

Guenther Laboratory

Project: Development and Space Validation of an In Situ Handheld Bioprinter

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Background: In situ bioprinting enables the direct deposition of biomaterials and bioinks at the site of interest, allowing tissue constructs to be formed directly on complex, three-dimensional biological surfaces. This approach overcomes key limitations of conventional benchtop bioprinting, which is typically restricted to planar substrates and gravity-dependent operation. By enabling conformal, on-demand deposition, in situ bioprinting represents an important advance in biofabrication for both terrestrial and space-based research environments. The Guenther Laboratory has developed a compact handheld in situ bioprinter designed to operate independent of orientation and gravitational direction. The system enables controlled extrusion of biomaterials and supports precise spatial patterning directly on target surfaces. This bioprinting platform has been validated in large-animal wound models, where in situ deposition of bioinks demonstrated effective wound coverage, enhanced tissue integration, and accelerated regenerative outcomes compared to conventional approaches (Cheng *et al.*, 2020). In parallel, the bioprinter has been experimentally evaluated in reduced-gravity environments through parabolic flight campaigns. These studies demonstrated gravity- and orientation-independent printing using advanced bioink formulations, with preservation of structural fidelity and high post-printing cell viability. The results confirm that in situ bioprinting can be performed reliably under microgravity conditions, supporting its potential use in space-based biofabrication research (Singh *et al.*, 2026).

Project Objectives: Building on these prior validations, the current project focuses on preparing the INSITE handheld bioprinter for its next phase of space testing on a suborbital platform. Specific project objectives may include:

- Mechanical and structural refinement of the handheld bioprinter
- Design for reliable assembly of critical subsystems
- Integration and testing of mechatronic and electronic components
- System-level validation through benchtop and simulated-environment testing

Student Opportunities: The Guenther Laboratory is seeking several **motivated undergraduate summer students** to contribute to this project. Students will work in a multidisciplinary research environment and gain hands-on experience in the development and validation of advanced biofabrication systems. Relevant backgrounds include:

- Mechanical design and manufacturing
- Mechatronics and electromechanical systems
- Embedded electronics, sensing, and instrumentation
- Prototyping, testing, and experimental research

References

1. [Cheng, Y. et al., *Biofabrication*, 12\(2\), 025007 \(2020\).](#)
2. [Singh, S. et al., *Biofabrication* 18, \(2026\).](#)