Evaluation of Research

EVALUATION REPORT ON THE UNIT:

RDP - Reproduction et Développement des Plantes

UNDER THE SUPERVISION OF INSTITUTIONS ANS RESEARCH BODIES:

École normale supérieure de Lyon - ENS Lyon

Centre national de la recherche scientifique - CNRS

Institut national de recherche pour l'agriculture, l'alimentation et l'environnement - INRAE

Université Claude Bernard Lyon 1 - UCBL

Institut national de recherche en sciences et technologies du numérique - Inria

EVALUATION CAMPAIGN 2025-2026
GROUP A

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High Council for the evaluation of research and higher education

On behalf of the committee of experts:

Cristina Ferrandiz, Chairperson of the committee

For Hcéres:

Coralie Chevallier, President

In accordance with articles R. 114-15 and R. 114-10 8° of the Research Code, evaluation reports drawn up by the committees of experts are signed by the chairpersons of these committees and countersigned by the president of Hcéres.

To facilitate the reading of the document, the terms used in this report to designate functions, occupations or responsibilities (expert, researcher, teacher researcher, professor, lecturer, engineer, technician, director, doctoral student, etc.) are generic and gender neutral.

This report is the outcome of an evaluation by a committee of experts the composition of which is specified below. The assessments it contains are an expression of the independent and collegial deliberation of the committee. The data within it are the certified accurate data extracted from the application forms submitted by the supervising bodies on behalf of the unit.

This version of the report is public under Article R. 114-23 of the Research Code. Sections of the report considered confidential, and responses to points of attention from supervisors are not included in it.

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UNIT CHARACTERISATION

- Name: Reproduction et Développement des Plantes
- Acronym: RDP
- Label and number: UMR 5667
- Number of teams: 8
- Composition of the executive team: Ms Gwyneth Ingram (director), Mr Yvon Jaillais (deputy director) and Mr Mohammed Bendahmane (deputy director) (who replaced Mr Olivier Hamant as deputy director 01/01/2025).

SCIENTIFIC PANELS OF THE UNIT

SVE Sciences du vivant et environnement
SVE2 Productions végétales et animales (agronomie), biologie végétale et animale, biotechnologie et ingénierie des biosystèmes

THEMES OF THE UNIT

The RDP is a medium size unit focused on plant developmental biology topics. While initially the main focus was reproductive biology and fertilization of flowering plants, which remains strong in the unit, the topics have evolved towards more general questions and the development of a highly integrative approach aligned with modern trends in the field, and not restricted to angiosperm reproductive structures.

Currently, the RDP is composed of 8 research teams, whose main themes are as follows:

T1- EpiCDev: Epigenetics, Chromatin and Development: focuses on understanding how epigenetic regulation impacts cell identity and function in plants, specifically investigating the interactions between transcription factors and chromatin organization in response to various cues, with a focus on Polycomb-mediated regulation and DNA methylation in plant development and fertility.

T2- EvoDevoFlower: Evolution and Development of the Flower: aims to enhance understanding of the molecular mechanisms of floral development, diversity, and evolution by analyzing and comparing gene regulatory networks across key species like *Amborella trichopoda* and *Petunia*, using detailed transcriptomic and bioinformatic methods to explore the conservation and divergence of these networks.

T3- MechanoDevo: Mechanotransduction in Development: investigates plant development from a biomechanical perspective, focusing on how organ shapes form through interactions between mechanical, biochemical, geometric, and genetic factors, with key research areas including cell edges, microtubules, and developmental robustness.

T4- MorphoFlo: Floral Morphogenesis: researches the coordination of cell proliferation and growth in *Arabidopsis*, gene regulatory networks for floral morphogenesis and scent production in roses, and the impact of high temperatures on these processes, with a new research axis exploring tissue communication in another development.

T5- MOSAIC: Morphogenesis Simulation and Analysis in Silico: seeks to uncover self-organizing principles of organismal development by creating mathematical, biophysical, and computational models, focusing on data-driven models for plant morphogenesis, developing innovative methodologies inspired by biological processes, and designing open-source tools for quantitative biology that aim to be widely used by the scientific community.

T6- SeedDev: Seed Development: analyses molecular mechanisms coordinating development and function during plant sexual reproduction, focusing on peptide-mediated signaling mostly in embryo-endosperm communication, mechanical signals in seed morphogenesis, and studies on Haploid Induction, using both *Arabidopsis* and maize.

T7- SiCE: Cell Signaling and Endomembranes: explores fundamental mechanisms of plant cell subcellular structures and dynamics, focusing on biological membranes (membrane composition regulation, the cell wall-membrane-cytoskeleton continuum) and how they connect subcellular processes with broader aspects of plant growth and reproduction.

T8- SIGNAL: Hormone Signaling and Development: investigates how plant hormones coordinate cell behavior during shoot architecture emergence, using interdisciplinary approaches with both seed plants and mosses to study organogenesis and shoot architecture robustness.

In addition to the research teams, the unit has 7 common support structures, some with dedicated staff (administration, plant culture, logistics, bioinformatics) and some with staff embedded in teams (microscopy, histology, in vitro culture/transgenesis).

HISTORIC AND GEOGRAPHICAL LOCATION OF THE UNIT

The laboratory of Reproduction and Development of Plants (RDP) was directed by Teva Vernoux until December 2020 and has been directed by Gwyneth Ingram since 2021 and is a UMR with around 140 personnel belonging to 5 different governing bodies: Ecole Normale Supérieure de Lyon (ENS de Lyon), CNRS, INRAE, and is also affiliated to the Claude Bernard Lyon 1 University (UCBL) and the National Institute for Research in Digital Science and Technology (Inria). The RDP has historically focused its research on reproductive biology and fertilisation (Seed development, floral biology and reproduction) although in the last ten years, the UMR themes have expanded towards more general developmental biology topics (epigenetic regulation of development, hormone signalling, shoot development, phyllotaxis). Indeed, the Unit developed a strong expertise in biophysics, cell biology, live imaging and mathematical modelling that makes them a worldwide recognized institution in quantitative biology of plant systems and mechanistic dissection of developmental processes. Indeed, they have developed very strong interdisciplinary research at the math-biology interface even after the departure of a major biophysics team in 2021. The Unit managed then to associate with INRIA and obtained also a professor position hosted in the MOSAIC team led by C. Godin. The MOSAIC team integrated well with several teams to maintain this high level of interdisciplinary research.

The RDP is hosted on the Monod Campus in Gerland (Lyon) and is one of the four laboratories dedicated to biological research. At the physical level, the laboratory is spread over 4 buildings including the historical "heart" of the laboratory in the M5 building, which also includes growth facilities and imagery facilities (principally ERC-funded). In 2017 the RDP expanded to the ground floor of the M3 building, which includes the logistics team and shared spaces for equipment. In 2018, the lab acquired office space on the 2nd floor of the GN1 building, hosting mainly the MOSAIC team, and lab members from at least 4 other teams, in mixed office spaces. Finally, a new building, M8, was acquired in 2021, which contained more important greenhouse facilities. This building is shared with the Geological Department and includes growth chambers and greenhouse personnel. Labs and office spaces are spread across the 4 buildings and allow strong interactions inside the campus that may help to support interdisciplinarity in RDP research projects. Despite this scattering of teams in different buildings, the level of interactions internally remains very significant, as reflected by many common publications and grants.

UNIT RESEARCH ENVIRONMENT

The RDP is one of the 4 biology laboratories (including the LBMC, IGFL and CIRI) of the ENS. This environment allows fruitful collaborations that are further supported by local initiatives such as the monthly "Molecular evolution" meetings or the one day "bioSymposium" meeting. The RDP is involved in the "Biology coordination structure" established locally to coordinate the activities of the 4 ENS Biology laboratories. This includes the purchase and management of equipment and services (Computer systems, Glassware washing, Biology stores, Autoclave) shared between at least 2 of these 4 laboratories, and the establishment of common strategies for equipment and staff requests to Lyon ENS. The RDP has also ongoing interactions with laboratories of UCBL and INSA and active collaborations with them (1 ANR, 2 private) that were recently funded, demonstrating the local anchoring of the laboratory. The RDP has also developed solid interactions with local scientific structures including the SFR Biosiences, the Platim facility and the "Centre technologique des microstructures" (CT-Mu). Members of the RDP are part of the direction committee of the SFR, and other members of the unit are involved in the governance of the Platim platform, as well as in local (Lymic) and national (France Bioimaging) imaging groups. The RDP has demonstrated its involvement in local (Phytobiome project) and national initiatives. At the national level, the AMAIZING and GENIUS PIAs are two examples of the leadership of the RDP unit in harnessing the genetic diversity in crops and their response to environmental constraints by bringing together public laboratories with cutting edge expertise and private companies. The RDP is also leader in the PEPR SVA (Selection végétale avancée), and in gene editing technologies in maize and rose. The RDP is one of the 4 core laboratories of the national spatial transcriptomic facility (EquipEx+ Spatial-cell-ID) coordinated by ENS Lyon and has been involved in the scientific coordination of the project during the past years.

In addition, the RDP has built strong interactions between its research and teaching and training activities. Members of the laboratories teach 3000 hours per year, covering diverse field such as genetics, developmental biology, evolution, mathematical biology among others. Staff of RDP are also involved in the coordination of master and bachelor programs at ENS, and in governing bodies at ENS Lyon (Vice president of research). At the international level, members of the unit have developed interactions with various HEI in Europe, Asia and North America. Teaching activities are strategic to RDP and have allowed them to attract talented students.

UNIT WORKFORCE: IN PHYSICAL PEOPLE AS OF 31/12/2024

Catégories de personnel	Effectifs
Professeurs et assimilés	2
Maitres de conférences et assimilés	5
Directeurs de recherche et assimilés	10
Chargés de recherche et assimilés	11
Personnels d'appui à la recherche	35
Sous-total personnels permanents en activité	**63**
Enseignants-chercheurs et chercheurs non permanents et assimilés	4
Personnels non permanents d'appui à la recherche	9
Post-doctorants	18
Doctorants	26
Sous-total personnels non permanents en activité	**56**
Total personnels	**120**

BREAKDOWN OF THE UNIT'S PERMANENT STAFF BY EMPLOYER: IN PHYSICAL PEOPLE AS OF 31/12/2024. NON-SUPERVISING EMPLOYERS ARE GROUPED ON THE HEADING "OTHERS".

Nom de l'employeur	EC	C	PAR
ENS Lyon	4	0	5
CNRS	0	11	14
INRAE	0	7	14
UCBL	3	0	1
INRIA	0	3	0
Autres	0	0	0
Total personnels	**7**	**21**	**35**

GLOBAL ASSESSMENT

The RDP Lab is a unit conducting disruptive and innovative research in plant developmental biology with a strong fundamental-science orientation. The lab is organized into eight teams, each with different lines of research and methodological expertise that are highly complementary in their approach. This provides a strong collaborative environment and a multidisciplinary character that has boosted RDP's performance and impact to the highest levels. The scientific objectives of the unit have evolved from an original interest in understanding the fundamental mechanisms of plant reproduction to broader questions of plant development, while remaining focused on generating highly integrative knowledge of the cellular and molecular processes that shape plant form, using biophysics, genetics, cell biology, and modeling. These objectives are outstanding and provide the unit with a strong identity on the international stage.

As a result of this coherent and multidisciplinary research, RDP has performed at an outstanding level in terms of research outputs (highly significant and groundbreaking publications, PhD theses, international collaborations). These outputs are not concentrated in a small number of PIs; despite some variation in performance, all teams and researchers at different career stages contribute significantly to this end. Likewise, the unit has secured an impressive number of grants and contracts at both national and international levels, including five highly competitive ERC grants and a large number of ANR grants. RDP operates under a shared-resources model that has worked extremely well to maintain a balanced level of activity across teams, but it requires a strong commitment to work collectively toward common objectives.

RDP is particularly well equipped, especially with respect to imaging infrastructure and other equipment required for cell biology and biophysical studies. The opening of the new greenhouses and the collective effort of the unit to implement best operational practices are major improvements in this reporting period and should have a substantial impact on facilitating future research. Only the bioinformatics platform and associated support staff appear insufficient for the unit's activities and need to be reinforced to keep up with increasing needs in this area.

