Learning Goals and Outcomes for LabScribe Physiology Exercises

The iWorx A/D Recorders and LabScribe Software Tutorial Chapter

Experiment T-1: LabScribe Tutorial - Pulse and ECG

Learning Goals:

1. Students will be able to successfully operate both the iWorx A/D converter and the LabScribe software.
2. Students will be able to load the appropriate lab settings group and file, exercise, and attached lab courseware in PDF format for use during lab.
3. Students will be able to attach peripheral devices and transducers to the iWorx A/D converter.
4. Students will be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed the Tutorial will:

1. have become skilled in the workings of the LabScribe software.
2. have been able to successfully use the Load Group function to open the lab exercise and pdf courseware.
3. feel comfortable attaching peripheral transducers to the A/D converter.
4. have used the functions available in the Analysis window to determine values for pulse amplitude and heart rate.

Animal Fluid Balance Chapter

Experiment FB-1: Osmoregulation

Learning Goals:

1. Students will weigh and observe polychaete worms in different marine salinity dilutions.
2. Students will understand the correlation between saline concentration and osmoregulation in marine organisms.
3. Students will determine the iso- hypo- and hyper- tonic environments based on the loss or gain of weight due to osmosis over time.
4. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. be able to accurately weigh living polychaete worms to determine weight changes due to osmosis.
2. have a better understanding of osmoregulation and survival of marine organisms.
3. understand the processes of osmosis and diffusion as they relate to living organisms.
4. graph the weight changes of the worms in different salinity concentrations over time to be able to visually understand the concepts.
5. have used the functions available in the Analysis window to determine values necessary for this exercise.
6. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.

Animal Metabolism Chapter

Experiment AMe-1: Small Animal Respiratory Exchange Ratio (RER)

This experiment can be completed using the GA-200 or GA-300 gas analyzers.

Learning Goals:

1. Students will distinguish between an ectothermic and endothermic animal.
2. Students will assemble the equipment to be able to record accurate gas analysis measurements.
3. Students will be able to place an animal in the small animal chamber.
4. Students will be able to maintain animal health and well being during recording.
5. Students will accurately analyze data to compare RER values between ectotherms and endotherms.
6. An an option, students may record using animals cooled to lower than body temperature and RER will calculated as they return to normal body temperature or to room temperature.

Outcomes: Students who have successfully completed this exercise will:

1. determine mean RER of an endotherm at rest.
2. determine the changes in CO_2 and O_2 volumes of an ectotherm.
3. make comparisons with the values obtained from an endotherm compared to an ectotherm.
4. design optional experiments to compare other values from different animals.

Animal Muscle Chapter

Experiment AM-1: Skeletal Muscle, Weight and Work

Learning Goals:

1. Students will dissect a frog leg to extract the gastrocnemius muscle of the lower limb.
2. Students will assemble the equipment needed to be able to stimulate the muscle and record muscle twitch.
3. Students will understand the correlation between the stimulus, the muscle twitch amplitude, and the effect of weight on muscle contractions.
4. Students will test afterloading, supporting the weight before contraction; and preloading, hanging the weight on the muscle without support before the contraction.
5. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. be able to successfully excise the gastrocnemius muscle of a frog's leg.
2. have a better understanding of electrical stimulation of the muscle and the equipment used to perform such stimulation.
3. gain an understanding of muscle stimulation and contraction (twitch) and how they relate to each other.
4. record muscle twitches from the gastrocnemius, test a variety of hypotheses and reach scientific conclusions
5. have used the functions available in the Analysis window to determine values necessary for this exercise.
6. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.

Experiment AM-2: Skeletal Muscle, Summation and Tetanus

Learning Goals:

1. Students will dissect a frog leg to extract the gastrocnemius muscle of the lower limb.
2. Students will assemble the equipment needed to be able to stimulate the muscle and record muscle twitch.
3. Students will understand the correlation between the stimulus, muscle twitch, and the strength of the stimulation on muscle contraction.
4. Students will test summation and tetanus by repeatedly stimulating the muscle.
5. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. be able to successfully excise the gastrocnemius muscle of a frog's leg.
2. have a better understanding of electrical stimulation of the muscle and the equipment used to perform such stimulation.
3. gain an understanding of muscle stimulation and contraction (twitch) and how they relate to each other.
4. successfully record muscle twitches from the gastrocnemius and correlate the reactions to stimulation to summation and tetanus.
5. have used the functions available in the Analysis window to determine values necessary for this exercise.
6. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.

Experiment AM-3: Heart Muscle

Learning Goals:

1. Students will dissect a frog to expose the heart.
2. Students will assemble the equipment needed to be able to stimulate the heart and will record cardiac contractions.
3. Students will understand the correlation between exogenous stimulus and heart muscle response.
4. Students will gather data corresponding to normal heart rhythms.
5. Students will test different parameters with regard to cardiac muscle function:
    - cold temperature.
    - epinephrine.
    - atropine.
    - isolation of the ventricle.
6. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. be able to successfully isolate the frog heart.
2. have a better understanding of electrical stimulation of the heart muscle and the equipment used to perform such stimulation.
3. gain an understanding of normal cardiac muscle contraction.
4. stimulate and record cardiac muscle contractions to test a variety of hypotheses and reach scientific conclusions.

5. have used the functions available in the Analysis window to determine values necessary for this exercise.
6. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.

Experiment AM-4: Uterine Motility

Learning Goals:

1. Students will dissect a female rat to excise the uterus to be able to examine smooth muscle contractions.
2. Students will assemble the equipment needed to be able to record smooth muscle contractions.
3. Students will gather data corresponding to normal rhythmic smooth muscle contractions.
4. Students will test different parameters with regard to uterine muscle function:
    - methergine.
    - acetylcholine.
    - atropine.
    - epinephrine.
    - stretch and tension.
5. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. be able to successfully isolate the rat uterus.
2. activate and record uterine muscle contractions to test a variety of hypotheses and reach scientific conclusions.
3. gain an understanding of rhythmic smooth muscle contractions.
4. have used the functions available in the Analysis window to determine values necessary for this exercise.
5. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.

Experiment AM-5: Intestinal Motility

Learning Goals:

1. Students will dissect a rat to excise the lower small intestine.
2. Students will gather data corresponding to normal rhythmic smooth muscle contractions.
3. Students will test different parameters with regard to intestinal function:
    - stretch.

- acetylcholine.
- curare.
- atropine.
- epinephrine.
- serotonin.
- changes in pH.
- changes in calcium levels.
- cyanide.

4. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. be able to successfully isolate the rat small intestines.
2. gain an understanding of rhythmic smooth muscle contractions.
3. activate and record intestinal muscle contractions to test a variety of hypotheses and reach scientific conclusions.
4. have used the functions available in the Analysis window to determine values necessary for this exercise.
5. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.

Experiment AM-6: Frog Electrocardiogram (ECG)

Learning Goals:

1. Students will dissect a frog to expose the heart.
2. Students will assemble the equipment needed to be able to stimulate the heart and will record cardiac contractions to look at an ECG.
3. Students will understand the correlation between external stimuli and heart muscle response.
4. Students will gather data corresponding to normal heart rhythms.
5. Students will test different parameters with regard to cardiac muscle function and ECG recordings:
    - cold temperature.
    - warm temperature.
    - epinephrine.
    - acetylcholine.

7. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. be able to successfully isolate the frog heart.
2. gain an understanding of normal cardiac muscle contraction and normal amphibian ECG waves.
3. record cardiac muscle ECG waves to test a variety of hypotheses and reach scientific conclusions.
4. have used the functions available in the Analysis window to determine values necessary for this exercise.
5. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.

Experiment AM-7: Crayfish Heart

Learning Goals:

1. Students will dissect a crayfish to expose the heart.
2. Students will assemble the equipment needed to record cardiac contractions.
3. Students will understand the correlation between eternal stimuli and heart muscle response.
4. Students will gather data corresponding to normal heart rhythms.
5. Students will test different parameters with regard to cardiac muscle function:
    - cold temperature.
    - serotonin.
    - GABA.
6. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. be able to successfully isolate the crayfish heart.
2. gain an understanding of normal cardiac muscle contraction.
3. record cardiac muscle contractions to test a variety of hypotheses and reach scientific conclusions.
4. have used the functions available in the Analysis window to determine values necessary for this exercise.
5. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.

Experiment AM-8: *Mytilus* Anterior Byssal Retractor Muscle

Learning Goals:

4. Students will dissect a marine mussel (*Mytilus sp.*) to expose the byssal retractor muscle.
5. Students will assemble the equipment needed to be able to stimulate the retractor muscle and will record muscle contractions to look at muscle twitch and responses to stimuli.
6. Students will be able to successively increase stimulation to cause changes in response of the muscle.
7. Students will deliver differing doses of neurotransmitters to see the effects on an actively contracting muscle:
    - acetylcholine.
    - serotonin.
8. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. be able to determine the relationship between the strength of the stimulus and the response of the muscle.
2. be able to measure the amplitude of contraction produced in a muscle that is stimulated with a long current pulse, and repeated pulses delivered at progressively higher frequencies.
3. understand the relationship between summation and tetanus.
4. observe the effects of acetylcholine and serotonin, the neurotransmitters that effect contraction and relaxation of the anterior byssal retractor muscle.
5. have used the functions available in the Analysis window to determine values necessary for this exercise and feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.

Experiment AM-9: Crayfish Gut Pharmacology

Learning Goals:

1. Students will dissect a crayfish abdomen to expose the gut and intestines.
2. Students will assemble the equipment needed to be able to dose the intestine with different drugs and will record muscle contractions to observe responses both type and concentration of drug.
3. Students will deliver differing doses of excitatory and inhibitory neurotransmitters to see the effects on an actively contracting muscle:
    - acetylcholine.
    - epinephrine.
    - GABA.

4. Measure and understand contraction amplitudes and durations.
5. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. be able to record the spontaneous contractions of the intestine.
2. describe any qualitative differences in the contractions produced by Acetylcholine, Epinephrine and GABA.
3. understand the difference between excitation and inhibition
4. have used the functions available in the Analysis window to determine values necessary for this exercise.
5. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.

Experiment AM-10: Summation, Tetanus, and Fatigue in an Intact Nerve-Muscle Prep

Learning Goals:

1. Students will dissect a frog leg to extract the sciatic nerve and the muscles of the lower limb (either the gastrocnemius or tibialis anterior).
2. Students will assemble the equipment needed to be able to stimulate the nerve and muscles, and record compound action potentials from both.
3. Students will understand the correlation between nerve stimulus and muscle responses.
4. Students will test synaptic delay between nerve and muscle compound action potentials.
5. Students will test stimulus frequency, fatigue, and myoneural blocking.
6. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. be able to successfully excise the sciatic nerve and muscles of a frog's leg.
2. have a better understanding of electrical stimulation of nerve fibers and the equipment used to perform such stimulation.
3. gain an understanding of both nerve and muscle compound action potentials and how they relate to each other.
4. record compound action potentials from the sciatic nerve and lower limb muscles to test a variety of hypotheses and reach scientific conclusions.
5. have used the functions available in the Analysis window to determine values necessary for this exercise.
6. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.

