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CourseSource

Lesson

Problem-Based Learning for Physiology: Synthesizing the Cardiovascular System, Respiration, Macronutrient Metabolism, and Renal Function

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Abstract

Problem Based Learning (PBL) is a valuable tool for helping students overcome reliance on memorization by scaffolding opportunities for them to practice the competency of "systems thinking," which is the ability to understand the organization of complex systems (such as those found in the human body) and to interpret and predict how different individual parts influence the system as a whole. In this way, a PBL activity uses skill-building as a stepping stone for correctly leveraging knowledge. In a PBL activity, students are presented with an ill-structured problem and are tasked to collaborate with each other to find a solution; this process builds metacognitive problem-solving skills that can be applicable outside of the classroom. In this specific PBL activity, students are presented with a clinical scenario that synthesizes content over multiple topics such as cardiac function, blood pressure, respiration, digestion, and renal function. Over the course of this 6-week, online-delivery PBL activity, students work remotely in small groups to interpret multiple pieces of clinical and environmental information, leverage their understanding of the human body, and research relevant resources to make conclusions and diagnoses about a hypothetical patient. The ultimate aim of using this PBL activity is to (a) improve student understanding of course content and (b) train students to utilize cognitive tools needed to think systemically about the human body, both of which could have positive implications for students as they progress in their educational programs, take licensing exams, and pursue careers in healthcare or related fields.

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Supporting Materials: Supporting Files S1. PBL Activity - Assignment Description; S2. PBL Activity – Case Report Rubric; S3. PBL Activity - Guiding Questions; S4. PBL Activity – Case Report Scenario; and S5. PBL Activity - Group Work Agreement.

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Learning Goals

Many of these Learning Goals have been aligned with the Core Principles of Physiology (1,2). Upon the conclusion of this PBL, students will...

- Develop scientific reasoning skills through searching for, interpreting, and utilizing primary and secondary literature to support hypotheses and arguments (Core physiology principle: Scientific Reasoning)
- Understand how the cardiovascular, respiratory, digestive, and renal systems work together to maintain homeostasis at multiple levels of organization (Core physiology principle: Multiple Levels of Organization and Interconnectedness).
- Understand how pathologies can disrupt multiple interconnected organ systems, resulting in systemic pathological consequences related to metabolic function (Core physiology principle: Interconnectedness).
- Value how the physiological concepts learned in class can be applied to real-world clinical scenarios.

Learning Objectives

Upon the conclusion of this PBL, students will be able to...

- Analyze and interpret normal and pathological chart reading and test results (e.g., electrocardiograms, spirometry test results, metabolic panel test results).
- Describe pathologies that can result from abnormally high blood pressure.
- Explain how pulmonary ventilation and cellular respiration are interconnected.
- Diagram how physiological parameters relating to the cardiovascular, respiratory, and renal systems are regulated.
- Demonstrate effective communication of physiological concepts, diagnoses, and prognoses to a hypothetical patient.

INTRODUCTION

Origin of the Lesson

In a Human Anatomy and Physiology (A&P) context, the crux of understanding the complex systems in the human body requires students to connect ways in which different parts of the body influence each other and contribute to body-wide homeostasis (2). Students and faculty alike express that the discipline of physiology itself is challenging, requiring students to demonstrate causal reasoning and use new terminology to integrate their understanding of multiple organ systems (3, 4, 5).

Problem-Based Learning (PBL) is a valuable tool to help students acquire the skill of "systems thinking," which is the ability to understand the organization of complex systems (such as those found in the human body), and to interpret and predict how different parts influence how the system operates (6). In this PBL activity, students are tasked with solving an ill-structured problem. Ill-structured problems are characterized by multiple possible paths to a solution, multiple tempting and/or actual solutions, and an absence of explicit direction as to which specific concepts are needed to solve the problem (7). Student collaborative efforts to solve the presented ill-structured problem build metacognitive problem-solving skills and systems thinking skills that can be applicable outside of the classroom (6, 8). In medical school, PBL activities in the form of investigative clinical scenarios are used extensively to train future clinicians in differential diagnoses and prognoses, skills which are inherently ill-structured as there are many different paths to a diagnosis, and often many different possible treatment plans and outcomes of a disease (6). We adapted this model for use in undergraduate pre-nursing and allied health education. This specific PBL activity takes the form of an extended, 6-week-long investigative clinical scenario in which students must interpret multiple pieces of clinical and environmental information, leverage their understanding of the human body, and conduct research with relevant resources to develop a diagnosis and prognosis for a hypothetical patient.