RDP has made an outstanding effort to reorganize administrative support structures and to promote the well-being of support staff. There is also a strong level of researcher involvement in the management of the unit and the organizations that support RDP (CNRS, INRAE, ENS Lyon, etc.) at several levels. All this promotes the collaborative environment characteristic of the unit.

RDP has also made an outstanding effort to implement practices that promote sustainability and social awareness. These initiatives have made a quantifiable impact on the unit's ecological footprint and its contributions to society and should be maintained, but it is important to balance the efforts and commitments of researchers so that scientific outputs are not affected by their strong commitments in societal and dissemination activities.

DETAILS OF THE EVALUATION OF THE UNIT

A - CONSIDERATION OF THE RECOMMENDATIONS IN THE PREVIOUS REPORT

The unit has globally implemented the recommendations of the previous evaluation. It was encouraged to pursue its scientific trajectory by producing high-quality research and publishing in the very best available journals. This objective has been met. During the contract period, the unit published several articles in leading international journals, including two in *Nature* and five in *Science*, as well as multiple papers in *Nature Plants*, *Nature Communications*, and *PNAS*. In addition, five ERC grants were obtained (including one starting in 2025), reflecting the excellence and attractiveness of the unit's research strategy.

The number of HDR-qualified staff increased by three over the period. However, the arrival of nine new HDRs was partially offset by the departure of six, limiting the net structural reinforcement. Interactions with non-academic partners have been strengthened through four Cifre PhD contracts and seven collaborative projects. The unit nonetheless indicates that applied research remains secondary in its strategy, which continues to prioritize fundamental research. Following the departure of the professor leading the biophysics team, a new professorship was secured, allowing the maintenance of expertise in this field.

Concerning governance and support functions, the administrative team has been fully renewed and stabilized. This has enabled effective management of financial and human resources across the different governing bodies. The administrative staff plays a central role in the functioning of the unit and in the interface between project coordinators and the direction. Bioinformatics and big data management were identified as strategic priorities. Progress has been achieved through the recruitment of an engineer and the structuring of a bioinformatics hub, supported by an advisory board and coordinated by a CNRS researcher. The activity is centered on data management following FAIR principles; however, the lack of permanent staff remains a limiting factor and constitutes an ongoing priority. Greenhouse facilities, previously identified as a critical issue, have now been secured. Measures have been implemented to reduce operational costs and environmental impact, including seasonal regulation of usage and the deployment of energy-efficient systems. The PLATIM imaging and biophysics facility operates as a shared platform with unit members involved in its governance, ensuring alignment with the scientific needs of the RDP.

At the scientific level, five main model systems are maintained in the unit, with no introduction of additional core models. However, a number of supplementary "as-needed" models are used. This diversity may still present a risk of dispersion of research activities, although the unit justifies this approach by its relevance for evolutionary and translational research questions. The unit sustains a high level of international collaboration, particularly with Europe, North America, Japan, and China, including the establishment of a LIA in China (LIA Hortilab) and an IRL with SLCU, Cambridge (UK). Additional partnerships are developing with India through a Franco-Indian initiative in life sciences coordinated by ENS Lyon, in which the RDP participates. Collaborations with the University of Singapore further illustrate the breadth of the unit's international network.

Regarding the Anthropocene, the unit identifies this theme as important but not central to its scientific strategy. Nonetheless, a long-standing engagement in this area exists within the laboratory, as reflected by the involvement of several researchers. Research on the Anthropocene is conducted in connection with the Michel Serres Institute, which brings together approximately 50 members but operates without dedicated administrative support or budget. Several publications and books on this topic were produced during the evaluation period.

B - EVALUATION AREAS

EVALUATION AREA 1: THE UNIT'S SCIENTIFIC OBJECTIVES, ORGANIZATION AND RESOURCES

Assessment of the unit's scientific objectives, organization and resources

The scientific objectives of the unit are excellent and exceptionally well integrated into a quite focused, common, and multidisciplinary line of research, that mostly has a fundamental science component. All teams contribute significant activity to these common goals in a fairly balanced manner. The different teams cover complementary expertise and approaches to plant developmental biology, allowing a highly integrated and interactive research environment that maximizes outputs.
The unit benefits from an internal policy that pools resources and infrastructure (both funding and equipment), which can be regarded as outstanding. While the organization seems complex, it supports the collaborative environment and the integration of scientific objectives across the Unit.

1/ The unit has set itself relevant scientific objectives and is organized accordingly.

2/ The unit has resources adapted to its scientific objectives, profile of activities and research environment and mobilizes them.

3/ The unit has premises, equipment and technical skills adapted to its scientific policy and research objects.

4/ The unit's practices comply with the rules and guidelines set by its supervisory bodies in terms of human resources management, safety, environment and data protection as well as scientific assets.

Context-related strengths and opportunities for the four references above

The unit has an impressively coherent approach to research, with a strong focus on fundamental mechanisms underlying plant development. This common scientific objective, which is developed at the frontier of current plant biology at a multidimensional scale, is supported and at the same time promotes the highly collaborative functioning of the unit, and directs the scientific strategy in terms of recruitment, equipment, etc. Currently, the eight scientific teams composing the unit have strong complementarity and collectively provide an outstanding multidisciplinary environment, and at the same time highly integrated research, that has placed RDP in a forefront position in plant biology internationally.

The unit has been able to adapt their complex structure to a highly cooperative operational functioning, where resources are pooled, support structures are common, and the five stakeholders (CNRS, INRAE, ENS Lyon, UCBL and INRIA) complement each other and back up the lab effectively. It is remarkable how all teams include members of at least two of the five stakeholders, and also how it is encouraged for RDP members to be implicated in management and other common activities of the Unit. This organization is not easy to build and to maintain, but it is clear how a lot of attention has been devoted to run the lab smoothly.

The unit has demonstrated an excellent and increasing capacity to secure competitive funding at national and international levels, reaching 4 million euros (without permanent salaries) in the last year. This is especially important since the proportion of core funding from stakeholders is relatively minor and the running budget of the Unit mostly relies on contracts. The number of ERC grants (5) obtained in the reporting period is remarkable. This reflects both the quality of the research in the unit and the environment that supports and promotes grant application to very competitive programs.

In the last years, efforts have been made to improve the integration procedures of new staff, especially those coming from other countries and cultures (including information booklets and a «buddy» support system), and to develop their careers.

RDP has experienced some increase in lab and office space, even though space is still perceived as short. However, and it can be considered a strength, the unit has maximized the collective use of space, promoting in this way the collaborative environment and common focus that characterizes the RDP.

The new greenhouses and growth facilities that have been opened in this reporting period are a significant improvement for research activities. A careful operational plan and a supervising team have been devised to assure the best functioning of the facilities and to maximize best-use practices.

In terms of lab infrastructure, the state-of-the-art imaging and biophysical equipment, adapted to the nature of RDP research places the unit in a forefront position internationally. Equally remarkable are the prospects offered by the full development of the Spatial Cell ID project which is coordinated by the unit involving three other labs, that represents a clear advantage for most modern cell and molecular plant biology research.

The unit has implemented in the reporting period several initiatives to improve human resources management, notably the appointment of two gender equality representatives, the organization of annual training plans upon evaluation of personnel requests and the increase in safety measures. More importantly, considerable attention has been paid to mental well-being. Altogether, these measures provide an improvement in the working environment and reinforce the highly cooperative character of the lab.

The efforts of RDP to promote sustainability are outstanding. There is a dedicated team composed of volunteers from different research/support teams across the lab that have made a truly huge effort to reduce the impact of the lab activity on the environment with very specific measures on clearly identified areas where impact is significant and quantifiable (travel, greenhouses, ultrafreezers). They have also been involved in numerous societal and dissemination activities and are very visible for the impact of plant research in sustainable development.

Context-related weaknesses and risks for the four references above

The team that was set up to improve the sustainability of research activities at the RDP has made an enormous impact - truly outstanding - driven by highly motivated and committed individuals. However, these responsibilities take time away from research and pose a threat to individual scientific productivity.

The RDP has always operated under space constraints and does well to ensure that individual teams are not isolated by dispersal of the unit across four separate buildings. However, this strongly depends on the lab culture of collaboration and requires a high level of respect and discipline to continue working well.

Despite developments of its IT infrastructure, the lab still lacks sufficient personnel and expertise to manage the volume of data it generates.

Significant improvements have been made to the onboarding and integration of scientists from abroad, but continued efforts are needed to attract and efficiently embed international scientists within the unit.

EVALUATION AREA 2: THE UNIT'S SCIENTIFIC RESULTS, IMPACT AND ATTRACTIVENESS

Assessment of the unit's scientific results, impact and attractiveness

The scientific output of the unit is outstanding both in quality and in quantity, with a consistent increase in these terms over the reporting period. This has reinforced the international visibility and position of the unit, also resulting in several members at different levels being recognized with awards and distinctions.
RDP attractiveness is excellent, because of the strong identity of the unit, the outstanding quality of researchers and infrastructure, and the multidisciplinary character of their combined research, all aspects that should be preserved by careful planning of recruitment.

1/ The unit is recognized for its scientific achievements that meet quality criteria.

2/ The research activities of the unit result in quality scientific production.

3/ The unit participates in the coordination and management of its community.

4/ The unit's scientific production respects the principles of scientific integrity, ethics and open science. It complies with the guidelines applicable in this field.

Context-related strengths and opportunities for the four references above

RDP has a strong identity in the field of plant developmental biology and performs at a very high level. The portfolio reflects the high standard of scientific production by convincingly representing the activity of the unit in the major themes of their research. The focus on understanding how gene regulation, cell processes, inter- and intracellular communication, and biomechanics integrate to control plant shape and morphological evolution has produced impactful science, widely recognized across the international community. Several publications led by RDP have represented true breakthroughs aligned with the recognized focus of RDP research (self-selected by the unit, most of outstanding impact in terms of advancement of knowledge and also for the career of those authors involved). Among these, there are truly groundbreaking contributions: Azpeitia et at Science 2021, is an unusual example of a paper led by modelers that by combining these modeling efforts with experimental validations demonstrate that specific perturbations of floral developmental programs and growth dynamics can generate complex fractal structures, in this case on easily recognized common-life cauliflower varieties; this work has reached academic and non-academic audiences and made a strong impact. In Doll et al., Science 2020, the authors uncover a novel mechanism for embryo-endosperm communication that opens up new perspectives while studying coordination of growth and development of distinct structures. Truskina et al., Nature 2021 sets a new paradigm on transcriptional regulation controlled by auxin signaling. Also, the development of advanced tools to study plant membrane dynamics by the SICE team has contributed to understanding fundamental principles governing intercellular trafficking and plasmodesmata function (as, for example, Li, Moreau *et al.*, Science 2024). These 4 publications qualify as highlights of the unit's scientific activity.

In the reporting period, there has also been an increase in grant applications and corresponding success. It is remarkable that, in addition to research contracts, there is a high degree of involvement and leadership in national investment programs such as Spatial Cell ID, GENIUS, and Phytobiome. These initiatives are likely to help maintain the leading position of RDP in cell/molecular plant biology and also, since many involve several teams, the collaborative spirit of the unit.

The unit has also been rewarded with multiple individual awards, both national and international. It is important to note that these not only apply to established researchers (for example, among others, three EMBO members: G. Ingram, T. Vernoux, and O. Hamant), but also to support staff and PhD students/postdocs, again backing up the collective efforts of RDP.

In the reference period, there has been a consistent increase in the quantity of published papers (around 35% more than in the last report), maintaining the quality and impact of the work. RDP publishes in highly regarded generalist and plant-specific journals, and this contributes to reinforcing the leading position of the unit in the field and reflects the originality and innovative character of their research. These high-level publications are not concentrated in the work of one or two teams but come from different ones, even though not evenly.

There is also a good level of participation in international conferences, many invited, although a bit restricted by the sustainability policies of the unit. On the other hand, it is remarkable that members from several teams actively participate in the organization of international scientific events in or close to Lyon and in different topics related to RDP themes (six in the reporting period) and also in online formats.

The reputation of the unit is reflected in the participation of several members in evaluation committees, panels, and SABs at national and international levels. In this sense, RDP's presence is significant, and the level of service of RDP members is high.

The lab is on its way to implementing electronic lab books, an important factor in modern science, that needs to be fully adopted in the near future. In any case, data management and transparency seem appropriate and well controlled.

