GRADUATE PROGRAM IN BIOSTATISTICS

Student Handbook

Division of Biostatistics
Medical College of Wisconsin
8701 Watertown Plank Road
Milwaukee, WI 53226
Phone: (414) 955-8280
Fax: (414) 955-6513
Email: phdbiostatistics@mcw.edu

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Introduction
This handbook is intended for students entering the graduate programs in the Division of Biostatistics in the Institute for Health and Society at the Medical College of Wisconsin. It describes the programs, including detailed course requirements and related academic processes throughout the student’s pursuit of a graduate degree in the Division.

The College:
The Medical College of Wisconsin is a private, national, freestanding educational institution that offers MD, PhD, MS, MA and MPH degrees. The Medical College was founded on May 20, 1893, as the Wisconsin College of Physicians and Surgeons. In 1913, the Wisconsin College of Physicians and Surgeons and the Milwaukee Medical College merged to become the Marquette University School of Medicine.

In 1967, Marquette University, due to financial constraints, terminated its sponsorship of the medical school. The school then continued as a private, freestanding institution. Its name was changed in 1970 to the Medical College of Wisconsin. The Medical College has more than 15,000 alumni.

In 1978, the College moved to its present location in suburban Milwaukee, on the 240 acre campus of the Milwaukee Regional Medical Center. Other institutions on the campus include Froedtert Memorial Lutheran Hospital, Children’s Hospital of Wisconsin, Milwaukee County Mental Health Complex, Curative Rehabilitation Center and the Blood Research Center of Wisconsin. The College benefits from a close working relationship with these institutions, as well as other Milwaukee institutions including the Zablocki Veterans Affairs Medical Center, Marquette University, the University of Wisconsin at Milwaukee, and the Milwaukee School of Engineering.

The Medical College of Wisconsin is internationally known for its research programs. These programs offer opportunities for students to study with funded investigators at the cutting edge of biomedical research. In addition to the traditional biomedical departments, several interdisciplinary research opportunities are available in areas such as cancer biology, functional imaging, molecular biology and genetics, neuroscience and cardiovascular physiology. Special research centers and facilities at the College include the Human and Molecular Genetics Center, Nuclear Magnetic Resonance Laboratories, Electron Microscope Laboratory, NIEHS Aquatic Biomedical Research Center, Protein and Nucleic Acid Laboratory, Center for International Blood and Marrow Transplant Research, Center for AIDS Intervention Research, Cardiovascular Research Center, Clinical Research Center, Injury Research Center, Cancer Center and Center for Patient Care and Outcomes Research. The research effort at the Medical College has grown remarkably over the past 20 years. Today, the college is among the upper half of academic medical institutions in terms of research support from the National Institutes of Health, and in the upper third of all medical institutions nationally in overall research and training support.

In 2007, the Higher Learning Commission of the North Central Association of Colleges and Schools (HLC-NCA) granted reaccreditation to the Medical College for the longest term possible (10 years). The NCA is the accrediting body for all institutions of higher education in the Medical College’s geographic region. (HLC - www.ncahlc.org)

In 2011, the Liaison Committee on Medical Education (LCME) awarded full, eight-year accreditation to the Medical College, the maximum period of accreditation. The LCME is the -accrediting body of all U.S. medical schools.
The Graduate School of Biomedical Sciences:
Programs of graduate study in biomedical sciences have been an integral part of the Medical College since early in the past century. The Graduate School of Biomedical Sciences at the Medical College of Wisconsin has as its primary mission the provision of graduate study and research training opportunities for degree-seeking students who wish to study in an interdisciplinary environment and desiring to achieve intellectually stimulating careers as productive biomedical scientists.

The Graduate School has programs leading to PhD degrees in basic and translational research; biochemistry; biophysics; biostatistics; cell biology, neurobiology and anatomy; microbiology, immunology and molecular genetics; pharmacology and toxicology; physiology; public and community health; and functional imaging (joint PhD program with Marquette University).

Master’s degrees are offered in: bioethics (MA), clinical and translational science (MS), and public health (MPH). Joint degree programs are offered in: bioinformatics (MS) and healthcare technologies management (MS) with Marquette University, and medical informatics (MS) with the Milwaukee School of Engineering. In addition, Graduate Certificate programs are offered in Clinical Bioethics, Public Health, Research Ethics, and a joint Bioethics Certificate with the American Medical Association. All programs emphasize biomedical research, and students are expected to make original contributions to knowledge in their chosen field.

Currently, there are more than 1,265 students enrolled in educational programs at the Medical College. This includes 816 medical students and more than 450 graduate students. Class sizes are small and the overall student-to-faculty ratio is better than 1:1. A low student-to-faculty ratio fosters individual attention and a close working relationship between student and faculty mentor.

The Division of Biostatistics:
The Division of Biostatistics is a part of the Institute for Health and Society at the Medical College of Wisconsin. Other divisions in the Institute include Center for Bioethics and Medical Humanities, Community Engagement, Education, Global Health, and Health Equity and Urban Clinical Care Partnerships. The Biostatistics Division has 12 full time faculty members, three faculty members with joint appointment with Biostatistics Division, and several adjunct faculty members whose primary appointments are in the Mathematical Sciences Department at the University of Wisconsin-Milwaukee.

The Biostatistics faculty are engaged in a number of collaborative research projects:
- Center for International Blood and Marrow Transplant Research
- General Clinical Research Center
- Center for Patient Care and Outcomes Research
- Medical College of Wisconsin- Clinical Cancer Center
- Functional Imaging Research Center
- Center for Human and Molecular Genetics
- Specific projects in genetics, medical imaging, clinical trials, and pharmacologic modeling

Students participate in these projects under faculty supervision. Dissertation research topics in statistical methodology often evolve from such participation, and students usually become co-authors on papers arising from these projects. Faculty is also engaged in research aimed at development of new statistical methodologies, evaluating recently developed methods and investigating their theoretical properties. The research areas of the faculty include survival analysis, random effect models, statistical genetics, model selection, Bayesian statistics, time series analysis, missing data problems, longitudinal
data analysis, nonparametric statistics, decision theory, functional magnetic resonance imaging, epidemiology, design of clinical trials, multiple comparisons, high dimensional data analysis, variable selection, and personalized medicine.

