research institutes to create EMERALD, the first European-wide PhD programme to train physician-scientists, funded by the European Union's Horizon 2020 programme. The institute also contributed to a hands-on guide and delivered three workshops on recommendations to implement Research Data Management at institutional level and issued a hands-on guide and a policy report on Postdoctoral Career Support. Two publications with the participation of the IGC, regarding stakeholder engagement in fundamental research (Garrison *et al* EMBO Reports) and postdoctoral training best practices (Krull *et al* EMBO Reports), were published.

COLLABORATIVE AGREEMENT WITH EMBL

Building on existing links and collaborations, in December 2021, the IGC and EMBL signed a memorandum of understanding (MoU) to reinforce their 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.

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. In light of this new agreement, EMBL and IGC have begun to apply for joint funding from the Horizon Europe programme

within the emerging fields of functional ecology and evolution, in particular host-microbe interactions, and in the fields of theory of living systems and data science.

Collaborative Initiatives

SYMBNET TWINNING

SymbNET is a European network between four outstanding national and international institutions for host-microbe symbiosis research funded by EU's H2020 Program (€900k), running between 2021 and 2023.

The project is coordinated by the FCG-IGC and it involves four other institutes: ITQB-NOVA, University of Lausanne (UNIL), EMBL and Kiel University (CAU), bringing together a consortium of leaders in the field of Host-Microbe Symbiosis. The project aims to promote the transfer of knowledge and collaborations through programs of Researchers and Staff visit exchanges, collaborative projects, sponsoring the use of new technologies, organizing 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

FCG-IGC's management and administrative capacity in collaborative grants (applying and managing), in the organization of international scientific events, and in career development.

SymbNET's Kick-off Meeting was held online in March 2021, bringing together over 140 participants from different research institutes. The SymbNET online seminar series were launched in April, with a total of 20 talks held throughout the year. The network also organized two courses in 2021: the CRC 1182/SymbNET Computational and Comparative Genomics Workshop and the Host-Microbe Interactions online course for PhD Students, part of IGC's IBB PhD Programme.

The 1st PhD Project Award was awarded to Maria Montoya (FCG-IGC) and the 1st call for the SymbNET Research Grants was opened. In October, SymbNET organized a virtual career development event where PhD students met a junior and a senior PI, to discuss career matters. SymbNET also participated in two outreach events: FIC.A and Sunday concerts at Gulbenkian Music and Science, reaching a broad audience who got to learn about how bacteria influence health and diseases.

MICROBIOTA VAULT

The Microbiota Vault initiative sets out to preserve the biodiversity of human-associated microbiota by supporting collection efforts and constructing an infrastructure for the safe preservation of microbiota samples.

The project is supported by a team of international experts, including IGC's principal investigators Karina Xavier and Luís Teixeira, who have

decisive roles on two fronts: contributing with scientific knowledge in this research area 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.

After 2020's feasibility study, which was supported by institutions and universities active in the field of the human gut microbiome, including the IGC, 2021 was marked by the start of the project's launch phase and the first Latin American Symposium of the global microbiome network.

EMERALD PROJECT

The IGC has joined six other European biomedical research institutes to train the next generation of physician-scientists.

The EMERALD, the first European-wide physician-scientist training programme, will provide medical doctors with state-of-the-art biomedicine skills and help bridge the gap between laboratory research and clinical practice. This project is part of IGC's strategy to promote scientific partnerships with different sectors to generate new knowledge with an impact on improving society's quality of life. Funded by the European Union's Horizon 2020 programme, EMERALD will provide medical doctors with unique opportunities to move to a different country to conduct their PhD research project, to participate in tailored summer schools, peer-mentoring and to explore new collaborations.

COVID-19 Efforts

In 2021, the IGC continued its efforts in the fight against the current pandemic. Several initiatives that started in 2020 continued throughout this year in search for new answers and solutions to this worldwide problem and ever-changing virus. These initiatives range from diagnostic and research to international and national cooperation with other research centers and public entities.

Monitoring the virus and its evolution

The SARS-CoV-2 virus is constantly mutating. The ability to follow and monitor its evolution in real-time is one of the greatest competitive advantages we have, to be one step ahead and to adjust strategies to tackle the pandemic and the disease.

