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Proposed Curriculum Revision for MCB Neurobiology Emphasis

November 12, 2014

The MCB department would like to apply for a change in curriculum for its Neurobiology emphasis. This proposal was adopted unanimously by MCB Neurobiology faculty, and approved by the MCB Undergraduate Advising Committee and the MCB Committee of Chairs and Division Heads (CCDH).

Summary

The Neurobiology emphasis is the most popular undergraduate emphasis within the Molecular & Cell Biology (MCB) major, with 120 majors per year. The current curriculum was established in 1986. It is built around a single core survey of Neuroscience, MCB 160 (Introduction to Neurobiology), followed by a choice of 2 neuroscience-related electives and a lab. Tremendous growth in knowledge in the past 30 years has made it impossible to teach a single-semester survey at a level appropriate for UC Berkeley MCB majors. We propose to replace MCB 160 with a required 2-course Core Neuroscience sequence (160: Cellular & Molecular Neuroscience, and 161: Circuits, Systems & Behavioral Neuroscience), followed by choice of a single elective course and a lab. This parallels the structure of two other MCB emphases (Biochemistry & Molecular Biology Track 1, and Immunology). We will also re-focus one of our popular elective courses, MCB 165, to become a course on Neurobiology of Disease.

Background and Need for Curriculum Revision

Growth in Neuroscience knowledge (facts, concepts, experimental paradigms) makes it no longer feasible to survey the field of Neuroscience in a single semester in MCB 160. This central problem creates a rippling effect in our elective classes: because 160 cannot adequately cover most topics, these are re-taught and extended in higher classes, leading to duplicative coverage. A related problem is that many majors delay 160 until senior year, so elective classes cannot generally require 160 as prerequisite, and must include even more remedial 160 material to bring all students up to basic level. These factors undermine the quality of the Neurobiology curriculum.

Curriculum Proposal

To remedy these problems, we propose to replace the single-semester MCB 160 survey with a required 2-semester sequence (MCB 160 FA + MCB 161 SP), while relaxing MCB 160 prerequisites to allow nearly all majors to take this class in Fall of Junior year. To offset the additional required course, we will only require choice of one elective class, instead of the current two. The choice of labs is unchanged. Two additional course requirements that are common for most MCB emphases are also unchanged (MCB 102: Biochemistry & Molecular Biology, and MCB 104: Genetics, Genomics & Cell Biology).

This reorganization will allow most students to take a comprehensive survey of Neuroscience in the Junior year, and to take the elective and lab class as Seniors.

Summary of course changes (to take effect in 2015-2016)

1. The current MCB 160 will be split into a new **MCB 160**, Cellular & Molecular Neuroscience, and **MCB 161**, Neural Circuits, Systems & Behavior. This will be a required 2-course sequence (160: Fall, 161: Spring). Each is 4 units (MWF lecture + required discussion section). To enable students to take MCB 160 in FA of junior year, the prerequisite of MCB 102 will be removed, and Physics 8B will be a co-requisite (instead of prerequisite). Bio 1A will remain a prerequisite.

2. **MCB 165** will be re-focused from its current topic of Molecular Neuroscience to a course on Neurobiology of Disease. Offered Spring. 3 units. (TTh lecture + required discussion section). Prerequisite: 160.

3. **MCB 167** will be eliminated. 167 is an elective class on Circuits, Systems & Behavioral Neuroscience, and is taken by about half the Neurobiology majors. Its content will be shifted into 161. In reality, the creation of the required 160-161 sequence is simply a rebranding of the (required) 160 – (elective) 167 sequence that many majors already take. Reorganizing material between these courses, and requiring both, allows us to provide a modern, comprehensive survey of neuroscience for all our majors.

The MCB 166 elective (Biophysical Neurobiology) remains unchanged. The laboratory classes MCB 160L and MCB 163 remain unchanged. The requirement for MCB 102 and 104 remains unchanged.

Existing Curriculum – 6 Required Courses

1.	MCB 102	Biochemistry & Molecular Biology
2.	MCB 104	Genetics, Genomics & Cell Biology
3.	MCB 160	Introduction to Neurobiology
4.	MCB 160L or 163	Neurobiology Lab or Mammalian Neuroanatomy Lab (choose one)
5.	Elective B	Chosen from MB 165 (Molecular Neurobiology), MCB 166 (Biophysical Neurobiology), or MCB 167 (Physiological and Genetic Basis of Behavior)
6.	Elective A or B	Chosen from Elective B, or a long list of approved classes in other MCB divisions and other departments.

