

Vision Science

Vision is one of the most valuable sensory modalities. It is also the source of a rich array of research questions relating to how we see, how and why vision fails, and what can be done about it. Investigators in Vision Science conduct human and animal research and modeling, yielding cutting-edge discoveries and applications in disciplines that include molecular genetics, clinical care, adaptive optics, neurobiology, cell biology, infectious disease, bioengineering, perception, and public health.

This Ph.D. program (<http://vision.berkeley.edu/>) emphasizes the interdisciplinary nature of vision science research through broad exposure to the basic concepts and techniques used in specialized fields. Engaged in laboratory-based and clinical research, our students (<https://vision.berkeley.edu/about-us/student-profiles/>) work with faculty (<https://vision.berkeley.edu/faculty/>) advisers whose research matches their interests. Current research topics include biomedical optics, perception and visual cognition, molecular and cell biology, neuroscience, computational vision, genetics, immunology, microbiology, and clinical science.

To complete our Ph.D. program, students must complete a minimum of 120 units. These units are required and are earned by taking VISC1 260A, VISC1 260B, VISC1 260C, VISC1 260D, VISC1 298, VISC1 201A, VISC1 201B, VISC1 299 and VISC1 375A/375B. Students in our program are also allowed to take course across campus as it fits into their research and progress towards their thesis.

Vision Science alumni (<https://vision.berkeley.edu/alumni/alumni-directory/>) are represented on the faculty of world-class universities — in medical schools, schools of optometry, and a wide range of other disciplines spanning psychology, physiology, bioengineering, and ophthalmology. Many others hold research positions in private institutes and federally sponsored agencies, including NASA and the NIH. Still, others can be found in the research and development divisions of the industry. Ophthalmic and biotechnology companies are among the major recruiters of our graduates.

Due to the program's interdisciplinary nature, we accept students with various backgrounds, including psychology, optometry, engineering, computer science, physics, chemistry, biophysics, neuroscience, mathematics, molecular and cell biology, and integrative biology.

Due to the program's interdisciplinary nature, we accept students with various backgrounds, including psychology, optometry, engineering, computer science, physics, chemistry, biophysics, neuroscience, mathematics, molecular and cell biology, and integrative biology. Because this program is designed to develop research scientists, it is also important that applicants are familiar with an experimental lab setting. Program-specific admissions guidelines can be found here (<https://vision.berkeley.edu/admissions/>).

Applying for Graduate Admission

Thank you for considering UC Berkeley for graduate study! UC Berkeley offers more than 120 graduate programs representing the breadth and depth of interdisciplinary scholarship. The Graduate Division hosts a complete list (<https://grad.berkeley.edu/admissions/choosing-your-program/list/>) of graduate academic programs, departments, degrees offered, and application deadlines can be found on the Graduate Division website.

Prospective students must submit an online application to be considered for admission, in addition to any supplemental materials specific to the program for which they are applying. The online application and steps to take to apply can be found on the Graduate Division website (<https://grad.berkeley.edu/admissions/steps-to-apply/>).

Admission Requirements

The minimum graduate admission requirements are:

1. A bachelor's degree or recognized equivalent from an accredited institution;
2. A satisfactory scholastic average, usually a minimum grade-point average (GPA) of 3.0 (B) on a 4.0 scale; and
3. Enough undergraduate training to do graduate work in your chosen field.

For a list of requirements to complete your graduate application, please see the Graduate Division's Admissions Requirements page (<https://grad.berkeley.edu/admissions/steps-to-apply/requirements/>). It is also important to check with the program or department of interest, as they may have additional requirements specific to their program of study and degree. Department contact information can be found here (<https://guide.berkeley.edu/graduate/degree-programs/>).

Where to apply?

Visit the Berkeley Graduate Division application page (<http://grad.berkeley.edu/admissions/apply/>).

Coursework

As a Ph.D. student, you are eligible to take any course on campus during the academic year. This is a great perk and should be taken advantage of, but please be aware that your tuition and fees do not extend into the summer, so any summer courses will be paid out of pocket.

