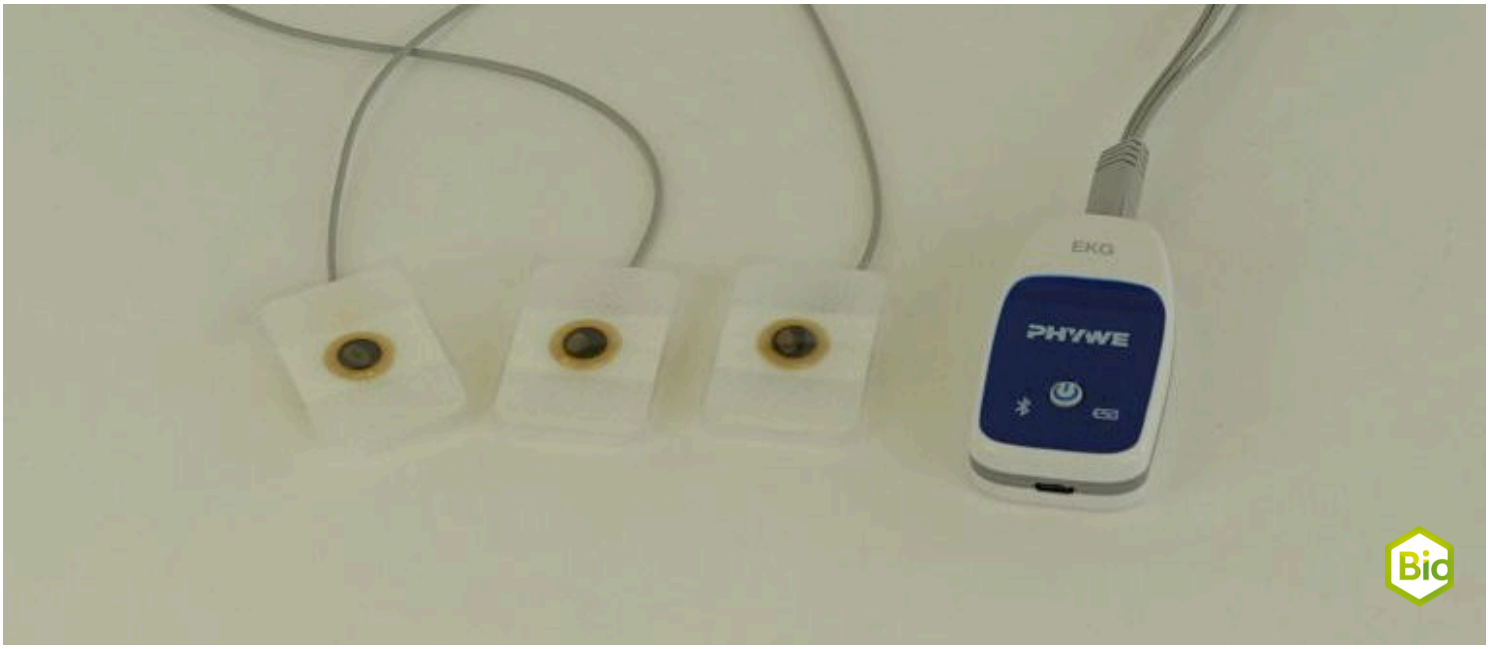
We examine our physical fitness - The heart under stress with Cobra SMARTsense



Biology > Human Physiology > Cardiovascular system

Difficulty level	Group size	Preparation time	Execution time
easy	2	10 minutes	10 minutes

This content can also be found online at:

http://localhost:1337/c/6135fcbffd803000038590ea

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Teacher information

Application

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Experiment setup

With the help of an electrocardiogram (ECG), the sum of the electrical activities of all heart muscle fibers can be registered. The heart activity increases with the load of the body, so that the stability of the cardiovascular system is maintained. The contraction of the heart cannot be controlled by humans at will. In this experiment, you can investigate how physical stress affects cardiac activity.

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Other teacher information (1/4)

Prior knowledge

Students should already know about the body's cardiovascular system and what an electrocardiogram (ECG) is.

Scientific Principle

With the help of an ECG, a comparison can be made between a heart at rest and a heart under physical exertion.

Other teacher information (1/4)

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Other teacher information (2/4)

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Learning objective

The students should realize that the heart has to work much harder under stress in order to supply the muscles with sufficient oxygen.

Tasks

The students create an ECG in the transition from a state of rest to a state of physical exertion (20 knee bends). Then they calculate the time in which the resting pulse is reached again. This is different for everyone, because it depends on the state of fitness.

