Undergraduate Program in Brain & Cognitive Sciences
BCS undergraduate Ian Zaun demonstrates ASL Eyetracking glasses. The glasses locate and track the retina and project its gaze points into camera footage by shooting infrared waves onto the glass monocle that reflects onto the eye. The eye then bounces these waves back to the eye tracker. By accounting for the differences between the initial infrared waves sent out and the infrared waves that bounced back, the tracker is able to show on scene camera video where the retina was focused, indicating where the subject was looking.

“Majoring in brain and cognitive sciences is so much more than just neuroscience and psychology. You can work with mice, you can work with computers, you can code – you’re really taking multiple disciplines and forging your own path. And after you’re done, you can take the skills you’ve learned here and work anywhere in the world, doing anything.”

- BCS undergraduate Ian Zaun
Tiered curriculum system

Our intensive undergraduate program is a tiered system that builds on the expertise gained at each preceding level. It begins with a first year introduction to neuroscience, cognitive science and computation, with a particular emphasis on courses that hone critical skills in programming and statistics. Students can focus on individual areas of interest as they progress through the program.
# TIER ONE: Foundation Courses
Required for all Majors

<table>
<thead>
<tr>
<th>Term</th>
<th>Course</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fall &amp; Spring</td>
<td>6.0001/6.0002 Introduction to Computer Science and Programming</td>
</tr>
<tr>
<td>Fall</td>
<td>9.01 Introduction to Neuroscience</td>
</tr>
<tr>
<td>Fall</td>
<td>9.07 Statistics for Brain and Cognitive Sciences</td>
</tr>
<tr>
<td>Spring</td>
<td>9.00 Introduction to Psychological Science</td>
</tr>
<tr>
<td>Spring</td>
<td>9.40 Introduction to Neural Computation</td>
</tr>
</tbody>
</table>

### 6.0001/6.0002 Introduction to Computer Science and Programming
Introduction to computer science and programming for students with little or no programming experience. Students learn how to program and how to use computational techniques to solve problems. Topics include software design, algorithms, data analysis, and simulation techniques. Assignments are done using the Python programming language. 12; REST

### 9.00 Introduction to Psychological Science
A survey of the scientific study of human nature, including how the mind works, and how the brain supports the mind. Topics include the mental and neural bases of perception, emotion, learning, memory, cognition, child development, personality, psychopathology, and social interaction. Consideration of how such knowledge relates to debates about nature and nurture, free will, consciousness, human differences, self, and society. 12; HASS-S
9.01 Introduction to Neuroscience
Introduction to the mammalian nervous system, with emphasis on the structure and function of the human brain. Topics include the function of nerve cells, sensory systems, control of movement, learning and memory, and diseases of the brain. 12; REST

9.40 Introduction to Neural Computation
Introduces quantitative approaches to understanding brain and cognitive functions. Topics include mathematical description of neurons, the response of neurons to sensory stimuli, simple neuronal networks, statistical inference and decision making. Also covers foundational quantitative tools of data analysis in neuroscience: correlation, convolution, spectral analysis, principal components analysis. Mathematical concepts include simple differential equations and linear algebra. 12: Prerequisite: Physics II (GIR), 6.0002, 9.01; or permission of instructor

9.07 Statistics for Brain and Cognitive Sciences
Provides students with the basic tools for analyzing experimental data, properly interpreting statistical reports in the literature, and reasoning under uncertain situations. Topics organized around three key theories: probability, statistical, and the linear model. Probability theory covers axioms of probability, discrete and continuous probability models, law of large numbers, and the Central Limit Theorem. Statistical theory covers estimation, likelihood theory, Bayesian methods, bootstrap and other Monte Carlo methods, as well as hypothesis testing, confidence intervals, elementary design of experiments principles and goodness-of-fit. The linear model theory covers the simple regression model and the analysis of variance. Places equal emphasis on theory, data analyses, and simulation studies. 12; Prerequisite: 6.0002
Choose Your Own Adventure:

- **Interested in a Cellular/Molecular Neuroscience concentration** go to page 7
  
  Example careers of our alumni who went into Cell/Molecular Neuroscience:
  
  - Pharmaceutical Scientist
  - Senior Research Scientist
  - Project Manager
  - Graduate school or Medical School

- **Interested in a Systems Neuroscience concentration** go to page 8
  
  Example careers of our alumni who went into Systems Neuroscience:
  
  - Data Scientist
  - Research Technician
  - Senior Business Analyst
  - Graduate school or Medical School

