

DEPARTMENT OF NEUROSCIENCE, DEVELOPMENTAL AND REGENERATIVE BIOLOGY

Mission Statement

The mission of the Department of Neuroscience, Developmental and Regenerative Biology is to conduct high impact, internationally recognized research and to educate and train the next generation of leaders in biological sciences. As a department of neuroscientists and developmental and regenerative biologists, we focus on understanding organismal, tissue, and cellular function from molecules to behavior in health and disease.

General Information

Faculty and students in the Department of Neuroscience, Developmental and Regenerative Biology study key questions relating to how the brain works in normal and disease states (neuroscience) and how cells and tissues are formed, maintained, and repaired (developmental and regenerative sciences). Collectively and collaboratively, we seek to learn, investigate, and communicate knowledge in these fields. Our diverse and recognized faculty and state-of-the-art laboratory facilities provide students with opportunities for personal interaction, mentorship, and undergraduate research projects.

Neuroscience

Neuroscience research at UTSA is interdisciplinary and explores neural function from molecules to cells to neural networks to behavior. Students will find a highly collaborative atmosphere across the department. Our neuroscience laboratories employ behavioral, cellular, computational, developmental, and molecular approaches to answer questions associated with neural function. Many of our faculty are leading investigators attempting to understand debilitating brain diseases, including Alzheimer's Disease, Parkinson's Disease, and Epilepsy. Students also can participate in various neuroscience-related activities supported by the UTSA Neurosciences Institute and UTSA's Brain Health Consortium, including weekly seminars and special seminar programs. Undergraduate study in the neurosciences is directly supported through a Bachelor of Science (B.S.) in Neuroscience degree and a Minor in Neuroscience.

Developmental and Regenerative Sciences

Faculty and students in the areas of **Developmental and Regenerative Sciences** study a wide range of questions relating to stem cells, cancer and cell cycle regulation, tissue regeneration, epigenetic regulation of cell fate and function, gene expression, fertility, and "Disease-in-a-Dish" models, including "organoid" systems. State-of-the-art technologies include genomics, epigenomics, proteomics, cell sorting, and cell imaging. A wide range of lecture and laboratory courses are available to undergraduate students in Developmental and Regenerative Biology, along with opportunities for seminar classes, independent study, and directed research. Many of our faculty and students are associated with UTSA's Institute of Regenerative Medicine, a joint collaborative initiative between UTSA's Klesse College of Engineering and Integrated Design and the College of Sciences, and multiple research institutions in San Antonio. Undergraduate students with interests in Developmental and

Regenerative Biology are encouraged to attend a weekly Developmental and Regenerative seminar series that frequently highlights research in this area.

Program Outcomes

The Department of Neuroscience, Developmental and Regenerative Biology programs provide students the opportunity to:

- Communicate across the biological, psychological, and computational sciences.
- Identify and explain fundamental concepts in molecular neuroscience, cellular neurophysiology and signaling, neuroanatomy, neural information processing, and behavior.
- Develop and conduct appropriate experimentation, analyze and interpret data, and use judgment to draw conclusions.

Degrees

The Department of Neuroscience, Developmental and Regenerative Biology offers a Bachelor of Science (B.S.) in Neuroscience, a Minor in Neuroscience, and a Bachelor of Science (B.S.) in Biology - Developmental and Regenerative Sciences Concentration.

Neuroscience is the interdisciplinary study of the nervous system across various levels—from molecules to cells, through circuits and behavior. Neuroscience represents a unique academic field, requiring students to understand and utilize a diverse knowledge base across multiple disciplines. The Department of Neuroscience, Developmental and Regenerative Biology offers a B.S. degree in Neuroscience and a Minor in Neuroscience for an interdisciplinary undergraduate experience for students interested in how the brain works.

The **B.S. Degree in Neuroscience** curriculum is conceptually structured around i) an interdisciplinary foundation in the biological, psychological, and computational sciences; ii) a broad scope of electives for students to individualize their degree or pursue one of three neuroscience concentrations (Behavioral, Molecular, and Pre-medical); and iii) opportunities for research/practical experience. At its foundation, all students will take an introductory course in Neuroscience (NDRB 2113), Biology (BIO 1203), and Psychology (PSY 1013). In subsequent years all students will take an upper-division class and laboratory in Neurobiology. Their first two years will also include a strong set of required courses in the sciences, math, and statistics. The remaining two years of the program are designed for the student to explore neuroscience across a wide range of disciplines, along with free electives, allowing for maximum flexibility in their chosen program of study. The B.S. in Neuroscience degree prepares students for careers in neuroscience-related fields, graduate-level study in master's and doctoral-level programs, and medical and dental school. Because of the broad training afforded by this program, graduates may find employment in many industries, including companies or government agencies associated with public health, biomedical engineering, education, psychology, and research.

The **Minor in Neuroscience** provides formal recognition for students who have focused a significant portion of their academic work in the interdisciplinary area of neuroscience. The minor can accommodate majors from all other departments.