Core Curriculum

The Core Curriculum comprises a series of four courses split between the Fall and Spring semester of your first year. The series is intended to provide a general overview of the main topic areas in Vision Science for students of widely varying backgrounds. The Core Curriculum requirement must be fulfilled by the end of their first year. Each course must be passed with a B or better. Failure to achieve a B or better will require the course to be retaken the following year for a letter grade.

VIS SCI 201A: SURVEY OF LABORATORIES

The goal of this course is to introduce first-year students to the faculty and labs in the Vision Science program. During the first year of the graduate program, students are presented with an overview of the various research opportunities represented in the Vision Science group. Weekly one-hour lectures and/or lab tours are presented by the Vision Science faculty.

VIS SCI 201B: sTUDENT eVENING RESEARCH SEMINAR (sers)

The goal of the Student Evening Research Seminar (SERS) is to provide a forum for VS graduate students to discuss and develop strategies for giving effective presentations and to have an opportunity to practice giving scientific presentations in an informal setting. SERS is a required course for all first-year and second-year students although all graduate students, faculty, and postdocs are welcome and encouraged to attend.

VIS SCI 260A: OPTICAL AND NEURAL LIMITS TO VISION

This course will provide an overview of the early stage limits to human vision, from the eye's optics to sampling and processing in the retina. Students will learn basic optical properties of the eye as well as objective and subjective techniques on how to measure the limits of human vision. The class will comprise a combination of lectures and active learning by the students in the form of a project, to be presented at the end of the semester.

VIS SCI 260B: INTRODUCTION TO OCULAR BIOLOGY

This course will provide an overview of eye development, anterior eye ocular anatomy and physiology, and ocular disease. The course will be a combination of didactic lectures and problem-based learning.

VIS SCI 260C: INTRODUCTION TO visual NEUROSCIENCE

This course will provide an overview of the neuroscience of vision, spanning the entire neural pathway from retinal neurobiology to cortical processing of visual signals. The class will comprise a combination of lectures and active learning by the students in the form of a project, to be presented at the end of the semester.

VIS SCI 260D: SEEING IN TIME, SPACE, AND COLOR

This course will provide an overview of how we see in time (temporal signal processing, eye motion, motion detection), space (stereo vision, depth perception), and color as well as the anatomical and physiological factors that facilitate these capabilities. The course will be a series of didactic lectures.

VIS SCI 230: ETHICS

In preparation for participation in research, each student is required to take the Ethics in Scientific Research course for a letter grade within the first 2 years of enrollment. Training in the responsible conduct of research is required for all students. This course examines a range of ethical issues that arise in the process of doing science.

VIS SCI 298: oXYOPIA SEMINAR

Oxyopia seminars are presented to the Vision Science and campus community on a weekly basis during the academic year. These seminars are given by local and visiting researchers and are an excellent way for students to become more familiar with the most recent developments in vision research. All graduate students, faculty, and postdocs are welcomed and encouraged to attend. All first-year and second-year students must take Oxyopia for a letter grade. Starting in their 3rd year, all VS students are required to make an annual presentation on a current research project at the Oxyopia lecture series.

VIS SCI 299: research

A required research course that is "instructed" by the professor that the student is rotating with. This course can be taken for up to 12 units. It can also be less if other coursework is being taken simultaneously.

VIS SCI 375A: tEACHING METHODS (Offered in fall)

As Graduate Student Instructors in the School of Optometry, all first-year students are required to enroll in a teaching methods course. There are two parts to this course, the first one offered in fall and the second in spring. This course provides instruction in teaching methods and materials and opportunities to practice teaching in classrooms and laboratories.

VIS SCI 375B: TEACHING METHODS (OFFERED IN SPRING)

As Graduate Student Instructors in the School of Optometry, all first-year students are required to enroll in a teaching methods course. There are two parts to this course, the first one offered in fall and the second in spring. This course provides instruction in teaching methods and materials and opportunities to practice teaching in classrooms and laboratories.

Additional Coursework

The following represent fields of study that may be beneficial for student success but are not required courses.

