











## I3D:bio's OMERO training material: Re-usable, adjustable, multi-purpose slides for local user training

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### Abstract:

The open-source software OME Remote Objects (OMERO) is a data management software that allows storing, organizing, and annotating bioimaging/microscopy data. OMERO has become one of the best-known systems for bioimage data management in the bioimaging community. The Information Infrastructure for BioImage Data (I3D:bio) project facilitates the uptake of OMERO into research data management (RDM) practices at universities and research institutions in Germany. Since the adoption of OMERO into researchers' daily routines requires intensive training, a broad portfolio of training resources for OMERO is an asset. On top of using the OMERO guides curated by the Open Microscopy Environment Consortium (OME) team, imaging core facility staff at institutions where OMERO is used often prepare additional material tailored to be applicable for their own OMERO instances. Based on experience gathered in the Research Data Management for Microscopy group (RDM4mic) in Germany, and in the use cases in the I3D:bio project, we created a set of reusable, adjustable, openly available slide decks to serve as the basis for tailored training lectures, video tutorials, and self-guided instruction manuals directed at beginners in using OMERO. The material is published as an open educational resource complementing the existing resources for OMERO contributed by the community.

### Introduction:

Microscopy data is generated throughout the life sciences and beyond, producing images and derived quantitative data in heterogeneous formats. Data management in bioimaging is challenging due to large file sizes, various proprietary file formats, divergent metadata records and formats, and the multitude of bioimaging modalities in modern research [1-3]. Among other solutions, the OME Remote Objects (OMERO) software, released as open-source software by the Open Microscopy Environment Consortium (OME), constitutes a tool allowing the centralized storage, sharing, annotation, and interrogation of imaging data [4, 5]. OMERO leverages the Bio-Formats library to access proprietary file formats,

including the metadata [6]. Moreover, a large international community of contributors supports the ongoing development and functional extension of OMERO (see #OMERO at <https://forum.image.sc/>, or examples on Github: <https://github.com/ome/omero-user-scripts>; <https://github.com/TheJacksonLaboratory/ezomero>). In a 2021 survey among bioimaging scientists in Germany, OMERO was the best-known and most widely used solution for bioimage data management [7]. Implementing a new OMERO instance requires collaboration between many different stakeholders within the organization and involves central IT staff, core facility personnel, researchers using bioimaging methods, and central administration to ensure proper setup and sustained operation.

The OME team provides comprehensive support and training for both the installation and the use of OMERO on the [openmicroscopy.org](https://openmicroscopy.org) website, which is the central entry hub to becoming knowledgeable about OMERO. Moreover, the OME team offers workshops and assists in setting up training server environments for workshops organized locally. Introductions on how to use OMERO are available online in the form of recordings from such workshops and live demos with durations between 10 and 60 min (e.g., <https://www.youtube.com/@OpenMicroscopyEnvironment/>; OMERO basics by E. Ratamero, Jackson Laboratory: <https://www.youtube.com/watch?v=e3u-Ugd4W7w>). Irrespective of these comprehensive information resources, experience shows that the adoption of OMERO by researchers and students at universities or institutions where the platform was implemented is often slow (e.g., as discussed in meetings of the RDM4mic group). Even where OMERO is used for data storage and visualization, only a few users leverage the potent functions of this platform like structured metadata annotation and streamlining image data analysis. Frequently, OMERO instances are implemented by or in collaboration with imaging core facilities that are a primary source of support when planning to use (new) bioimaging methods [7]. Core facilities, therefore, can act as important multipliers for the dissemination of good RDM practices in bioimaging, including using OMERO. Since OMERO instance configurations, server addresses, ports, installed extensions, and available scripts usually differ between institutions, core facility staff have to adapt generic training material to their respective institution's environment, e.g., offered as a web resource locally (examples at the time of publication: [WWU Münster](#), [Biozentrum Basel](#), [HHU Düsseldorf](#), [Uni Osnabrück](#), [EPFL BioImaging and Optics Platform](#)). Several such resources are openly accessible, but core facilities or organizations starting their own OMERO instance cannot entirely rely on these, and reuse is limited as it requires customization for use in internal lectures and seminars.