The **B.S. Degree in Biology with a Concentration in Developmental and Regenerative Sciences** is designed to provide students with a comprehensive understanding of the fundamental principles and mechanisms underlying the growth and development of organisms, as well as the processes involved in tissue regeneration and repair. This

interdisciplinary program draws on concepts from biology, genetics, epigenetics, molecular biology, biochemistry, and other related fields to explore the molecular, cellular, and physiological mechanisms that govern these processes. Students in this program will study a broad range of topics, including embryonic development, cell differentiation, organogenesis, tissue homeostasis, and wound healing. They will also explore the use of stem cells as models for studies of development and in conjunction with other regenerative therapies for the treatment of diseases and injuries. Throughout the program, students will have the opportunity to engage in hands-on laboratory research, developing their skills in experimental design, data analysis, and scientific communication. In addition, students will develop critical thinking, problem-solving, and communication skills, which are essential for success in a wide range of career paths, including biomedical research, biotechnology, and healthcare. Graduates of this program will be well-prepared for further study in graduate programs in developmental and regenerative biology, as well as for careers in academic research, biotechnology, military health, clinical research, and other related fields.

Student Success

The Department and Faculty supporting the B.S. in Neuroscience and Minor in Neuroscience, and B.S. in Biology with a Concentration in Developmental and Regenerative Sciences, are committed to championing and developing the next generation of Neuroscience, Developmental and Regenerative Sciences students at UTSA through multiple avenues of engagement and academic support. In addition to an innovative academic program, opportunities for participation in cutting-edge research, a vibrant “student-life”, and strong priorities of inclusion will foster student accomplishment within prestigious programs of study.

Health Careers Pathways

The Department of Neuroscience, Developmental and Regenerative Biology offers programs that support students interested in pursuing professional or graduate programs (e.g., medical, dental) in health-related professions through the Pre-Medical Neuroscience concentration in the B.S. Neuroscience degree. See the Degrees (p. 2) page for more information. Students can also visit the UTSA Health Professions office (<https://www.utsa.edu/healthprofessions/>) for more information.

COS Signature Experiences in Neuroscience, Developmental and Regenerative Biology

The Department of Neuroscience, Developmental and Regenerative Biology offers experiential learning opportunities for undergraduate students in which they can gain real-world experiences while also learning about the broader impacts of their work within their fields of study. All undergraduate students have the option to participate in a College of Sciences (COS) Signature Experience. Students should contact the Undergraduate Advisor of Record for the Neuroscience major for a list of relevant signature experiences.

- B.S. degree in Neuroscience (p. 2)
 - Concentration in Behavioral Neuroscience (p. 3)
 - Concentration in Molecular Neuroscience (p. 4)
 - Concentration in Pre-Medical Neuroscience (p. 4)

- B.S. in Biology with a Concentration in Developmental and Regenerative Sciences (p. 5)

Bachelor of Science Degree in Neuroscience

The B.S. in Neuroscience is an interdisciplinary degree that will provide students the opportunity to pursue an integrated course of study in Neuroscience. Neuroscience represents a unique academic field in that it requires students to understand and utilize a set of diverse knowledge from multiple disciplines. Neuroscience impacts almost all areas of science and business, and this degree is intended to prepare students for a wide range of careers in this area.

A minimum number of 120 semester credit hours is required for the B.S. in Neuroscience, including 42 hours of Core Curriculum requirements. At least 39 of the total semester credit hours required for the degree must be at the upper-division level.

All major and support work courses and required prerequisites must be completed with a grade of “C-” or better.

Core Curriculum Requirements (42 semester credit hours)

Students seeking the B.S. degree in Neuroscience must fulfill University Core Curriculum requirements in the same manner as other students. The courses listed below satisfy both degree requirements and Core Curriculum requirements; however, if these courses are taken to satisfy both requirements, then students may need to take additional courses in order to meet the minimum number of semester credit hours required for this degree.

MAT 1193 may be used to satisfy the core requirement in Mathematics as well as a major requirement.

PSY 1013 may be used to satisfy the core requirement in Social and Behavioral Sciences as well as a major requirement.

BIO 1203 & PHY 1943 may be used to satisfy the core requirement in Life and Physical Sciences as well as major requirements.

CS 1173 may be used to satisfy the core requirement in Component Area Option as well as a major requirement.