Animal Nerve Chapter

Experiment AN-1: Membrane Potentials

Learning Goals:

1. Students will dissect a crayfish tail to expose the fast extensor muscles.
2. Students will assemble the equipment to record membrane potentials.
3. Students will understand the Na+/K+ pump and how it works to keep membranes polarized for contraction.
4. Students will test the hypothesis that all fibers within a single muscle are the same and therefore have the same membrane potentials.
5. Students will also test the hypothesis that membrane potentials are dependent upon the concentration gradient of different ions.
6. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. be able to successfully expose the muscles of the crayfish tail and be able to distinguish between the different muscle types.
2. have a better understanding of microelectrode recording from muscle fibers and the equipment used to perform such recordings.
3. gain an understanding of the Na+/K+ pump and how it relates to membrane potentials.
4. record membrane potentials from the different crayfish tail muscles to test a hypothesis and reach a scientific conclusion.
5. test various saline solutions to determine if the concentration of K+ ions has any effect on muscle membrane potentials.
6. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
7. have used the functions available in the Analysis window to determine values necessary for this exercise.

Experiment AN-2: Compound Action Potentials

Learning Goals:

1. Students will dissect a frog leg to extract the sciatic nerve.
2. Students will assemble the equipment needed to be able to stimulate the nerve and record compound action potentials from nerves.
3. Students will understand the different types of fibers that make up the large sciatic nerve.
4. Students will test different hypothesis with regard to nerve function:

- Compound action potential: observing the one or more populations of different fiber types.
- Stimulus-response/axon recruitment: observing how the nerve response changes with increased stimulus voltage.
- Conduction velocity: measuring the speed at which action potentials propagate down the axons.
- Effects of temperature: observing how cooling affects the nerve conduction velocity.
- Bidirectionality: determining whether axons conduct in both directions.
- Refractoriness: observing how stimulus frequency affects the amplitude of compound action potentials
- Strength-Duration: observing how the amplitude of a stimulus required to stimulate axons is related to the duration of the stimulus.

5. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. be able to successfully excise the sciatic nerve of a frog and be able to understand the different fiber types within the nerve.
2. have a better understanding of electrical stimulation of nerve fibers and the equipment used to perform such stimulation.
3. gain an understanding of compound action potentials and how they relate to nerve function.
4. record compound action potentials from the sciatic nerve to test a variety of hypotheses and reach scientific conclusions.
5. have used the functions available in the Analysis window to determine values necessary for this exercise.
6. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.

Experiment AN-3: Neuromuscular Studies

Learning Goals:

1. Students will dissect a frog leg to extract the sciatic nerve and the muscles of the lower limb (either the gastrocnemius or tibialis anterior).
2. Students will assemble the equipment needed to be able to stimulate the nerve and muscles, and record compound action potentials from both.
3. Students will understand the correlation between nerve stimulus and muscle responses.
4. Students will test synaptic delay between nerve and muscle compound action potentials.
5. Students will test different drugs with regard to nerve and muscle function:

- eserine.
- curare.
- atropine.
- high acetylcholine concentration.
- nicotine.
- dantrolene.
- high magnesium concentration.
- high calcium concentration.

6. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. be able to successfully excise the sciatic nerve and muscles of a frog's leg.
2. have a better understanding of electrical stimulation of nerve fibers and the equipment used to perform such stimulation.
3. gain an understanding of both nerve and muscle compound action potentials and how they relate to each other.
4. record compound action potentials from the sciatic nerve and lower limb muscles to test a variety of hypotheses and reach scientific conclusions.
5. have used the functions available in the Analysis window to determine values necessary for this exercise.
6. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.

Experiment AN-4: Compound Action Potentials in Earthworms

Learning Goals:

1. Students will anesthetize an earthworm.
2. Students will assemble the equipment needed to be able to stimulate the nerve and record compound action potentials from nerves.
3. Students will understand the different types of fibers that make up the nerve.
4. Students will test different hypothesis with regard to nerve function:
    - Compound action potential: observing the one or more populations of different fiber types.
    - Stimulus-response/axon recruitment: observing how the nerve response changes with increased stimulus voltage.

- Conduction velocity: measuring the speed at which action potentials propagate down the axons.
- Effects of temperature: observing how cooling affects the nerve conduction velocity.
- Bidirectionality: determining whether axons conduct in both directions.
- Refractoriness: observing how stimulus frequency affects the amplitude of compound action potentials
- Strength-Duration: observing how the amplitude of a stimulus required to stimulate axons is related to the duration of the stimulus.

7. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. be able to successfully anesthetize an earthworm.
2. be able to understand the different fiber types within the nerve and record CAPs from that nerve.
3. have a better understanding of electrical stimulation of nerve fibers and the equipment used to perform such stimulation.
4. gain an understanding of compound action potentials and how they relate to nerve function.
5. test a variety of hypotheses and reach scientific conclusions.
6. have used the functions available in the Analysis window to determine values necessary for this exercise.
7. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.

Experiment AN-5: Cockroach Leg Mechanoreceptors

Learning Goals:

1. Students will explore the basic characteristics of the chordotonal organs.
2. Students will record their response to direction and intensity of leg movement, and determine if the responses are tonic or phasic.
3. Students will learn the basic characteristics of tibial spines on the cockroach leg.
4. Students will determine the effect of repeated stimulations on the frequency of action potentials.
5. Students will also determine the effect of cold and warm temperatures on the neuronal response of mechanoreceptors to mechanical stimulation.
6. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. understand the difference between tonic and phasic responses during flexion and extension.
2. determine whether flexion or extension causes a greater response in action potential frequency, number, or response duration.
3. determine if movement of the tibia spine in one direction or the other causes different responses in action potential frequency, number or duration.
4. understand adaptation of responses.
5. be able to explain how and why physiological processes are dependent on temperature in poikilotherms.
6. have used the functions available in the Analysis window to determine values necessary for this exercise.
7. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.

Experiment AN-7: Cockroach Cercal Sense Organs

Learning Goals:

1. Students will assemble the equipment needed to be able to stimulate the cercal sense organs.
2. Students will elicit a ventral nerve cord response to air puffs and become familiar the responses.
3. Students will explore the effects of stimulus intensity on the number and frequency of action potentials produced.
4. Students will determine the number of hairs needed to trigger an action potential in the ventral nerve cord.
5. Students will determine the effect of a continuous stimulus on the frequency of action potentials.
6. Students will look at the response to a single stimulus after fairly complete adaptation.
7. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. will be able to graph the response changes as a function of intensity.
2. understand whether the response is a change as a function of intensity.
3. be able to explain how the response differences would be important to the cockroach in its environment.
4. be able to determine the minimum number of hairs required to elicit a response.
5. understand the concept of adaptation and explain the importance to cockroach survival.
6. have used the functions available in the Analysis window to determine values necessary for this exercise.

7. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.

Experiment AN-8: Frog Sciatic Nerve Compound Action Potential

Learning Goals:

1. Students will dissect a frog leg to extract the sciatic nerve.
2. Students will assemble the equipment and neuroamplifier needed to be able to stimulate the nerve and record compound action potentials from nerves.
3. Students will understand the different types of fibers that make up the large sciatic nerve.
4. Students will test different hypothesis with regard to nerve function:
    - Compound action potential: observing the one or more populations of different fiber types.
    - Stimulus-response/axon recruitment: observing how the nerve response changes with increased stimulus voltage.
    - Conduction velocity: measuring the speed at which action potentials propagate down the axons.
    - Bidirectionality: determining whether axons conduct in both directions.
    - Refractoriness: observing how stimulus frequency affects the amplitude of compound action potentials
    - Strength-Duration: observing how the amplitude of a stimulus required to stimulate axons is related to the duration of the stimulus.
5. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. be able to successfully excise the sciatic nerve of a frog and be able to understand the different fiber types within the nerve.
2. have a better understanding of electrical stimulation of nerve fibers and the equipment used to perform such stimulation.
3. gain an understanding of compound action potentials and how they relate to nerve function.
4. record compound action potentials from the sciatic nerve to test a variety of hypotheses and reach scientific conclusions.
5. have used the functions available in the Analysis window to determine values necessary for this exercise.
6. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.

Cellular Metabolism Chapter

Experiment CM-1: Oxygen Consumption and Size

Learning Goals:

1. Students will learn to accurately weigh small organisms.
2. Students will learn to calibrate the dissolved oxygen sensor and measure the rate of oxygen consumption over time of different sized organisms.
3. Students will collect and analyze oxygen consumption curves to determine how oxygen consumption is related to the size of an organism.
4. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have accurately measured the weight of small animals.
2. have successfully calibrated the dissolved oxygen sensor and recorded the oxygen consumption over time of various sized organisms.
3. after analyzing the data collected, be able to relate oxygen consumption to size.
4. come to a conclusion about any trends shown by this experiment.
5. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
6. have used the functions available in the Analysis window to determine values necessary for this exercise.

Experiment CM-2: Mitochondrial Metabolism

Learning Goals:

1. Students will examine one step in the process of the Kreb's Cycle of Cellular Respiration, the oxidation of succinic acid to fumaric acid.
2. Students will use a spectrophotometer to observe changes in the color of dye-labeled mouse liver extract in order to examine rate of reaction.
3. Students will perform three (3) separate experiments: one without cyanide, one in the presence of cyanide, and one using a competitive inhibitor to respiration.
4. Students will collect data, and use linear regression analysis to find the line of best fit for each set of reactions.
5. Students will make a histogram to compare the rate of reaction of color change of the three experiments.

Outcomes: Students who have successfully completed this exercise will:

1. understand the process of Cellular Respiration at the mitochondrial level.

2. be able to successfully use a spectrophotometer to measure color changes over time.
3. understand the concept of competitive inhibition.
4. be able to explain what cyanide does to the rate of a cellular respiration reaction.
5. analyze data and design a histogram for data comparison.
6. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
7. have used the functions available in the Analysis window to determine values necessary for this exercise.

Experiment CM-3: Mitochondrial Respiration

Learning Goals:

1. Students will examine the electron transport process of mitochondrial respiration.
2. Students will use a dissolved oxygen electrode and cellular respiration chamber to observe changes in the amount of dissolved oxygen in a solution of mitochondria order to examine rate of reaction.
3. Students will perform experiments using couplers, uncouplers, inhibitors and donors to see the effects on cellular respiration.
4. Students will collect and analyze data to determine the effects of various chemicals on the respiration process.

