Experiment HC-6: Effects of Temperature on Peripheral Oxygen Saturation Levels

Equipment Required

PC or Mac Computer

IXTA, USB cable, IXTA power supply

ROAM ECG electrodes

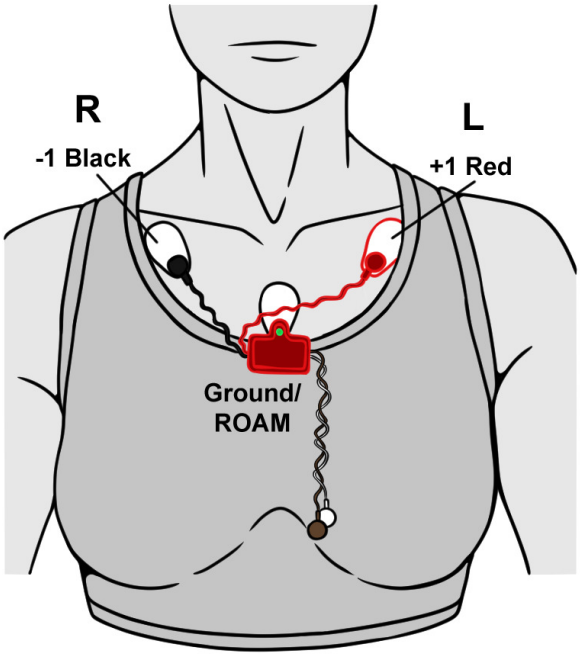
PPG-320 Pulse plethysmograph/oximeter

Disposable ECG electrodes

Ice, cold and hot water, plastic bag

ECG Cable and Pulse Oximeter Setup

1. Turn on the ROAM and attach the electrodes as shown.



2. Locate the PPG-320 pulse oximeter.
3. Plug the PPG-320 into the PT port. Place the sensor on the subject's left middle finger where the fingerprints are located (the volar surface).
4. Instruct the subject to sit quietly with their hands in their lap.

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Figure HC-6-S3: The PPG-320 pulse oximeter and TA with the ROAM in the dock.

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Experiment HC-6: Effects of Temperature on Peripheral Oxygen Saturation Levels

Exercise 1: Oxygen Saturation Level, Heart Rate, and Pulse Latency in a Resting Subject

Aim: To measure and correlate the oxygen saturation, heart rate, and the pulse latency in a resting individual.

Approximate Time: 15 minutes

Procedure

1. Type **Resting-Room Temp** in the Mark box.
2. Click on the Record button, located on the upper right side of the LabScribe Main window.

Figure HC-6-L1: ECG, pulse, oxygen saturation level, and heart rate displayed on the Main window.

3. Click the AutoScale All button. Your recording should look like the trace above.
    - If the signal on either the ECG or the Pulse channel is upside down when compared to trace click on the downward arrow to the left of the channel title and select the Invert function. The trace should now look similar to the one in the figure.
    - If the pulse signal is small or noisy, adjust the position of the pulse oximeter on the finger.

Work Lab

4. When the signals being recorded are suitably displayed, click the mark button to attach the comment to the data. Record for two minutes.
5. Click Stop to halt recording.
6. Select Save As in the File menu, type a name for the file. Click on the Save button to save the data file.

Data Analysis

1. Use the Display Time icons to adjust the Display Time of the Main window to show at least five to ten complete, exemplary ECG/Pulse cycles on the Main window.
2. Click on the Analysis window icon in the toolbar or select Analysis from the Windows menu to transfer the data to the Analysis window.
3. Look at the Function Table that is above the uppermost channel displayed in the Analysis window. The names of the mathematical functions used in the analysis, T2-T1, Max, Min, and Mean appear in this table. The values for T2-T1, Max, Min, and Mean from each channel are seen in the table across the top margin of each channel.
4. Once the cursors are placed in the correct positions for determining the oxygen saturation levels and heart rates on the ECG/Pulse cycles, the values of the parameters can be recorded in the on-line notebook of LabScribe by typing their names and values directly into the Journal, or on a separate data table.

