Biodesign x AI: Interactions in the Algorithmic Wet Lab

Raphael Kim
Biodesign Academy Ltd
London, United Kingdom
raphael@biodesign.academy

Yuning Chen
Design Informatics
University of Edinburgh
Edinburgh, United Kingdom
yuning.chen@ed.ac.uk

Carolina Ramirez-Figueroa
School of Communication
Royal College of Art
London, United Kingdom
c.ramirez-figueroa@rca.ac.uk

Jiwei Zhou
KTH Royal Institute of Technology
Stockholm, Sweden
jiweiz@kth.se

Orkan Telhan
Design.bio
Cambridge, United Kingdom
Biodesign Challenge
New York, USA
orkan@design.bio

Iohanna Nicenboim
Interdisciplinary Transformation
University Austria
Linz, Austria
Delft University of Technology
Delft, Netherlands
i.nicenboim@tudelft.nl

Martyn Dade-Robertson
Northumbria University
Newcastle, United Kingdom
martyn.dade-robertson@northumbria.ac.uk

Margherita Pevere
Linköping University
Linköping, Sweden
margherita.pevere@aalto.fi

Zoë Robaey
Wageningen University
Wageningen, Netherlands
zoe.robaey@wur.nl

Abstract

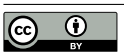
Artificial intelligence is entering biological laboratories not only as a computational tool but as a co-experimenter that proposes, selects, and learns from interactions with living matter. As models increasingly steer protein engineering, material morphogenesis, and bioart, design decisions and feedback loops become distributed across humans, algorithms, and organisms. This panel stages a focused debate around three questions for HCI: Who designs these hybrid workflows? Where does responsibility lie when outcomes emerge from coupled human–algorithm–organism systems? What counts as interaction when learning unfolds simultaneously in code, cells, and infrastructures? Panelists from design research, computational biology, ethics, and art offer contrasting provocations grounded in cases from automated wet labs, living interfaces, and critical biodesign. Through case-based debate and moderated audience discussion, the session introduces the algorithmic wet lab as a new locus of interaction, offering attendees an expanded vocabulary of material intelligence and contested directions for AI × Biodesign within HCI.

CCS Concepts

• **Human-centered computing → Human computer interaction (HCI)**.

Keywords

AI-biodesign, material intelligence, molecular-HCI, human–AI collaboration, design ethics, authorship.



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1 INTRODUCTION

The past five years have seen a rapid convergence of artificial intelligence and biological design that is changing how HCI understands "interaction". AI systems can now generate protein sequences [41], predict folding structures with near-experimental precision [18, 24, 25], and support machine-learning–assisted enzyme and material design [43]. At the same time, biodesigners and artists are increasingly integrating algorithmic processes into living artefacts—from microbial composites and hybrid bio-digital systems to robotic ecologies [4, 13, 20, 22, 28].

Together, these developments shift the locus of decision-making in design. What is emerging is an algorithmic wet lab: a setting where humans, learning models, and biological organisms co-produce outcomes through feedback loops that blur the boundaries between interaction, inference, and evolution. This moment extends earlier more-than-human and biodesign practices—long established in speculative, ecological, and critical design—but introduces a new condition: learning systems now act inside biological workflows. As a result, design trajectories can be steered by computational inference, organism adaptation, or friction between them.

For HCI, this raises foundational questions. Where does the interaction end and where does biological or algorithmic adaptation begin? Who or what counts as a designer when outcomes emerge from hybrid intelligence? These questions are based on ongoing discussions on biological-HCI [14, 15, 29] and hybrid intelligence

design [12], while pointing to a need for frameworks that can address distributed agency, shared responsibility, and entangled forms of practice. The panel convenes researchers from design research, computational biology, ethics, and art to address these tensions directly. These tensions also shape how biodesign competence is implicitly learned and assessed as AI enters biological workflows. By examining living interfaces, automated experimentation, and algorithmic biodesign, the session aims to equip the CHI community with a clearer vocabulary and conceptual foundation for engaging AI × Biodesign as a field where interaction unfolds between humans, models, and organisms learning.

