The NSF BioFoundry for Extreme & Exceptional Fungi, Archaea and Bacteria (ExFAB)

Strategic Implementation Plan

Version 2.0

NSF Cooperative Agreement No. DBI-2400327

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Revision History

May 27, 2025	Version 1.0
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1.0 Mission/Vision Statement

The National Science Foundation (NSF) Biofoundry for Extreme and Exceptional Fungi, Archaea, and Bacteria (ExFAB) operates a first-of-its-kind user facility that develops novel techniques and protocols to empower researchers to learn, prototype, and translate biology from "extreme and exceptional" microbes to advance biotechnology and biomanufacturing, open new market opportunities, and training the next-generation workforce for automated laboratories. ExFAB's vision is to become the nation's hub for innovation in extreme microbiology research, in order to assure our nation continues on the cutting-edge of biotechnology and biomanufacturing.

For ExFAB, "extreme" microbes are those that **do not conform to standard growth habits and culture conditions**, and "exceptional" microbes are those that defy our current understanding of biology yet they possess **traits** (e.g. phenotypes, pathways, proteins, or structures) **that biotechnology should harness**.

2.0 Roles and Responsibilities

ExFAB operations are overseen and managed by an internal and external governance structure, as described below and in the organizational chart attached as Appendix 1.

2.1 **Internal governance**

2.1.1. **Executive Level**

2.1.1.1 **ExFAB Director** (Dr. Michelle A. O'Malley). The ExFAB Director is the lead Principal Investigator and serves as ExFAB's chief executive officer. She is responsible for all technical and non-technical aspects of ExFAB, chairs the ExFAB Management Team, serves as ExFAB's primary liaison to the External Advisory Board and primary contact for the NSF Program Managers. The ExFAB Director also oversees and manages ExFAB activities, facilities and personnel on the UC Santa Barbara campus. The ExFAB Director reports to the UCSB Vice Chancellor for Research.

2.1.1.2. **ExFAB Co-Director** (Dr. Ian Wheeldon). The ExFAB Co-Director works collaboratively with the ExFAB Director to develop ExFAB's strategic priorities and manage all ExFAB activities. He also serves as the User Director, overseeing the ExFAB User Program, and provides senior leadership representation at Operation Team meetings. The ExFAB Co-Director also oversees and manages ExFAB activities, facilities and personnel on the UC Riverside campus. The ExFAB Co-Director represents the ExFAB Director when she is not available.

2.1.1.3 **ExFAB Managing Director** (Ms. Sherylle Mills Englander). The ExFAB Managing Director serves as the Chief Operating Officer for ExFAB. Working closely with the Director and Co-Director, she is responsible for the development and oversight of strategic programming,

including industry partnership and innovation programs. She also oversees all non-technical aspects of ExFAB including the management of ExFAB finances. She assures all reporting and approval obligations to NSF are met in a timely manner, the ExFAB website and social media accounts are continually maintained and updated, and the strategic implementation plan is appropriately updated, among other things. The Managing Director also leads the Operations Team and Education Team meetings, serves on the ExFAB Management Team, coordinates all external board meetings, and serves on the User Feasibility Committee.

2.1.1.4 **ExFAB Management Team**. The ExFAB Management Team meets weekly and consists of the five principal investigators (Michelle O'Malley, Ian Wheeldon, Jamie Snyder, David Valentine, Jason Stajich) and the Managing Director (Ms. Sherylle Mills Englander). It is chaired by the ExFAB Director (Michelle O'Malley). The Management Team is responsible for guiding ExFAB's activities as an executive-level committee. The Management Team issues final approval for all user proposals, focusing on mission fit, broader impact, intellectual merit and fit with ExFAB's strategic priorities.

2.1.2 **User Program**

2.1.2.1. **ExFAB User Program Director** (Dr. Ian Wheeldon). The ExFAB User Program Director oversees and manages all aspects of the ExFAB user program, including user recruitment, the user proposal submission and selection process, and the execution and close-out of approved user projects. The User Program Director serves as the primary liaison for the ExFAB User Committee and chairs the User Proposal Feasibility Committee. The User Program Director also leads ExFAB technical operations meetings and ensures that ExFAB capabilities can meet user needs. While the User Coordinator and the ExFAB technical staff are formally supervised by their campus principal investigators, the ExFAB User Program Director monitors the efficacy and efficiency of user program activities, offering recommendations to their supervisors, when appropriate.

In practice, the User Program Director, with the assistance of the User Coordinator, is expected to maintain a clear, user-facing process for moving projects from initial inquiry through feasibility review, proposal selection, project execution, data return, and project close-out. This includes ensuring that prospective users receive timely guidance on ExFAB capabilities, project scope, sample requirements, expected timelines, cost or resource needs, and whether the proposed work aligns with ExFAB's mission. The User Program Director works with the User Coordinator, Hub leads, and project scientists to translate approved user proposals into actionable project plans with defined technical milestones, staffing needs, and expected deliverables. The Director is also responsible for tracking the overall health of the user portfolio, including project throughput, completion rates, user satisfaction, external versus internal user balance, alignment with ExFAB strategic priorities, and opportunities to improve workflows or remove operational bottlenecks. The position is expected to provide regular updates to ExFAB leadership on user program performance and to recommend changes to proposal review, scheduling, staffing, documentation, or user support when needed to improve the efficiency, scientific impact, and sustainability of the ExFAB user program.

2.1.2.2. **ExFAB User Coordinator**. The ExFAB User Coordinator serves as ExFAB's primary liaison to its user community. The ExFAB User Coordinator is responsible managing calls for external user programs, interacting with internal and external users to assure the scope of proposed projects are reasonable and appropriate, guiding and supporting external users throughout their engagement with ExFAB, and assuring projects are closed out according to ExFAB procedures and processes (such as including the sample and protocols deposits). The User Coordinator supports the User Program Director in tracking incoming and active projects, and project close-outs.

2.1.2.3. **ExFAB User Proposal Feasibility Committee**. The ExFAB User Proposal Feasibility Committee meets as-needed to assess the feasibility of user proposals submitted to ExFAB. Their review includes confirming existing ExFAB capabilities are sufficient to perform the proposed experiments within a reasonable timeline, and the cost of the projects are reasonable and appropriate. The ExFAB Operations Team serves as the ExFAB User Proposal Feasibility Committee.

2.1.3. **ExFAB Education and Training**

2.1.3.1. **ExFAB Education Team**. The ExFAB Education Team meets biweekly. It is chaired by the CPP principal investigator (Dr. Jamie Snyder), and consists of the Managing Director and the education lead from each campus. The ExFAB Education Team is responsible for implementing all ExFAB educational and training programming, including the ExFAB Fellows program, the CSU Masters Scholars program, and the annual ExFAB Summer School. With respect to the ExFAB Fellows, the ExFAB Education Team is responsible for developing professional development activities, including a monthly ideation meeting for all active ExFAB Fellows, and tracking metrics for the program. With respect to the CSU Masters Scholars, the Education Team is responsible for recruiting and selecting each cohort of Masters Scholars, matching scholars with suitable ExFAB laboratories, mentors and projects; monitoring the mentor/mentee relationships; designing and implementing professional development activities and tracking metrics for the program. With respect to the Summer School, the Education Team is responsible for overseeing the summer school curriculum, professional development and activities, recruiting participants, and tracking metrics for the program.

2.1.3.2. **ExFAB Summer School Curriculum Committee**. The ExFAB Summer School Curriculum Committee meets biweekly from March through May to design the technical and professional development curriculum for the annual ExFAB Summer School. It consists of the Education Team, the Managing Director and the lab managers that will be responsible for teaching that year's technical modules.

2.1.4. **ExFAB Facilities**

2.1.4.1. **ExFAB Operations Team**. The ExFAB Operations Team meets bi-weekly and consists of the User Program Director, the Managing Director, the lab managers from all three campuses, and the User Coordinator. The ExFAB Operations team coordinates facility development and use, exchanges best practices, conducts troubleshooting for user projects, as needed, and collaborates in the development of tools and initiatives that span the facilities at three campuses. The Operations Team also serves as the User Proposal Feasibility Committee in the user proposal review process. The Operations Team also provides feedback on user project feasibility.

2.1.5. **ExFAB In-House Research**

2.1.5.1. **ExFAB In-House Research Director** (Dr. Michelle A. O'Malley). The ExFAB In-House Research Director oversees and coordinates all aspects of ExFAB's internal research program. Her responsibilities include fostering cross-campus research collaborations between UCSB, UCR and CPP researchers, assuring regular communications occur at all levels, and identifying and recruiting faculty into ExFAB that possess unique skill sets critical for advancing ExFAB's strategic priorities. Personnel supported through the in-house research program, including technicians, graduate students, postdoctoral researchers, and ExFAB Fellows, are supervised day-to-day by the principal investigator or technical lead responsible for the project and campus where the work is performed. The In-House Research Director is responsible for maintaining program-level oversight by ensuring that each in-house project has an identified faculty supervisor and an appropriate plan for mentoring and reporting progress. Progress is tracked through regular project updates, ExFAB Fellows activities, research sub-committee meetings, Operations Team coordination when facility resources are involved, and periodic reporting to the ExFAB Management Team so that staffing, project scope, and technical priorities can be adjusted as needed.

2.1.5.2. **ExFAB Strategic Scientific Leads (SSLs).** The SSLs are identified and designated by the ExFAB Director under advisement of the Management Team. The SSLs are faculty within UCSB, UCR, and CPP that are not members of the Management Team, who are academic advisors of ExFAB Fellows/Scholars. SSLs lead ExFAB in the development of new capabilities/technologies/workflows within the framework of the Internal Research Program that have been identified as key priorities for the External User Program. SSLs manage sub-group meetings of associated researchers within ExFAB across all campuses, and help to catalyze cross-campus capabilities.

