

EVALUATION REPORT OF THE UNIT  
String - Structure et instabilité des génomes

UNDER THE SUPERVISION OF THE  
FOLLOWING ESTABLISHMENTS AND  
ORGANISMS:

Muséum national d'histoire naturelle - MNHN,  
Centre national de la recherche scientifique -  
CNRS

Institut national de la santé et de la recherche  
médicale - Inserm

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**EVALUATION CAMPAIGN 2023-2024**  
GROUP D

Rapport publié le 15/03/2024



In the name of the expert committee :

Antonin Morillon, Chairman of the committee

For the Hcéres :

Stéphane Le Bouler, acting president

Pursuant to Articles R. 114-15 and R. 114-10 of the Research Code, the evaluation reports drawn up by the expert committees are signed by the chairmen of these committees and countersigned by the President of Hcéres.

This report is the result of the unit's evaluation by the expert committee, the composition of which is specified below. The appreciations it contains are the expression of the independent and collegial deliberation of this committee. The numbers in this report are the certified exact data extracted from the deposited files by the supervising body on behalf of the unit.

## MEMBERS OF THE EXPERT COMMITTEE

<b>Chairperson:</b>	Mr Antonin Morillon, Centre national de la recherche scientifique - CNRS, Paris
<b>Experts:</b>	Mr Raphaël Labruère, Université Paris Saclay, Orsay (representative of CoNRS) Ms Françoise Dantzer, CNRS, Illkirch Ms Stefania Millevoi, Inserm, Toulouse (representative of CSS Inserm) Ms Nadia Oulahal, Université Claude Bernard Lyon 1 - UCBL, Bourg en Bresse (representative of CNU) Ms Christelle Thibault-Carpentier, CERBM GIE, Illkirch (representative of research support staff)

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Sandrine Sagan, CNRS-INC  
Samir Messaoudi, CNRS-INC  
Cécile Bernard, MNHN  
Camille Chaudonneret, Inserm  
Emmanuelle Genin, Inserm  
Stéphane Regnier, Sorbonne Université

## CHARACTERISATION OF THE UNIT

- Name: Structure et Instabilité des Génomes (Genome Structure and Instability)
- Acronym: String
- Label and number: CNRS UMR7196, Inserm U1154
- Composition of the executive team: Mr. Jean-Baptiste Boulé, Mr. Jean-Paul Concordet deputy director, Mrs. Patrizia Alberti, deputy director

## SCIENTIFIC PANELS OF THE UNIT

SVE Sciences du vivant et environnement

SVE3 Molécules du vivant, biologie intégrative (des gènes et génomes aux systèmes), biologie cellulaire et du développement pour la science animale

## THEMES OF THE UNIT

The unit research is centred on nucleic acids structures, their dynamics at the molecular and genome level, and their interactions with cellular partners. The unit aims to characterize the cellular functions associated with nucleic acids, in particular the molecular mechanisms of genomic instability. The integration of such mechanisms ranges from molecules to cells using bacteria, fungi, rodents, primates and human cells as well as several original models as tardigrades, or food microbial consortia. The unit hosted four teams studying respectively: GE2R- Genome Editing, Repair and Cellular Responses; SANTE–Structure of Nucleic Acids, Telomeres and Evolution; Arche — Repeated DNA, Chromatin and Evolution and GPA-Genomics and Physiology of Adaptation.

## HISTORIC AND GEOGRAPHICAL LOCATION OF THE UNIT

The unit of Genome Structure and Instability is a direct filiation of the Biophysics Laboratory of the Museum National d'Histoire naturelle (Jardin des Plantes, Paris), established in 1961 by two molecular biophysicists pioneered in the field of nucleic acids, now translated in the unit within various disciplines, including biology, chemistry, physics and computational biology. Under the supervising authority of MNHN, CNRS and Inserm, the unit is currently under the direction of Jean Baptiste Boulé, has evolved in the last ten years to develop original research on genome structure and instability, bringing new models (old world monkeys, tardigrades, microbial consortia), extend its methods (genetic engineering, computational biology, microbiology) and its research topics (epigenetics, genome evolution, or microbial ecology).

## RESEARCH ENVIRONMENT OF THE UNIT

The unit is one of the fifteen research units of the Museum National d'Histoire Naturelle (MNHN), which belongs to the Alliance Sorbonne Université (ASU), created in 2018, which comprises Sorbonne Université (SU), the Technological University at Compiègne, Insead, France Education International and the 'Pôle supérieur d'enseignement artistique Paris Boulogne-Billancourt'. The unit is part of the department 'Adaptations du Vivant (Aviv)', which contains five research units within the Museum: Borea (UMR8067), MCAM (UMR 7245), Mecadev (UMR 7179), Phyma (UMR 7221) and String. The Aviv department has a general aim to decipher the mechanisms of adaptation of organisms, including microorganisms, to their environment. All the units develop functional, comparative, multidisciplinary, and integrative approaches to tackle their research questions. The String unit is part of the CNRS national chemistry institute (INC), composed of laboratories developing chemistry approaches at the interface of biology, physics, ecology, and engineering. The unit is part of Inserm dedicated to medical research at the fundamental and translational level. Affiliation to these three supervisory bodies reflects how the unit is positioned at the interface between different scientific approaches. The unit also hosts a genome editing platform (Taccgene) created in 2011 by the governmental Investment Program (PIA) to develop genome editing tools. Taccgene is part of the Celphedia (Creation, Breeding, Phenotyping, Distribution and Archiving of model organisms) infrastructure.

## UNIT WORKFORCE: in physical persons at 31/12/2022

Catégories de personnel	Effectifs
Professeurs et assimilés	4
Maîtres de conférences et assimilés	7
Directeurs de recherche et assimilés	3
Chargés de recherche et assimilés	5
Personnels d'appui à la recherche	12
<b>Sous-total personnels permanents en activité</b>	<b>31</b>
Enseignants-chercheurs et chercheurs non permanents et assimilés	1
Personnels d'appui non permanents	5
Post-doctorants	0
Doctorants	8
<b>Sous-total personnels non permanents en activité</b>	<b>14</b>
<b>Total personnels</b>	<b>45</b>

## DISTRIBUTION OF THE UNIT'S PERMANENTS BY EMPLOYER: in physical persons at 31/12/2022. Non-tutorship employers are grouped under the heading 'others'

Nom de l'employeur	EC	C	PAR
MNHN	9	0	4
CNRS	0	6	3
Inserm	0	2	5
AUTRES	2	0	0
<b>Total personnels</b>	<b>11</b>	<b>8</b>	<b>12</b>

## GLOBAL ASSESSMENT

The unit has an excellent scientific production with around 120 publications, some in well-recognised journals such as Nature Communications, eLife, Nucleic Acid Research, with some heterogeneity among the teams mainly due to the diversity of the collaborative aspects derived from the technological facilities. Deciphering the molecular basis of DNA double-strand break repair mechanisms led the unit to develop powerful gene-editing expertise made available to the scientific community via the platform Tacgene, fuelling translational projects and giving the unit visibility and a significant number of collaborations. During the term, the unit led an initiative aimed at developing innovative, cross-disciplinary and synergistic topics around the study model tardigrade. The adequation of resources is excellent with the MNHN hosting body providing the basic infrastructure to develop the research. The unit is embedded in the Aviv department of the MNHN and is strongly supported financially and staffed by the three supervising bodies (CNRS, Inserm and MNHN) with six newly arrived permanent positions (2 ITA, four researchers/professors) over the period and an average of 350k€ core funding yearly. The attractiveness and visibility of the unit are both excellent with a strong fund-raising capacity within the last six years, mostly national (incl 11 ANR as coordinators) and also with European supports as partners (1 EIC, 1 Horizon RISE). The non-academic activities are excellent with numerous actions towards the grand public via the MNHN missions (fête de la science, visits and comments of the Museum collections related to the unit research), but also with individual initiatives to combine sciences and arts. The embedded Tacgene platform has also attracted private partnerships with two biotech companies. Overall, the String unit is excellent and can envisage diversifying and consolidate the emerging expertise nurtured over the last period, and start to structure

better its future scientific strategy with an external SAB, and finally initiate call(s) for new teams, allowing further European and ambitious international grant applications.

