

ARTICLE

***microPublication Biology*: An introduction to Publishing and Teaching with a Small-Format, Peer-Reviewed Journal**Lina Dahlberg¹, Daniela Raciti², Karen Yook²¹Western Washington University, Biology Department, Bellingham, WA, 98225, USA; ²*microPublication Biology*, Division of Biology and Biological Engineering 156-29, California Institute of Technology, Pasadena, CA 91125, USA.<https://doi.org/10.59390/AUIV7625>

microPublication Biology (micropublication.org) is a non-profit, community-focused, peer-reviewed journal dedicated to publishing small (single-figure) reports of data, methods and software related to a variety of model organisms. A workshop on *microPublications* at the Faculty for Undergraduate Neuroscience (FUN) conference in Summer 2023 focused on 1) publishing data—especially student research experiences, and data gathered through course-based research, and 2) using the *microPublication* platform and article template in teaching and learning. In this article,

we further describe the *microPublication* platform and workflow and how PI's can use this venue to publish student work. We also provide examples of how the *microPublication* format can be adapted and adopted as tools for undergraduate teaching and learning.

Key words: microPublication; undergraduate teaching; undergraduate research; course-based undergraduate research experience (CURE); peer-review

Primary, peer-reviewed literature is a central form of science communication but incorporating it as a goal in undergraduate research and/or teaching can be daunting. Publishing student research can take longer than the 4-5 years that an undergraduate is enrolled in a college or university. Moreover, even straightforward primary literature can be overwhelming for students to read. In a workshop at the Faculty for Undergraduate Neuroscience (FUN) conference in Summer 2023, we presented a workshop on *micropublications* as an alternative to multi-figure peer-reviewed primary literature for publication and teaching.

microPublication Biology is an online journal that publishes single-figure, peer-reviewed articles that are indexed by PubMedCentral and discoverable in PubMed (Raciti et al., 2018). *microPublication Biology* was launched in 2016 with the vision to enable publication of peer-reviewed, single-result novel findings from research laboratories of primarily undergraduate through R1 institutions. The journal immediately expanded to other research findings. These data now include replications of published experiments, which are important for demonstrating reproducibility, and negative data, which are experimentally important and save effort for future researchers. *microPublication Biology* has successfully attracted leading scientists in the field of biology, with a primary emphasis on swiftly and openly sharing scientific research results on a fully Open Access website, www.micropublication.org. In its eight years, the journal has published over 900 articles.

Many laboratories generate data that never make it to the broader scientific community. Such data languish in laboratory notebooks or computer files for lack of a larger narrative. Data published in *microPublication Biology* do not need to be situated in larger narratives. Each article is a standalone result from solid experimentation, allowing the publication of high-quality data that might not otherwise be

published. Thus, *micropublication Biology* tackles a persistent problem of insufficient data sharing in a way that strengthens scientific discourse. In addition, the journal accepts a wide range of scientific data, including neuroscience, ecology and evolution, education research data, methods, data from course-based and student-driven research, and articles on science and society.

An early vision of the journal was to incorporate research findings into community-supported authoritative knowledgebases as the data are published. The founding team for *microPublication* stem from the Model Organism Database, WormBase (www.wormbase.org; (Harris et al., 2020)), the authoritative resource dedicated to the model organism *Caenorhabditis elegans*. Since its inception, the journal has grown organically to cover scientific communities beyond *C. elegans*. With each new community, the *microPublication Biology* team collaborates with the community's database to find experts and curators to help the editorial team. The team currently comprises more than 50 experts and database curators who volunteer for various roles, ranging from Scientific Curators (responsible for ensuring that reported data meet community standards) and Managing Editors to Senior Scientific Editors (Science Officers). Further, the data are curated making them available in relevant databases such as WormBase, FlyBase (Gramates et al., 2022) Saccharomyces Genome Database (SGD, www.yeastgenome.org, (Wong et al., 2023), the Arabidopsis Information Resource (TAIR, www.arabidopsis.org, (Berardini et al., 2015) , and linked to the Alliance of Genome Resources Consortium (Alliance of Genome Resources Consortium, 2020).

