A Series of Problem Based Learning Modules to be used in Living Environment Classrooms

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A Series of Problem Based Learning Modules to be used in Living Environment Classrooms

By

Katrina Ravi Cordeiro

December 2014

A culminating project submitted to the Department of Education and Human Development of The College at Brockport, State University of New York in partial fulfillment of the requirements for the degree of Master of Science in Education
A Series of Problem Based Learning Modules to be used in Living Environment Classrooms

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Abstract

Problem Based Learning (PBL) is an instructional which poses problems to students in life-like scenarios. The common feature among the many PBL models is “that it a constructivist pedagogy “ (Hill & Smith, 2005, p. 20). Research has indicated that PBL offers many advantages to learning high school science, including that students experience “the nature of authentic inquiry and the different methods of finding answers to their questions” (Chin & Chia, 2006, p. 62). Research also shows that the success of PBL is dependent on the design and the circumstances in which PBL is implemented. This project is a compilation of six custom made Problem Based Learning modules (PBL’s) based on New York State Living Environment standards. They are scaffolded so as to assist students who may be challenged by self-directed components of PBL, while also providing detailed instructions to aid teachers in their successful implementation.
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Chapter I: Introduction

Rationale

While there are now many PBL models, in the literature, the common feature is “that it a constructivist pedagogy and a subset of problem solving (Hill & Smith, 2005, p. 20). According to Savery & Duffy (1995), the PBL instructional principles derived from constructivism include 1) Anchor all learning activities to a larger task or problem. 2) Support the learner in developing ownership for the overall problem or task, and development of the solution, 3) Design an authentic task and learning environment, and 4) Encourage testing the ideas against alternative views and opportunities for reflection. Using a PBL approach in the high school science classroom takes advantage of this theoretical framework to enhance learning. The constructivist framework gives students a chance to learn through self-direction, and reflection, which enhances their lifelong learning skills. This higher level learning is further driven by motivation. This motivation is induced using the authentic scenarios and problems, or “puzzlements” that are the essence of PBL.

Research has indicated that PBL offers many advantages to learning high school science. Auftenspring (2005) notes that PBL can motivate students towards possible career choices involving the application of science. College students said authentic scenarios they engaged in during high school deepened there college biology learning experiences, while college professors said PBL provides a strong foundation for the independent study needed for college courses (Mackenzie, 2009).

By using the PBL approach teachers may cover less content, but this is offset by gains in motivation, extra general knowledge, and the acquisition of critical and creative thinking and problem-solving skills (Chin & Chia, 2006). Teachers found the role-play and cooperative
research and learning were motivating their students, as well as building their literacy skills (Markowitz et al., 2006). Students felt it promoted active learning, made science relevant, provided variety in learning, and supported group work (Goodnough & Cashion, 2006). Perhaps most importantly, students experience “the nature of authentic inquiry and the different methods of finding answers to their questions” (Chin & Chia, 2006, p. 62).

**Significance**

While there is increasing evidence that supports the positive impact that PBL has on students’ learning, there are also many challenges that science teachers need to overcome for the successful implementation of PBL. Factors to consider in this transition include selecting a PBL topic, determining the level of structure to be incorporated into the PBL experience, selecting appropriate assessment approaches, facilitating groups, and providing optimal student feedback (Goodnough & Cashion, 2006). Furthermore, PBL may not necessarily be appropriate for teaching a curriculum based heavily on facts, and there can be problems with lack of knowledge transfer, as well (Goodnough & Cashion, 2006). Another consideration when designing an appropriate PBL is the type of learner using it. According to Goodnough & Cashion (2006), the appropriate PBL choice depends on student abilities, skills and willingness to learn in different ways. Also, the successful implementation of a particular PBL is related to the degree of teacher preparedness for using this approach. Hill & Smith (2005) point out the effect of the teacher’s attitude and learning goals, among other environmental qualities, on the usefulness of PBL.

For these reasons, in my own classroom, I will provide quite a bit of structure and limit the scope of the PBL, as suggested by Chin and Chia (2006). Furthermore, when choosing PBL’s for this graduate thesis project, I will select subject matter which is specifically part of the
curriculum. To deal with background knowledge issues, I will suggest when best to use each PBL in the Living Environment curriculum, as well as introduce supplemental material which helps build the necessary knowledge base of the students.

**Overview of following chapters**

Chapter II: There is a review of the current scholarly literature of using PBL in the secondary science classroom. It describes the components of PBL, its historical development, and its theoretical framework. This is followed by a presentation of the advantages for using PBL, as well as the issues surrounding its successful implementation. The chapter also includes many suggestions on how implementation issues are mitigated.

Chapter III: This chapter is comprised of a series of six custom made Problem Based Learning modules (PBL’s); providing New York State Living Environment classrooms an opportunity to try out the style and format of a variety of PBLs. These modules are preceded by a brief description of each, as well as highlights of their common components.

**Definition of Terms**

**Active learning**: learning which involves the manipulation of knowledge.

**Authentic learning**: using real life paradigms or examples in instruction.

**Cognitive science**: the interdisciplinary scientific study of the mind and its processes.

**Constructivist learning**: learners construct knowledge for themselves---each learner individually (and socially) constructs meaning---as he or she learns.
**Problem-based learning:** a student-centered pedagogy in which students learn about a subject through the experience of problem solving. Students learn both thinking strategies and domain knowledge.
Chapter II: Review of the Literature

Overview

In this chapter the current scholarly literature pertaining to using PBL in the secondary science classroom is reviewed. It begins with a description of what PBL is, its historical development and the theoretical framework it embodies. Next there is an extensive discussion of the benefits of using PBL. This includes increased long term retention and college readiness, and gains in cognitive development, communication, and life skills. This is followed by a discussion of implementation issues, and how they might be mitigated. These issues involve cognitive processing, as well as those pertaining to student-directed work (independent and group) which PBL is centered upon.

What is PBL?

PBL can be traced back to a pioneer program created in the 1960’s by the Faculty of Medicine at McMaster’s University in Ontario, Canada (Hill & Smith, 2005). According to Jones (as cited in Hill & Smith, 2005), the PBL framework is completely aligned with the work of John Dewey and inquiry-based learning. Presently, PBL is used by medical schools worldwide, and is spreading into educational settings (Hill & Smith, 2005).

When PBL was first applied in medical schools in the 1970’s, students had to solve real-world diagnosis and treatment problems (Savery & Duffy, 1995). Students must find the best possible solution without being given sufficient information. In the initial discussion, the students draw previous experiences; identify relevant facts, as well as how they will go about finding a solution. Note there are no pre specified learning objectives. Facilitators are designated
to be available as consultants. These elements are what sets PBL apart from other instructional models (Savery & Duffy, 1995).

Recent interest in PBL in the high school setting is attributed to its constructivist pedagogical approach to instructional design (Obikwelu, Read, & Sim, 2012, p. 356). In the high school setting, PBL requires students to answer problems which are presented in authentic scenarios. “The PBL approach is a cognitive apprenticeship focusing on both the knowledge domain and the problem solving associated with that domain” (Savery & Duffy, 1995, p. 14). While there are now many PBL models in the literature, the common feature is “that it a constructivist pedagogy and a subset of problem solving” (Hill & Smith, 2005, p. 20).

In the high school setting, PBL activities usually have an entry document that spells out the student’s roles in an authentic problem. Then, after an initial research activity, the students are introduced to new information, which is an aspect that sets it apart from Project Based Learning (Aufdenspring, 2005). Aufdenspring (2005) notes that PBL develops a specific knowledge base, problem-solving abilities, and inquiry skills.

Markowitz, DuPré, and Holt (2006) present an example of a PBL unit using what is termed a five-part progressive disclosure PBL. In the first part, the students work alone and then in groups to discuss the information posed by the scenarios. They must then research, and report their findings to others. Each part discloses further information for more research and discussion sessions, which approach the problem from different perspectives (Markowitz, DuPré, and Holt, 2006). There are a lot of assessments provided, as well as suggested ones. This unit was developed at a secondary educational resource center based at a University of Rochester which uses a PBL framework in its medical school (Markowitz et al., 2006). Thus, the PBL units it
provides follow the same model used in the medical school, as well as being well-vetted by high school teachers.

Goodnough & Cashion (2006, p. 280) assert that “although PBL is not new and has an established tradition in medical education and other professional schools, the use and academic study of PBL in high school is only starting to emerge”. For this reason they conducted studies to examine its usefulness in the high school science setting as both a curriculum and instructional approach. The authors concluded that the PBL model used in medical schools needed to be adjusted for K-12 application (Goodnough & Cashion, 2006). According to Goodnough and Cashion, “The nature of the PBL that emerges will vary depending on student abilities, skills, and willingness to learn in different ways” Goodnough & Cashion, 2006, p.290).

**Theoretical framework**

PBL embodies the paradigm shift toward inquiry-based learning, and is well-grounded in the constructivist framework (Savery & Duffy, 1995). “Focus is on learners as constructors of their own knowledge in a context which is similar to the context in which they would apply that knowledge. From the start, the learning is synthesized and organized in the context of the problem.” Thus, our understanding is dependent on interactions with the learning environment. Also, according to Savery & Duffy (1995), it is the goal of the learner or “puzzlement” that determines what is learned. Furthermore, problem-solving occurs in a team structure, thus it is through social interactions that the facts of the case are determined. “Students are encouraged and expected to think both critically and creatively and to monitor their own understanding i.e. function at a metacognitive level” (Savery & Duffy, 1995).
According to Savery & Duffy (1995), PBL instructional principles derived from constructivism include 1) The problem or task is the basis of all learning. 2) Overall, the learner must feel ownership of the problem or task, and development of the solution, 3) The problem or Design an authentic task and learning environment, and 4) Encourage testing the ideas against alternative views and opportunities for reflection.

When creating a problem, there are two key considerations. The problems must deal with the relevant concepts for the content domain, and it must be “real” (Savery & Duffy, 1995, p. 11). Problems must address real issues because 1) they provide a rich problem for students to explore multiple dimensions, 2) they tend to engage learners because there is a familiar context, and 3) because they want to know the outcome, which “are not possible with artificial problems” (Savery & Duffy, 1995, p. 12).

PBL is also aligned with experiential learning theory, which “describes learning as a cyclic process through direct experience” (Obikwelu et al., 2012, p. 357). The model stresses reflective thinking, which “may take place in isolation or with collaboration with others” (Obikwelu et al., 2012, p. 357).

Hill and Smith (2005) have used the principles of PBL (that they must involve life-like situations), to support their proposed Theory of Authentic Learning. Student motivation stems from the desire to survive, both biologically and culturally. In school, “survival is enhanced by becoming competent in the signs valued by the surrounding culture.” (Hill & Smith, 2005, p. 24). Thus, by using life-like situations that mimic this culture, PBL fuels student motivation to learn the curriculum’s domain (Hill & Smith, 2005).
Educational advantages of PBL toward learning science

Long term retention and college readiness

A panel of high school biology teachers and university professors at the National Association of Biology Teachers' 2008 National Conference in Memphis, Tennessee, felt that high school teachers should facilitate their students' success in college sciences courses by fostering independent thinking and teaching problem-solving skills. Toward this end, they identified methods such as PBL, and inquiry, among others (Mackenzie, 2009). The authentic scenarios presented in PBL activities, “allow students to apply their knowledge of concepts in a thoughtful manner” (Mackenzie, 2009, p. 6).

College biology professors reported that students felt the authentic scenarios they engaged in during high school deepened there college biology learning experiences, while “one-dimensional learning in high school led to frustration” (Mackenzie, 2009, p. 6). Another point mentioned by the panel was that when high school science teachers foster independence in their students, they “provide a strong foundation for the necessary independent study required in college courses” (Mackenzie, 2009, p. 7).

PBL’s entrance onto the high school scene is a worldwide phenomenon. In Hong Kong, for instance, systematic educational reforms (post 2000) have focused on approaches which develop higher order skills (Wong & Day, 2008). These authors conducted a study using roughly one hundred twenty five high school biology students to examine the effectiveness, especially in light of the reluctance of school in general to enforce serious pedagogical reform (Wong & Day, 2008). As measured by pre- and post- testing, the study directly compared PBL to lecture based learning. It also tested whether long term effects were different between the pedagogies, using delayed post- testing to measure (Wong & Day, 2008).
The results of assessments showed PBL to hold ground for knowledge, while there was “a significant improvement in students’ comprehension and application of knowledge over an extended time” (Wong & Day, 2008). However, they noted that more studies were needed to consistently show better achievement outcomes (Wong & Day, 2008).

From review of PBL studies, it is found that,

students and faculty are highly satisfied with PBL and that there is some evidence that PBL seems to work. Graduates of PBL curricula view themselves as being better prepared in independent learning skills and some studies demonstrate that PBL students demonstrate self-directed study behavior. (Dolmans, De Grave, Wolfhagen, & Van Der Vleuten, 2005, p. 737).

Thus, PBL has shown to be an accepted means to increase college science readiness by both college students and college professors, because it provides an opportunity to practice the application of knowledge, problem-solving skills, and practice independent work. PBL also has shown to be useful in some circumstances toward significant improvement in long term retention of knowledge in high school science students.

Motivation

A study in Detroit, Ohio, addressed attitudes about science and learning, and problem solving skills, thus offering insights about dimensions of learning concerning habits of mind, motivation, and lifelong learning (Ferreira & Trudel, 2012). The test subjects for this study were roughly one hundred chemistry students. Among the most noteworthy outcomes of this study, was a sense of ownership and control of their own learning the student reported. Furthermore, analysis of the data showed that as “a pedagogical approach, problem-based learning was successful in improving student attitudes toward science, their problem solving skills, and their perceptions of the learning environment” (Ferreira & Trudel, 2012, p. 28).
In Singapore, The Ministry of Education initiated “Thinking Schools, Learning Nation” in 1998, partially in response to global reforms in education that emphasized inquiry type learning, as well as to encourage students to apply problem-solving skills and think critically and creatively (Chin & Chia, 2006). As still many teachers are inexperienced using PBL, Chin and Chia (2006) engaged in a case study so as to examine “how students handle ill-structured problems, identify some issues and problems related to the use of such problems, and offer some practical suggestions on the implementation of problem-base project work in science” (Chin & Chia, 2006, p. 49). The test subjects were thirty nine high school science students who engaged in problem-based project work over an eighteen week period.

The study shows that students felt a sense of ownership of the problem in having to role-play and enjoyed the “make-believe” quality to the extent that it motivated them to pursue areas of interest further. Similarly, as they were compelled to take a broader perspective and consider multiple dimensions of the problem, there was a multidisciplinary element in their learning (Chin and Chia, 2005).

Goodnough & Cashion (2006, p. 280) conducted a study to examine its usefulness in the high school science setting as both a curriculum and instructional approach. The test subjects for this study were twenty six high school science students and the PBL approach was used over the course of several months. The data indicated that most students “liked learning through PBL because it promoted active learning, made science relevant, provided variety in learning, and supported group work” (Goodnough & Cashion, 2006, p. 281).

Furthermore, Markowitz et al. (2006) report that the teachers using their five part disclosure model found the cooperative groups and role-play aspects both motivated their students and built their literacy skills.
These studies seem to indicate that the authentic nature and puzzlement aspect of PBL draw the students in to the learning experience and compel them to learn in a constructivist way. This learning style motivates them, and produces many positive associations with the students. These include a sense of ownership and control, gaining confidence in their problem solving skills, and heightened enjoyment of the science classroom experience. Additional benefits from the structure of the PBL would be gains in literacy, and multidisciplinary learning (Chin & Chia, 2006).

_Cognitive development, communication, and life skills_

The authentic scenarios presented in PBL activities, promote thoughtfulness in the students application of concepts (Mackenzie, 2009, p. 6). “Students are encouraged and expected to think both critically and creatively and to monitor their own understanding” (Aufdenspring, 2005, p.84). Chin and Chia (2006) admit that teachers may cover less content, but this is offset by gains in motivation, extra general knowledge, and the “acquisition of critical and creative thinking and problem-solving skills” (Chin & Chia, 2006, p. 62).

A big advantage of PBL mentioned by Aufdenspring (2005) is that students acquire several life skills. Life skills are enhanced because the authentic scenarios mimic those students will encounter beyond high school. Students experience “the nature of authentic inquiry and the different methods of finding answers to their questions” (Chin & Chia, 2006, p. 62). In fact, Aufdenspring (2005) notes that PBL can motivate students towards possible career choices that involve the application of science. Much of life both in the workplace and out requires constant use of problem solving skills. The nature of PBL lets them practice these skills because “they
must develop a variety hypotheses as they find, evaluate, and use data from multiple sources; they learn to integrate numerous perspectives” (Aufdenspring, 2005, p. 84).

Additionally, much success in life depends on good communication skills. As mentioned earlier in this literature review, the Goodnough & Cashion (2006) study and the Markowitz et al. (2006) study noted PBL experiences supported cooperative groups, and students develop their ability to defend their own viewpoint.

The cognitive development, communication, and life skills fostered by PBL, each develop in the context of the other two, and are more qualitative than quantitative learning outcomes. This is part of the reason why formative assessments used during the PBL consider the thinking process, as well as the product.

**Implementation considerations**

*Cognitive issues*

Kirschner, Sweller, & Clark, (2006) argue that guided instruction may be superior to PBL, among other “minimally guided approaches” (MGA’s). This is because 1) problem-solving places a significant load on the student’s working memory (Kirschner et al., 2006), and 2) “while working memory is being used to search for problem solutions, it is not available and cannot be used to learn” (Kirschner et al., 2006, p. 77). Working memory is limited in capacity and duration, so most information is lost if not rehearsed within 30 seconds. In contrast, the interactions between working and long-term memory are essentially limitless (Kirschner et al., 2006). This implies that students can commit information to long-term memory more efficiently through guided instruction, which attempts to assist students to process incoming information (scaffolding). The guided instruction strategy is supported by a significant study by Klahr and
Nigan (as cited in Kirschner et al., 2006) that showed unambiguously, “direct instruction involving considerable guidance, including examples, resulted in vastly more learning than discovery (pedagogies).” (Kirschner et al., 2006, p. 79–80).

