Twin Cities Campus

Health Informatics Ph.D.

Health Informatics, AHC Inst

Graduate School

Link to a list of faculty for this program.

Contact Information:
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- Program Type: Doctorate
- Requirements for this program are current for Spring 2018
- Length of program in credits: 70
- This program does not require summer semesters for timely completion.
- Degree: Doctor of Philosophy

Along with the program-specific requirements listed below, please read the General Information section of the catalog website for requirements that apply to all major fields.

Health informatics (also known as biomedical informatics) is an interdisciplinary field of scholarship that applies computer, information, statistical, management, and related scientific methods to enable biomedical discovery and support the effective and efficient use and analysis of data, management of information, and application of knowledge across the spectrum from basic science to clinical care. The ultimate goal of the field is to improve the health, well-being, and economic functioning of society. Students take a sequence of core courses in health informatics, computing, and biostatistics, and electives in technical and health science areas, and pursue one of four tracks: Data Science and Informatics for Learning Health Systems; Clinical Informatics; Translational Bioinformatics; or Precision and Personalized Medicine (PPM) Informatics. Students pursuing the Data Science and Informatics for Learning Health Systems track are expected to complete the Universitys Data Science MS degree en route to the PhD. Students pursuing any of the other three tracks are expected to complete the Health Informatics MS degree en route to the PhD. Phase I is the MS phase, and Phase II is the PhD phase of the program. Phase II is completed after students have earned the MS degree. Students who have an MS in Data Science or Health Informatics from a comparable program may be exempt from this requirement in whole or in part, subject to Academic Program Committee (APC) review and approval.

Program Delivery

This program is available:

- via classroom (the majority of instruction is face-to-face)

Prerequisites for Admission

The preferred undergraduate GPA for admittance to the program is 3.50.

Applicants must have a BS or equivalent in science, technology, engineering, computer science, math, or another pertinent field from a regionally accredited university or international equivalent.

Required prerequisites

Health or Biological Sciences

6-semester credits or 9 quarter-credits of health or biological coursework at the undergraduate or graduate level or department consent.

Computer Science

Clinical Informatics Track

Documented work or educational experience working with a general purpose programming language such as C, C++, Java, Visual Basic, PASCAL, etc.

or HINF 5502 - Python Programming Essentials for the Health Sciences (1.0 cr)

or **Other Tracks**

Applicants to the Data Science for Learning Health Systems, Translational Bioinformatics, and Precision and Personalized Medicine Informatics tracks must also have taken an introduction to data structures and algorithms, such as the course listed below.

CSCI 1933 - Introduction to Algorithms and Data Structures (4.0 cr)

Track-Specific Prerequisites

Applicants to the Data Science for Learning Health Systems, Translational Bioinformatics, and Precision and Personalized Medicine

Informatics tracks must also have the following prerequisites or must take remedial courses at the discretion of the admissions committee:

Mathematics

Applicants must have college-level calculus and linear algebra, such as the courses listed below.

MATH 1271 - Calculus I [MATH] (4.0 cr)
CSCI 2033 - Elementary Computational Linear Algebra (4.0 cr)
or MATH 4242 - Applied Linear Algebra (4.0 cr)

Statistics

Applicants must have college-level statistics, such as the courses below.

STAT 3011 - Introduction to Statistical Analysis [MATH] (4.0 cr)
or STAT 3021 - Introduction to Probability and Statistics (3.0 cr)

Applicants must submit their test score(s) from the following:

- GRE
  - General Test - Verbal Reasoning: 152
  - General Test - Quantitative Reasoning: 159
  - General Test - Analytical Writing: 4

International applicants must submit score(s) from one of the following tests:

- TOEFL
  - Internet Based - Total Score: 79
  - Internet Based - Writing Score: 21
  - Internet Based - Reading Score: 19
  - Paper Based - Total Score: 550
- IELTS
  - Total Score: 6.5
  - Reading Score: 6.5
  - Writing Score: 6.5
- MELAB
  - Final score: 80

The preferred English language test is Test of English as Foreign Language

Key to test abbreviations(GRE, TOEFL, IELTS, MELAB).

For an online application or for more information about graduate education admissions, see the General Information section of the catalog website.

Program Requirements

46 credits are required in the major.
24 thesis credits are required.

This program may be completed with a minor.

Use of 4xxx courses toward program requirements is permitted under certain conditions with adviser approval.

A minimum GPA of 3.00 is required for students to remain in good standing.