In 2021, the IGC sequenced over 2 500 viruses, in collaboration with INSA, adding up to more than 50 000 genetic codes sequenced since the beginning of the pandemic. Funding obtained for the project Test2Save allowed the IGC to reinforce laboratory capacity for human samples and pseudovirus handling and to develop new ways of testing, thus supporting strategies from the National Health Service in response to the pandemic. Overall, this thorough monitoring of positive samples from different hospital units in the country allows detecting the viruses that are in circulation, picking up on any variations between them and providing critical information for the adoption of public health measures.

Besides this epidemiological surveillance, the IGC also develops research to understand how different mutations can change the course of infection and immunological surveillance. An example is a study developed by the IGC in collaboration with Instituto de Tecnologia Química e Biológica António Xavier da Universidade NOVA de Lisboa and CEDOC that revealed structural points of the spike protein that are prone to evolve variants that escape the immune response, going unnoticed to the antibodies generated after vaccination or infection. This type of insight is crucial to adjust the available vaccines or vaccination plans in response to potential mutations.

Tracking immunity to SARS-CoV-2: INFO-VAC

The first vaccines against COVID-19 arrived in Portugal in December 2020 and started being rolled out to the vast majority of the population throughout 2021, a significant milestone for controlling the pandemic.

Following recommendations from the World Health Organization, the IGC organized an extensive national surveillance program – INFO-VAC – to monitor vaccine effectiveness in different groups from the very start of the vaccination plan. Through this program, the IGC has monitored vaccine effectiveness and impact, including immediate and long-term effects, in different age groups of the population and of different vaccines available in the country, in partnership with hospitals, health agencies and municipalities. Throughout the year, over 3000 individuals were followed, including healthcare professionals from Centro Hospitalar Lisboa Ocidental E.P.E. (CHLO, including Egas Moniz, Santa Cruz and São Francisco Xavier hospitals), teaching and non-teaching staff from several schools from Oeiras Municipality, and elderly living in nursing homes.

Findings from these studies have revealed the percentage of people that develop antibodies after the first and second doses of the vaccine and the continuous monitorization revealed for how long antibodies persist in different age groups. This data was crucial to adjust and update vaccination policies and has inclusively led to the recommendation to not increase the period between the first and second shots of the vaccine and to maintain individual protection measures.

Findings on vaccine mixing also revealed significant differences in antibody levels, supporting this vaccination strategy. The duration of the groups' immune responses will continue to be monitored over a period of one year to assess for how long the antibodies are maintained, if additional doses or boosters are needed and how the study members react if they eventually contract the disease.

Besides the groups mentioned above, the INFO-VAC project also follows vaccine effectiveness in cancer patients from the Hospital Professor Doutor Fernando Fonseca (Amadora-Sintra), which is particularly urgent as this is a population that is often immunocompromised and at higher risk of developing severe disease from COVID-19. In October 2021, this project received an award from the Gilead Sciences 2021 Program. This study provided important information regarding which vaccines are more effective in patients undergoing different oncological treatments. The prize will allow the research team to move on to a second phase and evaluate the type of immune response in this population.

Developing new testing methods and potential vaccines

SALIVA AS A DIAGNOSTIC SAMPLE

Research led by the IGC together with the Centro Hospitalar Universitário de Lisboa Central (CHULC) – Hospital Dona Estefânia and Hospital Professor Doutor Fernando da Fonseca –,

demonstrated that saliva can be used effectively in the diagnosis of SARS-CoV-2. The developed saliva test, combined with a molecular PCR, has a sensitivity similar to that of current tests with nasopharyngeal samples and substantially superior to that of rapid antigen tests. This practical solution for testing, particularly in children younger than 12 years old, was distinguished by the Portuguese Society of Pediatrics with the SPP Grand Prize, in October 2021.

This technique is used as a surveillance method in the Gulbenkian community, as an initiative promoted by the IGC and the FCG Clinical Center. In 2021, approximately 4000 tests samples were analyzed. This proved to be an important tool in the detection of SARS-CoV-2 infections and breaking transmission chains in the workplace.

ORAL VACCINE

Bacteria that have SARS-CoV-2 virus proteins on their surface are the basis of a potential oral vaccine that is being studied by researchers from the IGC and ITQB NOVA, in a joint effort to find more tools to stop the current pandemic. In 2021, preliminary data revealed that this potential vaccine induced the production of antibodies against the new coronavirus in mice. The second phase of the study will assess the quality of the immune system's response and the strength of protection against infection conferred after taking this vaccine, using the same model organism.