A study in the U.S. Midwest conducted by Nowak (2007) also revealed that under some circumstances, students who received standard textbook instruction learned fact-based content at a considerably higher rate than students who engaged in problem-based learning (Nowak, 2007). The test subjects in this study were roughly one hundred gifted middle school students in the Midwest, and the measurement was how well students would perform as well on multiple choice tests using PBL as a comparable group of students in a non-PBL classroom.

Thus, the degree of instructional support that may be required for a particular cohort of students must be addressed in designing an effective PBL. For instance, Nowak (2007) suggested that the best solution for a curriculum based heavily on facts, would be to use an “integrated PBL approach”, imbedding direct instruction. Also, Chin and Chia felt that “teachers must also help students to integrate what they have learned with the key concepts relevant to the curriculum” (Chin & Chia, 2006, p. 61).

Furthermore, when designing a PBL the teacher must consider “the particular science concepts the teacher wants students to learn, the skills to be acquired, and the understandings about the nature of scientific inquiry” (Chin & Chia, 2006, p. 67). The teacher should also specifically examine the curriculum/content objectives in the PBL, and revise the PBL if it does not match it closely enough (Chin & Chia, 2006). They suggest that teachers could also infuse shorter problems into the regular curriculum or use them for enrichment (Chin & Chia, 2006).

Thus, for curriculum objectives to be met in the high school science setting, PBL’s should be designed so as to lead the student directly toward curriculum objectives, as well as offer ways to
process new information into long-term memory. This entails designing PBL’s that are closely aligned with these objectives, imbedding forms of guided instruction, and offering means to review these objectives. Furthermore, the duration of the PBL’s may need to be reduced to stay within the confines of a curriculum with limited time and specific focus.

**Student-directed work (independent and group)**

Various studies examining the effectiveness of “minimally guided approaches” have concluded that students “often become lost and frustrated, and their confusion can lead to misconceptions” (Kirschner et al., 2006, p.80). For instance, Chin and Chia (2006) found that in the research portion of PBL, “the huge amounts of irrelevant information collected during searches also overwhelmed students”, and “when students found little information…they tended to indiscriminately include all other information” (Chin & Chia, 2006, p. 61). They suggested resolving this, students should be taught how to evaluate the resources for credibility, and accuracy, as well as how to sort out relevant from irrelevant information, and cite sources. (Chin & Chia, 2006, p. 61).

Obikwelu et al. (2012) assert that to make PBL suitable for the dependent learner, scaffolding toward each learner’s own Vygotzkian Zone of Proximal development (ZPD) must be used otherwise, the self-directed parts of PBL can be too difficult for “dependent (non-gifted) learners”. They propose that to make learner specific scaffolding, a system of regrouping at intervals might be used so that peer-tutoring can support the “non-expert” learners.

One could argue that “dependent learners” make up the majority of learners, for basically it means that students do not have sufficient background knowledge to learn via MGA’s by themselves. Indeed, Dolmans et al., felt one of the most important criterion for PBL to work is
that the problems need to fit in with the students’ prior knowledge. As a solution, Goodnough & Cashion (2006) suggest using preliminary activities to increase their comfort level.

Also, from a review of PBL studies, Dolmans et al. (2005) noted that group work can be problematic for reasons such as apathy, cynicism, lack of communication and lack of facilitator support. In addition to the obvious; that group work has a tendency to have some that do not prepare adequately, is the insidious; that groups can appear to be involved but their behavior is actually ritualistic.

The self-directed nature of PBL’s forces teachers to continually monitor students’ abilities, and make adjustments so that each student can meet the learning objectives. Case studies have shown that effective teachers introduce scaffolding when “students fail to make learning progress in a discovery setting….the teacher whose students achieved all of their learning goals spent a great deal of time in instructional interactions with students by simultaneously teaching content and scaffolding-relevant procedures” (Kirschner et al, 2006, p. 79).

Not only must teachers be ready to assist any students(s) who appear to be struggling to learn new information, but they must explicitly expand on the problem by discussing how it relates to another situation (Dolmans et al., 2005). This is due to the issue of the lack of knowledge transfer, which was one drawback that Ferreira & Trudel (2012) noticed in their Detroit school study, and in other studies (Ferraira & Trudel, 2012). This relates to cognitive capacity, which was discussed in the previous section, and speaks in support of guided instruction.

These issues with self-directed work offer solutions which require teachers to juggle multiple jobs during execution, even when a PBL has been specifically designed to meet curriculum learning objectives and cognitive loads, in general. Indeed, in Goodnough and Cashion’s study, where students gained positive attitudes using PBL over several months, the teachers tended to
keep learning activities teacher-directed, provided all the resources, and give students limited choices on how they would be assessed. Markowitz et al. (2006) found that even though the five-part disclosure model was well-vetted, and used by specifically trained teachers, many found it to be challenging. Dolman et al. (2005) also found is their review of PBL studies that facilitators were either too dominant or too passive. Finally, Hill & Smith (2005) suggested that in secondary science the teacher’s attitude and learning goals, among other environmental qualities may be critical to success.

Thus, for teachers new to the PBL approach, it might behoove them to start with PBL’s which are short in duration and well structured. This would allow teachers and students a chance to get accustomed to its style and what works best for their particular situation.

Clearly, there are a multitude of implementation issues to consider; the design of a PBL needs to be carefully constructed, as well as executed, for it to effectively meet learning objectives in the high school science setting. Factors to consider in this transition include, “selecting a PBL topic, determining the level of structure to be incorporated into the PBL experience, selecting appropriate assessment approaches, facilitating groups, and providing optimal student feed-back” (Goodnough & Cashion, 2006, p. 280). Furthermore, this literature indicated that PBL may not necessarily be appropriate for teaching a curriculum based heavily on facts, and teacher preparedness and resources need to be considered.

Summary and Implications

Several years have passed since Goodnough & Cashion (2006) noted that there is limited empirical research existing about effectiveness of PBL in K-12. At that time, academic studies about how teachers interpret and use PBL in their own classrooms were just beginning to emerge
They felt that research still needed to be conducted that addressed:

- Is it appropriate for use with younger children in science and other disciplines?
- What models of PBL for K-12 education are most efficacious to promote student learning (e.g., content learning, complex thinking skills)?
- What types of professional development approaches will be most effective in helping practitioners adopt PBL as part of their regular instructional repertoires?
- What types of learning does PBL promote in science and other disciplines? (Goodnough & Cashion, 2006, p.291-292)

Clearly, this literature review suggests these are valid questions still.

The literature review found several studies which indicated that PBL is not necessarily appropriate for teaching a curriculum based heavily on facts. Associated with this issue is the lack of knowledge transfer, which was mentioned in several studies. In my own classroom, this issue is quite relevant, as the Living Environment Regents exam requires students to have an extensive and explicit knowledge base. To deal with this, when choosing PBL’s for this graduate thesis project, I would select PLB’s whose subject specifically is part of the curriculum, and I would provide structure and limit the scope of the PBL, as suggested in the Singapore study.

Also, I would follow the PBL with a summative assessment of the domain that is covered by the LE curriculum. This would help the students focus on learning the new material presented in the PBL, and to commit it to memory. However, in keeping with the constructive tenets of PBL, the formative assessments used during the PBL will consider both the thinking process, as well as the product.

Furthermore, this literature review mentioned more than one study there were issues with lack of background knowledge. To deal with this, in my thesis project I will suggest when to use each PBL in the Living Environment curriculum, that is, what was taught prior to the PBL. I
will also suggest possible supplements that will help to scaffold the knowledge base of the students, as well as adding relevance and meaning to their experience.

This literature review has also shown that the question as to a teacher’s willingness and ability is also a big factor on how well a PBL is implemented. In the Hong Kong study, where the PBL method was successful, and carried out over several months, the teacher hadn’t used PBL before. On the other hand, in the Detroit study, teachers were not comfortable to give up control. For the PBL module created at the University of Rochester, the survey showed that teachers found the extensive five part disclosure model challenging, though it also had a positive impact on learning.

“The incompatibility of innovations with existing practice is often an important factor inhibiting their institutionalization”, (Goodnough & Cashion, 2006, p. 292). Therefore, it is my intent to make a small series of PBL’s which would be short and fairly basic, thus providing teachers and students new to the PBL approach a chance to get accustomed to it style and format. Furthermore, by providing or directing students toward resources, I will address the issue mentioned in the Singapore study concerning the lack of research skills of the students. Related to this, limiting the scope of the PBL’s would also minimize potential issues with dependent learners and dysfunctional groups alike, which were discussed earlier in this literature review.

Even though the design may be scaled back, I will aim to incorporate all the constructive principles that set the PBL approach apart. To reiterate, according to Savery and Duffy (1995), PBL instructional principles derived from constructivism include 1) The problem or task is the basis of all learning, 2) Overall, the learner must feel ownership of the problem or task, and development of the solution, 3) The problem or Design an authentic task and learning
environment, and 4) Encourage testing the ideas against alternative views and opportunities for reflection.

By designing the PBL’s as described above, I am expecting that students have the opportunity to reap the rewards offered by using PBL, as this literature review has suggested.

1) Long term retention and College readiness: Noteworthy findings included a “significant improvement in students’ comprehension and application of knowledge over an extended time” (Wong & Day, 2008, p.625). College professors said PBL provides “a strong foundation for the independent study needed for college courses” (Mackenzie, 2009, p. 7).

2) Motivation: Students felt “it promoted active learning, made science relevant, provided variety in learning, and supported group work”(Goodnough & Cashion, 2006, p. 290). Students felt it “was successful in improving student attitudes toward science, their problem solving skills, and their perceptions of the learning environment” (Ferreira & Trudel, 2012, p. 28).

3) Cognitive development, communication and life skills: “Students are encouraged and expected to think both critically and creatively and to monitor their own understanding” (Aufdenspring, 2005, p.84). The authentic scenarios presented in PBL activities, “allow students to apply their knowledge of concepts in a thoughtful manner” (Mackenzie, 2009, p. 6).

Chin and Chia (2006) admit that teachers may cover less content, but this is offset by gains in motivation, extra general knowledge, and the “acquisition of critical and creative thinking and problem-solving skills” (Chin & Chia, 2006, p. 62). Perhaps most importantly, students experience “the nature of authentic inquiry and the different methods of finding answers to their questions” (Chin & Chia, 2006, p. 62).
Chapter III: Project Design

Overview

This chapter is comprised of a series of six custom made Problem Based Learning modules (PBL’s). They are aimed at providing New York State Living Environment classrooms new to the PBL approach an opportunity to try out the style and format, by addressing the challenges discussed in chapter two. These modules are preceded by a brief highlight of their common components.

My series of PBL modules will help this cohort of teachers and students find PBL useful in preparing for the Living Environment (LE) exam, whose domain is both explicit and extensive. In creating my modules I incorporated material I found at PBL and similar type websites which addressed the New York State Living Environment standards. Depending on the module, I may have used a variety of small segments from websites, or I may have based the entire module around a single episode. In every case, I have credited sources for the material used, accordingly.

To every module, I have created extensive scaffolding to ensure quality group work, as well as independent work. This includes numerous peer and teacher evaluations which bring home the importance of accountability to the students. Also, to aid in the successful implementation of each module, which last between three and four days, I have created detailed teacher instructions for their execution.

There are a variety of styles used between the modules, yet they all adhere to the underlying PBL principles discussed in the literature review. I am hoping that my project gives the reader a good sampling of the diverse venues and creative opportunities PBL offers the secondary science classroom.
## PBL module series

<table>
<thead>
<tr>
<th>Title</th>
<th>days</th>
<th>Brief description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Biodiversity and climate change</td>
<td>4</td>
<td>Teams are tasked with researching the predicted climate changes and the corresponding impact, if any, that the change will have on biodiversity. Students present their research in a poster session during the International Panel on Climate Change conference (fictitious).</td>
</tr>
<tr>
<td>Global temperatures</td>
<td>4</td>
<td>Students research real data to formulate an accurate picture of the planet’s climate trends. As part of a team of research scientists, students present their report to the International Panel on Climate Change conference (fictitious).</td>
</tr>
<tr>
<td>A Kidney problem</td>
<td>3</td>
<td>Students analyze simulated urine samples to determine if the patient’s symptoms might be caused by kidney disease. They use information from an expository document to create an effective type 2 diabetes prevention program for the patient.</td>
</tr>
<tr>
<td>Disease</td>
<td>3</td>
<td>Students will use an interactive module found at the Access Excellence Mystery Spot website, to solve a three-part mystery on a disease outbreak. Students take steps to identify how it’s transmitted, categorize it, and figure out how to treat it. Students choose and write a summary about a real life disease outbreak.</td>
</tr>
<tr>
<td>Cancer causes and treatments</td>
<td>4</td>
<td>Each team researches a separate cancer treatment method, and each member is tasked with researching a specific aspect of a treatment for a brochure, using online sources. They then must work as a team to create a brochure using this information.</td>
</tr>
<tr>
<td>Genetic testing</td>
<td>3</td>
<td>This PBL employs a script and a storyline, for students to weigh the costs and risks of genetic testing. The students are responsible for researching their own question about Huntington’s disease and genetic testing, as well. They evaluate information to form their own informed opinion of whether to get tested.</td>
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</tbody>
</table>

### Each PBL include the following components:

- Title of PBL module
- Class time required
- Overview of PBL activities
- Explanation on how the module incorporates the principles of PBL discussed in the literature review
- When to use the module in the LE curriculum
• Precautions and/or advice
• NYS standards relevant to the module
• Detailed list of Daily Resources, Worksheets and Evaluations
• Detailed list of Daily Activities
PBL Modules
Biodiversity and climate change PBL
created by Katrina Cordeiro

The dhole is on the edge of extinction. It is the most endangered Asiatic top predator. 
Source http://ete.cet.edu/gcc/?/biodiversity_overview/

Class time required: Four 40-minute class periods

Overview:

<table>
<thead>
<tr>
<th>Day</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Call up prior knowledge concerning the question “why anyone care about biodiversity?” with a think, pair, share, Scenario and task presented, Initial individual research conducted using website provided.</td>
</tr>
<tr>
<td>2</td>
<td>Students will work individually to answer all five assigned questions, making notes in a word document.</td>
</tr>
<tr>
<td>3</td>
<td>Teams share responses to questions within their teams and provide feedback for the purpose of improving their poster segment. Each individual member creates their poster segment.</td>
</tr>
<tr>
<td>4</td>
<td>Each team hangs their 5 segment/part poster in the classroom, and is responsible for peer evaluating a certain segment for each team.</td>
</tr>
</tbody>
</table>

PBL principles incorporated:
1) The problem or design is an authentic task and learning environment.

In the scenario presented, students become part of a team of ecologists and environmental scientists working for the United States Panel on Global Climate Change Research. Teams are tasked with researching the predicted climate changes and the corresponding impact, if any, that the change will have on biodiversity. Students present their research in a poster session during the International Panel on Climate Change conference (fictitious). They are told that their “peers at the international conference are going to be using your accurate assessment to move on to resolutions that might alleviate any negative impacts”.
2) **The problem or task is the basis of all learning.**

The scenario and task presented on the first day focus the students on the problem, and outline the aspects of the problem that need to be addressed. Students will research real biodiversity data and climate change information found at the Exploring the Environment PBL website, so as to make a prediction about the world 30 years from now. Answering these issues form the activities/tasks within this PBL.

3) **Overall, the learner must feel ownership of the problem or task, and development of the solution.**

The students will be working as a team to collaborate on this poster, however initial research on all questions is done individually (the questions build upon the prior question), and each student does their own segment of the poster. They will be evaluated on their individual research and individual poster segment creation (peer evaluated) (together: 2/3 grade) and their group work effort (1/3 grade).

4) **Encourage testing the ideas against alternative views and opportunities for reflection.**

The PBL starts with a pre-assessment discussion about why anyone would care about biodiversity, using the Think-pair-share strategy. Individual research questions are designed to ask them to analyze the data they find. Research is followed by peer feedback. The poster segments are peer reviewed. They evaluate their peers on the quality of their group work.

**When to use:** This PBL will fit into the curriculum during human impact coverage, connecting it with prior curriculum coverage of ecosystems and biodiversity. It provides a nice segue into global climate change, and would be followed by continued curriculum coverage about global warming and other human impact issues.

**Precautions and/or advice:** The opening activity links this PBL to what has been learned previously about the importance of biodiversity. For this reason, as well as other modifications made to ensure the principles of PBL, as well as to aid students through this research PBL (as discussed in the literature review), it is prudent to follow the detailed daily activities as written, modified from the PBL originally found at http://ete.cet.edu

**New York Living Environment:**

**Standard 1:**
- Performance indicator 1.1, Major understandings 1.1a, 1.1c
- Performance indicator 1.2, Major understandings 1.2a, 1.2b, 3.1a

**Standard 4:**
- Performance indicator 1.1, Major understandings 1.1b-f
- Performance indicator 3.1, Major understandings 3.1l
- Performance indicator 6.1, Major understandings 6.1a-e
Performance indicator 6.2, Major understandings 6.2a, 6.2b
Performance indicator 6.3, Major understandings 6.3a-c
Performance indicator 7.1, Major understandings 7.1a-c,
Performance indicator 7.2, Major understandings 7.2a-c,
Performance indicator 7.3, Major understandings 7.3a, 7.3b

Appendix A:
analyzes results from observations/expressed data

Detailed list of Day 1 Resources, Worksheets and Evaluations
Copy of scenario and task (attached)
Copy of PBL criteria (attached)
Individual evaluation (for teacher use -attached)
PBL at http://ete.cet.edu create a user name and password to access teacher pages
Each student will need access to computers to create a word document and the internet.
Otherwise, the teacher may copy the information from this website, and provide it to the students
as a packet.

