

Opportunity Title: Exploiting Biology for Overmatch Compute Advantage

Opportunity Reference Code: ICPD-2025-08

Organization Office of the Director of National Intelligence (ODNI)

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How to Apply **Create and release your Profile on Zintellect** – Postdoctoral applicants must create an account and complete a profile in the on-line application system. **Please note: your resume/CV may not exceed 3 pages.**

Complete your application – Enter the rest of the information required for the IC Postdoc Program Research Opportunity. The application itself contains detailed instructions for each one of these components: availability, citizenship, transcripts, dissertation abstract, publication and presentation plan, and information about your Research Advisor co-applicant.

Additional information about the IC Postdoctoral Research Fellowship Program is available on the program website located at: <https://orise.orau.gov/icpostdoc/index.html>.

If you have questions, send an email to ICPostdoc@orau.org. Please include the reference code for this opportunity in your email.

Application Deadline 2/28/2025 6:00:00 PM Eastern Time Zone

Description **Research Topic Description, including Problem Statement:**

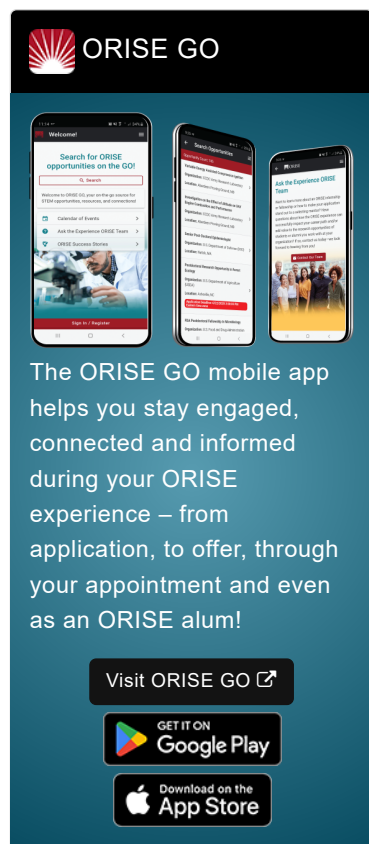
Whilst there is a continued push for faster, cheaper, lower power compute, much of this effort is placed into further developing proven technology, specifically silicon, either by continual scaling (Moore's Law), or by adapting architectures (SysMoore and Amdahl's Law). These developments, and other factors, mean silicon-based approaches will continue to provide the main core of computing resource for a considerable time. However, other computing approaches have the potential to provide extraordinary benefits, especially for particular applications.

There are currently three types of computers in widespread use: silicon-based; living brains, which have prompted significant research in artificial intelligence and neuromorphic computing; and Chemical Reaction Networks (CRNs), which (for example) control the behavior of every cell in the human body. Despite their prevalence, in comparison with other approaches, CRNs and other types of bio-based computing are heavily under-investigated.

As evidenced by their ubiquity in nature, bio-based computing approaches offer potential advantages over other forms of computation. For example, they can solve NP-complete problems⁴ and they exhibit different scaling properties to conventional (and quantum) computing⁵. Bio-based approaches can also operate at low-power and in environments that are hostile for traditional electronics.


This research topic aims to understand, develop, and evaluate (algorithmically) bio-based computing technologies that may provide Intelligence (and wider Defense) benefit, as well as facilitating a shift toward an evolutionary-proven, low power compute solution. Challenges include:

- evaluating and comparing different bio-based computing technologies.



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- developing a range of practically useful algorithms using bio-based computing methods (including, massively parallel approaches, using either concentration-based or string-based encodings).
- identifying integration and deployment challenges, to establish feasible routes toward exploitation.
- specifying verification, test, assurance, and robustness considerations, together with potential methodologies that would allow bio-based computing approaches to be used with confidence.

Example Approaches include:

- assessing the merits/demerits of bio-based computing for different classes of compute problem, through:
 - identifying key real-world problems that are well-suited to bio-based approaches and clarifying which problem characteristics are key to this suitability.
 - establishing sound development methodologies for bio-based computing (e.g. string-encoding approaches, which can be designed and simulated in available languages such as Thue6, or differential equation-based approaches, which represent concentration-based implementations).
 - using these methodologies to implement appropriate algorithms that exploit (and demonstrate) bio-based computing's unique properties.
 - proving conceptual algorithms through experimentation, using new or existing bio-based computing technologies.
 - comparing the effectiveness of bio-based computing with other computational paradigms (including silicon-based approaches), considering repeatability, robustness, timeliness, monotonicity, security, and Size, Weight, Power and Cooling requirements.
- developing integration methods for bio-based computing (e.g. interfaces with traditional computing, human machine interfaces), including miniaturization strategies of supportive interfaces, and identification of missing, or under-developed, components required for exploitation.
- understanding the potential offered by DNA-based storage, especially in combination with "processing in memory" techniques.

Key Words: Molecular Compute, Biological Compute, Organoid Intelligence, Chemical Reaction Networks, Algorithms, Computer Science, Biology, DNA, RNA

Qualifications Postdoc Eligibility

- U.S. citizens only
- Ph.D. in a relevant field must be completed before beginning the appointment and within five years of the appointment start date
- Proposal must be associated with an accredited U.S. university, college, or U.S. government laboratory
- Eligible candidates may only receive one award from the IC Postdoctoral Research Fellowship Program

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Research Advisor Eligibility

- Must be an employee of an accredited U.S. university, college or U.S. government laboratory
- Are not required to be U.S. citizens

Point of Contact [Keri Tarwater](#)

Eligibility • **Citizenship:** U.S. Citizen Only

Requirements • **Degree:** Doctoral Degree.

• **Discipline(s):**

- **Chemistry and Materials Sciences** ([12](#))
- **Communications and Graphics Design** ([3](#))
- **Computer, Information, and Data Sciences** ([17](#))
- **Earth and Geosciences** ([21](#))
- **Engineering** ([27](#))
- **Environmental and Marine Sciences** ([14](#))
- **Life Health and Medical Sciences** ([45](#))
- **Mathematics and Statistics** ([11](#))
- **Other Non-Science & Engineering** ([2](#))
- **Physics** ([16](#))
- **Science & Engineering-related** ([1](#))
- **Social and Behavioral Sciences** ([30](#))