



BIOPAC SCIENCE LAB

Bridging the gap between high school and college.

Hands-on, Technology-based Science for Students

Proven lab equipment that's used in thousands of science labs around the world.

Explore the inner workings of the human body with a new, inexpensive physiology monitor and practical science experiments where students are the subjects: the Biopac Science Lab system—specifically designed for secondary education.

- BIOPAC is a leader in the field of life science research and education data acquisition with over 20 years of experience
- BIOPAC education systems are used in most leading university and college undergraduate biology and physiology lab programs—over 2 million successful lab hours
- BIOPAC research products are used in labs around the world and cited in thousands of peer reviewed scientific journals

The Biopac Science Lab bridges the gap between high school and college by making the same physiology recording technology available at an earlier stage. The Biopac Science Lab brings practical science experiments to the classroom and engages student minds with exciting and fun science-based lessons that teach them today and prepare them for tomorrow. Students collect data from their own bodies, analyze it, and compare results with other students.

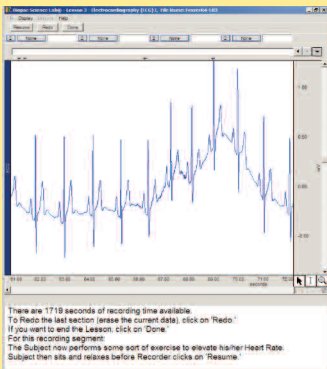
The Biopac Science Lab is specifically designed for the classroom. It connects to any computer—Windows or Mac. This robust, easy to use system is very powerful. Use it in your classroom to allow students to record signals from their own bodies. Curriculum is detailed on pages 3-12 and includes:

- EMG I Muscle - S01
- EMG II Muscle - S02
- ECG I Heart - S03
- ECG II Heart - S04
- EEG I Brain - S05
- EEG II Brain - S06
- EOG Eyes - S08
- Biofeedback - S09
- Aerobic Exercise - S10
- Reaction Time - S11
- Respiration - S12



Core Physiology Lessons

Promote scientific inquiry and participation as students record data from their own bodies with 11 tutorial-style lessons.



Advance the potential of your students—accept your free trial today!

All you need is a computer and students. No technical expertise required!

The handheld Biopac Science Lab works with your computer's sound card or USB audio adapter—it's as easy as connecting headphones. Runs on Windows or Mac.

- Complete an online request at www.biopac.com/InfoRequest.asp
- Email info@biopac.com
- Call (805) 685-0066

LESSON FEATURES

- Curriculum materials support the national science standards and provide objective-based and inquiry-based teaching options.
- On-screen prompts and buttons guide students through each experiment.
- Lessons share the same format and user interface to build familiarity and confidence.
- Video clips and downloadable sample data files provide additional insight about using the system to help ensure good results.
- Extremely easy to set up and record data.
- Active learning options — students can design and record a new experiment to test or verify the scientific principles covered in the Biopac Science Lab lesson.
- Preparation and distance learning tools in the software and online at www.biopac.com.
- Lessons are written by experienced physiology teachers.
- Data reports with sample questions challenge students to apply what they learn from the lesson.
- Teachers Guide includes sample questions and answers, normative values, and Biopac Science Lab support.

BIOPAC SCIENCE LAB INTRO SYSTEM

Includes: Curriculum, MP40 Recorder, Electrode Lead Set (three clip leads), and electrodes (pack of 60).

Optional: Stimulus/Response Pack — headphones and feedback cables for Reaction Time lesson.

Available in single units or class packs (x5).



EMG 1 Electromyography: Motor Unit Recruitment**MUSCLE**

EMG 1 investigates the properties of skeletal muscle. Students record the EMG data associated with the maximum clench strength for their dominant and non-dominant hand. The system records and displays both the raw and integrated EMG signals. Students compare clench strength from right to left hand and listen to the sound of their EMG. It is also possible for students to perform a cross-group analysis.

**Experimental Objectives**

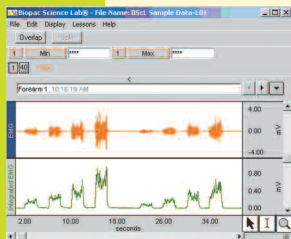
- To record maximum clench strength for each hand.
- To observe, record, and correlate motor unit recruitment with increased power of skeletal muscle contraction.
- *Optional:* To listen to EMG “sounds” and correlate sound intensity with motor unit recruitment.

Tasks Performed by Students

- Record EMG from the dominant and non-dominant hand.
- Clench fist four times, squeezing harder each time to reach maximum clench strength with the fourth clench.
- *Optional:* Listen to the sound of their EMG.

