EDUCATIONAL PRACTICES in Kinesiology

Teaching and Learning Resource

Structuring an Undergraduate Introductory Exercise Physiology Course: Learning-Practice-Evaluation

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ABSTRACT

Educational Practices in Kinesiology 4(1): 1-29, 2024. The purpose of this paper is to outline an introductory exercise physiology course structure for instructors. This is intended for classes with 15-25 students who possess an introductory biology, chemistry, and nutrition background; however, students taking those courses concurrently may also find success with this format. The course structure follows a learning-practice-evaluation content arc that repeats over content areas throughout the term. The main components of this arc are instructor lecture, student presentation, lab activities, and high and low stakes examinations. Individual components of the course are familiar within teaching practice but are scaffolded in a way to build skills and confidence of the students and create an overarching narrative across the term. This progression and specifics of each component are inspired by Kolb's experiential learning cycle. Kolb's learning cycle proposes that learning arises from a combination of two grasping and two transformative experiences. These experiences are concrete experience, abstract conceptualization, reflective observation, and active experimentation, respectively. It is critical for each of the experiences to be included in the overall learning structure and for students to be involved in each of those experiences. This course is intended to be performed in-person, utilizing in-class instruction, online databases, in-class presentations, lab activities, and laboratory resources such as metabolic carts. The benefits of this structure are that students will become familiarized with information and skills within the major through active experimentation, engaging in concrete experiences, thinking through abstract conceptualization, reflection that links experiences to outcomes, and traditional testing to meet learning objectives.

KEY WORDS: Kinesiology, bioenergetics, energy expenditure, experiential learning

INTRODUCTION

Exercise physiology is a foundational course in Kinesiology and Exercise Science programs. It is not uncommon, though not guaranteed, that students in this course have completed anatomy and physiology, nutrition, general biology, and chemistry before enrolling. This pre-requisite variability means that instructors can expect a wide range in basic science understanding from students in this course. The objective of many exercise physiology courses is to expand on basic science knowledge through the application of acute and chronic exercise with consideration of how nutrition supports those activities. This paper describes a framework that attempts to meet students where they are with those pre-requisite topics and builds upon them to achieve student learning outcomes.

The course structure of learning-practice-evaluation content arcs is meant to be superimposed over adapted themes from Kolb's experiential learning cycle (Kolb, 1984). The learning-practice-evaluation content arcs attempt to make the course accessible to students through a design that starts with the goal of answering a question about exercise physiology as opposed to diving into experiential learning theory. However, the instructor must understand what makes up the theory so that they can effectively create learning experiences that incorporate the four areas of Kolb's cycle. Kolb's theory advances the constructivist approach to reality building wherein experiential learning consists of elements that are formed and re-formed through experience (Kolb, 1984). Kolb and Kolb (2009) submitted a meta-cognitive theory where experiential learning can help students "learn how to learn" by following a cycle (see Figure 1). While meta-cognitive theories propose many types of cycles to help students conceptualize their progress and improve their learning, the current paper utilizes one where knowledge is created through transformative experiences that fit along a learning-practice-evaluation content arc. At its core, learning-practice-evaluation will mirror a lecture-skill development-testing sequence familiar to many traditional courses. The main differences are how learning is shared between instructor and student and how relevant experiences are scaffolded through labs along with low and high stakes evaluations relating to all parts of the arc.

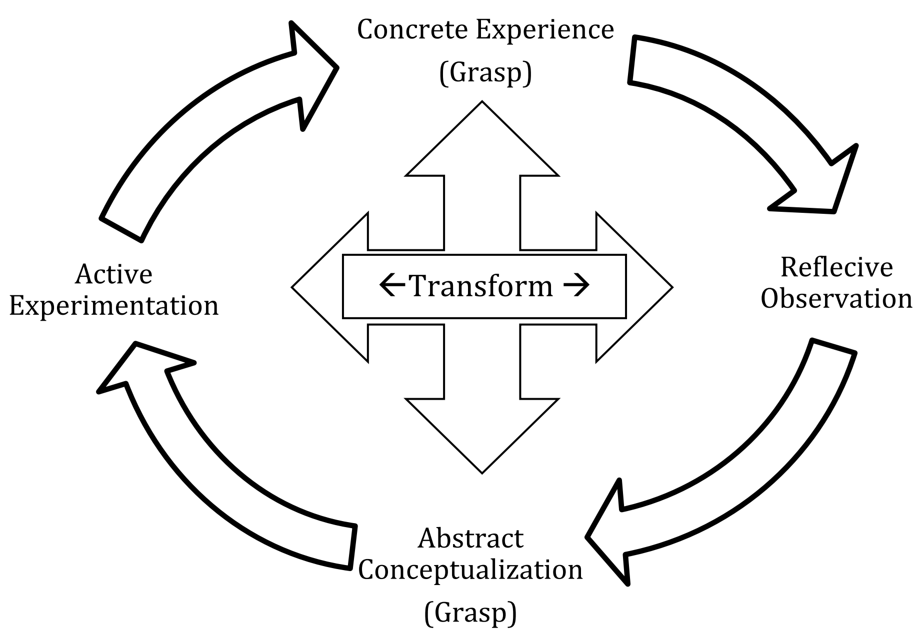

Figure 1. Kolb's experiential learning cycle stages.

The experiential learning cycle that Kolb put forward develops knowledge from the "combination of grasping and transforming experiences" (1984, p. 41). Each stage of the cycle informs the next and students should be exposed to all four of the stages to have the best chance of developing knowledge and skills. The stages represent opposing abilities that must be learned (see Figure 1): concrete experience (CE) which students may see as "feeling," reflective observation (RO) where students may be “watching” or “debriefing,” abstract conceptualization (AC) where students are asked to “think,” and active experimentation (AE) where students will be “doing” (Chmil et al., 2015; Stokes-Eley, 2007;). In other words, CE are what we base RO on, and the RO are used for AC from which students can undergo AE to test the AC (Kolb & Kolb, 2009). These stages can be applied to many traditional course activities, but it may be confusing to students if the stage names are used. Therefore, to make it easier for the instructor to communicate and students to understand what the actual task is, learning-practice-evaluation can be used to couch these stages in more traditional course terms. Table 1 aligns learning-practice-evaluation with Kolb’s cycle so that instructors and students can see how they interact without having to overwhelm students with theory.

While studies have successfully mapped some of Kolb’s elements to lab (Abdulwahed & Nagy, 2009) and clinical activities (Chmil et al., 2015), the course described in the current paper has expanded classroom components mapped to other areas of Kolb’s cycle. For instance, lectures, which fall under the “learning” component map to CE and AC, hands-on lab sessions, which fall under the “practice” component, map to AE, AC, and RO, and pre- and post-lab testing, which fall under the “evaluation” component, maps to CE, RO, AC (see Table 1). Expanding on the work of Abdulwahed and Nagy (2009), this course emphasizes a throughline across topics in labs over the entire course which is aimed to improve AC to demonstrate the interconnectedness of exercise physiology across bodily systems.

