La lettre de l'Institut Pasteur

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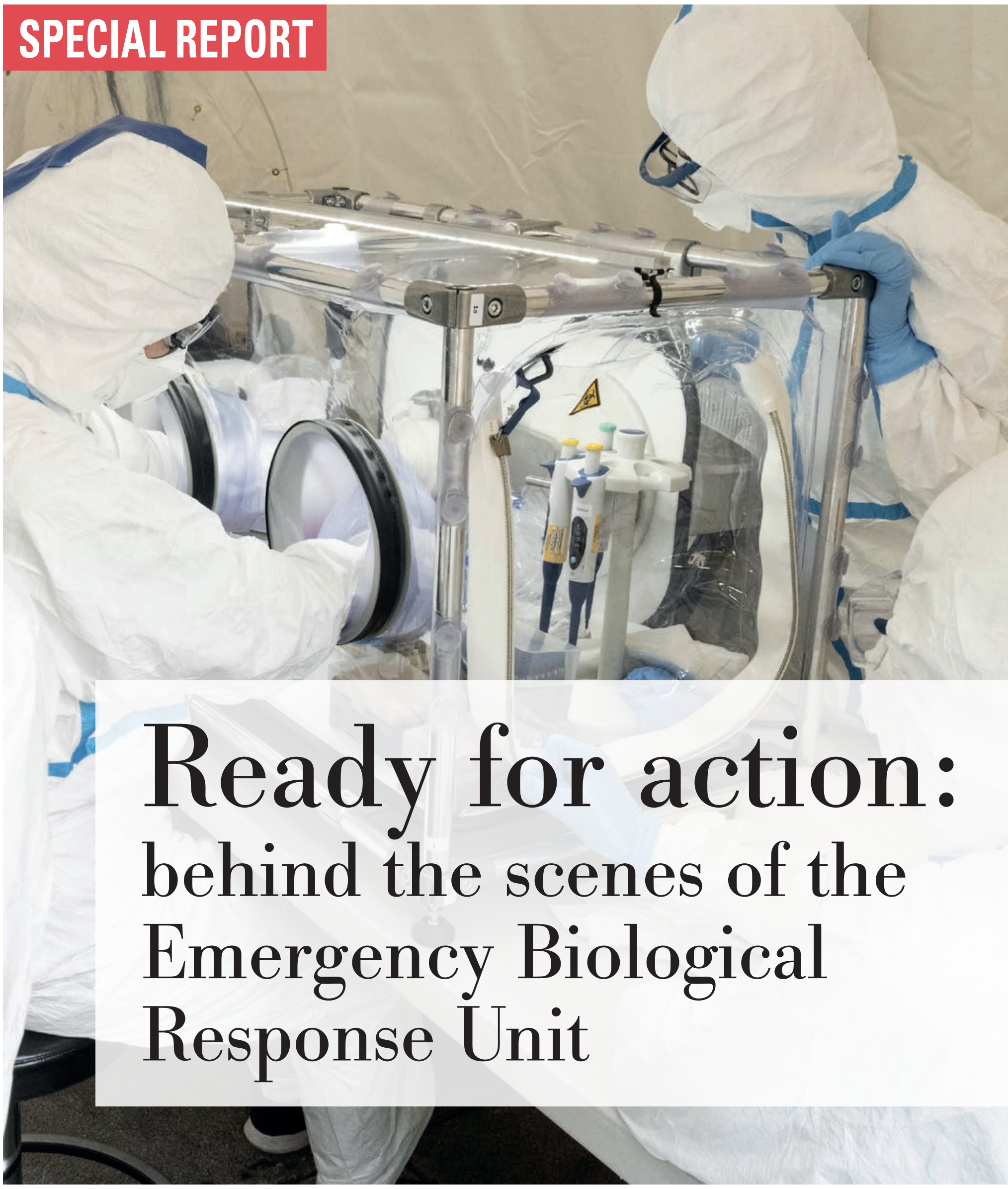
EDITORIAL

One Health

Strengthening our responsiveness to epidemics, in close coordination with local, national, and international initiatives, is crucial to prepare the world for tomorrow's health risks. With unmatched expertise in the field of infectious diseases, the Institut Pasteur is developing ambitious research programmes based on the One Health approach, integrating the effects of environmental changes on both human and animal health. As part of our strategic plan, Pasteur 2030, we will launch a wide-reaching pandemic preparedness initiative in which the Emergency Biological Response Unit and the Pathogen Discovery Laboratory – highlighted in these pages – play a key role. Their field-based work will help develop surveillance and disease control strategies and enable rapid response at the first signs of a health crisis, to contain its spread. This responsiveness is largely made possible thanks to your donations, which guarantee our independence in a changing world. I thank you from the bottom of my heart.

Prof. Yasmine Belkaid,
President of the Institut Pasteur

SPECIAL REPORT



Ready for action:
behind the scenes of the Emergency Biological Response Unit

There's a buzz in the corridors: Laurent Dacheux, deputy head, and Angela Brisebarre, technician, are preparing to leave for Lisbon for a European disaster response and intervention exercise. Armed with detailed inventory lists, the scientists pack crates of high-tech equipment and field repair supplies – yet the portable freezer is nowhere to be found. Researcher Jessica Vanhomwegen has taken it with her to Mayotte, which has just been hit by a violent storm: such are the logistical realities and uncertainties of emergency response.

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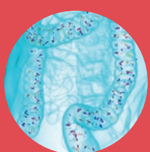


Logistics are critical in intervention missions: every crate of equipment is packed with care – every kilo counts.

