BZ 420 Evolutionary Medicine (Fall 2023)

Instructor Information

Instructor: Professor Michael F. Antolin (Dr. Mike)
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Phone: 970-491-1911
Office: 430 Biology Building

Communication Policy: Responses to emails and telephone calls will be provided within 48 hours.

Prerequisites for Course

Introductory biology course (LIFE 102, or BZ 110 and BZ 111), sophomore or higher standing.

Delivery Fall 2023

"Face-to-face" class meetings are in ANAZO H210 , 9:30-10:45 AM, Tuesdays and Thursdays.

Lecture slides (pdf format), reading assignments, and lecture review questions are provided in CANVAS.

The six reading assignments will include in person in class discussion sessions to review the first drafts of the write-ups for each assignment.

Additionally, for each mid-term and the final exam we will schedule review sessions for each, times/dates to be determined. The sessions will be moderated through ZOOM and will be recorded and posted on CANVAS before each exam.

Office Hours

I make time for office hours regularly twice a week, on Wednesdays and Fridays 1:30 - 3:30 PM. Each week I will post a message to the class with a ZOOM link for the office hours but will usually be in person in my office in 430 Biology. In other words, whether I'm on campus or remote I will be available on ZOOM. I will also let you know whether I will be in my office in person at the same times.

For those who can't make these times, please reach out to me and we can find an alternative time, whether in person or on ZOOM.

Course Description & Objectives

The course explores insights into medical research and practice (diagnosis and therapy) and human health from an evolutionary standpoint. Students will learn fundamentals of evolution, aspects of human evolutionary history as it relates to health, and the importance of evolutionary biology in building our understanding of definitions of health and the causes of human diseases. The goal is to relate evolution to detection and diagnosis, and then to therapy and treatment of disease. We will learn how evolutionary perspective integrates with genetics,

physiology, immunology, ecology, epidemiology, and behavior, and then to into medical research and clinical practice. Students will become acquainted with how to read and interpret primary scientific literature, learn basic research methods, and develop skills to critically analyze novel approaches and engage in scientific discourse.

LEARNING OBJECTIVES

Based in part on: Association of American Medical Colleges and (AAMC) and the Howard Hughes Medical Institute (HHMI), "*Scientific Foundations for Future Physicians*" (2009).

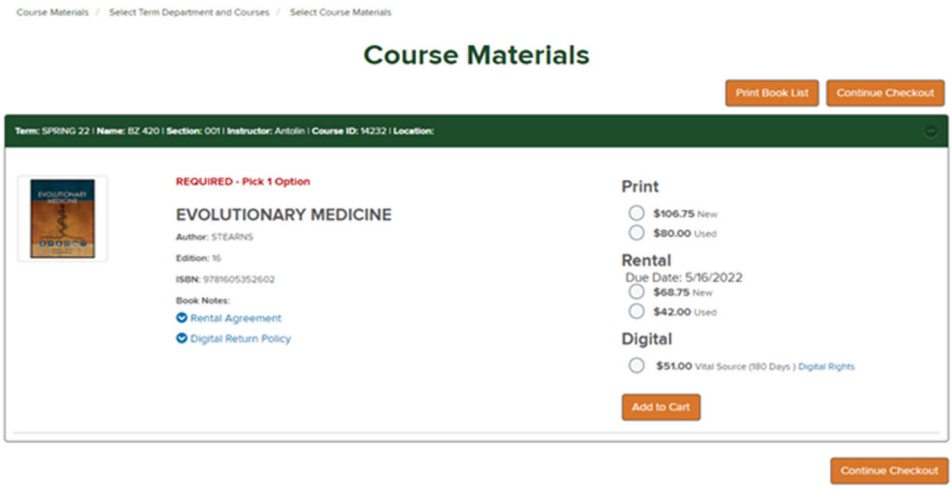
Upon the completion of this course, students will be able to use an evolutionary context to:

