

EVALUATION REPORT OF THE UNIT  
LCB - Laboratoire de Chimie Bactérienne

UNDER THE SUPERVISION OF THE  
FOLLOWING ESTABLISHMENTS AND  
ORGANISMS:

Aix-Marseille Université - AMU

Centre national de la recherche scientifique -  
CNRS

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**EVALUATION CAMPAIGN 2022-2023**  
GROUP C

Report published on July, 07 2023



In the name of the expert committee<sup>1</sup>:

Erick Denamur, Chairman of the committee

For the Hcéres<sup>2</sup>:

Thierry Coulhon, President

Under the decree n° 2021-1536 of 29th November 2021:

<sup>1</sup> The evaluation reports "are signed by the chairperson of the expert committee". (Article 11, paragraph 2;)

<sup>2</sup> The president of the Hcéres "countersigns the evaluation reports established by the expert committee and signed by their chairperson." (Article 8, paragraph 5).

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

## MEMBERS OF THE EXPERT COMMITTEE

**Chairperson:**

Mr Erick Denamur, Université Paris Cité

**Experts:**

Ms Patricia Bordes, CNRS, Toulouse (representative of CoNRS)

Ms Priscille Brodin, Institut Pasteur Lille

Mr Stéphane Genin, CNRS, Castanet-Tolosan

Mr Patrick Linder, Faculté de Médecine, Université de Genève, Suisse

Ms Magali Mondin, CNRS, Bordeaux (supporting personnel)

Mr Jacques Oberto, CNRS, Gif-sur-Yvette

Ms Suzana Salcedo, Inserm, Lyon

Ms Olga Soutourina, Université Paris Saclay (representative of CNU)

## HCÉRES REPRESENTATIVE

Ms Anne-Marie Di Guilmi

## CHARACTERISATION OF THE UNIT

- Name: Laboratoire de Chimie Bactérienne
- Acronym: LCB
- Label and number: UMR7283
- Number of teams: 13
- Composition of the executive team: Mr Târn Mignot

## SCIENTIFIC PANELS OF THE UNIT

SVE4 Immunité, infection et immunothérapie

## THEMES OF THE UNIT

The LCB has developed a multiscale approach to the bacterial cell with the ambitious goal to link deep molecular mechanisms to cellular, consortial and even ecological scales.

The Unit has four major research axes:

- *The molecular bacterial cell axis* studies conserved building blocks of the bacterial cell.
- *The sensory bacterial cell axis* studies adaptation mechanisms and regulations.
- *The environmental bacterial cell axis* studies interactions with the environment and between cells.
- *The ecological bacterial cell* studies microbial biodiversity and its evolution.

Bacterial models such as *E. coli* (and its phages) and *B. subtilis* are studied as well as other species, *P. aeruginosa*, *Myxococcus*, *N. Meningitidis*, magnetotactic bacteria, and cyanobacteria.

## HISTORIC AND GEOGRAPHICAL LOCATION OF THE UNIT

The LCB was created in 1962. It is a CNRS-AMU UMR depending for the CNRS of the INSB. It is a cornerstone in fundamental microbiology in the French landscape of microbiology. It is located on the CNRS Joseph Aiguier campus in Marseille.

## RESEARCH ENVIRONMENT OF THE UNIT

The research environment is excellent and the LCB activities are integrated into a rich interdisciplinary area thanks to interactions with several Aix-Marseille Institutes, namely the Institut de Microbiologie Biotechnologies et Bioénergies (IM2B) and the Institute of Marseille Imaging (IMI) as well as with the Turing Center for living systems (CENTURI).

One point merits attention, there is no contact with the IHU Méditerranée Infection. This is understandable with the previous direction of the IHU but, with the new direction, there might be some collaboration opportunities.

## UNIT WORKFORCE: in physical persons at 31/12/2021

<b>Permanent personnel in active employment</b>	
Professors and associate professors	3
Lecturer and associate lecturer	10
Senior scientist (Directeur de recherche, DR) and associate	10
Scientist (Chargé de recherche, CR) and associate	14
Other scientists (Chercheurs des EPIC et autres organismes, fondations ou entreprises privées)	0
Research supporting personnel (PAR)	23
<b>Subtotal permanent personnel in active employment</b>	<b>60</b>
Non-permanent teacher-researchers, researchers and associates	2
Non-permanent research supporting personnel (PAR)	12

Post-docs	1
PhD Students	22
<b>Subtotal non-permanent personnel</b>	<b>37</b>
<b>Total</b>	<b>97</b>

**DISTRIBUTION OF THE UNIT'S PERMANENTS BY EMPLOYER:** Non-tutorship employers are grouped under the heading "others".

Employer	EC	C	PAR
CNRS	0	23	20
Aix-Marseille Université	13	0	3
Inserm	0	1	0
<b>Total</b>	<b>13</b>	<b>24</b>	<b>23</b>

## UNIT BUDGET

Recurrent budget excluding wage bill allocated by parent institutions (total over 6 years)	2 362
Own resources obtained from regional calls for projects (total over 6 years of sums obtained from AAP idex, i-site, CPER, territorial authorities, etc.)	243
Own resources obtained from national calls for projects (total over 6 years of sums obtained on AAP ONR, PIA, ANR, FRM, INCa, etc.)	5 418
Own resources obtained from international call for projects (total over 6 years of sums obtained)	3 775
Own resources issued from the valorisation, transfer and industrial collaboration (total over 6 years of sums obtained through contracts, patents, service activities, services, etc.)	412
<b>Total in euros (k€)</b>	<b>12 210</b>

## GLOBAL ASSESSMENT

The global assessment of the LCB unit is outstanding.

It has been a pleasure for the committee to evaluate the LCB thanks to the benevolent atmosphere, the quality and the rigor of the presentations and the level of the scientific discussions. First of all, we appreciated the leadership of the new director that endorses perfectly the job, closing the point on the succession. In the same line, the committee was impressed by the commitment of the unit to develop technological innovation in a rational and efficient way. Interdisciplinarity was also appreciated. The unit is clearly talented to gather grants and recruit researchers. All members of the unit are publishing in a panel of excellent speciality journals and some of them in high profile generalist journals. The committee particularly appreciated the collective spirit of the people.

The main advice of the committee is that the unit should increase their efforts for interacting between teams, especially with the arrival of the new teams that should be very well integrated. This will come only if a strong incitation is coming from the direction (support to the teams collaborating, incitation to have common PhDs). The whole will be greater than the sum of the parts.

## DETAILED EVALUATION OF THE UNIT

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

**Area 1: While the excellent quality of research and publication output of the top teams is unquestionably already at the world level, other teams should be strongly encouraged to publish more in high-impact factor journals. This would further increase the international visibility of these teams and of the LCB as a whole, and promote its competitiveness for best students and postdoctoral researches at the international level.**

The present committee completely agree with this point that has been moderately improved. A strong implication of the direction is needed.

**Area 2: To maintain the academic reputation and appeal of the unit, everything should be done to retain the unit leader, who is currently in negotiation for a position. The current unit leader's science and overall leadership is central to the success of the unit.**

The previous head of the unit moved to the Pasteur Institute in Paris, but the new head of the unit together with the two adjunct directors, did an outstanding job in guiding the unit.

**Area 3: A unit-wide strategy, on the basis of a written summary, should be implemented to dispatch important decisions and information from the group leader meetings to the team members;**

- a dedicated forum should be established once a year to allow post-docs and students to have access to the director and discuss topics of their choice;

- currently the same person is designated as representative of support staff and students/postdocs. It is recommended that two different persons represent the two groups;

- a platform that is highly active but understaffed would benefit from greater personnel support.

The unit was able to hire a CNRS IR for the platform (team 13, IAM), and a CNRS IE for the development of digital PCR.

**Area 3: the director is confident that the move of all the research groups to the new building should be completed before summer 2018. Particular attention is recommended towards this issue, especially in terms of communication to all members of staff;**

The unit is unified in the new building.

**Area 3: the problem of promotions for qualified staff needs to be addressed, by raising this recurrent and general problem to the next administrative level.**

Point moderately solved.

### B – EVALUATION AREAS

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

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

The assessment on the unit's resources is outstanding.

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

The assessment on the scientific objectives of the unit is outstanding.

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

The assessment on the functioning of the unit is outstanding.

## *1/ The unit has resources that are suited to its activity profile and research environment.*

### Strengths and possibilities linked to the context

LCB activity is distributed as follows: 40% research, 30% research supervision, 10% research administration, 10% research dissemination and 10% research valorisation and innovation.

LCB counts 97 members organized in 13 teams (13 professors and lecturers, 24 researchers and 23 engineers-technicians with permanent positions) supported by common services such as financial administration and human resources. With more than 20 HDR in the institute, forces for research supervision are well represented. In the field of innovation, LCB hosts a team dedicated to technological developments applied to microbiology to answer the specific needs of the research teams. To improve research dissemination, LCB recruited in 2021 a communication officer to improve LCB visibility in the scientific community but also to non-academic world.

Over the evaluated period the LCB had an average budget of 2 million euros per year (excluding salaries for permanent personal). Recurrent funds from supervising bodies represented in average 25% of the total amount of the 6 years and only 9% for the last year, showing a very good capacity of the LCB teams to get high impact research grants (2 ERCs, 26 ANRs). A fixed percentage of each contract is pooled to fund common resources, that are invested to promote collective research (760k€ for the period). These expenses were used to mainly fund scientific operations such as participating to buy equipment accessible for the IMM community (MiSeq, DigPCR), investing in the development of new technologies (FACS, servers for scientific calculation for AI) and buying and maintaining common equipment for the unit (-80°C freezers, nanodrop, etc.). Another important part of LCB funds was dedicated to the lab life to foster interaction between LCB members and with other labs, organizing internal and external events such as a lab retreat or EMBO workshops. The unit is also paying attention to the wellbeing of each team and part of this investment was dedicated to support one team during the period and very interestingly, the unit dedicates funds every year to finance one Master student per team. Finally, the unit also decided to invest in the external communication by recruiting a dedicated engineer.

In January 2021, the LCB has been relocated to completely renovated lab spaces in one single building. This improved inter team interactions, for instance with the setting up of common spaces for lab members (culture rooms) or specifically for students (writing room). Free space that was kept to welcome new team will be fulfilled in 2022. The LCB hosts important equipment facilities (imaging, a cell biology or a screening) which facilitates the access for lab members projects.

Finally, LCB is strongly involved in its local research environment. It has important interactions with the IMM (other teams and facilities), develops interdisciplinary projects with the CENTURI network, and participates to teaching programs being part of the IM2B project.

### Weaknesses and risks linked to the context

Considering the human resources, it appears that the distribution of personals within the teams is not homogeneous. Some teams can count 10 or 16 persons while others are composed only of 2 or 3 people. The small teams could be at risk in terms of dynamism and ability to properly conduct their research activity.

On the financial aspect, there is also an imbalance in the amount of contracts obtained by the different teams which can impair the solidarity based system for running LCB operation.

The amount of grants and contracts obtained by LCB teams increased in volume in the last years. To answer that, the creation of a financial pole has been promoted. Still this pole is only composed of 2 persons, one assistant engineer and one technician. The human resources dedicated to financial administration may be overwhelmed at some point by the quantity of contracts to handle (2 million euros per year and actually 2 ERC contracts and 26 ANRs over the period) if the activity of the unit keeps growing.