Core Curriculum Component Area Requirements (<http://catalog.utsa.edu/undergraduate/bachelorsdegreeregulations/degreerequirements/corecurriculumcomponentarearequirements/>)

First Year Experience Requirement	3
Communication	6
Mathematics	3
Life and Physical Sciences	6
Language, Philosophy and Culture	3
Creative Arts	3
American History	6
Government-Political Science	6
Social and Behavioral Sciences	3
Component Area Option	3
Total Credit Hours	42

Degree Requirements

Code	Title	Credit Hours
A. Foundation Courses		
1. Required Biology Courses		
BIO 1203	Biosciences I for Science Majors	3
BIO 1201	Biosciences I Laboratory for Science Majors	1
BIO 2313	Genetics	3
2. Neuroscience required courses		
NDRB 2113	Introduction to Neuroscience	3
NDRB 3433	Neurobiology	3
NDRB 3442	Neurobiology Laboratory	2
PSY 1013	Introduction to Psychology	3
3. Math requirement		
MAT 1193	Calculus for the Biosciences	3
4. Data Analysis - pick one of the following		3
BIO 1173	Introduction to Computational Biology	
CS 1063	Introduction to Computer Programming I	
CS 1173	Data Analysis and Visualization	
DS 4003	Introduction to Data Science	
DS 4013	Programming for Data Science	
5. Chemistry Requirements		
CHE 1103	General Chemistry I	3
CHE 1121	General Chemistry I Laboratory	1
CHE 1113	General Chemistry II	3
CHE 1131	General Chemistry II Laboratory	1
6. Statistics		3
STA 1403	Probability and Statistics for the Biosciences	
or PSY 2073	Statistics for Psychology	
7. Physics. Select from one of the following options:		4
Option 1		
PHY 1603	Algebra-based Physics I	
PHY 1611	Algebra-based Physics I Laboratory	
Option 2		
PHY 1943	Physics for Scientists and Engineers I	
PHY 1951	Physics for Scientists and Engineers I Laboratory	
B. Support Courses		
1. Neuroscience. Select seven of the following:		21
NDRB 3453	Neuroscience and Our Future	
NDRB 3463	Brain Diseases	
NDRB 3563	Space and Time in the Brain	
NDRB 3613	Brain and Behavior	
NDRB 3623	Neuropsychopharmacology	
NDRB 4483	Developmental Neuroscience	
NDRB 4583	Emergent Properties of Neural Circuits	
NDRB 4683	Neural Data Science	
NDRB 4783	Computational Neuroscience	
NDRB 4823	Cognitive Neuroscience	
or PSY 4343	Cognitive Neuroscience	

NDRB 4913	Independent Study (must be neuroscience-related topic)	
NDRB 4923	Laboratory Research (must be neuroscience-related topic)	
NDRB 4953	Special Studies	
2. Additional Electives. Select four of the following:		12
Courses not taken in B.1 (above) can be taken as Additional Electives		
BIO 3523	Advanced Computational Biology	
NDRB 3813	Cell Biology	
NDRB 3913	Molecular Biology	
PSY 2503	Lifespan Developmental Psychology	
PSY 2513	Introduction to Psychopathology	
PSY 2563	Cognitive Psychology	
PSY 3153	Sensation and Perception	
PSY 3403	Experimental Psychology	
PSY 4253	Psychology of Health	
STA 3003	Statistical Methods and Applications	
STA 3013	Applied Multivariate Analysis	
MUS 3303	Music in Health	
PHI 3033	Philosophy of Science	
PHI 3083	Philosophy of Mind	
PHI 3203	Biomedical Ethics	

C. Free Electives

Select 12-21 semester credit hours of free electives, depending on the student's choice of Core Courses, to complete 120 hours, including a minimum requirement of 39 upper-division semester credit hours.

Total Credit Hours **84-93**

Concentrations

The Department of Neuroscience, Developmental and Regenerative Biology, within the B.S. in Neuroscience degree, offers three areas of concentration. To declare a concentration or obtain advice, students should consult an undergraduate academic advisor in the Life and Health Sciences Advising Center. To receive credit for a concentration, students must successfully complete all requirements for the B.S. degree, along with the requirements for the respective concentration. Students who do not successfully complete all courses of a given concentration area will receive a standard B.S. degree in Neuroscience.

Concentration in Behavioral Neuroscience

The coursework within the Behavioral Neuroscience concentration must be completed with a minimum cumulative grade point average of 3.0 or better. Students are also encouraged to enroll in NDRB 4923 Laboratory Research as part of their program of study. All candidates for the concentration in Behavioral Neuroscience must complete the following:

Code	Title	Credit Hours
NDRB 3613	Brain and Behavior	3
Select three of the following:		9
NDRB 3623	Neuropsychopharmacology	
NDRB 4583	Emergent Properties of Neural Circuits	
NDRB 4823	Cognitive Neuroscience	
NDRB 4923	Laboratory Research	

PSY 3153	Sensation and Perception
PSY 3403	Experimental Psychology
PSY 2563	Cognitive Psychology

Total Credit Hours 12

Concentration in Molecular Neuroscience

The coursework within the Molecular Neuroscience concentration must be completed with a minimum cumulative grade point average of 3.0 or better. Students are also encouraged to enroll in NDRB 4923 Laboratory Research as part of their program of study. All candidates for the concentration in Molecular Neuroscience must complete the following:

Code	Title	Credit Hours
NDRB 3913	Molecular Biology	3
Select three of the following:		
NDRB 3813	Cell Biology	
NDRB 4143	Developmental Biology	
NDRB 4163	Epigenetics	
NDRB 4173	Genomics and Bioinformatics	
NDRB 4483	Developmental Neuroscience	
NDRB 4923	Laboratory Research	
BIO 3413	General Physiology	
Total Credit Hours		12

