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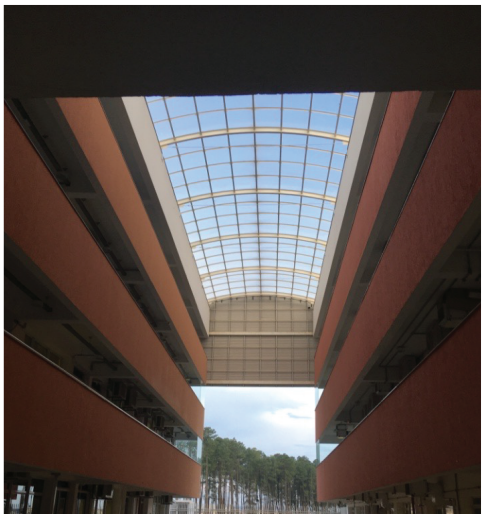
CEBEM CENTRO DE BIOLOGIA ESTRUCTURAL DEL MERCOSUR

# Latin America and Caribbean Structural Biology Landscape Analysis Report

# Providing the Tools Researchers Need: The Structural Biology Case


## Abstract

This landscape analysis explores the opinions of structural biologists on how access provision to research infrastructure is currently facilitated in Latin America. The analysis aims to understand the environment of structural biology research in Latin America, as well as the challenges to carry out excellent research in the region. A survey of 157 researchers, and in-depth interviews of 29 chosen respondents were carried out. By speaking to those who operate within the Latin American structural biology community day by day, the analysis found common themes affecting researchers, including bureaucratic obstacles, a general lack of stable funding, and a specific lack of funding and expertise for the maintenance of sophisticated instrumentation. The study found a strong community carrying out outstanding research in difficult circumstances, in many cases supported by international collaboration. The analysis indicates the need for better institutional support and training programmes to boost expertise in the region. Better communication between the research community and funding bodies is crucial for future development. Regional laboratories equipped with intermediate level instrumentation open to all researchers can not only improve access to infrastructure, but act as networking centres. The report recommends that a clear, strategic roadmap for structural biology infrastructure must be developed both at national and regional levels.



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## 1. Introduction

### 1.1 Motivation Behind the Present Study

This landscape analysis represents an Instruct-ERIC initiative to perform a bottom-up understanding of the situation of Latin America and the Caribbean (LAC) Region regarding research in Structural Biology. To achieve this goal, Instruct organised The Working Group for Landscape Analysis of Structural Biology Research Infrastructure in Latin America (hereinafter referred to as “Working Group”) that was established in the frame of the EU-LAC ResInfra project. Part of the aim of this latter Horizon 2020 project is to identify a

number of LAC Research Infrastructures (RIs) that may be considered eligible for the development of a bi-regional collaboration. Structural biology is represented in this project through Instruct-ERIC, a European RI making high-end technologies and methods in structural biology available to users. Within the Working Group, the LAC community is represented by members of the Mercosur Center for Structural Biology (CEBEM), a project initiated in 2008 by five groups from Brazil, Argentina and Uruguay, which then rapidly extended to Paraguay and Venezuela, all noted for their level of scientific excellence in the region and international recognition. CEBEM is a story of success, gathering now 11 nodes in four countries, and currently considering new partners to be incorporated. The network actively works to increase the collaboration within the LAC region in the area of structural biology and protein science, as well as between LAC and the EU. Recently CEBEM has received a significant grant from the Chan Zuckerberg Initiative, to increase Regional (LAC) cooperation, recognising the network's key role in the region.

Instruct-ERIC is a landmark RI set up within the European Strategic Forum for Research Infrastructure (ESFRI). This intergovernmental organisation has prepared a Research infrastructure Roadmap to analyse the needs and expectations of the research community looking to address societal challenges and increase the impact of research in innovation. The structural biology community, through Instruct, has developed a model of open access which democratises the access to high end technologies and expertise. A similar process might be of great help for the community in LAC. The Working Group set up to gain a better understanding of the present RI landscape in LAC, the community requirements regarding equipment and expertise, and the expectations of regional and international integration.

## 1.2 What is Meant by RI in the Case of Structural Biology

Here we take Research Infrastructure to refer to equipment and services which answer the need of a community of users, providing access and know-how. This often refers to shared equipment where the size of the community of users can vary. It may be limited to a single institution, or may provide access to scientists from an entire country, a region or even worldwide. Widening general access to all such RI in Latin America, where possible, is one of the focal points of the present study.

We perceive no limitation in terms of size or cost for such infrastructure. It encompasses anything from small-scale equipment (such as chromatographs, standard spectroscopic techniques etc.) all the way up to large-scale facilities such as synchrotron beamlines and cryo-electron microscopes. Mid-scale equipment, which may attend the needs of local communities, such as rotating anode-based X-ray equipment for diffraction experiments or entry level microscopes, are also encompassed by our definition. Although we may distinguish between them at times, we have included in this study both equipment which is typically used for making "final measurements" as well as support infrastructure which is essential to the viability of many research projects. The latter may include laboratories at different levels of biosafety, for example, or the necessary infrastructure for adequate sample preparation and transportation. Furthermore, we consider some aspects of research infrastructure to extend beyond the research laboratories themselves and may encompass things such as customs services and the associated bureaucracy. Finally, within our broad definition, we consider support staff, know-how and training to be intimately connected to the equipment itself and therefore part of Research Infrastructure.

## 1.3 Relevance of Structural Biology and its Socio-economic Importance

Over the course of the last few decades the strategic importance of structural biology for society and industry has become more and more apparent. Applications in biotechnology, including drug and vaccine design, as well as protein engineering with industrial purposes, have become ever more commonplace. Investing in the Research Infrastructure necessary for undertaking structural biology research in Latin America may be a means to reduce reliance on technology and products generated elsewhere in the world and to allow Latin America to benefit from the economic impact of home-grown technology and products on the global market. Furthermore, such products may never come into existence if they are required for dealing with problems which are specific to the developing world, such as neglected tropical diseases.

It is not necessary to look too far to find an obvious example of the impact of structural biology in socio-economic terms. It took no more than a few months after the outbreak of COVID-19 in Wuhan in November 2019 for the structural biology community to respond with concrete results. In a matter of only a few months, the first cryo-EM structure of the spike protein was reported, providing essential information concerning the way in which it interacts with the ACE2 receptor on human cells. Given that the spike protein is also the major SARS-CoV2 surface antigen, these advances also provided valuable information about how particular antibodies do (or do not) interact with it. This understanding led to very effective means of engineering the spike protein, turning it into a potent vaccine antigen. Structures of the RNA-dependent RNA polymerase and the main protease followed in quick succession during the first half of 2020.

It was only possible to derive this valuable structural information so quickly because the necessary research infrastructure was already in place, the result of significant levels of investment over the previous decades. NMR, cryo-EM facilities, and synchrotron beamlines were made immediately and exclusively available to researchers working on SARS-CoV2. Such a response to a global threat had never been seen previously within the field of structural biology. Furthermore, it is clear that this was not the result of scientists jumping onto the bandwagon of fashionable research, it was because the value of the information provided by the structural biologists was immediately and fully appreciated. The structure of the spike protein[1], has been invaluable, not only for the development of the vast majority of the currently available vaccines[2], but also for understanding the impact of viral mutations on vaccine efficacy and the possible threat for new waves of infection posed by newly emerging variants[3].

High-throughput crystallographic studies of the Main Protease via the Moon-Shot project[4], based at the Diamond synchrotron (part of Instruct-ERIC UK centre) is another successful example of global cooperation, made possible due to the existence of well-developed RI.

[1] https://doi.org/10.1016/j.cell.2021.02.032
[2] https://www.science.org/doi/10.1126/science.abd0826
[3] https://www.science.org/doi/10.1126/science.abh2315
[4] https://dndi.org/press-releases/2021/covid-moonshot-funded-by-wellcome-to-rapidly-develop-safe-globally-accessible-affordable-antiviral-pill/

Within a matter of months, hundreds of structures of complexes of the protease with small-molecule ligands were determined. By either extending such ligands or linking them together, drug-like compounds have been developed in a remarkably short space of time, using input from many laboratories throughout the world. Regarding cryo-EM, the resolution of hundreds of structures of many viral proteins, including the spike protein of virtually every known viral variant together with multiple antibodies, is helping us to understand in detail the antigenic profile of the virus.

Many other examples could be provided, but the take-home message would be the same. Structural biology is of strategic importance for biotechnology research and its applications in the areas of medicine and agriculture, and continues to be a key player in the future evolution and competitiveness of developed countries in these fields. This is also true for **developing** nations, which could then focus their research priorities to each nation/region's own prevalent concerns.

## 1.4 Aims and Objectives

This document reports on the results of the systematic survey undertaken since January 2021 and which is summarised in Figure 1.

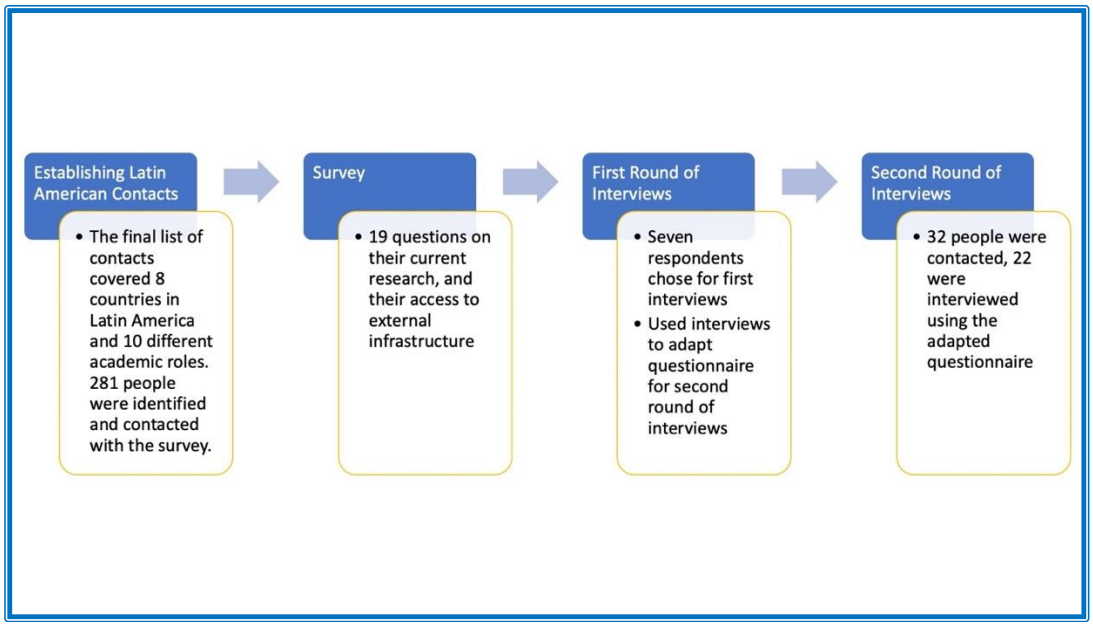


*Figure 1. Overview of analysis report methodology and process.*

Potentially interested parties were identified, based on the prior knowledge of the Working Group members, as well as through online research for countries which had poor coverage from initial contacts. Next, an online questionnaire was used to identify a set of representative respondents for a series of interviews. These occurred in two stages, with the format of the interview being adjusted as a result of the initial feedback during the first stage. The report which follows summarises and attempts to consolidate our findings. We then identify the most important conclusions and indicate possible actions for the future. To different extents, these may be relevant to individual researchers, universities, research institutions, funding bodies and governments.

During the study, many aspects of the difficulties associated with doing scientific research in Latin America were identified, even if these are not directly related to structural biology or to the use of research infrastructure itself. Key conclusions and recommendations came up from this landscape analysis regarding the needs of the structural biology community in LAC that are briefly exposed here and described fully in the report below.

