CHARTING A COURSE FOR SUCCESS: INTERNATIONAL RECOMMENDATIONS FOR IMAGING SCIENTIST CAREERS IN CORE FACILITIES

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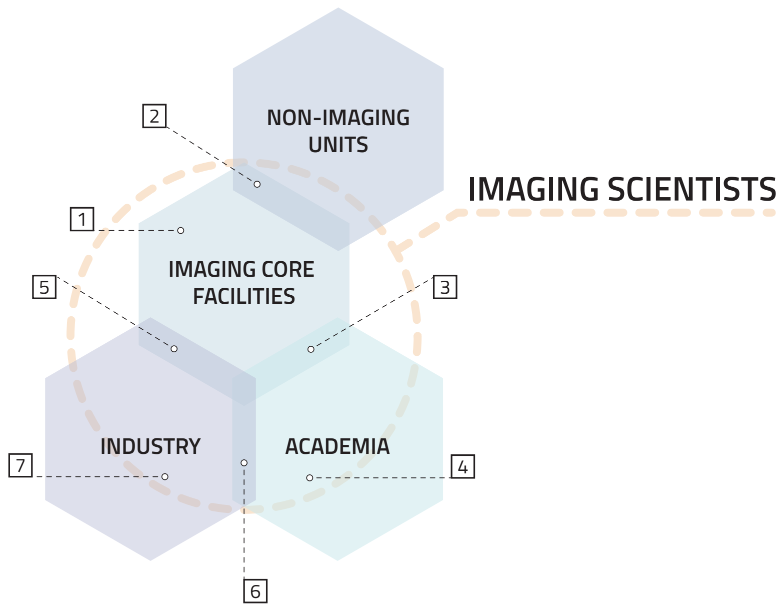
INTRODUCTION

Imaging core facilities play a crucial role in modern research, promoting collaboration and acting as catalysts for the establishment and advancement of an efficient and sustainable research ecosystem. Over time, as cutting-edge technologies have become increasingly expensive and technically challenging to master, the importance and prominence of core facilities has grown. Concurrently, core facilities have evolved beyond their traditional role of providing access to equipment and basic training to become integral contributors to the development, refinement, and applications of highly specialised imaging technologies. They are at the forefront of innovation, empowering and supporting researchers in their quest to explore new frontiers in science and technology [see Global BioImaging's international publication on the added value of open access imaging core faclities].

Box 1: What is an Imaging Scientist?

A term to describe a professional who specialises in the field of imaging science, which involves experimental design, acquisition, analysis, and interpretation of image data for various applications, including scientific research, medical diagnosis, engineering, industrial quality control, and many others in which imaging technologies are essential. Here, we have defined and classified distinct subgroups within the broader definition of Imaging Scientists (Figure 1), where each subgroup is characterised by overlapping tasks and affiliations. By employing this categorisation, we aim to investigate and analyse the career paths of Imaging Scientists, focusing on those working within an imaging core facility (Group 1). For the purpose of clarity for this work we have considered the following out of scope: (a) users of the core facility, and (b) dedicated administrators in imaging core facilities who do not have a technical or imaging remit/expertise.

Fundamental to imaging facilities are ***Imaging Scientists*** (Box 1, Figure 1) who provide the expertise, advice, and training to maximise impact and support researchers in pursuit of imaging-related excellence. Imaging Scientists are becoming increasingly involved in, and instrumental to the success of, cross-disciplinary research projects that require the application of multiple advanced technologies. Imaging Scientists in core facilities often participate in experimental design, sample preparation, technology adaptation, data acquisition and image analysis, whilst ensuring and instilling a healthy respect for research integrity and technical quality assurance (Mische *et al.* 2020). They are at the forefront of innovation in their respective fields, constantly pushing the boundaries of imaging technologies and their applications, contributing to scientific advancements, and addressing real-world challenges. Importantly though, to be effective, Imaging Scientists in core facilities have also developed and often need to apply a range of skills beyond their scientific and technical domain, extending to leadership, managerial, pedagogical (Imreh *et al.*, 2023) and administrative responsibilities. This can include effective time and people management, project management, communication skills, strategic planning, budgetary management, supervision of students, teaching, and grant writing. During the last two decades, forward-thinking scientists around the world, working in and with imaging core facilities, have pioneered new career paths (Figure 1; Farber & Weiss, 2011; Chang & Grieder, 2016; Charalambakis *et al.*, 2022, see the Imaging Scientist). However, significant challenges remain on the path to proper recognition of the value and impact of these Imaging Scientists and what they contribute to the research enterprise. There is often misalignment in performance indicators and limited opportunities for promotion, career advancement and job security (Fletcher & Anderson, 2022).



1	Dedicated Core Staff	Dedicated 100% to enabling access and providing support to imaging technologies (Facility operations, training, service, maintenance, and administration) EM/LM/HCS/Bioimaging/Image Analysis.
2	Core Staff with split remit	Shared role (may include staff working in another core facility other than imaging core (e.g. Image Analysis/Flow Cytometry/Histology/ Sequencing/Mass Spec/Biomedical (Preclinical)/Medical/In Vivo imaging/Animal Facility/Medical Imaging).
3	Not Core facility affiliated Imaging Scientists	*(Academic)* Staff engaged in the field of imaging technologies and applications, whether or not formally affiliated with a core facility, but who significantly contribute to core facility operations or perform equivalent core facility roles in institutions that lack dedicated core facilities.
4	Principal Researchers and Investigators	PIs with influence and/or responsibility for oversight, steering groups/committees. This may include roles in budget allocation, future-proofing, strategy, sustainability and staffing matters.
5	Industry-related	Industry funded positions or seconded staff working within core facilities.
6	Technology developers	In academia or industry, the people who are developing new imaging solutions.
7	Industry exclusive	Applications specialists, engineers and sales delegates.

Figure 1: *Defining Imaging Scientists, the varied roles they fulfil and positions in which they sit, which at times overlap. Throughout this work the discussion will focus on Imaging Scientists working within or very close to imaging core facilities (Groups 1, 2, 3 and 5).*

In order to address these challenges, the Global Bioimaging (GBI; Box 2) Working Group on *Career Development for Imaging Core Facility Staff* has developed this international recommendation for Imaging Scientists and their host institutions. The work aims to provide recommendations for navigating the persistent challenges, drawing on the collective experience of the global bioimaging community to support the careers of Imaging Scientists around the world. The work also highlights specific initiatives (Section D: Success Stories) promoting career progression and recognition of Imaging Scientists that have been established within institutions or more broadly at the regional or national scale.

Box 2: About Global Bioimaging and the GBI Working Groups

Global BioImaging (GBI) is a dynamic and far-reaching international consortium that unites diverse imaging infrastructures and communities with a primary mission to empower, connect, and champion the dedicated professionals at the heart of imaging core facilities. GBI's overarching goal is to foster excellence in imaging sciences and facilitate a seamless global exchange of knowledge and resources.

In addition to offering Training and Job Shadowing opportunities, GBI fosters International Working Groups. These specialized teams work collaboratively to generate internationally-recognized recommendations and publications that span a wide spectrum of scientific domains (for example: Measuring Imaging Core Facility Impact and Standard for Open Image Data Format and Repositories). In essence, Global BioImaging is a global hub for innovation, collaboration, and knowledge-sharing, accelerating imaging technology advancements and fostering an international imaging community. Unifying the expertise of imaging professionals and sharing best practices, GBI strives to propel the future of imaging sciences to unprecedented heights.

The presented recommendations are based on a comprehensive and long-running survey conducted among Imaging Scientists from around the world. The survey engaged 66 participants who are actively involved in bioimaging communities in 25 countries, encompassing all continents, except Antarctica. Alongside numerous consultations and focus group sessions at international conferences, we homed in on the five most commonly cited challenges in Imaging Scientists' career paths (Figure 2). This work is therefore a direct response to these globally common hurdles, offering practical solutions and guidance to elevate the careers of Imaging Scientists worldwide

This work sets out international recommendations across three interrelated topics: Section A: articulating the key value proposition and impact of Imaging Scientists; Section B: facilitating the recruitment and retention of Imaging Scientists; and Section C supporting and encouraging training and professional development of Imaging Scientists. A key theme that permeates throughout is re-thinking the divide between traditional academic positions and imaging scientist positions.

The guidance and recommendations presented here serve a threefold purpose. Firstly, they are intended to encourage researchers, as well as institutions, to recognize the important role of Imaging Scientists to their research programs. Secondly, they are designed to assist managers and directors of imaging core facilities in effec-

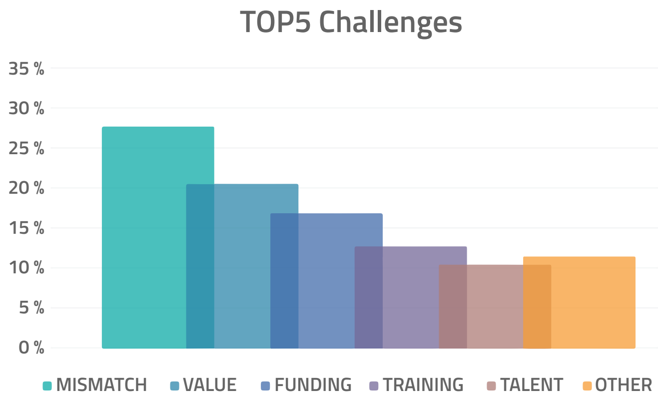


Figure 2: *Top 5 categories of challenges identified through a global survey, which prioritised the focus of this work: (1) MISMATCH between the classic academic career path and more service-oriented roles; (2) lack of understanding of the VALUE and impact of Imaging Scientists and core facilities; (3) lack of financial/sustainable strategy or insufficient FUNDING security; (4) insufficient dedicated TRAINING and professional development opportunities; and (5) challenges with recruiting and retaining TALENT and expertise. (242 submitted challenges, 66 individuals representing 25 countries)*

tively assessing performance and foster ongoing career development within their teams. Thirdly, they offer a blueprint for institutions to establish robust structures and frameworks that actively support the career progression of their Imaging Scientists.

