asap Aligning Science Across Parkinson's

Investing in Open Science

Key Considerations for Funders

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Executive Summary

Investing in Open Science: Key Considerations for Funders is a comprehensive report on how the **Aligning Science Across Parkinson's (ASAP)** initiative has invested in open science to date. The document walks through each component of the **ASAP Open Science Policy**, and potential costs and barriers associated with implementing and enforcing each. This document is intended to serve as a resource to other funders considering investing in open science within the biomedical research ecosystem.

Introduction

Open science is a multifaceted movement that aims to make the processes and outputs of scientific research findable, accessible, and reusable, with the goal of accelerating the pace of scientific discovery by allowing others to build upon the work of those who came before. The open science movement aims to transform the research landscape by promoting research transparency in order to enable reproducibility and replicability, lower the barriers for collaboration, and reduce unnecessary duplication.

Recently, in recognition of the value of open science, funding agencies have begun to mandate open science policies as a condition in grantee awards.[1–5] However, developing operational workflows to promote the adoption and implementation of open science policies can pose unanticipated costs and logistical barriers to funders (*Figure 1*).

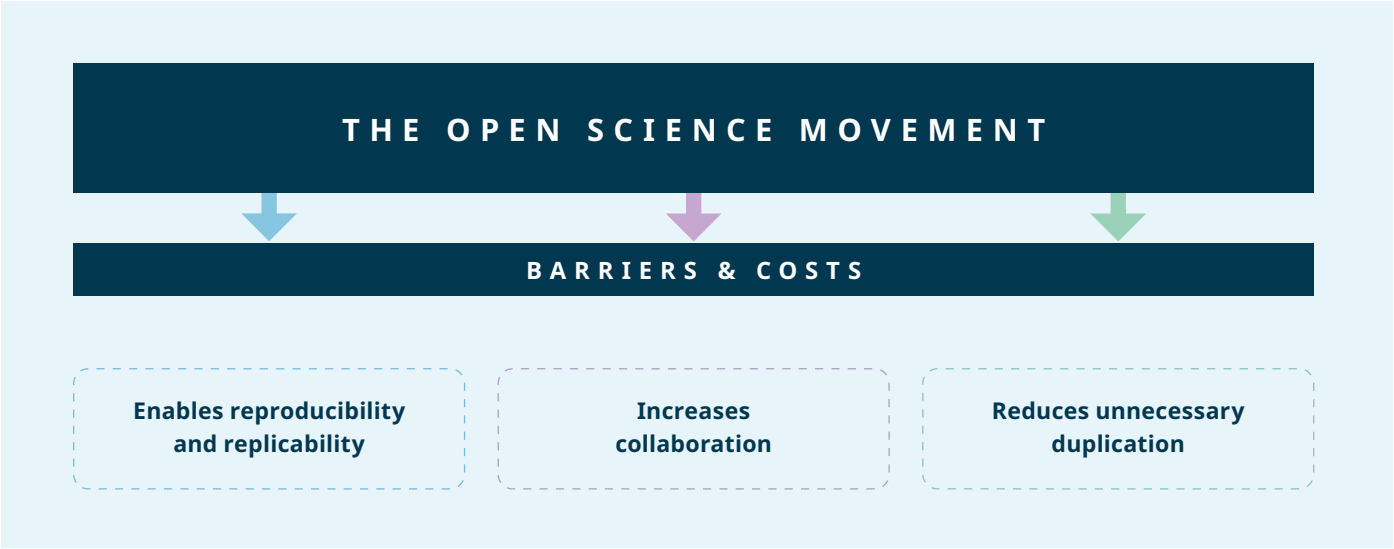


Figure 1. Goals of open science. *The open science movement aims to transform the research landscape by promoting research transparency in order to enable reproducibility and replicability, lower the barriers for collaboration, and reduce unnecessary duplication. Numerous barriers and costs prevent the goals of the open science movement from being reached.*

Aligning Science Across Parkinson's (ASAP) is a coordinated, global research initiative designed to accelerate discoveries for Parkinson's disease through facilitating collaboration, generating research enabling resources, and data sharing. Since its inception, the ASAP initiative has utilized a comprehensive **open science policy**, which, in addition to requiring immediate free online access to all publications, also requires all newly-generated datasets, protocols, code, and key lab materials to be shared by the time of publication.[6,7] Moreover, preprints must be posted to a preprint repository by the time of manuscript submission to a journal for review.

ASAP Theory of Change for Open and Collaborative Science

SUPPORT COLLABORATION

Scientific progress can be accelerated when researchers exchange ideas early and often, in a collaborative rather than competitive manner.

GENERATE RESOURCES

By supporting resource development, we are building an infrastructure, available to the larger scientific community, that improves access to research tools, reproducibility of studies, and process efficiency to accelerate discoveries.

SHARE DATA

By sharing research outputs like data, code, and protocols, we are allowing researchers to build upon the work of others. This facilitates collaboration among investigators, attracts new talent and expertise to the field, and allows us to increase the power of our studies through meta-analysis.

ACCELERATE DISCOVERIES

We believe that by supporting collaboration, facilitating research, enabling resource generation, and creating a culture of data sharing, we can deliver faster and better outcomes for Parkinson's disease research.

Here, we outline the potential costs associated with implementing and enforcing the ASAP Open Science Policy. We break down each of the five overarching requirements, outlining the barriers and costs associated with each. We recommend that funders take these considerations into account when investing in open science policies within the biomedical research ecosystem.

The ASAP Open Science Policy Requirements

The ASAP Open Science Policy is divided into five (5) overarching requirements. These requirements enhance our network's ability to make their processes and outputs findable, accessible, and reusable, so together we can accelerate the pace of scientific discovery. For a further breakdown of costs, refer to *Table 5*.

1. **Share Research Outputs.**
   Data, code, and protocols generated as part of an ASAP-funded study must be deposited in a discipline-specific, community-recognized repository by the time of publication, with accompanying information to facilitate reuse of those outputs and a license that allows for reuse. Key lab materials generated as part of an ASAP-funded study must be registered by the time of publication.

2. **Identify Research Inputs.**
   Data, software, protocols, and key lab materials used in a study — but which were not generated as part of an ASAP-funded study — must be unambiguously identified in the study's publication.

3. **Ensure Immediate Open Access.**
   Preprints must be posted no later than the date a manuscript is submitted to a journal for review. Preprints and publications must be immediately publicly available with a CC BY license or CC0 public domain dedication and include an Availability Statement outlining where all research outputs (Requirement 1) and research inputs (Requirement 2) can be accessed.

4. **Acknowledge Funding.**
   Manuscripts and other research outputs that were partially or fully funded by ASAP must acknowledge ASAP. Manuscripts must include an ORCID and a Collaborative Research Network (CRN) author affiliation for CRN investigators.

5. **Share Outputs With ASAP Network.**
   All ASAP-funded research outputs, including manuscripts, must be shared on the ASAP grantee virtual platform, no later than time of publication. Manuscript drafts must be sent to the ASAP Open Science Team no later than the time of posting a preprint.

REQUIREMENT 1:

Share Research Outputs

Data
Code and Software
Protocols
Lab Materials

ASAP defines **research outputs** as any data, code and software, protocols, or key lab materials that are generated during a research study.[6,7] Several funding agencies are moving towards mandating that data be shared as part of their open science policy.[8–10] The ASAP Open Science Policy goes beyond a data sharing mandate, requiring all research outputs (data, code and software, and protocols) generated as part of an ASAP-funded study be deposited in a community-recognized repository by the time of publication, with a license that allows for reuse. Any accompanying information (e.g., README files) necessary to facilitate reuse of research outputs must be included in the deposit, and the associated persistent identifier must be findable via the publication. In the early years of the ASAP initiative, we required deposition of all newly-generated lab materials by the time of publication. However, our grantees were rarely able to meet this requirement due to the lengthy process associated with depositing lab materials. In response to grantee feedback, we have modified our policy to require registration and a process of deposition initiated rather than deposition of the lab material output by the time of publication.

Research Outputs

Data

Barriers Associated With Sharing Data

From a funder's perspective, there are several implementation barriers when enforcing a data-sharing policy. Despite growing mandates for data sharing, datasets are often not shared in publicly accessible repositories, with one meta-analysis finding only 2% of medical and health sciences publications had associated publicly available data.[11] Some researchers believe that sharing data "upon request" or as supplemental files is sufficient. However, numerous studies have shown that, despite "data available upon request" statements in their papers, researchers are rarely willing or able to share their data upon request.[12–18] Additionally, supplemental files are often subject to link rot and content drift, underlining the importance of public repositories meeting best practices for the long-term preservation of data.[19–22] Perhaps not surprisingly, data from publications in journals with mandated data sharing policies are significantly more likely to be findable online compared to data from publications in journals with no mandate.[23] While the easiest mechanism for changing this cultural norm may rely on clear data-sharing mandates from journals themselves, this type of requirement is not widespread. Therefore, for now, grantee training and education about the importance of sharing data in public repositories for long-term preservation of data may help generate buy-in for a data sharing policy. The ASAP initiative has committed to providing resources, such as Open Science Guides and a Data Repository Wiki, for ASAP grantees, as well as the scientific community at large. However, the creation and maintenance of these resources costs time and effort for the ASAP Open Science Team.

Data curation and data standards are also important considerations. It is not enough for the data to be made available; for the data to be useful, its distribution must include additional support, such as README files and data dictionaries. Ensuring that datasets are well-curated is essential for their meaningful use and interpretation. However, curating datasets requires time, effort, and expertise. Data sharing standards vary across disciplines (or do not exist for some disciplines), making it challenging for researchers to navigate where and how to share their data effectively. While the burden of curating data often falls on the individual grantees, we have found that providing educational guidance (including templates and links to metadata standards for data types) helps grantees comply with this policy. Sharing cleaned, tabular data, as compared to non-tabular or raw data, can be easier for grantees. However, sharing tabular data effectively still requires a high degree of data management and documentation, and ultimately, sharing only cleaned data limits the extent to which the data can be aggregated for meta-analysis or reused in future studies.

