**ADVANCED MEDICINAL CHEMISTRY**

**The University of Toledo**

**College of Pharmacy and Pharmaceutical Sciences**

**CHM 4430-001 (61807), CHM 6430-001 (45057), CHM 8430-001 (45058)**

**MBC 6190-001 (41531), MBC 8190-001 (41613)**

**Coordinator:** Dr. Isaac Schiefer

**Email**: Isaac.schiefer@utoledo.edu

**Office Hours**: by appointment

**Office Location**: HEB284C

**Instructor Phone**: 4193831935

**Offered**: Fall 2021

**Course Website**: [Blackboard Learn](https://blackboard.utdl.edu/)

**Class Location**: BO2850 **Class Day/Time**: Tue and Thu 10-11:50 am

**Lab Location**: not applicable

**Lab Day/Time**: not applicable

**Credit Hours**: 4

**Instructor**: Dr. Ghassan Abushaikha

**Email**: ghassan.abushaikha@utoledo.edu

**Office Hours**: by appointment

**Office Location**: WO2221

**Instructor Phone**: 4195301570

**Offered**: Fall 2021

**Course Website**: [Blackboard Learn](https://blackboard.utdl.edu/)

**Class Location**: BO2850 **Class Day/Time**: Tue and Thu 10-11:50 am

**Lab Location**: not applicable

**Lab Day/Time**: not applicable

**Credit Hours**: 4

**Instructor**: Dr. Erin Prestwich

**Email**: erin.prestwich@utoledo.edu

**Office Hours**: by appointment

**Office Location**: WO2209

**Instructor Phone**: 4195301944

**Offered**: Fall 2021

**Course Website**: [Blackboard Learn](https://blackboard.utdl.edu/)

**Class Location**: BO2850 **Class Day/Time**: Tue and Thu 10-11:50 am

**Lab Location**: not applicable

**Lab Day/Time**: not applicable

**Credit Hours**: 4

**SPECIAL COURSE EXPECTATIONS DURING COVID-19**

Maintaining a safe campus during the ongoing COVID-19 pandemic remains a top priority. UToledo continues to follow the guidance of the U.S. Centers for Disease Control and Prevention and Ohio Department of Health to keep our campus safe.
 **ATTENDANCE** The University of Toledo has a missed class policy. It is important that students and instructors discuss attendance requirements for the course. Before coming to campus each day, students should take their temperature and complete a self-assessment for symptoms of COVID-19, such as cough, chills, fatigue or shortness of breath. Anyone with a temperature at or above 100.0 degrees Fahrenheit or who is experiencing symptoms consistent with COVID-19 should not come to campus and contact their primary care physician or the University Health Center at 419.530.5549. For more information on the symptoms of COVID-19, please go to <https://www.cdc.gov/coronavirus/2019-ncov/symptoms-testing/symptoms.html>

COVID-19 testing for sick students is available on both Main Campus and Health Science Campus. Call 419.383.4545 for an appointment. Absences due to COVID-19 quarantine or isolation requirements **are** considered excused absences. Students should notify their instructors and follow the protocols summarized in this document on [Navigating COVID-Related Course Concerns](https://www.utoledo.edu/offices/provost/docs/covid-19/COVID%20student%20flow%20chart.pdf).

In the event that you have tested positive for COVID-19 or have been diagnosed as a probable case, please review the [CDC guidance](https://nam04.safelinks.protection.outlook.com/?url=https%3A%2F%2Fwww.cdc.gov%2Fcoronavirus%2F2019-ncov%2Fif-you-are-sick%2Findex.html&data=04%7C01%7CDenise.Bartell%40UToledo.Edu%7Cc3ecf55590d548a6006a08d95c3b8e19%7C1d6b1707baa94a3da8f8deabfb3d467b%7C0%7C0%7C637642233117266556%7CUnknown%7CTWFpbGZsb3d8eyJWIjoiMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6Ik1haWwiLCJXVCI6Mn0%3D%7C1000&sdata=8jvRsGSu5bu%2BPHxfo75XszlKKqTfQig3w8ecZQR863w%3D&reserved=0) on self-isolation and symptom monitoring, and report the disclosure to the Division of Student Affairs by emailing StudentAffairs@utoledo.edu or by connecting with their on-call representative at 419.343.9946. Disclosure is voluntary and will only be shared on a need to know basis with staff such as in the Office of Student Advocacy and Support, The Office of Residence Life, and/or the Office of Accessibility and Disability Resources to coordinate supportive measures and meet contact tracing requirements.