**Landscape Analysis Highlights:**

- **There is a need to establish a regional roadmap to develop a clear and strategic view of structural biology in LAC. This should include long-term support.**
- **Regional Integration is fragile and requires consolidation. Particularly, connecting leaders of the scientific community with science policy makers is essential.**
- **Institutional support to strengthen research infrastructure is essential for real progress to me made.**
- **Funding bodies should be encouraged to invest in Multi-User Equipment calls in order to optimise resources and strengthen research infrastructure. These should include the practice of demanding a commitment towards maintenance and staffing on behalf of the recipient institutions.**
- **There is a need to improve the training strategy for facility staff and the scientific community as a whole.**
- **A communication strategy is required for the dissemination of available RIs, which will aid in better informing and connecting scientists in the region.**
- **The implementation and maintenance of regional hubs is recommended.**
- **Improving and strengthening international collaboration and integration is essential.**

# 2. Results

This landscape analysis was conducted in two phases. The first one was through a written survey distributed via email, while the second phase was a series of personal online interviews of approximately one hour length each, conducted by a scientific member of the Working Group together with an Instruct Hub member. A first round of seven interviews was carried out. Based on the results of these interviews, the Working Group made minor changes to the questionnaire to improve the interview process, to then carry out a second round of interviews. The goal of the much more time-consuming approach of the personal interviews was to get a more subtle understanding of the trends identified in the survey, and also to allow for an open communication channel to facilitate the identification and elaboration of issues that were unexplored or under-explored in the initial written survey.

## 2.1 Survey

281 people were contacted with the survey. Of these, 157 responses were received (56% response rate). This survey aimed to review the structural biology resources within Latin America and assess the needs in terms of research infrastructure (services, equipment, technologies) and training within the Structural Biology community.

The survey was answered by respondents in eight LAC countries (Figure 2). The geographical breakdown of respondents shows that the majority are based in Brazil and Argentina – between them accounting for 70% of respondents (43% and 27% respectively). Brazil and Argentina were also most heavily represented in the initial list of contacts. This is probably an adequate reflection of the research community, but it should be borne in mind that it may be slightly biased by the makeup of the Working Group itself. This may particularly account for the over-representation of Uruguay.

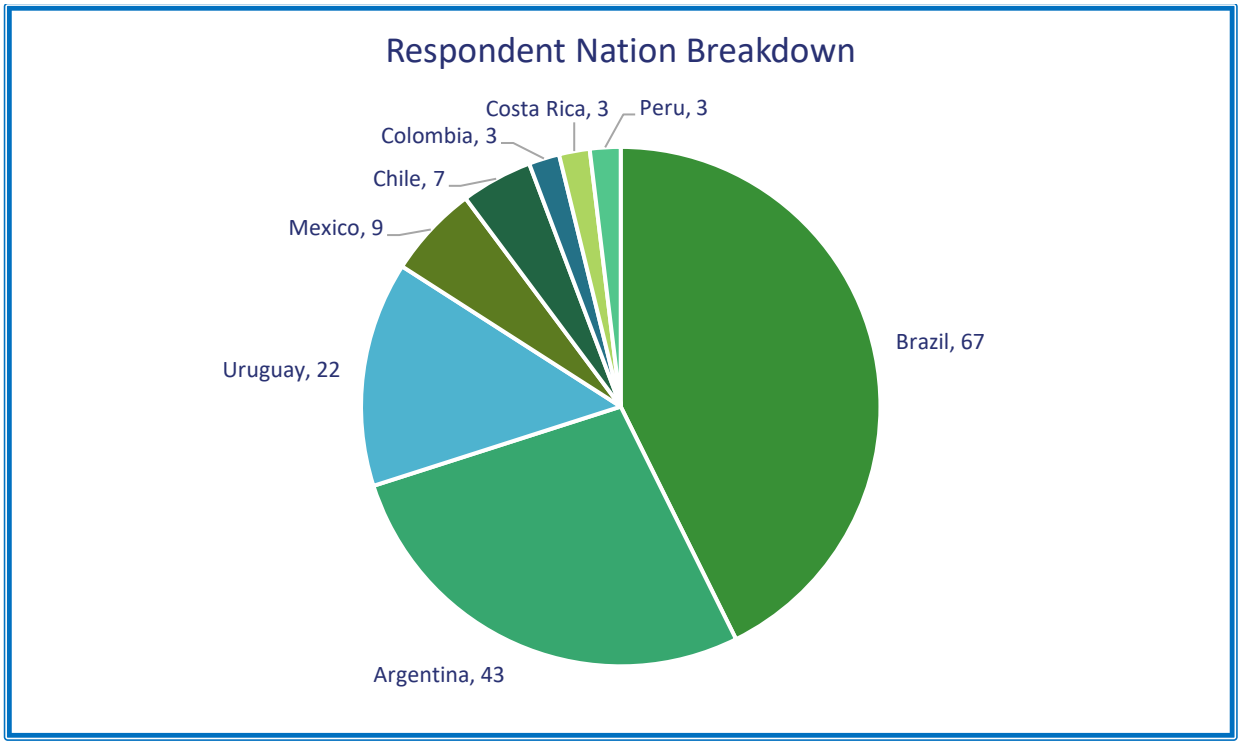


*Figure 2: The different number of national residences represented by respondents.*

Scientists at different career stages and from different career paths answered the survey (as categorised in the survey). Nine roles were represented; the most common role was Principal Investigator (PI), which accounted for 64% of all respondents. The roles, and their proportion of total responses, are shown below:

- Principal Investigator – 64%
- Research Scientist – 16%
- Postdoc – 10%
- Senior Research Scientist – 5%
- Technician – 2%
- Research Assistant – 1%
- Professor – 1%
- PhD Student – 1%
- Policy Maker (formerly senior research scientist) – 1%

### 2.1.1 Research Infrastructure Access

The survey found that 90% of respondents use research infrastructures – either internal or external to their institution. 92% of respondents' organisations offer research infrastructure to external users. This appears to be done by different means in different institutions and it was often the case that the existence of these infrastructures was not publicised enough to potential outside users.

**Use of International Research Infrastructure**

The survey indicated that researchers in different countries had different rates of accessing international facilities compared to infrastructure in their own country.

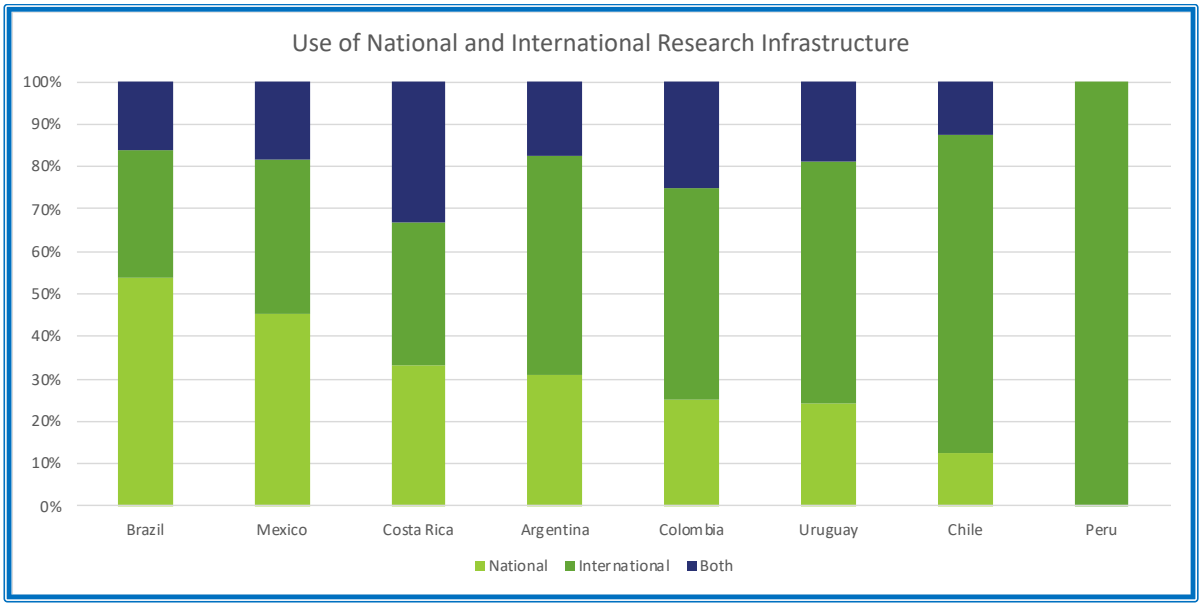


*Figure 3: Breakdown of use of national and international infrastructure by nation. Brazil is the only nation in which more than 50% of respondents access just their national infrastructure.* ***It should be noted that only Brazil, Argentina, and Uruguay had more than 10 respondents. The sample size was small for the remaining countries.***

As Figure 3 indicates, researchers in Brazil are more likely to access infrastructure in their own country, whereas researchers elsewhere in Latin America are more likely to access research infrastructure in other countries – both in Latin America and overseas. This may seem logical for Brazil, as the country invests significantly more in its own research and development (as a % of GDP) than any other Latin American nation (Figure 4). It should be noted that all Latin American nations, including Brazil, invest proportionally much less than developed nations who in most cases invest >2% in R&D.

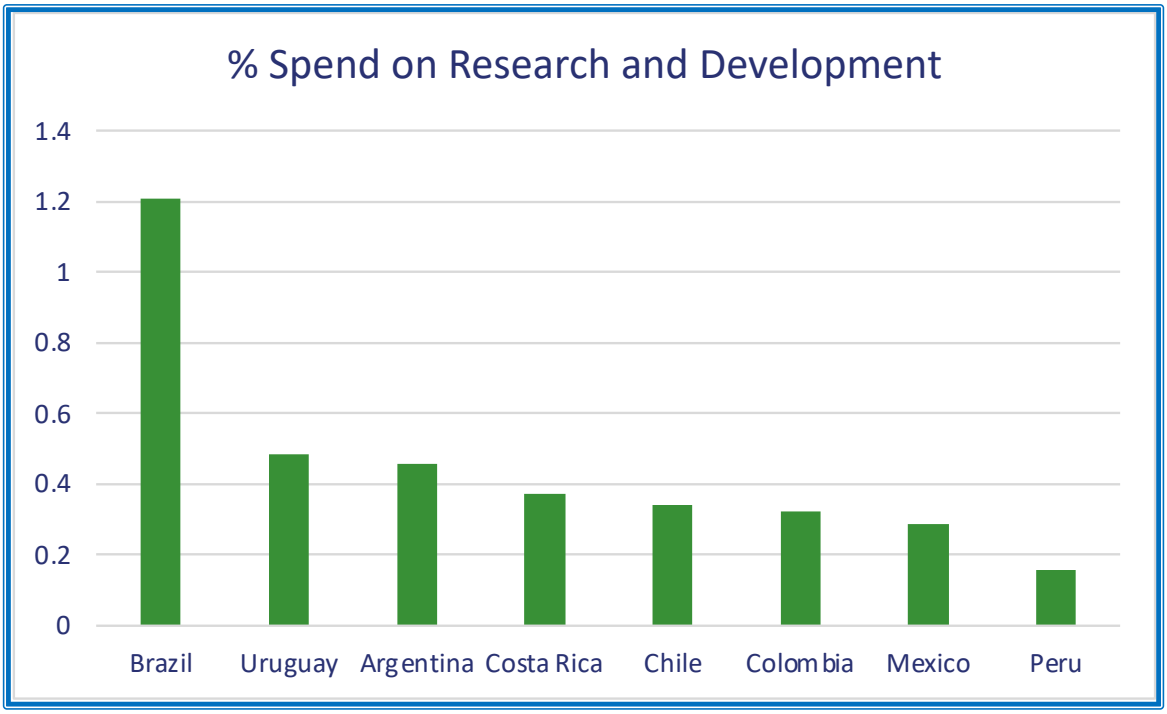


*Figure 4: Latin American and Caribbean spending on research and development as percentage of GDP, all data as of 2019. Brazil invests significantly more into R&D than other LAC nations, followed by Uruguay and Argentina. (https://data.worldbank.org/indicator/GB.XPD.RSDV.GD.ZS?locations=ZJ, accessed July 2022)*

**Location of International Research Infrastructure Accessed**

Of those who said that they access infrastructure at an international level, the breakdown is shown in Figure 5.