Schedule of MCB Neurobiology Classes (current, including 2014-2015)

Fall	**Spring**
160 (required survey of Neurobiology)	160
163 (lab)	160L (lab)
166 (elective)	165 (elective)
	167 (elective)

MCB 102 and 104 are offered in both semesters.

Proposed New Curriculum – 6 Required Courses

1.	MCB 102	Biochemistry & Molecular Biology
2.	MCB 104	Genetics, Genomics & Cell Biology
3.	MCB 160	Cellular & Molecular Neuroscience *
4.	MCB 161	Circuits, Systems & Behavioral Neuroscience *
5.	MCB 160L or 163	Neurobiology Lab or Mammalian Neuroanatomy Lab (choose one)
6.	One elective	From a list of MCB Neurobiology and approved outside classes[#] (choose one)

* Required 2-course sequence, offered FA-SP each year.

[#] The elective list merges all Elective A and Elective B classes from the existing curriculum. The second lab can also be taken as an elective (as in the current curriculum). The full elective list is in Appendix 1.

Schedule of MCB Neurobiology Courses (to begin 2015-2016)

Fall	**Spring**
revised 160 (Cellular/Molecular Neurobiology)*	new 161 (Circuits/Systems/Behavioral Neurobiology)*
163 (lab)	160L (lab)
166 (elective)	revised 165 (elective, Neurobiology of Disease)

* required 2-course sequence. 102 and 104 are still offered in both semesters.

Syllabi for the modified courses (160, 161, 165) are attached.

We will strongly recommend that students take the 160-161 sequence as Juniors, and then take the lab and elective in Senior year. However, there are workable progressions through the major for students who cannot take 160-161 until senior year. See Appendix 2 for details.

Implications for course enrollment

MCB 160 currently enrolls 220 students per year (90 FA, 130 SP). This includes both Neuro majors (120 per year) and students in other MCB divisions and departments who want a survey course in Neuroscience. In the new organization, 160 and 161 will each be offered only once per year (160 FA, 161 SP). Thus, 160 class size will increase. Because the new 160-161 sequence may be less attractive to students outside the major seeking a 1-semester Neuroscience survey, we anticipate that 160 enrollment may drop to ~ 180 students per year. We speculate that 161 enrollment may be ~150 students per year. These are large courses but are feasible given the lecture + required discussion format.

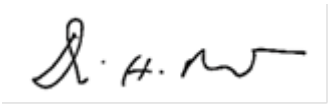
Implementation Plan for 2015-2016

We propose to implement this plan in 2015-2016. We would offer the revised 160 in FA 2015, and the new 161 in SP 2016. We would offer the updated 165 (Neurobiology of Disease) in SP 2016. We would NOT offer 160 or 167 in SP 2016.

This transition is rapid, but will work smoothly for our current majors and upcoming majors. All current students who have taken 160 (juniors and seniors) will be unaffected, and will graduate under the old curriculum. Current juniors who have not yet taken 160 could either take it in SP 2015, and graduate fulfilling the old requirements, or could take 160-161 in 2015-2016 and graduate fulfilling the new requirements. Current sophomores will use the new requirements. The MCB undergraduate advising office concurs that this time frame is feasible, because the new curriculum is a relatively modest change from the old.

Sincerely,

Marla B. Feller, Ph. D.
Professor of Neurobiology
Head of Neuroobiology Division



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Appendix 1: Neurobiology Elective List

MCB Neurobiology Courses (formerly Elective List B)

Molecular and Cell Biology

- 160L Neurobiology Lab (Sp; 4 units) (*allowed only if MCB 163 is used as lab requirement)*
- 163 Mammalian Neuroanatomy (F; 4 units) (*allowed only if MCB 160L is used as lab requirement)*
- 165 Molecular Neurobiology/Neurochemistry (Sp; 3 units)
- 166 Biophysical Neurobiology (F; 3 units)

Courses from Other MCB Divisions and Departments (formerly Elective List A)

Bioengineering

- 121 Introduction to Micro and Nanobiotechnology: MioMEMS (F, Sp; 3 units)
- BioEng 143 Computational Methods in Biology

Cognitive Science

- C127 Cognitive Neuroscience (F; 3 units)