At least 2 semesters must be completed before filing a Degree Program Form.

All courses taken, milestones met, and progress made in the program are subject to Academic Program Committee (APC) review. The inclusion of 4xxx-level coursework requires APC approval.

Required Core Coursework (14 credits)

Phase I (12 credits)

All students take the following core coursework for a total of 12 credits. HINF 5436 must be taken twice.

HINF 5430 - Foundations of Health Informatics I (3.0 cr)
HINF 8430 - Foundations of Health Informatics I Lab (2.0 cr)
HINF 5436 - AHC Informatics Grand Rounds (1.0 cr)
HINF 5440 - Foundations of Translational Bioinformatics (3.0 cr)
HINF 8440 - Foundations of Translational Bioinformatics Lab (2.0 cr)

Phase II (2 credits)

All students take the following core course after completing the Phase I core, and with the approval of the APC.

HINF 8525 - Health Informatics Teaching (2.0 cr)

Doctoral Thesis Credits (24 credits)

All students must take at least 24 doctoral thesis credits, in consultation with the APC.

HINF 8888 - Thesis Credit: Doctoral (1.0 - 24.0 cr)

Program Sub-plans

Students are required to complete one of the following sub-plans.
Students may not complete the program with more than one sub-plan.

Clinical Informatics

The Clinical Informatics track provides instruction and training for students interested in clinical applications methods and applications. The curriculum includes instruction in health data and coding, systems analysis, human-computer interaction, current informatics research, and current applications such as decision support systems, natural language processing, and predictive modeling. Additionally, students learn biostatistical methods, relational database theory and practice, analytics and data science methodologies, consumer health informatics, and interprofessional practice. Electives supplement individual student interests in areas such as computer programming, health data management, health care finance, and public and population health (with scope to include person-empowered participation and inter-professional engagement). Courses use a mixture of theoretical and applied subject matter to provide a solid grounding in current informatics thinking and practice.

Students who pursue the Clinical Informatics track must complete the Health Informatics MS degree en route to completing the PhD. Students must consult with the APC to coordinate completion of coursework and other requirements for the Health Informatics MS, the Health Informatics PhD, and the Clinical Informatics track. Students who have an MS in Health Informatics from a comparable program may be exempt from this requirement in whole or in part, subject to APC review and approval.

Clinical Informatics Coursework (32 credits)

Core Coursework (15 credits)

Take the following core courses:

HINF 5431 - Foundations of Health Informatics II (3.0 cr)
HINF 8431 - Foundations of Health Informatics II Lab (2.0 cr)
HINF 5510 - Applied Health Care Databases: Database Principles and Data Evaluation (3.0 cr)
HINF 5520 - Informatics Methods for Health Care Quality, Outcomes, and Patient Safety (2.0 cr)
HINF 5531 - Health Data Analytics and Data Science (3.0 cr)
HINF 5496 - Internship in Health Informatics (1.0 - 6.0 cr)
NURS 5116 - Consumer Health Informatics (2.0 cr)
NURS 7108 - Population Health Informatics (2.0 cr)

Required Biostatistics Coursework (8 credits)

Take the following two courses:

PUBH 6450 - Biostatistics I (4.0 cr)
PUBH 6451 - Biostatistics II (4.0 cr)

Elective Coursework (9 credits)

Select at least 9 elective credits, in consultation with the APC, to complete the 46 course credits required for the PhD degree.

Data Science and Informatics for Learning Health Systems

The Data Science and Informatics for Learning Health Systems track builds on the highly regarded data science program offered jointly by the School of Engineering, School of Public Health, and School of Statistics. It also takes advantage of School of Nursing's breadth of nursing and health informatics courses. It requires students to fulfill the requirements of the Masters in Data Science program and use their elective courses to gain exposure to health sciences and health care in the form of a suite of required foundational courses: Foundations of Health Informatics I and Lab, Foundations of Translational Bioinformatics I and Lab and the US Health Care System offered by the Institute for Health Informatics. The MS capstone project will address a research question related to health sciences or healthcare. Specialization to the health care field intensifies at the PhD level by offering additional courses focusing on advanced analytics and its applications to healthcare. The thesis research will naturally relate to health science or healthcare.

