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.

ADMISSIONS

Please consult the table below for key information about this degree program’s admissions requirements. The program may have more detailed admissions requirements, which can be found below the table or on the program’s website.

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

Requirements | Detail
---|---
Fall Deadline | January 12
Spring Deadline | The program does not admit in the spring.
Summer Deadline | The program does not admit in the summer.
GRE (Graduate Record Examinations) | Required.
English Proficiency Test | Every applicant whose native language is not English or whose undergraduate instruction was not in English must provide an English proficiency test score and meet the Graduate School minimum requirements (https://grad.wisc.edu/apply/requirements/#english-proficiency).
Other Test(s) (e.g., GMAT, MCAT) | The MCAT may be accepted as an alternate to the GRE.
Letters of Recommendation | 3

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.

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 restrictions 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

- **Accelerated**: Accelerated programs are offered at a fast pace that condenses the time to completion. Students are able to complete a program with minimal disruptions to careers and other commitments.
- **Evening/Weekend**: Courses meet on the UW–Madison campus only in evenings and/or on weekends to accommodate typical business schedules. Students have the
advantages of face-to-face courses with the flexibility to keep work and other life commitments.

Face-to-Face: Courses typically meet during weekdays on the UW-Madison Campus.

Hybrid: These programs combine face-to-face and online learning formats. Contact the program for more specific information.

Online: These programs are offered 100% online. Some programs may require an on-campus orientation or residency experience, but the courses will be facilitated in an online format.

**CURRICULAR REQUIREMENTS**

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Detail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Credit Requirement</td>
<td>31 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 (16 out of 31 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>
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<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.

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>Concentration Electives</strong></td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>I SY E 517</td>
<td>Decision Making in Health Care</td>
<td></td>
</tr>
<tr>
<td>B M I/STAT 541</td>
<td>Introduction to Biostatistics</td>
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<tr>
<td>or B M I/POP HLTH 551</td>
<td>Introduction to Biostatistics for Population Health</td>
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<tr>
<td>or STAT/F&amp;W ECOL/HORT 571</td>
<td>Statistical Methods for Bioscience I</td>
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<tr>
<td>B M I/POP HLTH 552</td>
<td>Regression Methods for Population Health</td>
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<tr>
<td>B M I/COMP SCI 567</td>
<td>Medical Image Analysis</td>
<td></td>
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<tr>
<td>STAT/F&amp;W ECOL/HORT 572</td>
<td>Statistical Methods for Bioscience II</td>
<td></td>
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<tr>
<td>B M I 573</td>
<td>Foundations of Data-Driven Healthcare</td>
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<tr>
<td>B M I/COMP SCI 576</td>
<td>Introduction to Bioinformatics</td>
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<tr>
<th>Code</th>
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<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>B M I/BIOCHEM/BMOLCHEM/MATH 609</td>
<td>Mathematical Methods for Systems Biology</td>
<td></td>
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<tr>
<td>I SY E/B M I 617</td>
<td>Health Information Systems</td>
<td></td>
</tr>
<tr>
<td>B M I/STAT 641</td>
<td>Statistical Methods for Clinical Trials</td>
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<tr>
<td>B M I/STAT 642</td>
<td>Statistical Methods for Epidemiology</td>
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<tr>
<td>B M I/POP HLTH 651</td>
<td>Advanced Regression Methods for Population Health</td>
<td></td>
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<tr>
<td>B M I/STAT 741</td>
<td>Survival Analysis Theory and Methods</td>
<td></td>
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<tr>
<td>B M I/COMP SCI 767</td>
<td>Computational Methods for Medical Image Analysis</td>
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<tr>
<td>B M I/STAT 768</td>
<td>Statistical Methods for Medical Image Analysis</td>
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<tr>
<td>B M I 773</td>
<td>Clinical Research Informatics</td>
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<tr>
<td>B M I/COMP SCI 776</td>
<td>Advanced Bioinformatics</td>
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<tr>
<td>B M I 826</td>
<td>Special Topics in Biostatistics and Biomedical Informatics (Topic: Computational Network Biology)</td>
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<tr>
<td>B M I/STAT 877</td>
<td>Statistical Methods for Molecular Biology</td>
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<thead>
<tr>
<th>Code</th>
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<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Data Science Electives</strong></td>
<td></td>
<td>12</td>
</tr>
<tr>
<td>STAT 609</td>
<td>Mathematical Statistics I</td>
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<tr>
<td>STAT 610</td>
<td>Introduction to Statistical Inference</td>
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<tr>
<td>STAT 627</td>
<td>Professional Skills in Data Science</td>
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<tr>
<td>STAT 771</td>
<td>Statistical Computing</td>
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<tr>
<td>STAT 849</td>
<td>Theory and Application of Regression and Analysis of Variance I</td>
<td></td>
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<tr>
<td>STAT 850</td>
<td>Theory and Application of Regression and Analysis of Variance II</td>
<td></td>
</tr>
<tr>
<td>COMP SCI 577</td>
<td>Introduction to Algorithms</td>
<td></td>
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<tr>
<td>COMP SCI 787</td>
<td>Advanced Algorithms</td>
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</tr>
<tr>
<td>COMP SCI 766</td>
<td>Computer Vision</td>
<td></td>
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<tr>
<td>COMP SCI 564</td>
<td>Database Management Systems: Design and Implementation</td>
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<tr>
<td>COMP SCI 764</td>
<td>Topics in Database Management Systems</td>
<td></td>
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<tr>
<td>COMP SCI 570</td>
<td>Introduction to Human-Computer Interaction</td>
<td></td>
</tr>
<tr>
<td>COMP SCI/ED PSYCH/PSYCH 770</td>
<td>Human-Computer Interaction</td>
<td></td>
</tr>
<tr>
<td>COMP SCI 540</td>
<td>Introduction to Artificial Intelligence</td>
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<tr>
<td>COMP SCI 760</td>
<td>Machine Learning</td>
<td></td>
</tr>
<tr>
<td>COMP SCI/E C E 761</td>
<td>Mathematical Foundations of Machine Learning</td>
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</tr>
<tr>
<td>COMP SCI 545</td>
<td>Natural Language and Computing</td>
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</tbody>
</table>
### Research Ethics Course