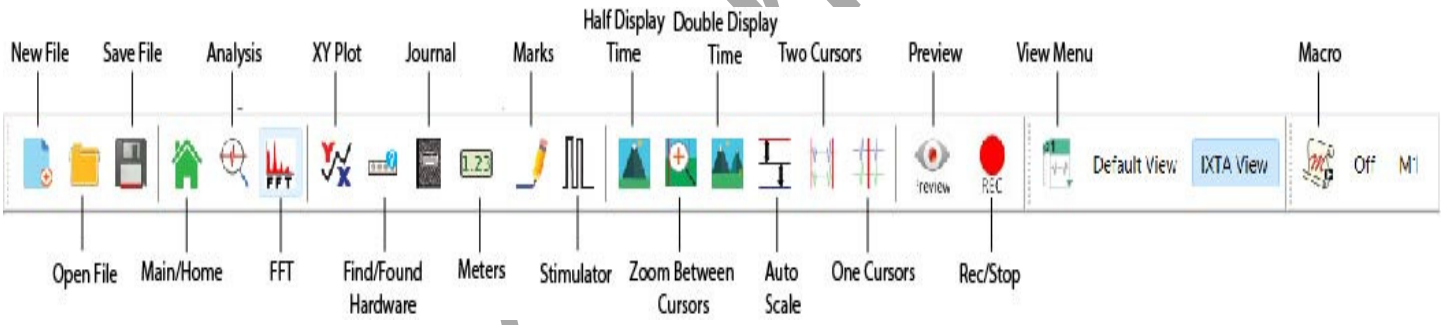

Figure HC-6-L2: The LabScribe toolbar.

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Figure HC-6-L3: ECG, pulse, oxygen saturation level, and heart rate displayed on the Analysis window.

5. The functions in the channel pull-down menus of the Analysis window can also be used to enter the names and values of the parameters from the recording to the Journal. To use these functions:
    - Place the cursors at the locations used to measure the amplitudes and period of the ECG/Pulse cycle.
    - Transfer the names of the mathematical functions used to determine the saturation levels, rates, and intervals to the Journal using the Add Title to Journal function in the ECG Channel pull-down menu.
    - Transfer the values for the saturation levels, rates, and intervals to the Journal using the Add Ch. Data to Journal function in the ECG Channel pull-down menu.
6. Place the cursors so that they are on either side of the group of ECG/Pulse cycles. Refer to Figure HC-6-L3.
7. Record the following from the O2 Saturation and the Heart Rate channels for the selected ECG/Pulse cycles. Record these values in the Journal using one of the techniques described in Step 6, and on Table 1.
    - Maximum Oxygen Saturation Level, which is the value for Max on the O2 Saturation channel.
    - Minimum Oxygen Saturation Level, which is the value for Min on the O2 Saturation channel.

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- Mean Oxygen Saturation Level, which is the value for Mean on the O2 Saturation channel.
- Maximum Heart Rate, which is the value for Max on the Heart Rate channel.
- Minimum Heart Rate, which is the value for Min on the Heart Rate channel.
- Mean Heart Rate, which is the value for Mean on the Heart Rate channel.

9. Measure the Pulse Latency, which is the time interval between the peaks of the R wave and the pulse wave that follows the R wave. Place one cursor on the peak of an R wave and the second cursor on the peak of the pulse wave to its right. The value for T2-T1 on any channel is the Pulse Latency. Measure this interval for two additional ECG/Pulse cycles. Refer to Figure HC-6-L4.
10. Record these values in the Journal using one of the techniques described in Step 6, and on the data table.
11. Calculate the average Pulse Latency and record your results into the Journal, and on the data table.
12. Click on the Save button in the File menu.