Addressing these barriers requires concerted effort from stakeholders across the research community, including funders, institutions, publishers, and researchers themselves, to develop standardized guidelines and foster a culture of data sharing and collaboration.

Costs Associated With Sharing Data

Data sharing costs for funders fall into three major categories: effective curation, data storage/hosting, and data infrastructure. Effective curation to prepare data for reuse may be performed by either a grantee or a designated data curator; in either case, there is a cost in personnel time and potentially in computational resources. The cost generally depends on the complexity and size of the dataset. Curation costs may be reduced by using a repository, which includes curation services, such as **Dryad** or an institutional repository, but these repositories may charge a service fee and may not cover all datatypes. The majority of discipline-specific and generalist data repositories are free to use for storage/hosting and distribution by default; however, costs can escalate for larger datasets and specialized platforms. For example, **Zenodo**, the generalist repository utilized by ASAP, provides free storage and distribution up to 1TB, but beyond that, users incur charges. For very large datasets, egress costs for distribution can be significant. Upgrades to and maintenance of platforms or services may require further financial investment, posing a barrier to researchers, especially those with limited funding. This is a particularly costly challenge for funders and researchers working with human subject data, which may have a higher bar to meet ethical and legal requirements, and often incur additional data sharing costs at every stage of sharing.

Data sharing costs for funders fall into three major categories:

EFFECTIVE CURATION

DATA STORAGE/HOSTING

DATA INFRASTRUCTURE

Example Data Sharing Platforms

AMP PDRD

crn cloud
An asap data platform


DANDI

Data sharing at scale relies on high-quality data and infrastructure.[24] We have found that it may be beneficial for funders to support and/or develop data infrastructure for the specific data types emerging from their programs. To that end, ASAP partners with multiple organizations to support the **AMP® PDRD** data repository, a public-private partnership for Parkinson's disease datasets. AMP® PDRD provides a platform to centralize, harmonize, and securely distribute genetic and multi-omic data relevant to Parkinson's alongside a standardized minimum set of key clinical data. ASAP also developed a data sharing tool, the **CRN Cloud**, which currently consists of harmonized collections of human postmortem-derived brain sequencing data, a precious resource for the scientific community. The CRN Cloud provides a data platform that allows these data to be stored securely within a cloud environment while still being accessible to the broader research community, and provides a collaborative environment where scientists can access, analyze, and share these datasets. Developing the CRN Cloud has allowed us to more cost-effectively and quickly curate, store, and distribute very large multimodal datasets, with additional collections in curation and scheduled for future distribution based on our strategic priorities. It has also provided an opportunity to enforce data standards, support consistent curation and data quality to enable interoperability between datasets, and develop more effective guidance for data reusers. Note that creating cloud-based resources like the CRN Cloud requires capital, and depending on the features required, can easily become a greater than million-dollar line item in a funder's budget.

Additionally, some disciplines are working towards standardized, non-proprietary file types, but this requires concerted efforts across the field and significant infrastructure support. For example, sharing neurophysiology data remains a challenge due to large file sizes and proprietary file types. Additionally, sharing of this data may require synchronization of neurophysiology data with other data streams (e.g., behavioral outputs). Therefore, we support a collaboration with **CatalystNeuro** to build bespoke conversion and transfer pipelines for neurophysiology data to allow for easy archiving of these datasets onto **DANDI**, the NIH BRAIN Initiative-sponsored neurophysiology repository. These curation efforts around building these workflow pipelines amount to around a $30,000 investment per lab we support. Supporting these data infrastructure projects represents a non-trivial cost and a strategic investment towards the preservation, accessibility, and reusability of ASAP-funded data.

Implementation of a data sharing policy may cost the funder nothing. However, this is dependent upon the design of the policy and the commitment on the part of the funder to support data infrastructure that may be needed to house data generated by grantees.

Code and Software

Barriers Associated With Sharing Code and Software

One of the primary barriers to implementing a code-sharing policy is inertia. Computational reproducibility is increasingly viewed as a minimum standard for scientific research to meet. Despite this, sharing of analytical scripts is not a common practice.[25,26] Estimates of analytical script sharing in scientific publications vary widely (<0.5% to 34%) and, even when shared, scripts are often insufficiently annotated or incomplete.[11,27,28] Many researchers may not have received training in best practices for code documentation as part of their technical training, and may not feel they need to improve this skill.

Enforcement of this policy is another barrier to implementation. In our current workflow, the ASAP Open Science Team checks whether or not the analytical scripts are shared, not if they are reusable. Checking that scripts are comprehensive and well-documented takes substantial time and expertise, and may not be feasible for a funder since it often requires access to specific computational resources. Additionally, for many manuscripts where analytical scripts are not generated due to the technology used (e.g., Excel, GUI-based analytics tools), specific details of cleaning, analysis, and visualization of data often go unreported. To address this, we recently began recommending that grantees write instructions for actions they perform in point-and-click software; however, standards, best practices, and examples need to be established in order to codify this as mandatory policy.

Addressing these barriers requires a concerted effort from stakeholders across the research community to develop standardized guidelines, foster a culture of sharing all analytical scripts, and assign all code deposits a persistent identifier.

Costs Associated With Sharing Code and Software

Requirements to share analytical scripts in a publicly accessible repository do not generally have any associated funder costs. Although paid plans offer more storage and technical support, which grantees may wish to take advantage of, it is free for grantees to share their code in a generalist repository such as **GitHub**. Additionally, licensing scripts is free and easy to achieve by generating a LICENSE file for the GitHub repository.

Sharing of open-source executable software or software tool libraries/packages is more complicated. Like analytical scripts, licensing of open-source software is free, and source code can be distributed via GitHub or language libraries. Additionally, registration of software via **RRID Portal** is also free. However, maintaining software comes with associated costs, especially if software needs to be debugged and/or upgraded due to high popularity/usage or if data storage is required. This cost often falls to the grantee, but in some cases, it may be a worthwhile strategic investment for funders to offset these costs if the software tool is of particular interest or use.

Protocols

Barriers Associated With Sharing Protocols

Funders that require grantees to share detailed protocols through a public repository should recognize that there are several barriers to implementing this policy. One of the main barriers is that grantees do not share sufficiently detailed protocols with researchers outside of their lab. In a small survey of researchers across disciplines, nearly a quarter (23%) of respondents reported not sharing protocols or detailed methods outside of their lab or group, and only a third (33%) indicated that they share their protocols in a written format.[29]

Another consideration for funders implementing a protocol sharing requirement is the time it takes for grantees to create detailed protocols and to learn how to use a protocol repository. In a survey of researchers, the majority (74%) reported not sharing protocols due to not knowing where to share detailed methods and the effort and time it takes to create detailed methods.[29] In an effort to assist grantees, ASAP has provided step-by-step instructions for how to use the protocol repository, **protocols.io**, and how to write a recipe-style protocol. Additionally, we cover fees associated with using the protocols.io **Protocol Entry Service**, which allows grantees to submit their protocols to be formatted and imported by the protocols.io team.

Addressing these barriers requires education and may involve strategic investment from funders to support development and sharing of recipe-style protocols.

Costs Associated With Sharing Protocols

In general, the costs that a funder might encounter for implementing a protocol sharing requirement can be relatively minimal. However, costs are highly dependent upon how much support the funder provides to the grantee. Some funders may choose to utilize the free version of **protocols.io**, which gives users the ability to create an unlimited amount of public protocols. (For example, see the **CZI Neurodegeneration Challenge Network** community, with over 100 protocols shared.)

ASAP grantees wanted the ability to share private protocols internally with the network before making them public, as there were concerns about publishing a protocol prior to a grantee completing troubleshooting. In light of this concern, we opted to support the creation of a paid, private ASAP workspace in protocols.io for members of the **Collaborative Research Network (CRN)**. Nearly 500 members of the ASAP workspace actively utilize this platform, which houses over 2,500 protocols, to create private protocols that are shared internally with the ASAP CRN prior to publication. Note that a majority of these private protocols do become public, with over 1,800 (67%) of protocols currently public. Maintaining a private workspace for grantees through protocols.io can be costly, ranging from $12,000 – $30,000 per year, depending on the tier and support provided to grantees. In addition, we cover fees associated with using the protocols.io **Protocol Entry Service**. Our grantees utilize the Protocol Entry Service an average of 139 times per year. Each entry costs $50, representing an average annual cost of $6,900 (*Table 1*).

Year	# protocols	Annual Cost
2021	151	$7,550
2022	134	$6,700
2023	131	$6,550
2024	199	$9,950
2025	78	$3,900
Total	693	$34,650
Average	138.6 ± 43.45	$6,930 ± $2,172.73

Table 1. Costs associated with Protocol Entry Service. *The Protocol Entry Service formats, edits, and publishes protocols to protocols.io on behalf of grantees. Each entry is $50. All amounts are listed in USD and averages are reported as mean ± SD.*

Lab Materials

Barriers Associated With Sharing Lab Materials

There are a couple of considerations for funders to be mindful of when requiring grantees to register and/or deposit lab materials. The time it takes to deposit lab materials at a repository is a major barrier to implementing this policy, particularly when it comes to deposition by time of publication. The time to deposit a new lab material ranges from 6 – 24 months to finalize agreements, import material, perform quality control, and prepare for distribution (*Table 2*). There are often delays related to communicating with the Tech Transfer Office of the depositing investigator's institution or missing information. Therefore, in order to ensure that a lab material is registered and deposited by time of publication, investigators should start the deposition process at the pre-publication stage.

