# Table of Contents

- Academic Calendar 2021-2022 | Page 3
- About FAES | Page 5
- FAES Administrative Staff | Page 8
- Admission | Page 9
- 2021-2022 FAES Board of Directors | Page 10

**Student Handbook | Page 12**
- Course Policies | Page 12
  - Attendance Policy | Page 12
  - Enrollment Options | Page 12
  - Course Levels and Grading Policy | Page 13
  - Course Materials | Page 13
  - Course Withdrawal Policy | Page 14
  - Refund Policy | Page 14
  - CoursesCanceled by FAES Academic Programs at NIH | Page 15

**University Partnerships | Page 15**

**Academic Records | Page 17**
- Transcripts | Page 17
- Microcredentials and Digital Badges | Page 17

**Tuition and Fees | Page 20**
- Tuition Rates | Page 20
- Payment Policies | Page 20
- Payment Options | Page 20
- Fees | Page 21
- Refund Policy | Page 21

**Scholarship and Funding | Page 22**

**Student Resources | Page 23**
- Student Privacy Rights | Page 23
- Policy on Academic Integrity | Page 23
- Inclusion and Accessibility | Page 24
- Harassment | Page 25

**Courses | Page 26**
- Biochemistry, Chemistry, Pharmacology, and Toxicology | Page 26
- Bioinformatics and Data Science | Page 35
- Biology, Genetics, and Medicine | Page 61
- Immunology and Microbiology | Page 92
- Languages and General Studies | Page 104
- Public Health and Public Policy | Page 116
- Technology Transfer, Business, and Industry | Page 131
- Faculty Biographies | Page 145
Academic Calendar 2021-2022

Workshops Calendar 2021
To view the FAES Workshops Calendar click here.

Academic Calendar 2021 - 2022

<table>
<thead>
<tr>
<th>Summer 2021 Term</th>
<th>June 14 – July 30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Registration</td>
<td>April 19 – June 11</td>
</tr>
<tr>
<td>Late Registration</td>
<td>June 14 – June 18</td>
</tr>
<tr>
<td>Deadline to Drop Courses</td>
<td>June 25</td>
</tr>
<tr>
<td>Deadline to Change Enrollment Status</td>
<td>July 9</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Summer 2021 Informational Events</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Open House</td>
<td>May 19, 12pm (EDT)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fall 2021 Term</th>
<th>August 30 – December 10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Registration</td>
<td>July 6 – August 27</td>
</tr>
<tr>
<td>Late Registration</td>
<td>August 30 – September 3</td>
</tr>
<tr>
<td>Deadline to Drop Courses</td>
<td>September 10</td>
</tr>
<tr>
<td>Deadline to Change Enrollment Status</td>
<td>September 24</td>
</tr>
<tr>
<td>Registration</td>
<td>July 6 – August 27</td>
</tr>
<tr>
<td>Late Registration</td>
<td>August 30 – September 1</td>
</tr>
<tr>
<td>Deadline to Drop Courses</td>
<td>September 1</td>
</tr>
<tr>
<td>Deadline to Change Enrollment Status</td>
<td>September 1</td>
</tr>
<tr>
<td>Registration</td>
<td>July 6 – October 22</td>
</tr>
<tr>
<td>Late Registration</td>
<td>October 25 – October 29</td>
</tr>
<tr>
<td>Deadline to Drop Courses</td>
<td>November 5</td>
</tr>
<tr>
<td>Deadline to Change Enrollment Status</td>
<td>November 19</td>
</tr>
<tr>
<td>Registration</td>
<td>July 6 – October 22</td>
</tr>
<tr>
<td>Late Registration</td>
<td>October 25 – October 27</td>
</tr>
<tr>
<td>Deadline to Drop Courses</td>
<td>October 27</td>
</tr>
<tr>
<td>Deadline to Change Enrollment Status</td>
<td>October 27</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Fall 2021 Informational Events</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Information Session (45 mins)</td>
<td>July 7, 12pm (EDT)</td>
</tr>
<tr>
<td>Virtual Open House (60 min)</td>
<td>August 12, 12pm (EDT)</td>
</tr>
<tr>
<td>Virtual Faculty Meet &amp; Greet (45 mins)</td>
<td>September 29, 12pm (EDT)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>January 2022 Intersession</th>
<th>January 10 – 28</th>
</tr>
</thead>
<tbody>
<tr>
<td>Registration</td>
<td>November 15 – January 7</td>
</tr>
<tr>
<td>Late Registration</td>
<td>January 10 – January 12</td>
</tr>
<tr>
<td>Deadline to Drop Courses Refund Policy</td>
<td>January 14</td>
</tr>
<tr>
<td>Deadline to Change Enrollment Status</td>
<td>January 14</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Spring 2022 Term</th>
<th>January 31 – May 13</th>
</tr>
</thead>
<tbody>
<tr>
<td>Registration</td>
<td>November 29 – January 28</td>
</tr>
<tr>
<td><strong>Spring 2022 Term</strong></td>
<td><strong>January 31 – May 13</strong></td>
</tr>
<tr>
<td>---------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>Late Registration</td>
<td>January 31 – February 4</td>
</tr>
<tr>
<td>Deadline to Drop Courses</td>
<td>February 14</td>
</tr>
<tr>
<td>Refund Policy</td>
<td>February 25</td>
</tr>
<tr>
<td>Registration</td>
<td>November 29 – March 25</td>
</tr>
<tr>
<td>Late Registration</td>
<td>March 28 – April 1</td>
</tr>
<tr>
<td>Deadline to Drop Courses</td>
<td>April 11</td>
</tr>
<tr>
<td>Refund Policy</td>
<td>April 22</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>Spring 2022 Informational Events</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Virtual Information Session</td>
</tr>
<tr>
<td>Virtual Open House</td>
</tr>
<tr>
<td>Session A Student Orientation</td>
</tr>
<tr>
<td>Virtual Information Session</td>
</tr>
<tr>
<td>Session B Student Orientation</td>
</tr>
<tr>
<td>CARD's Master of Professional Studies in Data Science Fellowship Virtual Information Session</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th><strong>May 2022 Intersession</strong></th>
<th><strong>May 18 – June 7</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>Registration</td>
<td>March 28 – May 13</td>
</tr>
<tr>
<td>CARD's Master of Professional Studies in Data Science Fellowship Application Deadline</td>
<td>May 2</td>
</tr>
<tr>
<td>Late Registration</td>
<td>May 16 – May 20</td>
</tr>
<tr>
<td>Deadline to Drop Courses</td>
<td>May 22</td>
</tr>
<tr>
<td>Refund Policy</td>
<td>May 22</td>
</tr>
<tr>
<td>Deadline to Change Enrollment Status</td>
<td>May 22</td>
</tr>
</tbody>
</table>
About FAES
Our Mission and Vision.

The Foundation for Advanced Education in the Sciences (FAES) is a non-profit foundation committed to promoting the productivity and attractiveness of professional life on the National Institutes of Health (NIH) campuses by providing advanced educational programs and supporting biomedical research within the NIH intramural program. Located at NIH's main campus in Bethesda, Maryland, FAES programs complement the work of the NIH in accomplishing its mission of research and training in the biomedical sciences.

Promoting biomedical research within the NIH intramural program since 1959.

In the early 1950s, a group of scientists at NIH organized a Graduate Evening Program to allow investigators to supplement their laboratory training with advanced formal education. The rapid growth of the program prompted the creation of a non-profit organization to administer this initiative and related programs. In 1959, FAES was created by 11 prominent NIH scientists, including future Nobel laureate Dr. Christian Anfinsen. More than sixty years later, FAES still maintains the core values on which it was founded.

FAES's range of programs and services include: academic credit-bearing scientific and non-scientific courses; workshops; microcredentials and digital badges; bookstore; conference management and training services; social and academic center; music and concert series; Fellows housing; sponsorship of NIH symposia, lecture and seminar series as well as select Office of Intramural Training and Education (OITE) programs such as Graduate Partnership Program (GPP) Student Lounge; and, group medical insurance plans for NIH Fellows.
FAES Academic Programs at NIH operates as a non-degree-granting independent postsecondary school. Our mission is to provide instruction at the cutting edge of biological sciences and its evolving applications. FAES goals also include responding to the educational and cultural needs of the NIH community and projecting FAES educational assets globally.

About the FAES Academic Programs at NIH.
FAES Academic Programs at NIH fosters education and research in the biomedical sciences by sponsoring formal and informal instruction as well as sharing of knowledge and collaboration on the NIH campuses.

FAES delivers high-quality and innovative educational programs in a dynamic, culturally diverse learning setting. We currently have seven departments and offer over 200 daytime workshops and credit-bearing evening courses annually to fit around the schedule of working professionals.

In 1984, FAES expanded its educational services to the NIH community by offering a series of short-term specialized biotechnology workshops, lectures, and hands-on laboratory exercises.

FAES Academic Programs workshops train biomedical researchers, technicians, and life sciences enthusiasts in the latest biomedical technologies and lab skills through a comprehensive selection of postgraduate-level lectures and laboratory trainings.

The FAES workshops have been developed by experienced bench scientists and computational biologists. The workshops are team taught by active researchers from the NIH, in addition to leading experts from academia and industry.

By taking FAES's workshops, researchers and professionals in the biomedical sciences or bio- and/or pharmaceutical industries will be able to hone their skills and get trained for the next job in their career.

In addition to high-level courses in biomedical sciences, FAES also sponsors and runs management and leadership training classes for scientists who want to bridge the gap between the bench/bedside and business or other fields. FAES provides full-service conference management services for members of the NIH community and affiliated organizations.

FAES Academic Programs trained over 100,000 scientists, technicians, entrepreneurs, and life sciences enthusiasts!

- We prepare learners for lifelong professional success in careers in biomedical research, academic research and education, clinical practice, private businesses, and non-profit organizations.

- We deliver broad and varied learning experiences that build a knowledgeable and skilled NIH research community.

- We share knowledge and develop skills and competencies to enhance the career trajectory and professional development of our students.

- We serve NIH's global researcher population by organizing English as a Second Language courses to improve spoken and written English language skills.

- We provide teaching opportunities for NIH postdoctoral Fellows in order to prepare them for an academic career.

- We attract dedicated, diverse, and highly-qualified faculty.

- We seek to cultivate a student population who develop a sense of responsibility for their ongoing development and professional competence consistent with the evolving needs of biomedical sciences, healthcare, and society.
Approvals.

FAES Academic Programs at NIH operates as a non-degree-granting independent postsecondary institution.

Credit-bearing courses of FAES Academic Programs may be accepted in transfer at other colleges and universities. For approval and specific information, students need to consult the transfer policies of the receiving institution.

Credit-bearing academic courses do not include laboratory work unless this activity is stated specifically in the course description. FAES daytime workshops are hands on, held in a laboratory setting and are not credit bearing.
### FAES Administrative Staff

#### ACADEMIC PROGRAMS

Dean of Education  
Mindy Maris, PhD  
melinda.maris@nih.gov

#### TEACHING AND LEARNING

Program Manager  
Hazuki Miwa, PhD  
hazuki.miwa@nih.gov

Faculty Development Specialist  
Jennifer Kagan  
jennifer.kagan@nih.gov

Instructional Designers  
Dedra L. Wright

Morgan Merriman  
morgan.merriman@nih.gov

Instructional Technologist  
Olivia Elwell  
olivia.elwell@nih.gov

#### STUDENT SERVICES

Senior Registrar  
Lesley O'Malley, MA  
lesley.omalley@nih.gov

Student Services Partnerships and Events Manager  
Terry Kerere  
terry.kerere@nih.gov

Programs and Events Registration Specialist  
Carline Coote  
carline.coote@nih.gov

Senior Development Coordinator  
Anna Hajdu  
anna.hajdu@nih.gov

#### BOOKSTORE & GIFT SHOPS

Retail Services Program Manager  
JT Knight-Inglesby

Retail Coordinators  
Billy Garcia

Jacqueline "Jackie" Jacobson

Customer Service Associates  
Paree Roper  
Kathryn Ganz

#### PROPERTIES: HOUSING & SOCIAL ACADEMIC CENTER (SAC)

Supervisor  
Ashley Burns

Associate  
Jacob Koehler

#### EXECUTIVE OFFICE

Chief Executive Officer & Executive Director  
Christina Farias, MBA

Executive Assistant  
Lisa Rogers

Communications & Office Manager  
Meghan Abrams
Admission
Courses are open to all qualified persons, both government and non-government. FAES Academic Programs at NIH has an open-enrollment policy, provided that students meet any applicable prerequisites as indicated in the course descriptions.

Enrollment requirements differ based on the level of the course for which the student wishes to register. Undergraduate courses, in general, are open to persons who are at the minimum high school graduates, or equivalent, and who qualify for the course because of satisfactory work experience. For admission to more advanced courses, college coursework in the same or related field is specified or understood. For some courses, prerequisites may be required. For yearlong courses, registration for the second half of the year (i.e. spring semester) requires the completion of the course in the first semester or the permission of the instructor.

Students who do not have a clear financial record with FAES will not be permitted to register for future courses.

FAES does not discriminate on the basis of race, color, religion, sex, age, handicap, national or ethnic origin or veteran status in the administration of its educational programs, admissions policies, scholarship programs, and other educational policies.

Registration for FAES Credit-Bearing Courses
The registration dates and deadlines are listed in the Academic Calendar. The FAES website contains the latest and most up-to-date information on class offerings and schedules. Registration is required each semester for yearlong courses, and for each part of a two-part course.

**Students must register online through the student portal after creating an account at** education.faes.org. **We also accept registration by email at registrar@faes.org or over the phone at (301)496-7976.**

Registration for FAES Workshops
FAES's workshops are open to the broader NIH community as well as to the general public. Registration occurs online throughout the year on a first-come, first-served basis and seats are limited in each workshop.

Please visit our website at education.faes.org/workshops to find the latest schedule of the workshops. FAES reserves the right to change the duration of the workshops as advertised in the Catalog of Courses or to modify workshop course content at any time. Course content will align with the main themes of the workshop, as indicated in the title of the workshop.

Deadline for Registration — Workshops
The deadline for registration is one week before the first day of each workshop. If you are unable to register before the deadline, please email registrar@faes.org or call 301-496-7977 to check on seat availability.

**Please note:** FAES workshops do not follow the enrollment timeline of the credit-bearing academic courses; dates and deadlines posted on the academic calendar of the FAES Academic Programs Credit-Bearing Courses are not applicable.
2021-2022 FAES Board of Directors

OFFICERS
Barbara Alving, MD, MACP
Board President & Board Chair

Alan Goldhammer, PhD
1st Vice President

Carol J. Thiele, PhD
2nd Vice President

Nancy Johnson, CPA
Treasurer

Joshua Farber, MD
Secretary

DIRECTORS
Candice Abate, JD
Director

Jennifer Catalano, MBA, PhD
Director

Steven Ferguson, CLP
Director

Mitchell Ho, PhD
Director

Robert Hohman, PhD
Director

Marita Hopmann, PhD
Director

John "Ted" Ibex, CPA
Director and Audit Oversight Committee Chair

Dennis Klinman, PhD
Director and Investments Committee Chair

Jeffrey Kopp, MD
Director

Alan Koretsky, PhD
Director

Henry Levin, PhD
Director

Gerry McLaughlin, PhD
Director

Louis Mkanganwi, CPA, CA, EML
Director and Audit Oversight Committee Vice Chair

Yosuke Mukoyama, PhD
Director

Phillip Murphy, MD
Director

Kathryn Norcross, JD
Director

Alan Schechter, MD
Director and Bookstore Committee Chair; Nominating Committee Chair

Karen Sibley, PhD
Director and Education Committee Chair

Peggy Thomas, RN
Director

Susan Wright, PhD
Director

NON-VOTING EX-OFFICIO MEMBERS
Susan Leitman, MD
Past President and Insurance Committee Chair

Christina Farias, MBA
Chief Executive Officer & Executive Director

Nicole Luna, CPA
Director of Accounting & Controller

Constance Noguchi, PhD
Dean

Larry Samelson, MD
Music Committee Chair
Student Handbook

Course Policies

Attendance Policy

Enrolled students are expected to complete the entire course, and even unavoidable absences do not relieve them from being responsible for work assigned during the course. Students may not attend classes until they have officially registered for the course through FAES's online registration portal or by submitting a complete Enrollment Form to FAES.

Enrollment Options

Credit

One credit corresponds to 15 standard classroom hours. A standard classroom hour is defined as 50 minutes of instruction time and 10 minutes break. Students registered for credit must complete all coursework as required by the instructor.

Audit

An auditor must pay the same tuition fee and meet the same prerequisites as a credit student. S/he receives full privileges of class participation, if s/he chooses to exercise them. An auditor does not receive a grade or credit; s/he receives a grade of “AUD.”

Enrollment Status Changes

Students may request status change from credit to audit, or vice versa, provided the request is submitted in writing to the FAES Academic Programs at registrar@faes.org and in accordance with the published timeline. Reporting a credit-audit change to the instructor does not constitute an official change. Students who have been sponsored by their home institutions or employers to take FAES courses must submit written approval from their Administrative Officers when requesting a change from credit to audit.
Course Levels and Grading Policy

The FAES Academic Programs at NIH offers courses at the following levels:

1 to 99 | general adult education (may not be at undergraduate level)
100 to 199 | lower-college level (Freshman/Sophomore)
200 to 299 | upper-college level (Junior/Senior)
300 to 399 | senior and graduate levels
400 to 499 | graduate students and qualified seniors
500 to 600 | graduate and/or professional level
600 to 700 | Board Examination subspecialty courses

FAES Academic Programs at NIH courses are graded as follows:

<table>
<thead>
<tr>
<th>Grade</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>A+</td>
<td>97–100</td>
</tr>
<tr>
<td>A</td>
<td>94–96</td>
</tr>
<tr>
<td>A-</td>
<td>90–93</td>
</tr>
<tr>
<td>B+</td>
<td>87–89</td>
</tr>
<tr>
<td>B</td>
<td>84–86</td>
</tr>
<tr>
<td>B-</td>
<td>80–83</td>
</tr>
<tr>
<td>C</td>
<td>70–79</td>
</tr>
<tr>
<td>D</td>
<td>Minimum Passing</td>
</tr>
<tr>
<td>F</td>
<td>69–60</td>
</tr>
<tr>
<td>I</td>
<td>59 and below</td>
</tr>
</tbody>
</table>

*“I” indicates that the required coursework has not been completed. “I” may be changed to another grade if the student provides the instructor with a satisfactory explanation and arranges to complete the work within a reasonable time. As of 7/1/2020, an incomplete (I) received must be resolved by the end of the following semester or grade automatically converts to a failing (F) grade.*

Course Materials

Textbooks

Required and recommended textbooks can be added to a purchase at the time of registration. Book orders are fulfilled by the FAES Bookstore within 1-2 business days pending availability. The textbooks will be shipped for a flat fee ($11.00) or in-store pick-up is available at no cost.

Textbook Returns

A full refund will be given for textbooks unopened and in original condition returned prior to one week from the first day of class. Textbooks purchased after the first week of class (but before the final week of class) must be returned within 2 business days of purchase. Textbooks purchased during the last week of classes or final exams are not returnable/refundable. Any textbooks returned via mail, will be at the customer’s expense.
Copyright
All course materials are the property of FAES and the author or the publisher and are to be used for the student’s individual academic purpose only. Any dissemination, copying, reproducing, modification, displaying, or transmitting of any course material for any other purpose is prohibited, will be considered misconduct, and may be cause for disciplinary action. In addition, encouraging academic dishonesty by distributing information about course materials or assignments which would give an unfair advantage to others may violate the FAES Academic Integrity policy. Course materials may not be exchanged or distributed for commercial purposes, for compensation, or for any purpose other than use by students enrolled in the course. Distributions of course materials may be subject to disciplinary action.

Course Withdrawal Policy

Drop Policy
Students may drop courses through self-service by logging into the Student Portal until the 2nd week of the term.

Alternatively, the intent to drop a course at the FAES Academic Programs must be made in writing to the Academic Programs at registrar@faes.org. Reporting a course withdrawal to the instructor is not considered official.

The dropped course will not appear on students' academic transcript.

Sponsored Students
Students whose courses will be paid for by their employers need to coordinate in advance with their Administrative Officers or HR departments to determine whether they are liable to pay the prorated portion of the tuition in cases when they wish to drop a course.

Students who are recipients of an FAES scholarship will have the prorated tuition withheld when refunds are to be paid due to dropping a course.

Involuntary Withdrawals
Students are allowed to drop a course involuntarily for the following reasons:

- Illness of student or immediate family member (child, parent, spouse, or member of household)
- Death of student or immediate family member (see above)
- Called to active military duty via enlistment, activation, or deployment (Note: Fees are non-refundable.)

In all cases, appropriate written documents of substantiation must accompany the request for withdrawal. Examples include: physician's note specifying the dates of treatment and that the illness made it impossible for student to continue enrollment in classes; notice, newspaper article, or funeral program; copies of military orders signed by an appropriate official, etc.

Refund Policy

Tuition Refunds
To obtain a refund, a course must be officially dropped by the refund deadline, as indicated in the academic calendar. The intent to drop (withdraw from) a course must be made in writing to the FAES Academic Programs at registrar@faes.org. Reporting a course withdrawal to the instructor is not considered official.
Refund of tuition fees will be granted only in cases when the FAES Academic Programs is notified in writing and in accordance with the published schedule for full-semester courses. For a refund schedule for courses of shorter duration, please contact the FAES Academic Programs at registrar@faes.org.

Refunds will be computed as of the date the written intent to drop is received in the FAES Academic Programs Office. In no case will tuition be reduced or refunded because of lack of attendance in classes or because students failed to consult with the instructor in advance of registration, in cases when the course description indicates that students must email the instructor for permission to enroll in the class.

Refund policy when dropping a seven-week course:
- **A week before the course starts**: 100% tuition refund less $25 refund fee
- **During the 1st week**: 100% tuition refund less $25 refund fee
- **During the 2nd week**: 80% of tuition refund less $25 refund fee
- **After the 2nd week**: no refund and no withdrawal will be granted

Refund policy when dropping a three-week course:
- **A week before the course starts**: 100% tuition refund less $25 refund fee
- **During the 1st week**: 80% tuition refund less $25 refund fee
- **After the 1st week**: no refund and no withdrawal will be granted

**Note:** All refunds are subject to a $25 refund/withdrawal fee per course. Refunds will not be granted to students who do not have a clear financial record with FAES.

**Note:** Fees are non-refundable.

Textbook Returns
A full refund will be given for textbooks unopened and in original condition returned prior to one week from the first day of class. Textbooks purchased after the first week of class (but before the final week of class) must be returned within 2 business days of purchase. Textbooks purchased during the last week of classes or final exams are not returnable/refundable. Any textbooks returned via mail, will be at the customer’s expense.

Courses Canceled by FAES Academic Programs at NIH
FAES reserves the right to cancel a course due to insufficient enrollment. In such cases, students will receive a 100% refund of tuition and fees. Further, FAES reserves the right to limit registration, and to cancel, combine, terminate, or postpone courses, and to require the withdrawal of any student at any time for any reason that FAES deems sufficient.

University Partnerships

Transfer of Credits and Advanced Standing Agreements With Higher Education Institutions in Area
Students who wish to transfer FAES academic credits to other institutions in the U.S. or worldwide should not assume that courses taken at FAES will be automatically accepted in transfer, although FAES courses may be accepted in transfer by U.S. colleges or universities. Students who wish to work for an undergraduate, graduate, or higher degree should consult, in advance, with the institution from which they expect to receive their future degree, and, if applicable, receive approval for any courses at FAES at NIH that they plan to use toward their degree.
Start at FAES, finish at some of the region's top institutions.
FAES has partnered with area universities to offer FAES Academic Programs students unique academic opportunities and pathways of study toward degree completion.

University of Maryland, Baltimore County (UMBC)
FAES students who have completed certain courses in technology transfer, bioinformatics and data science may transfer up to 15 credits, if accepted into UMBC’s Master’s of Professional Studies (MPS) in Biotechnology or MPS in Data Science. Conversely, qualified UMBC biotechnology and data science students may take up to 9 credits from certain FAES technology transfer, bioinformatics and data science courses, to be transferred as pathway courses into UMBC’s MPS in Biotechnology or MPS in Data Science. An additional 6 credits may be transferred in to fulfill core program requirements within the UMBC MPS (https://professionalprograms.umbc.edu/home/partnerships).

Built on this partnership, the Center for Alzheimer’s Disease and Related Dementias (CARD) at NIH offers a unique fellowship opportunity to eligible candidates. More information at: https://education.faes.org/CARD-FAES-UMBC_Fellowship.

University of Maryland Global Campus (UMGC)
FAES students who have completed certain courses at FAES in bioinformatics and technology transfer may waive up to 6-9 credits, if accepted into the following UMGC graduate programs: Master’s in Biotechnology with a specialization in Bioinformatics, Master’s in Biotechnology with a specialization in Regulatory Affairs, Master’s in Data Analytics or waive 6-9 credits toward a Certificate in Bioinformatics (https://www.umgc.edu/transfers-and-credits/transfer-credits/foundation-for-advanced-education-in-the-sciences.cfm).

Harrisburg University
FAES students who successfully complete the FAES Advanced Studies in Technology Transfer or Advanced Studies in Bioinformatics, Harrisburg University will award 6 credits toward its Master of Science in Biotechnology (https://www.harrisburgu.edu/news/nih-transfer-agreement/).

Hood College
FAES students who have completed certain courses at FAES in bioinformatics, public health, statistics, and technology transfer may receive up to 2-9 credits, if accepted into the following Hood academic programs: Bioinformatics Master’s in Science degree or Certificate program; Master’s in Biomedical Science; and, Master’s of Business Administration (https://www.hood.edu/discover/stories/hood-college-and-foundation-advanced-education-sciences-partners-education).

Maryland University of Integrative Health (MUIH)
FAES students who have completed certain courses at FAES in chemistry, pharmacology, public health, and toxicology may transfer credits, if accepted into MUIH’s graduate programs in integrative health (https://muih.edu/admissions/articulation-agreements/).

To learn more about credit transfer opportunities at area universities, please email registrar@faes.org.
Academic Records

Transcripts

Official Transcripts
Official transcripts can be requested online at FAES’s Parchment transcript ordering service.

*Official transcripts are $10.00 per transcript (electronic), and $10.00 per transcript, plus applicable mailing fees (paper).*

Transcripts are typically processed within one–three business days of receipt.

Unofficial Transcripts
Unofficial transcripts are available through self-service in the Student Portal OR they can be requested by filling out the Unofficial Transcript Request Form on the FAES website.

Unofficial transcripts are available at no cost.

Microcredentials and Digital Badges

**Advanced Cancer Biology Discovery Badge (6 credits)**
Researchers and others who are ready to study cancer-related topics in depth can earn this badge by taking 6 credits of selected courses from our immunology or medicine offerings.

- 6 credits from any three of the following courses: IMMU403, IMMU418*, IMMU419, MEDI330, MEDI340.
- May substitute BIOL039 for one of the three courses.
- *1 credit-course requires addition of BIOL039 or an additional project to be determined.

**Bioinformatics Curiosity Badge (6 credits)**

**Overview**
Professionals interested in expanding their knowledge of the bioinformatics can accomplish their learning goals as they pursue the Bioinformatics Curiosity Badge. Students may complete any 6 credits of 100-500 level courses or courses combined with a workshop. Completion of the courses in this badge will enable a student to confirm their fundamental interest in these areas and serve as a steppingstone for future studies and career development activities.

**Requirements**
Upon completion of the following badge requirements, students will be issued the Bioinformatics Curiosity digital badge for use on their resume, online portfolio, website, and social media pages.

- 6 credits from 100-500 level FAES courses in different areas of bioinformatics and data science: bioinformatics and data science (BIOF), statistics (STAT), or mathematics (MATH).
- 1 workshop can qualify for up to 2 credits of the digital badge.
- For all qualifying courses, students must earn a letter grade of C or above or a “pass” if the course is pass/fail. Audited courses do not qualify toward the digital badge.
- Courses and workshops completed since January 2021 can be counted toward the digital badge.
Biomedical Sciences Curiosity Badge (6 credits)

Overview

Professionals interested in expanding their knowledge of the biomedical sciences can accomplish their learning goals as they pursue the Biomedical Sciences Curiosity Badge. Students may complete any 6 credits of 100-500 level courses or courses combined with a workshop. Completion of the courses in this badge will enable a student to confirm their fundamental interest in these areas and serve as a steppingstone for future studies and career development activities.

Requirements

Upon completion of the following badge requirements, students will be issued the Biomedical Sciences Curiosity digital badge for use on their resume, online portfolio, website, and social media pages.

- 6 credits from 100-500 level FAES courses in different areas of biomedical science: biology (BIOL), biochemistry (BIOC), chemistry (CHEM), immunology (IMMU), genetics (GENE), medicine (MEDI), microbiology (MICR), neuroscience (NEUR), or pharmacology (PHAR), and public health (PBHL).
- 1 workshop can qualify for up to 2 credits of the digital badge.
- For all qualifying courses, students must earn a letter grade of C or above or a “pass” if the course is pass/fail. Audited courses do not qualify toward the digital badge.
- Courses completed since January 2021 can be applied toward the digital badge.

Biomedical Translation and Commercialization Curiosity Badge (6 credits)

Overview

The FAES program in Biomedical Translation and Commercialization offers scientists and engineers the ability to develop new business, regulatory, and technology transfer skills essential for non-laboratory jobs in science and industry. Professionals interested in expanding their knowledge of the life sciences beyond the laboratory can accomplish their learning goals as they pursue the Biomedical Translation and Commercialization Curiosity Badge. Students may complete any 6 credits of 100-500 level TECH courses or courses combined with a workshop. Completion of the courses in this badge will enable a student to confirm their fundamental interest in these areas and serve as a steppingstone for future studies and career development activities.

Requirements

Upon completion of the following badge requirements, students will be issued the Biomedical Translation and Commercialization Curiosity digital badge for use on their resume, online portfolio, website, and social media pages.

- 6 credits of technology transfer, business, and industry (TECH) courses (100-500 level).
- 1 project management workshop can qualify for up to 2 credits of the digital badge.
- For all qualifying courses, students must earn a letter grade of C or above or a “pass” if the course is pass/fail. Audited courses do not qualify toward the digital badge.
- Courses completed since January 2021 can be applied toward the digital badge.

The ‘Dean's Seal of Excellence’ Badge

Students may be eligible for the ‘Dean's Seal of Excellence’, a digital badge issued by the FAES Academic Programs that signifies successful completion of a specific series of courses and/or outstanding performance during coursework.
**Project Management: Health Sciences Badge**

This microcredential demonstrates the completion of professional programs designed for gaining proficiency in project management. Upon completion of the two FAES project management workshops, students will be issued the digital badge “Project Management: Health Sciences” for use on their resume, online profile, website, and social media pages. FAES will also issue a certificate of program completion. To earn this microcredential, students must (1) meet the class attendance requirements, (2) participate in class activities, and (3) pass a quiz assessment for both workshops.

To earn this microcredential, students must complete:

**TECH 071 | Project Management Essentials**

**TECH 073 | Advanced Project Management Essentials**

**Public Policy Workshops Series Digital Badges**

Attendees who complete one the following workshops will receive the corresponding digital badge to display on their digital resume, CV, LinkedIn and other social media. Attendees who successfully complete the complete series will also be awarded the Dean's Seal of Excellence.

**PPOL 071 | The Role of the White House, Congress, Federal Agencies, and Judiciary in Science & Technology Policy**

**PPOL 072 | Public Policy Analysis for Scientists, Engineers, and Health Professionals: A Systematic Process for Analyzing and Developing Policy Options to Respond to Societal Challenges**

**PPOL 073 | Public Policy Analytical Methods for Scientists, Engineers, and Health Professionals: Understanding and Evaluating Benefit-cost, Cost-effectiveness, and Risk Analysis**

**PPOL 074 | Program Evaluation for Scientists, Engineers, and Health Professionals**
Tuition and Fees

Tuition Rates
FAES Academic Programs at NIH offers great value and unparalleled cost-effectiveness. Tuition for credit-bearing courses is $275.00 per credit, unless otherwise noted. Courses are typically 1-4 credits, thus the tuition for most courses is between $275.00–$1,100.00. Please consult the course description section to determine the credit hours for each course.

Members of the NIH Community are eligible for $200.00 per credit reduced tuition.

Students 65 years and over are eligible for 50% reduced tuition ($137.50 per credit).

Discounts cannot be combined or applied to already discounted courses.

Payment Policies
FAES is a non-profit organization dedicated to providing an affordable and high-quality educational experience to the biomedical research community at the NIH and the general public. In order to continuously provide exceptional services, payments for classes must be received in a timely manner.

Self-funded students must pay for courses at the time of registration.

Students sponsored by their NIH labs or employers can enroll in the desired course online while waiting for authorization of payment. Receiving institutional approval for payment does NOT constitute enrollment in FAES courses. It is fully the responsibility of the student to either pay for their course registration or secure proper authorization for payment with their employer PRIOR TO ATTENDING THE CLASS.

Third-party sponsors, such as employers or Administrative Officers at NIH institutes, should submit payment prior to the course start date. In the event that an institute needs time beyond the course start date to process the request for training funds, please email us at registrar@faes.org for written permission to continue the course.

Payment Options
Payment Made by Credit Card
Self-funded students can make a payment through the Student Portal or alternatively via our secure Payment Portal.

Third-party sponsors should make a payment through our secure Payment Portal.

Payment Made by SF-182 Training Nomination Form
FAES accepts the SF182 VENDOR COPY as payment for courses. If the course will be paid for with an SF-182 Government Training Voucher, please contact your Administrative Officer for guidance on your institution’s internal process for requesting training funds. The VENDOR COPY - Training Nomination - SF182’ document must be sent to registrar@faes.org to ensure continued course enrollment.
Fees

Course Fees

Technology Fee | $60.00 per course

Late Registration Fee | $10.00 per course

Tuition Refund/Withdrawal Fee | $25.00 per course

Note: Fees are non-refundable.

Transcript Fees

Official Transcript Request (electronic) | $10.00 per transcript

Official Transcript Request (paper) | $10.00 per transcript, plus applicable mailing cost

Expedited Official Transcript (FedEx Next Day Delivery) | $35.00 per transcript

Refund Policy

Refund Policy

Tuition Refunds

To obtain a refund, a course must be officially dropped by the refund deadline, as indicated in the academic calendar. The intent to drop (withdraw from) a course must be made in writing to the FAES Academic Programs at registrar@faes.org. Reporting a course withdrawal to the instructor is not considered official.

Refund of tuition fees will be granted only in cases when the FAES Academic Programs is notified in writing and in accordance with the published schedule for full-semester courses. For a refund schedule for courses of shorter duration, please contact the FAES Academic Programs at registrar@faes.org.

Refunds will be computed as of the date the written intent to drop is received in the FAES Academic Programs Office. In no case will tuition be reduced or refunded because of lack of attendance in classes or because students failed to consult with the instructor in advance of registration, in cases when the course description indicates that students must email the instructor for permission to enroll in the class.

Refund policy when dropping a seven-week course:

A week before the course starts 100% tuition refund less $25 refund fee
During the 1st week 100% tuition refund less $25 refund fee
During the 2nd week 80% of tuition refund less $25 refund fee
After the 2nd week no refund and no withdrawal will be granted

Refund policy when dropping a three-week course:

A week before the course starts 100% tuition refund less $25 refund fee
During the 1st week 80% tuition refund less $25 refund fee
After the 1st week no refund and no withdrawal will be granted

Note: All refunds are subject to a $25 refund/withdrawal fee per course. Refunds will not be granted to students who do not have a clear financial record with FAES.

Note: Fees are non-refundable.
Textbook Returns
A full refund will be given for textbooks unopened and in original condition returned prior to one week from the first day of class. Textbooks purchased after the first week of class (but before the final week of class) must be returned within 2 business days of purchase. Textbooks purchased during the last week of classes or final exams are not returnable/refundable. Any textbooks returned via mail, will be at the customer’s expense.

Scholarship and Funding
The core mission of FAES is to provide affordable continuing education courses that remain accessible to working professionals and researchers who are interested in furthering their education and career goals and meet the applicable prerequisites for the course.

FAES Academic Scholarships
The FAES Academic Programs Student Scholarship provides tuition-remission scholarships, offering up to 50% tuition discount on one credit-bearing course per academic term, to self-funded researchers and scientists at all levels at the NIH who cannot obtain training funds to take an FAES Academic Programs course, as well as non-NIH government employees, non-profit employees and members of the general public who work in a health-sciences-related field (research, practice or education). Eligible students in need of financial assistance shall make a short but compelling justification discussing how the respective FAES course would help them in their career or professional development.

FAES will only consider applications for one course per academic term. Parts of a two-part course are considered separate courses. Expenses for textbooks are not covered.

Application Period by Term
FALL 2021, Session A | July 6 - August 16, 2021
FALL 2021, Session B | September 20 - October 11, 2021
SPRING 2022, Session A | November 29, 2021 - January 10, 2022
SPRING 2022, Session B | November 29, 2021 - March 7, 2022
SUMMER 2022 | April 18 - May 23, 2022

How to Apply
To apply, students should complete the Scholarship Application Form and upload the required attachments.

Deadlines for Scholarship Application
FALL 2021, Session A | August 16, 2021
FALL 2021, Session B | October 11, 2021
SPRING 2022, Session A | January 10, 2022
SPRING 2022, Session B | March 7, 2022
SUMMER 2022 | May 23, 2022
Terms and Conditions
FAES will only consider applications for one course per semester. Expenses for textbooks are not covered. Preference will be given to those applicants who apply for scientific courses and have not been awarded an FAES Academic Programs Scholarship before.

Scholarship recipients are required to take the course for Credit and complete the course satisfactorily, which is determined as “C,” or above, or “Pass,” when the course is graded on a Pass/Fail basis.

Only complete applications will be considered. All applicants, please be sure to first register for the class. You can select the invoice option at checkout to reserve your seat in the class without payment. If you do not register and the class fills up by the time the scholarships are determined, you will not be granted a seat in that class.

Successful applicants will be notified during the last week of registration. Please wait with payment until FAES has been able to determine whether you will be awarded a scholarship.

Review Criteria
• Compelling justification for how the FAES graduate course fits in with the career stage and overall career plan of applicant
• Evidence and commitment to continued professional development
• Explanation of how this learning experience builds on applicant’s current professional knowledge and/or skills
• Evidence and need for financial aid
• Professional and academic achievements and standing to date

Applications for scholarships are considered without regard to race, color, religion, sex, age, handicap, national or ethnic origin, disability, or veteran status.

Dropping a Course and Refunds
For information on dropping courses, obtaining refunds, and withdrawal policies, please visit the Policies page.

Student Resources

Student Privacy Rights
Student Privacy Rights
FAES Academic Programs at NIH protects each student’s education record following the Family Educational Rights and Privacy Act (FERPA) of 1974 of the federal government.