The Division of Biostatistics maintains a computing system composed of Linux client-server environment with networked workstations and PC's. All biostatistics graduate students are provided SUN workstations. Available software includes C++, FORTRAN, R, SAS, BUGS, MATHEMATICA, and MATLAB.

For up-to-date information on the Division of Biostatistics see the page: www.mcw.edu/biostatistics

Contact Us:
The Division of Biostatistics
Medical College of Wisconsin
8701 Watertown Plank Road
Milwaukee WI 53226
Phone: 414-955-8280
Fax: 414-955-6513
Email: phdbiostatistics@mcw.edu

PhD PROGRAM IN BIOSTATISTICS
The program leading to PhD degree in Biostatistics is offered through the Graduate School of Biomedical Sciences at the Medical College of Wisconsin. It is designed for students with strong undergraduate preparation in Mathematics. The curriculum includes a sound foundation in statistical theory and applications, and training in statistical consulting. In addition, students gain substantial training and experience in statistical computing and software packages. The degree requirements, including dissertation research, are typically completed in at most five years for a well-prepared student entering the program with a B.S. degree. The program is in collaboration with the faculty of the Department of Mathematics at the University of Wisconsin-Milwaukee. Courses in the program are offered in collaboration with the Department of Mathematics at the University of Wisconsin-Milwaukee with several required courses taught on the UWM campus.

Admission Requirements
The minimum admission requirements are:

A. Undergraduate degree in mathematics or closely related fields from an accredited college or university.
B. Overall grade point average of B or better.
C. B average or better in mathematics and science.
D. An average of 60% or greater on the scores of the Quantitative and Verbal components, and a 3.5 or greater on the Analytical Writing component of the Graduate Record Examination (GRE): http://www.ets.org/gre. Tests must have been taken within five years from the date of application.
E. Non-US citizens are required to take a Test of English as a Foreign Language (TOEFL): http://www.ets.org/toefl. A minimum acceptable TOEFL score is 100 on the Internet based version (including Speaking). Our Institution Code is 1519, Department code is 0000 (or leave the department code blank).
Applicants are also expected to have completed courses in advanced calculus, linear/matrix algebra and scientific programming with minimum grade of B in each of these courses. Those who have not done so may be considered for admission to the program upon approval of the biostatistics admission committee, and if admitted, these requirements must be completed during the first year of study. In addition to the above requirements, the applicant must have strong interest in pursuing research in biomedical sciences.

Financial Support
Every entering full time student is supported year round by a Fellowship for the first 18 months, followed by a Research Assistantship for the remaining part of the program, for a maximum of 5 total years of support. The research assistantships provide students with the opportunity to gain experience in statistical consulting and collaborative research. Both types of support include the cost of tuition and fees, a stipend to cover living expenses, and an allowance toward health insurance. The stipend for the academic year 2015-2016 is $28,422. The college provides the health insurance to all stipend students, with additional benefits for dental and vision coverage requiring a nominal cost for dental and vision coverage.

During the fellowship period the student is expected to give full time effort to graduate studies, taking minimum 12 credit hours of coursework per semester in the Fall and Spring, and 9 credit hours in the Summer. As a Research Assistant, the student works 20 hours per week on research projects under faculty supervision. The course load during this period is 9 credit hours per semester, 6 in the summer.

In addition to coursework and research, throughout the student’s graduate program, participation in the Division’s seminar series – the weekly lunch seminar and the biweekly Special Talks – is expected. General participation in the activities of the Division and the Graduate Student Association via committee memberships and volunteering is greatly encouraged.

Student Advising
Upon entering the program the Director of Graduate Studies serves as the student’s academic advisor until the student identifies a dissertation advisor with mutual agreement – usually at the beginning of the third academic year. The student’s choice of dissertation advisor must be approved by the Director of Graduate Studies and the Division Director. Dissertation advisors are typically chosen from the senior faculty. A junior faculty member who has not previously served as dissertation advisor may do so, provided a more experienced faculty member is chosen as co-advisor. Students are required to spend time reading with two faculty members prior to selecting a dissertation advisor.

Prior to selecting the dissertation advisor, students will work with the Director of Graduate Studies to complete a "Plan of Study” form. This form includes selection of appropriate elective courses, covers plans to make up deficiencies in admission requirements as soon as possible, and describes the planned course schedule to complete the required course work. This plan is to be completed prior to signing up for courses in each semester. Once a dissertation advisor is selected, the student works with this advisor to update the "Plan of study form", and then submits it to the Director of Graduate Studies for approval. From this point forward, the dissertation advisor monitors the student’s program and progress.
## Course Curriculum

### A. Required Courses:

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>10222a</td>
<td>Ethics and Integrity in Science</td>
<td>1</td>
</tr>
<tr>
<td>04214</td>
<td>Design and Analysis of Clinical Trials</td>
<td>3</td>
</tr>
<tr>
<td>04220</td>
<td>Research Seminar</td>
<td>1</td>
</tr>
<tr>
<td>04221</td>
<td>Theory of Consulting</td>
<td>2</td>
</tr>
<tr>
<td>04222</td>
<td>Statistical Consulting</td>
<td>3</td>
</tr>
<tr>
<td>04224</td>
<td>Biostatistical Computing</td>
<td>3</td>
</tr>
<tr>
<td>04231</td>
<td>Statistical Models and Methods I</td>
<td>3</td>
</tr>
<tr>
<td>04232</td>
<td>Statistical Models and Methods II</td>
<td>3</td>
</tr>
<tr>
<td>04233</td>
<td>Statistical Models and Methods III</td>
<td>3</td>
</tr>
<tr>
<td>04275</td>
<td>Applied Survival Analysis</td>
<td>3</td>
</tr>
<tr>
<td>04285</td>
<td>Introduction to Bayesian Analysis</td>
<td>3</td>
</tr>
<tr>
<td>04295</td>
<td>Reading and Research</td>
<td>1-9</td>
</tr>
<tr>
<td>04313</td>
<td>Statistical Computing</td>
<td>3</td>
</tr>
<tr>
<td>04363</td>
<td>Advanced Statistics I</td>
<td>3</td>
</tr>
<tr>
<td>04365</td>
<td>Linear Models I</td>
<td>3</td>
</tr>
<tr>
<td>04384</td>
<td>Statistical Genetics</td>
<td>3</td>
</tr>
<tr>
<td>04385</td>
<td>Advanced Bayesian Analysis</td>
<td>3</td>
</tr>
<tr>
<td>04386</td>
<td>Advanced Survival Analysis</td>
<td>3</td>
</tr>
<tr>
<td>04399</td>
<td>Doctoral Dissertation</td>
<td>1-9</td>
</tr>
<tr>
<td>04231/MTHSTAT 761*</td>
<td>Mathematical Statistics I</td>
<td>3 credit hours</td>
</tr>
<tr>
<td>04232/MTHSTAT 762*</td>
<td>Mathematical Statistics II</td>
<td>3 credit hours</td>
</tr>
<tr>
<td>PH721*</td>
<td>Introduction to Translational Bioinformatics</td>
<td>3 credit hours</td>
</tr>
</tbody>
</table>

