01:146:465 Topics in Cell Biology and Neuroscience:Neurobiology of Pain and Addiction Spring 2025

COURSE INSTRUCTOR AND CONTACT INFORMATION

Course Director & Instructor: Prof. Kelvin Kwan (kelvin.kwan@rutgers.edu)

Instructors: Prof. Victoria Abraira (victoria.abraira@rutgers.edu) and Prof. Santiago Cuesta (sc2524@dls.rutgers.edu)

Semester Offered: Fall, Spring

Credits: 3

Prerequisites

Fundamentals of Neurobiology (01:146:245) or Essentials in Cell Biology & Neuroscience (01:146: 295)

A) COURSE MEETING DAYS, TIMES, LOCATION, MODALITY

The person is designated as an In-Person Class. Students and Instructors will meet in person for 80 minutes twice per week. Attendance is highly recommended and short assignments will be provided after each class.

The course is divided into three modules taught by three instructors with expertise in each module's subject and may include research papers or a guest lecturer. Each module consists of 8 lectures and a review session, followed by an exam.

OFFICE HOURS / STUDENT SUPPORT HOURS

Student Support Hours will be available for each module and will be announced on the Canvas course site. Office hours with the faculty can be scheduled in person.

B) COURSE DESCRIPTION

This course is offered in the Fall and Spring semesters and is intended primarily for students majoring in Cell Biology and Neuroscience. It counts as an Advanced course towards the CBN major (R10) or a Life Science Elective (R11). Other students with background knowledge in neuroscience can also register for this course.

The opioid epidemic highlights how chronic pain may result in addiction to painkillers. Understanding the fundamental underpinnings of the debilitating sensations of pain and addictive behaviors provides potential therapeutic avenues for treatment and intervention. The course will focus on the molecular, cellular, and neuroanatomical correlates of pain

and addiction. The course consists of three modules. The first module will explore how different ion channels sense temperature, mechanical stimulus, or pain. The second module will cover the neural circuitries that convey, integrate, and combine these percepts. Finally, students will learn the neuroanatomy and circuits that participate in addictive behavior. Students must have a strong background in cell biology or neurobiology.

Topics: This course will address the fundamental neurobiology of pain and addiction. After completing this course, students should have a solid grasp of the following:

1. The ion channels and receptors in different sensory modalities and pain
2. The neural circuits underlying pain and somatosensation
3. Addiction mechanisms, including circuits, neuroanatomy, and behavior

Course Syllabus: The syllabus will be updated each semester, but will generally follow the topics and course format described.

C) RESTRICTIONS

All students with the appropriate prerequisites will be accepted into the course.

D) REQUIRED TEXTS AND COURSE MATERIALS

The course material will consist of lecture slides, assigned text open-access materials, textbooks, and supplemental videos illustrating key concepts.

The material will be provided on Canvas.

E) TECHNICAL / TECHNOLOGY REQUIREMENTS

Required Materials: Each student should have access to a high-speed internet connection and a laptop to access Canvas and complete assignments.

F) LEARNING GOALS

Course Learning Goals

Learning Goals: The learning goals for this course are consistent with general goals set by the Department of Cell Biology and Neuroscience, which are listed here, as well as the Division of Life Sciences.

1. Obtain factual and conceptual knowledge in fundamentals of cell biology and development (with a hint of neuroscience) that will provide a strong foundation for success in advanced training and professional careers.

2. Develop an ability to summarize, integrate, and organize information.

3. Use scientific reasoning to evaluate the potential for current research and discoveries to improve our understanding of cell biology and its relevance to human health and our society.

The Department of Cell Biology and Neurosciences (CBN) mission is to give students a first-rate educational experience in modern biology. Our graduates will have a solid foundation for any career opportunities that use biology. Furthermore, they will be inspired to become life-long learners in the ever-evolving world of biological sciences. The overarching goal of CBN is to prepare our students for successful entry into the workforce with a career in a health professions field or a biomedical research area

ASSESSMENT / GRADING COMPONENTS

Assignments are 20% of the grade. An assignment for each class will be given in the form of a multiple-choice question on Canvas.