Key Features

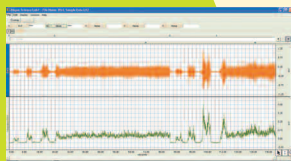
- Raw and Integrated EMG signals can be overlapped for easy interpretation of the data.
- Comparison between the dominant and non-dominant hand.
- Students listen to the sound of motor unit recruitment.

**EMG 2 Electromyography: Mechanical Work****MUSCLE**

EMG 2 examines motor unit recruitment and skeletal muscle fatigue. Students lift hand weights to demonstrate the use of skeletal muscle and record EMG while inducing muscle fatigue. Students see the level of motor unit recruitment associated with the amount of applied force.

Experimental Objectives

- To record EMG response to increased weights lifted by dominant and non-dominant arms.
- To compare differences between male and female students.
- To observe, record, and correlate motor unit recruitment with increased mechanical work by skeletal muscle.
- To record EMG and Integrated EMG when inducing fatigue.
- *Optional:* To listen to EMG “sounds” and correlate sound intensity with motor unit recruitment.



Tasks Performed by Students

- Lift weight (bicep curl) and hold for 2 seconds.
- Repeat cycles of weight lifting; add weight for each cycle until the Subject is lifting the maximum weight.
- Lift the maximum weight to 45 degrees and hold it until the onset of fatigue.
- Repeat the sequence for the non-dominant arm.
- *Optional:* Listen to the sound of their biceps EMG.

Key Features

- Classic, clinical grid markings available for quick and easy evaluations.
- Raw and Integrated EMG signals can be overlapped for easy interpretation of the data.
- Students compare their dominant and non-dominant arms.
- Force values are scaled to kilograms.
- A clear demonstration of mechanical work.

ECG I *Electrocardiography: Components of the ECG*

HEART

ECG I introduces the electrocardiograph and the recording of the heart's electrical signal. Students learn about Lead II ECG recording and the components of the ECG complex. They also learn to correlate the electrical events of the ECG (P, Q, R, S & T components) with the mechanical events of the cardiac cycle. After performing a number of tasks designed to promote changes in the ECG complex, students analyze their own ECG recording.

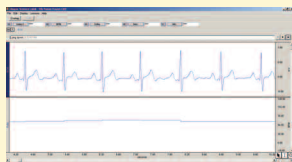


Experimental Objectives

- To become familiar with the electrocardiograph as a primary tool for evaluating electrical events within the heart.
- To observe rate and rhythm changes in the ECG associated with body position and breathing.

Tasks Performed by Students

- Lie down and relax.
- Take five deep breaths.
- Perform a physical exercise to increase heart rate.
- Relax while heart rate returns to normal.



Key Features

- Rate and ECG signals can be overlapped for easy interpretation of the data.
- The baseline can be adjusted for precise analysis and printing.
- Zoom in for a closer look at an individual ECG complex.
- See how the ECG complex changes under different conditions.
- Convenient electrode placement (wrists and ankles).

ECG 2 Electrocardiography: Einthoven's Triangle

HEART

ECG 2 explains Einthoven's triangle. Students record Leads I and III while performing a number of tasks designed to change the rhythm of the heart. After recording, students analyze the data and estimate the mean QRS axis and potential.



Experimental Objectives

- To record ECG from Leads I and III in the following conditions: lying down, sitting up, and breathing deeply while sitting.
- To compare the direction of the QRS complex (+ or -) with the direction of the lead axis.
- To estimate the mean ventricular potential.
- To estimate the mean electrical axis of the QRS complex.

Tasks Performed by Students

- Record ECG using bipolar Leads I and III.
- Lie down and relax.
- Sit and relax.
- Breathe in and out once in each position.

Key Features

- The software makes it very easy for the student to compute the ECG vectors (Lead I, Lead II, Lead III).
- Classic, clinical grid markings available for quick and easy evaluations.
- See how the ECG complex changes under different conditions.
- Students place markers for each wave component (P, Q, R, S, and T) of the electrocardiogram.



EEG I Electroencephalography: Brain Rhythms

BRAIN

EEG I introduces electroencephalographic recording techniques. Students record EEG from the occipital lobe while performing a number of different tasks to demonstrate how the brain's electrical activity varies depending on the task. The software filters the raw EEG signal to separate and display alpha, beta, delta, and theta rhythms.



Experimental Objectives

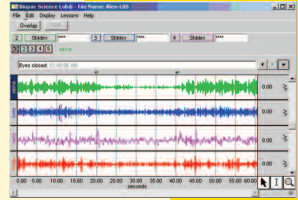
- To record an EEG from an awake, resting subject with eyes open and eyes closed.
- To identify and examine alpha, beta, delta, and theta components of the EEG complex.
- To compare differences between male and female students.

