

# L'Édition of université paris-saclay may

Year

2019

Country

France

Section and thematic

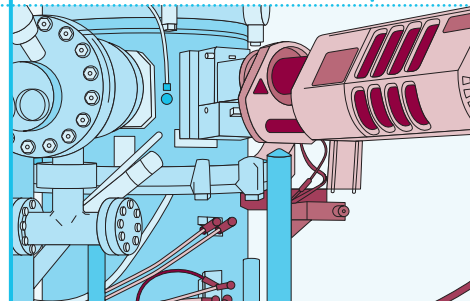
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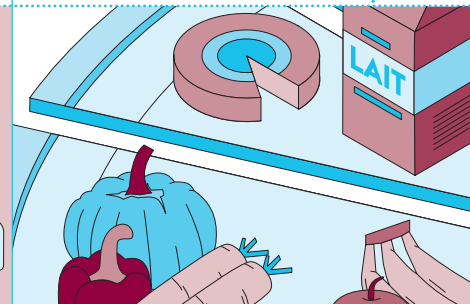
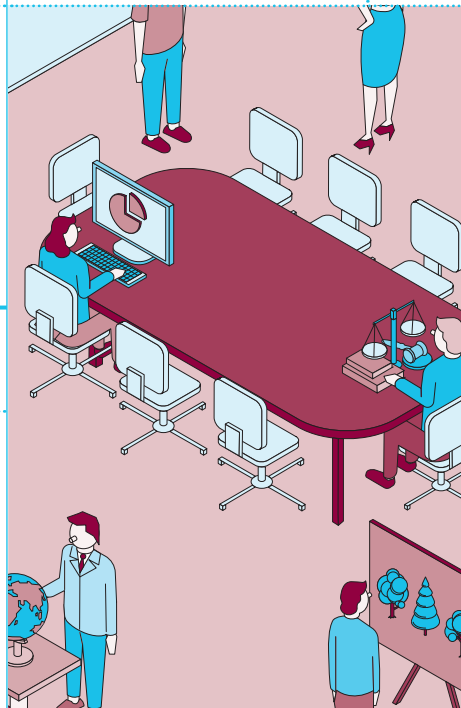
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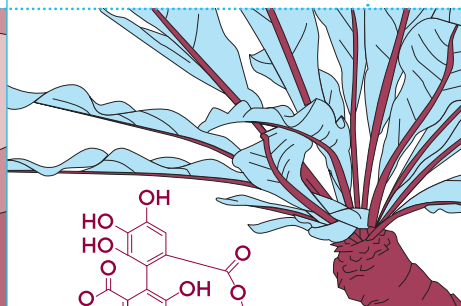
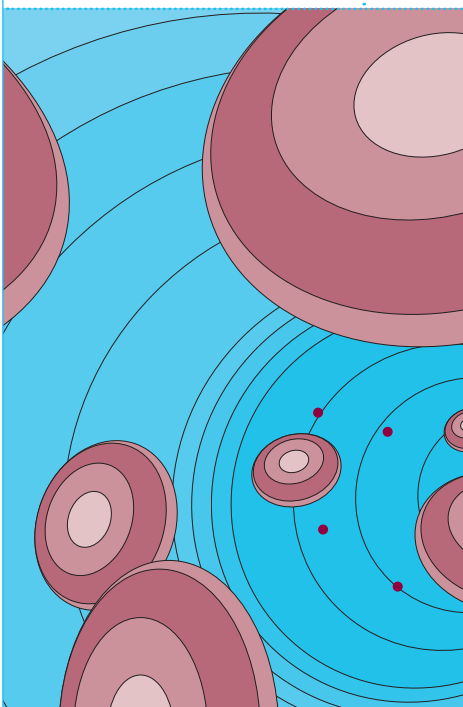
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Title

## A NEW BUILDING FOR THE PARIS- SACLAY INSTITUTE OF NEUROSCIENCE

# université PARIS-SACLAY

Address

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Website

[universite-paris-saclay.fr](http://universite-paris-saclay.fr)



## RESEARCHERS



© INRA

**Abdelhafid Bendahmane**, researcher at the **Paris-Saclay Institute of Plant Sciences** (IPS2 – CNRS/INRA/Université d'Évry/Université Paris-Diderot/Université Paris-Sud), received the **2018 "Scientific challenge" award** conferred by **France's National Institute for Agricultural Research (INRA)** for his pioneering work in genomics, translational research and plant selection.

**Alexandre Bresson, Yannick Bidet and Nassim Zahzam**, three engineers from the French Aerospace Lab (ONERA)'s Department of Physics, Instrumentation, Environment and Space, were awarded the **"Scientific Excellence" Prize** given by **France's Aeronautics and Astronautics Association (3AF)** for their work on cold atoms.

**Marie Cornu**, researcher at the **Institute of social and political sciences** (ISP – CNRS/ENS Paris-Saclay/Université Paris Nanterre), **Valérie Masson-Delmotte**, researcher at the **Laboratory for Climate and Environmental Sciences** (LSCÉ – CEA/CNRS/Université Versailles – Saint-Quentin-en-Yvelines), and **Marie-Hélène Schune**, researcher at the **Laboratory of the Linear Accelerator** (LAL – CNRS/Université Paris-Sud), were each awarded the **2019 silver medal** conferred by **French National Centre for Scientific Research (CNRS)** for the originality, quality and significance of their work, which has earned national and international recognition.

**Ivan Chupin**, senior lecturer with the **Professions, Institutions and Temporalities research group** (PRINTEMPS – CNRS/Université Versailles – Saint-Quentin-en-Yvelines), was awarded the **2019 Research prize of the Annual international conference for journalism** for his book *Les écoles du journalisme. Les enjeux de la scolarisation d'une profession (1899-2018)* ("Journalism schools. The schooling stakes of a profession (1899-2018)").



© Sophie Dotaro-UPSaclay

**Ruxandra Gref**, researcher at the **Orsay Institute of Molecular Science** (ISMO – CNRS/Université Paris-Sud), was awarded the **Étoiles de l'Europe ("Stars of Europe") special jury prize** for coordinating the Cyclon Hit project, which made it possible to develop new drug delivery systems to combat antibiotic-resistant bacteria. She also won the **2019 CNRS silver medal**.

**Christophe Gouel**, economist and specialist in the fluctuation of commodity prizes at the **Public Economics Laboratory** (AgroParisTech/INRA), was awarded the **2018 INRA "Scientific Hope"** prize. His work focuses on the impact of climate, demographic and nutritional changes on global food security.



© UPSud

**Jean-François Le Gall**, researcher at the **Orsay Laboratory of mathematics** (LMO – CNRS/Université Paris-Sud), was awarded the **Wolf Prize for Mathematics** for his profound, elegant work on stochastic processes.

**Satya Narayan Majumdar**, researcher at the **Laboratory of Theoretical Physics and Statistical Models** (LPTMS – CNRS/Université Paris-Sud), is the 2019 laureate of the **EPS Statistical and Non-Linear Prize** and the **2019 CNRS silver medal**. He earned these prizes with his research in the fields of statistical and non-linear physics, complex systems and complex networks.



© Cyril FRESILLON-CNRS

**Jean-Michel Morel**, professor at **ENS Paris-Saclay**, was conferred the title of **Doctor Honoris Causa by Uruguay's University of the Republic** (UDELAR), the country's leading institution for higher education and research. The title is a reward for his research in image processing.

The **Léon Brillouin Laboratory's** (LLB – CNRS/CEA) **"Small Angles" team** won the **CNRS Cristal collectif ("Collective crystal") award in the "Direct research support" category**. The team designs, builds and implements small-angle, neutron-scattering spectrometers and has very high-level expertise. It can thus offer the international community the very best instruments.

The **"Prion" team**, including **Human Rezaei**, biophysicist at **INRA's Molecular Immunology and Virology (VIM) research unit**, and **Jean-Luc Vilotte**, geneticist and biologist at the **Animal Genetics and Integrative Biology** research unit (GABI – AgroParisTech/INRA), was awarded the **2018 INRA prize for the impact of their agricultural research**. The research conducted by the team for twenty years has contributed to protecting human food and health from transmissible spongiform encephalopathies (TSEs).

## STUDENTS



© UPSud

A team of students in the second year of their **Master's degree in events management and recreational sports** at **UFR STAPS Paris-Sud**, Paris-Sud's Faculty for Sciences and Techniques of Sports and Physical Activities, was one of the finalists in the **national "Sport Business Challenge" competition**.

Two teams of students from Université Paris-Saclay, **GO Paris-Saclay** (AgroParisTech/ENSTA/Université Paris-Sud) and **Évry Paris-Saclay** (Université d'Évry/Université Paris-Sud), each earned a **gold medal in the 2018 International Genetically Engineered Machine (iGEM) competition in the "Synthetic biology" category**.

The student projects entitled **"Quantification and recognition of insects through image analysis and algorithms"** (AgroParisTech/CentraleSupélec) and **"Neutralisation of the Asian hornets surrounding bee hives through light pulses"** (AgroParisTech/Institut d'Optique Graduate School/HEC42) are finalists in the **Make IT Agri competition** intended to foster digital innovations to improve the environmental dimension of agricultural practices.

## BUSINESSES



© CentraleSupélec

**Junior CentraleSupélec** was voted best **2019 European Junior Enterprise** at the 2019 JADE Excellence Awards.



The **Vita DX** start-up, established through the research of Orsay Institute of Molecular Science (ISMO – CNRS/Université Paris-Sud), was awarded the **city of Paris' Grand Prize for Innovation in the "E-health" category**. The technology developed combines fluorescence microscopy and artificial intelligence to swiftly detect bladder cancer.



© UPSaclay

The year 2018-2019 has been designated as the "Year of Chemistry, from Elementary School to University" by the French Ministry of National Education and Youth and the Ministry of Higher Education, Research and Innovation. Moreover, the United Nations General Assembly proclaimed 2019 as the International Year of the Periodic Table of Chemical Elements, subsequently adopted

by Unesco. In other words, chemistry is in the spotlight this year! Even so, there is a tendency for the public at large to see it as "non-natural", "toxic" and "polluting". There are many preconceived ideas about chemistry and they are hard to eradicate. This is our chance to set the record straight by publicizing Université Paris-Saclay's courses (e.g. Master's programs) and research projects (e.g. on green chemistry). It's time to do away with misconceptions! Grossly caricatural, they fail to convey the variety and richness of this discipline or its contribution towards addressing major societal issues.

As European Sustainable Development Week approaches, we should all be questioning our own habits and practices as well. The "research and education" strategy set by Université Paris-Saclay aims to build knowledge in seven areas presenting society with challenges: health and wellness; energy, climate, environment and sustainability; biodiversity, agriculture and food; digital transformation and artificial intelligence; transportation and mobility; aeronautics and space; and industrial renewal.

The effectiveness of these investigations is augmented by support from the humanities and social sciences which, at Université Paris-Saclay, focus on interdisciplinarity. Backed by the Paris-Saclay Humanities and Social Sciences Center ("MSH Paris-Saclay"), these interdisciplinary projects investigate how we relate to the environment and land use, how digital has made its way into the humanities and how innovation figures in the process of transformation.

World-class equipment is also integral to our scientific identity. In this issue, you will read about the TEMPOS microscopy and nano-characterization platform used to observe the physical properties of nanomaterials. Its microscopes are evolutionary prototypes, a world premier!

Enjoy your read!

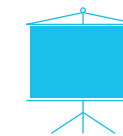
**Sylvie Retailleau**,  
President of Université Paris-Saclay



Chemistry

## Members of Université Paris-Saclay





Title

## Chemistry Masters' degrees: a world of treasures beneath the microscope



© M2 PCGE/UPsacalay

**As chemistry is in the spotlight this year, we give you feedback on the Masters' degrees offered by Université Paris-Saclay. The variety of fields and areas of expertise disproves common misconceptions entertained by the general public.**

On 4 October 2018, under the auspices of the Ministry of National Education and the Ministry of Higher Education, Research and Innovation, the year of school chemistry was launched at the university. On this occasion, France will host the 51<sup>st</sup> International Chemistry Olympiad from 21 to 30 July 2019 in Paris, as well as many other events intended to familiarise young people with the subject. Two hashtags were also put forward: #yearof-chemistry and #thankstochemistry.

**Chemistry: a great unknown for the public**

That decision was not taken lightly. Chemistry still incites distrust, perhaps, partly, "because among the general public, there is virtually no culture of chemistry. There is still an idea that

chemistry isn't 'natural', so it's bad", stated Philippe Minard, head of the second-year Master's in biomolecular engineering and chemistry and researcher at the Institute for integrative cell biology (I2BC – CEA/CNRS/ Université Paris-Sud). "All chemistry teachers combat the image whereby 'chemical products' are a synonym for 'toxic products'," said Laurent Salmon, head of the second-year Master's in chemical pollution and environmental management and researcher at the Orsay Institute of molecular chemistry and materials (ICMMO – CNRS/ Université Paris-Sud). Delphine Joseph, head of the second-year Master's in pharmaceutical chemistry and researcher at the Biomolecules: design, isolation and synthesis laboratory (BioCIS – CNRS/ Université Paris-Sud), concurred: "Chemistry is often decried because of its association with the terms 'pollution' and 'toxicity'. However, that does not allow for the crucial role it plays in our daily lives and well-being. Chemistry is what makes it possible to produce contact lenses and develop new medications!"

