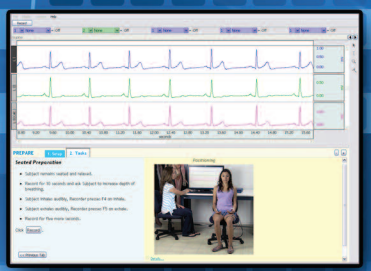
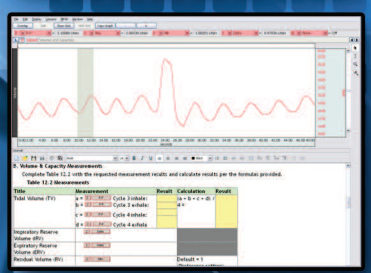
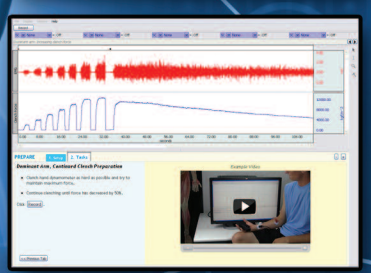
BIOPAC STUDENT LAB

An integrated system of hardware, software and a lab manual that revolutionizes life science education







BIOPAC® Systems, Inc.
Registered to ISO 9001:2008

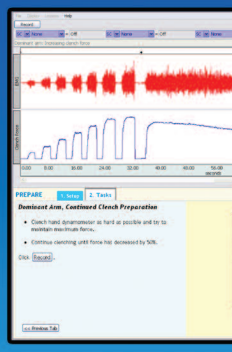
www.biopac.com

BIOPAC STUDENT LAB FOR TEACHING

Integrated Hardware, Software & Curriculum

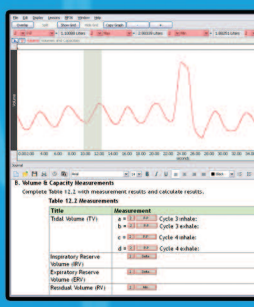
EMPOWER YOUR STUDENTS WITH INTERACTIVE, MULTI-MEDIA LESSONS

- Students Record Live Physiological Data
- Focus on Key Principles
- Develop Real-World Skills
- Use Clinical & Standardized Techniques
- Extensive Experiment Range
- Instructor and Student Prep Tools
- Millions of Successful Lab Hours
- Proven to Increase Confidence & Proficiency



STUDENTS RECORD FROM THEIR OWN BODIES, ANIMALS, OR TISSUE PREPS

- Easy Setup...Great Data!
- Add Student-Designed Experiments
- Create Your Own Lessons
- Use Advanced Analysis



COMPLETE SYSTEMS FOR LIFE SCIENCE LABS

- Physiology
- Biology
- Psychophysiology
- Neuroscience
- Exercise Physiology & Biomechanics
- Pharmacology & Toxicology
- Biomedical Engineering
- Nursing

Used in thousands of labs worldwide! Incorporated in major published lab manuals!

Runs on Windows or Mac

www.biopac.com

BIOPAC® Systems, Inc.

"...these systems have successfully transformed the physiology laboratory"

Research-Quality Tools for Education

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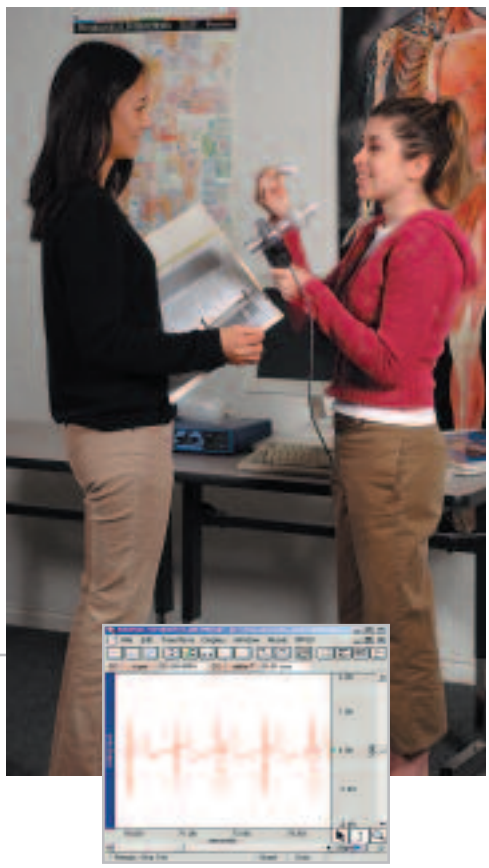
www.biopac.com
info@biopac.com

the #1 solution
for life science education just keeps getting better!

The Biopac Student Lab System is an integrated solution that includes hardware and software that students use to record data from their own bodies, animals or tissue preparations. Also includes 65+ life science lesson experiments and easy instructions to modify them or integrate your existing syllabus. The BSL is #1 in CLASS!

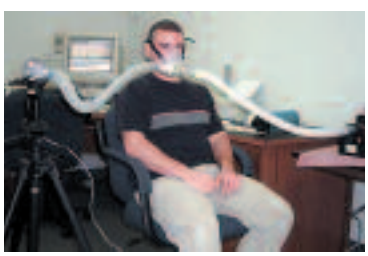


Curriculum

- Total of 65+ lesson experiments
- Comprehensive support from published Lab Manuals—
  Marieb: PEARSON Benjamin Cummings, Fox: WCB/McGraw-Hill,
  Wood: PEARSON Benjamin Cummings, Pflanzer: Kendall/Hunt
- Video demonstration clips
- Online lessons
- Distance learning
- Suitable for 2- & 4-year programs, medical schools and nursing programs
- Lesson development support from BIOPAC

Laboratory Disciplines

- Physiology (animal and human)
- Exercise Physiology and Biomechanics
- Psychophysiology and Neurophysiology
- Pharmacology and Toxicology
- Human Anatomy
- Biology
- Bioengineering
- And more!



New Gas Analysis lessons

Active Learning

- Students as subjects
- Inquiry-based, hypothesis-driven lessons
- Easy lesson customization for student experiment design
- Application Notes for advanced experiment design

S

2

total support

BIOPAC STUDENT LAB — *Total Solutions…with Total Support!*

Online Help – Quick Guide, Tutorials, searchable manuals (pdf), *PRO* Lessons
Video Help – movie clips of procedures and sample data
Data Examples – files for male and female subjects
Web Link – use your active browser to link to the full spectrum of support at www.biopac.com
Desktop Streaming – like having an on-site rep...this option allows remote viewing and mouse control so we can see your data and review your setup for targeted Tech Support!
Phone Support – qualified BSL Specialists provide telephone support
Lab Manuals – use the BSL Laboratory Manual or choose from major published A&P Lab Manuals

System Level Solutions

- Hardware—Data acquisition unit, transducers & electrodes
- Software—Building-block structure for guided lessons to open-ended discovery
- Advanced Programming Options—Application Programming Interfaces available to control MP36 hardware or access BIOPAC data files
- Curriculum Library & Extensive support materials
- Grant-friendly solutions—Recognized by the NSF, NIH, The Whitaker Foundation, and most major grant foundations
- Worldwide customer base—Thousands of users
- Multi-lingual support: English, Spanish, French, Chinese, Japanese, Russian, Italian

Gas Analysis Module

State-of-the-Art Technology

- Students learn real-world skills using clinical recording techniques
- Industry standard transducers—Over 60 currently available
- Tissue bath stations—Modular system with integrated heater
- Gas analysis module for CO_2 and O_2 measurements
- Stimulus generation functionality
- Digital control channels—8 Input/8 Output
- Visual presentation options—SuperLab, E-Prime, MediaLab, DirectRT, Inquisit
- Support for the latest operating systems
- New MP36 acquisition unit: 24-bit resolution, USB, high speed
- Interface with all major amplifier and transducer manufacturers—Use our ready-made connectors or the custom kit
- Continuous product development

Tissue Bath

Stimulator

dynamic lessons

The student-friendly BSL System reduces setup time by up to 90%, so students collect excellent data and focus on scientific principles. The multi-level learning features of the BSL software let you control the material and method of each experiment—you can even use the BSL for graduate programs and advanced research.

- Use the 18 guided BSL Lessons for introductory concepts
- Choose from 45+ *PRO* Lessons for introductory & advanced concepts
- Add analysis tools to existing Lessons
- Let students develop experiment protocols
- Modify a Lesson or incorporate existing lab procedures
- Easily create new experiments

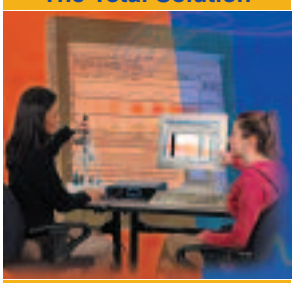
BSL lesson experiments are included in a number of the leading published Lab Manuals and have been successfully used to study:

- ECG
- EEG
- EMG
- EOG
- EDA (GSR)
- Biofeedback
- Bioimpedance/Cardiac Output
- Blood Pressure
- Heart Sounds
- Nerve Conduction
- Pulmonary Function
- Gas Analysis
- Reaction Time
- Respiration
- Temperature
- Metabolic Rate
- Force

- Engage students with dynamic lessons as they record data from their own bodies
- New Budget-Beating packages
- Customize lessons from BIOPAC's extensive Curriculum Library
- Incorporate clinical techniques in the lab—Students learn real-world skills
- Combine physiological data with stimulus presentation (Analog, Digital, and Calculation channels)
- No complicated knobs or dials

the gold standard for

BIOPAC STUDENT LAB
The Total Solution



Engage your students!

over 5 million successful lab hours

Since its introduction in 1995, the Biopac Student Lab has evolved based on input from many thousands of existing users and physiology instructors. To see for yourself why the BSL offers the most meaningful, flexible lab experience for students and teachers, visit www.biopac.com and check out demo video clips and sample lessons.

Give your students a proven advantage…give them the Biopac Student Lab!

new hardware features

- Increased performance 24-bit A/D converter
- Expanded amplifier settings
- New Stimulator and Output Controls
- Improved "Electrode Check" for electrode impedance
- New digital input & output capabilities
- Increased triggering options

BSL 4 - Major Upgrade!

Dynamic user interface improves lab experience!

- Students can prepare for the lab by downloading free BSL Analysis software that allows them to review the lesson physiology introduction and recording procedures, and play with the software. Lesson videos are included in the software and also on the BIOPAC YouTube channel to help students prepare and understand what they will be doing.
- Students work in groups of 3 to 6. Students are assigned roles: Subject, Recorder, and Director. Because of BSL's ease of use, students can rotate through the roles, allowing each to be a Subject and participate. Students are more engaged when they analyze their own data.
- Instructors can choose which experiments (tasks) within a lesson students will perform based on lab time restraints or on the level of the students.
- Students verify that their data is correct after each experiment.
- Students can analyze their data in the lab or at home by downloading our free analysis software.
- Data reports are "attached" to each student's data file. Measurements are taken, sections of graphs can be copied and pasted, and questions are answered. Instructors can easily change the data reports.
- Data reports can be printed or e-mailed to the instructor.

Streaming data videos help students identify signal characteristics for each lesson

Instructor support materials

Help your students get good data

- The Biopac Student Lab System includes videos of lesson procedure and recorded data, tutorials, sample data files, onscreen prompts and a detailed lab manual to help students acquire high-quality data
- Extensive curriculum library for human, animal, organ, and tissue lesson experiments
- Easy customization to suit your curriculum—create your own lessons with no programming required
- Language options: English, French, Spanish, Japanese, Italian, Russian
- Biopac Student Lab Specialists available for Technical Support

- ***Lab Manual Options***
  - Use the Biopac Student Lab Manual included with each BSL System for up to 18 scientific lessons
  - Use digital text of the lessons and create a custom lab manual with your own curriculum
  - Select from major published Lab Manuals using BIOPAC lesson experiments (see page 8)

- ***Data comparison tools for increased analysis***
  - Normative values provided for $FEV_{1,2,3}$, MVV, BP and ECG
  - Arrhythmia lesson, including sample data files from the NIH PhysioNet database
  - Sample data files for male and female subjects
  - Easily export for statistical analysis or archive student data

BSL 4 lessons show color setup images and videos to help students prepare for recording

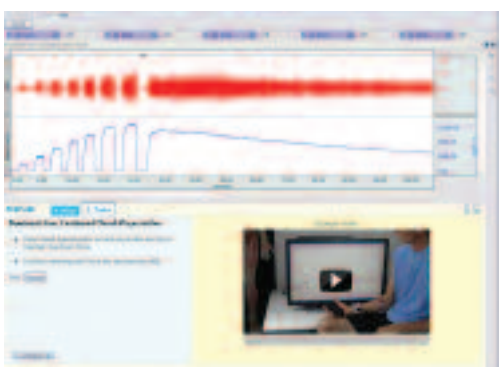
life science labs

simplify your labs & empower your students

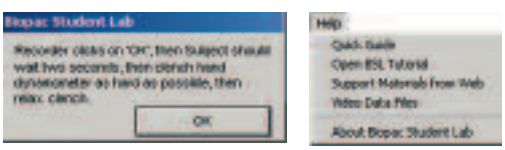
The BSL System helps students focus on scientific principles with…

- Unmatched guidance, power and flexibility
- Familiar point-and-click interface
- Extensive support materials to prepare for lab time, including videos & sample data files
- Onscreen prompts—additional instructions help students record the highest quality data
- Online instructions—guide the student through the lesson
- Simple sensors—validate transducer and signal connections
- Multiple data display—view data in industry standard formats: X/Y, overlap, clinical grids, chart recorder, oscilloscope, standard curve, dot display
- Adaptable lessons—follow the lesson tasks or assign new tasks to suit your course requirements
- Adaptable protocols—students can easily design experiments to develop and test their hypothesis with the BSL
- Data analysis and measurement tools—extract baseline and experimental response values and compare them to normative values
- Professional data reports—copy screen shots into lab reports and measurement values into statistical programs, or create high quality printouts with clinical grids, markers and full color
- Analysis options—distribute the analysis software so students can analyze data outside the lab—at home, library, etc.
- Reporting and analysis options—automatically paste measurements and graphs to the journal or other programs.
- Automated calibration—optimizes the display settings for the subject's own signal
- Autosave feature for lessons—includes student's name and lesson number and allows instructors to set file storage location

Intuitive interface with buttons and pop-up menus. Show or hide data channels and control size, color, label, scale, etc. Add markers and measurements.

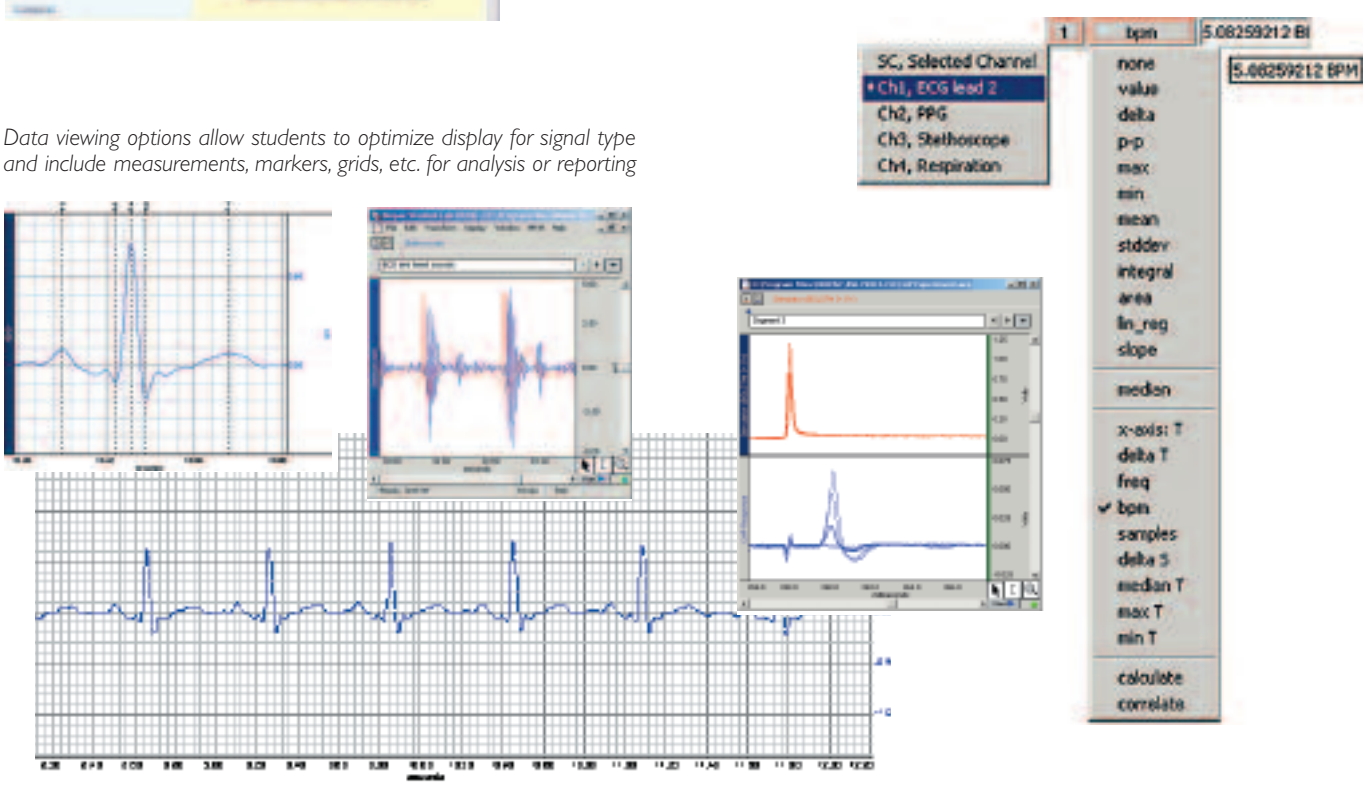


Onscreen prompts and expanded Help menu help students get good data with instructions and videos for setup, calibration, recording and file management.



Sophisticated measurement tools help students extract—and easily report—meaningful data

Data viewing options allow students to optimize display for signal type and include measurements, markers, grids, etc. for analysis or reporting



facilitate learning & enhance

A BSL system was used in a study aboard the "Vomit Comet" in the Zero-G program at the NASA Johnson Space Center by Dr. Rick Puzdrowski and students from the University of Houston—Clear Lake School of Natural and Applied Sciences. Students Carolyn Jessop (left) and Sonya Morgan with JSC techs (in blue).

Source: NASA Johnson Space Center. http://zerog.jsc.nasa.gov

The BSL System helps students get on track right away with data acquisition and analysis. The hardware has no knobs or dials and the lesson software uses automatic calibration and onscreen prompts. These features eliminate confusion and frustration and save a lot of time in the lab. More students can record data, which makes the whole laboratory experience much more productive.

For open-ended learning, use the BSL System for student projects and research, or use it to quickly create your own lessons.

- Adapt student task protocols to develop critical thinking skills
- Modify or expand BSL Lesson segments for hypothesis-driven studies

What will you do with the Biopac Student Lab?

Quick-click curriculum options let you use the lessons any way you want…

A. Use existing BSL Lessons to study the fundamentals of physiological systems like cardiovascular and pulmonary function

B. Use 45+ BSL *PRO* Lessons developed by instructors to explore principles like Habituation, Impedance Cardiography, and Nerve Conduction—downloads include lesson setup, procedure and data template

C. Customize BSL lessons to incorporate your protocols, add advanced analysis tools, and/or use existing equipment

D. Develop lessons with new or existing curriculum and BSL software tools like FFT, Histogram, Trigger, Averaging, and Rate Detection. Add setup & onscreen instructions and then save as a template

E. Allow students to design their own research projects. Use BSL Lessons as a starting point for inquiry-based experiments, then modify or expand recording parameters and protocols to test hypotheses

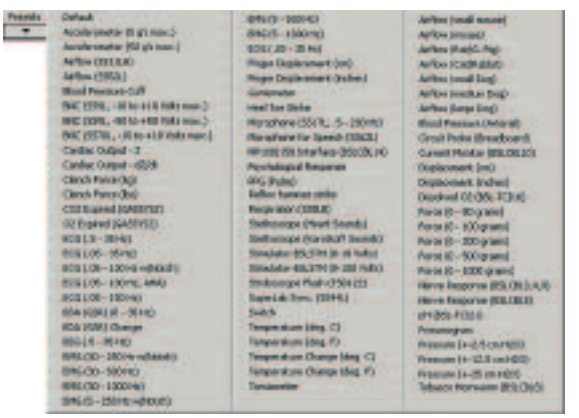
Lesson development made easy—for you and your students

Create your own lesson in just a few simple steps…

1. Pick from more than 100 signal and calculation channel Presets
2. Establish the recording parameters (sample rate, duration of experiment/lesson)
3. Add instructions to the journal—students will follow your lesson plan
4. Save the file as a template—students open the file with your settings in place

Presets simplify setup for custom projects

- Presets include all amplifier and filter settings for the signal to optimize data collection and display
- Presets can be used as is, or customized and saved under a new preset name for your protocol
- Organize and/or limit the list of Presets displayed to further simplify setup



Signal Presets

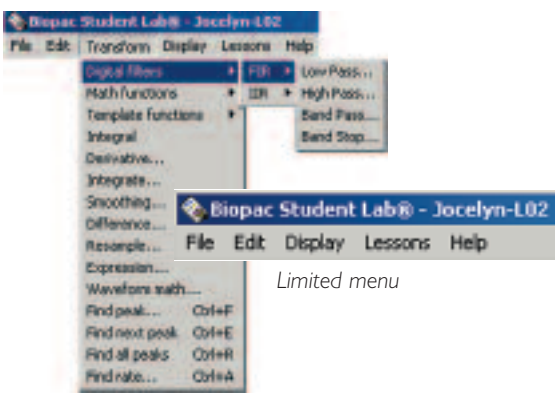
Calculation Presets

the lab experience

the biopac student lab—student-friendly & research-compatible

The multi-level learning features of the Biopac Student Lab, along with its proven success in thousands of labs worldwide, make the BSL the ideal teaching solution. BSL Lessons cover scientific fundamentals and simplify recording and analysis so your students can focus on lab objectives. As students advance, BSL recording and analysis options can be expanded to allow for sophisticated measurements, student-directed experiments, alternate curriculum and research-level studies.

Show or hide menus and analysis features based on the lesson requirements

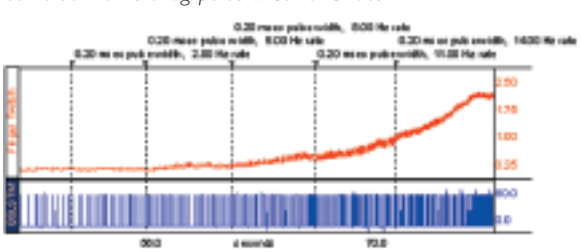


Limited menu

Expanded menu with increased analysis tools

Stimulator and other Output Control toolbars provide consistency and have intuitive controls and right-click access to Preferences. Plus, you can save multiple stimulus paradigms within a file.

Markers layer for printing to prevent overlap. Automatic stimulus markers log pulse width and rate.



To enhance any lesson, consider these options…

Control:

- Listen to the sound of EMG and other signals to emphasize a concept
- Utilize multiple display modes to optimize visual feedback for the signal type, in real time or offline. Select chart, scope, or X/Y plot, overlap segments or channels, histogram or FFT, display as vertical or horizontal bar graphs or numeric values, show filtered EEG data or calculate heart rate.
- Emulate standard lab equipment displays—chart recorder, oscilloscope, X/Y plotter, and metabolic cart
- Set up digital I/O channels to receive trigger information from products like SuperLab or E-prime, or control pumps, lights, etc.
- Select automatic file saving—save to a network server so students can access and analyze data outside the lab
- Control output functions such as sound, digital pulses and stimulation (low and high voltage)
  - Use stimulation features for human or animal subjects (visual, auditory, mechanical, or electric)
  - Set the stimulator to automatically start with the recording or for manual start and stop within the experiment
  - Set automatic stimulator event markers to note the stimulus frequency and pulse width
- Use filtering options to allow students to develop and display the filter response—online and offline
- Choose External or Analog (from any channel) triggering options

Analysis:

- Perform online measurements of heart rate, systolic, diastolic, mean blood pressure, dP/dt max and min with the rate detection features
- Identify frequency components of a signal—i.e., EEG alpha, beta, delta—with FFT functions
- Use the Equation Generator to calculate values such as RER and stroke volume
- Extract visual and auditory responses with signal averaging tools
- Use advanced integration features for pulmonary function studies
- Make metabolic studies easy with BSL software tools and the CO_2 & O_2 Analysis Module (GASSYS2, page 34)
- Calculate stroke volume and cardiac output with data from the Cardiac Output Sensor (SS31L, page 29)
- Select tools for spike sorting, spike counting and automatic measurements

Customization:

- Customize menu and toolbar options to show or hide analysis and editing controls based on the lesson requirements
- Customize the grid display—easily create clinical ECG grids
- Select the measurements that students must use to analyze the data
- Add text to the Journal so students have online access to your instructions
- Establish marker options to predefine recording segments or allow students to add comments to files
  - Predefine segment marker text—the marker describes each new recording segment (sit up, lay down)
  - Predefine event markers—set function keys to mark and describe events/segments in the experiment
- Set up acquisition and recording automation—repeat, trigger, autosave

core packages & applications

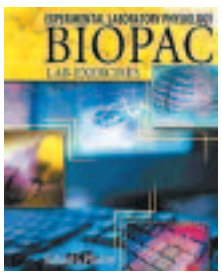
The Biopac Student Lab System is the total solution for a wide variety of scientific applications, including human, animal, organ and tissue studies. BSL Systems are available for general science—Basic, Advanced and Ultimate Systems—and core disciplines. Each Biopac Student Lab System includes a high performance data acquisition unit plus electrodes, transducers and consumable items required to run a specified number of lessons for each particular discipline. Any package can be used as a starting point to develop a custom system. Electrodes and transducers can be purchased separately in order to perform additional lessons not covered with the core package, and hardware upgrade kits are available.

- The BASIC, ADVANCED and ULTIMATE Systems have been offered since the Biopac Student Lab was launched in 1995, and are now in use in thousands of labs worldwide in 2-year and 4-year programs, medical schools, nursing programs, veterinary programs, chiropractic colleges, etc.
- The new CORE packages are offered to meet the diverging requirements of specific departments:

Human Physiology, page 10
Animal Physiology, page 12
Biology, page 14
Exercise Physiology & Biomechanics, page 16
Psychophysiology & Neurophysiology, page 18
Biomedical Engineering, page 20
Pharmacology & Toxicology, page 22

Suggested applications are outlined on the following pages, along with a CORE package with hardware targeted for each discipline. A BSL Lab Manual is included with each system, or you can choose from major published lab manuals that incorporate BSL experiments. Plus, *PRO* Lessons are available online, and you and your students can develop new applications.

BSL Lab Manual - one with each system
MANBSL4 - 18 lessons
MANBSL4-45 - 11 lessons



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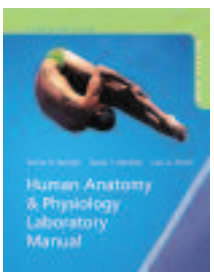

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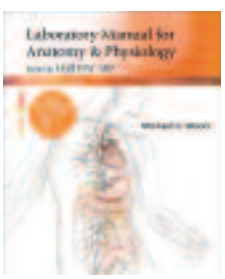

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Editeur : SAURAMPS
ISBN : 2840234041

budget-beating two-channel systems

Start with an Intro System and perform 6 guided BSL lessons: L1, L3, L4-6, L10. Choose a Health Sciences System to add spirometry, blood pressure, and dynamometry—and perform 11 BSL lessons: L1-L6, L10, L12-13, L16-17. Plus, use *PRO* lessons or create your own! See descriptions on pages 43-46.

Intro System BSLINTRO and five pack BSLINTRO5:
Data Acquisition Unit (MP45), BSL Software, BSL Lab Manual, Electrode Lead Sets (2 x SS2LB), Disposable Electrodes (EL503, 100/pk), Abrasive Pads (ELPAD, 10/pk).