Furthermore, our commitment to this cause extends beyond this paper. We see these recommendations as relevant to our colleagues working in other core facilities such as those supporting mass spectrometry, genomics, flow cytometry and bioinformatics, as well as part of a larger culture shift in how science is done and research contributions are valued. The GBI Working Group will continue to identify and analyze challenges facing Imaging Scientists, delving deeper into regional landscapes to tailor recommendations to different global contexts. Recognizing the significance of these recommendations is crucial, bearing in mind that their application may predominantly yield substantial advantages for institutions with existing imaging core facilities. It is important to acknowledge that these guidelines might not have direct applicability to all research institutions, particularly those situated in low-resource settings where the establishment of such facilities is still pending. Nevertheless, we assert that even in such contexts, the general considerations outlined here, such as the appreciation for imaging scientists and their pivotal roles, whether within core facilities or in equivalent capacities beyond them, remain pertinent. This extends to the facilitation of access to imaging systems and the thoughtful definition of these roles when developing core facilities, thereby potentially contributing valuable insights irrespective of the institution's current imaging infrastructure.

We acknowledge the challenges in developing recommendations on this topic with relevance in very diverse academic environments around the world and want to remind the reader that this international recommendation represents an ongoing effort. We anticipate its continual development, driven by the evolving needs of our field and community. This is the initial iteration of an international recommendation, and we hope it serves as a catalyst for future efforts to refine, expand upon, and contribute to its ongoing development - a foundational stepping stone towards further advancements in our field.

A. HIGHLIGHTING THE VALUE AND IMPACT OF THE IMAGING SCIENTIST IN A CORE OR PLATFORM

Although some local and regional initiatives are leading to improvements (Section D: Success Stories), in most institutions on a global scale, the impact of Imaging Scientists in core facilities is overlooked. Measuring the impact is critical to underscore and justify the required improvements in career paths and help open opportunities for career progression. While there has been significant effort in recent years on measuring impact and establishing appropriate Key Performance Indicators (KPIs) for academic researchers (going beyond simple publication counts and impact factors (Rice DB *et al.*, 2020, Byrne D *et al*, 2023), the parallel career path for core facility Imaging Scientists does not yet have equivalent measures adapted to the roles they fulfil and impact they have. Lejeune *et al.*, 2021, which originated from another Global BioImaging working group, provides a significant contribution to guide measurement of the impact of the core facility as a whole and is useful here.

Measuring the impact of Imaging Scientists is challenging, due to the diversity of their contributions to multiple and simultaneous research projects, when compared to a scientist being solely focussed on a single research project with its associated output. The researcher's impact can be more easily quantifiable and therefore, attributable to that individual. Where papers published or grants funded are used as impact measures for researchers, the impact and contribution Imaging Scientists have on these same outcomes are too often not accounted for (Pedersen & Hvidtfeldt, 2023). For example, they may not be co-authors but only included in the acknowledgments, which are much harder to quantify, standardise and automatically assess when compared to authorship. At the same time, it is undeniable that the training and support delivered by Imaging Scientists plays a crucial role in researchers delivering high-impact papers and being competitive for grant funding and succeeding in their own right (Kivinen K *et al.*, 2022).

The impact of an Imaging Scientist goes well beyond supporting individual publications or grant applications and should be assessed as such. They play central roles in the smooth operations of larger-scale infrastructures, both within individual institutions as well as at the cross-institutional level. We outline some of the key impacts below, which whilst difficult to quantify, have come to the fore (Figure 3).

We acknowledge that this list is likely incomplete, but hope to see it developed further by the wider community:

1. Imaging Scientists in core facilities serve as **guardians of high quality science.** This comes through two key pathways. Firstly, core facility staff are responsible for the quality management of the instruments in their core, with regular testing, evaluation, and adjustments. Significant initiatives for quality assurance, such as QUAREP-LiMi (Boehm *et al.*, 2021) are driven by Imaging Scientists working in core facilities. Secondly, Imaging Scientists have a broad wealth of experience and information which they regularly apply to ensure adherence to good scientific practices in rigorous experimental design and data analysis, instilling research ethics, serving as important checks against the introduction of unintentional bias (Jonkman et al., 2020). This comes thanks to their broad background and involvement and consultation during trouble-shooting in the experimental work of multiple and varied projects. Their expertise and commitment to quality play a vital role in supporting the research community and ensuring that research outcomes are reliable, reproducible, and of the highest calibre. They are instrumental in upholding the integrity of scientific research across a wide range of disciplines. In the clinical setting, Imaging Scientists contribute to improved medical diagnoses and treatments through the development of cutting-edge imaging technologies. Their work aids in early disease detection, surgical planning, and monitoring treatment progress. Imaging-guided surgeries and interventions have become standard procedures. Imaging Scientists contribute to the precision and safety of these procedures, reducing risks and complications. Their work directly impacts patient outcomes by enabling more accurate diagnoses, leading to timely and appropriate treatments, and reducing medical errors.

2. **Experimental Design.** They drive scientific innovation, helping to encourage the adoption of new technologies, adapt instrumentation, optimise sample preparation protocols, refine image acquisition and develop analytical approaches for the research projects they are involved with or support. Imaging Scientists in many cases directly support research, co-create research projects, and provide consultation to scientists on the latest technological and methodology developments, adaptation and customization of image acquisition and analysis protocols, and selection of the most suitable approaches to address their specific research questions.

3. The **training and education** provided by Imaging Scientists have far reaching impacts. Many Imaging Scientists act as mentors, where they train the next generation of Imaging Scientists, along with researchers, engineers and clinicians in general. This training takes on diverse forms, from teaching during courses and workshops, to the more widespread delivery of bespoke one-on-one practical training for facility users, the majority of whom are early career researchers. Core facility staff are therefore continuously educating the next generation of scientists with customised training in advanced technologies, tailored specifically to researchers needs. These long-term interactions support the skills development of researchers that then build their own career on the knowledge gained. Through the provision of high standard educational programmes, and access to key enabling technologies and research infrastructures, Imaging Scientists play a role in the recruitment of top-class students and graduates and hence bolster the national and international reputation of the institution.

4. **Methodological Innovation.** Imaging Scientists in core facilities go beyond just supporting the acquisition of image data, often assisting users in upstream **sample preparation** and optimisation, and downstream **image analysis and image data management,** to extract quantitative information. They often offer introductory training on both open-source and commercial software, provide and support imaging workstations, whilst consulting on and guiding research projects through the whole experimental pipeline. Although difficult to measure, this level of support, when compared to researchers starting with little knowledge or experience and on their own, undoubtedly has a significant impact on the pace of scientific advancement and discovery.

5. **Technological Innovation.** Overall, Imaging Scientists drive research and innovation by continuously improving imaging technologies, developing novel techniques, and collaborating with researchers from various disciplines to solve complex problems and answer important scientific questions. Some Imaging Scientists are also directly involved in **technology development** (Group 6 in Figure 1). This innovation can involve close interaction with industry or technology developer labs, for example licensing intellectual property or spin-out companies. Further, with deep insights into the needs of the research community they can effectively guide technology development by instrument manufacturers. Through serving as alpha/beta-testers, Imaging Scientists can gather crucial real-world feedback, making meaningful contributions to innovation and product development, whilst offering early access to emerging technologies for their local research community.

6. **Advancements in Knowledge and Knowledge Transfer.** Imaging Scientists are strong assets in realising the full potential of the technologies and disseminate their knowledge widely within their community. This contributes to the general increase of knowledge transfer of the latest research methods within the local research community and is a crucial aspect of training and education for students. Being well supported and positioned in a core facility ensures efficiency in capital equipment spending, with wide sharing ensuring high utilisation of expensive assets. Imaging Scientists have a profound impact on industry by developing and applying imaging technologies that improve product quality, enhance efficiency, and drive innovation across various sectors.

