

CH428 – Advanced Biochemistry

Birmingham –Southern College

Fall 2020

1 COURSE DESCRIPTION AND OBJECTIVES

CH428 is a one semester advanced biochemistry course that allows students to further study the physiological processes of the human body at a molecular level and utilizes a guided research project approach to teach students relevant laboratory skills, advanced biochemical techniques, and a wide array of analytical instrumentation. This course aims to apply the knowledge gained from organic chemistry, cellular biology and biochemistry in order to provide students with the skills required of a biochemistry research laboratory and deepen their existing knowledge. To apply the knowledge gained in this course, students in the laboratory will extract, purify and identify the enzyme Lactate Dehydrogenase. Students will then study the thermodynamics and kinetics of this enzyme under ideal cellular conditions, as well as in the presence of inhibitors and activators. Activities in the lab will enable students to gain insight on macromolecular structure, function and binding properties. After completion of this course students should be able to:

- Evaluate and discuss common diseases at the molecular level and propose avenues of possible treatments or research
- Evaluate and discuss common biochemistry techniques and how these techniques utilize macromolecular structural, functional and chemical properties for analysis
- Perform advanced biochemical research techniques such as preparation and analysis of macromolecules and macromolecule/ligand complexes
- Manage and approach an authentic research question like a biochemist through literature review, analytical method development and troubleshooting, and data analysis
- Discuss research findings with the scientific community through scientific writing and oral presentations.

2 COURSE INFORMATION

Meeting:	Lecture: 9:30 – 10:50 AM Tues and Thurs SSC 336 Lab: 12:30 – 3:20 PM Thurs SSC 207
Instructor:	Kate Hayden, SSC 342
Email:	khayden@bsc.edu
Phone:	205-223-4872
Office Hours:	Book an appointment with me
Text:	Tools and Techniques in Biomolecular Science by Aysha Divan and Janice Royds

3 COURSE WORK AND EVALUATION

Letter grades, as defined in the BSC Catalog, will be assigned at the end of the course based on the number of possible points that you can earn, where 93-100% = A, 90-92% = A-, 87-89% = B+, 83-86% = B, 80-82% = B-, 77-79% = C+, 73-76% = C, 70-72% = C-, 67-69% = D+, 60-66% = D, and <60% = F.

Item	Possible Points
Projects (3 X 100 points each)	300
Lab Notebook (2 checks at 25 points each)	50
Lab Protocols (10 X 5 points each)	50
Participation	50
Peer Reviews (5 X 10 points each)	50
Final Paper	100
Student Presentation	100
Total Possible	700

4 TAKING CH428 DURING A PANDEMIC

This is a unique time in our history and will certainly impact how our course proceeds. First, the semester will be compressed, we will start Monday 8/24 and will work straight through till the Thanksgiving Break without breaks. All students and faculty will always be required to wear facemasks while in the classroom or in the lab and to help minimize cross contamination, I will assign seating both in the lecture and laboratory space. Due to the nature of COVID-19 transmission, all group work will be done within our virtual workspaces (Microsoft Teams and Moodle). This course is highly collaborative, and I hope to maintain that as much as possible while maintaining social distancing and other CDC guidelines by requiring student groups to meet and work together virtually using Microsoft Teams.

To provide flexibility with students who may need to isolate due to exposure or are considered high-risk, I will run all lectures simultaneously face to face and online using Microsoft Teams during their normally scheduled time and date. Students online can still participate in discussions and questions as they normally would in the face to face environment. The lab component however requires face to face participation and students are expected to attend lab in person unless they are required to self-isolate due to exposure and/or contracting COVID-19. We will work together to schedule make ups of the missing lab hours or come up with a suitable alternative assignment. Should we have a serious outbreak on campus that forces us to move the course completely online, we will switch to an at-home laboratory experience instead.

Should I (the instructor) need to self-isolate due to exposure or contraction of COVID-19; I will continue to lead discussions and lectures from my home via Microsoft Teams for as long as I am physically able to do so. Students would not be expected to attend the class directly in the classroom but are expected to participate remotely themselves using Teams. I will do my best to notify students quickly should this occur.