Students at the FAES Academic Programs at NIH have the following rights:

• The right to inspect and review one’s own education records within 45 days of the day FAES receives a request for access

• The right to request to amend one’s own education records if a student believes they are inaccurate or misleading

• The right to limit the disclosure of personally identifiable information designated by FAES as directory information

Policy on Academic Integrity
The FAES Academic Programs at NIH prides itself on providing quality educational experiences and upholds the highest level of honesty, integrity, and mutual respect. It is our policy that cheating,
fabrication or plagiarism by students is not acceptable in any form. If a student is found to be in violation of any, or all of the below, his/her credits will be forfeited, and he/she may not be allowed to enroll in future courses or education programs administered by FAES.

- Cheating is defined as an attempt to give or obtain inappropriate/unauthorized assistance during any academic exercise, such as during examination, homework assignment, and class presentation.
- Fabrication is defined as the falsification of data, information or citations in any academic materials.
- Plagiarism is defined as using the ideas, methods, or written words of another, without proper acknowledgment and with the intention that they be taken as the work of the deceiver. These include, but are not limited to, the use of published articles, paraphrasing, copying someone else's homework and turning it in as one's own, and failing to reference footnotes. Procuring information from online sources without proper attribution also constitutes plagiarism.

Grade Disputes:

If a student does not agree with the grade an instructor assigned in a given course, the student must contact the instructor first to attempt to resolve the disputed grade. The initial dispute should be made within 30 days of the final grade being posted. If the instructor and the student are unable to reach an agreement, the student may present his/her argument to the Assistant Dean of Education in writing with supporting facts and documents. Facts considered during a grade dispute include but are not limited to:

1. Whether there was an arithmetic error;
2. Whether the faculty member applied consistent standards in assigning grades; and
3. Whether the grade was a result of a faculty member’s failure to follow the syllabus for assigning grades.

The Assistant Dean may solicit the instructor's evaluation in writing. The Assistant Dean then determines whether the disputed grade should be changed or retained and promptly informs the student and the instructor of its decision. The Assistant Dean's decision is final. Limited appeals to the Executive Dean are possible only regarding the Grade Dispute process, procedures or if new evidence is made available. This appeal must be made within 10 days of the receipt of the Assistant Dean's decision and include all supporting documentation.

Inclusion and Accessibility

FAES does not discriminate on the basis of race, color, religion, sex, age, handicap, national or ethnic origin or veteran status, in the administration of its educational policies, admissions policies, scholarship programs, and other educational programs.

FAES is an equal opportunity provider and employer. Individuals with disabilities who need reasonable accommodation to participate in our classes should contact FAES in advance either through email at registrar@faes.org.

Guidelines for Disability Accommodations

FAES is committed to providing reasonable and appropriate accommodations to students with disabilities. Students with documented disabilities should contact Dr. Mindy Maris, Assistant Dean of Academic Programs.
Harassment

FAES adheres to the NIH’s harassment policies, which can be found at the following link: https://hr.nih.gov/working-nih/civil/statement-workplace-harassment. Faculty and students in FAES courses are responsible for being familiar with the NIH’s harassment policies and adhering to them.
Courses
Biochemistry, Chemistry, Pharmacology, and Toxicology

BIOC 035: Imaging - From IF and FISH to Automated and Confocal Microscopy
This five-day online workshop will utilize a combination of lectures and remote Q&A lab sessions in a "boot camp"-like approach for cell-biologists who seek to learn imaging techniques used extensively in biomedical research. This workshop will first begin with training in immunofluorescence and cell transfection with an early introduction to automated imaging and widefield fluorescence microscopy. The workshop will then fully focus on the world of confocal microscopy, a powerful and popular extension of fluorescence microscopy, allowing 3-dimensional localization and dynamics of cellular components. Through interactive online lectures and labs, participants will be introduced to the most commonly used confocal microscopy techniques in addition to extensive training in image analysis using Fiji. Participants will also have interactive remote sessions with highly qualified scientists from Leica, Nikon, Olympus and Zeiss, where they will receive training in microscope basics and imaging techniques on each individual platform.

Class Type: Workshop

BIOC 053: Super Resolution Microscopy
Super Resolution Microscopy represents a group of recently developed light microscopic techniques that are able to exceed diffraction-limited resolution (less than 200nm). This workshop will focus on three types of Super Resolution Microscopy: Structured Illumination Microscopy (SIM); Stochastic Optical Reconstruction Microscopy (STORM); and, Stimulated Emission Depletion (STED). In addition, students will be exposed to cutting-edge super resolution microscopes developed at HHMI Janelia Research Center through the AIC (Advanced Imaging Center). The AIC will showcase several instruments, including iPALM, lattice light sheet and live-cell TIRF-SIM. The workshop is designed for cell biologists with prior experience in light microscopy who wish to add super resolution microscopy to their research portfolio. Participants will acquire both a theoretical understanding of super resolution microscopy and practical experience using state-of-the-art super resolution microscopes.

Class Type: Workshop

BIOC 062: Image Processing and Analysis
Bioimaging studies are rapidly becoming more quantitative due to enhanced imaging technologies, improved analytical and computational tools, as well as increasingly more stringent scientific scrutiny for accuracy and reproducibility. However, there is a paucity of systematic and introductory surveys easily accessible to biologists when faced with a plethora of technical issues in digital image processing and analyses. The lack of clarity on this issue, compounded by debate over the methods abundant in the niche literature, frequently leads to further confusion for those whose primary expertise is not in digital image processing. Unfortunately, erroneous or misguided application of methods in biological imaging analyses is not uncommon, and this can lead to artificial inflation or suppression of biological significance, often unintentionally. The goal of this hands-on workshop is to survey the fundamentals of how image pixel data can be used to extract biologically meaningful information. Participants will install Fiji on their own laptops and will be given ample opportunity to work on actual images for a hands-on learning experience.

Class Type: Workshop
**BIOC 101: Biochemistry in Health and Diseases**

This course is designed to provide a broad overview of basic biological chemistry and its relationship to human health and disease. Each class will cover a major category of the molecules of life and a human disease and/or health issue that relates to the topics: why we should eat fruits and vegetables; why milk is supplemented with vitamin D; why some people are lactose intolerant; or, how insulin helps people with diabetes. Particular emphasis will be placed on the interactions between metabolic pathways, the basis of human diseases, and current medical therapies. Lectures will be followed by group discussions of real-life case studies. By taking this course, students will gain a fundamental knowledge of biochemistry and the role of the molecules of life in control of human health and well-being.

**Learning Objectives**

- Describe major categories of the molecules of life
- Discuss how major metabolic pathways control human health
- Explain the ‘Central Dogma’ of molecular biology and give examples of genetic diseases
- Prepare an original presentation about a disease of interest to discuss with the class

**Credits:** 2  
**Class Type:** Graduate Course  
**Prerequisites:**  
open to anyone with an interest in science and basic (high-school or undergraduate-level) knowledge of chemistry and biology.

---

**BIOC 301: Introduction to Biochemistry: Molecular Biology**

This course is designed to introduce students to basic biochemistry concepts and build upon them to dive deep into topics such as transcription and translation. We will also explore various biochemical and molecular biology techniques such as ELISA, PCR, RNA-Seq and many more.

**Learning Objectives**

- Describe the importance of cellular processes such as DNA replication, transcription and translation.  
- Discuss primary literature related to course material.  
- Create a project based on various biochemical tools and techniques taught in class.

**Credits:** 2  
**Class Type:** Graduate Course  
**Prerequisites:**  
There are no specific prerequisites, but students are recommended to review chemistry and biology topics such as polarity, chemical bonding, mitosis, and gene expression.  
**Availability** Spring 2022  
**Session** Session A
BIOC 302: Introduction to Biochemistry: Metabolism
In this course we will discuss biochemical concepts within the context of metabolic pathways and disease. The topics will include, cell respiration, fat metabolism, protein metabolism and diseases associated with a perturbation of these processes. We will dive deep into the primary literature to gain knowledge of cutting-edge research being conducted. We will start from the beginning to discuss the different macromolecules present in our cell, and then continue to build until we have a comprehensive understanding of various metabolic processes occurring in the cell.

Learning Objectives

- Identify key concepts that are common in most metabolic pathways.
- Describe how the disruption of these processes can cause human disease and the treatments available to combat these diseases.
- Compare various metabolic techniques used to conduct research in the field of metabolic diseases.

Sample syllabus is subject to change.

Credits: 2
Class Type: Graduate Course
Prerequisites: BIOC 301
The above course(s) or equivalent background knowledge.
Availability Spring 2022
Session Session B

BIOC 303: Biochemistry II, part 1
Biochemistry II is a continuation of Biochemistry I. The two courses provide a comprehensive overview of biochemistry at the graduate level. The spring course will cover metabolism and biosynthesis of biological macromolecules, such as glycogen, fatty acid, amino acid and nucleotide.

This is the first part of a two-part course. Registration is required separately for each part of the course.

Learning Objectives

- Understand protein structure and thermodynamics
- Describe protein-protein interaction and structure-function relationships in biochemical systems
- Name structure and function of carbohydrates and lipids, aspects of central metabolism
- Identify nucleic acid biochemistry

Credits: 2
Class Type: Graduate Course
Prerequisites: BIOC 301
BIOC 302
The above course(s) or permission from the instructor.
**BIOC 304: Biochemistry II, part 2**

Biochemistry II is a continuation of Biochemistry I. The two courses provide a comprehensive overview of biochemistry at the graduate level. The spring course will cover metabolism and biosynthesis of biological macromolecules, such as glycogen, fatty acid, amino acid and nucleotide.

This is the second part of a two-part course. The completion of the first part (BIOC 303) is required before taking the second part. Registration is required separately for each part of the course.

**Learning Objectives**
- Understand protein structure and thermodynamics
- Describe protein-protein interaction and structure-function relationships in biochemical systems
- Name structure and function of carbohydrates and lipids, aspects of central metabolism
- Identify nucleic acid biochemistry

**Credits:** 2  
**Class Type:** Graduate Course  
**Prerequisites:**
- BIOC 301  
- BIOC 302  
- BIOC 303  
The above course(s) or permission from the instructor.

---

**BIOC 330: Principles of Protein Structure**

The goal of this course is to present and discuss popular structural biology techniques and data, and to teach students to analyze and evaluate their own and others’ data with a critical eye. Major topics of discussion will include nuclear magnetic resonance, X-ray crystallography, and cryo-electron microscopy. In addition, other biophysical techniques, used to assist in the determination of protein structure, will be covered, as directed by student interest. Assessments will include evaluation of in-class discussions, a presentation or paper, and various active learning assessments.

**Learning Objectives**
- Read and discuss primary literature concerning structural biology and biophysical techniques
- Describe principles used to determine structures from major structural biology techniques
- Interpret and evaluate the quality of macromolecular structures
- Compare different techniques used to determine biomolecule structure, kinetics, and thermodynamics

**Credits:** 2  
**Class Type:** Graduate Course  
**Prerequisites:**  
previous coursework in biology and chemistry is required or permission of the instructor.
**BIOC 532: Biological Importance of Modifications in DNA and Chromatin**

Chromatin modifications play important roles in many cellular processes, including the regulation of gene expression, DNA repair, and the heterochromatin formation. This course will explore the various biological roles chromatin modifications play in eukaryotic cells. Topics that will be discussed include: histone and DNA modifications and the enzymes responsible for these modifications; mechanisms of chromatin remodeling and transcription regulation; the role of non-coding RNAs in chromatin structure and gene regulation; higher-order chromatin organization and the use of various chromosome capture conformation methods; and, chromatin structure and DNA damage repair. In addition, this course will introduce students to the genome-wide analysis of ChIP-seq and RNA-seq data using a variety of softwares, including publicly accessible web servers such as Galaxy and UCSC genome browser.

**Learning Objectives**

- Understand basic concepts behind epigenetics
- Understand why epigenetics is important in understanding human diseases
- Explain how epigenetic mechanisms work

Sample syllabus is subject to change.

**Credits:** 2  
**Class Type:** Graduate Course  
**Prerequisites:**  
General understanding of basic concepts in genetics and biochemistry.

---

**CHEM 211: Organic Chemistry I, part 1**

This course will provide students with a solid foundation in organic chemistry through a systematic study of the chemistry of carbon compounds, including alkanes, alkenes, alkynes, alkyl halides, and aromatic compounds. These compounds will be discussed in relation to appropriate concepts of structure and bonding, stereochemistry, transition state theory, mechanisms, resonance, and spectroscopy. The application of the above to synthetic organic chemistry will be emphasized. Considerations in biochemistry, medicine, and pharmacology will be made. The first semester will be concerned with structural bonding, stereochemistry, aliphatic compounds and mechanism. Connections between the fields of organic chemistry and biochemistry, medicine, and pharmacology will be also highlighted.

This is the first part of a two-part course. Registration is required separately for each part of the course.

**Learning Objectives**

- Draw and interpret chemical structures  
- Predict chemical properties based on structural information  
- Predict products for chemical reactions  
- Draw mechanisms for chemical transformations

**Credits:** 2  
**Class Type:** Graduate Course  
**Prerequisites:**  
CHEM 102  
CHEM 104  
The above course(s) or equivalent. Solid understanding of general chemistry or permission from the instructor.
CHEM 212: Organic Chemistry I, part 2
This course will provide students with a solid foundation in organic chemistry through a systematic study of the chemistry of carbon compounds, including alkanes, alkenes, alkynes, alkyl halides, and aromatic compounds. These compounds will be discussed in relation to appropriate concepts of structure and bonding, stereochemistry, transition state theory, mechanisms, resonance, and spectroscopy. The application of the above to synthetic organic chemistry will be emphasized. Considerations in biochemistry, medicine, and pharmacology will be made. The first semester will be concerned with structural bonding, stereochemistry, aliphatic compounds and mechanism. Connections between the fields of organic chemistry and biochemistry, medicine, and pharmacology will be also highlighted.

This is the second part of a two-part course. The completion of the first part (CHEM 211) is required before taking the second part. Registration is required separately for each part of the course.

Learning Objectives
• Draw and interpret chemical structures
• Predict chemical properties based on structural information
• Predict products for chemical reactions
• Draw mechanisms for chemical transformations

Credits: 2
Class Type: Graduate Course
Prerequisites:
CHEM 211
The above course(s) or permission from the instructor.

CHEM 213: Organic Chemistry II, part 1
This is a continuation of Organic Chemistry I, with the goal of providing a solid foundation in organic chemistry. The second semester will cover alcohols, esters, carboxylic acids, amides, ethers, amines, aldehydes, and ketones, with a brief overview of some biologically relevant structures such as carbohydrates, amino acids, DNA, RNA, and lipids. The application of the above topics to synthetic organic chemistry will be emphasized, and connections between the fields of organic chemistry and biochemistry, medicine, and pharmacology will be highlighted.

This is the first part of a two-part course. Registration is required separately for each part of the course.

Learning Objectives
• Draw and interpret chemical structures
• Predict chemical properties based on structural information
• Predict products for chemical reactions
• Draw mechanisms for chemical transformations

Credits: 2
Class Type: Graduate Course
Prerequisites:
CHEM 212
The above course(s) or permission from the instructor.
CHEM 214: Organic Chemistry II, part 2
This is a continuation of Organic Chemistry I, with the goal of providing a solid foundation in organic chemistry. The second semester will cover alcohols, esters, carboxylic acids, amides, ethers, amines, aldehydes, and ketones, with a brief overview of some biologically relevant structures such as carbohydrates, amino acids, DNA, RNA, and lipids. The application of the above topics to synthetic organic chemistry will be emphasized, and connections between the fields of organic chemistry and biochemistry, medicine, and pharmacology will be highlighted.

This is the second part of a two-part course. The completion of the first part (CHEM 213) is required before taking the second part. Registration is required separately for each part of the course.

Learning Objectives
- Draw and interpret chemical structures
- Predict chemical properties based on structural information
- Predict products for chemical reactions
- Draw mechanisms for chemical transformations

Credits: 2
Class Type: Graduate Course
Prerequisites: CHEM 213
The above course(s) or permission from the instructor.

CHEM 327: The Art of Drug Design and Discovery
THIS COURSE WILL BE HELD AT NCI-FREDERICK
The objective of this course is to explore the fundamental principles of modern drug discovery, with an emphasis on antiviral and anticancer drug design. A brief history of the discovery of hallmark drugs, such as penicillin, will serve as a backdrop for in-depth discussions on state-of-the-art techniques for target discovery and validation, lead discovery and lead optimization. Several classes of compounds with therapeutic potential will be discussed, such as peptides, carbohydrates, nucleosides and their analogs (mimetics). The latest methods in molecular modeling, high throughput screening and structure-activity relationships will be presented. The concept of 'rational' drug design based on high-resolution target structures derived from NMR and X-ray crystallography will be stressed. The course will benefit from guest lectures from outstanding researchers in specific fields of interest.

Learning Objectives
- Gain a solid working knowledge of modern drug-discovery process
- Understand molecular basis for the mechanism of action of a variety of drug types
- Acquire chemical/biological insights necessary to apply what is learned to one's own research

Credits: 2
Class Type: Graduate Course
Prerequisites: organic chemistry.
PHAR 328: Regulatory Perspective on Drug Development
This course focuses on the responsibilities of the federal agency throughout the drug development process and understanding the processes and regulations surrounding drug and biologic approvals that guide how regulatory decisions are made. Course content will include lectures, weekly readings (including journal publications, articles, and regulatory documents). Assignments will include weekly discussion posts, midterm paper, final presentation, and final case study.

Specific topics covered will include: Animal Studies, In Vitro Studies, Good Laboratory Practice (GLP), Good Clinical practice (GCP), current Good Manufacturing Practices (cGMP), Chemistry, Manufacturing and Controls (CMC), Pharmacology/Toxicology, Clinical Trials, Statistics, Ethics, Inspections, and Labeling.

Note: This course is NOT meant to cover anything outside of the scope of what the FDA Regulates. This course is focused on drug and biologic regulation, not device regulation.

Learning Objectives
Upon successful completion of this course, students will be able to:

• Recognize the FDA drug development process, the laws and regulations that govern it in the United States.
• Identify the role of the regulatory affairs professional and other team members in the drug development process within industry and government settings.
• Address real-world drug development challenges through case studies.
• Understand the policies and procedures available to speed drug approvals for certain types of medical products.
• Demonstrate excellent communication skills through writing assignments related to ongoing course discussions.

Credits: 2
Class Type: Graduate Course
Prerequisites: College-level biological sciences.
Availability Spring 2022
Session Session B

PHAR 400: Molecular Pharmacology
This course is designed to present the pharmacological basis of therapeutics by discussion of the principles of drug action and the mechanism of action of representative agents. The course will focus on the chemistry, mechanism of action, and pharmacologic action of drugs on the autonomic and central nervous systems, the endocrine system, the cardiovascular system, immune system, and chemotherapy. A review of the relevant physiology and pathophysiology of each organ system will be presented, and the molecular basis for drug action will be presented in context of those systems.

Learning Objectives

• Identify the molecular mechanism of pharmacologic action of medications used in disorders of the autonomic and central nervous, endocrine, cardiovascular, and immune systems.
• Identify molecular mechanisms of chemotherapy for microbial infections and cancer.
• Apply this knowledge to explain how medications alter physiology and pathophysiology to treat disease.
• Explain how medications cause toxicity by affecting off-target molecular and physiologic pathways.
• Synthesize molecular and physiologic actions of medications to understand how medication classes that are used to treat diseases.
• Evaluate case reports of patients who are treated with medications.

Credits: 2
Class Type: Graduate Course
Prerequisites: Understanding of basic concepts in biology, chemistry, and biochemistry.
Availability Spring 2022
Session Session B
PHAR 500: Principles of Clinical Pharmacology

In partnership with NIH Clinical Center This course delivered by the NIH Clinical Center is an online lecture series covering the fundamentals of clinical pharmacology as a translational scientific discipline focused on rational drug development and utilization in therapeutics. The course focuses on the following core principles of pharmacology: pharmacokinetics; drug metabolism and transport; drug therapy in special populations; assessment of drug effects; drug discovery and development; pharmacogenomics and pharmacotherapy. This course will be of interest to graduate students, postdoctoral Fellows, medical and pharmacy students, scientists, and health professionals interested in expanding their pharmacology knowledge base.

Learning Objectives

- Provide an in-depth look at drug absorption, distribution, metabolism, and excretion
- Describe the impact of age, pregnancy, and disease on pharmacokinetics
- Describe the basic principles in the assessment of drug effects
- Describe the process of drug discovery and development
- Provide an overview of clinical pharmacotherapy, including pharmacogenomics and medication safety
- For questions regarding course content, please email odpcp@mail.nih.gov

Credits: 4
Class Type: Graduate Course

PHYS 333: Principles of Medical Imaging

Over the past decades, advances in diagnostic medical imaging have led to significantly improved patient outcomes. This course provides the foundation to help students understand the theory and applications of medical-imaging modalities (X-ray, CT, ultrasound, and MRI), with an emphasis on neuroimaging. Students will study the process of image formation from a signals and systems perspective and will learn the tools necessary to evaluate the performance of diagnostic imaging systems and will thus identify common sources of imaging artifacts. Through group activities and in-class discussions, students will be encouraged to apply their critical-thinking skills to current challenges in medical-imaging research.

Learning Objectives

- Explain how medical images are formed for each imaging modality
- Characterize the performance of diagnostic imaging systems using parameters, such as spatial resolution, signal-to-noise ratio, point spread function, etc.
- Describe and compare common image reconstruction algorithms
- Identify potential sources of imaging artifacts, such as signal bandwidth limitations, digitization, faulty hardware components, physiological motion, etc.
- Evaluate the strengths and weaknesses of different imaging modalities for specific clinical applications

Credits: 2
Class Type: Graduate Course
Prerequisites:
calculus; physics (mechanics, optics, and electromagnetism).
TOXI 303: Introduction to Toxicology

Toxicology is the study of the adverse effects of chemical, physical, or biological agents on living organisms and the ecosystem, including the prevention and amelioration of such effects. Knowledge of toxicology is essential in the areas of drug development, medicine, environmental, occupational and public health, as well as in chemical and pharmaceutical industries. The objective of this course is to introduce students to the general principles of toxicology, the various classes of toxic agents, and the organ and biochemical systems that these agents affect. The course will also focus on the prevention and management of toxicity from several agents. During the course, students will review several events of human and companion animal toxicity that are reported in the medical literature and/or in the media, with the aim to translate theoretical concepts into a real-world context. This is a great course for those contemplating graduate study in the fields of toxicology or pharmacology, or for those who work with toxicologists or pharmacologists in a regulatory or research setting, or for the layperson interested in learning more about toxicology.

Learning Objectives

- Understand basic toxicant mechanisms of action
- Compare acute and chronic intoxication scenarios and discuss prevention and management
- Gain insight into the significance and the use of main toxicological parameters
- Evaluate critically and discuss current events relevant to the field of toxicology
- Integrate knowledge acquired in an in-depth case study and presentation of a human drug overdose/toxicity

Credits: 3
Class Type: Graduate Course
Prerequisites: undergraduate biology and chemistry.

Bioinformatics and Data Science

BIOF 017: Introductory R Boot Camp

In this workshop, learners will learn the basics of how to use R to wrangle data, create visualizations, and conduct exploratory analyses. The workshop will use the popular “tidyverse” suite of packages and will also teach learners the concept of tidy data and how it facilitates analysis.

Learning Objectives

- Use RStudio and the tidyverse suite of packages to load and work with datasets
- Describe what makes data “tidy,” why tidy data is useful to work with, and how to make datasets tidy
- Transform data to prepare it for visualization and analysis
- Describe the “Grammar of Graphics” philosophy that underlies the ggplot2 visualization package
- Create visualizations including barplots, scatterplots, line graphs, and more using ggplot2
- Customize all aspects of visualizations
- Save and export visualizations for print, submission to journals, and other applications
- Use visualizations to explore and identify patterns in data Identify and handle missing data Identify covariation in variables
- Build simple linear models to identify relationships between variables

Class Type: Workshop
BIOF 018: Intermediate R Boot Camp
This workshop builds upon the principles of using R for data science by introducing intermediate concepts that will help learners advance their knowledge and use R for more complex tasks. These tasks include working with APIs and packages to access data on remote servers, iterating tasks over datasets, and writing custom functions.

Learning Objectives
- Use the apply family to repeat functions over multiple data objects
- Use if/else statements for conditional functions
- Use case_when to vectorize multiple if/else statements
- Use for loops to repeat functions
- Understand how to use tidyverse “verbs” to wrangle data
- Understand how and why to convert data from wide to long format
- Summarize and transform data using tidyverse verbs
- Understand when to create a custom function
- Write custom functions to carry out complex tasks
- Troubleshoot and debug functions

Class Type: Workshop
Prerequisites:
BIOF 017
Or adequate familiarity with R.

BIOF 019: Designing Effective Data Visualizations in R
This workshop will explore both the design side and the coding side of creating visualizations in R. The first session will introduce best practices for designing effective visualizations, and learners will put these into practice in the next two sessions to create static and interactive visualizations. Learners will be introduced to Shiny, an R package used to build interactive web apps.

Learning Objectives
- Understand how to use principles of human visual perception to create effective visualizations
- Describe elements of design such as line, shape, value, texture, and space and understand how to effectively use them in visualizations
- Use color to convey meaning, including using color-blind friendly palettes
- Describe the “Grammar of Graphics” philosophy that underlies the ggplot2 visualization package
- Create visualizations including barplots, scatterplots, line graphs, and more using ggplot2
- Customize all aspects of visualizations
- Save and export visualizations for print, submission to journals, and other applications
- Understand how to use the UI and server functions to create Shiny objects
- Create visualizations that change based on user input
- Build simple web apps incorporating visualizations

Class Type: Workshop
Prerequisites:
BIOF 017
BIOF 018
BIOF 043
BIOF 339
BIOF 501
Any one of the above FAES R courses or workshops* or equivalent experience with adequate knowledge of coding in R.
**BIOF 020: Python for Beginners**

In this introductory workshop, users will learn how to create, read, transform, and visualize data for scientific analysis. Learners will also gain skills in applying basic computer logic to scientific applications.

**Learning Objectives**

The workshop will guide learners through the following learning objectives:

- Script creation and execution
- Array creation
- Two variable plotting (x-y line graphs)
- Saving plots
- Data transformation and manipulation
- Loops
- Reading data from a file
- Logic statements
- Saving data to a file
- Handling missing data in files
- Simple linear model (e.g. time series analysis)
- Advanced visualizations: scatterplots, bar charts
- Real world biological concepts such as a deeper exploration (e.g., COVID-19 data, population modeling)
- A capstone where learners would visualize their own data or data the instructor would provide

**Class Type:** Workshop

**Prerequisites:**
Basic computer skills, including where to quickly find specific directories and files.

---

**BIOF 021: R for Analysis of Text Data**

This workshop will provide an introduction to working with text data in R and explore various approaches to analyzing text data. The first session will cover principles for wrangling text data as well as some basic text mining applications. The subsequent two sessions will delve into specific techniques to enable automated analysis of text data.

**Learning Objectives**

- Read text data into R and prepare it for analysis
- Understand and select from various options in preparing text, such as stemming, lemmatization, term frequency weighting, term frequency-inverse document frequency weighting (tf-idf), and tokenization
- Conduct simple text mining to explore content of a text corpus
- Describe how unsupervised approaches can be used to identify clusters of related documents
- Process text data to prepare for unsupervised analysis; o Build, train, and evaluate models for text clustering
- Interpret outputs of clustering algorithms
- Describe how supervised approaches can be used to develop text-based models for multi-class classification
- Process text data to prepare for supervised analysis; o Build, train, and test models for text classification

**Class Type:** Workshop

**Prerequisites:**
BIOF 017
BIOF 018
BIOF 019
BIOF 043
BIOF 339
BIOF 501
Any of the above courses and workshops or basic familiarity with R.
BIOF 043: For True BeginRs | Hands-on R Training

R is a free, cross-platform – Windows, Mac, and Linux – programming language, designed specifically to facilitate data management, analysis, and visualization. Boasting vibrant development and support communities, R has become an indispensable tool for bioinformaticians, statisticians, and data scientists. Created with true beginRs in mind, this training will teach participants the fundamental, transferable skills needed to unleash R’s full potential for producing publication-worthy analyses and visualizations.

Learning Objectives

- Interfacing with R using RStudio
- Using RStudio’s built-in help function – ? – as well as resources for troubleshooting, including rdocumentation.org, cheat sheets, vignettes, YouTube channels, and stackexchange.com
- Creating project files; Working with the RStudio command line
- Identifying and changing the current working file directory
- Variables – local vs. global – naming conventions, and assignment operators
- Writing their first R script and how to properly document their code via commenting
- Using the ‘$’ accessor function
- The most common data types, including character strings, numerical, integers, and logicals
- How to access data entries using [] and [[ ]]; The most common data structure types, including vectors, lists, factors, data frames, and tibbles
- Package libraries and how to install them; Loading data into R and basic troubleshooting when importing data
- Data management, manipulation, subsetting, piping, and exploration using dplyr
- Creating and exporting highly customizable, publication-quality data visualizations with ggplot2
- Using R to perform statistical analyses, including simple linear regression, χ² contingency table analysis, t-tests, and analysis of variance

Class Type: Workshop

Prerequisites:
Participants should be comfortable with basic computer skills.

BIOF 045: Next Generation Sequencing Data Analysis

This workshop will introduce the basics of next generation sequencing (NGS) data analysis. We will introduce NGS methods and platforms, bioinformatics tools and standards, and data analysis workflows, specifically for DNA-seq (variant analysis) and RNA-seq (transcriptome analysis). The lectures will introduce common software libraries and algorithms used in the bioinformatics community. During the hands-on training sessions, we will perform alignment and analysis of NGS data from scratch using standard software libraries and pipelines.

Learning Objectives

The workshop will:

1. start with a general introduction to working in a linux environment and running command-line tools. We will learn the common file formats: fasta, fastq, SAM, BAM, VCF, GTF
2. walk through:
   - DNA-Seq variant calling analysis
   - RNA-Seq analysis with downstream analysis in R
     - touch on data retrieval and best practices for making your analysis readable and reproducible.

Credits: 0

Class Type: Workshop

Prerequisites:

BIOF 017
BIOF 018
BIOF 019
BIOF 021
BIOF 043
BIOF 098
BIOF 339
BIOF 501

Completion of any of the above courses and workshops or experience with R is expected. Basic computing skills; a background in Linux and bash scripting is not required though preferred.
**BIOF 048: Singe Cell RNA Seq Analysis with R Package**

Bulk transcriptomes have provided considerable insights and fostered the discovery and characterization of GRN (Gene Regulatory Network). However, bulk transcriptomes provide population-based averaged measurements which blur cell heterogeneity and developmental dynamics of asynchronous cell populations. Single-cell transcriptome technologies (scRNA-seq) capture cell heterogeneity and thus are useful for the discovery of cell populations, identification of cell mutants, and quantification of subpopulations. Leveraging on the ability of generating thousands of individual measurements from scRNA-seq, lots of methods have been developed to capture spatial or temporal information from cell populations. This course will introduce basic steps of the scRNA-seq processing, starting from fastq coming off 10x sequencer to spatial and temporal analysis using popular R packages. Then, we will discuss case studies that can be addressed using scRNA-seq.

**Class Type:** Workshop

**Prerequisites:**

Experience with R is required; experience with seq analysis in general is advantageous, but not required. The course is designed for students with no scRNA-seq data analysis experience.

**BIOF 050: Introduction to Deep Learning**

In the past decade, neural networks have become a valuable tool for data scientists, revolutionizing fields such as text processing, image analysis, genomic/proteomic data analysis, data clustering, and much more. However, these algorithms can be very difficult to understand, interpret, and program. This workshop will first cover the theory and proper applications of various neural networks (multilayer perceptrons, convolutional neural networks, long-short term memory models, autoencoders, etc.). From there, powerful deep learning packages, such as Pytorch and Keras, will be introduced. Proper coding techniques will be shown through examples and practiced through exercises that will be completed in the Python 3 programming language. Finally, concepts in data visualization and software engineering will be discussed, helping researchers use neural networks in an effective and reproducible way to improve the impact of projects with a computational component.

**Class Type:** Workshop

**Prerequisites:**

- BIOF 017
- BIOF 020
- BIOF 043

**BIOF 052: Artificial Intelligence in Your Lab**

Artificial intelligence (AI) in biomedical research has grown exponentially in the past decade. AI can be used to uncover powerful new insights in data that your lab is already collecting. This workshop has two primary components. First, participants will engage in discussions that cover recent advances in artificial intelligence (AI) and how these developments can be used in biomedical research. Topics will include active learning, adversarial learning, Bayesian deep learning, reinforcement learning, semi-supervised learning, self-supervised learning, and transfer learning. These topics will be covered in an integrated manner: the discussions will explore how different facets of AI can interact with each other to generate high-quality results. Second, participants will work with the instructor to design and implement AI project(s). These projects will have direct relevance to the research being done by each participant. This workshop will have 1 day of discussion followed by 1 week of offline work where the participants communicate directly with the instructors about project development.

**Class Type:** Workshop
BIOF 075: Metagenomics Data Analysis

Metagenomics is gaining importance due to low-cost next generation sequencing technologies. This workshop introduces end-to-end solutions for analyzing metagenomic data, including data-quality analysis, alignment, community profiling, taxonomic comparison, and novel taxa discovery.

Credits: 0
Class Type: Workshop

BIOF 076: Visualization with R

R is the industry standard for creating specific graphs and plots. This workshop walks participants through creating interactive, static, and shareable plots using popular R packages. The workshop will cover formatting data, loading data, setting parameters, creating images, and saving outputs.

Credits: 0
Class Type: Workshop

BIOF 077: Molecular Modeling and Molecular Dynamics: Hands-on Training

Predicting the effect of a mutation on the structure and function of a protein is not just for researchers with computer facilities. Users with basic molecular biology background can set up and run intensive computational modeling and dynamics experiments. In this workshop, participants will use open-source tools and techniques to conduct molecular modeling and dynamics experiments.

Credits: 0
Class Type: Workshop

BIOF 082: Introduction to Bioinformatics: Theory and Application

Bioinformatics (Computational Biology) is a must skill required in every modern biomedical research lab. Installing and configuring a wide variety of computational biology tools is a cumbersome task that requires software engineering skills.

This workshop provides an introduction to basic concepts in using popular tools and techniques for sequence analysis, structure analysis, function prediction, biological database searching, “omics” data analysis, pathway analysis, data visualization, data curation and integration, and scripting basics.

Credits: 0
Class Type: Workshop

BIOF 084: Pharmacometric Dose-Response Analyses in Clinical Trials using R

In order for a drug to get approved by the FDA for market in the USA, the sponsor must ultimately demonstrate the drug has: 1) a predictable exposure profile with dose; 2) a good safety profile; and 3) is effective at safe doses. Therefore, the pharmacology of a drug is essentially being reviewed by the FDA. The ability of scientists to analyze drug exposure/response relationships is crucial to understanding what exposure amount will elicit the safest, most effective response, and ultimately what dose amount and frequency will produce the optimal exposure amount. Additionally, the ability to identify sub-populations that may produce differing exposure or response levels is key to providing as many subjects as possible a safe and effective dose. This quantitative exposure/response analyses, often referred to as pharmacometrics, is key to making go/no go decisions both during clinical trials by investigators and by the FDA during the subsequent review period. Participants will learn basic pharmacology theory with introductory statistics using a popular open-source software program (R Studio) that is capable of conducting pharmacokinetic (PK) exposure and pharmacodynamic (PD) response analyses from example clinical trial data. Ultimately, the framework of analyzing exposure/response relationships will be demonstrated in order to make go/no go decisions. This workshop is designed for researchers and clinicians interested in learning how to utilize freely available software to explore, visualize, and understand drug exposure/response relationships where responses include any clinical endpoint collected on a trial, or for researchers and clinicians interested in understanding and predicting the effect of different doses on drug exposure as well as the effect of exposure on a variety of clinically relevant response endpoints (biomarkers), or for medical, pharmacy, dental, nursing, and lab-based graduate-school students interested in obtaining a deeper understanding of pharmacokinetics, exposure/response analyses, as well as a broad understanding of clinical drug development and the impact of pharmacometrics on decisions.

Credits: 0
Class Type: Workshop
BIOF 085: Introduction to Data Science with Python
Scientists generate more data than ever before. It can be daunting to determine how to extract insights from a mountain of data. Data science is a relatively new discipline that combines traditional statistics and analytics with programming to produce novel insights, intelligently automated processes, and data-driven decisions.

This workshop will equip you with everything you need to complete a basic data science project using Python from beginning to end. Participants will be exposed to a practical, real-world use case, which will be built on throughout the workshop. Students will use the data from this use case to perform exploratory analysis and build their skills up to advanced analytics.

**Class Type:** Workshop

BIOF 088: Introduction to Text Mining Using Python
This course will introduce participants to a comprehensive set of text mining related topics, tools and techniques. It will cover three primary components: (1) basics of Python and its related packages, (2) an overview of text mining pipeline and techniques, and (3) an introduction to machine learning and development of text mining applications using machine learning. Each component will have hands-on exercises and case studies for practice.

**Learning Objectives**

At the end of the course a learner should be able to:

- Write basic Python codes and use Python-related packages such as Pandas, Numpy and Sklearn for textual data analysis
- Understand text mining pipelines and develop text mining methods for text processing
- Understand machine learning related concepts and develop text mining applications (such as text classification and named entity recognition) using machine learning techniques

**Class Type:** Workshop

BIOF 089: Microbiome Bioinformatics with QIIME2
Members of the QIIME development group will lead this hands-on workshop on bioinformatics tools for microbial ecology. The workshop will include lectures covering basic QIIME usage and theory, and hands-on work with QIIME, to perform microbiome analysis from raw sequence data through publication-quality statistics and visualizations. The workshop will also cover related bioinformatics tools including DADA2, Emperor, scikit-bio, and an introduction to applied bioinformatics. This workshop will provide the foundation on which participants can begin using these tools to advance their own studies of microbiome analysis or microbial ecology. This is a hands-on workshop. Participants must bring their laptop. This workshop will be on QIIME2 platform only.

**Credits:** 0

**Class Type:** Workshop

BIOF 090: MATLAB Fundamentals
MATLAB® is a programming platform designed for scientists and engineers. This workshop provides a comprehensive introduction to the MATLAB® technical computing environment. No prior programming experience or knowledge of MATLAB is assumed. Themes of data analysis, visualization, modeling, and programming are explored throughout the workshop.

**Credits:** 0

**Class Type:** Workshop

BIOF 091: Image Processing and Computer Vision with MATLAB
This workshop provides hands-on experience with performing image analysis. Examples and exercises demonstrate the use of appropriate MATLAB® and Image Processing Toolbox™ functionality throughout the analysis process. The workshop also provides hands-on experience with performing computer vision tasks. Examples and exercises demonstrate the use of appropriate MATLAB® and Computer Vision System Toolbox™ functionality.