Overview

This PBL activity spans six weeks and multiple physiology topics in the context of a clinical case of a fictitious patient and is scaffolded in such a way that the new information introduced each week builds upon concepts from each of the previous weeks. This progression allows students to slowly generate a "big picture" of the disease that might be affecting their patient and the physiological basis of that disease. Each week students work in small groups and take on specific predefined roles to answer teacher-generated questions relating to the weekly physiology topics, generate their own questions to research, and further their investigation into the clinical scenario. By the end of the six weeks, students have synthesized information over multiple levels of biological organization and have demonstrated how changes to one part of this biological organization can have broader systemic impacts.

Weeks 1 and 2 of the PBL activity focus on topics related to the cardiovascular system, which include cardiac function and blood pressure. During weeks 3 and 4, students then build upon the knowledge gained from the previous weeks by tying it to new information about respiration (external and cellular), followed by weeks 5 and 6 which bring in aspects of macronutrient metabolism and kidney function. As body-wide homeostasis depends on the actions of multiple interlinking physiological systems, this PBL activity highlights how the smallest changes to one particular organ system can have larger systemic impacts, ultimately resulting in the pathologies associated with metabolic syndrome.

Metabolic syndrome is a broad pathology. It occurs when a patient experiences multiple medical conditions simultaneously, resulting in a disruption of body-wide metabolism that ultimately increases the risk of type II diabetes, cardiovascular disease, and stroke. The clinical presentation of metabolic syndrome could include conditions such as high blood sugar, abnormal blood lipid panel (e.g., high triglycerides and cholesterol, low HDL to LDL ratio), hypertension, obesity, and visceral adipose accumulation (9). This pathology is ideal as an ill-structured problem, as many of the presenting symptoms and lab results can be interpreted independently, but students must integrate all the results together to practice differential diagnoses.

This lesson was originally designed to allign with weekly physiology topics in a laboratory class. However, it is possible to administer this PBL activity asynchronously with lecture or laboratory topics as long as the students were previously exposed to the physiological concepts covered in the PBL activity. It is intended that the succession of PBL activity topics each week allows students to review the physiological concepts introduced in the lectures, identify gaps in knowledge, and apply these concepts to a real-world clinical scenario as they collaborate to help diagnose and treat their hypothetical patient.

Intended Audience

During initial lesson development and implementation, the student population engaged in this PBL consisted of pre-nursing and allied health students (nutrition, exercise science, etc.) enrolled in a 200-level anatomy and physiology course sequence at a mid-size state university. These students were predominantly sophomores, although there were also some juniors and seniors enrolled in the course. We intend this lesson to be fitting for any 200 or 300 college-level anatomy and physiology course composed of biology, health science (e.g., nursing/pre-med), and/or allied health students.

Required Learning Time

This lesson is intended to take place over six weeks with students engaging in one 30-45 minute synchronous virtual meeting session per week (Table 1). Synchronous, virtual meetings of student groups are intended to be spaced a full week apart to allow students ample time to conduct individual follow-up research (further described in the Lesson Plan section). During this individual follow-up research, students are expected to asynchronously complete 30-40 minutes of research to report back to their groups each week.

Prerequisite Student Knowledge

Students should be previously or concurrently exposed to the physiological concepts presented in the PBL activity, which include:

- Glucose homeostasis
- Cardiac function
- Blood pressure regulation
- Pulmonary and Cellular respiration
- Macronutrient metabolism
- Renal function

Students do not need to obtain all this prerequisite knowledge prior to the start of the PBL activity but can gain relevant knowledge in increments over the successive weeks that the PBL activity spans. For example, if the weekly lecture and lab content align with the weekly PBL activity topics, then students would not need to have obtained all of this knowledge prior to the start of the PBL activity. However, if the weekly lecture and lab content is not aligned with the order of the weekly PBL activity topics, we recommend that the instructor wait to administer the PBL activity until all topics related to the above listed prerequisite knowledge have been covered.

There is no specific prerequisite skill knowledge for the PBL activity; the instructor is expected to introduce students to the required skills during the first week of the PBL activity and help students further develop required skills throughout the PBL activity. Such skills include:

- Searching for primary literature using online databases.
- Discerning between credible and non-credible courses of information.
- Interpreting given lab results using reference ranges.

