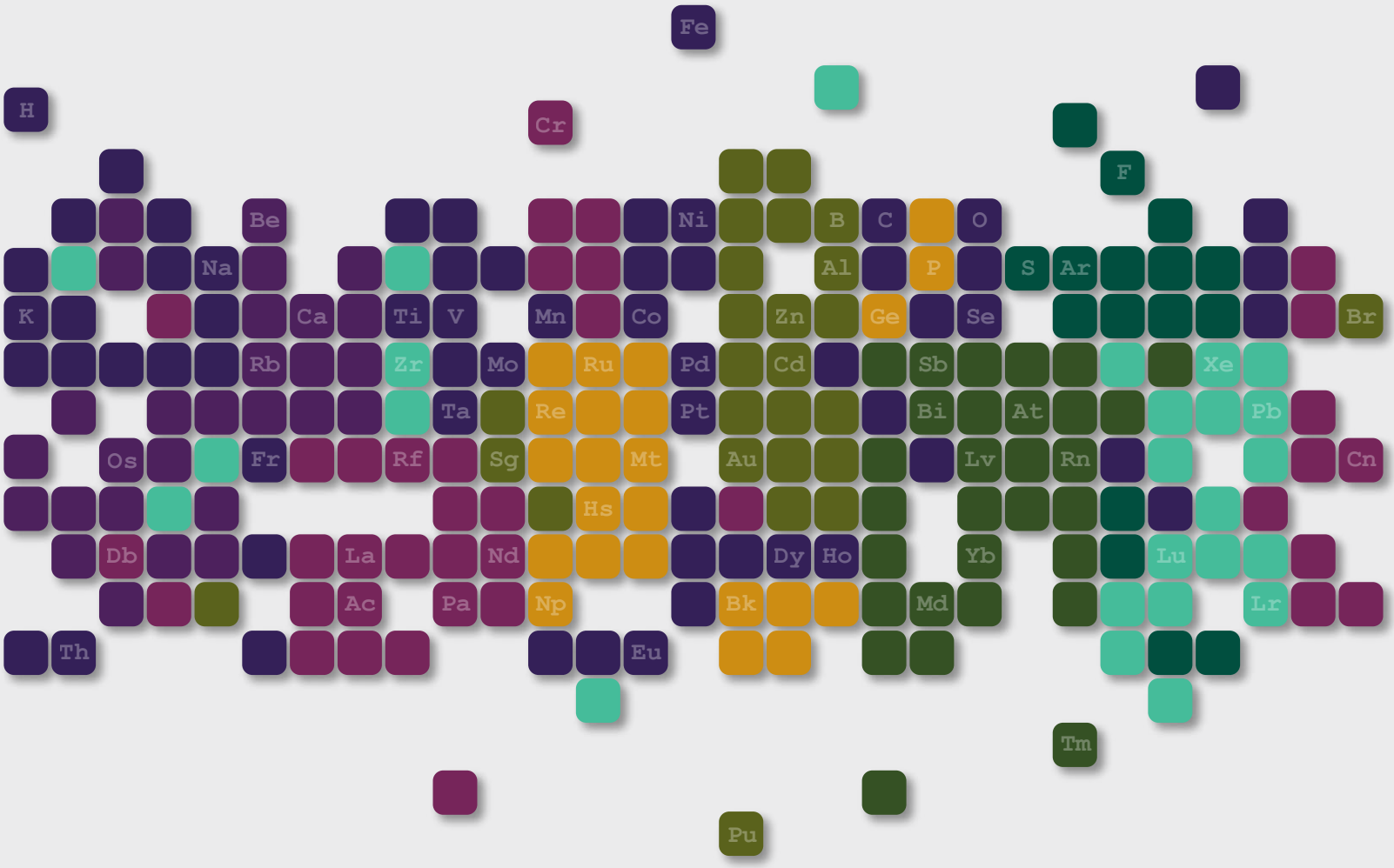
2017 2018 | CATALOG OF COURSES AND STUDENT HANDBOOK



FAES GRADUATE SCHOOL at NIH

FAES GRADUATE SCHOOL AT NIH

CALENDAR FOR 2017-2018

FALL 2017 SEMESTER SCHEDULE

July 10 – September 8	**Online Registration**
August 24	Open House
September 11	**Classes begin**
September 11 – September 29	Late Registration *($10.00 late registration fee per course applies)*
October 6	Last day to drop
November 10	Last day to change status *(credit or audit)*
December 15	**Classes end**

FALL TERM HOLIDAYS

October 9	Columbus Day – No classes
November 10	Veterans Day - No classes
November 23	Thanksgiving Day – No classes

SPRING 2018 SEMESTER SCHEDULE

November 13 – January 26	**Online Registration**
January 11	Open House
January 29	**Classes begin**
January 29 – February 16	Late Registration *($10.00 late registration fee per course applies)*
February 23	Last day to drop
March 30	Last day to change status *(credit or audit)*
May 11	**Classes end**

SPRING TERM HOLIDAY

February 19	Presidents' Day – No classes

MID-TERM START, HALF-SEMESTER OR SHORTER COURSES

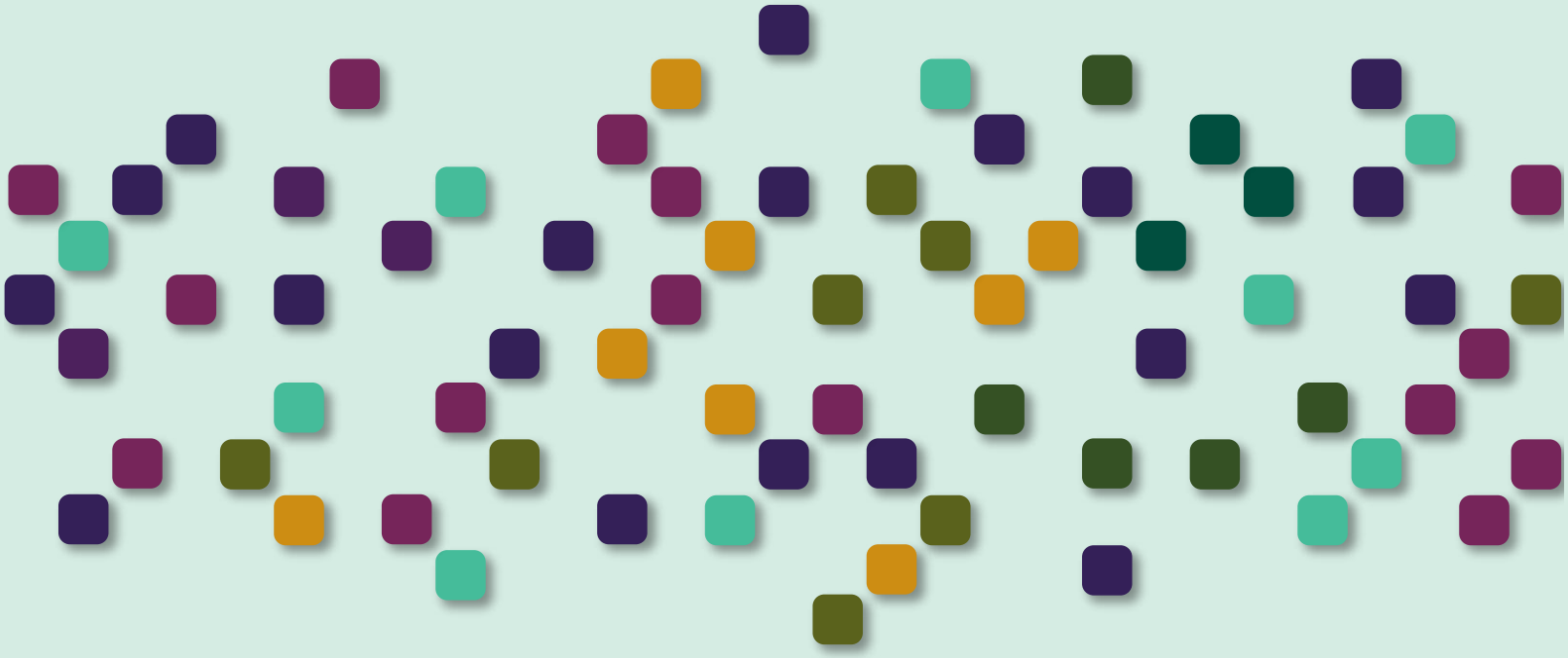
To find out about registration and drop deadlines for courses that run shorter than the full semester, please email us at **registrar@faes.org.** Generally, enrollments will be accepted until the first day of classes without a late registration fee.

IN ADDITION TO ONLINE REGISTRATION, THE GRADUATE SCHOOL ACCEPTS ENROLLMENT BY FAX, EMAIL OR IN PERSON.

FOUNDATION FOR ADVANCED EDUCATION IN THE SCIENCES

FAES GRADUATE
SCHOOL AT NIH

2017 2018 | CATALOG OF COURSES AND STUDENT HANDBOOK



Dean
Constance Tom Noguchi, Ph.D.

Director of Academic Programming
Krisztina Miner, Ph.D.

Registration Specialist
Lesley O' Malley, M.A.

Education Services/Web Resources Specialist
Anna Hajdu, M.Sc.

Location:
National Institutes of Health
10 Center Drive, Room 1N241
Bethesda, MD 20895-1115

Email: registrar@faes.org
Tel: 301-496-7976
Fax: 301-402-0174
www.faes.org

CONTENTS

WHAT'S NEW IN 2017-2018

FALL 2017

BIOL 225	Protein Quality Control in Health and Disease *(8 weeks)*
BIOF 339	Practical R
BIOF 501	Introduction to R: Step-by-Step Guide *(7 weeks)*
ENGL 355	English Listening and Conversation: Insights into U.S. Culture, Science, and Society *(10 weeks)*
GENE 220	Evolutionary Genetics and Genomics: From Charles Darwin to Integrated-Omics *(7 weeks)*
MATH 215	Introduction to Linear Algebra With Applications in Statistics
PBHL 425	Public Policy in Science and Medicine
PHYS 370	Single Molecule Biophysics: What Is It, and How Does It Work?
TECH 495	The FDA: Science, Health Policy, and Regulation in an Uncertain Environment

SPRING 2018

BIOF 395	Introduction to Text Mining
BIOL 342	Post-Translational Modifications of Proteins *(4 weeks)*
BIOL 385	The Biology of Aging
ENGL 355	English Listening and Conversation: Insights into U.S. Culture, Science, and Society *(10 weeks)*
MEDI510	Advances in Metastasis Research

REVIEW COURSES

FALL, SPRING	GENL 319	MCAT Review
FALL, SPRING	GENL 319 - PSY	Concepts in Psychology for MCAT Preparation *(7 weeks)*
FALL, SPRING	GENL 322	GRE Review *(7 weeks)*
FALL, SPRING	GENE 500	Introduction to Medical Genetics I and II
SPRING	GENE 514	Current Topics in Clinical Molecular Genetics and Molecular Diagnostics
FALL 2018-ALT	GENE 518	Medical Genetics and Genomic Medicine from Diagnosis to Treatment
SPRING 2019-ALT	GENE 644	Review of Medical Genetics

NEW COURSES NOT LISTED IN THIS CATALOG MAY BE ADDED BY FAES DURING THE ACADEMIC YEAR. FOR THE MOST UP-TO-DATE LIST OF NEW COURSES, PLEASE VISIT **WWW.FAES.ORG/GRAD.**

FAES GRADUATE SCHOOL at NIH

OPEN HOUSE

FALL TERM: **AUGUST 24, 2017 | 4:00 – 6:00 PM**
SPRING TERM: **JANUARY 11, 2018 | 4:00 – 6:00 PM**

FAES ACADEMIC CENTER | NIH CLINICAL CENTER, BETHESDA, MD

LIGHT REFRESHMENTS WILL BE SERVED!

TUITION ONLY **$160** TO **$480** PER COURSE!

REGISTER AND EARN CREDIT IN OVER 150 AFFORDABLE EVENING COURSES IN BIOMEDICAL SCIENCES, PUBLIC HEALTH, TECHNOLOGY TRANSFER, ESL, AND MORE!

OPEN TO THE NIH COMMUNITY, OTHER FEDERAL EMPLOYEES, AND THE GENERAL PUBLIC

WWW.FAES.ORG/GRAD | REGISTRAR@FAES.ORG

FAES MISSION

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.

ABOUT FAES

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 12 prominent NIH scientists, including future Nobel laureate Dr. Christian Anfinsen. More than 50 years later, FAES still maintains the core values on which it was founded.

FAES's range of programs and services include:

scientific and non-scientific courses, advanced studies programs in bioinformatics and data science, public health, and in technology transfer; bookstore; BioTech workshops; 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 and dental insurance plans for NIH fellows.

PROMOTING BIOMEDICAL RESEARCH WITHIN THE NIH INTRAMURAL PROGRAM SINCE 1959.

FAES GRADUATE SCHOOL at NIH

The FAES Graduate School at NIH operates as a non-degree-granting independent postsecondary school. Its 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 FAES GRADUATE SCHOOL AT NIH

The FAES Graduate School at NIH works to foster 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 Graduate School at NIH delivers high-quality and innovative courses in a dynamic, culturally diverse learning setting. We currently have 8 departments and offer over 150 evening courses annually to fit around the schedule of working professionals.

VISIT **WWW.FAES.ORG** FOR INFORMATION ON TUITION, CLASS TIMES, AND LOCATION.

- 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, many of whom are leading researchers and world-class experts.
- 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

The FAES Graduate School operates with the approval of the Maryland Higher Education Commission.

The FAES Graduate School at NIH is a non-degree-granting independent postsecondary institution. FAES courses do not currently lead to degrees.

Courses at FAES Graduate School at NIH are credit-bearing and can be accepted in transfer at other colleges and universities. For specific information, students need to consult the transfer policies of the receiving institution.

Courses at FAES Graduate School at NIH do not include laboratory work unless this activity is stated specifically in the course description.

GENERAL INFORMATION

ADMISSION

Courses are open to all qualified persons, both government and non-government. The FAES Graduate School 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 graduates of high school, or equivalent, or who qualify for the course because of satisfactory work experience. For admission to more advanced courses, college work 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 policies, admissions policies, scholarship programs, and other educational programs.

REGISTRATION

Our website contains the latest and most up-to-date information on class offerings and schedules. Courses that are shorter than the full semester (4-10 weeks) may have different registration dates, depending on the start date of the course. Registration is required each semester for yearlong Graduate School courses.

The registration dates and academic calendar can be viewed on the inside front cover of the Catalog of Courses and on our website at **www.faes.org/grad**.

The fastest and easiest way to register is online through our online registration portal. Register online with a credit card by following the link at **www.faes.org/grad**.

Note: Registration for BioTech and training workshops occurs on a rolling basis. The Training and Conferences Services Department does not follow the academic calendar of the Graduate School.

We also accept online payment from third parties. Employers, such as Administrative Officers or HR personnel, can make a payment by visiting the third-party Payment Gateway at **https://faes.org/student-payment**.

We also accept registration by email, fax, or in person. If registering by submitting the Enrollment Form by email, fax or in person, it is important that students submit accurate and complete information by filling out all required fields. Enrollment Forms can be downloaded from our website at **www.faes.org/grad**.

PAYMENT

FAES's is a non-profit organization dedicated to providing highly affordable and quality courses to the biomedical research community at the NIH and the general public. Therefore, payments for classes must be received in a timely manner.

PAYMENT MADE BY CREDIT CARD

All self-funded students must pay for the classes at the time of registration either through logging back into their account on the Student Portal at **https://my.faes.org/secure/Student/loginstu.aspx** OR by simply visiting our Payment Gateway at **https://faes.org/student-payment** to make a payment by credit card. Credit cards accepted are MasterCard, Visa, or Discover.

FAES expects payment by the start date of classes from **third-party sponsors**, such as employers or **Administrative Officers at NIH institutes**. Please email us for permission to be kept in the class in case your institute needs time beyond the start date of the term to process the request for training funds. **Third-party sponsors can make a payment with a credit card** through our secure and convenient Payment Gateway at **https://faes.org/student-payment**. Credit cards accepted are MasterCard, Visa, or Discover.

Students sponsored by their NIH labs or employers should make sure that they first enroll in the course online while waiting for the authorization of payment. Receiving institutional approval for payment does NOT constitute enrollment in FAES classes.

PAYMENT MADE BY CHECK OR SF-182 TRAINING FORM

FAES also accepts payment by check or SF-182 U.S. Government Training Voucher. If the course will be paid for with a SF-182 Government Training Voucher, please contact your Administrative Officer for guidance on your institution's process for requesting training funds.

If paying by check, please be sure to first enroll in the course online. Check payments, together with an Enrollment Form, should be mailed to:

Foundation for Advanced Education in the Sciences
PO Box 62861
Baltimore, MD 21264-2861

TUITION AND FUNDING

TUITION

FAES Graduate School at NIH courses offer great value and unparalleled cost-effectiveness. Tuition is $160.00 per credit; courses are typically 1-3 credits. The tuition for most courses ranges between $160–$480 (except for 600-level courses). Please consult the Catalog of Courses to determine credit hours and the applicable tuition fee for each course.

Students 65 years and over are eligible for 50% reduced tuition (for evening classes only).

SCHOLARSHIP AND FUNDING

FAES's core mission 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 provides limited partial scholarships, offering 40% tuition discount per credit, to eligible students in need of financial assistance and who can make a short and compelling justification as to how the respective FAES course would help them in their career or professional development. The award of a scholarship is contingent upon the recipient taking the course for credit and completing the course satisfactorily, which is determined as "C" or above, or "Pass," when the course is graded on a Pass/Fail basis.

The **FAES Student Scholarship Fund** provides partial scholarship to postbac, graduate, and postdoctoral Fellows, as well as non-NIH government or non-profit employees with limited income working in research, practice or education of health sciences.

FAES expects to offer 30 scholarships in the fall semester, and 20 scholarships in the spring semester.

HOW TO APPLY

To apply, students should complete the Scholarship Application Form available at **www.faes.org/grad** and submit the form electronically, including a current C.V./resume, to **registrar@faes.org**, with SUBJECT LINE: FAES Scholarship Application_(insert last name here).

Only complete applications will be considered. All applicants, please be sure to first register for the course online at **https://my.faes.org/Common/CourseSchedule.aspx** . If you do not register, and the course fills up by the time the scholarships are determined, you will not be granted a seat in the course.

All applicants will be notified of the outcome of their application during the last week of the regular registration season.

DEADLINE FOR APPLICATIONS

August 30, 2017 (Fall 2017) and January 17, 2018 (Spring 2018).

TERMS AND CONDITIONS

FAES will only consider applications for one course per semester. Expenses for textbooks are not covered.

The award of a scholarship is contingent upon the recipient taking the course for credit and completing the course satisfactorily, which is determined as "C" or above, or "Pass," when the course is graded on a Pass/Fail basis.

The application form is available on our website at **www.faes.org/grad**. The deadline for applications is typically ten days before the end of the regular registration period.

ADVANCED STUDIES

ADVANCED STUDIES IN BIOINFORMATICS AND DATA SCIENCE

The FAES Graduate School at NIH offers a unique Advanced Studies in Bioinformatics and Data Science to serve the quickly evolving needs of today's biomedical research community. As one of the most dynamic fields intersecting biology and computer science, bioinformatics and its data analysis tools equip life sciences researchers and professionals with highly in-demand skills in the pharmaceutical and biotechnology industries. Courses are offered in the evenings, making it convenient for working professionals and postgraduate fellows to gain expertise and experience in the theoretical foundations and practical skills to harvest the wealth of information contained in the vast amount of biological phenomena. The courses have been designed to train today's biomedical researchers in new methods and techniques in data science and to prepare them to translate and analyze the immensity of biological data.

The program is open to persons with an advanced degree in life sciences or STEM fields and comprises a 14-credit curriculum of required and elective courses. To learn more, please visit us at **www.faes.org/grad** or look up the Department of Bioinformatics and Data Science in the Catalog of Courses.

ADVANCED STUDIES IN PUBLIC HEALTH

FAES Graduate School at NIH offers a unique Advanced Studies in Public Health to persons with a Bachelor's degree or above. Courses are offered in the evenings, making it convenient for working professionals and postgraduate fellows to gain expertise and experience, to enhance current employment position or facilitate transitioning into a career in public health.

The program comprises a 21-credit curriculum of required courses, designed to give professionals an overview of the five core disciplines of public health: epidemiology; biostatistics; environmental health sciences; health policy and management; and, social and behavioral sciences. To learn more, please visit us at **www.faes.org/grad** or look up the Department of Public Health in the Catalog of Courses.

ADVANCED STUDIES IN TECHNOLOGY TRANSFER

FAES Graduate School at NIH offers a unique Advanced Studies in Technology Transfer to persons with a Bachelor's degree in science or engineering or a related field. Courses are offered in the evenings, making it convenient for working professionals and postgraduate fellows to gain expertise and experience in patenting, licensing, collaborative agreements, and other fundamental intellectual property transactions. The technology transfer profession employs more than 10,000 professionals in the U.S., with many practicing their trade in the greater Washington, D.C. metro area.The course instructors are leading practitioners in the field, so students can simultaneously gain the necessary knowledge and build professional networks.

The program comprises a 15-credit curriculum of required and elective courses. To learn more, please visit us at **www.faes.org/grad** or look up the Department of Technology Transfer, Business, and Industry in the Catalog of Courses.

STUDENT HANDBOOK

COURSE HOURS AND ATTENDANCE

Most classes are held between 4:30 and 8:30 PM. 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 class through FAES Graduate School's online registration portal or by submitting a complete Enrollment Form to FAES.

COURSE-LEVEL TABLE

As a continuing education school, FAES Graduate School 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

TRANSFER OF CREDIT AND TRANSFER AGREEMENTS WITH HIGHER EDUCATION INSTITUTIONS IN THE AREA

Students should not assume that courses taken at FAES will be accepted in transfer, although FAES courses can 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 a degree, and, if applicable, receive approval for any courses at the FAES Graduate School at NIH that they plan to use toward their degree.

The Master of Public Health Program (MPH) at The George Washington University (GWU) recognizes certain FAES courses as substitutes for those offered in the MPH Program. Successful completion of specific FAES courses allows students to apply for transfer of credit in the MPH Program. For further information about the MPH Program and currently eligible FAES courses, please contact the GWU MPH program office at **gwsphadmit@gwu.edu.**

TRANSFER AGREEMENTS

FAES has entered into a partnership with the University of Maryland University College to offer opportunities for students to get ahead with their academic and professional goals.

UNIVERSITY OF MARYLAND UNIVERSITY COLLEGE (UMUC), GRADUATE SCHOOL OF MANAGEMENT AND TECHNOLOGY

Students who have successfully completed the Advanced Studies in Technology Transfer at FAES can transfer all 15 credits as a block toward an M.S. degree at UMUC Graduate School. By completing only 21 more credits at UMUC, students can be awarded M.S. degrees (with a specialization

POLICY ON ACADEMIC INTEGRITY

The FAES Graduate School 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 will 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.**

in Technology Transfer) in Management or Information Technology or Biotechnology program. To learn more, please email registrar@faes.org.

CREDITS AND GRADES

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."

CHANGE FROM CREDIT TO AUDIT

Students may request status change from credit to audit, or vice versa, provided the request is submitted in writing to the Graduate School Office 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 workplace to take FAES courses must submit written approval from their Administrative Officers when requesting a change from credit to audit.**

GRADES

Grades are due to be submitted within three weeks of the end of the semester or within three weeks of the last class, as applicable. Grades will be posted and available for students to view in the online student portal.

Grades are assigned on the following scale:

A–Excellent	F-Failure	
B–Good	I-Incomplete*	Pass/Fail
C–Fair		
D–Poor	AUD-Auditor	

**"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.*

DROPPING COURSES AND REFUND POLICY

Students may drop courses themselves by logging into the Student Portal until the 4th week of the term.

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

In addition, students may fill out a **Withdrawal Form**, which is available on our website at **www.faes.org/grad**. Students are welcome to submit the completed Withdrawal Form in person or by email to **registrar@faes.org**.

REFUND

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 at the FAES Graduate School must be made in writing to the Graduate School Office at **registrar@faes.org**. A Withdrawal Form is available on our website at **www.faes.org/grad**. Reporting withdrawal from a course to the instructor is not considered official.

