

n° 25  
Autumn 2024

# *L'Édition*



université  
PARIS-SACLAY

**4** Teaching, learning  
Campus of Professions and  
Qualifications

**7** Science outreach  
Our inspiring stories No.2

**10** Research  
Sepsis, a long-term battle,  
new issues and goals

**13** Research  
The rise of generative AI

**16** Business  
& innovation  
Exploration and monitoring  
from the sky

**18** Research  
Giving a sense to smell

**21** Research  
When science becomes  
citizen science

**25** Seen from abroad  
Transatlantic cultures

**27** Campus life  
The network of libraries  
at Université Paris-Saclay

# Prizes & awards

## at Université Paris-Saclay

Université Paris-Saclay remains in the top 20 of the world's best universities in the Shanghai ranking. In 2024, it ranks 12th in the world and 1st in continental Europe, thereby reaffirming its position as a world-class research-intensive university.

### Researchers



© Patrick Couvreur

#### Patrick Couvreur

Professor emeritus in pharmacotechnics and biopharmacy at the Paris-Saclay Galien Institute (IGPS - Univ. Paris-Saclay/CNRS), was awarded the **Acta Biomaterialia Gold Medal**. He was rewarded for his innovative contributions to nanomedicine, which have led to significant advances in the treatment of serious diseases such as cancer.

At the annual meeting of the American Society for Clinical Oncology (ASCO), five researchers received awards from the ASCO and its foundation, Conquer Cancer:

#### Federica Gattazzo

PhD candidate in the Tumour Immunology and Anti-cancer Immunotherapy unit (ITIC - Univ. Paris-Saclay/Inserm/Gustave Roussy), was presented with the **Merit Award** for her innovative study of the impact of microbiota T lymphocytes on the response to immunotherapy.

#### Martina Pagliuca

medical oncologist and researcher in the Predictive Biomarkers and Novel Therapeutic Strategies in Oncology laboratory (PMNCO - Univ. Paris-Saclay/Inserm/Gustave Roussy), was presented with the **Merit Award** for her in-depth study of the influence of behavioural symptoms following breast cancer.

#### Pietro Lapidari

a medical oncologist and researcher in the Predictive Biomarkers and Novel Therapeutic Strategies in Oncology laboratory (PMNCO - Univ. Paris-Saclay/Inserm/Gustave Roussy), was presented with the **Merit Award** for his study of musculoskeletal pain associated with aromatase inhibitors in early breast cancer.



© Gustave Roussy

#### Ines Vaz Luis

a medical oncologist and researcher at the Predictive Biomarkers and Novel Therapeutic Strategies in Oncology laboratory (PMNCO - Univ. Paris-Saclay/Inserm/Gustave Roussy), who also runs the Interval medical-scientific programme on post-cancer, won the **Women Who Conquer Cancer International Mentorship Award**, which aims to highlight female doctor-researchers whose work helps reduce gender disparities within the oncology profession.



© Gustave Roussy

#### Fabrice André

oncologist and Director of Research at Gustave Roussy, and Professor of Medicine at Université Paris-Saclay, was awarded the **Giants of Cancer Care Award** in the Translational Science category for his contribution to the fight against cancer and the development of oncology research.



© André Torre

#### André Torre

Director of Research within the Science for Action and Development Laboratory - Activities, products and work (SADAPT - Univ. Paris-Saclay/AgroParisTech/INRAE), was awarded the **International Prize for Local/Territorial Development** in the "Scholar Prize" category for his research into the mechanisms of cooperation and conflict between actors, as well as the governance of development processes in rural and urban areas.

### Students

Several students or alumni from Université Paris-Saclay with careers in professional sports won medals at the Paris 2024 Olympic and Paralympic Games:

#### Maxime Grousset & Yohann Ndoye-Brouard

2nd year students at ENKRE and **bronze medallists** in the 4x100 m medley relay (swimming);

#### Enzo Lefort

ENKRE graduate and team **bronze medallist** in foil (fencing);

#### Auriane Mallo-Breton

ENKRE graduate and two-time individual and team **silver medallist** in epee (fencing).

One PhD candidate and one post-doctoral fellow from Université Paris-Saclay have been awarded the **2024 Jeunes Talents Prize** by the L'Oréal-UNESCO Foundation:

#### Léa Dubois

post-doctoral fellow who completed her thesis at the Charles Fabry Laboratory (LCF - Univ. Paris-Saclay/Institut d'Optique Graduate School/CNRS);

#### Marion Zannese

PhD candidate at the Institute of Space Astrophysics (IAS - Univ. Paris-Saclay/CNRS).

### Companies & projects

Five start-ups founded by Université Paris-Saclay alumni won awards in the **i-Nov, i-Lab and i-PhD** innovation competitions organised by the French government through France 2030:

#### Duplo - Ircam amplify

co-founded and chaired by CentraleSupélec alumnus Nathalie Birocheau, won the **i-Nov prize**. This start-up offers access to a complete range of cutting-edge audio technologies through an online store called Duplo.

#### Compliance Robotics

founded by Université Evry Paris-Saclay alumnus Christian Duriez, won the **i-Lab grand prize**. The company plans to roll out a new generation of robots for industrial use, including a hollow collaborative robot, the hollow ots, which is capable of performing tasks involving moving objects, without compromising speed or operator safety.

#### Orakl Oncology

founded by Fanny Jaulin, researcher and head of the Collective Invasion team in the Tumor Cell Dynamics laboratory (DCT - Univ. Paris-Saclay/Gustave Roussy/Inserm), won the **i-Lab grand prize**. This platform aims to accelerate the discovery of new drugs in oncology, and ensure their clinical success, thanks to a unique collection of patient tumor.

#### Raidium

co-founded by Pierre Manceron, alumnus of CentraleSupélec and ENS Paris-Saclay, won the **i-Lab grand prize**. This start-up, which specialises in imaging, plans to develop artificial intelligence which is capable of assisting radiologists in detection of diseases, but also in cases of cancer.

#### NYXIR

founded by ENS Paris-Saclay alumnus Adrien Khalil Lazarjani, was awarded an **i-PhD grand prize**. This project is developing a nanocrystal-based infrared camera to improve the performance of infrared detection for applications including plastics sorting in the recycling industry.



#### Zoe Care

a start-up founded by Piotr Antonik, a lecturer in artificial intelligence at Centrale-Supélec, and Thomas Saphir, is one of the winners of the **Silver Valley 2024 prize**, thanks to its innovative technology that uses Wi-Fi to detect movements and falls without cameras or handheld devices.

A strong sense of collective effort has been very clear, proving how our university is built on a solid foundation of members.



© Corinne Hameau

## Editor's letter

The start of the academic year is always a symbolic moment in university life. It is synonymous with reuniting with familiar faces, meeting new people, discovering new things and tackling fresh challenges.

The start of this 2024-2025 academic year has been even more eventful than usual. Not only was this my first start to the year as president of Université Paris-Saclay, but it was also marked by a large-scale cyberattack on 11 August 2024, which severely impacted the university's IT systems. Since then, the IT Department, supported by the French National Agency for the Security of Information Systems (ANSSI), has been working to gradually restore our IT services. While the situation has not yet fully returned to normal, a strong sense of collective effort has been very clear, proving how our university is built on a solid foundation of members and staff. I would like to take this opportunity to thank our communities once again for their resilience and commitment faced with such unprecedented circumstances. Thanks to them, we were able to maintain operational continuity with the start of the academic year on the university's various campuses.

This summer was certainly an emotional one, but it also brought with it plenty of good news. During the Paris 2024 Olympic and Paralympic Games, we were able to admire the talents and performances of some of our top-level athlete students and alumni, some of whom won medals.

Université Paris-Saclay was also proud to discover the results of the 2024 Shanghai Academic Ranking of World Universities, as the university rose to the 12th spot globally and 1st spot in Continental Europe. Five years after it first appeared in the ranking's global top 20, Université Paris-Saclay has continued to strengthen its international standing as a research-intensive university, whilst maintaining its missions in education and innovation to the highest standards, faced with the societal and environmental challenges of today and tomorrow.

For the first issue of this new academic year, *L'Édition* will take you on a tour of the Campuses of Professions and Qualifications (In French Campus des métiers et des qualifications, CMQ). This label is dedicated to professions of the future, and Université Paris-Saclay and its ecosystem are particularly involved in the initiative, as demonstrated by its CMQ for Industry of the Future, which was awarded the label for the second time in June, and the CMQ for Sustainable Energy, which will be officially launched in November.

This issue also explores the fascinating world of generative AI. While systems like ChatGPT become increasingly present in our daily personal and professional lives, do you really know how they work? And what are the questions they raise? Sepsis is another crucial subject we look at in this issue. The condition affects approximately 50 million people worldwide and is also one of the most frequent causes of death. This is why Université Paris-Saclay, its institutional, academic, non-profit and industrial partners came together to launch the Prometheus University Hospital Institute (IHU) in September, the world's first centre dedicated to research, training and healthcare in sepsis.

Finally, because research should not remain restricted to the confines of laboratories, our university has made it a point of honour to encourage the sharing of scientific knowledge with citizens and their involvement in research projects. You will get an incredible insight into this through the citizen science projects coordinated by the university's researchers.

I hope that you will enjoy reading this issue of *L'Édition*, and I invite you to join us in February 2025 for the next issue.

Camille Galap,  
Président de l'Université Paris-Saclay.

# Campus of Professions and Qualifications

A synergy of players supporting the professions of the future



The Innovation 4.0 Centre in Évry © CMQE Industry of the Future Île-de-France

**The Campus of Professions and Qualifications (in French, CMQ) is a label created in 2014 to meet companies' needs in terms of professions and skills in a field of study and sector of activity associated with a major economic challenge. Today, there are around ten such campuses in the Paris Region, including the CMQE Industry of the Future Île-de-France and the CMQE Sustainable Energy, headed by Université Évry Paris-Saclay and Université Paris-Saclay respectively.**

On this Friday morning in June, the Innovation 4.0 Centre in Évry was buzzing with activity. Under the watchful eye of a technician, a robotic arm worked on the skeleton of a scooter as it began its assembly. Wheels, headlights, a seat, a body and more would soon be added - all the essentials for getting around. Except that this scooter will never hit the road. It will shortly be disassembled before being reassembled. No errors were made, but this is not your average industrial chain.

Contrary to appearances, the aim of Évry's Innovation 4.0 Centre is not to produce scooters, but to enable future technicians to experience the reality of an assembly line and the new technologies that go with it. The platform launched in June 2022 and it is the flagship site of the Campus of Professions and Qualifications of Excellence (CMQE) Industry of the Future Île-de-France. "The building was specially created to host this venue focused on Industry 4.0," explains Sophie Gaufreteau, the campus's operational director. "This third-space facility is very important to us because it allows us to perform all our missions."

*"In industry, we have fundamental pillars - mechanics, electricity, etc. - onto which new layers of skills are grafted with each evolution." — Sophie Gaufreteau*

## Supporting skills development

Around one hundred Campuses of Professions and Qualifications (in French, *Campus des métiers et des qualifications*, CMQ) have opened across France since the label was created in 2014 by the Ministries of National Education, Higher Education and Research, Labour and Economy and Finance. Each one focuses on a specific territory and field of study. The CMQE Industry of the Future Île-de-France is no exception. Led by the Université Évry Paris-Saclay, it received its first label in August 2018 under the title "Aeronautics and Space: design, production, maintenance 4.0". Since then, the CMQ has changed its name to broaden its scope of activities, and was awarded a second label in June 2024 with the distinction of "excellence". "Our campus initially targeted the aeronautics and space industries. But our work has confirmed that the changes required in these two sectors are the same as in other industrial sectors," explains Sophie Gaufreteau. "With digital transformation, we are currently experiencing the fourth industrial revolution, and it is causing skills to evolve in many areas."

"In industry, we have fundamental pillars - mechanics, electricity, etc. - onto which new layers of skills are grafted with each evolution," continues the manager. The CMQE Industry of the Future Île-de-France is dedicated to supporting the region's industrial sector in these changes. It brings together a synergy of players from secondary and higher education and continuing education, companies, institutions and research laboratories, and is supported by the Île-de-France region and the Créteil, Paris and Versailles academies.

This synergy of players is at the heart of the campuses' DNA. It is also their strength, according to Bruno Darracq, Operational Director of CMQE Sustainable Energy. Supported by Université Paris-Saclay and awarded a five-year label in June 2024, this campus, housed at the Orsay Technical Institute (IUT), is the latest to open in the Paris Region. "Our CMQE focuses on the energy transition sector," says the director. "It is structured into four independent centres that bring together all the low-carbon energies - nuclear, renewable energies (RE), energy systems such as geothermal and heat pumps - as well as power grids." Each centre works with a wide network of partners, including companies such as EDF, Enedis and Schneider Electric, and institutional bodies such as France Travail. "It is not that often that communities are brought together, and that is really the added value of the campuses: getting everyone around the table to meet the challenges facing industry in terms of skills and professions," asserts Bruno Darracq. "Every partner is a building block for working on each of our lines of research and targets," adds Jean-Christophe Bardy, Deputy Operational Director of CMQE Sustainable Energy.

## Teaching, learning

### Education and attractiveness at the heart of CMQ strategy

While each CMQ has its own identity, they all share a common approach, with the development of training playing a central role. "The CMQ is an ongoing dialogue between the education sector and industry," confirms Jean-Christophe Bardy. The aim is to understand companies' needs in terms of short-staffed professions and the professions of the future, and to take stock of existing training courses in the Paris Region, at all levels and in all sectors: pre-baccalaureate and post-baccalaureate, from CAP (certificate of vocational aptitude) to PhD, apprenticeship, full-time academic programmes, continuing education, etc. "For a given job, for example, we ask ourselves whether all the necessary training courses are available in the Paris Region. Are they at the right level? Do they enable people to acquire all the skills and knowledge they need?" Based on this assessment, the campus and its partners then work either to complement or adapt existing education, or to create new degrees.

Under the impetus of the Sustainable Energy CMQE's Renewable Energy Department, some vocational baccalaureate, BTS (advanced technician certificate) and BUT (technical degree) study paths will have an additional module on hydrogen and battery issues added by the start of the 2025 academic year. Two inter-institutional degrees (DIU) on the same themes are also being created. Another example is the nuclear centre and its flagship site, the André-Malraux High School in Montreau-Fault-Yonne (Seine-et-Marne), where a "bridging" class, created in January 2023, is designed to introduce young people who are changing careers or returning to education to careers in nuclear maintenance and valves, with a view to their possible integration into a BTS.

Attractiveness is another crucial aspect of the CMQ strategy. "The difficulty with industry is that it is a sector you cannot discover by chance. If people do not have a



© CMQE Sustainable Energy.

*"It is not that often that communities are brought together, and that is really the added value of the campuses: getting everyone around the table to meet the challenges facing industry in terms of skills and professions."* — Bruno Darracq

relative or acquaintance there, they are unable to name a trade. But you can't love what you don't know," asserts Sophie Gaufreteau. This is one of the roles of Évry's Innovation 4.0 Centre. "We are demonstrating over 30 innovative industrial use cases on this production line. There are highly visible things, such as moving robots, and others that are less visible and explained through screens. This place is designed to introduce people to another world." In 2023 alone, the centre welcomed over 2,700 visitors, including some 70 schoolchildren, 500 college students, 700 high school students, 400 university students and 250 manufacturers.

### Fostering innovation and research

Introducing people to another world, and much more besides. "We also host a lot of manufacturers, academics, researchers, institutions and so on. We see this as a playground for education, innovation and research," adds the Operations

Director. In the field of augmented reality, for example, an academic from a vocational high school took advantage of the centre to digitally recreate a complete aircraft engine. Thanks to this initiative, his students are now able to see and dismantle the engine piece by piece during their practical classes, without the need for a real model. "The aim of this centre is not to produce, but to assemble, disassemble, make mistakes and test new things. For industrialists, this platform is a means of promoting technology transfer and speeding up research processes." Proof of its success can be seen in the fact that two years after it opened, the Évry's Innovation 4.0 Centre will soon be extended by a further 350 m<sup>2</sup> to include a second demonstration line and a second learning lab. "We hope to be up and running by spring 2025," says Sophie Gaufreteau.

At the CMQE Sustainable Energy, too, many projects are underway to make the sectors more attractive, accessible and inclusive. In Orsay, the House of Science Initiation and Awareness (in French, MISS), which has become one of the CMQE's flagship sites, offers primary and secondary school pupils workshops on energy-related themes. "We are also working with the YOOKAN association, which runs a space dedicated to career discovery and professional immersion in a shopping centre in Rosny-sous-Bois," adds Bruno Darracq. Other projects include the modernisation of a technical and educational platform at the Electrical engineering resource centre (CERGE) in Vitry-sur-Seine, and the creation of three platforms in the nuclear and renewable energy centres. The CMQE Sustainable Energy hopes that its actions will reach over 45,000 students and around 3,500 people in continuing education or retraining by 2028.

<https://cmq.univ-evry.fr/>

<https://ecole-universitaire-paris-saclay.fr/le-campus-des-metiers-et-des-qualifications>



© CMQE Industry of the Future Ile-de-France

## New Space

*An academy to meet the new challenges of the space industry*

**The *Campus des métiers et des qualifications* (Campus of Professions and Qualifications) label is not the only initiative aimed at the trades of the future. Université Paris-Saclay is also supporting other projects, such as the Space Academy of Île-de-France, which held its first summer school in June 2024.**

"New Space" is the name given to the profound transformation that the space industry has been undergoing since the turn of the millennium. *"In the past, the space sector was mainly driven by public organisations,"* explains Philippe Keckhut, geophysicist at Université de Versailles - Saint-Quentin-en-Yvelines and Scientific Director of the Space Academy of Île-de-France. *"This sector is rapidly becoming privatised and increasingly fragmented, with the emergence of a number of new players."*

It is estimated that the space market could reach more than 35 billion euros a year by 2040, with major technological advances. Satellites are a case in point. According to forecasts, some 70,000 satellites could be sent into space over the next few years. This is seven times more than the number of spacecraft launched since the beginning of the space age, around 60 years ago. And these new satellites are not only more numerous, they are also smaller, cheaper and much faster to produce. Their fields of application have also diversified. All these

developments are resulting in growing needs in the sector.

### *Making education clearly identifiable and accessible*

↓ It was from this observation that the Space Academy of Île-de-France (IDF) was founded. Spearheaded by Université Paris-Saclay and supported by a consortium of universities and companies including the French National Office for Aerospace Studies and Research (ONERA), Thales and SAFRAN, this project is one of the winners of the "Skills and professions of the future" (in French, CMA) scheme under the France 2030 programme. With funding of 21 million euros, its mission is to unite, improve and disseminate training opportunities in the space sector throughout the Île-de-France Region. *"We want to make education in this sector clearly identifiable and more accessible. We also want to create new training courses to integrate emerging needs and new professions,"* explains Philippe Keckhut. *"With the*

*proliferation of satellites, for example, we are seeing the emergence of security, legal and geopolitical issues in space, and we need people trained in these fields."*

Launched in January 2024, the Space Academy of Île-de-France is already increasing its actions. In June, it held its first summer school, the Junior Space Academy, which brought together around 30 undergraduates. They spent a week visiting the facilities of laboratories and companies specialised in the space industry, attending conferences and talking to industry professionals. *"This first event was a success, and we hope to organise a second one next year in a hybrid format so that thousands of students can attend,"* explains the Scientific Director. By 2030, the Space Academy of IDF hopes to make around 800,000 people aware of space-related professions and help train nearly 6,000 of them.