Allied health fields such as nursing, like kinesiology and exercise science, need to examine the body as a whole. Chmil et al. (2015) found that when applying Kolb's cycle to clinical experiences that two critical areas must be included to successfully apply the experiential learning model, 1) that all four areas must be included in the overall learning experience and 2) that the student must be involved in the activities for those areas.

To that end, the course presented in this paper uses student presentations which map to CE, RO, AC as they serve to inform the pre-lab testing and beyond that try to prevent students from simply following lab procedures and, instead, engaging to construct meaningful experiences from the activities. Including student presentations, which bridge instructor-led lectures and lab activities, and are preceded and followed by a form of evaluation, allows students multiple exposures to all elements of Kolb’s cycle (see Table 1). The unique structure of the learning-practice-evaluation content arc layers Kolb’s stages so that the two critical areas of Kolb’s model are met in a variety of ways. In practice, this allows students to be able to readily understand requirements such as engage in lecture, give a presentation, perform a lab, take a test without undue jargon, and allows the instructor to develop learning experiences specific to their learning outcomes, departmental and curricular needs, and student body.

Table 1. Alignment of the Learning-Practice-Evaluation Model with Course Attributes and Kolb's Learning Cycle

	Course Attributes	Kolb's Cycle Learning Construction
Learning	Lecture	CE, AC
	Student presentation	CE, AC, RO
Practice	Lab Activities	AC, RO, AE
	Pre/post lab testing	CE, AC, RO
Evaluation	Major exams	AC, AE, RO

■ METHODS

Classroom Management

The learning-practice-evaluation content arcs consist of three phases before a major exam (see Table 2) that start with the goal of answering a question for each arc. The questions should be approachable so that students can grasp the relation to the course regardless of their pre-requisite background. On a higher level, each question is meant to work toward one or more student learning outcomes. These questions, like the scaffolded experiences within the class, build on the previous question to illustrate a throughline over the course. This has an additional goal to create buy-in from the beginning of the term where, on a "Syllabus Day," the instructor can describe a narrative arc of the class that can be readily understood by students.

Table 2. The Three Phases of each Content Arc

Phase	Course Attribute
Phase 1	Instructor lecture
Phase 2	Student presentation
Phase 3	Lab activity

The example course in this paper sets out to answer the following questions (with specific instructor lecture example topics listed in parenthesis):

1. How do we fuel our physiology for sport and exercise? (Overview of basic and applied nutrition, introduction to macronutrient use during exercise based on intensity and duration).

2. Once the fuel (food) has been consumed, how do we convert it to usable energy? (Bioenergetics and metabolic aspects of exercise physiology including ATP producing pathways' adaptations to training).

3. Which systems use this energy? Can these systems adapt their use through exercise? (Cellular respiration and pulmonary ventilation: its assessment and use in exercise physiology, cardiovascular exercise physiology, muscular plasticity, and adaptation as related to optimal sport performance).

4. How quickly do we use this energy? (The energy cost of exercise).

5. How do we use this information to design training programs? (Exercise training theory including needs-based analysis, periodization, and different modes).

From these questions, students can see that the course is meant to answer five questions which take them from eating food to designing a training program. If the instructor has taught the course before or is teaching it before adapting this structure, informal surveys of students asking questions like "What do you want to get out of the course?" or "What do you think the course is about?" or "What's one question you have about exercise?" can provide insight into the way to develop these course questions so that they resonate with students.

The course is set up to vary the daily activities to prevent a stale classroom environment. Student presentations and labs break up instructor lectures to prevent some of the engagement pitfalls of lecture-heavy courses. Engaging in hands on activities regularly throughout the course also means that instructors can call on students to provide their own CE as examples within lecture (e.g., "After leaving our class, how long did you notice your body temperature and breathing rate were elevated?").

Equipment

Equipment availability such as metabolic carts, different resistance exercise implements, and aerobic stations can offer a degree of accessibility to students with disabilities. Each activity-based lab requires students to assume various roles outside of physical activity. For individuals that are unable to complete the physical components of the lab as prescribed or if adaptive equipment isn't available, there are options for engagement with these students.

Departments approach curriculum development differently based on the needs of their institution, student body, and accreditation requirements. While this paper outlines approaches taken at one institution it should not be considered the only viable path. For instance, an introductory exercise physiology course that precedes basic sciences, anatomy, or nutrition would need to emphasize more introductory topics than this one and may serve as a type of survey course for the field. Likewise, a course set for upper-level students would emphasize more advanced topics and even focus more on certain phases (phase 2 for example). Depending on the curriculum, an exercise physiology course may be a lead-in to an advanced version of the course, a clinical version, sport nutrition, or narrow topics such as exercise endocrinology, immunology, or genetics. Due to this variance broad examples may be appropriate for some programs but not others.

Course Structure

Phase 1: Lecture

In-class instructor-led presentation of material should expand beyond the material directly related to the second and third phases. Due to the nature of organizing an arc around answering a singular question, a myriad of content may need to be covered to contextualize the answer to said question. As is often the case in the field of exercise physiology, the most common answer is "It depends" and it can take some time to explain what it depends on. The focus of this phase is students remembering, understanding, and evaluating new knowledge. The most common way to identify errors in this phase is quizzing knowledge and concepts related to the material. Online or in-person quizzes, group discussions, or cold-calling reviews are examples of ways to identify errors. Depending on the background of the students, testing of content can span from CE to AC, with advanced students being able to engage in RO providing novel applications of the material.

Narratively, it may be more coherent to have the student presentation directly follow the relevant in-class material. However, planned university breaks, holidays, and other course requirements may prevent this scheduling. This paper does not outline specific lecture presentations that should be given, rather carryover from the lecture is suggested under each lab activity. This suggested carryover is content that will be revisited throughout each new arc aiming to improve retention of material and emphasize importance in the major. Table 3 outlines content that may be included in some lectures, but specific course and student learning outcomes will dictate what should be included. Some instructors may find it useful to call forward to classes that students will eventually take to lay some foundation for those topics, spark interest in a new area, or to illustrate the use in a professional setting.

