

## Build 2025 Proposal Submission

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### Title of the Submission

Quantum Bioinformatics: Revolutionizing Sequence Alignment with AZURE Quantum Computing

### Abstract

Quantum computing has the potential to change the whole computer industry due to the expected parallel execution potential based on the principles of quantum physics. This impact will spread to multiple use cases, and one of these promised applications is in the [pharmaceutical industry](#), specifically in [bioinformatics and systems biology](#).

Microsoft just made two very important announcements. One is 2025: [The Year to Become Quantum-Ready](#), which promises companies across the globe that, given the rapid pace of innovation, it's critical for organizations to start exploring, identifying, and building an application roadmap that sets them up for success in a quantum future. The second is the introduction of [Majorana 1](#). The world's first quantum processor powered by topological qubits, marking a transformative leap toward scalable quantum computing.

These two forces urge companies to start the PoC in [NISQ quantum](#) computing, enabling engineers to access innovation and disruptive ideas. This presents an important singularity due to integration at [multiple levels](#). The quantum market capital is expected to reach [\\$5.3 billion by 2029](#).

The current blog/content showcases a [Q# quantum circuit](#) that encodes the DNA nucleotides of a human and a monkey to perform a sequence comparison. [Sequence comparisons](#) are very compute-intensive workloads, and quantum computing propels potential gains once quantum supremacy is reached due to the parallelism achieved with quantum mechanics principles.

The current code can be executed on-premises and on the [Azure Quantum Computing Marketplace](#), enabling the reader to test and learn about these quantum principles and their application in a real educational quantum bioinformatics solution powered by the Microsoft ecosystem and technologies.

**Category**

Blog/Content

**Target Audience and Skill Level**

Beginner

**Objectives and Key Takeaways**

1. Quantum computing can efficiently encode and compare genetic sequences.
2. DNA bases are mapped to qubits using a binary representation.
3. CNOT gates highlight differences between genetic sequences.
4. Quantum measurements reveal sequence mismatches.
5. Potential applications include genetics, medicine, and evolutionary studies.

**Supporting Materials**

1. <https://github.com/evarelav/quantumbioinformatics>

**Speaker/Author Bio(s)**

Emmanuel Villegas holds a postgraduate degree in Quantum Computing from Universitat Politècnica de Catalunya (UPC) and a master's in bioinformatics and systems biology from Universidad de Costa Rica. With extensive experience at HP, Microsoft, and Intel, he specializes in high-performance computing, artificial intelligence, cloud computing, big data, quantum computing, and bioinformatics. Emmanuel is dedicated to bridging cutting-edge technology and scientific innovation, contributing to advancements in computational research and industry applications.

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