Detailed list of Day 1 Activities
Anticipatory activity:
Access the overview on the overhead at http://ete.cet.edu/gcc/?/biodiversity_overview/. Read
out the first three paragraphs, ending with the questions pertaining to why anyone care about
biodiversity? Call up prior knowledge concerning this question with a think, pair, share, where
they pen as many reasons as possible in one minute, then compile their list with a neighbors, and
then the responses are shared out as a class (think, pair, share).
PBL:
Handout the scenario and task to students. Read the rest of it out loud.
Hand out and explain the criteria and the evaluation to the class. Make it clear that every team
will be responsible to address all five questions in their 5-part poster, after individual research on
each question (note that some questions have two parts, and the questions build upon the answers
to prior questions).
Group the students into teams of five (if students are left over, duplicate questions for the
stronger and weaker achievers).
Individual research:
To assist the student in finding information to answer the questions, let the students spend 5
minutes exploring links on the website to answer the first question.
At this point, the teams get together to determine the three most frequently picked links that will
answer this question. The teacher visits each expert team to address any questions and give
direction.
Teacher evaluates group work contribution on Individual evaluation form.
Each student will have an additional 10 minutes to answer the question in a word document
based on one or more of the identified links.
Detailed list of Day 2 Resources, Worksheets and Evaluations
http://ete.cet.edu: the teacher pages
Each student will need access to computers to create a word document and the internet.
Handed out on Day 1: Copy of scenario and task, Copy of PBL criteria
Individual evaluation (for teacher use-attached)

Detailed list of Day 2 Activities
Individual research:
Proceed with individual research for the remaining questions (note: there is only time to identify
links for the last two questions, so students must answer these questions as homework):
To assist the student in finding information to answer the questions, let the students spend 5
minutes exploring links on the website to answer the first question.
At this point, the teams get together to determine the three most frequently picked links that will
answer this question. The teacher visits each expert team to address any questions and give
direction.
Teacher evaluates group work contribution on Individual evaluation form.
Each student will have an additional 10 minutes to answer the question in the word document
based on one or more of the identified links.
Everyone prints out 5 copies of their word document once all questions answered (homework).

Detailed list of Day 3 Resources, Worksheets and Evaluations
http://ete.cet.edu the teacher pages
Butcher block paper or poster stock, markers for class to make posters
5 copies of each student’s word document (printed out previously)
Handed out on Day 1: Copy of scenario and task, Copy of PBL criteria (attached)
Individual evaluation (for teacher use-attached)

Detailed list of Day 3 Activities
Discussion and poster creation with team:
At this point, the teams assemble to discuss the questions, and plan what information to use from
the responses to create the posters from.
In turn, each student has one minute to tell their team their response to the question, with the next
member adding something that had not been said yet.
The team then has 5 more minutes to discuss and highlight the information in their word
document to be used for poster segment creation which will address the criteria. They team
continues with the remaining questions in this manner.
After all questions are addressed, each team member is assigned to create a poster segment based
on the highlight material.
Each student will create their poster in the last 15 minutes of class, with support of their team
members or teacher, as needed. Remember to write your name on your poster segment
Each team member turns in a copy of their word document for individual research evaluation.
Teacher evaluates group work contribution on Individual evaluation form.
Detailed list of Day 4 Resources, Worksheets and Evaluations

http://ete.cet.edu the teacher pages
Team evaluation for each team.(attached)
Handed out on Day 1: Copy of scenario and task, Copy of PBL criteria, Individual evaluation (for teacher use-attached)

Detailed list of Day 4 Activities
Poster session at the conference:
Students place their five-part team posters around the room (should be 4 if the class is under 25 students). Alongside of it the team evaluation form is posted.
Each team is assigned one poster part to evaluate on all the team posters. Using round robin format, teams spend 5 minutes discussing and rating the poster part on the team evaluation that is posted alongside the five-part poster.
When the round robin is done, the average are tallied for the creators, the team with the highest combined total score will be identified, and the evaluations will be turned in to teacher.
As a 2 point exit ticket, each student will personally vote for their favorite team poster, and explain why in 3 sentences. (Results will be broadcast tomorrow).
Teacher evaluates group work contribution on Individual evaluation form.
Biodiversity and Climate Change PBL
Source: [http://ete.cet.edu](http://ete.cet.edu)

Scenario and Task:
Biodiversity loss threatens human security and well-being. Food chains on which we depend will be disrupted, water sources may disappear, and medicines and other resources obtained from lost organisms—or the organisms that depend on them—could be lost to us.


Climate change seems to be a major driver of the loss of biodiversity, and it is predicted to have an even greater impact in the decades to come. Melting Arctic sea ice, ocean acidification, warming temperatures, extreme weather events, and rising sea levels will have a devastating effect on some species.

In 2002 a Convention on Biological Diversity was held in The Hague, Netherlands, to address threats to Earth’s ecosystems. Given the state of rainforest deforestation, habitat destruction, and predicted global climate change, world leaders promised to "strengthen our efforts to halt biodiversity loss, which is taking place at an alarming rate...by the year 2010."

In 2010, the International Year of Biodiversity, scientists were still talking about threats to Earth’s biodiversity. While scientists attempt to focus the world’s attention and raise awareness of the fragile state of some of Earth’s ecosystems, things are worse.

The dhole is on the edge of extinction. It is the most endangered Asiatic top predator.

Source [http://ete.cet.edu/gcc/?/biodiversity_overview/](http://ete.cet.edu/gcc/?/biodiversity_overview/)

In a study published in *Science* magazine, scientists and environmentalists concluded: "Our analysis suggests that biodiversity has continued to decline over the past four decades, with most state indicators showing negative trends."
It’s not like we have totally ignored the problem. Responding to research results, some governmental policies have improved. More countries are setting aside protected lands and are managing resources for sustainability. Global pacts and agreements have included provisions for conservation and tackling the problems of invasive species. Why have our efforts fallen somewhat short of the mark? Some scientists suggest that our strategies so far, while important, may not be enough to offset the trends in global climate change. Some progress has been made, but strong, concentrated efforts are needed now if we are to protect our planet’s biodiversity.

Source http://ete.cet.edu/gcc/?/biodiversity_overview/

For your work on the United States Panel on Global Climate Change Research, you and your team of ecologists and environmental scientists have been studying some of the most exotic places on Earth.

Team members have scuba-dived around massive, colorful coral reefs, studied deep ocean water onboard submersibles, hiked through rainforests, and taken samples of grassland soils in Kansas and the Zambezi River basin in Africa.

Your major task has been to study Earth’s biodiversity and its importance. Biodiversity is the number different kinds of plant and animal species in a natural environment.

With a major international conference looming, you must now apply climate change information and the data you collected to make a prediction about the world 30 years from now. Your colleagues are gathered to share their experiences and their preliminary findings with the rest of your group.

This International Panel on Climate Change conference requires analysis of the data is required to present an accurate picture of Earth’s biodiversity. Climate changes have been the focus of heated controversy and debate for the last decade. As a scientist, you naturally look at the data from purely objective perspectives.

An important element of the ongoing research on global climate change is the study of how any climate changes might affect biodiversity. Understanding the mechanisms behind potential climate changes will allow you to make accurate predictions of the impacts to organisms because of environmental changes.

Your team is tasked with researching the predicted climate changes and the corresponding impact, if any, that the change will have on biodiversity. Your team must report both the changes and consequences.
Task: Describe to the international panel Earth’s biodiversity 30 years from now. In order to present accurate, complete, and valid findings, you should consider the following:

1) What do the data indicate about Earth’s biodiversity? Identify any trends that occurred in biodiversity.
   Think “before and after” to help you identify a big picture of the biodiversity on Earth and the changes that may have occurred over decades.

2) What are the impacts of changes to Earth’s physical environments on species diversity? Remember to report the impacts to humans, wildlife, ecosystems, etc.
   How are Earth’s environments changing? How does this affect species diversity?

3) What appears to be the source(s) of the changes? Can you identify a major cause?
   This is very important to understanding the mechanisms that drive the change and, therefore, important to finding a possible remediation of the impacts.

4) What are the impacts of changes in Earth’s biodiversity?
   Potential impacts of changes in Earth’s biodiversity are serious. Consider all impacts, not only to those species directly affected, but to those that might be affected as a consequence. The International Panel on Climate Change will need to know impending impacts in order to plan for the future.

5) What strategies do you see that could mitigate or lessen decreased species diversity?
   How long would the strategies take to make a difference?

(Source end)
Your peers at the international conference are going to be using your accurate assessment to move on to resolutions that might alleviate any negative impacts, so please do your best for this important assignment!
Assignment Criteria
As part of a team of ecologists and environmental scientists, you have been assigned to take part in a poster session during the International Panel on Climate Change conference. The poster will highlight research which predicts climate changes and the corresponding impact, if any, that the change will have on biodiversity thirty years from now. Your peers at the international conference are going to be using your accurate assessment to move on resolutions that might alleviate any negative impacts, so please do your best for this important assignment!

Criteria  This PBL has two tasks:

1) Each team member will create an independent research report (out of 30 possible points)
   You will create an initial research report as a word document which will include the following criteria for each of the five questions listed in the scenario and task handout.
   - The question (some have more than one part)
   - Your claim: what is your conclusion explanation or answer to the research question?
   - Your evidence and rationale: how do you know? (cite the link you used)
   - For each question, you must write between 50 and 100 words, citing at least 2 links.
   - Your report must include the analysis of at least one graph.

   Your report is submitted to your supervisor, Ms. Cordeiro, who will give you an independent evaluation.
   Note that your group work contributions in this PBL are also part of your individual evaluation.

2) Team member will create one segment/part of a five-part team poster based on the information determined during team discussion. This will be evaluated by your peers during the poster session (worth 4 possible points per student)

3) Individual evaluation (for teacher use - attached)
Name ____________________  period ________________

Evaluation of individual work (your word document is attached)
Rate the following questions for effort using this point system:

0.5 Very little  
1 Some, but not quite satisfactory  
1.5 Satisfactory, but not excellent  
2 Excellent

Report (out of 30 possible points):
A Is the explanation sufficient (i.e., it explains everything it needs to) and coherent (i.e., rational, sound, and free from contradictions)?  
B Did the researcher use genuine evidence (They cited data that shows a trend over time, a relationship between two variables, or a difference between groups?)  
C Did they meet all the criteria listed in the assignment?

<table>
<thead>
<tr>
<th>Question #</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>Total score</th>
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<td>5:</td>
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Group work (out of 16 possible points)
______ day 1: finding links and sharing with team members  
______ day 2: finding links and sharing with team members  
______ day 3: supported team in selecting information for posters and creating posters  
______ day 4: took turn filling out evaluation form in poster session.

______ Total score out of 32 points
**Team evaluation of peer’s posters (worth 4 points per member)**

Rate the following questions for effort using this point system:

1-  Very little  
2-  Some, but not quite satisfactory  
3-  Satisfactory, but not excellent  
4-  Excellent

**Poster:**
A Is the explanation sufficient (i.e., it explains everything it needs to) and coherent (i.e., rational, sound, and free from contradictions)?
B Did the researcher use genuine evidence (They cited data that shows a trend over time, a relationship between two variables, or a difference between groups?)
C Did they use enough evidence to support their ideas (i.e., All their ideas are supported by evidence?)
D Did they meet all the criteria?

<table>
<thead>
<tr>
<th>Poster part # / Creator name</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>average score</th>
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Global Temperatures PBL created by Katrina Cordeiro

Source: http://ete.cet.edu/gcc/?/globaltemp_scenario/

Class time required: Four 40-minute class periods

Overview:

<table>
<thead>
<tr>
<th>Day</th>
<th>Activities</th>
</tr>
</thead>
</table>
| 1   | Build the background knowledge needed for the global warming research.  
     | • Online global temperature timeline with discussion  
     | • Online (handout option) document to learn about Greenhouse effect  
     | Scenario and task presented,  
     | Initial individual research conducted using a jigsaw for discussion and feedback with the expert group |
| 2   | Students will work individually to answer their assigned question, making notes in a word document.  
     | Use jigsaw for discussion and feedback with the original “interdisciplinary” teams. |
| 3   | The teams get together to create a two-part presentation. |
| 4   | Each team 1 swaps presentation with another team to peer evaluate |

PBL principles incorporated:

1) The problem or design is an authentic task and learning environment.

Students will research real global temperature data and carbon cycle information found at the Exploring the Environment PBL website, so as to formulate an accurate picture of the planet’s climate trends. As part of a team of research scientists working for the United States Panel on Global Climate Change Research, students present their report to the International Panel on Climate Change conference (fictitious).
2) The problem or task is the basis of all learning.

The scenario and task presented on the first day focus the students on the problem, and outline the aspects of the problem that need to be addressed. Answering these issues forms the activities/tasks within this PBL.

3) Overall, the learner must feel ownership of the problem or task, and development of the solution.

The students will be working as a team to collaborate on their presentation, with each member being responsible for addressing one question presented in the scenario and task handout. Thus, initial research for each question is done individually. They will be evaluated on their individual research (one third grade), their group work effort (one third grade), and by their presentation, which is peer evaluated (one third grade). The PBL is worth a total of 50 points.

4) Encourage testing the ideas against alternative views and opportunities for reflection.

On day one, the PBL starts with a pre-assessment discussion about why global temperatures are increasing. They are given more information and they reexamine their ideas in another class discussion. Individual research questions are designed to ask them to analyze the data they find. This is followed by peer feedback on day two for the purpose of strengthening their presentation. On day 3 they must work with a partner to create the presentation.. Last, on day 4 the presentations are all peer reviewed. They evaluate their peers on the quality of their group work.

When to use: This PBL will fit into the human impact curriculum as required coverage pertaining to global warming.

Precautions and/or advice: The information gleaned in this PBL should cover curriculum requirements pertaining to global warming. This lesson begins with an activity that builds the background knowledge needed for the research. Since the lesson outline has modifications made to ensure the principles of PBL, as well as to aid students through this research PBL (discussed in the literature review), it is prudent to follow the detailed daily activities as written, modified from the original PBL found at http://ete.cet.edu

New York State Living Environment

Standard 1:
Performance indicator 1.1, Major understandings 1.1a, 1.1c
Performance indicator 1.2, Major understandings 1.2a, 1.2b, 3.1a

Standard 4:
Performance indicator 1.1, Major understandings 1.1b 1.1d, 1.1f
Performance indicator 3.1, Major understandings 3.1l
Performance indicator 6.1, Major understandings 6.1a-e
Performance indicator 6.2, Major understandings 6.2a, 6.2b
Performance indicator 6.3, Major understandings 6.3a-c
Performance indicator 7.1, Major understandings 7.1a-c,
Performance indicator 7.2, Major understandings 7.2a-c,
Performance indicator 7.3, Major understandings 7.3a, 7.3b
Appendix A: analyzes results from observations/expressed data

**Detailed list of Day 1 Resources, Worksheets and Evaluations**
Copy of Introduction to the Greenhouse Effect assessment (attached)
Copies of scenario and task (attached)
Copies of PBL criteria (attached)
Copies of individual evaluation (for teacher use -attached)
PBL at [http://ete.cet.edu create a user name and password to access teacher pages](http://ete.cet.edu)
Each student will need access to computers to create a word document and the internet.
Link for anticipatory activity at [http://climate.nasa.gov/interactives/climate_time_machine](http://climate.nasa.gov/interactives/climate_time_machine)

**Detailed list of Day 1 Activities**
Anticipatory activity:
Have students get out computers and access the climate machine interactive at:
[http://climate.nasa.gov/interactives/climate_time_machine](http://climate.nasa.gov/interactives/climate_time_machine)
Ask the students to move the timeline slider from 1890 to the time when their parents were born. What happened to the global temperatures over time? Now move the slider from when their parents were born (about 1970) to the present? Did the temperature change more or less than it did in the prior 80 years? Why? (take all answers, encourage discussion to call up background knowledge and pre-assess, in general)

Background activity:
Hand out the Introduction to the Greenhouse Effect worksheet. Using this handout, with the PBL link stated, each student answers the following questions as background knowledge development for the PBL. Once they turn it in for evaluation, they may help a neighbor locate where the information can be found. Once everyone is done, have a class discussion.

**Define global climate change**
**What is albedo? What causes it?**
**Name the first four greenhouse gases listed?**
**What does the greenhouse effect do?**
**What determines whether this effect is a good thing or a bad thing?**
**What your own thoughts as to why the greenhouse effect is occurring more rapidly?**

**PBL:**
Hand out the scenario and task and read it out. Hand out and explain the criteria and individual evaluations to the class.
Group the students in teams of four. Team members count off (1-4).
Explain that the student will conduct research on the question number they match, and then come back together to educate their “interdisciplinary” team and put together their presentation (jigsaw strategy).
**Individual research:**
To assist the student in finding information to answer their assigned question, let the students spend 5 minutes exploring links on the website to answer their question. Students get together with their “expert team”- those in other teams who are also assigned the question- for discussion, and making note the links which will provide useful information. The teacher visits each expert team to address any questions and give direction toward the research which they will conduct individually in the next class period. Teacher evaluates group work contribution on Individual evaluation form.

**Detailed list of Day 2 Resources, Worksheets and Evaluations**
http://ete.cet.edu: the teacher pages
Each student will need access to computers to create a word document and the internet. Handed out on Day 1: Copy of scenario and task, Copies of PBL criteria, copies of individual evaluation

**Detailed list of Day 2 Activities**
Individual research:
Students will work individually to answer their assigned question for 20 minutes, making notes in a word document. Each student either prints out or emails their work to the teacher to be evaluated, as well as leaving the document open for team work to follow.

Discussion with team:
At this point, the original “interdisciplinary” teams assemble to discuss the questions. In turn, each student has one minute to tell their team their response to the question. In turn, another “expert” (person to their right) must ask a follow-up question for the purpose of strengthening their presentation. Each follow-up question must be addressed to the satisfaction of the team either by the “expert” or by looking at the pertinent links. The “expert” must note on their word document each follow-up question and answer, and save it. They will use this information to create their presentation tomorrow. Teacher evaluates group work contributions for day 2 when receives updated document tomorrow.