Context-related weaknesses and risks for the four references above

The Unit has an excellent strategy to develop its attractiveness, original results and scientific impact notably including strong interdisciplinary projects and publications. Nevertheless, concerning the context-related weaknesses in these items there are very few points that can be considered.

1. The bioinformatics core facilities are lagging behind the needs as only 2 members seem involved and the Unit has strong programs that require bioinformatics support, both in cell biology and emerging genomics approaches, as well as modelling. There is a risk that this may become limiting to further attract researchers and postdocs as well as to cope with the ongoing international competition in the field.

2. The development of common projects and publications can be improved for certain teams as several, such as the MOSAIC team, develop strong collaborations with many teams whereas others are more isolated. The

dispersion in different buildings may be restricting internal team interactions. Promoting more intra-Unit collaborations to increase the proportion of co-authored papers across teams would allow them to better exploit their complementarity.

3. The evolution of the teams to favour reorganisation both to expand or close teams or activities could benefit from an external view (e.g. recommendations from a Scientific Advisory Board) notably as there is a certain risk of dispersion in many biological questions using different plant models.

4. The gender issue also needs to be more actively addressed by including woman in team leadership (as already implemented for certain teams in the trajectory) as well as giving more managerial responsibilities to them.

5. There is also a potential risk in confronting sustainability (e.g. diminished flight travelling) vs lack of visibility in relation to participation in congresses where the Unit can attract postdocs and students as well as future researcher's recruitments. Nevertheless, the Unit is nowadays very visible internationally with a strong interdisciplinary identity.

EVALUATION AREA 3: INCLUSION OF RESEARCH ACTIVITIES IN SOCIETY

Assessment of the inclusion of the unit's research activities in society

The unit is overall outstanding in its inclusion of research activities in society. In particular, its activities involving the Michel Serres institute are truly exceptional. These activities center around disseminating the concept of biological robustness - one of the central topics of the lab - to societal debates on the Anthropocene. In this way, the unit stands out for its capacity to translate scientific discoveries to society. This includes the development of software for Robotics for Microfarms and creation of the start-up company IN SITU LAB that applies phyllotactic principles to energy-efficient building design. In addition, multiple teams have added value to their own results and resources through interactions with non-academic partners, including one patent filed during the reporting period,

1/ The unit stands out for the quality of its interactions with the cultural, and socioeconomic world.

2/ The unit develops products and services for the cultural, socioeconomic world.

3/ The unit shares its knowledge with the general public and participates in social debates.

Context-related strengths and opportunities for the three references above

The unit has a very strong presence in societal debates around the socio-ecological crisis/Anthropocene. Active involvement of lab members with the Michel Serres institute has produced significant outputs where research findings on biological robustness were extrapolated to societal questions. Outputs include a PhD project and 2 publications, training on robustness for more than 100 associations, local authorities, businesses and institutions each year, presence in the media and conferences, and the publication of five books including English translations. The quality and quantity of these outputs is outstanding and is a highlight of the reporting period.
The unit participates in many outreach activities with schools and the general public, including an event supported by the L'Oreal Foundation "For Girls in Science" program, publication of two popular science books (fabrique des plantes), and development of an educational game for subsequent commercialization. We highlight this game "La Ronde du Pollen" that was produced by the French game publisher Bioviva in 2023 (https://www.bioviva.com/fr/jeux-cooperatifs/286-ronde-du-pollen.html) and sold 10 000 copies before selling out.

Teams in the unit have added significant value to their research outputs through non-academic contracts and patents. For example, rose molecular and genomics data generated in the lab has led to four industry-funded projects. Work on maize haploid induction, gene editing and fundamental research in the SeedDev team has led to numerous industry-funded projects and a patent being filed on accelerated breeding strategies.

The unit also turns its scientific expertise into societal value through contributing to position and analysis articles on future-proofing French and European agriculture, consultancy activities, and partnerships. We highlight the example of the Robotics for Micro farms (ROMI) project that involved interactions with non-academic partners

including Sony CSL, where the MOSAIC and SIGNAL teams developed an open source AI-based imaging platform to capture and analyse plant architectures.

We also highlight the example of the start-up company IN SITU LAB (co-founded by T. Vernoux in 2020 and based at the ENS de Lyon), which develops plant-inspired, bio-sourced solutions for architecture and urban design. By harnessing phyllotactic principles, the company created software that generates energy-efficient building and district designs. This software was patented in 2021 and a major Ministry of Culture grant (~700 000 €) awarded in 2024, with RDP as a partner, will propel this innovation toward market launch.

Context-related weaknesses and risks for the three references above

Despite an impressive range of interactions with society, several weaknesses and risks could limit the long-term coherence and sustainability of the unit's contributions.

Societal and industrial interactions are substantial but concentrated in a limited number of teams. This imbalance may result in heterogeneous visibility within the unit and may hinder the articulation of a clearly identifiable collective strategy. The unit's strong public outreach and policy-oriented discussions also relies on the initiative of a small number of highly engaged researchers. Any change in availability or career trajectory of these individuals could reduce the unit's visibility and weaken its overall societal impact.

Outreach efforts are rich and frequent, but they rely heavily on individual motivation rather than on a stable and structured institutional framework. This raises concerns about the continuity, coordination, and scalability of these activities as they continue to grow. Given the breadth of initiatives -from school programs to public events, media interventions, and contributions to socio-ecological debates- there is a potential risk of overextension.

Although patent and contractual collaborations exist, some innovations, tools, or datasets appear to follow a non-systematic valorization pathway. During the evaluation period, only one patent (EP22306616) was filed, suggesting that opportunities for technology transfer may not be fully exploited, possibly due to limited internal resources or insufficiently formalized procedures for assessing valorization potential.

ANALYSIS OF THE UNIT'S TRAJECTORY

The RDP Laboratory - containing around 140 members - depends on multiple governing bodies and universities. Historically, the Unit was focused on reproductive biology and fertilization and has moved towards more general developmental biology topics in the last years. They have made major breakthroughs by combining multiple disciplines from biophysics, computer science and modelling to cell biology, live imaging and genomics. The lab has created a unique interdisciplinary environment for Plant Sciences in France with a very strong worldwide recognition and international dimension. Even though a core focus remains on angiosperm reproductive structures, their research moved also into new questions such as shoot development in bryophyte models.

The research strategy is based on 5 pillars to permit the continuation of their actual trajectory as well as the emergence of new projects. These pillars combine scientific research targets (maintaining a coherent research focus for all new recruitments; investment in advancing technical and analytical tools, fostering collaborative networks notably to develop interdisciplinary research) as well as societal targets (reducing carbon foot print, increasing interactions with non-academic sectors both at innovation level with private companies as well as training and teaching levels, support platforms for plant growth, administration and informatics). The integration of the teams is very clear in certain cases, notably the MOSAIC team which is central to many interdisciplinary projects, although may be less evident for other teams. The Unit aims to maintain a team composition with a critical mass of at least two researchers and one permanent support staff member. This can be difficult in France and practically means that newly recruited permanent researchers almost always join an existing team upon arrival in the laboratory. Hence, they are integrated into an existing team structure with access to technical assistance and a team leader that needs to help him/her to become a new team. Although this rule may be seen as less dynamic for young researchers, it can assure an initial time to consolidate a project without the administrative burden of a team leader.

The Unit's international impact and visibility are demonstrated by their success in obtaining 5 ERC grants (including certain young group leaders) during the period and a large number of ANRs, 1 PEPRs coordinator, 1 Equipex coordinator and 2 PIAs and several grants supporting the interactions between Science and Society. The global budget of RDP is around 4 M euros per year which assures adequate resources for their research ambitions. Furthermore, the Unit pooled its diverse resources to define a global contribution for developing exploratory research and emerging teams. How decisions on team creation and evolution are taken could have been better developed particularly to balance the demands between common services (from administration to imaging and data management) and new research teams. Nevertheless, the RDP has a clear identity in plant fundamental research at an international level. The trajectory plan is highly relevant, matches the priorities of all supervising bodies and funding sources of the Unit, and keeps permitting the exploitation of all aspects of the available internal resources and expertise for the next quinquennial.

In the next quinquennial, the laboratory director will still be G. Ingram accompanied by 2 deputy directors, Y. Jaillais and M. Bendahmane and the Unit will have minor changes with respect to team structure except for M-C. Caillaud who will become co-leader of the SiCE team with Y. Jaillais and Y. Coudert who will co-direct the SIGNAL team with T. Vernoux. The laboratory plans to continue developing a leadership role in tool development in cell biology, biophysics, image analysis and mathematical modelling allowing them to maintain their outstanding global output in scientific research as mentioned in the evaluation part 1. They also plan to promote diversity in hiring although how this will happen could have been defined in a more specific way. The arrival of C. Kirchhele in the MecanoDev team in 2021 with her own ERC grant addressing growth sensing was a major achievement of the last period. The arrival of J. Derr will reinforce the interaction with INRIA and to prepare the evolution of the interaction with the Mosaic Team whose team leader, C. Godin, is a major name in plant interdisciplinary research and is predicted to retire in the next quinquennial. This team is central for many interdisciplinary projects after the departure of the previous leader in biophysics in 2020. Indeed, the interaction with physical sciences is a major achievement of the RDP laboratory and has been central for many of the ERC grants. Maintaining the thematic coherence but permitting new high-risk high-gain ideas has been achieved by the Unit as noticed by their participation in several EXPLOR'AE initiatives. In the last years, the RDP laboratory has recruited several research leaders that extend and/or complement existing research themes such as the arrival of: C. Kirchhelle, as mentioned before, to lead the MechanoDevo team, D. Bouyer in the EpiCDev team, J. Derr in the MOSAIC team and, more recently, N. Doll in the MorphoFlo team and L. Riglet in the EvoDevoFlower team. Interestingly, the Unit is now trying to recruit another young female scientist whose project involves the development of tools allowing the exploration of the *in silico* evolution of genomes and gene networks in the context of plant development. This analysis may be at the basis of a project in evolutionary dynamics of gene regulation which can integrate well with ongoing research of several RDP teams.

The Unit will also aim to maintain its excellence in imaging by developing spatial transcriptomics and cell-level biophysics profiting from their collaborative networks and their own expertise. This investment in the development of novel technologies is also a central aspect of RDP trajectory and resides both in contractual staff that actively develops novel methodologies through the different grants together with excellent permanent scientists accompanying them and keeping the "lab memory" of all these novel methodologies. The correct functional interactions of these researchers and engineers collectively are required to maintain highly qualified

and expert personnel in these platforms and will be essential to develop new cutting-edge technologies. This aspect needs to be supported by in-house development of data handling/management in a perennial way as now it seems to be mainly linked to the good will of certain researchers. A second critical common service of RDP is bioinformatics and biostatistics particularly challenging to develop the analysis of spatial transcriptomics data or cell-level biophysics. The underdeveloped status of bioinformatics and biostatistics at RDP was already mentioned in the previous Hcéres report and the unit should find ways to fill this urgent need rapidly. Nevertheless, the Unit can further advance on their cutting-edge technologies based on their extensive collaborative networks for frontier technological development such as acoustic imaging and Raman spectroscopy. However, they may become too dependent on external actors for their research if this need is not adequately addressed. Many of the ongoing and future research projects of RDP depend strongly on national level collaborations and strong links with strategic partners such as LBM (Bordeaux), IPSiM (Montpellier), IBMP (Strasbourg), IJPB (Versailles), LPCV (Grenoble) and others, many of which will be pursued in the next evaluation period. At an international level, RDP is also engaged in different networks involving Japan, India, Wuhan (China), Cambridge (UK), Lausanne (Switzerland) and VIB, Ghent (Belgium). Finally, the interaction with the Platim imaging facility of the SFR is assured to continue as several RDP members are implicated in the different scientific and purchase committees. These partners provide outstanding facilities and expertise supporting RDP research.