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This is daily life for the Emergency Biological Response Unit (*Cellule d'Intervention Biologique d'Urgence* – CIBU), a specialist team responding to microbiological emergencies in France and around the world. Based at the Institut Pasteur and led by Jean-Claude Manuguerra, this 16-person unit operates on a 24/7 call system and has a wide range of diagnostic and genetic sequencing tools ready to tackle any eventuality.

Public health sentinels

Founded in 2002 at the joint initiative of the French Directorate-General for Health and the Institut Pasteur, in the wake of the 9/11 attacks, CIBU was designed to handle any emerging epidemic or threat involving highly pathogenic agents, especially bioterrorism-related ones. However, nature quickly proved to be the more formidable adversary: within a year of its creation, the first five "CIBU members" faced the SARS outbreak. Since then, equipped with a high-security mobile laboratory (P3 level), they have regularly deployed internationally during epidemic outbreaks: Mexico (H1N1 flu), the Middle East (MERS), Africa (Ebola)… In France, CIBU supports National Reference Centres (CNRs) in monitoring numerous pathogens, 14 of which are based on the Pasteur Campus. CIBU's support proved

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ACTION PASTEUR

On-call duty: between urgency and patience

At the CIBU, on-call duty involves a supervisor and a technician for a full week, from Monday evening to the following Monday morning. "*We are reachable 24/7 and can be called out day or night*," says **Anne Le Flèche-Matéos**, Head of the Bacterial Identification Unit at CIBU. It all begins with a call from the Directorate General for Health, which is contacted by hospitals. "*We must be ready to receive the sample within the hour and deliver a result within eight hours.*" The procedure varies depending on the risk level of the pathogen, though caution is always a priority. "*This Sunday, for instance, we received a suspected case of diphtheria. The suspected agent is a level 2 risk bacterium, Corynebacterium diphtheriae. The urgency was to determine whether the bacterial strain isolated from the patient carried the diphtheria toxin gene. Bacterial toxins can be extremely virulent and may result in death.*" CIBU also works with class 3 pathogens, requiring the use of a high-security P3 laboratory under strict conditions: "*At the slightest spill or splash, we must undergo a disinfectant shower and shut down the lab*," explains the researcher. "*Handling time doubles because movement is slower than in a standard lab.*" Yet, after 20 years of on-call work, Anne's enthusiasm remains intact. "*To do this job, you need patience and mustn't fear being confined for several hours.*" Each on-call shift is different, but the CIBU team receives regular training to respond swiftly to public health authority requests. "*We've broadened our detection panel. From a single sample, we can now detect up to forty viruses and bacteria and deliver a diagnosis within hours.*"

Researchers Anne Le Flèche-Mateos and Jessica Vanhomwegen working with samples in the P3 mini-laboratory at Institut Pasteur.

ACTION PASTEUR

Mayotte: coordinating international expertise

When tropical cyclone Chido struck Mayotte on 14 December 2024 with winds reaching 226 km/h, the damage was extensive. Hospitals, water monitoring systems, and distribution networks were knocked out, raising fears of outbreaks such as the cholera epidemic that had affected the island earlier in the year (see p.10). **Jessica Vanhomwegen**, Head of the Viral Identification Unit at CIBU, was appointed coordinator of the WHO assistance mission requested by French authorities. On 15 January, the researcher arrived with three other international scientists. "*CIBU primarily conducts human diagnostics, but this mission also required expertise in water analysis and environmental investigation. The WHO therefore deployed, for the first time, a team combining experts from various mobile laboratories – a true test of international collaboration!*"

The team provided both material and human support to the Regional Health Agency, as well as to the field hospital to quickly identify the causes of widespread gastroenteritis linked to contaminated water. After a few days, the situation improved, allowing the team to shift focus to investigating the environmental sources of typhoid and shigellosis cases. "*Support from local NGOs was essential in navigating the maze of informal settlements*," Jessica notes. The team found that the rivers running through villages were highly contaminated, and the household plumbing formed a 'spaghetti network' where everything was interconnected, complicating source identification. "*Ultimately, we mainly focused on identifying safe water sources to help NGOs guide the population.*"

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vital during the H1N1 and COVID-19 pandemics, when the CNRs were constantly mobilised.

Yet most of the "CIBU members'" work involves urgently identifying pathogens in samples sent by French hospitals and the Directorate-General for Health. CIBU processes around 200 samples a year, containing bacteria or viruses – some harmless, some highly dangerous, some unknown.

Over time, CIBU has grown in size and capacity, incorporating the Viral Identification Unit (PIV), the Pathogen Genotyping Unit (PGP), and the Bacterial Identification Unit (PIB) at the Institut Pasteur. A key milestone was the creation of the Environment and Infectious Risk research unit in 2013, linking fundamental research with fieldwork on highly pathogenic infectious diseases. This unit – home to both CIBU and the Hantavirus CNR – has its own P3 lab and conducts research into identifying new pathogens, their modes of transmission, and persistence in the environment. The current mpox (monkeypox) outbreak highlights this: thanks to research over the past three years, detection tests were rapidly developed as soon as warning signs appeared.

From fundamental research to field operations

This Unit–CIBU structure has developed by combining a range of expertise: virologists, bacteriologists, bioinformaticians… Most are long-time volunteers, well-acquainted with the intense demands of on-call duty. To coordinate this 25-person team, Jean-Claude Manuguerra has opted for a collaborative approach – sharing skills and equipment. Given the hazardous

CIBU analyses around 200 samples of potentially dangerous pathogens every year.

