BIOMEDICAL DATA SCIENCE, PHD

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

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	December 15
Spring Deadline	The program does not admit in the spring.
Summer Deadline	The program does not admit in the summer.
GRE (Graduate Record Examinations)	Not required.
English Proficiency Test	Every applicant whose native language is not English, or whose undergraduate instruction was not exclusively in English, must provide an English proficiency test score earned within two years of the anticipated term of enrollment. Refer to the Graduate School: Minimum Requirements for Admission policy: https://policy.wisc.edu/library/UW-1241 (https://policy.wisc.edu/library/UW-1241/).
Other Test(s) (e.g., GMAT, MCAT)	n/a
Letters of Recommendation Required	3

Potential applicants 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., MD's, PharmD's, RN's). It is expected that admitted applicants 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 applicants 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
- International degree-seeking applicants must prove English proficiency using the Graduate School's requirements (https://grad.wisc.edu/apply/requirements/).
- 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://biostat.wiscweb.wisc.edu/education/prospective-students/) on the department website.

FUNDING

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

Face to Face	Evening/ Weekend	Online	Hybrid	Accelerated
Yes	No	No	No	No

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
Minimum Credit Requirement	51 credits
Minimum Residence Credit Requirement	32 credits
Minimum Graduate Coursework Requirement	26 credits must be graduate-level coursework. Refer to the Graduate School: Minimum Graduate Coursework (50%) Requirement policy: https://policy.wisc.edu/library/UW-1244 (https://policy.wisc.edu/library/UW-1244/).
Overall Graduate GPA Requirement	3.00 GPA required. Refer to the Graduate School: Grade Point Average (GPA) Requirement policy: https://policy.wisc.edu/library/UW-1203 (https://policy.wisc.edu/library/UW-1203/).
Other Grade Requirements	PhD 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.
Assessments and Examinations	Students must complete an Oral Preliminary Exam, ideally taken in the students' third year.
Language Requirements	No language requirements.
Graduate School Breadth Requirement	All doctoral students are required to complete a doctoral minor or graduate/professional certificate. Refer to the Graduate School: Breadth Requirement in Doctoral Training policy: https://policy.wisc.edu/library/UW-1200 (https://policy.wisc.edu/library/UW-1200/).

REQUIRED COURSES

Code	Title	Credits
Core Topics		
Biostatistics		*6-8*
Students select one of the following (Topics 1-2):		
Topic 1: Biostatistics Theory and Methods		
STAT 609 & STAT 610	Mathematical Statistics I and Introduction to Statistical Inference	
Topic 2: Biostatistical Methods		
STAT 849 & STAT 850	Theory and Application of Regression and Analysis of Variance I and Theory and Application of Regression and Analysis of Variance II	
Computer Science/Informatics		*6-7*
Students select one of the following (Topics 3-6):		
Topic 3: Machine Learning / AI		
COMP SCI 540 & COMP SCI/ E C E 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/ MATH/STAT 525 & COMP SCI/ I SY E/MATH/ STAT 726	Linear Optimization and Nonlinear Optimization I	
Topic 6: Algorithms		
COMP SCI 577 & COMP SCI 787	Introduction to Algorithms and Advanced Algorithms	
Additional Specializations		*6-8*
Students select any of the above or following topics (Topics 1-11):		
Topic 7: Clinical Informatics		
I SY E 417	Health Systems Engineering	
COMP SCI/ E C E 760	Machine Learning	
or COMP SCI 76	Advanced Natural Language Processing	
Topic 8: Clinical Biostatistics		
B M I/STAT 641 & STAT/B M I 642	Statistical Methods for Clinical Trials and Statistical Methods for Epidemiology	
Topic 9: Statistical Computing		
Students take the following courses:		
STAT 771	Statistical Computing	
STAT/ECON/ GEN BUS 775	Bayesian Statistics	
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/ E C E 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	**6**
Students consult with their advisor to select courses. Possible options listed below.	
POP HLTH 750	Cancer Epidemiology
POP HLTH 752	Principles of Population Health: Determinants of Health and Health Disparities
POP HLTH 753	Principles of Population Health: Population Health and Healthcare Systems
POP HLTH 795	Principles of Population Health Sciences
POP HLTH/ SOC 797	Introduction to Epidemiology
POP HLTH 801	Epidemiology of Infectious Diseases
POP HLTH 805	Advanced Epidemiology: Causal Inference in Epidemiological Studies
POP HLTH 847	Cardiovascular Epidemiology
POP HLTH/ AN SCI/ GENETICS 849	Genetic Epidemiology
MICROBIO 303	Biology of Microorganisms
MICROBIO 450	Diversity, Ecology and Evolution of Microorganisms
MICROBIO 526	Physiology of Microorganisms
BIOCHEM 501	Introduction to Biochemistry
GENETICS 466	Principles of Genetics
GENETICS 467	General Genetics 1
GENETICS 468	General Genetics 2
GENETICS/ MD GENET 565	Human Genetics
GENETICS/ BIOCHEM/ MD GENET 620	Eukaryotic Molecular Biology
GENETICS/ CHEM 626	Genomic Science
GENETICS 633	Population Genetics
GENETICS/ MD GENET 662	Cancer Genetics
GENETICS/ MD GENET 677	Advanced Topics in Genetics
Research Ethics Course	**1-2**
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	
OBS&GYN 955	Responsible Conduct of Research for Biomedical Graduate Students
OBS&GYN 956	Advanced Responsible Conduct of Research for Biomedical Students
Professional Development Elective	
B M I 800	Becoming a Biomedical Data Scientist 1
Second-Year Literature Seminar	
B M I 881	Biomedical Data Science Scholarly Literature 1 2
Third-Year Professional Skills Seminar	
B M I 883 & B M I 884	Biomedical Data Science Professional Skills 1 and Biomedical Data Science Professional Skills 2 2
Electives	**6**
Electives are selected in consultation with the student's faculty advisor.	
Pre-Dissertator Research	**6**
Three semester#long research rotations (2 credits of B M I 899 Pre-dissertator 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**

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 Credits Earned at Other Institutions

With program approval, students are allowed to transfer 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.

Undergraduate Credits Earned at Other Institutions or UW-Madison

Refer to the Graduate School: Transfer Credits for Prior Coursework (https://policy.wisc.edu/library/UW-1216/) policy.

Credits Earned as a Professional Student at UW-Madison (Law, Medicine, Pharmacy, and Veterinary careers)

Refer to the Graduate School: Transfer Credits for Prior Coursework (https://policy.wisc.edu/library/UW-1216/) policy.

Credits Earned as a University Special Student at UW–Madison

Refer to the Graduate School: Transfer Credits for Prior Coursework (https://policy.wisc.edu/library/UW-1216/) policy.

PROBATION

Refer to the Graduate School: Probation (https://policy.wisc.edu/library/UW-1217/) policy.

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

Refer to the Graduate School: Time Limits (https://policy.wisc.edu/library/UW-1221/) policy.

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/)
- Employee Assistance (http://www.eao.wisc.edu/) (for personal counseling and workplace consultation around communication and conflict involving graduate assistants and other employees, post-doctoral students, faculty and staff)
- Employee Disability Resource Office (https://employeedisabilities.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 Student Assistance and Support (OSAS) (https://osas.wisc.edu/) (for all students to seek grievance assistance and support)
- 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, inquiries 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

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

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

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