

Biology 1107 - Topics in the Study of Life
FYRIS Section - Drug Development and Bioassay I
CRN 11443
Fall, 2023

Dr. Marc Cox; mbcox@utep.edu
Office Hours: Biosciences 3.128, open door policy

Day/Time: Tuesday/Thursday 9:00 AM – 10:20 AM

Location: Physical Sciences 303

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Course Objectives: This course is designed to provide a broad understanding of the basic drug development process, including- understanding the molecular mechanisms of disease, drug target identification, high throughput drug screening, and hit-to-lead optimization focusing on prostate cancer therapeutics. The practical aspects of this course will focus on the hit-to-lead optimization of a novel prostate cancer drug that was initially identified and characterized for treating hormone-refractory prostate cancer. Students will be expected to develop a yeast-based assay for use in screening compound libraries and use this assay to screen drug modifications for improved drug activity. A more detailed description of the course, including learning outcomes and practical skills learned, is provided in the weekly schedule.

Textbook: There is no required textbook. All reading material will be uploaded to Blackboard in advance.

Quizzes: A quiz will be administered at the end of each learning module for a total of 5 quizzes.

In-class activities/lab notebook: In-class activities will be given at the end of specific modules to assess (i.e. grade) the topics covered. Each group will be assigned a laboratory notebook to document in a detailed manner the experimental procedures/results done during the class. Laboratory notebooks will be checked at the end of each learning module. The grades will be based on legibility and detailed documentation of experiments.

Experimental Summaries (Data analysis): At the end of each learning module, students will submit a brief summary report including the study objective, experimental design, and data analysis with an interpretation of results.

Data Presentation: Each group will present their findings for discussion at the end of the semester.

Final Report: Each student will compile their summary reports written throughout the semester into a more extensive final account that includes a final analysis and discussion of the data and provides conclusions and potential future directions.

Grading: All quizzes combined are worth 20% of your final grade. Attendance is worth 10% of your final grade. The in-class activities/lab notebook are worth 10% of your final grade. The experimental summaries and data presentation are each worth 15% of your final grade. The final report is worth 30% of your final grade. **Grading scale:** A=90-100%; B=80-89%; C=70-79%; D=60-69%; F is <60%.

Make-up Policy: There are no make-up quizzes except in extraordinary circumstances. If a student has a serious illness, email the instructor before the date of the quiz, and provide documentation of your excuse. If you have a legitimate excuse for being absent, make arrangements with the instructor to take the quiz at a different time.

Attendance: It is the student's responsibility to attend class regularly. Attendance will be monitored and graded. If a student has a serious illness or a legitimate excuse (includes military personnel called to active duty or training) for being absent, make arrangements with the instructor before.

Drop Policy: **November 3rd** is the last day students may drop with an automatic "W". Census day is September 13th.

Academic Integrity Policy: UTEP's policies regarding academic integrity apply in this course. Cheating will be reported to the appropriate administrative officer. Failure to take the final exam may result in receiving an F in this course. Incompletes are only given in exceptional circumstances.

Civility Statement: Please be respectful of all students' right to learn without disruptions. In line with this statement please make an active effort to keep the talking to a minimum during lectures and presentations. Also make an active effort to either turn cell phones off or turn them to vibrate mode prior to the start of class.

Disability Statement: If a student has a disability and need classroom accommodations, please contact The Center for Accommodations and Support Services (CASS) at 7475148, or by email to cass@utep.edu, or visit their office located in UTEP Union East, Room 106. For additional information, please visit the CASS website at www.sa.utep.edu/cass.

Learning Modules

Semester I (Fall 2023) - Weekly Schedule and Learning Outcomes

Daily Schedule:

Date		Topic	Assignment
8/29	Tu	No class	NA
8/31	Th	No class	NA

Module 1

Week 1: Introduction to Drug Discovery - A general introduction to the drug discovery process will be provided with an emphasis on current research in prostate cancer therapeutics. This general information will lead into the current efforts within the Cox laboratory to develop novel strategies for the treatment of prostate cancer. The students' work throughout the semester will directly contribute to these efforts through the development and utilization of a yeast-based screening assay to screen drug analogs for increased potency.

