

# The Genomics Education Partnership: Teaching and Research Opportunities



Genomics  
Education  
Partnership

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## Abstract

The Genomics Education Partnership (GEP; [thegep.org](http://thegep.org)) is a nationwide collaboration of faculty from 180+ institutions with the goal of increasing understanding of genetics and familiarity with bioinformatics in diverse student populations through the incorporation of Course-based Undergraduate Research Experiences (CUREs) in the curriculum. Participating institutions range from community colleges, to PUIs, MSIs, HBCUs, and R1 universities. To facilitate both faculty and student access to curriculum materials and support active participation in the research, GEP provides a web-based platform with curated curriculum/training materials that can easily be incorporated into existing courses. During the COVID-19 pandemic, the accessible and immersive GEP curriculum and custom bioinformatics tools provide an inexpensive online framework for students to participate in research despite the lack of access to a traditional lab environment. During the 2020-2021 academic year, GEP reached over 3900 students. Through the GEP curriculum, students learn to annotate newly-sequenced eukaryotic genomes. They learn to leverage evidence from related informant species, experimental data (e.g., RNA-Seq), gene prediction algorithms, evolutionary conservation, and basic molecular biology rules to create a defendable gene model. The GEP research projects include investigation of venom evolution in parasitoid wasps, the evolution of insulin pathway genes across 27 *Drosophila* genomes, and expansion of the F element in four *Drosophila* species. We plan to expand the projects to additional species. Student gene models are reconciled and collated to generate a large dataset for evolutionary genomic studies, with student/faculty co-authors. Additionally, GEP supports the publication of the gene models as microPublications, with students as lead authors. The GEP also engages in science education research. Our recent findings suggest that student perceptions of science, positive and negative, impact student learning outcomes. In addition to accessing the curriculum materials and tools, GEP faculty benefit from professional development opportunities and the support of a national network of like-minded colleagues. With the support of NSF and NIH, GEP is actively recruiting additional faculty members, particularly at MSIs and community colleges, and both science and science education partners to collaborate on additional projects. Supported by NSF grants 1915544 and 1431407, and NIH R25GM130517.

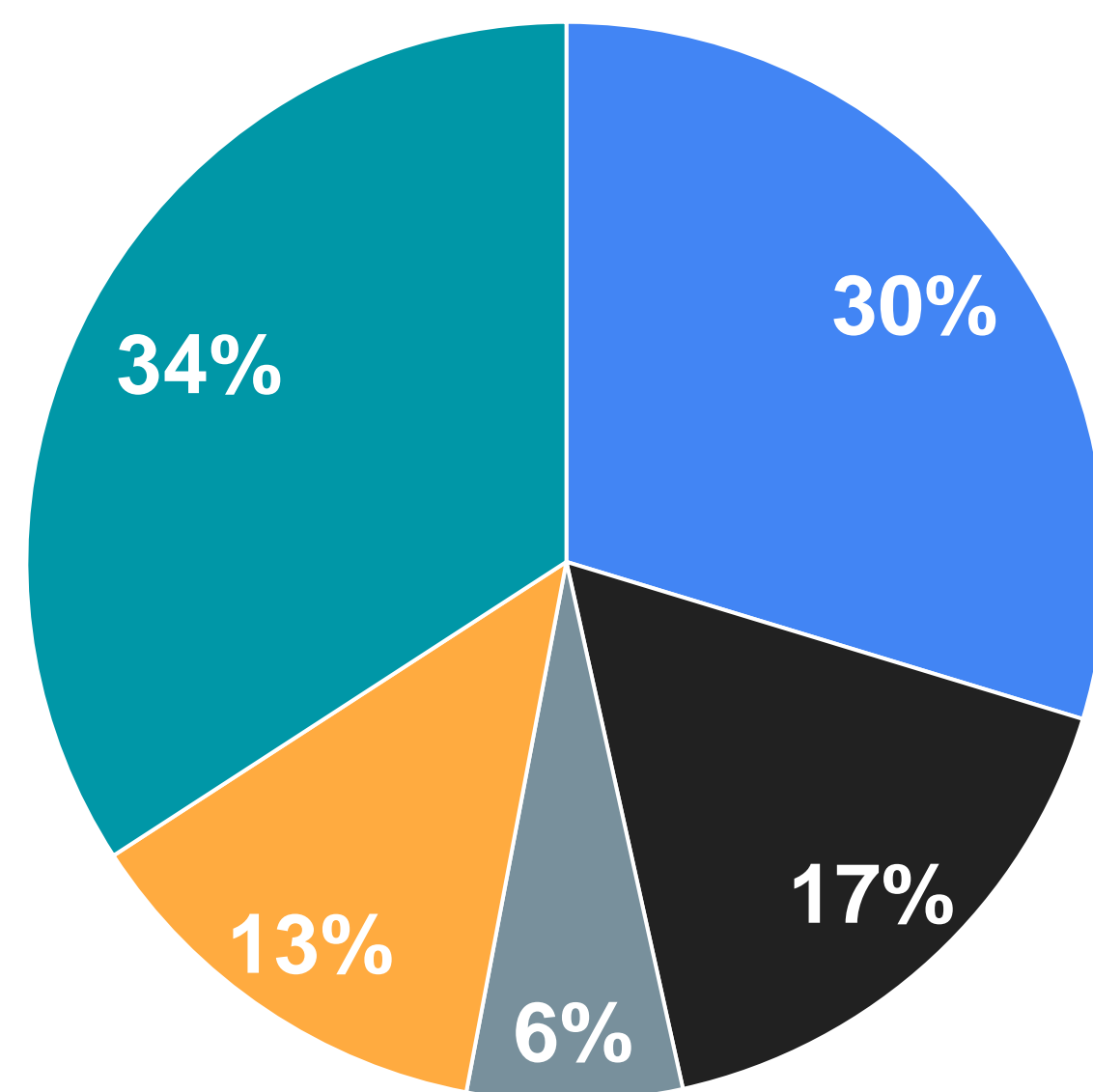
## GEP Faculty and Students Represent Different Backgrounds and Institutions