2 FROM BIOLOGICAL COLLABORATION TO ALGORITHMIC CO-EVOLUTION

The algorithmic wet lab arises from two converging trajectories: the recognition of biological agency in design and the emergence of machine-learning systems capable of generating, predicting, and optimising biological form. In biodesign, the early work repositioned living systems as collaborators rather than passive media ([16, 26]). It showed that microbial and material responsiveness introduces forms of agency, resistance, and temporal complexity that designers must negotiate ([21, 30, 44]), including recent biodesign and biological HCI work that frames living artefacts as multispecies interaction systems embedded in evolving ecological relations [17]. These approaches reframed biological variability not as noise but as a meaningful signal, preparing the ground for computational systems to enter the loop.

In parallel, AI systems began to demonstrate their own capacity to infer and propose biological forms. Protein-structure prediction [18], geometric deep learning [24, 25], and generative protein design [11], shifted the computation from analysis to proposition—introducing models that generate hypotheses, explore sequence space, and steer design trajectories. Increasingly, these capabilities are not external aids, but embedded in wet-lab practice. Hybrid biological–digital systems use sensing, actuation, and real-time learning to pair growth, computation, and fabrication within a single workflow [1, 37]. Self-driving laboratories extend this further, integrating robotics, active learning, and automated experimentation [36, 38], making machine-learning models continuous participants in biological inquiry. This convergence reconfigures authorship and agency. AI-native biological tools introduce new forms of epistemic opacity and workflow fragility, causing accessibility barriers for users limited by access, novices, or cross-disciplinary users [23]. At the same time, critical HCI and STS scholarship highlights how AI infrastructures carry hidden labour, resource extraction, and power asymmetries ([2, 3, 7]), which compound with the socio-ecological labour embedded in biodesign ecologies [5].

Ethics in synthetic biology offers complementary lenses. Responsible by design approaches [39] and multispecies RRI (Responsible Research and Innovation) frameworks [35] view governance as a distributed and iterative process rather than a constraint. Concepts such as epistemic care and shared responsibility [19, 32–34] resonate strongly with the exploratory nature driven by the uncertainty of machine learning. Speculative and critical design extend these positions by making hybrid intelligence systems legible, contestable, and culturally situated [6, 8–10, 31].

At larger scales, the notion of bio-novelty foregrounds how AI-guided biological interventions participate in evolving ecological systems [40]. Materials discovery platforms [42] and generative evolutionary algorithms [27] further demonstrate that design, computation, and ecology cannot be separated. These developments position the algorithmic wet lab not simply as a technical configuration but as an emergent practice where human, computational, and biological learning systems co-evolve—raising questions of authorship, responsibility, and interaction that motivate the panel.

3 RELEVANCE TO CHI

The convergence of AI and biodesign challenges the core assumptions of HCI: the interaction now extends across systems where humans, algorithms, and living matter jointly shape outcomes. As AI enters wet-lab workflows, established concepts—agency, authorship, responsibility, accessibility—are strained in ways that the CHI community has only begun to examine. The panel brings these tensions directly into ongoing work on hybrid intelligence, more-than-human interaction, and AI ethics. By treating the algorithmic wet lab as a new site of interaction, the session offers conceptual and methodological tools for understanding multi-scale, adaptive, and materially grounded forms of intelligence in contemporary HCI practice.

4 INTENDED AUDIENCE

This panel is aimed at HCI researchers and practitioners working in AI, interaction design, biological HCI, responsible innovation, and design research. It also speaks to computational biologists, bioengineers, and biodesign practitioners seeking a stronger dialogue with HCI. The structure is designed to support both newcomers and domain specialists: attendees unfamiliar with biological workflows receive clear grounding, while experts encounter new tensions arising from hybrid intelligence. Anyone interested in how interaction evolves when intelligence is shared between humans, models, and living systems will find the session directly relevant.