Finally considering space availability, with the gathering of all teams in the same building and recruitment of 2 new teams, there is not so much space left to plan the evolution of the unit in the future.

## *2/ The unit has set itself scientific objectives, including the forward-looking aspect of its policy.*

### Strengths and possibilities linked to the context

Scientific and financial strategies are decided by the group leaders. For major research strategies (team recruitment or major scientific directions of the unit), the unit consults with the Scientific advisory board (SAB) and the supervising bodies (INSB and AMU).

The study of microbial functions is essential to find solutions for societal challenging issues such as health and ecological crisis. These topics are considered as priorities by the INSB. LCB scientific strategy fit with these recommendations by following 4 major research axis to study the bacterial functioning: at molecular, cellular, multicellular and ecological level. To tackle these multi-scale objectives, the LCB teams are using a wide range

of models and techniques (genomics, transcriptomics, imaging etc.) thanks to the different accesses to facilities available in the local environment. In addition, to gather the necessary expertise to work on the different topics, LCB members were able to develop fruitful national and international collaborations. This latter point is illustrated, by the number of ANR/PRC projects obtained and published collaborative studies (see below for the quantitative analysis).

To expand its expertise, 2 young researchers will join the LCB early 2023 to set up their own team: one mathematician and one to develop microfluidic systems. The latter benefits from a "Chaire d'excellence" from AMU. The unit also strengthened the existing teams, recruiting new researchers and ITs. Five CRCN and 1 MCF were recruited through external CNRS and AMU competitions, 2 CRCN and 1 MCF from other units joined the LCB. LCB recruited 5 engineers from other units during the period to join research teams as well as the support services. This success in the recruitment of the LCB shows a clear attractiveness, and a strong support from the supervising bodies.

To be able to follow-up on the research, LCB invests in technological development mainly in 2 axes: imaging from atomic scale to community scale and high-throughput genetics and quantitative genomics. For both axes the investment consist in equipment and developments. Indeed, the unit invested in Super-resolution microscopy, but also in the development of the pipeline for high-throughput-genetics, deep sequencing and quantitative transcriptomics. The strategy chosen by the LCB is to couple equipment with the recruitment of expert personal to install the technology in house and make it accessible to the community. This strategy is possible thanks to LCB financial resources, completed by support from the institutions, and also through the IMM institute which allows to give access to complementary equipment and expertise.

## Weaknesses and risks linked to the context

The unit recently and rapidly created or recruited 5 teams. While one can recognize the dynamism of the structure it is also a risk of destabilization, creating new needs in personal or material that could impact the global operation of the LCB. Indeed, in the solidarity system that the unit applies, it can increase the needs for common funds to welcome all the new teams that may not be yet financial autonomous. On the aspect of administrative charge, increasing the unit perimeter rapidly can amplify the lack in human resources. This fast growing could also impact the dynamics in between teams and impair the general interactions by creating subgroups.

### *3/ The functioning of the unit complies with the regulations on human resources management, safety, the environment and the protection of scientific assets.*

## Strengths and possibilities linked to the context

LCB pays a particular attention to the wellbeing in the unit. The career evolution of staff members is well followed, trainings are encouraged (30% of the personal follows a training each year), and they are helped by the unit to get promotions (interview preparation, work on the "dossier carrière", workshop organization for ITs). As a result, over the 2016-2021 period 8 researchers and 11 ITs got a promotion. The insertion of newcomers is also well organized by the different referents for HR and H&S.

To maintain a favourable laboratory life environment and exchanges, scientific and non-scientific events are regularly organized to gather all LCB members (lab retreat, Christmas celebrations etc.). The building organization, where different common spaces (store, communication room and thesarium) have been set-up, creates informal places for LCB members to interact daily.

During the time of COVID crisis, LCB also supported its personal, with training to manage psychosocial risks, local support and reference to the delegation's social services or preventive medicine if needed. The LCB even organized special events for science students during the pandemic to avoid that they give up during this difficult isolation period. Generally, COVID crisis was well handled by promoting working from home and giving needed equipment for personal to do so. The return to the lab was organized so that the total amount of people on site didn't exceed the authorized density. Finally, lab members were provided all the necessary equipment to protect themselves (masks and hydro alcoholic solution), and COVID cases were followed up to ensure proper isolation and information to contact cases. Doing so even if some COVID cases were reported in the unit, there were no clusters from the unit.

LCB is careful about data storage and protection, all the network construction and management (Local Server with multiple copies of the data, access to the data through an active directory system etc.) is meant to ensure this. Following institutions recommendation, LCB started to set-up data management plan, electronic lab books and archiving.

LCB created the "Ecocell" (5 LCB members) working on reducing carbon footprint and improving wastes recycling. For instance, traveling has been reduced by the creation of the "com'box" to facilitate virtual meetings, and some plastic tools were replaced by glass to reduce waste.



## Weaknesses and risks linked to the context

Short term contracts ITs should be encouraged to follow trainings to secure their stay in the and/or to access permanent positions in the future.

In terms of parity, the distribution is uneven. The lab is composed of 75 members with tenured positions with a women/men balance of 60/40%. When focusing on researchers positions there is perfect 50% repartition between men and women, but looking at ITs position, 77% of ITs are women. When focusing on team responsibility only 23% of the 13 teams are led by women, 2 of the last 3 teams recruited to reinforce the unit are also led by men. There should be efforts to recruit women at responsibility position to improve women visibility.

## EVALUATION AREA 2: ATTRACTIVENESS

### Assessment on the attractiveness of the unit

The attractiveness of the unit through international oral presentations/invitations, participation at the organization of meetings, editorial activities, prizes and awards, as well as granting and recruitment of students, postdocs and group leaders, is outstanding.

*1/ The unit has an attractive scientific reputation and contributes to the construction of the European research area.*

## Strengths and possibilities linked to the context

The efforts of the unit to communicate at any level to share results, recruit students and hire international PhD students and postdocs, as well as the recruitment of new groups, and search for competitive funding are excellent and contribute to an outstanding visibility of the unit.

In more detail, members of the unit have participated or were invited 58 times to international seminars or meetings. The Unit has organized several meetings, national and international, like for example "Bacterial electron transfer, processes and regulation" in March 2018 and two EMBO Workshops in 2022 "Adherent Microbial Communities" and "Bacterial Networks". Some of these meetings (Ecole thématique de Microbiologie Moléculaire, Microbiology at a glance) are devoted to students and are contributing to the visibility of the unit and the potential recruitment of new members. Members of the unit participate actively at editorial boards of scientific journals (some of them with high impact (e.g., Scientific Reports, Faculty 1000, J.Bacteriology, eLife)) or at national and international committees and recruiting panels (34 times; e.g., CNRS, Hcéres, National Fund for Scientific report in Belgium, Search committee EMBL, Germany, Member of Scientific Advisory Board (CIRB, Collège de France)). Members of the unit received 6 prestigious awards or grants (e.g., Jacques Monod Award, ERC advanced grant, CNRS Bronze Medal). The unit is involved in the LIA-MagMC bringing together researchers and ressources from Israel and China. This connection with Asia is certainly a very strong asset.

## Weaknesses and risks linked to the context

None.

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

## Strengths and possibilities linked to the context

The unit has an international recruitment policy and therefore scientific and non-scientific communications are mainly performed in English. The unit recruited 9 researchers and 5 ITs during the period and obtained a chair of excellence by A\*MIDEX. This recruitment is at the time of this report writing is under way. The unit is also attractive to students, hosting many undergraduate and graduate students, 48 PhD students during the evaluation period have integrated the unit and 10 post-docs, 6 of whom were foreigners.

The unit profits from the RH provided by the delegation. New personnel is helped to integrate in the laboratory but also in social life. The unit offers the participation in training courses and holds sessions to guide personnel on career management and development. Several members of the unit have training in management of psychosocial risks to guard the wellbeing of the personnel and orient them when needed to the appropriate CNRS services.

## Weaknesses and risks linked to the context

Although significant improvement has been made since the last evaluation, but, despite its excellent scientific achievements and its international recognition, postdoc recruitment could be improved as not all teams have hosted postdocs during this mandate.

*3/ The unit is attractive because of the recognition gained through its success in competitive calls for projects.*

## Strengths and possibilities linked to the context

Members of the unit are very successful in obtaining highly competitive grants. A total of 26 ANR contracts were obtained among which 22 are coordinated by the unit which received the amount of 8,4 M€. An important contribution arises from charity agencies fundings: 7 contracts from FRM, AFAF, VLM for a total amount of about 300 k€. The CNRS and the region PACA supported 14 projects, among which the PIA-AMIDEX call devoted to a Chaire d'Excellence position (175 k€). One international contract was received and coordinated by a team, CEFIPRA (97 k€). Two Prestigious ERC contracts were received and coordinated by the two recipient team leaders for a total of 3,7 M€.

To exemplify the contribution of the contracts in the total budget of the unit, the data for 2021 are here provided. The total budget is of 2,46 M€, from which the institutional participation is of 430 k€, representing 17%. The ANR and ERC grants represent 51,3% and 25,8%, respectively of the total budget; the CNRS, AMU and region parts are of 6,5%, 2,4% and 1,2%, respectively. The fundings arising from foundations and industrial contracts represent 12,8% of the 2021 budget.

## Weaknesses and risks linked to the context

Two groups have not yet obtained ANR grants.

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

## Strengths and possibilities linked to the context

To be able to follow-up on the research, LCB invests in technological development mainly in 2 axes: imaging from atomic scale to community scale and high-throughput genetics and quantitative genomics. For both axes the investment consist in equipment and developments. Indeed, the unit invested in Super-resolution microscopy, but also in the development of the pipeline for high-throughput-genetics, deep sequencing, quantitative transcriptomics (MiSeq, DigPCR equipment) and development of new technologies (FACS, servers for scientific calculation for AI).

The strategy chosen by the LCB is to couple equipment with the recruitment of expert personal to install the technology in house and make it accessible to the community. This strategy is possible thanks to LCB financial resources, completed by support from the institutions, and also through the IMM institute which allows to give access to complementary equipment and expertise. Furthermore, a fixed percentage of each contract is pooled to fund common resources, that are invested to promote collective research (760k€ for the period). External users pay services or get access through scientific collaborations.

## Weaknesses and risks linked to the context

No major weakness are noticed.

## EVALUATION AREA 3: SCIENTIFIC PRODUCTION

### Assessment on the scientific production of the unit

The assessment of the unit production is excellent to outstanding.

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

##### Strengths and possibilities linked to the context

During the evaluation period 2016-2021, the LCB has published 155 scientific articles indexed in Pubmed in high and very high profile journals: *Nature*, *Nature Comm.*, *Nature Microbiol.*, *ISME J.*, *eLife*, *mBio*, *PLoS Genet.*, *PLoS Biol.*, *EMBO*, *PNAS*, *Front. Microbiol.*, *Appl. Micro.*, *Biotech.*, *ACS Catalysis*, *Appl. Environ.*, *Biotech.*, *Mol. Microbiol.*, *FRBM*, *Sci. Rep.*, *J. Bact.*, *JBC*. For 111 publications, members of the unit are leaders of the studies (last authorship position), among which in very prestigious journals, *Nature*, *Nature Microbiol.*, *Nature Comm.*, *mBio*, *PLoS Genet.*, *PNAS*.

