BIOMEDICAL DATA SCIENCE, PH.D.

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.

Blending the best of statistics and computer sciences, biostatistics and biomedical informatics, this program provides students the training they need to make sense of large-scale biomedical data, and to be scientific leaders in the team science that invariably accompanies such data. Unique features of the program include cross-training in computer science and biostatistics, and research rotations mentored by a program faculty member jointly with a scientific collaborator.

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 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/).

<table>
<thead>
<tr>
<th>Requirements</th>
<th>Detail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall Deadline</td>
<td>December 15</td>
</tr>
<tr>
<td>Spring Deadline</td>
<td>The program does not admit in the spring.</td>
</tr>
<tr>
<td>Summer Deadline</td>
<td>The program does not admit in the summer.</td>
</tr>
<tr>
<td>GRE (Graduate Record</td>
<td>Not required.</td>
</tr>
<tr>
<td>Examinations)</td>
<td></td>
</tr>
<tr>
<td>English Proficiency</td>
<td>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 (<a href="https://grad.wisc.edu/apply/#english-proficiency">https://grad.wisc.edu/apply/#english-proficiency</a>).</td>
</tr>
<tr>
<td>Other Test(s) (e.g.,</td>
<td>n/a</td>
</tr>
<tr>
<td>GMAT, MCAT)</td>
<td></td>
</tr>
<tr>
<td>Letters of Recommendation</td>
<td>3</td>
</tr>
<tr>
<td>Required</td>
<td></td>
</tr>
</tbody>
</table>

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
- 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

For additional information about admission to the program, see PhD Program in Biomedical Data Science (https://www.biostat.wisc.edu/PHD-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

The program is designed such that almost all students who are accepted to the program will receive guaranteed funding for five years. This funding may take a number of forms including, but not limited to training grants, teaching assistantships, and research assistantships. For more information about funding opportunities, see Graduate Assistantships (https://grad.wisc.edu/studentfunding/currentstudents/).

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>
</tr>
</tbody>
</table>


Mode of Instruction Definitions

**Accelerated:** Accelerated programs are offered at a fast pace that condenses the time to completion. Students typically take enough credits aimed at completing the program in a year or two.

**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

**Requirement Detail**

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Detail</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Minimum Credit</strong></td>
<td>51 credits</td>
</tr>
<tr>
<td><strong>Minimum Residence Credit Requirement</strong></td>
<td>32 credits</td>
</tr>
<tr>
<td><strong>Minimum Graduate Coursework</strong></td>
<td>26 credits must be graduate-level coursework. Details can be found in the Graduate School’s Minimum Graduate Coursework (50%) policy (<a href="https://policy.wisc.edu/library/UW-1244/">https://policy.wisc.edu/library/UW-1244/</a>).</td>
</tr>
<tr>
<td><strong>Overall Graduate GPA</strong></td>
<td>3.00 GPA required. This program follows the Graduate School’s policy: <a href="https://policy.wisc.edu/library/UW-1203/">https://policy.wisc.edu/library/UW-1203/</a>).</td>
</tr>
<tr>
<td><strong>Other Grade Requirements</strong></td>
<td>Ph.D. candidates should maintain a 3.0 GPA in all core curriculum courses and may not have any more than two Incompletes on their record at any one time.</td>
</tr>
<tr>
<td><strong>Assessments and Examinations</strong></td>
<td>Students must complete an Oral Preliminary Exam, ideally taken in the students’ third year.</td>
</tr>
<tr>
<td><strong>Language Requirements</strong></td>
<td>No language requirements.</td>
</tr>
<tr>
<td><strong>Breadth Requirement</strong></td>
<td>All doctoral students are required to complete a doctoral minor or Graduate/Professional certificate.</td>
</tr>
</tbody>
</table>

REQUIRED COURSES

**Core Topics**

- **Biostatistics**
  - **Topic 1:** Biostatistics Theory and Methods
    - STAT 609 & STAT 610 Mathematical Statistics I and Introduction to Statistical Inference
  - **Topic 2:** Biostatistical Methods
  - **Topic 3:** Machine Learning / AI
    - COMP SCI 540 & COMP SCI/ECE 760 Introduction to Artificial Intelligence and Machine Learning
  - **Topic 4:** Database Systems
    - COMP SCI 564 & COMP SCI 764 Database Management Systems: Design and Implementation and Topics in Database Management Systems
  - **Topic 5:** Optimization
    - COMP SCI/I SY E Linear Optimization
    - MATH/STAT 525 & COMP SCI/I SY E/MATH/STAT 726 and Nonlinear Optimization I
  - **Topic 6:** Algorithms
    - COMP SCI 577 & COMP SCI 787 Introduction to Algorithms and Advanced Algorithms
  - **Additional Specializations**
    - Students select any of the above or following topics (Topics 1-11):
      - **Topic 7:** Clinical Informatics
        - I SY E 417 Health Systems Engineering
        - & B M I/I SY E 617 and Health Information Systems
      - **Topic 8:** Clinical Biostatistics
        - B M I/STAT 641 Statistical Methods for Clinical Trials
        - & STAT/B M I 642 and Statistical Methods for Epidemiology
      - **Topic 9:** Statistical Computing
        - Students take the following courses:
        - STAT 771 Statistical Computing
        - STAT/ECON/ GEN BUS 775 Introduction to Bayesian Decision and Control I
      - **Topic 10:** Bioinformatics / Statistical Genomics
        - Select two of the following courses:
        - B M I/COMP SCI 576 Introduction to Bioinformatics
        - B M I/COMP SCI 776 Advanced Bioinformatics
        - B M I/STAT 877 Statistical Methods for Molecular Biology
      - **Topic 11:** Biomedical Image Analysis
        - Select two of the following courses:
        - COMP SCI 765 Data Visualization
        - COMP SCI 766 Computer Vision
        - B M I/COMP SCI 767 Computational Methods for Medical Image Analysis
B M I/STAT 768  Statistical Methods for Medical Image Analysis

**Biology Courses**

Students consult with their advisor to select courses.