### GEP goals:

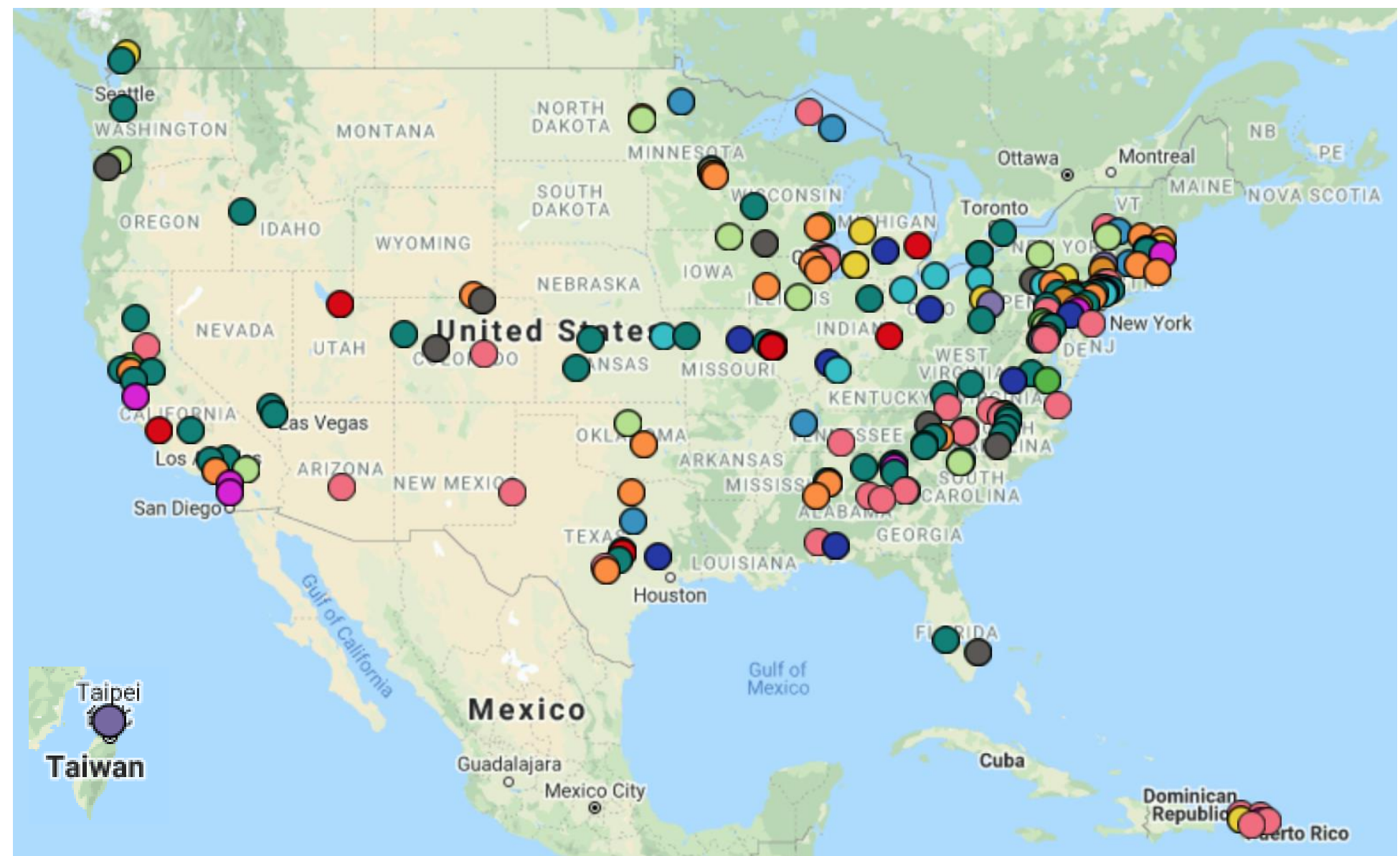
- Incorporate **genomics and bioinformatics** into the undergraduate curriculum
- Enable undergraduates to participate in **genomics research** during the academic year