Integrative Biology

- 131 Human Anatomy (F, Su; 3 units)
- C139 The Biology of Stress (Alt F, 3 units)
- C143A Biological Clocks: Physiology & Behavior (Alt F; 3 units)
- C143B Hormones & Behavior (Sp; 3 units)
- 144 Animal Behavior (F; 4 units)

Mathematics

- 110 Linear Algebra (F, Sp, Su; 4 units)
- 127 Mathematical and Computational Methods in Molecular Biology (F; 4 units)
- 128A Numerical Analysis (F; 4 units)
- 128B Numerical Analysis (Sp; 4 units)

Molecular and Cell Biology

- C100A Biophysical Chemistry (F, Sp; 4 units)
- 130A Cell and Systems Biology (Sp; 4 units)
- 132 Biology of Cancer (F; 4 units)
- 135A Molecular Endocrinology (F; 3 units)
- 136 Physiology (F; 4 units)
- 137 Computer Simulation in Biology (Sp; 3 units)
- 141 Developmental Biology (Sp; 4 units)
- MCB C145 Genomics
- 150 Molecular Immunology (F, Sp; 4 units)

Physics

- 112 Introduction to Statistical and Thermal Physics (F, Sp; 4 units)
- Physics 132 Contemporary Physics

Psychology

- C112 The Biology of Stress (Alt F; 3 units)
- C113 Biological Clocks: Physiology and Behavior (Alt F; 3 units)
- C116 Hormones and Behavior (Sp; 3 units)
- 117 Human Neuropsychology (Sp, Su; 3 units)
- C127 Cognitive Neuroscience (F; 4 units)

Public Health

- 141 Introduction to Biostatistics (Su; 5 units)
- 142 Introduction to Probability and Statistics in Biology & Public Health (F, Sp; 4 units)

Statistics

- 131A Statistical Inferences for Social and Life Scientists (F, Sp; 4 units)

Appendix 2: Anticipated Progress through the Neurobiology Emphasis

Complete prior to FA Jr year:

Bio 1A
Bio 1AL
Physics 8B (most students take this in FA of Junior year, which will still work)

Recommended progression:

FA Jr: 160 (and Physics 8B for many students)
SP Jr: 161 and 102
FA Sr: 163* and/or Elective. 104. * Choose one. This is the lab.
SP Sr: 160L* and/or Elective. 104.

Progression for students who cannot take 160 until senior year

FA Jr: 163 and Physics 8B.
SP Jr: Elective*. 102. * Except 165, which requires 160 as prereq.
FA Sr: 160. Elective if needed. 104.
SP Sr: 161 and/or Elective and/or 160L.

Progression for students who join emphasis in Spring of Junior year

FA Jr: None.
SP Jr: Elective*. 102. Physics 8B if needed. * Except 165, which requires 160 as prereq.
FA Sr: 160. 163 or 104.
SP Sr: 161. 160L or 104.

Syllabi for Proposed Courses

MCB 160: Cellular & Molecular Neuroscience (MWF lecture + required discussion, 4 units)

	1	Introduction. Gross anatomy. Golgi vs. Cajal in the neuron doctrine. Structure of a neuron. Cell types.
		Cellular neurophysiology
	2	The plasma membrane
	3	Passive electrical properties of neurons
	4	Origin of the membrane potential
	5	Selective permeability of ion channels
	6	Gating of ion channels
	7	The action potential
	8	Propagation of action potentials
		The synapse
	9	Physiology of synaptic transmission
	10	Molecular mechanisms of exocytosis and endocytosis
	11	Postsynaptic receptors (ionotropic)
	12	Synaptic excitation, inhibition, and integration
	13	Neurotransmitters
		MIDTERM 1
	14	Metabotropic receptors, intracellular messengers and neuromodulation
	15	Dendrites, spines, and dendritic excitability
	16	Preview of neural circuits and systems. A simple, completely understood sensorimotor pathway: crayfish tail flip escape response. Basic architecture of mammalian sensory and motor pathways.
		Synaptic plasticity
	17	Synaptic plasticity and learning: Aplysia as case study
	18	Short-term plasticity
	19	LTP
	20	LTD, STDP, and structural synaptic plasticity
		Sensory transduction
	21	Phototransduction in rods & cones
	22	Retinal processing of vision (*illustrates synaptic integration, inhibition)
	23	Evolution of color vision (or maybe melanopsin and circadian rhythms)
	24	Transduction for taste & olfaction
	25	Olfactory processing (*illustrates synaptic target selection, circuit construction)
	26	Pain and temperature transduction
		MIDTERM 2
	27	Motor neurons and muscle
		Neural development
	28	Neural differentiation
	29	Axon guidance