As Imaging Scientsts in core facilities support many different research projects from different domains and departments, they function as **central multipliers and interdisciplinary bridges** in their local research environment, connecting researchers and projects that may otherwise remain remote from one another (Figure 1). This is especially key in facilitating interdisciplinary cutting-edge science and can help to avoid unnecessary uncoordinated duplicative efforts. Through their work they continually gain from, and draw on, experiences of different scientific disciplines (e.g. cell biology, neuroscience, biophysical tools, computational/physical sciences). This ability to

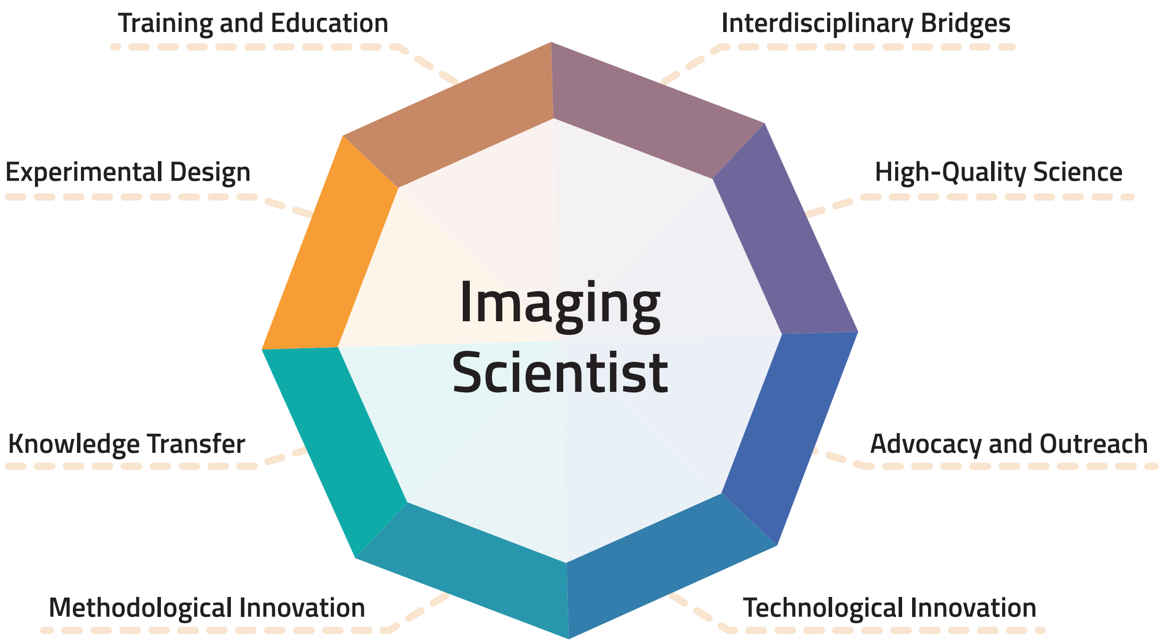


Figure 3: *What is the Role of Imaging Scientists? This diagram highlights the diverse range of tasks undertaken by Imaging Scientists within core facilities.*

connect researchers, provide essential resources, and facilitate collaboration across disciplines results in innovative research, advances in imaging technology, and the successful integration of imaging into various scientific fields. Their work enhances the overall academic ecosystem by breaking down silos and promoting interdisciplinary approaches to complex research challenges.

Advocacy and Outreach. Thanks to its visual and aesthetic nature, imaging is a very popular vehicle for engagement with and **outreach of scientific research** to the general public, school students and institutional visitors. Facilities often passionately contribute to community work and outreach activities, but these are often poorly recognised or rewarded, despite the clear benefits to science and society.

Core facility staff may not pursue all these different facets of work at any one time, but the variety and flexibility of responsibilities and roles is often an aspect that makes the profession attractive (Figure 3). Imaging Scientists in core facilities often need to adapt to a wide range of research projects and disciplines. Their roles may vary from one project to another, making it challenging to define a fixed set of responsibilities. The nature of research projects can also be highly variable in terms of duration and complexity. Imaging Scientists may work on short-term, intensive projects, or in long-term, ongoing research efforts. This temporal variability can also affect their workload. This diversity and variability of the position sets a key challenge for determining roles and assessing performance. Institutional hierarchies are typically more embedded on the research side, and therefore primarily use more traditional academic metrics. In designing the roles and responsibilities for Imaging Scientists in core facilities, institutional leadership needs to be clear on what is expected of staff (Appendix A), how their contributions will be measured (below), and how this equates to the potential for career progression (Appendix B); Turpen, *et al.*, 2016).

We recommend a **2-tiered evaluation system** comprising:

1. **Academic metrics:**
    a) Contributions to publications and thesis (including co-authorship, acknowledgements, involvement)
    b) Presentations at conferences/meetings
    c) Contributions to grant applications
    d) Contributions to student and staff training and academic supervision (e.g. academic courses, curriculum development, research ethics training)
    e) Grant reviewing
    f) Publication reviewing, journal editing
    g) National and international strategy and review committees
    h) Organising conferences, meetings, networks, and community events.

2. **Core facility-specific metrics:**
    a) Performance management within the facility
        i Financial measures e.g. cost recovery (where applicable), funding breakdown
        ii Equipment utilisation
        iii Maximising the user base (where applicable, when sharing/openness of resources is an expectation)
        iv Core staff training and development
        v Quality management (e.g. Standard Operating Procedures (SOPs), International Organisation for Standardisation (ISO) certification where applicable)
    b) Users satisfaction surveys, endorsements, post-training feedback
    c) Contributions to student and research staff training (e.g. microscopy courses, 1:1 customized practical training sessions, image analysis training)
    d) Technology and application adaptation/development (could include, but not limited to, patents and licencing)
    e) Industry partnerships (where applicable)
    f) Contributions to outreach initiatives (including facility visits and tours)
    g) Contributing to city, regional, national and/or international-level networking initiatives

Involvement with learned societies and organisations (e.g. Royal Microscopical Society, Association of Biomedical Resource Facilities, Core Technologies for the Life Sciences, Global Bioimaging, international or national bioimaging communities (e.g Latin America BioImaging, Singascope)

Leadership (e.g. bringing novel technologies to the core facility, new standards, new players, promoting and supporting the needs and importance of core facilities to the highest level of institutional administration).

B. RECRUITING AND RETAINING STAFF – SUSTAINABLE FUNDING MECHANISMS

This section centers on recommendations for the recruitment and retention of Imaging Scientists in core facilities. Imaging Scientists are key repositories of institutional knowledge within these facilities. As research groups undergo natural turnover due to academic transitions, such as students completing their PhDs or postdocs moving on, Imaging Scientists play a vital role in maintaining research continuity, preserving long-term memory, bridging knowledge gaps, and training new lab members. These recommendations have a global perspective and represent general best practices, adaptable to specific hiring events and contexts. The section is divided into two parts: (1) **Recruitment** for those with the authority to create and fill new Imaging Scientist positions, and (2) **Retention** to support existing Imaging Scientists in core facilities.

In contrast to the well-established and defined career pathways and hierarchies in traditional academic positions at universities and research institutes, core facility staff roles, including Imaging Scientists, are relatively recent additions to the research landscape. As a result, job descriptions for managerial and instrument scientist positions vary significantly between institutions and lack universal standardization. Recognizing the importance of diverse career paths, encompassing both academic and core facility roles, is vital for a thriving research ecosystem. These paths complement each other in advancing scientific knowledge and require distinct skill sets and expertise. Furthermore, different countries have varying approaches and levels of support for centralized research facilities, with some countries not yet adopting a core facility strategy and others offering a range of operating models, from free services to fee-for-service structures, often with subsidies (Hockberger *et al.*, 2018).

Core facility staff tend to occupy a role which blends technical, administrative, managerial and research skills (Figure 4), but their job descriptions and scope of role and responsibilities often do not match the actual work carried out. Consequently, they often go unacknowledged and unrecognised for their contributions. The need for clarity and recognition that values the contributions of Imaging Scientists, outside of the traditional academic career trajectory, is essential to recruiting and retaining talented and valuable

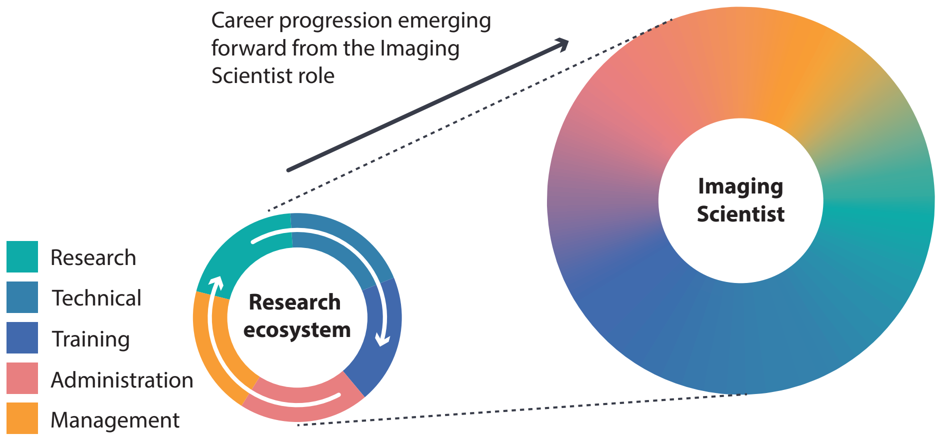


Figure 4: *The multifaceted job components of the Imaging Scientist role, highlighting the diverse skills that may be required in a core facility career. The emergence of this combination of skills and responsibilities is relatively new to the broader global academic sector, and tends not to fit with the traditional career progression models.*

people. The persistent challenge is that traditionally Human Resources personnel are unfamiliar with core facility careers as a separate path. This often results in attempting to fit the core jobs into the more traditional academic/research construct.

Acknowledging the significant contributions of Imaging Scientists in core research facilities, it's worth noting initiatives such as the UK Technician Commitment, which has increased the visibility of technical staff roles and aims to provide career development, recognition, and sustainability within institutes and universities. However, we contend that the term 'technician' fails to adequately convey the expertise, specialization, and scientific impact of Imaging Scientists within core research facilities. Therefore, we recommend a change in terminology to more accurately describe professionals in imaging core facilities.

This work adopts the term 'Imaging Scientist' in place of 'technical staff' to explicitly affirm and recognize the substantial scientific and intellectual contributions these individuals make to the forefront of research. This terminological shift better reflects the essential role played by Imaging Scientists in advancing research. Furthermore, this change is necessary because they are often excluded from critical policy decisions and, in some cases, have a minimal role in grant applications, despite their potential for more significant contributions. Recognizing this limitation underscores the importance of acknowledging and redefining their roles within the research community. A shining testament to the UK Technician Commitment's mission is the establishment of the 'Professor of Practice for Enabling Technologies' position at the University of Newcastle, exemplifying the growing recognition and significance of these roles (see Success story on the Technician Commitment).

