



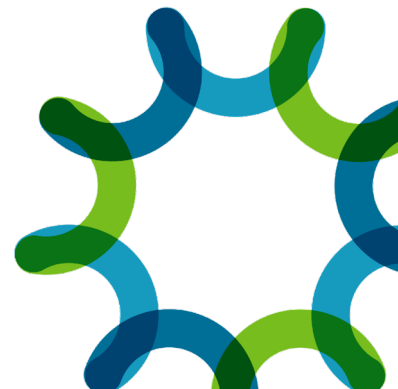
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DOE BioEnergy Technologies Office (BETO)  
2023 Project Peer Review

# ABF Future Strategy – Goals and Deliverables

April 4, 2023  
Conversion Technologies

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# Project Overview

# Project History

- **In September 2022, BETO instructed ABF strategic planning**
  - Included guidance regarding the process, timeline, and representative deliverables to focus the process
- **In December 2022, the ABF completed its strategic plan**
  - Minor updates to the strategic plan were made through February 2023
- **Goals and deliverables were included in the strategic plan**
  - Milestones were moved to the implementation plan (next presentation)
- **In February 2023, the ABF requested feedback on strategic plan**
  - From both BETO leadership, and ABF Advisory Board members (current and emeritus)
- **In April 2023, the ABF requested feedback at BETO Peer Review**
  - (Now) as an additional forum, with the added benefit of a recently completed implementation planning process

# Project Goal and BETO Relevance

- **Goal:** Establish revised ABF goals that fall within the new mission and contribute to the realization of the new vision. For each revised goal, develop FY25 deliverables that specify what will be accomplished over the next three years
- **Relevance to BETO's goals:** This activity ensures that ABF goals and deliverables are timely and well-aligned with BETO's goals
- **Specific research question:** How to set goals that will continue to serve the ABF and BETO beyond FY25, and deliverables that do not dictate their implementation and are likely to be accomplishable (prior to implementation planning and precise budget constraints)?



# 1 – Approach

# Technical Approach

- **Follow BETO's guidance for ABF strategic planning process**
  - Provides BETO's suggestions of representative / adjustable ABF deliverables to focus the process
- **Use ABF strategic planning working groups' input**
  - reviewing history, baselining, industry, culture, partnering
- **Use inclusive strategic planning tools and processes**
  - Miro for online real-time collaborative ideation and refinement
  - Strategic planning process templates
- **Divide and conquer work across goal areas**
  - Define clear accountability and responsibility for goal and deliverable development
- **Use small / focused groups to make progress as needed**
  - Straw-person proposals may rapidly advance work when a large inclusive group is converging slowly
- **Request feedback from BETO leadership and ABF advisors**
  - Make corresponding adjustments as needed, including those suggested at BETO Peer Review



## 2 – Progress and Outcomes

# Progress made towards project goal

- **Goals developed**

- **Partnerships:** Actively develop funds-in and BETO-funded projects that result in technology transfer to industry
- **Tools:** Develop and demonstrate engineering biology, computational, and bioprocess tools that advance strain performance for the sustainable production of fuels and chemicals
- **Sustainable Aviation Fuels:** Develop innovative pathways, strains, and processes for the production of sustainable aviation fuels
- **Biochemicals:** Develop innovative pathways, strains, and processes for the sustainable production of direct replacement and performance-advantaged chemicals

- **The following slides list key FY25 deliverables for each goal**



# Partnerships – FY25 deliverables

- **Achieve  $\geq 50\%$  of ABF's budget committed to external partnerships**
- **Demonstrate clear impact on industry from ABF projects**
  - Enable at least 500 kT CO<sub>2</sub>e reduction through ABF commercial partnership projects
  - Document industry partner-assessed commercialization time and cost reduction savings for 6 projects
  - Record at least \$5M in attributable private sector funding raises
  - By way of industry projects, advance 5 or more technologies into at least TRL4
  - At least 4 ABF technologies disclosed, published or patented, and then adopted or licensed by industry
- **Identify new opportunity areas for ABF collaborations**
  - Across FY23-25, establish at least 2 funds-in projects
  - By end of FY25, achieve 5% of ABF's annual budget as funds-in support, and based on learnings, strategize paths to future expansion
- **Work with external groups through a variety of funding mechanisms**
  - Support at least 10 funding-opportunity projects
  - Train at least 5 collaborator affiliates at ABF facilities
  - Collaborate with at least 4 MSI-based investigators
  - Reach an average of  $\geq 5$ -fold oversubscription for ABF's funding opportunities
  - Leverage at least \$2M from collaborating funding agencies

# Tools – FY25 deliverables

## • Capabilities development, assessment, and application

- All capabilities and activities must clearly connect with strategic goals
- Advance SAF, biochemical, and industry projects by developing and using benchmarked technologies that outperform state of the art
- Track technology usage in industry projects and number of times technologies transferred to industry
- Demonstrate process for sunseting technologies where benchmarking fails to show value
- Demonstrate at least 6 new technologies across Design (including TEA/LCA), Build, Test (including scale-up), and Learn between FY23 and FY25
- Demonstrate operational performance gains of significant impact for at least 2 ABF technologies benchmarked to state of the art
- Measure ABF capability capacities and advertise capabilities and their technical advantages

## • Host onboarding and development

- Following assessment for strategic opportunities, extend diversity (process, phylogeny, metabolic) of hosts, and demonstrate how this extended diversity enhances process performance (TRY, TEA) and industrial engagement (industry licensing/uptake)
- As needed, select and onboard approximately 5 additional hosts for internal and external projects for use in industrial processes related to SAF and renewable chemical production
- All work beyond onboarding will be internal project and industry-driven

# Sustainable Aviation Fuels – FY25 deliverables

## • Thermophilic ethanol for Sustainable Aviation Fuels

- Deliver an anaerobic thermophilic strain and an associated conversion process to convert lignocellulose directly at near industrially-relevant solids loadings, solubilization extent, and ethanol titers that would meet at least 50% GHG emissions reductions relative to fossil-based jet fuel, with a path towards economically viable ethanol production at higher solids loadings for out-years

## • Microbial alkanes for Sustainable Aviation Fuels

- Develop route of economic microbial production of an alkane-rich biomolecule as a feedstock for an ASTM certified jet fuel, e.g. HEFA, HC-HEFA, SIP and CHJ
- TEA and LCA will examine stand-alone scenarios and scenarios that integrate the microbial production routes with current industrial SAF processes, e.g. conversion of oil seed lignocellulosics into microbial oils that are then co-extracted with seed oils prior to HEFA processing
- Target lipid titers that would meet at least 50% GHG emissions reductions and at costs approaching parity with fossil-based jet fuel