There are also several legal and ethical considerations when implementing a policy requiring lab materials to be deposited and/or registered. A detailed history of source material (i.e., background, original creator, mutations, transfer agreements, and previous crosses) used to generate lab materials is required to protect the intellectual property (IP) rights of the investigator and institution of material origin. This is often overlooked and can delay or prohibit deposition or registration of lab materials for sharing with the wider research community. Other considerations include confirming proper consent for the generation and sharing of human-derived cell lines, Material Transfer Agreements (MTA) that allow deposition and registration of materials by institutions beyond the original one, and licensing barriers for non-profit and for-profit organizations. We have found that having a Tools Program dedicated to walking grantees through this process is essential for funders who would require that lab materials be made commercially available as part of their open science policy.

Addressing these barriers requires education and may involve strategic investment from funders to support deposition and registration of lab materials.

Tool	Information to Provide	Material to Ship	Covered Activities	Timeline
Rodent	• Mutation(s) and transgene(s) • Genetic background • Phenotype • Genotyping assay • Associated publications	1 mouse	• Shipping and transport • Line rederivation • Cryopreservation • Colony generation • Product page • Maintenance as a live colony for 1 year	6-9 months
Induced pluripotent stem cells (iPSC)	• Mutation(s) • Genetic background • Phenotype • Quality control • Associated publications	12 vials of cells	• Shipping • Storage • Line expansion • Cryopreservation • Product page • Maintenance	3-6 months
Plasmids	• Vector maps and components	15 uL DNA or bacterial streaks	• Prepaid shipping envelope, small boxes, and barcode labels	1-3 months

Table 2. Activities and timelines associated with lab material deposition. *The Michael J. Fox Foundation for Parkinson's Research (MJFF) Research Tools Program assists grantees with deposition of newly-generated lab materials, including rodent models, iPSCs, and plasmids. The Tools Program does not currently support deposition of antibodies. The timeline column encompasses the "covered activities;" however, time to distribution may take up to 24 months to finalize legal agreements.*

Costs Associated With Sharing Lab Materials

Registration of newly-generated lab materials can be done at no cost through resource information networks and databases, such as **RRID Portal**, **Cellosaurus**, and **MGI**. Deposition is ideal compared to registration since it also allows the Contract Research Organization (CRO) to manage orders and maintain quality for distribution. However, supporting deposition of lab materials can be very costly, ranging from $0 – $20,000 per tool. ASAP has partnered with **The Michael J. Fox Foundation for Parkinson's Research (MJFF) Research Tools Program** to help facilitate and oversee this process. Although running a Tools Program represents a further financial investment in addition to the costs associated with deposition itself, grantees benefit from utilizing the Tools Program to provide support and guidance during the deposition process.

REQUIREMENT 2:

Identify Research Inputs

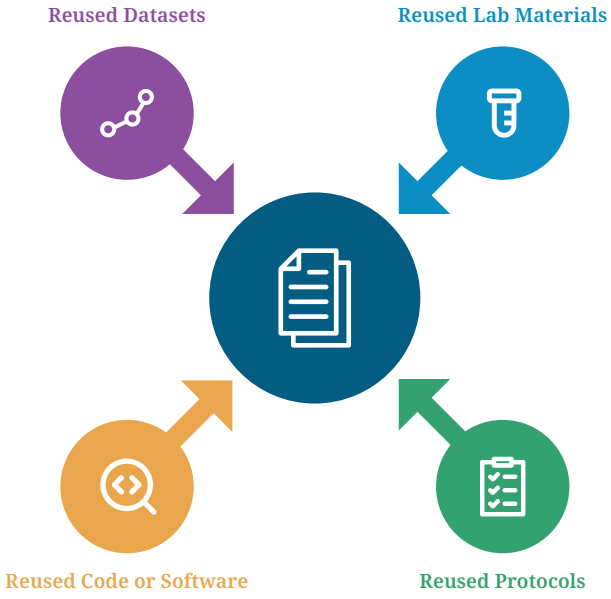
Barriers Associated With Identifying Research Inputs

Costs Associated With Identifying Research Inputs

ASAP defines **research inputs** as any data, protocols, code and software, or key lab materials that are *not* generated in a manuscript (i.e., inputs are re-used outputs from previous work).[6,7] Unambiguously identifying research inputs, particularly protocols, software, and lab materials, has been shown to be critical for replicability and reproducibility of science.[30–33] Journals have taken note of the need for transparency when it comes to the sharing of lab materials, with several (e.g., Cell Press and eLife) requiring or encouraging the inclusion of Key Resource Tables in publications, which detail lab materials used in a study and their associated persistent identifiers.[34,35]

The **ASAP Open Science Policy** requires that all data, software, protocols, and key lab materials used in a study — but which were not generated as part of an ASAP-funded study — are unambiguously identified in the study's publication.

Research Inputs



Barriers Associated With Identifying Research Inputs

From the funder's perspective, there are a few barriers to the implementation of an open science policy requiring the identification of research inputs with persistent identifiers. The primary barrier to implementation is a lack of education from grantees about what should be shared. For example, many grantees share catalog numbers, however, this is not sufficient to uniquely identify the material, as vendors may merge, and catalog numbers can change.[31] We have found that requiring Key Resource Tables (KRT; see the **ASAP Open Science Guides** for a template) in a manuscript is a useful tool to facilitate the sharing of research inputs and specifying the precise type of information grantees are being asked to share.

Costs Associated With Identifying Research Inputs

Requirements to share research inputs do not have any associated funder costs. Grantees can use platforms like **RRID Portal** for free to search for persistent identifiers associated with plasmids, cell lines, antibodies, organisms, and software tools.

REQUIREMENT 3:

Ensure Immediate Open Access

Preprints

Publications

Following the Budapest Open Access Initiative (BOAI) declaration in the early 2000s, open access mandates have been implemented by funders in many countries.[4,36–39] Although open access is not yet the default publishing model, the number of scientific publications available via open access has grown since open access mandates first began, and some subscription journals are transitioning to open access models.[40–42] Researchers are also taking advantage of preprints, with submissions to the preprint server bioRxiv steadily increasing since its inception in 2013.[43,44]

The **ASAP Open Science Policy** requires preprints to be posted to a preprint repository no later than the date a manuscript is submitted to a journal for review. Publications must be immediately publicly available with no embargo. Additionally, both preprints and publications must be licensed for reuse with a CC BY 4.0 or CC0 license.

Preprints

Barriers Associated With Preprint Deposition

From a funder's perspective, the primary barrier to implementing a preprint policy is addressing concerns from grantees about spreading misinformation or low-quality science, and the potential for authors to be "scooped."[45–47] Despite these concerns, the majority of papers posted to the preprint servers **bioRxiv** and **medRxiv** are subsequently published in a peer-reviewed journal with no significant differences in the content and experimental results between the preprint and publication.[43,48–50] Additionally, the majority of preprint authors (99.3%) report no problems with scooping.[48,51–53] Preprints provide date-stamped priority claims and establish intellectual precedence, with some journals even offering scoop protection policies that honor priority claims of preprints.[53–55]

Addressing this barrier requires concerted effort from stakeholders across the research community, including funders, to foster a culture of sharing research early and often.

Costs Associated With Preprint Deposition

Requirements to post preprints to a preprint server do not have any associated funder costs. Posting a preprint is free via a number of preprint servers such as **arXiv**, **bioRxiv**, and **medRxiv**. Funders can create a **channel**, a curated collection of preprints from bioRxiv and medRxiv that share the subject area of a particular organization (e.g., ***Aligning Science Across Parkinson's***) on bioRxiv for no cost. However, the funder is responsible for curation of these channels, by either manually entering each preprint associated with their channel or by submitting a list of preprint DOIs, which represents a small associated labor cost. A new bioRxiv feature now allows select channels to auto-populate based on funder metadata.

Publications

Barriers Associated With Open Access Publications

From a funder's perspective, there are two ways to approach an open access publication requirement:

1. Funders may choose to **provide coverage of article processing charges** (APCs) for publishing in gold or hybrid open access journals, or
2. Funders may choose to **promote the "green route"** whereby the "author accepted manuscript" is deposited to a community-accepted repository (e.g., self-archiving).

Should a funder elect to pay for APCs, they should be aware that this route requires funders to establish a standardized workflow for processing payments. Using automation and/or collaborating with publishers for invoice payment can reduce administrative burden. Additionally, education of grantees about publishing open access, especially with regard to open access licenses, is needed. We have found that many journals treat review articles differently than original research articles, such that a journal that appears to be open access through the **Open Policy Finder** may not be for review articles. This results in review articles being hidden behind a paywall and requires effort on the part of the author to share the review via the green route after an embargo period. Education and clear guidelines for grantees on how to approach review articles are needed.

Costs Associated With Open Access Publications

If funders choose to pay APCs to ensure publications are open access via gold or hybrid journals, costs can vary widely, with higher impact journals typically charging the highest APCs (*Figure 2*). These costs can be offset if organizations or institutions have memberships with publishers to provide authors with discounted or waived APCs. Additionally, some open access journals offer fee waivers or discounts for authors from low-income countries, students, early-career researchers, or others who may have difficulty covering full publication costs.

