Minding microscopy metadata

Guidelines for improving reporting and reproduciblity in microscopy take center stage in this month's Focus issue.

Microscopes have long been a workhorse in the life sciences. Despite their abundance and how familiar scientists are with seeing microscopy data, there are still important gaps in how microscopy experiments are reported. These gaps limit how readers of published work can assess the data and can hobble reuse and reproducibility.

Even the most straightforward of microscopy experiments can have numerous intricate steps, and knowing which details to track is not always obvious. Between details about the sample preparation, specifics about the microscope, details of the data acquisition and particulars of the image analysis, important aspects can get lost in the shuffle. These details, the data behind the data, are known as metadata.

The metadata reporting problem was brought to the spotlight by a 2020 study from Guillermo Marqués, Thomas Pengo and Mark Sanders published in *eLife*, in which the researchers took a close look at reporting of light microscopy data in 240 research papers from eight journals. Their conclusions were that reporting was poor, with many papers lacking basic information about how images were acquired.

In this Focus issue, we feature a suite of papers offering guidelines and solutions for collecting and reporting microscopy metadata. These papers come from groups of experts and large consortia with the common goals of improving reporting and reproducibility in light (and electron) microscopy and supporting data sharing in line with the FAIR (Findability, Accessibility, Interoperability and Reusability) data principles. The guidelines are meant to be both rigorous and flexible, keeping in mind that microscopes and imaging experiments are quite diverse and have differing needs in terms of reporting. They also strive to improve reporting without creating an undue burden on experimentalists.

A Perspective from Paula Montero Llopis and colleagues clearly describes minimal guidelines to ensure rigor and reproducibility in fluorescence microscopy. A Comment from Ugis Sarkans, Gerard Kleywegt, Alvis Brazma and colleagues describes the Recommended Metadata for Biological Images (REMBI). These recommendations were developed as part of three working groups and cover cryo-electron microscopy and cryo-electron tomography, volume electron microscopy and correlative imaging, and light microscopy.

A series of papers comes from the Quality Assessment and Reproducibility for Instruments & Images in Light Microscopy (QUAREP-LiMi) group and colleagues. A Comment from Roland Nitschke and colleagues describes the group and its goals. Another Comment, from Caterina Strambio-De-Castillia and colleagues from the 4D Nucleome Initiative (4DN) Imaging Standards Working Group and the BioImaging North America (BINA) Quality Control and Data Management Working Group, which are closely aligned with QUAREP-LiMi, describes a tiered set of metadata recommendations that extend the Open Microscopy Environment (OME) data model.

Also from QUAREP-LiMi and 4DN/BINA/OME researchers are three papers describing complementary tools for tracking and reporting metadata. These include MDEmic (MetaData Editor for microscopy) from Susanne Kunis, Stefanie Weidtkamp-Peters and colleagues, which offers flexible editing of microscopy metadata; Micro-Meta App from Caterina Strambio-De-Castillia and colleagues, which is a user-friendly tool for extraction and collection of relevant microscopy metadata; and MethodsJ2 from Claire Brown and colleagues, which serves to capture metadata and automatically generate a template methods text.

These papers herald a larger movement in microscopy, where open software, open hardware and data sharing are becoming top priorities and underscoring innovation. Cutting-edge methods like deep learning, along with many large-scale atlas projects, have highlighted the benefits of sharing increasingly large and well-annotated datasets. For such sharing to be meaningful, the provenance of the data must be clear, and proper metadata recording and reporting are crucial. Along these lines, a Comment from Shuichi Onami, Jason Swedlow and colleagues in the Global Bioimaging group describes specifications and usability requirements for image data repositories, such that users can properly share and reuse shared data. A separate research paper from Swedlow and colleagues describes OME-NGFF, a next-generation file format for bioimaging that, importantly, uses a common metadata format for FAIR data.

These papers also highlight an important trend in microscopy—the rise of imaging core facilities and especially the roles of 'imaging scientists'—in the future of biological research. As microscopes increase in complexity and become more tailored to specific biological questions, the role of core facilities and imaging experts in hosting and maintaining microscopes and training users has become critical.

These imaging experts, unsurprisingly, comprise many of the authors of the papers in this issue. The reasons are clear: they understand the nuances of microscopy intimately from front to back, they know what details are needed to reproduce a study, and they likely have been frustrated trying to reproduce incompletely published methods. They also represent a crucial link between biologists and microscope developers, and therefore are well-poised to serve in global bioimaging communities and propose guidance. For these facilities and indeed imaging scientist positions to continue to exist, their work must be acknowledged on research papers, they must be given authorship when appropriate, and their positions must be actively funded by institutions and funding agencies.

What metadata reporting will *Nature Methods* require? This remains an open question that we will follow closely. We fully support the guidelines published in these pieces and encourage researchers to use the tools described to improve their microscopy reporting. As the guidelines become more widely disseminated and explored, we envisage consensus standards emerging, becoming commonly implemented by users, becoming expected by referees, and becoming requirements in our pages. We are not the alone in publishing on this topic and point readers to two papers from Teng-Leong Chew and colleagues in the *Journal of Cell Science* for more (Aaron and Chew, 2021; Heddleston et al., 2021). We are moved by this wave of interest from the microscopy community in improving rigor, reproducibility and sharing, and have every reason to be excited about the future of bioimaging. ❐

Published online: 3 December 2021
https://doi.org/10.1038/s41592-021-01347-5