- **B M I 826**  
  Special Topics in Biostatistics and Biomedical Informatics (Topic: Ethics for Data Scientists)

*Note: B M I 826 is recommended. If a student is unable to take B M I 826, one of the following courses may be substituted.*

- **ONCOLOGY 715**  
  Ethics in Science

- **BIOCHEM 729**  
  Advanced Topics (Topic: Responsible Conduct of Research)

- **NURSING 802**  
  Ethics and the Responsible Conduct of Research

- **SURG SCI 812**  
  Research Ethics and Career Development

- **OBS & GYN 955**  
  Responsible Conduct of Research for Biomedical Graduate Students

- **OBS & GYN 956**  
  Advanced Responsible Conduct of Research for Biomedical Students

#### Electives

**Research**  
3-6 credits

**Electives**  
0-3 credits

- **B M I 699**  
  Independent Study

Additional elective credits are not required if student completes two semesters (6 credits) of research.

**Total Credits**  
31

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1. Between the Concentration Electives and Data Science Electives, students must complete at least 6 credits of computer sciences-oriented courses and 6 credits of statistics-oriented courses. Computer sciences-oriented courses include those in the Department of Computer Sciences course listing (COMP SCI). Statistics-oriented courses include those in the Department of Statistics course listing (STAT), in addition to B M I / POP HLTH 552 Regression Methods for Population Health and B M I / POP HLTH 651 Advanced Regression Methods for Population Health. A specific section of B M I 826 Special Topics in Biostatistics and Biomedical Informatics can count as either a computer sciences-oriented course or a statistics-oriented course at the discretion of the MS Program Steering Committee.

2. Graduate students must have knowledge of basic operations research (like I S Y E 323 [https://guide.wisc.edu/search/?P=I%20SY %E2%80%93323]) in order to be successful in this course.

3. Students who take only 3 credits of research may need an additional electives course to reach the program minimum requirement.

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## 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

### 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.

### Credits Per Term Allowed

15 credits

### Time Constraints

Master's degree students who have been absent for five or more consecutive years lose all credits that they have earned before their absence. Individual programs may count the coursework students completed prior to their absence for meeting program requirements; that coursework may not count toward Graduate School credit requirements.

### Grievances and Appeals

These resources may be helpful in addressing your concerns:

- Bias or Hate Reporting (https://doso.students.wisc.edu/bias-or-hate-reporting/)
- Graduate Assistantship Policies and Procedures (https://hr.wisc.edu/policies/gapp/#grievance-procedure)
- Hostile and Intimidating Behavior Policies and Procedures (https://hr.wisc.edu/hib/)
Grievance Policy for Graduate Programs in the School of Medicine and Public Health

Any student in a School of Medicine and Public Health graduate program who feels that they have been treated unfairly in regards to educational decisions and/or outcomes or issues specific to the graduate program, including academic standing, progress to degree, professional activities, appropriate advising, and a program's community standards by a faculty member, staff member, postdoc, or student has the right to complain about the treatment and to receive a prompt hearing of the grievance following these grievance procedures. Any student who discusses, inquires about, or participates in the grievance procedure may do so openly and shall not be subject to intimidation, discipline, or retaliation because of such activity. Each program's grievance advisor is listed on the "Research" tab of the SMPH intranet (https://intranet.med.wisc.edu/).

Exclusions

This policy does not apply to employment-related issues for Graduate Assistants in TA, PA and/or RA appointments. Graduate Assistants will utilize the Graduate Assistantship Policies and Procedures (https://hr.wisc.edu/policies/gapp/) (GAPP) grievance process to resolve employment-related issues.