Refund of tuition fees will be granted only in cases when the Graduate School is notified in writing and according to the published schedule for full-semester courses. For courses of shorter duration, please contact the Graduate School at **registrar@faes.org**.

Until end of 1st week	100% tuition, less $25.00 per course
2nd week	80% of tuition
3rd week	60% of tuition
4th week	40% of tuition
After 4th week	No refund and no withdrawal will be granted

Note: late fees are not refundable. Refunds or withdrawals will not be granted to students who do not have a clear financial record with FAES.

Refunds will be computed as of the date the written intent to drop is received in the Graduate School 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.

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 have been 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.

FEES

Late Registration	$10.00 late fee per course
Official Transcript	$10.00 per transcript
Expedited Fed-Ex Delivery (Next Day) Official Transcript	$30.00 per copy
Unofficial Transcript	No cost
Returned Check	$25.00 fee per check

COURSES CANCELLED BY FAES GRADUATE SCHOOL 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.

OFFICIAL TRANSCRIPTS

Official transcripts can be requested by filling out the online Transcript Request Form at **https://faes.org/transcript-request**.

Official transcripts are $10.00 per copy.

Please complete and submit the online Transcript Request Form, along with complete payment information, and, if applicable, additional forms required by the receiving institution to the Graduate School Office.

Transcripts are typically processed within one-two business days of receipt. Please allow two-three additional business days for processing if transcripts have been paid for by check.

MAILING ADDRESS FOR NON-CHECK PAYMENTS

FAES Administrative Office, National Institutes of Health
10 Center Drive, MSC 1115, Bethesda, MD 20892-1115

MAILING ADDRESS FOR PAYMENTS MADE BY CHECK*

Foundation for Advanced Education in the Sciences (FAES)
PO Box 62861, Baltimore, MD 21264-2861

**Please allow two-three additional business days for processing if transcripts have been paid for by check.*

UNOFFICIAL TRANSCRIPTS

Unofficial transcripts for courses taken after Fall 2011 are available for downloading in the Student Portal OR they can be requested in writing by filling out the Transcript Request Form at **www.faes.org/grad** and by emailing it to **registrar@faes.org**.

Unofficial transcripts for courses taken prior to Fall 2011 can be requested in writing by filling out the Transcript Request Form and by emailing it to **registrar@faes.org**.

Unofficial transcripts are available at no cost.

MAILING ADDRESS FOR UNOFFICIAL TRANSCRIPT REQUESTS

FAES Administrative Office, National Institutes of Health
10 Center Drive, MSC 1115, Bethesda, MD 20892-1115

CLASSROOM ACCESSIBILITY

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 or by calling 301-496-7976.

STUDENT PRIVACY

FAES Graduate School 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 Graduate School 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

INCLEMENT WEATHER POLICY

FAES Graduate School classes are held in federal government facilities. Consequently, FAES follows the snow and dismissal procedures of the Office of Personnel Management (OPM). When government offices are closed early or all day due to hazardous weather conditions, or when hazardous weather conditions are probable for the evening hours, classes will not be held.

FAES will notify in advance students and faculty of any cancellation due to inclement weather. Cancellation information will be posted on the FAES homepage at **www. faes.org**, on our Facebook page as well as over the radio. FAES will aim to determine whether classes need to be cancelled by 1:00 PM on the day of inclement weather. If in doubt, students are welcome to send inquiries to **registrar@faes.org** or call 301-496-7976.

FALL 2017 SEMESTER SCHEDULE

July 10 – September 8	**Online Registration**
August 24	Open House
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May 11	**Classes end**

SPRING TERM HOLIDAY

February 19	President's Day – No classes

NOW AVAILABLE

Fellows Advantage Program

A comprehensive set of solutions to help Fellows achieve financial success.

- Special borrowing options for Fellows with no credit history*
- Free online and mobile banking services
- Convenient branches and ATMs
- Free financial tools and counseling

Visit **nihfcu.org/fellows**
Call **800.877.6440**
Stop by **any branch**

nih | Federal Credit Union

nihfcu.org

EQUAL OPPORTUNITY LENDER NCUA

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BIOCHEMISTRY, CHEMISTRY, PHARMACOLOGY AND TOXICOLOGY

FOR CLASS DATES, TIMES, LOCATION, AND TUITION, PLEASE VISIT WWW.FAES.ORG/GRAD.

MITCHELL HO, DARÓN FREEDBERG, FRANK PUCINO, CO-CHAIRS

SPRING	BIOC 101	Biochemistry in Health and Diseases
FALL	BIOC 301	Biochemistry I
SPRING	BIOC 302	Biochemistry II
FALL	BIOC 330	Principles of Protein Structure *(7 weeks)*
SPRING	BIOC 505	Emerging Trends in Membrane Biology: Advanced Cell Trafficking
SPRING 2019-ALT	BIOC 527	Lipid Metabolism in Physiology and Diseases *(8 weeks)*
SPRING	BIOC 532	Biological Importance of Modifications in DNA and Chromatin
FALL	CHEM 101	General Chemistry I
SPRING	CHEM 102	General Chemistry II
FALL	CHEM 211	Organic Chemistry I
SPRING	CHEM 212	Organic Chemistry II
SPRING	CHEM 327	The Art of Drug Design and Discovery
SPRING	PHYS 333	Principles of Medical Imaging *(10 weeks)*
FALL NEW	PHYS 370	Single Molecule Biophysics: What Is It, and How Does It Work?
FALL	PHAR 328	FDA Perspective on Drug Development
SPRING	PHAR 400	Pharmacology
FALL	PHAR 401	Medical Pharmacology
FALL	TOXI 303	Introduction to Toxicology

BIOC 101

Spring, 2 credits

Biochemistry in Health and Diseases

Mauro Tiso

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 fundamental knowledge of biochemistry and of the role of the molecules of life in control 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

Prerequisites: open to anyone with an interest in science and basic (high school- or undergraduate-level) knowledge of chemistry and biology.

BIOC 301

Fall, 3 credits

Biochemistry I

Pamela Gallagher, Mitchell Ho*, Dylan Murray, Jennifer Symonds

BIOC 301and BIOC 302 provide a comprehensive survey of biochemistry at the graduate level. BIOC 301 will cover the structure and function of biological macromolecules as well as topics on metabolic pathways, including glycolysis, citric acid cycle and oxidative phosphorylation. The course will also cover current methods used in biochemistry and medicine.

Learning objectives:

- Understand protein structure and thermodyanimcs
- 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

Prerequisites: organic chemistry or consent of the instructor.

BIOC 302

Spring, 3 credits

Biochemistry II

Pamela Gallagher, Mitchell Ho*, Dylan Murray, Jennifer Symonds

BIOC 302 is a continuation of BIOC 301. 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.

Learning objectives:

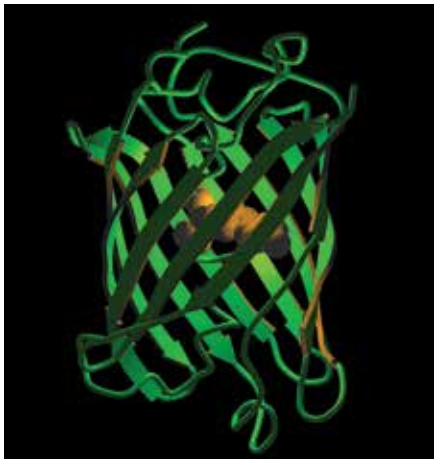
- Understand protein structure and thermodyanimcs
- Describe protein-protein interaction and structure-function relationships in biochemical systems
- Name structure and function of carbohydrates and lipids, aspects of central metabolism
- Identify nucleic acid biochemistry

BIOC 330

Fall, 1 credit

Principles of Protein Structure *(7 weeks)*

Andrew Kehr



This course will introduce students to the basics of biomolecule form, function, and the applied concepts behind using structural approaches for therapeutic design. Examples include anti-cancer drugs, vaccines as well as a new class of drugs biologics. While the focus of this course is not MCAT preparation, the concepts and techniques discussed will be a useful practice.

Learning objectives:

- Describe atomic structures of biomolecules and evaluate their quality
- Compare the different techniques used to determine biomolecule structure, kinetics, and thermodynamics
- Explain how structures can be used to design therapeutics and understand the advantages and limitations of this design
- Interpret and discuss current scientific literature on the topic of bimolecular structure

Prerequisites: prior coursework in college-level biology and chemistry.

BIOC 505

Spring, 2 credits

Emerging Trends in Membrane Biology: Advanced Cell Trafficking

Marko Jović

Membrane trafficking plays a fundamental role in several biological processes and the deregulation of the components regulating this process is the leading cause of several diseases ranging from cancer and immune-deficiencies to neurodegenerative and metabolic diseases. The course will consider modern concepts relating to the structure and function of cell membranes with an emphasis on human diseases. Starting from the physical properties of membranes, the course will examine membrane biogenesis, membrane dynamics, and intracellular trafficking. Examples will be drawn from specific membrane functions in the various organelles. Topics will include nuclear transport, ER to Golgi transport, endocytosis, carbohydrate and lipid trafficking.

Learning objectives:

- Understand principles that govern membrane biogenesis and membrane remodeling
- Become familiar with state of the art methods to study membrane dynamics

- Understand how changes in the biology of membranes can lead to disease states
- Gain insight into possible therapeutic interventions correcting membrane dysfunctions

Prerequisites: BIOC 301-302 or equivalent.

In order to run this course, minimum 10 students need to register.

BIOC 527

Spring 2019, Alternate Years, 1 credit (8 weeks)

Lipid Metabolism in Physiology and Diseases

Laura Allende

The functions of lipids have been largely underestimated by designating lipids as molecules providing only structural support and as molecules for energy storage and high-calorie values. But, the enormous diversity of lipids with respect to their molecular architecture, intra-cellular organization and roles in regulating variety of cellular and physiological events proves beyond doubt that our understanding of lipid biology has only just started.

The objective of this course is to address lipid biology in normal physiology and during pathological states. We will first introduce basic topics, such as categories and structures of lipids, cellular aspects of the synthesis degradation, and transport of lipids within the cell and functions and regulation of lipid metabolism. The course will then discuss lipid metabolic disorders including obesity, diabetes, cardiovascular disease, and hereditary metabolic disorders. The relationship between lipids, nutrition and health, including the benefits associated with their consumption, will be also examined. Each lecture will focus on certain aspects of the lipid metabolism, often in relation to associated disease conditions. Current concepts related to specific lipid functions, lipid-protein interaction, and disorders of lipid metabolism will be covered by discussing relevant published research papers.

Learning objectives:

- Describe the various classes of lipids which are relevant in human physiology
- Learn how lipids are digested, absorbed and metabolized in the organism
- Discuss the regulation of lipid biosynthesis in normal physiology
- Understand the causes and phenotypes of lipid hereditary metabolic disorders

In order to run this course, minimum 10 students need to register.

BIOC 532

Spring, 2 credits

Biological Importance of Modifications in DNA and Chromatin

Kevin Brick, Inbal Gazy, Daman Kumari, Tiaojiang Xiao*, Xiaonan Zhao, Zhuo Zhou

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 the Galaxy and UCSC web servers and other bioinformatics software tools.

Learning objectives:

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

Prerequisites: general understanding of basic concepts in genetics and biochemistry.

CHEM 101

Fall, 3 credits

General Chemistry I

Herman Nikolayevskiy

In this introduction to chemistry, a conceptual understanding will be emphasized to show how chemistry can apply to health-related situations. The goal is to familiarize students with chemistry concepts and to provide the skills necessary to carry out lab work using these skills. Problem solving will be also stressed. **CHEM 101** will be taught at a chemistry-major level, and will provide the background for organic chemistry, biochemistry, and other health sciences where chemistry is utilized.

Learning objectives—specific topics included cover:

- properties of matter
- units of measurement
- elements & compounds
- homogeneous and heterogeneous mixtures
- conservation of mass
- states of matter
- symbols and formulae
- stoichiometry
- the periodic table
- electronic structure
- covalent bonding
- molecular structure
- gas laws
- acid base reactions
- solution properties

CHEM 102

Spring, 3 credits

General Chemistry II

Herman Nikolayevskiy

As in CHEM 101, a conceptual understanding will be emphasized to show how the chemistry learned during the course can apply to health-related situations. The goal is to familiarize students with chemistry concepts and to provide the skills necessary to carry out lab work using these skills. We will also stress problem solving. **CHEM 102** will be taught at a chemistry-major level, and will provide the background for organic chemistry, biochemistry and other health sciences where chemistry is utilized.

Learning objectives—specific topics included cover:

- chemical equilibrium
- redox reactions
- pH solubility
- reaction kinetics
- introduction to organic and biochemistry

Prerequisites: CHEM 101 or equivalent.

CHEM 211

Fall, 3 credits

Organic Chemistry I

Lisa Rastede

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. The application of the above topics to synthetic organic chemistry will be emphasized. Connections between the fields of organic chemistry and biochemistry, medicine, and pharmacology will be also highlighted.

Learning objectives:

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

Prerequisites: general chemistry or consent of the instructor.

CHEM 212

Spring, 3 credits

Organic Chemistry II

Lisa Rastede

This is a continuation of CHEM 211, with the goal of providing a solid foundation in organic chemistry. This 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.

Learning objectives:

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

Prerequisites: CHEM 211 or equivalent.

CHEM 327

Spring, 2 credits

The Art of Drug Design and Discovery

Joseph J. Barchi, Jr.

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 throughout 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

Prerequisite: organic chemistry.

This course is an elective for Advanced Studies in Technology Transfer.

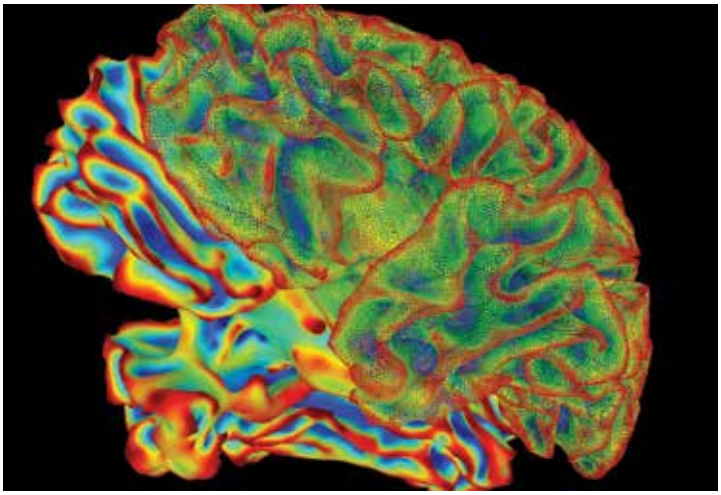
PHYS 333

Spring, 2 credits (10 weeks)

Principles of Medical Imaging

Alexandru Avram

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 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

Prerequisites: linear algebra; introductory physics (mechanics and electromagnetism).

PHYS 370

Fall, 2 credits

NEW Single Molecule Biophysics: What Is It, and How Does It Work?

Andrew Dittmore, Kathleen Maria Mills

Single-molecule biophysical techniques enable researchers to study the structural, mechanical, and time-dependent properties of individual biomolecules with great sensitivity. The objective of this course is to provide an overview of the most widely used techniques, including super-resolution tracking, single-molecule FRET, optical tweezers, and magnetic tweezers. This course is aimed at students interested in applying these techniques as well as those who would like to be able to understand and evaluate the literature.

The course will be particularly useful for postbac students who are interested in pursuing graduate school and would like to learn about biophysical methods. The theory and biological applications of each technique will be covered in lecture. Students will be assigned journal articles to read and will be expected to participate in class discussions. As a final project, students will write a brief research proposal utilizing one or more of the methods discussed. This course is designed for a general scientific audience.

Learning objectives:

- Appreciate the utility of single-molecule methods to the study of biological systems
- Demonstrate understanding of the various techniques and the advantages and limitations of each
- Read and analyze current scientific literature in the field
- Design a research project using single-molecule methods

Prerequisites: some basic knowledge of biology and physics is required.

PHAR 328

Fall, 2 credits

FDA Perspective on Drug Development

Ilona Bebenek, Hanan Ghantous*

This course will cover drug development from the FDA perspective. The FDA's roles and responsibilities related to the various components of the Investigational New Drug (IND) phase of drug development will be covered in detail, including Chemistry, Manufacturing and Controls (CMC), Pharmacology/Toxicology, Biometrics, Clinical Trials, Statistics and Inspection. In addition, a comparison of the development of biologic drugs versus small molecule drugs will be presented. Discussion of pediatric testing and the use of juvenile animal studies in this respect will be also included. The New Drug Application (NDA) process will be discussed in terms of product-label development. Aspects of the post-approval phase of drug development will be covered, in addition to OTC products and drug shortage issues. Finally, attendees will have the opportunity to discuss case studies, labels, analyze data, and make approval decisions.

Learning objectives:

- Understand drug development from the FDA perspective, including data analysis, label review, and final approval decisions
- Participate in case studies of real-world drug development scenarios
- Apply knowledge gained in this course to positions in industry and government

Prerequisite: college-level biological sciences.

This course is an elective for Advanced Studies in Technology Transfer.

PHAR 400

Spring, 3 credits

Pharmacology

Salina Gairhe, Sudhir Yanpallewar

The objective of this course is to present the pharmacological basis of therapeutics by discussion of the principles of drug action and the mechanism of action of representative agents. The initial portion of the course will be devoted to an exploration of concepts such as pharmacokinetics, drug metabolism, dose-response relationships, and resistance, and toxicity. Subsequent portions of the course will focus on the chemistry, mechanism of action, and pharmacologic action of drugs affecting the autonomic and central nervous systems, the cardiovascular, and renal systems, pathogenic microbes, cancer, and hormones. A review of the relevant physiology of each organ system will be presented.

Learning objectives:

- Provide basic scientific concepts and principles that will serve as the foundation for understanding the pharmacology of specific drugs
- Introduce comprehensively fundamental pharmacology and uses of the major classes of clinically important drugs

PHAR 401

Fall, 3 credits

Medical Pharmacology

Suneet Shukla*, Tristan Sissung

The objective of this course is to provide students with a comprehensive introduction to the fundamental pharmacology, scientific principles of drug action, the mechanisms by which drugs mediate their pharmacological effect, and the basics of drug development and approval processes. The first half of the course will cover basic scientific concepts and principles that will serve as the basis for understanding the pharmacology of specific drugs. The second half will focus on the introduction to major physiological systems of human body, such as the nervous system, the endocrine system, the pharmacology and clinical use of the major class of clinically important drugs, chemistry, mechanism of action and pharmacologic action of drugs affecting these systems, pathogenic microbes, viruses, and cancer.

Learning objectives:

- Understand basic concepts in pharmacology
- Identify the basics of clinical studies, drug development, and approval processes
- Describe drug action and understand the mechanisms of individual drug action at the cellular, organ, and body level
- Acquire fundamental knowledge of central concepts in chemotherapy
- Comprehend the basis of drug action in the context of disease treatments

Prerequisites: basic concepts in biology, chemistry, and biochemistry.

TOXI 303

Fall, 2 credits

Introduction to Toxicology

Mohammed Bourdi, Vera Spagnolo*, Pramod Terse

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, 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 the medical literature and/or in the media as well , 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 the 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

Prerequisites: undergraduate biology and chemistry.

ADVANCED STUDIES IN BIOINFORMATICS AND DATA SCIENCE

WHAT IS BIOINFORMATICS?

Precipitated by the immensity and explosion of publicly available genomic information, the field of bioinformatics has emerged as an important and dynamic interdisciplinary field in biomedical studies. Bioinformatics develops and applies computer technology as well as informatics, including mathematics and statistics, to store, analyze, interpret, and manage vast amounts of biological data. Data science is a quickly evolving interdisciplinary field that allows biomedical researchers to extract knowledge and insights from data in various forms. Through the integration of computer technology, software tools, databases, data analysis, systems and processes for data mining, bioinformatics and data science make it possible to generate large data sets and models, and thus address important biological questions and advance biomedical knowledge.

ADVANCED STUDIES IN BIOINFORMATICS AND DATA SCIENCE

The FAES Graduate School at NIH offers a unique Advanced Studies in Bioinformatics and Data Science to serve the quickly evolving needs of today's biomedical research community. As one of the most dynamic fields intersecting biology and computer science, bioinformatics and its data analysis tools equip life sciences researchers and professionals with highly in-demand skills in the pharmaceutical and biotechnology industries.

The Advanced Studies in Bioinformatics and Data Science will provide students with the theoretical foundations and practical skills to harvest the wealth of information contained in the vast amount of biological phenomena. The courses have been designed to train today's biomedical researchers in new methods and techniques in data science and to prepare them to translate and analyze the immensity of biological data generated by advances made through recent applications of genomic research. NIH researchers and others will be also able to use these techniques to new applications relevant to basic biology and other data-science research projects.

GENERAL REQUIREMENTS

The program is designed for participants who hold an advanced degree in life sciences or STEM fields.

The Advanced Studies comprises a 14-credit curriculum. Courses are held in the evenings to fit the needs of working professionals and postgraduate fellows.

REQUIRED COURSES

BIOF 309	Introduction to Python OR BIOF 312 Introduction to Perl
BIOF 518	Theoretical and Applied Bioinformatics
BIOF 521	Bioinformatics for Analysis of Next Generation Sequencing

VISIT **WWW.FAES.ORG** FOR INFORMATION ON TUITION, CLASS TIMES, AND LOCATION.

ELECTIVES

BIOF 339	Practical R
BIOF 395	Introduction to Text Mining
BIOF 450	Evolutionary Genomics and Computational Biology
BIOF 475	Introduction to New Technologies in Data Science
BIOF 501	Introduction to R: Step-by-Step Guide *(7 weeks)*
BIOF 509	Machine Learning and Object-Oriented Programming With Python
BIOF 529	Super R with Shiny!
STAT 500 I	Statistics for Biomedical Scientists I
STAT 500 II	Statistics for Biomedical Scientists II

LEARNING OUTCOMES

Upon completion, students will be able to:

- Learn to use effectively different techniques to analyze biological data from high throughput approaches
- Perform statistical analysis and visualization of biological data
- Apply bioinformatics techniques for analysis of genomic, expression, and proteomic data
- Understand the uses and limitations of bioinformatics data-analysis tools and technologies
- Learn how the computational methods are used in new applications in basic biology, and also how they are translated into the development of new drugs and diagnostic tools

BIOINFORMATICS AND DATA SCIENCE

FOR CLASS DATES, TIMES, LOCATION, AND TUITION, PLEASE VISIT WWW.FAES.ORG/GRAD.

BEN BUSBY, CHAIR

FALL, SPRING	BIOF 309	Introduction to Python
FALL ONLINE	BIOF 312	Introduction to Perl
FALL NEW	BIOF 339	Practical R
SPRING NEW	BIOF 395	Introduction to Text Mining
SPRING	BIOF 450	Computational Biology and Evolutionary Genomics
SPRING	BIOF 475	Introduction to New Technologies in Data Science
FALL NEW	BIOF 501	Introduction to R: Step-by-Step Guide *(7 weeks)*
FALL, SPRING	BIOF 509	Machine Learning and Object-Oriented Programming with Python
FALL	BIOF 518	Theoretical and Applied Bioinformatics
SPRING	BIOF 521	Bioinformatics for Analysis of Data Generated by Next Generation Sequencing
SPRING	BIOF 529	Super R with Shiny!
FALL	MATH 127	Elementary Calculus I
SPRING	MATH 128	Elementary Calculus II
FALL NEW	MATH 215	Introduction to Linear Algebra With Applications in Statistics
FALL, SPRING	STAT 200	Experimental Statistics I and II
FALL ONLINE	STAT 317	Introduction to Epidemiology
FALL	STAT 321	Methodology in Clinical Trials
SPRING ONLINE	STAT 325 - O	Epidemiologic Research Methods
FALL, SPRING	STAT 500	Statistics for Biomedical Scientists I and II
SPRING ONLINE	STAT 500 I - O	Statistics for Biomedical Scientists I
FALL ONLINE	STAT 500 II - O	Statistics for Biomedical Scientists II

BIOF 309

Fall and Spring, 2 credits each semester

Introduction to Python

Martin Skarzynski

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 texts 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.

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)

INDIVIDUAL LAPTOP IS NEEDED FOR EACH CLASS.