**Chemistry in all its states**

While there is still much to be done in raising the awareness of the general public, Philippe

Minard noted that for Master's students, "that's practically no longer an issue. Those questions are tackled during the bachelor's degree." At Université Paris-Saclay, students quickly see the varied fields that involve chemistry. Talal Mallah, also a researcher at ICMMO and head of the second-year Master's in inorganic chemistry: molecules, surfaces and nano-objects, explained that for his Master's, "materials with a molecular basis and nano-objects" were studied, "mainly through their physical and chemical properties". Delphine Joseph explained that for the second-year Master's in pharmaceutical chemistry, "our aim is to train students in strategies for discovering and developing medicines that are synthetic or of natural origin. Once you have identified one of the biological targets involved in a disease, the goal is to develop the drug capable of acting upon the target and treating the illness." As for the second-year Master's in biomolecular engineering and chemistry, which serves as an interface between chemistry and biology, Philippe Minard stated that "the aim is to study the molecular mechanisms in living beings." He added, "In cells, you find macromolecules that are unbelievably sophisticated! Consequently, you need to know not only how to produce them,

but also how to determine their form and their potential evolutions. Our students actually have to become 'mechanics' for living macromolecules." Regarding the second-year Master's in chemical pollution and environmental management, the aim is to train managers capable of diagnosing and managing soil, water and air pollution, or of working in the waste sector.

**Environmental concerns**

Chemistry actually benefits the environment. For Delphine Joseph, that is not a new development. "This dimension has been considered for many years. In chemistry, we use derivatives stemming from fossil matter. As it is finite, one of the goals of chemistry is to transform renewable resources, produced by nature, as a substitute." In the second-year Master's she heads, one course unit is thus dedicated to "Emerging techniques and processes in eco-compatible chemistry". Students who take the course are made aware of the emerging methods reducing the impact of their activity on nature. They can reduce their use of solvents and learn methods that require less energy. "We've had very positive feedback," she said. "Students are made aware of things they had not considered before." As for the second-year Master's managed by Laurent Salmon, environmental concerns are evidently at the heart of the course... and ensuing employment. "90% of our students go on to work in the environmental sector," he said.

**Significant insertion rates**

After a second-year Master's degree in chemistry, students do not find themselves at a loss. Following the second-year Master's in chemical pollution and environmental management, which aims to train managers, graduates leave to seek employment in companies. The students who graduated in 2018 all found employment "within four months after they had earned their diploma," said a jubilant Laurent Salmon. Over ten years, 90% of students found a job in the year following their graduation. For her part, Delphine Joseph sees most of her graduates turn towards research. "However, among our Master's students who also have a pharmacy degree, some turn to industry and easily find work," she said.

Philippe Minard also noted a "strong interest in research, perhaps kindled by the exceptionally rich academic setting". He further specified that "Two thirds of students wish to complete a PhD and successfully pass the competitive exams to the requisite doctoral schools". As for the remaining third, the degree's mix of chemistry and biology enables them to display a dual competence, for instance, in industrial property. Talal Mallah's students, too, overwhelmingly choose research. Moreover,

the 'nano' dimension appeals to some start-ups that recruit students once they have completed their PhDs. Can the image of chemistry be changed? "It's also up to chemists to have a care and show that their discipline is very different to what people may think," said Laurent Salmon. At Université Paris-Saclay, that momentum is already under way.

<https://www.universite-paris-saclay.fr/fr/formation/master/chimie#mention>

Title

### Everyone to the Design Spot!



© Design Spot

Operational since January 2018, in November 2018, the Design Spot made an original offer to "all those belonging to the Paris-Saclay ecosystem", said Vincent Créance, its director. Design discovery sessions lasting half a day have thus been held every third Thursday to enable participants to "better understand the field and gain basic knowledge they can use to work with designers".

Science and design, a match made in Heaven? Vincent Créance commented that "Scientific developments must mesh with common practices. Design is capable of creating that connection." The first sessions attracted a diverse public: "50% of participants were actors with links to innovation (laboratories, fabrication laboratories, communications departments, start-ups, company relations, etc.). The rest were inquiring minds who wanted to discover a discipline they didn't know very well, students and people who thought design could be useful to them in the future," Vincent Créance noted.

As these sessions leave participants with the desire to learn more at the end of the half day, since March 2019, the Design Spot has offered a quarterly module over two whole days, open to twenty participants. Two designers are present, in a more personalised project-development approach.

<https://www.designspot.fr/formations/>

Title

### The Emulator is inspired!



© IGEV Évry

"Depending on the stream, drop-out rates can reach 50%. We couldn't just stand by and do nothing!" Patrick Curmi, Vice-Chancellor of the Université d'Évry, said with conviction. It was decided to better understand and supervise a young generation that was constantly changing, and perhaps even help students to find a new direction and face the challenges of higher education. To that end, Patrick Curmi and his team set up the Emulator, an astonishing 300m<sup>2</sup> site located within the Chamber of Trades and Crafts, only a stone's throw from the university. With its modular furniture, the phrases such as "Caution, being in the making" decorating the site and its butterfly logo, everything in the Emulator elicits "understanding and benevolence, without prejudice", in the words of the Vice-Chancellor. All for young people trying to discover themselves... It is hoped that they will prevail.

After interviews, they can take part in workshops on one or several, cross-cutting subjects, which make up most of the Emulator's offerings: methodology, public speaking, self-confidence, sophrology. There is even a workshop that supports dyslexic students. Established at the beginning of the university year 2018, the Emulator has already played host to about 300 students. "Those who persevered have seen its benefits," said Patrick Curmi. "The skills they acquired at the Emulator will enable them to triumph in different areas throughout their lives."

[www.univ-evry.fr/formation/lemulateur.html](http://www.univ-evry.fr/formation/lemulateur.html)



Title

## Exoplanets: The Game



© Exoplanètes le jeu

**Astrophysicist Pauline Zarrouk has developed a board game to help people learn about exoplanets while having fun. Ready for a game?**

Pauline Zarrouk holds a PhD in cosmology from the Institute of Research into the Fundamental Laws of the Universe (IRFU), a division of France's Alternative Energies and Atomic Energy Commission (CEA). In 2018, she also won a Research Fellowship for Women in Science from the L'Oréal-UNESCO Foundation. Pauline Zarrouk not only loves astrophysics, but has a penchant for board games. When studying fundamental physics at the Orsay campus of Université Paris-Sud in 2012, Pauline Zarrouk chose an elective on popularizing physics. She teamed up with fellow students Alexandre Bordas and Dimitri Chuard to

**“Players of the exoplanet game slip into the role of an astrophysicist. It's up to them to choose an exoplanet detection method.”**

Pauline Zarrouk

create a game starring the exoplanets, i.e. the planets located outside our solar system. “This topic was just emerging at the time. It dealt with big questions, ranging from extraterrestrial life to fundamental research,” she recalls. In other words, it could not fail to interest the public.

### Information-rich play

Players of the exoplanet game slip into the role of an astrophysicist. It's up to them to choose an exoplanet detection method in hopes of winning a prize – the Nobel Prize, no less! There are several methods to choose from, including radial velocity, direct imaging, gravitational microlense, transit timing or transit photometry. The game is information-rich: players encounter quiz questions of general knowledge along the board path as they strive to acquire the detection instruments they need. “The facts are all grounded in science,” notes Pauline Zarrouk. “Players reading a popular science article about exoplanets will run across facts that they have already encountered in the game.”

### 250 copies distributed

The game was first created in 2012, then overhauled by Pauline Zarrouk and her co-founders when she was doing her thesis at the IRFU division of the CEA. “I received funds from IRFU, was selected by La Diagonale Paris-Saclay – a Université Paris-Saclay institution for dialogue between science and society – further to a call for proposals and invested part of my L'Oréal-UNESCO grant in the project.” Two hundred and fifty copies of the game have already been circulated to laboratories, middle and high schools, associations and science venues. The next step will be to find a publisher and bring it to market so that more fans can learn about cool planets!

[www.facebook.com/exoplaneteslejeu](http://www.facebook.com/exoplaneteslejeu)

Title

## Fifth Festival de Robotique in Cachan



© Ménagerie technologique

The program is so full and varied that one would have to be triplets or quadruplets to enjoy all of the opportunities on offer at the Festival de Robotique (Robotics Festival) in Cachan (June 5 to 11). One can pay a visit to the robot photographer: it will scan one's face and reproduce it using a 3D printer. And there's an exciting hackathon in store for spectators: students from top schools will compete in programming a robot to throw a ball. Furthermore, in an electrical engineering and industrial IT contest, teams from twenty university institutes of technology will tackle the mechanical programming for that same robot. Also on the agenda are the finals of Eurobot Junior, an international robotics contest for young people under 18.

Other events are also planned, such as exhibitions, workshops and surprising artistic performances held off-site. Perhaps you'd like to see a one-ton robot carry a Chinese pole act? Engage in a session of robot-taming? Attend a weekend drone workshop? It's hard to decide! It's almost a shame not to be a robot oneself... Actually, that's how to tell a robot from a human: humans make fully conscious decisions, all by themselves!

[www.festivalrobotiquecachan.fr](http://www.festivalrobotiquecachan.fr)

Title

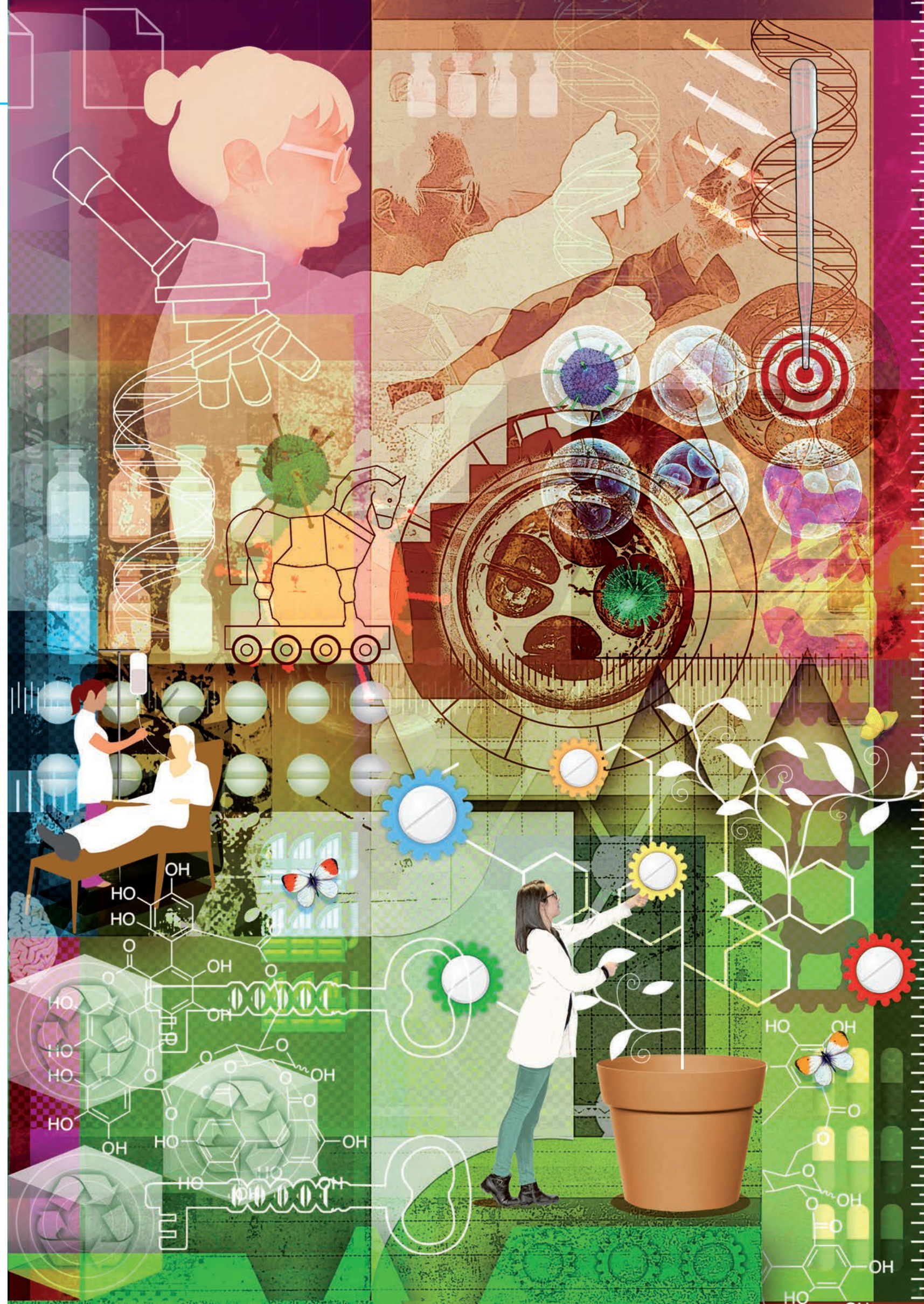
## Upcoming participative discussions

The first step in organizing public debates on scientific issues of societal import is to listen. This is especially true when, like at Université Paris-Saclay, the plan is to closely involve not only students and university staff, but also local residents and local authorities. A series of bi-monthly public meetings will start in September 2019. To maximize their effectiveness, organizers carried out a preliminary phase, i.e. “a thought process with external persons

accustomed to taking part in public consultations,” explains Sandrine Le Flohic, project manager for the Sciences & Society project at Université Paris-Saclay. A second phase kicked off this spring: a methodology devised to identify the public's expectations regarding these public discussions. “Our investigation runs from March through June,” continues Sandrine Le Flohic. “It relies on face-to-face meetings in cities, data collection and person-in-

the-street interviews.” How does she imagine the discussion sessions in her mind? “Each one should be like an agora, an assembly devoted to the exchange of views and access to science, at which each participant has their rightful place.” Stay tuned!

