



NFDI4
BIOIMAGE

From Microscope to Repository: Managing Image Data with OMERO

SFB 1551 Data Week

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What you will learn

- NFDI4BIOIMAGE: Who we are and what we offer
- Basic Research data management (RDM) for image data
- Image storage and organisation with OMERO
- Publishing image data: how and where

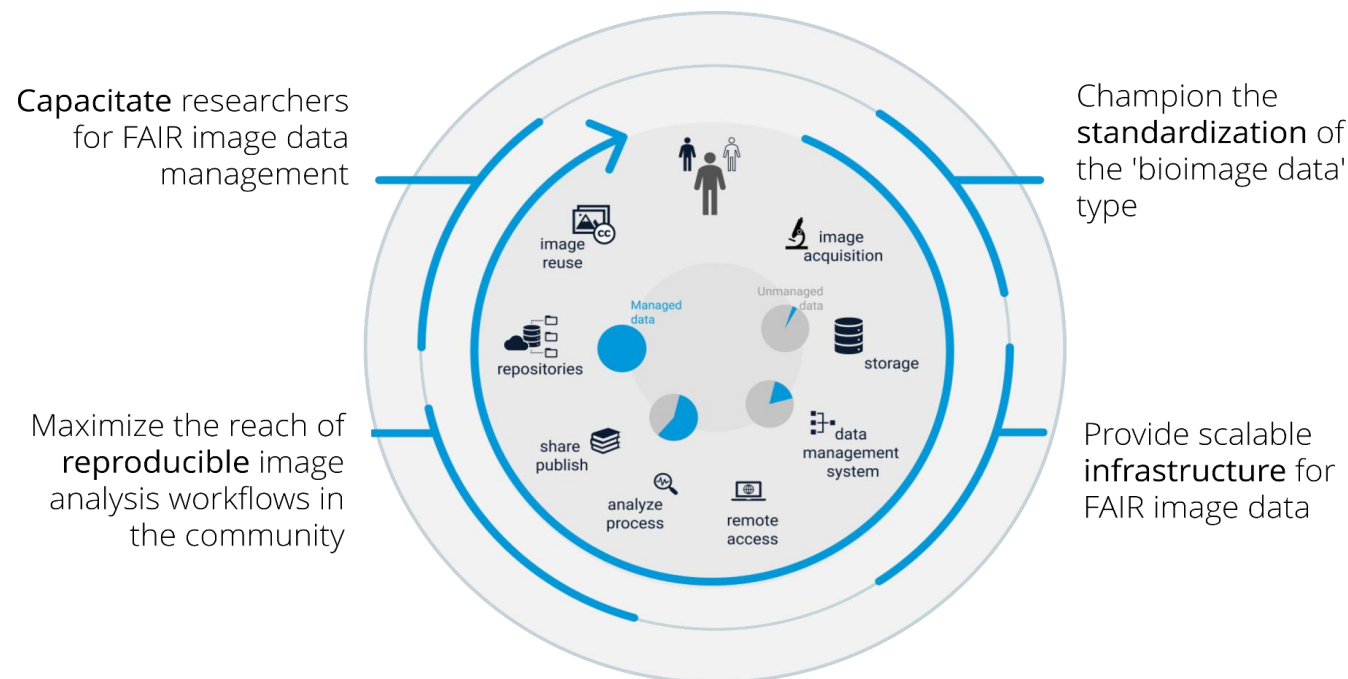


Introduction NFDI4Bioimage

NFDI → **N**ationale **F**orschungs**D**aten**I**nfrastruktur is a Germany-wide initiative that

- systematically organizes,
- preserves,
- and makes research data accessible across disciplines

NFDI4Bioimage → **N**ationale **F**orschungs**D**aten**I**nfrastruktur für Bioimaging



Introduction NFDI4Bioimage



- **Support** the bio-imaging community in RDM topics via our [helpdesk service](#) or direct contact
- **Guide** data handling, metadata annotations, data upload to community repositories (such as BioImage Archive, Image Data Resources and others)
- **Develop** tools and workflows for the community
- **Connect** to experts in the consortium and beyond
- **Share** training materials and offer trainings

reach us with questions and feedback via
helpdesk@nfdi4bioimage.de or forum.image.sc



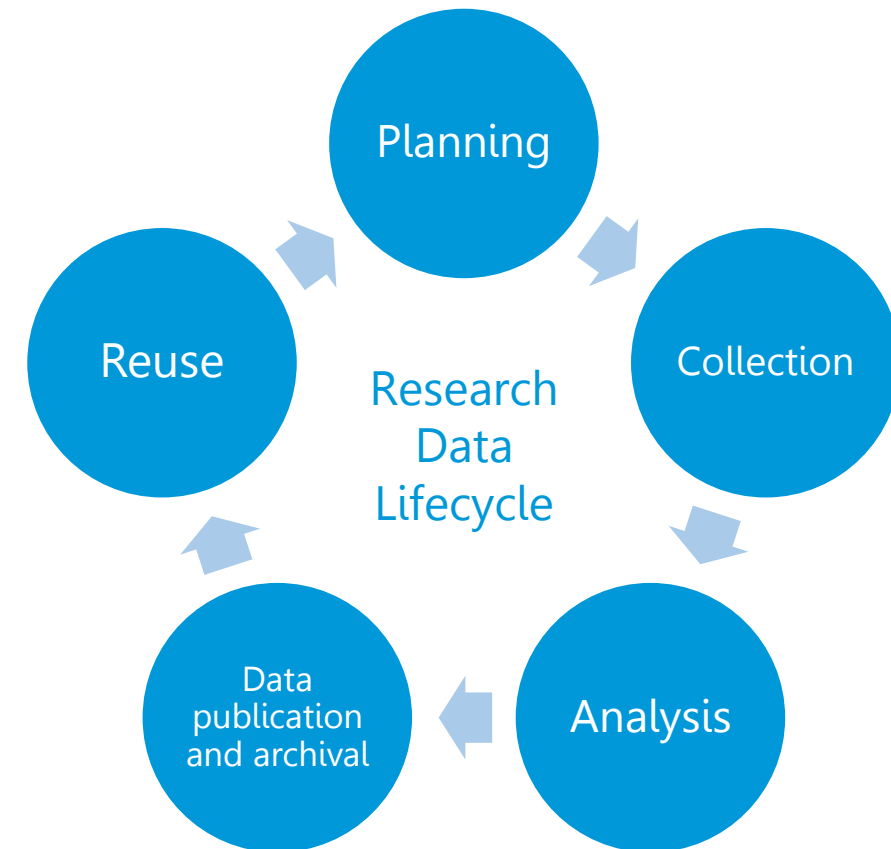


Research data management (RDM)

...is about the process of:

- Handling
- Organizing
- Storing
- Preserving
- Sharing

...research data throughout its lifecycle





Why RDM?

- Basic prerequisite for good scientific practice
- Credibility, traceability of own research by third parties
- Reproducibility of research results
- Compliance with the requirements of research funders and publishers
- Minimising the risk of data loss
- Simplifying future reuse and ensuring long-term interpretability of data
- Supporting open science, enabling new findings, meta-analyses and collaborations

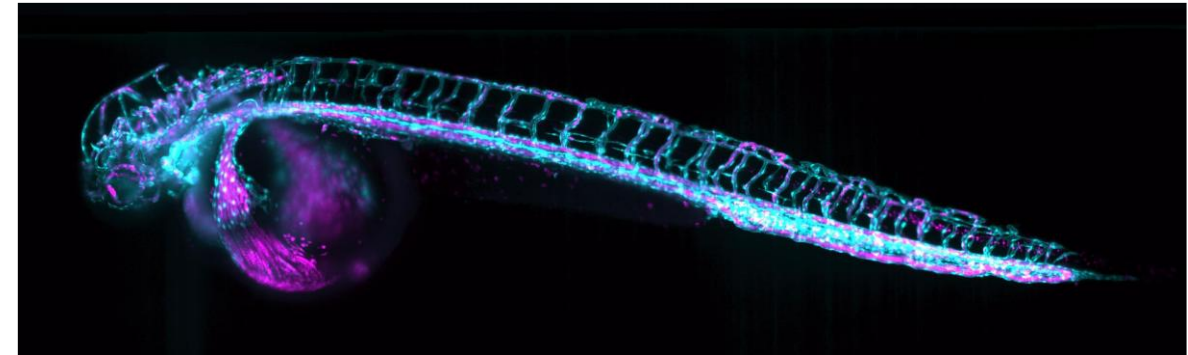


The bioimage data type

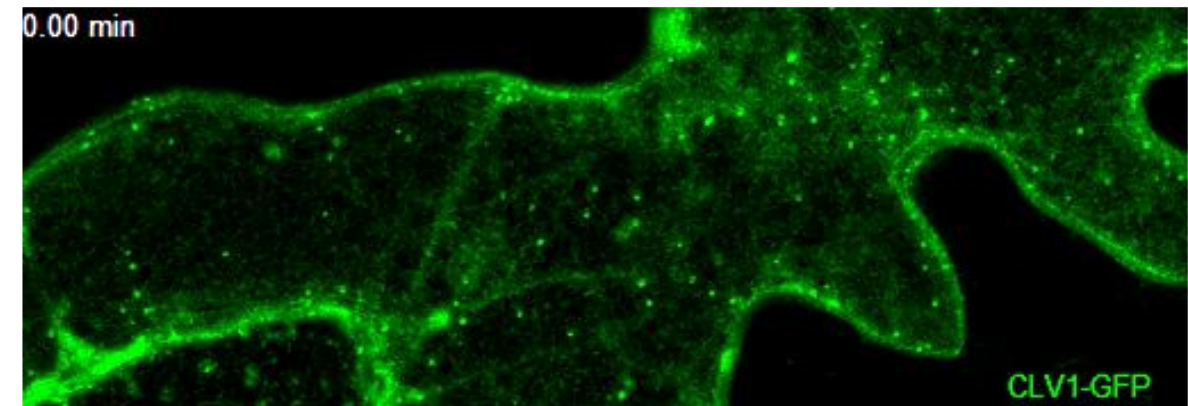
Microscopy data is (often):

