Accelerate your research with BioPACIFIC MIP

Michael Lake, Ph.D.
Technical Director, Living Biofoundry
September 21, 2022

Sign-up at
biopacificmip.org

BioPACIFIC

NSF Materials Innovation Platform DMR-1933487

NSF

Materials Innovation Platform (MIP)

A unique mid-scale infrastructure program in NSF Division of Materials research

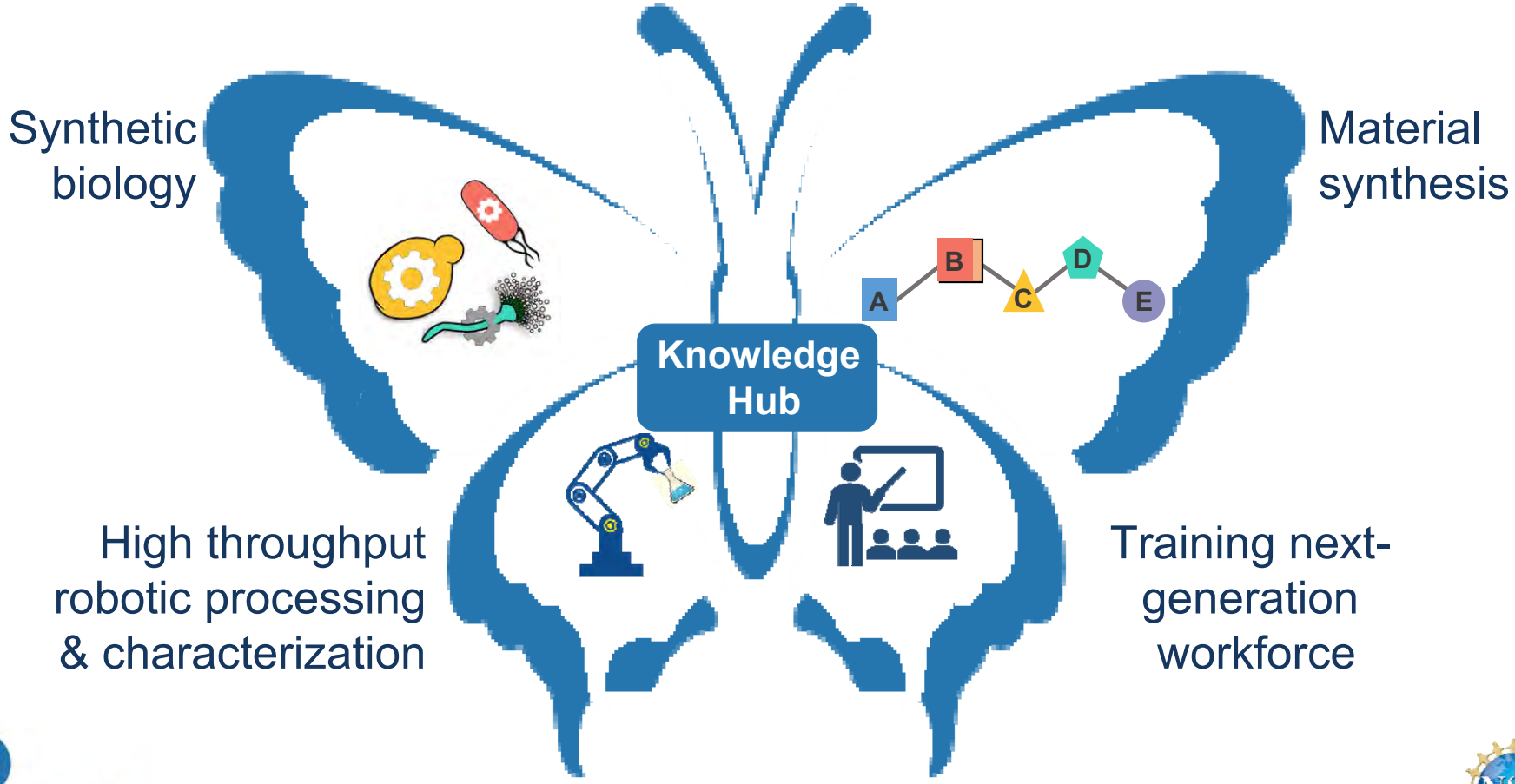
Conduct in-house research to address a grand challenge in material science

Develop next-generation experimental and computational tools to advance discovery and development of new materials

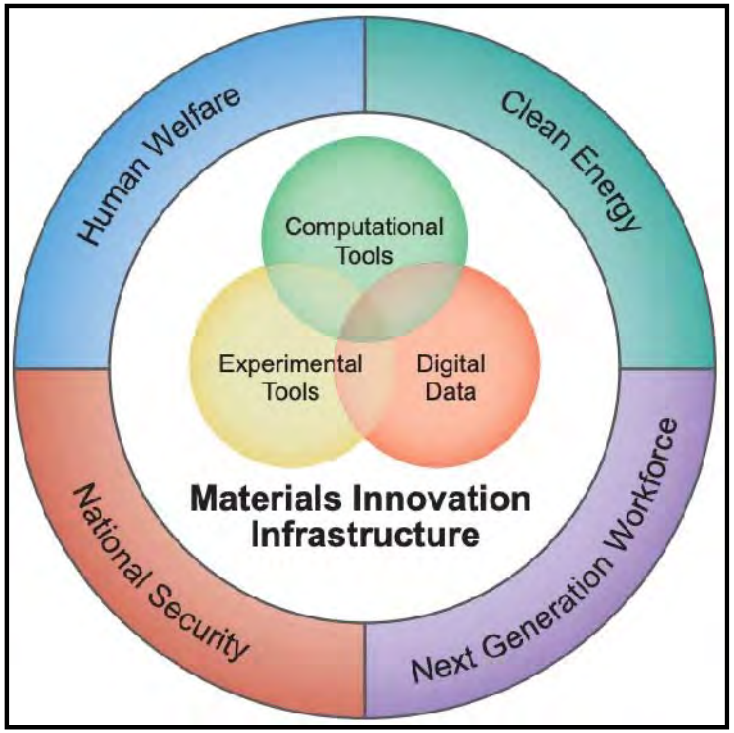
Operate a user facility that provides unique materials research tools, samples, data, and technical services open to diverse community