#### Diversity of the 202 affiliated institutions

- Minority Serving Institutions
- Hispanic Serving Institutions
- Historically Black Colleges or Universities
- Community Colleges
- Other



## In 2020/2021 Genomics Education Partnership (GEP) Engaged >3945 Students Nationwide



Year: 2006 (red), 2007 (dark blue), 2008 (green), 2009 (yellow), 2010 (orange), 2011 (purple), 2012 (grey), 2013 (teal), 2014 (blue), 2015 (dark blue), 2016-2017 (light green), 2018 (orange), 2019 (yellow), 2020 (teal), 2021 (pink)

- 242 active faculty members
- 202 active affiliated institutions
- >3,945 undergraduate students participated in 2020/2021
- 20 faculty and 51 undergraduate students represented GEP at conferences/workshops in 2020/2021

## Benefits for Faculty and Students

Students participate in research learning from the annotation process

Curriculum for beginning students

Use the UCSC Genome Browser to teach eukaryotic gene structure:

- Laakso *et al.* (2017) CourseSource.

Curriculum for advanced students

Hidden Markov Models

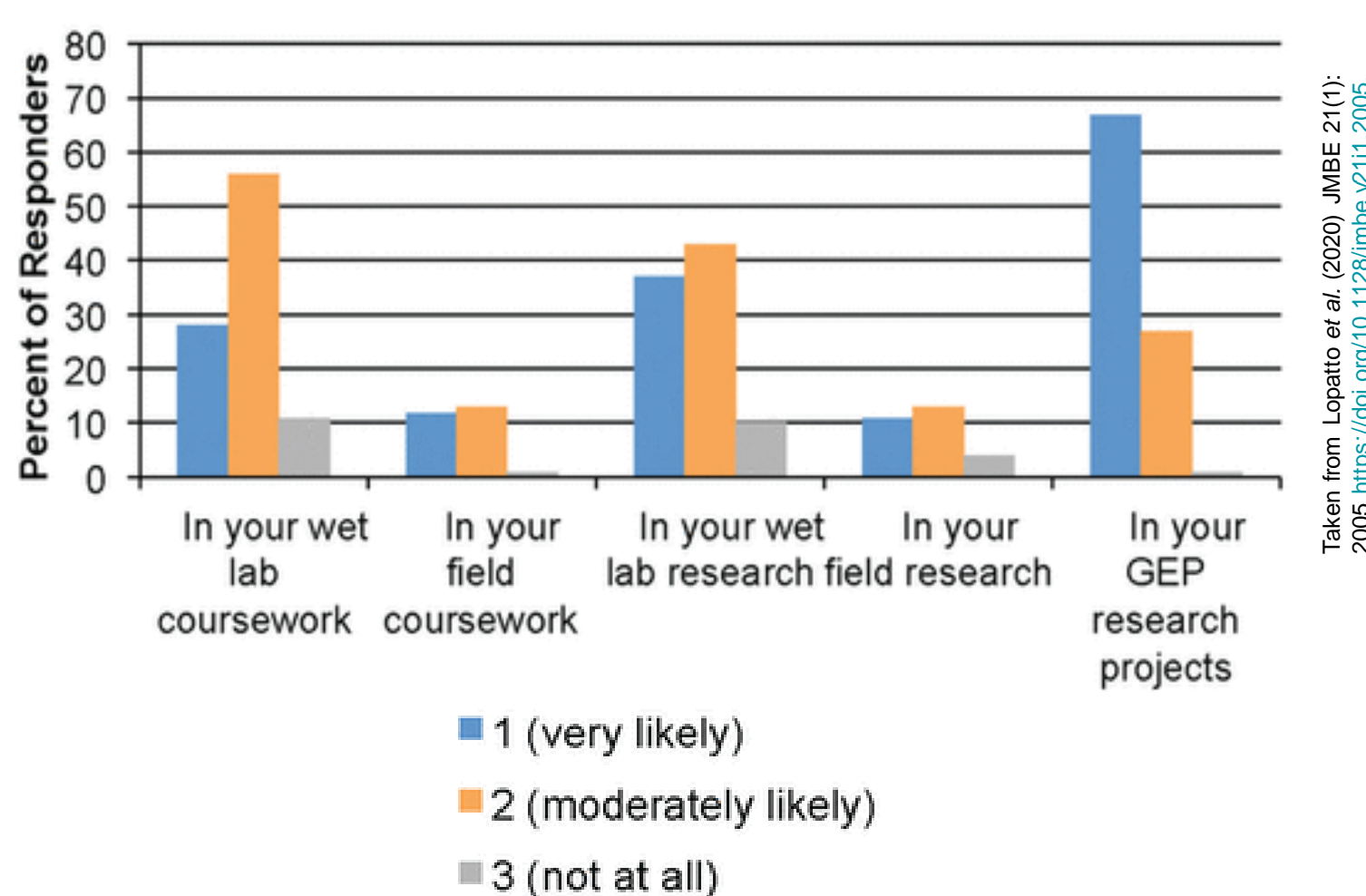
- Weisstein *et al.* (2016)