Since 2016, the FAIR principles for research data (i.e., data must be findable, accessible, interoperable, and reusable) have been acknowledged widely by the scientific community, funders, and policymakers, as a guidance framework for research data management [8]. In

bioimaging, OMERO offers an entry point for FAIR data handling, and it is continuously being advanced by the community to allow better FAIR compliance for researchers. Thus, OMERO user training is also a means to facilitate knowledge about FAIR-compliant data management including the important aspect of metadata annotation and curation. Community-based recommendations and technical solutions to help with metadata annotation in bioimaging with different degrees of standardization were recently developed [9-13], and educational material on metadata is among the top five requested resources by participants in the 2021 NFDI4BIOIMAGE community survey [7].

The Information Infrastructure for BioImage Data (I3D:bio) project (<https://www.i3dbio.de>), funded through the German Research Foundation (DFG, Deutsche Forschungsgemeinschaft), arose from regular exchange within the bioimaging community occurring in the frame of both the informal Research Data Management for Microscopy group ([RDM4mic](#)) and German Bioimaging, the German Society for Microscopy and Image Analysis ([GerBI-GMB](#)). The project focuses on supporting the implementation of OMERO instances at German universities and research institutions. In collaboration with use case partners, several OMERO installations are implemented *de novo*, and the partners are supported in user training, too. An explicit demand by the use case partners and by the RDM4mic group members concerned the availability of easily accessible, modifiable, and reusable training material in classical presentation formats (i.e., slideshows) that can be used to lower the entry barrier for naïve users of OMERO ([meeting 2022](#)). The I3D:bio project team collected existing material from partner sites, but also created a new set of OMERO training slides for the project's use cases. The slides should serve three discrete purposes:

- as **reusable slides for on-premise or online training** courses by core facility staff (and others).
- as a **self-guided instruction manual** with substantial visual support (e.g., step-by-step screenshots).
- as a basis for **short video tutorials** (~ 4 min to 11 min, each) about specific aspects of using OMERO, targeting absolute beginners.

The slides are

- designed with original screenshots in a neutral format to be published with an open permissive reuse license ([CC-BY 4.0](#)).
- providing information and links to other community-curated OMERO training material and the OMERO guides (<https://omero-guides.readthedocs.io/en/latest/>).

Each training modality or format has strengths and weaknesses, and comes with somewhat different material requirements. The presented slideshows are intended to meet a sweet spot between those different requirements. For example, while individual slides have denser content than would be ideal for video clips, animated walk-throughs allow keeping focus in audiovisual presentations or in talks. At the same time, a slide contains the essential information to be used for a self-guided walk-through by the users including links to the OME guides or other resources.

The slides are published with a generic master slide template that can be readily adapted for presenting other institution-compliant layouts. The screenshots are neutral with respect to persons or institutions (we used “Mary Mayperson“ as the default user). Where screenshots must contain the institution-specific information (e.g., the discrete OMERO web address with the correct port), these fields are marked in yellow and can be edited in the original slides. The notes below the slides in the pptx format contain useful information for trainers or video producers; for example, if the training slide content can only be used if a specific extension is installed on the OMERO server.

We tested the usefulness as video tutorials during the test phase of a newly installed OMERO instance at the German Cancer Research Center (DKFZ) in Heidelberg, Germany. Moreover, experienced core facility members and voluntary pilot users from the I3D:bio project's partner sites reviewed the video tutorials and provided feedback. Since videos are requested as an educational format in the field of bioimaging and image analysis [14], we designed videos with a short length (on average ~6.5 minutes) about specific topics, since this length has been found optimal for effective engagement [15, 16]. The production of video tutorials demands time and requires suitable equipment. Therefore, we re-recorded the tutorials using the presented slides with generic screenshots in a neutral I3D:bio slide design ([published on Youtube](#)). Other institutions can use these video tutorials without modification while providing the adjusted underlying slide decks for their users containing the institution-specific information.