- high-dimensional (X, Y, Z, Channel, Time, ...)
- saved in proprietary file formats
- of large file size
(often in GB-, sometimes in TB-range)
- produced with complex experimental setups
- used for quantitative analysis → derived data

→ cumbersome to handle, store, and share



Courtesy of: Jan Huisken, University of Göttingen



Courtesy of: Y. Stahl, S. Weidtkamp-Peters, HHU Düsseldorf

OMERO

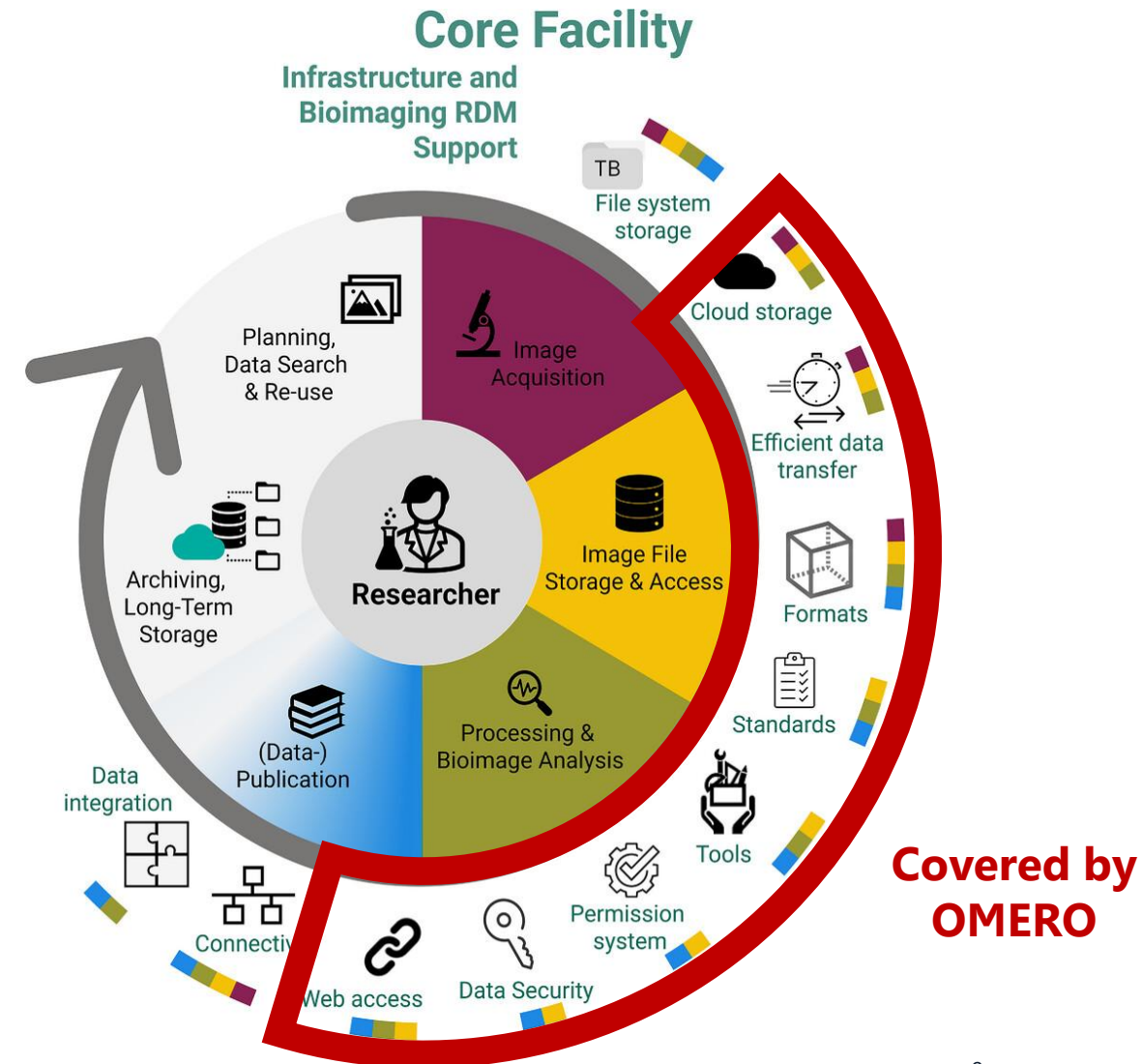
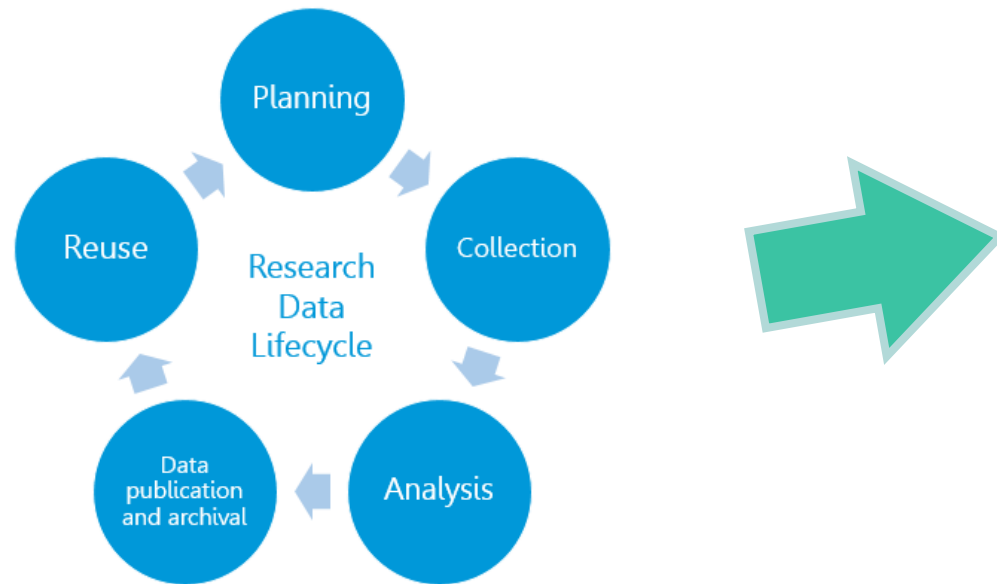


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Day-to-day image data management with OMER0