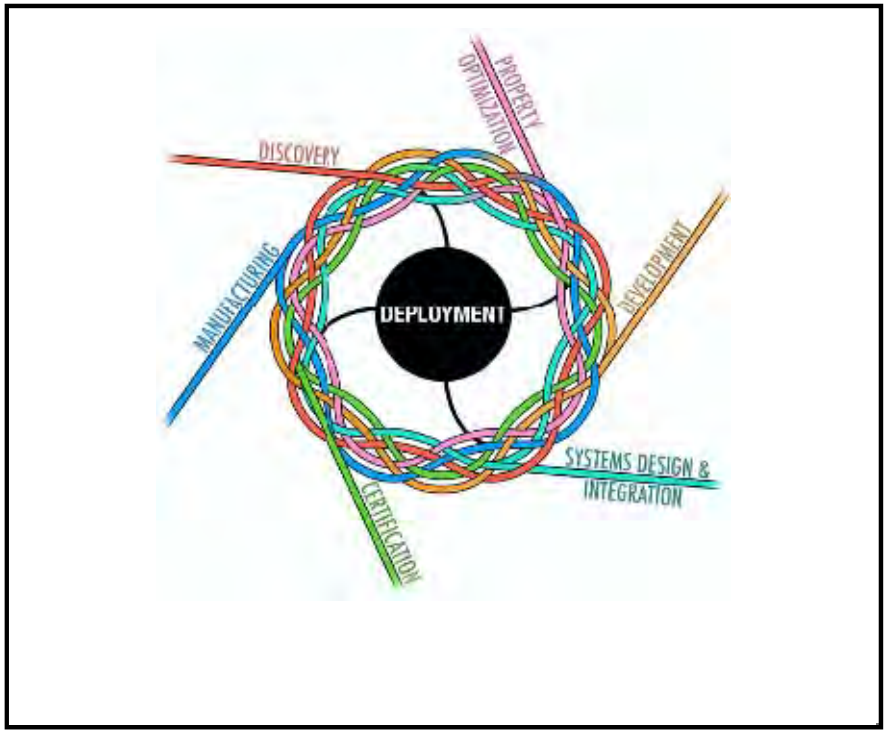
Serve as an educational focal point for training the next generation of tool developers and users