Recruiting

To enhance the recruiting process for Imaging Scientists in core facilities, we recommend the following strategies:

1. **Broad Outreach and Job Posting:** We encourage the posting and advertising of positions through a variety of imaging community networks including but not limited to Microscopy.db, Global BioImaging's partner communities and their respective newsletters, Association of Biomolecular Resource Facilities (ABRF), Microlist, confocal listserv, image.sc forum, ELMI website, to ensure wide reach to the target audience and encourage diverse applications. We have proposed a generic job description template (Appendix A) to cover a broad range of potential positions within a core facility which can be tuned for purpose. Appendix B proposes a job family, including roles, responsibilities and expectations into a hierarchical/progression framework.

2. **Inclusive Application Process:** In the application process we recommend requesting applicants to self-describe their experience with imaging, analysis and service roles. We strongly encourage a commitment to equality, diversity, and inclusion (EDI) in the recruitment process. Job advertisements should include statements about leave options, family/dependent-related benefits, accommodations, and visa support to foster diversity. Supporting relocation costs and visa application fees can significantly broaden the applicant pool by attracting international candidates.

3. **Structured Interview Steps:** Several rounds of interviews for candidates are recommended, with consistent first round questions for each candidate and a broad representation on the interview panel, which should include people with appropriate technical backgrounds. During interviews we encourage asking applicants about their experiences of managing others and having to negotiate with, or manage conflicts. Where possible, we recommend an on-site visit for candidates prior to a job offer. This should include; (1) the opportunity for the candidate to demonstrate their teaching methods (e.g. the candidate to teach a staff member a task), (2) the chance to meet with core staff, users, and collaborators in small groups or one-on-one, to gather valuable feedback and perspectives from these important stakeholders, (3) a demonstration of operation of a microscope to showcase and evaluate their skills and (4) an opportunity to give a seminar to present their previous microscopy knowledge and experience. Evaluation should be performed by diverse representatives (e.g. Imaging Scientists, facility users, research faculty) with a consistent template to ensure that all applicants are evaluated according to similar criteria in pursuit of fairness.

4. **Stable Funding Commitment:** Funding for core positions should be carefully considered. The institutions must guarantee investment (i.e. stable institutional funds) to provide assurance and stability to highly trained and experienced staff, and provide resilience in the event of downtime or fluctuations in utilisation. While the cost of maintenance agreements and consumables required to operate a core facility can often be recovered from user fees based on a cost recovery model, it is typically not feasible to fully recover staff salaries, requiring institutional commitment and support for staff salaries. Where possible, fully institutionally funded positions can be used to provide unique immersive and high-impact professional development for building a career as an Imaging Scientist (e.g. Advanced Microscopy Fellowship at Harvard Medical School and Janelia Research Campus).

5. **Longer-Term Employment:** Several articles have noted the need for creating permanent staff positions in the biomedical sciences and cite core facilities as examples of how this advances the research ecosystem (Alberts *et al.*, 2014; Daniels, 2015, Gould, 2015). Imaging Scientists in core facilities have to be hired with a 3-5 year or ideally in longer term with options for renewal and promotion without competitive (re)application. Permanent positions can offer a highly beneficial stability and retention of qualified staff, but due to their permanent nature such positions should be filled following an open recruitment process. Such stable longer term roles can help to attract talented individuals dedicated to working in a core facility and help support more strategic approaches to growing the facility and professional development. It also contributes to sustained detailed knowledge about the technologies and research base that the facility supports.

Retaining

To facilitate the retention of Imaging Scientists, we propose the following measures:

1. **Development of Job Families and Title Framework**: Institutions and hiring managers should establish job families and a structured title progression framework for core facility staff roles (see Appendix B). This framework should incorporate mechanisms for recognizing and rewarding employees through promotions and salary increases while providing transparency regarding their position within the framework, potential career progression, and clear expectations for different levels. For guidance, the ABRF offers Career Development Education Resources, including specific core research facility job families and descriptions. Alternatively, adapting existing academic appointment and promotion frameworks (Section D: Success Stories) can be considered to streamline this process.

2. **Involving Imaging Scientists in Strategic Decision-Making Process:** Incorporating Imaging Scientists into the strategic decision-making process is a strategic imperative for institutions. These professionals possess invaluable expertise in advanced imaging technologies and their applications, making them essential contributors to the innovation and efficiency of imaging facilities. By involving Imaging Scientists, institutions can align their imaging capabilities with broader institutional goals, optimize resource allocation, foster collaboration, and promote transparency.

3. **Recognition of Impact, Experience, and Continuous Professional Development (CPD):** Mechanisms should be in place to acknowledge the contributions, expertise, and ongoing professional development of Imaging Scientists, in addition to relevant performance metrics (Section A: 2-tiered evaluation system). This recognition should extend beyond formal qualifications to encompass relevant experience and expertise. This approach enhances the flexibility to attract, hire, and retain top talent, whether or not they hold advanced degrees. It is essential to communicate the positive impact of Imaging Scientists within core facilities to core staff, users, principal investigators, administrators, and institutional leadership to provide justification for staff retention and promotion. Evaluating the impact of an Imaging Scientist should consider a holistic assessment of their contributions to knowledge, technology, healthcare, education, collaboration, ethics, and society.

4. **Knowledge Sharing and Collaboration:** Institutions should seize the opportunity to share best practices, resources, and lessons learned with other organizations to enhance visibility, clarity, and consistency in roles, responsibilities, recognition, and career pathways for Imaging Scientists. To this end, we have outlined key communication points in Appendix C that can be used when engaging with stakeholders to emphasize the value and impact of core imaging facilities and the role of Imaging Scientists.

5. **Partnership Models:** Collaboration between research groups and Imaging Scientists in core facilities should adopt partnership models. Initiating project kickoff meetings is encouraged to discuss and document consensus on experimental design, responsibilities, roles, and, importantly, recognition in research publications and outcomes. These discussions should occur at the project's outset to ensure alignment of expectations among all participants (Section C3, Bennett A, et al, 2023).

6. **Task Prioritization and Transparency:** Managers are encouraged to define the desired allocation of time and effort for staff members responsible for the effective operation of an imaging core facility. Despite the diversity and temporal variability of tasks and user support needs, prioritizing tasks with quantifiable outcomes will establish clear expectations and enhance transparency in performance evaluations. This empowers incoming staff to better judge their time and effort and relative importance of tasks.

7. **Enhancing Mentoring and Career Development:** Within core facilities, managers play a pivotal role in supporting research initiatives through comprehensive mentoring and career development dialogues with Imaging Scientists. These dialogues should encompass a spectrum of growth opportunities, including the potential for equipment oversight, team management, and the assumption of supplementary administrative responsibilities such as budget management, coordination of major funding requests, asset lifecycle supervision, and space allocation. Furthermore, avenues for contributions beyond individual departments should be explored, ultimately benefiting the entire institution. It is imperative to ensure that as senior Imaging Scientists engage in external endeavors, such as participation in national and international imaging communities, their core competencies and commitment to the core facility and its user base remain steadfast. This can be achieved through methods like additional recruitment and the continual training and development of junior staff, safeguarding the core's functionality and vibrancy.

C. TRAINING AND PROFESSIONAL DEVELOPMENT OF IMAGING SCIENTISTS

Training and professional development opportunities are required to ensure that the career paths for Imaging Scientists in core facilities are both nurtured and supported. In this section we provide recommendations, based on our collective experience. We encourage core directors and institutional leaders to embrace these recommendations to ensure that Imaging Scientists thrive and can continue to grow and effectively support their institution's research programs.

There are a host of professional development activities available to Imaging Scientists including advanced technical training, leadership and management training, participation in imaging-related scientific societies and their meetings, grant writing, authorship of scientific papers, teaching and outreach activities. In addition, mentorship programs provided by professional societies are available to provide one-on-one sharing of experiences, best practices, and career advice (e.g. RMS Mentoring Track, ABRF Mentoring Program, CTLS Mentors).

We elaborate on these activities in the following recommendations for Imaging Scientists and their institutions:

1. Imaging Scientists should be **encouraged and supported to attend advanced technical training** including (i) participation in in-person imaging courses and workshops, (ii) making use of the curated self guided online training content which grew significantly as a result of COVID-19 restrictions (e.g., GBI Virtual Training Platform, iBiology Microscopy, Microcourses, NEUBIAS), and (iii) Quality management courses, such as ISO certification programs, where relevant. Participation in specific scientific discipline meetings are also valuable experiences, when appropriate (e.g., ASCB, SfN, SPIE, FEBS, FENS).

2. Imaging Scientists should be **encouraged and supported to attend regional, national and international meetings of imaging and other core-related scientists** (e.g., those organised by Global Bioimaging, Euro-Bioimaging, BINA, LABI, ABRF, CTLS, ELMI, ESMI). These present excellent opportunities to share information and experiences with colleagues, build and sustain professional networks and keep up-to-date on the latest technological developments. Several of these organisations help to facilitate job shadowing opportunities to visit and learn from peers in other facilities which in our experience can be incredibly valuable (e.g. GBI Job Shadowing, BINA Exchange of Experience).

3. Imaging Scientists should be **encouraged and supported to participate in grant writing and publishing of research results** - which is in itself often a valuable learning opportunity. These activities leverage the technical expertise of the Imaging Scientist to ensure experimental results meet rigor and reproducibility standards, and reward Imaging Scientists for their invaluable contributions. Importantly, Imaging Scientists share responsibility for ensuring that data meets the FAIR Principles. There remains several challenges in the identification of core facility involvement in scientific publications (Kivinen *et al.*, 2022). We remind institutions that the fee-for-service model is insufficient reason for denying co-authorship of manuscripts since it is likely that all co-authors have been paid for their work. When in doubt, we highly recommend that institutions consult the International Committee of Medical Journal Editors (ICMJE) that describes who is an author and what merits authorship in publications. Furthermore, the RMS have drafted guidelines and policy for acknowledgements of core facilities, and provide a poster to highlight the importance of this recognition to a facilities user base.