**Detailed list of Day 3 Resources, Worksheets and Evaluations**
http://ete.cet.edu the teacher pages
Pairs of students will need access to computers to create word documents and presentations. Handed out on Day 1: Copy of scenario and task. Copies of PBL criteria (attached) Copies of individual evaluation (for teacher use -attached)

**Detailed list of Day 3 Activities**
Create presentation:
The teams get together to create a two-part presentation. Using the criteria scale as a guide, the first two questions form part one of the presentation, and is created by those partners in the team. The partnership allows mutual support for this task,
though each team member will be evaluated separately. The last two questions are part two, and is created by those partners in the team.
The presentation is emailed to the teacher along with the updated word document that has the team comments.
Teacher evaluates group work contributions for day 2 and day 3 on Individual evaluation form.

**Detailed list of Day 4 Resources, Worksheets and Evaluations**
http://ete.cet.edu the teacher pages
Teams of students will need access to computers to view presentations
Peer evaluation for each team.(attached)
Handed out on Day 1: Copy of scenario and task, Copies of PBL criteria, copies of individual evaluation (for teacher use -attached)

**Detailed list of Day 4 Activities**
Peer evaluation of presentation:
Hand out peer evaluation.
There are an estimated 6 presentations if the class size is 24 students.
Each team will swap a presentation with another team to peer evaluate.
10 minutes per question for the team evaluation sheet is filled out, scoring each blank as the average vote of the evaluating team. The team will discuss the strengths and weaknesses for each question, and each member will take a turn scribing comments for each question on the evaluation form. The evaluations will be turned in to the teacher.
Teacher evaluates group work contributions for day 4 on Individual evaluation form.
Introduction to the Greenhouse Effect

Go to link at  [http://ete.cet.edu/gcc/?/globaltemp_overview/](http://ete.cet.edu/gcc/?/globaltemp_overview/)

Each question is worth 0.5 point

1) Define global climate change.

2) What is albedo? What causes it?

3) Name the first four greenhouse gases listed?

4) What does the greenhouse effect do?

5) What determines whether this effect is a good thing or a bad thing?

6) What are your own thoughts as to why the greenhouse effect is increasing?
Global Temperatures PBL Scenario and Task:

source: (http://ete.cet.edu/gcc/?/globaltemp_scenario/)

As a research scientist working for the U.S. Panel on Global Climate Change Research, you and your colleagues have been collecting data in the field for months. You’ve studied research on varying aspects of Earth’s diverse ecosystems, and your colleagues are now gathering to share their experiences and preliminary findings with the rest of the group.

With a major international conference looming, it’s time for all of you to analyze the data to formulate a comprehensive presentation which reports on global climate change on planet Earth. This conference requires you to fully present an accurate picture of the state of the planet’s climate and trends that have been the focus of heated controversy and debate for the last decade.

As a scientist, you naturally look at the data from purely objective perspectives. Given the ongoing controversy surrounding the recorded rise in Earth’s global mean temperatures, your team will have to provide some concrete analysis of temperature data for the report to the international commission.

In order to present accurate, complete, and valid findings, your team will:

1. **Analyze data and identify any trend that occurred in global mean temperatures.**
   Think “before and after” to help you identify a big picture of the temperature on Earth and the changes that may have occurred over decades.

2. **What are the impacts of this change? Remember to report the impacts to humans, wildlife, ecosystems, etc.**
   Impacts of changes in environmental temperatures are long reaching and possibly slow to develop. This doesn’t mean they are not significant. Look at the long-range effects. The International Panel on Climate Change will need to know impending impacts in order to plan for the future.

3. **What appears to be the source(s) of the changes? Can you identify a major cause?**
   This is very important to understanding the mechanisms that drive the change and, therefore, important to finding ways to deal with those causes.
4. What strategies do you see that could mitigate or lessen the change? How long would they take to make a difference? What are the pros and cons of the approach?

(Source end)

Your peers at the international conference are going to be using the information in your report to make some critical decisions in their own country’s energy policy, so please do your best for this important assignment!
Name __________________________ Period ____________

Global temperature Report and Presentation

Assignment Criteria
As part of a team of research scientists on Global Climate change, you have been assigned to present a report on one of the specific questions written in the scenario and task. Your peers at the international conference are going to be using the information in your report to make some critical decisions in their own country’s energy policy. Please do your best for this important assignment!

This PBL has two tasks:

3) Team members will conduct independent research (total possible is 32 points)
   You will create a report as a word document which will include the following criteria:
   - The Question assigned
   - Your claim: what is your conclusion, explanation or answer to the research question?
   - Your evidence and rationale: how do you know? (cite the link you used)
   - You must write between 200 and 400 words, including the analysis of at least one graph, and cite at least 3 links as sources for your information.

   Your report is submitted to your supervisor, Ms. Cordeiro, who will give you an independent evaluation.
   Note that your group work contributions in this PBL are also part of your individual evaluation.

4) Teams will create a two part presentation. Working as partners, part one will be created by team members #1 and #2, and part two will be created by team members #3 and #4. Each part will have the following criteria:
   - Each question assigned has the first slide which names the team member responsible and the links you cited as sources.
   - In addition, each question will have 3 to 5 slides which will highlight your independent research.
   - Your slides should have no more than 50 words to a slide.
   - Copy and paste the graph that each partner analyzed.

5) Your team will swap presentations with another team, and each team will evaluate one another’s work. (worth 16 possible points per student)
Name ____________________  period ________________

Evaluation of individual work (your word document is attached)

Grading scale:
Rate the following questions for effort using this point system:

5- Very little
6- Some, but not quite satisfactory
7- Satisfactory, but not excellent
8- Excellent

Score
______ Is the explanation sufficient (i.e., it explains everything it needs to) and coherent (i.e., It is free from contradictions)?
______ Did the researcher use genuine evidence (They cited data that shows a trend over time, a relationship between two variables, or a difference between groups?)
______ Did they use enough evidence to support their ideas (i.e., They used more than one piece of evidence, and all their ideas are supported by evidence?)
______ Did they meet all the criteria listed in the assignment?

Group work
______ day 1: finding links and sharing with “expert team”
______ day 2: recorded and addressed follow-up question
______ day 3: supported partner in creating presentation
______ day 4: took turn filling out and scribing comment on evaluation form for a question in the presentation

______ Total score out of 32 points
Team evaluation of peer’s presentation (16 point total per team member)

**Grading scale:**
Rate the following questions for effort using this point system:

1- Very little
2- Some, but not quite satisfactory
3- Satisfactory, but not excellent
4- Excellent

---------------------------------------------------------------
Part 1, question 1

**Score**

_____ Is the explanation sufficient (i.e., it explains everything it needs to) and coherent (i.e., rational, sound, and free from contradictions)?

_____ Did the researcher use genuine evidence (They cited data that shows a trend over time, a relationship between two variables, or a difference between groups?)

_____ Did they use enough evidence to support their ideas (i.e., All their ideas are supported by evidence?)

_____ Did they meet all the criteria?

_____ Total score out of 16 points

Comments: scribed by _______________________

---------------------------------------------------------------

Part 1, question 2

**Score**

_____ Is the explanation sufficient (i.e., it explains everything it needs to) and coherent (i.e., rational, sound, and free from contradictions)?

_____ Did the researcher use genuine evidence (They cited data that shows a trend over time, a relationship between two variables, or a difference between groups?)

_____ Did they use enough evidence to support their ideas (i.e., All their ideas are supported by evidence?)

_____ Did they meet all the criteria?

_____ Total score out of 16 points

Comments: scribed by _______________________

---------------------------------------------------------------

Part 2, question 3

**Score**

_____ Is the explanation sufficient (i.e., it explains everything it needs to) and coherent (i.e., rational, sound, and free from contradictions)?

_____ Did the researcher use genuine evidence (They cited data that shows a trend over time, a relationship between two variables, or a difference between groups?)
Part 2, question 4

Score

Did they use enough evidence to support their ideas (i.e., All their ideas are supported by evidence?)

Did they meet all the criteria?

Total score out of 16 points

Comments: scribed by _______________________

____________________________________________________________________________

Presentator name: _______________________

____________________________________________________________________________
A Kidney Problem PBL created by Katrina Cordeiro

Class time required: Three 40-minute class periods

Overview:

<table>
<thead>
<tr>
<th>Day</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Background activity: Introduce the excretory system using the guided notes. Anticipatory activity: Read out the “The Case”, leaving out the last sentence, and instead ask the students to write down what organ may not be working correctly. Teams perform the urine test, interpret the results. Assessment of day 1 is a take home quiz on excretory system.</td>
</tr>
<tr>
<td>2</td>
<td>Students learn from the student worksheet, how do normal kidneys work? And answer questions individually, before discussion as class. 10 minutes: Individuals assessment Partner up to review with tutorial/animation reviews basic urinary structure and function at <a href="http://www.biologymad.com/resources/kidney.swf">http://www.biologymad.com/resources/kidney.swf</a>.</td>
</tr>
<tr>
<td>3</td>
<td>Partners prepare a type 2 diabetes prevention, based on information found in the Diabetes prevention article, as well as 2 other sources from the internet. Share program with the other half of team, and they write the comment on the program. A general discussion about how diabetes may have touched their own lives. Students work through review individually, then the teacher will take on the role of the patient, and call on various “doctors” in the class to answer the questions. Students rate all their teammates for their contribution to group work in this PBL.</td>
</tr>
</tbody>
</table>
PBL principles incorporated:
1) The problem or design is an authentic task and learning environment.

The students are asked to take on the role of doctors and provided with a hypothetical medical case for a patient. Students analyze simulated urine samples to determine if the patient’s symptoms might be caused by kidney disease. They use information from an expository document to create an effective type 2 diabetes prevention program for the patient.

2) The problem or task is the basis of all learning.

The case presented on the first day focuses the students on helping the patient stay healthy. All learning objectives stem from this premise, and form the basis for the activities within this PBL.

3) Overall, the learner must feel ownership of the problem or task, and development of the solution.

Throughout this PBL students play the role of a doctor. They work individually and in teams to diagnose the problem, investigate the body system involved, share this information with the patient, and create a long-term medical plan for her.

4) Encourage testing the ideas against alternative views and opportunities for reflection.

The PBL starts with a pre-assessment discussion about what might be wrong with the patient? The students must use the results from their real lab test as evidence for their diagnosis. Students explore an interactive computer simulation to learn. Students share their answers to questions posed with the class. They evaluate information provided in an expository document to propose a type 2 diabetes prevention program with a partner, which is then shared and evaluated by another pair. Class discussion on how diabetes has effected them personally. They evaluate their peers on the quality of their group work.

When to use: Students will be learning about human body systems, and how they help maintain homeostasis. They will have already been introduced to the concept of homeostasis, as well as learned about cell function (membranes, etc.). This PBL pertains to the excretory system, and could follow after the sequence of digestive, respiratory, and circulatory systems.

Precautions and/or advice: Typically, students have learned about blood glucose levels during coverage of the circulatory system. Since this PBL discusses kidney function, it should be precluded by coverage of the excretory system. Therefore, I have included the necessary background information as the first activity on day 1. This PBL does not need additional background knowledge, as they learn the information about kidney function during the PBL. Because of modifications made to ensure the principles of PBL, (as discussed in the literature review), it is prudent to follow the detailed daily activities as written, modified from the PBL
New York State Living Environment

Standard 1:
Performance indicator 1.1, Major understandings 1.1a, 1.1c
Performance indicator 1.2, Major understandings 1.2a, 1.2b

Standard 4:
Performance indicator 1.2, Major understandings 1.2b-j
Performance indicator 5.2, Major understandings 5.2a, 5.2h, 5.2j
Performance indicator 5.3, Major understandings 5.3a, 5.3b

Appendix A: analyzes results from observations/expressed data

Detailed list of Day 1 Resources, Worksheets and Evaluations

Body systems packet- pages 19-22 (attached)
Teacher copy (answers) A Kidney Problem? (attached)
Copies of A Kidney Problem? –student worksheet (attached)
Copies of Instructions for Urine Testing, (attached)

Lab materials for each student:
• A 2 mL microtube or small test tube filled with pH 12 buffer or a 5% dilution of colorless household ammonia that has been colored with a small amount of yellow food coloring. Label this tube “Patient Urine”
• A small plastic bag that contains 1 strip of EMD pH 0 -14 pH paper (Order from VWR: Catalog # EM-9590-1, Colorpast pH Test strips Universal Range 0-14, EMD Chemicals. Pack of 100 strips is approximately $17.00. http://vwrlabshop.com/colorbphbast-ph-teststrips-emd-chemicals/p/0011566/ )

Excretory assessment (attached)

Detailed list of Day 1 Activities

Background activity: Introduce the excretory system using the guided notes on pages 19-22 of the body systems packet.

Anticipatory activity
From the student worksheet, teacher reads out the “The Case”, leaving out the last sentence, and instead ask the students to write down what organ may not be working correctly. Have the class vote if they do not unanimously say kidneys, and let them try to convince others by explaining why. They should choose kidneys because they just learned about the excretory system prior to this PBL.

PBL
For each student hand out: “A Kidney Problem” student worksheet, Instructions for Urine Testing, and Excretory diagram sheet. (teacher answers are on the Teacher copy A Kidney Problem?).
Let the students know that they will be evaluated on how well they performed group work at the end of the PBL, and it will be worth 10 points out of 50 of the PBL total.

Group students in heterogeneous teams of four, and handout lab materials. From the student worksheet, teacher reads out the team tasks: “Part 1: Are the patient’s kidneys functioning normally?” Give the teams 10 minutes to complete Part 1 and complete questions 1-3 (perform the urine test, interpret the results). As a class, confirm that everyone has correct results before continuing.

Assessment of day 1 is a take home quiz on excretory system.

**Detailed list of Day 2 Resources, Worksheets and Evaluations**

Teacher copy Excretory assessment answers (attached)
access to computers and internet for interactive animation of kidney function at [http://www.biologymad.com/resources/kidney.swf](http://www.biologymad.com/resources/kidney.swf)
Teacher copy (answers) A Kidney Problem? (attached)
Handed out yesterday: Copies of A Kidney Problem? –student worksheet
Copies of Excretory diagram sheet (attached)
Copies of assessment for day 2 (attached)

**Detailed list of Day 2 Activities**

Students turn in assessment for day 1.
From the student worksheet, “Part 2: How do normal kidneys work?”: Students work through this individually. As they finish up, have the students pair up to compare their answers with a “consultant doctor”/classmate.

Once they have reconsidered their answers, they are free to help any remaining students locate the information to answer the questions. When everyone has completed this part, the teacher will take on the role of the patient, and call on various “doctors” in the class to answer the questions.

Students turn in their work sheet for a grade (10 points maximum). Note that they should be achieving all points if they paid attention in class.

10 minutes: Individuals assessment by answering questions in part 3, referring to their notes, and turning in for grade (5 points maximum)
Within the team of 4, partner up to review with tutorial/animation reviews basic urinary structure and function at [http://www.biologymad.com/resources/kidney.swf](http://www.biologymad.com/resources/kidney.swf).

**Detailed list of Day 3 Resources, Worksheets and Evaluations**

Day 3 kidney problem student worksheet (attached)
access to computers and internet for research
Copies of the article diabetes prevention (attached)
Worksheet for diabetes prevention program

**Detailed list of Day 3 Activities**

For the final consultation with your patient:
15 minutes: Hand out the diabetes prevention program worksheet, and perform task. Partners prepare a type 2 diabetes prevention program for the patient as a means to prevent further kidney dysfunction. They must base their program on information found in the Diabetes prevention article, as well as 2 other sources from the internet.

Take turns scribing answers to the following questions: What is type 2 diabetes, and what condition precedes it? What factors associated with diabetes can be altered by the patient? What would you ask your patient to do? Base your answer on three pieces of evidence found in your research.

Share your program with the other half of your team. The listeners should comment on the strengths and weaknesses of the program, and write the comment on the program. After five minutes, the class convenes to share one or two comments they made, and have a general discussion about how diabetes may have touched their own lives.

Partners turn in their program for a grade (10 points maximum).

Day 3 kidney problem student worksheet: Students work through this review individually. As they finish up, have the students pair up to compare their answers with a “consultant doctor”/classmate.

Once they have reconsidered their answers, they are free to help any remaining students locate the information to answer the questions. When everyone has completed this part, the teacher will take on the role of the patient, and call on various “doctors” in the class to answer the questions.

Students turn in their worksheet for a grade (10 points maximum). Note that they should be achieving all points if they paid attention in class.

Students rate all their teammates for their contribution to group work in this PBL on an index card. They need to put their name, and “assessment of” student’s name.

Worked well with each team mate
Did their share of the task

Using grade scale as-
1: rarely
2: sometimes
3: half the time
4: usually
5: always
The Case:
You are a doctor working in a hospital in Rochester, New York. Ten years ago, your patient was diagnosed with Type 2 diabetes. She has been careless about following the treatment needed to keep her blood glucose levels regulated. Now she is experiencing fatigue, muscle cramps, swollen legs, nausea and back pain. She explains that sometimes her urine is pinkish and cloudy. What organ may be not functioning properly?

Part 1: Are the patient’s kidneys functioning normally?
You and your team of medical professional have the following tasks:

- Conduct a urine test.
- Analyze the information from the urine test to determine if the patient’s kidneys are functioning normally (see Instructions for Urine Testing)

1. Test the patient’s urine sample

<table>
<thead>
<tr>
<th>Urine Tests</th>
<th>Patient’s Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ketones</td>
<td></td>
</tr>
<tr>
<td>Blood</td>
<td></td>
</tr>
<tr>
<td>Protein</td>
<td></td>
</tr>
<tr>
<td>Glucose</td>
<td></td>
</tr>
</tbody>
</table>

2. Read the information in “Interpreting Urine Test Results.” What substances are present in the patient’s urine that are not present in normal urine?

_________________________________________________________________________

3. Are the patient’s kidneys functioning normally? State two evidences to support your answer.

_________________________________________________________________________

_________________________________________________________________________

Part 2: How do normal kidneys work?
The Case:
Your patient doesn’t understand how normal, healthy kidneys work to remove wastes and keep blood composition stable—within normal ranges.