Micropublications are highly adaptable tools that engage students with inclusive, student-centered practices for teaching and learning. The single-figure format, clearly written template, and short length help students with important scientific practices, including reading and

interpreting primary scientific literature. In addition, students can use the microPublication article format to practice hypothesis building, data analysis and interpretation, science communication and record keeping in research labs and laboratory courses. Finally, published microPublications can form the basis of peer-review and scientific writing lessons.

The FUN workshop focused on how micropublication articles can be integrated into undergraduate research and teaching. Here, we describe the introduction to publishing and teaching with microPublications. We also describe resources and future directions that resulted from the workshop.

WORKSHOP FORMAT at FUN

Participants in the FUN workshop on microPublication were provided with presentation slides, rubrics, and examples of student microPublication assignments and work (anonymized) through a shared Google drive. Readers who are interested in seeing these items should contact L. Dahlberg (corresponding author).

MICROPUBLICATION BIOLOGY: PUBLISHING AND TEACHING

The FUN workshop was divided into two parts, which were designed to introduce participants to *micropublication Biology's* platform for publishing research done by undergraduate students and to provide ideas for using the format in teaching.

Publishing Undergraduate Research with *micropublication Biology*

micropublication Biology publishes original single-figure, peer-reviewed manuscripts that have not been published anywhere else. The publication process is analogous to other peer-reviewed journals, but there are several features of microPublications that make them particularly amenable to undergraduate research. Importantly, submission and communication with editorial staff all takes place on the microPublication portal and dashboard, which require a user account and login (Figure 1).

The single figure format can be important for faculty working with undergraduate researchers because a single research figure (with one or more panels) may represent years of student work, across numerous undergraduate researchers' tenure. Importantly, *micropublication Biology* is dedicated to publishing high-quality data, but not necessarily "positive results." Along with "new findings" authors can identify articles as "replication-successful," "replication-not successful" and "negative results," among others. Thus, faculty and student researchers whose work might otherwise not be included in a larger manuscript because of time constraints or the nature of the findings, can still publish their research, and be cited in future publications.

All microPublications are peer-reviewed, and authors are required to suggest reviewers at the time of submission. Reviewers, who can be additionally recommended by Science Officers, are often Principle Investigators (PIs) but can also be post-docs or senior graduate students, although these reviewers need to be endorsed by their PIs.

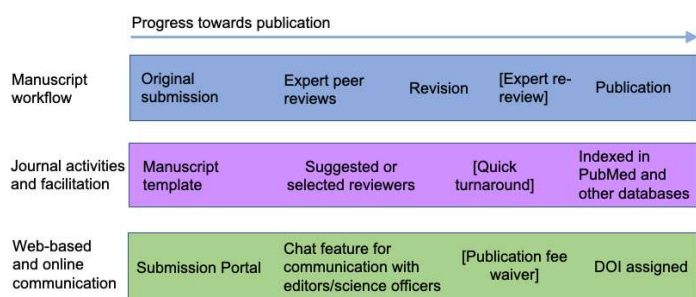


Figure 1. Overview of publication timeline with microPublication. The online format for *micropublication Biology* facilitates publication following a typical manuscript submission and review process (blue). The journal itself depends on a clear writing template and community and author engagement to find expert reviewers; following review, which is usually relatively fast, the single-figure publications are indexed in PubMed and data is annotated in online databases. The web-based submission and communication platform facilitates interactions between editors and authors.

Reviewers may choose to remain anonymous, but many do not. Because reviewers are only asked to review a single figure of data, reviews are usually received quickly. Reviewers may ask for further experiments if they are warranted (for example if an important control is missing), but the mission of the journal is to publish good data efficiently. Thus, a change in interpretation or qualification may be suggested in lieu of requiring further data collection.

microPublications that are accepted for publication are deposited as an OpenAccess article in PubMedCentral and assigned a Digital Object Identifier. There is a \$250 publication fee for accepted manuscripts, but waivers may be granted depending on funding situations (requests must be accompanied by a letter from your department chair). This can be particularly important for faculty and students at Primarily Undergraduate Institutions (PUIs) who may have limited funds to defray publication costs.

