Experiment HH-11: ECG ~ Simulations and Comparisons

Background

The cardiac cycle involves the sequential contractions of the atria and the ventricles which are triggered by action potentials in specialized sinoatrial (SA) node on the right atrium of the heart. The electrical activity spreads from the node across the muscle fibers of the atria, through another node and a set of fibers that go to the ventricles. The resulting sequential contraction and relaxation of the heart moves blood to the lungs and other organs.

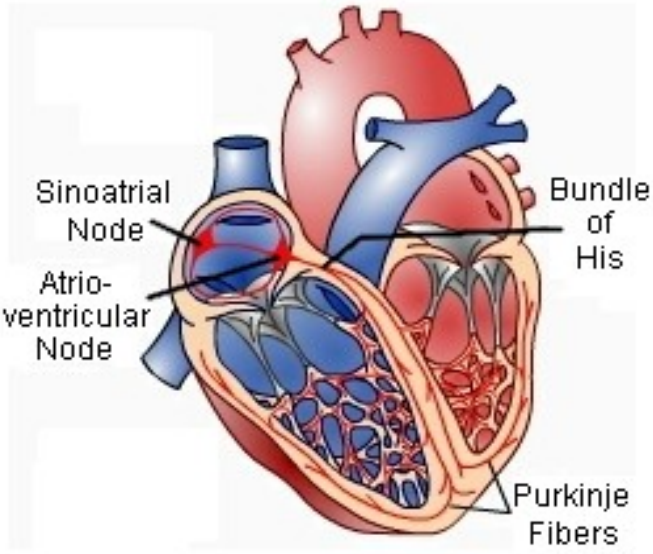

Figure HH-11-B1: The heart - showing the SA and AV nodes responsible for the continual, repetitive contraction of the cardiac muscle fibers.

The combined electrical activity of the myocardial cells produces electrical currents that spread through the body fluids. These currents are large and detectable by recording through electrodes placed on the skin. The regular pattern of signals produced by the heart is called the electrocardiogram or ECG (Figure HH-11-B2).

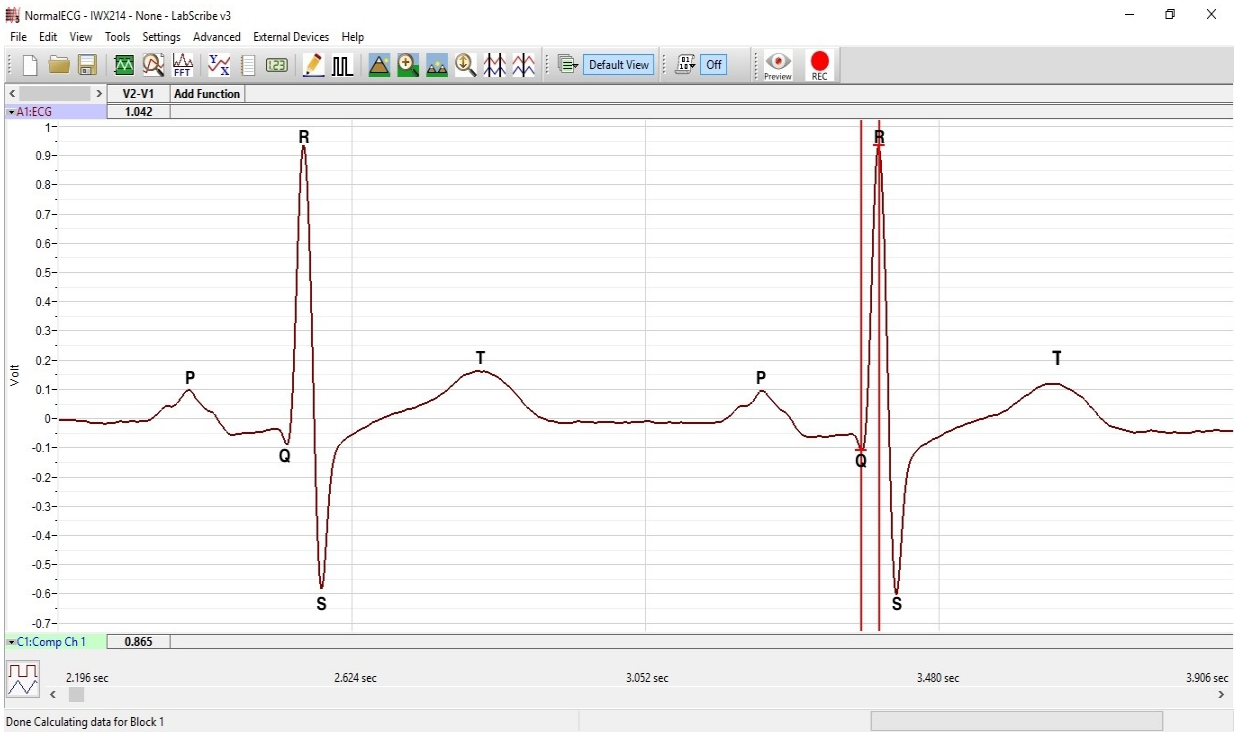

Figure HH-11-B2: ECG recording displayed in the Main window with labels showing the P, QRS, and T waves.

The components of the ECG (Figure HH-11-B2) are correlated to electrical activity in the atria and ventricles such that:

- The P wave is the summation of the action potentials from the muscle fibers in the atria. This event is known as atrial depolarization and causes the contraction of the atria.
- The QRS complex results from the return of the atrial muscle fibers to their resting membrane potential in a event known as atrial repolarization. The second event is the summation of the action potentials from all the muscle fibers in the ventricles. This process is known as the ventricular depolarization and causes the contraction of the ventricles.
- The T wave results from the return of the ventricular muscle fibers to their resting membrane potential, or ventricular repolarization.

The normal depolarization and repolarization of the myocardial cells of the heart are collectively known as “normal sinus rhythm” when looking at an ECG recording. However, the heart can under go changes that cause abnormal rhythms/ECG waves that are hard to record in a laboratory situation. These can include: atrial fibrillation, ventricular tachycardia, bundle branch blocks, and many others.

In this experiment, you will record and analyze a three lead ECG directly from a live subject, as well as recording a variety of simulated ECG heart rhythms. These laboratory exercises will demonstrate the differences between normal and abnormal electrical events in the heart. Students can also examine the differences between adult ECG heart rhythms and those of an infant.