Université Paris-Saclay Scientific framework

université PARIS-SACLAY

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Université
Paris-Saclay

Université Paris-Saclay

A SCIENTIFIC POWERHOUSE...

With over 8,000 academic staff and 48,000 students, Université Paris-Saclay is a major global research powerhouse and one of the leading European universities.

Created in 2020 through the merger of universities and *grandes écoles*, with the support of national research organisations,[1] Université Paris-Saclay is a comprehensive university, covering most scientific fields in the domains of humanities & social sciences, life sciences and sciences & engineering.

The Orsay campus.

Christophe Peus/Université Paris-Saclay

The university is situated south of Paris, at the heart of one of the main European research and innovation ecosystems, in the vicinity of very large scientific infrastructures (SOLEIL synchrotron, NeuroSpin human MRI imager, etc.) and research headquarters of multinational companies (Air Liquide, Danone, EDF, Horiba, Kraft, Renault, Thales...), with a thriving start-up scene.

[1] Université Paris-Saclay benefits from its strong links with national research organisations in France - CNRS, CEA, IHES, Inserm, Inria, Inrae and ONERA.

... IN A WORLD WHERE SCIENCE IS MORE IMPORTANT THAN EVER

Université Paris-Saclay was born at a moment of growing geopolitical uncertainty, major socio-economic shifts and dramatic environmental challenges.
Intimately linked to the development of technologies which offer hope, give rise to new risks and sometimes amplify problematic evolutions, the Anthropocene is accelerating momentous shifts such as human-induced climate change and loss of biodiversity. Science is expected to contribute to addressing such contemporary challenges, and is at the same time the target of increasing scrutiny and even defiance. These trends are intertwined with rising geopolitical tensions and a renewed global race for technological dominance, in which political considerations for sovereignty and security clash with the academic ideals of openness.

These deep phenomena have led to a sobering re-evaluation of the current existential risks facing humanity. They question the role of science and technology and the traditional missions of universities, and they guide the way we view our role: Université Paris-Saclay has both the potential to contribute to creating a better world and the responsibility to act.

This document sets out our scientific framework to achieve this. It defines our commitments towards Better Science and presents the seven transversal topics where we aim to increase our scientific impact.

université PARIS-SACLAY

The Lumen Learning Centre at Université Paris-Saclay.

Fernando & Sergio Guerra

18
Graduate Schools
1 institute

13,000
publications a year

More than **220**
Laboratories

13%
of French research

Nearly **50,000**
students

8,100
researchers
and academic staff

Nearly **8,500**
administrative
and technical staff

More than **50**
startups created
each year

6
incubators

More than **500**
experimentals
platforms

Leader of the EUGLOH
European university

EUGLOH

over **400**
international partners

TOP 20
in the ARWU ranking

11
Fields medals

5
Nobel Prize
winners

Nearly **200**
ERC grants

Our commitments for better science

Our commitments for better science

The pivotal role played by science within the evolution of society in the past hundred years is momentous. While it has overwhelmingly acted as a beacon of progress and a source of solutions to the challenges of everyday life (access to energy, health, food security, etc.), it has also occasionally amplified global issues. Therefore, universities have a unique responsibility not only in the advancement of knowledge but in ensuring that this shared knowledge serves society ethically and responsibly.

Furthermore, the place of universities in society extends beyond just scientific pursuits as they are live hubs of culture, education, thought and innovation, contributing to societal trajectories. As we navigate these shifting landscapes, it becomes imperative for universities to self-reflect, evolve, and reaffirm their commitment to both science and society, ensuring that their intertwined roles remain harmonious, constructive and forward-looking:

- Firstly, there is a growing awareness of the path-dependency of technological changes opened by scientific advances: science and technologies do not only offer solutions but have also been contributing in some aspects to widening social inequalities and developing the ways of life that caused the ecological crisis. This requires universities to renew their concern for the societal impact of their endeavours.

- Secondly, cases of science being enrolled by lobbyists, breaches of consent, and other unethical behaviour have created a groundswell of doubt amongst the general public. Such doubts are exacerbated by questions surrounding science's funding model but have also been instrumentalised by lobbyists fighting certain environmental and societal evolutions, also reinforcing doubts in society. In a context where science is increasingly expensive, universities must take specific care to preserve their independence and integrity as they grow more interconnected with a wide set of stakeholders.

- Finally, the role of universities in safeguarding and creating knowledge has changed dramatically due to the information revolution. Today, we need to critically assess information more than ever. Information is being shared at an unprecedented speed and scale, making it harder to ensure scientific robustness of the information, whether misinformation is intentional or not. The emergence of social media communication also restrains nuanced discussions, while the development of generative AI creates a further challenge in assessing the epistemological status of information. In short, we are living through a massive paradigm shift in terms of *access to*, *generation of* and *sharing of* knowledge, which deeply questions the role of universities.

Together these changes question the way universities fulfil their core missions of education, research, innovation and societal outreach. They drive our seven commitments for Better Science.

This aims to ensure that Université Paris-Saclay, as a crucible of curiosity-driven and fundamental research, is better integrated with our wider ecosystem by reinforcing innovation, embedding research even more strongly within our *educational programmes*, and increasing *societal outreach*.

The commitments have been chosen to better ensure our public accountability and align with societal challenges by reinforcing our involvement in open science, ethics and scientific integrity, diversity and sustainability.

RESEARCH-BASED EDUCATION

At a time when information is freely available in our pockets and many of the jobs in which our students will be employed in ten years' time do not yet exist, it is clear that our educational models must continue to evolve. That is one of the reasons why Université Paris-Saclay puts education at the core of its mission. Each year, 20,000 students and 1,200 PhDs graduate from our institution: they are our most significant and sizable impact on society. These graduates are starting new businesses, reinventing existing companies, and coming up with creative solutions to important societal challenges. Beyond full-time education, thousands of participants engage in life-long learning programmes, with a specific effort placed on areas which are driving contemporary innovation (artificial intelligence, aerospace, hydrogen technologies, etc.).

The density of research on all our campuses enables us to offer research-based learning by default and ensure that the benefits of studying next door to world-class research laboratories. are made available to all students on campus.

Our 18 Graduate Schools and one Institute aim to ensure interaction between education and research. They serve as pillars for academic excellence, underpinning the university's mission to be a world leader in higher education and research. They offer a diverse range of specialised programmes and courses tailored to the specific needs of each scientific discipline and promote an interdisciplinary approach, facilitating synergies between different domains, and fostering an environment where students and researchers can thrive and innovate. They will also educate students about the best environmentally friendly practices in their disciplines and will spur reasoning about the environmental and societal impacts as well as challenges for ecological transition of their disciplines.

Mechanical and manufacturing engineering students at the Cachan University Technical Institute (IUT).

Christophe Peus/Université Paris-Saclay

Fostering research-based education, as a foundation for careers in academia and beyond. At Université Paris-Saclay, we ensure that research-based training starts at the undergraduate level. Indeed, a research-based approach to education benefits all students, beyond the fraction who aim for a career in academia, and cultivates qualities which are directly relevant to a wide range of professional pursuits. From the capacity to analyse information critically, to that of formulating and testing hypotheses; from the confidence to go out and explore new territory, to the ease at interacting with people from different backgrounds; from the capacity to formulate a problem to that of feeling at ease with uncertainty and complexity, research-based education is one of the major social contributions of Université Paris-Saclay.

Our approach to teaching through research is not confined to our academic laboratories as it has expanded through close collaboration with the R&D departments of our industrial partners. The researchers from these companies are not mere collaborators; they are integral to our teaching, ensuring that students get a holistic view of both academic and industry research landscapes.

Supporting the development of research-based practices across our course offer. Since research-based education demands more than simply putting a researcher and a student in the same classroom, Université Paris-Saclay supports the development of dedicated teaching and learning approaches adapted to the level of studies, from the undergraduate level onwards, and to the specificities of the disciplines. One of the impulses for this university-broad effort comes for the FAIR project (*Former, Apprendre et Innover par la Recherche*), which funds initiatives selected by the Graduate Schools to improve research-based education both to scale up successful activities (Junior Congress, Junior Labs, etc.) and to test new pilot programmes.

LEGAL CLINICS AT PARIS-SACLAY

The Paris-Saclay legal clinic was founded with the aim of providing legal services to people in civil society facing conflicts, at the same time as providing law students with suitable legal and ethical tools to resolve these conflicts. Its ultimate objective is to support the younger generation of lawyers in building a better world.

The services offered by the Paris-Saclay legal clinic are free of charge and cover a wide range of cases, such as helping start-ups to create an ethical business, preventing disputes with mobile phone or hotel service providers, providing support and expertise to associations working to protect human rights, the environment and climate change.

Creating a reflective space where academic staff can debate and improve their research-based teaching & learning approaches. Our commitment to research-based education is perhaps best illustrated by our strategic decision to create a transversal Graduate School dedicated to Higher Education and Research. It differs from most other Graduate Schools because it involves the whole academic community. It provides a space where academic staff and graduate students can exchange on their practices and keep track with the latest international developments in terms of research-based teaching and learning.

PROJECT FAIR
FORMER, APPRENDRE ET INNOVER PAR LA RECHERCHE

Université Paris-Saclay deploys the "FAIR" project to strengthen its activities in the field of research-based education, fostering the interface between students and laboratories, and enabling them to acquire the skills needed for tomorrow's innovation.

This consist mostly of hands-on, practical schemes to develop innovative research-based learning approaches, which are being tailored by each Graduate School to the specific requirements of the corresponding field of studies.

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INNOVATION AND TECHNOLOGY TRANSFER

The cutting-edge tools and methodologies currently being transformed by innovation, from artificial intelligence to personalised medicine, require the combined efforts of researchers and practitioners, the know-how of established businesses and the daring spirit of entrepreneurs. Fundamental research serves as the bedrock for these advancements. However, fundamental research alone is not sufficient. To truly tackle the complexities of modern challenges, it is essential to collaborate with users, as they offer vital insights into real-world applications and needs.

As one of the leading research-intensive institutions, Université Paris-Saclay embraces its role as a partner in sustainable innovation projects, whether they are led by companies, public actors, or our own students and staff. We are convinced that by engaging with socio-economic partners, we can bridge the gap between foundational knowledge and actionable solutions. This integration ensures that innovation is not only groundbreaking but also addresses the societal and environmental imperatives of our era.

Université Paris-Saclay also follows a clear compass, in which innovation is never pursued for innovation's sake, but as an instrument for a better world

While doing so, Université Paris-Saclay also follows a clear compass, in which innovation is never pursued for innovation's sake, but as an instrument for a better world, a way to tackle the momentous challenges of feeding, caring for, transporting, interconnecting and educating nine billion human beings in a complex international context. Simply responding to market demand or expressed needs does not meet our criteria. In fact, the innovation projects stemming from our labs are strongly driven by a concern for social impact. Université Paris-Saclay is currently strengthening this commitment sby formalising it in its strategic innovation roadmap, giving precedence to projects that present scalable remedies to urgent challenges and promise enduring beneficial and shared outcomes.

Inspired by leading universities in this field, we are working across the board to scale up our capacity in the area of knowledge transfer and innovation: from the development of proof-of-concepts funding, to the creation of unique innovation and collaboration places such as the Design Spot or the Paris-Saclay Playground, from the setup of a dedicated investment fund to the development of a service dedicated to industrial relations, from student internships to joint labs.

Supporting a shift in mindset: students, researchers, staff as innovators. Innovation and technology transfer used to be a synonym of patents. While the protection of intellectual property remains an important aspect of our innovation and technology transfer policy, our main priority is to support a shift in mindset among our community: to ensure that students, alumni, researchers, staff at Université Paris-Saclay all see themselves as innovators in their own way. We are progressively extending our set of training activities, from undergraduate students to PhDs, post-doctoral fellows and experienced researchers, to ensure that all members of Université Paris-Saclay who want to engage in innovation feel supported and equipped to do so successfully.

Boosting startup creation. Many of the maturation projects supported by Université Paris-Saclay in the past have led to the creation of knowledge-intensive, promising startups, tackling major social challenges (see a list here). In line with the national priorities of the Deeptech plan, Université Paris-Saclay is intensifying its efforts towards the creation of innovative startups. To this end, we are

developing a range of activities tackling all the critical steps leading to high-quality projects: awareness training for all students and staff, tailored programmes for students-entrepreneurs, proof-of-concept funding, dedicated mentoring schemes and professional support (notably thanks to its network of incubators), up to creation and fundraising. As a testimony to this overall ambition, the Paris-Saclay Seed Fund ensures that new ventures have the financial resources at the critical stage of their development.

QUANDELA: AN EXAMPLE OF A DEEPTECH STARTUP AT UNIVERSITÉ PARIS-SACLAY

Founded in 2017, Quandela is a start-up company based at the Centre for Nanoscience and Nanotechnology, where a unique technology for the fabrication of quantum light sources has been developed for more than 20 years. These sources are useful for multiple strategic applications such as:

- Optical quantum computers.
- Quantum communications.
- Quantum light-based imaging and detection.

Quandela has already provided several photon sources in different countries and their high efficiency has allowed its customers to increase their working speed and complexity by several orders of magnitude.

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Developing an efficient, multifaceted interface between labs and socio-economic actors. Across the world, innovation-intensive universities are characterised by the density and diversity of their connections with non-academic actors. With many established collaborations with industrial partners and society, at the heart of a fast-growing innovation ecosystem of both large companies and SMEs, Université Paris-Saclay is one of these innovation clusters in the world. We have a responsibility to make the most of it and facilitate both directions:

1. From our labs to society: we are strengthening our labs' understanding of the potential for industrial transfer of the research they carry out. We are developing our economic intelligence capabilities, to enable researchers to explore potential application markets for their discoveries, in coherence with regional, national and European strategies. We encourage industrial PhDs, who place early-stage researchers in close contact with companies, and we develop specific training courses so that academic staff are equipped to take part in private company's boards.

2. From society to our labs: we are making it easier for potential partners to identify the skills and know-how of our labs so that industrial partners can easily formulate their requests, identify the right people to carry out their collaborative projects successfully, and benefit from a clearer, more fluid interface with our research labs.

OPEN SCIENCE

Open science fortifies the integrity and transparency that we view as fundamental to research. It fosters a more democratic, inclusive culture where knowledge is more widely accessible and ensures that scientific progress is truly a collective endeavour. It also has the potential to significantly accelerate research and innovation cycles: as the magnitude of modern scientific challenges requires data on scales that individual studies or institutions cannot feasibly produce or manage alone, open science approaches make it possible to share datasets, ensuring that our research is poised on the appropriate scale.

However, the journey towards fully adopting open science is paved with cultural and institutional barriers. Indeed, although open science is not necessarily antinomic with concerns of information sovereignty, privacy and commercialisation, it does require a shift in approach. Deeply-rooted in the academic landscape is a competitive ethos, and researchers are sometimes incentivised to guard their findings and avoid open collaboration and early data sharing. Researchers justifiably fear that premature sharing could lead to their work being "scooped" or used without appropriate attribution, thereby jeopardising their career advancement. Additionally, without proper management, the large amounts of data being shared through open science risk becoming overwhelming silos of isolated information, often inaccessible or incomprehensible to other researchers. Finally, geopolitical tensions are having an increasing impact on cutting-edge research fields and raise complex issues related to secrecy.

Effective data management and standardisation are, themselves, no trivial task and require a coherent framework, comprehensive guidelines and often, specialised tools or platforms. Researchers need not only the tools but also the training and incentives to manage and standardise data sharing effectively.

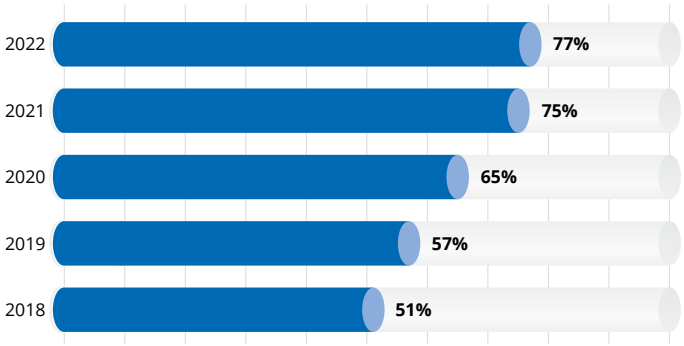
Establishing Saclay's open science strategy. Because the accessibility of scientific publications and data fits the vision of our role for a public research university today, Université Paris-Saclay has made open science a priority. We have defined an explicit open science strategy, based on the major available frameworks at the national, European and international level, to ensure that our efforts are aligned with those of the scientific community as a whole.

This strategy takes into account the needs and practices of different disciplinary fields from the issue of large international data bases in astrophysics, to acute concerns for the protection of individual data in health or social sciences, and concerns of sovereignty and industrial spying in key technological fields. It is embedded throughout the university in our research teams and institutional structures, and monitored through our Open Science Barometer.

Promoting and encouraging publications in open access. Université Paris-Saclay is dedicating significant resources to increase open-access publications, by promoting the use of the HAL portal and by encouraging researchers to work within the principles of open science. The push for open access publication is monitored through a dedicated tool and is bearing fruit, with significant progress in the proportion of Université Paris-Saclay's publications now being openly accessible (more than 75% for 2022 - see image).

To make the effort of publication in HAL as easy as possible for the research labs, an application to assist with submission to the HAL portal ("BiblioHAL"), based on an interconnection with ORCID, has been deployed throughout the University. By offering a robust service designed to help researchers streamline and manage their publication, our aspiration is to efficiently guide our teams through every stage to ensure our researchers focus remains on making scientific contributions while easing the challenges of research administration.

Optimising our scientific data and infrastructure. Proper storage, management and publication of scientific data is key both for tackling the issue of reproducibility of scientific results, and for maximising the opportunities for use and re-use of scientific data. Recent national guidelines as well as the evolution of requirements from research funding agencies strongly invite for a change of practice in the matter, promoting FAIR principles (Findable, Accessible, Interoperable, Reusable). Université Paris-Saclay is particularly proactive in this domain, to ensure that a maximum of scientific data resulting from our teams' research is freely and easily accessible, in compliance with intellectual property and personal data requirements. Concretely, we are consolidating a network of experts who are helping the change of practices towards Open Scientific Data, by providing support, training, and curation for the implementation and maintenance of the proper data infrastructure. This support mobilises a whole range of competencies, from legal expertise to library and database management. It is built on our technical capacity, and benefits from the fact that Université Paris-Saclay is the node of several national and European data platform infrastructures such as Recherche-Data-Gouv or EOSC. It is being tested in scientific communities, where open data present particular challenges and relevance such as humanities and social sciences, agriculture and environment, engineering sciences. It will be deployed throughout all research units of the university.



Université Paris-Saclay: open access rate of scientific publications of Université Paris-Saclay, with a Crossref DOI published during the previous year by observation year.

Raising awareness, training and change management. Open science transforms established scientific practices. Its quick adoption depends critically on training and awareness-raising of new generations of researchers so that they acquire the habits of proper data management, storage, use and publications. Our training is focused on the familiarisation of open access primarily to the next generation of researchers in a collaborative effort between *La Maison du Doctorat* and the Department of Libraries, Information and Open Science. Université Paris-Saclay offers systematic training sessions on the issues surrounding open data management, balanced with considerations of confidentiality and protection of personal information. This concern is particularly strong in some fields, such as medical research, where personal data must be rigorously protected to guarantee the right to privacy. As an example, researchers in public health have been working on the initiative "Open CESP" to develop a tool to clone patient's cohorts' data, into artificial datasets with the same joint distribution as the source data. The aim is to offer free access to these artificial datasets in order to stimulate broad collaboration and the scientific exploitation of the cohorts (with the real data being analysed at a later stage, if the results with the cloned dataset are promising), and to enable students and researchers from other Graduate Schools to familiarise themselves with this data.