## DETAILED EVALUATION OF THE UNIT

### A – CONSIDERATION OF THE RECOMMENDATIONS IN THE PREVIOUS REPORT

1-*'focus on research themes that leverage the unique scientific environment of the MNHN as a signature'*

The unit actively invested recurrent resources for the development research on tardigrades as a transversal project between teams. The project was developed by the GE2R team together with a researcher from the GPA team. Both teams managed to receive financial support for the development of their project from local grants and one PHD thesis was completed in early 2023.

2-*'facilitate more the scientific environment as a benefit for the unit in particular students'*

This recommendation has not been specifically addressed yet.

3-*'continue strengthening multidisciplinary (physics, chemistry, biology) and to foster cross-team projects.'*

The unit actively looked at reinforcing their resources in chemistry and recently recruited (2022) a senior chemist who brings back to the laboratory high-end research in organic chemistry applied to biology and medicine (team SANTE) especially in the field of bioluminescence.

4-*'increase the international visibility by applying for international grants.'*

The unit managed to raise fund at the European level with one MSCAA fellowship, one EIC pathfinder and one Rise Horizon2020 fundings.

5-*'Organisation of a SAB'*

This recommendation has not been addressed yet.

### B – EVALUATION AREAS

#### EVALUATION AREA 1: PROFILE, RESOURCES AND ORGANISATION OF THE UNIT

##### Assessment on the scientific objectives of the unit

The unit has excellent supports, both at the financial and human resource levels from three supervising bodies (MHCN, CNRS-INC, Inserm), which help sustaining pluridisciplinary research oriented towards the nucleic acids structure and evolution.

##### Assessment on the unit's resources

The unit visibility and support by the supervising bodies are excellent to outstanding giving the size of the unit with significant recurrent budget of around 350k€ annually, which allows fostering innovative research projects and maintaining its common equipment and infrastructure. The unit and especially each team are excellent in acquiring independent resources, from local, national and international levels (around 300k€ annually in total as project grants).

##### Assessment on the functioning of the unit

The internal organisation of the unit with four teams presenting specific research themes, in a community organisation, fosters an excellent work environment. The involvement of the unit towards sustainability but also integrating its scientific animation and creativity within the outstanding local community of research institutes remain to be improved.

## *1/ The unit has set itself relevant scientific objectives.*

### Strengths and possibilities linked to the context

The unit has three supervising bodies: the MNHN, the CNRS and Inserm. In terms of human resources, the unit is currently composed of about a third of CNRS agents, Inserm, MNHN agents, and two Sorbonne Université assistant professors. Over the last period, the unit produced around 120 publications with more than 80% published in Q1 journals. Weekly unit meetings gathering all lab members, contributes to a critical appraisal of the research conducted in the lab and warrants a high level of requirements towards their scientific output. Pluridisciplinarity and interdisciplinarity are key features as the unit publishes top tier papers in chemistry, biophysics, bioinformatics, comparative genomics, computational biology, molecular and cellular biology and molecular genetics. The GE2R team has recently contracted collaborations with two biotech companies for the development of genome editing tools and many of their collaborative projects are geared towards developing new tools for gene therapy, in parallel to their basic science endeavor. More modestly, the GPA team is involved in collaboration with a food biotech company for the study and development of fermented drinks of health interest based on their ongoing large-scale survey of microbial diversity of water kefir.

### Weaknesses and risks linked to the context

The unit has been in a great scientific ebullition over the last period and is now in the process of consolidating some of the scientific axes (tardigrades, bioluminescence). However, the decisive strategic choices to allocate important human, financial or technical resources lack independent and objective scientific evaluation by an external board.

The infrastructure though currently under refurbishment is still having difficulties and necessitates further renovation especially for a time-off relaxing room.

## *2/ The unit has resources adapted to its activity profile and research environment, and makes use of them.*

### Strengths and possibilities linked to the context

On average, the total budget of the unit per year is around 500 to 700 k€ which originated from recurrent budget and project-based contracts. The unit received a recurrent annual budget of ~350k€ from which, each team benefits of 25 k€ to use freely. The rest of the budget is used for common consumables (~60k€/year), informatics needs (~25k€/year), infrastructure and office supplies, common lab equipment, annual maintenance fees (~30 k€/year). The specific equipment of common and shared usage and missions >2k€ are discussed for acquisition during unit councils as illustrated by the acquisition of an Olympus microscope and incubators to support emerging research on tardigrades which subsequently helped the teams involved in tardigrade research to obtain independent funding.

Each team has been able to acquire independent funding, including grants through MNHN and Sorbonne University programs (~10) and ANR grants (11 grants as coordinators or partners).

Regarding the premises, the unit is hosted in the underground and ground floor of the Becquerel building at the MNHN. The building has been undergoing a renovation program for the last 5 years, including renovation of several rooms, dedicated at first to common areas. The unit has supported the costs for benches and common lab equipment, the rest being supported by the MNHN.

In terms of organisation, all team members are mixed within lab space as well as in offices, according to space availability and the needs of the teams.

### Weaknesses and risks linked to the context

The unit has no major weakness and the benefit of an outstanding core funding. Of note, the team participates as partners in two major European grants (1 EIC, 1 Horizon RISE). The excellence of the different teams and of the PIs should certainly open opportunities for future ERC applications.

*3/ The unit's practices comply with the rules and directives laid down by its supervisory bodies in terms of human resources management, safety, the environment, ethical protocols and the protection of data and scientific heritage.*

#### Strengths and possibilities linked to the context

The internal rules document of the unit is waiting final validation but is based mainly on the CNRS template including annexes concerning gender equality, harassment or prevention of psychological risks, emanating from MNHN, Inserm or CNRS.

Members needing support can access to the prevention assistants, who orientate towards institutional support. Since the unit is organised in a 'dispatched' mode, exchanges and support are facilitated, thus contributing to the favourable work atmosphere.

The women/men ratio is excellent (1/1) and has been stable over the years.

The technical/engineer staff (12 members; 33%) participates to the organisation of the unit (health and safety, equipment, social events). Over the last period, two engineers obtained a promotion 'hors classe' exemplifying the high value and promotion of the direction towards the ITA/engineer.

Regarding the protection of the informatics data, the unit server is hosted at the DSI of the MNHN to allow storage of datasets. With Microsoft TEAMS, the unit guarantees an online communication and organisation (admin resources and others) structure that every member of the unit can access.

All the waste generated is eliminated by a third party contracted by the MNHN, including chemical waste. In terms of energy saving, the unit has started to monitor the impact of cryogenics for electrical consumption (~11kW).