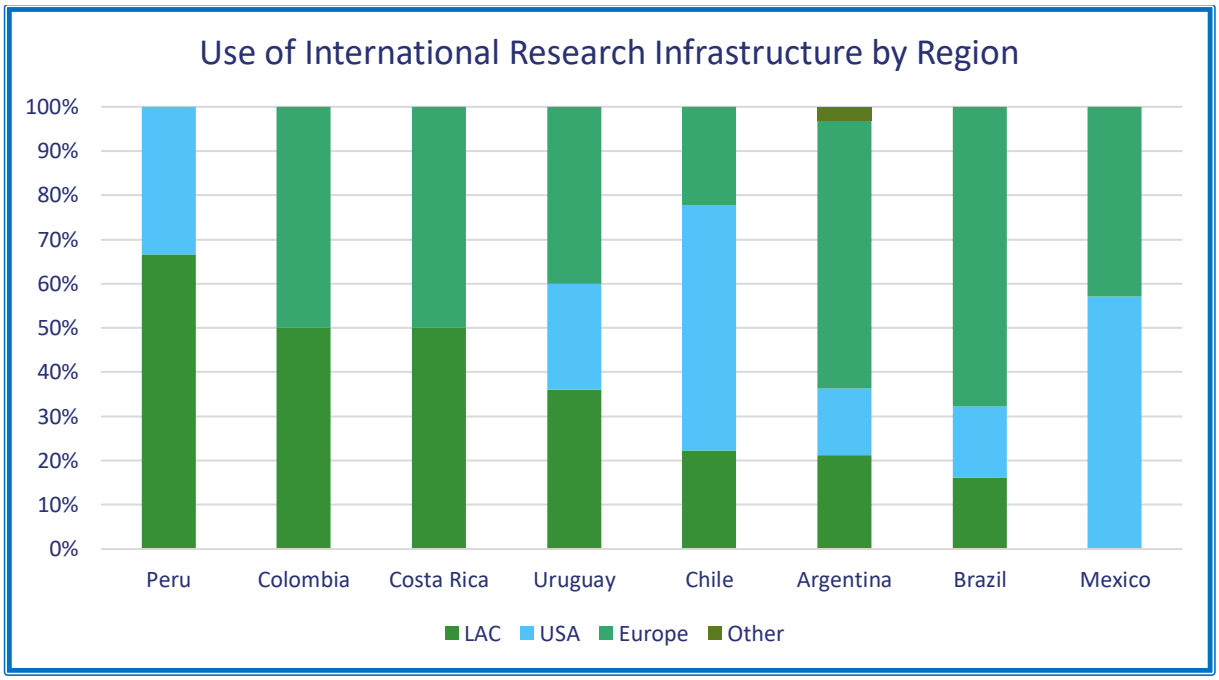


*Figure 5: Breakdown of use of Latin American, United States, European or Other research infrastructures, by nation. Researchers in Brazil and Argentina are most likely to access research infrastructure in Europe.*

*It should be noted that only Brazil, Argentina, and Uruguay had more than 10 respondents. The sample size was small for the remaining countries.*

As the graph indicates, the countries that have the highest proportion of their international researcher access to EU are Argentina and Brazil in spite of the difference in their economies, and it is possibly due to long-standing relationships between Argentina and Brazil with research infrastructures and facilities in Europe. This situation could be an indicator that strategic EU RI efforts oriented to better coordination of road maps and strategic joint work on infrastructure growth may advance faster in these countries.

Researchers in Peru, Colombia, and Costa Rica are more likely to use Latin American research infrastructure than those from other LAC nations. Infrastructure in the USA is preferred by those in Mexico and Chile.

**Use of External Research Infrastructure**

Respondents were asked which structural biology services they accessed at external research infrastructures. Among respondents, a wide range of structural biology services are accessed, shown in Figure 6.

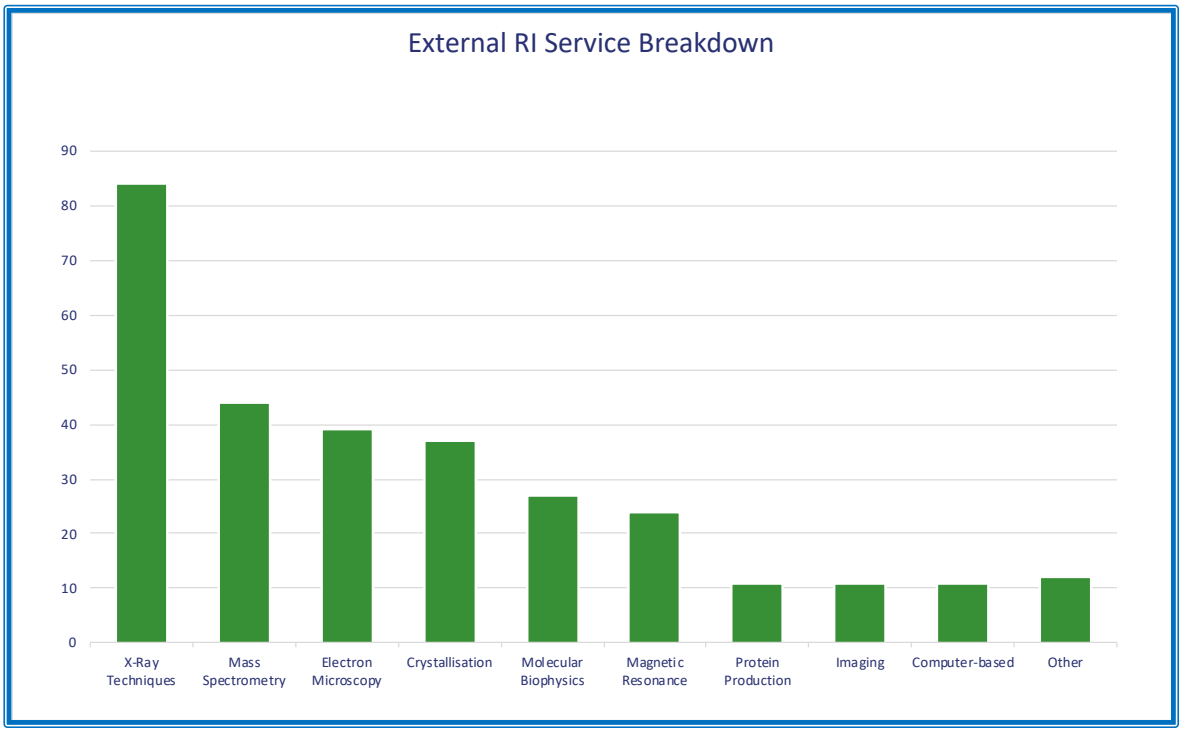


*Figure 6: Breakdown of structural biology services used by Latin American researchers who access external research infrastructures.*

The most common services accessed are X-Ray techniques, mass spectrometry, electron microscopy, and crystallisation techniques. There is a relatively even spread of services accessed, however notably X-Ray techniques are much more commonly accessed (55% of respondents). The incorporation of these techniques into the LAC structural biology programme has been in progress for several years across nations – the survey figures

suggest that this promotion has been at least partially successful, and the strategies used to achieve this could be applied to other techniques.

Another notable highlight from Figure 6 is “Protein Production”. This is an important prerequisite service as high-quality protein samples are required to make optimal use of all other services, and is only accessed by 7% of respondents. This may point to the fact that LAC researchers are not yet extensively using high-end RIs and have not yet faced many of the “sample issues” that experienced facilities in any part of the world continuously report. While it cannot be ruled out that protein production simply takes place at the respondent’s own laboratory (rather than accessing external infrastructure to do so) in some cases it is found that researchers will access high-end equipment with poor quality samples, and waste the technology with a sample that does not yield useful results. It is probably an early “warning” indicator that the promotion of the use of advanced instrumental facilities in LAC countries must rely on the concurrent development of suitable sample production facilities (as well as sufficient screening facilities), possibly organised as Regional Hubs.

Respondents were also asked for the most common barriers that prevent them from accessing structural biology services at external research infrastructures. Figure 7 shows the breakdown of the responses.

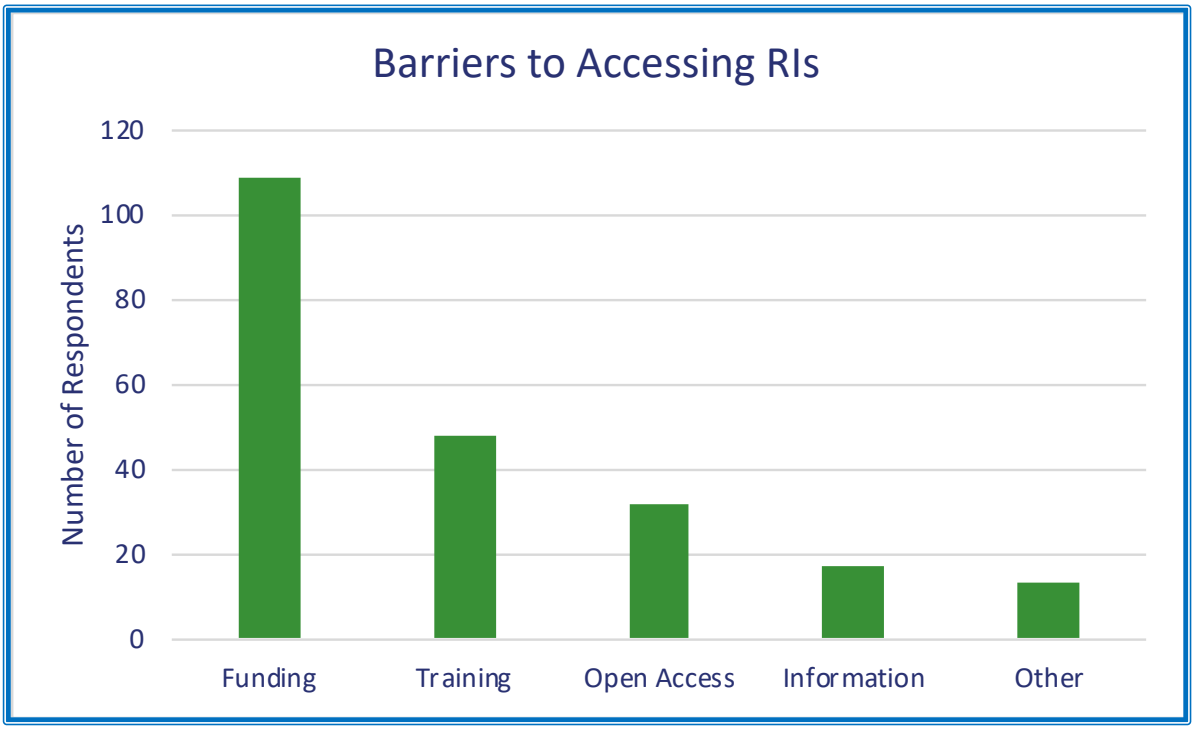


*Figure 7: The main barriers facing researchers in Latin America to accessing external infrastructures.*

Funding was the most common response (77%), followed by respondents having the necessary training or expertise required to actually use the equipment at the external infrastructure.

**Limitations in Access to Structural Biology Services**

Respondents were asked which structural biology services they lack access to. A large proportion of respondents (77%) emphasised that their research is suffering due to lack of research infrastructure.
Electron microscopy, despite being accessed by only 25% of respondents, was cited most frequently as the service which people feel would most improve their research (Figure 8), which suggests that there is currently a significant delay in electron microscopy availability in Latin America, partially explainable by the fact that this this technology has evolved very fast in the last decade.