Prerequisite Teacher Knowledge

The role of the instructor in facilitating this activity is akin to a "tutor" who prompts students to investigate their questions and helps students interpret the results of scientific literature. To field questions about these physiological systems in a healthy state, an instructor should have background knowledge about the homeostatic regulation of the physiological systems that are presented in the PBL activity. As the physiological concepts presented in this activity are also concepts often taught in 200 and 300 college level A&P courses, it is likely that college-level A&P instructors and graduate teaching assistants possess enough background to facilitate this lesson. Instructors must also become familiar with the student roles (Supporting File S1. PBL Activity – Assignment Description), daily and weekly workflow (Table 1 and Table 2), broader learning goals, and specific learning objectives so that they can facilitate this lesson effectively.

SCIENTIFIC TEACHING THEMES

Active Learning

Students will be actively engaged in the learning process by participating in group discussion and working collaboratively to answer questions, identifying gaps in knowledge for further research, and synthesizing information over multiple weeks in order to make the appropriate diagnosis and accompanying prognosis. Student groups will take responsibility for their own learning process by managing their own time and workflow during in-class sessions, and by holding themselves and each other accountable for completing the necessary amount of research out-of-class in order for the whole group to be prepared for the following week.

Assessment

The primary method of assessment is a collaborative, student-generated Case Report, which students turn in at the end of the 6-week PBL activity.

Briefly, the Case Report has components that are graded as a group and components that are graded for individual contribution. Students are assessed both for their *process* in conducting a thorough investigation and for creating an informative and accurate *product* that explains their diagnosis, rationale, and prognosis (Supporting File S2. PBL Activity - Case Report Rubric). The content-related Learning Objectives are assessed primarily through answers to the Guiding Questions worksheets provided as part of the lesson (Supporting File S3. PBL Activity - Guiding Questions) and Learning Objects (Supporting Files S1. PBL Activity – Assignment Description) that students generate out of their own inquiry. The skills-related Learning Objectives are practiced as a part of the process of completing the report and assessed by items on the rubric relating to evidence-generation and literature citation (Supporting File S2. PBL Activity - Case Report Rubric).

Due to the open access nature of Course Source, we do not wish to publish answer keys to the Guiding Questions worksheets that might be easily accessible by students. However, we would be happy to provide these answer keys upon request: please email Vita2837@bears.unco.edu with "PBL Answer Keys for CourseSource" in the subject line.

Inclusive Teaching

PBL structure is inherently designed to leverage diversity in the classroom and place value on each students' unique contributions to their group's progress (10). Students are expected to take on specific, predefined roles each week (further described in Lesson Plan and in Supporting File S1. PBL Activity – Assignment Description) that utilize different skill sets, thus allowing students to use their different strengths to fulfill the obligations of these roles to support their group, as well as develop new skills of interest in a supportive environment. Students may leverage their own experiences in exploring potential paths of inquiry and, through the lens of healthcare, can engage in discussions about equity within healthcare contexts.

LESSON PLAN

This lesson plan is broken down into three sections: (1) *General Overview*, which offers a brief overview of the PBL Activity workflow and a table highlighting the main components and weekly workflow of the lesson; (2) *Lesson Description*, which gives a detailed description of the lesson components and the typical workflow of 30-45 minute in-class student discussions; and (3) *Guiding Your Students Through the PBL Activity*, which gives instructors an explanation of how to initiate the activity and how to provide students with appropriate guidance throughout the activity.

General Overview

Over the course of six weeks, students work in the same small groups of 3 to 4 to investigate a clinical scenario of a hypothetical patient experiencing a multi-faceted ailment (Supporting File S4. PBL Activity – Case Report Scenario). Each week, student groups work together in one 30-minute synchronous online session to answer a weekly Guiding Questions worksheet (Supporting File S3. PBL Activity - Guiding Questions) related to their hypothetical patient's pathology, and generate and investigate research questions that will further help them determine and communicate a plausible diagnosis for this patient. During these synchronous meetings students will also generate additional research questions to investigate asynchronously on their own. The specific online platform for synchronous virtual collaboration (e.g., Microsoft Teams, Zoom, Connect, etc.) may vary across institutions, but we recommend that every student group within a specific course section use the

same platform. At the end of six weeks, students will compile a Case Report delineating the entirety of their investigations and the diagnosis, rationale, treatment plans, and prognosis they arrived at as a group. This Case Report is the only formal assessment and is further described in the sub-section *Guiding Your Students Through the PBL Activity* and in Supporting File S2. PBL Activity - Case Report Rubric.