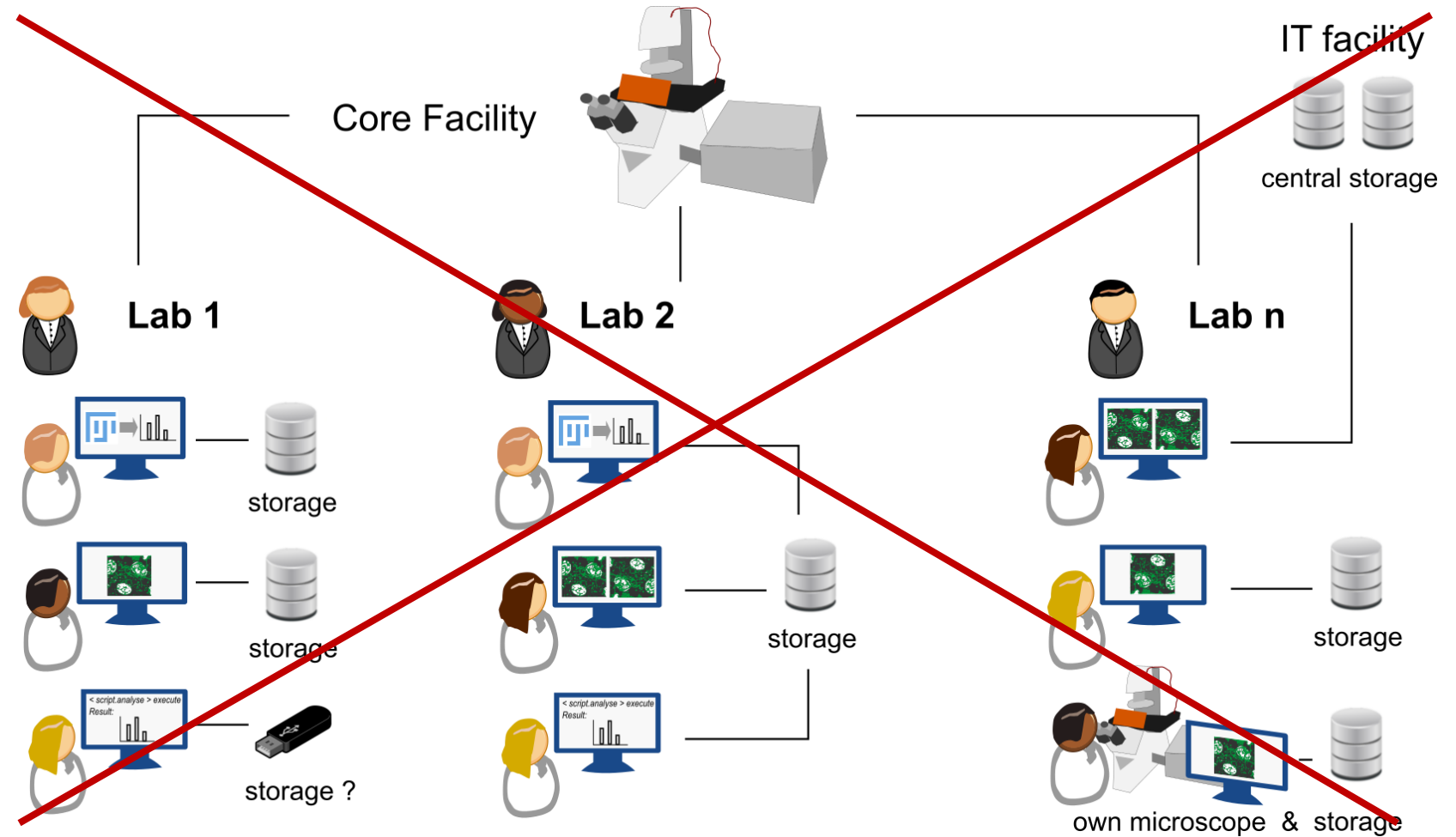


- **O**pen **M**icroscopy **E**nvironment **R**emote **O**bjects
- RDM platform for microscopy data
- Access open training server: <https://omero-training.gerbi-gmb.de/>
- Open software for managing, sharing and analysing image data



OMERO – What is it?

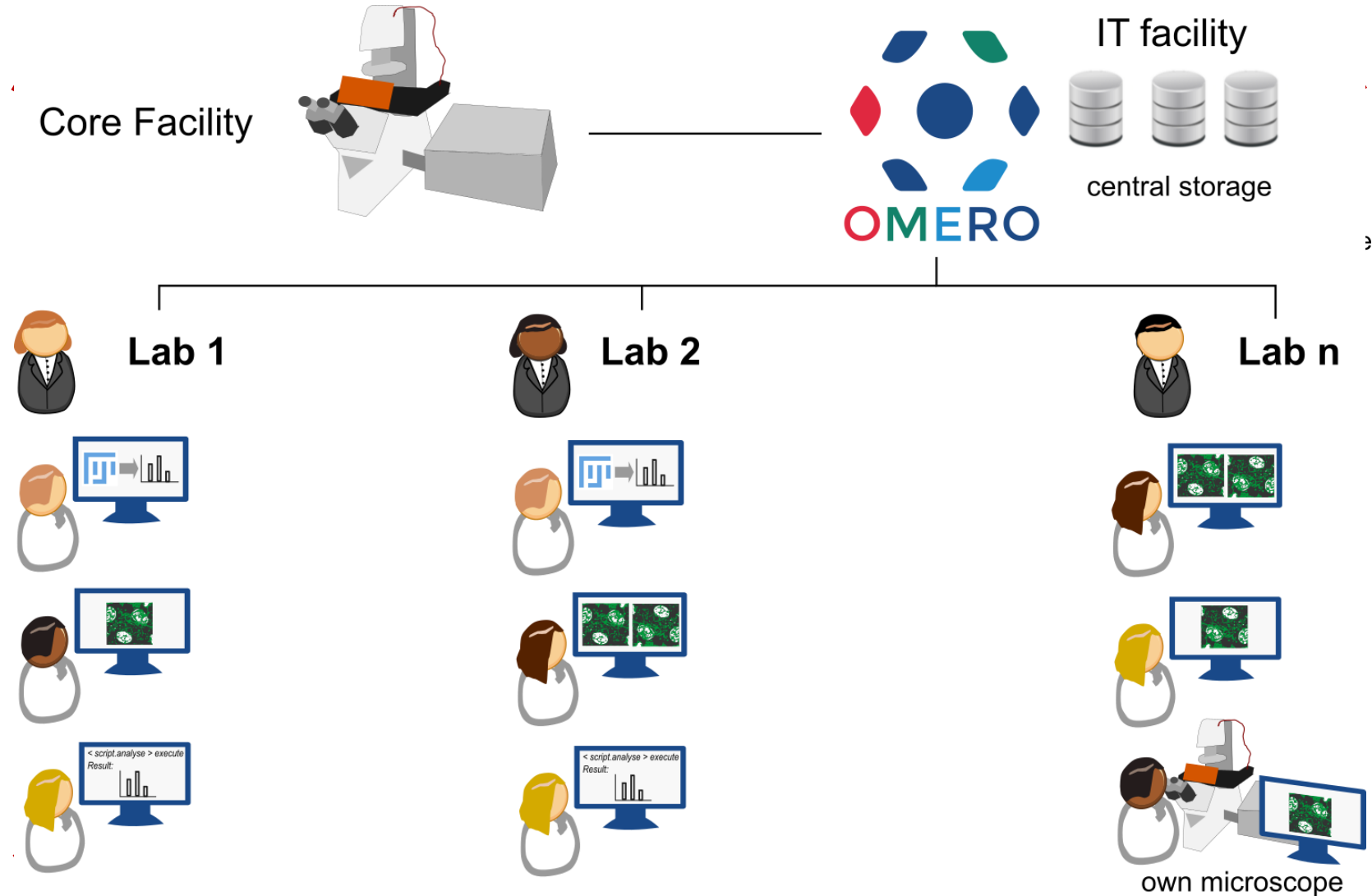
From isolated data silos...





OMERO – What is it?

... to centralized, structured
data management





OMERO – What is it?

OMERO: An open-source software for image data management

OMERO = „OME Remote Objects“

Created by the **O**pen **M**icroscopy **E**nvironment Consortium (OME)

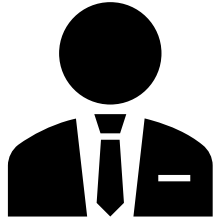


- User computer
- Microscope computer
- Processing / analysis server

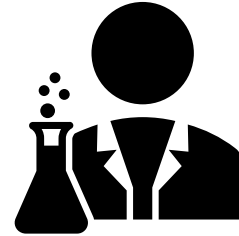


- Installed on an institute or central IT server
- Storage and handling of imaging data
- Accessible from outside via „clients“

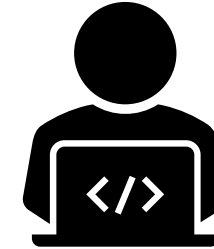
Data management for everyone in the lab



- Group leaders
 - Overview of projects
 - Monitor progress
 - Long term archiving

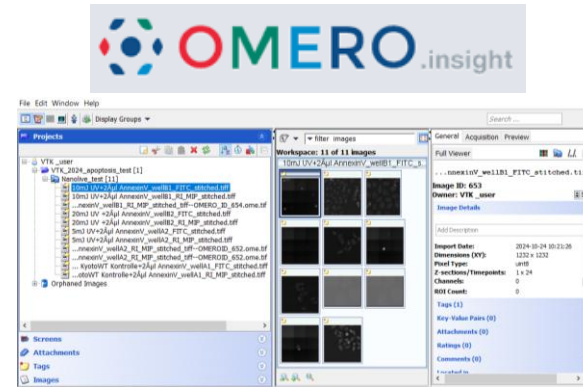


- Experimenters
 - Knows all the details of a project, which experiment worked, which had an issue
 - Can organize and annotate data

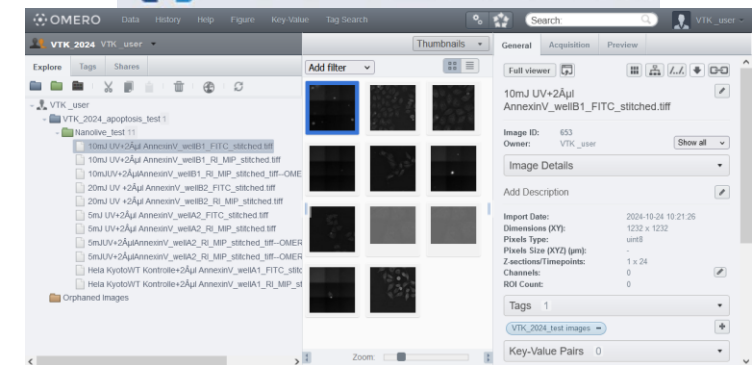


- Bioimage analyst
 - Needs metadata for processing
 - Share results back
 - Traceability of analysis