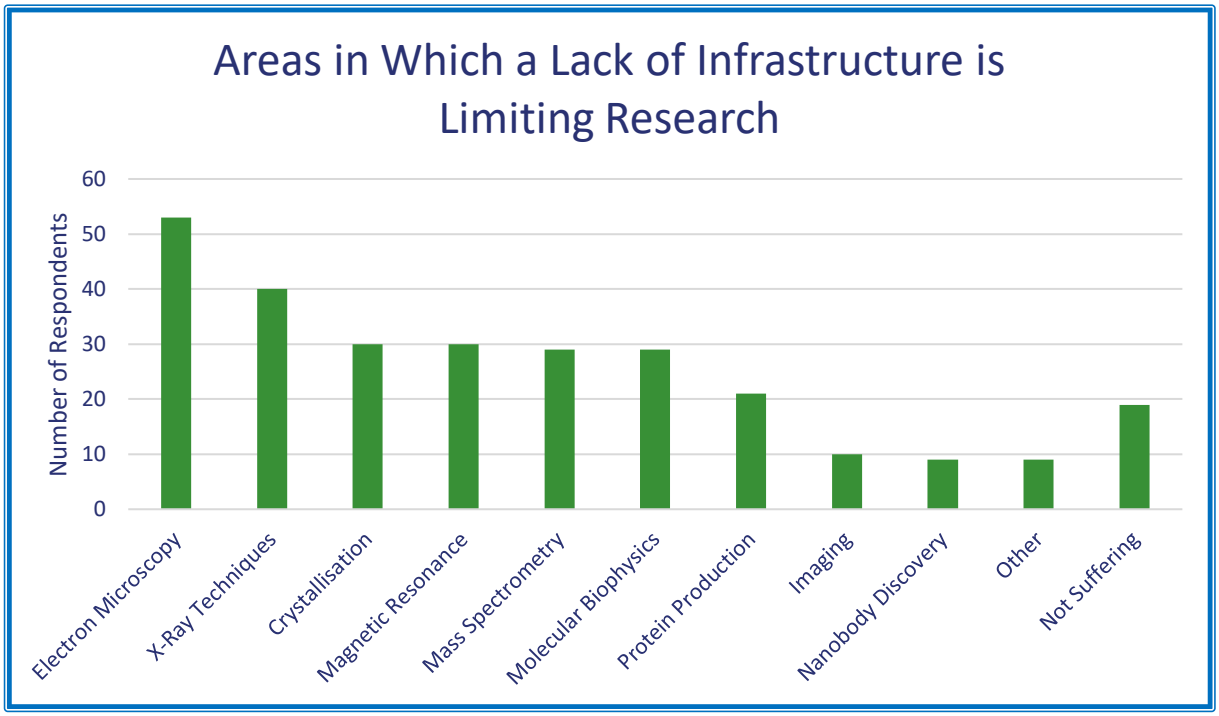


*Figure 8: Breakdown of the structural biology services that respondents most feel that they are unable to access, and their research is suffering as a result.*

Enhancing the RI capability for a particular service would require improved access to these services, perhaps by increasing the number of RIs offering access to a specific technology type. Additionally, improved training and expertise in a service will improve its accessibility and potential scientific impact.

**Training Required for Structural Biology Services**

The path for a facility to efficiently support users is complex and requires many associated activities. Therefore, it is not surprising that a very high percentage of respondents, up to 86%, indicate that they require specialist training to understand the best way to make use of the facility (Figure 9). Cryo-EM was again the most commonly cited technique, with 41% of respondents wanting more specialist training in the area. Coupled with the information in Figure 8, it indicates that researchers are keen to move into the area of cryo-EM, however they suffer from a lack of access and expertise in the technique.


*Figure 9: Breakdown of which structural biology services respondent feel that they would need specialist training in in order to use/access.*

### 2.1.2 Provision of Research Infrastructure

Among respondents that were in charge of a facility, the vast majority (up to 92%) indicated that their facility did offer access to external researchers: either at an institutional, national, or international level. However, the way they did this opening varied a lot among countries, a fact that will be analysed in detail in subsequent sections

The breakdown of the level of access provided is shown in Figure 10

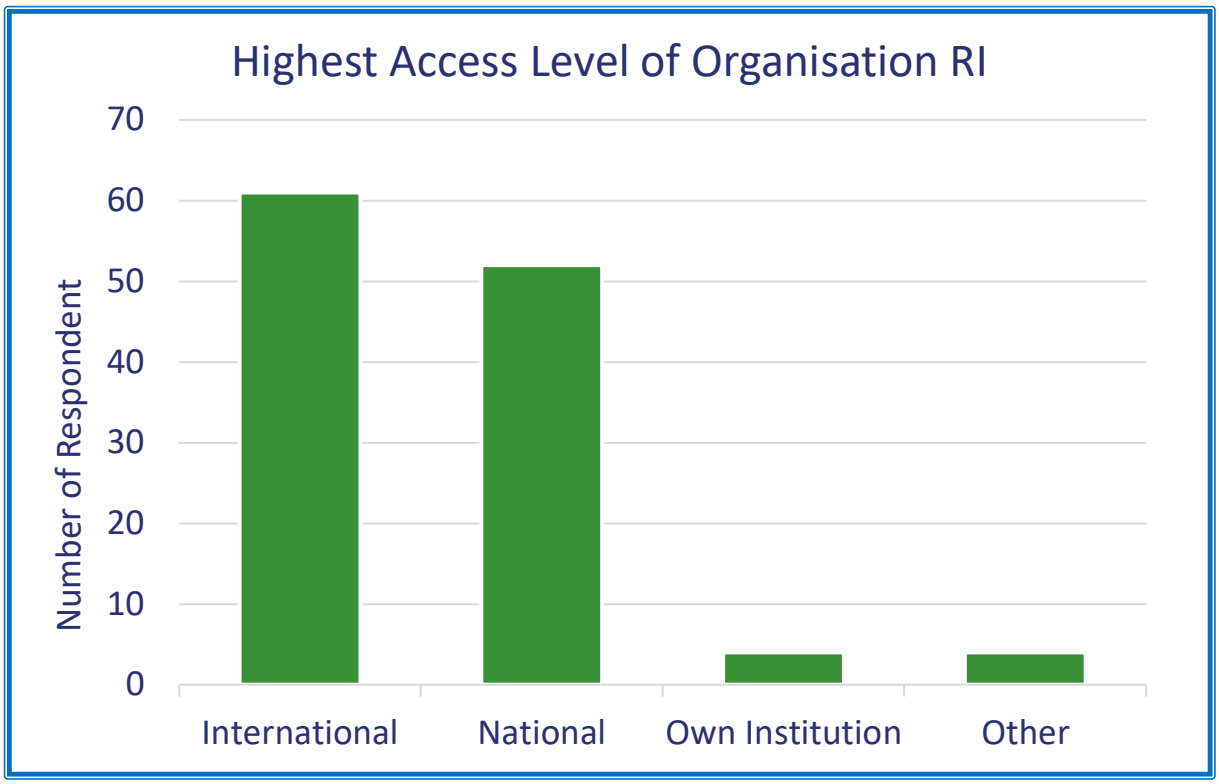


*Figure 10: The level of access that respondents' facilities offer to users.*

Identifying the highest level of access available to external users, the most common response was that international users (50%) could access the laboratory, however this was closely followed by facilities that only offer access to National users (43%). Just 3% of respondents said that their facility only offered access to users from within their own institution.

When looking at the national breakdown (Figure 11), Argentina and Mexico have a much higher proportion of facilities which are open to researchers within the same nation. The centralised government structure of Argentina (as opposed to federal), may lead to this more efficient coordination with its national research system.

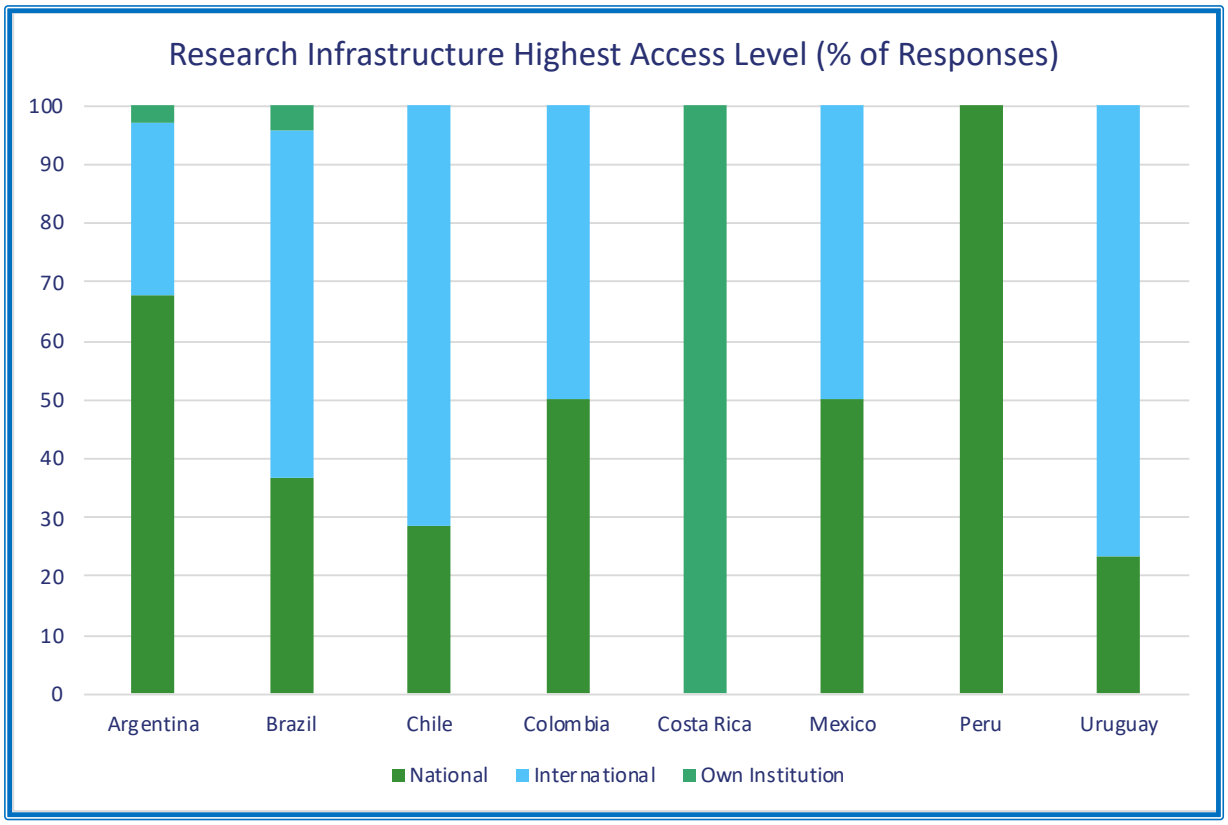


*Figure 11: National breakdown of research infrastructure provision, by access level. Note, Brazil, Argentina and Uruguay are the only nations with more than 10 responses. All other nations have a relatively small sample size.*

Brazil, Uruguay, and some other nations (with smaller sample sizes) have a relatively even split between national and international access, with a slight lean towards international users. Argentina has vastly more national users than international.

**External Research Infrastructure Referral Method**

To understand how research infrastructure access is promoted and communicated to the Latin America research community, respondents were asked how they had heard of the infrastructure that they accessed (Figure 12).

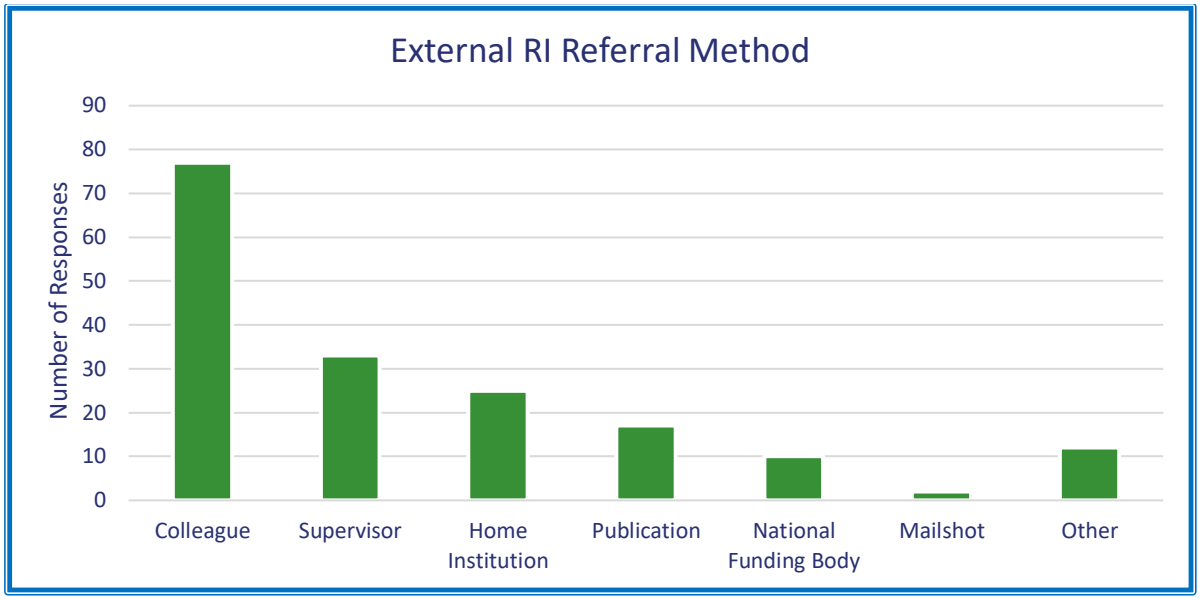


*Figure 12: Breakdown of referral methods that researchers had to find out about the external research infrastructures they access. Word of mouth (colleague, supervisor) is the most commonly answered method.*

57% of respondents heard of opportunities at external research infrastructures directly from a colleague or supervisor. Relatively few heard of them via their institution, or external communication channels. An institutional-wide approach to promote RIs would be needed. That word-of-mouth (and by implication, personal connections) is of such importance that may explain why researchers in certain countries tend to favour the use of RI in Europe over the USA, for example. To some extent, this may simply be a matter of historical connections brought by the founder of the group.