*courses taken at UW-Milwaukee

### B. Reading and Research:

Beginning with the summer after the first academic year students take Readings & Research (04295) hours with various faculty members. The purpose of this is to become familiar with faculty interests and engage in independent preparatory work in possible areas of dissertation research to begin later in the program. Over the first two years students are required to read with at least two different faculty members before making a choice of dissertation topic and advisor. During the third academic year students continue to take Readings & Research hours, now with one faculty member, concentrating in an area of research that will lead to a dissertation proposal. After passing the Qualifying Examination and presenting a dissertation proposal, research is carried out under Readings & Research hours until the final semester in which the student defends the dissertation and graduates.

### C. Writing Requirement:

Students are required to prepare written reports on two consulting/collaborative research projects during the first two years of study. These reports should include a description of the biological problem, a discussion of the statistical methods used in the analysis and a presentation of results. The reports must be written for presentation to the clinical investigator and not be focused solely on statistical techniques. A guide to writing consulting reports can be found in The Statistical Consultant in Action by DJ Hand & BS Everitt, Cambridge University Press, 1987.
Reports can be based either on projects from the student’s consulting classes or from the student’s work assignment. The papers should be 5-10 pages in length as a guide. The documents must be approved by a faculty member (typically the instructor of the consulting class or the supervising faculty member for a collaborative project).

D. **Elective Courses:**
A minimum of 6 credit hours of biological/medical science electives are required. Students may take appropriate courses from MCW, UWM or Marquette to satisfy the elective requirements. Electives must be approved by the student’s advisor and the Graduate Committee of the Division. Examples of courses meeting this requirement are:

- **BIOETH 201 Medical Ethics** 2 credit hours
- **BIOETH 222 Ethics and Integrity in Science** 2 credit hours
- **BIOETH 232 Ethics, Policy and Genetic Technology** 2 credit hours
- **BIOPHYSICS 215 Medical Physics** 1 credit hour
- **CELLBIO 150 Introductory Cell Biology** 1 credit hour
- **CELLBIO 152 Human Development** 1 credit hour
- **CELLBIO 207 Introduction to Neuroscience** 2 credit hours
- **EPI 201 Clinical Epidemiology** 3 credit hours
- **EPI 256 Research Methods in Epidemiology** 3 credit hours
- **EPI 272 Epidemiology of Cardiovascular Disease** 1 credit hour
- **EPI 274 Cancer Epidemiology** 1 credit hour
- **PHARM 202 Survey of Pharmacology** 3 credit hours
- **PHY 285 Mathematical Biology** 3 credit hours

E. **Research Seminar:**
Each semester, students are required to participate in the Division’s two seminar series – the weekly seminar at lunch and the biweekly series of Special Talks. Credit for this activity is obtained by registering for 1 hour of 04220 Research Seminar.

**Examination Process**

A. **Preliminary Examinations:** Upon completion of the necessary courses, the student is given two written preliminary examinations. One addresses Theory of Statistics, covering the subject matter from Statistical Inference I & II. The other, on Applied Statistics, covers Statistical Models and Methods I, II and III, Design and Analysis of Clinical Trials and Biostatistical Consulting. Both examinations are organized and administered by the Division’s Graduate Studies Committee. Evaluation is done by the entire faculty. The criteria for evaluation are the student’s understanding and competency in basic principles and foundations of biostatistics, and his/her potential for conducting independent research in statistical methods and applications. To continue in the Ph.D. program, both examinations must be successfully completed by the end of August in the student’s second year. The examinations are offered every August. If a student does not pass an exam, he/she is given a second opportunity to take it in January.

B. **Choosing an Advisor and forming a Dissertation Committee:** By the beginning of the Fall semester in the student’s third year in the program, the student chooses a member of the Division’s faculty as his/her advisor with mutual agreement. It is expected that this choice will grow out of the student’s coursework, two research and readings courses, seminar participation
and general immersion in the Division’s academic activities. The two readings courses are taken in the first summer and the second spring or summer semesters. The student’s choice of advisor must be approved by the Director of Graduate Studies and the Division Director. Advisors are typically chosen from the senior faculty. A junior faculty member who has not previously served as dissertation advisor may do so provided a more experienced faculty member is chosen as co-advisor.

In close consultation with the advisor, the student forms the Dissertation Committee in full accordance with the requirements of the Graduate School. The committee consists of five graduate faculty members including the advisor. Four of the five must be from the Division of Biostatistics (including Joint and Adjunct faculty) and one must be from outside the Division of Biostatistics. The committee must be approved by the Director of Graduate Studies and the Division Director. The process of committee formation, including submission of the appropriate form to the Graduate School, must be completed by the end of September in the student’s third year. From this date forward the student’s progress is monitored by the advisor and the Dissertation Committee.

C. **Qualifying Examination:** Upon successful completion of the preliminary exam and at a time determined by the Dissertation Committee, the student is given a qualifying examination. This examination is individualized for each student, and it is organized, administered and evaluated by his/her Dissertation Committee. The evaluations are based on student’s in-depth understanding and competency in advanced topics in biostatistics, and his/her ability and maturity to apply the knowledge earned from the course-work in conducting meaningful research. The exam consists of two parts. One part is an oral examination testing the student’s general statistical knowledge at the advanced level. The other part consists of writing a dissertation proposal and presenting it to the Division. This proposal must be approved by his/her Dissertation Committee. A student not passing either part of the exam may be given another chance to retake that part within three months of the first attempt. Students passing this exam will be admitted to Ph.D. candidacy.