In addition to the large success of RDP in plant research, the trajectory of the Unit adequately addresses also several aspects of the socio-economic environment. They will continue to consolidate existing interactions with non-academic partners and participate in events organised by the ENS de Lyon aiming to explore potential novel partnerships with companies. Their policy is to focus interactions with non-academic partners in areas where these can reinforce the fundamental research focus, to avoid thematic dissipation. Another major aspect they want to develop is a policy to reduce the environmental impact of their research in a sustainable manner. Several axes are described: 1. Improvements of plant growth facilities efficiency; 2. Control of energy consumption for data storage and heavy computing, 3. Promote a reduction of the environmental impact of laboratory consumables and 4. Implement a rational strategy to diminish the cost of travels and missions. Furthermore, a continuous effort to support science communication at all levels will be developed. The Unit participate and will pursue its contribution to various outreach initiatives to allow personal interactions with school children and the general public. The idea of reinforcing this aspect through the creation of a group of volunteer researchers to promote participatory research and citizen science is interesting despite the major difficulties to implement these aspects. Finally, the Unit needs to address the gender issues that remain still rather distorted (2 out of the 8 RDP teams are led by a woman actually). Even though this is difficult globally, the actions proposed are going in the right direction and may lead to a better distribution of responsibilities at management level.

Overall, the Unit has designed an excellent trajectory not only to make its current projects successful but also to keep at the forefront of Plant Sciences. This includes the choice of priorities well-fitting current societal challenges and priorities of its supervising bodies. The project takes into account the RDP scientific originality, the latest scientific developments and technological breakthroughs for the development of existing and novel tools and platforms as well as the search for potential funding agencies and programs. The evolution of the unit and team scientific projects and its recruitment strategy should allow them to maintain and even expand their international visibility in the next years.

Team Trajectories are described below for each individual team.

RECOMMENDATIONS TO THE UNIT

RECOMMENDATIONS REGARDING THE EVALUATION AREA 1: SCIENTIFIC OBJECTIVES, ORGANIZATION AND RESOURCES OF THE UNIT

The unit should maintain the robust and collaborative environment they have achieved and maximize a balanced growth of the teams by paying attention to the composition (senior/junior) of some of them, also with the added challenges of upcoming retirements.

The reinforcement of bioinformatics support has been addressed in this period by establishing a Bioinformatics Hub, but this still needs to be consolidated and implemented to specifically address the unit's needs. IT maintenance also needs to be reinforced. Data storage and data management policies have been improved, but it is important to consolidate these dedicated personnel and to ensure the smooth adoption of practices by the whole lab.

Due to the increasing volume of work in the Unit, administration needs to be reinforced by trained personnel.

The Plant culture team is facing personnel shortages together with an increased volume of work and these issues should be solved by new recruitment.

A dedicated position to manage infrastructure and practical organization of the lab is advisable.

Internal policies to promote women in PI positions should be seeked, both through presenting female candidates for recruitment or by helping advance their careers with any instrument available).

The committee encourages the unit to facilitate the scientific activity of teacher researchers by promoting co-supervision or co-leadership in long-term collaborations.

The dispersion of the unit into different buildings is not optimal and needs a solution in the long term. In the current arrangement, more social activities among the teams may facilitate cohesion of the lab.

RECOMMENDATIONS REGARDING THE EVALUATION AREA 2: THE UNIT'S SCIENTIFIC RESULTS, IMPACT AND ATTRACTIVENESS

The Unit should continue with their excellent interdisciplinary research (both projects and publications).

The MOSAIC team is integral for collaborative and interdisciplinary research within the unit and it cannot be jeopardized. MOSAIC will face a strong change in composition and it is important to make plans to maintain its excellence and strong collaborations with the other teams.

Also, recruiting a cell-based biophysicist (experimental or theoretical) would be a key asset for fostering new directions and conceptual frameworks in mechanobiology and beyond.

The rose genomics project is highly visible and will need to be reinforced by the recruitment of a new scientist since the current team leader will depart during the next quinquennial.

The teams are the main actors of RDP strategy and there are novel young researchers recruited that should be considered for team evolution and new creations including researchers and engineers and technicians. This process may profit also from close interactions with external members to RDP (e.g.; SAB, interdisciplinary panels).

Despite the reinforcement of the bioinformatic hub already taken into account, the specific needs of the Unit for the core interdisciplinary activity, together with growing needs in -omics (and more notably single-cell experiments or epigenomics) needs to be efficiently addressed by a strong bioinformatic capacity.

Proteomics capacities should be reinforced in the unit.

RECOMMENDATIONS REGARDING EVALUATION AREA 3: INCLUSION OF RESEARCH ACTIVITIES IN SOCIETY

The unit is encouraged to maintain its strong commitment to societal engagement. Its key role as collaborator for societal projects involving the Michel Seres Institute should continue at the conceptual level as planned. Going forward, such activities are likely to extend beyond the RDP, with the newly created "Center for Transitions" at ENS Lyon.

The committee recognizes the outstanding outreach activities of the lab. Supporting training, mentorship, and progressive engagement in public communication is recommended in order to help reduce the reliance on a small number of highly committed individuals.

The unit may benefit from reinforcing its valorization processes by adopting a more systematic and forward-looking approach. Regular internal discussions on innovation potential, clearer decision-making procedures, and earlier engagement with technology transfer offices would help ensure that transferable outputs -tools, datasets, or methodological innovations- are more consistently identified and developed.

TEAM-BY-TEAM ANALYSIS

Team 1: Epigenetics, Chromatin and Development (EpiCDev)

Name of the supervisors: Mr François Roudier and Mr Daniel Bouyer

THEMES OF THE TEAM

Since it's creation in 2017, the team has studied the mechanisms that determine the acquisition and maintenance of cell identity and functions during plant development. A major aspect is the study of polycomb functions in *Arabidopsis thaliana* and the moss *Physcomitrium patens* in meristems and the role of DNA methylation in male fertility in the Arabidopsis genus.

CONSIDERATION OF THE RECOMMENDATIONS IN THE PREVIOUS REPORT

The previous recommendations encouraged to develop the study of the roles of PRC2 in meristem development of the moss *Physcomitrella patens*; to increase HDR numbers in order both to increase the hiring of PhD students and to encourage more team members to become involved in team management; and to hire a permanent technical staff with competence in bioinformatics and statistics.

The studyof the roles of PRC2 in meristem function in *Physcomitrella patens*was developed mainly in the context of a PhD thesis project, in collaboration with the SIGNAL team within RDP, and will be continued. In 2020, the arrival of Daniel Bouyer, a CNRS researcher, increased the number of HDR and PhD hiring possibilities and strengthened the leadership of the team. D. Bouyer is co-leader of the team since oct 2023. The team has two full-time technical staff, while the team seems still lacking in technical support with competence in bioinformatics and statistics.

TEAM WORKFORCE: IN PHYSICAL PEOPLE AS OF 31/12/2024

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

EVALUATION OF THE TEAM

Overall assessment of the team

The team was overall assessed as very good to excellent. The team has developed a recognized expertise in the analysis of the role of epigenetic dynamics during plant development and response to environmental signals. The team has secured a very good level of funding and demonstrated a very good publications record with publication in outstanding journal (Nature), even though the number of publications could be improved. The team has developed an original line of research using the moss *Physcomitrella patens* likely to make an impact in the study of the role of PRC2 in cell type identity. The team has made an excellent contribution to the diffusion of knowledge.

Context-related strengths and opportunities

The EpiCDev team develops research to analyze the complex role of epigenetic dynamics in the response of cells to developmental or environmental signals, combining genetics, genomics, molecular studies, and imaging technologies. This research area is highly competitive and developing research on the moss *Physcomitrella patens* in addition to *Arabidopsis thaliana*, provides an original perspective to the work performed. Research activities are mainly focusing on repressive epigenetic pathways including the Polycomb proteins and DNA methylation. The latter was initiated after the arrival of a new scientist in the team in 2020.

During the evaluation period, the EpiCDev team has published 8 articles, 4 in excellent journal (2 Plant cell, 1 Nature, 1 nature com), which illustrates the quality of the research developed to understand the role of the Polycomb Repressive Complex 2 (PRC2) in cell differentiation. Innovative approaches have been developed to target the role of this complex in a cell type specific manner in Arabidopsis in order to investigate in addition to its role during embryogenesis the importance of PRC2 during post embryonic development. The importance of PRC2 in determining cell type identity has been developed in the moss model. An additional research axis includes the study of the transcriptional responses to various signals (developmental and environmental) essentially addressed through different collaborations. This was recently enriched by the implementation of a project addressing the complex role of DNA methylation during plant reproduction with a focus on male fertility.

The EpiCDev team which is of moderate size (4,5 ETPR), shows a high quality publishing activity, quite moderate though (0,66 ACL/ETP/an), and is in leading positions in 3 of the 12 articles published. However, the publication activity reflects the quality of the research collaborations that have been developed by the team. The team also participates to an international research network between France and Japan, that involves more than 40 research institutions. The team members have been invited in some international meetings to present their data. The team has obtained 4 grants in competitive calls (ANR), and more recently in local calls. The team has also contributed to the diffusion of knowledge by contributing to an educational game designed for the general public, more specifically children. This game "La Ronde du Pollen" was produced by the French game publisher Bioviva,at the end of 2023.

Context-related weaknesses and risks

The team is relatively small and lacks technical personnel with expertise in bioinformatics and statistics, which may undermine its competitivity and development of appropriate approaches for data acquisition and analysis.

There are two PhD projects ongoing in the team with a third in official co-supervision with the EvoDevoFlow team. The team has few non-permanent staff and no postdoctoral researcher.

The team was successful in obtaining national funds with 4 ANR, while two ended and the other 2 will end soon.

ANALYSIS OF THE TEAM'S TRAJECTORY

The team trajectory is in line with the research project developed the last 5 years. The team will maintain the three research axes that have been developed during the current contract. Part of them relies on the collaborations that have already been established. This choice can be questionable with regards to the administrative load of one of the group leaders, the anticipated retirement of a team member with moss expertise and the necessity to find funding for most of the current projects (most funding will stop in 2026). The team could take this as an opportunity to secure a limited number of research projects in terms of research strength and funding's. A clear strategy for the bioinformatics support which is strategic for the team should be proposed.

RECOMMENDATIONS TO THE TEAM

The team would benefit from better exploiting all types of funding sources, including international agencies and private sector. In this respect, the team could take advantage of its network of collaborations to secure international or European grants. The team may exploit translational potential for looking for funds from the private sector.

Recruiting more post-doctoral researchers would allow this team to strengthen their expertise and to prepare or attract candidates for permanent positions to increase the size of the team.

The team should prioritize the publication of the nice results already available. The team is in a good position to develop interactions with other teams and implement modelling of chromatin dynamics during cell type definition.

Team 2: Evolution and Development of the Flower (EvoDevoFlower)

Name of the supervisor: Mr Michiel Vandenbussche

THEMES OF THE TEAM

The research of the team focuses on understanding the molecular mechanisms of floral development and evolution. They use comparative analyses across key species like *Amborella trichopoda* and *Petunia hybrida* to explore the evolutionary conservation and divergence of gene functions and gene regulatory networks (GRNs). Their work involves advanced bioinformatics and transcriptomics techniques to uncover insights into the genetic basis of flower development, as well as the development and implementation of tools for functional studies in the mentioned species.

CONSIDERATION OF THE RECOMMENDATIONS IN THE PREVIOUS REPORT

The team followed the recommendation to focus on obtaining international funding by applying for ERC starting grants. Although these applications were unsuccessful, national funding was acquired by all research groups in the team. Hypothesis-led enquiry is a prominent component of currently funded projects as recommended. The team leader will apply for EIC Pathfinder funding in 2026.

Funding opportunities for the petunia genetics platform fell through, but recommendations to stay current in the era of genome editing led to the routine use of CRISPR and new tool development to allow massively parallel forward and reverse genetic screens in petunia.

The recommendation to strengthen bioinformatics was addressed by external collaborations and improving in-house skills as evidenced in the scRNAseq work and the Amborella transcriptome/co-expression network analysis. The recent launch of the RDP bioinformatics hub will greatly strengthen bioinformatics at the team and lab levels.

Recommendations to extend the visibility of the team by recruitment (new permanent researcher, PhD and M2 students), collaborations within the RDP (MOSAIC team), international links, and master's teaching, were all addressed.