Directory

BOARD OF DIRECTORS

Mónica Bettencourt-Dias, Director

Caren Norden, Deputy Director for Science
Manuel Sampaio e Melo Schmidt, Executive Director
Susana Miranda, People Management Director for Research

RESEARCH GROUPS

Bacterial Signalling Group — Karina Xavier

Ana Matias, MSc Student
Carina Galhofa, PhD Student
Filipe Vieira, PhD Student
Inês Torcato, PhD Student
Joana Amaro, Lab Manager
Maria Montoya, PhD Student
Miguel Pedro, Technician
Rita Oliveira, Postdoc
Tanja Dapa, Postdoc
Vitor Cabral, Postdoc

Cell Biology of Tissue Morphogenesis — Caren Norden

Diana Garcia Morales, Postdoc
Elisa Nerli, PhD Student
Jaakko Lehtimäki, Postdoc
Karen Soans, PhD Student
Lucrezia Ferme, PhD Student

Mariana Gil, PhD Student
Mauricio Rocha, Postdoc
Patrícia Ramos, Postdoc
Tânia Ferreira, Visitor

Cell Biology of Viral Infection — Maria João Amorim

Marta Alenquer, Postdoc
Sílvia Costa, Postdoc
Filipe Ferreira, Postdoc
Temitope Akhigbe Etibor, PhD Student
Christian Diwo, PhD Student
Mónica Medina, MSc Student
Daniela Brás, PhD student
Victor Mello, PhD Student
Filipa Sena, Postdoc
Nuno Santos, PhD Student

Cell Cycle Regulation

— Mónica Bettencourt-Dias
Ana Rita Pimenta-Marques, Postdoc
Camila Mariano, PhD student
Carla Lopes, Postdoc
Catarina Peneda, PhD student
Irina Fonseca, PhD student
Leonor Nunes, Research Technician
Mafalda Pimentel, Postdoc
Marco Louro, PhD student
Mariana Lince-Faria, Lab Manager
Miguel Pereira, MSc Student
Núria Marin, Postdoc
Paulo Duarte, Research Technician
Pilar Ramos, Postdoc
Sónia Pereira, PhD student
Sophie Dias, Research Technician

Swadhin Jana, Postdoc
Tânia Perestrelo, Postdoc
Chromosome Dynamics
— Raquel Oliveira

Alexandra Tavares, Laboratory Manager
João Coelho, Postdoc
Inês Milagre, Postdoc
Carolina Pereira, Research Technician (left to the IBB program)
Paola Gaetani, Research Technician (left to the IBB program)
Catarina Carmo, PhD student
Margarida Araújo, PhD student
Catarina Pedro, PhD student
Neide Silva, MSc student
Arunabha Bose, Postdoc
Laura Tovini, Postdoc

Complex Adaptive Systems and Computational Biology — Luís Rocha

Paulo Alexandre Navarro Costa, Postdoc
Rion Brattig Correia, Postdoc

Disease Genetics

— Carlos Penha Gonçalves
Abdul Muktar Dir Shafi, PhD Student
Nádia Duarte, Lab Manager
Teresa Pais, Postdoc

Evolution and Development — Élio Sucena

Catarina Nunes, PhD Student

Cláudia Freitas, Technician
David Duneau, Visitor
Diogo Roque, MSc Student
Priscilla Akyaw, PhD Student
Tânia Paulo, PhD Student

Evolutionary Biology — Isabel Gordo

Beatriz Abreu, Technician
Diogo Antunes, Technician
Francisco Cerqueira, Postdoc
Lindsay Kosack, Technician
Morgane Tomé, Trainee
Paulo Durão, Postdoc
Roberto Balbontín, Postdoc

Functional Ecology — Giulia Ghedini

Genome Maintenance and Evolution

— Marco Fumasoni
Francesca Rizzo, Trainee
Mariana Natalino, PhD Student
Veronika Fitz, Lab Manager

