Cell Biology & Neuroscience Curriculum Assessment AY2016/2017

National Standards

Cell Biology and Neuroscience curricula have no nationally agreed upon standards or metrics, but the majority of students in these curricula are destined for careers in the health sciences, and many go on to take the MCAT exam for entrance to medical school. The MCAT exam has changed to incorporate more analytical skills and less content memorization, so changes to our curriculum need to take this into account[1]. The new exam has well defined goals and tests for competence in many of the areas our majors should be proficient in, so we as a faculty have examined it and compared it with the content and goals of our curricula. This new curriculum was then incorporated into the spring semester offering of BioB260, our introductory cell and molecular biology class.

Program Learning Outcomes

Our program learning outcomes have not changed since 2015/16.

Our graduates will:

- Understand intra and inter-cellular signaling pathways at the molecular level.
- Be able to describe the functional organization of sensory and motor systems of the human nervous system both in terms of structure and function.
- Be able to describe the function and physiology of major organ systems such as the heart and kidney.
- Be able to describe some of the signaling mechanisms that mediate embryonic development.
- Understand the relationship of genetics to inherited diseases, the development of new therapies, and the molecular basis for these diseases.
- Be able to read modern cell biology or neuroscience paper published in a top journal, appreciate the strengths and weaknesses of the paper's approach and develop a coherent, synthetic review of this paper's place in our knowledge.
- Be able to design and carry out experiments that address fundamental questions about cell biology or neuroscience.
- Effectively communicate complex biological concepts in presentations and in writing.

Components of Program Learning Outcomes

- Understand intra and inter-cellular signaling pathways at the molecular level.
- Be able to describe the action potential as it travels down an axon and the synaptic function it controls.

1. https://aamc-orange.global.ssl.fastly.net/production/media/filer_public/24/19/2419a765-fc49-466b-bcf8-b6470a8ff273/mcat-bb-content-outline.pdf

- Be able to diagram and succinctly describe a G-protein coupled receptor pathway, describing at least 8 molecular components of the signaling.
- Be able to describe a pathway whereby an extracellular signal leads to a change in gene transcription within the nucleus.
- Be able to describe at the molecular level, an example of where aberrant signaling leads to human disease.
- Be able to give examples of molecular conformational changes that lead to signaling, in proteins, DNA and/or RNA.
- Be able to understand the role of the cytoskeleton in the cell and how it pertains to cellular processes such as chemotaxis and migration.
- Be able to describe vesicular trafficking as it relates to synapses, protein and cell cargo delivery.
- Be able to understand the role of motor proteins, how they function and their contribution to cell signaling
- Be able to describe the major proteins and their roles in promoting cell-cell adhesion and cell-extracellular matrix adhesion.
- Be able to describe the functional organization of sensory and motor systems of the human brain both in terms of structure and function.
- Be able to distinguish the components of the peripheral and central nervous system.
- Be able to diagram and label a chemical synapse vs an electrical synapse.
- Be able to describe long-term depression and long-term potentiation and their roles in memory.
- Be able to describe the function and physiology of major organ systems such as the heart and kidney.
- Be able to describe for each system the controlled variable, the sensors, integrating mechanisms, effector mechanisms, and how these work so the body can respond to stress.
- Be able to describe the sliding filament model of muscle contraction, power stroke and excitation-contraction coupling.
- Be able to describe some of the signaling mechanisms that mediate embryonic development.
- Be able to describe the types of extracellular signals and intracellular signals that regulate cell division, cell survival, cell migration, cell differentiation and how these events ultimately orchestrate embryonic development.
- Understand the relationship of genetics to inherited diseases, the development of new therapies, and the molecular basis for these diseases.
- Students will comprehend the difference between dominant and recessive modes of inheritance.
- Students will be able to compute the frequency of progeny who will be unaffected non-carriers, unaffected carriers, and affected given the genotype of any two parents.
- Students will comprehend that mutations in DNA manifest dysfunction at the protein level and how this results in disease.
- Students will recognize that genetic diseases have different degrees of penetrance that can be altered by environment and genetic background.
- Students will comprehend the difference between gene and pharmacological therapies and the distinct ways these therapies are developed.
- Be able to read a modern cell biology or neuroscience paper published in the top journals, appreciate the strengths and weaknesses of the approach and develop a coherent, synthetic review of this paper's place in our knowledge.