### 2.1.3 Survey Conclusions

The survey demonstrated that although a significant number of scientists in LAC are using RIs, and many facilities offer external access to their services, the majority of scientists suffer from a lack of access to certain infrastructures and techniques. In order to better understand the main limitations for the access of RIs (lack of infrastructure, lack of funds for access, lack of training, lack of awareness of available infrastructure, etc.) and the limitations to access provision (lack of resources, staff, maintenance, etc.) the decision was made to organise interviews with a subset of the survey participants that represent the overall structural biology community in LAC.

## 2.2 Interview Stage

The interview stage of the analysis took place in two rounds. The first round of interviews, including only a small number of scientists, was designed to get an understanding of what sort of information could be gleaned by face-to-face questioning. This involved a questionnaire being created, based on the results of the survey to ensure more information was being collected through the interview process. Following this pilot study, the questionnaire was edited slightly, streamlining it and reducing the number of questions to ensure they were more relevant for what respondents could answer. This new questionnaire was used for the second round of interviews.

Interviewees were asked about their own research, their access to external infrastructure, and how they manage access to their own infrastructure. The following results show the key insights from the interviews in both the first and second rounds.

29 people were interviewed in total. The breakdown of these people by gender and geographical location can be seen in Figure 13. The majority of those interviewed were from Argentina and Brazil. The remaining represented nations are Mexico, Chile, Uruguay, and Peru, in order of proportion.

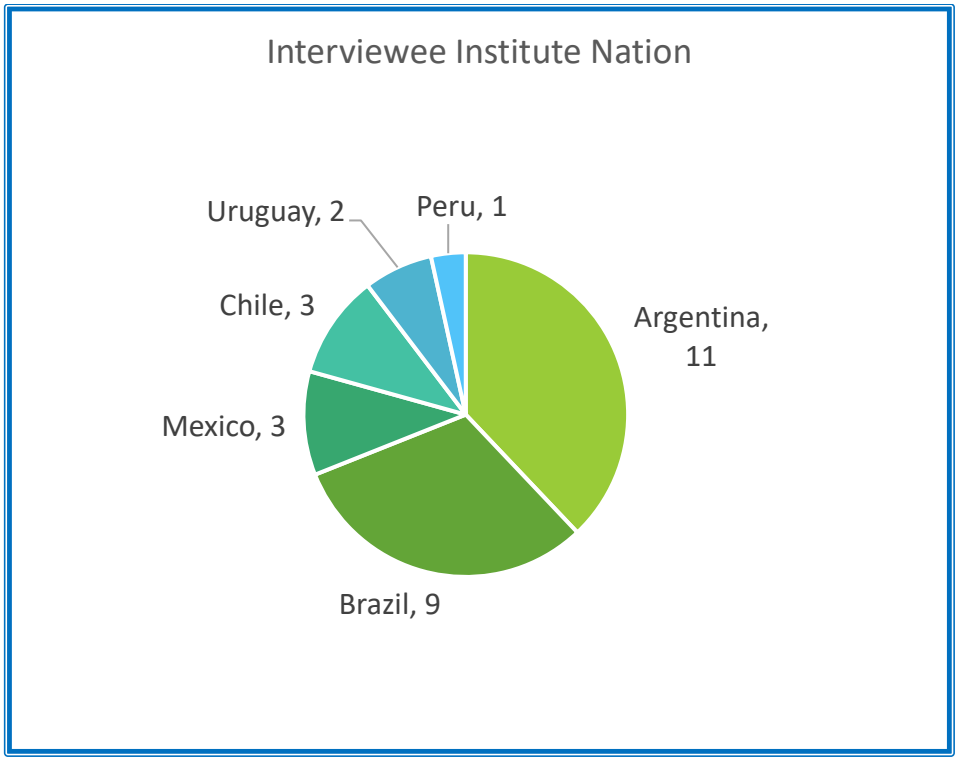


*Figure 13: National breakdown of respondents to the second round of interviews.*

The gender distribution of those interviewed was 18 Male and 11 Female.

The interviews revealed a number of common issues regarding RI access and provision and research in general shared by structural biologists in LAC that we summarise in this report.

### 2.2.1 Main issues or Impediments Limiting Researchers

When asked about the impediments and barriers to their research, common responses from the interviewees are listed below (Table 1).

| **Issue or Impediment** | **Number of Responses (out of 29)** |
|---|---|
| Funding | 23 |
| Bureaucracy | 13 |
| Community size / acquiring new students | 9 |
| External infrastructure access | 9 |
| Lack of training | 7 |

| | |
|---|---|
| Maintenance problems | 5 |
| Time required to get basic equipment/reagents | 6 |
| Distance to other infrastructure/maintenance | 4 |
| Access to Level 3 facilities | 4 |

*Table 1: Frequency of common responses to questions regarding issues or impediments to research in Latin America. Each number is out of 29.*

We will now analyse in more detail each of these impediments:

1. **Funding**
   23 of the 29 respondents directly cited a lack of funding as a barrier to their research. All of these respondents referred to the state or national science funding body when explaining that funding was a problem for their research. Funding was considered a problem in two different ways.
   a. The most common was simply a lack of money to conduct research, pay staff, maintain equipment, access external infrastructure. Many respondents noted that funding is starting to increase, or that they are aware of increases in funding planned for the future. Additionally, many respondents said that they could only get funding for their project if it was in a scientific field of trending interest (for example, COVID-19).
   b. Three respondents, all from Argentina, explained that although funding may be sufficient when it is awarded, the significant fluctuation in value of currency over the course of a grant makes it unreliable, and often researchers must spend the money as soon as they can in order to guarantee that they get their money's worth.

2. **Bureaucracy**
   13 researchers across all nations in Latin America cited bureaucracy as a limitation. The paperwork and administrative requirements to either receive funding, equipment, or other vital resources has significant time and monetary detriments to researchers. Bureaucracy problems affect researchers in almost all countries in Latin America, but most significantly affects those in Brazil. The proportion of Brazil-based researchers who cited bureaucracy as a barrier is far higher than the proportion of those interviewed (46% of those who cited bureaucracy as a limitation were based in Brazil; only 31% of interviewees were based in Brazil). One respondent specifically highlighted problems with Brazil's tax exemption for transporting biological material/samples, which has led to significant paperwork/customs checks to confirm materials are legitimate. This leads to significant delays in receiving and sending materials.

3. **Drain of Young Researchers in Structural Biology Community**
   There are growing difficulties in offering attractive opportunities for students (a situation that seems common to other scientific areas in the academic sector), which appears to generate a drain of young people towards other employment sectors, despite the strategic need to capture talent in Structural Biology. Additionally, nine respondents specifically mentioned that Structural Biology was not receiving the

necessary funding attention from their governments. They considered it could be related to the size of this scientific community of researchers not being large enough.

4. **Lack of External Infrastructure Access**
   Nine respondents said that a lack of easy access to external infrastructure was impeding their research.

5. **Maintenance Problems**
   Maintenance of their own equipment and machinery was cited by five researchers as impeding their research. This was also covered later in the questionnaire as respondents were asked specifically about how their institution funds maintenance of equipment.

6. **Training**
   Lack of training was deemed a big problem for seven respondents. They refer to training for scientists and also for technical personal, the latter being normally very scarce. An often-repeated suggestion was that too much effort was going towards the purchase of equipment or machinery, but not enough towards hiring and training people to use them effectively.

7. **Acquisition of Basic Materials**
   Six people said that it takes too long or is too expensive to acquire basic research equipment or reagents. This may be due to bureaucracy problems or simply distance. Many have said that it can take months to receive reagents after an order is made, which produces difficulties in planning projects. Additionally, one respondent said that some companies will not sell directly to them due to the distance and customs problems, so a representative is needed to make the order. This still brings significant time delays, and increases the price by 70%, on average.

8. **Distance to Other Facilities**
   Respondents in institutes which are geographically far from others found that there are problems with accessing external infrastructure (4 out of 29), and with maintenance of equipment. Furthermore, due to the significant travel time, engineers from machinery companies will not travel to facilities, and instead will insist on providing remote instructions, decreasing the quality of service.

9. **Access to Level 3 (or Higher) Facilities**
   The need to access to Level 3 biosafety facilities has become more visible following the COVID-19 pandemic, and four respondents said that there are not enough such facilities available to them.

### 2.2.2 Support for Researchers from their Home Organisation

When asked whether their institution supports them with these impediments, the most common response was that they were not supported by their own institutions, although

there were exceptions. It became clear that there are several different areas in which more support is needed. All 29 interviewees responded to this. The breakdown is presented below:

Respondents indicating “More Support is Needed” in the areas of

1. Research
2. Equipment maintenance
3. Bureaucracy/Administration
4. Access to external infrastructure

1. **Research**
   Ten respondents said that their institution did not offer sufficient funding for them to carry out their research, if any. These respondents explained that they relied on external funding agencies to obtain grants for research. Some had their salaries paid by their institution, so whilst they were supported in that sense, they received nothing more in terms of equipment or students.

2. **Equipment Maintenance**
   Eight respondents said that they received little to no support from their institution to maintain equipment or technology at their facility. Similarly, many respondents had broken equipment at their facility, and their institution would not or could not provide sufficient funds for an engineer to fix them. The institution also would not pay for an in-house technician to maintain equipment on site.

3. **Bureaucracy/Administration**
   Two respondents said that their institute did not help with the significant paperwork/administration required to obtain external funding. In this particular instance, the respondent explained that they themselves had taken a course in university administration in order to better understand the processes.

4. **Access to External Infrastructure**
   One respondent said that they generally did receive support from their institution, but not the funds required to travel to external, advanced infrastructure.

There was, however, a very significant fraction of respondents who considered they were supported, indicating that the pool of respondent was heterogenous in this respect. It should also be noted that the same respondent may have said that their institute does not support them in one aspect but does provide support in another.

Respondents indicating “Do Support” in the areas of

1. Research
2. Equipment maintenance
3. Bureaucracy/Administration
4. Access to external Infrastructure

1. **Research**
   Five respondents said that their institution does offer the necessary support for

them to carry out their research, whether through research grants, purchasing equipment, or providing laboratory space.

2. **Equipment Maintenance**
   Seven respondents said that their institution offers support for maintaining equipment or technology when broken or funds a technician to ensure machinery is working. Both interviewees based in Chile said that their institute did provide support for maintenance when required, whilst only one interviewee from other nations said that their institute supported maintenance problems.

3. **Bureaucracy/Administration**
   Four respondents said that their institution provided support with administration and bureaucracy required to gain external funding/equipment.

4. **Access to External Infrastructure**
   Zero respondents said that their institution provided support to access external infrastructure.

### 2.2.3 Funding for External RI Access, Travel and/or Shipping

Respondents were asked if they received funding to access external research infrastructures, and whether this funding also covered their travel/remote shipping expenses. All 29 interviewees responded to this. The common responses are listed below:

1. **Travel Funding**
   Six respondents said that they could get additional funding to cover travel or shipping costs from their institution or funding agency. However, almost half of respondents (14 out of 29) said that they could not get funding for travel to access external infrastructure. Whilst they may be able to receive funding to access and use the equipment itself, this would not cover any travel expenses, and they would need to use money from their own research grant in order to cover costs.
   One respondent even said that they must use personal money to cover travel costs.
   One respondent said that the infrastructure they access would provide paid accommodation, but they could not acquire funding for the travel or access itself.
   Four respondents said that they cannot get funding for shipping costs.
2. **Access Funding**
   Nine respondents said that their institution or national funding agency would provide money for access costs, whereas six said that this was not the case for them, and that they would need to cover these costs from their own research grant. Seven further respondents said that it was not necessary, as the platform they were accessing was free to them, or of such negligible cost that additional funding was not required and would not be a problem to cover by their own grant.
3. **Funding Available for Local Access**
   Two respondents said that their funding agency will provide travel and access money, but only for local or national visits, with no funding available for transnational access.