Several reviews and opinions (33) have been published again in high profile journals: *Mol. Microbiol.*, *Nature Reviews Microbiol.*, *Médecines/Sciences*, *FEMS Microbiol. Rev.*, *Curr. Opin.*, *Cell Biol.*, *Curr. Opin. Microbiol.*, *Methods in Mol. Biol.*

##### Weaknesses and risks linked to the context

An effort should be made to encourage some teams to increase publication in high profile journals.

#### *2/ Scientific production is proportionate to the research potential of the unit and shared out between its personnel.*

##### Strengths and possibilities linked to the context

The scientific production of LCB is of excellent level with several articles and reviews published in highly renowned journals. The overall production is shared equally between the different members and includes the direction, researchers, PhDs and postdocs.

##### Weaknesses and risks linked to the context

The number of publications that result from a collaboration between LCB teams should definitively increase.

#### *3/ The scientific production of the unit complies with the principles of research integrity, ethics and open science.*

##### Strengths and possibilities linked to the context

Publications from IGS are available through the HAL platform and therefore complies with the open science principle. Several opinion articles challenge scientific dogmas and participate to the scientific debate.

##### Weaknesses and risks linked to the context

No specific weaknesses have been identified.

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

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

Interactions with non-academic and socio-economic world are excellent. The communication activity with general public is outstanding.

#### *1/ The unit stands out by the quality of its non-academic interactions.*

##### Strengths and possibilities linked to the context

Contacts with the non-academic agencies are identified through the funding of projects addressing environmental and health issues. The unit received 2 contracts from FRM of 36 k€ and 102 k€, one contract from AFAF (Association Française de l'Ataxie de Friedreich) and 4 from VLM (Vaincre la Mucoviscidose) for a total of 128 k€.

##### Weaknesses and risks linked to the context

Only three teams are concerned by such interactions.

#### *2/ The unit develops products for the socio-economic world.*

##### Strengths and possibilities linked to the context

The unit is involved in value-adding activities through its various research areas. Contracts have been established with BIOLINE Agrosciences France and NEOMERYS (183 k€) to promote the therapeutic potential of bacteriophages in the phytosanitary field. The company Idylle markets microscope slides coated with chitosan to promote bacterial adhesion. Patents have been filed to develop CO<sub>2</sub> bioremediation approaches. Other projects are in the process of maturation via the SATT-Sud Est agencies, France Relance plan, CNRS pre-maturation, Capenergies to develop recombinant microorganisms whose functionalized membranes offer innovative biotechnological perspectives.

##### Weaknesses and risks linked to the context

No specific weaknesses have been identified.

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

##### Strengths and possibilities linked to the context

The remarkable reputation of the unit and the strong will of the management team have led to the setting up of an extremely efficient communication unit. The involvement of people who master computer tools (computer graphics, video, social networks) and the active participation of the unit's members combine to produce a large number of mediation actions for the general public: Fête de la science (10 years of participation), Year of Biology 2021-2022 (YouTube videos, conferences and visits to the LCB), Chroniques Microbiennes series and COVID-19 communication (YouTube videos), Apprentis Chercheurs and Déclics (workshops), meetings between and with researchers (Pint of Science, Comptoir des Sciences), communication in the local (La Marseillaise) and international written press (Huffpost blog).

##### Weaknesses and risks linked to the context

No specific weaknesses have been identified.

## C – RECOMMENDATIONS TO THE UNIT

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

Continue to obtain national and international grants. Be sure that there is not too much disequilibrium between the teams by eventually compensatory mechanisms. Push for inter-teams collaboration by strong incentive measures.

### *Recommendations regarding the Evaluation Area 2: Attractiveness*

Be careful to be able to receive the new groups in the same favourable conditions that the groups already present.

### *Recommendations regarding Evaluation Area 3: Scientific Production*

Continue like that but also push all teams to publish in high profile journals.

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

Extend the valorisation and the diffusion of knowledge.

## TEAM-BY-TEAM ASSESSMENT

**Team 1:** Phage cycle and bacterial metabolism  
 Name of the supervisor: Ms Mireille Ansaldi

### THEMES OF THE TEAM

The team works in the field of phage biology and develops three main axes in the interface between basic and applied research. First axis is devoted to the analysis of phage-bacteria interactions and integration in bacterial regulatory networks. The cross-regulations themes include the study of host factors involved in the maintenance of prophages and host takeover in early steps of infection and the prophage genes contributing to the host stress responses. The second axis addresses topics aimed to develop therapeutic phages, biocontrol and diagnostic tools by studying phage-antibiotic synergy, a control strategy against emerging phytopathogen infection disease and a phage biosensor based on epigenetics. The third emerging axis deals with the analysis of genomic and functional biodiversity of phages.

### CONSIDERATION OF THE RECOMMENDATIONS OF THE PREVIOUS REPORT

Concerning publications, the auto-evaluation report indicates that the scientific production has been delayed during the current period and will be resumed in coming years. During the evaluated period 2016-2022, 11 publications are reported in the team composed by 3 permanent scientists (DR, CR and lecturer)

The comments on the attractiveness for young students/foreign postdocs and international collaborations are well addressed with the recruitment of several PhD and postdocs/CDD, supervising of Bachelor, Master, DUT students and international mobility of the team leader to Spain for collaborative project.

The recommendation to maintain strong academic-industrial partnerships is well followed with various academic and industrial projects associated with grants.

The point on rapid acquisition of HDR by two newcomers remains to be addressed. The assistant professor and CR1 researcher actively participate in the co-supervision of the students, in leading of research topics and getting their projects funded. With some publications co-signed with co-supervised students all the criteria will be met for them to obtain an HDR.

The evaluation committee recommended to concentrate on basic projects with existing funding. The team was successful in combining both basic and applied projects related to phage-bacteria interactions and the use of phages as biocontrol agents and diagnostic tools.

Based on the accumulated genomic data and the establishment of a phage collection a new basic research axis emerged on the genomic and functional diversity of phages supported by the new research engineer that joined the team in 2021.

### WORKFORCE OF THE TEAM

<b>Permanent personnel in active employment</b>	
Professors and associate professors	0
Lecturer and associate lecturer	1
Senior scientist (Directeur de recherche, DR) and associate	1
Scientist (Chargé de recherche, CR) and associate	1
Other scientists (Chercheurs des EPIC et autres organismes, fondations ou entreprises privées)	0
Research supporting personnel (PAR)	1
<b>Subtotal permanent personnel in active employment</b>	<b>4</b>
Non-permanent teacher-researchers, researchers and associates	1
Non-permanent research supporting personnel (PAR)	2
Post-docs	0

PhD Students	3
<b>Subtotal non-permanent personnel</b>	<b>6</b>
<b>Total</b>	<b>10</b>

## EVALUATION

### Overall assessment of the team

The overall assessment of the team is very good to excellent. The strength is in the balance between basic and applied projects with industrial partners and regular funding.

### Strengths and possibilities linked to the context

The team has completed an impressive increase in its workforce with a good balance between permanent and non-permanent staff, increased its international visibility by attracting international students and postdocs. The international mobility of the team leader in 2017-2018 had a positive impact on the attractiveness of the team and the development of fruitful collaborations. The expertise in bioinformatics has been strengthened by the arrival of research engineer.

The projects are organized in three jointly led axes with strong interactions and complementary expertise. The PIs have obtained several grants from national public (ANR grants TakeOverBact (2017-2022), Salmo\_prophages (2016-2021), BacPhageChat (2018-2022)). They developed strong academic-industrial partnership associated with industrial funding for 3 projects (BIOLINE Agrosiences France 2016-2019; 2020-2022; NEOMERYS 2019-2022). The XyloPhage project obtained the support of the Plan France Relance for the creation of a Joint Laboratory between the LCB and BIOLINE Agrosiences.

The team is developing high quality projects in the field of phage biology with well-balanced basic and applied science topics matching with current society challenges for health and agriculture that have multiple applications for therapy (animal, plant, human health), health and environmental monitoring.

The team published 11 publications during the period including 6 signed at leading positions in specialized or more general journals (*Viruses 2021*, *Environ Microbiol 2020*, *Mol Microbiol 2019*, *Environ Sci Pollut Res Int 2017*), in high-impact journals (*ISME J 2020*) and 5 reviews (*Viruses*, *Mol Microbiol*, *Virologie*). The current successful projects will lead to additional publications in coming months (PhD thesis 2022, BioRxiv deposit 2022).

The team participates in teaching (Aix-Marseille University assistant professor) and in supervision of various level students, succeed in obtaining a variety of resources to fund PhD thesis (French ministry fellowships, Cifre thesis, CNRS Prime'80 program, international thesis) and projects (institutional, public/private partnerships and foundation funding).

The team benefits from stimulating environment within the LCB and has access to cutting-edge technologies available in LCB and various platforms in IMM.

The team is strongly involved in the national Phage.fr network (the team leader is a board member and has received a price François Sommer Homme Nature in 2018) and has created a society for bacteriophage studies in 2019. The team leader has established editorial activity in *Viruses MDPI* journal 2018-2022 and as a guest editor for *PLoS Genetics*.

The team participates in various actions toward the general public as exemplified by several participations in media programs (TV5 Monde, France Culture, AFP, Le Parisien), in development of e-learning support and in awareness and popularization actions.

### Weaknesses and risks linked to the context

The scientific production of the team is very good but has been delayed during the current period and needs to be resumed in coming years with finalization of ongoing projects.

Only the team leader holds her HDR for a total of 3 potential HDR in the team.

The team leader is heavily involved in collective responsibilities as a deputy-director of the unit, as a member of scientific council of the platform, joint commission of CNRS, recruitment committees and thesis juries. These functions are basically positive but can become negative if they overwhelm research activity.

With the growing number of projects and experimental models handled in the team, the focus on high priority projects needs to be considered.

## RECOMMENDATIONS TO THE TEAM

The difficulties with growing team and limited space and technical support available should be anticipated.

The team should now be stabilised and avoid dispersion.

The preparation of two additional HDR by PIs of the team could have a positive impact in the whole team and personal PI developments.

The team should continue to publish their results in high-profile journals.

The prioritization of the projects and implemented new models for plant and human pathogens may be considered in line with available human resources and equipment.



**Team 2:** Oxidative stress damage and repair in enterobacteriaceae  
 Name of the supervisor: Mr Benjamin Ezraty

## THEMES OF THE TEAM

The team is involved in 3 out of 4 main axes of LCB: molecular bacterial cell (Axis 1), sensory bacterial cell (Axis 2) and ecological bacterial cell (Axis 4). The team focuses on understanding the mechanisms of protein repair subsequent to an oxidative stress (ROS) in Gram-negative bacteria, *Escherichia coli* and *Salmonella*. The team's 4 main objectives are: 1) characterization of the periplasmic Msr system; 2) identification of Msr-dependent processes; 3) deciphering the role of Msr during Reactive chlorine stress (RCS); 4) understanding the contribution of Msr in pathogenicity in a newly developed model of *Salmonella* infection of *Galleria mellonella* larvae.

## CONSIDERATION OF THE RECOMMENDATIONS OF THE PREVIOUS REPORT

The team "Oxidative stress damage and repair in enterobacteriaceae" emerged during this period. There is thus no recommendations from the previous report. The team was created through a smooth established procedure involving the LCB faculty and SAB and approval of the INSB and AMU.