TEAM WORKFORCE: IN PHYSICAL PEOPLE AS OF 31/12/2024

Catégories de personnel	Effectifs
Professeurs et assimilés	0
Maitres de conférences et assimilés	0
Directeurs de recherche et assimilés	2
Chargés de recherche et assimilés	1
Personnels d'appui à la recherche	1
Sous-total personnels permanents en activité	**4**
Enseignants-chercheurs et chercheurs non permanents et assimilés	0
Personnels non permanents d'appui à la recherche	1
Post-doctorants	1
Doctorants	3
Sous-total personnels non permanents en activité	**5**
Total personnels	**9**

EVALUATION OF THE TEAM

Overall assessment of the team

The EvoDevoFlower team was overall assessed as excellent. The team has a strong reputation in comparative genetics of flower development. It holds a leading position in Petunia research, thanks to the development of rich genetic/genomic resources. Likewise, they have made important contributions to the study of the origin of flowers and carpels, being one of the few labs actively working in Amborella. They have secured an excellent level of funding in this period, mainly national, and maintained a very good productivity, with highly visible papers in a leading journal like Plant Cell (with cover) and others highly respected journals in the plant and evodevo field.

Context-related strengths and opportunities

The Petunia genomic resources developed and maintained in the team are unique and allow deep comparative development studies. A significant outcome of these efforts has been the recent publication by Chopy et al., 2024 The Plant Cell, a pioneer work in petunia with single-cell omics, and that makes use of unique mutants from the valuable collection developed by the team.

The research on basal angiosperms is strong and has produced highly valuable tools for the Evodevo field. Importantly, the publication by Rivarola-Sena et al., 2022 Annals of Botany provides spatially defined transcriptomic data in Amborella female flowers and comparative transcriptomic tools pipelines highly useful for the EvpDevo community.

The arrival of a new permanent scientist to the team will bring a new complementary topic and additional methods/tools to exploit Petunia resources.

The team has shown an excellent training capacity, with 3 PhD theses defended and three more underway in this period. For the size of the team, it is remarkable.

The team has a significant activity in science dissemination to wider audiences, as for example, as for example 3D conference at the Planétarium of Vaulx-en-Velin, that represented an important interaction with general public and stunning material as output.

It also achieved high visibility in the plant science community with two papers in Plant Cell selected for covers (Morel et al. 2019, Chopy et al. 2024).

Context-related weaknesses and risks

Maintaining the petunia mutagenesis platform depends on non-permanent staff and is subject to biological and technical risks from seed aging and storage. Generating new mutant populations and tools for forward genetic screens are important to mitigate some of these threats.

Possible loss of in-house bioinformatics expertise developed in scRNAseq due to departure of one of the scientist's group should be mitigated by support from the RDP bioinformatics hub to strengthen and improve bioinformatics in the team.

Steps should be taken to manage the risks posed by upcoming retirements of permanent staff.

To maintain the unique expertise of the team in evo-devo research, it is important ensure that returns are maximised on the investments in time and resources that have been spent to develop non-model species.

The interactions among team members and with other teams in RDP could be stronger, there is little evidence of joint publications of initiatives.

While national funding is significant, the team has not secured international grants, despite the new and the potential interactions that could be established with other groups thanks to the unique resources of the team.

ANALYSIS OF THE TEAM'S TRAJECTORY

The three axes proposed are the logical continuation of the team's main lines of recent research. Studies on the origin of the angiosperm flower will benefit from recent collaborative efforts, expanding to side themes strengthened by the strong position of the team in Amborella biology. The second axis, focus on the petal morphogenesis, has the potential to impact our knowedge in wider aspects of developmental biology and may benefit from the new tools and approaches provided by the incorporation of L. Riglet, always with the advantage of the unique Petunia mutants available to the team. Axis 3 follows the strong line of the team on solanaceae inflorescence architecture, righly aiming to implement some advanced molecular techniques and new collaborations. Finally, the reinforcement and expansion of the Petunis genetic resources are well justified.

RECOMMENDATIONS TO THE TEAM

The new group is a great addition to the team and should be encouraged and supported to apply for starting grants e.g. ERC, HFSP.

Maintaining and strengthening expertise in petunia genetics and developmental analysis is important to encourage synergism between the two groups working on petunia.

Developing new collaborations, as proposed with the Soyk lab, are important to extend the reach of the team and encourage petunia genetic resources to be used more by the Solanaceae community.

Groups are encouraged to increase collaborative efforts in related topics with other teams within the RDP. A good example in this direction is the proposed collaboration between the new group and the MOSAIC team.

Team 3: Mechanotransduction in Development (MechanoDevo)

Name of the supervisor: Ms Charlotte Kirchhelle

THEMES OF THE TEAM

MecanoDevo studies how mechanical forces shape plant development through three main research axes. The first axis examines mechanical feedbacks and their sensing across scales, from microtubule patterning influenced by geometry and stress to nuclear mechanoperception and the impact of mechanical stress on tissue hydraulics. The second axis investigates how cell-scale variability in growth and gene expression contributes to the robustness of organ-scale morphogenesis. The third axis, a newer research direction, focuses on the role of cell edges in growth control, addressing the molecular mechanisms of cell-edge detection and signalling. In parallel, the team is engaged in public outreach, extending the concept of biological robustness to broader societal contexts.

CONSIDERATION OF THE RECOMMENDATIONS IN THE PREVIOUS REPORT

The team was initially identified as highly promising for its innovative topics and approaches and has fully met these expectations. Beyond consolidating its core research axis and producing excellent scientific outputs, it opened a new research direction and maintained a focus on parallels between plant and animal biology (bioRxiv 2024) as recommended.

The recommendation to create a junior-led group was addressed through the recruitment of Kirchhelle, who is now team leader. The team's commitment to the Anthropocene collective was encouraged and has now expanded to take up 50% of Hamant's time. Productive collaborations with the MOSAIC team have been established as encouraged, and the suggested broadening toward non-Arabidopsis studies is now clearly reflected in the team's trajectory.

The team's focus on mechanical forces in development has now been complemented by exploring shape-mediated signalling as suggested. These geometric mechanisms have been extensively investigated, notably through the new research axis on the role of cell edges in plant growth (Nat Plants 2024) and the identification of exceptions to CMT's alignment with stress during cell division (PNAS 2024).

Finally, despite the lab biophysics team's departure (effective in 2022), key collaborations were maintained and MecanoDevo developed new ones with MOSAIC and external physicists in Lyon, although this remains a point of attention.

TEAM WORKFORCE: IN PHYSICAL PEOPLE AS OF 31/12/2024

Catégories de personnel	Effectifs
Professeurs et assimilés	0
Maitres de conférences et assimilés	1
Directeurs de recherche et assimilés	1
Chargés de recherche et assimilés	1
Personnels d'appui à la recherche	2
Sous-total personnels permanents en activité	**5**
Enseignants-chercheurs et chercheurs non permanents et assimilés	0
Personnels non permanents d'appui à la recherche	1
Post-doctorants	5
Doctorants	3
Sous-total personnels non permanents en activité	**9**
Total personnels	**14**

EVALUATION OF THE TEAM

Overall assessment of the team

The team was overall assessed as outstanding. MecanoDevo is a small, highly dynamic team, internationally recognized in plant mechanobiology, notably for the identification of a feedback mechanism linking mechanical stress to microtubule organization. During the period under review, the retirement of a major scientific figure and the increasing involvement of another central team member in Science and Society were balanced by the recruitment of a highly promising young scientist hosting an ERC grant on a new research axis. Overall, the team demonstrates outstanding attractiveness, success in highly competitive funding schemes, publications in major journals, and strong international visibility. Its outreach activities also stand out for the transfer of the concept of robustness in biology to non-scientific fields. Sustaining this level of activity with limited permanent staff will, however, require careful planning.

Context-related strengths and opportunities

The team demonstrates outstanding quality and originality of its research, with major achievements, including the identification of original microtubule patterns in cell division (PNAS 2024), cell edges as mechanical hotspots for growth (Nature Plants 2024), the role of water fluxes in meristem growth patterning (Nature Communications 2024), and the contribution of transcriptional noise to organ robustness (PNAS 2023), among the most recent results.

The team's excellence is evidenced by strong international recognition and collaborative networks (>80 invited talks; EMBO and EMBO YIP memberships; Editor-in-Chief of Quantitative Plant Biology; co-organization of six international conferences, two-thirds of publications co-authored internationaly), by high-quality publications as senior or corresponding authors, including original research articles (Nature Plants (2), PNAS (4), Current Biology (4)) and opinion and review papers (e.g. Science (1), Nature (1), Nature Communications (1), Nature Plants (2), Current Biology (2), Annual Review of Cell and Developmental Biology (1)), by success in securing highly competitive international and national funding (about €5.5M, including 2 ERC grants, 1 HFSP grant, 4 ANR grants, 2 EMBO long-term fellowships, and 2 DFG long-term fellowships), and by a strong training record, with supervision of 7 PhD students and >15 postdoctoral researchers during the period (8 poster, talk, or thesis prizes, including the L'Oréal Prize).

These achievements are all the more remarkable given that one team member has significant teaching responsibilities, while another devotes half of their time to public outreach activities (see below).

Another key milestone has been the recruitment of a young permanent scientist (CR INRAE) in 2021—who has become team leader since 2024— developing a new research axis on cell edges in plant growth, supported by a Starting ERC grant. This opens opportunities for new national and international collaborations across diverse biological systems, including mosses and brown algae.

The development of a high-tech micromechanical platform coupled to confocal microscopy, reinforced by the recruitment of dedicated technical staff, provides the team with a major experimental asset. This platform enables the investigation of microfluidics at the single-cell or whole-tissue level (BioArXiv 2024), mechanical compression or extension of small-scale tissues (PNAS 2021), and microindentation or microinjection in mechanoperception studies.

Over the past years, the team has developed new science–society interactions, notably through outreach activities led by one team member on the concept of robustness. This has resulted in a major impact on the general public and institutions, including several books and >100 public talks. Both permanent and non-permanent team members regularly participate in outreach activities.

Context-related weaknesses and risks

The small size of the team in terms of permanent staff, combined with a focus on basic research, results in a strong dependence on competitive grant funding to sustain projects and maintain or acquire new equipment. This situation also makes it difficult to preserve expertise in the long term. Increased competition in the field may pose a threat to the sustainability of this strategy.

The team has undergone significant structural changes during the period, including the departure of a historical scientific figure and the increased involvement of the team's senior PI in societal projects (50% of Hamant's time), which has reduced the availability of PIs to lead core biological projects. Combined with the broad range of topics being addressed as scientific priorities, this increases the risk of fragmentation within the team.

The departure of the biophysics team from the laboratory represents a loss of a complementary expertise that was important for the interpretation of mechanical data and the development of new physical frameworks.

Proteomics is identified as a future priority area for the team, but this expertise is not yet present within the permanent staff.

ANALYSIS OF THE TEAM'S TRAJECTORY

During the evaluation period, MecanoDevo experienced significant changes, including the retirement in 2023 of a central and long-standing figure of the laboratory, the increasing commitment of the former team leader to science-society activities, and the departure in 2022 of the lab's biophysics team, with which many projects had been shared. At the same time, the team saw the recruitment in 2021 of a young CR INRAE scientist, who has developed a new research axis and now leads the team, as well as the recruitment of a permanent technical staff to secure the team's dedicated micromechanics platform.

This internationally recognized, world-class team has made major contribution in plant mechanobiology, most notably the identification, 15 years ago, of a feedback mechanism linking mechanical stress to microtubule organization, which remains a key research axis. Over the period, the scientific scope has expanded to include nucleus mechanoperception, hydraulics, variability in organ robustness, similarities between animals and plants mechanisms, and new research directions on the role of cell edges in plant growth and on the application of the biological concept on robustness in societal contexts.

The main objective of the team for the next evaluation period is to consolidate these activities by fostering shared projects that integrate complementary expertise across the team. Scientifically, the team aims to deepen its work on microtubule patterning through a shared proteomics-based project (ANR proposal in preparation), further investigate variability and robustness in fluctuating environments (ERC proposal planned), and broaden its cell-edge research theme across diverse biological systems (EXPLOR'AE grant starting in 2025, ongoing BMIC fellowship, ERC Consolidator proposal planned), in particular through new external collaborations in Lyon. In parallel, the team will maintain strong societal outreach activities centred on the concept of robustness, with one member dedicating 50% of their time to these actions. On the administrative side, the team leader aims to complete her HDR to independently supervise PhD students.

This project is ambitious and of high scientific quality. A key challenge for the team will be to implement it with only one principal investigator working full time. In this context, considering additional permanent recruitments, both at the researcher and technical staff levels, appears essential to sustainably distribute the workload and maintain the team's high level of performance.

