

BIOMEDICAL AND HEALTH INFORMATICS, PHD

The PhD in Biomedical and Health Informatics is an interdisciplinary doctoral program offered by UWM through collaboration between several academic units at UWM and the Medical College of Wisconsin. The Program is housed in the UWM Department of Electrical Engineering and Computer Science. It is guided by a Steering Committee consisting of faculty from the academic units participating in the Program.

Biomedical and health informatics is a field that is concerned with the cognitive, information processing, and communication aspects of medicine and healthcare including the information sciences and technology to support these tasks. The field covers the application of information technology in clinical medicine, medical record keeping, medical instrumentation, and healthcare management.

The main goal of the PhD program is to prepare graduates to perform advanced research in the discipline and to assume leadership roles in medical and healthcare industries. The degree is philosophically conceptualized as involving several disciplines in a collaborative learning process with the goal of fostering inter-professional interactions and inquiry. This degree will build upon existing graduate programs and research in the participating units. Qualified students with strong academic records in any of these programs will be considered for admission.

Other participating units:

- College of Health Sciences
- College of Nursing
- Lubar School of Business
- School of Information Studies
- Zilber School of Public Health
- The Medical College of Wisconsin

Requirements

Admission Requirements

Application Deadlines

Application deadlines vary by program, please review the application deadline chart (<http://uwm.edu/graduateschool/program-deadlines/>) for specific programs. Other important dates and deadlines can be found by using the One Stop calendars (<https://uwm.edu/onestop/dates-and-deadlines/>).

Admission

An applicant must meet the UWM Graduate School requirements as well as the following to be considered for admission to the program:

Master's degree in biomedical and health informatics or a related area such as Computer Science, Electrical Engineering, Health Sciences, Business Administration, Nursing; or an MD degree. Exceptionally strong candidates with Bachelor's degree in a related area will also be considered for admission.

1. At least two letters of recommendation that attest to academic and/or professional qualifications.

2. Scores from the GRE (general) or GMAT or MCAT (test taken within the last five years.)
3. Reason statement explaining reasons for graduate study, specific interests, and background.

For applicants who intend to satisfy the English proficiency requirement by submission of test scores, a score of at least 79 on the computer-based Test of English as a Foreign Language (TOEFL) IBT is required. A score of 6.5 on the international English Language Testing Systems (IELTS) examination will be required in lieu of the TOEFL.

Requests for financial support must also be submitted below:

Co Director
Biomedical and Health Informatics Program
College of Engineering and Applied Science
University of Wisconsin-Milwaukee
Milwaukee, WI 53201

Areas of Concentration

The PhD program requires a student to follow one of the following six areas of concentration. (At the time of application, each applicant should indicate a preferred area of concentration in their statement of Reasons for Graduate Study.)

Translational Bioinformatics Track

The track in Translational Bioinformatics centers on driving the flow of knowledge from "bench to bedside", bridging the gap between basic and clinical informatics research. This discipline has applications to drug development, genetics research, and the use of animal models to develop new understandings or treatments, which has implications both to basic science and to commercialization.

Knowledge Based Systems Track

The Knowledge Based Systems track is designed to train students in the development of techniques to support decision-making in medical practice (including both clinical and administrative decision-making) and customized instruction on health and medical topics for patients and health care providers. Technical areas include decision analysis, expected utility theory and cost-effectiveness analysis, computer-based decision support systems, user modeling and user interface design, intelligent tutoring systems, knowledge representation, structured reporting, and data mining and knowledge discovery.

Health Services Management & Policy Track

Health services management and policy research is broad in scope and touches on all of the standard functional business areas (e.g., management, strategy and marketing, finance/economics, management information systems, human resources management) in addition to government health policy/reimbursement/regulation, insurance and other payer mechanisms, dealing with health professionals, and illness/health in individuals and in populations. The track is designed to equip students to deal with both management information and with population health and illness information and research to understand the implications of such information and research, and to transform inferences from that information and research into practical recommendations on the national, state, and local level. By its nature, it is applied to health services settings including hospitals, skilled-nursing facilities, medical group practices, public health agencies, mental health services, managed care organizations, and integrated health networks.