<https://academiespatiale.fr/>

## Reform of the second cycle of the medical studies

*Future doctors put to the test*

**Last year, 6th-year medical students experienced for the first time the changes introduced by the reform of the second cycle of their studies, initiated in 2021 to promote the acquisition of skills by future doctors.**

Medical studies are reputedly difficult due to the amount of knowledge required, and are now undergoing a major transformation. This is particularly true for the second cycle - from the fourth to the sixth year of medical studies - the subject of a reform which, since 2021, has shaken up the teaching, acquisition of skills and also the examinations to which future doctors are subject.

*"The spirit of this reform is to focus on skills and reduce the volume of knowledge to be acquired,"* explains Prof. Vincent Gajdos, paediatrician at Hôpital Antoine Bécélère, Clamart, and academic at the Faculty of Medicine of Université Paris-Saclay, Kremlin-Bicêtre. Until now, assessment in the second cycle of the medical studies has focused on knowledge acquisition and taken place at the end of the 6th year through written examinations known as *"Épreuves classantes nationales"* (or ECN - National competitive examinations). Future doctors were allocated to the different internship specialities depending on their results in these exams and their preferences.

With the reform, the ECN has been replaced by the *"Épreuves dématérialisées nationales"* (EDN - National online

examinations), which take place at the beginning of the 6th year and require a reduced scope of knowledge. Now, *"knowledge is ranked,"* explains Prof. Gajdos. *"Knowledge considered fundamental is subject to fairly high standards. In practice, this means that a minimum score of 14/20 on questions relating to this knowledge is required to move on to the third cycle of medical studies."* These exams also assess students on more specific knowledge intended to influence their orientation towards a certain speciality.

### *Simulations to assess skills*

↓ The reform introduces another new feature at the end of the 6th year, in the form of practical examinations called *"Examens cliniques objectifs structurés"* (ECOS - Objective structured clinical examinations). These are simulation exercises in which future doctors deal with a person playing the role of a patient or professional. *"The aim is to confront students with situations that cover the different fields of competence expected of a doctor, such as making a diagnosis, writing a prescription, etc.,"* explains the doctor.

Last year, 6th-year students were the first to experience these changes. *"It was very stressful to be the first year to go through*

*this. There was a lot of uncertainty,"* confides Florence de La Bigne, a student at Université Paris-Saclay's Faculty of Medicine, now in her 3rd cycle. The ECOS in particular, *"were very unsettling because we are not used to dealing with oral exams."*

These new tests are *"difficult to organise and require a great deal of investment,"* says Prof. Gajdos. *"But I think it is a very interesting and powerful pedagogical tool because it changes the way we teach and learn. It helps to freshen up education."*

As to whether the reform will achieve its objective of better training future doctors, it is still too early to tell. *"We do not yet have enough perspective on the initial results,"* admits the paediatrician. *"I think we should wait until we start our internships to see if we are more comfortable and competent,"* says the post-graduate student.

# Our inspiring stories No.2

## Alumni astrobiologists and explorers of (extra)terrestrial worlds

In early October, a new Université Paris-Saclay alumni conference, *Our inspiring stories (Nos belles histoires, in French)*, featured Caroline Freissinet and Cyprien Verseux. The two astrobiologists captivated the audience with their fascinating experiences of exploring extreme environments, on Earth, Mars and beyond, in the search for signs of life.



© Christophe Peus.

On the evening of Tuesday 8 October, on the stage at the Rousseau Theatre at CentraleSupélec in Gif-sur-Yvette, two speakers took turns to talk about their careers and research, in front of an audience of students and curious attendees who were quickly fascinated with their compelling accounts. Caroline Freissinet and Cyprien Verseux are astrobiologists, or exobiologists. They focus on the processes that could lead to the emergence of life beyond Earth, as well as the potential indicators of extraterrestrial life, past or present. The pair took the audience on a journey through their explorations of extreme environments on Earth, its close neighbour Mars, and even as far as the icy moons of Jupiter and Saturn, hundreds of millions if not billions, of kilometres away. Their presentation was part of the series of alumni conference, *Our inspiring stories (Nos belles histoires, in French)*, launched in December 2023 by Université Paris-Saclay, which aims to introduce the public to figures with particularly inspiring careers.

### How do you become an exobiologist?

Both Caroline Freissinet and Cyprien Verseux agree that their careers to date have not followed any kind of set path. Instead, they have taken advantage of, or created, opportunities as they arose. "There isn't really a typical educational route to becoming an exobiologist," explains Cyprien. "Researchers come from a range of different disciplines." As a child, Cyprien dreamed of "searching for life on other planets" only to be told that "that's not a real job". As he grew older, he studied biology at the school of biotechnology engineers, Sup'Biotech, while concurrently taking a 2nd year Master's degree in Systems & Synthetic Biology at University Évry Paris-Saclay.

Realising that his childhood passion was indeed a real career, he secured, through sheer determination, an end-of-study

internship at NASA in California. There he worked on a synthetic biology project applied to space exploration. After graduating, he began a PhD in molecular and cellular biology at the University of Rome Tor Vergata, co-supervised by NASA, focusing on the search for life on Mars and the development of biological life-support systems for the exploration of this planet.

### Preparing for future human missions to Mars

It was during his PhD that Cyprien had some of his most unique experiences. In 2015, he was selected to join five other scientists on NASA's HI-SEAS IV (Hawaii Space Exploration Analog and Simulation) mission, spending 366 days isolated in a dome in Hawaii to simulate the conditions of a mission to Mars.

In 2018, he embarked on another extraordinary adventure, spending a year in Antarctica as the Station Leader of the French-Italian Concordia research station. This station is managed by the French Polar Institute Paul-Émile Victor and the Programma Nazionale di Ricerche in Antartide, and the most isolated base on Earth, located in one of the most hostile environments. "Temperatures can drop to -80°C, and in early May, the sun sets for the last time, not to reappear again for three months." An experience which he shared with twelve other team members, during which time he defended his PhD thesis remotely.

Following his polar experience, in 2019, Cyprien founded the Laboratory of Applied Space Microbiology at ZARM (Center of Applied Space Technology and Microgravity) at the University of Bremen, Germany, where he continues to work today. Together with his team, he studies cyanobacteria, microorganisms capable of photosynthesis, and is focusing his research on developing biological systems that could produce some of the essential resources

needed by a team of astronauts during a long-term mission on Mars, using materials they can find in the soil and atmosphere.

### Mars exploration, Martian analogues on Earth and ocean worlds

Caroline's journey is just as unusual. As a teenager, she loved watching the TV series, *The X-Files*, in which FBI Special Agents Mulder and Scully investigate paranormal phenomena involving extraterrestrials. The show sparked her interest in extraterrestrial life. "It was also the first time we saw a female scientist as a heroine on TV. It inspired many women to pursue careers in science, including me!"

Caroline studied biology, becoming increasingly interested in the origins of life on Earth, in extreme conditions, and elsewhere in the solar system. After graduating with a degree in biochemistry and molecular biology from ENS Lyon and a 2nd year Master's degree in evolutionary biology from Université Paris-Sud (now Université Paris-Saclay), and taking "a year off to study sheep in New Zealand", she embarked on a PhD in analytical chemistry applied to space at the École Centrale Paris (now CentraleSupélec). Her research focused on developing analytical chemical methods for the ExoMars mission, which is designed to study the Martian atmosphere and search for signs of past or present life using a rover and its instruments.

With her PhD completed, Caroline spent six years as a researcher in astrochemistry and planetary sciences at NASA's Goddard Space Flight Center in Greenbelt, USA. In 2017, she was recruited by the French National Centre for Scientific Research (CNRS) and joined the Atmospheric Space Observations Laboratory (LATMOS - Univ. Paris-Saclay/UVSQ/CNRS/Sorbonne Univ.). Her work takes place with her "feet on Earth", in her laboratory and in field studies, through analytical chemistry studies on samples from extreme terrestrial environments that resemble extraterrestrial sites. But also "with her head in the stars", through the analysis of data collected by space probes and their onboard instruments. She is also involved in the construction of some of these instruments, such as those for the Dragonfly mission, set to launch to Saturn's icy moon, Titan, in 2028.

*Our inspiring stories* will continue in 2025 with new, equally inspiring teams. Don't miss the next event!

Watch the conference online (in French): <https://youtu.be/SKjxrKwScU0?si=5ZM2xWyG2MjRATFd>

# ClimarisQ

## Play the game to understand the complexity of climate change

Would you be able to lead a country through its ecological transition without going bankrupt or losing popularity? That's the aim of the smartphone game **ClimarisQ**, conceived and designed by a researcher at **Université Paris-Saclay**. A scientific mediation tool used in schools and universities, the app, based on real scientific models, highlights the complexity of the effects of climate change and how to manage them.

Davide Faranda, a researcher at the Laboratory for Climate and Environmental Sciences (LSCE – Univ. Paris-Saclay/CEA/CNRS/IPSL/UVSQ), came up with the idea of creating a video game to help understand the complexity of climate change, at a workshop bringing together researchers and science mediators, organised by the CNRS. Having already been involved in creating the board game *Climat Tic-Tac*, in which players have to work together to tackle climate change, Davide Faranda wanted to develop a new game based on the same issue, but which was quicker to pick up and required nothing more than a smartphone. He joined forces with developer Opal games and, with financial support from La Diagonale Paris-Saclay, the arts, culture, science and society department at Université Paris-Saclay, developed the first version of the *ClimarisQ* game. Prototypes were presented at the Cannes Games Festival in February 2020, thanks to support from CEA, which also invested in the project. The mobile app was released the same year on all platforms, and now has tens of thousands of downloads.

### An interactive game based on actual scientific models

So how does the game work? The player is the government of a country, and their decisions are reflected by playing cards, which the player has to accept or reject. Over the course of a game, for example, you can decide whether or not to accept the development of a new oil field, or the financing of a nature park. Each decision taken by the government (the player) not only affects the level of carbon

dioxide (CO<sub>2</sub>) in the atmosphere, but also the government's popularity rating and the country's economy and ecology, as shown by three gauges. If one of the gauges runs completely empty, the game is over. The aim of the game is to keep the gauges full for as long as possible.

But the mission is not that simple. Each season, one or more extreme weather events are likely to occur, which automatically lowers the three gauges. The likelihood of these extreme events occurring during a game isn't random, but is calculated using models from the Geophysical Fluid Dynamics Laboratory (GFDL) of the U.S. National Oceanic and Atmospheric Administration (NOAA). Also used by the Intergovernmental Panel on Climate Change (IPCC), these models link atmospheric CO<sub>2</sub> levels to the likelihood of extreme weather events such as heat waves, cold snaps, floods and droughts. The game highlights the complexity of climate change, its effects and how to manage them, in a rigorous but entertaining way.

*ClimarisQ* also raises awareness of the importance of the Paris Climate Agreement, the international treaty adopted in 2015 to limit global warming. At the start of each game, the player chooses whether to be in today's world, or in a future world that may or may not adhere to the treaty, in different parts of the world. The player can then compare the different scenarios and the resulting difficulties. "Some regions of the world are especially vulnerable to climate change, for example South America, where the Amazon is highly vulnerable to

extreme events. In this region, and with the 2050-2070 scenarios without adhering to the Paris Agreement, we could have up to thirty floods each season, which makes the game very difficult," explains Davide Faranda.

### A scientific mediation tool for schools and universities

Many of the game's tens of thousands of enthusiasts discovered it at science mediation events at schools, universities and forums. "You can start playing *ClimarisQ* from the age of 10. We therefore present it to secondary schools, where students are always really interested in games," explains the lecturer.

The app then serves as a tool to stimulate discussion about climate change and the extreme weather events it causes. The game takes the form of a role-playing game during these sessions, with three ministers (one for popularity, one for ecology and one for the economy) having to work together to make decisions. The game becomes a vehicle for discussion and reflection on the ecological transition and its challenges.

*ClimarisQ*'s popularity has not been limited to France. Available in six languages, the game is enjoying success around the world. "We're delighted by the fact it is getting distributed internationally. I know that it is widely used in universities and schools in Italy, the United States and Spain," enthuses the creator.

The team is now working on an update for *ClimarisQ*. As Davide Faranda explains: "There will be more interactivity with extreme events. Players will be able to protect the population, for example. There will also be a roulette wheel, like at a casino, which will stop on a given extreme event with a likelihood depending on the CO<sub>2</sub> level." Thanks to this new version, which will be released at the end of 2024, *ClimarisQ* will have no problem raising awareness among new players of the complexity of climate change.

<https://climarisq.ipsl.fr/en/>







● **Research**

**10** Sepsis, a long-term battle, new issues and goals

**13** The rise of generative AI

**18** Giving a sense to smell

**21** When science becomes citizen science

● **Business & Innovation**

**16** Exploration and monitoring from the sky

# Sepsis

## A long-term battle, new issues and goals

Sepsis (or septicaemia) is a disease resulting from a dysregulated immune system response to infection. It affects several million people a year, including children, and is one of the world's leading causes of death, now representing a major public health problem. How can this disease be effectively treated? What solutions can be offered to patients? How can complications be avoided? These are questions that the Prometheus University Hospital Institute (IHU), which comprises Université Paris-Saclay, the French Alternative Energies and Atomic Energy Commission (CEA), Greater Paris University Hospitals (AP-HP), the National Institute of Health and Medical Research (Inserm) and other academic, associative and industrial partners, aims to answer. Officially launched on 17 September 2024, this first centre in the world to integrate prevention, treatment, research, education and technology transfer within a single ecosystem, aims to halve mortality and sequelae caused by sepsis within ten years.

### Keywords

- Dysimmune response
- Infection
- Corticoids
- Antibiotic resistance

Defined by the World Health Organization (WHO) as one of the most frequent causes of death worldwide, sepsis (or septicaemia) is a serious condition resulting from a loss of control of the inflammatory system following an infection, leading to impairment of the body's vital functions. According to the UN organisation, it affects almost 50 million people around the world every year (45% of them children under the age of five), and is responsible for one in five deaths. It also causes mental and motor disabilities in half of all survivors.

*"Sepsis is a dysimmune disease caused by an initial bacterial, viral, parasitic or fungal infection with an acute and sudden onset. The disease is also defined by its long-term evolutionary potential, with relapses experienced by around a third of first-time patients, and after-effects impacting cognitive functions and leading to physical disabilities or the triggering of new inflammatory or autoimmune diseases,"* describes Djillali Annane, head of the neuroendocrine response to sepsis study team (SEPSIS), within the Infection and Inflammation Laboratory (2I - Univ. Paris-Saclay/UVSQ/Inserm). A specialist in this disease, to which he has devoted thirty years, Djillali Annane is now head of the Prometheus University Hospital Institute (IHU), whose aim is to halve the mortality rate and the social and financial cost of sepsis within the next ten years. In 2019 alone, there were over 400 cases of sepsis per 100,000 inhabitants in France, with hospitalisation costs of around €16,000 per person.

### A new approach to sepsis

The 2023 winner of the call for projects issued as part of the government's France 2030 Plan, the Prometheus IHU brings together more than 250 scientists from some 60 laboratories, mainly from Université Paris-Saclay, the French Alternative Energies and Atomic Energy Commission (CEA), Greater Paris University Hospitals (AP-HP), and the National Institute of Health and Medical Research (Inserm), as well as their academic, associative and industrial partners, to fight this disease and the health, social and economic burden it represents. Integrating researchers, caregivers, patients, private partners and institutions

within an ecosystem of prevention, care, research, education and technology transfer, it should help develop new diagnostic tests and new drugs.

In addition to research teams that already specialise in sepsis and have worked on this disease for many years, the Prometheus IHU also involves new teams whose subject matter is more remote, with the aim of uncovering disruptive innovations. *"We are bringing together colleagues whose areas of expertise include mathematics, chemistry, physics, climate, fundamental immunology, veterinary science, etc. and who will be devoting part of their research time over the next ten years to sepsis, leading original, diverse and unprejudiced approaches,"* enthuses Djillali Annane. The stakes are high, as despite decades of extensive research, the mechanisms behind the disruption of the immune response to pathogens are still poorly understood, and there is still no entirely satisfactory treatment. One of the scientific ambitions of the Prometheus IHU is to gain a better understanding of the molecular and cellular interactions between the host organism and the pathogens involved in the progression from uncomplicated infection to sepsis. A longitudinal cohort of 10,000 patients, monitored over ten years, should make it easier to understand the social and economic consequences of long-term sepsis.

### Corticoids: a first step towards curbing sepsis mortality

Generally speaking, when an organism is confronted with a pathogen (bacterium, virus, parasite, fungus, etc.), its immune system triggers an adapted response that circumscribes the pathogen's development before destroying it and removing it from the body. *"Most infections are generally pretty harmless to the body,"* says Djillali Annane. *"In the vast majority of cases, infections are only moderately symptomatic, and many disappear thanks to our natural defences alone."*

In some cases, however, the immune response to an infection in the body is disproportionate, in that it is either excessive, damaging a large number of tissues and impairing the functioning of the body's organs, or it is insufficient,

Sepsis affects

**47 to 50 million**

people around the world every year.



Sepsis is responsible for at least

**11 millions**

deaths every year

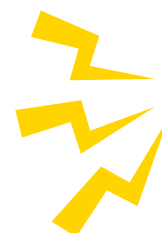
and for one death every

**2.8**

seconds..



in the world is caused by sepsis.



Survivors may suffer long-term after-effects.

exposing the body to the risk of superinfection. "We speak of immunoparalysis when the immune system becomes fragile and is unable to respond to any new aggression," explains the professor.

In their search for a treatment for sepsis, from 1994, Djillali Annane and his team demonstrated the benefits of using corticoid-based treatment with moderate time and dosage scales, to reduce the mortality associated with the disease. Corticoids are a group of steroid hormones secreted by the body's adrenal glands, located in the abdomen. They influence stress, sugar use and the body's immune and inflammatory systems. "Corticoids are part of the body's defence arsenal; cortisol, aldosterone, etc. are naturally produced by our bodies to defend themselves against external aggression, including pathogens and infections," confirms Djillali Annane. Corticoids also exist today in the form of synthetic molecules, which have been developed since the 1950s.

Used in high concentrations, corticoids have an immunosuppressive effect that disrupts the activity of the immune system. "We are working on the contribution of corticoids to this dysregulation, this dysimmune response to infection synonymous with sepsis. We have shown that, through a variety of mechanisms, pathogens do indeed cause an alteration in the defence system, including corticoids, and contribute to a disproportionate response to the threat by the body. Fortunately, corticoids can now be synthesised. We therefore conducted experiments aimed at using corticoids to compensate for this deregulation of the body. We have done a lot of work on the molecular mechanisms involved, on animal and cell models, and also on patients, to try and

*"We are trying to define signatures, prints that we can then use at a patient's bedside to determine whether they will benefit from corticoid treatment. In a way, our work on corticoid therapy represents a 'proof of concept'." — Djillali Annane*

*better understand the different stages that alter the body's defence mechanisms and how to compensate for them,"* explains Djillali Annane, a true pioneer in the treatment of the disease through the controlled administration of corticoids. "We were the first to establish that a certain modality in administering the combination of hydrocortisone with fludrocortisone, given in moderate doses over durations not exceeding seven days, compensates, at least partially, for the alteration that caused sepsis," confirms the researcher.