Health Sciences System BSLHSCS and five pack BSLHSCS5:
Complete BSLINTRO, Headphones (40HP), Airflow Transducer (SS11LA) with Accessories (AFT6A, 10/pks: AFT1, AFT2, AFT3), Blood Pressure Cuff (SS19L), Stethoscope (SS30L), and Clench Force (bulb) Transducer (SS56L)

basic system

These hardware suggestions will enable you to perform a variety of lessons for human subjects. Use BIOPAC lessons or easily create your own experiments with the BSL *PRO* software included with each system. Order the Basic System or select items à la carte. If you start with the Basic System, hardware upgrades are available to create Advanced or Ultimate Systems. See BSL Hardware (page 23) for all available transducers, electrodes and accessories.

Basic System BSLBSC-W (Win) or BSLBSC-M (Mac)		BSL Lab Manual	MANBSL4, p. 40	Abrasive Pads (10/pk)	ELPAD, p. 36
Data Acquisition Unit	MP36, p. 24	Electrode Lead Sets (2x)	SS2LB, p. 25	USB Cable	CBLUSB, p. 40
BSL Software	BSL 4 with Lessons & *PRO*	Disposable Electrodes (100/pk)	EL503, p. 37	Power Transformer	AC300A, p. 40

Perform 19 or more lessons with the BASIC System:

Muscular
- BSL1 Standard & Integrated EMG
- H07 EMG Contractions—Active Learning
- H27 Facial EMG
- H34 Electrogastrogram (from human)

Cardiovascular
- BSL5 Components of the ECG (Lead II)
- BSL6 Leads I, II, III & Einthoven's Law
- H08 Dive Reflex—Active Learning
- H23 Signal Averaged ECG
- H32 Heart Rate Variability

Bioengineering
- H20 Filtering
- H33 FFT Fast Fourier Transform

Neurophysiology
- BSL3 EEG Relaxation & Brain Rhythms
- BSL4 Alpha Rhythms in the Occipital Lobe
- BSL10 Eye Movement, Saccades & Fixation
- H10 EEG & Hemispheric Asymmetry
- H12 EOG Saccades & Displacement
- H13 EOG Visual Tracking
- H14 Ocular Fixation while reading
- H15 Ocular Fixation while viewing an image

advanced system

These hardware suggestions will enable you to perform a variety of lessons for human subjects. Use BIOPAC lessons or easily create your own experiments with the BSL *PRO* software included with each system. Order the Advanced System or select items à la carte. A hardware upgrade kit is available to upgrade to the Ultimate System. See BSL Hardware (page 23) for all available transducers, electrodes and accessories.

Advanced System BSLADV-W (Win) or BSLADV-M (Mac)

- Basic BSL System — BSLBSC, p. 8
- Airflow Transducer — SS11LA, p. 27
- Airflow Filters (10/pk) — AFT1, p. 34
- Airflow Mouthpieces (10/pk) — AFT2, p. 34
- Airflow Nose Clips (10/pk) — AFT3, p. 34
- Calib. Syringe (600 ml) — AFT6A, p. 34
- EDA (GSR) Lead — SS57L, p. 26
- EDA Electrodes (100/pk) — EL507, p. 37
- Colored Paper — PAPER1
- Surgical Tape — TAPE1, p. 36
- Respiratory Effort Trans. — SS5LB, p. 26
- Temp Trans. — SS6L, p. 26
- Hand Switch — SS10L, p. 26
- Headphones — OUT1A, p. 26
- Pulse Plethysmograph — SS4LA, p. 26

Perform 33 or more lessons with the Advanced System:

Muscular

- BSL1 Standard & Integrated EMG
- H07 EMG Contractions—Active Learning
- H27 Facial EMG
- H34 Electrogastrogram (from human)
- H36 Muscular Biofeedback

Cardiovascular

- BSL5 Components of the ECG (Lead II)
- BSL6 Leads I, II, III & Einthoven's Law
- BSL7 ECG & Pulse
- H05 WAnT Wingate Test
- H08 Dive Reflex—Active Learning
- H23 Signal Averaged ECG
- H32 Heart Rate Variability

Pulmonary Function

- BSL8 Respiratory Cycle
- BSL12 Pulmonary Function: Vol. & Capacities
- BSL13 Pulmonary Flow Rates: FEV and MVV
- BSL15 Aerobic Exercise Physiology

Neurophysiology

- BSL3 EEG Relaxation & Brain Rhythms
- BSL4 Alpha Rhythms in the Occipital Lobe
- BSL9 GSR and Polygraph
- BSL10 EOG Eye Movement, Saccades & Fixation
- BSL11 Reaction Time & Learning
- BSL14 Biofeedback: Relaxation & Arousal
- H10 EEG & Hemispheric Asymmetry
- H11 Mirror Test–EDA Sensory motor learning
- H12 EOG Saccades & Displacement
- H13 EOG Visual Tracking
- H14 Ocular Fixation while reading
- H15 Ocular Fixation while viewing an image
- H16 Reaction Time
- H24 Habituation

Bioengineering

- H02 Compartmental Modeling
- H20 Filtering
- H33 FFT Fast Fourier Transform

See page 43-45 for a description of all available lessons.

Contact BIOPAC to discuss your specific needs. www.biopac.com • info@biopac.com

ultimate system

These hardware suggestions will enable you to perform a variety of lessons for human and animal subjects. Use BIOPAC lessons or easily create your own experiments with the BSL *PRO* software included with each system. Order the Ultimate System or select items à la carte. See BSL Hardware (page 23) for all available transducers, electrodes and accessories.

Ultimate System BSLULT-W (Win) or BSLULT-M (Mac)

- Basic BSL System — BSLBSC, p. 8
- Airflow Transducer — SS11LA, p. 27
- Airflow Filters (10/pk) — AFT1, p. 34
- Airflow Mouthpieces (10/pk) — AFT2, p. 34
- Airflow Nose Clips (10/pk) — AFT3, p. 34
- Calib. Syringe (600 ml) — AFT6A, p. 34
- EDA (GSR) Lead — SS57L, p. 26
- EDA Electrodes (100/pk) — EL507, p. 37
- Colored Paper — PAPER1
- Surgical Tape — TAPE1, p. 36
- Respiratory Effort Trans. — SS5LB, p. 26
- Temp Trans. — SS6L, p. 26
- Hand Switch — SS10L, p. 26
- Headphones — OUT1A, p. 26
- Pulse Plethysmograph — SS4LA, p. 26
- Electrode Gel — GEL1, p. 36
- Pressure Transducer — SS13L p. 27
- BP Cuff Transducer — SS19LA, p. 27
- Hand Dynamometer — SS25LA, p. 27
- Force Transducer — SS12LA, p. 27
- Electronic Stethoscope — SS30L, p. 28
- Multi-lead ECG Cable — SS29L, p. 27
- BSL Stimulator — BSLSTMB, p. 25
- Stim. Electrode for humans — HSTM01, p. 28

Perform 43 or more lessons with the Ultimate System:

Muscular

- A05 Visceral Smooth Muscle
- BSL1 Standard & Integrated EMG
- BSL2 Motor Unit Recruitment & Fatigue
- H06 Finger Twitch
- H07 EMG Contractions—Active Learning
- H27 Facial EMG
- H34 Electrogastrogram (from human)
- H36 Muscular Biofeedback

Cardiovascular

- A04 Frog Heart
- BSL5 Components of the ECG (Lead II)
- BSL6 Leads I, II, III & Einthoven's Law
- BSL7 ECG & Pulse
- BSL16 Blood Pressure & Korotkoff
- BSL17 Heart Sounds & Cardiac Events
- H01 12-Lead ECG
- H04 Blood Pressure (Isometric or Straining exercise)
- H05 WAnT Wingate Test
- H08 Dive Reflex—Active Learning
- H23 Signal Averaged ECG
- H32 Heart Rate Variability

Pulmonary Function

- BSL8 Respiratory Cycle
- BSL12 Pulmonary Function: Vol. & Capacities
- BSL13 Pulmonary Flow Rates: FEV and MVV
- BSL15 Aerobic Exercise Physiology

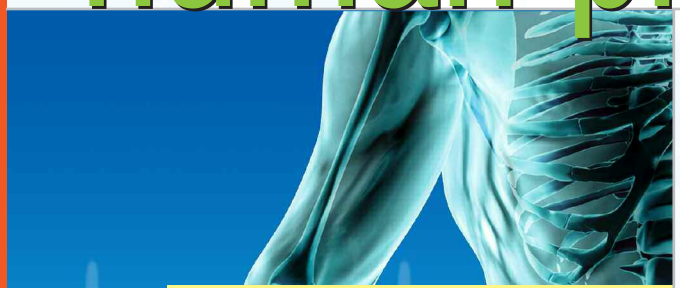
Neurophysiology

- A01 Frog Pith & Prep
- BSL3 EEG Relaxation & Brain Rhythms
- BSL4 Alpha Rhythms in the Occipital Lobe
- BSL9 GSR and Polygraph
- BSL10 EOG Eye Movement, Saccades & Fixation
- BSL11 Reaction Time & Learning
- BSL14 Biofeedback: Relaxation & Arousal
- H03 Nerve Conduction (ulnar nerve)
- H10 EEG & Hemispheric Asymmetry
- H11 Mirror Test–EDA Sensory motor learning
- H12 EOG Saccades & Displacement
- H13 EOG Visual Tracking
- H14 Ocular Fixation while reading
- H15 Ocular Fixation while viewing an image
- H16 Reaction Time
- H24 Habituation

Bioengineering

- H02 Compartmental Modeling
- H20 Filtering
- H33 FFT Fast Fourier Transform

human physiology



Use the power of the BSL System to conduct the most widely studied responses in physiology labs and perform analysis online or off. Lessons target the circulatory system, respiratory system, muscular function, brain function, ANS, exercise physiology and neurophysiology. Dynamic experiments with students as subjects increase interest and retention and develop critical thinking. Basic lessons guide and prompt students—promote hypothesis-driven student inquiry with advanced options or develop user-defined lessons and research projects.

features

- 25 lessons targeted for Human Physiology
- ECG, EEG, EMG, EOG & EGG
- Pulmonary Function $FEV_{1,2,3}$, MVV, PV Loops
- Airflow
- Blood Pressure
- Heart Sounds & Korotkoff Sounds
- Nerve Conduction
- Electrodermal Activity (GSR)
- Pulse
- Reaction Time
- Temperature
- Stimulation & Response (Somatic Reflexes)
- Gas Analysis (O_2 & CO_2)
- Colorimetry Tools
- Force & Pressure
- Cardiac Output (via bioimpedance), Stroke Volume
- Auditory, Somatosensory & Visual Evoked Response
- Angle of Movement
- Acceleration

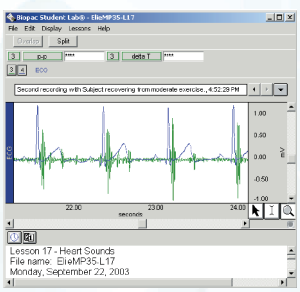
Suitable for inquiry-based, active learning in 2-yr. & 4-yr. programs, medical schools, and nursing programs

We have been using the Biopac Student Lab system in our Human Anatomy & Physiology labs at IU South Bend for about 5 years. Students enjoy being able to analyze data that was generated from a member of their lab group. It certainly has more meaning to them than using traditional "canned" lab data.

—Mary Truex, Indiana University South Bend, Biology Department

Cardiovascular

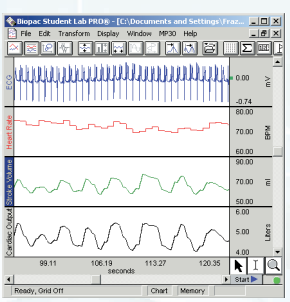
The BSL System covers a wide range of cardiovascular measures based on the heart's electrical signal. Record standard (LI, LII or LIII) or augmented (aVR, aVL or aVF) leads; add a multi-lead ECG cable to simultaneously record a pre-cordial lead. Students attach Leads I and III and the software uses Einthoven's law to display Lead II. Identify, isolate and measure components of the ECG complex under varying conditions. Use the averaging features to automate ECG analysis. View arrhythmia data obtained from the NIH PhysioBank archive. Calculate R-R interval to display heart rate variability or determine vagal tone. Use the electronic stethoscope to listen to and record heart sounds and then correlate the sounds with the mechanical and electrical events of the cardiac cycle. Record cuff pressure and Korotkoff sounds to measure systolic and diastolic blood pressure. Determine pulse wave velocity. For advanced studies, use the noninvasive cardiac output sensor to record stroke volume and cardiac output.



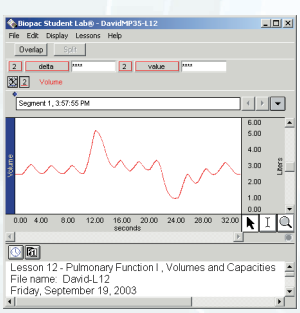
Overlapped ECG and heart sounds

Respiratory & Pulmonary Function

The BSL provides an excellent introduction to volumes and capacities, respiratory flow rates, breathing mechanics, and ventilation. Display and/or print a clinical grid on the data for effective interpretation and training. The software guides the student in measuring FVC and in calculating FEV and MVV. The airflow transducer is hand-held, lightweight, easy to clean and very easy to use. Take measures before, during and after exercise to study ventilation and heat exchange. The new Gas Analysis module provides online measures of CO_2 and O_2 levels for Respiratory Exchange Ratio, O_2 Consumption and Basal/Resting Metabolic Rate lessons. Non-rebreathing T-valves, air chambers, facemasks, and tubing options provide setup options to suit any protocol.



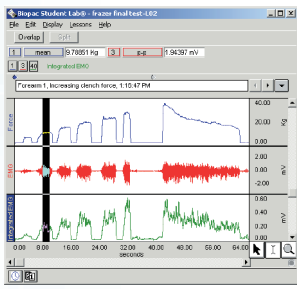
Cardiac output and stroke volume



Pulmonary volume

Muscular

Record EMG data to investigate the properties of skeletal muscle. Record and display raw and integrated EMG signals; overlap the signals for better correlation of the data. Measure strength and repeat trials for motor unit recruitment, summation and fatigue. Use the reflex hammer transducer to study reflex response (neural control), or add the dynamometer to study handgrip strength profiles. Use the new Finger Twitch transducer for threshold, summation, tetanus and fatigue analysis. Students can listen to the muscle activity through headphones and note the increase in sound intensity as grip strength is increased through motor unit recruitment.



EMG and force

Nerve Conduction

Combine the human-safe stimulating electrode with the stimulator to record nerve conduction experiments. Stimulate the ulnar nerve at three different points and record nerve conduction time. Measure the distance between the stimulation and recording points and then calculate velocity.

Neurophysiology

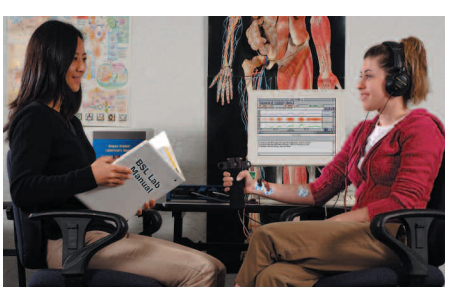
Study EEG under a variety of conditions to explore relaxation and brain rhythms—software will filter and display each rhythm separately: Alpha, Beta, Delta, and Theta. Select from a variety of lessons to study Alpha rhythms in the occipital lobe, reaction times, and hemispheric asymmetry. Add the EOG (occipital signal) to study eye movement, saccades, tracking, angular displacement, or ocular fixations. Use the Stimulator to study evoked response—auditory, visual, or somatosensory. The new high-speed MP36 hardware allows for the recording of spontaneous nerve activity, continuously, at speeds of 100,000 samples a second. Add the SuperLab stimulus presentation package to perform psychophysiology stimulus/response protocols examining high-level brain activity. Conduct microelectrode recordings and study action potentials.

Autonomic Nervous System

Record a wide variety of ANS-related signals such as EDA/GSR, temperature, ECG, pulse, respiration, airflow, nerve conduction, continuous blood pressure, and continuous non-invasive cardiac output (using bioimpedance technique) to demonstrate changes in the parasympathetic and sympathetic nervous system activity. Use the Polygraph lesson for simultaneous heart rate, electrodermal activity (GSR), and respiration rate. See Psychophysiology & Neurophysiology on page 18 for more details.

Exercise Physiology & Biomechanics

Combine a wide range of respiratory system and pulmonary function signals with biomechanical data. Use the new Gas Analysis Module for online analysis of expired O_2 and CO_2 levels. Options are available for continuous blood pressure and cardiac output, and the system easily interfaces with force plates and other instrumentation (more than 18 ready-made connectors available). There are more than 27 specialized lessons—see page 16 for details.



Dynamic lessons engage students

human physiology

The following hardware suggestions will enable you to perform a wide variety of applications targeted for **human physiology**. Use BIOPAC lessons or easily create your own experiments with the BSL *PRO* software included with each system. Order the core package or select items à la carte.

See **BSL Hardware** (page 23) for all available transducers, electrodes and accessories.

Human Physiology Core
BSLHPY-W (Win) or BSLHPY-M (Mac)

Basic BSL System	BSLBSC, p. 8
Hand Dynamometer	SS25LA, p. 27
BP Cuff Transducer	SS19LA, p. 27
Electronic Stethoscope Transducer	SS30L, p. 28
Airflow Transducer	SS11LA, p. 27
Airflow Filters (10/pk)	AFT1, p. 34
Airflow Mouthpieces (10/pk)	AFT2, p. 34
Airflow Nose Clips (10/pk)	AFT3, p. 34
Calibration Syringe (600 ml)	AFT6A, p. 34

Perform 25 or more lessons with this core package:

Muscular

BSL1	Standard & Integrated EMG
BSL2	Motor Unit Recruitment & Fatigue
H07	EMG Contractions - Active Learning
H27	Facial EMG
H34	EGG Electrogastrogram
H36	Muscular Biofeedback

Cardiovascular

BSL5	Components of the ECG (Lead II)
BSL6	Leads I, II, III & Einthoven's Law
BSL16	Blood Pressure & Korotkoff Sounds
BSL17	Heart Sounds & Cardiac Events
H08	Dive Reflex - Active Learning
H23	Signal Averaged ECG
H32	Heart Rate Variability

Pulmonary Function

BSL12	Pulmonary Function: Vol. & Capacities
BSL13	Pulmonary Flow Rates: FEV and MVV

Neurophysiology

BSL3	EEG Relaxation & Brain Rhythms
BSL4	Alpha Rhythms in the Occipital Lobe
BSL10	Eye Movement, Saccades & Fixation
H10	EEG & Hemispheric Asymmetry
H12	EOG Saccades & Displacement
H13	EOG Visual Tracking vs. Imagination
H14	Ocular Fixation while reading
H15	Ocular Fixation while viewing an image

Biomedical Engineering

H20	BME Filtering
H33	FFT Fast Fourier Transform

See page 43-45 for a description of all available lessons.

Increase your lab options with…

Stimulator	BSLSTMB, p. 25
Stim. Electrode for humans	HSTM01, p. 28
Finger Twitch Transducer	SS61L, p. 30
O_2 & CO_2 Analysis Module	GASSYS2-EA, p. 34
Dissolved O_2 Probe	RXPROBE02, p. 31
pH Probe	RXPROBE01, p. 31
Reflex Hammer Transducer	SS36L, p. 30
Multi-Lead ECG Cable	SS29L, p. 27
Cardiac Output Sensor	SS31L, p. 29
Goniometer	SS21L, p. 29
Respiratory Effort Trans.	SS5LB , p. 26
Temperature Trans.	SS6L, p. 26
Headphones	OUT1A, p. 26
EDA (GSR) Lead	SS57L, p. 26
SuperLab System	STP35W, p. 32
Transducer Accessory Pack	BSLHPY-TA, p. 42

animal physiology & intro human phys

The Biopac Student Lab provides a wide range of options for animal and tissue experiments. Lessons allow students to study animal and human species for comparative physiology programs. Use the new Gas Analysis Module for human and animal experiments for the analysis of expired O_2 and CO_2. The new Dissolved Oxygen probe allows students to monitor the oxygen consumption of a goldfish. Perform intracellular recording and membrane transport studies.

■ See Human Physiology on pages 10-11 for more details.

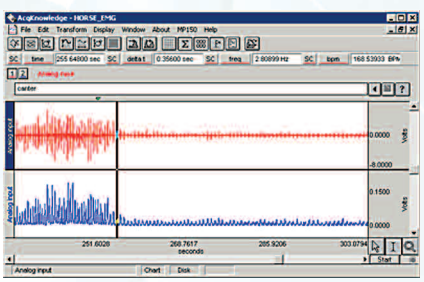
features

- 31 lessons targeted for Animal & Intro. Human Phys.
- ECG, EEG, EMG, EOG & EGG
- Temperature
- Gas Analysis CO_2 & O_2
- pO_2
- pH
- Bioimpedance & Cardiac Output
- Force
- Neurophysiology
- Hemodynamics
- Respiratory & Pulmonary Function
- Reaction Time
- Nerve Recordings & Compound Action Potentials
- Membrane Transport (drug delivery)
- Tissue Baths
- Stimulation & Response
- Isolated Heart, Lung, Muscle
- Auditory, Somatosensory & Visual Evoked Response
- Compatible with Crawdad Lab Manual

Suitable for inquiry-based, active learning in 2-yr. & 4-yr. programs, medical schools, and nursing programs

Cardiovascular Hemodynamics

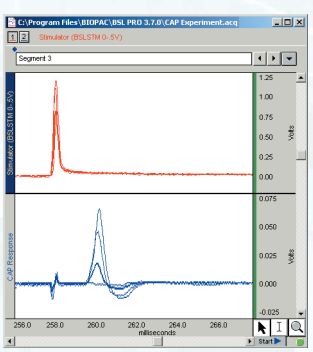
Lessons cover ECG (1-12 lead) and allow students to isolate components of the ECG complex and use the averaging features in the software for further ECG analysis. Use the electronic stethoscope to examine heart sounds and then overlap the data to correlate the sounds with the mechanical and electrical events of the cardiac cycle. Record arterial blood pressure and record systolic, diastolic, mean, dP/dt max and min, and use the noninvasive Cardiac Output Sensor to record stroke volume and cardiac output. If flow signals are available, record them simultaneously with pressure to examine vascular resistance and compliance. Plot pressure versus flow to obtain P/V Loops. See the Frog Heart and Turtle Heart lessons on page 45 for refractory heartblock and vagal escape.



EMG from a horse

Muscular

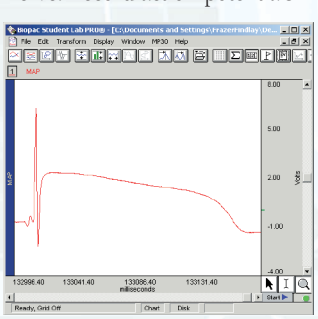
Record EMG to investigate the properties of skeletal muscle. Record and display raw and integrated EMG signals; overlap the signals for better correlation of the data. Measure strength and repeat trials for motor unit recruitment/summation and fatigue. Demonstrate the treppe (staircase) phenomenon. Study the contractility of skeletal muscle with the force transducer and stimulator. The Frog Gastrocnemius lesson records threshold, maximal response, summation, tetanus, and fatigue.



CAP in Overlap Mode

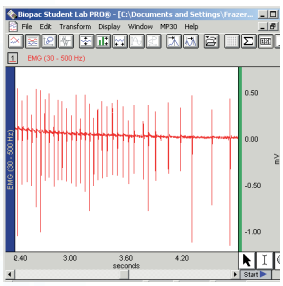
Compound Action Potential

Use the new Nerve Chamber (or an existing chamber) with the Low Voltage Stimulator (SS58L, page 25) to record the compound action potential and nerve conduction from the frog sciatic nerve. Record action potentials from cockroaches, crawfish and earthworms. Add a range of drugs and determine the effect they have on the nerve. The new Nerve Chamber includes a drug delivery chamber (agent well) with lid to maximize the quality of the results and improve experimental repeatability.



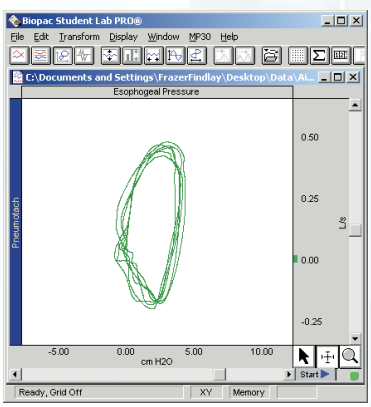
MAP—Guinea Pig

Neurophysiology



Cockroach nerve

Study EEG under a variety of conditions to explore relaxation and brain rhythms—the software can filter and display each rhythm separately: Alpha, Beta, Delta and Theta. Select from a variety of *PRO* Lessons to study Alpha rhythms in the occipital lobe, reaction times, and hemispheric asymmetry. Add the EOG (ocular signal) to study eye movement, saccades, tracking, angular displacement, or ocular fixations. Use the stimulator to study evoked response—auditory, visual, or somatosensory. The new high-speed MP36 hardware allows the recording of spontaneous nerve activity, continuously, at speeds of 100,000 samples a second. Add the SuperLab stimulus presentation package to perform stimulus response studies investigating higher order neuronal function in humans. Conduct intracellular and extracelluar recordings with glass microelectrodes and Ag-AgCl wire electrodes to study action potentials from a variety of subjects.



Flow vs. pressure in X/Y mode

Respiratory & Pulmonary Function

The BSL System provides an excellent introduction to respiratory system and pulmonary function volumes and capacities, respiratory rates, breathing, and ventilation. Display and/or print a clinical grid on the data for effective interpretation and training. A complete range of airflow and pressure transducers is suitable for small, medium and large animals as well as humans.

Gas Analysis

Use the new gas analysis system for detailed metabolic studies in small and medium sized animals. Chambers, couplers, facemasks, and tubing options provide setup options for any protocol. The system can provide online measures of O_2 and CO_2 for RER, VO_2 and BMR/RMR. Use the Dissolved O_2 probe and lesson to measure the oxygen consumption of a goldfish.

Intracellular & Membrane Transport

Use the new High-Impedance Cable (BSLCBL8/9, page 36) to record from the cockroach ventral nerve and for a variety of intracellular and extracellular recordings.

In vitro Applications

The new Tissue Bath Stations provide students with research-quality equipment in a modular, flexible configuration. The Visceral Smooth Muscle lesson guides students through the entire recording and analysis process. Students can also electrically stimulate tissue preparations, including field stimulation, with the BSL Stimulator. Interface with Ussing chambers for ion transport studies. Record and analyze data from isolated heart and lung experiments.

animal physiology

The following hardware suggestions will enable you to perform a wide variety of applications targeted for **animal physiology**. Use BIOPAC lessons or easily create your own experiments with the BSL *PRO* software included with each system. Order the core package or select items à la carte.

See **BSL Hardware** (page 23) for all available transducers, electrodes and accessories.