Statistics

Strongly recommended for most areas of Vision Science. Meet with your Graduate Advisor to discuss your statistics background and appropriate courses for your intended area of research.

advanced courses and seminars

These are given as a continuation of the different themes established in the proseminar series. Courses offerings vary, and a complete list will be provided each semester. Please visit the Schedule of Classes for the most current listing.

Beyond vision science

Students may also consider courses offered by other departments on campus, according to their needs. Additional coursework is not recommended during the first 2 semesters. Students are encouraged to meet with their research advisor to discuss their needs and the options that are available to them.

Curriculum**Courses Required**

VIS SCI 201A	Seminar in Vision Science	2
VIS SCI 260A	Optical and Neural Limits to Vision	3
VIS SCI 260B	Introduction to Ocular Biology	3
VIS SCI 260C	Introduction to Visual Neuroscience	3
VIS SCI 260D	Seeing in Time, Space and Color	3
VIS SCI 298	Group Studies, Seminars, or Group Research	1
VIS SCI 299	Research in Vision Science (two required lab rotations)	1-12
VIS SCI 230	Ethics in Scientific Research	2
VIS SCI 201B	Seminar in Vision Science	2
VIS SCI 375A	Teaching Methods in Vision Science, I	1
VIS SCI 375B	Teaching Methods in Vision Science, II	1
Electives per approved individualized study list		

Vision Science

VIS SCI 201A Seminar in Vision Science 2 Units

Terms offered: Fall 2024, Fall 2023, Fall 2021

Graduate seminar in vision science.

Rules & Requirements

Prerequisites: Consent of instructor

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of seminar per week

Additional Details

Subject/Course Level: Vision Science/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

Instructor: VS faculty

VIS SCI 201B Seminar in Vision Science 2 Units

Terms offered: Spring 2024, Spring 2023, Spring 2022

Graduate seminar in vision science.

Rules & Requirements

Prerequisites: Consent of instructor

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of seminar per week

Additional Details

Subject/Course Level: Vision Science/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

Instructor: Gronert

VIS SCI 230 Ethics in Scientific Research 2 Units

Terms offered: Spring 2024, Spring 2023, Spring 2022

This seminar will examine a range of ethical issues that arise in the process of doing science. Beginning with the philosophical and social foundations, we will consider the pathogenesis of fraud, statistics and deception, the ethics of authorship and publication, research with human subjects, the use of animals, the definition(s) of misconduct and the difference between misconduct and questionable research practices, the relationship between industry and science, and finally, the responsibilities and obligations of the scientist in society.

Hours & Format

Fall and/or spring: 15 weeks - 30 hours of seminar per week

Additional Details

Subject/Course Level: Vision Science/Graduate

Grading: Letter grade.

VIS SCI 260A Optical and Neural Limits to Vision 3 Units

Terms offered: Fall 2024, Fall 2023, Fall 2022

The course will provide an overview of the early stage limits to human vision, from the eye's optics to sampling and processing in the retina. Students will learn basic optical properties of the eye as well as objective and subjective techniques on how to measure limits of human vision. The class will comprise a combination of lectures and active learning by the students in the form of a project, to be presented at the end of the semester. This is one of the four courses that form the Vision Science core curriculum.

Rules & Requirements

Repeat rules: Course may be repeated for credit with instructor consent.

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Vision Science/Graduate

Grading: Letter grade.

Instructor: Austin Roorda

VIS SCI 260B Introduction to Ocular Biology 3 Units

Terms offered: Fall 2024, Fall 2023, Fall 2020

The course will provide an overview of eye development, anterior eye ocular anatomy and physiology and ocular disease. The course will be a combination of didactic lectures and problem-based learning. This is one of the four courses that form the Vision Science core curriculum.

Rules & Requirements

Repeat rules: Course may be repeated for credit with instructor consent.

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Vision Science/Graduate

Grading: Letter grade.

Instructor: Suzanne Fleiszig

VIS SCI 260C Introduction to Visual Neuroscience 3 Units

Terms offered: Spring 2025, Spring 2024, Spring 2023

The course will provide an overview of the neuroscience of vision, spanning the entire neural pathway from retinal neurobiology to cortical processing of visual signals. The class will comprise a combination of lectures and active learning by the students in the form of a project, to be presented at the end of the semester. This is one of the four courses that form the Vision Science core curriculum.