Continuum Analytics Installer Anaconda (V3) will be utilized to install Python and the necessary packages.

BIOF 312

Fall, 2 credits

ONLINE Introduction to Perl

Andrei Mamoutkine

This course will introduce students to the Perl programming language and to general principles of computer programming. Class exercises will focus on using Perl to parse, analyze, and process large bioinformatics data sets, especially FASTA sequence data and BLAST results, as well as .bed files derived from RNAseq data. Topics will include fundamental elements of programming, such as variables, control structures, functions, elements of the Perl programming language used for as regular expressions and reading and writing to files, basic program design techniques, and the basic use of the Perl debugger.

Learning objectives:

- Perform basic Perl scripting
- Understand redefined variables, arrays, subroutines and regular expressions
- Discuss how to use and manage files and directories from Perl scripts
- Perform running and interacting with external programs from Perl
- Analyze bioinformatics data sets

Prerequisites: no prior computer programming experience is required.

INDIVIDUAL LAPTOP IS NEEDED FOR EACH CLASS.

Contact the faculty for links to free software on Windows PC. Unix or Mac should have a built-in Perl; with questions about how to check, please contact the faculty.

BIOF 339

Fall, 2 credits

NEW Practical R

Eugen Buehler, Abhijit Dasgupta

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.

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

BIOF 395

Spring, 2 credits

NEW Introduction to Text Mining

Ben Busby, Lanhao (Philip) Chen, Lena Pons

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

Prerequisites: prior exposure to programming and Python is encouraged but not required to attend this class

BIOF 450

Spring, 3 credits

Computational Biology and Evolutionary Genomics

Igor Rogozin*, Tatiana Tatusova

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

BIOF 475

Spring, 2 credits

Introduction to New Technologies in Data Science

Antej Nuhanovic

What is Data Science, and how can one use Big Data technologies to unlock value in massive data stores? How can one explore scientific data to gain new insights or make better data-management decisions? The objective of this course is to provide an overview of the history of Data Science platforms and its current landscape in order to enable students to implement their own Data Science solution, while also providing hands-on experience with these tools. The course will cover the basics of some tools that students can subsequently use to work with Data Science, such as Hadoop's MapReduce, Apache Spark, Pig, Hive, Python, and R. In addition, the course will cover advanced data structures as well as real-world data scraping, cleansing, and wrangling. The course will also include a high-level overview of machine-learning concepts.

Learning objectives:

Technical Side:

- Gain basic understanding of elementary concepts common in Data Science analytics: distributed file system, NoSQL databases, job scheduling, and more
- Gain experience with integrating Data Science components into a Data Science platform, loading data, querying, and extracting value
- Gain hands-on experience connecting to and modifying installations and scripts
- Be able to rework an existing script to meet the students' needs

Data Side:

- Learn predictive modeling: find correlations; supervised segmentation; visualization segmentation, probability estimation
- Fit a model to data and avoid overfitting: choose goals for data; loss functions; cross validation; tree pruning; regularization

- Find natural clusters and neighbors—nearest neighbor, clustering methods, distance similarity
- Pivot from thinking about data to solving a problem
- Complete a short research project using Data Science techniques and technologies

Prerequisites: Previous programming experience is not required, but is recommended.

INDIVIDUAL LAPTOP IS NEEDED FOR EACH CLASS (Mac, Linux or Windows).

BIOF 501

Fall, 1 credit (7 weeks)

NEW Introduction to R: Step-by-Step Guide

Kyung Ko

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

BIOF 509

Fall and Spring, 2 credits each semester

Machine Learning and Object-Oriented Programming with Python

Alexander Goncearenco, Jonathan Street*

Python is an open-source and general-purpose programming language with widespread adoption in a variety of fields. It has been used to implement state-of-the-art machine learning programs. At the start of the course, students will implement simple machine-learning algorithms to illustrate key concepts. Next, students will utilize packages, including scikit-learn in regression, classification, clustering, and other machine learning tasks. A summary of advanced techniques, such as deep learning, will conclude the focus on machine learning.The course will introduce packages such as jupyter notebook, in addition to useful tools and approaches including documentation, testing and profiling, thus enabling students to produce analyses and programs that are easier to understand, less susceptible to errors, and more performant. Object-oriented programming will be covered in detail. Examples will include graphical user interfaces and web applications.The course will culminate in a short research project utilizing machine learning and/or object-oriented programming.

Learning objectives:

- Identify and apply appropriate machine-learning techniques for different tasks
- Design programs utilizing an object-oriented approach
- Complete a short research project using machine learning and/or object-oriented programming

Prerequisites: Basic level of familiarity with Python is assumed. Students should have previously completed BIOF 309 Introduction to Python or have equivalent experience.

INDIVIDUAL LAPTOP IS NEEDED FOR EACH CLASS. INSTRUCTIONS FOR INSTALLING SOFTWARE WILL BE GIVEN AHEAD OF COURSE.

BIOF 518

Fall, 3 credits

Theoretical and Applied Bioinformatics

Igor Rogozin*, Tatiana Tatusova

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

Prerequisites: solid understanding of biology, computer science or mathematics.

BIOF 521

Spring, 3 credits

Bioinformatics for Analysis of Data Generated by Next Generation Sequencing

Sijung Yun

In this course, students will learn to analyze Next Generation Sequencing data, particularly for DNA-seq, RNA-seq, CHIP-seq, and DNA-methylation. The course will be divided between lectures and hands-on sessions. Lectures will cover background knowledge, and a survey of various software programs. For hands-on sessions, the course will primarily focus on the use of the Galaxy platform for analysis of raw data obtained from an Illumina's HiSeq-2000 and data available in the NCBI-SRA. Use of distributed and abstracted computing, such as Biowulf and cloud computing will be also covered. There will be a term project in which students will design projects relevant to their research.

Learning objectives:

- Learn to analyze Next Generation Sequencing data, including DNA-seq, RNA-seq, and CHIP-seq in Graphical User Interface, using Galaxy or in command line
- Write short scripts to do this analysis using command line resources

INDIVIDUAL LAPTOP IS NEEDED FOR EACH CLASS.

BIOF 529

Spring, 2 credits

Super R with Shiny!

Kyung Ko

The course covers R as a programming language. Students will learn to write R functions, use control structures, and write R programs relevant to life sciences. Introductory R skills will be extremely helpful; previous completion of practical R, or experience using R is highly recommended.

The course will cover: R Data Structures; Functional Programming; R Graphics & Visualizations; R Workspace Development; Probabilistic Implementations; R Machine Learning Applications.

Learning objectives:

- Acquire strong, concise, and efficient programming practices for data analysis and program implementation
- Develop a foundational understanding of functional programming
- Build a conceptual understanding of data analysis and visualization

INDIVIDUAL LAPTOP IS NEEDED FOR EACH CLASS.

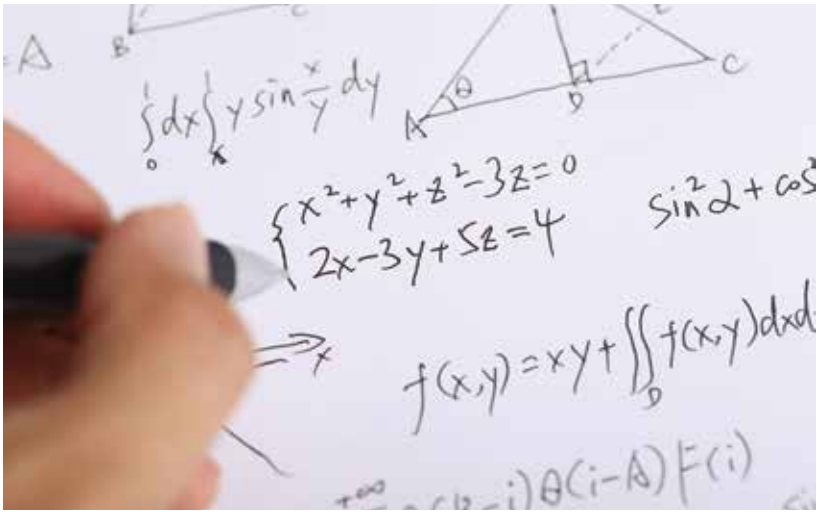
MATH 127

Fall, 3 credits

Elementary Calculus I

Joshua Chang

This course is an introduction to calculus and is aimed at students who have not taken calculus in their previous education. The course will begin with a review of pre-calculus topics, including functions and algebra, which are then used as the groundwork for exploring the core topics of limits, continuity, differentiation, and integration. Where possible, problems considered in class will be of a biological nature and problem sets will be available to promote understanding.



Learning objectives:

- Understand the concept of functions, their limits, and continuity
- Become reasonably familiar with differentiation and integration of functions
- May satisfy the minimum requirement for medical/dental schools, if taken together with MATH 128

Prerequisites: knowledge of trigonometry, basic algebra, and graphing are required.

MATH 128

Spring, 3 credits

Elementary Calculus II

Joshua Chang

This is a continuation of MATH 127. Topics will include application of differentiation and integration to life sciences, differential equations, functions of many variables, partial derivatives, constrained and unconstrained optimization.

Learning objectives:

- Understand the concept of differential equations and multivariate functions
- Learn how to solve differential equations

Prerequisites: MATH 127 or equivalent course.

MATH 215

Fall, 3 credits

NEW Introduction to Linear Algebra With Applications in Statistics

Joshua Chang

Introduction to linear algebra and statistics, including systems of linear equations, matrix algebra, linear independence, vector spaces and subspaces, bases and dimension, determinants, eigenvalues and eigenvectors, diagonalization, multiple linear regression, singular value decomposition, principle components analysis. This course provides a comprehensive introduction to linear algebra with the intention of developing intuition into contemporary statistical modeling techniques. Most commonly used statistical tests are either implicitly or explicitly related to some underlying linear model. For example, two-sample t-tests correspond to simple linear regression, while ANOVA and ANCOVA correspond to multiple regression and mixed effects models, respectively. In addition, many non-model-based data exploration techniques, such as principle components analysis, are based on concepts in linear algebra.

This course provides the mathematical foundations linking together all of these techniques. In addition, it will have a lab component using Python and R.

Learning objectives:

- Analyze and solve systems of linear equations
- Become proficient in matrix manipulation and arithmetic
- Learn the concept of vector spaces, subspaces, and linear dependence
- Learn spectral methods for analyzing matrices
- Understand statistical methods based on linear models and their analyses

Prerequisite: one semester of differential calculus.

STAT 200

Fall and Spring, 3 credits each semester

Experimental Statistics I and II

Niraj Trivedi

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 first semester: probability and random variables; mean and variance; distribution theory; point estimation and confidence interval; R introduction.

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.

Learning objectives:

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

Prerequisites: working knowledge of algebra II; one semester of calculus is preferred.

STAT 317

Fall, 3 credits

ONLINE Introduction to Epidemiology

Robert Hirsch

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.

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
- Critically evaluate epidemiology studies as presented in journal articles and the popular press

Prerequisites: STAT 200 or STAT 500 or equivalent.

This is a required course for the Advanced Studies in Public Health.

STAT 321

Fall, 3 credits

Methodology in Clinical Trials

Yves Rosenberg

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.

Learning objectives:

- Acquire a fundamental understanding of metho-dological 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

In order to run this course, minimum 10 students need to register.

STAT 325 - O

Spring, 3 credits

ONLINE Epidemiologic Research Methods

Robert Hirsch

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

Prerequisites: STAT 200 or STAT 500 and STAT 317.

STAT 500

Fall and Spring, 3 credits each semester

Statistics for Biomedical Scientists I and II

Deven Shah

The objective of this course is to provide an overview of statistics through a series of integrated lectures on analysis and interpretation of medical research data to biomedical researchers and clinicians who are interested in the interpretation of the results of statistical analyses. Emphasis is on ideas and understanding rather than mechanics. Topics covered in the first semester include the foundation of statistical logic and the most commonly encountered statistical procedures in medical research. The second semester expands on the material covered in the first semester by looking at assumptions, extensions, and alternatives for common procedures.

STAT 500 is a yearlong course. Material covered in the first semester is necessary to satisfactorily undertake the second semester. Those who will be routinely engaged in computing statistical procedures should consider STAT 200.

Learning objectives:

- Enable biomedical researchers to critique statistical analyses of classical biomedical and clinical research problems
- Understand the probability basis of statistical estimation and hypothesis testing
- Interpret statistical software printout from popular programs such as SAS, Excel, etc.
- Compute sample sizes for classical statistics hypothesis

This is a required course for the Advanced Studies in Public Health.

STAT 500 I - O

Spring, 3 credits

ONLINE Statistics for Biomedical Scientists I

Robert Hirsch

The objective of this course is to provide an overview of statistics for biomedical research workers 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.

STAT 500 is a yearlong course. Material covered in the first semester is necessary to satisfactorily undertake the second semester. Those who will be routinely engaged in computing statistical procedures should consider STAT 200.

Learning objectives:

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

This is a required course for the Advanced Studies in Public Health.

STAT 500 II - O

Fall, 3 credits

ONLINE Statistics for Biomedical Scientists II

Robert Hirsch

The second semester expands on the material covered in the first semester. Materials covered in the first semester is necessary to satisfactorily undertake the second semester. The objective of this course is to provide an overview of statistics for biomedical research workers 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.

Learning objectives:

- Learn the statistical aspects of processes of planning and execution of biomedical research
- Know the assumptions of statistical methods, how to evaluate them, and responses 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

Prerequisite: STAT 500 I or equivalent.

This is a required course for the Advanced Studies in Public Health.

BIOLOGY AND GENETICS

FOR CLASS DATES, TIMES, LOCATION, AND TUITION, PLEASE VISIT WWW.FAES.ORG/GRAD.

DEBORAH HINTON, CHAIR

FALL	BIOL 101	Introductory Biology
SPRING	BIOL 102	Introduction to Genetics
FALL ONLINE HYBRID	BIOL 222	The Human Genome
FALL NEW	BIOL225	Protein Quality Control in Health and Disease *(8 weeks)*
SPRING	BIOL 254	Non-Coding RNAs (miRNAs, lncRNAs, and circRNAs) and Exosomes: Biology and Diseases *(8 weeks)*
FALL	BIOL 262	Research Tools for Studying Diseases
FALL	BIOL 313	Molecular Biology and Recombinant DNA Technology
FALL ONLINE HYBRID	BIOL 325	Human Neuroscience
FALL 2018-Alt	BIOL 327	Modern Embryonic and Developmental Biology
SPRING	BIOL 332	Introduction to Nanomedicine *(8 weeks)*
SPRING NEW	BIOL 342	Post-Translational Modifications of Proteins *(4 weeks)*
SPRING 2018-Alt	BIOL 350	Foundations of Cellular Neuroscience
FALL	BIOL 355	Principles of Biology of Bone and Other Connective Tissues
SPRING NEW	BIOL 385	The Biology of Aging
FALL	BIOL 425	RNA Interference and Applications *(7 weeks)*
FALL 2017-Alt	BIOL 435	Current Trends in the Neurobiology of Mental Illness
FALL 2018-Alt	BIOL 450	Stem Cell Biology
FALL NEW	GENE 220	Evolutionary Genetics and Genomics: From Charles Darwin to Integrated-Omics *(7 weeks)*
FALL, SPRING	GENE 500	Introduction to Medical Genetics I and II
FALL 2017-Alt	GENE 505	Embryology, Developmental Biology and Human Malformations
FALL, SPRING	GENE 510	Genetic Counseling: Professional Topics Seminar
SPRING	GENE 514	Current Concepts in Clinical Molecular Genetics and Molecular Diagnostics
FALL 2018-Alt	GENE 518	Medical Genetics and Genomic Medicine: From Diagnosis to Treatment
SPRING 2019-Alt	GENE 644	Review of Medical Genetics

BIOL 101

Fall, 2 credits

Introductory Biology

Joseph Darling, Ginger Hunter, Sukanya Suresh*

This is an introductory course to biology, covering contents in cell biology, molecular biology, genetics, and human physiology. The course will start with explaining how cells are organized and function to maintain our daily life. Next, the course will cover how DNA conveys the genetic information to determine our appearance and health. The principles of heredity will be also introduced to understand how personal traits are passed between generations. The second part of the course will focus on human physiology and nutrient metabolism, while highlighting the development of some common diseases, such as cancer, autoimmune disease, and obesity.

Learning objectives:

- Describe the structure of a cell and understand the central dogma of DNA
- Apply Mendel's principles of inheritance
- Recognize the major systems involved in human physiology
- Differentiate the metabolism of carbohydrate and fat
- Gain knowledge to be able to follow the recent scientific advancement against common diseases

BIOL 102

Spring, 2 credits

Introduction to Genetics

Nicole DeVaul*, Jyoti Iyer

This course will introduce students to fundamental concepts of genetics, including mechanisms of inheritance (Mendelian genetics, mitosis and meiosis, linkage) and the molecular basis of inheritance (DNA and chromosome structure, replication, recombination, gene regulation, mutation, DNA repair). In addition, the course will cover methods and applications of genetics to fields such as developmental genetics, cancer genetics, genomics, and biotechnology. Course format will include lectures, problem solving, and discussion.

Learning objectives:

- Understand nomenclature and terms used in genetics
- Learn about molecular basis of genetics and mechanisms of inheritance
- Gain familiarity with a range of genetics techniques and how they are used to solve biological problems
- Apply knowledge of genetics to assess current advances in genetics, emerging technologies, and potential impact on society

Prerequisites: basic biology course useful, but not required.

BIOL 222

Fall, 2 credits

ONLINE HYBRID

The Human Genome

Mauro Tiso

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

BIOL 225

Fall, 1 credit (8 weeks)

NEW Protein Quality Control in Health and Disease

Fatemeh Navid

A cell produces many proteins in its lifetime. Protein quality control is essential to make sure that only correctly folded and functional proteins are synthesized. Incorrectly folded proteins, which can form cytotoxic protein aggregates, are recognized by this machinery and either assisted to refold or marked for degradation. There are two major proteolytic systems that can degrade protein aggregates: the ubiquitin-proteasome system and the autophagy pathway. A dysregulation in the protein quality control is associated with neurodegenerative and inflammatory diseases like Parkinson's disease, Alzheimer disease and Crohn's disease, while altered protein-quality control is also observed in aging.

This course will give an introduction to the different mechanisms of protein-quality control and its immense role in maintaining cell homeostasis under physiological and stress conditions. Based on relevant research papers, students will discuss different strategies targeting protein quality control for therapeutic treatment of a variety of diseases caused by protein overload and/or misfolding.

Learning objectives:

- Gain an understanding of protein-quality control in cells under physiological condition and stress conditions to prevent protein aggregation
- Compare protein degradation by the ubiquitin-proteasome system versus autophagy pathway
- Understand how autophagy and the ubiquitin-proteasome system interact with each other
- Learn how dysregulation in protein quality control is associated with neurodegenerative diseases, inflammation, cancer, and aging
- Interpret and discuss relevant therapeutic strategies developed to improve protein-quality control in several diseases

BIOL 254

Spring, 1 credit (8 weeks)

Non-Coding RNAs (miRNAs, lncRNAs, and circRNAs) and Exosomes: Biology and Diseases

Kotb Abdelmohsen, Lena Diaw*

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 current technologies and databases. 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
   - » Cardiovascular diseases and diabetes
   - » Immune responses
   - » Stem cells

BIOL 262

Fall, 2 credits

Research Tools for Studying Diseases

Philip Ryan, Philip Y. Wang

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

Prerequisites: undergraduate biology and chemistry.

BIOL 313

Fall, 2 credits

Molecular Biology and Recombinant DNA Technology

Soumyadeep Dey*, Suna Gulay, Eric Refsland

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, but not limited to: 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

BIOL 325

Fall, 3 credits

ONLINE HYBRID

Human Neuroscience

Stacia Friedman-Hill

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 our investigation of neuronal mechanisms.

BIOL 325 is a blended course that will include classroom-based instruction, synchronous online lectures, and asynchronous online homework assignments and learning activities. Students should plan to spend five to eight hours per week on the course. Access to and familiarity with the internet is required for students to participate in this class.

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

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 327

Fall 2018, Alternate Years, 2 credits

Modern Embryonic and Developmental Biology

Robert S. Adelstein, Susan Mackem, Yosuke Mukoyama*, Constance Tom Noguchi

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 will survey the fundamentals as well as recent progress in vertebrate development, including stem cell biology. It will also cover cutting-edge techniques such as advanced genetic manipulations, high-resolution imaging and induced pluripotent stem cells (iPS). The experts will not only give a basic lecture about developmental biology, but also introduce recent leading-edge and important findings is each topic during the lecture. The first half of the class will consist of a lecture, based on a relevant chapter in the latest edition of Scott Gilbert's textbook *Developmental Biology.* The second half of each class will be devoted to a presentation and discussion of important articles underlying vertebrate 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 critically discuss 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

Prerequisites: BIOL 101 or college-level biology.

BIOL 332

Spring, 1 credit (8 weeks)

Introduction to Nanomedicine

Andrew DuFresne, Don Ho, Barbora Piknova*, Laxminath Tumburu

This course will introduce students to the basic concepts of nanomaterials and nanotechnologies, and their use in medicine. Use of nanotechnologies in current medical practice and current clinical trials as well as the long-term potential of nanomedicine will be presented. Potential toxicity of nanomaterials will be also discussed.

Learning objectives:

- Gain insight into the basics of nanomedicine
- Familiarize participants with basic concepts, use and difficulties of nanomedicine

There are no prerequisites for this course. This course will be taught by junior faculty members.

BIOL 342

Spring, 0.5 credit (4 weeks)

NEW Post-Translational Modifications of Proteins

Suna Gulay

Post-translational modifications (PTMs) are covalent changes introduced to proteins during or after protein synthesis. This course will cover common, enzymatic PTMs observed in proteins, focusing on phosphorylation, acetylation, glycosylation and palmitoylation. Each class will feature a short introduction to one type of modification, followed by discussions of literature to explore the functions of this modification in cellular processes and human diseases. Through such discussions, the students will also develop an understanding of the common methods to study PTMs and will be encouraged to apply what they have learned to their own research through preparation of a short research proposal.

Learning objectives:

- Describe the PTMs frequently observed in proteins and their roles in cellular processes
- Discuss original research papers that have shaped the current understanding on PTMs
- Propose a short study to explore the role(s) of known or predicted PTMs on your favorite protein in relation to cellular function and/or a disease model

Prerequisites: prior coursework in molecular biology and cell biology.

BIOL 350

Spring 2018, Alternate Years, 3 credits

Foundations of Cellular Neuroscience

Jeffrey Diamond

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

BIOL 355

Fall, 2 credits

Principles of Biology of Bone and Other Connective Tissues

Elena Makareeva*, Shakib Omari, Anna Roberts-Pilgrim

Bone and other connective tissues such as basement membrane, cartilage, tendons, ligaments, and skin are crucial for providing structural support and contextual cues that sustain proper function of other organs and tissues in the body. The purpose of this course is to provide students with a framework for understanding the extracellular matrix environment that surrounds cells and organs commonly studied in biomedical research.

This course builds upon fundamentals of biochemistry, biophysics, and cell biology in order to understand the structure, function, pathology, and repair mechanisms of bone and other connective tissues. The course will provide a review of common experimental techniques used to study bone pathology, properties of extracellular matrix, and cell functions relevant to various diseases (i.e., osteoporosis, osteogenesis imperfecta, fibrosis, cancer) and applications of regenerative medicine.

Learning objectives:

- Master basic structure and function of connective tissues and how they relate to other organs
- Review common experimental techniques used in bone and connective tissue biology
- Demonstrate and present principles of biology of bone and other connective tissues

Prerequisites: college-level knowledge of biochemistry and cell biology.

BIOL 385 NEW

Spring, 2 credits

NEW The Biology of Aging

Sarah Clatterbuck Soper

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

Prerequisites: cell biology.

BIOL 425

Fall, 1 credit (7 weeks)

RNA Interference and Applications

Sinu John

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. Detailed understanding of this mechanism enabled adaptation of this as a tool to study the gene function and to develop therapeutics. This course is designed to provide a deeper understanding of RNA interferences and CRISPR (Clustered regularly-interspaced short palindromic repeats) and their applications in different fields of biology.

Learning objectives:

- Understand the mechanism of RNA interference
- 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

Prerequisites: basic understanding of molecular biology and cell biology.