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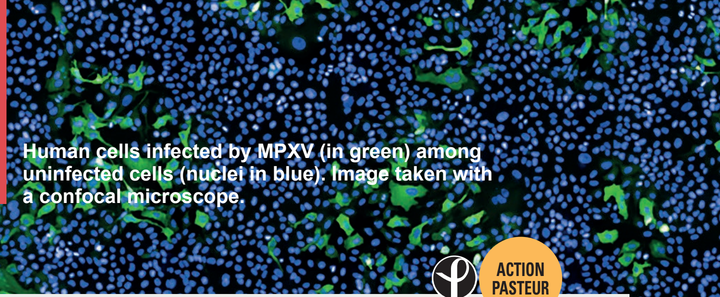
Ready for action: behind the scenes of the Emergency Biological Response Unit



Human cells infected by MPXV (in green) among uninfected cells (nuclei in blue). Image taken with a confocal microscope.

ACTION PASTEUR

From Covid-19 to mpox: how do viruses survive in the environment?

A virus's ability to retain its infectious properties in the environment is a key factor in epidemic prevention and control. "*Environmental virology, which examines this data, long remained a niche field with little recognition – until the COVID-19 pandemic changed everything*," explains **India Leclercq**, a researcher in the Environment and Infectious Risks Unit. "*As we had been studying the infectivity of flu viruses in external environments for years, we were called on to address very practical concerns – the persistence of SARS-CoV-2 on food, in public transport, its inactivation by heat or disinfectants...*" Following this renewed interest, the researcher turned to other pathogens: "*We had already identified the monkeypox virus (MPXV) as an emerging threat, and began fundamental research on it as early as 2021. We were right!*" In 2022, the virus, usually confined to Africa, caused a large-scale epidemic worldwide. CIBU, mobilised from the first alerts, drew on the research unit's expertise to develop on-site PCR tests and better understand the immune response. Today, new MPXV strains are circulating and research continues: "*We've recently welcomed a PhD student,* ***Jose Pablo Marin-Obando****, to study a protein possibly involved in MPXV replication and potentially important for cross-species transmission. Regarding respiratory viruses, we're focusing on airborne transmission in built environments.*" India's work spans animal health and architecture, uniting a broad range of expertise: "*The aim is to create tools capable of responding rapidly to new epidemics.*"

Members of the Emergency Biological Response Unit (CIBU) in a Level 3 biosafety training exercise at the Institut Pasteur in April 2023.

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nature of the pathogens handled, training, safety, and traceability requirements are extremely strict, and all emergencies must be anticipated.

As a result, most CIBU members are trained to analyse a wide variety of pathogens and must master around 50 protocols to qualify for on-call duty. This system allows CIBU to respond to multiple situations simultaneously – an increasingly important capability as international collaboration becomes a central pillar of epidemic response.

> Most "CIBU members" are trained to analyse a wide range of pathogens and must master around 50 protocols to qualify for on-call duty.

Tracking emerging diseases around the world

With global air travel, a microbe can circle the globe in under 24 hours. As a partner of the World Health Organization (WHO), CIBU can dispatch field teams within hours to set up diagnostic labs, collect environmental samples, ensure the safe transport of human specimens, and work closely with local medical teams.

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INTERVIEW

Jean-Claude Manuguerra

Director of the Emergency Biological Intervention Unit and Head of the Environment and Infectious Risks Unit at Institut Pasteur.

“To prepare for and respond to epidemics, we need continuity and permeability between fundamental research and the field.”

How was the CIBU developed within the Institut Pasteur?

From the outset, the CIBU was fully integrated into the ecosystem of the National Reference Centres, as well as into the research laboratories and technological platforms of the Institut Pasteur. The initial idea was for our technicians to train within these structures, with the aim of acquiring diverse knowledge and skills. A good example of this approach was our baptism by fire: the 2003 SARS epidemic, when the CIBU was still taking shape and didn’t have fixed premises. At the time, I was still co-director of the National Reference Centre for influenza and respiratory viruses, so I went to the French hospital in Hanoi, while CIBU members supported the Centre, to which I sent the samples. My deputy at the time, Christophe Batéjat, quickly set up the permanent P3 lab that we used until 2016. Without the close human and physical proximity we maintained, that speed would not have been possible. We officially launched our epidemiological on-call service in July 2004, and it has never stopped since.

What motivates the volunteers?

The CIBU brings variety and adrenaline – elements that can be missing from often highly specialised fundamental research. The hardest part isn’t finding volunteers, but training them: it requires a genuine long-term personal commitment of at least 3 years. Personally, I stopped on-call shifts this year, at age 62: I had always said I’d do so when I reached retirement age! Beyond on-call duties, there are also field missions, which can be challenging both physically and emotionally. Generally, our role isn’t to be close to patients, but to provide diagnostic answers. In this way, we seek solutions to real-world problems, drawing on fundamental research. Nonetheless, we are fully aware of the meaning of the results we send back. The COVID crisis was particularly moving in that regard.

How is the link made between the CIBU and the research unit?

In the organisational chart, each division has a certain degree of autonomy, but we strive to align the research activities with those of the CIBU in terms of pathogen selection and themes. The unit was built around and in coherence with the CIBU. For instance, we don’t work on HIV because we focus on pathogens that cause emerging epidemics – acute, not chronic, infectious diseases. The CIBU and the research unit are interconnected since I lead both. Although they are two separate entities, we aim to operate as one system: the quality standards guiding the CIBU are also applied across the rest of the unit. This setup is quite unique within the Institut Pasteur and is sometimes seen in the National Reference Centres.

> “We officially launched our epidemiological on-call service in July 2004, and it has never stopped since.”

What is specific about your research approach?

There is a true continuum between fundamental and applied research in our structure – what could be described as ‘operational research’, with the objective of preparing for and responding to epidemics. We have strict requirements for traceability of documents and procedures according to current standards. There is also systematic and standardised verification of lab equipment, as well as oversight by public authorities – unlike in standard research units. This administrative load is necessary given the dangerous nature of the pathogens we work with and the significance of our role in public health decision-making. We’ve therefore structured ourselves to avoid any internal redundancy and to enable the CIBU to be as effective as possible in its emergency response efforts.