2.2 **External governance**

2.2.1 **ExFAB External Advisory Board**. The External Advisory Board (EAB) meets annually and reports to the UCSB Vice Chancellor for Research. It is composed of leaders from industry, national laboratories, government, universities and nonprofit organizations. The EAB's charge is to ensure that ExFAB remains relevant on the national scale and to guide ExFAB's long-term strategic growth. A list of current EAB members is attached as Appendix 2.

2.2.2 **ExFAB User Committee**. The ExFAB User Committee meets as-needed during external user calls, either in whole or by a subset of members who have expertise in the proposed project. It is staffed by the ExFAB User Coordinator. The ExFAB User Committee is responsible for reviewing external user proposals to provide feedback to the Management Team on scientific and intellectual merit, broader impact, and mission fit. It is externally sourced, composed of subject

matter experts from academia and industry who are not affiliated with UCSB, UCR, and CPP and who have no connection to the proposed projects. Members rotate on a yearly basis.

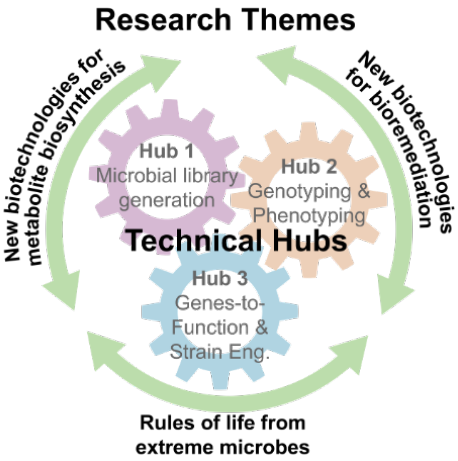
3.0 Scope

3.1 Research

ExFAB's in-house research is structured around three areas that stem from extreme and exceptional microorganisms — Bioremediation, Biosynthesis, and Discovering new Rules-of-Life. Each research area is supported by the technical Hubs that comprise ExFAB's infrastructure as an end-to-end design vision for biotechnology. The main mechanism of in-house research support is through the ExFAB Fellows and ExFAB Scholars research program (described below), which support trainees pursuing research in ExFAB PI laboratories. Importantly, new instrumentation, workflows, and protocols developed as part of the internal research program will drive new infrastructure that is available for the external user program. New workflows and capabilities developed for external user projects will also add to the internal research program.

ExFAB's internal research program focuses on microbes that do not conform to standard growth habits and culture conditions, and those that defy our current understanding of biology yet they possess traits (e.g. phenotypes, pathways, proteins, structures) that biotechnology should harness. Key strategic priorities for ExFAB's in-house research program are:

- Filamentous, non-colony forming, non-canonical morphology that do not grow on liquid culture (e.g. things that traditional OD600 doesn't work for)
- Anaerobes and Anoxic/oxic interfaces
- Low density, difficult/impossible to culture samples (e.g. chemoautotrophy, chemolithotrophy, oligotrophs)
- Microbial Community Assembly, and Interactions
- Identifying & manipulating exceptional metabolism



Research Sub-committees

ExFAB is establishing Research Sub-committees composed of ExFAB faculty across all campuses to help drive research that addresses important challenges in Bioremediation, Biosynthesis, and Discovering new Rules-of-Life. Initial members of each sub-committee and the research goal of each are listed in Appendix 3. These committees are dynamic and reevaluated on an annual basis. Sub-committees will meet quarterly to discuss research progress and initiate new ideas and projects. Given the multidisciplinary nature of ExFAB's research, we anticipate that ~75% of our publications will be collaborative with 2 or more ExFAB PIs per publication.

3.2 User access program

ExFAB facilities are open to researchers (PIs, scientific staff, students) from academic, industry, nonprofit and government institutions. Users can use the facilities directly (in person, hands-on), or indirectly (projects performed by ExFAB's technical staff). Users access the ExFAB facility through one of two avenues: i) by submitting a user project through the user proposal process; or ii) through payment of an access ("recharge") fee. The user proposal process allows ExFAB to identify, and support the facility costs for, projects that align with its research priorities. For proprietary projects (including industry projects) or projects that do not align with ExFAB's research priorities, users can access ExFAB facilities through a pay-per-use system by paying a recharge fee. Facility access for approved user projects always takes precedence over generalized recharge-based access.

3.3 Knowledge transfer and partnerships

3.3.1 Knowledge Transfer. ExFAB knowledge transfer occurs robustly and multi-directionally. Users share their research experiences with ExFAB's technical staff to help ExFAB identify protocol, workflow and technology gaps that limit research conducted on extreme or exceptional microbes, and then collaborate with ExFAB staff to develop solutions to overcome these challenges. As solutions are developed and novel research outcomes are generated, the knowledge and technology is transferred through application to future user projects, as well as through publications, conference presentations and seminars and, when appropriate, intellectual property licensing. Knowledge transfer is also accomplished through ExFAB's training and education programs (the Fellows, CSU Master Scholars and Summer School), and through its newsletter and social media channels. ExFAB's intellectual property policy was specifically designed to create a strong foundation for knowledge transfer, embracing open source principles and incorporating use rights to assure ExFAB can access the novel workflows and protocols its users develop for future projects.

ExFAB will also publish broadly useful workflow protocols developed through its facilities, including automated methods for culturing, phenotyping, transforming, and analyzing extreme and exceptional microbes, using accessible platforms such as protocols.io and the ExFAB website. This commitment reflects ExFAB's philosophy that workflows developed with public support should become community resources that accelerate research beyond the originating project. ExFAB also seeks to integrate with complementary biofoundries and user facilities, including ORNL, iBioFAB, AGF, JGI, Agile BioFoundry, and others, through advisory board interactions, shared workshops, personnel exchanges, cross-facility referrals, and coordinated protocol comparisons that allow lessons learned in automating non-model organisms to be shared across the broader biofoundry ecosystem. These partnerships will help ExFAB minimize duplication, learn from facilities with established automation and DBTL expertise, and contribute its own specialized knowledge in anaerobic, filamentous, low-density, slow-growing, community-based, and otherwise non-standard microbial systems.

3.3.2. Partnerships. ExFAB's approach to partnerships is three-fold: (1) to develop collaborative relationships with synergistic biofoundries to allow ExFAB to focus on its core strengths and to

minimize duplication across the nation; and, (2) to develop partnerships with industry leaders to develop a strong industry user base, support workforce training, perform collaborative research projects and support technology translation; and (3) to develop partnerships with leaders in the innovation ecosystem (including investors, incubators and accelerators) to support ExFAB technology translation and ExFAB-affiliated startup companies.

3.4 Training and Education

ExFAB offers three primary programs for training and education: the ExFAB Fellows program, the ExFAB CSU Master Scholars Program and the ExFAB Summer School. Collectively, these programs serve as a foundation to train UCR and UCSB graduate students and postdocs, Cal State University (CSU) Master's students, and external users/researchers. The ExFAB Fellows program provides research training and professional development for UCR and UCSB postdocs and graduate students who are in ExFAB-affiliated labs and are conducting in-house research that will develop new technologies for the benefit of the microbiology research community. The CSU Masters Scholars Program embeds CSU masters students in ExFAB-affiliated labs at UCSB or UCR for a 10-week, in-depth research experience. And finally, the ExFAB Summer School provides in-depth technical training to enable researchers to leverage ExFAB's unique facilities for their own research and build their technical expertise in automation. The ExFAB Summer School is open to the entire microbial research community: graduate students, researchers, faculty, and industry professionals from institutions at non-R1 and R1 institutions across the state and nation.

4.0 Project Schedule

ExFAB seeks to complete a minimum of 100 user projects in its first six years, as outlined in the below table. Year 1 projects focus on developing automated workflows and protocols; as of April 2026, 3 internal projects have been completed, the experimental work for an additional 7 has been completed and the projects are in the close-out phase. Twenty internal projects are currently active, 14 of which are ExFAB Fellows projects. ExFAB conducted its first call for external projects in Fall 2025. This call resulted in the submission of 16 projects from external users. Twelve of these projects were approved and scheduled for execution in the winter, spring, and summer of 2026. A second call for external projects is scheduled for the beginning of Year 3, fall 2026. This external call will enable ExFAB to ramp-up external user projects, with the expectation that by the end of Year 3, ExFAB will dedicate 50% of project time toward external projects and 50% time to internal projects.

ExFAB's annual cycle of programs, meetings and events, with the development tasks and milestones, are set forth in the GANTT chart attached as Appendix 5, and ExFAB's lifecycle goals are set forth in Appendix 6.

5.0 User Facility

5.1 **Development**. In developing its facilities, ExFAB's primary directive is to develop and enable automated workflows for the discovery and engineering of extreme and exceptional microbes, as defined in Section 3.1. A full list of ExFAB equipment is attached as Appendix 7.

5.1.1. *UCSB Facility.* The ExFAB UCSB facility enables automated workflows for studying extreme microbes with a focus on anaerobes. It is supported and managed by two lab managers, one automation specialist, and ExFAB "Workshop Wizards," undergraduate students who serve as laboratory assistants. The UCSB facility currently provides access to seven (7) stand-alone pieces of equipment including a high content imager and two mass spectrometers. Fully installed in fall 2025, the facility has a fully operational, custom-built anaerobic platform that encloses fourteen (14) instruments connected to a robotic arm and coordinated by a single scheduling software. With this integration, the platform will enable fully automated multi-step workflows using advanced liquid handling, imaging, flow cytometry, environmental control and nucleic acid processing within an environmentally controlled chamber. By summer 2026, ExFAB UCSB installed four (4) additional offline instruments expanding capabilities to include cell sorting of both small and large cells, as well as high-resolution mass spectrometry, bringing the total number of available instruments to twenty-one (21) (see Appendix 4 for a full instrument list and estimated dates of installation). Lab managers prioritize user support through hands-on training, development of SOPs, and implementation of workflows.