Acknowledging Open Science and European Sovereignty. Finally, any open science policy must take into account the rise of geopolitical tensions and the renewed emphasis on technological sovereignty, as well as concerns for secrecy in the circulation of knowledge. This is all the more important seeing that European universities have fallen behind their Chinese and American competitors in key scientific fields such as biomedical engineering,

computer science or nanotechnology. The shift in this respect has been particularly rapid: whereas five years ago talks about sovereignty applied to the scientific field would have seemed antiquated, today scientific espionage and the intervention of national security agencies are increasingly common. However, as a leading scientific actor, we are also convinced that Europe's commitment to academic freedom and open science is one of our greatest assets. This commitment goes hand in hand with our mission to strengthen European scientific sovereignty.

ETHICS AND SCIENTIFIC INTEGRITY

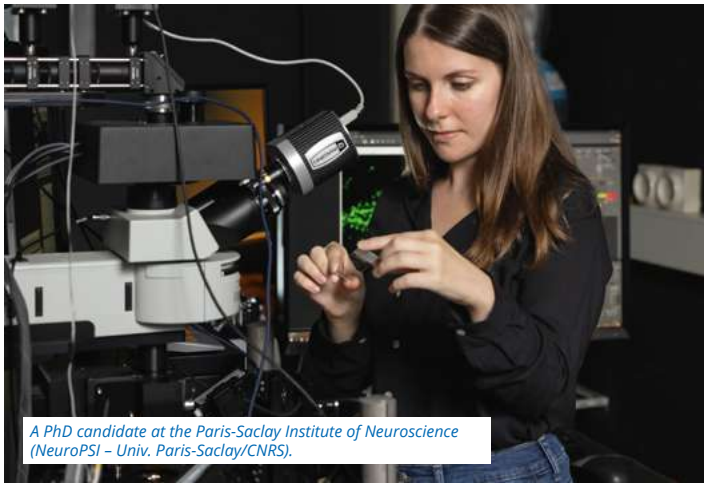
Public trust in science is currently faltering. Scientific integrity has never been so present in the news with cases of plagiarism, data alteration, and problematic links with funders highlighted around the world. At the same time, the environmental and societal consequences of scientific practices and technological development constantly raises ethical issues.

These issues reinforce the importance of Université Paris-Saclay's commitment to promote high standards of scientific integrity and its resolution to create mechanisms to debate explicitly the ethical implications of its activities.

Indeed, scientific excellence is only meaningful if it goes together with impeccable research integrity practices and environmental and societal awareness. This is not only a matter of individual practice, but a deeply collective and institutional issue: we can and should promote collective scientific practices which make it easier, and not more difficult, to abide by good deontological and scientific integrity practices. Scientific integrity will truly progress only if we acknowledge the fact that some features of the scientific sector - such as the high level of competition and the pressure to publish - make research integrity more challenging.

By signing the *Charte nationale de déontologie des métiers de la recherche*, Université Paris-Saclay emphasises scientific integrity to ensure that they prevail across our missions. We view this as a crucial step towards a democratic state where moral reasoning is discussed openly.

Setting up internal processes and bodies in ethics and scientific integrity. To pursue this goal, Université Paris-Saclay has taken steps that go beyond its regulatory obligations as per the French *Code de l'Éducation*. Thus, Université Paris-Saclay has recently reinforced Poléthis, its internal body in charge of coordinating efforts in the area of scientific integrity and ethics. A pioneering bodycreated in 2018, Poléthis offers researchers support in terms of thematic ethics monitoring and consultation,



A PhD candidate at the Paris-Saclay Institute of Neuroscience (NeuroPSI – Univ. Paris-Saclay/CNRS).

Fondation L'Oréal

enabling them to anticipate the ethical aspects as well as environmental and societal impacts of their research projects within the framework of a dedicated committee. Poléthis is also supported by a network of representatives of scientific integrity throughout the community ("*référents intégrité scientifique*"), to provide advice on dealing with cases of scientific integrity breaches and to design specific training sessions in scientific integrity for doctoral students and supervisors.

Scientific excellence is only meaningful if it goes together with impeccable research integrity practices and environmental and societal awareness

Poléthis gathers the people in charge of ethics, deontology and legal aspects of research integrity. The President of the university may refer to this body to provide an opinion on any question of scientific ethics and integrity. It does not have a decision-making authority, but can highlight potential conflicts of values in specific projects, collaborations or partnerships. It thus creates a reflective space within the university where intrinsically complex ethical issues entailed by our scientific practices can be made explicit, pondered and discussed.

Efforts to promote research integrity are relayed throughout the university, with Graduate Schools, research laboratories and individual staff and students developing their own initiatives. Together with Poléthis, Graduate Schools are placing a specific emphasis on the training of younger generations of researchers and of the 4,500 doctoral candidates, by embedding these issues in training programmes, by creating explicit criteria to select collaborating institutions, or by raising awareness about plagiarism issues.

Changing research evaluation frameworks. Beyond these actions to promote ethics and scientific integrity, Université Paris-Saclay is well aware that a deeper transformation of the research evaluation framework is

SMALL PRIVATE ONLINE COURSE ETHICS & STICS: SCIENTIFIC INTEGRITY, RESEARCH ETHICS & INFORMATION ETHICS FOR ICTS

An 8-chapter online course designed to help students understand what integrity in research means and why it is important to follow an ethical conduct in research work.

Université Paris-Saclay

necessary. The prevailing bibliometric indicators used for evaluating scientific progress often become self-referential, inadvertently promoting behaviours that might compromise scientific integrity: an academic researcher will be rewarded for publishing articles, which are highly cited by their peers, independently of the societal impact of their research or of their investment in teaching. This creates a world in which researchers are valued for having highly-cited papers rather than for ground-breaking scientific discoveries, and might dissuade researchers from dedicating time to undergraduate teaching or engaging in meaningful industry collaborations.

Efforts to promote research integrity are relayed throughout the university, with Graduate Schools, research laboratories and individual staff and students developing their own initiatives

Addressing this issue will take time because citation impact still drives both university rankings and researcher evaluation and career paths, and because no clear collective alternative exists at the moment. Université Paris-Saclay is committed to working both internally in our recruitment and evaluation processes and externally as signatories of major international agreements such as DORA, the San Francisco Declaration on Research Assessment and members of CoARA, the Coalition for Advancing Research Assessment. As a concrete example, Université Paris-Saclay is currently reviewing its recruitment and promotion guidelines for academic staff to go beyond simple bibliometric indicators and encourage a broader, more complete assessment of scientific contributions and other commitments over the course of careers.

OUTREACH AND SCIENCE-SOCIETY ACTIVITIES

In a knowledge-intensive society, science and technological development must be anchored much more deeply in the principles of democracy, equity, and political participation. In this perspective, science is the outcome of a dialogue between university and society, in a world in which knowledge is shared with all audiences and sustains shared democratic values.

Université Paris-Saclay thus views scientific outreach and participatory science as one of its core missions. We have a responsibility to be far more present as a place of constant debate around the great societal challenges, where we can contribute methods and knowledge and where our scientists, students, the general public and policy makers exchange on an equal footing.

This commitment to promoting open, rational discussion is particularly relevant today and requires specific settings, as public discussion is often led in ways that prevent the expression of doubt and nuance. We therefore actively engage in initiatives which promote rational debate, and protect and support the academics who decide to engage in public outreach and media.

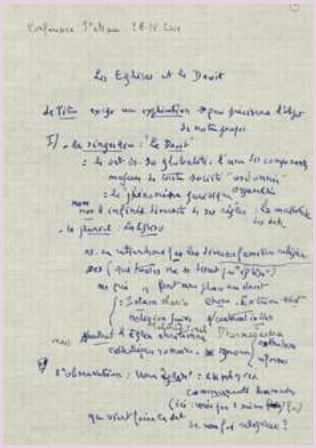
The first strategy is focused on outreach and engagement to bring science closer to citizens. Université Paris-Saclay has long been supporting its staff and students who engage in science outreach activities.

Our science outreach activities target the general public, thanks notably to *La Diagonale*, a service centre designed to assist staff and students in their Science with and for Society activities. Actions range from scientific outreach, social and cultural engagement, arts-science interfaces, or the promotion of scientific heritage. Université Paris-Saclay benefits in this respect from unique infrastructures, such as the *Scène de Recherche*, a fully equipped professional theatre dedicated to the dialogue of arts, sciences and technologies with an emphasis on outreach and public participation.

An important dimension of scientific outreach deals with academic staff either being asked by the media to speak as experts, or actively writing blogs, newspaper articles or opinion pieces. To guide our academic staff in this important but complex area where professional expertise is sometimes closely intertwined with personal convictions, we provide support as well as media training and development of scientific communication and mediation skills.

The second strategy is to encourage participatory science. Participatory science practices are continuously growing, from involving the public in data collection and observation, to requesting public collaboration in analysis

PROMOTING SCIENTIFIC HERITAGE: THE EXAMPLE OF THE DIGITAL LIBRARY NUMACLAY



Numaclay, the digital library of Université Paris-Saclay, facilitates access to scientific heritage and scientific archives - such as the Jean Gaudemet archive presented in the image.

and data treatment, and up to the more ambitious co-design and co-implementation of research projects by mixed teams involving scientists and members of the general public. Université Paris-Saclay supports academic staff in the development of this range of practices. Notable examples include involvement in the Vigi-ciel project, which relies on public participation to identify and analyse meteorites, or the development of the *Living Lab* in Corbeville - a place for experimentation in the field of urban agriculture and food transition, which involves researchers, citizens, local authorities and local socio-economic actors.

DIVERSITY

Universities are born from a powerful ideal: a community which is organised around the quest for knowledge and ideals of openness and respect. The real-life translation of this ideal is far from perfect. Universities are, like any other human collectives, vulnerable to powerful social dynamics which, if left unchecked, create exclusions, favour silos, or are prone to power dynamics. We cannot simply accept such consequences as a fatality: we need to look at them lucidly and understand them, so we can take energic steps to fight them.

Université Paris-Saclay is deeply committed to protecting a diverse, respectful collective, which it does both by supporting research and innovation on issues of discrimination, equality and inclusion, and by taking active steps to implement on its campuses.

Staying true to our strong commitment to equity and inclusion. Université Paris-Saclay is resolutely committed to promote a culture of equity and inclusion, within its campuses and beyond. It is committed, beyond what is legally required, to the fight against discrimination based on gender, sexual orientation, social origin and disability.

Access to higher education and the success of all are encouraged by equal opportunity measures (see text box on the "*Cordées de la Réussite*", in the section below). Various awareness-raising events are being organised by the university, in particular around the international days for the fight for women's rights, against LGBTphobia, and against violence against women.

Empowering the next generation through education, inclusion and scientific exploration. The younger generation is a key target of this approach. In order to train young people to exercise their citizenship in a critical and enlightened way, to learn more about the world of research and to become more familiar with scientific methods, we support initiatives such as the Maison d'Initiation et de Sensibilisation aux Sciences (MISS), where pupils from primary and secondary schools are welcomed for a day of fun and educational activities in our laboratories. One of our programmes is directed specifically towards secondary school girls to give them a new perspective on mathematics, computing and the physical sciences by enabling them to meet women staff and role models and discuss their future career paths and professional motivations.

CORDÉES DE LA RÉUSSITE

The *Cordées de la réussite* scheme aims to promote access to higher education for young people from all socio-cultural backgrounds, by giving them the keys to successfully embark on the pathways to excellence.

It aims to:

- Promote educational success for all, parity and equal opportunities.
- Combat self-censorship among young people, particularly in priority, rural and isolated areas, and in technological and vocational streams.
- Help pupils discover careers and career paths.
- Promote cultural and scientific awareness among pupils.

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With the aim to increase social equity and inclusion, our students are encouraged to take part in the *Cordées de la réussite* which offers secondary school pupils a chance to learn about science and its careers, whatever their

A Bridgman furnace for the development of ceramic materials.

Onera, centre de Châtillon

socio-cultural background. Every year, roughly 1,800 students from 80 secondary schools from disadvantaged neighbourhoods or isolated rural areas engage regularly with 300 tutors selected amongst the students from our university. The objectives are to encourage a taste for the sciences, demystify higher education and give young people the opportunity to find out more about careers and courses.

Fighting sexist and sexual violence. Determined to create a serene work and study environment for all, Université Paris-Saclay is committed and a pioneer in the fight against gender-based and sexual violence. We have a "zero tolerance" policy for sexist and sexual acts, support victims and witnesses through a dedicated unit and various local partners, and deploy a training plan, which covers all university communities, from students to leadership teams.

SUSTAINABILITY

The Université of Paris-Saclay has long been committed to researching environmental issues and the effects of climate change, including its impact on our societies and living organisms. Université Paris-Saclay also recognises its responsibility to disseminate knowledge and to take action to limit detrimental impacts of its activities on the environment. It has thus made a commitment, through its sustainable development charter, to be a lever for socio-ecological transition. This commitment translates into the support for the production of knowledge on environmental changes, on the associated risks and on the means (technical and natural) of transformation for sustainability. It also involves supporting the training and raising awareness of our communities, particularly our students, who are called upon to experience these changes and to be actors in societal transitions. We will continuously deepen our strategy to reduce our own environmental impacts.

Promoting a sober, sustainable campus. In the years to come, important efforts are required to reduce the environmental impact of our teaching or research practices. Sufficiency is a major aspect of these efforts, in parallel with longer-term decarbonisation actions. Many of the involved changes require an in-depth transformation of our existing work and study practices. However the urgency of the challenge requires us to implement the required changes as quickly as possible. The action plan currently being discussed within the whole Université Paris-Saclay community relies on four major impact areas:

1. Procurement - a thorough analysis of current practices aims at ensuring that we buy less and better, through a better screening of needs and mutualisation of resources.

2. Transportation - as home-to-campus and on-campus mobility are a significant source of greenhouse gas emissions, Université Paris-Saclay is implementing a transportation blueprint to offer sustainable alternatives (bike, public transport, car pooling, etc).

3. Energy consumption on campus - a process is underway to improve the energy efficiency of our real-estate, and requires a multi-year planning and investment process.

THE GREEN DEAL OBSERVATORY

This initiative is a scientific, educational and institutional project that aims to mobilise the academic community to analyse the actions taken as part of the European Green Deal presented by the European Commission in December 2019, with the aim of making Europe climate neutral by 2050. Nearly 150 legislative and non-legislative initiatives have been launched by the European Union, providing fertile ground not only for research but also for teaching.

Led by researchers at the Université of Paris-Saclay, the Green Deal Observatory relies on contributors in domestic law, European law, international law and political science, who can publish their work on the dedicated website with the aim of centralising ideas and gathering information useful for understanding the issues at stake in this vast political programme.

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4. Food and catering - discussions are underway with the catering providers for students and staff to diminish their environmental impact.

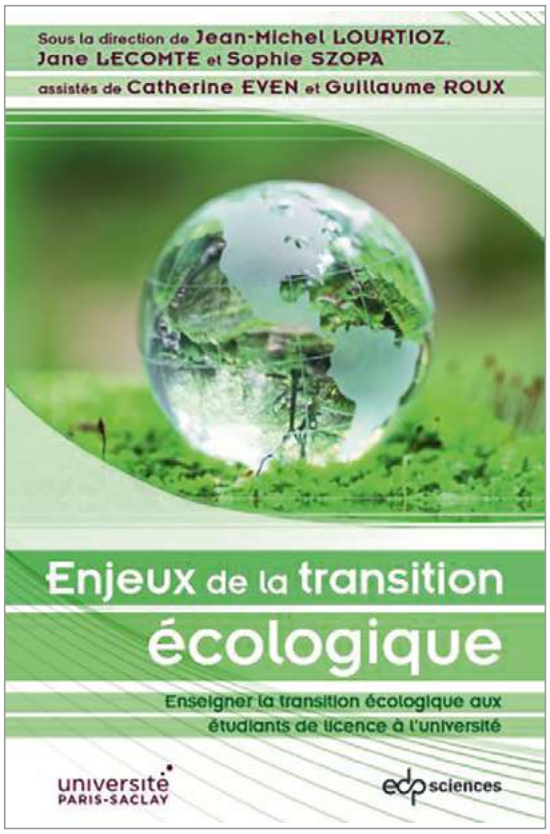
Developing research on sustainable development. Université Paris-Saclay has identified seven major interdisciplinary societal challenges. Many of them (Health & well-being; Energy, climate, sustainable development; Biodiversity, agriculture and food; Transport and mobility) are key for sustainable development. The breadth of the research carried out at the University in this area is presented in the dedicated section below, and deals with:

- The better understanding of environmental changes and associated risks for human societies and living beings.
- Solutions for a sustainable future.
- Issues related to equity in resource distribution and use.

The urgency of the environmental crisis raises deep issues, which are currently being debated collectively throughout the university, in the wake of recent seminars and conferences - among others, to what extent should we actively prioritise research directly relevant to sustainability concerns, or to what extent should we refrain from engaging in research which into research lines which might favour non-sustainable applications.

Université Paris-Saclay

Orienting research practices towards sustainability. At the same time as our research teams explore the mechanisms of environmental changes and possible solutions, research activities themselves generate a significant environmental impact. We cannot ignore this tension. Université Paris-Saclay is taking active steps to analyse the carbon-footprint of its research activity, and promote accessible practices, adapted to each lab on a case-by-case basis.



Université Paris-Saclay

Raising awareness and reaching out. Université Paris-Saclay offers a significant number of study paths which are directly relevant to sustainable development and train future professionals equipped to tackle the challenges of the environmental transitions: five professional undergraduate degrees, more than 30 Master's tracks, more than 15 engineering specialisation tracks are currently being offered within departments ranging from natural sciences (geosciences, engineering, etc.) to humanities and social sciences (law, economics, public policy, etc.). Université Paris-Saclay has been also a pioneer with the introduction, as early as 2020, of a large-scale undergraduate teaching module dealing with ecological transition, accessible as a SPOC and mandatory for second-year undergraduate students. A result of the collaboration of more than 40 academic staff from many disciplinary fields, this module is the basis for the open access book, *Enjeux de la transition écologique*.

Our seven transversal challenges for more impactful science

Our seven transversal challenges for more impactful science

SCIENTIFIC POTENTIAL AND CHALLENGES

FUNDAMENTAL RESEARCH AS THE BASIC BUILDING BLOCK OF SCIENCE

Université Paris-Saclay is particularly renowned for its excellence in fundamental science, in fields where science proceeds with the sole objective to explore and push the limits of knowledge.

This is true, for instance, in mathematics, where Université Paris-Saclay is amongst the very best universities in the world; in physics, where a critical mass of scientists covers all major domains - from fundamental to applied research, from theory, modelling and simulation to instrumentation, from lab experiences to large research infrastructures; and many other areas, from clinical medicine, chemistry, biology, engineering, to political and social sciences.

Université Paris-Saclay is particularly renowned for its excellence in fundamental science, in fields where science proceeds with the sole objective to explore and push the limits of knowledge

All these fields delve into the core principles and laws governing matter, life, and society, and they come together within interdisciplinary projects to lift scientific barriers which require the combined expertise of formal sciences, health sciences, engineering, humanities and social sciences.

This commitment to curiosity-driven exploration is also true for many of our researchers in applied sciences, which study complex entities often resulting from human endeavours, like agronomy, legal studies, and economics.

This is why Université Paris-Saclay is committed to the long-term view. Science is a bet on the future. The technologies which transform care, food production, transport or education today have been decades in the making. They were made possible because universities around the world have supported exploration, with the unique compass of scientific rigour. The same is true for the concepts, ideas, regulations that enable us to articulate technological advances with concerns for equity and social flourishing: these exist because we nourish spaces for open dialogue, research and exploration.

In a context where the pressure for accountability is growing, and where public funders as well as citizens rightly ask about impact, stating this fact is not trivial: it means that we intend to continue to be a place which invests for the long-term.