# Biochemicals – FY25 deliverables

- Target biochemicals: muconic acid, 3HP
- Transfer microbial strains and processes to industry to produce direct replacement and performance-advantaged chemicals at industrially relevant titers, rates, and yields and at 70% reduction in GHG emissions relative to fossil-based production
- One chemical production process with a commercial partner and path to commercialization by 2030



# 3 – Impact

# Impact on state of technology/industry if successful

## • Goals

- The goals set across partnerships, tools, sustainable aviation fuels, and biochemicals will directly influence the ABF's impact on industry and on the state of technology for many years to come

## • FY25 Deliverables

- **Partnerships:** At least 500 kT CO<sub>2</sub>e reduction through ABF commercial partnership projects
- **Tools:** operational performance gains of significant impact for at least 2 ABF benchmarked technologies
- **SAFs:** at least 50% GHG emissions reductions for both ethanol and alkanes to SAF routes
- **Biochemicals:** at least 70% GHG emissions reductions for both muconate and 3HP routes

# Summary

- **Goal:** Establish revised ABF goals that fall within the new mission and contribute to the realization of the new vision. For each revised goal, develop FY25 deliverables that specify what will be accomplished over the next three years
- **Relevance to BETO's goals:** This activity ensures that ABF goals and deliverables are timely and well-aligned with BETO's goals
- **Outcomes:** The ABF has set goals that are likely to serve the ABF and BETO beyond FY25, and accomplishable and impactful deliverables that do not dictate their implementation

# Quad Chart Overview

## Timeline

- Project start: *October 1, 2022*
- Project end: *September 30, 2025*

## Project Goal

Develop biomanufacturing tools, processes, and partnerships that enable sustainable industrial production of renewable fuels and chemicals for the nation

## End of Project Milestone

- Transfer strains and bioprocesses for SAF and biochemicals to industry at industrially relevant titers, rates, and yields and at 70% reduction in GHG emissions relative to fossil-based production.
- Achieve 5% of ABF's annual budget as funds-in support, and based on learnings, strategize paths to future expansion
- Demonstrate at least 6 new technologies across Design (including TEA/LCA), Build, Test (including scale-up), and Learn

## Funding Mechanism

AOP

## Project Partners

LBNL (23%), SNL (20%), NREL (18%), PNNL (17%), LANL (8%), ORNL (8%), ANL (6%)

	FY23 Costed	Total Award
DOE Funding	(10/01/2022 – 9/30/2023)	\$15M
Project Cost Share		





**Additional Slides**

# Publications, Patents, Presentations, Awards, and Commercialization

## 70 publications, 189 presentations to date

- 54 publications and 115 presentations since FY2019
- The following slides list these publications and presentations

## 17 patents, 10 records of invention, 9 software disclosures, & 2 licenses

- The following slides list these intellectual property assets

# Publications

- Garima Goyal, Zak Costello, Jorge Alonso Guitierrez, Aram Kang, Taek Soon Lee, Hector Garcia Martin, and Nathan J Hillson. (2018) "Parallel Integration and Chromosomal Expansion of Metabolic Pathways" ACS Synthetic Biology DOI: 10.1021/acssynbio.8b00243
- Jha RK, Narayanan N, Pandey N, Bingen JM, Kern TL, Johnson CW, Strauss CEM, Beckham GT, Hennelly SP, Dale T. Sensor-enabled alleviation of product inhibition in chorismate pyruvate-lyase. ACS Synthetic Biology (2019), 10.1021/acssynbio.8b00465.
- Oyetunde, T., Liu, D., Martin, H. G., & Tang, Y. J. "Machine learning framework for assessment of microbial factory performance." PloS one 14.1: e0210558 (2019).
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- Costello, Zak, and Hector Garcia Martin. "How to Hallucinate Functional Proteins." arXiv preprint arXiv:1903.00458 (2019).
- Chen Y, Vu J, Thompson MG, Sharpless WA, Chan LJG, et al. (2019) A rapid methods development workflow for high-throughput quantitative proteomic applications. PLOS ONE 14(2): e0211582. <https://doi.org/10.1371/journal.pone.0211582>

# Publications

- Paul Opgenorth, Zak Costello, Takuya Okada, Garima Goyal, Yan Chen, Jennifer Gin, Veronica T. Benites, Markus de Raad, Trent R. Northen, Kai Deng, Samuel Deutsch, Edward E.K. Baidoo, Christopher J. Petzold, Nathan J Hillson, Hector Garcia Martin, and Harry R Beller. (2019) "Lessons from two Design-Build-Test-Learn cycles of dodecanol production in Escherichia coli aided by machine learning". ACS Synth. Biol., DOI: 10.1021/acssynbio.9b00020 <https://pubs.acs.org/doi/10.1021/acssynbio.9b00020>
- Nathan Hillson, Mark Caddick, Yizhi Cai, Jose A. Carrasco, Matthew Wook Chang, Natalie C. Curach, David J. Bell, Rosalind Le Feuvre, Douglas C. Friedman, Xiongfei Fu, Nicholas D. Gold, Markus J. Herrgård, Maciej B. Holowko, James R. Johnson, Richard A. Johnson, Jay D. Keasling, Richard I. Kitney, Akihiko Kondo, Chenli Liu, Vincent J. J. Martin, Filippo Menolascina, Chiaki Ogino, Nicola J. Patron, Marilene Pavan, Chueh Loo Poh, Isak S. Pretorius, Susan J. Rosser, Nigel S. Scrutton, Marko Storch, Hille Tekotte, Evelyn Travnik, Claudia E. Vickers, Wen Shan Yew, Yingjin Yuan, Huimin Zhao & Paul S. Freemont. (2019) "Building a global alliance of biofoundries". Nature Communications, 10:2040 <https://doi.org/10.1038/s41467-019-10079-2>