While microPublications cannot contain more than one figure, if there are related data sets that connect or tell a cohesive story, they can be submitted as an *Integrations* article set. Integrations are stand-alone microPublications that are connected by a theme and/or by a short integration article that ties the articles together with a focused discussion. Examples could include analysis of related mutant alleles or cell lines, or complimentary experiments on a single system (ex. (Hulsey-Vincent et al., 2023a, 2023b, 2023c).

microPublications have proven to be an important space for articles that feature undergraduate co-authors. To date there are over 60 microPublications based on undergraduate and high-school laboratory research and course-based research at two- and four-year colleges (Attix et al., 2021; Leonard and Vidal-Gadea, 2021; Alfonso et al., 2023). Because they are short and follow a clear template, students can more easily be included in the writing, revision, and publication process. In addition, all author contributions need to be acknowledged using the CRediT system of Contributor Roles Taxonomy, which provides a clear representation of how collaboration functions in scientific communication. For researchers who work closely with

Potential student gains:	Potential instructor gains:
Ownership of laboratory and research work.	Reasonable amounts of text for reading/grading/revising
Condensing work into readable, annotated figures with thorough figure legends.	A record of methods and reagents associated directly with results.
Communicating hypotheses, rationale, and findings concisely.	Clear products for building future courses.
Putting research into a broader context.	Records of successes, failures, and troubleshooting.
A product that they can include in portfolios.	Student-generated future directions.

Table 1. Descriptions of how using the micropublication format in lieu of student laboratory reports in a Course-Based Research Experience can benefit students and instructors.

undergraduates in labs or laboratory courses, microPublications are an important venue for high quality data that might otherwise not be included in a publication.

Beyond individual faculty-driven research, *microPublication Biology* also publishes work from Large-scale Course-based Research Experiences. Data generated by students enrolled in the nationally distributed Genomics Education Partnership (Rele et al., 2022), Fly-CURE (Merkle et al., 2023), and smaller recurring CUREs have published student generated data as microPublications (exs. Zirkel et al., 2023; Rubenstein et al., 2024). Thus, student contributions to the scientific process and the scientific community can be integrated into laboratory classroom learning and disseminated beyond the classroom. In addition, participation in the micropublication process builds science identity for students (Rubenstein et al., 2024).

As part of the FUN workshop, participants were encouraged to brainstorm or outline their own micropublication article, based on existing data, or a planned experiment. The subsequent discussion focused on whether microPublications could be based on non-model systems research (they can), how many data panels a single figure can contain (it is variable), and whether education research can be submitted for publication (yes). Participants were also provided with a printable form of the submission template, which is available from the journal website.

Teaching and learning using microPublications

microPublications are well-suited to teaching undergraduates in a variety of settings. They can be the basis for iterative writing assignments, serve as alternatives to laboratory reports, and be used as templates for practicing peer-review. These important scientific communication skills can be difficult to integrate into curricula (Kim et al., 2023).

The short format of these articles presents a manageable length for teaching and learning. The articles' brevity provides a reasonable length for students to practice and revise scientific writing about data. Because the template format is constrained, feedback can be succinct and targeted, keeping it from being burdensome for instructors.

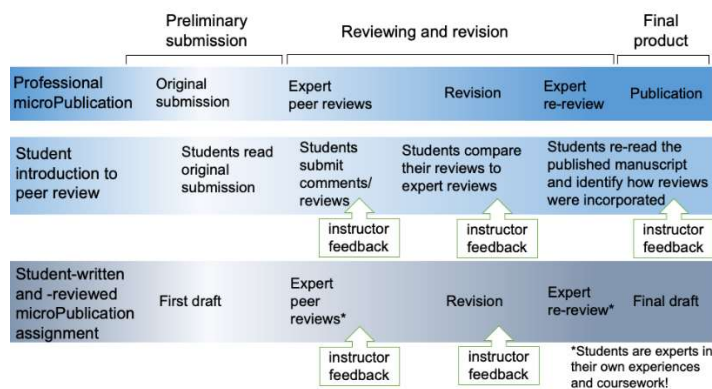


Figure 2. An example of how published microPublications and student assignments using the microPublication format can be combined to introduce students to peer-review and scientific writing. Using the progression of professional publication as a template (dark blue section, top), students can read and review an original submission and receive instructor feedback on their work (light blue section, middle). Once students are comfortable with the review process, they can give and receive peer-reviews from other “student experts” (asterisks) on their own iterative writing assignments (grey section, bottom). This scheme can be used in laboratory or seminar-style courses.