Students who pursue the Data Science and Informatics for Learning Health Systems track are expected to earn the Universitys Data Science MS degree en route to completing the PhD. Students must consult with the APC to coordinate completion of coursework and other requirements for the Data Science MS, the Health Informatics PhD, and the Data Science and Informatics for Learning Health Systems track. Credits earned in the Universitys Data Science MS program may be used to fulfill required courses or elective credits in the Data Science and Informatics for Learning Health Systems track, subject to APC approval. Students who have an MS in Data Science from a comparable program may be exempt from this requirement in whole or in part, subject to APC review and approval.

Data Science and Informatics Coursework (32 credits)

Core Coursework (18 credits)

Take the following courses, in consultation with the APC, after completion of the Data Science MS degree.

HINF 5496 - Internship in Health Informatics (1.0 - 6.0 cr)
HINF 5510 - Applied Health Care Databases: Database Principles and Data Evaluation (3.0 cr)

HINF 5630 - Clinical Data Mining (3.0 cr)
HINF 8220 - Computational Causal Analytics (3.0 cr)
HINF 8492 - Advanced Readings or Research in Health Informatics (1.0 - 6.0 cr)

Elective Coursework (14 credits)

Select at least 14 elective credits from the following list, in consultation with the APC, to complete the 46 course credits required for the PhD degree. Credits earned in pursuit of the Data Science MS may be used to fulfill elective course requirements for this track, subject to APC approval.

Informatics

HINF 5431 - Foundations of Health Informatics II (3.0 cr)
HINF 8431 - Foundations of Health Informatics II Lab (2.0 cr)
HINF 5610 - Foundations of Biomedical Natural Language Processing (3.0 cr)
HINF 5620 - Data Visualization for the Health Sciences (3.0 cr)
MATH 5467 - Introduction to the Mathematics of Image and Data Analysis (4.0 cr)

Applications

NURS 7113 - Clinical Decision Support: Theory (2.0 cr)
PUBH 6102 - Issues in Environmental Health (2.0 cr)
PUBH 6560 - Operations Research and Quality in Health Care (3.0 cr)
PUBH 6717 - Decision Analysis for Health Care (2.0 cr)
PUBH 6751 - Principles of Management in Health Services Organizations (2.0 cr)
PUBH 6765 - Continuous Quality Improvement: Methods and Techniques (3.0 cr)
PUBH 6809 - Advanced Methods in Health Decision Science (3.0 cr)
PUBH 6814 *{Inactive}*(2.0 cr)
PUBH 6862 - Cost-Effectiveness Analysis in Health Care (3.0 cr)
PUBH 6876 *{Inactive}*(2.0 cr)

Advanced Methodology

PUBH 6341 - Epidemiologic Methods I (3.0 cr)
PUBH 8452 - Advanced Longitudinal Data Analysis (3.0 cr)
PUBH 8462 - Advanced Survival Analysis (3.0 cr)
PUBH 8472 - Spatial Biostatistics (3.0 cr)

Translational Bioinformatics

The Translational Bioinformatics track bridges genomics and bioinformatics to precision medicine through its methods and techniques development and innovation that directly relate to the study of basic biological science and diseases. The computational methods related to genomics, epigenomics, transcriptomics, proteomics, metabolomics and pharmacogenomcis are included, which build the connection of molecular findings and phenotypes to characterize disease susceptibility or determine disease markers, and predict response to treatment and prognosis. The program offers three specialized areas: structural and functional genomics, microbiomics and metagenomics, and cancer genomics.

Students pursuing the Translational Bioinformatics track are expected to earn the Health Informatics MS degree en route to completing the PhD. Students must consult with the APC to coordinate completion of coursework and other requirements for the Health Informatics MS, the Health Informatics PhD, and the Translational Bioinformatics track. Students who have an MS in Health Informatics from a comparable program may be exempt from this requirement in whole or in part, subject to APC review and approval.

Translational Bioinformatics Coursework (32 credits)

Phase 1 (22 credits)

Take the following courses for a total of 22 credits:
CSCI 5421 - Advanced Algorithms and Data Structures (3.0 cr)
CSCI 5525 - Machine Learning: Analysis and Methods (3.0 cr)
HINF 8220 - Computational Causal Analytics (3.0 cr)
HINF 5650 - Integrative Genomics and Computational Methods (3.0 cr)
STAT 8051 - Advanced Regression Techniques: linear, nonlinear and nonparametric methods (3.0 cr)
STAT 8052 - Applied Statistical Methods 2: Design of Experiments and Mixed -Effects Modeling (3.0 cr)
BIOC 8007 - Molecular Biology of the Genome (2.0 cr)
BIOC 8008 - Molecular Biology of the Transcriptome (2.0 cr)