FROM FUNDAMENTAL RESEARCH TO SOCIETAL IMPACT

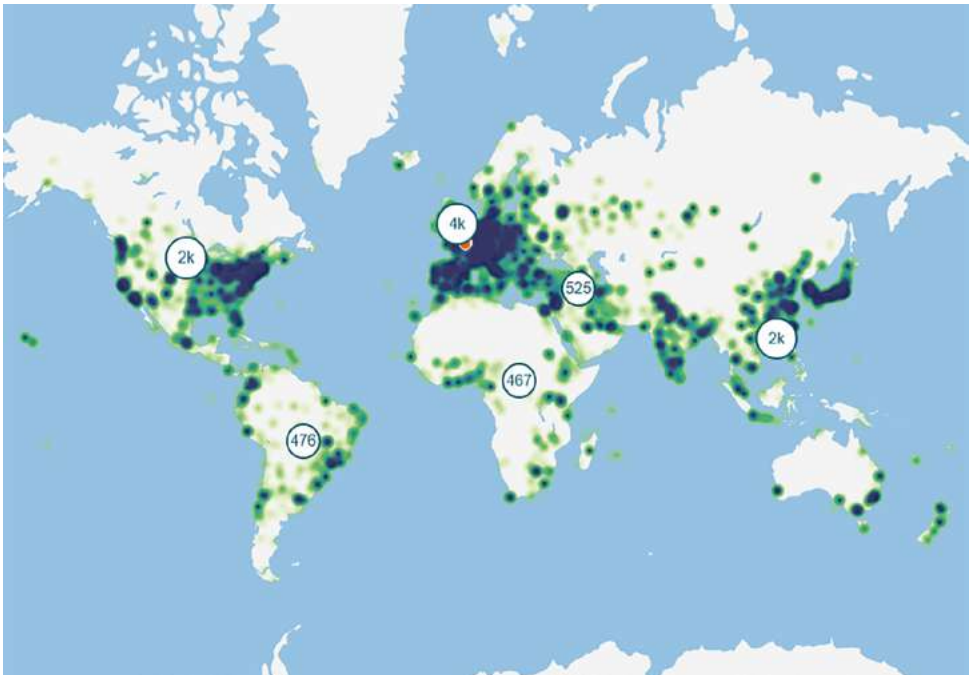
This value placed on curiosity-driven research is necessary to feed our concern for societal impact. Time and again, the history of scientific discoveries shows that major advances in our understanding of fundamental aspects of the universe happen hand in hand with the efforts to solve concrete problems. Exploration and application are two faces of the same coin to serve social progress.

When looking at the scientific dynamics within a sector devoted to a given social finality - such as batteries, photovoltaic sources of energy, therapeutic advances - some projects are very close to application and some delve into more fundamental problems. These feedback loops are key. They are only possible if research-intensive universities are sufficiently connected with society, free to encourage exploration, large and diverse to enable serendipitous encounters, and with the right incentives

in the right places to maximise the likelihood of success.

The role of Université Paris-Saclay is to be both a place for exploration and for connection, both a protected space to cultivate bold ideas and a crucible for interactions. Because the best exploration science feeds the most innovative ideas, we will fulfil our mission if we continue to be a place which supports curiosity-driven projects while sustaining dense interactions with the non-academic stakeholders.

This place for exploration and connection is also a hub of international cooperation: as a research-intensive university, the labs of Université Paris-Saclay are nodes in a scientific network which unfolds globally. This commitment unfolds at different scales: by supporting one-to-one international collaboration between single scientists, by ensuring that the educational experience offered to students at Université Paris-Saclay opens them up to the world and global realities, by committing to the European Education and Research Area and by cultivating institution-wide strategic partnerships.



Map of Université Paris Saclay's partner institutions, on the basis of co-publications. Source: Scopus - period: 2013-2022.

OUR SEVEN CORE SCIENTIFIC CHALLENGES

The following pages shed light on seven major transversal challenges where the interdisciplinary range of Université Paris-Saclay contributes to topics of immediate social interest - Health & well-being; Energy, climate, sustainable development; Biodiversity, agriculture and food; Digital transformation and artificial intelligence; Transport and mobility; Space and aeronautics; Industrial renewal.

Not all the projects being developed at the university are directly relevant to these challenges. It is essential that we create space for pursuing ideas simply for the sake of pushing the boundaries of knowledge. However, a significant share of the research, education, and innovation activities which take place at Université Paris-Saclay directly impacts these seven broad areas, by mobilising the relevant interdisciplinary connections.

Address societal challenges

Health and well-being

Energy, climate, environment, sustainable development

Biodiversity, agriculture & food

Digital transformation and artificial intelligence (AI)

Transport and mobility

Aerospace and aeronautics

Industrial renewal

These challenges are tackled:

- In *research*, where scientific teams come together to address open issues.
- In *innovation*, where public and private partners collaborate to codesign new solutions and products, and develop education programmes to train future innovators.
- In *education*, where the 20,000 new graduates trained each year by Université Paris-Saclay, have been prepared to relate their academic expertise with today's challenges.

1. HEALTH AND WELL-BEING

Placed in a large-scale perspective, recent progress in health and well-being has been nothing short of astounding. However, in light of modern research, health is being viewed not just through the lens of traditional medicine but in a broader paradigm that spans from the molecule to the planet. And yet, many diverse, new or persistent challenges remain unresolved, as recalled by the COVID-19 pandemic, the plateauing of human life expectancy witnessed in many countries, or the persistence of large health inequities among populations.

The teams at Université Paris-Saclay bring the combined expertise in molecular modelling, chemistry, synthetic biology, molecular and cellular biology, omic sciences, pharmacology and toxicology, which are necessary to reap the benefits from new approaches

The research community is called to invent new approaches to issues sharing a common feature: their radical interdisciplinarity, as they mobilise a number of scientific fields from biology and chemistry to sociology and economics, material sciences or mathematics. Today, the health sector is not merely about medicine; it has become a platform where various disciplinary fields come together.

The contributions of Université Paris-Saclay, both in research, education and innovation, are directly related to tackling a series of major diseases, from cancer, cardiovascular diseases, immune and infectious diseases, neurological disorders, hepatic and metabolic diseases, major depressive disorders, up to rare diseases. They are also directly relevant to other pressing concerns such as mental health up to psychiatric diseases, ageing, notably through expertise in the range of neurodegenerative and inflammatory diseases, but also nutrition or the quality of life in conditions of disabilities.

EXISTING ASSETS

Université Paris-Saclay is well placed to take part in these momentous challenges:

- It has a considerable scientific community in the core disciplines - medicine, pharmacy, biology, health sciences, chemistry.

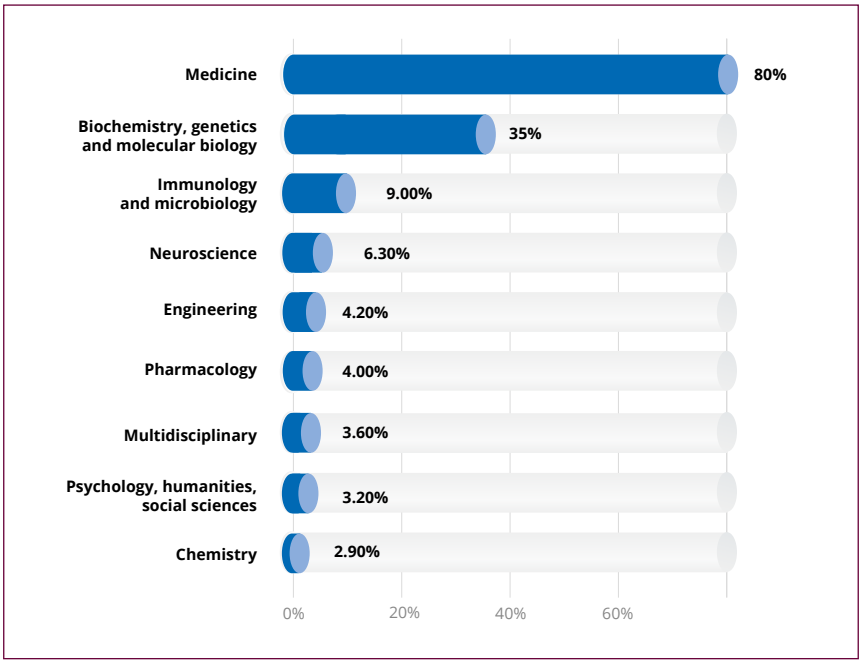
- A strong centre of epidemiology research, of which it is one of the historical birthplaces (in Villejuif), it adds consolidated expertise in public health with a social sciences perspective, to the core disciplines.

- It actively cultivates interfaces with a whole range of relevant disciplines, notably:
  - Mathematics and computer science, to bring the capacities in modelling, simulation and big data analysis which are required by contemporary health challenges.
  - Engineering and material science, to push forward new medical devices, implants, prosthetics, and treatments.
  - Social sciences, to broaden the approach to health encompassing social, cultural, economic and political factors.

- It is at the heart of many large-scale, nationally supported initiatives, totalling multi-million funding over ten years: university hospital institute on sepsis (IHU), several national programmes in health (notably on biotherapies and innovative therapies; emerging infectious diseases; food systems, microbiome and health; digital health), the Paris-Saclay Cancer Cluster, etc.

- Finally, it benefits from extensive pioneering infrastructure. Université Paris-Saclay is home to world-leading teaching and research hospital facilities, renowned cancer centres, and leading medical-surgical centres. It can also rely on more than 100 specialised platforms with advanced equipment, adapted to the characterisation of potential therapeutic targets, genomic analyses or molecular screening through innovative imaging techniques, allowing for the study of the continuum from the molecular scale to the individual. It also benefits from the maintenance of many cohorts for longitudinal studies.

Our academic focus in the interconnected realms of health and well-being is effectively illustrated through our publications records. The diagram shows, for Université Paris-Saclay's publication relevant for this challenge, the share of the respective disciplines.



Distribution of publications relevant for health and well-being.
The graph is read as follows: among the publications of Université Paris-Saclay in health and well-being, 80.9% pertain to medicine. Note that the total is superior to 100% because one publication can pertain to several fields.

ACTIVE FOCUS AREAS RELATED TO THIS CHALLENGE AT UNIVERSITÉ PARIS-SACLAY

Understanding the fundamental mechanisms behind health and pathology. Therapeutic advances today rely largely on our capacity to understand the underlying mechanisms at the molecular level. In particular, the new rise of precision medicine is made possible because of this ever-improving capacity to reach and understand molecular and cellular events. The teams at Université Paris-Saclay bring the combined expertise in molecular modelling, chemistry, synthetic biology, molecular and cellular biology, omic sciences, pharmacology and toxicology, which are necessary to reap the benefits from new approaches. They benefit from a strong basis of biological research with a wide diversity of experimental models such as: mammals, insects, nematodes, microorganisms, and plants. These research lines aiming at deciphering the most minute mechanisms of life rely on cutting-edge technological platforms in optical imaging, mass spectroscopy, high-flow sequencing, and biophysics. The proximity with the synchrotron SOLEIL is a key asset as it offers a last-generation electron cryo-microscope, essential to advance structural biology. Another important field of expertise of Université Paris-Saclay at that level lies with its large microbiology community (more than 100 research teams), going from the study of microorganisms to microbial communities and microbiota. Furthermore, another domain where Université Paris-Saclay is contributing to our understanding of the fundamental conditions of health and pathology is that of neurosciences: with two highly recognised institutes (NeuroPSI and NeuroSpin), the teams at Université Paris-Saclay study brain functioning from the molecular level to the neuronal circuit level and from basic to clinical aspects.

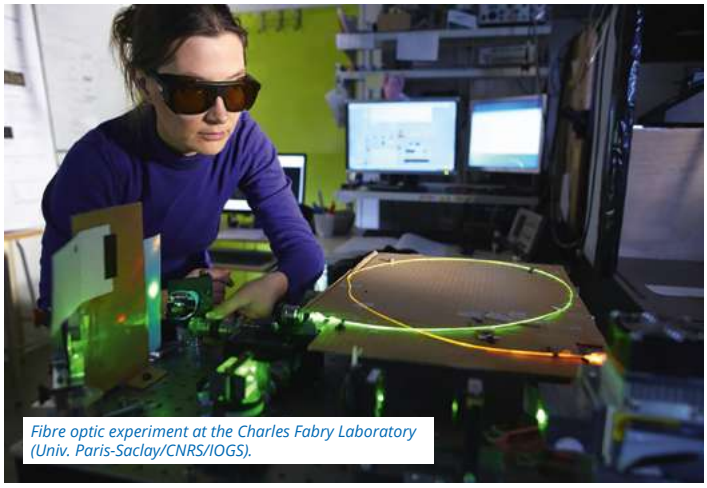
Emerging frontiers in synthetic biology. Synthetic biology is an emerging science that combines biology, mathematics, computer science, physics and chemistry to design new applications in biotechnology and health. Within Université Paris-Saclay, our teams work on the development of active design and machine learning tools, innovative bioactive molecules and microbial chassis. However, despite the advancements of this field, the major socio-economic challenges in synthetic biology concern applications in: (i) programmable medicine with a living/electronic interface for diagnosis and treatment, the synthesis of new compounds, and the design of innovative biosensors for disease detection; (ii) bio-manufacturing, including living/materials interfaces (e.g. living materials that repair themselves) and the engineering of cell-free systems; (iii) digital tools for a change of scale in the bioengineering of biological circuits, including design tools, machine learning, and the automation of the Design-Build-Test-Learn (DBTL) cycle; and in the longer term (iv) artificial design of microbiomes for the benefit (e.g. protection

HUB PASREL: A NETWORK TO PROMOTE CLINICAL TRANSFER

The PASREL Hub aims to support the projects of laboratory and industrial partners, by connecting them to relevant resources (experts, academic or industrial partners, valorisation structures, etc.) and by facilitating tests in a hospital environment.

It also aims to develop training at the interface of technology and medicine and to reflect on the professions of tomorrow, in conjunction with caregivers and manufacturers.

More information: *https://www.pasrel.universite-paris-saclay.fr/en/the-pasrel-hub/*



Fibre optic experiment at the Charles Fabry Laboratory (Univ. Paris-Saclay/CNRS/IOGS).

A. Chézière/Institut d'Optique Graduate School

against disease) of the host organism. A more global vision of synthetic biology is needed to meet these challenges.

Identifying and validating new therapeutic targets. Based on this expertise in the underlying mechanisms of pathologies, the teams at Université Paris-Saclay are actively engaged in the identification of new therapeutic targets, by combining knowledge in pharmacology, therapeutic chemistry, antibodies engineering, molecular and cellular biology, genetics, nanomedicines for drug delivery and drug targeting. Université Paris-Saclay teams are particularly strong in the upstream part of the chain, involving the research and validation of targets, screening, structural analysis and medicinal chemistry. Cancer research, specifically immunotherapy, personalised cancer treatment and radiotherapy, are major areas of strength at Université Paris-Saclay. These areas of strength are enhanced by therapeutic trials, high-level publications which include work on the links between the efficacy and toxicity of anti-cancer immunotherapies and the microbiota, the links between therapeutic response and advances in imaging and artificial intelligence, projects on the toxicity of new anti-cancer drugs developed and research into paediatric oncology.

Creating the conditions for translational research, innovative therapies, clinical research and advanced medical devices. Université Paris-Saclay actively associates academic and clinical staff to ensure a bidirectional flow of knowledge, from fundamental research to the patient and vice versa, promoting a strong continuum "from bench to bedside". The aim is to produce new ways to address currently unmet societal needs (rare diseases, chronic diseases, transmissible and non-transmissible diseases), to unlock the promises of precision medicine and to develop pharmacogenomics. In a context where regulations on medical devices are increasingly stringent, the teams at Université Paris-Saclay can access cutting-edge platforms for physical and chemical analyses which enable them to understand the biocompatibility of implantable medical devices. The challenge in this respect is for fundamental research to go hand-in-hand with clinical research and regulations to support industrial partners and health authorities in their need to evaluate medical devices throughout their life cycle, from design to commercialisation and use.

The COVID-19 crisis showed how crucial it was to rapidly develop diagnosis and therapeutic approaches and make them widely accessible. It emphasised how deeply challenging it was to share solutions with developing countries and in general ensure a general access to health. It also revealed the gaps in our understanding of the interactions between pathogens and immunity - all the more concerning that new viral emergence is likely and antibiotic resistance increases. Infectious diseases are, however, just one example among many of the need to strengthen translational research. Other obvious examples include cancer, in particular to test the promises of immunotherapies or targeted therapies, as well as neurological and hepatic diseases, where teams are exploring the possibility to repair and regenerate tissues and cells. The teams at Université Paris-Saclay are heavily involved in clinical trials in order to measure and characterise the pharmacodynamic effects of active molecules in the human body, to assess their pharmacokinetic features, and to evaluate both their biological and clinical innocuity and efficiency. Such clinical trials rely notably on the cohorts and registries controlled by the hospital services, the clinical research centres and the clinical research units within the perimeter of Université Paris-Saclay.

Another particularly relevant area of development for innovative therapies and medical devices in Université Paris-Saclay lies in the capacity to create synergies between the community of material scientists, nanoscientists and health scientists to produce advances in medical devices. This collaboration promotes advancements in medical devices. Furthermore, the interface of health with computer science and bio-manufacturing opens up promising avenues for innovation, leveraging synthetic biology and exploring biomaterials potential. These various activities in the domain of therapeutic innovation and medical devices are leading to an intense activity of technology transfer and start-up creation, which is supported by the various technology transfer support services in the area of Saclay, as well as by competitiveness clusters. The dense network of economic partners contributes to the success of technology transfer, with collaborations with national and international pharmaceutical companies and many biotechnology companies.

Applying a multidisciplinary approach to public health and life-circumstance well-being. Université Paris-Saclay is one of the cradles of French epidemiology and health research. Today, it is home to a very large community in the domain, which leads multidisciplinary

THE EUROPEAN UNIVERSITY ALLIANCE FOR GLOBAL HEALTH (EUGLOH)

EUGLOH is a strategic partnership between Université Paris-Saclay and eight other universities across Europe in the context of the European Commission's European Universities Initiative.

Within the EUGLOH alliance, part of the main aims are in establishing a long-term strategic alliance focused on the pursuit of excellence in the field of global health across nine diverse and complementary partner institutions located in all four corners of Europe (North, South, East, West).

It also focuses on acting as a driving force in solving global health challenges ranging from public health, emerging diseases, climate change and environmental hazards to digital technologies and predictive, preventive, participative and personalised medicine.

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research ranging from epidemiology, clinical research, and biostatistics to social sciences and humanities. They cultivate an integrative perspective which combines fundamental biological phenomena with environmental aspects, as well as a concern for social inequalities and culture. This research notably benefits from large-scale studies and data collections and resorts to a wide range of methods including large-scale statistical techniques and bioinformatics.

An important dimension of the work conducted in this respect at Université Paris-Saclay deals with the ethical issues raised by medical and scientific advances in public health. Future challenges include notably the integration of the spectacular progress in the exploitation of large-scale data sets, including through the use of artificial intelligence. Another key issue requiring a strong multidisciplinary approach is the chronicisation of diseases, as well as the growing impact of environmental risk factors. A third such momentous challenge deals with the need for regulation evolution which systematically appears with advances in care and requires the combined efforts of pharmacologists, health care specialists, jurists, political scientists, economists, etc. All these challenges make it absolutely necessary to increase synergies between methods and disciplines to support the quick evolution of research questions.

In line with this, Université Paris-Saclay's research teams are strongly committed to leveraging their comprehensive understanding of diseases and pathologies to improve well-being in diverse life circumstances. This includes addressing challenges such as ageing, disability, and ergonomics. The aim is to promote a multidimensional quality of life, whether that means preserving well-being as populations age, encouraging physical activity, improving workplace conditions, or developing means to compensate for disabilities. Two key lines of development in this respect include (1) the integration of health sciences with humanities and social sciences; (2) the research in the area of human-machine interaction through user-centred methods, with applications ranging from the training of social skills for children on the autistic spectrum, to motivational applications for back-pain or diabetic patients.

