

Seeing Your Heart in Action - the EKG

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Overview: We will be presenting the perspectives of bioengineering graduate students through a focused lesson on one of the most important medical inventions in the past century: the electrocardiogram (EKG or ECG). In this lesson, we will begin with a Powerpoint explanation of the electrical basis for heart motion, continue on to how this electrical activity is measured, and end the presentation with what the measured signal looks like and how to interpret it. Afterwards, we will show a demonstration of our own EKG waveforms and give the students a chance to measure their own EKGs. Throughout this activity, we hope to infuse our own scientific experiences and aspirations into the lesson and inspire more students to become interested in science and engineering.

Materials: The presenters will bring all required electrical and electronic components including: EKG electrodes (1000), EKG circuit boards (4+1 backup), 9V batteries (8+8 backup) and oscilloscopes (4). We will also bring our own laptop computers with the presentation.

Some materials that are needed in the classroom are:

- 1) A projector to hookup to the laptop during the presentation.
- 2) Power outlets for the oscilloscopes at 4 areas spread out throughout the classroom.
- 3) Adequate space at each of the 4 areas for both the presenters and $\frac{1}{4}$ of the class to see the oscilloscope.

Lesson Plan: Total 50 Minutes

5 Minutes: Setting up and Introductions. The teacher can spend a little bit of time to introduce us as a group to the students, and then we can each introduce and talk a little bit about ourselves.

15 Minutes: Presentation on the heart and EKGs, with question session from students. The presentation PPT should be sent as an email attachment along with this lesson plan. Please review it and provide feedback as necessary.

5-10 Minutes: Explanation of how the demonstration EKGs are hooked up to the “patient”, and how we can see the electrical activity on the oscilloscope.

All of the electronic circuit boards have been designed and soldered by the presenters. The design was used to teach UC Berkeley Bioengineering undergrads about circuit design and soldering this semester, and has been determined to be safe for demonstration purposes.

In this section, we will explain that the commercially available electrodes (which look like band-aids) will be put on the left and right wrists. Wire clips from the circuit boards will clip onto the ends of the electrodes. Then, after the batteries are attached to the circuit, the output of the circuit will go into a channel of an oscilloscope. The oscilloscope is a wonderful instrument – it allows us to see very fast changes in the voltage, or electrical activity, of anything electrical with great precision.

We can also just plug our electrodes directly into the oscilloscope – but we wouldn't be able to see much of anything. This is because the voltage generated by our heart is tiny – around 10-100 thousand times smaller than the average power outlet. To be able to see anything at all, we would need to increase (amplify) the signal first, and remove any other interfering signals that might be present. Hence we need a special circuit to do that function between the patient's electrodes and the output oscilloscope.

15-20 Minutes: Demonstration. In this section, we will break up the class into four different groups – each group would gather around an oscilloscope and a presenter, who would then show their own EKG. To help the students gain an appreciation for the difficulty in acquiring a clean EKG, the presenter can then do things like moving around, grounding themselves (to a piece of metal), or flexing their forearm muscles in order to show the effects of electrical interference. Additionally, the presenter may elect to wear a reference electrode on their leg or back, which serves to decrease electrical interference from showing up in the oscilloscope signal.

Afterward, the students can volunteer to try looking at their own EKG signals under the supervision of the presenters and the teacher.

5 Minutes: Demonstration wrap-up and area cleanup.