Concentration in Pre-Medical Neuroscience

The B.S. degree in Neuroscience with a concentration in Pre-Medical Neuroscience is designed to prepare students for professional programs in medicine. This concentration has a recommended curriculum that is designed to meet the requirements for entry to medical school and to prepare students for the MCAT examination. For completion of the Pre-Medical Neuroscience Concentration, students must have both an overall math/science GPA of 3.5 or higher and complete all required coursework within the concentration with a minimum GPA of 3.5 or higher. All candidates for the concentration in Pre-Medical Neuroscience must complete the following:

Code	Title	Credit Hours
BIO 1223	Biosciences II for Science Majors	3
CHE 2603	Organic Chemistry I	3
CHE 2612	Organic Chemistry I Laboratory	2
CHE 3643	Organic Chemistry II	3
BCH 3303	Essentials of Biochemistry	3
Select one of the two Physics options:		4
Option 1		
PHY 1623	Algebra-based Physics II	
PHY 1631	Algebra-based Physics II Laboratory	
Option 2		
PHY 1963	Physics for Scientists and Engineers II	
PHY 1971	Physics for Scientists and Engineers II Laboratory	
Total Credit Hours		18

Course Sequence Guide for the B.S. in Neuroscience Degree

First Year

Fall		Credit Hours
AIS 1263	AIS: Life and Health Sciences	3
BIO 1203 & BIO 1201	Biosciences I for Science Majors and Biosciences I Laboratory for Science Majors (core and major)	4
WRC 1013	Freshman Composition I (core)	3
MAT 1193	Calculus for the Biosciences	3
Credit Hours		13

Spring

PSY 1013	Introduction to Psychology (core and major)	3
NDRB 2113	Introduction to Neuroscience	3
CHE 1103	General Chemistry I	3
CHE 1121	General Chemistry I Laboratory	1
WRC 1023	Freshman Composition II (core)	3
STA 1403	Probability and Statistics for the Biosciences	3
Credit Hours		16

Second Year

Fall

BIO 2313	Genetics	3
PHY 1943	Physics for Scientists and Engineers I (core)	3
PHY 1951	Physics for Scientists and Engineers I Laboratory	1
POL 1013	Introduction to American Politics (core)	3
CHE 1113	General Chemistry II	3
CHE 1131	General Chemistry II Laboratory	1
Credit Hours		14

Spring

CS 1173	Data Analysis and Visualization	3
NDRB 3433	Neurobiology	3
NDRB 3442	Neurobiology Laboratory	2
American History (core)		3
Language, Philosophy & Culture (core)		3
Additional Neuroscience Elective (B.2)		3
Credit Hours		17

Third Year

Fall

POL 1133	Texas Politics and Society (core)	3
Neuroscience Support Course (B.1)		3
Neuroscience Support Course (B.1)		3
Additional Neuroscience Elective (B.2)		3
Elective		3
Credit Hours		15

Spring

American History (core)		3
Neuroscience Support Course (B.1)		3
Neuroscience Support Course (B.1)		3

Additional Neuroscience Elective (B.2)	3
Elective	3
Credit Hours	15

Fourth Year**Fall**

Creative Arts (core)	3
Neuroscience Support Course (B.1)	3
Neuroscience Support Course (B.1)	3
Additional Neuroscience Elective (B.2)	3
Elective	3
Credit Hours	15

Spring

Neuroscience Support Course (B.1)	3
Neuroscience Support Course (B.1)	3
Elective	3
Elective	3
Elective	3
Credit Hours	15

Total Credit Hours **120**

B.S. in Biology with a Concentration in Developmental and Regenerative Sciences

The B.S. in Biology with a Concentration in Developmental and Regenerative Sciences (DRS) is designed to provide students with a comprehensive understanding of the fundamental principles and mechanisms underlying the growth and development of organisms and the processes involved in tissue regeneration and repair. The B.S. in Biology with a Concentration in Developmental and Regenerative Sciences (DRS) is housed in the Department of Neuroscience, Developmental and Regenerative Biology. The coursework within the DRS Concentration must be completed with a minimum cumulative grade point average of 3.0 or better. Students are also encouraged to enroll in NDRB 4923 as part of their program of study. Students should plan on taking courses for this concentration in their third and fourth years.

See the Department of Integrative Biology (<http://catalog.utsa.edu/undergraduate/sciences/integrativebiology/#degreestext>) for more information about the B.S. in Biology degree.