### The need for precision medicine

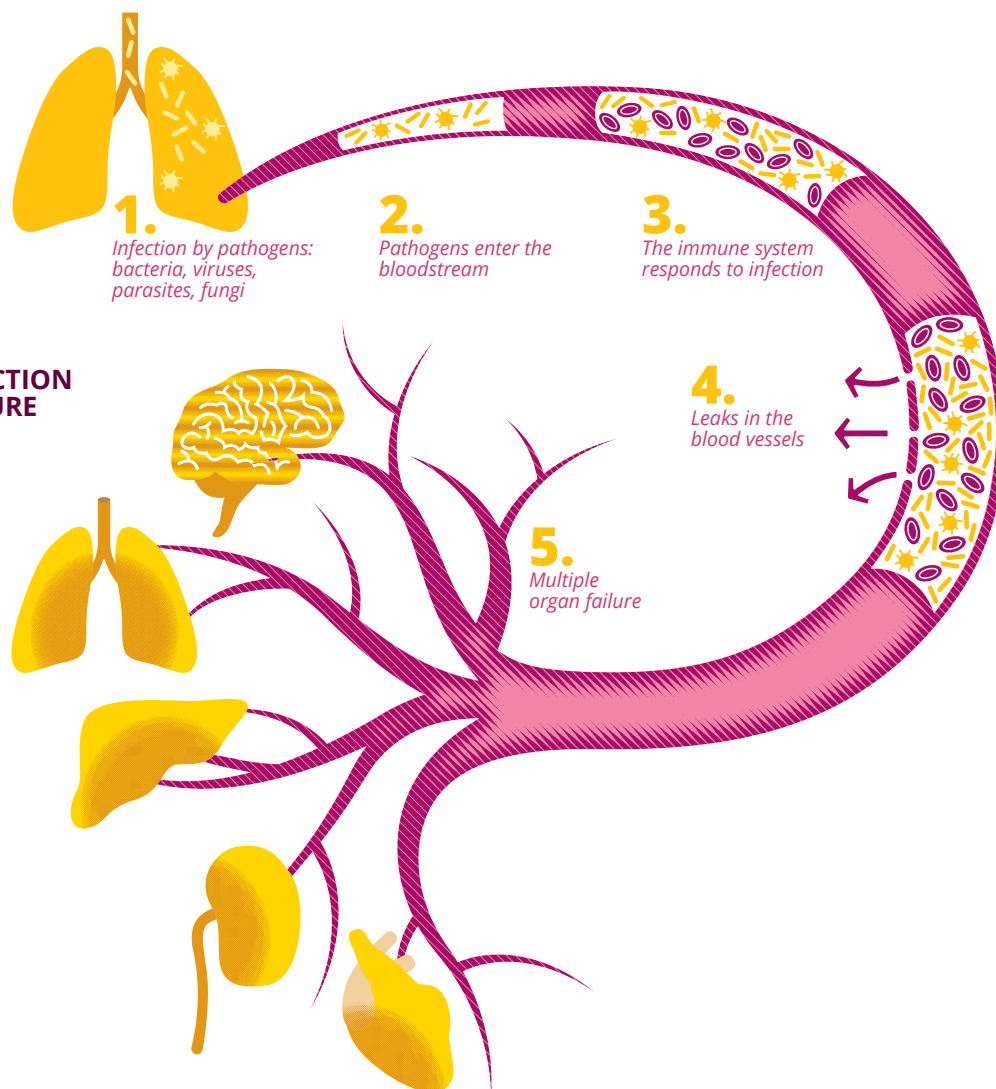
However, as each human's sensitivity to treatments and molecules is highly variable, Djillali Annane and his team have spent ten years identifying patient "profiles". "In medicine, we know that it is possible to improve the efficiency of treatments by personalising their administration. This is achieved by identifying those patients who will particularly benefit from a treatment, and those who, on the contrary and for various reasons, will receive no benefit - or worse, whose situation will deteriorate. This is precision medicine."

For this, they use molecular biology tools such as transcriptomics (the study of

ribonucleic acids, RNA) and metabolomics (the study of metabolites), combined with predictive artificial intelligence tools such as machine learning and deep learning. "We are trying to define signatures, prints that we can then use at a patient's bedside to determine whether they will benefit from corticoid treatment. In a way, our work on corticoid therapy represents a 'proof of concept'. Now that this has been established, the Prometheus IHU aims to roll it out and embrace the different possible therapeutic options, particularly in terms of immunotherapy," says the doctor. "Ultimately, this 'profiling' will be beneficial beyond sepsis, for example in cases of inflammatory disease or cancer." Djillali Annane's team will be working with other international teams to check that this profiling can be adapted to any socio-economic context.

Precision medicine is also at the heart of Prometheus IHU's scientific ambitions, with a particular focus on validating and marketing a rapid testing platform to characterise host response to infection and therapeutic targets at the individual level. This will involve creating a sepsis-specific digital twin to accurately anticipate the individual's response to treatment.

### SEPSIS: FROM INFECTION TO ORGAN FAILURE



### Bacteria and childhood sepsis

Director of Research in the Pathogen, Immunity, Microbiota (PIMs) team at the Food Microbiology for Health Laboratory (MICALIS - Univ. Paris-Saclay/French National Research Institute for Agriculture, Food and Environment, INRAE), Nalini Rama Rao has been studying the interactions between pathogenic bacteria and the host immune response for over twenty years. In particular, she has deciphered the virulence mechanisms of the *Bacillus cereus* bacterium. "It is a known food contaminant, but I have been studying it more from the angles of hospitals and virulence factors: *Bacillus cereus* is responsible for serious infections in newborns, particularly septicemia," explains the researcher. "Hospitals were not really concerned about this bacterium for a long time, as it was a contaminant of bedding and carers. I wanted to show that it was a true pathogenic bacterium, with a real impact on this target group," says Nalini Rama Rao, who is particularly keen to ensure that her research has clinical relevance. "For example, I have worked with hospitals to change the procedures linked to collecting breast milk, and the feeding tubes for premature infants, to reduce the presence of *Bacillus cereus* and thus the risk of septicemia," she explains.

Sepsis is the third leading cause of infant mortality worldwide and is responsible for the death of over 300,000 newborns every year. Bacterial resistance to antibiotics complicates the treatment of infections and increases the risk of sepsis. Nalini Rama Rao therefore extended her research beyond *Bacillus cereus* and is currently studying how to block the virulence of pathogenic bacteria that are resistant to current treatments and cause sepsis.

### When antibiotic resistance adds to the problem

But how can we fight pathogens effectively today, when their survival in the face of the antibiotics designed to destroy them (antibiotic resistance) is increasing worldwide? "Current antibiotics work by targeting general bacterial survival mechanisms. Basically, the antibiotic will inhibit the bacterium's ability to survive, whatever the circumstances," explains Nalini Rama Rao. "It is effective, but it has a twofold deleterious effect, in that it impacts all the bacteria in the host's microbiota, whose importance we now know, and causes collateral health damage. The other problem is resistance induction. Bacteria mutate to survive, becoming increasingly resistant to the antibiotics originally designed to eliminate them." New therapeutic solutions are therefore needed that do not contribute to antibiotic resistance.

In 2017, the WHO published for the first time a list of pathogens for which antibiotic resistance is becoming critical. In May 2024, three new bacterial families were added to this list. Six of these most antibiotic-resistant pathogens - *Enterococcus faecium*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Acinetobacter baumannii*, *Pseudomonas aeruginosa* and the *Enterobacter* species - form the acronym ESKAPE. All these bacteria, and

*Bacillus cereus* in particular, share a common protein, namely the Mfd (mutation frequency decline) protein. "This protein, which I initially identified as a virulence factor in *B. Cereus*, is produced by all bacteria and is essential for them to resist the host immune system," explains Nalini Rama Rao. Following this discovery, the researcher studied the possibility of targeting Mfd in the development of new drugs, while taking a sensitive approach to antibiotic resistance. "Rather than kill the bacteria, the idea is to disarm them. Mfd is a protein that is only useful at times of immune stress and inflammation. We are developing a compound that blocks the protein at that precise moment, making the bacteria vulnerable to the immune system, which then gets rid of it. As the microbiota is not a target of the immune system, our compound has an impact on the pathogenic bacteria, without affecting the microbiota."

"Hospitals were not really concerned about *Bacillus cereus* for a long time, as it was a contaminant of bedding and carers. I wanted to show that it was a true pathogenic bacterium, with a real impact on this target group." — Nalini Rama Rao

### A universal protein that paves the way

For Nalini Rama Rao, studies linked to this protein open up new perspectives: "After all, this protein is universal; it is conserved by all bacteria. That is where I got the idea to extend our knowledge to other pathogens and bacteria responsible for antibiotic resistance and sepsis." Following this real proof of concept, Nalini Rama Rao and her team have seen their project financed by the AXA Mutual Health Fund to the tune of around one million euros, with the aim of developing a preclinical research project and ultimately creating new drugs. The team has been awarded funding from the French National Research Agency (ANR), to continue its fundamental research on the subject. The project is also supported by Université Paris-Saclay, via the POC in Labs maturation programme and the SATT Paris-Saclay, the Technology Transfer Acceleration Office of the Paris-Saclay Cluster.

The development of new treatments, such as innovative small molecules, nanomedicines, biotherapies and vaccines, as well as strategies to modulate microbiota, is also one of Prometheus IHU's key research areas.

Nalini Rama Rao is convinced that the fight against antibiotic resistance is a constant battle that everyone can join, and is developing related projects that go far beyond research. In 2019, the researcher joined forces with cartoonist Claire Fouquet to publish a comic strip, *Résistances croisées* (Cross-resistances), which describes life in the laboratory and the PIMs team, presenting the major

challenges of antibiotic resistance. Three years later, a new, larger-scale project was born - a cooperative board game, *Propag'Action*, based on the use of cards and suitable from the age of ten.

### Publications

Pitre, T., et al. Corticosteroids in community-acquired bacterial pneumonia: a systematic review, pairwise and dose-response meta-analysis. *Journal of General Internal Medicine*, 38(11), 2023.

Tran, S.L., et al. An anti-virulence drug targeting the evolvability protein Mfd protects against infections with antimicrobial resistant ESKAPE pathogens. *BioRxiv*, 2024

<https://bd-bacterie.com/>

# Generative AI

## The algorithms revolutionising content creation

Since the launch of ChatGPT in 2022, generative artificial intelligence (AI) has continually found new applications in various areas of our day-to-day lives. But what is generative AI? How does it work? And what are its benefits and limitations? We take a deeper look at a technology that has become ubiquitous.

*"Over the last few decades, artificial intelligence (AI) has made a spectacular headway, and among its most promising branches is generative AI. Unlike traditional algorithms, generative AI is capable of creating new data which has never been seen before. This possibility opens up unprecedented horizons in a wide variety of fields, including copywriting..."*

If you haven't had a chance to test the capabilities of generative AI yet, you've just had a demonstration. The paragraph above was not written by a human, but by ChatGPT, the chatbot from OpenAI. Launched in November 2022, the impact of this system on the general public has been revolutionary. Two months after its launch, it already had over 100 million users. ChatGPT is still the best-known and most widely used generative AI, with around 1.8 billion monthly visits to the dedicated platform.

Université Paris-Saclay has also been swept along in this generative AI revolution. But how is this reflected? This question was addressed at a day-long event organised on the Plateau de Saclay on 5 June by the Pedagogical Innovation Department (DIP) and the Graduate School for Professional careers in research and higher education (GS MRES), with the support of the DATAIA Institute, Université Paris-Saclay's artificial intelligence institute. *"The aim was to demystify generative AI and offer a multidisciplinary overview of the use of tools like ChatGPT at the university,"* explains Serge Pajak, researcher at Network, Innovation, Territories, Globalization (RITM - Univ. Paris-Saclay) and Coordinator of the Generative AI project at the university. *"ChatGPT has become so popular that many students are already using it. In a way, this obliges the academic community to take a position in relation to this technology, to guide best practice."* Teachers at Université Paris-Saclay have already taken up the technology, for example, by asking the chatbot questions on the course material and discussing its response with students. *"It is an interesting method because it is highly effective for integrating AI into teaching and applying it in a critical way, by discussing the quality of its content."*

Mapping the uses and competences of generative AI within the university is in fact Serge Pajak's main role. *"With the DIP and the GS MRES, I am also working on building a support system for using these tools. Specifically, the idea is to offer training in the form of acculturation, together with a fairly practical approach, as well as raising awareness of the potential misuses of this technology."* For example, misuse could be

allowing ChatGPT to decide whether or not to validate a project after analysing the file. But *"its internal mechanics are not at all hardwired for that,"* Serge Pajak asserts. To understand why, we need to delve into the very heart of generative AI, or rather of the multiple systems that fall under this term.

### Generative AI: a single term for very different systems

Although people think generative AI has emerged only recently, it is the fruit of several decades of innovation in the field of machine learning. These innovations have accelerated over the last ten years, and this has given rise to generative AI as we know it. *"We should emphasise first and foremost that generative AI is a very commercial term. It is a key word used as a communication engine, but it is too vague in scientific terms,"* warns Vincent Guigue, a lecturer attached to the Applied Mathematics and Computer Science laboratory (MIA - Univ. Paris-Saclay/AgroParisTech/INRAE).

In practice, generative AI is indeed based on a scientific concept: computer systems capable of generating data. *"The problem is that we are grouping very different architectures together under this umbrella."* The term is used for ChatGPT, designed to generate text, MidJourney, which is used to create images, GitHub Copilot, conceived to provide computer code, and AlphaFold, specialised in protein modelling. *"From a technical perspective, these models are not at all based on the same components, nor the same data modalities,"* the lecturer explains.

Although their architectures differ, generative AI models share a common basis: deep learning. These are highly complex mathematical operators made up of elementary units: artificial neurons. These are grouped into networks which are made up of dozens or even hundreds of layers of interconnected neurons which analyse the data supplied. The hyper-flexible architectures can be adapted to a wide variety of data types - text, images, sound, digital data, etc. - for equally diverse applications. Natural Language Processing (NLP) is just one of these.

In artificial intelligence, *"processing textual information is an extremely complicated task,"* explains Vincent Guigue. *"There are hundreds and hundreds of thousands of words. Not to mention the spelling mistakes we make every day. Handling textual data is therefore difficult."* Yet this is exactly what ChatGPT and other tools, such as Claude, developed by Anthropic, or LaMDA, created by Google, are now capable of.

### Language models: "fantastic tools" for processing text

Their secret lies in language models, architectures specifically designed to process text. *"These models are interesting because they can better represent textual information, by projecting words into a continuous vector space. Each word becomes a point in space."* And the position of each of these points is vital. The closer the points are, the more they have a similar meaning. There are also regularities in this space: when making translations, we switch from a feminine to a masculine noun, from singular to plural, and so on. When transferred into a vector space, a text becomes easier to analyse and understand.

*"Language models are fantastic tools for classifying words, extracting insights from documents or summarising texts."* — Vincent Guigue.

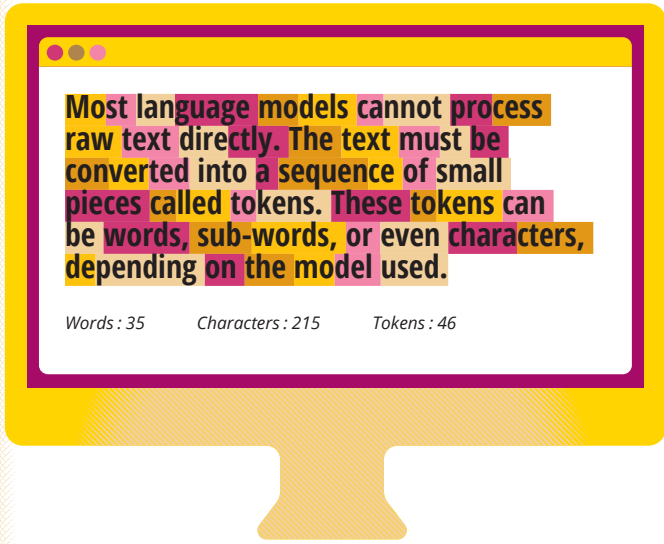
In fact, it is not really the words that are analysed. The models perform what is known as tokenisation: the text is divided into small elements called tokens, which are words, syllables or sequences of characters. Dividing the text up like this helps the models have less linguistic variability, adapt to spelling mistakes, or model multiple languages with a limited vocabulary. But in order to properly process the texts supplied to them, the algorithms first have to train themselves on vast amounts of data. ChatGPT, for example, is based on a Transformer model, or more precisely a GPT (Generative Pre-trained Transformer), which is trained to predict the next token. Its task is to complete a sequence, token by token, with the most likely sequence possible, based on the previous context.

This analysis capability is the basis for a wide range of applications. *"Language models are fantastic tools for classifying words, extracting insights from documents or summarising texts,"* confirms Vincent Guigue. The reason why ChatGPT has been revolutionary is that the chatbot goes much further than that. *"Up until now, these models have been intermediate tools for getting better at language processing tasks. But the fact that a model is capable of generating knowledge-based texts and giving relevant answers to complex questions, that is totally new."*



### Keywords

Deep learning  
—  
Neural networks  
—  
Language models  
—



**Optimised output thanks to reinforcement learning**

OpenAI is based on a Large Language Model (LLM). In other words, a much larger neural network trained on much more data. At its launch, the chatbot ran on a version of GPT-3 with 175 billion parameters. By way of comparison, "the transformer model in vogue in 2017 had 100 million parameters, which was already huge," recalls Vincent Guigue. As regards the volume used to train it, there is a colossal body of several terabytes (TB) of data, comprising hundreds of thousands of articles, books and other texts from the web. "It is estimated that the whole content of Wikipedia makes up just 3% of the archive used for training ChatGPT."

The model trained itself on this massive body of data to predict the next word, in order to model the language and memorise knowledge. But OpenAI hasn't stopped there. Thanks to additional, more high-quality data, the company has also trained the GPT in the question-and-answer game and other reasoning tasks. Finally, "there was a final reinforcement learning stage with a human in the loop: a question was put to the system, which generated ten answers. The human operator then noted the answers, directing the system to the most relevant ones. Thanks to this step, the quality of our answers became much higher. We can also censor sensitive

subjects," explains the lecturer. Before ChatGPT, this type of learning had never been used to optimise the output of a model.

Thanks to this specific learning process, the chatbot is now able to respond in startlingly natural language to the wide range of requests (or prompts) it receives. Whether writing a speech or finding a recipe, ChatGPT always follows the same process: identifying the most likely next word, one after the other. "For ChatGPT, the answer is a succession of plausible words that follow the sentence which was given as the input." That's why, as mentioned above, this type of system is unsuited for being asked its opinion on a file or homework assignment.

Language processing is not the only application to witness spectacular advances thanks to neural networks. This is also the case for image creation, where advances have been made in systems such as MidJourney, which can now generate images that are stunningly realistic. "The field of machine learning is not moving at the same speed as other sciences, far from it. Looking back over the past ten years, it has been a bullet train. My fellow teachers and I all had to update our courses more than five times, otherwise we would be teaching things that were no longer relevant," confirms Vincent Guigue.

