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# CHEM 563: NUCLEIC ACID FUNCTION AND PROTEIN SYNTHESIS

**DATES:** FALL 2022 (AUGUST 22<sup>ND</sup> THROUGH DECEMBER 16<sup>TH</sup>)

## COURSE INFORMATION

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**Instructor:** Professor John Love

**Email:** [jlove@sdsu.edu](mailto:jlove@sdsu.edu)

**Phone:** 619-594-2063

**Class Meeting Days:** Mondays and Wednesdays from August 22<sup>nd</sup> through December 16<sup>th</sup>

**Class Times:** Face-To-Face from 1:00 PM until 1:50 PM in GMCS 314

**Office Hours:** Mondays and Wednesdays from 2:15 PM until 3:15 PM in CSL 339.

**Class Location:** GMCS 314

**Course attendance Policy:** Students are expected to attend all lectures.

**Syllabus is Subject to Change:** This syllabus and schedule are subject to change in the event of extenuating circumstances. If you are absent from class, it is your responsibility to check on Canvas announcements made while you were absent.

**ABOUT YOUR INSTRUCTOR:** Dr. Love is a Professor in the Chemistry and Biochemistry Department at SDSU. He is also the Director/Advisor for the Environmental Science major. Dr. Love runs a full-time research laboratory in which all students are welcome and include undergraduate, MS, and PhD students pursuing projects in the field of Protein Design. Currently, an ongoing research project is the engineering of novel proteins that are completely monomeric in the absence of metals yet form high affinity dimers in the presence of metals such as Zn<sup>2+</sup>. In addition, Dr. Love and his students are engineering proteins that bind cellulose in order to generate bio-composite material that could possibly be used to replace much of the single-use petroleum-based plastic that is so pervasive in our world. The cellulose derives from various waste streams such as sugarcane bagasse, nutshells from the California almond industry, palm fronds, and other forms of waste cellulose. Dr. Love also has extensive experience using Nuclear Magnetic Resonance (NMR) spectroscopy to elucidate the structure of a transcription factor protein bound to its cognate DNA sequence.

## COURSE DESCRIPTION

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Recent exciting developments in the use of DNA as a tool to fight disease include the successful development of effective mRNA vaccines against diseases such as Covid-19 and its many variants. Classically, DNA and RNA are responsible for the transmission of genetic information, but they have also been shown to fulfill a number of critical functions in eukaryotic and prokaryotic cells. This course will initially provide an overview of the structures and functions of nucleic acids and

we will also study many biochemical methods used in the study and production of nucleic acids including *in vitro* selection, nucleic acids in medical applications, nucleic acid nanotechnology and the roles of nucleic acids in molecular biology. Students will also obtain experience in reading current literature about scientific findings associated with nucleic acids such as genome editing with the CRISPR-Cas9 system.

**From the SDSU Catalog:** DNA replication, RNA transcription, RNA processing, and protein translation, including chemical mechanisms of synthesis and cellular mechanisms of regulating gene expression; genomics, recombinant DNA, and DNA topology.

## COURSE LEARNING OBJECTIVES

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Following this course, students will be able to:

1. Describe the chemical make-up of nucleic acids in terms of elemental and molecular composition, as well as a range of nucleic acid functions.
2. To be able to explain in molecular detail how all living cells synthesize DNA and RNA polymers and how these lead to protein synthesis.
3. To recognize and explain how macromolecules such as DNA, RNA, and proteins interact with each other, and to be able to predict the outcomes of such interactions.
4. To recognize and explain how the structure of macromolecules relates to their function, and to be able to rationalize macromolecule biochemical function based upon structure.
5. To explain how the expression of genetic information is regulated at the molecular level.
6. To explain the theory behind important nucleic acid-based technologies utilized in biochemistry, biotechnology, and forensic research laboratories.
7. To discuss the correspondence of molecular abnormalities with cancer, aging, and genetic disease across all organisms.

## ENROLLMENT INFORMATION

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### PREREQUISITE

Students absolutely must have completed either CHEM560 (General Biochemistry) or CHEM365 (Fundamentals of Biochemistry) or the equivalent at another university (one semester of upper-level biochemistry) prior to taking CHEM 563.