- Be able to read and understand a current basic research paper published in a top journal.
- Be able to acknowledge deficiencies in understanding the paper and remedy those gaps with background reading and research.
- Be able to diagram each experiment and the logic that leads to the conclusions in the paper.
- Be able to describe feasible experiments that would further test the proposed models in the paper.
- Be able to organize and present a coherent presentation on the paper that summarizes the strengths and weaknesses of each experiment.
- Be able to write synthetically a coherent summary of the paper in one page of grammatically correct sentences and paragraphs.
- Be able to design and carry out experiments that address fundamental questions about cell biology or neuroscience.
- Understand the philosophical structure of scientific knowledge and experimentation, being able to recognize strong predictions and experiments and clearly distinguish between scientific hypotheses and correlative observations.
- Be able to write simple computer programs for the analysis of data sets from experiments. Be versed in the computations tools and strategies to retrieve and analyze DNA, protein, and 3 dimensional protein structures.
- Understand the time and scale of the biology that occurs within organelles, cells, and organ systems.
- Be able to describe the modern experimental approaches and measurements that are the foundation of biological knowledge including patch-clamp recordings from excitable cells, DNA sequencing, mRNA analysis and gene expression profiling, protein interaction studies, and conditional knockouts at the genomic level.
- Effectively communicate complex biological concepts in presentations and in writing.
- Effectively integrate data from multiple experiments and knowledge from multiple scientific sources in support of (or to refute) a hypothesis. Clearly communicate these arguments orally and in writing with accurate use of figures, statistics and citations.
- Understand and effectively communicate proper ethical design and reporting of scientific experiments as well as bioethical concerns in research utilizing animal and human subjects.

Assessment Plans

Time Table for assessment activities over the current academic year.

Assessments for Fall 2016 were discussed in faculty meetings in January 2017, while assessments for the spring semester will be discussed September 2017. Both meetings will focus on necessary curricular changes for AY2017/2018.

Plan for assessments from AY 2014 through 2020

2014/2015	2015/2016	2016/2017	2017/2018	2018/2019	2019/2020	2020/2021
Pre-test of basic neuroscience concepts in BioH440	Pre-test assessment of cell biology concepts and signaling pathways in BioB425	Pre-test assessment of cell biology concepts and signaling pathways in BioB425	Pre-test assessment of cell biology concepts and signaling pathways in BioB425	Pre-test assessment of cell biology concepts and signaling pathways in BioB425	Pre-test assessment of cell biology concepts and signaling pathways in BioB425	Pre-test assessment of cell biology concepts and signaling pathways in BioB425
Evaluation of analytical skills and literacy in BioH455	Assessment of fundamental genetics concepts with strategically placed questioned in BioH320 final	Evaluation of analytical skills and literacy in BioB425	Assessment of fundamental genetics concepts with strategically placed questioned in BioH320 final	Evaluation of analytical skills and literacy in BioB425 or BioH313	Assessment of fundamental genetics concepts with strategically placed questioned in BioH320 final	Evaluation of analytical skills and literacy in BioB425 or BioH313
Completed	Completed	Completed	Not yet started			

Summary of outcomes and changes for 2013-2016 academic years.

2013 marked the first year we did comprehensive assessment. The assessment was done with a pre-test at the beginning of BioH 440 and an evaluation of papers submitted by senior students in BioH445. The assessment revealed two glaring deficiencies in our student's learning: 1) fundamental concepts about the structure and function of the nervous system taught at several different levels, in different courses, were not being retained by the students. 2) the majority of our senior students are not prepared to analyze the basic literature and write synthetically. These are skills crucial to success in future MCAT exams as well as in many biomedical professions.

Given these poor results, we felt that changes needed to be made. Inspection of our curriculum lead to the realization that we were requiring the students to take too much introductory biology courses that focused on vocabulary and memorization (3 full courses) before they entered upper level courses that taught analytical skills. We dropped Biol 258 from our curriculum, which enables us to move students more quickly into smaller, upper level courses. We also decided to offer BioB 260 each semester to lower the size of the class and focus more on delivering a course that

stresses concepts rather than memorization.

The other significant change made to the curriculum involved the upper level BioB 425 course. Because this is required for all of our majors, it provided another opportunity to adjust the curriculum and stress analytical skills. Starting in 2015/16 this class is now taught both fall and spring semester, instead of just once a year. This has eliminated a bottleneck in our curriculum and has reduced the class size. The smaller class size allows the professor to incorporate more scientific journal reading, writing and discussion into the class. This has been the major change that has allowed us to focus on literacy and analytical skills assessment.

Outcomes for AY 2016/17

BioB 425 was assessed on schedule. In the fall BioB425 class, students were assessed on their writing and analytical skills. The results, in detail, with writing examples, are attached. However, the take home message is that juniors and seniors had difficulty with reading and analyzing a relevant science article, but drastically improved over the course of the semester when writing and analytical skills were stressed. The amount of feedback that must be given by the professor is substantial, on top of the regular lectures and exams. This is only sustainable if the class size is kept low and the class is offered each semester. Additionally, these results suggest that a scientific/technical writing class geared more towards biology and biomedicine would be extremely useful in our curriculum, but this would require discussions and buy-in from the English Department.

In the spring BioB425 class, students were assessed with a pre-test. In general, the students performed well on the pre-test (average class score of 97%), indicating that they are successfully retaining the material that they were supposed to have learned in the two prerequisites for the course: BioB260 and Biochem 340.

Plan for AY 2017/2018

Pretests in BioB425 in the Spring are now incorporated into the first quiz and will continue each year, in order to gauge the level of comprehension of students entering the class. This will allow the instructor to adjust the lectures in response to any incoming deficiencies. Next year, and alternating years, we will also assess student comprehension of fundamental genetic and molecular biology skills with questions embedded in the BioH320 final exam.