BioPACIFIC MIP Mission

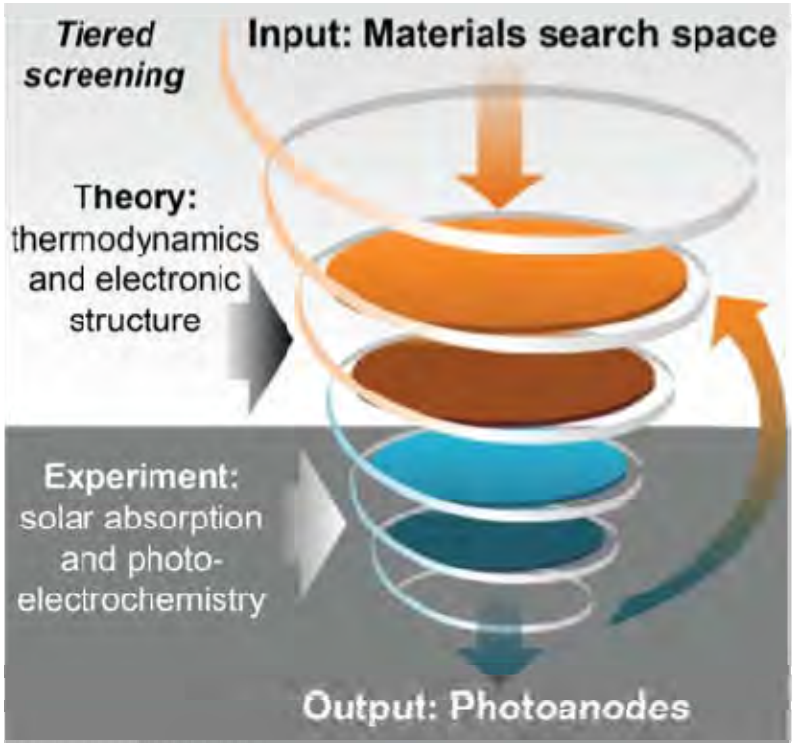


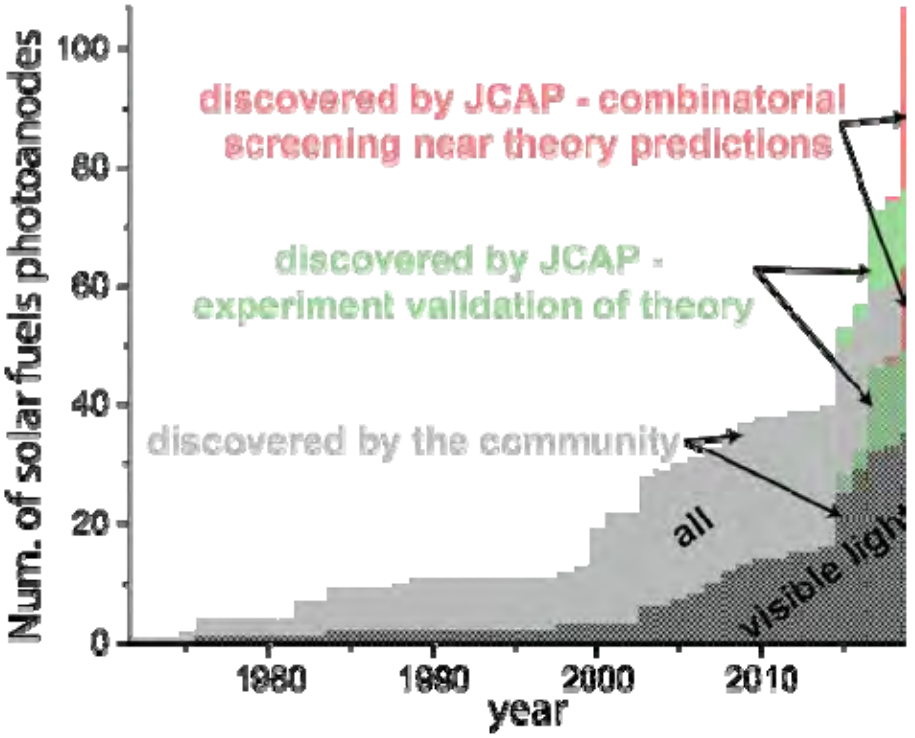
The Materials Genome Initiative





MGI Photoanode Example





Nature Has Provided Us With Remarkable Materials

Strong

Source: iStockphoto

Hydrophobic

Source: Science Photo Library

Tough

Source: Louise Murray

Adhesive

Source: Shutterstock

Camouflage

Source: Monterey Bay Aquarium

Eco-Friendly

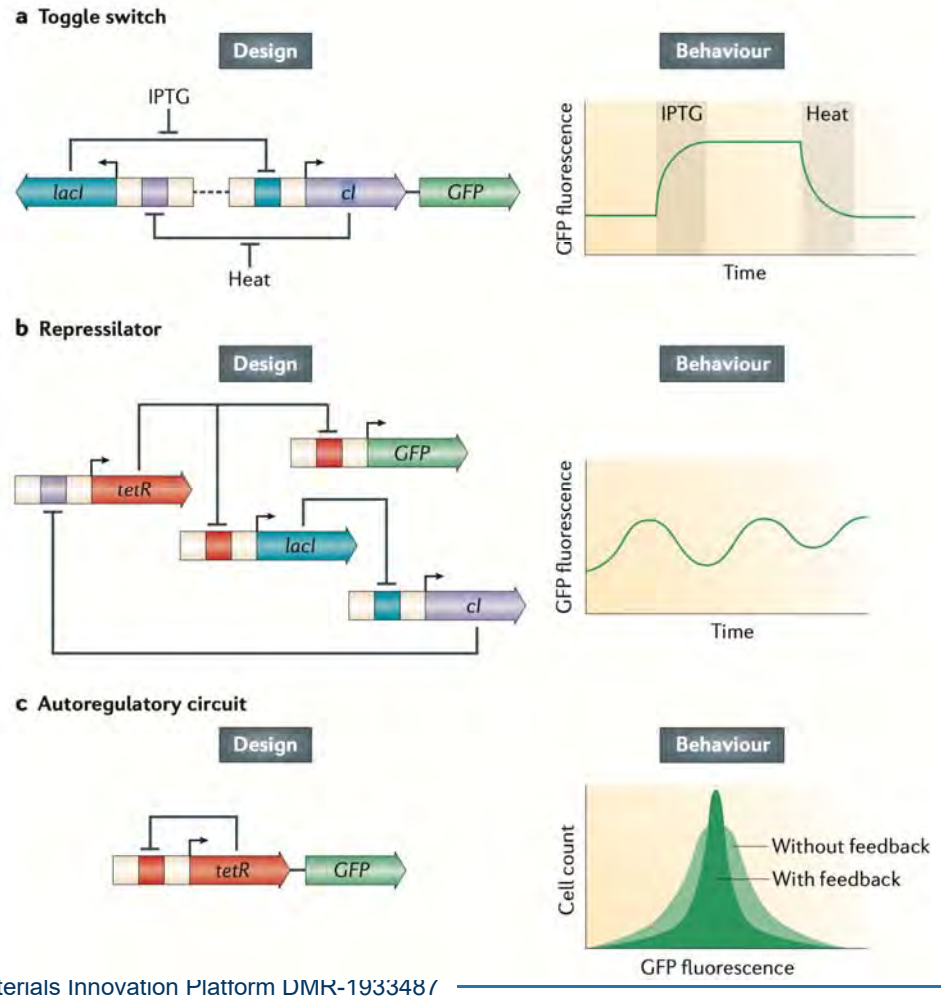
Source: iStockphoto

Synthetic Biology: Coupling Design to Behavior

"We will also need synthetic biologists to dissect these subsystems, both by rewiring them and by the creation of functions through their transplantation to new settings. And biologists will need the help of mathematicians, computer scientists, and engineers to make sense of the enormously complicated network of molecular interactions found in even the least complex living cells."

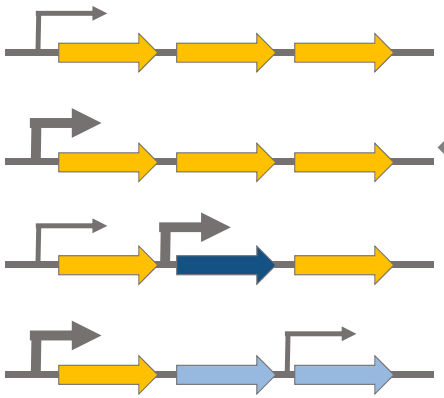
-Bruce Alberts, Editor-in-Chief of *Science*

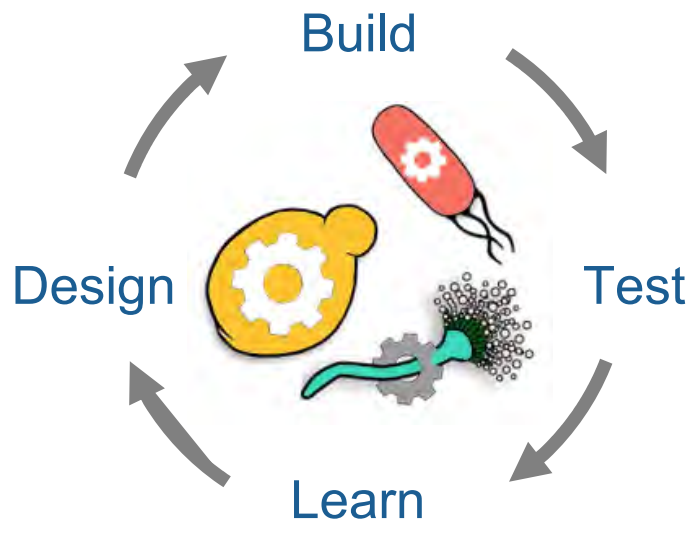
Alberts B. A grand challenge in biology. Science. 2011 Sep 2;333(6047):1200.



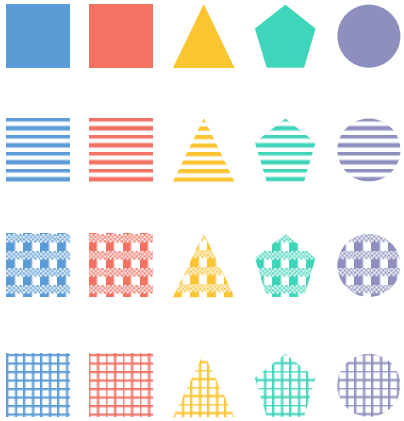
Opportunity To Greatly Expand Material Properties

Engineered Library of pathways and strains





Novel bioderived monomer library

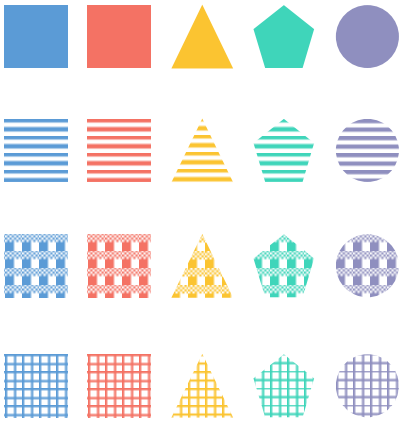


Synthetic biology offers tremendous advantages as a **sustainable** source to create a vast array of **novel compounds**

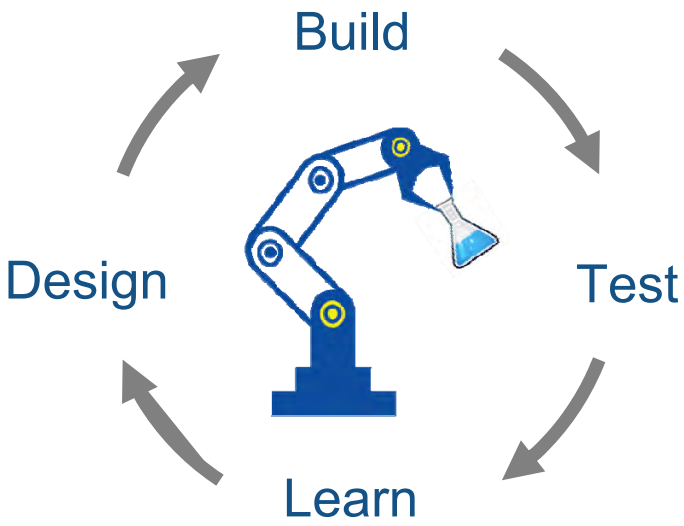
Engineer biological systems to discover, optimize and produce new monomers that are bio-derived and eco-friendly

Opportunities: Rapid Development, Access and Training

Monomer library



Bioderived + bioinspired synthetic monomers



High throughput robotic platform

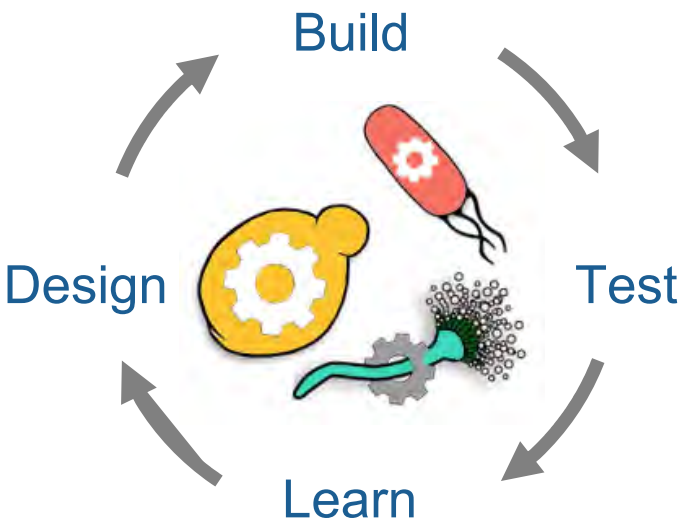
Next generation workforce will be trained in data-driven synthesis