5 LABORATORY PROTOCOLS

Each week students will be asked to develop protocols or procedures that we will utilize in the following week for the laboratory project. To develop these protocols, students can use any resource at their disposal such as peer reviewed literature, texts, and professionals in the field. Students are encouraged to work together and seek out advice from faculty. These assignments will be due at the start of class on Thursday, and should be submitted as typed, organized documents to our course Microsoft Teams page under the assignment "Lab Protocols".

6 PROJECT BASED LEARNING

Instead of exams, students will complete three independent projects (100 points each) throughout the term to assess student knowledge, and student progress in the course. Students are expected to complete all projects on the dates and times scheduled. Students may use their laboratory notebooks, homework assignments, current literature (utilizing proper citations), and course text book on the projects, but all projects should be original and all resources properly cited.

7 FINAL PAPER AND PEER REVIEW

At the end of the term, students will submit a clearly organized, concise, neat and typed final lab report in the form of a scientific peer-reviewed paper summarizing the project goals, methodology, theoretical background, experimentation and results. This report will include an abstract, introduction, methods and materials, results and discussion, and conclusion section and will adhere to proper American Chemical Society formatting. Writing rubrics will be given to assist students as they prepare their report.

Throughout the term, students will provide feedback on their peers' papers utilizing peer review. Each section of the paper (Abstract, Introduction, Methods and Materials, Results, and Discussion) will be submitted to the class at a given date and reviewed by student colleagues utilizing a grading rubric. Students will be assessed on their feedback on their peer's work.

8 LAB SAFETY

Even though we have an excellent safety record in our chemical and biochemical laboratories, the laboratory can be a dangerous place. A few hazards that are present include hot water or hot surfaces, toxic or corrosive chemicals (ethidium bromide, acrylamide, trichloroacetic acid etc), electricity, ultraviolet light, operating centrifuges, and broken glass. The general advice to safety is: know what you are doing by preparing for lab. Students have a right to view Material Safety Data Sheets (MSDS) for chemicals used in the class. These can be accessed from www.siri.org/msds/. You will be reminded of the potential hazards before and during each class; however, you are ultimately responsible for your safety.

You must follow basic safety rules to ensure safety for yourself and fellow students during the class.

1. Always wear some sort of protective eyewear. You must wear either lab goggles that protect from the sides as well as from the front or a face shield. You can purchase lab goggles during the first weeks of the class from the department. There are two face shields in the laboratory. If you are wearing normal glasses, wear goggles over them as normal glasses do not provide side-protection. You may wear contact lenses along with lab goggles. Protective eyewear is not required in the computer lab.
2. Wear gloves when required, or when you are working with dangerous chemicals. Replace gloves when they become contaminated with toxic materials, such as ethidium bromide. Throw used gloves into the trash.
3. Wear appropriate clothing. You must wear closed shoes, and a shirt that covers the midsection. No shorts are allowed, and long pants and long sleeves are recommended.
4. Label all solutions that you prepare clearly. If the solution is in a container larger than 5 mL, make sure that the label conveys information about the content of the container and also identify your group or you personally as the person responsible for this solution. Unlabeled solutions will be discarded.
5. Familiarize yourself with the safety equipment in the lab. Our lab has one fire extinguisher near the back door, and eyewash/shower station near the front door. First aid kits are available in the storerooms on the first and second floor. Emergency phone numbers are posted in the lab. In case of fire, earthquakes, or other major disasters leave the lab if this is safe, and meet your instructor on the lawn out front of the rec

This document may be modified as needed due to COVID-19 center patio.

6. Do not eat or drink in the laboratory. Closed containers with food may be brought into the laboratory but must be stored in your bag or backpack placed in the cabinet box. You may eat or drink outside the laboratory if time permits.

7. Never work alone. Never use mouth suction. Never open the lid of a spinning centrifuge. Do not perform any unauthorized experiments.