Host-Microorganism Interactions — Luís Teixeira

André Coppe Pimentel, Postdoc
Beatriz Alexandra Sousa dos Reis, Technician
Catarina Ramos do Carmo, Postdoc
Gonçalo Matos, PhD Student
Migla Miskinyte, Postdoc
Miguel Correia Landum, PhD Student
Nelson Martins, Postdoc
Pedro Miguel Festas Marinho, Technician
Rafael Rodrigues Caetano, Technician
Rita Valente, Laboratory Manager
Sergio López Madrigal, Postdoc
Teresa Gonçalves Carreira Maia, Technician

Host-Pathogen Co-Evolution — Jonathan Howard

Ana Lina Pereira Rodrigues, PhD Student
Claudia Campos, Lab Manager

Martha Catalina Alvarez Meneses, PhD student

Inflammation

— Miguel Soares

Ana Figueiredo, PhD Student
Elisa Jenthó, Postdoc
Gil Pires, Research technician
Jamil Zola Kitoko, Postdoc
Jessica Thompson, Postdoc
Qian Wu, Postdoc
Rui Martins, Postdoc
Sílvia Cardoso, Research Technician
Sofia Rebelo, Lab Manager
Susana Ramos, Postdoc
Temitope Wilson Ademolue, PhD Student

Innate Immunity and Inflammation — Luís Moita

Ana Costa, Postdoc
André Barros, PhD Student
Catarina Moita, Visitor
Dora Pedroso, Lab Manager
Isa Santos, PhD Student
Katharina Willmann, Postdoc
Kátia Jesus, PhD Student
Lindsay Kosack, Technician
Tiago Velho, PhD Student

Integrative Behavioural Biology — Rui Oliveira

Ana Rita Nunes, Postdoc
Bianca Fusani, PhD Student
Carla Henriques, PhD Student
Claudia Gonçalves, PhD Student
Felipe Espigares, Postdoc
Gonçalo Melo, MSc Student
Kyriakos Kareklas, Postdoc
Magda Teles, Postdoc
Pedro Rego, MSc Student
Pol Sorigue, PhD Student
Rafael Infantes, MSc Student
Rita Gageiro, MSc Student
Ruben Correia, MSc student
Susana Varela, Postdoc
Thais Reis, MSc Student
Victoria Alvarez, Postdoc

Living Physics

— Pablo Sartori

Rodrigo Braz, PhD Student
Tommaso Cossetto, Postdoc
Victor Mello, PhD student

Lymphocyte Development and Leukemogenesis

— Vera Martins

Camila Ramos, PhD Student
Sara Azenha, MSc Student
Ricardo Paiva, Postdoc
Pedro Mesquita, Research Assistant
Rafael Paiva, PhD Student

Lymphocyte Physiology — Jocelyne Demengeot

Ana Brennand, Postdoc
Barbara Parreira, Postdoc
Iris Caramalho, Postdoc
Ligia Gonçalves, Postdoc
Marie-Louise Bergman, Lab Manager
Onome Akpogheneta, Postdoc
Patricia Borges, Technician
Paula Matoso, Technician
Vanessa Malhero, Technician
Vital Domingues, PhD Student

Mechanisms of Morphogenesis — Elias Barriga

Fernando Ferreira, Postdoc
Jaime Espina, Postdoc
Joana Saraiva, PhD Student
João Mata, Lab Manager
Marília Cordeiro, Postdoc
Sara Azenha, PhD Student
Sofia Moreira, Postdoc

Microbial Genomics and Symbiosis

— Waldan Kwong

Cláudia Campos, Lab Manager

Optical Cell Biology — Ricardo Henriques

Estibaliz Gómez de Mariscal, Postdoc
Afonso Mendes, PhD Student
Mário Del Rosario, Postdoc
Simão Coelho, Postdoc
Hannah Heil, Postdoc

Patterning and Morphogenesis**— Moises Mallo**

Ana Casaca, Lab Manager
 Anastasiia Lozovska, PhD Student
 André Dias, PhD Student
 Patricia Duarte, PhD Student
 Triin Tekko, Postdoc

Physics of Intracellular Organization**— Ivo Telley**

Ana Milas, PhD student
 Diana Vieira, Postdoc
 Leonor Ferraz, MSc Student
 Margarida Araújo, PhD Student
 Rita Carlota, Undergraduate Student

