**ELECTROCARDIOGRAM**

**LEARNING OBJECTIVES**

- By the end of today’s laboratory you will:
- Know where to place electrodes to record the standard limb lead ECG (leads I, II and III)
- Be able to identify the major components of the ECG (P wave, QRS complex, T wave) in these leads
- Be able to relate the electrical activity in the heart to these major components

**ELECTROCARDIOGRAM OR ECG**

The beating of the heart is associated with electrical activity and sound. The pattern of electrical activity recorded at the body surface is called the electrocardiogram or ECG.

**BASIC ECG WAVE**

**Standard Connection**

Attach the positive electrode to the left wrist, the negative to the right wrist, and the ground to the right leg.

**Standard Connection**

Using a pen, mark each point where electrodes will be placed. Clean the skin with alcohol swabs and lightly abrade the area with abrasive gel or a pad. This reduces the electrical resistance of the outer layer of skin and ensures good electrical contact.

If you are using the Reusable Clamp Electrodes, apply a small amount of electrode cream to the electrodes before attaching. Electrode cream is not necessary if you are using disposable electrodes which have electrode gel on them already.

If, after looking at the signal during the first exercise, you find that this does not produce a good signal, try the alternative method.

**Alternative Electrode Connection**

- positive electrode to the left upper arm
- negative electrode to the right upper arm
- ground to either wrist

*Do not place the electrodes over the major muscles of the upper arm, because muscle activity interferes with the signal recorded from the heart.*
Exercise 1

You will record and examine the major components of the Electrocardiogram (ECG).

**PROCEDURE**

- The subject should relax and sit as still as possible to minimize signal artifacts due to movements.
- Type the subject's name into the Comment panel.
- Click Start, then add the comment.
- Click Autoscale as required to ensure that you can see all the data as it is being recorded.
- If the ECG cannot be seen, check that all three electrodes are correctly attached. If the signal is noisy and indistinct, make sure that the subject is relaxed; consider using the alternative attachment positions.
- Click Stop.
- Click Start again. While recording, ask the subject to open and close his or her hands, and then move both arms across the chest.
- The trace moves all over the place, and the ECG becomes distorted. This shows you why it is necessary for subjects to keep still and stay relaxed while their ECG is being recorded.
- With the subject sitting quietly, click Start again. When you have a trace without movement artifacts, type 'Resting ECG ' and the subject's name, and add the comment.
- Click Stop.

**Analysis**

- Scroll through your data and observe the regularly occurring ECG cycles.
- In a representative cycle, measure the amplitudes and durations of the P wave, QRS complex and T wave.
- To measure the amplitudes, place the Marker on the baseline immediately before the P wave. Then move the Waveform Cursor to the peak of a wave. Click to place the number in the Value panel.
- Drag the number from the Value panel into the appropriate column of the upper table.
- To measure the durations, leave the Marker at the start of the wave or complex and position the Waveform Cursor at the end of the wave or complex.
- Click to place the number in the Value panel and then drag the number from the Value panel into the appropriate column of the table.
- Now investigate how the heart rate may vary from beat to beat. To do this, set the horizontal compression to 10:1. Measure the time interval (in seconds) between three pairs of adjacent R waves using the Marker and Waveform Cursor.
Record your results in the lower table. For each interval, the heart rate is shown in column 3 of the table, calculated using the equation HR = 60 ÷ t, where HR = Heart Rate (beats/min) and, t = time interval (seconds).

**QRS Complex**

**Troubleshooting**

**Safety**

The push button switch and cardio microphone are perfectly safe when connected to Input 1 or Input 2 of a Power Lab. However, those inputs are not isolated and must not be used for direct electrical connection to human subjects.

**No visible ECG signal**

Check electrode connections, and make sure lead wires are attached correctly.

**Noisy ECG signal**

The most common issue when recording ECG is noise from external sources, including:

- Computer monitors
- Fluorescent overhead lamps
- Power supplies
- Biological noise

Turn off fluorescent lamps before recording ECG. Have the subject move away from CRT monitors in the room. Most biological noise comes from muscle contractions by the student. Have the subject remain motionless during ECG recording.

**POOR CONNECTION QUALITY**

Make sure students are not wearing metal jewelry. Lightly abrade the skin with an abrasive pad before applying the electrodes. Make sure that electrode cream is used on the reusable ECG electrodes. Alternatively, use disposable ECG electrodes to achieve better contact.

Two possible electrode connection sites are given in the student text. If the electrodes are connected to the upper arms, they are best positioned on the outer arm below the deltoid insertion and not over the biceps and triceps muscle groups.

- Make sure students check the electrode connections and placement.
- Artifacts can result from movement of the Bio Amp cable and leads.
- If the electrodes are connected backwards (i.e. positive electrode on right arm), the ECG signal will appear inverted. Reattach the cables the in the proper configuration.
ECG in a resting volunteer

1. What can you say about the amplitude of the various waves in different cardiac cycles? QRS normally has the greatest amplitude, and P wave has the smallest. There is usually very little difference from cycle to cycle.

2. The P wave and the QRS complex represent depolarization of the atrial and ventricular muscle respectively. Why does the QRS complex have the largest amplitude? Ventricles are bigger than atria, and ventricular muscle is thicker than atrial muscle.

3. In Steps 7 and 8 heart rate was calculated based upon the peak-to-peak interval of the R waves. Was there variability between the beats? Would you expect the interval between beats to be identical? Why or why not? Heart rate normally varies slightly with respiration (respiratory sinus arrhythmia). Heart rate usually varies a bit in healthy individuals.

4. The range for a normal resting heart rate is 60 to 90 bpm. A trained athlete could have a resting heart rate of 45 to 60 bpm. Why might a very fit person have a slower heart rate than someone of average fitness? The stroke volume may be larger, so that a sufficient cardiac output can be obtained with a lower heart rate.