Overview of graduate admissions

- **BCS is a very diverse department; faculty interests cover a broad range of topics:**
  - Mathematical models of cognition / Human brain imaging
  - Neurophysiology in behaving non-human primates
  - Circuit analysis in animal models
  - Cellular/network level analysis of neuronal function
  - Synaptic function, plasticity, development
- Interface with the Biology department through the Molecular and Cellular Neuroscience Graduate Program
- Our graduate program applicants have a similarly broad range of interests

Faculty ‘tracks’ in BCS

- Cognitive
- Computational
- Systems
- Cell/Molecular

Each track has a leader. The tracks are administrative only.

Students can conduct research with any faculty member.

Applicants who fall between the cracks are handled by ‘cross-track’ leaders.

Each track and cross track is given an annual ‘quota’ of invitees based in current department needs and resources.

Systems neuroscience track

- **Diverse range of techniques and model systems**
  - Electrophysiology, optogenetics, two-photon imaging, new fMRI imaging techniques, TMS, high-throughput behavioral analysis, localized brain cooling, intracellular recording in behaving animals, genetic manipulation (viral and transgenic)
- A common theme is technical and quantitative sophistication
The future of systems neuroscience: Reverse engineering the brain

- New experimental techniques for recording and manipulating neural circuits
  - Physics, chemistry, electrical engineering, genetics

- New ways of thinking about brain circuits and computation
  - Physics, mathematics, computer science

- New ways of analyzing large quantities of data
  - Computer science, mathematics

What I look for in applicants

- A strong record of coursework in quantitative methods and physical sciences
  - Math, computer science, electrical engineering, physics, computer programming skills

- Prior laboratory research experience

Academic preparation

- Strong record of coursework in quantitative methods and physical sciences
- Math, computer science, electrical engineering, physics, computer programming skills
- Prior laboratory research experience
**Statement of Objectives**

Please note instructions carefully before you complete this form.

*Type or print using black ink.
*Use neat and of necessary or square form.
*Keep a copy for your file. You may also wish to provide copies to your supervisor before they complete their forms.
*Retain this form with the completed application to the appropriate MIT department (see pages 4–18).

Since before I can remember, I’ve been fascinated with figuring out how things work. I vividly recall the day my family brought home their first personal computer. Unlike most four-year-olds, I wasn’t contented merely to play the numerous educational games available for the machine. Instead, I wanted to figure out what the computer could do and how it could...

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### New quantitative methods course

**Proposed Topics:**

**Weeks 1 – 6: Statistics and Hypothesis Testing**
- **Week 1 & 2:** Introduction/Data Basics
  - Experimental Design
  - Descriptive Statistics (Variance, Std Dev, Unrelated, Independent etc.)
  - Probability Theory
  - Probability Distributions
- **Central Limit Theorem**
- **Confidence Intervals**
- **Week 3:** Signal Detection Theory (ch. 6 in MATLAB for Neuroscientists)
- **Week 4 & 5:** Basics of Hypothesis Testing
  - Parametric Tests
  - Nonparametric Tests
  - Tests for Categorical Data
  - ANOVA
- **Week 6:** Correlation
  - Intro to fitting data, least squares
  - Regression

(Assignment topics can also include Neural Encoding (ch 13) and Neural Decoding (ch 16, 17))

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### ‘Hardening’ the undergraduate curriculum

- Additional requirements for quantitative coursework
  - Differential equations
  - Statistics
- Introduction to computer programming (Matlab)
- More quantitative approach to undergraduate neuroscience undergraduate coursework
  - Quantitative problem sets
  - Integration of Matlab programming for data analysis, etc.

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### New quantitative methods course

**Weeks 7 – 14: Linear algebra and Differential Equations applied to BCS**

- **Week 7:** Linear Systems
  - Linear dependence/independence
  - Inverse/Pseudo-inverse
- **Week 8:** Eigenvalue/Eigenvector
  - SVD
- **Week 9:** PCA (ch 14)
- **Week 10:** 1d and 2d Frequency Analysis (ch 7 and 8)
- **Week 11:** Information Theory (ch 15)
- **Week 12:** Review of differential equations
- **Week 13:** Neuroscience examples using differential equations such as:
  - Models of ion channels (ch 19)
  - Models of single neurons (ch 20)
  - Decision Theory (ch 24)
Introduction to Computational Neuroscience

The systems neuroscience track at MIT now recruits students with a strong quantitative background in math, physical sciences and engineering.

Hardening the undergraduate curriculum: prepare students ready to attack the highly technical next-generation problems in neuroscience.