## COURSE MATERIALS

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### REQUIRED MATERIALS

- **Required Textbook:** Voet, Voet, and Pratt: "Fundamentals of Biochemistry", 5<sup>th</sup> Edition, Wiley, 2016. (Most of you have used this same text and edition for CHEM 560.) Purchasing and owning this textbook is absolutely required. Everyone will be required to demonstrate that they own a good working version of the required textbook.

- PDF files that contain PowerPoint slides for all lectures will be provided on the Canvas webpage for this course.
- All classes are conducted live (face-to-face) in GMCS 314, yet each class will also be recorded on the cloud and made available to all students after each class period.
- Students will also be provided PDF files of newspaper, magazine, and scientific journal articles on the Canvas webpage for this course.
- Regarding PowerPoints and your lecture notes: PDF files of the PowerPoint slides will be available for download from SDSU Canvas webpage for this course. Essentially all of the slides will be available as PDF files. It is recommended that you print out those pages before class and that you write your lecture notes directly on the pages with the PowerPoint images.
- You are not responsible for knowing everything in the textbook. Unless noted otherwise, you are responsible for everything presented in the PowerPoint slides and for everything written on the whiteboard during lecture, as well as what is discussed/explained in lecture. There will definitely be additional material presented in lecture and written on the board that is not in the PowerPoints. Thus, attendance at lecture is required!

#### RECOMMENDED OR OPTIONAL MATERIALS

- PDF files of associated material such as recent manuscript articles, or other forms of current literature such as newspaper articles will be provided to all students through the Canvas page for this course.

#### COURSE STRUCTURE

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This course is only being offered **face-to-face** using traditional lecture delivery. In addition, potential collaborative group activities and individual assignments may also be assigned to students. This course is **NOT** an online course, and therefore all students must attend every class. Course information and content is housed in the Canvas (canvas.sdsu.edu) learning Management System (LMS) for CHEM 563.

#### COURSE REQUIREMENTS

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Course Attendance Policy: Students are expected to attend **all** lectures. Grades are based on the following:

- **Examinations:** There will be a total of four exams, each worth 100 points. Therefore there are a total of 400 points possible for the entire course. The fourth exam will **not** be cumulative but will be given during the scheduled final exam period (Friday, December 16 from 1 PM to 3 PM).
- Exams will contain primarily multiple choice, but also possibly short answer questions.
- The multiple-choice questions on the exams will be answered on SCANTRON forms.
- All students are expected to supply and bring a SCANTRON form No. 882-E to each exam.

- The use of any electronic devices is not permitted during the exams, unless approved beforehand by the instructor.
- Examples of past exam questions from previous years will be provided on the Canvas webpage for the course.
- The lecture schedule on the next page is approximate and subject to change.
- However, the dates for the four exams are fixed and will not change.
- **Grading scale:**

360-400 points (90-100%):	A
320-359 points (80-89%):	B
280-319 points (70-79%):	C
240-279 points (60-69%):	D
<240 points (<60%):	F

## COURSE ASSESSMENTS AND SCORING

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### GRADE SCALE

A	Excellent = 90-100%	B	Above Average = 80-89%
C	Average = 70-79%	D	Marginal = 60-69%
F	Unsatisfactory = 59% or below	I	Incomplete = Did not complete

### LATE EXAM COMPLETION POLICY

Exams are considered late if they are not taken on the scheduled date and time as shown on the course schedule below. A makeup for a missed exam must be scheduled with the instructor **PRIOR** to the actual exam date. Makeup exams must be taken within 24 hours of the exam date and time and may incur a 25% deduction in points. You must contact the instructor in advance if you are unable to attend an exam.

### OVERALL COURSE OUTLINE

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	DATE	TOPIC	Reading
1	Aug. 22	Nucleotides, Nucleic Acid Structure	Chapter 3 pp 42-53
2	Aug. 24	Chemical properties of DNA and RNA; RNA enzymes and the RNA World; the size of DNA molecules.	Chapter 24 pp 831-856
3	Aug. 29	The Central Dogma; DNA/Genome sequencing, Molecular Evolution and derivation of phylogenies from molecular sequence data; Prokaryotic DNA replication.	Chpt.3 pp 49-51, pp 54-66; Chapter 25 pp 857-884
4	Aug. 31	Prokaryotic DNA replication.	Chapter 25, pp 867-884