Other teacher information (3/4)

Additional information

Like skeletal muscle, cardiac muscle is classified as striated muscle. However, the heart muscles are not subject to voluntary control as is the case with skeletal muscles. An electrocardiogram is used to visualize the electrical excitations of the different phases in the course of the heart's activity. During physical exertion, the heart rate increases so that the stability of the cardiovascular system remains stable. On the one hand, the level of the heart rate at rest depends on the body size of a person. This is related to the size of the heart in relation to the rest of the body volume. Thus, a relatively small heart (e.g., in an infant) must beat more frequently to pump the same amount of blood through the circulatory system. On the other hand, the heart muscle is trainable. In a person with a relatively large and strong heart muscle (such as an endurance athlete), correspondingly fewer cardiac contractions are necessary to maintain the stability of the cardiovascular system. Endurance athletes therefore generally have a lower resting heart rate than untrained people. A resting rate of 30-35 heart contractions per minute is quite possible.

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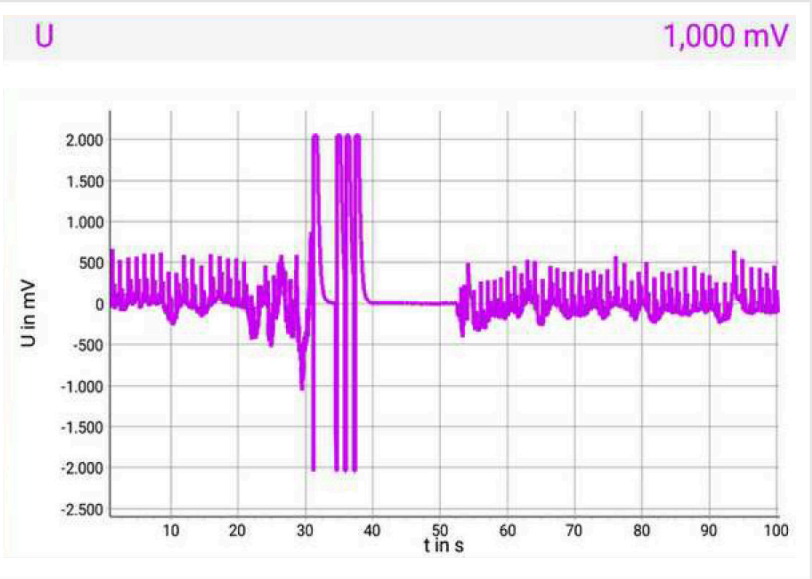
Other teacher information (4/4)

Result

After completion of the measurement, the students should select suitable sections of the measurement using the "Zoom"-function and evaluate them. The "Measure"-button is well suited for this.

Make sure that the students take care that the subject does not move during the measurement in the resting position. Even small movements, such as raising a hand, will cause overlap of cardiac muscle activity during the measurement.



Safety instructions

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- Take into account the physical constitution of the students within the framework of physical stress!
- An ECG recorded at school should not be over-interpreted if there are deviations from exemplary ECGs in the illustrations. Circulatory disorders or damage to the heart muscle can only be determined with certainty by a doctor.
- The general instructions for safe experimentation in science lessons apply to this experiment.

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Student Information

Motivation

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In professional cycling races, cardiac activity is constantly measured and radioed to the team car.

With the help of an electrocardiogram (ECG), the sum of the electrical activities of all heart muscle fibers can be registered. The heart activity increases with the load of the body, so that the stability of the cardiovascular system is maintained. The contraction of the heart cannot be controlled by humans at will. In this experiment, you can investigate how physical stress affects cardiac activity.

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Equipment

Position	Material	Item No.	Quantity
1	Cobra SMARTsense - EKG, 0 ... 4,5 mV (Bluetooth + USB)	12934-01	1
2	measureAPP - the free measurement software for all devices and operating systems	14581-61	1

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Structure (1/4)

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For measurement with the **Cobra SMARTsense sensors** the **PHYWE measureAPP** is required. The app can be downloaded free of charge from the relevant app store (see below for QR codes). Before starting the app, please check that on your device (smartphone, tablet, desktop PC) **Bluetooth** is **activated**.

iOS

Android

Windows

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Structure (2/4)

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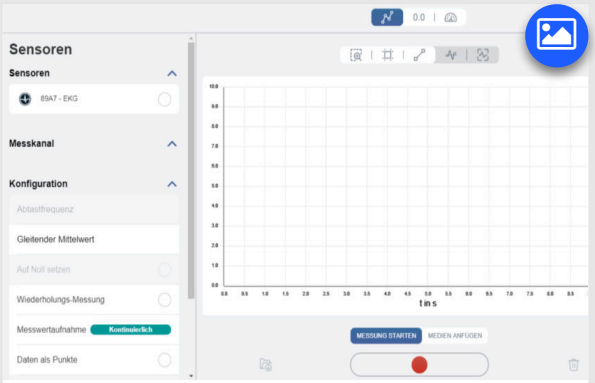

User interface measureApp

in the Windows 10 version

- Turn on the SMARTsense ECG sensor by pressing and holding the power button.
- Connect the sensor in the measureAPP under the item "Measure" with the device as shown in the figure on the left.
- The SMARTsense ECG sensor is now displayed in the app.