- Understand that Dr. Mike thinks "***Rogue One***" is THE BEST Star Wars film. You didn't even know this was coming, but are you willing to take a chance, and another, on and on, until you win, or the chances are spent? If you send Dr. Mike an e-mail with "ROGUE ONE" in the subject line by Friday, August 25 before 11:59 PM, you will earn two bonus points.
- Outcome #1 Apply knowledge of evolutionary biology and genetics to explain how the human body functions in health and disease.
- Outcome #2 Explain the conditions necessary for adaptations to evolve by natural selection within populations, and limitations that may prevent adaptations from evolving.
- Outcome #3 Draw a phylogenetic tree that shows both the genetic relationship among species (populations) and the ancestral or derived traits found in those species.
- Outcome #4 Apply basic mathematical tools and concepts, including functions, graphs and modeling, measurement and scale, and quantitative reasoning to an understanding of the specialized functions in human biology, in both health and disease.
- Outcome #5 Apply elements of the scientific process, such as inference, critical analysis of research design, and appreciation of the difference between association and causation, to interpret the findings, applications, and limitations of observational and experimental research in clinical decision making.
- Outcome #6 Use principles of feedback control to explain how specific homeostatic and reproductive systems maintain the internal environment and identify (1) how perturbations in these systems may result in disease, (2) how homeostasis may be changed by disease, and (3) the functional trade-offs that underlie both heath and disease.
- Outcome #7 Describe the functional elements in the human genome, their evolutionary origins, their interactions, and the consequences of genetic and epigenetic changes on adaptation and health.
- Outcome #8 Describe the major forms and frequencies of genetic variation and their consequences on health in different human populations.
- Outcome #9 Explain how genetic and environmental factors interact to produce phenotypes and provide the basis for individual variation in response to toxic, pharmacological, infectious, or other exposures.
- Outcome #10 Use the principles of symbiosis (commensalisms, mutualism, and parasitism) to understand the role of microbiomes in the maintenance of health and disease.
- Outcome #11 Predict the consequences of structural variability and damage or loss of tissues and organs due to maldevelopment and disease, especially for reproductive biology, aging, and mental health.
- Outcome #12 Describe the major defenses against disease, the costs of defense, and how costs result in trade-offs between defenses against disease.
- Outcome #13 Apply knowledge of how immunological diversity and specificity are generated and applied to the diagnosis and treatment of disease.
- Outcome #14 Use knowledge of mechanisms for distinguishing self from non-self (immune tolerance and surveillance) to understand maintenance of health and autoimmunity.

- Outcome #15 Apply (1) the principles of host–pathogen interactions and (2) knowledge of structure, genomics, life cycles, pathogenesis, transmission, and natural history of pathogens to the prevention, diagnosis, and treatment of infectious disease.
- Outcome #16 Apply an understanding of somatic cell division and general regulation of cell division and cell death to explaining normal and abnormal growth and development (e.g. cancer).
- Outcome #17 Apply knowledge of the molecular basis of neoplasia (tumor growth) to an understanding of the biological behavior, morphologic appearance, classification, diagnosis, prognosis, and targeted therapy of specific cancers.
- Outcome #18 Describe the evolutionary pathway (e.g. selection pressures arising from fetal growth, length of gestation, and birth weight) that led to evolution of the human placenta (compared to other mammals) and how negative health outcomes like pre-eclampsia and eclampsia arise as a consequence.
- Outcome #19 Define the process of decidualization and its relationship to human menstruation
- Outcome #20 Explain the several hypotheses put forward to explain human menopause
- Outcome #21 Understand the mechanisms underlying genome imprinting and its role in parent-offspring conflict
- Outcome #22 Describe how interactions between natural selection and trade-offs in adaptations may result in evolutionary mismatches and causes of disease.
- Outcome #23 Apply the principles of epidemiology to maintaining and restoring the health of communities and individuals.
- Outcome #24 Describe the major changes in human health that arose from the demographic transitions to "modernity", including infectious, metabolic, and genetic diseases/disorders.

TEXTBOOK / COURSE READINGS

Evolutionary Medicine (2016), by Stephen Stearns and Ruslan Medzhitov, Sinauer Associates (ISBN 978-1-60535-260-2). The textbook is available through the CSU bookstore, as new or used paper copies (purchase or rental), or as an e-book. If you visit the CSU Bookstore web site, you should see the following:



COURSE MATERIALS & EQUIPMENT

Additional readings are available on CANVAS, including chapters from other books and papers from primary literature. You should read the Chapter and required reading before coming to the class to have a productive discussion. Optional Reading are also within a page of each Module in CANVAS, for your reference. Writing assignments (see below) include reading several research/concept publications from the primary literature and writing incisive critiques.