An overview of the entire six-week lesson, its topics, instructor obligations, student obligations, and materials are broken down by week (Table 2. Components of the Lesson at a Glance.)

Lesson Description

During the first week of the PBL activity, instructors introduce the activity to their students (outlined in the subsection *Guiding Your Students Through the PBL Activity*) and provide their students with handouts explaining their hypothetical patient's background story, medical history, and medical charts (Supporting File S4. PBL Activity – Case Report Scenario), basic instructions for the PBL activity (Supporting File S1. PBL Activity – Assignment Description), and the first of six weekly Guiding Questions worksheets (Supporting File S3. PBL Activity – Guiding Questions). Each week during the PBL activity, the instructor will give student groups a new Guiding Questions worksheet relating to the patient scenario for students to answer. Each of the Guiding Questions worksheets highlight a different physiological system related to the hypothetical patient's pathology, and contain questions intended to help students review the concepts needed to understand the physiological basis for the pathology their patient is experiencing.

Throughout each synchronous meeting session, students will work together to answer the Guiding Questions worksheet to the best of their ability. They may search internet databases to answer the Guiding Questions, and to research their hypothetical patient's pathology and identify gaps in knowledge for further asynchronous research (i.e., things the students want to research further to help them answer any lingering questions and to help them make their diagnosis). These identified gaps in knowledge will then take the form of formal, student-generated research questions, which are written down and distributed among group members to be researched asynchronously. Assigned research questions and any unanswered questions from the Guiding Questions worksheet are expected to be researched and answered asynchronously prior to reconvening the following week.

To encourage students to take responsibility for their own learning, groups are free to structure their own weekly synchronous discussions as they see fit. In this regard, each student group may take on tasks differently, expand on their questions in different ways, and hold discussions of different lengths and depths of inquiry; some student groups may even surpass the minimum 30-minute time requirement for weekly synchronous discussions. However, we do provide an example breakdown of time to offer an idea as to what the workflow *could* look like (Table 1).

During each synchronous meeting session, students will also fill one of the following predefined roles within their group and are expected to rotate roles each week: Facilitator, Researcher(s), or Scribe (Supporting File S1. PBL Activity – Assignment Description). These student roles dictate what unique contribution each student will make during these synchronous sessions, and allow students to practice different skills such as time management, organization, and scientific investigation. Briefly, the Facilitator acts as a moderator for the group. Facilitators primarily focus on managing the time that is spent on specific tasks, making sure that work is evenly distributed, and that all student voices are heard. The Scribe writes down procedural notes for the group, such as keeping track of assigned student roles, main points from group discussions, and research questions that are generated. The Researcher(s) primary role is investigating questions that arise throughout the collaborative session and support their group's inquiry into the patient scenario. A more thorough description of student roles can be found in Supporting File S1. PBL Activity – Assignment Description.

Student groups compile their notes, findings and conclusions over the course of this multi-week investigation into a Case Report, which is the only formal assessment of the PBL activity (Supporting File S2. PBL Activity - Case Report Rubric) and is divided into both a group and an individual graded component. Briefly, for the group graded portion students compile the weekly Scribe Notes, Guiding Questions worksheets, explanations of any clinical test result provided in the patient scenario, the diagnosis and prognosis into one document, and submit this document through their course's online learning platform (e.g., Canvas, Blackboard). Individually, students will turn in one of their Learning Objects, and fill out a peer review and self-reflection form. Detailed descriptions of each of these components can be found in the supplemental file. At this time each student will also turn in the PBL Group Work Agreement (Supporting File S5. PBL Activity - Group Work Agreement), which students outlined and agreed upon during the first week of class. It is important to note that while this Case Report is the only formal graded assessment and is turned it at the completion of the PBL activity, student groups should receive informal feedback from their instructors throughout the process (as described below in *Guiding Your Students Through the PBL Activity: The Role of the Instructor*).