All candidates for the concentration in Developmental and Regenerative Sciences must complete the following:

Code	Title	Credit Hours
NDRB 3913	Molecular Biology	3
NDRB 4132	Developmental Biology Laboratory	2
NDRB 4143	Developmental Biology	3
Select two of the following:		6
NDRB 3663	Human Embryology	
NDRB 3993	Principles of Cancer Biology	
NDRB 4153	Frontiers in Human Pluripotent Stem Cells	
NDRB 4163	Epigenetics	
NDRB 4173	Genomics and Bioinformatics	
NDRB 4483	Developmental Neuroscience	

NDRB 4913	Independent Study (must be DRS-related topic)
NDRB 4923	Laboratory Research (must be performed in a laboratory engaged in DRS-based research)
NDRB 4953	Special Studies (must be DRS-related topic)
NDRB 4993	Directed Research (must be DRS-based research)
Total Credit Hours	14

Minor in Neuroscience

The Minor in Neuroscience is open to all majors in the University. To declare a Minor in Neuroscience or obtain advice, students should consult with their academic advisor. All students pursuing the minor must complete a minimum of 18 semester credit hours of neuroscience courses. It should be noted that students seeking a minor must also complete applicable support coursework in biology, chemistry, computer science, physics, mathematics, and statistics, as needed to fulfill the normal prerequisites for any course listed below. All neuroscience courses and their prerequisites must be completed with a grade of "C-" or better, and students must achieve a grade point average of at least 2.0 on all work used to satisfy the requirements of the minor.

Code	Title	Credit Hours
A. Required Courses		12
BIO 1203	Biosciences I for Science Majors	
BIO 1201	Biosciences I Laboratory for Science Majors	
NDRB 2113	Introduction to Neuroscience	
NDRB 3433	Neurobiology	
NDRB 3442	Neurobiology Laboratory	
B. Organized Neuroscience Courses (select 6 credit hours from the following)		6
NDRB 3453	Neuroscience and Our Future	
NDRB 3463	Brain Diseases	
NDRB 3563	Space and Time in the Brain	
NDRB 3613	Brain and Behavior	
NDRB 3623	Neuropsychopharmacology	
NDRB 4483	Developmental Neuroscience	
NDRB 4583	Emergent Properties of Neural Circuits	
NDRB 4683	Neural Data Science	
NDRB 4783	Computational Neuroscience	
NDRB 4823	Cognitive Neuroscience	
or PSY 4343	Cognitive Neuroscience	
NDRB 4923	Laboratory Research	
Total Credit Hours		18

Neuroscience, Developmental and Regenerative Biology (NDRB) Courses

NDRB 1033. Drugs and Society. (3-0) 3 Credit Hours.

An examination of licit and illicit drugs and their biosocial effects. Topics include the pharmacology of alcohol, stimulants, hallucinogens, addiction, and abuse. May be applied toward the Core Curriculum requirement in Social and Behavioral Sciences. Formerly BIO 1033. Credit cannot be earned for both NDRB 1033 and BIO 1033. Generally offered: Fall, Spring. Course Fee: LRC1 \$12; LRS1 \$46.20; STSI \$21.60.

NDRB 2113. Introduction to Neuroscience. (3-0) 3 Credit Hours.

Prerequisite: BIO 1203. An introduction to the interdisciplinary field of Neuroscience, including understanding of the foundations of brain function, behavior, and neurological diseases from molecular, neuroanatomical, neurophysiological, neurochemical, and behavioral points of view. Generally offered: Fall, Spring. Course Fee: LRS1 \$46.20; IUB1 \$10.

NDRB 2952. Undergraduate Research Experience. (1-3) 2 Credit Hours.

Prerequisite: BIO 1203 and BIO 1201 with a grade of at least a 'B-'. Organized laboratory for students to obtain an introduction to research in neuroscience, developmental or regenerative biology, paralleling ongoing research activities in faculty research labs. Students will have the opportunity to be trained in laboratory techniques such as electrophysiology, cell culture, computational neuroscience, fluorescence microscopy, or bioinformatics. Topics will also include an experimental design and interpretation of results. Topics will vary by semester, course section, and instructor. May be repeated for credit, but no more than 4 semester credit hours will apply to a bachelor's degree. Generally offered: Fall and Spring. Course Fee: L001 \$30; IUB1 \$10; DL01 \$50; LRS1 \$30.8; STSI \$14.4.

NDRB 3433. Neurobiology. (3-0) 3 Credit Hours.

Prerequisite: NDRB 2113. Anatomy and physiology of nervous systems and the mechanisms of neuronal functions. (Formerly BIO 3433. Credit cannot be earned for both NDRB 3433 and BIO 3433.) Generally offered: Fall, Spring. This course has Differential Tuition. Course fee: IUB1 \$10.

NDRB 3442. Neurobiology Laboratory. (0-6) 2 Credit Hours.

Prerequisite: NDRB 2113 and completion of or concurrent enrollment in NDRB 3433. A laboratory course emphasizing principles presented in NDRB 3433. (Formerly BIO 3442. Credit cannot be earned for both NDRB 3442 and BIO 3442.) Generally offered: Fall, Spring. This course has Differential Tuition. Course Fee: IUB1 \$10; L001 \$30.

NDRB 3453. Neuroscience and Our Future. (3-0) 3 Credit Hours.