Modernizing the way we process and formulate polymers

MIP users will be able to do research faster, safer and more reproducible

Structure-Property Platform

Vision: Structure-Property Platform will establish relationship that inform development of predictive models to guide the design and synthesis of material targets



High-resolution analysis:

Atomic scale characterization of (sub-)micro crystals of building blocks to identify structure-property relationships

Intermediate scale analysis:

Advanced analysis of structural organization in identified building blocks at mesoscopic length scales (5-500 nm)

Rapid analysis and down-selection:

Feature selection of biomolecular building blocks that provide targeted material properties

BioPACIFIC MIP Facilities

Living Biofoundry

Additive Manufacturing

Hierarchical Computation

Automatic Synthesis

High-throughput Characterization

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Living Biofoundry Facility

Automated synthetic biology suite

ThermoFisher Synthetic Biology Automation System

Accelerates the DBTL cycle from tens of sample-per-week to >500 samples-per-week

Manufacturing Plasmid Libraries

Clone and express proteins into microorganisms

Purify proteins

Living Biofoundry Facility

Supplemental Capabilities

- TSQ Altis MS w/ Vanquish Flex UHPLC
- Inline triple quadrupole UHPLC/MS/MS
- Agilent 7890A gas chromatography
- BIOFLO CELLIGEN 310 fermenter/bioreactor

Living Biofoundry Facility

Dr. Michael Lake
mlake@cnsi.ucla.edu

BioPACIFIC MIP Facilities

Living Biofoundry

Automatic Synthesis

Additive Manufacturing

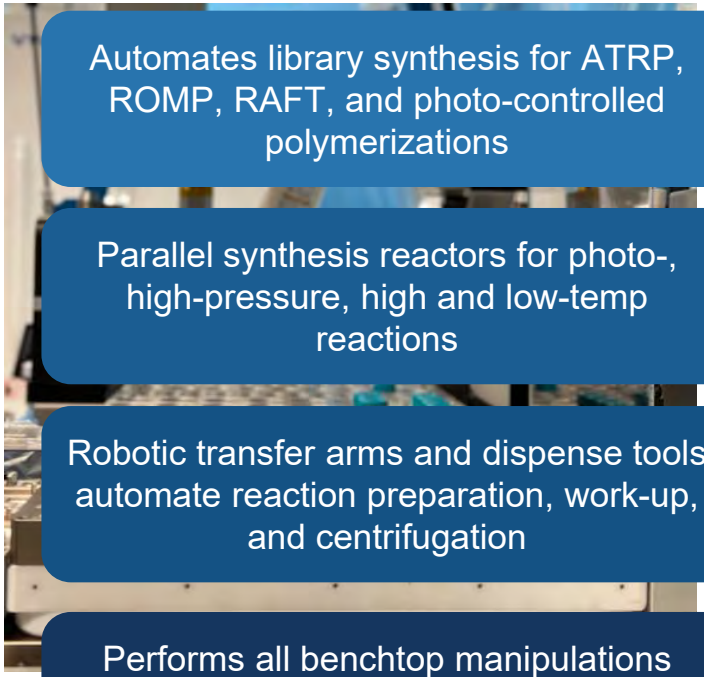
High-throughput Characterization

Hierarchical Computation

Automated Chemistry Platform

for reaction/solubility screening, formulation testing, material library synthesis, and purification

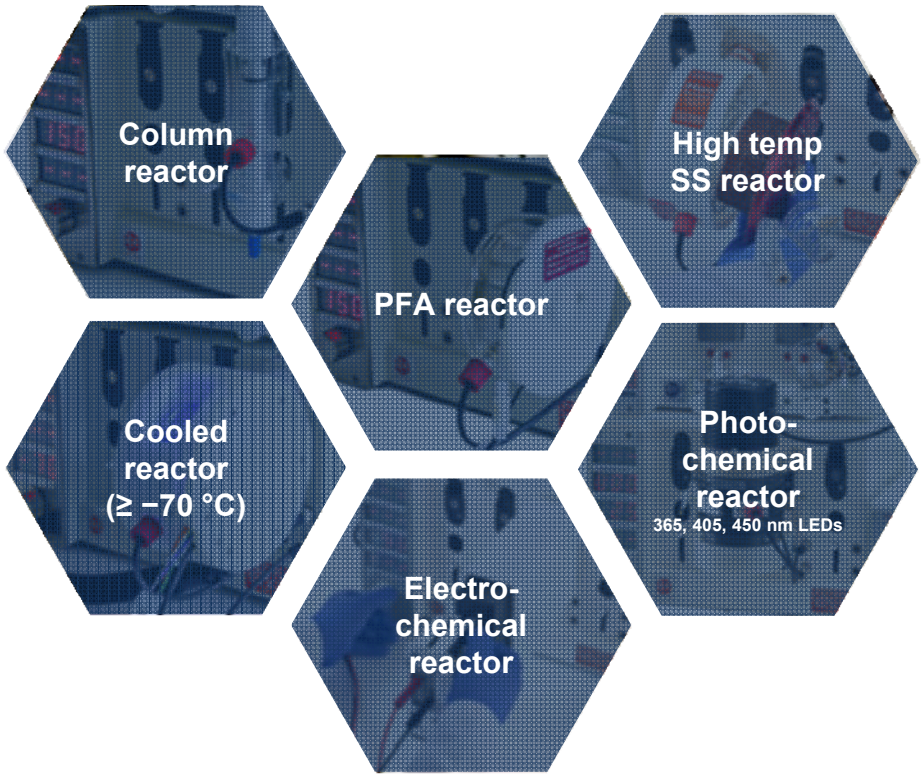
Adapted video from chemspeed.com



- Automates library synthesis for ATRP, ROMP, RAFT, and photo-controlled polymerizations
- Parallel synthesis reactors for photo-, high-pressure, high and low-temp reactions
- Robotic transfer arms and dispense tools automate reaction preparation, work-up, and centrifugation
- Performs all benchtop manipulations (filtration, evacuation, degassing, stirring, etc.) with minimal-to-no user intervention

Flow Chemistry System

for continuous synthesis, reaction optimization, and automated generation of material libraries



Vapourtech R-series

Flow Chemistry System

for continuous synthesis, reaction optimization, and automated generation of material libraries