**Models that make mistakes**

Despite the fact that generative models have become successful, they still have their limitations. ChatGPT and similar systems "have no notion of what is good or bad in their answers. They have a notion of what is likely and what is not likely," stresses Vincent Guigue. They are therefore perfectly capable of generating errors, answers that are statistically correct but factually wrong. These "hallucinations" are particularly common when the machine is asked about knowledge that is rare, or that dates from after its training data. But "the models don't know how to say they don't know. They are very confident in their correct answers as well as their mistakes."

Another essential limitation of the models is their lack of predictability and explainability. Why did this model give this answer rather than another one? "We are

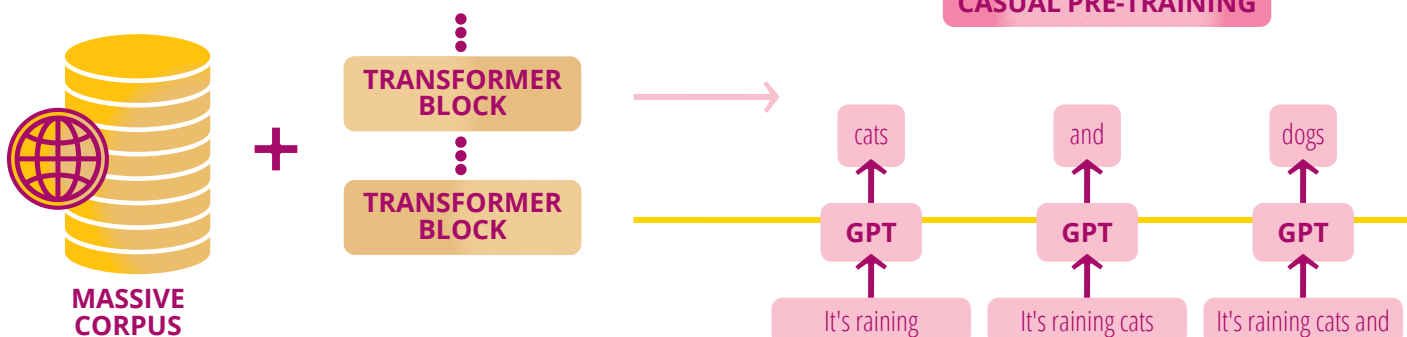
currently unable to explain the decision-making process of these models, because there are too many combinations of parameters." Studies have shown that certain unusual prompts, such as asking the machine to "take a deep breath", improve the quality of its responses. Although no-one knows why.

"There are plenty of applications where the limits of the models are not acceptable. If we say a model is 97% reliable, that sounds good. But a self-driving vehicle that is 99% reliable would be a disaster," the lecturer explains, citing as an example the fatal accident in 2018 involving an Uber vehicle and a pedestrian. "The day after the accident, we knew everything about what had happened, we were able to explain everything after the fact. The problem was that we hadn't been able to predict that the algorithm would make mistakes under certain conditions."

Medicine is another field where generative AI has recently made its entry. "It is very good that doctors can benefit from assistance in diagnostics. Algorithms can highlight elements that doctors have overlooked, and which may be logical," confirms Vincent Guigue. "But these things can also be completely illogical. That's why it is essential that the decisions are still taken by humans. These systems are very good assistants, but not very good replacements."

**References**

The conference of June 5 2024 (in French): <https://parisclaay.mediasite.com/Mediasite/Channel/iagenerative/>



# Generative AI and ethics

## The challenge of regulating an emerging technology

The rise of generative AI is not without its challenges and risks. This revolutionary technology raises many ethical and legal questions, linked to its design, uses and societal impact. Various initiatives are attempting to regulate generative AI at the global level, but they are confronted with the challenge of legislating for a technology that is still in its early stages of development.

### Keywords

Ethics

Regulation

AI ACT

An historic law came into force in the European Union (EU) in August 2024. Called the AI Act, it aims to lay the foundations for regulating artificial intelligence (AI) within the EU. The European bodies had been working on this draft legislation for three years, with intense debate along the way. And for good reason: at the global level, the EU is the first to adopt legislation to address the rise of AI, including generative AI.

While in a general sense AI raises various ethical and legal questions, generative AI systems prompt their own set of questions. Large language models (LLMs), like the one used by ChatGPT, are capable of generating what is known as toxic language. These include insults, hate speech, incitement to violence, offensive or disrespectful statements. Some content is also likely to reflect bias, such as racist or discriminatory stereotypes.

To reduce this type of output, the companies behind the systems are applying filters or controls via human moderators during the models' learning phase. However, this process is currently neither transparent nor verified. It is not infallible either. "These filters and controls do not eliminate toxic language. They just make it less likely," confirms Alexei Grinbaum, Director of Research at CEA Paris-Saclay and Chairman of CEA's Digital Ethics Operational Committee. Conversely, this moderation can also lead to excessive oversight.

The origin and quality of the data used to train the models is another source of concern. "What we have here is the first level of generative AI ethics. It is all about the technical aspect: how are the models designed and how are they being used?" questions the physicist from the CEA.

"But we also have another type of ethical consideration regarding the long-term effects of this technology on society and human beings. For example, how are the models changing professional practice?"

Experts in digital ethics already had their concerns about the challenges of these systems before the launch of ChatGPT in November 2022. In France, the National Pilot Committee for Digital Ethics (CNPEN), under the aegis of the National Advisory Ethics Council (CCNE) and set up two years earlier, published its first opinion on chatbots in 2021. "We discussed the Transformer language models and their impact on society. At the time, we were already anticipating the scale and magnitude of the issues that would be raised," recalls Alexei Grinbaum, member of the CNPEN and co-rapporteur of this opinion. A second opinion was published in 2023, with around thirty recommendations for designing, researching and governing generative AI systems. The CNPEN - whose mission ends in 2024, making way for a permanent body - "was the first at the national and international level to take a stand on these questions."

### An "essential" regulatory framework

The challenges involved in these systems are so pressing that "it is essential to put a regulatory framework in place," Alexei Grinbaum believes. With this in mind, the European Union adopted the AI Act, the measures of which will gradually begin to apply from 2025. Among the most important provisions, this legislation introduces the notion of high-risk AI systems when used in critical domains such as education, employment or the issuing of bank loans. "This means that all systems operating in the sectors in question are subject to obligations and certifications," Alexei Grinbaum explains. Similarly, the Act establishes a classification of general-purpose AI models, with various obligations imposed according to the associated risk.

In the AI Act, "we find all the principles that already existed for AI in 2019: transparency, explainability, robustness, and security. What I find very interesting is that it establishes a new ethical principle: making distinctions." Indeed, the Act requires that content generated by a model is distinguishable from content created by a human. "This is a fundamental principle that we discussed with the CNPEN. But from a scientific perspective, it is difficult to implement for certain content." Elements such as watermarks are proving effective in helping identify AI-generated images and videos. With text, on the other hand, the

task is far more complex. "There are obligations in the AI Act for which we currently have no scientific solutions," the specialist admits.

This example, among others, illustrates the challenge of "operationalising" - putting into practice - the principles laid down in the Act. According to Alexei Grinbaum, it also underlines the importance of establishing dialogue between the technical players in the sector and the regulatory bodies. This is all the more crucial as generative AI is a rapidly emerging and evolving technology: "Eight months is the equivalent of a century in the field of artificial intelligence. The advance of these technologies is much faster than the legislative process." Is establishing a law for AI the best solution? "The problem is that we have to adopt legislation which is flexible enough to evolve very quickly so that we don't regret it in five or ten years' time. Which, in my opinion, is not completely the case with the AI Act." In May 2025, the AI Office, set up by the European Commission, is due to publish codes of practice to enforce the EU's AI Act. "That is when we will see the concrete, practical scope of the Act's highly political articles," predicts Alexei Grinbaum.

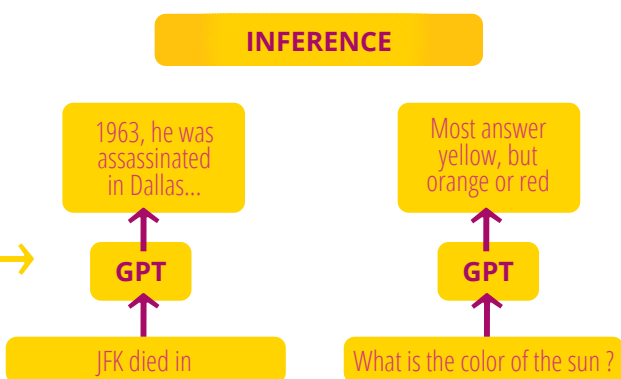
Elsewhere too, similar initiatives are seeing the light of day. In 2023, China, along with the U.S., introduced new regulations to govern the development and use of AI, including generative AI. In the hope of catching up with the evolutions of recent years. But the technology will probably always stay one step ahead. "With this technology spreading to all sectors, it is not possible to consider every angle. It is clear that in 20 years' time, there will be a whole host of new questions that we can't even imagine yet," Alexei Grinbaum predicts.

### References

Alexei Grinbaum, *Parole de machines*, humenSciences, 2023

<https://artificialintelligenceact.eu/>

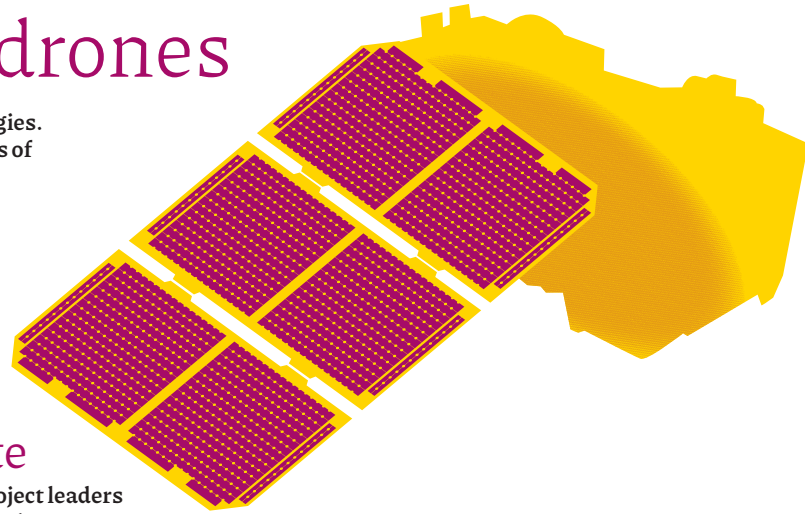
CNPEN Opinion n°7: *Systèmes d'intelligence artificielle générative : enjeux d'éthique (In french)*: [https://www.ccne-ethique.fr/sites/default/files/2023-09/CNPEN\\_avis7\\_06\\_09\\_2023\\_web-rs2.pdf](https://www.ccne-ethique.fr/sites/default/files/2023-09/CNPEN_avis7_06_09_2023_web-rs2.pdf)



# New frontiers

## Satellite environmental monitoring and cargo drones

Sky-based exploration and surveillance are booming thanks to new technologies. Satellite-based ecological monitoring and cargo drones are just two examples of the innovative technologies being developed at Université Paris-Saclay.



### Kanop

#### Measuring the impact of forestry projects by satellite

Founded in 2021, this start-up enables forest carbon project leaders and forest managers to effectively measure their climate impact.

Kanop is the result of a meeting between CentraleSupélec alumnus Louis de Vitry, the start-up's co-founder and Chief Technology Officer (CTO), and Romain Fau, co-founder and Chief Executive Officer (CEO). The raison d'être of this start-up is to allow forest carbon project leaders to measure and verify their climate impact in terms of carbon sequestration, biodiversity preservation index, etc. The urgent nature of the climate crisis makes it vital to protect these areas, but projects like this require considerable funding. "The aim is to provide transparency and credibility for these projects and their impacts, to encourage financing," confides Romain Fau.

To meet these challenges, the start-up offers a platform that uses state-of-the-art satellite imagery and artificial intelligence to produce indicators. The data production process begins with the strategic selection of remote sensing images. "To provide information, the satellites are equipped with two main types of sensors, namely multispectral optical sensors and radar sensors. This involves the Sentinel-2 and Landsat-8 satellites, and the Sentinel-1 and PALSAR satellites respectively," explains Romain Fau. At the heart of Kanop's methodology is a deep neural network model - a machine learning process based on artificial intelligence - with global coverage. This

model is based on a dataset that covers 60 million hectares of forest, and guarantees a high level of accuracy.

For the past two years, the start-up has been supported by the 21st by Centrale-Supélec accelerator - "they help us structure fund-raising in particular" - and by AgroParisTech's Forest Inn Lab.

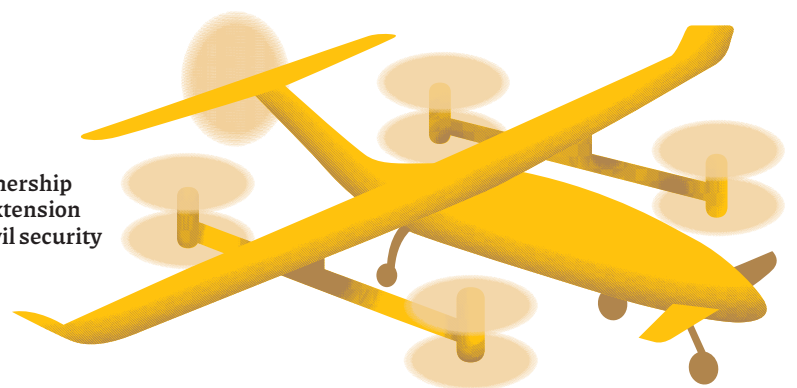
<https://www.kanop.io/>

### Windlair

#### A hybrid cargo drone is possible!

Windlair, a start-up founded in 2022 in close partnership with ONERA, is developing and building a high-extension cargo drone for the energy, transport, industry, civil security and defence sectors.

Armin Taghizad, the expert helicopter missions coordinator at ONERA's Information Processing and Systems Department, Novine Taghizad and Robert Roma all come from aeronautical backgrounds, so it was a natural step for them to join forces and create Windlair. This start-up has developed and built an autonomous aircraft based on VTOL (Vertical Take-Off and Landing) technology. Between a drone and an aeroplane, the aircraft's special feature is its hybrid wing and engine. "It has a fixed wing so it can take off and land like an aeroplane. But it also has a rotating wing that enables it to maintain a vertical position like a helicopter," explains Robert Roma, Windlair's Sales Director.



Currently in the R&D phase, the 630 kg aircraft is designed to be used for transport, logistics and airfreight missions, as well as in a range of sectors - energy, transport, industry, civil security and defence - thanks to a 150 kg payload that can be moved over 400 km. "The cargo drone will be an important asset in crisis management," asserts Robert Roma, since it will be able to serve disaster zones and bring in first-aid supplies and food. "It is a fast and less risky solution since there is no pilot or passenger on board."

Since the project's inception, Windlair's founders have received support from SATT Paris-Saclay and ONERA, which have helped them to develop their intellectual property around the hybrid propulsion chain. The next stage of the programme is the wind tunnel. And what better way than to release the small-scale flying prototype to celebrate the new year 2025!

<https://www.linkedin.com/company/windlair/>



# When innovation meets action

## Welcome to the 503 at the Institut d'Optique Graduate School

On 1st October, the Institut d'Optique Graduate School officially opened the 503 - the centre for entrepreneurship and innovation, on the Université Paris-Saclay campus in Orsay. After two years of work, the building boasts a new look, covering a floor area of more than 10,000 m<sup>2</sup> - it is now dedicated to innovation and technological entrepreneurship. The future looks bright for the venue, which is already teeming with projects.

The hall of building 503 was packed to the rafters on 1st October for the official opening of the Institut d'Optique Graduate School's new centre, dedicated to entrepreneurship and innovation. The morning began with a talk entitled "Lighting the way for innovation", in which Rémi Carminati, Director General of the Institut d'Optique Graduate School, underlined the fact that this centre *"lies at the crossroads of education, technological innovation and fundamental research."* He concluded by reaffirming the Institute's ambition to *"keep going down the path of excellence and openness."* Camille Galap, President of Université Paris-Saclay, together with several representatives of the French government, including Clara Chappaz, the new Secretary of State for Artificial Intelligence and the Digital Economy, and local elected representatives such as Rémi Darmon, the Mayor of Orsay, and Valérie Pécresse, the President of the Île-de-France region, then shared their vision for the renaissance of this centre for innovation and entrepreneurship.

groups. Each of these round table discussions was even more enriching than the last, thanks to their highly varied points of view, with numerous speakers sharing their inspiring testimonies and success stories in the Paris-Saclay region. They included Alain Aspect, the emeritus director of research at the CNRS and professor at the Institut d'Optique Graduate School/Université Paris-Saclay, working at the Charles Fabry Laboratory (LCF - Univ. Paris-Saclay/Institut d'Optique Graduate School/CNRS) and winner of the 2022 Nobel Prize in Physics, who agreed that one of the keys to the success of projects in the Paris-Saclay region is, in his own words, *"the proximity of players, particularly basic research laboratories and industrialists, to the transfer process and the start-up of projects."*

Later in the afternoon, a photographic exhibition entitled "The History of 503" immersed visitors in the building's past and future. The day concluded with an exploration of the "Photonics and Innovation" village, featuring stands showcasing innovation projects and partnerships between the Institut d'Optique Graduate School and the region.

These were moments of inspiration, exchange and discovery, perfectly illustrating the ambitions and new dynamism of the 503.

### A catalyst for innovation

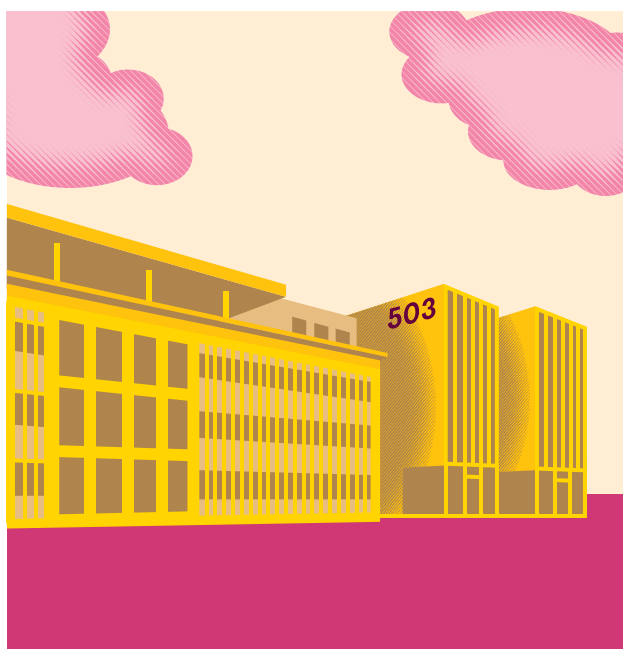
Anchored in the Université Paris-Saclay ecosystem, the 503 aims to be an accelerator of innovation and entrepreneurship, promoting local exchanges between students, companies and players from the area.

In 2006, the Institut d'Optique Graduate School set up the Entrepreneurial innovation sector (FIE in French), one of the best courses in France in the field of technological entrepreneurship, providing students with the opportunity to start their own business. The 503 is the place to be. Students are surrounded by entrepreneurs and experienced engineers, as well as their FIE elders who have already set up their own businesses.