LECTURE/EXAM/ASSIGNMENT SCHEDULE

Course Topics and Tentative Schedule

(Modules generally follow chapters in ***Stearns and Medzhitov***, with some additional readings available in CANVAS):

1. Introductory Concepts in Evolution and Evolutionary Medicine (Aug 22, Aug 24, Aug 29, Aug 31)

    Introduction, Natural selection, Neutral evolution, Adaptation

    ***Stearns and Medzhitov*: Chapter 1 Introduction to Evolutionary Thinking (posted in CANVAS, FYI)**

    AAMC/HHMI. (2009) "*Scientific Foundations for Future Physicians*", pages 1-19

    Gluckman et al 2016 Chapter 13 Evolutionary Principles Applied to Medical Practice and Public Health, *in* Principles of Evolutionary Medicine, 2nd Edition

Reading Assignment #1 (Sep 7 first draft due, Sep 14 final draft due)

2. Patient's and Genotype/Phenotype and Disease (Sep. 5, Sep 7, Sep 12, Sep 14)

    Human evolutionary history, Genomes and gene discovery, Consequence of genetic variation, Life history traits, Plasticity, Tradeoffs, Aging, Microbiome

    ***Stearns and Medzhitov*: Chapter 2 What is a Patient?**

    Gluckman et al 2016 Chapter 4 Evolution and Development, *in* Principles of Evolutionary Medicine, 2nd Edition

    Price et al 2015 GWAS and human disease Proc R Soc B

Reading Assignment #2 (Sep 19 first draft due, Sep 22 final draft due)

3. Disease Genotype/Phenotype (Sep 19, Sep 21, Sep 26, Sep 28)

    Proximate and ultimate causes of disease, Genetic versus physiological/metabolic versus environmental diseases

    Stearns and Medzhitov: Chapter 3 What is a Disease?

4. Defense Mechanisms (Oct 3, Oct 5, Oct 10, Oct 12)

    Physiological mechanisms, Inducible and constitutive mechanisms, Immunity

    ***Stearns and Medzhitov*: Chapter 4 Defense**

    ***Gluckman et al.* 2016. Chapter 13 Evolutionary Principles Applied to Medical Practice and Public Health, *in* Principles of Evolutionary Medicine, 2nd Edition.**

Reading Assignment #3 (Oct 10 first draft due, Oct 13 final draft due)

Midterm Exam #1 (Oct 17)

5. Pathogen Evolution (Oct 17, Oct 19, Oct 24, Oct 26)

Virulence, Transmission, Antibiotic resistance

Stearns and Medzhitov: Chapter 5 Pathogen Evolution

Davies, J. and D. Davies. 2010. Origins and Evolution of Antibiotic Resistance. Microbiol Molec. Biol. Rev. 74: 417–433.

Reading Assignment #4 (Oct 24 first draft due, final draft due Oct 27)

6. Cancer (Oct 31, Nov 2, Nov 7, Nov 9)

Genetics and somatic evolution (somatic, clonal) of cancer, Immune suppression, Chemotherapy

Stearns and Medzhitov: Chapter 6 Cancer

The Cancer Almanac - The New York Times May 2016

Reading Assignment #5 (Nov 7 first draft due, Nov 10 final draft due)

7. Reproductive Medicine (Nov 9, Nov 14, Nov 17)

Pregnancy, Menstruation, Menopause

Stearns and Medzhitov: Chapter 7 Reproductive Medicine

Sievert, L.L. 2008. "Chapter 9: Should women menstruate? An evolutionary perspective on menstrual-suppressing oral contraceptives."

Robillard, P., et al. 2008. "Chapter 11: Possible role of eclampsia/preeclampsia in evolution of human reproduction."

Midterm Exam #2 (Nov 16)

FALL BREAK – Nov 18 - 26

8. Lifestyle and Mismatch (Nov 28, Nov 30)

Obesity, Diabetes, Cardiovascular disease, Autoimmune diseases

Stearns and Medzhitov: Chapter 8 Mismatch

Kondrashova, A. et al. 2012. The 'Hygiene hypothesis' and the sharp gradient in the incidence of autoimmune and allergic diseases between Russian Karelia and Finland. APMIS 121: 478–493.

Reading Assignment #6 (Dec 5 first draft due, Dec 8)

10. Individual versus Population Health and the Big Picture (Dec 5, Dec 7)

The Epidemiological Demographic Transitions, and Vaccination, etc.