In-line characterization and triggerable product collection

Automates calculations, data recording, and dispersion modeling

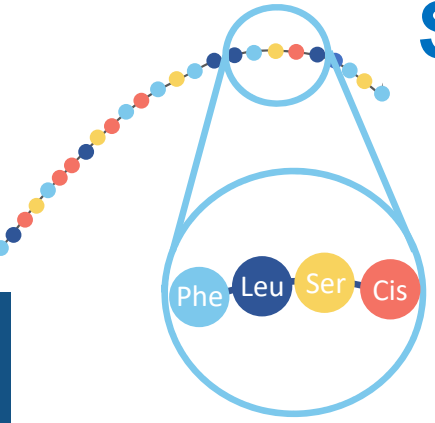
In-situ monitoring

Vapourtech R-series

Mettler Toledo Flow FT-IR
Diamond ATR Probe

Magritek 60 MHz NMR
^{1}H, ^{19}F nuclei

Solid Phase Peptide/Peptoid Synthesizer



Aminoacids

UNIQUE MONOMERS **40**

REACTION VESSELS **24**

SOLVENTS **7**

GR OF RESIN/VESSEL **2**

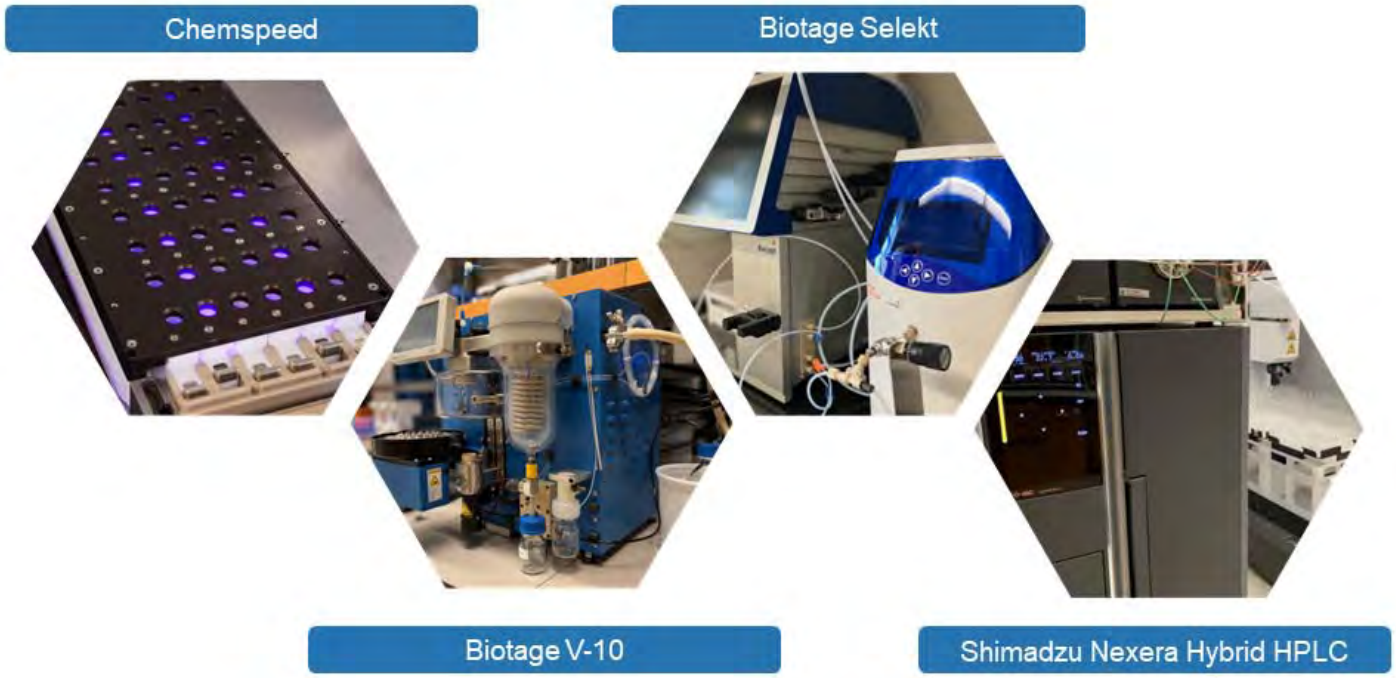
Autocleave

Monomer recovery

Gyros Proteins Symphony X

Complete Synthesis Facility

synthesis, purification, analysis, and quality control



Shimadzu Nexera Hybrid HPLC

Prep and Analytical HPLC
Collection based on UV or MS

Biotage Selekt Automated Flash Purification System

Two column channels with an external ELSD

Biotage V-10 Touch Evaporator

Rapid drying of aqueous and organic media

Automated Synthesis Facility

Dr. Morgan Bates
morganbates@ucsb.edu

BioPACIFIC MIP Facilities

Living Biofoundry

Additive Manufacturing

Hierarchical Computation

Automatic Synthesis

High-throughput Characterization

New Capabilities in Additive Manufacturing

Carbon M2 Printer

Continuous liquid interface technology

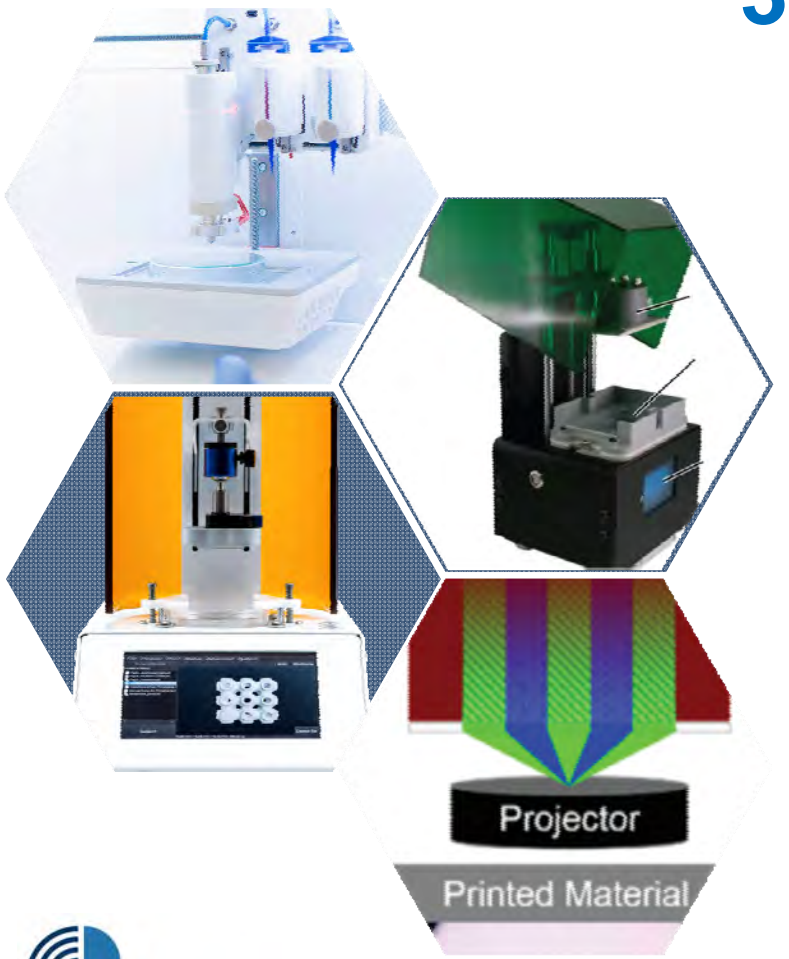
25 to 100 times faster than SLA

Mono 3Z2 Printer

5 LED Visible Light Printer (UV to NIR)

2 LEDs at a time for multilateral objects

3-D Printers



Extrusion, Digital Light Processing (DLP), Stereolithography (SLA) printers

Thermoplastic, hydrogel, living cells etc

Properties ranging from: Rigid to flexible, Stimuli responsive to cross-linked thermosets