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- Jesus F. Barajas, Ryan P. McAndrew, Mitchell G. Thompson, Tyler W. H. Backman, Bo Pang, Tristan de Rond, Jose H. Pereira, Veronica T. Benites, Héctor García Martín, Edward E. K. Baidoo, Nathan J. Hillson, Paul D. Adams, and Jay D. Keasling. (2019) "Structural insights into dehydratase substrate selection for the borrelidin and fluvirucin polyketide synthases" J Ind Microbiol Biotechnol <https://doi.org/10.1007/s10295-019-02189-z>
- Jesus F. Barajas, Maren Wehrs, Milton To, Lauchlin Cruickshanks, Rochelle Urban, Adrienne McKee, John Gladden, Ed-Been-Goh, Margaret E. Brown, Diane Pierotti, James M. Carothers, Aindrila Mukhopadhyay, Jay D. Keasling, Jeffrey L. Fortman, Steven W. Singer, Constance B. Bailey. (2019) "Isolation and characterization of bacterial cellulase producers for biomass deconstruction: A microbiology laboratory course" J Microbiology and Biology Education. Just accepted. <https://doi.org/10.1128/jmbe.v20i2.1723>
- Mitchel G. Thompson, Jacquelyn Blake-Hedges, Pablo Cruz-Morales, Jesus F. Barajas, Samuel C. Curran, Christopher B. Eiben, Nicholas C. Harris, Veronica T. Benites, Jennifer W. Gin, William A. Sharpless, Jose H. Pereira, Edward E.K. Baidoo, Christopher C. Petzold, Paul D. Adams, Adam P. Arkin, Adam M. Deutschbauer, Jay D. Keasling (2019) "Massively parallel fitness profiling reveals multiple novel enzymes in pseudomonas putida lysine metabolism" MBio. <https://doi.org/10.1128/mBio.02577-18>

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- Chen, Yan; Guenther, Joel; Gin, Jennifer; Chan, Leanne Jade; Costello, Zak; Ogorzalek, Tadeusz; Tran, Huu; Blake-Hedges, Jacquelyn; Keasling, Jay D; Adams, Paul; Garcia Martin, Hector; Hillson, Nathan; Petzold, Christopher. (2019) "An automated 'cells-to-peptides' sample preparation workflow for high-throughput, quantitative proteomic assays of microbes" Journal of Proteome Research Manuscript ID: pr-2019-00455n Submitted July 8, 2019 Accepted 8/22/2019 <https://doi.org/10.1021/acs.jproteome.9b00455>
- Carbonell, P., Radivojevic, T. and Garcia Martin, H., 2019. Opportunities at the Intersection of Synthetic Biology, Machine Learning, and Automation. ACS Synthetic Biology 1474-1477 (2019)
- Roell, G.W., Carr, R.R., Campbell, T., Shang, Z., Henson, W.R., Czajka, J.J., Martín, H.G., Zhang, F., Foston, M., Dantas, G. and Moon, T.S. A concerted systems biology analysis of phenol metabolism in *Rhodococcus opacus* PD630. Metabolic engineering (2019).
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# Publications

- Gayle J. Bentley, Niju Narayanan, Ramesh K. Jha, Davinia Salvachúa, Joshua R. Elmore, George L. Peabody, Brenna A. Black, Kelsey Ramirez, Annette De Capite, William E. Michener, Allison Z. Werner, Dawn M. Klingeman, Heidi S. Schindel, Robert Nelson Lindsey Foust, Adam M. Guss, Taraka Dale, Christopher W. Johnson, Gregg T. Beckham, "Engineering glucose metabolism for enhanced muconic acid production in *Pseudomonas putida* KT2440", in press at Metabolic Eng.
- Peabody GL, Elmore JR, Martinez-Baird J, and Guss AM. Engineered *Pseudomonas putida* KT2440 co-utilizes galactose and glucose. *Biotechnol Biofuels* 12, 295 (2019) doi:10.1186/s13068-019-1627-0
- Christopher B. Eiben, Tristan de Rond, Clayton Bloszies, Jennifer Gin, Jennifer Chiniquy, Edward E. K. Baidoo, Christopher J. Petzold, Nathan J. Hillson, Oliver Fiehn, Jay D. Keasling. (2019) "Mevalonate Pathway Promiscuity Enables Noncanonical Terpene Production", *ACS Synth. Biol.* <https://doi.org/10.1021/acssynbio.9b00230>
- Yan Chen, Deepwanita Banerjee, Aindrila Mukhopadhyay, Christopher J. Petzold. (2020) "Systems and synthetic biology tools for advanced bioproduction hosts", *Curr. Op. Biotechnol.* <https://doi.org/10.1016/j.copbio.2019.12.007>

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- Jacquelyn M. Blake-Hedges, Jose Henrique Pereira, Pablo Cruz-Morales, Mitchell G. Thompson, Jesus F. Barajas, Jeffrey Chen, Rohith N. Krishna, Leanne Jade G. Chan, Danika Nimlos, Catalina Alonso-Martinez, Edward E. K. Baidoo, Yan Chen, Jennifer W. Gin, Leonard Katz, Christopher J. Petzold, Paul D. Adams, Jay D. Keasling. (2019) "Structural Mechanism of Regioselectivity in an Unusual Bacterial Acyl-CoA Dehydrogenase", J. Am. Chem. Soc. <https://doi.org/10.1021/jacs.9b09187>
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- Chen, Yan; Guenther, Joel; Gin, Jennifer; Chan, Leanne Jade; Costello, Zak; Ogorzalek, Tadeusz; Tran, Huu; Blake-Hedges, Jacquelyn; Keasling, Jay D; Adams, Paul; Garcia Martin, Hector; Hillson, Nathan; Petzold, Christopher. (2019) "An automated 'cells-to-peptides' sample preparation workflow for high-throughput, quantitative proteomic assays of microbes" Journal of Proteome Research Manuscript ID: pr-2019-00455n Submitted July 8, 2019 Accepted 8/22/2019 <https://doi.org/10.1021/acs.jproteome.9b00455>
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- Peabody GL, Elmore JR, Martinez-Baird J, and Guss AM. Engineered *Pseudomonas putida* KT2440 co-utilizes galactose and glucose. *Biotechnol Biofuels* 12, 295 (2019) doi:10.1186/s13068-019-1627-0
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- Ernst Oberortner, Robert Evans, Xianwei Meng, Sangeeta Nath, Hector Plahar, Lisa Simirenko, Angela Tarver, Samuel Deutsch, Nathan J. Hillson, and Jan-Fang Cheng. (2020) "An Integrated Computer-Aided Design and Manufacturing Workflow for Synthetic Biology". In: Chandran S., George K. (eds) DNA Cloning and Assembly. Methods in Molecular Biology, vol 2205. Humana, New York, NY. [https://doi.org/10.1007/978-1-0716-0908-8\\_1](https://doi.org/10.1007/978-1-0716-0908-8_1)
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- Isabel Pardo‡, Ramesh Jha‡, Molly Gaddis, Ryan Bermel, Felicia Bratti, Molly Gaddis, Emily McIntyre, William E. Michener, Ellen L. Neidle, Taraka Dale, Gregg T. Beckham\*, Christopher W. Johnson\*, Gene amplification, laboratory evolution, and biosensor screening reveal Muck as a terephthalic acid transporter in *Acinetobacter baylyi* ADP1, *Metabolic Eng.* (2020), 62, 260-274.
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- Riley LA and Guss AM\*. Approaches to genetic tool development for rapid domestication of non-model microorganisms. Biotechnol (2021) 14:30. doi: 10.1186/s13068-020-01872-z.
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- Pomraning, K., Dai, Z., Munoz, N., Kim, Y., Gao, Y., Deng, S., Kim, J., Hofstad, B., Swita, M., Lemmon, T., Collett, J., Panisko, E., Webb-Robertson, B., Zucker, J., Nicora, C., De Paoli, H., Baker, S., Burnum-Johnson, K., Hillson, N., and Magnuson, J. (2021) Integration of Proteomics and Metabolomics Into the Design, Build, Test, Learn Cycle to Improve 3-Hydroxypropionic Acid Production in *Aspergillus pseudoterreus*. *Frontiers in Bioengineering and Biotechnology*.
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# Publications