Plant Molecular Biology**— Paula Duque**

Alba Rodríguez Díez, PhD Student
 Clarisse Zigue, MSc Student
 Dóra Szakonyi, Postdoc
 Esther Novo-Uzal, Postdoc
 Guiomar Martín, Postdoc
 José Pedro Melo, PhD Student
 María Niño-González, Postdoc
 Romana Yañez, PhD Student
 Rui Albuquerque-Martins, PhD Student
 Tom Laloum, Postdoc

Plant Stress Signaling**— Elena Baena Gonzalez**

Ana Confraria, Postdoc
 Borja Belda-Palazón, Postdoc
 Bruno Peixoto, PhD Student
 Diana Reis, PhD Student
 Filipa Lopes, PhD Student
 Leonor Margalha, Postdoc
 Liliana Ferreira, Postdoc
 Mónica Costa, PhD Student

Population and Conservation Genetics**— Lounes Chikhi**

Filipa Borges, Visitor (PhD Student)
 Gabriele Sgarlata, PhD Student
 Inês Carvalho, Postdoc
 Maria Margarida Henrique Cardoso, Trainee

Ravi Vishwakarma, PhD Student
 Rémi Tournabize, Postdoc
 Tânia Minhós, Postdoc

SCIENTIFIC SUPPORT UNITS**Advanced Imaging****— Gabriel Martins, Head**

Alexandre Lopes, Technician
 Donald Fowler, Postdoc
 José Marques, Technician
 Mária Hanulóva, Technician
 Patricia Rodrigues, Trainee

Bioinformatics**— Jingtao Lilue, Head**

António Sousa, Technician
 Miriam Corraliza, Visitor
 Ricardo Ramiro, Postdoc

Electron Microscopy**— Erin Tranfield, Head**

Ana Laura Vinagre Costa e Sousa, Technician
 Ana Sofia Nunes Pacheco, Technician
 Maria João Pinto Fernandes da Silva
 Tavares Almeida, Technician

Flow Cytometry & Antibodies**— Marta Monteiro, Head**

Ana Regalado, Technician
 Ana Teresa Branco, Technician
 Beatriz Teixeira, Technician
 Denise Brito, Technician

Genomics**— Ricardo Leite, Head**

Cathy Paulino, Technician
 João Costa, Technician
 João Sobral, Technician
 Susana Ladeiro, Technician

Histopathology**— Pedro Faísca, Head**

Andreia Mindouro, Technician
 Joana Rodrigues Lóios, Scientific Support Unit Manager

Mafalda Casanova, Technician

Model Organism**— Manuel Rebelo, Head**

Adérito Vieira, Technician
 Ana Cristina Borges, Manager of the Aquatic Facility
 Ana Raquel Machado, Technician
 Ana Ribeiro, Technician
 Ana Sofia Leocádio, Technician
 Carine Santos, Animal Care Staff
 Carla Almada, Animal Care Staff
 Cláudia Gafaniz, Animal Care Staff
 Inês Santos, Technician
 Joana Bom, Manager of the Mouse Facility

João Lopes, Animal Care Staff
 Lévi Pires, Animal Care Staff
 Liliana Vale, Technician
 Liliana Vieira, Manager of the Fly Facility
 Marco Rocha, Animal Care Staff
 Marília Pereira, Technician
 Mário Rocha, Animal Care Staff
 Maysa Franco, Technician
 Pedro Pinto, Technician
 Rodrigo Pires, Animal Care Staff
 Rute Marques, Animal Welfare Officer
 Sandra Crisóstomo, Technician
 Vera Nunes, Manager of the Plant Facility

Quantitative & Digital Science**— Tiago Paixão, Head****Transgenics****— Moises Mallo, Head**

Ana Nóvoa, Research Technician
 Leonardo Gaston Guilgur, Research Technician

TECHNICAL SUPPORT UNITS**Biosafety Unit****— Tiago Carneiro, Head**

Rita Silva, Technician

Gulbenkian Collaborative Centre**— Luís Valente, Head**

Carolina Mendes Amaro de Almeida, Trainee
 Fabrice Pinto, Staff
 Leonor Maria Teles Grilo Ruivo, Staff
 Luana Alexandra Sérgio Ribeiro, Trainee

Innovation Unit**— Marta Ribeiro, Head**

Pedro Miguel Pedrosa, Staff

Institutional Communication**— Ana Morais, Head**

André Ferreira Santos, Trainee
 Ivana Marisa da Costa Martins, Staff
 Joana Carvalho, Staff
 Joana Gomes das Neves Saraiva, Staff
 Margarida Reis, Trainee