Prerequisite: NDRB 2113. A discussion of the implications of recent Neuroscience discoveries. Students will use available literature and their own powers of reason to separate fact from fantasy and determine what future applications of Neuroscience may be possible. (Formerly BIO 3453. Credit cannot be earned for both NDRB 3453 and BIO 3453.) Generally offered: Spring. This course has Differential Tuition. Course Fee: IUB1 \$10.

NDRB 3463. Brain Diseases. (3-0) 3 Credit Hours.

Prerequisite: NDRB 2113. A study of selected major brain diseases and neurological disorders, their underlying causes and treatments, and an emphasis on molecular mechanisms. Generally offered: Fall. This course has Differential Tuition. Course Fee: IUB1 \$10.

NDRB 3563. Space and Time in the Brain. (3-0) 3 Credit Hours.

Prerequisite: NDRB 2113 or equivalent. The course centers on brain regions and circuits involved in spatial navigation and memory, focusing on the various types of spatial cells found in the hippocampus and related areas. The topic is at the intersection of neurophysiology and cognitive science, encompassing experimental observations, possible neuronal mechanisms, neuroscience concepts, and open questions. Classes will alternate between traditional lectures and guided discussions of research articles. Generally offered: Fall. This course has Differential Tuition. Course Fee: IUB1 \$10.

NDRB 3613. Brain and Behavior. (3-0) 3 Credit Hours.

Prerequisite: NDRB 2113. This course explores the brain basis of behavior with a focus on understanding the neurophysiological, neurochemical, and neuroanatomical underpinnings for a variety of simple and complex behaviors. Students will have the opportunity to explore topics such as sensation and perception, pain, movement, sleep, biological rhythms, emotion, addiction, learning and memory, and neurodevelopment. The topics are grounded with examples of typical human behavior and disorders such as Parkinson's disease, Autism, Schizophrenia, and psychopathology. (Formerly NDRB 4813 and BIO 4813. Same as PSY 4183. Credit can only be earned for one of the following: NDRB 3613, NDRB 4813, BIO 4813, or PSY 4183.) Generally offered: Fall. This course has Differential Tuition. Course Fee: IUB1 \$10.

NDRB 3623. Neuropsychopharmacology. (3-0) 3 Credit Hours.

Prerequisite: NDRB 3433. A study of the pharmacology of drugs that affect the function of the central nervous system. Topics include drug-receptor interactions, drugs of abuse, and drugs used to treat mental illness. (Formerly BIO 3623. Credit cannot be earned for both NDRB 3623 and BIO 3623.) Generally offered: Fall. This course has Differential Tuition. Course Fee: IUB1 \$10.

NDRB 3663. Human Embryology. (3-0) 3 Credit Hours.

Prerequisite: BIO 2313. Development of the human embryo from fertilization to the birth of the fetus. The origin of various tissues and organs will be followed during development. Environmental and genetic factors that can alter development will be discussed. (Formerly BIO 3663. Credit cannot be earned for both NDRB 3663 and BIO 3663.) Generally offered: Fall. This course has Differential Tuition. Course Fee: IUB1 \$10.

NDRB 3813. Cell Biology. (3-0) 3 Credit Hours.

Prerequisite: BIO 2313; prior completion of BCH 2903, BCH 3303, or BCH 3313 is recommended. A study of cellular molecules and metabolic processes, synthesis and regulation of macromolecules, differential gene expression, membranes and organelles, cytoskeleton, cell cycle, and growth of normal and neoplastic cells. (Formerly BIO 3813. Credit cannot be earned for both NDRB 3813 and BIO 3813 or BME 3114.) Generally offered: Fall, Spring, Summer. This course has Differential Tuition. Course Fee: IUB1 \$10; DL01 \$75.

NDRB 3913. Molecular Biology. (3-0) 3 Credit Hours.

Prerequisite: BIO 2313; prior completion of BCH 2903, BCH 3303, or BCH 3313 is recommended. A study of nucleotides, DNA, replication, recombination, RNA, transcription, genetic code, translation, genomes, and chromosomes. (Formerly BIO 3913. Credit cannot be earned for both NDRB 3913 and BIO 3913.) Generally offered: Fall, Spring. This course has Differential Tuition. Course Fee: IUB1 \$10.

NDRB 3993. Principles of Cancer Biology. (3-0) 3 Credit Hours.

Prerequisite: BIO 1203. A broad introduction to mechanisms that produce oncogenes and tumor suppressor genes. Methodologies of cancer assessment and prevention will be reviewed. (Formerly BIO 3933. Credit cannot be earned for both NDRB 3993 and BIO 3933.) Generally offered: Fall, Spring. This course has Differential Tuition. Course Fee: IUB1 \$10.

NDRB 4132. Developmental Biology Laboratory. (0-6) 2 Credit Hours.