**Credits:** 0

**Class Type:** Workshop

**Prerequisites:**
- BIOF 090
  - The above workshop or equivalent MATLAB experience.
BIOF 093: Machine Learning with MATLAB
MATLAB is a high-level language that enables you to quickly perform computation and visualization through easy-to-use programming constructs.

This two-day workshop focuses on data analytics and machine learning techniques in MATLAB® using functionality within Statistics and Machine Learning Toolbox™ and Deep Learning Toolbox™. The workshop demonstrates the use of unsupervised learning to discover features in large data sets and supervised learning to build predictive models. Examples and exercises highlight techniques for visualization and evaluation of results. Topics include:

- Organizing and preprocessing data
- Clustering data
- Creating classification and regression models
- Interpreting and evaluating models
- Simplifying data sets
- Using ensembles to improve model performance

Class Type: Workshop

BIOF 097: Practical Scientific Statistics
As big data becomes the norm and experiments continue to increase in scale, proper understanding and use of statistics is becoming increasingly important for scientists in every field. While experimental researchers are expert in concepts related to their respective fields and receive extensive scientific education, statistical training is relatively lacking. As a result, experimental researchers may feel overwhelmed or uncertain about how to correctly use statistics to quantify their experimental results and how to properly interpret the results of those statistical tests. Unfortunately, this knowledge gap can result in both reduced understanding of reported results in scientific publications as well as superficial or potentially inaccurate reported statistics. This workshop serves as a practical, hands-on workshop to close the knowledge gap and help experimental researchers learn how to choose a statistical test for their data, how to perform those tests, and how to interpret the results. The workshop starts by establishing a solid foundation in basic statistical theory before advancing to practical applications of statistical tests on real data.

Learning Objectives
As big data becomes the norm and experiments continue to increase in scale, proper understanding and use of statistics is becoming increasingly important for scientists in every field. While experimental researchers are expert in concepts related to their respective fields and receive extensive scientific education, statistical training is relatively lacking. As a result, experimental researchers may feel overwhelmed or uncertain about how to correctly use statistics to quantify their experimental results and how to properly interpret the results of those statistical tests. Unfortunately, this knowledge gap can result in both reduced understanding of reported results in scientific publications as well as superficial or potentially inaccurate reported statistics. This workshop serves as a practical, hands-on workshop to close the knowledge gap and help experimental researchers learn how to choose a statistical test for their data, how to perform those tests, and how to interpret the results. The workshop starts by establishing a solid foundation in basic statistical theory before advancing to practical applications of statistical tests on real data.

Class Type: Workshop
Prerequisites:
Attendees should have access to and basic knowledge of Excel. Analyses will also be demonstrated in SPSS and R, but no formal programming skills are required.

**BIOF 098: Introduction to Statistical Analysis in R**

R is a popular platform to perform statistical analysis. This workshop introduces how to perform basic statistical analysis using the R platform. First, participants will learn to use the R and RStudio software platforms. Followed by an introduction to basic statistical concepts, participants will do hands-on exercises to perform basic statistical analysis using the R platform.

**Credits:** 0  
**Class Type:** Workshop

**BIOF 099: Advanced Statistical Analysis using R**

In this interactive workshop, participants will first learn the theory underlying analyses, then watch demonstrations of running analyses in R, and finally practice running analyses themselves.

**Learning Objectives**

Upon completing the workshop, attendees will have the confidence, knowledge, and resources to:

- Understand and fit statistical models (ANOVA, regression)  
- Perform model selection  
- Run empirical statistical analyses (bootstrapping, simulations, imputation)  
- Understand and fit basic machine learning models

**Class Type:** Workshop  
**Prerequisites:**  
BIOF 098  
STAT 101  
The above course(s), workshop(s) or prior knowledge of basic R and statistics are required to be successful in this workshop.

**BIOF 101: Introduction to Coding Skills in Python**

This course will teach students key programming skills needed for success in biomedical research or other coding applications. The assignments will be done in Python, which is one of the most popular and widely-used programming languages (redmonk.com/sogrady/2020/02/28/language-rankings-1-20/), but the concepts learned in the course will be transferrable to many other languages, allowing students to more easily transition to another language if they so desire. The assignments will also encourage students to think about scientific applications for programming.

**Learning Objectives**

- Define and understand foundational programming concepts (i.e. algorithms, functions)  
- Gain familiarity with key components of Python programming such as variables, conditionals, and loops  
- Analyze basic functions written in python, and use Python to implement basic functions  
- Assess the relevant applications of programming in their own work/life

**Credits:** 1  
**Class Type:** Graduate Course  
**Prerequisites:**  
None.

Register Now

**Availability**  
May 2022  
**Session** Intersession
BIOF 309: Introduction to Python
Python is a free, open-source and powerful programming language that is easy to learn. This course is intended for non-programmers who want to learn how to write programs that expand the breadth and depth of their daily research. Most elementary concepts in modern software engineering will be covered, including basic syntax, reading from and writing to text files, debugging Python programs, regular expressions, and creating reusable code modules that are distributable to peers. The course will also focus on potential applications of Python to bioinformatics, including sequence analysis, data visualization and data analysis. Students will also learn to use the Jupyter Notebook and the PyCharm integrated development environment (IDE), which are available at no cost.

INDIVIDUAL LAPTOP IS NEEDED FOR EACH CLASS.
Continuum Analytics Installer Anaconda (V3) will be utilized to install Python and the necessary packages.

Learning Objectives
• Gain basic understanding of elementary concepts ubiquitous in modern software engineering: regular expressions; reading from and writing to text files; and, recursion
• Apply Python to important functions in bioinformatics such as sequence analysis, data analysis and data visualization
• Learn how to obtain and rework an existing script to meet current needs
• Gain experience in two programming environments (Jupyter Notebook and PyCharm IDE)

Credits: 2
Class Type: Graduate Course
Availability Spring 2022
Session Session A and B

BIOF 339: Practical R
The goal of this course is to introduce biomedical research scientists to R as an analysis platform rather than a programming language. Throughout the course, emphasis will be placed on example-driven learning. Topics to be covered include: installation of R and R packages; command line R; R data types; loading data in R; manipulating data; exploring data through visualization; statistical tests; correcting for multiple comparisons; building models; and, generating publication-quality graphics. No prior programming experience is required.

INDIVIDUAL LAPTOP IS NEEDED FOR EACH CLASS.

Learning Objectives
• Run R GUI and make use of command line features, including command history and help pages
• Find and make use of the extensive libraries (R add-ons) available for analyzing biological and other forms of data
• Load, manipulate, and combine data to make it amenable to further analyses
• Visualize data with extensive graphics capabilities of R (including ggplot)
• Use appropriate statistical tests on data within R that will conform to standards expected in scientific journals

Credits: 2
Class Type: Graduate Course
Availability Spring 2022
Session Session A and B
BIOF 395: Introduction to Text Mining
Between Electronic Medical Records and Electronic Health Records, PubMed, and collections of biomedical grant applications, there exist large quantities of medical information stored in databases waiting to be explored. Besides tables of numbers, medical records also contain a great amount of free-text paragraphs that are comprehensible to human readers but challenging to computers. Text mining is an interdisciplinary area that primarily combines advances in Natural Language Processing (NLP), Information Retrieval (IR), and Machine Learning (ML) to help the computers understand human written language and thus extract medical and clinical information from free-text records. This class aims to introduce fundamental subjects in text mining such as tokenization, named entity recognition (NER), grammars, parsing, relation extraction, and document classification. The class is oriented towards hands-on experience with Python and Natural Language Toolkit (NLTK).

Learning Objectives
• Learn basic programming in Python
• Master fundamental building blocks of Natural Language Processing
• Acquire hands-on experience with NLTK, a Python toolkit for NLP
• Gain an introduction to statistical models of Machine Learning applied to NLP and IR

Credits: 2
Class Type: Graduate Course
Prerequisites:
Prior exposure to programming and Python is encouraged but not required to attend this class
Availability Spring 2022
Session Session A

BIOF 398: Practical Deep Learning
Deep learning (DL) is emerging as a major disruptive technology in biomedical and clinical research. It is also a skill with high demand in the decade to come. This course aims to teach the foundations to understand how neural network works and also introduce latest developments. You will build your own neural networks and gain skills to apply deep learning to your field. The course consists of a set of lectures over the 7 weeks. A number of course videos and assignments will be released every week to cover basis and advanced topics in deep learning. The assignments consist of multi-choice and short-answering questions, and coding problems. We will start from basics of neural networks, introduce the loss function, optimization and how to setup and manage the training session. The next section is the convolutional neural network for imaging and vision tasks. We will learn the recurrent neural network (RNN) for the sequence data. More recently, attention mechanism and transformer models (BERT, GPT family etc.) are very popular. They are introduced after RNN. We will teach generative model and in details the GAN (generative adversarial network). The technique to visualize the neural network is introduced to help understand how and why the neural network works. The course will end with a focus on how to handle "small dataset" use case, as in many practical applications, we may not be able to acquire large labelled dataset. Three techniques are introduced, transfer learning, meta learning and contrastive learning (as the more recent development of self-supervised learning).

Learning Objectives
• Introduce the theory of deep learning
• Present in-depth how DL model works
• Present the widely used DL architecture
• Grow the mindsets of machine learning and DL based problem solving
• Provide practices to build your own model
• Prepare students for DL related job opportunities.

Credits: 2
Class Type: Graduate Course
BIOF 399: Deep Learning for Healthcare Image Analysis
In this course, students will learn how to apply Convolutional Neural Networks (CNNs) to MRI scans to perform a variety of medical tasks and calculations. Upon completion of this course, students will be able to apply CNNs to MRI scans to conduct a variety of medical tasks. INDIVIDUAL LAPTOP IS NEEDED FOR EACH CLASS (Mac, Linux or Windows).

Learning Objectives

- Understand how to use popular image classification neural networks for semantic segmentation
- Use the popular R programming language with deep learning framework MXNet to create a powerful GPU accelerated convolution neural network (CNN) solution for quantitative medical image analysis
- Use deep-learning techniques to predict genomic biomarkers from medical image analysis
- Explore other areas of innovation and research
- Get hands-on guidance to try many different deep-learning frameworks

Credits: 2
Class Type: Graduate Course
Prerequisites:
Previous programming experience is not required, but is recommended.

BIOF 439: Data Visualization with R
This course will demonstrate and practice the use of R in creating and presenting data visualizations. After a short introduction to R tools, especially the tidy verse packages, the course will cover principles for data visualization, examples of good and bad visualizations, and the use of ggplot2 to create static publication-quality graphs. Students will also have the chance to learn about modern web-based interactive graphics using the html widgets packages as well as dynamic graphics and dashboards that can be created using flex dashboard and Shiny. The course will explore ways in which bioinformatics data can be presented using static and dynamic visualizations. Finally, RMarkdown and other packages will be used to develop webpages for presenting data visualizations as self-explanatory and possibly interactive storyboards.

Learning Objectives

- Understand principles of good data visualization to avoid poor or inappropriate data visualization
- Gain knowledge of appropriate use of color, symbols, and small multiples
- Learn about static and dynamic data visualizations, using the web as a presentation medium

Credits: 1
Class Type: Graduate Course
Prerequisites:
none, however, BIOF 339 Practical R or equivalent introductory course to R would be useful.
BIOF 440: Data Visualization with Python
This course will demonstrate and practice the use of Python in creating and presenting data visualizations.

Learning Objectives
• Understand principles of good data visualization to avoid poor or inappropriate data visualization
• Gain knowledge of appropriate use of color, symbols, and small multiples
• Learn about static and dynamic data visualizations, using the web as a presentation medium

Credits: 1
Class Type: Graduate Course
Prerequisites:
BIOF 309
None, however, the above course or equivalent introductory course to Python would be useful.

BIOF 450: Evolutionary Genomics
Enormously large series of complex and chaotic events have shaped the genomes of eukaryotes, prokaryotes, and viruses. This course will address cutting-edge approaches to the computational investigation of these events, with an eye toward developments in translational systems biology. The course will begin by presenting the fundamentals of evolutionary genomics, including basic properties of genomes and comparative genomics, population genetics, and sequence-structure-function relationships. Experimental design and biological project integration will be a major theme of the course. Specific lectures on statistical analysis, similarity searches, Next Generation Sequencing, epigenomics, and other specialized topics will supplement those given in the earlier part of the course.

Learning Objectives
• Perform statistical analysis and display data
• Learn applications of evolutionary genomics, including cancer genomics, evolution of immune systems, and analysis of brain developmental problems
• Apply the skills acquired to complete a computational biology project

Credits: 2
Class Type: Graduate Course

BIOF 475: Introduction to Data Science
Learning from data in order to make useful predictions or obtain insights is a cornerstone of modern science. The goal of this course is to introduce students to the basic tools and workflows for doing this, with a focus on biological- and health-related data. In this course, students will learn how to use Python-based tools, particularly Numpy, SciKit-learn, Pandas, and Matplotlib.

Learning Objectives
• Load and clean data
• Choose what type of model (e.g. supervised or unsupervised) to use based on the questions being asked of the data
• Build and validate the chosen model
• Visualize and explain what that model learned from the data

Credits: 2
Class Type: Graduate Course
Prerequisites:
Previous programming experience is not required, but is recommended.

BIOF 501: Introduction to R: Step-by-Step Guide
R is a free statistics software that is becoming increasingly popular and important for data analysis in biology. During the course, students will first learn how to handle the R programming environment. Next, students will learn how to simulate data for analysis, while the background for R programming will be provided in accompanying lectures. At the end of the course, students will become familiar with simple R programming, which they will be then able to apply for their own data analysis.

Learning Objectives
• Introduce R programming environments for scientific analysis
• Understand the concepts of basic data structures, such as Vectors, Matrices, Arrays, List, and Data Frames
• Introduce data handling and visualization in R
• Understand the concepts of Packages and simple R programming

Credits: 2
Class Type: Graduate Course
Availability: Spring 2022
Session: Session A and B
BIOF 509: Applied Machine Learning

Machine learning is a computational field that consists of techniques allowing computers to learn from data and make data-driven predictions or decisions. The ability to effectively implement machine learning approaches is a crucial component of data analysis. BIOF 509 provides a comprehensive overview of machine learning concepts, project design, and implementation. The course will give a conceptual overview of the most popular machine learning algorithms with examples of how/when to apply them to datasets. Algorithms that will be covered include: support vector machines, decision trees, random forests, multiple clustering approaches, and deep learning. Best practices in designing machine learning projects will also be emphasized, and this course will introduce strategies to avoid common pitfalls and to accurately interpret results. To reinforce key concepts, this course contains 4 written homework assignments and a research project. Through the homework assignments, students will (i) study theory behind common machine learning algorithms and (ii) explore examples of successful machine learning projects in biomedical research. For the research project, students will use python machine learning packages (Scikit-Learn, Tensorflow, Pytorch) to design a multistep pipeline to analyze a dataset of their choice. Students will also be expected to use Github to demonstrate proper documentation and version control practices when completing the project.

Learning Objectives

- Choose appropriate machine learning techniques for data analyses and interpret their results
- Design properly machine learning analysis pipelines and avoid common pitfalls
- Complete a short research project using machine learning

Credits: 2  
Class Type: Graduate Course  
Prerequisites:  
BIOF 309 Introduction to Python or have equivalent experience. While the course will include a brief Python refresher, the emphasis of the course will be on applying machine learning.

BIOF 510: Advanced Applications of Artificial Intelligence

In the past decade, big data has become increasingly prominent in many fields, including healthcare and biomedical research. These increasingly large datasets pose a unique challenge to researchers. In these cases, nuanced approaches to machine learning are often necessary to extract important information. BIOF 510, a continuation of BIOF 509, will cover advanced applications of popular machine learning algorithms, including support vector machines, random forests, and neural networks. Neural network algorithms that will be covered include multi-layer perceptrons, convolutional neural networks, recurrent neural networks, probabilistic neural networks, and autoencoders. To reinforce key concepts, this course contains 4 written homework assignments and a research project. Through the homework assignments, students will (i) study theory behind common machine learning algorithms and (ii) explore examples of successful machine learning projects in biomedical research. For the research project, students will use python machine learning packages (Scikit-Learn, Tensorflow, Pytorch) to design a multistep pipeline to analyze a dataset of their choice. Students will also be expected to use Github to demonstrate proper documentation and version control practices when completing the project.

Learning Objectives

- Choose appropriate machine learning techniques for data analyses and interpret their results
- Design properly machine learning analysis pipelines and avoid common pitfalls
- Complete a short research project using machine learning

Credits: 2  
Class Type: Graduate Course  
Prerequisites:  
BIOF 509  
The above course(s) or permission from the instructor.
### BIOF 518: Theoretical and Applied Bioinformatics: Genes and Proteins

The objective of this course is to give students an introduction into the theory and practice of a wide range of bioinformatic techniques and applications, enabling them to use these tools in their own research. This course will be divided into five modules: statistical approaches in sequence analysis; phylogenetic analysis of nucleotide and protein sequences; acquisition and analysis of sequence datasets, including EST and RNA-seq data; analysis of genomic datasets from an evolutionary perspective; and, prediction of protein secondary structure. Two or three of the five sessions in each module will be divided roughly 60 percent theoretical lecture and 40 percent learning to use relevant computational tools. The final session of each module will be split between a discussion of computational tools, a journal club, and a discussion of work on a project assigned for each module. By the end of the course, students should be able to acquire many types of sequence data, identify orthologous and paralogous genes, predict domains and motifs, identify alternative splicing, analyze genomic/protein alignments, and make a prediction of secondary protein structure from primary sequence.

**Learning Objectives**

- Introduce the theory and practice of a wide range of bioinformatic techniques and applications, enabling students to use these tools in their own research
- Search database searches using BLAST and hidden Markov models
- Predict gene structure and analyze domains and motifs
- Conduct phylogenetic analysis of nucleotide and protein sequences and identify orthologous and paralogous genes
- Analyze genomic and protein alignments, prediction of secondary protein structure from primary sequence

**Credits:** 2  
**Class Type:** Graduate Course  
**Prerequisites:**  
Solid understanding of biology, computer science and mathematics.  
**Availability** Spring 2022  
**Session** Session A

### BIOF 519: Theoretical and Applied Bioinformatics: Genomics and Metagenomics

This is the second part of a two-part course. The completion of the first part (prerequisite) is required before taking the second part. Registration is required separately for each part of the course.

**Learning Objectives**

- Introduce the theory and practice of a wide range of bioinformatic techniques and applications, enabling students to use these tools in their own research
- Search Genome Resources at NCBI
- Conduct genome assembly and gene prediction
- Analyze molecular evolution and genome comparison

**Credits:** 2  
**Class Type:** Graduate Course  
**Prerequisites:**  
BIOF 518  
The above course(s) or permission from the instructor. Solid understanding of biology, computer science and mathematics.  
**Availability** Spring 2022  
**Session** Session B
BIOF 521: Bioinformatics for Analysis of Data Generated by Next Generation Sequencing

In this course, students will learn to analyze data generated by a variety of sequencing techniques (such as DNaseq, RNaseq and CHIP-seq) particularly in relation to biomedical applications (such as analysis of gene expression and identification of medically relevant sequence variation). While recorded lectures and readings will provide necessary background, the course emphasizes hands-on, self-paced lessons featuring real-world data sets to give the learner experience with all major steps of sequencing analyses, from filtering of raw data to creating polished figures. As the course progresses, students will work on a term project in which they design a sequencing project based on their own research interests. To make this course accessible to all students, we will focus on the use of publicly available resources, such as the NCBI SRA and the Galaxy platform, that can be accessed from anywhere.

Learning Objectives

Students in the course will:

- Compare and contrast a variety of modern sequencing techniques and their applications.
- Utilize and compare several platforms for the analysis of sequencing data.
- Carry out bioinformatics analyses on biomedically relevant sequencing data sets.
- Interpret the results of these analyses by generating figures and written summaries.
- Develop a sequencing and analysis plan for a project relevant to their own research interests.

Credits: 2
Class Type: Graduate Course

Prerequisites:
This course has no official pre-requisites. However, the course material assumes that you are familiar with general genetics and statistics concepts at the level expected from undergraduate coursework. No prior knowledge of bioinformatics data analysis or programming languages is required.

Availability Spring 2022
Session Session B

BIOF 540: Gene Expression Analysis

The gene expression programs that instantiate eukaryotic cell states are complex and dynamic, but ultimately essential to understanding development, homeostasis, real-time environmental adaptation and cellular dysregulation. This course will aim to equip you with a broad range of tools for analyzing gene expression and elucidating the regulatory influences affecting it. By the end, students will have an appreciation for the many layers of expression regulation and a familiarity with common methods for analyzing gene expression and its regulation that will enable interpretation of such results in the literature and the ability to choose the right tool for answering their own gene expression-related research questions in the future.

Learning Objectives

- Develop an understanding of the many layers of regulation influencing gene expression
- Become familiar with common gene expression measurement methods and know how to choose the right one for the job
- Be able to perform differential gene expression analyses, and identify and use gene expression signatures
- Know how to find genomic regulatory elements that may influence a gene's expression
- Appreciate gene expression in the context of functional pathways and dynamic gene regulatory networks/programs

Credits: 2
Class Type: Graduate Course
BIOF 544: Getting the Message: High Resolution Analysis of Transcriptomes

The human genome reference sequence took decades and vast resources to complete. The human transcriptome reflects how the genome is deployed, and is vastly more complex and elusive, but great strides in characterizing transcriptomes have been enabled by sequencing technology in the last decade. The objective of this course is to gain an understanding of the ways transcriptomes are analyzed with modern sequencing methods. In this course, students will move beyond thinking of gene expression as getting lists of up and down genes, and gain an appreciation for the multiple interacting mechanisms at play that determine protein levels from transcripts - including splicing, RNA modifications, and translational control. Starting from a biological question about gene regulation, the student will learn to design the experiment to assay that question, as well as choose the appropriate tools and perform the analysis. The student will also gain an understanding of current and cutting edge sequencing technology to know what assays are possible.

Learning Objectives

• Understand complex mechanisms of transcriptional and post-transcriptional gene regulation
• Describe and identify the major sequencing experiment data types and tools
• Plan a data analysis strategy for a sequencing experiment
• Execute a data analysis strategy for a transcriptomic dataset

Credits: 2
Class Type: Graduate Course
Prerequisites:
BIOF 339
BIOF 501
The above course(s) or familiarity with R and basic command line usage or Unix/Linux.
Availability: Spring 2022
Session: Session B

MATH 127: Elementary Calculus I, part 1

This is a first course in calculus and is aimed at students of diverse backgrounds who have previously not taken any formal course on the subject. The course includes a brief review of pre-calculus topics, including functions and algebra, and then moves on to computations using infinity and beyond: infinitesimal quantities, differentials, infinite sequences, and whether it is possible to divide by zero. Scientific applications and achievements will motivate the exploration of the essential single-variable calculus concepts of limits, derivatives, and integrals. This is the first part of a two-part course. Registration is required separately for each part of the course.

Learning Objectives

• Understand the concept of functions, their limits, and continuity
• Become familiar with differentiation and integration techniques of single-variable functions
• Introduce applications of calculus to scientific research

Credits: 2
Class Type: Graduate Course
Prerequisites:
A pre-calculus course (including online) is recommended, but not required. Knowledge of trigonometry, basic algebra, and graphing is required.
MATH 128: Elementary Calculus I, part 2
This is a first course in calculus and is aimed at students of diverse backgrounds who have previously not taken any formal course on the subject. The course includes a brief review of pre-calculus topics, including functions and algebra, and then moves on to computations using infinity and beyond: infinitesimal quantities, differentials, infinite sequences, and whether it is possible to divide by zero. Scientific applications and achievements will motivate the exploration of the essential single-variable calculus concepts of limits, derivatives, and integrals.

This is the second part of a two-part course. The completion of the first part (MATH 127) is required before taking the second part. Registration is required separately for each part of the course.

Learning Objectives

- Understand the concept of functions, their limits, and continuity
- Become familiar with differentiation and integration techniques of single-variable functions
- Introduce applications of calculus to scientific research

Credits: 2
Class Type: Graduate Course
Prerequisites:
MATH 127
The above course(s) or permission from the instructor.

MATH 129: Elementary Calculus II, part 1
This course is a continuation of MATH 127 and is focused on multivariable and vector calculus. It covers calculus of curves in space, vector functions, functions of more than one variable, and introduces vector calculus. Applications of this more general descriptions of calculus to scientific research will also be presented. This is the first part of a two-part course. Registration is required separately for each part of the course.

Learning Objectives

- Understand how to describe curves in space and apply calculus parametric functions
- Understand functions of more than one variable, partial derivatives and multiple integrals
- Become acquainted with vector calculus

Credits: 2
Class Type: Graduate Course
Prerequisites:
MATH 127
MATH 128
The above course(s) or permission from the instructor.

MATH 130: Elementary Calculus II, part 2
This course is a continuation of MATH 127 and is focused on multivariable and vector calculus. It covers calculus of curves in space, vector functions, functions of more than one variable, and introduces vector calculus. Applications of this more general descriptions of calculus to scientific research will also be presented. This is the second part of a two-part course. The completion of the first part (MATH 129) is required before taking the second part. Registration is required separately for each part of the course.

Learning Objectives

- Understand how to describe curves in space and apply calculus parametric functions
- Understand functions of more than one variable, partial derivatives and multiple integrals
- Become acquainted with vector calculus

Credits: 2
Class Type: Graduate Course
Prerequisites:
MATH 129
The above course(s) or permission from the instructor.
MATH 215: Introduction to Linear Algebra With Applications in Statistics, part 1
This is a first course in linear algebra, aimed at students with diverse backgrounds. It covers the content of a standard textbook: linear systems, vectors and matrices, dimensions and bases of vector spaces, eigenvalues and eigenvectors, singular value decomposition. It is also dedicated to explaining applications of these linear algebra concepts in classic analysis methods as well as state-of-the-art statistical inference and machine learning approaches. In the application portion of the course we will strive to tailor the content to the interests and research needs of the students.

This is the first part of a two-part course. Registration is required separately for each part of the course.

Learning Objectives
• Understand systems linear equations and their matrix representation
• Learn the concept of vector spaces, subspaces, and linear dependence
• Learn spectral methods for analyzing matrices
• Understand statistical methods based on linear models

Credits: 2
Class Type: Graduate Course
Prerequisites:
One semester of analytic geometry or calculus is recommended, but not required. Basic knowledge of vectors, cartesian coordinates, and algebra is required.

MATH 216: Introduction to Linear Algebra With Applications in Statistics, part 2
This is a first course in linear algebra, aimed at students with diverse backgrounds. It covers the content of a standard textbook: linear systems, vectors and matrices, dimensions and bases of vector spaces, eigenvalues and eigenvectors, and singular value decomposition. It is also dedicated to explaining applications of these linear algebra concepts in classic analysis methods as well as state-of-the-art statistical inference and machine learning approaches. In the application portion of the course, we will strive to tailor the content to the interests and research needs of the students.

This is the second part of a two-part course. The completion of the first part (MATH 215) OR an equivalent course OR the knowledge of vectors, matrix operations, orthogonality, and determinants is highly recommended before taking the second part. Registration is required separately for each part of the course.

Learning Objectives
• Understand systems linear equations and their matrix representation
• Learn the concept of vector spaces, subspaces, and linear dependence
• Learn spectral methods for analyzing matrices
• Understand statistical methods based on linear models

Credits: 2
Class Type: Graduate Course
Prerequisites:
MATH 215
The above course OR an equivalent course OR the knowledge of vectors, matrix operations, orthogonality, and determinants is highly recommended before taking MATH 216. One semester of analytic geometry or calculus is recommended, but not required.
STAT 101: Introduction to Statistics
In this course, students will be introduced to basic statistical theory, real-world statistics applications, and statistical test implementations in R. Students will learn the theory behind common statistical tests and how to perform them before moving on to perform statistical analyses using a dataset of their choice. Through this process, students will learn how to select the correct test for a dataset, how to design experiments amenable to statistical analyses, and how to avoid common statistical analysis pitfalls.

Learning Objectives

• Use and interpret results of basic statistical tests
• Select the appropriate statistical test for a given data analytics problem
• Design experimental procedures with statistics in mind
• Use R to run basic statistical analyses

Credits: 1
Class Type: Graduate Course
Availability: May 2022
Session: Intersession

STAT 201: Experimental Statistics I, part 1
This course introduces statistical concepts and essential techniques that are frequently used in biomedical data analysis. The emphasis will be equally divided between solid understanding of basic principles and their applications. R software is introduced and used for demonstration throughout the course. Topics covered in the second semester: test of statistical hypothesis; one- and two-sample tests; power and sample size calculation; analysis of variance (ANOVA); nonparametric tests; linear regression; analysis of categorical data; permutation and bootstrap; data analysis using R.

This is the first part of a two-part course. Registration is required separately for each part of the course.

Learning Objectives

• Understand basic principles of probability and statistics
• Use appropriate statistical tools to analyze data for research

Credits: 2
Class Type: Graduate Course
Prerequisites: STAT 201
The above course(s) or permission from the instructor.
STAT 203: Experimental Statistics II, part 1
This course introduces statistical concepts and essential techniques that are frequently used in biomedical data analysis. The emphasis will be equally divided between solid understanding of basic principles and their applications. R software is introduced and used for demonstration throughout the course. Topics covered in the second semester: test of statistical hypothesis; one- and two-sample tests; power and sample size calculation; analysis of variance (ANOVA); nonparametric tests; linear regression; analysis of categorical data; permutation and bootstrap; data analysis using R.

This is the first part of a two-part course. Registration is required separately for each part of the course.

Learning Objectives
- Understand basic principles of probability and statistics
- Use appropriate statistical tools to analyze data for research

Credits: 2
Class Type: Graduate Course
Prerequisites: STAT 202
The above course(s) or permission from the instructor. Working knowledge of Algebra II and one semester of Calculus is preferred.

STAT 204: Experimental Statistics II, part 2
This course introduces statistical concepts and essential techniques that are frequently used in biomedical data analysis. The emphasis will be equally divided between solid understanding of basic principles and their applications. R software is introduced and used for demonstration throughout the course. Topics covered in the second semester: test of statistical hypothesis; one- and two-sample tests; power and sample size calculation; analysis of variance (ANOVA); nonparametric tests; linear regression; analysis of categorical data; permutation and bootstrap; data analysis using R.

This is the second part of a two-part course. The completion of the first part (STAT 203) is required before taking the second part. Registration is required separately for each part of the course.

Learning Objectives
- Understand basic principles of probability and statistics
- Use appropriate statistical tools to analyze data for research

Credits: 2
Class Type: Graduate Course
Prerequisites: STAT 203
The above course(s) or permission from the instructor. Working knowledge of Algebra II and one semester of Calculus is preferred.
STAT 321: Methodology in Clinical Trials
The objective of this course is to learn the concepts and methodology used in the design and conduct of randomized clinical trials. Topics to be covered will include the description of main types of trial designs, principles of randomization and stratification, issues in protocol development (defining objectives and endpoints, blinding, choice of control), recruitment and retention, data collection and quality control issues, monitoring, and analyses of trials reports. Textbook material will be frequently supplemented by material from the literature. Guest lecturers will give lectures on power and sample size calculations, life table analysis, quality of life and cost evaluation. Examples from the cardiovascular, pulmonary, and cancer areas will be used when appropriate. The course is intended for biomedical researchers desiring exposure to the clinical-trial field. In order to run this course, minimum 10 students need to register.

Learning Objectives

• Acquire a fundamental understanding of methodological principles and concepts in clinical trials
• Describe essential elements of clinical trials and use this knowledge to contribute to the successful conduct of a clinical trial
• Read critically clinical trials literature

Credits: 3
Class Type: Graduate Course

STAT 323: Epidemiology: A Practical Approach to Research Methods
This course offers an introduction to the concepts and methodologies of population-based epidemiologic principles. This is an introductory course for biomedical researchers and medical professionals who are not majoring in Epidemiology. The lectures will cover the following topics: (1) Epidemiology key terms and core concepts; (2) Calculation and interpretation of measures of disease frequency and measures of association; (3) Evaluation of epidemiologic study designs and their restrictions; (4) Applications of epidemiologic methods in different fields of public health. Upon completion of the course, students will have a comprehensive understanding of the investigation, causality, and inference in public health using the practical epidemiologic methods.

Learning Objectives

• Calculate basic epidemiology measures using hospital and clinical data
• Understand the research methods and causal reasoning based on developing and testing hypotheses in epidemiology
• Conduct appropriate inferences from epidemiologic data and apply analytical skills using modern statistical approaches
• Identify the causes and factors that may influence the occurrence of pandemic disease and health condition
• Learn to communicate epidemiologic information with professional and general audiences

Credits: 2
Class Type: Graduate Course
Availability Spring 2022
Session Session B
**STAT 325: Epidemiologic Research Methods**

The objective of this course is to provide a deeper understanding of epidemiologic research methodology that can be used to interpret critically the results of epidemiologic research. This understanding will result from investigating conceptual models for study designs, disease frequency, measures of association and impact, imprecision, bias, and effect modification. The course will emphasize the interpretation of research, even when the design or execution of the respective research is less than ideal.

**Learning Objectives**

- Be able to distinguish design options in the conduct of epidemiologic research
- Learn about choices for measures of disease frequency, association, and impact
- Understand the origin of selection, information, and confounding biases, and its effect on research results
- Know the origin of imprecision and its effect on research results
- Recognize the origin of effect modification and its effect on research results

**Credits:** 3  
**Class Type:** Graduate Course  
**Prerequisites:** STAT 200 or STAT 500 and STAT 317.

---

**STAT 330: Introduction to SAS**

The course will cover the fundamentals of the SAS program and its variables, creating data, importing data (from text and Excel files), exporting data (to text, pdf, and Microsoft-related formats), manipulating data, and providing descriptive statistics. Students will have the opportunity to practice in class, using sample datasets. Homework and project assignments will be provided as well.

**Learning Objectives**

- Recognize different types of raw data and learn how to import them into SAS
- Understand different types of variables as well as how to manipulate and convert between them
- Understand how to set up and conduct merging and transposing of data tables
- Obtain descriptive statistics such as mean, median, min, and max
- Generate reports and output reports into a variety of file types.

**Credits:** 2  
**Class Type:** Graduate Course  
**Prerequisites:**  
Basic understanding of Microsoft Excel; prior programming experience and basic knowledge of statistics (i.e. mean vs. median vs. mode) would be beneficial, but is not required.
STAT 430: Advanced SAS

The course will cover advanced SAS coding concepts such as the use of SAS Macro, SAS SQL, as well as a combination of both. The course will also introduce students to SAS STAT coding for common statistical tests (such as t-test, ANOVA, linear regression, and others). Students will have the opportunity to practice in class, using sample datasets. Homework and project assignments will be provided as well.

Learning Objectives

- Understand the principles of Macro variables and Macro functions
- Become proficient with writing Macro coding for new programs and adding Macro coding to existing programs
- Understand how to create tables using SAS SQL with a variety of conditions
- Combine knowledge of STAT330 concepts with SAS SQL and SAS Macro to solve complex data issues
- Use SAS STAT to perform statistical tests (t-test, ANOVA, correlation, linear regression, Chi-Squared, logistic regression)

Credits: 2

Class Type: Graduate Course

Prerequisites:
STAT 330 Introduction to SAS or equivalent at another college/university.

STAT 500: Statistics for Biomedical Scientists I, part 1

The objective of this course is to provide an overview of statistics for biomedical researchers and clinicians who are interested in the interpretation of the results of statistical analyses. This is a series of integrated lectures, readings, and exercises on analysis and interpretation of medical research data using Excel. Emphasis is on ideas and understanding rather than mechanics. Topics covered include the foundation of statistical logic, interpretation of the most commonly encountered statistical procedures in medical research, and selection of an appropriate method to analyze a particular set of data. The second semester expands on the material covered in the first semester.

This is the first part of a two-part course. Registration is required separately for each part of the course.

Learning Objectives

- Understand the role of chance in biomedical research
- Become knowledgeable about processes of estimation and statistical inference
- Learn about the statistical methods most often used in biomedical research
- Select appropriate statistical approach to analyze a set of biomedical research data
- Use Excel to analyze biomedical research data

Credits: 2

Class Type: Graduate Course
STAT 501: Statistics for Biomedical Scientists I, part 2
The objective of this course is to provide an overview of statistics for biomedical researchers and clinicians who are interested in the interpretation of the results of statistical analyses. This is a series of integrated lectures, readings, and exercises on analysis and interpretation of medical research data using Excel. Emphasis is on ideas and understanding rather than mechanics. Topics covered include the foundation of statistical logic, interpretation of the most commonly encountered statistical procedures in medical research, and selection of an appropriate method to analyze a particular set of data. The second semester expands on the material covered in the first semester.

This is the second part of a two-part course. The completion of the first part (STAT 500) is required before taking the second part. Registration is required separately for each part of the course.

Learning Objectives
- Understand the role of chance in biomedical research
- Become knowledgeable about processes of estimation and statistical inference
- Learn about the statistical methods most often used in biomedical research
- Select appropriate statistical approach to analyze a set of biomedical research data
- Use Excel to analyze biomedical research data

Credits: 2
Class Type: Graduate Course
Prerequisites: STAT 500
The above course(s) or permission from the instructor.

STAT 502: Statistics for Biomedical Scientists II, part 1
The objective of this course is to provide an overview of statistics for biomedical researchers and clinicians who are interested in the interpretation of the results of statistical analyses. This is a series of integrated lectures, readings, and exercises on analysis and interpretation of medical research data using Excel. Emphasis is on ideas and understanding rather than mechanics. Topics covered include the foundation of statistical logic, interpretation of the most commonly encountered statistical procedures in medical research, and selection of an appropriate method to analyze a particular set of data. Those who will be routinely engaged in computing statistical procedures should consider STAT 200.

This is the first part of a two-part course. Registration is required separately for each part of the course.

Learning Objectives
- Learn the statistical aspects of processes planning and execution of biomedical research
- Know the assumptions of statistical methods, how to evaluate them, and how to respond to concerns
- Learn more complicated statistical methods than those presented in STAT 500 I
- Be able to build multivariable models and learn how they contribute to causal inference

Credits: 2
Class Type: Graduate Course
Prerequisites: STAT 501
The above course(s) or permission from the instructor.
STAT 503: Statistics for Biomedical Scientists II, part 2
The objective of this course is to provide an overview of statistics for biomedical researchers and clinicians who are interested in the interpretation of the results of statistical analyses. This is a series of integrated lectures, readings, and exercises on analysis and interpretation of medical research data using Excel. Emphasis is on ideas and understanding rather than mechanics. Topics covered include the foundation of statistical logic, interpretation of the most commonly encountered statistical procedures in medical research, and selection of an appropriate method to analyze a particular set of data. Those who will be routinely engaged in computing statistical procedures should consider STAT 200.