**FACE COVERINGS**Face coverings are required while on campus, except while eating, alone in an enclosed space, or outdoors practicing social distancing. Students will not be permitted in class without a face covering. If you have a medical reason preventing you from wearing a face covering due to a health condition deemed high-risk by the CDC, submit an [online application](https://teton.accessiblelearning.com/Toledo/) to request an accommodation through the Office of Accessibility and Disability Resources. Students will need to provide documentation that verifies their health condition or disability and supports the need for accommodations. Students already affiliated with the Office of Accessibility and Disability Resources who would like to request additional accommodations due to the impact of COVID-19, should contact their accessibility specialist to discuss their specific needs. You may connect with the office by calling 419.530.4981 or sending an email to StudentDisability@utoledo.edu.

**VACCINATION**
Doctors and other health care professionals agree that the best way to protect ourselves and each other is to get vaccinated. Case data clearly show that vaccines remain highly effective at preventing serious illness from COVID, including the highly contagious delta variant. If you have not yet received your COVID vaccine, the University encourages you do so as soon as possible. No appointment is needed to get the shot at the UTMC Outpatient Pharmacy, University Health Clinic or Main Campus Pharmacy. Once you receive the COVID vaccination, please register on the COVID Vaccine Registry site at: <https://utvaccinereg.utoledo.edu/>.

**SPECIAL NOTES**It’s important to note, that based on the unpredictability of the COVID-19 virus, things can change at any time. So please be patient and understanding as we move through the semester. I also ask that you keep me informed of concerns you may have about class, completing course work/assignments timely and/or health concerns related to COVID.

**COURSE/CATALOG DESCRIPTION**

Discussion of the qualitative and quantitative aspects of the design of new therapeutic agents. Approaches to the design of drugs and new therapeutic modalities directed at enzymes, receptors, membrane transport proteins and nucleic acids are examined.

**COURSE OVERVIEW**

A detailed look at the chemistry and techniques involved in the design and development of pharmaceutical agents will be covered. We focus our discussion for a large part of the class on the design and development of selective estrogen receptor down-regulators. This will allow us to look at the design principles of a class of molecules over a broad time range and evaluate how the advance in various areas of scientific endeavor facilitate drug development. We will discuss specifically how proteomics, genomics, combinatorial synthesis and highly efficient analytical techniques have contributed to this process. These advances have also made the field of Drug Discovery a dynamic one with approaches, methods and theories evolving at an alarming rate. The properties and reactivity of organic functional groups is the foundation of this course. To perform well, it will be very important for each student to be well versed in the chemistry of the organic functional groups. A firm knowledge of biochemical theories is also mandatory. Do not attempt to memorize large volumes of information in this course, but try to understand the concept of structure-activity relationships and mechanism.

**STUDENT LEARNING OUTCOMES**
Students who are successful in this course should leave with a sophisticated understanding of

* The relationship between the structure of a drug and its pharmacological activity.
* The methods and techniques involved in the design and development of pharmaceutical agents.
* State of the art approaches to the development of therapeutics for various disorders.
* The factors that dictate drug toxicity.

**TEACHING METHODOLOGY**

This course material will be delivered with online lectures available on the course blackboard site. Students will be engaged in the class discussion board to respond to questions by the instructor and are expected to complete the assigned readings and assignments by the due dates.

**PREREQUISITES AND COREQUISITES**
This is a graduate level course. Appropriate course work in biology, chemistry and medicinal chemistry should have been completed.

**REQUIRED TEXTS AND ANCILLARY MATERIALS**

**There are no required texts.** The following book can serve as a reference**:**

**The Organic Chemistry of Drug Design and Development**, Richard Silverman and Mark W. Holladay, ISBN 978-0-12-382030-3, Academic Press

**Top Drugs, Their History, Pharmacology and Syntheses,** Jie Jack Li, ISBN 978-0-19-936258-5, Oxford University Press

**Basic Concept of Medicinal Chemistry**, Harrold and Zavod, ISBN 978-1-58528-266-1, ASHP publications

**Organic Chemistry and Biochemistry Textbooks**

**TECHNOLOGY REQUIREMENTS**

The official **Blackboard**® site for this course can be accessed through the myUT portal after login or directly at [https://**blackboard**.utdl.edu/](https://blackboard.utdl.edu/). All class notes will be posted at this site along with additional resources associated with the course, such as, electronic versions of suggested and required readings and hyperlinks). The website will also be used for official, course-related announcements.