Health Information Systems Track

The track in Health Information Systems is designed to explore the role of administrative and clinical information systems in health care organizations. Attention will be directed at the design, implementation, and maintenance of the broad array of computer applications used in the health care industry. An interdisciplinary approach will be taken drawing on expertise from the health professions, management information systems, and library and information science. Curricular content will range from systems analysis and design, system efficacy and management, to e-commerce.

Medical Imaging and Instrumentation Track

The track in Medical Imaging and Instrumentation is designed to train students in understanding and developing medical imaging systems and medical electronic instrumentation. The aspects emphasized in this track are medical imaging systems, image processing, computer vision, pattern recognition, medical instrumentation development and optimization, computer modeling, applications of electric and magnetic fields, and wireless communication.

Public Health Informatics Track

The Public Health Informatics track is designed to train students in the development of techniques, methods and tools to conduct public health research and to provide public health programs and tools for practical use. Graduates of this track will also be able to provide customized instruction on public health and related biomedical topics for public health workers, the public and others such as those in public health policy who will benefit from public health informatics. Technical areas include databases, tools and techniques for acquiring, processing, warehousing, and analyzing public health data. Other areas of expertise include utility theory and cost-effectiveness analysis, computer-based decision support systems, user modeling and user interface design, intelligent tutoring systems, structured reporting, and data mining.

Credits and Courses

Students enrolled in this program must follow all UWM Graduate School requirements and regulations. The minimum requirement for the Ph.D. in Biomedical and Health Informatics will be 58-63 credits beyond the bachelor's degree. Up to 24 credits from a related master's degree may be applied toward the Ph.D.

The curriculum will consist of a common set of core courses for all tracks, required and elective courses for each individual track, and the dissertation. The purpose of the core is to ensure that all graduates of the program share a basic common knowledge in biomedical and health informatics. The purpose of the tracks is to enable the students to develop significant strengths in specific sub-areas within biomedical and health informatics. The courses identified in the curriculum are offered by UWM or MCW and, in some case, by both institutions. Following are descriptions of these components and their corresponding credit requirements.

Core Courses

The core courses provide a comprehensive structure for the foundations needed for all students in biomedical and health informatics irrespective of their special interests. This includes a series of seminars that deal with different aspects of biomedical and health informatics. All students must take the following core courses or must have taken equivalent courses in previous study.

Code	Title	Credits
Core Courses		
Select one of the following:		2-3
MCW 13200(A,B)	Medical Informatics, 6 quarter cr	
HI 700	Introduction to Health Care Informatics	
Select one of the following:		3
BMS 701	Human Pathophysiology I	
HCA XXX	Physiology and Disease Informatics	
Select the following for four 1-credit semesters		4
COMPSCI 870	Medical Informatics Seminar (or at MCW)	
COMPSCI 557	Introduction to Database Systems	3
or BUS ADM 749	Data and Information Management	
Select one of the following:		1-3
HI 722	Legal, Ethical and Social Issues in Health Care Informatics	
MCW 12202	Medical Ethics (1cr)	
MCW 10222	Ethics and Integrity in Science (1cr)	
Total Credits		13-16

Knowledge Based Systems Track

Code	Title	Credits
Required		
COMPSCI 535	Algorithm Design and Analysis	3
COMPSCI 710	Artificial Intelligence	3
or HI 742	Computational Intelligence in Health Informatics	
BUS ADM 741	Web Mining and Analytics	3
or COMPSCI 425	Introduction to Data Mining	
COMPSCI 743	Intelligent User Interfaces	3
or COMPSCI 747	Principles & Practices of User Interface Design	