- **Interested in a Cognitive Science concentration** go to page 9
  
  Example careers of our alumni who went into Cell/Molecular Neuroscience:
  
  - Pharmaceutical Scientist
  - Senior Research Scientist
  - Project Manager
  - Graduate school or Medical School

- **Interested in a Computation concentration** go to page 10
  
  Example careers of our alumni who went into Computational Neuroscience:
  
  - Computational Neuroscientist
  - Software Developer
  - Computational Modeling and Machine Intelligence Scientist
  - Data Analytics Specialist
  - Graduate school
Brain and Cognitive Sciences – Class Recommendations

**Cellular/Molecular Neuroscience**
9.URG Undergraduate Research

**Tier 2**
9.09J Cellular and Molecular Neurobiology
9.16 Cellular and Synaptic Neurophysiology
9.18J Developmental Neurobiology

**Laboratory**
9.12 Experimental Molecular Neurobiology

**Tier 3**
9.24 Disorders and Diseases of the Nervous System
9.26J Principles and Applications of Genetic Engineering for Biotechnology and Neuroscience
9.28 Current Topics in Developmental Neurobiology
9.32 Genes, Circuits and Behavior

**Restricted Electives**
7.03 Genetics
7.05 General Biochemistry

**Engineering/Chemistry/Biology**

5.07J Biological Chemistry I
5.08J Biological Chemistry II
6.802 Foundations of Computational and Systems Biology
7.06 Cell Biology
7.15 Experimental Molecular Genetics
7.22 Developmental Biology
7.28 Molecular Biology
7.32 Systems Biology

An image of neurons in a mouse hippocampus taken with expansion microscopy. Ed Boyden, Fei Chen, Paul Tillberg, Synthetic Neurobiology laboratory
Brain and Cognitive Sciences – Class Recommendations

**Systems Neuroscience**
9.URG Undergraduate Research

**Tier 2**
9.15 Neural Circuits, Neuromodulation and Neuropharmacology
9.16 Cellular and Synaptic Neurophysiology
9.31 Neurobiology of Learning and Memory

**Laboratory**
9.17 Systems Neuroscience Laboratory

**Tier 3**
9.26J Principles and Applications of Genetic Engineering for Biotechnology and Neuroscience

**Restricted Electives**
18.03 or 18.034 Differential Equations
18.06 Linear Algebra
18.404J Theory of Computation
18.510 Introduction to Mathematical Logic and Set Theory

**Engineering/Physics/Chemistry**

**Restricted Electives**
2.003J Dynamics and Control I
5.07J Biological Chemistry I
5.12 Organic Chemistry I
6.01 Introduction to EECS 1
6.002 Circuits and Electronics
6.003 Signals and Systems
6.034 Artificial Intelligence
6.045J Automata, Computability, and Complexity
7.03 Genetics
7.05 General Biochemistry
20.309J Instrumentation and Measurement for Biological Systems

White matter fiber tracts in the adult human brain, visualized using a diffusion-weighted MR imaging scan. Zeynep Saygin, Gabrieli and Kanwisher laboratories
Brain and Cognitive Sciences – Class Recommendations

**Cognitive Science**
9.URG Undergraduate Research

**A student interested in language:**

**Tier 2**
- 9.66J Computational Cognitive Science
- 9.19 Computational Psycholinguistics
- 9.85 Infant and Early Childhood Cognition

**Laboratory**
- 9.59J Laboratory in Psycholinguistics

**Restricted Electives**
- 6.003 Signals and Systems
- 18.510 Introduction to Mathematical Logic and Set Theory
- 24.902 Language and Its Structure II: Syntax
- 24.903 Language and Its Structure III: Semantics and Pragmatics

**A student interested in cognitive neuroscience:**

**Tier 2**
- 9.13 The Human Brain
- 9.31 Neurobiology of Learning and Memory
- 9.35 Perceptual Systems
- 9.66J Computational Cognitive Science
- 9.85 Infant and Early Childhood Cognition

**Laboratory**
- 9.59J Laboratory in Psycholinguistics

**Tier 3**
- 9.46 Neuroscience of Morality

**A student interested in cognitive development:**

**Tier 2**
- 9.66J Computational Cognitive Science
- 9.85 Infant and Early Childhood Cognition

**Laboratory**
- 9.59J Laboratory in Psycholinguistics

**Restricted Electives**
- 6.003 Signals and Systems
- 6.034 Artificial Intelligence
- 6.801 Machine Vision
- 20.309J Instrumentation and Measurement for Biological Systems
Brain and Cognitive Sciences – Class Recommendations