Phase II (6 credits)

Take the following courses after competing Phase I, and with the approval of the APC:
HINF 5496 - Internship in Health Informatics (1.0 - 6.0 cr)
HINF 8492 - Advanced Readings or Research in Health Informatics (1.0 - 6.0 cr)

Elective Coursework (4 credits)

Select at least 4 elective credits from the following list, in consultation with the APC, to complete the 46 course credits required for the PhD degree.
HINF 5431 - Foundations of Health Informatics II (3.0 cr)
HINF 8431 - Foundations of Health Informatics II Lab (2.0 cr)
HINF 5450 - Foundations of Precision Medicine Informatics (3.0 cr)
HINF 5610 - Foundations of Biomedical Natural Language Processing (3.0 cr)
MEDC 5245 - Introduction to Drug Design (3.0 cr)

PHAR 6224 - Advanced Pharmacogenomics and Precision Medicine (2.0 cr)
PUBH 7415 - Introduction to Clinical Trials (3.0 cr)
PUBH 7420 - Clinical Trials: Design, Implementation, and Analysis (3.0 cr)
PUBH 8445 - Statistics for Human Genetics and Molecular Biology (3.0 cr)
STAT 8053 - Applied Statistical Methods 3: Multivariate Analysis and Advanced Regression (3.0 cr)

Precision and Personalized Medicine Informatics

The Precision and Personalized Medicine Informatics track provides a didactic program for students training in informatics who will develop specialized knowledge in precision informatics methods applied to personal and population health-focused problems. The scope of this track includes social determinants of health and inter-professional research and expertise. Students will develop skills in quantitative methods and biomedical sciences for their application to precision medicine. In addition, students will gain an understanding of medical and biological science to provide needed context on which to apply informatics methods.

Students who pursue the Precision and Personalized Medicine Informatics track are expected to earn the Health Informatics MS degree en route to completing the PhD. Students must consult with the APC to coordinate completion of coursework and other requirements for the Health Informatics MS, the Health Informatics PhD, and the Precision and Personalized Medicine Informatics track. Students who have an MS in Health Informatics from a comparable program may be exempt from this requirement in whole or in part, subject to APC review and approval.

Precision and Personalized Medicine Informatics Coursework (32 credits)

Phase I (18 - 19 credits)

Take the following coursework for at least 18 credits.
HINF 5450 - Foundations of Precision Medicine Informatics (3.0 cr)
HINF 5510 - Applied Health Care Databases: Database Principles and Data Evaluation (3.0 cr)
HINF 5520 - Informatics Methods for Health Care Quality, Outcomes, and Patient Safety (2.0 cr)
HINF 8770 - Plan B Project (4.0 cr)
PUBH 7401 - Fundamentals of Biostatistical Inference (4.0 cr)
PUBH 7402 - Biostatistics Modeling and Methods (4.0 cr)
HINF 5531 - Health Data Analytics and Data Science (3.0 cr)
or HINF 5630 - Clinical Data Mining (3.0 cr)

Phase II (8 credits)

Take the following courses after completing Phase I, and with the approval of the APC.
HINF 5496 - Internship in Health Informatics (1.0 - 6.0 cr)
HINF 8492 - Advanced Readings or Research in Health Informatics (1.0 - 6.0 cr)
PHAR 6224 - Advanced Pharmacogenomics and Precision Medicine (2.0 cr)

Elective Coursework (5 -6 credits)

Select at least 5 elective credits, in consultation with the APC, to complete the 46 course credits required for the PhD degree.
HINF 5431 - Foundations of Health Informatics II (3.0 cr)
MATH 5652 - Introduction to Stochastic Processes (4.0 cr)
MATH 5445 - Mathematical Analysis of Biological Networks (4.0 cr)
PUBH 7430 - Statistical Methods for Correlated Data (3.0 cr)
PUBH 7440 - Introduction to Bayesian Analysis (3.0 cr)
PUBH 7445 - Statistics for Human Genetics and Molecular Biology (3.0 cr)
PUBH 8432 - Probability Models for Biostatistics (3.0 cr)
PUBH 8442 - Bayesian Decision Theory and Data Analysis (3.0 cr)
PUBH 8445 - Statistics for Human Genetics and Molecular Biology (3.0 cr)
PUBH 8446 - Advanced Statistical Genetics and Genomics (3.0 cr)
STAT 5511 - Time Series Analysis (3.0 cr)
STAT 5401 - Applied Multivariate Methods (3.0 cr)