Accelerating our understanding of global health challenges. Université Paris-Saclay is actively supporting the recent attention to the "global" dimensions of health, which articulates its human, animal, vegetal and ecological aspects. The university notably benefits in this respect from the expertise of research teams coming from economics and management sciences, which are studying the economy and management of the health sector, territorial health policies, as well as the articulation between nutrition and health from a political and social point of view. Our understanding of the preconditions of health, therefore, extends to that of the management of health institutions and of the underlying factors explaining health inequalities. This emphasis placed on global health is particularly relevant to prevent zoonoses and pandemics. The teams at Université Paris-Saclay are also actively contributing to the "one health" paradigm, notably by setting up a new health clinic in France dedicated to health law, biotechnology law and the law of living organisms.

2. ENERGY, CLIMATE, ENVIRONMENT, SUSTAINABLE DEVELOPMENT

The momentous challenges generated by rapid climate change are currently making us question the fundamentals of our collective organisations and ways of life. The urgency to transition away from fossil fuels combines with issues of fairness and social justice as we need to deal with the increasing scarcity and eventual exhaustion of resources, sovereignty issues, and various forms of pollution which expand the environmental impact beyond just global warming. While scientists have documented the ongoing environmental transformation for more than five decades, social awareness of their gravity has only begun to catch up recently which has led to collective tensions. Consequently, addressing these multifaceted challenges necessitates a collaborative approach that draws insights from all sciences, from experimental to social & political sciences. This integration and collaboration is crucial in harnessing the potential

of our enhanced abilities in for instance data, producing synthetic materials and understanding social dynamics.

EXISTING ASSETS

Université Paris-Saclay holds a prime position to contribute significantly to this massive, existential challenge that currently engrossed global efforts:

- The various scientific communities relevant to tackle these challenges benefit from a long-term experience of scientific collaboration both in research (with the example of the Strategic Research Initiative SpaceObs launched in 2017) and in education (with the example of the STEPE Master's programme (Sciences de la Terre et des Planètes, Environnement - Earth & Planetary Sciences, Environment), created in 2013, to offer students comprehensive training covering all aspects of Environment Sciences, and the sciences of planets and the earth system.

- Natural science labs in the domain benefits from a complete chain of methodological competencies, going from experimental settings to spatial observations and field work to process modelling.

- Université Paris-Saclay is lucky to host several internationally-recognised laboratories in the domain and is one of the pillars of the Institut Pierre Simon Laplace, a key international hub for climate sciences.

- Université Paris-Saclay is intricately woven into major national, European, and international networks, catering to data gathering, data sharing, and earth and space observation (for instance: observation networks NDACC, SIRTA, RENOIR, or research infrastructures ACTRIS, ICOS, CLIMERI, PARADISE, REGEF).

- Lastly, a distinguishing feature of Université Paris-Saclay is its implication in assessing the scientific knowledge underlying social debates at the highest level, as exemplified through the active and long-standing involvement of its scientists in the IPCC and the IPBES.

ACTIVE FOCUS AREAS RELATED TO THIS CHALLENGE AT UNIVERSITÉ PARIS-SACLAY

Enhancing the sustainability of socio-political systems. Université Paris-Saclay is host to many teams in the fields of economics, management, law, political science and social sciences who are directly contributing to tackling the various dimensions of this challenge. Axes of research and training include notably ways to enhance the sustainability and resilience of socio-political systems, starting at the individual scale and going up to the level of organisations. A common thread being pursued by Université Paris-Saclay's social scientists is that of the mutation and evolution of socio-political systems so that they can evolve towards more sustainable equilibrium. Approaching such questions requires the combined insight from organisational sciences as well as public policy design, implementation and evaluation.

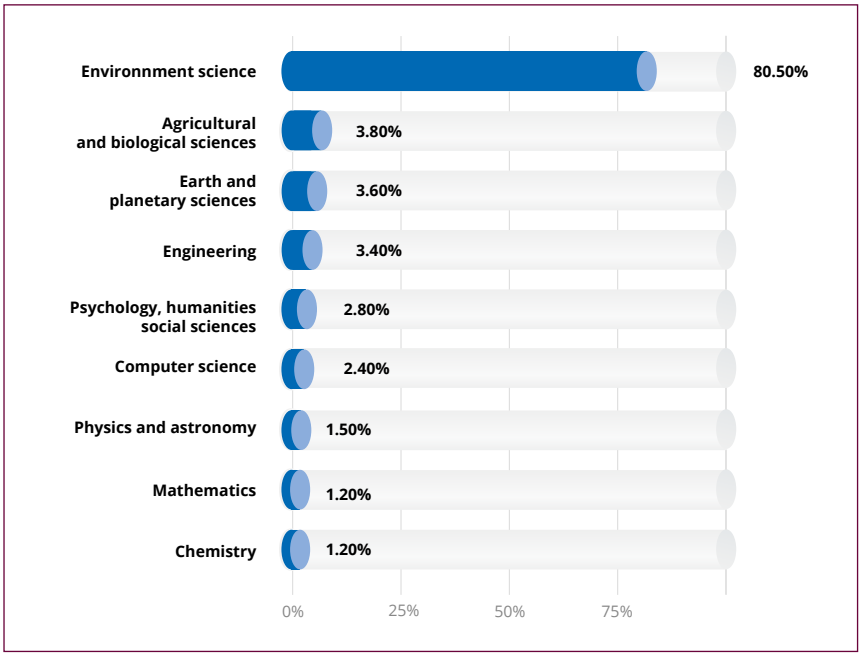
Specific areas of applications of these reflections include, for example, the collective management of landscape and agricultural / food value chains, in order to foster ecosystems preservation and diversity. The lens of political science is of course particularly relevant, as we need to develop new approaches for environmental evaluation, foster collective management practices and care for environmental commons. Another key area of application is that of political and management strategies to tackle the reduction of greenhouse gas emissions and carbon capture to mitigate climate change, and to facilitate transitions in the energy mix.

An asset brought by the work done by Université Paris-Saclay's team in this respect is the emphasis placed on the geographical and territorial dimension of environmental issues and on the transition of socio-ecological systems. Legal expertise on topics related to the environment (sustainable development, biodiversity, climate change, energy transition, etc.), terrestrial or extra-atmospheric space, as well as natural common goods (air, water, protected environmental zones, vegetal and mineral resources, etc.) is also being developed. Finally, as these issues profoundly affect the social contract and the political equity in sharing the burden of the transformations, topics such as intra-generational and inter-generational justice and fairness are being explored, with the aim to understand how to properly deal with the global changes induced by the environmental and ecological transition.

Understanding the fundamental dynamics behind climate change. A necessary condition to face the current energy, climatic, environmental and ecological challenges is to advance our understanding of their complex and intertwined mechanisms. At Université Paris-Saclay, scientific teams are developing new methods, experimental approaches and simulations to measure and study greenhouse gas emissions, aerosols emissions and their precursors, to track the evolution of the composition of the atmosphere, of reactive species, and of the water cycle. Paleoclimatologists are providing a long-term perspective to decipher the dynamics of the climatic system and forecast its evolution, thus shedding light on past, present and future climates. Another key area of research deals with the study of continental and marine hydrosystems to characterise

biogeochemical cycles at different scales (from local to global). Similarly, other projects aim to research the composition of soils and subsoils to understand the potential for exploitation while also considering how to mitigate the adverse consequences of using natural resources.

Improving climatic forecasts and better understanding the impact of climate and environmental change demands data at the right spatial and temporal scale, in order to understand the underlying dynamics and provide actors with relevant information. An open scientific path for improvement and exploration lies with the documentation of human activities and territories evolution at a very small scale, both spatially (a city, a catchment area, a definite agricultural area, a forest massif, etc.) and temporally (very short time-spans to refine weather forecasting, notably for extreme events, and 20-30 years spans for climate projections). We also need to better understand the interplay between the various scales, and focus on the modelling of the major transitory periods of the past (e.g. deglaciation period) to disentangle natural from anthropic influences and grasp better feedback loops in geoclimatic evolutions.



Distribution of publications relevant for energy, climate, environment, sustainable development.
The graph is read as follows: among the publications of Université Paris-Saclay in energy, climate, environment, sustainable development, 80.5% pertain to environmental science. Note that the total might be superior to 100% because one publication can pertain to several fields.

Deciphering the interactions between human activities and the environment. Our teams are also involved in providing more accurate descriptions of the interactions between all aspects of human activities (ecological, physical, biological, chemical and economic) and the environment. A focus point deals with the interactions between the biosphere, the atmosphere and the climate, in particular through agrosystems. This implies evaluating economic factors and the impact of human activities, mobilising a wide range of disciplines: environment sciences, soil sciences, biology, ecology, agronomy, ecotoxicology, physics of the atmosphere, (bio)climatology, economics, sociology, political science.

UNIVERSITÉ PARIS-SACLAY'S RESEARCHERS LEADING THE WORKING GROUP I OF THE IPCC

After Valérie Masson-Delmotte in 2015, Robert Vautard has been designated Chair of the Working Group I of the IPCC, devoted to the physical science basis of climate change.

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Designing sustainable, efficient, low-carbon-footprint energy systems. Université Paris-Saclay can rely on consolidated expertise investigating the potential of (nano) materials and systems for the development of technologies adapted to the sustainable production, storage, distribution and use of energy. Energy production, storage and distribution are indeed major levers for the ecological transition, which requires taking into account the specific constraints of each sector in terms of security, reliability, dispatch, etc.

Université Paris-Saclay's teams are strongly involved in the development of new technologies to produce a low-carbon-footprint energy, notably through the characterisation and synthesis of nanomaterials, in link with photonics and electrochemistry, or through the development of materials and reactors adapted to produce green hydrogen. Indeed, the efficiency of such new techniques strongly depends on our capacity to develop new materials (and notably new catalytic materials) and new processes, to support the design of effective batteries, fuel cells, (photo)catalytic systems, (photo)electrochemical systems, which need to make limited use of critical resources and should be easily coupled to distribution networks. Université Paris-Saclay also boasts very strong expertise in the field of electrical engineering, which is of particular relevance to accelerate the energy transition and the development of innovative and sustainable energy production, smart grids, as well as storage and distribution systems. Activities span a continuum from the synthesis and characterisation of materials to the design and the development of new efficient systems, trying to find the right

compromises between contradictory demands: improving the reliability of energy, miniaturising energy production systems, transitioning towards more sustainable and more ecological energy, etc.

Balancing needs for resources and environment preservation. The exploration and exploitation of biodiversity is a key domain of interest to develop new molecules with relevant economic, pharmaceutical and biotechnological properties in a context of scarce natural resources. The exploration of biomass and its residue is opening a promising path to offer renewable carbonate raw materials, as alternatives to petro-sourced chemistry for the production of molecules of high industrial interest. At the interface of biology, chemistry, engineering and industrial applications, the development of catalytic sciences is paving a promising path to valorise waste and develop an eco-responsable circular economy. Université Paris-Saclay's teams bring to this effort in-depth expertise and a capacity to design active systems in organocatalysis, metallic and organometallic catalysis, electro-, photoredox- and biocatalysis. Other major environmental questions being tackled by our teams revolve around the assimilation of azote and phosphorus by plants, as well as the detection, degradation, valorisation and treatment of pollutants and industrial byproducts.

Developing advanced data analysis methods and instrumentation to support investigation. The understanding of terrestrial and planetary climatic evolution is critically dependent on the production of complex, massive and heterogeneous data. This challenge is therefore heavily dependent on the recent evolution in data production, analysis, management and the interaction with mathematics and computer science is essential. The scientific issues are also pushing the boundaries of our data visualisation methods, and creating new bridges between the physical modelling in earth and environmental sciences, and recent Artificial Intelligence approaches. The need for more accurate, fine-grained and timely data is also creating a need for better instrumentation and data sensors, where Université Paris-Saclay can bring top-level experience in the development of active and passive instruments for atmospheric monitoring, geophysical soil analysis, or isotopic material dating.

Microscope experiment at the Food Process Engineering and Microbiology Laboratory (Univ. Paris-Saclay/INRAE/AgroParisTech).

Carme Arisa/Université Paris-Saclay

3. BIODIVERSITY, AGRICULTURE AND FOOD

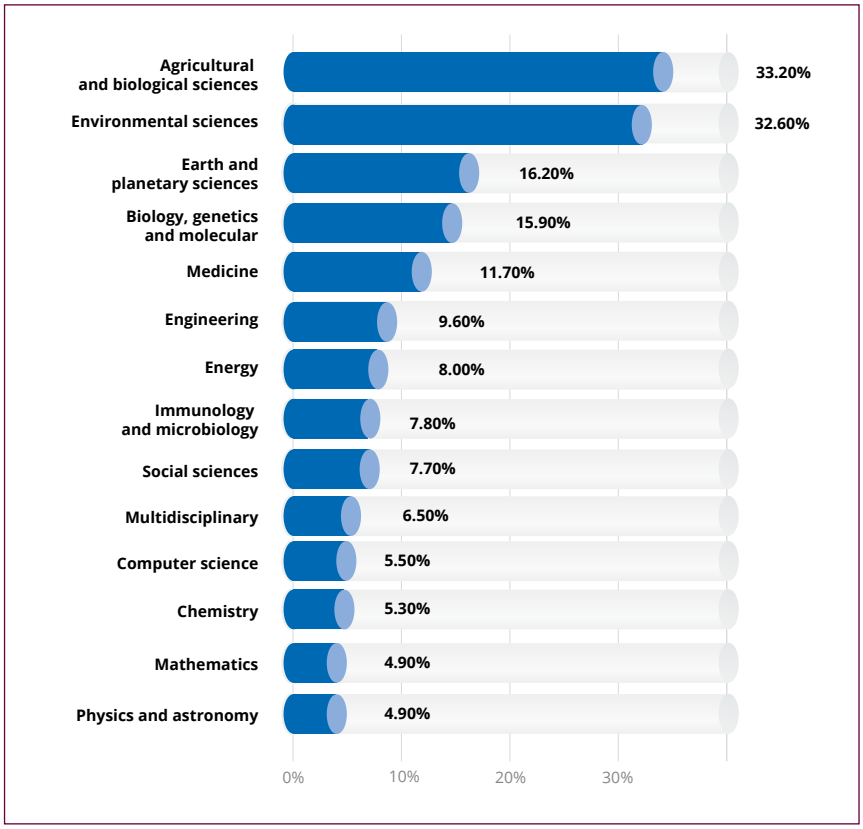
The challenge of "Biodiversity, agriculture and food" articulates the environment and essential human needs and practices. This challenge requires a nuanced understanding that encompasses not only the quantity but also the quality of food, with a special focus on the interplay between nutrition and public health. The environmental risks associated with food production, such as soil degradation, water scarcity, and biodiversity loss, are critical considerations. Livestock farming also presents unique challenges, situated at the intersection of food security, health, climate change, and ethical considerations.

The global and systemic dimension of this challenge, which requires the capacity to articulate contextual and local considerations, with a sensitivity for world-wide interconnections, makes the extensive international network of Université Paris-Saclay particularly relevant: as an example, we are leveraging existing membership in the European Bioeconomy University network. Because it requires the capacity to analyse large amounts of data in a multi-scale perspective, this challenge is also strongly dependent on the development of new analytical tools and digital capabilities.

At stake is not merely the question of producing enough food of the desired quality but also of distributing it where it is needed most, as poor infrastructure, conflict, and climate change contribute among others to the imbalances in food availability. This imbalance frequently leads to dependency on food imports and compromises a nation's sovereignty, leaving it vulnerable to external political and economic pressures. This challenge is particularly pressing for regions where rapid urbanisation, lack of resources, and natural adversities have often made local agricultural efforts insufficient.

To transition to sustainable methods that can bolster

biodiversity and maintain a richer and more resilient ecological tapestry for future generations, we are also deeply committed to preserving biodiversity and minimising environmental impact. Teams of researchers at Université Paris-Saclay not only focus on the science behind these elements but also emphasises the social, economic, policy and scientific aspects. This includes a dedicated effort in merging agroscience with ecology, understanding the complexities of food systems and ensuring public engagement in biodiversity policies. We, at Université Paris-Saclay, strive to illuminate the importance of each research area in preserving our future.



Distribution of publications relevant for biodiversity, agriculture and food.
The graph is read as follows: among the publications of Université Paris-Saclay in biodiversity, agriculture and food, 33% pertain to agricultural and biological sciences. Note that the total is superior to 100% because one publication can pertain to several fields.

EXISTING ASSETS

Université Paris-Saclay's unique stature in the field of agriculture science stands out for several defining reasons:

- Our emphasis on agricultural sciences is evident through the depth and density of our capabilities in this domain, which is built upon partnership collaborations.
- Université Paris-Saclay also benefits from a network of original technological platforms as well as observational and experimental installations.
- An important asset in this respect is the long experience of Université Paris-Saclay's teams in approaching this challenge with a multidisciplinary lens, which is visible in the image on the right, representing the many different disciplinary fields contributing to the research output related to that challenge. Many research teams in Université Paris-Saclay from a range of academic disciplines frequently collaborate with each other. These collaborations can be regular or on an ad hoc basis, especially within specific interdisciplinary projects within the university.

ACTIVE FOCUS AREAS RELATED TO THIS CHALLENGE AT UNIVERSITÉ PARIS-SACLAY

Investigating resource pressures and ecosystem balance. Teams at Université Paris-Saclay are dedicated to the study of natural resources, and their focus is on understanding the essential services provided by ecosystems, from research on water and water systems to international biodiversity policy. This research is vital to maintaining biodiversity and human well-being, and requires a holistic approach, involving environmental assessment, willingness-to-pay evaluation, and participatory and collective management of the commons. Our scientists also contribute to this category with its focus on understanding the complex dynamics of terrestrial and marine hydrosystems, characterising biogeochemical cycles, and studying soil and subsurface heterogeneity to improve management, exploitation, and environmental impact assessment.

Championing biodiversity in sustainable agriculture research. Université Paris-Saclay is working on major issues to understand and analyse the future of the biosphere and our societies, taking into account their environmental, social, economic and political dimensions. These issues contribute to food security and sovereignty and to global or ecosystemic health: the agro-ecological transition to promote sustainable agri-food systems from production (livestock, crops) to consumption; global changes and their impact on communities and ecosystems; the management and use of resources (soil and water); the

preservation of biodiversity and ecosystem services and, more generally, of the environment; regional development strategies incorporating the environmental dimension; food, nutrition, human nutrition and food transitions; the processing of bio-resources and the recovery of bio-waste.

C-BASC: A CENTRE FOR INTERDISCIPLINARY STUDIES ON BIODIVERSITY, AGROECOLOGY, SOCIETY AND CLIMATE

This interdisciplinary programme ambitions to contribute to the study and implementation of the United Nations' 2030 Agenda on Sustainable Development and the European "Green Deal".

It fosters research on the continuum of agricultural production, food processing, distribution and consumption to address key scientific and societal challenges.

Its foci include the transition to sustainable socio-ecological systems, ecosystem management and the ecological transition, the dynamics and management of biodiversity, and the promotion of sustainability in peri-urban territories.

C-BASC | université PARIS-SACLAY

Research activities at Université Paris-Saclay focus on the relationship between food design and engineering, nutrition and human health. We aim to bring together disciplines such as food science, food process engineering, consumer science, microbiology, physiology, toxicology, nutrition and epidemiology. This programme develops research on humans and animal models to meet the major economic and societal challenges linked to food and health: sustainability of food production processes; innovative ways to act on the nutritional, sanitary and organoleptic qualities of food; better control of environmental impacts; development of short-distance circuits adapted to local areas; impact of food and the exposome on development and health; food safety of populations and prevention of risks of emergence of new health risks; support for food transitions; development of personalised food.

Fostering sustainable agriculture through biodiversity research. Biodiversity forms the backbone of sustainable agriculture, providing a wide range of ecosystem services and fostering the development of bio-based industries. Research in this domain supports genetic variety and ecosystem resilience critical for crop and livestock health and adaptability. Teams at Université Paris-Saclay articulate such concerns with expertise in the field of bioeconomy, which leverages these biological resources to drive sustainable agriculture practices. Established infrastructure at Université Paris-Saclay allows us to focus specifically on biodiversity research for agriculture and food production. This research is conducted in the context of global change and the growing urban influence on agricultural land, and focuses on the functioning of agro-ecosystems in interaction with their environment. It uses the levers of agroecology to mitigate and adapt to climate change, to show that agriculture plays a part in the bioeconomy of territories and to move towards a global approach to health.