### 2.2.4 Information on Provision of Access to Users

The third and final section of the questionnaire asked respondents about their provision of access to researchers, if at all. From our 29 interviewees, 21 of them provide access to their equipment/facility to external users; the majority of them providing access to all users regardless of whether they are internal to the institution, or external users altogether. Seven respondents also mentioned providing access to industrial users.

The interviewees were asked about their service, who it is open to, how the access is managed, and how funding for their service is managed. The 21 interviewees whose facility provided access responded.

**Access Availability**

Respondents gave insight into the access level of their facility: whether it could be accessed by external users, or not, and whether industry users could apply and use the machinery.

1. **Open to All Users**
   The most common response (21 out of 29) was that access to services is available to all users, regardless of whether they are internal to the facility, institution, or are external users altogether.
2. **Facility Not Accessible**
   Eight respondents said that their facility does not provide access to users.
3. **Open to Industry**
   Seven respondents said that their facility is open to industrial or commercial users, in addition to academic users.

**Access Management**

The management process for access to structural biology infrastructures/facilities varies a lot in Latin America, dependent on the institutions and nation.

1. **Only Advertised on Facility Website**
   Although the majority of equipment and facilities appear to be open to external users, it seems that the availability of these services is not always broadly disseminated to external users and the technology is not systematically managed in an external catalogue of services. Ten respondents said that their services are advertised on their facility/institutional website or portal. All of these are managed by the institution itself, rather than an external catalogue service. In this instance, this does not mean that users can apply for the service(s) directly from the website, just that their services are promoted.
2. **Access via Direct Email**
   Ten interviewees said that they manage access to their facility via direct contact with the user through email. Either their email address or contact details are visible on their website or portal, or it is through previous communication that users contact them.
3. **External/National System**
   Eight respondents said that their services are available to access via an external

application system. It should be noted that seven of these eight interviewees were based in Argentina and were referring to the National Systems in place.

4. **Automated Proposal System**
   Seven interviewees said that their facility had an automated proposal process or form, which users could access through their website or webpage, rather than through direct email or external catalogue.
5. **No Review Process**
   Three respondents explicitly made it clear that their facility did not have a review process to access their services. They explained that the only requirement to access their facility was that they had selected the suitable machinery to conduct their research.

**Access Funding and Costs**

Different institutions have varying policies regarding covering access costs. Some elect to charge users to visit facilities a fixed rate, some a contribution towards maintenance costs, whilst others offer it for free.

1. Eight respondents said that there is a fee charged to access the services at their lab. One of the respondents explained that the fee to access their equipment is minimal ("cost not comparable to costs in US/Europe", for example). One respondent also said that access to their facility has no charge, however users are expected to pay if equipment is damaged. Although a pay for access system exists in many facilities, it seems that access is often provided free of charge through collaborations in which facility staff will be cited in papers once it is published. It was also mentioned that in some cases, the low costs for access provision and the lack of support from institutions, makes it difficult to provide an effective service.
2. Two respondents said that they receive funding from their institution to run their facility, or that it is self-sustained.
3. Two respondents said that their facility has no fee charged for access.

**Maintenance Funds**

A repeated point made by interviewees is the issue of maintenance, whether as a limitation for their own research or as a reason that they cannot provide access to external users. This highlighted the fact that in certain facilities, even if they have cutting edge equipment, they are not able to consistently offer it to external users.

1. Six respondents said that their facility has no specific maintenance budget, even when offered to external users. This means that facilities are not able to use or offer the cutting-edge, and expensive, equipment that they hold. All three respondents based in Mexico said that they did not have a budget to maintain the equipment they offered (Figure 14).

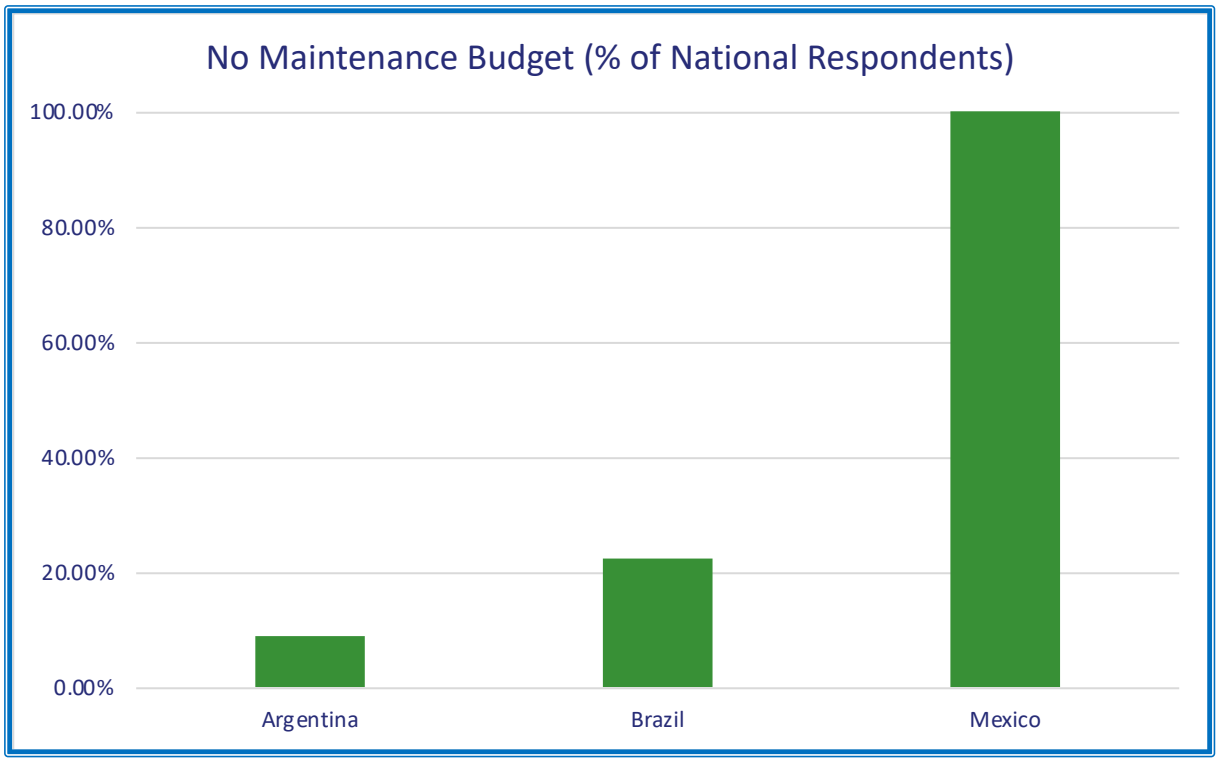


*Figure 14. The nations represented by respondents that said their institution did not have a maintenance budget. Argentina (1 out of 11 interviewees), Brazil (2 out of 9 interviewees), Mexico (3 out of 3 interviewees).*

2. 4 respondents said that they are able to apply within their institution or funding agency to receive funding for maintenance if required. However, many of these said that this is often a time-consuming and bureaucracy-heavy process.

### 2.2.5 Type of Access (Physical, Remote/virtual)

There are different ways of accessing external infrastructure. Physical access refers to visiting the facility in-person, and either using the equipment or working with a technician to gather results. Remote or virtual access does not involve visiting the facility, but to receive data remotely either shipping the sample and being sent the data, or by accessing a dataset. 21 interviewees responded to this question.

1. **Both Physical and Remote/Virtual**
   Many of the respondents (ten) who do provide access to external users can offer both physical and remote access to their services. They have the technicians available to carry out the experiment with samples sent, but can also accommodate visiting researchers, and can run experiments physically. The majority of respondents who said their facility offers both remote and physical access were based in Argentina.
2. **Remote/Virtual Only**
   Six respondents only offer remote access, if samples are shipped to their lab. For most, this is due to the equipment being expensive, or maintenance costs being so high, that they cannot risk untrained researchers using the machinery. These

respondents in said that they must also be in a region with sufficient infrastructure to receive biological samples soon after they are shipped, crucial for gel or frozen samples.

3. **Physical Only**
   Four respondents can only carry out physical research. One person said that this is due to not having enough technicians in their lab to spare one to run other people's research – therefore people must come to the lab physically to use the machinery themselves.

### 2.2.6 Any collaboration with EU organisations?

Respondents were asked whether their facility or institution, to their knowledge, has any existing collaborations with European institutions or labs. 22 interviewees responded to this question The results are outlined below:

1. **Formal Collaboration**
   Only 4 out of 22 respondents said that their institute has a current formal collaboration with a European institution.
2. **Informal Collaboration**
   11 respondents said that their facility has an informal collaboration with a European institute or laboratory. This may be due to having personal connections, or former colleagues who work in Europe. Of these respondents, there were more than proportionally expected from Brazil, as shown in Figure 15.

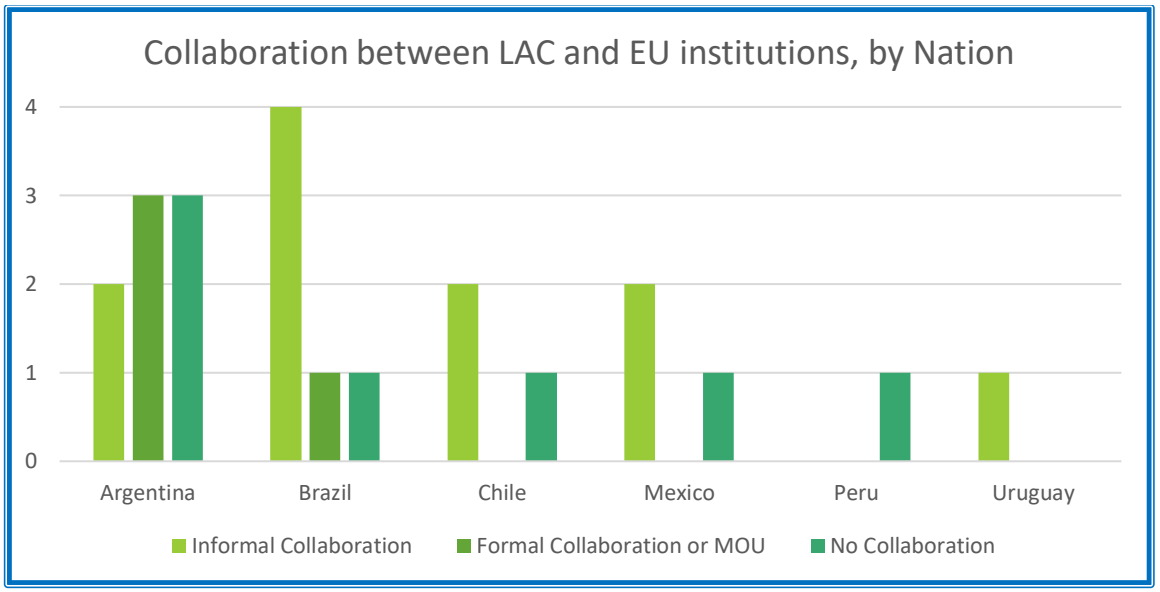


*Figure 15. Collaborations between LAC laboratories and the EU*

3. **No European Collaboration**
   Seven respondents said that their facility does not have any collaboration with European organisations. They might have collaborations in place with non-European organisations.

4. **Historic/Concluded Collaboration**
   Two respondents said that they previously collaborated with European organisations but have no current partnerships.

### 2.2.7 National Structural Biology Roadmaps

Interviewees were asked whether they were aware of a national roadmap for structural biology. They were also asked if they were aware if their facility featured on this roadmap, if it existed. This examined whether these roadmaps, which are common in Europe, are implemented in Latin America, and also assessed how well they are communicated with the structural biology community. 24 interviewees responded to this question.