CourseSource.

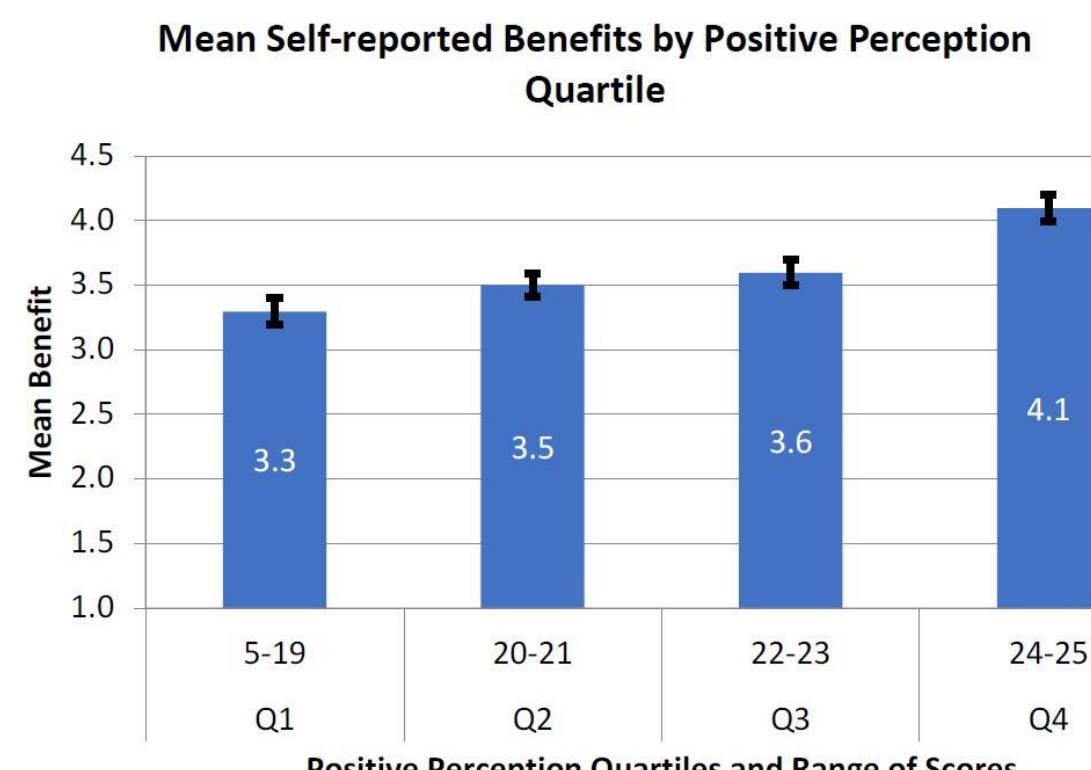
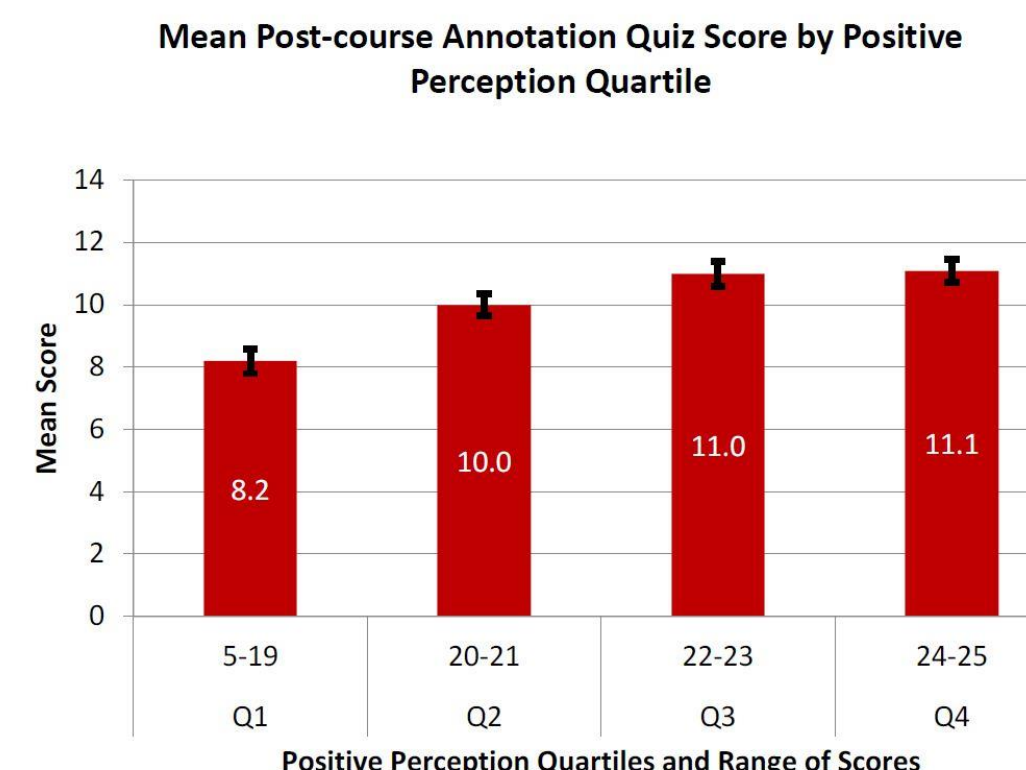
Dynamic Programming

- "Beyond Annotation" section of the GEP web site: <http://thegep.org>

Faculty are more likely to let their students risk failure in GEP research projects



- Advantages of online GEP platform : low cost, elimination of lab safety issues, 24/7 access, inexpensive mistakes. Students learn how to work through mistakes.
- Faculty are more likely to allow students risk failure in a supportive manner.
- Students that approach the CURE with positive attitude are more likely to have learning gains.



One-way ANOVA between groups yields statistically significant results. Students with positive perception of science score significantly higher and report having more benefits than students with more negative perceptions ( $p < 0.05$ ). Error bars represent 2 SEM. Taken from Lopatto *et al.* (2022), in revisions.