D. **Final Examination:** The PhD candidate must submit a dissertation representing an original research contribution. It must show high attainment and clear ability to carry out independent biostatistics research of publishable quality. The final oral examination, including a public defense of the dissertation, is administered by his/her Dissertation Committee after the student has completed all other formal requirements for the PhD degree. The student is expected to demonstrate a good understanding of the general field in which the dissertation is written. The student’s Dissertation Committee will evaluate the performance of the student in the dissertation defense.
**Sample Program Plans**

Typical sequence for the completion of required courses (starting in even year):

<table>
<thead>
<tr>
<th>Fall 1:</th>
<th>Spring 1:</th>
<th>Summer 1:</th>
</tr>
</thead>
<tbody>
<tr>
<td>04214: Clinical Trials</td>
<td>04232: Models &amp; Methods II</td>
<td>04222: Statistical Consulting</td>
</tr>
<tr>
<td>04224: Biostat Computing</td>
<td>04262: Statistical Inference II*</td>
<td>04295: Readings &amp; Research</td>
</tr>
<tr>
<td>04231: Models &amp; Methods I</td>
<td>04285: Intro. Bayesian</td>
<td>Elective/Prob/Programming</td>
</tr>
<tr>
<td>04261: Statistical Inference I*</td>
<td>04221: Theory of Consulting</td>
<td></td>
</tr>
<tr>
<td>Elective/Math/Programming</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fall 2:</th>
<th>Spring 2:</th>
<th>Summer 2:</th>
</tr>
</thead>
<tbody>
<tr>
<td>04385: Advanced Bayesian</td>
<td>04275: Applied Survival</td>
<td>04295: Readings &amp; Research</td>
</tr>
<tr>
<td>04313: Advanced Computing</td>
<td>Bioinformatics*</td>
<td></td>
</tr>
<tr>
<td>Epi Elective Course</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fall 3:</th>
<th>Spring 3:</th>
</tr>
</thead>
<tbody>
<tr>
<td>04275: Linear Models I</td>
<td>04384: Statistical Genetics</td>
</tr>
<tr>
<td>04386: Advanced Survival</td>
<td>Elective Course</td>
</tr>
<tr>
<td>Elective Course</td>
<td></td>
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</tbody>
</table>

Typical sequence for the completion of required courses (starting in odd year):

<table>
<thead>
<tr>
<th>Fall 1:</th>
<th>Spring 1:</th>
<th>Summer 1:</th>
</tr>
</thead>
<tbody>
<tr>
<td>04231: Models &amp; Methods I</td>
<td>04232: Models &amp; Methods II</td>
<td>04222: Statistical Consulting</td>
</tr>
<tr>
<td>04224: Biostat Computing</td>
<td>04262: Statistical Inference II*</td>
<td>04295: Readings &amp; Research</td>
</tr>
<tr>
<td>04261: Statistical Inference I*</td>
<td>04285: Intro. Bayesian</td>
<td>Elective/Prob/Programming</td>
</tr>
<tr>
<td>Elective/Math/Programming/Epi</td>
<td>04221: Theory of Consulting</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fall 2:</th>
<th>Spring 2:</th>
<th>Summer 2:</th>
</tr>
</thead>
<tbody>
<tr>
<td>04214: Clinical Trials</td>
<td>04285: Intro. Bayesian</td>
<td>04295: Readings &amp; Research</td>
</tr>
<tr>
<td>04386: Advanced Survival</td>
<td>04384: Statistical Genetics</td>
<td>Consulting/Elective</td>
</tr>
<tr>
<td>04275: Linear Models I</td>
<td>Bioinformatics*</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fall 3:</th>
<th>Spring 3:</th>
</tr>
</thead>
<tbody>
<tr>
<td>04264: Advanced Bayesian</td>
<td>04363: Advanced Statistics I</td>
</tr>
<tr>
<td>04233: Models &amp; Methods III</td>
<td>Elective</td>
</tr>
<tr>
<td>04313: Advanced Statistical Computing</td>
<td></td>
</tr>
<tr>
<td>Elective Course</td>
<td></td>
</tr>
</tbody>
</table>

**Dissertation Research Requirements**

The student begins his/her dissertation research during the third year. The initial step consists of identifying a topic that is of mutual interest to the student and a member of the faculty who serves as the dissertation advisor. Courses, talks and presentations by the faculty assist the student in this process. After a literature survey and a clearer definition of the scope of the research under the direction of the advisor, the student submits a written proposal and presents it orally to the advisory committee. During the conduct of dissertation research the advisory committee meets periodically to monitor the student’s progress. Upon completion of the proposed research the student submits the dissertation and defends it in a public presentation.

*Courses taught at UWM Mathematics Department*
The dissertation must be an original contribution to scientific knowledge. It can involve development of new statistical methodologies, evaluation of existing methodologies and study of their properties, innovative application of existing methodologies, or any combination of the above. The dissertation should be of publishable quality in peer reviewed journals in biostatistics or statistics.

**Academic Life/Activities:**
The Division’s academic activities include regular Biostatistics Seminar Series and consulting meetings. Students are expected to participate actively in both. The faculty, staff and students in the Division work together in an informal environment. There are regular social gatherings to facilitate and enhance interaction among the faculty, staff and students. In addition, students are urged to participate in the activities of the Graduate Student Association, including its fund raising efforts.

**MS Program in Biostatistics:**
The Division of Biostatistics offers a Master’s degree in Biostatistics. Currently no students are admitted to this degree program, reserving all admissions to those intending to complete the PhD program. The MS degree is thus only occasionally awarded to those who must discontinue the PhD program but have met the MS requirements.