Working individually, use the information on Excretory System handout, part A. Show her the diagrams, and answer her following questions:
1. What blood component should be completely removed from the blood as it passes through the kidney?

2. What five blood components should be kept in the blood as they pass through the kidney?

3. In addition to water, what blood components should be balanced so that they are presented in the correct concentrations in the blood?

4. What three substances would you expect to find in the urine that is excreted by the kidney?

Use the information on Excretory System handout, part B. Show her the diagrams, and answer her following questions:

5. What five substances form the filtrate?

6. What determines which blood components remain in the blood and which end up in the filtrate in the nephron?

7. Which substances in the filtrate does your body need?

Use the information on Excretory System handout, part C. Show her the diagrams, and answer her following questions:

8. What two substances in the filtrate are essential and need to be completely reabsorbed?
9. What two substances should be balanced by being selectively reabsorbed?

(Source end)

Now to see if your patient understand, ask her about something she may have noticed before:

10. If you drink a lot of water, you may produce large amounts of urine that has a light yellow color. If you do not drink enough water, you may produce a small amount of urine that has a dark yellow color. How would you explain these observations?

_________________________________________________________________________

_________________________________________________________________________

_________________________________________________________________________
**Instructions for Urine Testing**
Source: Life Sciences Learning Center, Copyright © 2009, University of Rochester
May be copied for classroom use

1. Dip the test strip (for 1 second) into the tube containing the urine sample.
2. Immediately compare the color of the test strip to the strips shown below.
3. Record whether the levels of each substance (Ketones, Blood, Protein, and Glucose) are NORMAL or HIGH on the “A Kidney Problem worksheet”.

![Image of test strips showing normal and high levels of Ketones, Blood, Protein, and Glucose]

**Interpreting Urine Test Results**

**Ketones**
Ketones are present in the urine when a person does not eat enough carbohydrates (for example, in cases of starvation or high-protein diets), or when a person eats enough carbohydrates but his body can’t use them properly (for example, if he has diabetes). Ketones are produced when the body metabolizes fat (instead of carbs) to get the energy it needs to keep functioning.

**Protein**
Protein is not normally present in the urine. Healthy kidneys take wastes out of the blood but leave protein in the blood. Damaged kidneys may fail to separate blood protein from the wastes and protein may leak into the urine. A small amount of protein in urine can be an early sign of kidney disease. As kidney function worsens, the amount of proteins in the urine increases. Other conditions may also result in protein in the urine.

**Blood (Hemoglobin)**
Normally, red blood cells and hemoglobin are not present in urine. Healthy kidneys do not allow blood cells to move from the blood into the urine. Even small increases in the amount of red blood cells or hemoglobin in urine may indicate disease. Numerous diseases of the kidney and urinary tract, as well as trauma, medications, smoking, or strenuous exercise, can cause red blood cells or hemoglobin to be present in the urine.

**Glucose**
Glucose is normally not present in urine. When glucose is present it may result from a high concentration of glucose in the blood (due to diabetes) or a kidney problem. Therefore, when glucose is present in the urine, further testing is recommended to identify the specific cause.

(Source end)
Take home quiz (5 points)

EXCRETORY SYSTEM:

1. What is the overall function of the excretory system?

2. List the most important organs of the excretory system.

3. How do these organs work together to maintain homeostasis?

4. How does the excretory system work with another system to maintain homeostasis?

5. Name one disorder and describe how it is (or leads to) a disruption in homeostasis.
ANSWERS EXCRETORY SYSTEM:

1. What is the overall function of the excretory system?
   
The excretory system removes chemical wastes from the body.

2. List the most important organs of the excretory system.
   
   Kidney (with the ureters, bladder and urethra), Skin, lungs

3. How do these organs work together to maintain homeostasis?
   
   They help to prevent a build up of excess wastes in the body, thus keeping the body balanced.

4. How does the excretory system work with another system to maintain homeostasis?
   
   The excretory system uses the circulatory system to get the wastes from the cells to the organs that can help to remove them.

5. Name one disorder and describe how it is (or leads to) a disruption in homeostasis.
   
   Kidney damage or failure – prevents the excretory system from filtering waste from the blood.
   Kidney stones – can get lodged in the ureter or the urethra creating pain and a decrease in flow.
   Urinary Tract Infection – a bacterial infection found in the organs of the urinary tract.
A. Kidneys Regulate the Composition of Blood

Your kidneys play a vital role in maintaining homeostasis. They excrete (remove) urea and other wastes, regulate the amount of water in the blood, and adjust the concentration of various substances in the blood. The substances removed from the blood form urine. The cleaned blood then travels to the heart and is pumped to the rest of the body. As blood travels through the kidney, some blood components need to be:

- **Kept** in the blood because they are essential. Red blood cells, white blood cells, protein, glucose and amino acids should be kept in the blood. These components should not be present in urine.
- **Removed** from the blood and excreted in the urine because they are toxic (poisonous). Urea is a toxic substance that should be removed from the blood.
- **Balanced** so they are present in the correct concentration in the blood. A certain amount of water and salt is needed by the body and will remain in the blood. If excess water and excess salt are present in the blood, they should be excreted in the urine.
Assessment for day 2

So far you have modeled the function of normal kidneys. Now you will consider what might be going wrong in patients with kidney disease. In patients with kidney disease, the kidney structure is damaged and does not function properly. Kidney damage may occur as a result of diabetes, high blood pressure, abnormal kidney development, damage by viruses or bacteria, or by an auto-immune response in which antibodies attach to the kidneys.

1. Your patient’s diabetes has caused kidney disease. What substances in the patient’s urine indicate that her kidneys are not functioning properly. (Refer to Part 1, question 2) (1 point)

________________________________________________________________________

2. Your patient reported pinkish and cloudy urine. What substance might cause her urine to be pink? (1 point) __________

What substance might cause her urine to be cloudy? (1 point) __________

3. What process (filtration or reabsorption) was not working properly in your patient? Explain to her how you know. (2 points)

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

_______________________________________
Reviewing and Applying What You Learned (10 points maximum)

1. Label the diagram using the following terms: renal artery, renal vein, nephron, glomerulus, and urine entering the ureter.

2. Draw a labeled arrow on the diagram to represent the process of filtration. In your own words, explain the process of filtration.

_________________________________________________________________________

_________________________________________________________________________

3. Draw a labeled arrow on the diagram to represent the process of reabsorption. In your own words, explain the process of reabsorption.

_________________________________________________________________________

_________________________________________________________________________

4. Excretion involves an interaction between the circulatory system and the excretory system. On the diagram above:
   • Put an X in front of the labels for structures that are part of the circulatory system.
   • Put an O in front of the labels for structures that are part of the excretory system.
6. Each day the millions of nephrons in your kidneys produce a total of about 180 liters (47 gallons) of filtrate that flows into your nephron. What would your life be like if your kidneys only carried out filtration (and did not also carry out reabsorption) and all of that fluid became urine?

_________________________________________________________________________
_________________________________________________________________________

7. Explain why drinking large amounts of water results in the production of large amounts of urine.

_________________________________________________________________________
_________________________________________________________________________

8. Explain why eating large amounts of salty foods increases the amount of salt in the urine?

_________________________________________________________________________
_________________________________________________________________________

9. In addition to diabetes, what other things may cause kidney disease?

_________________________________________________________________________
_________________________________________________________________________

10. Why is kidney disease a serious health risk? What would happen to a person if their kidneys did not function properly?

_________________________________________________________________________
(Source end)
Diabetes prevention program

Your task (worth 10 points for each partner):
Partners prepare a type 2 diabetes prevention program for the patient as a means to prevent further kidney dysfunction. They must base their program on information found in the Diabetes prevention article which follows, as well as 2 other sources from the internet.
Take turns scribing answers to the following questions: What is type 2 diabetes, and what condition precedes it? What factors associated with diabetes can be altered by the patient? What would you ask your patient to do? Base your answer on three pieces of evidence found in your research.
Share your program with the other half of your team. The listeners should comment on the strengths and weaknesses of the program, and write the comment on the program below.

The following was adapted from National Institute of Diabetes and Digestive and Kidney Diseases, August 8, 2001 press release, http://www.niddk.nih.gov/welcome/releases/8_8_01.htm, viewed on 2/25/03.

Diet and Exercise Dramatically Delay Type 2 Diabetes
People can develop type 2 diabetes at any age. In type 2 diabetes, the pancreas does not make enough insulin, and the fat, muscle, or liver cells do not use it properly. At least 10 million Americans are at high risk for type 2 diabetes which can have serious health consequences if untreated.
Most common in adults, type 2 diabetes can develop at any age, even childhood. It is strongly associated with obesity (more than 80% of the people with type 2 diabetes are overweight), inactivity, family history of diabetes, and racial or ethnic background. Compared to whites, black adults have a 60% higher rate of type 2 diabetes and Hispanic adults have a 90% higher rate. The prevalence of type 2 diabetes has tripled in the last 30 years, and much of the increase is due to the dramatic upsurge in obesity.
Results from a major study bring good news about type 2 diabetes. As announced by HHS Secretary, Tommy G. Thompson, at the National Institutes of Health, Americans at high risk for type 2 diabetes can sharply lower their chances of getting the disease with diet and exercise. "In view of the rapidly rising rates of obesity and diabetes in America, this good news couldn’t come at a better time," said Secretary Thompson. "So many of our health problems can be avoided through diet, exercise and making sure we take care of ourselves.”
The findings came from the Diabetes Prevention Program (DPP). This is a major study that compared diet and exercise to drug treatment among 3,234 people with impaired glucose tolerance, a condition that often precedes diabetes. On the advice of the DPP’s external data monitoring board, the study ended a year early.
Participants were randomly assigned to one of three groups, as shown below.
<table>
<thead>
<tr>
<th>Group</th>
<th>Intervention</th>
<th>Description</th>
<th>% Developed Diabetes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Lifestyle Intervention</td>
<td>Participants received intensive training in diet, exercise (most chose walking), and behavior modification skills aimed at reducing weight by 7% through a low-fat diet and exercising for 150 minutes a week.</td>
<td>14%</td>
</tr>
<tr>
<td>2</td>
<td>Metformin &amp; Information</td>
<td>Participants received treatment with the drug metformin (850 mg twice a day) and received information on diet and exercise.</td>
<td>22%</td>
</tr>
<tr>
<td>3</td>
<td>Placebo &amp; Information</td>
<td>Participants received placebo pills, in place of metformin, and received information on diet and exercise.</td>
<td>29%</td>
</tr>
</tbody>
</table>

Those randomly assigned to the lifestyle intervention (Group 1) maintained their physical activity for 30 minutes per day, usually with walking or other moderate intensity exercise, and lost 5-7% of their body weight. Group 1 had the fewest participants (14%) develop diabetes during the three-year study period. The study also found that fewer participants who were treated with the oral diabetes drug Metformin (Group 2) developed diabetes (22%) compared to the placebo group (29%).

DPP participants ranged from age 25 to 85 (average 51). At the beginning of the study, no participants had diabetes, but all were at high risk of developing type 2 diabetes because they had impaired glucose tolerance and were overweight. Nearly half of the participants were from minority groups who suffer more from type 2 diabetes: African Americans, Hispanic Americans, Asian Americans and Pacific Islanders, and American Indians. The study also recruited other higher risk groups, including people over 60 and those with a close relative with Type 2 diabetes.

"Every year a person can live free of diabetes means an added year of life free of the pain, disability, and medical costs incurred by this disease," said Dr. Allen Spiegel, director of the National Institute of Diabetes and Digestive and Kidney Diseases, which sponsored the DPP. "The DPP findings represent a major step toward the goal of containing and ultimately reversing the epidemic of type 2 diabetes in this country."

(source end)
Diabetes prevention program

Type 2 diabetes prevention program for ________________________ (patient name)

Prepared by doctor _____________________ and doctor ________________________

Comments by teammates:
Disease PBL created by Katrina Cordeiro

Source: 1994-2009 by Access Excellence @ the National Health Museum.

Class time required: Three 40-minute class periods

Overview:

<table>
<thead>
<tr>
<th>Day</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><strong>Anticipatory activity</strong>: On overhead, access “the Blackout Syndrome” module, episode 1. Read out to class. Hand out worksheets and read through PBL task – day 1 to class. Partner up students and have them work through “Bleeding baby” online with worksheet. After working for 10 minutes, class lists on the board possibilities they’ve identified. Hand out Copies of clues at third victims’ home: “A Third Victim”. Students proceed with mystery, write response and turn it in. Final class discussion. Then on the overhead access the explanations given by contest winners. Do the partner evaluation as exit ticket.</td>
</tr>
<tr>
<td>2</td>
<td><strong>Anticipatory exercise</strong>: episode 2, “Your New Assignment”, give them 5 minutes to read with a NEW partner and answer the first 3 task questions. Then as a class, call for answers, and fill out the observation table with the information we know so far. <strong>Group work</strong>: each team member answers one question on the task hand out, then share their information with their team, so data tables are filled out. Partners continue through the episode until they get to the “Test Results”, where they then compare the observed condition of the mouse with the data tables, and the provided characteristics of the pathogen. Do partner work task from the hand out. Final class discussion. Then on the overhead access the explanations given by contest winners.</td>
</tr>
</tbody>
</table>
Do the partner evaluation as exit ticket, and collect the task handouts for grading.

3
Select NEW partner and work through episode 3 “The Intruder”, answering the questions in task day 3.
After students turn in their index cards with the solution, have partners continue with the conclusion to the story. Did they choose the right antibiotic?
Do the partner evaluation.
For the remainder of class time students choose and examine a report of real life disease outbreak.
Collect the task handouts for grading.

PBL principles incorporated:
1) The problem or design is an authentic task and learning environment.
Situation: The student is a medical investigator working for Dr. Susan Lydell. As a blackout paralyzes the city, you are called in to investigate an outbreak of a new disease. You must take steps to identify how it's transmitted, characterize it (virus? bacterium? fungus?), and figure out how to treat it. The narrative itself is fictional, but the scenario is based on actual events and contemporary science research and discoveries. Students read about a real life disease outbreak at [http://www.who.int/csr/don/en/ World Health Organization Disease Outbreak News](http://www.who.int/csr/don/en/). 

2) The problem or task is the basis of all learning.
The case presented on the first day focusses the students on the virtual (online) investigation to identify what is responsible for the presentation of symptoms in a victim, so as to treat the victims. All learning objectives stem from this premise, and form the basis for the activities within this PBL.

3) Overall, the learner must feel ownership of the problem or task, and development of the solution.
Students will use an interactive module found at the Access Excellence Mystery Spot website, to solve a three-part mystery, “The Blackout Syndrome”, about the outbreak of a new disease. Working as individuals, partners and groups, students take steps to identify how it’s transmitted, categorize it (virus? bacterium, fungus?), and figure out how to treat it. Students choose and write a summary about a real life disease outbreak.

4) Encourage testing the ideas against alternative views and opportunities for reflection.
The module incorporates the reader’s proposed solution into the story; if the answer is incorrect, the story turns to show why it’s incorrect; the correct answer is given, and the story continues. Students work in partners and groups to answer questions, with occasional breaks to discuss and review as a class. They evaluate their peers on the quality of their group work.

When to use: This PBL will fit into the disease and homeostasis curriculum after students have learned about categories of disease, and the classes of organisms that cause disease. They will have to understand the scientific method, which is covered at the beginning of the school year.
Precautions and/or advice: Due to modifications made to ensure the principles of PBL, as well as to aid students through this student-led PBL (as discussed in the literature review), it is prudent to follow the detailed daily activities as written, modified from the PBL originally found at http://www.sciencemystery.com/

Modifications to this PBL to make it more aligned with principles
1) The problem or task is the basis of all learning,
2) Overall, the learner must feel ownership of the problem or task, and development of the solution,
3) The problem or Design an authentic task and learning environment, and
4) Encourage testing the ideas against alternative views and opportunities for reflection.

New York Living Environment:
Standard 1:
Performance indicator 1.1, Major understandings 1.1a
Performance indicator 1.2, Major understandings 1.2a, 1.2b,
Performance indicator 3.1, Major understandings 3.1a

Standard 4:
Performance indicator 5.2, Major understandings 5.2a. 5.2b. 5.2h, 5.2j, 1.1b-f

Appendix A:
Makes observations of biological processes
Differentiates between independent and dependent variables
Identifies the control group and/or controlled variables
Organizes data through the use of data tables and graphs
Analyzes results from observations/expressed data
Formulates an appropriate conclusion or generalization from the results of an experiment

Detailed list of Day 1 Resources, Worksheets and Evaluations
Copies of PBL task - day 1 (attached)
Index cards

Detailed list of Day 1 Activities
Anticipatory activity:
On overhead, access “the Blackout Syndrome” module, episode 1. Read out to class: You, the reader, are a medical investigator working for Dr. Susan Lydell. As a blackout paralyzes the city, you are called in to investigate an outbreak of a new disease. You must take steps to identify how it's transmitted, characterize it (virus? bacterium? fungus?), and figure out how to treat it. The narrative itself is fictional, but the scenario is based on actual events and contemporary science research and discoveries.
PBL
Episode 1: Outbreak
Hand out Copies of clues at victims’ homes: “Bleeding baby”, “Another Victim”. Hand out the copies of PBL task – day 1, and read through it to class. Point out that they will be peer evaluated on how well they work together on every day of this mystery PBL. Partner up students.
Tell the students they are going to be investigating what caused the disease first by looking for clues in the homes of two separate victims of the disease. Ask the class, would finding similar clues in both homes help in finding the correct cause? They need to know that they are looking for what evidence is present in both homes.
After working for 10 minutes, get the class together to make sure everyone is heading in the right direction. Query the class and list on the board possibilities they’ve identified, and on what basis. However, to prevent full disclosure, don’t allow further discussion.
Hand out Copies of clues at third victims’ home: “A Third Victim”.
Allow another 10 minutes for the students to write out their answer on an index card, and turn it in. If some seem stuck, point out there is a review at the end of the hand out.
Bring class together for a final discussion: did the third victim’s home confirm or change your mind? Why? On the overhead access the explanations given by contest winners for why it is the milk (in episode 2, after “call Dr. Lydell”), to see if our class explanation is on par with “the winners”.
Do the partner evaluation as exit ticket.