1. **Not Aware of Roadmap or does Not Exist**
   14 of the respondents said that they are not aware of a national roadmap, or it does not exist. Three of these respondents also said that there previously was a roadmap or strategic plan, which has now ended.

2. **Roadmap does Exist**
   Five respondents said that there is a national roadmap, or at least a strategic plan or central resource for structural biology in their country. Of these, four were based in Argentina.

3. **Facility Not on Roadmap**
   Three respondents said that their facility does not sit on a roadmap or strategic plan. Two of these did not specify if they were aware of a roadmap at all. One respondent said that they are aware of a national plan, but their facility does not sit on it.

4. **Facility is on Roadmap**
   Two respondents said that their facility does sit on a national roadmap or plan.

5. **Do Not Know**
   Two respondents said that they do not know.

## 3. Discussion and Conclusions

One of the clearest outcomes of the analysis is how the use of research infrastructure is not an isolated necessity felt by the research community. The efficient use of RI is only possible if many other research needs are also in place. Many aspects of the points raised during the discussions are clearly interconnected. Sufficient funding for research itself is self-evident but it is far from being the only limitation. For example, if measurements at a large-scale central facility require the movement of samples, then efficient mechanisms must be in place for guaranteeing sample integrity and handling. This may require the appropriate training of customs officials, for example, if samples must cross borders. Or, if samples from pathogenic organisms are involved, then adequate biosafety level 2/3/4 facilities need to be in place where needed. This requires investment in infrastructure which may be less obvious

to policy makers and funders since it is not, *per se*, a generator of scientific results. Nevertheless, it could be essential for the success or failure of certain types of projects. Often the purchase of a particular piece of equipment is short-sightedly seen to be a "solution" to a problem. However, if not adequately backed up by funding for maintenance and proper operation by technical staff, then such equipment can remain idle for large periods of time. Overall, there appears to be a need for changing the mindset in Latin America in order to generate a long-term view which is research sustainable, naturally leading to the requirement of roadmaps, of vital strategic importance.
While the questions above concern themes that consistently come across, interviews have shown that the heterogeneity of opinions among our pool of respondents in some critical issues is quite large. The origins of these differences are complex to trace from a limited number of interviews, but often seem to be associated to important differences among countries, which were indeed expected.
The following specific bottlenecks and limitations were identified:

## 3.1 Funding

### 3.1.1 General

Investment in science and technology in Latin America countries in relation to GDP is still well below ideal, and significantly below developed nations in general. Brazil has traditionally invested around 1% of GDP and other countries typically less. The situation is likely to worsen as the world economy recovers from the pandemic. Lack of funding obviously has an impact in all aspects of scientific research, from the maintenance of small individual laboratories to national facilities. This point was raised time and time again during the interviews and is not limited to structural biology alone. Although perceived (correctly) to be a general phenomenon which applies to the region as a whole, there is significant variation from one country to another. Brazil stands out in terms of research infrastructure in structural biology. It not only has the only operational synchrotron in the region (with a functional beamline for protein crystallography) but also houses the only high-energy cryo-electron microscope on the sub-continent. Although a second microscope should be installed shortly, also in Brazil, this is still a very limited availability for such an important technology, when compared with other regions of the world. According to a user-filled map resource[5], the northern hemisphere currently houses the vast majority of all high-end transmission cryo-electron microscopes suitable for single particle analysis. It is hard to imagine the local research community flourishing under such circumstances.

The need to see scientific research as "investment" rather than "expenditure" has been a constant for many years in the region. This mindset must change if Latin American countries are to be given their proper opportunity to become significant players on the global stage.

[5] Lists of high-end bio cryo-EMs, cryo-FIB/SEMs, & cryo-EM labs worldwide; https://www.google.com/maps/d/u/0/viewer?mid=1eQ1r8BiDYfaK7D1S9EeFJEgkLggMyoaT&ll=-3.81666561775622e-14%2C127.20100234399985&z=1

### 3.1.2 Travel funding or sample shipping

Being able to access external infrastructure is the cornerstone of research, as it reduces the need for advanced machinery to be placed in every facility, and allows researchers to get hands on experience, training, or collaboration with external experts. Access to instrumentation around the world has become more commonplace over recent years, especially due to the advent of remote data collection ("Fedex" data collection) which has become particularly popular among structural biologists. However, many researchers in Latin America do not have sufficient funding to carry out external visits, whether they are physical or remote. Travel and shipping costs often must be paid by the research grant itself, and in some cases, researchers use their own personal money to cover costs.

The statistics from interviews show that more infrastructures are available remotely or virtually than physically, which suggests that perhaps a focus on enhancing remote access provision by reducing shipping costs or addressing bureaucratic issues could pay significant dividends in the short and long term.

### 3.1.3 Funding for in-house infrastructure allowing for good sample preparation

Sample preparation is the fundamental first step in structural biology. Access to the equipment itself allows complex experiments to take place, but all machinery requires correctly prepared samples in order to deliver meaningful results.

Interviewing researchers in Latin America suggests that high-quality sample preparation expertise may be lacking in many cases. Therefore, whilst expensive machinery may be available, some research teams are unable to make full use of them, as the samples are not of high enough quality to be properly analysed with the equipment.

A focus on in-house infrastructure and training of researchers to ensure samples are produced with the highest possible quality, is essential in order to make full use of external and internal infrastructure.

Part of this also comes from the often-cited issue of import of reagents and samples. If a sample is insufficient, and a replacement cannot be prepared for a long time due to delays in receiving key reagents/buffers, then the pressure to prepare the first sample correctly is significant. If there is a lack of experience or understanding in how to do this, then this can greatly increase the time required to carry out an experiment, which is not suitable for research.

### 3.1.4 Maintenance and technical support

A key finding from the analysis has been that only a small proportion of researchers receive funding for maintenance of their facility's equipment.

The general feeling is that whilst funding may be made available to purchase equipment in the first instance, there is insufficient future funding to effectively maintain the equipment, and certainly not enough funding to repair the equipment if it breaks. Several respondents said that their facility currently (or until recently) had a key piece of machinery that was unusable.

Ensuring that there is sufficient funding from national agencies or institutions to maintain equipment is crucial. The acquisition of advanced machinery is only the first step in developing structural biology infrastructure, as it is important that the machinery is in good working order to collect results. This may require more care from equipment manufacturers to ensure all researchers have equal access to maintenance teams, or the enhanced training and hiring of technicians at the facilities themselves. For example, some respondents said

that manufacturers will not send a repair person to their facility due to its geographical location, instead opting to carry out the procedure virtually, which can be inefficient. There is also wide evidence that manufacturers will "retire" a machine after a certain period of time, which requires facilities to either regularly turn over their equipment, or to train technicians to repair them in case of malfunction, as the manufacturer will no longer send a repair person. The increased training of technical staff is crucial, as well as ensuring sufficient funding to hire trained staff. Expertise in the maintenance of specialist equipment is limited in the region and increasing the base of knowledge of equipment would be beneficial.

## 3.2 Training

Training has appeared as a constant topic in this analysis. Researchers needs more training than currently available to make efficient use of infrastructure, so their future planning should have the training component as a key element.

Training should cover a range of facets in structural biology. Training in advanced techniques is essential for conducting cutting-edge research, whether this is done directly through programmes or workshops in Latin America, through staff exchanges between facilities in the region, or between facilities in Latin America and Europe. Deepening the understanding of advanced structural techniques will help to grow the community and enhance the research conducted in the region.

Additionally, efforts should be devoted to training researchers in sample preparation and protein production, often overlooked as essential steps of structural biology. Without these, access to advanced infrastructure will not deliver as meaningful results, which can lead to a waste of time and funding. Putting more emphasis in training researchers in the broader aspects of structural biology can lead to significant benefits in terms of access provision and can help to increasingly widen the Latin American structural biology community.

## 3.3 Sample preparation

### 3.3.1 Knowing how to prepare a sample can be a limitation

The analysis has suggested that while there is a clear need to invest in the training and funding for high-end, advanced structural biology machinery and techniques, care is also needed for smaller-scale support structures. Increasing the base level of training in sample preparation and protein production will pay significant dividends in the future.

Currently, the use of advanced machinery at national or regional infrastructure is mostly carried out by scientists and technicians at the host laboratory. Therefore, detailed knowledge of how to operate the equipment is not completely necessary. However, preparing samples or solutions for study is the role of the researcher themselves, and they must have experience or training in how to correctly develop and store the sample for analysis in external laboratories, in order to make the most effective use of the time and funding available.

The need for investment in paying for full-time technical support in order to train and/or help users with sample preparation where the infrastructure exists is also a common theme.

### 3.3.2 Local infrastructure is necessary for validating sample quality in-house prior to trips to large centres of RI

In addition to improving facility-level experience and understanding of sample preparation, offering infrastructure services that can validate and confirm sample quality before physical or remote access to advanced RI would be beneficial. This may require establishing regional “hubs” where samples can be validated. A typical example would be entry-level transmission electron microscopes. These are absolutely essential for checking a microscope grid for sample quality prior to shipping to a high-end data collection centre. The absence of such microscopes means that samples are often of poor quality and the high-end microscope time is wasted or inefficient at best. Since it is unrealistic to imagine each user having his own local infrastructure, the concept of regional hubs strategically distributed around Latin America is an attractive compromise. In this way time, money and valuable laboratory resources are not wasted.

## 3.4 Local bureaucracy

### 3.4.1 Difficulty in importing reagents

Nine interviewees indicated that bureaucracy was a barrier for their research, with only two interviewees saying that their institution offered support for this. In this context, respondents say that bureaucratic problems interfere with the import and export of reagents and samples. For researchers in more remote areas of Latin America, import times for reagents or equipment can take more than a month (often MUCH more than a month), significantly slowing research, requiring increased planning, and leaving little room for flexibility or error in the research. However, the problem is certainly not limited to those in remote regions, and researchers in all nations have experienced problems when importing reagents or equipment.

The major issues appear to be due to strict bureaucracy at customs. Many respondents cited packages labelled “biological” (or similar) to be the problem, as this led to significant delays in allowing the material through. Some respondents claim that they have even received delays in acquiring equipment (beakers, flasks, etc.) which have been held up at customs, as the packaging is labelled “biological”, despite containing no biological material at all. This severely impacts the speed and efficiency of research throughout the region and should be addressed. It is extremely difficult for Latin American scientists to be internationally competitive under these circumstances, but nevertheless this is often still demanded of them by their home institutions and funding bodies.

### 3.4.2 Shipping samples through customs

Another bureaucratic problem faced by researchers is the export of samples to research infrastructures accessed remotely. This requires the preparation of samples in the researchers´ home institution, which are then sent to the host laboratory. However, many respondents have indicated that these samples often get held at customs for a substantial amount of time. This is problematic for samples which have a short period before they are unusable, particularly if they must be kept on ice. Researchers may pay increased shipping costs, selecting the fastest method of travel, only for the sample to be held at customs for an extended period, wasting money and the sample. Interaction with national authorities would be extremely helpful in generating "fast track" procedures to exchange scientific samples across borders, protocols that exist in many other regions in the world.

### 3.4.3 Administrative bureaucracy

Bureaucracy problems are not limited to the import and export of materials. Many respondents also cited overwhelming bureaucracy and administrative requirements for the applications for funding, the process of applying for research infrastructures, and the process of applying for maintenance grants/funding.

Some respondents said that their institution did help with these problems, but many others said that their institutes offer no support here. These researchers have had to either learn how to manage the various forms, processes and documents required, or have had to pay for external help with the extensive bureaucracy.

## 3.5 Isolation and lack of critical mass

Multiple respondents suggested that there is a lack of critical mass in their local/national structural biology community. Cited reasons include students not taking up structural biology, as well as people actively leaving due to the barriers outlined earlier in the report. For those in more remote areas, this is even more a problem, as the community is already a smaller pool to begin with. The introduction of regional hubs providing structural biology services for those in these regions, without the need for complex/funded access to long-distance institutions, appears as a very interesting solution to be developed.

## 3.6 Improving Communication

The fact that 57% of survey respondents heard of opportunities at external research infrastructures through word-of-mouth sources suggests that there is considerable room for improvement. However, this responsibility falls as much on the research scientists themselves as the funding bodies, universities, and research centres. Providing online catalogues for national and regional infrastructure, as well as direct contact (mailing lists, institutional contact) to researchers throughout LAC, will be a significant benefit. Additionally, turning to increased social media presence and engagement to communicate offers, calls and training opportunities could be an effective measure.

