SIMON-INSTITUTE White Paper

A Degree Framework for Undergraduate, Master's, Doctoral, and Federation Honors Education

Proposed curriculum architecture for prestigious, diploma-bearing programs in advanced AI, quantum, supercomputing, and governed research systems

This white paper synthesizes the proposed undergraduate curriculum in AI, Quantum & Supercomputing Systems, the thesis-based M.S. in Computational Medical Research, and the proposed Ph.D. in Hybrid AI, Quantum & Federated Systems.

Prepared for SIMON-INSTITUTE and the SIMON-INSTITUTE Federation

Draft strategic framing based on internal curriculum documents

Executive Summary

SIMON-INSTITUTE is designed as more than a collection of AI or computer science courses. It is a focused academic discipline that joins advanced AI, quantum literacy, high-performance computing, federated research, cybersecurity, governance, reproducibility, and domain application into one coherent degree pathway. The attached curricular frameworks already outline three distinct programs: a four-year B.S. in AI, Quantum & Supercomputing Systems with Medical Research or Physics specialization and an optional accelerated master's pathway; a thesis-required M.S. in Computational Medical Research with bridge support, core research design and governance courses, and three applied concentrations; and a research-intensive Ph.D. in Hybrid AI, Quantum & Federated Systems organized around AI systems, GPU superclusters, quantum workflows, secure federation, and dissertation-level research. Together, these programs provide a university with a diploma-bearing institute rather than a short-term certificate initiative, and they create workforce pathways that reach far beyond traditional AI or CS classes.

Program	Degree	Structure	Distinctive Value
Undergraduate	**B.S. in AI, Quantum & Supercomputing Systems**	8 semesters; Medical Research or Physics specialization; optional AMP	Builds full-stack technical fluency across AI, quantum, supercomputing, security, governance, and domain application.
Master's	**M.S. in Computational Medical Research**	36 credits; thesis required; bridge support; 3 concentrations	Prepares research-capable graduates for biomedical, clinical, and quantum-enabled discovery environments.
Doctoral	**Ph.D. in Hybrid AI, Quantum & Federated Systems**	Core + two depth areas; practicum; teaching; milestones; dissertation	Forms frontier researchers in AI systems, quantum workflows, and secure multi-institution research platforms.

Why This Curriculum Must Exist as a Focused Discipline

Many universities now offer machine learning, data science, software engineering, or prompt-design courses. Those offerings matter, but they are often fragmented. The SIMON-INSTITUTE curriculum solves a larger problem: how to prepare graduates who can build, govern, audit, and apply advanced intelligent systems across real research environments. In the undergraduate curriculum, students progress from programming, logic, linear algebra, and quantum information into GPU fundamentals, machine learning, distributed systems, cybersecurity, federated learning, MLOps, hybrid quantum-classical workflows, and capstone design. The program also requires students to choose a domain sequence in Medical Research or Physics, and it offers senior-year 500-level coursework through an accelerated master's pathway.

The master's curriculum then moves from broad technical formation into a thesis-centered research degree. It is intentionally built for entrants from biology, medicine, and public health as well as quantitatively prepared computing students, using bridge modules to bring non-CS entrants into research computing, mathematics, and reproducible workflows. Its core courses in research design, biostatistics, causal inference, biomedical data engineering, secure data governance, machine learning, and quantum foundations form a shared research language before students move into Population Health and Federated Research, Quantum-Enabled Discovery, or Clinical AI.

The doctoral curriculum completes the discipline by treating large-scale learning systems, quantum workflows, and secure multi-institution research platforms as one scholarly field. Its core in research methods, advanced machine learning, deep learning systems, distributed AI, GPU superclusters, quantum computing, hybrid algorithms, and federated learning is complemented by a Goldilocks Practicum, teaching practicum, scientific writing, two depth areas, and research milestones that include rotations, qualifying exams, proposal defense, publications, and dissertation work.

> **SIMON-INSTITUTE is best understood as a unified discipline in advanced AI, quantum literacy, supercomputing, secure federation, and research accountability - not as a loose bundle of technical electives.**

This is why SIMON-INSTITUTE should be framed as a prestigious degree architecture rather than a branded concentration. Prestige in higher education comes from seriousness of method, clear academic identity, visible standards, and durable outcomes. SIMON-INSTITUTE meets that test because it is thesis- and dissertation-capable, infrastructure-aware, domain-connected, and explicitly designed around reproducibility, governance, and research accountability. Students are not only taught to generate outputs; they are trained to defend evidence, manage high-value compute, work across institutional boundaries, and translate advanced intelligence into credible scientific or operational results.