**A. Required Courses:**

*All of the following courses:*

- BIOST 214 Design and Analysis of Clinical Trials 3 credit hours
- BIOST 224 Biostatistical Computing 3 credit hours
- BIOST 231 Statistical Models and Methods I 3 credit hours
- BIOST 232 Statistical Models and Methods II 3 credit hours
- BIOST 233 Statistical Models and Methods III 3 credit hours
- BIOST 275 Applied Survival Analysis 3 credit hours
- BIOST 285 Introduction to Bayesian Analysis 3 credit hours
- BIOST 221 Theory of Consulting 2 credit hours
- BIOST 222 Statistical Consulting 3 credit hours
- BIOETH 1022a Ethics and Integrity in Science 1 credit hour
- 04231/MTHSTAT 761* Mathematical Statistics I 3 credit hours
- 04232/MTHSTAT 762* Mathematical Statistics II 3 credit hours

*Any two of the following courses:*

- BIOST 264 Time Series Analysis* 3 credit hours
- BIOST 280 Applied Probability* 3 credit hours
- BIOST 313 Advanced Statistical Computing 3 credit hours
- BIOST 363 Advanced Statistics I 3 credit hours
- BIOST 365 Linear Models I 3 credit hours
- BIOST 384 Statistical Genetics 3 credit hours
- BIOST 385 Advanced Bayesian Analysis 3 credit hours
- BIOST 386 Theory of Survival Analysis 3 credit hours
- PH721* Introduction to Translational Bioinformatics 3 credit hours

*Courses taught at UWM Mathematics Department*
B. **Writing Requirement:** Students are required to prepare written reports on two consulting/collaborative research projects. These reports should include a description of the biological problem, a discussion of the statistical methods used in the analysis and a presentation of results. The reports must be written for presentation to the clinical investigator and not be focused solely on statistical techniques. A guide to writing consulting reports can be found in The Statistical Consultant in Action by DJ Hand & BS Everitt, Cambridge University Press, 1987.

Reports can be based either on projects from the student’s consulting classes or from the student’s work assignment. The papers should be 5-10 pages in length as a guide. The documents must be approved by a faculty member (typically the instructor of the consulting class or a member of the student’s examination committee).

**Description of Courses**

**04214 Design and Analysis of Clinical Trials.** 3 credits.
Prerequisites: Statistical Models and Methods I or concurrent registration
This course covers issues in clinical trials including the clinical trial protocol, sources of bias in clinical trials, blinding, randomization, sample size calculation; phase I, phase II, phase III and hybrid trials; interim analysis, stochastic curtailment, Bayesian designs, and administrative issues in study design.

**04220 Research Seminar.** 1 credit.
Prerequisites: Concurrent registration
Students present plans for an analysis of research projects and research data. Projects and examples from classical and current literature are discussed by students and faculty.

**04221 Theory of Statistical Consulting.** 2 credits.
Prerequisites: Statistical Models and Methods I
Theory of consulting, statistical techniques most often used in consulting, practical experience in the real consulting setting and writing statistical reports.

**04222 Statistical Consulting.** 1-3 credits.
Prerequisites: Statistical Models and Methods I & II
This course is designed for students to gain experience in statistical consulting by working with the biostatistics faculty members on various consulting projects.

**04224 Biostatistical Computing.** 3 credits.
Prerequisites: Statistical Models and Methods I or concurrent registration
This course will cover the details of manipulating and transforming data required for statistical analysis. Topics include reshaping the data from a per-case to a per-event within a case and vice-versa. It will also cover the techniques necessary to write functions and macros in both SAS and R for developing new/modified data analysis methods. How to use R packages and C/C++ codes in R will also be covered. The LaTeX document production system is also introduced.
04231 Statistical Models and Methods I. 3 credits.
Prerequisite: Three semesters of calculus and one semester of linear algebra
This course will cover statistical techniques for basic statistics. Topics include one-sample/two-sample
tests, analyses for count data and contingency tables, basic nonparametric methods including sign, rank-
sum and signed-rank tests, simple linear regression model and inference, checking model assumptions,
model diagnostics, correlation analysis, one-way analysis of variance, Kruskal-Wallis one-way ANOVA,
simple logistic regression, and weighted linear regression. SAS/R will be used throughout the course.

04232 Statistical Models and Methods II. 3 credits.
Prerequisite: Statistical Models and Methods I
This course will cover various regression models for independent and correlated data. Topics include
multiple linear regression, model diagnostics, variable selection, influence/leverage, outliers,
collinearity, transformation, GLM including logistic and Poisson regression, overdispersion, GEE, mixed
models, and GLMM. SAS/R will be used throughout the course.

04233 Statistical Models and Methods III. 3 credits.
Prerequisite: Statistical Models and Methods II
This course will cover modern and specialized topics in regression. Topics include lasso type penalized
regression (frequentist and Bayesian), graphical lasso, p>>n problems, random forests, regression trees,
additive models, spline smoothing, PCA, ridge regression, causal inference, propensity score, quantile
regression, and Bayesian CART/BART.

MTHSTAT 761 * Mathematical Statistics I. 3 credits. (UWM registration)
Fundamentals of probability, independence, distribution and density functions, random variables,
moments and moment-generating functions, discrete and continuous distributions, exponential families,
location and scale families, marginal and conditional distributions, transformation and change of
variables, multivariate distributions, random samples, convergence concepts, sampling from normal
distributions, order statistics.

MTHSTAT 762 * Mathematical Statistics II. 3 credits. (UWM registration)
Point estimation, interval estimation, hypothesis testing, minimal sufficiency and completeness, ancillary
statistics, likelihood and invariance principle, asymptotic properties of estimators and likelihood ratio
tests, LMP tests, union-intersection tests, pivotal quantities, coverage probability, large-sample
estimation and testing.

PH721 * Introduction to Translational Bioinformatics. 3 credits. (UWM registration)
Bioinformatics has become one of the major disciplines in modern biomedical research. Knowledge and
analytic skills to retrieve the most relevant information imbedded in the large omic data are key to the
discovery for translational research. This course will review high-throughput technologies that produce
various omic data, along with the methodologies and tools to analyze and interpret these different
layers of information. Topics will cover a variety of data mining techniques and the use of several
widely-used bioinformatics software and programming tools with emphasis on guiding students through
the process of translating genomics data into biological knowledge, towards the discovery of novel
therapeutic targets, biomarkers and the dissection of gene networks and pathways.
04275 Applied Survival Analysis. 3 credits.
Prerequisites: Statistical Models and Methods I
Basic parameters in survival studies; Censoring and truncation, Competing risks; Univariate estimation including the Kaplan-Meier and Nelson-Aalen estimator; tests comparing two or more populations, the log rank test; Semi-parametric regression, the Cox model; Aalen’s Additive hazards regression model; regression diagnostics.

04285 Introduction to Bayesian Analysis. 3 credits.
Prerequisites: Statistical Models and Methods I
This course introduces basic concepts and computational tools for Bayesian statistical methods. Topics covered include one and two sample inference, regression models and comparison of several populations with normal, dichotomous and count data.

04295 Reading and Research. 1-9 credits.
Prerequisites: Concurrent registration
Readings in recent literature and supervised research project.