8. Dispose of all toxic solutions, glass, and other paraphernalia in a safe and approved manner (you will be instructed on how to do this). DO NOT POUR SOLUTIONS DOWN THE SINK.

9. In case of accident, alert fellow students and immediately take an appropriate action. Explain to your TA what happened and seek further help if necessary.

Ignoring safety rules while in the laboratory will lead to oral warning on the first instance, and deduction of points for each following instance. Serious intentional violations of safety rules will lead to the dismissal from the course.

9 LAB NOTEBOOK

In any research scenario the lab notebook is an essential element. It is a legal document and has been known to not only save or destroy projects, but careers as well. Accurate and diligent documentation of your work in the lab is of the utmost importance. You are expected to write in paragraph form, using proper grammar and complete sentences. In instances, such as parts of the method section, a bullet point list for procedural steps may be used, but note that the methods section should be written clearly enough that anyone not familiar with the experiment should be able to repeat it.:

Prelab: It is expected that every student come to lab fully prepared

- Clearly state lab objectives and goals
- Rewrite a methods section in your own words, leaving spaces for notes and observations (such as actual weights or temperatures) to use while performing the lab
- State all safety concerns and proper techniques for avoiding an accident

During Lab: First and foremost: Participate in the lab with your lab members and pay attention

- Record all necessary observations such as actual weights or instrumental parameters used.
- Record personal notes/observations that may help you to perform this experiment better in the future
- Affix any raw data such as spectra directly into your notebook using tape and label appropriately. Each individual is responsible for having his or her own data before leaving the lab.
- Note sources of error such as the error stated on glassware and balances, or manmade error from the sometimes unavoidable spill or bump.

Post Lab: The post lab is made up of a calculations/result section and a discussion section. Simply restating the results in the discussion will not give you full credit, you must strive to find the implications of your results as they pertain to the real world. Feel free to research outside sources such as textbooks or peer reviewed journal articles to help you form a thoughtful discussion. This is also a good place to discuss error in the experiment, where it came from and how to avoid it. Feel free to also address problems in the experiment, or sections that were confusing so that we can strive to address these issues for future classes.

- Perform all required data analysis and calculations, clearly state results using a variety of means such as a tables or figures.
- Clearly discuss the results as they pertain to the experiment and draw conclusions on the physical meaning of your results. Address any additional questions that may appear in your handout, as these are meant to guide you in your discussion.

This document may be modified as needed due to COVID-19

A composition notebook is required for a laboratory notebook. Keep all handouts in a ring-binder. Use pen with BLUE INK for your written portion of your notes. Date all pages. The copy of the notebook that you present to your TA is very important. Your notebook is the primary way you have to convey that you understand the laboratory exercises. All raw data should be handwritten directly into the notebook with BLUE INK and not onto scrap paper for later recopying into the notebook, if something was written in error, simply mark out the error with a single slash and rewrite the correct value next to it. Of course, legible handwriting is a key to effective communication. If we can't read it, it's wrong, should you prefer to type your pre and post lab sections you may, just cut and paste the sections into your physical notebook but remember to leave space for handwritten notes during the lab. Please note that while these experiments are performed while working in groups, your lab notebook should be your own personal work and not a team effort. Lab notebooks will be checked twice by the instructor for 25 points each, points may be deducted for failure to date, failure to include a table of contents, failure to include page numbers, and for poor penmanship. Notebook checks will be indicated on the project schedule.

10 LAB CLEANLINESS

It is important to maintain cleanliness in this laboratory. Even minor impurities on the glassware or on the pipette tip may ruin an otherwise well-done experiment. For example, using the same pipette tip to transfer two enzymes from their containers into your micro centrifuge tube will most surely contaminate the contained of the second enzyme with the first one and will likely ruin the results for the whole class. You will be working a lot with pipettors that use disposable tips. Discard the tip as soon as you do not need it. They are a lot cheaper than the chemicals that you are working with. Most used plastic ware, such as micro centrifuge tubes or Falcon tubes (15 mL, 50 mL size) are for one-time use. Empty all the tubes before discarding them (it's OK to leave less than 50 μ L in micro centrifuge tubes). Discard broken glassware and used glass pipets into the broken glass container. Do not discard functional glassware or any parts of the equipment used. If your glassware is visibly dirty, wash it with Alconox and hot water, otherwise rinse several times with distilled water from the tap, and place on the drying racks. Do not leave any glassware or other items in the sink. Each student is responsible for completely cleaning the workplace and all the glassware used. Your TA will adjust your grade based on your work ethics. Leaving a mess will result in a bad grade..