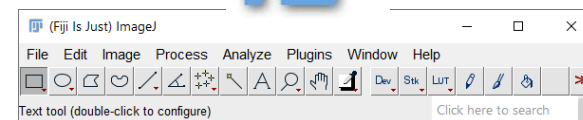
Data transfer workflow



<https://omero.uni-konstanz.de>

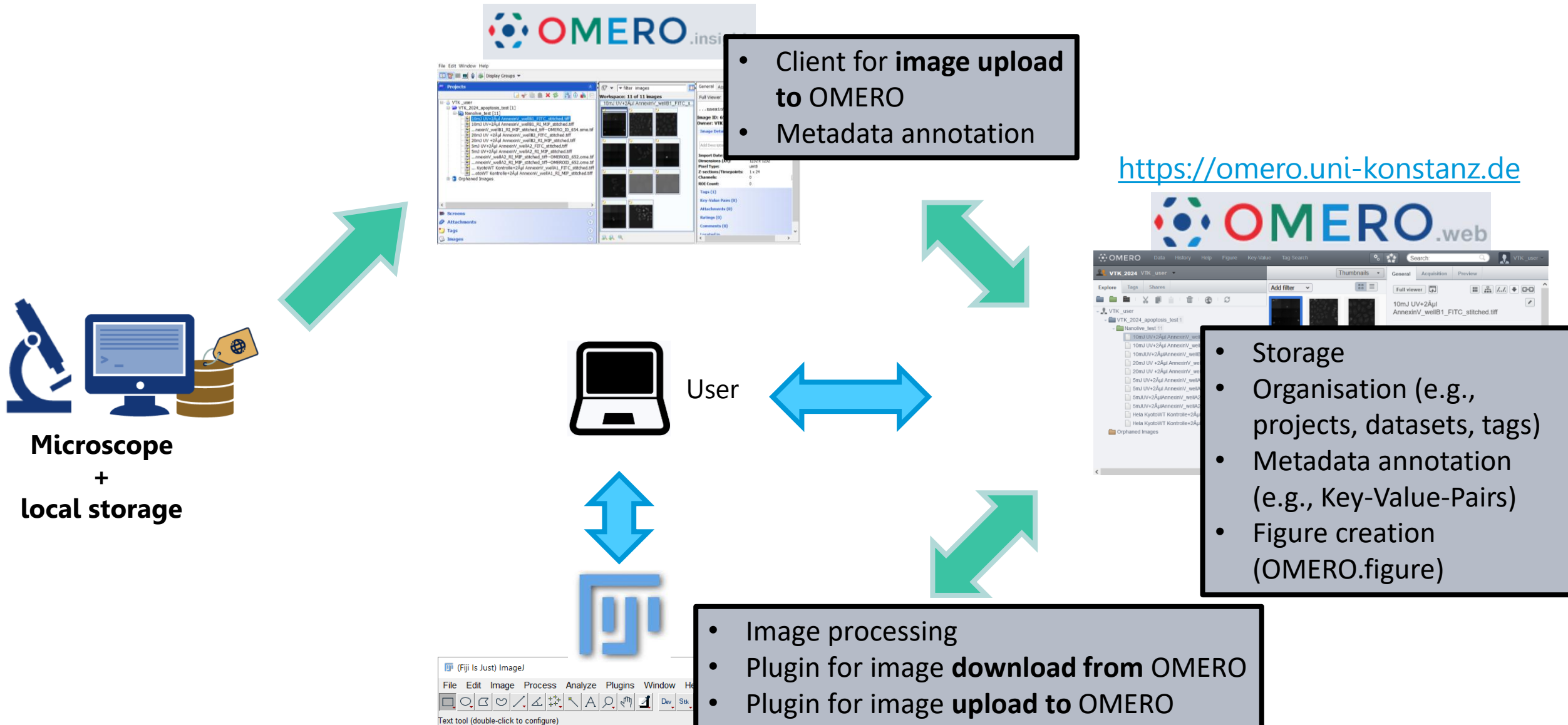


User





Data transfer workflow





Data transfer workflow

Upload to
OMERO

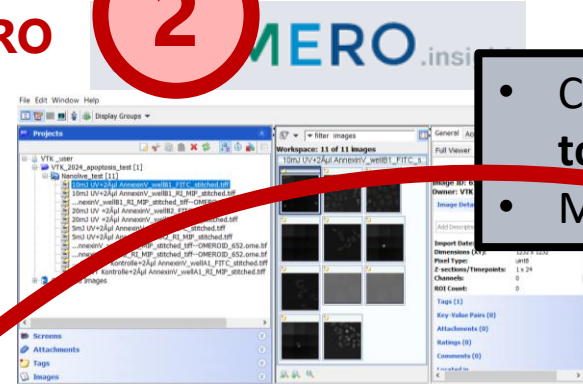
2

Image
acquisition

1



Microscope
+
local storage

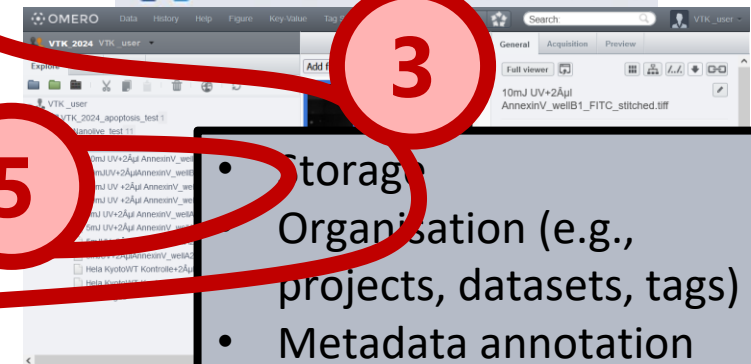


- Client for image upload to OMERO
- Metadata annotation

Organisation &
metadata annotation



3



- Storage Organisation (e.g., projects, datasets, tags)
- Metadata annotation (e.g., Key-Value-Pairs)
- Figure creation (OMERO.figure)

Figure
creation

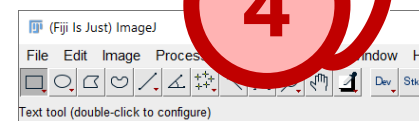
5



User

Image
processing

4



- Image processing
- Plugin for image download from OMERO
- Plugin for image upload to OMERO



OMERO.web – the main user interface

User-Project-Dataset-Image file

Figure preparation

Technical metadata

Tags for flexible organization

Key-Value pairs for metadata annotation

Preview of the images in the dataset

General Acquisition Preview

Import Date: 2023-10-26 22:17:26
Dimensions (XY): 476 x 476
Pixels Type: uint8
Pixels Size (XYZ) (µm): 0.09 x 0.09 x -
Z-sections/Timepoints: 1 x 1
Channels: Alexa Fluor 647, Alexa Fluor 568, Alexa Fluor 488, DAPI
ROI Count: 0

Tags 0

Key-Value Pairs 0

Add Key Add Value

Added on Project Modul_WSe_23-24

Study	
study type	master course
study name	CAI-Module_WS-2023/24
study description	practical microscopy course for master students

Added on Dataset 2023-10-25_LSM780

Study component	
imaging method	confocal laser scanning microscopy
imaging method term accession number	http://purl.obolibrary.org/obo/CHMO_0000089
imaging method term accession number source REF	chemical methods ontology
Biosample	
biological entity	HeLa cells
biological entity term accession number	http://www.ebi.ac.uk/efo/EFO_0001185
biological entity term accession number source REF	Experimental Factor Ontology
species	human
species term accession number	http://purl.obolibrary.org/obo/NCBITaxon_9606
species term accession number	



OMERO.web – the main user interface

User-
Project-
Dataset-
Image file

Figure
preparation

Technical
metadata

1. Two-tier folder hierarchy
→ Use TAGS for data organisation
2. Data belongs to a user in a group
→ membership in multiple groups possible