5.1.2. *UCR Facility*. The focus of ExFAB's UCR facility is to develop automated workflows suitable for isolating, phenotyping, and engineering aerobic microbes. UCR's facility includes robotic liquid handlers, a high throughput low magnification imaging system, automated microbial culturing, automated nucleic acid extraction, and the computational, scheduling, and tracking systems needed to coordinate user projects across both UCSB and UCR's ExFAB facilities.

During the initial stand-up phase, UCR's facility is focused on designing and validating automated workflows for (1) microbial phenotyping, (2) microbial arraying, (3) colony picking, (4) genomic DNA library preparation, and (5). In Year 2, ExFAB has extended these workflows to fungi with hyphal morphologies. The workflows were selected based on input from the ExFAB community and have enabled internal user projects during year 1 and external user projects in year 2

These workflows are enabled by two liquid handling robots: one is a low cost, easy to use Opentrons system, which is used to pilot new protocols; a second is a Tecan Fluent 780 with associated peripheral equipment (UV-vis spectrometry, shaker incubator, and centrifuge), which will be used to access rapid, high throughput workflows previously validated on the Opentrons system. Automated nucleic acid extractions are accomplished on a QiaCube HT. Sample prep and storage equipment includes: temperature controlled shaker and stationary incubators, thermocyclers, and 4°, -20°, and -80°C fridge and freezers.

The UCR facility is also leading the development of computational workflows for data analysis and the establishment and operation of a laboratory information system (LIMS) that supports all ExFAB sites. ExFAB's LIMS is an open source platform built to meet our needs. Functionalities include sample and project tracking, data storage, and reporting. The system is built organically

and piloted against the most common workflows to assure efficacy. Initial stand-up of the system is being conducted with internal and external user project at UCR and expanding to UCSB and CPP in the spring of 2026. Additional features and functionalities will be developed on an as-needed basis.

5.1.3. *CPP Facility*. The ExFAB CPP facility is primarily a CSU training facility that will offer training for CSU students and faculty. The CPP facility offers long read sequencing capabilities as well as other instrumentation (for example, high temperature shaking incubators, ultracentrifuge, qPCR machine) that others can utilize. AnOxford Nanopore minION sequencing instrument has been purchased and will be utilized for the long read sequencing. This facility will be the first core facility established at CPP. Led by Dr. Snyder and with the assistance of the User Program Director and a lab technician, low cost, long read capabilities are being established for use by CSU students and faculty, ExFAB fellows and MS scholars. These sequencing capabilities are currently integrated into ExFAB user projects as needed. For projects with larger sequencing needs, ExFAB will engage sequencing cores at UCR, UC Berkeley and UC Davis, all of which have high capacity sequencing equipment that can be accessed by ExFAB PIs at competitive rates.

5.1.4. *Ongoing Facility Development*. ExFAB's technical staff align the development of new workflows and additional automated workflows with user needs and the research goals defined during ExFAB quarterly all-hands meetings. Future equipment acquisitions are identified and assessed through use patterns, annual user surveys, informal interactions with users as they engage the ExFAB facilities, coordination with other campus facilities, review of functionalities at other BioFoundries, and consultation with the ExFAB External Advisory Board. A needs assessment for LIMS is made no less than annually, through discussions with the lab managers and in user surveys.

5.2 Cross Institution Coordination.

ExFAB recognizes the need to create an integrated user facility across three physical sites – UCSB, UCR, and CPP. To enable this, ExFAB centralizes user support and project management, and enables the creation of common workflows and protocols by leveraging common equipment vendors, and creating ExFAB-wide research collaborations. ExFAB's Director and Co-Director, serving as the In-House Research Director and User Program Director, leads these efforts. User project management is centralized through the User Coordinator with assistance from ExFAB administrative staff. The technical team for each campus holds weekly project meetings to assure user projects are progressing appropriately. Troubleshooting, when needed, occurs both during weekly project meetings and, for cross campus challenges, at the biweekly Operations Team Meeting. Protocol, data, and project information sharing occurs through a single LIMS platform integrated into both the UCSB and UCR facilities that is managed by UCR ExFAB's tech team. The LIMS collects sample data, tracks sample progress from beginning to end, and reports project status, information that is accessible to the technical teams, leadership group, the user program team and individual users (with respect to their projects) via a centralized system.

5.3 Use Strategies

5.3.1. *User Base*. ExFAB facilities are open to researchers (PIs, scientific staff, students) from academic, industry and government institutions. Users fall into one of three categories: (1) Internal Users, consisting of researchers accessing the facilities for In-House Research activities; (2) External Users, consisting of researchers who are accessing the facilities under an approved External User Proposal; and, (3) "Recharge Users," consisting of researchers accessing the facilities for independent research activities. To assure the facilities are broadly accessed, ExFAB lab managers are responsible for managing access in a manner consistent with the use percentages set forth NSF award terms and conditions (Section 2A.iii and 3.A.vii of the Award Specific PTC).

5.3.2 *User Access.* ExFAB supports the costs when Internal Users or External Users access its facilities. Recharge Users access ExFAB facilities through a pay-per-use system by paying a fixed recharge fee approved by the host campus. Facility access for approved Exernal User and Internal User projects always takes precedence over recharge-based access. Travel support is available to External Users affiliated with a non-R1 university to support in-person visits to ExFAB facilities for hands-on research and training.

5.3.3. *Recruitment of Users*. ExFAB acquires new users through five primary channels: i) its educational and training activities such as the ExFAB Summer School and CSU Masters Scholars program, ii) leveraging existing networks such as the CSUBIOTECH Network, LinkedIn, professional organizations, and the ExFAB mailing list, iii) direct engagement at users' home institutions, with a strong focus the California State University system, iv) collaborations with other user facilities, such as the Joint Genome Institute, and v) participation in technical conferences and trade shows. ExFAB holds a minimum of two calls for external user proposals each year – one in Fall and one in Spring. Each call has a theme (such as genotyping and phenotyping) that is set by the Management Team and addresses ExFAB's strategic priorities for the development of technologies, protocols and workflows as well as the facilities' current bandwidth.

5.3.4 *User Proposal Review and Approval Process*. The user proposal submission and review process allows ExFAB to identify, and support the facility costs for, Internal User and External User projects that align with its mission and research priorities. To be considered for funding, users submit proposals in a specified, standardized format through the ExFAB website. The proposals must clearly demonstrate how the proposed research will enhance ExFAB's capabilities and/or knowledge of extreme and exceptional fungi, archaea, and bacteria. Potential users are strongly encouraged to contact the ExFAB User Coordinator to discuss their proposed project prior to submission. Potential users can propose three levels of projects: Exploratory, Developmental or Full, depending on the complexity and scope of the proposed project. ExFAB conducts calls for external user proposals no less than twice annually; proposals from internal users can be submitted on a rolling basis. All new user proposals, whether internal or external, are first assessed by the User Proposal Feasibility Committee for feasibility and cost. Proposals that pass the feasibility review are forwarded to the next step in the approval process. External User Proposals are then reviewed by the ExFAB User Committee for broader impact, scientific

merit and mission fit, who provide recommendations to the Management Team (Internal User proposals are not reviewed by the ExFAB User Committee since they are a part of the In-House Research Program). The Management Team provides the final review for both Internal User and External User proposals for alignment with ExFAB's mission and strategic priorities, considering the recommendations and observations of both the User Proposal Feasibility Committee and the External User Committee. A streamlined review process is available for user projects that "graduate" up the tiers (e.g., from exploratory to developmental). In these instances, the User Director and User Coordinator may review the request and approve the "graduation" and continued investment in the project, subject to the approval of the Principal Investigator for the campus where the work will be performed.

5.3.5. User onboarding. The ExFAB User Coordinator assures all required documentation and lab safety training is in place before the User accesses the facility. The User's institution must execute an appropriate facilities use agreement and provide evidence of insurance (academic institutions may apply for a waiver of insurance requirements. The facility use agreement and insurance requirements are set using the host university's standard forms and processes. Both Internal and External Users must also sign the ExFAB Policy Acknowledgement, where they agree to provide ExFAB with use rights and to acknowledge ExFAB in resulting papers and presentations, among other things. Lab safety training requirements are determined by the Lab Managers, leveraging the host university's lab safety training modules whenever possible.

5.3.6 *Project execution*. Following approval, each project receives a unique identification number and is assigned a lead lab manager, responsible for managing the project's technical execution. Each project is subsequently tracked for expenditures, equipment utilization, and ExFAB scientific staff engagement hours. Projects are expected to have a 6-12 month execution window, with potential extensions, as-needed. Prior to execution, the User Coordinator is responsible for holding a project kick-off meeting between the user, assigned lab manager and User Coordinator to set expectations and discuss the project's timeline and implementation plan. The User Coordinator keeps in regular contact with the user and lab managers to check on activity and progress. ExFAB allocates an average of $7500 in user support per project, with increased budgets considered for high-impact initiatives. At project closure, the User Coordinator assures the user has received all deliverables, samples and their associated data have been deposited, any new protocols are uploaded into ExFAB's protocol.io account for broad access, and a project summary has been created to capture project impact and metrics. Users are also reminded of ExFAB's policies on knowledge sharing, acknowledging ExFAB in presentations and publications, and potential sharing of project completion and outcomes to spread awareness.

5.3.7 *Project Goals*. In the first 6 years of operation, ExFAB will complete a total of 100 user projects as set forth in the table below. A detailed timeline of the schedule of projects and major ExFAB activities is provided in the Appendix 5 Gantt chart.

Table 1. Projected internal and external user-based projects to be managed at UCSB or UCR. Steady-state between external and internal users reached by Year 3, after an internal development phase. ExFAB facilities at CPP can be accessed through a user proposal routed through and managed by UCSB or UCR.