Undergraduate Degree: A High-Rigor Entry into the Field

The B.S. degree is the institute's foundational diploma. Structured over eight semesters with a typical five-course pattern, it establishes computational fluency, mathematical depth, technical communication, and early exposure to quantum information and data ethics before moving students into data structures, algorithms, architecture, operating systems, machine learning, networking, numerical methods, deep learning, distributed AI, MLOps, cybersecurity, federated learning, and high-performance supercluster work.

The degree's distinctive value lies in its architecture. First, it treats compute as a physical and institutional reality rather than a hidden utility. Students learn how CPUs and GPUs behave, how clusters are used, and how secure environments are maintained. Second, it introduces quantum literacy early and then matures it into programming, algorithms, and hybrid workflows. Third, it pushes students into a domain specialization rather than leaving them at the level of general tools. A Medical Research track develops biomedical data engineering, imaging and signals, omics, and privacy-preserving health research, while a Physics track develops computational physics, quantum physics for computing systems, AI for materials and molecular design, and scientific simulation at scale.

The optional Accelerated Master's Pathway deepens the program's academic prestige. By allowing qualified seniors to complete graduate-level coursework in machine learning theory, distributed training, quantum information theory, secure AI governance, computational biology, or computational physics, the institute creates a credible bridge from undergraduate mastery to graduate research.

- Builds foundational fluency in programming, mathematics, machine learning, systems, networks, and quantum information.

- Teaches students how to route work across local compute, quantum experimentation, and larger-scale research environments.
- Differentiates graduates through domain pathways in Medical Research or Physics rather than generic AI survey coursework.

Master's Degree: Thesis-Based Formation for Computational Medical Research

The M.S. in Computational Medical Research is not a conventional analytics degree. It is a research-centered program intended to produce professionals who can translate biomedical questions into defensible computational studies. Its thesis requirement immediately signals seriousness. Students are not graduating on course completion alone; they are expected to propose, execute, document, and defend a research project with robustness checks and a reproducibility package.

The curriculum's design is especially important for workforce differentiation. It is accessible to strong entrants from biology, medicine, and public health, but it does not lower expectations. Instead, it adds bridge modules in research computing and mathematics so that non-CS entrants can participate fully in computational research. This means the degree expands opportunity without diluting rigor. The core sequence in research design, biostatistics, causal inference, biomedical data engineering, secure governance, machine learning, and quantum foundations prepares graduates to work in regulated, evidence-sensitive environments where clinical consequences, privacy boundaries, and auditability matter.

Its three concentrations provide market relevance beyond generic AI coursework. Population Health and Federated Research prepares graduates for cross-institution analytics, privacy-preserving studies, real-world evidence pipelines, and health equity modeling. Quantum-Enabled Discovery prepares students for molecular and protein research environments in which hybrid workflows, generative models, active learning, and simulation matter. Clinical AI prepares graduates for EHR and NLP research, multimodal biomedical modeling, imaging, pathology, and high-stakes model validation. This is a workforce pathway into translational research, biomedicine, health systems innovation, and sponsor-funded discovery, not simply another master's in data science.

- Creates a bridge for strong biology, medicine, and public-health entrants without sacrificing technical standards.
- Requires publication-quality methods, governance awareness, and reproducibility artifacts.
- Provides clear pathways into population health, clinical AI, and quantum-enabled discovery workforces.

Doctoral Degree: Frontier Research in Hybrid AI, Quantum, and Federated Systems

The Ph.D. in Hybrid AI, Quantum & Federated Systems completes the institute's academic identity by forming researchers who can invent at the frontier. The program is explicitly designed around the Goldilocks compute model: on-site AI superclusters, on-site quantum capability, and cloud-based quantum or HPC access. That design matters because it turns the institute into a research system rather than a purely classroom-based program.

Doctoral students are trained across an integrated core of research methods, advanced machine learning, deep learning systems, distributed systems, GPU superclusters, quantum computing, hybrid quantum-classical workflows, and federated learning, security, and governance. They then deepen into two research areas such as population health and federated research, quantum-enabled discovery, clinical AI, physics and scientific computing, or AI systems and data center operations.

The program's practicum, teaching, seminar, and milestone structure is especially important for prestige. A serious Ph.D. is defined not just by coursework but by scholarly culture. The qualifying exam, proposal defense, annual reviews, publications, and dissertation expectations establish that culture, while the Goldilocks Practicum ensures that every doctoral graduate has worked across the full compute stack and produced research artifacts that are reproducible, auditable, and publishable.

- Trains doctoral researchers to invent methods and platforms, not simply apply existing tools.
- Organizes advanced work around the Goldilocks model of on-prem AI, on-site quantum, and cloud-scale experimentation.
- Connects doctoral scholarship to teaching, grantcraft, and reproducible artifact production.