RECOMMENDATIONS TO THE TEAM

This is an outstanding team in all aspects: publications, grant funding including 2 ERC, teaching, recruitment, international visibility including EMBO member and YIP awards, and with phenomenal commitment and contributions to Science & Society. The obvious recommendation is to maintain this high level of productivity! However, this will require careful planning with only one PI working 100% in lab-based research and the broad range of topics being addressed by the team.

Proteomics is identified as a future priority area for the team and would benefit from recruitment of a permanent engineer so that expertise in this area is conserved in the long term.

It may be worth considering, at the team or laboratory level, the recruitment of a biophysicist (experimental or theoretical) to foster new directions and conceptual frameworks in mechanobiology and beyond.

Team 4: Flower Morphogenesis (MorphoFlo)

Name of the supervisor: Mr Mohammed Bendahmane

THEMES OF THE TEAM

The research of the team aims to understanding morphogenesis of floral organs, with a strong focus on rose as species of choice, although also using Arabidopsis as model species. The team has several lines of research open in rose developmental biology and genomics, specially related to traits of horticultural value (flower form, scent, pigmentation) and it also has made significant contributions to the study of the control of cell proliferation during floral organ morphogenesis. Recently it has added an interest in interorgan communication, specifically in the context of anther development.

CONSIDERATION OF THE RECOMMENDATIONS IN THE PREVIOUS REPORT

The previous recommendations primarily suggested to secure in vitro culture activities, increase the number of HDR-holding scientists, and maintain a high level of scientific output and funding through H2020 or ERA-CAPS.

Since then, the team has maintained a high publication record, including publication in *Science* (1), and *Plant Cell* (2), alongside successful fundraising. The team is currently coordinating three ANR projects and has secured an additional private funding. At the European level, ERC applications were submitted but not funded, and no proposals have yet been submitted to H2020.

In line with the recommendations, in vitro culture expertise has been maintained through the recruitment of an INRAE staff member. The number of HDR-holding scientists has increased by one, with two additional HDR defenses planned for 2026.

The team has reinforced its leadership in rose genomics, developing the rose pangenome and single-cell/nuclei transcriptomics to support advanced research on rose fragrance and floral morphogenesis. Research activities have been reorganized, integrating Arabidopsis studies into other team research themes. Finally, the team has focused on pathways controlling mitotic growth and their conservation across plants and animals. All these projects are supported by ANR funding.

TEAM WORKFORCE: IN PHYSICAL PEOPLE AS OF 31/12/2024

Catégories de personnel	Effectifs
Professeurs et assimilés	0
Maitres de conférences et assimilés	1
Directeurs de recherche et assimilés	1
Chargés de recherche et assimilés	1
Personnels d'appui à la recherche	5
Sous-total personnels permanents en activité	**8**
Enseignants-chercheurs et chercheurs non permanents et assimilés	0
Personnels non permanents d'appui à la recherche	1
Post-doctorants	2
Doctorants	4
Sous-total personnels non permanents en activité	**7**
Total personnels	**15**

EVALUATION OF THE TEAM

Overall assessment of the team

The Morphoflo team was overall assessed as excellent. The team is an international reference in rose floral development and genomics. It has continued to develop new tools and resources, and importantly, stable links with international groups, including the creation of an LIA France-China. The level of funding is very good, mostly national, and importantly through contracts with the private sector, but despite their international presence, the international funding is limited. Productivity in terms of publications is excellent and reflects the level of international collaboration.

Context-related strengths and opportunities

The team holds a strong position in the study of floral development in rose. This has led to both strengthening their international relevance by the creation of an International Associated lab France-China, an important collaboration that resulted in a Science paper among other significant publications, and to stronger interactions with industrial partners. It is remarkable that four companies are involved in translational efforts and fund the team.

The team has contributed with outstanding genetic and genomic resources for rose studies, including, genome and transcriptome sequences, a homozygous rose genotype and transformation protocols.

The incorporation of a young promising researcher, as a permanent scientist to the team will bring a new complementary topic on the study of programmed cell death in another development that will likely expand the impact of the team's research.

The topics under study are attractive for industry and for general audiences and the team has made an effort to maximize this, engaging in wide dissemination and outreach activities participated by most members of the team.

Context-related weaknesses and risks

Funding is mainly at the national level, and international funding is limited. Part of the team activity will require important bioinformatics resources (single cell transcriptomic/genomic activities) that do not seem to be secured. For example, the relation of the team with the bioinformatics hub of the unit is not defined. The development of transformation protocols requires in vitro culture facilities, and green house space. This may become limiting in time. Transfer of knowledge from Rose to rosacea crops should be more developed.

ANALYSIS OF THE TEAM'S TRAJECTORY

The three axes proposed are the logical continuation of the two main lines of recent research on TCTP and on rose flower development, including a third to be developed by the recently recruited new researcher. All those are strong and logical lines, although to some extents are not too connected among them and have several different species under study (among those mentioned Arabidopsis, Drosophila, tomato, roses, other rosaceae…) that might represent a challenge even if relying on collaborators.

RECOMMENDATIONS TO THE TEAM

The team is excellent in many aspects (productivity, national and international collaborations, funding, collaboration with private companies). An important recommendation will be to maintain this excellency and reinforce the team leadership in rose genomics and functional genomic, for example by reinforcing the rose genomic activity through a specific recruitment. The development of translational biology approaches to extend the research activity to crops of the rosacea family will provide additional funding opportunity, and allow developing fundraising activity at the international (e.g. Horizon Europe or other calls). An important challenge for the team is to secure skills and man power in bioinformatics as an important part of its research activities depends on it. The leadership of the team should be reinforced when contributing to collaborative articles.

Team 5: Morphogenesis Simulation and Analysis in Silico (MOSAIC)

Name of the supervisor: Mr Christophe Godin

THEMES OF THE TEAM

The MOSAIC team studies self-organization in morphogenesis and development using mathematical, biophysical, and computational models of biological form. Its work combines data-informed modelling of plant morphodynamics—including the role of geometry, mechanics, hydraulics, hormonal signalling, and gene regulatory networks—in close collaboration with experimental biology teams; the development of original theoretical and computational methods for biology (image analysis, machine learning approaches, algorithms, and stochastic models); and the dissemination of open-source tools for quantitative biology, supporting reproducible and collaborative research.

CONSIDERATION OF THE RECOMMENDATIONS IN THE PREVIOUS REPORT

Previous recommendations mainly concerned three points.

First, strengthening the integration between modelling and experimentation. This has been impressively addressed through the development of strong interactions with several groups within RDP and beyond, broadening the biological questions tackled and reinforcing the team's capability to address diverse challenges. While the team contributed to major studies in animals (Science 2020), it has chosen to focus primarily on plant systems, in line with previous recommendations highlighting the difficulty of sustaining parallel work on highly distinct biological systems). This strategic choice is well justified, considering the integration of the team in RDP and the composition of the team, and has not diminished the impact of the team's research.

Second, the team was encouraged to develop theoretical and computational tools beyond specific biological applications and to publish them in more technical journals. MOSAIC has responded very positively, with strong publications reflecting significant methodological advances.

Finally, concerns were raised regarding open science practices, data storage and training, given the team's intensive computational activity. These aspects have been very well addressed, notably through coordinated actions such as workshops organized with computer scientists (SCLU) to promote and implement best practices.

TEAM WORKFORCE: IN PHYSICAL PEOPLE AS OF 31/12/2024

Catégories de personnel	Effectifs
Professeurs et assimilés	1
Maitres de conférences et assimilés	0
Directeurs de recherche et assimilés	1
Chargés de recherche et assimilés	2
Personnels d'appui à la recherche	4
Sous-total personnels permanents en activité	**8**
Enseignants-chercheurs et chercheurs non permanents et assimilés	0
Personnels non permanents d'appui à la recherche	1
Post-doctorants	2
Doctorants	5
Sous-total personnels non permanents en activité	**8**
Total personnels	**16**

EVALUATION OF THE TEAM

Overall assessment of the team

The team was assessed as outstanding overall. MOSAIC is internationally recognized for its leadership in computational and mathematical modeling of plant morphogenesis. Its strongly interdisciplinary approach—combining data-driven modelling, formal theoretical developments, and software platforms—has resulted in high-impact publications, competitive funding, and excellent training outcomes. The team also plays a key structuring role within both the laboratory and the international community. The main challenge ahead will be to anticipate the renewal of expertise linked to the future departure of the team leader.

Context-related strengths and opportunities

The team is internationally recognized for its leadership in computational and mathematical modelling of plant morphogenesis, extending to animal and fungal systems. Its impact is reflected in publications in major journals (2 Science, 2 PNAS, 4 Nature Communications, 1 Nature Plants, 3 eLife, 2 Current Biology, 2 PLoS Computational Biology, 1 Physical Review Letters, etc.) and high visibility (>45 invited talks, French Academy of Sciences prize for the Science paper on cauliflower phyllotaxis, co-organization of six conferences, editorial role at PLoS Computational Biology, etc.). It has pioneered morphoelastic models of plant organ growth and is recognized for contributions to applied mathematics, computational science, and software development (17 of such papers over 45). The team has also been successful in securing competitive funding (22 grants, including H2020, and 7 ANR) and in training (7 PhDs completed, 6 ongoing).

A key strength is its interdisciplinary approach at the interface of mathematics, computer science, mechanics, physics, and biology. Data-driven modelling in close collaboration with biologists is combined with formal theoretical developments and open-source tools. The 2022 recruitment of a professor strengthened the experimental and biophysical dimension and opened a new axis on the biophysics of large-scale growth-driven movements.

The team plays a highly structuring role within the lab and the international morphogenesis modelling community, bridging formal and life sciences. About half of its publications arise from collaborations with Signal, Biophysics/MecanoDevo, Seed-Evo, and Floral Morphogenesis teams (eLife 2020, Nature Plants review, Nature Com 2023–2024, Current Biol 2020, PNAS Nexus, EMBO J), and it co-organizes the annual Computational Plant Biology Workshop with the Sainsbury Lab. It has also developed open-source platforms, including GNOMON v1.0 for in-silico morphogenesis simulations, MORPHONet, and ROMI, highly valuable for the lab.

Finally, the team demonstrates strong engagement beyond academia. Through projects such as ROMI (H2020), it develops AI-based robotics and image analysis for sustainable agriculture with Sony SCL Paris, organic farms, and research institutions. Collaborations with Bayer Crop Science applied machine learning to predict essential genes in pathogenic fungi, and team members contribute to public science via masterclasses and ambassador roles at national science festivals.

Context-related weaknesses and risks

The team composition and structure are excellent, but they will face challenges with the upcoming retirement of the team leader in five years and the potential departure of one key member, both of whom ensure the team's strong expertise in computer science and mathematics.

MOSAIC's interactions with experimental scientists mostly involve plant biologists. As the team itself notes, the physics expertise of their collaborators is limited.
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The strongly interdisciplinary nature of the team's research can make publishing more challenging for PhD students (11 articles for 13 PhD students), although the scientific payoff is often high.

The project's trajectory does not clearly mention associated funding, which could represent a risk.

ANALYSIS OF THE TEAM'S TRAJECTORY

The MOSAIC team was established at RDP in 2018, partly as a continuation of the Inria Virtual Plants team in Montpellier, with additional contributions from an Inria team in Nancy. Its initial objective was to work in close, day-to-day interaction with experimental biologists to address ambitious questions in plant morphogenesis, while developing advanced computational and modelling tools in the field. After six years, the team has clearly met—and even exceeded—this expectation, achieving outstanding results in both scientific output and integration within the laboratory.

The trajectory for the next years aims at consolidating the scientific themes, around three tightly linked priorities.

The team will pursue data-driven modelling of morphogenesis across scales, from cellular processes to organ and whole-plant development, addressing how geometry, mechanics, and signalling shape growth and form, in a wide range of systems: pollen tubes, roots, seeds apical meristem, anther, leaves, climbing plant tendrils, in collaboration with teams at RDP and abroad. In parallel, the team will strengthen original theoretical frameworks inspired by biology, with a focus on growth in curved spaces (using Discrete Element Calculus or differential geometry concepts), multiphysics descriptions of tissues, and advanced algorithmic methods, supported by reinforced collaborations in mathematics and physics. Finally, computational platforms and open-source tools will remain central, with sustained efforts on robustness, usability, and integration of experimental data, alongside training and community-building initiatives to structure the emerging field of plant morphodynamics.