In case of emergencies, the rules of evacuation are set by the MNHN and are implemented by an evacuation team in the unit.

#### Weaknesses and risks linked to the context

The unit is lacking proactive incentives and training for gender equality, ethics and harassment in the direction of the young scientists. The Aviv department and the unit do not seem to be structured locally to gather altogether young scientists in an informal manner. The risk is a lack of information and limited scientific or technical exchanges as well as loss of visibility for the unit.

## EVALUATION AREA 2: ATTRACTIVENESS

### Assessment on the attractiveness of the unit

The unit attractiveness is very good to excellent given the size in particular thanks to success in acquiring funding to complement the recurrent core allowance (around 500–700k€/year). This funding acquisition policy has attracted young researchers (7 PhDs, 3 postdoctoral students) and technical staff. The permanent staff recruitment has been excellent over the period with two engineers and four researchers (1 Prof, 2 Assistant Prof and 1 DR2).

*1/ The unit has an attractive scientific reputation and is part of the European research area.*

*2/ The unit is attractive because for the quality of its staff support policy.*

*3/ The unit is attractive through its success in competitive calls for projects.*

*4/ The unit is attractive for the quality of its major equipment and technical skills.*

Strengths and possibilities linked to the context for the four references above



Over the last period, members of the unit have been invited to speak at ~60 conferences at the national or international level and have co-organised ~ten national and international conferences and workshops (as 'Molecular Gastronomy – meeting series 1 to 4' in 2021 in Paris, or 'Crispr and Translational Medecine Congress' in 2022 in Bordeaux). In addition, members of the unit participate to administration of research (direction of the Aviv-MNHN, direction of ITMO-Aviesan and IT Inserm Bases moléculaires et structurales du vivant, coordination of WP within the Celphedia network, direction of the Dired-MNHN), or various SAB (MNHN, ENS Lyon, Ibisa-Chair). Through the participation to the RISE Horizon exchange program, the unit is contributing to the construction of the European research area. Visitors are hosted as regular members of the unit and attributed an office space and the necessary computing they need (from Brazil, USA, Iran, but also from the Polytechnique engineering school).

Over the last period, the unit has recruited two permanent engineers (MNHN and Inserm). New staff is given a dedicated office space and computing resources and ITA staff meet on a regular basis (organisation of the lab). PHDs benefit from the same resources. Given the organisation (mixed teams), none of the PHD work in isolation. PHD students present their work on a regular basis. Every team holds a weekly lab meeting. Two international postdoctoral students were recruited, one with a Marie Curie fellowship. Finally, over the last period, the unit has recruited one MNHN professor, two assistant professors from Sorbonne Université and the MNHN and one DR2 CNRS.

All teams applied for local (MNHN ATMs, SU-Emergence calls) and national grants on a yearly basis for the financing of their research project. As a result, the unit has some positive results on European grants (1 MSCAA and two partnerships RISE H2020 and EIC pathfinder, 2022). The unit had also success applying to associative funds (AFM, FRM) and ANR. The total budget of the unit/year is around ~500–700 k€ and shows a stable amount of acquired resources.

The unit hosts an Ibisa labelled platform for genome editing (Taggene) which is part of the national infrastructure Celphedia. Supervised by two researchers (PIs of GE2R), its activity is supported by three permanent engineers and strongly associated with the GE2R team. The platform contributes to GE2R scientific research on DNA repair and is open to external collaborations. Since 2022, the unit also coordinates, in collaboration with MCAM unit at the MNHN, the MNHN photonic microscopy platform. This platform is endowed with a Zeiss LSM 880 microscope, a large field Nikon Eclipse TE 300 microscope and a motorised Zeiss binocular. Supervised by the Arche PI, in collaboration with MCAM, the platform recruited one engineer in 2021 to work with a permanent engineer (MCAM). Equipment and maintenance of the platform are supported by users billing and MNHN funds (around 30 k€/year). Another significant common equipment of the laboratory is a protein purification station (Akta pure, Cytiva), acquired in 2022 using core funding. Every heavy equipment has at least one dedicated staff member.

### Weaknesses and risks linked to the context for the four references above

Two weaknesses were identified. First, the absence of Junior PI recruitment will have an impact in short – and long-term turnover of themes and expertise. Second, the lack of coordination for European funding as ERC advanced or synergy might have a large impact on the unit visibility and young scientists' recruitment but also for the emergence of novel innovative expertise.

## EVALUATION AREA 3: SCIENTIFIC PRODUCTION

### Assessment on the scientific production of the unit

The production of original research has been excellent for the four teams of the unit with a total of 126 publications with all members publishing as authors including PHD and postdoctoral students and a total of 45 publications as the main author. The quality, integrity and open access to science are encouraged by the direction but not forced or strongly reviewed.

*1/ The scientific production of the unit meets quality criteria.*

*2/ The unit's scientific production is proportionate to its research potential and properly shared out between its personnel.*

*3/ The scientific production of the unit complies with the principles of research integrity, ethics and open science. It complies with the directives applicable in this field.*



## Strengths and possibilities linked to the context for the three references above

Over the last period, the unit has produced works of diverse nature, as highlighted in the portfolio, ranging from peer-reviewed articles, peer-reviewed books and book chapters. The repartition per team shows that the production top-recognised journals ranges from 66% to 89%, highlighting the quality of publications in scientific journals.

The unit produced a total of 126 peer reviewed publications with respectively 57 (GE2R), 33 (SANTE), 22 (Arche) and sixteen (GPA). In quantitative terms, the GE2R team has a high production and reflects the high number of collaborations using genome editing and the platform Tacgene. The unit produced 45 peer-reviewed articles, reviews or book chapters where members of the unit are corresponding (36%). In addition, 10 articles are the results of transversal works between teams. The seven PHDs and three postdoctoral students have published their works except one who was recruited as Inserm CRCN. For the rest of the senior staff, the production has been constant over the period with the exception of one assistant professor who reoriented her project and has not published yet.

The unit provides every member of the lab with lab notebooks, external hard drives for data storage as well as a dedicated storage space, which is duplicated for long-term stability. The unit does not have per se a specific procedure for internal peer review of work before submission for publication even though an internal guideline asked that every published work needs to be submitted to the direction before being sent to an editor for peer review. Regarding open science policy, members of the unit are encouraged, by internal diffusion of institutional incentives emanating from the governing bodies, to deposit all their published work in HAL and to publish in open access journals.

## Weaknesses and risks linked to the context for the three references above

No specific weakness has been identified but the impact of publication could be improved given the quality of the projects and the scientific leaderships of some team members. The risk would be that the attractiveness and visibility of the unit would decrease in a long-term.

## EVALUATION AREA 4: CONTRIBUTION OF RESEARCH ACTIVITIES TO SOCIETY

### Assessment on the inclusion of the unit's research in society

The unit has an excellent activity in terms of outreach towards non-academic partners and the general public. It benefits from the highly favourable environment of the MNHN in that regard, and also benefits from research topics that carry a strong societal impact, either for ethical considerations (genome editing, artificial intelligence) or for sustainability considerations (alimentation and epigenetics for example).