Tags for
flexible
organization

Key-Value
pairs for
metadata
annotation

Preview of
the images
in the
dataset



If you like detective games and riddles, try the **OMERO Treasure Hunt!** 

 **Start your adventure here:**

<https://omero-training.gerbi-gmb.de/webclient/?show=image-27511>

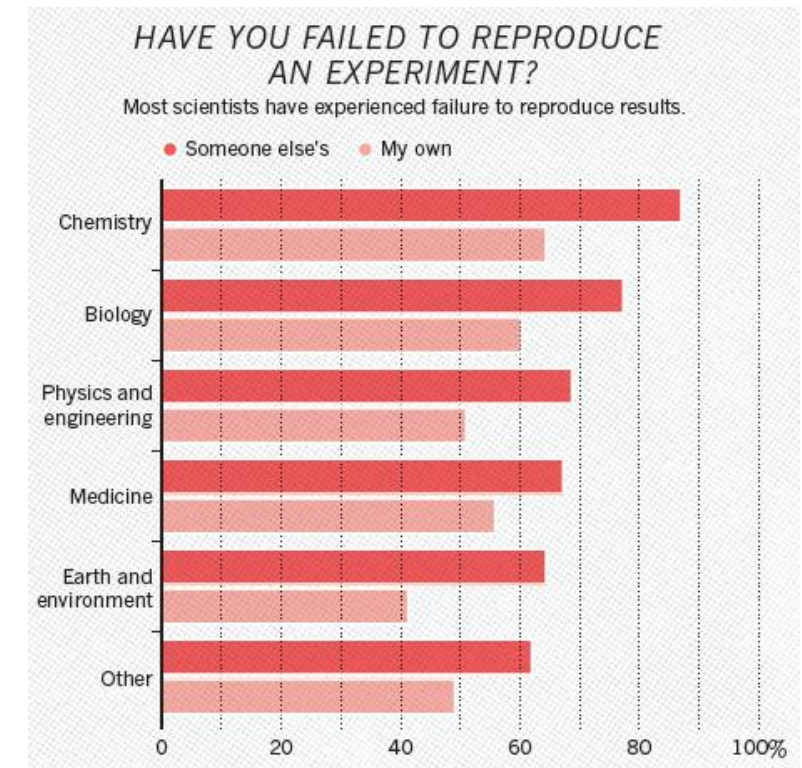
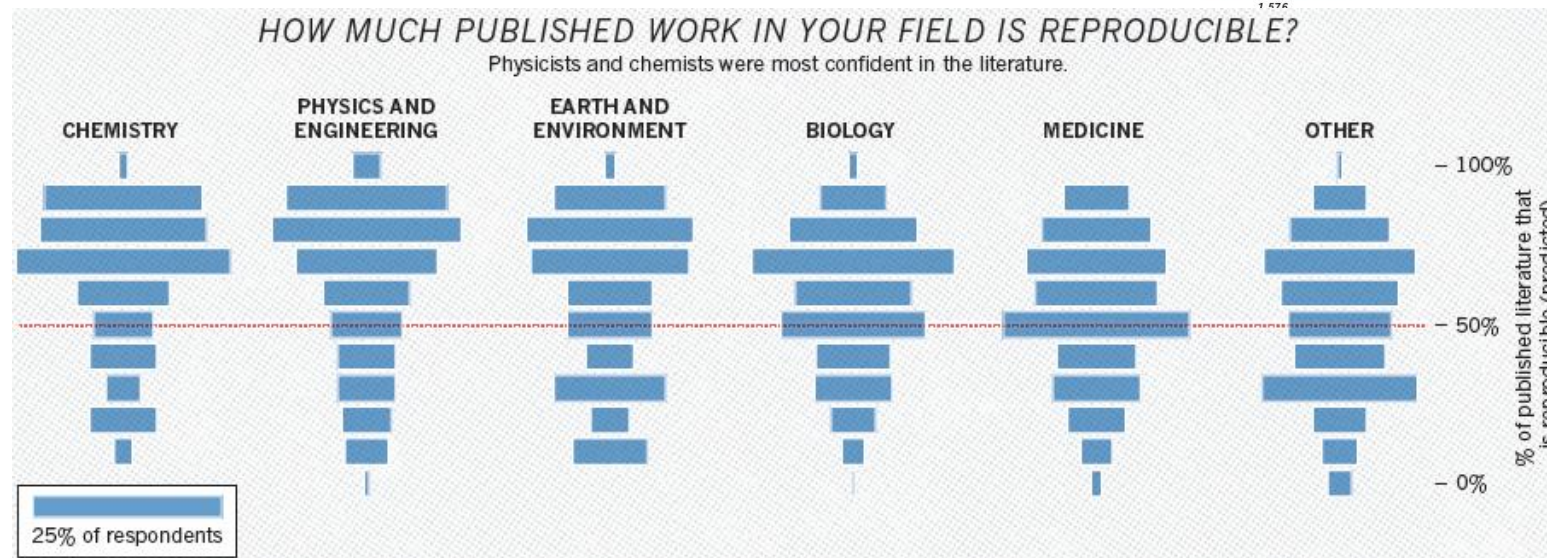
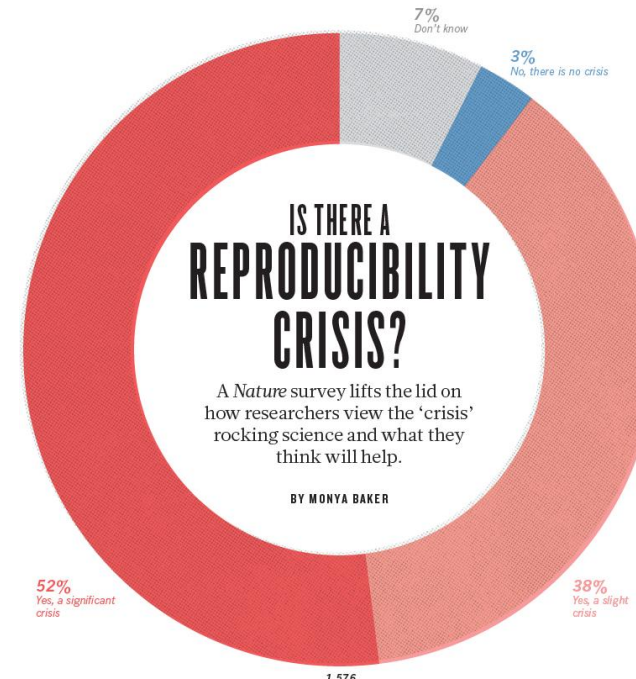


Public image data deposition

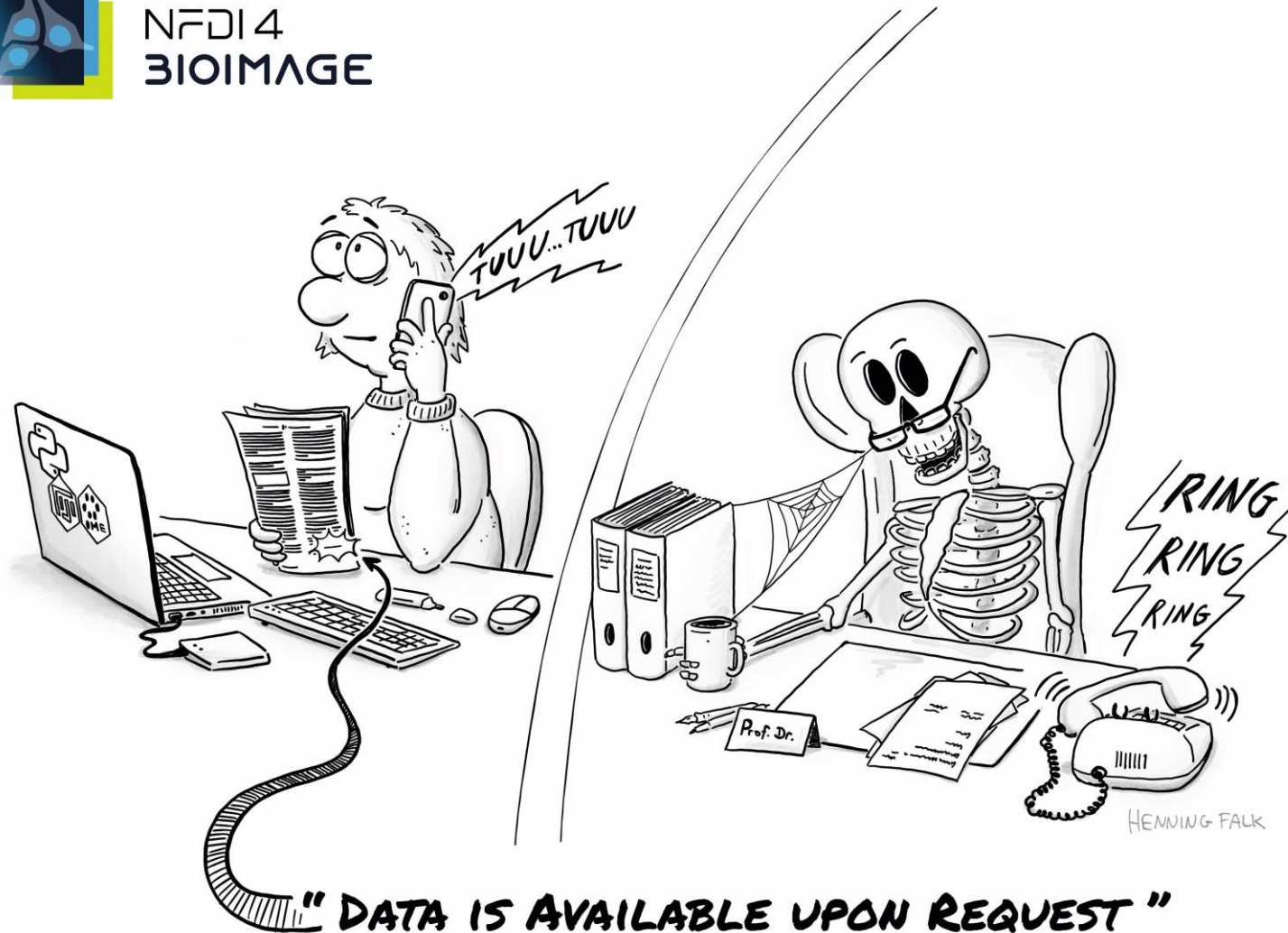


Reproducibility crisis

... the persistent observation that numerous scientific findings cannot be confirmed in repeated studies.