	Site	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Total Projects
Internal Projects	UCSB	4	3	3	4	5	5	48
	UCR	4	3	3	4	5	5	
External Projects	UCSB	0	2	3	6	7	8	52
	UCR	0	2	3	6	7	8	
	Total	8	10	12	20	24	26	100

5.3.8 *Additional User Support*. External Users from non-R1 universities are eligible for additional support to encourage and support visits to ExFAB facilities. Upon approval of the external user proposal, eligible users are invited by the Managing Director or User Coordinator to request additional travel support. The Lab Managers review the requested level of support to confirm reasonableness and timing. The Director approves additional support for users accessing the UCSB facility; the Co-Director approves additional support for users accessing the UCR facility.

3.2.8 *Outcome tracking.* ExFAB will track project progress and outcomes through a series of activities. All user proposal reviews and approvals are tracked through a Smartsheet database, which retains project descriptions and budgets for future reference. The User Coordinator monitors project progress and reports to the Managing Director and User Director on a regular basis. The goal of this reporting is to help understand the composition of the overall project portfolio so that adjustments can be made to best match the project goals stated above. The User Coordinator also solicits feedback from users at the conclusion of each project, with the goal of capturing the user experience and identifying potential bottlenecks in the user program and highlighting project and process successes, and tracks actual costs v. the estimated costs at the project outset. These activities allow ExFAB to be able to accurately estimate the resources required to complete each project, thus enabling a streamlined process for project evaluation, approval, and execution.

In addition, ExFAB conducts annual user surveys each Fall to track program efficacy, as well as all publications and presentations that report the results of research projects supported by ExFAB's facilities.

5.4 Recharge User Access Fees

5.4.1. *The University of California.* The development of user fees for shared experimentation facilities on UC campuses is governed by policies issued by the UC Office of the President (Business & Finance Bulletins A-47, A-56 and A-59) as well as campus-specific policies and procedures. The ExFAB facilities at the UC Santa Barbara and UC Riverside campuses follow these policies in the development of their user fees (i.e. "recharge rates").

At each campus, the ExFAB facility submits a detailed recharge rate proposal that calculates the estimated costs of supplies, equipment and technical staff, and the estimated number of users, broken down by type. The calculations for the first year of operation are based on reasonable

estimates. Annual revisions are based on the previous years' actual costs and activities, as well as a future trend analysis.

The initial recharge proposal is submitted to the host department's control point for review and approval, then to a central rate and recharge committee for final review and approval. The reviews assure all costs are properly accounted for, an acceptable cost allocation basis is used, the rates will result in full cost recovery, and the rates comply with all applicable federal regulation.

UC recharge facilities operate on a "no-gain/no loss" basis and are expected to operate close to break-even over time. To accomplish this, all recharge rates (including ExFAB user fees) are updated on an annual basis. An updated recharge rate proposal is developed by the facility based on the previous year's actual activities and future trend analysis. The updated rate proposal is submitted for review and approval by the central rate and recharge committee in February of each year. Any modifications in the user fees are typically effective on September 1 to coincide with the ExFAB grant periods of performance.

If a user fee needs to be adjusted upwards, the policy recognizes the importance of rate stability for the user base. If the adjustment is dramatic, it may be phased in over several fiscal years.

At UCSB, the Managing Director (Ms. Sherylle Englander) is responsible for gathering data and submitting both the initial and annual recharge proposal to the campus' central rate and recharge committee. At UCR, these duties will be performed by its lead principal investigator (Dr. Ian Wheeldon). Once a campus has approved the annual rate and recharge proposal, the campus-approved fees will be submitted to NSF for its approval.

ExFAB uses the following types of user fees (recharge rates):

- *Internal User Rate*. The internal user rate is used for: (a) users affiliated with the University of California or CPP; (b) users accessing the ExFAB facility under approved external user proposals; (c) users accessing the ExFAB facility for other federally-funded research projects.

- *External User Rate*. The external user rate is used for all other users, including industry users pursuing proprietary research projects. The current external user rate is equivalent to the internal user rate, plus a NUD (non-university differential) that is equal to the host university's federally-negotiated indirect cost rate.

The schedule of approved user fees are posted on the ExFAB website.

CalPoly Pomona. The ExFAB facility at CPP is a training and education facility for CPP faculty and students and for occasional use for In-House Research, as appropriate. A recharge rate is not required for the contemplated uses.

5.5 Operations/staffing levels

5.5.1 *UCSB Facility.* The UCSB ExFAB facility is staffed by two project scientists, an automation specialist and one part-time postdoc. The technical staff are supported by several ExFAB "Workshop Wizards." Workshop Wizards are UCSB undergraduate students who join ExFAB as laboratory assistants to help with sample prep and equipment maintenance. CNSI, where ExFAB is housed, also employs a full-time building manager who provides infrastructure assistance and support to the ExFAB facility. The lab managers are administratively supported, as necessary, by the ExFAB Program and Administrative Coordinator.

5.5.2 *UCR Facility.* UCR ExFAB operates with four full time staff including, one project administrator, one project scientist, and two research specialists. The ExFAB team is rounded out with one post doc. Lab management is shared between the project scientist and the administrator, who is also responsible for communications, record keeping, scheduling, meeting organization, and assisting ExFAB's user coordinator. Led by the project scientist, the UCR tech team (the project scientist, two research specialists, and a post doc) maintains and operates the facilities and executes the work needed to complete ExFAB user projects and develop new capabilities. In addition to leading the tech team, the project scientist is the technical lead for ExFAB user projects. In the initial start-up phase, staff expertise is focused on software coding, script development, data storage, and the development of data analysis pipelines. This focus on software and scripting is necessary at the outset so that these critical systems are operational prior to a ramp-up in facilities use and data generation. In year 3 and going forward, one research specialist will shift 50% of their time to lab operations as needed to meet user demand.

5.5.3 *CPP.* The CPP facility is managed by co-PI Jamie Snyder, and has one lab manager.

5.6 Intellectual Property Policy

The ExFAB Intellectual Property Policy (exfab.org/IPPolicy) recognizes the different categories of assets produced through ExFAB activities and the needs of its various users through the following key elements:

- *Intellectual Property Ownership.* ExFAB's host universities do not assert ownership over intellectual property developed through the use of ExFAB facilities unless ExFAB technical personnel are sufficiently involved to qualify as an inventor or author under U.S. patent law. Since the majority of users will either directly access ExFAB facilities or send detailed protocols for ExFAB staff to follow, it is unlikely that ExFAB's host universities will acquire ownership over intellectual property developed by ExFAB's external user base.
- *Protocols, Workflows and Equipment Improvements/Modifications.* To preserve ExFAB's ability to effectively serve the microbiology research community, ExFAB requires all users to provide ExFAB's host universities with non-exclusive, royalty-free, paid-up licenses to use, and authorize the use of, any novel protocols, workflows or equipment improvements/modifications within ExFAB facilities. This license does not reach through

to the results generated through the use of the novel protocols, workflows or equipment improvements/modifications.

- *Physical Samples.* Except in the case of proprietary research, upon request, users are required to deposit with ExFAB a portion of any biological sample brought to ExFAB facilities, together with any sequencing, phenotyping, metabolomic or other data generated from the use of the ExFAB facilities for academic research and educational use. The samples and associated data will be retained by ExFAB for at least one year, after which ExFAB will help facilitate transfer of the sample to an appropriate depository. At the request of the depositing user, ExFAB will agree to embargo public access to the samples and related data for up to two (2) years or until publication, whichever occurs first.
- *Genetically-Engineered Microbes.* Except in the case of proprietary research, ExFAB's host universities retain the standard academic use rights to any genetically-engineered microbes developed through the use of ExFAB facilities; however, external users remain in full control of the commercial exploitation of the engineered microbes.
- *Proprietary Research.* Proprietary research occurs when a user directly pays the full user fee to access ExFAB's facilities, rather than through an approved user proposal.

5.7 Safety

UCSB's laboratory is a Biosafety Level 2 (BSL2) designated facility that hosts an integrated robotic system housed within a large anaerobic chamber. At UCR, ExFAB operates in a BSL2 certified laboratory. Laboratory safety is managed by ExFAB's technical staff, with guidance from campus Environmental Health and Safety (EH&S). The User Coordinator assures all users complete required lab safety training prior to accessing the facilities. Periodic review of ExFAB facilities and lab processes are performed by EH&S to advise on necessary safety protocols and user training. Current Standard Operating Procedures (SOP) for all equipment and processes, as well as Safety Data Sheets (SDS), and laboratory-specific Chemical Hygiene Plans (CHP) are maintained in a dedicated location (UCSB:Box folder, UCR: on-site and in a shared drive) and made available to all users to comply with OSHA's Hazard Communication Standard (29 CFR 1910.1200(g)). Prior to gaining access to laboratory spaces, users complete all necessary on-boarding and safety training. All users are required to complete Fundamentals of Lab Safety and Biosafety Training courses, provided online through the UC Learning Center. Facility staff then deliver lab-specific safety training, covering the location of exits, safety documents, chemical and biohazard spill kits, eye wash stations, and fire extinguishers. Additional training requirements are identified on an as-needed basis for individual users, and as new hazards are introduced to the facility.

Access to ExFAB facilities at UCSB and UCR are managed according to campus-wide protocols for laboratory safety and security. All physical laboratory spaces are secured by centralized keycard access-controlled security systems, and users are only provided physical access to the facilities following completion and certification of all required safety training and laboratory-specific orientations. When applicable, access to laboratory equipment is managed using user-specific login credentials for workstations, assigned only after equipment training has been completed.

Equipment training, usage, and access are managed with FBS, a centralized laboratory management system.

The ExFAB Director assures appropriate lab safety programs and protocols are developed and implemented at all ExFAB facilities. The lead PI for each campus (UCSB: O'Malley; UCR: Wheeldon; and, CPP: Snyder) manages lab safety programs and protocols within their campus' facilities on a day-to-day basis, and directly supervises the ExFAB staff on their campus that are responsible for lab safety. The ExFAB User Coordinator assists new users in understanding and accessing the necessary lab safety training as part of the user on-boarding process. Each ExFAB lab manager is responsible for assuring all users (including those accessing facilities through the recharge program) have completed all necessary lab safety training and all required certifications are in place prior to accessing the ExFAB facilities and equipment under their direction.