Guiding Your Students Through the PBL Activity: The Role of the Instructor

<u>Prior to starting the PBL activity, the instructor will:</u>

- Introduce students to the purpose of the PBL activity and the instructions for the assignment
- Explain the four graded components of the Case Report assessment
- Explain the specific student roles group members need to fill each week (Facilitator, Scribe, Researcher)
- Describe the general weekly and daily workflow of the PBL activity
- Give examples of how to generate good Research Questions
- Introduce recommended internet-based literature research platforms (e.g., PubMed, Science Direct, Google Scholar, university library search engine, etc.).
- Distribute Guiding Questions worksheets weekly

<u>Throughout the duration of each synchronous work session, the instructor acts as an outside facilitator of small group discussion and will:</u>

- Construct a social presence online (e.g., via Microsoft

Teams or Zoom) by welcoming students to their meeting rooms and responding to student questions via chat or video calls.
- Check in with groups throughout their synchronous meeting to ask what features of the patient scenario are salient to them and what students believe is happening with the patient to cause the described symptoms.
- Help students refine the research questions guiding their investigation. Good research questions should fill in the gaps of what they understand and what they would need to know to make a formal diagnosis. For example, asking "Do our patient's symptoms line up with diabetes" would not be a good research question, but "What are the reference ranges and diagnostic requirements of diabetes" would be an actionable direction of inquiry.
- Help students interpret results from primary and secondary scientific literature when needed. If students ask for confirmation about whether a proposed diagnosis is correct, instead of giving them the response, ask them to provide their rationale. Provide guidance on whether more research is needed for the final product and help them generate Research Questions to build evidence behind their diagnosis.

<u>At the close of each synchronous work session, the instructor will:</u>
- Confirm that students have actionable next steps to guide their asynchronous work. Ask what diagnoses they are contemplating, what they think might be happening with the patient, and what they need to know more about to investigate these potential diagnoses.
- If the group needs extra accountability, ask them to summarize the Learning Objects that were presented that day and what Research Questions they will be investigating the following week.

TEACHING DISCUSSION

Lesson Effectiveness

This PBL activity was last in a series of three PBL Case Studies completed by undergraduate advanced A&P students during the Spring 2020 semester. While the initial plan was to administer this lesson in-person, the move to online instruction partway through the semester due to COVID-19 meant we needed to adjust this activity for distance learning, which these rubrics (Supporting File S2. PBL Activity - Case Report Rubric) and assignment descriptions (Supporting File S1. PBL Activity – Assignment Description) now reflect.

The content-related Learning Objectives supported with this activity are primarily accomplished through the Guiding Questions, as they frame several physiological systems as the basis for symptoms that indicate systemic disruptions. Students were encouraged to create diagrams for Guiding Questions and Learning Objects to illustrate physiological processes and relationships.

The skill-related Learning Objectives relating to scientific inquiry and communication were best supported by the Learning Objects and Patient Communication sections. Students informally reported that investigating the Case Scenarios yielded information that we would not have been able to discuss formally in the classroom. They were enabled to follow their curiosity, and as such explored many possible diagnoses and mechanisms and learned to discuss and discern scientific evidence. While students were able to practice gathering and using scientific information as evidence when making their diagnoses, we did note that some experienced the problem of plagiarizing instead of explaining their evidence in their own words. This suggests that our students will need additional support in identifying and correcting plagiarism in their own writing and in the writing of their peers.

When discussing this clinical case, students often commented about how the health challenges that the fictitious patient was experiencing were preventable. This opened the door to discussion and questions about patient education, communication, and psychological factors that impact compliance with healthcare recommendations. These types of discussions were part of the reason we included accessible patient communication as an assessable item in the Case Report Rubric. The ability to interpret and communicate science information is a literacy that can serve students in their future professions and in their personal lives.

Potential Improvements and Adaptations

In our context, student groups met and collaborated synchronously with Microsoft Teams while a Teaching Assistant was online and available to facilitate and answer questions. Other meeting platforms could host student meetings, and this collaboration could also potentially take place in socially distanced classrooms using shared, cloud-based documents. We included an attendance grade to encourage students to meet in groups rather than complete all parts of the assignment asynchronously, however showing up to complete group work is not an explicit Learning Objective, thus this activity may be adapted by removing the attendance portion of the rubric and giving greater weight to the student product (i.e., the Case Report). While we implemented these activities in a lab course, the same structure and format could easily be applied in a flipped classroom. Additionally, the length of this activity may be shortened by combining the Guiding Questions of multiple weeks. We recommend combining the Guiding Questions of Weeks 1 and 2 (cardiac function and blood pressure) and Weeks 3 and 4 (external respiration and cellular respiration) if the PBL activity is scheduled for fewer than six weeks Reducing the number of class sessions when students can work on the PBL together offers fewer check-ins for students to discuss research questions and Learning Objects, however, this could be remedied by requiring that all students present Learning Objects each week.