Transforming food systems through research insights. The concept of a food system offers an integrated vision of the different processes required to feed a population: agricultural production, food transformation & processing, food quality, marketing, and consumption. It raises a number of issues that are key to the ecological transition: sustainable resource management, the design of a metropolitan metabolism that enables cycles to be looped, the re-territorialisation of agriculture and food supply, and spatial justice. At Université Paris-Saclay, our teams explore themes like the territorial governance of public action (revitalisation of the urban/rural link, intersectionality of public policies for local supply and access to food), transformations in land tenure systems (access to land, coexistence of agricultural models, the fight against artificialisation), the dynamics of ecological transition contributing to healthy and sustainable food, the recomposition of food landscapes with a view to reducing socio-spatial inequalities (access to local and quality products for vulnerable populations). Our teams connect specialists of agriculture, ecosystems, economics and political science to stimulate research on these issues from the point of view of the analysis of social systems and public policies. This sociology and political science research agenda will be able to build on the momentum created by the VIVAGRILAB living laboratory on the Plateau de Saclay, into which the work being carried out could be integrated. Another relevant expertise of Université Paris-Saclay focuses on sustainable and circular bioeconomy, which investigates the production of resources (biomass), their transformation

and uses, to promote circularity. We are thus fully equipped to investigate the multifaceted relations between design and conception of food, nutrition and human health, by combining disciplines such as: food science, food processing engineering, consumer sciences, microbiology, physiology, toxicology, nutrition, epidemiology, etc.

Driving legal, public engagement and policy initiatives for biodiversity conservation. One of the characteristics of biodiversity is that it deals with long-term issues that require profound changes in lifestyles and related technologies and innovations. The question of the transformation of systems and their transition towards greater sustainability is therefore central to the work of Université Paris-Saclay, as well as the issue of socio-ecosystems and the management of agricultural lands and their rural and urban environments, in a context of transitions. The study of organisations and their evolution through the evaluation and design of public policies is therefore a core area of attention at Université Paris-Saclay. Université Paris-Saclay also has recognised expertise in legal research devoted to natural common goods such as air, water, protected environmental areas, plant and mineral resources by promoting the comparison of their legal regimes with other legal definitions of "heritage" (cultural heritage, personal heritage, genetic heritage).

Another highlight is the strong support to participatory science approaches: indeed, the study of biodiversity is one of the fields which pioneered participatory science, and continues to drive their deployment with approaches such as data collection, co-design of knowledge and the implication of citizens, decision makers and scientists in research projects. This also means that the role of expertise for decision makers and public policy is particularly emphasised in this domain, with a strong participation of Université Paris-Saclay's scientists in public expertise commissions (e.g. biotechnologies, phytosanitary risks, etc.), interprofessional technical commission on zoo-genetic resources, etc.

4. DIGITAL TRANSFORMATION AND ARTIFICIAL INTELLIGENCE

The digital transition has been taking momentum in the last decades, with a game-changing acceleration in the last few years. Central to this conversation are the advancements in artificial intelligence, not only revolutionising industries and societies but also ushering in a transformation of pedagogy. The maturity of AI has reached a point where its integration into various facets of life and work is not just beneficial but often essential. The challenge facing academia is twofold: firstly, there is the 'core AI' research and teaching aimed at developing new algorithms and addressing issues such as explainable, frugal, and ethical AI. Secondly, there is the need for educators in other disciplines to become adept at using AI as a tool that serves broader scientific and societal goals.

To meet the needs related notably to the development of AI, the university has established AI and data infrastructure for training and research through the Mesocentre at Université Paris-Saclay, thereby equipping itself to navigate the computational demands of this transformative technology. This infrastructure also facilitates our efforts in ethical AI, allowing us to place training and research at the core of responsible AI development.

Université Paris-Saclay's academic staff enable this combination of legal and technological expertise, as our teams' work underscores the necessity for appropriate legal frameworks to manage the ethical, privacy, and societal implications of digital transition

The research challenges concerning digital transformation and AI connect to many other research areas, ranging from fundamental physics (for the development of future quantum computers) to social sciences (to design responsible and ethical AI models), life sciences (with the recent successes of bioinformatics) or engineering sciences (e. g. for the design of future materials). This interdisciplinary reach underscores the complexity and breadth of the technological landscape, indicating that any attempt to understand or guide it will require concerted efforts across multiple domains of human knowledge.

Its development will not just shape but will be shaped by advancements in numerous other fields. Given this interconnectedness, a siloed approach to AI research and policy would be insufficient for capturing the full scope of its implications and opportunities. Instead, a wide-ranging, collaborative effort is needed to navigate the nuanced challenges and potentials that the digital age presents.

EXISTING ASSETS

Université Paris-Saclay is remarkably positioned to address the cutting-edge areas of digital transformation and artificial intelligence:

- Teams at Université Paris-Saclay are actively engaged in tackling the major challenges of the digital transition:

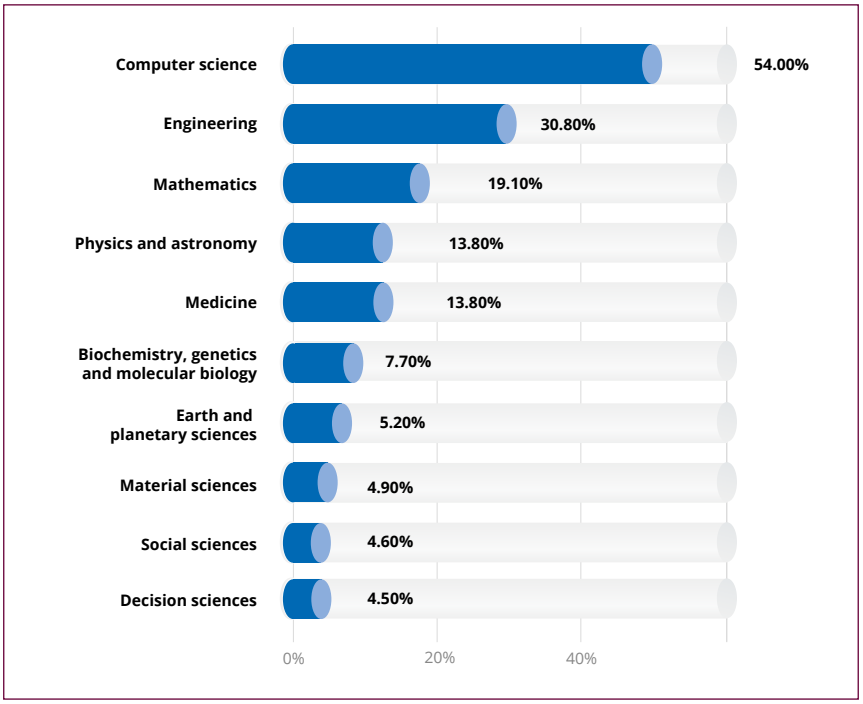
- Protection of data, calculations, and exchanges: this includes cybersecurity measures, ensuring system reliability, and safeguarding privacy.
- Programming and Architectures for Distributed Systems and Quantum Computing: researchers are exploring the frontier of quantum computing as well as how to develop robust and efficient distributed systems.
- Applications in Health and Biology: from digital health solutions to advancements in bioinformatics, this area focuses on how digital technologies can revolutionise healthcare and biological research.
- Communication Networks of the Future and the Creation of a 'Sustainable' Digital World: sustainability is an emerging concern, encompassing the energy-efficient design of future communication networks as well as the broader environmental impact of digital technologies.
- Human-Machine Interaction and the Seamless Integration of Digital Technology into Systems: this entails designing intuitive and adaptive interfaces and ensuring that technology augments rather than disrupts human activities.
- Robotic System Design and Digital Twins: research here focuses on creating more efficient and intelligent robotic systems, as well as developing digital twins that can simulate and predict real-world behaviour.
- Signal and Image Processing: this area deals with improving the techniques for analysing and interpreting signals and images, critical in sectors ranging from healthcare to entertainment.
- Issues of Rights, Use, Health, and Equity in Tomorrow's Digital Society: beyond the technological aspects, researchers are also delving into the ethical, legal, and social implications of digital transformation, seeking to ensure it is carried out in a way that is equitable and just.

• Paris-Saclay houses a comprehensive ecosystem of infrastructures:
  - Research infrastructures like DATAIA, an interdisciplinary institute at Saclay focused on advancing data sciences and artificial intelligence across various sectors like healthcare, transport and energy, and *Maison de la simulation*, a research centre dedicated to fostering computational simulations in multiple scientific disciplines ranging from climate models to biological systems.
  - Paris Saclay is involved in new training schemes as those developed in the simulation lab at the Faculty of Medicine (LabForSims). Students and professionals can acquire new skills thanks to various simulatory procedures, and a continuous training of the teachers is developed.
  - We are engaging constantly with independent service entities geared towards societal engagement and innovation, like VEDECOM, IRT SystemX, and SATT Paris-Saclay.
  - Our expansive multidisciplinary approach in the fields of digital transformation and artificial intelligence is effectively showcased in our publication records. The figure below details our areas of research pivotal for understanding the full scope of digital and AI advancements.

ACTIVE FOCUS AREAS RELATED TO THIS CHALLENGE AT UNIVERSITÉ PARIS-SACLAY

Tackling social and ethical issues at the same pace as technological advances. The rapid pace of scientific and technological development in the digital sector in general, and in AI in particular, is raising a series of challenges to social, political and legal systems, which require the joint efforts of various disciplines as well as non-academic stakeholders. Such challenges revolve around three main topics. Firstly, ethical issues surrounding the development of AI, from concerns for biases and discrimination, to questions of explainability and safety are immense and require the combined expertise of AI specialists, legal scholars, political scientists and sociologists. Secondly, digital technologies raise the risk of growing inequalities both in terms of access and in terms of digital literacy, which need to be tackled now. Thirdly, new issues of privacy and protection of individuals rights are arising with the development of new applications and require fast regulation at the same time as we maintain space for experimentation and innovation. Université Paris-Saclay's academic staff enable this combination of legal and technological expertise, as our teams' work underscores the necessity for appropriate legal frameworks to manage the ethical, privacy, and societal implications of digital transition.

Developing as well as framing AI and data sciences. Université Paris-Saclay comprises multiple departments contributing to this innovative domain, known worldwide for their pioneering research in diverse areas such as machine learning and artificial intelligence, data science, big data management, and natural language processing. With the support of the DATAIA institute, Université Paris-Saclay aims to improve the state of the art in data science, preparing the emergence of innovative artificial intelligence services (from algorithms to proofs of concepts), and to join the human sciences and the digital revolution. This institute provides the links to foster the dialogue between the academic and the industrial communities and consolidate the international visibility and expertise of the Paris-Saclay AI community by hosting major scientific personalities. DATAIA brings together experts of the highest international standards in various disciplines: mathematics, computer science, physics, life sciences, economics and management, humanities and social sciences. This disciplinary breadth is an unparalleled opportunity in France, covering the entire spectrum of data science and artificial intelligence as well as societal issues.



Distribution of publications relevant for digital transformation and artificial intelligence.
The graph is read as follows: among the publications of Université Paris-Saclay in digital transformation and artificial lintelligence, 54% pertain to computer science. Note that the total is superior to 100% because one publication can pertain to several fields.

Exploring the potential of quantum computing. The rise of quantum computing and communication, and the establishment of the qubit as a fundamental concept, offers new foundations for computer science as a science, as well as new research opportunities. Conversely, computer science plays an essential role in research into the quantum world. Université Paris-Saclay has a Quantum Centre to develop research on post-quantum cryptography, the design and verification of quantum programmes, and quantum simulation. The university itself is at the forefront of quantum communication technology, researching compact photon sources, stationary quantum states, and non-thermal phases of matter. These cutting-edge explorations seek to challenge existing scientific paradigms and instigate the genesis of novel quantum information concepts. By concentrating on quantum technology, we pave the way for breakthroughs in secure communication and ultra-high-speed computation. In this domain, fundamental research activities at the highest international level are matched by an important innovation and entrepreneurship effort - as represented in the case of Alain Aspect, Nobel Prize laureate in Physics and co-founder of the Quandela startup.

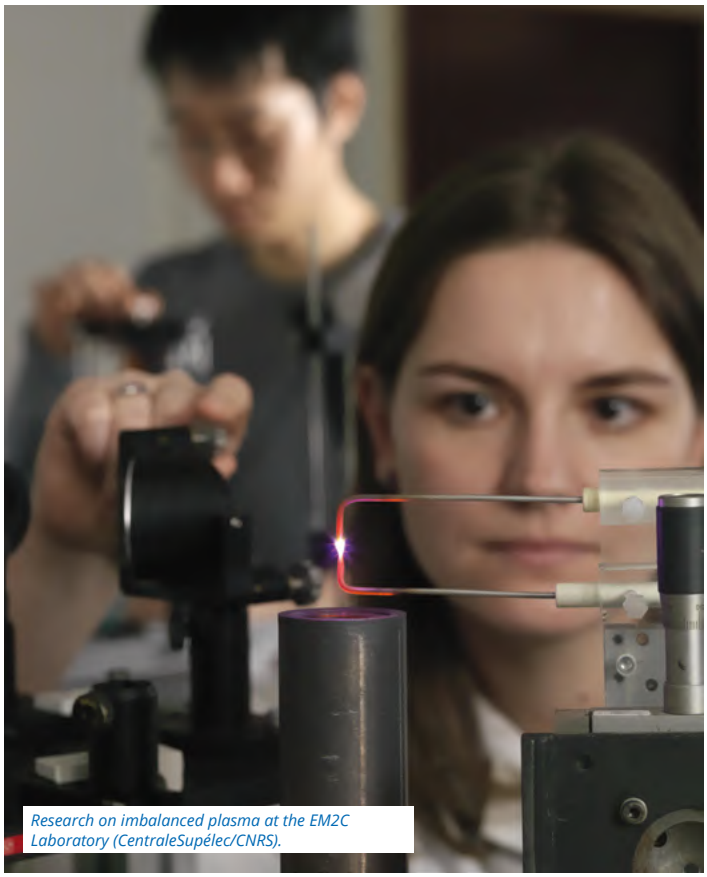
Improving health and well-being via digital advances. Université Paris-Saclay channels the digital transformation paradigm through the prism of health from clinical to public health. By advocating innovative research in large-scale health data analysis fused with computational sciences, they help develop artificial intelligence applications from theory to a safe and usable digital format to help healthcare systems. Our researchers also highlight the transformative power of AI in scientific research. By exploring the utilisation of machine learning, neural networks, and AI, this school emphasises the potential for AI to revolutionise every stage of the research process. From the inception of a hypothesis to its translation into real-world application, the work being done at Université Paris-Saclay showcases how AI can expedite and enhance public health research. On the side of medicine, imaging and biosensing for diagnosis and disease detection (particularly non-invasive) are a major research challenge. A great deal of translational research is associated with this area, particularly in terms of diagnostic tools, modulation of the microbiota and intervention coupled with clinical trials. The challenge is to make optimal use of the new digital technologies in a context of personalised medicine. Strong collaboration with mathematical and AI organisations is crucial.

THE "AUGMENTED OPERATING ROOM": DIGITAL ADVANCES FOR SURGERY

Launched in January 2020, the *Bloc Opératoire augmenté* group accelerates the development of digital technologies, whether in development or already existing, which make it possible to increase the senses (sight, speech and touch) of the various staff in the operating room. These devices that help improve practices are tested in a space that includes a "mock operating room".

Hôpital Paul Brousse AP-HP

Improving interfaces: human-machine interaction. Université Paris-Saclay regroups over a hundred researchers in the field of Human-Computer Interaction, which makes it a distinguished leader in this domain. Our research aims at building new adaptive interfaces using AI algorithms, developing the future of multimodal interactions, conversational systems and interactive robotics (from autonomous vehicles to exoskeletons and medical devices) and inventing the next generation of data visualisation. Our researchers lead the Equipex+ Continuum project, that aims aims to build a unique collaborative research infrastructure composed of 30 platforms located all over France, to develop new models for visualisation, interaction, perception, human cognition, immersion, and collaboration, in the context of virtual and augmented reality. All of our research is driven by the importance of human-centred computing, as we aim to transcend the limitations of current modalities and devise interfaces that are natural extensions of human intent. New uses of digital systems and AI push the limits of existing technology and force us to reconsider our fundamental assumptions about interaction design, to invent data-centric interactive systems and to understand how digital devices can help people in their everyday life. To address this challenge, our labs have long developed interdisciplinary research that combines human cognition and ergonomics with computer science and robotics.



Research on imbalanced plasma at the EM2C Laboratory (CentraleSupélec/CNRS).

CentraleSupélec

5. TRANSPORTATION AND MOBILITY

Interculturality and an openness to the world are cornerstones of a healthy democracy and these values help facilitate mutual understanding and respect among individuals and nations. They require transport and mobility as necessary conditions for interactions and the exchange of ideas at all scales: not just international but also intrinsically local, whether it is commuting or increasing accessibility in rural areas. Therefore, it becomes crucial for us to address transport solutions at both local and international levels, while also considering their environmental impact. In this way, we can responsibly develop sustainable travel solutions that allow continued connectivity without compromising future generations. Scientific barriers are emerging in the face of these new challenges, and recent technological developments are questioning fundamental knowledge about how we mitigate the environmental impact of transport, society organisation and how we can ensure fair access to transport for all members of society, for example.

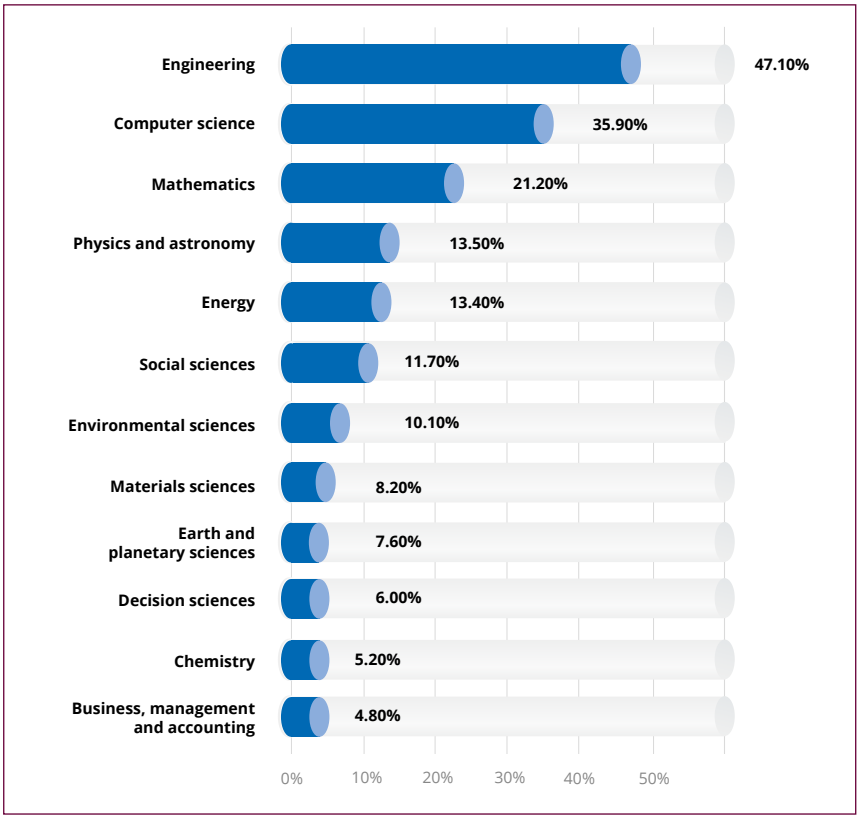
In this context, Université Paris-Saclay serves as an important hub which fosters support skills for the dynamic scientific communities addressing these research fields. Here, we are continuously innovating, creating new tools and methodologies to change the way in which we move as a society. Our transport research spans smart cities, autonomous vehicles, and logistics, emphasising the automation of tasks, machine-human interaction, and robotics. We are incorporating major shifts in electrical infrastructure. In addition, in recognising that mobility needs to be facilitated at all scales we therefore also prioritise individual ergonomics and human movement. Here, we are dedicated to creating mobility solutions for those with disabilities, addressing occupational injuries, and enhancing Human-Computer Interaction.