But exchanges don't just take place internally, as the 503 is also open to the outside world. Solid partnerships are being developed with other educational institutions, research centres and companies, which benefit from scientific expertise, technological and entrepreneurial support, and access to a prototyping platform: the Photonic Fablab.

The 503's ambition doesn't stop there. In this collaborative urge, the link between the Institut d'Optique Graduate School and Université Paris-Saclay has been reinforced since the creation of the Université Paris-Saclay University Innovation Cluster (in French, Pôle universitaire d'innovation - PUI) - a France 2030 label, obtained in July 2023, whose goal is to promote innovation that will contribute to solving contemporary challenges in society and thus foster human progress. The Institut d'Optique Graduate School, one of the founding members of the Université Paris-Saclay University Innovation Cluster (PUI), is also a key player in two of the PUI's four pillars. In this way, it contributes to raising awareness of innovation and entrepreneurship within the university community, by helping to train current and future higher education executives in innovation. It also plays a significant role in supporting projects and start-ups, monitoring initiatives in the pre-creation phase and organising networking events. The 503 will be a privileged space for these activities and will host initiatives to meet these challenges.

Embodying both a dynamic and collaborative ecosystem, the 503 is already establishing itself as a key innovation hub in the Université Paris-Saclay area.



The morning continued with round table discussions exploring topics such as investment, innovation and collaborative research, entrepreneurship and innovation in photonics and quantum physics in major

# Nose, olfaction and fragrance

## Giving a sense to smell



### Keywords

- Olfactory receptor
- 
- Anosmia
- 
- Respiratory viruses
- 
- Fragrances
- 

Long misunderstood, then unfairly ignored, the sense of smell generated renewed public interest during the Covid-19 pandemic. And yet, scientists from a wide range of fields have been studying this very subject for many years now. Researchers from Université Paris-Saclay reveal their approaches and recent discoveries in this area.

"What do you call someone who cannot see? Someone who cannot hear? And someone who cannot smell?" It was with these three questions that Claire de March, CNRS Researcher at the Institute of the Chemistry of Natural Substances (ICSN – Univ. Paris-Saclay/CNRS), started most of her lectures until recently. It was a way for her to prove that, while the terms "blind" and "deaf" are often familiar, the notions of anosmia (loss of sense of smell) and olfaction are far less familiar to the general public.

Studies dedicated to the sense of smell are relatively recent; the discovery of olfactory receptors, i.e. the structures that enable most mammals to smell, dates back only to 1991. "More than 20 years after *Man walked on the Moon!*" says Claire de March. The scientific community now estimates that the human nose is made up of around 400 different olfactory receptors, capable, by creating multiple combinations, of smelling between ten thousand and one trillion (one billion billion) different

odours. Activated olfactory receptors create an electrical signal that stimulates olfactory neurons, which transmit the signal to the brain. The brain then interprets it as a scent.

### The first experimental structure of a human olfactory receptor

What does a human olfactory receptor look like? This is the question Claire de March has been trying to answer for several years. After initial experience in sensory analysis in the agri-food sector, the researcher specialised in molecular chemistry in 2012 and decided to dedicate her research to studying the general functioning of the olfactory system.

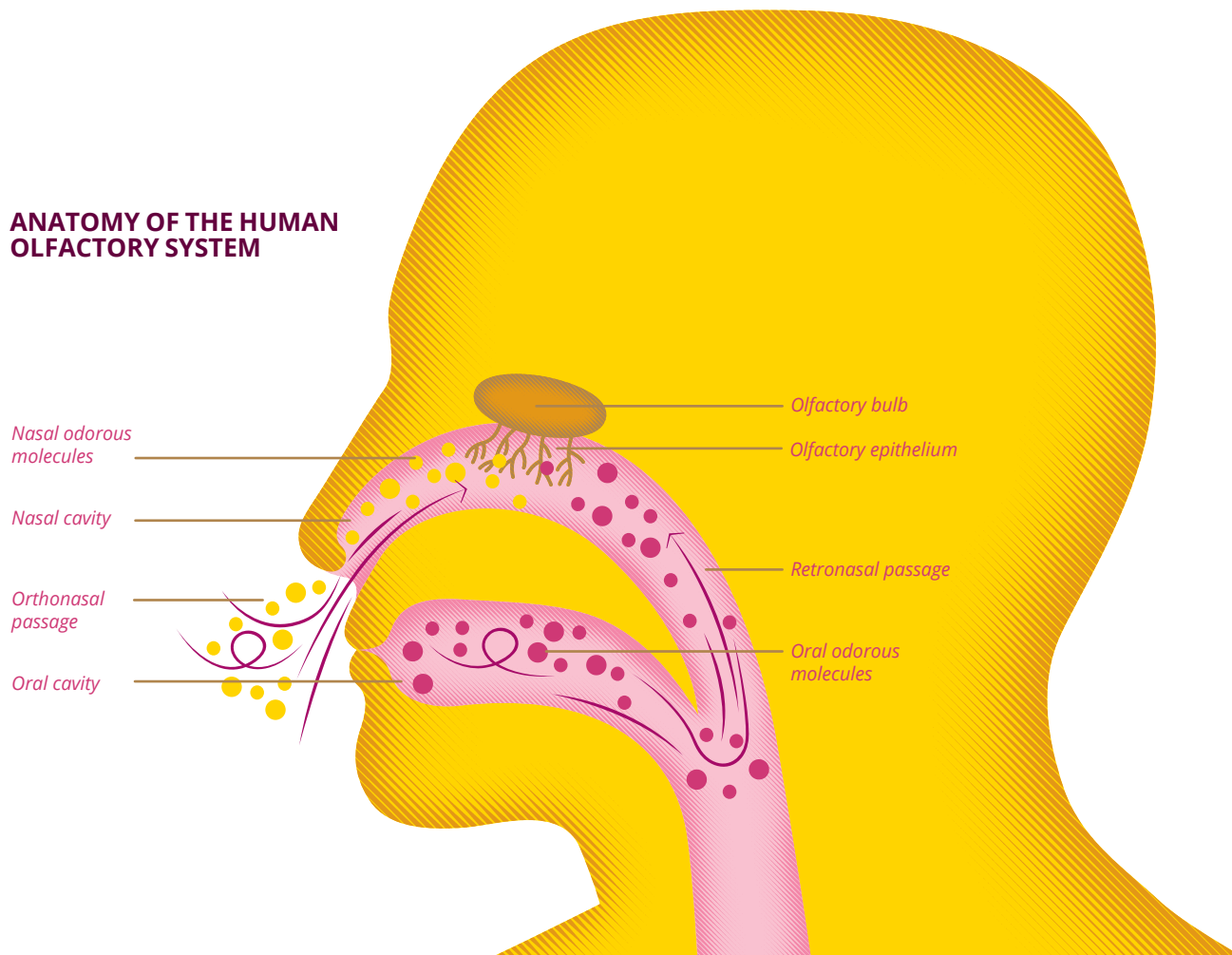
It was during her post-doctoral programme in the United States that Claire de March quickly realised the limitations of biochemical studies on olfaction. The problem was the instability and insufficient expression of olfactory receptors in the cellular models used in the laboratory.

This made it impossible for scientists to study the structure of these receptors and precisely measure their interactions with odorant molecules. Furthermore, some theoretical model receptors used for olfaction studies were still inspired by light receptors - involved in vision - which, although very different, are more easily expressed and cloned in the laboratory.

To overcome these experimental limitations, Claire de March proposed applying consensus theory to olfactory receptors. "This theory suggests that the amino acid most frequently present in a protein subfamily is the one that optimises its function, rather than a randomly selected amino acid," explains the researcher. In other words, the fact that an amino acid is often present in a protein sequence would mean that this amino acid is useful to the protein.

Based on this theory, Claire de March and her team selected all the amino acids most frequently present in olfactory

### ANATOMY OF THE HUMAN OLFACTORY SYSTEM



receptors to recreate "consensus" olfactory receptors, which do not exist in the human nose but are comparable to ancestral receptors from which all other receptors would have evolved. The result was that in the majority of cases, the manufactured consensus receptor was expressed at better levels than the native human olfactory receptors. "These ancestral receptors have mutated over the years so that they can sense more molecules, but they have also lost effectiveness. This may explain why these ancestral receptors express themselves better than others", adds the researcher.

In addition to unlocking a major problem in olfaction research, this study also enabled Claire de March and her colleagues to identify the human olfactory receptor OR51E2. This receptor, which exists in the human nose, is very well conserved in evolution and is therefore one of the best-expressed native receptors. In 2023, the study of its structure led to the first experimental structure of a human olfactory receptor in history. The researcher and her colleagues achieved this at the University of California (UCSF) using cryo-electron microscopy, which recreates a three-dimensional image from hundreds of thousands of photos of a structure immobilised by cold. This discovery earned Claire de March the Irène Joliot-Curie "Young Female Scientist" Prize for 2023.

The discovery of this structure was also the starting point for a wide range of research and applications. The OR51E2 receptor is expressed not only in the nose but also in the prostate and is suspected of playing a role in cancer cell proliferation and metastasis in prostate cancer. A better understanding of this receptor would therefore have therapeutic implications that go beyond those - already very diverse - of olfaction.

### Understanding the impact of respiratory viruses on the sense of smell

Alongside studies on the fundamental structure of the olfactory epithelium - the tissue responsible for odour detection in the nasal cavity - other research teams at Université Paris-Saclay are working to better understand this epithelium's interactions with the external environment. One of these scientists is Nicolas Meunier, a neurobiologist in the Virology and Molecular Immunology Laboratory (VIM - Univ. Paris-Saclay/INRAE).

A specialist in olfaction since 2005, Nicolas Meunier began focusing his research on the interactions between the environment and the nasal cavity in 2015. In 2017, he and his team demonstrated that nasal microbiota - similar to the better-known gut microbiota - influences odour detection. He spent the years that followed studying the interactions of the olfactory mucosa with the immune system. "I am particularly interested in understanding how a respiratory virus can infect the nasal cavity and how the local immune system responds to this infection," he explains. These studies are particularly relevant as they took place a few years before the Covid-19 pandemic, which at the time demonstrated the important role of respiratory viruses in disrupting the sense

*"It is disturbing that some patients are completely anosmic but regain their sense of smell in just a few days. This seems incompatible with the complete destruction of the olfactory epithelium, as regeneration cannot be that quick."* — Nicolas Meunier

of smell. "Our team was very reactive when SARS-CoV-2 appeared, because we already had all the tools to understand what was happening," explains the researcher.

Since 2020, Nicolas Meunier, who was then working on the bronchiolitis and influenza virus, has switched his focus to the mechanisms responsible for loss of smell after infection with SARS-CoV-2, one of the most common symptoms of Covid-19. This research led him to propose that the loss of sense of smell observed in a patient with Covid-19 is linked to significant desquamation (destruction) of the olfactory epithelium following viral infection. In 2022, his new study suggested that this destruction of the olfactory epithelium is not directly linked to SARS-CoV-2 infection, but rather to the associated immune response. Neutrophils, the first cells in the immune system to react to infections in the body, are thought to play a major role in destabilising the olfactory epithelium and thus in the loss of the sense of smell.

To achieve these results, the researcher used behavioural studies carried out on different rodents - mice and hamsters - whose olfactory systems are similar to those of humans. However, Nicolas Meunier calls for caution: "The transposition of our results to humans is not straightforward. There are anatomical differences between rodents and humans, and although the hamster model closely mirrors the pathophysiology of mild Covid-19 in humans, there are undoubtedly differences. We can never be certain of anything."

The researcher is now trying to explain the differences between short-term and long-term loss of smell, which he believes are linked to two quite distinct processes. "It is disturbing that some patients are completely anosmic but regain their sense of smell in just a few days. This seems incompatible with the complete destruction of the olfactory epithelium, as regeneration cannot be that quick."

One of the hypotheses put forward by the researcher explains this transient loss of smell by the obstruction of the olfactory cleft, a very narrow passage that allows air to pass from outside the nose to the olfactory epithelium. This obstruction, caused by cell debris resulting from the desquamation of the epithelium by neutrophils, implies a transient loss of sense of smell while the debris is eliminated. If the loss persists, it would be linked to greater destruction of the epithelium following the viral infection. And, depending on the individual, it may take more or less time to regenerate in a context of persistent inflammation.

Further studies are underway to better understand this transient loss of smell - in particular, the difference between several

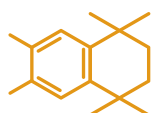
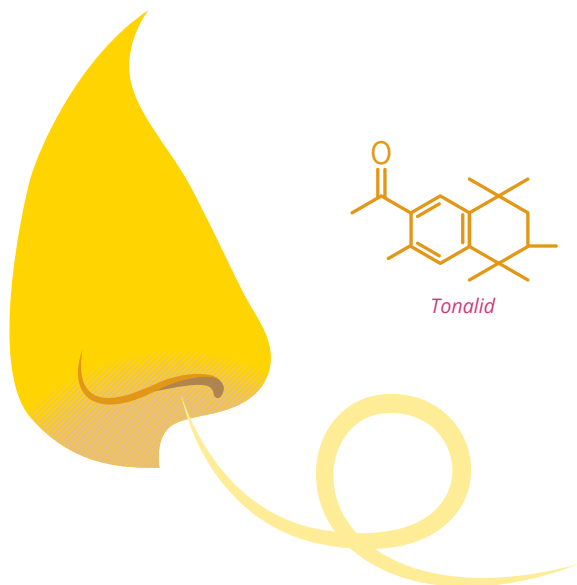
SARS-CoV-2 variants - and to study the mechanisms of virus dissemination via the nasal cavity. An antiviral treatment to limit virus transmission by this route is also being tested on animal models. "There is still a huge amount to study regarding the links between the olfactory epithelium and its environment," adds the researcher. "This is an area that had barely been explored before Covid-19. Many virologists started to look at the nasal cavity and how it works during the pandemic, and there is still a lot of work to be done," he says.

### Recreating lost fragrances

Nicolas Meunier is not the only scientist whose field of research has developed more rapidly since the Covid-19 pandemic. This is also the case for Olivier David, a lecturer in organic chemistry at the Lavoisier Institute of Versailles (ILV - Univ. Paris-Saclay/UVSQ/CNRS). While teaching trainee perfumers, cosmeticians and aromaticians, he has noted a renewed interest in the subject since 2020. "Covid-19 may not explain everything, but the number of students in these disciplines is growing, and there is a greater social mix," he analyses.

Olivier David joined the Lavoisier Institute in 2005 and specialised in perfumery in 2012. "It all fell into place when I started teaching trainee perfumers. I discovered that this field had a number of challenges to overcome from a chemistry point of view!" Today, the lecturer devotes a large part of his research to the history of the ingredients used in perfumery. In 2020, he published the chemical and industrial history of polycyclic musks, a family of synthetic molecules widely used in perfumery. "Musk was originally an animal product derived from the secretion of a special gland. But its harvesting results in the death of the animal and is therefore strictly forbidden today. Synthetic musks, which replace the natural molecule, were among the very first discoveries made by chemists in the world of perfumery. I wanted to tell the story of how scientists achieved such feats in the 19th century, and the consequences these discoveries had for industry."

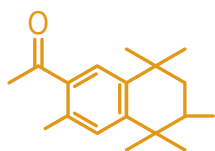
For these studies, performed outside the lab, Olivier David gathered and analysed a large number of archives and publications to reconstruct these little-known parts of history. "The work was made even more difficult as the culture of secrecy is particularly important in perfumery. Some manufacturers did not publish their chemical formulas or discoveries." In 2023, Olivier David also published a history of the great advances in perfumery.



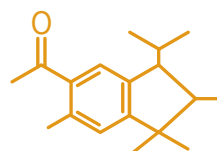
Versalid



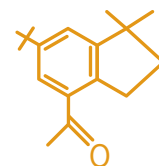
Galaxolid



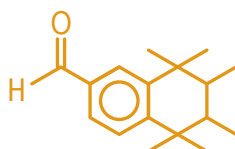
Tonalid



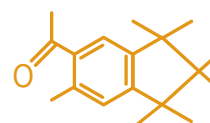
Traseolid



Celestolid



Vulcanolid



Phantolid

### STRUCTURES OF SEVEN POLYCYCLIC MUSKS

In addition to his work as a science historian, Olivier David is also a chemist; once the history had been unravelled, he set about reproducing certain lost musks using the original methods, to enhance the collections of the Osmothèque, a conservatory of perfumes and perfumery ingredients.

*"Our research suggests that Neanderthals had a weaker sense of smell than we do, but that Denisovans were more sensitive to sweet and sulphurous odours."*

— Claire de March

As attached to the past as he is to the future, Olivier David is now seeking to reproduce certain molecules with less impact on the environment and health. His latest goal is to reconstitute the scent of birch tar, an odorant used since ancient times but containing substances harmful to the skin, for use in perfumery. "In addition to preserving the heritage of scents and perfumes, I want to provide new, more respectful ingredients for the perfumery of the future," says the lecturer.

#### A transdisciplinary research subject

In addition to organic chemistry, molecular chemistry and neurology, the sense of smell seems to be a theme that is relevant to many other disciplines. Olivier David, for example, uses his knowledge of the history of chemistry to foster collaboration in literature. "Researcher Érika Wicky

specialises in 19th century literature and is interested in descriptions of the smell of painters' studios. She noted that black paints were often cited and therefore concluded that they had a strong and distinctive smell. The idea behind our collaboration is to recreate the smell of painters' studios and better understand the composition of certain paintings," explains the lecturer.

Claire de March also applies her discoveries in fundamental chemistry to more societal applications. In a recent study, carried out with neurobiologist Noam Sobel, the researcher focused on the smell of tears and the consequences of inhaling them. Also in 2023, she succeeded in "resuscitating" the olfactory receptors of a Denisovian and a Neanderthal, two cousins of *Homo sapiens* who disappeared 30,000 to 40,000 years ago. "The aim was to retrace the evolutionary history of olfactory receptors in the *Homo* genus, in particular to determine whether the three species had different perceptions of odours," explains the researcher. The results suggest that, while Neanderthals appeared to have a large number of receptors comparable to those of *Homo sapiens*, most are no longer functional. The olfactory receptors of Denisovans, different from those of *Homo sapiens*, seemed to function in the same way as modern olfactory receptors. "Our research suggests that Neanderthals had a weaker sense of smell than we do, but that Denisovans were more sensitive to sweet and sulphurous odours," says an enthusiastic Claire de March. "This study is one of the greatest thrills of my career. The receptor we reconstructed had not been active for 30,000 years!"

Linking such research, rooted at the atomic level, with social issues is "very exciting", Claire de March confides. Olivier

David confirms: "One of the elements that I find specific to olfaction research is that researchers from very different backgrounds, from biochemistry to philosophy, can exchange ideas and understand each other. Talking about our perception of smells also involves sharing emotions. Few subjects manage to create such links between disciplines," he concludes.

#### References

- Billesbølle, C.B., de March, C.A., van der Velden, W.J.C. et al. Structural basis of odorant recognition by a human odorant receptor. *Nature* 615, 742-749 (2023).
- Olivier R.P. David. A Chemical History of Polycyclic Musks. *Chemistry*. 2020 Jun 18;26(34):7537-7555.
- Bourgon, C., Albin, A.S., Ando-Grard, O. et al. Neutrophils play a major role in the destruction of the olfactory epithelium during SARS-CoV-2 infection in hamsters. *Cell. Mol. Life Sci.* 79, 616 (2022).