Structure (3/4)

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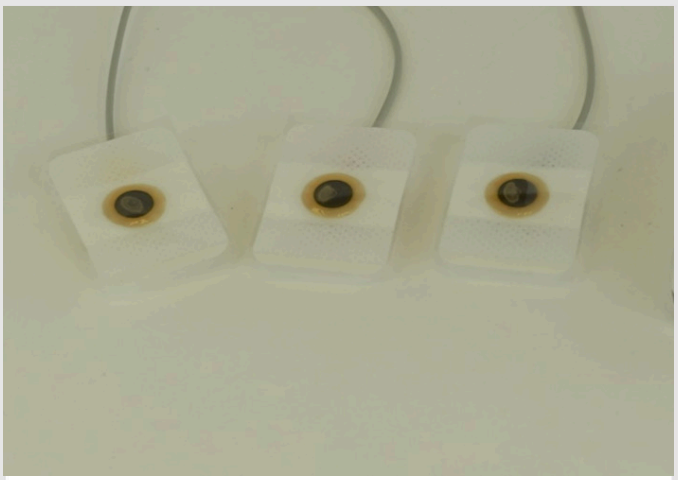
Preparation and attachment of the disposable electrodes

Heart, muscle and eye activity is measured on the surface of the skin. For each organ, measurements are taken at different skin positions. For example, for the heart below the palms of the hands and above a foot on the inside of the calf.

For starters, disposable electrodes are best because you can simply stick them on the skin positions mentioned in the experiment descriptions without any further accessories and they provide acceptable results. For measurement, simply use the push buttons on the three cables to attach the disposable electrodes.



Disposable electrodes, fixed with press studs

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Structure (4/4)

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- At least two people are involved in the experimental setup. One subject to whom the electrodes are applied and one person who operates the computer/tablet.
- Attach one disposable ECG electrode each with the adhesive side to the inside of the right and left wrist and to the left ankle. The subject should now sit down in as relaxed a position as possible.
- Now you can connect the electrode collector cable to the SMARTsense sensor ECG Connect.

Procedure (1/2)

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The subject during physical exercise

- Select the ECG sensor mode.
- Start the measurement when the voltage has settled.
- **Important** is that during the measurement, before and after the physical stress, the test subject must **completely calm** otherwise other muscle activities will be recorded as well.

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Procedure (2/2)

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Measurement 1:

- Start the measurement when the test person is at rest. 20 seconds after the start of the measurement, the test person exerts physical strain on the body (e.g. 20 knee bends). Afterwards, the subject must immediately return to a calm posture (sit down on the chair) so that the resting pulse rate is restored for measurement 2.
- Save the measurement and start the next measurement.

Measurement 2:

- Set a countdown of 300 seconds. Use either the integrated stopwatch of the PHYWE measure app or any other timer. Now start the measurement immediately after the test person has performed 20 squats and has moved to the rest position.
- When the 300 seconds are over, finish the measurement and save it.

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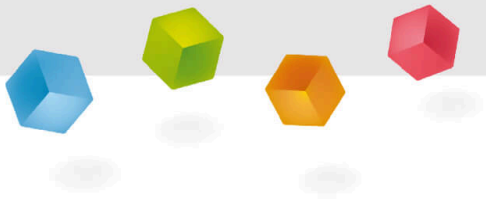

Report

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Task 1

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How quickly does cardiac activity change after physical exertion ends?

Calculate the time after which the resting pulse is reached again. To do this, look at three sections of the ECG and determine the heart rate (f/min) by measuring the time interval between two upper transition points in the so-called QRS complex of the ECG:

Directly after the end of the load - **100 seconds** after the end of the load - **250 seconds** at the end of the load

Task 2

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What factors positively influence the heart rate?

- ☐ Sports
- ☐ Stress
- ☐ Overweight
- ☐ Healthy diet

Check

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Task 3

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The heart rate in a healthy adult is between 50 and 100 beats per minute, depending on physical condition.

○ True ○ False

Check

The time interval between two heartbeats is 10-15 seconds.

○ True ○ False

Check

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