



Master of Biomedical Informatics (MBMI)

Student Handbook

MBMI Program Contacts

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Introduction

The Master of Biomedical Informatics (MBMI) program serves the needs of Penn Medicine by training the next generation of clinical informaticians. These are individuals who seek to leverage their background and practice as professional clinicians to bring state-of-the-art informatics theory and practice to the clinical setting. As a result, the program is dedicated to training applied clinical informaticians, rather than informatics researchers.

Program Learning Objectives

Our program's objectives are drawn from the key competencies identified by the American Medical Informatics Association's 2017 guidelines, which identify the skills and knowledge that informatics practitioners need to set themselves apart in a rapidly developing field. By graduation, students should be able to:

1. Identify the applicable information science and technology concepts, methods, and tools, which may be dependent upon the application area of the training program, to solve health informatics problems.
2. Identify and draw on the social, behavioral, legal, psychological, management, cognitive, and economic theories, methods, and models applicable to health informatics to design, implement, and evaluate health informatics solutions.
3. Identify possible biomedical and health information science and technology methods and tools for solving a specific biomedical and health information problem. Design a solution to a biomedical or health information problem by applying computational and systems thinking, information science, and technology.
4. Define and discuss the scope of practice and roles of different health professionals and stakeholders including patients, as well as the principles of team science and team dynamics to solve complex health and health information problems.

Academic Program

The MBMI curriculum consists of 10 course units (CUs), which include required courses, electives, and a capstone project. Students are also required to complete the online HIPPA and CITI training modules required of all PSOM students.

The 10 CUs in the MBMI program are divided as follows:

A. 4CUs in "Core BMI" (common courses across IBI programs):

- **BMIN 501: Introduction to Biomedical Informatics (Fall)** This course is designed to provide a survey of the major topics areas in medical informatics, especially as they apply to clinical research. Through a series of lectures and demonstrations, students will learn about topics such as databases, natural language, clinical information systems, networks, artificial intelligence and machine learning applications, decision support, imaging and graphics, and the use of computers in education.
- **BMIN 502: Databases for Biomedical Informatics (Spring)** This course is intended to provide in-depth, practical exposure to the design, implementation, and use of databases in biomedical research. This course is intended to provide students with the skills needed to design and conduct a research project using primary and secondary data. Topics to be covered include: database architectures, data modeling approaches, data normalization, database implementation, client-

server databases, concurrency, validation, Structured-Query Language (SQL) programming, reporting, maintenance, and security. All examples will use problems or data from biomedical domains. MySQL will be used as the database platform for the course, although the principles apply generally to biomedical research and other relational databases.

- **BMIN 503: Data Science (Fall)** This course will use R and other freely available software to learn fundamental data science applied to a range of biomedical informatics topics, including those making use of health and genomic data. After completing this course, students will be able to retrieve and clean data, perform exploratory analyses, build models to answer scientific questions, and present visually appealing results to accompany data analyses; be familiar with various biomedical data types and resources related to them; and know how to create reproducible and easily shareable results with R and github.
- **BMIN 504: Special Topics in Biomedical Informatics (Spring)** This course is designed to provide an in-depth look at four topics that are of essential importance in biomedical informatics. Each topic will be allotted four consecutive weeks in the class schedule, as four modules, with the intention that each module becomes its own “mini-course”. The topics for each module may rotate from semester to semester, based on these criteria: historical importance to the current field of biomedical informatics research and/or practice; cutting-edge developments in biomedical informatics; topics not covered in depth in BMIN 501; and consensus of the program leadership and teaching faculty.