# Citizen science

## Projects that help advance science thanks to citizens

Citizen science has become a tool of choice for disseminating scientific knowledge while involving the general public in research work. Citizen science is also making its mark at Université Paris-Saclay, as evidenced by these four citizen projects led or supported by research staff from the university.

### Keywords

Volunteers

Conservation

Meteorite

Observation

Growing beans, hunting for meteorites, watching birds feed, or... collecting stool samples. At first glance, there is no connection between these more or less unusual activities. But they all have one thing in common: they are research projects. Except that in this case, it is not researchers who are carrying out the experiments, but citizens who have volunteered to give scientists a helping hand.

Over the past 20 years, citizen (or participatory) science has become increasingly popular. The number of programmes designed to involve the general public in scientific research continues to grow, in a variety of forms and disciplines. While some projects are just getting off the ground, others are already reaping the rewards of years of citizen collaboration. Some have even been rewarded for their approach, including the INCREASE project, winner of the 2024 EU Prize for Citizen Science last June. To date, over 20,000 volunteers have taken part in this initiative across Europe. A fine performance for the common bean, the focus of this unique initiative.

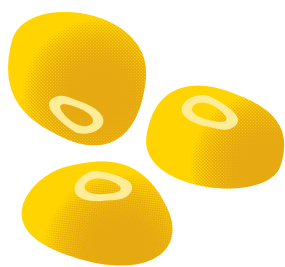
Having started in 2021, the experiment involves asking volunteers to grow beans at home to study the different varieties in different environments.

You don't need to be a plant expert in order to take part in the project. *"Anyone can take part, all that is needed is a bit of soil on a balcony, in a garden or a field."* After registering, volunteers receive a packet of five seed varieties - plus a control variety - selected from the thousand bean varieties chosen for the experiment. *"70% of our varieties come from Europe. 75% are climbers and 25% are dwarfs,"* explains the researcher from the QGE laboratory. *"We're basically demonstrating that a bean doesn't have to be a white bean just a few centimetres long."*

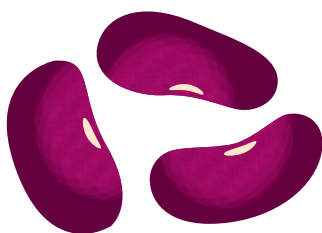
### TYPES OF LEGUMES STUDIED BY THE INCREASE PROJECT



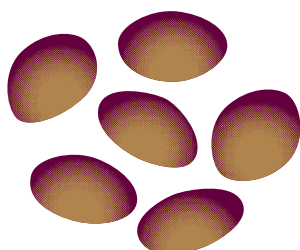
Chickpea



Lupin



Common bean



Lentil

### Decentralising conservation of the common bean

Launched in May 2020, the INCREASE (Intelligent Collections of Food-Legume Genetic Resources for European Agrofood Systems) project *"will implement a new approach to conserve, manage and characterise genetic resources, focusing on chickpea, common bean, lentil and lupin,"* explains Maud Tenaillon, research director at Quantitative Genetics and Evolution laboratory (QGE - Univ. Paris-Saclay/INRAE/CNRS/AgroParisTech) and French relay of the project led by a team from the Università Politecnica delle Marche in Italy. *"We believe that legumes have a crucial role to play in the agro-ecological transition. While meat consumption is declining across Europe, there is a real demand for more protein-rich legumes."*

While these plants boast significant diversity, the number of varieties cultivated today is much lower than in the past. Fortunately, this diversity is preserved in gene banks, which are responsible for inventoring and characterising the varieties. *"The problem is that each gene bank has its own modus operandi, and it is hard to know exactly what is where."* This observation was the impetus to launch the INCREASE project: *"The idea is to put everything together, to enhance the knowledge and conservation of the four target legumes."*

For the common bean, however, the team is taking a novel approach. Rather than leaving the seeds in the hands of professionals in a few places, it has launched a participatory experiment to "decentralise" conservation. *"We thought: why shouldn't citizens reappropriate this diversity and play a part in the conservation of genetic resources?"* explains Maud Tenaillon.

Then comes the crucial moment: sowing the beans and starting the observations. Emergence date, leaf shape, pod colour, seed appearance, etc. The plants are scrutinised from top to bottom. *"We tried to establish a precise protocol by providing colour scales, measurement grids, etc. To simplify the process, we ask participants to take photos which are then analysed by artificial intelligence, which is capable of automatically measuring the characteristics of leaves, seeds, etc."* All the data and photos are sent by the volunteers via the INCREASE GSA mobile app developed for the experiment.

After four campaigns - organised each year from mid-November to the end of February - the team already has thousands of data records. But we'll have to wait and see before these deliver any initial results. *"Managing the project, especially sending out the seeds, involves a lot of work,"* confirms Maud Tenaillon. In 2023 alone, more than 8,000 bags of seeds were sent out by the Italian team. *"When the data comes in, it also has to be cleaned, which takes a considerable amount of time."* That doesn't stop the researchers from planning to extend the experiment beyond the initially planned five years. Besides scrutinising their beans, the volunteers are now invited to share tips, videos, recipes and even seeds. As long as they follow the instructions provided by the app. *"Seeds can't be exchanged any old way!"* cautions Maud Tenaillon. That is also one of the objectives of INCREASE: *"Make citizens aware that seeds are an important and precious asset."*

**METEORES AND METEORITES**

**1. COMET**

Solid object made up of ice and dust, which sometimes leaves behind a luminous trail called a tail.

**2. ASTEROID**

Small celestial body made up of rock, metals and ice, ranging in size from one metre to several hundred kilometres

**3. METEOROID**

Asteroid or comet fragments ranging in size from a few microns to a metre.

**4. METEORE**

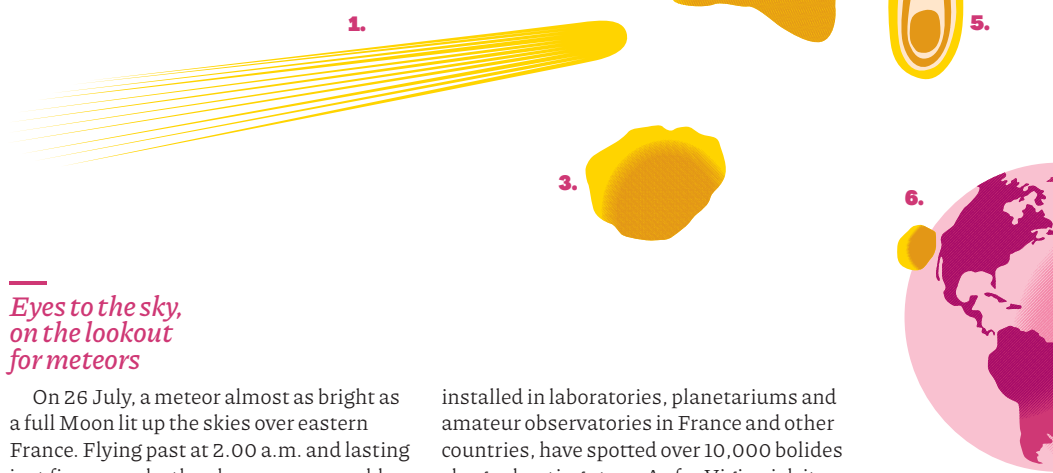
Light phenomenon caused by a meteor entering the atmosphere. Low-intensity meteors are known as shooting stars..

**5. BOLIDE**

Meteor brighter than the planet Venus.

**6. METEORITE**

Fragment of a meteoroid that survived its transit through the atmosphere and fell on the Earth's surface.



**Eyes to the sky, on the lookout for meteors**

On 26 July, a meteor almost as bright as a full Moon lit up the skies over eastern France. Flying past at 2.00 a.m. and lasting just five seconds, the phenomenon could well have gone unnoticed. But the FRIPON cameras and observers from Vigie-ciel didn't miss it. Thanks to these observations, everything about this meteoroid was already known shortly thereafter: its origin, speed, trajectory, etc. Proof that beans aren't the only things to benefit from citizen science. The FRIPON and Vigie-ciel programmes, run by the National Museum of Natural History (MNHN), the Observatoire de Paris and Université Paris-Saclay, are another example.

FRIPON (Fireball Recovery and Inter Planetary Observation Network) was set up in 2014, following two events a few years earlier: a meteorite that fell in the town of Draveil (Essonnes) and a large shooting star that flew over Brittany. "At the time, we received a lot of eye-witness reports, but we couldn't respond to anyone," recalls Sylvain Bouley, a planetologist attached to the Geosciences Paris-Saclay laboratory (GEOPS - Univ. Paris-Saclay/CNRS). "Having sensed the interest, we decided to set up a network of cameras capable of monitoring the sky 24 hours a day and detecting meteorite falls."

To make sure the human witnesses who are willing to share their observations were not overlooked, a second programme, Vigie-ciel, is taking shape. "That is the participatory aspect of FRIPON," explains the lecturer and co-founder of both programmes. "Vigie-Ciel offers witnesses the possibility to fill in a form to tell us what they saw." This is done through a dozen questions developed in partnership with the American Meteor Society. "These reports quickly give us an idea of the intensity of the event: when you have two hundred eye-witness reports, you know that something important has happened. It is an early warning to go and look at the camera data".

The performance of FRIPON and Vigie-ciel testifies to their effectiveness. Since 2018, the two hundred cameras,

installed in laboratories, planetariums and amateur observatories in France and other countries, have spotted over 10,000 bolides - large shooting stars. As for Vigie-ciel, it has notched up almost 13,000 reports for around 4,000 observed events. This latest programme doesn't just encourage volunteers to scan the skies. It also takes them on meteorite hunts. "This is the second aspect of Vigie-ciel: we have regional coordinators who provide training and organise meteorite hunts when meteorite falls are suspected," confirms Sylvain Bouley. "Since 2018, there have always been one or two falls a year for which we have organised hunts. But we soon realised that looking for meteorites in France isn't easy." The first successes of the project only came in 2023.

In February of that year, an asteroid was spotted seven hours before it was timed to enter the atmosphere. Once the alert was given, the FRIPON network and the Vigie-ciel community were mobilised. "The next day, we knew that something had fallen in Normandy. The day after that, we were out in the field and the meteorite had been found within two days", recalls the planetologist. "It is the nicest example of citizen science, because it wouldn't have been possible without all the amateurs who filmed the entry of the asteroid, and without all the local residents who came to look for the meteorite with us. The asteroid was found in a field by an 18-year-old student. We could have totally missed it".

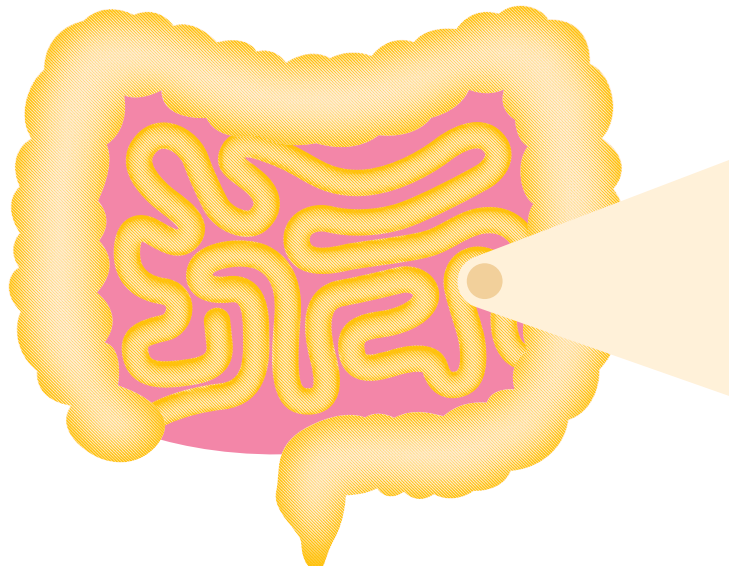
The second success came in September after another bolide was spotted in the sky. Astronomers suspected there would be a fall in Sologne, but in private forests, which were difficult to access for a hunt. And then came a surprise: a resident contacted a relay from FRIPON/Vigie-ciel. The object had landed on her property, destroying her garden table. "The surveillance camera even recorded the sound of the asteroid falling on the table! It is another great story of participatory science, because it meant we could inform this local resident about the event and acquire the meteorite."

**Will stool donations soon shed light on the secrets of the microbiota?**

The health sector is no exception to the boom in participatory research. While some citizens are keeping an eye on cosmic rocks, others are opening up an unprecedented window to scientists onto the billions of micro-organisms that inhabit our gut. Le French Gut is the name of the initiative launched by the MetaGenoPolis unit (MGP - Univ. Paris-Saclay/INRAE), in collaboration with Greater Paris University Hospitals (AP-HP), to accelerate research into gut microbiota. The aim is, by 2027, to recruit no fewer than 100,000 volunteers who are willing to donate a stool sample. "We're looking for individuals of any age, anywhere in France, in good health or otherwise," explains Anne-Sophie Alvarez, communications manager for the project.

Le French Gut is part of a large-scale international initiative, the "Million Microbiome of Humans Project" (MMHP), which aims to build the world's largest database of human microbiota, with a million samples from the gut, skin and mouth. "I have been working on gut microbiota for 40 years and have seen the field evolve considerably," enthuses Joël Doré, Scientific Director of MetaGenoPolis and Le French Gut project, and a researcher at the Micalis Institute (Univ. Paris-Saclay/INRAE/AgroParisTech). "We have gone from studies on a few dozen subjects to studies on a few hundred and then a few thousand individuals. But it is obvious that this is not enough. We really need a very large number of people, in order to characterise the microbiota of the human population and identify its specificities in health or disease."

Characterise the microbiota, i.e. better understand its composition. This is one of the initiative's research orientations. We now know that the composition of the intestinal microbiota varies significantly from one individual to another. Research has also made it possible to establish links between the microbiota and certain chronic diseases such as diabetes, obesity, cancer and inflammatory bowel disease. But what actually is a healthy microbiota? "We want to build up a reference of microbiota for the French population, related to both healthy and sick individuals," explains the



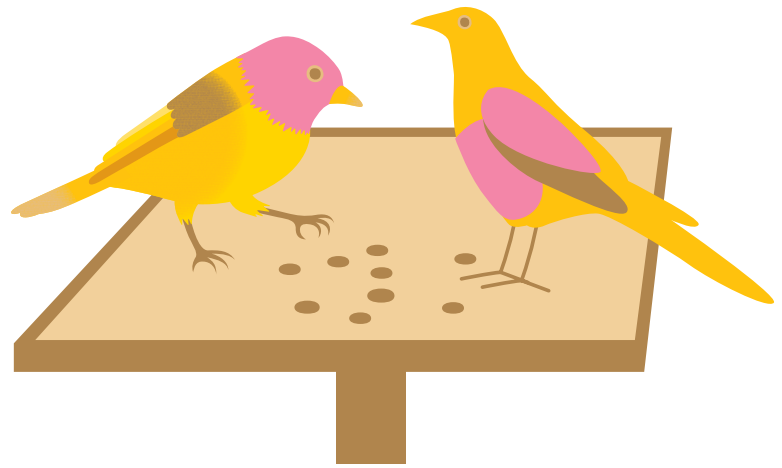
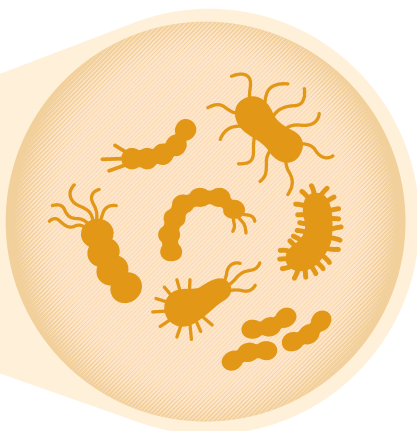
researcher. "We also hope to better understand how dietary habits, lifestyles and exposure to certain environmental factors can influence the microbiota. Finally, we want to take our research into the links between the microbiota and the most common chronic diseases a step further."

Following a pilot phase launched in 2022, Le French Gut is shifting up a gear, with a target of 100,000 donations. To join the cohort, volunteers have to register online on the project's website and fill in a 20-minute questionnaire on their state of health, diet and so on. "This data is crucial, because it will be cross-referenced with the respondents' microbiota," explains Anne-Sophie Alvarez. A kit is then sent to their home to collect stool samples, which are then returned by post. "It is a simple swab, we don't really need much."

All the samples are then verified and anonymised before being sent to MetaGenoPolis for analysis. From the samples, "we extract and sequence the DNA to determine the microbial genomes present," explains Joël Doré. "We have worked intensively on the logistics for collecting the samples, because the target of 100,000 is crucial." The prospects of the project are just as important. "The biggest potential imaginable is predicting diseases. Thanks to the health data to which we have access, we will be able to track individuals for at least 20 years. If some of them develop diseases, we can go back to the samples and try to identify predictive signatures in the microbiota."

Collecting a stool sample can be a daunting experience. And yet, Le French Gut had no problems recruiting the 3,000 volunteers for the pilot phase, who were brought together in just one week. "We were slightly surprised by the public's response," admits Joël Doré. But "the general public is increasingly aware of the microbiota issue," assures Anne-Sophie Alvarez. The samples from this pilot phase are currently being analysed.

## MICROBIOTA IN THE GUT



## A serious game to mimic birds at feeders

Playing games to advance research. This other form of citizen science is proving its worth with the BirdLab project, launched in 2014 by Carmen Bessa-Gomes and François Chiron, lecturers at the Ecology, Systematics and Evolution laboratory (ESE - Univ. Paris-Saclay/CNRS/AgroParisTech), in collaboration with Vigie-nature and the National Museum of Natural History (MNHN). With this initiative, citizens are invited to witness the behaviour of birds at feeders in winter through a serious game which is available on the BirdLab mobile app.

You don't need to be an expert in ornithology to take part, or even be familiar with the 29 species featured in the game, selected from among the most common species. Volunteers simply stand in front of two identical feeders in a garden, balcony or public place, which is filled with seeds or fat balls, and watch the birds land on them. Once the game is launched, "each game lasts five minutes, during which players replicate the movements of the birds in real time, selecting the species that are there and moving them to the feeders," explains François Chiron.

It is a fun activity for the volunteers, but above all extremely instructive for the ecologists. "The aim is to study the recruitment dynamics of species at feeders and the interactions between them." Are some species avoided by others because they are more competitive? On the other hand, do some of them facilitate the arrival of other bird species that are more followers or even pilferers? And are these same behaviours observable between individuals of the same species? These are the questions the BirdLab team intends to answer using the data it has collected. "We are also trying to understand how these clustering or avoidance behaviours vary according to the environment, weather conditions, landscape, etc." adds François Chiron.