Stearns and Medzhitov: Chapter 10 Individual versus Population Health, Chapter 11 Open Questions

Final Exam: Monday, December 11, 9:40 - 11:40 AM

Participation/Behavioral Expectations

In-person lectures will be delivered at the scheduled time. Files with all slides (pdf format) will be posted before each class meeting.

Scheduled ZOOM time will be used for reviews of study guides before each exam. Those sessions will be recorded and posted on CANVAS.

Students are expected to access and answer the lecture review quiz questions for each module in CANVAS, following the lecture schedule.

Please review the core rules of netiquette for some guidelines and expectations on how to behave in an online learning environment.

Course Policies (late assignments, make-up exams, etc.)

Writing assignments are due as in the syllabus and course schedule and are to be submitted through CANVAS at the times provided, with no points for late submissions (except in the case of DOCUMENTED medical or family emergencies).

No make-up exams, except in the extremes of medical or family emergencies. Exams will be administered in person in class and will comprise short essay questions. Study guides with the exam question prompts will be provided before each midterm exam and the final exam so that you may prepare your answers ahead of time.

Grading Policy (follows university guidelines)

Grade	Range of Scores
A+	100% to 98%
A	<98% to 92%
A-	<92% to 90%
B+	<90% to 88%
B	<88% to 82%
B-	<82% to 80%
C+	<80% to 78%
C	<78% to 70%
D	<70% to 60%
F	<60% to 0.0%

As a student enrolled in this course, one of your responsibilities is to submit course work by the due dates listed in Canvas. With that said, I take my role as your instructor very seriously, and, in fact, I care about how well you do in this course and that you have a satisfying, rewarding experience.

To that end, it is my commitment to you to respond individually to the work you submit in this class and to return your work in a timely manner. Smaller, weekly assignments and quizzes will be returned within 1 week and major assignments, exams, and essays will be returned within 1 week. (If, however, due to unforeseeable circumstances, the grading of your work takes longer than the times I have listed here, I will keep you informed of my progress and make every effort to return your work with feedback as soon as I can.)

EVALUATION

You will be graded on (1) Two midterm exams with a set of short-answer type questions, (2) Six writing assignments, (3) "participation" points related to your reading and review of each review quiz questions for each module in CANVAS, (4) a final exam.

NOTE: While daily attendance is not REQUIRED, I reserve the right to assign BONUS points to those who come to class on days when attendance falls below the threshold of <51%.

Midterms: Tuesday October 17, Thursday November 16

Final: Monday, Monday Dec 11, 9:40 - 11:40 AM

Writing Assignments: The writing assignments will be graded upon your ability to discuss a broad topic, the specifics of some primary literature that address the topic, and your own perspective on the topic. Each writing assignment has two parts (5 points first draft/participation, then 10 points final draft). First, you turn in a draft of your written assignment in CANVAS (2 points), and answer a few "participation" questions also in CANVAS (3 points). Second, for your final draft (10 points) you must demonstrate (a) your understanding of the general topic (4 points), (b) specifics from the readings (3 points), and good writing skills (3 points). The writing should be both scientifically literate and easy to read. First drafts are due at 9 AM before class time on the day of in-class discussion, final drafts are due three or more days later.

Submissions of writing assignments are to be on page (single spaced, typed, font no smaller than 11 point, 0.75 in margins, typically a WORD document of PDF file), answer the assigned questions about the articles. In order to answer these in the allotted space you must get to the point like a laser beam. We will not read anything after the first page.

Points and Grading:

Midterms: 2 exams x 50 points each = 100 points (each exam for that part of the class, not cumulative, 5 short essay questions x 10 points each).

6 writing assignments x 15 points = 90 points (Readings and critiques of primary literature – each assignment is 1 written page, single spaced, typed, font no smaller than 11 points, 0.75 in margins).

Participation points via CANVAS lecture review questions for each Module = 60 points (1 point for each review question), which are self-correcting review questions about the content of the Modules.

Final Exam = 100 points (half of exam for the last part of the class, not cumulative with five short answer questions x 10 points (50 points); five cumulative short answer questions x 10 points each (50 points).

CLASS ELEMENT	Points	Percentage
Midterm Exams (2 exams 50 points each)	100	28.5%
Writing assignments (6 x 15 pts)	90	26%
Participation points for lecture review questions (1 point reach question)	60	17%
Final Exam	100	28.5%
Total:	350	100%

*Keep a copy of all work created for the course, including work submitted through the Canvas course learning management system.