Animal Physiology Core

BSLAPH-W (Win) or BSLAPH-M (Mac)

Basic BSL System (with BSLCBL8 substituted for SS2LB)	BSLBSC, p. 8
Dissolved O_2 Probe Interface	BSL-TCI16, p. 39
Force Transducer (200 g)	SS65L, p. 31
Lead (unshielded) x 2	LEAD110, p. 36
Leads (shielded) x 2	LEAD110S-W/R, p. 36
Low Voltage Stimulator	SS58L, p. 25
Needle Electrodes x 3	EL452, p. 38
Nerve Chamber	NERVE2, p. 38
Recording Nerve Cable	BSLCBL4B, p. 39
Stim. Electrodes for animals	ELSTM2, p. 38
Stimulator Nerve Cable	BSLCBL2A, p. 39

Perform 31 or more lessons with this core package:

Muscular

A02	Frog Gastrocnemius
A05	Visceral Smooth Muscle
A11	Resting Potential from Crawdad Manual
A15	Earthworm Smooth Muscle
BSL1	Standard & Integrated EMG
H07	EMG Contractions - Active Learning
H27	Facial EMG
H34	EGG Electrogastrogram

Cardiovascular

A04	Frog Heart
A09	Turtle Heart
BSL5	Components of the ECG (Lead II)
BSL6	Leads I, II, III & Einthoven's Law
H08	Dive Reflex - Active Learning
H23	Signal Averaged ECG
H32	Heart Rate Variability

Pulmonary Function

A07	Dissolved O_2 (goldfish)–with your probe

Neurophysiology

A01	Frog Pith & Prep
A03	Frog Nerve
A06	Cockroach Nerve
A08	Action Potential
A14	CPG Hornworm
BSL3	EEG Relaxation & Brain Rhythms
BSL4	Alpha Rhythms in the Occipital Lobe
BSL10	Eye Movement, Saccades & Fixation
H10	EEG & Hemispheric Asymmetry
H12	EOG Saccades & Displacement
H13	EOG Visual Tracking vs. Imagination
H14	Ocular Fixation while reading
H15	Ocular Fixation while viewing an image

Biomedical Engineering

H20	BME Filtering
H33	FFT Fast Fourier Transform

See page 43-45 for a description of all available lessons.

Increase your lab options with…

Cardiac Output Sensor	SS31L, p. 29
Dissolved O_2 Probe	RXPROBE02, p. 31
pH Probe	RXPROBE01, p. 31
O_2 & CO_2 Analysis Module	GASSYS2-EA, p. 34
Tissue Bath Station	ITBS100, p. 33
Temperature Transducer	SS6L, p. 26
Transducer Accessory Pack	BSLAPH-TA, p. 42

biology

The BSL System can record signals from cells, organs, insects, animals and human subjects to facilitate a spectrum of application opportunities. The system has new options for pH, dissolved oxygen and calorimetry (connections & software features). A wide range of lessons covers the cardiovascular, immune, respiratory, pulmonary, metabolic, digestive and nervous systems. User-friendly recording options and analysis tools promote student inquiry and active learning. Employ new software options to develop new lessons specifically tailored to unique course material.

features

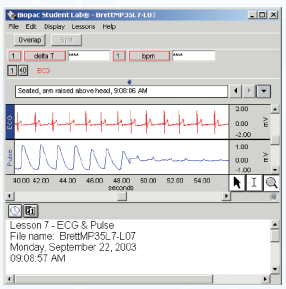
- 52+ lessons targeted for Biology
- ECG, EEG, EMG, EOG & EGG
- Respiratory & Pulmonary Function
- Temperature
- pH
- Dissolved O_2
- Gas Analysis (O_2 & CO_2)
- Oxygen uptake
- Blood Pressure
- Cardiac Output (via bioimpedance)
- Stroke Volume
- Tissue Baths
- Force
- Calorimeter Interface
- Pulse
- Autonomic Nervous System
- Nerve Conduction Velocity
- Colorimetry Tools

Suitable for inquiry-based, active learning in 2-yr. & 4-yr. programs, medical schools, and nursing programs

Biology covers a wide spectrum of applications. To complement those outlined below, see the applications detailed for Human Physiology (page 10) and Animal Physiology (page 12). As with all disciplines, the selected applications only begin to suggest what you can do with the BSL System. Contact a Biopac Student Lab Specialist to discuss your application needs.

Cardiovascular

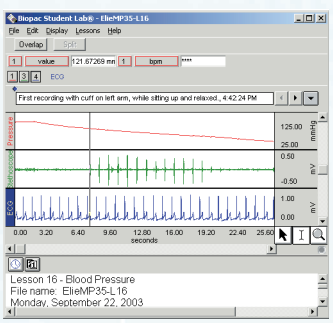
Lessons include blood pressure, ECG analysis, heart sounds, and pulse. Students can make single-, three-, six- and 12-lead ECG recordings, familiarizing themselves with Einthoven's triangle and mean electrical axis of the frontal plain. Students perform blood pressure measurements using a cuff, with stethoscope, employing Korotkoff sounds to make determinations of systolic/diastolic pressure. Students can also utilize the latest technology for continuous non-invasive BP recordings. Use the noninvasive Cardiac Output Sensor (SS31L, page 29) on human and animal subjects to record stroke volume and cardiac output. By measuring continuous mean arterial pressure simultaneous with flow (cardiac output), students can examine vascular resistance.



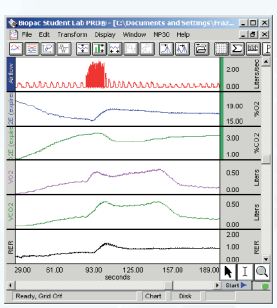
ECG and pulse

Respiratory & Pulmonary Function

Students can record the pattern of breathing as well as perform comprehensive cardiopulmonary tests. There are lessons for determining tidal volumes and lung capacities, including $FEV_{1,2,3}$ and MVV, plus full gas analysis studies.



Gas Analysis



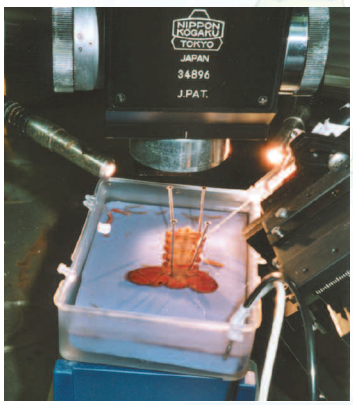
Students can use the new gas analysis system to monitor expired CO_2 and O_2 levels for detailed metabolic studies with human and animal subjects. Take measures to study ventilation and heat exchange. Use the Dissolved O_2 probe and lesson to measure the oxygen consumption of a goldfish. Chambers, facemasks, and tubing accessories provide setup options for any protocol.

Neurophysiology

Study EEG under a variety of conditions to explore relaxation and brain rhythms—the software can filter and display each rhythm separately: Alpha, Beta, Delta, and Theta. Study Alpha rhythms in the occipital lobe, reaction times, and hemispheric asymmetry. Use the system to demonstrate changes in parasympathetic and sympathetic tone. Add EOG (ocular signal) to study eye movement, saccades, tracking, angular displacement, or ocular fixations. Use the stimulator to study evoked response—auditory, visual, or somatosensory. Record reaction time and measure nerve conduction velocity. The system samples quickly enough to easily record spontaneous nerve activity from small animals and insects.

Digestive System

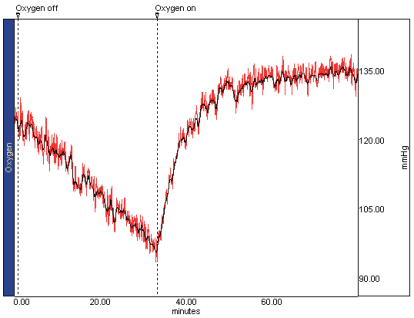
Use the system to record gastric signals in humans and animals or monitor isolated intestinal (gut) strips in a tissue bath experiment. Monitor the EGG (Electrogastrogram) before and after food digestion. Examine gastric slow wave propagation, peristaltic (slow wave) propagation, and gastrointestinal motility.



Membrane potential using crawfish and glass microelectrodes

Cellular Biology

Use the BSL hardware with suitable glass microelectrodes to demonstrate membrane potential of crawfish. These experiments demonstrate the principle of homeostasis and serve as a good introduction to electrophysiology recording techniques. The system will also work with the popular ***Crawdad*** CD-ROM Lab Manual for Neurophysiology by Wyttenbach, Johnson, and Hoy (ISBN 0-87893-947-4).



Dissolved oxygen (goldfish)

Comparative Biology

The Biopac Student Lab system is an excellent tool for comparative biology programs because students can compare data from their own bodies with data recorded from a variety of animals. The curriculum covers most of the major physiological systems, including: brain, muscle, pulmonary, cardiovascular and CNS.

biology

The following hardware suggestions will enable you to perform a wide variety of applications targeted for **biology**. Use BIOPAC lessons or easily create your own experiments with the BSL *PRO* software included with each system. Order the core package or select items à la carte.

See **BSL Hardware** (page 23) for all available transducers, electrodes and accessories.

Biology Core

BSLBIO-W (Win) or BSLBIO-M (Mac)

Basic BSL System	BSLBSC, p. 8
Airflow Filters (10/pk)	AFT1, p. 34
Airflow Mouthpieces (10/pk)	AFT2, p. 34
Airflow Nose Clips (10/pk)	AFT3, p. 34
Airflow Transducer	SS11LA, p. 27
BP Cuff Transducer	SS19LA, p. 27
Calibration Syringe (600 ml)	AFT6A, p. 34
Colored Paper (for BSL9)	PAPER1
Dissolved O_2 Probe Interface	BSL-TCI16, p. 39
EDA (GSR) Lead	SS57L, p. 26
EDA (Isotonic) Electrodes (100/pk)	EL507, p. 37
Electrode Gel	GEL1, p. 36
Electronic Stethoscope Transducer	SS30L, p. 28
Force Transducer	SS12LA, p. 27
Hand Dynamometer	SS25LA, p. 27
Hand Switch	SS10L, p. 26
Headphones	OUT1A, p. 26
High-Impedance Cable	BSLCBL9, p. 36
Multi-Lead ECG Cable	SS29L, p. 27
Needle Electrodes x 3	EL452, p. 38
Nerve Chamber	NERVE2, p. 38
pH Probe Interface	BSL-TCI21, p. 39
Pressure Transducer	SS13L, p. 27
Pulse Transducer	SS4LA, p. 26
Recording Nerve Cable	BSLCBL4B, p. 39
Respiratory Effort Transducer	SS5LB, p. 26
Stimulator	BSLSTMB, p. 25
Stim. Electrode for humans	HSTM01, p. 28
Stim. Electrode for animals	ELSTM2, p. 38
Stimulator Nerve Cable	BSLCBL2A, p. 39
Surgical Tape	TAPE1, p. 36
Temperature Transducer	SS6L, p. 26

Perform 52 or more lessons with this core package:

Muscular

- A02 Frog Gastrocnemius
- A05 Visceral Smooth Muscle
- A11 Resting Potential from Crawdad Manual
- A15 Earthworm Smooth Muscle
- BSL1 Standard & Integrated EMG
- BSL2 Motor Unit Recruitment & Fatigue
- H06 Finger Twitch
- H07 EMG Contractions - Active Learning
- H27 Facial EMG
- H34 EGG Electrogastrogram
- H36 Muscular Biofeedback

Cardiovascular

- A04 Frog Heart
- BSL5 Components of the ECG (Lead II)
- BSL6 Leads I, II, III & Einthoven's Law
- BSL7 ECG & Pulse
- BSL16 Blood Pressure & Korotkoff Sounds
- BSL17 Heart Sounds & Cardiac Events
- H01 12-lead ECG
- H04 BP Response to Straining
- H05 WAnT Wingate Test
- H08 Dive Reflex - Active Learning
- H23 Signal Averaged ECG
- H32 Heart Rate Variability

Pulmonary Function

- A07 Dissolved O_2 (goldfish)–with your probe
- BSL8 Respiratory Cycle
- BSL12 Pulmonary Function: Vol. & Capacities
- BSL13 Pulmonary Flow Rates: FEV and MVV
- BSL15 Aerobic Exercise Physiology

Neurophysiology

- A01 Frog Pith & Prep
- A03 Frog Nerve
- A06 Cockroach Nerve
- A08 Action Potential-Earthworm
- A09 Turtle Heart
- A14 CPG Hornworm
- BSL3 EEG Relaxation & Brain Rhythms
- BSL4 Alpha Rhythms in the Occipital Lobe
- BSL9 GSR and Polygraph
- BSL10 EOG Eye Movement, Saccades & Fixation
- BSL11 Reaction Time
- BSL14 Biofeedback: Relaxation & Arousal
- H03 Nerve Conduction (ulnar nerve)
- H10 EEG & Hemispheric Asymmetry
- H11 Mirror Test–EDA Sensory motor learning
- H12 EOG Saccades & Displacement
- H13 EOG Visual Tracking vs. Imagination
- H14 Ocular Fixation while reading
- H15 Ocular Fixation while viewing an image
- H16 Reflexes & Reaction Time - Active Learning
- H24 Habituation

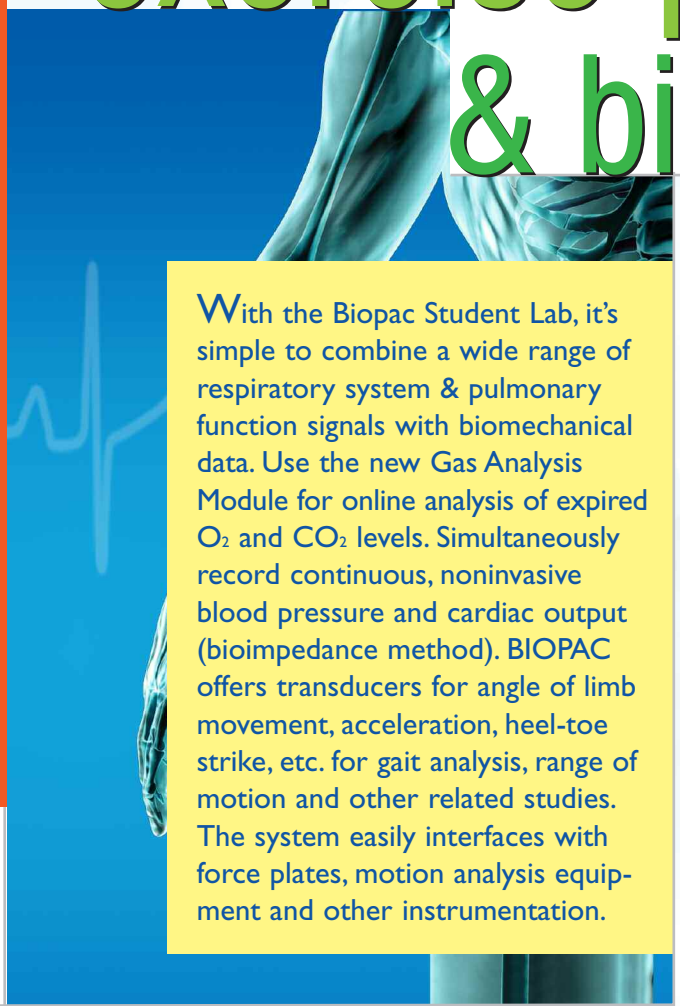
Biomedical Engineering: H02, H20 & H33

See page 43-45 for a description of all available lessons.

Increase your lab options with…

Cardiac Output Sensor	SS31L, p. 29
Dissolved O_2 Probe	RXPROBE02, p. 31
Finger Twitch Transducer	SS61L, p. 30
O_2 & CO_2 Analysis Module	GASSYS2-EA, p. 34
pH Probe	RXPROBE01, p. 31
Reflex Hammer Transducer	SS36L, p. 30

exercise physiology & biomechanics



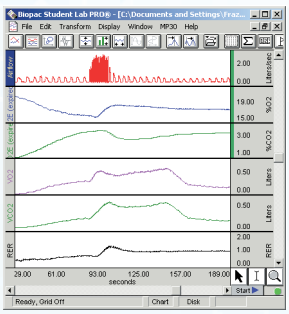
With the Biopac Student Lab, it's simple to combine a wide range of respiratory system & pulmonary function signals with biomechanical data. Use the new Gas Analysis Module for online analysis of expired O_2 and CO_2 levels. Simultaneously record continuous, noninvasive blood pressure and cardiac output (bioimpedance method). BIOPAC offers transducers for angle of limb movement, acceleration, heel-toe strike, etc. for gait analysis, range of motion and other related studies. The system easily interfaces with force plates, motion analysis equipment and other instrumentation.

features

- 27 lessons targeted for Exercise Phys. & Biomechanics
- ECG, EEG, EMG, EOG & EGG
- Respiration
- Temperature
- Airflow & Lung Volume
- Gas Analysis (CO_2 & O_2) — Metabolic Cart
- Cardiac Output (via bioimpedance)
- Respiratory Exchange Ratio
- Basal or Resting Metabolic Rate
- Motor Unit Recruitment
- 12-Lead ECG
- Heart Sounds
- Blood Pressure
- Stroke Volume
- Gait Analysis (including Heel-Toe Strike)
- Range of Motion
- Acceleration, Velocity, Distance

Suitable for inquiry-based, active learning in 2-yr. & 4-yr. programs, medical schools, and nursing programs

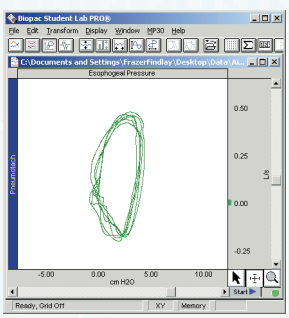
Respiratory & Pulmonary Function



Respiratory exchange ratio

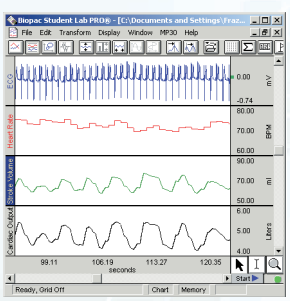
The BSL includes a range of experiments for pulmonary function and Gas Analysis studies. Detailed lessons guide students through the classical pulmonary function tests, including tidal volume, inspiratory capacity, expiratory capacity, functional residual capacity, vital capacity, total lung capacity, forced vital capacity, forced expiratory volume ($FEV_{1, 2, 3}$) and Maximal Voluntary Ventilation (MVV).

Gas Analysis



Airflow Pressure/Volume loop

Use the new Gas Analysis Module to create a powerful metabolic analyzer (cart) for students to measure expired O_2 and CO_2 and use lessons for VO_2, Respiratory Exchange Ratio, and Basal or Resting Metabolic Rate. Combine metabolic and cardiac output measurements to give students a detailed view of a variety of cardiopulmonary responses. If your protocol examines CO_2 above 5% or requires high-speed response, contact BIOPAC to discuss the full range of gas analyzers.



Cardiac output data

Cardiovascular

The BSL System includes many ECG lessons, including 12-lead ECG, cardiac output, and continuous blood pressure lessons. A Heart Sounds lesson allows students to listen to and record heart sounds, while comparing them to the ECG complex. There are also lessons for the Wingate test and Blood Pressure Response to Isometric Straining Exercise. Record cardiac output from human subjects—connect the bioimpedance electrodes to a subject and record stroke volume and cardiac output in real time pre- and post-exercise. There is also an option for continuous blood pressure monitoring, during exercise.

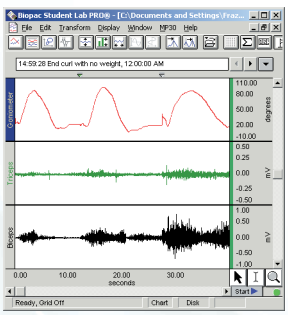
Biomechanics

Students can use the new Reflex Hammer in conjunction with EMG recordings to compare responses and reflex actions. For advanced studies,

I purchased the Advanced System and have found the student labs helpful in explaining and demonstrating physiological concepts and current technology. Personally, I have been using the *PRO* software for my own research purposes. I have instrumented an old cybex isokinetic ergometer with a force transducer to measure force and a potentiometer to measure joint angle. Data acquisition has been going very smoothly. I have been quite impressed with the *PRO* software and its abilities. I have set up a calculation channel that accounts for gravity's affect on limb weight at all joint angles throughout a range of motion. This allows me to accurately estimate muscular resistance. Our area rep took the time to come down to see us and has been helpful with questions.

—*Dain LaRoche, Johnson State College, Environmental and Health Sciences*

add angle of limb movement as a subject performs a variety of tasks. The system has transducers for recording heel and toe strike and acceleration for gait analysis studies. Use the Hand Dynamometer and Tri-Axial Accelerometer to measure isotonic and isometric performance. Goniometers are available for evaluating one or two degrees of freedom from the same joint (e.g. wrist flexion/extension and radial/ulnar deviations). Record Sit & Reach tests and analyze range of motion. Use the X/Y display mode to monitor motion resulting from two degrees of freedom. The BSL software will determine velocity of motion and calculate acceleration.



Goniometry data

Nerve Conduction

Combine the human-safe stimulating electrode with the stimulator to record nerve conduction experiments. Stimulate the ulnar nerve and record nerve conduction time (Lesson H03). The procedure allows students to stimulate a subject at three different points along the ulnar nerve. The distance between the stimulation and recording points is measured and the velocity of signal propagation along the nerve is calculated.

Muscular

Students can measure EMG and Integrated EMG, including force and angle of limb movement. Students can listen to the sound of the electrical activity coming from muscle as they squeeze a hand dynamometer and equate changes in sound with changes in force. Add the BSL Stimulator and human-safe stimulation electrode for a variety of muscle stimulation experiments. Include visual and auditory feedback with touch for Muscular Biofeedback studies.

Ergometer modified to record WAnT using BIOPAC

Photo courtesy A. Zidermanis, PhD, formerly at Parker College of Chiropractic

Interface with Existing Equipment

The BSL System offers over 60 industry-standard transducers. Further, the system easily interfaces with other major amplifier and transducer manufacturers encompassing the most commonly used exercise physiology lab products such as force plates, ergometers, motion analysis systems, and metabolic carts. The BSL System can trigger or receive trigger information from other equipment. For interfacing, choose from a variety of ready-made connectors and cables, or use the custom connector kit (page 39). BIOPAC support staff can help determine the appropriate interface for any complete system.

exercise physiology & biomechanics

The following hardware suggestions will enable you to perform a wide variety of applications targeted for **exercise physiology & biomechanics**. Use BIOPAC lessons or easily create your own experiments with the BSL *PRO* software included with each system. Order the core package or select items à la carte.

See **BSL Hardware** (page 23) for all available transducers, electrodes and accessories.

Exercise Physiology Core
BSLEXP-W (Win) or BSLEXP-M (Mac)

Basic BSL System	BSLBSC, p. 8
Airflow Filters (10/pk)	AFT1, p. 34
Airflow Mouthpieces (10/pk)	AFT2, p. 34
Airflow Nose Clips (10/pk)	AFT3, p. 34
Airflow Transducer	SS11LA, p. 27
BP Cuff Transducer	SS19LA, p. 27
Calibration Syringe (600 ml)	AFT6A, p. 34
Electronic Stethoscope Transducer	SS30L, p. 28
Hand Dynamometer	SS25LA, p. 27
Hand Switch	SS10L, p. 26
Headphones	OUT1A, p. 26
Pulse Transducer	SS4LA, p. 26
Respiratory Effort Transducer	SS5LB, p. 26
Temperature Transducer	SS6L, p. 26
Surgical Tape	TAPE1, p. 36

Perform 27 or more lessons with this core package:

Muscular

BSL1	Standard & Integrated EMG
BSL2	Motor Unit Recruitment & Fatigue
H07	EMG Contractions - Active Learning
H27	Facial EMG
H34	EGG Electrogastrogram
H36	Muscular Biofeedback

Cardiovascular

BSL5	Components of the ECG (Lead II)
BSL6	Leads I, II, III & Einthoven's Law
BSL7	ECG & Pulse
BSL16	Blood Pressure & Korotkoff Sounds
BSL17	Heart Sounds & Cardiac Events
H05	WAnT Wingate Test
H08	Dive Reflex - Active Learning
H23	Signal Averaged ECG
H32	Heart Rate Variability

Pulmonary Function

BSL8	Respiratory Cycle
BSL12	Pulmonary Function: Vol. & Capacities
BSL13	Pulmonary Flow Rates: FEV and MVV
BSL15	Aerobic Exercise Physiology

Neurophysiology

BSL3	EEG Relaxation & Brain Rhythms
BSL4	Alpha Rhythms in the Occipital Lobe
BSL11	Reaction Time
H10	EEG & Hemispheric Asymmetry
H16	Reflexes & Reaction Time - Active Learning

Biomedical Engineering

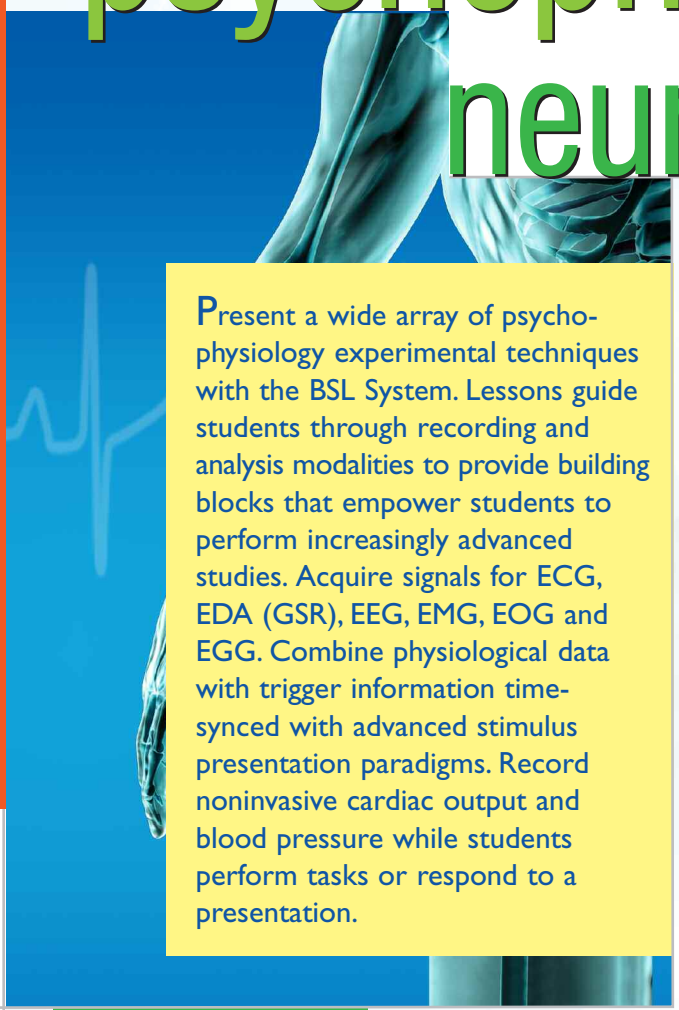
H02	Compartmental Modeling
H20	BME Filtering
H33	FFT Fast Fourier Transform

See page 43-45 for a description of all available lessons.

Increase your lab options with…

Airflow Transducer for Ex. Phys.	SS52L, p. 33
Calibration Syringe (2 L)	AFT26, p. 35
Cardiac Output Sensor	SS31L, p. 29
O_2 & CO_2 Analysis Module	GAS-SYSTEM2-EA, p. 34
Finger Twitch Transducer	SS61L, p. 30
Goniometer	SS21L, p. 29
Reflex Hammer	SS36L, p. 30
Stimulator	BSLSTMB, p. 25
Transducer Accessory Pack	BSLEXP-TA, p. 42

psychophysiology & neurophysiology



Present a wide array of psycho-physiology experimental techniques with the BSL System. Lessons guide students through recording and analysis modalities to provide building blocks that empower students to perform increasingly advanced studies. Acquire signals for ECG, EDA (GSR), EEG, EMG, EOG and EGG. Combine physiological data with trigger information time-synced with advanced stimulus presentation paradigms. Record noninvasive cardiac output and blood pressure while students perform tasks or respond to a presentation.

features

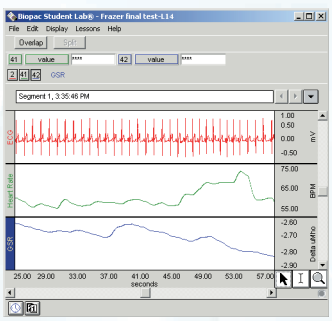
- 28 lessons targeted for Psychophys. & Neurophys.
- ECG, EEG, EMG, EOG & EGG
- Autonomic Nervous System
- Auditory & Visual Evoked Response
- Event Related Potential
- Startle Eye Blink Experiments
- Nerve Conduction
- Habituation
- Stroop
- Sensory Motor Learning
- Electrodermal Activity (GSR)
- Heart Rate Variability
- Visual Presentation System (SuperLab & E-Prime)
- Cardiac Output (via bioimpedance)
- Pre-ejection Period (PEP)
- Automatic Continuous Noninvasive Blood Pressure

Suitable for inquiry-based, active learning in 2-yr. & 4-yr. programs, medical schools, and nursing programs.