## WORKFORCE OF THE TEAM

<b>Permanent personnel in active employment</b>	
Professors and associate professors	1
Lecturer and associate lecturer	0
Senior scientist (Directeur de recherche, DR) and associate	0
Scientist (Chargé de recherche, CR) and associate	1
Other scientists (Chercheurs des EPIC et autres organismes, fondations ou entreprises privées)	0
Research supporting personnel (PAR)	1
<b>Subtotal permanent personnel in active employment</b>	<b>3</b>
Non-permanent teacher-researchers, researchers and associates	0
Non-permanent research supporting personnel (PAR)	1
Post-docs	0
PhD Students	2
<b>Subtotal non-permanent personnel</b>	<b>3</b>
<b>Total</b>	<b>6</b>

## EVALUATION

### Overall assessment of the team

The team publication record is excellent with regards to the size of the team. The training of 4 PhD with high-profile publications is excellent. The team's involvement in transfer and connections to the economic world and dissemination to the society are also excellent.

## Strengths and possibilities linked to the context

The 4-year old team comprises 6 members on average for the evaluation period: 2 permanent researchers, 1 permanent PAR and trained 3 PhD. During the evaluated period, the team highlighted 4 key discoveries. First, in collaboration with EMBL, the team showed that silver is able to potentiate the activity of antibiotics (aminoglycosides) and even sensitize anaerobic bacteria to aminoglycosides (*Mol Mic, Nature*). Second, the team demonstrated that ROS induced the oxidation of RecA recombinase at its methionine residues resulting in impaired RecA-mediated recombination. The team further showed that methionine sulfoxide reductases MsrA and MsrB are able to restore RecA activity, thereby revealing a central role of MsrA/B in bacterial homeostasis (*Elife*). Third, the team established that RCS induced the expression of MsrP/Q via the two component system HprS (*J Bact* 2021) thus suggesting HprSR to be the first two component system to detect RCS in *E. coli*. Fourth, the team developed a host-pathogen interaction model of *Galleria mellonella* worm infection by *Salmonella* and studied the impact of ROS. Their results led to the conclusion that ROS production in this system is critical for clearing the bacterial colonization. The team authors as PDC 5 primary research articles in excellent journals (*Mol Microbiol, eLife, Front. Cell. Infect. Microbiol., J. Bact, Free Radical Biology and Medicine (FRBM)*) and 6 reviews (*Nature Reviews Microbiology, Med Sciences, Front Mol Biosci. Antibiotics*). The team also is joint authors in several other publications from the Unit or through international collaboration (*Nature*). There is a well-balanced publication output from the two researchers. The same holds for the 3 PhD students that were trained during the period.

The team has the necessary funding for its research at national level and international level (3 ANR, CNRS support, CEFIPRA, JPI-ANR).

The team has established collaborations with key partners in Europe (CNRS PICS-Belgium, Spain, EMBL-Germany) and honoured invitations in 2<sup>n</sup> international conferences. The team is also involved in the GDR Nox/ROS.

The team is involved in technology transfer and connections to the economic world through partnerships with CNRS, SATT-Sud Est, CIFEC and ERDYN company for the detection chlorinated contaminants. For instance, the team set-up an easy-to-use and inexpensive chlorine-derivative detection test for the unmet need in agrifood companies.

The team is also very active in communication to the public: active publication on *Médecine Sciences*, organization of the exhibition of the 80<sup>th</sup> anniversary of CNRS, participation in Declic action, MT180, general conferences on mRNA and vaccines, present on social networks. Taken together the team made excellent contributions in all areas.

## Weaknesses and risks linked to the context

No strong weaknesses were identified. The team has not significantly attracted postdocs during this mandate, nor international staff.

## RECOMMENDATIONS TO THE TEAM

The team would benefit to attract international post-doc and students. Increasing its presence in international meetings could help attract candidates for European fellowships (EMBO J, Marie Curie).

**Team 3:** Cellulosomes and degradation of plant polymers  
 Name of the supervisor: Mr Henri Pierre Fierobe

## THEMES OF THE TEAM

The research theme of the team focuses on the degradation of polymers constituting the plant cell wall, by characterizing the enzymatic activities of the strict anaerobic bacterium *Ruminiclostridium cellulolyticum*, which has the remarkable property of degrading and metabolizing almost all the polysaccharides contained in the plant cell wall. By combining biochemical, genomic and molecular genetic approaches, the team has characterized the degradation pathways of several polysaccharidic compounds (cellulose, arabinoxylan, xyloglucan) and has recently started the study of the lignin degradation pathway using a transcriptomic approach to identify candidates. A synthetic biology project resulted in the creation of a prototype *E. coli* strain with cellulolytic activity.

## CONSIDERATION OF THE RECOMMENDATIONS OF THE PREVIOUS REPORT

Considering that four permanent researchers had heavy teaching duties, the previous evaluation recommended the recruitment of post-doctoral researchers or an additional permanent researcher. Although not successful for the post-doctoral researchers, the team recruited one permanent CNRS researcher in 2020, which fully meets the recommendation. MCFs were also encouraged to obtain their HDR to increase the potential of the team to host PhD students. It is thus satisfying to see that one additional HDR has been obtained during the mandate, for a total of 3. The team was also recommended to develop collaborative links with other groups, and this was achieved during the mandate by participating in an international project involving 5 laboratories from 5 European countries, which also allowed the team to recruit an engineer.

## WORKFORCE OF THE TEAM

<b>Permanent personnel in active employment</b>	
Professors and associate professors	1
Lecturer and associate lecturer	3
Senior scientist (Directeur de recherche, DR) and associate	1
Scientist (Chargé de recherche, CR) and associate	1
Other scientists (Chercheurs des EPIC et autres organismes, fondations ou entreprises privées)	0
Research supporting personnel (PAR)	1
<b>Subtotal permanent personnel in active employment</b>	<b>7</b>
Non-permanent teacher-researchers, researchers and associates	0
Non-permanent research supporting personnel (PAR)	1
Post-docs	0
PhD Students	2
<b>Subtotal non-permanent personnel</b>	<b>3</b>
<b>Total</b>	<b>10</b>

## EVALUATION

### Overall assessment of the team

The scientific production over the period is excellent considering the number of permanent researchers, as several team members are strongly involved in teaching. The team is also strongly connected with industrial partners and develops relevant projects of potential biotechnological applications.

### Strengths and possibilities linked to the context

The team has an undeniable expertise in its field. One of its strengths is combining genetic and biochemical approaches to address the scientific questions. The team has made significant advances on the characterization of the mechanisms involved in the transport and catabolism of several complex wall carbohydrates. The mechanisms of cellulose, xyloglucan and araboxylan depolymerization have been accurately described, including the characterization of the transport processes of the degradation products and the regulation of gene expression in these catabolic pathways.

During the evaluation period, the group has produced 16 publications in very good specialized journals [such as *mBio* (1), *Biotechnol. Biofuels* (3), *FEBS J.* (2), *Metab. Eng. Commun.* (1), *Appl. Environ. Microbiol* (1)...], or generalist journals [*Scientific Reports* (2)], among which 12 have contributions of team members either as lead or last author. This is a very good achievement considering that four permanent researchers have heavy teaching duties, which testifies to their strong investment in research production.

The team has attracted a newly recruited CNRS researcher in 2020, which is a very positive aspect for the team and has allowed the increase of permanent staff dedicated full time to research. The team has also attracted and trained many trainees, as well as 4 PhDs during the evaluation period, which is a good record. All PhD students have published articles as first author, attesting for the quality of the supervision. There is a strong involvement of the team members in the teaching and pedagogical and administrative responsibilities.

The team has successfully developed industry-based projects, the most recent being in collaboration with other European partners. A significant marker is the filing of a patent for a modified *E. coli* strain for biotechnological applications. The team has also been very successful in seeking funding from contracts since 3 ANR contracts with a member of the team as project leader were obtained during the evaluated term, as well as a contract with a private partner.

The team actively participates in science outreach programs in schools and communities (e.g. Declics, Fête de la Science, supervision of high-school student interns).

### Weaknesses and risks linked to the context

Considering the quality of the work produced and its members proven expertise, the visibility of the team at the international level is below what is expected. The contribution of the team to high-standard international conferences is limited. The panel also notes the limited implication of the team in editorial activities, or the production of review articles (none during the evaluation period), as well as no notable activity in the media or social networks, all different types of actions that would improve the team's visibility and recognition.

## RECOMMENDATIONS TO THE TEAM

The quality of the articles produced over the period is of a very good level but the team should continue its efforts to publish in the best journals, as was done recently for the xyloglucan case study article in *MBio*, which will also help to broaden the audience of the team research. We recommend an increase in communicating the team's work in international conferences, and to the general public to increase the interaction with the social and cultural environment. Increasing the team's visibility will help attract post-docs which would strengthen the research projects of the team.

Although the team is strongly linked to the industrial partners, no staff was partially or totally financed by them (e.g. PhD thesis), and this aspect could probably be improved.

**Team 4:** Metabolism and regulation of cellular processes in bacillus subtilis  
 Name of the supervisor: Ms Anne Galinier

## THEMES OF THE TEAM

Team 4 uses *Bacillus subtilis* as a model system to study cell wall integrity and bacterial shape, the mode of action of antimicrobial peptides, protein kinases and phosphorylation events in the regulation of cellular processes, and - in collaboration - the effect of proteases in quality control of membrane proteins. The projects are very timely and reflect the interest in elucidating fundamental processes in a bacterial cell. A research axis developed on the Internet page of the laboratory on "sRNA interactome dynamics along environmental changes" is not mentioned in the RAE.

## CONSIDERATION OF THE RECOMMENDATIONS OF THE PREVIOUS REPORT

**Recommendation: The value of this work might have better visibility by putting more emphasis on the "big picture" of "interrelations between central metabolism and cell developmental processes, including division, morphogenesis and chromosome dynamics".**

The team responded in putting emphasis on cell division, elongation and sporulation and how these processes are influenced by the carbon metabolism.

**Recommendation: It would be advantageous for the team to increase its presentations and participations to meetings for greater interactions and visibility.**

As an example, the team presented its work on "PrkA protein and its role in the regulation of *Bacillus subtilis* sporulation" at the international conference on Bacilli and Gram-positive bacteria.

**Recommendation: The project in future calls could be more attractive by a more concept-oriented presentation, to put more emphasis on its relevance.**

The title of the work projects remains very general and very interesting to include the various axis taken on the basic and applied research.

## WORKFORCE OF THE TEAM

<b>Permanent personnel in active employment</b>	
Professors and associate professors	0
Lecturer and associate lecturer	0
Senior scientist (Directeur de recherche, DR) and associate	1
Scientist (Chargé de recherche, CR) and associate	2
Other scientists (Chercheurs des EPIC et autres organismes, fondations ou entreprises privées)	0
Research supporting personnel (PAR)	1
<b>Subtotal permanent personnel in active employment</b>	<b>4</b>
Non-permanent teacher-researchers, researchers and associates	0
Non-permanent research supporting personnel (PAR)	1
Post-docs	0
PhD Students	1
<b>Subtotal non-permanent personnel</b>	<b>2</b>
<b>Total</b>	<b>6</b>

## EVALUATION

### Overall assessment of the team

The assessment of the team is very good. The work is solid and the team publishes regularly in recognized journals. The team has interactions with other teams in the unit and groups in other institutes, on national and international.