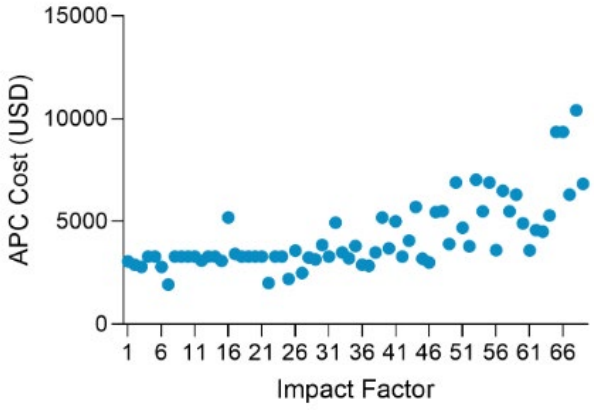


Figure 2. Association of journal impact factor and article processing charge (APC) costs. *APCs and impact factors for the most common journals for ASAP publications. Journals with the highest impact factor have the highest APCs. All amounts are listed in USD.*

In order to facilitate open access publishing, we offer APC coverage for ASAP-funded publications in addition to the grantee research budget. The number of publications for which we have covered APCs has grown since 2021 (*Table 3*). On average, we spend $4,900 per publication, investing over $800,000 since 2021 (*Table 3*).

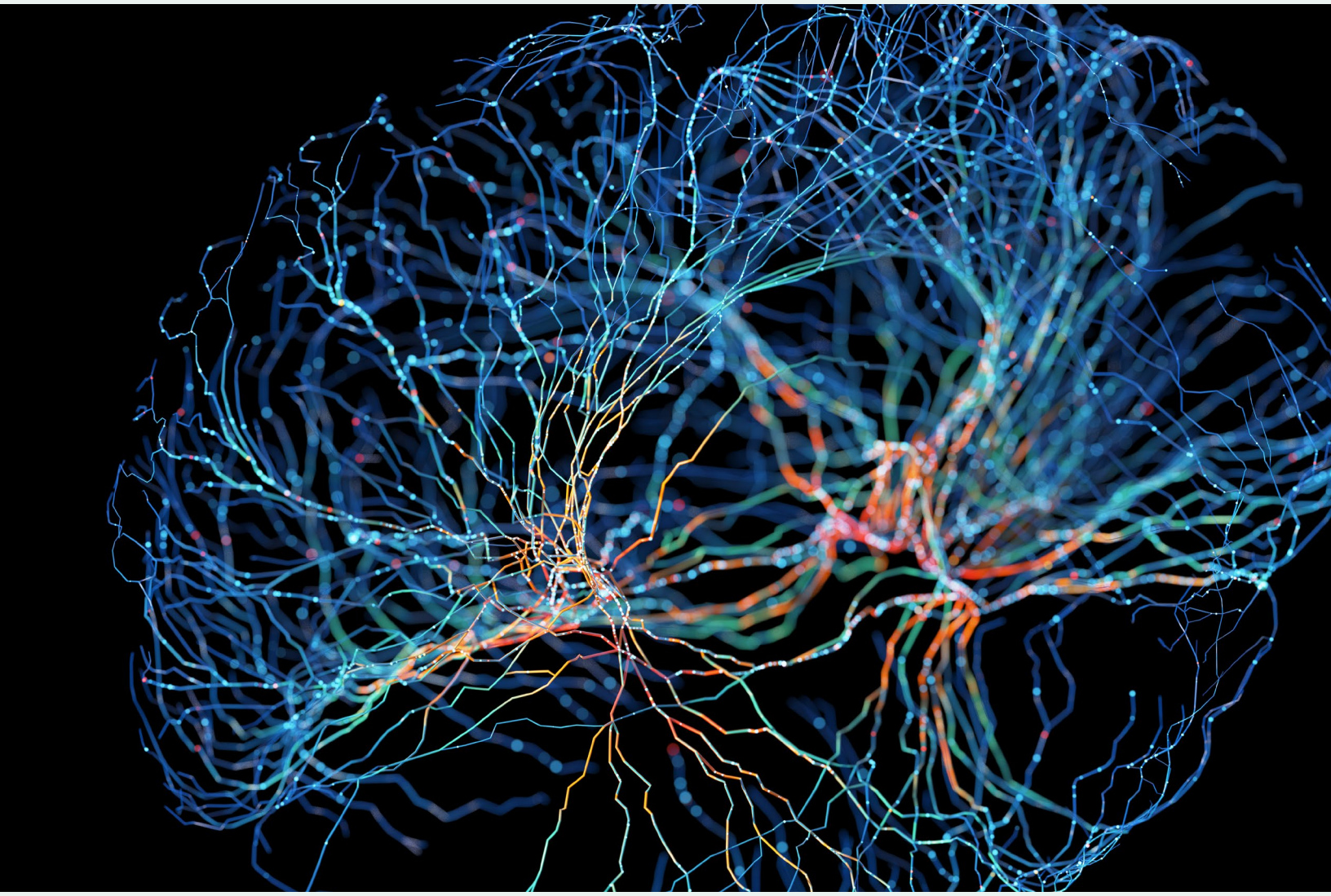
Year	# Publications Covered	Average APC Cost	Total APC Cost
2021	7	**$3,496.14 ± $1,253.83**	**$24,473.00**
2022	40	**$4,120.98 ± $1,564.97**	**$164,839.00**
2023	40	**$5,399.36 ± $3,455.16**	**$215,974.38**
2024	54	**$4,901.41 ± $2,491.93**	**$264,676.64**
2025	23	**$6,286.20 ± $43,463.95**	**$144,582.64**
All Years	164	**$4,966.74 ± $2,774.93**	**$814,545.66**

Table 3. Article processing charge expenditures associated with the ASAP Open Science Policy. *APCs paid for ASAP-funded publications were tracked over time. All amounts are listed in USD and averages are reported as mean ± SD.*

Funding APC coverage is a strategic investment we have undertaken in our commitment towards advancing open science and increasing adoption of our policy by grantees. We have paid APCs for about 47% (164/349) of all ASAP-funded publications as of November 2025. In the early days of the program, we paid APCs for all ASAP-funded manuscripts to ensure open access. However, in 2023, we began applying stricter eligibility criteria, requiring that manuscripts must be fully compliant with the **ASAP Open Science Policy** to be eligible for APC coverage. This policy change has further incentivized grantees to adhere to the ASAP Open Science Policy. However, this policy change also requires extensive compliance checks by ASAP staff to ensure the final publication is compliant.

While providing APC coverage offers many benefits, APC costs continue to rise, therefore, offering this coverage involves a substantial financial commitment on the part of the funder.[56–58] Funders may choose to require self-archiving in place of publishing in open access journals. This method has a financial advantage, but funders should know that if a manuscript is published under an embargo period, self-archiving cannot happen until after the embargo is lifted, and some journals do not permit authors to self-archive.[59,60] However, new policies are changing the conversation surrounding self-archiving.[61] Publishing in platinum or diamond journals is another APC-free publishing pathway; however, only 4.3% of diamond journals are compliant with the coalitionS PlanS Open Science Standards, an initiative committed to full and immediate open access publishing.[62] This suggests that these journals are not yet an ideal route for publishing open access, but as they grow and receive more support, diamond journals could become a viable option for free open access publishing.[63–65]

Some funders are approaching open access publishing in yet another way, by choosing to require only preprint deposition as a part of their open science policy, entirely bypassing the costs and politics associated with the publishing world. For example, the Gates Foundation made waves when they announced the launch of their own preprint server for Gates Foundation grantees, **VeriXiv**, in collaboration with F1000.[66] Beginning in 2025, the Gates Foundation now requires preprint deposition and will no longer pay APCs for publications.[67] Recently, the NIH announced an intent to establish new policies to reduce publishing costs and issued a Request for Information. In response, ASAP highlighted the effectiveness of our monitored preprint policy: 98% of ASAP-funded studies published between January 1, 2024, and April 30, 2025 had an associated preprint.[68,69] Preprints were posted a median of four days before submission to the journal in which they were eventually published, and eight months before they were published in a journal.[70]



REQUIREMENT 4:

Acknowledge Funding

Barriers Associated With Funding Acknowledgments

Costs Associated With Funding Acknowledgments

Acknowledgment of funding sources enhances the research process by ensuring transparency and mitigating conflicts of interest.[71] From a funder's perspective, requiring funding acknowledgments is important for tracking the number of research publication outputs associated with a funder, as well as for assessing impact and tracking collaboration.[71,72]

The **ASAP Open Science Policy** requires that manuscripts and other research outputs that were partially or fully funded by ASAP must acknowledge ASAP. In addition, all ASAP-affiliated authors must share their ORCID and include ASAP as an affiliation.

