Presentation Overview

EARTH-LIFE SCIENCE INSTITUTE
TOKYO INSTITUTE OF TECHNOLOGY

Blue Marble Space
Institute of Science
Celebrating 10 years of exploration

- Research topic
  - **Membraneless Protocells at the Origins of Life**
- Research question
  - How did membraneless protocells contribute to the origins of life?
- Table of contents
  - Introduction to Tony and overview of our lab at ELSI
  - History of polyester protocells – Pt 1
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  - References
  - Acknowledgements

tzjia@elsi.jp
tonyjia@bmsis.org
@t_z_jia

Prof. Tony Z. Jia
Earth-Life Science Institute, Tokyo Institute of Technology, Japan
Blue Marble Space Institute of Science, USA
75th Tokyo International Exchange Center Research & Presentation

Introduction to Tony and our lab at ELSI

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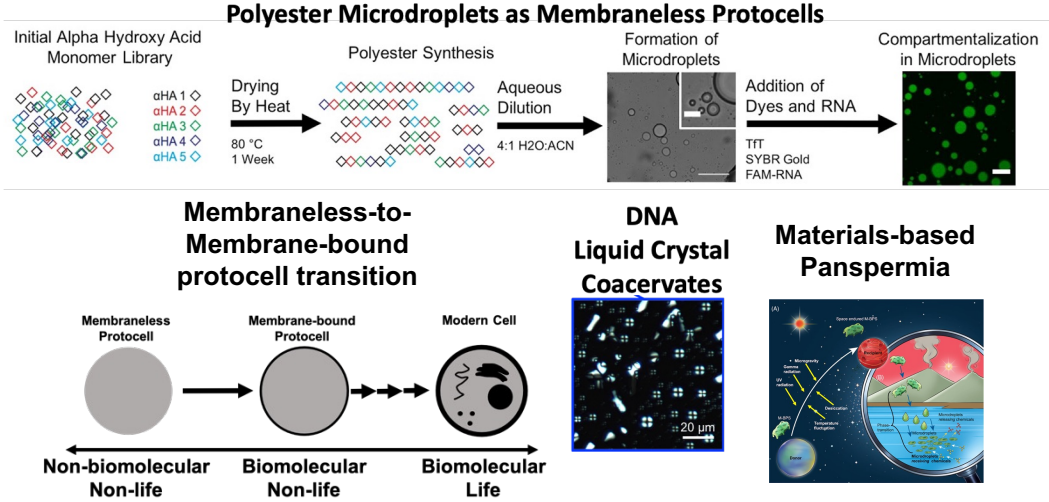
What were the first cells on Earth made of?
How did the first cells on Earth assemble?
What primitive chemistries were relevant?

What was the role of membraneless droplets as protocells on early Earth?
How can protocells derive function?

About Tony:

- **BS Chemistry & Business, Econ., Mgmt. at Caltech '10**
  Studying proteins and Lipids
- **MS and PhD Chemistry at Harvard '16**
  Studying DNA and RNA
- **Researcher at ELSI since 2017**
  Since 2019, Specially Appointed Assistant Professor, **Unit C** Lab Manager
  Since 2022, Specially Appointed Associate Professor, Associate PI

Research interests of our lab



tzjia@elsi.jp
tonyjia@bmsis.org
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History of Polyester Protocells – Pt. 1