In terms of enhancing research integrity and traceability in scientific outputs and outcomes, the use of Persistent Identifiers (PIDs) such as Digital Object Identifiers (DOIs), Research Resource Identifiers (RRIDs) for instruments and Research Organization Registry (RoR) can help. Integrating PIDs for key facility contributions fosters transparency, acknowledges an individuals' intellectual efforts, gives greater visibility to a core facility, and indicates their liabilities.

4. Imaging Scientists should be **encouraged and supported to lead internal training initiatives** to enable staff to be cross-trained on various instruments, to allow for redundancy and back-up of critical tasks (e.g., maintenance, user training, basic troubleshooting) bringing variety into daily tasks, whilst providing coverage in the event of staff shortages.

5. Imaging Scientists should be **encouraged and supported to participate in curricular teaching activities**. These activities might include training users in basic and advanced imaging technologies, and techniques, potentially contributing to more formal curricular courses and importantly learning pedagogical techniques for how to train more effectively (Imreh *et al.*, 2023).

6. Imaging Scientists should be **encouraged and supported to lead professional outreach activities**. These activities might include events and programs for school-age students and community partners. Leading lab tours of visitors is another effective way to showcase Imaging Scientists talents and the capabilities of core facilities, whilst providing an invaluable opportunity honing skills and experience of presenting to diverse audiences. The visual and aesthetic nature of imaging typically makes it popular for such outreach initiatives. Besides promoting good will and encouraging interest in STEM subjects, it may also lead to philanthropic opportunities for the institution.

7. Imaging Scientists should be **encouraged and supported to develop broader leadership and management skills**. This is especially important for Imaging Scientists employed in fee-for-service facilities where business administration skills are particularly valuable. There are a variety of ways to address this need including executive education courses (see Success Story on programs at Northwestern University), network-sponsored workshops (e.g. Global BioImaging, BINA, German-Bioimaging, ABRF), and business courses offered through consulting firms (e.g. hfp consulting), or within your institution. Leadership development can also be facilitated through participation in leadership roles (Working Groups, Management Boards) in organisations and societies supporting core laboratories (e.g. CTLS, ABRF). Training courses for operators and managers of research infrastructures have also more recently become available (e.g., ARISE and RITrainPlus with a goal to establish a European School for Research Infrastructure/Core Facility management).

8. Institutions are **encouraged to adopt management structures that promote local, independent decision-making by Imaging Scientists**. This would allow Imaging Scientists to make regular operational decisions without having to seek permission from their immediate supervisor. By empowering the Imaging Scientist in this manner, institutions would increase decision-making dynamics and foster a more agile operational environment.

9. Institutions are **encouraged to support the growth and development of Imaging Scientists** working in core facilities to prepare them for senior roles such as Core Director and Core Administrator (overseeing many cores). Both roles are available to individuals who have accumulated many years of experience, having grown a skillset of significant depth and breadth. Encouraging and enabling Imaging Scientists to attend a broad spectrum of training and CPD initiatives outlined above will provide an excellent platform to build on as they gain experience.

D. SUCCESS STORIES

Whilst compiling the recommendations in this work we have made reference to, and highlighted *success stories* collected from our global colleagues. These individual stories, collected through interviews with the contributors, demonstrate examples of positive initiatives and solutions from around the world. They offer potential tips and strategies to apply in various contexts to better advocate for Imaging Scientists in core facilities and improve opportunities to build career paths in core facilities. We have broadly classified them, aligning to some of the key themes of this International recommendation:

High-level strategy - Influencing government and policymakers

Instigating a national change in policy can require direct engagement with government or relevant policymakers and funding bodies. Globally speaking, the effectiveness and success of this method varies, but we highlight some positive examples.

In 2019, Albuquerque et al. conducted an analysis of the microscopy landscape in Brazil and led by **Kildare Miranda**[1], aimed to understand how this technology is introduced and shared in a society, as well as the strategic value of doing so for planning and developing the microscopy activity in various regions of the country (Albuquerque *et al.*, 2019). For example, through providing an open imaging research infrastructure network across the Amazon, unique rainforest biomes and specimens can now be studied at high-resolution across the length scales. This work has also contributed to a better understanding of the needs of the Brazilian research community and, together with other initiatives in the scientific community, led to the development of new funding opportunities, including federal programs for instrument repair, payment of service contracts and acquisition of new instruments. Most importantly it helped with "rethinking" the careers of the imaging facility staff, who demonstrated their importance to the sustainability and dissemination of imaging infrastructure.

The Swedish Foundation for Strategic Research is another example, through its provision of funding for "*Research Infrastructure Fellows*". The Foundation is an independent player in the Swedish public research funding landscape and aims to "*contribute to an increased and more efficient utilisation of research infrastructures and at the same time create career paths for key people who work with the development, construction and operation of research infrastructure at Swedish Universities*". Importantly this funding is directed to people who have chosen a career path other than the classical academic path and who are of crucial importance to the research community. They can be, for example, research engineers, instrument managers, machine or lab managers - people who all actively develop research infrastructures. Key Euro-BioImaging stakeholders such as **Julia Fernandez-Rodriguez**[2], **Rafael Camacho**[3], **Linda Sandblad**[4] have all been awarded fellowships. This national recognition in Sweden demonstrates commitment to develop both research infrastructures, and importantly, the staff leading and operating them.

1 Associate Professor at the National Center for Structural Biology and Bioimaging and Biophysics Institute, Federal Univer sity of Rio de Janeiro, Brazil
2 Head of the Centre for Cellular imaging, University of Gothenburg, Sweden
3 Operative Manager of the Centre for Cellular Imaging, University of Gothenburg, Sweden
4 Assistant Professor, Umeå University, Sweden

Influencing local structures - Career mapping and planning for Imaging Scientists

Effecting a change at national government level is often not feasible for an individual in charge of a core facility. It is much more tangible to instigate a change at a local level i.e. within the host University or Institute. This involves significant collaboration and effort among administrative and academic leadership and stakeholders, including Senior Academic Administrators or Provosts, Human Resources, Faculties/Schools and Core Facilities. With the ever evolving need for advanced imaging technologies and demonstrable impact, clear career mapping for the cohort of scientists working in this space is becoming increasingly important. Two initiatives which highlight how this can be achieved are led by **Peter O'Toole**[5] and **Andy Chitty**[6] (Fletcher *et al.*, 2023). Both Peter and Andy are Directors of large multi-technology shared resource facility programs. Independently, over the past number of years they both have negotiated progression and promotion pathways specifically designed for core facility staff. This work demonstrates that proactive advocates can facilitate long term positive changes for their staff and emphasise the importance of core facilities on an institutional level.

In Australia, **Sach Jaysinghe**[7] and **Jamie Riches**[8] have adopted a distinct approach to address progression and promotion limitations faced by core staff. In their context, core facility staff are designated as Research Infrastructure Specialists (RIS) and are employed on a modified Academic Scale, tuned to properly accommodate the roles, responsibilities and expectations. The position descriptions stress the need to facilitate research through their technology specific domain knowledge and recognise the training of end-users and maintenance of instruments/platforms as essential parts of the role. At higher levels, RIS staff are expected to take leading roles in method development, technology specific grant applications and represent the University on matters pertaining to their specialisation. The promotion process has been modified in several ways to reflect the nature of the role - applicants can opt to focus on only two of the three selection categories (Teaching and Learning, Research and Research Training, Service and Engagement) with applicants predominantly focussed on the latter two categories. Another key element to this initiative is the participation of the Pro Vice-Chancellor (Research Infrastructure) in the promotions process, thus educating the rest of the promotions committee on nuances of each research infrastructure capability.

Collectively these initiatives demonstrate that advocates for effective change have an innate understanding of the precarity core staff often face and have enabled these transformative pathways to be rolled out in conjunction within their local structures.

5 Head of Imaging and Cytometry at the University of York, UK
6 Director University Shared Resources (USR) at Oregon Health and Science University, USA
7 Former Director and current Associate, Research Infrastructure, the Queensland University of Technology
8 Principal Research Infrastructure Specialist (Electron Microscopy) at the Queensland University of Technology, Australia

Training and continuous professional development - evidence for promotion and progression

Generally speaking, there is a global expectation for employers to provide, and employees to participate in, continuous professional development (CPD) or training activities to further themselves. CPD can take many forms (Section C). Here we have chosen to spotlight two opportunities that have made a significant impact.

Firstly, the Leadership and Management in Core Facilities 4-day program offered by Northwestern University's Kellogg School of Management, instigated and developed by **Phil Hockberger**[9], has been running annually since 2014. The program provides leadership and management training for core facility directors, staff and administrators to meet the unique challenges of operating a fee-for-service core facility within a non-profit organisation. The program was developed to help participants think strategically and to develop a sustainable business strategy for operating core facilities more effectively. Topics covered include defining your value proposition, pricing strategies, managerial accounting, marketing, team building & leadership, growth & sustainability, and innovation. During it's course, participants are encouraged to initiate "applied learning projects" that enable them to implement something new in their core facility. Places are competitive and limited to 30 people, and taught by faculty affiliated with Kellogg's Centre for Nonprofit Management. Phil worked along with the Office for Research and a unit called Core Facilities Administration (CFA) in Northwestern University, whose responsibilities include the career development of core scientists. Such a department, where it exists, is typically led by a senior university position such as a Core Administrator, Vice Provost, Vice President or similar. Since its inception the CFA has supported staff to progress through to the leadership of facilities in the following locations: Yale, Boston College, Northwestern and Howard Hughes Medical Institute in the USA.