Learning Outcomes:

Key Concepts: At the end of this module students will:

1. understand the essential role of academic science in the development of new therapeutic strategies.
2. understand the process of drug target identification and validation.
3. have a broad understanding of innovative approaches to drug discovery.
4. understand the current challenges in the treatment of prostate cancer and the molecular pathways that contribute to disease progression.

Practical Skills Gained:

1. General Laboratory Safety
2. Keeping and maintaining a proper laboratory notebook.

Daily Schedule:

Date		Topic	Assignment
9/05	Tu	Introduction to General Laboratory Safety/The Scientific Method	Read Provided Research Paper Due 9/07
9/07	Th	Biology of Cancer/Prostate Cancer/Drug Development	In-class activity

Module 2

Week 2: Preparation of Hormone and Drug Molecule Stocks - In preparation for the drug screening project students will be required to prepare serially diluted stocks of the hormone and drug molecules that will be used in the drug screening assay that the students will develop over the course of the semester. In order to achieve competency in basic sterile technique and pipetting the students will generate a protein standard curve using the Bradford method. This standard curve will be used to assess technical accuracy and reproducibility before using these newly acquired skills to prepare the hormone and drug stocks.

Learning Outcomes:

Key Concepts: At the end of this module students will:

1. understand the utility of colorimetric assays in biomedical research.
2. have a broad understanding of drug solubility.
3. understand drug delivery strategies for poorly water-soluble drugs.

Practical Skills Gained:

1. Proper Sterile Technique
2. Proper Pipetting Technique
3. Serial Dilution
4. Bradford Assay for Measuring Protein Concentration

Daily Schedule:

Date		Topic	Assignment
9/12	Tu	Pipetting/Protein Standard Curve and Serial Dilution/Hormone Stocks	Quiz #1 Module 1
9/14	Th	Pipetting/Protein Standard Curve and Serial Dilution/Hormone Stocks	In-class activity

Module 3

Weeks 3-4: Preparation of Recombinant DNA for Expression of Androgen Receptor and the Androgen Receptor-Dependent Reporter - The yeast-based screening assay will be used to assess the effects of candidate drug molecules on human androgen receptor activity. Thus, DNA plasmids for the expression of the human androgen receptor gene and the reporter gene will first need to be amplified in bacteria, extracted and purified.

Key Concepts: At the end of this module students will:

1. have a broad understanding of recombinant DNA technology.

Practical Skills Gained:

1. General growth and maintenance of bacterial cultures
2. bacterial transformation
3. plasmid mini-prep
4. DNA separation, agarose gel electrophoresis

Daily Schedule:

Date		Topic	Assignment
9/19	Tu	Bacterial Transformation	Quiz #2-Module 2 Notebook inspection 1
9/21	Th	Bacterial Transformation	In-class activity
9/26	Tu	Plasmid Isolation & Analysis	In-class activity
9/28	Th	Plasmid Isolation & Analysis	Turn in Experimental Summary from Module 3

Module 4

Weeks 5: Computational Biology – The incorporation of the Bioinformatics tools in biology and medicine will be introduced, focusing on the importance of the genome sequencing/Next-generation sequencing in understanding and developing precision medicine/treatment methodology leading to personalized medicine. Transcriptomic data of the drug treated prostate cancer cell lines will be used in analyzing the KEGG enriched pathways to understand the effect of drug in specific pathways.

Key Concepts: At the end of this module students will:

1. have basic understanding of genomics and bioinformatics.
2. have knowledge of databases such as NCBI, KEGG
3. know how to use transcriptomic data for analyzing enriched pathways.

Practical Skills Gained: Students will be expected to have achieved competency in all practical skills needed to complete this section.