This is the second part of a two-part course. The completion of the first part (STAT 502) is required before taking the second part. Registration is required separately for each part of the course.

Learning Objectives
- Learn the statistical aspects of processes planning and execution of biomedical research
- Know the assumptions of statistical methods, how to evaluate them, and how to respond to concerns
- Learn more complicated statistical methods than those presented in STAT 500 I
- Be able to build multivariable models and learn how they contribute to causal inference

Credits: 2
Class Type: Graduate Course
Prerequisites:
STAT 502
The above course(s) or permission from the instructor.

STAT 510: Statistics for Healthcare Providers
This seminar course provides a non-mathematical review of statistical tests commonly encountered in medical research. Readings and class discussions will focus on understanding and interpreting the results from studies, as well as critiquing observational and experimental studies. The target audiences for this course are clinicians, fellows who are participating in journal club/literature review activities, and researchers who want to strengthen skills in interpreting statistical tests.

Learning Objectives
- Describe observational and experimental study designs commonly encountered in biomedical research.
- Discuss applications, strengths, and limitations of various statistical tests commonly seen in the medical literature.
- Interpret point estimates in terms of magnitude, precision, and statistical significance.
- Identify factors that influence sample size and discuss how these factors ultimately influence point estimates.
- Evaluate and critique a study in terms of appropriate design, application of statistical methods, and interpretation of results.

Credits: 2
Class Type: Graduate Course
STAT 515: Statistics for Biomedical Researchers

Statistical analyses are a fundamental component of experimental design in many biomedical research fields. Particularly when working with large, messy data, proper understanding of statistics is essential to perform proper statistical analyses. This course will build on students' existing knowledge of statistics to help them expand their analysis toolkits and will cover topics including modeling, bootstrapping, simulations, imputation, and basic machine learning. Students will attend lectures to gain theoretical understanding of topics before applying concepts through practice problems and projects using the R programming language. Note that students should have basic proficiency in R and simple statistical analyses before enrolling in this course to be successful.

Learning Objectives

By the end of this course, students should be able to:

- Fit and interpret multiple regression models including interaction and non-linear terms
- Fit and interpret logistic regression models
- Evaluate model fit to perform model selection
- Perform bootstrapping and simulation analyses to quantify statistical confidence
- Fit basic machine learning models
- Understands the strengths and weaknesses of different machine learning models.

Credits: 2
Class Type: Graduate Course
Availability: Spring 2022
Session: Session A

BIOL 039: Epigenetics

Sequencing of the human genome was not the endpoint of our goal in understanding human genetics. The chemical modifications to DNA and histones, as well as the chemical interactions involving the manufacture of proteins, represents a second level of human genetics termed epigenetics or epigenomics. Epigenetics refers to the study of heritable changes in gene expression that occur without a change in DNA sequence. Research has shown that epigenetic mechanisms provide an additional layer of transcriptional control that regulates how genes are expressed. Epigenetic abnormalities are associated with genetic disorders, cancer, autoimmune diseases, aging and pediatric syndromes, among others.

Credits: 0
Class Type: Workshop
**BIOL 042: Bio-Techniques**

Bio-techniques, a three-week credit bearing training course, consists of online and hands-on laboratory components. The course examines the fundamental concepts underlying biomedical science as well as principles and methods of scientific techniques commonly used in molecular biology labs. Additionally, during the 5-day lab sessions, students will practice some of these techniques and learn when and how to apply these techniques when designing their own experiments.

Online: Basic concepts of molecular and cell biology; Principles and methods of experimental techniques used in a molecular biology laboratory

Laboratory: general lab safety, pipetting, microscope, mammalian cell culture, molecular cloning, bacterial transformation, nucleic acids and protein isolation, polymerase chain reaction, transfection, SDS-PAGE and Western blotting, bioinformatics tools

The goals of the course are to describe the characteristics of the major cellular macromolecules; explain the structure and function of major cellular components; build and hone critical thinking skills; gain a working knowledge of practical scientific techniques commonly used in a molecular biology research lab; and Brainstorm experimental design and best practices for technique applications

**Students will earn 4 graduate credits through the FAES Academic Programs after successful completion of the course.**

**Credits:** 0

**Class Type:** Workshop

---

**BIOL 055: Genome Editing with CRISPR**

This workshop will focus on the general principles of genome editing protocols, including design, choice of format, delivery, efficiency, specificity, clonal isolation, genotyping, and validation. The second part of the workshop will address different applications including genome editing in mice, zebrafish, and iPS cells, disease modeling, generation of reporter lines, and high throughput approaches. We will discuss strategies to make CRISPR gene editing more efficient, flexible, and specific. We will explore recent advances in the CRISPR field including base editors and epigenome editing. We will also examine sequencing and quality control considerations for genome editing projects. Hands-on laboratory exercises will accompany the lecture material to provide practical training in design, assembly, transfection, and detection/evaluation steps of a typical genome editing workflow.

**Credits:** 0

**Class Type:** Workshop
BIOL 101: Foundations in Biomedical Science I

This course examines the fundamental concepts underlying biomedical science, including the structure and function of biomolecules, such as proteins, enzymes, carbohydrates, lipids, and DNA, as well as the structure and function of cellular components, such as membranes, vesicles, organelles, and the cytoskeleton. This course is designed for students who may have previously studied biology but need a refresher on the main concepts in biomedical science as well as students without a science background who wish to gain a foundation in basic biological mechanisms.

**Learning Objectives**

- Describe the characteristics of the major cellular macromolecules
- Explain the structure and function of major cellular components
- Build and hone critical thinking skills

Sample syllabus is subject to change.

**Credits:** 2  
**Class Type:** Graduate Course

BIOL 102: Foundations in Biomedical Science II

This course continues the exploration of the fundamental concepts underlying biomedical science, including DNA replication, transcription, translation, signal transduction mechanisms, apoptosis, the cell cycle, and cancer. This course is designed for students who may have previously studied biology but need a refresher on the main concepts in biomedical science as well as students without a science background who wish to gain a foundation in basic biological mechanisms and is a continuation of Foundations in Biomedical Science I.

**Learning Objectives**

- Trace the flow of genetic information at the intracellular level, from DNA to protein
- Summarize the cell cycle and will analyze examples of cell cycle dysfunction
- Build and hone critical-thinking skills

Sample syllabus is subject to change.

**Credits:** 2  
**Class Type:** Graduate Course  
**Prerequisites:**  
BIOL 101  
The above course(s) or permission from the instructor.
**BIOL 103: Introduction to Research**
Research experience is a significant advantage for students hoping to obtain internships, fellowships, undergraduate admission, or graduate/professional school admission. This course will serve as a first introduction to research, covering basic scientific knowledge and best-practices for impactful research. This course will also include seminars/lectures from prominent scientists, including those from underrepresented groups in STEM fields. By the end of the course, students will have proposed and designed a research project. Successful completion of this course will increase preparedness for research opportunities and increase the quality of applications submitted to various educational programs.

**Learning Objectives**
- Understand the theory behind common biomedical laboratory techniques and identify pitfalls of each method.
- Critically analyze problems using their knowledge of experimental design, and subsequently design basic experiments.
- Develop their own research interests and communicate these ideas through written and oral presentations.

**Credits:** 2  
**Class Type:** Graduate Course

**BIOL 222: Genomics in Modern Society**
The human genome is the DNA book of life, containing information to create networks of proteins that construct a human being. The course discusses how the genome was read, how variants in DNA information are detected, and how this information changes views of disease, medical treatments, and our image of ourselves as a species. Through an historical perspective, students will discover the role of DNA, RNA, and proteins as the molecules of life and explore some of the most current applications of molecular biology and biochemistry to biomedical research, forensic analyses, and molecular anthropology. Students will be provided with the basic scientific foundations necessary to understand the vast impact of biotechnology on modern society. The class format will combine lectures with case-studies discussions, presentations, and screenings of media. Students are required to actively search media and scientific sources to find recent breaking news pertinent to the field. Each week will feature a critical discussion based on a specific topic.

**Learning Objectives**
- Place life sciences into a historical perspective and describe current developments
- Describe the role of DNA, RNA, and proteins as the chemical foundations of life
- Summarize and explain some of the key aspects of biotechnology, such as DNA sequencing, cloning and amplification through PCR, the biological production of drugs and the –omics world (genomics, transcriptomics, proteomics, metabolomics)
- Critically examine the application of DNA-based analyses to the study of human evolution (molecular anthropology) and forensic science

Sample syllabus is subject to change.  
**Credits:** 2  
**Class Type:** Graduate Course
BIOL 254: Non-Coding RNAs (miRNAs, IncRNAs, and circRNAs) and Exosomes: Biology and Diseases

This course will address the biology, function, and expression of non-coding RNAs, including microRNAs, long noncoding RNA, and circular RNAs. It will address exosomes in the light of these non-coding RNAs. The course will also highlight the involvement of non-coding RNAs and exosomes in human diseases as well as the potential treatment with RNA therapeutics. The objective of this course is to provide an overview of cutting-edge scientific knowledge to researchers who need to understand this fast-emerging field and who plan to investigate non-coding and exosomes. Classes will cover different aspects of non-coding RNAs and exosomes from the perspectives of molecular biology, their role in diseases and RNA therapeutic implications as well as reference databases for data mining. By the end of the course, students should be able to discuss basic science, the disease biology of non-coding RNAs and exosomes; students should also gain knowledge of technology approaches suitable for their research projects.

Learning Objectives

- Learn the basics and latest scientific findings in the field of non-coding RNAs, such as microRNAs, long noncoding RNA, and circular RNAs, and exosomes
  - 1. MicroRNAs biogenesis and functions
  - 2. Long non-coding RNAs biology and functions
  - 3. Exosomes, microRNAs, and non-coding RNAs
  - 4. Non-coding RNAs and Exosomes in Disease Biology » Microbiome » Immune responses » Stem cells

Credits: 1
Class Type: Graduate Course

BIOL 262: Research Tools for Studying Diseases

This course is designed to help students gain an appreciation of essential scientific approaches and techniques in studying various human diseases and biological disorders. A variety of techniques are discussed, including molecular, cellular, biochemical, genetic, imaging, computational, and high-throughput screening approaches. Students will learn applications and recent advances for each approach as well as gain a historical perspective on the development of each technique. Emphasis will be placed on the appropriate application of each technique, with a focus on the exploration of the progression and therapeutic effects of treatments to various diseases. The course provides individuals of all backgrounds and levels of experience with the opportunity to become knowledgeable in a wide variety of scientific approaches in biomedical research.

Learning Objectives

- Introduce various approaches to biomedical and translational research
- Provide fundamental knowledge of various scientific techniques essential for conducting research
- Develop critical-thinking and problem-solving abilities and learn about practical applications of research techniques covered in this course
- Learn about various diseases and how research leads to better therapeutic applications

Sample syllabus is subject to change.

Credits: 2
Class Type: Graduate Course
Prerequisites:
Solid knowledge of undergraduate biology and chemistry.
BIOL 313: Molecular Biology and Recombinant DNA Technology

This course is specifically designed for students who have limited knowledge in molecular biology and biotechnology. The course will develop and equip students with a strong foundation in molecular biology, genomics, and molecular bioengineering in a changing world of biotechnology. It focuses on: 1) fundamental principles of molecular biology and genomics; and, 2) application of recombinant DNA technologies in gene therapy, vaccine development as well as genetically modified agricultural products. Topics covered will include: basic structure and organization of the prokaryotic and eukaryotic genome; mechanisms of DNA replication; gene transcription and protein translation; chromatin structure and function; post-translational regulation; epigenetics; DNA-protein interaction dynamics, and regulation of gene expression by different types of RNA. Faculty will present real-life examples to explain how gene cloning, plasmid construction, site-directed mutagenesis, DNA sequencing, genome editing, gene-expression profiling, are conducted in order to solve biological problems. At the end of this course, students will gain an understanding of how life works at the molecular level and gain knowledge of cutting-edge biotechnological application in research, medicine, and industry.

Learning Objectives

- Gain basic molecular biology knowledge of how genetic material (DNA and RNA) is the key to our survival and function and how this information is transferred over generations
- Understand how changes in this basic information encoded by the genetic material lead to changes in biological characteristics
- Master and use the most advanced tools and experimental techniques to study cell and molecular biology
- Describe how recombinant DNA techniques are used in modern applications in the lab or industry to develop cures for diseases and biotechnological advancements that affect daily life

Credits: 2
Class Type: Graduate Course

BIOL 325: Human Neuroscience I

This course will use a systems neuroscience approach to understanding the relationship between the structure and function of the human brain. Course material will span the level of cellular neurophysiology of neurons and synaptic signaling to circuits and brain regions involved in sensory processes, motor function, emotion, attention, and learning and memory. Neuroanatomy will be emphasized throughout the course. Deviation from normative structure and function will be considered through clinical case studies and translational research. Although the focus of this course will be the human brain, research from animal models, particularly non-human primates and rodents, will be included in the investigation of neuronal mechanisms.

Learning Objectives

- Identify neuroanatomical landmarks of the human brain in schematic illustrations, magnetic resonance images, and micrographs of sections of post-mortem tissue
- Analyze clinical cases and evaluate which neural regions are likely to be involved in symptoms and injury
- Describe basic neurophysiological properties and be able to explain: how the properties of the neuronal membrane relate to changes in potential and salutatory conduction of action potentials; the evidence for quantal transmission of chemical signals at the synapse; and the effects of various neurotoxins on receptor-binding kinetics or neurotransmission
- Apply knowledge of receptive fields, neuronal ‘tuning,’ neuronal codes, and topographic maps to compare and contrast the structural and functional properties of the somatosensory, motor, and sensory systems
- Think critically about scientific investigations by participating in an online discussion of scientific papers, giving careful consideration to potential confounds, alternative explanations, significance of findings, and unanswered questions for future inquiry

Credits: 2
Class Type: Graduate Course
Prerequisites:
Prior introductory biology coursework is encouraged; supplemental materials will be
available for students who have not had a prior introduction to biophysical properties of cell membranes and cell signaling processes.

**BIOL 326: Human Neuroscience II**
This course will use a systems neuroscience approach to understanding the relationship between the structure and function of the human brain. Course material will span the level of cellular neurophysiology of neurons and synaptic signaling to circuits and brain regions involved in sensory processes, motor function, emotion, attention, and learning and memory. Neuroanatomy will be emphasized throughout the course. Deviation from normative structure and function will be considered through clinical case studies and translational research. Although the focus of this course will be the human brain, research from animal models, particularly non-human primates and rodents, will be included in the investigation of neuronal mechanisms.

**Learning Objectives**

- Identify neuroanatomical landmarks of the human brain in schematic illustrations, magnetic resonance images, and micrographs of sections of post-mortem tissue
- Analyze clinical cases and evaluate which neural regions are likely to be involved in symptoms and injury
- Describe basic neurophysiological properties and be able to explain: how the properties of the neuronal membrane relate to changes in potential and salutatory conduction of action potentials; the evidence for quantal transmission of chemical signals at the synapse; and the effects of various neurotoxins on receptor-binding kinetics or neurotransmission
- Apply knowledge of receptive fields, neuronal 'tuning,' neuronal codes, and topographic maps to compare and contrast the structural and functional properties of the somatosensory, motor, and sensory systems
- Think critically about scientific investigations by participating in an online discussion of scientific papers, giving careful consideration to potential confounds, alternative explanations, significance of findings, and unanswered questions for future inquiry

**Credits:** 2  
**Class Type:** Graduate Course  
**Prerequisites:**  
Prior introductory biology coursework is encouraged; supplemental materials will be
BIOL 327: Modern Embryonic and Developmental Biology

This course covers the molecular mechanisms that regulate vertebrate embryonic development. Discussions range from conserved evolutionary processes to defects and genetic mutations in human development and disease. Specific topics include: cell-cell interactions; organogenesis; brain, cardiovascular and limb development; stem cell generation, maintenance and migration; cloning and genetic manipulations; epigenetic modification and system biology. Each class will include discussions of current literature, with emphasis on processes and mechanisms of development. This course is suitable for students preparing to pursue careers in research, medicine, and/or health, Fellows studying mouse models with developmental defects, and those wishing to expand their understanding of growth and development of complex organisms. Students will have opportunities to read, evaluate, and discuss critically research articles.

Learning Objectives

• Expand on knowledge of elementary cell biology to include development of complex organisms and genetic origin of human disease
• Acquire understanding of developmental processes and resulting impact of genetic mutations
• Advance scientific communication skills toward critical evaluation of scientific literature

Credits: 2
Class Type: Graduate Course

Prerequisites:
BIOL 101
The above course(s), understanding of college level biology, or permission from the instructor.

BIOL 350: Foundations of Cellular Neuroscience I

This course explores a wide range of cellular neuroscience, including: membrane biophysics and action potentials; ion channels; synaptic transmission and plasticity; dendritic integration and computation. Lectures also introduce techniques used to record and image activity and signaling in neurons as well as quantitative methods used to analyze experimental data. The course also features in-depth discussions of classic and current literature, with problem sets and exams to enhance and test the understanding of lecture materials.

Learning Objectives

• Develop conceptual and quantitative understanding of basic cellular physiology and biophysics
• Learn about electrophysiological and imaging techniques used in neuroscience experiments
• Gain a historical perspective on the study of ion channels, synapses and neurons

Credits: 2
Class Type: Graduate Course

BIOL 351: Foundations of Cellular Neuroscience II

This course explores a wide range of cellular neuroscience, including: membrane biophysics and action potentials; ion channels; synaptic transmission and plasticity; dendritic integration and computation. Lectures also introduce techniques used to record and image activity and signaling in neurons as well as quantitative methods used to analyze experimental data. The course also features in-depth discussions of classic and current literature, with problem sets and exams to enhance and test the understanding of lecture materials.

Learning Objectives

• Develop conceptual and quantitative understanding of basic cellular physiology and biophysics
• Learn about electrophysiological and imaging techniques used in neuroscience experiments
• Gain a historical perspective on the study of ion channels, synapses and neurons

Credits: 2
Class Type: Graduate Course
BIOL 356: Connective Tissue Biology
Connective tissues such as bone, cartilage, tendons, ligaments, basement membrane, skin, teeth, fat and blood are crucial for providing structural support and contextual cues that sustain proper function of other tissues and organs in the body. The purpose of this course is to provide students with a framework for understanding these tissues, their cellular and extracellular interactions and their roles in organs commonly studied in biomedical research. The course will review pathologies of connective tissues and discuss how biomaterials interact with tissues for use in regenerative medicine. This course incorporates fundamentals of biochemistry and cell biology to understand the structure, function, pathology, and repair mechanisms of connective tissues.

Learning Objectives

• Master basic structure and function of connective tissues and how they relate to other organs
• Appreciate the role of connective tissues in diseases
• Discuss properties of biomaterials required for regenerative medicine applications

Credits: 2
Class Type: Graduate Course
Prerequisites: college-level cell biology and biochemistry.

BIOL 385: The Biology of Aging
The process of aging is fascinating because it is one that we all expect to experience, if we are fortunate. It is natural to wonder if the decline of aging can be avoided. Through research into the biological underpinnings of the aging process, scientists are beginning to understand how aging may be evolutionarily programmed, including the cellular pathways that promote it. In this course, students will discuss these exciting findings. With an emphasis on primary literature and discussion, students will critically consider factors that affect the aging process. The course will also touch on mechanisms behind diseases associated with aging, such as Alzheimer’s disease and Parkinson’s disease. Finally, the course will review prospects for the extension of healthy lifespan in humans.

Learning Objectives

• Describe the evolutionary theories that explain aging
• Outline the cellular pathways that influence the aging phenotype
• Understand factors that influence the aging process
• Gain fluency with reading and interpreting primary literature

Credits: 2
Class Type: Graduate Course
Prerequisites: cell biology.
BIOL 410: Human Memory Systems

Everything you know was gained through the efforts of several memory systems working together to acquire knowledge and skills from your past experiences. Not only is memory necessary for all other human cognition, from remembering how to ride a bike or reflecting on your undergraduate days to acquiring language or making decisions about the future, but collectively our memories allow us to form a learned identity. This course will provide a broad introduction to foundational concepts and classic and current issues in human memory, examining both the psychological and neurological approaches to data and theory. Topics covered include working memory, episodic encoding and retrieval processes, forgetting and false memories, skill learning, implicit learning, and the effects of aging and disease on memory systems.

**Learning Objectives**

- Compare and contrast different memory systems, including the type of knowledge gained and their neural underpinnings
- Apply theories of memory systems to other contexts, including research into human cognition or learning strategies for future coursework
- Formulate a hypothesis and design an experiment to test a type of memory
- Given a disease or lesion location, assess the symptoms that would likely occur

**Credits:** 2

**Class Type:** Graduate Course

**Availability** Spring 2022

**Session** Session B

---

BIOL 425: RNA Interference and CRISPR

RNA interference (RNAi) is the process of inhibition of gene expression by RNA molecules. The mechanism for RNAi in prokaryotes and eukaryotes was evolutionarily developed as defense against pathogen invasion. CRISPR, Clustered Regularly Interspaced Short Palindromic Repeats is a similar defensive mechanism found in certain bacteria. Detailed understanding of their molecular mechanism enabled adaptation of these as tools for down regulating specific gene expression in mammalian cells. This course is designed to provide a deeper understanding of RNA interference and CRISPR and their applications in different fields of biology.

**Learning Objectives**

- Understand the mechanism of RNA interference and CRISPR
- Learn different types of RNA interferences and study of gene function using RNAi
- Learn challenges in RNAi and CRISPR applications and adaptation to high throughput screens
- Learn computational approaches of high throughput RNAi/CRISPR screen data analysis
- Review of therapeutic applications of RNAi/CRISPR

**Credits:** 1

**Class Type:** Graduate Course

**Prerequisites:**
Basic understanding of molecular biology and cell biology.
BIOL 427: Advances and Applications in Developmental Biology

Advances and Applications in Developmental Biology will employ current and cutting-edge medical and research publications to explore the principles of developmental biology. Together we will discuss how these publications are rooted in lessons from developmental biology but apply those lessons at a high level to medically relevant research. Each week we will include a lesson on the historical context and advances in developmental biology that have led us to the current point. We will then discuss the significance of current research, its place in the field, and what contributions it makes to developmental biology as well as medical science as a whole.

Learning Objectives

- Connect concepts in papers with classical developmental biology principles.
- Evaluate hypotheses and experimental design of research groups based on principles of developmental biology.
- Analyze choice of model organism/system for the goal of each study.
- Debate the implications of the study for advancement of health science research.
- Design alternative or entirely novel experiments/studies to test ideas.

Credits: 2
Class Type: Graduate Course
Prerequisites: BIOL 327

BIOL 435: Current Trends in the Neurobiology of Mental Illness

The objective of this graduate-level course is to provide an overview of the biological basis of major neuropsychiatric disorders as well as to explore the emerging methodologies (both basic sciences and clinical) utilized in the study of these brain disorders. A group of leading scientists and clinicians has been recruited to provide lectures in their areas of expertise. Disorders to be covered include: bipolar disorder; major depression; anxiety disorders; schizophrenia; autism; and, substance dependence. Speakers will discuss the evidence supporting current theories related to each disorder, with particular emphasis on the limitations of current diagnostic systems and methodologies, the prospects for the greatest advances, and their individual contributions to the field. Additionally, specific lectures will focus on methodologies that are rapidly having a major impact on neuroscience research as well as advancing our understanding of neural function, disease mechanisms, diagnostic systems, biomarkers, and drug discovery and development. Areas to be discussed will include: positron imaging tomography; magnetic resonance imaging (functional and structural); animal models; biochemical techniques; genetic and epidemiological analysis; and, statistical modeling. Students enrolled in the course will be expected to develop an understanding of the advanced techniques used to study these illnesses and pathways to develop new treatments.

Learning Objectives

- Demonstrate a familiarity with recent and groundbreaking novel research regarding the biological basis of major neuropsychiatric disorders.
- Develop a broad knowledge of the scope and impact of mental illness through the synthesis of recent advances in etiology and treatment of pathophysiology.
- Identify and describe the methodologies impacting neuroscience research, including positron emission tomography, magnetic resonance imaging, animal models, and genetics.
- Discover real-world applications of material into future research, medical or graduate study pursuits.
- Complete a final short-answer examination which incorporates material from all topics and guest speakers.
BIOL 440: Medical and Veterinary Entomology

Designed for entomology, biology, veterinary, and medical students, this course is an introduction to the natural history of the major groups of the Phylum Arthropoda that directly or indirectly impact the health of humans, pets, and livestock. Classes will cover the life-cycles of arthropods and parasites, clinical signs and symptoms of disease, disease epidemiology, and approaches to control of arthropod-borne diseases with an emphasis on vector control. Recent advances in the field of medical/veterinary entomology research and case studies will be discussed. Guest lecturers will share their expertise with the students.

Learning Objectives

- Describe the natural history of the major insect-based and arachnid-based arthropods that impact the health of humans, companion, and livestock animals
- Explain the biology of arthropod vector-mammalian host-pathogen relationships
- Outline the transmission cycles of major arthropod-borne diseases
- Recognize the general signs, symptoms, and epidemiology of major arthropod-borne diseases
- Identify some of the approaches and applications for the control of vector-borne diseases

BIOL 450: Stem Cell Biology

This course covers the new field of inquiry of stem cells, in recognition of the role that stem cells play in the post-embryonic phase of life. The course will also examine current understanding of the working of the stem cells in embryogenesis. This course will address, both from the theoretical and practical perspectives, the question of self-renewal, pluripotency, immortal strand synthesis as well as the nature and reasons for differential routes of differentiation into various tissue types. For example, the idea of ‘context’ will be discussed as will the realization that the microenvironment (the stem cell niche) plays an important role in fate determination. The class will also discuss the problems around whether induced pluripotent cells—a technical achievement—can be useful for tissue regeneration and therapeutics.

Learning Objectives

- Learn the origin and residence of stem cells in embryos and adult tissues
- Discuss the basis for self-renewal and pluripotency of stem cells, the regulation of stem cells in embryogenesis and their differentiation into adult tissues
- Survey the role of stem cells in human disease, with focus on cancer
- Consider the pros and cons of induced pluripotent stem cells in tissue regeneration and therapeutics
- Discover normal and cancer stem cell niche and fate determination
BIOL 550: Overview of Extracellular Vesicles and their Research Applications in Health and Diseases

There is an increased interest in purifying, identifying and engineering extracellular vesicles for both research and therapeutic benefits. Until now, there is no single method that can give the maximum yield with high purity level needed for mass production. There are numerous methodologies available to isolate and analyse these vesicles. This course aims to provide the basic understanding of extracellular vesicles (EV) a term that includes exosomes, microvesicles, oncosomes, and many others. It will introduce participants to the basics, pros and cons of different methods implemented in the purification, quantification, and validation/characterization of extracellular vesicles. It covers areas such as EV biogenesis, cargo, and different release and uptake mechanisms. Also, the course will touch base on the different research and therapeutic strategies used to understand the role of these vesicles in health and disease. The course is divided into 7 weeks.

Learning Objectives

After course completion, participants will be introduced to the best available resources and guidelines for methods used for purification and characterization/identification of extracellular vesicles. They should be able to:

- Describe the basic concepts for the different isolation and characterization techniques and how these techniques are used in the EV field.
- Describe the biogenesis, release and uptake mechanisms of EV.
- Communicate the pros and cons of the different isolation, quantification, and characterization methods.

Credits: 2
Class Type: Graduate Course
Availability Spring 2022
Session Session B

GENE 220: Evolutionary Genetics and Genomics: From Charles Darwin to Integrated-Omics

This course teaches key concepts of evolutionary genetics, using a historical framework. Class discussions will use historical examples from the literature, primary and review literature, modern and historical, with each class session focusing on progressively modern material. The course will start with Charles Darwin’s theory of evolution: selection, variation, and the historical background of selective breeding and heredity. Subsequent classes will cover population genetics and the modern evolutionary synthesis, chromosomal theory and the central dogma of molecular biology as well as phylogenetics, diversity, and common descent. Molecular genetics will be introduced in the context of bacterial gene regulation and gene regulatory networks. The course will end with a discussion on genomics, post-genomics, and epi-genomics. Student assignments will include an essay about a specific topic on breeding and heredity, a presentation about traits or diseases associated with cytogenetic abnormalities or the research of a modern synthesis contributor, and a descriptive report about a disease-causing gene and its genomic setting. At the end of the course, students will understand how the paradigms of evolution and genetics have advanced since Darwin and will be able to discuss our modern-omics-oriented understanding of heritable disease and evolution in its historical context.

Learning Objectives

- Explain key paradigms, advancements, and scientists contributing to evolutionary genetics and evolutionary theory, starting with early nineteenth-century scientific thought
- Analyze experimental strategies and key studies of evolutionary genetics, focusing on specific examples of advancements in understanding hereditary disorders and genetic conditions
- Discuss early paradigms of selective breeding and hereditary, the “Modern Synthesis,” discoveries of chromosomal inheritance as well as the central dogma of molecular biology
- Discuss basic gene regulation paradigms, developmental genetics and evolutionary-developmental biology, and conceptualization of genetics in the ‘-omics era’
• Review and report on a specific historical example of evolutionary genetics of own interest or relevance

Credits: 2
Class Type: Graduate Course
Prerequisites: undergraduate-level genetics.

GENE 340: Underlying Genetics of Cancer
Cancer as a genetic disease has been the focus of many cancer researchers of the past decade. Today, with the ability to sequence genomes and analyze our genetic code at extremely high depth, new cancers with underlying genetic predispositions are continuing to be discovered. This course will place a special focus on such cancers, driven either due to hereditary factors (such as familial breast cancer and others) or due to specific genetic aberrations (fusion driven cancers). Students taking this course can expect an in-depth insight to the effect of such genetic aberrations to the onset and development of malignancies in individuals. Throughout, the course aims to provide a framework for better understanding the role of genetics in not just cancer but also human biology.

Learning Objectives

• Explain how certain cancers are driven by hereditary factors and its implications.
• Describe how aberrant genes drive malignant transformation.
• Explain how various signaling cascades affect different aspects of malignancy.
• Develop a theoretical and practical framework on the applicability of this knowledge in therapeutic interventions.

Credits: 2
Class Type: Graduate Course
Prerequisites: IMMU 101, MEDI 339
The above course(s) with specific knowledge of tumor suppressors, oncogenes and major signaling pathways.

GENE 500: Introduction to Medical Genetics
The objective of this two-semester course is to provide an introduction to clinical and human genetics for Fellows and genetic counseling students who are preparing for subspecialty examinations of the American Board of Medical Genetics and for others who wish to learn about the expanding role of genetics in medicine. The first semester will introduce basic concepts of genetics, cytogenetics, and molecular genetics. The second semester will include presentations on clinical topics emphasizing the diagnosis and management of patients with genetic disorders. This course is designed for Fellows and genetic counseling students who are preparing for subspecialty examinations of the American Board of Medical Genetics and others who wish to learn about the expanding role of genetics in medicine.

This is the first part of a two-part course. Registration is required separately for each part of the course.

Learning Objectives

• Fall:
  • Appreciate organization of the human genome and tools used to investigate it
  • Acquire skills to determine the most likely mode of inheritance of a trait, to interpret the results of linkage and association studies

• Spring:
  • Appreciate the impact genetic disorders have on the various organ systems
  • Acquire skills to develop a differential diagnosis and appropriate work-up for a given phenotype

Credits: 1
Class Type: Graduate Course
Prerequisites:
Graduate-level training or experience in the biomedical sciences or consent of the course instructor.
Availability Spring 2022
Session Session A
GENE 505: Embryology, Developmental Biology, and Human Malformations
The objective of this course is to familiarize students with modern developmental biology and to use this knowledge to understand common human malformations. The course will begin with lectures on the methodology and model systems of developmental biology, a review of preimplantation development and gastrulation, and embryogenesis/organogenesis. Subsequent lectures will focus on the development of several organ systems (e.g. central nervous system, cardiovascular, limb, urogenital, gut/respiratory, and craniofacial). These systems will be covered in two lectures each. A closing lecture on developmental pleiotropy will round out the course.

Learning Objectives

- Connect conceptually the apparently distinct disciplines of embryology, developmental biology, and clinical medicine to appreciate mechanisms of normal and abnormal development
- Appreciate the role of evolution for understanding the mechanistic basis of malformations and as a basis for the study of these disorders in animal models
- Develop skills of integrating data from clinical, anatomic and molecular studies to form a comprehensive description of malformations

Credits: 1
Class Type: Graduate Course
Prerequisites: permission of the course instructor.

GENE 510: Genetic Counseling: Professional Topics Seminar
The objective of this course is to address the psychological, clinical, social, and ethical issues in genetic counseling (GC). This class offers a dynamic forum for discussion, focusing on genetics counseling research, policy and education, and their impact on clinical practice. A diverse group of professionals present topics well suited for class discussions. Student-led case presentations and discussions highlight pertinent psychological, social, and ethical issues in genetic counseling. Clients who have had personal experiences with a genetic condition or risk expose students to a variety of attitudes, reactions, and experiences. Students enrolled in related graduate programs are encouraged to enroll to maximize the opportunity for exchange among disciplines. This course presents an opportunity to college graduates interested in genetic counseling to learn about the theoretical and practical aspects of the profession.

This is a required course for graduate students enrolled in the JHU/NHGRI Genetic Counseling Training Program. Tuition: $500 per credit.

Learning Objectives

- Participate in dynamic discussions of provocative issues in the field of GC, with faculty input
- Facilitate appreciation for pursuing GC as a profession both for professional and pertinent issues in clinical work
- Foster ideas and model projects in GC research
- Learn directly from clients about their personal experiences with genetic conditions
- Promote interaction among graduate students to facilitate mentoring, strategizing, and camaraderie

Credits: 1
Class Type: Graduate Course
Prerequisites: Permission of the instructors.
Availability Spring 2022
Session Session A
GENE 511: Genetic Counseling: Professional Topics Seminar Part II
The objective of this course is to address the psychological, clinical, social, and ethical issues in genetic counseling (GC). This class offers a dynamic forum for discussion, focusing on genetics counseling research, policy and education, and their impact on clinical practice. A diverse group of professionals present topics well suited for class discussions. Student-led case presentations and discussions highlight pertinent psychological, social, and ethical issues in genetic counseling. Clients who have had personal experiences with a genetic condition or risk expose students to a variety of attitudes, reactions, and experiences. Students enrolled in related graduate programs are encouraged to enroll to maximize the opportunity for exchange among disciplines. This course presents an opportunity to college graduates interested in genetic counseling to learn about the theoretical and practical aspects of the profession.

This is the second part of a two-part course. The completion of the first part (prerequisite) is required before taking the second part. Registration is required separately for each part of the course.

This is a required course for graduate students enrolled in the JHU/NHGRI Genetic Counseling Training Program. Tuition: $500 per credit.

Learning Objectives
- Participate in dynamic discussions of provocative issues in the field of GC, with faculty input
- Facilitate appreciation for pursuing GC as a profession both for professional and pertinent issues in clinical work
- Foster ideas and model projects in GC research
- Learn directly from clients about their personal experiences with genetic conditions
- Promote interaction among graduate students to facilitate mentoring, strategizing, and camaraderie

Credits: 1
Class Type: Graduate Course
Prerequisites: GENE 510
The above course(s) or permission from the instructor.

GENE 514: Current Concepts in Clinical Molecular Genetics and Molecular Diagnostics
The objective of this course is to provide a review of molecular diagnosis of common hereditary or neoplastic disorders for which DNA-based diagnosis is now in routine use. Topics include FGFR3 disorders, fetal blood typing, thrombophilias, hemochromatosis, fragile X syndrome, polyglutamine disorders, hereditary breast cancers, Charcot Marie Tooth and spinal muscular atrophy, PraderWilli and Angelman syndromes, mitochondrial diseases, Duchenne and Becker muscular dystrophy, cystic fibrosis, and Smith-Lemli-Opitz Syndrome. Sessions also include genetic risk prediction, using linkage and Bayesian analysis as well as DNA forensics and paternity testing. The course is designed as part of the required curriculum for Clinical Genetics residents and Fellows preparing for the Clinical Molecular Genetics Boards given by the American Board of Medical Genetics.

Learning Objectives
- Appreciate the types of techniques used in molecular genetic diagnostic laboratories, including the limitations of each assay
- Acquire skills in calculating residual risks after molecular testing

Credits: 1
Class Type: Graduate Course
Prerequisites: GENE 500 and permission of the instructor.
Availability Spring 2022
Session Session A
GENE 518: Medical Genetics and Genomic Medicine: From Diagnosis to Treatment I

The objective of this course is to discuss how advances in genetics have impacted genetic disorders, from their diagnosis to treatment, by building upon the foundations learned in GENE 500. Topics include Smith-Lemli-Opitz syndrome, Rasopathies, neurocutaneous syndromes, muscular dystrophies, cohesinopathies, connective tissue disorders, ciliopathies, and psychosocial and genetic counseling issues in the era of genomic medicine. The course is designed as part of the required curriculum for residents, Fellows, and students preparing for the Genetics Certification Boards given by the American Board of Medical Genetics and the American Board of Genetic Counseling.

This is the first part of a two-part course. Registration is required separately for each part of the course.

Learning Objectives

• Appreciate how advances in genetics have impacted genetic disorders, from their diagnosis to treatment
• Acquire skills to conduct a dysmorphology examination

Credits: 1
Class Type: Graduate Course
Prerequisites:
GENE 501
The above course(s) or permission from the instructor.

GENE 519: Medical Genetics and Genomic Medicine: From Diagnosis to Treatment II

The objective of this course is to discuss how advances in genetics have impacted genetic disorders, from their diagnosis to treatment, by building upon the foundations learned in GENE 500. Topics include Smith-Lemli-Opitz syndrome, Rasopathies, neurocutaneous syndromes, muscular dystrophies, cohesinopathies, connective tissue disorders, ciliopathies, and psychosocial and genetic counseling issues in the era of genomic medicine. The course is designed as part of the required curriculum for residents, Fellows, and students preparing for the Genetics Certification Boards given by the American Board of Medical Genetics and the American Board of Genetic Counseling.

This is the second part of a two-part course. The completion of the first part (prerequisite) is required before taking the second part. Registration is required separately for each part of the course.

Learning Objectives

• Appreciate how advances in genetics have impacted genetic disorders, from their diagnosis to treatment
• Acquire skills to conduct a dysmorphology examination

Credits: 1
Class Type: Graduate Course
Prerequisites:
GENE 518
The above course(s) or permission from the instructor.
GENE 527: Cytogenetics and Molecular Genetics in the Era of Cancer Genomics: Diagnostic, Prognostic and Therapeutic Applications

The course will cover basic and advanced concepts in cancer genomics and will address practice guidelines created and adopted by authoritative resources such as ACMG, AMP, ASCO and NCCN. The major focus will be on the applications of cytogenetic and molecular genetics in the diagnosis, prognosis and therapeutics. The didactic and core lectures will be supplemented by clinical case discussion in germline genetics, hematopathology and solid tumors.