B. 3CUs in “Core Clinical Informatics”:

- **HPR 611: Implementation Science (Spring)** In this course, we will highlight a suite of qualitative, quantitative and mixed research methods that address the features of implementation science. The course will include an introduction to the foundational aspects of implementation science, followed by guest speakers who describe their implementation science research. The structure of the course will focus on 3 successive stages-(1) introduction to the foundation/theory of implementation science, (2) exposure to researchers conducting implementation research, and (3) and learning how to critically evaluate and design implementation science studies. An emphasis on specific tools in qualitative and mixed methods approaches is included.
- **BMIN 505: Precision Medicine in Health Policy (Spring)** This course is designed to provide an in-depth exploration in various health policy implications of informatics research and ways to incorporate precision medicine science into the healthcare system using informatics. The course will be divided into four modules. The first will cover topics regarding hospital performance, comparing hospitals with each other using standardized metrics and algorithms, quality-of-care assessments and will engage students to learn ways to improve on the current standards using informatics approaches. The second module will focus on understanding biases in the current clinical practice guidelines and informatics methods designed to assess these biases and improve guidelines for the future. We will touch on topics such as ethnicity bias: e.g., many medications were not tested on diverse populations and this could have important implications for members of those populations; gender bias: e.g., many laboratory value ‘normals’ are not gender-specific but were generated on male-only populations. The implications that these factors was/may have

in future will be discussed along with informatics solutions. The third module will focus on interpretation of genetic results, focusing on gene variants with known clinical implications. Several different types of genetic variants will be discussed (e.g., variant of uncertain significance, potentially deleterious, etc.) and their implications for the design of clinical decision support tools. The fourth module will center around the prenatal genetic testing space and the implications for patients, and providers regarding having detailed genetic information from prenatal through to birth and beyond. The implications this will have in the next decade of clinical science will be discussed along with health policy implications, and the role of clinical decision making in this space.

- **BMIN 506: Standards and Vocabularies** (Fall) This survey course is designed to provide an overview of health information standards and clinical terminologies. Through a series of lectures, demonstrations, and hands-on exercises, students will learn about topics such as standards, interoperability, data modeling, vocabularies, and health information exchange.
- **BMIN 507: Human Factors** (Fall) The course will cover five main topic areas: 1. usability, 2. evaluation and measurement of usability, 3. workflow, 4. user-centered design, 5. implementation, and 6. continuing improvement/optimization. Each topic area will incorporate principles, methods, and applications. In the principles section for each topic, the course will clearly define terminology related to the topic area (e.g., What is workflow?), review how key concepts relate to each other (e.g., relationship between human factors engineering and human-computer interaction), and examine the relevance of the topic area in Applied Clinical Informatics. The methodology section for each topic will address qualitative, quantitative, and computational methods used for the design, implementation, and evaluation of health information technology. The applications section for each topic will use case studies based in the topic area to examine the real-world application of principles and methods. The course will cover a wide range of contexts, from homes/communities to organizations to a broader regional scale.

C. 2CUs of electives (further expertise in clinical informatics methods or issues)

Possible electives include, but are not limited to:

- Systems Thinking in Patient Safety (HPR 650)
- Longitudinal and Clustered Data (EPID 621)
- Decision Models and Uncertainty (OIDD 621)
- Data visualization and interaction design (CIS 560)
- Data ethics, IP, and privacy (LAW 506)
- Data mining (ESE 545)
- Medical Devices (HCMG 853)
- Comparative Health Care Systems (HCMG 859)
- Introduction to Bioinformatics (GCB 535)
- Decision Support Systems (OPIM 672)
- E-Health: Business Models and Impact (HCMG 866)
- Process Improvement Tools and Strategies (DYNM 634)

- Qualitative Methods Research (HPR 503)
- Clinical Economics and Decision Making (HPR 550)
- Principles and Practice of Quality Improvement and Patient Safety (HPR 504)
- Impact Evaluation (PUBH 54)
- Health Communication in the Digital Age (PUBH 565)
- Organizational Project Management (DYNM 619)
- Introduction to Machine Learning (CIS 519)
- Big Data Analytics (CIS 545)

D. 1 CU Capstone Project (formal, mentored practicum)

- BMIN 990: Capstone

Capstone Projects

General description

The MBMI program requires that students engage in a mentored Capstone Project in clinical informatics. This is accomplished in the context of a weekly seminar in which students develop, propose, implement, and present their capstone project. During the semester, students meet with their Capstone Advisor, who is also invited to attend the seminars. The seminar affords both students and advisors the opportunity for cross-fertilization of ideas and skills, and ultimately the honing of projects to a high level of value for the students and the clinical environments in which they conduct their projects.