*1/ The unit stands out for the quality and the amount of its interactions with the non-academic world.*

*2/ The unit develops products for the cultural, economic and social world.*

*3/ The unit shares its knowledge with the general public and takes part in debates in society.*

### Strengths and possibilities linked to the context for the three references above

Members of the unit from all four teams have diverse nonacademic interactions, which contribute to the appeal of the laboratory. All the interactions are listed in the team's self-evaluations, but we will summarise the diversity and quality of these interactions over the last period here. The unit obtained one Cifre contract (SANOFI). It has partnered with a small food biotech company (Symbiose Kefir) for the development of fermented drinks, through a valorisation contract coordinated by the MNHN. It has also recently partnered with two biotech companies for the development of new gene editing approaches. Through these partnerships, the unit contributes to meeting technological challenges and involve economical partners implicated in applied research for the European market. Furthermore, the unit has started to develop since 2017 a research program on microbial consortia found in kefir that is largely based on interacting with non-academic partners, from private cultivators, small food biotech companies, restaurants, food schools. In parallel to developing fundamental approaches in microbial ecology on this topic, the unit was recently awarded a grant from the first participative science research program of the ANR (described more in detail in GPA's self-evaluation). The unit has not developed patents or licenses, nor created any company over the last period.

The unit is highly involved in sharing knowledge with the general public through workshops and conferences for example at the yearly Fête de la science with a very successful workshop on tardigrades at the Museum Balcon des Sciences. Members of the unit participate to numerous conferences and debates with the general audience often about genome editing and alimentation, both subjects having a high societal impact. They also regularly intervene in the national media (Le monde, Liberation, France Culture, ARTE, Futura Sciences, La recherche, The conversation...) on three main themes: genome editing (GE2R team), food/fermentation (GPA team), or computational biology (Arche team). This represents a minimum of 10 interviews/year. Members of the unit have often contributed to books for the general public, either in collective volumes (Manifeste du MNHN, La vie, la Terre les Hommes) or on more thematic works (see the several books authored by Christophe Lavelle on topics surrounding alimentation, sustainability). In terms of developing products for the cultural world, one of the team (GPA) has been involved in art & science project in collaboration with the atelier Philippe Parreno in Paris. The collaboration has been exhibited in NY, London, Mexico City, Berlin and Paris in various galleries and Museum.

### Weaknesses and risks linked to the context for the three references above

The link with the socio-economic world could be reinforced, especially with the Tacgene platform allowing appropriate budget for up-to-date maintenance and investment in novel equipment.

## ANALYSIS OF THE UNIT'S TRAJECTORY

Beside its historical topics on the functions of unusual DNA structures and the development of molecular approaches to modify the DNA sequence and control gene expression, the proposed trajectory promotes the emergence of several novel topics: DNA repair in the resistance of tardigrades to ionising radiation and extreme abiotic conditions, epigenetic control of repeated DNA, deep learning for genomics and adaptation in microbial consortia.

In the beginning of the next evaluation period (by 2025), an important focus will be to publish original research on emerging topics. In this respect, the arrival of a professor in computational biology put the unit in a good position to further develop a strong computational research program, as well as the arrival of an experienced CNRS research director with a strong interest in developing bioluminescent probes.

At the organisational level, the unit aims to continue improving the use of recurrent and grant resources towards achieving scientific goals and to strengthen the relationship with Sorbonne University as supervising body. The attractiveness will be carefully looked by targeting early career researchers who will define the future leadership of the unit.

The unit also intends to better assess its environmental impact by organising regular audits on plastic and other consumables usages, developing an environmentally conscious policy regarding missions, and by prioritising the necessary renovation.

In brief, the unit will continue its research program and will aim at consolidating its status at the national and international level in the fields of genome editing, comparative and computational genomics, telomere biochemistry and adaptation in microbial consortia.

## RECOMMENDATIONS TO THE UNIT

### Recommendations regarding the Evaluation Area 1: Profile, Resources and Organisation of the Unit

The main recommendation for the unit is to carefully validate the scientific strategic choices by an external and preferentially international SAB. In term of organisation, the students and postdoctoral students should structure better their group to benefit and initiate intradepartment and local interactions in a transversal manner.

### Recommendations regarding the Evaluation Area 2: Attractiveness

The unit should improve its overall attractiveness and visibility. Thus, the effort should be devoted to the recruitment of postdoctoral scientists and renewal of the unit expertise. One recommendation is to mentor and encourage European ERC grant applications, probably by hosting or recruiting a project manager dedicated in part for such activity.

### Recommendations regarding Evaluation Area 3: Scientific Production

The recommendation is to continue the excellent scientific activity and increase the impact of publications by targeting general journals.

### Recommendations regarding Evaluation Area 4: Contribution of Research Activities to Society

The recommendation is to pursue grand public communication and outreach activity as well as building more partnerships with the private sector.

## TEAM-BY-TEAM OR THEME ASSESSMENT

**Team 1:** Genome Editing, Repair and Cellular Responses (GE2R)

Name of the supervisor: Mrs. Carine Giovannangeli

### THEMES OF THE TEAM

The research of the team concerns DNA repair and is organised along two axes with a back-and-forth strategy. The team past work, the taskforce and the team's organisation provide substantial background and expertise that support the strength of the research plan. The first axis is aimed at developing new and innovative genome editing strategies and exploit the benefit of various DNA repair pathways to improve genome editing. The second axis explores the expertise of the team in DNA repair to investigate DNA repair mechanisms involved in tardigrade resistance to DNA damage in extreme conditions.

### CONSIDERATION OF THE RECOMMENDATIONS OF THE PREVIOUS REPORT

To the recommendation that the team perpetuates its leading position in the fields of DNA repair and genome editing at the national and international level as well as maintaining its balance between research and platform activity, the team has been excellent. This is exemplified by a strong scientific production, their capacity to obtain competitive funding, such as ANR (6), AFM (2), Horizon Rise (1) and EIC Pathfinder (1) and the significant number of collaborations achieved in the field of gene editing.

On the recommendation that they should recruit a young researcher to consolidate their research activity, they have recruited a MNHN assistant professor to reinforce the topic on tardigrade genomics.

### WORKFORCE OF THE TEAM: in physical persons at 31/12/2022

Catégories de personnel	Effectifs
Professeurs et assimilés	0
Maîtres de conférences et assimilés	2
Directeurs de recherche et assimilés	1
Chargés de recherche et assimilés	1
Personnels d'appui à la recherche	3
<b>Sous-total personnels permanents en activité</b>	<b>7</b>
Enseignants-chercheurs et chercheurs non permanents et assimilés	0
Personnels d'appui non permanents	3
Post-doctorants	0
Doctorants	2
<b>Sous-total personnels non permanents en activité</b>	<b>5</b>
<b>Total personnels</b>	<b>12</b>

### EVALUATION

#### Overall assessment of the team

Science is excellent to outstanding based on their strong level of publications (incl 2 Nat. Com, 1 Hum. Mol. Genet, 1 NAR, 1 J Cell Sci, 1 eLife). Visibility and attractiveness are excellent to outstanding enabling to secure national and international fundings (incl 1 EIC Pathfinder, 6 ANR). Team reputation in genome editing and the TACCGENE facility empowers collaborations and diversified the team activity (e.g. tardigrades), allowing the recruitment of an assistant professor. Non-academic activities are excellent to outstanding with several partnerships with private biotech companies, one patent and divers outreach actions.

## Strengths and possibilities linked to the context

The team is of high quality, effective and well organised. Their research activity and their TACCGENE platform activity appear well balanced. They show a strong ability to develop innovative and state-of-the-art genome editing approaches applied to different systems biology including animal models and by exploiting the specificities of the different repair mechanisms involved. This expertise that benefits to numerous projects seeds a high level of fruitful collaboration and contributes to the significant success of the team.