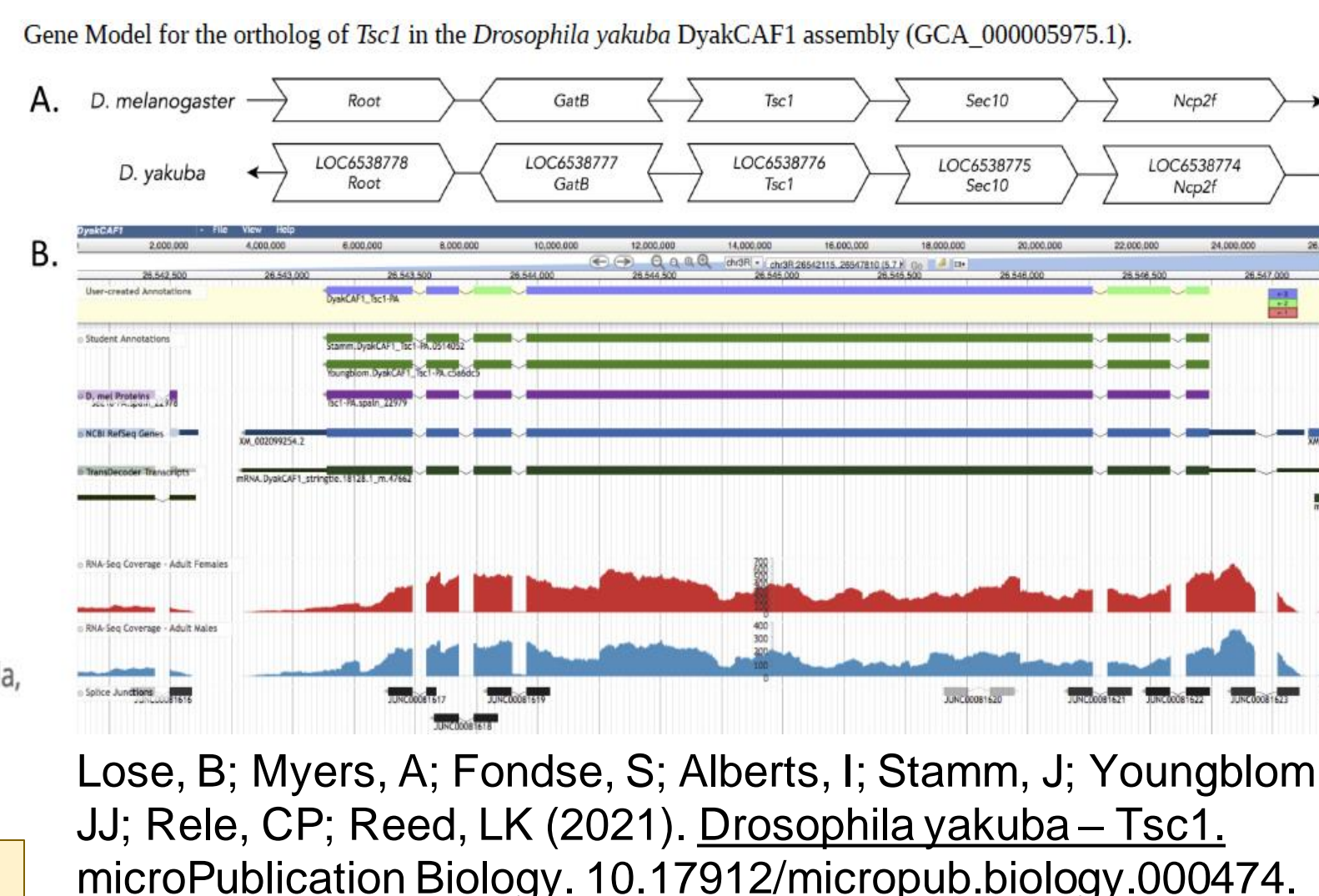
## Students as Co-authors in Publications and Lead Authors in microPublications

G3  
Genes | Genomes | Genetics

Retrotransposons Are the Major Contributors to the Expansion of the *Drosophila ananassae* Muller F Element

Wilson Leung, Christopher D. Shaffer, Elizabeth J. Chen, Thomas J. Quisenberry, Kevin Ko, John M. Braverman, Thomas C. Giarla, Nathan T. Mortimer, Laura K. Reed, Sheryl T. Smith, Srebrenka Robic, G3 (Bethesda). 2017 Aug 7;7(8):2439-2460.

(239 co-authors participated as students)

