

Department of Chemistry and Biochemistry
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Current Position

2020 – present Postdoctoral Research Fellow at the Department of Chemistry and Biochemistry, UC San Diego (Devaraj Lab), specializing in the development of artificial cells. My research focuses on building artificial cell membranes with advanced functional properties.

Education

2014 – 2019 Ph. D. in Organic Chemistry at the Department of Chemistry and Applied Sciences, ETH Zurich, Switzerland. Thesis title: “*Lipid nanoparticles as MRI contrast agents for the detection of atherosclerotic plaques*”. Mentor: Professor Yoko Yamakoshi

2012 – 2014 M. S. in Chemistry at Sapienza University of Rome, Italy. Thesis title: “*Synthesis and characterization of glycosylated cationic surfactants*”. Mentor: Dr. Giovanna Mancini

2007 – 2011 B. S. in Chemistry at Sapienza University of Rome, Italy. Thesis title: “*Influence of the preparation protocol on the physicochemical properties of pegylated liposomes*”. Mentor: Dr. Giovanna Mancini

Teaching

Feb 2018 – Jun 2018 Teaching assistant in Supramolecular Chemistry (OCVII), Prof. Y. Yamakoshi and Dr. B. Lewandowski.

Feb 2017 – Jun 2017 Teaching assistant in Supramolecular Chemistry (OCVII), Prof. F. Diederich and Prof. Y. Yamakoshi.

Feb 2016 – Jun 2016 Teaching assistant in Supramolecular Chemistry (OCVII), Prof. F. Diederich and Prof. Y. Yamakoshi.

Oct 2015 – Dec 2015 Teaching assistant in Practical Course of Organic Chemistry (OCP1), Prof. Y. Yamakoshi

Awards and Grants

2006 Gran Sasso-Princeton physics summer school. One of 40 high school students chosen in the region of Abruzzi, Italy. This program stems from the scientific collaboration between the physics department at Princeton University and the Laboratorio Nazionale del Gran Sasso (LNGS), where Princeton scientists conduct research on neutrinos and dark matter.

2023 SynCell 2023 travel award, University of Minnesota, Minneapolis, USA.

2024 Australian Synchrotron Beamtime Grant (ANSTO) \$ AUD 65568.00

2024 Build-a-Cell 2024 travel award, Massachusetts Institute of Technology (MIT), Boston, USA.

2025 UCSD Postdoctoral Research Symposium 2025, best presentation award, UCSD, San Diego, USA.

Research Achievements and Projects

- *Synthetic Phospholipid Metabolism for Dynamic Artificial Membranes*
I designed and implemented a synthetic lipid metabolism to assemble dynamic artificial phospholipid membranes, enabling previously inaccessible functional properties such as membrane remodeling, lipid phase transitions, and lipid mixing.
- *Convolutd Morphologies of Lipid Assemblies for Artificial Cells*
I investigated nonlamellar lipid phases to develop lipid compartments with convoluted morphologies capable of mimicking the complexity of membrane architectures, advancing their integration into artificial cells.
- *Advanced Lipid-Based Imaging Agents for Atherosclerosis detection*
I developed LDL-mimetic lipid nanoparticles for selective targeting and imaging of atherosclerotic plaques, leading the process from designing and functionalizing the lipid platform to demonstrating their successful in vivo application for plaque imaging.

Invited talks

- Invited speaker at Thursday Morning Science, L'Aquila University, L'Aquila, Italy, June 2020.
- Invited speaker at University of Rome Sapienza, Rome, Italy, July 2021.
- Invited speaker at Monash University, Melbourne, Australia, 2024.
- Invited speaker at the University of New South Wales (UNSW), Sydney, Australia, 2024.

Selected presentations and upcoming conferences

- Gordon Research Conference 2025. Self-assembly and Supramolecular Chemistry. Oral presentation, May 10-16, 2025, Les Diablerets, Switzerland.
- ACS Spring 2025. Oral presentation. March 23-27, 2025, San Diego, USA.
- ACS Fall 2023. Oral presentation. August 13-17, 2023, San Francisco, USA.
- SynCell 2023. Oral presentation. May 22-24, 2023, Minneapolis, USA.
- ACS Fall 2022. Oral presentation. August 21-25, 2022, Chicago, USA.
- Pacifichem 2021. Oral presentation. December 16 - 21, 2021, Honolulu, USA.

Public Engagement, Outreach and Science Communication

- Contributor to the Build-a-Cell open collaboration supporting the science and engineering of building synthetic cells.
- Actively participating as an ACS outreach volunteer of the ACS San Diego chapter.
- Contributor to the outreach community of "AIRIcerca" (International Association of Italian Researchers).
- Contributor to the outreach community of "Scienza Live" (Nonprofit Italian-speaking network for science communication and public understanding of science).