6.0 Education and Training

ExFAB currently runs three programs centered on education and training: (1) the CSU Masters Scholars Program; (2) the ExFAB Fellows Program; and, (3) the ExFAB Summer School.

6.1. CSU Masters Scholars. The CSU Masters Scholars is designed to broaden the biotechnology workforce by training CSU master's students (CSU MS Scholars) in automated labs-of-the-future using the ExFAB facilities. Each CSU Masters Scholar is embedded in an ExFAB-affiliated research laboratory at UCSB or UCR for ten (10) weeks during the summer months. The Scholars conduct in-depth research projects and participate in various professional development opportunities (leveraging existing programs on the host campus, when possible). A graduate student from the host lab serves as the Scholar's mentor. The summer program culminates with a special event where each Scholar presents their research project to the broader ExFAB community through both a presentation and a poster session. ExFAB pays for the Master Scholar's lodging and provides each Scholar with a $12,000 stipend. Mentors also receive a modest stipend to recognize their time and effort.

6.1.1. *Recruitment Cycle.* To assure top candidates, ExFAB's primary recruitment is through CSUBIOTECH, the CSU System's affinity group for biology and the life sciences. CSUBIOTECH holds an annual research symposium each January, which is attended by faculty and students from all 23 CSU campuses. ExFAB representatives attend the CSUBIOTECH research symposium maintaining a dedicated table during poster sessions and participating in special events that highlight opportunities for students. Supplemental recruitment strategies include info sessions (Zoom and live), email outreach to relevant CSU campus department chairs and professors, social media channels, posting on ExFAB's website, and announcements in ExFAB's newsletter. Word of mouth also increases visibility for the program.

6.1.2. *Application Process*. A call for applications is timed to open in January or February, just prior to CSUBIOTECH's annual research symposium, with a deadline approximately one month later. Students apply through a portal on the ExFAB website with a Smartsheet backbone. Application materials include a brief application form, as well as a statement of interest, statement

of research and three letters of recommendation. The host laboratories, mentors and project descriptions are posted on the ExFAB web during the call for applications to allow students to review opportunities and include preferences for placement in their application materials.

6.1.3. *Selection Process.* The ExFAB Education Team reviews each complete application to confirm eligibility and assess strength. The Education Team then meets to select a list of finalists (a number that is approximately double the number of open slots). The finalists are interviewed by the Education Team, via Zoom, with a prepared set of questions. The education team scores each finalist against a pre-prepared rubric to determine the top candidates and alternates (who are ranked). The top candidates are then matched to host laboratories according to interests and experience and offered a slot. In the event an invitation is declined, the alternate list is used to assure all positions are filled.

6.1.4. *Scholar On-Boarding.* Once the scholar selection is final, the Education Team schedules a 1:1 Zoom meeting between each mentor/mentee pair, with suggested discussion topics. These meetings are designed to assure the mentors have a strong understanding of the goals and experience level of their mentee, as well as assure the contemplated project is appropriate in scope. Project scopes are modified after the meeting, as needed. Additionally, during the meeting, the mentor provides literature and other background material for the Scholar to review prior to the commencement of the internship.

6.1.5. *Program Metrics and Tracking.* For its first two years, the CSU Masters Scholars program seeks to place four (4) Masters Scholars, two (2) at each host campus. In Years three and four, ExFAB will place six (6) Masters Scholars and in years five and six, ExFAB will place eight (8) Scholars. The ExFAB Education Team will follow-up with each Masters Scholars no less than annually for three years after they participate to track the students' education and career progress. The Education Team will further monitor the progress of the CSU Masters Scholars through LinkedIn. The goal of the program is to matriculate Masters Scholars into PhD programs or employment in the biotechnology industry.

6.2 ExFAB Fellows Program. The ExFAB Fellows program provides research training and professional development for UCR and UCSB postdocs and graduate students who are affiliated with ExFAB and are conducting in-house research that will develop new technologies for the benefit of the microbiology research community. The Fellows program targets individuals who have at least one year remaining in their research. The program focuses on three primary elements: research development, professional and career development, and community.

ExFAB Fellows receive in-depth training on EXFAB's facilities and processes with strong focus on automation, either through the ExFAB Summer School program or specialized training courses tailored to the Fellows. Training sessions include exposure to industry perspective through talks by industry representatives. Fellows also participate in monthly Research Ideation Meetings during the academic year in order to exchange ideas around new research projects and problem solve project challenges and are required to participate in both innovation and professional development activities (both in person and virtually. Fellows are expected to submit user

proposals to access the ExFAB facilities for specific research projects and to present their research findings and new technologies at the quarterly ExFAB All-Hands meetings.

ExFAB Fellows receive financial support during the period where they are actively engaging with the ExFAB facilities, typically for 6-9 months. However, ExFAB Fellows are eligible to participate in all programming and ExFAB activities throughout their time at UCSB or UCR, even after the period of financial support has ended. Fellows that are in a position to meaningfully contribute to the development of technologies, protocols and workflows beyond the standard 6-9 month period may be elevated to Contributing Fellows by the Management Team, making them eligible for longer term financial support.

6.2.1. *Recruitment.* ExFAB issues a call for applications for the ExFAB Fellows program no less than twice annually, in July for the Fall and Winter quarters, and in February for the Spring and Summer quarters. The call for applications is announced through messages sent to ExFAB's Google Group (which reaches all ExFAB-affiliated research groups), on the ExFAB website, and through targeted communications to laboratories that are not yet affiliated with ExFAB but possess cross-disciplinary knowledge and skills that would advance ExFAB technology.

6.2.2. *Application Process.* Interested graduate students and postdocs apply to the ExFAB Fellows program through a portal on the ExFAB website. Application materials include a brief application form, as well as a statement of research, a description of the technologies they desire to develop, how those technologies will benefit the microbiology research community, and their curriculum vitae.

6.2.3 *Selection Process.* The ExFAB Management Team reviews all complete applications to select ExFAB Fellows, reviewing experience and credentials, as well as the potential impact the proposed research and technology could have on the microbiology research community. The PIs select Fellows for their campus, subject to the review and concurrence of the entire Management Team. If the student or postdoctoral scholar is a member of a management team member's group, that member recuses themselves from the discussion of, or voting upon, that candidate.

6.2.4. *Program Grown and Outcome Tracking.* ExFAB appoints between ten (10) and sixteen (16) ExFAB Fellows annually, with approximately equal representation at UCSB and UCR. Further expansion is dependent on research needs and available funding. Each cohort of Fellows will complete an initial onboarding survey to solicit input on their expectations for participating in the ExFAB Fellows program (research and career-related interests). Fellows will complete a post-program feedback survey (annually, Summer) to track effectiveness of the programming elements, as well as steer future programming modifications and directions.

6.3. Summer School. The ExFAB Summer School is a one-week, intensive program at UC Santa Barbara designed to provide in-depth technical training to enable researchers to learn how to use and leverage ExFAB's unique suite of instrumentation for their own research. The curriculum includes four (4) all-day technical modules, which include lectures and hands-on laboratory training, as well as industry panels, an academic keynote talk, and a user proposal development

session. Topics include how to build workflows and schedules and how to evaluate whether automation is worthwhile. The theme of and technical modules vary from year-to-year and are set, in part, by the experience and knowledge gaps observed in the ExFAB user base. There is no fee or tuition to attend the ExFAB Summer School. Course materials, lodging and most meals are provided by ExFAB.

6.3.1. *Recruitment Cycle.* Recruitment strategies include info sessions (Zoom and live), posting on LinkedIn and other social media channels, distribution of on-campus flyers, and targeted emails to relevant UC and CSU labs, posting on ExFAB's website and announcements in ExFAB's newsletter. Word of mouth also increases visibility for the program. Recruitment of users from the CSU system is driven through CSUBIOTECH. Students who express interest are added to a special ExFAB mailing list.

6.3.2. *Application Process.* A call for applications is issued in early February, with a deadline approximately one month later, in early March. Throughout the application period, ExFAB sends regular reminders to apply through its various outreach channels. Individuals apply through a portal on the ExFAB website. Application materials include a brief application form, as well as a statement of interest, statement of research, CV, and a letter of support (for students/postdocs only).

6.3.3. *Selection Process.* Members of the ExFAB Education and Operations teams review each complete application to confirm eligibility and assess its strength. The review panel scores each participants against a pre-prepared rubric to determine the top candidates and alternates (who are ranked). The review team then meets to select a list of finalists. In the event an invitation is declined, the alternate list is used to assure all participant slots are filled. Qualified applicants from nonR1 universities receive priority.

6.3.4. *Program Metrics and Tracking.* In future years, the Summer School will be open more broadly to external participants. The goal of the Summer School is to increase the user base of ExFAB. Key metrics include whether participants submit user proposals and become regular users of the ExFAB facilities. A survey is also sent at the end of each Summer School to quantify the skills gained through the Summer School and the users' overall satisfaction with the curriculum.

7.0 Knowledge Sharing

7.1. Communications. ExFAB employs an open communication policy. All ExFAB researchers are strongly encouraged to share research results, technologies, workflows and protocols enabled by ExFAB through academic publications, conference presentations, and public lectures and media outreach. As part of the onboarding process, ExFAB Users agree to acknowledge ExFAB support in all the above communications.

ExFAB directly transfers knowledge of new technologies, protocols and workflows it develops, as well as key external resources and advances in microbiology through the ExFAB's Summer

School, Fellows and Masters Scholars programs, regular seminars and lectures, conference presentations and ExFAB's social media accounts. Users are also taught relevant protocols and workflows during 1:1 training with lab managers during their use of the facilities.

The ExFAB newsletter, issued quarterly, announces upcoming programs and events, provides facility updates and reports out key publications and presentations. The Managing Director oversees the newsletter. Each issue is developed by the ExFAB Managing Director and the ExFAB Program and Administrative Coordinator, with input from the ExFAB Management Team and relevant staff. Interested parties can sign up on the website. The subscriber database is maintained in MailChimp, allowing ad-hoc communications through email blasts in addition to the quarterly newsletter.