Similarly, **Graham Wright**[10] is an example of an Imaging Scientist having pursued a traditional Masters of Business Administration (MBA), which subsequently opened the opportunity for him to take on the role of Director of the Agency for Science, Technology & Research's (A*STAR's) Research Support Centre (RSC), in Singapore. The education proved valuable in comparable topics to the Northwestern Kellogg program, though in a longer, more in-depth format (2-year part-time MBA at Warwick Business School); with topics ranging from marketing, strategic commercial thinking, accounting/financial planning to people management, all of which are generally not commonplace in academic/scientific research training or CPD opportunities for core facility staff. As with the Northwestern program, these skills are directly applicable enabling improved, efficient and professional management of imaging facilities and more broadly, in the coordination and oversight of a range of core facilities in support of the wider research ecosystem. Broadened institutional (financial) support for Imaging Scientists to partake in these types of programs and learnings would be welcomed in the future.

Image data analysis is an in-demand service within imaging core facilities, but experienced bioimage data analysts can be difficult to recruit and retain, due to the lack of specific or comprehensive funding for such roles. Within France BioImaging (FBI), a dedicated program for image analysis services exists, underpinned by significant country-wide investment and a multi-research infrastructure strategy. Within this, a group of FBI bioimage analysts, led by **Jean-Yves Tinevez**[11] are building a community to

9 Partner at Waymaker Group, Chicago, IL USA
10 Director, Research Support Centre at A*STAR - Agency for Science, Technology and Research, Singapore
11 Head of Image Analysis Core Facility at Institute Pasteur, Paris, France

support and engage individual analysts working in isolation across the country. Another skill sharing initiative, led by **Caroline Thiriet**[12] and **Fabrice Cordelieres**[13], is working to coordinate and integrate numerous existing training courses into a streamlined progressive training portfolio of democratised FAIR complaint resources dedicated to biological imaging. Important aims are to ensure long term benefits and recognition for the participants with a positive impact on their professional status. In 2024, they plan to launch a number of Massive Open Online Courses (MOOCs) for the community.

The impact of philanthropic funders in developing communities

In recent years philanthropic funders including the Chan Zuckerberg Initiative, Wellcome Trust, Bill & Melinda Gates Foundation, Gordon & Betty Moore Foundation and Howard Hughes Medical Institute have delivered funding programmes specifically aimed to support developing nations and regional imaging communities. The strategy is to enhance and encourage the growth and development of nascent communities, foster an interest and awareness of technologies, and to assist with their dissemination among underserved regions whilst supporting the recognition of Imaging Scientists and their career track.

In 2022, one such initiative, the Africa Microscopy Initiative (AMI), was launched as a result of successfully communicating the need for advanced imaging facilities in underserved areas to these philanthropic bodies (Reiche *et al.*, 2023). Amongst its champions are **Teng-Leong Chew**[14] of the HHMI Janelia Research Campus, along with **Michael Reiche**[15] and **Caron Jacobs**[16] from the University of Cape Town, the founders of the Africa BioImaging Consortium. AMI is a multi-pronged, continent-wide undertaking aimed at addressing the inequitable access to advanced microscopy in Africa. It combines an all-expense-covered, open-access microscopy centre in South Africa, with multifaceted educational opportunities, and an instrument distribution program. Its vision is propelled by the recognition that effective capacity-strengthening for microscopy in Africa hinges on the con uence of technology access, dissemination, and education. This program provides an unbroken ow of technology and expertise that will elevate life scientists in Africa. A multi-tiered approach to education and instrument dissemination is strategically designed to create a deployable, critical mass of microscopy instruments and trainers who will empower African scientists. AMI is funded in part by the Chan Zuckerberg Initiative (CZI) which has committed $6.4 billion over 20 years to accelerate science and awarded more than 1,400 grants to support researchers in 34 countries around the globe. AMI is funded by CZI and the Gates Foundation to provide a platform through which modern, operational pre-owned microscopes can be efficiently transferred to African institutions with justifiable needs. In addition, AMI offers international fellowship to pair African microscopists with their international counterparts and the opportunity to be mentored by highly experienced Imaging Scientists to run microscopy workshops in Africa, thus greatly expanding the number of trained personnel who will engage in microscopy teaching in Africa. The long term and sustainable approach will be positive for the promotion of the Imaging Scientist career path in this nascent structure. Having the ability to clearly define the role, without perhaps the constraints of legacy posts, will hopefully encourage a new wave of scientists utilising and expanding microscopy.

12 External Affairs Manager for the National Research Infrastructure France-BioImaging, Bordeaux, France
13 CNRS Research Engineer at Bordeaux Imaging Center, France
14 Director for the Advanced Imaging Center (AIC) at Janelia Research Campus, Ashburn, USA
15 Operations Manager at the Africa Microscopy Initiative (AMI) Imaging Centre, Cape Town, South Africa
16 CZI Imaging Scientist at the University of Cape Town, South Africa

Success story on the Technician Commitment with one voice through networks and communities

The **Technician Commitment** stands as a foundational pillar in reshaping the academic landscape, championing the cause of technicians in higher education and research across various disciplines. This commitment is dedicated to guaranteeing the visibility, recognition, career development, and sustainability of technicians, whose contributions are often the unsung heroes of scientific progress. Universities and research institutions are encouraged to embrace this commitment by becoming signatories, pledging to take substantial actions to address the critical challenges that affect their technical staff. The recent appointment of **Professor Andy Filby**[17] as the first-ever Professor of Practice in Enabling Technologies at Newcastle University's Faculty of Medical Sciences vividly demonstrates the tangible impact of the Technician Commitment, and how collaborative efforts are reshaping career pathways for these essential contributors within academia. This proactive approach not only reshapes perceptions but also establishes new career pathways, setting a compelling precedent for institutions worldwide.

CONCLUSION

This work illuminates the intricate landscape within which Imaging Scientists operate, navigating roles that are simultaneously research-oriented, service-driven, and richly multifaceted. Our recommendations aim to serve as a compass for bolstering the advancement and recognition of this vital role.

In our collective journey, we've recognized the imperative for support, often extending beyond one's home institution. This support may take the form of guidance from peers who intimately understand the unique challenges faced within this emerging career path. Initiatives such as mentoring programs offered by organisations like the RMS, CTLS, and our own Global Bioimaging job shadowing program have made significant strides in acknowledging and addressing this need. These programs offer a holistic approach, encompassing not only soft skills and application coaching but also technical mentoring.

Moreover, they foster a sense of community that extends beyond technical expertise. Being part of such initiatives provides not only essential technical support but also a psychological lifeline. It ensures that no Imaging Scientist, regardless of whether they are the sole representative in their facility, laboratory, institute, or university, need ever feel isolated. Instead, they become part of a larger, supportive network, uniting individuals on a shared journey, and amplifying the impact of this critical field.

As we continue to champion the cause of Imaging Scientists, we acknowledge the progress made and anticipate the promising developments on the horizon. This work serves as both a testament to our collective commitment and a call to action, urging stakeholders to invest in the growth and recognition of this frontier science post.

17 Professor of Practice in Enabling Biomedical Technologies at Newcastle University, UK

APPENDIX A: JOB DESCRIPTION TEMPLATE FOR IMAGING SCIENTISTS WORKING IN A CORE FACILITY

This template aims to comprehensively cover a broad range of potential positions within a core facility and should be tuned for specific recruitment for open positions. Appendix B puts these roles, responsibilities and expectations into a job family with a hierarchical/progression framework. We strongly encourage all employers to ensure that their job descriptions comply with Equity, Diversity, and Inclusion (EDI) principles.

1. **Qualifications & skills**

   a) Graduate degree (or equivalent experience) in STEM-related research field.
   b) Solid theoretical knowledge and understanding of basic to advanced imaging technologies & techniques.
   c) Practical experience with one or more of the following advanced imaging technologies, related skills and their application to biomedical research (tuned as relevant to open positions). In certain instances some skills may be designated as required or desirable:
      i Atomic and molecular microscopy.
      ii Organelle and cellular microscopy.
      iii Tissue and organ microscopy.
      iv Pre-clinical (animal) imaging.
      v Clinical (human) imaging.
      vi Image processing and analysis.
      vii Data Science.
   d) Thrive on working with others in a team and through collaboration.
   e) Embrace opportunities for leading others.
   f) Strong time-management and organisational skills.
   g) Enjoy being involved in a wide range of research projects with a variety of samples.
   h) Enjoy working with many researchers with diverse backgrounds and experience.
   i) Possess strong problem-solving skills.
   j) Possess strong communication and teaching skills.
   k) Possess strong technical-writing skills.
   l) Possess strong computer literacy and experience with working with image processing or analysis software.
   m) Enjoy developing new techniques and services, as needed, thereby continuously looking into opportunities for novel applications.
   n) Passionate in keeping up to date with new technique developments with an attitude of continuous/lifelong learning.
   o) Exhibit high standards in data quality, rigor and ethics
   p) Publication record or demonstrable examples of projects supported in applying basic and/or advanced imaging technologies.