BIOL 435

Fall 2017, Alternate Years, 2 credits

Current Trends in the Neurobiology of Mental Illness

Elizabeth Ballard, Carlos Zarate, Jr.*

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

Prerequisites: familiarity with college-level neurobiology, biochemistry, and genetics.

BIOL 450

Fall 2018, Alternate Years, 1 credit

Stem Cell Biology

Suresh K. Arya

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, pluripotentcy, 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 and the realization that the microenvironment (the stem cell nitch) 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 and 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

GENE 220

Fall, 1 credit (7 weeks)

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

Jeffrey Robinson

This course teaches the key concepts of evolutionary genetics using a historical framework. Class discussions will use historical examples from the literature, with each session focusing on progressively modern material. The course will start with (1) Charles Darwin's theory of evolution: selection; variation; and, the historical background of selective breeding and heredity. Then, the course will cover (2) population genetics and the modern evolutionary synthesis, (3) chromosomal theory and the central dogma of molecular biology, (4) phylogenetics, diversity, and common descent, and (5) molecular genetics, which will be introduced in the context of bacterial gene regulation and gene regulatory networks. The course will end with a discussion on (6) genomics, post-genomics, and epi-genomics.

Class materials will come from the primary and review literature, modern and historical. 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
- Analyze experimental strategies and key studies of evolutionary genetics, focusing on specific examples of advancements in understanding of hereditary disorders and genetic conditions
- Discuss early paradigms of selective breeding and hereditary, the "Modern Synthesis," the discoveries of chromosomal inheritance, 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

Prerequisites: undergraduate-level genetics course.

GENE 500

Fall and Spring, 2 credits

Introduction to Medical Genetics I and II

Suzanne Hart*, Maximilian Muenke

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.

Topics to be covered in the fall semester include Mendelian and non-Mendelian inheritance, congenital malformations, dysmorphology, teratology, storage disorders and other inborn errors of metabolism, mitosis, meiosis, structural abnormalities and segregation, X chromosome inactivation, new advances in cytogenetic technology including FISH, the molecular organization, regulation and manipulation of genes.

In the spring semester, topics will include genetic polymorphism and disease susceptibility, DNA diagnosis, prenatal and pre-implantation diagnosis, multifactorial inheritance, population genetics, linkage analysis, oncogenes, tumor suppressor genes, the molecular basis of breast and colon cancer and relevant counseling issues, genetic disorders of specific organ systems, newborn screening, gene therapy, the consumer's view of genetic services and ethics and genetic technology. This course should impart basic principles of genetics as applied to medicine and provide an approach to a patient with a suspected genetic disorder.

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.

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

Learning objectives—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

Prerequisites: graduate-level training or experience in the biomedical sciences or consent of the course instructor.

GENE 505

Fall 2017, Alternate Years, 1 credit

Embryology, Developmental Biology and Human Malformations

Leslie Biesecker

The objective of this course is to familiarize students with modern developmental biology and 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

Prerequisites: permission of the course instructor.

GENE 510

Fall and Spring, 2 credits

Genetic Counseling: Professional Topics Seminar

Barbara Biesecker*, Lori Erby

Tuition: $600

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 the graduate students enrolled in the JHU/NHGRI Genetic Counseling Training Program.

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

Prerequisites: permission of the instructors.

GENE 514

Spring, 1 credit

Current Concepts in Clinical Molecular Genetics and Molecular Diagnostics

Suzanne Hart

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

Prerequisites: GENE 500 and permission of the instructor.

GENE 518

Fall 2018, Alternate Years, 2 credits

Medical Genetics and Genomic Medicine: From Diagnosis to Treatment

Suzanne Hart, Maximilian Muenke*

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.

Learning objectives:

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

Prerequisites:
GENE 500 or permission of the instructor.

GENE 644

Spring 2019, Alternate Years, 2 credits

Review of Medical Genetics

Suzanne Hart

Tuition: $600

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

Prerequisite:
Board candidate for any subspecialty exam of the American Board of Medical Genetics.

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IMMUNOLOGY AND MICROBIOLOGY

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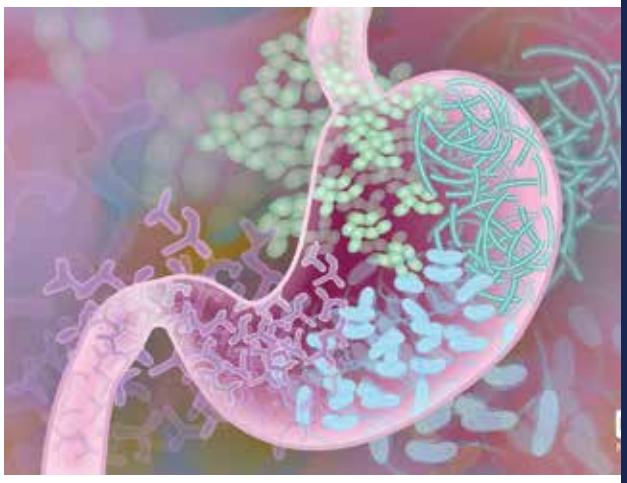
JOHN FINERTY, CHAIR

FALL	IMMU 325	The Human Microbiome: New Concepts in Health and Disease *(7 weeks)*
FALL	IMMU 403	Basic Principles of Immunology and Hypersensitivity
FALL	IMMU 419	Cancer Immunotherapy
FALL	IMMU 521	Molecular and Cellular Mechanisms of Immunity I
SPRING	IMMU 522	Molecular and Cellular Mechanisms of Immunity II
FALL	MICR 317	Molecular Virology
SPRING	MICR 418	Emerging Infectious Diseases
SPRING	MICR 432	Human Virology

IMMU 325

Fall, 1 credit (7 weeks)

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 the 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

Prerequisites: general knowledge of biology or consent of instructor.

IMMU 403

Fall, 2 credits

Basic Principles of Immunology and Hypersensitivity

John Finerty, Hans Spiegel

The immune system encompasses a broad highly interactive network of cells, tissues, and anatomical structures in our body that protects us from infection and cancer and 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 throughout the course. 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:

- Gain knowledge on key cellular components of the immune response
- Distinguish the function of innate/natural and adaptive immune systems
- Understand 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
- Learn how cytokine activity affects cell signaling and function
- Understand how the immune system plays a role in the resistance to infection, induction of allergies, autoimmunity, and cancer

Prerequisites: familiarity with cell biology.

IMMU 419

Fall, 2 credits

Cancer Immunotherapy

Elad Sharon, Howard Streicher

Over the past decade, new therapies have led to the successful application of basic immunologic principles to treat human malignancies. The development of adoptive T cell transfer and the use of monoclonal antibodies to turn on an inhibited or 'exhausted' immune system are the type of radical innovations that are generating a remarkable series of clinical results. New concepts are emerging to explain how even large tumors can be eliminated or controlled for long periods of time.

The course will discuss the successes of the newly emerging era of the immunotherapy of cancer. The course will emphasize the remarkable accomplishments of the past five years in molecular and immune biology, as well as will provide a detailed review of emerging therapies using adoptive T cell transfer and immune check point inhibitors, prospects for new agents, and the application of biomarkers and bioinformatics in this rapidly developing field. Throughout, the course aims to provide an underlying framework for how the human immune system functions in infectious diseases, tumor immunity, and in immune-mediated adverse events.

Learning objectives:

- Gain an understanding of the rapidly emerging results in basic and clinical studies using innovative therapies for human malignancies
- Develop theoretical and practical framework for studying the human immunology of infectious disease, malignancy, and autoimmunity
- Understand the nature of 'final common pathway' of successful T cell-mediated immunotherapy

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

IMMU 521

Fall, 2 credits

Molecular and Cellular Mechanisms of Immunity I

B. J. Fowlkes, Pierre Henkart*

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

Prerequisites: previous immunology course or working knowledge of basic immunology. IMMU522 is designed as a follow-up.

IMMU 522

Spring, 2 credits

Molecular and Cellular Mechanisms of Immunity II

Scott Durum

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 designed as a follow-up to the fall-semester course, IMMU 521. It is a series of lectures by NIH researchers covering basic science and clinical aspects of adaptive and innate immunity to viruses, parasites, and bacteria. AIDS, primary immune deficiencies, autoimmunity, allergy, and asthma will be discussed. Lectures on cytokines and their receptors will include interleukins, interferons, chemokines, the TNF family, TGFs, and virokines. Regional immune systems of the skin and bowel will be discussed. Bone marrow transplantation and immunotherapy of cancer will be covered.

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

Prerequisites: previous immunology course or working knowledge of basic immunology, IMMU 521, or equivalent.

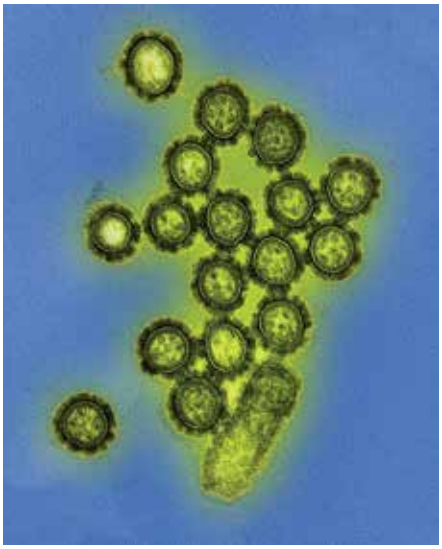
MICR 317

Fall, 2 credits

Molecular Virology

Suresh K. Arya*, Cristina Bergamaschi

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 discussion 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

Prerequisites: background in biochemistry/molecular biology and microbiology or consent of the faculty.

MICR 418

Spring, 3 credits

Emerging Infectious Diseases

Robert Hall

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 to 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

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.

Students interested in acting as a TA, please email faculty at emerginginfections@verizon.net.

MICR 432

Spring, 2 credits

Human Virology

Suresh K. Arya*, Cristina Bergamaschi

This course will begin with the description of diseases that turned out to be caused by viruses, such as cancer and AIDS, from antiquity to the present. This will lead to the methods of discovery of viruses, their general properties, modes of infection and propagation, genetics and evolution, viral pathogenesis, and host defense. This will be followed by a consideration of select viruses and diseases in organ systems, such as respiratory tract, nervous system, blood-born infections, and sexually transmitted infections.

Learning objectives:

- Acquire fundamental and practical knowledge of virology and human viral infections
- Discuss how viruses infect some hosts and not others, as well as the diverse mechanisms of infection that viruses employ
- Consider why some infections become epidemic, while others remain self-limiting
- Illustrate viral reproduction strategies and host-defense strategies
- Identify gaps in our knowledge of virology and consider why it is so difficult to control viral infections

Prerequisites: college graduate; knowledge of biology or consent of the instructor.

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SUZANNE EPSTEIN, CHAIR

FALL	ENGL 105	Fundamental English Conversation I
SPRING	ENGL 108	Fundamental English Conversation II
FALL	ENGL 205	Intermediate English Conversation I
SPRING	ENGL 207	Intermediate English Conversation II
FALL	ENGL 302	Advanced English Conversation I
SPRING	ENGL 304	Advanced English Conversation II
FALL	ENGL 305	Advanced English Written Grammar I
SPRING	ENGL 306	Advanced English Written Grammar II
FALL, SPRING	ENGL 308	Practice Your American English Pronunciation
FALL, SPRING	ENGL 355	English Listening and Conversation: Insights into U.S. Culture, Science, and Society *(10 weeks)*
FALL	FRCH 101	French for Beginners I
SPRING	FRCH 102	French for Beginners II
FALL	ITAL 101	Italian for Beginners I *(10 weeks)*
SPRING	ITAL 102	Italian for Beginners II *(10 weeks)*
FALL	SPAN 101	Spanish for Beginners I
SPRING	SPAN 102	Spanish for Beginners II
FALL, SPRING	SPAN 208	Spanish for Healthcare Providers
FALL	GENL 098	Argentine Tango 101: Learn and Dance! *(7 weeks)*
SPRING	GENL 099	Argentine Tango 201: Learn and Dance! *(7 weeks)*
SPRING	GENL 195	Mindfulness and Stress Reduction *(8 weeks)*
FALL	GENL 275	Introductory American Sign Language
FALL, SPRING	GENL 319	Concepts in Science for MCAT Preparation
FALL, SPRING	GENL 319-PSY	Concepts in Psychology for MCAT Preparation *(7 weeks)*
FALL, SPRING ONLINE	GENL 322	GRE Review *(7 weeks)*
SPRING	GENL 375	Intermediate American Sign Language
SPRING	GENL 511	Boot Camp for University Teaching

ENGL 105

Fall, 3 credits

Fundamental English Conversation I

Fran Miller

This course is designed to assist students who have already studied English, but whose ability to express ideas through oral communication is limited. The core emphasis of the course is on improving rhythm, intonation, stress, and individual vowel/consonant sounds, with the goal of developing good conversational skills. This process will help students to express ideas clearly in spoken English and to improve communication both in the workplace and in daily life. Idiomatic usage, useful vocabulary, and sentence structure will be also covered to help students to communicate orally more effectively and fluently.

Discussions of American culture and customs will be also incorporated to develop language skills. To enhance learning and personalized practice, the course will take advantage of online learning tools and computer programs.

Learning objectives:

- Converse with general clarity using pronunciation and intonation patterns that allow for overall intelligibility
- Demonstrate effective word choice, vocabulary, idioms, grammar, and sentence structure
- Articulate ideas clearly in conversation
- Develop effective listening skills and respond appropriately to other speakers

ENGL 108

Spring, 3 credits

Fundamental English Conversation II

Fran Miller

This course is a continuation of ENGL 105.

ENGL 205

Fall, 3 credits

Intermediate English Conversation I

Fran Miller

The goal of this course is to enable intermediate learners of English to understand and speak English more accurately, confidently, and fluently. New vocabulary and idioms will be embedded in oral exercises, conversation models, pair-work activities and listening texts. Students will learn to listen for details and to summarize not only workplace lectures, but also conversations they hear in everyday situations in the cafeteria, on the bus, and at social gatherings. The oral topics studied are very current and will motivate students to speak with confidence. Fascinating discussions and debates will be developed and facilitated. Students will improve accents, rhythm, intonation, and stress patterns. Individual weekly student oral reports will be analyzed and evaluated to assist students in improving their spoken English. To enhance learning and personalized practice, the course will also take advantage of online learning tools and computer programs.

Learning objectives:

- Increase active conversational skills to intermediate level by improving accent, vocabulary, and grammar
- Build confidence by improving conversational skills
- Increase professional and personal success at a U.S. workplace and in daily life

Prerequisites: ENGL 108 or equivalent.

ENGL 207

Spring, 3 credits

Intermediate English Conversation II

Fran Miller

This course is a continuation of ENGL 205.

Prerequisite: ENGL 205 or equivalent.

ENGL 302

Fall, 3 credits

Advanced English Conversation I

Fran Miller

This course incorporates methodologies to improve students' ability to communicate effectively in spoken English. Accent reduction techniques through proper usage of vowel and consonant sounds, stress, and intonation are emphasized, so students can be understood more easily in both the workplace and everyday life. Extensive oral idiomatic usage and vocabulary building are incorporated into the program. Advanced conversation and listening selections for English comprehension and expression improvement will be utilized. Discussions, debates, and improvisations will be conducted at the advanced level. American cultural topics will be explored. Weekly oral reports will be thoroughly analyzed. To enhance learning and personalized practice, the course will also take advantage of online learning tools and computer programs.

Learning objectives:

- Reduce foreign accent and increase conversational skills to the advanced level
- Improve ability to debate ideas
- Improve ability to summarize meetings, events, and articles at the advanced level
- Move up more quickly on the professional ladder

Prerequisites: ENGL 205 or 207 or equivalent or permission of instructor.

ENGL 304

Spring, 3 credits

Advanced English Conversation II

Fran Miller

This course is a continuation of ENGL 302.

Prerequisites: ENGL 302 or permission of the instructor.

ENGL 305

Fall, 3 credits

Advanced English Written Grammar I

Fran Miller

This course is designed for non-native English speakers who need improvement in communicating their ideas correctly in writing. The course will tackle a great variety of grammatical forms, structures, and writing techniques in order to guide students in how to convey ideas in writing clearly and accurately. By the end of the semester, students will be able to analyze and practice writing interoffice reports, emails, and letters, with the goal of acquiring writing skills for various target audiences. To enhance learning and personalized practice, the course will also take advantage of online learning tools and computer programs.

Learning objectives:

- Improve ability to convey ideas in written English by using correct grammar in written English
- Enhance and polish English writing skills
- Facilitate comprehension of ideas and thoughts in written words for colleagues, business associates, and friends

Prerequisite: contact instructor for details.

ENGL 306

Spring, 3 credits

Advanced English Written Grammar II

Fran Miller

This course is a continuation of ENGL 305.

Prerequisite: ENGL 305 or equivalent; contact instructor for details.

ENGL 308

Fall and Spring, 3 credits

Practice Your American English Pronunciation

Katherine Grossman

The goal of this course is to help students become more confident and effective communicators in spoken English. It will help them to identify and improve the areas of their speech that are unclear. Intermediate and advanced speakers of English as a second language can still struggle to be understood by native speakers. Whether students give presentations of their work, chat informally with their colleagues, or speak to potential employers, communicating clearly in English is critical. This course will focus on stress and intonation, as well as vowels and consonants in American Standard English. There will be time dedicated to listening skills, idiomatic language, collocations, and conversational skills. The instructor and fellow students will provide feedback on both the speaker's pronunciation and presentation skills, such as voice projection and eye contact. Since a student's native language influences his or her accent in a foreign language in specific ways, an individual screening will identify the areas for each student to work on independently.

Learning objectives:

- Modify pronunciation of spoken American English to increase comprehensibility in personal and professional environments
- Gain confidence in speaking English
- Identify weaknesses that cause communication breakdowns
- Apply knowledge of features of spoken American English to improve communication skills

Prerequisites: ENGL 205 or 207 or equivalent or permission of the instructor.

ENGL 355

Fall and Spring, 3 credits each semester (10 weeks)

English Listening and Conversation: Insights into U.S. Culture, Science, and Society

Jennifer Kagan - English Now!

This course is designed for biomedical researchers 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.

Targeted listening practice and readings will be followed by class discussions on topics related to science, medicine, technology, as well as U.S. culture. Students will increase their academic vocabulary and fluency in English and will be able to practice new ways to express and debate issues and ideas related to current affairs and science research. Throughout the course, students will develop their knowledge of English grammar and will have the chance to practice and improve their pronunciation.

Listening selections will include stories and reports from National Public Radio and Ted Talks. In addition to class discussions, students will engage in debates, role plays, and formal presentations. This course will increase students' confidence and effectiveness when using English at work and in daily life.

Learning objectives:

- Listen to spoken English with a high degree of accuracy
- Articulate the main ideas and key details of a story or report
- Express a personal opinion or argument using persuasive, effective language
- Discuss issues with a wide range of relevant vocabulary and increased fluency, especially as they relate to biomedical research and technology

FRCH 101

Fall, 3 credits

French for Beginners I

This introductory French course will focus on oral and written communication, listening and reading, pronunciation, grammar, as well as French culture and francophonie. Lessons will be based on immersion into authentic situations and will include conversation, role-play and short composition.

Learning objectives:

- Greet and talk about oneself (identity, interests, profession); locate places in a town and understand an itinerary; make travel reservations
- Understand and use basic grammatical structures, including present tense
- Write a short text

FRCH 102

Spring, 3 credits

French for Beginners II

This course is a continuation of FRCH 101. Students will expand their use of vocabulary and grammar as well as oral and written expression and comprehension skills.

Learning objectives:

- Tell the time and ask hours of operation; discuss daily activities using reflexive verbs; conduct phone conversations; tell events in the past
- Understand and use imperative, future tense, and past tense
- Write a short letter

ITAL 101

Fall, 2 credits (10 weeks)

Italian for Beginners I

Nicoletta Aiken - The Italian Cultural Society of Washington, D.C.

This course will teach students basic Italian grammar as well as proper pronunciation. It will cover basic conversations, using the present tense; medical terminology will be taught. The course format includes guided conversations, role play, readings, listening comprehension, exercises from the text book and other sources, including songs and videos.

Throughout the course, references to biomedical and healthcare terminology and situations will be made.

Learning objectives:

- Greet and introduce oneself in a formal and informal way
- Describe objects and people, learning gender distinction for nouns and adjectives
- Ask and give information and directions (time, days of the week and months, numbers, street direction)
- Converse in the present tense in everyday as well as in medical situations

ITAL 102

Spring, 2 credits (10 weeks)

Italian for Beginners II

Nicoletta Aiken - The Italian Cultural Society of Washington, D.C.

This follow-on course will further build student's foundation of Italian grammar by covering irregular verbs, modal verbs, and past tense. The course will also focus on improving students' use of adjectives and prepositions. The conversations will cover daily activities at work, incorporating medical terminology at the same time. Vocabulary will be also built by discussing leisure time, inviting or accepting/declining invitations, describing one's home, expressing possession and doubts. The course format includes guided conversations, role play, readings, listening comprehension, exercises from the textbook and other sources, including songs and videos.

Throughout the course, references to biomedical and healthcare terminology and situations will be made.

Learning objectives:

- Write letters and emails
- Communicate on the telephone
- Communicate at the restaurant, bar, and in similar situations
- Describe events and trips, using the past and the future tenses

Prerequisites: ITAL 101 or equivalent.

SPAN 101

Fall, 3 credits

Spanish for Beginners I

Humberto Segura

This course is an introduction to the Spanish language within a cultural context. It will emphasize the development of basic listening, speaking, and reading skills. Other competencies such as comprehension, pronunciation, reading, and role-playing will be also practiced in class. Class time will include vocabulary building, language drills, and communication activities in order to introduce students to Hispanic culture.

Learning objectives:

- Express orally basic ideas in Spanish
- Identify some high-frequency words and expressions and use them at a rudimentary level
- Understand basic reading texts written in simple present tense

SPAN 102

Spring, 3 credits

Spanish for Beginners II

Humberto Segura

This course is the continuation of SPAN 101. It is an introduction to the Spanish language, with emphasis on basic communication skills. Other competencies such as comprehension, pronunciation, and reading are will be also practiced in class. Class time will include vocabulary building, language drill, and communication activities to introduce students in order to Hispanic culture.

Learning objectives:

- Express orally basic ideas in Spanish
- Identify some high-frequency words and expressions and use them at a rudimentary level
- Understand basic reading texts written in simple present tense

Prerequisites: SPAN 101 or equivalent.

SPAN 208

Fall and Spring, 3 credits

Spanish for Healthcare Providers

Humberto Segura

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, 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. It includes basic Spanish concepts and correct pronunciation.

Some basic knowledge of Spanish is helpful, but anyone who wants to increase their verbal skills will benefit from this 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

Prerequisites: some basic knowledge of Spanish is recommended, but students who wish to increase their verbal skills will also benefit from this course.

GENL 098

Fall, 1 credit (7 weeks)

Argentine Tango 101: Learn About It and Dance!

Mirjana Nesin, Joshua Rigley*

This course will introduce students to a beautiful dance with multiple benefits on the physical, emotional, and social aspects of life. For thousands of dancers worldwide, Argentine tango is a lifelong passion and hobby. The course will consist of practical (dance technique) and theoretical (history, tango culture, music, etc.) parts. Students will learn basic aspects of three related dances: tango; milonga; and, vals. The ultimate goal of the course is to enable students to attend social dances—milongas. At the end of the course, students will be invited to attend a local milonga.

Learning objectives:

- Dance posture, axis, balance, 'tango walk'; basic steps and figures
- Improvise through nonverbal communication between leader and follower
- Develop a sense of musicality: interpret music (rhythm and melody) through body motion

Prerequisites: none; students should bring comfortable shoes with leather soles.

GENL 099

Spring, 1 credit (7 weeks)

Argentine Tango 201: Learn About It and Dance!

Mirjana Nesin, Joshua Rigley*

Argentine tango provides a vast opportunity for improvisation and self-expression. Similarly to learning languages or sports, tango dancers improve by taking classes and practicing for years. This course will further refine students' tango technique and introduce more complex concepts and figures. On alternating weeks, students will learn new material and participate in guided practice. The ultimate goal is to enable students to dance comfortably at milongas and attend more advanced classes by local and guest teachers.