Outcomes: Students who have successfully completed this exercise will:

1. understand the process of Cellular Respiration at the mitochondrial level.
2. be able to successfully use a dissolved oxygen probe to measure oxygen concentration changes over time.
3. understand the concept of competitive inhibition how donors, coupler and uncouplers work within the cellular metabolism process.
4. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
5. have used the functions available in the Analysis window to determine values necessary for this exercise.

Experiment CM-4: Photosynthesis

Learning Goals:

1. Students will examine the process of photosynthesis using isolated thylakoids from chloroplasts.
2. Students will use a dissolved oxygen electrode and photosynthesis chamber to observe changes in the amount of dissolved oxygen in a thylakoid solution in order to examine rate of reaction.

3. Students will learn how to measure the functionality of isolated thylakoids and how to measure electron transport in a complete photosystem.
4. Students will also learn how to measure electron transport in a single photosystem (PS I).
5. Students will collect and analyze data to determine the effects of various chemicals on the photosynthetic process.
6. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. understand the process of Photosynthesis at the level of chloroplasts and photosystems within isolated plant organelles.
2. be able to successfully use a dissolved oxygen probe to measure oxygen concentration changes over time.
3. understand how uncouplers affect oxygen production rates in terms of phosphorylation, electron transport and chemiosmosis.
4. understand the relationship between light intensity and the rate of oxygen production in the whole electron transport process and in a single photosystem.
5. be able to compare coupled and uncoupled reactions between different experiments.
6. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
7. have used the functions available in the Analysis window to determine values necessary for this exercise.

Experiment CM-5: CO2 Fixation

Learning Goals:

1. Students will examine the process of carbon dioxide fixation using intact algal cells.
2. Students will use a dissolved oxygen electrode and photosynthesis chamber to observe changes in the amount of dissolved oxygen in a thylakoid solution in order to examine rate of reaction.
3. Students will use three compounds to compare the effect on the rate of carbon dioxide fixation in intact cells:
    - Iodoacetamide (IAA), which inhibits certain enzymes of the Calvin cycle, but should have no effect on photosynthetic electron transport.
    - 3-(3,4-dichlorophenyl)-1,1-dimethylurea (DCMU), which blocks electron transport between the Q_a and Q_b quinones in the chain.
    - Methylamine (MA), which should increase the rate of electron transport by uncoupling ATP synthesis from electron transport.
4. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. understand the process of Photosynthesis and CO2 fixation in intact algal cells.
2. be able to successfully use a dissolved oxygen probe to measure oxygen concentration changes over time.
3. understand how uncouplers affect oxygen production rates in terms of phosphorylation, electron transport and chemiosmosis.
4. understand the relationship between CO2 fixation in intact algal cells in both the dark and light; and the rate of oxygen production during the Calvin Cycle.
5. be able to compare oxygen production in algal cells and isolated thylakoids using the different chemicals.
6. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
7. have used the functions available in the Analysis window to determine values necessary for this exercise.

Experiment CM-6: Photosynthetic Gas Analysis using an Entire Plant

Learning Goals:

1. Students will assemble the equipment to be able to record accurate gas analysis measurements.
2. Students will determine the rate of oxygen production and carbon dioxide utilization in a photosynthesizing organism.
3. Students will accurately analyze REE values.
4. An an option, students may record:
    - A plant a room temperature and compare to a plant at either high or low temperature.
    - A plant contained in one concentration of CO_2 compared to a plant in a higher concentration of CO_2.
    - A plant with the light shining on the leaves to a plant in the dark.

Outcomes: Students who have successfully completed this exercise will:

1. determine mean REE of a plant.
2. determine the changes in CO_2 and O_2 concentrations over time.
3. make comparisons with the values obtained under different circumstances.
4. Use advanced analysis features to gather mathematical data.

Experiment CM-7: Oxygen Consumption and Aerobic Respiration in Goldfish

Learning Goals:

1. Students will learn to accurately weigh small organisms.
2. Students will learn to calibrate the dissolved oxygen sensor and measure the rate of oxygen consumption over time of organisms under different metabolic conditions.
3. Students will collect and analyze oxygen consumption curves to determine how oxygen consumption is related to the diet or ambient temperature of an organism.
4. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have accurately measured the weight of small animals.
2. have successfully calibrated the dissolved oxygen sensor and recorded the oxygen consumption over time of organisms under various conditions.
3. after analyzing the data collected, be able to relate oxygen consumption to diet or ambient temperature.
4. come to a conclusion about any trends shown by this experiment.
5. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
6. have used the functions available in the Analysis window to determine values necessary for this exercise.

General Biology - Ecology Chapter

Experiment GB-1: Biological Buffers

Learning Goals:

1. Students will determine the buffering capabilities of a variety of solutions by measuring the pH of the solutions
2. Students will compare buffering capabilities when the solutions are treated with either a weak acid or a weak base.
3. Students will measure the pH changes that occur in deionized (DI) water, a buffered physiological saline, and another solution chosen from a list provided.
4. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. understand the concept of pH and biological buffers.
2. understand the importance of buffering capabilities in biological systems.
3. be able to mathematically calculate percent change in pH and relate this to the addition of a weak acid or base to a buffered solution.
4. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
5. have used the functions available in the Analysis window to determine values necessary for this exercise.

Experiment GB-2: Membrane Permeability

Learning Goals:

1. Students will examine some of the properties of passive transport mechanisms across a simulated membrane.
2. Students will learn to create a “cell” using dialysis tubing.
3. Students will fill the “cells” with different solutions to understand the movement of ions across a cell membrane.
4. Students will measure the change in pH of the water surrounding the simulated cell.
5. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. understand the concept of passive transport and the movement of ions across a cell membrane.
2. be able to explain how the movement of large particles causes a change in pH.
3. be able to understand the rate of diffusion of ions across the membrane.

4. be able to explain the factors that could increase the rate of diffusion of an ion across a membrane.
5. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
6. have used the functions available in the Analysis window to determine values necessary for this exercise.

Experiment GB-3: Water Quality

Learning Goals:

1. Students will collect water samples from a variety of sources, like streams and ponds, around their community.
2. Students will measure the temperature of the water at the site where it is collected.
3. Students will measure the pH, dissolved oxygen concentration, and specific gravity of water samples.
4. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. be able to collect water samples from a wide variety of sources.
2. be able to successfully use pH and DO2 electrodes to measure these parameters in a variety of water samples.
3. understand how pH, dissolved O2 and specific gravity impact water quality.
4. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
5. have used the functions available in the Analysis window to determine values necessary for this exercise.

Experiment GB-4: Ecological Balance

Learning Goals:

1. Students will create an environment into which a small aquatic animal, a goldfish, is introduced.
2. Students will measure the changes in the dissolved oxygen concentration and the pH level of the water in which the fish is respiring.
3. Students will also create an environment into which a piece of aquatic plant is introduced.
4. Students will measure the changes in the dissolved oxygen concentration and the pH level of the water when the plant is exposed to light and photosynthesis takes place.
5. Students will create an environment in which both the plant and fish are present.

6. Students will measure the changes in the dissolved oxygen concentration and pH level of the ecosystem will be measured.
7. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. be able to create specific environments in which to measure pH and dissolved oxygen concentrations.
2. be able to successfully use pH and DO2 electrodes to measure these parameters in three ecological environments.
3. understand how pH, dissolved O2 impact the quality of an ecosystem and be able to determine which biological system is more balanced.
4. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
5. have used the functions available in the Analysis window to determine values necessary for this exercise.

Experiment GB-5: Acid Rain

Learning Goals:

1. Students will generate the gases that create acid rain: carbon dioxide, nitrogen dioxide, and sulfur dioxide.
2. Students will bubble the gases through water.
3. Students will monitor the acidity of the water using a pH electrode.
4. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. understand the concept of pH and acid rain.
2. understand the importance of regulating pH in biological systems.
3. be able to mathematically calculate percent change in pH and relate this to the addition of an acid rain producing gases to water.
4. explain why acid rain is deleterious to ecosystems and habitats.
5. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
6. have used the functions available in the Analysis window to determine values necessary for this exercise.

Experiment GB-6: Conductivity of Solutions

Learning Goals:

1. Students will learn to use a conductivity meter.
2. Students will calibrate the conductivity meter using standard solutions.
3. Students will test the conductivity of various electrolytes.
4. Students will study the effect of concentration on the conductivity of solutions.
5. Students will graph the concentration vs. conductivity of the various solutions tested.

Outcomes: Students who have successfully completed this exercise will:

1. determine the conductivity of different electrolyte solutions.
2. understand the effect of concentration on the conductivity of various solutions.
3. understand the main contributor to the difference in conductivity values between the solutions tested.
4. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
5. have used the functions available in the Analysis window to determine values necessary for this exercise.

Human Circulation Chapter

Experiment HC-1: Blood Pressure, Peripheral Circulation, and Body Position

Learning Goals:

1. Students will be able to successfully record pulse waves using a plethysmograph, and blood pressure using a non-invasive blood pressure cuff (sphygmomanometer).
2. Students will be able to interpret data from these recordings and understand the difference between systolic and diastolic blood pressure.
3. Students will look at the effects of different cuff and body positions on pulse and blood pressure.
4. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have successfully calibrated a non-invasive blood pressure cuff.
2. have recorded recognizable pulse and blood pressure waves and be able to calculate the pulse rate and blood pressure of an individual from the recorded data.
3. have been able to interpret the effects of different cuff and body positions on both pulse and blood pressure.
4. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.

Experiment HC-2: Blood Pressure, Peripheral Circulation, and Imposed Conditions

Learning Goals:

1. Students will be able to successfully record pulse waves using a plethysmograph, and blood pressure using a non-invasive blood pressure cuff (sphygmomanometer).
2. Students will be able to interpret data from these recordings and understand the difference between systolic and diastolic blood pressure.
3. Students will look at the effects of imposed conditions doing either short- or long- term experiments. The effects of food additives, exercise, apnea and temperature changes may be examined.
4. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have successfully calibrated a non-invasive blood pressure cuff.
2. have recorded recognizable pulse and blood pressure waves and be able to calculate the pulse rate and blood pressure of an individual from the recorded data.

3. have been able to interpret the effects of different imposed conditions on both pulse and blood pressure.
4. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.

Experiment HC-3: Pulse Wave Velocity

Learning Goals:

1. Students will be able to successfully record pulse waves using a plethysmograph and a three-lead electrocardiogram (ECG).
2. Students will be able to interpret data from these recordings and understand the amplitudes and values of the ECG waves.
3. Students calculate pulse wave velocity from the ECG and pulse recording data in a resting subject and in subjects after exercise.
4. Students can perform an optional exercise to determine the effect of different temperatures on the pulse wave velocity.
5. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have successfully recorded pulse waves and an ECG.
2. have been able to calculate the pulse rate and ECG amplitudes of an individual from the recorded data.
3. have been able to calculate the normal resting pulse wave velocity (PWV) and the PWV after hand exercises.
4. been able to calculate the normal resting pulse wave velocity (PWV) and the PWV after the forearm has been exposed to different temperatures (Optional).
5. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.