Prerequisite: Completion of or concurrent enrollment in NDRB 4143. Students will have the opportunity to explore the intricate processes of embryonic development in a hands-on, hypothesis-based laboratory setting. A variety of experimental techniques will be employed to investigate different aspects of developmental biology, including live imaging of embryonic development and genetic analysis of developmental pathways using model organisms. Through these laboratory exercises, students will have the opportunity to gain practical skills in experimental design, data analysis, and scientific communication. Generally offered: Fall. This course has Differential Tuition. Course Fee: IUB1 \$10; L001 \$30.

NDRB 4143. Developmental Biology. (3-0) 3 Credit Hours.

Prerequisite: BIO 2313; prior completion of NDRB 3813 is recommended. How does a newly fertilized egg cell develop all the organs to make an adult? How are these principles applied during tissue regeneration? This course will cover the foundational concepts and emerging technologies in the study of developmental biology. Subjects include cell differentiation, pattern formation, morphogenesis, organogenesis, and post-embryonic tissue homeostasis. (Formerly BIO 4143. Credit cannot be earned for both NDRB 4143 and BIO 4143.) Generally offered: Fall. This course has Differential Tuition. Course Fee: IUB1 \$10.

NDRB 4153. Frontiers in Human Pluripotent Stem Cells. (3-0) 3 Credit Hours.

Prerequisite: BIO 2313; prior completion of NDRB 3813 is recommended. The course covers interrelated topics such as pluripotency, cell fate specification, differentiation, patterning, organogenesis, morphogenesis, regeneration, and tissue engineering with an emphasis on human pluripotent stem cells and translational applications/emerging technologies related to regenerative medicine such as CRISPR/Cas9 gene editing and 3D organoids. Generally offered: Spring. This course has Differential Tuition. Course Fee: IUB1 \$10.

NDRB 4163. Epigenetics. (3-0) 3 Credit Hours.

Prerequisite: NDRB 3913; prior completion of BCH 2903, BCH 3303, or BCH 3313 is recommended. An exploration of heritable changes in gene expression that occur without alteration to the underlying DNA sequence. This course will introduce fundamental concepts of gene regulation by DNA methylation, histone modifications, chromatin remodeling, and non-coding RNA regulation. Specific topics will include the role of epigenetic regulation in development, chromosome inactivation, and chromatin dysfunction in cancer. Classical and emerging technologies used in chromatin biology and epigenetics will be covered. Generally offered: Spring. This course has Differential Tuition. Course Fee: IUB1 \$10.

NDRB 4173. Genomics and Bioinformatics. (3-0) 3 Credit Hours.

Prerequisite: NDRB 3913 and STA 1403. An introduction to the use of computational tools to analyze and interpret biological data from eukaryotic organisms, including genomic, transcriptomic, proteomic, and metabolomic data. Students will have the opportunity to learn how to use publicly available bioinformatics databases, including Sequence Read Archive, Gene Expression Omnibus, gnomAD, and Encode data, and tools to analyze and interpret these data types, including UCSC genome and table browser. Topics may include protein and nucleic acids sequence alignment, gene prediction, functional annotation, comparative genomics, genome organization, and gene expression analysis, as well as emerging technologies used in chromatin biology and epigenetics. Generally offered: Spring. This course has Differential Tuition. Course Fee: IUB1 \$10.

NDRB 4483. Developmental Neuroscience. (3-0) 3 Credit Hours.

Prerequisite: NDRB 3813 and NDRB 3433, or consent of instructor. A comparative developmental approach will be used to understand patterning mechanisms that control formation of the nervous system along the major axes of the body. Other topics include epigenetic mechanisms regulating neuronal plasticity and disease. Generally offered: Fall. This course has Differential Tuition. Course Fee: IUB1 \$10.

NDRB 4583. Emergent Properties of Neural Circuits. (3-0) 3 Credit Hours.

Prerequisite: NDRB 3433. An exploration of how interesting and useful functions arise in networks of neurons based on fundamental principles of cellular neurophysiology, neuroanatomy, and neurochemistry. (Formerly BIO 4583. Credit cannot be earned for both NDRB 4583 and BIO 4583.) Generally offered: Spring. This course has Differential Tuition. Course Fee: IUB1 \$10.

NDRB 4683. Neural Data Science. (3-0) 3 Credit Hours.

Prerequisite: STA 1403, CS 1063, and NDRB 3433, or equivalents, or consent of instructor. Analysis and interpretation of neurophysiological data, such as spike trains and EEG traces recorded from behaving animals or human subjects. While gaining hands-on computer-programming experience, this course will examine how neuroscientists use data analysis to investigate open questions. Lastly, more advanced "data science" techniques will tackle the complex data sets that arise from innovative brain-machine interfaces. Generally offered: Spring. This course has Differential Tuition. Course Fee: IUB1 \$10.

NDRB 4783. Computational Neuroscience. (3-0) 3 Credit Hours.

Prerequisite: MAT 1193 and CS 1063 (or equivalents), and NDRB 2113, or consent of the instructor. An introduction to brain modeling and computational approaches to brain function. Topics include neural coding and the computational properties of neurons and neuronal networks. Generally offered: Fall. This course has Differential Tuition. Course Fee: IUB1 \$10.