Detailed list of Day 2 Resources, Worksheets and Evaluations
Copies of PBL task - day 2 (attached)
Index cards
Copies of the lab library (attached)

Detailed list of Day 2 Activities
Episode 2 Pathogen
Hand out copies of the lab library and copies of PBL task - day 2.
Anticipatory exercise:
Have students get out computers and access episode 2, “Your New Assignment”, and give them 5 minutes to read with a NEW partner and answer the first 3 task questions. Then as a class, call for answers, and fill out the observation table with the information we know so far.
Group work:
Group the students in teams of four by pairing up partners, and have them count off by fours. Read out the group work task.
5 minutes: Each team member needs to answer one of the four questions on the task handout.
15 minutes more to share their information with their team, so that everyone has the questions and data tables filled out. The teacher circulates to make sure everyone is on track.
Tell the partners continue through the episode until they get to the “Test Results”, where they then compare the observed condition of the mouse with their data tables, and the characteristics of the pathogen that were provided in the episode to identify the pathogen.
Read out the partner work task from the hand out. If they need assistance from their other teammates, they must first describe what they have done so far, and only be given tips on where to find the information that they need, NOT given the answer!

Bring class together for a final discussion and consensus.

On the overhead access the explanations given by contest winners for why it’s a bacterium. (in episode 2, “You tell Fran It’s a bacterium”), to see if our class explanation is on par with “the winners”.

Do the partner evaluation as exit ticket, and collect the task handouts for grading.

**Detailed list of Day 3 Resources, Worksheets and Evaluations**

Copies of PBL task - day 3 (attached)


Index cards


**Detailed list of Day 3 Activities**

Copies of PBL task - day 3

Episode 3 “The Intruder”

Select NEW partner and work through episode 3 “The Intruder”, answering the questions in task day 3.

After 10 minutes call the class together, to keep everyone on the right track. Go through the first four task questions as a class, then let them continue again as partners.

After students turn in their index cards with the solution, have partners continue with the conclusion to the story. Did they choose the right antibiotic?

Do the partner evaluation.

For the remainder of class time students choose and examine a report of real life disease outbreak at [http://www.who.int/csr/don/en/ World Health Organization Disease Outbreak News](http://www.who.int/csr/don/en/ World Health Organization Disease Outbreak News), and write a 50 -100 paragraph summary, as stated on the task handout.

Collect the task handouts for grading.
Outbreak of the Blackout Syndrome, TASK for day 1:

**Partner work  worth 8 points total**
On an index card, partners need to present their case for the most probable cause of the sickness. They must use evidence based on clues found at each home where the three victims lived. They must describe the evidence in such a way as to exclude all other possibilities. Write your names on the card and turn it in to the teacher.

**Secret peer evaluation 4 points**
Students rate their partner for their contribution on an index card. They need to put their name, and “assessment of” student’s name and rate:
- Worked well with partner.
- Did their share of the task.

Using grade scale as-
1: rarely
2: sometimes
3: half the time
4: usually
5: always

Turn in the index card to the teacher
Late at night, on a hot summer night, your phone rings. It's your boss, Dr. Susan Lydell. "I'm at Mercy Hospital," she tells you. "We have an urgent case here, a child, Isabella Allinger, nine months old. She's bleeding uncontrollably from her eyes and hands. We don't know why. I need you to go back to the Allinger's apartment and investigate things there."
"What am I looking for?" you ask.
"That's just it," she rushes on, practically yelling. "We don't know. Something happened to her in the last one or two hours. Maybe she ate something. Maybe something stung her. Maybe it's a chemical. It looks like a new disease, but why would Isabella be the first to get it?"
"Who else lives in the apartment?" you ask.
"The mother and father, Carmen and Julian Allinger. They're here, and they both seem fine. But wear gloves and a mask, just to be sure." She gives you the Allinger's address. "Whatever caused this disease, it affected only the baby. See if you can find it!"
"I'm on my way," you say.

The Allinger Apartment

The woman anxiously waiting by the door of the Allinger apartment introduces herself as Rita, Carmen Allinger's younger sister. "I'll come in with you," she says, so you give her a mask and some gloves.
The apartment is small and dead silent. You and Rita move into the first room, looking for clues to what made Isabella Allinger sick.

IN THE KITCHEN
The first thing you notice are the supper dishes on the table. In front of the high chair is a baby's plate messy with mashed food and a baby's cup half-full of milk. By examining the plate, it's easy to reconstruct Isabella's whole dinner menu. She had peas, applesauce, and a little piece of pizza with mushrooms.
Where Carmen and Julian sat are two empty plates with pizza crumbs on them, forks, two empty beer bottles, and two salad plates smeared with white dressing.
Beyond the table is a refrigerator. A milk bottle is sitting on the counter next to it.

You Open the Refrigerator

In the refrigerator you find seven jars of baby food; a jar of olives, nearly empty; old-looking bottles of ketchup and mustard; four bottles of beer. The bottom shelf is crammed full of fresh greens and vegetables in plastic bags: you see lettuce, carrots, beans, peas, and spinach.

You and Rita Look at the Milk Bottle
The old-fashioned milk bottle is labeled "Pure Whole Milk from Donnybrook Farms -- Unpasteurized, Unhomogenized, Nothing Added! Keep Refrigerated." It's been opened, but is almost full.
Rita wrinkles her nose. "This won't be good anymore," she says, and moves to pour it out. "Don't touch!" you warn her, and she jumps back in alarm.

IN THE HALLWAY
It's a tight little space. In the corner you spy a plastic garbage can. "Yuck!" grimaces Rita when you heave the plastic liner out of it. Inside the liner you find an empty applesauce baby food jar, a "Rollo's Take-Out Pizza" box, a nursery tag that reads "Lady's Slipper (paphiopedilum)," and a few greasy paper napkins.
Something rattles underfoot; it's an empty **pet food dish**.

You Find the Family Pet

"Your sister has a pet?" you ask Rita.
"Omygawd! Iggy!" Rita yells. "I forgot all about him!"

You and Rita search the apartment carefully and finally locate Iggy in the bathtub. Iggy is a green iguana, about two feet long.

"What does Iggy eat?" you ask Rita. "Iguana chow?"
"No way!" Rita squeals. "Vegetables. Leafy greens."

"Does Isabella play with Iggy?" you ask.
"She's not supposed to," Rita answers, "but yeah, she does. All the time. Watch out -- those claws are SHARP."

IN ISABELLA'S BEDROOM
Rita gasps. Inside the **baby's crib** is a blanket mottled with bloodstains. On the headboard a baby's hand is perfectly traced in blood.

Rita Reveals a New Suspect

You look closer at the crib. There's blood everywhere.

Suddenly, Rita bursts out, "It was that man. The exterminator. He's the one who made Isabella sick!"
"Exterminator!" you say. "Tell me more." Blinking back tears, Rita tells you that a man came and sprayed all the apartments earlier today. "He was from the Hitchcock Chemical Company," she says. "My sister said he assured her it would be harmless." "What was he spraying for?" you ask. "Roaches," she sobs.

IN THE LIVING ROOM
You again pass through the living room, where an old couch faces a TV set. The VCR still flashes "12:00... 12:00... 12:00..." A houseplant sits on the coffee table. You Examine the Houseplant
You see that some leaves and flowers have recently been pulled off the plant. A bit of leaf under the table looks chewed on. "Hey," says Rita. "Who's been scratching at the table?" She points to sharp claw marks going up one table leg. You notice a few on the table top.

IN THE MASTER BEDROOM
A man's work clothes are heaped in a corner. On the nightstand, the clock radio flashes the wrong time. "Looks like they had a power outage," Rita says. "The electricity went out this afternoon in the office where I work, and that's not far from here. It got so hot they sent us home early."

Rita points to the nightstand, where a red light blinks on an answering machine. "I heard the phone ring while I was waiting for you."

You Listen to a Message
It's a message for you from Dr. Lydell. "Isabella has what we call an acquired bleeding disorder," she shouts. Behind her, it sounds like an emergency is going on. "Profound hemophilia. If she scratches herself, the bleeding doesn't stop. Plus something is hemorrhaging the tissues around her eyes, her gums, her hair -- even around her fingernails. It's horrible to see. Her parents are holding up pretty well, considering. No sign of the disease in either of them, by the way. "What causes this? Some kind of pathogen. An invading agent like a bacterium or virus, or maybe a toxic chemical, or insect venom. I haven't noticed marks on her skin, but with all this blood, it's hard to be sure.

"Look, I have to go. Call me when you're finished gathering facts." She slams the phone down. After a moment, the answering machine beeps and rewinds.

READY TO MOVE ON
"I think I've learned all there is to learn here," you tell Rita. "Time to call Dr. Lydell and move on to the next step."
Another Victim
Source: 1994-2009 by Access Excellence @ the National Health Museum.

You call Dr. Lydell.
"Good thing you called, " she says urgently. "We've got trouble. We have to move fast."
"What happened?" you ask. "Is Isabella -- ?"
"We have another victim," Dr. Lydell rushes on. "Just came in. A fourteen-year-old boy named Troy Belindo. Same symptoms -- bleeding profusely from his eyes, nose, fingers, neck, feet... The Allingers say they don't know him, but it's definitely the same new disease."
"What do you want me to do?" you ask.
"Get over to his house," she says. "This boy must have something in common with Isabella. I need you to find out what it is. Right now!"
She gives you the address, and you write it down. "I'm on my way," you say, and hang up. Rita looks at what you've written down. "That's not far from here," she says, and gives you directions. "Goodbye!" you say as you run out the door.

The Belindo House

Mrs. Belindo meets you at the door to her house, an old bungalow with sagging window screens and peeling paint. She doesn't say much. She waves for you to go into Troy's bedroom, and then shuffles off in the direction of the kitchen.

IN TROY'S BEDROOM
Sprawled on the bed a teenaged girl jumps up when you come in. "Like, someone's here," she says into a cordless phone. "Someone. I gotta go, bye bye bye."
"Who are you?" you ask after she's hung up.
"Rosario. Troy's girlfriend. Where is he?" she wants to know.
"Didn't Mrs. Belindo tell you?"
"Nah. We don't talk much anymore," she shrugs. "Like, what's with the mask?"
"Troy's sick," you tell her. "He's in the hospital." This hits her hard.
"What - what's wrong with him?"
"We don't know. I'm here looking for clues. Better put these on," you add, handing her a mask and some gloves. She stares at them with alarm.
"He's really sick, isn't he?" she asks, and you don't deny it.
Looking around the cluttered bedroom, you notice a soda can on a desk.

You Look at the Soda Can

You pick it up. A little soda sloshes around in the bottom.
"That's mine," Rosario says. "From dinner. Troy and I had hot dogs."
"Troy had soda too?" you ask.
"Yes. He tried some milk but he poured it out," Rosario remembers.
"What did you have on your hot dogs?" you ask. "Did you and Troy have the same thing?"
"What about Mrs. Belindo?" you ask.
"She went grocery shopping after work," Rosario says. "Troy and I ate alone. Troy and Ninny and I," she corrects herself.
"Ninny?" you ask.
"Troy's cat. His name is actually Nine Inch Nails, because of his claws, you know? We call him Ninny for short."

You continue to investigate the old Belindo house, looking for possible causes of Troy Belindo's mysterious illness.

IN THE KITCHEN

Everything is neat, in a tired, gloomy sort of way. The stove looks like it hasn't been used in years. A big microwave sits on the kitchen table, its digital clock blinking "PF... PF... PF...". You look around for a garbage can, but don't see one.

You Examine the Garbage Can

On top of a load of junk mail you find an empty wrapper for six hot dogs, an empty wrapper for six hot dog buns, an empty soda can, a greasy paper towel and an empty "Donnybrook Farms" milk bottle.

Suddenly Mrs. Belindo is alongside you. "That shouldn't be in there," she scolds. Before you can stop her, she grabs the milk bottle and rinses it out vigorously. Then with a crash she tosses it into a glass recycling bin under the sink.

There's a phone caddy mounted on the wall; the cordless phone itself is missing. A picture calendar of endangered wildlife hangs alongside. Someone has written "HITCHCOCK EXTERMINATORS 4pm" in the box for today.

The old refrigerator clanks when its compressor comes on. Opening it, you find an open carton of milk, plus margarine, eggs, an almost-empty package of mushrooms, jars of relish and brown mustard, and a six-pack of soda with two cans missing.

You Read the Calendar

"They never came," says Mrs. Belindo, who sees what you're looking at. "Twice now I make an appointment, and they don't come."
"You have pests?" you ask her. She points to the ceiling, festooned with cobwebs. "Spiders," she says tiredly. "I hate them. And I wake up with their bites," she says, holding out one fleshy arm. There's a mark on it like a mosquito bite.

IN THE FAMILY ROOM
Mrs. Belindo sits in her chair, fanning herself and drinking from a glass. The TV is tuned to a late-night movie with the sound turned down low. It's a comedy, but you notice Mrs. Belindo is crying softly to herself. There's a raggedy houseplant on the table next to her.

You Examine Mrs. Belindo's Houseplant

"Be careful," Mrs. Belindo warns you. "That's an amyrillis belladonna. Beautiful plant, but poisonous, you know. They call it the Deadly Nightshade."
"Looks like something's been scratching at it," you observe. "A cat maybe?" Mrs. Belindo shrugs.

You Talk with Mrs. Belindo

You ask Mrs. Belindo if she has any idea how her son Troy got sick.
"It's that girl," she hisses, nodding her chin at the door to Troy's bedroom. "So bossy. She calls him at all hours. They sneak around at night. He -- he doesn't eat right!" She cries softly some more.
"Are you all right?" you ask her.
"Yes," she says. "Just tired. Very tired. And I'm scared at what will happen to my son." She stops to take a drink from a glass of milk.
"You're drinking milk," you observe.
"Yes," she says. "Want some? It's nice and cold."
Suddenly a sleek young tabby cat jumps up into her lap, its eyes upon the glass in Mrs. Belindo's hand. "Oh, all right," she sighs, and tips the glass so the cat can lap at the milk. "Troy would never do this. He says milk is bad for cats. Have you ever heard anything so ridiculous in all your life?"

You Try to Examine the Tabby Cat

You look closer at the cat, and notice a scratch on one of its ears. "Where'd he get that?" you ask Mrs. Belindo. She shrugs.
You reach out to examine the scratch and suddenly the cat whirls, strikes and jumps away. You look down at your hand, where blood wells up through your shredded latex glove.
"Well, now look what he's done," Mrs. Belindo says, dabbing a napkin at her blouse. "Made me spill my milk."

BACK IN TROY'S BEDROOM
Rosario is pacing up and down, up and down. Her mascara is a mess.
Looking around the cluttered bedroom, you notice a soda can on a desk, and a door to another room. "What's in there?" You ask. "Bathroom," shrugs Rosario, and she nudges the door open.
Inside is a crimson-stained towel and a floor slick with blood. **Rosario** starts to scream, and it takes you a minute to get her calmed down. "It's all my fault," she sobs. "Call the hospital -- I gotta find out if Troy's all right."

"When I'm through here," you tell her. "Once I've figured out what Troy Belindo and Isabella Allinger have in common."

You Talk with Rosario

You ask Rosario why she thinks she made Troy sick. Her hands shaking, she pulls a piece of paper out of a skinny little purse.

On the paper, someone's sketched something that looks like a beaded necklace with a cross.

"That's a rosary," Rosario says. "Troy got a tattoo. I made him get it. Because my name means 'rosary,' right? And, like, he was bleeding. A lot."

"After he got it?" you ask. She nods. "A long time after?" She shakes her head no.

"When did Troy get this tattoo?" you ask her.

"Two days ago," Rosario sobs, and refuses to say anything more about it.

"Do you know the Allingers?" you ask.

"Yeah," Rosario says. "Sure. Kinda. Last year, when they were on vacation, I took care of their iguana. Iggy, right?"
A Third Victim
Source: 1994-2009 by Access Excellence @ the National Health Museum.

You are about to tell Dr. Lydell your theory about when you hear a commotion in the background. "Hang on..." she says, and you hear her shouting orders to someone.
"What happened?" you ask. "Is Isabella -- ?"
"Another case," she snaps. "Young woman. Bleeding all over. Heavens, what a mess. Get over to her condo!" She rattles off a name and address: Jessica Willton, The Albany Arms, 659 Center Street, Unit 609.
"What do you want me to do?" you ask.
"Something made these three people sick -- Isabella, Troy, and now Jessica," she reminds you. "Some common thread. Find it! And hurry!" In the background you hear someone scream. She slams the phone down.

Inside the Albany Arms

Except for emergency lights, the condo building is dark. In the lobby, some people with flashlights are trying to free someone trapped in an elevator. You find the stairs and climb five stories to reach Unit 609.
The door is locked. You move toward a light flickering next door.

IN UNIT 610

Two neighbors huddle around a table ablaze with candles. They're eager to tell you what happened.
"Jessica knocked on my door," the woman, Stella, tells you. "I opened up -- it was like a horror movie. 'Mask of Blood.'"
"I called the ambulance," the man, Eric, says. "I tried to clean her up but Jessy just wouldn't stop bleeding. She got blood all over me," he says, rubbing at smears on his arms.
"I need to get into her condominium," you say.
"I share a balcony with Jessica," Stella pipes up. "Maybe you can get in that way. Are you afraid of heights?"

Candles in hand, the three of you inspect the balcony. A wall separates Stella's side of the balcony from Jessica's side.
"Look," Eric says. "Simple. I'll go see if her balcony door is open." And before you can say anything he steps over the rail, swings around the wall and over onto Jessica's side of the balcony. You hear pottery fall and shatter. Eric curses, then falls silent.
"Eric," you shout. "Eric!" There is no response.