### Strengths and possibilities linked to the context

This is a small team with a very good and regular publication record. Within the evaluation period the team published 9 papers in very good journals (e.g., *Sci. Rep.*, *EMBO*, *Mol. Micro*), 6 times as first and last author, once as first author. The team also published five review articles. The research topics are highly relevant to understand bacterial survival and development in changing conditions. The team had an excellent career evolution and witnessed mobility: one researcher left, but a new one was recruited during the period. It hosted one PhD students and several stagiaires.

The PI has an ongoing ANR grant.

The PI has good visibility in being member of editorial boards of several international journals (e.g., *Scientific Reports*, *Frontiers in Microbiology* and others).

The team has strong endeavour to engage in lowering our impact on the environment.

### Weaknesses and risks linked to the context

Although the output is very good, the team approaches many research axes despite its small size. Concentrating on less topics may help to publish in high profile journals. Related to the remark in the last evaluation report ("*better visibility by putting more emphasis on the "big picture"*") the attractiveness of the research topic should be placed under an attractive umbrella (filte) related to an important biological question, "*Metabolism*" is a vast subject, as is "*Regulation of cellular processes*" and are as such not sufficiently appealing.

## RECOMMENDATIONS TO THE TEAM

The output of the team is excellent on the basic and translational research. Concentrate on research topics that will give the team more international visibility and recognition. Put the work under an important and attractive umbrella.

**Team 5:** Cell signaling and differentiation in cyanobacteria

Name of the supervisor: Ms Amel Latifi

## THEMES OF THE TEAM

Team 5 model organisms are cyanobacteria, photosynthetic bacteria exhibiting a diazotrophic metabolism and cellular differentiation of certain cells, under nitrogen starvation, into heterocysts with an anoxic cellular environment to promote N<sub>2</sub> fixation. A first research axis aims to understand the cell signaling involved in the differentiation and their conservation among the phylum. In a second axis, the circadian rhythm of cyanobacteria is explored with an emphasis on regulators implicated in this process and their involvement in heterocyst differentiation. A third axis deals with the ecology of nitrogen-fixing cyanobacteria in marine environment by focusing on *Crocospaera watsonii*. The fourth axis focuses on applications in bio-remediation and hydrogen biofuel.

## CONSIDERATION OF THE RECOMMENDATIONS OF THE PREVIOUS REPORT

The previous report mentioned a lack of international visibility, recommended objectives prioritization and expressed concerns related to the departure of two senior scientists. As a response, the team initiated two international collaborations, published a number of articles in all proposed axes and was able to recruit a CNRS researcher and two assistant professors.

## WORKFORCE OF THE TEAM

<b>Permanent personnel in active employment</b>	
Professors and associate professors	1
Lecturer and associate lecturer	2
Senior scientist (Directeur de recherche, DR) and associate	0
Scientist (Chargé de recherche, CR) and associate	1
Other scientists (Chercheurs des EPIC et autres organismes, fondations ou entreprises privées)	0
Research supporting personnel (PAR)	2
<b>Subtotal permanent personnel in active employment</b>	<b>6</b>
Non-permanent teacher-researchers, researchers and associates	0
Non-permanent research supporting personnel (PAR)	1
Post-docs	0
PhD Students	1
<b>Subtotal non-permanent personnel</b>	<b>2</b>
<b>Total</b>	<b>8</b>

## EVALUATION

### Overall assessment of the team

The assessment of the team is very good. The scientific production is excellent as the ability to recruit new members and attract funding.

## Strengths and possibilities linked to the context

The production of this relatively small team, involved significantly in teaching, is excellent in qualitative and quantitative terms in the multiple proposed axes and based on multidisciplinary approaches. Nine articles, among which 4 led by team members, were published in a generalist journal: *eLife* (1) and in several more specialized ones: *MGG* (1), *Micropub. Biol.* (1), *Microorganisms* (1), *Life*, (2), *Microb. Cell Fact* (1), *Front. Micro.* (1), *Appl. Micro. Biotech.* (1), *Front. Genet.* (1).

The multiple research axes allow the diversification of the funding: two ANR grants as coordinator and one CNRS project as partner have been obtained. The team is attractive to outside researchers: the departure of several staff members could be compensated by the arrival of two assistant professors originating from other LCB teams and the recruitment of a CNRS researcher. National collaborations are well established and two international collaborations have been initiated.

## Weaknesses and risks linked to the context

The multiple research axes might divert the efforts of this relatively small team composed of a professor and two assistant professors involved in substantial teaching and a CNRS researcher.

## RECOMMENDATIONS TO THE TEAM

The different research axes of the team are well integrated into a mainstream approach. The team is encouraged to continue to perform as well in the future.



**Team 6:** Molecular and cell biology of respiration in enterobacteriaceae  
 Name of the supervisor: Mr Axel Magalon

## THEMES OF THE TEAM

The team studies bacterial respiration using *Escherichia coli*, *Bacillus subtilis* and lactic acid bacteria as models, from the atomic to the cellular scale. The team research focuses on the folding and dynamic assembly of respiratory chain complexes in oxidative phosphorylation to ensure reactivity towards their substrates, and their potential as models for CO<sub>2</sub> conversion. Besides, the team investigate how heterogeneous expression of respiratory actors can result in distinct metabolic capacities at the population level during environmental changes.

## CONSIDERATION OF THE RECOMMENDATIONS OF THE PREVIOUS REPORT

**Recommendations: A more proactive search for post-docs and students for example, at international meetings or via collaborators, might help attract foreign scientists.**

The successful recent collaborations of the team with several labs abroad, and the involvement of the PI in the organization of international events attests for the team visibility both at a national and international level. The lab hired a post-doc from Netherlands between 2015 and 2017.

## WORKFORCE OF THE TEAM

<b>Permanent personnel in active employment</b>	
Professors and associate professors	0
Lecturer and associate lecturer	2
Senior scientist (Directeur de recherche, DR) and associate	1
Scientist (Chargé de recherche, CR) and associate	0
Other scientists (Chercheurs des EPIC et autres organismes, fondations ou entreprises privées)	0
Research supporting personnel (PAR)	1
<b>Subtotal permanent personnel in active employment</b>	<b>4</b>
Non-permanent teacher-researchers, researchers and associates	0
Non-permanent research supporting personnel (PAR)	1
Post-docs	0
PhD Students	3
<b>Subtotal non-permanent personnel</b>	<b>4</b>
<b>Total</b>	<b>8</b>

## EVALUATION

### Overall assessment of the team

The assessment of the team is excellent.

## Strengths and possibilities linked to the context

The number of permanent and non-permanent staff members in the team is well distributed among 3 permanent researchers (one from the CNRS and 2 from University) 1 permanent and 1 non-permanent technical staff, and 2 PhD students. During the past term a permanent technical staff retired and the team was successful in recruiting a new MCF from Aix-Marseille University. All team members are actively involved in training activities of Master and PhD students. The team obtained 5 PhD thesis fundings from different sources (Ministry funding, PACA region) and 3 PhD thesis were successfully defended.

The team has well-established expertise in the study of bacterial respiration using a combination of physics-, chemistry- and biology-based approaches. During the past period, the main objective of the team was to focus on the reactivity of molybdenum enzymes to better understand substrate selectivity and molecular functioning of formate dehydrogenase (FDH) enzymes that catalyse the reversible interconversion of formate and CO<sub>2</sub>. The control of this reactivity has strong potential in carbon recycling and production of biofuels. The team conducted a structure-function analysis of the functioning of the *E. coli* respiratory complex chaperone FdhD to assist sulfur transfer from the sulfur-donor IscS to the molybdenum cofactor of FDHs. They also elaborated electron paramagnetic resonance spectroscopy methods to track structural rearrangements of respiratory nitrate reductases around their Mo/W-bisPGD cofactor, allowing future investigations of the structure of molybdenum active sites in the presence of various substrates or inhibitors. This allowed them to unravel the crucial role of distant structural factors from the active site for the control of nitrate reductases reactivity by modulating the substrate access tunnel and long distance proton translocation. In addition, the team discovered a new atypical subfamily of formate dehydrogenase (FDH) enzymes in *B. subtilis* and characterized two representatives using biophysical techniques. Both have Mo-bisPGD cofactor and Fe-S clusters, and show unique subunit composition, amino acid conservation around the Mo cofactor and catalytic mechanism. These results show that these new FDHs are really promising for "green" bioconversion and the team will follow up the characterisation of the molecular determinants of their reactivity. A second research axis of the team is to investigate the reactivity of respiratory complexes with quinones. Their experimental set-up allowed them to assess the asymmetric binding mode of menaquinone with an unprecedented level of resolution and also resulted in international collaborations. The third research axis of the team is about the spatial organization of respiratory actors in *E. coli*. Mainly, they showed that the clustering of respiratory complexes at the poles of the cell, which is essential for optimal functioning of the respiratory chain, implies the concomitant clustering of proteins involved in NO detoxification or homeostasis, probably to handle the toxicity of the respiratory process. The team initiated a collaborative project to study polar clusters of respiratory complexes by cryo-electron microscopy. Finally, the most recently introduced research axis in the team aims at investigating the heterogeneity of the expression of respiratory actors at the population level and the resulting metabolic capacities of bacterial cells during environmental changes.

The team-leader has secured funding with 3 ANR PRC (D2OX 2021-2025 as coordinator; FLAGMOTOR 2018-2023 and MOLYERE 2016-2021 as partner). The team has also developed applied research projects leading to financial support from the CNRS (prematuration project SATT Sud-Est, PEPS 2021 project).

In the five year period, the scientific production of the team was excellent, with 1 invited review, 1 invited book chapter and 11 original research publications; 4 of which have contributions of team members as lead and last author (1 *mBio*, 1 *ACS catalysis*, 1 *JBC* and 1 *Scientific Reports*), attesting for the quality of the projects. 2 PIs from the team also applied for a European patent.

The team is highly visible at a local and national level, and two recently published research papers have been done with international collaborators. The leader of the team is an internationally recognized scientist who has organized three international meetings, the 9<sup>th</sup> "Bacterial electron transfer processes and their regulation" meeting (2018), the 21<sup>st</sup> "European Bioenergetics Conference (EBEC)" (postponed from 2020 to 2022), and the 12<sup>th</sup> edition of the "Mo and W enzymes Conference (MoTEC)" (2021). Moreover team members have received five invitations as speaker to international meetings. The team leader is guest editor of journals *Inorganics* (2021) and *BBA Bioenergetics* (2020-2022).

## Weaknesses and risks linked to the context

No major risks have been identified. The most recent research axis is not securely funded and is rather far from the expertise of the team. Collaborative works mostly involve the team leader only. Relatively moderate production from PhD students who graduated (one does not have publications yet).

## RECOMMENDATIONS TO THE TEAM

The team should continue to publish in high-profile journals and maintain fruitful collaborations.

The team would benefit to attract post-doc and students outside of the local environment.

The team could benefit to attract a permanent full time CR to reinforce the research activity and animation.

Team members are substantially involved in teaching and they should be vigilant not to broaden too much their research programs.

**Team 7:** Stringent response and bacterial multidrug tolerance  
 Name of the supervisor: Mr Etienne Maisonneuve

## THEMES OF THE TEAM

The team, established since 2017, aims at elucidating the regulation of the stringent response using genetic screens, biochemical analysis and structure function analysis. The main interest is the regulation of SpoT, which increases or decreases the alarmone ((p)ppGpp) concentrations depending on interacting proteins to allow survival under stress conditions.