	Sept. 5	<b>Holiday – Labor Day, Campus closed, no class.</b>	
5	Sept. 7	Restriction Enzymes; Gel Electrophoresis of nucleic acids; Recombinant DNA and PCR; practical applications	Chap. 3, pp 52-54; pp 847-851 Chapter 3 pp 62-65, 67-72
6	Sept. 12	Nucleic acid purification, fractionation, geometry of DNA	Chapter 24 p 846; 848-855
7	Sept. 14	DNA Supercoiling and Topoisomerases	Chapter 24 pp 830-838
8	Sept. 19	DNA Supercoiling, Topoisomerases; Transcription, Bacterial RNA polymerase, Promoters	Chapter 24 pp 830-838 Chapter 26 pp 919-930
<b>9</b>	Sept. 21	<b>FIRST MID-TERM EXAMINATION</b>	
10	Sept. 26	Transcription: Bacterial RNA polymerase; Promoters, Initiation	Chapter 26 pp 919-930
11	Sept. 28	Transcription elongation and termination; Eukaryotic RNA polymerases	Chapter 26 pp 924-935
12	Oct. 3	Eukaryotic promoters; Eukaryotic General Transcription Factors and Preinitiation Complex Assembly	Chapter 26 pp 935-942
13	Oct. 5	Post-transcriptional RNA processing: eukaryotic mRNA capping, poly-adenylation, and mRNA splicing	Chapter 26 pp 942-947
14	Oct. 10	mRNA splicing; snRNPs	Chapter 26 pp 944-949
15	Oct. 12	Alternative Splicing; RNA editing; Transport of RNA to the cytoplasm	Chapter 26 pp 949-953
16	Oct. 17	rRNA processing; Group II and Group I self-splicing introns; tRNA processing	Chapter 26 pp 953-959
<b>17</b>	<b>Oct. 19</b>	<b>SECOND MID-TERM EXAMINATION</b>	
18	Oct. 24	Translation: the genetic code; tRNAs and aminoacylation	Chapter 27 pp 962-974
19	Oct. 26	Translation: Codon-anticodon interactions; Wobble; Ribosomes	Chapter 27 pp 974-984
20	Oct. 31	Polypeptide chain initiation, elongation, and termination.	Chapter 27 pp 984-1004
21	Nov. 2	Protein synthesis inhibitors (antibiotics); posttranslational processing	Chapter 27 pp 1000-1009
22	Nov. 7	Regulation of prokaryotic gene expression; the lac operon and its repression and activation; helix- turn-helix DNA-binding motif ; Riboswitches	This Chapter 28 pp 1023-1028 Chapter 24 pp 851-852; 1030-1032
23	Nov. 9	<b>THIRD MID-TERM EXAMINATION</b>	

24	Nov. 14	Regulation of Eukaryotic Gene Expression: Activators and Repressors of Transcription; DNA binding domains in eukaryotic transcription factors	Chapter 28 pp 1043-1049 Chapter 24 pp 854-857
25	Nov. 16	Eukaryotic chromosomes and chromatin structure; histones; nucleosomes	Chapter 24 pp 858-863
26	Nov. 21	Role of Chromatin in eukaryotic gene regulation; RNA interference; Genomics	Chapter 28 pp 1032-1043 1049-1055; 1013-1023
	Nov. 23	<b>Thanksgiving Holiday Campus closed, no class.</b>	
27	Nov. 28	Cell Cycle, Cancer and Apoptosis (programmed cell death)	Chapter 28 pp 1059-1068
28	Nov. 30	Eukaryotic DNA Replication	Chapter 25 pp 884-891
29	Dec. 5	Retroviruses; Reverse Transcriptase; Telomerase;	Chapter 25 pp 884-891
30	Dec. 7	Aging DNA damage and repair; DNA recombination	Chapter 25 pp 891-904
31	Dec. 12	Antibodies and DNA rearrangements for antibody production	Chapter 7, pp 208-213 Chapter 28 pp 1056-1059
32	<b>Dec. 16</b>	<b>FOURTH EXAM – Friday, Dec. 16, 1:00-3:00, GMCS 314</b>	<b>Covers Lectures after Thanksgiving</b>

## STUDENT SUPPORT

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### WRITING SUPPORT

For help with improving your writing ability, the staff at the SDSU [Writing Center](#) is available online. Most students find it helpful to use technology tools to support the writing process. The following resources are provided as needed.

