SUPPLEMENTARY MATERIALS

A. Instructor Course Evaluation Survey

Key: # = Total Responses; 1 = Strongly Disagree; 2 = Disagree; 3 = Neutral; 4 = Agree; 5 = Strongly Agree; N/A = Not Applicable										
Course Structure and Grading										
General Structure	**#**	**1**	**2**	**3**	**4**	**5**	**N/A**	**Median**	**Mean**	**SD**
The course syllabus was comprehensive, clear, and accurate.	19	0	0	0	2	17	0	5	4.89	0.32
The learning goals were clearly stated in the syllabus.	19	0	0	0	2	17	0	5	4.89	0.32
Classes started and ended on time.	18	0	0	1	1	16	0	5	4.83	0.51
Grading	**#**	**1**	**2**	**3**	**4**	**5**	**N/A**	**Median**	**Mean**	**SD**
Content of tests and assignments was consistent with content of lectures and/or reading.	19	0	0	0	2	16	1	5	4.89	0.32
Assignments and/or exams were returned promptly.	19	0	0	0	2	16	1	5	4.89	0.32
The grading policies were clear and consistently followed.	19	0	0	0	3	16	0	5	4.84	0.37
The graded assignments allowed me to demonstrate what I learned in the course.	19	0	0	0	3	15	0	5	4.83	0.38
Content and Workload	**#**	**1**	**2**	**3**	**4**	**5**	**N/A**	**Median**	**Mean**	**SD**
The content covered in this course was challenging.	19	0	0	1	14	4	0	4	4.16	0.5
This course requires a lot of work.	19	0	2	7	6	4	0	4	3.63	0.96
Student Responsibilities										
	#	**1**	**2**	**3**	**4**	**5**	**N/A**	**Median**	**Mean**	**SD**
I completed the course readings.	19	0	0	0	8	11	0	5	4.58	0.51
I kept up with work as it was assigned.	19	0	0	0	8	11	0	5	4.58	0.51
Instructor Responsibilities and Skills										
	#	**1**	**2**	**3**	**4**	**5**	**N/A**	**Median**	**Mean**	**SD**
The instructor was effective as a lecturer and/or class leader.	19	0	0	0	2	17	0	5	4.89	0.32
The instructor's presentations were clear and organized.	19	0	0	0	2	17	0	5	4.89	0.32
The instructor stimulated interest in the subject.	19	0	0	0	2	17	0	5	4.89	0.32

Responsiveness of the Instructor										
	#	1	2	3	4	5	N/A	Median	Mean	SD
The instructor was available and helpful to students outside the class.	19	0	0	0	2	17	0	5	4.89	0.32
The instructor respected students' ideas.	19	0	0	0	2	17	0	5	4.89	0.32
The instructor was concerned about student learning and development.	19	0	0	0	2	17	0	5	4.89	0.32
I received feedback that helped me see ways in which I could improve my learning and understanding.	19	0	0	0	2	17	0	5	4.89	0.32

Overall Instructor Rating			
	Course Average		
	Response Count	Mean	Median
The instructor was effective as a lecturer and/or class leader.	19	4.89	5
The instructor's presentations were clear and organized.	19	4.89	5
The instructor stimulated interest in the subject.	19	4.89	5
The instructor was available and helpful to students outside the class.	19	4.89	5
The instructor respected students' ideas.	19	4.89	5
The instructor was concerned about student learning and development.	19	4.89	5
I received feedback that helped me see ways in which I could improve my learning and understanding.	19	4.89	5
Overall	-	4.89	-

Contribution to Learning										
	#	1	2	3	4	5	N/A	Median	Mean	SD
The stated learning goals for the course were met.	19	0	0	0	2	17	0	5	4.89	0.32
This course improved my writing ability.	19	0	0	2	5	11	1	5	4.5	0.71
This course improved my oral communication skills.	19	0	0	0	4	15	0	5	4.79	0.42
This course improved my quantitative skills.	19	0	0	0	2	9	8	5	4.82	0.4
This course helped me develop my creative abilities.	19	0	0	0	3	4	12	5	4.57	0.53
This course helped me to analyze, interpret and synthesize information.	19	0	0	0	3	16	0	5	4.84	0.37
This course helped me to reason better and to think more critically about its subject matter.	19	0	0	1	3	15	0	5	4.74	0.56
This course helped me to consider alternative perspectives on complex issues.	19	0	0	0	2	12	5	5	4.86	0.36
Overall Quality of the Course	**#**	**1**	**2**	**3**	**4**	**5**	**N/A**	**Median**	**Mean**	**SD**
The overall quality of this course was excellent.	19	0	0	0	0	19	0	5	5	0