Another goal of the group is to decipher the molecular mechanisms that lead Tardigrades to resist to extreme environmental conditions focusing first on DNA repair adaptation. The group has recently published a first paper in this field that should help to secure this axis, the recent recruitment of an assistant professor that brings expertise in evolution and genomics/bioinformatics comes in support of the IR engineer involved.

The reputation of the team is excellent to outstanding. Team leaders are internationally renowned as revealed by their numerous invitations to 31 conferences, the organisation of two conferences and their scientific responsibilities.

The attractiveness of the team is also robust when considering the recruitment of three postdoctoral students in the last period, four visiting students/postdoctoral students and a professor assistant to consolidate the Tardigrade axis.

The team also shows excellent training during the previous period as exemplified by important teaching activities (lectures, organisation of courses, workshops and modules for Masters 2) and the organisation of practical courses on genome editing approaches (2 Inserm workshops, Trend courses in Africa). Mentoring is very good (5 PHD students in the last period, 4 theses defended).

Given the social interest for genome editing, both group leaders and team members are highly active in conferences, debates and connections with the media and general public to discuss the potential, limits and future challenges in this discipline (more than 10 public conferences, five radio interventions, five interviews/year by journalists). Interaction with non-academic structures is also strong (1 Cifre and RD science awards with Sanofi).

## Weaknesses and risks linked to the context

The team will have to face a loss of staff with three departures and one reorientation. While its staff composition for the next period is still strong, it can impact progression. If maintaining efficiency in both platform activities and research might become difficult, a reflection for setting realistic goals might be considered.

The team has shown an effort in attracting PHD students and postdoctoral students in the last period, they are encouraged to pursue this intention.

Understanding DNA repair adaptation in tardigrades is also done by other groups, internationally. Thus, it will be key to consider competition. Recruiting PHD students and/or postdoctoral students on this axis as well as increasing funding will help to be competitive.

## Analysis of the team's trajectory

For the next period, the team will pursue its science in genome editing with the objective to improve prime editing and get it functional in specific cell models for gene therapy applications. Using Crispr screen strategies, they aim to identify PE enhancers, and new proteins of the MMEJ repair pathway that play a prominent role in the modification of the genome. Two ANR fundings in this theme cover the first years of the next period.

The second axis still in construction benefits from the recruitment of a young professor assistant that brings expertise in evolution and bioinformatics. The objectives are diverse: (i) functional characterisation of TDR1, a new candidate involved in resistance to DNA damage, (ii) characterisation of the cellular response to DNA damage at the level of the single cell, (iii) evaluating genome evolution in asexual and sexual species and investigate asexual and sexual reproduction to understand their contribution in adaptation, (iv) exploring the potential protective role of tardigrade proteins in human cells. For now, only the objectives centred on tardigrade resistance to DNA damage are funded. This axis will need human resources (PHD postdoctoral students) to be developed efficiently.

## RECOMMENDATIONS TO THE TEAM

The team is renowned for its expertise and efficiency in genome editing. They are encouraged to pursue this science.

Their efforts on developing the research on tardigrades is significant and has been fruitful (1 article published in eLife). This will help to seed funding and recruit students and postdoctoral students to develop the different ambitious objectives of this theme and secure competitiveness. If this line of research continues to develop positively, it might be worthwhile in the medium term to think about the possibility of creating an individualised team.



More generally, scientific output is high but predominantly represented by projects from collaborators. The recruitment of PHD students and postdoctoral students will help to increase the rate of internal publications. The project/group leaders are encouraged to defend their HDR.

**Team 2:** Structure of Nucleic Acids, Telomeres and Evolution (SANTE)

Name of the supervisor: Mr. Jean-François Riou

## THEMES OF THE TEAM

The SANTE research team focuses on the study of telomere evolution and regulation. These nucleoprotein structures play an essential role in protecting the terminal regions of linear chromosomes in eukaryotes. The team studies the mechanisms by which single-stranded DNA-binding proteins, operating at telomeres, manage and interact with the various secondary DNA structures that can appear in these regions. A second research theme concerns the development of tools to control telomere regulation, such as original small ligands, AsiDNA and epigenetics.

Recently, the team has integrated a new research theme devoted to the design of new luciferase substrates as tools for improving bioluminescent signalling systems.

### CONSIDERATION OF THE RECOMMENDATIONS OF THE PREVIOUS REPORT

The team had to cope with a significant reorganisation over the period, therefore, taking into account previous recommendations was made difficult. The team experienced the departure of a young CR CNRS and no further recruitment occurred during the period.

The number of PHD students has remained constant (five in total) in relation to the new number of supervisors over this period (one/HDR globally), no postdoctoral students have been recruited. It should be noted, however, that the arrival of an experienced synthetic chemist was made possible at the end of the mandate, offering the possibility of maintaining the chemistry-biology interface that is the team's strength.

### WORKFORCE OF THE TEAM: IN PHYSICAL PERSONS AT 31/12/2022

Catégories de personnel	Effectifs
Professeurs et assimilés	3
Maîtres de conférences et assimilés	3
Directeurs de recherche et assimilés	1
Chargés de recherche et assimilés	0
Personnels d'appui à la recherche	2
<b>Sous-total personnels permanents en activité</b>	<b>9</b>
Enseignants-chercheurs et chercheurs non permanents et assimilés	1
Personnels d'appui non permanents	1
Post-doctorants	0
Doctorants	1
<b>Sous-total personnels non permanents en activité</b>	<b>3</b>
<b>Total personnels</b>	<b>12</b>

## EVALUATION

### Overall assessment of the team

The team's overall visibility is excellent, thanks to its local and national commitments (DU up to 2018, director of Aviv-MNHN, chairman of an ANR scientific committee, preparatory work for COP15). The team's attractiveness is excellent, as demonstrated by the arrival of a senior research chemist to strengthen the chemistry-biology interface in the team. The team's scientific output is excellent in terms of both publications (Blood-1-, Nucleic Acids Res. -3) and ability to obtain funding (ANR PRC-3). Non-academic activities remain excellent with outreach actions linked to the MNHN.

## Strengths and possibilities linked to the context

The team is essentially composed of Associate Professors, Professors and a CNRS researcher who bring complementary expertise at the interface of chemistry and biology. Over the period 2017–2022, the team has had to deal with staff movements linked to the departure of two people (1 CR CNRS transfer, 1 team change). This was offset by the arrival of one person (1 DR CNRS), a specialist in synthetic chemistry who brings a new focus on the development of bioluminescent probes, demonstrating the excellent team's attractiveness.

The two current thematic axes are: (i) regulation of G4 structures and their interactions with proteins; (ii) regulation of telomeres, their instability and repair. Notably, they observed that the instability of repeated DNA sequences folding into hairpins leads to evolutionary elimination of hairpin-prone telomeric motifs that are difficult for Replication protein A to unfold.

More than half of the team's members are qualified to supervise research. Four theses were defended during the period, and one student has started his thesis in 2022. The team has also benefited from several short-term contracts for IEs and has invested in the training of ten interns.

Team members were invited to eleven conferences in France and abroad (including 2 talks given by a researcher before joining the team). Team members have taken part in sixteen thesis defences and one HDR defence committees.