**Computation**
9.URG Undergraduate Research

**Neuroscience**

**Tier 2**
- 9.16 Cellular and Synaptic Neurophysiology
- 9.53 Emergent Computations Within Distributed Neural Networks
- 9.66J Computational Cognitive Science
- 9.19 Computational Psycholinguistics
- 9.21 Cellular Neurophysiology and Computing

**Laboratory**
- 9.17 Systems Neuroscience Laboratory

**Restricted Electives**
- 6.002 Circuits and Electronics
- 6.003 Signals and Systems
- 18.03 or 18.034 Differential Equations
- 18.06 Linear Algebra
- 18.404J Theory of Computation
- 18.510 Introduction to Mathematical Logic and Set Theory
- 20.309J Instrumentation and Measurement for Biological Systems

Students in the Poggio laboratory
Image: Justin Knight
**REFERENCE: Course 9 Subjects Offered**

**AY 2018 - 2019**

(Updated 8/2018)

**Tier 1 Subjects (all five subjects required):**
Transfer credit will *not* be given for 9.00, 9.01, or 9.40

<table>
<thead>
<tr>
<th>Term</th>
<th>Course #</th>
<th>Title</th>
<th>Prerequisites</th>
</tr>
</thead>
<tbody>
<tr>
<td>FA &amp; SP</td>
<td>6.0001/6.0002</td>
<td>Introduction to Computer Sciences &amp; Programming</td>
<td>12; REST</td>
</tr>
<tr>
<td>SP</td>
<td>9.00</td>
<td>Introduction to Psychological Science</td>
<td>12; HASS-S</td>
</tr>
<tr>
<td>FA</td>
<td>9.01</td>
<td>Introduction to Neuroscience</td>
<td>12; REST</td>
</tr>
<tr>
<td>SP</td>
<td>9.40</td>
<td>Introduction to Neural Computation</td>
<td>12; Physics II (GIR,) 6.0002, 9.01; or permission of instructor</td>
</tr>
<tr>
<td>FA</td>
<td>9.07</td>
<td>Statistics for Brain and Cognitive Sciences</td>
<td>12; 6.0002</td>
</tr>
</tbody>
</table>

**Tier 2 Subjects: three subjects required; up to seven may be taken**

<table>
<thead>
<tr>
<th>Term</th>
<th>Course #</th>
<th>Title</th>
<th>Prerequisites</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP</td>
<td>9.09J</td>
<td>Cellular and Molecular Neurobiology</td>
<td>12; 7.05 or 9.01</td>
</tr>
<tr>
<td>SP</td>
<td>9.13</td>
<td>The Human Brain</td>
<td>12; 9.00 or 9.01, or permission of instructor</td>
</tr>
<tr>
<td>FA</td>
<td>9.15</td>
<td>Neural Circuits, Neuromodulatory, and Neuroendocrine Systems</td>
<td>12; CI-M; 7.29 or 9.01, or permission of instructor</td>
</tr>
<tr>
<td>FA</td>
<td>9.16</td>
<td>Cellular and Synaptic Neurophysiology</td>
<td>12; 9.40</td>
</tr>
<tr>
<td>SP</td>
<td>9.18J</td>
<td>Developmental Neurobiology</td>
<td>12; 9.01, 7.03, 7.05, or permission of instructor</td>
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<tr>
<td>SP</td>
<td>9.19</td>
<td>Computational Psycholinguistics</td>
<td>12; 6.00; 6.041B, 9.40, or 24.900; or permission of instructor</td>
</tr>
<tr>
<td>FA</td>
<td>9.21</td>
<td>Cellular Neurophysiology and Computing</td>
<td>12; Physics II (GIR); 18.03; 2.005, 6.002, 6.003, 6.071, 10.301, 20.110, or permission of instructor</td>
</tr>
<tr>
<td>SP</td>
<td>9.35</td>
<td>Perceptual Systems</td>
<td>12; 9.00, 9.01; or permission of instructor</td>
</tr>
<tr>
<td>SP</td>
<td>9.53</td>
<td>Emergent Computations Within Distributed Neural Circuits</td>
<td>12; 6.008, 6.036, 6.041B, 9.40, 18.05, or permission of instructor</td>
</tr>
<tr>
<td>FA</td>
<td>9.66J</td>
<td>Computational Cognitive Science</td>
<td>12; 6.08, 6.036, 6.041B, 9.40, 18.05, or permission of instructor</td>
</tr>
<tr>
<td>FA</td>
<td>9.85</td>
<td>Infant and Early Childhood Cognition</td>
<td>12; HASS-S, CI-M; 9.00</td>
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</table>
## Laboratory: one subject required