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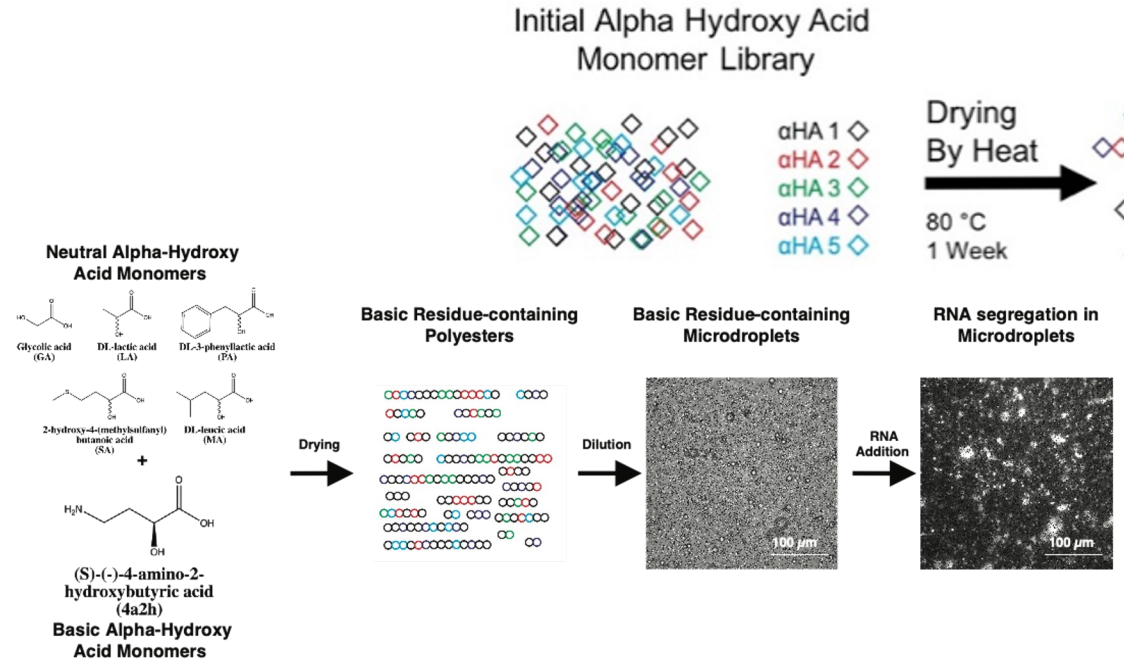
- 2018: Combinatorial polyester synthesis from alpha hydroxy acids
  - Chandru, et al. *Commun. Chem.* 1, 30 (2018).
- **2019: Assembly of polyester microdroplets**
  - Jia, et al. *PNAS*. 116, 15830-15835 (2019).
- 2020: Polyester synthesis through ring opening polymerization
  - Chandru, et al. *Sci. Rep.* 10, 17560 (2020).
- **2021: Segregation of RNA in polyester microdroplets**
  - Jia, et al. *Biomacromolecules.* 22, 1484-1493 (2021)



History of Polyester Protocells – Pt. 2

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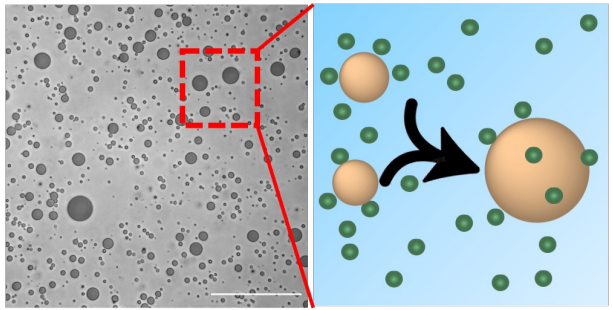
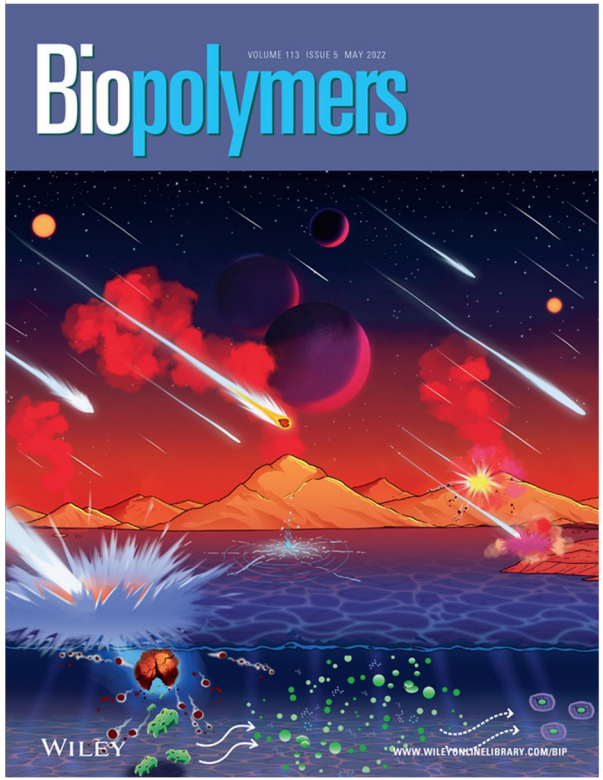
- **2022: Proposal of gel-based pansmermia seeds**
  - Sithamparam, et al. *Biopolymers*. 113, e23486 (2022).
- 2022: Temperature and chirality-dependent polyester synthesis
  - Afrin, et al. *Macromol. Chem. Phys.* 223, 2200235 (2022).
- **2023: Preferential salt uptake in polyester microdroplets**
  - Chen, et al. *Small Methods*. 7, 2300119 (2023).