The team's overall involvement is excellent. The team leader headed the unit until 2018. One of the members is director of a department gathering five UMRs within MNHN, was president of an ANR scientific evaluation committee and took part in the preparatory work for COP15. Other team members are involved in teaching administration and in local bodies (ED, University boards, HDR correspondent, MCF/PR selection committee, organisation of an annual scientific day).

Scientific output is excellent as it includes 32 articles, eight books and journal chapters, taking into account staff departures and arrivals during the period, corresponding to an average of two publications per ETPR per year. Fifteen percent of publications are in reputed journals in their field of research (Blood – 1 –, Nucleic Acids Res. (3), Chemical Communications – 1). Out of 32 publications, ten are the result of internal team projects (corresponding authors) and 22 are the result of numerous collaborations (String, MNHN, national and international). Nine are first-authored by the team's Masters and PHD students.

Several team members take part in the annual 'Fête de la science'. In particular, one member leads scientific workshops for secondary school students (around 30 classes a year). Another member has published 3 books for the general public on the 'one health' concept.

Last but not least, the team has obtained one ANR grant (2021–2025, 178 k€) as coordinator and two others as partners (2016–2021, 156 k€; 2020–2024, 100 k€), as well as local contracts to initiate emerging programs (ATMs – 3 –, 8–10 k€).

## Weaknesses and risks linked to the context

The team is firmly rooted in teaching, with five (Associate) Professors and one CNRS researcher. Changes in the team's human resources have punctuated this period. Departures have been or will be only partially compensated by the arrival of new members or the return of a former one. The attractiveness of the PHD program is certain, but the number of PHD students per supervisor fluctuates. It would be important to ensure that scientific output is evenly distributed among all team members, especially as one of the most productive researchers will no longer be present in the next contract.

Interactions with the socio-economic world are not represented over this period, except through research carried out in a different unit by a researcher who recently joined the unit (4 patents filed). Results obtained by the team that are likely to be valorised could be identified by the intervention of a SATT.

Despite the departures, a large number of projects were funded over the period, and it is desirable to maintain this level of success in calls for projects to ensure the sustainability of the activities developed. In particular, the retirement of the team leader, who had been awarded several grants, could be offset by the arrival of a CNRS DR who has demonstrated his ability to obtain funding.

## Analysis of the team's trajectory

In the coming period, the team will see the departure of an internationally recognised expert in the pharmacology of G-quadruplex ligands and topoisomerases. The return to the team of a specialist in telomere biology will maintain the team's recognised expertise in this field. In regard to the chemistry of DNA ligands, the team will see the definitive departure of a volunteer researcher, accentuating the loss of skills in this field already observed with the departure of a young CR CNRS during the previous period. The arrival of a DR CNRS chemist will increase the team's level of expertise in synthetic chemistry, even if the skills brought in are not specialised in DNA ligands. As a result, the two current thematic axes: (i) regulation of G4 structures and their interactions with proteins; (ii) regulation of telomeres, their instability and repair will not be continued in the same way.

The team will therefore pursue its research project on telomere evolution with the study of single-stranded DNA-binding proteins, such as RPA and POT1-TPP1, and their coevolution with DNA secondary structures originating from telomeric DNA, in particular G-quadruplexes. The second axis will be refocused on the study of variant proteins in telomere dysfunction using mutated RPA complexes and the  $\Delta$  133p53 isoform of the p53 tumour suppressor. A new research theme devoted to the design of new luciferase substrates as tools for improving bioluminescent signalling systems is brought to the team with the recent arrival of an experienced organic chemist. Projects are currently funded by two ANR and one ATM (MNHN) projects. The team's strengths in biology are supported by six permanent members, whereas chemistry is supported by only two permanent members. The potential arrival of a professor with expertise in biophysics would reinforce the team's biology skills.

## RECOMMENDATIONS TO THE TEAM

Scientific output remains high, but is mainly (two thirds) from projects led by collaborators. Team member output per FTE is average, and could be increased by recruiting more PHD students. Increased external communications should raise the profile of the team's activities. This could lead to the attraction of M2 or postdoctoral student candidates (via personal funding: Marie Curie grants, etc.).

With the reduction in the number of permanent members and the arrival of a new research axis within the team, it is important that the new team leaders ensure the coherence and synergy of the group..

Interaction with the socio-economic world could be ensured by a researcher who has recently joined the unit. The results obtained by this researcher should be presented to a local valorisation organisation.

**Team 3:** Repeated DNA, Chromatin and Evolution (Arche)

Name of the supervisor: Mr. Christophe Escudé et Mr. Julien Mozziconacci

## THEMES OF THE TEAM

Understanding the impact of repetitive sequences on evolution by dissecting their interplay with genome folding, epigenetic marks, gene expression, and cell differentiation. The project combines biocomputational (analysis, prediction, machine learning) and multidisciplinary experimental (including genomics, imaging) approaches and uses non-model organisms to study evolutionary mechanisms.

### CONSIDERATION OF THE RECOMMENDATIONS OF THE PREVIOUS REPORT

The previous evaluation of the team pointed out that productivity was uneven in relation to critical mass (5CR, 1PI, 1MCU), that thematic diversity necessitated a refocusing of project objectives, and that there were difficulties in obtaining funding, which could be overcome by the publication of work in progress and more targeted projects. Overall, these issues have been successfully addressed, as evidenced by the reorganisation of the team (change of director) with a project focused on centromeres developed by a restricted permanent staff (6 now including 1 P1, 1MCU, 2CR versus 9 in the previous mandate), by obtaining funding until 2025, and by the publication of several articles by the team and in collaboration.

### WORKFORCE OF THE TEAM: IN PHYSICAL PERSONS AT 31/12/2022

Catégories de personnel	Effectifs
Professeurs et assimilés	1
Maîtres de conférences et assimilés	1
Directeurs de recherche et assimilés	0
Chargés de recherche et assimilés	2
Personnels d'appui à la recherche	2
<b>Sous-total personnels permanents en activité</b>	<b>6</b>
Enseignants-chercheurs et chercheurs non permanents et assimilés	0
Personnels d'appui non permanents	0
Post-doctorants	0
Doctorants	3
<b>Sous-total personnels non permanents en activité</b>	<b>3</b>
<b>Total personnels</b>	<b>9</b>

## EVALUATION

### Overall assessment of the team

The scientific output is excellent (22 published, 5 in progress, 1 review; including Genome Research), achieved through multidisciplinary and focused projects, the use of non-model organisms (cercopithecini). Excellent visibility based on the implication in consortiums (e.g. EU), memberships (including IUF), local/national, international (Univ. of Edinburg) collaborations valued by prestigious grants (ANR, IUF), and invitation to international meeting (as 3D Genomics). Excellent interaction with the public (as 'fête de la science' and interview 'France Culture').

### Strengths and possibilities linked to the context

The team's productivity during the period was excellent (of 21 articles, 15 were signed by the team members – PHD, researchers – in first/last/corresponding position, and of the five deposited in bioRxiv, three were in leading

positions). This is the result of a strategy in which one central theme (focused on centromeres) is addressed from four different and complementary angles (evolution, epigenetics, visualisation, annotation) with multiple approaches (combining experimental and computational) ranging from chromatin studies, 3D fluorescence microscopy visualisation, to deep learning annotation) and leveraging in-house platform and collaborations, locally (team GPA), national (Institutes Pasteur and Langevin) and international (University of Edinburgh). It is worth noting that the team's project includes non-model organisms for which they have access to biological material, making their research even more original and helping to advance knowledge of the evolutionary history of primates. A strength of the team, in line with current research directions, is their expertise in artificial intelligence leveraged by several publications including peer reviewed articles (e.g. Genome Research) and science outreach (e.g. interview for France Culture). This expertise exploit sequencing data from model species to associate biological functions with sequences (motifs) and then transfer these data to non-model species (under investigation at the MNHN), predict the effects of mutations and design sequences with specific/controlled functions.