Capstone Advisors

Each project is supervised by an IBI Senior Fellow, selected by the student and vetted by the Advising Committee. The Capstone Advisor will be selected for expertise in the topic being addressed. Additional individuals with expertise relating to the student's project can join the advisory team as needed. The Capstone Advisor will be responsible for ensuring a high degree of quality of the project and the student's work thereupon. The Capstone Advisor will be responsible for guiding and evaluating the student's progress throughout the semester, and for submitting the final evaluation and grade.

Capstone projects

Capstone projects may align with the day-to-day responsibilities of the student's employment or may be in a new area of interest. Projects should be completed in the course of a 15-week semester. Sample projects could include:

1. Design, implementation, and evaluation of a clinical decision rule
2. A workflow analysis pertinent to a given clinical environment
3. Evaluation of a feature or set of features of an existing clinical information system
4. Development and evaluation of a training program for new users of a clinical information system
5. Assessment of clinical information system adoption by health professionals
6. Design, implementation, and evaluation of a novel feature in a patient portal system
7. Development and evaluation of a program for improving patient engagement in using patient portals
8. Design and evaluate a clinical process improvement

Deliverables

The capstone will culminate in the preparation of a written final report and a poster presentation at the annual Informatics Day. All projects should include a thorough critical review of pertinent literature; a statement of the problem or research question; a clearly articulated statement of the goal(s) of the project; a description of the aims proposed to address the goal(s), the methods used to address the aims, the results, a discussion of the results; and a conclusion and description of future directions. Two IBI Senior Fellows will evaluate the capstone project presentation and provide oral and written feedback to the student and Capstone Advisor.

Informatics Day

MBMI students are expected to participate in the annual Informatics Day, organized by the Institute for Biomedical Informatics. This day-long symposium includes a keynote lecture by an invited speaker, short talks by informaticians from the Penn and CHOP communities, and a poster session during which students will present their capstone projects for evaluation.

Sample Schedules

We expect most students to complete the program over the course of 2-3 years, but highly-motivated students may complete the program in 3 semesters. Some possible course plans are given below.

Full time:

	Fall	Spring	Summer
Year 1	BMIN 501: Intro to BMI	BMIN 502: Databases	Elective
	BMIN 503: Data Science	BMIN 505: Precision Medicine in Health Policy	Capstone Project
	BMIN 506: Human Factors (.5 CU)	HPR 611: Implementation Science	
	BMIN 507: Standards and Vocabularies (.5 CU)	BMIN 504: Special Topics in BMI	
	Elective		

Part time:

	Fall	Spring
Year 1	BMIN 501: Intro to BMI	BMIN 502: Databases
	BMIN 503: Data Science	BMIN 505: Precision Medicine in Health Policy
		Elective
Year 2	BMIN 506: Standards and Vocabularies (.5 CU)	HPR 611: Implementation Science
	BMIN 507: Human Factors (.5 CU)	BMIN 504: Special Topics in BMI
	Elective	Capstone Project

MBMI Policies

Grading

The grading system is as follows: A, excellent; B, good; C, fair; D, poor; and F, failure. At the MBMI graduate level, the grade of C, while passing, does not constitute satisfactory performance. Letter grades may be modified by a plus (+) or minus (-) sign at the discretion of the course director. The minimum standard for satisfactory work in each course is a B-, and students must maintain a cumulative GPA of 3.0 to remain in good standing. The MBMI degree program additionally requires that the quality of the students work and their conduct in the program is of an appropriate professional quality to ensure advancement. Failure to meet these requirements may result in a student being placed on probation and/or require a student to withdraw despite a satisfactory grade average.