NDRB 4823. Cognitive Neuroscience. (3-0) 3 Credit Hours.

Prerequisite: NDRB 2113 or PSY 4183, or consent of instructor. This course explores the neurobiological basis of cognition and introduces students to the use of cognitive neuroscience techniques to study the brain basis of complex behavior and cognitive disorders. Topics will focus on human cognition and may include perception, attention, learning, memory, emotion, language, executive function, development and aging. Students will read primary research articles and develop hypothetical experiments within these topic areas. (Formerly BIO 4823. Credit can only be earned for one of the following: NDRB 4823, BIO 4823, or PSY 4343.) Generally offered: Spring. This course has Differential Tuition. Course Fee: IUB1 \$10.

NDRB 4911. Independent Study. (0-0) 1 Credit Hour.

Independent reading, research, discussion, and/or writing under the direction of a faculty member. May be repeated for credit, but no more than 6 semester credit hours will apply to a bachelor's degree, regardless of discipline. Only 6 semester credit hours of NDRB 4911-3, NDRB 4923, and NDRB 4993, in any combination, can be taken as NDRB electives. Additional research hours of these courses (excluding Independent Study) may be taken as free electives, for a maximum of 12 research hours being applied to the bachelor's degree. Generally offered: Fall, Spring, Summer. This course has Differential Tuition.

NDRB 4912. Independent Study. (0-0) 2 Credit Hours.

Independent reading, research, discussion, and/or writing under the direction of a faculty member. May be repeated for credit, but no more than 6 semester credit hours will apply to a bachelor's degree, regardless of discipline. Only 6 semester credit hours of NDRB 4911-3, NDRB 4923, and NDRB 4993, in any combination, can be taken as NDRB electives. Additional research hours of these courses (excluding Independent Study) may be taken as free electives, for a maximum of 12 research hours being applied to the bachelor's degree. Generally offered: Fall, Spring, Summer. This course has Differential Tuition.

NDRB 4913. Independent Study. (0-0) 3 Credit Hours.

Independent reading, research, discussion, and/or writing under the direction of a faculty member. May be repeated for credit, but no more than 6 semester credit hours will apply to a bachelor's degree, regardless of discipline. Only 6 semester credit hours of NDRB 4911-3, NDRB 4923, and NDRB 4993, in any combination, can be taken as NDRB electives. Additional research hours of these courses (excluding Independent Study) may be taken as free electives, for a maximum of 12 research hours being applied to the bachelor's degree. Generally offered: Fall, Spring, Summer. This course has Differential Tuition.

NDRB 4923. Laboratory Research. (0-0) 3 Credit Hours.

Supervised laboratory research mentored by a faculty member engaged in active research within the student's designated area of concentration. May be repeated for credit, but no more than 6 semester credit hours will apply to a bachelor's degree. Only 6 semester credit hours of NDRB 4911-3, NDRB 4923, and NDRB 4993, in any combination, can be taken as NDRB electives. Additional research hours of these courses (excluding Independent Study) may be taken as free electives, for a maximum of 12 research hours being applied to the bachelor's degree. Generally offered: Fall, Spring, Summer. This course has Differential Tuition. Course Fee: IUB1 \$10.

NDRB 4951. Special Studies. (1-0) 1 Credit Hour.

An organized course offering the opportunity for specialized study not normally or not often available as part of the regular course offerings. Special Studies may be repeated for credit when the topics vary, but no more than 6 semester credit hours will apply to a bachelor's degree, regardless of discipline. No more than 6 semester credit hours of NDRB 2953, NDRB 4951, or NDRB 4953 can be applied to a B.S. degree in Neuroscience. Generally offered: Fall, Spring, Summer. This course has Differential Tuition.

NDRB 4953. Special Studies. (3-0) 3 Credit Hours.

An organized course offering the opportunity for specialized study not normally or not often available as part of the regular course offerings. Special Studies may be repeated for credit when the topics vary, but no more than 6 semester credit hours will apply to a bachelor's degree, regardless of discipline. No more than 6 semester credit hours of NDRB 2953, NDRB 4951, or NDRB 4953 can be applied to a B.S. degree in Neuroscience. Generally offered: Fall, Spring, Summer. This course has Differential Tuition. Course fee: IUB1 \$10.

NDRB 4993. Directed Research. (0-0) 3 Credit Hours.

Prerequisite: Approval from the instructor, the Department Chair, and the Associate Dean of Undergraduate Studies in the College for which this course is offered; form available on the College of Sciences website. Supervised research mentored by a faculty member engaged in active research within the student's designated area of concentration. Students may produce a thesis in addition to active research. This course can also be used for students pursuing the COS Undergraduate Thesis Option. Additional research hours of these courses (excluding Independent Study) may be taken as free electives for a maximum of 12 research hours being applied to the bachelor's degree. Generally offered: Fall, Spring. This course has Differential Tuition.