This policy does not apply to instances when a graduate student wishes to report research misconduct. For such reports refer to the UW-Madison Policy for Reporting Research Misconduct for Graduate Students and Postdoctoral Research Associates (https://research.wisc.edu/kb-article/?id=84924).

Requirements for Programs

The School of Medicine and Public Health Office of Basic Research, Biotechnology and Graduate Studies requires that each graduate program designate a grievance advisor, who should be a tenured faculty member, and will request the name of the grievance advisor annually. The program director will serve as the alternate grievance advisor in the event that the grievance advisor is named in the grievance. The program must notify students of the grievance advisor, including posting the grievance advisor's name on the program's Guide page and handbook.

The grievance advisor or program director may be approached for possible grievances of all types. They will spearhead the grievance response process described below for issues specific to the graduate program, including but not limited to academic standing, progress to degree, professional activities, appropriate advising, and a program's community standards. They will ensure students are advised on reporting procedures for other types of possible grievances and are supported throughout the reporting process. Resources (https://grad.wisc.edu/current-students/#reporting-incidents) on identifying and reporting other issues have been compiled by the Graduate School.

Procedures

1. The student is advised to initiate a written record containing dates, times, persons, and description of activities, and to update this record while completing the procedures described below.

2. If the student is comfortable doing so, efforts should be made to resolve complaints informally between individuals before pursuing a formal grievance.

3. Should a satisfactory resolution not be achieved, the student should contact the program's grievance advisor or program director to discuss the complaint. The student may approach the grievance advisor or program director alone or with a UW-Madison faculty or staff member. The grievance advisor or program director should keep a record of contacts with regards to possible grievances. The first attempt is to help the student informally address the complaint prior to pursuing a formal grievance.

4. If the issue is not resolved to the student's satisfaction, the student may submit a formal grievance to the grievance advisor or program director in writing, within 60 calendar days from the date the grievant first became aware of, or should have become aware of with the exercise of reasonable diligence, the cause of the grievance. To the fullest extent possible, a grievance shall contain a clear and concise statement of the grievance and indicate the issue(s) involved, the relief sought, the date(s) the incident or violation took place, and any specific policy involved.

5. On receipt of a written grievance, the following steps will occur. The final step must be completed within 30 business days from the date the grievance was received. The program must store documentation of the grievance for seven years. Significant grievances that set a precedent may be stored indefinitely.

   a. The grievance advisor or program director will convene a faculty committee composed of at least three members to manage the grievance. Any faculty member involved in the grievance or who feels that they cannot be impartial may not participate in the committee. Committee composition should reflect diverse viewpoints within the program.

   b. The faculty committee, through the grievance advisor or program director, will obtain a written response from the person or persons toward whom the grievance is directed. The grievance advisor or program director will inform this person that their response will be shared with the student filing the grievance.
c. The grievance advisor or program director will share the response with the student filing the grievance.
d. The faculty committee will make a decision regarding the grievance. The committee's review shall be fair, impartial, and timely. The grievance advisor or program director will report on the action taken by the committee in writing to both the student and the person toward whom the grievance was directed.

6. If either party (the student or the person or persons toward whom the grievance is directed) is unsatisfied with the decision of the program's faculty committee, the party may file a written appeal to the SMPH senior associate dean for basic research, biotechnology and graduate studies within 10 business days from the date of notification of the program's faculty committee. The following steps will occur:
   a. The grievant will be notified in writing, within 5 business days of the written appeal, acknowledging receipt of the formal appeal and establishing a timeline for the review to be completed.
   b. The senior associate dean or their designee may request additional materials and/or arrange meetings with the grievant and/or others. If meetings occur, the senior associate dean or their designee will meet with both the grievant and the person or persons toward whom the grievance is directed.
   c. The senior associate dean or their designee will assemble an ad hoc committee of faculty from outside of the student's graduate program and ask them to prepare a written recommendation on whether to uphold or reverse the decision of the program on the student's initial grievance. The committee may request additional materials and/or arrange meetings with the grievant and/or others. If meetings occur, the committee will meet with both the grievant and the person or persons toward whom the grievance is directed.
   d. The senior associate dean or their designee will make a final decision within 20 business days of receipt of the committee's recommendation.
   e. The SMPH Office of Basic Research, Biotechnology, and Graduate Studies must store documentation of the grievance for seven years. Grievances that set a precedent may be stored indefinitely.

7. The student may file an appeal of the School of Medicine and Public Health decision with the Graduate School. See the Grievances and Appeals section of the Graduate School's Academic Policies and Procedures (https://grad.wisc.edu/documents/grievances-and-appeals/).

Time Limits

Steps in the grievance procedures must be initiated and completed within the designated time periods except when modified by mutual consent. If the student fails to initiate the next step in the grievance procedure within the designated time period, the grievance will be considered resolved by the decision at the last completed step.

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