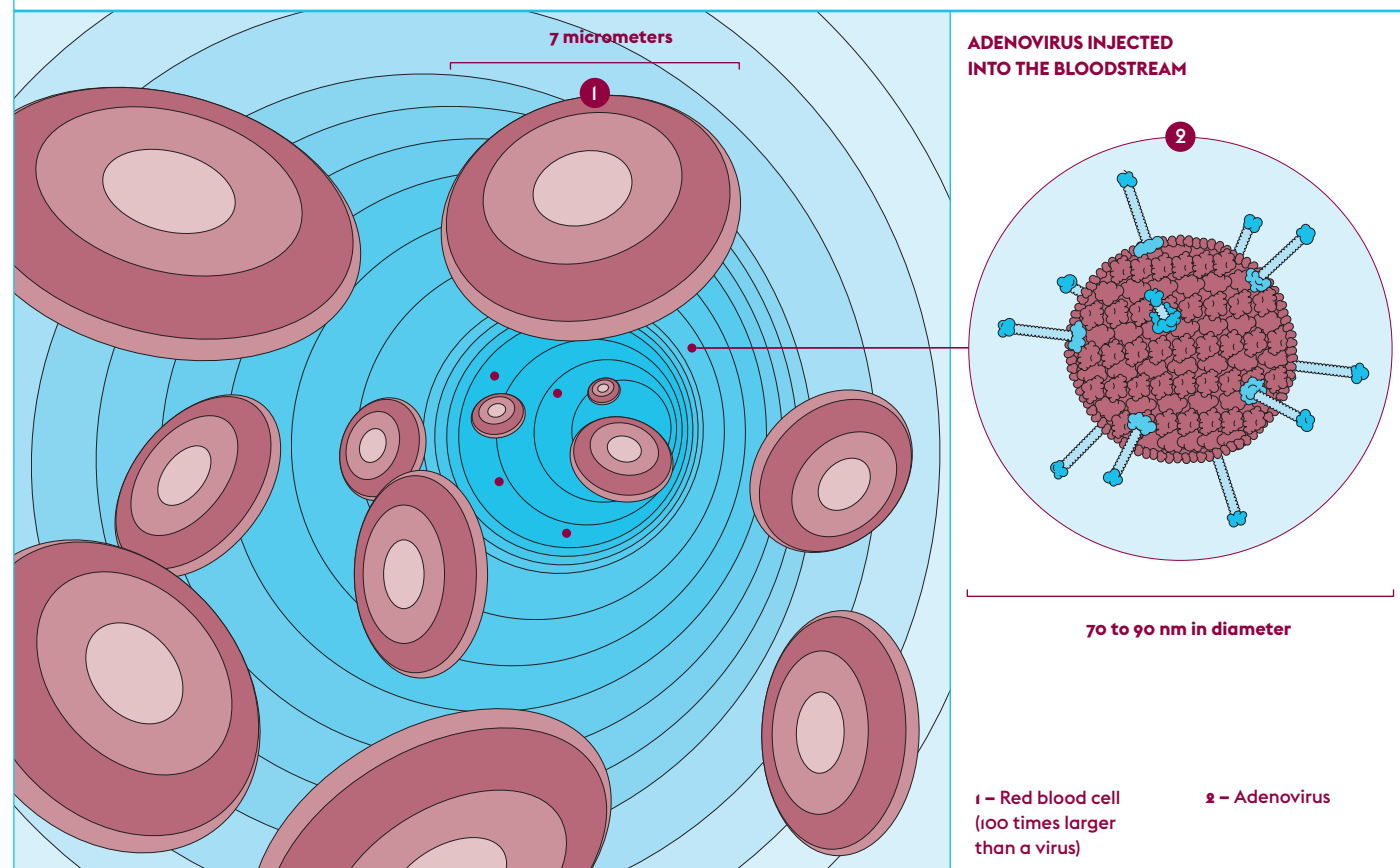
Illustrations  
on the right page  
and page 18:  
Nini La Caille





Title

## Cancer-killing viruses



**Armed with oncolytic viruses, researchers of Université Paris-Saclay are attacking tumors. The vesicular stomatitis virus and adenoviruses figure among the subjects of their investigations.**

Using viruses to destroy tumors is a promising therapeutic approach developed by researchers to supplement conventional cancer therapies. Virotherapy in cancer treatment capitalizes on the fact that certain viruses are able to specifically infect tumor cells and induce their cell death by means of direct lysis and/or the response of the immune system, without affecting healthy cells. This preferential replication, called “oncotropism”, is naturally present in viruses or acquired after genetic modification.

“As a general rule, a virus does not infect all types of cells, because its spectrum of hosts is relatively limited. In order to penetrate a cell, specific molecules present on its surface must recognize a specific receptor on the cell surface” explains Yves Gaudin, a researcher at the Institute of Integrative Cell Biology (I2BC – CEA/CNRS/

Université Paris-Sud). “Often prone to deregulation of their cellular mechanisms, tumor cells express a number of unusual membrane proteins, some of which, if we knew how to target them, could play the role of viral receptor.”

### The VSV, a multi-talented oncolytic virus

An excellent laboratory model, the vesicular stomatitis virus (VSV) is a naturally oncolytic virus that is the subject of many studies and widely used in gene therapy. Benign for humans, this “enveloped” virus infects many species of mammal and certain insects. “The problem is that this virus lacks targeting specificity and rapidly causes the death of the infected cell,” notes Yves Gaudin. The glycoprotein G present in its envelope ensures recognition of the targeted cell receptors, then the release – thanks to the fusion of the viral envelope and the cell membrane – of the viral genome inside the cell, both of which are stages required for infection to continue. These receptors belong to the same family as those of low density lipoproteins (LDL), responsible for carrying lipids in the blood and present at the surface of many cells. All feature a structural cysteine-rich repeat motif encasing a calcium ion.

Thanks to a collaboration with researchers at Synchrotron SOLEIL, France’s national synchrotron facility, Yves Gaudin and Aurélie Albertini recently identified, using X-ray crystallography, the precise points at which the VSV glycoprotein anchors to the LDL receptors as well as the regions of glycoprotein G involved. Located in two cysteine-rich domains of the receptor, these binding sites involve two amino acids in the glycoprotein G. “Their mutation leads to a total failure to recognize the LDL receptor. The virus cannot bind to the cell and loses its infectious capability. On the other hand, the membrane fusion activity, essential for cargo release, is maintained,” remarks Yves Gaudin.

Being able to decouple receptor recognition and viral fusion opens up numerous perspectives. “What we’re seeing is the construction of new glycoproteins that no longer recognize their natural receptor, but target other receptors at the surface of cells and conserve their membrane fusion properties,” points out Yves Gaudin, who is testing the association of glycoproteins with nanobodies, i.e. small single-chain antibodies derived from llamas. “The idea is to put these antibodies into our viral glycoprotein to confer a specificity that it did not originally have and direct the virus to new targets.”

### Genetic manipulations and the oncotropism of adenoviruses

At the Vectorology and Anticancer Therapies Laboratory (CNRS/Université Paris-Sud) at Gustave Roussy, Karim Benihoud and his team are working for the most part on another type of virus, adenovirus serotype 5, and, more recently, on that of serotype 3. These replicating viruses lyse cells at the end of their cycle. His focus is on controlling their toxicity and tropism when these viruses are administered by a systemic route. “Normally, an adenovirus preferentially targets liver cells. Once injected into the bloodstream, it becomes covered with coagulation factors that function like adaptors between itself and the receptor on the surface of the hepatocytes. By genetically modifying the capsid proteins, it is possible to eliminate the pathway by which the virus naturally enters the cell or, on the contrary, create a new one after adding a ligand for addressing purposes.”

### “Tumor cells express a number of unusual membrane proteins.”

Yves Gaudin

As adenoviruses are not naturally oncolytic, researchers have two strategies that they can use to render these viruses tumor-selective. “The first way is to put the entire viral genome under the control of a tumor-specific promoter, such as that of PSA (prostate-specific antigen), CEA (carcinoembryonic antigen) or telomerase, known to function in tumoral cells,” explains Karim Benihoud. “The other involves mutating certain regions of the viral genome so that, once the virus has entered the cell, it only replicates in cycling cells, i.e. tumoral cells for the most part.” In the laboratory, he works with adenoviruses with mutated E1A proteins, responsible for initiating the viral cycle. In normal cells, the mutated protein E1AΔ24 is not capable of trapping the Rb protein, a tumor suppressor, or of removing cell cycle inhibition. On the contrary, the adenovirus will be able to replicate its genome in the tumoral cells, often mutated for Rb, and the new virions produced will lead to the lysis of the cells.

The other benefit of oncolytic viruses resides in the activation of the antitumor immune response. The tumor environment, generally immunosuppressive, changes in contact with them. The injection of a virus into a tumor creates a pro-inflammatory context: infection

of the cells induces the production of cytokines (IL-1, IL-6, interferons and TNF-α) that will activate the immune system. “Once adenoviruses enter tumor cells, they begin to replicate and kill cells, releasing tumor antigens that are processed and presented by antigen presenting cells.”

Ready to wage war on tumors from every angle, researchers are investigating the use of oncolytic viruses in association with chemotherapies, with encouraging results. “As far as colon carcinomas are concerned, we have shown the synergistic effect of combining oncolytic adenovirus and valproic acid in a murine model,” said Karim Benihoud.

### Publications

- Jovan Nikolic et al., Structural basis for the recognition of LDL-receptor family members by VSV glycoprotein. *Nature Communications*, 2018; 9: 1029
- Bressy C. et al., Combined therapy of colon carcinomas with an oncolytic adenovirus and valproic acid. *Oncotarget*, 2017, 8 (57): 97344 – 97360.



© Karim Benihoud

The genome of the adenovirus can be easily manipulated using the tools of molecular biology and the vectors derived from it can be produced in large quantity.

Karim Benihoud is a professor of cell signaling and immunology at Université Paris-Sud and heads the anti-tumor viral vectorology group of the Vectorology and Anticancer Therapies Laboratory (CNRS/Université Paris-Sud) at the Gustave Roussy cancer campus. His work focuses on vectors and oncolytic viruses derived from human adenoviruses, seeking to control their tropism and develop new vaccination strategies. He has applied for, and been granted, several patents.

» focus

## A receptor for the GLN endogenous virus in mice

Endogenous retroviruses are remnants of ancestral infectious retroviruses that have made a stable insertion of their genome into that of their host and been transmitted to following generations. They are found in all vertebrates and, in mice, they represent up to 10% of the genome. Some – such as the GLN endogenous retrovirus – have retained their infectious nature and still encode complete viral particles. Researchers at the Laboratory for the Study of the Molecular Physiology and Pathology of Infectious Endogenous Retroviruses (CNRS/Université Paris-Sud) at Gustave Roussy have identified the receptor responsible for its cell entry: the folate transporter SLC19A1 (solute carrier family 19, member 1), from the SLC superfamily. They have shown that infection by the GLN endogenous retrovirus is limited to mouse cells, due to a mutation in the coding gene for SLC19A1 that prevents its glycosylation. This discovery confirms that SLC proteins are involved in retroviral infections in mammals.

**Publication** · Tsang J. et al, Identification of the receptor used by the ecotropic mouse GLN endogenous retrovirus, *J Virol*, 2018 Dec 12.

» focus

## Nanobalances for weighing viruses

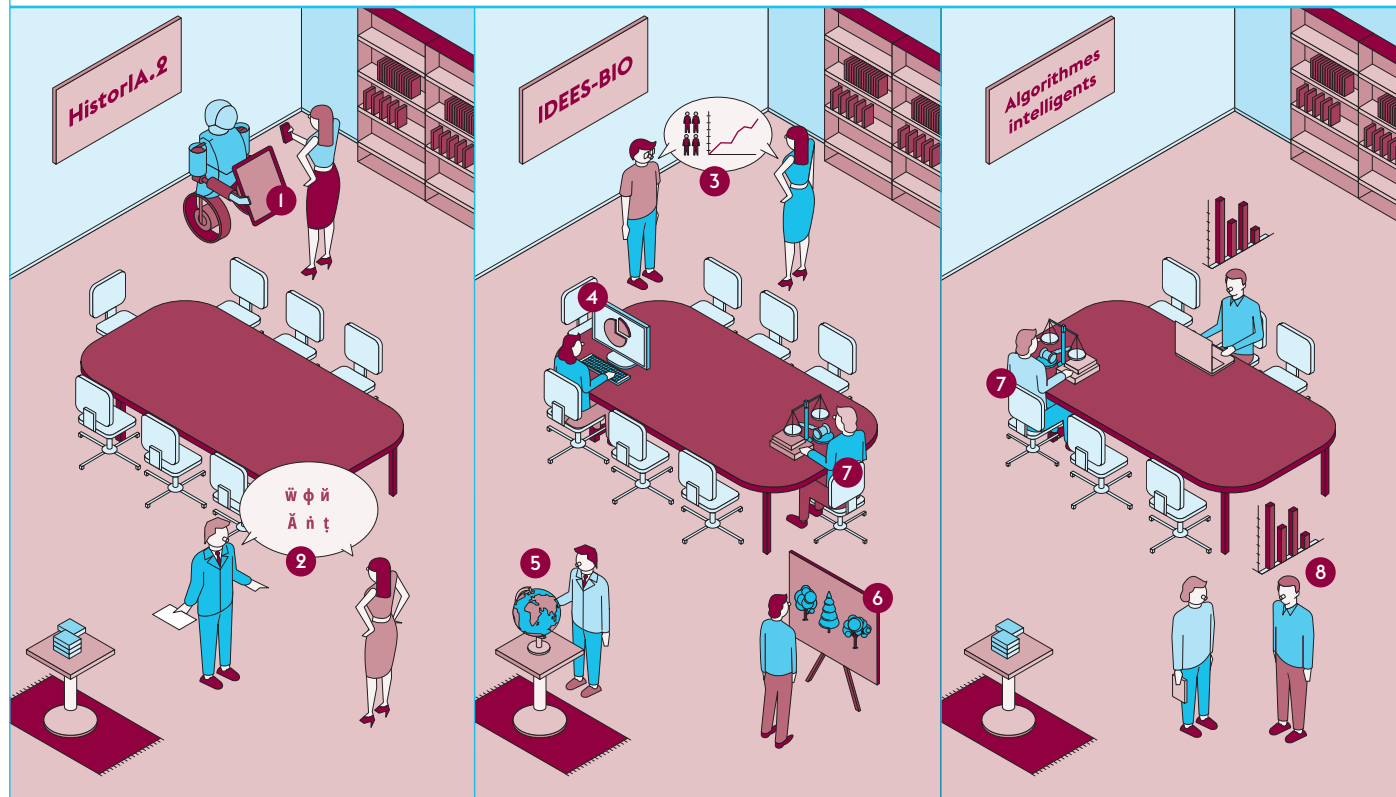
A team of researchers from the CEA in Grenoble and from the Institute for Integrative Biology of the Cell (I2BC – CEA/CNRS/Université Paris-Sud) has developed a new mass spectrometry technology based on nanomechanical resonators able to measure particle masses that previously could not be measured using commercial technologies. The team demonstrated their nanobalance’s efficiency by measuring the mass of the capsid of a bacterial virus, Bacteriophage T5. The new technology will enable development of applications in the characterization, quality control and production of nanoparticles for medical use.