One can note excellent team dynamics in terms of i) training including teaching (co-responsibility of modules, occasional teaching at the M2/PHD level), ii) PHD student supervision (3 past with first author publications, 3 ongoing) and participation to PHD committees (15), iii) organisation of courses (1 Curie, one international), scientific responsibilities (Analysis Hub at MNHN, consortium Genome Project-write – GP-write), iv) qualifications to direct research (HDR), interaction with the public (conferences and workshop organisation at the 'Fête de la science', interview France Culture, articles for web journals on IA). The team displays an excellent attractiveness based on participation in collaborations supported by prestigious grants (ANR), the scientific responsibility mentioned above, membership of the Institut Universitaire de France, invitations (2, international school and symposium). The 4 team's researchers have secured funding (around 500K) for the period up to 2025 from local funds and prestigious national bodies (ANR as a partner).

## Weaknesses and risks linked to the context

Weaknesses relate to visibility and attractiveness, the ability to attract postdoctoral students (absent from the current organisation chart), fundraising in relation to team size, methodologies and the program's scope as an IP. It appears that the team has gone through a complicated three-year period, yet the team's strengths show that they are in an excellent dynamic, which will enable them to leverage their recently published and ongoing works, indicating no major risks for the next mandate.

## Analysis of the team's trajectory

The project for the next term is a continuation of past/ongoing research on DNA repeats and their role in genome regulation and evolution. It will build on the results, analyses and technologies developed and currently being analysed, new avenues are also opening up. These include the study (identification, analysis) of new repeats (transposable elements and retrotransposons), the exploitation of long read sequencing data, new questions concerning the mechanisms underlying the appearance of multicellular organisms within eukaryotes, new models (primates, fungi, mouse embryonic stem), new tools for studying the recruitment of chromatin-modifying markers, mechanisms underlying the appearance of multicellular organisms within eukaryotes, new models (mouse embryonic stem), new tools for studying the recruitment of chromatin-modifying markers to specific loci in the genome (optogenetic tools), new approaches for the deep learning.

## RECOMMENDATIONS TO THE TEAM

The team has already achieved a dynamic upward trajectory, but to reach the next level it could increase its visibility, for example by participating more actively in international meetings, which would help it to establish collaborations and attract postdoctoral students. The involvement of all scientists will be important in creating a strong team dynamic that will enable them to raise their visibility locally, nationally and internationally. A special effort must be made to secure funding to keep this project feasible. Orienting projects towards more mechanistic analyses could help guarantee outstanding scientific output.

**Team 4:** Genomics and Physiology of Adaptation (GPA)

Name of the supervisor: Mr. Jean-Baptiste Boulé

## THEMES OF THE TEAM

The aims of Team GPA are to contribute to the knowledge on how organisms adapt at the genetic, epigenetic, and metabolic levels in response to environmental constraints using a multidisciplinary approach. The research is centred around three primary experimental systems: budding yeast (investigating metabolic adaptation, molecular memory, genome evolution during prolonged experimental adaptation), water kefir microbial consortia (examining the evolution and adaptation of symbiotic microbial consortia to culture conditions, exploring the potential health benefits), tardigrades (studying cellular and nuclear reorganisations in tardigrades after dehydration and exposure to cold atmospheric plasma, to provide insights into the mechanisms of adaptation in hostile conditions).

## CONSIDERATION OF THE RECOMMENDATIONS OF THE PREVIOUS REPORT

During the previous mandate, this team was identified as new, and one of the weaknesses identified was the risk of thematic dispersion. During the present term, efforts have been made to enhance thematic cohesion. Another recommendation was to foster cross-team projects: the project regarding the role of dna repair in resistance of tardigrades to ionising radiations is conducted by a gpa team researcher together with the ge2r team. One HDR (accreditation as PhD supervisor) defence in 2019 reinforced the PhD thesis supervision capacity of the GPA team (2 PhD students end of 2022), as suggested in the previous Hcéres committee's report.

## WORKFORCE OF THE TEAM: in physical persons at 31/12/2022

Catégories de personnel	Effectifs
Professeurs et assimilés	0
Maîtres de conférences et assimilés	1
Directeurs de recherche et assimilés	1
Chargés de recherche et assimilés	2
Personnels d'appui à la recherche	1
<b>Sous-total personnels permanents en activité</b>	<b>5</b>
Enseignants-chercheurs et chercheurs non permanents et assimilés	0
Personnels d'appui non permanents	1
Post-doctorants	0
Doctorants	2
<b>Sous-total personnels non permanents en activité</b>	<b>3</b>
<b>Total personnels</b>	<b>8</b>

## EVALUATION

### Overall assessment of the team

The scientific output is excellent with the publication of eleven articles (including 3 NAR, 1 J Am Ch Soc) and the coordination of successful funded research proposals (2 projects supported by ANR, 1 MSCA grant). The leading role of the GPA team is clear with internal and external collaborations. The team's attractiveness is excellent (the arrival of an assistant professor and a research engineer). Contribution of research activities to society is excellent to outstanding. The team is regularly engaged in outreach activities and interactions with the non-academic world (start-up company, art & science, the web platform, exhibitions).



## Strengths and possibilities linked to the context

One Assistant Professor joined the team in September 2021. Her skills, in food science and technology, will be useful for the project related to fruit kefir microbial diversity. The unit was successful at obtaining a CNRS mobility for a research engineer in signal analysis and instrumentation, this person integrated the GPA team in July 2023. One postdoctoral and four PHD students were hosted during the period (two Ph D are still ongoing). To date, four original research articles as first author are issued from their work.

GPA team funding over the period is remarkable (700 k€ of cumulated funding) with namely three ANR-funded projects (from which 2 as coordinator). It is noteworthy that one of the two ANR-funded projects coordinates involves a participatory science approach. Moreover, a MSCA (Marie Skłodowska Curie Action) was funded by EU and supported for two years one postdoctoral fellow. The main other funding bodies are MNHN and Alliance Sorbonne Université.

ANR KefirSpace project coordinated by the team involves a small food biotech company (Symbiose Kefir) and a valorisation contract for the development of fermented drinks coordinated by the MNHN has been undersigned with this company. Fundings from foundations were also obtained (Fondation Pinault), 30 k€ from Fondation de France.

Eleven original research articles and eight reviews and book chapters were co-authored by GPA team. Six out of eleven original research articles are issued from internal collaboration with researchers from other teams of the StrinG Unit, one is internal to the team and eight have external co-authors. Seven out of eleven original research articles have a first or last author position by GPA team members. Two researchers participated in fourteen national and international seminars. The leading role of GPA's team is thus clear and the internal and external collaboration policy of the team is well reflected by the number of co-authored publications.