Data availability?



In fact, data is mostly **NOT** available upon request:

Example studies:

- Vines et al., 2014: only ~ 26 % of data available upon request
- Tedersoo et al., 2021: only ~ 39 % of data available upon request (with large variability)

"Data is available upon request", NFDI4BIOIMAGE Consortium (2024): NFDI4BIOIMAGE data management illustrations by [Henning Falk](#), Zenodo, <https://doi.org/10.5281/zenodo.14186100>, is used under a [CC BY 4.0](#) license. Modifications to this illustration include cropping.

Tedersoo, L., Küngas, R., Oras, E. et al. *Sci Data* **8**, 192 (2021). <https://doi.org/10.1038/s41597-021-00981-0>

Vines et al, *Current Biology*, Volume 24, Issue 1, 2014, <https://doi.org/10.1016/j.cub.2013.11.014>

Reused from: C. Schmidt, T. Boissonnet, M. Müller. (2025) Introduction to FAIR data bioimage management, and OMERO. OMERO workshop at University of Konstanz.



Why publish your research data?



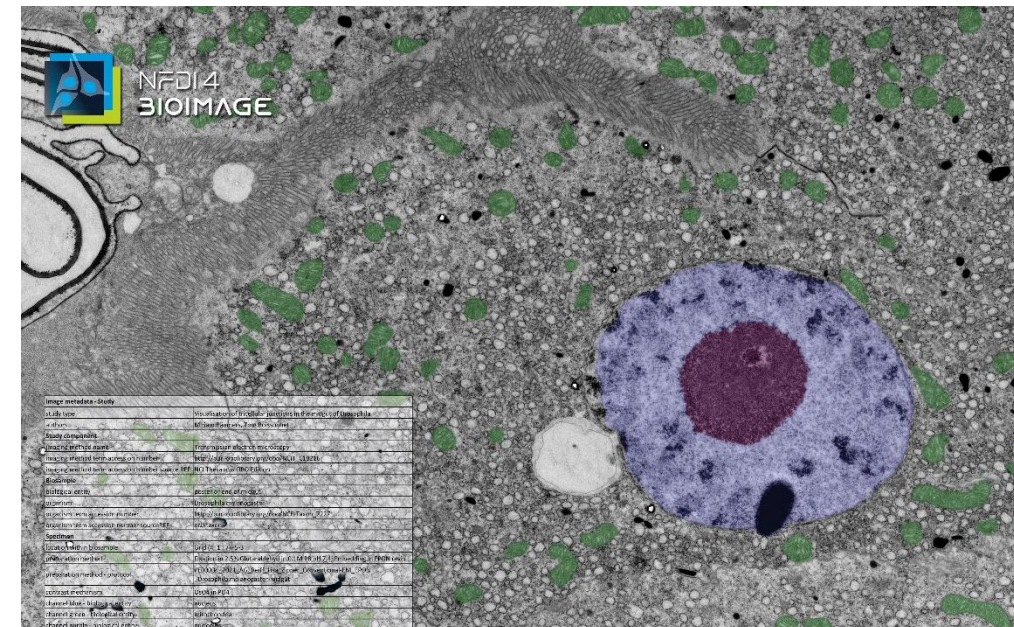
- Proof of your scientific work
- Increased visibility of your research
- Data reuse leads to new scientific findings
- Increased efficiency of reuse
- Increased transparency of your research
- Mandatory by funders



- Data may contain sensitive information → Pseudonymisation
- The timing of the publication might not be optimal → Embargo



- FAIR (meta)data
(Findable, Accessible, Interoperable, Reusable)
- „fit for purpose“
- Rich metadata annotation
- Way of publication
(e.g., discipline-specific repository)



The FAIR principles

Findable



- Use **machine-readable metadata** to describe data
- Assign unique **identifiers** (e.g., DOI) to data and metadata
- Register data and metadata in a **searchable resource**

Accessible



- **Standardized and open** communication protocol for data retrieval (e.g., https)
- **Authentication** and **authorization** if possible
- **Metadata remains accessible** even if the actual data is no longer available

Interoperable



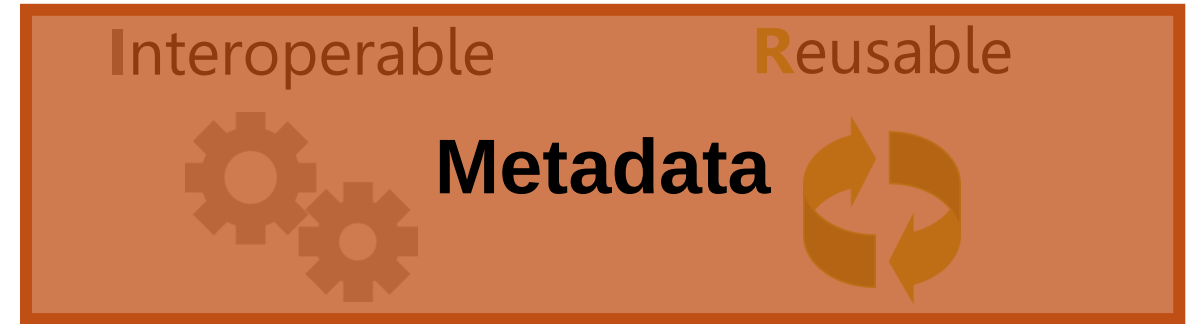
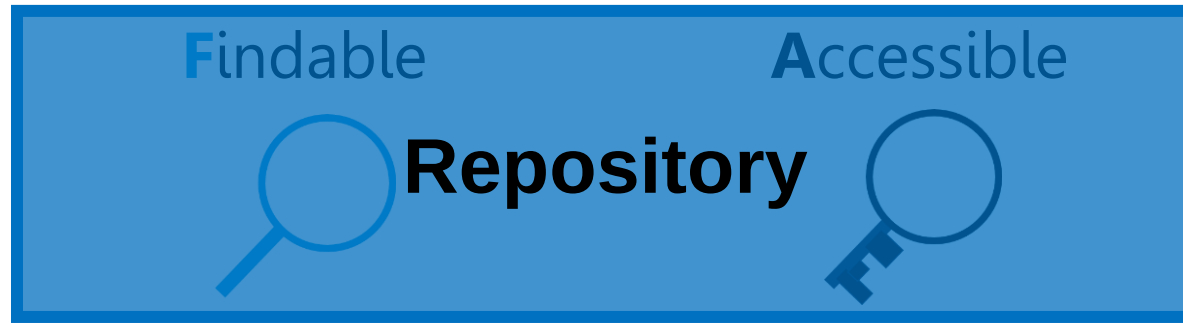
- Metadata use **controlled vocabulary**
- utilize **universal** knowledge representation **languages**
- **References** to other data and metadata

Reusable



- Enrich data and metadata with **precise and relevant** attributes
- **Usage rights** and acknowledgement
- Follow **community standards**

The FAIR principles



- Use **machine-readable metadata** to describe data

- Assign unique **identifiers** (e.g., DOI) to data and metadata

- Register data and metadata in a **searchable resource**

- **Standardized and open** communication protocol for data retrieval (e.g., https)

- **Authentication** and **authorization** if possible

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- Metadata use **controlled vocabulary**

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- **References** to other data and metadata

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- **Usage rights** and acknowledgement