Student Demographics							
	#	First Year	Sophomore	Junior	Senior	Master's	Doctoral
Your class standing?	19	0	0	6	13	0	0
	#	SCI	SocSCI	HUM	ART	Undecided	
What is your school of major?	19	19	0	0	0	0	
	#	University req.	Major req.	Minor req.	Interest		
Why did you choose this course?	19	0	16	0	3		

Course and Instructor Comments
Available upon request

B. EXAMPLE COURSE CONTENT (1 WEEK)

Topic of the week: Mechanotransduction

Meeting 1

Lecture outline:

- What is mechanotransduction & why is it important
- Review: ion channel function
- How to hunt force-gated ion channels
    - Techniques for investigating force-gated ion channels
    - Experimental criteria to prove their existence
- The journey of discovery
    - Hair Cells
    - MscS & MscL
    - NOMPC
    - TREK1 & TRAAK
    - PIEZO1 & PIEZO2
- Gating mechanisms

Meeting 2

Discussion selection:

Coste, B., Mathur, J., Schmidt, M., Earley, T. J., Ranade, S., Petrus, M. J., Dubin, A. E., & Patapoutian, A. (2010). Piezo1 and Piezo2 are essential components of distinct mechanically activated cation channels. *Science*, *330*(6000), 55–60.

Example Discussion Assignments:

Name	Assignment		
Student 1	Figure 2, Panel C & D	Student 14	Figure 4, Panel G-L
Student 2	Figure 6	Student 15	Figure 1, Panel E & F
Student 3	Not Selected	Student 16	Not Selected
Student 4	Not Selected	Student 17	Figure 5, Panel G-I
Student 5	Figure 1, Panel A & B	Student 18	Not Selected
Student 6	Not Selected	Student 19	Figure 3
Student 7	Figure 4, Panel A-F	Student 20	Figure 2, Panel A & B
Student 8	Not Selected	Student 21	Not Selected
Student 9	Introduction		
Student 10	Figure 1, Panel C & D		
Student 11	Conclusion		
Student 12	Not Selected		
Student 13	Not Selected		

C. DISCUSSION GUIDE

Title of the Article: _____

Introduction:

- In ± 200 words, answer these questions after reading the introduction:
    - What was the phenomenon of interest? Why is this an important thing to study? What were the knowledge gaps? How did the author aim to fill these gaps?

Results:

- In ± 200 words, answer these questions for a figure and its panel as you go:
    - What is the overarching research question this figure is attempting to test? What are the methods or approaches being utilized? What are the experimental conditions and how do they test the research question? What are the specific units and axis of a panel? Lastly, summarize the conclusion or finding of each panel.
    - Note: Many of these questions can be clarified by looking at the figure legends and what the authors themselves conclude in the results section.

Discussion (Conclusion):

- In ± 200 words, answer these questions after reading the discussion:
    - What are the findings/conclusion from the individual experiments? What is the greater, overarching, finding/result? Did the experiments satisfy any predictions or expectations that the authors presented in the introduction? What are the remaining gaps? Are you convinced? What are potential future experiments you would like to see?
    - Note: Allow yourself to think freely about these ideas and the big picture without getting lost in little details.

D. COURSE SYLLABUS

NBIO 80b. The Neurobiology of Somatosensation: Feeling the World

Contact Details

Raul A. Ramos

Office location: Shapiro Science Center (SSC-1-32), Turrigiano Lab

Email: rramos@brandeis.edu

Emmanuel J. Rivera-Rodríguez

Office location: Shapiro Science Center (SSC-2-06), Griffith Lab

Email: erivera11@brandeis.edu

About Us: Raul is a systems neuroscientist that uses molecular, electrophysiological and behavioral techniques to study the role of homeostatic synaptic plasticity in learning. Emmanuel combines the use of genetics, molecular science and behavior to understand the regulation of sleep. For this course, we hope to bring a broad understanding of modern experimental neuroscience as we explore the somatosensory system. We expect to make this class an exciting experience for everyone involved.

Communications: All communications will occur through the LATTE mailing system. Instructors are available via email as needed. We encourage you to reach out.

Meeting Times

Classes

Tuesdays & Thursdays 12:00pm-1:30pm

Office Hours

Raul: Fridays 11:30am-12:30pm

Emmanuel: Wednesdays 11:00am-12:00pm

Course Description

Our ability to feel the world, to gently hold someone's hand in our own, or quickly withdraw our hand when painfully squeezed is possible because of our somatosensory system. This course will take a deep dive into the different modalities of somatosensation, including touch, itch, and pain. We will explore these topics from the level of genetics,

molecular mechanisms, neural circuits, and behavior. Additionally, we will examine special topics, including force-gated ion channels, thermosensation, multisensory integration, and diseases of the somatosensory system.

