# 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 (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

<table>
<thead>
<tr>
<th>Requirement</th>
<th>Detail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall Deadline</td>
<td>December 1</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 Examinations)</td>
<td>Required.</td>
</tr>
<tr>
<td>English Proficiency Test</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/requirements/#english-proficiency">https://grad.wisc.edu/apply/requirements/#english-proficiency</a>).</td>
</tr>
<tr>
<td>Other Test(s) (e.g., GMAT, MCAT)</td>
<td>The MCAT may be accepted as an alternate to the GRE.</td>
</tr>
<tr>
<td>Letters of Recommendation</td>
<td>3 Required</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
- 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:** December 1

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

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

**Requirements Detail**

<table>
<thead>
<tr>
<th>Requirement Type</th>
<th>Detail</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Credit Requirement</td>
<td>51 credits</td>
</tr>
<tr>
<td>Minimum Residence Credit Requirement</td>
<td>32 credits</td>
</tr>
<tr>
<td>Minimum Graduate Coursework Requirement</td>
<td>Half of degree coursework (26 out of 51 total credits) 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>
</tr>
<tr>
<td>Other Grade Requirements</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>
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</tbody>
</table>

Assessments and Examinations

Students must complete an Oral Preliminary Exam, ideally taken in the students’ third year.

Language Requirements

No language requirements.

Doctoral Minor/ Breadth Requirements

All doctoral students are required to complete a minor.

REQUIRED COURSES

**CORE TOPICS**

Three year-long course sequences (18 credits) will be selected from a set of core topics.

1. A Biostatistics Theory and Methods sequence (topics 1–3)
2. A Computer Science/Informatics sequence (topics 4–7)
3. A sequence from any of the listed topics from Biostatistics Theory and Methods, Computer Science/Informatics, and the Specializations (topics 1–12)

**SEQUENCES IN BIOSTATISTICS THEORY AND METHODS (TOPICS 1–3)**

**Topic 1: Biostatistics Theory and Methods—Mathematical Statistics AND Introduction to Statistical Inference**

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>STAT 609</td>
<td>Mathematical Statistics I and Introduction to Statistical Inference</td>
<td></td>
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</tbody>
</table>

**Topic 2: Biostatistical Methods—Statistical Methods Series OR Regression Theory and Application Series**

<table>
<thead>
<tr>
<th>Code and Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>STAT 601 and Statistical Methods I</td>
<td>8</td>
</tr>
<tr>
<td>&amp; STAT 602 and Statistical Methods II</td>
<td></td>
</tr>
<tr>
<td>or</td>
<td></td>
</tr>
<tr>
<td>STAT 849 and Theory and Application of Regression and Analysis of Variance I</td>
<td>6</td>
</tr>
<tr>
<td>&amp; STAT 850 and Theory and Application of Regression and Analysis of Variance II</td>
<td></td>
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</tbody>
</table>

**Topic 3: Applied Biostatistics—Data Science AND Data Visualization**

<table>
<thead>
<tr>
<th>Code and Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>STAT 628 and Data Science Practicum and Data Visualization</td>
<td>6</td>
</tr>
</tbody>
</table>

**SEQUENCES IN COMPUTER SCIENCE / INFORMATICS (TOPICS 4–7)**

**Topic 4: Machine Learning / AI—Intro to Artificial Intelligence AND Machine Learning**

<table>
<thead>
<tr>
<th>Code and Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMP SCI 540 and Introduction to Artificial Intelligence and Machine Learning</td>
<td>6</td>
</tr>
<tr>
<td>&amp; COMP SCI 760</td>
<td></td>
</tr>
</tbody>
</table>

**Topic 5: Database Systems—Database Management AND Database Management Topics**

<table>
<thead>
<tr>
<th>Code and Title</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>COMP SCI 564 and Database Management Systems: Design and Implementation and Topics in Database Management Systems</td>
<td>7</td>
</tr>
<tr>
<td>&amp; COMP SCI 764</td>
<td></td>
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</tbody>
</table>

**Topic 6: Optimization—Linear Program Methods AND Nonlinear Optimization**

<table>
<thead>
<tr>
<th>Code and Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>COMP SCI/I SY E/ MATH/STAT 525 and Nonlinear Optimization I</td>
<td>6</td>
</tr>
<tr>
<td>&amp; COMP SCI/I SY E/ MATH/STAT 726</td>
<td></td>
</tr>
</tbody>
</table>
A second-year literature seminar (4 credits)

SEQUENCES IN ADDITIONAL SPECIALIZATIONS (TOPICS 8-12)

Topic 8: Clinical Informatics—Health Systems Engineering AND Health Information Systems

Topic 9: Clinical Biostatistics—Clinical Trials Statistical Methods AND Epidemiological Statistical Methods


Topic 11: Bioinformatics / Statistical Genomics—Introduction to Bioinformatics AND Advanced Bioinformatics OR Statistical Methods for Molecular Biology

Topic 12: Biomedical Image Analysis (2 of 3)—Computer Vision OR Computer Methods for Medical Image Analysis OR Statistical Methods for Medical Image Analysis

ADDITIONAL REQUIREMENTS

In consultation with their faculty advisor, students will select 6 credits of biology courses, 6 credits of elective courses, and a research ethics course (1 credit). Students will also complete:

A second-year literature seminar (4 credits)

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 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
For well-prepared advanced students, a student’s program may decide to accept up to 7 credits numbered 300 or above of required or elective courses from the undergraduate work completed at UW–Madison toward fulfillment of minimum degree and minor credit requirements. However, this work would not be allowed to count toward the 50% graduate course work minimum unless taken at the 700 level or above. This work will not appear on the graduate career portion of UW–Madison transcript nor count toward the graduate career GPA. The Graduate School’s minimum graduate residence credit requirement can be satisfied only with courses taken as a graduate student at UW–Madison.

UW–Madison University Special
After admission to a graduate program, the student’s program may decide to accept up to fifteen University Special student credits as fulfillment of the minimum graduate residence, graduate degree, or minor credit requirements on occasion as an exception (on a case-by-case basis). In all these cases, the student would have to pay the difference in tuition for the terms in question. UW–Madison course work taken as a University Special student would not be allowed to count toward the 50% graduate course work minimum unless taken at the 700 level or above. This work will not appear on the graduate career portion of UW–Madison transcript nor count toward the graduate career GPA.
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.

A candidate for a doctoral degree who fails to take the final oral examination and deposit the dissertation within five years after passing the preliminary examination may by require to take another preliminary examination and to be admitted to candidacy a second time.

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/)
  - Office of the Provost for Faculty and Staff Affairs (https://facstaff.provost.wisc.edu/)
  - Dean of Students Office (https://doso.students.wisc.edu/) (for all students to seek grievance assistance and support)
- Employee Assistance (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://employee.disabilities.wisc.edu/) (for qualified employees or applicants with disabilities to have equal employment opportunities)
- Graduate School (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)

Students should contact the program director with questions about grievances.

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. 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