Powerful set-up and analysis tools make the BSL ideal for graduate level studies and personal research.

Autonomic Nervous System

Use the BSL system to record changes in the parasympathetic and sympathetic nervous system activity. Acquire a wide variety of ANS-related signals such as EDA (GSR), skin temperature, ECG, pulse, respiration, airflow, nerve conduction, continuous blood pressure, and continuous noninvasive cardiac output (bioimpedance method). Simultaneous graphing shows heart rate, electrodermal activity (GSR) and respiration rates. After the experiment, evaluate the data using the powerful and user-friendly analysis functions.



Electrodermal activity (GSR) from Lesson 14

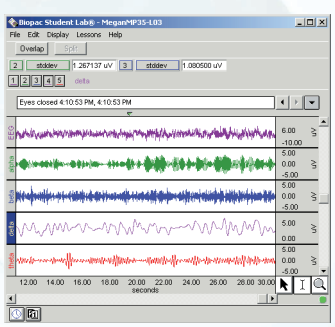
Event Related Potentials

Combine the BSL with a visual presentation system such as SuperLab to explore a wide variety of experiments like Stroop, Oddball, Habituation, and Startle Response. SuperLab is user-friendly and greatly simplifies development of a range of visual and auditory presentations. As each stimulus is presented, SuperLab sends a digital pulse to the BSL System to mark the onset of the stimulus. The stimuli are classified into different groups with each group assigned a unique digital channel. The BSL software will identify the digital pulse and automatically measure the associated response, and provide the average or perform measurements on each response in the stimulus classification.

Facial EMG electrodes

Evoked Response

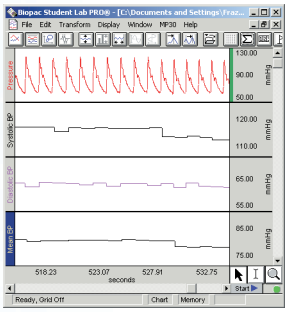
Lessons guide students through evoked response recordings. Use the system to trigger a stimulus and derive the average response. Use with headphones, stroboscope, or electrical or mechanical stimulation for auditory, visual or somatosensory response.



EEG filtered from Lesson 3

EEG

Introductory lessons allow students to record EEG and look at the differences between Alpha, Beta, Delta and Theta activity levels. Students can record EEG from both hemispheres while listening to music, reading and performing mental tasks. The software guides them through the recording and then shows them how to analyze the frequency components of the signal. The Fast Fourier Transformation is used to show the frequency levels of the activity on each hemisphere.



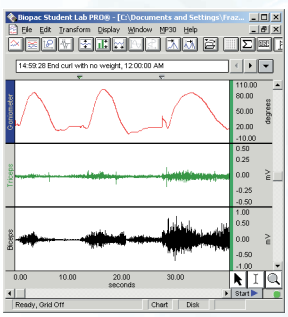
Noninvasive blood pressure data

Cardiovascular

Students can record the changes in pre-ejection period and cardiac output relative to a variety of different stimuli. The new noninvasive Cardiac Output Sensor greatly simplifies previously complex procedures to allow students to record stroke volume and cardiac output. Combine these signals with ECG and blood pressure to demonstrate cardiovascular regulation by the Autonomic Nervous System. The system can also perform detailed Heart Rate Variability tests and Averaged ECG recordings.

Muscular

Students can measure EMG and Integrated EMG, including force and angle of limb movement. They can listen to the sound of the electrical activity coming from the muscle as they squeeze a hand dynamometer and equate changes in sound form and intensity with changes in force. Add the BSL Stimulator and human-safe stimulation electrode for a variety of muscle stimulation experiments. Use the Tri-Axial Accelerometer to examine movement of limbs, head and torso in three-dimensional space. Couple the resultant acceleration, velocity and distance data with EMG recordings to obtain a comprehensive picture of skeletal muscle performance.



EMG data: Goniometer, Triceps, Biceps

EOG

Students can record horizontal and vertical eye movements while observing fixation and tracking. The X/Y display mode will plot horizontal vs. vertical eye movement to track eye position relative to an image or object. By using the zoom and measurement tools, students can measure duration of saccades and fixation. A simple light fixture becomes an excellent tool for measuring angular displacement.

EDA mirror test (Lesson H11)

Nerve Conduction

Combine the human-safe stimulating electrode with the stimulator to record nerve conduction experiments. Stimulate the ulnar nerve at three different points and record nerve conduction time. Measure the distance between the stimulation and recording points and then calculate the velocity of signal propagation along the nerve (motor response). Use the Finger Twitch transducer coupled with nerve stimulation to examine the relationship between applied (external) nerve stimulation and associated motor recruitment.

psychophysiology & neurophysiology

The following hardware suggestions will enable you to perform a wide variety of applications targeted for **psychophysiology & neurophysiology**. Use BIOPAC lessons or easily create your own experiments with the BSL *PRO* software included with each system. Order the core package or select items à la carte.

See **BSL Hardware** (page 23) for all available transducers, electrodes and accessories.

Psychophysiology Core
BSLPSY-W (Win) or BSLPSY-M (Mac)

Basic BSL System	BSLBSC, p. 8
BP Cuff Transducer	SS19LA, p. 27
Colored Paper (for BSL9)	PAPER1
EDA (GSR) Lead	SS57L, p. 26
EDA (Isotonic) Electrodes (100/pk)	EL507, p. 37
Electronic Stethoscope Transducer	SS30L, p. 28
Hand Switch	SS10L, p. 26
Headphones	OUT1A, p. 26
Pulse Transducer	SS4LA, p. 26
Respiratory Effort Transducer	SS5LB, p. 26

Perform 28 or more lessons with this core package:

Muscular

BSL1	Standard & Integrated EMG
H07	EMG Contractions - Active Learning
H27	Facial EMG
H34	EGG Electrogastrogram
H36	Muscular Biofeedback

Cardiovascular

BSL5	Components of the ECG (Lead II)
BSL6	Leads I, II, III & Einthoven's Law
BSL7	ECG & Pulse
BSL16	Blood Pressure & Korotkoff Sounds
BSL17	Heart Sounds & Cardiac Events
H08	Dive Reflex - Active Learning
H23	Signal Averaged ECG
H32	Heart Rate Variability

Neurophysiology

BSL3	EEG Relaxation & Brain Rhythms
BSL4	Alpha Rhythms in the Occipital Lobe
BSL9	GSR and Polygraph
BSL10	EOG Eye Movement, Saccades & Fixation
BSL11	Reaction Time
BSL14	Biofeedback: Relaxation & Arousal
H10	EEG & Hemispheric Asymmetry
H11	Mirror Test–EDA Sensory motor learning
H12	EOG Saccades & Displacement
H13	EOG Visual Tracking vs. Imagination
H14	Ocular Fixation while reading
H15	Ocular Fixation while viewing an image
H16	Reflexes & Reaction Time - Active Learning
H24	Habituation

Biomedical Engineering

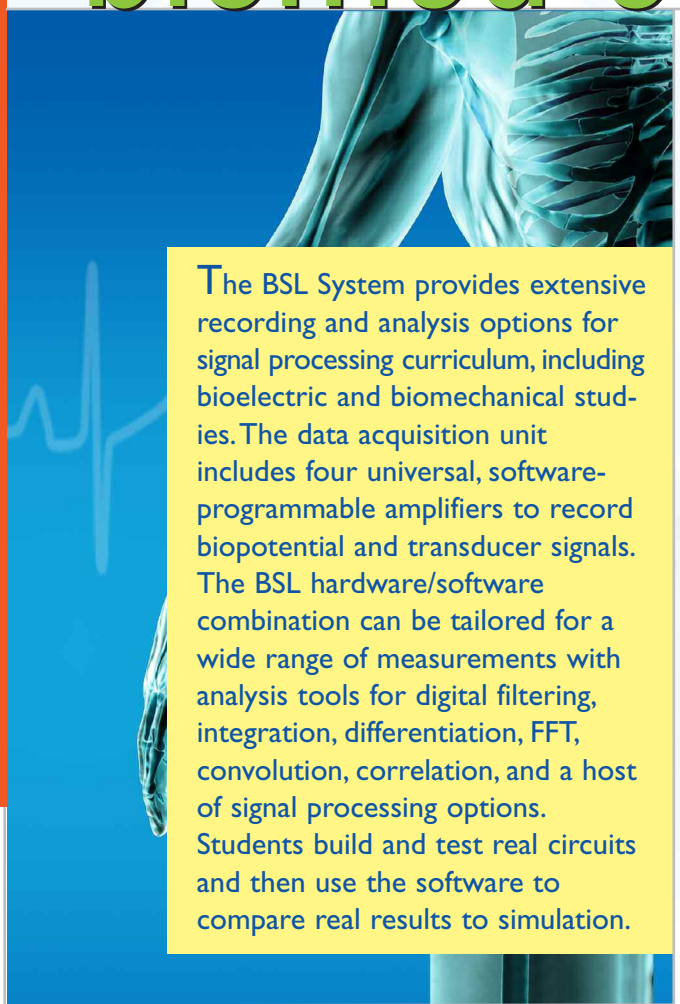
H02	Compartmental Modeling
H20	BME Filtering
H33	FFT Fast Fourier Transform

See page 43-45 for a description of all available lessons.

Increase your lab options with…

Cardiac Output Sensor	SS31L, p. 29
Noninvasive Blood Pressure Monitor	NIBP100D, p. 32
Psych. Variable Assessment Trans.	SS43L, p. 30
Stimulator	BSLSTMB, p. 25
SuperLab Package	STP35, p. 32
Finger Twitch Transducer	SS61L, p. 30
Stim. Electrode for Humans	HSTM01, p. 32
Transducer Accessory Pack	BSLPSY-TA, p. 42

biomed engineering



The BSL System provides extensive recording and analysis options for signal processing curriculum, including bioelectric and biomechanical studies. The data acquisition unit includes four universal, software-programmable amplifiers to record biopotential and transducer signals. The BSL hardware/software combination can be tailored for a wide range of measurements with analysis tools for digital filtering, integration, differentiation, FFT, convolution, correlation, and a host of signal processing options. Students build and test real circuits and then use the software to compare real results to simulation.

features

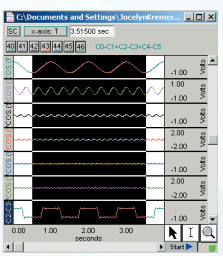
- 60+ lessons targeted for Human & Animal Physiology
- Signal Analysis & Processing
- ECG, EDA (GSR), EEG, EGG, EMG & EOG
- Force, Pressure, Strain, Flow, Temperature, Sound, Light
- Filters (FIR & IIR)
- Instrumentation Design
- Respiratory System & Pulmonary Function
- Bioimpedance (Cardiac Output & Blood Flow)
- Biomechanics—Angle, Acceleration, Distance, Velocity
- Transducers & Calibration
- Physiological Control Systems
- Compartmental Modeling
- Blood Pressure & Heart Sounds
- Gait Analysis
- Chart, Overlap, Scope & X/Y Displays
- Spectral Analysis & Histograms
- Export to MatLab®, LabVIEW®, and MS Excel/Word®

Suitable for inquiry-based, active learning in 2-yr. & 4-yr. programs, medical schools, and nursing programs

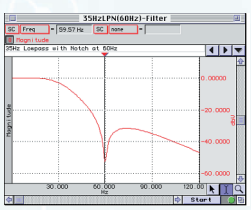
"During each [BIOPAC] laboratory exercise, students follow detailed procedures that are designed to demonstrate principles of biophysics and biological measurement. Student feedback on the laboratories has been phenomenal, with the hands-on experiences motivating the students in a way that no lecture-only course can." — *IEEE Engineering in Medicine and Biology, July/August 2003 (Vol. 22, No. 4, pg. 106)*

Signal Analysis & Processing

The BSL software has an extensive library of signal processing functions permitting graphical insight to analytical methods. The software can demonstrate the procedure and consequences associated with simple to complex signal processing methodologies. For example, students can view data before and after IIR or FIR filter processing, build a complex waveform from periodic signals (i.e., create a square wave from multiple sine waves) and decompose the result, or apply non-linear processing methods to data. Use the X/Y display mode to generate Lissajous patterns and investigate chaotic phenomena and demonstrate phase relationships between two variables. Signals can be correlated and convolved. Use the histogram function to focus on distribution of specific signal measures.



BME Square



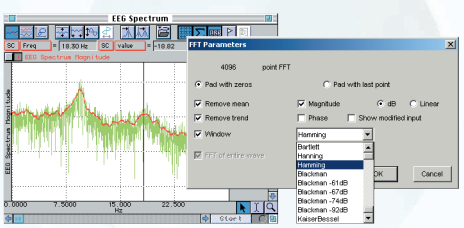
FFT of Biopotential filter frequency response

Transducers & Calibration

The BSL System employs a wide array of transducers that transform physical measures into electrical signals. The generic input design of the MP36 acquisition unit allows it to interface a huge variety of third-party or completely unique transducers. Students can use the BSL software to linearize and calibrate transducers and then compare results to expected values. Relate fundamental physical standards to more complicated measures. For example, calibrate the Airflow Transducer with a syringe, and then use the Airflow Transducer to calibrate a respiration sensor designed to monitor thoracic circumference.

Human & Animal Physiology

The wide range of human and animal physiology experiments provide a powerful tool for teaching students the best technique and methodology for making a measurement. Each experiment demonstrates fundamental physiological concepts and educates students in the setup, recording and analysis process. Physiology basics are clearly explained. See pages 10-13 for details.



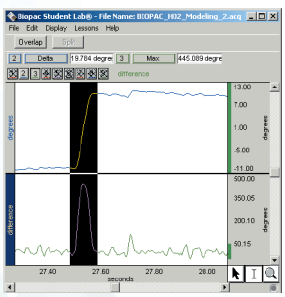
FFT dialog and EEG spectrum

Programming Options

Students can create their own programs to control the MP36 hardware with the BHAPI hardware application program interface. Students can also develop their own analysis programs to read the BIOPAC file format with the ACKAPI software application program interface. See page 24 for details.

Physiological Control Systems & Compartmental Analysis

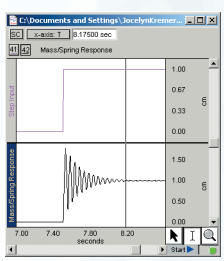
Implement simple experiments illustrating physiological control systems and compartmental analysis with the BSL System. The students can observe signal changes and then effect a change to observe a particular response. Investigate linear and nonlinear control paradigms. Create simple to intricate feedback loops where students perform a specific role in the loop operation. For instance, students can explore Westheimer's saccadic eye movement model which represents the eye as a 2nd order system —then record eye motion via EOG set up, and then compare the real results to the modeled results to validate or adjust the model.



Compartmental Modeling (EOG)

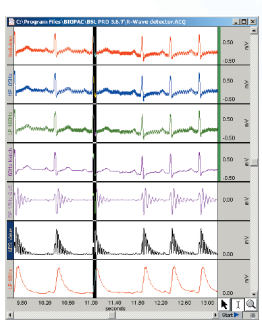
Biomechanics

The Student Lab System has a comprehensive ability to monitor gait and other mechanical responses. The system works with Goniometers, Accelerometers, Heel-Toe Strike transducers and Tri-Axial Accelerometers. Biopotential signals such as EMG can be synchronously recorded. Use the Hand Dynamometer and Tri-Axial Accelerometer to measure isotonic and isometric performance. Goniometers are available for evaluating one or two degrees of freedom from the same joint (e.g. wrist flexion/extension and radial/ulnar deviations). Use the X/Y display mode to monitor motion resulting from two degrees of freedom. Model mechanical systems, demonstrate principles of biomechanical resonance or inertial navigation (acceleration, velocity and position), or convert gravity vectors (from Tri-Axial Accelerometers) into associated "tilt" angles for use in ergonomic evaluations. See page 16 for details.



BME Step

Instrumentation Design



Circuit simulation

The new signal processing breadboard allows students to build and test real-world signal processing circuit modules and then verify their performance against mathematical simulation using graphical comparisons. Students can combine circuit modules, collect physiological signals and then analyze the results. Each circuit module constitutes an important subset of circuit design when recording and processing physiological signals. The BSL system is used like an oscilloscope to make measurements for circuit module evaluation.

Interface with Existing Equipment

The BSL System offers over 60 industry-standard transducers. Further, the BSL System interfaces with other major amplifier and transducer manufacturers encompassing the most commonly used biomedical engineering instruments and sensors by using a wide variety of interface connectors and cables. Choose from 18 ready-made interface connectors, or build your own with the custom interface kit.

biomedical engineering

The following hardware suggestions will enable you to perform a wide variety of applications targeted for **biomedical engineering**. Use BIOPAC lessons or easily create your own experiments with the BSL *PRO* software included with each system. Order the core package or select items à la carte.

See **BSL Hardware** (page 23) for all available transducers, electrodes and accessories.

Biomedical Engineering Core
BSLBME-W (Win) or BSLBME-M (Mac)

Basic BSL System	BSLBSC, p. 8
Airflow Filters (10/pk)	AFT1, p. 34
Airflow Mouthpieces (10/pk)	AFT2, p. 34
Airflow Nose Clips (10/pk)	AFT3, p. 34
Airflow Transducer	SS11LA, p. 27
BP Cuff Transducer	SS19LA, p. 27
Calibration Syringe (600 ml)	AFT6A, p. 34
Electronic Stethoscope Transducer	SS30L, p. 28
Hand Dynamometer	SS25LA, p. 27
Hand Switch	SS10L, p. 26
Headphones	OUT1A, p. 26
Pulse Transducer	SS4LA, p. 26
Signal Processing Breadboard Lab	SS39L, p. 30

Perform 29 or more lessons with this core package:

Muscular

BSL1	Standard & Integrated EMG
BSL2	Motor Unit Recruitment & Fatigue
H07	EMG Contractions—Active Learning
H27	Facial EMG
H34	EGG Electrogastrogram
H36	Muscular Biofeedback

Cardiovascular

BSL5	Components of the ECG (Lead II)
BSL6	Leads I, II, III & Einthoven's Law
BSL7	ECG & Pulse
BSL16	Blood Pressure & Korotkoff Sounds
BSL17	Heart Sounds & Cardiac Events
H08	Dive Reflex—Active Learning
H23	Signal Averaged ECG
H32	Heart Rate Variability

Pulmonary Function

BSL12	Pulmonary Function: Vol. & Capacities
BSL13	Pulmonary Flow Rates: FEV and MVV

Neurophysiology

BSL3	EEG Relaxation & Brain Rhythms
BSL4	Alpha Rhythms in the Occipital Lobe
BSL10	EOG Eye Movement, Saccades & Fixation
BSL11	Reaction Time
H10	EEG & Hemispheric Asymmetry
H12	EOG Saccades & Displacement
H13	EOG Visual Tracking vs. Imagination
H14	Ocular Fixation while reading
H15	Ocular Fixation while viewing an image
H16	Reflexes & Reaction Time - Active Learning

Bioengineering

H02	Compartmental Modeling
H20	BME Filtering
H25	BME Signal Processing (8 modules)
H26	ECG R-wave Detector
H33	FFT Fast Fourier Transformation

See page 42-44 for a description of all available lessons.

Increase your lab options with…

Cardiac Output Sensor	SS31L, p. 29
O_2 & CO_2 Analysis Module	GASSYS2-EA, p. 34
Finger Twitch Transducer	SS61L, p. 30
Heel/Toe Strike Transducer	SS28LA, p. 29
Stimulator	BSLSTMB, p. 25
Tri-Axial Accelerometer	SS26L, p. 29
Transducer Accessory Pack	BSLBME-TA, p. 42

pharmacology & toxicology

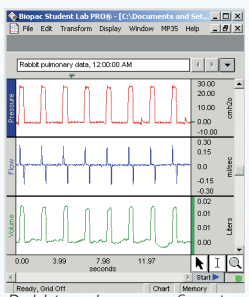
The BSL System combines a range of experiment options for cardiovascular hemodynamics, respiratory system & pulmonary function, *in vitro* tissue and cellular studies. The new range of tissue bath stations provide an extra level of functionality for *in vitro* tissue experiments. Powerful, real-time analysis functions for pressure recordings include systolic, diastolic, mean BP, and dP/dt max and min. Similar tools are available for smooth muscle experiments, including peak, area, and derivative measurements. Add the noninvasive Cardiac Output Sensor to record stroke volume and cardiac output.

features

- 31 lessons targeted for Pharmacology & Toxicology
- ECG, EEG, EGG, EOG & EMG
- Temperature
- Tissue Bath Station with integrated heating circulator
- Stimulator (direct or field)
- Cardiac Output (via bioimpedance)
- Dose Response Studies
  - Smooth Muscle
  - Cardiac Muscle
  - Skeletal Muscle
- Epithelial Transport
- Ion Transport/Ussing Chamber Measurements
- Gas Analysis Module
- Blood Pressure
- Isolated Heart/Lung
- Isolated Muscle
- Nerve Activity

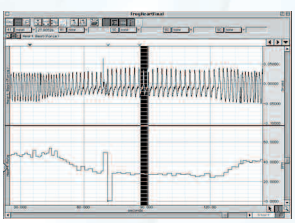
Suitable for inquiry-based, active learning in 2-yr. & 4-yr. programs, medical schools, and nursing programs

Respiratory & Pulmonary Function



Rabbit pulmonary function

The BSL lessons include measurements of tidal volume, inspiratory capacity, expiratory capacity, functional residual capacity, vital capacity, total lung capacity, forced expiratory volume and maximal voluntary ventilation. The new Gas Analysis Module provides a powerful tool for metabolic studies. Measure expired O_2 and CO_2 with lessons for VO_2 max, respiratory exchange ratio, and basal or resting metabolic rate. Perform metabolic, respiratory and pulmonary measurements on a variety of species.

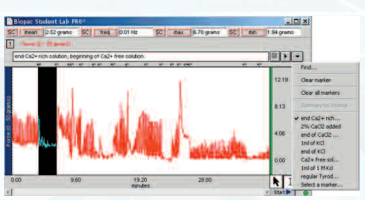


Frog heart rate response to drugs

Cardiovascular Hemodynamics

Lessons cover ECG (1- through 12-lead), cardiac output, and continuous blood pressure. A heart sounds lesson allows students to listen to and record heart sounds, while comparing them to the ECG complex. The frog heart lesson explores cardiac rate and contractile response using a range of drug doses. Students can analyze blood pressure signals in real time.

In vitro & Cellular Pharmacology



Drug effect and marker summary

The new Tissue Bath Stations provide students with research-quality equipment in a modular, flexible configuration. The Visceral Smooth Muscle lesson guides students through the entire recording and analysis process. Students can also electrically stimulate tissue preparations, including field stimulation, with the BSL Stimulator. Interface with Ussing chambers for ion transport studies. Record and also analyze data from isolated heart and lung experiments. Use the Nerve Chambers (page 38) for compound action potential studies. The system can record monophasic action potentials and spontaneous nerve activity.

New Tissue Bath

pharmacology & toxicology

The following hardware suggestions will enable you to perform a wide variety of applications targeted for **pharmacology & toxicology**. Use BIOPAC lessons or easily create your own experiments with the BSL *PRO* software included with each system. Order the core package or select items à la carte.

See **BSL Hardware** (page 23-40) for all available transducers, electrodes and accessories.

Pharmacology & Toxicology Core
BSLPHA-W (Win) or BSLPHA-M (Mac)

Basic BSL System (with BSLCBL8 substituted for SS2LB)	BSLBSC, p. 8
Airflow Filters (10/pk)	AFT1, p. 34
Airflow Mouthpieces (10/pk)	AFT2, p. 34
Airflow Nose Clips (10/pk)	AFT3, p. 34
Airflow Transducer	SS11LA, p. 27
Pressure Transducer	SS13L, p. 27
Calibration Syringe (600 ml)	AFT6A, p. 34
Force Transducer (200g)	SS65L, p. 31
Lead (unshielded) x 2	LEAD110, p. 36
Leads (shielded) x 2	LEAD110S-W/R, p. 36
Needle Electrodes x 3	EL452, p. 38
Nerve Chamber	NERVE2, p. 38
Recording Nerve Cable	BSLCBL4B, p. 39
Stimulator	BSLSTMB, p. 25
Stimulator Nerve Cable	BSLCBL2A, p. 39
Stim. Electrodes for animals	ELSTM2, p. 38

Perform 30 or more lessons with this core package:

Muscular

A03	Frog Gastrocnemius
A05	Visceral Smooth Muscle
A11	Resting Potential from Crawdad Manual
A15	Earthworm Smooth Muscle
BSL1	Standard & Integrated EMG
H07	EMG Contractions—Active Learning
H27	Facial EMG
H34	EGG Electrogastrogram

Cardiovascular

A04	Frog Heart
A09	Turtle Heart
BSL5	Components of the ECG (Lead II)
BSL6	Leads I, II, III & Einthoven's Law
H08	Dive Reflex—Active Learning
H23	Signal Averaged ECG
H32	Heart Rate Variability

Pulmonary Function

BSL12	Pulmonary Function: Vol. & Capacities
BSL13	Pulmonary Flow Rates: FEV and MVV

Neurophysiology

A01	Frog Pith & Prep
A02	Frog Nerve
A06	Cockroach Nerve
A08	Earthworm Action Potential
A14	CPG Hornworm
BSL3	EEG Relaxation & Brain Rhythms
BSL4	Alpha Rhythms in the Occipital Lobe
BSL10	EOG Eye Movement, Saccades & Fixation
H10	EEG & Hemispheric Asymmetry
H12	EOG Saccades & Displacement
H13	Visual Tracking vs. Imagination
H14	Ocular Fixation while reading
H15	Ocular Fixation while viewing an image

See page 43 for a description of all available lessons.

Increase your lab options with…

Cardiac Output Sensor	SS31L, p. 29
O_2 & CO_2 Analysis Module	GASSYS2-EA, p. 34
Temperature Transducer—Immersible	SS8L, p. 28
Transducer Accessory Pack	BSLPHA-TA, p. 42

intro to bsl hardware

The Biopac Student Lab offers a comprehensive line of electrodes, transducers and accessories that work with the MP36 high performance data acquisition unit for a wide variety of applications on human, animal, organ or tissue preparations.

Electrodes are easy to use and transducers are durable and simple to handle. "Simple Sensor" connectors detect which electrode or transducer is plugged into each channel, and generate an on-screen prompt if students mistakenly plug in the wrong transducer for a lesson.

The BSL software contains presets that simplify setup for each transducer and signal type offered (i.e., Temperature, Airflow, Dissolved O_2 and ECG, EEG, EMG). Presets keep the hardware student-friendly just connect and collect. You can easily customize presets to match your protocol and existing transducers.

If you have legacy transducers that you'd like to continue using, you can select from more than 20 interface options for manufacturers like Narco, Gilson, Lafayette, Harvard, and Vernier (see page 39). The BSL's interfacing flexibility can save a great deal of money and increases the system's usefulness.

BSL hardware can be ordered individually or as a system package.

- Packages contain everything—including consumable items—necessary to run a specified number of lessons, specific to that particular discipline.
- BASIC, ADVANCED and ULTIMATE Systems (MP36) have been offered since the Biopac Student Lab was launched in 1995, and are now in use in thousands of labs worldwide.
- CORE packages (MP36) are offered to meet the diverging requirements of specific departments.
- INTRO and HScS Health Sciences Systems (MP45) provide a budget-beating physiology lab solution.
- Any package can be used as a starting point to develop your own custom system.

Please contact a **Biopac Student Lab Specialist** to request a formal quotation and to learn more about our quantity discounts. If you prefer, you can build a quote online at **www.biopac.com**.