Solution Mask Liquid Lithography (SMaLL)

Photochromatic molecule which allows precise control over placement of hard/soft segments

Additive Manufacturing Facility

Dr. Juan Manuel Uruena Vargas
jmuruena@ucsb.edu

BioPACIFIC MIP Facilities

Living Biofoundry

Additive Manufacturing

Hierarchical Computation

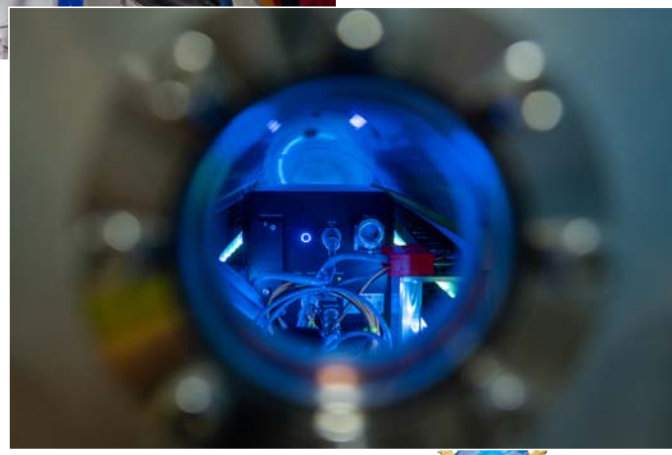
Automatic Synthesis

High-throughput Characterization

X-ray Scattering (SAXS-WAXS)

Available Now!

- Broad application for intermediate scale characterization (0.1nm-100nm)
- High-brilliance x-ray source and large area photon counting detector
- Impacts: >100% boost in measurement throughput with improved resolution
- ~10X increase in beam flux
  ~4X increase in detector area

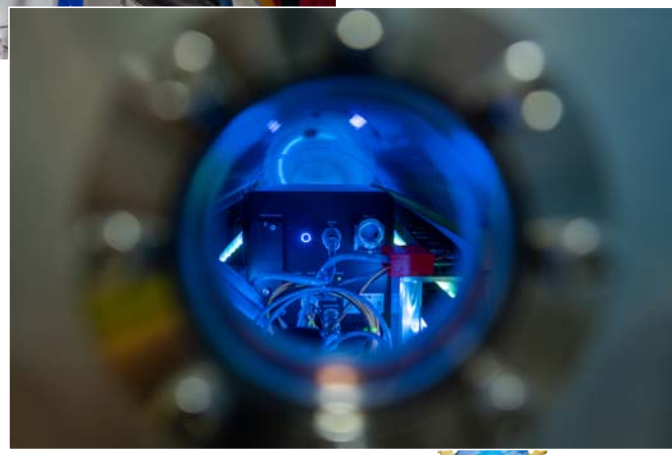


X-ray Scattering (SAXS-WAXS)

Available Now!

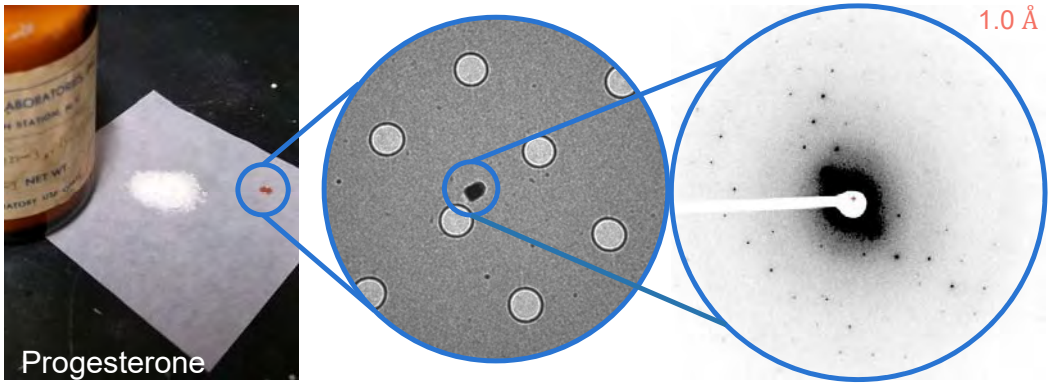
Sample environment for in situ mixing during small angle X-ray scattering (mix-SAXS) and optical microscopy

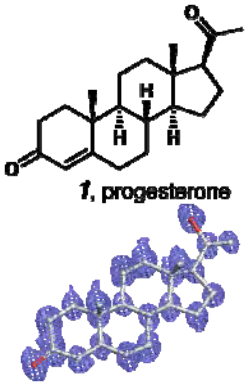
Kinetic structural characterization of complex and biological fluids across an unprecedented range of length and time scales



MicroElectron Diffraction (microED)

Enables rapid, atomic scale characterization of biomolecular materials



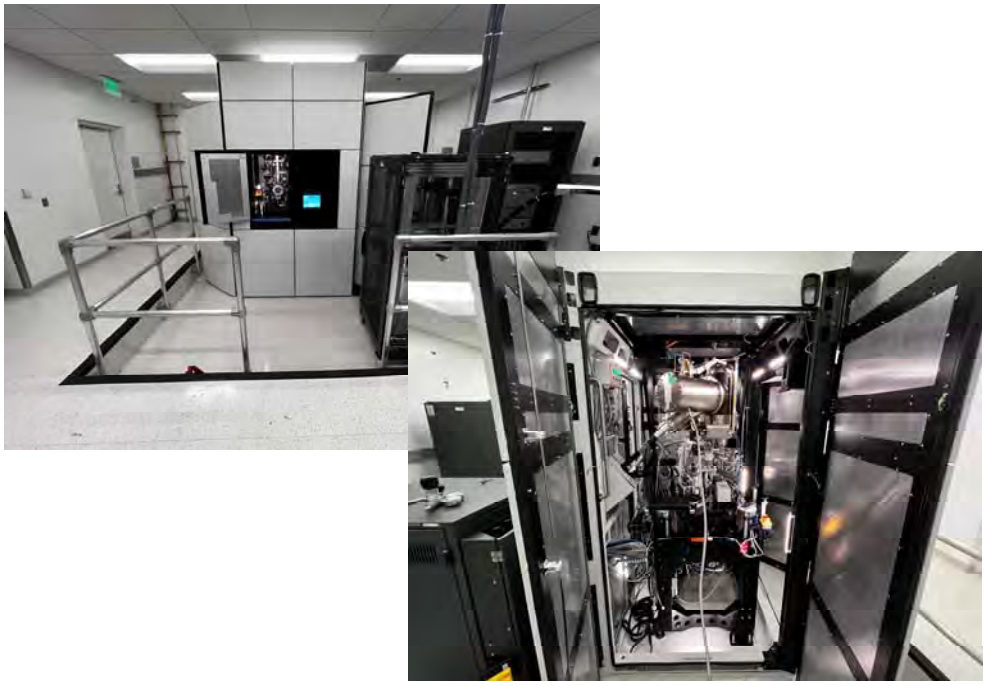


Powder	Grid – nanocrystals	Full MicroED dataset	Structure
~10^{-1} g	~10^{-15} g	< 3 min	~10 min

MicroElectron Diffraction (microED)