2. **Roles & Responsibilities**

a) Service-orientated approach specialising in the application of imaging for enhancing and advancing a wide variety of research projects (Team Science).

b) Understanding the institute's scientific research so as to better advise researchers and to develop collaborative projects applying advanced microscopy techniques, where the opportunity exists.

c) Provide advanced imaging technology consultation, advice, training, support and service for users of the facility.

d) Integrate new imaging technologies & techniques into the laboratory.

e) Ensuring high standards of laboratory performance and quality, that equipment is well-maintained and quality controlled to operate consistently and according to industry standards and specifications. Build strong relationships with manufacturers for repairs, upgrades and application support.

f) Emphasise and advocate rigor and reproducibility in experiments and results.

g) Write grants, for example for new instrumentation, technique and application development and infrastructure network building.

h) Contribute to the strategic direction of the laboratory and regional, national and international-level initiatives.

i) Health, safety and risk management: identification, assessment and mitigation of potential occupational hazards and risks for staff and users of the facility.

j) Occupancy & Human Factors: Facilitating comfortable and highly productive usage experience.

k) Sustainability: Insuring environmentally responsible and resource-efficient procedures and practices.

l) Publish scientific papers, attend and present at conferences on core-related topics.

m) Perform (administrative) duties as part of the wider core facility operations, for example:

   i Managing online facility management software/booking system, e.g. user accounts, permissions, training requests, etc.

   ii Organising, and contributing to, international courses and workshops.

   iii User feedback and satisfaction surveys collection and analysis.

   iv Administering billing processes.

   v Health & Safety matters and risk assessments

   vi Building infrastructure and facilities matters.

   vii Procurement processes (e.g tendering for new equipment).

APPENDIX B: CORE IMAGING FACILITY JOB FAMILY FOR IMAGING SCIENTISTS AT DIFFERENT LEVELS WITHIN CORE FACILITIES

Career stage	Imaging scientist titles	Roles, responsibilities and expectations
Early career	**Scientific Officer/ Technical Scientist**	▪ Graduate degree or relevant experience. ▪ Developing domain expertise, with relatively limited prior experience. ▪ Able to support users on the more basic equipment and demonstrate standard operating procedures according to established protocols and procedures. ▪ Perform routine maintenance of equipment. ▪ Provide administrative support for facility operations (e.g. procurement).
	Support Scientist	▪ Postgraduate degree or relevant experience. ▪ Building deeper domain expertise with detailed knowledge of microscopy and imaging techniques. ▪ Demonstrate research skills to support the wider experimental pipeline of a biological imaging experiment, (e.g. sample preparation and image analysis). ▪ Able to undertake development and writing of facility and technical protocols and procedures. ▪ Participates in workshops and conducts training sessions. ▪ Capable of supporting a broader group of users. ▪ Capable of maintaining the equipment to a quality standard and troubleshooting problems. ▪ Provide administrative support for facility operations to ensure compliance with institutional policies. ▪ Able to support and train junior colleagues.
Mid-career	**Scientist**	▪ Postgraduate degree (with advanced imaging techniques and analysis) or relevant experience. ▪ Capable of managing projects, e.g., developing and running practical courses. ▪ Deep domain expertise across multiple microscopy techniques, with complementary analytical skills. ▪ Supports a portfolio of users providing services and consultation to facilitate scientific research projects. ▪ Advise users on selection of techniques, their limits, results interpretation, and ensure follow-up. ▪ Keep up to date with technological developments and involved in instrument procurement. ▪ Write experiment or study reports and technical notes. ▪ Able to develop and implement performance assessment of equipment within the facility to maintain high-standards. ▪ Assist in the development and implementation of policy, procedures and techniques within the facility.

	Senior Scientist	▪ PhD or postgraduate degree or relevant experience. ▪ Deep domain expertise across multiple microscopy techniques, with complementary analytical skills. ▪ Management of a suite of equipment, including their training demands. ▪ Capable of conceiving, developing and project managing international courses and workshops. ▪ Well developed portfolio of users and projects, with involvement and collaboration that may lead to co-authorship on papers. ▪ Design and conduct training activities. ▪ Development of budgeting and financial management skills. ▪ Running committees (e.g. user groups). ▪ Capable of developing and writing protocols and SOPs relevant to the facility. ▪ Assisting in grant writing with collaborators and superiors. ▪ Lead technological development projects. ▪ Continually keep up to date on emerging state of the art technological developments, identifying opportunities to support research projects and leading their procurement and integration into the facility. ▪ Advise users and partners on the possibilities and limits of available techniques and on the interpretation of data. ▪ Manage the performance assessment of equipment within the facility to maintain high-standards. ▪ Experience with administering facility management systems. ▪ Developing leadership competencies.
Advanced career	**Facility Manager**	▪ Facility Management of a larger facility or collection of labs. ▪ PhD or postgraduate degree or relevant experience, including management and supervision experience. ▪ Extends the Senior Scientist responsibilities by managing staff, research projects, infrastructure, planning the budget and strategic direction of the facility. ▪ Able to draw on their network across the wider research ecosystem to help support research projects in the facility and continued facility development. ▪ Identify emerging techniques to prepare the facility and institute for future scientific trends. ▪ Responsible for the administrative and reporting activities ▪ Delivers high quality service and support for the research community. ▪ Disseminate and promote the impact of the facility in the form of reports, patents, publications, oral presentations, training. ▪ Lead grant writing and funding proposal for new equipment. ▪ Networking with other Facility Managers (not limited to imaging) to exchange experience and continually develop the core facility. ▪ Oversee the quality control initiatives in the facility ▪ Responsible for safety, policy and ethics adherence at the operational level - establishing policy and SOPs. ▪ Able to drive continuous improvement initiatives. ▪ Managing and supporting the development of the staff within the facility. ▪ Demonstrating leadership competencies.

	Facility Director	▪ Strategic direction and final decision maker across a core research facility whilst ensuring alignment with institutional goals and overseeing financial and budgetary management. ▪ PhD or postgraduate degree or relevant experience, including experience with management and supervision. ▪ Extends the Facility Manager with ultimate responsibility whilst leading and developing the strategic direction of the facility. ▪ Develops technology roadmaps to prepare for future scientific trends and asset lifecycle management. ▪ Leads the facility to ensure high quality service for the research community. ▪ Disseminate and promote in the form of reports, patents, publications, oral presentations, training. ▪ Initiates and leads grant writing for competitive funds to support equipment purchases, staff positions, technique development, etc. ▪ Networking with other facilities at a regional, national and international level whilst building a international strong reputation personally and for the facility. ▪ Demonstrate strong leadership competencies. ▪ Develop the staff within the facility and their careers. ▪ Financial management. ▪ To effect influences with the multiple stakeholders of the facility, at all levels, which may include coordinating the advisory/steering committee.
Refer to Section C point 8 for an example of a further level of **Core Administrator**, responsible for overseeing and coordinating multiple core facilities across an institution.		

APPENDIX C: GUIDE FOR ENGAGING STAKEHOLDERS IN CONVERSATIONS ABOUT THE IMPACT AND VALUE OF CORE IMAGING FACILITIES, AS WELL AS PROMOTIONS AND JOB POSITION UPGRADES FOR IMAGING SCIENTIST ROLES.

Core facilities are an indispensable component of an advanced and high impact research ecosystem. In the realm of life science research, imaging stands out as a technology driven by high expenses and technical intricacies, demanding specialized expert assistance. Imaging facilities epitomize a remarkably cost-effective and sustainable investment for institutions. They enhance research efficiency and quality by ensuring the optimal upkeep and quality management of cutting-edge equipment and offering valuable support in planning both experimental and data acquisition and analysis strategies. The Imaging Scientists working within imaging core facilities play a pivotal role in facilitating grant applications, thereby elevating the likelihood of securing funding. Additionally, by pooling resources and investing in high-cost equipment, institutions can reduce their overall expenditure while boosting equipment utilization rates and fostering interdisciplinary collaborations among researchers. Through demand aggregation and negotiation of maintenance contracts and increased purchasing power, core facilities can also lead to savings in equipment and operational costs. Ultimately, well-trained core Imaging Scientists are instrumental in driving higher efficiency and quality of research through well-maintained systems and through the support for experimental and analysis planning.

Core facility staff have a broad remit, including training and knowledge retention, enabling collaboration across typically transient research group members. Within open access imaging core facilities, they bridge external researchers, including those from industry, with internal academic researchers, catalyzing fresh collaborations and bolstering high-impact research. Notably, many Imaging Scientists working in core facilities actively engage in the development and optimization of techniques and technologies, leading to innovations in research with the potential for wide-reaching dissemination, commercialization, and product development.

The multifaceted roles of imaging scientists demand a diverse skill set encompassing technical expertise, a service-oriented mindset, and a blend of scientific and management skills. They are highly specialized professionals, making them invaluable assets for universities and institutions. To retain these professionals, it is essential to establish appropriate career conditions within the university or institute system. This includes recognizing their contributions beyond the binary academic or technical/administrative classification, as well as providing opportunities for progression and promotion. Failure to do so can lead to talent seeking employment elsewhere, disrupting research infrastructure, technologies and support provided by cores.

Our recommendations encompass the following key points:

1. **Introduction of Dedicated Core Facility Career Path:** Institutions should establish a dedicated core facility career path within the university system, mirroring the structure found in the academic career path (e.g., Assistant/Associate/Full Professor).
2. **Clear Role and Responsibility Definitions:** When formulating job profiles within imaging core facilities, institutions should provide precise and well-defined roles and responsibilities.
3. **Broadened Performance Evaluation Metrics:** Performance evaluations of core facility Imaging Scientists should not rely solely on academic metrics such as publications but should also account for the range of services delivered within the core facility, including training, usage hours, and consultations.
4. **Independent Grant Application Rights:** Leaders of imaging core facilities should have the autonomy to apply for grants independently.
5. **Recognition of Training and Supervision:** The valuable contributions of Imaging Scientists of core facilities in training, teaching, and supervision should be recognized both in terms of evaluation and career metrics, as well as in their rights to (co)supervise students and through institutional recognition.
6. **Investment in Technology Training and Professional Development:** Institutions should invest in technology training and professional development opportunities for core facility staff, which can be facilitated through participation in local, national, and international initiatives.
7. **Recognition and Awareness:** Additionally, it is crucial to acknowledge and raise awareness of the pivotal role played by core facilities within the institution, as this recognition greatly influences job performance and enhances the satisfaction of research professionals.