BSL Hardware

Data Acquisition Unit	page 24
Stimulators	page 25
Transducers ("SS Series")	page 26-31
Stimulus Presentation	page 32
Noninvasive Blood Pressure	page 32
Tissue Bath Stations	page 33
Airflow & Gas Analysis	page 33-35
Electrodes	page 36-38
Interface Options	page 39
Core Package Summary	page 41

For a full hardware list, see the Index on page 47

IMPORTANT USAGE NOTICE

BIOPAC Systems, Inc. instruments, components, and accessories are designed for educational and research oriented life science applications and investigations. BIOPAC Systems, Inc. does not condone the use of its instruments for clinical medical applications. Instruments, components, and accessories provided by BIOPAC Systems, Inc. are not intended for the diagnosis, cure, mitigation, treatment, or prevention of disease.

• See ***Compliance & Ratings*** on page 24 for details.

Data Acquisition Units – MP36 and MP45

The data acquisition unit is the heart of the Biopac Student Lab System. An MP36 or MP45 is included with each BSL System order. The unit connects to your computer using a USB port. The MP36 has four universal, analog input channels, while the smaller MP45 has two. The inputs are human safe (certified to IEC60601-1) and can record data from a wide range of signal sources, including: biopotential signals such as ECG, EEG, EMG, and EOG; transducer signals such as force, pressure, temperature, pH, and bioimpedance; and microelectrode signals from intra- and extracellular sources.

The BSL System software controls the MP36/45 hardware to create a comprehensive teaching system. The teaching system, centered around dozens of lesson experiments, can be applied to complement a wide range of curriculum from human physiology to biomedical engineering. Powerful measurement tools help extract meaningful data. The BSL System Software can automatically calculate many measurements from raw data, such as heart rate, systolic and diastolic blood pressure, lung volume, etc. See the BSL Software overview (pages 2-7) to learn more about the power and flexibility of the BSL System.

Additional Features for MP36 Only

Built-in control features support low- and high-voltage stimulation, trigger pulses, sound output, and digital I/O options. Use the BSLSTMB Stimulator for human subjects, use the MP36's built-in low voltage stimulator (with OUT3) for animal studies. The system can also record from and send digital trigger information to other software and devices such as SuperLab® and E-Prime®, switches, and relays. The fast processor, coupled with a variety of triggering functions, allows the system to be used like an oscilloscope, chart recorder or X/Y monitor.

BSL System Safety Compliance & Ratings
BIOPAC MP36 and MP45 Systems and accessories are safe for use on human, animal, organ, and tissue preparations.

The MP36/45 Systems were tested by an accredited product safety testing and certification agency and classified as Class II Type BF equipment.

The MP36/45 Systems comply with applicable requirements for the following product and safety standards:

- CE mark
  - IEC 60601-1
  - EN 60601
  - EMC: IEC 60601-1-2
- UL 60601-1
- CAN/CSA-C22.2 No. 601.1-M90
- JIS T 1001

Application Programming Interface

Student software developers can use BIOPAC API options to design and execute their own programs to control BIOPAC hardware or analyze data in other programs.

BIOPAC Hardware API - BHAPI

Control the BIOPAC MP3X acquisition unit. Use API functions to: acquire data; acquire at different sample rates; set triggers; get the MP3X status; use the Analog Output channels or the Digital I/O.

- Reference manual and sample programs available for C/C++, C#, LabVIEW, MATLAB, and VB.NET.

BIOPAC File Format API - ACKAPI

Use the base functions of this software library in a variety of combinations to use and parse specific data from BIOPAC's binary file format in other analysis programs. Retrieval options include: channel information; samples by segment of a specified channel; all samples of a specified channel; a particular sample of a specified channel; samples by time slice of a specified channel; marker information; text of a specified marker.

- Designed to be compatible with Microsoft C++ and Microsoft Visual Basic.

Specifications

Analog Inputs	Front panel DSUB 9f labeled "CH #"
Number of Channels:	Isolated human-safe universal input amplifiers MP36: 4 Channels MP45: 2 Channels
A/D sampling resolution:	MP36: 24-bit MP45:16-bit
Gain Ranges:	5x to 50,000x (13 steps)
Input Voltage Range:	Adjustable from ± 200 µVolts to ± 2 Volts (MP36 ±10 V with SS70L, page 39)
Signal to Noise Ratio:	MP36: 89 dB min MP45: 75 dB min
CMRR:	85 dB minimum
Filters:	Programmable analog and digital (IIR) filters; automatic or user-adjustable
Analog Output	±1 V output Headphone Jack: 3.5 mm stereo jack connection
Sample Rate:	MP36: 100k samples/sec each channel MP45: 48k samples/sec each channel
Serial Interface Type:	USB
Certification:	Complies with IEC60601-1 EMC complies with IEC60601-1-2 CE Marked
Dimensions / Weight:	MP36: 7 cm x 29 cm x 25 cm / 1.4 kg MP45: 3 cm x 18 cm x 10 cm / 0.3 kg
Additional Specs MP36 Only	
Analog Output:	Back panel DSUB 9m labeled "Analog Out"
Voltage Output:	Range -10 V to +10 V Resolution: 16-bits
Pulse Output:	Width: variable, 50 µsec - 100 msec Repetition: variable, 100 µsec - 5 seconds
Pulse Level:	Adjustable from10 V to +10 V With BSLSTMB Stimulator: 0 – 100 V
Input Triggering Options	
External Trigger:	Back panel BNC labeled "Trigger" TTL positive or negative edge
Analog Trigger:	Any input channel (front panel "CH 1 - CH 4")
Digital Trigger:	Any of the eight input lines (back panel DSUB 25m)
Electrode Check:	Impedance Range 0-1 MΩ Checks impedance between: Vin+ and GND, Vin- and GND

(See www.biopac.com for detailed specifications)

Biopac Student Lab Stimulator - BSLSTM

The BSL stimulator can be used on Human, Animal, Organ or Tissue Preparations for the following physiological measurements:

- Twitch sub-threshold
- Tetanic contraction
- Twitch threshold
- Muscle tension/length versus force
- Maximum twitch response
- Fatigue
- Single twitch, summation
- Nerve conduction velocity
- Field Stimulation

Stimulator Features

- Safety locking key switch to establish the operating range
- Output via the front panel BNC (female) connector
- Set the stimulus voltage level and view it on the digital display
- Output pulse trains (1-254 pulses), continuous or individual pulses
- Lock pulse width and frequency safety limits for your protocol
- Red warning LED flashes when a stimulus pulse is output
- Connects to the Analog Out on the back of the MP36
- Reference Output Cable: Stimulus marker output cable connects to any of the four analog input channels on the MP36 to record the stimulator marker pulse
- Reference Switch controls the output signal pulse width to Actual or Fixed (15 ms)
- Diagnostic test switch sends a fixed pulse width of 2.5 ms

The BSL Stimulator plugs directly into the MP36 and is controlled by the BSL *PRO* software. The *PRO* software is used to set up the stimulation pulse width, frequency and output (single pulse or series) options, and automatically notes any change to the stimulator parameters (e.g. pulse, width, and frequency) by inserting an event marker with descriptive text at the point of change. The stimulator Preset automatically scales the display for pulse amplitude. The BSL Stimulator can be set to start automatically with the recording, or manually at any point during the recording. Stimulus data can be displayed and monitored independently of the sample rate or stimulus frequency. Use with the HSTM01 (page 28) for human subjects.

BSLSTMB - for MP36/35 and BSLSTMA - for MP30

BSLSTM Specifications

Pulse level amplitude:	10 V Range or 100 V Range
Range (selectable):	.025-10 V or .12-100 V
Pulse width:	0.05-100 milliseconds
Pulse repetition:	5 seconds-0.5 milliseconds (0.2-2,000 Hz)
Stimulator isolation:	2,000 V_{RMS} DC (HI POT test)
Capacitance coupling:	60 pF
Power requirements:	BSLSTMB for MP36/35: no additional power required BSLSTMA for MP30: 12 V DC 1 Amp adapter (included)
Fuse:	250 V fast blow 2 Amp
Module dimensions:	16 cm x 16 cm x 5 cm (610 grams)
Compliance:	IEC-60601-2-10 section 51.104

(See www.biopac.com for detailed specifications)

See Lessons A02, A03, A08, A09, H03, H06, H09, page 43.

MP36 Built-in Stimulator Adapter – OUT3

Sample Connection: OUT3 to MP36 and BSLCBL2A nerve chamber cable.

The MP36 includes a built-in low voltage stimulator that is accessed via the Analog Out port with OUT3. The OUT3 female BNC adapter outputs signals and supports easy connection to nerve chambers, stimulation electrodes, clip leads, LED lights, and more.

See Lessons A02, A03, A08, A09, page 45.

Low Voltage Stimulator - SS58L

Use SS58L with MP35 units for low voltage stimulation. MP36 systems have a built-in low voltage stimulator and do not require the SS58L—see OUT3 BNC adapter above.

Use the Low Voltage Stimulator with any electrode or lead with a BNC connector (such as needle electrodes or clip leads, page 38) for direct stimulation of animal or tissue preps. Interface with nerve chambers via BSLCBL3A or BSLCBL4B, page 39. Use with headphones or speakers for sound output. Control the stimulus with the Output Control option of the BSL *PRO* software. You can monitor the output directly on the computer without any external cable.

SS58L Specifications

Interface:	MP35 Analog Out port (unisolated)
Pulse level:	-10 V to +10 V, software adjustable in 5 mV increments
Pulse width:	0.05-100 milliseconds
Pulse repetition:	5 seconds-0.1 millisecond (0.2-10,000 Hz)
Power:	No aditional power required

See Lessons A02, A03, A08, A09, page 45.

Additional Output Options:

- OUT1A Headphones, page 26
- HSTM01, Stim. Electrode for humans, page 28
- TSD122C Stroboscope, page 32
- STP35W Stimulus Presentation System, page 32
- ELSTM2 Stim. Electrodes, page 38
- BSLCBL7/11/12 Clip Leads, page 38

Shielded Lead Set - SS2LB

General-purpose electrode lead—*two* SS2LBs are included with every BSL System*

The SS2LB cable connects disposable electrodes to the MP36 unit to measure biopotential signals. Each lead set has three pinch leads that snap directly onto standard disposable electrodes (such as the EL500 series electrodes): Red (positive), white (negative), and black (ground). Each 1-meter pinch lead terminates in a yoke connected to a 2-meter cable (total length 3 meters). Used in over 30 Lessons to record ECG, EEG, EGG, EMG, EOG, etc., see page 46. *Core Animal and Core Pharmacology, substitute BSLCBL8 for SS2LB.

See also SS1LA, BSLCBL8 and BSLCBL9 (page 36).

transducers

Connect directly to the MP36 Data Acquisition Unit

EDA Lead Transducer for Disposable Setups - SS57L

The SS57L EDA Lead Transducer snaps to two disposable EDA (isotonic gel) electrodes (EL507 on page 37). See the EDA (GSR) Transducer (SS3LA on page 28) as an alternative reusable option.

Range:	.1-100 µMho (normal human range is 1-20 µMho)
Excitation:	0.5 V DC (constant)
Pinch Leads:	Red (+), Black (GND)

See Lessons BSL9, BSL14, H11, H24, page 44.

Pulse Photoplethysmogram - SS4LA

Measure blood density changes in the fingertip or other body locations, caused by varying blood pressure. Record the pulse pressure waveform. Attach to the finger by the Velcro® strap or tape to other body parts.

Sensor type:	IR
Dimensions:	16 mm (long) x 17 mm (wide) x 8 mm (high)

See Lessons BSL7, H05, pages 43-44.

Respiratory Effort Transducer - SS5LB

Record respiration via chest or abdominal expansion and contraction. The strap presents minimal resistance to movement and is extremely unobtrusive. The novel (non-Piezo) design permits the recording of arbitrarily slow respiratory activity.

Response:	True DC
Circumference Range:	10 cm - 140 cm (increase with a longer nylon strap)
Dimensions:	95 mm (long) x 47 mm (wide) x 15 mm (thick)

See Lessons BSL8, BSL9, pages 43-44.

Fast-response Thermistor - SS6L

Measure small variations in temperature, either on the skin surface or in an air stream. Record temperature changes in airflow during breathing to indicate respiration rate. Attach to the skin surface with surgical tape (TAPE1).

Response time:	0.6 sec	Compatibility:	YSI® series 400
Max operating temp:	100°C	Dimensions:	5 m (long) x 1.7 m (diameter)
Accuracy & Interchangeability:	±.02°C		

See Lessons BSL8, BSL15, pages 43-44.

**See other Temperature Sensors on page 28 (SS7L and SS8L).*

Hand Switch - SS10L

Use this hand switch for remote event marking or for psychophysiological response tests. Monitor switch data as an input channel. Connects to any analog input channel. Switch type: momentary push-button.

See Lessons BSL11, H11, H16, H24, H27, H30, pages 43-44.

**See digital switch options for the MP36 unit on page 30 (SS53L-SS55L).*

Headphones

Use headphones to listen to real-time physiological signals (like EMG), or to present auditory stimuli.

OUT1A Ultra-wide frequency response headphones. Connect to headphone port on MP36 only.

40HP Monaural headphones. Connect to headphone port. *Ships with MP45 BSLHScS Systems.*

See Lessons BSL1, BSL2, BSL11, H09, H16, H31, pages 43-44.

**See the Tubephone (OUT101) on page 31.*

**MP35/30 users: Visit BIOPAC online for OUT1 headphones with analog out connection.*

connecting to the mp system

Unless otherwise specified, all transducers connect directly to the MP36 acquisition unit and have a 3-meter cable. All BIOPAC "Simple Sensor" transducer connectors are DSUB 9m for analog input and DSUB 9f for output. There is only one way to plug Simple Sensor connectors into the MP36, so you don't have to worry about plugging things in upside down or into the wrong socket. We offer a wide range of transducer interface connectors so that you can connect your existing equipment, or you can build your own interface by using one of our custom interface kits (see page 39).

Airflow Transducer (Med. Flow) - SS11LA

Airflow Transducer for resting human & light exercise. Use the SS11LA to perform a variety of tests relating to airflow and lung volume; integrate the airflow signal to obtain volume measurements. The pneumotach can be mounted on a camera tripod and has a clear, removable head for sterilization (using Cidex or a dishwasher) and replacement. Connects to industry standard bacteriological filters (AFT1) and disposable mouthpieces (AFT2). For hygiene, do not share disposable mouthpieces and disposable filters.

Flow Rate:	±300 liters/min
Dead space:	93 ml
Dimensions:	Head: 82.5 mm diameter x 101.5 mm length
	Handle: 127 mm (long) x 23 mm (thick) x 35 mm (wide)
Ports:	22 mm ID/30 mm OD

The following consumable items are required for the SS11LA Airflow transducer to perform the pulmonary function lessons: AFT1 Disposable Filter, AFT2 Disposable Mouthpiece, AFT3 Disposable Noseclip, AFT6A Calibration Syringe. See page 34 for Airflow Accessories. Available in bulk, low-cost quantities for student accessory packs.

Replacement Airflow Head - RX117

The RX117 is a sterilizable replacement transducer head for the SS11LA Airflow Transducer.

See Lessons BSL12, BSL13, BSL15, H29, H19, pages 43-44.

**See High Performance Air Flow options on page 35.*

Variable Range Force Transducer - SS12LA

Use the SS12LA force transducer for tissue bath and isolated organ experiments, frog gastrocnemius and human finger twitch experiments. The SS12LA will operate in five ranges (50 g, 100 g, 200 g, 500 g or 1,000 g), is extremely stable and incorporates impact and drop shock protection to insure against rough laboratory handling. The SS12LA mounting rod can be attached in three different locations, two on the top and one on the end surfaces of the transducer, to provide a variety of mounting options. The SS12LA includes two aluminum S-hooks: one has a 1.26 mm (.032") wire diameter; the other is 2 mm (.051").

Sensitivity:

Range	Noise (1 Hz LP)
50 g	1.0 mg
100 g	2.0 mg
200 g	4.0 mg
500 g	10.0 mg
1,000 g	20.0 mg

Temperature Range:	-10°C to 70°C
Dimensions:	19 mm x 25 mm x 190 mm

See Lessons A02, A04, A05, A09, A15, H06, pages 43-45.

**See the Tension Adjuster (HDW100A) on page 31.*
See the Fixed-Range Force Transducers (SS63L-SS66L) on page 31.

Pressure Transducer - SS13L

Measure direct arterial or venous blood pressure in animals or record pressure changes within a closed system (such as an organ or tissue bath system). Connect tubing via male Luer-lock fittings. The disposable transducer has a 30 cm cable that attaches to a reusable cable. Supplied non-sterile but can be cold sterilized.

Range:	-50 to 300 mm Hg
Operating temperature:	10°C to 40°C
Transducer dimensions:	67 mm long X 25 mm wide

Replacement Element - RX104A

The RX104A replacement element for the SS13L Pressure Transducer does not include the Simple Sensor connector and cable.

See Lessons H04, pages 44-45.

Blood Pressure Cuff Transducers

SS19LA *for MP36/MP35*

Onscreen gauge

SS19L *for MP45/30*

Mechanical gauge

Measure blood pressure via oscillometric or auscultatory methods. Use with the SS30L to record BP and Korotkoff sounds. Includes adult cuff (RX120D), pump bulb, and pressure sensor. Additional cuff sizes available. SS19LA requires BSL 3.7.5 or above software.

Pressure range:
20 mmHg to 300 mmHg

Manometer accuracy:
±3 mmHg

Cuff	Circumference	Width	Length
RX120A	9.5-13.5 cm	5.2 cm	18.5 cm
RX120B	13.0-19.0 cm	7.5 cm	26.1 cm
RX120C	18.4-26.7 cm	10.5 cm	34.2 cm
RX120D	25.4-40.6 cm	14.5 cm	54.0 cm
RX120E	34.3-50.8 cm	17.6 cm	63.3 cm
RX120F	40.6-66.0 cm	21.0 cm	82.5 cm

See Lessons BSL16, H04, pages 43-44.

Hand Dynamometer - SS25LA

Use in isolation or combine with EMG recordings for in-depth studies of muscular activity. The lightweight, ergonomically designed transducer provides direct readings in kilograms or pounds. Use to measure grip force.

Range: 0-90 kg Weight: .323 kg
Dimensions: 17.78 cm x 5.59 cm x 2.54 cm

See Lesson BSL2, page 43.

Clench Force Bulb Dynamometer - SS56L

Measure force on the basis of the proportionality of clench force to pressure in the bulb. Select units of Kgf/m^2 or psi. *Ships with MP45 HScS Systems.*

See Lesson BSL2, page 43.

Multi-Lead ECG - SS29L

The multi-lead ECG cable connects to standard snap-connector disposable electrodes (EL503 series) to simultaneously record Leads I, II, III, aVR, aVL, aVF, plus one alternating precordial chest lead V(1-6) for 12-lead studies. Incorporates a Wilson terminal. Each 1-meter pinch lead terminates in a yoke connected to a 2-meter cable that has three Simple Sensors (three input channels required).

See Lesson H01, page 43.

Connect directly to the MP36 Data Acquisition Unit

Electronic Stethoscope Transducer - SS30L

This is a standard clinical stethoscope with a built-in electronic microphone to simultaneously capture sound. Listen to heart sounds and Korotkoff sounds, and simultaneously record the sound data (a variety of acoustical signals can be recorded). When recording ECG, you can correlate the timing of the heart sounds with the cardiac cycle. Use with the SS19LA/L Blood Pressure Cuff to record Korotkoff sounds for easy determination of systolic and diastolic blood pressure. Microphone Bandwidth: 20-100 Hz (does not interfere with stethoscope earphones).

See Lessons BSL16, BSL17, H04, H21, pages 43-44.

*See also the Physiological Sounds Microphone (SS17L, below) for a higher bandwidth alternative and the Speech Frequency Microphone (SS62L, page 30).

Human-safe Stimulation Electrode - HSTM01

Provides a superior degree of safety and comfort when using the BSLSTMB Stimulator for human stimulation. The ergonomic design allows the user to focus on electrode placement when locating a subcutaneous nerve. Stimulus presentation is allowed by pressing the red safety switch and stopped by releasing it. Complies with IEC 60601-2-10 for limitation of stimulation signal and interfaces with the BSLSTMB stimulator (BNC connector).

Isolation Voltage:	1500 V_{RMS}
Isolation Capacitance:	120 pF

See Lessons H03, H06, pages 43-44.

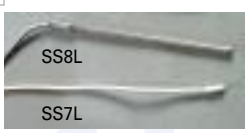
EDA (GSR) Transducer - SS3LA

Measure electrodermal activity and response (galvanic conductance/GSR). The built-in, reusable electrodes fit around the tip of a person's finger and attach via Velcro® straps or can be taped to any other body part.

Electrode Type:	Ag-AgCl, shielded
Excitation:	0.5 V DC (constant)
Range:	0.1-100 µMho (normal human range is 1-20 µMho)
Surface Area:	6 mm diameter contact area
Gel Cavity Depth:	1.66 mm
Dimensions:	16 mm (long) x 17 mm (wide) x 8 mm (high) [each]

See Lessons BSL9, BSL14, H11, H24, page 44.

*See the EDA (GSR) Disposable Option (SS57L) on page 26.



Waterproof Temp. Probe - SS7L

Use this vinyl probe for core (oral/rectal) temperature recordings.

Response time:	1.1 sec
Max operating temp:	100°C
Accuracy & Interchangeability:	±0.2°C
Compatibility:	YSI® series 400
Dimensions:	3 mm (dia) x 9.8 mm (long)

Liquid Immersion Temp. Probe - SS8L

Use this stainless steel probe for dry or wet bath temperature measurements.

Response time:	3.6 sec
Max operating temp:	100°C
Accuracy & Interchangeability:	±0.2°C
Compatibility:	YSI® series 400
Dimensions:	4 mm (dia) X 115 mm (long)

*See the Fast-response Thermistor (SS6L) on page 26.

Displacement Transducer - SS14L

Record very slight movements (up to 100 mm) in a range of physiological preparations. Incorporates a semi-isotonic strain gauge (500 ohm silicon) and a nickel-plated cantilever beam device (27 cm) for holding the transducer. Features high linearity.

Sensitivity range:	Up to 100 mm
Dimensions (mm):	Body: 95 x 25 x 25; Blade: 305 x 1.27 x 0.6; Support rod: 127 x 9.5 (dia)

Physiological Sounds Microphone - SS17L

Use to record a variety of acoustical signals, including heart sounds and sounds associated with rubbing or grinding (e.g., Bruxism). Use with the SS19LA/L noninvasive Blood Pressure Cuff to record Korotkoff sounds for easy determination of systolic and diastolic blood pressure. Use as a higher bandwidth alternative to the electronic stethoscope (SS30L, above).

Microphone Bandwidth:	35 Hz to 3,500 Hz
Housing:	Stainless Steel
Transducer Weight:	9 grams

See Lesson H04, page 44.

*See also Speech Frequency Microphone SS62L, page 30.

Goniometers & Torsiometers - SS20L-SS24L

Goniometers measure bending strain along or around a particular axis to transform angular position into a proportional electrical signal. All goniometers have a telescopic endblock that compensates for changes in distance between the two mounting points as the limb moves. Goniometers can be attached to the body surface using tape (TAPE1 or TAPE2, page 36).

- Twin-axis goniometers (SS20L/21L) are dual output devices and measure angular rotation about two orthogonal planes simultaneously (e.g. wrist flexion/extension and radial/ulnar deviations).
- Torsiometers (SS22L/23L) measure angular twisting (as on the torso, spine or neck) as opposed to bending and measure rotation about a single axis (e.g. forearm pronation/supination).
- The single axis goniometer (SS24L) measures finger, thumb or toe joint movement and will measure the angle in one plane only.

	SS20L	SS21L	SS22L	SS23L	SS24L
Type:	Goniometer	Goniometer	Torsiometer	Torsiometer	Goniometer
Channels:	2	2	1	1	1
Max Length:	110 mm	150 mm	110 mm	170 mm	35 mm
Min Length:	75 mm	130 mm	75 mm	150 mm	30 mm
Range:	±150°	±150°	±150°	±150°	±150°
Typical Placement:	wrist or ankle	elbow, knee or shoulder	neck	torso or spine	fingers, thumb or toes
Weight:	23 g	25 g	22 g	23 g	8 g

See Lessons BSL20, H17, H28, H35, pages 44-45.

Accelerometers

These tri-axial accelerometers measure accelerations in the X, Y, and Z directions. For simultaneous measurement, three input channels are required. The design conforms to body contours and includes a Velcro® strap for easy attachment.

SS26LB: Optimal for measuring slow movements, such as walking.
SS27L: Optimal for measuring quick movements, such as swinging a tennis racket.

Range (Output): SS26LB: ±5 g, SS27L: ±50 g
Bandwidth: DC - 500 Hz (-3 dB)
Dimensions: SS26LB: 16 mm (long) x 17 mm (wide) x 8 mm (high)
SS27L: 33 mm (long) x 28 mm (wide, at base) x 19 mm (high)

Heel/Toe Strike - SS28LA

Use this transducer to record heel and toe strike activity as the subject walks. The heel/toe strike data is recorded as a single channel; the heel strike generates a negative deflection and the toe strike results in a positive deflection. Two force sensitive resistors (FSR) attach to the sole of a shoe; use two SS28LA transducers to simultaneously record from both feet.

Nominal Contact Force: 200 g to indicate heel/toe strike
Attachment: TAPE1, TAPE2
FSR Dimensions: 18.3 mm wide x 0.36 mm (thick) x 30 cm long
FSR Active Area: 12.7 mm (dia)
Cable Length: 7.6 meters

Cardiac Output Sensor - SS31L

Measure cardiac output noninvasively using electrical bioimpedance techniques; the sensor is suitable for human and animal measurements. Use the sensor to record stroke volume and CO before and after exercise, or during a psychophysiology test. The sensor provides a noninvasive, powerful cardiovascular hemodynamic demonstration that allows students to see the real-time changes in stroke volume and cardiac output. Typically used with disposable bioimpedance strip electrodes (EL506 on page 37), but can function with spot or band electrodes, reusable electrodes, or needle electrodes.

Number of Channels: 2 - Impedance (Zo) and dZ/dt
Operational Frequency: 100 kHz
Outputs: Impedance Zo 0-100 ohms
dZ/dt ±20 ohms/sec
Configuration: Tetrapolar—4 Electrodes
Excitation: 400 µA RMS constant current

See Lesson H21, page 43.

Connect directly to the MP36 Data Acquisition Unit

Reflex Hammer - SS36L

This is a classic reflex hammer with a transducer attached to perform reflex measurements. It uses a Taylor Hammer®-the most common type of reflex hammer used by doctors—and incorporates electronics to record the time and the relative strength of the impact. This allows students to measure how much of an impact is needed to elicit a response.

See Lessons BSL20, H28, page 44.

Signal Processing Breadboard - SS39L

The Bioengineering Breadboard Lab consists of circuitry hardware and lessons (with schematics and design notes) that demonstrate a very important subset of circuit design for recording and processing physiological signals. Includes electrode signal lead interface. Use with SS60L cables to record circuit performance on more than one channel. Students will use the MP36 and BSL *PRO* software to evaluate their designs.

Included Hardware:
1 - Breadboard
1 - Power/Signal Cable (includes fuses with built-in, automatic reset)
1 - Parts kit including op-amps, capacitors, diodes, resistors, and jumper wires as required to complete projects

Lesson Modules:

Lab 1: Square Wave Oscillator	Lab 5: Notch Filter for 60 Hz Rejection
Lab 2: Instrumentation Amplifier	Lab 6: *QRS Detection:* Band Pass Filter
Lab 3: High Pass Active Filter	Lab 7: *QRS Detection:* Absolute Value Circuit
Lab 4: Active Gain Block and Low Pass Filter	Lab 8: *QRS Detection:* Low Pass Filter and Overall System Test

Combine modules to build a complete ECG Signal Processor.

Optional Signal Processing Cable - SS60L

Use this signal cable to record additional channels with the SS39L Signal Processing Breadboard.

See Lessons H25, H26, page 45.