EXISTING ASSETS

In the world of transport, civil engineering and mobility, Université Paris-Saclay's position and contribution to these challenges are being thoroughly engaged with for several reasons:

- We cultivate strong ties with our partners around specific concerns like transport and civil engineering. These connections delve into everything from societal considerations down to individual-level analyses, emphasising a holistic view of mobility structures in society.

- Our commitment to health research dynamics and our role in research-driven training accentuates our



Distribution of publications relevant for transportation and mobility.
The graph is read as follows: among the publication of Université Paris-Saclay in transportation and mobility, 47.1% pertain to engineering. Note that the total is superior to 100% because one publication can pertain to several fields.

mission to embed health and well-being considerations in transport and mobility solutions.

- Our publications breakdown in the realm of transport and mobility paint a vivid picture of our depth and breadth of expertise. The diagram above showcases our expansive reach in research fields focusing on these topics.

ACTIVE FOCUS AREAS RELATED TO THIS CHALLENGE AT UNIVERSITÉ PARIS-SACLAY

Elevating the efficiency through Smart Grids for transportation. The central position of the electricity vector and the massive electrification of systems are leading to major changes in electrical infrastructure and usage. Electricity networks such as smart grids or µ-grids, whether connected or isolated/embedded, with or without storage, are responsible for transporting and distributing electrical energy, incorporating extensive instrumentation. The aim of Université Paris-Saclay is to push infrastructures as close to their physical limits while considering the diversity of energy sources, including renewable and intermittent sources, as well as the various uncertainties associated with consumer behaviour and global diversity.

One of our focuses at Université Paris-Saclay is on new paradigms that are therefore needed for optimal management of flows and storage of electrical energy in these networks. Energy conversion chains, made up of power electronic and electromechanical converters, are subject to severe integration constraints in harsh environments. This is particularly true in the field of mobility, with the increase in on-board electrical power and voltages. As a result, we are focused on improving the current infrastructure by calling into question the current structures, topologies and control of power converters, which must integrate physical and technological constraints such as the introduction of wide-gap electronic components, the physical phenomena associated with voltage rise and the use of electromagnetic or functional materials under high mechanical and thermal stress.

Assessing the sectoral influence on smart transport evolution. In the sphere of smart and autonomous transport systems, through our digital science research teams, Université

UNDERSTANDING AND IMPROVING URBAN MOBILITY

Smart cities must allow an urban or peri-urban territory to adapt dynamically to the human and goods mobility and transport needs of citizens as well as public and economic actors at different time scales. This, without depriving elected representatives of their governance capacity, and by anticipating the evolution of the organisation of the territory and its activities. In this context, Université Paris-Saclay supports interdisciplinary research programmes with the objectives of:

- Understanding urban mobility
- Enabling agile and coordinated governance of mobility means and infrastructures
- Allowing mid and long-term dimensioning, deployment and adaptation of equipment

Paris-Saclay has been making significant strides. In this area our research focuses primarily on three application areas: smart cities, autonomous vehicles, and logistics. Automation in the broadest sense includes both the field of automation of tasks by machines operating without human intervention, as well as that of automated systems, which today take a variety of forms: autonomous, collaborative/communicating, assistance systems, interacting with humans or with other living or artificial systems. This capacity for autonomy in terms of energy, decision-making and mobility is also a major objective of robotic systems, which closely links the two fields of automation and robotics. Our researchers approach fundamental questions regarding the use of networks for inter-vehicle communication and cybersecurity in all its infrastructures. This involves multi-disciplinary research combining applied mathematics, artificial intelligence, digital sciences, law, ethics, economics, policy, computer science, and electronics.

The aim of Université Paris-Saclay is to push infrastructures as close to their physical limits while considering the diversity of energy sources, including renewable and intermittent sources, as well as the various uncertainties associated with consumer behaviour and global diversity

Enhancing experiences: ergonomy engineering in human movement. A focus on smart transport at a societal scale cannot lead us to lose focus on exploring the individual ergonomics and engineering, as the effectiveness of broad mobility solutions hinges upon how well the physical and cognitive needs of individuals are catered for. Therefore, understanding the individual needs of citizens and retaining a focus on individualism within movement is a key aspect of the research conducted at Université Paris-Saclay.

Université Paris-Saclay has been leading the way with innovative research in the field of mobility assistance and accessibility. Our multidisciplinary projects focus on overcoming transport and mobility challenges faced by individuals with disabilities. These projects represent the intersection of fundamental and applied sciences, creating practical solutions that enhance the quality of life for individuals with physical impairments. For instance in France, nine out of ten occupational injuries are musculoskeletal disorders (MSDs). Certain risk factors, such as repeated, forceful movements associated with inappropriate postures, are found in many occupational activities. In order to detect and prevent these MSDs, as part of a physical ergonomics approach, we are developing a method combining the continuous measurement of joint angles with the automation of a risk score calculation, applied in several professional fields.

Additionally, research into Human-Computer Interaction is exploring user-centred methods for designing and evaluating interactive applications based on movement: for example, virtual and tangible training in social and motor skills for children with Autistic Spectrum Disorders, and motivational applications for patients suffering from low back pain or diabetes. Robotic assistance is also a promising avenue for motor rehabilitation and/or MSD prevention. The benefits of robotics, which include flexibility, repeatability, and precision, form the foundation of their usage. One line of research involves analysing, modelling and optimising interactions between a human and an upper limb robotic exoskeleton. The aim of this work is to meet the challenges of well-being and lifelong adaptation for all (able-bodied and/or disabled).

6. AERONAUTICS AND SPACE

Continuously striving to expand the frontiers of human exploration, aeronautics and space research have played a central role in driving technological progress. Over the years, solutions to previous space-related challenges have yielded numerous spin-off technologies that have now become integral parts of our everyday lives. However, as we venture further into space, new complex problems emerge that demand innovative solutions, encompassing a wide range of aspects. Technological hurdles, such as improving materials, propulsion systems and communication networks for long-duration missions are ongoing research areas. Human space exploration also poses unique questions, related to the health effects of space travel, resource utilisation, and logistical complexities associated with extended missions. Furthermore, space debris management remains a pressing concern, as the number of satellites and debris in orbit increases, endangering operational spacecraft and hindering future missions. Closer to home, aeronautical research also faces its own unique set of challenges in advancing aviation capabilities. Enhancing aerodynamics and fuel efficiency, reducing noise pollution, ensuring safety and reliability, and integrating autonomous systems are ongoing priorities.

Addressing these challenges requires interdisciplinary collaboration, cutting-edge technologies, and a commitment to improving the efficiency, safety, and sustainability of air transportation. Beyond that, it is also crucial to find a responsible approach to these issues, taking into account the environmental, ethical, and legal aspects. Balancing the pursuit of scientific discovery and technological advancement

with considerations of sustainability, responsible use of resources, and international cooperation will be critical to the future of aeronautics and space exploration.

With a diverse range of expertise and multidisciplinary collaboration at its core, Université Paris-Saclay is at the forefront of tackling the challenges presented by aeronautics and space exploration. Leveraging its rich tradition of space research, advanced capabilities in astronomy, astrophysics, and fluid mechanics, as well as a strong emphasis on digital science and legal considerations, the university is poised to drive scientific advancements, develop cutting-edge instruments, address issues of life's origins, and navigate the evolving legal landscape of outer space exploration.

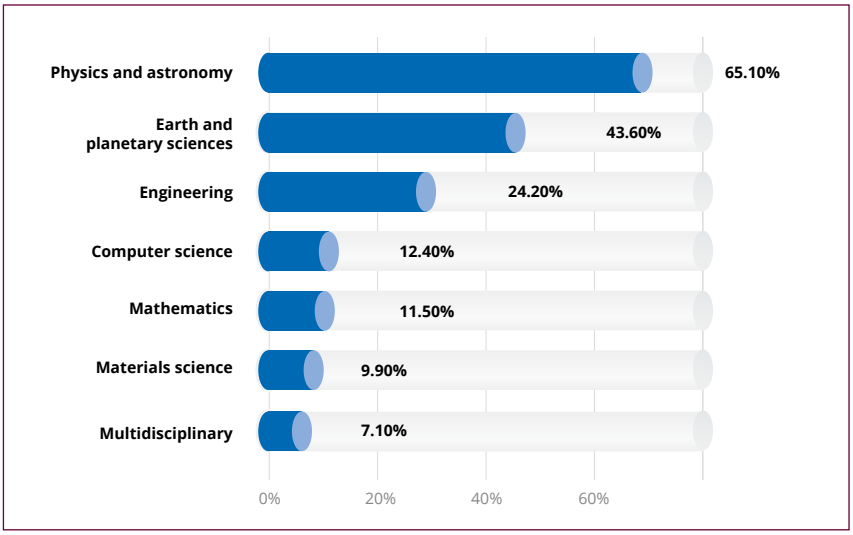
EXISTING ASSETS

Université Paris-Saclay has accumulated a great deal to address these challenges:

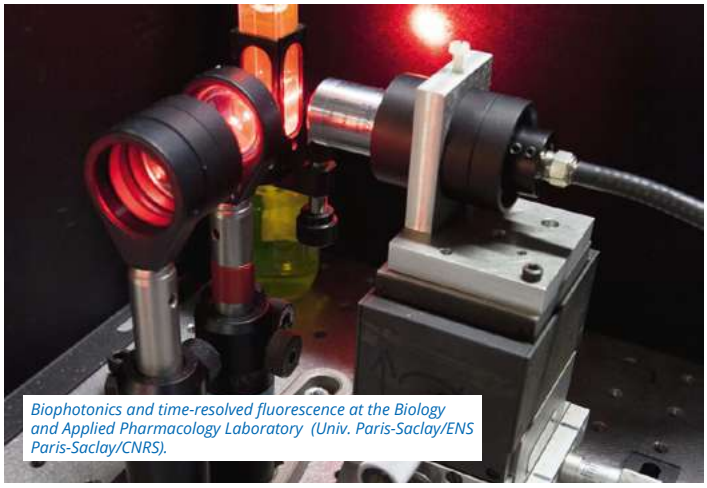
- Université Paris-Saclay presents a long space research tradition, encompassing domains from astronomy, and earth & planetary observation to theoretical physics.
- The strong multidisciplinarity and integration between disciplines of excellence at Université Paris-Saclay, such as astrophysics, particle physics and nuclear physics, enables us to carry out original, leading-edge space research, for example using multi-messenger and multi-wavelength approaches.
- Université Paris-Saclay's important participation in international collaborative projects and networks both displays its recognition and maximises the impact of its research.
- The creation of relevant resources allows the Université Paris-Saclay to efficiently address the rapid evolution of the sector, with its ever-increasing volume of data and complexity of systems.
- The creation of the Université Paris-Saclay Space Science Centre illustrates that effort and promotes multidisciplinary actions to meet new challenges linked to space research evolution, focusing on future instrumentation, data analysis, and developments related to the New Space.
- Finally, in order to tackle issues going beyond the scope of the sole technological challenges of space research, Université Paris-Saclay promotes broader interdisciplinary approaches and fosters collaborations, not only between physicists and engineers, but also with chemists, biologists, as well as specialists of law, economics and geopolitics.

ACTIVE FOCUS AREAS RELATED TO THIS CHALLENGE AT UNIVERSITÉ PARIS-SACLAY

Extending our understanding of astroparticles, nuclear astrophysics and cosmology. At the basis of Université Paris-Saclay's contribution to spatial exploration lie outstanding capacities in astronomy and astrophysics. Researchers from Université Paris-Saclay are collaborating with international colleagues to explore some of the most violent events in the cosmos and to identify the origins of cosmic rays. Additionally, they are delving into the birth and evolution of the universe, investigating the mystery of dark matter and dark energy, and aiming to comprehend nucleosynthesis. Research teams at Université Paris-Saclay have for instance played an important role in the discovery of gravitational waves through the development of the VIRGO interferometer and are engaged in the development of the new generation of instruments, following the roadmap of the European Strategy Forum on Research Infrastructure. The scientific axes pursued at Université Paris-Saclay thus cover all the major open issues in today's fundamental research in astronomy, astrophysics and cosmology; understanding the process which led to the formation



Distribution of publications relevant for aeronautics and space.
The graph is read as follows: among the publications of Université Paris-Saclay in aeronautics and space, 65.1% pertain to physics and astronomy. Note that the total is superior to 100% because one publication can pertain to several fields.



Biophotonics and time-resolved fluorescence at the Biology and Applied Pharmacology Laboratory (Univ. Paris-Saclay/ENS Paris-Saclay/CNRS).

Carme Arisa/Université Paris-Saclay

and evolution of the solar system, studying the origins and evolution of stars, or galaxy formation, understanding extreme conditions in the Universe.

Understanding the origin of life and developing exobiology. The question of the origins of life and diversity of life forms generates intense social interest and is amongst those explored at Université Paris-Saclay. Approaches vary from the understanding of the conditions of habitability of a planetary environment, and the conditions of emergence of life, by studying the planets of the solar system as well as exoplanets. Teams at Université Paris-Saclay are at the forefront of tackling this challenge with multidisciplinary contributions from our specialist laboratories in both chemistry and planetary geomorphology approaches.

Making the most of fluid mechanics for aeronautical engineering. Going from existential concerns to domains with more immediate industrial applications, the community of physicists and engineers of Université Paris-Saclay counts with strong expertise in the domain of fluid mechanics, with the capacity to characterise the deformation and evolution of matters under its forms solid, liquid, gas or plasma. Our capacities at modelling, experimenting and simulating are directly relevant for aeronautics and spatial explorations. They are being reinforced by recent advances in conception and design methods (such as 3D printing), which enable them to quickly obtain materials with new mechanical properties and functions. Most of our work is carried out in partnership with industry, in laboratory networks, in national or European projects or in international cooperation. Strong links have been forged with industrial partners around targeted issues such as energy, transport or civil engineering. These industrial partnerships play a key role in the dynamics of research and in training through research.

Creating the next generation of instruments and observational methods. Research in astronomy and space has always been deeply dependent on the advancement of observational devices and methods. The capacity of our teams to articulate instrumentation, observation, theory, modelling, simulation and lab experiments is a key asset at Université Paris-Saclay. Our involvement in large spatial projects feeds directly into the structuration of science and technological development. Our contribution in the development of large international instruments and platforms also relies on our large community of experimental physicists able to design new instruments. For example, at the interface of physics and engineering, our expertise in the field of (nano)photonics covers the whole chain for instrumentation - including signal emission, propagation, detection, treatment and conversion,- in wavelengths going from X-rays to microwaves. High resolution sensors are being developed for astrophysics, as well as for other fields from geosciences to biology. Our capabilities in the domain of spectroscopy are of specific relevance here, with the capacity to develop ad-hoc tools for studying chemical reactions in the atmospheres of planets and their satellites.

Developing digital tools and approaches. Aeronautics and space is another major challenge where Université Paris-Saclay's strengths in digital science and mathematical modelling supports scientific advances. ad hoc data centres have been developed for specific needs, such as in-flight operations. As an example, we are particularly interested in the development of advanced methods for storage and secure treatment for the massive data generated by spatial exploration, as well as in the verification of softwares for in-vehicle systems.

Next to observations, digital simulations are taking a growing importance with the development of massively

EXOTRAIL SPACE - STARTUP CREATED AT UNIVERSITÉ PARIS-SACLAY AND PARTNERS

Exotrail is an end-to-end space mobility operator. Their mission is to enable small satellites to move in space, optimise their deployment, increase their service performance, and reduce space pollution.

A combination of factors and expertise resulted in the creation of the startup in 2017. The thrusters that Exotrail develops for small satellites enable the satellites to optimise their orbits, increase their performance, avoid collisions and return to the atmosphere at the end of their life so as not to pollute space. Until quite recently, only large satellites incorporated thrusters using Hall-effect technology. Now, it is also possible for small satellites thanks to the miniature thrusters created by Exotrail.

parallel computers: the volume of data generated through simulation is now similar to that of observation data, and is proving decisive to advance understanding in domains as varied as galaxy evolution, star formation, magnetic, protoplanetary disks, star winds, star-planet interactions, etc. Digital simulation is equally important for aeronautics development, as digital simulation replaces wind-tunnel testing for plane design.

Finally, digital tools are playing a central role in the development of 4.0 aeronautics, in particular in further automation processes used for flight technology, from security processes to the development of advanced avionics and "fly-by-wire" flight control systems.

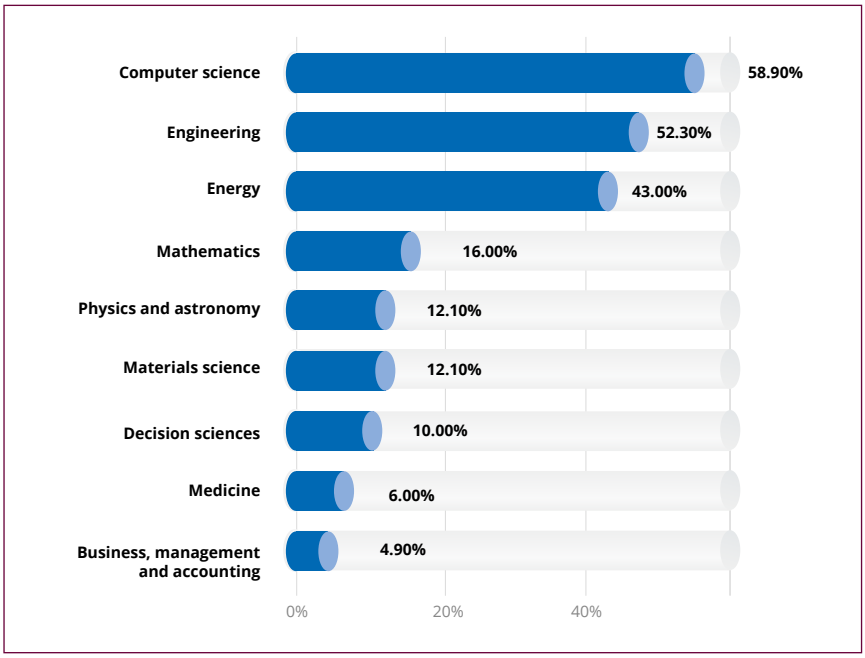
Legal approaches to keep pace with spatial exploration. As our capacity to understand, reach and exploit outer space grows, so do the accompanying legal and regulatory challenges. Teams of legal and geopolitical experts at Université Paris-Saclay are actively engaged in expanding our regulatory capacity to include both terrestrial and extraterrestrial space by collaborating with international organisations and examining common natural assets in the context of legal systems.

7. INDUSTRIAL RENEWAL

Redeveloping industrial capacities in France and Europe has been a strategic orientation for the last decades, backed by significant and growing public investment. The funding devoted to higher education, research and innovation has in a large part been given on the premise that this sector is one of the long-term engines behind a successful industrial policy in France. Université Paris-Saclay recognises its role in the social contract between universities and society that financially supports them. Our university understands that some major expected outcomes include maintaining sovereignty, contributing to a strong job market and promoting a beneficial trade balance. Beyond, what is at stake is our collective capacity to design resilience, durable productive systems which are compatible with considerations of environmental and social sustainability.

As such, the challenge of reindustrialisation is different in nature from the other six challenges which we have described so far. Indeed, the six other challenges contribute directly, each in its sector, to the challenge of reindustrialisation. From material sciences to synthetic biology, from digital transformation to sustainable agrifood, from pharmaceutics to design & production systems, the previous sections have highlighted how the research teams and training programmes at Université Paris-Saclay contribute to the major sectoral challenges of reindustrialisation. We therefore do not focus here on the specific application sectors, but on the way in which Université Paris-Saclay helps to remove practical obstacles and create the conditions for 21st century industry in general, with a focus on material and immaterial design and production systems.

