

# 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.)

For applicants who intend to satisfy the English proficiency requirement by submission of test scores, a score of at least 250 on the computer-based (or 600 on the paper-based) Test of English as a Foreign Language (TOEFL) 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
Select one of the following:		2
MCW 13200(A,B)	Medical Informatics, 6 quarter cr	
HCA 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
HCA 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		13-15

### Knowledge Based Systems Track

Code	Title	Credits
<b>Required</b>		
COMPSCI 535	Algorithm Design and Analysis	3
COMPSCI 710	Artificial Intelligence	3
or HCA 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	Educational Statistical Methods I	
IND ENG/OCCTHPY 786	Applied Biostatistics in Ergonomics	
MTHSTAT 761	Mathematical Statistics I	

### *Probability*

ECON 413	Statistics for Economists	3
or MATH 771	Theory of Probability	

### Track Electives

#### *Computing and Applications*

Select 12-15 credits with approval of advisor and steering committee	12-15
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#### *Quantitative Analysis*

Select up to 6 credits with approval of advisor and steering committee	6
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### 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	
HCA 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
<b>Required</b>		
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:		
BUS ADM 714	Multivariate Techniques in Management Research	3
ECON 513	Introduction to Econometrics	
ED PSY 624	Educational Statistical Methods 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	
HCA 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
<b>Required</b>		
BUS ADM 744	Information Technology Strategy and Management	3
BUS ADM 747	Service-Oriented Analysis and Design	3
BUS ADM 817	Infrastructure for Information Systems	3
or COMPSCI 759	Data Security	
COMPSCI 720	Computational Models of Decision Making	3
HCA 721	Health Information Technology Procurement	3

HCA 723	Health Care Systems Applications - Administrative and Clinical	3
or HCA 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	
HCA 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
<b>Required</b>		
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	
HCA 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
<b>Required</b>		
PH 701	Public Health Principles and Practice	3
PH 704	Principles and Methods of Epidemiology	3
PH 709	Public Health Informatics	3
COMPSCI 535	Algorithm Design and Analysis	3
<b>Required Statistics &amp; Quantitative Methods</b>		
PH 702	Introduction to Biostatistics	3
PH XXX	Seminar in Biostatistics and Bioinformatics	1
PH 713	Analyzing Observational and Experimental Data	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	
HCA 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
<b>Required</b>		
Select one of the following:		2-3
BIO SCI 490	Molecular Genetics	
BIO SCI 597	RNA Structure, Function, and Metabolism	
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
HCA 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
HCA 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 771	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:

NURS 727	Epidemiology	
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	
HCA 890	Health Care Informatics Research and Thesis	
INFOST 998	Doctoral Dissertation	
NURS 997	Doctoral Dissertation	

PH 990	Research and Dissertation
Total Credits	45-48

**Time Limit**

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

## Program 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.