Table 3. Example Topics for the Course or Lead-in Topics for Subsequent Courses

Topic
Acute and chronic immune response and inflammation from exercise and disease
Altitude
Body composition
Careers in Exercise Science
Clinical exercise testing and evaluation
Exercise and injury recovery and rehabilitation
Exercise testing in special populations
Facility design
Genetic predisposition and adaptation to sport and disease
Hormonal response to exercise and diet
Medical terminology
Metabolic, cardiovascular, respiratory, or renal disease
Microgravity
Nutrition through the lifecycle
Planes, axis of rotation, introductory biomechanics
Overuse injuries
Sport diving
Sport psychology
Sport specific exercise training
Thermal stress

Phase 2: Student Presentations

In phase 2, student groups present professor-selected peer-reviewed research articles examining aspects of the content covered in phase 1. This phase focuses on students understanding, analyzing, and evaluating the new information and prepares the class for phase 3 (lab activity). Error detection and correction in phase 2 can be done by question prompts (either online or in person) that can be answered by paying attention to the student-presented content. These prompts should require the use of phase 1 information and may also serve as an introduction to the lab activity in phase 3 or as a pre-lab test. As future course questions are answered (subsequent content arcs), there should be a focus to self-evaluate previous experiences and apply concepts from those activities to new ones (i.e., RO). Presentations and pre-lab/post-presentation testing focuses on CE, AC, and RO in addition to building soft skills like group work, public speaking, meeting time limits, and deadlines and task skills like database article retrieval. The emphasis the instructor puts on each element will vary based on the student body or the overall goals of the course.

Within the first few days of the semester, students are asked to form groups for presentations. Typically, groups of 3-4 students are ideal. With the assumption that many students complete work in the week that precedes a presentation, the presentations for this class are staggered throughout the semester, separated by 4-8 class periods depending on number of groups and university schedule. Gamification can be used to determine which group presents first (rolling dice, a physical skills challenge, etc.). Each group will send a representative forward to compete for which group goes first. In this sense, winning runs counter to what students may consider the norm. They may believe that putting off work is the prize but in this scenario being up sooner to finish the work is what is valued. This may work well with undergraduate students developing time management and study skills. Once a winner is determined, they are presented with a note containing some, but not all the information regarding the peer-reviewed paper they are to present. Examples of the note that a group may receive are as follows:

Example 1: Author last name, year of publication, two key words.
Example 2: Journal name, partial title, range of publication years.
Example 3: 2 Author names, key word, text word.

Depending on the coursework completed before this class, this may be the first exposure some students have to reading peer-reviewed studies. Some institutions require first-year student courses where students are taught how to use PubMed or other database advanced search features. This may be part of an "Introduction to Exercise Science" course that all new students in the major take. If there is a librarian assigned to the department or college, they may be able to guest lecture, covering some of the basics. Some campus libraries or centers for student learning may provide an interactive mini course that can be added through the Learning Management System (e.g., Banner, Brightspace). If students have some exposure to reading peer-reviewed literature, then this should be revisited as a mini section in this exercise physiology course. However, if students have not been exposed to any of form of research retrieval or reading then the instructor would need to decide which aspects of the process to emphasize to meet learning objectives. This paper follows a curriculum that includes some exposure to retrieval and reading prior to enrollment in an exercise physiology course. Students may be taking an introductory statistics class concurrently, but it is not guaranteed. This does not overly focus on statistical analysis but rather broad ideas. In this curriculum, students will take a research methods course the following year which will focus on the minimized aspects of this phase. If students in this course have no experience with research before this, then bringing in librarians or including outside modules may not be a good use of semester time. The instructor would need to decide what the most important outcomes of this activity are. It may be that for underclass students building soft skills is a fine goal and future courses will develop other areas. This three-phase system allows for modification to meet the needs of an instructor and maybe that phase 2 is best used as a transition from lecture to lab activities. A presentation rubric, given to students, is included in the manuscript resources. Students more comfortable with research-related coursework should be asked to give a more detailed analysis than what is in the rubric. The included resources can be modified accordingly as instructors determine primary outcomes for their course.

The first part of the presentation assignment is for the group to identify the correct paper to present and confirm it with the instructor. This additional layer of challenge offers a micro-task of AE and CE areas of Kolb's theory. The paper should be reflective of course material that has been discussed leading to the presentation in phase 1. The instructor should ensure that the information given will lead to the correct paper so long as the parameters are input to the advanced search correctly. If this course is offered at a commuter heavy school or one that has limited access to online journal subscriptions, then choosing a paper that is freely available through PubMed Central avoids access issues. For illustrative purposes, all example papers included with the resources fit these criteria. The instructor may choose to suggest specific areas of emphasis for the presentation when students confirm they have found the correct one. For instance, if the topic is the cardiovascular system or acute changes with exercise then the instructor may decide a paper on wearable technology could be engaging and work well with the equipment students regularly wear to class and that the program has available in the lab. To this end, the instructor may make suggestions on direction for the "applications to the field of exercise science" portion of the presentation or request students go beyond the paper's methods to include some brief differences between optical sensors versus electrodes in preparation for the phase 2 quiz (evaluation) or the phase 3 activity (practice). This discretion provides malleability to this phase that should allow a smoother flow across this arc.

For this phase's evaluation, a short quiz given after the presentation, usually online, aims to encourage engagement from the class and to serve as pre-lab questions for the activity that follows. With lecture and student presentations serving as the "learning" of the learning-practice-evaluation content arc (see Table 1), the paper students present will contain methods used in the lab activity (practice). The instructor should follow the student presentation with their own rundown of important pre-lab instructions, procedures, and clarifications of material. During the rundown the instructor may also find it necessary to discuss aspects of the presented paper that go beyond the upcoming lab activity. Depending on the level of student and prerequisite courses completed, this may include discussion on why a population was chosen, how limitations with human participants may influence study design choices, or statistical analysis. For instance, deeper thinking or discussion may be had by posing questions about the difference between statistical significance and practical importance (dollar or time cost vs benefit) for an average gym-goer or how data could be presented as a percent change versus absolute change and what that alters the messaging of the paper. Indeed, certain papers may even be chosen to exemplify these aspects of research to drive a conversation. The next presenting group should be decided on this presenting day as well.

Phase 3: Laboratory Activity

In phase 3 students participate in hands on activities replicating part of the phase 2 peer-reviewed study methodology which endeavors to directly measure attributes of the lecture material in phase 1. Each lab example in the resources section emphasize lecture carryover and student presentation carryover. These carryovers represent throughlines across the learning-practice-evaluation content arc and are generally major points for the course or ways to ground CE and AC for AE. These carryovers can also demonstrate the importance of the lab activity by giving the instructor something to refer to as a "why" of what they're doing. Phase 3 aims to promote understanding, application, analysis, evaluation, and creation of content related to the learning component of the arc. Phase 3 is evaluated through questions on the lab sheet and other post-lab testing, which require AE, AC, and RO (see resource section). Further evaluation of learning objectives and synthesis of ideas can be achieved at the end of each three-phase arc with exams.