## CONSIDERATION OF THE RECOMMENDATIONS OF THE PREVIOUS REPORT

**Recommendation: The expert committee recommends the team leader to take advantage of the excellent scientific community and platforms at the LCB, and take his time to build a good team.**

The Team leader has been stabilized and established a solid research with his appointed (non-permanent) team.

**Recommendation: Continue to communicate and collaborate on an important topic.**

Collaborations are in place, but still need to get to be published. One member of the group participated (probably as a previous postdoc) in a publication of a german-danish collaboration.

## WORKFORCE OF THE TEAM

<b>Permanent personnel in active employment</b>	
Professors and associate professors	0
Lecturer and associate lecturer	0
Senior scientist (Directeur de recherche, DR) and associate	0
Scientist (Chargé de recherche, CR) and associate	1
Other scientists (Chercheurs des EPIC et autres organismes, fondations ou entreprises privées)	0
Research supporting personnel (PAR)	0
<b>Subtotal permanent personnel in active employment</b>	<b>1</b>
Non-permanent teacher-researchers, researchers and associates	0
Non-permanent research supporting personnel (PAR)	0
Post-docs	0
PhD Students	0
<b>Subtotal non-permanent personnel</b>	<b>0</b>
<b>Total</b>	<b>1</b>

## EVALUATION

### Overall assessment of the team

Despite the recent establishment of the team within the unit at the beginning of the mandate, its assessment is very good to excellent.

## Strengths and possibilities linked to the context.

The strength is a highly attractive topic of research, survival under stress conditions. The PI has now a permanent CNRS position. Excellent combination of open-ended genetic screens with biochemical and biophysical methods. Despite the small size, the team published two high profile journals (*Nat. communication*, *Elife*) as leader as well as a third publication (*Front Microbiology*). A fourth publication comes from previous work of one of the collaborators.

## Weaknesses and risks linked to the context

As mentioned in the RAE, the team has, except the PI, no permanent member. A permanent technical member to assure continuity and "memory of methods, strains, and equipment" is missing.

## RECOMMENDATIONS TO THE TEAM

Continue the excellent work. Define the next important questions to pursue the work.

**Team 8:** Cell biology of bacterial motility

Name of the supervisor: Mr Târn Mignot

## THEMES OF THE TEAM

Team 8 is developing several research themes using the soil bacterium *Myxococcus xanthus*, more particularly on the aspects of predation towards other organisms. Four main research questions are studied, which are: the growth of the bacterium on its prey, the mobility and cellular interaction behaviors and finally the evolutionary and ecological aspects of the predation behavior. This research is carried out in an integrative, multidisciplinary way, from the molecular scale to that of bacterial communities in the soil, with methodologies combining mechanistic and theoretical approaches.

## CONSIDERATION OF THE RECOMMENDATIONS OF THE PREVIOUS REPORT

The main recommendation made during the previous evaluation was the importance of maintaining continuity of funding, especially from international funding bodies, in order to guarantee the recruitment of external researchers. We can consider that this point has been addressed with the obtaining of an ERC grant 'Advanced' by the team leader, as well as a French-Indian CEFIPRA grant, which have allowed the recruitment of several post-doctoral researchers.

## WORKFORCE OF THE TEAM

<b>Permanent personnel in active employment</b>	
Professors and associate professors	0
Lecturer and associate lecturer	0
Senior scientist (Directeur de recherche, DR) and associate	2
Scientist (Chargé de recherche, CR) and associate	2
Other scientists (Chercheurs des EPIC et autres organismes, fondations ou entreprises privées)	0
Research supporting personnel (PAR)	3
<b>Subtotal permanent personnel in active employment</b>	<b>7</b>
Non-permanent teacher-researchers, researchers and associates	1
Non-permanent research supporting personnel (PAR)	2
Post-docs	1
PhD Students	4
<b>Subtotal non-permanent personnel</b>	<b>8</b>
<b>Total</b>	<b>15</b>

## EVALUATION

### Overall assessment of the team

The team conducts original, brilliant and interdisciplinary research, validated by outstanding scientific productivity and striking internationally recognized expertise. The projects follow a remarkable continuous evolution, from fundamental research to more applied aspects. The public outreach is also notable and is led by an omnipresent team leader.

## Strengths and possibilities linked to the context

The team produces outstanding research both in terms of productivity and quality of the work performed. As a highlight, major advances have been made in the understanding of the mechanisms responsible for the different types of mobility of *M. xanthus*. The work is carried out through original and multidisciplinary approaches (most often in the frame of collaborations), based for example on structural biology, cell biology, experimental biophysics, with innovative image analysis tools as well as theoretical approaches (computational modeling). The productivity in terms of publications is exceptional considering the number of permanent researchers in the team, with more than twenty articles published in prestigious generalist or specialized journals [including *Nature* (1), *Nature Microbiology* (2), *PLoS Biology* (1), *PNAS* (1), *eLife* (2), *PLoS Genetics* (2)...] with half of them for which team members have lead and/or last author position. Moreover, 8 review articles can be added to this list [including *FEMS Microbiol Rev* (2), *Curr Opin Cell Biol* (1), *Curr Opin Microbiol* (1)...].

The team has an excellent visibility and notoriety at the national and international level. This is evidenced by the impressive number of invitations to communicate in international congresses, the organization of colloquia (such as EMBO workshops), the participation in editorial committees, and the award of scientific prizes or distinctions (e.g. a "Medaille de Bronze du CNRS" in 2020, an election to the European Academy of Microbiology). The visibility of the team can also be appreciated by its strong involvement in knowledge sharing and intervention in social debates, notably in the form of blogs, videos, conferences or popular articles in newspapers.

The team has been successfully able to obtain funding through research contracts over the period, including an 'Advanced' ERC grant for the group leader that allowed to start an ambitious research project and to recruit several contractual researchers. This contributes to the attractiveness of the team, which has been joined by a permanent CNRS researcher in 2019; the team also hosted a visiting scientist. The team contributes satisfactorily to the training of students (6 PhD students graduated over the evaluated period, i.e. about one per permanent researcher).

The team has developed chitosan films for microfluidic, a product that has been patented and then licensed to a private laboratory to market the product. It is therefore a remarkable output in terms of interaction with the socio-economic world.

## Weaknesses and risks linked to the context

Many aspects of the life of the team such as obtaining contracts, participation in editorial boards, communications to scientific conferences or to the general public, seem to rely solely on the activity of the team leader, who is a very involved scientist. In addition, he is the director of the unit, which represents a significant additional workload.

## RECOMMENDATIONS TO THE TEAM

It is important that the reputation and attractiveness of the team is maintained in the future. The attractiveness of young researchers would allow to reinforce the team on some of the developed themes, as for example the axis 1 which is currently led by a researcher with strong teaching duties, or to relieve the team leader who is already leading multiple tasks. In the same vein, the committee encourages other scientists in the team to be more involved in funding applications or communication activities.

**Team 9:** Biology of type IV filamentous nanomachines

Name of the supervisor: Mr Vladimir Pelicic

## THEMES OF THE TEAM

The team has joined LCB recently (2021) and is therefore not included in this evaluation. The prospected research topics at LCB have not been presented in the report but based on previous performance and on the oral presentation, it is expected that the team will integrate very well within the unit. This positive comment of the committee is based on the quality of the team presentation.

## CONSIDERATION OF THE RECOMMENDATIONS OF THE PREVIOUS REPORT

None.

## WORKFORCE OF THE TEAM

<b>Permanent personnel in active employment</b>	
Professors and associate professors	0
Lecturer and associate lecturer	0
Senior scientist (Directeur de recherche, DR) and associate	1
Scientist (Chargé de recherche, CR) and associate	1
Other scientists (Chercheurs des EPIC et autres organismes, fondations ou entreprises privées)	0
Research supporting personnel (PAR)	1
<b>Subtotal permanent personnel in active employment</b>	<b>3</b>
Non-permanent teacher-researchers, researchers and associates	0
Non-permanent research supporting personnel (PAR)	1
Post-docs	0
PhD Students	0
<b>Subtotal non-permanent personnel</b>	<b>1</b>
<b>Total</b>	<b>4</b>

**Team 10:** Fe-S clusters biogenesis and homeostasis

Name of the supervisor: Ms Béatrice Py

## THEMES OF THE TEAM

The research activities of the team are organized in two main axes for molecular characterization of the Fe-S cluster biogenesis components and regulation mechanisms of the Fe-S cluster biogenesis. These axes are combined within two transversal axes to study the role of Fe-S cluster biogenesis in antibiotic resistance and prokaryotic diversity to maintain Fe-S cluster homeostasis.

## CONSIDERATION OF THE RECOMMENDATIONS OF THE PREVIOUS REPORT

This is a new team composed by the members of the former team headed by F. Barras that continued their projects on Fe-S cluster biogenesis and sRNA-dependent regulation. The previous committee has identified no significant weaknesses but underlined a relatively small number of postdocs in the team. Current team workforce list includes 3 PhD students and no postdocs. With several ANR grants obtained by the PIs, the recruitment of postdocs should be encouraged to attract international young researchers.

## WORKFORCE OF THE TEAM

<b>Permanent personnel in active employment</b>	
Professors and associate professors	0
Lecturer and associate lecturer	0
Senior scientist (Directeur de recherche, DR) and associate	1
Scientist (Chargé de recherche, CR) and associate	2
Other scientists (Chercheurs des EPIC et autres organismes, fondations ou entreprises privées)	0
Research supporting personnel (PAR)	2
<b>Subtotal permanent personnel in active employment</b>	<b>5</b>
Non-permanent teacher-researchers, researchers and associates	0
Non-permanent research supporting personnel (PAR)	0
Post-docs	0
PhD Students	3
<b>Subtotal non-permanent personnel</b>	<b>3</b>
<b>Total</b>	<b>8</b>

## EVALUATION

### Overall assessment of the team

The assessment of the team is excellent. The team develops high quality research projects on various facets of Fe-S cluster biogenesis and publishes their research as leading position authors in internationally recognized journals. The two PIs of the team have obtained their HDR during the reporting period and got their projects funded by several ANR grants as coordinators or participants. They attracted three PhD students with funding from Ministerial and FRM grants.



## Strengths and possibilities linked to the context

The team workforce is well balanced between permanent researchers (3), permanent supporting personnel (2) and non-permanent staff (3 PhD students). The two PIs of the team have obtained their HDR during the reporting period that allows to host PhD students. During the evaluation period the team hosted 12 master students, 3 PhD thesis have been defended (all started when Frédéric Barras was the team leader) and 2 PhD thesis are ongoing (1 PhD student gave up).

High quality research projects on various facets of Fe-S cluster biogenesis are developed by the team. The research is organized in two main axes for molecular characterization of the Fe-S cluster biogenesis components and regulation mechanisms of the Fe-S cluster biogenesis. These axes are combined within two transversal axes to study the role of Fe-S cluster biogenesis in antibiotic resistance and prokaryotic diversity to maintain Fe-S cluster homeostasis including sRNA-mediated post-transcriptional regulatory mechanisms. This team organization leads to the personal recognition in the field for each PI having specific topic in charge but also tight interactions within the team feeding all research axes.

Among the strengths of the team are the developments of molecular genetics approach to study the Fe-S cluster homeostasis mainly in *E. coli* model. This internal expertise is combined with external collaborations for biochemical and biophysical analyses of molecular mechanisms involved in studied processes. The team is also using cutting-edge technologies available in LCB for studies of Fe-S cluster biogenesis regulations at the single cell level by microscopy and microfluidics. The team is developing fruitful national and international collaborations.