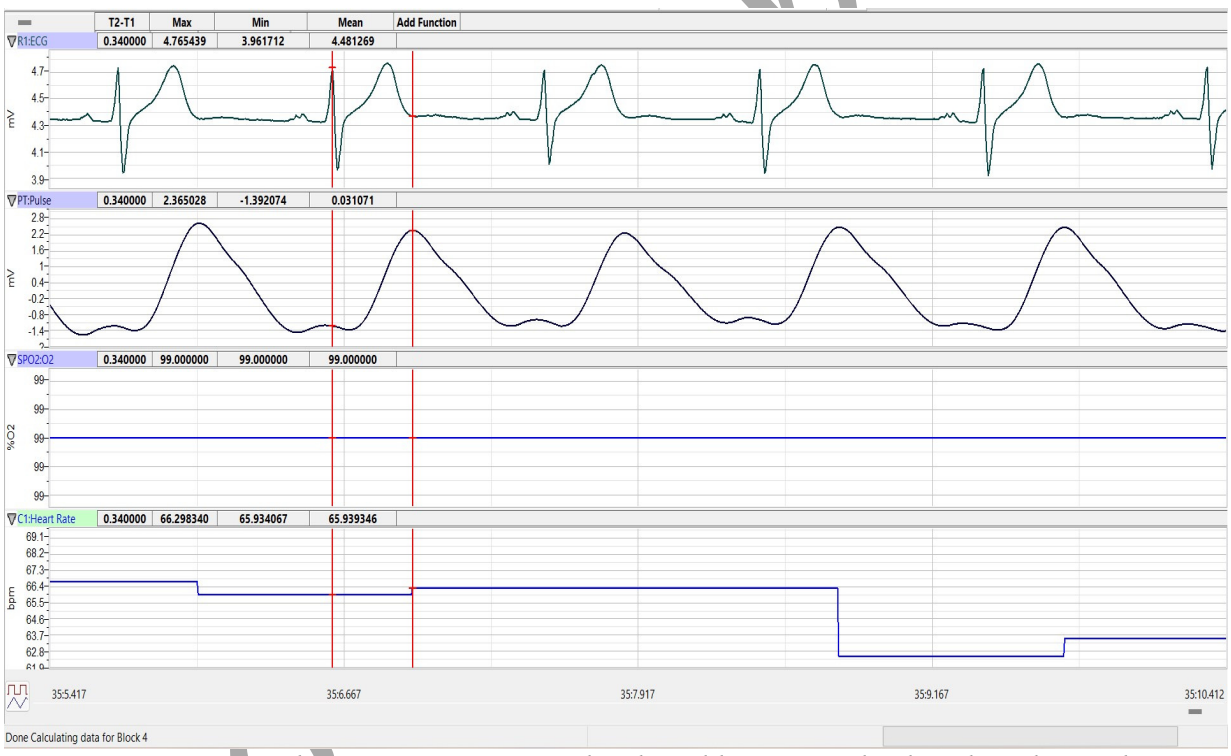

Figure HC-6-L4: ECG, pulse, oxygen saturation level, and heart rate displayed on the Analysis window with cursors in position to measure pulse latency.

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Questions

1. What electrical and mechanical events take place during the R wave?
2. What events take place in the cardiovascular system during the R and pulse waves?
3. Does the subject's oxygen saturation level remain constant throughout the ECG cycles?
4. If the levels fluctuate during the ECG cycles, what could be a cause for this fluctuation?
5. Is the heart rate consistent throughout the recordings? If there are changes in heart rate, what could be causing these changes?

Exercise 2: Oxygen Saturation Levels, Heart Rates, and Pulse Latencies in Other Subjects

Aim: To measure and correlate the ECG, oxygen saturation and the pulse in other subjects.

Approximate Time: 30 minutes depending on number of subjects

Procedure

Use the same procedures used in Exercise 1 on other subjects.

Data Analysis

Use the same techniques employed in Exercise 1 to analyze the data in Exercise 2.

Questions

1. Is the pulse latency the same for each subject? Does this time interval differ with heart rate?
2. Do you see any differences in the oxygen saturation levels from different subjects?
3. Is there any correlation between physical fitness, heart rate and blood oxygen saturation level?