5 PANEL OBJECTIVES

This panel examines how the integration of AI into biological workflows forces HCI to confront new configurations of intelligence, agency, and responsibility. By treating the algorithmic wet lab as a site where humans, models, and organisms jointly shape outcomes, the session aims to move beyond descriptive accounts and instead surface concrete disagreements, methodological challenges, and research directions for the CHI community. Through structured provocations, cross-panel debate, and audience participation, the panel will deliver the following objectives:

5.1 Defining Value of Material Intelligence for HCI Practice

The panel will introduce material intelligence as a framework for analysing systems in which learning and adaptation occur across code, cells, and infrastructures. Rather than a conceptual device, we aim to demonstrate with examples from automated wet labs, living interfaces, and computational biology, how the framework clarifies ways to reason about interaction when behaviour emerges from coupled human–algorithm–organism activity.

5.2 Surfacing Conflicting Views on Authorship, Control, and Responsibility

A core objective is to expose, not resolve, tensions around agency and accountability. Panelists from ethics, design, art, and biology will take deliberately contrasting positions on who designs, who decides, and who is responsible when AI-driven systems influence and are influenced by biological agencies. The aim is to make these disagreements explicit so attendees can recognise how hybrid intelligences challenge established HCI assumptions around creativity, intent, and governance. These disagreements also surface assumptions that are increasingly embedded in how biodesign practice is learned and enacted, even when they remain unnamed.

5.3 Identifying Methodological and Governance Directions for CHI

Finally, the panel will map actionable implications for HCI research. This includes highlighting methodological shifts required to study systems that operate across experimental, ecological, and evolutionary timescales, and outlining governance questions that arise when human, computational, and biological learning processes co-evolve. The objective is to leave attendees with specific research questions, opportunities for collaboration, and clearer entry points to engage AI × Biodesign in their own work.

6 EXPECTED OUTCOMES AND IMPACT

This panel aims to introduce new concepts and clarify friction points, methodological gaps, and future research directions for the CHI community. By confronting how AI participates in biological workflows, the session will articulate where current HCI tools fall short and what new frames are required. Three outcomes structure this contribution:

6.1 A Contested but Actionable Vocabulary for Material Intelligence

The panel will produce a shared vocabulary, though deliberately incomplete, for talking about learning and adaptation in code, cells, and infrastructures. Rather than presenting a unified framework, the session will expose where panelists diverge on what counts as intelligence, agency, or interaction in hybrid biological–computational systems. Attendees will leave with concrete conceptual tools that they can use in their own work, alongside a clearer sense of the tensions that must be resolved to advance HCI's engagement with AI × Biodesign.

6.2 Clear Methodological and Governance Challenges for HCI

Through debate grounded in cases from automated wet labs, living interfaces, and critical biodesign, the panel will identify specific methodological challenges that current HCI approaches struggle to address. These include observing systems that learn on experimental and ecological timescales, attribution of responsibility within distributed workflows, and studying interaction when outcomes emerge from entangled human–algorithm–organism processes. The panel will distill these challenges into a set of actionable research questions and agenda items for the CHI community.

6.3 Field-Level Pathways for Collaboration and Knowledge Building

Finally, the panel will outline the pathways for interdisciplinary collaboration in HCI, computational biology, biodesign, and ethics. These connections will be consolidated in a post-panel synthesis intended for ACM Interactions or Design Issues, ensuring long-term visibility and impact. The session will also serve as the foundation for future community initiatives, including a CHI 2027 workshop on AI and the Living Interface, extending the conversation beyond the panel toward a sustained research trajectory.

7 PANEL FORMAT AND AUDIENCE INTERACTION

The 90-minute session adopts a case-anchored, debate-oriented format to surface conceptual tensions and disciplinary disagreements around AI-mediated biological workflows. Rather than seeking consensus or quantitative audience feedback, the structure prioritises interpretive depth, critical questioning, and cross-disciplinary translation. Audience participation is integrated through moderated discussion and intervention, ensuring engagement without reducing complex issues to simplified metrics.