The capacity to mass-produce technological devices, as well as therapeutic approaches, enables a large diffusion of technological advances. However, it is also clearly inducing adverse effects on health, resource depletion, economic factors, or the environment. A major challenge of this new phase of industrialisation is to ensure that it actively counteracts such adverse effects and develops solutions which integrate the point of view of users at large and prevent lock-in or path-dependency effects. This is where the approach of "individualisation" in engineering brings the promise of technological uses which are better adapted to individual uses and contexts, and where the teams at Université Paris-Saclay are researching the contextualisation of solutions, the development of knowledge on human factors and their integration in cyberphysical systems, with



Distribution of publications relevant for industrial renewal.
The graph is read as follows: among the publications of Université Paris-Saclay in industrial renewal, 58% pertain to computer science. Note that the total is superior to 100% because one publication can pertain to several fields.

a specific focus on the interactions of material and industrial processes with life.

Studies on the conditions of reindustrialisation [2] point towards two types of barriers which are relevant for universities: the need to innovate, which requires strong research capacities in close interaction with industrial actors, echoing Université Paris-Saclay's renewed emphasis on innovation & technology transfer; and the need to train future generations and equip them with the relevant skills, in link with Université Paris-Saclay's extensive capabilities in terms of engineering education.

ACTIVE FOCUS AREAS RELATED TO THIS CHALLENGE AT UNIVERSITÉ PARIS-SACLAY.

Researching industrial processes. Industrial and manufacturing engineering is a focus at Université Paris-Saclay, where our research teams and graduates can be essential to the current national effort of reindustrialisation. The study of productive systems enables us to analyse, model, simulate and design them all along their life cycle to optimise resources, ergonomics, and results. A strong emphasis is naturally placed on all developments which enable to accelerate the switch to a new industrial paradigm: sustainable, decarbonated, resilient and circular. This overall approach is being deployed at four different scales: at the level of industrial sectors and value chains; at the level of production units; at the level of technological and manufacturing processes; at the level of 4.0 enabling technologies.

Industrial and manufacturing engineering is a focus at Université Paris-Saclay, where our research teams and graduates can be essential to the current national effort of reindustrialisation

Multi-scale and multitechnology integration emerged industrially with approaches such as the "beyond complementary metal oxide semiconductor" technologies in microelectronics, exploring the hybridisation of technologies to optimise processes and tackle the challenge of processor miniaturisation. A similar approach is now supporting advances in systems integrating mechanical, optical and electronic components. This same concept of "systems" is being applied to other domains as well, paving the way for industrial advances in areas as diverse as: the hybridisation of materials and technologies; the development of new components, architectures and systems; the progress in manufacturing processes (additive fabrication, 4.0 factory, etc.). The autonomisation of systems makes them more difficult to design and forces interdisciplinary questioning, but is paving the way for improved reproducibility, security, resource optimisation, and dynamic self-adaptation. Université Paris-Saclay is particularly interested in exploring the issue of interactions in complex environments in order to design robust, reliable, interactive, autonomous systems which can function in open or controlled environments.

Embracing the potential of digital approaches for reindustrialisation. Home to a very strong community in mathematics, computer science and engineering, Université Paris-Saclay is well placed to contribute to the digital transformation of industry. In less than two decades, digital advances completely reshaped industry by opening up the possibility of developing digital models for complex phenomena and to test them, thus facilitating applications. Digital models can now be coupled with the environment in an interactive fashion, accelerating industrial developments and production methods. The massive deployment of connected objects (Internet of things) and the progress of cyberphysical systems are key enablers for new industrial processes, but suppose high-quality Cloud and IoT architecture, and communication networks, as well as the capacity to stem processing, management and security of the generated data. The promises of such deployment and advances in digital approaches include faster, cleaner, less-resource intensive design and production processes.

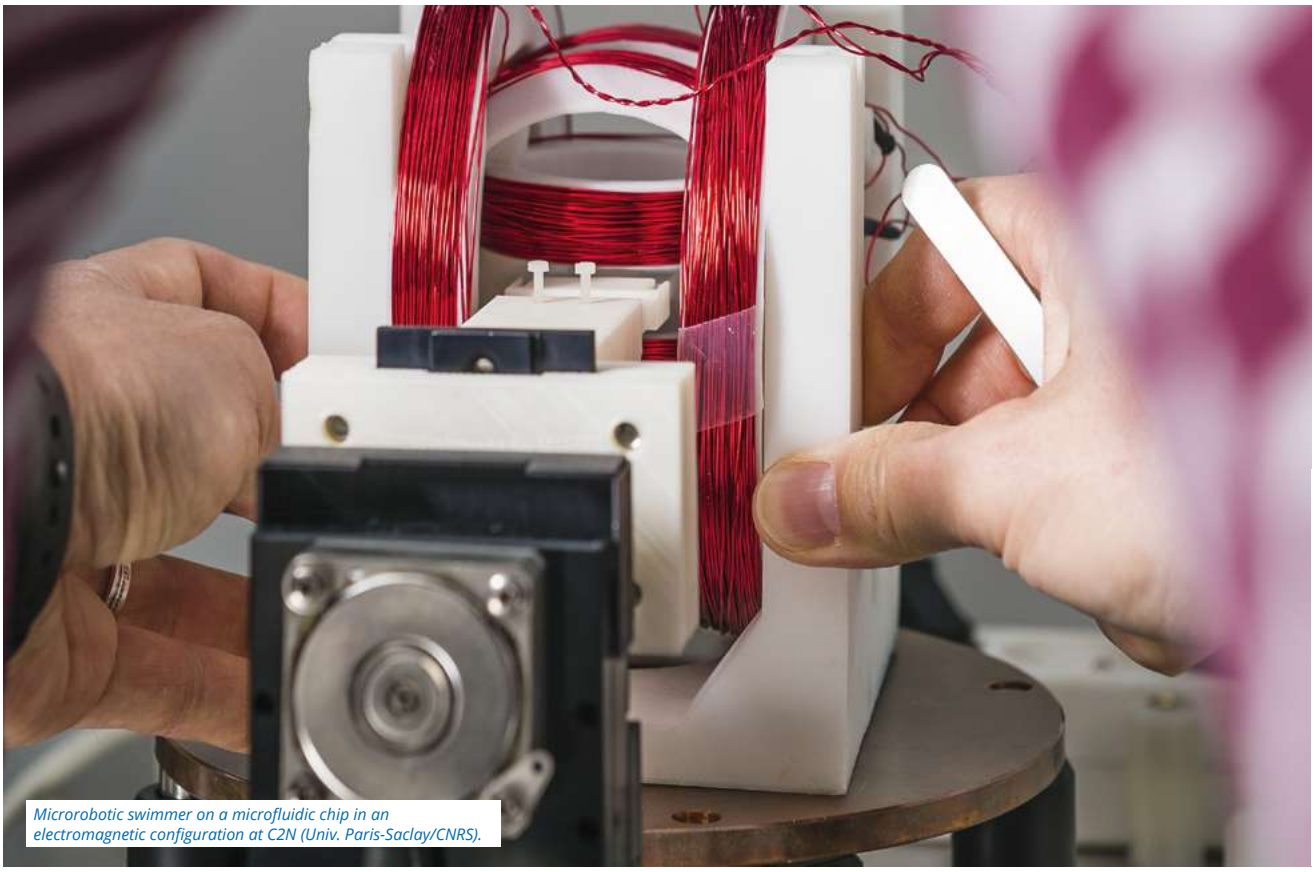
Supporting the continuum between research, technological research and innovation and industry. In a context of intense international competition and geopolitical tensions with the resulting pressure on global supply chains and the growing importance of strategic autonomy and sovereignty in public discourse, many of the more technologically advanced countries are devoting sizable public funding to push for reindustrialisation.

C2N - AN EXCEPTIONAL TECHNOLOGICAL PLATFORM

The C2N technological facility is one of the technological platforms at Université Paris-Saclay that supports research and innovation related to the cross-cutting challenge of Industrial Renewal.

Hosted in a clean room of 2,900 sqm, the three platforms, representing more than 50M€ of investment in state-of-the-art equipment, are dedicated to micro and nanofabrication processes, to the growth, epitaxy and characterisation of materials. Some areas are also devoted to education and continuous training in micro-nanotechnologies, and 250 sqm are dedicated to start-up or SME activities.

[2] https://www.economie.gouv.fr/files/files/directions_services/igpde-seminaires-conferences/Infographie%20Renouveau%20industriel.pdf?v=1688126016



Microrobotic swimmer on a microfluidic chip in an electromagnetic configuration at C2N (Univ. Paris-Saclay/CNRS).

Cyril Fresillon / C2N / CNRS Images

France too strives to ensure a dynamic continuum between fundamental research, technological research, innovation and industry. We have already highlighted above (see cross-section) the ambitious policy pursued by Université Paris-Saclay in terms of innovation. This policy can build upon the key assets testifying to the presence of outstanding research teams in fundamental academic fields (mathematics, physics, chemistry, biology, computer science, etc.) and the long-standing culture of collaboration with industry embodied by our engineering schools. This puts us in a position to be direct contributors to all the major industrial fields which depend on engineering advances: biochemical engineering, biomedical engineering, optical engineering, electrical engineering, material sciences, robotics and automatics, networks and communications.

Supporting public policy to create a propitious environment. Reindustrialisation is also a matter of creating the right conditions at the organisational, legal and job market levels. This requires the combined insights from economics, law, sociology, management, political sciences and organisational sciences, to create favourable conditions. At the collective level, this raises the issue of the emergence of new institutional and organisational settings of economic activities and production. Social sciences can support the reflection on the best governance practice, policy design and regulations and incentives, and feed public policy through expertise, advice and impact evaluation. The legal expertise of Université Paris-Saclay's teams will also be directly relevant to designing the regulations adapted to new production modes and working arrangements, leveraging specific expertise on the legal implications of technical developments. Lastly, the various studies carried out on the evolution of work, labour markets and competencies are directly relevant for the proper implementation of a reindustrialisation policy. Such a policy needs to be linked to the deep trends affecting the relation of new generations to the workplace (diversification of the forms of job contracts, role of platform economies, impact of new work organisation and management approaches, articulation between individual tasks and the contribution to large-scale societal issues).

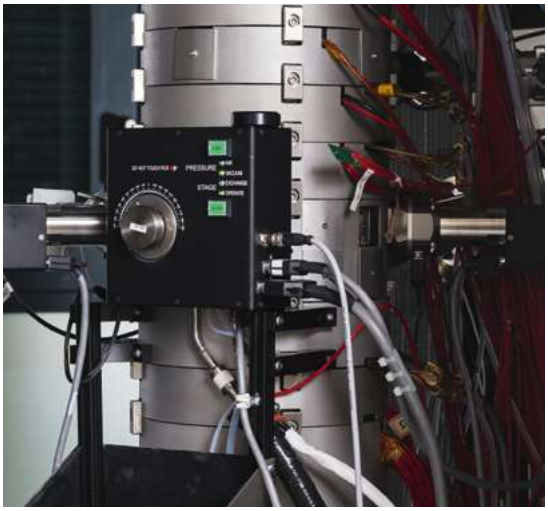
Get in touch

Get in touch

Université Paris-Saclay

Future students interested in the research-based education on offer at Université Paris-Saclay, you can find information about our course offer by exploring our online catalogue.

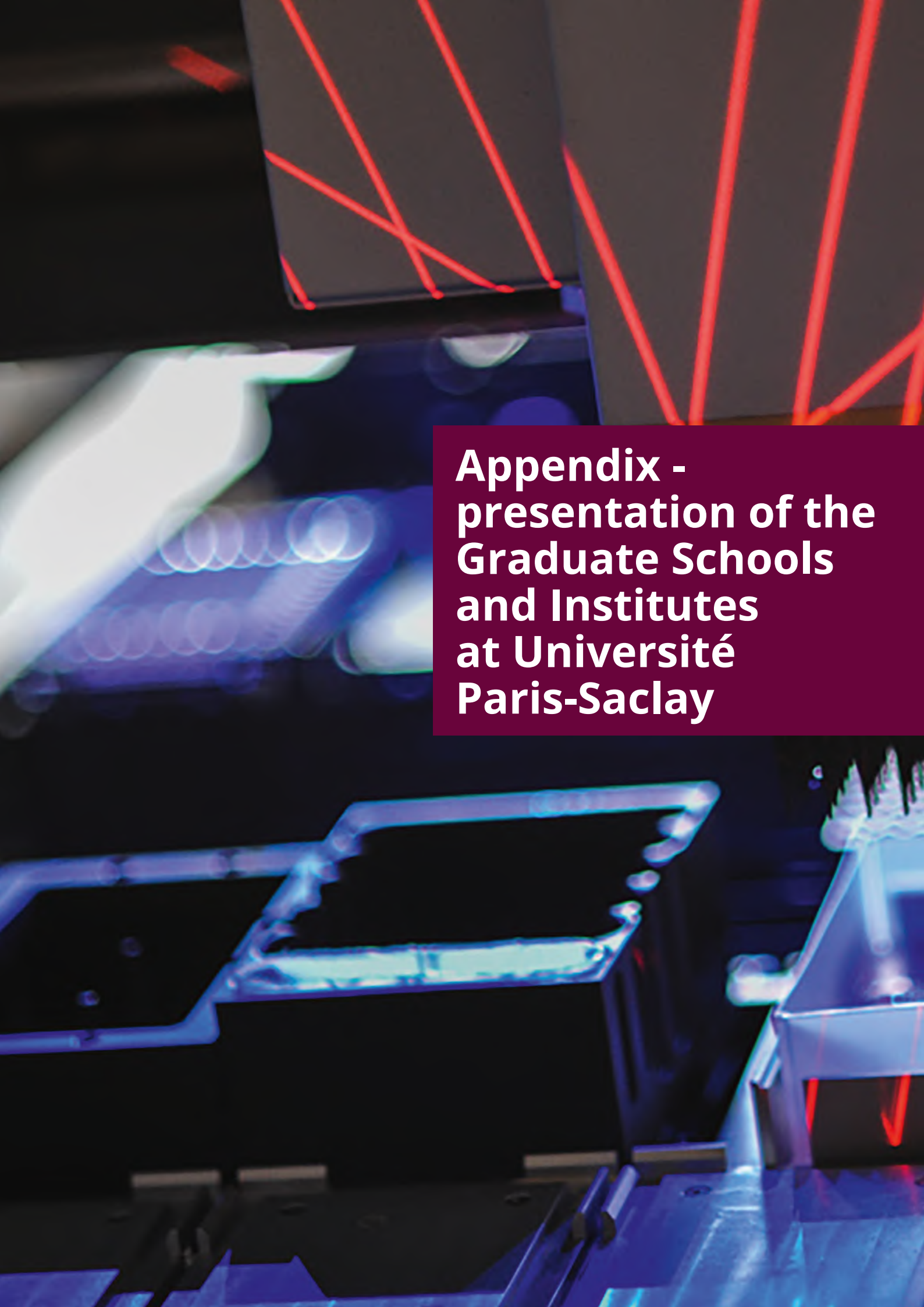
SMEs, large companies, associations and government bodies with a question which requires the advanced expertise of our labs, you can get in touch with our dedicated office for partnerships, which will help you define your needs and orient you towards the relevant labs.



Cyril Fresillon/LPS/CNRS Images

Plug in labs
Université Paris-Saclay

The expertise of our labs and technical capabilities is presented on the platform Plug-in labs, which also interfaces with a network of domain experts.



Appendix - presentation of the Graduate Schools and Institutes at Université Paris-Saclay

université PARIS-SACLAY

GRADUATE SCHOOL
Biosphera

OVERVIEW

The Biosphera (Biology, Society, Ecology & Environment, Resources, Agriculture & Food Systems) Graduate School focuses on life sciences and the interactions between living organisms and their environments, with the goal of addressing issues concerning the future of the biosphere and our societies.

Subjects include the ecological transition towards sustainable production systems in agriculture, resource management and utilisation, and more broadly, global changes and their impacts. Biosphera addresses these issues by integrating their social, economic, and political dimensions. It mobilises a spectrum of research, ranging from fundamental research to translational research. Interdisciplinary in nature, Biosphera collaborates, in particular, with the Economics and Management,' 'Geosciences, Climate, Environment and Planets,' 'Life Sciences and Health,' 'Sociology and Political Science,' and 'Chemistry' Graduate Schools.

MAIN AREAS OF RESEARCH

• **9 areas of research.**
- Ecological transition: towards sustainable socioecosystems and agrosystems.
- Global changes: mitigation, adaptation and impacts.
- Management and use of resources: circular economy.
- Preservation of biodiversity: ecosystemic services.
- Territorial development strategies: integrating the environmental dimension.
- Food security: food nutrition and transitions.
- Transformation of biosources: waste valorisation, energy.
- Global health: the environment, a shared heritage.

GRADUATE SCHOOL - BIOSPHERA - KEY FIGURES

1,000 staff members
300 PhD candidates
550 Master's students

100 research teams
28 laboratories

CONTACT US

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LinkedIn: www.linkedin.com/in/graduate-school-biosphera-656910245

université PARIS-SACLAY | GRADUATE SCHOOL Chimie

OVERVIEW

The Chemistry Graduate School offers cutting-edge education that combines theory, practice, and high-level skills. This enables each student to progressively refine their career plans by gaining access to a wide range of research or professional pathways, covering various fields of chemistry while paying attention to both their future needs and interdisciplinary perspectives.

The activities of the Chemistry Graduate School revolve around the unifying concept of sustainable chemistry, aiming to address major societal challenges related to energy, the environment, and health. Specifically, these challenges include accessing natural resources, their transformation, valorisation, and waste recycling. These activities encompass developments at the core of the discipline and applications in the fields of life sciences, physical sciences, and environmental sciences.

Leveraging an exceptional concentration of research infrastructures and national facilities (SOLEIL, ATTOLAB, IDRIS, etc.), the laboratories of the Chemistry Graduate School host numerous experimental platforms and computing centres. They have expertise in instrument development and the analysis of all types of samples, including solid, liquid, gaseous, organic, inorganic, and biological.

MAIN AREAS OF RESEARCH

• 3 key areas of research.
- Physical, biophysical and analytical chemistry.
- Organic and biomolecular chemistry.
- Inorganic chemistry and materials.

• Interdisciplinary themes at the interface with physics and the life sciences.
- Health, well-being and life Master's students.
- Materials of the future.
- Energy: processes, production, transfers and storage.
- Resources, environment and catalysis.

GRADUATE SCHOOL - CHEMISTRY - KEY FIGURES

950 staff members
300 PhD candidates
350 master students

25 research structures
5,000 scientific publications during 4 years

CONTACT US

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GRADUATE SCHOOL
Informatique et Sciences du Numérique

OVERVIEW

The School for Computer Science trains the engineers and researchers of the future, educating them in key subjects such as Big Data, artificial intelligence, the Internet of Things, cybersecurity, and quantum computing. It also addresses major societal challenges and cross-disciplinary issues, including energy, industrial renewal, health, transport, education, and personal safety.

The School has numerous industrial partnerships, collaborating with SMEs as well as prominent partners such as EDF, Thales, IBM, SNCF, PSA, Danone, Renault, Airbus D&S, etc. These partners are involved in Master's and doctoral courses, facilitating patent applications, company start-ups, and international publications.

MAIN AREAS OF RESEARCH

• 3 main areas.
- Automation, robotics, signals, images, communications
- Data, knowledge, learning, interactions
- Programming, models, algorithms, architecture, networks

• 21 themes of research.
- Algorithms.
- Machine learning.
- Architecture of machines and systems.
- Automatic control.
- Bioinformatics.
- High-Performance computing.
- Cybersecurity.
- Quantum computing.
- Artificial intelligence.
- Human-machine interaction.
- Internet of Things.
- Languages.
- Formal methods.
- Programming.
- Knowledge representation.
- Networks, telecommunications.
- Robotics.
- Data science.
- Automatic language processing.
- Image.

