BIOMEDICAL DATA SCIENCE, M.S.

The current explosion of biomedical data provides an awesome opportunity to improve understanding of the mechanisms of disease and ultimately to improve human health care. However, fully harnessing the power of high-dimensional, heterogeneous data requires a new blend of skills including programming, data management, data analysis, and machine learning.

The M.S. degree program in biomedical data science covers core concepts and allows for concentrated coursework, in both methodology and application. The goal of the program is to prepare graduates to:

1. Understand and apply key concepts and methodologies from computer science and statistics to biology and biomedicine.
2. Demonstrate knowledge of biological, biomedical, clinical, and population health concepts and problems.
3. Contribute to the solutions of the central computational problems in biology and medicine, using methods from computer science and statistics.

ADMISSIONS

Potential students include both those with bachelor’s degrees in an area of data-science (e.g., computer science, statistics), as well as health professionals and clinicians (e.g., M.D.’s, Pharm.D.’s, R.N.’s). It is expected that admitted candidates will have demonstrated an aptitude for computer science and math, fundamental programming skills, knowledge of data structures and algorithms, and at least two semesters of college calculus. We will however consider candidates who have a wide range of undergraduate backgrounds; providing opportunities to develop necessary skills immediately upon entering the program.

Applying to the Program:

- A formal online application (https://grad.wisc.edu/apply) with required fee through the UW–Madison Graduate School
- Three letters of recommendation
- Transcripts from each higher-education institution attended
- A statement of purpose
- GRE or MCAT scores
- Applicants whose native language is not English, or whose undergraduate instruction was not in English, must provide an English proficiency test score (TOEFL, MELAB, or IELTS)
- Evidence of quantitative preparation, including at least two semesters of college calculus (similar to MATH 221–MATH 222) and either a course in linear algebra (similar to MATH 340) or courses in programming and data structures

Application Deadline: January 12

For additional information about admission to the program, see MS Program in Biomedical Data Science (https://www.biostat.wisc.edu/content/ms_program_in_biomedical_data_science) on the department website.

GRADUATE SCHOOL ADMISSIONS

Graduate admissions is a two-step process between academic degree programs and the Graduate School. Applicants must meet requirements of both the program(s) and the Graduate School. Once you have researched the graduate program(s) you are interested in, apply online (https://grad.wisc.edu/admissions).

FUNDING

GRADUATE SCHOOL RESOURCES

Resources to help you afford graduate study might include assistantships, fellowships, traineeships, and financial aid. Further funding information (https://grad.wisc.edu/funding) is available from the Graduate School. Be sure to check with your program for individual policies and processes related to funding.

PROGRAM RESOURCES

Funding guarantees are not provided for students in this program. Students are encouraged to explore funding options available across campus.

REQUIREMENTS

MINIMUM GRADUATE SCHOOL REQUIREMENTS

Review the Graduate School minimum academic progress and degree requirements (http://guide.wisc.edu/graduate/#policiesandrequirementstext), in addition to the program requirements listed below.

MAJOR REQUIREMENTS

MODE OF INSTRUCTION

<table>
<thead>
<tr>
<th>Face to Face</th>
<th>Evening/Weekend</th>
<th>Online</th>
<th>Hybrid</th>
<th>Accelerated</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
<td>No</td>
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</table>

Mode of Instruction Definitions

**Evening/Weekend**: These programs are offered in an evening and/or weekend format to accommodate working schedules. Enjoy the advantages of on-campus courses and personal connections, while keeping your day job. For more information about the meeting schedule of a specific program, contact the program.

**Online**: These programs are offered primarily online. Many available online programs can be completed almost entirely online with all online programs offering at least 50 percent or more of the program work online. Some online programs have an on-campus component that is often designed to accommodate working schedules. Take advantage of the convenience of online learning while participating in a rich, interactive learning environment. For more information about the online nature of a specific program, contact the program.

**Hybrid**: These programs have innovative curricula that combine on-campus and online formats. Most hybrid programs are completed on-campus with a partial or completely online semester. For more information about the hybrid schedule of a specific program, contact the program.

**Accelerated**: These on-campus programs are offered in an accelerated format that allows you to complete your program in a condensed time-frame. Enjoy the
advantages of on-campus courses with minimal disruption to your career. For more information about the accelerated nature of a specific program, contact the program.