Required Mathematics & Quantitative Methods

<i>Statistics</i>		
Select one of the following:		3
BUS ADM 795	Seminar-in-Management:	
BUS ADM 995	Doctoral Seminar in Decision Sciences:	
ED PSY 624	Statistical Methods for Professionals and Practitioners I	
MTHSTAT 871	Mathematical Statistics I	
<i>Probability</i>		
ECON 413	Statistics for Economists	3
or MATH 883	Theory of Probability	

Track Electives

<i>Computing and Applications</i>		
Select 12-15 credits with approval of advisor and steering committee		12-15
<i>Quantitative Analysis</i>		
Select up to 6 credits with approval of advisor and steering committee		6
Dissertation		
Select 12 credits from the following (use course from program of major advisor):		12
BUS ADM 997	Doctoral Dissertation	
COMPSCI 998	Doctoral Thesis	

ELECENG 998	Doctoral Thesis
HI 890	Health Care Informatics Research and Thesis
INFOST 998	Doctoral Dissertation
NURS 997	Doctoral Dissertation
PH 990	Research and Dissertation

Total Credits **48-51**

Health Services Management & Policy Track

Code	Title	Credits
Required		
BUS ADM 755	Health Care Administration and Delivery Systems	3
BUS ADM 757	Managed Care and Integrated Health Networks	3
BUS ADM 744	Information Technology Strategy and Management	3
BUSMGMT 720	Strategic Management in Health Care Organizations	3
BUSMGMT 727	Health Care Accounting, Law and Ethics	3
BUS ADM 990	Doctoral Seminar in Strategic Management:	3
BUS ADM 996	Doctoral Seminar in Organizations:	3

Required Mathematics & Quantitative Methods

BUS ADM 918	Doctoral Seminar in Behavioral Research Methods in Management	3
Select one of the following:		3

BUS ADM 714	Multivariate Techniques in Management Research
ECON 513	Introduction to Econometrics
ED PSY 624	Statistical Methods for Professionals and Practitioners I
ECON 710	Applied Econometrics

Track Electives

Select 9 credits with approval of advisor and steering committee 9

Dissertation

Select 12 credits from the following (use course from program of major advisor): 12

BUS ADM 997	Doctoral Dissertation
COMPSCI 998	Doctoral Thesis
ELECENG 998	Doctoral Thesis
HI 890	Health Care Informatics Research and Thesis
INFOST 998	Doctoral Dissertation
NURS 997	Doctoral Dissertation
PH 990	Research and Dissertation

Total Credits **48**

Health Information Systems Track

Code	Title	Credits
Required		
BUS ADM 744	Information Technology Strategy and Management	3
BUS ADM 747	Service-Oriented Analysis and Design	3
BUS ADM 817	Connected Systems for Business	3

or COMPSCI 759	Data Security	
COMPSCI 720	Computational Models of Decision Making	3
HI 721	Health Information Technology Procurement	3
HI 723	Health Care Systems Applications - Administrative and Clinical	3
or HI 760	Biomedical and Healthcare Terminology and Ontology	

Research Methods

Select one of the following: 3

IND ENG 716	Engineering Statistical Analysis
BUS ADM 714	Multivariate Techniques in Management Research
BUS ADM 918	Doctoral Seminar in Behavioral Research Methods in Management
BUS ADM 991	MIS Doctoral Seminar II: (Subtitled)
NURS 882	Qualitative Methods in Health Research
NURS 883	Quantitative Methods in Health Research

Track Electives

Select 12 credits with approval of advisor and steering committee 12

Dissertation

Select 12 credits from the following (use course from program of major advisor): 12

BUS ADM 997	Doctoral Dissertation
COMPSCI 998	Doctoral Thesis
ELECENG 998	Doctoral Thesis
HI 890	Health Care Informatics Research and Thesis
INFOST 998	Doctoral Dissertation
NURS 997	Doctoral Dissertation
PH 990	Research and Dissertation