**Publication** · Sergio Dominguez-Medina et al., Neutral Mass Spectrometry of Virus Capsids Above 100 Megadaltons with Nanomechanical Resonators, *Science*, Novembre 2018.



Title

# Interdisciplinarity in the HSS: laying the groundwork for tomorrow's research



1 – Artificial intelligence  
2 – Linguistic

3 – Sociology  
4 – Political science

5 – Geography  
6 – Ecology

7 – Law  
8 – Economy

At Université Paris-Saclay, many of the projects selected for development are in study areas conducive to interdisciplinarity in HSS. Often, the latter deal with environmental issues, the management of large databases or innovations.

The recent “Gilets Jaunes” citizens’ protest movement in France and the ensuing large-scale national debate remind us that the humanities and social sciences (HSS) are necessary and vital in the construction of an enlightened, participative and inclusive society. “At Université Paris-Saclay, the HSS Department is home to about fifteen disciplines that fall into four main categories – namely, economics and management; law; sociology and political science; and the humanities and heritage sciences – as well as 36 research laboratories and about a thousand researchers,” reports Jean-Paul Markus, head of this Department at Université Paris-Saclay.

Interdisciplinarity enables each discipline to situate its particular study area within a broader context. “Today, society’s global problems are very complex and it’s increasingly improbable that any single scientific discipline

will be able to devise solutions for them,” comments André Torre, director of the Paris-Saclay Humanities and Social Sciences Center (MSH Paris-Saclay).

Created in 2015 to foster cross-pollination, MSH Paris-Saclay (See Focus opposite) “is specialized in research engineering for the purpose of facilitating collaboration between researchers,” says its director. It funds the organization of scientific events and the development of research projects in three categories: “environment, spatial planning, health”; “digital and humanities sciences”; and “transition and innovation”. “They often involve some of the most innovative interdisciplinary research.”

## Massive amounts of data and the automatic exploration of language resources

One of these innovative projects is HistorIA.2, championed by linguist Ioana Vasilescu of the Computer Science Laboratory for Mechanics and Engineering Sciences, or LIMSI (CNRS). HistorIA.2 draws on conventional linguistics as well as artificial intelligence to study the evolution of languages, using automatic speech processing systems that can explore massive amounts of spoken language data.

Assisted by fellow linguists and a LIMSI automatic processing specialist, Ioana Vasilescu is studying sound changes occurring over time in certain Romance languages (Spanish, Italian and Romanian) in particular regions.

**“Today, society’s global problems are very complex. It’s becoming increasingly improbable that any single scientific discipline will be able to devise solutions for them.”**

André Torre

With regard to the Spanish language, she is especially interested in the lenition of the consonants “b”, “d” and “g” placed between two vowels and the consonant “s” at the end of a word. “For instance, the word *abogado*, the Spanish word for lawyer, has come to be

pronounced ‘aoo’,” says Ioana Vasilescu. “We wanted to know the extent to which Spanish was affected by this phenomenon.” By “hijacking” LIMSI’s automatic processing systems for her own purposes, she is able to quantify the sound variations detected in several hundred hours’ worth of recorded radio and television news programs. “In order to do this, we have to force the system to leave transcription errors that it would normally correct,” she explains.

## Biodiversity and land use planning: fraternal adversaries?

Another MSH undertaking, IDÉES-BIO, deals with the project impact of environmental assessment in regional planning policies, mobilizing specialists in ecology, law, political science, geography and sociology. It bears on the planned metro line (Line 18) between Orly Airport and the Versailles Chantiers rail station and the consequences for the flora and fauna in the Saclay plateau. “With hindsight, we realized that the alignment coincided exactly with the movement paths of certain animal species,” observed team member Nathalie Frascaria-Lacoste, professor and researcher in ecology at the Ecology, Systematics and Evolution Laboratory (ESE – AgroParisTech/CNRS/Université Paris-Sud). “Today, impact assessments only go partway in identifying the biodiversity of a given territory.”

In addition to analyzing eco-indicators, the team also seeks to understand the regulatory environment and develop new work methodologies. “In cases where environmental impairment cannot be avoided or reduced, planners find themselves constrained to take compensatory measures, which are often restrictive and very difficult to implement. Our purpose is to find a way to do things better, all together,” says Nathalie Frascaria-Lacoste. The goal is to work in concert with land use planners and, in three years, propose guidelines to help them more effectively reconcile land use planning and economic development with the protection of the environment, knowing that environmental assessment is a complex matter.

## For non-discriminating intelligent algorithms

At the RITM economics and management laboratory (Université Paris-Sud), specialized in the study of networks, spatial issues and globalization, economists Serge Pajak, Matthieu Manant and a legal expert have tackled a project to evaluate the economic origin of discrimination bias generated by the intelligent algorithms used by social media or matchmaking platforms. “We were inspired by previous research showing that, on Facebook, the allocation of ad space by means of an auction mechanism and the difference

in marketing advantage inherent to targeting a male or female cause disparities in display depending on the gender of the user. It is harder to ‘win’ an auction to display an ad to a woman user,” points out Serge Pajak. “Advertisers think they are not discriminating, but the behavior of the algorithm yields a result that is not neutral.”

In the summer of 2018, the team set out to learn more about this behavior. They supervised ad campaigns for an engineering school on Facebook and Snapchat. “We wanted to see if ad distribution varied according to type (feminine, masculine or neutral) or content,” said Matthieu Manant. The results, still being analyzed, seem to indicate that, on Snapchat, distribution in provincial France is similar to that of Paris, “as if the algorithm had learned from its experience in Paris how to distribute ads in cities for which it lacked data.”

## Publications

· Vasilescu, I., et al. *Exploring Temporal Reduction in Dialectal Spanish: A Large-scale Study of Lenition of Voiced Stops and Coda-s*. INTERSPEECH 2018, 2728-2732.

· Colloque Gaié MSH 2018 « À quoi sert l'évaluation environnementale? Pratiques, Enjeux et Perspectives » du 10 décembre 2018: <http://www2.agroparis-tech.fr/podcast/-Colloque-Gaie-MSH-2018-.html>

· Manant M., et al. Can social media lead to labor market discrimination? Evidence from a field experiment. *Journal of Economics & Management Strategy*. 2018; 1-22.

## Profile

André Torre



© André Torre

Now we work with nearly all of the teams in humanities and social sciences at Université Paris-Saclay.

An economist by training, André Torre is the director of the MSH Paris-Saclay, which fosters and supports research in humanities and social sciences. He is also a research director at INRA, involved in AgroParisTech, and is the director of research programs “for and about regional development”. His research focuses on analyzing proximity relations and their importance in processes of coordination between people. He is also President of the European Regional Science Association (ERSA) and managing editor of the journal *Revue d'économie régionale et urbaine* (RERU).

» focus

## A center devoted to interdisciplinarity in the humanities and social sciences (HSS)

MSH Paris-Saclay is a joint research and services unit of CNRS and Université Paris-Saclay. Its mission is to foster interdisciplinarity within the HSS Department and mobilize synergies between HSS and other scientific fields of study at the university. It provides communication support to interdisciplinary projects and raises awareness of major social issues. It also provides financial assistance via calls for proposals over a period of 12 or 18 months.

[www.msh-paris-saclay.fr](http://www.msh-paris-saclay.fr)

» focus

## Digital reconstruction of historic buildings in 2D and 3D

The objective of the vast research program undertaken by the Laboratory for the Study of Institutions and Economic and Social Dynamics over History (IDHES-Évry – CNRS/ENS Paris-Saclay/ Université d'Évry/Université Panthéon-Sorbonne/Université Paris Nanterre/ Université Vincennes - Saint-Denis), in collaboration with the Center for Research on the History of Sciences and Techniques, the Laboratory for Digital Technology in the Humanities, and the Heritage Department of the Ministry of Culture, is the digital reconstruction of buildings in 2D or 3D to show how they looked like at some point in their history. The team implemented a specific methodology, including archives’ identification, documents’ digitization, database creation and its supply of metadata, film restitution, scriptwriting and camera paths’ creation. Over a decade, with the assistance of Archéotransfert, the team made films about Renault’s C5 production shop in Boulogne-Billancourt, the Clément Bayard plant in Levallois-Perret, the Peugeot Sochaux facility, forges in Marcenay (Burgundy), and the birth of the Citroën factory on Quai de Javel in Paris. And recently: the glory days of Spa (Belgium) in the 18<sup>th</sup>-century, the maritime town of Port-Louis (Brittany) in the 18<sup>th</sup> century, and the deadly hurricane of September 1930 in Brittany.

[www.idhes.cnrs.fr/usines-3d](http://www.idhes.cnrs.fr/usines-3d)

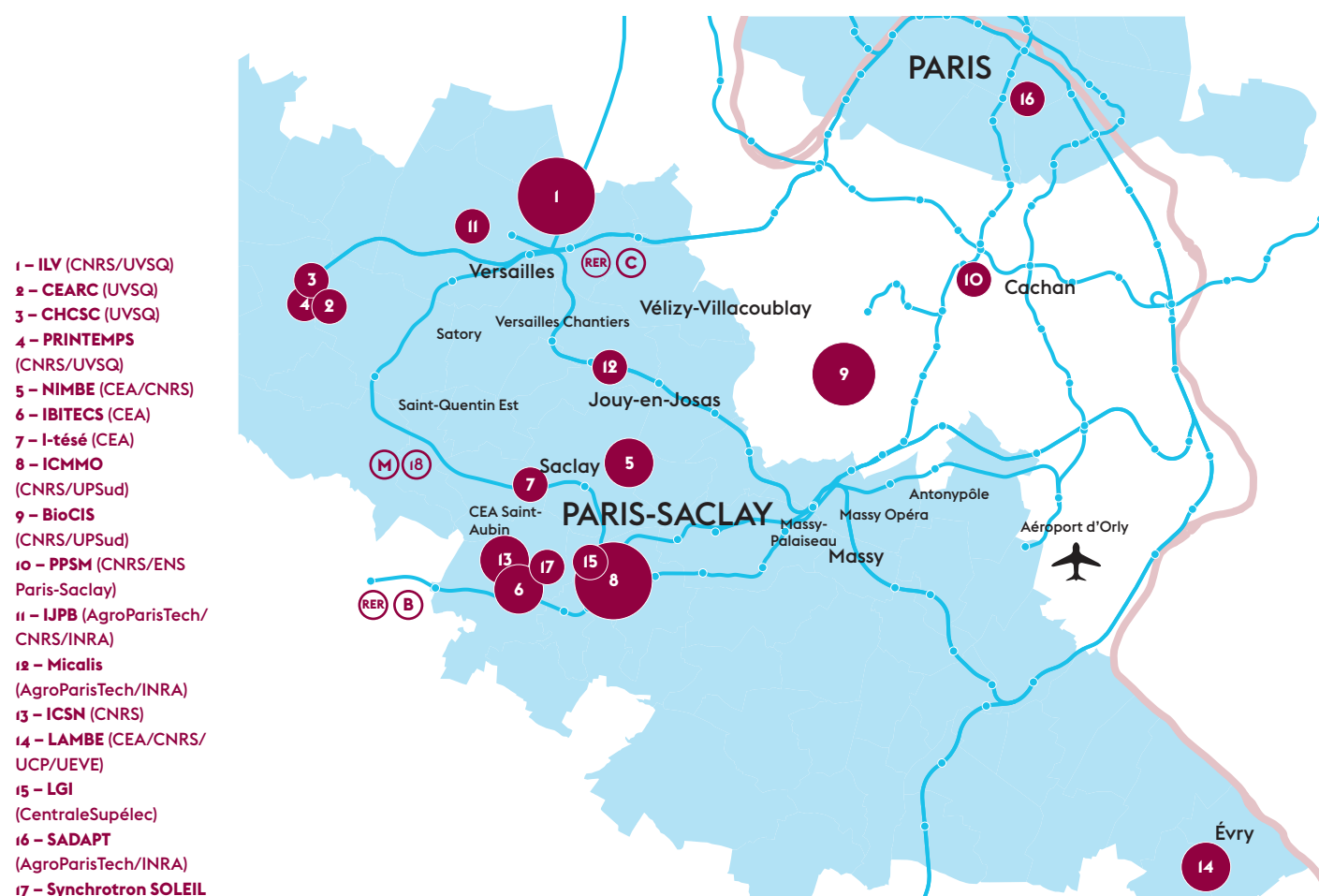
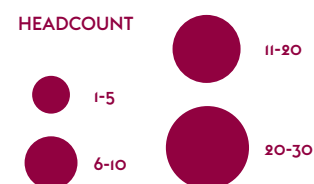


Title

## Green chemistry at Université Paris-Saclay



At Université Paris-Saclay, chemistry is more than equipped to face the challenges posed by the chemistry of the future, namely, making chemistry sustainable and contributing to the protection of the planet. Green chemistry plays a part in the research activities of many of the university's research units and is featured in an array of high-level courses.



### The challenges for green chemistry:

- Predict and master the life cycle of the products, components and systems developed through chemistry.

- Economise solvents, energy and atoms by devising concepts or systems to improve recycling, returns and selectivity.