Learning Objectives

Somatic Cancers

- Describe the use of cytogenetics in somatic cancer
- Describe molecular profiling in somatic cancer
- Describe variants using appropriate nomenclature Interpret variants according to standardized criterion

Hereditary Cancers

- Describe the pathogenesis of the most common inherited cancer syndromes
- Describe the methods for detection and interpretation of results for the disorders
- Describe variants using appropriate nomenclature Interpret variants according to standardized criterion
- Discuss detection as secondary findings of NGS testing

Credits: 2
Class Type: Graduate Course
Prerequisites: 
GENE 500
Completion of or concurrent enrollment in the above course(s) or permission from the instructor.
Availability Spring 2022
Session Session A

GENE 540: Gene Expression Analysis

The gene expression programs that instantiate eukaryotic cell states are complex and dynamic, but ultimately essential to understanding development, homeostasis, real-time environmental adaptation and cellular dysregulation. This course will aim to equip you with a broad range of tools for analyzing gene expression and elucidating the regulatory influences affecting it. By the end, students will have an appreciation for the many layers of expression regulation and a familiarity with common methods for analyzing gene expression and its regulation that will enable interpretation of such results in the literature and the ability to choose the right tool for answering their own gene expression-related research questions in the future.

Learning Objectives

- Develop an understanding of the many layers of regulation influencing gene expression
- Become familiar with common gene expression measurement methods and know how to choose the right one for the job
- Be able to perform differential gene expression analyses, and identify and use gene expression signatures
- Know how to find genomic regulatory elements that may influence a gene's expression
- Appreciate gene expression in the context of functional pathways and dynamic gene regulatory networks/programs

Credits: 2
Class Type: Graduate Course
GENE 644: Review of Medical Genetics
Tuition: $1,100.00.
The objective of this course is to provide a review for candidates for the American Board of Medical Genetics Subspecialty examinations: clinical genetics; molecular genetics; biochemical genetics; cytogenetics; and, genetic counseling. Topics to be covered include statistical and mathematical subjects in clinical genetics and population genetics, clinical cytogenetics, dysmorphology, ophthalmologic genetics, and general treatment and management of genetic diseases.

Learning Objectives
- Review the fundamentals of genetics and a variety of genetic disorders in preparation for the American Board of Medical Genetics certification examination
- Acquire skills to recognize and eliminate distractors on the certification exam

Credits: 2
Class Type: Graduate Course
Prerequisites: nBoard candidate for any subspecialty exam of the American Board of Medical Genetics.

MEDI 067: Evidence-Based Medicine
Evidence-Based Medicine provides tools that enable physicians and other healthcare providers to navigate complex clinical scenarios and deliver patient-centric care. This approach requires providers to be familiar with biomedical study designs, statistical tools, and frameworks for translating research into practice. It also encourages providers to be continuously alert for "clinical questions" that can be addressed using existing knowledge and for "knowledge gaps" that should be addressed through research.

Learning Objectives
This workshop will enable participants to:
- Discuss the “hierarchy of evidence” in biomedical research and the applications of specific observational and experimental study types in medicine and public health.
- Identify the strengths and weaknesses of study designs commonly encountered in medicine and public health practice.
- Interpret results from statistical tests and analyses commonly observed in observational and experimental studies.
- Apply PICO, Spider, and other frameworks to develop a clinical or research question.
- Conduct a literature search to answer a clinically oriented question or to support a research proposal that addresses a knowledge gap.

Class Type: Workshop
MEDI 234: Precision Medicine

The Human Genome Project (HGP) revolutionized biomedical research through the discovery and integration of Big Data. Post-HGP endeavors, such as ClinVar and the All of Us Research Program, formerly known as the Precision Medicine Initiative Cohort Program, have been designed to rapidly accelerate our research progress into clinical practice. Prevention and treatment strategies that take individual variability into account are not new concepts. However, precision medicine advances the field by leveraging technological progresses and ‘omics’ data to improve prediction, diagnosis, prognosis, and treatment for individual patients. This course will explore the possibilities, promises, and pitfalls of precision medicine, using real-world examples, and is intended to bridge the gap between basic biomedical research and its practical clinical applications. “What is needed now is a broad research program to encourage creative approaches to precision medicine, test them rigorously, and ultimately use them to build the evidence base needed to guide clinical practice.” Dr. Francis Collins, 2015.

Learning Objectives

- Assess how The Human Genome Project has advanced technology in biomedical research
- Translate research and technology into the delivery of healthcare and basic science research findings to the benefit of the general public
- Discuss implications in privacy and policy laws for precision medicine in the age of the Affordable Care Act and the All of Us Research Program
- Present coherent case studies encompassing previous objectives, including caveats in the use of current technologies

Credits: 1
Class Type: Graduate Course

MEDI 275: Fundamental Principles of Histology

This course examines the morphology of different cell types and their arrangement within tissues using both light microscopy and electron microscopy images. The course will begin with a detailed overview of the basic tissues: epithelial; connective; muscle; and, nervous tissues. The four basic tissues will then be applied to organ systems, and a discussion of some clinical pathologies will follow. The course will also cover cell functions within the different tissues as well as tissue preparations and types of stains to highlight different characteristics of tissue.

Learning Objectives

- Define and describe histological characteristics of different cell types
- Identify different tissue types and organization within organs
- Understand functions of cell types within the tissue
- Gain general knowledge of tissue preparation and commonly used staining techniques
- Understand how the different cell types and basic tissues come together to function as a whole organ

Credits: 2
Class Type: Graduate Course

Prerequisites: Knowledge of biology and/or cell biology.

MEDI 303: Physiological Mechanisms of Acupuncture

This course provides an introduction to therapies practiced for thousands of years in China and recently around the world. The Traditional Chinese Medicine (TCM) has its unique theory and interventions that are based on the understanding of the world and human body with systems approaches. This introductory course is aimed to bridge the gap between traditional Chinese medicine and modern science.

Learning Objectives

- Understand the basic theories of TCM, including acupuncture
- Explore the mechanisms of TCM therapies from the perspective of modern science

Credits: 1
Class Type: Graduate Course
Prerequisites: basic medical knowledge.
MEDI 309: Introduction to Molecular Medicine

The objective of this course is to introduce students to the molecular basis of human diseases and current medical therapies, providing a bridge between medicine and biochemistry. The course is designed to cover fundamental concepts of molecular biology, genetics, and basic biochemical principles and to use these principles to analyze commonly occurring health-related problems. Each lecture will be set in the context of a major disease or a public-health concern, such as obesity, diabetes, cardiovascular diseases, cancer, infectious diseases, HIV/AIDS, Alzheimer’s, and other neurodegenerative diseases. Presentation, analysis, and group discussions of clinical cases selected to exemplify the subject topic will be integral part of the lectures. An historical perspective of how molecular medical knowledge and recent technological developments that have been instrumental in medical treatments will be also presented. The course differs significantly from a comprehensive biochemistry or biology course and is aimed at students in the health sciences or prospective medical students.

Learning Objectives

- Identify interactions between metabolic pathways and human diseases
- Describe recent advances in medical applications of biotechnology and genetics
- Discuss health issues in relation to molecular mechanisms of the cell
- Prepare an original presentation about a disease of interest to the class

Credits: 2
Class Type: Graduate Course
Prerequisites: college-level knowledge of biology and/or chemistry.

MEDI 311: Principles of Endocrinology

The endocrine system exerts control over the internal environment of the body through physiological detection, signaling, and feedback. It interacts with the systems of the body (digestive, nervous, renal, reproductive, cardiovascular, respiratory, skeletal, and metabolic) to provide a homeostatic environment. It adapts to stress, and it is essential for normal growth and development.

The objective of this course is to provide students with an overview of endocrine physiology and pathophysiology. The course will describe how the endocrine system is integrated with the other physiological systems, along with the biochemistry of hormone synthesis and actions. Problem solving with endocrine disorders will form a basis for understanding the principles of hormone function. Students seeking basic knowledge on the principles of endocrinology to apply in their research or clinical training will find this course useful.

Learning Objectives

- Identify and describe the key hormones and their roles in metabolism, digestion, reproduction, and growth
- Understand regulation of hormonal control, including the principles of feedback control and hormone-receptor interactions
- Problem solve the biological basis of endocrine disorders and treatments
- Develop the scientific background needed to understand the literature about endocrine function and pathology

Credits: 2
Class Type: Graduate Course
Prerequisites: general biology and chemistry required; prior coursework in introductory biochemistry and human physiology recommended.
MEDI 317: Human Physiology I
In this two-semester sequential course, students will be provided with an in-depth study of the physiology of human body systems. Topics studied in the fall semester are: molecular basis of physiology; the nervous system; and, cardiovascular system. The course sequence is intended as a bridge to advanced studies in pathophysiology and medicine.

Learning Objectives

- Understand structure-function relationships of the systems of the human body
- Identify the structural and functional levels of organization from cellular to organ system levels
- Describe how the body adapts to different everyday situations and environmental stresses
- Explain the principle of homeostasis and feedback-control mechanisms as they relate to body systems
- Develop active learning styles through problem solving in physiology
- Apply knowledge of functional mechanisms and their regulation to explain the pathophysiology underlying common disorders
- Communicate physiologic concepts to a variety of audiences

Credits: 2
Class Type: Graduate Course
Prerequisites: general biology; BIOL 101 or equivalent.

MEDI 318: Human Physiology II
In this two-semester sequential course, students will be provided with an in-depth study of the physiology of human body systems. Topics studied in the spring semester are: respiratory; renal; gastrointestinal; endocrine; and, reproductive physiology. The course sequence is intended as a bridge to advanced studies in pathophysiology and medicine.

Learning Objectives

- Understand structure-function relationships of the systems of the human body
- Identify the structural and functional levels of organization from cellular to organ system levels
- Describe how the body adapts to different everyday situations and environmental stresses
- Explain the principle of homeostasis and feedback-control mechanisms as they relate to the body systems
- Develop active learning styles through problem solving in physiology
- Apply knowledge of functional mechanisms and their regulation to explain the pathophysiology underlying common disorders
- Communicate physiologic concepts to a variety of audiences

Credits: 2
Class Type: Graduate Course
Prerequisites: general biology; BIOL 101 or equivalent; MEDI 317 Human Physiology I or equivalent.
MEDI 330: Molecular Mechanisms of Cancer
Cancer is a term used to define over 200 subtypes of diseases all with the ability to divide uncontrollably. While these varied subtypes are identified by their place of origin or the tissues they affect, their most distinct features are the underlying signaling cascades that drive the disease. This course will discuss the roles of tumor suppressors and oncogenes in tumor growth at the molecular level. It will also explore in detail exemplar pathways that are disrupted in cancer as well as how such knowledge translates to novel therapies. Throughout, the course aims to provide a framework for how molecular mechanisms function and the important role they play in human biology.

Learning Objectives

- Define tumor suppressors and oncogenes and their respective roles along with examples.
- Gain an understanding of important molecular pathways in cells and how they are affected in cancer.
- Understand how cancer cells hijack various signaling cascades to drive different aspects of malignancy.
- Develop a theoretical and practical framework on the applicability of this knowledge in therapeutic interventions.

Credits: 2
Class Type: Graduate Course

MEDI 335: Current Topics in Omics Research for Metabolic Syndrome, IBD, and Gastrointestinal Cancers
This course provides a comprehensive survey of the pathophysiology of digestive and metabolic diseases and disorders, focusing on the most common diseases with public health implications. Diseases include, but are not limited to inflammatory bowel diseases (IBDs), diabetes and metabolic syndrome, common microbial infections, liver disease, irritable bowel syndrome (IBS), and GI cancers. Diagnoses, symptomology, and treatment strategies will be presented by guest lecturers with clinical and research expertise in specific disease pathologies. Within the context of these clinical topics on GI and metabolic disease, the underlying physiological, molecular, and cellular mechanisms will be reviewed and discussed along with current research. The course will be comprised of a combination of lectures and discussions, with reading assignments, an exam, a writing assignment, and a group presentation assignment.

Learning Objectives

- Identify the most common gastrointestinal/metabolic diseases
- Explain diagnostic criteria and symptoms associated with each disease/disorder; describe treatment strategies for each disorder
- Describe and discuss the underlying physiological, cellular, and molecular mechanisms associated with each disease
- Demonstrate an understanding of the relationship between pathology and the underlying physiological, molecular, and cellular mechanisms for each disease
- Analyze and critique research publications and data investigating the pathophysiological mechanisms for a selected disease

Credits: 1
Class Type: Graduate Course

Prerequisites:
Undergraduate coursework in cell biology, genetics, physiology, or college degree in biomedical sciences.
MEDI 339: Advanced Cancer Biology
Cancer is an ancient disease with specific characteristics. Students taking this course will discuss the genetic basis of cancer, the initiation and progression of cancer, aberrant signal transduction in tumor cells and metastasis. This course will also have a journal-club component, which will enable students to read and discuss scientific journal articles related to the course.

Learning Objectives
At the end of this course students will be able to:

- Identify cancer biology terms and apply terms and information in textbook to case studies.
- Differentiate various aspects that characterize a cancerous vs normal cell.
- Identify potential therapeutic strategies using knowledge of various effectors in cancer cells.
- Develop a detailed scientific presentation to include background information, experimental design, and findings.

Credits: 2
Class Type: Graduate Course
Prerequisites: IMMU 101
The above course(s) or equivalent background knowledge.
Availability: Spring 2022
Session: Session A

MEDI 340: Underlying Genetics of Cancer
Cancer as a genetic disease has been the focus of many cancer researchers of the past decade. Today, with the ability to sequence genomes and analyze our genetic code at extremely high depth, new cancers with underlying genetic predispositions are continuing to be discovered. This course will place a special focus on such cancers, driven either due to hereditary factors (such as familial breast cancer and others) or due to specific genetic aberrations (fusion driven cancers). Students taking this course can expect an in-depth insight to the effect of such genetic aberrations to the onset and development of malignancies in individuals. Throughout, the course aims to provide a framework for better understanding the role of genetics in not just cancer but also human biology.

Learning Objectives
- Explain how certain cancers are driven by hereditary factors and its implications.
- Describe how aberrant genes drive malignant transformation.
- Explain how various signaling cascades affect different aspects of malignancy.
- Develop a theoretical and practical framework on the applicability of this knowledge in therapeutic interventions.

Credits: 2
Class Type: Graduate Course
Prerequisites: IMMU 101
MEDI 339
The above course(s) with specific knowledge of tumor suppressors, oncogenes and major signaling pathways.
MEDI 345: Human Anatomy and Physiology I: Musculoskeletal, Cardiovascular, and Nervous Systems

Human anatomy will be taught using a systemic approach and emphasizing the connection between function and structure as it relates to physiological conditions and diseases. To this end, lectures will integrate elements of embryology and histology. Modern imaging methods will be introduced as well. Selected topics of topographic anatomy will be also examined, including head/neck and pelvis. A mid-term and final exam will be offered to allow students to assess their comprehension of the material. This course is suitable for advanced undergraduate and/or postbac students planning a career in medicine and biomedical research and will be taught at a level of complexity that is similar to courses offered at most medical schools. Other biomedical researchers who seek to better understand the structural underpinnings of normal and pathologic functions of the human body may also find the course useful.

Learning Objectives

• Describe principles of human anatomy using a systemic approach
• Discuss the fundamentals of embryology and general microanatomy (histology)
• Identify the anatomical structures of the musculoskeletal, nervous, and cardiovascular systems
• Explain how these systems interact, and how structural and functional characteristics of tissues, organs, and systems are interdependent

Credits: 2
Class Type: Graduate Course
Prerequisites:
College degree; basic knowledge of cell biology.
Availability Spring 2022
Session Session A

MEDI 346: Human Anatomy and Physiology II: Lymphatic, Immune, Respiratory, Digestive, Endocrine, and Urogenital Systems

Human anatomy will be taught using a systemic approach and emphasizing the connection between function and structure as it relates to physiological conditions and diseases. To this end, lectures will integrate elements of embryology and histology. Modern imaging methods will be introduced as well. Selected topics of topographic anatomy will be also examined, including head/neck and pelvis. A mid-term and final exam will be offered to allow students to assess their comprehension of the material. This course is suitable for advanced undergraduate and/or postbac students planning a career in medicine and biomedical research and will be taught at a level of complexity that is similar to courses offered at most medical schools. Other biomedical researchers who seek to better understand the structural underpinnings of normal and pathologic functions of the human body may also find the course useful.

Learning Objectives

• Describe principles of human anatomy using a systemic approach
• Discuss the fundamentals of embryology and general microanatomy (histology)
• Identify the anatomical structures of the lymphatic, immune, respiratory, digestive, endocrine, and urogenital systems
• Explain how these systems interact, and how structural and functional characteristics of tissues, organs, and systems are interdependent

Credits: 2
Class Type: Graduate Course
Prerequisites:
College degree; basic knowledge of cell biology.
Availability Spring 2022
Session Session B
MEDI 418 : Cancer Immunology

Cancer immunotherapy is a rapidly advancing field in research and in the clinic, which focuses on the interface between the immune system, inflammation and cancer biology. To advance research in this field an understanding of each of these systems and how they interact to suppress or promote cancer progression is vital. Students taking this class will gain an understanding of how the tumor microenvironment alters and evades the immune system and the contribution of inflammation in promoting cancer progression. This course will serve as an introduction to further studies in cancer immunotherapies.

Topics covered:

- Tumor microenvironment – the interactions between immune cells and cancer cells.
- Polarization of Macrophages and Recruitment of Inflammatory Cells by Cancer Cells.
- Mechanisms of Tumor-Induced Tolerance/Escape from the Immune System.
- Immunosuppression by Myeloid-Derived Suppressor Cells (MDSCs)
- Innate immune system in cancer and therapies utilizing cytokines and interferons.
- Cancer Vaccines: preventative and therapeutic.
- Viruses and cancer: cancer-causing viruses (eg HPV, HTLV1), oncolytic viruses and use of viruses in gene therapy.
- Anti-cancer antibodies (including ADCs) to target cancer cells.

Learning Objectives

- Students will list the mechanisms by which cancer cells evade the immune system.
- Students will describe the relationships between viruses and cancer, and give examples of cancer vaccines.
- Students will explain how cancer cells interact with and ‘corrupt’ immune cells in the tumour microenvironment.
- Students will demonstrate how the innate immune system can be utilized in cancer therapy.

Credits: 1
Class Type: Graduate Course

MEDI 419: Cancer Immunotherapy

Immunotherapy for cancer treatment has become a popular and important topic of study, and has been refined over recent years as our understanding of the interactions between tumors and the immune system improves. This seven week course will provide a brief background of the relationship between tumors, their microenvironment, and the immune system, before diving into the history of the earliest immune therapies, and making our way through the progression and development of newer therapeutic approaches. This course will focus on different ways to train our immune system to recognize and attack cancer cells, including vaccines, chimeric antigen receptor therapy, antibody therapy, adoptive cell transfer, oncolytic viruses, as well as clinical trials and other more theoretical methods which are still being developed with current research. This course will provide a current overview of immunotherapeutic approaches to treating cancer for those with a working knowledge of cancer and immunology.

Learning Objectives

- Describe how the immune system detects tumors, and how cancer cells can evade this detection
- Explain why various mechanisms of immune escape are exploitable with therapeutic targeting
- Discuss the benefits and fallbacks of immunotherapies from past and present
- Demonstrate where the field requires improvement moving into the future

Credits: 1
Class Type: Graduate Course

Prerequisites:
Familiarity with basic immunology is strictly required; prior college-level coursework in immunology is highly encouraged.

Availability Spring 2022
Session Session B
MEDI 450: Fundamental Principles of Pathology
Pathology is the study of disease etiology and progression. It investigates the molecular underpinnings of disease, ultimately leading to the gross appearance of the affected area. Such comprehensive understanding contributes to developing cutting-edge diagnostic testing, treatment recommendations, and preventive care. In Fundamental Principles of Pathology, we will examine both microscopic and gross specimens of diseased tissues and organs, while learning the molecular and physiological etiology of such conditions. As an introductory course, it will showcase the four main foci of pathology: anatomical, clinical, molecular, and oral and maxillofacial pathology, though the main focus will be anatomical pathology. As a core course in many health professions and biomedical research curricula (e.g. medical, physician assistant, physician scientist), it will introduce aspiring students to not only disease etiology, but also diagnostic identification, associated treatments, functional and clinical aspects of disease burden, and potential for targeted preventive care.

Learning Objectives

- Understand the immunological cascade of tissue injury.
- Learn the triggers, aggravators, and facilitators of select congenital, hemodynamic, inflammatory, infectious, metabolic, environmental, and neoplastic diseases.
- Explain the natural history of select diseases
  - Identify disease stages and associated prognosis from diagnostic imaging.
- Understand the molecular mechanisms of select diseases, their progression, and therapeutic targets.
- Determine the diagnostic investigations (e.g. laboratory, radiological imaging, microscopy) warranted in sample case scenarios.

Credits: 2
Class Type: Graduate Course

MEDI 501: Principles of Preclinical Translational Science
Translation is the process of turning observations in the laboratory, clinic and community into interventions that improve the health of individuals and the public — from diagnostics and therapeutics to medical procedures and behavioral changes.

Translational Science is an emerging field that seeks to identify broadly generalizable scientific and operational principles for translational research. Translational science examines translational research from a systems perspective to develop approaches that can improve the efficiency and effectiveness of translational research endeavors, broadly.

In this course, students will learn key principles of translational science, taught by way of a case study of a highly successful translational research partnership involving the National Center for Advancing Translational Sciences (NCATS), the National Cancer Institute (NCI), Northwestern University and the University of Kansas. The partnership produced a promising potential drug shown to inhibit metastasis in animal models, which is being examined in a first-in-human clinical trial in 2020.

Learning Objectives

- Understand the definitions and goals of translational research and translational science and how they differ.
- Identify a range of scientific and operational principles that can be applied to enhance preclinical translational research projects.
- Learn about the research process necessary to enable a scientific discovery to produce an effective compound that can be used in humans.
- Learn about the varied roles of different disciplines, as well as agencies — including industry, government agencies, and academic faculty and institutions — in advancing translational research and how to facilitate effective interagency and team-based partnerships.

Sample syllabus is subject to change.

Credits: 1
Class Type: Graduate Course
Availability: Spring 2022
Session: Session B
MEDI 502: Translational Science in the COVID-19 Pandemic - Accelerating and Enhancing our Response Across Preclinical, Clinical and Population Health Research

The course describes in detail a range of recent or ongoing research activities – from preclinical to clinical to population health – that were led or supported by NCATS in response to the COVID-19 pandemic. Through this lens, the course teaches students effective approaches and strategies in translational science that have been key to the success of these efforts and are generalizable to other translational research activities. The course begins with an introduction to translational research and translational science, as well as an orientation to NCATS’ programs and resources, including our internal labs and extramural programs that are engaged in COVID research. We will highlight resources (e.g. access to technology, infrastructure, etc.) that allowed these programs to pivot quickly to respond to COVID-19. We then delve into an array of translational science challenges that NCATS and the broader scientific community have had to tackle to respond effectively to the COVID-19 pandemic. Having set up the challenges we move on to highlight specific examples of NCATS-led or supported projects responding to COVID-19 that effectively address these challenges. Each week, students will learn about one or more NCATS-led or supported projects addressing the COVID-19 pandemic, and the translational science approaches and principles exemplified through the project. Overall, students will learn about the myriad ways NCATS is contributing to research to address the COVID-19 pandemic, and will leave the course equipped with a set of wide-ranging translational science strategies they can apply in their future work in translational research.

Learning Objectives

By the end of the course, students will be able to:

- Understand the definitions, scope, and goals of translational research and translational science, and how they differ
- Identify key translational science challenges in responding to the COVID-19 pandemic
- Identify effective translational science approaches NCATS has utilized to address multiple aspects of the COVID-19 pandemic, spanning preclinical to clinical translational research
- Explain how the translational science approaches NCATS utilized in the context of a variety of COVID-19 related projects could be applied broadly to research focused on other diseases and conditions
- Reflect on the translational science principles highlighted throughout this course and how these relate to one’s own (current or future) work and career sector
- Learn about the partnerships and collaborations needed to advance translational research, as well as the legal approaches that help to establish effective partnerships.

Credits: 1
Class Type: Graduate Course
Availability Spring 2022
Session Session A

MEDI 507: Inborn Errors of Metabolism

The objective of this course is to provide an overview of the principles and practice of human biochemical genetics. Topics to be covered include amino acidopathies, organic acidoses, disorders of carbohydrate metabolism and lipid metabolism, lysosomal storage diseases, peroxisomal diseases, purine and pyrimidine disorders, and a variety of other inborn errors of metabolism. Students will research a topic and present the lectures. Several quizzes are planned, and student participation will be strongly encouraged.

Learning Objectives

- Recognize the signs and symptoms of biochemical disorders of man
- Understand the principles of diagnosing and treating inborn errors of metabolism based upon knowledge of human biochemical pathways
- Prepare for managing patients with biochemical disorders and for taking the American Board of Medical Genetics examination in biochemical genetics.

Credits: 3
Class Type: Graduate Course
Prerequisites: graduate degree; this is an advanced course, largely geared toward Ph.D.s and M.D.s.
MEDI 525: Genetic Polymorphisms Affecting Human Cognition

The study of relationships between human genotype and cognitive phenotypes are in their infancy, but even at this early stage there are a number of very well documented correlations between specific genetic polymorphisms and cognitive phenotypes such as risk of alcoholism, cognitive outcome after traumatic brain injury, and, particular personality phenotypes. We will review some of the classic papers describing specific genetic effects on cognitive phenotypes, but the focus of the course will be on the underlying molecular biology and genetics rather than the nuances of psychological testing. This course will not address the thorny questions of how to precisely define and measure cognitive phenotypes or, once the phenotypes are defined, to assess the genetic contributions to their variability. Rather we will discuss the molecular biology of specific genetic polymorphisms which are commonly studied in this context the biological reasonableness of some of these results.

Learning Objectives

At the conclusion of the course the student should:

- Be familiar with the most commonly studied human genetic polymorphisms associated with variation in cognitive phenotypes.
- Have a basic understanding of the molecular biology and neuroanatomy associated with those polymorphisms.
- Understand the basic concepts population genetics and the limitations of genetic association studies.

Credits: 2
Class Type: Graduate Course

MEDI 550: Psychiatric Pharmacogenetics

Psychiatric pharmacogenetics involves the study of four classes of genes:

- Pharmacodynamic genes: These are genes encoding drug targets (or proteins physiologically related to those targets).
- Pharmacotypic genes: Genes impacting disease presentation and subtype (genetics of the disease itself)
- Pharmacokinetic genes:
  - Genes associated with drug transport (e.g. ABCB1/MDR1)
  - Genes associated with metabolism (e.g. CYP genes)
- Adverse drug reaction susceptibility genes (e.g. G6PD or HLA genes)

This course builds on the FAES course "Genetic Polymorphisms Affecting Human Cognition". The present course will focus on the genetics of psychiatric disease (pharmacotypic genes) and on genetic polymorphisms relevant to commonly used psychiatric medications (pharmacokinetic genes and the genetics of adverse drug reaction susceptibility genes).

Learning Objectives

At the conclusion of the course the student should:

- Be familiar with the common genetic polymorphisms that affect the risk of psychiatric disease, and response to psychoactive drugs.
- Have a basic understanding of the molecular biology and neuroanatomy associated with those polymorphisms.
- Understand the basic concepts population genetics and the limitations of genetic association studies.

Credits: 2
Class Type: Graduate Course
Prerequisites: MEDI 525
NEUR 410: Human Memory Systems

Everything you know was gained through the efforts of several memory systems working together to acquire knowledge and skills from your past experiences. Not only is memory necessary for all other human cognition, from remembering how to ride a bike or reflecting on your undergraduate days to acquiring language or making decisions about the future, but collectively our memories allow us to form a learned identity. This course will provide a broad introduction to foundational concepts and classic and current issues in human memory, examining both the psychological and neurological approaches to data and theory. Topics covered include working memory, episodic encoding and retrieval processes, forgetting and false memories, skill learning, implicit learning, and the effects of aging and disease on memory systems.

Learning Objectives

- Compare and contrast different memory systems, including the type of knowledge gained and their neural underpinnings
- Apply theories of memory systems to other contexts, including research into human cognition or learning strategies for future coursework
- Formulate a hypothesis and design an experiment to test a type of memory
- Given a disease or lesion location, assess the symptoms that would likely occur

Credits: 2
Class Type: Graduate Course
Availability: Spring 2022
Session: Session B

PSYC 201: Introduction to Psychological Principles

Psychology is the science of mind, specifically its function and effects on behavior. Through social change, its five schools of thought – biological, behavioral, cognitive, social, psychoanalytic, and existential-humanistic theories – have collectively improved workplace environments, education delivery, mental healthcare, and even military intelligence. Psychologists and psychiatrists collaborate in not only treating mental health conditions, but ascertaining their etiology, whether genetic, iatrogenic, and/or familial, individual, and ethnocultural environment. Along with learning neural mechanisms and associated function, such understanding can uncover potential therapies and preventive care for mental illnesses. Furthermore, much of the brain's functional anatomy and its associations with behavior and underlying neural mechanisms remain to be discovered. This warrants thorough knowledge of research methods, from computer simulations to animal studies, and the ethics that have coincidingly evolved. Therefore, the application of experimental and principles of psychology can benefit virtually any industrial or organizational setting.

Learning Objectives

- Apply basic knowledge of neuroanatomy and biological principles to explain behavioral responses.
- Understand the evolution of personality psychology and the four main theories of personality.
- Articulate the basic principles, major theories, and research concerning learning and cognition.
- Understand the physical, cognitive, and emotional development that occurs from infancy through childhood.
- Explain the diagnostic criteria, etiology (environmental, genetic, biological), and therapies indicated for select mental illnesses and disorders.
- Apply the scientific method to critically appraise peer-reviewed research in psychology.

Credits: 2
Class Type: Graduate Course
PSYC 525: Genetic Polymorphisms Affecting Human Cognition

The study of relationships between human genotype and cognitive phenotypes are in their infancy, but even at this early stage there are a number of very well documented correlations between specific genetic polymorphisms and cognitive phenotypes such as risk of alcoholism, cognitive outcome after traumatic brain injury, and, particular personality phenotypes. We will review some of the classic papers describing specific genetic effects on cognitive phenotypes, but the focus of the course will be on the underlying molecular biology and genetics rather than the nuances of psychological testing. This course will not address the thorny questions of how to precisely define and measure cognitive phenotypes or, once the phenotypes are defined, to assess the genetic contributions to their variability. Rather we will discuss the molecular biology of specific genetic polymorphisms which are commonly studied in this context the biological reasonableness of some of these results.

Learning Objectives

At the conclusion of the course the student should:

- Be familiar with the most commonly studied human genetic polymorphisms associated with variation in cognitive phenotypes.
- Have a basic understanding of the molecular biology and neuroanatomy associated with those polymorphisms.
- Understand the basic concepts population genetics and the limitations of genetic association studies.

Credits: 2
Class Type: Graduate Course

PSYC 550: Psychiatric Pharmacogenetics

Psychiatric pharmacogenetics involves the study of four classes of genes:

- Pharmacodynamic genes: These are genes encoding drug targets (or proteins physiologically related to those targets).
- Pharmacotypic genes: Genes impacting disease presentation and subtype (genetics of the disease itself)
- Pharmacokinetic genes:
  - Genes associated with drug transport (eg ABCB1/MDR1)
  - Genes associated with metabolism (eg CYP genes)
- Adverse drug reaction susceptibility genes (eg G6PD or HLA genes)

This course builds on the FAES course "Genetic Polymorphisms Affecting Human Cognition". The present course will focus on the genetics of psychiatric disease (pharmacotypic genes) and on genetic polymorphisms relevant to commonly used psychiatric medications (pharmacokinetic genes and the genetics of adverse drug reaction susceptibility genes).

Learning Objectives

At the conclusion of the course the student should:

- Be familiar with the common genetic polymorphisms that affect the risk of psychiatric disease, and response to psychoactive drugs.
- Have a basic understanding of the molecular biology and neuroanatomy associated with those polymorphisms.
- Understand the basic concepts population genetics and the limitations of genetic association studies.

Credits: 2
Class Type: Graduate Course
Prerequisites: PSYC 525
IMMU 004: Cellular Immunology: Principles and Methods
The objective of this workshop is to learn, through lecture and laboratory sessions, those research approaches which form the foundation of our understanding of the immune system, with particular emphasis on the cellular elements and their roles in the orchestration of the immune response. This field is contributing to novel therapies and is in a high state of flux, so due attention will be given to new directions.

Credits: 0
Class Type: Workshop

IMMU 024: Flow Cytometry Data Analysis and Visualization
This workshop provides practical approaches for the understanding flow cytometry data, its analysis, Flow Cytometry Standard (FCS) format, and to produce visualizations for presentation and/or publication. During this two-day workshop, students are introduced to data management and quality control, processing of data with the package FlowJo, generate figures and statistical data for effective communication. This workshop is tailored to researchers with limited flow cytometry experience, researchers doing less than 10-parameter cytometry, and experience researchers interested in becoming familiar with functional assay data, cytometry data model, and other areas of cytometry. At the end of the course, you will be able to import flow cytometry data, evaluate the quality of the data, extract statistics, and produce clear figures. Participants would learn to use FlowJo with practical examples.

Learning Objectives
- Import data to FlowJo and evaluate its quality
- Compensation Identify examples of good and bad data display
- Extract statistics Produce clear figures
- Analyze a simple immunostaining experiment
- Analyze a Cell Cycle experiment Analyze a Functional assay experiment
- Analyze a Cytometry Bead Assays experiment
- Effective and ineffective data visualization

Class Type: Workshop
Prerequisites:
Familiarity with the basic principles of flow cytometry.
IMMU 101: Introduction to Cancer Biology
The six Hallmarks of Cancer were first presented by Douglas Hanahan and Robert Weinberg in 2000 to organize the complexity of cancer into broader principles based on function. In 2011, the Hallmarks of Cancer were updated to ten to include additional hallmarks based on advances in research in the role of the tumor microenvironment in carcinogenesis. This course will examine each of the ten Hallmarks of Cancer, going into detail about the biological functions and major signaling pathways of each, as well as mechanisms to target them. Overall, an introduction to the hallmarks of cancer will provide an excellent baseline of knowledge about cancer characteristics and why they are targeted for therapy.

Learning Objectives
- Describe how the hallmarks of cancer contribute to the abnormality of cancer.
- Compare different therapeutic options targeting various hallmarks of cancer.
- Explain why targeting multiple hallmarks has therapeutic benefit.

Credits: 1
Class Type: Graduate Course
Availability May 2022
Session Intersession

IMMU 102: Emerging Coronaviruses
Emerging microbial pathogens are of increasing concern both nationally and internationally with the potential to cause widespread morbidity and mortality at an unprecedented level. The current outbreak of COVID-19 provides evidence that unknown microbial agents have the ability to emerge from their natural hosts to spread, adapt, and cause disease on a global scale. This course will investigate the microbiological, environmental, and social factors that contribute to emergence of novel coronavirus outbreaks (SARS, MERS, COVID-19), and review the basic biology, diagnostics, immunology, potential therapies, and preventive strategies necessary to control and prevent these outbreaks.

Learning Objectives
- Describe the basic biology, pathogenesis and epidemiology of novel coronaviruses.
- Review the laboratory methods used to identify and study these pathogens.
- Discuss the environmental factors that allow for emergence of novel coronaviruses.

Credits: 1
Class Type: Graduate Course

IMMU 103: COVID-19 Vaccines: A Comparative Approach
By the end of 2019, a new coronavirus emerged in Asia and quickly spread around the world. This virus, now known as SARS-CoV-2, has become a global public health emergency due to its high death toll. Understanding the virus's physiology and developing vaccines to prevent more infections are currently main global scientific efforts. This course will explore the cutting-edge technologies used to create COVID-19 vaccines and compare the mechanisms of the different types of vaccines now available. Overall, this course will provide an overview of the vaccine development field's current state and provide a glimpse of the vaccines that will protect the population from the virus's new variants in the future.

Learning Objectives
- Describe the structure and physiological effects of the virus SARS-CoV-2.
- Describe the different scientific approaches used to develop COVID-19 vaccines.
- Compare the COVID-19 vaccines available in the US and the rest of the world.

Credits: 1
Class Type: Graduate Course
**IMMU 325: The Human Microbiome: New Concepts in Health and Disease**

Ever wonder whether the latest headlines about ‘good bacteria’ are true or just hype? This course will cover the science behind the news and will address how the human microbiome is shaping our understanding of health, disease, and medical treatments. Topics will include current technologies being used to study the microbiome, microbial diversity, mucosal immunity and Immunotolerance as well as the impact of diet on the microbiome. The course will explore how dysbiosis of the microbiome contributes to human diseases, such as obesity, diabetes, and cancer. Students will discuss how increased understanding of the microbiome impacts our usage of probiotics, prebiotics, and antibiotics. This course is designed for postdoctoral fellows, postbacs, graduate students, and other individuals who are interested in expanding their understanding of the microbiome and probiotics in health and disease. By the end of the course, students should have an understanding of the integral role of the microbiome in promoting human health and of how dysbiosis contributes to disease.

**Learning Objectives**

- Identify and compare important constituents of the human microbiome
- Describe technological methods used in microbiome analysis
- Assess the effects of probiotics and prebiotics on human health and disease
- Evaluate the contribution of the microbiome in various human disease states

**Credits:** 1

**Class Type:** Graduate Course

**Prerequisites:**

- General knowledge of biology or consent of instructor.

---

**IMMU 339: Advanced Cancer Biology**

Cancer is an ancient disease with specific characteristics. Students taking this course will discuss the genetic basis of cancer, the initiation and progression of cancer, aberrant signal transduction in tumor cells and metastasis. This course will also have a journal-club component, which will enable students to read and discuss scientific journal articles related to the course.

**Learning Objectives**

At the end of this course students will be able to:

- Identify cancer biology terms and apply terms and information in textbook to case studies.
- Differentiate various aspects that characterize a cancerous vs normal cell.
- Identify potential therapeutic strategies using knowledge of various effectors in cancer cells.
- Develop a detailed scientific presentation to include background information, experimental design, and findings.

**Credits:** 2

**Class Type:** Graduate Course

**Prerequisites:**

- IMMU 101
- The above course(s) or equivalent background knowledge.

**Availability** Spring 2022

**Session** Session A
IMMU 369: Epidemics, Vaccines, and Prevention
When a large number of people become ill due to the same infectious agent, it is called an epidemic—or, if the disease spreads to affect even greater numbers globally, a pandemic. For example, the Bubonic Plague was active in the fourteenth century in Europe, killing almost one-third of the continent’s population, while the 1918 flu killed an estimated 50 million people worldwide. More recently, the Ebola epidemic in West Africa showed that our global response to a potential pandemic is slow and lacking in early detection systems and global coordination. Vaccines, arguably one of the most important scientific breakthroughs of modern times, have allowed us to defend ourselves against rampant infections. The world community has managed to eradicate smallpox, and is close to eradicating polio. For both, the key tool was the implementation of routine vaccinations. This course will explore historic and current threats by infectious diseases with epidemic or pandemic potential as well as strategies to prevent and control outbreaks. The course will emphasize the important role of vaccines and will cover the immunological mechanisms on which successful vaccines are based. Vaccines currently in use and major challenges in novel vaccine development and implementation will be also discussed.