Learning Goals:

At the end of this course, students will have developed

- A deeper understanding of the neurobiology of somatosensation
- A deeper understanding of modern experimental neuroscience including genetic, molecular, physiological, and behavioral techniques.
- The ability to critically evaluate primary science research literature
- The ability to synthesize their understanding of scientific research and communicate it in written and oral formats

Teaching/learning strategies/class format

The class will be fully online for the Spring 2021 semester. The composition of course content will be a mix of synchronous lectures & discussions combined with asynchronous supplementary material. **Synchronous Content**: The course will meet twice a week, for 90-minutes. All students are expected to attend these two sessions, unless special permission has been granted for asynchronous participation. Session 1 of every week will be dedicated to a lecture that will introduce the topic of the week in depth. The lectures are designed with two goals in mind: 1) to convey the necessary background information needed to tackle the weekly reading and 2) to give students a broad understanding and context that cannot be gained by reading the selected paper. Session 2 of every week will be dedicated to group discussions that will center around a selected research article. The papers were selected based on their contributions to advancing the field, creativity, and accessibility to students. For each group discussion, there will be a rotating set of responsibilities that include: 1) briefly introducing the research article of the day 2) explaining key figures and 3) summarizing our understanding at the end. These tasks will help ensure that every student has an opportunity to be involved in our discussions and successfully fulfill their participation requirement. **Asynchronous Content:** Every week we will post additional content to be reviewed asynchronously (on your own time). The goal of our asynchronous content is to help students understand the selected readings and to help sharpen key science communication skills. To this end, once a week we will post 1 video (5-10mins) on experimental neuroscience research techniques and 1 video (5-10mins) on professional development skills that are important for Jr scientists. The techniques video will review techniques important for understanding the research article of the week. The professional development video will review the skills needed to navigate our scientific discussions, the midterm paper & the final presentation.

Course Materials: The assigned reading for this class will be scientific research articles, also known as primary literature. These "papers", as they are more commonly referred to as, are available online and will be made accessible to students via LATTE. Supplemental readings will also be available to help prime students for certain topics, but they will not be required.

Prerequisites: NBIO-140 Principles of Neuroscience

Credit Hours:

Success in this four-credit course is based on the expectation that students will spend a minimum of 9 hours of study time per week reading papers and in preparation for discussions.

Course Requirements

Academic Integrity

Every member of the University community is expected to maintain the highest standards of academic integrity. A student shall not submit work that is falsified or is not the result of the student's own effort. Infringement of academic honesty by a student subjects that student to serious penalties, which may include failure on the assignment, failure in the course, suspension from the University or other sanctions (see section 20 of R&R). Please consult Brandeis University Rights and Responsibilities for all policies and procedures related to academic integrity. Students may be required to submit work to TurnItIn.com software to verify originality. A student who is in doubt regarding standards of academic honesty as they apply to a specific course or assignment should consult the faculty member responsible for that course or assignment before submitting the work. Allegations of alleged academic dishonesty will be forwarded to the Department of Student Rights and Community Standards. Citation and research assistance can be found at Brandeis Library Guides - Citing Sources (https://guides.library.brandeis.edu/c.php?g=301723)."

Assignments

Assignments and dates are described under course description. Assignments will be submitted via LATTE. Delay in assignment submission without proper justification may lead to loss of credit.

Participation

Students are expected to attend virtual lectures, unless arranged otherwise in advance and with justification, in which case the student must access the lecture recordings available on LATTE. Additionally, students are required to complete the article readings

and other asynchronous material each week before coming to class in order to be prepared for active discussions.

Evaluation

In-Class Discussion: Students must participate during discussion sessions. Instructors will facilitate and record student participation.

Midterm Paper: Students will work independently to write a news and views style essay on a somatosensory research article of their choice. The asynchronous professional development videos will aim to support students through the writing process. Students will give a short presentation (5 mins) on the paper they chose and why they chose it. Additionally, students will participate in a peer review process.

Final Presentation: Students will work in teams to give a "journal club" style presentation. The asynchronous professional development videos will aim to support students through the process of designing a scientific presentation. Additionally, students will be required to attend a Brandeis SciComm Lab appointment in order to further develop their presentations.