Differential Pressure - SS40L-SS42L

These transducers interface a variety of small animal breathing circuits to the MP36 for air pressure monitoring. The transducers are extremely sensitive and come in three ranges to suit a number of different applications. Included with each SS46L-SS52L (page 33).

Range:	
SS40L:	±2.5 cm H_2O
SS41L:	±12.5 cm H_2O
SS42L:	±25.0 cm H_2O
Dynamic Response:	100 Hz
Connection ports/ID:	3 mm to 4.5 mm tubing accepted
Dimensions:	8.3 cm (high) x 3.8 cm (wide) x 3.2 cm (deep)
Weight:	76 grams

Variable Assessment Transducer - SS43L

Use this handheld, slide control transducer to record subjective responses for a variety of different stimuli. Use multiple transducers to allow several people to simultaneously answer the same question or otherwise respond to stimuli. Easily customize the response scale by inserting parameters into the scale sleeve on the front of the unit. 7.6 meter cable.

Digital Switches - SS53L-SS55L

Use for remote event marking or to externally trigger data acquisition for psychophysiological response tests. Monitor switch data as a digital input channel. The following switches interface with the I/O port on the rear of the MP36 unit for digital input.

Hand Switch, Digital - SS53L

Dimensions:	19 mm (dia) x 63 mm (long)
Cable Length:	2 meters
Connector Type:	DSUB 25f

Foot Switch, Digital - SS54L

Dimensions:	69 mm (wide), 90 mm (long), 26 mm (high)
Cable Length:	1.8 meters
Connector Type:	DSUB 25f

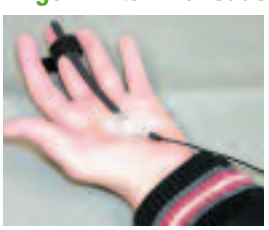
Eight-channel Marker Box, Digital - SS55L

Independently mark events, or provide responses, on up to eight channels simultaneously. Assign separate digital channels as event markers for individual analog input channels. Easily customize the switch indicators by inserting parameters into the label sleeve on the front of the unit.

Dimensions:	19 cm (wide), 11 cm (deep), 4 cm (high)
Cable Length:	2 meters
Connector Type:	DSUB 25f

See Lessons H11, H16, H24, H27, H30, pages 43-44.

Finger Twitch Transducer - SS61L



Use this transducer to record finger twitch responses from human subjects receiving electrical stimulation (using the HSTM01, page 28). The transducer conforms to the shape of the finger and attaches via a Velcro® strap and tape.

Transducer Dimensions:	14.6 cm (long), 0.50 cm (wide)
Weight:	6 g

See Lesson H06, page 43.

Speech Frequency Microphone - SS62L

Use this precision microphone for speech frequency analysis and other acoustic studies. Requires continuous high-speed sample rate - use with the MP36 and MP35 only.

Frequency Range:	60-12,000 Hz
Impedance:	600 Ohms
Type:	Cardioid
Cable:	6 meters
On/Off Switch:	none

* See also Physiological Sounds Microphone (SS17L) and Electronic Stethoscope Transducer (SS30L) on page 28.

Fixed-Range Force Transducers - SS63L-SS66L

Use force transducers for *in vitro* tissue bath studies, *in vivo* force measurements and other applications where low noise, accuracy and repeatability are critical. The most sensitive units are ideal for use with small preparations such as aortic rings. When fine tension and position adjustments are required, use the Tension Adjuster (HDW100A, page 31).

Part #	Full Scale Range (FSR)	Noise with 10 Hz LP Filter	Noise with 1 Hz LP Filter
SS63L	50 g	2.5 mg	1.0 mg
SS64L	100 g	5.0 mg	2.0 mg
SS65L	200 g	10.0 mg	4.0 mg
SS66L	500 g	25.0 mg	10.0 mg

Temperature Range: -10°C to 70°C
Weight: 250 grams
Mounting Rod: 9.5 mm (dia)- variable orientation
Dimensions: 100 mm (long) x 19 mm (wide) x 25 mm (thick)

See Lessons A02, A04, A05, A09, A15, H06, pages 43-45.

See also the Variable Range Force Transducer (SS12LA, page 27).

Pneumogram Transducer - SS67L

Capture respiratory signals from small, unconscious animals—just lay them on top of the sensor pad. Ideal for MRI-applications. Affix to subjects with single-sided adhesive (TAPE1, page 36). This unobtrusive, multipurpose pneumogram transducer can:

1. Noninvasively measure respiration—from a small mouse to large rodent.
2. Measure small pressing forces (like pinching fingers together) for Parkinson's evaluations.
3. Measure human smiling (with the sensor on the cheekbone).
4. Measure pulse when placed close to the heart.
5. Measure spacing and pressure between teeth coming together.

SS67L components:
1- Differential Pressure Transducer (SS41L, page 30)
1- Pneumogram Sensor (RX110, below)
1- Tubing (1.6m)

RX110 - Replacement Sensor

The RX110 is a self-inflating pressure pad connected to tubing terminating in a Luer male connector. The RX110 sensor is included with the SS67L Pneumogram Transducer.

pH Probe - SS68L

This double-junction pH probe measures pH within the range of 0-14. Use the pH Probe Adapter (BSL-TCI21, page 39) to use a third party pH probe with the MP36. Order probe only as RXPROBE01.

SS68L Components: RXPROBE01 and BSL-TCI21
Output: 5 mV/pH (0 mV @ pH=7)
Weight: 99.22 g
Length: 3.25 cm
Diameter: 1.2 cm

Dissolved O_2 Probe - SS69L

Measures dissolved oxygen levels. Includes electrolyte solution, replacement membrane cap and replacement O-ring. Use the Vernier Adapter (BSL-TCI16, page 39) if you already have a Vernier Dissolved O_2 Probe. Order probe only as RXPROBE02.

SS69L Components: RXPROBE02 and BSL-TCI16
Type: Polarographic
Oxygen Range: 0-40 ppm
Electrodes: Platinum and silver
Minimum sample velocity: 20 cm/sec.

See Lesson A07, page 45.

Tubephone - OUT101

Use the OUT101 with a stimulator module to deliver clicks in auditory evoked response applications (i.e., ABR). The tubephone design consists of a monaural acoustic transducer attached to a short, flexible, plastic tube, which fits into the subject's ear with the aid of a foam tip. Compares to TDH-39, 49 or 50 audiometric headphones. Includes ¼" to ⅛" phono adapter.

Dimensions: 3.8 cm (wide) x 5 cm (high) x 1 cm (thick)
Cable termination: 6.3 mm (1/4") phone plug
Cable length: 1.8 meter

See Lesson H09, page 44.

*See the Headphones (OUT1A) on page 26

Tension Adjuster - HDW100A

Use the HDW100A to adjust the tension between the preparation and a Force transducer (SS12LA on page 27 or SS63L-SS66L on page 31). The position adjuster is located on the top for easy access and smooth operation and mounts on typical lab stands. Vertical scales are provided for both metric and standard units. Works with most commercial force transducers.

Travel Range: 25 mm
Resolution: 0.0025 mm per degree rotation
Stand Clamp: 12.80 mm ID
Transducer Clamp: 14.60 mm ID
Dimensions: 93 mm (high) X 19 mm (thick) x 74 mm (deep)

See Lessons A02, A04, A05, A09, A15, page 45.

Tension Adjuster Adapter - HDW200

This adapter allows third-party tension adjusters with an arm diameter of 6.35 mm (¼) or less to work with BIOPAC force transducers.

visual and auditory stimulus presentation

SuperLab Stimulus Presentation

SuperLab presents visual or auditory stimuli and simultaneously (1 ms resolution) sends trigger signals to the MP36 for data synchronization and collection purposes. Images and sounds are presented on a second computer screen (auditory stimuli via headphones or speakers). Images and sounds are grouped by type and have a digital sync signal assigned to each group. As each image or sound is presented, a sync pulse is sent to the MP36. The BSL software identifies the pulses and provides the average response to the group stimulus. Measurements can be taken over the response data such as max, min, mean, time of max, etc. *Note: Second PC Required.*

SuperLab System for MP36/35 - STP35W

Complete SuperLab package for the MP36/35. Includes an interface cable permitting up to eight synchronization signals (input or output) between the STP35W and the BSL System. Different trigger channels can be paired to different visual or auditory stimuli to perform sophisticated evoked response averaging tests (e.g., P300). The STP35W also includes a six-pushbutton response box for performing accurate reaction time measurements.

See Lessons H24, H27, H30, H31, pages 43-44.

StimTracker Marker Interface - STK100

The StimTracker delivers markers from the stimulus presentation computer running SuperLab via USB to the MP36/35 via the STP35 cable (sold separately). The STK100 includes Stimtracker device and two photocells, and works with your existing copy of SuperLab.

SuperLab Interface Cable - STP35

If you already have SuperLab and an MP36/35 unit, you can use the STP35 Interface Cable to connect the two systems. The STP35 Cable interfaces with the I/O Port on the rear of the unit.

E-Prime Experiment Generator

E-Prime is a powerful suite of applications combining precise millisecond timing, a user-friendly environment, and the flexibility to create simple to complex experiments for both advanced and novice users. MP36 or MP35 Systems—Use the STP35A 3-meter ribbon cable (sold separately, see below) to interface the computer printer port to the I/O Port on the back panel of the MP unit. *Note: Second PC Required.*

EPM100: E-Prime 2.0 Software, Standard Edition.

EPM100P: E-Prime 2.0 Professional, offers enhanced capabilities for more sophisticated presentation designs.

Parallel Port Interface Cable - STP35A

Use to connect MP36/35 system to the parallel (printer) port of the computer running E-Prime.

*Can also be used with MediaLab, DirectRT, and Inquisit.

Visual Stimulation for Evoked Response

Stroboscope – TSD122C

The stroboscope connects directly to the MP36 Input or Output channels for visual evoked response applications, and includes BSLCBL5 (page 39) to interface with the BSL System. The stroboscope operates from zero to 12,000 flashes a minute and can generate or respond to a TTL synchronizing signal.

I/O Ports:	TTL (Sync input and output)-3.5mm phone jacks
Flash Duration:	30 µsec
Power:	Battery, built-in, rechargeable
Battery Life:	60 hours at 100 strobes/sec
Interface Cable:	BSLCBL5 (included) connects to an analog input (CH1-CH4) to record the strobe flash as a pulse and trigger the MP unit.
Body Dimensions:	9.3 cm (wide) x 9 cm (high) x 23 cm (long)
Weight:	1.1 kg

See Lesson H22, page 44.

noninvasive blood pressure

- Accurate noninvasive blood pressure values
- Easy to use
- Comfortable for subjects
- Real-time, continuous, noninvasive BP
- Module display languages: EN, DE, FR, ES, IT

Noninvasive Blood Pressure Monitoring—NIBP100D

See Lesson H18, page 44.

Initial setup and calibration period takes less than three minutes!

The NIBP100D is a stand-alone noninvasive blood pressure monitoring system that provides a continuous, beat-to-beat, blood pressure signal recorded from the fingers of a subject. Uses a double finger cuff sensor that is comfortable for the subject to wear and easy to place on the hand– three included cuff sensors fit small to large fingers. The system outputs a continuous blood pressure waveform that is similar to a direct arterial pressure waveform. Monitor displays values for systolic, diastolic, mean blood pressure, and heart rate. Add BSL-TCI5 to use with an MP36 System.

NIBP100D System includes:

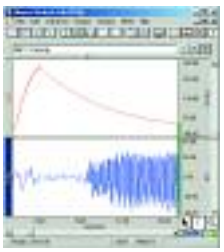
Blood Pressure Module with external mains power and interface cables
Finger cuff sensors (3): small 10-18 mm, medium 18-24 mm, and large 24-28 mm
BP cuffs for calibration (4): xs 12-19 cm, small 17-25 cm, medium 23-33 cm, and large 31-40 cm
Finger cuff sensors are a consumable item and typically last ~12 months based on 3-4 hours/week.

Order additional finger cuffs as RXNIBPDFINGER-L, RXNIBPDFINGER-M, or RXNIBPDFINGER-S.

Module Dimensions: 280 x 270 x 250 mm (11 x 10.6 x 9.8 in.) Weight: 7.5 Kg (16.6 lbs)

noninvasive blood pressure for animals

Noninvasive Small Animal Tail Blood Pressure Systems



NIBP Amplifiers with built-in pump automatically inflate the tail cuff to occlude the vessel in the tail of a rat or similar small animal, and then slowly deflate the cuff when the inflation point is reached, providing a linear drop in pressure. A single control starts both the inflation and deflation cycles, making the system very operator friendly. Amplifiers have two analog outputs for pressure and pulse waveforms, plus gain adjustment to amplify or attenuate the pulse signal. Systolic, diastolic, and mean BP values.

NIBP250 Touchscreen LCD controls & displays data for local analysis and storage of Use as a stand-alone system or interface to BIOPAC or third-party A/D hardware. USB 1.1 compatible flash memory port and SD card slot.

NIBP200A Amplifier for use with Tail Cuff Sensor

Tail Cuff Sensor

NIBP250

NIBP200A
A1 110 V
A2 220 V

Systems include:

- Amplifier — order NIBP250 or NIB200A
- Cuff Sensor: 11 cm — *or request* 9.5 or 13 cm
- Restrainer: medium — *or request* small or large
- Analog outputs: — pressure 0-3 V DC, Pulse 0-4 V DC
- Output cables: — pressure cable and pulse cable
- Interface cables: — to BIOPAC or third-party A/D hardware
- User's Manual

Optional Tail Heater: TAILHEATA 110 V or TAILHEATB 220 V

tissue baths

Integrated Tissue Bath & Heater System - ITBS100

A modular, durable solution for your lab

Features include:

- Jacketed bath and reservoir in a range of volumes
- Integrated, heating circulator, programmable temperature range 20° - 44° C
- 500 ml/min circulation flow
- Movable micrometer-transducer assembly
- User-friendly display and controls
- One-switch control of fill/drain cycle
- Microprocessor control
- Low-level alarm for water temperature
- Acrylic, robust bath
- Small, lightweight setup

Components:

- 1 x Bath (specify 20 ml, 30 ml, or 50 ml)
- 1 x Reservoir (800 ml)
- 1 x Integrated Heater (1600 ml volume, 20° - 44° C)
- 1 x Circulator Pump (15 W; 500 ml/min)
- 1 x Micrometer (fits BIOPAC transducers)
- 2 x Triangle Tissue Clip (Stainless Steel; reorder as RXCLIP-TRI)
- 2 x Tissue Clip (Stainless Steel; reorder as RXCLIP)
- 1 x Tissue Holder (Stainless Steel; reorder as RXHOLDER-S)
- 1 x 3-way Rotary Valve
- 1 x Power Supply (specify 110 V/60 Hz. or 220 V/50 Hz)

See Lessons A05, A15, page 45.

**Contact BIOPAC for modular, multi-channel tissue bath stations and independent heating circulator.*

Field Stimulation Electrode - BSLSTIMHLD

This tissue holder with built-in field stimulation electrodes works with Tissue Bath Stations and the BSLSTMB Stimulator.

Electrodes:	Platinum rings
Ring size:	5 mm
Ring spacing:	2.0 cm
Connector:	BNC

airflow & gas analysis

Airflow Transducers- SS46L-SS52L

*See also the Medium Flow Airflow Transducer (SS11LA) on page 27.

Perform a variety of pulmonary measurements relating to airflow, lung volume and expired gas analysis of small animals or exercising humans. Each Airflow Transducer consists of a flow head, a precision, highly sensitive, differential pressure transducer (SS40L), and 1.8 meter tubing. Airflow Transducers connect directly to a breathing circuit or plethysmogram chamber; for airflow and lung volume measurements, connect a short airflow cannula to the flow head. RX237 series' novel design greatly reduces thermal inertia and minimizes condensation no heater required! SS52L is a heated pneumotach and includes a 6 V power supply (AC137, page 40). For switchable or replacement heads, see RX Series part for head only.

Part #	Head	Linear Range	Dead Space	Approx. Flow 10 mm H20	Port OD	Length	Weight
SS46LA	RX237B	±1 L/min	0.6 ml	1.2 L/min	5 mm	40 mm	13.8 g
SS48LA	RX237D	±10 L/min	2.0 ml	12 L/min	8 mm	54 mm	21.8 g
SS50LA	RX237F	±100 L/min	9.0 ml	90 L/min	16 mm	54 mm	37.7 g

Exercising Human

Part #	Head	Max Range	Dead Space	Output ÌV/[ml/sec]	Ports ID; OD	Length	Weight
SS52L*	RX137H1	±8 L/sec	80 cc	0.0385	43 mm; 45 mm	60 mm	250 g

**Requires one coupler (AFT11F, page 35) to interface with the GASSYS2 (page 34) and other airflow accessories.*

Gas Analysis Module - GASSYS2

SPECIAL

O_2 and CO_2 Gas Analysis Module measures expired O_2 and CO_2 concentrations. Obtain real-time Oxygen Consumption (VO_2), Basal Metabolic Rate (BMR) and Respiratory Exchange Ratio (RER) measurements using the MP36 System with the GASSYS2 module. Available with a 5-liter chamber or a 1-liter chamber for small children/medium sized animals. Chambers are modular so you can interchange them with one base module and they are easy to clean. The GASSYS2 includes tubing (AFT7), coupler (AFT11E), non-rebreathing "T" valve (AFT22), and a separate 12 V power supply (AC100A), creating a low-cost solution for BSL users already using the SS11LA Airflow Transducer and accessories. Flap valve prevents expired air from returning to chamber, and gas calibration port allows O_2/CO_2 sensor calibration.

CO_2 Range: 0-5%
O_2 Range: 0-25%

Note: Two couplers (2 x AFT11F) required when interfacing with the Airflow Transducer (SS52L).

GASSYS2-EA - Module with 5-liter chamber
GASSYS2-EB - Module with 1-liter chamber
RX-GASA - 5-liter chamber/screw fixture
RX-GASB - 1-liter chamber/screw fixture

See Lessons H29 and H19, page 43.

*See gas calibration options on page 35 (GASCAL and GASREG). The GASSYS2 can measure both O_2 consumption and CO_2 production in real time. CO_2 production is measured to a 5% maximum for RER or RQ calculations, and real-time VO2 measurements can be performed on subjects at rest or exercising. If your protocol examines CO_2 above 5% or requires high-speed response, contact BIOPAC to discuss the full range of gas analyzers.

SS11LA accessories

*See SS11LA Airflow Transducer on page 27.

Disposable Bacterial Filters (22 mm ID/OD) - AFT1

Use between the Airflow Transducer (SS11LA) and the 22mm disposable Mouthpiece (AFT2) to remove airborne bacteria. Ports: 22 mm ID/OD.

AFT1 Pack of 10
AFT1-250 Pack of 250

See Lessons BSL12, BSL13, BSL15, H29, H19, pages 43-44.

Disposable Mouthpieces (22 mm OD) - AFT2

Connects to the Airflow Transducer (SS11LA) via the disposable Bacterial Filter (AFT1).

AFT2 Pack of 10 **AFT2-250** Pack of 250

See Lessons BSL12, BSL13, BSL15, H29, H19, pages 43-44.

Disposable Nose Clips - AFT3

Plastic clip gently squeezes the nostrils shut. Use with the Airflow Transducer (SS11LA).

AFT3 Pack of 10 **AFT3-250** Pack of 250

See Lessons BSL12, BSL13, BSL15, H29, H19, pages 43-44.

BSL Accessory Pack - BSL-ACCPACK

Have students purchase their own disposable accessories for hygenic purposes and reduce the burden on department budgets—sell these student accessory packs through your school bookstore. Each pack includes disposable (one-use only) items required to run BSL Lessons:

60 x Disposable Electrodes (EL503)
1 x Disposable Mouthpiece (AFT2)
1 x Disposable Bacterial Filter (AFT1)
1 x Nose Clip (AFT3)
8 x Abrasion Pads (ELPAD)
8 x EDA Electrodes (EL507)

Standard Syringe - AFT6A

Use the 0.6 liter calibration syringe with the SS11LA Airflow Transducer or the GASSYS2 (incorporates a 22 mm OD, 15 mm ID coupler); use the AFT26 for increased calibration precision.

See Lessons BSL12, BSL13, H29 and H19, page 43.

T-Valves

AFT23 Low-cost, non-rebreathing T-valve, 35 mm OD; includes 8 replacement valves. Fits AFT13 filter & mouthpiece set.

AFT22 Interfaces with SS11LA Airflow Transducer and AFT7 tubing via the AFT11E coupler. Suitable for static applications with low to medium flow rates. Requires AFT1 and AFT2 for proper operation. All ports 22 mm OD; includes 22 mm OD coupler.

See Lessons H29 and H19, page 43.

Reusable Mouthpiece - AFT8

Autoclavable Use with the SS11LA Airflow Transducer to reduce the cost of disposable parts. 30 mm ID.

AFT8 Pack of 1 **AFT8-10** Pack of 10

Disposable Adult Facemask - AFT10

This disposable facemask connects to 22mm breathing circuits (22mm ID, 25mm OD). Connects directly to the AFT1, AFT22 non-rebreathing T-valve or SS11LA Airflow transducer via tubing (AFT7) and two couplers (AFT11B and AFT11E). Includes hook-ring to secure adjustable head strap (AFT10S).

Strap - AFT10S

This fully adjustable non-latex reusable head strap holds the AFT10 disposable facemask securely to the subject's head. Use one strap to securely fasten the mask. (1 per pkg.)

High Performance Airflow Accessories

The following items interface with the Airflow Transducer SS52L, (page 33), which is intended for exercise physiology and other high volume pulmonary function studies. To use with the SS11LA Airflow Transducer (page 27), use AFT7 tubing and AFT11E coupler.

T-Valve - AFT21

High-performance, very low dead space, low airflow resistance valve; suitable for high airflow applications. Interface with the Airflow Transducer (SS52L) via the Tubing (2 x AFT7) and Coupler (AFT11F) and the GASSYS2. All ports are 35 mm OD and 30 mm ID; AFT11D coupler included to fit AFT4 filter.

Head Support - AFT24

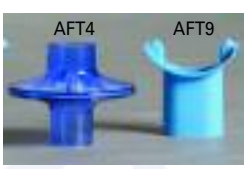
Use the head support when breathing directly into the AFT21 non-rebreathing T-valve for exercise physiology measurements. The AFT24 secures the AFT21 directly in front of the subject and minimizes the strain associated with valves and tubing.

See Lessons H29 and H19, page 43.

Facemask with Valve - AFT25

Use the AFT25 facemask when performing gas analysis tests on an exercising subject or for other high airflow applications. The adult facemask has an integral high-performance non-rebreathing T-valve, and very low dead space and low flow resistance. Interface with the Airflow Transducer (SS52L) via tubing (2 x AFT7) and coupler (AFT11E) and the GASSYS2.
All ports are 35 mm OD and 30 mm ID.

See Lessons H29 and H19, page 43.



Disposable Bacterial Filter - AFT4

Use with the Airflow Transducer (SS52L) and the 35 mm reusable mouthpiece (AFT9) to remove airborne bacteria when measuring bi-directional airflow.

Reusable Mouthpiece - AFT9

Use with the Airflow Transducer (SS52L) or the 35mm bacterial filter (AFT4) to connect to the non-rebreathing T-valve (AFT21). 35 mm ID.

AFT9 Pack of 1 **AFT9-10** Pack of 10

General Airflow Accessories

Premium Calibration Syringe - AFT26

This 2.0 liter syringe provides a larger volume calibration value and is recommended for exercise physiology applications and higher quality, more consistent calibrations where greater precision is required. Aluminum casing improves durability. Works with Airflow Transducers or the GASSYS2, and fits AFT7 tubing (35 mm OD coupler).

See Lessons BSL12, BSL13, H29, H19, page 43.

Tubing - AFT7

Smooth bore tubing for use with Airflow Transducers (SS11LA or SS52L) and other large bore accessories such as the AFT25 Facemask with Valve or the AFT21 T-valve for gas analysis studies; included with the GASSYS2. 35 mm ID, 38 mm OD, 1 meter.

AFT7-L: 3 meters.

See Lessons H29 and H19, page 43.

Couplers - AFT11 Series

Couplers connect a variety of air flow port IDs and ODs to transducers, tubing and calibration syringes. Pick an AFT11 Series coupler that matches the port sizes that need to be interfaced.

Coupler	Size	Interface
AFT11A	25 MM OD/35 MM ID	AFT6A to AFT1
AFT11B	15 MM OD/22 MM ID	AFT10 to SS11LA
AFT11E	22 MM OD/35 MM ID	AFT7 to AFT22/25
AFT11F	35 MM OD/45 MM OD	SS52L to GASSYS2
AFT11H	35 MM OD/28.6 MM ID	AFT13 to SS11LA
AFT11I	22 MM OD/22 MM ID	AFT26 replacement coupler

Gas Cylinder - GASCAL

Calibration Gas Cylinder: 4% CO_2, 16% O_2, Bal. N_2 (not for drug use, not for inhalation). Contains 560 Liters @ 2200 psig, 70°F (21°C). Please allow time for drop shipment.

Regulator - GASREG
Regulator output connects to GASSYS2. Calibration port via tubing.

Airflow Guide

Item	Applications	BIOPAC Part
Airflow Transducers (Pneumotachs)	Human/Animal respiration, pulmonary function, exercise physiology. See Lessons BSL11, BSL12, H29, H21, BSL15, H19 (page 43-44).	SS11LA (med), page 27 SS46L-SS52L, page 33
Calibration Syringes	Use the AFT26 for increased precision. See Lessons BSL11, BSL12, H29, H19 (page 43-44).	AFT6A, page 34 • AFT26, page 35
Calibration Gas	Use to verify calibration settings.	GASCAL, page 35
Couplers	Interface tubes and ports. Fit to specified ID/OD sizes—more port sizes available upon request.	AFT11B, AFT11E, AFT11F, page 35
Facemask & Strap	Exercise physiology.	AFT10 and AFT10-S, page 34
Facemask with Valve	Exercise physiology, pulmonary function, metabolic rate (BMR). See H29 and H19 (page 43).	AFT25, page 35
Filters, Disposable	AFT1 for SS11LA. AFT4 for SS52L.	AFT1, page 34 • AFT4, page 35
Head Support	Exercise Physiology. See Lessons H29 and H19 (page 43).	AFT24, page 35
Mouthpieces	Disposable and reusable options.	AFT2, page 34 • AFT8, page 34 AFT9, page 35
Nose Clips	Reduce leakage errors in mouth-breathing circuits.	AFT3, page 34
Student Pack	Multi-purpose airflow accessories for use with the SS11LA. Used in BSL Lessons.	BSL-ACCPACK, page 34
T-valves, non-rebreathing	Standard and High-performance options. See Lessons H29 and H19 (page 43).	AFT21, page 35 • AFT22, page 34
Tubing	Interface the Airflow Transducers (SS11LA and SS52L) with the GASSYS2. See Lessons H29, H21, H19 (page 43).	AFT7 and AFT7-L, page 35

electrodes & recording accessories

input adapters

Recording cables require multiple leads and electrodes and accept Touchproof connections.

Shielded Electrode Adapter - SS1LA

Interfaces the MP36 with shielded or unshielded reusable surface and needle electrodes (such as the EL250 and EL450 series). Accepts Touchproof 1.5 mm socket electrode leads. Can be used as an alternative to the SS2LB for reusable electrodes.

Adapter - CBL201: If you have an older model SS1L, use CBL201 to convert the 2 mm pin connection to the Touchproof 1.5 mm connection.

High-Impedance Cables

The fully-shielded high-impedance electrode interface cable permits high resolution recording of extracellular signals from small preparations using reusable electrodes (EL250, EL350 or EL450 series, pages 37-38), your own custom Ag-AgCl electrodes, or glass microelectrodes. The 2-meter cable terminates with standard Touchproof connectors.