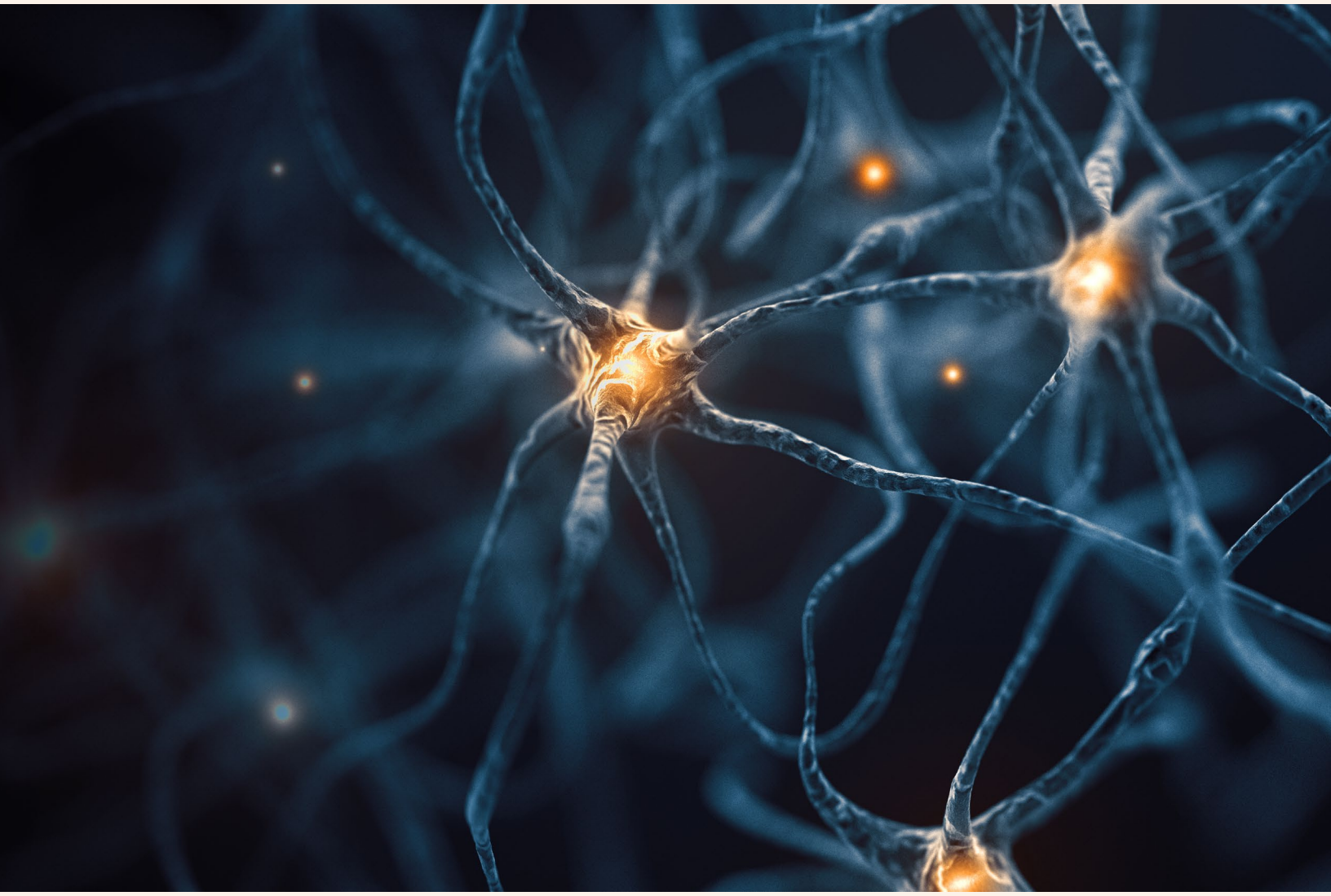
Barriers Associated With Funding Acknowledgments

When implementing a funding acknowledgment as part of an open science policy, funders should recognize that there may be confusion from grantees about what to include in a funding acknowledgment and when to include an acknowledgment.[71] In order to facilitate compliance with this policy, we provide boilerplate text for grantees to use in their funding acknowledgment and affiliation. We also provide resources for grantees that explain how to determine if their manuscript should be considered ASAP-funded or not, and provide staff support to determine this as well. Although the requirement to acknowledge funding in preprints and publications is relatively easy for grantees to comply with, grantees are less likely to include funding acknowledgments in their research outputs, such as a dataset or protocol. Education and training can help improve compliance with this aspect of the policy.

Finally, if requiring funding acknowledgments, funders will need to ensure they have a research organization identifier from the **Research Organization Registry** (ROR), as most repositories and publishing platforms use the ROR to provide dropdown options for their users to select the funding agencies to be acknowledged.

Costs Associated With Funding Acknowledgments

Requirements to include funding acknowledgments do not have any associated funder costs.



REQUIREMENT 5:

Share Outputs With ASAP Network

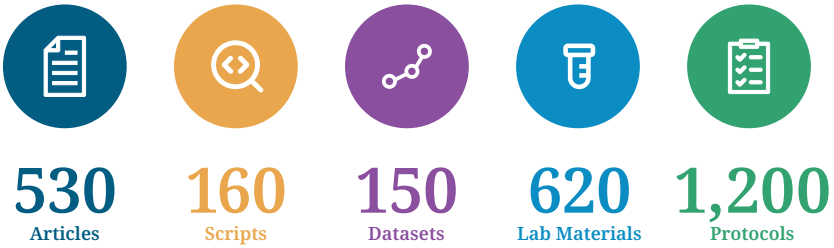
Barriers Associated With a Within-Network Sharing Policy

Costs Associated With a Within-Network Sharing Policy

In an effort to encourage knowledge and resource sharing, ASAP collaborated with **YLD**, a software engineering and design consultancy group, to create the ASAP Collaborative Research Network (CRN) and Global Parkinson's Genetics Program (GP2) Hubs, private, virtual platforms for grantees. The Hubs provide grantees with a research output management system, a space to share their research outputs and findings with the larger ASAP network even earlier than a preprint would allow, further accelerating discovery and increasing collaboration.

The **ASAP Open Science Policy** requires that all ASAP-funded research outputs, including manuscripts, be shared on the ASAP CRN Hub no later than the time of publication. While sharing research outputs on the Hub provides an avenue for grantees to learn more about available resources, it also acts as a source for sharing ASAP-funded outputs with the scientific community at large. Any research output on the Hub that is both ASAP-funded and public is also added to our publicly available **ASAP Catalog** via an automated API between the two platforms. As of November 2025, the external ASAP Catalog showcased over 530 articles, 160 scripts, 150 datasets, 620 lab materials, and 1,200 protocols.

ASAP Catalog Outputs as of November 2025

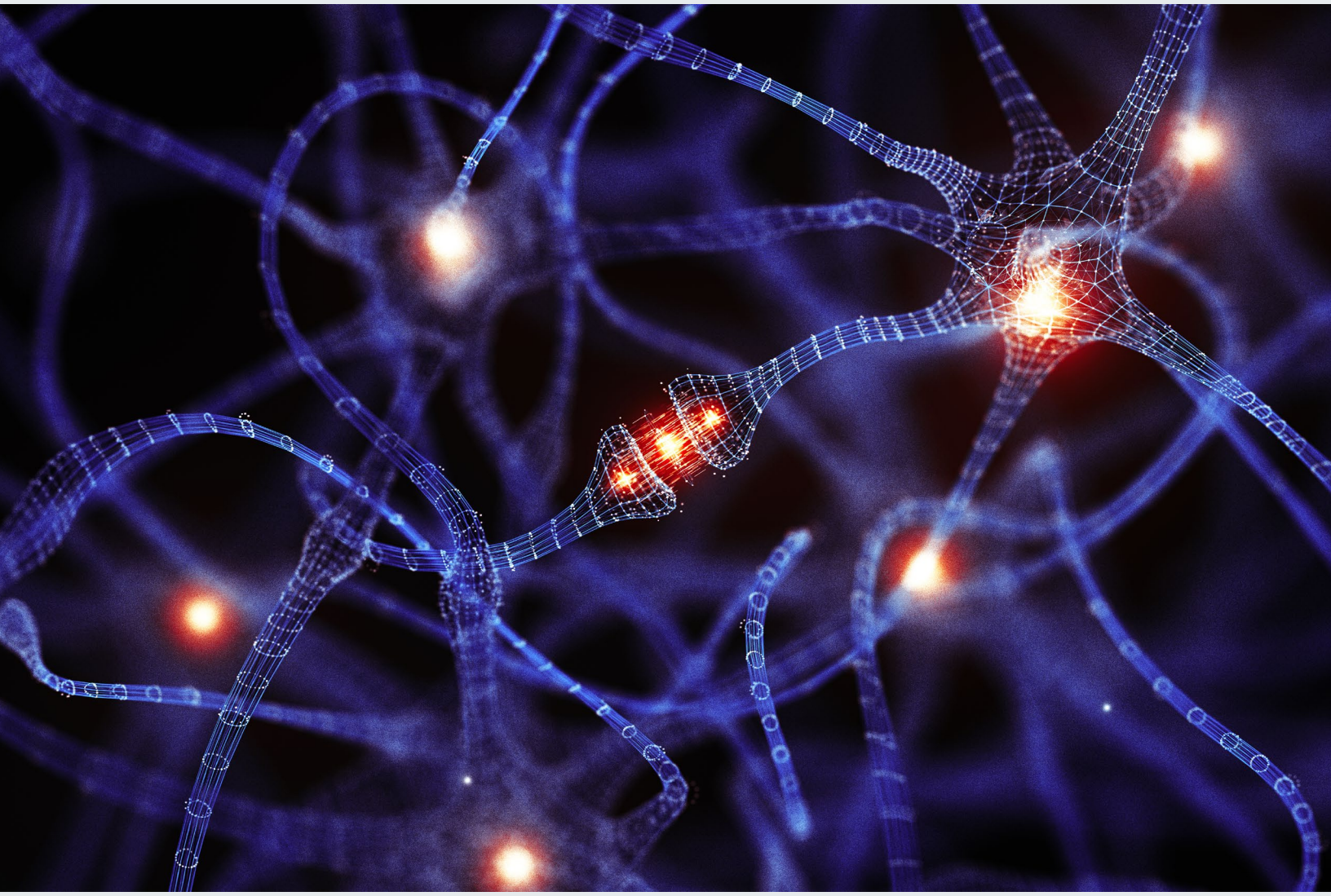


Barriers Associated With a Within-Network Sharing Policy

One of the primary barriers to implementing a within-network sharing policy is generating buy-in and motivating grantees to share their outputs on the Hub by the time of publication. While some grantees regularly share their outputs on the Hub, others wait until annual progress reports are due, a time when they know that ASAP leadership is assessing their team's progress. In an effort to assist grantees, we have recently started reminding grantees of this requirement and provide a list of research outputs that have been identified in manuscripts and need to be added to the Hub as a gentle reminder to grantees about our policy.

Costs Associated With a Within-Network Sharing Policy

Creation of a virtual grantee platform could be accomplished using free, online tools like **Notion**, where the investment may be in the thousands for additional add-on features. Funders may also choose to develop their own custom platform, which could cost up to millions of dollars for development and maintenance. The use of a virtual grantee platform is not necessary in order to implement an open science policy; however, it can provide benefits to the grantees and provide an important means of tracking grant-related outputs.