Learning objectives:

- Learn new elements such as sacadas, barridas, boleos, ganchos, etc.
- Integrate combination of elements into dance
- Deepen communication between leader and follower
- Refine interpretation of tango music

Prerequisites: Tango 101, or equivalent experience in dancing tango; comfortable shoes with leather soles.

GENL 195

Spring, 2 credits (8 weeks)

Mindfulness and Stress Reduction

Rezvan Ameli

LOCATION: Shanti Yoga Center for Harmony, Bethesda

This experiential and participatory course will introduce students to the practice of mindfulness, with focus on guided instructions and cultivation of mindfulness, gentle stretching and movement, group dialogue and home practice. Mindfulness is a set of timeless practices most fully articulated by the Buddha 2,500 years ago. Interest in mindfulness and its beneficial effects on health and well-being have greatly blossomed in the West in recent years. The application of mindfulness in medicine and stress reduction has also vastly increased.

No prior experience with meditation and reflective practices is required. This class can complement, but is not a substitute for, medical, psychological, and/or psychiatric treatment. If you have any concerns about the appropriateness of this course for your well-being, please consult your care provider. In case of serious conditions or disability, please contact the course instructor prior to registration to evaluate whether you would benefit from participation at this time.

First eight sessions will consist of 2.5-3-hour workshops. On the last week, on Saturday, there will be a full-day 'Mindful Day' retreat.

Learning objectives:

- Learn and practice a number of mindfulness techniques and their application, such as mindful breathing, body scan, mindful walking, and mindful eating
- Acquire skills to apply mindfulness practices in daily life
- Understand the importance of taking steps towards developing a regular mindfulness practice
- Experience the impact of practicing mindfulness on reducing stress

GENL 275

Fall, 3 credits

Introductory American Sign Language

Michael Dunham

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

GENL 319

Fall and Spring, 2 credits each semester

Concepts in Science for MCAT Preparation

Stefan Barisic (biology), Cody Peer* (chemistry), Lisa Rastede (organic chemistry), Bora Sul (physics)

This review course prepares students for the Medical College Admission Test (MCAT). For a complete description of MCAT exam prerequisites and eligibility, please visit **www.aamc.org**. If you have not completed the prerequisites for taking the MCAT and have questions about this course, please contact the instructors. This course extends beyond a review of general biology, chemistry, and physics. It also reviews problem-solving, critical-thinking, and writing skills, as well as scientific concepts and principles required for the study of medicine. The course provides students with rigorous coursework and extracurricular assignments to expand their foundational knowledge and increase practice in using that knowledge specifically for critical analysis and problem solving. It enables students to devote time to reviewing relevant material for MCAT preparation.

The course has 16 units; one will be covered each week. Each unit covers a portion of Physical Sciences, Verbal Reasoning, and Biological Sciences. This is a systematic review, covering each unit in an organized way, using a PowerPoint slide format and in-class problem solving. Homework will be presented in the multiple-choice format of the MCAT and is suitable for class, group, and individual instruction. Students will be expected to identify topics that are unfamiliar and to use their graduate textbooks and notes as applicable.

Learning objectives:

- Review major disciplines and concepts for each MCAT section
- Understand basic scientific concepts and principles as they pertain to living organisms
- Apply foundational knowledge to solving problems presented in MCAT format
- Critically analyze discipline-specific text passages and arguments

GENL 319 – PSY

Fall and Spring, 1 credit each semester (7 weeks)

Psychology for MCAT Preparation

Sarah Williams

This course will cover concepts tested on the psychology and sociology portion of the MCAT. It is designed for students who have no background in the subject and want to do well on this portion of the test. Instruction will cover a review book from the Princeton Review. Specifically, the course will cover strategy for the following portions of the MCAT: biological foundations of behavior; interaction with the environment (attention, cognition, consciousness, etc.); learning and memory; personality; motivation; psychological disorders; self and group identity.

This course will also complement the skills of researchers working in neuroscience, mental health, addiction or physiology.

Learning objectives:

- Understand the basic structure of the nervous system
- Learn how the brain receives, processes, and sends signals
- Become familiar with basic psychology principles
- Complete practice questions

GENL 322

Fall and Spring, 1 credit each semester (7 weeks)

ONLINE GRE Review

Tristan Sissung

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

GENL 375

Spring, 3 credits

Intermediate American Sign Language

Michael Dunham

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 course is designed to build on the foundations taught in the Introductory American Sign Language course. The goal is to provide students with a way to be able to express themselves freely among members of the Deaf community.

Learning objectives:

- Use simple and complex sentences, accuracy of expression, and variety in style
- Employ non-manual grammar and facial expressions to match the appropriate signs
- Participate in more challenging conversations, modify the signs to use in new situations
- Develop and employ lexicalized fingerspelling in everyday situation
- Understand and develop the use of classifiers to describe appearance, location, and motion
- Create an anecdote using American Sign Language

GENL 511

Spring, 2 credits

Boot Camp for University Teaching

Andrew DuFresne, Don Ho, Barbora Piknova*, Laxminath Tumburu

This course is designed for researchers and other professionals interested in teaching at colleges and universities. Specific topics include systematic and proven methods of developing dynamic lectures, laboratory activities and student-centered learning. Templates for constructing syllabi, lesson plans, lecture schedules and novel ways to appeal to a wide variety of learning styles will be provided. Opportunities will be given to develop and present sample lectures on nanomedicine.

Special attention will be given to help build individual strategies for applying for college and university faculty positions, thus increasing future employment options.

Learning objectives:

- Practice lecturing on unfamiliar topic in front of a real class
- Understand different components of a teaching portfolio
- Receive help to assemble a teaching portfolio

Prerequisites: graduate degree.

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MEDICINE AND PHYSIOLOGY

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JOHN TISDALE, CHAIR

FALL	MEDI 211	Principles of Endocrinology *(10 weeks)*
FALL	MEDI 217	Human Physiology I
SPRING	MEDI 218	Human Physiology II
SPRING	MEDI 234	Precision Medicine *(8 weeks)*
FALL	MEDI 275	Fundamental Principles of Histology *(10 weeks)*
FALL	MEDI 303	Introduction to Acupuncture and Traditional Chinese Medicine *(8 weeks)*
FALL	MEDI 309	Introduction to Molecular Medicine
FALL	MEDI 339	Introduction to Cancer Biology
SPRING	MEDI 345	Human Anatomy
SPRING 2019-ALT	MEDI 507	Inborn Errors of Metabolism
SPRING NEW	MEDI 510	Advances in Metastasis Research *(7 weeks)*

MEDI 211

Fall, 2 credits (10 weeks)

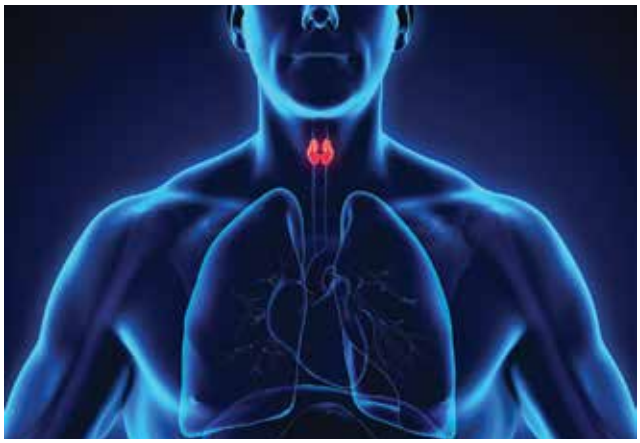
Principles of Endocrinology

Victor Krauthamer

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



Prerequisites: general biology and chemistry required; prior coursework in introductory biochemistry and human physiology recommended.

MEDI 217

Fall, 2 credits

Human Physiology I

Victor Krauthamer

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: nervous; musculoskeletal; blood and lymphatic; and, cardiovascular systems.

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

Prerequisites: general biology; BIOL 101 or equivalent.

MEDI 218

Spring, 2 credits

Human Physiology II

Victor Krauthamer

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; digestive; endocrine; and, reproductive systems.

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

Prerequisites: general biology; BIOL 101 or equivalent; MEDI 217 Human Physiology I or equivalent.

MEDI 234

Spring, 1 credit (8 weeks)

Precision Medicine

Jaira Ferreira de Vasconcellos*, Sabrina Helmold Hait

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 the 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 the previous objectives, including caveats in the use of current technologies

MEDI 275

Fall, 2 credits (10 weeks)

Fundamental Principles of Histology

Nicole DeVaul

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 then 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

Prerequisites: knowledge of biology and/or cell biology.

MEDI 303

Fall, 1 credit (8 weeks)

Introduction to Acupuncture and Traditional Chinese Medicine

Ashley Xia

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 the traditional Chinese medicine and modern science.

Learning objectives:

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

Prerequisites: basic medical knowledge.

MEDI 309

Fall, 2 credits

Introduction to Molecular Medicine

Mauro Tiso*, Patrick Weitzel

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

Prerequisites: open to everyone who has a basic (undergraduate) knowledge of biology and/or chemistry.

MEDI 339

Fall, 2 credits

Introduction to Cancer Biology

Jennifer Symonds, Sundaresan Venkatachalam*

This course will cover the genetic basis of cancer, initiation and progression of cancer, signal transduction, tumor microenvironment and metastasis. Additional topics will include cancer genomics, epithelial to mesenchymal transition, adhesion, angiogenesis, targeted therapies, and animal models. 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:

- Identify cancer biology terms and apply terms and information in textbook to case studies
- Discuss and present a scientific paper in detail (background information, experimental design, and findings)

MEDI 345

Spring, 2 credits

Human Anatomy

Nazzarena Labo

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 undergraduates 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:

- Master principles of human anatomy using a systemic approach
- Revise fundamentals of embryology and general micro-anatomy (histology)
- Learn macro-anatomy, including musculo-skeletal, nervous, cardiovascular, respiratory, digestive, urogenital, and endocrine systems
- Acquire ability to understand how anatomical systems interact and how structural and functional characteristics of tissues, organs, and systems are intimately interdependent
- Describe topographic anatomy of selected regions

Prerequisite: college degree; basic knowledge of cell biology.

MEDI 507

Spring 2019, Alternate years, 3 credits

Inborn Errors of Metabolism

Carlos Ferreira

The objective of this course is to provide on 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. The faculty will add to the class by offering experience, and, when possible, presenting individual cases. 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 Medial Genetics examination in biochemical genetics.

Prerequisites: graduate degree; this is an advanced course, largely geared toward Ph.D.s and M.D.s.

MEDI 510

Spring, 1 credit (7 weeks)

NEW Advances in Metastasis Research

Nancy Boudreau*, Shannon Hughes

This course will cover recent advances in the field of cancer metastasis. The topics to be covered will include: 1) early metastatic dissemination and circulating tumor cells; 2) acquisition of the metastatic phenotype; 3) intravasation and extravasation; 4) conditioning of the metastatic niche; 5) metastatic dormancy; 6) emergence from dormancy and

colonization; 7) systems biology approaches to study metastasis. Each class will consist of an introductory lecture to the topic, followed by student-led presentations of two recent papers describing novel findings relevant to the topic. The course will cover novel and high-impact publications relevant to metastasis in the current scientific literature.

Learning objectives:

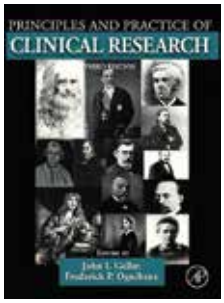
- Gain in-depth knowledge and an overview of current research in the field of metastasis
- Get an introduction to methods and models used for current research in metastasis
- Identify unresolved questions and barriers to progress in understanding metastasis

Prerequisites: advanced degree in biological sciences.

OFFICE OF CLINICAL RESEARCH TRAINING AND MEDICAL EDUCATION

Introduction to the Principles and Practice of Clinical Research - ONLINE

Course Directors: John I. Gallin; Laura Lee Johnson; Frederick P. Ognibene
Course Coordinator: Daniel McAnally



The primary objective of this course is to provide an overview of the principles and practice of clinical research to individuals who are interested in learning how to effectively and safely conduct clinical research studies. The course is divided into modules and contains information on scientific, biostatistical, bioethical, legal, regulatory, clinical research quality, research compliance, and other issues important for the conduct of clinical research. The IPPCR course is conducted entirely online each year from September through May.

The course is comprised of approximately 40 online lectures. The lectures are didactic and cover all aspects of clinical research and also include practical experiences such as a mock institutional review board (IRB) and case studies. The length of the individual lectures ranges from 30 to 120 minutes. The entire course takes approximately 50 hours to watch, and participants will need additional time for course readings, discussion board participation, and for the online multiple choice final examination. There is no cost to register.

The IPPCR course will be of interest to physicians, scientists, medical students, nurses, pharmacists, biostatisticians, epidemiologists, and all other health professionals engaged in or planning a career in clinical research.

For more information on the topics covered in this course, general information, information on registration, the final exam, and how to get your certificate of completion, please visit the course website at: **https://clinicalcenter.nih.gov/training/training/ippcr1.html**.

For questions, please email the course coordinator at: **IPPCR2@mail.nih.gov.**

Demystifying Medicine

Tuesdays: January through May
4:00pm - 6:00pm
Building 50 Conference Room (unless otherwise noted)

THE COURSE: Demystifying Medicine Series, jointly sponsored by FAES and NIH, features the presentation of patients, pathology, diagnosis and therapy in the context of major disease problems and current research. Primarily directed toward Ph.D. students, clinicians and program managers, the course is designed to help bridge the gap between advances in biology and their application to major human diseases. Each session includes clinical and basic science components presented by NIH staff and invitees. Students, fellows and staff are all welcome.

SIGN UP: Register through the course email list. To subscribe to this email list, send an email message to this address: **Listserv@List.nih.gov**. Substituting your name for Jan Doe's, the body of your message should say: Subscribe DeMystifyingMed Jan Doe. Alternatively, you may sign up for Demystifying Medicine through the **ListServ website**, and enter your name and email address.

COURSE INFORMATION: For most up-to-date information about time and location, please check the Demystifying Medicine website: **http://demystifyingmedicine.od.nih.gov/**

Recommended reading, PowerPoint notes and other information will be distributed through the: Demystifying Medicine website and email list. Registrants who attend at least 10 sessions and pass a computerized final exam will receive a certificate. Classes will be available at **http://videocast.nih.gov**.

Please contact Dr. Win Arias at ariasi@mail.nih.gov for further course information. For additional information, sign language interpretation, or accommodations for disabilities, please contact the Federal Relay 1-800-877-8339.

ADVANCED STUDIES IN PUBLIC HEALTH

WHAT IS PUBLIC HEALTH?

Public health addresses the needs of human populations and focuses on protecting and improving the health of entire communities while they are still healthy. The field of public health can be distinguished by this proactive, preventive approach and a focus on the community as its patient rather than an individual. To learn more about public health, visit **http://www.apha.org**, or **http://www.101careersinpublichealth.com**, or **http://publichealthbuyersguide.com/.**

ADVANCED STUDIES IN PUBLIC HEALTH

FAES Graduate School at NIH offers a unique Advanced Studies in Public Health, developed to broaden the perspective and enhance the skills of current health sciences professionals as well as to give a competitive edge to those who are considering a career in public health. The program is designed to build competencies in the five core disciplines of public health, as defined by the Association of Schools of Public Health (ASPH):

- epidemiology
- biostatistics
- environmental health sciences
- health policy and management
- social and behavioral sciences.

The program culminates in a **Capstone Project** through which students will be required to demonstrate their understanding and mastery of core disciplinary knowledge and the practice of public health.

ADVANCED STUDIES IN PUBLIC HEALTH WITH A SPECIAL EMPHASIS ON GLOBAL HEALTH

Students who have completed all the required coursework for the Advanced Studies in Public Health, with a capstone project focused on global health, and who have, in addition, taken both PBHL 500 Introduction to Global Health and PBHL 533 Chronic Diseases in Global Health courses will be awarded a certificate of completion as follows: "Advanced Studies in Public Health With a Special Emphasis on Global Health."

GENERAL REQUIREMENTS

The Advanced Studies in Public Health is open to persons with a Bachelor's degree or above. Courses are offered in the evenings, generally on the NIH campus in Bethesda, making it convenient for working professionals and postgraduate/postdoctoral Fellows to acquire expertise in public health and enhance current employment position or to take the first step on a career path in public health.

Students are required to complete a 21-credit curriculum comprised of seven required courses. The Advanced Studies in Public Health can be completed in two years, although students can complete the requirements at their own pace.

Shortly after I took up appointment with the Radiation Epidemiology Branch at the National Cancer Institute (NCI), I desired to know more about epidemiologic research. So, I enrolled in FAES classes. These classes helped to satisfy my heart's desire and provided the needed insight and knowledge to do my work better, as well as to understand the technical content of the Branch/Division's seminars and presentations. The courses I enjoyed most were social and behavioral sciences as well as environmental epidemiology. They helped me to understand the importance of the social milieu as a determinant of public health outcome, which has motivated me to explore opportunities, including further studies on how to help improve the health infrastructure in my home country Nigeria.

Epidemiology Program Specialist, National Cancer Institute

Students planning to pursue a Masters of Public Health degree at an accredited university or college are responsible for contacting the institution to determine if credits earned for FAES courses can be transferred under the university's transfer policy.

LEARNING OUTCOMES

Upon completion, students will be able to:

- Apply statistical reasoning and methods to address, analyze, and solve problems in public health, healthcare, biomedical, clinical and population-based research
- Describe and explain patterns of disease and injury in human populations and apply this study to the control of health problems
- Understand and describe environmental factors, including biological, physical and chemical factors that affect the health of a community
- Explain and describe factors that affect the delivery, quality, and costs of healthcare for individuals and populations; understand from a managerial and policy perspective the structure, process, and outcomes of health services, including the costs, financing, organization, outcomes, and accessibility of care
- Describe and explain behavioral, social and cultural factors related to individual and population health and health disparities; understand how programs and policies in public health and health services promote and sustain healthy environments and healthy lives for individuals and populations

As a basic research scientist, the advanced studies helped me to extend my professional experience, building solid foundations in the core disciplines of public health. I also had the chance to apply my scientific knowledge and experience to global and public health topics. I expect this experience to serve as a first step in transitioning from basic research to careers in public health.

Visiting Fellow, National Institute of Diabetes and Digestive and Kidney Disease

REQUIRED COURSES

STAT 317	Introduction to Epidemiology
STAT 500 I	Statistics for Biomedical Scientists I
STAT 500 II	Statistics for Biomedical Scientists II
PBHL 501	Environmental Health Sciences
PBHL 512	Social and Behavioral Sciences
PBHL 517	Health Policy and Management
PBHL 607	Capstone Project in Public Health

COURSES OFFERED BY OTHER DEPARTMENTS THAT ARE REQUIRED COURSES FOR ADVANCED STUDIES IN PUBLIC HEALTH

STAT 317	Introduction to Epidemiology
STAT 500 I	Statistics for Biomedical Scientists I
STAT 500 II	Statistics for Biomedical Scientists II

PUBLIC HEALTH

FOR CLASS DATES, TIMES, LOCATION, AND TUITION, PLEASE VISIT WWW.FAES.ORG/GRAD.

STEPHEN MARCUS, CHAIR

FALL NEW	PBHL 425	Public Policy in Science and Medicine
FALL	PBHL 500	Introduction to Global Health
SPRING 2019 - Alt	PBHL 501	Environmental Health Sciences
FALL	PBHL 502	Systems Thinking and Policy Modeling I
SPRING	PBHL 512	Social and Behavioral Sciences
FALL	PBHL 517	Health Policy and Management
SPRING	PBHL 518	Introduction to Program Evaluation for Planning, Improvement, and Measurement of Public Health
SPRING	PBHL 521	Cancer Screening *(8 weeks)*
SPRING	PBHL 533	Chronic Diseases in Global Health
FALL	PBHL 580	Health Economics and Econometrics Applied to the Evaluation of Research
FALL, SPRING	PBHL 607	Capstone Project in Public Health

PBHL 425

Fall, 2 credits

NEW Public Policy in Science and Medicine

Pierre Cartier

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, health care delivery, patient engagement, professional regulations, and workforce infrastructure. This course will allow students to understand how public policy influences scientific research and healthcare practice by examining topics and cases drawn from dental medicine and related areas, such as medical education, primary care, healthcare innovation, and public health. Further, students will develop and refine skills in oral and written communication, research, analysis, and critical thinking, preparing them for policy-related positions in the federal government, non-profit organizations, and the private sector.

Learning objectives:

- Describe the relationship between healthcare and health-science entities, policymakers, and various stakeholders
- Develop communication, research, and analytical skills that may be applied to policy-related positions in the federal government, non-profit organizations, and the private sector
- Discuss key contemporary public policy issues in the health sciences and potential solutions

PBHL 500

Fall, 2 credits

Introduction to Global Health

Tilda Farhat

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

This course is an elective for the Advanced Studies in Public Health With a Special Emphasis on Global Health.

PBHL 501

Spring 2019, Alternate Years, 3 credits

Environmental Health Sciences

Pertti Hakkinen*, Alfredo Sancho

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 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

This is a required course for Advanced Studies in Public Health.

PBHL 502

Fall, 2 credits

Systems Thinking and Policy Modeling I

David Broniatowski

LOCATION: George Washington University

This course serves as an introduction to methods of policy modeling in the systems-engineering and public health domains. Specific techniques to be covered include systems dynamics, agent-based modeling, and network analysis. Key concepts, such as system boundary definition, complexity, uncertainty, model verification, and model validation, will be covered. The utility of models for exploring behavioral and social aspects of population health and engineering design will be discussed. The variety of ways models can be formulated will be noted. Some extant models will be explored in depth. Models will range from individual interactions to international policy formulation. Ways to apply models to situations of interest will be indicated. Choice of model strategy will be addressed including whether new models should be developed. Ways to allocate efforts and resources appropriately will be discussed. The course will provide an opportunity for students to create and present conceptual models in problems that involve their personal research interests. The course describes different world views adopted by various modeling platforms.

Learning objectives:

- Construct a model to answer a research or policy question of their own choosing
- Identify the strengths and weaknesses of various modeling approaches
- Explain the circumstances under which models provide accurate predictions and descriptions of reality
- Define a model's operating limits and the conditions under which it is no longer trustworthy
- Apply systems thinking to real-world problems

PBHL 512

Spring, 3 credits

Social and Behavioral Sciences

David Clark

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

This is a required course for Advanced Studies in Public Health.

PBHL 517

Fall, 3 credits

Health Policy and Management

Health policy and management is an interdisciplinary field of inquiry and practice concerned with the delivery, quality, and costs of healthcare for individuals and populations. This definition assumes both a managerial and a policy concern with the structure, process, and outcomes of health services, including the costs, financing, organization, outcomes, and accessibility of care.

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.
- 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
- Apply 'systems thinking' for resolving organizational problems
- Demonstrate leadership skills for building partnerships

This is a required course for Advanced Studies in Public Health.

PBHL 518

Spring, 3 credits

Introduction to Program Evaluation for Planning, Improvement, and Measurement of Public Health

Rachel Britt, Amanda Greene*

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

PBHL 521

Spring, 1 credit (8 weeks)

Cancer Screening

Pamela Marcus

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

PBHL 533

Spring, 2 credits

Chronic Diseases in Global Health

Blythe Beercroft, Linda Kupfer*, Derek Simon

Which diseases account for the greatest number of deaths in low- and middle-income countries (LMICs)? As best stated in a recent report from the Council on Foreign Relations, the "gravest health threats facing low- and middle-income countries are not the plagues, parasites, and blights that dominate the news cycle and international relief efforts. They are the everyday diseases the international community understands and could address, but fails to take action against […] cardiovascular diseases, cancer, diabetes, and other non-communicable diseases (NCDs) have emerged as the leading cause of death and disability in developing countries. […] The chronic nature of NCDs means patients are sick and suffer longer and require more medical care. The resulting economic costs are high and escalating." The picture gets even more complicated because the lines between chronic and acute diseases and infectious and NCDs have become blurred; for example, HIV/AIDS, once an acute and deadly infectious disease, is now a chronic disease, while cervical cancer, classified as a non-communicable disease, is caused by an infectious, sexually transmitted agent HPV.