**Research Ethics Course**

B M I 738  Ethics for Data Scientists

B M I 738 is recommended. If a student is unable to take B M I 738, 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

**Second-Year Literature Seminar**

B M I 881  Biomedical Data Science Scholarly Literature 1

& B M I 882  and Biomedical Data Science Scholarly Literature 2

**Third-Year Professional Skills Seminar**

B M I 883  Biomedical Data Science Professional Skills 1

& B M I 884  and Biomedical Data Science Professional Skills 2

**Electives**

Electives are selected in consultation with the student’s faculty advisor.

**Pre-Dissertation Research**

Three semester-long research rotations (2 credits of B M I 899 Pre-dissertation Research per semester) concerning a substantive problem in biomedical data science, advised by a program faculty member in collaboration with a UW faculty member from the biological, biomedical, or population health sciences.

Students take additional research and elective credits to reach 51 credits.

**Total Credits**  51

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**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 course work from other institutions toward the graduate degree credit and graduate course work (50%) requirements. Course work earned ten years or more prior to admission to a doctoral degree is not allowed to satisfy requirements.

**UW–Madison Undergraduate**

This program follows the Graduate School’s policy for Satisfying Requirements with Coursework from Undergraduate Career at UW–Madison. ([https://policy.wisc.edu/library/UW-1217/](https://policy.wisc.edu/library/UW-1217/))

**UW–Madison University Special**

This program follows the Graduate School’s policy for Transfer from UW–Madison University Special Student Career at UW–Madison ([https://policy.wisc.edu/library/UW-1216/](https://policy.wisc.edu/library/UW-1216/)).

**PROBATION**

This program follows the Graduate School's Probation policy. ([https://policy.wisc.edu/library/UW-1217/](https://policy.wisc.edu/library/UW-1217/))

**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 LIMITS**

This program follows the Graduate School's Time Limits policy. ([https://policy.wisc.edu/library/UW-1221/](https://policy.wisc.edu/library/UW-1221/))

**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/](https://doso.students.wisc.edu/bias-or-hate-reporting/))
- Graduate Assistantship Policies and Procedures ([https://hr.wisc.edu/policies/gapp/#grievance-procedure](https://hr.wisc.edu/policies/gapp/#grievance-procedure))
- Hostile and Intimidating Behavior Policies and Procedures ([https://hr.wisc.edu/hib/](https://hr.wisc.edu/hib/))
  - Office of the Provost for Faculty and Staff Affairs ([https://facstaff provost.wisc.edu/](https://facstaff provost.wisc.edu/))
  - Dean of Students Office ([https://doso.students.wisc.edu/](https://doso.students.wisc.edu/)) (for all students to seek grievance assistance and support)
  - Employee Assistance ([http://www.eao.wisc.edu/](http://www.eao.wisc.edu/)) (for personal counseling and workplace consultation around communication and conflict involving graduate assistants and other employees, postdoctoral students, faculty and staff)
  - Employee Disability Resource Office ([https://employeedisabilities.wisc.edu/](https://employeedisabilities.wisc.edu/)) (for qualified employees or applicants with disabilities to have equal employment opportunities)
- Graduate School ([https://grad.wisc.edu/](https://grad.wisc.edu/)) (for informal advice at any level of review and for official appeals of program/departmental or school/college grievance decisions)
• Office of Compliance (https://compliance.wisc.edu/) (for class harassment and discrimination, including sexual harassment and sexual violence)
• Office of Student Conduct and Community Standards (https://conduct.students.wisc.edu/) (for conflicts involving students)
• Ombuds Office for Faculty and Staff (http://www.ombuds.wisc.edu/) (for employed graduate students and post-docs, as well as faculty and staff)
• Title IX (https://compliance.wisc.edu/titleix/) (for concerns about discrimination)

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. The student is also encouraged to talk with their faculty advisor regarding concerns or difficulties.
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**

n/a

**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. Articulate the biological context of a research question and the scientific relevance of analysis results.
2. Communicate with scientific and quantitative (computational and statistical) colleagues about data analysis goals, methods, and results.
3. Extract the statistical or computational problems from a scientific problem. Develop, characterize, and implement suitable analysis methods to answer questions from biomedical data. Evaluate the validity of analysis methods.
4. Analyze data; extract knowledge and guide decisions based on biomedical data. Organize data and software so that quantitative analyses are meaningful and reproducible.
5. Critically evaluate quantitative approaches in the scientific literature.
6. Evaluate and develop study designs and recognize limitations and potential biases in research data sets.
7. Identify the ethical and regulatory issues surrounding a research project.
8. As part of a biological, biomedical or population health investigative team, serve as the leader in the area of rigorous computational and statistical investigation.

**PEOPLE**

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