Learning Objectives
- List major historical epidemics and their impact on society
- Discuss how both genetic mutations and changes in the environment together with human social behavior can give rise to new infectious diseases
- Explain how vaccines can help prevent infections
- Compare different types of vaccine strategies and their underlying immunological mechanisms
- Assess the potential of a developmental vaccine candidate

Credits: 1
Class Type: Graduate Course

---

IMMU 403: Basic Principles of Immunology and Hypersensitivity
The immune system encompasses a broad, highly interactive network of cells, tissues, and anatomical structures that protects us from infection and cancer, yet can also induce autoimmune disease. The course will explore the genetics, cell biology, and physiology that govern both our resistance to infection and the induction of autoimmune disease and allergy. Distinctions between the innate/natural immune system and the adaptive immune system will be discussed. The role of intestinal microbiota, inflammatory reactions, and vaccines will be also studied. Central to the discussions will be the role of cellular subsets (B cells, T cells, macrophages), serum proteins (immunoglobulins and complement), and cell surface receptors whose coordinated activities comprise the immune response. Specific immune pathologies or deficiencies associated with human disease will be also highlighted.

Learning Objectives
- Summarize key cellular components of the immune response.
- Distinguish the function of innate/natural and adaptive immune systems.
- Recall how the key antigen recognition molecules (TCR, BCR) arise from genetic recombination, and how the specificity of the immune repertoire is shaped.
- Discuss the role of inflammation during infection, autoimmunity, and cancer.
- Illustrate how cytokine activity affects cell signaling and function.
- Predict how the immune system plays a role in the resistance to infection, induction of allergies, autoimmunity, and cancer.

Credits: 2
Class Type: Graduate Course
Prerequisites: Familiarity with cell biology.
Availability Spring 2022
Session Session B
IMMU 411: Innate and Adaptive Immune Memory: Theory and Applications

When you are infected with a pathogen, your body generates a protective immune response to control and eliminate that threat. Months or even years later, you get infected again, but now your body response is faster and stronger, and you don’t get sick anymore. This is called immune cell memory. It is well established that T and B lymphocytes are the main memory cells of the adaptive immune response, however recent studies have shown that cells from our innate immune system may also be “trained” to respond more efficiently to a second encounter with a pathogen. This course will bring the latest insights into immune memory, highlighting the difference between innate and adaptive immunological memory and how factors such as vaccines, diet, and infectious diseases influence memory development.

Learning Objectives

• Define and distinguish innate and adaptive immune cell memory.
• Recognize recent discoveries in immune memory, specifically how infectious diseases, vaccines, and diet influence memory development.
• Predict how innate or adaptive memory responses may be protective, such as by limitation of infection, or deleterial, such as by hyperinflammation in tissues.
• Integrate this knowledge in different areas of research or in your daily life.

Credits: 2
Class Type: Graduate Course
Prerequisites: IMMU 403
The above course or equivalent graduate-level immunology course or knowledge.
Availability Spring 2022
Session Session B

IMMU 418: Cancer Immunology

Cancer immunotherapy is a rapidly advancing field in research and in the clinic, which focusses on the interface between the immune system, inflammation and cancer biology. To advance research in this field an understanding of each of these systems and how they interact to suppress or promote cancer progression is vital. Students taking this class will gain an understanding of how the tumor microenvironment alters and evades the immune system and the contribution of inflammation in promoting cancer progression. This course will serve as an introduction to further studies in cancer immunotherapies.

Topics covered:

• Tumor microenvironment – the interactions between immune cells and cancer cells.
• Polarization of Macrophages and Recruitment of Inflammatory Cells by Cancer Cells.
• Mechanisms of Tumor-Induced Tolerance/Escape from the Immune System.
• Immunosuppression by Myeloid-Derived Suppressor Cells (MDSCs)
• Innate immune system in cancer and therapies utilizing cytokines and interferons.
• Cancer Vaccines: preventative and therapeutic.
• Viruses and cancer: cancer-causing viruses (eg HPV, HTLV1), oncolytic viruses and use of viruses in gene therapy.
• Anti-cancer antibodies (including ADCs) to target cancer cells.

Learning Objectives

• Students will list the mechanisms by which cancer cells evade the immune system.
• Students will describe the relationships between viruses and cancer, and give examples of cancer vaccines.
• Students will explain how cancer cells interact with and ‘corrupt’ immune cells in the tumour microenvironment.
• Students will demonstrate how the innate immune system can be utilized in cancer therapy.

Credits: 1
Class Type: Graduate Course
IMMU 419: Cancer Immunotherapy
Immunotherapy for cancer treatment has become a popular and important topic of study, and has been refined over recent years as our understanding of the interactions between tumors and the immune system improves. This seven week course will provide a brief background of the relationship between tumors, their microenvironment, and the immune system, before diving into the history of the earliest immune therapies, and making our way through the progression and development of newer therapeutic approaches. This course will focus on different ways to train our immune system to recognize and attack cancer cells, including vaccines, chimeric antigen receptor therapy, antibody therapy, adoptive cell transfer, oncolytic viruses, as well as clinical trials and other more theoretical methods which are still being developed with current research. This course will provide a current overview of immunotherapeutic approaches to treating cancer for those with a working knowledge of cancer and immunology.

Learning Objectives

- Describe how the immune system detects tumors, and how cancer cells can evade this detection
- Explain why various mechanisms of immune escape are exploitable with therapeutic targeting
- Discuss the benefits and fallbacks of immunotherapies from past and present
- Demonstrate where the field requires improvement moving into the future

Credits: 1
Class Type: Graduate Course
Prerequisites: Familiarity with basic immunology is strictly required; prior college-level coursework in immunology is highly encouraged.
Availability: Spring 2022
Session: Session B

IMMU 420: Advanced Immunology and Host Microbe Interactions
"Immunology taught me that germs are bad, so why do I feel sick when I take antibiotics? What's a monoclonal antibody? Why is transplantation so complicated?" If you've found yourself wondering these questions, which are typically beyond the scope of an introductory immunology course, this is the perfect course for you. IMMU 420 builds upon the foundations laid in introductory immunology courses such as IMMU 403. We explore concepts such as autoimmunity, transplantation, and mucosal immunity while also introducing the concept of host pathogen interactions: pathogenic and beneficial. We also discuss therapeutic modulators of the immune system, common laboratory techniques as practical applications of the immune concepts covered.

Learning Objectives

- Identify and discuss the mechanisms used by natural killer cells to guard against infection throughout the body. Discuss the role of NK cells in innate immune defenses at various tissue sites.
- Compare and contrast the players of mucosal immunity versus systemic immunity to distinguish the difference between infections and vaccines at mucosal surfaces.
- Distinguish between and classify various types of autoimmune diseases.
- Predict the outcome of transplantation after examination of various histocompatibility markers. Predict how various histocompatibility markers can adversely affect transplantation.
- Devise a treatment plan for hypothetical patients with autoimmune diseases based on student knowledge of immune modulating drugs.
- Discuss some of the ways the microbiome influences the immune system of the host.
- Set up theoretical experiments using common immune system experimental protocols to test provided hypotheses.

Credits: 2
Class Type: Graduate Course
Prerequisites: IMMU 403
The above course(s) or a solid foundation in immunology.
Availability: Spring 2022
Session: Session B
IMMU 521: Molecular and Cellular Mechanisms of Immunity I
The objective of this course is to provide a survey of recent advances in immunology to students who have already had a basic immunology course. The course is offered as a series of lectures by NIH researchers, covering recent concepts of innate and adaptive immune responses, lymphocyte development and function, the genetic and biochemical basis of immune receptors and effector molecules. Recent research using biochemical, genetic, and cell biology approaches to immune function will be discussed in the context of experimental results. Grades will be based on take-home mid-term and final exams as well as on a short review-style paper on a topic related to the course.

Learning Objectives
- Survey recent advances in immunology
- Discuss lymphocyte development and interactions, receptor signal transduction, genetic and biochemical basis of immune receptors and effector function

Credits: 2
Class Type: Graduate Course
Prerequisites: IMMU 403 Basic Principles of Immunology and Hypersensitivity or equivalent graduate-level immunology course.

IMMU 522: Molecular and Cellular Mechanisms of Immunity II
This is an advanced immunology course designed for those individuals who have had a basic immunology course at FAES or elsewhere. The course is a learning opportunity for postdoctoral Fellows, graduate students, postbacs, and others who wish to gain more knowledge in contemporary immunology. The course offers a chance to meet leaders in the field. Experts of the NIH immunology community contribute their time to this series of 30 one-hour lectures (two lectures delivered in each evening session). Topics include immunity to viruses, bacteria, fungi, parasites, immune systems of the gut, lung and skin, vaccines, autoimmune diseases, asthma, immune deficiencies, tumor immunology, dendritic cells, innate lymphocytes, and cytokines.

Learning Objectives
- Learn advanced immunological concepts from world authorities at NIH
- Apply these concepts to research projects, medicine, and management
- Identify fundamental mechanisms of innate and adaptive immunity
- Learn advanced principles of host defense against pathogens and the relationship with commensals
- Understand the bases of autoimmunity and immunodeficiency

Credits: 2
Class Type: Graduate Course
Prerequisites: previous immunology course or working knowledge of basic immunology, IMMU 521 or equivalent.
**MICR 101: Introduction to Virology**

This course overviews the origin, definition, classification, life cycle, and structure of viruses. Students will define basic virology terms to prepare to continue their studies in more advanced virology classes. This course will discuss viruses causing pandemics of the 20th and 21st centuries to emphasize the importance of studying and understanding viruses.

**Learning Objectives**

- Define viruses and reflect on theories of their origin.
- Break down the life cycle of a virus.
- Link virus groups to selected specifics in the life cycle of various viruses.
- Associate historically important outbreaks, epidemics, and pandemics with viruses and related pathologies.
- Discuss the importance of vaccination.

**Credits:** 1  
**Class Type:** Graduate Course  
**Availability** May 2022  
**Session** Intersession

---

**MICR 317: Molecular Virology I**

This course provides an introduction to the molecular virology of virus infection and progeny virus production and spread. It details molecular mechanisms of virus entry, replication, transcription, translation, and propagation in the host. Starting with the molecular structure of select viruses, the course will focus on strategies used by various viruses for successful infection and propagation, including molecular mechanism of host defense and its evasion by the viruses. Select viruses important to human health (e.g., influenza virus, papillomavirus, HIV) will be considered in detail, highlighting recent advances in the understanding of their biology and pathogenesis. The lectures will include discussions of current strategies for vaccine development and viruses as vectors for gene transfer in functional genomics and gene therapy.

**Learning Objectives**

- Acquire fundamental and practical knowledge of virology from the molecular perspective
- Revisit the question of whether viruses are living organisms throughout the course
- Discuss how viruses infect a host, and the molecular determinants of infection and pathogenesis
- Identify gaps in our knowledge of virology and discuss how to fill those gaps
- Discover how the study of viruses is helping usher in the age of synthetic biology

**Credits:** 1  
**Class Type:** Graduate Course  
**Prerequisites:** Understanding of biochemistry, molecular biology, and microbiology or permission from the instructor.
MICR 318: Molecular Virology II
This course provides an introduction to the molecular virology of virus infection and progeny virus production and spread. It details molecular mechanisms of virus entry, replication, transcription, translation, and propagation in the host. Starting with the molecular structure of select viruses, the course will focus on strategies used by various viruses for successful infection and propagation, including molecular mechanism of host defense and its evasion by the viruses. Select viruses important to human health (e.g., influenza virus, papillomavirus, HIV) will be considered in detail, highlighting recent advances in the understanding of their biology and pathogenesis. The lectures will include discussions of current strategies for vaccine development and viruses as vectors for gene transfer in functional genomics and gene therapy.

Learning Objectives
- Acquire fundamental and practical knowledge of virology from the molecular perspective
- Revisit the question of whether viruses are living organisms throughout the course
- Discuss how viruses infect a host, and the molecular determinants of infection and pathogenesis
- Identify gaps in our knowledge of virology and discuss how to fill those gaps
- Discover how the study of viruses is helping usher in the age of synthetic biology

Credits: 1
Class Type: Graduate Course
Prerequisites: MICR 317
The above course(s) or permission from the instructor.

MICR 325: Molecular Microbiology I
This course will cover concepts in molecular microbiology, including microbial cell biology, bacterial biochemistry, bacterial genetics and genomics, and molecular interactions with host or microbiome communities. Select bacteria important to human health and disease (e.g. Staphylococcus aureus, Pseudomonas aeruginosa) will be considered in detail, highlighting advances in the understanding of their biology and pathogenesis. During the course, students will read primary scientific literature that highlights evolving technologies and experimental approaches that enable a deeper understanding of molecular microbiology. Class sessions will include active student participation in discussions and case studies.

Learning Objectives
- Explain fundamental and advanced principles of molecular microbiology, including microbial cell biology, bacterial biochemistry, bacterial genetics and genomics, and cell-cell interactions
- Identify key questions in the field and analyze how these apply to biomedical research and product development
- Interpret and analyze scientific literature in molecular microbiology
- Apply new knowledge to discuss case studies relevant to molecular microbiology

Credits: 2
Class Type: Graduate Course
Prerequisites: Introductory understanding of microbiology.
**MICR 326: Molecular Microbiology II**

This course will cover concepts in molecular microbiology, including microbial cell biology, bacterial biochemistry, bacterial genetics and genomics, and molecular interactions with host or microbiome communities. Select bacteria important to human health and disease (e.g. Staphylococcus aureus, Pseudomonas aeruginosa) will be considered in detail, highlighting advances in the understanding of their biology and pathogenesis. During the course, students will read primary scientific literature that highlights evolving technologies and experimental approaches that enable a deeper understanding of molecular microbiology. Class sessions will include active student participation in discussions and case studies.

**Learning Objectives**

- Explain fundamental and advanced principles of molecular microbiology, including microbial cell biology, bacterial biochemistry, bacterial genetics and genomics, and cell-cell interactions
- Identify key questions in the field and analyze how these apply to biomedical research and product development
- Interpret and analyze scientific literature in molecular microbiology
- Apply new knowledge to discuss case studies relevant to molecular microbiology

**Credits:** 2

**Class Type:** Graduate Course

**Prerequisites:**

MICR 325

The above course(s) or permission from the instructor.

---

**MICR 418: Emerging Infectious Diseases I**

Emerging infectious pathogens are predators that exploit changes in human biology, behavior, and the environment to overcome public health measures and host defenses. Domestic examples include Zika, Ebola, influenza, dengue, and West Nile virus. Hospital-acquired infections, usually multidrug resistant, take the lives of over 90,000 Americans annually. Vaccine-preventable diseases reemerge in populations at both ends of the wealth spectrum, such as tetanus or rabies among the world’s poorest children, measles or mumps among conscientious objectionists. In South America, dengue fever, schistosomiasis, leishmaniasis, and persistent childhood diarrhea feature prominently. In Sub-Saharan Africa, co-infections and drug resistance increasingly frustrate the struggle against malaria, tuberculosis, salmonellosis, and HIV/AIDS. In East Asia, the recent origin of novel influenza viruses, SARS, and pan-resistant gonorrhea meets a particularly interesting nexus of economic transformation, societal upheaval, and government policy. Additional complications include an arising pandemic of hepatitis C, promiscuous drug-resistant genetic elements, rolling waves of HIV, the unfolding effects of climate change, and, of course, the specter of biological weapons. The class will survey a wide range of pathogens whose emergence relates to contemporary human, microbiological, and environmental factors and will examine how microbes have overcome medical marvels that took 150 years to develop. Common themes will be developed from almost 50 examples of today’s emerging infectious diseases. The course will explore the spectacular opportunities for research science to liberate humanity from existing infectious diseases and prepare for the next emergence.

**Learning Objectives**

- Understand where, how, and why infectious diseases emerge
- Discuss over 50 emerging infections in the context of U.S. and global health
- Get to know the impact of infectious disease and disease control on human genetics, behavior, and society
- Explore how infectious disease molds human science, art, and society
- Gain insight into important new opportunities in infectious disease

**Credits:** 2

**Class Type:** Graduate Course

**Prerequisites:**
Interest in the interface of science and medicine, and, for credit students, willingness to make one class presentation on an emerging infectious disease chosen from a list.

MICR 419: Emerging Infectious Diseases II
Emerging infectious pathogens are predators that exploit changes in human biology, behavior, and the environment to overcome public health measures and host defenses. Domestic examples include Zika, Ebola, influenza, dengue, and West Nile virus. Hospital-acquired infections, usually multidrug resistant, take the lives of over 90,000 Americans annually. Vaccine-preventable diseases reemerge in populations at both ends of the wealth spectrum, such as tetanus or rabies among the world’s poorest children, measles or mumps among conscientious objectionists. In South America, dengue fever, schistosomiasis, leishmaniasis, and persistent childhood diarrhea feature prominently. In Sub-Saharan Africa, co-infections and drug resistance increasingly frustrate the struggle against malaria, tuberculosis, salmonellosis, and HIV/AIDS. In East Asia, the recent origin of novel influenza viruses, SARS, and pan-resistant gonorrhea meets a particularly interesting nexus of economic transformation, societal upheaval, and government policy. Additional complications include an arising pandemic of hepatitis C, promiscuous drug-resistant genetic elements, rolling waves of HIV, the unfolding effects of climate change, and, of course, the specter of biological weapons. The class will survey a wide range of pathogens whose emergence relates to contemporary human, microbiological, and environmental factors and will examine how microbes have overcome medical marvels that took 150 years to develop. Common themes will be developed from almost 50 examples of today’s emerging infectious diseases. The course will explore the spectacular opportunities for research science to liberate humanity from existing infectious diseases and prepare for the next emergence.

Learning Objectives

- Understand where, how, and why infectious diseases emerge
- Discuss over 50 emerging infections in the context of U.S. and global health
- Get to know the impact of infectious disease and disease control on human genetics, behavior, and society
- Explore how infectious disease molds human science, art, and society
- Gain insight into important new opportunities in infectious disease

Credits: 2
Class Type: Graduate Course
Prerequisites:
MICR 418
The above course(s) or permission from the instructor.

MICR 432: Human Virology I: Host Virus Relationships
This course will explore the mechanistic and evolutionary relationship between viruses and their hosts with an emphasis on human viruses. We will discuss basic mechanisms of viral replication as well as the host defenses to counteract viruses such as adaptive and innate immunity. We will also talk about the development of vaccines and antivirals in a historical context and explore the mechanistic details of various vaccine platforms and antivirals. Other topics discussed include the discussion on the viruses in our genome (endogenous viruses) and their evolution and the tools to study viral evolution.

Learning Objectives
- Outline the steps of the replication cycle for each viral genome type
- Explain viral evolutionary mechanisms and their contribution to the emergence and re-emergence of human viral diseases
- Distinguish between the roles of adaptive and innate immune systems during viral infections
- Compare and contrast different vaccine development strategies
- Discuss the mechanism of action of various antivirals targeting different phases of the viral replication cycle
- Illustrate the replication mechanisms of transposable elements and endogenous retroviruses
- Convey detailed concepts of a chosen virology topic to other people

Credits: 2
Class Type: Graduate Course
Prerequisites: College degree; knowledge of biology or consent of the instructor.
Availability Spring 2022
Session Session A

MICR 433: Human Virology II: Viral Pathogenesis
This course will explore the epidemiology, pathogenesis, prevention and treatment of major human diseases caused by viruses with an emphasis on viral molecular biology. We will discuss in detail the replication cycle of clinically important viruses such as HIV, Hepatitis C, Influenza, Coronaviruses, Ebola and Zika. We will also talk about zoonosis and how it contributes to emerging of viral infections.

Learning Objectives
- Illustrate the basic structures and replication strategies of the major classes of human viruses
- Give examples of viruses that can cause cancer in humans
- Compare and contrast the life cycle and epidemiology of viruses that cause hepatitis
- Discuss the immune evasion mechanisms utilized by HIV and Herpesviruses
- Give examples of emerging viral infections that jump from animals to humans
- Convey detailed concepts of a chosen virology topic to other people

Credits: 2
Class Type: Graduate Course
Prerequisites: College level understanding of biology or consent of the instructor.
Availability Spring 2022
Session Session B

MICR 440: Emerging Viruses I
Emerging viruses are of increasing concern both nationally and internationally with the potential to cause widespread morbidity and mortality at an unprecedented level. The current outbreak of SARS-CoV-2 and other Coronaviruses provide ample evidence that these viral agents have the ability to emerge from their natural hosts to spread, adapt, and cause epidemic disease on a global scale. The first part of this course will focus on the biological, immunological, environmental, and social factors that contribute to emergence of Coronaviruses (SARS-CoV-1, SARS-CoV-2, and MERS-CoV), seasonal influenza virus, and pandemic Influenza viruses. In addition, a review the current diagnostic, therapeutic, and preventative strategies will be discussed for these emerging pathogens.

Credits: 2
Class Type: Graduate Course
MICR 441: Emerging Viruses II
This a continuation of Emerging Viruses I course and will investigate additional emerging and re-emerging viruses associated with epidemic and pandemic potential, which include Ebola virus, Zika virus, West Nile virus, Chikungunya virus, Monkeypox virus, Nipah virus, Hanta virus, Dengue virus, Lassa Fever virus, Hendra virus, measles virus, and Enterovirus D68. This course will investigate the microbiological, environmental, and social factors that contribute to re-emergence of these viral agents as well as the current diagnostic, therapeutic, and preventive strategies being implemented.

Credits: 2
Class Type: Graduate Course
Prerequisites: MICR 440
The above course(s) or permission from the instructor.
ENGL 205: Intermediate English Conversation I, part 1

The goal of this course is to enable intermediate learners of English to understand and speak English more accurately, confidently, and fluently. Each seven-week online course has asynchronous (self-paced) and synchronous (scheduled) components. The purpose of the weekly online meetings is to engage in interactive conversations and practice the skills that students develop during the week independently. The instructor will facilitate theme-based conversations among the students in a weekly Zoom session, which students prepare for through textbook and online exercises (Summit 1, English for Today's World and MyEnglishLab web site). Weekly discussion boards will provide an opportunity to engage with peers, using the vocabulary and conversation strategies presented in each unit.

This course is fast-paced and requires a significant time commitment and a self-motivated attitude. Students complete one unit each week, learning new vocabulary and idioms in the context of theme-based oral exercises, conversation models, pair-work activities, and listening texts. In addition, students learn strategies to improve accents, rhythm, intonation, and stress patterns. Students deliver oral presentations and share them with their classmates through the course web site and weekly meetings on Zoom.

This is a two-part course. Registration is required separately for each part of the course.

Learning Objectives

- Increase active conversational skills by building vocabulary, improving pronunciation, and applying grammar concepts
- Develop communication skills by focusing on speaking to be understood, listening to understand, and responding meaningfully in conversations
- Develop a personal toolbox of resources to further develop English conversation skills in a variety of contexts

Credits: 2
Class Type: Graduate Course
Prerequisites:

No prerequisites are required. Students may take both parts or one part of the course. However, students must begin the course with a basic conversational ability in English. The textbook, Summit 1, is designed for students at the B2 level (GSE 57-70).
ENGL 206: Intermediate English Conversation I, part 2
The goal of this course is to enable intermediate learners of English to understand and speak English more accurately, confidently, and fluently. Each seven-week online course has asynchronous (self-paced) and synchronous (scheduled) components. The purpose of the weekly online meetings is to engage in interactive conversations and practice the skills that students develop during the week independently. The instructor will facilitate theme-based conversations among the students in a weekly Zoom session, which students prepare for through textbook and online exercises (Summit 1, English for Today's World and MyEnglishLab web site). Weekly discussion boards will provide an opportunity to engage with peers, using the vocabulary and conversation strategies presented in each unit. This course is fast-paced and requires a significant time commitment and a self-motivated attitude. Students complete one unit each week, learning new vocabulary and idioms in the context of theme-based oral exercises, conversation models, pair-work activities, and listening texts. In addition, students learn strategies to improve accents, rhythm, intonation, and stress patterns. Students deliver oral presentations and share them with their classmates through the course web site and weekly meetings on Zoom.

This is a two-part course. Registration is required separately for each part of the course.

Learning Objectives

- Increase active conversational skills by building vocabulary, improving pronunciation, and applying grammar concepts
- Develop communication skills by focusing on speaking to be understood, listening to understand, and responding meaningfully in conversations
- Develop a personal toolbox of resources to further develop English conversation skills in a variety of contexts

Credits: 2  
Class Type: Graduate Course  
Prerequisites: No prerequisites are required. Students may take both parts or one part of the course. However, students must begin the course with a basic conversational ability in English. The textbook, Summit 1, is designed for students at the B2 level (GSE 57-70).
ENGL 207: English Conversation for Daily Life: Goals, Fears, and Humor

The goal of this course is to enable high intermediate learners of English to understand and speak English more accurately, confidently, and fluently. Each seven-week online course has asynchronous components through the Canvas web site (weekly assignments/due dates) and synchronous components (scheduled Zoom meetings.) The purpose of the weekly online meetings is to engage in interactive conversations and practice the skills that students develop during the week independently. The instructor will facilitate theme-based conversations among the students in a weekly Zoom session, which students prepare for through textbook and online exercises (Summit 2, 3rd Edition and MyEnglishLab web site). Weekly discussion boards will provide an opportunity to engage with peers, using the vocabulary and conversation strategies presented in each unit.

This course is fast-paced and requires a significant time commitment and a self-motivated attitude. Students complete one unit each week, learning new vocabulary and idioms in the context of theme-based oral exercises, conversation models, pair-work activities, and listening texts. In addition, students learn strategies to improve accents, rhythm, intonation, and stress patterns. Students deliver oral presentations and share them with their classmates through the course web site and weekly meetings on Zoom.

Learning Objectives

• Demonstrate increased conversational skills by building vocabulary, improving pronunciation and applying grammar concepts.
• Participate in interactive discussions with natural social language conversation models.
• Describe social and professional situations encountered in everyday life.
• Create short presentations on VoiceThread to share with the class.
• Complete weekly writing assignments to demonstrate understanding of new vocabulary and language constructions.

Credits: 2
Class Type: Graduate Course
Prerequisites:
Prerequisites No prerequisites are required. Students may take English 207 and 208 separately or combine both courses. However, students must begin the course with a basic conversational ability in English. The textbook, Summit 2, is designed for students at the B2-C1 level (Global Scale of English 70-82).

Availability Spring 2022
Session Session A
ENGL 208: English Conversation for Daily Life: Travel, Predictions, and Globalization

The goal of this course is to enable high intermediate learners of English to understand and speak English more accurately, confidently, and fluently. Each seven-week online course asynchronous components through the Canvas web site (weekly assignments/due dates) and synchronous components (scheduled Zoom meetings.) The purpose of the weekly online meetings is to engage in interactive conversations and practice the skills that students develop during the week independently. The instructor will facilitate theme-based conversations among the students in a weekly Zoom session, which students prepare for through textbook and online exercises (Summit 2, Third Edition and MyEnglishLab web site). Weekly discussion boards will provide an opportunity to engage with peers, using the vocabulary and conversation strategies presented in each unit. This course is fast-paced and requires a significant time commitment and a self-motivated attitude. Students complete one unit each week, learning new vocabulary and idioms in the context of theme-based oral exercises, conversation models, pair-work activities, and listening texts. In addition, students learn strategies to improve accents, rhythm, intonation, and stress patterns. Students deliver oral presentations and share them with their classmates through the course web site and weekly meetings on Zoom. This is a two-part course. Registration is required separately for each part of the course.

Learning Objectives

• Demonstrate increased conversational skills by building vocabulary, improving pronunciation and applying grammar concepts.
• Participate in interactive discussions with natural social language conversation models.
• Describe social and professional situations encountered in everyday life.
• Create short presentations on VoiceThread to share with the class.
• Complete weekly writing assignments to demonstrate understanding of new vocabulary and language constructions.

Credits: 2
Class Type: Graduate Course
Prerequisites:

No prerequisites are required. Students may take ENGL 207 and ENGL 208 separately or combine both courses. However, students must begin the course with a basic conversational ability in English. The textbook, Summit 2, is designed for students at the B2-C1 level (Global Scale of English 70-82).

Availability Spring 2022
Session Session B

ENGL 209: Advanced Conversation: Using TED Talks to Discuss Innovative Ideas

The goal of this course is to enable advanced learners of English to understand and speak English more accurately, confidently and fluently. New vocabulary, idioms and expressions will be incorporated in TED Talks and articles about current innovative ideas. Students will complete self-paced textbook exercises and participate in guided conversation at weekly meetings. Students will practice listening for details and summarizing issues that require critical analysis and deep thinking. Interesting discussions and debates will be developed and facilitated. Students will give oral presentations on VoiceThread, participate in online discussion boards and submit weekly written assignments. Completion of Intermediate Conversation II or the permission of the instructor is required for this class.

Learning Objectives

• Increase active conversational skills to advanced level by improving vocabulary, grammar and accent
• Increase authentic listening skills and presentation skills
• Use language creatively by listening and speaking deeply about current topics
• Build confidence by improving conversational skills

Credits: 2
Class Type: Graduate Course

108 2021-2022
ENGL 356: Sharing Ideas About Language Culture and Medicine II
Researchers from all over the world use English as the common language to share their findings with colleagues and debate current issues. This course is designed for biomedical researchers and others at the NIH and beyond who are intermediate and advanced students of English and who wish to improve their listening and speaking skills in the scientific workplace and/or in other academic settings, such as at conferences or symposia. The course is designed so that students will have the opportunity to work toward their individual goals, which they will communicate to the instructor at the beginning of the course.

Learning Objectives

- Improve English-language conversational skills by speaking clearly and concisely, and finding new ways to express ideas
- Learn how to speak to a variety of audiences by using everyday English to discuss scientific topics
- Express a personal opinion or argument using persuasive, effective language
- Answer questions about one’s area of interest and practice with confidence

Credits: 2
Class Type: Graduate Course
Prerequisites:
ENGL 355
The above course(s), upper-intermediate to advanced level of proficiency in English, or permission from the instructor.

ENGL 365: Better English Communication: Writing and Speaking for Your Audience I
The overall goal of this course is to achieve better results from your writing and speaking by considering the interests and experience of your audience. This is not a course on writing for scientific journals. Rather, we will focus on making scientific language more understandable to the broader scientific community and the general public. In this course, we will examine ways to communicate complex ideas in terms that are appropriate and engaging for the intended audience. This course is designed for native or non-native speakers of English who are interested in improving the effectiveness of their written and spoken communication.

Learning Objectives

After completing this course you will be able to:
- Communicate ideas and information that is of interest to your intended audience
- Convey the appropriate tone (friendly, collegial, respectful) through your word choice in your written communication
- Write clear and concise emails to respond to questions, make a suggestion, or make a request
- Summarize a scientific study in easy-to-understand language that can inform and engage a general audience

Credits: 2
Class Type: Graduate Course
ENGL 366: Better English Communication: Writing and Speaking for Your Audience II

The goal of this course is to achieve better results from our writing. In this course, we will examine ways to communicate complex ideas in terms that are appropriate for the intended audience. This course is designed for native or non-native speakers of English who are interested in improving the effectiveness of their writing.

Learning Objectives

After completing this course you will be able to:

- Write an engaging introductory email to a professional contact who you would like to collaborate with
- Respond to questions from your colleagues in writing, using clear and relevant statements and maintaining a collegial tone
- Make a suggestion or request to your supervisor, using clear and concise language with a friendly and respectful tone
- Summarize a scientific study in easy-to-understand language that can inform and engage a general audience

Credits: 2
Class Type: Graduate Course
Prerequisites: ENGL 365
The above course(s) or permission from the instructor.

GENL 275: Introductory American Sign Language I

American Sign Language (ASL) is a visual-gestural language that possesses all of the properties of a natural language. It is rule governed and has a rich history. This introductory-level course is designed to provide students with a way to communicate and function comfortably in a variety of situations in the Deaf community. Through visual-gestural activities, guided practice, presentations, and practical assignments, students will explore the language, education, and culture of the American Deaf community.

Learning Objectives

- Understand and use target sign vocabulary expressively and receptively
- Describe and distinguish the five parameters of a sign
- Understand the importance of non-manual signals (NMS) in ASL
- Develop expressive fingerspelling in short words and name
- Identify technology and assistive devices used by people who are deaf and hard of hearing
- Know the diverse educational placement options for students who are deaf and hard of hearing
- Show awareness and respect for Deaf culture

Credits: 2
Class Type: Graduate Course
GENL 276: Introductory American Sign Language II

American Sign Language (ASL) is a visual-gestural language that possesses all of the properties of a natural language. It is rule governed and has a rich history. This introductory-level course is designed to provide students with a way to communicate and function comfortably in a variety of situations in the Deaf community. Through visual-gestural activities, guided practice, presentations, and practical assignments, students will explore the language, education, and culture of the American Deaf community.

**Learning Objectives**

- Understand and use target sign vocabulary expressively and receptively
- Describe and distinguish the five parameters of a sign
- Understand the importance of non-manual signals (NMS) in ASL
- Develop expressive fingerspelling in short words and name
- Identify technology and assistive devices used by people who are deaf and hard of hearing
- Know the diverse educational placement options for students who are deaf and hard of hearing
- Show awareness and respect for Deaf culture

**Credits:** 2

**Class Type:** Graduate Course

**Prerequisites:**

GENL 275

The above course(s) or permission from the instructor.

---

GENL 319: MCAT Review and Test Preparation: Chemistry and Physics

This review course prepares students for the Medical College Admission Test (MCAT™). Students will develop a study plan for the MCAT and be presented with foundational scientific information that every future medical student should know in order to excel at the exam. The course will heavily rely on solving MCAT-style questions with the goal of promoting genuine understanding of the material, decreasing ineffective memorization, and improving students’ confidence. This course condenses MCAT-relevant material within general and organic chemistry and physics, with the main emphasis being on the Chemistry/Physics section of the MCAT. Critical Analysis and Reasoning will also be an emphasis throughout the course. Students will be expected to use MCAT review books, identify topics that are unfamiliar or difficult, and focus on those topics during the course of study. For a complete description of the MCAT exam, prerequisites, and eligibility, please visit www.aamc.org.

An MCAT test prep book set is a requirement for this course. The course is primarily structured off of the Princeton Review books, and those books can be purchased through FAES, but other book sets (Kaplan, etc.) may be used instead if you wish.

**Learning Objectives**

- Determine MCAT knowledge concept deficiencies
- Create a study plan for the MCAT
- Review major disciplines and concepts for the MCAT
- Apply foundational knowledge to solving problems presented in MCAT format
- Critically analyze discipline-specific text passages and arguments
- Understand basic scientific principles as they pertain to living organisms and medicine

**Credits:** 2

**Class Type:** Graduate Course

**Availability** Spring 2022

**Session** Session A
GENL 320: MCAT Review and Test Preparation: Biological and Social Sciences
This review course prepares students for the Medical College Admission Test (MCAT™). Students will develop a study plan for the MCAT and be presented with foundational scientific information that every future medical student should know in order to excel at the exam. The course will heavily rely on solving MCAT-style questions with the goal of promoting genuine understanding of the material, decreasing ineffective memorization, and improving students’ confidence. This course condenses MCAT-relevant material within biology, physics, biochemistry, psychology, and sociology, with the main emphasis being on content that will be covered within the Biology/Biochemistry and Psychology/Sociology sections of the MCAT. Critical Analysis and Reasoning passages will also be covered throughout the course. Students will be expected to use MCAT review books, identify topics that are unfamiliar or difficult, and focus on those topics during the course of study. For a complete description of the MCAT exam, prerequisites, and eligibility, please visit www.aamc.org.

An MCAT test prep book set is a requirement for this course. The course is primarily structured off of the Princeton Review books, and those books can be purchased through FAES, but other book sets (Kaplan, etc.) may be used instead if you wish.

Learning Objectives
- Determine MCAT knowledge concept deficiencies
- Create a study plan for the MCAT
- Review major disciplines and concepts for the MCAT
- Apply foundational knowledge to solving problems presented in MCAT format
- Critically analyze discipline-specific text passages and arguments
- Understand basic scientific principles as they pertain to living organisms and medicine

Credits: 2
Class Type: Graduate Course
Availability: Spring 2022
Session: Session A

---

GENL 322: GRE Review
This review course will prepare students for the Graduate Record Examinations (GRE) General Test. Initially, the focus will be on content and test-taking strategies for the Quantitative, Verbal, and Writing portions of the General Test. Numerous example problems will be conducted during class to reinforce the concepts and strategies that will be discussed by the instructor. In the final weeks, students will take full GRE exams as homework and discuss the solutions to problems. The lectures will be interactive, with student participation strongly encouraged. All homework materials will be taken from the Official GRE Verbal and Quantitative Reasoning Practice Question Books or from Official GRE Practice Tests that are provided by ETS (the makers of the test).

Learning Objectives
- Refresh knowledge on math concepts, verbal reasoning, and analytic writing
- Sharpen skills for and gain confidence in GRE test-taking
- Improve GRE general test score

Credits: 1
Class Type: Graduate Course
GENL 355: The Poetry of Science, the Science of Poetry

It has been suggested that metaphor, a mainstay of poetry, is essential to explaining scientific concepts to the general public. One example is the physicist John Ellis’s analogy of a “snowfield” to explain the Higgs Boson. Through the centuries, many poets, including scientist-poets, have pursued similar efforts. But, poetry and science also have other, deeper connections. Just as Francis Collins and Renée Fleming have explained that music is a window into brain science, so is poetry—especially poetry that contains music in the form of rhyme and meter. Through examining essays on poetry’s intersection with neurology and psychology (by Frederick Turner, Ernst Pöppel, and others), close reading of time-honored poems, and informal writing exercises, students will develop a deeper understanding of these connections and of the craft of poetry, both as an art form and as a tool to enhance all writing.

Learning Objectives

- Learn the basics of metaphor, meter and rhyme; become acquainted with classic forms such as sonnet and villanelle; and, discover how psychology and neurology interact with poetry
- Use these skills as a reader and writer: understand factors that make time-honored poems work, and experiment with writing new poems or revising poems students have written
- Examine selected classic and contemporary poems about science to consider whether they can enhance understanding of science
- Explore how conscious attention to meter, rhyme, and other patterns can increase a writer’s expressive power and bring deeper insights to the surface, enhancing all forms of writing

Credits: 1
Class Type: Graduate Course
Prerequisites: basic mastery of the English language; previous experience with poetry is optional.