Three example labs are included in the resource section. The availability of lab helpers such as graduate assistants and lab managers can make the management of groups and separation of students who use metabolic carts easier. In large classes or ones with short durations, it might be useful to have some students use carts as demonstrative examples while the rest of the class completes a different aspect of the lab. However, this may be disruptive to the workflow of the students and the overall timing of the lab. Lab helpers can be especially useful in these cases. All lab activities are presented with options for the use of metabolic carts and without.

Assessment

Generally, each arc concludes with a major exam as the high stakes assignment for the topic. However, major exams are not covered in detail in this paper. There is high variability in the design of an exam which may need to consider class time, schedule, and class and program learning outcomes. For example, a program might use shared questions across sections of a course which may limit number or depth of questions that are included. Frequent, smaller quizzes might be deployed so that major exams may be made up of as little as one to three open-ended questions that require deep explanation of the primary topic of that learning-practice-evaluation content arc. Further, a class with many students with academic accommodations may need to design exams in a way that is different from one that does not. Given these variations, the goal of these exams is for students to demonstrate their knowledge and understanding and perhaps apply what they've learned to new scenarios. Depending on how the other evaluation measures are structured a variety of question types and exam formats may be appropriate to promote learning and retention.

Students have low-stakes assessments following lecture as a quiz or reflection, again as quiz questions following the student presentation, and finally as a lab activity sheet. Low-stakes assignments like these across the different timepoints of the learning-practice-evaluation content arc have a variety of forms they can take. For example, online quizzes after lecture may focus on recalling discrete information from the lecture (CE). In this case setting a target performance grade (e.g., achieve 80% or higher on this quiz) instead of a best performance grade appears to improve learning outcomes (Lubrick & Wellington, 2022). A RO oriented low-stakes assignment may be desired following student presentations in peer readership form and again following the lab activity in private form. These two reflections formats might offer distinct advantages. The peer readership following student presentations may compel students to take more intellectual risks which could benefit pre-lab preparation and the private reflection following the lab may compel more personal risks relating the experience to their own life (Foster, 2015). Lab activity sheets can range from low to high stakes depending on the goals within a single lab or across labs. For example, a goal for one lab might be creating graphs in a spreadsheet where the goal for a different lab could be devising their own experiment.

■ DISCUSSION

This is the first description of an exercise physiology course utilizing Kolb's experiential learning cycle as a framework for course structure. This course is designed to offer understandable content arcs for instructors and students to follow decreasing reliance on jargon and background knowledge through the learning-practice-evaluation structure. However, this is not the first course to utilize Kolb's cycle for improving student learning outcomes. Kolb's model of learning has been successfully utilized in hands-on labs in engineering (Abdulwahed & Nagy, 2009) and in clinical labs for nursing (Chmil et al., 2015). Abdulwahed and Nagy found many engineering labs tended to focus on technology in the classroom and not pedagogy of lab teaching, while this often resulted in students understanding a process, there was less than the desired retention following course completion. To address this, they created a lab-based course that mapped Kolb's model to pre- and post-lab activities (such as a virtual lab run-through and quizzing) and major exams along with concept reinforcement during the lab. By combining pre- and post-lab information gathering with testing and hands on in-lab activities they were able to improve information retention and observed deeper learning through examinations. Like Abdulwahed and Nagy, this paper's proposed exercise physiology course maps in-class and lab activities to the four areas of Kolb's model (see Table 1). One challenge for exercise physiology courses is that they do not always have dedicated credit hours for labs. The course structure in this paper offers a solution to having in-class labs that provide a narrative-driven approach to scheduling labs that reinforce class material. Historically, a lab component may be primarily focused on AE as students are heavily engaged in completing the activity; however, the structure that Abdulwahed and Nagy and we propose adds to that approach by including other areas of experiential learning (i.e., AC and RO).

A main objective of physiology-based coursework is constructing throughlines aimed at assisting students in seeing the body as a whole. In nursing, like exercise physiology, students need an appreciation for the whole person, but AE is challenging for this group in traditional labs as described by Abdulwahed and Nagy (2009). Instead, clinical experiences are used to promote this understanding and test knowledge through case studies or hands on application. Chmil et al. (2015) applied Kolb's cycle to a course where, like the virtual labs of Abdulwahed and Nagy (2009), simulated clinical cases were undertaken with associated activities to touch on all the areas of Kolb's cycle. This group found the clinical judgement score was significantly higher in the students who underwent the Kolb's experiential learning structure than in students who did not go through the simulated clinical cases. The lower scoring iteration of the class did have some components of Kolb's model but were missing out on others. The proposed structure of an exercise physiology course ensures that all four areas of Kolb's model are met to offer the highest likelihood of success.

While theoretical course design can be useful, the variation in classroom application is vast and requires tailored approaches for successful implementation. Ideas for course alterations are found throughout this paper. The *Equipment* section of this paper addressed some considerations for accessibility needs, the example lab activities found in the *Resources* section of this paper outline modifications based on class size and pre-requisite knowledge, and evaluation has been discussed in the *Assessment* section. Nevertheless, a persistent challenge for any course is student engagement. Both in class and online learning presents barriers to student engagement. It became well known before and especially during COVID-19 shelter in place that structuring online courses exactly like in-person courses doesn't produce good engagement (Mashifana, 2022). A major contributor to overall engagement is the structure of the course and how students can interact with the material, instructor, and peers (Patall et al., 2023). Students must understand the outcomes sought in the course as the nature by which they're presented is highly correlated with their engagement towards those outcomes (Mashifana, 2022). For example, online courses may benefit from more frequent graded assignments (Mashifana, 2022) and shorter, highly focused lectures (Ndu, 2023) whereas in-person classes benefit from projects and overarching assignments (Tierney et al., 2023) and have the option to draw lectures out into discussions. The present paper offers a clear structure, as needed for student understanding and engagement (Patall et al., 2023), while providing flexibility to adjust to a variety of course schedules and requirements. For instance, moving this framework to online learning the questions that each narrative arc in the course attempts to answer can serve as central points around which to base highly focused mini teaching.

Overall, this learning-practice-evaluation structure of Kolb's experiential learning model is meant to be comprehensive while flexible and to provide a framework that allows deep instruction with an eye towards application. Patall et al. (2023) noted that organization and predictability help students effectively reach desired learning outcomes. This organization must be based on effective strategies to support learning and this paper outlines a course that achieves these goals: one that follows predictable arcs that are couched in sound experiential learning.

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■ RESOURCES:

Example Presentation Outline (see Figure 2 for Grading Rubric)

Presentations last at least 8 minutes but no more than 15 minutes. Points are deducted for going overtime.

Each member must present some aspect of the paper.

First, each group will be given some information about how to search for the paper (keywords, publication year, Author name). These are set up so that if you put the correct terms into a database like PubMed you will only get 1 paper that matches the criteria. Use skills you've obtained from this course, intro classes, or librarians to find the paper. This is to familiarize you with campus resources and the process of finding answers when you have questions outside of classes.