04313 Advanced Statistical Computing. 3 credits.
Prerequisites: Statistical Models and Methods II, Statistical Inference II, Biostatistical Computing
This course will focus on numerical computing of statistics and algorithm programming. Topics include: numerical random number generation, likelihood maximization, numerical integration using quadrature and Monte-Carlo methods, the EM algorithm, Monte Carlo simulation, resampling (Bootstrap, permutation, Jackknife), optimization for penalized regression, parallel computing, and creating R packages.

04363 Advanced Statistics I. 3 credits.
Prerequisites: Statistical Models and Methods II, Statistical Inference II
This course covers both the theoretical framework and practical aspects of statistical models. The course will cover likelihood inference, properties of likelihood, exponential families and GLM, large sample properties of likelihood based inference, likelihood based regression models, GEE, conditional and marginal likelihood, asymptotics of penalized regression.

04365 Linear Models I. 3 credits.
Prerequisites: Statistical Inference II
This course will cover review of matrix algebra and vector spaces, multivariate normal distribution, quadratic forms, least squares estimation, ANOVA, testing contrasts, multiple comparison, lack-of-fit test, multiple regression models, and mixed models. Emphasis is on theory.

04384 Statistical Genetics. 3 credits.
Prerequisites: Linear Models I, Statistical Inference II
This course will cover the fundamental concepts in population genetics and statistical models and methods on genetic linkage and association mapping studies. Topics include Mendelian inheritance, Hardy-Weinberg equilibrium, linkage disequilibrium, allele identity by descent (IBD), inbreeding and coancestry coefficients, genetic models heritability, genetic variance components, linkage analysis, haplotype analysis, case-control association analysis, and association analysis using family data, adjust for population admixture, rare variants, microarray data analysis, eQTL, CNV, proteomic and methylation data analysis.
04385 **Advanced Bayesian Analysis.** 3 credits.
Prerequisites: Introduction to Bayesian Analysis
A combination of Bayesian principles, tools and methods; emphasis is on models, computations and analysis. Likelihood function, prior, posterior and predictive distributions, Bayes factors, HPD regions, conjugate and non-informative priors in the exponential family, Markov chain Monte Carlo methods for the generalized linear model, hierarchical models, restricted parameter spaces and censored data, examples of Bayesian analyses of complex biomedical models.

04386 **Theory of Survival Analysis.** 3 credits.
Prerequisites: Applied Survival Analysis, Statistical Inference II
Analysis of survival data using counting process techniques. Topics include the mathematical theory of counting process, censoring and truncation, estimation of the survival and cumulative hazard functions, extensions of k sample nonparametric tests to censored and truncated data, proportional hazards and additive hazards regression models.

04391 **Special Topics in Statistics.** 1-3 credits.
Prerequisites: Concurrent registration
This course is designed to cover special topics in biostatistics that are not covered in regular courses. The topics will depend on the research interests of the instructor and the students.

04399 **Doctoral Dissertation.** 9 credits.
Prerequisites: Concurrent registration

**Faculty & their Research Interest:**
The Division of Biostatistics currently has 13 full-time faculty members all dedicated to specific areas of statistical methodology. Please visit their personal faculty pages on the Biostatistics webpage here: [www.mcw.edu/biostatistics/FacultyStaff.htm](http://www.mcw.edu/biostatistics/FacultyStaff.htm)

**Purushottam W. (Prakash) Laud, PhD, Professor**
University of Missouri-Columbia (Statistics) 1977
Professor Laud joined the Division of Biostatistics in the spring of 1994. He was previously in the Division of Statistics at Northern Illinois University. In statistical research, his general area of interest is Bayesian nonparametric models and computation. Specifically, his interests include analysis of time-to-event data and Bayesian parametric and nonparametric methods for observational data using instrumental variables.

In medical research, Dr. Laud is involved in health services and outcomes research, working with large observational databases as well as with survey data and randomized trials. He collaborates extensively with researchers in the Center for Patient Care and Outcomes Research and the Injury Research Center. He has published over 85 papers in statistical and medical research journals.
Brent R. Logan, PhD, Professor
Northwestern University (Statistics) 2001
Professor Logan joined the Division of Biostatistics in the summer of 2001 after completing his PhD degree at Northwestern University.

Dr. Logan is a biostatistician for the Blood and Marrow Transplant Clinical Trials Network of the Center for International Blood and Marrow Transplant Research, and a statistical consultant for the National Marrow Donor Program. He has research interests in survival analysis, clinical trials, multiple testing, dose-response analysis, and neuroimaging studies. Professor Logan has published over 120 papers, including more than 20 statistical methodology publications.

Mei-Jie Zhang, PhD, Professor
Florida State University (Statistics) 1991
Professor Zhang came to the Medical College of Wisconsin to serve as an assistant professor and a biostatistician for the Center for International Blood and Marrow Transplant Research (CIBMTR) in 1992. Professor Zhang joined the Division of Biostatistics in 1994.

Professor Zhang’s major research areas are survival analysis, inference from stochastic processes, non-linear models and diagnostic testing. As a biostatistician for the CIBMTR he is interested in developing statistical model and methodology for analyzing complex transplant data. His research is funded by the National Institute of Health and the National Cancer Institute. Professor Zhang has published more than 180 original articles in peer-reviewed journals. Dr. Zhang is an Associate Editor for the Lifetime Data Analysis.

Kwang Woo Ahn, PhD, Associate Professor
The University of Iowa (Statistics) 2008
Professor Kwang Woo Ahn joined the Division of Biostatistics in August 2008 coming from the University of Iowa where he received his PhD in August of 2008. His research interests include survival analysis and variable selection.

Ruta Brazauskas, PhD, Associate Professor
Medical College of Wisconsin (Biostatistics) 2003
Professor Ruta Brazauskas joined the Division of Biostatistics in June 2008 coming from the Marquette University where she served as Assistant Professor. Her research interests include survival analysis and competing risks. Most recent methodological work on the issues of paired studies in survival analysis was funded by the CTSA supplemental grant awarded to a group of faculty members at the Division.