Input Impedance (Common-Mode):	5e11 Ohms (500 GigaOhm)
Input Bias Current:	3 pA Typical
Voltage Noise:	1.3 µV p-p
Voltage Noise Density:	36 nV / √(Hz)
Current Noise Density:	0.01 pA / √(Hz)

BSLCBL8 Attenuation: none
Input Range: MP36/45 ±2 V, MP35 ±1 V, MP30 ±70 mV

BSLCBL9 Attenuation: ÷ 10
Input Range: MP36/35/45 ±3.8 V, MP30 ±700 mV

See Lessons A06, A11, A14, page 45.

recording electrode leads

Pinch Leads - LEAD110 Series

Lead110 series electrode pinch leads terminate in standard Touchproof connectors for interfacing to the SS1LA, BSLCBL8, or BSLCBL9. These leads have no ferrous parts. Use shielded leads for minimal noise interference. Generally, for biopotential recordings, one each of LEAD110S-W, LEAD110S-R and LEAD110 are required. LEAD110 works best as a ground or reference lead.

LEAD110 Unshielded Electrode Lead - Black (1 m)
LEAD110A Unshielded Electrode Lead - Black (3 m)
LEAD110S-R Shielded Electrode Lead - Red (1 m)
LEAD110S-W Shielded Electrode Lead - White (1 m)

Contact Post Lead - LEAD120

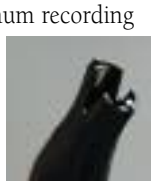
Shown with EL120

This 1-meter lead with Touchproof connector works with the reusable EL120 electrode (page 38). Snap the electrode into place and then plug the lead in via the SS1LA adapter.

LEAD120-R Red Cable
LEAD120-W White Cable

Clip Leads - LEAD140 Series

Use these leads to interface with silver wire/platinum recording



electrodes, or to connect directly with an animal preparation. Choose from three styles: electronic test clip, alligator clip and toothless alligator clip. Leads terminate with a Touchproof connector to interface with the SS1LA shielded electrode adapter, or BSLCBL8 or BSLCBL9.

LEAD140 Alligator Clip Lead
LEAD141 Toothless Alligator Clip Lead
LEAD142 Electronic Test Clip Lead (spring-loaded)

See these lead options:

- General-purpose Electrode Lead Set (SS2LB), page 25
- Multi-lead ECG Cable (SS29L), page 27
- Nerve Chamber, page 38
- Nerve Chamber Leads, page 39
- EDA Snap Lead, see SS57L, page 26
- Cardiac Output Sensor, (SS31L), page 29

electrode accessories

See also: BSL-ACCPACK (page 34) includes all consumable items required to run BSL Lessons.

Hypoallergenic Gel

Conductant for EL250 series reusable electrodes and the EDA (SS3LA) Transducer.
GEL1 30 g
GEL100 250 g

Isotonic Gel - GEL101

GEL101 is specially formulated with 0.5% saline in a neutral base and is primarily used as a conductant for the electrodermal activity (GSR) studies. Recommended for research studies only. 125 g.

Abrasive Pads - ELPAD

Use to abrade the skin to remove non-conductive skin cells for improved signal quality.

Tape

Attach goniometers and other devices to the body.
TAPE1 Single-sided adhesive, 9.1 meters
TAPE2 Double-sided adhesive, 25.6 meters

Adhesive Disks

Two-sided adhesive collars hold reusable electrodes in place.
ADD204 For EL254 and EL254S; 4 mm ID; 19 mm OD
ADD208 For EL258 and EL258S; 8 mm ID; 22 mm OD

electrodes - disposable Ag-AgCl "snap" series

For the complete range of BIOPAC electrodes, including radiotranslucent MRI-compatible options, visit www.biopac.com or electrodesales.com

Use for added convenience and hygiene; get the same signal transmission as reusable electrodes. Each peel-and-stick electrode is pre-gelled with hypoallergenic gel and intended for one use only. Snap fastener attaches to BIOPAC's SS2LB electrode leads.

SPECIAL

General-purpose Electrodes - EL503

Included in every BSL System (pack of 100). Used in over 25 Lessons. These unique electrodes provide excellent signals and are suitable for all biopotential and nerve conduction recordings. 35 mm diameter vinyl tape, 10 mm contact area.

EL503 100/pack
EL503-10 1,000/pack

See the Student Accessory Pack (BSL-ACCPACK, page 34) as a packaged alternative for consumables.

Paired Electrodes - EL500

Use for general-purpose EMG measurements, nerve conduction measurements, and cardiac output. Spacing (center to center): 41 mm x 82 mm x 1.5 mm foam; 25 pairs/pack.

See Lesson H21, page 43.

Stress Test Electrodes - EL501

Use for short-term recordings where the subject may be in motion or when electrodes should be closely placed, such as multi-channel ECG, EGG, EMG or EOG recordings. 38 mm diameter, mounted on 1.5 mm thick foam with strong adhesive; 50/pack.

Long-term Electrodes - EL502

Moisture-resistant backing; solid gel adheres well to skin. 41 mm diameter tape, 10 mm contact area.

EL502 50/pack
EL502-10 500/pack

Cloth Base Electrodes - EL504

Use these compliant, trimmable and flexible electrodes in difficult locations, such as the face for EMG or fingers for nerve conduction. 2.5 cm squares.

EL504 30 pack
EL504-10 300/pack

See Lessons H27, H31, page 43-44.

Bioimpedance Strip Electrodes - EL506

25 cm (trimmable), Ag-AgCl—replace band electrodes! Use with the noninvasive Cardiac Output Sensor (SS31L, page 29).

EL506 8/pack
EL506-10 80/pack

See Lesson H21, page 43.

EDA (GSR) Electrodes - EL507

Use with the EDA Lead (SS57L, page 26) for skin conductance and resistance setups. Electrodes have an increased contact area and isotonic wet gel.

EL507 100/pack
EL507-10 1,000/pack

See Lesson BSL9, BSL14, H11, H24, page 44.

electrodes - reusable

Ag-AgCl Electrodes - EL250 Series

Silver-silver chloride reusable electrodes. Use EL250 series electrodes as an alternative to the SS2LB and EL500 series disposable electrodes. Typically, for one biopotential input, you will need two shielded electrodes for signal inputs and one unshielded electrode for ground. The 1-meter leads terminate in Touchproof 1.5 mm socket connectors for direct connection to the SS1LA, BSLCBL8 or BSLCBL9 lead adapters (page 36). All EL250 Series electrodes require adhesive disks (ADD200 series) and recording gel (GEL1 or any preferred recording gel); see page 36. Available shielded or unshielded. Shielded use one color lead for electrode contact and a different color lead for shield.

EL254 4 mm contact, 7.2 mm housing, unshielded Ag-AgCl
EL254S 4 mm contact, 7.2 mm housing, shielded Ag-AgCl
EL258 8 mm contact, 12.5 mm housing, unshielded Ag-AgCl
EL258S 8 mm contact, 12.5 mm housing, shielded Ag-AgCl

See Lesson H27, page 43.

Bar Electrodes for Animals - EL350 Series

Use on animals to record a signal during nerve conduction, somatosensory or muscle twitch studies. The bar configuration permits easy electrode placement without disturbing electrode-to-electrode spacing. Two tin electrode disks are placed 30 mm apart in a watertight acrylic bar; non-ferrous. When using bar electrodes for signal recording, a single ground lead (LEAD110 with EL503) is required. The leads (61cm long) terminate in standard Touchproof 1.5 mm socket connectors, which connect to the SS1LA, BSLCBL8 or BSLCBL9 lead adapters.

EL350 Unshielded, concave bar lead electrode
EL350S Shielded, concave bar lead electrode
EL351 Unshielded, convex bar lead electrode

See the HSTM01 on page 28 for use on human subjects.

electrodes - reusable

Needle Electrodes - EL450 Series

Use for recording in animal subjects and tissue preparations. Shipped non-sterile, so pre-sterilization is required. 28-gauge stainless steel needles, with a flexible cable terminating in standard Touchproof connectors, which connect to the SS1LA shielded electrode lead adapter, or BSLCBL8 or BSLCBL9.

EL450 - Unipolar, Teflon®-coated
Teflon¤ coating covers the entire length of the electrode, exposing just the tip for effective isolation of subcutaneous recording points.
Dimensions: 300 µm (dia), 4 cm (long), 1.2 mm x 61 mm lead

EL451 - Bipolar, Teflon®-coated
Use when recording from a single site, as in studies of single muscle fibers.
Dimensions: 460 µm (dia), 3.0 cm (long), 1.2 mm x 91 mm lead

EL452 - Unipolar, Uncoated
Use for small animal preparations.
Dimensions: 300 µm (dia), 1.5 cm (long), 1.2 mm x 61 mm lead

Contact Posts - EL120

The EL120 Ag-AgCl electrode has contact posts designed to improve contact through fur or hair. Twelve posts create a 10 mm contact area. The posts are 2 mm deep to push through fur/hair to provide good contact with the skin surface. Requires LEAD120, page 36. Shipped 10/pack.

Micromanipulator - MANIPULATOR

This manual micromanipulator is a reliable, durable, and economical solution for high-precision experiments. Vernier scales allow readings to 0.1 mm. X-axis fine control allows readings to 10 m. Includes a tilting base and ships with a standard 12 mm clamp and electrode holder (14 cm long). All control knobs project to the rear, so units can be tightly grouped. Specify left- or right-handed unit when ordering.

Travel Range:	Resolution:
X-axis Fine	10 mm 0.01 mm
X-axis	35 mm 0.1 mm
Y-axis	25 mm 0.1 mm
Z-axis	25 mm 0.1 mm

stimulator clip leads

Use these clip leads to interface stimulating electrodes, or to connect directly with an animal preparation. Each 1 meter cable has two clips and terminates with one BNC connector to interface with the BSLSTMB or SS58L Stimulator (page 25) and silver or platinum wire electrodes.

BSLCBL7 - BNC to 2x Alligator
BSLCBL11 - BNC to 2x Electronic Test Clip (spring-loaded)
BSLCBL12 - BNC to 2x Toothless Alligator

stimulation options

Animal Stim. Needle Electrode - ELSTM2

Use when applying a stimulus to animal and tissue preparations (not for use on humans); connect to the BSLSTMB or SS58L stimulators (page 25). The dual stainless steel needles are 2.5 cm long x 0.3 mm diameter and are Teflon® coated. Needle electrodes are shipped non-sterile, so pre-sterilization is required. 2.5 meter cable with BNC input.

See Lessons A02, A09, page 45.

See also Human-safe Stimulation Electrode (HSTM01, page 28) and Field stimulation electrode (BSLSTIMHLD, page 33)

Output Adapter - BSLCBL6

Each stimulator lead connects to the BNC connector on the front panel of the BSLSTMB stimulator. BSLCBL6 outputs signals from the BSLSTMB with a cable that terminates in a 3.5 mm phone plug socket with a 1.3 m cable and can be used to connect headphones for auditory evoked response.

nerve chamber & accessories

The acrylic, desktop Nerve Chambers incorporate 15 stainless steel electrodes for recording and stimulating a variety of different nerve preparations. Each stainless steel electrode is spaced 5mm apart to provide a variety of recording and stimulating configurations. Chambers have a 35 ml reservoir and include a drain with valve and hose. Interface with the BSLSTMB or SS58L stimulator via BSLCBL2A and BSLCBL4B nerve conduction cables. The NERVE1 chamber includes a convenient agent well for adding compounds (ether or dry ice, etc.) and a lid to enclose the preparation when protocol requires it.

Dimensions: (cm): 4.5 (h) x 7 (w) x 14 (l)
NERVE1 - with agent well and lid
NERVE2 - standard chamber

See Lesson A03, page 45.

Nerve Chamber Recording

BSLCBL3A - banana plugs x 3; for third-party nerve chambers
BSLCBL4B - 2 mm pin plugs x 3; for BIOPAC NERVE1 & 2

BSLCBL3A and BSLCBL4B Specifications

Gain:	1/10 (divide by 10)
Input Impedance (Common-Mode):	500 GigaOhm
Common-Mode Rejection:	90 dB
Input Bias Current:	3 pA
Noise Voltage:	1.3 µV p-p
Cable	1.2 meters

Nerve Chamber Stimulation

BSLCBL1A - BNC to 2 x banana. Use to connect the BSLSTM or SS58L stimulator to third-party nerve chambers; 1.2-meter cable.
BSLCBL2A - BNC to 2 x 2 mm banana pin with ground jumper. Use to connect the BSLSTM or SS58L stimulator to BIOPAC nerve chambers; 1.2-meter cable.

interface cables

Analog Input

BNC Input

Connect to an analog input port ("CH1" —"CH4") on the MP unit to record signals from other devices, such as amplifiers, third-party chart recorders, and signal generators.

Safety Note: Always use the SS70L when working with human subjects. Never use the SS9LA unisolated BNC input with human subjects as isolation can be broken. SS9LA for animal use only!

SS70L Isolated Female BNC Attenuation: ÷ 10, Input range (max) ±10 V
SS9LA Unisolated Male BNC Attenuation: ÷ 10
Input Range (max): MP36/45 ±20 V
MP35 ±10 V

3.5 mm phone plug adapter - BSLCBL5

Use this 3.5 mm phone plug adapter to interface the MP3X with equipment that outputs high-level voltage signals. The built-in attenuation of 1/200 translates 10 V to 50 mV. Included with the TSD122C.

Input Adapter for Research Amplifiers - BSLCBL14A

Use this 3.5 mm phone plug cable to interface with BIOPAC research amplifiers via the IPS100C Isolated Power Supply. Contact BIOPAC for details.

Touchproof "Y" Adapter - CBL204

This "Y" electrode lead adapter (25 cm long) provides two Touchproof sockets and one Touchproof plug. Use to connect multiple electrode sites (such as Vin- and GND from BSLCBL8/9, page 36) to a glass microelectrode. Connect multiple CBL204s to reference three or more electrode leads to the same input or output.

Analog Out Cables

BNC Output - OUT2

Analog output cable connects to the Analog Out port on the rear of the MP36. DSUB 9m connector. The cable terminates in a male BNC connector.

**See OUT1A Headphones on page 26.*

Custom Output Interface - SS-KIT-OUT

The kit comes with a Simple Sensor connector, cable, and components to properly interface with speakers, stimulators and other equipment requiring a trigger or analog output signal. See the BSL-TCI series for existing transducer interfaces.

transducer interface options

Transducer Connector Interfaces - BSL-TCI SERIES

Save money and interface with your existing transducers. BSL-TCI Series connectors for common transducer manufacturers are listed below if you don't see the part you need, call BIOPAC Support or use the SS-KIT to build a custom interface.

Part #	Connector Make	Works with Transducers from...
BSL-TCI0	6-pin	Grass and Gilson
BSL-TCI1	5-pin	Beckman
BSL-TCI2	8-pin	AD Instruments, iWorx, and WPI Transducers
BSL-TCI3	9-pin hexagonal	Lafayette and Narco
BSL-TCI4	6-pin	Honeywell
BSL-TCI5	4-pin phone jack	BIOPAC NIBP100D or NIBP100A BP module
BSL-TCI6	12-pin	Beckman
BSL-TCI7	5-pin	Nihon Koden
BSL-TCI8	7-pin	Narco
BSL-TCI9	8-pin	Fukada
BSL-TCI11	6-pin male	Hugo Sachs and Harvard Apparatus
BSL-TCI12	5-pin, 240 degrees	Thornton
BSL-TCI13	Piezo (BNC)	iWorx PT100
BSL-TCI14	1/4" phono socket	Lafayette Force
BSL-TCI15	5-pin DIN	Vernier
BSL-TCI16	BT Connector	BIOPAC RXPROBE02 and Vernier
BSL-TCI17	5-pin DIN	Intelitool
BSL-TCI18	2 x 2 mm sockets	Mercury Strain Gauge or Indium Gallium
BSL-TCI19	6-pin mini DIN	Intelitool
BSL-TCI20	3.5 mm phono jack	Intelitool
BSL-TCI21	BNC	BIOPAC RXPROBE01 and 3rd-party pH probes
BSL-TCI22	Breadboard/Electrode	BIOPAC Breadboard SS39L to LEAD SS2LB

Note: All company names listed above are ®.

Custom Input Interface - SS-KIT-IN

Adapt third-party transducers to the MP36. The kit comes with a Simple Sensor connector, cable, and components to properly interface with quarter, half or full bridge transducers (pressure, force, strain, acceleration, sound, etc.). See the BSL-TCI series for existing transducer interfaces.

power & cables

USB Cable - CBLUSB

2.5-meter replacement USB cable connects the MP36 to a USB Port. Includes and provides EMI protection to maintain BSL System certified safety rating (CE, EMC).

power transformers

IEC 60601-1 Certified - AC300A

+12V, 1.25 amp for MP36 to mains wall outlet. Included with each BSL System and GASSYS2 Gas Analysis System. Specify power cord: ACCORD-HUS (Hospital grade, USA) or ACCORD-EURO (Europe).

+6V, 1.50 amp - AC137A

For heating elements to mains wall outlet. Powers the heating element for the SS52L pneumotach (or RX137H1 replacement head). Specify power cord: ACCORD-US (USA) or ACCORD-EURO (Europe).

BSL Laboratory Manual

BIOPAC lessons provide online instructions and real-time prompts to guide students through setup, calibration and recording. This Laboratory Manual provides further details for recording (such as hardware and subject setup), background material and a student Lab Report with guided analysis for BSL Lessons. One current manual is included with each system—order additional copies through your bookstore for students. Check online or contact BIOPAC for translation options including French, Italian, Japanese, Russian, or Spanish.

MANBSL4 editions include 18 lessons: BSL 1-17 and 20
MANBSL4-45 editions include 11 lessons: BSL 1-6, 10, 12, 13, 16, 17
MANBSL3-XX editions are for BSL 3.7 and include 18 lessons: BSL 1-17 and 20

See also published Lab Manuals, page 8.

Battery Pack - BAT100A

For portability, use the BAT100A rechargeable battery pack and charger with the BSL System. The maintenance-free battery pack is built into a carrying case with a shoulder strap. The fully-charged battery will operate a BSL System for a minimum of 24 hours. Includes battery pack, universal recharger and all necessary cables. Specify power cord: ACCORD-US (USA) or ACCORD-EURO (Europe).

Output Capacity:	12 V @ 15 amp-hours
Operating Time:	26 hours nominal for MP36 with 4 transducers
Charge Time:	15 hours
Dimensions:	14 cm (high) x 19 cm (wide) x 14 cm (deep)
Weight:	2.45 kg

Recharger:

Charge Voltage:	Max Nominal Charge 14.4 V @ 3.0 amps
Input:	120/240 VAC @ 50/60 Hz
Dimensions:	3.8 cm (high) x 6.4 cm (wide) x 15 cm (long)
Weight:	285 g

Upgrade to MP36 System

Trade-in Your MP30 or MP35

If you have an existing MP30 or MP35 unit, take advantage of the discounted trade-in program. Simply send back your unit and receive a discounted upgrade to the MP36 System with the latest Biopac Student Lab Software! Contact the BIOPAC team or visit us online at www.biopac.com for details and upgrade options for your lab!

MP36U-W Upgrade for Windows
MP36U-M Upgrade for Mac

Packages, specifications and lessons subject to change without notice.

core packages

BIOPAC offers a comprehensive line of electrodes, transducers and accessories that work for a wide variety of applications. Core packages are just one ordering option, any system can be used as a starting point to develop your own custom package.

- The BASIC System is the foundation for MP36 based packages.
- The INTRO System is the foundation for MP45 based packages.
- The BASIC, ADVANCED and ULTIMATE Systems (with MP36) provide a general system for cross-disciplinary users.
- The BSL Health Science System, BSLHScS with MP45, provides a budget-beating solution for any lab looking to add a physiology component!
- The BASIC, ADVANCED and ULTIMATE Systems have been offered since the Biopac Student Lab was launched in 1995, and are now in use in thousands of labs worldwide.
- The CORE packages are offered to meet the diverging requirements of specific departments.
- Review the Core Package Components table to determine which package meets your requirements, or talk to a Biopac Student Lab Specialist to create your own custom package.
- Packages contain everything including consumable items—necessary to run a specified number of lessons, specific to that particular discipline.

Each package is discounted to reflect the number of transducers and accessories included.

If you have existing transducers that you'd like to continue using, you can select from more than 20 interface options (page 39) for manufacturers like Grass, Gilson, Harvard and Vernier.

BIOPAC is continually adding and improving products and lessons. Visit www.biopac.com for the latest additions!

core packages

- Packages are offered as a comprehensive building block for discipline-specific applications.
- Increase application potential by adding more hardware.

Core Package Components

BIOPAC Hardware	Part #	Page	Basic	Advanced	Ultimate	Human	Animal	Biology	Exercise Phys.	Psychophys.	Biomed. Eng.	Pharm. & Tox.	Intro MP45	HScS MP45
			MP36	MP36	MP36	MP36	MP36	MP36	MP36	MP36	MP36	MP36	MP45	MP45
Data Acquisition Unit & Cables	ships with system	24												
BSL Software—Lessons & PRO	ships with system	2-7	x	x	x	x	x	x	x	x	x	x	x	x
Lab Manual—BSL lessons	MANBSL4/4-45	40	x	x	x	x	x	x	x	x	x	x	x	x
PRO Lessons—40+ experiments	on web	43-45	x	x	x	x	x	x	x	x	x	x	x	x
Electrode Lead (x2)	SS2LB	25	x	x	x	x		x	x	x	x		x	x
High-impedance Cable ±1V Input (x2)	BSLCBL8	36					x					x		
High-impedance Cable ±5V Input	BSLCBL9	36						x						
Electrodes, Disposable (100/pk)	EL503	37	x	x	x	x	x	x	x	x	x	x	x	x
Abrasive Pads (10/pk)	ELPAD	36	x	x	x	x	x	x	x	x	x	x	x	x
Airflow Transducer	SS11LA	27		x	x	x		x	x		x	x		x
Calibration Syringe—600ml	AFT6A	34		x	x	x		x	x		x	x		x
Bacterial Filters, Disposable (10/pk)	AFT1	34		x	x	x		x	x		x	x		x
Mouthpieces, Disposable (10/pk)	AFT2	34		x	x	x		x	x		x	x		x
Nose Clips, Disposable (10/pk)	AFT3	34		x	x	x		x	x		x	x		x
Electrodermal Activity (GSR) Lead	SS57L	26		x	x			x		x				
EDA (GSR) Electrodes (100/pk)	EL507	37		x	x			x		x				
Hand Switch—Pushbutton	SS10L	26		x	x			x	x	x	x			
Headphones	A: OUT1A or B: 40HP	26		A	A			A	A	A	A			B
Pulse Plethysmograph Transducer	SS4LA	26		x	x			x	x	x	x			
Respiratory Effort Transducer	SS5LB	26		x	x			x	x	x				
Temperature Transducer	SS6L	26		x	x			x	x					
Colored Paper—for L09 Polygraph	PAPER1	-		x	x			x		x				
Electrode Gel	GEL1	36			x			x						
Tape—Single-sided	TAPE1	36		x	x			x	x					
Blood Pressure Cuff Transducer	A: SS19LA or B: SS19L	27			A	A		A	A	A	A			B
Electronic Stethoscope Transducer	SS30L	28			x	x		x	x	x	x			x
Force Transducer— Variable range	SS12LA	27			x			x						
Hand Dynamometer	A: SS25LA or B: SS56L	27			A	A		A	A		A			B
Multi-Lead ECG Cable	SS29L	27			x			x						
Pressure Transducer	SS13L	27			x			x				x		
Stimulator—BSL	BSLSTMB	25			x			x				x		
Stim. Electrode—human-safe	HSTM01	28			x			x						
Stimulator—Low Voltage	SS58L	25					x							
Stim. Electrode—animal	ELSTM2	38					x	x				x		
Dissolved O_2 Probe	SS69L	31												
Dissolved O_2 Interface	BSL-TCI16	39					x	x						
Signal Processing Breadboard	SS39L	30									x			
Electrode Lead—unshielded (x2)	LEAD110	36					x					x		
Electrode Leads—shielded (x2)	LEAD110S-W & -R	36					x					x		
Force Transducer—200g	SS65L	31					x					x		
Needle Electrodes (x3)	EL452	38					x	x				x		
Nerve Chamber	NERVE2	38					x	x				x		
Nerve Cable—Recording	BSLCBL4B	39					x	x				x		
Nerve Cable—Stimulator	BSLCBL2A	39					x	x				x		
pH Interface (SS68L or other pH probe)	BSL-TCI21	39						x						
			Basic	Advanced	Ultimate	Human	Animal	Biology	Exercise Phys.	Psychophys.	Biomed. Eng.	Pharm. & Tox.	Intro MP45	HScS MP45
			8	9	9	10	12	14	16	18	20	22	8	8

Hardware Options

- This table only lists parts included in CORE PACKAGES.
- For a full list of hardware options, see the BSL Hardware section (pages 24-40) or check the Index (page 47).
- All parts can be ordered individually—you can add hardware options, or create your own package to suit your curriculum.

Visit www.biopac.com or contact a Biopac Student Lab Specialist to discuss your specific application needs.

See the page indicated for an overview of each discipline, including lessons the Core Package supports and suggested hardware options and potential applications.

transducer accessory "TA" packs

The following "TA" Packs are suggested transducer accessories for any core package to increase the application potential of your lab. Each "TA" Pack allows you to perform the additional lessons listed—or you can create your own experiments. All items can be ordered individually.

- See the Core Packages summary (p41).
- For a full list of hardware options, see the BSL Hardware section (page 23-40).
- For an overview of each lesson, see the Lessons Summary (page 43-46).

Human Physiology TA — BSLHPY-TA

See Core Human Phys. on page 11

This hardware
Stimulator BSLSTMB, page 25
Stimulation Electrode for Humans HSTM01, page 28
Finger Twitch Transducer SS61L, page 30
Reflex Hammer SS36L, page 30

Adds these lessons
BSL20 Spinal Cord Reflexes, page 44
H03 Nerve Conduction Velocity, page 44
H06 Finger Twitch, page 43
H28 Reflex Response (patellar tendon), page 44

Animal Physiology TA — BSLAPH-TA

See Core Animal Phys. on page 13

This hardware
Cardiac Output Sensor SS31L, page 29
Bioimpedance Strip Electrodes EL506-10 (80/pk), page 37

Add this lesson
H21 Impedance Cardiography (CO), page 43

Exercise Physiology TA — BSLEXP-TA

See Core Exercise Phys. on page 17

This hardware
Multi-lead ECG Cable (12-lead) SS29L, page 27
Cardiac Output Sensor SS31L, page 29
CO_2 & O_2 Analysis Module GAS-SYSTEM2, page 34
Bioimpedance Strip Electrodes EL506-10 (80/pk), page 37

Adds these lessons
H21 Impedance Cardiography (CO), page 43
H29 Basal Metabolic Rate, page 43
H01 12-lead ECG, page 43
H19 VO2 & RER, page 43

Biomechanics TA — BSLEXM-TA

See Core Exercise Phys. on page 17

This hardware
Reflex Hammer Transducer SS36L, page 30
Goniometer (Twin axis) SS21L, page 29
Stimulator BSLSTMB, page 25
Stimulation Electrode for Humans HSTM01, page 28
Heel/Toe Strike Transducer SS28LA, page 29

Adds these lessons
BSL20 Spinal Cord Reflexes, page 44
H03 Nerve Conduction Velocity, page 44
H17 Biomechanics (Goniometry & EMG), page 44
H28 Reflex Response (patellar tendon), page 44
H35 Range of Motion: Sit & Reach, page 45

Psychophysiology TA — BSLPSY-TA

See Core Psychophys. on page 19

This hardware
Cardiac Output Sensor SS31L, page 29
SuperLab Stimulus Presentation Pkg. STP35W, page 32
Bioimpedance Strip Electrodes EL506-10 (80/pk), page 37

Adds these lessons
H21 Impedance Cardiography (CO), page 43
H30 Stroop Effect, page 44
H31 Prepulse Inhibition, page 44

Biomedical Engineering TA — BSLBME-TA

See Core Biomed. on page 21

This hardware
Cardiac Output Sensor SS31L, page 29
Stimulator BSLSTMB, page 25
Stimulation Electrode for Humans HSTM01, page 28
Bioimpedance Strip Electrodes EL506-10 (80/pk), page 37

Adds these lessons
H03 Nerve Conduction Velocity, page 44
H21 Impedance Cardiography (CO), page 43

Pharmacology & Toxicology TA — BSLPHA-TA

See Core Pharm. & Tox. on page 23

This hardware
Tissue Bath Station ITBS100, page 33

Adds this lesson
A05 Visceral Smooth Muscle, page 45

CARDIOVASCULAR

BSL LESSON 5: ECG I

Record Lead II ECG and examine components of the ECG complex as an introduction to the electrocardiograph and the recording of the heart's electrical signal.