- Nicholas A. Rorrer,‡ Sandra F. Notonier,‡ Brandon C. Knott,‡ Brenna A. Black,‡, Avantika Singh,‡ Scott R. Nicholson,‡ Christopher P. Kinchin, Graham P. Schmidt, Alberta C. Carpenter, Kelsey J. Ramirez, Christopher W. Johnson, Davinia Salvachúa, Michael F. Crowley, Gregg T. Beckham\*, Production of B-ketoadipic acid from glucose in *Pseudomonas putida* KT2440 for use in performance-advantaged nylons, in review at Cell Reports Phys. Sci.
- Precise genomic riboregulator control of metabolic flux in microbial systems. Naresh Pandey, Steffi A. Davison, Malathy Krishnamurthy, Daniel Trettel, Chien-Chi Lo, Shawn Starkenburg, Katherine L. Wozniak, Theresa Kern, Sean D. Reardon, Clifford J. Unkefer, Scott P. Hennelly and Taraka Dale. Submitted to ACS Synthetic Biology December 2021.
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# Publications

- Making Security Viral: Shifting Engineering Biology Culture and Publishing Rebecca Mackelprang, Katarzyna P. Adamala, Emily R. Aurand, James C. Diggans, Andrew D. Ellington, Samuel Weiss Evans, J. L. Clem Fortman, Nathan J. Hillson, Albert W. Hinman, Farren J. Isaacs, June I. Medford, Shadi Mamaghani, Tae Seok Moon, Megan J. Palmer, Jean Peccoud, Elizabeth A. Vitalis, India Hook-Barnard, and Douglas C. Friedman ACS Synthetic Biology 2022 11 (2), 522-527 DOI: 10.1021/acssynbio.1c00324
- Hyun Gyu Lim, Kevin Rychel, Anand V. Sastry, Gayle J. Bentley, Joshua Mueller, Heidi S. Schindel, Peter E. Larsen, Philip D. Laible, Adam M. Guss, Wei Niu, Christopher W. Johnson, Gregg T. Beckham, Adam M. Feist, Bernhard Palsson, Machine-learning from Pseudomonas putida KT2440 transcriptomes reveals its transcriptional regulatory network, Metabolic Eng. (2022) 72, 297-310.
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# Publications

- Chen Ling, George L. Peabody, Davinia Salvachúa, Young-Mo Kim, Colin M. Kneucker, Michela A. Monninger, Nathalie Munoz, Brenton C. Poirier, Kelsey J. Ramirez, Peter C. St. John, Sean P. Woodworth, Jon K. Magnuson, Kristin E. Burnum-Johnson, Adam M. Guss,\* Christopher W. Johnson,\* Gregg T. Beckham\*, Muconic acid production from glucose and xylose in *Pseudomonas putida* KT2440 via evolution and metabolic engineering, *Nature Comm.* (2022) 13, 4925
- Hector Garcia Martin\*, Tijana Radivojevic, Jeremy Zucker, Kristofer Bouchard, Jess Sustarich, Sean Peisert, Dan Arnold, Nathan Hillson, Gyorgy Babnigg, Jose Manuel Marti, Christopher J. Mungall, Gregg T. Beckham, Lucas Waldburger, James Carothers, ShivShankar Sundaram, Deb Agarwal, Blake A. Simmons, Tyler Backman, Deepanwita Banerjee, Deepti Tanjore, Lavanya Ramakrishnan, Anup Singh, Perspectives for self-driving labs in synthetic biology, submitted to *Curr. Opin. Biotech*
- N. Pandey, S.A. Davison, M. Krishnamurthy, D.S. Trettel, C. Lo, S. Starkenburg, K.L. Wozniak, T.L. Kern, S.D. Reardon, C.J. Unkefer, S.P. Hennelly and T. Dale. 2022. Precise genomic riboregulator control of metabolic flux in microbial systems. *ACS Syn. Biol*  
<https://doi.org/10.1021/acssynbio.1c00638>

# Publications

- Pomraning K.R., Z. Dai, N. Munoz Munoz, Y. Kim, Y. Gao, S. Deng, and T.L. Lemmon, et al. 2022. "Itaconic acid production is regulated by *laeA* in *Aspergillus pseudoterreus*." *Metabolic Engineering Communications*
- Kyle R. Pomraning; Shuang Deng; Joonhoon Kim; Kristen B. Campbell; Ana L. Robles; Beth Hofstad; Nathalie Munoz; Yuqian Gao; Teresa Lemmon; Marie S. Swita; Jeremy D. Zucker; Young-Mo Kim; Kristin E. Burnum-Johnson; Jon K. Magnuson; Ziyu Dai. 2022 "Metabolic engineering to improve production of 3-hydroxypropionic acid from corn-stover hydrolysate in *Aspergillus* species." *Metabolic Engineering*
- Kevin J. McNaught, Eugene Kuatsjah, Michael Zahn, Érica T. Prates, Huiling Shao, Gayle J. Bentley, Andrew R. Pickford, Josephine N. Gruber, Kelley V. Hestmark, Daniel A. Jacobson, Brenton C. Poirier, Chen Ling, Myrsini San Marchi, William E. Michener, Carrie D. Nicora, Jacob N. Sanders, Caralyn J. Szostkiewicz, Dušan Veličković, Mowei Zhou, Nathalie Munoz, Young-Mo Kim, Jon K. Magnuson, Kristin E. Burnum-Johnson, K.N. Houk, John E. McGeehan, Christopher W. Johnson, Gregg T. Beckham, "Initiation of fatty acid biosynthesis in *Pseudomonas putida* KT2440", *Metabolic Engineering*, Volume 76, 2023, Pages 193-203, <https://doi.org/10.1016/j.ymben.2023.02.006>