- Use a free Chrome browser plug-in such as [Grammarly](#) or MS Office tools to proofread and provide edits in real time in your own copy of MS Office.
- Review APA formatting:
  - [APA Manual](#)
  - [Purdue University's OWL](#)
  - [APAStyle.org Quick Answers-Formatting](#)
  - PC: Set up and use [APA Formatting](#) video or [LibrarianEnumerations Blog](#)
  - Mac: Set up and use [APA Formatting](#) video
  - [Citation Machine](#) tool for creating citations

### TECHNICAL SUPPORT FOR CANVAS

- <https://its.sdsu.edu/canvas/>

## EXPECTATIONS

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Students are expected to take all exams on the schedule exam dates, and participate fully in class activities and discussions.

The instructor will respond to student email within 24-72 hours and will provide grades for assignments within 1-2 weeks of the due date.

## NETIQUETTE

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Netiquette is online etiquette and is applicable to all course communications. It is important that all students be aware of proper behavior and show respect to one another.

Netiquette guidelines are common sense and ask all to use appropriate language for an educational environment:

- Use complete sentences
- Use proper spelling and grammar
- Avoid slang and uncommon abbreviations
- Avoid obscene or threatening language

The University values diversity and encourages discourse. Be respectful of differences while engaging in discussions. Consult SDSU's netiquette guidelines for more information.

## UNIVERSITY POLICIES

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### ACADEMIC HONESTY

The University adheres to a strict [policy regarding cheating and plagiarism](http://studentaffairs.sdsu.edu/srr/cheating-plagiarism.html). These activities will not be tolerated. Become familiar with the policy and what constitutes plagiarism (<http://studentaffairs.sdsu.edu/srr/cheating-plagiarism.html>). Any cheating or plagiarism will result in failing this class and a disciplinary review by the University. These actions may lead to probation, suspension, or expulsion.

Examples of Academic Dishonesty include but are not limited to:

- copying, in part or in whole, from another's test or other examination;
- obtaining copies of a test, an examination, or other course material without the permission of the instructor;
- collaborating with another or others in work to be presented without the permission of the instructor;
- falsifying records, laboratory work, or other course data;
- submitting work previously presented in another course, if contrary to the rules of the course;

- altering or interfering with grading procedures;
- assisting another student in any of the above;
- using sources verbatim or paraphrasing without giving proper attribution (this can include phrases, sentences, paragraphs and/or pages of work);
- copying and pasting work from an online or offline source directly and calling it your own;
- using information you find from an online or offline source without giving the author credit;
- replacing words or phrases from another source and inserting your own words or phrases.

The California State University system requires instructors to report all instances of academic misconduct to the Center for Student Rights and Responsibilities. Academic dishonesty will result in disciplinary review by the University and may lead to probation, suspension, or expulsion. Instructors may also, at their discretion, penalize student grades on any assignment or assessment discovered to have been produced in an academically dishonest manner.

#### ACCESSIBILITY

If you are a student with a disability and believe you will need accommodations for this class, it is your responsibility to contact Student Ability Success Center at (619) 594-6473. You can also learn more about the services provided by visiting the [Student Ability Success Center](#) website.

To avoid any delay in the receipt of your accommodations, you should contact Student Ability Success Center as soon as possible. Please note that accommodations are not retroactive, and that accommodations based upon disability cannot be provided until you have presented your instructor with an accommodation letter from Student Ability Success Center. Your cooperation is appreciated.

#### STUDENT SUPPORT SERVICES:

A complete list of all academic support services is available on the [Academic Success](#) section of the [SDSU Student Affairs](#) website.

#### CLASSROOM CONDUCT STANDARDS

SDSU students are expected to abide by the terms of the Student Conduct Code in classrooms and other instructional settings. Prohibited conduct includes:

- Willful, material and substantial disruption or obstruction of a University-related activity, or any on-campus activity.



- Participating in an activity that substantially and materially disrupts the normal operations of the University or infringes on the rights of members of the University community.
- Unauthorized recording, dissemination, or publication (including on websites or social media) of lectures or other course materials.
- Conduct that threatens or endangers the health or safety of any person within or related to the University community, including
  1. physical abuse, threats, intimidation, or harassment.
  2. sexual misconduct.