11 ATTENDANCE POLICY

With COVID-19 mandatory attendance has been waived. Please reach out to me early if you believe you will miss class due to isolation or illness.

12 HONOR CODE

Each student is expected to follow the BSC Honor Code. If it is determined that you have violated the honor code during a pre-activity, in-class activity, homework assignment, quiz, project, or exam you will receive a zero on that component of your grade.

13 PORTABLE DEVICES

Use of cell phones or other electronic devices to send or receive calls, text messages, surf the internet, etc. are not allowed in the classroom for personal use. Such devices can only be used to aid in group activities when suitable. However, these devices are NOT allowed for use during exams and should be turned off before the start of the exam so they will not ring, vibrate, or otherwise disturb you, your fellow students, or your instructor.

14 ACADEMIC SUPPORT SERVICES

Birmingham-Southern College complies with Section 504 of the Rehabilitation Act and the Americans with Disabilities Act. Students with disabilities who seek accommodations must make their request by

This document may be modified as needed due to COVID-19 contacting the Office of Accessibility in-person, via email (accessibility@bsc.edu), or by calling 205-226-7909. The Office of Accessibility is located in the Counseling and Health Services Suite of Norton Center Room 241. Students who are registered with the Office of Accessibility are responsible for providing faculty with a copy of their accommodation letter and scheduling a meeting to discuss how their approved accommodations will apply to this course. Visit the Office of Accessibility website for additional information or contact Angela Smith at awsmith@bsc.edu

15 WRITING CENTER

The Writing Center is located in Hum. 102, and it has a new structure and vibe this year. Two graduate student coordinators will be on site at all times the Writing Center is open to supervise peer tutors and to conduct tutorials themselves, as needed. We will be open Sunday-Thursday late afternoon and evenings, and students do not need an appointment. Tutorials are about 30 minutes long, free of charge, and available on a drop-in basis. Tutors will not proofread or "fix" student papers. They will provide one-on-one consultation about writing issues--small and large--for any student from any major at any point in the writing process. There is no limit to how many tutorials a student may attend. We are here to help.

16 TITLE IX

Birmingham-Southern College is committed to the creation and maintenance of a safe learning environment for students and the campus community. The College forbids any type of sexual or gender-based misconduct among its students, faculty, and staff. The College encourages all members of the academic community to report suspected sexual and gender-based misconduct to the appropriate authorities so that it can be investigated, remedied, and eliminated. Such misconduct is prohibited whether the actor is a student, faculty member, staff member, contractor, visitor, or another member of the College community. BSC forbids retaliation against any person who has opposed, reported or participated in an investigation concerning sexual or gender-based misconduct.

In accordance with federal policy, all College employees are required to report information related to discrimination and harassment which includes, but is not limited to, sexual assault, relationship violence, stalking, and sexual harassment. For this reason, if you tell a faculty member about a situation of sexual harassment or sexual violence or other related misconduct, the faculty member must share that information with the Title IX coordinator. As a student, you can report allegations of sexual misconduct to officials in Student Development (Assistant Dean of Students, Dana Bekurs; Associate Dean of Students, W. David Miller; Vice President for Student Development, David Eberhardt), Campus Police, or confidential resources in Counseling Services, Health Services, and Religious Life. Please refer to the Title IX section of the BSC website for more information on filing a report and available resources.