Canvas Information & Technical Support

Canvas is where course content, grades, and communication will reside for this course.

- Login for Canvas
- Canvas Support
- For passwords or any other computer-related technical support, contact the Central IT Technical Support Help Desk.
  - (970) 491-7276
  - help@colostate.edu

The Technical Requirements page identifies the browsers, operating systems, and plugins that work best with Canvas. If you are new to Canvas quickly review the Canvas Student Orientation materials.

Academic Integrity & CSU Honor Pledge

This course will adhere to the CSU Academic Integrity/Misconduct policy as found in the General Catalog and the Student Conduct Code.

Academic integrity lies at the core of our common goal: to create an intellectually honest and rigorous community. Because academic integrity, and the personal and social integrity of which academic integrity is an integral part, is so central to our mission as students, teachers, scholars, and citizens, I will ask that you affirm the CSU Honor Pledge as part of completing your work in this course.

Plagiarism - defined as presenting the work of others as one's own work – does not fit into the values of either this class or the university. Plagiarism includes copying of others' work as well as copying and pasting from the Internet – this is becoming more important as we move especially important this year since all the assignments are online. If you are unsure about what plagiarism is, check out this web site: http://sja.ucdavis.edu/avoid.htm. We use the TURNITIN software implemented in CANVAS to detect verbatim-copied sentences and phrases, from ALL over the internet (including web pages, other published works, other students essays at this university and across the world, essentially anything that is searchable on the worldwide web). Plagiarism will result in a 0 for the assignment.

Please note that using an Artificial Intelligence (AI) writing tool, such as ***ChatGPT***, to write your short essays is considered plagiarism and falls under the same expectations for academic integrity stated above and linked below.

While AI has found its way into creating content for entertainment and for some analytical applications, using AI to do ***your*** work in the realm of education and learning does not belong. We are asking you to THINK on your own and to problem-solve in authentic ways. The short assignments are specifically designed for you to be able to practice these skills while getting feedback from a real person (i.e. me). The use of AI robs us all of us of opportunities to learn from our experiences and from each other, to creatively problem-solve, and to contribute our ideas in authentic ways.

I could use ***ChatGPT*** just like you might, and I while I may find it interesting to see what computers can synthesize from billions of internet sources, I'm sure this will get old for me quickly. I wish to respond to your original work, and it is takes a lot to time and effort to read and respond to your writings. Please respect this.

It has been interesting to see that prompts to ***ChatGPT*** about current scientific topics have produced some whoppers and easily seen errors. For instance, unless you have the subscription-level version of ***ChatGPT***, its database is a few years old, so answers are often out of date in really hot areas of science. Second, many times ***ChatGPT*** has made citations to completely made-up references (i.e. fictional, non-existent outside the virtual cobwebbed AI "brain", things that DO NOT EXIST)!

In the end, AI is remarkable mostly for how quickly it reflects the virtual world that it samples. So, what is it that looks back at us from AI? Narcissus? Platonic ideals? A less pixilated pencil smudge?

TURNITIN said they have figured out how to tell if students are using ***ChatGPT*** for assignments. To reiterate, I use ***TURNITIN*** to scan your submissions for obvious plagiarism, so keep that in mind.

Further information about Academic Integrity is available at CSU's Academic Integrity - Student Resources.

Universal Design for Learning/Accommodation of Needs

I am committed to the principle of universal learning. This means that our classroom, our virtual spaces, our practices, and our interactions be as inclusive as possible. Mutual respect, civility, and the ability to listen and observe others carefully are crucial to universal learning.

If you are a student who will need accommodation in this class, please contact me to discuss your individual needs. Any accommodation must be discussed in a timely manner. A verifying memo from The Student Disability Center may be required before any accommodation is provided.

The Student Disability Center (SDC) has the authority to verify and confirm the eligibility of students with disabilities for most accommodations. While some accommodations may be provided by other departments, a student is not automatically eligible for those accommodations unless their disability can be verified and the need for the accommodation confirmed, either through SDC or through acceptable means defined by the particular department. Faculty and staff may consult with the SDC staff whenever there is doubt as to the appropriateness of an accommodative request by a student with a disability.

The goal of SDC is to normalize disability as part of the culture of diversity at Colorado State University. The characteristic of having a disability simply provides the basis of the support that is available to students. The goal is to ensure students with disabilities have the opportunity to be as successful as they have the capability to be.