Ready for action: behind the scenes of the Emergency Biological Response Unit

The mobile laboratory tent set up in Lisbon's abandoned docks.

Laurent Dacheux and Angela Brisebarre (centre) and their collaborators during the EU MODEX.

Lisbon: a slightly too realistic exercise

ACTION PASTEUR

Preparing for and responding to epidemics requires international collaboration among a wide range of stakeholders. "*To address tomorrow's challenges, we need to be more integrated into emergency medical and environmental monitoring systems, closer to the events*," emphasises **Laurent Dacheux**, Deputy Director of the CIBU. With this in mind, Laurent and **Angela Brisebarre**, a technician at CIBU, travelled to Lisbon for four days at the end of January 2025 to take part in a European urban search and rescue exercise (EU MODEX). "*It was a simulation of a natural disaster – specifically, an earthquake followed by a tsunami in the fictional country of Lusitania*," explains the researcher. This large-scale event brought together 1,200 people, including medical and rescue teams and, of course, a mobile laboratory, from several European countries. "*We engaged in a full-blown role-playing game, with fake administrations, mock victims to rescue from rubble, a collapsing hospital… all set in abandoned docks – a true apocalyptic setting*!"
The aim was to test everyone's protocols and methods, but also to strengthen coordination and international partnerships. "*It was the first time the CIBU had been integrated into an emergency medical team during such a large-scale exercise. We were able to see how valuable real-time diagnostics are to physicians*." However, field conditions quickly caught up with the researchers: "*We experienced such strong gusts of wind that tents were blown away, forcing us to evacuate the camp. Even an exercise can prove dangerous, but this is how we prepare for any eventuality*."

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These missions can be extremely intense, especially after natural disasters – such as the recent one in Mayotte.

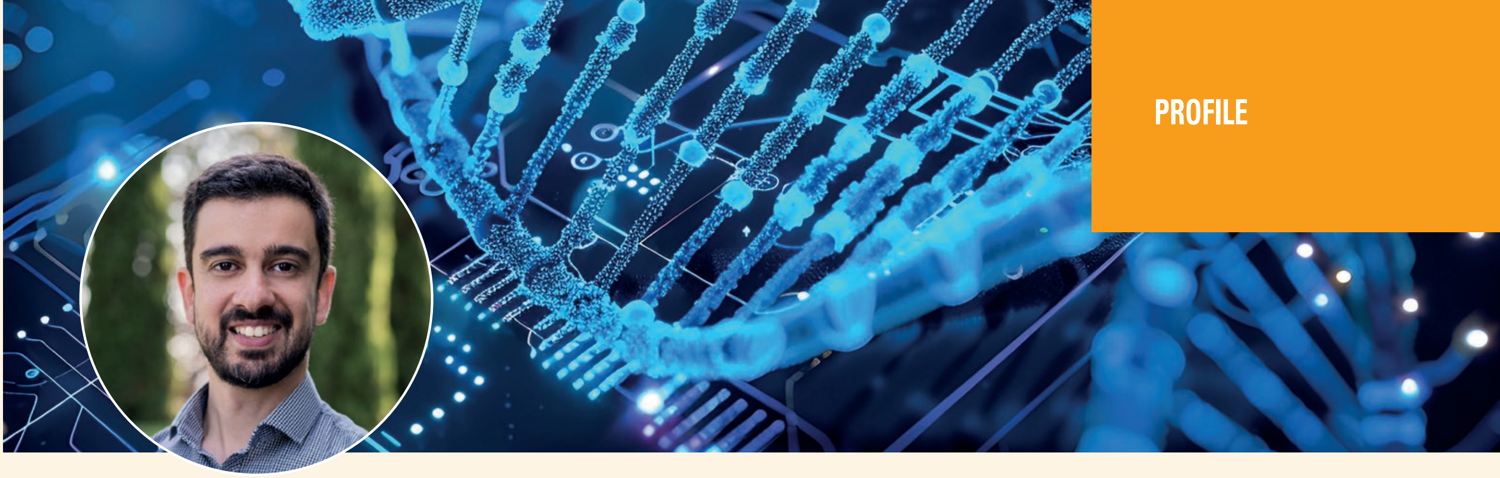
But the real turning point for international cooperation was the 2013–2016 Ebola epidemic, whose challenges and successes highlighted the need for shared expertise and standardised methods. Here, CIBU was already ahead, thanks to its unique organisation, its early involvement in European mobile lab networks (since 2008), and its longstanding role in the WHO's Global Outbreak Alert and Response Network (GOARN), which Jean-Claude Manuguerra coordinated until 2018. Together with his deputy Laurent Dacheux, he contributed to the WHO's initiative that led to the publication of the first international standard for mobile laboratories in early 2025. The aim is for these diverse labs to become interoperable and allow animal and environmental surveillance experts to join forces with human diagnostics teams. This model reflects the WHO's One Health strategy and has already proven successful in the field – such as in Mayotte.