GENL 401: Leading with Emotional Intelligence

Emotional Intelligence (EI) is a skill that enables one to identify moods, impulses, and behaviors in order to manage them in a positive way. This seven-week course will focus on the four core competencies of emotional intelligence – self-awareness, self-management, social awareness, and relationship management – in order to teach learners how to manage stress, demonstrate empathy to others, and communicate effectively while leading and making impactful change to organizations and teams.

Learning Objectives

After successful completion of this course, students will be able to:

- Identify the benefits of emotional intelligence
- Outline the four core competencies needed to practice emotional intelligence
- Articulate, interpret, and manage emotions – especially uncertainty, anxiety, and stress
- Demonstrate coping and relaxation techniques to regulate and gain emotional control
- Balance optimism and pessimism
- Effectively impact others in professional and personal environments

Credits: 3
Class Type: Graduate Course
GENL 411: Human Nutrition: Macronutrients and Micronutrients
This course covers macronutrients (carbohydrates, lipids, and proteins) and micronutrients (vitamins, minerals, trace elements, accessory nutrients and various phytochemicals) from a mind/body perspective. Nutrients will be addressed in terms of ingestion, digestion, absorption, transportation, metabolism, and storage. Consideration will be also given to nutrient building blocks as well as psychological and physical reasons for and health effects of insufficiency, excess, supplementation, and interaction.

Learning Objectives

• Assess an individual's diet and modify behavior, choice, and intake to optimize health outcomes
• Discuss structure, physiological roles, digestion, absorption, and metabolism of macronutrients
• Describe absorption, bioavailability, metabolism, food sources, dietary requirements, excess, and toxicities of micronutrients
• Explain factors contributing to increased need for B vitamins, vitamin C, fat-soluble vitamins, and major minerals
• Evaluate clinical symptoms of vitamin and mineral deficiencies and toxicity

Credits: 3
Class Type: Graduate Course

GENL 510: Empathetic Communication in Clinical Care
This course is ideal for anyone interested in developing and strengthening their empathetic practice during patient interaction. This course will focus on trust building as a foundational tenet of quality care, and self-awareness/self-monitoring as a means to convey empathy and compassion when communicating in a healthcare landscape.

Credits: 3
Class Type: Graduate Course

GENL 521: Morality and Ethics in a Pandemic World I
Philosophical approaches to ethics and morality involve longstanding questions of value. What is good, what is right, and how can we determine these goods or right actions? Does ethics involve doing the right thing, having the right intent, or being the right sort of person? In each of these cases, how do we determine what exactly is the right action, state of mind, or the best way of life? Do we use reason or emotions or a combination of the two? Can we make these determinations in general, or are such decisions relative to the individual? And finally, how do ethical concerns bear on our relationships with our selves, other individuals, and members of a larger society? A pandemic is a disease occurring over a wide geographic area and affecting an exceptionally high proportion of the population. Today headlines usually include the following pandemics: Covid-19, systemic and institutionalized racism, economic inequality, nationalism and religious extremism. By examining the writings of several key thinkers in the history of philosophy, we will explore different ethical theories in the context of our pandemic world.

Credits: 2
Class Type: Graduate Course
GENL 522: Morality and Ethics in a Pandemic World II
Philosophical approaches to ethics and morality involve longstanding questions of value. What is good, what is right, and how can we determine these goods or right actions? Does ethics involve doing the right thing, having the right intent, or being the right sort of person? In each of these cases, how do we determine what exactly is the right action, state of mind, or the best way of life? Do we use reason or emotions or a combination of the two? Can we make these determinations in general, or are such decisions relative to the individual? And finally, how do ethical concerns bear on our relationships with our selves, other individuals, and members of a larger society? A pandemic is a disease occurring over a wide geographic area and affecting an exceptionally high proportion of the population. Today headlines usually include the following pandemics: Covid-19, systemic and institutionalized racism, economic inequality, nationalism and religious extremism. By examining the writings of several key thinkers in the history of philosophy, we will explore different ethical theories in the context of our pandemic world.

Credits: 2
Class Type: Graduate Course
Prerequisites:
GENL 521
The above course(s) or permission from the instructor.

GRAD 500: Writing and Publishing a Scientific Paper
This four-session, non-credit writing-intensive online workshop is designed for all scientists who plan to publish results of their work in scientific journals. Participants will write a draft of a research paper based on data generated from their current or previous study for publication in a peer-reviewed science journal. This workshop focuses on the organization of a scientific research paper, with an emphasis on the two most difficult sections to write, Introduction and Discussion. It will also cover designing tables and figures and writing a clear and concise abstract and cover letter for submission to a science journal. In addition, participants will learn about the publication process from a journal editor's perspective, along with how to choose the right journal for their paper as well as how to navigate peer review.

Learning Objectives

- Write a rough draft of a scientific paper, focusing on the two hardest sections to write—the introduction and the discussion
- Understand the publishing process, including why manuscripts get accepted/rejected
- Discuss construction of figures and tables
- Writing exercises include the all-important abstract and a cover letter for submission of your manuscript to a journal

Class Type: Workshop
SPAN 208: Spanish for Healthcare Providers
This course is designed to help health providers to improve verbal communication skills with Spanish-speaking patients. It will help health professionals to build competence in interviewing, examining, and treating patients. It includes conversation and role-play situations in the context of different common medical situations. Students will learn the names of body parts, action verbs, and useful phrases typically used in a medical setting. Spanish concepts and correct pronunciation will be also covered.

This is the first part of a two-part course. Registration is required separately for each part of the course.

Learning Objectives

- Learn to greet and get accurate detailed personal information from patients
- Discuss parts and relationships of body organs, muscles, etc.
- Understand and use vocabulary describing pain and discomfort
- Communicate about basic ailments and illness
- Pronounce Spanish medical vocabulary and develop Spanish phrases that can be used in own role/workplace

Credits: 2
Class Type: Graduate Course
Prerequisites: SPAN 101
The above course(s), basic knowledge of Spanish, or permission from the instructor.

Availability Spring 2022
Session Session B

Public Health and Public Policy

PBHL 317: Introduction to Epidemiology I
The objective of this course is to provide an introduction to the principles and methods of epidemiology, defined as the study of the distribution and determinants of disease in populations. Lectures, problem sets, and outside reading will cover ecologic, case-control, cohort, and experimental studies. Topics to be discussed will include study design, measures of disease risk, sources of bias, methods of controlling for extraneous factors, principles of screening, and interpretation of data. Illustrations will include classic and contemporary examples in acute and chronic disease.

This is the first part of a two-part course. Registration is required separately for each part of the course.

Learning Objectives

- Calculate measures of disease risk and association
- Summarize steps involved in investigation of an infectious disease outbreak
- Describe and compare epidemiologic study designs
- Define bias and confounding
- Evaluate critically epidemiology studies as presented in journal articles and the popular press

Credits: 2
Class Type: Graduate Course
Prerequisites:
STAT 201
STAT 500
STAT 502
STAT 200 or STAT 500 or equivalent.
PBHL 318: Introduction to Epidemiology II
The objective of this course is to provide an introduction to the principles and methods of epidemiology, defined as the study of the distribution and determinants of disease in populations. Lectures, problem sets, and outside reading will cover ecologic, case-control, cohort, and experimental studies. Topics to be discussed will include study design, measures of disease risk, sources of bias, methods of controlling for extraneous factors, principles of screening, and interpretation of data. Illustrations will include classic and contemporary examples in acute and chronic disease.

This is the second part of a two-part course. The completion of the first part (PBHL 317) is required before taking the second part. Registration is required separately for each part of the course.

Learning Objectives

- Calculate measures of disease risk and association
- Summarize steps involved in investigation of an infectious disease outbreak
- Describe and compare epidemiologic study designs
- Define bias and confounding
- Evaluate critically confounding studies as presented in journal articles and the popular press

Credits: 2
Class Type: Graduate Course
Prerequisites:
PBHL 317
The above course(s) or permission from the instructor.

PBHL 402: Social Determinants of Health
The purpose of this course is to provide an introduction to the social factors that impact individual and population health. The course presents students with theories and evidence supporting multiple underlying determinants of health in populations. We consider how health is affected by a variety of determinants, and we will explore how social influences affect population health. Social influences include socioeconomic status, environment, policy, gender, race, sexual orientation, and neighborhood quality. We examine structural factors that impact population health in the United States, and we explore the potential for structural interventions to address health inequities and improve population health outcomes.

Learning Objectives

Students will be encouraged to consider how they can make a difference in reducing or closing the health inequality gap that otherwise results from poor understandings of patients’ health ecologies. Through a range of case studies, students will gain a better understanding of health inequalities and social determinants of health. Students will be able to articulate their potential to have a positive impact on the health of the populations they treat.

- Describe the types of social determinants of health and how each can impact health outcomes;
- Explore the relationship between social determinants of health and health disparities;
- Identify social determinants of health when working with people and communities; and
- Describe how individuals, health systems, and communities can address social determinants of health to improve outcomes and health equity.

Credits: 3
Class Type: Graduate Course
PBHL 450: Global Health and Infectious Diseases
This course will provide an overview of topics that are important for the understanding of global health from an infectious disease perspective. Students will be exposed to subjects ranging from the biological characteristics that increase the chance of a pathogen causing a pandemic, the basics of epidemiology of infectious disease transmission, One Health and the environment, public health preparedness, scientific communication before and during a pandemic, and international policy and response. Historic examples, scientific literature, and current news will be used to illustrate these topics. Students will have the opportunity to explore these aspects of infectious diseases in depth throughout the course through the development of a multi-part term paper on a selected infectious disease.
Credits: 2
Class Type: Graduate Course

PBHL 455: Global Health and Non-Communicable Diseases
Global health has traditionally focused on communicable, or infectious, diseases. However, 71% of all deaths globally can be attributed to non-communicable diseases, such as cardiovascular diseases, cancers, and diabetes. Eighty percent of all cardiovascular deaths occur in low- and middle-income countries. The burden of non-communicable diseases is also unequally distributed within high-income countries. This course aims to provide an overview of the epidemiology, etiology, and interventions for non-communicable diseases among the world’s disadvantaged populations. We will not only focus on populations in low-resource settings but also on ethnic minority groups and migrant populations living in high-income countries, such as the US and Europe. Students will learn to use data to debunk misconceptions in global health, to examine social, environmental, lifestyle, and genetic causes of non-communicable diseases in diverse populations, and to evaluate and critique interventions.

Learning Objectives

- Describe global disparities in the burden of non-communicable diseases and their determinants.
- Use publicly available data and tools to quantify the burden of non-communicable diseases in low- and middle-income countries and in ethnic minority groups.
- Examine the scientific literature on the social, environmental, lifestyle, and genetic determinants of non-communicable diseases.
- Evaluate and criticize health systems and interventions aimed at reducing the burden of non-communicable diseases in disadvantaged populations.

Credits: 2
Class Type: Graduate Course
Availability: Spring 2022
Session: Session B
**PBHL 500: Introduction to Global Health**

Global Health is described as “an area for study, research and practice that places a priority on improving health and achieving equity in health for all people worldwide” (Koplan J, 2009. Lancet. 373:1993). During the course, a broad snapshot of global health will be presented, providing students with insight into the challenges currently facing global health. Students will also gain an understanding of why tackling global health issues is such an important endeavor with the potential to reduce poverty, build stronger economies, and promote peace. Students will not only be exposed to the major communicable and non-communicable diseases posing a profound effect on health (especially within the developing world), but will also learn how socioeconomic and demographic differences can influence the burden of disease. A number of other critical underlying factors, including environmental, behavioral, and cultural influences, will be also presented. Through the use of case reports from around the world, the course will explore how research findings are transferred into policy and practice. Students will be encouraged to understand that solving global-health problems requires the input of multiple disciplines. To emphasize this point, speakers will be drawn from diverse fields, including the sciences, ethics, economics, and diplomacy. An interactive group exercise will be part of the course.

**Learning Objectives**

- Demonstrate a thorough understanding of the transitions and socioeconomic determinants of population health across the globe through a comparative analysis of the etiology and prevalence of communicable and non-communicable diseases and trauma/injury conditions
- Describe in detail two or more variables that interact to influence the health status of a population, including environmental, behavioral, and cultural effects
- Articulate the importance and necessity of multidisciplinary teams to solve global health problems

**Credits:** 2  
**Class Type:** Graduate Course

---

**PBHL 501: Environmental Health Sciences**

Environmental health is the branch of public health that deals with the human health effects of exposure to chemical, physical, biological, and psychosocial agents in the community, workplace, and at home. Environmental health as a discipline includes the fields of medicine and epidemiology as well as ecology and environmental policy. Environmental health scientists focus on recognizing, studying, and mitigating the impacts of chemical, physical, and biological agents as well as on understanding how human behavior and actions (and inactions) impact the environment. The field of environmental health is multidisciplinary and relies on team-science approaches. The course surveys the essential scientific components and control strategies of major environmental health problems.

**Learning Objectives**

- Understand residential, occupational, and other environmental agents and exposures that can affect human health
- Understand methodologies and approaches for assessing, preventing, controlling, and communicating environmental risks
- Understand subpopulations, such as children and pregnant women, and environmental justice and equity
- Understand informatics approaches for responding to and monitoring environmental health-related disasters and other events
- Understand resources for keeping up with environmental health issues, research, legislation, and regulations

**Credits:** 3  
**Class Type:** Graduate Course
PBHL 510: Alcohol Across the Lifespan
This course will serve as an introduction to alcohol and its effects across the lifespan, with emphasis on examining how alcohol use and the risk for alcohol-related problems change over a person’s lifespan. This course is taught at the graduate level and is designed to help students understand the importance of preventing, diagnosing, and treating alcohol misuse and alcohol use disorders. It is also designed to help students understand how various stages of development have different risks for problematic drinking behaviors, while the lifespan-development approach will give students a framework from which to work. Topics will include: epidemiology of alcohol use; neurobiology of addiction; genetics of alcohol, fetal alcohol spectrum disorders; binge drinking; health consequences of drinking (including liver disease and various cancers); prevention of alcohol use disorders; treatment of alcohol use disorder (AUD); and, medications management. Lectures will include discussions of the latest alcohol research findings and evidence-based practices, with ample time allowed for questions and answers at the end.

Learning Objectives

- Gain an understanding of the prevalence of alcohol use and misuse, including alcohol use disorder in the U.S. and its harmful costs to society
- Understand alcohol and the health problems it can cause across the lifespan, from the developing fetus to older adults
- Learn about current research and evidence-based practices for the prevention and treatment of alcohol misuse and alcohol use disorders
- Examine the disease of addiction, including effects of alcohol on both the developing and the developed brain, and how the brain changes in addicted individuals
- Discuss how alcohol affects special populations, in particular in the context of diversity issues, health disparities, and women

Credits: 2
Class Type: Graduate Course
Prerequisites:
understanding of basic epidemiology, such as incidence and prevalence, will be helpful, but not required.

PBHL 512: Social and Behavioral Sciences
The social and behavioral sciences in public health address the behavioral, social, and cultural factors related to individual and population health and health disparities over the course of life. Research and practice in this area contributes to the development, administration, and evaluation of programs and policies in public health and health services to promote and sustain healthy environments and healthy lives for individuals and populations.

Learning Objectives

- Identify the causes of social and behavioral factors that affect health of individuals and populations
- Identify critical stakeholders for the planning, implementation, and evaluation of public health programs, policies, and interventions
- Describe the role of social and community factors in both the onset and solution of public health problems
- Discuss merits of social and behavioral science interventions and policies
- Apply evidence-based approaches in the development and evaluation of social and behavioral science interventions

Credits: 3
Class Type: Graduate Course
PBHL 516: Health Policy and Administration I
This course provides an analysis of the current organizational arrangements and patterns for provision and financing of medical care services in the U.S. Specifically, topics would include: the medical care process, policies, and factors which affect need, access, and use of services; factors affecting supply and distribution of health professionals and health facilities; current issues pertinent to these healthcare services; factors related to healthcare costs; quality assessment and assurance; and, financing of care through health insurance and governmental programs. Additionally, the course covers the various components of the U.S. healthcare system over the entire continuum of care. Attention will be given to private and public financing mechanisms, the forces of market competition, government regulation, and the impact of health policy on key stakeholders.

Learning Objectives
- Describe main components, issues, legal, and ethical bases of organization, financing, and delivery of health services and public health systems in the U.S.
- Describe and analyze current issues of health policy, quality, and legislation
- Discuss policy process for improving the health status of populations
- Identify and apply principles of program planning, development, budgeting, management, and evaluation in organizational and community initiatives

Sample syllabus is subject to change.

Credits: 2
Class Type: Graduate Course

PBHL 517: Health Policy and Administration II
This course provides an analysis of the current organizational arrangements and patterns for provision and financing of medical care services in the U.S. Specifically, topics would include: the medical care process, policies, and factors which affect need, access, and use of services; factors affecting supply and distribution of health professionals and health facilities; current issues pertinent to these healthcare services; factors related to healthcare costs; quality assessment and assurance; and, financing of care through health insurance and governmental programs. Additionally, the course covers the various components of the U.S. healthcare system over the entire continuum of care. Attention will be given to private and public financing mechanisms, the forces of market competition, government regulation, and the impact of health policy on key stakeholders.

Learning Objectives
- Describe main components, issues, legal, and ethical bases of organization, financing, and delivery of health services and public health systems in the U.S.
- Describe and analyze current issues of health policy, quality, and legislation
- Discuss policy process for improving the health status of populations
- Identify and apply principles of program planning, development, budgeting, management, and evaluation in organizational and community initiatives

Credits: 2
Class Type: Graduate Course
Prerequisites:
PBHL 516
The above course(s) or permission from the instructor.
PBHL 518: Introduction to Program Evaluation I

Government agencies and private organizations have implemented multiple health programs. Usually, labor and resources are spent developing and implementing these programs. But, how do we know if public needs are being addressed? How can we tell if it works? If it does work, how well does it work? If it does not work, what is the reason for it? Can it be fixed? The answers to these questions are at the heart of program evaluation. This has led to program evaluation rapidly gaining visibility and prominence as an objective basis for program and policy decision making. This course will introduce students to program evaluation approaches and methodological tools that can be used to evaluate public health programs and research.

Learning Objectives

• Explain major concepts, approaches, and key elements of program evaluation, and how to apply these to public health practice and research
• Identify standards for conducting good program evaluations (i.e., utility, feasibility, propriety, and accuracy)
• Describe five aspects of health program evaluation—its relevance, progress, efficiency, effectiveness, and impact
• Identify evaluation-design techniques, and how these compare to methods used in traditional research
• Design a basic program evaluation plan that includes measurable program objectives, evaluation questions, logic model, timeline, evaluation measures, budget, and a plan to enhance utilization of findings

Credits: 2
Class Type: Graduate Course

PBHL 519: Introduction to Program Evaluation II

Government agencies and private organizations have implemented multiple health programs. Usually, labor and resources are spent developing and implementing these programs. But, how do we know if public needs are being addressed? How can we tell if it works? If it does work, how well does it work? If it does not work, what is the reason for it? Can it be fixed? The answers to these questions are at the heart of program evaluation. This has led to program evaluation rapidly gaining visibility and prominence as an objective basis for program and policy decision making. This course will introduce students to program evaluation approaches and methodological tools that can be used to evaluate public health programs and research.

Learning Objectives

• Explain major concepts, approaches, and key elements of program evaluation, and how to apply these to public health practice and research
• Identify standards for conducting good program evaluations (i.e., utility, feasibility, propriety, and accuracy)
• Describe five aspects of health program evaluation—its relevance, progress, efficiency, effectiveness, and impact
• Identify evaluation-design techniques, and how these compare to methods used in traditional research
• Design a basic program evaluation plan that includes measurable program objectives, evaluation questions, logic model, timeline, evaluation measures, budget, and a plan to enhance utilization of findings

Credits: 2
Class Type: Graduate Course
Prerequisites:
PBHL 518
The above course(s) or permission from the instructor.
PBHL 521: Cancer Screening
Cancer screening aims to detect the disease at a stage when it is asymptomatic and curable. This course will introduce students to the theory and practice of cancer screening in the United States. Students will learn to draw conclusions about the benefits and harms of screening for cancer, given available evidence from epidemiologic studies and clinical trials. Issues surrounding screening for breast, colorectal, lung, cervical, and prostate cancer will be covered; other cancers will be covered if time permits. Class sessions will include lectures as well as student-led discussions.

Learning Objectives
- Learn about the methodology used to assess cancer-screening tests and how to interpret cancer-screening data
- Identify potential benefits and harms of cancer screening
- Become familiar with the evidence in favor of and against population-based screening for breast, colorectal, lung, cervical, and prostate cancer as well as with the controversies that surround mass screening for these diseases

Credits: 1
Class Type: Graduate Course
Prerequisites: Previous undergraduate or graduate coursework in public health or permission of the instructor.

PBHL 525: Current Public Policy Topics in Science and Medicine
The policy-making process plays a key role in the sciences and medicine. Initiatives proposed by advocacy groups and decisions made by legislators can influence research funding, disease prevention, healthcare delivery, patient engagement, professional regulations, and workforce infrastructure. This seminar-format course will provide an opportunity to examine current issues drawn from public health, workforce development, healthcare innovation, clinical practice, and biomedical research. Oral presentations and brief written exercises will allow students to further refine their skills in communication, research, analysis, and critical thinking.

Learning Objectives
- Discuss key contemporary public policy issues in public health, biomedical research, clinical medicine, and related areas
- Refine communication, research, analytical, and critical thinking skills that may be applied in policy-related positions with the federal government, non-profit organizations, and the private sector

Credits: 2
Class Type: Graduate Course
Prerequisites: PBHLS17, PBHLS27, or previous graduate-level coursework on health policy administration and/or management recommended.
PBHL 527: Healthcare Management I
This course provides an overview of concepts and issues related to healthcare leadership through competency-based learning. Through the examination of management topics and healthcare situations, students explore the skills and knowledge needed to be successful in a diverse healthcare environment. Topics include: healthcare leadership; organizational design as it relates to the uniqueness of healthcare organizations; managing professionals; and, diversity in the workplace. Day-to-day operational management of healthcare organizations, including hospitals, private practice, ambulatory settings, and specialty services, with a focus on issues influencing the administration of today's healthcare organizations will be also evaluated. Specifically, attention will be given to those issues that affect the delivery of care, and how decisions are made and can evolve into the development of new initiatives.

Learning Objectives

- Describe and identify organizational structure of the healthcare delivery systems and administrative processes
- Identify theoretical models of healthcare organizations and structures
- Describe and discuss functional areas of healthcare management
- Assess organizational performance through successful leadership and cultural strategic models

Credits: 2
Class Type: Graduate Course

PBHL 528: Healthcare Management II
This course provides an overview of concepts and issues related to healthcare leadership through competency-based learning. Through the examination of management topics and healthcare situations, students explore the skills and knowledge needed to be successful in a diverse healthcare environment. Topics include: healthcare leadership; organizational design as it relates to the uniqueness of healthcare organizations; managing professionals; and, diversity in the workplace. Day-to-day operational management of healthcare organizations, including hospitals, private practice, ambulatory settings, and specialty services, with a focus on issues influencing the administration of today's healthcare organizations will be also evaluated. Specifically, attention will be given to those issues that affect the delivery of care, and how decisions are made and can evolve into the development of new initiatives.

Learning Objectives

- Describe and identify organizational structure of the healthcare delivery systems and administrative processes
- Identify theoretical models of healthcare organizations and structures
- Describe and discuss functional areas of healthcare management
- Assess organizational performance through successful leadership and cultural strategic models

Credits: 2
Class Type: Graduate Course
PBHL 537: Health Policy Analysis Using SAS and STATA

Each year, the federal government makes considerable amounts of population health data available to researchers. In this course, students will gain theoretical and practical knowledge of databases that are frequently used to support population health, health policy and health services research, including the NHANES, NHIS, NEDS, and MEPS. Understanding and selection of research designs and statistical methods will be reinforced through the review of select manuscripts from the population health, health policy, and health services literature. Didactic material and problem sets will enable students to use SAS and STATA for preparing datasets, creating customized variables, and conducting common statistical analyses. Further, students will build and reinforce skills in research question development, project design, data management, statistical analyses, technical writing, and data presentation through a course-long research project.

Learning Objectives

- Identify a question or problem in population health, health policy, or health services that can be addressed through an analysis of existing datasets, such as the NHANES, NHIS, MEPS, or NEDS.
- Distinguish among different types of study designs and methods used in population health, policy, and health services research in regard to applications, methods, and utility.
- Develop a brief plan that outlines research objectives, datasets and pertinent variables that will be needed, and specific analyses to be conducted.
- Write SAS and/or STATA code to conduct data management activities and statistical analyses.
- Develop written reports, oral presentations, and visual mechanisms for conveying research to various professional and lay audiences.

Credits: 3
Class Type: Graduate Course
Prerequisites:
Access to SAS (student version is satisfactory) or STATA required; undergraduate or graduate course in statistics or comparable experience required; graduate course or comparable experience in policy analysis required.

PBHL 540: Qualitative Data in Policy and Program Evaluation

Evaluators are expected to be proficient in the use of both qualitative and quantitative research methods; however, many persons assigned evaluation tasks have no formal training in designing, collecting, analyzing, and reporting qualitative data. Commonly used qualitative methods in program and policy analysis include document reviews, individual and group interviews, and observations. In this introductory course, we will review the collection, analysis, and reporting of qualitative data used in the evaluation of public health policies and programs.

Learning Objectives

Students will improve and enhance their skills in the following activities: • Critical appraisal of published evaluation and research articles about public health policies and programs that include qualitative methods; • Design of evaluations to include qualitative methods, including data collection instruments; • Content analysis of qualitative data; • Presentation and reporting of analysis of qualitative data.

Credits: 2
Class Type: Graduate Course
Prerequisites:
Formal training or on the job training in evaluation and an introductory course or experience in statistics will be helpful.
**PBHL 544: Logic Models for Planning, Performance Measurement, and Evaluation**

Logic models are a tool that support designing, planning, changing, monitoring, and evaluating programs. These evidence-based models can be an aid in multiple contexts ranging from basic research programs to community-based initiatives. An added benefit of modeling is that it can enhance stakeholders understanding of the relationship between resources, actions, outcomes, and impacts and thereby aid decision making. In this course, we will discuss how to build and use a logic model for biomedical research and public health programs.

**Learning Objectives**

Students will improve and enhance their skills in the following activities:
- Understanding program logic models (operational) versus theory of change models (conceptual)
- Identifying the components of a logic model that lead to understanding your program
- Using a logic model for planning, monitoring, and evaluating programs, initiatives, and projects
- Developing a logic model and preparing a narrative that promotes a shared understanding of the program

**Credits:** 2  
**Class Type:** Graduate Course  
**Prerequisites:**  
Formal training or on the job training in program planning, analysis, and evaluation will be helpful.

---

**PBHL 580: Evaluating Economic Outcomes of Health Research**

The evaluation of research, particularly biomedical research, has entered a period of intense demand for rigorous methods and actionable results, including economic analyses. Several years ago, the NIH convened an expert external panel to consider the broad area of assessing the value of biomedical research. The panel put forward an overarching assessment and measurement framework that included healthcare costs as an output and healthcare-related costs savings as an outcome. Challenges and opportunities exist in meeting this demand. Two distinct perspectives are important: one is the perspective of a grantee or principal investigator who uses economic variables to establish the need and predicted outcomes for basic or applied research for specific observed health conditions, as well as the efficiency and costs of the research; the other perspective is that of the science policy in which the grantor has the need to establish research priorities and evaluate research program efficiency and costs. In this introductory class, students will learn the foundations of health economics and econometric modeling and will apply them to the evaluation of biomedical research and public health programs.

**Learning Objectives**

- Develop economic perspectives of health and healthcare
- Distinguish among different types of cost studies in regard to applications, methods, and utility
- Explore regression analysis as a major econometric tool
- Develop a working knowledge of the evaluation hierarchy
- Apply knowledge gained to economic evaluation of publicly funded research and health programs

**Credits:** 2  
**Class Type:** Graduate Course
PBHL 591: Advanced Seminar in the Evaluation of Research

The public funding of research includes many discrete components: setting research priorities; securing funds; funding research infrastructure; selecting and funding meritorious projects; conducting research; monitoring research progress; communicating research findings; and, training researchers. This survey course is designed to review theories, methods, and practices in program and policy evaluation as they relate to research, particularly publicly funded biomedical research. The full range of the evaluation hierarchy (needs assessment and program planning, feasibility and implementation evaluation, process evaluation, and outcome and impact evaluation) will be considered as students will be guided to develop a comprehensive framework for the evaluation of federally funded biomedical research.

Learning Objectives

- Apply methods for systematic reviews of literature to a specific body of knowledge
- Employ methods of data synthesis to develop a comprehensive framework for the evaluation of research
- Explore the application and utility of the framework in their workplaces

Credits: 3
Class Type: Graduate Course
Prerequisites:
Graduate-level coursework in program or policy evaluation or considerable work experience in program or policy evaluation.

PPOL 071: The Role of the White House, Congress, Federal Agencies, and Judiciary in Science & Technology Policy

Whether you’re a scientist, engineer, or health professional interested in a career in science and technology policy or a researcher who’s interested in improving how they describe the potential societal implications of their research, you need better understanding of science and technology policy. You also need to understand the key principles involved in evaluating programs, analyzing potential public policies that might respond to societal implications, and then communicating your results to policymakers and the public.

Learning Objectives

In this “learn by doing” class, students will enhance their understanding of:

- What encompasses science & technology (S&T) policy
- The role of the White House, Congress, and Judiciary in S&T policy
- The role of international government and U.S. states & cities in S&T policy
- The role of scientists, engineers, and health professionals in public policy.
- The analytical and communication techniques that support scientific, engineering, and health-focused communications with policymakers.
- An overview of careers in S&T policy.

Class Type: Workshop
PPOL 072: Public Policy Analysis for Scientists, Engineers, and Health Professionals: A Systematic Process for Analyzing and Developing Policy Options to Respond to Societal Challenges

Policy analysis provides a systematic process to analyze public policy options to respond to a societal challenge such as COVID-19, climate change, and homelessness. It involves identifying the underlying problem, key decision makers, stakeholders, policy question, and policy options. These options are then analyzed to identify which is likely to be the most effective, efficient, equitable, and ease of political acceptability. Once that analysis is concluded, the analyst makes a recommendation based on those criteria. The analyst then communicates the results to policymakers and the public.

Learning Objectives

In this “learn by doing” class, students will enhance their understanding:

- What policy analysis is and why it is important
- The eight-step process to do a public policy analysis based on the 4Es (effectiveness, efficiency, equity, and ease of political acceptability)
- An overview of ways to communicate that message through 1-pagers, op-eds, presentations, videos, and infographics.

Class Type: Workshop

PPOL 073: Public Policy Analytical Methods for Scientists, Engineers, and Health Professionals: Understanding and Evaluating Benefit-Cost, Cost-Effectiveness, and Risk Analysis

Benefit-cost analysis, cost-effectiveness analysis, and risk analysis are quantitative techniques used to support the assessment of effectiveness, efficiency and equity in the policy analysis process. More than any other analytical technique they are critical in policymaker decision-making as benefit-cost is required by executive orders or regulations and risk-based regulations and enforcement activities -- particularly those related to the environment, health, worker safety, transportation, privacy/security, and energy policy.

Learning Objectives

In this “learn by doing” class, students will enhance their understanding of:

- What are benefit-cost analysis (BCA), cost-effectiveness analysis (CEA), and risk analysis (RA) and why are they important to program evaluation and policy analysis
- The steps and methods used to conduct BCA, CEA, and RA, including sources of information, and sensitivity analysis.
- Communicating the results of BCA, CEA, and RA, and how this related to policymaker decisions.
- Understanding the difference between a good and poor BCA, CEA, and RA

Class Type: Workshop
PPOL 074: Program Evaluation for Scientists, Engineers, and Health Professionals

While policy analysis focuses on the future, program evaluation looks at the past performance of a program to see if it has met its societal goals, how it can be improved, and whether funding for that program should be continued.

Whatever the source of funding for your program, you'll likely be asked to evaluate it on a regular basis. And when developing a proposal for funding, one common element requested is how you will evaluate the program to determine if it is successful in achieving the proposed outcomes.

And when doing a policy analysis, your first step is to understand the "status quo." That is, what is the current program and how well does it work according to the 4E's: effectiveness, efficiency, equity, and ease of political acceptability. Based on this information, you can develop policy options to respond to what does not work well in the current program while maintaining those elements that do work well relative to the desired societal outcome.

Learning Objectives

In this “learn by doing” class, students will enhance their understanding of:

- What program evaluation is and why it is important
- Program evaluation framework (e.g., stakeholder participation)
- Methods for evaluating programs (e.g., population-based vs. program-based)
- Program evaluation standards
- Development of a program evaluation plan
- Understanding the difference between a good and poor program evaluation

Class Type: Workshop

PPOL 101: Introduction to National Security in Science and Medicine

Science and medicine are often thought of as life-saving, life-changing, and pillars of which we measure progress. However, we must always keep in mind the darker implications of tomorrow's scientific advancements. In this course you will learn to have a more holistic view of science and medicine by studying these topics through a national security lens. Students will have the opportunity to further their knowledge in the sciences while also learning new skills found in the national security field. Some of the subjects covered include chemical and biological weapons, industrial espionage, and climate change, all presented within a national security theme.

Learning Objectives

- Assess red-team analysis techniques and their value to the scientific community.
- Design a briefing where they critically think about the effects industrial espionage in the sciences has on national security.
- Recognize the steps necessary to produce an analytical product on the threat of climate change, relative to a country's national security.

Credits: 1

Class Type: Graduate Course

Availability May 2022

Session Intersession
PPOL 102: Introduction to National Security in Health

When it comes to national security, America must be prepared for more than just acts of terrorism, climate change, nuclear proliferation, and the other hot button issues. America’s public health and the health of global citizens is also a pressing concern. In this course, you will learn to have a more holistic view of the health industry by viewing it through a national security lens. Not only will you further your knowledge on health topics but you will gain new skills while working through these issues as a national security analyst. Some of the subjects covered include communicable diseases, the transnational nature of health issues, drug/alcohol abuse, inadequate access to health services, and more; all presented with a national security theme.

Learning Objectives

- Assess structured analytical techniques used by the intelligence community and their value to the health field
- Consider the effect public health has on U.S. national security
- Design an intelligence product that analyzes a current global health crisis
- Deliberate on possible solutions to the growing problems facing U.S. public health today

Credits: 1
Class Type: Graduate Course

STAT 011: Conducting a Systematic Review and Meta-Analysis in Biomedical Research

We live in times of evidence-based medicine, where we use the best evidence available to make decisions about patient care and healthcare interventions at population level. But what is the best evidence available? Usually a research question is studied more than once, often by independent research teams in different locations. In many instances, the results of these multiple small studies are diverse and conflicting, making it difficult to draw a conclusion regarding the answer to the question under study. That’s where systematic reviews come in. Systematic reviews integrate and synthesize the results of several independent studies on a given research question in order to provide a summary of the literature that can inform practice. Moreover, systematic reviews may reveal heterogeneity in results, leading to new research hypotheses about sources of such heterogeneity. Systematic reviews can be qualitative or quantitative. Meta-analysis, top-ranking in the hierarchy of evidence, is a statistical procedure that in some cases can be applied to a quantitative systematic review.

Learning Objectives

In this hands-on two-day online workshop, we will take participants through all the steps of conducting a systematic review and meta-analysis on a biomedical topic, including developing a research questions, defining inclusion and exclusion criteria, developing a protocol, designing a systematic search, critically appraising studies, screening studies, extracting data, performing a meta-analysis, and synthesizing the evidence both qualitatively and quantitatively. Specifically, after completion of this workshop, the participant will be able to:

- Describe the utility of a systematic review and meta-analysis.
- Apply the essential steps for conducting a systematic review.
- Design and conduct a meta-analysis.
- Critically appraise published systematic reviews and meta-analyses.

Class Type: Workshop
MGMT 499: Personal Leadership Development

Developing effective leadership capabilities is critical to the success of individuals at all levels of an organization. This course is designed to grow students’ understanding and knowledge of their own leadership skills and potential. Students will learn about the traits, qualities, and styles of effective leaders. They will evaluate and define their own leadership and gain insights on effective communication as leaders. The course also provides students with experiential learning on how personal leadership development influences their capacity to (1) lead and work in teams, (2) drive change in organizations, and (3) embody leadership as a way of being in the world.

Learning Objectives

When you complete the course successfully, you will be able to:

- Demonstrate knowledge of different leadership traits, qualities, and styles;
- Evaluate and define your own leadership traits, qualities, and styles;
- Practice effective communication as a leader in teams and organizations;
- Engage in effective leadership in guiding teams and leading change;
- Reflect on your leadership and develop your own leadership credo;
- Apply the knowledge and skills from this course to your own work and life.

Credits: 2
Class Type: Graduate Course

Prerequisites: There are no prerequisites for this course.

Availability Spring 2022
Session Session B

TECH 071: Project Management Essentials

According to the latest edition of A Guide to the Project Management Body of Knowledge, project management is the application of knowledge, skills, tools, and techniques to a broad range of activities in order to meet the requirements of the particular project. These results are defined in terms of four factors: cost; schedule; performance; and scope. Cost is the budget allocated to the project; schedule is the timeline for the project’s deliverables; scope is the magnitude of the job and, performance captures how well the team members do their work. This workshop provides a comprehensive introduction to the essential aspects of project management for scientists. The workshop will draw on relevant case studies, and prepare participants to apply learning gained from the workshop in their organizations.

Credits: 0
Class Type: Workshop

TECH 073: Advanced Project Management Essentials

In the knowledge economy, we create value using projects and project teams. Advanced Project Management Fundamentals is the second in the series of workshops developed for the Foundation for Advanced Education in the Sciences (FAES). This class builds on the foundational knowledge from the Project Management Essentials workshop. In Essentials, students learn how to plan and execute a project. In this workshop, they discover how to structure and organize the project for success. Best practices for managing programs and portfolios and advanced Agile are also part of the curriculum.

Class Type: Workshop
Prerequisites: TECH 071
TECH 328: Regulatory Perspective on Drug Development
This course focuses on the responsibilities of the federal agency throughout the drug development process and understanding the processes and regulations surrounding drug and biologic approvals that guide how regulatory decisions are made. Course content will include lectures, weekly readings (including journal publications, articles, and regulatory documents). Assignments will include weekly discussion posts, midterm paper, final presentation, and final case study.

Specific topics covered will include: Animal Studies, In Vitro Studies, Good Laboratory Practice (GLP), Good Clinical Practice (GCP), current Good Manufacturing Practices (cGMP), Chemistry, Manufacturing and Controls (CMC), Pharmacology/Toxicology, Clinical Trials, Statistics, Ethics, Inspections, and Labeling.

Note: This course is NOT meant to cover anything outside of the scope of what the FDA Regulates. This course is focused on drug and biologic regulation, not device regulation.