17 ARC CENTER

The Academic Resource Center (ARC), located on the ground floor of the Library, offers drop-in tutoring and one-on-one assistance for all BSC students. We offer assistance in Accounting, Arabic, Biology, Business, Chemistry, Chinese, Economics, History, Latin, Marketing, Music Theory, Philosophy, Physics, Physiology, Political Science, Psychology, Religion, Sociology, Spanish, and Statistics. Peer tutoring is free and tutors spend an hour or more per one-on-one appointment, and there is no limit to the number of tutoring sessions you can have. The drop-in schedule for tutoring will be posted on our course moodle page as soon as it is created. For more information or to make an appointment email arc@bsc.edu or visit the Academic Resource Center web page and submit a form. Reach out to us, we can help!

This document may be modified as needed due to COVID-19

Lecture Schedule:

Date	Topic	Ch.
8/25	Course introduction and General Laboratory Procedures	
8/27	Protein expression and extraction	7
9/01	Protein purification	8
9/03	Protein sequencing	14
9/08	Determining protein structure – NMR and X-ray crystallography	12
9/10	Determining protein stability – Differential Scanning Calorimetry	HO
9/15	Protein intermolecular interactions and small molecule binding	10
9/17	Analyzing protein/ligand interactions - ITC and Spectroscopy	11
9/22	Journal Club Discussions	
9/24	Project 1 – Manuscript Review Due	
9/29	Enzymology	HO
10/01	How to determine enzyme mechanism	HO
10/06	Effects of inhibitors and activators on mechanism	HO
10/08	Student projects brainstorming session	
10/13	Immunochemistry	9
10/15	Use of antibodies in biochemical studies	HO
10/20	Motor proteins and Analysis of Motor Proteins	HO
10/22	Peer Review Cycle 1 (Introduction/Grant Proposal)	
10/27	Project 2 – Final Grant Proposal	
10/29	Mathematical Models in Biomolecular Sciences	20
11/03	Molecular Modeling	HO
11/05	Drug Design and Computational Drug Discovery	HO
11/10	Peer Review Cycle 2 (Methods and Materials)	
11/12	Proteomics and Bioinformatics	14
11/17	Metabolomics and Diagnostics	HO
11/19	Peer Review Cycle 3 (Results and Discussion)	
11/24	Project 3 – Virtual Poster Session	
11/26	Thanksgiving	
	Student Final Presentations and Papers Due	

This document may be modified as needed due to COVID-19

Lab Schedule:

Lab Schedule – For this laboratory section, no lab manual is provided. Materials such as primary literature, related textbook chapters, and student selected readings can be found in the course moodle page as well as the project wiki page (www.ldhproject.wikispaces.com). Students are expected to draft a lab protocol and submit their protocol to the project wiki page prior to class on the day of lab. We will then, as a group, go over the protocols in class and draft a finalized protocol based on each students' submissions.

Date	Topic	CH.
8/27	Transformation – We will transform expression cell vectors with an assigned enzyme plasmid for use in our project this term	7
9/03	Protein Purification Part I: Salting out – We will lyse the cells and use ammonium sulfate to precipitate our proteins for a crude extract.	8.4-8.5
9/10	Protein Purification Part II: Affinity Chromatography – We will lyse the cells and begin purification of our enzymes using the his-tag tails and nickel columns	8.6
9/17	Protein Purification Part III: Size Exclusion Chromatography – We will use pre-packed size exclusion columns to further purify the collected fractions from affinity chromatography. (note, this is also called gel exclusion or gel filtration chromatography)	8.4-8.5
9/24	Determining purity and concentration – We will use gel electrophoresis to determine the purity of our fractions from size exclusion purification and colorimetric assays (Bradford and BCA assays) to determine the concentration of LDH in our samples	8.6
10/01	Enzyme Kinetics using UV-Vis spectroscopy – We will begin analyzing cPK in the coupled LDH assay.	
10/08	Enzyme Kinetics using UV-Vis spectroscopy – Continued training, analysis with known inhibitors or activators.	
10/15 10/22 10/29 11/05 11/12 11/19	Independent Lab Projects: Use this time to perform preliminary experiments in designing your grant proposal and then execute your project. Students will present their results in a virtual poster session and will write their results up in a scientific style, peer reviewed manuscript.	