The grade "I" is used to designate "incomplete." A student who fails to complete a course and does not withdraw or change his/her status to auditor within the prescribed period shall receive at the instructor's discretion either a grade of I (incomplete) or F (failure). It is expected, in general, that a student shall complete the work of a course during the term in which that course is taken. The instructor **may permit an extension of time up to one year for the completion** of the course. In such cases, any course which is still incomplete after one calendar year from its official ending must remain as "incomplete" on the student's record and shall not be credited toward a degree.

Academic Standing

The MBMI degree program has specific academic standards that are expected of all students. If a student fails to obtain a passing grade (B-or higher) for a required course he/she will be placed on academic probation. Students may continue to enroll in other courses while on probation with the permission of the MBMI Program Director and input from the course director, as needed. The student must make arrangements retake, or take an approved equivalent of, any course in which they receive a grade lower than a B-. A cumulative GPA lower than 3.0 will also result in academic probation. Arrangements for remediation must be approved by the Program Director with input from the Advising Committee as needed.

Any student who receives an unacceptable grade in a course for the second time or fails to meet the remediation plan will be dismissed and will not be eligible for re-admission. The status of any student who is or has previously been on probation and who receives an unacceptable grade for an additional course will be reviewed by the Advising Committee and the Program Director. The committee is authorized to dismiss the student or allow the student to remain in the program on a probationary status.

Any student who exhibits unprofessional behavior as determined by the programmatic leadership will be evaluated for probation. Continued unprofessional behavior will be grounds for removal from the program.

Academic Grievances

Students who have a concern about a matter related to the MBMI program, whether it concerns a course, instructor, or mentorship, are encouraged to come to the MBMI Program Office (D204 Richards Building) to discuss their concern. Alternatively, the student may wish to speak directly with their Capstone Mentor, the MBMI Executive Committee, and/or the Program Director. Serious problems or concerns may be referred to the Penn Medicine Masters and Certificate Programs Office.

Transfer Credit Policy

Ten course units including completion of one capstone project credit are required for the MBMI degree. MBMI students may request to transfer credit for graduate level courses completed at other schools within the

University or from an external accredited program. All transfer of credit requests will be considered on a case by case basis.

Transfer credit may not be applied to the Capstone Project. Courses taken on a pass/fail basis will not be considered for transfer credit. Only courses in which the student received a grade of "B" (3.0) or higher will be considered for transfer credit. No course may be counted toward degree requirements if it has been used toward the requirements for more than one other degree.

Requests for transfer credit should be submitted to the Program Director together with a course syllabus for the course under consideration. The director will request a review of the course by an MBMI faculty member in that content area for its appropriateness for transfer credit.

Students may request substitution of a core course with a more advanced course in that content area. The process for substitution is the same as that for transfer credit.

Audit Policy

Students who wish to audit a course are expected to designate the audit at the time of registration. It is important to note that students who audit a course must pay tuition, but they will not receive credit towards their degree. If a student wishes to change a course status from credit to audit, they must obtain permission from the course instructor *before* the "drop/add" period ends. The audited course will appear on the transcript with the grade of "AUD" and no credit will be earned toward graduation. Students are not permitted to change the course status from graded to audit after the course has ended.

Student Conduct

MBMI students must comply with the University's Code of Student Conduct and other University policies related to student conduct that appears in *The PennBook: Resources, Policies and Procedures Handbook*. These include, but are not limited to, policies on sexual harassment, acquaintance rape and sexual violence, appropriate use of electronic resources, open expression, and drug and alcohol usage. Students are also expected to abide by the policies adopted by PMCP as well as University Policies relevant to Graduate Education. Further information regarding University policies can be found in the Pennbook at <https://catalog.upenn.edu/pennbook/>.