# Presentations

- Gregg Beckham, Hybrid biological and catalytic processes to manufacture and recycle plastics, Princeton University, November 28th, 2018
- Nathan J. Hillson. “DOE Agile BioFoundry Overview”. Invited Talk, SynBioBeta 2018 visit to ESE, Emeryville, CA, October 1, 2018
- Nathan J. Hillson. “Recent developments at the U.S Department of Energy Agile BioFoundry”. Invited Talk, 2nd Darmstadt RoboWorkshop, Darmstadt, Germany, November 7, 2018
- Nathan J. Hillson. “DIVA (DNA Design, Implementation, Validation Automation) Platform”. Invited Talk, 2nd Darmstadt RoboWorkshop, Darmstadt, Germany, November 8, 2018
- Garcia Martin, H. “Towards a predictive synthetic biology enabled by machine learning and automation”. Ginkgo Bioworks, Boston, MA, November 12, 2018; AIChE annual meeting, Pittsburgh, PA, October 31 2018; Thermo Fisher, San Jose, CA, October 19, 2018; DTRA Tech Watch, Ft. Belvoir, VA, October 10, 2018.
- Garcia Martin, H. “A New Approach to Flux Analysis”. ABF Annual Meeting, Berkeley CA, September 7, 2018.
- Nathan J. Hillson. “BioDesign Department Overview”. Invited Talk, BSE Annual Meeting, Berkeley, CA, January 24, 2019

# Presentations

- Nathan J. Hillson. “Agile BioFoundry Overview”. Invited Talk, BETO Peer Review, Denver, CO, March 7, 2019
- Nathan J. Hillson. “Agile BioFoundry DBTL Infrastructure”. Invited Talk, BETO Peer Review, Denver, CO, March 7, 2019
- Nathan J. Hillson. “DNA Synthesis Science at the U.S. DOE Joint Genome Institute: Biosecurity Sequence Screening and Broader Aspects Review”. Invited Talk, EBRC Spring Retreat 2019, Boston, MA, March 23, 2019
- Nathan J. Hillson. “ABF: plans for the next 3-year cycle”. Invited Talk, BETO Quarterly FY19Q2, Washington DC, March 27, 2019
- Jennifer Chiniquy. “Emery Station East DIVA DNA Sequencing”. Invited Talk, BSE Annual Meeting, Berkeley, CA, January 24, 2019
- Garcia Martin, H. " Towards a predictive synthetic biology enabled by machine learning and automation". EmeryStation Campus, Emeryville, CA, February 7th, 2019.
- Garcia Martin, H. "Metabolic modeling, drug synthesis, and their interaction". LBNL Biosciences Experts Advisory Committee, Berkeley, CA, February 8th, 2019.
- Garcia Martin, H. " Towards a predictive synthetic biology enabled by machine learning and automation". Google X, Mountain View, CA, February 14th, 2019.

# Presentations

- Garima Goyal, Z. Costello, J.A. Gutierrez, A. Kang, T.S. Lee, H.G. Martin, and N.J. Hillson. “PIACE: Parallel Integration and Chromosomal Expansion of metabolic Pathways”. Invited Talk, ACS Conference, Orlando, Florida, April 4, 2019
- Nathan J. Hillson. “DNA synthesis use and biosecurity screening at U.S. DOE projects including the Joint Genome Institute, Joint BioEnergy Institute, and Agile BioFoundry”. Invited Talk, Gene Synthesis Governance Meeting, Johns Hopkins Center for Health Security, St. Regis Hotel, Washington, DC, April 9, 2019
- Nathan J. Hillson. “DOE Agile BioFoundry: Overview and Recent Highlights”. Invited Talk, SBFC 2019 Session ST-2: Global Research Consortia, Seattle, WA, May 1, 2019
- Nathan J. Hillson. “2019 BETO Merit Review Process”. Invited Talk, ABF IAB FY19Q3, Zoom Videoconference, May 17, 2019
- Nathan J. Hillson. “Machine Learning-assisted MiSeq library loading”. Invited Talk, ABF IAB FY19Q3, Zoom Videoconference, May 17, 2019
- Nathan J. Hillson. “Global Biofoundries Alliance: 2019 Annual Meeting Report Out”. Invited Talk, ABF IAB FY19Q3, Zoom Videoconference, May 17, 2019
- Nathan J. Hillson. “2019 BETO Peer Review Report Out”. Invited Talk, ABF IAB FY19Q3, Zoom Videoconference, May 17, 2019

# Presentations

- Nathan J. Hillson. "ICE/DIVA, EDD, and ART". Invited Talk, Software for Synthetic Biology Workflows Workshop, SEED 2019, New York, NY, June 27, 2019
- Nathan J. Hillson. "DOE Agile BioFoundry: Overview and Recent Highlights". Invited Talk, JBEI Annual Meeting 2019, Monterrey, CA, May 30, 2019
- Henrique C. De Paoli. "Overview of Synthetic Biology principles". Invited Talk, Xu's Research Group, UC Dept. of Materials Science and Engineering, Berkeley, CA, May 13, 2019.
- Nathan J. Hillson "ABF: CRADA updates and FY20-22". Invited Talk, BETO Conversion Call, July 1, 2019
- Wei Xiong and Nathan Hillson, "Synthetic C1 Condensation Cycle for Formate-Mediated ElectroSynthesis". Invited Talk, BETO Conversion Call, July 8, 2019
- Ernst Oberortner, Nathan J. Hillson, and Jan-Fang Cheng. "The Operon Refactoring and Construction Assistant (ORCA): Streamlined gene cluster refactoring". Invited Talk, 11th International Workshop on Bio-Design Automation, University of Cambridge, UK July 9, 2019
- Nathan J. Hillson "ABF Overview, FY19 Update, and FY20-22 Plans". Invited Talk, ABF Annual Meeting, Richland, WA, July 30, 2019
- Nathan J. Hillson "FY22Q4\_DBTL\_AS1: 5x efficiency improvements". Invited Talk, ABF Annual Meeting, Richland, WA, July 31, 2019

# Presentations

- Nathan J. Hillson "DOE Agile BioFoundry: Overview and Recent Highlights". Invited Talk, VIP Visit - Wendy Pulling | Director of ESG Integration University of California Office of the Chief Investment Officer, Emeryville, CA, Aug 6, 2019
- Nathan J. Hillson "DOE Agile BioFoundry: Overview and Recent Highlights". Invited Talk, Tiangong Forum Distinguished Lecture, Tianjin Institutes of Industrial Biotechnology (TIB), Chinese Academy of Sciences (CAS), Tianjin, China, August 16, 2019
- Nathan J. Hillson "DOE Agile BioFoundry: DBTL Infrastructure". Invited Talk, SynBioYSF 2019, Tianjin Institutes of Industrial Biotechnology (TIB), Chinese Academy of Sciences (CAS), Tianjin, China, August 17, 2019
- Nathan J. Hillson "U.S. DOE Agile BioFoundry: Overview and Recent Highlights", Invited Talk, Genscript Double Helix Symposium 2019, San Francisco, CA September 30, 2019
- Jennifer Chiniquy "DIVA DNA Sequencing". Invited Talk, 2019 ABF All Hands Meeting, Pacific Northwest National Laboratory, Richland, WA, July 30, 2019.
- Tijana Radivojevic, "Automatic Recommendation Tool", Invited Talk, ABF Annual Meeting 2019, Richland, WA, July 30, 2019
- Nurgul Kaplan."Automated DNA Construction: "from j5 protocol design to Laboratory Robotics" Invited Talk, ABF Annual Meeting 2019, Pasco, WA, July 30, 2019