7.1 Opening: The Algorithmic Wet Lab (5 min)

The panel opens with an audio-visual grounding sequence drawn from AI-mediated biological workflows, including automated experimentation, living interfaces, and bio-digital fabrication systems. This establishes the algorithmic wet lab as a situated site of interaction. The moderator then introduces the three framing questions: Who designs hybrid biological workflows? Where does responsibility lie when outcomes emerge from coupled HAO (human, algorithm, organism) systems? What counts as interaction when learning unfolds simultaneously in code, cells, and infrastructures?

7.2 Case Provocations (20 min)

Each panelist presents a concise case-based provocation (2–3 minutes) from their research or practice. These focus on concrete situations—such as self-driving laboratories, AI-guided biodesign workflows, or living interfaces—where tensions around agency, authorship, responsibility, or interaction become visible. Each case foregrounds a specific friction point, providing shared reference material for discussion.

7.3 Moderated Tension Mapping (15 min)

The moderator leads a structured discussion mapping points of convergence and divergence across the cases. Panelists respond to one another's examples, clarifying where interpretations align, conflict, or break down across disciplinary perspectives. This segment surfaces implicit assumptions and establishes the key tensions guiding the remainder of the panel.

7.4 Audience Interventions: Critical Questions and Counter-Examples (20 min)

Audience participation is enabled through open-ended interventions rather than real-time voting. Attendees are invited to pose questions, challenge case framings, or introduce counter-examples

from their own work, either via roving microphones or written submission. Moderator curates interventions to maintain conceptual focus and productive engagement.

7.5 Cross-Disciplinary Reflection (20 min)

Each panelist responds to a case or tension from outside their primary disciplinary domain. This exchange foregrounds how concepts shift across fields and exposes points where disciplinary vocabularies fail to align, emphasising translation rather than resolution.

7.6 Closing: Open Questions for HCI (10 min)

The session concludes with a moderated synthesis of insights, unresolved disagreements, and methodological challenges. Rather than producing definitive conclusions, this segment articulates open questions and research directions for the CHI community, leaving attendees with a clearer conceptual vocabulary and productive tensions for engaging AI × Biodesign within HCI.

8 PANELIST BACKGROUNDS

Orkan Telhan is a designer and researcher working at the intersection of living systems, computation, and cultural infrastructures. Formerly Chief Information and Data Officer at Ecovative, he has led AI/ML integration in large-scale mycelium manufacturing and brings deep insight into how algorithmic systems shape biological practice. His experience in industry, design, and computation allows him to speak directly to agency, automation, and accountability in hybrid intelligences—providing a crucial bridge between speculative discourse and operational biotechnical systems.

Iohanna Nicenboim is an Assistant Professor in More-than-Human Design and Regenerative AI (IT:U Linz) and a researcher at TU Delft. Her work develops design methods that integrate ecological thinking with algorithmic tools. She has organised multiple CHI panels and workshops, making her invaluable for structuring interdisciplinary debate. She brings expertise in regenerative design and more-than-human temporalities, offering a critical counterpoint to technologically driven framings of intelligence and interaction.

Carolina Ramirez-Figueroa is an Associate Professor at the Royal College of Art, working across architecture, living systems, and critical technologies. She leads the Interspecies Entanglements studio and has extensive experience convening dialogues that combine speculative design, environmental justice, and material practice. She brings expertise in structuring encounters across epistemic standpoints and helps anchor the panel in broader socio-ecological implications.

Margherita Pevere is an internationally recognised bioartist whose practice interrogates vulnerability, ecology, and the cultural imaginaries of biotechnology. Her work with living matter offers a unique lens on material agency and embodied speculation. Margherita extends the panel beyond scientific or design-centric perspectives, revealing how hybrid intelligences are sensed, contested, and made public through artistic research.

9 DIVERSITY STATEMENT

This panel brings together contributors with markedly different disciplinary, geographic, and institutional backgrounds, an essential condition for examining hybrid intelligence. Because the algorithmic wet lab distributes agency across humans, algorithms, and organisms, it requires perspectives that span biological practice, computational systems, ethics, and cultural critique. The panelists represent design research, computational biology, bioart, architecture, and philosophy and are based in the UK, US, The Netherlands, Austria, Sweden, and Germany. This diversity introduces productive friction: each field brings distinct assumptions about intelligence, responsibility, and care, which the panel's debate format makes explicit rather than smoothing over. Including academic, industry, and independent practitioners ensures that both institutional and non-institutional expertise shape the discussion.