<table>
<thead>
<tr>
<th>Term</th>
<th>Course #</th>
<th>Title</th>
<th>Prerequisites</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP</td>
<td>9.12</td>
<td>Experimental Molecular Neurobiology</td>
<td>12; LAB, CI-M; 9.01, Biology (GIR)</td>
</tr>
<tr>
<td>FA</td>
<td>9.17</td>
<td>Systems Neuroscience Laboratory</td>
<td>12; LAB, CI-M; 9.40; Coreq 9.07</td>
</tr>
<tr>
<td>SP</td>
<td>9.59J</td>
<td>Laboratory in Psycholinguistics</td>
<td>12; LAB, CI-M; 9.00 or 24.900</td>
</tr>
<tr>
<td>SP</td>
<td>9.60</td>
<td>Machine Motivated Human Vision</td>
<td>12; LAB, CI-M; 9.00, 9.07</td>
</tr>
</tbody>
</table>

## Research: one subject required: Laboratory cannot be double counted

<table>
<thead>
<tr>
<th>Term</th>
<th>Course #</th>
<th>Title</th>
<th>Prerequisites</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP</td>
<td>9.12</td>
<td>Experimental Molecular Neurobiology</td>
<td>12; LAB, CI-M; 9.01, Biology (GIR)</td>
</tr>
<tr>
<td>FA</td>
<td>9.17</td>
<td>Systems Neuroscience Laboratory</td>
<td>12; LAB, CI-M; 9.01 or permission of instructor</td>
</tr>
<tr>
<td>FA</td>
<td>9.41</td>
<td>Research and Communication in Neuroscience</td>
<td>18; CI-M; 9.URG, permission of instructor</td>
</tr>
<tr>
<td>FA &amp; SP</td>
<td>9.50</td>
<td>Research in Brain &amp; Cognitive Sciences</td>
<td>12; 9.00, permission of instructor</td>
</tr>
<tr>
<td>SP</td>
<td>9.59J</td>
<td>Laboratory in Psycholinguistics</td>
<td>12; LAB, CI-M; 9.00 or 24.900</td>
</tr>
<tr>
<td>SP</td>
<td>9.60</td>
<td>Machine Motivated Human Vision</td>
<td>12; LAB, CI-M; 9.00, 9.07</td>
</tr>
<tr>
<td>FA &amp; SP</td>
<td>9.URG</td>
<td>Undergraduate Research</td>
<td>None</td>
</tr>
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</table>

## Tier 3: Up to four subjects

<table>
<thead>
<tr>
<th>Term</th>
<th>Course #</th>
<th>Title</th>
<th>Prerequisites</th>
</tr>
</thead>
<tbody>
<tr>
<td>SP</td>
<td>9.24</td>
<td>Disorders and Diseases of the Nervous System</td>
<td>12; 9.00, 9.01, 9.09</td>
</tr>
<tr>
<td>SP</td>
<td>9.26J</td>
<td>Principles &amp; Applications of Genetic Engineering for Biotechnology and Neuroscience</td>
<td>12; 7.28, 7.32, or 20.020; 9.01 or 9.09</td>
</tr>
<tr>
<td>SP</td>
<td>9.32</td>
<td>Genes, Circuits and Behavior</td>
<td>12; 9.09J, 9.16, 9.18J; or permission of instructor</td>
</tr>
<tr>
<td>SP</td>
<td>9.42</td>
<td>The Brain and It’s Interface with the Body</td>
<td>7.28, 9.01, 9.09, or permission of instructor 12; CI-M;</td>
</tr>
<tr>
<td>FA</td>
<td>9.46</td>
<td>Neuroscience of Morality</td>
<td>None. <em>Coreq</em> 9.18</td>
</tr>
</tbody>
</table>
## Restricted Electives: Up to four subjects