	Points	Percentage
In Class Discussion	40 Points	20%
Midterm Paper	Peer Review – 20 Points Submitted Paper – 60 Points	40%
Final Presentation	SciComm Lab Appointment – 20 Points Final Presentation – 60 Points	40%
Total	200 points	100%

Essential Resources

Accommodations

Brandeis seeks to welcome and include all students. If you are a student who needs accommodations as outlined in an accommodations letter, we want to support you. **In order to provide test accommodations, we need the letter more than 48 hours in advance.** We want to provide your accommodations but cannot do so retroactively. If you have questions about documenting a disability of requesting accommodations, please contact Student Accessibility Support (SAS https://www.brandeis.edu/accessibility/) at 781.736.3470 or access@brandeis.edu."

Apps or Tools/Equipment

All synchronous lectures will be held via Zoom. Asynchronous materials including recorded lectures will be available on LATTE.

LATTE

LATTE is the Brandeis learning management system: http://latte.brandeis.edu. Login using your UNET ID and password.

Library

The Brandeis Library collections and staff offer resources and services to support Brandeis students, faculty and staff. These include workshops, consultations, collaboration, materials and instruction on emerging trends in technologies such as machine learning, emerging trends in research such as data visualization, and emerging trends in scholarship such as open access. Librarians at the Circulation Desk, Research Help Desk, Archives & Special Collections, Sound & Image Media Studios, MakerLab, AutomationLab, and Digital Scholarship Lab are available to help you. https://www.brandeis.edu/library/about/index.html

Privacy

This class requires the use of tools that may disclose your coursework and identity to parties outside the class. To protect your privacy, you may choose to use a pseudonym/alias rather than your name in submitting such work. You must share the pseudonym/ alias with the professors as needed. Alternatively, with prior consultation, you may submit such work directly to me.

Student Support

Brandeis University is committed to supporting all our students so they can thrive. The following resources are available to help with the many academic and non-academic factors that contribute to student success (finances, health, food supply, housing, mental health counseling, academic advising, physical and social activities, etc.). Please explore the many links on this Support at Brandeis page (https://www.brandeis.edu/support/undergraduate-students/browse.html) to find out more about the resources that Brandeis provides to help you and your classmates to achieve success.

Teaching Continuity

All course materials will be available on LATTE for the entirety of the semester. If you predict long-term absences, or other disruptions please communicate with the professors so accommodations can be made.

Course Plan

	Meeting 1	Meeting 2	Asynchronous Material
Week 1: February 2nd & 4th	**Lecture 0**: Introductions A Review of Somatic Nervous System Supplemental Reading: Probing Mammalian Touch Transduction	**Lecture 0.5**: Review of Perception & Principles of Sensory Coding	**Techniques Video**: The Patch-Clamp **Prof. Dev. Video**: The Sections of a Research Article
Week 2: February 9th & 11th	**Lecture 1**: Mechanotransduction: Force-Gated Ion Channels Supplemental Reading: The quest to decipher how the body's cells sense touch	**Discussion 1**: Coste, Bertrand, et al. 2010. "***Piezo1 and Piezo2 Are Essential Components of Distinct Mechanically Activated Cation Channels***." *Science* 330 (6000): 55–60. Discovery of Piezo	**Techniques Video**: Genetic Screens, RNA Seq., & RNA-i **Prof. Dev. Video**: How to Critically Evaluate a Figure

Week 3: February 16th & 18th	**Lecture 2**: Touch Supplemental Reading: The Sensory Neurons of Touch	**Discussion 2**: Maksimovic, Srdjan, et al. 2014. "***Epidermal Merkel Cells Are Mechanosensory Cells That Tune Mammalian Touch Receptors***." *Nature* 509 (7502): 617–21. Merkel Cells (Non-neuronal cell type) are light touch receptors **Featuring: Ellen Lumpkin**	**Techniques Video**: Optogenetics **Prof. Dev. Video**: Scientific Writing
Week 4: February 23rd & 25th **<u>Midterm Begins</u>**	**Lecture 3**: Active Touch Midterm Details Explained Supplemental Reading: <u>Whisking</u>	**Discussion 3**: Jadhav, Shantanu P., Jason Wolfe, and Daniel E. Feldman. 2009. "**Sparse Temporal Coding of Elementary Tactile Features during Active Whisker Sensation**." *Nature Neuroscience* 12 (6): 792–800. Somatosensory cortex encoding of tactile features **Featuring: Shantanu Jadhav**	**Techniques Video**: In-Vivo Electrophysiology **Prof. Dev. Video**: What is a News & Views Article