**ACADEMIC POLICIES**Ethical behavior within the scientific community is an issue that all present and future pharmacists and pharmaceutical scientists should take very seriously. The University of Toledo has very clear policies for academic conduct and these policies will be followed in all issues related to this matter. This policy can be found at the following website: <http://www.utoledo.edu/dl/students/dishonesty.html>. Cheating and plagiarism will not be tolerated in any form. Please read the material on the website and feel free to ask questions if you need clarity or if you have concerns.

**COURSE EXPECTATIONS**

The class will begin with a brief overview of basic concepts governing the physicochemical properties of drugs. We will then move to understand the interaction of drugs with their targets. Thirdly we will cover some of the tools and techniques that are utilized in the drug design and development process. A discussion of case studies in drug design and development will then follow. These discussions will cover some of the drugs that have grossed the most amount of sales in recent history. Finally, the students will be expected to produce an original document outlining a plan to design a new potential drug and transition the drug from the bench to the market.

**Assigned Readings**: Journal articles and book chapters will be assigned as a part of this course. Please download these articles as soon as possible to make sure that they are available. If need be, order them through interlibrary loan. It is your responsibility to make sure that you obtain all assigned articles. These articles will be discussed in class and tested on exam day.

In consideration of your classmates as well as the instructor please refrain from the use of cell phones and other electronic devices that produce distracting sounds during the lecture.

OVERVIEW OF COURSE GRADE ASSIGNMENT\*

There will be one midterm exam and one Final Exam. The exams will cover the lecture material, text material, as well as reading from the primary literature. If you have any concerns regarding your grade on an exam, please speak with the instructors within 48 hours after the exam is returned to you. **ALL** questions on exams to be regraded will be reevaluated. If discrepancies exist, contact the course coordinator. Exams will begin punctually at the assigned time and will not be allowed to extend past the end of class.

Pop quizzes will be given periodically during class. These will focus on the most important foundational knowledge you will need to have success in the course, your qualifying exams, and career in pharmaceutical sciences.

In the event that a student misses an exam for a valid reason (medical, conference attendance, jury duty…) the instructors reserve the right to examine to offer a make-up exam. The make-up exam can be written or oral.

**Return of Exams; Posting Class Scores & Keys**: Following the grading of each exam, the exam key will be posted on the Blackboard® course website. Individual student scores can be accessed using the Blackboard® system. Exams scores will not be publicly posted.

**Grades:**

Midterm Exam = 25%

Final Exam = 25%

Pop Quizzes = 25%

Special Topics Presentations = 25 %

**Course Grading:**

 A = 90 - 100%

 B = 80 - 89%

 C = 70 - 79%

 D = 65 - 69%

 F = Below 65%

 + or – grades may be assigned upon final analysis of grades at the discretion of the instructor.

\*Midterm grades for the class will be assigned to assess the provide the students with a clear indication of their understanding of the material midway through the semester. Grading scale is subject to change based on grade distribution.

COMMUNICATION GUIDELINES

The Instructor for this course will accept inquiries via email, phone and in person concerning matters related to course materials, exam etc.

## UNIVERSITY POLICIES\*

**Policy Statement on Non‐Discrimination on the Basis of Disability (ADA**)\* The University is an equal opportunity educational institution. Please read [The University’s Policy Statement on Nondiscrimination on the Basis of Disability Americans with Disability Act Compliance.](http://www.utoledo.edu/policies/administration/diversity/pdfs/3364_50_03_Nondiscrimination_o.pdf) Students can find this policy along with other university policies listed by audience on the [University Policy webpage](http://www.utoledo.edu/policies/audience.html/#students) (http://www.utoledo.edu/policies/audience.html/#students).

**Academic Accommodations**\* The University of Toledo embraces the inclusion of students with disabilities. We are committed to ensuring equal opportunity and seamless access for full participation in all courses. For students who have an accommodations memo from Student Disability Services, I invite you to correspond with me as soon as possible so that we can communicate confidentially about implementing accommodations in this course. For students who have not established affiliation with Student Disability Services and are experiencing disability access barriers or are interested in a referral to healthcare resources for a potential disability or would like information regarding eligibility for academic accommodations, please contact the [Student Disability Services Office](http://www.utoledo.edu/offices/student-disability-services/index.html) (http://www.utoledo.edu/offices/student-disability-services/) by phone: 419.530.4981 or email at StudentDisability@utoledo.edu.