<table>
<thead>
<tr>
<th>Course #</th>
<th>Title</th>
<th>Course #</th>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.003J</td>
<td>Dynamics and Control</td>
<td>18.03</td>
<td>Differential Equations</td>
</tr>
<tr>
<td>2.184</td>
<td>Biomechanics and Neural Control of Movement</td>
<td>18.034</td>
<td>Differential Equations</td>
</tr>
<tr>
<td>5.07J</td>
<td>Biological Chemistry 1</td>
<td>18.06</td>
<td>Linear Algebra</td>
</tr>
<tr>
<td>(or 7.05 – NOT both)</td>
<td></td>
<td>18.404J</td>
<td>Theory of Computation</td>
</tr>
<tr>
<td>5.12</td>
<td>Organic Chemistry 1</td>
<td>18.515</td>
<td>Mathematical Logic</td>
</tr>
<tr>
<td>5.13</td>
<td>Organic Chemistry II</td>
<td>20.309</td>
<td>Instrumentation and Measurement for Biological Systems</td>
</tr>
<tr>
<td>6.003</td>
<td>Signals and Systems</td>
<td>24.211</td>
<td>Theory of Knowledge</td>
</tr>
<tr>
<td>6.034</td>
<td>Artificial Intelligence</td>
<td>24.900</td>
<td>Introduction to Linguistics</td>
</tr>
<tr>
<td>6.045J</td>
<td>Automata, Computability, &amp; Complexity</td>
<td>24.901</td>
<td>Language and It’s Structure I: Phonology</td>
</tr>
<tr>
<td>6.046</td>
<td>Design and Analysis of Algorithms</td>
<td>24.902</td>
<td>Language and It’s Structure II: Syntax</td>
</tr>
<tr>
<td>7.03</td>
<td>Genetics</td>
<td>24.904</td>
<td>Language Acquisition</td>
</tr>
<tr>
<td>7.05</td>
<td>General Biochemistry (or 5.07 – NOT both)</td>
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<tr>
<td>9.S52</td>
<td>Vision in Art and Neuroscience</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The following graduate subjects in Course 9 have been approved by the Education Committee and may substitute for a Restricted Elective, with the approved pre-requisite. Please note: undergraduate and graduate versions of the same subject cannot both be taken, or counted twice.

<table>
<thead>
<tr>
<th>Term</th>
<th>Course #</th>
<th>Title</th>
<th>Prerequisites</th>
</tr>
</thead>
<tbody>
<tr>
<td>FA</td>
<td>9.016J</td>
<td>Acoustics, Production and Perception of Speech</td>
<td>12; 8.03, 6.003; or permission of instructor</td>
</tr>
<tr>
<td>SP</td>
<td>9.073J</td>
<td>Statistics for Neuroscience Research</td>
<td>12; permission of instructor</td>
</tr>
<tr>
<td>FA</td>
<td>9123J</td>
<td>Neurotechnology in Action</td>
<td>12; permission of instructor</td>
</tr>
<tr>
<td>SP</td>
<td>9.175J</td>
<td>Robotics</td>
<td>12; 2.151 or permission of instructor</td>
</tr>
<tr>
<td>SP</td>
<td>9.285J</td>
<td>Neural Coding and Perception of Sound</td>
<td>12; 9.35; 9.40</td>
</tr>
<tr>
<td>SP</td>
<td>9.301J</td>
<td>Neural Plasticity in Learning and Memory</td>
<td>12; permission of instructor</td>
</tr>
<tr>
<td>FA</td>
<td>9.422J</td>
<td>Principles of Neuroengineering</td>
<td>12; permission of instructor</td>
</tr>
</tbody>
</table>
Department events for undergraduates

Year round

MIT Colloquium on the Brain and Cognition
The Colloquium on the Brain and Cognition is the flagship seminar series of the BCS community, providing an opportunity for faculty, students, and postdocs to be exposed to a wide variety of speakers and topics. The series runs each Thursday during the academic term from 4-5 pm. All students are welcome to attend.

Spring Semester

BCS Spring Undergraduate Awards Dinner
All department undergraduates are invited to join their fellow students and BCS faculty for an evening of food and celebration. Academic and Research awards will be presented to selected recipients.

MIT Campus Preview Weekend
Students who have been accepted to MIT are invited along with their families to attend various receptions and events coordinated across campus. This spring, the department will host a number of lab tours. Course 9 students interested in CPW with the department are welcome to stop by the BCS HQ academic office for more information on how they can become involved.

As part of the weekend, the department’s student group, the BCS Society, also hosts a fun event each year for both current majors and prospective students.

BCS Commencement Luncheon
Each year, the department hosts a congratulatory luncheon after commencement. Friends and families welcome!

For more information about these and other department sponsored events, please visit our event calendar at bcs.mit.edu/events
MRI testing
Image: Justin Knight