### CURRICULAR REQUIREMENTS

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Minimum Credit Requirement</th>
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<tbody>
<tr>
<td>Minimum Credit Requirement</td>
<td>30 credits</td>
</tr>
<tr>
<td>Minimum Residence Credit Requirement</td>
<td>16 credits</td>
</tr>
<tr>
<td>Minimum Graduate Coursework Requirement</td>
<td>Half of the coursework (15 out of 30 total credits) must be completed in graduate-level coursework; courses with the Graduate Level Coursework attribute are identified and searchable in the university's Course Guide.</td>
</tr>
<tr>
<td>Overall Graduate GPA Requirement</td>
<td>3.00 GPA required.</td>
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</tbody>
</table>

Other Grade Requirements: Students must earn a B or above in all core curriculum coursework.

Assessments and Examinations: No formal examination required. The research track requires a research project of 3–6 credits.

Language Requirements: No language requirements.

### REQUIRED COURSES

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Core Courses Required</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>BMI/COMP SCI 576</td>
<td>Introduction to Bioinformatics</td>
<td>3</td>
</tr>
<tr>
<td>BMI I/COMP SCI 567</td>
<td>Medical Image Analysis</td>
<td>3</td>
</tr>
<tr>
<td>BMI 826</td>
<td>Special Topics in Biostatistics and Biomedical Informatics (BMI 573 Health Informatics)</td>
<td>3</td>
</tr>
<tr>
<td>BMI I/STAT 541</td>
<td>Introduction to Biostatistics</td>
<td>3</td>
</tr>
<tr>
<td>or BMI / POP HLTH 551</td>
<td>Introduction to Biostatistics for Population Health</td>
<td></td>
</tr>
<tr>
<td>or STAT/ F&amp;W ECOL/ HORT 571</td>
<td>Statistical Methods for Bioscience I</td>
<td></td>
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</tbody>
</table>

**Concentration Electives**: 6

In consultation with their faculty advisor, students will select electives in an area of concentration within biomedical informatics. Examples include but are not limited to:

- BMI I/STAT 641: Statistical Methods for Clinical Trials
- BMI I/STAT 642: Statistical Methods for Epidemiology
- BMI I/ COMP SCI 776: Advanced Bioinformatics
- BMI I/STAT 877: Statistical Methods for Molecular Biology
- BMI I/ COMP SCI 767: Computational Methods for Medical Image Analysis
- BMI I/STAT 768: Statistical Methods for Medical Image Analysis

**Data Science Electives**: 6-7

In consultation with their faculty advisor, students will select two courses as electives in computer science and/or statistics. Coursework of high relevance includes the following areas:

- BMI I/ COMP SCI 767: Computational Methods for Medical Image Analysis
- BMI I/STAT 768: Statistical Methods for Medical Image Analysis
- STAT 601: Statistical Methods I
- STAT 602: Statistical Methods II
- STAT 609: Mathematical Statistics I
- STAT 610: Introduction to Statistical Inference
- STAT 627: Professional Skills in Data Science
- STAT 771: Statistical Computing
- STAT 849: Theory and Application of Regression and Analysis of Variance I
- STAT 850: Theory and Application of Regression and Analysis of Variance II
- COMP SCI 577: Introduction to Algorithms
- COMP SCI 787: Advanced Algorithms
- COMP SCI 766: Computer Vision
- COMP SCI 564: Database Management Systems: Design and Implementation
- COMP SCI 764: Topics in Database Management Systems
- COMP SCI 570: Introduction to Human-Computer Interaction
- COMP SCI/ ED PSYCH/ PSYCH 770: Human-Computer Interaction
- COMP SCI 540: Introduction to Artificial Intelligence
- COMP SCI 760: Machine Learning
- COMP SCI/ E C E 761: Mathematical Foundations of Machine Learning
- COMP SCI 545: Natural Language and Computing
- COMP SCI 769: Advanced Natural Language Processing
- COMP SCI/I SYE/ MATH .425: Introduction to Combinatorial Optimization
- COMP SCI/I SYE/ MATH/STAT 525: Linear Programming Methods
- COMP SCI/ I SY E 635: Tools and Environments for Optimization
- COMP SCI 642: Introduction to Information Security

**Professional Track Electives**: 6-7

**Research Track Electives**: 7

1 These tracks are internal to the program and represent different pathways a student can follow to earn this degree. Track names do...
not appear in the Graduate School admissions application, and they will not appear on the transcript.

