PhD Opportunities

Lead supervisor & contact: Prof. Natalio Krasnogor — Natalio.Krasnogor@newcastle.ac.uk

Join ICOS to work at the intersection of AI, engineering biology, nanotechnology and biosecurity—leveraging our state-of-the-art experimental facilities and extensive networks, externally funded programmes (e.g., EBIC, CYBER, EnDROIDS, etc), and a vibrant spin-out/start-up ecosystem (e.g., GitLife Biotech, Invenirex, Nanovery, etc).

Project 1) Generative AI, Monte Carlo Tree Search & Reinforcement Learning for Biosecurity Screening

Focus. Build a rigorous red-team/blue-team framework that uses Generative AI, Monte Carlo Tree Search (MCTS) and Reinforcement Learning (RL) to generate realistic adversarial transformations of protein sequences/structures of concern to harden next-generation biosecurity screening pipelines.

What you'll do.

- Formalise threat models and perturbation budgets (synonymy, codon bias, 2D/3D motifs).
- Develop LLM/VAE/diffusion generators guided by MCTS & RL to explore evasion spaces.
- Design uncertainty-aware, ensemble detectors with calibration and abstention policies; release safety-gated benchmarks.

Ideal background. Strong AI/ML and optimisation; excellent programming; interest in bioinformatics/biosecurity and synthetic biology.

Project 2) Computational DNA Data Structures for DNA Data Storage

Focus. Computationally design and simulate DNA nanostructures that are *data structures* (e.g. lists, stacks, trees, hash maps, queues, etc) capable of storage, retrieval and molecular information processing for DNA data storage and computing.

What you'll do.

- Design abstract data structures in DNA; model read/update via strand-displacement and molecular logic.
- Simulate error modes (leaks, mispairing, degradation) and develop redundancy/ECC strategies.
- Analyse theoretical bounds on complexity, scalability and energy.

Ideal background. CS/maths/physics with strong programming; interest in molecular simulation (DNA nanotech experience a plus).

Project 3) Experimental DNA/RNA Data Structures for DNA Data Storage

Focus. Experimentally realise DNA/RNA origami devices that encode arrays/trees/stacks and execute basic data operations via strand-displacement and molecular logic; characterise stability and performance in the lab.

What you'll do.

- Design/fold DNA/RNA origami; implement search, enqueue/dequeue and update operations with DNA molecules in the lab.
- Characterise with AFM/TEM, gels, FRET; assess stability, error rates and scalability.
- Integrate with data-encoding schemes and report protocols for reproducible molecular devices.

Ideal background. Molecular biology/chemistry/nanotech; practical DNA nanotech, cloning or microscopy skills desirable.

4) ECC-Backed Genetic Watermarks for Environmental Engineering Biology Bioforensics

Focus. Engineer robust, verifiable DNA barcodes/watermarks for microbial chassis by integrating error-correcting codes (ECC) to support attribution, traceability and bio-forensics under realistic evolutionary and environmental pressures.

What you'll do.

- Design and clone ECC-based genetic barcodes; evaluate stability under growth, stress and mutation regimes.
- Run microcosm assays (contained) to test persistence and tamper-resilience; develop decoding/attribution protocols.
- Contribute to emerging standards for safe deployment and monitoring of engineered microbes.

Ideal background. Molecular biology/microbiology/synthetic biology; sequence analysis skills helpful; ECC familiarity welcome but not essential.