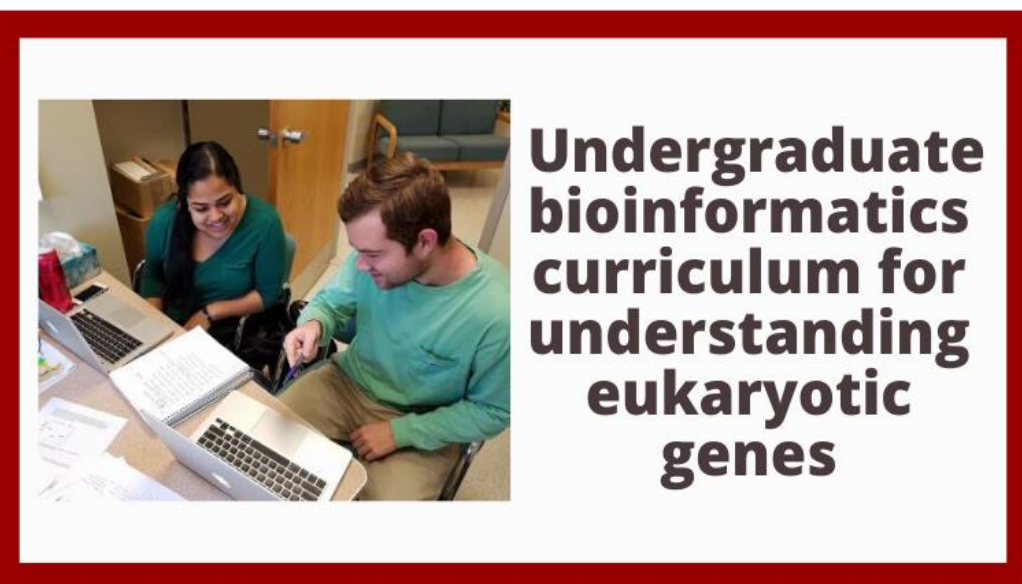


Lose, B; Myers, A; Fondse, S; Alberts, I; Stamm, J; Youngblom, JJ; Rele, CP; Reed, LK (2021). *Drosophila yakuba*—Tsc1. microPublication Biology. 10.17912/micropub.biology.000474.

## Science Education Publications

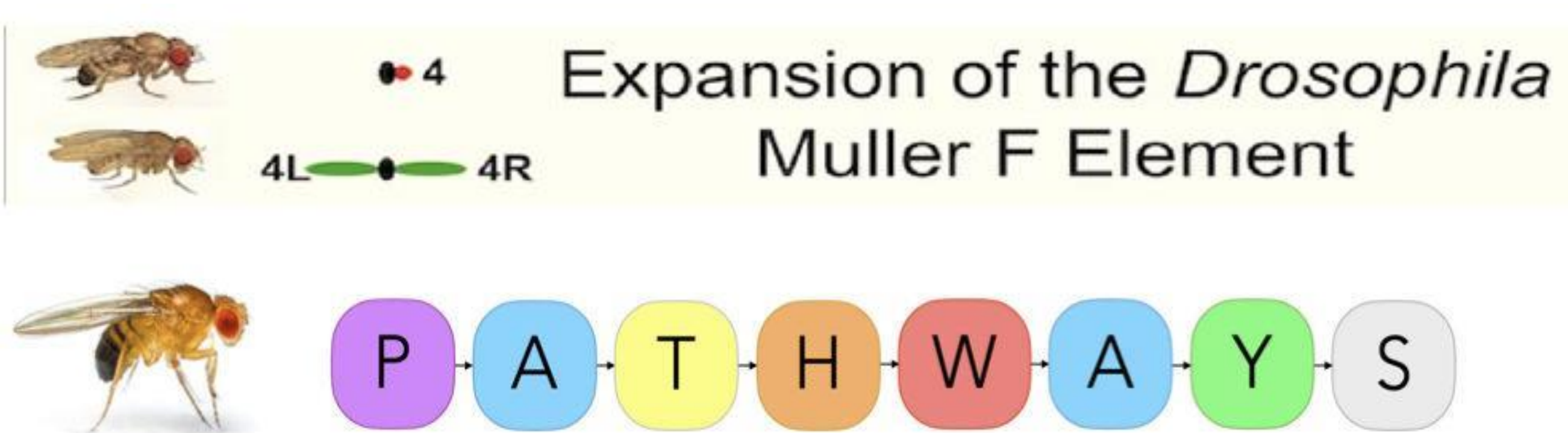


Lopatto D, et al. Facilitating Growth through Frustration: Using Genomics Research in a Course-Based Undergraduate Research Experience. *J Microbiol Biol Educ.* 2020;21(1):21.1.6. Published 2020 Feb 28. doi:10.1128/jmbe.v21i1.2005



Laakso, M.M., et al. 2017. An undergraduate bioinformatics curriculum that teaches eukaryotic gene structure. CourseSource. <https://doi.org/10.24918/cs.2017.13>