Tasks Performed by Students

- Record EEG from the occipital lobe.
- Record EEG from a relaxed subject with their eyes closed, eyes open, and eyes closed again.

Key Features

- Alpha, beta, delta and theta EEG wave components are automatically filtered and displayed.
- Notice how the wave relationships change on the basis of different mental tasks.
- Overlap the EEG wave components for a better view of the data.



EEG 2 Electroencephalography: Alpha Rhythms

BRAIN

In EEG 2, students will discover how the brain constantly receives sensory input and integrates the information before processing it. Students record EEG data from the occipital lobe while performing a number of tasks. The system records and displays the raw EEG together with alpha wave and alpha-RMS activity. Students compare baseline EEG with data recorded during different tasks.

Experimental Objectives

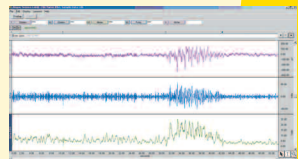
- To record an EEG from an awake, resting subject under the following conditions:
 - relaxed with eyes closed
 - performing mental arithmetic with eyes closed
 - hyperventilating (breathing quickly and deeply)
 - relaxed with eyes open.

Tasks Performed by Students

- Record EEG from the occipital lobe.
- Lie down and relax with eyes closed.
- Perform mental math problem with eyes closed.
- Hyperventilate for two minutes.
- Recover from hyperventilation with eyes open.

Key Features

- Alpha wave activity and alpha-RMS waveforms are automatically filtered and displayed.
- Overlap the EEG wave components for different views of the data.



EOG I Electrooculogram: Fixation & Tracking**EYES**

In EOG I, students record horizontal eye movement and observe eye fixation and tracking. Students perform tasks that allow them to record the duration of saccades and fixation. Students also record spatial position of eye movements.

Experimental Objectives

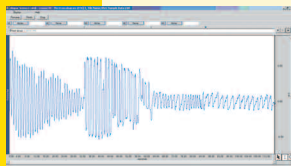
- Record EOG on the horizontal plane and compare eye movements under the following conditions: pendulum tracking, pendulum simulation, reading silently, reading aloud, and reading challenging material or material written in an unfamiliar language.
- Measure duration of saccades and fixation during reading.
- *Optional:* explore microsaccadic eye movement.

**Tasks Performed by Students**

- Record horizontal EOG.
- Track real pendulum movement with eyes only.
- Simulate pendulum movement (decreasing swing cycles) with eyes only.
- Read Passage 1 (easily understandable material) silently.
- Read Passage 2 (challenging material) silently.
- Read Passage 1 aloud.
- *Optional:* Focus on an on-screen guide; position of guide represents point of focus.

Key Features

- Tools for zooming in to see the saccades.
- Great introduction to EOG.
- Explore relationship between reading ability and EEG waveform shape.

**Biofeedback: Autonomic Tone****AUTONOMIC NERVOUS SYSTEM**

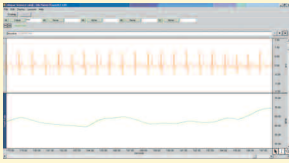
The Biofeedback lesson explores the concept of biofeedback training and its effect on autonomic control of heart rate. An onscreen, thermometer-style heart rate display rises and falls with changes in heart rate, allowing students to become conscious of their heart rates. Student attempts to influence the reading without physical movement.

**Experimental Objectives**

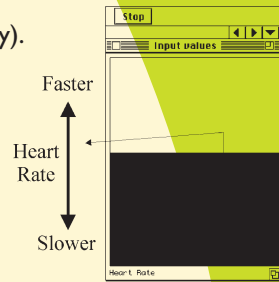
- Introduce the concept of biofeedback as a technique to alter autonomic tone.
- Measure changes in autonomic tone via heart rate.

Tasks Performed by Students

- Record ECG and heart rate.
- Sit and relax with eyes open, facing away from the screen to establish baseline heart rate and ECG.
- Watch heart rate monitor and mentally try to voluntarily increase parasympathetic tone (lower heart rate display).



- Watch heart rate monitor and mentally try to voluntarily increase sympathetic tone (increase heart rate display).
- Watch two PowerPoint presentations and try to remain relaxed.



Key Features

- Great introduction to biofeedback techniques.
- Shows students how they can influence and control the autonomic nervous system.
- Excellent display format for immediate visual feedback.

Aerobic Exercise Physiology

HEART & METABOLIC DEMANDS

In the Aerobic Exercise Physiology lesson, students record ECG and heart rate under a variety of activity conditions. Students see how the electrical activity of the heart and their heart rate vary to meet changing metabolic demands. Students exercise to elevate heart rate.