The lab test results provided in the patient scenario were in-line with our course learning objectives. Including additional lab results, family history, radiographic images, or other features would give students additional physiological mechanisms to explore. Our Guiding Questions also aligned with the lab topics and activities scheduled within our course. Weighting the Guiding Questions differently or revising them to better meet the Learning Objectives in other courses is encouraged. Adding more Guiding Questions or placing additional emphasis on research questions could encourage students to increase the amount of synchronous time they invest in the inquiry process. While our goal was for students to practice science communication to a general audience, the Case Report product could be adapted to a more formal lab report format.

SUPPORTING MATERIALS

- S1. PBL Activity - Assignment Description
- S2. PBL Activity – Case Report Rubric
- S3. PBL Activity - Guiding Questions
- S4. PBL Activity – Case Report Scenario
- S5. PBL Activity - Group Work Agreement

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Table 1. Example Work-Flow for 30-45 Minute Synchronous Student Discussions

Activity	Description
Learning Objects	~5-10 minutes: Present Learning Objects (answers from the previous week's research questions that were generated by the group). *During the first week, you will use this time to complete the Group Work Agreement and to review the patient's history and medical charts given in the Case Scenario.*
Review	~0-5 minutes: If needed, review previous week's Guiding Questions worksheet responses.
Guiding Questions	~15-20 minutes: Complete current week's Guiding Questions worksheet
Discuss and Question	~5-10 minutes: Discuss potential diagnoses/directions of inquiry/gaps in knowledge and identify further research questions to be answered at home.
Assign Asynchronous Tasks	~1-3 minutes: Assign research questions to different group members to be answered and turned into Learning Objects asynchronously at home.

Table 2. Components of the Lesson at a Glance. All components are further described in the Lesson Manuscript and in the Supporting Files.

Instructor Obligations	Student Obligations	Supporting Files
Week 1: Cardiac Function/Heart Contraction and Rate		
• Introduce students to PBL activity and provide them with the assignment description • Review assessments and PBL Group Work Agreement with students • Provide Case Report Scenario and Week 1 Guiding Questions worksheet to students	• Form groups of 3 to 4 • Assign Student Roles • Generate a PBL Group Work Agreement • Answer Guiding Questions worksheet • Generate research questions and assign to group members for at-home research	• S1. PBL Activity - Assignment Description • S2. PBL Activity – Case Report Rubric • S6. PBL Activity - Group Work Agreement • S4. PBL Activity – Case Report Scenario • S3. PBL Activity - Guiding Questions
Week 2: Blood Pressure Regulation		
• Provide Week 2 Guiding Questions worksheet to students • Check in with each student group	• Assign Student Roles • Review Learning Objects generated from previous week's research questions • Answer Guiding Questions worksheet • Generate research questions and assign to group members for at-home research	S3. PBL Activity - Guiding Questions
Week 3: Respiration		
• Provide Week 3 Guiding Questions worksheet to students • Check in with each student group	• Assign Student Roles • Review Learning Objects generated from previous week's research questions • Answer Guiding Questions worksheet • Generate research questions and assign to group members for at-home research	S3. PBL Activity - Guiding Questions
Week 4: Exercise Physiology		
• Provide Week 4 Guiding Questions worksheet to students • Check in with each student group	• Assign Student Roles • Review Learning Objects generated from previous week's research questions • Answer Guiding Questions worksheet • Generate research questions and assign to group members for at-home research	S3. PBL Activity - Guiding Questions
Week 5: Macronutrient Metabolism		
• Provide Week 5 Guiding Questions worksheet to students • Check in with each student group	• Assign Student Roles • Review Learning Objects generated from previous week's research questions • Answer Guiding Questions worksheet • Generate research questions and assign to group members for at-home research	S3. PBL Activity - Guiding Questions
Week 6: Renal Function		
• Provide Week 6 Guiding Questions worksheet to students • Check in with each student group	• Assign Student Roles • Review Learning Objects generated from previous week's research questions • Answer Guiding Questions worksheet • Make a diagnosis • Work on generating *Case Report* (both group and individual components)	S3. PBL Activity - Guiding Questions
Week 7		
Collect and grade *Case Reports* and *Individual Contributions Assignment*	Turn in *Case Report* (both group and individual components)	--