## Current Science Projects

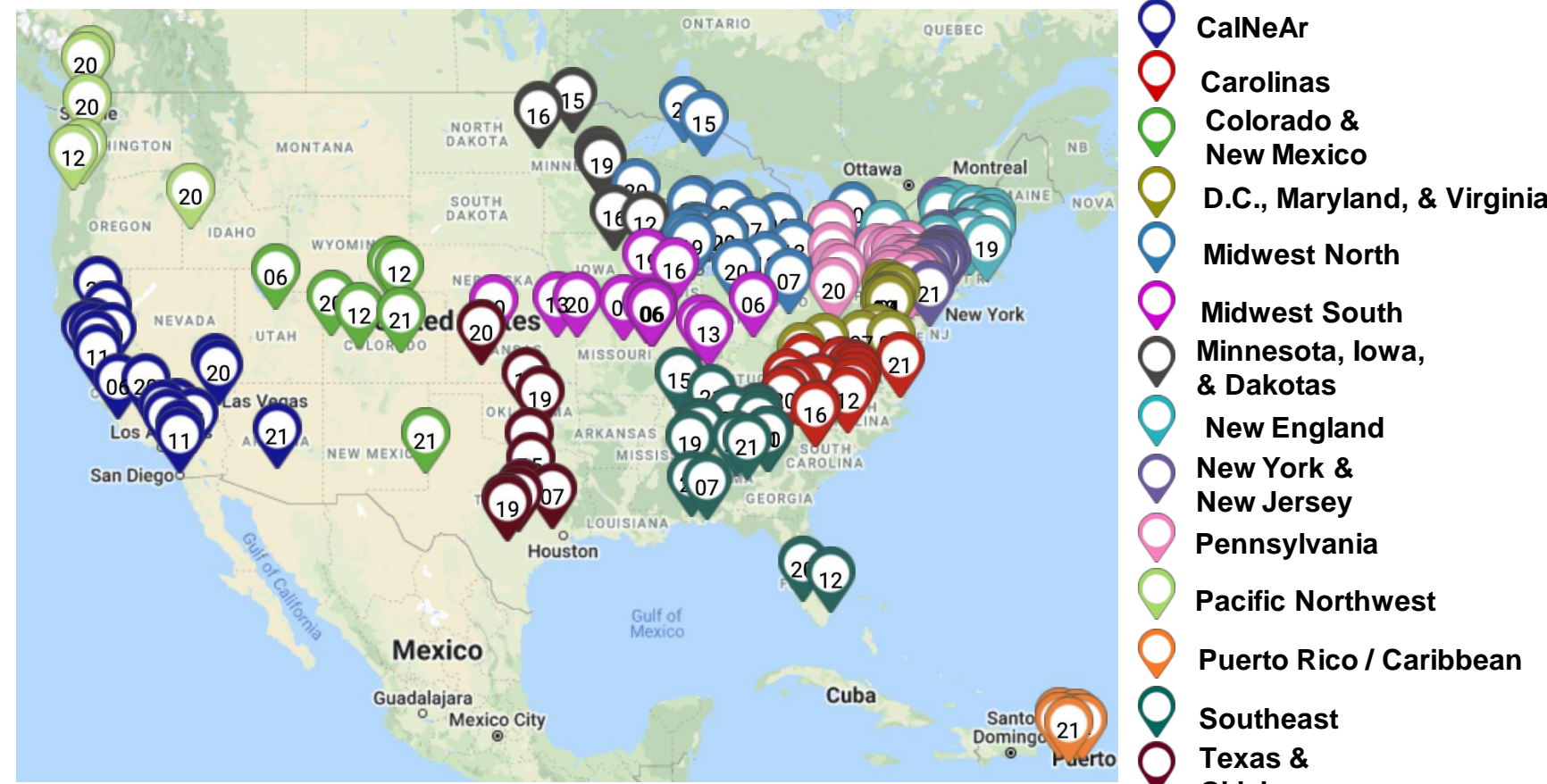


## Parasitoid Wasp Project

## GEP is a Supportive Community of Practice

### 15 Regional Nodes

GEP Virtual TAs experienced students support their peers during the semester and reconcile novel annotated genes from CURE projects.



GEP Alumni Workshop held each summer to network and discuss on-going science, implementation, curriculum, assessment, and professional development, planning for the future.

## Future Directions

- Increase the number and the diversity of undergraduate and faculty participants.
- Provide responsible conduct of research training to all our faculty and students.
- Hold additional Regional Node New Member Trainings during the 2022-2023 academic year
- Contact us if you are interested in joining GEP! <https://thegep.org>



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