- Follow **community standards**

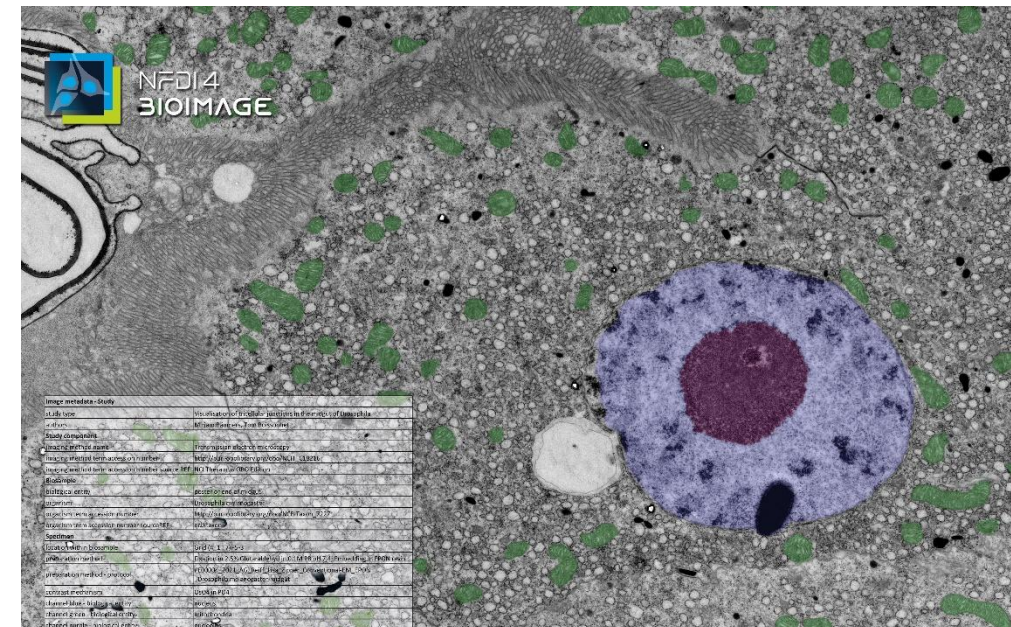
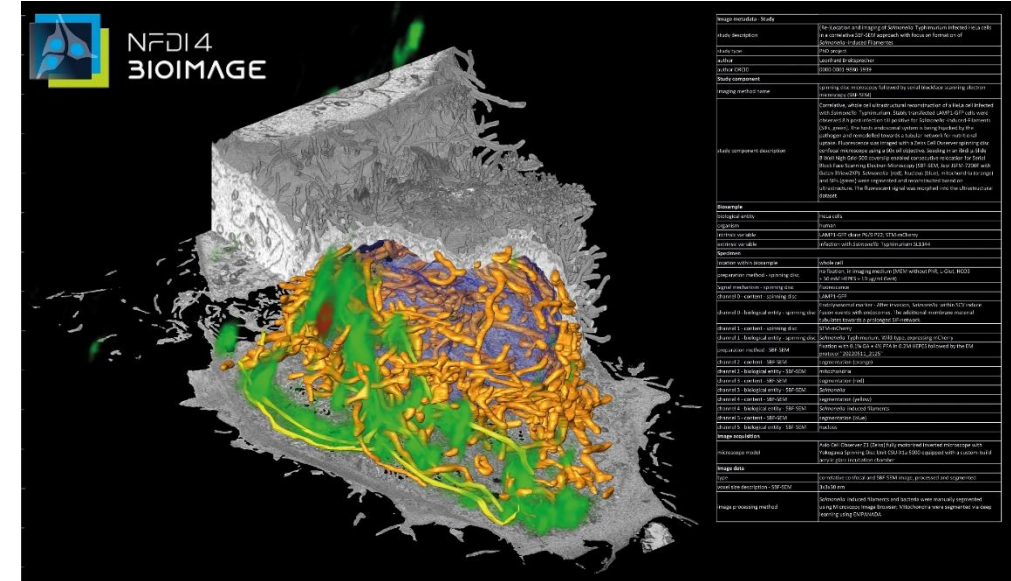
→ **Note:**

Comprehensive metadata annotation and the right repository alone already have a major impact on FAIRness



How to get the most out of your data publication?

- FAIR (meta)data
(Findable, Accessible, Interoperable, Reusable)
- „fit for purpose“
- Rich metadata annotation
- Way of publication
(e.g., discipline-specific repository)



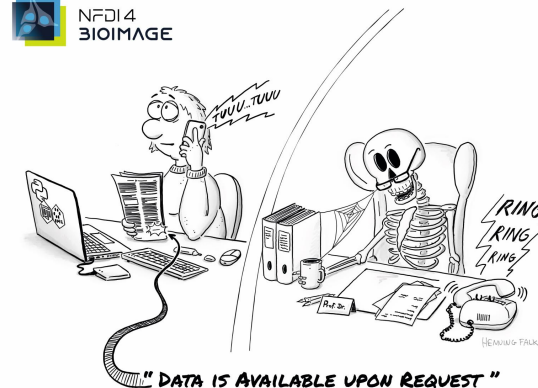
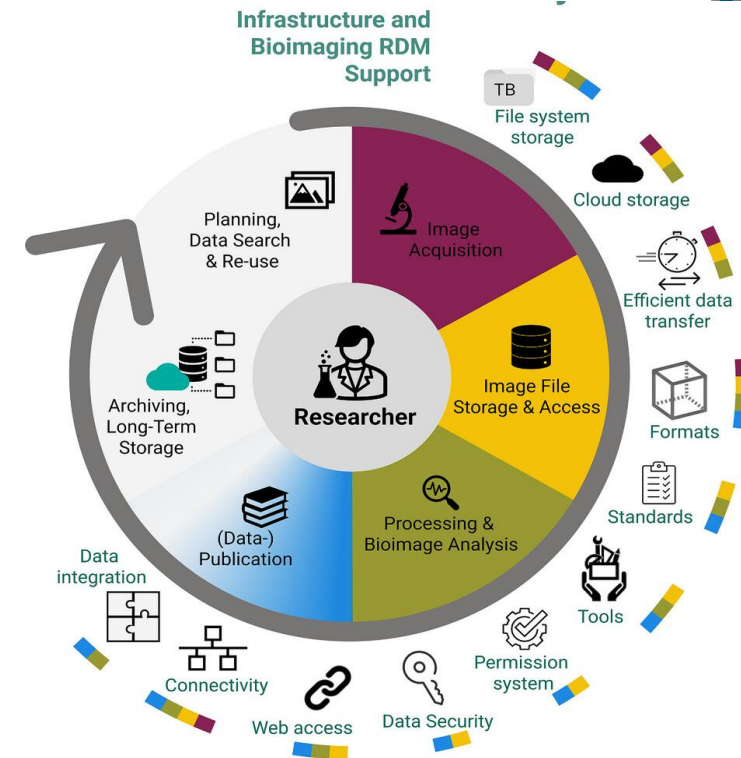


What is a repository?

Digital storage space for data (and metadata) with the goal of

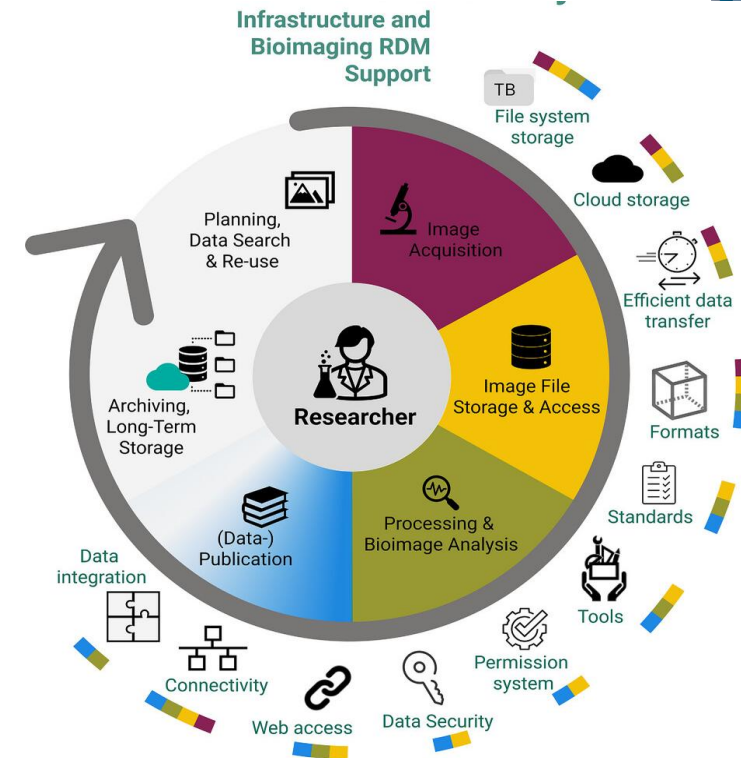
- preserving the data
- making data findable
- making data accessible

- Paper publication and data publication to a suitable repository should go hand in hand
- DOI of the data publication can be put into the data availability statement of the paper

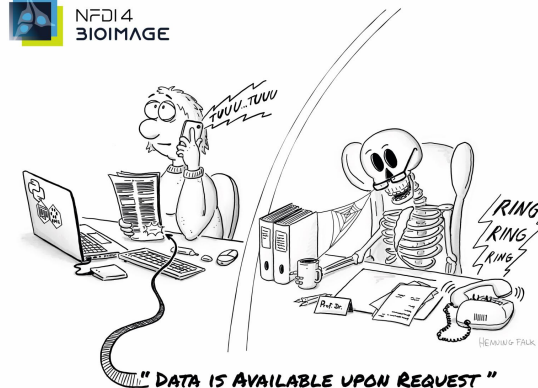


Why using a repository?

- This is where your community searches for data
- They capture discipline specific and machine readable metadata
- They offer curation of the metadata and (in some cases) research data
- Makes your data FAIR



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How to find a suitable repository?

You can use these repository registries:

- re3data.org - Registry of Research Data Repositories

<https://www.re3data.org/>

- FAIRsharing.org - Standards, Databases, Policies

<https://fairsharing.org/>

- OpenAIRE - Explore

<https://explore.openaire.eu/>



Bioimage Archive (BIA)

Type:

- archive image data repository

Location:

- implemented at the European Molecular Biology Laboratory – European Bioinformatics Institute (EMBL-EBI) at Hinxton, UK

Data uploaded:

- as of January 2025 600 TB was deposited
- in over 800 studies



BioImage Archive User Forum and User Survey

The second BioImage Archive User Forum will be held virtually on 10th March 2025! Please check the [agenda](#) and [register here](#). We also have a very short user survey for all our potential users. Please take two minutes to give us feedback by filling in [this form](#).

The BioImage Archive is a free, publicly available online resource which stores and distributes biological images. It accepts submissions of data from any imaging modality, as long as the data are either associated with a peer-reviewed publication, or of value beyond a single experiment.