Experiment HC-4: Pulse Contour Analysis

Learning Goals:

1. Students will be able to successfully record pulse waves using a plethysmograph and blood pressure using a non-invasive blood pressure cuff (sphygmomanometer).
2. Students will be able to interpret data from these recordings and understand the difference between systolic and diastolic blood pressure.
3. Students will determine the arterial stiffness, vascular tone, and blood pressures of individual subjects.
4. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have successfully calibrated a non-invasive blood pressure cuff.
2. have recorded recognizable pulse and blood pressure waves and be able to calculate the pulse rate and blood pressure of an individual from the recorded data.
3. interpret the collected data to determine the Student Stiffness Index (SSI) of the subject's major arteries.
4. determine the Student Reflection Index (SRI), the indicator of vascular tone in the subject's large vessels.
5. understand systolic and diastolic blood pressure and make a determination as to whether the subject is hypo-, hyper- or normo-tensive.
6. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.

Experiment HC-5: Body Position, Exercise and Cardiac Output

Learning Goals:

1. Students will be able to successfully record pulse waves using a plethysmograph and blood pressure using a non-invasive blood pressure cuff (sphygmomanometer).
2. Students will be able to interpret data from these recordings and understand the difference between systolic and diastolic blood pressure.
3. Students will determine the cardiac output and stroke volume of a subject in various body positions.
4. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have successfully calibrated a non-invasive blood pressure cuff.
2. have recorded recognizable pulse and blood pressure waves and be able to calculate the cardiac output and stroke volume of an individual from the recorded data.
3. interpret the collected data to determine the systolic and diastolic pressures, and cardiac output of the subject in the reclining, sitting, and standing positions.
4. compare systolic and diastolic pressures, and cardiac output of the subject in the reclining, sitting, and standing positions.
5. understand systolic and diastolic blood pressure and make a determination as to whether the subject is hypo-, hyper- or normo-tensive.
6. compare blood pressures and cardiac output of a subject at various times after exercise.
7. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.

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

Learning Goals:

1. Students will be able to successfully record pulse waves and oxygen saturation levels using a pulse oximeter.
2. Students will be able to successfully record an ECG (electrocardiogram).
3. Students will be able to interpret data from these recordings and understand oxygen saturation, heart rate and pulse latency in individuals at rest and during exercise.
4. Students will be able to analyze the ECG for the events taken place during the cardiac cycle.
5. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have successfully recorded pulse waves and an ECG.
2. have been able to calculate the pulse rate and ECG amplitudes of an individual from the recorded data.
3. been able to analyze and understand the parts of the cardiac cycle and how the cycle relates to oxygen saturation and heart rate.
4. have been able to determine resting oxygen saturation levels in the subjects.
5. been able to determine the effects of changes in temperature on the ECG and oxygen saturation levels of subjects.
6. be able to discuss the physiological mechanisms behind the cooling and heating on peripheral circulation and oxygen saturation levels,
7. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.

Human Exercise Chapter

Experiment HE-1: Metabolic and Thermal Response to Exercise

Learning Goals:

1. Students will be able to successfully record a pulse using the plethysmograph.
2. Students will be able to calibrate the temperature sensor to accurately measure body skin temperature.
3. Students will be able to examine sweat gland density of subjects at rest.
4. Students should be able to measure the changes in the heart rate, skin temperature, core temperature, and active sweat gland density of subjects during exercise and recovery from exercise.
5. Students will be able to perform a variety of mathematical calculations to determine the amount of work performed, energy used, oxygen consumed, net mechanical efficiency, heat storage, and evaporative heat loss during the course of the experiment.
6. Students will then determine a subject's metabolic and thermal response at rest and during exercise; and calculate relative cardiac health by looking at recovery from exercise.
7. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have recorded both a recognizable pulse wave and skin temperature trace on a resting individual.
2. have recorded a recognizable pulse wave and skin temperature trace on an individual during and after exercise.
3. be able to determine the pulse rate of an individual from the recorded data and understand the effects of exercise on pulse rate and body temperature.
4. calculate net mechanical efficiency and evaporative heat loss in order to understand the metabolic and thermal responses to exercise.
5. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
6. have used the functions available in the Analysis window to determine values necessary for this exercise.
7. as an additional analysis, have calculated the subject's relative cardiac health by examining the time it takes the subject's heart rate to return to normal after exercising.

Experiment HE-2: Recovery from Exercise

Learning Goals:

1. Students will be able to successfully record a pulse using the plethysmograph.

2. Students should be able to measure the changes in the heart rate during exercise and recovery from exercise.
3. Students will be able to determine a subject's overall "Fitness Rating" based on the time it takes the heart rate to return to normal after exercise.
4. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have recorded a recognizable pulse wave at rest.
2. have recorded a recognizable pulse wave on an individual during and after exercise.
3. be able to determine the pulse rate of an individual from the recorded data and understand the effects of exercise on pulse rate.
4. determine a subject's overall fitness and heart health after examining pulse rate recovery from exercise.
5. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
6. have used the functions available in the Analysis window to determine values necessary for this exercise.

Experiment HE-3: Exercise, Blood Pressure and Oxygen Saturation Levels

Learning Goals:

1. Students will be able to successfully record a blood pressure using a non-invasive blood pressure cuff (sphygmomanometer).
2. Students will be able to determine the oxygen saturation level in subjects using a pulse oximeter.
3. Students will be able to interpret data from these recordings and understand the difference between systolic and diastolic blood pressure.
4. Students should be able to measure the changes in the heart rate, blood pressure and oxygen saturation levels during exercise and recovery from exercise.
5. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have recorded a recognizable blood pressure and oxygen saturation levels recorded at rest.
2. have recorded a recognizable oxygen saturation levels, BP and pulse on an individual during and after exercise.
3. be able to determine the pulse rate of an individual from the recorded data and understand the effects of exercise on pulse rate.

4. be able to determine the BP and oxygen saturation levels of an individual from the recorded data and understand the effects of exercise on systolic and diastolic blood pressure, and blood oxygen levels.
5. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
6. have used the functions available in the Analysis window to determine values necessary for this exercise.

Experiment HE-4: Respiratory Exchange Ratio (RER)

Learning Goals:

1. Students will learn how to use and calibrate an O2/CO2 Gas Analyzer.
2. Students will learn how to measure breathing parameters using a spirometer and mixing chamber.
3. Students will use spirometry data to measure VO_2, VCO_2, and RER.
4. Students will calculate the proportion of fat and carbohydrates utilized while the subject was resting, hyperventilating, recovering from hyperventilation, and recovering from light or moderate exercise.
5. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have recorded a recognizable breathing pattern using a spirometer.
2. have recorded recognizable expired oxygen and expired carbon dioxide curves.
3. be able to determine relative VO2 and VCO2.
4. be able to determine the RER from their subject at rest and during various testing protocols.
5. be able to understand how VO2, VCO2 and RER are affected by changes in breathing patterns.
6. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
7. have used the functions available in the Analysis window to determine values necessary for this exercise.

Experiment HE-5: Resting Metabolic Rate (RMR)

Learning Goals:

1. Students will learn how to use and calibrate an O2/CO2 Gas Analyzer.
2. Students will learn how to measure breathing parameters using a spirometer and mixing chamber.
3. Students will use spirometry data to measure VO_2, VCO_2, and RMR.

4. Students will measure oxygen consumption and use four formulas to determine the subject's heat production, and predicted and observed metabolic rates at the time of the experiment.
5. Students will also determine the metabolic rate of the subject after recovering from moderate exercise.
6. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have recorded a recognizable breathing pattern using a spirometer.
2. have recorded recognizable expired oxygen and expired carbon dioxide curves.
3. be able to determine relative VO2 and VCO2.
4. be able to determine the RMR from their subject at rest and during various testing protocols.
5. be able to understand how VO2, VCO2 and RMR are affected by changes in exercise levels.
6. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
7. have used the functions available in the Analysis window to determine values necessary for this exercise.

Experiment HE-6: Breath by Breath Measurement of Respiratory Exchange Ratio (RER)

Learning Goals:

1. Students will learn how to use and calibrate an O2/CO2 Gas Analyzer.
2. Students will learn how to measure breathing parameters using a spirometer.
3. Students will use spirometry data and breath by breath analysis to measure VO_2, VCO_2, and RER.
4. Students will calculate the proportion of fat and carbohydrates utilized while the subject was resting, hyperventilating, recovering from hyperventilation, and recovering from light or moderate exercise.
5. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have recorded a recognizable breathing pattern using a spirometer.
2. have recorded recognizable expired oxygen and expired carbon dioxide curves.
3. be able to determine relative VO2 and VCO2.
4. be able to determine the RER from their subject at rest and during various testing protocols.
5. be able to understand how VO2, VCO2 and RER are affected by changes in breathing patterns.
6. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.

7. have used the functions available in the Analysis window to determine values necessary for this exercise.

Experiment HE-7: Breath by Breath Measurement of Resting Metabolic Rate (RMR)

Learning Goals:

1. Students will learn how to use and calibrate an O2/CO2 Gas Analyzer.
2. Students will learn how to measure breathing parameters using a spirometer.
3. Students will use spirometry data and breath by breath analysis to measure VO_2, VCO_2, and RMR.
4. Students will measure oxygen consumption and use four formulas to determine the subject's heat production, and predicted and observed metabolic rates at the time of the experiment.
5. Students will also determine the metabolic rate of the subject after recovering from moderate exercise.
6. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have recorded a recognizable breathing pattern using a spirometer.
2. have recorded recognizable expired oxygen and expired carbon dioxide curves.
3. be able to determine relative VO2 and VCO2.
4. be able to determine the RMR from their subject at rest and during various testing protocols.
5. be able to understand how VO2, VCO2 and RMR are affected by changes in exercise levels.
6. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
7. have used the functions available in the Analysis window to determine values necessary for this exercise.

Experiment HE-8: Regulation of Body Temperature and the Respiratory Exchange Ratio (RER)

Learning Goals:

1. Students will learn how to use and calibrate an O2/CO2 Gas Analyzer.
2. Students will learn how to measure breathing parameters using a spirometer.
3. Students will use spirometry data and breath by breath analysis to measure VO_2, VCO_2, and RER of a subject while resting, while body temperature is raised (and the body is using energy to keep cool), and while cooling the body (using energy to keep warm).
4. Students will calculate the proportion of fat and carbohydrates utilized while the subject was resting and while the subject was placed at various body temperatures.

5. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have recorded a recognizable breathing pattern using a spirometer.
2. have recorded recognizable expired oxygen and expired carbon dioxide curves.
3. be able to determine relative VO2 and VCO2.
4. be able to determine the RER from their subject at rest and during various testing protocols.
5. be able to understand how VO2, VCO2 and RER are affected by changes in body temperature.
6. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
7. have used the functions available in the Analysis window to determine values necessary for this exercise.

Experiment HE-9: Resting, Active and Exercising Metabolic Rates

Learning Goals:

1. Students will learn how to use and calibrate an O2/CO2 Gas Analyzer.
2. Students will learn how to measure breathing parameters using a spirometer.
3. Students will use spirometry data and breath by breath analysis to measure VO_2 and VCO_2 during various exercise activities.
4. Students will measure the heart rate of a subject while he or she is resting while reclining; performing an activity, like reading or working on a computer while sitting; and, exercising at various levels of intensity from easy to moderate.
5. Students will determine the subject's RER, proportion of energy sources utilized, and effectiveness of cardiac fitness.
6. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have recorded a recognizable breathing pattern using a spirometer.
2. have recorded recognizable expired oxygen and expired carbon dioxide curves.
3. be able to determine relative VO2 and VCO2.
4. be able to determine the RER and cardiac fitness from their subject at rest and during various testing protocols.
5. be able to understand how VO2, VCO2 and RER are affected by changes in exercise levels.
6. be able to understand the physiology involved in using different energy sources during exercise.
7. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.

8. have used the functions available in the Analysis window to determine values necessary for this exercise.

Experiment HE-10: Aerobic Fitness Testing

Learning Goals:

1. Students will learn how to use and calibrate an O2/CO2 Gas Analyzer.
2. Students will learn how to measure breathing parameters using a spirometer.
3. Students will use spirometry data and breath by breath analysis to measure VO_2 and VCO_2 during various exercise activities up to VO2max and/or completion of a "stress" test.
4. Students will measure the heart rate of a subject while he or she is resting while exercising at various levels of intensity from easy to moderate to full VO2max protocols.
5. Students will determine the subject's RER, proportion of energy sources utilized, and effectiveness of cardiac fitness.
6. Students will learn to choose the correct Fitness Protocols based on the fitness level of the subject being tested.
7. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have recorded a recognizable breathing pattern using a spirometer.
2. have recorded recognizable expired oxygen and expired carbon dioxide curves.
3. be able to determine relative VO2 and VCO2 and VO2max.
4. be able to determine anaerobic threshold.
5. be able to determine the RER and cardiac fitness from their subject at rest and during various levels of testing protocols.
6. be able to understand how VO2, VCO2 and RER are affected by changes in exercise levels.
7. be able to understand the physiology involved in using different energy sources during exercise.
8. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
9. have used the functions available in the Analysis window to determine values necessary for this exercise.

Human Heart Chapter

Experiment HH-1: The Electrocardiogram and Peripheral Circulation

Learning Goals:

1. Students will be able to successfully record a three-lead Electrocardiogram (ECG) and examine the relationship of the ECG to the peripheral circulation.
2. Students will be able to record and look at the effects of hot and cold on an ECG and pulse in the extremities.
3. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have recorded a recognizable ECG.
2. have been able to interpret an ECG, especially the individual P and T waves, and the QRS complex.
3. be able to calculate the heart rate of an individual from the recorded data.
4. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
5. have used the functions available in the Analysis window to determine values for arterial pulse amplitude and heart rate, and the amplitudes of various ECG waves.
6. have been able to examine and interpret the effects of hot and cold on peripheral circulation.

Experiment HH-2: The Electrocardiogram and Heart Sounds

Learning Goals:

1. Students will be able to successfully record a three-lead Electrocardiogram (ECG) and listen to heart sounds using a stethoscope.
2. Students will be able to compare the ECG to the heart sounds and determine when the sounds occur during a cardiac cycle.
3. continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have recorded a recognizable ECG.
2. have been able to interpret an ECG, especially the individual P and T waves, and the QRS complex.
3. be able to calculate the heart rate of an individual from the recorded data.
4. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.

5. have been able to examine and interpret the heart sounds and when they occur in an ECG recording.

Experiment HH-3: Exercise, the Electrocardiogram, and Peripheral Circulation

Learning Goals:

1. Students will be able to successfully record a three-lead Electrocardiogram (ECG) and examine the relationship between the ECG and the peripheral circulation.
2. Students will be able to record and look at the effects of exercise on an ECG and pulse in different subjects during the lab period.
3. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have recorded a recognizable ECG.
2. have been able to interpret an ECG, especially the individual P and T waves, and the QRS complex.
3. be able to calculate the heart rate of an individual from the recorded data.
4. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
5. have used the functions available in the Analysis window to determine values for arterial pulse amplitude and heart rate, and the amplitudes of various ECG waves.
6. have been able to examine and interpret the effects of exercise on ECG and pulse amplitudes and timing.

Experiment HH-4: The Six-Lead Electrocardiogram

Learning Goals:

1. Students will be able to successfully record a six-lead Electrocardiogram (ECG) and interpret a six-lead ECG.
2. Students will interpret data looking at the different ECG leads: I, II, III, aVL, aVR, and aVF.
3. Students will be able to calculate amplitudes of the P, R and T waves; the QRS axis; and the heart angle from the data collected during recording.
4. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have recorded a recognizable six-lead ECG.
2. have been able to interpret an ECG, especially the individual P and T waves, the QRS complex, and answer questions about these waves.

3. be able to calculate the heart angle of an individual from the recorded data.
4. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
5. have used the functions available in the Analysis window to determine values for arterial pulse amplitude and heart rate, and various ECG amplitudes.

Experiment HH-5: The Diving Reflex

Learning Goals:

1. Students will be able to successfully record a pulse using the plethysmograph.
2. Students will be able to record and look at the effects of apnea, and facial immersion into both room temperature and cold water on the pulse wave.
3. As an optional exercise, students will be able to examine the effects of apnea, and facial immersion into both room temperature and cold water on respiration rate and depth.
4. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have recorded a recognizable pulse wave and heart rate trace on a resting individual.
2. have recorded a recognizable pulse wave and heart rate trace on an individual during apnea and facial immersion into room temperature and cold temperature water.
3. be able to calculate the pulse rate of an individual from the recorded data and understand the effects of the diving reflex.
4. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
5. have used the functions available in the Analysis window to determine values necessary for this exercise.
6. as an optional exercise have been able to examine and interpret the effects of apnea, and facial immersion into both room temperature and cold water on respiration rate and depth.

Experiment HH-6: Heart Rate Variability (HRV)

Learning Goals:

1. Students will be able to successfully record a three-lead Electrocardiogram (ECG) and examine heart rate variability (HRV) while resting, after exercise and during a psychological test.
2. Students will be able to record and look at the effects of exercise and a stressful test on HRV.
3. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have recorded a recognizable ECG and be able to calculate the heart rate of an individual from the recorded data.
2. have been able to interpret an ECG, especially the individual P and T waves, and the QRS complex.
3. be able to interpret data to look at HRV after exercise and during a psychological test.
4. answered questions about HRV and how HRV is influenced during times of "stress".
5. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.

Experiment HH-7: The Electrocardiogram using Six Chest Leads

Learning Goals:

1. Students will be able to successfully record a six-lead Electrocardiogram (ECG) and interpret a six-lead ECG.
2. Students will interpret data looking at the different ECG chest leads: V1, V2, V3, V4, V5 and V6.
3. Students will be able to calculate amplitudes of the P, R and T waves; the QRS axis; and the heart angle from the data collected during recording.
4. Students will look at transition points of the ECG and compare subjects to look at trends in wave patterns.
5. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have recorded a recognizable six-lead ECG.
2. have been able to interpret an ECG, especially the individual P and T waves, the QRS complex, and answer questions about these waves.
3. be able to determine transition points between individual subjects and make physiological comparisons regarding ECG patterns.
4. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
5. have used the functions available in the Analysis window to determine values for arterial pulse amplitude and heart rate, and various ECG amplitudes.

Experiment HH-8: Heart Sounds and Auscultation

Learning Goals:

1. Students will be able to successfully record a three-lead Electrocardiogram (ECG) and listen to heart sounds using a heart sounds microphone.

2. Students will be able to compare the ECG to the heart sounds and determine when the sounds occur during a cardiac cycle.
3. Students will understand and be able to locate the 4 major auscultation areas on the chest.
4. Students will monitor ECG and heart sounds under varying conditions.
5. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have recorded a recognizable ECG.
2. have been able to interpret an ECG, especially the individual P and T waves, and the QRS complex.
3. have calculated the ratio of the average area to the average duration of the heart sound integrals for the S1 and S2 heart sounds from each auscultation area.
4. have determined the relative amplitude of each heart sound from each auscultation area.
5. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
6. have been able to examine and interpret the heart sounds and when they occur in an ECG recording.

Experiment HH-9: Electrocardiogram (ECG) using an Electronic Stethoscope

Learning Goals:

1. Students will be able to successfully record a three-lead Electrocardiogram (ECG) and listen to heart sounds using an electronic stethoscope.
2. Students will be able to use a stethoscope correctly and accurately.
3. Students will understand and be able to locate the 4 major auscultation areas on the chest.
4. Students will be able to compare the ECG to the heart sounds and determine when the sounds occur during a cardiac cycle.
5. Students will monitor ECG and heart sounds under varying conditions.
6. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have recorded a recognizable ECG.
2. have been able to interpret an ECG, especially the individual P and T waves, and the QRS complex.
3. have calculated the ratio of the average area to the average duration of the heart sound integrals for the S1 and S2 heart sounds from each auscultation area.
4. have determined the relative amplitude of each heart sound from each auscultation area.

5. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
6. have been able to examine and interpret the heart sounds and when they occur in an ECG recording.

Experiment HH-10: The 12-Lead Electrocardiogram (12-Lead ECG)

Learning Goals:

1. Students will be able to successfully record and interpret a 12-lead Electrocardiogram (ECG).
2. Students will interpret data looking at the different ECG leads: I, II, III, aVL, aVR, and aVF, and the 6 chest leads.
3. Students will be able to calculate amplitudes of the P, R and T waves; the QRS axis; and the heart angle from the data collected during recording.
4. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have recorded a recognizable 12-lead ECG.
2. have been able to interpret an ECG, especially the individual P and T waves, the QRS complex, and answer questions about these waves.
3. be able to calculate the heart angle of an individual from the recorded data.
4. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
5. have used the functions available in the Analysis window to determine values for arterial pulse amplitude and heart rate, and various ECG amplitudes.