The team is very well positioned to address this ambitious project, thanks to its strong interdisciplinary expertise, further strengthened by the recent recruitment of an experimental physicist. A key challenge for the coming period will be to anticipate, both scientifically and administratively, the retirement of the team leader, which will coincide with the formal end of the Inria team, as well as the possible departure of a key member contributing expertise in stochastic modelling and machine learning. The succession is of high quality and well prepared, with the recent completion of an HDR and the reinforcement of the team's experimental and biophysical expertise. Nevertheless, additional strengthening in computer science and/or applied mathematics would be important to sustain the team's long-term ambitions.

RECOMMENDATIONS TO THE TEAM

The team is outstanding in all respects (productivity, academic and non-academic interactions, funding, visibility, open-science), and holds a strong leading international position in the field of computational biology and modelling. The primary recommendation is therefore to maintain and further strengthen this position (for instance by targeting additional international funding such as ERC grants).

The team is encouraged to continue providing a high level of interdisciplinary training for its students, while ensuring a balanced and sustainable publication output for PhD candidates.

New collaborations should be explored to further strengthen interactions with experimental physicists, either within ENS or through external collaborations.

The team will face significant changes in its composition in the coming years, including the retirement of the team leader within five years and the possible departure of a key member with expertise in applied mathematics and machine learning. It will be extremely important to design a recruitment strategy that secures the complementary expertise and excellence of the research.

Team 6: Seed Development Team (SeedDev)

Name of the supervisor: Ms Gwyneth Ingram

THEMES OF THE TEAM

The Seed Dev team studies the molecular mechanisms that enable cells and tissues to coordinate their development and function during sexual reproduction using the models Arabidopsis and maize. The group has developed several research themes, **1.** Peptide-receptor signalling acting to establish and monitor apoplastic barrier integrity in seeds and anthers; **2.** The role of mechanical signals in endosperm and seed coat morphogenesis; **3.** Maize haploid induction for breeding tools and to study pollen development and fertilization; **4.** The role of the embryo-endosperm interface in both maize and Arabidopsis.

CONSIDERATION OF THE RECOMMENDATIONS IN THE PREVIOUS REPORT

The Unit managed to replace the Biophysics expertise that was lost in the previous quinquennial (A. Boudaud) and the team interacts well with the MOSAIC team and produced a major publication on the role of mechanical signals in endosperm and seed coat morphogenesis. The team maintained strong interactions with the private sector even if P. Rogowsky is not anymore in the team (3 projects and 4 Cifre PhDs in the period). The different axes involving young team leaders developed strongly and lead to major publications without subject dispersion. All the recommendations from the previous report were addressed.

TEAM WORKFORCE: IN PHYSICAL PEOPLE AS OF 31/12/2024

Catégories de personnel	Effectifs
Professeurs et assimilés	0
Maitres de conférences et assimilés	1
Directeurs de recherche et assimilés	2
Chargés de recherche et assimilés	1
Personnels d'appui à la recherche	4
Sous-total personnels permanents en activité	**8**
Enseignants-chercheurs et chercheurs non permanents et assimilés	0
Personnels non permanents d'appui à la recherche	1
Post-doctorants	2
Doctorants	4
Sous-total personnels non permanents en activité	**7**
Total personnels	**15**

EVALUATION OF THE TEAM

Overall assessment of the team

The SeedDev team was overall assessed as outstanding. The team has high international visibility and is positioned at the forefront of research on cell-cell communication during reproduction. It has outstanding scientific productivity, impressive funding and exciting projects. All researchers have developed coherent projects that are well integrated in the global strategy of the team. The team stands out for its inter-disciplinary research and also has strong interactions with non-academic partners (notably through its leadership at national level in maize genome editing and transformation).

Context-related strengths and opportunities

Scientific productivity of the team is outstanding both qualitatively (Science, EMBO J., Nat Comm., PNAS) and quantitatively (29 papers, 2 patents, 17 reviews). A particular highlight is the Doll et al. 2020 Science paper, which describes the first example of a two-way peptide-mediated dialogue between embryo and endosperm that is required to establish and maintain an intact embryonic cuticle. Breakthrough papers such as this have helped the team achieve high international visibility, which is apparent in the high number of meeting and seminar invitations to PIs (53).

A key strength of the team is its ability to leverage diverse funding sources (public and private), amounting to a total of 3.787 Mill Eur over the reporting period. It secured 26 contracts, including 8 ANR, 4 ANRT and 2 ANR PEPR, and was coordinator for 22 of these contracts.

It is impressive to see how well the research projects across all groups align and integrate with the overall scientific goals of the team.

The team stands out for its strongly interdisciplinary research. This has been maintained by an IE in AFM indentation joining the team and the establishment of one of the team's scientists group focused on mechanical signalling. Highly productive collaborations with the MOSAIC team resulted in a major publication (Creff et al. Nature Comm 2023) and the Crystal medal award to one of the team's technical engineers which was first author of the Nature Comm paper.

The team has maintained its leading position at a national level in maize gene editing despite the loss the former group leader. The team's interactions with non-academic partners has been strengthened by the arrival of permanent personnel in maize genome editing and transformation. An impressive output of the team's long-term partnership with Limagrain plant breeding company was the filing of patent EP22306616.

Context-related weaknesses and risks

The team leader is the Director of the Unit, which entails large time commitments. There is a risk that she will have insufficient time to develop research projects and apply for funding at the current levels achieved by the team.

Another risk related to the current role of the team leader as Unit Director is that she may not have enough time to adequately guide and mentor the researchers and members of the team. To mitigate this risk, she could be supported by other team leaders to share administrative duties.

The interdisciplinary activities of the team must be maintained. Interactions with the MOSAIC team should be strengthened.

ANALYSIS OF THE TEAM'S TRAJECTORY

The team has four coherent research axes in cell-cell communication during reproductive development that have produced excellent recent publications. The first axis on apoplastic communication has many projects funded to continue with national and international collaborations. The increased focus on the role of ROS signalling in cuticle integrity and HAIKU signalling is exciting, as is the proposed link with axis 2. The second axis on mechanical regulation of seed growth will focus on strengthening existing collaborations with the MOSAIC team and international labs, and on exploring funding opportunities. The third axis on maize haploid induction is set to continue investigating the role of the peri-germ cell membrane in gamete release and developing breeding tools. The fourth axis on the embryo-endosperm interface in maize and Arabidopsis has ongoing projects with international collaborators. The perspectives of all research axes are excellent and the repartition of leadership is well explained. The funding already obtained (including 8 ANR, 4 ANRT, 2 ANR PEPR) assures the feasibility of the team's trajectory.

RECOMMENDATIONS TO THE TEAM

The team is outstanding in all aspects (scientific production, research integration, interactions with non-academic partners, communication and teaching) and the primary recommendation is therefore to maintain this level of outstanding scientific excellence and encourage the team leader to apply for an ERC grant.

The RDP director being the team leader should be able to delegate certain of her administrative duties to not penalize the activity of such an outstanding team.

Team 7: Cell Signalling and Endomembranes (SiCE)

Name of the supervisor: Mr Yvon Jaillais

THEMES OF THE TEAM

The SiCE team investigates basic mechanisms regulating cellular membrane system organization and dynamics underlying intra and inter cellular communications as well as the continuum of cell wall-plasma membrane-cytoskeleton to control cellular interaction affecting cell polarization and division plan. The team developed advanced tools for quantitative imaging and manipulation of membrane systems and employed highly interdisciplinary approaches to study subcellular mechanisms in the context of plant development.

CONSIDERATION OF THE RECOMMENDATIONS IN THE PREVIOUS REPORT

The team has addressed previous recommendations with excellence. Methodological developments are now convincingly linked to developmental biology, as demonstrated by high-impact work on nanoscale membrane signaling and cytokinesis. Modelling has been significantly strengthened through collaborations with MOSAIC and physics groups, providing deeper conceptual insights across the project. The leadership transition was well anticipated and has preserved coherence and productivity. HDR capacity has improved, with three HDRs now active and non-HDR scientists engaged in the process, allowing a more balanced distribution of doctoral supervision. A data-management strategy has been initiated and aligned with unit-level initiatives, although further consolidation would be beneficial. Administrative load, previously identified as a risk, has been contained, and the team has maintained strong scientific productivity, including major national distinctions and substantial grant acquisition. Overall, the team has constructively addressed recommendations and reinforced its scientific strategy.

TEAM WORKFORCE: IN PHYSICAL PEOPLE AS OF 31/12/2024

Catégories de personnel	Effectifs
Professeurs et assimilés	0
Maitres de conférences et assimilés	1
Directeurs de recherche et assimilés	2
Chargés de recherche et assimilés	1
Personnels d'appui à la recherche	2
Sous-total personnels permanents en activité	**6**
Enseignants-chercheurs et chercheurs non permanents et assimilés	1
Personnels non permanents d'appui à la recherche	3
Post-doctorants	5
Doctorants	1
Sous-total personnels non permanents en activité	**10**
Total personnels	**16**

EVALUATION OF THE TEAM

Overall assessment of the team

The SiCE team was overall assessed as outstanding. This team remains outstanding in both scientific productivity (with 43 research articles all published in high profile journals) and research fund raising (with 3 ERC and 8 ANR grants). The team undertakes highly interdisciplinary approaches, develops advanced methods and performs cutting edge research addressing fundamental questions in plant cell biology. It has established excellent collaborative networks, displaying high international visibility and leadership in plant membrane biology. The SiCE team demonstrates excellent links with society through strong industrial partnerships and public engagement.

Context-related strengths and opportunities

This is an outstanding research team. This team holds a leading position in plant membrane biology. The team has developed advanced methods at different levels (from molecular genetics, quantitative live imaging, to mechanical modelling) to investigate membrane composition or dynamics and function in cell signalling, cell division plan determination, and intra/intercellular communications in the context of plant tissues or pollen-stigma interaction. The team's work has led to the "membrane domain" concept in plant signalling.

The scientific output of the team is impressive with 43 research papers, 24 review articles and 3 book chapters (2.6 publications/FTE/year), mostly published in top ranked journals. From the 43 research papers, 18 were driven by team members as first and/or (co-) corresponding authors, including 1 Cell (appeared in 2025), 1 Science Advances; 1 Nature Plants, 1 Nature Protocol, 1 Current Biology; 2 eLife; 1 Plant Cell, 1 PLoS Computational Biology; 1 New Phytologist, 2 J. experimental Botany. Most of the review papers appeared also in very high-profile journals including Science, Nature Plants, Current Biology, Developmental Cell, Plant Cell, New Phytologist, Plant Physiology, Trends in Plant Science, Current Opinion in Plant Biology, and Annual review of Plant Biology. Many of the collaborative papers are published in highly visible and respected journals such as Science (1), Cell (1 published in 2025), Nature Communications (4), Nature Plants (1), Science Advances (2), Journal of Cell Biology (1), PLoS Biology (1), Current Biology (2) and eLife (2). The team has strong interactions with other teams within RDP in both methodological and conceptual development. In addition, the team has established a partnership with companies in microscopy and microfluidics sectors, which underscores the impact of technological advancement developed by the team.

The fundraising capacity of SiCE is outstanding, with 21 projects funded during the assessed period, including 3 ERC, 4 EMBO, 8 ANR, total >9000 k€ (335k€/FTE/year). The 3 ERC grants obtained by team members during the period can be considered as highlights of the team's activity.

Team members are highly visible internationally and are regularly invited to present seminars and conferences at international meetings and institutions and are active in organization of international webinar and networking. Several team members received prestigious national awards (Prix Axa-Académie des Sciences, 2 CNRS crystal medals).

The panel has also selected as a highlight of the team's activity the development of advanced tools to study plant membrane dynamics. Two engineers from the team are recipients of the CNRS Crystal Medal (2020 and 2022). The tools developed by the team contributed to several important discoveries, including fundamental principles governing intercellular trafficking by demonstrating, in a landmark *Science* paper (Li, Moreau *et al.*, 2024), that plasmodesmata arise from incomplete cytokinesis stabilized by ER–PM tethering complexes. Their subsequent *Cell* study (Perez-Sancho *et al.*, 2025) reveals that PI4P-dependent membrane contact site regulation fine-tunes plasmodesmatal architecture and cell-to-cell permeability. Together, these results establish plasmodesmata as dynamic, membrane-based communication hubs and redefine how tissues achieve supracellular coordination.