Altogether, the training material provided here is intended as a complementary community-contributed educational format in addition to the OMERO guide. The material contains links to OME's original and community-contributed resources. The video tutorials and slideshows are specifically intended to lower perceived entry barriers for beginners in using OMERO. The slides may be complemented or updated over time. All slides are provided in original pptx format, in the open odp format, and as pdf files in the neutral design. The slides and videos can be downloaded, and may be edited for reuse, or can be reviewed online.

## Description of the training material

The training slides and video tutorials are targeted to address researchers at all career levels who are beginners in using OMERO, and who may have limited literacy in computer science, software architectures, file formats, etc. To lower entry hurdles for adopting OMERO, we created nine chapters, starting with a basic, high-level introduction to OMERO. The tutorials guide through the most essential first steps of using OMERO and point to other resources for more advanced users looking for additional details. For individual slides, we have used own example data, or publicly available datasets published under CC-0 license to demonstrate steps of using OMERO. Data was reused from the BioImage Archive [17] from the following studies: Barry et al. (2018). *BioStudies*, S-BSST110. Retrieved from <https://www.ebi.ac.uk/biostudies/bioimages/studies/S-BSST110>; Hanyaloglu et al. (2021). *BioStudies*, S-BSST749. Retrieved from <https://www.ebi.ac.uk/biostudies/bioimages/studies/S-BSST749>). The choice was arbitrary based on open licenses.

### Chapter 01: What is OMERO? (video link: [https://youtu.be/D5UHx3d\\_JxA](https://youtu.be/D5UHx3d_JxA))

This is a high-level description, and information on how to use OMERO at the institution with little details. It is intended for the first engagement of new users or as a quick information for stakeholders generally interested in OMERO.

### Chapter 02: How to connect to OMERO (video link: <https://youtu.be/hTp4utPDs-4>)

A practical guide on how to access the OMERO instance at the institution. Differences between the OMERO.insight client and the OMERO.web client are explained and recommendations are given.

### Chapter 03: OMERO software explained (video link: <https://youtu.be/3d2ppWKYNYs>)

This chapter is an optional explanation about what is hidden from front-end users when relying on OMERO. The chapter is intended to create trust in data safety and convey a glance of the well-designed complexity behind OMERO.

### Chapter 04: User Groups in OMERO (video link: <https://youtu.be/bCvPHbjm0x4>)

Users should understand the rationale behind user group policies in OMERO. The chapter explains which user group settings exist, who manages the groups and which features are associated with the group settings. It is particularly important for the collaborative use of OMERO. The chapter must partially be adjusted to present the respective default group settings at each institution.

**Chapter 05: How to upload data to OMERO** (video link: [https://youtu.be/p\\_2CJPEpRd8](https://youtu.be/p_2CJPEpRd8))

A step-by-step introduction to the most frequently used scenario for data upload, which is the manual upload using OMERO.insight. The chapter also points to command line upload options, including a note on in-place import. It contains also a note on OMERO.mde as a metadata editor used during import with OMERO.insight.

**Chapter 06: Data organization (with one subchapter)** (video link: [https://youtu.be/wTuEkd\\_8kwl](https://youtu.be/wTuEkd_8kwl))

A frequently reported entry barrier for new users is the seemingly too flat folder hierarchy in OMERO. Many new users have to become acquainted with object-based organization first, since file folder hierarchies are most commonly used. The chapter introduces how to rethink data organization and explains the advantages of OMERO's data organization. With this chapter, metadata annotation concepts, most importantly, Tags and Key-Value Pairs are introduced, while being detailed later in subsequent chapters. The **subchapter 06.1** (video link: <https://youtu.be/LW1g34ERt0Q>) shows how to make use of the search function in OMERO, leveraging OMERO's data structure in combination with structured annotations.