The ExFAB website (exfab.org) is the hub of all communications. It provides information about ExFAB's facilities, education and training programs, events and policies, as well as the ExFAB leadership, staff, researchers, Fellows and Scholars. It also contains a list of all ExFAB products (currently, publications, presentations and protocols). The website is the platform to apply to all ExFAB programs (Fellows, Scholars, Summer School, the User Program, User Grants, etc.). ExFAB uses Smartsheet to generate application forms and manage and archive submissions. ExFAB also maintains a Wiki as a companion to the website with lab details, equipment specs, and travel and visitor information.

The website is overseen by the ExFAB Managing Director. The ExFAB Program and Administrative Coordinator, who reports to the Managing Director, is responsible for day-to-day updates. Content on specific programs is developed through a collaboration between the Managing Director, Program and Administrative Coordinator, in consultation with the team responsible for the relevant subject area. The website includes a generic email, info@exfab.org, that can be directed to multiple ExFAB personnel to ensure timely response. Contact information for key staff and the ExFAB leadership is also included on the website.

ExFAB also maintains a social media presence on numerous social media platforms, including LinkedIn and Blue Sky. The accounts are used to promote an ExFAB community. The social media accounts have several purposes: to publicize calls for various ExFAB programs (Summer School, Masters Scholars, External User Proposals, etc.); to communicate ExFAB research results, publications and presentations to both academia and the public; to generate an interest in extreme and exceptional microbes; to generate metrics on program impacts; and to build an active ExFAB research community. The social media accounts are overseen by the Managing Director and managed on a day-to-day basis by the User Coordinator and ExFAB Program and Administrative Coordinator.

7.2 Biological Samples and Data.

Biological samples and materials sent to ExFAB facilities are managed by the host university's standard material transfer agreement policies and processes. Except in the case of proprietary research (where a user directly pays the full access fee), Users must agree to deposit a sample of any material they bring to ExFAB facilities, together with any sequencing, phenotyping,

metabolomic, or other data on the material that is generated through the use of the ExFAB facility. Users grant ExFAB the right to use these materials and the associated data for any research or educational purpose. ExFAB keeps the deposited materials and data for up to one (1) year, after which the User may either deposit the material in an appropriate third-party depository that allows access for research and educational use or the User may directly provide the materials to interested researchers upon request. Users may request that access to the materials or associated data is embargoed for up to two (2) years or the earliest publication, whichever occurs first.

8.0 Metrics of Success

As a user facility, ExFAB's primary goal is to enable science and engineering for our community and region. We will use a range of metrics to measure our success. ExFAB users, number of students and researchers trained, and number of training opportunities offered are key metrics to understand success in workforce development. Projects initiated, projects complete, workflows developed, and the costs of these activities, will help understand our productivity in meeting user needs. Papers published, student degrees and collaboration among the ExFAB community will be used to measure our academic productivity. IP development and new connections with the biotech industry will be tracked to help understand our innovations and our impact on the regional biotech economy. Annual user surveys will assist in understanding the facility's ease of use.

Consistent with the guidance document, ExFAB will evaluate these metrics annually to assess progress toward its user facility, research, training, partnership, and knowledge transfer goals. The External Advisory Board will review ExFAB's annual metrics (as defined in Appendix 5), user survey results, project outcomes, and progress toward strategic milestones, and will provide written recommendations to the ExFAB Management Team. The ExFAB Management Team will determine what corrective actions or programmatic changes should be implemented and establish timelines for completion.

Using the anticipated project timeline (see Table 1, Appendix 5), we aimed to initiate 18 projects by the end of year 2. On a yearly basis we will train at least 20 ExFAB fellows and scholars and engage an average of 3 researchers per user project. We expect that each project will generate at least one publication, a peer-reviewed work of research and/or a published protocol describing the project workflows. Years 1 and 2 data collected for user projects and outcomes of this work will help inform year 3 metrics and beyond.

9.0 Budget Guidance and Policies

ExFAB will adhere to the approved budget.

9.1.1 *User Program.* With respect to user projects, the budget allocates an average of $7,500 to each approved project. Project budgets will vary and we anticipate that some high value projects, for example those that develop new ExFAB workflows that meet community needs, will be allocated as much as $20,000 or more.

9.1.2 *Staff.* Staff time is allocated to external and internal projects through campus-provided scheduling systems, with the goal of 50% commitment to external projects by year 3. During the initial start-up phase, staff time and supplies was largely allocated to internal projects and start-up operations (e.g., protocol development, validation, and optimization), with increased support of external projects as ExFAB matures.

9.1.3 *Equipment.* We anticipate potential changes to the equipment budget as ExFAB adjusts capabilities to meet user needs. Regular equipment maintenance and vendor warranties help minimize the risk of increased costs due to equipment failure, but repair costs may require changes to the budget. In the event that equipment budget is underspent in a given year, the carry over will be saved and used toward future equipment repairs, capacity expansion, or the acquisition of new equipment. Similarly, carry over in user project funds will be used for additional projects in subsequent years.

9.1.4. *Program Income.* Program income will be realized primarily when users pay the recharge rate for proprietary research. In accordance with applicable federal and UC policy, program income is reinvested in ExFAB through equipment purchases, graduate student support, additional user projects, and other activities that help achieve ExFAB goals.

9.1.5. *Ongoing Oversight*. The ExFAB Director, Co-Director and Managing Director monitor grant expenditures on no less than a quarterly basis against internal budget forecasts and advise the ExFAB Management Team if expenditures overall or within specific budget categories do not track within an expected bandwidth. Potential changes to the budget will be discussed with the PI and co-PIs, with advice from the Managing Director, on a case-by-case basis.

9.1.6 Rebudgeting. When spending is substantially higher or lower than projected, the Director, Co-Director, and Managing Director will review the cause of the variance and develop a recommended rebudgeting plan for consideration by the Management Team. Rebudgeting decisions will prioritize activities that advance ExFAB's core mission, maintain user facility operations, support completion of approved user and in-house research projects, and sustain training and knowledge transfer commitments. In the case of higher than projected spending, the Leadership team will convene and review detailed budgets, to include an analysis of cost of user projects (to include ExFAB staff time, reagents, and instrumentation). When necessary, the Director will work with NSF to make an additional request for funds as justified (e.g. where staff support is limiting user progress) for in-demand capabilities. Resource-intensive, low-demand user capabilities will be deprioritized in favor of capabilities and projects that support more users. Approved rebudgeting actions will be documented, incorporated into internal budget forecasts, and reflected in future SIP updates when they affect ExFAB priorities, operations, timelines, or resource allocation. With respect to equipment purchases not in the original scope of the proposal at or above $100k will be approved by the Director, Co-Director, and Managing Director, whereby the equipment/infrastructure are found to align with strategic user priorities (Section 3.1) and capabilities to increase internal and external user engagement.

10.0 Sustainability Plan

The research and training goals of ExFAB are synergistic with a sustainability plan. ExFAB seeks to create a robust user base comprised of users external to ExFAB, industry users, and internal users from all three of ExFAB's campuses. Through the various feedback mechanisms outlined above (see section 5), ExFAB will offer services and workflows that meet users' needs that cannot be provided at other biofoundries. After the grant period, users' need for ExFAB's unique capabilities will continue and access will be subject to the university's standard recharge (access) fee programs, providing revenue to support ExFAB at the end of the grant period and beyond. ExFAB will also develop a fee-based training program to retrain the biotech and biomanufacutring workforce, which will generate additional revenue.

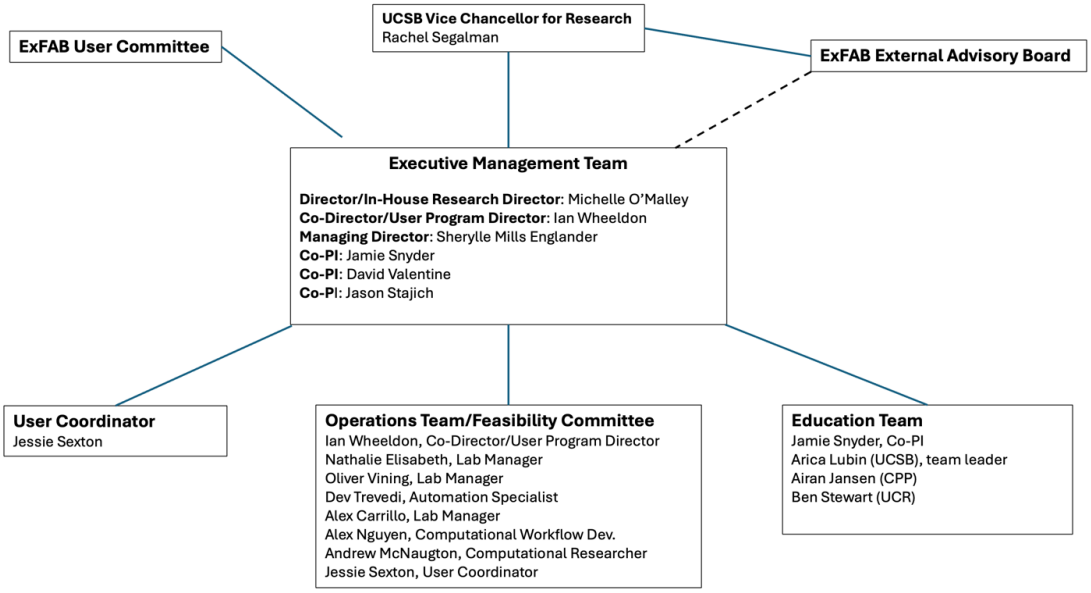
ExFAB will also seek out industry sponsored research. By understanding and meeting the needs of our industrial partners, we anticipate sustainable income through industry-sponsored research. In addition, ExFAB PIs and users will leverage ExFAB capabilities to support the successful submission of new grants targeting research collaborations, workforce development, and research translation and commercialization in response to relevant federal, state and nonprofit funding calls, as well as philanthropic organizations.