Context-related weaknesses and risks

The main structural vulnerability of the team lies in its limited technical support. The shortage of technician/lab-manager-level staff places a significant operational burden on researchers and engineers, generating a fragility in day-to-day laboratory functioning and potentially slowing down experimentation and student training. This constraint also amplifies other weaknesses, such as the lack of sustained biochemical expertise, which remains dependent on intermittent personnel and external collaborators. While this has not impeded high-quality science so far, it limits autonomy for certain mechanistic questions and could constrain future project diversification.

Data and biological material management remains another area of risk. The team produces substantial imaging, genetic and molecular datasets, yet long-term storage and standardized documentation are still insufficiently consolidated. As expectations regarding FAIR data increase, this point could become critical for reproducibility and compliance.

Although the team has navigated the recent leadership transition well, it remains a potential point of vulnerability: collective adaptation is ongoing, and maintaining strategic coherence will require continued attention. Human-resource capacity for supervision is also somewhat stretched.

Several external factors amplify these internal constraints. Administrative obstacles for international staff continue to complicate recruitment and onboarding in a team that relies heavily on global talent. Broader systemic uncertainties -energy costs, climate-related constraints on infrastructure, political instability affecting research funding- pose additional risks to long-term planning. Practical issues such as difficulties in accessing seed stocks since Brexit can result in delays and additional logistical burden.

Overall, none of these weaknesses compromise the team's current excellence, but they represent points where structural reinforcement will be essential to sustain its trajectory over the next evaluation period.

ANALYSIS OF THE TEAM'S TRAJECTORY

The team holds a strong position in studying fundamental mechanisms of membrane systems and interplay between components of the "cell wall-plasma membrane-cytoskeleton" continuum in development and reproduction, which will be boosted by developing next generation sensors for lipids and Rho GTPase activity and by employing targeted depletion of cytoskeletal components, as well as by a multidisciplinary approach and a strong interaction with other groups at RDP. The proposed 2 research axis benefit from funded European or French national projects and collaboration with chemists, physicists and mathematicians.

RECOMMENDATIONS TO THE TEAM

We encourage the team to maintain this level of excellence.

Nevertheless, we recommend expanding long-term expertise in biochemistry, which would enhance autonomy and complement existing strengths in imaging and cell biology.

The team is also encouraged to explore private and innovation-driven funding, leveraging partnerships with companies such as Carl Zeiss and other technology providers.

Team 8: Hormone Signalling and Development (SIGNAL)

Name of the supervisor: Mr Teva Vernoux

THEMES OF THE TEAM

The SIGNAL team studies how plant hormones, mainly auxin, act spatially and temporally to coordinate cell dynamics during the emergence of the shoot (phyllotaxis). The team developed biosensors coupled with a combination of interdisciplinary approaches to explore how new organs develop using seed plants (a multiple cell meristem) and mosses (a single cell meristem) as well as evo-devo approaches to dissect this developmental mechanism. They also develop high throughput robotics in the frame of an EU project (ROMI for Robotic microFarms). The team communicates through various media on how plant biology addresses societal needs and their research led to the creation of an original start-up company, the In Situ Lab (hosted by the ENS de Lyon).

CONSIDERATION OF THE RECOMMENDATIONS IN THE PREVIOUS REPORT

The recommendations raised during the previous evaluation notably emphasized ensuring that PhD students obtain first-author research papers - and not only review articles - within the timeframe of their PhD. During the reporting period, this recommendation was partially followed: three PhD students published first-author research articles (in *bioRxiv, Development* and *Nature*), although these publications appeared after the completion of their PhD. Two additional students authored review articles. It should be noted that while publishing in the best possible journals is encouraged, achieving this within a three-year PhD remains challenging and cannot realistically be guaranteed.

Regarding PhD supervision, the committee also recommended increasing the number of HDR holders. This recommendation has since been implemented, and the current number of HDR holders is four.

Finally, the committee advised the team to avoid the risk of dispersion by continuing to develop co-supervised projects. This recommendation was also followed, with the team leading several collaborative projects - notably in partnership with the MOSAIC team within RDP - on how plant hormones coordinate cell dynamics and shoot architecture across scales. Within the current organization of the SIGNAL team, the strong interdisciplinarity and the use of multiple model systems represent a clear strength and do not constitute a source of unproductive dispersion.

TEAM WORKFORCE: IN PHYSICAL PEOPLE AS OF 31/12/2024

Catégories de personnel	Effectifs
Professeurs et assimilés	0
Maitres de conférences et assimilés	1
Directeurs de recherche et assimilés	1
Chargés de recherche et assimilés	2
Personnels d'appui à la recherche	5
Sous-total personnels permanents en activité	**9**
Enseignants-chercheurs et chercheurs non permanents et assimilés	0
Personnels non permanents d'appui à la recherche	0
Post-doctorants	5
Doctorants	6
Sous-total personnels non permanents en activité	**11**
Total personnels	**20**

EVALUATION OF THE TEAM

Overall assessment of the team

The SIGNAL team was overall assessed as **outstanding**. The scientific production is outstanding both qualitatively (Nature, Cell) and quantitatively (26 papers). Together with collaborators they performed original interdisciplinary research and obtained outstanding funding. One young researcher contributed to developing the moss model in the team. Coordination of tasks was excellent for the global strategy (natural diversity, interaction with the MOSAIC team, cellular and quantitative biology on meristems). Excellent interactions with non-academic partners (EU ROMI project) and they created a spin-UP company.

Context-related strengths and opportunities

- Outstanding level of funding in fundamental research (175k€/FTE/year) and notably on the quantitative integration of auxin signalling in phyllotaxis (ERC TEMPO, Cell and Nature publications).
- The development of the moss model (lead by Y. Coudert) will bring nice perspectives to the work excelled in Arabidopsis (Curr. Biol.).
- Evo-devo approaches (eLIFE)
- The complementary research collaborators in computer modelling permitting the development of highly elaborated interdisciplinary research using the tools developed by the team
- Their outstanding expertise in biosensors and signal integration to address specific questions in the hormone field in auxin but also in many other hormones (cytokinins and gibberellins)
- Exceptional research environment at RDP for interdisciplinary research in plants.
- During the evaluated period, the team published 26 primary articles, 13 review articles, 3 book chapters and 2 science books (1.1 publications/FTE/year).

During the last reporting period the team achieved two highlights of its scientific activity consisting of: 1*: Truskina et al., Nature 2021*. They reveal that auxin sensitivity is hard-wired by a repressor network controlling ARF activators—reviving the Jacob–Monod model—and redefine how auxin shapes transcriptional diversity in plant development.: T. Vernoux co-founded In Situ Lab in 2020, a start-up developing plant-inspired, bio-sourced solutions for architecture and urban design. By harnessing phyllotaxis principles, the team created software that generates energy-efficient building and district designs, now protected and ready for deployment. A major 2024 Ministry of Culture grant (~700 000 €) is propelling this innovation toward market launch.

Context-related weaknesses and risks

Despite its strong performance, the team faces risks linked to the high interdisciplinarity of its projects, which require sustained coordination and technical support notably for mathematical modelling. Technical dependencies on external collaborators is nice but may also limit autonomy, including reliance on external modelling expertise and limited internal support for bioinformatics. Dependence on multiple model systems and advanced imaging/data-analysis platforms, together with challenges in data and biological material storage, may increase vulnerability to staff turnover and funding fluctuations.

ANALYSIS OF THE TEAM'S TRAJECTORY

The signal team will change its name to SIGNALS in DEVELOPMENTAL DYNAMICS to further reinforce this view and will have two co-leaders (Teva Vernoux and Yoan Coudert) to further mark an increased importance of the moss model in their research. The new themes follow logically the past research activities and will address how the spatio-temporal dynamics of meristem cells build plant shoots using quantitative cellular approaches, systems biology and computational modelling. Research axis 1 follows the recent paper on temporal integration of auxin information at the basis of the ERC Tempo project (T. Vernoux) and an EXPLOR'AE project (T. Vernoux). The team will now collaborate more strongly with the EpicDev team who can bring expertise in epigenomics. The second research axe aims to assess developmental robustness and will profit from the output of the ROMI EU project, the analysis of natural diversity in shoot branching using high throughput robotics and IA. They proposed to follow on the identified mutations affecting the plastochron and phyllotaxis in order to combine genetics with cell biology approaches for detailed mechanistic dissection of the process. The project will be led by a young researcher (F. Besnard) in the team and is supported by the ANR 4D plants. A 3rd axis, deals with bryophytes and is led by Y. Coudert. This axe is very original and can open nice perspectives on the regulatory mechanism involved in phyllotaxis. Globally, the trajectory of the team is excellent and follows on the

outstanding results obtained with an increased leadership of the young researchers in the team, mentored by T. Vernoux, on specific projects.

RECOMMENDATIONS TO THE TEAM

This team has done outstanding work during the last reporting period and the primary recommendation is to maintain its level of scientific excellence. It is also recommended to strengthen internal technical capacities in bioinformatics. We also recommend moving forward with the translation of the ROMI project into participatory science.

CONDUCT OF THE INTERVIEWS

DATES

Beginning: 5 February 2026 at 09:00

Ending: 6 February 2026 at 18:00

Interview conducted: remotely

PROGRAMME OF THE INTERVIEWS

February 5, 2026

08:40 – 08:55: Preparation of review

09:00 – 09:15 Presentation of the evaluation process and of the committee to the Unit
09:15 – 10:15 General presentation of the RDP (Gwyneth INGRAM) (30 min past activities, 10 min trajectory + 20 min questions)
10:15 – 10:30 Break

10:30 – 11:00 Team 1 (EPICDEV: Daniel BOUYER) (Presentation 20 min + questions 10 min)
11:00 – 11:30 Team 2 (EVODEVOFLOWER: Lucie RIGLETand Charlie SCUTT) (Presentation 20 min + questions 10 min)
11:30 – 12:00 Team 7 (SICE: Marie Cécile CAILLAUD and Yvon JAILLAIS) (Presentation 20 min + questions 10 min)
12:00 – 12:30 Team 4 (MORPHOFLO: Mohammed BENDAHMANE) (Presentation 20 min + questions 10 min)
12:30– 13:00 Hcéres committee debriefing

13:00 – 14:00 Lunch

14:00 – 14:30 Team 5 (MOSAIC: Christophe GODIN) (Presentation 20 min + questions 10 min)
14:30 – 15:00 Team 6 (SEEDDEV: Benoit LANDREIN and Gwyneth INGRAM) (Presentation 20 min + questions 10 min)
15:00 – 15:30 Team 3 (MECHANODEVO: Charlotte KIRCHHELLE) (Presentation 20 min + questions 10 min)
15:30 – 16:00 Team 8 (SIGNAL: Teva VERNOUX) (Presentation 20 min + questions 10 min)
16:00 – 16:15 Break
16:15 – 16:30 Bioinformatics platform (The HUB), Daniel Bouyer (Presentation 10 min + questions 5 min)
16:30 – 16:45 Plant Culture platform, Benoit Landrein (Presentation 10 min + questions 5 min)

February 6, 2026

9:00 – 09:30 Discussion with technicians and engineers (French)
09:35 – 10:05 Discussion with students and postdocs
10:10– 10:40 Discussion with permanent scientists (including team leaders but without directors)
10:45 – 11:15 Hcéres committee debriefing and coffee break
11:20 – 11:50 Discussion with the governing bodies
11:55 – 12:30 Discussion with the direction of RDP

12:15– 13:30 Lunch

13:30 – 16:30 Hcéres committee debriefing and report editing

GENERAL OBSERVATIONS OF THE SUPERVISORS

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La Vice-Présidence Recherche de l'ENS de Lyon à Madame la Présidente du HCÉRES, Les Conseiller scientifique et membres du Comité d'Experts,

Objet : HCERES – Rapport d'évaluation RDP –

Les tutelles n'ont pas d'observations de portée générale à faire remonter, si ce n'est les remerciements au comité pour le travail réalisé.

Evaluation of universities and schools
Evaluation of research units
Evaluation of the academic formations
Evaluation of the national research organisms
Evaluation and International accreditation

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