The PIs of the team make efforts to get competitive funding from various resources from national and private agencies and industrial partners either as coordinators or as participants (ANRs FRACOL 2018-2022 as coordinators; ERACoBioTECH IronPlug&Play 2018-2020 as participants, Association française de l'Ataxie 2021, Metallomix program 2021-2022, IM2B program 2020). The team is applying for various resources for PhD thesis funding and obtained two Ministry grants 2014-2018; 2015-2019 and FRM grant 2019.

The production of the team is excellent during the reporting period (16 publications) with 6 research papers in leading position (*PLoS Genetics* 2019, 2020, *Mol Microbiol* 2021, *Sci Reports* 2019, *J Biol Chem* 2018, *mBio* 2016), 3 papers in collaboration (*Nature* 2018, *Environ Microbiol* 2018, *J Biol Inorg Chem* 2016) and 7 reviews (*Advances in Micro Physiol* 2020, *Mol Microbiol* 2020, *Microb Spectrum* 2018, *Coordination Chem rev*, *Methods in Mol Biol* 2021). The active participation in review articles has a positive impact on the team visibility.

## Weaknesses and risks linked to the context

No major risks have been identified. Including two new bacterial models (aerobic and anaerobic) *Myxococcus xanthus* and *Desulfovibrio vulgaris* could be challenging for the team. No postdocs have been hosted during the evaluation period.

## RECOMMENDATIONS TO THE TEAM

The team should continue to publish in high-profile journals and maintain fruitful collaborations. Various grants postdoctoral recruitment should be beneficial for the team. The potential difficulties with integration of two new models should be considered.

**Team 11:** Biology of transport systems in *Pseudomonas aeruginosa*  
 Name of the supervisor: Mr Romé Voulhoux

## THEMES OF THE TEAM

The team studies the transport mechanisms across the bacterial envelope of *Pseudomonas aeruginosa*. During this mandate, the project focused on the Xcp type 2 secretion system (T2SS) and the mechanisms of transport of metallophores. Regarding the T2SS, the team undertook a detailed characterization of the structural properties and molecular interactions occurring during the secretion process. A second project was centred on the discovery and elucidation of the Cnt pathway in the synthesis, export and re-import of a new metallophore pseudopaline involved in nickel and zinc uptake under metal deficiency conditions often encountered during infection. This work also highlighted the involvement of the MexAB/OprM pump in the pseudopaline transport across the outer membrane.

## CONSIDERATION OF THE RECOMMENDATIONS OF THE PREVIOUS REPORT

The team was not a part of the LCB Unit in the previous mandate and only joined LCB at the end of 2017. As the team composition at the LCB differs significantly from the last team, only some recommendations are relevant in the new context.

**Recommendation: Aim to increase visibility by international conference organisation and by applying for collaborative grants.**

This recommendation was significantly addressed as the number of collaborative grants has greatly increased, even though the new team has fewer permanent researchers. The PI's participation as an invited speaker at several international meetings attests to increased visibility.

**Recommendation: The expert committee recommends to continue to develop industrial collaborations and the excellent links with the local charity.**

The links with charity organisations such as the VLM (French Cystic Fibrosis Foundation) have been strengthened (e.g. participation in the scientific council). The number of industrial collaborations still needs to grow.

**Recommendation: The team should continue to collaborate to progress the work most effectively but ensure that they retain intellectual control of the projects. The team should explore funding opportunities to increase its size.**

This has been fully achieved with 3 ANRs (1 as coordinator) and 4 VLM projects.

## WORKFORCE OF THE TEAM

<b>Permanent personnel in active employment</b>	
Professors and associate professors	0
Lecturer and associate lecturer	0
Senior scientist (Directeur de recherche, DR) and associate	1
Scientist (Chargé de recherche, CR) and associate	1
Other scientists (Chercheurs des EPIC et autres organismes, fondations ou entreprises privées)	0
Research supporting personnel (PAR)	1
<b>Subtotal permanent personnel in active employment</b>	<b>3</b>
Non-permanent teacher-researchers, researchers and associates	0
Non-permanent research supporting personnel (PAR)	1
Post-docs	0
PhD Students	2
<b>Subtotal non-permanent personnel</b>	<b>3</b>

<b>Total</b>	<b>6</b>
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## EVALUATION

### Overall assessment of the team

The assessment of the team is excellent. The team has very good to excellent scientific production and ability to raise funds considering its small size in terms of permanent researchers/lecturers. Its visibility and science outreach activities are also excellent.

### Strengths and possibilities linked to the context

The team's scientific objectives are timely and important for understanding the virulence mechanisms of *Pseudomonas aeruginosa*, a pathogen of major concern, especially in the context of hospital-acquired infections and cystic fibrosis. The discovery of the mechanisms of transport of a new metallophore pseudopaline is an important finding in the field that will have significant consequences in the context of cystic fibrosis. This substantial expansion of the team's thematics is positive and will help increase the team's long-term attractiveness.

The team has an excellent ability to raise resources, having obtained 3 ANRs (1 as coordinator), 4 VLM contracts and 1 regional collaborative contract during the evaluation period, with guaranteed funding until 2025.

The team has recognized expertise in T2SS, nationally and internationally, and membrane transport in *Pseudomonas aeruginosa*. The team's attractiveness is attested by several invitations for oral communications in major international meetings in the field (a total of 5, e.g. 2 EMBO conferences in South Africa and India). The team is attractive for students, having supervised 3 PhD students and 1 postdocs, all of them could publish as first authors. A PhD student and a post-doc have been recently hired.

Despite the small number of permanent researchers (for half of this mandate, only 1 DR), the team has regularly produced excellent publications in the field, primarily in speciality journals (e.g. *Structure* (1), *MBio* (1), *Mol Micro* (1), *Journal of Biological Chemistry* (1)), with a few in more generalist journals (*Scientific Reports* (2)). Important collaborative publications were also obtained, notably in top generalist journals (*Science* (1)).

The PI of the team has active participation in editorial boards (BMC Microbiology), evaluation panels (ANR, Hcéres, FNRS) and charities (VLM-scientific council). The group actively participates in science outreach programs (e.g. Fête de la science, Declics, Comptoir de Sciences, Nuit Européenne des Chercheurs).

### Weaknesses and risks linked to the context

The small size of the team is its main weakness. Although the team has recently recruited one staff researcher and one postdoc, efforts should be made to expand this to ensure enough critical mass for the new topics. More applied research thematic are also emerging in the team, notably with the study of new targets for antimicrobial molecules. Despite this, during the evaluation period, the team only obtained a small number of contracts with the non-academic world, including industrial partners (SANOFI).

## RECOMMENDATIONS TO THE TEAM

The team is encouraged to continue the new research axis to maintain a strong impact in the field and increase its attractiveness for students and post-docs (by expanding from the established T2SS topic). Efforts should be made to recruit post-docs with European funding programs such as Horizon2020 or from national agencies such as the FRM.

**Team 12:** Functional architecture of bacterial cells  
 Name of the supervisor: Mr Long Fei Wu

## THEMES OF THE TEAM

Team 12 questions how bacteria adapt to various ecosystems for instance geomagnetic fields and marine environments (Mediterranean Sea and China Sea). The methods used are molecular biology, metagenomics, and microscopy and rely on strong international collaborations.

The team focuses on three themes: 1) studies on multicellular magnetotactic prokaryotes (MMPs); 2) research on amphitrichous magnetotactic bacteria, which led to the identification of a new family of bacterial glycosyltransferases, with the resolution of the structure of Maf. 3) bacterial adaptation to deep sea environments within the LIA MagMC. This approach, using metagenomics tools, enables to study the impact of light, temperature and high pressure on bacterial population structure.

## CONSIDERATION OF THE RECOMMENDATIONS OF THE PREVIOUS REPORT

**Assessment of scientific quality and outputs. Emphasize when possible the comparative genomic approaches.**

The team performed extensive comparative genomics approaches that were published in mSystems, Marine Genomics, Microb. Genom. Extremophiles.

**Assessment of the team academic reputation and appeal. Reinforce the team and continue the international collaboration.**

The team has been recently reinforced with a Chair d'Excellence from AMU on a project on biomimetic microfluidic devices to study the soil ecology of motile bacteria to be hold by Dr. Nicolas Waisbord starting in fall 2022. Over the last 6 years, the team hosted 13 persons: 3 permanent 1 DR (CNRS Section 20), 1 MCU (64-CNU), 1 PAR (CNRS IGE) and 8 non-permanent: 1 post-doc, 1 PhD who defended in 2019 and 6 trainees. The permanent PAR has retired in 2020.

**Assessment of the team interaction with the social, economic and cultural environment. The topic has the potential to be very attractive for a non-specialist audience, this could be improved.**

This is not mentioned in the current report.

**Assessment of the team involvement in training through research. The expert committee recommends to attract students from various horizons.**

The team is involved in the LIA MagMC, trained 1 post-doc from Israel, 1 PhD from China and 6 students during the last 6 years.

## WORKFORCE OF THE TEAM

<b>Permanent personnel in active employment</b>	
Professors and associate professors	0
Lecturer and associate lecturer	1
Senior scientist (Directeur de recherche, DR) and associate	1
Scientist (Chargé de recherche, CR) and associate	0
Other scientists (Chercheurs des EPIC et autres organismes, fondations ou entreprises privées)	0
Research supporting personnel (PAR)	0
<b>Subtotal permanent personnel in active employment</b>	<b>2</b>
Non-permanent teacher-researchers, researchers and associates	0
Non-permanent research supporting personnel (PAR)	0
Post-docs	0

PhD Students	1
<b>Subtotal non-permanent personnel</b>	<b>1</b>
<b>Total</b>	<b>3</b>

## EVALUATION

### Overall assessment of the team

The assessment of the team is excellent.

### Strengths and possibilities linked to the context

The publication output of the team during this period is impressive. During this period, the team authored 41 articles or reviews in specialty journals (*Appl. Environ Microbiol*, *Environ Microbiol Rep*, *Extremophiles*, 8 in *Journal of Oceanology and Limnology*) and for a broader audience (*Front. Microbiol*, *Scientific Reports*, 2 in *mSystems*). The PhD student authors 3 articles as 1st author. Given the small size of the team, the scientific output is really excellent.

The team secured regional funding on "Photosensitive magnetic compass of Mediterranean magnetic bacteria" (PhotoBioCompass) (PIA AMIDEX 175 kE in 2018).

The team is involved in international collaborations in Asia (Japan, Osaka; China, Beijing, CAS) for the study of structure and function of flagella apparatus, for the ecology and electromicroscopy characterization of magnetotactic bacteria. The team is involved in LIA-MagMC allowing staff exchanges.

The team honoured 7 invitations in international conferences (International Conference on Genomics (ICG-13, ICG-16, 8<sup>th</sup> conference of magnetotactic microorganisms, International conference on Genomics Ocean, 5<sup>th</sup> international workshop on Deep-sea microbiology).

The team is involved in editorial activities and boards (*Journal of Oceanology and Limnology*, *BMC Microbiology*, *Marine Life Science & Technology*), in national evaluation committee (Inserm)

### Weaknesses and risks linked to the context

No major weaknesses have been observed.