This course will focus on chronic disease burden, preventative interventions, and care in LMICs. It will include views from scientists working on various aspects of the disease, implementers who have worked in LMICs and have on-the-ground healthcare experience, and science-policy advisors from various USG agencies. Using case studies, students will discuss chronic disease prevention and care interventions that have been implemented in LMICs by addressing both the disease and its risk factors. Scientific literature will be drawn upon to help students understand cutting-edge research in the field.

Learning objectives:

- Understand and be able to describe the health burden of chronic diseases in LMICs
- Discuss how existing healthcare platforms and resources in LMICs currently address chronic diseases, and how they can be strengthened/reoriented/leveraged to accomplish this task
- Explore outstanding gaps in research and implementation of chronic care in LMICs

This course is an elective for the Advanced Studies in Public Health With a Special Emphasis on Global Health.

PBHL 580

Fall, 3 credits

Health Economics and Econometrics Applied to the Evaluation of Research

Sue Hamann

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, 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 cost 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; a second 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.

Critical questions to be explored include the identification of relevant direct and indirect economic costs related to health, the identification and measurement of federal biomedical research costs, and the attribution of changes in health outcomes to federally funded research.

In this introductory class, students will learn the foundations of health economics and econometric modeling and 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

PBHL 607

Fall and Spring, 3 credits

Capstone Project in Public Health

Stephen Marcus

The Capstone Project is the culminating experience of the Advanced Studies Program in Public Health. This culminating experience allows the student to demonstrate the acquisition of skills and the integration of knowledge across all coursework in the Advanced Studies Program. This is achieved by demonstrating a mastery of select public health competencies. Between five and 10 of these competencies are selected, at least one from each core discipline, and up to five additional ones from either discipline-specific or interdisciplinary/cross-cutting competency lists (see **http://www.asph.org/document.cfm?page=851**), to serve as specific learning objectives as well as evaluation criteria for the Capstone Project.

The Capstone Project is a mentored course. The student will be required to spend approximately one day per week for the duration of the semester at an appropriate professional setting to put the classroom learning into practice.

Many different models or types of projects are possible. Examples include: 1) design, conduct, and analyze data from an original research or evaluation study; 2) conduct secondary data analysis of existing data; 3) conduct a policy or regulatory analysis; 4) perform administrative or managerial functions within the healthcare delivery system; 5) develop an outreach or community-based health program; or 6) work on an educational or health campaign for a professional association, nonprofit association, or advocacy group.

Learning objectives:

- Synthesize and integrate knowledge acquired in coursework and other learning experiences
- Apply theory and principles in a situation that approximates some aspect of professional practice
- Demonstrate proficiency in selected competencies
- Determine, through examination by Capstone Project Mentor and Chair of Department of Public Health, whether the body of knowledge in the Advanced Studies Program has been mastered

PRIOR TO ENROLLMENT, STUDENTS MUST CONSULT WITH THE DEPARTMENT CHAIR OF PUBLIC HEALTH.

This is a required course for Advanced Studies in Public Health.

ADVANCED STUDIES IN TECHNOLOGY TRANSFER

WHAT IS TECHNOLOGY TRANSFER?

Technology transfer is a term used to describe a formal transfer of rights to another party to use and commercialize new discoveries and innovations resulting from scientific research. Universities typically transfer technology through protecting new innovations, by use of patents and copyrights, then licensing them. Major steps in this process include the disclosure of innovations, patenting the innovation concurrent with the publication of scientific research, and licensing the rights to innovations to industry for commercial development (**www.autm.net**). The technology transfer field employs more than 10,000 professionals in the U.S., many of whom practice their trade in the greater Washington, D.C. area.

ADVANCED STUDIES IN TECHNOLOGY TRANSFER

FAES Graduate School at NIH developed a unique Advanced Studies in Technology Transfer to serve the needs of scientists or engineers who wish to gain expertise in patenting, licensing, collaborative agreements, and other fundamental intellectual property transactions and/or to provide additional training to professionals already in the field.

The program culminates in an independent **Capstone Project** through which students will be required to demonstrate their knowledge of the theory and practice of technology transfer by completing a project of their design and choice at the NIH or in the regional community.

NIH is the nation's leader in health research and is one of the world's foremost medical research centers. After the landmark legislations in the 1980s, NIH also led the nation in technology transfer and spawned, from its research, the development of a number of lifesaving drugs, vaccines and medical devices (**www.ott.nih.gov**). Research scientists and technology transfer professionals at the NIH work together to ensure that basic results in the lab get transplanted successfully to the marketplace as useful biomedical products.

GENERAL REQUIREMENTS

The Advanced Studies in Technology Transfer is open to persons with a Bachelor's degree in science or engineering. Courses are offered in the evenings, making it convenient for working professionals and postgraduate Fellows to seek additional training or to gain expertise and experience in patenting, licensing, collaborative agreements, and other fundamental intellectual property transactions. Faculty are leading practitioners in the field, so students can simultaneously gain the necessary knowledge and build professional networks.

The program comprises a self-paced 15-credit curriculum that can be completed in approximately two years.

I was interested in leaving the bench, and I thought technology transfer would be a logical transition as it would allow me to take technology from the bench to the bedside. During the program, I enjoyed the coursework, professors and the classmates.

When I found out about the agreement between UMUC and FAES through which FAES credits could be transferred to UMUC, I decided to pursue my Master's degree in biotechnology at UMUC. I will graduate in May 2015. The classes from the Advanced Studies in Technology Transfer prepared me for the coursework I encountered at UMUC.

Biologist, National Cancer Institute

I took FAES's classes to explore alternative career possibilities besides bench science. I really enjoyed the coursework because it opened my eyes widely. I learned a lot about business development, patent law, finance, and negotiation skills. The advanced studies in technology transfer served as a stepping-stone for a new career. It helped me to land my current job as a technology transfer specialist in the Navy.

Technology Transfer Specialist, Naval Medical Research Center

REQUIRED COURSES

TECH 513	Introduction to Technology Transfer (or TECH 513A)
TECH 565	Biomedical Business Development for Scientists
TECH 607	Capstone Course in Technology Transfer

ELECTIVES

CHEM 327	The Art of Drug Design and Discovery
PHAR 328	FDA Perspective on Drug Development
TECH 495	The FDA: Science, Health Policy, and Regulation in an Uncertain Environment
TECH 508	Regulatory Affairs and FDA Regulation
TECH 512	Global Bioethics
TECH 521	Tools for Technology Transfer
TECH 525	Legal and Ethical Issues in Public Health and Biomedical Sciences
TECH 528	Preclinical Evaluation of Novel Drugs and Beyond *(10 weeks)*
TECH 566	Building a Biotech Company: Business Leadership and Management Strategies
TECH 567	International Strategic Partnering and Business Development
TECH 572	Marketing Strategies for Scientific Organizations
TECH 575	Business Finance and Accounting Principles for Scientists
TECH 582	Intellectual Property and Patent Prosecution for Scientists
TECH 583	Patent Research for Non-Legal Practitioners
TECH 584	Translational Medical Product Development
TECH 586	International Health Science, Technology, and Innovation
TECH 588	FDA Regulatory Strategy in Medical Product Development
TECH 607	Capstone Course in Technology Transfer *(second time would count as an elective)*

The Advanced Studies in Technology Transfer at FAES has a strong curriculum to provide the knowledge and skills necessary for every aspect of technology transfer and commercialization. Faculty members are experts in the field and provide information using case studies, thus giving a feel of real-world situations. Both required and elective courses provided me with in-depth understanding and prepared me well to transition to the field of technology transfer. I would recommend this program to anyone willing to pursue technology transfer as a career.

Technology Transfer Liaison, The Henry M. Jackson Foundation for the Advancement of Military Medicine, Inc.

LEARNING OUTCOMES

Upon completion, students will be able to:

- Understand fundamental technology-transfer processes for transferring scientific findings from one organization to another for the purpose of further development and commercialization
- Explain and describe the role that intellectual property will play in the transition from a manufacturing-based economy to a knowledge-based economy as part of industrial and societal development
- Describe and explain specific technology transfer processes involved with: (1) identifying new technologies; (2) protecting technologies through patents and other forms of intellectual property; and, (3) forming development and commercialization strategies, such as marketing and licensing to existing private sector companies, or creating new startup companies based on the technology
- Learn to apply technology-transfer processes to ensure that new discoveries have the opportunity to reach the stream of commerce and that investments in intellectual property are returned to the public through products that benefit the public and increase employment as well as state and federal taxes
- Understand how commercialization of scientific innovations can be pursued without disrupting the core research institution values of publication and sharing of information, research results, materials, and know-how

AGREEMENTS WITH AREA UNIVERSITIES

FAES has entered into a partnership with the **University of Maryland University College** to offer an exciting opportunity for students to get ahead with their academic and professional goals.

UNIVERSITY OF MARYLAND UNIVERSITY COLLEGE (UMUC), GRADUATE SCHOOL OF MANAGEMENT AND TECHNOLOGY

Students who have successfully completed the Advanced Studies in Technology Transfer at FAES can transfer all 15 credits as a block to work toward an M.S. degree at UMUC Graduate School. By completing only 21 more credits at UMUC, students can be awarded M.S. degrees (with a specialization in Technology Transfer) in Management or Information Technology or Biotechnology program. To learn more, please email registrar@faes.org.

TECHNOLOGY TRANSFER, BUSINESS, AND INDUSTRY

FOR CLASS DATES, TIMES, LOCATION, AND TUITION, PLEASE VISIT WWW.FAES.ORG/GRAD.

STEVEN FERGUSON, CHAIR

FALL NEW	TECH 495	The FDA: Science, Health Policy, and Regulation in an Uncertain Environment
SPRING	TECH 508	Regulatory Affairs and FDA Regulation
SPRING 2019-Alt	TECH 512	Global Bioethics
SPRING	TECH 513	Introduction to Technology Transfer
FALL	TECH 513A	Introduction to Technology Transfer - Issues and Processes
FALL	TECH 521	Tools for Technology Transfer
FALL 2017-Alt	TECH 525	Legal and Ethical Issues in Public Health and Biomedical Sciences
SPRING	TECH 528	Preclinical Evaluation of Novel Drugs and Beyond *(10 weeks)*
FALL	TECH 565	Biomedical Business Development for Scientists
SPRING	TECH 566	Building a Biotech Company: Leadership and Management Strategies
FALL	TECH 567	International Strategic Partnering and Business Development
SPRING	TECH 572	Marketing Strategies for Scientific Organizations
FALL	TECH 575	Business Finance and Accounting Principles for Scientists
SPRING	TECH 582	Intellectual Property and Patent Prosecution for Scientists
SPRING	TECH 583	Patent Research for Non-Legal Practitioners
SPRING	TECH 584	Translational Medical Product Development
FALL	TECH 586	International Health Science, Technology, and Innovation
FALL	TECH 588	FDA Regulatory Strategy in Medical Product Development
FALL, SPRING	TECH 607	Capstone Course in Technology Transfer

TECH 495

Fall, 2 credits

NEW The FDA: Science, Health Policy, and Regulation in an Uncertain Environment

Lawrence Bachorik

The FDA is a science-based regulatory agency whose mission is to protect 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

This course is an elective for Advanced Studies in Technology Transfer.

TECH 508

Spring, 2 credits

Regulatory Affairs and FDA Regulation

Rochelle Fink

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

This course is an elective for Advanced Studies in Technology Transfer.

TECH 512

Spring 2019, Alternate Years, 2 credits

Global Bioethics

Gladys White

The birth of bioethics as a field of study is generally identified as a mid-twentieth-century phenomenon that occurred largely within the United States. But, important issues of moral concern can only be meaningfully understood within a global context. The purpose of this interdisciplinary course is to conduct ethical analyses of a cluster of cutting-edge issues in order to understand the human values and policy issues at stake.

Key topics will include: international exchanges of human tissues; organs and body parts; whole genome sequencing and the personal genome map; public health ethics, including management of communicable disease, cross-border reproductive care; pharmaceuticals and the developing world; nanotechnology; human subjects' research; research using animals and sports ethics. Classes will be based on at least one important controversy, and debates will be encouraged.

Learning objectives:

- Identify and describe some of the major issues in global bioethics
- Analyze the ethical dimensions and human values implications of these problems
- Synthesize relevant information across disciplines of philosophy, ethics, and science in order to demonstrate an understanding of the relevant issues

This course is an elective for Advanced Studies in Technology Transfer.

TECH 513

Spring, 2 credits

Introduction to Technology Transfer

Susan Ano, Steve Ferguson*, Fizie Haleem

This introductory survey course is aimed at both scientists as well as new or would-be technology-transfer professionals. Specific topics will include: the history, legislation and public policy that drive federal technology transfer; the role of the Office of Technology Transfer at NIH; the role of the Technology Development Coordinators at NIH; forms of intellectual property; the definition of a patentable invention and the definition of an inventor; the patent application process; licensing of inventions; patent litigation; infringement and interference; collaborative research; and, transactional agreements. Federal, state, international, academic, and small and large industrial perspectives will be also explored. Special topics will include biomedical technology development, third-party considerations in natural products development, and technology-assistance programs.

The course utilizes a number of outside expert speakers from the local technology transfer, business, and legal communities. Students will be also able to see a number of role models for non-traditional careers in science

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 technology-transfer-related career options that are available for scientists

This course is required for Advanced Studies in Technology Transfer.

TECH 513A

Fall, 2 credits

Introduction to Technology Transfer – Issues and Processes

Richard Leshuk

Technology Transfer Society / Washington, D.C. Chapter

This introductory survey course is aimed at both scientists as well as new or would-be technology-transfer professionals. Specific topics will include: the history, legislation and public policy that drive federal technology transfer; the role of the Office of Technology Transfer at NIH; the role of the Technology Development Coordinators at NIH; forms of intellectual property; the definition of a patentable invention and the definition of an inventor; the patent application process; licensing of inventions; patent litigation; infringement and interference; collaborative research; and, transactional agreements. Federal, state, international, academic, and small and large industrial perspectives will be also explored. Special topics will include biomedical technology development, third-party considerations in natural products development, and technology assistance programs.

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This course is required for Advanced Studies in Technology Transfer.

TECH 521

Fall, 2 credits

Tools for Technology Transfer

Bruce Goldstein

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

Prerequisites: TECH 513 Introduction to Technology Transfer is recommended, but not required.

This course is an elective for Advanced Studies in Technology Transfer.

TECH 525

Fall 2017, Alternate Years, 2 credits

Legal and Ethical Issues in Public Health and Biomedical Sciences

Carol Spiegel

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 issues.

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 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

This course is an elective for Advanced Studies in Technology Transfer.

TECH 528

Spring, 2 credits (10 weeks)

Preclinical Evaluation of Novel Drugs and Beyond

John Dubinion, Claudia Wrzesinski

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

Prerequisites: college-level biology.

TECH 565

Fall, Spring (Spring-term course will be held at Frederick campus), 2 credits

Biomedical Business Development for Scientists

Matthew Miessau, Michael Salgaller*

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.

The course will be taught as a semester-long simulation in which students take on the various roles of entrepreneurs and investors in all aspects of science focused on venture-capital dealings. Lectures by seasoned biotechnology executives and venture investors will provide for a real-world approach to learning. Students will be expected to develop a draft business plan by the end of the semester and present it to venture-capital professionals as if asking for funding in a real-world pitch meeting. Student plans may be selected for use in marketing or commercialization efforts by the NIH Office of Technology Transfer.

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

Prerequisites: basic or advance knowledge of science; no business credits required.

This course is required for Advanced Studies in Technology Transfer.

TECH 566

Spring, 2 credits

Building a Biotech Company: Business Leadership and Management Strategies

Jennifer Catalano, Steve Ferguson, James Hawkins

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.

The course will include onsite visits and lectures relating to various-sized biotechnology companies in the region. A variety of topics related to the biotech company will be examined, including intellectual property, entrepreneurship, professional advisors, different types of investors and fundraising, applied research and product development, regulatory considerations, manufacturing, sales and marketing, as well as leadership and senior management. For a final grade, students will provide an oral presentation and complete a written summary of a chosen management topic. Student interaction with speakers is highly encouraged.

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

Prerequisites: basic or advanced knowledge of science; TECH 565 is helpful, but not required.

This course is an elective for Advanced Studies in Technology Transfer.

TECH 567

Fall, 2 credits

International Strategic Partnering and Business Development

Rita Khanna

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.

This course seeks to understand the content and nature of international S&T partnerships, including approaches taken by different institutions and the major forms and types of international agreements, particularly those involving the NIH. The course will also look at sources of funding (venture capital, philanthropic, and others) and its relation to innovation and the development of products. The course will examine technology-transfer issues related to the new institutional frameworks, such as product-development partnerships (PDPs), advanced market commitments (AMCs), and other partnerships. Students will be expected to assess a technology of their choice, and develop a draft executive summary of a new bio business concept, with a potential commercial advantage in the international marketplace, or to write a research paper on one of the topics covered. Student efforts may be selected for use in commercialization efforts by the NIH Office of Technology Transfer, or in presentations to international business-plan groups, or for publishing in an international journal. The course will provide a real-world flavor through guest lectures from representatives who play major roles in global markets and are affiliated with biotech/pharma industry and the public sector.

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

Prerequisites: basic or advanced knowledge of science; no business credits required.

This course is an elective for Advanced Studies in Technology Transfer.

TECH 572

Spring, 2 credits

Marketing Strategies for Scientific Organizations

Barry Datlof

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 start-up marketing, socially responsible marketing, and marketing technologies in international markets, specifically in developing countries.

Students, in groups, will be asked to utilize key marketing concepts to develop a marketing plan for a biomedical technology, product or service that may be chosen for the technology portfolio of the NIH Office of Technology Transfer or other biomedical organizations.

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

This course is an elective for Advanced Studies in Technology Transfer.

TECH 575

Fall, 2 credits

Business Finance and Accounting Principles for Scientists

Diana Ororbia-Knapton

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

Prerequisites: experience with or interest in collaborations or agreements with for-profit organizations.

This course is an elective for Advanced Studies in Technology Transfer.

TECH 582

Spring, 2 credits

Intellectual Property and Patent Prosecution for Scientists

Lee Heiman

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 our 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. Students will also review the many different ways to resolve conflicts involving intangible property.

Learning objectives:

- Understand invention, discovery, creative work, secret, and how they can give a business advantage
- Gain a high-level understanding to distinguish between or obtain the four types of IP: patents; trademarks and service marks; copyrights; and, trade secrets in the context of supporting business development

- Describe U.S. patenting process, both historically and in the context of the movement toward global harmonization through international IP frameworks
- Explore some common career options in the IP field, such as patent agents and attorneys, licensing professional, technology-transfer professional, technology searcher, and patent examiner
- Draft a basic patent application

This is an elective for Advanced Studies in Technology Transfer.

TECH 583

Spring, 2 credits

Patent Research for Non-Legal Practitioners

Chirag Shah, Stephen Tedeschi

In every stage of research, knowledge of patent data is essential to developing a clear understanding of the technology landscape. A significant amount of scientific information can be found in a patent that is not available in any other publication. Therefore, patent research does not only drive common legal decisions, including patent protection, licensing, enforcement, due diligence, and litigation strategies, but also provides critical information that improves one's ability to understand the state-of-the-art in one's technology, refine invention, plan research, quicken development, assist sales, and enable product protection, along with many other research and business decisions throughout the innovation lifecycle.

Designed for scientists, engineers, and researchers, this course teaches students where to find patent data, how the data are organized, and the strategies and mechanics required to conduct high-quality research of patent literature. It will also provide an overview and training on many leading free and subscription-based patent databases. Students will also receive unlimited access to top-tier subscription databases during the course. Students will be exposed to the basic legal framework underlying patent research that is 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. Upon completion of the course, students will have gained the know-how to develop the search strategy required to inform their research decisions and the ability to select the best resources to conduct patent research in diverse technology areas.

Learning objectives:

- 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 legal requirements for common patent-research goals in order to assess references uncovered during a search

- Craft search strategies and develop specific search steps to conduct effective patent research to achieve research, business, and legal goals
- Survey publicly available patent and non-patent databases and gain in-depth training on proprietary patent databases required for this type of research

This course is an elective for Advanced Studies in Technology Transfer.

TECH 584

Spring, 2 credits

Translational Medical Product Development

Mary Ann Shallcross

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

This course is an elective for Advanced Studies in Technology Transfer.

TECH 586

Fall, 2 credits

International Health Science, Technology, and Innovation

Luis A. Salicrup

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 the 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 equip 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

This course is an elective for Advanced Studies in Technology Transfer.

TECH 588

Fall, 2 credits

FDA Regulatory Strategy in Medical Product Development

Shrinagesh Koushik, Michael Matthews

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. The curriculum will provide a brief overview of drugs, biologics and medical devices, diagnostics, including radiological products. The curriculum will provide a brief overview of drugs, biologics and device development, 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

This course is an elective for Advanced Studies in Technology Transfer.

TECH 607

Fall and Spring, 3 credits

Capstone Course in Technology Transfer

Steve Ferguson*, Frederick Provorny

This course is designed as a final course of the FAES Advanced Studies 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 the regional community.

This course is customarily taken after a student has completed at least six previous courses in technology transfer and has compiled 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

Prerequisites: permission of the instructor.

This course is required for Advanced Studies in Technology Transfer. This course may be taken two times.

COURSES OFFERED IN OTHER DEPARTMENTS THAT ARE ELECTIVES FOR THE ADVANCED STUDIES IN TECHNOLOGY TRANSFER

CHEM 327	The Art of Drug Design and Discovery
PHAR 328	FDA Perspective on Drug Development

THREE- TO FIVE-DAY HANDS-ON

Laboratory Workshops

CORE BIOTECHNIQUES

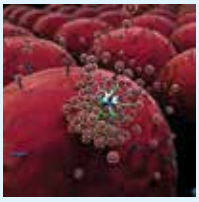
BIOTECH 1 BioTechnology Techniques
BIOTECH 2 Recombinant DNA Methodology
BIOTECH 7 Animal Cell Culture: Method and Applications
BIOTECH 16 Expression, Detection, and Purification of Recombinant Proteins in Prokaryotic and Eukaryotic Cells
BIOTECH 27 PCR Basics, Real Time and Quantitative PCR
BIOTECH 42 Bio-Techniques

BIOINFORMATICS AND COMPUTATIONAL BIOLOGY

BIOTECH 25 Proteomics: Principles, Methods, and Application to Biomarker Discovery
BIOTECH 40 Protein Informatics
BIOTECH 45 Bioinformatic Analysis of Next Generation Sequencing (NGS) Data
BIOTECH 66 Computational Drug Design and Discovery
BIOTECH 73 Cloud Computing for Biomedical Researchers
BIOTECH 74 Advanced Transcriptomics (RNA-Seq) Analysis
BIOTECH 75 Metagenomics Data Analysis
BIOTECH 76 Creating Plots, Graphs, and Maps Using R
BIOTECH 77 Molecular Modeling and Molecular Dynamics
BIOTECH 78 Data Integration, Analysis, and Visualization
BIOTECH 79 Variant Analysis
BIOTECH 82 Bioinformatics for Beginners
BIOTECH 84 Pharmacometric Analyses in Clinical Trials Using R
BIOTECH 85 3D Printing: Scientific Visualization, Molecular, and Anatomical Applications
BIOTECH 86 Creating Scientific Illustrations
BIOTECH 87 Programming for Biomedical Researchers

DNA/RNA TECHNOLOGY

BIOTECH 21 Mitochondrial Molecular Biology and Pathology
BIOTECH 34 Advanced Microarray Analyses and Pathway Integration
BIOTECH 39 Epigenetics
BIOTECH 41 miRNA: Tools and Technologies for the Quantitative and Functional Analysis in Mammalian Cells
BIOTECH 55 Engineering With CRISPR, TALENs, and ZFNs
BIOTECH 56 RNA-Seq
BIOTECH 81 Nanotechnology: Principles and Methods



IMMUNOLOGY AND FLOW CYTOMETRY

BIOTECH 4 Cellular Immunology: Principles and Methods
BIOTECH 8 Immunohistochemistry and Monoclonal Antibody Production
BIOTECH 22 Hybridization Techniques: Labeling, Detection, and Applications
BIOTECH 23 Flow Cytometry: Principles and Methods
BIOTECH 31 Vaccines: Development and Evaluation of Efficacy
BIOTECH 61 High-Dimensional Single Cell Analysis
BIOTECH 63 Protein-Protein Interactions
BIOTECH 64 Imaging Flow Cytometry
BIOTECH 80 CAR T-Cells: Principles and Methods

MICROSCOPY AND IMAGE ANALYSIS

BIOTECH 29 Laser Capture Microdissection (LCM): Methods for Microgenomics Analysis
BIOTECH 35 Immunofluorescence and Confocal Microscopy
BIOTECH 38 Digital Imaging in Microscopy
BIOTECH 53 Super Resolution Microscopy
BIOTECH 60 Intravital Microscopy: Principles and Methods
BIOTECH 62 Image Processing and Analysis

STEM CELL TECHNIQUES

BIOTECH 18 Stem Cells
BIOTECH 47 iPSC II: Human Induced Pluripotent Stem Cells (hiPSC); Differentiation to Neural Lineages
BIOTECH 49 Making iPSCells From Blood
BIOTECH 54 Making Cardiomyocytes From iPSCells

OTHER

BIOTECH 71 Project Management Training for Scientists

- **Taught by teams of expert researchers from the NIH, academia, and industry**
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- **Earn Continuing Education Units (CEUs)**

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BIOTECHNOLOGY TRAINING WORKSHOPS

FAES TRAINING AND CONFERENCES —BIOTECH WORKSHOPS

FAES at the NIH was founded in 1959 to provide educational programs to biomedical researchers at the National Institutes of Health through the establishment of the Graduate School. In 1984, the organization expanded its educational services to the NIH community by offering a series of short-term specialized biotechnology workshops, lectures, and hands-on laboratory exercises.