### Three specific strategic research initiatives (SRIs):

- ISC2D: Paris-Saclay institute of catalytic science for sustainable chemistry

- MOMENTOM: Molecules and materials for the energy of tomorrow

- SysABCD: Analytical systems for biomarkers and sustainable chemistry

**Green chemistry:**  
the core of the Master's degrees of Université Paris-Saclay

6  
master's  
degrees

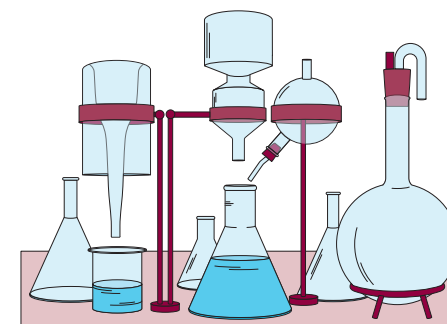
120  
students

- First-year Master's in chemistry
- First-year Master's in chemical pollution and environmental management

- Second-year Master's in procedures for energy
- Second-year Master's in pharmaceutical chemistry

- Second-year Master's in organic chemistry
- Second-year Master's in chemical pollution and environmental management

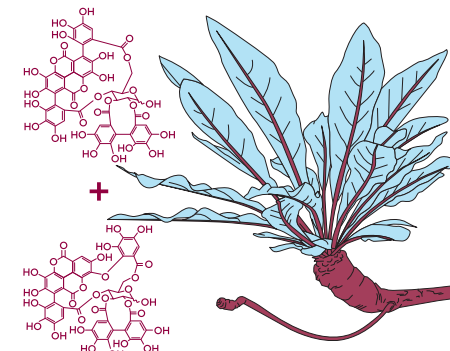
### NOVECAL: high-performing, cyclic catalysts



NOVECAL, a start-up that originated from Orsay Institute of molecular chemistry and materials (ICMMO - CNRS/Université Paris-Sud) and was established in March 2018, has just offered an effective, innovative solution to one of the problems encountered by fine chemical industries: easily eliminating the toxic metallic catalysts used in synthesising chemicals. Its new supported, reproducible catalysts are based on cyclic molecules, with a high metal content. They work with bulky or electron-rich substrates and can simply be filtered out at the end of syntheses. Very stable in open air, they are compatible with "green" solvents such as ethanol, propanol and butanol. NOVECAL's development was supported by the high-level laboratories (LabEx) NanoSaclay and CHARM3AT, as well as the Paris-Saclay Technology Transfer Accelerator Office (TTO).

[www.novecal.com](http://www.novecal.com)

### When botany combats cancer and infectious diseases

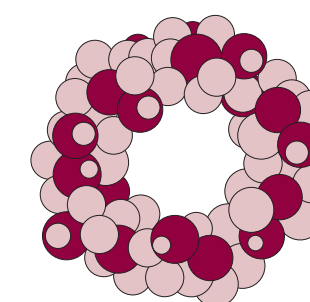


*N*-myristoyltransferases (NMT) are enzymes responsible for co-translational and post-translational changes in proteins, like those involved in cell death. Catalysing the addition of a myristic acid to the *N*-terminal end of a protein, NMT are also essential to cell growth and proliferation. As NMT's activity is both amplified in some kinds of cancers and necessary for the

survival of several human pathogens, inhibiting these proteins is one of the strategies adopted in the development of anti-cancer and anti-infectious medications. Researchers from the Institute for the chemistry of natural substances (ICSN – CNRS), the Institute for integrative cell biology (I2BC – CEA/CNRS/Université Paris-Sud), the Réunion Laboratory for the chemistry of natural substances and food science, and the Liège Interdisciplinary Centre for Drug Research, thus tested different natural molecules derived from the bark of *Terminalia bentzoë* or Benzoin, a tree endemic to the Mascarene Islands. For the first time, they showed that punicalagin and isoterchebulin significantly inhibited human *N*-myristoyltransferase 1 and the NMT of *Plasmodium falciparum*, in vitro and in cellulo.

**Publication** - Cécile Apel et al., *N-myristoyltransferases inhibitory activity of ellagitannins from Terminalia bentzoë (L.) L. f. subsp. Bentzoë*, Fitoterapia, Volume 131, November 2018, Pages 91-95.

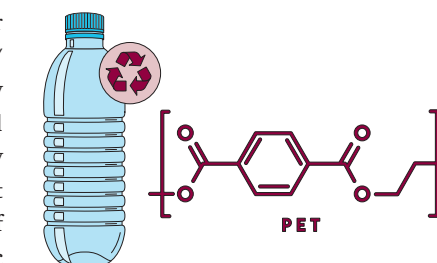
### Medications in the eye of CYCLON



Cyclodextrin-based metal-organic frameworks (CD-MOFs) are sparking a growing interest because of their multiple applications in energy storage, separation techniques and, more recently, nanomedicine. Ruxandra Gref from Orsay Institute of molecular science (ISMO – CNRS/Université Paris-sud) and Hynd Remita from the Physical Chemistry Lab (LCP – CNRS/Université Paris-Sud) are currently taking interest in CD-MOFs containing both active ingredients and metallic nanoparticles measuring only a few millimetres in diameter. With the synergies created, these complex, supramolecular blends can be used to treat serious infections. Developed as part of the CYCLON project launched in September 2018 and funded by LabEx NanoSaclay, these systems were studied in the Anatomix beamline of France's SOLEIL synchrotron. Their antimicrobial and antifungal activity has also been proven.

**Publication** - Li X. et al., *Compartmentalized Encapsulation of Two Antibiotics in Porous Nanoparticles: an Efficient Strategy to Treat Intracellular Infections*, Particle & Particle Systems Characterization, 1800360, 2019.

### The depolymerisation of plastic waste as a recycling method



Thibault Cantat and his colleagues from Nanoscience and innovation for materials, biomedicine and energy laboratory (NIMBE) at the French Alternative Energies and Atomic Energy Commission (CEA Saclay), who are experts in reducing the carbon-oxygen bonds of small molecules or biomass waste, have developed recycling methods for plastic waste through the use of robust catalytic systems that break these bonds.

With stable, economical, non-toxic reducers, they have successfully depolymerised polyethylene terephthalate (PET), polylactic acid (PLA) and polycarbonate (PC) made from bisphenol A (BPA), using everyday rubbish.

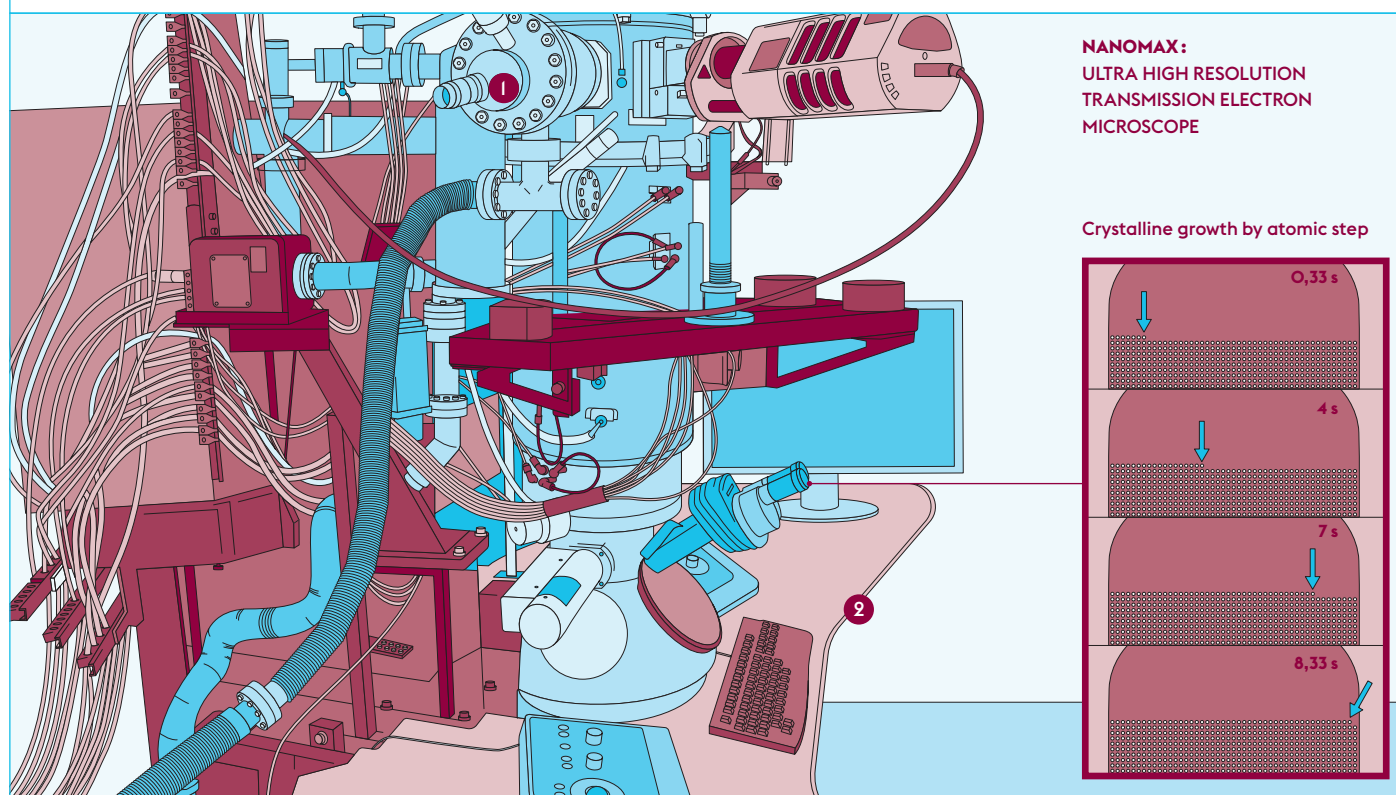
Made of an iridium-based metal-organic framework, the catalyst allows for fast depolymerisation speeds at room temperature. It turned out to be reactive and stable enough to isolate monomers, despite the imperfections and additives present in waste.

**Publication** - Louis Monsigny et al., *Depolymerization of waste plastics to monomers and chemicals using a hydrosilylation strategy facilitated by Brookhart's iridium(III) catalyst*, ACS Sustainable Chem. Eng., 2018, 6 (8), pp 10481-10488.



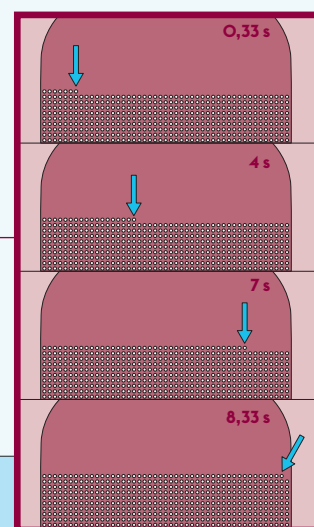
Title

# Low-dimensional materials: observing and controlling matter at nanoscale level



**NANOMAX:**  
ULTRA HIGH RESOLUTION  
TRANSMISSION ELECTRON  
MICROSCOPE

Crystalline growth by atomic step



1 – Molecular jets (MBE) or bundles of gaseous radicals (radical-assisted CVD) 2 – Under the desk: Gatan K2 IS camera

Using original optical microscopy techniques and cutting-edge electronic microscopy platforms, the laboratories of Université Paris-Saclay are leaving no stone unturned to push forward the limits of the observation and the characterization of nanomaterials, carried out on a scale of a few atoms or even at monoatomic level.

At the Laboratory of Innovation in Surface Chemistry and Nanosciences (LICSEN) at the Alternative Energies and Atomic Energy Commission's research center at Saclay, Stéphane Campidelli, Vincent Derycke and their colleagues explore the chemistry and electrochemistry of nanomaterials and bidimensional materials such as graphene and its derivatives or monolayer molybdenum disulfide (MoS<sub>2</sub>). In collaboration with the researchers at the Institute of Molecules and Materials in Le Mans (IMMM – CNRS/Université du Maine), they have adapted a new optical microscopy technique to observe and characterize ultra-thin, transparent materials in real time, especially during their chemical functionalization. Known as Backside Absorbing Layer

Microscopy (BALM), this technique invented at IMMM is based on a simple optical principle, i.e. absorbing antireflection layers. Composed of a metal film a few nanometers thick, this substrate ensures that, in the absence of an object to be observed, no light is reflected. "The intercalation of a material, even ultra-thin, disturbs the antireflection effect and the material then shows up in very high contrast," explains Stéphane Campidelli.

## High-contrast optical microscopy to study chemical reactivity

The technique has proven particularly powerful when applied to 2D materials. "The contrast obtained is striking and it is easy to observe even a monoatomic layer of a transparent material, such as graphene oxide," adds Vincent Derycke. Thanks to the reverse geometry of the microscope, working with a solvent medium is also possible. "BALM offers tremendous benefits in that it's very easy to implement and it's versatile," he notes.

The team is also investigating the kinetics involved in the adsorption and intercalation of small molecules. "We study in parallel and in real time the grafting of molecules onto monolayers, bilayers or trilayers of graphene oxide

and its reduced form. While very close in chemical state, these two materials do not absorb light in the same way and their optical response is very different," remarks Vincent Derycke. By analyzing each pixel individually, image by image, the researchers extract quantitative and local data, such as reaction times. "The efficiency of the chemical reaction is not homogeneous, because it depends on whether edge or bulk sites are involved. Thanks to this technique, we can identify which ones are more reactive and improve the design of the nanomaterials."

Today, researchers are coupling the BALM technique with electrochemistry. "The antireflection substrate is a conductor, so it can serve as an electrode to set off electrochemical reactions," explains Stéphane Campidelli.