Once you've found the paper, confirm with the instructor to ensure it is the correct one (1 point) - Send the paper you found, and your group member names to the instructor.

How to present this information and points for each section: use the following questions to direct your presentation.

- Why is this an area of interest for research (2 points)?
- Who were the participants and why they were selected (2 points)?
- What testing methods were used to do this (2 points)?
- What were the primary findings of the paper (2 points)?
- What conclusions can be made from the paper (3 points)?
- What application do you see to the field of exercise science (3 points)?

Feel free to add additional information that might be interesting. For example, if this paper intersects with some career, current topic, or area of interest.

Do not go into undue detail, you have at most 15 minutes and that'll go by quickly. If you can't determine if something deserves to be thoroughly explained, please ask the instructor. Here's an example, if a paper includes a Bruce protocol graded exercise test n the methods, you may want to briefly indicate what a graded exercise test is and why it is used, but you should not outline each stage of the Bruce protocol.

Work on paraphrasing. Can you put the paper into your own words? Are you just reading word for word what the authors wrote? How easy is it for someone that didn't read this paper to understand? These are all skills that take time to develop but are important for a health professional. Take time to consider whether you're clearly communicating the same ideas as the authors.

Concerns	Criteria	Notable
Did not link to recent course content.	Adequately describes why this is this an area of interest for research (2 points)? __1.75___	Added to the introduction rationale by linking to a recent local sporting event.
	Who were the participants and why they were selected (2 points)? ___2__	Expanded on rationale for inclusion/exclusion criteria.
	What testing methods were used to do this (2 points)? __2____	Showed the class a social media post of the local sports team using this testing in the off season.
Did not label units.	What were the primary findings of the paper (2 points)? ___1.75___	Good explanation of graphs instead of only writing from results section.
Copied and pasted the conclusions section of the paper. Did not summarize.	What conclusions can be made from the paper (3 points)? ___1.75____	
	What application do you see to the field of exercise science (3 points)? ___3___	More connections to sports.
	Additional comments Total Score: ___12.25__/15	Minimal reading off slides. Did not use distracting hand gestures. Did not speak overly fast.

Figure 2. Example evaluator comments on holistic scoring rubric.

Example Laboratory Activities

Course questions 1, 2 and 4 from the classroom management section are described with suggested lab assignments. Time and equipment are often limiting factors when determining the approach to content delivery. These examples are presented with alterations for differing class sizes, durations, and equipment availability.

Lab activity answering question 1: "How do we fuel our physiology for sport and exercise?"

This lab will take roughly 40 minutes to complete and is designed to introduce students to the use of metabolic carts and familiarize them with caloric calculations and resting energy expenditure (REE), energy cost of exercise, and macronutrient distribution. It is designed to directly measure 1-2 students via metabolic cart and the rest of the class through estimation equations.

<u>Background information to be covered in lecture</u>: Resting metabolic rate, resting energy expenditure, total daily energy expenditure, respiratory quotient, macronutrients, Atwater numbers, caloric deficit and surplus, calorimetry, caloric constraints for macronutrient allotment.

<u>Example paper for student presentation</u>: Bray, G. A., Smith, S. R., de Jonge, L., Xie, H., Rood, J., Martin, C. K., Most, M., Brock, C., Mancuso, S., & Redman, L. M. (2012). Effect of dietary protein content on weight gain, energy expenditure, and body composition during overeating: a randomized controlled trial. *Journal of the American Medical Association*, *307*(1), 47-55. https://doi:10.1001/jama.2011.1918

<u>Student presentation carryover</u>: Suggested papers will use calorimetry to determine REE. The paper should also look at macronutrient content of diet and manipulate it in some way. Papers may also cover different macronutrient allotments based on age or activity requirements.

<u>Pre-lab procedures</u>: The instructor should outline the lab procedures and call for volunteers to undergo REE testing with a metabolic cart, if applicable. The instructor should outline how a metabolic cart functions and relate the collected gases to the presented paper and previous lecture topics. A brief discussion on using estimation equations should take place and a reiteration of lecture content concerning macronutrient values within total caloric constraints. Revisiting macronutrient needs across ages and activities for students who have experience in basic nutrition.

<u>Lab procedures</u>: Volunteers will undergo REE testing via metabolic cart (if available), depending on lab duration and number of carts, more than one student should be tested. If there is time to demonstrate a metabolic cart set-up, reiteration of the pre-lab and lecture topics should be described to the group while observing the display of the metabolic cart (VO2, RQ, VE, etc). With these tests underway the remaining students should begin the activity for the day (Example lab 1 in submission section). The activity has students complete increasingly complex prediction equations for REE. If students have had a nutrition course as a prerequisite for this class, then they should be asked to bring in their diet recall or other similar activity done in that class to compare numbers. The activity then builds on the REE by including energy expenditure for activity for the day. Variant questions have been suggested for Part 5 of the assignment depending on the

background of the students. This worksheet is to be submitted for a grade and can be found in Section 3 under "Example Lab 1 Caloric needs."

Common issues: If students have not yet had nutrition (or read the book material explaining how to use activity multipliers) they may often overestimate their activity level and think that an hour in the gym would equate them to heavy manual laborers. This can be used as a teachable moment following the lab or during. This activity can also be used as a soft check on math skills as converting from Kcal to grams and using percentages can offer challenges.

Student Lab Worksheet

Caloric Needs (ACSM, 2021; Gonzalez, 2021; Schofield et al., 1985)

Name: ___________________

Part 1: Complete the prediction equations for resting energy expenditure (REE)

Rule of 10 or 11:

Males: 11 x weight in lbs
Females: 10 x weight in lbs

Results: ___________________

Sterling-Pasmore:

Both sexes: LBM (in lbs) x 13.8

Results: ___________________

Harris-Benedict:

Males: 66.5 + 13.8 x (Weight in kg) + 5 x (Height in cm) - 6.8 x age
Females: 655.1 + 9.6 x (Weight in kg) + 1.9 x (Height in cm) - 4.7 x age

Results: ___________________

World Health Organization:

Males aged 18-29: 15.3 x (Weight in kg) + 679
Females aged 18-29: 14.7 x (Weight in kg) + 496

Results: ___________________

Helpful conversions: 1 lb = 0.4536 kgs; 1 kg = 2.204 lbs. 1 in = 2.54 cm; 1 cm = 0.3937 in

Part 2: Compare

1. How large was the range of calories given across the prediction equations? Which gave you the highest values and which gave you the lowest?

Part 3: What's missing?