You Explore Jessica's Condominium by Candlelight
ON THE BALCONY
There are plants everywhere, many of them bearing exotic flowers. Each plant is carefully labeled with names like Cymbidium and Epiphyllum.
Near the rail, a rack of young plants has been knocked over. Terra cotta pot shards crunch underfoot. A rich smelly dirt covers the floor.

IN THE LIVING ROOM
Everything is neat as a pin. More of the exotic plants adorn the coffee table. On a side table, a fat candle gutters, illuminating an electric clock with hands frozen at 2:03. The front door is wide open. There is no sign of Eric.

IN JESSICA'S BEDROOM
Everything is neat and clean. A business blouse and skirt, neatly pressed, hang from the closet doorknob. You see jewelry and other things arranged on the dresser.
There's a book face down upon the rumpled bed. Above the bed, the windows are thrown wide open in hopes of a cooling breeze. Outside, the entire city is dark, except for a tall building all lit up in the distance. You recognize that building: Mercy Hospital.

You Examine What's On Jessica's Dresser
First thing you pick up: a name badge. The picture is of a young woman with clear eyes and a mischievous smile. Beside the picture is printed "Jessica Willton, Chemist, Rillstone-Mercury Biosystems Inc." Then in red letters: "Security Clearance Level Two." Next you find a pair of gold earrings for pierced ears, still in their original package.
A gold charm bracelet and a gold lady's wristwatch are laid out side by side, atop a black address book. You look to see if Jessica knows the Allingers, the Belindos, or Rosario, but apparently she doesn't.
Last there is a wide-mouth jar of facial moisturizing cream. "Works while you sleep!" the label boasts. The jar is open. You look inside: the application pad is thick with blood.

You Examine Jessica's Book
The book is titled "A Plague Upon Both Houses." It seems to be a science thriller about bacteriological warfare. The bookmark, inserted at the chapter break on page 51, is Jessica's "To Do" list for yesterday. It reads:
TO DO:
✓ groceries
✓ cherries
✓ plant food
✓ cleaner
✓ mushrooms
✓ milk -- for Stella too
✓ ears pierced
✓ make pie

replant Epiphyllum

All but the last one have been checked off.

The kitchen is immaculate. On the refrigerator hangs a pad that says "TO DO TODAY!" across the top. You open up the refrigerator, and see it's completely empty.

Instead of a garbage can, there is a dark chute which sends the garbage down into the bowels of the building. The dishwasher holds only a pie plate and an empty milk glass.

Everything is dead silent except for a soft drip-drip-drip.

You Read Jessica's "To Do" List

Today's list reads

TO DO:

✓ replant Epiphyllum
balance checkbook
call Terry
e-mail

Only the first one has been checked off.

You Find Out What's Dripping

Something milky is dripping from under the freezer door.

You open the freezer to find it crammed with such things as ketchup, packaged chickens, frozen vegetables and cans of fruit juice concentrate. On top of everything, there is a cherry pie with one slice gone; it looks homemade. You look for milk and mushrooms, but don't find any.

You trace the drip to a quart of vanilla ice cream, turned on its side.

Review Clues in Jessica's Condominium

Jessica grows many exotic orchids. She works as a chemist for the Rillstone-Mercury Biosystems company, in a high-security area. She is reading a novel about bacteriological warfare.

Her condo lost power about 10 hours ago.

According to her "to do today" lists, Jessica recently got her ears pierced. She also bought cherries, plant food, cleaner, and mushrooms, plus she got milk for herself and her neighbor, Stella.

She recently made a cherry pie, and ate a piece with a glass of milk. According to her lists, the latest thing she did was to replant one of her orchids, the Epiphyllum.

Jessica's refrigerator is empty, because she crammed everything into her freezer in an attempt to keep it cold. There is no milk container in the freezer, so Jessica must have thrown it away, down her garbage chute.

The applicator pad of her facial cream is thick with blood.
Name ___________________________            period ______________

Episode 2: Pathogen of the Blackout Syndrome, TASK for day 2:
source: 1994-2009 by Access Excellence @ the National Health Museum.

1) What are the 4 pathogen categories do they test?

2) What is the control group?

3) What is the experimental group?

Group work: 8 points
From the lab library handout and information from episode 2,

a) Describe how the technique will give them data to learn the category of the pathogen,
   including the basic procedure (3 sentences per question).

1) AT THE OPTICAL MICROSCOPE?

2) AT THE FILTRATION UNIT?

3) AT THE PETRI DISH?

4) AT THE ATOMIC ABSORPTION FLAME PHOTOMETER?

b) In the table that follows, write what the sample label represents for your question.

<table>
<thead>
<tr>
<th>Observations:</th>
<th>“good” milk</th>
<th>“evil” milk</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Odor</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Photometer readouts

<table>
<thead>
<tr>
<th>sample label</th>
<th>Represents</th>
</tr>
</thead>
<tbody>
<tr>
<td>MA</td>
<td></td>
</tr>
<tr>
<td>MB</td>
<td></td>
</tr>
<tr>
<td>MC</td>
<td></td>
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<tr>
<td>F100A</td>
<td></td>
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<tr>
<td>F100B</td>
<td></td>
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<tr>
<td>F5A</td>
<td></td>
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<tr>
<td>F5B</td>
<td></td>
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<tr>
<td>F0A</td>
<td></td>
</tr>
<tr>
<td>F0B</td>
<td></td>
</tr>
<tr>
<td>CWA</td>
<td></td>
</tr>
<tr>
<td>CYA</td>
<td></td>
</tr>
<tr>
<td>CYB</td>
<td></td>
</tr>
</tbody>
</table>

**Partner work: 6 points**
On an index card, partners need to present their case for the most probable identity (category) of the pathogen. They must describe the evidence in such a way as to exclude all other possibilities.

**Write your names on the card and turn it in to the teacher.**

**Secret peer evaluation: 4 points**
Students rate their partner for their contribution on an index card. They need to put their name, and “assessment of” student’s name and rate:
- Worked well with partner.
- Did their share of the task.

Using grade scale as-
1: rarely
2: sometimes
3: half the time
4: usually
5: always

**Turn in the index card to the teacher.**
"Hey, here's a book that explains the atomic absorption flame photometer," Zack says. "It's used for detecting poison -- well, some poisons, anyway. Many poisons have metal salts in them, like sodium in sodium cyanide. Metal salts give off a distinctive color when burned. So a substance laced with sodium cyanide would have a stronger readout of sodium than normal."

"I found out something about microbe sizes," you say, hefting a big microbiology text. "Funguses, or fungi, or whatever, are many-celled creatures that are generally larger than 10 microns. Bacteria are one-celled creatures and they're between a half-micron and 10 microns in size. Viruses are way smaller than bacteria. Both viruses and chemicals would pass right through a half-micron filter."

"I told you already, it's not a virus," Zack says pointedly. "So don't waste your time reading about them."

"Petri dishes really excel at growing bacteria and fungi," you say, reading on. "Heck, I could have told you that," Zack says, unimpressed. "Say, you writing all this down?"

In a chemistry book, you learn that metal salts such as sodium cyanide each give off a distinctive color when burned. A chart helps you conclude that both sample A and sample B contained equal amounts of these salts.

In a microbiology text, you see that fungi are, typically, larger than 10 microns. Bacteria are one-celled creatures typically larger than a half micron, but smaller than 10 microns. Viruses are always much smaller than a half micron. Chemicals are also much smaller than a half micron.

Bacteria, and to a lesser extent, fungi, are among the organisms that culture well in petri dishes.
Episode 3: Treatment for the Blackout Syndrome, TASK for day 3:
Source: 1994-2009 by Access Excellence @ the National Health Museum.

**Partner work: 8 points**

1) What color would a Gram positive bacterium be stained? What color would a Gram negative bacterium be stained?

2) **Microscope**— what is the description of the pathogenic bacterium?

3) **Culture Dish**— What type of antibiotic is on the culture dish in Fran’s knapsack? Is it effective against the “Blackout syndrome” disease?

4) **Black’s Book— Food poisoning.** On a culture dish, how does a scientist know if the antibiotic being tested is effective? What disease bacterium name most likely causes “Blackout Syndrome”?

5) **Textbook** - given the descriptions for the antimicrobial drugs, list any that might be used against the “Blackout Syndrome” bacteria (notice your answer to question #3).

**Secret partner evaluation: 4 points**
Students rate their partner for their contribution on an index card. They need to put their name, and “assessment of” student’s name and rate:

- Worked well with partner.
- Did their share of the task.

Using grade scale as-
1: rarely
2: sometimes
3: half the time
4: usually
5: always
Turn in the index card to the teacher.

**Independent research task:** 8 points
For the remainder of class time students choose and examine a report of real life disease outbreaks at [World Health Organization Disease Outbreak News](https://www.who.int/disease-outbreak-news), and write a 50 – 100 word paragraph summary below:
Class time required: **Four** 40-minute class periods

Overview:

<table>
<thead>
<tr>
<th>Day</th>
<th>Activities</th>
</tr>
</thead>
</table>
| 1   | Read out scenario and task.  
        Call up background knowledge/pre-assess with a quick write  
        They explore an interactive computer simulation to learn about cancer and fill out a worksheet followed by a class discussion.  
        For assessment, there is quick write about what they learned about cancer. |
| 2   | Give and go over the cancer treatment letter and brochure guidelines.  
        Committees are formed and choose which cancer treatment to research.  
        Students begin their research by identifying spots where they can get information and taking notes in a word document. |
| 3   | Students finish their research and begin placing their information into a brochure.  
        Review the criteria on the feedback form and on the evaluation form, and let students polish up their document.  
        Each student reviews a team member’s brochure, fills out the feedback form and returns it to them. |
| 4   | Students revise their brochure, using the peer feedback form as guidance.  
        Students put together their brochure.  
        Students view the brochures of other teams.  
        At end class, vote on the best one. |
PBL principles incorporated:

1) **The problem or design is an authentic task and learning environment.**

On day 1 of this PBL, the students learn that a fictitious friend has been diagnosed with skin cancer, and has many questions. They are going to do research to help her learn more about cancer. Furthermore, they receive a letter of the cancer treatment center requests they volunteer to work on a committee that will create an engaging and informative brochure for adult cancer patients or their family members explaining medical information on cancer treatments.

2) **The problem or task is the basis of all learning.**

The case presented on the first day focuses the students on helping their friend understand more about cancer and how it is treated. All learning objectives stem from this premise, and form the activities within this PBL.

3) **Overall, the learner must feel ownership of the problem or task, and development of the solution.**

Each team decides which treatment method they want to research from a list, and each member is asked with researching a specific aspect of the treatment for the brochure. They do individual research using online sources. They then must work as a team to put together the information they each collected into a brochure.

4) **Encourage testing the ideas against alternative views and opportunities for reflection.**

The PBL starts with students doing a quick write about what cancer is and what causes it. They then explore an interactive computer simulation to learn about cancer, and reflect upon the information to fill out a worksheet followed by a class discussion where students share their answers to questions posed with the class. Once their brochures are created, they each student reviews a team member’s brochure, and provide feedback. Finally, the students view the brochures created by the other teams. They evaluate their peers on the quality of their group work.

**When to use:** Students will have learned most of the LE curriculum pertaining to cell function, including DNA mutations. Most recently, they will have learned about mitosis.

**Precautions and/or advice:** Since the background knowledge building activity on day 1, which describes mechanisms and causes of cancer, is technical, try to do this PBL soon after students have learned about mitosis and how genes work, to help them connect with the content. This PBL does not need additional background knowledge about cancer, as they learn this information during the PBL, as well as during research on cancer treatment. Because of modifications made to ensure the principles of PBL, (as discussed in the literature review), it is prudent to follow the
detailed daily activities as written, modified from the lessons for “Understanding Cancer: National Cancer Institute Tutorial” and, “Cancer Treatments” found at http://www.urmc.rochester.edu/Life-Sciences-Learning-Center/Resources/Lessons-Registration/Lessons/Cancer-Biology.aspx

New York State Living Environment
Performance indicator 1.1, Major understandings 1.1c
Performance indicator 1.2, Major understandings 1.2a, 1.2b
Standard 4:
Performance indicator 1.2, Major understandings 1.2b-j
Performance indicator 2.1, Major understandings 2.1a, 2.1f-i
Performance indicator 2.2, Major understandings 2.2a-e
Performance indicator 3.1, Major understandings 3.1b-d
Performance indicator 5.2, Major understandings 5.2a, 5.2c, 5.2d, 5.2f-j

Detailed list of Day 1 Resources, Worksheets and Evaluations
Copies of scenario and task
Online cancer videos at 1) what is cancer?: http://science.education.nih.gov/supplements/nih1/cancer/activities/activity2_animations.htm
Copies of worksheet for day 1 (attached)
Copy of teacher answers (attached)
Index cards

Detailed list of Day 1 Activities
Hand out copies of the scenario and task, as well as copies of the worksheet for day 1. Point out that part of their evaluation will be on how well they work together. Group students into teams of four.
Anticipatory activity
Read out scenario. Call up background knowledge/pre-assess by asking the students to do a 2 minute quick write for, “What exactly is cancer? What makes a body cell become cancerous?” Have the students share their quick writes at their tables, and then call on each table to report out (think, pair, share). Encourage responses that point out that cancer involves the uncontrolled division of body cells.
Partner work (refer to teacher answers)
Have students partner up within their team and get out computers to learn about cancer via online videos and task sheet:
10 minutes Section 1: Sheena wants to know what exactly is cancer? http://science.education.nih.gov/supplements/nih1/cancer/activities/activity2_animations.htm
Ask one or more teams to read their statements to the class, then invite clarifying comments and questions from the rest of the students. Point out that:
1) their five statements constitute a basic explanation of what goes wrong when a cell becomes cancerous.
2) understanding disease typically requires scientists to examine basic cellular processes, and that understanding those processes can, in turn, help health care workers develop better prevention and treatment strategies.

Anticipatory activity Section 2: Sheena wants to know what causes cancer? Part 1
Introduce the activity by noting that people have wondered about the cause of cancer for thousands of years. Throughout this time, many correlations have been noted between the development of cancer and various internal and external factors. Explain that each news item describes what has proven to be a real relationship between the development of cancer and the factor described.

10 minutes to fill out Section 2 with partner:

Then ask one team to describe what a particular video suggests about the cause of cancer and a different team to describe the evidence on which this claim was based. At the close of the reporting, you may wish to ask students whether the evidence presented in these videos is convincing and why. This is a good point in the activity to remind students of the difference between correlation and causation and ask what type of evidence would demonstrate causation.

Anticipatory activity Section 3: Sheena wants to know what causes cancer? Part 2 Ask students what general question all four videos raise when they are considered collectively. If students are having difficulty recognizing the question that these four videos raise about cancer's cause, you may wish to rephrase the question as, "What do you think may have confused researchers trying to understand what goes wrong in cancer cells?" or "The number of different agents that can cause cancer was one of the most confusing aspects of cancer to early researchers. Why was this confusing?" or "What do you think all these agents had in common and why was it important to discover that?" – Give them a hint that it relates to information they learned in Section 1 (cell division regulated by genes). Take all ideas and proceed to Section 3:

10 minutes to fill out Section 3 with partner or teams if need additional support. Ask one or more teams to read their statements to the class, then invite clarifying comments and questions from the rest of the students.

Students may have difficulty with this step, primarily because they lack sufficient background in biology to make the connections required to explain "causative" agents of cancer. For this reason, you may provide only the most basic explanations, such as those provided in bold type in the teacher’s answers. After they have done so, you can explain as much of the detail as you think is appropriate and will be interesting to the class.

Exit ticket: Pass out index cards.

1) “On the index card provided, 4 things you learned about cancer in today’s lesson, using a complete sentence for each thing— a half point per answer maximum,
2) also rank your partner’s contribution according to the grading scale on the worksheet.”

Detailed list of Day 2 Resources, Worksheets and Evaluations
Handed out in earlier lesson: Copies of scenario and task,
Copies of “Cancer Treatment Center letter and Brochure Guidelines”
Copies of individual evaluations
Provide computers for students to be able to create brochures (word docs) as well as for Internet access to use the following websites:
http://www.cancer.gov/cancertopics/treatment/types-of-treatment
http://www.oncolink.com/treatment/

Detailed list of Day 2 Activities
Anticipatory activity
From the “scenario and task”, re-read the scenario, and then read out the task about making a brochure for the cancer center. Ask which of Sheena’s questions the students answered yesterday with their internet activity (the first two). Now they are going to do research to answer her last two questions, and use it to make the brochures with others in your committee.
Distribute one copy of “Cancer Treatment Center and Cancer Treatment Brochure Guidelines”, and the individual evaluations. Read the letter to the class. Go over both the brochure guidelines and individual evaluation from.

Assign students to work in committees of 4 students, then have students count off within their committee. Tell students that they are expected to do research and prepare their section of the brochure that matches their number. Each section 2 questions (a and b) that must be addressed. They will have 45 minutes of class time to research and create their section of the brochure.
Have students get out computers for access to the following sites:
http://www.cancer.gov/cancertopics/treatment/types-of-treatment
http://www.oncolink.com/treatment/
Allow 10 minutes for the committee meeting during which each team decides which treatment method they want to do (suggest that each student look over one that sounds interesting for 2-3 minutes, and then discuss with their team, if can’t decide, draw straws):
Chemotherapy
Radiation therapy
Surgery
Angiogenesis Inhibitors
Biologic Therapy
Targeted Therapy
Bone Marrow Transplantation
Gene Therapy
Hormone Therapy
Photodynamic Therapy
For any remaining class time, students begin their research by identifying spots where they can get information and taking notes in a word document. Support them in this by circulating around the room, as well as suggesting teammates help out with this as well.