## ACADEMIC AND SUPPORT SERVICES\*

Please follow this link to view a comprehensive list of [Student Academic and Support Services](http://www.utoledo.edu/studentaffairs/departments.html) (http://www.utoledo.edu/studentaffairs/departments.html) available to you as a student

## SAFETY AND HEALTH SERVICES FOR UT STUDENTS\*

Please use the following link to view a comprehensive list [Campus Health and Safety Services](http://www.utoledo.edu/offices/provost/utc/docs/CampusHealthSafetyContacts.pdf) available to you as a student.

INCLUSIVE CLASSROOM STATEMENT

In this class, we will work together to develop a learning community that is inclusive and respectful. Our diversity may be reflected by differences in race, culture, age, religion, sexual orientation, gender identity/expression, socioeconomic background, and a myriad of other social identities and life experiences. We will encourage and appreciate expressions of different ideas, opinions, and beliefs so that conversations and interactions that could potentially be divisive turn, instead, into opportunities for intellectual and personal development.

COURSE SCHEDULE\*

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| Physicochemical Properties of Drugs | Week 1 | **Tuesday, August 31, 2021** | **Physicochemical Properties Bootcamp** |
| Thursday, September 2, 2021 | Drug Discovery Design and Development |
| Week 2 | Tuesday, September 7, 2021 | Basic Concepts in Medicinal ChemistryIntroduction, Functional Groups Characteristics and RolesIdentifying Acidic and Basic Functional Groups  |
| Thursday, September 9, 2021 | Basic Concepts in Medicinal ChemistrySolving pH and pKa ProblemsSalts and Solubility  |
| Week 3 | Tuesday, September 14, 2021 | Basic Concepts in Medicinal ChemistryDrug Binding InteractionsStereochemistry and Drug Action |
| Thursday, September 16, 2021 | Basic Concepts in Medicinal ChemistryDrug Metabolism and PharmacokineticsStructure Activity Relationships and Concepts in Drug Design |
| Drug Discovery, ADME, PK/PD  | Week 4 | Tuesday, September 21, 2021 | Drug Targets |
| Thursday, September 23, 2021 | Drug Receptor Interactions |
| Week 5 | Tuesday, September 28, 2021 | Enzymes, Enzymes Inhibition and Inactivation |
| Thursday, September 30, 2021 | Drug Metabolism |
| Week 6 | Tuesday, October 5, 2021 | Prodrugs and Drugs delivery Systems |
|  |   | **Thursday, October 7, 2021** | **Exam I-One Hour** |
| Techniques in Medicinal Chemistry | Week 7 | **Tuesday October 12, 2021** | **Principles of Chromatography** |
| Thursday, October 14, 2021 | Fall Break (no class) |
| Week 8 | **Tuesday, October 19, 2021** | **Principles of Chromatography** |
| **Thursday, October 21, 2021** | **Mass Spec in Drug Design and Development** |
| Week 9 | **Tuesday, October 26, 2021** | **Mass Spec in Drug Design and Development** |
| Thursday, October 28, 2021 | Use of NMR in Drug Design and Development |
| Week 10 | **Tuesday, November 2, 2021** | **Exam II** |
| Thursday, November 4, 2021 | Special Topics in Medicinal Chemistry |
| Selected Topics in Medicinal Chemistry | Week 11 | Tuesday November 9, 2021 | Special Topics in Medicinal Chemistry |
| Thursday, November 11, 2021 | Veterans Day (no class) |
| Week 12 | Tuesday, November 16, 2021 | Special Topics in Medicinal Chemistry |
| Thursday, November 18, 2021 | Special Topics in Medicinal Chemistry |
| Week 13 | Tuesday, November 23, 2021 | Special Topics in Medicinal Chemistry |
| Thursday, November 26, 2021 | Thanksgiving Holiday (no class) |
|  | Week 14 | Tuesday, November 30, 2021  | Special Topics in Medicinal Chemistry |
| Thursday, December 3, 2021 | Special Topics in Medicinal Chemistry |
| Week 15 | Tuesday, December 10, 2021 | FINAL EXAM |