GRADUATE SCHOOL - COMPUTER SCIENCE - KEY FIGURES

500 PhD candidates
1,000 master students

1,000 researchers
21 laboratories
100 software patents per year

CONTACT US

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GRADUATE SCHOOL
Economics & Management

OVERVIEW

The Graduate School for Economics & Management combines the best of research and education in economic and management sciences. This school sets the standard in subjects such as digitisation, strategic management and innovation, territories and mobility, sustainable economics, food, health, energy, environment, climate, public decision-making, responsible management, and marketing.

With a wide range of expertise on key societal issues for public authorities, it actively engages in both public debates and scientific outreach, whilst also encouraging the social and economic contributions of its researchers in the form of patents and startups. It fosters collaborations with industrial partners, non-academic entities, and stakeholders to further research initiatives in Europe and worldwide.

MAIN AREAS OF RESEARCH

• 6 main areas of research.
- Networks, digitalisation, and innovation.
- Risks, growth, and cycles.
- Territories, globalisation, and development.
- Food, health, environment, and energy.
- Public policies and organisations.
- Data, modelling, and support for decision-making.

GRADUATE SCHOOL - ECONOMICS AND MANAGEMENT - KEY FIGURES

250 staff members
100 PhD candidates
1,850 students

21 research units
11 Master's tracks
1 Doctoral School

CONTACT US

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GRADUATE SCHOOL
Éducation
Formation
Enseignement

OVERVIEW

The Education Graduate School is a learning community dedicated to education, vocational training, academic teaching, and educational innovation, with a focus on the teaching professions and academic staff. Its purpose is to offer undergraduate studies and continuing education for teachers and academic staff across all levels of education, from nursery school to higher education. The School's mission is to enhance the recognition and appeal of teaching professions whilst supporting both fundamental and applied research in the field of education.

MAIN AREAS OF RESEARCH

• 7 teaching disciplines.
- Economic and social sciences.
- English.
- History-geography.
- Life and earth sciences.
- Mathematics.
- Physics-chemistry.
- Physical and sports education.

• 3 key focus areas of research.
- Multicategory and multidisciplinary teaching.
- Building an 'innovative pedagogy' approach.
- Development of research programmes in education.

GRADUATE SCHOOL - EDUCATION - KEY FIGURES

300 staff members
1,200 students

7 teaching disciplines
3 Master's tracks
11 programmes preparing for national exams
7 affiliated laboratories

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GRADUATE SCHOOL
Engineering and Systems Sciences

OVERVIEW

The School for Engineering and Systems Sciences offers programmes in the fields of engineering sciences and related digital sciences. It covers various major subject areas, exploring and developing innovative approaches to designing, manufacturing, using, and maintaining systems that lead to future ecological and economic advancements for our societies. Its Master's and Ph.D. programmes enjoy significant international recognition, with international students comprising half of the student body, and they prepare graduates for R&D professions in France and internationally.

With 67 research laboratories that contribute to addressing significant societal challenges through research and innovation, the Graduate School strives to strike a balance between the ecological and economic development of our societies by conducting research at the highest global level.

Situated in a unique ecosystem that brings together academic centres and industrial partners in one territory, the Graduate School benefits from this comprehensive ecosystem for transferring results from laboratories to the market at all stages: SATT (*Société d'Accélération du Transfert de Technologies*), Fab Labs, incubators, calls for projects, and seed funds.

MAIN AREAS OF RESEARCH

• 9 areas of research.
- Automation, control, and robotics.
- Electrical and applied physics engineering.
- Industrial engineering and manufacturing.
- Materials.
- Applied mathematics and digital sciences.
- Fluid and solid mechanics.
- Optics.
- Biochemical, chemical and biomedical processes.
- Telecommunications.

GRADUATE SCHOOL - ENGINEERING AND SYSTEMS SCIENCE - KEY FIGURES

2,800 staff members
600 PhD candidates
1,500 Master's students

67 laboratories
4 doctoral schools
2,300 publications per year

CONTACT US

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université PARIS-SACLAY

GRADUATE SCHOOL
Géosciences, Climat, Environnement, Planètes

OVERVIEW

Students, academic staff, and researchers at the Graduate School for Geosciences, Climate, Environment, and Planets study the surface layers of the Earth and other planets, exploring how they work.

At the core of scientific, societal, and environmental challenges related to climate change, pollution, natural resource management, energy transition and space exploration, the Graduate School and its laboratories create an interdisciplinary environment for both education and cutting-edge research. This strengthens the combined use of approaches, ranging from fieldwork to space missions and digital modelling.

MAIN AREAS OF RESEARCH

• 3 key focus areas of research.

- Fluid surfaces and climate (greenhouse gases and aerosols, climate system modelling, air pollution, etc.).
- Geosciences and environment (mineral deposit formation and environmental impact of resource extraction, subsurface heterogeneity for sustainable resource management and development, etc.).
- Solar system and planetology (space missions from design to results, planetary surfaces and envelopes, history of the solar system, current and past planetary climates, etc.).

GRADUATE SCHOOL - GEOSCIENCES, CLIMATE, ENVIRONMENT, PLANETS - KEY FIGURES

650 staff members
120 PhD candidates
250 Master's students

7 laboratories
3 Doctoral Schools
775 publications per year

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GRADUATE SCHOOL
Health and Drug Sciences

OVERVIEW

The Graduate School for Health and Drug Sciences coordinates research and education teams in the fields of therapeutic innovation, drugs, and health products, fostering cross-disciplinary health research in pharmaceutical sciences, drugs, medical devices, diagnostics, physiopathology, translational medicine, and clinical research. It strikes a balance between fundamental and applied research.

The School actively promotes European and international relations and trains future scientific experts with a global outlook through various internationalised courses and practices within its six internship programmes and over one hundred international agreements. It also addresses socio-economic challenges related to health and well-being, industrial renewal, biodiversity, food, big data, and artificial intelligence.

MAIN AREAS OF RESEARCH

• 5 assets for therapeutic innovation.
- Assistance, promotion, support.
- Public-private R&D cooperation.
- Technology transfer.
- Safeguarding innovation.
- Entrepreneurship.

• 7 research areas.
- Molecular and cellular physiopathology.
- Microbiology and anti-infective therapies.
- Engineering of proteins and therapeutic targets.
- Pharmaceutical chemistry.
- Pharmacology - toxicology.
- Pharmaceuticals and pharmaceutical physical chemistry.
- Immunology and biotherapies.

GRADUATE SCHOOL - HEALTH AND DRUG SCIENCES - KEY FIGURES

550 staff members
310 PhD candidates
500 Master's students

350 scientific articles and 26 patents in 5 years
100 international internship agreements

CONTACT US

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université PARIS-SACLAY

GRADUATE SCHOOL
Humanités
Sciences du Patrimoine

OVERVIEW

The Graduate School for Humanities and Heritage Science is dedicated to research, innovation, and Master's and doctoral level education in various fields, including arts, design, history, literature, French and foreign cultures and civilizations, musicology, information and communication sciences, and heritage science (encompassing disciplines like archaeometry, archaeology, archaeomaterials, chemistry, history of the arts, physics, paleoenvironment, and associated methods).

The interplay between the disciplinary dimension of research and interdisciplinary or multidisciplinary practices is central to the School's mission. It supports research teams and laboratories in their development strategies, assisting numerous individual and collective projects recognised for their international excellence. The School also fosters innovative research approaches, leading to new methods, objects, and research questions. The Master's and doctoral programmes provide students with a high level of expertise, knowledge, and skills, enabling them to engage with research and development hubs in both the public and private sectors.

MAIN AREAS OF RESEARCH

• 2 main research areas.
- Heritage science and its foundation (archeometry, archaeology, archaeo-materials, chemistry, art history, physics, paleoenvironment).
- Science(s) and culture(s): knowledge societies and knowledge outreach.

• Disciplinary range.
- Humanities: arts, design, history, literature cultures and civilizations, musicology.
- Social sciences: information and communication sciences.

GRADUATE SCHOOL - HUMANITIES - HERITAGE SCIENCE - KEY FIGURES

160 staff members
105 PhD candidates
550 Master's students

22 Master's tracks
12 research laboratories

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GRADUATE SCHOOL
Droit

OVERVIEW

The Law Graduate School offers a comprehensive education and research framework that encompasses all areas of law and promotes an understanding of legal regulations at the national, European, and international levels. It prepares students for competitive examinations and provides pathways to various legal professions in both the public and private sectors. It is built on three key areas: international openness, direct involvement in the socio-economic fabric of the region (including entities currently practising judicial and legal professions), and establishing stronger interdisciplinary links to conduct research and training projects in various fields, such as the environment, social and solidarity economy, and artificial intelligence.

MAIN AREAS OF RESEARCH

• 3 main areas of strategic research.
- Environnements & heritages.
- Justice & liberties.
- Regulations & technologies.

• 4 methodological guidelines for research.
- Foundations of the law & innovations.
- History, dissemination and internationalisation of legal doctrines.
- Integration of legal research into the society.
- Training through legal research and professional practice.

GRADUATE SCHOOL - LAW - KEY FIGURES

200 staff members
175 PhD candidates
800 Master's students

9 cross-disciplinary research centres
60 partner universities worldwide

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GRADUATE SCHOOL
Life Sciences and Health

OVERVIEW

The Graduate School for Life Sciences and Health offers education and research in the fields of Biology, Bioinformatics, and Medicine. It adopts an integrative approach to life sciences, encompassing the study of molecular mechanisms in biological systems and their interactions at various levels, including the evolutionary, pathophysiological, and biotechnological scales. It focuses on understanding fundamental mechanisms in models representing the biodiversity of living organisms, with a strong emphasis on microorganisms, plants, animals, and humans.

The Graduate School provides a collaborative space that encourages interaction across various aspects of Life Sciences and establishes a productive relationship between fundamental and applied research. Its initiatives align with significant scientific and societal challenges and are central to the objectives of the European University, EUGLOH, for Global Health. Additionally, the School's emphasis on Biotechnology and Health is particularly conducive to innovation.

MAIN AREAS OF RESEARCH

• 3 main areas of research.
- Fundamental mechanisms of biodiversity in the living world.
- Human and animal health and biotechnologies.
- Data sciences & advanced technologies for the exploration and engineering of living organisms.

• Graduate programmes.
- Biochemistry and structural biology.
- Bioinformatics.
- Oncology and biotherapy.
- Cell biology, development, ageing, reproduction.
- Clinical sciences.
- Endocrinology, biosignaling, metabolism & physiology.
- Evolutionary biology.
- Genetics & genomics.
- Immunology.
- Microbiology.
- Neurosciences.
- Systems & synthetic biology.
- MD-PhD programme.

GRADUATE SCHOOL - LIFE SCIENCES AND HEALTH - KEY FIGURES

2,000 staff members
500 PhD candidates
1,000 master students

70 laboratories / **6** doctoral schools
60 licensed patents and **70** startups in 5 years

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GRADUATE SCHOOL
Mathématiques

OVERVIEW

The Mathematics Graduate School covers a wide range of pure mathematics disciplines, including algebra, geometry, analysis, arithmetic, topology, dynamical systems, partial differential equations, probability, and statistics.

The School, in partnership with the Fondation Mathématique Jacques Hadamard (EDMH), offers excellent career opportunities in both academic and industrial research for the world's top young mathematicians. The Master's programme, "Mathematics and Applications," is the largest mathematics Master's programme globally.

With a strong focus on interdisciplinary research, the Mathematics Gradiate School maintains close collaborations with neighbouring graduate schools and disciplines, such as biology, computer science, scientific computation, engineering, theoretical physics, and actively participates in interdisciplinary initiatives at local, national, and international levels.

MAIN AREAS OF RESEARCH

• 3 areas of research.
- Fundamental mathematics.
- Applied mathematics.
- Mathematics at interfaces.

GRADUATE SCHOOL - MATHEMATICS - KEY FIGURES

350 researchers
20 ERC grants
300 PhD candidates
750 Master's students

12 laboratories
10 Fields medals
3 Abel prizes

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GRADUATE SCHOOL
Physique

OVERVIEW

The Physics Graduate School is internationally recognised for its research and education that covers the entire spectrum of physics, including theoretical work, modelling, simulation, instrumentation, and laboratory experiments. With 115 scientific and technical platforms, capable of accommodating external activities, it spans a wide range of thematic scientific areas, including chemistry, engineering, and biology, facilitating cutting-edge disciplinary research within laboratories.

The School possesses strong potential for scientific and technological innovation and contributes significantly to socio-economic challenges related to energy, the environment, and health. Its research activities involve extensive collaborations at local, national, European, and global levels, with strong ties to industrial sectors. The School also benefits from the support of three Labex initiatives: P2IO (Physics of the Two Infinities and Origins), PALM (Physics of Atoms, Light, and Matter), and NanoSaclay.

MAIN AREAS OF RESEARCH

• 4 main areas of research.
- Waves and Matter.
- Physics of the Two Infinities.
- Astronomy and Astrophysics.
- Fundamental Physics.

GRADUATE SCHOOL - PHYSICS - KEY FIGURES

3,400 staff members
500 PhD candidates
550 Master's students

115 scientific and technical platforms
40 laboratories
4 doctoral schools
2 Nobel prizes

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GRADUATE SCHOOL
Santé publique

OVERVIEW

The Graduate School for Public Health, built on research conducted by the Centre for Research in Epidemiology and Population Health (CESP) and its affiliated units, focuses on significant health issues throughout a person's lifespan and the complexities of public health phenomena.

The School's key objectives include reducing social health inequalities, managing infection and environmental risks, promoting both physical and mental well-being, contributing to the protection of human and animal populations, and upholding the values of healthcare and health research.

These issues and objectives are approached through a highly multidisciplinary and integrative perspective, integrating epidemiology, biostatistics, health economics, clinical research, and social sciences. This approach combines biological and environmental aspects and relies on extensive health databases, advanced analytical methods, while considering ethical, environmental, cultural, and social factors.

MAIN AREAS OF RESEARCH

• **Epidemiology.**
- Etiological epidemiology.
- Clinical epidemiology.
• **Genomics.**
• **Health systems.**
- Treatment evaluation.
• **Health sciences.**
• **Humanities and social sciences.**
- Social issues.
- Ethics.
• **Methods: biostatistics and qualitative methods.**

GRADUATE SCHOOL - PUBLIC HEALTH - KEY FIGURES

700 staff members
150 PhD candidates
500 Master's students

1 School of Public Health
11 research teams
2 research service units dedicated to therapeutic trials in infectious diseases and large cohorts

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GRADUATE SCHOOL
Métiers de la Recherche et de l'Enseignement Supérieur

OVERVIEW

The mission of the Graduate School - Research and Higher Education is pertinent to all other Graduate Schools at Université Paris-Saclay.
On one hand, it offers foundational skills for early-career students and doctoral candidates aspiring to work in research and/or higher education. This training strategy follows a personalised 'pre-doctorate + doctorate' approach, providing complementary educational pathways closely integrated with discipline-specific training. It also ensures close collaboration with research teams, enabling students to maintain strong connections with the research community.
On the other hand, the Graduate School proposes tailored training and events for educators, teaching researchers, active researchers, and newly recruited researchers, serving as an interdisciplinary platform for collaborative discussions and the development of training programs for research and higher education careers.
The Graduate School of Research and Higher Education collaborates closely with discipline-specific Graduate Schools to provide comprehensive research-focused training and is committed to remaining flexible and responsive to the ever-evolving landscape of research, innovation, and technology.

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GRADUATE SCHOOL
Sociologie et Science politique

OVERVIEW

The Graduate School for Sociology and Political Science brings together two social science disciplines employing both qualitative and quantitative methods to analyse contemporary issues, with a particular emphasis on public policy evaluation. It maintains a prominent position at regional, national, and international levels in areas such as justice, labour, environment, and governance.

The Graduate School is actively engaged in several international and European research networks, including the European University Alliance for Global Health, the International Public Policy Association, and the European Consortium for Political Research.

MAIN AREAS OF RESEARCH

• 4 main research areas.
- Environment, regions, and transitions.
- Work, employment, and professions.
- Sociology of public action.
- Data analysis.

• 6 key topics.
- Evaluation of public policies.
- Justice and security.
- Labour and markets.
- Science, technology, and society.
- International policy.
- Environment.

GRADUATE SCHOOL - SOCIOLOGY AND POLITICAL SCIENCE - KEY FIGURES

100 staff members
120 PhD candidates
1,000 Master's students

7 research units
1 research federation

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GRADUATE SCHOOL
Sport
Mouvement
Facteurs Humains

OVERVIEW

The Graduate School for Sports, Motor, and Human Movement Sciences maintains high standards of excellence in the study of sports, physical education, adapted physical activity, training and performance optimisation, ergonomics, management, and engineering with the aim of advancing human movement.

It offers a dynamic environment rooted in top-quality academic research and supported by professional partners in the sports, leisure, and health sectors. Through its research and education in leisure, sports events, prevention, health, ageing, well-being, and disability, it is relevant to the entire population, spanning from the youngest to the oldest, from beginners to elite athletes, and from non-disabled individuals to those with disabilities.

MAIN AREAS OF RESEARCH

- **Physical and sports education.**
- **Adapted physical activity and sports health.**
- **Training and sports performance optimisation.**
- **Sport management: sports events and public policies.**
- **Engineering for human movement.**
- **Basic and applied research in motor control, psychology, cognitive and behavioural neuroscience, exercise physiology, and biomechanics.**

GRADUATE SCHOOL - SPORTS, MOTOR AND HUMAN MOVEMENT SCIENCES - KEY FIGURES

80 staff members
130 PhD candidates
500 Master's students

17 laboratories
1 doctoral school
1 federative research organisation

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université PARIS-SACLAY | Institute for the Sciences of Light

OVERVIEW

Université Paris-Saclay's Institute for the Sciences of Light, originally established as the Institute of Optics in 1917, upholds a century-old legacy of both fundamental and applied research in optics. With over a century of development, marked by numerous remarkable milestones and achievements, it actively fosters cross-cutting research projects spanning six Graduate Schools. It continues to advance quantum technologies, observe gravitational waves, explore matter and life, study the sun, planets, climate, and master energy.

As a cross-disciplinary institution without walls, the Institute encourages collaborations between teams working in this field and contributes to advancements in sciences of light across all areas, from the most theoretical to the most applied. It benefits from a diversity of world-class facilities on the Saclay site, including Synchrotron SOLEIL, Free Electron Laser, Attosecond X-UV Laser Platform, and the Nanotechnology Centre at C2N, among others.

MAIN AREAS OF RESEARCH

• 11 main areas of research.
- Atomic and molecular physics, plasmas, spectroscopy.
- Biophotonics.
- Extreme light, specialised optics (ultra-high intensity, relativistic optics, ultrashort pulses, X-UV optics and sources).
- Imaging (biomedical imaging and microscopy, super-resolution, image sensors, lensless imaging, SNOM, image processing).
- Information and communication technologies (optoelectronics, fibre optics).
- Instrumentation (sensors, detectors, LIDAR, optical diagnostics, metrology).
- Lasers.
- Materials for optics (inorganics, semiconductor, organic, liquid crystals, photochromic).
- Nanophotonics (plasmonics, metamaterials, 2D materials, surfaces and interfaces, optomechanics).
- Photochemistry.
- Quantum technologies.

INSTITUTE FOR THE SCIENCES OF LIGHT - KEY FIGURES

690 researchers and academics
60 PhD candidates
200 engineers

26 laboratories
8 R&D infrastructures
23 ERC projects

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Opening pages

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Page 47 / *Robot from the high-throughout put cloning-phenotyping platform at the Métagenopolis research unit (Univ. Paris-Saclay/INRAE) and MICALIS (Univ. Paris-Saclay/INRAE/AgroParisTech)* - Nicolas Bertrand/INRAE

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