Learning Objectives
Upon successful completion of this course, students will be able to:

• Recognize the FDA drug development process, the laws and regulations that govern it in the United States.
• Identify the role of the regulatory affairs professional and other team members in the drug development process within industry and government settings.
• Address real-world drug development challenges through case studies.
• Understand the policies and procedures available to speed drug approvals for certain types of medical products.
• Demonstrate excellent communication skills through writing assignments related to ongoing course discussions.

Credits: 2
Class Type: Graduate Course
Prerequisites:
College-level biological sciences.
Availability: Spring 2022
Session: Session B

TECH 490: Communication in Biomedical Sciences
This course introduces the relevant skills needed for effective oral and written scientific communication in the diverse settings encountered within biomedical vocations. Students will interpret and critically review scientific information, practice oral presentations for defined audiences, and construct effective arguments to inform and/or influence listeners.

Students will have an opportunity to leverage communication models and learning theories within their practice in order to strengthen their speech and authorship qualities. In this course, special emphasis is placed on field-specific activities performed by biomedical professionals, such as communicating with the public or scientifically untrained audiences and ensuring understanding.

Learning Objectives
After successful completion of this course, students:

• Will understand the elements that are important for communicating effectively to mixed audiences in written and oral formats;
• Will have developed relevant knowledge regarding communication studies theoretical underpinnings pertinent to scientific communication; and
• Will be able to write persuasive, engaging, and effective scientific information.

Credits: 3
Class Type: Graduate Course
TECH 491: Market Assessment for Innovative Technologies in Biomedical Sciences

The course provides an introduction to the financial and business aspects of valuation in biomedical sciences. We use practical presentations and case study methods to give students hands-on valuation experience. Assigning a value to an innovative technology or a valuation to a technology company in biomedical sciences can be seen as challenging, given their novelty. This course helps students identify the assumptions and factors required to establish value. We then develop a framework to help prioritize which factors affect that value the most. Students will learn how to assign current and future worth to a technology, a product, or a company, based on the market potential, market need, and competition. Students will work on projects involving evaluation of a therapeutic, a diagnostic, and/or a life sciences tool/instrument. This course provides the framework for making judgments and valuations, including: Market analysis and market research processes to form assumptions and define elements that contribute to a technology's or a company's value; Market sizing techniques; How to assess a biotech company for financing rounds and M&A; How to consider future value of a product when assessing the value of the intellectual property today; Net present value models in Excel; Assigning value to a management team's expertise and track record; Types of risks (discounting); Excel models for defining market sizes and valuation (NPV). This class is interactive, and students work in groups to allow interactive learning.

Learning Objectives

Students will learn:

- The basic factors involved in assessing a technology, market or company
- Which concepts, tools and techniques are useful for assessing a market and valuation
- How to assess a company prior to the valuation
- How to value an idea, platform, technology, or company
- How to calculate value of a technology students may currently be working on
- Understanding the key components of a therapeutic product valuation, and which are the key value drivers
- Understanding investors’ objectives in considering a biomedical company/product

Sample syllabus is subject to change.

Credits: 2
Class Type: Graduate Course

TECH 495: The FDA: Science, Health Policy, and Regulation in an Uncertain Environment

The FDA is a science-based regulatory agency whose mission is to protect and promote the public health. It exists at the interface of science, law, and policy—and some would say, increasingly, politics. This course explores the complex scientific and policy issues the FDA must address in regulatory decisions that affect all Americans and cover products that account for approximately one-fifth of the American economy. It reviews some of the major forces that have shaped the FDA, surveys the broad range of FDA’s regulatory mandate, explores the FDA’s role as gatekeeper for emerging medical technologies, and examines the current state of the agency in a rapidly changing environment.

Learning Objectives

- Understand the FDA’s mission, how that mission has evolved, and how science informs the FDA’s policy and product decisions
- Explore potential career paths at the FDA and in industries that produce FDA-regulated products
- Appreciate the importance of effectively communicating FDA’s decisions on a multitude of complex scientific, medical, and public health matters
- Identify the various forces and interests that confront the FDA, and evaluate their potential impact on the agency in an uncertain and evolving political environment

Credits: 2
Class Type: Graduate Course
TECH 498: Leadership Strategies in Biomedical Sciences I
This course focuses on learning to manage and lead people who report to you, across team, and your supervisor. You will learn through scenarios, case studies, and experiential learning, how what you say and do directly impacts outcomes. The roles of managers and leaders in biomedical science companies undergo constant change. This course includes in-depth discussions of leadership skills, communication, conflict resolution, and goal integration. You will have the opportunity to manage and lead your own team to a desired outcome, analyze what works and does not work within the management systems, and suggest alternatives.

Learning Objectives
Sample syllabus is subject to change.

Credits: 2
Class Type: Graduate Course

TECH 499: Personal Leadership Development
Developing effective leadership capabilities is critical to the success of individuals at all levels of an organization. This course is designed to grow students' understanding and knowledge of their own leadership skills and potential. Students will learn about the traits, qualities, and styles of effective leaders. They will evaluate and define their own leadership and gain insights on effective communication as leaders. The course also provides students with experiential learning on how personal leadership development influences their capacity to (1) lead and work in teams, (2) drive change in organizations, and (3) embody leadership as a way of being in the world.

Learning Objectives
When you complete the course successfully, you will be able to:

- Demonstrate knowledge of different leadership traits, qualities, and styles;
- Evaluate and define your own leadership traits, qualities, and styles;
- Practice effective communication as a leader in teams and organizations;
- Engage in effective leadership in guiding teams and leading change;
- Reflect on your leadership and develop your own leadership credo;
- Apply the knowledge and skills from this course to your own work and life.

Credits: 2
Class Type: Graduate Course
Prerequisites:
There are no prerequisites for this course.
Availability Spring 2022
Session Session B
TECH 508: Regulatory Affairs and FDA Regulation

The FDA regulates, to differing extents, drugs, biologics, medical devices, foods, cosmetics, and tobacco. The Federal Food, Drug & Cosmetic Act (FD&C Act) gives FDA authority to regulate these products. Students will gain familiarity with FDA’s regulatory authority under the FD&C Act. The course will begin with an overview of the United States Government and Administrative Law. Then, it will provide an overview of drug, biologic, and medical device approval processes. It will also cover how FDA regulates food, dietary supplements, cosmetics, and tobacco. Students will learn how FDA enforces its regulations. Individual and/or group projects may be assigned.

Learning Objectives

- Become familiar with the U.S. legal system and FDA’s administrative regulatory authority
- Learn about FDA’s regulatory oversight over drugs, biologics, medical devices, foods, cosmetics, and tobacco
- Gain an understanding of current FDA news

Credits: 2
Class Type: Graduate Course

TECH 513: Introduction to Technology Transfer — Issues and Processes

This introductory survey course is designed for both scientists as well as new or future technology transfer professionals. This course will be a hands-on experience and employ a "workshop" approach for internalizing the concepts presented. Specific topics will include: the history, legislation, and public policy that drive federal technology transfer (i.e., life before and after codification of the Bayh-Dole Act); the role of Technology Transfer Offices both in the Federal Government and in Universities; the major types of intellectual property; patents and patentability; the patent application process (i.e., reading patents and drafting claims); freedom to operate; patent litigation; infringement and invalidity; licensing of inventions; collaborative research; and, transactional agreements. Special emphasis will be placed on understanding and drafting the foundational documents of technology transfer. These documents include Non-Disclosure Agreements ("NDAs"); Material Transfer Agreements ("MTAs"); Data Transfer Agreements ("DUA s"); Licensing Agreements; and Collaborative Research and Development Agreements ("CRADAs").

Learning Objectives

- Develop a basic understanding of technology transfer and its role in the biological sciences
- Comprehend the basis and subsequent interaction of technology transfer in the overall developmental process of moving new discoveries to the marketplace
- Gain a greater appreciation of career options in technology transfer
Develop a basic understanding of technology transfer with a bias towards technology transfer in the biological sciences. Comprehend the basis and subsequent interaction of technology transfer in the overall developmental process of moving new discoveries to the marketplace. Understand the fundamental documents used in the technology transfer process.


**TECH 514: Technology Transfer: Transitions, Processes, and Players**

Course Description: This course targets scientists and others interested in learning how research discoveries are brought to market and transformed into commercial products and the issues encountered along the pathway of moving from invention to innovation. Students will gain insight from professionals in a variety of institutions with substantial experience and expertise in the field. This course provides a unique opportunity for students to comprehend the processes and issues in technology transactions and to prepare for careers in technology transfer.

Learning Objectives

When you successfully complete the Learning Activities, you will be able to:

- Explain TT and its role in transitioning technology towards commercialization.
- Analyze the basic steps and interactions for moving technology into the marketplace.
- Summarize and compare the motivations of the different stakeholders involved in technology transfer.
- Evaluate and assess potential career opportunities in technology transfer.

**TECH 521: Tools For Technology Transfer Managers — Handling Intellectual Property, Collaborations, and Agreements**

Designed for technology transfer specialists new to the field or scientists and other individuals wanting to learn the nuts and bolts of technology transfer activities, this course will delve into the day-to-day tools utilized by professionals in the field. The course will begin with setting the context with an introduction to intellectual property law and, then, will turn to a focused review of the various types of agreements relating to collaborations, exchanges of materials, license agreements, and clinical trials, along with the potential issues or problems they are designed to address. Finally, the field of technology transfer will be put into a broader context, with a look at its relationship to contracts, grants, and other forms of government/non-government interactions, in addition to customer-service techniques and negotiation tactics.

Learning Objectives

- Develop a working understanding of basic intellectual property law
- Comprehend the broad regulatory and business framework for technology transfer
- Assess the different tools available for transferring technology, with a focus on federal labs
TECH 525: Legal and Ethical Issues in Public Health and Biomedical Sciences
This course offers an overview of legal issues affecting biotechnology and other science-based industries and frames basic philosophical and ethical considerations regarding genetic data and manipulation. The course includes a discussion of intellectual property issue.

Learning Objectives

- Discuss ethical issues, the basis and influence of moral theories on resolving bioethical issues
- Survey the legal, medical, and scientific aspects of current bioethical issues
- Learn about the U.S. patent process and the interdependency of marketplace and laws which regulate it
- Explain how the principles of property and ownership relating to intellectual property and biological materials impact the development of new therapies and diagnostics
- Understand the impact of biotechnology on healthcare and the medical community

Credits: 3
Class Type: Graduate Course

TECH 528: Preclinical Evaluation of Novel Drugs and Beyond
This course will discuss in detail various aspects of nonclinical evaluation of novel drugs. Students will gain an understanding of animal studies submitted to support the safety of clinical studies and marketing application. Specific nonclinical study design, interpretation, and risk assessment for general toxicity, genotoxicity, reproductive toxicity, immunotoxicity, local toxicity, and carcinogenicity will be discussed in detail. Nonclinical studies that address alternate routes of administration, such as inhalation or intravaginal application, will be explored. Further, students will explore how the pharmaceutical industry uses nonclinical studies to prioritize and make business decisions, including in-licensing, academic/professional partnering, and entering the international market. Students will also investigate how nonclinical studies can be used to address the new paradigm of pharmacy compounding and after-market safety evaluations. By the end of the class, students will have the opportunity to discuss case studies, analyze nonclinical studies of various drugs, and make decisions based on the interpretation of these studies.

Learning Objectives

- Review the history and fundamentals of pharmacology/toxicology and challenges faced by these disciplines in the drug-approval process
- Discuss how non-clinical study results are interpreted, and how the pharmacology/toxicology discipline assesses hazard identification that affects advice provided regarding safety and efficacy in human clinical trials and for drug approval
- Explain the nonclinical study requirements and types of data reviewed by the pharmacology/toxicology Center for Drug Evaluation and Research (CDER) reviewer discipline
- Discuss how the pharmaceutical industry uses nonclinical studies to make business decisions, including partnering with academic and contract-research organizations, in-licensing, and moving to international markets
- Explore post-marketing safety of drugs via epidemiology, and how nonclinical studies can be used to address after-market safety concerns as well as pharmacy compounding

Credits: 2
Class Type: Graduate Course
**Prerequisites:**
college-level biology.

**TECH 540: Introduction to Life Sciences Licensing Basics: Beyond Technology Transfer**
Licensing life science products has become a critical avenue for many established life science companies to fill their pipeline needs for new products. This course is designed to provide functional knowledge of the elements, tools and processes of licensing deals for a variety of life science products. Students will gain an understanding of the “buy” and “sell” side of licensing deals from non-confidential disclosure meetings through financial term sheet considerations. We will also examine the various types of licenses such as business to business, academic to business, as well as the variations of licensing constructs which are most common and “in vogue”. Finally, students will share in analysis of case studies throughout the course and a team project (buy and sell side) as a final project. All designed to enhance students career skills in licensing with immediate applicability. This course is designed for Life Sciences professionals in Tech Transfer, entry level licensing professionals, scientists and professionals engaging in Business Development/Licensing activities.

**Learning Objectives**
- Develop a working knowledge of the elements, tools and processes of life science licensing deals
- Analyze existing life-science licenses to understand current standards & benchmarks
- Perform term sheet design for a license of a “real-world” life science product

**Credits:** 2  
**Class Type:** Graduate Course

**TECH 565: Biomedical Business Development for Scientists**
This course will take a practical, hands-on approach to business plan development, venture capital, and technology transactions. Using current examples from the active technology portfolio of the NIH Office of Technology Transfer or an example of their own choosing, students will learn and participate in reviewing a scientific innovation and determining whether the discovery makes a realistic business proposal. The course will look at the history of venture-capital and its relation to science and technology. The course will emphasize technology-transfer issues (particularly from the NIH standpoint) related to real-world technology partnerships and venture capital investments. Issues related to legal considerations, including due diligence and licensing issues, will be also highlighted.

**Learning Objectives**
- Develop an appreciation of the role of venture capital and other investors in the development of new biomedical technologies
- Understand and be able to complete the essential elements of a business plan
- Communicate effectively, orally and in writing, to potential investors the commercial advantages of a new technology

Sample syllabus is subject to change.

**Credits:** 2  
**Class Type:** Graduate Course  
**Prerequisites:**  
Basic or advanced knowledge of science; no business credits required.
TECH 566: Building a Biotech Company: Business Leadership and Management Strategies
This course will take a practical, hands-on approach to studying the strategy and dynamics necessary for the growth of a biotechnology company from a basic research effort located in a research institution to a fully financed, stand-alone business operation prepared to place finished products in the life science marketplace and to generate a financial return for investors. Through a different panel of expert speakers each week—with specific experience in the week’s topic—the discussion will build on the previous weeks’ topics to arrive at a finished construct of a fully operational biotechnology company. There will be an emphasis on interactive discussions between class members and panelists. Panel members will offer first-hand observations, insights, and personal anecdotes concerning their experiences in building different aspects of a life-science company. Discussions will include critical-thinking and management decisions during times of technology challenge, financial adversity, and growth.

Learning Objectives

- Develop a working understanding of the structure and management of biomedical business firms
- Comprehend the critical thinking needed for management decisions during times of financial hardship and growth
- Be able to effectively interact with biotech stakeholders to discuss issues relating to finance, R&D, marketing, manufacturing, and human resources

Credits: 2
Class Type: Graduate Course
Prerequisites: basic or advanced knowledge of science; TECH 565 is helpful, but not required.
Availability: Spring 2022
Session: Session B

TECH 567: International Strategic Partnering and Business Development
This course will assess the growing global marketplace for innovative biomedical products and research, particularly in developing countries, with a focus on business plans, market development, venture capital, technology transactions, and relevant international partnerships. Using current examples from the technology portfolio of NIH and other organizations, students will review scientific innovations and determine whether a particular discovery constitutes a realistic business proposal from an international perspective.

Learning Objectives

- Understand the growing marketplace for innovative biomedical products and research, particularly as they relate to developing countries
- Examine approaches taken by different institutions, including the NIH, and new institutional frameworks such as PDPs
- Assess sources of funding in relation to innovation and the development of biomedical products

Sample syllabus is subject to change.

Credits: 2
Class Type: Graduate Course
Prerequisites: basic or advanced knowledge of science; no business credits required.
TECH 572: Marketing Strategies for Scientific Organizations
This course explores the role of marketing in science-based organizations that seek to reach their goals in technology development, product development, public health impact, or other societal needs. The course will start with a clarification of what constitutes marketing by providing the students with the basic concepts, terminology, and practices of marketing. Next, the course will focus on the role of marketing in a research or scientific organization and the specific issues related to marketing technologies. Using a case-study approach, students will be provided with examples of conducting market analyses in the biomedical area. Students will use real-world examples of technologies to create an effective marketing strategy, with details of administering specific marketing programs. Additional topics will include startup marketing, socially responsible marketing, and marketing technologies in international markets, specifically in developing countries.

Learning Objectives
- Develop expertise in branding products and companies
- Use market research tools to develop strategies for real technologies
- Interact with guest lecturers to learn how people get to be marketers
- Understand the basics of marketing: Product, Price, Promotion, and Place

Credits: 2
Class Type: Graduate Course

TECH 575: Accounting and IP Valuation for Non-Accountants
Finance and accounting are the language of business, yet this language is not well understood by people in non-profit or scientific research institutions who work with for-profit companies. This course will give an overview of how companies keep score, and how outsiders can understand the financial health of internal activities. The course will make extensive use of financial statements (Annual and Quarterly Reports) from well-known companies and use these reports to introduce principles of financial accounting. These principles will be tied to an understanding of: (1) how an individual can assess the financial stability and capabilities of a partner; (2) how financial issues can impact potential collaborations and deals with companies; (3) how financial issues directly impact agreements in which students may participate. The class will also look at the operation of financial markets, and how the reported financial issues of a company interact with the broader financial markets. Students will make extensive use of publicly available financial information that may be found online. The class will have periodic assignments that will provide an opportunity for students to present their analyses in class.

Learning Objectives
- Develop basic understanding of accounting principles and financial statements as they apply to biotech and other life-science companies
- Utilize transactions as the basis for building balance sheets, income statement, and other financial statements
- Analyze the performance of public biotech and life science companies using standard financial tools

Credits: 2
Class Type: Graduate Course
Prerequisites:
Experience with or interest in collaborations or agreements with for-profit organizations.
TECH 582: Intellectual Property and Patent Prosecution for Scientists

This course will provide a general review of the intellectual property (IP) ecosystem and a comprehensive analysis of the patenting process from a business perspective. IP is a currency that connects the global community, and this course explores how patents and other intellectual property spur innovation, new product development, and business growth. The course will also explore how one values and uses a protected technology, covering issues such as the place of technology in the research and development pipeline, and the effects of regulatory compliance. Using an historical approach to account for social, economic, and technological changes, students will gain greater knowledge of the history of the patent system, the evolution of U.S. patent law, the process of obtaining, defending, and attacking patents.

Learning Objectives

- Distinguish between patents, trademarks and service marks, copyrights, and trade secrets.
- Compare four primary types of Intellectual Property in supporting business development.
- Draft the essential parts of a basic patent application based upon the application of core principles of U.S. patent law and practice.
- Compare U.S. and international patenting processes in the context of movement toward global harmonization.
- Identify common career positions in the intellectual property field.
- Apply technical/legal terms in intellectual property related written and oral communications.

Credits: 2
Class Type: Graduate Course

TECH 583: Patent Research for Scientists and Engineers

A significant amount of scientific information is available in a patent that is not available in any other publication. Therefore, in every stage of research, knowledge of patent data is essential to developing a clear understanding of the state-of-the-art. Designed for scientists, engineers, and researchers, this course teaches students where to find patent data, how they are organized, and what strategies are required to conduct high-quality patent research. An overview of leading patent databases is provided, while students will also receive training and free access to a number of top-tier subscription-based databases for the semester. Databases required for biology and chemistry research are also covered. Students will be exposed to the basic legal framework underlying patent research required at key points of the innovation lifecycle along with strategies for developing state-of-the-art reviews, patentability and invalidity assessments, freedom to operate analysis, and competitive intelligence through patent analytics.

Learning Objectives

- Gain the know-how to develop the search strategy required to make informed research decisions and the ability to select the best resources to conduct patent research in diverse technology areas.
- Understand what information is found in patents, and how patent research is leveraged to inform research-related decisions throughout the innovation lifecycle.
- Develop an understanding of the basic strategies and legal requirements for common patent research goals required in research.

Sample syllabus is subject to change.

Credits: 2
Class Type: Graduate Course
TECH 584: Translational Medical Product Development
To be competitive in industry, scientists must understand the intricate process of translating basic research into innovative, market-driven products. Further, these scientists must be able to navigate the complex pathways of intellectual property management and regulatory affairs of agencies such as the FDA. This course will provide life-sciences students with the skills to integrate industry-relevant training and experience with basic science education. This course will explore the licensing, marketing, and regulatory processes through which a bioscience product is developed and brought to commercialization.

Learning Objectives

- Acquire knowledge and tools of different aspects of medical product development
- Understand strategic considerations of medical product development

Credits: 2
Class Type: Graduate Course

TECH 586: International Health Science, Technology, and Innovation
This course provides a comprehensive overview of policy and programmatic issues related to the support of research & development (R&D) and innovation internationally. It addresses U.S. domestic as well as international issues and is concerned with governmental and non-governmental policies related to scientific innovation and making medicines, devices, and other technologies affordable and accessible to Low- and Middle-Income countries in a sustainable way. The course also includes discussion of how R&D-based innovation is now seen as crucial to advancing public health and economic growth and development as well as societal well-being. This course will examine public policy and programs and the role of the U.S. Government, national governments abroad, foundations, universities, industries and international organizations in the R&D health-innovation policy system. Additionally, this course will prepare students who are either currently in the field of or are planning careers in global health, international R&D, and scientific innovation to get involved in policymaking and/or national and international program management.

Learning Objectives

- Discuss the importance of R&D and its impact on science, technology, and health systems internationally
- Understand the NIH model for enhancing public health, R&D, and technology transfer process
- Discuss case studies related to public health and technology transfer applicable to different countries
- Share global health R&D activities and programs at NIH, other U.S. government agencies, international organizations, and institutions in different countries

Credits: 2
Class Type: Graduate Course
TECH 588: FDA Regulatory Strategy in Medical Product Development
This course offers an overview of the historical development of food and drug laws and regulations as they apply to drugs, biologics, and medical devices, including radiological products, with an introduction to marketing clearance and approval processes, regulations covering import, export, current good manufacturing practices, labeling, reclassification, establishment registration, and medical device listing.

Learning Objectives

- Gain an understanding of the history and development of food and drug laws and regulations as applied to drugs, biologics, and medical devices
- Get introduced to processes, regulations, manufacturing practices, reporting, listing, inspection involved in medical device and product development

Credits: 2
Class Type: Graduate Course

TECH 607: Capstone Course in Technology Transfer
Students will utilize the information and experience gained in the other technology transfer courses, along with scientific training, to complete a project of their design and choice at the NIH or in their regional community. This course is customarily taken after a student has completed at least six previous courses in technology transfer and has accumulated a strong academic record. As part of the course, students will be identifying a research topic and a mentor who is familiar with their prospective inquiry and who is willing to provide guidance and oversee the project. Assistance is available to students in selecting a topic and locating a mentor. The research project must be independent of current work-related responsibilities, as determined by the project mentor. The mentor may be from the NIH, the local business community, a supervisor from the student’s place of work, or any expert with appropriate credentials. Students are required to submit a formal proposal for review and approval by the course instructors. Student projects can include internships, but such are not specifically required. Students must meet with the course instructors periodically to discuss the project’s progress. A written document, poster presentation, or similar outcome, must be completed and approved by the course instructors and project mentor in order for the student to receive credit.

Learning Objectives

- Identify an area related to technology transfer or technology development that is of strong interest to the student and merits further exploration and independent study
- Complete the project for a client or mentor that will focus on a practical experience outcome
- Utilize the project and practical experience obtained as part of a career-development or transition strategy for future employment

Credits: 2
Class Type: Graduate Course
Availability Spring 2022
Session Session A and B
Akacem, Lameese, Ph.D., University of Colorado Boulder, AAAS Science & Technology Policy Fellow, Office of Policy, Communications and Education, National Center for Advancing Translational Sciences, National Institutes of Health.

Andreev, Ilya, B.S., University of Virginia; Postbaccalaureate Fellow, Systems Biology and Genome Engineering Section, Genetic Disease Research Branch, National Human Genome Research Institute, National Institutes of Health.

Avram, Alexandru, Ph.D., Duke University; Research Fellow, Section on Quantitative Imaging and Tissue Sciences, National Institute of Biomedical Imaging and Bioengineering, National Institutes of Health.

Bachorik, Lawrence, Ph.D., McGill University, Canada; Assistant Commissioner for Communications, Office of the Commissioner, Food and Drug Administration (retired).

Bandres Ciga, Sara, Pharm.D., Ph.D., University of Granada, Spain; Postdoctoral Research Fellow, Laboratory of Neurogenetics, National Institute on Aging, National Institutes of Health.

Babenek, Ilona, Ph.D., University of California, Los Angeles; Toxicologist, Division of Antiviral Products, Office of Antimicrobial Products, Food and Drug Administration.

Bofill-De Ros, Xavier, Ph.D., Universitat de Barcelona, Spain; Postdoctoral Fellow, RNA Biology Laboratory, National Cancer Institute, National Institutes of Health.

Boso, Guney, Ph.D., University of Minnesota, Research Fellow, National Institutes of Allergy and Infectious Diseases, National Institutes of Health.

Bowes, Debra K., M.B.E.E., Johns Hopkins University, Serial Biotech Industry Executive, Licensing/BD & strategic specialist.

Caceres, Maria Esther, M.A., B.A., Communication Sciences, San Antonio Abad University of Cusco, Peru; Community Affairs Director and Radio Host, CBS Radio, TuFamiliaZol, Washington D.C.; Spanish teacher, International School of Languages, Bethesda, MD.

Cartier, Pierre, D.M.D., University of Kentucky, M.P.H., The George Washington University; Lead Dentist, Arlington Free Clinic Dental Medicine Department.

Chang, E. Sally, Ph.D., University of Kansas. Postdoctoral Fellow in Bioinformatics and Evolutionary Genomics, Computational and Statistical Genomics Branch, National Human Genome Research Institute, National Institutes of Health.

Chen, Qingyu, Ph.D., The University of Melbourne, Australia; Postdoctoral Fellow, National Library of Medicine, National Institutes of Health.

Cummings, Patrick J., M.S., Sc.D., University of Pittsburgh Graduate School of Public Health; Director, Center for Biotechnology Education (Retired), School of Arts and Sciences, Johns Hopkins University.

Dasgupta, Abhijit, Ph.D., University of Washington, Seattle; Director and Chief Data Scientist, ARAASTAT.

Dubinion, John Ph.D., University of Pittsburgh; Pharmacologist, Division of Antiviral Products, Food and Drug Administration.

Dunham, Michael, B.A., Gallaudet University; Adjunct Professor, Department of Special Education, University of Maryland, College Park. Hearing and Speech Agency, ASL instructor. Greenbelt Community Center, ASL instructor.

Epstein, Benjamin, Ph.D., University of California, Berkeley; Postdoctoral Fellow, Genetic Disease Research Branch, National Human Genome Research Institute, National Institutes of Health.

Erby, Lori, Ph.D., The Johns Hopkins University; Acting Program Director, Genetic Counseling Program, Social and Behavioral Research Branch, National Human Genome Research Institute. National Institutes of Health. Adjunct Assistant Professor, The Johns Hopkins University, Bloomberg School of Public Health.

Fabryova, Helena, Ph.D., Charles University in Prague, Czech Republic; Postdoctoral Fellow, Viral Biochemistry Section. National Institute of Allergy and Infectious Diseases, National Institutes of Health.

Faupel-Badger, Jessica, Ph.D., M.P.H., Mayo Clinic Graduate School of Biomedical Sciences;
Janet D. L. Fouts, Chief, Education Branch, National Center for Advancing Translational Sciences, National Institutes of Health.

Ferguson, Steven, M.B.A., The George Washington University; Special Advisor, Office of Technology Transfer, National Institutes of Health.

Gairhe, Salina, Ph.D., University of South Alabama; Research Fellow, Critical Care Medicine Department, Clinical Center, National Institutes of Health.

Grabowski, Jeff, Ph.D., Purdue University; Intramural Research Training Award (IRTA) Postdoctoral Fellow, Biology of Vector-Borne Viruses Section, Laboratory of Virology, Rocky Mountain Laboratories, National Institute of Allergy and Infectious Diseases, National Institutes of Health.

Greene, Amanda, Ph.D., University of Maryland; Program Evaluation Lead; NIH Common Fund, Office of the Director, National Institutes of Health.

Hamann, Sue, Ph.D., The Ohio State University; Science Evaluation Officer, Office of the Director, National Institute of Dental and Craniofacial Research, National Institutes of Health.

Harrington, Brittney, Ph.D., University of Queensland, Australia; Postdoctoral Fellow, Cellular Oncology Branch, National Cancer Institute, National Institutes of Health.

Hart, Suzanne, Ph.D., Virginia Commonwealth University; Associate Investigator, Director, Molecular Genetics Fellowship Program, National Human Genome Research Institute, National Institutes of Health.

Hawkins, James, M.B.A., George Mason University, Ph.D., Baylor College of Medicine; Managing Director, FOCUS Investment Banking, Washington, D.C.

Haynes, Brittany, Ph.D., Wayne State University School of Medicine; Scientific Program Specialist, Office of Policy, Communications, and Education, National Center for Advancing Translational Sciences, National Institutes of Health.

Heiman, Lee, J.D., Loyola University Chicago; Registered Patent Attorney, Chief IP and Licensing Counsel, Azos AI, LLC.

Helmold Hait, Sabrina, Ph.D., Federal University of Rio de Janeiro, Brazil; Postdoctoral Fellow, Immune Biology of Retroviral Infection Section, Center for Cancer Research, National Cancer Institute, National Institutes of Health.

Henkart, Pierre, Ph.D., Harvard University; Chief, Lymphocyte Cytotoxicity Section, Experimental Immunology Branch, National Cancer Institute, National Institutes of Health (retired).

Ho, Mitchell, Ph.D., The University of Illinois at Urbana-Champaign; Chief, Antibody Therapy Section, Laboratory of Molecular Biology, National Cancer Institute, National Institutes of Health.

Kesner, Andrew, Ph.D., The Johns Hopkins University; Postdoctoral Fellow, Section on Synaptic Pharmacology, National Institute on Alcohol Abuse and Alcoholism, National Institutes of Health.

Ko, Kyung Dae, Ph.D., Pennsylvania State University; Research Fellow, National Institute of Arthritis and Musculoskeletal and Skin Diseases, National Institutes of Health.

Kowalczyk, Amanda, Ph.D., University of Pittsburgh/Carnegie Mellon University; Postdoctoral Research Fellow, Neuroscience Institute, Carnegie Mellon University.

Kropp, Peter, Ph.D., Vanderbilt University; Postdoctoral Fellow, Laboratory of Biochemistry and Genetics, National Institute of Diabetes and Digestive and Kidney Diseases, National Institutes of Health.

Langer, Eric, M.S., American University; President and Managing Partner, BioPlan Associates, Inc.

Langer, Lynn Johnson, Ph.D., Antioch University, M.B.A. Johns Hopkins University; Executive Dean, Foundation for Advanced Education in the Sciences.

Lu, Yuan-Chiao, Ph.D., Virginia Tech; Scientist, Radiology and Imaging Sciences Department, Clinical Center, National Institutes of Health.

Maris, Melinda, Ph.D., Emory University; Assistant Dean, Education, Foundation for Advanced Education in the Sciences.
<table>
<thead>
<tr>
<th>Name</th>
<th>Institution and Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>Matthews, Michael, M.S., R.A.C.</td>
<td>University of Maryland University College; Senior Specialist, Regulatory Affairs, Emergent Biosolutions, Inc.</td>
</tr>
<tr>
<td>Meeks, Karlijn A.C., Ph.D.</td>
<td>University of Amsterdam, the Netherlands; Postdoctoral Fellow, Center for Research on Genomics and Global Health, National Human Genome Research Institute, National Institutes of Health.</td>
</tr>
<tr>
<td>Meitzler, Marguerite, B.A.</td>
<td>Founder and CEO, Science Writing.</td>
</tr>
<tr>
<td>Miessau, Matthew, M.S.</td>
<td>Georgetown University; Analyst, Epidarex Capital</td>
</tr>
<tr>
<td>Mimm, Nancy, R.N., M.S.N., D.N.P.</td>
<td>Rutgers University; Assistant Professor of Population Health Nursing, Harrisburg University of Science and Technology.</td>
</tr>
<tr>
<td>Muenke, Maximilian, M.D.</td>
<td>Free University of Berlin, Germany; Chief, Medical Genetics Branch, National Human Genome Research Institute, National Institutes of Health.</td>
</tr>
<tr>
<td>Mukoyama, Yosuke, Ph.D.</td>
<td>The University of Tokyo, Japan; Senior Investigator, Laboratory of Stem Cell and Neurovascular Biology, National Heart, Lung, and Blood Institute, National Institutes of Health.</td>
</tr>
<tr>
<td>Noguchi, Constance, Ph.D.</td>
<td>The George Washington University; Chief, Molecular Cell Biology Section, Molecular Medicine Branch, National Institute of Diabetes and Digestive and Kidney Diseases, National Institutes of Health.</td>
</tr>
<tr>
<td>Nordman, Jacob Ph.D.</td>
<td>George Mason University; Research Fellow, National Institute of Mental Health, National Institutes of Health.</td>
</tr>
<tr>
<td>Pessenda, Gabriela, Ph.D.</td>
<td>Sao Paulo University; Postdoctoral Fellow, Intracellular Parasite Biology Section, Laboratory of Parasitic Diseases, National Institute of Allergy and Infectious Diseases, National Institutes of Health.</td>
</tr>
<tr>
<td>Rana, Jessica, B.A.</td>
<td>Johns Hopkins University; Post-baccalaureate Fellow, Computationl Structural Biology Unit, National Institute of Neurological Disorders and Stroke, National Institutes of Health.</td>
</tr>
<tr>
<td>Ricotta, Emily, Ph.D., M.Sc.</td>
<td>University of Basel (Basel, Switzerland); Research Fellow, Epidemiology Unit, Laboratory of Clinical Immunology and Microbiology, Division of Intramural Research, National Institute of Allergy and Infectious Diseases, National Institutes of Health.</td>
</tr>
<tr>
<td>Romaine, Joan, M.P.H.</td>
<td>The George Washington University; Senior Public Health Advisor, Global Alcohol Research Program, National Institute on Alcohol Abuse and Alcoholism, National Institutes of Health.</td>
</tr>
<tr>
<td>Rosenberg, Yves, M.D.</td>
<td>University of Lyon, France; M.P.H., The Johns Hopkins University; Chief, Atherothrombosis and Coronary Artery Disease Branch, Division of Cardiovascular Sciences, National Heart, Lung, and Blood Institute, National Institutes of Health.</td>
</tr>
<tr>
<td>Ryan, Philip, Ph.D.</td>
<td>The George Washington University; Deputy Director, Graduate Programs and Student Services, NIH Graduate Partnerships Program, Office of Intramural Training and Education, Office of the Director, National Institutes of Health.</td>
</tr>
<tr>
<td>Shukla, Amita, M.B.A.</td>
<td>Stanford Graduate School of Business; B.A. (Biochemistry), Harvard University; Founder, Vitamita.</td>
</tr>
<tr>
<td>Sissung, Tristan, Ph.D.</td>
<td>The George Washington University, M.Sc., University of California, Riverside; Staff Scientist, Office of the Clinical Director, National Cancer Institute, National Institutes of Health.</td>
</tr>
<tr>
<td>Souto-Maior, Caetano, Ph.D., M.P.H.</td>
<td>Instituto Gulbenkian de Ciência, Portugal; IRTA Postdoctoral Fellow, Laboratory of Systems Genetics, National Heart, Lung, and Blood Institute, National Institutes of Health.</td>
</tr>
<tr>
<td>Sova, Thomas, J.D.</td>
<td>University of Baltimore School of Law; Intellectual Property Manager II, Frederick National Laboratory for Cancer Research.</td>
</tr>
<tr>
<td>Sturgill, David, Ph.D.</td>
<td>University of Maryland College Park; Staff Scientist, Laboratory of Receptor Biology and Gene Expression, National Cancer Institute, National Institutes of Health.</td>
</tr>
</tbody>
</table>
Tatusova, Tatiana, Ph.D., Moscow State University, Russia; Senior Scientist, National Center for Biotechnology Information, National Library of Medicine, National Institutes of Health.

Tetreault, Jesse, M.Sc., Clemson University; Solutions Architect, Deep Learning and Healthcare, NVIDIA Corporation.

VanHeusen, Margaret, M.B.A., Johns Hopkins University; ORISE Fellow at the FDA Center for Drug Evaluation and Research.

Varadharajan Suresh, Ragavan, Ph.D., New York Medical College, Post Doctoral Research Fellow, Malaria Immunology Section, Laboratory of Malaria and Vector Diseases, National Institute for Allergies and Infectious Diseases, National Institutes of Health.

Wai, Thanda, Ph.D., Michigan State University; Senior Technology License Monitoring and Enforcement Specialist, Office of Technology Transfer, National Institutes of Health.

Wang, Philip, Ph.D., University of Maryland, College Park; Director, NIH Graduate Partnerships Program, Office of Intramural Training and Education, Office of the Director, National Institutes of Health.

Warren, Kristen, Ph.D., Neuroscience, Northwestern University; Postdoctoral IRTA Fellow, Behavioral Neurology Unit, National Institute of Neurological Disorders and Stroke, National Institutes of Health.

Williams Avram, Sarah, Ph.D., University of North Carolina at Chapel Hill; Contractor, Office of the Director, National Institute of Mental Health, National Institutes of Health.

Wisniewski, David, Ph.D., University of Maryland, Baltimore; Postdoctoral Fellow, Women's Malignancies Branch, National Cancer Institute, National Institutes of Health.

Wood, Brandon, D.H.A., Central Michigan University; Commander, Unites States Public Health Service; Senior Program Management and Public Health Project Officer, Office of Southern Health Services, Health Resources and Services Administration.

Wrzesinski, Claudia, Ph.D., German Cancer Research Center, Germany, D.V.M., Ludwig Maximilian University of Munich, Germany; Pharmacologist, Office of Vaccines Research and Review, Food and Drug Administration.

Xiao, Tiaojiang, Ph.D., University of North Carolina at Chapel Hill; Staff Scientist, Laboratory of Molecular Biology, National Institute of Diabetes and Digestive and Kidney Diseases, National Institutes of Health.

Yun, Sijung, Ph.D., Boston University; Founder and CEO of Yotta Biomed, LLC.; Contractor, Developmental Biology Section, National Institute of Diabetes and Digestive and Kidney Diseases, National Institutes of Health.

Zarrella, Tiffany, Ph.D., Albany Medical College; Postdoctoral Fellow, Laboratory of Molecular Biology, National Cancer Institute, National Institutes of Health.