How IBM Quantum is Enabling Healthcare and Biology Research

In the first ever Q4Bio Challenge, research teams sought to demonstrate scalable quantum algorithms for healthcare, with Algorithmiq's work alongside Cleveland Clinic and IBM earning $2 million Q4Bio prize.

• Q4Bio aims to accelerate development of quantum algorithms for healthcare that can run on quantum computers expected within three to five years.

• Teams were required to run large scale demonstrations on real quantum hardware.

• Five out of the six finalists used IBM quantum hardware for their research.

• Quantum computing has potential as a practical tool for healthcare, with hybrid quantum classical approaches paving the way toward real-world applications.

YORKTOWN HEIGHTS, N.Y., April 16, 2026 - Quantum computing is at an inflection point. In recent years, quantum computers have shown the ability to run quantum programs at a scale beyond exact classical simulation. They're becoming useful tools for solving real-world problems, with provable quantum advantage close on the horizon. Community-led initiatives that provide funding and prizes for high-quality research can offer an early look at how quantum computing will impact fields like healthcare and the life sciences.

That's one reason the non-profit Wellcome Leap established **the Quantum for Bio (Q4Bio) Supported Challenge Program.** Q4Bio aims to identify, develop, and demonstrate quantum algorithms for human health applications that have the potential to run on near-term quantum computers expected to arrive in the next three to five years. The program launched in 2023 with twelve research teams from around the world receiving access to a combined $40 million in funding. By March 2026, that group had narrowed to six Phase III finalists. Now, the winners have been announced.

Wellcome Leap funds high-risk, high-reward global health research, with the aim of facilitating medical breakthroughs on time scales of 5-10 years rather than over the course of decades. That ambition is evident in the Q4Bio challenge requirements: To be eligible for a $2 million Phase III award, participating teams needed to demonstrate algorithms using more than 50 qubits and circuit depths on the order 1,000 to 10,000 gates—while also showing a clear path to scaling. More details here.

In practice, meeting those requirements meant working directly with today's most capable quantum hardware. That's why five of the six Phase III finalist teams used IBM quantum computers to generate their results, underscoring the role of "utility-scale" quantum computers with 100+ qubits in tackling demanding problems at the intersection of quantum information science and real-world use cases.

Below, we highlight the work carried out by Q4Bio's Phase III finalists on IBM quantum hardware. Their projects offer an exciting glimpse at how quantum computing is beginning to support meaningful research in healthcare and the life sciences.

Biology at scale on IBM quantum computers

The results from these multidisciplinary, multi-organizational teams span drug discovery, genomics, biomarkers, and fundamental biochemistry. In each area, researchers found a healthcare problem they could execute at significant scale on quantum computers today, with real potential to scale even further in the future.

Agorithmiq, Cleveland Clinic, and IBM

The winning project—led by quantum startup Algorithmiq in collaboration with Cleveland Clinic and IBM—used quantum computing to simulate key processes in photodynamic therapy (PDT), a cancer treatment based on light-activated drugs.

Algorithmiq developed an end-to-end hybrid quantum–classical framework in which novel methods for active space selection, state preparation, measurement, and post-processing enabled large-scale molecular electronic structure simulations on IBM's quantum hardware. By executing circuits for ground- and excited-state experiments on up to 100 qubits, the teams demonstrated a scalable path toward quantum advantage in drug discovery and development.

Sabrina Maniscalco, CEO and co-founder of Algorithmiq, said the results highlight how Algorithmiq's approach to tightly integrated quantum-classical algorithms could play a key role in unlocking real-world quantum advantage.

"This work provides one of the clearest indications to date that quantum computing can begin to impact real, chemically relevant problems, rather than simplified benchmarks," she said. "IBM's quantum systems enabled execution of circuits at scales approaching 100 qubits and supported the continuous, end-to-end validation loop required to identify real bottlenecks and ensure robustness of the approach."

Dr. Vijay Krishna, associate staff in biomedical engineering at Cleveland Clinic, added that "Q4Bio showed that when teams with complementary expertise work toward a common goal, they can make meaningful progress on problems that no single discipline can solve alone."

The Quantum Pangenomics project

Meanwhile, the University of Oxford and Sanger Institute's Quantum Pangenomics project focused on converting genome problems to quadratic unconstrained binary optimization (QUBO) formulations. Recent research has highlighted the potential of quantum optimization methods based on QUBO to help solve challenging real-world problems and deliver near-term quantum advantage.

As part of their efforts, the team used an IBM Quantum Heron r2 to encode the Hepatitis-D genome. In their workflow, classical systems handle problem formulation, iteration, and analysis, and quantum hardware is invoked for the most computationally challenging subproblems.

“Encoding a whole genome onto a quantum computer is a world first and represents at least one order of magnitude improvement over any other efforts to represent DNA on quantum machines,” said **James McCafferty, Chief Information Officer at the Wellcome Sanger Institute**. “And full credit goes to IBM in helping us achieve this.”