ACTIVITY LEVEL	ACTIVTY FACTOR	
	Male	Female
REST SLEEP, LAYING DOWN	1.0	1.0
SEDENTARY WATCHING TV, READING	1.3	1.3
LIGHT OFFICE WORK, WALKING 2-3 MPH, USUALLY INCLUDES 1 HR OF MODERATE ACTIVITY	1.6	1.5
MODERATE WALKING 3-5MPH, CYCLING, YARD WORK	1.7	1.6
VERY ACTIVE FULL TIME ATHLETE, AGRICULTURAL LABOR	2.1	1.9
EXTREMELY ACTIVE HEAVY MANUAL LABOR, CONSTRUCTION, LUMBERJACK, ATHLETES WITH STRENUOUS TRAINING	2.4	2.2

Take the REE from Part 1 that you think is closest to your needs and complete the following equation.

Your REE x Your Activity Factor = Your Total Energy Expenditure Calories

1. To maintain weight, you need ___________________________ Calories per day.
2. If you know your daily caloric intake, which was the most accurate?

(Only applicable is students have taken previous nutrition classes)

Part 4: Macronutrients (Protein = 4kcal/gram, CHO = 4kcal/gram, fat = 9kcal/gram)

1. Use the total calories from part 3 (caloric constraint). If you set your protein intake at 1.2g/kg and your carbohydrate at 2g/kg, how much would you consume of each macronutrient and how much fat (in grams) would you need to maintain your body mass?

   Answers vary, but the importance of this question is that under caloric constraints the low carbohydrate intake tends to result in high fat intake.

2. Complete the following table using the total calories from Part 3.

	%1	How much you need (g)	%2	How much you need (g)	%3	How much you need (g)
PRO	20		20		40	
CHO	65		50		40	
FAT	15		30		20	

3. Do the macronutrient amounts in questions 1 and 2 seem doable? If not, which do not? How does each compare to your current intake?
   Answer: This is an optional question that is best answered by students who have taken a nutrition course.

4. Go back and write in an activity (sport) that may require these macronutrient distributions for the three percentage breakdowns. For example, which would make sense for a distance runner?
   Answer: %1 might be good for aerobic athletes, %2 is what's generally recommended with the Mediterranean diet, %3 might be for a body builder. These are all contrived examples to get practice at calculating macronutrients and getting a feel for what's practical.

Lab activity answering question 2: "What systems use this energy? Can these systems adapt their use through exercise?"

In this lab Wingate Anaerobic Testing (WAT) will be completed. A metabolic cart may can illustrate excess post exercise oxygen consumption (EPOC). This lab is designed to take roughly 40 minutes and allow for direct participation of a dozen students with 10 minutes of leeway given for instruction by the instructor. All students are to complete the worksheet and lab questions.

Background information to be covered in lecture: Respiratory quotient (RQ) changes with activity, substrate utilization during exercise, energy system involvement for activities of differing intensities and durations, differences in carbohydrate-loaded versus carbohydrate-depleted exercise, EPOC, fast and slow components of VO_2.

Example paper for student presentation: Franchini, E., Takito, M. Y., & Dal'Molin Kiss, M. A. (2016). Performance and energy systems contributions during upper-body sprint interval exercise. *Journal of Exercise Rehabilitation, 12*(6), 535-541. https://doi.org/10.12965/jer.1632786

Student presentation carryover: Anaerobic and aerobic energy system use. Wingate anaerobic testing. Substrate utilization during exhaustive exercise.

Pre-lab procedures: The instructor should outline lab procedures so that all are familiar with WAT. Additional jobs such as timekeeper and recorder should be assigned prior to lab. The instructor should prepare a spreadsheet to graph results in real time during the lab. If a metabolic cart is to be used, then a brief review should take place. Reiteration of EPOC and what happens during exercise recovery before beginning the lab is recommended.

Lab procedures: Have all necessary devices and papers ready: stopwatch, clipboard and recording charts printed. Students who are selected or volunteer to perform a WAT should begin their warmup. Students not completing the WAT who are given responsibilities of recording revolutions and timing the test should explain how they will be set up and describe a complete test during this warmup period. The instructor can hold the bike and offer verbal encouragement (along with students not assigned a role) to the student completing the test. The results are input to the pre-made spreadsheet that automatically generates a line graph which is projected onto a screen in the lab, if available. The instructor should create two graphs, one for relative power and one for absolute power. The completed spreadsheet is to be shared with students so that they can calculate fatigue index and answer questions regarding the lab on the worksheet.

Common issues: Calculation of percent change for the fatigue index may be difficult for some students so additional directions may be necessary on the lab sheet. Using the metabolic cart to collect expired gases will greatly reduce the number of students who can complete the WAT so collecting EPOC data on only a few students would be best for shorter duration classes. As with any maximal exertion exercise test, proximity to feeding can influence the results and students may feel unwell following the WAT. A rule where no student leaves the room without another student watching them following WAT may be enforced.

Student Lab Worksheet

WAT (Beam & Adams, 2022; McArdle, Katch & Katch, 2023)

Name: ___________________

Instructions: Download the spreadsheet from the LMS. In the cell indicated input the formula for fatigue index. This is a percent change equation noting the drop in peak power from the first 5 second interval to the last 5 second interval. Calculate for all participants.

Using the information in the spreadsheet answer the following questions:

1. Which energy systems are involved in completing this test?
   Answer: Immediate and non-oxidative glycolytic. However, some students may note that all energy systems are always being used, it just depends on which one is the dominant energy provider.
   a. According to the student presentation and our textbook, roughly how much of each energy system contributes to a test?
      Answer: Will vary based on the text. Somewhere around immediate: 20%, non-oxidative glycolytic: 45%, oxidative: 35% (Beam & Adams, 2014).
   b. How does this compare to the repeated WAT for upper body presented in class?
      Answer: During the repeated upper body WAT, the oxidative pathway took on a greater role in providing energy with each subsequent interval. But the initial interval is close to the lower body estimates (Franchini et al., 2016: immediate: 21%, non-oxidative glycolytic: 44%, oxidative: 33%).
   c. Why might the term "anaerobic power" be misleading given these results? Is it truly misleading?
      Answer: With some energy being supplied through aerobic pathways and the ability to re-phosphorylate creatine via mitochondrial creatine kinase, students may argue that it is not a fully anaerobic event. However, during the 30-second ride, much of the energy comes from immediate and non-oxidative glycolytic sources.

2. What is an example of a sporting event that would benefit from this type of training/testing? Why would it?
   Answer: Good answers may reference training and testing specificity. General answers could include sports like hockey, certain positions in soccer or lacrosse. Judo would likely be a common answer since that was the population in the example student presentation.

(If metabolic cart was used)

3. Following exercise, why is there a large spike in RQ?
   Answer: Non-metabolic CO_2 production from rapid glycolysis and the oxidation of lactate during EPOC.