## World-class equipment for investigating the physical properties of nano-objects

At the other end of these nanometric observations is TEMPOS, the microscopy and nano-characterization platform that came onstream on the Saclay plateau at year-end 2018. Funded within the context of the "Equipex" call for projects bearing on next-generation equipment, this platform is intended for the study of nano-

materials, from their growth to the most local measurement of their physical properties. It is the result of the combined efforts of Université Paris-Sud, the French National Centre for Scientific Research (CNRS), École Polytechnique and the French Alternative Energies and Atomic Energy Commission (CEA), with the assistance of two industrial firms, Saint-Gobain and Thales, to create a world-class center for transmission electron microscopy. It features two cutting-edge microscopes, Chromatem and Nanomax, as well as Nanotem, a more generalist electron microscopy facility that is complementary to the two others. Chromatem is used for experiments in photonic and electronic spectrometry, Nanomax to synthesize and observe nano-objects using imaging with high spatial resolution. "These evolutionary prototypes represent a world premier," comments project coordinator Odile Stephan.

In a low-temperature environment, Chromatem reveals the particular optical properties of nano-objects at finer-than-atomic resolution. Its technical innovations include lab-developed light injection and detection instrumentation that enables coupling the electron and photon beams used. By combining spatial and spectral resolution, "we are able to explore the elementary excitations (e.g. plasmons, excitons, phonons and magnons) that govern most of the original properties of nanomaterials, which is key to understanding how they work and developing new ones," points out Odile Stephan. Mechanisms of metal-insulator phase transitions, new electronic states, optoelectronic properties of semiconductor nanostructures... The range of research possibilities is a broad one.

## Observing and controlling crystalline growth

Nanomax, a high-resolution transmission electron microscope, is used to observe and characterize – in situ and at the atomic scale – the growth of semiconductor nanowires and carbon nanotubes. When matter is added and a vacuum maintained, it serves to synthesize varied nanostructures and control their growth kinetics. Matter is added using an original method, i.e. via a stream of atoms, either gas molecules or gaseous radicals. According to Odile Stephan, "the idea is to use lab-designed collimators to get highly concentrated matter as close as possible to the sample. The flow is very well controlled so that we can act on nanostructure growth rates."

Like Chromatem, Nanomax has already yielded very good results. Recently, teams at the Center of Nanoscience and Nanotechnology (C2N – CNRS/Université Paris-Sud) under Jean-Christophe Harmand and Gilles

Patriarche and at the Laboratory of Physics of Interfaces and Thin Films (LPICM – CNRS/École Polytechnique) under Ileana Florea and Jean-Luc Maurice filmed a crystalline nanowire's growth in real time and followed the formation of each of its atomic planes, step by step. "They showed that the nucleation sites were located at the triple point, i.e. at the intersection of the substrate, the drop of liquid used as a growth catalyst and the gas phase. They also saw that nanotube growth occurred in monoatomic steps, whose shape resulted from a reduction in the energy used by the system during its growth," she adds.

## "These evolutionary prototypes represent a world premier."

Odile Stephan

Currently available for use by all nanoscience researchers on the Saclay plateau, TEMPOS will open up within a year to the community in France via the national network METSA, and to the international community via the European network ESTEEM3.

## Publications

- Kévin Jaouen et al., Ideal optical contrast for 2D material observation using bi-layer antireflection absorbing substrates, *Nanoscale* (2019).
- M.Kociak et al., A spectromicroscope for nanophysics, *Ultramicroscopy*, 180, 81-92 (2017).
- Jean-Christophe Harmand et al., Atomic Step Flow on a Nanofacet, *Phys. Rev. Lett.* 121, 166101 (2018).

## Profile

Odile Stephan



© UPSud

We ordered our dream machines. Not only did they meet our expectations, but they far surpassed them!

Odile Stephan did a doctoral thesis on the latest developments in scanning transmission electron microscopes to study carbon nanotubes at the Solid State Physics Laboratory (LPS – CNRS/Université Paris-Sud). She became the LPS electron microscope team director in 2009 and subsequently coordinated the TEMPOS Equipex project. Co-director of the LabEx NanoSaclay, she also serves as Vice-President for Research at the Physics Department at Université Paris-Sud. Highly involved in teaching, she sits on the relevant committee for the Physics Department and directs the Master I Physics and Applications course at Université Paris-Saclay.

» focus

## Orienting nanocrystals with light

Researchers from the Orsay Institute of Molecular Chemistry and materials (ICMMO – CNRS/Université Paris-Sud) and from the Institute of Chemistry and Materials Paris-Est (CNRS/Université Paris-Est Créteil) teamed up to break new ground by manipulating light to orient nanocrystals in a solid.

This phenomenon, observed using a scanning transmission electron microscope, was generated in a multicomponent silicate glass irradiated by means of a femtosecond pulse laser. The chosen composition produce, after irradiation, lithium niobate crystals (LiNbO<sub>3</sub>) dispersed in the vitreous matrix. The phase separation accompanying the nucleation structures itself into nanoplanes and can be oriented by laser polarization. The result is a strong birefringence, useful in integrated optics.

**Publication** · J. Cao et al., Pulse energy dependence of refractive index change in lithium niobium silicate glass during femtosecond laser direct writing, *Optics Express*, (2018) 26(6), 7460-7474.

» focus

## Nanostructuring materials for optics

Researchers are attracted to hybrid nanocomposites, due to their optical, electrical and mechanical properties. In particular, they are focusing on the incorporation of gold nanoparticles (AuNPs) in matrices of sequenced polymers (BCPs) to obtain anisotropic geometries possessing unusual light propagation properties.

A team of researchers from the Interdisciplinary Laboratory on Nanoscale and Supramolecular Organization (LIONS – CEA/CNRS), Synchrotron SOLEIL (France's national synchrotron facility) and the Paul Pascal Research Center in Bordeaux has developed an unusual method for incorporating AuNPs into cylinders of BCPs oriented by means of irradiation or sonication. Experiments using microscopy (AFM, TEM), GISAXS and spectroscopy yielded their full characterization.

**Publication** · Florian Aubrit et al., Ligand-free synthesis of gold nanoparticles incorporated within cylindrical block copolymer films, *J. Mater. Chem. C*, 2018, 6, 8194.



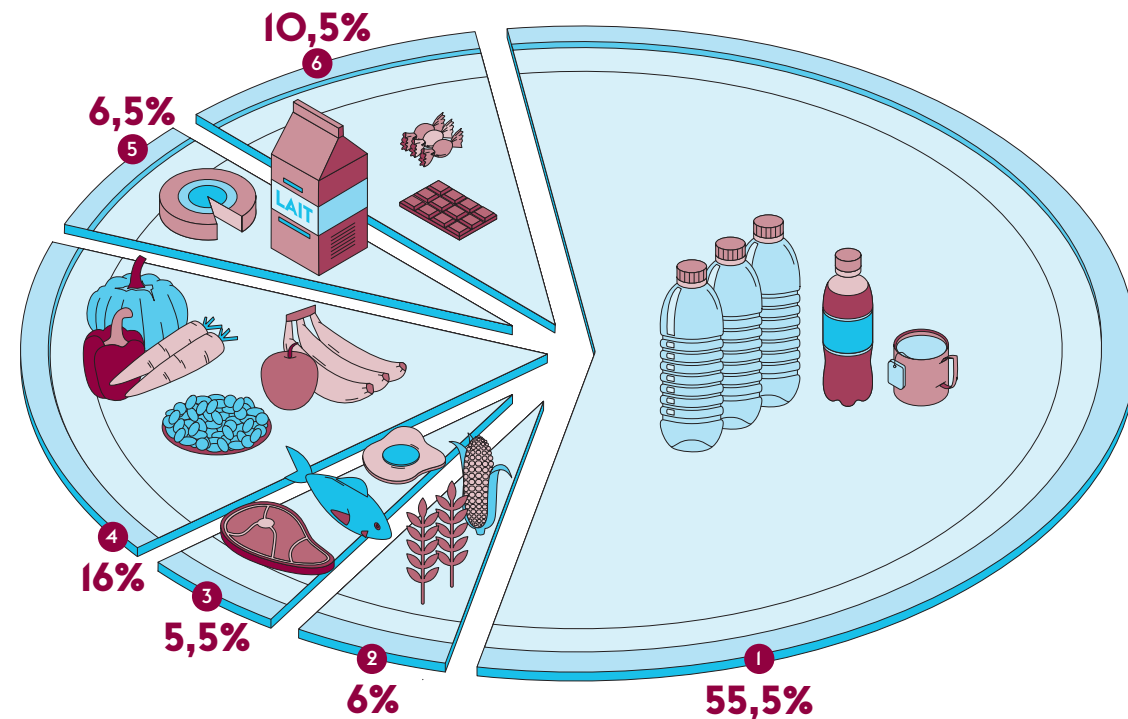


Title

## Exploring the psychological basis of diet

**DISTRIBUTION OF FOOD CONSUMED PER DAY BY ADULTS AGED 18 TO 79 YEARS**  
INCA3, July 2017:  
Study carried out by the Agency for Food, Environmental and Occupational Health and Safety (ANSES)

1 – Dairy products (including milk)  
2 – Fruits and vegetables / fruit and vegetable-based foods (including juices)  
3 – Meat, fish, eggs, and meat, fish and egg products  
4 – Grain products  
5 – Water and other beverages  
6 – Other



The dietary choices of the French are currently in the limelight: there seems to be a trend towards a decreasing consumption of animal products and an increasing intake in plant proteins. It is key to look at that behaviour in a psychological light.

Eat at least five portions of fruit and vegetables a day, consume enough dairy products, avoid eating foods that are too fatty, too salty or too sweet... The recommendations made in France's National Nutrition and Health Programme (PNNS), launched in 2001 by the Agency for Food, Environmental and Occupational Health and Safety (ANSES) and intended to improve the health of the French population by influencing their nutrition, now resonate like a familiar song. The statistics highlight the extent of the challenges faced: cardiovascular disease causes about 180,000 deaths a year in France, just ahead of cancer (150,000), obesity and diabetes concern respectively about 15% and 5% of the population, osteoporosis affects about 30% of women aged 50 and 50% of those aged over 60, and high

cholesterol affects about one in five adults. The deep socio-economic changes that started in the 1950s prompted the French to change their lifestyles, diet and tastes. Products of animal origins and those with a high glycaemic index dominated in their plates, to the detriment of bread, cereals, potatoes and pulses.

However, today, that trend seems to be reversing. Over the last ten years, the meat consumption of French people has dropped by 12%. While vegetarians and vegans – for the most part, young people – still represent only 2.5% of the French population, more than a third of the population said they had adopted a “flexitarian” diet and significantly reduced their consumption of animal proteins.

### Towards greener, healthier diets

“We are currently experiencing an inverse evolution to that of the years following the Second World War,” confirmed François Mariotti, professor of nutrition at AgroParisTech, the Paris Institute of Technology for Life, Food and Environmental Sciences. “We are much more critical of meat consumption, given the rise of

environmental concerns and issues regarding health and animal well-being. People are asking new questions: for instance, is it ethical to exploit animals so we can eat them?” The beginning of that inversion coincided with health crises such as the outbreak of mad cow disease and the loss of trust caused by the lack of traceability – not to mention the economic reason and the cost of meat. “As everything is converging, there is a good chance the downward trend will continue further.”

While most French people do not plan to completely rule meat out of their diet, nutritionists are in agreement that plant-dominant diets are healthier. “The idea is to eat more vegetables and restore the balance between animal and plant proteins,” said François Mariotti. The new recommendations published by ANSES or Santé publique France, the national public health agency serving the French population, support that idea: less meat and more legumes, fruit, vegetables, wholegrain cereals, nuts... “From a scientific standpoint, we also think that eating large amounts of red meat heighten the risks of developing colorectal cancer or a cardiovascular disease, and we are quite certain for transformed meats such as cold cuts,” he added.

### Questioning the French population's dietary behaviour

Identifying the population groups that have risky diets and devising their psychological profile would make it possible to develop an appropriate communication inciting them to adopt a diet less damaging for their health. The Psychofood project, launched in 2017 with the support of MSH Paris-Saclay and initiated by Antoine Nebout, researcher for the Food and Social Sciences laboratory (ALISS) of France's National Institute for Agricultural Research (IRNA), could be used for that purpose. The aim of this project, which involves behavioural economics and nutritional epidemiology, is to evaluate, within a single questionnaire, the diet of the French population and their attitude towards two fundamental psychological variables: risk and time. “By connecting these dimensions, we would be able to explain, with a currently unparalleled degree of precision, how these psychological variables affect the French population's dietary behaviour,” commented Antoine Nebout.

Based on the questionnaire initially developed by the Generations and health team of the Centre for the epidemiology of mental and physical health (CESP–Inserm), this semi-quantitative food frequency questionnaire was reduced to 28 questions and addressed to the ELIPSS cohort study (Internet longitudinal study for social science). The cohort study is representative of the French population, gathering 3,000 participants equipped with tactile tablets and 4G subscriptions.

## “Understanding individual decisions and their biases to better understand the challenges of prevention in public health.”

Antoine Nebout

The first part of the questionnaire focused on respondents' general dietary habits. It tackled all their meals, whether or not they were taken at home. Responders gave an average consumption (in days, weeks or months) of different foods throughout the previous twelve months. The second part tackled time preferences and respondents' attitude to risk. “In the second part, using brief, hypothetical scenarios, we evaluate the importance given to luck and time in the event of monetary gains of varying amounts. Are respondents ready to take risks to obtain a higher amount

than they could get straightaway, even if they don't gain anything at all? Are they willing to wait a long time to gain a higher amount than they could have got straightaway?” Antoine Nebout explained. Two psychometric self-assessment questions using a Likert scale closed the questionnaire.

The collected data, which is currently being analysed, will shine a light on individuals' socio-economic and demographic characteristics with regard to the psychological variables and diets observed. It will also give a very precise picture of the French population's dietary behaviour in 2018.

“The complete overhaul of our diet will involve an intellectual, psychological and cultural reassessment of the act of feeding ourselves,” François Mariotti predicted.