References

- **TZ Jia***,†, K Chandru*,†, et al. Membraneless Polyester Microdroplets as Primordial Compartments at the Origins of Life. *PNAS*, 116(32), 15830-15835 (2019).
- K Chandru, **TZ Jia**, et al. Prebiotic Oligomerization and Self-Assembly of Structurally Diverse Xenobiological Monomers. *Scientific Reports*, 10, 17560 (2020).
- TP Fraccia†, **TZ Jia**†. Liquid Crystal Coacervates Composed of Short Double Stranded DNA and Cationic Peptides. *ACS Nano*, 14(11), 15071-15082 (2020).
- **TZ Jia***, et al. NV Bapat, Incorporation of Basic Alpha-Hydroxy Acid Residues into Primitive Polyester Microdroplets for RNA Segregation. *Biomacromolecules*, 22(4), 1484-1493 (2021).
- M Sithamparam, N Satthiyasilan, C Chen, **TZ Jia***, K Chandru*. A Material-based Panspermia Hypothesis: The Potential of Polymer Gels and Membraneless Droplets. *Biopolymers*, 113, e23486 (2022).
- R Afrin, et al. [incl **TZ Jia***]. The Effects of Dehydration Temperature and Monomer Chirality on Primitive Polyester Synthesis and Microdroplet Assembly. *Macromolecular Chemistry and Physics*, 223(23), 2200235 (2022).
- C Chen*, et al. [incl **TZ Jia***]. Spectroscopic and Biophysical Methods to Determine Differential Salt-Uptake by Primitive Membraneless Polyester Microdroplets. *Small Methods*, 2300119 (2023).

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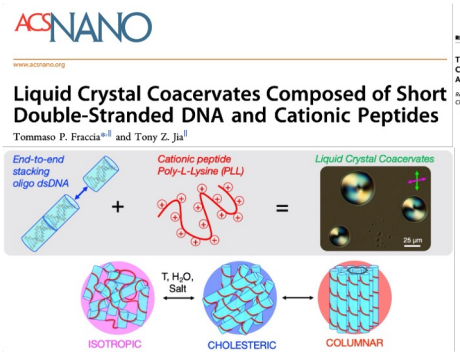
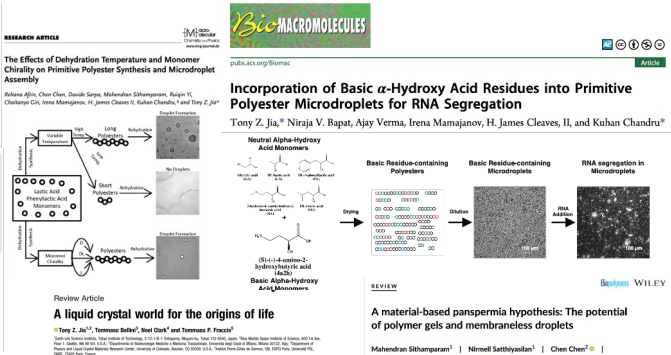
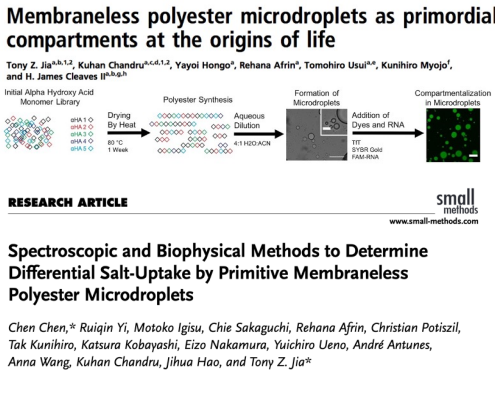
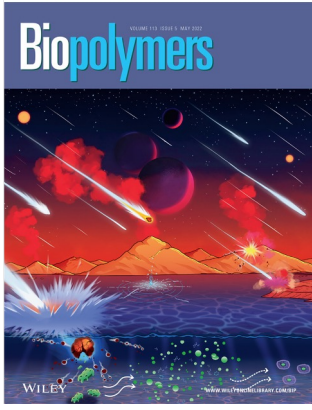
Selected lab publications since 2019









Acknowledgements

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  - Rehana Afrin
  - Chen Chen (RIKEN)
  - Mahendran Sithamparam (UKM)
  - Ming-Jing He (NCU)

Collaborators' Institutes

- **Asia/Oceania**
  - JAMSTEC (Japan)
  - RIKEN (Japan)
  - Okayama University-IPM (Japan)
  - Nara Medical University (Japan)
  - University of Tokyo (Japan)
  - JAXA (Japan)
  - USTC (China)
  - China University of Geosciences
  - MUST/SKL Planets (Macau, China)
  - National University of Malaysia
  - University of New South Wales (Australia)
  - National Central University (Taiwan)
  - National Cheng Kung University (Taiwan)
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  - IISER-Pune (India)
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  - University of Southampton (UK)
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  - Carnegie Institute of Washington (USA)
  - BMSIS (USA)
  - New York Institute of Technology (USA)
  - Columbia University (USA)
  - University of Colorado (USA)

If you're interested in working with us, let us know!

tzjia@elsi.jp
tonyjia@bmsis.org
@t_z_jia