Quizzes are 20% of the total grade. Each module will have 2-3 short scheduled quizzes taken on Canvas. Quizzes consist of multiple-choice questions.

The three exams will count for the remaining 60%. An exam will be given at the end of each module. Exams are in-person paper exams consisting of multiple-choice questions. There will not be a cumulative final exam. The exam for module three will be scheduled during the final exam week on the specified date and time.

Acknowledgment of the honor pledge, module questionnaire, and the SIRS survey will constitute up to 5% extra credit.

We will have one makeup exam session for each module. Additional makeup exams will be at the discretion of the instructors. Please contact the instructor for each module and the Dean of Students if there are extenuating circumstances.

G) STUDENT SUPPORT AND MENTAL WELLNESS

Technology Challenges
Please visit the Rutgers Student Tech Guide page for resources that are available to all students. If you do not have the appropriate technology for financial reasons, please email the Dean of Students at deanofstudents@echo.rutgers.edu or contact the Dean of Students – Student Support Office: https://success.rutgers.edu/resource/dean-students-student-support-office

Disability Services
Lucy Stone Hall, Suite A145, Livingston Campus, 54 Joyce Kilmer Avenue, Piscataway, NJ 08854, Phone: **(**848) 445-6800
https://ods.rutgers.edu/

Rutgers University welcomes students with disabilities into all of the University's educational programs. To receive consideration for reasonable accommodations, a student with a disability must contact the appropriate disability services office where they are officially enrolled, participate in an intake interview, and provide documentation: https://ods.rutgers.edu/students/documentation-guidelines. If the documentation supports your request for reasonable accommodations, your campus's disability services office will provide you with a Letter of Accommodation. Please share this letter with your instructors and discuss the accommodations with them as early in your courses as possible. To begin this process, please complete the Registration form on the ODS website at https://webapps.rutgers.edu/student-ods/forms/registration.

Other Links for Student Support and Mental Wellness

- Student Success Essentials: https://success.rutgers.edu
- Student Support Services: https://www.rutgers.edu/academics/student-support
- The Learning Centers: https://rlc.rutgers.edu/
- Rutgers Libraries: https://www.libraries.rutgers.edu/
- Bias Incident Reporting: https://studentaffairs.rutgers.edu/bias-incident-reporting
- Dean of Students – Student Support Office: https://success.rutgers.edu/resource/dean-students-student-support-office
- Office of Veteran and Military Programs and Services: https://veterans.rutgers.edu
- Student Health Services: http://health.rutgers.edu/
- Counseling, Alcohol and Other Drug Assistance Program & Psychiatric Services (CAPS): http://health.rutgers.edu/medical-counseling-services/counseling/
- UWill: free immediate access to teletherapy; you can choose a therapist based on your preferences including issue, gender, language, ethnicity. http://health.rutgers.edu/uwill/
- Office for Violence Prevention and Victim Assistance: www.vpva.rutgers.edu/
- Office of Disability Services: https://ods.rutgers.edu/
- Basic Needs Assistance (food, housing, and other essentials): https://ruoffcampus.rutgers.edu/basic-needs
- Rutgers Student Food Pantry: https://ruoffcampus.rutgers.edu/food-pantry

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SCHEDULE OF TOPICS (SPRING 2025)