### Publications

- Mariotti F, Editor. *Vegetarian and plant-based diets in health and disease prevention*. Elsevier, Academic Press. 2017.
- Workshop interdisciplinaire sur les déterminants psychologiques des comportements alimentaires du 10 mai 2019: <https://psychofood.sciencesconf.org/>

### Profile

François Mariotti



© JLS-UPSaclay

We know that plant-based diets are good for our health, the textbook example being the Mediterranean diet.

A graduate of the Paris-Grignon National Agricultural Institute (INA P-G), François Mariotti has a PhD in nutritional physiology and metabolism. He has been a lecturer and researcher at AgroParisTech since 2001. He has also presided ANSES' panel of nutritional experts since 2012. Since 2015, he has headed a research team within the Nutritional Physiology and Feeding Behaviour research unit (AgroParisTech/INRA). Through their research, the team aims to understand the relations between the consumption of plant and animal proteins, nutritional security and cardiometabolic health.

» focus

## When a metabolite upturns the brain

Intestinal microbiota are all the microorganisms in a host's digestive tract that produce a wide array of metabolites during the breakdown of nutrients. As the pathway linking intestinal microbiota and brain has been demonstrated, research is focusing on how the metabolites produced are involved in the pathophysiology of brain conditions and behavioural and mood disorders. Researchers from the Micalis Institute (AgroParisTech/INRA) and Metagenopolis studied motor activity, blinking frequency and activation of the vagus nerve in rats subjected to varying concentrations of indole, a metabolite produced through the breakdown of tryptophan by tryptophanase, an enzyme present in intestinal bacteria. They also evaluated their anxiety and resignation levels. Their findings suggested that people whose intestinal microbiota produce a high concentration of indole could be more likely to develop anxiety and mood disorders.

Publication · Mathilde Jaglin *et al.*, *Indole, a Signaling Molecule Produced by the Gut Microbiota, Negatively Impacts Emotional Behaviors in Rats*, *Frontiers in Neuroscience*, April 2018, Volume 12, Article 216.

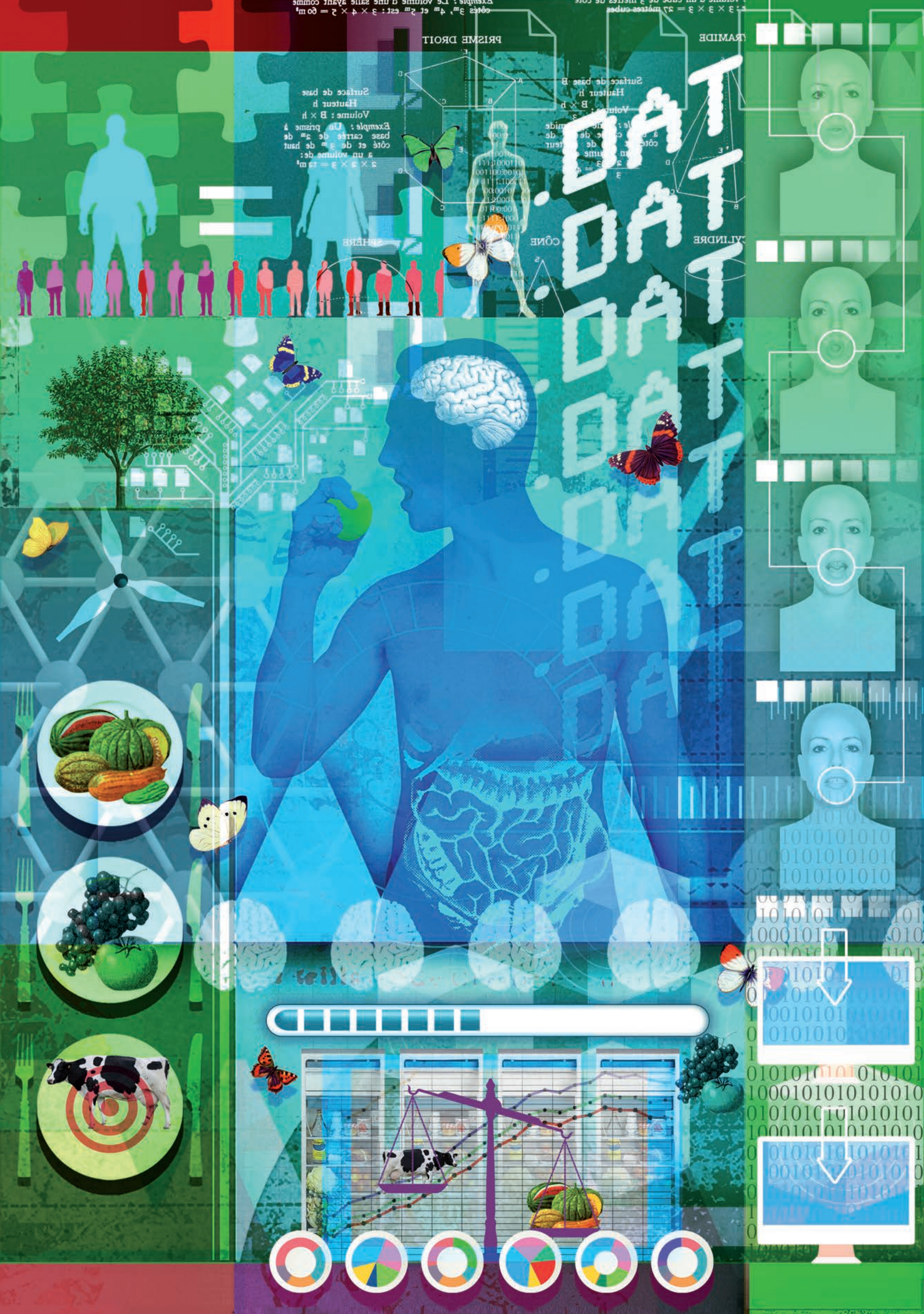
» focus

## A chair to promote a healthy, sustainable diet

It is the ambition of the ANCA (Food, Nutrition, Dietary Behaviour) chair to raise awareness regarding the benefits of a healthy, sustainable diet. The ANCA chair is partnered with AgroParisTech and was established in 2010 on the initiative of the Nutritional Physiology and Feeding Behaviour research unit (PNCA – AgroParisTech/INRA) and Danone Nutricia Research.

ANCA is developing major innovative programmes, based on digital technology. The idea is to make people aware of tomorrow's food challenges, understand what causes a change in dietary behaviour and reduce health and social inequalities linked to diet. A few examples of implemented programmes: the digital comic “Manger vers le futur” (“Eat for the future”), the Food Ninja programme for teenagers and the connected programme FacilEA-T4All for lower-income populations.

[www.chaire-anca.org](http://www.chaire-anca.org)

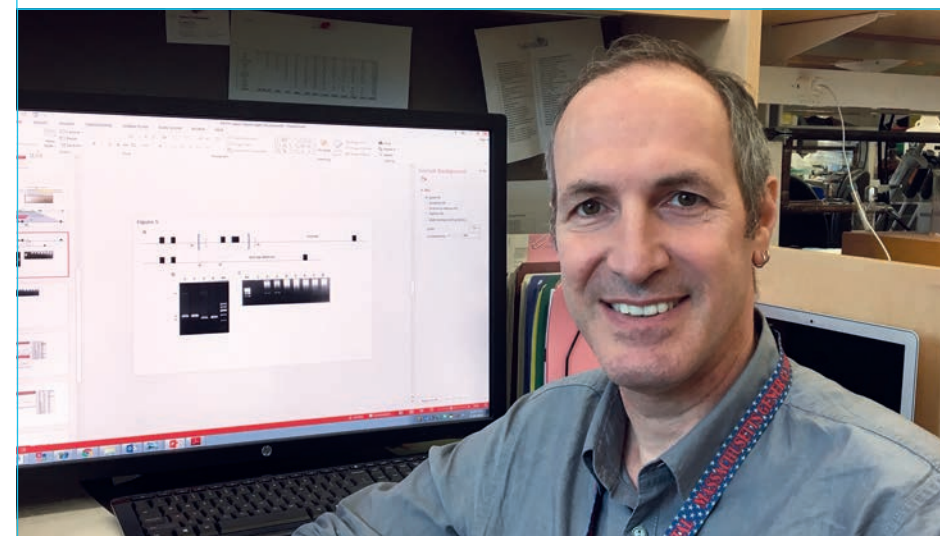


Section  
**SEEN FROM ABROAD**



Seen from

**Murat Bastepe,**  
from Massachusetts General Hospital  
and Harvard Medical School (Boston, US)



© Bastepe Lab

Murat Bastepe is an associate professor and a researcher at the Endocrine Unit of Massachusetts General Hospital and Harvard Medical School. His research broadly entails the regulation of calcium and phosphate metabolism in the body and disorders that affect it. His primary focus is on G proteins that mediate the action of hormones regulating this metabolism. He is very much interested in pseudohypoparathyroidism, a rare disorder caused by mutations affecting the gene encoding *Gsa*, a member of the heterotrimeric G protein family. If the synthesis or expression of *Gsa* is impaired, it prevents the proper actions of a number of hormones, including primarily the

parathyroid hormone, and leads to significant consequences on blood calcium levels, bone growth and skeletal metabolism.

Such as Harald Jueppner and Michael Mannstadt from Massachusetts General Hospital, Murat Bastepe collaborates for many years with Agnès Linglart, head of the Department of Paediatric Endocrinology and Diabetes at Bicêtre Paris-Sud Hospital. These collaborations concern projects related to pseudohypoparathyroidism or other disorders caused by mutations of *Gsa* protein. Currently, they're collaborating on a project that started within 2018.

*Agnès Linglart and her colleagues observed that some of their patients presented with specific craniofacial and tooth development abnormalities. They hypothesized that these abnormalities were directly related with pseudohypoparathyroidism and may cause some of the disease symptoms. They approached my group to help them investigate this hypothesis.*

*We're currently using a mouse model of pseudohypoparathyroidism to address whether*

*the deficiency of the *Gsa* protein does actually lead to a craniofacial development and a tooth generation abnormality.*

*We started establishing this mouse model in my lab. We are now collecting the craniofacial bones and the teeth of the mice. These samples will then be sent to Agnès Linglart's lab in France to be analysed regarding growth, development, and histological parameters.*

*The first set of results are anticipated within this*

*year. Depending on the outcome, we may pursue this project to identify the origin of the abnormal development process at the molecular level.*

*My special satisfaction on this project is that I will know more about this important disorder and the functions of the defective protein.*

[https://scholar.harvard.edu/bastepe\\_lab](https://scholar.harvard.edu/bastepe_lab)

Journal

**DAILY NEWS**

Titre

**MENTALLY  
TIRING WORK  
INCREASES TYPE  
2 DIABETES RISK  
IN WOMEN**

THE DAILYHERALDS.ORG

A cohort of French women who reported having jobs with mentally tiring work were 21% more likely to develop type 2 diabetes during 2 decades of follow-up vs. women who reported working in fields that were not mentally tiring, according to findings from an observational study published in the European Journal of Endocrinology.

<https://dailyheralds.org/diabetes/mentally-tiring-work-increases-type-2-diabetes-risk-women-60064820>

Journal

**Techsite**

Titre

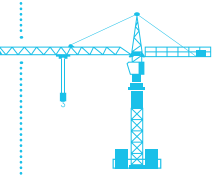
**AI CLASSIFIES  
SLEEP DISORDERS  
LIKE SLEEP APNEA,  
HYPOPNEA, AND  
AROUSAL**

AI capable of detecting restless sleep is nothing new — in April, researchers at Stanford and Université Paris-Saclay proposed a system that can predict location, duration, and type of sleep events in EEG charts.

And in November Oxford scientists described a framework that could automatically detect REM sleep behavior disorder.

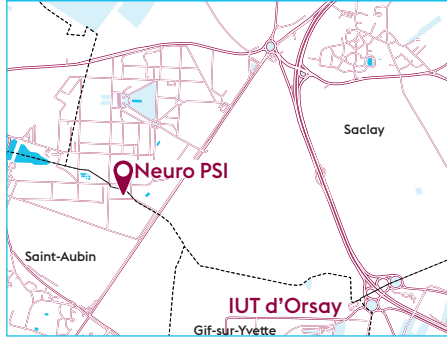
But a method described in a preprint paper published on Arxiv.org ("SleepNet: Automated sleep disorder detection via dense convolutional neural network") takes a slightly different tack than most.

[www.techsite.io/p/1033892/t/ai-classifies-sleep-disorders-like-sleep-apnea-hypopnea-and-arousal](https://www.techsite.io/p/1033892/t/ai-classifies-sleep-disorders-like-sleep-apnea-hypopnea-and-arousal)



Title

## A new building for the Paris-Saclay Institute of Neuroscience



It's time to pack up! The Paris-Saclay Institute of Neuroscience (Neuro-PSI) will soon leave its old premises for a new building near NeuroSpin, the research centre for innovation in brain imaging at Gif-sur-Yvette. The reasons behind the move? "There are several," explained Philippe Vernier, head of the Institute and project manager for the construction of the new building. "Our Orsay and Gif-sur-Yvette premises were dilapidated. We've also needed to group the neuroscience teams of south Île-de-France for a long time. It will enable us to build more synergies and set up more ambitious projects. Finally, the proximity of NeuroSpin will be a major asset in forging the future of neuroscience in Paris-Saclay."

The project was initiated as early as 2014 and the works started in 2016 with a project ownership ensured by France's Alternative Energies and Atomic Energy Commission (CEA). Currently, "the greatest part of the work is over, although there are still some developments to complete. The project should be finalised in the next few months." The result is a building with clean, sharp lines and five levels of 14,000m<sup>2</sup> of useful surface area, designed by the architect firms Dietmar Feichtinger and Celnikier & Grabli. Three large patios structure the building and allow for good natural lighting. The building is located between the heart of the CEA and the landscaped peripheral crown, opening towards Université Paris-Saclay and thus making access easier for Master's students. "That was a very deliberate choice from the beginning," said Philippe Vernier. "It's important that our students be in contact with researchers so that research isn't an abstract concept for them." Members of the public will also be welcome during conferences and scientific demonstrations, as there is a large, open-access area. Save the date: at the end of 2019, we will be moving in!

