Interdisciplinary Undergraduate Workshop on Dynamics of Excitable Systems

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Workshop Overview

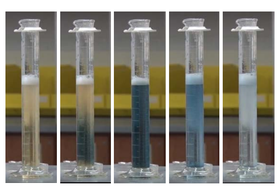
- Held January 8-14, 2017 (5 full and 2 half days).
- Located at RIT using a standard classroom, computer lab, and chemistry lab.
- Key goal of the workshop: provide students with an interdisciplinary perspective.
- Students had the opportunity to learn about excitable and oscillatory systems using complementary theoretical, experimental, and computational approaches.
- Participants were assembled into teams that included at least two different majors to facilitate learning from different perspectives and communicating across disciplines.

Participant Information

- 18 student participants.
- 50-50 gender breakdown (9 female, 9 male).
- 2 AALANA.
- 8 institutions:
  Harvey Mudd College · University of Delaware
  Stony Brook University · University of Rochester
  Nazareth College · Georgia Institute of Technology
  Rochester Institute of Technology
  University of Maryland Baltimore County

Preliminary Activities

- Human spiral wave.
- Lectures on the mathematics of dynamical systems (fixed points, bifurcations, oscillations, and chaos).
- Chemical and physical demonstrations of these properties (oscillating Briggs-Rauscher reaction, propagating Belousov-Zhabotinsky reaction, saline oscillator, candle oscillator.
- Computational exercises (logistic map, pendulum, FitzHugh-Nagumo equations) helped students understand how the mathematics they learned and the physical systems could be understood geometrically.

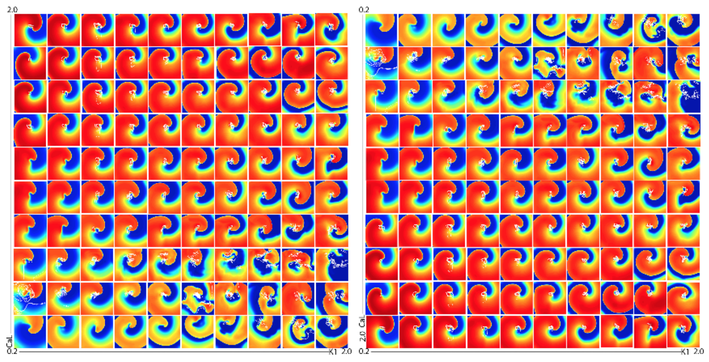


Heart Anatomy

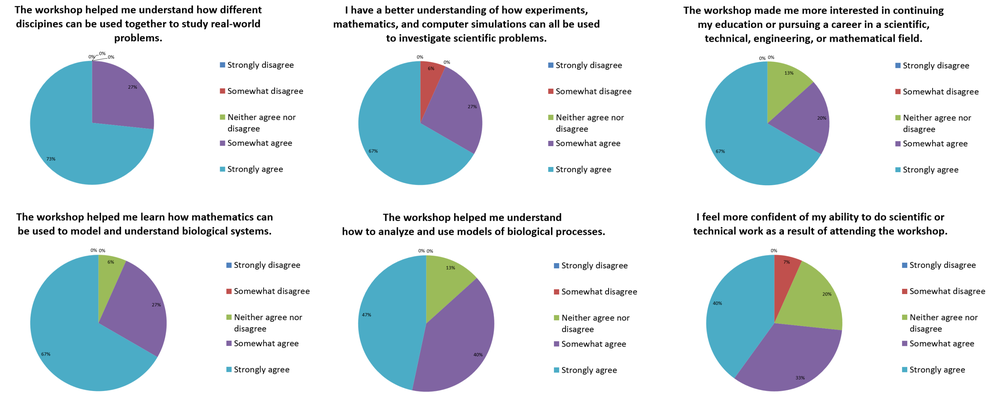
- Introduction to cardiac action potentials, electrical waves in the heart, and the heart's conduction system.
- Dissection of preserved sheep hearts in groups to learn cardiac anatomy.

Computational Experiments

- Project used GPU-accelerated web-based codes to map out the dynamics of parameter space in a popular cardiac model.
- Students varied the strength of ion channel conductances in models of cardiac action potentials coupled together in tissue and studied the effects on spiral wave stability/breakup.
- The students' results will be incorporated in a manuscript currently in preparation.



Assessing Outcomes



Student Comments

- *I enjoyed pondering the human spiral wave (done at Georgia Tech) and creating a program to simulate it; this activity bettered my understanding of spiral waves and coding, which I enjoyed.*
- *The hands-on experiments were nice complements to computer simulations.*
- *The saline oscillator was quick to get up and running, as well as the best example for how we can vary different parameters and get different results.*
- *I liked that the three approaches (analytical, graphical, and computational) were used and taught together because if I felt weak in grasping one, the other bolstered it.*
- *Learning about using WebGL was extremely useful as parallelization is an essential tool in scientific computing. (It seemed very interesting, too!)*
- *Using Matlab to improve our understanding of the behavior of fixed points in dynamic systems and studying n-cycles definitely heightened my understanding of the impact of fixed points on dynamical systems.*
- *Running simulations on the TNNP [ten Tusscher-Noble-Noble-Panfilov] model that had never been done before was awesome! Felt like I was helping to advance science.*
- *I really enjoyed being able to share our findings and have discussions regarding what they meant in a broader sense.*

Acknowledgements

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