BSL LESSON 6: ECG II

Record ECG using bipolar Leads I and III; the software calculates Lead II to demonstrate Einthoven's law.

BSL LESSON 7: ECG & PULSE

Use a pulse plethysmogram transducer and Lead II ECG to examine the mechanical action of the heart and peripheral pulse pressure to learn how the heart pumps blood throughout the body.

BSL LESSON 16: SYSTEMIC BLOOD PRESSURE

Record arterial blood pressure using the ausculatory (cuff) technique, Korotkoff sounds using an amplified stethoscope, and ECG using Lead II.

BSL LESSON 17: HEART SOUNDS

Record ECG Lead II and place an amplified stethoscope at four different locations to listen to the sounds of the heart's valves and correlate the sounds with the cardiac cycle.

H01 12-LEAD ECG

Record a 12-lead ECG and observe changes in the frontal plane vectors throughout a cardiac cycle.

H08 ECG DIVE REFLEX ACTIVE LEARNING

Subjects immerse their face in cold water and record the change in heart rate that occurs to investigate the physiological reason for the observed response.

H21 IMPEDANCE CARDIOGRAPHY

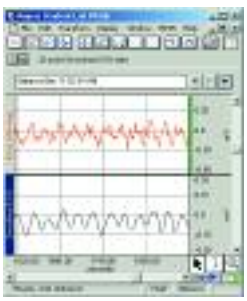
Noninvasively record and measure stroke volume and heart rate data and correlate with cardiac output.

H23 SIGNAL AVERAGED ECG

Record ECG data under different experimental conditions and perform a Signal Averaged ECG recording for each segment of data.

MUSCULAR

BSL LESSON 1: EMG I



Record maximum grip clench for the dominant and non-dominant hand to investigate the properties of skeletal muscle.

BSL LESSON 2: EMG II

Use a hand dynamometer to record maximum grip strength for both hands and explore the role of skeletal muscle in performing mechanical tasks.

H06 FINGER TWITCH HUMAN

Record the force generated from a finger twitch and measure the stimulus frequency required to induce fatigue. (Alternative to Frog Gastroc.)

H07 EMG ACTIVE LEARNING

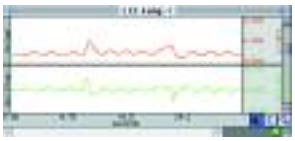
Investigate the electrical activity of different muscles as they contract with varying degrees of force and design experiments by selecting muscles to record from and creating activities those muscles will perform.

H27 FACIAL EMG

Record EMG response on the corrugator supercilii & zygomaticus major muscles.

H34 ELECTROGASTROGRAM

Record electrical activity through stomach muscles (EGG) and note the power and frequency of contractions at rest and after eating.



RESPIRATORY & PULMONARY FUNCTION

BSL LESSON 8: RESPIRATORY CYCLE I

Record chest contraction & expansion and ventilation, then correlate respiration changes with ventilation to examine the effects of cerebral influence and chemoreceptor influence on the medullary control centers.

BSL LESSON 12: PULMONARY FUNCTION I

Perform a variety of pulmonary measurements: Tidal volume, Inspiratory capacity, Expiratory capacity, Functional residual capacity, Vital capacity and Total lung capacity.

BSL LESSON 13: PULMONARY FUNCTION II

Record and analyze Forced Vital Capacity, Forced Expiratory Volume ($FEV_{1,2,3}$) and Maximal Voluntary Ventilation (MVV) to build on the principles established in Lesson 12.

H29 BASAL METABOLIC RATE

Record indirect basal metabolic rate (BMR) and post-exercise metabolic rate.

H19 VO_2 & RER

Record and measure oxygen consumption (absolute VO_2) and respiratory exchange ratio (RER) under a variety of conditions and observe the relationship between VO_2 and RER.

NEUROPHYSIOLOGY

BSL LESSON 3: EEG I

Record EEG from the occipital lobe while performing a variety of tasks to demonstrate how the brain's electrical activity varies dependent upon the task being performed.

BSL LESSON 4: EEG II

Discover how the brain constantly receives sensory input and integrates the information before processing it. The system records and displays raw EEG, alpha wave and alpha-RMS activity.

Lesson Update

See www.biopac.com for lesson additions and product updates.

BSL LESSON 9: GSR & POLYGRAPH (EDA)

Record changes in respiratory rate, heart rate and electrodermal activity (skin conductance) to become familiar with the standard physiological measures recorded by a polygraph and study the effects of cognitive behavior and emotion.

BSL LESSON 10: ELECTROOCULOGRAM (EOG) I

Record horizontal and vertical eye movement to demonstrate eye fixation and tracking. Students perform a number of tasks that allow them to record the duration of saccades and fixation.

BSL LESSON 11: REACTION TIME I

Subject hears two schedules of clicks through headphones and reacts by pressing a pushbutton hand switch as quickly as possible to demonstrate the effect of learning and physiological processes on reaction times.

BSL LESSON 14: BIOFEEDBACK

Record ECG, heart rate and electrodermal activity, and try to influence heart rate and EDA (GSR) to control the position of a bar graph to demonstrate the principles of biofeedback training for relaxation purposes.

BSL LESSON 20: SPINAL CORD REFLEXES

Record and examine properties of spinal neuromuscular reflexes commonly tested in physical diagnosis.

H03 NERVE CONDUCTION VELOCITY

Record responses along the ulnar nerve of a human subject to observe the Threshold, Maximal and Supra-Maximal response levels and determine nerve conduction velocity along the ulnar nerve.

H09 AUDITORY EVOKED POTENTIAL (AEP)

Present an auditory stimulus to a human subject and record Auditory Evoked Potential.

H10 HEMISPHERIC EEG

Record EEG and study effects of sensory stimulation or change in attitude/attention on alpha rhythm, beta rhythm, and hemispheric asymmetry.

H11 MIRROR TEST: SENSORY MOTOR LEARNING & EDA

Correlate efficiency in a task requiring movement and attention focus with reticular tone (which indirectly indicates emotional fluctuations) and analyze performance over repeated trials.

H12 SACCADES: EOG

Explore applications of electrooculography and observe the constant saccade durations for a variety of given angular displacements.

H13 TRACKING: EOG

Observe tracking movements used while watching a moving object and demonstrate the difference between eye movement based on actual visual stimulation and imagined recreations.

H14 FIXATION I: EOG

Record horizontal EOG and observe Ocular Fixation while reading.

H15 FIXATION II: EOG

Record a horizontal and vertical EOG and observe spontaneous gaze changes produced when viewing an image, and then correlate results from the plot with the subject's attitude or level of interest.

H16 REFLEXES & REACTION TIME

Measure basic reflex and reaction time (visual stimulus) exercises and record reaction time to auditory stimulus. Compare reaction times from fixed interval and pseudo-random presentation to study the effects of learning and physiological processes on reaction times.

H22 VISUAL EVOKED RESPONSE

Present a visual stimulus to a human subject and record Visual Evoked Potentials (P100 test).

H24 HABITUATION

Record EDA (GSR) and Heart Rate response to repeated stimulus to demonstrate habituation and its probabilistic trend toward decreased response.

H28 REFLEX RESPONSE

Record knee and ankle reflex response with the SS36L Reflex Hammer transducer. Option: Use the SS20L Goniometer to measure angular movement in response to varying strike force.

H30 STROOP EFFECT

Record strength of interference between two associative tasks: naming and reading.

H31 PREPULSE INHIBITION

Record the startle response with and without a prepulse inhibition stimulus.

H32 HEART RATE VARIABILITY

Explore statistical measures, geometric measures, and spectral analysis in heart rate variability.

EXERCISE PHYSIOLOGY

BSL LESSON 15: AEROBIC EXERCISE PHYSIOLOGY

Record ECG, heart rate, airflow and skin temperature as the body responds to changing metabolic demands.

BSL LESSON 20: SPINAL CORD REFLEXES

Record and examine properties of spinal neuromuscular reflexes commonly tested in physical diagnosis.

H04 BLOOD PRESSURE

Record noninvasive BP with isometric or straining exercise.

H05 WINGATE TEST (WAnT)

Record the Wingate Anaerobic Test and complete calculations.

H17 BIOMECHANICS (Goniometry & EMG)

Record muscle activity from the triceps and biceps while recording angle of limb movements.

H18 EXERCISE PHYSIOLOGY (Blood Pressure)

Record Automatic Noninvasive Blood Pressure in pre- and post-exercise conditions and compare the conditions.

H35 RANGE OF MOTION: SIT & REACH

Students use a goniometer to record angle of joint movement (i.e., hip, ankle etc.) during a Sit & Reach test.

H36 MUSCULAR BIOFEEDBACK

Students record EMG and use auditory and visual (bar graph) biofeedback and touch to increase muscle performance.

BME - BIOMEDICAL ENGINEERING

H02 COMPARTMENTAL MODELING

Explore Westheimer's saccadic eye movement model, which represents the eye as a 2nd order system. Record eye motion via EOG setup and compare to modeled results.

H20 FILTERING

Design and develop software-based digital filters to perform a variety of physiological signal filtering tasks. Cascade 2nd order biquads to create high order filters.

H25 SIGNAL PROCESSING BREADBOARD I (8 Circuits)

Schematic and design notes for Square Wave Oscillator, Instrumentation Amplifier, High Pass Active Filter, Active Gain Block and Low Pass Filter, Notch Filter for 60 Hz Rejection, *QRS Detection:* Band Pass Filter, *QRS Detection:* Absolute Value Circuit; *QRS Detection:* Low Pass Filter.

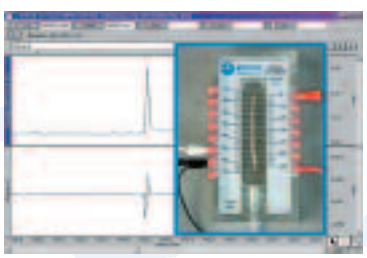
H26 SIGNAL PROCESSING BREADBOARD II (System)

Block diagram to build ECG Signal Processor with SS39L.

H33 FFT FAST FOURIER TRANSFORM

Build up a square wave from cosine components and use the FFT function to analyze the composite response.

ANIMAL

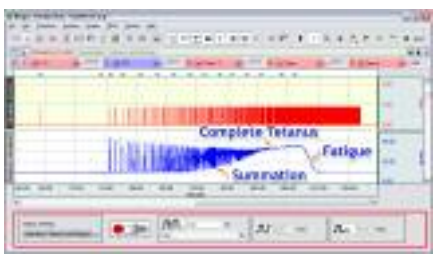


A01 FROG PITH & PREPARATION

Explanation of how to pith and prepare a frog for experiments A02, A03 and A04.

A02 FROG GASTROCNEMIUS

New! Scripted template guides students.
Directly stimulate the frog gastrocnemius muscle (or stimulate the muscle via the sciatic nerve) and record threshold voltage and contractile responses.



A03 FROG SCIATIC NERVE

New! Scripted template guides students.
Record compound action potentials of the dissected sciatic (somatic motor and sensory) nerve.

A04 FROG HEART - CARDIAC RATE & CONTRACTILITY

New! Scripted template guides students.
Record cardiac rate and contractile responses of the surgically exposed frog heart. Option: Study the effects of chronotropic and inotropic agents on the heart.

A05 VISCERAL SMOOTH MUSCLE

Study the effects of media ionic composition, temperature, and various pharmacological agents on the contraction of the visceral smooth muscle of the rabbit ileum.

A06 COCKROACH VENTRAL NERVE

Record nerve activity from the ventral nerve cord while stimulating the cerci with puffs of air.

A07 Q_{10} PRINCIPLE (Dissolved O_2 Goldfish)

Demonstrate the Q_{10} principle by measuring the metabolic rate of goldfish at two temperatures: 22° C (acclimation temperature) and 32° C (acute exposure temperature).

A08 ACTION POTENTIALS IN EARTHWORM

Use extracellular recording techniques to stimulate and record action potentials from an earthworm's nerve cord. Measure conduction velocity and refractory period, and plot a strength versus duration curve.

A09 PROPERTIES OF CARDIAC MUSCLE (Turtle Heart)

Measure the duration of systole and diastole and observe the effects of diastolic loading. Monitor the effect of vagal stimulation, temperature changes and spontaneous rhythmicity of the heart.

A11 RESTING POTENTIAL (Crayfish Muscle)

Follow BSL setup and use "Lab 4: Crayfish Muscle Resting Potential" from the Crawdad CD-ROM Lab Manual for Neurophysiology (ISBN 0-87893-947-4) to record and alter resting potential by changing external ion concentration.

A14 CENTRAL PATTERN GENERATORS

Perform extracellular recording on tobacco hornworm pupae to study central pattern generators (CPGs) and neural mechanisms.

A15 EARTHWORM SMOOTH MUSCLE

Setup earthworm gut with a force transducer and tissue bath to measure contractions and the effect of drugs.

A17 FROG HEART — INTRACELLULAR ACTION POTENTIAL

Examine electrical properties of myocardial cells in the vertebrate heart and study the effects of pharmacological probes on the cardiac action potential.

lesson hardware guide

using Core Package hardware

	Page	Basic	Adv.	Ult.	Human	Animal	Biology	Psych	Ex. Phys.	BME	Pharm.	Intro MP45	HScS MP45	Hardware Used (optional)
BSL1: EMG I	43	x	x	x	x	x	x	x	x	x	x	x	x	SS2LB p25, (OUT1A/40HP p26)
BSL2: EMG II	43			x	x		x		x	x			x	SS2LB p25, SS25LA p27, (OUT1A/40HP p26)
BSL3: EEG I	43	x	x	x	x	x	x	x	x	x	x	x	x	SS2LB p25
BSL4: EEG II	43	x	x	x	x	x	x	x	x	x	x	x	x	SS2LB p25
BSL5: ECG I	43	x	x	x	x	x	x	x	x	x	x	x	x	SS2LB p25
BSL6: ECG II	43	x	x	x	x	x	x	x	x	x	x	x	x	SS2LB x2 p25
BSL7: ECG & Pulse	43		x	x			x	x	x	x				SS2LB p25, SS4LA p26
BSL8: Respiratory Cycle I	43		x	x			x		x					SS5LB and SS6L p26
BSL9: GSR & Polygraph	44		x	x			x	x						SS2LB p25, SS5LB and SS57L p26
BSL10: Electrooculogram (EOG) I	44	x	x	x	x	x	x	x	x	x	x	x	x	SS2LB x2 p25
BSL11: Reaction Time I	44		x	x			x	x	x	x				SS10L and OUT1A p26
BSL12: Pulmonary Function I	43		x	x	x		x		x	x	x		x	SS11LA p27, AFT6A p34
BSL13: Pulmonary Function II	43		x	x	x		x		x	x	x		x	SS11LA p27, AFT6A p34
BSL14: Biofeedback	44		x	x			x	x						SS2LB p25, SS57L p26
BSL15: Aerobic Exercise Physiology	44		x	x			x		x					SS2LB p25, SS6L p26, SS11LA p27
BSL16: Systemic Blood Pressure	43			x	x		x	x	x	x			x•	SS2LB p25, SS19LA/L p27, SS30L p28
BSL17: Heart Sounds	43			x	x		x	x	x	x			x	SS2LB p25, SS30L p28
BSL20: Spinal Cord Reflexes	43													SS2LB p25, SS36L p30, (SS20L p29)
H01 12-Lead ECG	45			x			x							SS29L p27
H02 BME Compartmental Modeling	44		x	x			x	x	x	x				SS2LB p25
H03 Nerve Conduction Velocity	44			x			x							SS2LB p25, BSLSTMB p25, HSTM01 p28
H04 Blood Pressure Response to Straining Exercise	44			x	x		x	x	x	x			x	SS19LA/L p27, SS30L p28
H05 Wingate Test (WAnT)	43		x	x			x		x					SS4LA p26
H06 Finger Twitch	43			x			x							SS61L p30, BSLSTMB p25, HSTM01 p28
H07 EMG - Active Learning	43	x	x	x	x	x	x	x	x	x	x	x	x	SS2LB p25
H08 ECG Dive Reflex - Active Learning	44	x	x	x	x	x	x	x	x	x	x	x	x	SS2LB p25
H09 Auditory Evoked Potential (AEP)	44													BSLSTMB p25, OUT101 p31, BSLCBL6 p38
H10 Hemispheric EEG	44	x	x	x	x	x	x	x	x	x	x	x	x	SS2LB x2 p25
H11 Mirror Test: Sensory Motor Learning & EDA	44		x	x			x	x						SS10L and SS57L p26
H12 Saccades: EOG	44	x	x	x	x	x	x	x	x	x	x	x	x	SS2LB p25
H13 Tracking: EOG	44	x	x	x	x	x	x	x	x	x	x	x	x	SS2LB p25
H14 Fixation I: EOG (3-lead)	44	x	x	x	x	x	x	x	x	x	x	x	x	SS2LB p25
H15 Fixation II: EOG (6-lead)	44	x	x	x	x	x	x	x	x	x	x	x	x	SS2LB x2 p25
H16 Reflexes & Reaction Time - Active Learning	44		x	x			x	x	x	x				SS10L and OUT1A p26
H17 Biomechanics	44													SS2LB x2 p25, SS21L p29
H18 Exercise Phys. - Continuous Noninvasive BP	43													NIBP100D p32
H19 VO_2 & RER	45													SS11LA p27, GASSYS2 and AFT6A p34
H20 BME Filtering	43	x	x	x	x	x	x	x	x	x	x	x	x	no transducers required
H21 Impedance Cardiography (Cardiac Output)	44													SS2LB p25, SS30L p28, SS31L p29
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H23 Signal Averaged ECG	44	x	x	x	x	x	x	x	x	x	x	x	x	SS2LB p25
H24 Habituation	45		x	x			x	x						SS2LB p25, SS10L and SS57L p26
H25 BME Signal Processing I (8 circuits)	45									x				SS39L and (SS60L) p30
H26 BME Signal Processing II (ECG R-Wave Detector)	43										x			SS39L and (SS60L) p30
H27 Facial EMG	44	x	x	x	x	x	x	x	x	x	x	x	x	SS2LB x2 p25, (SS10L p26)
H28 Reflex Response (patellar tendon)	43													SS2LB p25, SS36L p30, (SS20L p29)
H29 Basal Metabolic Rate	44													SS11LA p27, GASSYS2 and AFT6A p34
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H32 Heart Rate Variability Analysis	45	x	x	x	x	x	x	x	x	x	x	x	x	SS2LB p25
H33 BME FFT Fast Fourier Transform	43	x	x	x	x	x	x	x	x	x	x	x	x	no transducers required
H34 Electrogastrogram from human (stomach)	45	x	x	x	x	x	x	x	x	x	x	x	x	SS2LB p25
H35 Range of Motion: Sit & Reach	45													SS21L p29
H36 Muscular Biofeedback (auditory, visual, touch)	45		x	x			x	x	x	x			x	SS2LB p25, OUT1A/40HP p26
A01 Frog Pith & Prep	45	x	x	x	x	x	x	x	x	x	x			no transducers required
A02 Frog Gastrocnemius	45					x	x			x				SS12LA p27, STIM p25, ELSTM2 p38
A03 Frog Sciatic Nerve	45					x	x			x				STIM p25, NERVE1/2 p38, BSLCBL p39
A04 Frog Heart	45			x		x	x				x			SS12LA p27, (HDW p31)
A05 Visceral Smooth Muscle	45			x+		x+	x+				x+			SS12LA p27, (HDW p31), (ITBS100 p33)
A06 Cockroach Ventral Nerve	45					x	x				x			BSLCBL8/9 p36, EL452 x3 p38
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A08 Action Potential in Earthworm	45					x	x			x				STIM p25, NERVE1/2 p38, BSLCBL p39
A09 Properties of Turtle Heart Cardiac Muscle	45					x	x			x				SS12LA p27, STIM p25, STM2+452 p38, CBL8 p36
A11 Resting Potential - Crayfish Muscle	45					x†	x†				x†			BSLCBL8 p36, (CBL204 x2 p39)
A14 Central Pattern Generator (hornworm pupa)	45					x	x			x				BSLCBL8 p36, EL452 x3 p38
A15 Earthworm Smooth Muscle	45			x		x	x			x				SS12LA p27, (HDW p31), (ITBS100 p33)

*interface included, probe required +tissue bath required †requires Crawdad CD-ROM Lab Manual -glass microelectrode required • no ECG

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Biopac Student Lab users

A partial list of satisfied Biopac Student Lab users follows. If you would like a list tailored to identify users in your area or your application of interest, contact **BIOPAC** at **info@biopac.com**

www.biopac.com

United States

Alma College
Augusta State University
Austin Peay State University
Bakersfield College
Barry University
Baylor College of Medicine
Baylor University
Bellarmine University
Bethel College
Birmingham Southern College
Boston University
Bowling Green State University
Brevard Community College
Brigham Young University
Bristol Heart Institute
Bucknell University
Cal State University:
Bakersfield; Fullerton;
Los Angeles; Northridge;
Sacramento; Stanislaus
California Lutheran University
California Polytechnic:
Pomona; San Luis Obispo
Case Western Reserve Univ.
Catawba College
Claremont McKenna College
Clemson University
Cleveland State University
College of Holy Cross
College of the Siskiyous
Columbus State University
Cornell University
Cosumnes River College
Cuesta College
Dartmouth College
Diablo Valley College
Dixie College
Duke University
Eastern Oregon University
Elizabethtown College
Emory University
Everett Community College
Evergreen State College
Florida International University
Florida State University
Georgia College & State Univ.
Georgia Institute of Technology
Georgia State University
Golden West College
Gordon College
Harvard University
Hofstra University
Imperial Valley College
Indiana State University
Indiana Univ. - Purdue Univ.
Iowa State University
Ithaca College
Ivy Tech State College
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Lenoir-Rhyne College
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Loyola College
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Mississippi Valley State Univ.
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Ohio State
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Aiken; Columbia; Spartanburg
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University of Virginia
University of Wisconsin
University of Wyoming
Victor Valley College
Wake Forest University
Washington University
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Yale University
Yavapai College
Yuba College

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Acadia University
Adnan Menderes Üniversitesi
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Sciences
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Science & Technology, Beirut
Ankara University
Aston University
Bar-Ilan University
Baskent University
Berner Fachhochschule
Brunel University
Bryansk State Petrovsky
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Camosun College
Cardinal Tien Nursing School
CEGEP de Sainte-Foy
CEGEP de Trois-Rivières
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Technology College
Charles Sturt University
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China Medical College
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zu Kiel
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CNAM
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Dicle University
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Singapore
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NgeeAnn Polytechnic
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Sciences
Northumbria University
Obirin University
Osmangazi University
Pingtung Technology University
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Sciences & Research
Queensland University of
Technology
Rajguru College of Applied
Sciences
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Royal College of Surgeons in
Ireland
Sedaya International College
Semmelweis Medical University
Showa University
Singapore Polytechnic
Taipei Medical University
Taipei Municipal Physical
Education College
Tamagawa University
Technological Educational
Institute of Heraklion
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Coahuila
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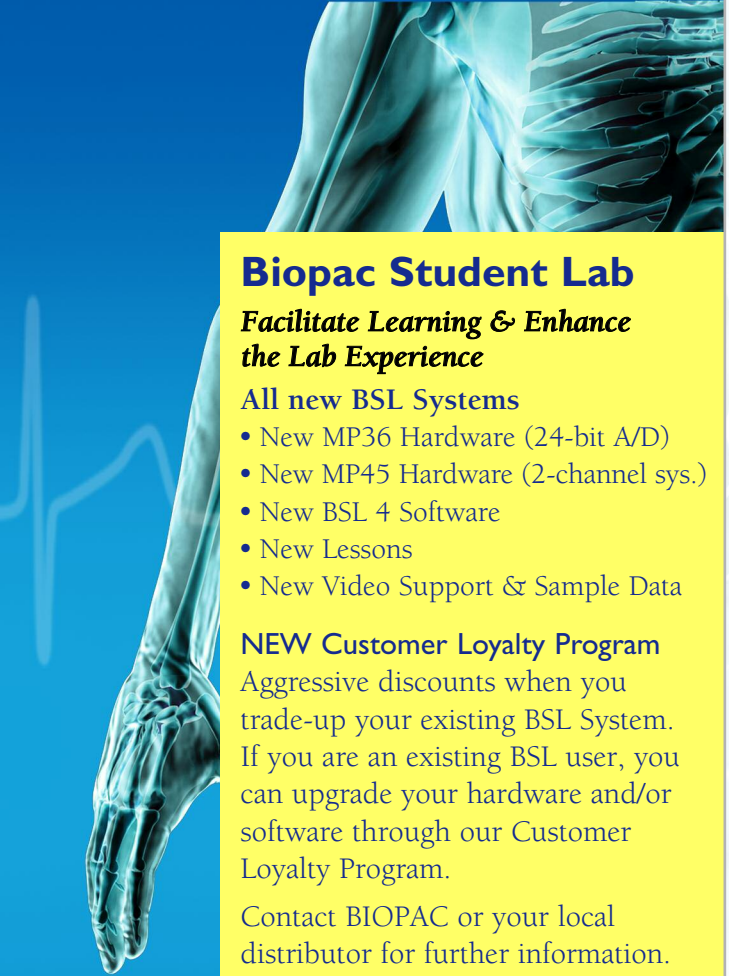

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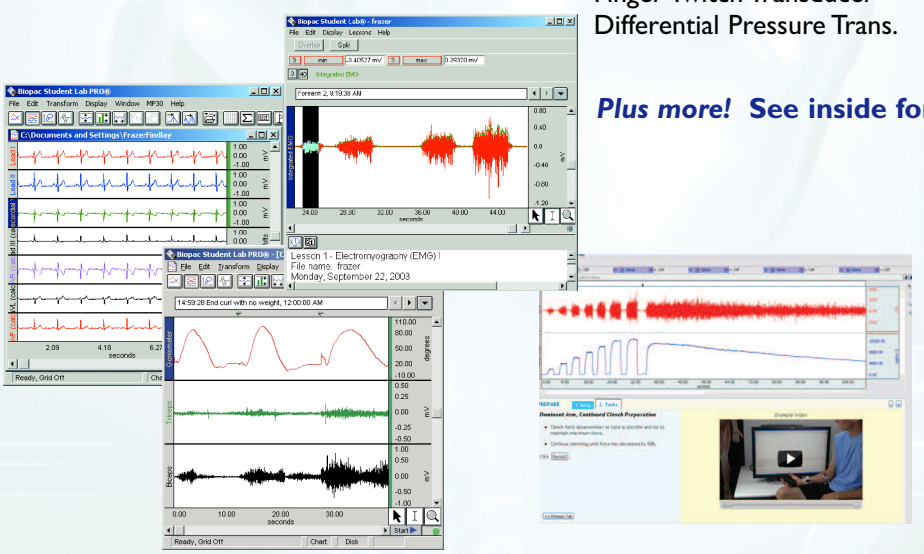

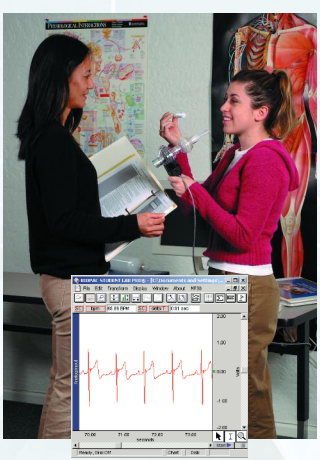

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