A Federation-Wide Honors Program

A federation-wide honors framework should be built as an extension of these curricula. Because the current documents already emphasize reproducibility, secure governance, practicum work, thesis research, and multi-institution collaboration, honors at SIMON-INSTITUTE should measure more than grades alone. The Federation should therefore adopt honors criteria that recognize academic distinction, technical seriousness, ethical stewardship, and evidence-based service.

Level	Federation Distinction	Recommended Requirements
B.S.	**Federation Honors Scholar**	High academic standing, capstone with distinction, reproducibility package, and at least one cross-federation research or symposium experience.
M.S.	**Federation Research Distinction**	Thesis with distinction, strong governance and data-lineage record, public presentation, and demonstrable maturity in uncertainty disclosure and translational usefulness.
Ph.D.	**Federation Doctoral Fellow**	Dissertation excellence, peer-reviewed publication or platform artifact, teaching or mentoring contribution, and meaningful multi-institution collaboration.

At the undergraduate level, a Federation Honors Scholar designation should require exceptional academic performance in the SIMON core, successful completion of a capstone with distinction, a reproducibility package, and at least one cross-federation experience such as a symposium paper, collaborative project, summer research placement, or shared Goldilocks lab module.

At the master's level, a Federation Research Distinction should be tied to thesis quality, documented data lineage and governance, public defense or federation colloquium presentation, and demonstrable research maturity in uncertainty disclosure, reproducibility, and translational usefulness.

At the doctoral level, a Federation Doctoral Fellow designation should recognize dissertation excellence, peer-reviewed research or equivalent platform artifacts, teaching or mentoring contribution, and participation in cross-institution collaboration consistent with the federated design of the institute.

Across all three levels, honors should appear in the university transcript record and in a federation registry or diploma supplement. This would give member universities a common language of distinction while preserving each institution's own academic authority.

Diploma Recognition, Workforce Value, and Institutional Advantage

For SIMON-INSTITUTE to create real institutional value, the credential must be a recognized university award, not a workshop badge. The cleanest model is for the host university to confer the degree under its own academic authority while naming the program on the diploma or transcript as awarded through SIMON-INSTITUTE. That allows the institute to function as a recognized academic home within the university, much as schools, honors colleges, and named institutes already do in other disciplines.

This diploma-bearing model also creates a sharper workforce signal. Employers, sponsors, and graduate committees do not simply need candidates who have 'taken AI classes.' They need graduates who understand how to operate in research, regulatory, and high-consequence environments. A SIMON-INSTITUTE diploma tells the market that the graduate has studied AI in combination with GPU or cluster computing, quantum literacy, secure infrastructure, federated collaboration, reproducibility, and domain application. That is a materially different preparation from a transcript composed of isolated CS electives.

The workforce implications are broad. Undergraduate graduates can move into research software engineering, AI and ML engineering, MLOps and LLM operations, HPC or supercomputing support, quantum workflow assistance, scientific computing, cybersecurity for research environments, or junior roles in biomedical and physics-focused labs. Master's graduates can enter computational medical research, biomedical data engineering, clinical AI validation, real-world evidence analytics, translational informatics, privacy-preserving or federated health research, and quantum-enabled discovery teams. Doctoral graduates are prepared for faculty and postdoctoral pathways, advanced R&D roles, research platform architecture, federated systems design, quantum-AI benchmarking, clinical AI governance, and leadership of mission-critical research infrastructure.

For universities, the strategic value is equally clear. SIMON-INSTITUTE gives an institution a credible academic vehicle for faculty recruitment, sponsored research growth, student differentiation, interdisciplinary coordination, and federation-based collaboration. Because the degree framework spans undergraduate, master's, doctoral, and honors levels, a host university can create a pipeline from first exposure to dissertation research while also connecting to peer institutions through common academic language and shared infrastructure practices.

> **A SIMON-INSTITUTE diploma should signal more than familiarity with AI tools. It should signal readiness to work where intelligence, infrastructure, governance, and human consequence meet.**

Conclusion

SIMON-INSTITUTE should therefore be advanced as a focused discipline and a diploma-bearing academic model. It answers a real educational gap: the world does not only need graduates who can use AI tools; it needs graduates who can build, govern, verify, secure, and apply intelligent systems across complex institutional settings. By organizing undergraduate, master's, doctoral, and federation honors education around AI, quantum, supercomputing, federated research, and accountable practice, the institute offers universities a way to confer degrees that are academically serious, professionally differentiated, and aligned with the future of research and workforce development.

Source basis: SIMON Degree Requirements (B.S. in AI, Quantum & Supercomputing Systems), Master Degree Requirements (M.S. in Computational Medical Research), and PhD Program Syllabus (Ph.D. in Hybrid AI, Quantum & Federated Systems).