**Chapter 07: Metadata curation (with three subchapters)** (video link: <https://youtu.be/rHDNYtwbF-A>)

This chapter provides a more comprehensive introduction to metadata, outlining the importance of metadata from various perspectives. It provides an overview of the metadata annotation features in OMERO, which are further detailed in the subchapters. Noteworthy, since the discrete use of Tags, Key-Value Pairs, and ontology terms in OMERO are neither standardized nor self-explanatory, we focus on the possibilities offered by OMERO and provide a high-level recommendation. Our recommendations are aligned with community-established recommendations based on exchange with the international bioimaging community. However, it is highlighted that no one “best” or “correct” way for metadata annotation in OMERO exists.

The **subchapter 07.1 focuses on the use of Tags**. We recommend using Tags to support the data organization making use of Tag categories and the search function and thus substituting for the habit of creating deep folder hierarchies. (video link: [https://youtu.be/62z\\_5erjAF0](https://youtu.be/62z_5erjAF0))

**Subchapter 07.2** offers more detailed explanations on the use of **Key-Value Pairs** and introduces community-supported OMERO Bulk Annotation Tools. (video link: <https://youtu.be/Y965QiB7wVs>)



**Subchapter 07.3 introduces the concept of ontologies.** Experience shows that many beginners in OMERO are not yet familiar with ontologies. OMERO has no strict rules about how to use ontologies. Here we provide a suggestion in the context of bioimaging. We mainly relate to the Recommended Metadata for Biological Images (REMBI) [13]. For the annotation of ontology-derived terms in Key-Value Pairs, we suggest combining REMBI items in the Keys with ontology-derived natural language terms as values where adequate based on previously proposed standards (e.g.: ISA [18]). (video link: [https://youtu.be/MvB0Mz\\_abfk](https://youtu.be/MvB0Mz_abfk))

**Chapter 08: Using OMERO together with Fiji** (video link: <https://youtu.be/x-PvOZPKjD0>)

Fiji/ImageJ [19, 20] is the most widely used image analysis software for researchers using bioimaging [7, 21]. Many other, open as well as proprietary, image analysis software can be used in combination with OMERO. However, here we focus on the connection of Fiji and OMERO to showcase the immediate benefit of using OMERO for data organization when working with the data (“hot data”). The Fiji plugin for OMERO is introduced, and we point to community-developed Fiji/ImageJ macro extensions for OMERO [22].

**Chapter 09: More features, functions, and ways to use OMERO** (no video)

Having focused on absolute beginners for the use of OMERO as the primary target group, here we provide links and information for the many additional features that OMERO offers to advanced users. Where available, we point to online tutorials and training material and/or to original publications. Chapter 9 is not presented as a video tutorial.

## How to use this material

The intended use of our material is to download the slideshows, change the layout using the master slide and adjust the slide content as required. Notes for presenters may give hints on which slides should likely be adjusted. Yellow markings highlight where slide content requires manual changes. The content including the figures and text (but excluding logos) is - unless marked otherwise - published with a [CC-BY 4.0 license](https://creativecommons.org/licenses/by/4.0/) as an open educational resource. We intend to provide FAIR training material by sharing in open formats, with permissive license, accompanying metadata, and versioning [23]. Suggestions for slide improvements may be communicated to the authors directly for adoption in updated versions of the material. Contributions may be addressed to: [i3dbio@gerbi-gmb.de](mailto:i3dbio@gerbi-gmb.de). Furthermore, if you use the material at your own institution, we would greatly appreciate being notified to get in touch for feedback over time.

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#### **Data availability**

All material is available under the Zenodo record 10.5281/zenodo.8323588.

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#### **Conflict of Interest:**

The authors declare that there is no conflict of interest.

#### **Author contributions:**

CS drafted the concept, created the slides, recorded the tutorials, wrote the manuscript, and coordinated the project. MB and TB contributed to the concept and with slides, and reviewed the material and the manuscript. NK, PZ, CFG, and TZ contributed with raw material as the basis for the concept and the slides, and reviewed the material and the manuscript. JD reviewed and tested the material. SK, SWP and EFM contributed conceptionally, reviewed the material and the manuscript, and provided funding.

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