Experiment HH-11: The Electrocardiogram Simulation

Learning Goals:

1. Students will be able to successfully record an Electrocardiogram (ECG) both on a live subject and using an ECG Simulator.
2. Students will be able to record a normal sinus rhythm both on the their subject and using the simulator.
3. Students will be able to use the ECG simulator to record abnormal cardiac rhythms.
4. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have recorded a recognizable ECG with a normal sinus rhythm.

2. have been able to interpret an ECG, especially the individual P and T waves, and the QRS complex.
3. be able to calculate the heart rate of an individual from the recorded data.
4. be able to recognize and understand the differences in ECG recordings during abnormal cardiac situations.
5. understand the physiology behind normal and abnormal cardiac rhythms.
6. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
7. have used the functions available in the Analysis window to determine values for arterial pulse amplitude and heart rate, and the amplitudes of various ECG waves.

Experiment HH-12: Heart Rate Variability (HRV) using Pulse

Learning Goals:

1. Students will be able to successfully record pulse waves using a pulse plethysmograph and examine heart rate variability (HRV) while resting, after exercise and during a psychological test.
2. Students will be able to record and look at the effects of exercise and a stress-type test on HRV.
3. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have recorded recognizable pulse waves and be able to calculate the heart rate of an individual from the recorded data.
2. be able to interpret data to look at HRV after exercise and during a psychological test.
3. answered questions about HRV and how HRV is influenced during times of “stress”.
4. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.

Human Kidney Chapter

Experiment HK-1: Human Kidney

Learning Goals:

1. Students will be able to successfully follow experimental procedure for human subjects.
2. Students will gain understanding of the functionality of the human kidney.
3. Students will understand the osmoregulatory controls in the human body.
4. Students will learn accuracy and measuring procedures for urine output.
5. Students will understand the concepts and importance of specific gravity, urinary flow rate, pH, and urinary glucose levels.

Outcomes: Students who have successfully completed this exercise will:

1. have successfully followed laboratory procedures using human subjects and calculated the volumes of solutions to be ingested by these subjects.
2. understand the function of human diuretic hormone (ADH) in the functioning of the kidney.
3. be able to relate different types of fluid intake to overall urine output.
4. be able to calculate specific gravity and understand how it relates to urine concentration.
5. understand and be able to calculate urinary flow rate for different individuals.
6. be able to accurately discuss the importance of urine pH and glucose levels in the healthy functioning of the human kidney.

Human Muscle Chapter

Experiment HM-1: Grip Strength and Electromyogram (EMG) Activity

Learning Goals:

1. Students will successfully record electromyograms (EMGs).
2. Students will learn how to calibrate a dynamometer and convert pounds to kilograms.
3. Students will gain an understanding of the relationship between the electric current from the nerves and the response of the muscle or muscle group being innervated.
4. Students should be able to measure the EMG produced and corresponding muscle force.
5. Students will measure the force produced by the muscle in both the dominant and non-dominant forearms.
6. Students will also study and measure the effect of fatigue on the muscles in the dominant and non-dominant forearms. Comparison of the measurement will also be examined.
7. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. understand and be able to record an EMG.
2. understand how nerves send electrical signals to muscles to cause a response.
3. be able to determine the relationship between the nerve impulses and the resulting EMG recording.
4. have gained understanding of the reasons for different responses in the dominant and non-dominant forearm, and the correlation between fatigue and muscle strength.
5. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
6. have used the functions available in the Analysis window to determine values necessary for this exercise.

Experiment HM-2: Electromyogram (EMG) Activity in Antagonistic Muscles

Learning Goals:

1. Students will successfully record electromyograms (EMGs) from antagonistic muscle groups in both the forearm and lower leg.
2. Students will learn how levers, fulcrums, and load affect the workings of antagonistic muscles.
3. Students will gain an understanding of the muscle groups involved in flexion, extension, dorsiflexion and plantar flexion.
4. Students will use weights to put load on muscles groups while examining changes in the EMG.

5. Students will gain an understanding of the relationship between the electric current from the nerves and the response of the muscle or muscle group being innervated.
6. Students should be able to measure the EMG produced and corresponding muscle force.
7. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. understand and be able to record an EMG.
2. understand how nerves send electrical signals to muscles to cause a response.
3. be able to determine the relationship between antagonistic muscles during movement.
4. have gained understanding of the relationship between load and muscle activity.
5. have measured the EMG force difference between muscle groups without and without lifting a weight.
6. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
7. have used the functions available in the Analysis window to determine values necessary for this exercise.

Experiment HM-3: Oculomotor Muscle Activity

Learning Goals:

1. Students will successfully record electroculograms (EOGs) from the oculomotor muscle group of the eye.
2. Students will learn how the six oculomotor muscles control eye movement during saccades, pursuit, the vestibular ocular reflex (VOR), and vergence.
3. Students will perform tasks that will generate electrical activity in oculomotor muscles that are unique to each of four different types of eye movement (saccades, VOR, pursuit, and vergence).
4. Students will gain an understanding of the relationship between the electric current from the nerves and the response of the muscle or muscle group being innervated.

Outcomes: Students who have successfully completed this exercise will:

1. understand and be able to record an EOG.
2. understand how nerves send electrical signals to muscles to cause a response.
3. be able to determine the relationship between saccades and reading; pursuit and following a moving target; VOR and head rotation; and vergence and focusing near to far.
4. have measured the EOG amplitude to determine the motion of the subject's eyes during various oculomotor activities.
5. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.

6. have used the functions available in the Analysis window to determine values necessary for this exercise.

Experiment HM-4: Stimulus Response, Work, Summation, and Tetanus in Human Muscle

This exercise requires a stimulus isolator unit which allows students to electrically stimulate various muscles of the human body.

Learning Goals:

1. Students will learn how to apply a stimulus pulse to human muscle to elicit a muscular contraction.
2. Students will record finger twitches to be able to recognize contraction and relaxation times and twitch amplitudes.
3. Students will demonstrate the effect of increasing stimulus strength on the strength of a muscle contraction, the effect of
    - increasing weight on twitch amplitude and work of a preloaded muscle,
    - increasing the frequency of stimulation on the contraction strength and muscle fatigue.
4. Students will gain an understanding of the relationship between the electric current from the nerves and the response of the muscle or muscle group being innervated.
5. Students should be able to measure the EMG produced and corresponding muscle force.
6. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. understand and be able to record a simple finger twitch.
2. understand how nerves send electrical signals to muscles to cause a response.
3. be able to determine the relationship between stimulus and muscle twitch amplitudes.
4. understand the concepts of muscle recruitment, fatigue, summation, and tetanus
5. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
6. have used the functions available in the Analysis window to determine values necessary for this exercise.

Experiment HM-5: Flexibility and Range of Motion

Learning Goals:

1. Students will successfully record electromyograms (EMGs) from antagonistic muscle groups in both the forearm and lower leg.
2. Students will learn how levers, fulcrums, and load affect the workings of antagonistic muscles.

3. Students will gain an understanding of the muscle groups involved in flexion, extension, dorsiflexion and plantar flexion.
4. Students will use a goniometer to measure angle of motion and flexibility of muscle groups.
5. Students will gain an understanding of how the range of motion determines the joint's functionality.
6. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. understand and be able to record an EMG.
2. understand how flexibility and range of motion are used by physical therapists and athletic trainers when looking at joint dysfunction..
3. be able to determine the relationship between antagonistic muscles during movement and how that related to range of motion..
4. understand how flexion and extension of joints with and without weights affects the range of motion of that joint.
5. gain an understanding of why different joints have different flexibilities and ranges of motion in certain directions.
6. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
7. have used the functions available in the Analysis window to determine values necessary for this exercise.

Experiment HM-6: Stimulation of Antagonistic Muscles

This exercise requires a stimulus isolator unit which allows students to electrically stimulate various muscles of the human body.

Learning Goals:

1. Students will learn how to apply a stimulus pulse to human muscle to elicit a muscular contraction.
2. Students will record finger twitches to be able to recognize contraction and relaxation times and twitch amplitudes.
3. Students will gain an understanding of the muscle groups involved in flexion, extension, dorsiflexion and plantar flexion.
4. Students will use a goniometer to measure angle of motion and flexibility of muscle groups.
5. Students will gain an understanding of how the range of motion determines the joint's functionality.
6. Students will gain an understanding of the relationship between the electric current from the nerves and the response of the muscle or muscle group being innervated.

7. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. understand and be able to record a simple muscle twitch.
2. understand how nerves send electrical signals to muscles to cause a response.
3. be able to determine the relationship between stimulus and muscle twitch amplitudes.
4. understand contraction and relaxation times of muscles.
5. understand how stimulus frequency compares to the ranges of motion for dorsiflexion and plantar flexion of the foot, and flexion and extension of both the wrist, elbow and knee.
6. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
7. have used the functions available in the Analysis window to determine values necessary for this exercise.

Experiment HM-7: Electromyogram (EMG) Activity during Arm Wrestling

Learning Goals:

1. Students will successfully record electromyograms (EMGs) from antagonistic muscle groups in the forearm, upper arm and shoulder.
2. Students will learn how levers, fulcrums, and load affect the workings of antagonistic muscles.
3. Students will gain an understanding of the muscle groups involved in flexion and extension while performing a specific task.
4. Students will put load on muscles groups while examining changes in the EMG.
5. Students will gain an understanding of the relationship between the muscle action and function using preselected muscles and then using muscles groups for studying their own hypotheses.
6. Students will gain an understanding of the relationship between the electric current from the nerves and the response of the muscle or muscle group being innervated.
7. Students should be able to measure the EMG produced and corresponding muscle force.
8. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. understand and be able to record an EMG.
2. understand how nerves send electrical signals to muscles to cause a response.
3. be able to determine the relationship between antagonistic muscles during movement.
4. have gained understanding of the relationship between load and muscle activity.
5. have measured the EMG force difference between muscle groups while performing a specific task.

6. have designed optional experiments or muscle groups and test varied hypotheses.
7. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
8. have used the functions available in the Analysis window to determine values necessary for this exercise.

Experiment HM-8: Electrogastrogram (EGG) and the Growling Stomach

Learning Goals:

1. Students will record an EGG on an empty stomach.
2. Students will record an EGG on a full stomach.
3. Students will use a Fast Fourier Transform to analyze both frequency and power of the gastrogram waves.
4. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. understand and be able to record an EGG.
2. understand how nerves send electrical signals to muscles to cause a response.
3. be able to determine the relationship between eating and gastric muscle movement.
4. have gained understanding of the relationship between frequency and power of gastric activity before and after eating.
5. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
6. have used the functions available in the Analysis window to determine values necessary for this exercise.