## 3.7 Positive aspects

During many of the interviews there was very significant enthusiasm on the part of participants. The field of structural biology, which is in a flux of change at the moment, excites its practitioners. The existence of CEBEM as an initial attempt to bring the community together was seen to be a positive aspect. Overall, there seemed to be a belief that, given the right conditions, Latin American scientists are more than capable of making significant contributions to structural biology worldwide. The initiative to bring CEBEM and Instruct-ERIC into alignment is also highly positive and the calls for proposals to use Instruct infrastructure are a step in the right direction.

# 4. Recommendations to Policy Makers and Institutions and the research community

## 4.1 Roadmap

It seems clear from the analysis that more work needs to be done to grow and manage the structural biology community in Latin America. There is a need for a regional roadmap to establish objectives, strategies, timelines, milestones, funding etc. In other words, there is a need for a clear and strategic view of structural biology in LA including long-term support. The roadmap should identify regional synergies which can lead to the creation of intermediate level infrastructures to facilitate research, (see "Hubs" section 4.5). Often it is not only a lack of funding which is an issue, it is the uncertainty associated with funding which is often promised but not delivered. Any effective roadmap must bring with it a serious commitment on the part of all involved including those providing the resources (funding bodies or governments). This EU-LAC ResInfra working group itself could be a useful starting point for elaborating such a roadmap. **Establishing some sort of roadmap is seen to be an essential element for success.**

## 4.2 Regional Integration

A regional roadmap requires regional integration. Scientists must be the catalysts for this to occur. It is necessary to inform politicians in each of the constituent countries of the need for, and advantages of local integration. The community is still small and far flung and many groups feel isolated in small universities and research centres. Efforts must be made to contact and inform politicians in the individual countries in order to establish regional initiatives. Notwithstanding considerable political volatility in the region, it still seems that once a conversation has begun at the ministerial level, the chances of establishing a realistic roadmap will be improved. **Direct conversation and teamwork between leaders of the scientific community and science policy makers are essential.**

## 4.3 Institutional support

A commitment is needed on the part of the institution housing the RI to provide running money, maintenance and, principally, trained support staff. However, there must be clear mechanisms to guarantee that the home institutions fulfil their obligations. It is therefore desirable that funding bodies demand a signed commitment on the part of the host institution to guarantee effective use of the equipment prior to taking the decision to fund or not to fund. FAPESP (in Brazil) has recently implemented such a policy with respect to its Multi-User Equipment Program. **Funding bodies should be encouraged to invest in such Multi-User Equipment calls in order to optimise resources and strengthen Research Infrastructure. These should include the practice of demanding a commitment towards maintenance and staffing on behalf of the recipient institutions. Proper credit from the institutions and scientific system to the RI staff is also extremely important, to ensure valorisation of the human resources' careers.**

## 4.4 Training strategies

The chronic need for improvements in staff training is evident. Funding for this could be included as part of projects which support RI. It could include travel money for training staff scientists and technicians in established centres around the world. Courses for training students are already abundant in the region. These are effective up to a point but can be limited if the student is unable to implement their new knowledge on returning home. Such courses should therefore be seen as part of a package which involves the other items

highlighted in this document. An initiative run by FAPESP in recent years (SMolBNet – Structural Molecular Biology Network) may serve as an example. In one of its versions, post-docs were shared between a structural biology group on the one hand with a molecular/cell biology laboratory, on the other. The objective was to "contaminate" the research community with the use of the basic structural biology toolbox. The aim was to increase the appreciation of the value of structural biology and to improve basic training in the wider community (particularly with respect to sample preparation). By bringing laboratories together it also had the advantage of sharing resources and optimising their use. CEBEM, if adequately funded, could play an important catalytic role in the process. **Initiatives of this sort should be encouraged.**

### 4.5 Communication strategies

It would appear that communication is somewhat haphazard. The community needs to be better connected. Initiatives such as CEBEM are welcome and need to be strengthened. This requires a more formal structure and transparency and principally better articulation with policy makers and funding bodies. Ideally, this would be an integral component of a regional roadmap requiring integration at governmental level. This would be facilitated by establishing **regional hubs.** These are envisioned to be laboratories equipped with intermediate level instrumentation which is neither a full data collection facility nor an individual home laboratory. Entry-level microscopes are a good example as they are still too expensive for most individual groups but provide the means to evaluate samples prior to data collection at a central facility (often outside the region). By being strategically distributed they will also serve to improve communication and experience amongst the community members which they serve. **Searching for funding to implement and sustain regional hubs is recommended. Strengthening the role of CEBEM and broadening its reach are also encouraged.**

### 4.6 International collaboration

The current initiative is a result of previous collaborative efforts between CEBEM and Instruct-ERIC. This type of initiative needs to be strengthened and broadened. Although many institutions in Latin America now have MOUs signed with Instruct to facilitate access to infrastructure, there is still plenty of room for expansion. **Strengthening links between Latin America and the developed world is essential for moving forward.**

## 5. Methodology

### 5.1 Establishing Latin American Contacts

The first task for the working group was to establish the contacts that would be the subject of the landscape analysis. The working group is comprised of representatives from Argentina, Uruguay, and Brazil, as well as European institutions. Members of the working group identified all available contacts in Latin American research, irrespective of location or

career stage; the intention being to understand the opinions of, and challenges facing, all structural biologists in Latin America.

The contact list was designed to be an exhaustive list of structural biology contacts in Latin America, devised by the working group. The aim was for the contacts to strike a balance in terms of countries represented, roles and gender. The final list of contacts covered eight countries in Latin America and nine different academic roles. 281 people were identified and contacted with the survey.

## 5.2 Survey

The survey was made up of 19 questions. A number of these were preliminary administration questions, to get an understanding of which nation and institution the respondent is working at, as well as their current career stage. Respondents were also asked to specify what sort of institution their facility is.

The next section of the survey focused on the respondent's access to external research infrastructures – whether they utilise equipment or machinery at institutions other than their own as part of their research. This was a Yes/No question; any respondent that answered "No" was directed to the next section of the survey. With regard to accessing external infrastructure, respondents were asked for the location of the external institution (by region e.g., Latin America, Europe, USA, etc.), the techniques or services that they used there, and how they had heard of the availability of the infrastructure.

The next section of the survey focused on the infrastructure that the respondent's own institution offered to external researchers, if at all. This section asked what services the institution offered in total, and what was available specifically for external users. In addition, where those external users were from (e.g., Institutional, National, International).

The final section of the survey asked respondents if there were any techniques or services that they do not have access to, and that their research is suffering as a result of being unable to utilise this equipment. The survey asked which techniques or services the respondent would need specialist training for in order to use it. They were also asked if there were any barriers that were stopping them accessing external research infrastructures.

Respondents were invited to submit any general comments that they saw fit, and were asked if they were happy to be contacted further in the future.

## 5.3 Preliminary Interviews

Following the survey, the aim was to get more detailed answers from targeted respondents, in the form of interviews conducted by the working group.

First, a round of preliminary interviews were conducted. These were carried out with seven specifically chosen interviewees. For the preliminary round it was important to ensure as wide a range as possible of locations, career stages, genders and institution types. This way any questions which had not been considered by the working group could be captured and

used in the second round of interviews. The interviewees selected for the preliminary round therefore fit these criteria.

This preliminary round of interviews was designed to streamline the questionnaire, and ensure it covers the important topics, and to remove any redundant questions.

The interview was framed by a questionnaire developed by the working group. The questionnaire was split into four sections:

1. Administrative information to identify interviewee
2. About Your Research
3. Research Infrastructure as a User
4. Research Infrastructure as a Provider

The first section was largely filled with the responses already provided by the interviewee, stating where their institution is, their career stage, and also if there were any other people that they would recommend contacting for interview.

The second section was based on the research of the interviewee, to get an idea of what they are working on, the techniques they use, and what grand societal challenges they aim to address with their research. A key question in this section then asked the interviewee what the main barriers or impediments to their research are. This was an opportunity to provide detailed explanations for what is impeding their research, how it affects them or their team, and what they would suggest to amend this. The next question flowed on from this, enquiring how the interviewee's own institution provided support with any impediments, if at all. The final question in this section asked how the interviewee was evaluated by their organisation, and how they defend their research.

Section three was based on the experiences of the interviewee of a user of external infrastructure. This section could only be completed if the interviewee did indeed access external infrastructure. If not, the section could be skipped.
Section three went through the key components of accessing external RIs as a user: the techniques and services accessed, how the user acquires the funding for the access and travel, what training is available at the facility when access is provided, and which research infrastructures or techniques would they like to access, but currently cannot. The section also provides an opportunity for the interviewee to provide additional information on accessing external infrastructure, which may not have been covered in the initial questions.

The fourth section was aimed at understanding the experiences of the interviewee as a provider of infrastructure to external users. This section also could be skipped if the institution of the interviewee did not provide access to external users, or at least if they did not have sufficient knowledge of how access was managed/provided.

Section four went through: how access is managed at the facility, who is eligible to apply, how it is advertised or promoted, whether there is a centralised catalogue of services and technologies, whether training is provided by specialised staff, whether the facility can be accessed remotely or physically or both, and an estimation of how much of the equipment is available to external users, and whether this information is collected and recorded.

Additionally, the interviewee is asked if they are aware of any plans to collaborate with European research infrastructures in the future, or if they are aware of plans to upgrade or expand their own facility.

At the end of the questionnaire is a question regarding their knowledge of any roadmap of structural biology in their national or regional government, akin to ESFRI in Europe. The questionnaire ends with a final opportunity for the interviewee to offer their own independent thoughts on the landscape of structural biology in Latin America.

All interviews were recorded for the purposes of ensuring the information recorded was all correct – once the recordings had been reviewed, they were deleted. Interviewees were then provided the final version of the questionnaire for their own review; they were invited to ensure all of the information was accurate and add any additional information that had not been covered in the interview. All preliminary interviews were carried out by the same two members of the working group

### 5.4 Second Round of Interviews

Following the preliminary interviews, the questionnaire was streamlined for the second round of interviews. This involved removing certain redundant questions that often were already answered during previous questions. In addition, new questions and prompts were added. For example, with regards to the impediments that interviewees had against their research, commonly cited barriers were included in the question as prompts, to help the interviewee think of any ways that their research may be being obstructed. Another additional question was regarding computational tools, an occasionally overlooked aspect of structural biology infrastructure provision, and a topic which was not covered in the initial interview questionnaire.

The second round of interviews was conducted by all members of the working group – one interviewer plus one note taker, with the interviewee. Interviewees were selected again based on the diversity of their location, gender, career stage, and institution type, but also based on the answer to some of their questions in the initial survey. For example, a respondent who answered that they did not access external infrastructure at all may have been chosen for interview, to understand why that is and what could be put in place to make external access a more attractive prospect.
In addition, any names provided by previous interviewees as suggestions for future interviews were also contacted. In total, 32 people were asked to participate in the second round of interviews.

The total number of people interviewed as part of the second round was 22. Of the remaining 10 individuals contacted, 5 did not respond, and 4 explained that they did not work in structural biology so felt they would not provide useful information for the interview. The other person explained that they no longer worked as a researcher and were now a policy maker as a state representative in their country. A discussion was still had with this respondent, to gather their input on how policy is made in science and technology in Latin America, but this is not included in the analysis of structural biology.

## 6. Appendix

## 6.1 Survey Form

1. Name
2. Job title
3. Organisation name
4. Website address of the organisation
5. Organisation address
6. Organisation type
7. Do you use external research infrastructures (services, equipment or technologies) not available at your home lab?
8. If yes, specify for which area?
9. Specify the location of the external research infrastructure
10. How did you learn of it?
11. Does your institute offer research infrastructures in one or more of the following areas?
12. Are these research infrastructures open to external users?
13. Which of these research infrastructures are open to external users?
14. What level of access is available?
15. Is your research suffering for lack of infrastructure? If yes, specify for which area
16. Would you need training on using available research infrastructure? If yes specify for which area
17. Which are the main limitations on accessing the research infrastructure you need for your research
18. General comments
19. Would you be happy for us to contact you to follow up on your response to the survey? If 'yes', please provide email address