Lessons Learned

Policy Enforcement

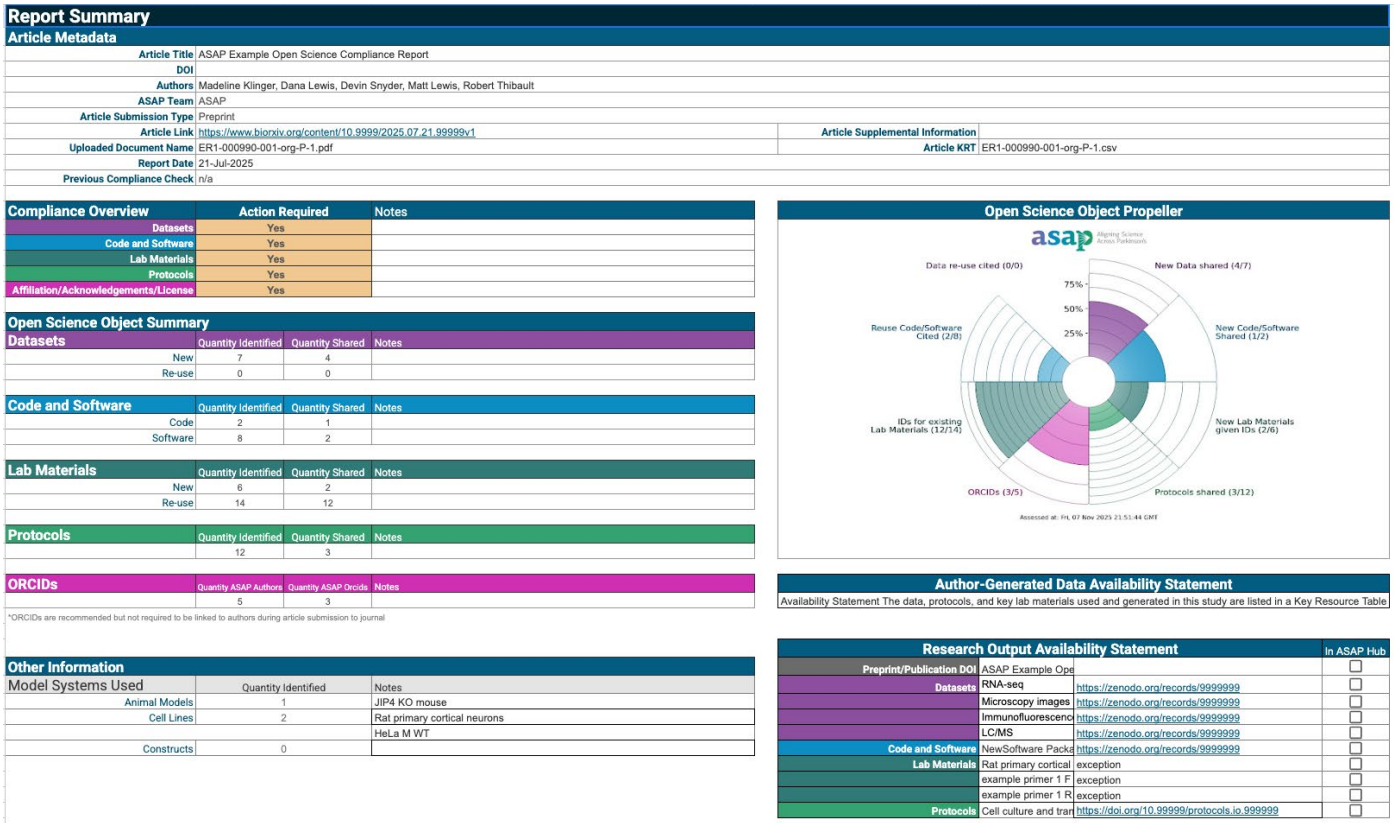
Incentivization and Education

Project Managers

The ASAP initiative has yielded many lessons learned with regard to the implementation of and costs associated with an open science policy so far. Importantly, we have found that policy enforcement, education and training, and utilization of ASAP-funded project managers are key to the successful implementation of a progressive open science policy.

Policy Enforcement

The **ASAP Open Science Policy** consists of five overarching requirements, with which every ASAP-funded manuscript must comply. To ensure compliance, the ASAP Open Science Policy requires that manuscript drafts be shared with the ASAP Open Science Team no later than the time of posting a preprint to undergo a comprehensive review process. We partner with **DataSeer**, which uses artificial intelligence and natural language processing to catalog research inputs and outputs into compliance reports. DataSeer generates a compliance report for every ASAP-funded manuscript, which is subsequently reviewed by the ASAP Open Science Team and shared with authors (*Figure 3*).



Report Summary

Article Metadata

Article Title	ASAP Example Open Science Compliance Report
DOI	
Authors	Madeline Klinger, Dana Lewis, Devin Snyder, Matt Lewis, Robert Thibault
ASAP Team	ASAP
Article Submission Type	Preprint
Article Link	https://www.biorxiv.org/content/10.9999/2025.07.21.99999v1
Article Supplemental Information	
Uploaded Document Name	ER1-000990-001-org-P-1.pdf
Article KRT	ER1-000990-001-org-P-1.csv
Report Date	21-Jul-2025
Previous Compliance Check	n/a

Compliance Overview	Action Required	Notes
Datasets	Yes	
Code and Software	Yes	
Lab Materials	Yes	
Protocols	Yes	
Affiliation/Acknowledgements/License	Yes	

Open Science Object Summary

Datasets	Quantity Identified	Quantity Shared	Notes
New	7	4	
Re-use	0	0	

Code and Software	Quantity Identified	Quantity Shared	Notes
Code	2	1	
Software	8	2	

Lab Materials	Quantity Identified	Quantity Shared	Notes
New	6	2	
Re-use	14	12	

Protocols	Quantity Identified	Quantity Shared	Notes
	12	3	

ORCIDs	Quantity ASAP Authors	Quantity ASAP Orcids	Notes
	5	3	

*ORCIDs are recommended but not required to be linked to authors during article submission to journal

Other Information

Model Systems Used	Quantity Identified	Notes
Animal Models	1	JIP4 KO mouse
Cell Lines	2	Rat primary cortical neurons
		HeLa M WT
Constructs	0	

Open Science Object Propeller

Author-Generated Data Availability Statement

Availability Statement The data, protocols, and key lab materials used and generated in this study are listed in a Key Resource Table

Research Output Availability Statement			In ASAP Hub
Preprint/Publication DOI	ASAP Example Ope		☐
Datasets	RNA-seq	https://zenodo.org/records/9999999	☐
	Microscopy images	https://zenodo.org/records/9999999	☐
	Immunofluorescenc	https://zenodo.org/records/9999999	☐
	LC/MS	https://zenodo.org/records/9999999	☐
Code and Software	NewSoftware Packa	https://zenodo.org/records/9999999	☐
Lab Materials	Rat primary cortical	exception	☐
	example primer 1 F	exception	☐
	example primer 1 R	exception	☐
Protocols	Cell culture and tran	https://doi.org/10.99999/protocols.io.999999	☐

Figure 3. Example summary page of a deidentified ASAP compliance report. *DataSeer generates compliance reports in Google sheets that provide an itemized list of all research outputs and inputs, if and how they are shared, and what still needs to be shared. The compliance report also provides information to grantees about licensing, ORCIDs and affiliations, and whether or not research outputs have been shared on the CRN Hub.*

This partnership with DataSeer represents a large annual expenditure. However, it is a strategic investment towards ensuring the enforcement of the ASAP Open Science Policy. Additionally, enforcement requires a team of scientists who can evaluate manuscripts and/or DataSeer compliance reports for openness and accuracy, which represents a potentially substantial labor cost depending on the influx of manuscripts being reviewed. At the beginning of the ASAP grant period, there were no designated 100% full-time effort (FTE) employees for the open science workflow. As of November 2025, however, the ASAP Open Science Team has grown to three staff (1 x 100% FTE, 2 x 25% FTE). These labor costs are critical to ensure that our open science policy is upheld.

Additionally, in 2025, ASAP invested in the creation of an Open Science Compliance Submission System on the ASAP CRN Hub. The Compliance Submission System is a private area of the virtual Hub that allows grantees to submit their ASAP-funded manuscripts for compliance review to the Open Science Team, receive reports about those manuscripts, and discuss questions with the Open Science Team (*Figure 4*). The Compliance Submission System streamlines and centralizes the compliance review process, with all compliance reviews in one location with clear version history. The use of a Compliance Submission System is not necessary to implement an open science policy, and could be accomplished using email correspondence or free platforms. However, the use of a Compliance Submission System reduces staffing and labor costs and streamlines the review process for grantees.