Today, our popular BioTech program offers over 32 core biotechnology workshops to the NIH community, universities and colleges across the U.S., as well as to private industry. As the flagship program of FAES's Conferences and Training Department, BioTech prepares and trains 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.

FAES's BioTech curriculum has been developed by experienced bench scientists. The training workshops are team taught by active researchers from the NIH, in addition to leading experts from academia and industry. Participants will receive a comprehensive binder containing all the presentations delivered during the workshop, along with laboratory protocols and reference materials.

CEU CREDIT

BioTech workshops provide CEU credit. Please note that 1 CEU = 10 contact hours

By taking FAES's BioTech 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.

We have trained over 16,000 scientists, technicians, entrepreneurs, and life sciences enthusiasts!

REGISTRATION

FAES's BioTech 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. Seats are limited in each workshop, so make sure to grab your seat in advance.

Please visit our website at **www.faes.org/biotech** to find **the latest schedule of the BioTech workshops.** Online enrollment and payment is quick and easy through a simple click on the title of the workshop of interest.

DEADLINE FOR REGISTRATION

The deadline for registration is one week before the first day of the respective BioTech workshop. If you are unable to register before the deadline, please email **training@faes.org** or call **301-496-7977** to check on seat availability.

Please note: the BioTech department does not follow the enrollment timeline of the Graduate School; dates and deadlines posted on the academic calendar of the Graduate School are not applicable.

VISIT **WWW.FAES.ORG/BIOTECH** FOR INFORMATION ON BIOTECH WORKSHOP SCHEDULES AND RATES.

CORE BIOTECHNIQUES

BioTech 1

BioTechnology Techniques (5 days)

This lecture and laboratory course will provide the theoretical basis and the hands-on experience needed for the understanding and execution of those laboratory procedures that are widely used in biotechnology, molecular genetics, immunology, and biochemistry. While the subject matter will be discussed in the context of broadly stated research objectives, the emphasis will be on the techniques rather than on specific applications and strategies. Thus, the participants will acquire skills in the use of "generic" methods, and through an understanding of such methods, improve their effectiveness as workers in a contemporary research laboratory.

BioTech 2

Recombinant DNA Methodology (4 days)

This lecture and laboratory course is designed to provide participants with an introduction to the molecular biology of nucleic acids. An approach emphasizing both principles and methodology provides life scientists with the essential fundamentals needed for gene cloning and for an appreciation of the strategies of recombinant DNA technology as well as other molecular techniques.

BioTech 7

Animal Cell Culture: Method and Applications (5 days)

This lecture and laboratory course is structured to provide life scientists who are not experienced in cell culture with an introduction to the principles and practices that will facilitate their ability to develop the use of in vitro systems. Additionally, investigators without formal training in tissue culture techniques will find the information and laboratory exercises extremely useful. This workshop is predicated on the application of the most rigorous principles of quality control and will be taught by experienced researchers with extensive years of experience in the field.

BioTech 16

Expression, Detection, and Purification of Recombinant Proteins in Prokaryotic and Eukaryotic Cells (3 days)

This lecture and laboratory course will provide participants with a theoretical background and practical experience in the expression and purification of recombinant proteins from a variety of expression systems. Furthermore, the course will address new methods to overcome traditional challenges in recombinant protein expression and purification. Finally, participants will be introduced to methods to prepare their samples for downstream applications, such as immunofluorescence studies.

BioTech 27

PCR Basics, Real Time and Quantitative PCR (4 days)

From its conception in 1983 to its modern-day use in a myriad of clinical and research applications, the Polymerase Chain Reaction (PCR) has revolutionized modern molecular biology. This lecture and laboratory course will focus on the conventional Polymerase Chain Reaction and its applications in basic molecular biology research, genetics, and molecular pathology, including cancer and genetic diseases and identification of viral, bacterial and other pathogens. The course will include training in both basic PCR reactions as well as real-time RT-PCR as the method of choice not only for quantitative gene expression but also for validating results obtained from array analyses and other techniques that evaluate gene expression changes on a global scale.

BioTech 42

Bio-Techniques (formerly Junior Scientist Training Program - JSTP)

Bio-Techniques is the beginner's comprehensive lecture and hands-on laboratory program that covers core laboratory techniques in molecular biology. The methods have been identified by NIH scientists and private-industry representatives as techniques that research technicians would implement on a day-to-day basis. Lab workshops are designed to practice full protocols that are standard in molecular biology labs. The course is suitable for postbacs, fourth-year biology majors, recent college graduates, or those in the sciences who need to strengthen their life sciences/biotechnology laboratory skills.

BIOINFORMATICS AND COMPUTATIONAL BIOLOGY

BioTech 25

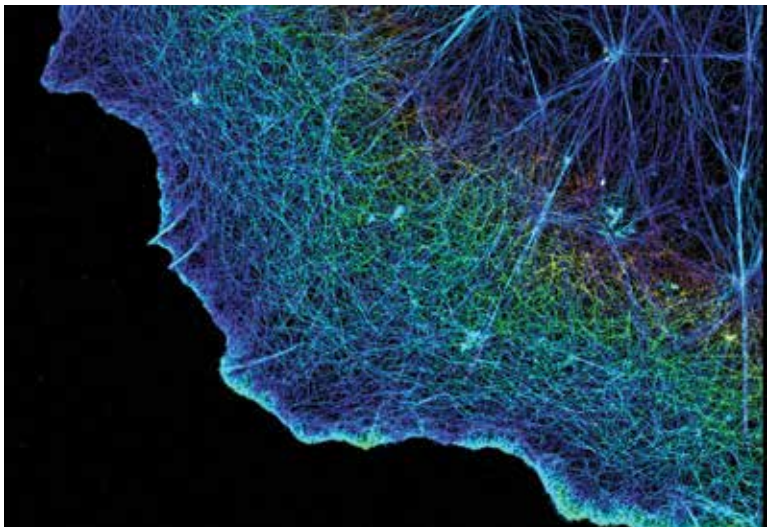
Proteomics: Principles, Methods, and Application to Biomarker Discovery (5 days)

Proteomics is the large-scale study of a specific complement of proteins, including information on the protein abundances, variations and modifications, interacting partners and functional networks. Because of the vast options and combinations of modifications and alternative splicing, the proteome is comparatively larger than the genome. This workshop provides an introduction to technologies used to perform proteomics experiments, with particular emphasis on their application to biomarker discovery. Principles and advanced methodologies will be discussed, with an emphasis on protein-identification tools, methods for sample preparation, and bioinformatics technologies. Additionally, participants will be exposed to the unique analytical platforms and challenges particular to biomarker discovery projects.

BioTech 40

Protein Informatics (3 days)

The logical next step after genome sequencing or proteomics analyses—and a necessary prequel to biomarker and drug target discovery—is to identify proteins of interest and their activities. This course will combine lectures with computer labs to provide an introduction to the bioinformatics resources and methodologies commonly used for protein analyses. Participants will be expected to know the basic biology of proteins and will leave with the ability to perform detailed analyses of protein sequences and structures.



BioTech 45

Bioinformatic Analysis of Next Generation Sequencing (NGS) Data (4 days)

This course will introduce participants to bioinformatics tools and methods for analyzing next generation sequencing data, particularly for DNA-seq (Variant analysis), RNA-seq (Transcriptome analysis), ChIP-seq (Transcriptional factor binding analysis), and Network based integration of NGS data. The course will include interactive lectures and hand-on sessions. Lectures will cover background knowledge and survey various software programs. Hands-on training sessions using popular command line and web based tools will be used to perform primary and secondary NGS data analysis. A fully loaded, custom Unix machine in the Cloud will be used for the training. Participants will be provided with a free copy of this machine image, containing all the popular NGS tools used in the workshop, along with all the example input and output data.

BioTech 66

Computational Drug Design and Discovery (4 days)

Computational drug design and discovery has been a challenging task due to limitations in available computing resources. Public cloud computing facilities have dramatically changed this scenario, by bringing the most powerful computing systems within a click away, with unprecedented low-cost options. This hands-on training will introduce researchers to the concepts, methods, and tools for structure and ligand-based computational drug designing and discovery using the open source tools and the cloud computing facilities.

This course is designed for researchers, clinicians, and academics interested in learning the tools to computationally design, screen and validate drugs or program administrators who are interested in getting a first-hand experience with the concepts and methods used for open source structure and ligand based drug designing.

BioTech 73

Cloud Computing for Biomedical Researchers (3 days)

Cloud offers computers with hundreds of cores and terabytes of memory, on an hourly basis, for a couple of dollars and on demand, to all users. This democratizes high-performance computing. Participants will create personal cloud-computing accounts and instances, set security, configure storage, create snapshots, create clusters, images, access instances and perform routine tasks.

The course is designed for researchers, academics, clinicians and students who are looking to avail themselves of the latest software even in the absence of a personal Windows or Linux machine, or for users who are facing issues with hardware limitations, such as not having access to a powerful machine to handle their large data or a computer-intensive task, or for researchers, academics, clinicians, and students who would like to perform computations on an on-demand hourly basis cheaply and by using any popular operating system, or for program administrators interested in learning the standard tools, techniques, and concepts in cloud computing.

BioTech 74

Advanced Transcriptomics (RNA-Seq) Analysis (4 days)

Apart from performing the routine differential expression analysis using two different suites of tools, this hands-on training will help participants learn advanced RNA-Seq analysis techniques and tools for detecting snps, fusion genes, allele specific expressions, circular RNAs, viral/bacterial sequence identification, alternative polyadenylation and transcriptional regulatory network analysis.

BioTech 75

Metagenomics Data Analysis (4 days)

Metagenomics is gaining importance due to low-cost next generation sequencing technologies. This training will introduce participants to end-to-end solutions for analyzing metagenomic data, starting from data-quality analysis, alignment, community profiling, taxonomic comparison, and novel taxa discovery. Participants will work with a graphical user interface-based Linux desktop environment in the Amazon Cloud, specially configured to run popular open -ource metagenomics analysis tools. Participants will be able to save and take home a copy of the fully configured Amazon Machine Image for their personal use after the training. Participants will also receive a manual for all the hands-on exercises. After training, support will be also provided through exclusive members-only forum.

This course is designed for researchers and academics who are aspiring to learn the popular tools and techniques to analyze metagenomic/microbiome data, or for linicians who are interested in discovering metagenomics-based biomarkers for diagnostic and therapeutic uses, or for biomedical students who are interested in pursuing research on metagenomics, or for scientists in program administration interested in learning the standard tools for metagenomic analysis.

BioTech 76

Creating Plots, Graphs, and Maps Using R (3 days)

R is the industry standard for creating scientific graphs and plots. There are several different R packages available for creating impressive plots, graphs, and maps, including plotly, ggplot2, ggvis, diagrammer—for diagrams, dygraphs—for time series data, leaflet—for plotting maps, graphviz—for graphs. This training will walk participants through creating interactive, static, and shareable plots using popular R packages. Participants will get a brief hands-on introduction to

the R platform, followed by hands-on walkthrough for creating several different popular plots, graphs, and maps, such as scatter plots, density plots, correlation plots, pca plots, surface plots, dot plots, star plots, circular plots, trees, heatmaps, panel graphs, 3D graphs, and network graphs. The course will start with formatting data and will cover loading data, setting parameters, creating the images, and saving outputs.

Highlights: Participants will work with RStudio. A copy of all the scripts used in the class to create plots, graphs, and maps would be provided to participants at the end of the training. Participants will also receive a manual for all the hands-on exercises. After training, support will be also provided through exclusive members-only forum.

This course is designed for researchers and academics who are aspiring to learn to create scientific plots, graphs, and maps using R, or for clinicians and biomedical students interested in learning the ways and means to visualize their data using R, or for scientists in program administration interested in learning the standard tools and techniques used for R-based data visualization.

BioTech 77

Molecular Modeling and Molecular Dynamics (4 days)

Predicting the effect of a mutation on the structure and function of a protein is not just for researchers with super-computer facilities. Thanks to public cloud-computing options, users with basic molecular biology background can set up and run intensive computational modeling and dynamics experiments. Participants will use popular open-source tools and techniques to conduct successfully molecular modeling and dynamics experiments in the cloud.

This course is designed for researchers and academics interested in learning tools to explore, visualize, and understand biomolecular structures and their functions in three dimensions, or for clinicians, researchers, and academics interested in understanding/predicting the effect of mutations or drug molecules on the structure and function of a biological molecule, using three-dimensional structural modeling and molecular dynamics, or for program administrators who are interested in getting first-hand experience with cutting-edge, structure-based modeling/dynamics methods and tools.

BioTech 78

Data Integration, Analysis, and Visualization (4 days)

Data integration is an enormous challenge in biomedical research, especially in the era of NGS data, BigData, “omics,” precision medicine, etc. Network-based approach is one of the interesting and efficient ways to integrate data. This hands-on training will introduce participants to network concepts, data preparation and integration methods, data analysis, exploration and visualization using Cytoscape and other open-source tools. The training also includes a one-day Bring-Your-Own-Data (BYOD) clinic.

This course is designed for researchers and academics interested in learning network-based data integration, analysis, exploration, and visualization tools and techniques, or for clinicians interested in exploring a network medicine approach to identify novel markers and therapeutic targets, or for program administrators who are interested in getting first-hand experience with network-based methods and tools for data integration, exploration, and visualization, or for users who have their own data that they would like to analyze, explore, and visualize in the context of networks.

BioTech 79

Variant Analysis (4 days)

Next Generation Sequencing technologies have made genotyping a day-to-day research and diagnostic tool. Genotyping has come all the way from bench to bedside. Genetic variants are being used in personalized medicine to identify susceptibility genes, common disease variants, and mutations relevant for diagnosis and therapy. Participants will use popular open-source tools and techniques necessary for analyzing variants starting from raw data-quality control. Apart from regular analysis, such as alignment, variant calling, and annotation, this training will walk participants through several advanced variant analysis methods and techniques.

This course is designed for researchers and academics interested in learning the tools and methods to identify and study variants using techniques, such as DNA-Seq and other methods, or for clinicians, researchers, and academics interested in understanding/predicting the effect of mutations on the structure and function of a biological molecule for diagnostic and treatment potentials, or for program administrators who are interested in getting first-hand experience working with tools and techniques to understand variant analysis.

BioTech 82

Bioinformatics for Beginners (4 Days)

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 hands-on training course will introduce participants to a custom, all-in-one fully loaded Linux desktop, with Windows-like graphical user interface, machine, that comes with hundreds of popular computational biology (bioinformatics) tools required in a successful modern biomedical research lab.

Participants will be provided with end-to-end hands-on training, along with 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, Linux, R, Perl, and scripting basics.

This course is designed for researchers, clinicians, and academics who are interested in learning bioinformatics tools and techniques, or for researchers interested in setting up an all-in-one bioinformatics open-source solution in their lab/group, or for biomedical students who are interested in learning and understanding basic concepts, tools, and methods in bioinformatics, or scientists in program administration interested in learning about the standard tools and techniques used in computational biology.

BioTech 84

Pharmacometric Analyses in Clinical Trials Using R (4 days)

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 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 course 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 interesting 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.

BioTech 85

3D Printing: Scientific Visualization, Molecular, and Anatomical Applications (3 days)

3D printing is an advancing technology that offers new possibilities in scientific visualization and communication. This workshop covers the skills required to design and 3D print models of biomolecular or anatomical structures from 3D scientific data. Participants will learn how to develop models that are scientifically accurate and physically printable as well as how to print structure/s. Instruction will be provided on molecular modeling, image segmentation, 3D file processing, print preparation, and post-processing. Participants are encouraged to come with a structure of interest and 3D data in molecular coordinate, electron microscopy map, or DICOM format.

This course is designed for structural and molecular biologists interested in physical models of biomolecules involved in their research, or for clinicians interested in the use of anatomical models for simulation, training or surgical planning, or for researchers and investigators considering utilizing 3D printing in their lab, or anyone interested in the use of physical 3D models in visualization, communication, or education

BioTech 86

Creating Scientific Illustrations (3 Days)

Science is better explained and understood using creative illustrations. There are numerous small computer programs that allow the creation of illustrations, but when it comes to industry standard, Inkscape is the open-source equivalent of Illustrator. This training will walk participants through creating industry-standard illustrations. Participants will get a brief hands-on introduction to the Inkscape platform, followed by a hands-on walkthrough in creating scientific illustrations, along with introduction to relevant concepts and methods as well as saving outputs in high resolutions. Participants will work with Inkscape, an open source tool

This course is designed for researchers and academics who are aspiring to learn to create scientific illustrations, or for clinicians and biomedical students interested in learning the ways and means to visually present their scientific findings, or for scientists in program administration interested in learning the standard tools and techniques used for creating industry standard illustrations.

BioTech 87

Programming for Biomedical Researchers (4 Days)

Computer programs are meant to perform repeated, monotonous, fast and reproducible tasks, while at the same time handling any amount of data. Researchers often come across situations where existing programs do not suit their needs. In the era of BigData, researchers face a road block if they lack the ability to quickly put together a program that would solve their problem. This training will walk participants through writing programs that would help them solve scientific problems. During the course, participants will get a brief introduction to the programming concepts, followed by hands-on walkthrough in writing scripts using the Unix Shell, R, Perl, and Python. The course will cover reading the data through processing and saving the processed data.

This course is designed for researchers, clinicians, students, and academics who are aspiring to learn to write their own scripts and programs, or for scientists in program administration interested in learning the standard tools and techniques for biomedical programming.

DNA/RNA TECHNOLOGY

BioTech 21

Mitochondrial Molecular Biology and Pathology (5 days)

The purpose of this workshop is to provide a foundational knowledge to those beginning to investigate mitochondrial function and biogenesis or those simply interested in understanding these essential subcellular organelles. Participants will learn of the important metabolic reactions occurring within the mitochondria and how nuclear and mitochondrial DNA lesions can result in a wide variety of mitochondrial disorders. The workshop will include a combination of lectures and hands-on laboratory experiments designed to familiarize participants with the skills necessary to work with these organelles.

BioTech 34

Advanced Microarray Analyses and Pathway Integration (4 days)

In response to the growing demand to learn how to extract the maximum information from the tremendous amount of data generated in a microrarray experiment, this course begins with a hybridized array and will spend extensive time on optimizing the scanning process and acquiring an informative scan. These data will then be analyzed using GeneSpring software to generate clustering associations. Finally, using microarray and protein interaction data, pathways defining gene interactions will be assessed using PathwayAssist software.

BioTech 39

Epigenetics (5 days)

This course will address the basic principles of epigenetics, the role of epigenetic mechanisms in normal development and human disease, and the development of epigenetically effective drugs. The objective is to provide a solid foundation of information enabling participants to design experiments when returning to their own research lab. The course will also provide a solid background in order to understand the literature in this rapidly growing field. Sequencing of the human genome has been the first step in understanding human genetics. The chemical modifications to DNA and 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.

Lectures cover basic mechanism underlying DNA methylation, histone modification, chromatin organization, noncoding RNA, and gene repression. Moreover, a broad range of topics will be covered in epigenetic research, including cancer, development, environmental health, and immunology. In addition, the lectures will provide participants with practical information concerning current techniques in epigenetic research. For example, the application of CHARM, Illumina bead arrays, restriction enzyme analysis, and bisulfate sequencing is discussed in designing experiments and interpreting data. In the laboratory, participants will gain hands-on experience in techniques including methyl specific PCR, chromatin immunoprecipitation, and global DNA methylation assays.

BioTech 41

miRNA: Tools and Technologies for the Quantitative and Functional Analysis in Mammalian Cells (3 days)

MicroRNAs (miRNAs) are evolutionarily conserved, endogenous, noncoding small RNAs that act as post-transcriptional gene regulators. miRNAs as gene regulators play a vital role in many biological processes. In addition to normal human development involving cell growth and proliferation, tissue differentiation, embryonic development, and apoptosis, human diseases are also impacted by miRNAs. Mutation, dysfunction, and/or dysregulation of miRNAs may give rise to diseases, such as coronary artery disease, cancer, diabetes, AIDS, hepatitis, and obesity. In this hands-on training workshop, participants will learn the latest information about miRNA and the use of miRNA as a diagnostic tool.

Recent advances in whole genome analyses have vastly improved our appreciation of the extensive repertoire of non-coding RNAs, including initially the well-known small microRNAs (miRNAs), and more recently, the long noncoding RNAs (lncRNAs). While miRNA-target interactions appear to be important in control of post-transcriptional levels, lncRNAs appear to have a diverse array of functions including regulation of transcription, mRNA processing and post transcriptional control. Thus, the current state of the art transcriptional profiling should include technologies for the analyses of protein coding mRNA, miRNAs and lncRNAs. In this hands-on training workshop, participants will learn the latest information about miRNA and the use of miRNA as a diagnostic tool.

BioTech 55

Engineering With CRISPR, TALENs, and ZFNs (5 days)

Gene engineering provides the ability to manipulate gene expression in a desired cell type. In order to realize the full potential of stem cells, the development of tools to modify targeted genes is paramount. This course will provide an overview of three different engineering platforms including CRISPR, TALENs, and ZFNs.

The first part of the course will cover the general principles of each of these technologies, including design and assembly, along with the platforms available and different costs associated with each of them. The second part of the course will transition into different applications including engineering in mice, disease modeling, generating iPSC reporter lines, and high throughput approaches. We will also consider sequencing and quality control considerations for these technologies. Hands-on laboratory exercises will accompany lectures to provide training in design, assembly, transfection, and confirmation assays.

BioTech 56

RNA-Seq (5 days)

RNA-seq or RNA sequencing is a new technology that utilizes the latest in Next-Generation Sequencing approaches to obtain information about the presence/absence as well as the quantity of transcribed RNA (mRNA, rRNA, tRNA, or miRNA). Soon RNA-seq will be transplanting microarrays as the go-to procedure for analyzing the transcriptome of any genome. In this workshop, we will provide hands-on experience with RNA-seq—from the bench to the post-sequencing data acquisition (Illumina NextSeq) and analysis, using the latest bioinformatics approaches.

With a team of researchers from the NIH, area academic institutions and Illumina, the course will cover examples of methodological approaches and applications of RNA-seq analysis to a variety of basic science and clinical biomedical research problems. The course has both wet lab components and data analysis sessions.