Aniko Szabo, PhD, Associate Professor
The University of Memphis (Applied Statistics) 1998
Aniko Szabo is Associate Professor and Director of the Biostatistics Consulting Service. She joined the Division of Biostatistics in the summer of 2007. Prior to joining the Medical College of Wisconsin, she was an Assistant Professor at the Huntsman Cancer Institute and Department of Oncological Sciences at University of Utah. Dr. Szabo’s research interests are in statistical modeling of biomedical data. She has worked on developing tree models of oncogenesis, nonparametric models of clustered discrete data, and population level models of the effect of screening on prostate cancer incidence.
Sergey Tarima, PhD, Associate Professor
University of Kentucky (Statistics) 2005
Professor Tarima joined the Division of Biostatistics in the fall of 2005 after completing the doctorate degree in statistics. In a pre-doctoral position he worked on missing data problems in the Injury Research Center at the University of Kentucky. Professor Tarima's current research interests include methods for using additional information in statistical estimation, estimation with missing, censored and partially grouped data, and survey data analysis.

Tao Wang, PhD, Associate Professor
North Carolina State University (Statistics) 2001
Professor Wang joined the Division of Biostatistics in January 2002, coming from North Carolina State University where he was a PhD student in the Bioinformatics Research Center. He also holds a joint appointment at the Human Molecular Genetic Center (HMGC) here at MCW. Dr. Wang's research interest focuses on statistical genetics. His current researches include theoretical modeling and analysis of quantitative trait loci (QTL), and statistical methods for association mapping of disease genes using polymorphic genetic markers such as single nucleotide polymorphisms (SNPs).

Anjishnu Banerjee, PhD, Assistant Professor
Duke University (Statistics) 2013
Professor Anjishnu Banerjee joined the Division of Biostatistics in July 2014 coming from Amazon Inc. where he was employed as a Research Scientist. He received his PhD from Duke University in May 2013. His research involves statistical modeling for large, complex and high dimensional data using B

Raphael Fraser, PhD, Assistant Professor
Florida State University (Statistics) 2015
Dr. Raphael Fraser works as a Statistician for Bone Marrow Transplant Clinical Trials Network and the Center for International Blood and Marrow Transplant Research. His work includes plasma cell disorders, mainly multiple myeloma. He joined the Division of Biostatistics in the fall of 2015 and is also an adjunct professor in the Department of Mathematical Sciences at the University of Wisconsin, Milwaukee. Before joining the Division of Biostatics, Dr. Fraser worked at the Tropical Medicine Research Institute in Kingston, Jamaica where he focused primarily on sickle cell disease. His research interests are survival analysis, clinical trials, Bayesian biostatistics, survey methods and empirical process theory.

Soyoung Kim, PhD, Assistant Professor
University of North Carolina at Chapel Hill (Biostatistics) 2013
Professor Soyoung Kim joined the Division of Biostatistics in September 2015, coming from Fred Hutchinson Cancer Research Center where she served as Postdoctoral research fellow. Her research interests include survival analysis, case-cohort studies, casual inference, biomarker evaluation, variable selection, and missing data.

Ying Liu, PhD, Assistant Professor
Columbia University (Biostatistics) 2016
Dr. Ying Liu joined the Division of Biostatistics in summer 2016. The focus of her research is in merging statistical modeling with medical domain knowledge and machine learning algorithms to help making personalized medical decisions to fulfill the promise of medical big data to bring about more efficient and affordable patient-centered health care to everyone.
Rodney Sparapani, PhD Assistant Professor  
Medical College of Wisconsin (Biostatistics) 2011  
Dr. Sparapani joined the Division of Biostatistics in December 2013 coming from the Center for Patient Care and Outcomes Research at MCW where he served as the Sr. Biostatistician. His research focuses on applying Bayesian methodology to modern biostatistical problems such as survival analysis, health services research, causal inference, comparative effectiveness research and big data/omics.

Adjunct Faculty  
*From Department of Mathematical Sciences, University of Wisconsin – Milwaukee:*

- Pippa Simpson, PhD, Professor, Medical College of Wisconsin, Quantitative Health Sciences  
  University of Kentucky, Lexington 1988  
  Research Interests: Biostatistics, Clinical Effectiveness and Outcomes, Genetic Diseases/Genomics

- Jay Beder, PhD, Professor  
  George Washington University 1981  
  Research Interests: Gaussian Processes, Design

- Vytaras Brazauskas, PhD, Associate Professor  
  University of Texas - Dallas 1999  
  Research Interests: Robust & Nonparametric Methods, Actuarial Science

- Daniel Gervini, PhD, Associate Professor  
  University of Buenos Aires 1999  
  Research Interests: Robust & Nonparametric Methods, Dimension Reduction

- Jugal Ghorai, PhD, Professor  
  Purdue University 1977  
  Research Interests: Nonparametric Estimation, Survival Analysis

- Eric Key, PhD, Professor  
  Cornell University 1983  
  Research Interests: Probability Theory, Stochastic Processes

- Tom O’Bryan, PhD, Associate Professor, Associate Dean UWM Letters & Science  
  Michigan State University 1972

- Gilbert Walter, PhD, Professor Emeritus  
  University of Wisconsin 1962  
  Research Interests: Mathematical Analysis, Sampling Theorems

- Daniel Rowe, PhD, Associate Professor, Marquette University, Department of Biophysics  
  University of California- Riverside 1998  
  Research Interests: Statistical Methods in fMRI, Matrixvariate Bayesian Analysis, Time Course Modeling
Collaborative Research Opportunities
Faculty and students in the Division of Biostatistics play important roles in a number of centers and program projects at the Medical College of Wisconsin. The types of problems encountered in these projects often motivate dissertation topics for students.

Biostatistics Consulting Service
http://www.mcw.edu/Biostatistics-Consulting-Service.htm
The consulting service in the Division of Biostatistics at the Medical College of Wisconsin offers comprehensive statistical consulting, computing and data entry services for clients within and outside the Medical College. A full time statistician serves as the manager of the statistical consulting services, and a Biostatistics faculty member is in charge of overseeing the operation. Each consulting project is supervised by a faculty member, and the consulting is provided by the faculty member and/or the manager of the services. Biostatistics graduate students also become involved in consulting under the supervision of the faculty. Specific services offered include assistance in grant proposal preparation, design of clinical trials, experimental design, survey design, determination of sample size requirements, randomization, data management, modeling, data analysis and interpretation. The Biostatistics Division has state of the art statistical software packages and computing facilities. For more information about the Biostatistics Consulting Service please visit their website

Cancer Center at MCW
http://www.mcw.edu/cancercenter.htm
The Cancer Center at the Medical College of Wisconsin is actively involved in clinical and basic science research in the areas of bone marrow transplantation, biological response modifiers, gene regulation experimental radiotherapy, cell biology and experimental therapeutics. MCW participates in multi-institutional cooperative group studies as well as serves as coordinating center for some clinical trials. Today, the statistician is recognized as an integral partner in the design of cancer clinical trials from concept to execution. Survival outcomes are frequently the principal measurement of effect of therapy in clinical trials. Statistical research in the area of survival (time of event) analysis has become a major area of research in biostatistics. Cancer research at the Medical College of Wisconsin offers biostatistics students the opportunity to gain familiarity and experience in the design and conduct of clinical trials.