Daily Schedule:

Date		Topic	Assignment
10/03	Tu	Bioinformatics database search	Quiz #3-Module 3
10/05	Th	Enrichment analysis	In-class activity

Module 5

Weeks 6-7: Develop the Strain for the Yeast-Based Screening Assay - Although *Saccharomyces cerevisiae* lacks steroid hormone receptors, most of the chaperone components known to function in steroid hormone receptor complexes are highly conserved in yeast. Thus, vertebrate receptors exogenously expressed in yeast can fold to a hormone binding conformation and, in the presence of hormone, activate a hormone inducible reporter gene. This, combined with the fact that yeast is a genetically tractable organism, makes yeast genetics a highly attractive model system for the identification and characterization of steroid hormone receptor modulators. The yeast-based androgen receptor (AR)-mediated β -galactosidase reporter assay can be used as a quantitative measure of androgen receptor function. This assay is used for the identification and characterization of androgen receptor regulatory proteins, and to screen compound libraries for androgen receptor inhibitors (i.e. prostate cancer drugs). Thus, students will transform the androgen receptor plasmid and β -galactosidase reporter plasmid into yeast and select for plasmid maintenance. Once complete these strains will be stored at -80°C and can be recovered at any time for growth and assays.

Key Concepts: At the end of this module students will:

1. understand the use of yeast as a model system for the study of human signaling pathways.
2. understand the use of plasmids for exogenous expression of genes in yeast.

Practical Skills Gained:

1. General growth and maintenance of yeast
2. yeast transformation
3. cryopreservation

Daily Schedule:

Date		Topic	Assignment
10/10	Tu	Yeast Transformation	Notebook inspection 2
10/12	Th	Yeast Transformation	Turn in Experimental Summary from Module 4
10/17	Tu	Yeast Transformation and Clone Selection	In-class activity
10/19	Th	Yeast Transformation, Clone Selection and Cryopreservation	Quiz #4-Module 4

Module 6

Weeks 8-9: Determination of Optimal Hormone Dose for Drug Screening - Students will be using the androgen receptor-dependent reporter assay to screen drug molecules for inhibition of hormone-dependent receptor activity. Thus, the drug candidates will be assayed for the ability to inhibit the receptor in the presence of hormone. The hormone concentration used in these assays typically falls within the middle of the hormone dose response curve. Thus, students will perform a reporter assay in the presence of a range of hormone concentrations to generate a hormone dose response curve and use that curve to determine the effective concentration 50% (EC_{50}) for the hormone. This will be the hormone concentration used in the drug screens.


Key Concepts: At the end of this module students will:

1. have a broad understanding of the use of reporter assays for the assessment of transcription factor function.
2. understand dose response for the assessment of compound potency and efficacy.
3. understand the principles of chemiluminescent detection.

Practical Skills Gained:

1. hormone-dependent reporter assay
2. dose response analysis

Daily Schedule:

Date		Topic	Assignment
10/24	Tu	Reporter Assay	Notebook inspection 3
10/26	Th	Reporter Assay	Turn in Experimental Summary from Module 5
10/31	Tu	Reporter Assay	
11/02	Th	Dose-Response Curve Assessment and Determination of EC_{50}	Quiz #5-Module 5

Module 7


Weeks 10-12: Perform Drug Screen - Starting with a hit molecule that was identified in a high throughput drug screen combinatorial chemistry was used to make a library of analogs. Each molecule in the library is a slightly modified version of the hit molecule. The goal will be to screen the entire library of analogs for inhibitory activity. The primary goal will be to identify a more potent analog. The secondary goal will be to elucidate the chemical structure leading to effective drug inhibition. Students will use the hormone dependent reporter assay that they have developed to screen as many molecules as they can for hormone receptor inhibition within the allotted time frame.

Key Concepts: At the end of this module students will:


4. have a broad understanding of the hit-to-lead optimization process.
5. know how to design proper positive and negative experimental controls.

Practical Skills Gained: Students will be expected to have achieved competency in all practical skills needed to complete this section during previous sections.