Publication List

Peer-reviewed publications

- 1) P. Ji, A. Harjung, C. Knittel, **A. Fracassi**, J. Chen, N. K. Devaraj. Photochemical synthesis of natural membrane lipids in artificial and living cells. *Nat. Commun.* **2025** (In Press)
- 2) **A. Fracassi**, A. Seoane, R. J. Brea, N. K. Devaraj. Abiotic lipid metabolism enables membrane plasticity in artificial cells. *Nat. Chem.* **2025** (In Press)
- 3) **A. Fracassi**, H. Qiao, A. N. Lowell, J. Cao, J. W. Bode, H. Masai, N. Yoshizawa-Sugata, Y. Yamakoshi, R. Zhou. Natural and synthetic LDL-based imaging probes for the detection of atherosclerotic plaques. *ACS Pharmacol. Transl. Sci.* **2025**, 8, 578-591.
- 4) C. Cho, T. An, Y. C. Lai, A. Vázquez-Salazar, **A. Fracassi**, R. J. Brea, I. A. Chen, N. K. Devaraj. Protocell by spontaneous reaction of cysteine with short-chain thioesters. *Nat. Chem.* **2025**, 17, 148-155.
- 5) A. Harjung, **A. Fracassi**, N. K. Devaraj. Encoding extracellular modification of artificial cell membranes using engineered self-translocating proteins. *Nat. Commun.* **2024**, 15, 9363.
- 6) Y. Lee, **A. Fracassi**, N. K. Devaraj. Control of giant vesicles assemblies by stimuli-responsive lipids. *Chem. Commun.* **2024**, 60, 3930-3933.
- 7) Y. Lee, **A. Fracassi**, N. K. Devaraj. Light-driven membrane assembly, shape-shifting, and tissue formation in chemically responsive synthetic cells. *J. Am. Chem. Soc.* **2023**, 145, 47, 25815-25823.
- 8) J. Chen, R. J. Brea, **A. Fracassi**, C. J. Cho, A. Wong, M. Salvador-Castell, I. Budin, S. K. Sinha, N. K. Devaraj. Rapid formation of non-canonical phospholipid membranes by chemoselective amide-forming ligations with hydroxylamines. *Angew. Chem. Int. Ed.* **2023**, e202311635.
- 9) A. Bhattacharya, L. Tanwar, **A. Fracassi**, R. J. Brea, M. Salvador-Castell, S. Khanal, S. K. Sinha, N. K. Devaraj. Chemoselective esterification of natural and prebiotic 1,2-amino alcohol amphiphiles in water. *J. Am. Chem. Soc.* **2023**, 145, 49, 27149-27159.
- 10) C. Xu, **A. Fracassi**, C. P. Baryames, A. Bhattacharya, N. K. Devaraj, C. R. Baiz. Sponge-phase lipid droplets as synthetic organelles: An ultrafast study of hydrogen bonding and interfacial environments. *ChemPhysChem*

- 11) **A. Fracassi**, K. A. Podolsky, S. Pandey, C. Xu, J. Hutchings, S. Seifert, C. R. Baiz, S. K. Sinha, N. K. Devaraj. Characterizing the self-assembling properties of monoolein lipid isosteres. *J. Phys. Chem. B*, **2023**, 127, 8, 1771-1779.
- 12) J. Flores, R. Brea, A. Lamas, **A. Fracassi**, M. Salvador-Castell, C. Xu, C. R. Baiz, S. K. Sinha, N. K. Devaraj. Rapid and Sequential Dual Oxime Ligation Enables De Novo formation of Functional Synthetic Membranes from Water Soluble Precursors. *Angew. Chem. Int. Ed.* **2022**, 61, e202200549.
- 13) M. Moinpour, **A. Fracassi**, R. J. Brea, M. Salvador-Castell, S. Pandey, M. E. Edwards, S. Seifert, S. Joseph, S. K. Sinha, N. K. Devaraj. Controlling Protein Enrichment in Lipid Sponge Phase Droplets Using SNAP-tag Bioconjugation. *ChemBioChem* **2022**, e202100624.
- 14) **A. Fracassi**, A. Ray, N. Nakatsuka, C. Passiu, M. Tanriver, D. Schauenburg, S. Scherrer, A. O. Chaib, J. Mandal, S. N. Ramakrishna, J. W. Bode, N. D. Spencer, A. Rossi, Y. Yamakoshi. KAT ligation for Rapid and Facile Covalent Attachment of Biomolecules to Surfaces. *ACS Appl. Mater. Interfaces* **2021**, 13, 24, 29113-29121.
- 15) **A. Fracassi**, J. Cao, N. Yoshizawa-Sugata, E. Toth, C. Archer, O. Gröninger, E. Ricciotti, S. Y. Tang, S. Handschin, J. P. Burgeois, A. Ray, K. Liosi, S. Oriana, W. Stark, H. Masai, R. Zhou, Y. Yamakoshi. LDL-mimetic lipid nanoparticles prepared by surface KAT ligation for *in vivo* MRI of atherosclerosis. *Chem. Sci.* **2020**, 11, 11998-12008.
- 16) S. Oriana, **A. Fracassi**, C. Archer, Y. Yamakoshi. Covalent Surface Modification of Lipid Nanoparticles by Rapid Potassium Acyltrifluoroborate Amide Ligation. *Langmuir* **2018**, 34, 13244-13251.
- 17) L. Giansanti, G. Bozzuto, **A. Fracassi**, C. Bombelli, A. Stringaro, A. Molinari, A. Piozzi, S. Sennato, G. Mancini. Effect of Preparation Protocol on Physicochemical Features and Interaction of Pegylated Liposomes. *Colloids and Surfaces A*, **2017**, 532, 444-450.
- 18) A. R. Royappa, M. Ayer, **A. Fracassi**, M. O. Ebert, S. Aroua, Y. Yamakoshi. Conformationally Selective Synthesis of Mononitrocalix[4]arene in Cone or Partial Cone. *Helv. Chim. Acta* **2017**, 100, e1600391.
- 19) A. Mauceri, **A. Fracassi**, M. D'Abramo, S. Borocci, L. Giansanti, A. Piozzi, L. Galantini, A. Martino, V. D'Aiuto, G. Mancini. Role of the Hydrophilic Spacer of Glucosylated Amphiphiles Included in Liposomes Formulations in the Recognition of Concanavalin A. *Colloids and Surfaces B: Biointerfaces* **2015**, 136, 232-239.