Support and services are offered to student with functional limitations due to visual, hearing, learning, or mobility disabilities as well as to students who have specific physical or mental health conditions due to epilepsy, diabetes, asthma, AIDS, psychiatric diagnoses, etc. Students who are temporarily disabled are also eligible for support and assistance.

Any student who is enrolled at CSU, and who self-identifies with SDC as having a disability, is eligible for support from SDC. Specific accommodations are determined individually for each student and must be supported by appropriate documentation and/or evaluation of needs consistent with a particular type of disability. SDC reserves the right to ask for any appropriate documentation of disability in order to determine a student's eligibility for accommodations as well as in support for specific accommodative requests. The accommodative process begins once a student meets with an accommodations specialist in the SDC.

Third-party Tools/Privacy

Please note that this course may require you to use third-party tools (tools outside of the Canvas learning management system), such as ZOOM, TEAMS, and others. Some of these tools may collect and share information about their users. Because your privacy is important, you are encouraged to consult the privacy policies for any third-party tools in this course so that you are aware of how your personal information is collected, used and shared.

Copyrighted Course Materials

Please do not share material from this course online, online, print, or other media. Course material is the property of the instructor who developed the course. Materials authored by third parties and used in the course are also subject to copyright protection. Posting course materials on external sites (commercial or not) violates both copyright law and the CSU Student Conduct Code. Students who share course content without the instructor's express permission, including with online sites that post materials to sell to other students, could face appropriate disciplinary or legal action.

Undocumented Student Support

Any CSU student who faces challenges or hardships due to their legal status in the United States and believes that it may impact their academic performance in this course is encouraged to visit Student Support Services for Undocumented, DACA & ASSET for resources and support. Additionally, only if you feel comfortable, please notify your professor so they may pass along any additional resources they may possess.

Title IX/Interpersonal Violence

For the full statement regarding role and responsibilities about reporting harassment, sexual harassment, sexual misconduct, domestic violence, dating violence, stalking, and the retaliation policy please go to: Title IX – Sexual Assault, Sexual Violence, Sexual Harassment.

If you feel that your rights have been compromised at CSU, several resources are available to assist:

- Student Resolution Center, 200 Lory Student Center, 491-7165

- Office of Equal Opportunity, 101 Student Services, 491-5836

A note about interpersonal violence: If you or someone you know has experienced sexual assault, relationship violence and/or stalking, know that you are not alone. As instructors, we are required by law to notify university officials about disclosures related to interpersonal violence. Confidential victim advocates are available 24 hours a day, 365 days a year to provide support related to the emotional, physical, physiological and legal aftermath of interpersonal violence. Contact the Victim Assistance Team at: 970-492-4242.

Religious Observances

CSU does not discriminate on the basis of religion. Reasonable accommodation should be made to allow individuals to observe their established religious holidays. Students seeking an exemption from attending class or completing assigned course work for a religious holiday will need to fill out the Religious Accommodation Request Form and turn it in to the Division of Student Affairs, located on the second level of the Administration building.

Once turned in, the Division of Student Affairs will review the request and contact the student accordingly. If approved, the student will receive a memo from the Dean of Students to give to their professor or course instructor.

Students are asked to turn in the request forms as soon as the conflict is noticed. Similarly, unanticipated conflicts requiring a religious observance, such as a death in the family, can also be reviewed.

CSU Principles of Community

Inclusion: We create and nurture inclusive environments and welcome, value and affirm all members of our community, including their various identities, skills, ideas, talents and contributions.

Integrity: We are accountable for our actions and will act ethically and honestly in all our interactions.

Respect: We honor the inherent dignity of all people within an environment where we are committed to freedom of expression, critical discourse, and the advancement of knowledge.

Service: We are responsible, individually and collectively, to give of our time, talents, and resources to promote the well-being of each other and the development of our local, regional, and global communities.

Social Justice: We have the right to be treated and the responsibility to treat others with fairness and equity, the duty to challenge prejudice, and to uphold the laws, policies and procedures that promote justice in all respects.

Diversity and Inclusion

The Mission, Vision, and Focus webpage of the Vice President for Inclusive Excellence includes a comprehensive statement of CSU's commitment to diversity and inclusion.

COVID -19 Precautions and Expectations

For the latest information about the University's response, please visit the CSU COVID-19 site (https://covidrecovery.colostate.edu/).