REPORT BY THE EDITORIAL TEAM

ACTION PASTEUR

Paris Olympics: enhanced surveillance

The 2024 Olympic Games in Paris were not only a major sporting event but also a significant public health challenge: 11 million people, including nearly 3 million tourists, gathered in Paris and the Île-de-France region. "*As early as 2023, the CIBU began preparing to respond to mass gatherings: the Rugby World Cup, the Olympic and Paralympic Games*," explains **Véronique Hourdel**, a bioinformatician in the Environment and Infectious Risks Unit.
Initially, the unit developed diagnostic techniques and implemented rapid detection approaches for pathogens, as well as sequencing for various syndromic panels. "*The goal was to target multiple pathogens with similar clinical symptoms using a single test*," says the research engineer. Several different viral and bacterial targets can thus be identified in just a few hours, thanks to next-generation sequencing. "*My role as a bioinformatician is to make this data available as quickly as possible to assist researchers with diagnostics*."
From respiratory viruses to haemorrhagic fevers and even bioterrorism agents, the CIBU prepared for every possibility. "*We increased staff during on-call periods and set up a mobilisation system, drawing lessons from the COVID-19 experience. In the end, there were no alerts – and that's a relief!*"
Some of these tests also contributed to a research project monitoring airborne pathogens: "*We collected samples from public places for six weeks during the Olympics – restaurants, bars, nightclubs*," Véronique explains. The goal is to determine whether fluctuations in airborne pathogen levels could indicate the onset of an epidemic, similar to wastewater monitoring. "*This project, called AirSampling, is ongoing – we plan to increase the number of panels and explore other environments and collection sites*."



PROFILE

Rayan Chikhi, bioinformatics to lay the foundations of life

"By analysing all the sequenced DNA available on Earth, we have ushered in a new era in health research."

To navigate the labyrinth of genetic data, the head of the Algorithms for Biological Sequences Unit at Institut Pasteur has championed on bringing research computing to the heart of biology labs.

Computing comes naturally to Rayan Chikhi: "*My parents ran a small computer sales business – I was helping assemble them at eight years old and started programming in primary school, self-taught.*" Nevertheless, it was through mathematics preparatory classes that he made it to the École Nationale Supérieure in Rennes: "*I can't help but mention my teacher, Mrs Chevallier, who helped me go that far.*" Passionate about maths and computer science, Rayan discovered biology during an internship on protein structure studies – chosen almost at random – and decided to specialise in DNA sequence analysis, a field producing vast amounts of data. "*I've always wanted to do something useful and, ideally, have societal impact. In France, computing education has a strong mathematical tradition, often focused on theoretical problems – but the flip side is a certain detachment from practical applications like disease and health.*"

After a PhD and postdoc in the United States, Rayan joined CNRS in Lille in 2014. He later applied to Institut Pasteur to set up a five-year team supported by the INCEPTION programme, which promotes interdisciplinarity between computer science and infectious disease research. "*It's quite rare in France for a research computing lab to be part of a biology institute.*"

This environment allows Rayan to tackle questions that matter to biologists – from reconstructing viral or bacterial genomes to detecting variations between human genomes. To align or analyse genetic sequences, his team develops computational tools rooted in scientific research: "*We conduct computer science, not just technical tasks; our algorithms yield new insights, advancing knowledge in both computing and biology.*"

The algorithms for biological sequences unit during a team seminar near Annecy.

The researcher is cautious about the term Artificial Intelligence: "*Saying we do AI is often a misnomer – we use it, yes, but mainly to enhance our methods, not to contribute to AI development per se. For me, AI is a crucial tool to advance scientific goals. My aim is to explore the microbial world, not the world of AI itself.*"

At 40, Rayan coordinates several national and European research projects developing new algorithms, particularly for analysing huge datasets. "*Massive genetic data is opening a new era in biological and health research.*" In 2022, he and his team catalogued all known RNA viruses and every version of coronavirus in global databases. In just two weeks of computing and a few months of analysis, they uncovered nearly ten times more new species than previously known. This work earned Rayan the 2023 Mme Victor Noury Prize from the French Academy of Sciences – and it's far from his only accolade.

Presentation of the 2023 "Mme Victor Noury Prize" by the french academy of sciences.

Several other awards have also recognised the IndexThePlanet project: "*We indexed all sequenced DNA on Earth – an immense 50-petabyte dataset – in just 30 hours. On a single computer, it would have taken 3,400 years!*" The results have been made available to the scientific community and are already leading to the discovery of new viruses and previously unknown microbial species.

Human cells expressing the F13 protein of the poxvirus (in red). Cell nuclei in blue.

MONKEYPOX

Better understanding the resistance of the mpox virus

Mpox presents as a milder form of human smallpox, with lower symptoms and mortality. In response to the resurgence of outbreaks outside endemic areas in Central and West Africa, the World Health Organization (WHO) declared a public health emergency of international concern for the second time since 2022, in mid-August. In France, 215 infection cases were reported to Santé publique France (the national public health agency) in 2024.

To treat patients infected with the mpox virus, tecovirimat is the most commonly used drug. Unfortunately, it sometimes proves ineffective against certain virus variants that carry mutations in an enzyme, phospholipase F13, essential for the formation of the viral particle's outer envelope.

Using biochemical and computational methods, scientists* analysed the structure of phospholipase F13 to clarify the interactions between the drug and the enzyme. They showed that tecovirimat acts like a kind of glue binding two phospholipase F13 molecules together, thereby preventing viral particles from exiting infected cells.

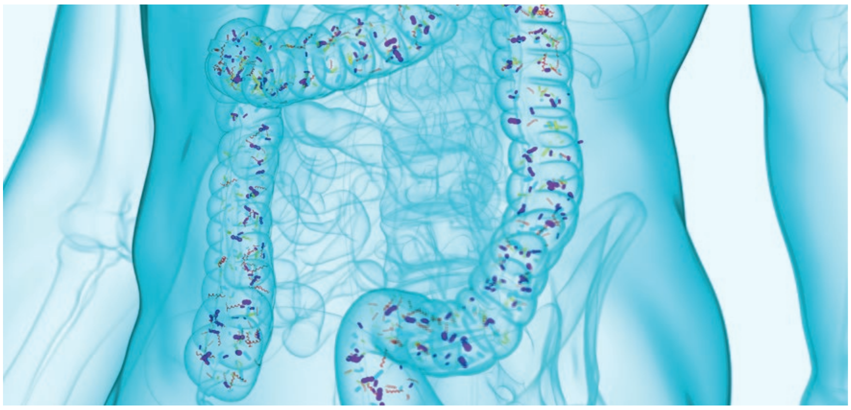
Understanding how the drug works and the virus's resistance mechanisms is essential for developing new therapeutic approaches that remain effective regardless of the mpox strain.