Human Nerve Chapter

Experiment HN-1: Auditory and Visual Reflexes

Learning Goals:

1. Students will gain an understanding of a reflex arc and how the spinal cord and peripheral nerves function in the human body
2. Students will be able to successfully record responses from subjects to auditory and visual stimuli.
3. Students should be able to measure the response time of their subjects to different cues and relate it to the functioning of the spinal nerves.
4. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. understand and be able to draw a reflex arc.
2. have recorded responses of subjects to both auditory and visual stimuli.
3. determine a subject's response time to various cues.
4. be able to determine the effect of different types of auditory cues on response time.
5. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
6. have used the functions available in the Analysis window to determine values necessary for this exercise.

Experiment HN-2: Stretch Receptors and Reflexes

Learning Goals:

1. Students will successfully trigger and record electromyograms (EMGs) using a reflex hammer and iWorx software, respectively.
2. Students will gain an understanding of the muscles in the leg and how they work and respond to stimuli.
3. Students will gain an understanding of the both the Achilles and patellar stretch reflexes and the reflex arc.
4. Students should be able to measure the conduction times and nerve velocities for the Achilles and patellar reflexes using electromyograms (EMGs).
5. Students will measure the effect of pre-existing tension in the effector muscle, or motor activity in other muscle groups, upon reflex responses.
6. Students will also study the coordination of motor activity in antagonistic muscles.

7. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. understand and be able to draw a reflex arc.
2. have recorded EMG responses of subjects to stimulation of the Achilles and patellar tendons using a reflex hammer.
3. be able to determine the conduction times and nerve velocities using EMG recordings.
4. have measured the effect of pre-existing tension on muscles or muscle groups.
5. have gained understanding of the reasons for different conduction and reaction times of reflexes at different locations on the human body.
6. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
7. have used the functions available in the Analysis window to determine values necessary for this exercise.

Experiment HN-3: Human Nerve Conduction Velocity

This exercise requires a stimulus isolator unit which allows students to electrically stimulate various muscles and nerves of the human body.

Learning Goals:

1. Students will gain an understanding of how a stimulus is applied to a nerve to gain a response.
2. Students will gain an understanding of the Compound Action Potential (CAP) generated by a nerve as a response to a stimulus.
3. Students will be able to successfully measure CAPs of the nerves in the forearm.
4. Students will gain an understanding of summation and the relationship to nerve conduction velocity.
5. Students will understand the relationship between stimulus strength and the amplitude of the nerve/muscle response; the latency of the nerve as a function of the polarity of the stimulus pulse; and the nerve conduction velocity.
6. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have gained an understand of the effect of stimulus strength of the response of the innervated muscle.
2. understand how the amplitude of the CAP relates to threshold.
3. have gained an understanding of how the polarity of the stimulus pulse effects the latency and amplitude of the CAP.

4. have calculated the nerve conduction velocity of the ulnar nerve and understand how that relates to the functionality of the nerve/muscle response.
5. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Experiment HN-4: Hand vs. Foot Reactions

Learning Goals:

1. Students will gain an understanding of a reflex arc and how the spinal cord and peripheral nerves function in the human body
2. Students will be able to successfully record responses from subjects to auditory and visual stimuli on reactions of both the hand and the foot.
3. Students should be able to measure the response time of their subjects to different cues and relate it to the functioning of the spinal nerves.
4. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. understand and be able to draw a reflex arc.
2. have recorded responses of subjects to both auditory and visual stimuli.
3. determine a subject's response time to various cues using the hand vs. the foot - looking at eye-hand vs. eye-foot coordination.
4. be able to determine the effect of using different body parts on response time to various cues.
5. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
6. have used the functions available in the Analysis window to determine values necessary for this exercise.

Experiment HN-5: Visual Reflexes and Color Stimulation

Learning Goals:

1. Students will gain an understanding of a reflex arc and how the spinal cord and peripheral nerves function in the human body
2. Students will be able to successfully record responses from subjects to visual stimuli of different colors.
3. Students should be able to measure the response time of their subjects to different colors and relate it to the functioning of the spinal nerves.
4. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. understand and be able to draw a reflex arc.
2. have recorded responses of subjects to both red and green visual stimuli.
3. determine a subject's response time to the different colors under differing circumstances.
4. be able to determine the effect of different types of visual cues on response time.
5. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
6. have used the functions available in the Analysis window to determine values necessary for this exercise.

Experiment HN-6: Soleus-HReflex

This exercise requires a stimulus isolator unit which allows students to electrically stimulate various muscles and nerves of the human body.

Learning Goals:

1. Students will gain an understanding of how a stimulus is applied to a nerve to gain a response.
2. Students will gain an understanding of the Compound Action Potential (CAP) generated by a nerve as a response to a stimulus.
3. Students will be able to successfully measure CAPs of the nerves in the lower leg, specifically those for the soleus muscle.
4. Students will investigate the H-reflex response and the M-wave response during muscle stimulation.
5. Students will design optional exercises, including but not limited to:
    - using the Jendrassik maneuver and determine the result on the Hoffman Reflex.
    - adding a small weight to the foot.
    - altering the temperature, using either an ice pack or moist heat pack, to determine the H-reflex in both situations.
    - collecting a maximal M-wave. Calculate the Hmax:Mmax ratio which is the standard for reporting in sports medicine.
6. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have gained an understand of the effect of stimulus strength of the response of the innervated muscle.
2. understand how the amplitude of the CAP relates to threshold.
3. be able to design their own hypothesis and carry out the experiment to record and collect data accurately.

4. understand that different parameters can have varying effect on the CAP action and muscle response.
5. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
6. have used the functions available in the Analysis window to determine values necessary for this exercise.

Human Psychophysiology Chapter

Experiment HP-1: The Electroencephalogram (EEG)

Learning Goals:

1. Students will learn to collect electroencephalogram (EEG) signals from the left and right cerebral hemispheres.
2. Students will learn to recognize common EEG artifacts caused by movements such as eye blinks, facial muscle contractions, and head movement.
3. Students should be able to recognize and analyze Alpha and Beta EEG patterns associated with closed and open eye conditions;
4. Students will observe the Alpha block.
5. Students will test an experimental hypothesis about relative levels of Alpha and Beta EEG waves in each hemisphere in two psychological states.
6. Students will test an experimental hypothesis about personality and EEG.
7. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have recorded recognizable EEG traces for Alpha and Beta waves on both the right and left cerebral hemispheres.
2. be able to recognize common EEG artifacts.
3. be able to determine the effects of eye conditions (open or closed) and Alpha block on an EEG recording.
4. have tested a hypothesis and reached a conclusion about psychological states and brain hemisphere dominance.
5. have taken personality profile test and explored a hypothesis about EEG and personality.
6. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
7. have used the functions available in the Analysis window to determine values necessary for this exercise.

Experiment HP-2: The Galvanic Skin Response (GSR) and Emotion

Learning Goals:

1. Students will learn to measure the tonic level of skin conductance, the frequency of spontaneous conductance responses, and the habituation of the skin conductance response.
2. Students will observe and measure the galvanic skin response (GSR) as an orienting response to being asked neutral content questions.

3. Students will observe and measure the GSR in response to questions with emotional content.
4. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have recorded GSR traces.
2. be able to recognize changes in the GSR as a response to neutral content or emotional content questions.
3. be able to determine and understand the effects of these questions on an individual's GSR.
4. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
5. have used the functions available in the Analysis window to determine values necessary for this exercise.

Experiment HP-3: The Galvanic Skin Response, Deception, Cognitive Complexity, and Vigilance

Learning Goals:

1. Students will learn to measure the tonic level of skin conductance, the frequency of spontaneous conductance responses, and the habituation of the skin conductance response.
2. Students will observe and measure the galvanic skin response (GSR) as an orienting response to being asked neutral content questions.
3. Students will test an experimental hypothesis about deliberate deception, *guilty knowledge*, and the amplitude of the GSR.
4. Students will test an experimental hypothesis about cognitive complexity and the latency of the GSR.
5. Students will test an experimental hypothesis about personality, vigilance, and the lability of skin conductance levels.
6. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have recorded GSR traces.
2. be able to recognize changes in the GSR as a response to neutral content questions and habituation.
3. come to a conclusion after testing the hypothesis on deliberate deception and guilty knowledge. This will allow students to gain an understanding of the nature of Polygraph Tests.
4. come to a conclusion with regard to the hypotheses about cognitive complexity, personality and vigilance; and how these play a role in the GSR of individuals.
5. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.

6. have used the functions available in the Analysis window to determine values necessary for this exercise.

Experiment HP-4: Skin Temperature, Stress, Calming, and Embarrassment

Learning Goals:

1. Students will learn to measure and record skin temperature.
2. Students will observe and measure the changes in skin temperature during a mild psychosocial stressor, a mental arithmetic test.
3. Students will measure the effect of calming mental imagery in a biofeedback paradigm on skin temperature.
4. Students will test an experimental hypothesis about embarrassability and, blushing and gender.
5. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have successfully calibrated the temperature probe and recorded skin temperature traces.
2. be able to recognize changes in skin temperature as a result of a mild stressor and when using calming mental imagery.
3. come to a conclusion with regard to the about gender and embarrassability, using changes in skin temperature as the correlating factor.
4. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
5. have used the functions available in the Analysis window to determine values necessary for this exercise.

Experiment HP-5: Heart Rate, Blood Pressure, and Vagal Tone

Learning Goals:

1. Students will learn to measure and record heart rate and blood pressure as a baseline measurement.
2. Students will collect data and analyze heart rate and blood pressure changes during a stressful task and during a reaction time test.
3. Students will test a hypothesis that persons with high perceived shyness and behavioral inhibition have lower Vagal tone than persons with low perceived shyness.
4. Students will learn how these measurements coordinate with heart rate and breathing.
5. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have successfully calibrated the blood pressure cuff (sphygmomanometer) and recorded blood pressure and pulse.
2. be able to recognize changes from baseline measurements in blood pressure and pulse rate during a stressful task and a reaction time test.
3. come to a conclusion with regard to these changes.
4. come to a conclusion about shyness and the relationship with heart rate and breathing, and how this corresponds to vagal tone.
5. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
6. have used the functions available in the Analysis window to determine values necessary for this exercise.

Experiment HP-6: Cynicism/Hostility and the "Hot Reactor"

Learning Goals:

1. Students will participate anonymously in a personality assessment for the cynicism/hostility personality trait.
2. Students will learn to measure and record heart rate and blood pressure as a baseline measurement.
3. Students will collect and analyze heart rate and blood pressure during a social issues debate and during a recovery to baseline period.
4. Students will test hypotheses about personality and changes in heart rate and/or blood pressure that may have occurred during the debate.
5. Students will learn how these measurements coordinate with being a “hot reactor”.
6. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have taken a personality profile test specifically designed to gauge hostile reactions to certain questions.
2. have successfully calibrated the blood pressure cuff (sphygmomanometer) and recorded blood pressure and pulse.
3. learn about current social issues, proper debate procedures and presenting in front of their peers.
4. be able to recognize changes from baseline measurements in blood pressure and pulse rate during a debate on social issues.
5. come to a conclusion about personality with regard to these changes.
6. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.