# Presentations

- Nathan J. Hillson “U.S. DOE Agile BioFoundry: Organization and Capabilities”, Invited Talk, ABF Industry Day 2019, Emeryville, CA October 4, 2019
- Garcia Martin, H. “Machine Learning, Synthetic Biology and Automation: Engineering Life for the Benefit of Society”. NERSC data seminar, Berkeley CA, November 1st, 2019.
- Garcia Martin, H. “ART: a machine learning Automated Recommendation Tool for guiding synthetic biology”. AI4Synbio Symposium, Arlington VA, November 8th, 2019.
- Garcia Martin, H. “Opportunities in the intersection of:Artificial Intelligence & Synthetic Biology & Automation”. Army Science Planning and Strategy Meeting, Burlington MA, November 13th, 2019.
- Nathan J. Hillson “ABF: CRADA updates and FY20-22”. Invited Talk, BETO Conversion Call, July 1, 2019
- Wei Xiong and Nathan Hillson, “Synthetic C1 Condensation Cycle for Formate-Mediated ElectroSynthesis”. Invited Talk, BETO Conversion Call, July 8, 2019
- Ernst Oberortner, Nathan J. Hillson, and Jan-Fang Cheng. “The Operon Refactoring and Construction Assistant (ORCA): Streamlined gene cluster refactoring”. Invited Talk, 11th International Workshop on Bio-Design Automation, University of Cambridge, UK July 9, 2019



# Presentations

- Nathan J. Hillson “ABF Overview, FY19 Update, and FY20-22 Plans”. Invited Talk, ABF Annual Meeting, Richland, WA, July 30, 2019
- Nathan J. Hillson “FY22Q4\_DBTL\_AS1: 5x efficiency improvements”. Invited Talk, ABF Annual Meeting, Richland, WA, July 31, 2019
- Nathan J. Hillson “DOE Agile BioFoundry: Overview and Recent Highlights”. Invited Talk, VIP Visit - Wendy Pulling | Director of ESG Integration University of California Office of the Chief Investment Officer, Emeryville, CA, Aug 6, 2019
- Nathan J. Hillson “DOE Agile BioFoundry: Overview and Recent Highlights”. Invited Talk, Tiangong Forum Distinguished Lecture, Tianjin Institutes of Industrial Biotechnology (TIB), Chinese Academy of Sciences (CAS), Tianjin, China, August 16, 2019
- Nathan J. Hillson “DOE Agile BioFoundry: DBTL Infrastructure”. Invited Talk, SynBioYSF 2019, Tianjin Institutes of Industrial Biotechnology (TIB), Chinese Academy of Sciences (CAS), Tianjin, China, August 17, 2019
- Nathan J. Hillson “U.S. DOE Agile BioFoundry: Overview and Recent Highlights”, Invited Talk, Genscript Double Helix Symposium 2019, San Francisco, CA September 30, 2019
- Jennifer Chiniquy “DIVA DNA Sequencing”. Invited Talk, 2019 ABF All Hands Meeting, Pacific Northwest National Laboratory, Richland, WA, July 30, 2019.

# Presentations

- Tijana Radivojevic, “Automatic Recommendation Tool”, Invited Talk, ABF Annual Meeting 2019, Richland, WA, July 30, 2019
- Nurgul Kaplan.”Automated DNA Construction: “from j5 protocol design to Laboratory Robotics” Invited Talk, ABF Annual Meeting 2019, Pasco, WA, July 30, 2019
- ART: A machine learning Automatic Recommendation Tool for guiding synthetic biology”, Invited Talk, Computational Bio-Science Meeting, Berkeley, CA, April 23, 2020
- Garcia Martin, H. “Opportunities in the intersection of machine learning, synthetic biology, and automation”. ABLC 2020, Virtual meeting, July 10th, 2020.
- Garcia Martin, H. “Leveraging machine learning and automation to make synthetic biology predictable”. SPIE Optics + Photonics 2020, Virtual meeting, August 24th, 2020.
- Nathan J. Hillson, "FY20 ABF CRADA Call: Process, Applications, and Selections", Conversion R&D Standing Lab Update Call, via WebEx, July 27, 2020
- Nathan J. Hillson, "Perspectives from the U.S. DOE Agile BioFoundry”, OECD BNCT Virtual Workshop, Session 1: Biofoundries and COVID-19, via Zoom, July 29, 2020
- Nathan J. Hillson, "DIVA, EDD, and ART: Software spanning the Design/Build/Test/Learn cycle", invited talk, COMBINE 2020, via Zoom, October 5, 2020

# Presentations

- Nathan J. Hillson, "DIVA, EDD, and ART: Software spanning the Design/Build/Test/Learn cycle", invited talk, SPARC Workshop (IIT Kharagpur) 2020, via Zoom, October 19, 2020
- Invited talk: Guss AM. "Domestication of non-model microbes for the production of renewable fuels and chemicals" (2021) The Metabolic Engineering Virtual Seminar Series at the University of Texas-Austin. Virtual.
- Garcia Martin, H. "Leveraging machine learning and automation to make bioengineering predictive". The Metabolic Engineering Virtual Seminar, UT Austin, February 12th, 2021.
- Garcia Martin, H. "Machine Learning for Bioengineering". JBEI Board of Directors, March 12th, 2021.
- Nathan J. Hillson, "ABF Overview", invited talk, BETO Peer Review 2021, via Zoom, March 9, 2021
- Nathan J. Hillson, "ABF DBTL Infrastructure", invited talk, BETO Peer Review 2021, via Zoom, March 9, 2021
- Nathan J. Hillson, "ABF Overview", invited talk, BSA ExComm, via Zoom, March 12, 2021
- Guss AM. "Synthetic biology and metabolic engineering of non-model microbes for the production of renewable fuels and chemicals" Seminar at Purdue University Northwest. April 16, 2021.