	30	Synapse formation
	31	Activity-dependent synaptic refinement
	32	Neural repair and aging; stem cells and adult neurogenesis
	33	Regeneration in PNS and CNS
		Molecular basis of behavior and disease
	34	Genes, circuits & behavior (Drosophila courtship or C. elegans escape)
	35	Genes, circuits & behavior (Social behavior in prairie voles)
	36	Traumatic brain injury and epilepsy
	37	Neurodevelopmental and neurodegenerative diseases
	38	Optical methods in neurobiology

MCB 161: Circuit, Systems & Behavioral Neuroscience. (MWF lecture + required discussion, 4 units)

1	Introduction. Anatomy of CNS and PNS. Goals of systems neuroscience.
	Vision
2	Retina, receptive fields, computation of local contrast
3	Retinal computation of motion
4	Central vision to V1: local feature detectors
5	Extrastriate cortex: object and face cells, motion
6	Quantitative approaches to vision: reverse correlation, LNP models, population coding.
	Somatic sensation
7	Touch: Pathways, maps, place coding and texture/form coding in S1
8	Pain and Temperature: Pathways and coding
9	Common circuit motifs and computation. Includes lateral inhibition, recurrent excitation, feedforward inhibition.
10	Canonical cortical circuits
	Chemical senses
11	Taste & olfactory pathways: circuits for innate vs. learned behavior
12	Olfaction: gain control
13	Olfaction: pheromones
	MIDTERM 1
	Auditory system
14	Cochlea, hair cells, and auditory transduction
15	Molecular mechanisms for mechanotransduction
16	Sound localization: circuits and computation
17	Central auditory processing
18	Bat echolocation
19	Vestibular system

	Motor Systems
20	Spinal cord, motor neurons, control of muscle force
21	Voluntary control of movement: M1 and motor pathways
22	Central Pattern Generators
23	Basal Ganglia. Parkinson's and Huntington's Disease.
24	Cerebellum, coordination and motor learning.
25	Hypothalamus and autonomic nervous system
	MIDTERM 2
	Neurobiology of Learning
26	Memory systems of the brain. Working memory. Cortical plasticity and critical periods
27	Cortical plasticity II (mechanisms, restoring plasticity in adults)
28	Hippocampal learning I (space)
29	Hippocampal learning II (memory)
30	Sensorimotor learning: Bird song learning I
31	Sensorimotor learning: Bird song learning II
	Higher functions
32	Emotion and mood: dopamine and serotonin
33	Amygdala and fear
34	Reward and drugs of abuse
35	Sleep and brain state
36	Higher functions: value, decision, attention
37	Brain Evolution
38	Review, principles, challenges

MCB 165: Neurobiology of Disease. Designed to be taken as an elective after 160-161 sequence.

TTh lectures + required discussion. 3 units.

	1	Introduction.
		Neurochemistry and Its Disorders
	2	Neurotransmitters: synthesis, receptors, degradation, uptake
	3	Neuromodulators: peptides, catecholamines
	4	Glia in health and disease
	5	The mysterious enteric nervous system
	6	Presynaptic modulators: cannabinoids, adenosine
	7	Synaptic Plasticity
	8	Psychoactive drugs and reward systems: VTA, nucleus accumbens
	9	Addiction
		Midterm I
		Neurodevelopmental and Neurodegenerative Disorders and CNS Injury
	10	Review of Development and Synaptogenesis
	11	Autism
	12	Fragile X
	13	Other developmental disorders: Down Syndrome and ADHD
	14	Prion Diseases
	15	Parkinson and Huntington Disease
	16	The Aging Brain
	17	Spinal cord organization and injury.
	18	Stem cells, regeneration, and repair.
		Midterm II
		Neurobiology of Psychiatric Disorders
	19	Overview of Mood and Psychotic Disorders
	20	Depression and Manic Disorder: Symptoms, Etiology and Neuropathology
	21	Depression Manic Disorder: Monoamine, corticoid and neurotrophic hypothesis
	22	Anxiety Disorder, PTSD and the Amygdala
	23	Schizophrenia: Symptoms and Neuropathology (Developmental Disorder?)
	24	Schizophrenia: Glutamate and Dopamine Hypothesis
	25	Dementia and Alzheimer's Disease
	26	Epilepsy