During the observation campaigns, which take place every year from mid-November to mid-March, each participant plays as many games as they wish. Ten years after the game was launched, there have been almost 100,000 games, and millions of interactions observed between the birds. Thanks to this project, "we have obtained much more data than with a conventional study based on scientists' observations." But the participative aspect

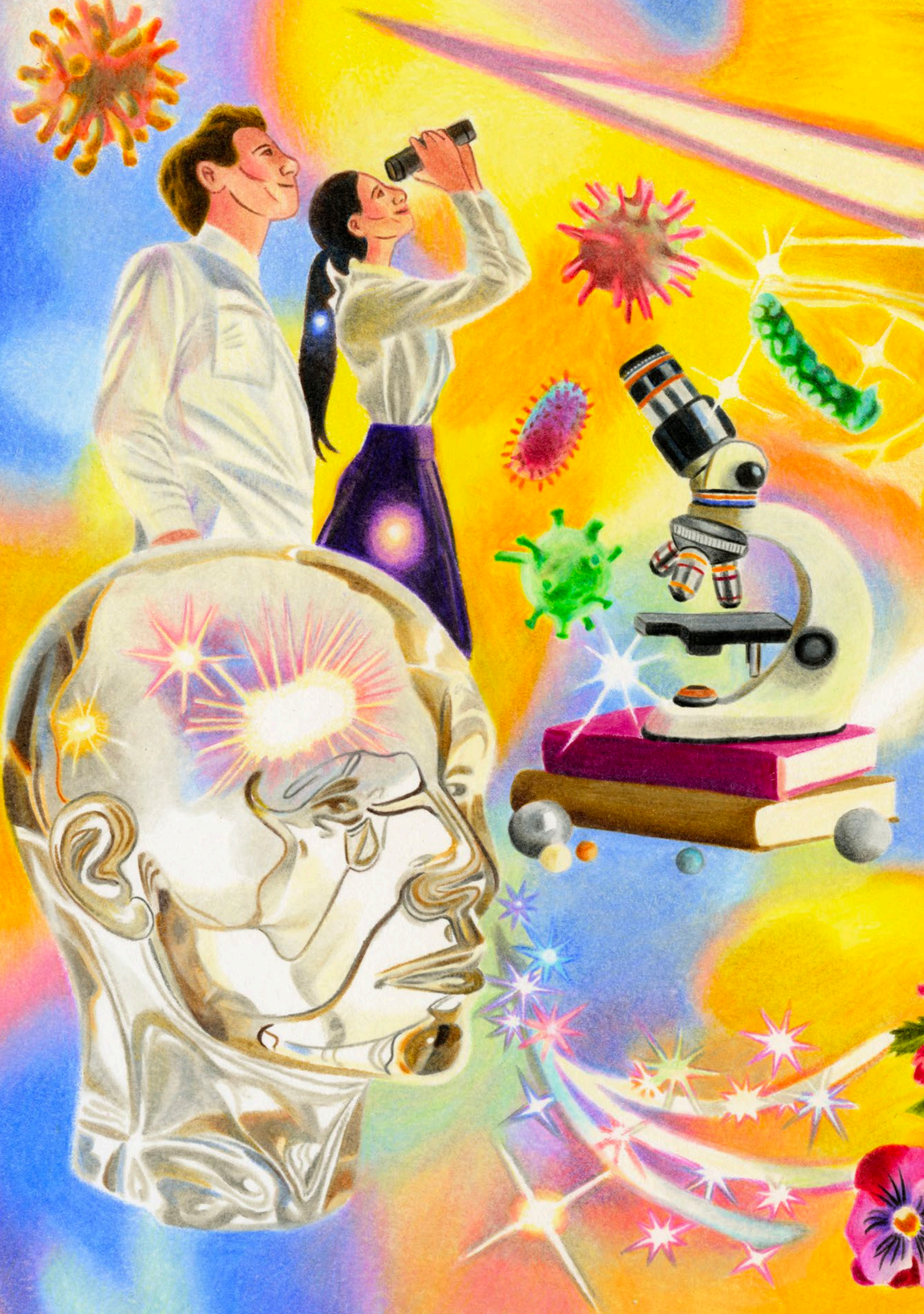
doesn't stop there. "In ecology, the questions we ask are based on observations. That's why it is crucial that we develop the experiment in line with the actual observations and questions of the players," notes François Chiron.

This is how, for example, the ring-necked parakeet became a BirdLab species. "People were worried about its presence at feeders, particularly in the Paris region, and wondered whether they should be prevented from feeding there." This surveying and the data collected with the game led to initial results on the subject in 2020. The verdict: although perceived as invasive, the parakeet is no more competitive at the feeder than other species of a similar size, such as the collared dove or the magpie. While these results may challenge the conventional wisdom, the data generated by BirdLab confirm certain behavioural traits already well known in other birds, such as the solitary nature of the robin or the aggressive tendencies of the blue tit.

Whether it is beans, meteors or birds, keeping these projects going over the long term is no easy task, especially when they involve tools such as mobile apps or cameras that require technical maintenance. "That was the main difficulty we encountered," admits François Chiron. On top of that, there is the need to keep the programmes interesting to recruit new volunteers for each campaign. For the ecologist François Chiron, the stakes of these projects go beyond gathering data: "What I find great is the impact of our work on nature conservation. With citizen science, people observe, learn and develop a certain empathy for birds. Various studies have shown that observing nature also has benefits for individuals' health and well-being. I think we underestimate the indirect positive effects of this kind of work."

## References

- <https://www.pulsesincrease.eu/experiment>
- [www.vigie-ciel.org](http://www.vigie-ciel.org)
- <https://lefrenchgut.fr/the-french-gut-project/>
- [www.birdlab.fr](http://www.birdlab.fr)





# Transatlantic Cultures

## A window onto the cultural history of the transatlantic space

The *Transatlantic Cultures* (TRACS) programme analyses how intellectual, literary and artistic works have circulated between Europe, Africa and the Americas since the 18th century. To disseminate its reflections, the programme has designed a digital platform offering articles in four languages on a range of themes, opening a window onto the cultural history of the transatlantic space.

Did you know that the first photo-novel in history was published in Italy in 1947? And that the genre then spread to the rest of Europe followed by Latin America, becoming one of the most popular media formats of the time? These are the findings of an article by Jan Baetens, Professor of Literary and Cultural Studies at the University of Leuven in Belgium, published on the *Transatlantic Cultures* platform.



The Italian photo-novel « *Amarti e dirte addio* », Grand Hôtel, 1950 (no. 228, p. 5). Source : Private collection

The example of the photo-novel may make you smile. Yet it delivers a remarkable example of the *Transatlantic Cultures* (TRACS) programme launched in 2015 by the Centre for Cultural History of Contemporary Societies (CHCSC – Univ. Paris-Saclay/UVSQ), in collaboration with the Institute of Latin American Studies (IHEAL) at Université Sorbonne Nouvelle and the University of São Paulo in Brazil. This research project aims to analyse how intellectual, literary and artistic works have circulated between Europe, Africa and the Americas from the end of the 18th century to the present day, and understand their contribution to the more general process of globalisation in its economic, social and political dimensions.

### "International research project" label

TRACS, which brings together an international, transdisciplinary team, is still going strong nearly nine years after its launch, says Anaïs Fléchet, lecturer at CHCSC and project leader. "Our project has been awarded the 'International research project' label by CNRS for the period 2024-2028. This is directly in line with the international partnerships we had already

established, notably with the University of São Paulo." Last September, CNRS launched a new International Research Laboratory with the Brazilian university. "We are the first certified human and social sciences project to be integrated into this laboratory," explains Anaïs Fléchet.

"This new stage will enable us to continue to carry out research into our themes, and also to pursue our project to disseminate knowledge," continues the lecturer. This is where the TRACS digital platform, which went live in 2021, comes in. It currently contains around 140 articles written by over forty researchers from three continents, specialising in a wide range of disciplines. "We cover a wide range of themes, from the performing arts to literature, sport and cultural diplomacy. We also have collections dedicated to other research programmes, such as the Americanisation through the Arts project." Supported by MSH Paris-Saclay and Princeton University, this programme looks more specifically at the processes of artistic appropriation between the United States and France since the end of the 19th century. The platform's collection features jazz, American photography and the films of Jacques Tati.

### A platform in four languages

"The way our platform works is similar to that of a magazine: the themes are coordinated by one or two members of our editorial board, who act as contacts and links for the authors. The articles are then revised and edited. We also put a lot of effort into translation," explains Anaïs Fléchet. The platform is available in four languages - English, French, Spanish and Portuguese. Most articles are currently available in the original language of the author and in English translation. "We have indicators that tell us our articles are read in different parts of the world, not just Europe. So we want to make the articles accessible to as many people as possible. Particularly as not all our readers are from the academic world."

The proof can be seen in the platform's most-read article, an essay dedicated to the Brazilian footballer Pelé, written by Clément Astruc, a researcher at the Université Sorbonne Nouvelle's IHEAL, which saw its consultations soar after the sportsman's death in December 2022. "Our aim is not to keep up with current events but to deal with issues that are still of cultural importance today. This article is a very good example of this," assures the lecturer. "Our project has a public history dimension. Our work aims to show that these cultural exchanges have shaped the Atlantic area, and

also respond to current issues. Through the site, we are trying to offer a form of deconstruction, cross-referencing points of view as much as possible and returning to the major themes that run through our contemporary society."

### A new seminar season for 2024-2025

The platform echoes the seminar programme organised every year as part of TRACS. In 2023-2024, eight seminars took place at the National Institute for Art History (INHA) in Paris, on subjects as diverse as novels and thrillers, radio creations and indigenous cultures in museum policies. "This is one of the signs of the project's success. We are now attracting more and more researchers, both to take part in seminars and to write articles for our platform," notes Anaïs Fléchet.

And the TRACS team is determined to keep the momentum going. The editorial committee met this summer in São Paulo, and the 2024 - 2025 seminar season kicked off at the beginning of October. At the same time, "we are also working to enrich the platform with new tools such as an interactive timeline and a media wall. A new version is due to go online next autumn."

<https://transatlantic-cultures.org/en/index>

# International student mobility

## How to go abroad while studying medicine

On 7 November, the Faculty of Medicine of Université Paris-Saclay will hold its annual International Student Mobility Day (in French, JMIE), an event designed to showcase the mobility opportunities available to its students. It is also an opportunity for those who left during the previous year to share their experiences.



© Jane Brégier-John

Every autumn, the Faculty of Medicine of Université Paris-Saclay organises a competition like no other: a poster competition whose objective is to encourage students who have taken part in an international mobility programme during the previous year to share their experiences. "We ask all outgoing students to produce a vibrant, illustrated poster that describes their mobility," explains Jane Brégier-John, Administrative Manager of the Faculty's International and European Relations department. All the posters are displayed during the International Student Mobility Day (in French, JMIE) organised by the Faculty at Kremlin-Bicêtre. On the evening of the event, each person must give a five-minute presentation of their poster to a panel of professors specially set up for the occasion. "Prizes are then awarded to the best poster. The idea is really to make it a friendly event. Last year, we added a People's Choice Prize to the three existing prizes, and it was a great success, with over 2,500 votes cast!"

Thirty-seven students from the Faculty of Medicine embarked on the adventure of international mobility in the 2023 - 2024 academic year. But to take the plunge, students need to be well-informed about the possibilities available during their mobility. This is the aim of the JMIE, the next edition of which will take place on 7 November 2024. In addition to the poster competition, the event programme includes a number of presentations on the different schemes available for international mobility. Due to the new medical curriculum and the latest reforms, "students cannot leave whenever they want," says Jane Brégier-John. "Mobility is only possible at certain times in the curriculum."

### Internship opportunities abroad from the Master's programme onwards

↓ The first of these periods is in the 3rd year of the Diploma in Medical Sciences (DFGSM3), which corresponds to the 1st cycle of the curriculum. At this stage, "it is possible to study for two semesters at a partner university", explains the manager. Last year, four of the 37 outgoing students took the plunge. The second opportunity comes in the 1st, 2nd or 3rd year of the Advanced Diploma in Medical Sciences (DFASM), which corresponds to the 2nd cycle of the curriculum. During this period, candidates can take part in a six-week internship abroad, at different times between January and September. "At the Faculty of Medicine of Université Paris-Saclay, we are very lucky to be able to offer two internship mobility campaigns a year, because we have a special format. The curriculum rotates between six weeks of courses and six weeks of internship, which means that students can go abroad without having to wait for the programme to end, as it is the case in other faculties where the rhythm is half-days of internship and courses," explains Jane Brégier-John. "Thanks to this format, we have almost doubled the number of outgoing students. Before 2020, we were averaging 15 to 20 a year."

There are a lot of possible destinations thanks to the different agreements signed by Université Paris-Saclay. The ERASMUS + programme, for example, offers study and internship opportunities in over 20 universities across Europe, including Spain, Germany, Italy and Portugal. The list also includes partner universities and members of the EUGLOH (European University

Alliance for Global Health), such as Lund University in Sweden. "Over the past three years, we have also done a great deal of groundwork on international agreements. In 2020, we had very few partners outside Europe, maybe two or three. We now have around 20, many of which are English-speaking, such as the universities of Cork and Dublin in Ireland. And we are still growing," says the manager. Since 2010, an exchange programme with American universities via the Inter-university Coordination Mission for Franco-American Exchanges (MICEFA) has also been running. Last year, MICEFA led to two students attending New York's Albert Einstein College of Medicine. "Students can also find their own internships. As long as it is a university hospital, there is no problem. We are here to support them."

### International mobility: how it works

↓ Mobility is a significant step regardless of the chosen period or destination. "You really cannot start to plan it the day before. It requires at least four to six months of preparation," warns Jane Brégier-John. It is also important to keep to the set schedules. For the ERASMUS+ programme in particular, applications are accepted from October to March. This is followed by the selection and nomination phases at the partner universities. "From April, students have to prepare their study plan, which requires a lot of work. This is where we help students a lot." The process can be even more tiresome outside ERASMUS+. "Some partners have so many requests that it can take a long time. There are also other factors to consider, such as safety aspects. So we do a lot of support work." But that is not enough to discourage candidates. Especially as it is often well worth the effort.

In 2023, Lucie Garay, then a 2nd-year DFASM student, spent six weeks at Léonard de Vinci hospital in Montigny-Le-Tilleul, Belgium, on a palliative care internship. "It was an extraordinary experience. During my internship, I met a caring team that was very attentive to patients' needs. This experience in a different hospital environment taught me a lot about the meaning of care," she confides. "So, if you are interested in doing an internship abroad, go for it! It opens up incredible perspectives" she adds.

<https://www.medicine.universite-paris-saclay.fr/node/176653>

# OMEGA

## A new aquatic centre for taking the plunge

The OMEGA aquatic centre has opened on the Moulon plateau in Gif-sur-Yvette after two years of work. Built on Université Paris-Saclay land, in collaboration with the municipality of Gif-sur-Yvette and the Établissement public d'aménagement Paris-Saclay (EPA - Public Development Institution), this 4,000-square-metre complex is designed to be a driving force for sporting activities, as well as a wellness area open to all, including university communities.

There are over a thousand square metres of water, divided between twelve to fourteen swimming lanes, a leisure pool with massage jets and a flowing river, a water playground and more. The list is enough to make you want to jump straight in! This has been possible since 1st October at the OMEGA aquatic centre on the Moulon plateau in Gif-sur-Yvette. The complex opened to visitors after two years of work, unveiling its many facilities dedicated to swimming, relaxation and fitness.

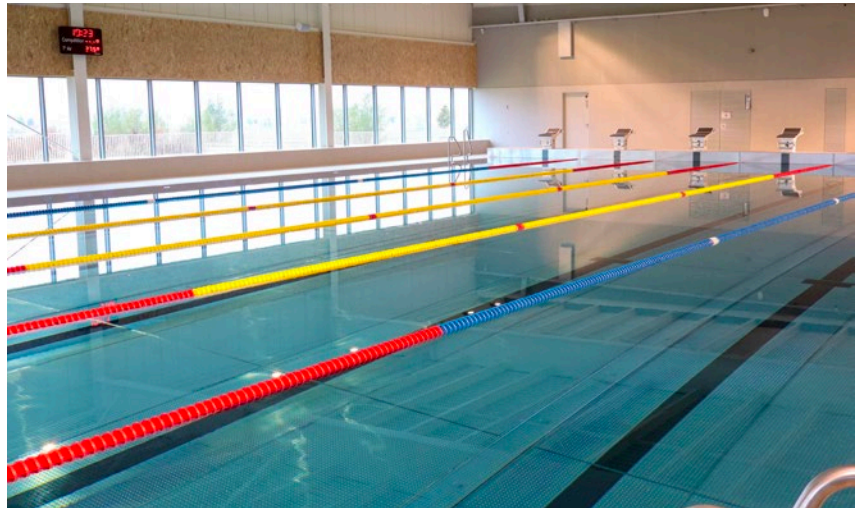
"The opening of OMEGA is very important for our town and for the Moulon district as a whole. Gif-sur-Yvette has not had a dedicated swimming facility for 22 years," says a delighted Yann Cauchetier, the town's Mayor. At a cost of 22.6 million euros, this extensive project was built on land belonging to Université Paris-Saclay, in collaboration with the municipality of Gif-sur-Yvette and the Établissement public d'aménagement Paris-Saclay (EPA - Public Development Institution). "This project has been designed to meet the needs of local residents and support the life of the rapidly expanding Université Paris-Saclay campus," continues the Mayor.

### A pool open primarily to university communities

The brand-new 4,150-square-metre complex sets the tone as soon as you enter. Large picture windows offer a breathtaking view of the aquatic area, which includes two 25-metre sports pools and a whirlpool. The OMEGA centre was designed to be "as flexible and multi-purpose as possible," in order to accommodate different practices, explains Cécilia Gross, architect with the VenhoevenCS agency involved in the project, who also co-designed the Saint-Denis Olympic Aquatic Centre.

Each pool has its own practices and its own target group. The 1.8-metre-deep competition pool, located in a separate hall, is open primarily to university public. 13,800 hours of swimming lanes per year are already reserved for the training needs of Université Paris-Saclay students, as well as for campus life. The University Service for Physical and Sports Activities (SUAPS) offers no fewer than 17 swimming slots, from Monday to Friday, for all levels.

The second sports pool, located in the main hall and varying in depth from 1.30 to 1.80 metre, is open to all swimmers, from learn-to-swim and line swimming to water sports. Lastly, the 31°C-heated whirlpool is ideal for families, as well as for bathers in



© Emeline Féraud

search of relaxation. These facilities are complemented by a paddling pool for younger children and an outdoor water play area, integrated into a plant-filled solarium, for the ultimate summer experience.

### Swimming, wellness and fitness

The OMEGA aquatic centre is open seven days a week and promises its visitors more than just swimming; it includes two additional areas: one dedicated to well-being and the other to fitness.

A path close to the whirlpool leads visitors to a succession of facilities for relaxation and rejuvenation: a steam room, saunas, sensory showers, a Zen terrace, a salt room and an ice room. From very hot to very cold, there is something for everyone. The fitness area features a complete cardio-training space, a room for group classes and an indoor cycling (or RPM) room.

With these facilities, "we want to increase the opportunities to play sport" at the aquatic centre, stresses Guillaume Mortelier, Managing Director of Récréa, a company specialising in the construction and management of sports and leisure facilities. The wellness and fitness areas are also open seven days a week and have special admission and membership fees. There are reduced rates for the aquatic area for residents of Gif-sur-Yvette and students.