Any student who exhibits unprofessional behavior as determined by program leadership will be evaluated for probation. Continued unprofessional behavior will be grounds for removal from the program.

Code of Academic Integrity

The most fundamental value of any academic community is intellectual honesty; accordingly, all academic communities rely upon the integrity of each and every member. Students are responsible not only for adhering to the highest standards of truth and honesty but also for upholding the principles and spirit of the Academic Code. Violations of the Code include but are not limited to the following acts:

A. *Cheating*: using or attempting to use unauthorized assistance, material or study aids in examinations or any other academic work, or preventing, or attempting to prevent another from using authorized assistance, material, or study aids. Example: using a cheat sheet in a quiz or exam, altering a graded exam and resubmitting it for a better grade, etc.

B. *Plagiarism*: using the ideas, data or language of another without specific and proper

acknowledgment. Example: copying another person's paper, article, or computer work and submitting it for an assignment, cloning someone else's ideas without attribution, failing to use quotation marks where appropriate, etc.

C. *Fabrication*: submitting contrived or altered information in any academic exercise. Example: making up data for an experiment, fudging data, citing nonexistent articles, contriving sources, etc.

D. *Multiple Submission*: submitting, without prior permission, any work submitted to fulfill another academic requirement.

E. *Misrepresentation of Academic Records*: misrepresenting or tampering with or attempting to tamper with any portion of one's own or any other person's transcripts or academic record, either before or after coming to the University of Pennsylvania. Example: forging a change of grade slip, tampering with computer records, falsifying academic information on one's resume, etc.

F. *Facilitating Academic Dishonesty*: knowingly helping or attempting to help another violate provisions of this Code. Example: working together on a take-home exam, etc.

G. *Unfair Advantage*: attempting to gain unauthorized advantage over fellow students in an academic exercise. Example: gaining or providing unauthorized access to examination materials, obstructing or interfering with another student's efforts in an academic exercise, lying about a need for an extension for an exam or paper, continuing to write even when time is up during an exam, destroying or keeping library materials for one's own use., etc.

Alleged violations of the BGS Code of Academic Integrity are adjudicated in accordance with the Charter of Biomedical Graduate Studies Student Judicial System. Alleged research ethics violations are handled in accordance with the University's Procedures Regarding Misconduct in Research for Non Faculty Members of the Research Community. If a student is unsure whether his action(s) constitute a violation of the Code of Academic Integrity, then it is that student's responsibility to consult with the instructor to clarify any ambiguities.

Time Limitation

The MBMI program is designed primarily for part-time students, but may be completed in as few as 18 months. Government policies dictate that the total time to degree may not exceed 150% of the student's academic plan at the time of matriculation.

Registration

Continuous Registration

Continuous registration as a Master's student is required unless a formal leave of absence is granted by the Program Director. A leave of absence will be granted for military duty, medical reasons, and for family leave; this leave is typically for up to one year and "stops the clock" on time to completion. Personal leave for other reasons may be granted for up to one year with the approval of the Program Director, but it does not automatically change the time limit.

Leave of Absence

A student who wishes to take a leave of absence must submit a written request to the Program Director for approval. The granting of a leave of absence does not automatically change the time limit for the degree.

Registration Process

Students are responsible for registering for courses. Students can change their course schedule without penalty during the add/drop period.

To register for electives, students must contact the course instructor to request permission to enroll. Once the instructor grants permission, then the student must notify the program coordinator who will request a "permit" be entered to complete the elective registration. Electives not listed in the [Academic Program](#) section of this handbook must be approved by the Program Director.

Students are strongly encouraged to verify course registration, tuition bills and grades through the student portal: <http://pennintouch.apps.upenn.edu>

Information on course offerings (e.g. timetables, classrooms, and course descriptions) can be found on the Registrar's website.