Total Credits **45**

Medical Imaging & Instrumentation Track

Code	Title	Credits
Required		
ELECENG 436	Introduction to Medical Instrumentation	3
ELECENG 437	Introduction to Biomedical Imaging	3
ELECENG 439	Introduction to Biomedical Optics	3
ELECENG/COMPSCI 712	Image Processing	3
or ELECENG 716	Tomography: Imaging and Image Reconstruction	
ELECENG 737	Medical Imaging Signals and Systems	3
or ELECENG 765	Introduction to Fourier Optics and Optical Signal Processing	

Track Electives

Select 21 credits with approval of advisor and steering committee 21

Dissertation

Select 12 credits from the following (use course from program of major advisor): 12

BUS ADM 997	Doctoral Dissertation
COMPSCI 998	Doctoral Thesis

ELECENG 998	Doctoral Thesis
HI 890	Health Care Informatics Research and Thesis
INFOST 998	Doctoral Dissertation
NURS 997	Doctoral Dissertation
PH 990	Research and Dissertation

Total Credits **48**

Public Health Informatics Track

Code	Title	Credits
Required		
PH 701	Public Health Principles and Practice	3
PH 704	Principles and Methods of Epidemiology	3
PH 709		3
COMPSCI 535	Algorithm Design and Analysis	3
Required Statistics & Quantitative Methods		
PH 702	Introduction to Biostatistics	3
PH XXX	Seminar in Biostatistics and Bioinformatics	1
PH 713		3
PH XXX	Data Management, Visualization, and Advanced Statistical Computing	3

Track Electives

Computing and Applications

Select 6 credits with approval of advisor and steering committee 6

Quantitative Analysis

Select 6 credits with approval of advisor and steering committee 6

Dissertation

Select 12 credits from the following (use course from program of major advisor): 12

BUS ADM 997	Doctoral Dissertation
COMPSCI 998	Doctoral Thesis
ELECENG 998	Doctoral Thesis
HI 890	Health Care Informatics Research and Thesis
INFOST 998	Doctoral Dissertation
NURS 997	Doctoral Dissertation
PH 990	Research and Dissertation

Total Credits **46**

Translational Bioinformatics Track

Code	Title	Credits
Required		
Select one of the following:		2-3
BIO SCI 490	Molecular Genetics	
MCW 20240	Translational Genetics, 2 cr	
Select one of the following:		3
PH XXX	Introduction to Bioinformatics, 3 cr	
MCW 17201	Bioinformatics I: Introduction to Bioinformatics, 3 cr	
MARQ BIIN 6000	Introduction to Bioinformatics. 3 cr	
MARQ BIOL 5201	Genomics and Bioinformatics, 3 cr	
Select one of the following:		2-3

PH XXX	Translational Bioinformatics, 3 cr
Or both of the following:	

MCW 20100	Introduction to Clinical and Translational Research, 1 cr
and MCW 20261	Clinical Trial Design, 1 cr

Select one of the following: 3

COMPSCI 425	Introduction to Data Mining
ELECENG/COMPSCI 711	Introduction to Machine Learning
BUS ADM 741	Web Mining and Analytics
MARQ ENMA 6060	Innovation and Technology, 3cr

Select one of the following: 3

HI 760	Biomedical and Healthcare Terminology and Ontology
BUS ADM 814	Enterprise Knowledge & Semantic Management
COMPSCI 810	Knowledge Representation
InfoSt 714	Metadata, 3cr

Select one of the following: 2-3

HI 723	Health Care Systems Applications - Administrative and Clinical
MCW 14230	Product Development of Medical Devices, 2 cr

Quantitative Methods

Select 9 credits from the following: 9

NURS 883	Quantitative Methods in Health Research
MATH 883	Theory of Probability
PH 702	Introduction to Biostatistics
PH XXX	Statistical Genetics and Genetic Epidemiology, 3cr
PH XXX	Applied Quantitative Methods for Studying Population Health and Health Disparities, 3 cr

Select a maximum of one of the following:

MCW 11200	Introduction to Epidemiology, 3 cr
PH 704	Principles and Methods of Epidemiology

Select a maximum of one of the following:

PH 711	Intermediate Biostatistics
MCW 04201	Biostatistics II, 3cr

Track Electives

Select 9 credits with approval of advisor and steering committee 9

Dissertation

Select 12 credits from the following (use course from program of major advisor): 12

BUS ADM 997	Doctoral Dissertation
COMPSCI 998	Doctoral Thesis
ELECENG 998	Doctoral Thesis
HI 890	Health Care Informatics Research and Thesis
INFOST 998	Doctoral Dissertation
NURS 997	Doctoral Dissertation

Additional Requirements

Major Professor as Advisor

The Graduate School requires that the student have a major professor to advise, supervise and approve the program of study before registering for courses. The Biomedical and Health Informatics Steering Committee will assign the incoming student to a temporary Program Advisor at the time of admission. Prior to the completion of 12 credit (9 credits for a part-time student), the student must select a major professor who will be the student's dissertation advisor. The student, in consultation with the major professor, develops a program of study which is submitted to the Biomedical and Health Informatics Steering Committee for approval. For subsequent changes, the student must file a revised program of study for approval.

Doctoral Program Committee

The Doctoral Program Committee is proposed by the Major Professor in consultation with the student by the end of the student's first year of enrollment. The Program Committee, subject to the approval of the Biomedical and Health Informatics Steering Committee, shall consist of the Major Professor and at least four graduate faculty members, including at least one with health care and/or medical background, and one with informatics background.

Residence

The student must meet Graduate School residence requirements.

Qualifying Examination

A qualifying examination must be taken to determine whether the student is qualified to perform advanced doctoral level work in biomedical and health informatics. This examination is administered by the steering committee and must be taken prior to the completion of 21 credits of coursework in the program.

Doctoral Preliminary Examination

The student is also required to take a preliminary examination after all the coursework is completed and prior to the advancement of candidacy to determine the student's preparation for independent research. Prior to the examination, the student must present a proposal for a doctoral dissertation. The preliminary examination may cover both graduate course material and the dissertation proposal. The preliminary examination must be successfully completed within five years of initial enrollment.

Dissertation

The candidate must complete a dissertation presenting independent original research that adds to the existing body of knowledge in biomedical and health informatics. It should be of such caliber that warrants publication in respected journals.

Dissertation Defense

The final oral examination will be an oral defense of the dissertation but may also cover the general field of the primary area of study. The examination may not be taken until all other degree requirements are satisfied. A majority of the examination committee members must approve the dissertation in order for the student to pass. The final oral examination must be taken within five years after passing the preliminary examination. Candidates who exceed this time limit may be required

to retake the preliminary examination and be admitted to candidacy a second time.

Time Limit

All components of the PhD program must be completed within 10 years of matriculation.

Biomedical and Health Informatics PhD Learning Outcomes

Students graduating from the Biomedical and Health Informatics PhD Program will be able to:

1. Apply advanced knowledge of biomedical and health informatics, including data and information management.
2. Conduct informatics research that demonstrates academic, professional, and ethical responsibility.
3. Apply advanced knowledge of mathematics and statistics to analyze and interpret complex data.
4. Develop, study, and apply advanced theories, methods and processes for the generation, storage, retrieval, use, and sharing of biomedical data, information, and knowledge.
5. Identify, formulate, and solve complex biomedical and health information problems and conduct research that makes an original contribution to the field.
6. Communicate their research effectively via scholarly writing and oral presentations.
7. Contribute to enhancing local or global economic development or quality of life through biomedical and health informatics.

All outcomes are assessed by the doctoral committee at the Preliminary Exam (a defense of a dissertation proposal) and at the defense of the dissertation itself, using a rubric form, using a scale of one to five, where 1-doesn't meet expectations, 3-meets expectations, and 5-exceeds expectations.