Week 5: March 2nd & 4th	**Lecture 4**: Itch Supplemental Reading: Eczema, A Lifelong Conflict	**Discussion 4**: Morita, Takeshi, et al. 2015. "**HTR7 Mediates Serotonergic Acute and Chronic Itch.**" *Neuron* 87 (1): 124–38. Molecular Mechanisms of Itch **Featuring: Diana Bautista**	**Techniques Video**: Calcium Imaging **Prof. Dev. Video**: How to Peer Review
Week 6: March 9th & 11th **<u>Last Week of Midterm</u>**	No Lecture. **No University Exercises**	No Lecture. Students will use this time to peer-review	No New Asynchronous Content.
Week 7 March 16 & 18	**Lecture 5**: Pain Mu and Delta Opioid Receptors Diverge Supplemental Reading: <u>A world without pain.</u>	**Discussion 5**: Scherrer, G., et al. 2009. "**Dissociation of the Opioid Receptor Mechanisms that Control Mechanical and Heat Pain."** Cell 137: 1148-1159	**Techniques Video**: Immunohistochemistry

Week 8 March 23 & 25	**Lecture 6**: Thermosensation Supplemental Reading: TRP channels in mechanosensation: direct or indirect activation	**Discussion 6**: Greppi, C., et al. 2020. **"Mosquito heat seeking is driven by an ancestral cooling receptor."** Science 367: 681-684. Mosquito Heat Seeking, Cooling Receptors, IR21a **Featuring: Paul Garrity**	**Techniques Video:** CRISPR
Week 9 March 30, April 1	**Lecture 7**: Proprioception & Multi-Sensory Integration **Featuring: Vivekanand Vimal**	**Discussion 7**: Woo SH, et al., 2015. **"Piezo2 is the principal mechanotransduction channel for proprioception."** Nature Neuroscience 18	
Week 10 April 6 & 8	**Lecture 8**: Diseases and the Somatosensory System	**Discussion 8**: Orefice, L. L. *et al.* 2016. **"Peripheral Mechanosensory Neuron Dysfunction Underlies Tactile and Behavioral Deficits in Mouse Models of ASDs."** *Cell* 166: 299–313	

Week 11 April 13 & 15	**Discussion 9**: Where do we go from here? A round table discussion	**Discussion 10**: Pinho-Ribeiro, F. A. *et al.* 2018. **"Blocking Neuronal Signaling to Immune Cells Treats Streptococcal Invasive Infection."** *Cell* 173, 1083–1097.e22	
Week 12 April 20 & 22 Brandeis Holiday! 20	No Class Brandeis Holiday!	Student Presentations	No New Content
Week 13 April 27 & 29	Student presentations	Student presentations	No New Content
Week 14 May 4th	Student Presentations	-Fin-	No New Content

E. MIDTERM RUBRIC

Section	Complete? (Y/N) - 7pts	Content - 3pts
Title and summary statement		
• Short and creative title.		
• 1-2 summary sentences.		
Introduction		
• Brief paragraph putting in context the general topic of the article being critiqued.		
• Catchy-hook introduction for general audience.		
• Main findings presented explicitly.		
Background		
• 1-2 paragraphs summarizing previous research relevant to the critiqued article.		
Description of Results		
• Question of interest explicitly highlighted.		
• What method was used to address the specific question?		
• Result obtained.		
• Implication or significance of the result.		
Conclusion		
• Strengths, novelty and relevance of the overall findings to the field.		
• Weaknesses, discrepancies with previous findings, remaining gaps.		
• Future directions.		
References		
• 10-15 references.		
• Ordered as mentioned in text.		
• Nature Journal format.		

F. FINAL PRESENTATION CONTENT GUIDE

Section	Tentative "A"	Tentative "B"	Tentative "C"
Background	Clearly communicates the information necessary to understanding the paper, the research question, and the significance of the study. The content helps the audience interpret the results	Communicates some of the information necessary to understanding the paper, but either misses an important point or two, includes information irrelevant to the main points, or fails to establish the significance.	Totally misses the mark. Fails to give context or provide the information necessary for following along. Demonstrates a clear lack of preparation/effort.
Results	Succinctly provides context for individual experiments, explains the result, and synthesizes what the results mean with respect to the big picture.	"A" but with a few mistakes, like: Getting lost in the details or including erroneous information Failing to motivate the logic behind different experiments	Inability to explain the results and what they mean
Conclusion	Summarizes how everything fits together. At this point, the background, results and conclusions of the study are coherent. It is clear how the results advanced our understanding in the context of the background.	The conclusion from the results its clear, but the significance, or how it all fits together is ambiguous.	Conclusions are incorrect
Discussion	This is more freeform. It could be constructive criticism of the research, future directions, or both.	Making invalid points (unlikely).	Lacking discussion.