* Study led by Pablo Guardado-Calvo, head of the Structural Biology of Infectious Diseases Unit at the Institut Pasteur.

MICROBIOME

Predicting individual sensitivity to food additives

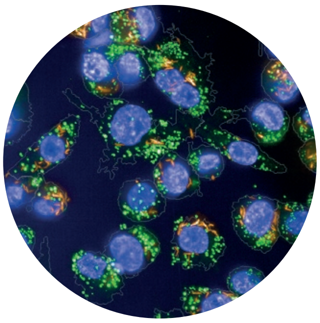
Widely used by the food industry, emulsifiers – a class of food additives – have become a real public health issue. After demonstrating that long-term consumption of certain emulsifiers could negatively impact the gut microbiome and thereby promote chronic inflammatory diseases, researchers* turned their attention to the individual characteristics of each person's microbiome.



In the lab, they developed a model capable of replicating different human microbiomes to test the effects of an emulsifier known as carboxymethylcellulose (CMC), commonly found in industrial brioche, sliced bread and ice cream. By analysing bacterial DNA present in the gut microbiome, scientists then identified a specific signature indicating sensitivity to CMC, allowing them to predict whether a given microbiome is sensitive or resistant to this emulsifier. Their results show that some people, known as sensitive, may have a microbiome that is highly reactive to emulsifiers, while others have a resistant one.

The scientists are now conducting a large clinical study on patients with Crohn's disease – a chronic inflammatory bowel disease – to validate these predictive approaches for assessing individual sensitivity to these additives.

* Study led by Benoit Chassaing, Inserm research director and head of the Microbiota-Host Interactions team at the Institut Pasteur (Inserm/Université Paris Cité/CNRS).



Human macrophages forming lipid droplets in response to infection by *Mycobacterium tuberculosis*. In orange: *tuberculous bacilli*. In green: lipid droplets. In blue: macrophage nuclei.

START-UP

New therapeutic molecules in development

At the Institut Pasteur, researchers have been studying for several years mycolactone, a toxin produced by the bacterium responsible for a severe skin disease prevalent in West Africa: Buruli ulcer.

In 2016, its mechanism of action was discovered*: mycolactone targets a structure known as the "translocon", the blockage of which prevents cells from secreting proteins. This research revealed a new way of blocking pathogenic molecules and degrading them within the cell. To turn this research into practical applications, the Institut Pasteur and the incubator Argobio created Enodia Therapeutics, a biotechnology company that will use AI to develop a new generation of molecules capable of targeting the translocon, with the aim of creating new treatments for cancer, inflammatory diseases and viral infections.

* Research led by Caroline Demangel, head of the Immunobiology and Therapy Unit at the Institut Pasteur.

LABORATORY

What is a high-security laboratory?

Microorganisms are classified into four groups based on the severity of the infections they can cause. Secure research laboratories are assigned a protection level – "P"1, 2, 3 or 4 – depending on the group of pathogens that can be studied there, thanks to specific equipment ensuring the safety of both scientists and the environment.

Level 3 (P3) biosafety laboratory.

In a P1 laboratory, for example, harmless organisms are handled. A simple lab coat and proper handwashing are sufficient, similar to high school practical labs. P2 laboratories offer more security: researchers wear gloves and goggles and handle potentially harmful microbes (such as cholera vibrios, E. Coli, influenza virus...) under hoods known as "microbiological safety cabinets".

Beyond level 2, laboratories become "bubbles" isolated from the outside world. P3 is a "high-security" laboratory: behind an airlock with double doors, air is filtered and maintained under negative pressure to draw it inward and prevent any escape. Researchers must follow a strict protocol: protective clothing, working in pairs, and decontamination of all items by autoclave or validated disinfection methods before leaving the lab. This allows for the study of highly contagious, health-threatening agents for which treatments or vaccines may exist (SARS-CoV-2, HIV, hepatitis B and C viruses, tuberculosis or plague bacteria, etc.).

P4 high-security laboratories are reserved for the most dangerous pathogens, such as the Ebola or Marburg viruses, which can spread rapidly and for which few treatments exist. Around sixty such labs are operational worldwide, and the constraints, in addition to those already in place in P3 labs, are extreme: full-body suits for researchers and mandatory decontamination showers before exiting.

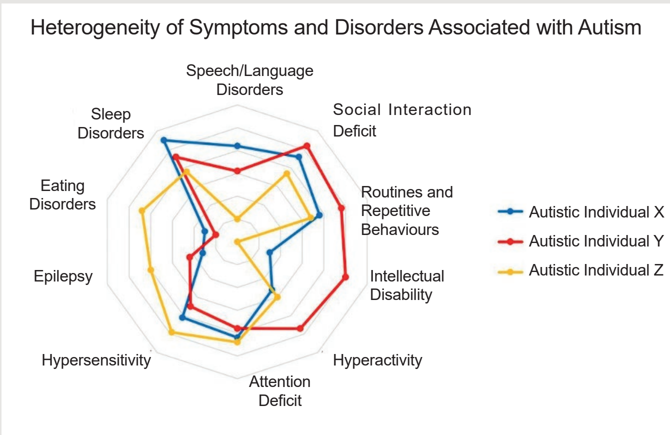
FOCUS

Are there effective forms of support for autism?

To date, there is no absolute or exclusive "method", nor any medication, that claims to "cure" autism spectrum disorders. Their heterogeneity makes it essential to consider the individual difficulties encountered by each person concerned.