“This is not a toy demonstration, it involves biologically significant sequences, represented on quantum hardware using data partitioning techniques and tailored depth-reduction we developed specifically for genomic data,” said **Sergii Strelchuk, associate professor of Computer Science at Oxford University**. “The fact that the encoded information can be retrieved through our index-reported verification method sends a clear signal: quantum data encoding for genomics is no longer aspirational, it is ready to scale.”

Infleqtion

Infleqtion, a Chicago-based quantum startup, used an IBM Quantum Heron r2 as part of the project they led with the University of Chicago and MIT on quantum-enhanced biomarker discovery from multimodal cancer data, using hybrid quantum-classical optimization algorithms. Their work involved GPUs and QPUs working together, an exciting emerging avenue for hybrid workflows.

Fred Chong, Professor at University of Chicago and Chief Scientist for Quantum Software at Infleqtion, says Heron QPUs were the only available hardware that could meet the Wellcome Leap criteria of demonstrating quantum algorithms with greater than 50 quantum bits and a program length of greater than 1,000 quantum gates. Access to that hardware allowed his team to demonstrate a convincing proof-of-concept that a hybrid quantum-classical approach could improve a purely classical approach to identifying biomarkers.

“Our work has already identified novel cancer biomarkers for clinical evaluation, and future quantum machines will allow us to discover even more promising biomarkers that we hope will improve treatment outcomes,” Chong said.

Stanford, Michigan State University, and other collaborators

A team comprising researchers from many scientific institutions used VQE and an IBM Quantum Heron r2 processor to study ATP and GTP hydrolysis in proteins. These are fundamental biochemical reactions that power most cellular processes.

By demonstrating quantum algorithms for modeling metaphosphate hydrolysis and rigorously analyzing their resource costs, the team showed how near-term quantum computers could act as accelerators in computational workflows for biology. They also explored potential workflows for fault-tolerant quantum computers.

“Although classical methods for biochemistry have a decades long headstart, quantum methods are really starting to become competitive,” said **Ryan LaRose, a researcher on the team and professor at Michigan State University** “For our project, IBM hardware provided the number of qubits, gate fidelity, and sampling rate needed to make our experiments viable.”

University of Nottingham, Phasecraft, and QuEra

Another finalist team, led by Jonathan D. Hirst at the University of Nottingham, explored quantum-enhanced strategies for covalent inhibitor design in collaboration with Phasecraft and QuEra. Covalent inhibitors are a cornerstone of modern therapeutics—particularly in oncology and antiviral treatments—owing to their ability to form strong, durable bonds with target proteins.

The team applied quantum algorithms to generate high-fidelity molecular data, which they then used to augment classical Density Functional Theory (DFT) calculations—computer simulations estimating molecular behavior by modeling electron density. This enabled more accurate simulations of covalent binding processes.

The researchers deployed this hybrid quantum–classical workflow within a drug discovery program focused on the disorder Myotonic dystrophy type 1 (DM1), highlighting the potential of quantum-enhanced methods to tackle complex, currently untreatable diseases.

As part of their study, the team utilized IBM Quantum hardware, including an IBM Quantum Nighthawk processor with 120 qubits—part of a broader effort to evaluate the capabilities of near-term quantum systems for chemically relevant modeling.

Quantum-centric supercomputing for biology and human health

Viewed as a whole, these results underscore just how quickly quantum computing is maturing as a tool for biological research. According to **Ashley Montanaro, Co-founder of Phasecraft and Professor of Quantum Computation at University of Bristol**, the rapid advancement of IBM quantum hardware and software played a crucial role in enabling the rapid experimental cycles required for their work.

“When the Wellcome Leap Q4Bio challenge began three years ago, it was far from obvious that any of this would work. The fact that we now have encouraging results on a real drug discovery target is a significant milestone,” he said. “The pace of progress in quantum hardware and software throughout this project has been notable as we continuously incorporated new capabilities and explored cutting-edge advancements month by month.”

The impressive results from Q4Bio’s Phase III finalists reflect progress toward IBM's vision of quantum-centric supercomputing (QCSC). Hybrid quantum–classical workflows integrate HPC, GPUs, and QPUs. Access to utility-scale quantum processors and cloud-based platforms enable global teams to collaborate, iterate quickly, and move toward scalable, end-to-end biological workflows.

Together, these results point to a broader transition: quantum computing in biology as elsewhere is shifting from a speculative experiment to a phase of measurable, application-driven progress, with growing potential to become part of the life-sciences computational stack.

“It’s encouraging to see so many research teams implementing QCSC workflows, where classical and quantum resources work together to achieve what neither can alone,” said **Jay Gambetta, director of IBM Research**.

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Visit www.ibm.com for more information.

Media contacts:

Brittany Forgione
IBM
Brittany.Forgione@ibm.com

Chris Nay
IBM
cnay@us.ibm.com