In addition, the small volume of writing per article provides both a challenge for students learning to write scientifically and reassurance because there is no expectation for a long product. Table 1 highlights some of the other gains for students and instructors when using microPublications as a final assessment in lieu of a laboratory report for a 10-week CURE.

Peer-review is central to reliable scientific discourse, but it can be hard for students to grasp how peer-review is able to improve scientific communication (McDowell et al., 2022; Otto et al., 2023). One way to help guide students towards providing better peer-reviews is to have them look at actual expert reviews. *microPublication Biology* maintains a record of original submissions, reviews, and revised manuscripts, which can be used to teach students the skills to provide thoughtful, critical, and helpful feedback to peers. Once they are comfortable with how peer-review can work, students are more likely to provide useful feedback to their own peers on class writing assignments. Thus, students learn skills to provide thoughtful, critical, and helpful feedback.

Figure 2 shows how a combination of the iterative reviewing and writing assignments can parallel the submission, review, and publication process. Importantly, instructor feedback throughout the process helps guide students and can be included as formative or summative assessments. This scheme also includes ample opportunities to include student self-reflection (metacognition) throughout the process.

SUMMARY

Single-figure, short-form articles can be an efficient way to ensure that data generated as part of undergraduate research in laboratories and classrooms is shared with the greater scientific community. In addition, short-form writing assignments can be useful for teaching effective strategies for scientific communication and peer-review.

microPublication Biology provides a venue for these types of publications and their format serve as templates for teaching scientific writing and review to undergraduate students. The community-minded organization of *microPublication Biology* enhances the value of the journal for publication and learning by offering connections to a field of like-minded reviewers and editors, and a commitment to the education of the next generation of scientists.