ThermoFisher (FEI) Spectra-C TEM

- First-of-its-kind TEM configured for microED & 4D STEM
- X-CFEG (cold field emission gun) with low dose exposure
- Wide gap C-TWIN lens enables +/- 80 degree tomography
- Cryo-transfer holder and automatic cryo-box
- Advanced scripting for automated data collection

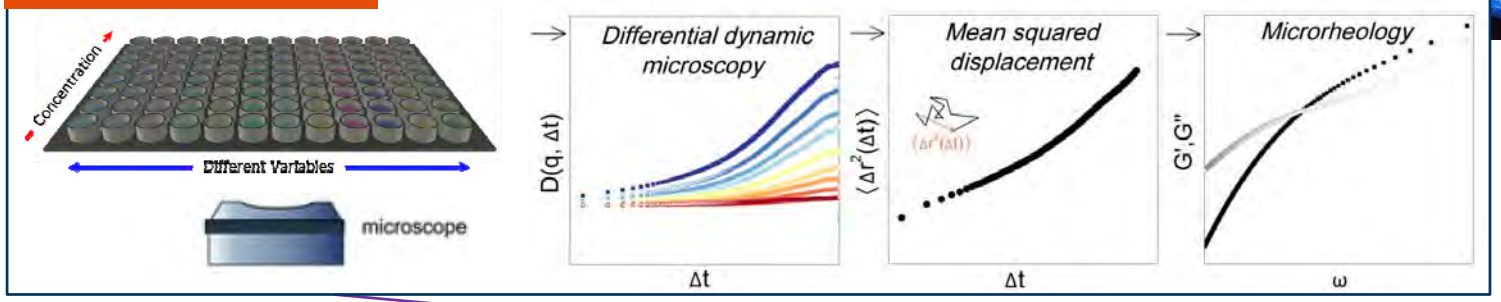


Available Fall 2022

Micro-rheology

passive, high-throughput method for automated micro-rheology

Workflow:



Experimental Design
- *Sample composition*
- *Solution conditions/history*

→ **Data acquisition** *~ 1 min/sample* → **Data analysis** *~ 1 min/sample* → **Rheological data** *In a matter of minutes*

Experimental design feedback (ML/AI)

Increases throughput by 30X for data acquisition and 60X for analysis for microscale volumes of fluids and soft solids

MicroED

Dr. Matt Mecklenburg
mmecklenburg@cnsi.ucla.edu

New Generation X-ray

Dr. Youli Li
youli@mrl.ucsb.edu

Microrheology

Dr. Juan Manuel Uruena Vargas
jmuruena@ucsb.edu

BioPACIFIC MIP Facilities

Living Biofoundry

Additive Manufacturing

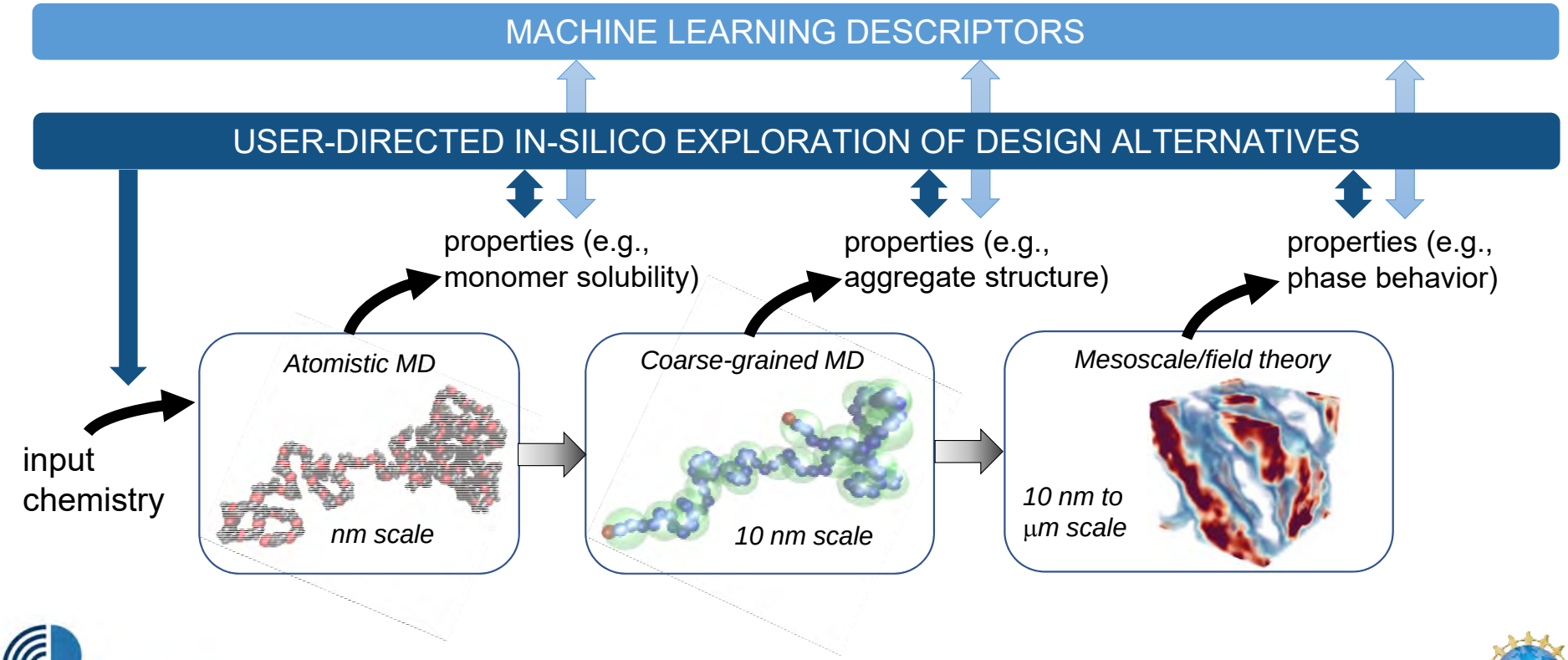
Hierarchical Computation

Automatic Synthesis

High-throughput Characterization

Forward multiscale simulation workflow

Vision: Versatile tools to enable systematic mapping of design space



BioPACIFIC
NSF Materials Innovation Platform
DMR-1933487

FREE TO ALL US RESEARCHERS
THROUGH A PEER REVIEWED PROPOSAL
SUBMISSION PROCESS

Synthetic Biology

Materials
Synthesis

Automation and high-
throughput experimentation

A USER FACILITY DEDICATED TO BIOMATERIALS

Become a User:
BioPACIFIC MIP Proposal Based Process

User Proposals

1.
PROPOSAL SUBMISSION

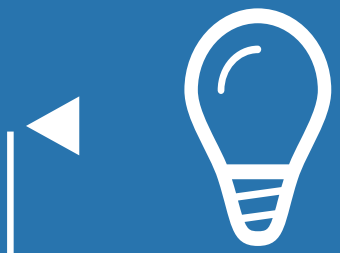
Rolling submissions

Service requests or in-person research

Recommend discussing scope with technical team and directors before submission

Proposal submission via online portal on website

For awarded proposals users are NOT charged for time with technical staff, supplies, or for use of equipment acquired through the MIP award. *Fees charged for proprietary research*



2.
FEASIBILITY REVIEW

<u>In-house review</u>

Resource assessment:
Equipment, Staffing, Materials
*50% external users at steady-state