BioTech 81

Nanotechnology: Principles and Methods (3 days)

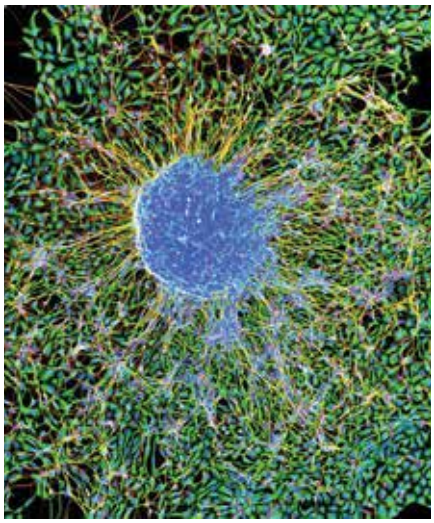
In this course, participants will learn the basics of nanotechnology in medicine, in addition to the preparation and clinical use of different nanotechnologies. In laboratory sessions, participants will prepare and characterize two such systems. These techniques will then be used in a bioassay to deliver material to cells in vitro. This training program also provides opportunity to participants to network with experts in nanotechnology field from both academia and industries. Each participant will receive printed course materials.

IMMUNOLOGY AND FLOW CYTOMETRY

BioTech 4

Cellular Immunology: Principles and Methods (4 days)

The objective of this course 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. Because this field is contributing to novel therapies and is in a high state of flux, due attention will be given to new directions.



BioTech 8

Immunohistochemistry and Monoclonal Antibody Production (4 days)

The objective of this lecture and laboratory course is to provide investigators with information on approaches to the isolation, purification and characterization of antibodies and antigens. Special emphasis will be given to monoclonal antibody production, assay, and characterization.

BioTech 22

Hybridization Techniques: Labeling, Detection, and Applications (4 days)

This course is designed to introduce participants to molecular hybridization and *in situ* hybridization techniques. The application of these techniques to current research questions in genetics and gene expression, molecular pathology, and pathogen detection and identification will be discussed. Probe application and detection systems will serve as the basis for both RNA and DNA *in situ* hybridization techniques to be addressed in lecture and laboratory. This course will be taught by clinical and basic scientists familiar with the applications of hybridization techniques to the problems of human disease.

BioTech 23

Flow Cytometry: Principles and Methods (4 days)

Flow cytometry has been a fundamental technology utilized for cell counting, cell sorting, biomarker detection, and protein engineering. This lecture and laboratory workshop will cover various applications of flow cytometry in research. Selected lecture topics will provide a broad background about the functions of a flow cytometer, choice of fluorochromes, data analysis and presentation, technical protocols for flow cytometric procedures and troubleshooting during data acquisition and analysis. The hands-on sessions will include BD Acuri Flow Cytometer, MACSQuant Analyzer, and ImageStream imaging flow cytometer, along with training on DIVA and FlowJo software.

BioTech 31

Vaccines: Development and Evaluation of Efficacy (4 days)

Vaccines are used or developed for a wide range of diseases such as cancer, autoimmune diseases, allergies, and for the prevention of communicable and parasitic diseases. The purpose of this course is to provide an overview of a broad spectrum of vaccine related topics, from the design of vaccines to their delivery with adjuvants and by different delivery systems. The target audience is researchers with various scientific backgrounds and with interest in vaccine research, but also those dealing with regulatory aspects of vaccines who wish to acquire a scientific understanding of vaccines.

BioTech 61

High-Dimensional Single Cell Analysis (3 days)

Present-day flow cytometry instrumentation enables assessment of over 10 parameters for individual cells over a larger number of samples. This course aims to identify and remove common obstacles in the execution of high dimensional cell measurement experiment. This course addresses experimental design, technical considerations, and analytical aspects of high-dimensional single cell analysis. Attendees will receive methods to perform studies in their area of expertise. The lectures will cover experimental design, data acquisition, and data analysis. Participants will have the opportunity to use different platforms for data analysis provided by major bioinformatics developers. Registration is open to anyone with intermediate flow cytometry experience. Participants will have the opportunity submit a project idea to be used as an educational example during the workshop.

BioTech 63

Protein-Protein Interactions (2 days)

Proximity Ligation Assay (PLA) provides the ability to see and quantitate protein posttranslational modifications, define complex interaction, illuminate complex protein clusters or amplify low abundant single events. Duolink is a versatile tool for detection, quantification and localization of cytoplasmic signaling events. This 2 day course will introduce participants to the key concepts of Duolink including technology development, assay design, antibody validation, best practices, trouble shooting and future applications. This workshop features hands-on lab exercises designed to provide participants with working knowledge of Duolink.

BioTech 64

Imaging Flow Cytometry (3 days)

This workshop on imaging flow cytometry is focused on understanding how imaging flow cytometers work, experimental design and planning. Participants will be provided with hands-on practice of running samples on the instrument as well as with data analysis using image analysis software. The workshop will also include two keynote speakers showcasing data derived from imaging flow cytometers.

VISIT **WWW.FAES.ORG/BIOTECH** FOR INFORMATION ON BIOTECH WORKSHOP SCHEDULES AND RATES.

Specifically geared toward life scientists, this intensive hands-on workshop will survey basic and advanced topics in imaging flow cytometer sample preparation, data/image acquisition, processing and analysis. This is an intensive hands-on workshop. FAES will provide laptops with necessary software for the duration of the course.

BioTech 80

CAR T-Cells: Principles and Methods (3 days)

Chimeric antigen receptor-modified T cells (CAR-T cells) are T cells engineered to target and eliminate a specific type of cancerous cells. Substantial investments have been made in this field over the past few years due to the great promise this technology shows in targeting virtually any antigen-presenting tumor cell. This course will combine lectures and hands-on training to introduce participants to the potential of CAR-T cells and the different approaches for the utilization of this technology in different applications, along with techniques for the production and automation of manufacturing of CAR-T cells. This intensive training program also provides opportunity to participants to network with experts in CAR-T field from both academia and industries. Each participant will receive printed course materials.

MICROSCOPY AND IMAGE ANALYSIS

BioTech 29

Laser Capture Microdissection (LCM): Methods for Microgenomics Analysis (5 days)

Laser Microdissection systems allow for the procurement of specific populations of cells from tissue and cytology and live cell culture samples containing heterogeneous populations of cells. The specificity of analyses is therefore much more representative of the disease process being studied. This approach to microdissection ensures that biological molecules, such as DNA, RNA and proteins, remain undamaged during the microdissection process. Downstream molecular analysis of these molecules produces accurate and assured results that have led to over 2,000 peer-reviewed publications by independent researchers. In this training program, participants will learn to prepare tissue specimens for microdissection, then select and acquire homogenous cell populations using the mmi-CellCut, Leica LMD, Arcturus XT, and PALM microdissection systems. Instruction emphasizes operation of these LM systems, appropriate tissue handling and sample preparation for subsequent DNA, RNA or protein analysis, and methods for proper molecular extraction.

BioTech 35

Immunofluorescence and Confocal Microscopy (4 days)

This course will focus on two important methods that are used extensively in biomedical research. Fluorescence microscopy is a useful tool for observing cellular morphology and function that is readily available and relatively simple to learn. Confocal microscopy has emerged as a powerful and popular extension of fluorescence microscopy, allowing 3-dimensional localization and dynamics of cellular components. The course is designed as a boot camp for those cell biologists who are just entering the world of confocal microscopy, wishing to utilize the technology to its fullest potential. Several related advanced topics are introduced to give participants an overview of future possibilities.

BioTech 38

Digital Imaging in Microscopy (4 days)

Imaging of cells and tissue through the microscope in years past had embraced the use of film to capture pertinent events. Improvements in recent years have led to the rise of digital imaging techniques, which allows for considerably more flexibility and accuracy in obtaining these images. Digital imaging effectively addresses the demands of high resolution, color accuracy, speed of acquisition, imaging flexibility, and low cost, all of which are demanded by the field today. This workshop presents techniques for effective imaging as they relate to microscope-fixed camera specifications and setup to gain optimal results.

BioTech 53

Super Resolution Microscopy (4 days)

Super Resolution Microscopy represents a group of recently developed light microscopic techniques that are able to exceed diffraction-limited resolution (less than 200nm). This course 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 course 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.

BioTech 60

Intravital Microscopy: Principles and Methods (5 days)

Intravital microscopy encompasses various light microscopy-based techniques, such as confocal and two-photon microscopy, which enables imaging and investigating biological events in live multicellular organisms under both physiological and pathological conditions. This hands-on course will focus on intravital microscopy in rodents and will provide NIH investigators with the opportunity to perform pilot studies in their area of expertise. Participants will be assisted in their experiments by trained personnel and will have the opportunity to use different platforms that will be kindly provided by the major microscope manufacturers.

The course will start with a one-day symposium featuring lectures from leading experts in the field. The daily schedule will include one hour of introductory lectures followed by intensive hands-on training.

BioTech 62

Image Processing and Analysis (2 days)

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.

STEM CELL TECHNIQUES

BioTech 18

Stem Cells (5 days)

Stem cells have emerged as important tools for biomedical research. During the workshop, lectures will cover the importance, origin, and fate of diverse stem cells (hematopoietic, muscle, nerve, skin, and embryonic) and the factors that control their differentiation. Special emphasis will be on isolation, identification, culture, and use of stem cells, and their progeny.

BioTech 47

iPSC II: Human Induced Pluripotent Stem Cells (hiPSC); Differentiation to Neural Lineages (5 days)

Induced pluripotent stem cells (iPSC) represent enormous potential in that they are capable of differentiating into virtually any cell type in the human body. This hands-on workshop will provide participants with the training and knowledge to help the researcher bring iPSC technology to the laboratory. Students will gain practical knowledge for developing new cell lines from different cell types. Lectures will discuss the expression of genes required for inducing pluripotency and methods of making (virus, RNA, plasmid) and maintaining iPS cells. Lectures on conditions needed for differentiating

iPSC to neural, epithelial, and hematopoietic lineages will also be discussed. The emphasis of the course is placed on deriving iPSC and differentiation to the neural lineage. Labs will cover methods for making iPSC and picking iPSC colonies. *In situ* analysis of pluripotency on live cells will be also conducted.

BioTech 49

Making iPSCells From Blood (5 days)

Recent advances in generating iPSCs now allow for their derivation from blood. This recent advance enables basic and clinical researchers to reprogram a blood cell into an iPSC and then further differentiate into any cell type. This capability allows researchers to develop 'disease in a dish' paradigms to investigate disease and therapy mechanisms.

In this five-day workshop, participants will learn how to generate iPSC from blood samples using a non-integrating approach. Due to the length of this procedure (iPSC generation ~3-4 weeks etc.) starting material (CD34+ cells or mononuclear cells) will be provided for each investigator and only critical stages will actually be performed during the laboratory portion of the workshop.

In addition to learning how to culture cells and reprogram blood cells into iPSCs, some of the latest methodologies for directing differentiation of these iPSCs into different lineages will be also presented. Therefore, this course will package together the essential methodology to take a CD34+ cell isolated from blood, reprogram this cell, and then direct differentiation into multiple different lineages.

BioTech 54

Making Cardiomyocytes From iPSCells

There is a great need to develop proper screens that are predictive of human clinical response to medications, especially because late-stage clinical trials are often terminated due to cardiotoxicity. This course will cover numerous applications using cardiomyocytes. The lectures will cover cardiac development and cardiac diseases, which will then provide the necessary background for appreciating how stem cells can be differentiated from iPSCs and be used to develop "disease in a dish" models as well as screens to monitor specific cardiac phenotypes, such as arrhythmia and cardiac toxicity. Lectures will also cover the methodology to drive differentiation of iPSCs toward cardiac lineages and the development of cardiac reporter lines that will be useful for screening applications.

OTHER

BioTech 71

Project Management Training for Scientists (2 Days)

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 course provides a comprehensive introduction to the essential aspects of project management for scientists. The course will draw on relevant case studies, and prepare participants to apply learning from the course in their organizations.

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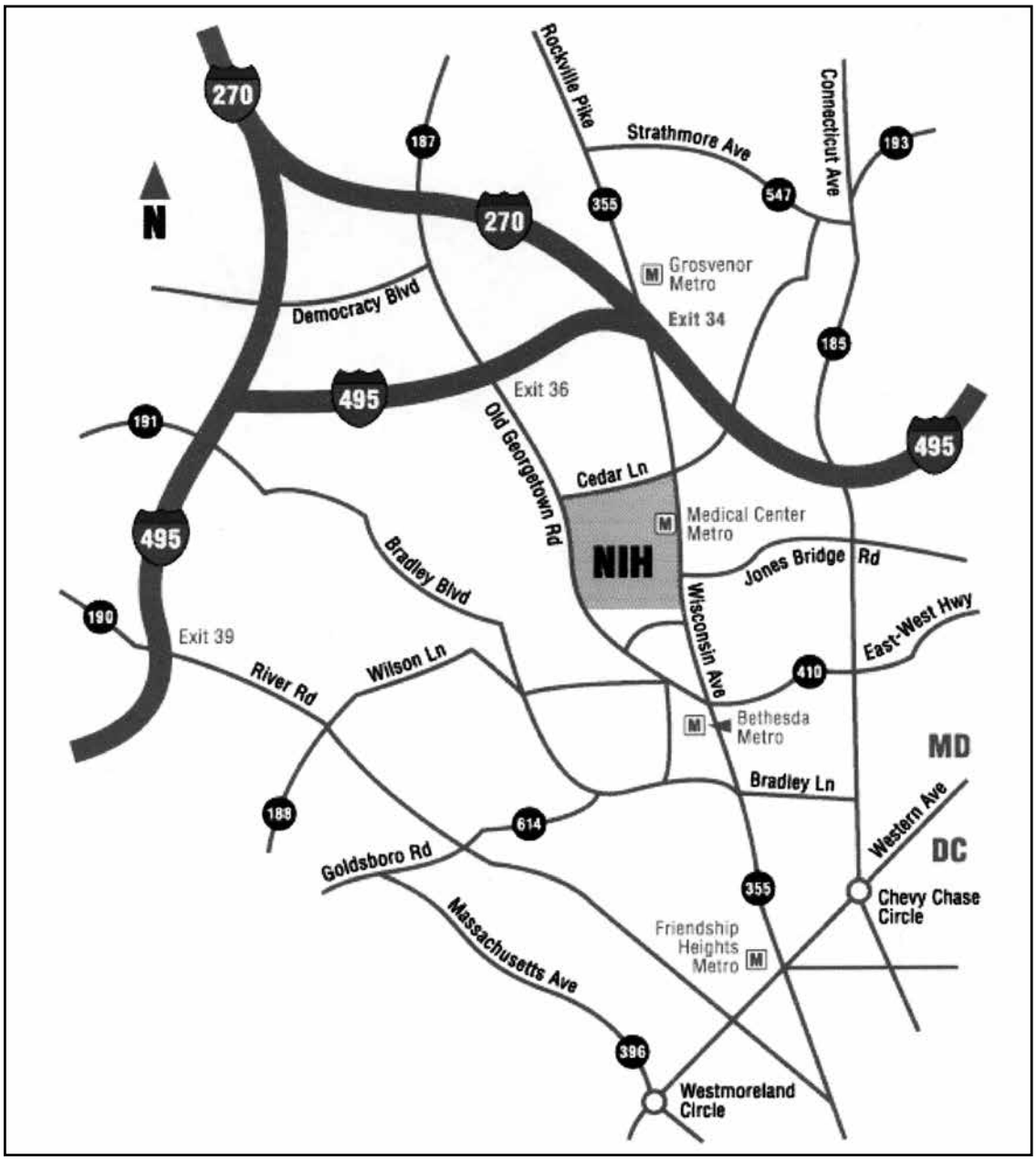
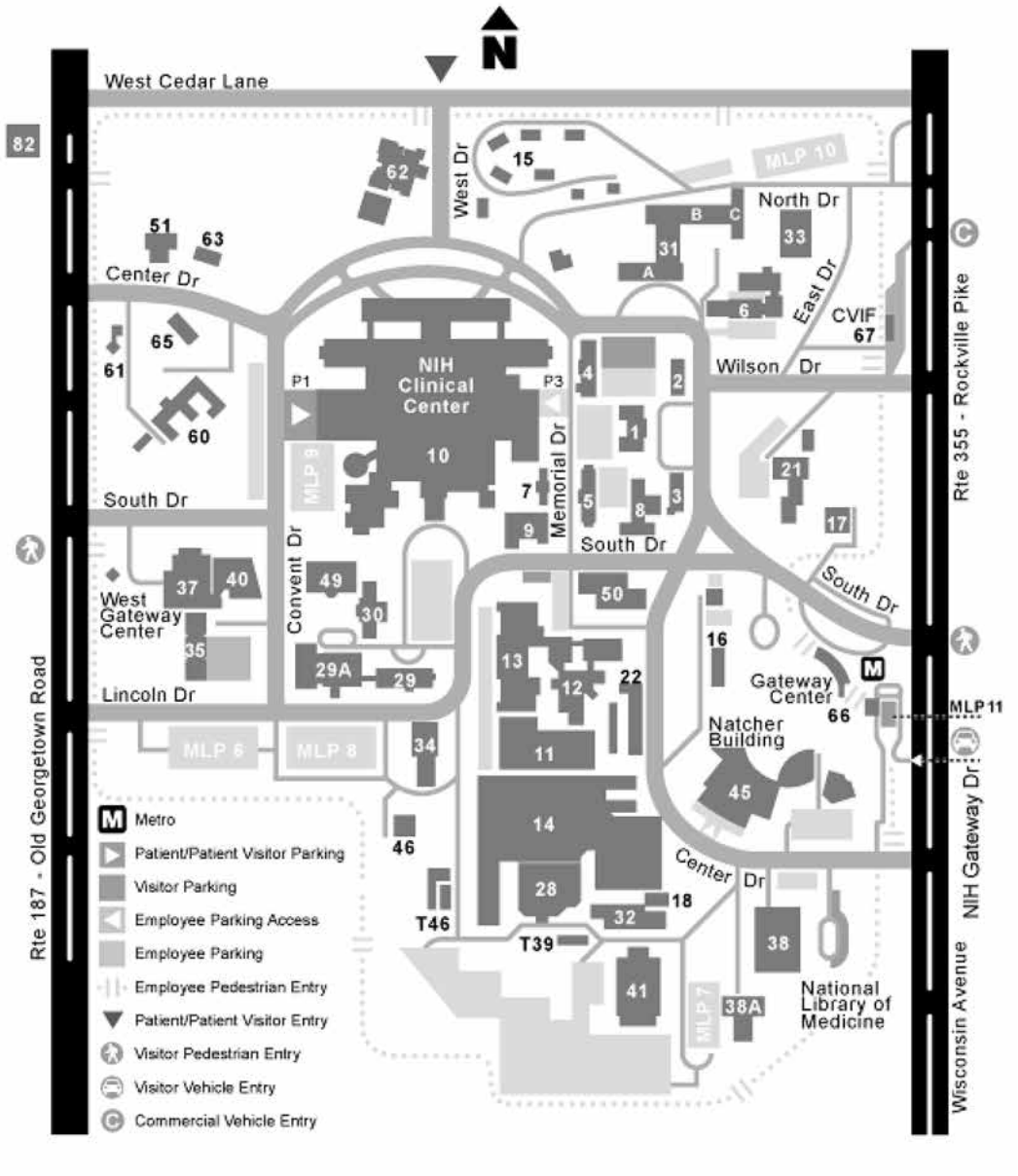


NIH VISITOR'S MAP



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NIH Gateway Center

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NIH VISITOR'S MAP WITH PERIMETER SECURITY

INFORMATION FOR PATIENTS AND VISITORS
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Welcome to the NIH. Please take the time to read this bulletin. It contains important parking and security information you need when visiting the NIH campus.

GENERAL VISITOR PARKING INFORMATION:

Visitors (*other than patients*) parking at the ***Gateway Parking Garage (MLP-11)*** and in designated visitor parking lot:

Monday — Friday, 7am – 7pm: $2.00 per hour for the first three hours $12.00 for the entire day

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The NIH has implemented security measures to help ensure the safety of our patients, employees, guests and facilities. All visitors must enter through the NIH Gateway Center at Metro or the West Gateway Visitor Center. You will be asked to submit to a vehicle or personal inspection.

Visitors over 15 years of age must provide a form of government-issued ID such as a driver's license or passport. Visitors under 16 years of age must be accompanied by an adult.

Vehicle Inspections – All vehicles and their contents will be inspected upon entering the campus. Additionally, all vehicles entering certain parking areas will be inspected, regardless of any prior inspection. Drivers will be required to present their driver's license and may be asked to open the trunk and hood. If you are physically unable to perform this function, please inform the inspector and they will assist you.

Vehicle inspection may consist of any combination of the following: Detection Dogs Teams (K-9), Electronic Detection Devices and Manual Inspection.

After inspection, you will be issued a vehicle inspection pass. It must be displayed on your vehicle's dashboard while you are on campus. The inspection pass is not a "parking permit." It only grants your vehicle access to enter the campus. You can only park in designated parking areas. (See campus map.)

Personal Inspections – All visitors should be prepared to submit to a personal inspection prior to entering the campus. These inspections may be conducted with a handheld monitoring device, a metal detector and by visible inspection. Additionally, your personal belongings may be inspected and passed through an x-ray machine.

Firearms, explosives, archery equipment, dangerous weapons, knives with blades over 2 1/2 inches, alcoholic beverages and open containers of alcohol are examples of prohibited items on the NIH campus.

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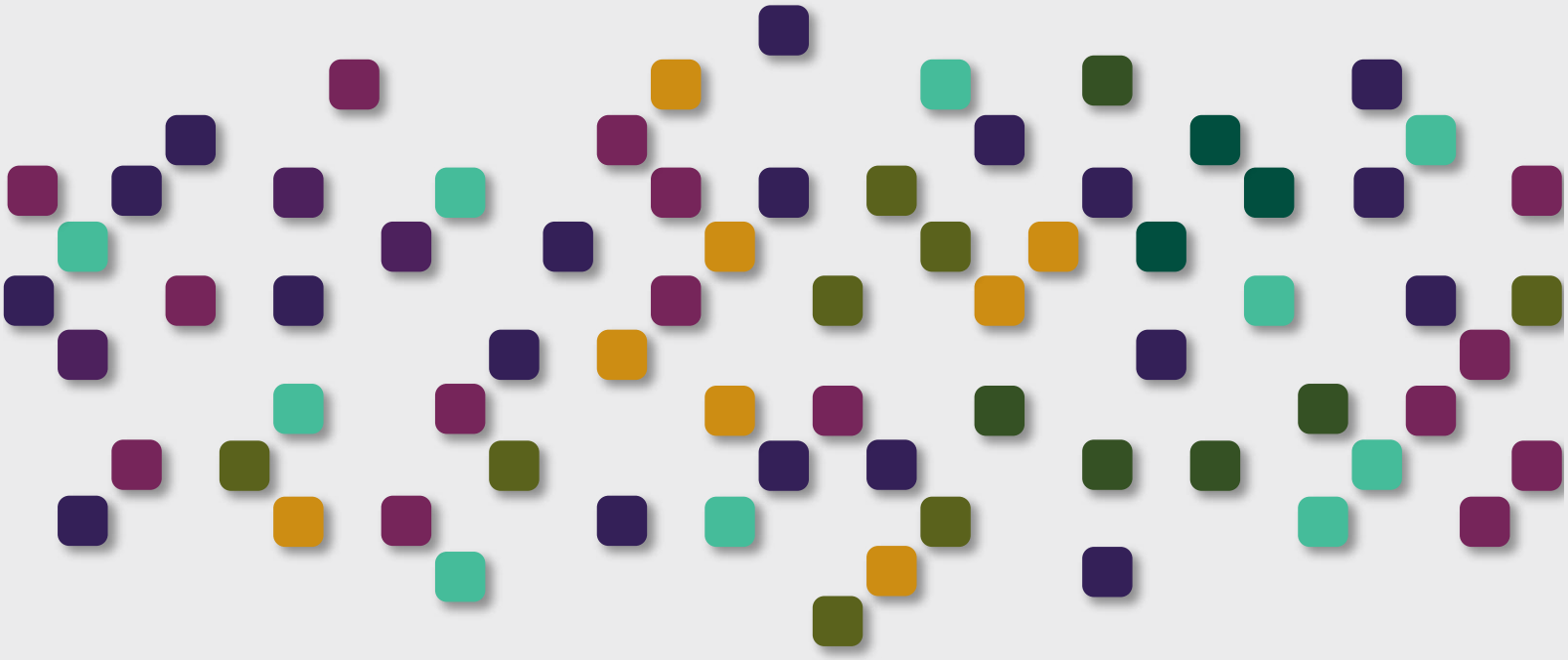

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