Drawing from the collective experience of the global community, as exemplified by Global Bio-Imaging and our working group, and the showcased success stories, we affirm that implementing these recommendations and establishing a dedicated career path system will yield profoundly positive impacts, benefiting not only individual core facilities but also enhancing institutional recognition, impact, and the broader research ecosystem.

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WEB RESOURCE LINKS

GBI resources:

Global BioImaging's International Recomendations
Training
GBI Virtual Training Platform
Job Shadowing
Working Groups
Measuring Imaging Core Facility Impact
Standard for Open Image Data Format and Repositories

Other resources:

Association of Biomedical Resource Facilities (ABRF)
Career Development Education Resources
European Light Microscopy Initiative (ELMI)
German Bioimaging (GerBio)
Northwestern courses
Royal Microscopical Society (RMS)
Core Technologies for the Life Sciences (CTLS)
Microscopy.db
Harvard Medical School (HMS)
Janelia Research Campus
iBiology Microscopy
Microcourses
NEUBIAS
ASCB
Socienty for Neuroscience (SfN)
International society for optics and photonics (SPIE)
Federation of European Biochemical Societies (FEBS)
Federation of European Neuroscience Societies (FENS)
International Committe of Medical Journal Editors (ICMJE)
The American Society for Cell Biology (ascb)

GLOBAL BIOIMAGING

Global BioImaging (GBI) is an international, open network of imaging infrastructures and communities, which was initiated in 2015 by Euro-BioImaging and partners in India and Australia with the mission to cooperate internationally and propose solutions to the challenges faced by the imaging community globally. Furthermore, the partners support each other to build a strong case towards the funders that imaging technologies and research infrastructures are key in the advancement of life and health sciences; and GBI activities aim to build capacity internationally, leveraging on each other's strengths and capabilities.

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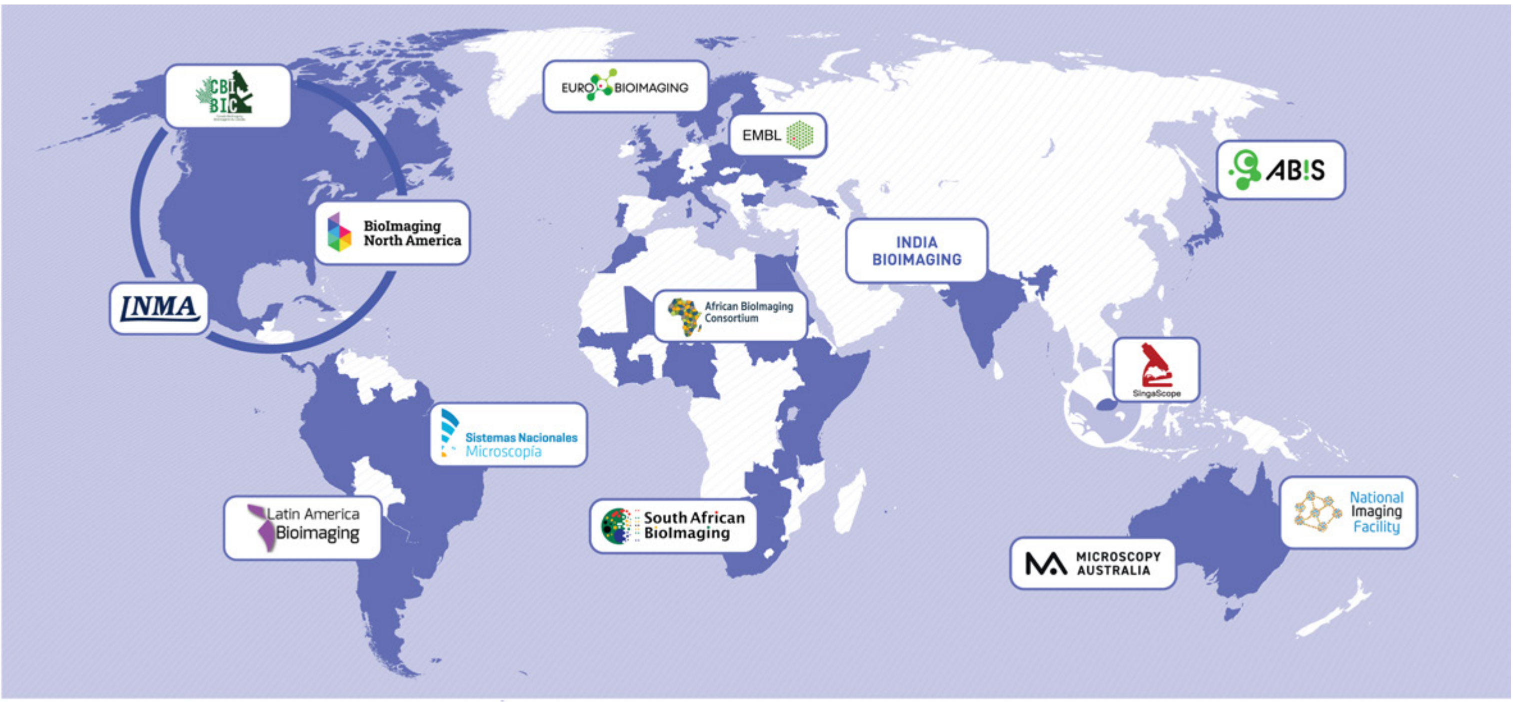

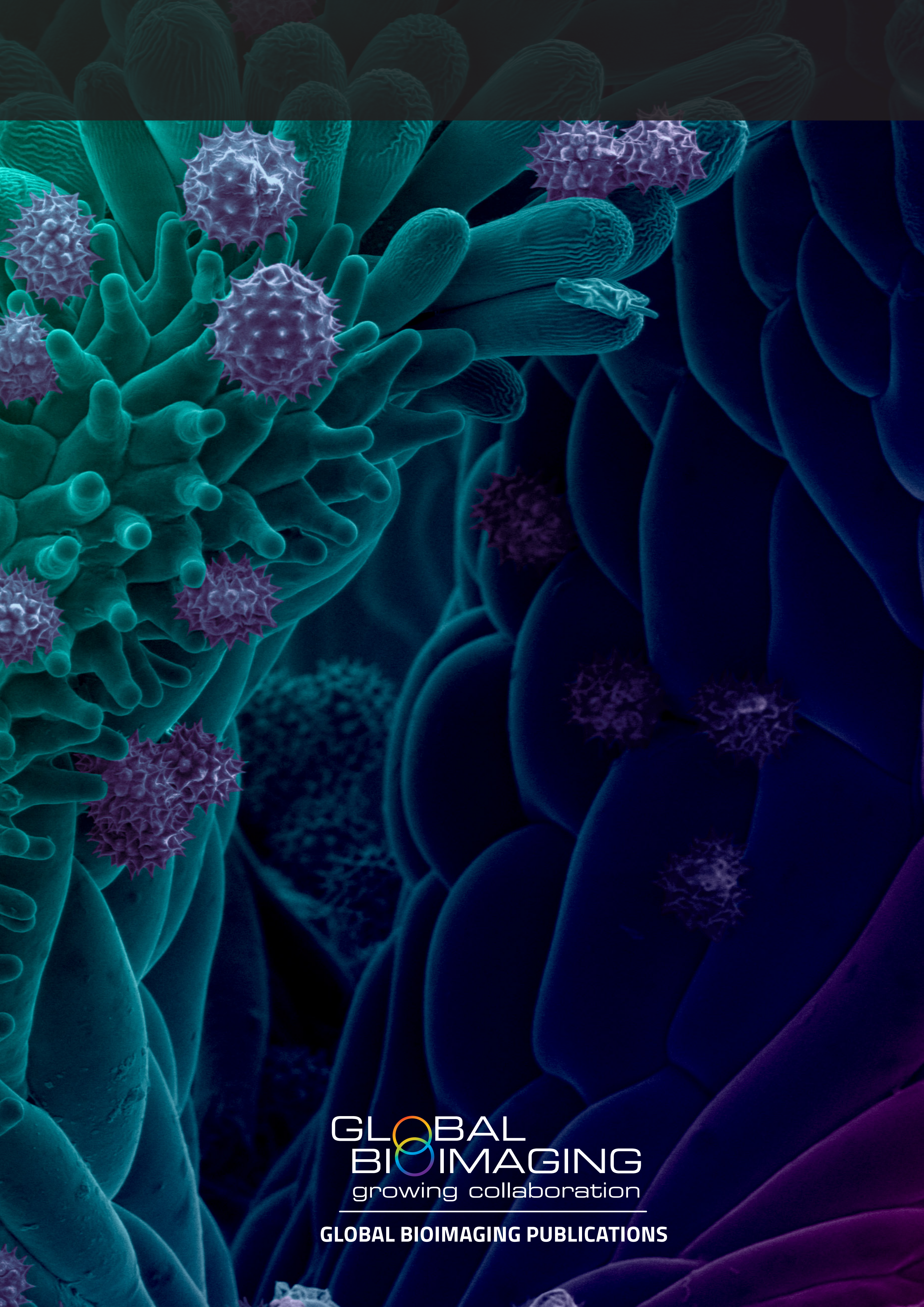

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