IT Unit**— João Sousa, Head**

João Manuel Baptista Garcia, Technician
 José Gonçalo Barateiro Sousa Faria, Staff
 Manuel Augusto De Almeida Carvalho, Technician
 Marco António Antunes Dias, Technician

Maintenance Unit**— Pedro Alves & João Madureira, Heads**

Nuno Miguel Soares Granjeiro, Maintenance Personnel
 Bruno Velez Curto, Technician

People Management Unit**— Susana Miranda, Head**

Nádia Sofia Patarra Chegado, Assistant
 Olena Shydenko, Assistant
 Teresa Carmona, Assistant

Procurement & Logistics**— António Bretanha, Coordinator**

Ayrton Valério, Staff
 Joana Botelho Gusmão, Administrative Personnel
 Tiago Gil Quaresma Rodrigues dos Santos, Staff

Projects Management & Accounting**— Ana Sofia Oliveira, Head**

Ana Rita Batalha Augusto, Project Manager
 Maria De Fátima Loureiro Mateus, Accounting Personnel
 Nuno Alexandre Rocha da Silva, Project Manager
 Patrícia Maria Rodrigues dos Reis Fernandes Lopes, Project Manager
 Rute Ruivo Ascenso Vieira, Project Manager
 Tânia Margarida Lobão, Accounting Personnel
 Tatiana Portela Abreu Almeida Rocha, Project Manager
 Vítor Carvalho, Project Manager
 Vítor Manuel Lopes Dos Santos, Accounting Personnel
Other Project Managers
 Mariana Coelho Correia da Silva – CoLife
 Mariana Guedes Simões – SymbNET

Public Engagement**— Ana Mena, Head (until May 2021)**

Eugénia Fernandes, Staff
 Inês Bravo, Staff
 Joana Loureiro, Staff
 Raquel Gomes, Staff
 Rodrigo Abreu, Staff
 Vanessa Borges, Staff

Research Funding Affairs Unit**— Sheila Vidal, Head**

Ana Sofia Alves, Postdoc
 Beatriz García Fernández, Postdoc
 Teresa Costa, Staff

Events & Welcome Team

Regina Abreu Fernandes, Staff
 Rita Caré, Staff

Scientific Equipment & Infrastructures**— Nuno Moreno, Head**

Ana Homem, Technician
 Hamza Bin Ijaz, Technician
 Jorge Augusto Dias Ventura de Carvalho, Postdoc
 Bernardo Monteiro, Staff
 Tamires Silva, Staff
 Vera Alexandra Lucas Teixeira, Staff

Washing Room**— Paolo Duarte & Vera Teixeira, Heads**

Catarina Batista Mendes, Technician
 Catarina Santiago Santana, Technician
 Maria Lucinda Costa Furtado, Staff
 Sónia Maria Vaz Gomes, Staff

TRAINING**Education and Training Unit****— Ana Aranda Da Silva, Head**

Patrícia Maria Firmino Gomes, Staff

PhD Programme in Integrative Biology and Biomedicine (IBB)**— Jorge Carneiro, Head****Gulbenkian Training Programme in Bioinformatics**

Pedro Fernandes, Coordinator

Coordination

Ana Morais

Editors

Ivana Martins

Layout & Design

Mariana do Vale

Twitter - @IGCiencia

Instagram - @igciencia

Facebook - @InstitutoGulbenkianCiencia

LinkedIn - Instituto Gulbenkian de Ciencia

Youtube - IGCiencia

All the information available on the report was shared by the researchers, scientific support units and services to whom we are thankful for the help.

GULBENKIAN.PT/CIENCIA**For any inquiries, please contact:**

Institutional Communication Unit

Unidade de Comunicação Institucional

T: +351 214407913

@: icomm@igc.gulbenkian.pt

This is an open access publication, and with the exception of images and illustrations, the content may, unless otherwise stated, be reproduced free of charge in any format or medium, subject to the following conditions: content must not be used in a misleading context, the IGC must be credited as the original author and the title of the document specified in the attribution.

First published by the Instituto Gulbenkian de Ciência, 2022.



GULBENKIAN
CIÊNCIA