Compliance Workflow

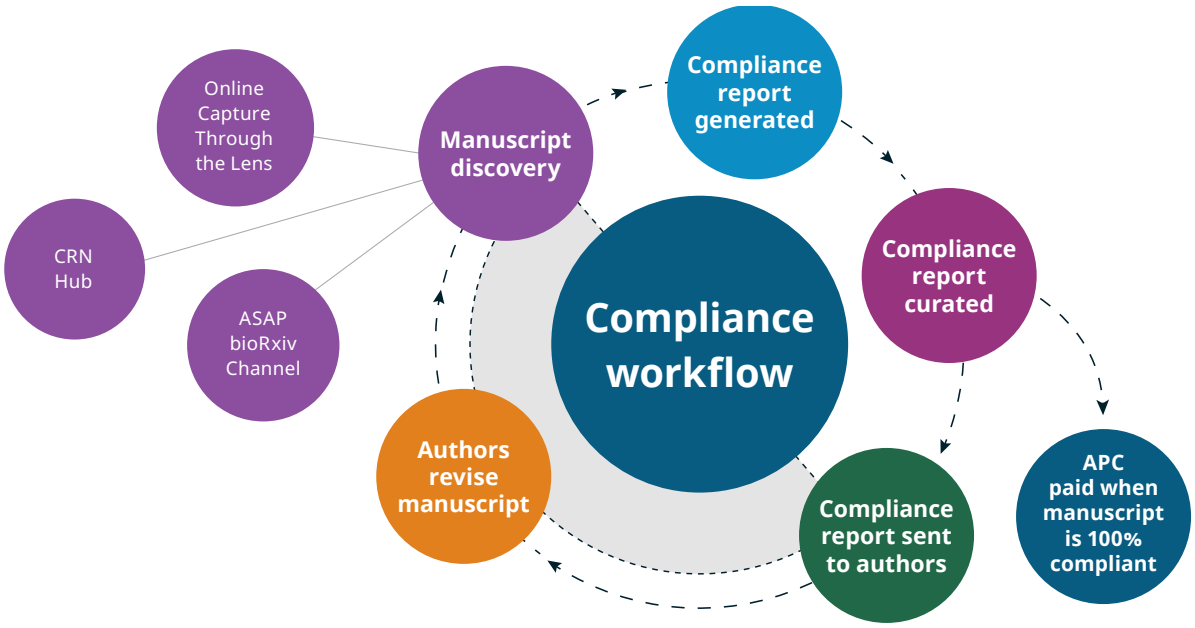


Figure 4. ASAP compliance workflow. *ASAP discovers manuscripts via the CRN Hub, the Lens, or the ASAP bioRxiv channel. Compliance reports are generated for these manuscripts, which are then curated by the ASAP Open Science Team and shared with authors. Authors revise the manuscript and this process continues until the manuscript is fully compliant with the ASAP Open Science Policy, at which point the manuscript is eligible for APC coverage.*

The compliance review process is critical for the enforcement of the ASAP Open Science Policy. An analysis of ASAP-funded studies published between January 1, 2024, and April 30, 2025, demonstrated the efficacy of the ASAP open science review process at increasing policy compliance.[70] Between the version of a manuscript first shared with the ASAP Open Science Team and the associated final publication, there were substantial increases in the deposition of newly-generated datasets (21% to 88%), unambiguous identification of reused datasets (72% to 86%), deposition of newly-generated code (15% to 72%), unambiguous identification of software used (35% to 79%), registration of newly generated key lab materials (22% to 78%), unambiguous identification of key lab materials used (44% to 87%), and deposition of newly generated protocols and unambiguous identification of existing protocols (35% to 81%; data on protocols was collapsed) (*Table 4*).

Resource Type	Publications With Resource	Resources Shared	Resources Used	Percent Shared	Increase in Sharing vs Manuscript Draft
Data, new	95	657	744	88%	**67%**
Data, reused	45	159	184	86%	**14%**
Code, new	64	109	152	72%	**57%**
Software, reused	102	942	1189	79%	**44%**
Lab Materials, new	36	190	245	78%	**56%**
Lab Materials, reused	92	1820	2091	87%	**43%**
Protocols, all	97	716	885	91%	**46%**

Table 4. Rates for the deposition of unambiguous identification of various research resources. *A cross-sectional study on articles supported by the ASAP CRN and published between January 1, 2024, and April 30, 2025 (N=102). Compliance was calculated as the number of a particular resource type that was deposited or unambiguously identified divided by the total instances of that resource type that could be deposited or unambiguously identified (i.e., the percentage shared). These data were collected as part of the ASAP Open Science Compliance Review workflow. Percentages are rounded to the nearest whole number. Additional information is available at [70]. Code and Data are available at [73].*

In addition to the compliance review process, funders should consider possible labor costs associated with tracking preprints and publications. ASAP becomes aware of preprints and publications through three main mechanisms: 1) a grantee has shared the manuscript with the ASAP Open Science Team via the Hub, 2) a preprint is automatically added to the ASAP bioRxiv channel when the author includes ASAP in the funder metadata field, or 3) we discover new publications through service(s) that use automated and manual searches of online databases to identify ASAP-funded publications (*Figure 4*). We previously used **OA.Report**, which cost around $10,000 annually, to capture ASAP-funded publications to be added to our tracking system. As of December 2024, we use **The Lens**, which is free to use.

Incentivization and Education

Incentivizing grantees to share research outputs and providing educational resources has been key to grantee compliance with the ASAP Open Science Policy. Grantees awarded ASAP funding agree to follow our open science requirements during the contracting phase. However, we recognize that proactively following the policy is not

trivial. So, we incentivize compliance by paying APCs and through recognition of outstanding efforts towards open science via the ASAP CRN **Open Science Champion** award.

In addition, current grantees are aware that if they apply for future funding opportunities, their past record of compliance with the ASAP Open Science Policy will be a factor in the funding decision. We provide feedback to grantees on how they are doing in regard to open science compliance on an annual basis. Additionally, we provide a variety of educational resources to grantees about open science, including a suite of **Open Science Guides** and an itemized **Policy Handbook**, available on Zenodo. The ASAP Open Science Team also provides open science consultation calls and private workshops to grantees. Project managers, part of ASAP grantee teams, receive additional training through an hour-long onboarding process that covers the policy requirements and the compliance review workflow. We also publish **blog posts** that share case studies and stories behind the requirements of the ASAP Open Science Policy, in an effort to generate buy-in for these practices.

Project Managers

The ASAP CRN requires that each research team hire a project manager as part of their awarded ASAP grant budget. Project managers are responsible for facilitating communication between labs and disseminating information from ASAP to their team about new guidance and updates to the ASAP Open Science Policy. Project managers play a key role in ensuring compliance with the ASAP Open Science Policy, providing guidance and expertise on where and how to share data, generation of key resource tables, writing and sharing of protocols, etc. Within the compliance workflow, project managers are tasked with sharing all team manuscripts with the ASAP Open Science Team and are responsible for keeping their team's outputs on the Hub up to date.

Conclusion

The ASAP initiative is committed to accelerating the pace of discovery in Parkinson's disease research through three foundational principles: supporting collaboration, generating research enabling resources, and data sharing. These principles are built upon a strong, comprehensive open science policy. The **ASAP Open Science Policy**, as described throughout this paper, has several key requirements, each of which has varying financial and labor costs. Here, we have outlined the benefits and costs associated with our policy so that other funding agencies can take these into consideration as they design their own open science policies. Overall, costs that a funder will incur while operationalizing and implementing an open science policy will vary depending on policy requirements respective to the funder (*Table 5*). When designing and implementing an open science policy, funders should consider which aspects align with their resources, budget, and capacity. Nevertheless, open science policies, whether fully comprehensive or selectively implemented, can foster greater transparency, collaboration, and accessibility in research, contributing to the advancement of scientific knowledge and accelerating the pace of discovery (*Figure 5*).