Center for AIDS Intervention Research
The Center for AIDS Intervention Research represents an interdisciplinary research team collaborating with a primary thematic focus of developing, studying and evaluating behavior change interventions to prevent the spread of HIV infection. The Center includes four basic science and clinical cores: Intervention Model Development, Assessment Methodologies, Quantitative Models Analysis and Epidemiology, and Cost-Benefit Analysis. These cores interact synergistically with one another and with individual projects of the Center’s investigators to facilitate the conduct of established studies, new investigator research, and pilot and developmental studies. The overall intent of the Center is to advance both conceptual and applied scientific knowledge concerning effective HIV prevention intervention strategies and mental health services research related to HIV.

Center for Patient Care and Outcomes Research
http://www.mcw.edu/PCOR.htm
The Center for Patient Care and Outcomes Research has the mission of conducting state-of-the-art research of effective/efficient patient care services and related health outcomes. The purposes of the Center are to conduct research on patient care services and related health outcomes, to facilitate a
supportive environment for MCW investigators new to this area, to determine the need for and recruit new faculty in targeted methodological areas, and to provide a seminar series to enhance collaboration. A strong emphasis of the Center is cancer prevention and control. Women's health is another area of content emphasis.

**General Clinical Research Center**

The General Clinical Research Center at the Medical College of Wisconsin is designed to be a central focus for clinical research projects funded by the National Institute of Health, as well as other foundations supporting clinical research. Some highlights of the current CRC are the Endocrine Section where studies in the etiology of obesity and diabetes are conducted; Renal Section where studies of causes and prevention of kidney stones are conducted; Gastroenterology Section where studies of swallowing disorders are conducted. The endocrine studies involve the use of statistical methods to identify and characterized the frequency and spectrum of pulses of insulin secretion and develop mathematical models that reflect the deep psychologic data obtained from these studies. Opportunities abound for students to gain experience with multi-factorial designs and repeated measures designs to maximize the information gained from a clinical study. There are also opportunities to gain experience with genetic studies of factors for obesity and diabetes and with statistical methods for genetic studies, such as segregation and linkage analyses.

**Epidemiology Data Service**

The Epidemiology Data Service Center (EDSC) was created in January of 1995 to meet the needs of researchers in the areas of Epidemiology and Health Services Research. Since then, the staff has been trying to meet those needs by collecting and cataloging local and national datasets for use by the Medical College of Wisconsin Community. Currently there are 40 titles in the EDSC Data Resource Catalog, with over one half of these titles coming from departments other than the EDSC. These include two datasets created by MCW faculty. Other titles in the catalog were purchased by the EDSC, received through the National Center for Health Statistics Public Use Data Tape Program, or downloaded from the Internet. The EDSC has a homepage on the World Wide Web which allows users to read our newsletter and browse our catalog. The homepage has attracted the attention of researchers from across the country which we hope will allow us to expand our services and resources in the future.

**Statistical Center of the Center for International Blood and Marrow Transplant Research (CIBMTR)**


CIBMTR collaborates with the global scientific community to advance hematopoietic cell transplantation and cellular therapy research worldwide. A combined research program of the National Marrow Donor Program and the Medical College of Wisconsin, CIBMTR facilitates critical research that has led to increased survival and an enriched quality of life for thousands of patients. Our prospective and observational research is accomplished through scientific and statistical expertise, a large network of transplant centers and a clinical database of 350,000 transplant recipients.

The Statistical Center is the core component of the registries and is located at the Medical College of Wisconsin in Milwaukee. The Statistical Center provides the biostatistical expertise for designs, conduct, analysis and interpretation of scientific studies. Professor Zhang serves as the Statistical Center Director and Professors Logan, Wang, Brazauskas, Ahn, Kim, Fraser, and Liu serve as the biostatisticians of the Statistical Center which brings the close relationship between the Division of Biostatistics and the Center, and provides the biostatistical students with a broader range of opportunity to analyzing complex transplant data.
Human and Molecular Genetics Center
The HMGC at the Medical College of Wisconsin provides academic support for researchers at MCW who use the genomic sequence to understand disease and translate this information from the laboratory to the patient. Most of the research projects in the Center are funded by government agencies such as the National Institutes of Health. The research areas include various directions in genomics, high throughput sequencing and the development and use of single nucleotide polymorphisms (SNP’s), microarray analysis and bioinformatics. Prof. Tao Wang is the main biostatistics faculty member associated with this Center.

Injury Research Center
The IRC at the Medical College conducts research in wide ranging aspects of injury and its treatment. Ongoing projects include quality of life after trauma, biomechanics of penetrating brain injury, violence related fatalities and injuries, and psychological factors in adjustment after traumatic injury. Professors Laud and Tarima from the Biostatistics Division collaborate with various researchers in the Center.

Life in Milwaukee
Milwaukee, a Great Place on a Great Lake!
Milwaukee is located in southeastern Wisconsin, about 90 minutes from Chicago, IL and Madison, WI. Milwaukee is on the shores of Lake Michigan, the fifth largest lake in the world where Summerfest, the world’s largest music festival and many ethnic festivals take place throughout the summer. There is something for everyone in Milwaukee; you can experience old world charm, diverse cultures, historic neighborhoods and it’s a great place to raise a family.

Like sports? Milwaukee is home to several professional sports teams which include the Bucks (NBA), Brewers (MLB\NL), Packers (NFL), Wave (MISL), Admirals (AHL) or Milwaukee Iron (AFL). Visit one of our many culture centers to include the Pabst Mansion, the Marcus Center for the Performing Arts and the Milwaukee Art Museum which includes the first Santiago Calatrava-designed building in the United States. Visit the MCW “About Milwaukee” webpage for more useful links and resources: http://www.mcw.edu/MCW/About-Milwaukee.htm