# Presentations

- Radivojevic, T., “Automated Recommendation Tool (ART): Design of Experiments via Probabilistic Predictive Modeling”, Autonomous Discovery in Science and Engineering Workshop, April 21, 2021 (Invited Tutorial)
- Radivojevic, T., “Guiding synthetic biology via machine learning”, Symposium on Biomaterials, Fuels and Chemicals (SBF): Speeding up synthetic biology, April 27, 2021
- Radivojevic, T., “Guiding synthetic biology via Automated Recommendation Tool (ART)”, Synthetic Biology: Engineering, Evolution & Design (SEED) 2021, Computation, Artificial Intelligence, and Machine Learning for Biological Design Session, June 17, 2021 (Invited Speaker)
- Guss AM. “Domestication of non-model microbes for the production of renewable fuels and chemicals” Student-invited seminar at North Carolina State University. September 27, 2021.
- Radivojevic, T. “Guiding synthetic biology via machine learning and multi-omics technologies”, IWBD 2021, 13th International Workshop on Bio-Design Automation, September 20, 2021 (virtual)
- Hillson, Nathan J. “Session Introduction”, Metabolic Engineering 14, Block 8: Session – Biofoundries, (Virtual via Remo), July 15, 2021

# Presentations

- Hillson, Nathan J. “Updates on DOE assets including Agile BioFoundry, Joint BioEnergy Institute, and Joint Genome Institute”, Digital Biology Engineering Meeting (Air Force) via zoom, September 23, 2021
- Garcia Martin, H. “Machine Learning Tools Can Make Synthetic Biology Predictable”. SIMB, August 9th, 2021.
- Garcia Martin, H. “Leveraging machine learning and automation to make bioengineering predictable”. Indo-US Workshop on Application of Data Science in Biological Systems, September 7th, 2021.
- Garcia Martin, H. “Leveraging machine learning and automation to make bioengineering predictable”. Air Force Research Laboratory MIRAACLE Forum, September 10th, 2021.
- Garcia Martin, H. “Challenges and opportunities in high-throughput data synthesis”. NSF Challenges and Opportunities in Synthesizing Massively Parallel Assays and High-Throughput Datasets Workshop, September 17th, 2021.
- Garcia Martin, H. “Guiding metabolic engineering via kinetic deep learning and multi-omics”. Quantitative Modelling of Cell Metabolism Conference, September 21th, 2021.
- Davison, S. Reprogramming Microbes for Biomanufacturing, Science in 3 at Los Alamos National Laboratory, September 2021

# Presentations

- Wozniak, K. Engineering a Sustainable Future: Fine-tuning Gene Expression for Biomanufacturing, Science in 3 at Los Alamos National Laboratory, September 2021
- Davison, S. Fine-tuning gene expression in bioproduction pathways in diverse bacterial hosts, SIMB Annual Meeting, August.
- Wozniak, K. Targeting global regulatory responses using precise and programmable cis-riboregulators SIMB Annual Meeting, August
- Adam Guss. “Genetic tools and microbial engineering for biological production of sustainable fuels and chemicals” Presented to Weekly Seminar for DOE CCI/SULI Students. October 27, 2021
- Adam Guss. “Domestication of diverse non-model microbes for plastics upcycling and sustainable fuel and chemical production” Biological Sciences Departmental Seminar, Michigan Technical University. Oct 28, 2021.
- Garcia Martin, H. “Guiding metabolic engineering via kinetic deep learning and multi-omics”. Quantitative Modelling of Cell Metabolism Conference, October 20th, 2021.
- Garcia Martin, H. “Machine learning for industrial biotechnology ”. Delft Advanced Course Integrated Multi-Omics approaches for Improvement of Industrial Microbes, November 5th, 2021.

# Presentations

- Hillson, Nathan J. “Opportunities for CABBI collaboration with JBEI (and other DOE assets) in laboratory operations and data management infrastructure”, CABBI seminar, via zoom, October 19, 2021
- Hillson, Nathan J. “Automation in Biotechnology: Challenges and Opportunities”, Panelist at SENAI CETIQT (Brazil), via zoom, October 29, 2021
- Hillson, Nathan J. “ABF Overview and Capabilities”, ABF Industry Day (via zoom), November 19, 2021
- Hector A Plahar, Stephen D. Lane, William C Morrell, Nathan J. Hillson and Christopher J. Petzold. “A Biological Parts Search Portal and Updates to the ICE Parts Registry Platform”, JBEI Annual DOE Review, Dec 6-8, 2021
- Tijana Radivojevic, “Creating a Machine Learning Chassis to Maximize the Efficiency of the DBTL Cycle in Synthetic Biology”, Synthetic Biology-Based Therapeutics Summit, December 9, 2021 (virtual)
- Hillson, Nathan J. “Overview and capabilities of the ABF and opportunities for collaboration with CSU”, Colorado State Seminar Series (via zoom), February 3, 2022
- Hillson, Nathan J. “ABF prospective collaboration with other BETO consortia and projects”, BETO Conversion Call (via MS Teams), March 7, 2022

# Presentations

- Bilbao, A. "Investigating deep learning approaches to advance data processing in Liquid Chromatography, Ion Mobility and Data-Independent Acquisition Mass Spectrometry Omics". 70th ASMS Conference on Mass Spectrometry and Allied Topics, Minneapolis, Minnesota, June 9th, 2022.
- Dai Z., K.R. Pomraning, S. Deng, J. Kim, K.B. Campbell, A.L. Robles, and B.A. Hofstad, et al. 05/02/2022. "Assessment and Optimization of 3-hydroxypropionic acid production in industrial filamentous fungus-Aspergillus species." Presented by Z. Dai at 44th Symposium on Biotechnology for Fuels and Chemicals (SBFC 2022), New Orleans, Louisiana
- Adam Guss. "High efficiency DNA integration in diverse non-model microbes for rapid tool and pathway prototyping" SIMB SBFC. New Orleans, LA, May 3, 2022
- Magnuson, J.K.; Beckham, G.T.; Gladden, J.M.; Dale, T.; Guss, A.M.; Laible, P.; Hillson, N.J. 05/03/2022. "The Agile BioFoundry" Presented by Jon Magnuson at the 44th Symposium on Biotechnology for Fuels and Chemicals (SBFC 2022), New Orleans, Louisiana.
- Poirier, B.C. et al. "Mechanical cell disruption enhances the extraction of metabolites from bacterial and fungal species commonly used in metabolic engineering". 70th ASMS Conference on Mass Spectrometry and Allied Topics, Minneapolis, Minnesota, June 5-9, 2022.