International Students

International Student & Scholar Services (ISSS) provides information and guidance on the regulations and laws required to remain in the U.S. legally. Information on pre-arrival, immigration documents, orientation, enrollment, travel information, employment, transfers and counseling related to adjusting to academia and life in University of Pennsylvania are just a few of the services provided. Please visit the [ISSS Website](#) for more information.

Administrative Requirements

Throughout the program, students will be required to keep track of and follow through on all administrative requirements for the MBMI degree. Below is a summarized list of the requirements:

- 1) Graduation application – In order to be considered for conferral of the degree students must complete an online graduation application approximately two months prior to the expected conferral date. The graduation application initiates an academic audit that, assuming all requirements are met, places the student with the next graduation cohort. The MBMI degree is conferred by the University of Pennsylvania Perelman School of Medicine and is granted in May, August, and December of each year.
- 2) Course evaluations – students are required to complete an evaluation for every MBMI course. Students will receive an email notification and website link to the online evaluation at the end of each term. Grades will not be released until evaluations are complete.

Research Regulations Compliance

Because much of the research conducted by our students involves clinical data, it is essential that all studies comply with various research regulations. These policies are designed to protect patient and human subject privacy.

Penn Resources

PennCard

PennCard is the official identification card of the University of Pennsylvania and is required for all students. The PennCard Center is located on the 2nd floor of the Penn Bookstore at 3601 Walnut Street. A valid government issued photo I.D. will be required in order to pick up your new PennCard. The Office can be reached at <http://www.upenn.edu/penncard>.

PennKey

Your PennKey name and password gives you access to PennNet, a Penn e-mail account, and many other essential services managed through the MBMI Program. All students are required to have a current, active PennKey and password.

Penn InTouch

Penn InTouch provides secure web access to view current billing information, course registration and schedules, academic records, student health insurance, etc. Access to this site requires login with PennKey and password: <http://pennintouch.apps.upenn.edu>

The PennPortal

The PennPortal webpage bundles together links to important information for students. Access the PennPortal at www.upenn.edu/penn_portal/

Canvas

Canvas is the online course site system used for the majority of MBMI courses and by the University. Individual pages are set up for each course and can be accessed with PennKey and Password. Log in at <https://canvas.upenn.edu>.

Financial Information

Description of Fees

Program tuition for fall and spring semesters is calculated based on the MBMI tuition rate plus general and technical fees. Tuition for summer courses is based on the tuition rate set by the course's home department. Students should contact the individual department to verify tuition cost. For current MBMI tuition rates, visit <https://www.med.upenn.edu/mbmi/tuition.html>.

General Fee: The amount of the general fee is based on the number of course units taken. The general fee enables the University to maintain essential facilities such as the library system, museums and institutes, special laboratories, the Student Health Service, Athletics, and Career Services, all of which provide benefits to students both before and after graduation.

Technical Fee: Students are charged a technical fee for computing services such as access to computer labs and use of email accounts.

Administrative Structure

The Master of Biomedical Informatics Program falls under the academic umbrella of the Perelman School of Medicine (PSOM) Penn Medicine Masters and Certificate Programs office (PMCP) (<http://www.med.upenn.edu/masters.shtml>) within the Office of the Vice Dean for Research and Research Training. The administrative home for the MBMI program is the Institute for Biomedical Informatics (IBI).

The Program Director is responsible for administrative oversight and academic leadership of the program. The Director also serves as a primary academic advisor to MBMI students and is the chairperson of the Admissions Committees. The current Program Director is John Holmes, PhD.

The Executive Committee serves generally to advise the program leadership on all matters related to implementation and evaluation of the MBMI program and other related activities. This committee is responsible for formal decision-making on academic aspects of the MBMI program, and providing guidance and approval during course selection. The committee is primarily composed of course directors and program mentors who evaluate existing curriculum and implement modifications.

The Admissions Committee meets to review applications and prepare offers of admission. The committee is responsible for reviewing all applications to the MBMI program and selecting applicants to admit.