7. have used the functions available in the Analysis window to determine values necessary for this exercise.

Experiment HP-7: Interference of Stimuli on Associative Tasks - The Stroop Effect

Note: This experiment can also be performed using *OpenSesame*, an automatic time-stamp application.

Learning Goals:

1. Subjects will perform tasks that demonstrate the Stroop Effect
2. Subjects will look at the effect of word stimuli on color naming, the effect of color stimuli on reading words, the effect of word stimuli on naming directions, and stimuli of your own choice or design.
3. Students will analyze how the completion time of each task is used as an indicator of the strength of the interference of the stimuli on the task.
4. Students will measure the heart rate and skin conductance level of each subject before, during, and after each task.
5. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. understand how activities can have an effect of skin conductance and heart rate.
2. have an understanding how some tasks performed are considered "interference" tasks and be able to explain the physiology behind the reaction.
3. be able to make predictions and create their own hypothesis with regards to interference tasks.
4. have tested and analyzed their hypothesis to see how it relates to other parameters tested.
5. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
6. have used the functions available in the Analysis window to determine values necessary for this exercise.

Experiment HP-8: The Galvanic Skin Response (GSR) and Emotion

Learning Goals:

1. Students will learn to measure the tonic level of skin conductance, the frequency of spontaneous conductance responses, and the habituation of the skin conductance response.
2. Students will observe and measure the galvanic skin response (GSR) as an orienting response to being asked neutral content questions.
3. Students will observe and measure the GSR in response to questions with emotional content and about performing a certain task (lying or telling the truth).

4. Students will measure skin conductance and form conclusions about "lie detector" tests based on the lab experiment.
5. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have recorded GSR traces.
2. be able to recognize changes in the GSR as a response to neutral content or emotional content questions.
3. be able to determine and understand the effects of these questions on an individual's GSR.
4. understand the nature of "lie detector" tests and be able to articulate whether these tests are accurate or inaccurate based on data collected.
5. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
6. have used the functions available in the Analysis window to determine values necessary for this exercise.

Experiment HP-9: Facial Electromyograms (EMG)

Learning Goals:

1. Students will successfully record electromyograms (EMGs) from facial muscle groups, especially those involved in smiling and frowning.
2. Students will gain an understanding of the muscle groups involved in making certain facial expressions.
3. Students will study the subject's emotional response while looking at a series of images based on EMG activity.
4. Students will gain an understanding of the relationship between the electric current from the nerves and the response of the muscle or muscle group being innervated.
5. Students should be able to measure the EMG produced and corresponding muscle activity.
6. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. understand and be able to record an EMG.
2. understand how nerves send electrical signals to muscles to cause a response.
3. be able to determine the relationship between EMG activity and smiling or frowning.
4. have gained understanding of the relationship between emotion and certain muscle activity.
5. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.

7. have used the functions available in the Analysis window to determine values necessary for this exercise.

Experiment HP-10: Visual Evoked Potentials (VEP)

Learning Goals:

1. Students will set up equipment and image generator to be able to record electrical activity generating visual evoked potentials (VEPs).
2. Students will learn how to record VEP activity from the subject while the eyes are closed.
3. Students will identify the VEP pattern for both the left and right eyes while looking at a flashing checkerboard.
4. Students will identify the VEP pattern for the both the left and right eyes while looking at a rotating dartboard pattern.
5. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. understand and be able to record a VEP from both left and right eyes.
2. understand how nerves send electrical signals to cause a visual response.
3. be able to determine the relationship between VEP activity and right vs. left eyes.
4. be able to determine the difference in VEP activity using a flashing checkerboard and a rotating dartboard.
5. have gained understanding of the latency and response time.
6. understand what is happening physiologically during the latent period and evoked potential.
7. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
8. have used the functions available in the Analysis window to determine values necessary for this exercise.

Human Spirometry Chapter

Experiment HS-1: Breathing Parameters at Rest and After Exercise

Learning Goals:

1. Students will be able to successfully record respiratory cycles.
2. Students should be able to measure respiration volumes including: tidal volume, reserve capacities, vital capacity, and be able to calculate overall lung volume.
3. Students will be able to determine the difference in lung volumes of a subject at rest, immediately after exercise, and up to a few minutes after exercise.
4. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have recorded a recognizable respiratory cycle at rest.
2. have recorded recognizable respiratory cycles on an individual immediately after exercise and a few minutes after exercise.
3. be able to determine the respiratory volumes of an individual from the recorded data and understand the effects of exercise on lung volumes.
4. determine a subject's overall fitness and lung health after examining breathing rate recovery from exercise.
5. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
6. have used the functions available in the Analysis window to determine values necessary for this exercise.

Experiment HS-2: Breathing and Gravity

Learning Goals:

1. Students will be able to successfully record respiratory cycles.
2. Students should be able to measure respiration volumes including: tidal volume, reserve capacities, vital capacity, and be able to calculate overall lung volume.
3. Students will examine the effects of gravity on breathing by measuring the differences in lung volumes of a resting subject while he or she is sitting, standing, or lying down.
4. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have recorded a recognizable respiratory cycle at rest.
2. have recorded recognizable respiratory cycles on an individual while he or she is sitting, standing and lying down.

3. be able to determine the respiratory volumes of an individual from the recorded data and understand the effects of gravity on lung volumes.
4. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
5. have used the functions available in the Analysis window to determine values necessary for this exercise.

Experiment HS-3: Factors that Affect Breathing Patterns

Learning Goals:

1. Students will be able to successfully record respiratory cycles.
2. Students should be able to measure respiration volumes including: tidal volume, reserve capacities, vital capacity, and be able to calculate overall lung volume.
3. Students will examine how factors, like concentrating on the completion of a task or sitting up quickly, influence breathing.
4. Students will record and measure lung volumes during these tasks and answer questions based on the data collected.
5. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have recorded a recognizable respiratory cycle at rest.
2. have recorded recognizable respiratory cycles on an individual while performing different tasks like concentrating on the completion of a problem or sitting up quickly.
3. be able to determine the respiratory volumes of an individual from the recorded data and understand the effects of these tasks on lung volumes.
4. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
5. have used the functions available in the Analysis window to determine values necessary for this exercise.

Experiment HS-4: Lung Volumes and Heart Rate

Learning Goals:

1. Students will be able to successfully record respiratory cycles and pulse waves.
2. Students should be able to measure tidal volume and be able to calculate both breathing and heart rate.
3. Students will determine the heart rate and respiratory sinus arrhythmia (RSA) prominence of a subject breathing at rest.

4. Students will also determine the effect of apnea, different inhalation volumes, and the movement of the muscles involved in breathing on heart rate.
5. Students will record and measure lung volumes during these tasks and answer questions based on the data collected.
6. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have recorded recognizable respiratory cycles and pulse waves.
2. be able to measure tidal volume amplitudes, and calculate breathing and heart rate.
3. be able to determine the effects of apnea, use of different muscle groups and inhalation volumes on heart rate.
4. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
5. have used the functions available in the Analysis window to determine values necessary for this exercise.

Experiment HS-5: Breathing Techniques and Heart Rate

Learning Goals:

1. Students will be able to successfully record respiratory cycles and pulse waves.
2. Students should be able to measure tidal volume and be able to calculate both breathing and heart rate.
3. Students will determine the heart rate and respiratory sinus arrhythmia (RSA) prominence of a subject breathing at rest.
4. Students will also determine the effect of apnea, shallow abdominal breathing, rapid bellows breathing, and deep abdominal breathing on heart rate.
5. Students will record and measure lung volumes during these tasks and answer questions based on the data collected.
6. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have recorded recognizable respiratory cycles and pulse waves.
2. be able to measure and calculate breathing and heart rates.
3. be able to determine the effects of apnea, use of different muscle groups and inhalation volumes on heart rate.
4. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.

5. have used the functions available in the Analysis window to determine values necessary for this exercise.

Experiment HS-6: Ventilation and Oxygen Saturation Levels - Part I

Learning Goals:

1. Students will record oxygen saturation levels in the blood of the subject during normal breathing, apnea, hyperventilation, the Valsalva maneuver, and chest expansion.
2. Students will successfully record the subject's heart rate.
3. Students will monitor breathing s a demonstration of the integration of the cardiovascular and pulmonary systems.
4. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have recorded and calculated heart rate, and compared heart rate and oxygen saturation levels during the different breathing techniques.
2. have looked at the relationship between normal breathing, apnea, hyperventilation, the Valsalva maneuver, and chest expansion, on blood oxygen saturation.
3. be able to explain how and why oxygen saturation levels may change during inhalation and exhalation.
4. have gained an understanding of the physiology of maintaining a steady oxygen saturation level.
5. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
6. have used the functions available in the Analysis window to determine values necessary for this exercise.

Experiment HS-7: Ventilation and Oxygen Saturation Levels - Part II

Learning Goals:

1. Students will record oxygen saturation levels in the blood of the subject during normal breathing, and during different abdominal and thoracic breathing techniques.
2. Students will successfully record the subject's heart rate.
3. Students will monitor breathing s a demonstration of the integration of the cardiovascular and pulmonary systems.
4. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have recorded and calculated heart rate.
2. have looked at the relationship between normal breathing, shallow abdominal breathing, bellows breathing,and deep abdominal breathing on blood oxygen saturation.
3. be able to explain how and why oxygen saturation levels and heart rate may change during different types of breathing patterns.
4. gain an understanding of the physiology of maintaining a steady oxygen saturation level.
5. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
6. have used the functions available in the Analysis window to determine values necessary for this exercise.

Experiment HS-8: Restrictive and Obstructive Airway Diseases

Learning Goals:

1. Students will be able to successfully record resting respiratory cycles.
2. Students should be able to measure tidal volume and be able to calculate breathing rate.
3. Students should be ale to use the Analysis window to calculate Max and Min dv/dt.
4. Students will determine FVC, FEV1 and FEV3 and the FEV/FVC ratios.
5. Students will also determine the effect of breathing with a corset on and breathing through a narrowed airway.
6. Students will record and measure lung volumes during these tasks and answer questions based on the data collected.
7. Students will continue to be successful at using the LabScribe software to move cursors, analyze data, record data to the Journal, and add functions to the Analysis window.

Outcomes: Students who have successfully completed this exercise will:

1. have recorded recognizable respiratory cycles.
2. be able to measure and calculate breathing rates, breathing parameters and specific ratios.
3. be able to determine the effects of restriction and obstruction on lung volumes and breathing rate.
4. understand the differences between restrictive and obstructive airway diseases.
5. feel comfortable transferring data to the Journal and interpreting that data to answer questions about their recordings.
6. have used the functions available in the Analysis window to determine values necessary for this exercise.