A group dynamic activity for learning the cardiac cycle and action potential

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To learn best, a person must be engaged in a subject that leads to a genuine interest and promotes lifelong learning (1). Some students consider physiology difficult mainly due to the breadth of content and the complexity of body functions (2, 3). Teaching cardiovascular physiology to a large group of students can be challenging, and the traditional lectures commonly used to present complex topics often fail to engage students. One example is the cardiac cycle: many students feel overwhelmed with all the details and names involved.

To make learning more interesting and bring students’ attention to the “big picture” while including important details, I developed, with my students’ help, a group dynamic activity that simulates the action potential and cardiac cycle. A group of voluntary students from the School of Medicine at UNIGRANRIO (Caxias RJ, Brazil) created a study group. Among other activities, we planned to develop alternative ways to efficiently teach physiology to students of different academic backgrounds. The medical school in Brazil is a 6-yr program after high school, so these students would be comparable to advanced undergraduates in the United States system.

Group Dynamic Activity

Action potential: a group of students formed a single cell. Students formed a circle to represent one excitatory cell (cardiac pacemaker or myocardial cell). Holding colorful balloons representing ions (red = Na\(^+\), blue = K\(^+\), and green = Ca\(^{2+}\)), students moved the ions in and out of the circle/cell to demonstrate the depolarization/repolarization state of the cell. We also mimicked modulation by the autonomic nervous system by altering the speed of the ionic movement.

Cardiac cycle: a group of students formed a heart in which each student was a single cell. Students holding hands formed two interconnected circles (figure 8 shape) representing the atrium and ventricle on the right or left side of the heart. To represent depolarization of a cell, each student would raise their arms and then drop them to represent the repolarization, allowing time for the refractory period. The teacher (or designated student) acted as the sinoatrial (SA) node, dictating the contraction rate. The cycle started when the SA node depolarized (indicated by lifting hands) and was followed by the “atrium” students on both sides of the SA node sequentially lifting their hands and moving one step toward the center of the circle (contraction). This movement would continue, one by one, until the electrical wave spread through the whole circle. Another student positioned between the atria and ventricle acted as the atrioventricular (AV) node, delaying the transmission to Purkinje fibers. As the signal from the Purkinje fibers reached the “ventricle” students, they sequentially depolarized and then contracted toward the center of the circle. The atrium relaxed as the ventricle contracted, thus emphasizing that the two chambers contracted and relaxed at their own times. In this fashion, the electrical event (lifted hands) preceded the mechanical event (contraction of the circle). Students paused after the contraction (refractory period) and knew they should return to the starting position sequentially, not all at once. To represent heart rate modulation by the autonomic nervous system, the SA node would accelerate or decelerate according to whether it received sympathetic or parasympathetic stimulation (instructor instructions).

At the beginning, students tended to move together, allowing the discussion of cardiac arrhythmia. If an individual student depolarized too soon, we discussed ectopic focus. All mistakes were used as a learning moment. Many aspects can be discussed with this simulation, including the effects of exercise and impact of heart diseases.

When the number of students was sufficient and we had adequate space, a group of students would walk thru the atria and ventricle acting as blood cells. As the atria contracted, the blood cells were pushed to the ventricle, forcing their passage through a couple of students acting as AV valves. After blood passed and the ventricle contracted, the AV valve closed with the sound of the two student’s hands slapping each other (mimicking heart sounds).

The time used in this activity did not need to exceed 30 min. To prepare for the activity, it is necessary to introduce students to the subject either by reading related material (action potential or cardiac cycle) or by receiving a basic lecture on the subject. It is also important to have help from experienced students who know their roles as “cardiac valves,” “SA node,” or “AV node.”

Summary

Students enjoyed this dynamic lesson and verbally communicated their enthusiasm and great satisfaction. No formal assessment of their learning was performed, but an informal survey was passed out at the end of the semester asking about their perception of learning. The response was overwhelmingly favorable, indicating that “play” in physiology alleviated the stress of learning. Some students suggested adding more simulations in other areas of physiology. This exercise was designed to permit students to experience the cardiac cycle, and it was treated as a fun subject. Our unforgettable lessons led to a lifelong learning experience, as I have heard many times from students who participated several years earlier. In fact, a past student recently declared that his cardiac cycle experiences influenced his decision to become a cardiologist.
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DISCLOSURES

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REFERENCES