You can submit your data on our [submission page](#). All data submitted to the BioImage Archive must be consented for a public release and the submitter self certifies that they have the rights to submit such data to a public archive. You can find more about our policies [here](#).

The BioImage Archive also provides data archiving services to the broader bioimaging database community including added-value bioimaging data resources such as [EMPIAR](#) and [IDR](#). Submission to related community resources may be more appropriate for some data types. You can find out more about the BioImage Archive's scope, and where your data should best be archived [here](#) and [here](#). The BioImage Archive cannot accept patient-identifiable medical data, such as that derived from clinical imaging.

The BioImage Archive supports [FAIR Sharing](#) and implements the [REMBI guidelines](#) to enable [FAIR data](#).

Funders

Ongoing development is enabled by capital investment from the UKRI Strategic Priorities Fund and operational costs supported by EMBL member state funding.

UK Research and Innovation EMBL

Further information

ONLINE TUTORIAL
BioImage Archive
Quick tour

The BioImage Archive Online Tutorial

The BioImage Archive Building a Home for Life-Sciences Microscopy Data

The BioImage Archive – Building a Home for Life-Sciences Microscopy Data - the paper describing the BioImage Archive
[Read more](#)

<https://www.ebi.ac.uk/bioimage-archive/>

Bioimage Archive (BIA)



Image preview:

- working on alpha version of image preview using OME-Zarr

Type of data:

- BIA accepts bioimaging data in general

Metadata requirements:

- minimal mandatory metadata requirements

The screenshot shows the BioImage Archive website interface. At the top, there's a navigation bar with links like Home, Browse, Submit, Galleries, Help, Metadata Help, Policies, and About us. Below this is a search bar with the text "Search BioImages" and examples like "brain, microscopy". The main content area displays a study titled "Characterization of the small Arabidopsis thaliana GTPase and ADP-ribosylation factor-like 2 protein TITAN 5" by Inga Mohr. It includes a description of the study, keywords, and acknowledgements. On the right side, there's a "Data files" section showing a list of files for download, including "Fig_3B_Fig_S6B.czi", "Fig_3C_Fig_S6C.czi", "Fig_3D_Fig_S6D.czi", "Fig_3E_Fig_S6E.czi", and "Fig_3F_Fig_S6F.czi". Each file entry shows its size, section, and component.

<https://www.ebi.ac.uk/biostudies/bioimages/studies/S-BIAD1241>
<https://alpha.bioimagearchive.org/bioimage-archive/study/S-BIAD1241/>

Image Data Ressource (IDR)



Type:

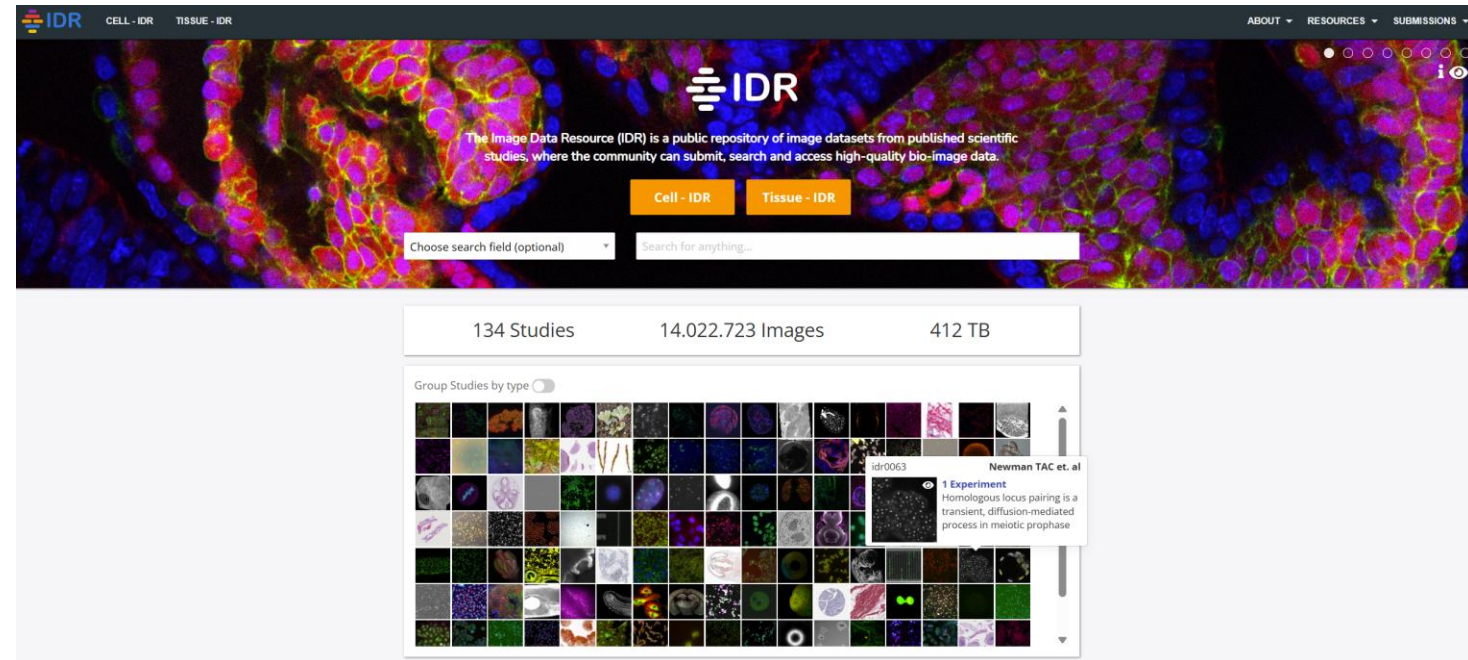
- added-value database

Location:

- developed as a collaboration of the EMBL-EBI at Hinxton, UK, and the Open Microscopy Environment consortium (OME) at University of Dundee

Data uploaded:

- as of May 2026 415 TB was deposited
- in over 140 studies



<https://idr.openmicroscopy.org/>

Image Data Ressource (IDR)



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Image preview:

- image preview possible with BIO-FORMATS plugin (as in OMERO)

Type of data:

- curated datasets that will be valuable to broad scientific audience, cell- and tissue-centric

Metadata requirements:

- moderate mandatory metadata requirements

Example of a data publication

The screenshot displays the IDR web client interface. On the left, a sidebar lists various experiments under the 'Public' tab. The central area shows a grid of image thumbnails, with a zoom slider at the bottom. The right sidebar provides detailed metadata for a selected experiment, including:

- General:** experiment_01, Plate ID: 6391, Public data.
- Plate Details:** 96 Greiner uClear.
- Creation Date:** 2019-02-22 17:16:40.
- Attributes:** 0.
- Added on Screen:** id0037-vigilante-hpsc-screen.
- Sample Type:** cell.
- Organism:** Homo sapiens.
- Study Title:** Identifying Extrinsic versus Intrinsic Drivers of Variation in Cell Behavior in Human iPSC Lines from Healthy Donors.
- Study Type:** high content screen.
- Screen Type:** primary screen.
- Screen Technology Type:** cell line screen.
- Imaging Method:** fluorescence microscopy.
- Publication Title:** Identifying Extrinsic versus Intrinsic Drivers of Variation in Cell Behavior in Human iPSC Lines from Healthy Donors.
- Publication Authors:** Vigilante A, Laddach A, Moosa N, Malickiya R, Laha A, Ghassemani A, Culley OJ, Katheria R, Hurling C, Vickers A, Wiseman E, Tenney B, Zandstra PJ, HigSci Consortium, Durbin R, Fraternali F, Shadle D, Birney E, Lincum NM, Danovici D, Watt FM.
- PubMed ID:** 30764590.
- PMCID:** PMC6381797.
- Publication DOI:** https://www.ncbi.nlm.nih.gov/pubmed/30764590, https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6381797, https://doi.org/10.1016/j.celrep.2019.01.094.
- Release Date:** 2019-02-26.
- License:** CC-BY 4.0.
- Copyright:** Vigilante et al.
- Data Publisher:** University of Dundee.
- Data DOI:** https://doi.org/10.17667/10000120.
- External URL:** http://www.hpsc.org/.
- Annotation File:** id0037-screenA-annotation.csv, https://github.com/IDRdata/id0037-vigilante-hpsc/blob/HEAD/screenA/id0037-screenA-annotation.csv.
- Attachments:** 0.
- Comments:** 0.
- Tags:** 0.
- Ratings:** 0.
- Others:** 0.

<https://idr.openmicroscopy.org/webclient/?show=screen-2051>

Need help?



The NFDI4BIOIMAGE Data Steward team is there to help with any question related to bioimaging data

- OMERO workshop
- Data management plan (DMP) creation
- Data publication
- RDM training
- Metadata
- Etc.

reach us with questions and feedback via
helpdesk@nfdi4bioimage.de or forum.image.sc



Acknowledgments

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Forschungsgemeinschaft (DFG, German
Research Foundation) under the
National Research Data Infrastructure –
NFDI 46/1 – 501864659



The NFDI4BIOIMAGE consortium comprises legally independent partners and does not act autonomously towards third parties. The authors represent the contributions from their respective affiliated institutions and work together for the project.