4. On average, how long did it take participants to return to resting respiratory rate?
   Answer: Variable times, but generally it will be near baseline within 3-5 minutes.
   a. What is this elevated respiratory rate called and what is occurring during this period?
      Answer: EPOC. Students may list several physiological changes that are occurring here to return the body to a resting state.

5. How many Kcal were used during this activity? How many during EPOC?
   Answer: Only available if metabolic cart was used.

(For more advanced students or as an application question)

6. How might aerobically trained individuals differ from anaerobically trained individuals in the test?
   Answer: Aerobically trained individuals would likely not reach the same absolute peak power output, but they would recover more rapidly following the test. Anaerobically trained individuals would likely reach a higher peak power and peak RQ during the test. They would also have a slower recovery following.

7. How often would this be used as exercise testing to reveal changes in conditioning?
   Answer: Once every 4-6 weeks in moderately to well-trained individuals. Perhaps more frequently in novice trainees.

Lab activity 3 answering question 4: "How quickly do we use this energy?"

In this lab students will compare the volume of oxygen consumed during activity (VO_2) and total energy used in kilocalories (Kcal) requirements of aerobic exercise to resistance exercise. It is designed to allow 10-20 students to directly complete exercise testing in a 40-minute period depending on equipment availability with 10 minutes of leeway given for final instructions by the instructor. One to two students may be measured via metabolic cart for each cart available. All students are meant to complete the lab worksheet.

Background information to be covered in lecture: Respiratory quotient (RQ) changes with activity, substrate utilization during exercise, energy system involvement for activities of differing intensities and durations, excess post-exercise oxygen consumption (EPOC), fast and slow components of VO_2, anerobic vs aerobic activity, acute vs chronic exercise, and challenges in equating differing modes of exercise.

Example paper for student presentation: Falcone, P. H., Tai, C. Y., Carson, L. R., Joy, J. M., Mosman, M. M., McCann, T. R., Crona, K. P., Kim, M. P., & Moon, J. R. (2015). Caloric expenditure of aerobic, resistance, or combined high-intensity interval training using a hydraulic resistance system in healthy men. *Journal of Strength and Conditioning Research, 29*(3), 779-785. https://doi:10.1519/JSC.0000000000000661

Student presentation carryover: Mode of exercise energy requirements.

Pre-lab procedures: Have students select from a list of available modes of exercise. Stations can be created so that groups may work together and reduce any bottle necks that would appear. This may be done ahead of time during the pre-lab rundown. Students measured via metabolic cart should be selected ahead of time. Ideally, students that have not yet underwent metabolic cart testing will be chosen for this lab.

Lab procedures: Students not using metabolic carts should determine their fat and fat-free mass via bioelectrical impedance analysis (BIA) (or use their values from lab 1). Students using metabolic carts should begin inputting their information and be fitted for masks and heart rate (HR) monitors. If groups were assigned, those that are involved in metabolic cart testing should assume their various roles. Students or groups should then go to their assigned stations and begin the lab. Students are to perform aerobic exercise at a moderate intensity steady-rate level and maintain it for roughly 5-10 minutes. Resistance training is performed along American College of Sports Medicine (ACSM) or National Strength and Conditioning Association recommendations of 3-5 working sets of 8-12 repetition max (RM) with 30 seconds-2-minute rest, depending on the class duration and specific learning outcomes. Comparisons are to be made against aerobic vs resistance for total work being done, ratings of perceived exertion (RPE), time, peak RQ, peak VO_2, pre to post exercise RQ and VO_2, HR, blood pressure (BP). Prediction equations for VO_2 of exercise are to be converted into Kcal/min and then summed for total exercise time.

Student questions for assessment deal with exercise duration and energy systems use. Depending on how advanced the students are, or which topics have been covered in class, this is also an opportunity to ask questions regarding acute and chronic changes resulting from exercise

training, or specificity of prior training to our testing. Even in early curriculum classes students may be asked to speculate on these changes before they are discussed in class. The worksheet associated with this lab is to be submitted for a grade.
Common issues: Forming groups of students and assigning them to stations for their exercise bouts saves time by creating direction. While the groups are exercising, one student can begin the aerobic bout while another begins the resistance exercise bout, after which both switch. Some examples of exercise combinations for large classes are using stairwells for the aerobic part and then dumbbells for the resistance training. This can allow for more students to participate with fewer resources.

Student Lab Worksheet

Aerobic vs Anaerobic Comparison (ACSM, 2021; Beam & Adams, 2022; Lytle et al., 2019; McArdle, Katch & Katch, 2023; Porcari, Bryant & Comana, 2015)

Name: ___________________________

Pick one aerobic and one resistance exercise that the instructor has made available. All students will perform 5 minutes of moderate to moderately hard intensity (use RPE) aerobic exercise. Rest for 5 minutes (or until HR and RR return to baseline) then complete 4 sets of 8-12RM resistance exercise with 1 min rest between sets.

Pre question 1: Which condition do you expect to use more Kcal and why?
Answer: Student assumption. Based on the suggested student presentation they might say resistance training. However, our book would likely lead them to aerobic training.

Students assigned to use a metabolic cart follow bullet point 1. Students without a metabolic cart follow bullet point 2.

1. Perform a brief warm up. If you are assigned to a metabolic cart, then input your information and have your group members fit you with the mask and HR monitor.

	Aerobic	Resistance
HR rest:	___________	___________
HR peak:	___________	___________
VO2 peak:	___________	___________
VO2 net:	___________	___________
RQ rest:	___________	___________
RQ peak:	___________	___________
Kcal used:	___________	___________

2. For the groups without a metabolic cart, use the following prediction equations to determine VO2 and Kcal used.

   Useful conversions:
   5.05 kcal = 1L O_2/min

Miles per hour (mph) to meters per minute (m/min), multiply mph by 26.82; to convert m/min to mph, multiply m/min by 0.03728.