2 The Professional track is intended for students who are interested in a terminal M.S. degree that will equip them to work as a professional in industry (e.g., developers of health information systems and electronic health records, and of novel genetic tests—as just a few examples), a hospital, or a research lab. In consultation with their advisor, students will select courses that will provide them with additional biomedical background for future employment opportunities. For example, if the Professional track is chosen, students may focus their studies on genetics or neuroscience.

3 The Research track is for students who are interested in developing their skills as an independent researcher. Students will conduct an independent research project with their faculty advisor. In consultation with their advisor students will select a course in responsible conduct of research. In addition, the advisor will help students select an elective specifically orientated to the topic of the their research. For example, if the Research track is chosen, a student could conduct an independent research project on breast cancer risk prediction. For the responsible conduct of research, the student could take Ethics for Data Scientists. For the research-oriented elective, the student might take a course in cancer genetics or machine learning.

Policies

Graduate School Policies

The Graduate School’s Academic Policies and Procedures (https://grad.wisc.edu/acadpolicy) provide essential information regarding general university policies. Program authority to set degree policies beyond the minimum required by the Graduate School lies with the degree program faculty. Policies set by the academic degree program can be found below.

Major-Specific Policies

Graduate Program Handbook

The Graduate Program Handbook (https://www.biostat.wisc.edu/sites/default/files/Handbook2017.pdf) is the repository for all of the program’s policies and requirements.

Prior Coursework

Graduate Work from Other Institutions

With program approval, students are allowed to count no more than 9 credits of graduate coursework from other institutions. Coursework earned five or more years prior to admission to a master’s degree is not allowed to satisfy requirements.

UW–Madison Undergraduate

With program approval, students are allowed up to 7 credits numbered 300 or above from a UW–Madison undergraduate degree to count toward the degree. Coursework earned five or more years prior to admission to a master’s degree is not allowed to satisfy requirements.

UW–Madison University Special

With program approval, students are allowed to count no more than 9 credits of course work numbered 300 or above taken as a UW–Madison Special student. Coursework earned five or more years prior to admission to a master’s degree is not allowed to satisfy requirements.

Probation

The status of a student can be one of three options:

1. Good standing (progressing according to standards; any funding guarantee remains in place).
2. Probation (not progressing according to standards but permitted to enroll; loss of funding guarantee; specific plan with dates and deadlines in place in regard to removal of probationary status).
3. Unsatisfactory progress (not progressing according to standards; not permitted to enroll, dismissal, leave of absence or change of advisor or program).

Advisor / Committee

All students are required to conduct a yearly progress report meeting with their advisor, scheduled by December 17 and completed by April 30. Failure to do so will result in a hold being placed on the student’s registration.

Credits Per Term Allowed

15 credits

Time Constraints

If students have been absent for five or more years, they must file a new Graduate School application for admission and submit it with a new application fee. Master’s degree students who have been absent for five or more consecutive years lose all credits that they have earned before their absence. Students may count the coursework completed before their absence for meeting graduate degree-credit requirements; the Graduate School will not count that work toward the Graduate School’s minimum residence credit requirement.

Other

Funding guarantees are not provided for students in this program. Students are encouraged to explore funding options available across campus.

Professional Development

Graduate School Resources

Take advantage of the Graduate School’s professional development resources (https://grad.wisc.edu/pd) to build skills, thrive academically, and launch your career.

Learning Outcomes

1. Understand, apply, and evaluate common informatics theories, methods, and tools related to biological and biomedical problems, health care and public health.
2. Apply, adapt, and validate an existing approach to a specific biomedical and health problem.
3. Produce solutions that address academic or industrial needs using informatics tools and knowledge.
4. Evaluate the impact of biomedical informatics applications and interventions.

5. Understand the challenges and limitations of technological solutions.

6. Demonstrate scholarly oral and written presentations.

7. Adhere to the professional and legal standards of conduct in Biomedical Data Science.

**PEOPLE**

*Faculty:* Broman, Buchanan, Burnside, Chappell, Chen, Chung, Craven, Dewey, Doan, Dyer, Elwert, Gangnon, Gianola, Gitter, Keles, Kendziorski, Kim, Lu, Mao, Mendonça, Mumford, Newton, Ong, Page, Palta, Patel, Peissig, Rathouz (Chair), Rosa, Rosenberg, Roy, Singh, Sorkness, Tang, Wahba, Yandell, Velten, Yu, Zhang, Zhu