Lecturer	Topic	Assignment
Kwan	Introduction to Pain and Addiction	https://www.ncbi.nlm.nih.gov/books/NBK458655/
Kwan	Molecular Basis of Sensation: TRP Channels	https://www.ncbi.nlm.nih.gov/books/NBK476120/
Kwan	Sensory Modality I - Mechanosensation	https://www.ncbi.nlm.nih.gov/books/NBK541068/ https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8921412/
Kwan	Sensory Modalities II - Thermoception	https://www.ncbi.nlm.nih.gov/books/NBK5244/
Kwan	The Forgotten Sensory Modality - Acute and Neuropathic Pain	https://www.ncbi.nlm.nih.gov/books/NBK57271/
Kwan	Integrating Sensory Modalities - Somatosensation	https://www.ncbi.nlm.nih.gov/books/NBK92834/
Kwan	Past Research - TRPA1 Antagonist: A Non-Opiod Analgesic for Alleviating Pain	https://pubmed.ncbi.nlm.nih.gov/20547126/
Kwan	Exam Review	
Kwan	Exam I	
Abraira	Introduction to advanced studies of somatosensory and pain circuits	Touch: The Science of the Hand, Heart, and Mind. 1st Ed. Chapter 1
Abraira	Advanced studies of touch circuits (part 1)	Touch: The Science of the Hand, Heart, and Mind. 1st Ed. Chapter 2
Abraira	Advanced studies of touch circuits (part 2)	Touch: The Science of the Hand, Heart, and Mind. 1st Ed. Chapter 2
Abraira	Advanced studies of thermoreception molecules and circuits	Touch: The Science of the Hand, Heart, and Mind. 1st Ed. Chapter 4
Abraira	Advanced studies of the molecules and circuits of pain	Touch: The Science of the Hand, Heart, and Mind. 1st Ed. Chapter 5
Abraira	Experimental techniques to study pain in cells and model organisms	Touch: The Science of the Hand, Heart, and Mind. 1st Ed. Chapter 1-5 (here I will highlight overlapping techniques from primary papers that have led to the discoveries in these chapters)
Abraira	Spring Break	
Abraira	Spring Break	
Abraira	The Placebo effect (Part 1)	Touch: The Science of the Hand, Heart, and Mind. 1st Ed. Chapter 6
Abraira	The Placebo effect Part 2: live Q and A with Dr. Eric Jacobson (Harvard Medical School)	https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2364862/
Abraira	**Exam Review**	

Abraira	**Exam 2**	
Cuesta	Introduction I: Conceptualization, definitions and key aspects of SUDs	1- Determinants of Addiction: Neurobiological, Behavioral, Cognitive, and Sociocultural Factors. 1st edition. Chapter 1
Cuesta	Introduction II: Drug dependence. Stigma and Impact associated with SUDs. Opioids crisis	1- Determinants of Addiction: Neurobiological, Behavioral, Cognitive, and Sociocultural Factors. 1st edition. Chapter 1
Cuesta	Substrate of addiction I: About neurons and neurotransmitters	2- Volkow, N.D., Blanco, C. The changing opioid crisis: development, challenges and opportunities. Mol Psychiatry 26, 218–233 (2021). https://doi.org/10.1038/s41380-020-0661-4
Cuesta	Substrate of addiction II: Themotivation circuitry	1- Determinants of Addiction: Neurobiological, Behavioral, Cognitive, and Sociocultural Factors. 1st edition. Chapter 2
Cuesta	Classes of drug and animal models of addiction	1- Determinants of Addiction: Neurobiological, Behavioral, Cognitive, and Sociocultural Factors. 1st edition. Chapter 3
Cuesta	Experimental techniques to study addiction	1- Determinants of Addiction: Neurobiological, Behavioral, Cognitive, and Sociocultural Factors. 1st edition. Chapter 1
Cuesta	Addiction in the microbiome era	2- Determinants of Addiction: Neurobiological, Behavioral, Cognitive, and Sociocultural Factors. 1st edition. Chapter 3
Cuesta	Cuesta Lab Research	1- Determinants of Addiction: Neurobiological, Behavioral, Cognitive, and Sociocultural Factors. 1st edition. Chapter 3
Cuesta	**Exam Review**	2- Determinants of Addiction: Neurobiological, Behavioral, Cognitive, and Sociocultural Factors. 1st edition. Chapter 4
	Reading Period	1- Hofford R.S. & Kiraly D.D., Clinical and preclinical evidence for gut microbiome mechanisms in substance use disorder., Biological Psychiatry (2023), doi: https:// doi.org/10.1016/j.biopsych.2023.08.004.
Cuesta	**Exam 3**	1- Cuesta S, Burdisso P, Segev A, Kourrich S, Sperandio V (2022): Gut colonization by Proteobacteria alters host metabolism and modulates cocaine neurobehavioral responses. Cell Host Microbe 30: 1615-1629.e5.