Medical and educational support for people with autism is often not personalised and is purely symptomatic (it targets the symptoms rather than the origin of the disorder). Non-pharmaceutical therapeutic strategies are available: speech therapy, psychoeducation, psychomotor rehabilitation... These are especially effective when implemented early in life, highlighting the importance of early diagnosis.

While pharmaceutical and non-pharmaceutical therapeutic trials are ongoing to identify additional treatment strategies, it is well established that a combination of educational, cognitive-behavioural and developmental interventions helps to offset difficulties, regulate certain states, and improve the quality of life and autonomy of autistic individuals.



This approach is all the more relevant given that autism is frequently associated with other neurodevelopmental disorders, such as attention deficit disorder with or without hyperactivity (ADHD), developmental coordination disorder, specific learning disorders or intellectual disability, but also with psychiatric disorders, and certain medical conditions such as epilepsy or gastro-oesophageal reflux. Unfortunately, it is only very recently that these associated conditions have been considered in research. They are in fact extremely important, both for understanding the origins of autism and for improving support for those affected.

CHOLERA

From Yemen to Mayotte: the journey of a highly resistant bacterial strain

Antibiotic susceptibility of the Vibrio cholerae strain responsible for the 2024 Mayotte outbreak.

Between March and July 2024, the island of Mayotte was affected by a cholera outbreak (221 identified cases) caused by a strain of Vibrio cholerae highly resistant to antibiotics.

In its most severe forms, cholera – a diarrhoeal disease – can be fatal within hours if left untreated. Treatment mainly consists of rehydration. Antibiotics are used as a complementary measure and are essential to reduce the duration of the infection and therefore the contagiousness of patients.

A strain resistant to ten antibiotics – including two of the three recommended for cholera treatment – was first identified in Yemen in 2018, during the largest cholera outbreak in decades. Scientists* were able to trace the spread of this strain through bacterial genome analysis. After Yemen, it was next identified in Lebanon in 2022, Kenya in 2023, and finally in Tanzania and the Comoros, including Mayotte – a French overseas department off the southeast coast of Africa – in 2024.

This study highlights the need to strengthen global surveillance of the cholera pathogen and, in particular, the importance of real-time monitoring of its antibiotic resistance. If this newly circulating strain were to acquire additional resistance to tetracyclines, it could jeopardise all oral antibiotic treatment options.

* Study led by Professor François-Xavier Weill, Head of the National Reference Centre for Vibrios at the Institut Pasteur, in collaboration with the Mayotte Hospital Centre.

TUNISIA

Charles Nicolle Chair: strengthened scientific cooperation

Dr Odette Tomescu-Hatto, Director of International Affairs at the Institut Pasteur in Paris, and Professor Samia Menif, Director General of the Institut Pasteur in Tunis.

On Friday 17 January, the Institut Pasteur of Tunis and the Institut Pasteur of Paris signed an agreement to establish the Charles Nicolle Scientific Chair. The initiative is supported by the French Embassy in Tunisia, the Tunisian Ministry of Research and Higher Education, and the Tunisian Ministry of Health. The chair aims to strengthen scientific exchange between Tunisia and France in biology, medicine, and health. It is committed to annually supporting a young Tunisian researcher by offering them a mobility placement at the Institut Pasteur in Paris.

Charles Nicolle (1866–1936) was Director of the Institut Pasteur of Tunis from 1902 to 1936 and received the Nobel Prize in Physiology or Medicine in 1928 for his discovery in 1909 of the transmission of typhus by lice.

GUINEA

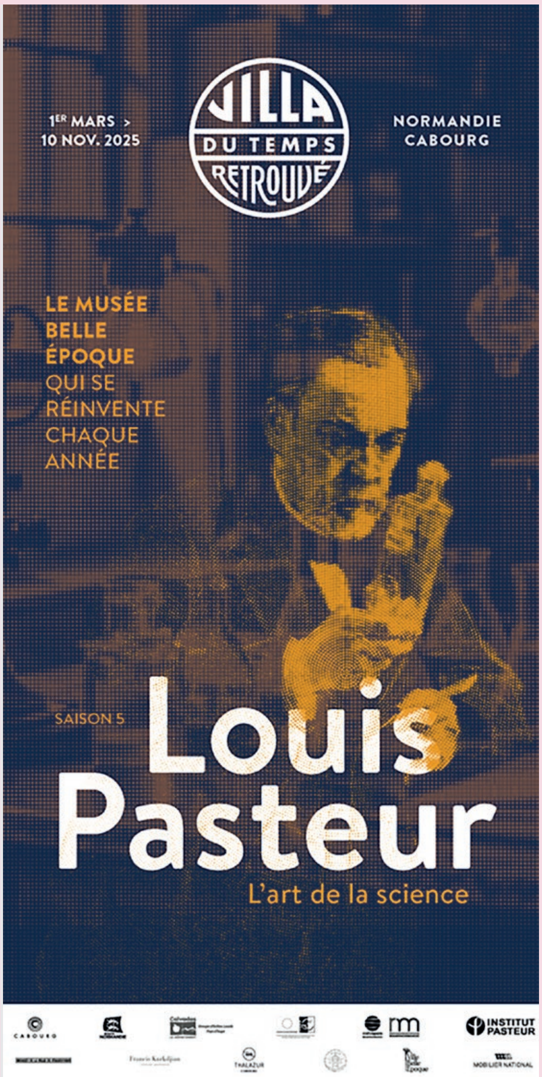
Sleeping Sickness Is No Longer a Public Health Threat

Sleeping sickness, also known as human African trypanosomiasis, is caused by the flagellated parasite *Trypanosoma brucei*, transmitted to humans by the tsetse fly. The disease occurs exclusively in 29 sub-Saharan African countries, including Guinea, where it was declared eliminated as a public health problem at the end of 2024.