11.0 Revision History

May 27, 2025	Version 1.0
May 5, 2026	Version 2.0

APPENDIX 1

EXFAB ORGANIZATIONAL STRUCTURE CHART



APPENDIX 2

EXTERNAL ADVISORY BOARD MEMBERS

Name	Title	Organization	Expertise
Dr. Carrie A. Ekert	Synthetic Biology Group Leader	Oak Ridge National Laboratory	High throughput methods for genotype-phentoype discovery for applications in metabolic engineering of microbes.
Dr. Nathan Hillson	Vice President of Manufacturing Execution Systems	Twist Bioscience	Development of experimental wetware, software, and laboratory automation devices that facilitate, accelerate, and standardize the engineering of microbes.
Dr. Trent Northern	Senior Scientist	DOE Joint Genome Institute	Development of mass spectrometry and fabricated ecosystem approaches to study processes by which microbes interact to harness microbes for sustainability applications.
Dr. Ikhide Imumorin	Executive Director, CSUBIOTECH	Cal State University, San Diego	Leader in CSU System for biotechnology education; research background in genetics and genomics.
Dr. Michael Koepke	Chief Innovation Officer	LanzaTech	Responsible for LanzaTech's genetic engineering and automation platforms and strain development programs.
Dr. Caroline Ajo-Franklin	Professor and Director, Rice Synthetic Biology Institute	Rice University	Applies biophysics and synthetic biology to engineer the nanoscale interface between living microbes and inorganic materials, with applications in carbon capture and sequestration and bio-solar energy.
Dr. Arye Lipman	Co-Founder & COO	Biosphere	Investor focused on synthetic biology and materials science

			with deep ties to Los Angeles investors and accelerator programs.
Dr. Jens-Uwe Kuhn	Dean of Math and Sciences	Santa Barbara City College	Chemist and microbiologist with deep experience with preparing students to seek advanced degrees and engage the research environment.
Dr. Claudia Schmidt-Dannert	Distinguished Professor and Director, Biotechnology Institute	University of Minnesota	Design of self-organizing systems from genetically encoded protein building blocks for applications in biocatalysis, biosynthesis and functional materials, including the engineering of microbial cells to produce living materials and biocomposites as well as synthetic biofilms.

APPENDIX 3

ExFAB Internal Research Subcommittees

Bioremediation
ExFAB team: Valentine, Greene, Men, O'Malley, Santoro, Stajich, Wang
Goals: In the presence of manmade pollution and contamination, many natural microbial communities adjust to and begin to thrive in the new harsh environment. One research focus of ExFAB is to collect, identify, phenotype, study, and ultimately engineer these microbial communities to advance biotechnology using microbial systems sourced from soil to the sea.

Biosynthesis
ExFAB team: Wheeldon, O'Malley, Stajich, Mills, Borkovich, Petras
Goals: The research of this theme exploits novel phenotypes of extreme microbes to design and realize strains that can efficiently convert low-cost and waste carbon sources into high value and commodity chemicals. Automated culture manipulation and environmental controls provided by ExFAB infrastructure support microbial phenotyping and transformation to engineer strains across multiple species for biomanufacturing applications.

Rules-of-Life
ExFAB team: O'Malley, Santoro, Wilbanks, Borkovich, Volland, Snyder
Goals: Research captured in this in-house theme focuses on understanding the rules of life through extreme examples of microbiology by integrating the knowledge learned in functional genetic studies of extreme microbes and in our application-oriented research. In particular, a key goal of ExFAB is to identify and characterize microbes that host non-conventional compartments (e.g. prokaryotes with nuclei), novel pathways and energy generation mechanisms, and feature unique ultrastructures that alter our conventional understanding of cellular life.

APPENDIX 4

ExFAB UCSB INSTALLATION TIMELINE

	Equipment	Ordered	Delivered	Installed	Open Use
Integrated	Anaerobic Enclosure		06/25	06/25	07/25
	Robotic system			07/25	07/25
	PlateLoc (Plate sealer)				
	Xpeel (Plate peeler)			07/25	07/25
	Echo 525 (Liq handler)				
	Fluent 780 (Liq Handler)		06/25	07/25	07/25
	Multidrop (Liq Handler)			07/25	07/25
	4x ATC (Thermocyclers)			07/25	07/25
	Ultra Seal Pro (Plate sealer)			07/25	07/25
	2x Cytomats (Incubators)			07/25	07/25
	Cytoflex S (Flow cytometer)				07/25
	HiG4 (Centrifuge)			07/25	07/25
	Cytation C10 (High content Imager)				
Offline	Optima XE-90 (Ultracentrifuge)				
	5300 Fragment Analyzer				
	Orbitrap Ascend Tribrid (MS)				07/25
	TSQ Altis Plus Triple Quad (MS)				
	ISQ7610 GC (MS)				
	UIP400MTP (Sonicator)	TBD			
	BioSorter (Large particle sorter)	TBD			
	Aurora CS (Sorter)	TBD			
	Bruker Neoflex MALDI (MS)		06/25		

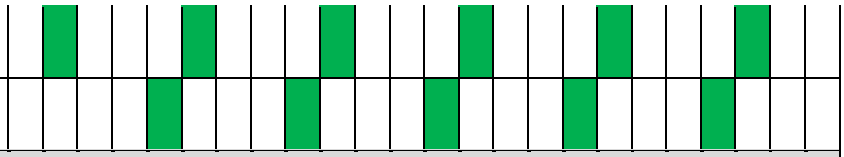
: Completed task

MM/YY : Estimated date of completion

TBD : To be determined

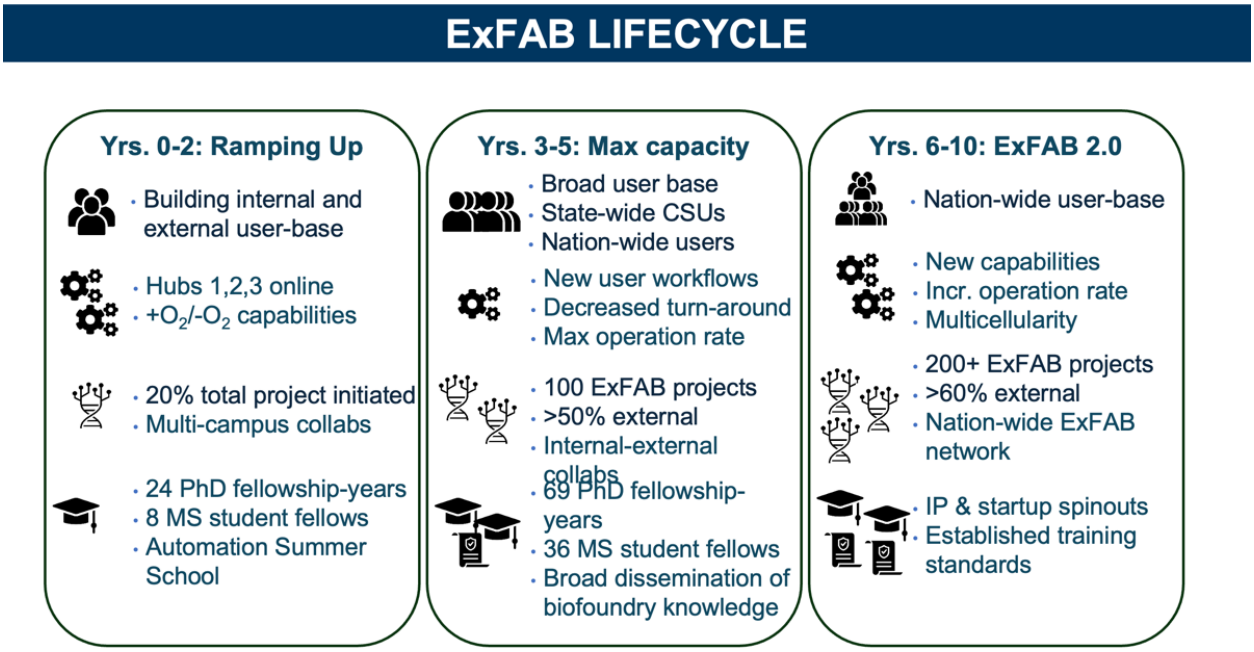
APPENDIX 5

	Year 1				Year 2				Year 3				Year 4				Year 5				Year 6			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Governance and Reporting																								
Activity 1.1: Form Management Team, Education Team, Operations Teams, establish meeting schedules																								
Activity 1.2: Form External Advisory Board																								
Activity 1.3: Draft initial Strategic Implementation Plan																								
Activity 1.4: Draft Intellectual Property Policy																								
Activity 1.5: Hold first All-Hands Meeting																								
Milestone 1.1: Hold initial Executive Advisory Board meeting																								
Activity 1.6: All-Hands Meetings																								
Activity 1.7: Update Strategic Implementation Plan																								
Activity 1.8: Annual EAB Meeting																								
Activity 1.9: Annual NSF Site Visit																								
Activity 1.10: Annual NSF report																								
Facilities																								
Activity 2.1: Onboard core lab team																								
Activity 2.2: Acquire and install core equipment for anaerobic use																								
Activity 2.3: Establish initial recharge rates (lab access fees)																								
Activity 2.4: Develop Integrated, cross-campus LIMS system																								
Milestone 2.1: Core Facilities Fully Operational for aerobic use																								
Milestone 2.2: Launch LIMS System																								
Milestone 2.3: UCSB Facility - Anaerobic Capabilities Fully Operational																								