Contribution of Research Activities to Society are one of the goals of MNHN activities (e; g; one researcher is the main contributor of the web platform 'L'alimentation en questions' and the main commissioner of the exhibition 'Je mange, donc je suis' – Musée de l'Homme, 2019-2020 – . Non-academic interactions are frequent for at least one researcher namely regarding food and fermentation. In terms of developing products for the cultural world, GPA team has been involved in art & science project in collaboration with the atelier Philippe Parreno in Paris. The collaborative Exposition Anywhen has been exhibited in New York, London, Mexico City, Berlin and Paris in various galleries and museums. GPA team is also actively involved in 'Fête de la Science' each year.

## Weaknesses and risks linked to the context

With five permanent and two non-permanent staff, GPA team could hire more non-permanent staff. With only one out of five permanent staff dedicated to research support, this might be a limit for further development of GPA team's projects. Non-permanent – CDD – technicians or engineers are frequently recruited along funded projects to compensate. Nevertheless, this does not allow the same continuity of research efforts.

## Analysis of the team's trajectory

GPA team 2017–2029 project is illustrated by three themes of research projects related to the general theme of biological adaptation. Two of these projects are related to microorganisms: – i – the first project investigates the microbial community of fruit kefir grains requiring microbial ecology approaches, while the second one – ii – is focused on yeast or bacteria-yeast consortium adaptation. The third one – iii – is related to the adaptation of Tardigrades to desiccation and cold plasma radiations at the cellular and chromatin levels. All these projects require instrumented bioreactors. Tardigrades are known for their capacity to survive under extreme conditions and are thus a model for exploring the limits of multicellular life.

## RECOMMENDATIONS TO THE TEAM

One recommendation is to maintain a focus on its expertise. For instance, the effects of kefir on the health/physiological parameters of consumers could be studied in collaboration with clinicians, and the sequential and phylogenetic study of kefir would be carried out in close collaboration with Micalis – Inrae unit – . It is advised to delineate the complementary skills necessary to strengthen the proposed trajectory and to identify strategic partnerships for consolidation/initiation in the upcoming years. There is potential to welcome more early-career researchers, as demonstrated by a previous postdoctoral fellowship. Encouraging the GPA team's continuous efforts to regularly respond to calls, such as MSCA calls, is essential for recruiting early-career researchers in the coming years. The strategic identification of foreign research units interested in acquiring the GPA team's skills can serve as a pathway to secure grants/subsidies supporting bilateral scientific cooperation between France and various countries.



## CONDUCT OF THE INTERVIEWS

### DATE

**Start:** 11 décembre 2023 à 8 h

**End:** 11 décembre 2023 à 19 h

**Interview conducted: on-site or online**

### INTERVIEW SCHEDULE

<b>8 h 15 – 8 h 20</b>	<b>Déroulé de la visite Hcéres</b>
<b>8 h 20 – 8 h 30</b>	<b>Présentation des membres du comité.</b> Antonin Morillon
<b>8 h 35 – 9 h 45</b>	<b>Présentation des activités de l'unité, bilan et trajectoire.</b> Jean-Baptiste Boulé
<b>9 h 45 – 10 h</b>	<b>Pause</b>
	<i>Audition des équipes [comité + membres de l'équipe + direction + tutelles]</i>
	<i>12 min présentation + 12 min discussion + 5 min PI</i>
<b>10 h – 10 h 30</b>	<b>Edition du Génome, Réparation des cassures double-brin de l'ADN et Réponses cellulaires [GE2R]</b>
	Carine Giovannangeli/Jean-Paul Concordet
<b>10 h 30 – 11 h</b>	<b>Structure des Acides Nucléiques, Télomères et Evolution [SANTE]</b>
Carole Saintomé/Patrizia Alberti	
<b>11 h – 11 h 30</b>	<b>ADN répété, Chromatine et Evolution [Arche]</b>
Julien Mozziconacci	
<b>11 h 30 – 12 h</b>	<b>Génomique et Physiologie de l'Adaptation [GPA]</b>
	Jean-Baptiste Boulé
<b>12 h – 12 h 15</b>	<b>Pause</b>
<b>12 h 15 – 13 h</b>	<b>Discussion interne comité [comité]</b>
<b>13 h – 13 h 30</b>	<b>Déjeuner</b>
	<i>Audition des catégories de personnes [comité + personnel]</i>
<b>13 h 30 – 14 h</b>	<b>Réunion avec personnel ITA</b>
<b>14 h 5 – 14 h 35</b>	<b>Réunion chercheurs et enseignants-chercheurs</b>
<b>14 h 40 – 15 h 10</b>	<b>Réunion avec étudiants et post-docs</b>
<b>15 h 10 – 15 h 30</b>	<b>Pause</b>
<b>15 h 30 – 16 h</b>	<b>Réunion avec les représentants des tutelles [comité + tutelles]</b>
<b>16 h – 16 h 30</b>	<b>Discussion interne comité [comité]</b>
<b>16 h 30 – 17 h 15</b>	<b>Réunion avec la direction de l'Unité [comité + DU]</b>
<b>17 h 15 – 19 h</b>	<b>Rédaction du rapport final [comité]</b>
<b>19 h</b>	<b>Fin de la visite</b>

### PARTICULAR POINT TO BE MENTIONED

N/A

# GENERAL OBSERVATIONS OF THE SUPERVISORS



## MUSÉUM NATIONAL D'HISTOIRE NATURELLE

### Direction de la Recherche

Direction Générale Déléguée à la Recherche, l'Expertise, la Valorisation et l'Enseignement-formation  
(DGD REVE)

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Tél. : 33 1 40 79 31 83 - E-mail : cecile.bernard@mnhn.fr

**UNITE** : StrInG - Structure et instabilité des génomes

#### **SOUS TUTELLE DES ÉTABLISSEMENTS ET ORGANISMES :**

MNHN - Muséum national d'histoire naturelle

CNRS - Centre national de la recherche scientifique

Inserm - Institut national de la santé et de la recherche médicale

#### **Réponse générale de la tutelle Muséum au rapport d'évaluation :**

D2025-EV-0753494R-DER-ER-DER-PUR250024316-SVE3-STRING-RT

Le Muséum national d'Histoire naturelle tient à remercier le comité d'évaluation HCERES de l'UMR7196 MNHN-CNRS et l'U1154 INSERM « Structure et instabilité des Génomes » (StrInG) pour l'évaluation approfondie réalisée, la qualité du rapport très complet qui a été produit et les remarques constructives formulées, notamment sur la future trajectoire proposée par l'Unité et ses équipes. Cette évaluation externe par ces experts sera très utile aux tutelles pour l'accompagnement de l'Unité et de ses équipes constitutives pour le prochain contrat 2025-2029 afin de renforcer ses compétences qui sont uniques au Muséum dans le domaine de la génomique, reposant sur des modèles non conventionnels, et dans un contexte de rapide évolution des technologies et des concepts. Les orientations choisies contribuent de façon originale à nourrir le lien entre environnement et évolution et ouvrent des portes sur les applications médicales tout en maintenant une expertise sur les aspects fondamentaux liés à la stabilité des génomes en réponse aux perturbations.

Le Muséum prend bonne note des recommandations qui sont faites à l'unité et à ses équipes. A ce titre, il veillera à la mise en place, comme suggéré, d'un Scientific Advisory Board, qui contribuera à hiérarchiser les priorités scientifiques.

C. Bernard

Directrice de la Recherche, DGD-REVE

The Hcéres' evaluation reports are available online:  
[www.hceres.fr](http://www.hceres.fr)

**Evaluation of Universities and Schools**  
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