3.
MERIT REVIEW

<u>External committee</u>

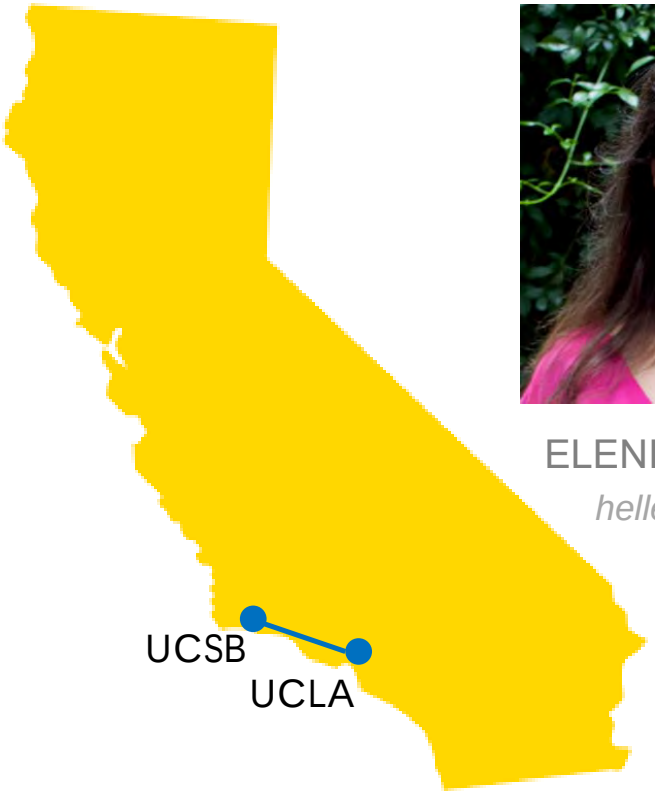
Key criteria:
Intellectual Merit
Broader Impacts
Alignment with BioPACIFIC MIP mission
Growth of knowledge hub / libraries
Diversity

4.

EXECUTION

Policies and Forms
Travel logistics (as applicable)
Scheduling
Funding available to enhance diversity of participation

BioPACIFIC MIP User Coordinator



ELENI PAPANANOU
hellen@ucsb.edu

Role

- Leading the User Program
- User engagement before, during and after
- User Proposal Coordination
- Connecting potential users to technical staff / Senior Participants / Resources

Proposal Submission Process

Tal Margalith
margalith@ucsb.edu

Eleni Papananou
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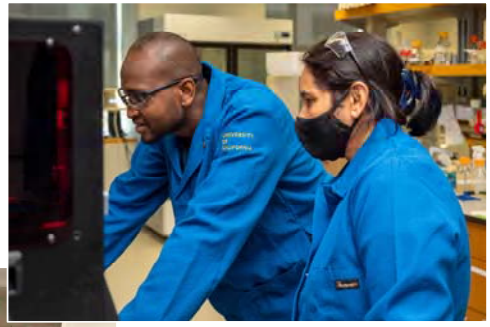
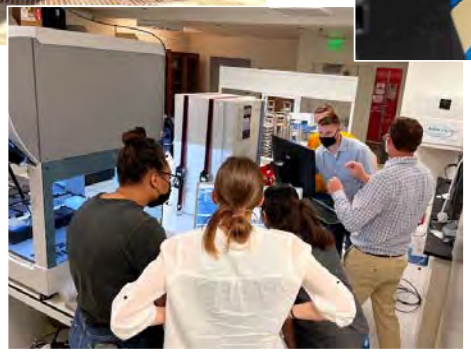
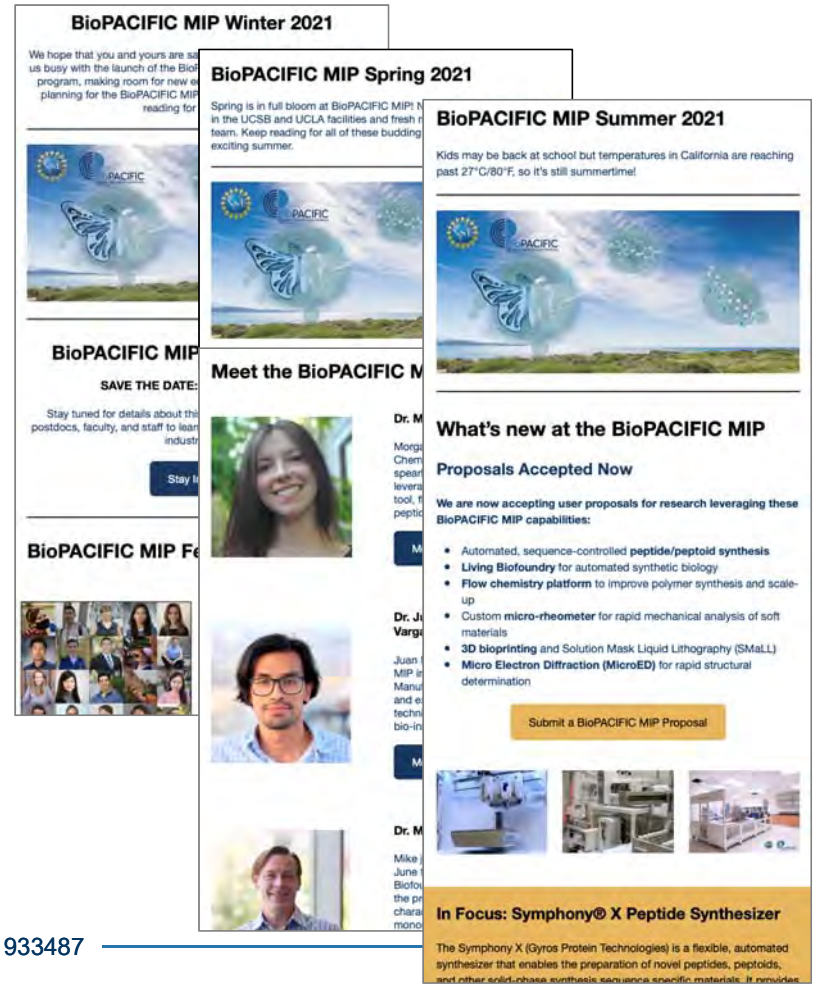
Adam Stieg
stieg@cnsi.ucla.edu

Sign up for our newsletter

BioPACIFIC MIP SUMMER SCHOOL







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Become a member
of our community!
biopacificmip.org

BioPACIFIC
NSF Materials Innovation Platform
DMR-1933487

Talk with our Technical and Operations team:

TUESDAY AUGUST 30
11AM PST / 2PM EST

NEW USER TOWN HALL

AGENDA

BIOPACIFIC MIP OVERVIEW
11:00-11:20AM

OFFICE HOURS
11:20AM-12:00PM

OFFICE HOURS

Tal Marglith
Executive Director

Eleni Papananou
User Coordinator

Adam Stieg
Executive Director

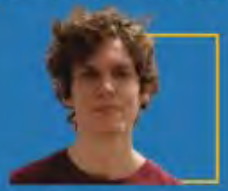
Opportunity to switch breakout rooms every 10 minutes!

Michael Lake
Living Biofoundry

Morgan Bates
Synthesis and Automation

Youli Li
X-Ray

Juan Manuel Urueña
Additive Manufacturing



Chris Dunham
Computation and Data

Matthew Mecklenburg
MicroElectron Diffraction