# Presentations

- Poirier B.C. et al. “Behavior of lactam molecules during aqueous sample preparation and mass spectrometry analysis”. 70th ASMS Conference on Mass Spectrometry and Allied Topics, Minneapolis, Minnesota, June 5-9, 2022.
- Hillson, Nathan J. "Overview and Capabilities of the DOE Agile BioFoundry", ABF Webinar (via zoom) April 29, 2022
- Hillson, Nathan J. "Overview and Capabilities of the DOE Agile BioFoundry", Lessafre visit to ESE (via zoom) May 6, 2022
- Hillson, Nathan J. "Overview and Capabilities of the DOE Agile BioFoundry" (Keynote Presentation) Bioindustry 4.0 – Synthetic Biology & Biofoundry, CHEY Institute – Scientific Innovation Series (via zoom) 12 May 17 (PDT) 18 (KST), 2022
- Hillson, Nathan J. "Overview and Capabilities of the DOE Agile BioFoundry", Wageningen University visit to ESE (via zoom) May 31, 2022
- Hillson, Nathan J. “ABF overview and DBTL Infrastructure”, BETO Conversion Call (via MS Teams), June 13, 2022
- Nathan Hillson. “ABF Decarbonization Efforts”, Invited Talk, LBL Carbon Negative Initiative – Biological Applications – Lightning Talk Session (via zoom) 6/27/2022

# Presentations

- Radivojevic, Tijana. “Guiding synthetic biology via machine learning”, Boston University, April 14, 2022, Guest lecture
- Deng S., J. Kim, K.R. Pomraning, Z. Dai, Y. Gao, N. Munoz Munoz, and Y. Kim, et al. 08/07/2022. "Identification of a specific exporter that enables high production of aconitic acid in *A. pseudoterreus* ATCC32359." Presented by S. Deng at SIMB annual meeting, San Francisco, California.
- Pomraning K.R., Z. Dai, S. Deng, N. Munoz Munoz, Y. Kim, B.A. Hofstad, and Y. Gao, et al. 08/10/2022. "Bioconversion of lignocellulosic feedstocks to 3-hydroxypropionic acid using acidophilic fungi." Presented by K.R. Pomraning at Society for Industrial Microbiology and Biotechnology, San Francisco, California.
- Jha RK. High throughput test tools for industrially relevant microbial chassis, SIMB 2022, San Francisco, August 2022 (invited talk).
- Adam Guss. “Using synthetic biology to solve challenges in plastic waste and renewable chemical production”. Biological Sciences Departmental Seminar, Missouri S&T, Rolla, MO. September 27, 2022.
- Nathan Hillson. “Agile BioFoundry Connections with NSF, MSRDC, and Beyond”, Invited Talk, LBL Biosciences Expert Advisory Committee: connections beyond Biosciences July 8, 2022

# Presentations

- Nathan Hillson. “Biosecurity concern anecdote”, Screening Tools for Genome Engineering and Genome Editing (Inscripta-funded; Sarah Carter organized), via MS Teams, 9/9/2022
- Nathan Hillson. “Webinar Agenda and ABF Overview”, ABF Webinar: Cutting-Edge Technologies for Accelerating Bioproduct Development at the Agile BioFoundry, 9/22/2022
- Garcia Martin, H. “Machine Learning and Automation for Predictive Synthetic Biology”. Basque Center for Applied Mathematics, Bilbao, Spain, July 15th, 2022.

# License partners and patent applications

## Technologies licensed

- Bioproduction of limonene from syngas
- Method to produce branched chain polyhydroxyalkanoates and branched chain 3-hydroxyacids

## Provisional Patents

- ROI-18-92 U.S. provisional patent applications 63/163,518 63/321,207 63/479,918, not published
- ROI-21-104 U.S. provisional patent application 63/321,332
- ROI-21-63 U.S. provisional patent applications 63/163,518 63/321,207 63/479,918, not published

## Patent Applications

- Post-transcriptional genome regulation in bacteria with next generation CRISPR-Cas tools
- Terephthalate biosensor and applications thereof
- Mutant transporters for bacterial uptake of terephthalic acid
- Alleviating the bottleneck in enzyme evolution and pathway optimization using novel biosensors (Disclosure Title) Modified Biosensors and Biocatalysts and Methods of Use (Application Title)
- Mutant transporters for bacterial uptake of terephthalic acid
- ART: A machine learning Automated Recommendation Tool for guiding synthetic biology

# Patent applications

## Patent Applications (cont.)

- A Generative Model for Protein Sequences for the Purpose of Protein Design or Phenotypic Inference
- Predicting Metabolic Pathway Dynamics from Time Series Multiomics Data Using Machine Learning Techniques
- Use of Statistical Learn Approaches to Predict Next Generation Sequencing Subsequence Depth of Coverage
- Mutant transporters for bacterial uptake of terephthalic acid
- Method and strain for sugar conversion
- Engineered Microorganisms for the Production of Intermediates and Final Products (1<sup>st</sup>)
- Engineered Microorganisms for the Production of Intermediates and Final Products (2<sup>nd</sup>)
- Production of organic acids from *Aspergillus pseudothraus* cadA deletion strain (1<sup>st</sup>)
- Production of organic acids from *Aspergillus pseudothraus* cadA deletion strain (2<sup>nd</sup>)
- Genetically engineering an industrial filamentous fungus *Aspergillus niger* for 3-hydroxypropionic acid production
- A specific exporter responsible for aconitic acid high production in *Aspergillus pseudothraus*

# Records of invention

## Records of Invention

- Bioproduction of limonene from syngas
- Mutant transporters for bacterial uptake of terephthalic acid
- Method to produce branched chain polyhydroxyalkanoates and branched chain 3-hydroxyacids
- A genetic circuit to reduce cell-to-cell production heterogeneity
- High yield conversion of D-xylose to D-arabitol in *R. toruloides*
- Manipulation of tRNA thiolation gene *ncs2* for enhanced production of fatty-acyl-CoA derived chemicals in *R. toruloides*
- Efficient production of cis, cis-muconic acid from mixed substrates of glucose, D-xylose and L-arabinose
- Whole cell biosensors for industrially relevant polymers precursors
- Engineered Microorganisms for the Production of Intermediates and Final Products
- Method and strain for sugar conversion

# Software disclosures

## Software Disclosures

- Automated Recommendation Tool (ART) v2.0
- Kinetic Learning v0.1
- Automated Recommendation Tool (ART): v1.0
- PIACE: Parallel Integration and Chromosomal Expansion of Metabolic Pathways
- OMG, Omics Mock Generator Library: v0.1.1
- Fermentation Data Processing
- Fermentation Data Manipulation and Analysis Once imported
- DIVA/Device Editor 3.1
- DIVA/Device Editor (DIVA) v6.0.0