Rules & Requirements

Repeat rules: Course may be repeated for credit with instructor consent.

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Vision Science/Graduate

Grading: Letter grade.

Instructor: Michael Silver

VIS SCI 260D Seeing in Time, Space and Color 3 Units

Terms offered: Spring 2025, Spring 2024, Spring 2023

The course will provide an overview of how we see in time (temporal signal processing, eye motion, motion detection), space (stereo vision, depth perception), and color as well as the anatomical and physiological factors that facilitate these capabilities. The course will be series of didactic lectures. This is one of the four courses that form the Vision Science core curriculum

Rules & Requirements

Repeat rules: Course may be repeated for credit with instructor consent.

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Vision Science/Graduate

Grading: Letter grade.

Instructor: Martin Banks

VIS SCI 262 Visual Cognitive Neuroscience 3 Units

Terms offered: Fall 2021, Fall 2018, Spring 2016

The course will provide an overview of visual cognitive neuroscience, drawing from neuroanatomy, neurophysiology in humans and animal models, psychophysics, neuroimaging, neuropharmacology, neuropsychology, and computational models of vision and cognition. Topics will include basic anatomy and physiology of the mammalian visual system, motion perception and processing, depth perception and representation of visual space, brightness and color, object and face recognition, visual attention, developmental and adult plasticity, perceptual learning, multisensory integration, and visual awareness.

Rules & Requirements

Prerequisites: Consent of instructor

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 2 hours of lecture per week

Additional Details

Subject/Course Level: Vision Science/Graduate

Grading: Letter grade.

Instructor: Silver

VIS SCI 265 Neural Computation 3 Units

Terms offered: Fall 2024, Fall 2022, Fall 2020

This course provides an introduction to the theory of neural computation. The goal is to familiarize students with the major theoretical frameworks and models used in neuroscience and psychology, and to provide hands-on experience in using these models. Topics include neural network models, supervised and unsupervised learning rules, associative memory models, probabilistic/graphical models, and models of neural coding in the brain.

Rules & Requirements

Prerequisites: Calculus, differential equations, basic probability and statistics, linear algebra, and familiarity with high level programming languages such as Matlab

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Vision Science/Graduate

Grading: Letter grade.

Instructor: Olshausen

VIS SCI C265 Neural Computation 3 Units

Terms offered: Not yet offered

This course provides an introduction to the theory of neural computation. The goal is to familiarize students with the major theoretical frameworks and models used in neuroscience and psychology, and to provide hands-on experience in using these models. Topics include neural network models, supervised and unsupervised learning rules, associative memory models, probabilistic/graphical models, and models of neural coding in the brain.

Rules & Requirements

Prerequisites: Calculus, differential equations, basic probability and statistics, linear algebra, and familiarity with high level programming languages such as Matlab

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Vision Science/Graduate

Grading: Letter grade.

Instructor: Olshausen

Also listed as: NEU C231

VIS SCI C280 Computer Vision 3 Units

Terms offered: Spring 2025, Spring 2024, Spring 2023

Paradigms for computational vision. Relation to human visual perception. Mathematical techniques for representing and reasoning, with curves, surfaces and volumes. Illumination and reflectance models. Color perception. Image segmentation and aggregation. Methods for bottom-up three dimensional shape recovery: Line drawing analysis, stereo, shading, motion, texture. Use of object models for prediction and recognition.

Rules & Requirements

Prerequisites: MATH 1A; MATH 1B; MATH 53; and MATH 54 (Knowledge of linear algebra and calculus)

Hours & Format

Fall and/or spring: 15 weeks - 3 hours of lecture per week

Additional Details

Subject/Course Level: Vision Science/Graduate

Grading: Letter grade.

Instructor: Malik

Also listed as: COMPSCI C280

VIS SCI 298 Group Studies, Seminars, or Group Research 1 Unit

Terms offered: Spring 2025, Fall 2024, Spring 2024

Enhance skills in scientific writing and critical analysis of research literature.