### Geothermal energy to heat the aquatic centre

In addition to its multi-purpose facilities, the OMEGA complex features a number of special design features. One of these quickly catches the eye of swimmers

venturing into the pools. There is no tiling like in traditional pools. The pools are made of pure stainless steel, a material chosen for its durability, strength and low maintenance requirements, according to the project designers.

Particular attention was also paid to the complex's energy consumption. A process is in place to recover and reuse the heat generated by the air and wastewater treatment systems for showers, pools and footbaths. The aquatic centre is also connected to the heating and cooling exchange network installed on the Paris-Saclay urban campus. Commissioned in 2019, this network is supplied by geothermal energy via wells dug into the Albien underground water table.

A new source will heat OMEGA's water from 2026. The heating and cooling exchange network will integrate the SOLEIL Synchrotron located in Saint-Aubin following the signing of a partnership agreement in April 2024. The potential heat recovered from the research centre's particle accelerator is estimated at almost 6,500 MWh/year, equivalent to the annual consumption of the aquatic centre and over a thousand new homes in the Moulon district, according to SOLEIL and EPA Paris-Saclay.

<https://omegagif.fr/>

# Libraries

## At the intersection of research and student life

The network of libraries at Université Paris-Saclay sets itself apart through its diversity and its constant ability to evolve to meet the needs of the university community. Continuously developing, this network is built around both university and research libraries, maintaining a strong connection between these structures.



© Christophe Peus

Libraries are far more dynamic than their neatly arranged shelves suggest. Their staff closely observe and regularly adjust the operation and organisation of spaces to cater to the changing demands and varied profiles of their users. In 2023, over a million students, academics, researchers and entrepreneurs visited Université Paris-Saclay's network of libraries.

"All the libraries are designed to accommodate the variety of uses observed and the diverse audiences they welcome," explains Émilie Barthet, director of the Department of Libraries, Information and Open Science (DiBISO) at Université Paris-Saclay. This department oversees the definition and implementation of the university's documentary and open science policies, coordinating between the documentary and cultural facilities of Université Paris-Saclay, CentraleSupélec and ENS Paris-Saclay.

### University libraries, the most important service for student life

"The 2023 national survey by the Observatory of Student Life showed that 85% of students consider university libraries to be the most important service for student life,"

says Émilie Barthet. Université Paris-Saclay has four university libraries (UL): the Orsay library on the Vallée campus, the Sceaux library on the campus of the Jean Monnet Faculty, the Kremlin-Bicêtre library and the Lumen on the Moulon plateau.

For several years, DiBISO has been conducting user experience surveys and observations, leading to the regular introduction of new services to facilitate the multiple uses of the libraries. At the Sceaux library, this has resulted in the addition of five rooms for group work and play. At the Kremlin-Bicêtre library, renovations are underway to increase seating capacity. The Orsay library has redesigned its foyer to include leisure collections, relaxation areas and a welcome desk for international students.

Another symbol of the revival of libraries and a true hub of campus life at Gif-sur-Yvette campus, Lumen was designed to host not only the activities and services of a university library, but also, more broadly, activities and services for teaching and research, culture, scientific outreach and innovation. It also houses the first publicly accessible materials library.

### Libraries supporting research

Alongside the university libraries and Lumen, the research libraries within the Université Paris-Saclay network are also undergoing constant change, offering new services to meet the needs of their users. Some research libraries at Université Paris-Saclay have gained a reputation for excellence across the entire scientific community by offering high-quality collections in certain disciplines, such as mathematics and law. These libraries provide documentary services and methodological support, primarily aimed at researchers, but from which master's and PhD students can also benefit.

"The goal is to offer services that are timely and relevant, by anticipating the needs of researchers and advanced students, always with a view to being useful to them and facilitating their research activities," explains Angélique Malec, coordinator of Université Paris-Saclay's associated libraries and manager of the research library at Jean Monnet Faculty in Sceaux. "In particular, we offer services tailored to their disciplines," such as digitisation and online access to heritage collections and scientific archives.

### "Research advisors" to support researchers

The challenge for these libraries, which are often affiliated with one or more research laboratories, is to maintain lasting relationships with research staff, acting as a direct link to DiBISO. "I like to say that we are 'permanently based in the laboratories', as our close proximity to researchers helps us to stay connected with the reality on the ground. This intermediary role enables us to act as a gateway, conveying their needs to DiBISO," adds Angélique Malec.

The network of university and research libraries has developed the role of "research advisors", who are responsible for assisting researchers in submitting their publications to the HAL platform and managing their data in line with the university's open science policy.

University and research libraries also provide students with the opportunity to train in documentary research and electronic resources and receive methodological assistance for writing their dissertations.



© Christophe Peus

## Campus life

### Numaclay, a digital library of exceptional works

↓ The research libraries sometimes house exceptional works, such as the library of the Law and Religious Societies (DSR) research centre in Sceaux. In 2009, this centre acquired a legal history collection from the library of legal scholar Gabriel Le Bras, containing a treasure trove of around one hundred 16th-century works, including some very rare volumes.



Heritage work from the library of the Law and Religious Societies research centre © Salaheddine Karmous

The work carried out on this heritage collection led to the creation of an iconic project in 2016: the "Yvette" digital library, a collaboration between DSR centre researchers, research library staff and Sceaux UL staff. During the project's first phase, no fewer than 30,000 pages of books, including those acquired by the DSR centre, were digitised. Yvette has since been integrated into the Numaclay digital library, along with several other collections. "This is a great example of what can be achieved through a partnership between a research library, researchers and a university library," says Angélique Malec, who was involved in the project. Such initiatives "also help research centres to raise their profile through documentary collections beyond their usual scientific circles."

While libraries remain places of "resources", they are no longer limited to documentary services, conservation and the lending of physical books. They are evolving to meet the new needs of their users, remaining spaces for both work and research, but also for relaxation and student life.

<https://www.universite-paris-saclay.fr/en/bibliotheques-universitaires-bu/>

<https://numaclay.universite-paris-saclay.fr>



# Spotlight

## The Orsay University Library

**Founded in 1962, the Orsay University Library (UL) is located at the heart of Université Paris-Saclay's Vallée campus. This library initially focused on life sciences due to its proximity to the Orsay Faculty of Sciences. This led the Maison de la Chimie (Chemistry House) to gift some of its collections to enhance the collections of this fledgling library.**

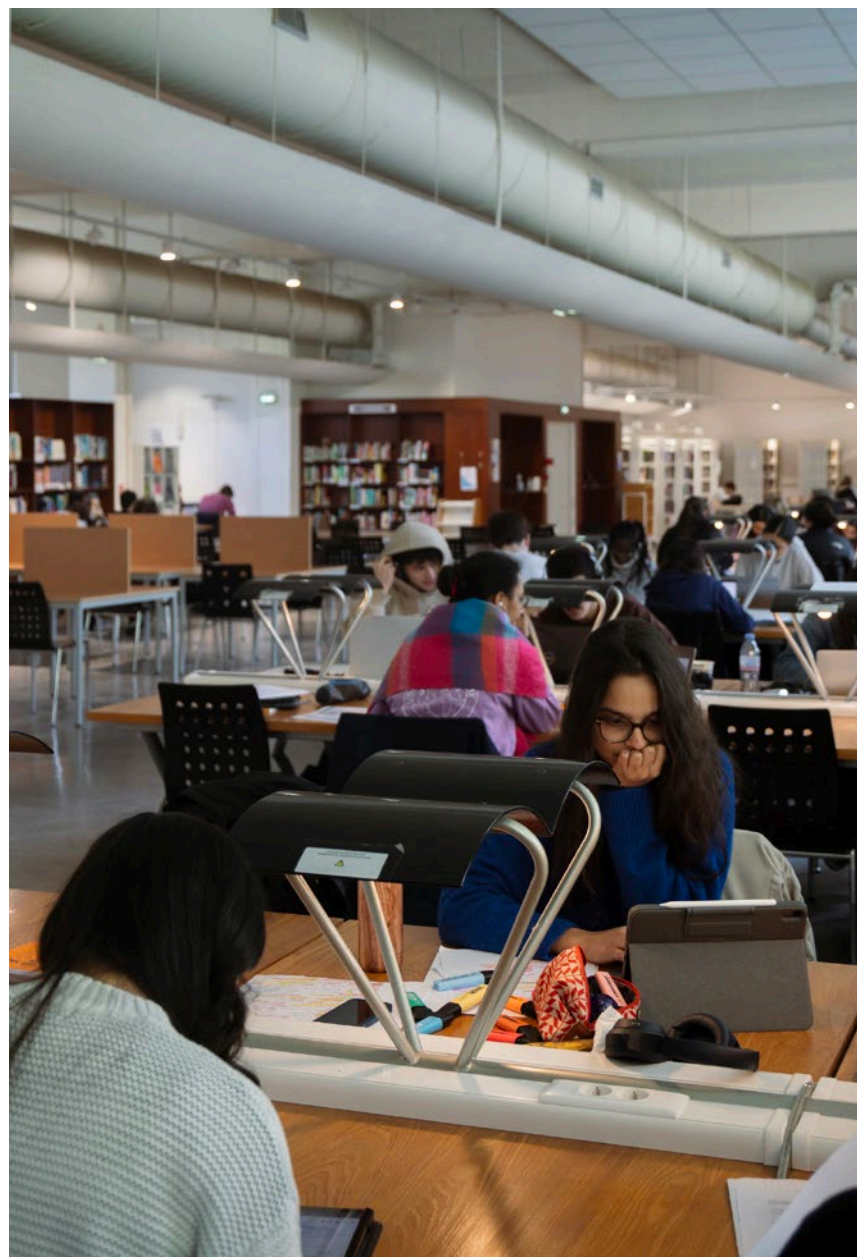
Like the rest of the university campus, the role of the Orsay UL has evolved significantly and it now welcomes 300,000 visitors annually. At a time when digital resources are consulted fifty times more often than printed documents, the Orsay UL has expanded its scientific information and mediation mission. Claire Lemauff, library manager, explains: "We play a key role, particularly for undergraduate students, who often have their first experience with documentary research here. We help them learn how to make the most of the library's resources, spaces and working methods."

### Exhibitions and equipment loans to diversify services

↓ Along with the entire library network, the Orsay UL continues to diversify. While it still offers print and

digital resources, its spaces are increasingly used by students to work or relax, alone or in groups, without necessarily consulting or borrowing materials. "We are fully aware of the changing needs and uses of the libraries by students," says Claire Lemauff. "For instance, we host exhibitions, often themed, organised by student associations and provide services regularly requested by the community, such as the loan of headphones, atomic or anatomical models. Last year, we recorded over 3,500 computer loans."

In addition to facilitating access to specialised tools, the university library has created a relaxation area where students can read mangas and comic books, further enhancing the library's appeal and the range of facilities on offer.



© Christophe Peus

# Calendar

Autumn 2024 / Winter 2025

We were there

## OCTOBER

📍 Campuses of Versailles, Évry, Orsay, Bures-sur-Yvette and Gif-sur-Yvette  
🏠 Université Paris-Saclay

4 → 14 october



**Event**

### Science Festival

As it is every year, the Université Paris-Saclay Science Festival was packed with participants ready to meet the scientific community and discover the world of research in a fun way. From the health of the ocean to antibiotic resistance, from superconductivity to the power of smell, young and old alike were able to try their hand at a wide range of sciences, free of charge, through workshops, laboratory visits, exhibitions and scientific games.  
<https://www.universite-paris-saclay.fr/en/fete-de-la-science-du-4-au-14-octobre-2024-initiez-vous-a-la-recherche/>

📍 Carrousel du Louvre, Paris  
🏠 Cosmetic Valley

16 → 17 october



**Innovation**

### Cosmetic 360

Université Paris-Saclay took part in Cosmetic 360, an international event highlighting the latest technological advances, emerging trends and innovations in the cosmetics and perfumery industry. It had a stand to present the research carried out by Université's scientific teams, as well as the cutting-edge expertise in this field within its ecosystem.  
<https://www.cosmetic-360.com/fr>

Not to be missed

## NOVEMBER

📍 Mainly online  
🏠 Université Paris-Saclay

4 → 8 november



**Event**

### Open Science Week

This international event, in which Université Paris-Saclay participates every year, aims to promote open science initiatives and access to the results of scientific research. This year, the university

has put together a programme of webinars, roundtables and conferences, mainly online, to highlight practices and challenges in various disciplines, including the human and social sciences, astrophysics, bioinformatics and epidemiology.  
<https://osw2024.sciencesconf.org/>

📍 La Scène de recherche, Gif-sur-Yvette  
🏠 La Scène de recherche – ENS Paris-Saclay

12 november



**Theatre**

### L'excentrique, impromptu scientifique

(The eccentric, scientific impromptu)

Have you heard of *Trichoplax adhaerens*? Considered the simplest form of multicellular animal, this astonishing and enigmatic being, which intrigues biologists, takes on the lead role in an unusual show in the form of a scientific investigation led by actor Guillaume Mika and biologist Andrea Pasini from Université Aix-Marseille.  
<https://ens-paris-saclay.fr/agenda/lexcentrique-impromptu-scientifique>

📍 Jean Monnet Faculty, Sceaux  
🏠 Institute of Public Law Studies (IEDP), Jean Monnet Faculty, Maison des sciences de l'homme (MSH) Paris-Saclay

20 november

**Conference**

### Soil erosion

This conference is the third in a series of five conferences organised by the Jean Monnet Faculty's Institute of Public Law Studies (IEDP) on the theme of "New fields of research in environmental law" through the prism of soil. In the presence of a river geographer and a professor of public law, it proposes a discussion on soil erosion and the actions taken to deal with this phenomenon.

<https://msh-paris-saclay.fr/nouveaux-champs-de-recherche-en-droit-de-lenvironnement-le-20-novembre-2024/>

📍 Henri Moissan building, Université Paris-Saclay  
🏠 CMQE Sustainable Energy, Université Paris-Saclay

28 november



**Education**

### CMQE Sustainable Energy kick-off

A few months after its official certification, the Campus of Professions and Qualifications of Excellence (CMQE in French) Sustainable Energy, supported by Université Paris-Saclay, is holding a launch event to present its objectives and actions for meeting companies' needs in terms of professions and skills in the energy transition sector in the Paris Region.

📍 Place 🏠 Host

## JANUARY

📍 Henri Moissan building, Gif-sur-Yvette  
🏠 Université Paris-Saclay University Innovation Cluster (PUI), Bpifrance

30 january



**Innovation**

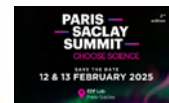
### Deeptech Tour

For the first time, the Deeptech Tour, organised by Bpifrance and the French government, is stopping off at the campus of Université Paris-Saclay, home of the Université Paris-Saclay University Innovation Cluster (PUI in French). The programme includes testimonials from start-ups and their support structures, meetings with entrepreneurs and a start-up village to celebrate the region's collective dynamic, facilitate exchanges and increase the visibility of start-ups and the ecosystem's support structures.

## FEBRUARY

📍 EDF Lab Paris-Saclay, Palaiseau  
🏠 Paris Saclay urban community, Le Point, Île-de-France Region, Essonne department, Impulse Partners, Université Paris-Saclay

12 → 13 february



**Festival**

### Paris-Saclay Summit – Choose Science

Following the success of its first edition, the Paris-Saclay Summit – Choose Science Festival is back for another two days, designed to put science at the heart of society. More than 50 conferences and debates with scientists, including experts from Université Paris-Saclay, inventors, citizens, politicians, students and entrepreneurs, will be on the programme for this second event, which will address key topics such as health, energy, artificial intelligence and the ecological transition.

# Reading highlights

Autumn 2024

The Conversation

## Why every island's wildlife ends up looking alike

On a global scale, there are currently no less than 37,000 non-native species, in other words species that have one day been moved from their original environment to another. Human activities are a key vector in this introduction, particularly on islands. But why are some islands home to more non-native species than others? This is what an international team of researchers, including Céline Bellard and Clara Marino from the Ecology, Systematics and Evolution laboratory (ESE - Univ. Paris-Saclay/CNRS/AgroParisTech), is trying to understand, using the example of birds found on the world's islands.

<https://theconversation.com/why-every-islands-wildlife-ends-up-looking-alike-236731>

## 3D imaging revolutionises archaeological research into "mineralised" textiles

In archaeology, textiles are potential sources of information about ancient civilisations that have left few traces. However, as well as being rare, these remains are also very fragile and therefore difficult to study. Thanks to 3D imaging techniques, a new way of analysing archaeological textiles has opened up. Loïc Bertrand and Clémence Iacconi, respectively research director and PhD student at the Supramolecular and Macromolecular Photophysics and Photochemistry laboratory (PPSM - Univ. Paris-Saclay/ENS Paris-Saclay/CNRS), explain how their team of scientists succeeded in revealing the secrets of a textile set from a Celtic burial site from the Iron Age.

<https://theconversation.com/l'imagerie-3d-revolutionne-la-recherche-archeologique-sur-les-textiles-fossilises-234428>  
(In french)

Members of the editorial committee who contributed to this issue:

**Chloé Aubisse, Émilie Autin, Julie Bernede, Juliette Berny, Reine Bou Fadel, Aude Brianto-Escande, Julie Dugast, Christine Duvaux-Ponter, Claire Fournio, Annelise Gounon-Pesquet, Gaëlle Giraudier, Alexandre Henry, Laurence Hoffmann, Richard Kruel, Véronique Marracci, Cécile Oriot, Lucie Peinturier, Cécile Pérol, Bertrand Poumellec, Tiina Suomijarvi, Virginie Tallio, Marjorie Tarjon, Nabil Touili**

Publishing editor: **Camille Galap**

Managing editor: **Karine Wecker**

Editor-in-chief: **Véronique Meder**

Deputy Editor-in-chief: **Émeline Férard**

Editors: **Cindy Augusto Dos Santos, Jeanne Bourdier, Eva Desvigne-Hansch, Antoine Duval, Émeline Férard, Robin Locatelli, Véronique Meder, Nicolas Sebe**

Art direction: **Atelier Corbin/Corpus**

Illustration: **Laura Ottone**

Printing: **STIPA**

ISSN 2679-4845 (print) - ISSN 2777 4007 (online)

Legal deposit at publication

# The area map

of Université Paris-Saclay



## Faculties

- 1 Jean Monnet Faculty
- 2 Faculty of Medicine
- 3 Faculty of Pharmacy
- 4 Orsay Faculty of Sciences
- 5 Faculty of Sport Sciences

## Technical Institute (IUT)

- 6 Cachan IUT
- 7 Orsay IUT
- 8 Sceaux IUT

## Grandes écoles

- 9 PolyTech Paris-Saclay
- 10 Institute for Optics Graduate School
- 11 AgroParisTech
- 12 CentraleSupélec
- 13 ENS Paris-Saclay

## Associate Institutions

- 14 Université Évry Paris-Saclay
- 15 UVSQ

## Associate National Research Organisations

- 16 French Alternative Energies and Atomic Energy Commission (CEA)
- 17 French National Centre for Scientific Research (CNRS)
- 18 Institut des Hautes Études Scientifiques (IHES)
- 19 National Research Institute for Agriculture, Food and Environment (INRAE)
- 20 French National Institute for Research in Digital Science and Technology (Inria)
- 21 French National Institute of Health and Medical Research (Inserm)
- 22 French National Aerospace Research Centre (ONERA)