Exercise 3: Effect of Cold on Oxygen Saturation Level, Heart Rate, and Pulse Latency

Aim: To measure the effects of cold on blood oxygen saturation level, heart rate, and pulse latency.

Approximate Time: 30 minutes

Procedure

1. Instruct the subject to sit quietly with their hands in their lap.
2. Type **RoomTemp** in the Mark box. Click on the Record button. The signal should begin scrolling across the screen.
3. Use the same techniques used in Exercises 1 and 2 to display the signals properly.
4. Click the mark button to attach the comment to the data. Record for one minute
5. Type **Cooling Begins** in the Mark box. Place a bag containing a mixture of ice and cold water on the inside of the subject's left forearm. At the same time, click the mark button to attach the comment to the data. Continue recording.

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6. Type **Cooling-One Minute** in the Mark box to the right of the Mark button.
7. One minute after the cooling pack was placed on the subject's forearm, click the mark button to attach the comment to the data. Continue recording.
8. Type **Cooling Pack Removed** in the Mark box.
9. Two minutes after the cooling pack was placed on the subject's forearm, remove the cooling pack from the subject's forearm and click the mark button to attach the comment to the data. Continue recording.
10. Type **Rewarming-One Minute** in the Mark box.
11. One minute after the cooling pack was removed from the subject's forearm, click the mark button to attach the comment to the data. Continue recording.
12. Type **Rewarming-Two Minutes** in the Mark box.
13. Two minutes after the cooling pack was removed from the subject's forearm, click the mark button to attach the comment to the data. Then, click the Stop button to halt the recording.
14. Select Save to save the data.

Data Analysis

Use the same techniques employed in Exercises 1 and 2 to analyze the data in Exercise 3.

Questions

1. What effect does cooling have on the amplitude of the pulse wave?
2. Does cooling of the forearm affect the heart rate or the oxygen saturation levels of the blood as it moves through the forearm? Does it affect both?
3. Through what mechanism does cooling affect the peripheral circulation?
4. What other factors may affect peripheral circulation?

Exercise 4: Effect of Heat on Oxygen Saturation Level, Heart Rate, and Pulse Latency

Aim: To measure the effects of heat on blood oxygen saturation level, heart rate, and pulse latency

Approximate Time: 30 minutes

Procedure

1. Attach the pulse oximeter to the subject's right middle finger. Instruct the subject to sit quietly with their hands in their lap.

NOTE – you are changing arms for this exercise, so make sure to change the pulse oximeter to the subject's right middle finger.

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2. Use the same procedures employed in Exercise 3 to record the subject's ECG, pulse, oxygen saturation level, and heart rate before, during, and after the subject's right forearm is warmed with a heat pack.
3. Mark the recording with comments at the appropriate points in the recording.
4. Select Save to save the data.

Data Analysis

Use the same techniques employed in Exercises 1, 2, and 3 to analyze the data in Exercise 4.

Questions

1. What effect does warming have on the amplitude of the pulse wave?
2. Does warming the forearm affect the heart rate or the oxygen saturation levels of the blood as it moves through the forearm? Does it affect both?
3. Through what mechanism does warming affect the peripheral circulation?

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Table HC-6-L1: Oxygen Saturation Levels, Pulse Rates, and Pulse Latencies at Room Temperature and while Cooling and Warming the Forearm.

Subject:	%O2 Saturation			Pulse Rate (BPM)			Pulse Latency			
Conditions	Max	Min	Mean	Max	Min	Mean	Cycle1	Cycle2	Cycle3	Mean
Resting, Room Temperature										
Control, Room Temperature										
After 1 Minute of Cooling										
After 2 Minutes of Cooling, Pack Removed										
After 1 Minute of Warming to Room Temp										
After 2 Minutes of Warming to Room Temp										
Control, Room Temperature										
After 1 Minute of Warming										
After 2 Minutes of Warming, Pack Removed										
After 1 Minute of Cooling to Room Temp										
After 2 Minutes of Cooling to Room Temp										

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