<http://neuro-psi.cnrs.fr/>



Title

## Team spirit at Centrale Sevens



© Centrale7

Rugby sevens amateurs noted the dates in their diaries – in this case, 8 and 9 May. Two days to enjoy the Centrale Sevens, the famous seven-a-side rugby tournament, founded in 2005 by the students of CentraleSupélec, an internationally renowned higher education and research institute. This year, the tournament was celebrating its fifteenth anniversary. Players in university and semi-professional teams from all over the world have faced one another there, even coming from England, South Africa and Australia. On the grass of the Orsay stadium, the first day was dedicated to pools, while the second was for finals and classification matches. Transport and logistics were handled by the organisers and the players were hosted at the CentraleSupélec campus, encouraging post-game fraternisation on the field.

[www.centrale7.fr](http://www.centrale7.fr)

Title

## A wind of change is blowing through the Moulon district!

Developed by the Paris-Saclay Development Authority, the Moulon district is playing the diversity card. CentraleSupélec has now been established for two years and the district is to welcome several other schools. Not far from the Orsay Institute of Technology and Polytech Paris-Sud Engineering School, the Cachan École Normale Supérieure (higher education and research institute – ENS), renamed ENS Paris-Saclay, will be established at the beginning of the university year 2019. However, while students and researchers roam the area, they will not be alone. As part of the O'rizon eco-district project, the site will be home not only to student lodgings, but also family flats.

At the beginning of the university year 2019, the district could also include a mini-market, a driving school, a doctor's office and a bank. Yvette is already on-site. The name hides not a resident, but a living space including two bars, a space for local produce and a concert hall... Then, in 2020, the Lumen learning centre for writing and digital services will open. Ever thriving and expanding, the Moulon district is definitely becoming *the* place to be!

© DFA - Dietmar Feichtinger Architecte



PAST EVENTS			JUNE			Date	Location	Host
<b>MARCH</b>			Date	Location	Host	7 to 12	Paris	IUPAC
<p>4, 5, 11, 12, 13</p> <p>Orsay</p> <p>SATT Paris-Saclay</p>			<p><b>DOCTOR'PRENEURIALES – VALORISATION CAMP</b></p> <p>PhD students, set out on an entrepreneurial adventure, alone or in a team! The Doctor'Preneuriales course is one of the "doctor career" courses enabling PhD students from Université Paris-Saclay to expand their knowledge in the areas of entrepreneurship and innovation. <a href="https://www.universite-paris-saclay.fr/fr/parcours-les-doctopreneuriales">https://www.universite-paris-saclay.fr/fr/parcours-les-doctopreneuriales</a></p>			<p><b>FORTY-SEVENTH IUPAC WORLD CHEMISTRY CONGRESS</b></p> <p>The title of the event is "Frontiers in Chemistry: Let's create our future! 100 years with IUPAC". On the occasion of this congress and to highlight its universality, IUPAC has committed not only to hosting chemists from all over the world, but also to encouraging scientists working in industry and the academic world who regularly attend colloquia to participate. <a href="https://www.iupac2019.org/">https://www.iupac2019.org/</a></p>		
Date	Location	Host	Date	Location	Host	28	Cachan	ENS Paris-Saclay
<p><b>THIRD HIV/AIDS EVENT: INFORM YOURSELF TO PROTECT YOURSELF – RESEARCH FOR PREVENTION – "JOURNÉE SIDACTION" (AIDS ACTION DAY)</b></p> <p>On the occasion of the "Journées Sidaction 2019", together with ENS Paris-Saclay, the Laboratory of Biology and Applied Pharmacology (LBPA- CNR/ ENS Paris-Saclay) held conferences, thematic round tables and workshops on HIV/AIDS. These were led by experts recognised in their field with a view to taking stock of AIDS research, whether fundamental, clinical, societal or preventive. <a href="https://vih-rsp-2019.sciencesconf.org">https://vih-rsp-2019.sciencesconf.org</a></p>			<p>26</p> <p>Gif-sur-Yvette</p> <p>Synchrotron SOLEIL</p>			<p>16 to 18</p> <p>Strasbourg</p> <p>French Society of Plant Biology</p>		
<b>MARCH-APRIL</b>			<b>MEET MY PLATFORM – CHEMISTRY</b>			<b>TWELFTH CONGRESS OF THE FRENCH SOCIETY OF PLANT BIOLOGY</b>		
Date	Location	Host	<p>A day of meetings between platforms and companies, organised by the Chemistry department of Université Paris-Saclay. <a href="https://www.universite-paris-saclay.fr/fr/mmp-chimie">https://www.universite-paris-saclay.fr/fr/mmp-chimie</a></p>			<p>The congress will revolve around four themes: development, stress responses, biology of organelles and plant metabolism. International and national speakers will be invited. Each session will end in presentations selected by the scientific committee. <a href="https://sfbv2019.sciencesconf.org/">https://sfbv2019.sciencesconf.org/</a></p>		
30, 31 march and 1 <sup>st</sup> april	Gif-sur-Yvette	Centrale Supélec	<p><b>JULY</b></p> <p>8</p> <p>Bures-sur-Yvette</p> <p>IHES</p>			<p><b>SEPTEMBER</b></p> <p>12-13</p> <p>Gif-sur-Yvette</p> <p>Centrale Supélec</p>		
<p><b>SECOND "START-UP FOR KIDS" EVENT</b></p> <p>Children and their families discovered the innovations that will be commonplace tomorrow. Université Paris-Saclay organised an innovation house showcasing its different start-ups. These start-ups invited visitors to experiment with cooking, understand light and its possible uses in the future and even improve their mathematical genius! <a href="http://www.events.startupforkids.fr/paris-saclay">www.events.startupforkids.fr/paris-saclay</a></p>			<p><b>SUMMER SCHOOL ON ASPECTS OF THE GEOMETRIC GROUP THEORY</b></p> <p>Some major trends in the geometric group theory will be taught to students holding degrees in all areas of mathematics. <a href="https://indico.math.cnrs.fr/event/3784/overview">https://indico.math.cnrs.fr/event/3784/overview</a></p>			<p><b>FOURTH JUNIOR CONFERENCE ON DATA SCIENCE AND ENGINEERING (JDSE)</b></p> <p>This conference is for first-year PhD students, second-year Master's students and third-year students from the Paris-Saclay engineering schools. It will give students the opportunity to present scientific work conducted during their internships or the first year of their PhD, and also develop their sense of criticism through a professional conference hosting prestigious academics and scientists hailing from the industrial world. <a href="https://jdse-paris.github.io/jDSE2019/">https://jdse-paris.github.io/jDSE2019/</a></p>		
<b>UPCOMING EVENTS</b>			<b>JULY</b>			<b>SEPTEMBER</b>		
Date	Location	Host	<p><b>MAY</b></p> <p>27</p> <p>Sceaux</p> <p>Faculty Jean Monnet</p>			<p>8 to 12</p> <p>Nantes</p> <p>French Physics Society</p>		
<p><b>SEMINAR ON ENVIRONMENTAL ETHICS</b></p> <p>The demands to better protect animals from the suffering they have endured are constantly increasing. This forces us to question the relations we have had with them until now and those we could forge in the future. <a href="http://www.l84gbxrp.evenium.net">www.l84gbxrp.evenium.net</a></p>			<p><b>TWENTY-FIFTH GENERAL CONGRESS OF THE FRENCH PHYSICS SOCIETY</b></p> <p>Every two years, the General Congress of the French Physics Society offers an up-to-date, multidisciplinary overview of the latest breakthroughs across all fields of physics. <a href="https://indico.in2p3.fr/event/6792/">https://indico.in2p3.fr/event/6792/</a></p>					

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## READING HIGHLIGHTS

**Risques chimiques liés aux aliments: principes et applications ("Chemical risks linked to food: principles and applications")**  
This book presents the founding principles of risk analysis and how actors in the field go about assessing risks and offering management measures to eliminate or reduce them. Illustrated by many concrete examples, it enables the reader to embrace the methodology while simultaneously absorbing very up-to-date scientific knowledge, specific to each danger mentioned, and the historical context. The book targets scientists, from students to professionals working in the field.

Coll. Sciences et techniques agroalimentaires. Lavoisier Tec&Doc, Paris. ISBN: 978-2-7430-2388-1

**"Whatever happened to antimatter?"**  
Yves Sacquin, experimental physicist at the French Alternative Energy and Atomic Energy Commission (CEA Saclay – Université Paris-Saclay), sets out to search for antimatter particles and explains how researchers create them.

[www.theconversation.com/mais-ou-est-passee-lantimatiere-113261](http://www.theconversation.com/mais-ou-est-passee-lantimatiere-113261)

## ISSUE NO. 11

TO BE RELEASED  
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91190 Saint-Aubin – France

Thank you and happy reading!

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adress ..... city .....

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# STRATEGIC RESEARCH INITIATIVES

## IN CHEMISTRY, ENVIRONMENTAL SCIENCES, MATERIALS AND ENERGY



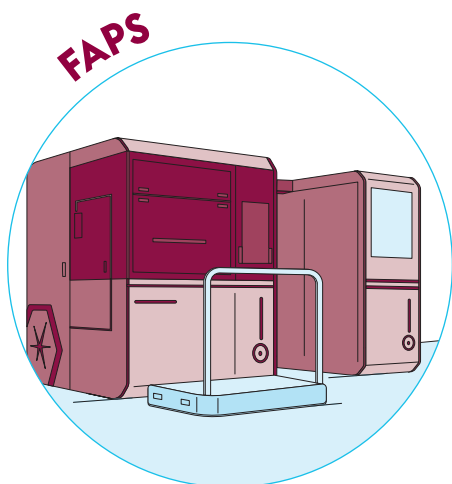
ACE-ICSEN (Adaptation to environmental changes – Climate, society and environment institute) explores the processes by which living organisms adapt, the erosion of biodiversity and its impacts on the health of living organisms in their natural environment and environments modified by human activity, as well as potentially sustainable economic solutions.

### BIOPROBE

BIOPROBE is on the synthesis of molecular markers to monitor living matter through analytical cellular imaging, in diagnosis and personalized medicine.

### BME

BME (BioMedical Engineering) focuses on chemistry and explorative physics of living cells, new microfluidic, biocompatible and autonomous sensors, and systems and imaging methods in medicine.



FAPS (Additive manufacturing Paris-Saclay) an additive manufacturing project that involves setting up an experimental platform featuring an SLM Form AddUp 350 machine and a hybrid robot.

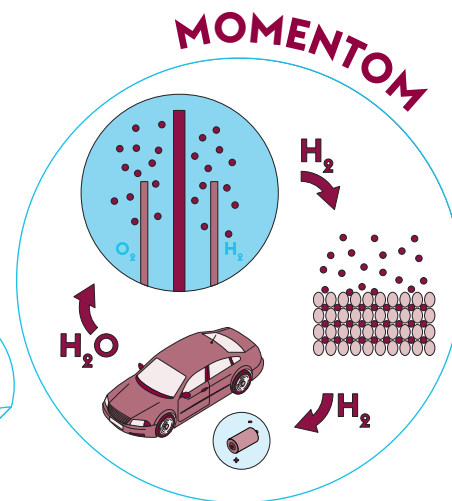
### ISC<sub>2</sub>D

ISC<sub>2</sub>D (Institute of Catalytic Sciences for Sustainable Chemistry) studies oxygen-rich renewable raw materials (e.g. CO<sub>2</sub> and biomass), bio-based materials as well as efficient, selective and environmentally-respectful material transformation processes using enzymatic tools.

Université Paris-Saclay has awarded the status of “Strategic Research Initiative” (SRI) to 23 inter-establishment research projects addressing high-level scientific and technological challenges. These undertakings build on existing projects and seek to develop knowledge and expertise, often in collaboration with business and industry.

### SysABCD

SysABCD (Analytical Systems for Biomarkers and Sustainable Chemistry) involves research partners and hospitals to develop miniaturised analytical systems and methods to define disease biomarkers and diagnostic tools.



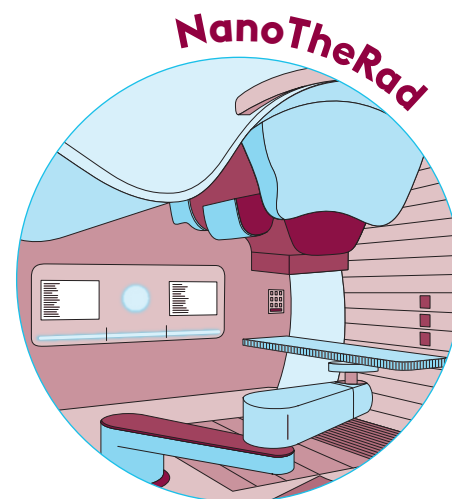
MOMENTOM (Molecules and materials for the energy of tomorrow) concerns molecules and materials with a view to ensuring clean, safe and efficient energy in future. It tackles major energy transition challenges such as the capture, conversion, catalysis and storage of energy.

### NAN'EAU

NAN'EAU aims to study the behavioral dynamics of organic, inorganic and living nano-objects in situ and in liquid media. The research team is developing a multiple microscopy imaging approach (electron, photon and X-ray imaging).

### PhyChiM<sub>3</sub>

PhyChiM<sub>3</sub> (Multi-scale physico-chemistry: temporal, spectral, spatial) is a research project to study solar energy, photosynthesis and photoreactive materials as well as atmospheric chemistry and its effects on the environment and human health.



NanoTheRad aims to improve and personalise radio and chemotherapy cancer treatments. It focuses on developing innovative therapeutic strategies based on the use of new radiation sources, nano-objects and radio sensitising agents.