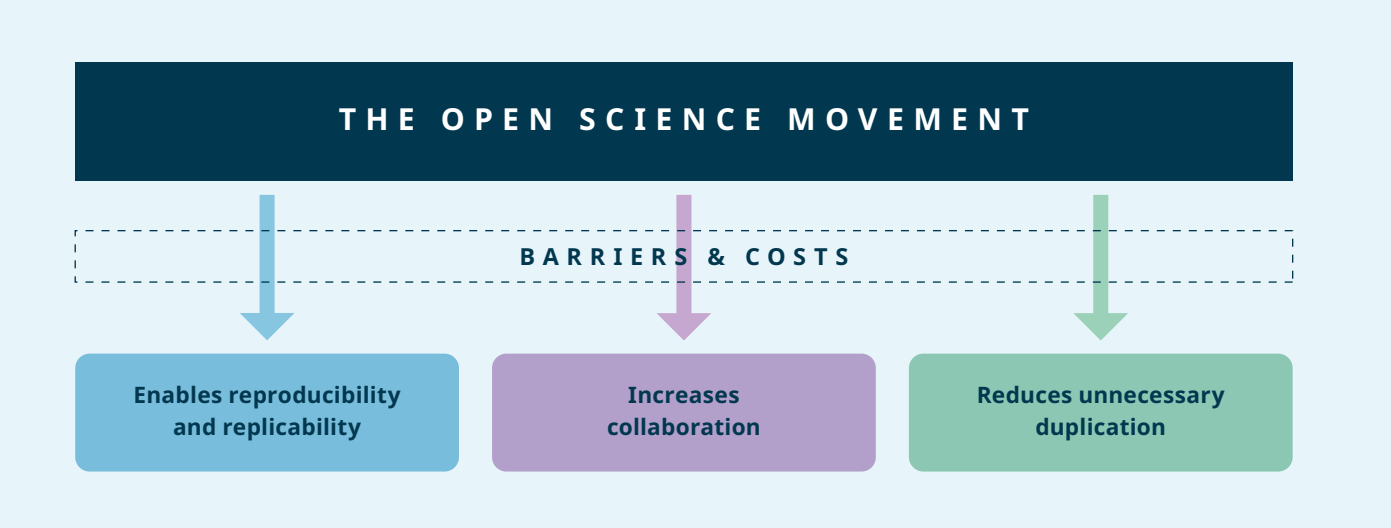
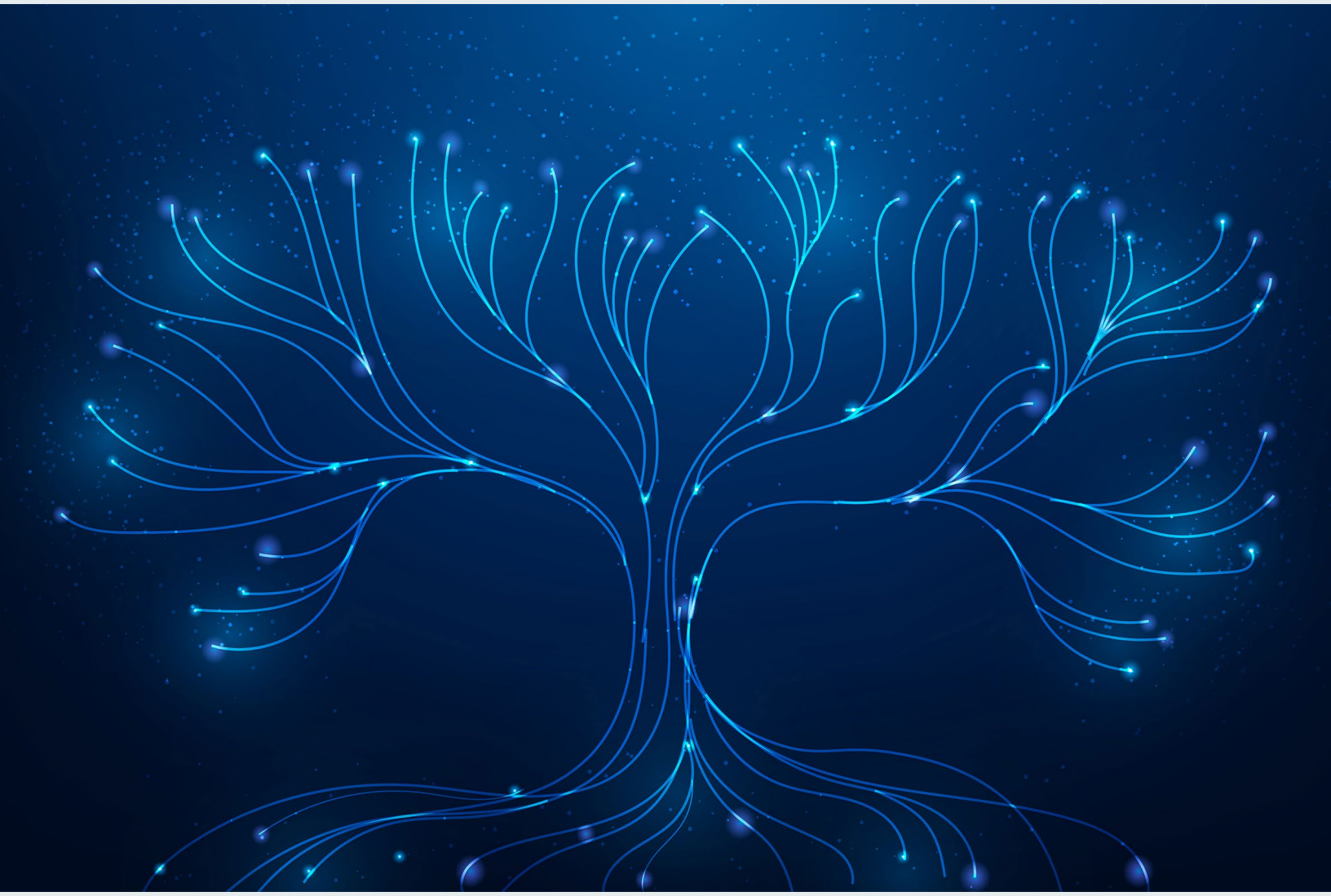


Figure 5. Implementing an open science policy. *Implementing an open science policy can reduce barriers to the goals of the open science movement. When designing an open science policy, funders should consider strategies to reduce barriers and costs to ensure these goals are met.*

Purpose	Tool	Annual Cost
Requirement 1: Share Research Outputs		
Data Sharing	Zenodo	Free *cost may be incurred if a deposited dataset is > 1TB
	Discipline-specific repositories (see Wiki)	Free
Code Sharing	GitHub	Free
Software Registration	RRID Portal	Free
Protocol Sharing	protocols.io	Free
	Protocol Entry Service	average $6,900
	Private protocols.io consortium	$12,000 – $30,000
Registration of Lab Materials	Addgene (plasmids)	Free
	Cellosaurus (cell lines)	Free
	MGI or RGD (rodent models) Access other animal model repositories	Free
	RRID Portal (antibodies)	Free
Deposition of Lab Materials	Addgene (plasmids)	Free
	Cell Lines	$2,000 – $10,000 per line
	Rodent Models	$12,000 – $20,000 per line
Requirement 2: Identify Research Inputs		
RRID Lookup	RRID Portal	Free
Requirement 3: Ensure Immediate Open Access		
Preprint Deposition	bioRxiv or medRxiv	Free
	bioRxiv channel	Free
Open Access Publication	Green route	Free
	APC Coverage	$4,900 average per publication
Requirement 4: Acknowledge Funding		
Funding Acknowledgement	Boilerplate text	Free
Requirement 5: Share Outputs With the ASAP Network		
Within Network Sharing	Virtual Hub	Cost varies
Policy Enforcement		
Compliance Review	DataSeer	$79,200 for up to 240 articles/year
	Staff	1.5 FTE
Manuscript Discovery	The Lens	Free

Table 5. Costs associated with implementing an open science policy. *This table outlines the estimated annual cost of implementing and enforcing each aspect of the ASAP Open Science Policy using repositories and resources recommended by ASAP. The table is broken down by each requirement of the policy. Note that the largest expenditure comes from supporting lab material deposition, covering article processing charges, and policy enforcement. Costs associated with lab material deposition vary based on Contract Research Organizations (CROs) and contract negotiations. All amounts are listed in USD.*



Appendix

ASAP Open Science Resources

ASAP has generated a number of resources for the public related to implementing an open science policy. This includes:

- **ASAP Open Science Guides**: The ASAP Open Science Guides, housed on Zenodo, are a suite of guides and resources generated by the ASAP Open Science Team to promote open science best practices.
- **ASAP Data Repository Wiki**: The ASAP Data Repository Wiki contains recommended repositories for the data types most commonly used by ASAP grantees, as well as a brief description of best practices for sharing that data type.
- **ASAP Open Science Policy Handbook**: The ASAP Open Science Policy Handbook, housed on Zenodo, provides fine-grained detail and unambiguous explanations of what ASAP expects from its grantees in the Collaborative Research Network (CRN) in terms of open science for their original research.

About Authors

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Dr. Dana E. Lewis is a Program Officer at Coalition for Aligning Science and serves as an ASAP Program Officer. She earned her PhD in Neuroscience from The George Washington University in the laboratory of Dr. Zayd Khaliq at the National Institute of Neurological Disorders and Stroke. Dr. Lewis completed her postdoctoral training at the Johns Hopkins University School of Medicine in the laboratory of Dr. Maya Opendak at the Kennedy Krieger Institute.

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Dr. Sonya Dumanis is the Executive Vice President of the Coalition for Aligning Science and serves as the ASAP Managing Director. Previously, Dr. Dumanis was the Vice President of Research and Innovation at the Epilepsy Foundation. Prior to joining the Epilepsy Foundation, she worked at the Milken Institute Center for Strategic Philanthropy, tasked with identifying key philanthropic opportunities poised to have a transformative impact on the state of research and developing research programs. Dr. Dumanis completed her postdoctoral training at both the Johns Hopkins University and the Max-Delbrück Center in Berlin, Germany. She earned her PhD in neuroscience from Georgetown University.

Robert Thibault, PhD

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Dr. Robert Thibault is an Open Science Consultant at the Coalition for Aligning Science, primarily working with the ASAP open science team. He completed postdoctoral training with leaders in the field of Open Science at the Meta-Research Innovation Center at Stanford University (METRICS) and the UK Reproducibility Network at the University of Bristol. Dr. Thibault aims to make scientific research more trustworthy, reproducible, open, and efficient. He earned a PhD in Cognitive Neuroscience from McGill University.

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Dr. Elisia Clark is a Senior Scientist at MJFF on the Preclinical Resources Team. In her role she helps identify field-enabling, high-quality research tools and reagents to help speed research, enable new discoveries, and support reproducibility. She earned her PhD in Systems Pharmacology and completed postdoctoral trainings in Biomedical Tissue Engineering and Molecular Biology at the University of Pennsylvania.

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About Us

Aligning Science Across Parkinson's

Aligning Science Across Parkinson's (ASAP) is a global research initiative devoted to accelerating the pace of discovery for Parkinson's disease research through collaboration, research-enabling resources, and data sharing. ASAP is managed by the Coalition for Aligning Science and is working with The Michael J. Fox Foundation for Parkinson's Research to implement its programs. ASAP builds on the significant strides made by the research community, funders, other experts, and strategists around the world. With input across sectors and disciplines, we've developed a strategic roadmap to collectively tackle field-wide challenges together. To learn more, visit **www.parkinsonsroadmap.org**.

Coalition for Aligning Science

The Coalition for Aligning Science (CAS) designs and implements programs to address unmet needs across biomedical research. Dr. Ekemini Riley led the development and launch of the ASAP initiative while at the Milken Institute and has since continued ASAP program leadership and management under the auspices of CAS. ASAP is the largest initiative currently under management; however, the CAS portfolio extends to other neurological conditions, wastewater-based epidemiology, and more. To learn more, visit **www.aligningscience.com**.

The Michael J. Fox Foundation for Parkinson's Research

The Michael J. Fox Foundation for Parkinson's Research (MJFF) is a nonprofit dedicated to finding a cure for Parkinson's disease through funded research and ensuring the development of improved therapies for those living with Parkinson's today. MJFF is the implementation partner for the ASAP initiative and has been involved since the initiative's inception. ASAP leverages the MJFF grantmaking infrastructure and staff to coordinate and manage resource acquisitions and data sharing. To learn more about MJFF, visit **www.michaeljfox.org**; and to learn more about MJFF's role in ASAP, visit **www.michaeljfox.org/asap**.

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