The career stages range from early-career researchers to senior academics, enabling multigenerational dialogue and contrasting methodological priorities. Diversity is therefore not incidental, it is integral to exploring how interaction, agency, and responsibility shift when intelligence is shared between humans, models, and living systems.

10 LOGISTICS AND ACCESSIBILITY

The session is designed for reliability, accessibility, and smooth delivery using only standard CHI room equipment. The panelists will be seated in a semicircle to maintain clear sight lines between disciplines and toward the audience. Table microphones and two roving microphones will support both panel dialogue and audience participation, and a short technical run-through before the session will confirm audio levels and cueing for the sensory elements.

A single projector will display all visual materials, including the opening grounding sequence and discussion prompts. All videos, images, and audio files will be stored locally on a dedicated laptop to avoid streaming or connectivity issues. Audience participation will be supported through spoken questions using roving microphones and optional written question submission, ensuring accessibility without reliance on personal devices.

The sensory introduction and sound cues have been designed with accessibility and comfort in mind: they are low-volume, non-intrusive, and free from strobing or rapid transitions. Alt-text descriptions and short transcripts for audio-visual materials will be provided through QR codes. All slides and visual prompts will use high-contrast palettes and accessible typography. Audience participation will be enabled through multiple channels, including QR-based question submission, roving microphones, and written cards for those who prefer non-digital engagement. Clear aisles will ensure mobility access, and prompts will be shown in high-contrast formats with alt-text included for archival use.

Overall, the panel requires only discussion and projection; no laboratory demonstrations or specialised equipment, making the session low-risk and straightforward to run. Each interactive component includes a fallback option, ensuring the session remains reliable and fully deliverable within standard CHI constraints.

11 ORGANIZING TEAM

Raphael Kim (organizer & moderator) is a researcher and designer working at the intersection of biodesign, interaction design, and emerging biotechnologies. His work examines how AI-mediated

biological workflows redistribute agency, responsibility, and interaction across humans, algorithms, and living systems. Drawing on a background in biotechnology, HCI, and design research, he focuses on the implications of these shifts for how biodesign practices are learned, taught, and evaluated. Raphael serves as lead moderator, with extensive experience convening interdisciplinary debate around living systems and hybrid intelligence.

Yuning Chen (co-organizer) is a PhD researcher at the University of Edinburgh, specialising in labour, politics, and more-than-human ecologies in bioengineering. Her work blends STS, HCI, and critical biodesign, making her well-placed to highlight the infrastructural and political tensions behind hybrid intelligence. Yuning contributes to designing debate structure and ensuring that the panel foregrounds issues of labour, access, and more-than-human participation.

Jiwei Zhou (co-organizer) is a postdoctoral researcher at KTH focusing on biological HCI, care ethics, and phenomenological approaches to human–microbe interactions. Her research on microbial temporalities and living artefacts provides grounded examples of how interaction shifts when living systems co-shape outcomes. Jiwei supports the panel's attention to care, temporality, and accessibility, and contributes to shaping audience interaction components.

Martyn Dade-Robertson (advisor) is a Professor of Emerging Technology at Northumbria University and a leading figure in engineered living materials and synthetic biology for the built environment. His work integrates design theory, biotechnology, and fabrication. Martyn contributes a technical and architectural perspective on how biological and computational processes co-produce form and will help ground discussions of agency and responsibility in large-scale, real-world applications and infrastructural systems.

Zoë Robaey (advisor) is an Assistant Professor in Ethics of Technology at Wageningen University and a specialist in responsibility, uncertainty, and governance in biotech systems. Her concepts of shared responsibility, epistemic care, and safe-by-design provide essential frameworks for analysing accountability when outcomes arise from human–algorithm–organism entanglements. She anchors the panel's ethical dimension with conceptual clarity and policy relevance.

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