REFERENCES

- Alfonso SA et al. (2023) Argentine ant extract induces an osm-9 dependent chemotaxis response in *C. elegans*. *microPublication Biology* Available at <https://www.micropublication.org/journals/biology/micropub-biology-000745>.
- Alliance of Genome Resources Consortium (2020) Alliance of Genome Resources Portal: unified model organism research platform. *Nucleic Acids Res* 48:D650–D658. Available at <https://doi.org/10.1093/nar/gkz813>
- Attix H, George A, Panchal H, Cortez A, Cho M, Zarilla K, Hastie E (2021) Wild Caught Nematode Identification and Early Embryo Development: An accessible undergraduate research experience. *microPublication Biology* Available at <https://www.micropublication.org/journals/biology/micropub-biology-000447>.
- Berardini TZ, Reiser L, Li D, Mezheritsky Y, Muller R, Strait E, Huala E (2015) The arabidopsis information resource: Making and mining the “gold standard” annotated reference plant genome. *genetics* 53:474–485 Available at: <https://onlinelibrary.wiley.com/doi/10.1002/dvg.22877>.
- Gramates LS, Agapite J, Attrill H, Calvi BR, Crosby MA, Dos Santos G, Goodman JL, Goutte-Gattat D, Jenkins VK, Kaufman T, Larkin A, Matthews BB, Millburn G, Strelets VB, the FlyBase Consortium (2022) FlyBase: a guided tour of highlighted features. *Genetics* 220:iyac035. Available at <https://doi.org/10.1093/genetics/iyac035>
- Harris TW et al. (2020) WormBase: a modern Model Organism Information Resource. *Nucleic Acids Res* 48:D762–D767. doi: 10.1093/nar/gkz920
- Hulsey-Vincent H, Alvinéz N, Witus S, Kowalski JR, Dahlberg C (2023a) A Fiji process for quantifying fluorescent puncta in linear cellular structures. *microPublication Biology*. Available at <https://www.micropublication.org/journals/biology/micropub-biology-001003>.
- Hulsey-Vincent H, Athanasopoulos A, McGehee A, Kowalski JR, Dahlberg C (2023b) A Fiji protocol for analyzing puncta is a robust tool for measuring GLR-1::GFP accumulation in the ventral nerve cord of *C. elegans*. *microPublication Biology*. Available at <https://www.micropublication.org/journals/biology/micropub-biology-001004>.
- Hulsey-Vincent H, McClain M, Buckley M, Kowalski JR, Dahlberg CL (2023c) Comparison and agreement between two image analysis tools for quantifying GFP::SNB-1 puncta in *fshr-1* mutants of *C. elegans*. *microPublication Biology*. Available at <https://www.micropublication.org/journals/biology/micropub-biology-001005>.
- Kim C, Preston K, Braga A, Fankhauser SC (2023) Increasing Student Confidence in Writing: Integrating Authentic Manuscript Writing into an Online 8-Week Research Program McCartney M, ed. *J Microbiol Biol Educ* 24:e00199-22 Available at <https://journals.asm.org/doi/10.1128/jmbe.00199-22>.
- Leonard N, Vidal-Gadea AG (2021) Affordable *Caenorhabditis elegans* tracking system for classroom use. *microPublication Biology* Available at <https://www.micropublication.org/journals/biology/micropub-biology-000377>.
- McDowell GS, Fankhauser S, Saderi D, Balgopal M, Lijek RS (2022) Use of preprint peer review to educate and enculturate science undergraduates. *Learned Publishing* 35:405–412 Available at <https://onlinelibrary.wiley.com/doi/abs/10.1002/leap.1472>.
- Merkle JA, Devergne O, Kelly SM, Croonquist PA, Evans CJ, Hwalek MA, Straub VL, Hamill DR, Puthoff DP, Saville KJ, Siders JL, Villanueva Gonzalez ZJ, Wittke-Thompson JK, Bieser KL, Stamm J, Vrailas-Mortimer AD, Kagey JD (2023) Fly-CURE, a Multi-institutional CURE using *Drosophila*, Increases Students' Confidence, Sense of Belonging, and Persistence in Research. *bioRxiv:2023.01.16.524319*. Available at <https://doi.org/10.1101/2023.01.16.524319>
- Otto JL, McDowell GS, Balgopal MM, Lijek RS (2023) Preprint Peer Review Enhances Undergraduate Biology Students' Disciplinary Literacy and Sense of Belonging in STEM. *Journal of Microbiology & Biology Education* 24:e00053-23 Available at <https://journals.asm.org/doi/10.1128/jmbe.00053-23>.
- Raciti D, Yook K, Harris TW, Schedl T, Sternberg PW (2018) Micropublication: incentivizing community curation and placing unpublished data into the public domain. *Database (Oxford)* 2018. Available at <https://doi.org/10.1093/database/bay013>
- Rele CP, Sandlin KM, Leung W, Reed LK (2022) Manual annotation of *Drosophila* genes: a Genomics Education Partnership protocol. *F1000Res* 11:1579 Available at <https://f1000research.com/articles/11-1579/v1>.
- Rubenstein LD, Woodruff KA, Taylor AM, Olesen JB, Smaldino PJ, Rubenstein EM (2024) “Important Enough to Show the World”: Using Authentic Research Opportunities and Micropublications to Build Students' Science Identities. *Journal of Advanced Academics:1932202X241238496* Available at <https://journals.sagepub.com/doi/10.1177/1932202X24123849>.
- Wong ED, Miyasato SR, Aleksander S, Karra K, Nash RS, Skrzypek MS, Weng S, Engel SR, Cherry JM (2023) *Saccharomyces* genome database update: server architecture, pan-genome nomenclature, and external resources. *Genetics* 224:iyac191. Available at <https://doi.org/10.1093/genetics/iyac191>
- Zirkel J, Hulsey-Kemp AM, Storm AR (2023) *Gossypium hirsutum* gene of unknown function, Gohir.A02G039501.1, encodes a potential DNA-binding ALOP protein involved in gene regulation. *microPublication Biology* Available at <https://www.micropublication.org/journals/biology/micropub-biology-000670>.

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