Teneral male (prior to first meal) *Glossina morsitans morsitans*, vector of the *Trypanosoma brucei* parasite, agent of sleeping sickness.

In the 1990s, sleeping sickness resurfaced along the Guinean coast due to increased human activity in the mangroves, driven by the economic and demographic growth of the capital, Conakry. In response, the Guinean Ministry of Health launched a national control programme in 2002, with support from the WHO and the French National Research Institute for Sustainable Development (IRD), followed by other partners including the Drugs for Neglected Diseases initiative (DNDi), of which the Institut Pasteur is a founding member, and the Institut Pasteur of Guinea.

The programme began with mass medical screenings to diagnose and treat cases, followed by vector control campaigns and trials of new treatments. After a resurgence of sleeping sickness cases during the Ebola outbreak (2013–16), the threshold of 1 case per 10,000 inhabitants per year has been maintained since 2019, leading the World Health Organization (WHO) to validate its elimination in Guinea – the last endemic hotspot in West Africa.



EXHIBITION

Louis Pasteur, the art of science

From 1 March to 10 November 2025, the City of Cabourg is paying tribute to the work of Louis Pasteur and revealing the artistic side of the scientist – a lesser-known aspect of his remarkable career.

For more information, visit ***villadutempsretrouve.com***

A museum of the Belle Époque, the Villa du Temps Retrouvé explores the cultures at the turn of the 19th and 20th centuries through key figures and topics deeply rooted in collective imagination.

Jeanne-Etiennette Pasteur, née Roqui (1793–1848), mother of Louis Pasteur. Pastel portrait on paper by Louis Pasteur, 1836.

After exhibitions on Fantomas, Gustave Eiffel, Max Linder and Jules Verne, the new temporary exhibition will showcase several little-known facets of Louis Pasteur's scientific career in partnership with the Institut Pasteur Museum.

The scientist began drawing at the age of 13, and although he later abandoned artistic practice, he remained passionate about art throughout his life, maintaining close relationships with artists and writers. His inquisitive and universalist outlook led him to apply scientific progress to the arts: in addition to his influence on hygienist architecture, he taught at the École des Beaux-Arts from 1863 to 1867, where his lectures laid the foundation for preventive conservation.

The exhibition also highlights his scientific achievements, such as his refutation of spontaneous generation, his research on fermentation, and his discoveries in the field of infectious diseases.

THE INSTITUT PASTEUR MUSEUM COLLECTION IN THE SPOTLIGHT

Among the more than 40 objects loaned by the Institut Pasteur Museum, visitors can discover pastels created by Louis Pasteur himself, as well as his laboratory equipment. This exhibition has also provided the opportunity to restore three paintings from the museum's collection, which is currently undergoing an ambitious restoration and expansion programme.

Watch a video of the restoration of two paintings linked to Jean Binot, creator of the Institut Pasteur's first microbial collection: *https://www.youtube.com/watch?v=Ly-YuaXoSXg*

Jean Binot's laboratory (1867–1909) or "The Collection of Microbial Species at the I.P." Oil on canvas by Amédée Buffet (1869–1934).

PASTEUR and you

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The Institut Pasteur relies on donations

As donors and benefactors of the Institut Pasteur, you know how vital your support is to the continuation of our mission. With research costs rising and public funding decreasing, science must be defended.

This year, we have chosen to communicate more openly about our resources. Many believe the Institut Pasteur is a public institution, funded by the State. However, without the generosity of our donors, Pasteurian research could come to a halt.

The donation campaign you will receive by post or see online, symbolised by an empty laboratory chair, conveys this pressing concern. Only with your support can we continue our mission!

The French tax system allows you to choose how your taxes are used, whether you are subject to income tax (IR) or real estate wealth tax (IFI).

All About the IFI
ifi.pasteur.fr

On the ifi.pasteur.fr page, you'll find:

- the 2025 tax declaration schedule;
- a tax guide;
- a calculator to estimate your deduction amount for a donation to the Institut Pasteur.

Contact us with any questions about donation tax matters or to develop your philanthropic project:
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TEMPORARY DONATION OF USUFRUCT

This donation consists of temporarily transferring the usufruct of a property (income, coupons or rent) to a foundation such as the Institut Pasteur, via a notarised deed, for a minimum period of 3 years. It is particularly beneficial for property owners subject to IFI. For instance, if the usufruct applies to a rental property, this allows exemption from IFI on that asset. This tax advantage is not capped. The foundation receives the rental income for the duration of the donation, and the donor regains full ownership at the end. Alongside the IFI donation mentioned earlier, this remains the only way to optimise your IFI tax benefits tied to generosity. To learn more, contact us for personalised guidance.

INVITATION TO THE INSTITUT PASTEUR

You are invited to attend two lectures on

MONDAY, 16 JUNE
from 2:30 pm to 4:30 pm

"Depression: towards new treatments?"

by Pierre-Marie Lledo, head of the Perception and Action unit

"Microbes on our plates"

by François-Xavier Weill, head of the Enteric Pathogenic Bacteria unit

Free lectures upon registration: scan this QR code or visit:
https://institutpasteur16juin.eventbrite.fr

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☐ **On www.pasteur.fr**

☐ **By bank check made payable to the Institut Pasteur**

☐ I wish to continue receiving the Institut Pasteur Newsletter and I am enclosing the amount for a one-year subscription: 4 issues at the price of €6 (non-deductible).

☐ I would like to receive, in complete confidentiality and without obligation, information on the possibilities of bequests, donations, and life insurance benefiting the Institut Pasteur.

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La lettre de l'Institut Pasteur

INSTITUT PASTEUR

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