Daily Schedule:

Date		Topic	Assignment
11/07	Tu	Drug Screening Analysis	Notebook inspection 4
11/09	Th	Drug Screening Analysis	Turn in Experimental Summary from Module 6
11/14	Tu	Drug Screening Analysis	Work on Final lab Report and Data Presentation
11/16	Th	Drug Screening Analysis	Work on Final lab Report and Data Presentation
11/21	Tu	Drug Screening Analysis	Work on Final lab Report and Data Presentation
11/23	Th	Drug Screening Analysis	

Module 8**Week 13: Group Discussions and Analysis of Data**Daily Schedule:

Date		Topic	Assignment
11/28	Tu	Drug Screening Analysis	Turn in Experimental Summary from Module 7 Work on Final lab Report and Data Presentation
11/30	Th	Drug Screening Analysis	Work on Final lab Report and Data Presentation
12/5	Tu	Data Presentations	Final Lab Reports Due
12/7	Th	Final Class Discussions	

Semester II (Spring 2018) - Weekly Schedule and Learning Outcomes

To Be Determined

Synopsis - In Semester I the students will have learned the concepts of basic drug development and the application of a yeast-based bioassay for drug screening. In semester II the students will use their newly acquired knowledge and adapt their bioassay for use in screening environmental samples for the presence of hormone mimicking contaminants.

Daily Schedule:

Date		Topic	Assignment
8/29	Tu	No class	NA
8/31	Th	No class	NA
9/05	Tu	Module 1: Introduction to General Laboratory Safety/The Scientific Method	Read Provided Research Paper Due 9/07
9/07	Th	Module 1: Biology of Cancer/Prostate Cancer/Drug Development	In-class activity
9/12	Tu	Module 2: Pipetting/Protein Standard Curve and Serial Dilution/Hormone Stocks	Quiz #1 Module 1
9/14	Th	Module 2: Pipetting/Protein Standard Curve and Serial Dilution/Hormone Stocks	In-class activity
9/19	Tu	Module 3: Bacterial Transformation	Quiz #2-Module 2 Notebook inspection 1
9/21	Th	Module 3: Bacterial Transformation	In-class activity
9/26	Tu	Module 3: Plasmid Isolation & Analysis	In-class activity
9/28	Th	Module 3: Plasmid Isolation & Analysis	1- Turn in Experimental Summary from Module 3
10/03	Tu	Module 4: Bioinformatics database search	Quiz #3-Module 3
10/05	Th	Module 4: Enrichment analysis	In-class activity
10/10	Tu	Module 5: Yeast Transformation	Notebook inspection 2
10/12	Th	Module 5: Yeast Transformation	2- Turn in Experimental Summary from Module 4
10/17	Tu	Module 5: Yeast Transformation and Clone Selection	In-class activity
10/19	Th	Module 5: Yeast Transformation, Clone Selection and Cryopreservation	Quiz #4-Module 4
10/24	Tu	Module 6: Reporter Assay	Notebook inspection 3
10/26	Th	Module 6: Reporter Assay	3- Turn in Experimental Summary from Module 5
10/31	Tu	Module 6: Reporter Assay	Happy Halloween
11/02	Th	Module 6: Dose-Response Curve Assessment and Determination of EC50	Quiz #5-Module 5

Daily Schedule (Cont.):

Date		Topic	Assignment
1/07	Tu	Module 7: Drug Screening Analysis	Notebook inspection 4
11/09	Th	Module 7: Drug Screening Analysis	4- Turn in Experimental Summary from Module 6
11/14	Tu	Module 7: Drug Screening Analysis	Work on Final lab Report and Data Presentation
11/16	Th	Module 7: Drug Screening Analysis	Work on Final lab Report and Data Presentation
11/21	Tu	Module 7: Drug Screening Analysis	Work on Final lab Report and Data Presentation
11/23	Th	Module 7: Drug Screening Analysis	Happy Thanksgiving
11/28	Tu	Module 8: Data Presentations	5- Turn in Experimental Summary from Module 7 Work on Final lab Report and Data Presentation
11/30	Th	Module 8: Data Presentations	Work on Final lab Report and Data Presentation
12/5	Tu	Module 8: Data Presentations	Final Lab Reports Due
12/7	Th	Final Class Discussions	