Violation of these standards will result in referral to appropriate campus authorities.

### MEDICAL-RELATED ABSENCES

Students are instructed to contact their professor/instructor in the event they need to miss class, etc. due to an illness, injury or emergency. All decisions about the impact of an absence, as well as any arrangements for making up work, rest with the instructors. [Student Health Services](#) (SHS) does not provide medical excuses for short-term absences due to illness or injury. When a medical-related absence persists beyond five days, SHS will work with students to provide appropriate documentation. When a student is hospitalized or has a serious, ongoing illness or injury, SHS will, at the student's request and with the student's consent, communicate with the student's instructors via the Vice President for Student Affairs and may communicate with the student's Assistant Dean and/or the [Student Ability Success Center](#).

### SDSU ECONOMIC CRISIS RESPONSE TEAM

If you or a friend are experiencing food or housing insecurity, or any unforeseen financial crisis, visit [sdsu.edu/ecrt](https://sdsu.edu/ecrt), email [ecrt@sdsu.edu](mailto:ecrt@sdsu.edu), or walk-in to Well-being & Health Promotion on the 3rd floor of Calpulli Center.

### COPYRIGHT POLICY

SDSU respects the intellectual property of others and we ask our faculty & students to do the same. It is best to assume that any material (e.g., graphic, html coding, text, video, or sound) on the Web is copyrighted unless specific permission is given to copy it under a [Creative Commons License](#). For more information about the use of copy written material in education, consult the [TEACH Act](#) and [Copyright Fair Use Guidelines](#). Whenever possible, you should attribute the original author of any work used under these provisions.

### NETIQUETTE AND COMMUNICATION GUIDELINES

Consult SDSU's netiquette guidelines for information on appropriate communication.

### NON-DISCRIMINATION POLICY

SDSU is committed to providing a safe and welcoming campus environment for all students, faculty and staff. The CSU has affirmed its commitment to ‘protecting access, affordability, intellectual freedom, inclusivity, and diversity for all students, including supporting DACA students.’ Discrimination, harassment, or retaliation against students, faculty, and staff on the basis of race, religion, gender, sexuality, disability, nationality, immigration status and other categories of identity is prohibited. If you have concerns about your status at the university, visit the [Student Affairs](#) site for information or contact the Dean of Students or the Assistant Dean for Student Affairs in your College.

#### RELIGIOUS OBSERVANCES

According to the University Policy File, students should notify the instructors of affected courses of planned absences for religious observances by the end of the second week of classes.

#### STANDARDS FOR STUDENT CONDUCT

The university is committed to maintaining a safe and healthy living and learning environment for students, faculty, and staff. Each **member** of the campus community should choose behaviors that contribute toward this end. Refer to the [Center for Student Rights and Responsibilities](#) to learn more.

#### STUDENT PRIVACY / FERPA / INTELLECTUAL PROPERTY

SDSU complies with the federal Family Educational Rights and Privacy Act. Grades, personal identification and any other records will not be released to others without your express written permission. Refer to the [Office of the Registrar](#) for detailed information on student privacy.

The [Family Educational Rights and Privacy Act](#) (FERPA) mandates the protection of student information, including contact information, grades, and graded assignments. Your instructor may use [Canvas / Blackboard] to communicate with you, and will not post grades or leave graded assignments in public places. Students will be notified at the time of an assignment if copies of student work will be retained beyond the end of the term or used as examples for future students or the wider public. Students maintain intellectual property rights to work products they create as part of this course unless they are formally notified otherwise.

#### Land Acknowledgement

We stand upon a land that carries the footsteps of millennia of Kumeyaay people. They are a people whose traditional lifeways intertwine with a worldview of earth and sky in a community of living beings. This land is part of a relationship that has nourished, healed, protected and embraced the Kumeyaay people to the present day. It is part of a world view founded in the harmony of the cycles of the sky and balance in the forces of life. For the Kumeyaay, red and

black represent the balance of those forces that provide for harmony within our bodies as well as the world around us.

As students, faculty, staff and alumni of San Diego State University we acknowledge this legacy from the Kumeyaay. We promote this balance in life as we pursue our goals of knowledge and understanding. We find inspiration in the Kumeyaay spirit to open our minds and hearts. It is the legacy of the red and black. It is the land of the Kumeyaay. Eyay e'Hunn My heart is good.