## RECOMMENDATIONS TO THE TEAM

The publication output is excellent for a 2-researcher team. The team has also an excellent international visibility with Asia.

**Team 13:** Instrumentation and data Analysis in Microbiology  
 Name of the supervisor: Mr Léon Espinosa

## THEMES OF THE TEAM

The IAM team aims at producing methods and tools in several technological fields (imaging, cell screening, robotics, image and data analysis) to support the research from the LCB teams.

## CONSIDERATION OF THE RECOMMENDATIONS OF THE PREVIOUS REPORT

In the previous evaluation, the need to develop artificial intelligence for the analysis of large bacterial consortia was noticed by the Hcéres committee. In response to that comment, with the support of the CNRS, the IAM team recruited a research engineer specialized in IA and deep learning. After a short duration contract, he was then stabilized into the team by the obtention of a full-time CNRS position.

## WORKFORCE OF THE TEAM

<b>Permanent personnel in active employment</b>	
Professors and associate professors	0
Lecturer and associate lecturer	0
Senior scientist (Directeur de recherche, DR) and associate	0
Scientist (Chargé de recherche, CR) and associate	1
Other scientists (Chercheurs des EPIC et autres organismes, fondations ou entreprises privées)	0
Research supporting personnel (PAR)	4
<b>Subtotal permanent personnel in active employment</b>	<b>5</b>
Non-permanent teacher-researchers, researchers and associates	0
Non-permanent research supporting personnel (PAR)	0
Post-docs	0
PhD Students	0
<b>Subtotal non-permanent personnel</b>	<b>0</b>
<b>Total</b>	<b>5</b>

## EVALUATION

### Overall assessment of the team

The assessment of the team is excellent.

### Strengths and possibilities linked to the context

As the IAM team aims to support the work of other teams through technological development, by definition, the team members are working in collaboration with other scientists to provide their expertise to the research projects (microscopy, image and data analysis, AI, cytometry, robotic, electronics and computer science). This is illustrated by 16 publications co-authored by the IAM members during the 2016-2021 period, 12 are in

collaboration with 8 teams of the LCB, showing a very good interaction inside the unit but also an ability to diffuse the productions outside of the lab. In addition, one member of the team is partner in a current ANR contract showing again the collaborative capacity. In particular, one study published in *Nature* in 2016 is co-authored by IAM team leader, has been awarded by a prestigious price from the "Académie des Sciences: Les Grandes Avancées Françaises en Biologie" in 2017, showing the high quality of the work produced by the IAM team.

The IAM team produced tools that are now available for the community, one can for instance cite the 2 softwares that were produced during the period. Particularly the software Coviax which helps to diagnose severe COVID cases from thoracic scan images of patients, is now deployed in the radiology department of the Conception hospital in Marseille. This shows again the collaborative capacity of the IAM team but also its anchor into actual societal challenges.

During the period, 7 interns were welcomed to the IAM teams showing a strong involvement in teaching and transmission. Concerning science dissemination, one member of the team is particularly involved in the promotion and implementations of actions of communication and scientific mediation for the overall laboratory. Thanks to this energy, the LCB is involved in several dissemination events such as "les chemins de la découverte", several web series ("Diffusons la science" & "Microbial Chronicles") and actions directed to schools such as "letter to Jade", "fête de la science" and "the apprentice researchers".

## Weaknesses and risks linked to the context

By definition the aim of the team is to bring technological and methodological input to research projects conducted within the LCB. Thus the IAM team members don't have personal scientific projects which makes it more difficult to publish as first or last author. In the same context, it is also noticed that the team has difficulties to be leader on financial contracts, but inclusion as ANRs partner for instance should be encouraged. With the level of collaboration that the IAM team presents it should be feasible to get more partnership and thus reduce the financial impact of the IAM developments on the unit's funds.

## RECOMMENDATIONS TO THE TEAM

The inclusion of the IAM teams in financial contracts could be more important. Participation in ANRs for instance should be more encouraged. With the level of collaboration that the IAM team presents it should be feasible to get more partnership and thus reduce the financial impact of the IAM developments on the unit's funds.

## CONDUCT OF THE INTERVIEWS

### Dates

**Start:** 17 November 2022 at 8:00 a.m.

**End:** 18 November 2022 at 7:00 p.m.

**Interview conducted: online**

### INTERVIEW SCHEDULE

#### Day 1: 17th November 2022

<b>9h30 – 9h35</b>	<b>Committee introduction</b> <i>Public Session (all unit members)</i>
<b>9h35 – 10h25</b>	<b>Administrative and scientific presentation of the Unit by the Director</b> 10 min presentation + 10 min discussion <i>Public Session (all unit members)</i>
<b>10h30 – 12h30</b>	<b>Scientific presentations by group leaders. Part 1</b> 10 min presentation + 10 min discussion <i>Public Session (all unit members)</i>
<b>10h30 – 10h50</b>	<b>Team 1. Mireille Ansaldi</b>
<b>10h55 – 11h15</b>	<b>Team 2. Benjamin Ezraty</b>
<b>11h20 – 11h40</b>	<b>Team 3. Henri-Pierre Fierobe</b>
<b>11h45 – 12h05</b>	<b>Team 4. Anne Galinier</b>
<b>12h10 – 12h30</b>	<b>Team 5. Amel Latifi</b>
<b>11h30 – 12h30</b>	<b>Debriefing-1 committee</b> <i>Closed-door meeting</i>
<b>12h30 - 14h00</b>	<b>Lunch Break</b>
<b>14h00 – 17h35</b>	<b>Scientific presentations by group leaders. Part 2</b> 10 min presentation + 10 min discussion
<b>14h00 – 14h20</b>	<b>Team 6. Axel Magalon</b>
<b>14h25 – 14h45</b>	<b>Team 7. Etienne Maisonneuve</b>
<b>15h50 – 15h10</b>	<b>Team 8. Tãm Mignot</b>
<b>15h15 – 15h35</b>	<b>Team 9. Vladimir Pelicic</b>
<b>15h35 - 16h00</b>	<b>Break</b>
<b>16h00 – 16h20</b>	<b>Team 10. Béatrice Py</b>
<b>16h25 – 16h45</b>	<b>Team 11. Romé Voulhoux</b>
<b>16h50 – 17h10</b>	<b>Team 12. Long Fei Wu</b>
<b>17h15 – 17h35</b>	<b>Team 13. Léon Espinosa</b>

#### Day 2: 18th November 2022

<b>8h30 – 9h00</b>	<b>Debriefing-2 committee</b> <i>Closed-door meeting</i>
<b>9h00 – 9h45</b>	<b>Meeting with ITAs (in French)</b> <i>In the absence of any managing staff (DU, team leaders)</i>
<b>9h00 – 9h45</b>	<b>Meeting with researchers</b> <i>In the absence of any managing staff (DU, team leaders)</i>
<b>9h00 – 9h45</b>	<b>Meeting with post-docs and students</b> <i>In the absence of any managing staff (DU, team leaders)</i>
<b>10h00 – 10h30</b>	<b>Debriefing-3 committee</b> <i>Closed-door meeting</i>



<b>10h40 – 11h30</b>	<b>Meeting with institution representatives: CNRS/Aix-Marseille University</b> <i>Closed-door meeting</i>
	<b>Lunch break</b>
<b>13h00 – 13h40</b>	<b>Meeting with the Unit director</b> <i>Closed-door meeting</i>
<b>13h45 – 17h00</b>	<b>Redaction of the final report</b> <i>Closed-door meeting</i>
<b>17h00</b>	<b>End of the interview</b>

## GENERAL OBSERVATIONS OF THE SUPERVISORS

Le Président de l'université

au

Département d'Évaluation de la recherche -  
Hcéres

Objet : Observations de l'unité relatives au  
rapport d'évaluation des experts Hcéres  
N/Réf. : VPR/LS/AMS/CM – 23-06

Dossier suivi par : Cécile Merle  
Tél : 04 13 94 95 90  
[cecile.merle@univ-amu.fr](mailto:cecile.merle@univ-amu.fr)

Vos réf : DER-PUR230023222 - LCB - Laboratoire de chimie bactérienne

Marseille, le mercredi 5 juillet 2023

Madame, Monsieur,

Je fais suite à votre mail du 24/05/2023 dans lequel vous me communiquez le rapport d'évaluation Hcéres de l'Unité de Recherche LCB - Laboratoire de chimie bactérienne.

Comme demandé dans ledit mail, je vous indique que les tutelles du LCB, Aix-Marseille Université et le CNRS, n'ont pas d'observation à formuler.

Vous souhaitant bonne réception des présentes,

Je vous prie de croire, Madame, Monsieur, l'expression de mes respectueuses salutations.



**Eric BERTON**



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

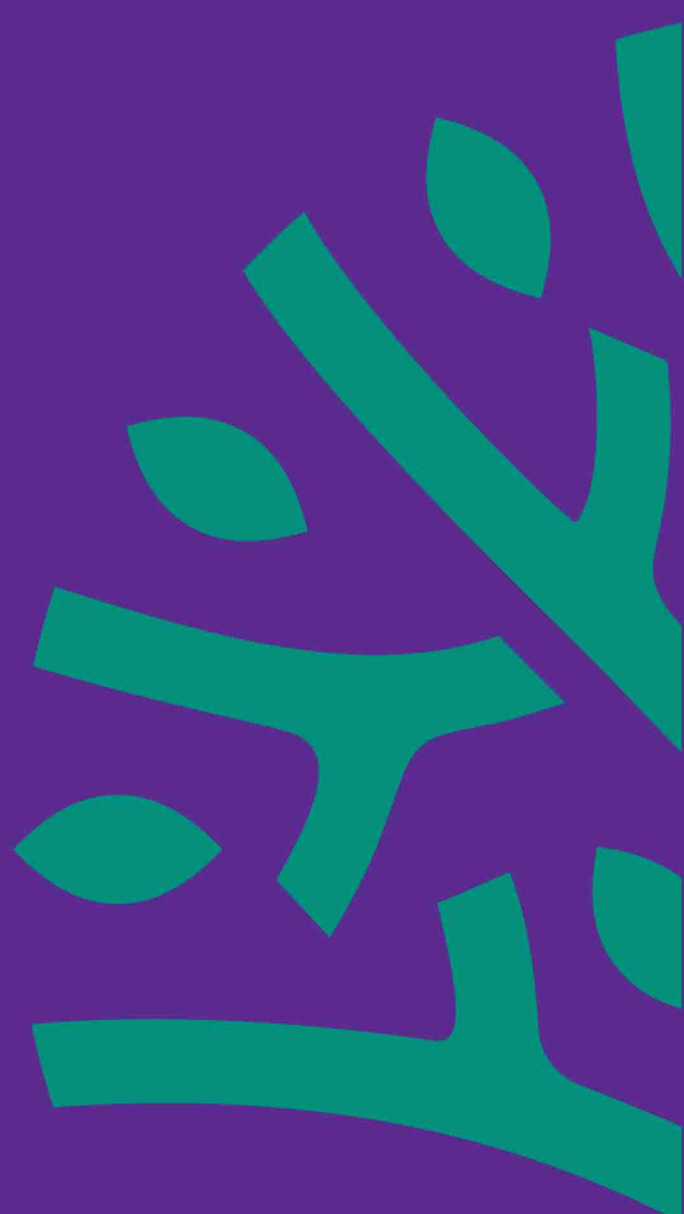
**Evaluation of Universities and Schools**

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