Activity 2.5: Annual recharge rate updates/approvals	
Activity 2.6: Annual facility assessment for strategic investments	
User Program	
Activity 3.1: Onboard User Coordinator	
Activity 3.2: Develop recharge procedures/onboarding documents	
Milestone 3.1: First In-House User Project Kick-Off	
Activity 3.3: Design External User Call program	
Activity 3.4: Biannual External User Project Calls	
Milestone 3.2: First External User Project Kick-Off	
Milestone 3.3. Onboard 50th User Project	
Milestone 3.4: Onboard 100th User Project	
Activity 3.5: Annual User Survey	
Education and Training	
Milestone 4.1: Launch ExFAB Fellows program	
Activity 4.1: Bi-annual Calls for Fellows	
Activity 4.2: Calls for CSU Master Scholars	
Activity 4.3: CSU Masters Summer Program	
Milestone 4.2: Launch CSU Masters Scholars program	
Activity 4.4: Calls for Summer School Participants	
Activity 4.5: ExFAB Summer School	
Milestone 4.3: Launch ExFAB Summer School program	
Activity 4.6: Annual Survey of Fellows	
Activity 4.7: Annual Survey of Masters Scholars (current and alum)	

Activity 5.8: Annual Survey of Summer School Participants																								
Activity 5.9: Market Assessment - Industry Training Program feasibility																								
Activity 5.10: Launch initial industry training bootcamp																								

APPENDIX 6
EXFAB GOALS



APPENDIX 7

EXFAB EQUIPMENT LIST

NSF ExFAB BioFoundry - UC Santa Barbara Site

Category	Environmental Chamber and Integrated Equipment	
G	MBraun Custom 9' x 20' Environmental Chamber	Houses 15 pieces of equipment. Atmospheric control (Pure nitrogen, can supplement with <4% hydrogen and/or <10% carbon dioxide)
G	Thermo Spinnaker Robotic Plate Mover	Plate transfer, lidding/delidding
CC	2 Thermo Cytomat 2 C450-Lin shaking incubators	Each: 42 standard or 14 deepwell microplate capacity, 4-50°C, shaking); atmospheric control (up to 10% CO2)
LH, CP	Tecan Fluent 780 workstation with Pickolo colony picker & vacuum manifold	Liquid handler (1 µL to 5 mL per dispense; 8 channel head w/ independent channels, 96 channel head. Heating, cooling, shaking, and magnetic blocks.
LH	Beckman Echo525 Acoustic liquid handler	Small volume liquid handler (25 nL to ~1.5 µL per dispense)
LH	Thermo Multidrop Combi liquid handler	Bulk dispensing, 6-1536w plates, 0.5 to 2500 µL dispense range
G	HiG4 centrifuge	Microplate format, holds 2 plates, deepwell compatible, 5000 xg max RCF
NA	2 Thermo ATC Thermocyclers	96w and 384w format
G	Agilent PlateLoc microplate sealer	Plate sealer - gas impermable opaque seal
G	Finneran-Povair Ultraseal Pro microplate sealer	Plate sealer - gas permeable, transparent seal
G	Azenta Xpeel microplate peeler	Plate peeler
I, A	Agilent BioTek Cytation C10 confocal imaging & multimode plate reader	Automated spinning disk confocal and widefield microscopy with 6 objectives including 60x water immersion, and sets of standard fluorescence filters (from DAPI to Cy5) for Widefield fluorescence & confocal; UV/Vis absorbance, fluorescence, luminescence; 4°C above RT to 45°C
A	Agilent BioTek Synergy H1 multimode plate reader	UV/Vis absorbance, fluorescence, luminescence; reagent injector module
CS	Beckman CytoFlex S 4-B2-Y4-R3 flow cytometer	Non-sorting; 4 lasers including violet for small particle detection, 13 fluorescence channels, tube or 96w format

Category	Benchtop Equipment with Current or Planned Anaerobic Capability	
CC	Distek BIOne 1250 Bioreactor	Precision cell culture (agitation, temperature, DO, pH control); 2 L vessel (max working vol 1.5 L)
CS	Cytek Aurora CS 4L FACS system	Cell sorting; 4 lasers including violet for small particle detection, full-spectrum detection
CT	HBio BTX Gemini X2 electroporation system with HT200	96w format
CL	QSonica Q500 multiprobe sonicator	Cell lysis with 24 probe head
CL	Omni Bead Ruptor Elite bead beater	Cell lysis; holds 24 x 2 ml, 12 x 15 ml, or 6 x 50mL sample tubes
G, I	Thermo Vitrobot Mark IV system	Semi-automated cryo-EM sample prep

Category	Additional Equipment	
CC	2x New Brunswick Scientific I26 incubator shakers	2 large orbital shakers for cell culture, 25-400 RPM, 5-60°C, 1" orbit
LH	Thermo Multidrop Combi liquid handler	Bulk dispensing, 6-1536w plates, 0.5 to 2500 µL dispense range
G	Eppendorf 5904R refrigerated benchtop centrifuge	Centrifugation of plates or microtubes. Fixed angle rotor: 30 x 2 ml tubes, 20,800 xg max RCF; swinging bucket rotor: 2 x microplates, deepwell compatible, 2250 xg max RCF; -11-40°C
G	Beckman Optima XE-90 Ultracentrifuge (BNL partner facility)	Max RCF 694,000 xg; swinging bucket rotor (6 x 13.2 mL), fixed-angle rotor (8 x 39 mL); 0-40°C
NA	Agilent 5300 Fragment Analyzer	Automated, 48 channel capillary electrophoresis; high-resolution size separation of nucleic acids; sample purity and quality analysis
CS	Union Biometrica BioSorter large particle sorter	Sorts particles between 10-1500 µm; 3 filters: 498.5-521.5 nm, 532.5-557.5 nm, 603-627 nm
I	Molecular Devices ImageXpress HCS.ai confocal high-content imager	Automated spinning disk confocal and widefield microscopy paired with In Carta AI-powered analysis software; 4 objectives including 40x water immersion; 5 color LED illumination; RT + 5°C - 40°C
A	Orbitrap Ascend Tribrid with Thermo Vanquish Neo UHPLC (LC-MS)	Liquid chromatography-mass spectrometry; best for proteomics, metabolomics and structural characterization
A	TSQ Altis Plus Triple Quad with Thermo Vanquish Flex UHPLC (LC-MS)	Liquid chromatography-mass spectrometry; best for targeted analysis of proteins and metabolites
A	ISQ7610 GC-MS with TriPlus RSH Autosampler	Gas chromatography-mass spectrometry; best for analysis of volatiles, lipids and low MW metabolites
A	Bruker NeofleX Imaging MALDI TOF/TOF	Standard sample and imaging MALDI mass spectrometer; best for rapid metabolite screening, biomolecule and polymer analysis, spatial analysis

CC	Cell culture
CS	Cell sorting
CT	Cell transformation
CL	Cell lysis
CP	Colony picking/ pinning
LH	Liquid handling
G	General
NA	Nucleic acids
I	Imaging
A	Analysis

NSF ExFAB BioFoundry - UC Riverside Site

Category	Tecan Fluent 780 and integrated equipment	
LH	Tecan Fluent 780 work station	Liquid handling for molecular, biochemical, or cellular workflows. 0.5 µL to 1 mL per dispense; 8 channel pipetting head w/ independent channels; 96 channel head; heating, cooling, shaking, and magnetic blocks
A	Tecan Spark UV/Vis Plate Reader	Absorbance detection for molecular, biochemical, cellular assays (96w, 384w)
G	Rotanta 460 Robotic Centrifuge	Molecular, biochemical, cellular workflows, microplate format, deepwell compatible, 5000 xg max spin
CC	Liconic StoreX STX44 Incubator	Cell culture, temperature control, 44 microplate and 20 deep well capacity, 4-50°C, shaking

Category	S&P Robotics Biomatrix BM3-BC Bench-top and associated equipment	
CP	S&P Robotics Biomatrix BM3-BC Bench-top Configuration	Automated, high-throughput cell transfer, cell pinning
CP	Pin replicator head 96 pins	Static pin replication head for cell transfer (liquid to liquid, solid to solid, liquid to solid, solid to liquid)
CP	Pin replicator head 384 pins	Static pin replication head for cell transfer (liquid to liquid, solid to solid, liquid to solid, solid to liquid)
CP	Colony picking head 96 pins	Dynamic pin replication head for colony picking and re-arraying (liquid to liquid, solid to solid, liquid to solid, solid to liquid)

Category	S&P Robotics SPImager-A3 and associated equipment/capabilities	
I	S&P Robotics SPImager-A3	Colony imaging over time (incubates up to 160 SBS plates)
G	Geneva Scientific Incubator Model I-41NL	S&P Robotics SPImager-A3 sits inside this incubator (4-44°C)
A	PhenoTypic custom image analysis software	Automated quantification of colony growth rate, morphology, color

Category	Opentrons Flex and integrated equipment	
LH	Opentrons Flex liquid handling robot Opentrons NGS Workstation w/ HEPA UV	Liquid handling, molecular, biochemical, or cellular workflows, assay setup
G	Temperature block	96w format or individual microtubes (4–95°C)
G	Heater/Shaker block	96w format or individual microtubes (Ambient - 95°C, 300-3000 RPM)
A	Absorbance block	Measures the optical density of samples, 96w format
NA	Thermocycler block	96w format or individual microtubes (4-99°C)

Category	Miscellaneous equipment	
CT	HBio BTX Gemini X2 Electroporation System with HT200	96w format
NA	4x Applied Biosystems MiniAmp Thermal Cyclers	96w format or individual 0.2 ml tubes (4-99°C)
CC	Infors HT Minitrons Incubator Shaker	96w format or individual tubes, 4-65°C, 50-400 RPM
CC	Excella E-25R Incubator Shaker	96w format or individual tubes, 4-65°C, 50-400 RPM
CC	Heratherm Static Incubator (x2)	96w format or individual tubes, ambient+5-75°C

CC	Cell culture
CS	Cell sorting
CT	Cell transformation
CL	Cell lysis
CP	Colony picking/pinning
LH	Liquid handling
G	General
NA	Nucleic acids
I	Imaging
A	Analysis