<u>Leg ergometry</u>: For power outputs between 300-1200 kgm/min, or 50-200 watts
VO2 (mL/kg/min) = (1.8 x kgm/min)/ M (wt. in kg) +(7) **<u>Or</u>** VO2 (mL/kg/min) = (10.8 x watts) / M (wt. in kg) + (7)

<u>Running</u>: VO2 (mL/kg/min) = Resting component (1 MET) + (Horizontal component (speed m/min) * 0.2 ml O2/kg/min) + vertical component (percentage grade * speed (m/min) * 0.9 ml O2/kg/min)

<u>Arm ergometry</u>: For power outputs between 150-750 kgm.min or 25-125 watts:
VO2 (mL/kg/min) = (3 x kgm) / kg + 3.5 Or VO2 (mL/kg/min) = (18 x watts) / kg + 3.5

<u>Stepping</u>: VO2 (mL/kg/min) = (0.2 x stepping rate) +(1.33 x 1.8 x step height in meters x rate) +3.5

<u>Resistance exercise</u>: Total net kilocalorie = 0.874 (height, cm) - 0.596 (age, yr) - 1.016 (fat mass, kg) + 1.638 (lean mass, kg) + 2.461 (TV × 0.001) - 110.742

Total exercise volume (TV) is calculated as sets × reps × weight lifted

Use the BIA scale to determine fat mass and fat free mass

	Aerobic	Resistance
HR rest:	________	________
HR immediately post:	________	________
RR rest:	________	________
RR immediately post:	________	________
HRR 30sec/1min/2min:	________ ________ ________	________ ________ ________
RR rec 30sec/1min/2min:	________ ________ ________	________ ________ ________
Est. VO2 net:	________	________
Kcal used:	________	________

3. When comparing aerobic to resistance exercise, which activity required more net Kcal to complete?
   Answer: It's likely easier to hit the desired intensity when doing aerobic exercise depending on the equipment available for resistance exercise. Answers will vary.

   a. If you were to assume a steady use of Kcal for 60 minutes what would the total amount be for each type of exercise?
      Answer: This is just an extrapolation of their results.

4. Which energy systems are used in each activity?
   Answer: This answer requires recalling information from lecture. Answers should contain a combination of immediate, non-oxidative glycolytic, and oxidative systems.

Excellent answers would reference the cross-over concept from the first arc material.

5. Based off what you've learned in class, would there be a change in energy systems as the workout progresses towards 60 minutes?
Answer: This answer requires recalling information from lecture and the second suggested student presentation. Generally, a 60-minute workout wouldn't completely deplete carbohydrate stores so exercise intensity wouldn't suffer too much. However, good answers may include information about fluid loss, fatigue, and the individual's training status as ways to further explain changes.

6. Which condition had a greater EPOC (use HRR and RR recovery to inform your answer). How does EPOC influence Kcal usage post workout?
Answer: This answer is somewhat subjective. EPOC influence calls upon previous lecture and lab information.

Example Assessments

Below are example questions which may be used following lecture or after student presentations that aim to span a range of student backgrounds and content that could be covered.

Post Lecture Quizzes

Post lecture quizzes usually focus on the "What and Why" of the material covered.

Lecture 1:

1. __**T**__ T/F Deamination is the removal of an amine group from an amino acid.

2. __**T**___T/F Essential amino acids cannot be synthesized natively by the human body and must be supplied through diet.

3. As aerobic exercise intensity increases, carbohydrates become the dominant energy provider over fats. This is known as:
   a. Cross-over concept ←
   b. Carbohydrate sparing
   c. Caloric constraint
   d. Sympathetic guided metabolism
   e. Blue zone theory
4. You have a REE of 1800 Kcal and use an additional 200 Kcal during your daily activities. You consume 1500 Kcal today. What should happen to your body mass if you repeat this pattern all week?
   a. Increase
   b. Decrease ←
   c. No change
5. List one potential positive and one potential negative of carbohydrate depleted exercise.
   Answer: Positive: more fat utilization. Negative: more protein utilization/decreased exercise intensity.

Lecture 2:

1. ___**T**__ T/F PFK is the rate limiting step of glycolysis.

2. ___**F**__ T/F Performance in a power event, such as shot put, is limited by glycogen stores.

3. ___**F**___ T/F Byproducts of the immediate energy system (e.g. AMP, Pi, ADP) inhibit other energy pathways, such as glycolysis.

4. List three things that occur during EPOC.
   Answer: Resynthesize ATP and PCr, oxidize lactate, resynthesize lactate to glycogen in the Cori cycle.

Lecture 3:

1. ____**F**___ T/F Systolic blood pressure remains unchanged during graded exercise.

2. ___**T**____ T/F Although the terms lactate threshold and OBLA may be used interchangeably in media, each represents an operationally different precise point for exercise intensity and blood lactate level.

3. What does the arteriovenous oxygen difference describe?
   a. The difference in oxygen content in the blood pre- and post-exercise
   b. The difference in oxygen content of arterial blood and mixed-venous blood ←
   c. The range of oxygen content in blood from forced exhale to inhaled deep breath
   d. The amount of oxygen attached to hemoglobin immediately preceding a breath

4. The sliding filament theory states that:
   a. Concentric muscle action results in an increase in space between Z lines
   b. Eccentric muscle action results in A band widening ←
   c. Isometric muscle action results in A band widening
   d. All of the above
   e. None of the above

Post Presentation Quizzes

Post presentation quizzes usually focus on the "Why and How" of the material covered.

Presentation 1:

1. What does REE estimate?
   Answer: Energy expenditure while a person lies awake.

2. How do caloric constraints inform our macronutrient intake?
   Answer: You are limited by the goal of weight gain/loss/maintenance. Once that amount of Kcal is set, you must fit all macronutrients under that limit.

Presentation 2:

1. Describe the procedures for a WAT.
   Answer: Measure and record body weight. Determine force to be used as resistance (7.5% body weight). Adjust seat height so the participant has a slight knee bend at full down stroke. Participants pedals against light resistance for ~5 minutes to warm up. Participant does 2-3 bouts of short high-speed spins under light resistance to get a feel for the testing speed. Participant accelerates to full speed and instructor counts down 3-2-1 and then fully loads the resistance on the bike. At the end of every 5 seconds the recorders mark the number of revolutions. At the 30 second mark the test is concluded. Participant completes a cool down.

2. Repeated WAT appears similar to which type of training discussed in class? How might you modify this for longer duration exercise?
   Answer: High intensity interval training. Different work to rest ratios can be used. While high intensity implies shorter durations, distance athletes may use repeat training for longer distances (e.g., 800m-1 mile). These may be in the form of tempo runs, race pace, fartlek, or other interval workouts. For example, a cross country runner may perform 5 1-mile repeats at 85% race pace with a 1:2 work to rest ratio.

3. What effect would carbohydrate depletion have on repeated WAT?
   Answer: Exercise intensity would decrease over trials.

Presentation 3:

1. What is volume load?
   Answer: A way to calculate work completed during resistance training. Most often it is the product of the weight lifted by number of repetitions by number of sets.

2. How does circuit training differ from super sets, trisets, and giant sets?
   Answer: A super set has a person complete two exercises back-to-back without rest then a break before completing another super set. These are often antagonistic movements. Trisets involve three exercises done in a row without breaks before breaking and doing another triset. Giant sets involve four or more exercises done in succession without rest before breaking for rest. Circuit training also involves doing multiple exercises in sequence but the rest time between exercises is limited. Circuit training can create a larger aerobic demand because of the expanded and linked nature of the sets.

3. What are ratings of perceived exertion (RPE)?
   Answer: RPE represents a subjective measurement of difficulty or stress the participant is feeling while undergoing exercise.