Experimental Objectives

- Measure changes in heart rate associated with a specified set of dynamic exercises.
- Assess individual physical fitness by measuring elevated heart rate at the immediate end of a specific exercise period.
- Assess individual physical fitness by measuring the time from the end of exercise to the return of resting heart rate.
- Compare performance levels between groups, such as young women vs. young men, or persons with body weight 75–150 lbs. vs. persons with body weight 151–250 lbs.



Tasks Performed by Students

- Record ECG and heart rate.
- Calculate personal maximum heart rate.
- Sit and relax.
- Exercise (e.g. running in place/jumping jacks) to elevate heart rate.
- Recover from exercise (sit and relax).



Key Features

- Great introduction to physiological changes associated with exercise.
- The equipment does not interfere with the exercise.
- No specific exercise equipment is required to run the lesson.

Reaction Time: *Fixed & Pseudo-random Trials*

BRAIN

The Reaction Time lesson demonstrates the effect of learning and psycho-physiological processes on reaction times. Students hear two presentation schedules of clicks through a set of headphones. With electrodes in place to record the activity of the extensor digitorum (the primary muscle used to lift a finger), the Subject lifts a finger as quickly as possible after hearing a click. Students then perform a statistical analysis of the results, including: group mean, variance, and standard deviation.



Experimental Objectives

- Measure and compare reaction times of an individual subject using two stimulus presentation schedules: fixed intervals and pseudo-random intervals.
- Introduce elements of statistics into data analysis.
- Use statistics to determine the effects of learning on reaction times.

Tasks Performed by Students

- React to a schedule of fixed interval clicks (two trials).
- React to a schedule of pseudo-random clicks (two trials).

Key Features

- The software automatically calculates the reaction time.
- Students are guided through the statistical analysis of a data set.
- The lesson can operate on a variety of stimuli.

Respiration I: *Apnea*

RESPIRATORY SYSTEM

In Respiration I, students observe physiologic modifications of the respiratory cycle associated with voluntarily increasing and decreasing blood carbon dioxide content by holding breath and hyperventilating. Students will qualitatively determine changes in respiratory minute volume by recording and analyzing the EMG from respiratory muscles of the thorax.

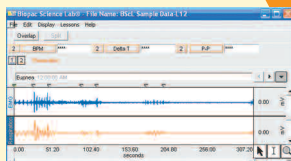


Experimental Objectives

- To observe and record the EMG from thoracic respiratory skeletal muscle during eupnea (normal unlabored breathing at rest).
- To record changes in the EMG associated with modifications in the rate and depth of the respiratory cycle that occur before, during, and after periods of apnea vera (involuntarily holding of breath) and voluntary apnea (holding of breath) and to compare those changes to eupnea.

Tasks Performed by Students

- Record EMG and respiration.
- Breathe normally with mouth open.
- Hyperventilate.
- Recover from hyperventilation.
- Hold breath.
- Hyperventilate and then hold breath.



Key Features

- Great introduction to the respiratory effects of increased or decreased blood carbon dioxide content.
- No special respiratory equipment required to run the lesson.
- The lesson setup can record and allow students to study other respiratory variations.

NATIONAL SCIENCE EDUCATION STANDARDS

Content Standard Science Levels 9-12	Lesson Correlation											
	S01	S02	S03	S04	S05	S06	S08	S09	S10	S11	S12	
A3 Unifying Concepts and Processes: Change, Constancy, and Measurement	◆	◆	◆	◆	◆	◆	◆	◆	◆		◆	
A5 Unifying Concepts and Processes: Form and Function	◆	◆	◆	◆	◆	◆	◆		◆	◆	◆	
B1 Science as Inquiry: Abilities Necessary to do Scientific Inquiry	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	
B2 Science as Inquiry: Understandings About Scientific Inquiry	◆	◆	◆	◆	◆	◆	◆	◆		◆	◆	
D5 Life Science: Matter, Energy, and Organization in Living Systems	◆	◆	◆		◆	◆	◆	◆		◆	◆	
G1 Science in Personal and Social Perspectives: Personal and Community Health		◆	◆	◆	◆	◆	◆	◆	◆	◆	◆	

- S01 • EMG I Muscle
- S02 • EMG II Muscle
- S03 • ECG I Heart
- S04 • ECG II Heart
- S05 • EEG I Brain
- S06 • EEG II Brain
- S08 • EOG Eyes
- S09 • Biofeedback
- S10 • Aerobic Exercise
- S11 • Reaction Time
- S12 • Respiration

Go to BIOPAC.COM for a detailed standards report.

Engage your students with exciting lab experiments!

Try Biopac Science Lab in your classroom.

Take advantage of a **FREE 14-Day Trial !**

We pay UPS shipping to and from your secondary school.

Request your free trial today:

www.biopac.com/InfoRequest.asp • Info@biopac.com