Develop effective communication techniques for presenting complex research information.

Foster a collaborative research environment where students can engage in meaningful scientific inquiry and problem solving. Oxyopia is a seminar series featuring lectures on basic, clinical, and applied research in vision

Rules & Requirements

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 2-2 hours of lecture per week

Additional Details

Subject/Course Level: Vision Science/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

VIS SCI 299 Research in Vision Science 1 - 12 Units

Terms offered: Summer 2025, Summer 2025 First 6 Week Session, Spring 2025

Research.

Rules & Requirements

Prerequisites: Consent of instructor

Hours & Format

Fall and/or spring: 15 weeks - 0-0 hours of independent study per week

Summer:

6 weeks - 1-16 hours of independent study per week

8 weeks - 1-12 hours of independent study per week

Additional Details

Subject/Course Level: Vision Science/Graduate

Grading: Offered for satisfactory/unsatisfactory grade only.

VIS SCI 300 Teaching Methods in Vision Science 1 Unit

Terms offered: Spring 2025, Spring 2024, Spring 2023
Instruction in teaching methods and materials, in vision science and optometry; practice teaching in classrooms and laboratory.

Rules & Requirements

Prerequisites: Graduate standing in vision science

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 1 hour of lecture per week

Additional Details

Subject/Course Level: Vision Science/Professional course for teachers or prospective teachers

Grading: Offered for satisfactory/unsatisfactory grade only.

Instructor: Silver

VIS SCI 375A Teaching Methods in Vision Science, I 1 Unit

Terms offered: Fall 2024, Fall 2023
Instruction in teaching methods and materials in vision science and optometry; practice teaching in classroom and laboratory. Lectures, discussion and outside work related to learning effective teaching styles, developing optimal teaching environments, accessing teaching resources, and fostering professional development.

Rules & Requirements

Prerequisites: This course is restricted to student in the Vision Science graduate program

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 1 hour of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Vision Science/Professional course for teachers or prospective teachers

Grading: Offered for satisfactory/unsatisfactory grade only.

VIS SCI 375B Teaching Methods in Vision Science, II 1 Unit

Terms offered: Spring 2025
Instruction in teaching methods and materials in vision science and optometry; practice and reflect on teaching in the classroom and laboratory. Lectures, discussion and outside work related to teaching methods and assessment of student learning, including lecture-based, problem-based, active, and inquiry-based learning. Instruction on student engagement and effective communication.

Rules & Requirements

Prerequisites: This course is restricted to students in the Vision Science graduate program

Repeat rules: Course may be repeated for credit without restriction.

Hours & Format

Fall and/or spring: 15 weeks - 1 hour of lecture and 1 hour of discussion per week

Additional Details

Subject/Course Level: Vision Science/Professional course for teachers or prospective teachers

Grading: Offered for satisfactory/unsatisfactory grade only.

VIS SCI 601 Individual Study for Master's Students 1 - 6 Units

Terms offered: Spring 2021, Spring 2020, Spring 2019
Individual study for the comprehensive requirements in consultation with the adviser in vision science.

Rules & Requirements

Prerequisites: Consent of instructor

Credit Restrictions: Course does not satisfy unit or residence requirements for master's degree.

Hours & Format

Fall and/or spring: 15 weeks - 0 hours of independent study per week

Additional Details

Subject/Course Level: Vision Science/Graduate examination preparation

Grading: Offered for satisfactory/unsatisfactory grade only.

VIS SCI 602 Individual Study for Doctoral Students 1 - 6 Units

Terms offered: Fall 2024, Fall 2023, Fall 2022

Individual study in consultation with the adviser in vision science, intended to provide an opportunity for qualified students to prepare themselves for the various examinations required for the Ph. D.

Rules & Requirements

Prerequisites: Consent of instructor

Credit Restrictions: Course does not satisfy unit or residence requirements.

Hours & Format

Fall and/or spring: 15 weeks - 0 hours of independent study per week

Additional Details

Subject/Course Level: Vision Science/Graduate examination preparation

Grading: Offered for satisfactory/unsatisfactory grade only.