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| **Title of Unit** | Excitable Cells  Title of Tidbit: *Understanding Membrane Potential* |
| **Date and**  **Location of SI** | Stony Brook University, New York |
| **Unit Developers & Contact Information** | *Kristen Kimball, University of Connecticut (kristen.kimball@uconn.edu*  *Thomas Abbott , University of Connecticut (thomas.abbott@uconn.edu)*  *Howard Sirotkin, Stony Brook University (howard.sirotkin@stonybrook.edu)*  *Abhay Deshpande, Stony Brook University (abhay.deshpande@stonybrook.edu)*  *Jagan Srinivasan, Worcester Polytechnic Institute (jsrinivasan@wpi.edu)*  *Elizabeth Ryder, Worcester Polytechnic Institute (ryder@wpi.edu)* |
| **Context** | Introductory Biology Course / Applications of Physics to Biology,  Beginning of Neurophysiology Section (Biology) / After Intro to Electrostatics and Capacitance (Physics) |
| **Abstract**  (< 200 words) | Research on active learning supports the premise that using techniques such as discovery learning, cooperative learning and student-centered learning promotes student engagement and construction of knowledge. This course unit can be adaptable to either an animal/human physiology course, or an introductory course on physics for life sciences. The “teaching tidbit” is designed as an introduction to how neurons establish membrane potential. It centers on a learning activity, which encourages students to discover how chemical and electrical gradients are established and maintained. Students use an activity sheet with movable pieces to work through various scenarios depicting the movement of ions. In-class clicker questions and an activity board exercise are crucial to the learning of this concept. These activities will be a part of formative assessment to gauge the student’s understanding of the establishment and maintenance of membrane potential. Implementation and assessment of this active learning will contribute to the collective body of knowledge on the use of active learning models in classrooms. |
| **Rationale** | Recognition that neurobiology is very interdisciplinary.  Understanding excitable cells is fundamental to all processes in neurobiology.  Misconceptions / Difficult topics: Potential difference vs. membrane potential; ion flows vs. changes in concentration; probabilistic movement of ions |
| **Learning Goals:** what students will know, understand, and be able to do; includes content knowledge, attitudes, & skills | **Learning Goal for Tidbit**   * To understand what membrane potential is, how it is generated, and why it matters * To recognize the interdisciplinary nature of neurobiology |
| **Learning Outcomes:** Student behaviors or performances that will indicate they have successfully accomplished the goals | **Learning Outcome for Tidbit**  Students will be able to:   * Diagram how chemical and electrical gradients generate membrane potential |

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| **Incorporation of Scientific Teaching Themes** | | |
| **Active Learning** | **Assessment** | **Diversity** |
| How students will engage actively in learning the concepts | How teachers will measure learning; how students will self-evaluate learning | How the unit is designed to include participants with a variety of experiences, abilities, and characteristics |
| *Activities outside of class:*  Pre-quiz on material (ion concentrations, membrane structure) previously covered; knowledge of which is required to succeed with the activity.  Homework on learning advanced concepts of membrane potential.  *Activities in class:*  Activity boards, clicker questions, group discussions in class.  *Activities during tidbit*:  Working with activity sheet  Clicker questions  Group discussion | *Pre-assessments:*  Before-class quiz (e.g. on Blackboard) assessing their knowledge of material needed for this activity (ion concentrations across the membrane and membrane structure.)  Use results to inform introduction.  *Post-tidbit assessments:*  **Clicker question results.**  Clicker results are for formative assessment, to adjust comments as necessary during the activity; but also can serve for post-assessment. One would hope to see a progression in how many get the correct answer for the clicker questions.  **Homework results.** | This unit is designed to   * Introduce biology majors and students from pre-med and health professional disciplines to the fundamentals of membrane potential * Motivate these students (and introductory physics students) to WANT to understand this material.   Multiple activities address different learning styles. By addressing the formation of membrane potential at a very basic, qualitative level, all students can be prepared for more formal quantitative approaches to modeling membrane potential. |

**Sample** Presentation Plan (general schedule with approximate timing for unit)

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| **Session 1** | | | |
| **Time (min)** | Learning Outcome(s) | Activity/assessment | Explanation, notes, suggestions, tips |
| *Preclass 15* | Student can describe membrane structure and ion concentrations | Quiz (e.g. on blackboard) | Short quiz tests on knowledge of phospholipid bilayer and distribution of ions across the neural membrane (see resources) |
| *Enter approx. class time for learning activity*  *preparatory*  *material presentation*  *3 min* |  |  | Introduce the topic of the tidbit (going up to the “many people excited” slide) |
| *Enter approx. class time for learning activity #1 15 min* | Diagram how chemical and electrical gradients generate membrane potential | Use activity board to set up MODEL of cell membrane and move ions to see how membrane potential can be generated  /Clicker questions for assessment | Address incorrect answers; explain why they are incorrect. |
| *Enter approximate time for additional learning activities and associated class*  *Work/preparatory materials* |  |  |  |
| *Enter approximate time for post-activity summing up or transition 2 min* | Note the interdisciplinary nature of neurobiology. | The capacitor circuit slide introduces the electrical analog of a neuronal membrane; and final slides summarize what was learned through the activity and how this will proceed into a more formal quantitative discussion of membrane potential – as well as a discussion of the ACTION POTENTIAL (next class!) – and HOW we ‘get cells’ (and people) excited. | Capacitor circuit slide is especially useful for biology students in an introductory physics class, as well as serving as introduction to more formal quantitative approaches to modeling membrane potential (parallel conductance model). |

*Add additional activities information as needed for the unit.*

Resources for Teaching the Unit

*(other files and information needed/helpful to teach the unit, including files for papers from which original data for class activities is taken, supporting information for the instructor, handouts, in class activities materials, assessments with answer keys, homework assignments, etc.)*

Effectiveness of unit (if you have used it in your own teaching)

Not used yet.

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