Detailed list of Day 3 Resources, Worksheets and Evaluations
Detailed list of Day 3 Activities
For the first 15 minutes, students finish their research and begin placing their information into a brochure. Again, support them in this by circulating around the room, as well as suggesting teammates help out with this as well.
Check in: review the criteria on the feedback form and on the evaluation form.
For next 15 minutes, students polish up their document.
For the last 15 minutes, each student reviews a team member’s (the member with the next higher question number, with #4 doing the part for member #1) brochure, fills out the feedback form and returns it to them.

Detailed list of Day 4 Resources, Worksheets and Evaluations
Handed out in earlier lesson: Copies of scenario and task, Copies of “Cancer Treatment Center letter and Brochure Guidelines”, Copies of individual evaluations, Copies of “Feedback Form for Cancer Treatment Brochure”
Arrange for Internet access to use the following websites
http://www.cancer.gov/cancertopics/treatment/types-of-treatment
http://www.oncolink.com/treatment/

Detailed list of Day 4 Activities
For the first 15 minutes students revise their brochure, using the peer feedback form as guidance.
For the next 15 minutes students put together their brochure by emailing documents to one student, and polishing its presentation. Then they send a copy to the teacher, as well as to other classmates.
For the last 15 minutes, students view the brochures of other teams. With a class of 24 students, they will be viewing 5 other brochures, so they should spend about 3 minutes on each.
At end class, vote on the best one!
**Cancer PBL scenario and task**

Modified from Life Sciences Learning Center – Cancer Education Project, Copyright © 2007, University of Rochester, May be copied for classroom use

**Scenario: Catching Some Killer Rays**

Sheena had always liked to lie out in the sun. She just wasn’t happy unless her skin was a golden brown color. Even in the winter, she insisted upon removing the cold white appearance of her skin. “I’ve got to get to the tanning bed!” would be her weekly slogan.

Towards the end of her senior year in college, Sheena began to notice a strange black spot on her back. It had not been there a few years ago, and it seemed to look a little different every day.

Sheena decided to show this strange black mark to her doctor. He diagnosed her with malignant melanoma, a serious form of skin cancer. Her doctor described “Melanoma” as a disease of the skin in which cancer (malignant) cells are found in the cells that color the skin (melanocytes).” He further explained that the first step in treatment is the removal of the melanoma, and the standard method of doing this is by surgical excision - cutting it out. If the cancer has spread, then chemotherapy will be necessary.

Sheena’s head was spinning. She knew she needed a minute to digest the information just given to her. So many questions came to mind. What exactly is cancer? What causes it? Are all cancers the same, and do they get treated the same way? Sheena needs some answers -fast! She’s relying on friends like you to help her out with the research.

**Task: Cancer treatment Brochure**

You learn of an opportunity to help out other cancer patients at the local cancer treatment center. They are looking for volunteers to make brochures explaining various treatment options. What a great way to put you research for your friend Sheena to good use!
Name ______________________ period ____________

Understanding Cancer PBL, Worksheet for day 1
Source: Copyright ©1999 by the BSCS and Videodiscovery, Inc.
(each answer is worth 0.5 point for a total of 9 possible points)

2 minute quick write: What exactly is cancer? What makes a body cell become cancerous?

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Section 1: Building an Explanation for the Cause of Cancer

Go to website: http://science.education.nih.gov/supplements/nih1/cancer/activities/activity2_animated.htm

Think about the information each animation presents, then write a one-sentence statement for each that summarizes what you learned.

Animation 1: Cancer involves . . .

Animation 2: Cell division normally is . . .

Animation 3: Cell cycle regulation is accomplished by . . .

Animation 4: Cancer-causing agents often . . .

Animation 5: When damage occurs to genes that regulate the cell cycle . . .

Section 2: Factors Reported to Be Associated with Cancer
Go to website: 
View the News Alert videos and use the information provided to identify what each video suggests is the cause of cancer and what evidence supports that claim.

<table>
<thead>
<tr>
<th>News Alert Video</th>
<th>Factors Proposed to Cause Cancer</th>
<th>Evidence</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cancer and Chemical Poisons</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cancer and Your Family History</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cancer and Radiation Exposure</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Cancer and UV Light</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Section 3: Explaining Factors Associated with Cancer**
Review your notes from Section 2, then write a sentence that describes how our current understanding of cancer explains the role that each factor plays in causing cancer.
Cancer and Chemical Poisons
Cancer and Your Family History
Cancer and Radiation Exposure
Cancer and UV Light
(source end)

Secret partner evaluation 4 points

Students rate their partner for their contribution on an index card. They need to put their name, and “assessment of” student’s name and rate how well they worked with partner, using grade scale as:

9- Very little
10- Some, but not quite satisfactory
11- Satisfactory, but not excellent
12- Excellent

Turn in the index card to the teacher
Day 1  Teacher answers  
Source: Copyright ©1999 by the BSCS and Videodiscovery, Inc.

Section 1: Sheena wants to know what exactly is cancer?

- **Animation 1** (the animation of abnormal cell growth) should lead students to conclude that **cancer involves the uncontrolled division of body cells**.
- **Animation 2** (the introduction to the cell cycle) should lead students to conclude that **cell division normally is precisely regulated**.
- **Animation 3** (the information on proto-oncogenes and tumor-suppressor genes) should lead students to conclude that **cell cycle regulation is accomplished by two major types of genes**.
- **Animation 4** (the information on the mutagenicity of carcinogens) should lead students to conclude that **cancer-causing agents often damage genes**.
- **Animation 5** (the information on the effect of damaging cell cycle genes) should lead students to conclude that **when damage occurs to genes that regulate the cell cycle, the balance between signals that stimulate cell division and signals that inhibit cell division can change, leading the cell to divide more often than it normally would**.

Section 3: Sheena wants to know what causes cancer?

- **News Alert! Cancer and Chemical Poisons.** Students should be able to suggest that a **chemical in the coal dust caused damage to genes that regulate the cell cycle**.
Pott was probably the first person to associate a specific type of cancer (scrotal cancer) with a specific occupation (chimney sweeping). Pott believed the problem was the coal soot that caught in the skin folds of the scrotum. In 1918, coal tar was shown to cause skin cancer in rabbits, and in 1924 the causative agent was identified as polycyclic aromatic hydrocarbons, especially benzo (a) pyrene.

- **News Alert! Cancer and Your Family History.** Students should be able to suggest that **children with inherited retinoblastoma have inherited an error (mutation) in a gene that regulates the cell cycle**.

Retinoblastoma, a relatively rare cancer, is a highly malignant tumor of the eye. If left untreated, the malignancy moves from the eye along the optic nerve to the brain, from where it metastasizes to other tissues. Slightly more than one-third of retinoblastoma cases are inherited. The remaining cases are sporadic (not inherited). The age of onset of the inherited type is approximately 10 months, on average 8 months earlier than the sporadic type. Tumors of both eyes occur only with the inherited type.

A mutation or deletion in the long arm of chromosome 13 is associated with the development of retinoblastoma. Both alleles of the gene involved, the **RB** gene, are either missing or altered in nearly every case of retinoblastoma (whether inherited or sporadic). The gene's normal product has an inhibitory effect on cell division.

Children who inherit an altered allele of the **RB** gene are heterozygous for the chromosome 13 abnormality. They are at high risk for developing retinoblastoma because only a single mutation or deletion of the normal **RB** gene will result in a cell initiating uncontrolled cell division. The mutation rate for this gene is high enough that there is significant risk of experiencing the
mutation in the cells of both eyes (thus, the risk of developing retinoblastoma in both eyes in the inherited type).

In sporadic (nonhereditary) retinoblastoma, both alleles of the RB gene are normal, and each one must be mutated in the same cell for the tumor to arise. In contrast with hereditary retinoblastoma, the likelihood of this occurring in both eyes is so low that for all practical purposes, it does not occur.

- **News Alert! Cancer and Radiation Exposure.** Students should be able to suggest that exposure to X-rays damages genes that regulate the cell cycle.

Ionizing radiation is a well-known human carcinogen. The first reports of association between X-rays and cancer appear in the literature in the early 1900s. Subsequent reports include the association between radium exposure and leukemia (for example, Marie Curie died of leukemia); radium exposure and osteosarcomas (for example, cancer developed among painters of luminescent dials in watch factories in the 1930s); and radiation from nuclear tests and cancer (for example, children in the Marshall Islands exposed to radioactive iodine released from a nuclear test displayed a significant increase in thyroid cancer).

Carcinogenesis from ionizing radiation is believed to occur through the formation of mutagenic oxygen free radicals. Ionizing radiation is clearly carcinogenic when presented at unusually high doses, but it has been difficult to quantify its effect when presented at low doses. Because the assumption is that any amount of exposure has some effect, federal regulations mandate that exposure to radiation be kept "as low as reasonably achievable."

- **News Alert! Cancer and UV Light.** Students should be able to suggest that exposure to UV light damages genes that regulate the cell cycle.

The relationship between sun exposure and skin cancer has been clarified greatly across the past century. In the late 1800s, observers noticed that sailors exposed to the sun developed a variety of abnormal lesions called "sailor's skin," and in the early 1900s, an increased risk of skin cancer was observed among farmers. By 1928, researchers had demonstrated the carcinogenic effect of UV radiation on the skin of laboratory animals. Today, scientists recognize excessive exposure to UV radiation (whether from the sun or other sources) as a key risk factor for skin cancer.

(source end)
**Cancer Brochure task**

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**Cancer Treatment Center**
University Medical Center
Anytown, New York

Dear Volunteer:

Thank you for adding your name to a list of individuals who would be willing to volunteer their help to support cancer patients and their families.

A significant number of our cancer patients have difficulty reading and understanding the medical information on cancer treatments that is provided on our current website. To solve this problem, we have established several committees to design brochures that explain cancer treatments to these patients. You will work on a committee that will create an engaging and informative brochure for adult cancer patients or their family members (see guideline below).

Thank you for agreeing to assist the cancer center by working on these committees. If you have any questions, please contact me by calling xxx-xxx-xxxx. I would be happy to answer any questions that you have.

Ms. Cordeiro

Director of Patient Services
Cancer Treatment Center

(source end)
Evaluation of individual work for cancer treatment brochure

Grading scale: Rate the following questions for effort using this point system:

1- Very little
2- Some, but not quite satisfactory
3- Satisfactory, but not excellent
4- Excellent

Score for your section topic

Part A
_______ Is the explanation sufficient (i.e., it explains everything it needs to) and coherent (i.e., rational, sound, and free from contradictions)?
_______ Did they use enough evidence to support their ideas (i.e., They used more than one piece of evidence, and all their ideas are supported by evidence?)
_______ Did they meet all the criteria listed in the assignment?

Part B
_______ Is the explanation sufficient (i.e., it explains everything it needs to) and coherent (i.e., rational, sound, and free from contradictions)?
_______ Did they use enough evidence to support their ideas (i.e., They used more than one piece of evidence, and all their ideas are supported by evidence?)
_______ Did they meet all the criteria listed in the assignment?

Group work
_______ day 2: contributed to preliminary treatment research
_______ day 3: filled out feedback form for assigned team member
_______ day 4: contributed putting together final brochure, and during allotted time viewed all other group brochures.

_______ Total score out of 26 points
Feedback Form for Cancer Treatment Brochure

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Type of Cancer Treatment: _______________________________________

Section Topics: _________________________________________________

Name of Author: ________________________________________________

Name of Reviewer: ______________________________________________

1. **Three** specific suggestions for revisions, additions, or deletions to ensure that the content of the section provides accurate and essential information for the patient.

2. **Two** specific suggestions to make the section more engaging and understandable by the patient.

3. **One** specific suggestion to improve the consistency between different parts of the brochure?

(source end)
Class time required: Three 40-minute class periods

<table>
<thead>
<tr>
<th>Day</th>
<th>Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Read out scenario, and then have students read the section on Huntington’s Disease, and do the DBQ’s that follow to build the background knowledge needed about Huntington’s disease. The students begin researching their own question about Huntington’s disease and genetic testing using websites provided.</td>
</tr>
<tr>
<td>2</td>
<td>The students finish researching their own question about Huntington’s disease and genetic testing. Students respond to peer research for each member of their group.</td>
</tr>
<tr>
<td>3</td>
<td>Students fill out Jenny’s pedigree to identify her risk of inheritance of the HD gene. In partners, they evaluate a script discussing the costs and benefits of genetic testing, followed by a group and class discussion, and vote. The results of the test are presented.</td>
</tr>
</tbody>
</table>

PBL principles incorporated:
1) The problem or design is an authentic task and learning environment.
This PBL gives students a life-like experience on the treatment of inheritable diseases as a result of increased scientific knowledge about the genetics. Therefore, this PBL is designed to show how learned curriculum relating to inheritance and genetic technology, pertains to the real world.

2) The problem or task is the basis of all learning.

On Day 1, the students learn that a young woman named Jenny is trying to decide whether to have genetic testing done, in order to find out whether she carries the gene for Huntington’s disease. The scenario presented focuses the students on the problem and outlines aspects of the problem that need to be addressed. Answering these issues forms the tasks/activities within this PBL.

3) Overall, the learner must feel ownership of the problem or task, and development of the solution.

The students are responsible for researching their own question about Huntington’s disease and genetic testing, as well. They evaluate information to form their own informed opinion of whether to get tested.

4) Encourage testing the ideas against alternative views and opportunities for reflection.

They evaluate information provided in an expository document about Huntington’s disease, followed by a class discussion that encourages differing opinions about genetic testing. Students respond to and evaluate peer research: what did this essay make you think about?, what are the strengths of this essay? They evaluate a script discussing the costs and benefits of genetic testing. This is followed by a group discussion naming the one benefit and one risk that are very important to each member and why. There is a class vote on whether the costs outweigh the risks. They evaluate their peers on the quality of their group work.

When to use: Students will have learned the Living Environment curriculum for the sequence of genetic topics: meiosis, Punnett squares, and pedigrees, as well as have familiarity with the genetic technique, electrophoresis.

Precautions and/or advice: There is a background building exercise on day 1 which introduces students to Huntington’s disease. Because of modifications made to ensure the principles of PBL, (as discussed in the literature review), it is prudent to follow the detailed daily activities as written, modified from the lessons for “Genetic Testing for Huntington’s disease” found at http://www.urmc.rochester.edu/Life-Sciences-Learning-Center/Resources/Lessons-Registration/Lessons/Genetic-Testing-Huntingtons-Disease.aspx

New York State Living Environment
Standard 1:
Performance indicator 1.1, Major understandings 1.1c
Performance indicator 1.2, Major understandings 1.2a, 1.2b
Standard 4:
Performance indicator 2.1, Major understandings 2.1a-c, 2.1e, 2.1f, 2.1h
Performance indicator 2.2, Major understandings 2.2c-e
Performance indicator 3.1, Major understandings 3.1b-d
Performance indicator 5.2, Major understandings 5.2a, 5.2h, 5.2j

Detailed list of Day 1 Resources, Worksheets and Evaluations
Copies of worksheet for day 1 (attached)
Copy of teacher answers (attached)
Copies of student research on genetic testing and HD
Provide computers for students for Internet access to use the following research websites:
http://www.ygyh.org/hd/whatisit.htm
http://www.stanford.edu/group/hopes/

Detailed list of Day 1 Activities
Hand out worksheet for Day 1. Partner up students, and point out that part of their evaluation is based on how well they work together.
Anticipatory activity (refer to teacher answers)
Read out scenario, and then have students read the section on Huntington’s Disease, and do the DBQ’s that follow. Once they finish, they may help a neighbor locate where the information can be found. Once everyone is done, partners share their answers to opinion questions #4 and #5, which introduce the PBL.

4. Why might a person who doesn’t have symptoms of Huntington’s disease consider genetic testing?
5. Would you want to have a gene test that told you whether or not you had the gene for Huntington’s disease? Explain why or why not.
Ask a few of the students to read their statements to the class. Encourage differing opinions.

Individual research work
Hand out “Student research on genetic testing and HD”, and have students get out computers for Internet access to research websites listed on the handout. Go over the task, telling students they will have 20 minutes today (remainder of class time) to collect information in a rough draft, and 20 minutes tomorrow to do the final draft.
They will have to choose which of their questions (#6. On worksheet) will be best in meeting the criteria, so let the students spend 5 minutes exploring links on the website to decide which question will provide a response that best meets the criteria OR they may create a new question based on available information.
With partner support when requested, let students take notes, and make a rough draft of their essay. The teacher circulates to address any questions and give direction toward the research which they will conduct individually in the next class period.
Exit ticket: Rank your partner’s contribution according to the grading scale on the worksheet, and turn in the worksheet for a grade.
Detailed list of Day 2 Resources, Worksheets and Evaluations
From previous day: Copies of student research evaluation

Detailed list of Day 2 Activities
Individual research work
Review the criteria on the evaluation and give the students 20 more minutes to write their final draft on the back of the evaluation form. Again, allow partner support, and teacher circulates to address any questions.

Group work
Form groups of 4 students. Students will now respond to peer research. For each essay they will have 5 minutes to write a response on their evaluation form to the questions:
What did this essay make you think about? What are the strengths of this essay?
Students turn in their evaluation to be graded.

Detailed list of Day 3 Resources, Worksheets and Evaluations
Copies of worksheet for day 3 (attached)
Laboratory results transparency

Detailed list of Day 3 Activities
Anticipatory activity: Jenny’s Chances
Hand out copies of worksheet for day 3 (attached). Read out the family history information, and call on volunteers to fill in the H and h alleles for the family line that ends with Jenny. This calls up previous knowledge they learned on using pedigrees. Then go through questions 1-3 as a class. The students must fill in their worksheets for credit.
Partners have 2 minutes to answer a question. Then it is gone over as a class.
Partner work: Jenny’s Choices
10 minutes: Read out the information for Jenny’s choices. Then, partners read through the script, following the directions for highlighting the important information, and create a list of at least 2 benefits and 2 risks.
Ask partners to pair up with another partnership.
3 minutes: They the compare lists: they must identify how and why their lists are different for class discussion, by writing the new information into their charts.
Taking turns, each student in the group spends 1 minute telling the others in the group the one benefit and one risk that are very important to you and why.
5 minutes: Each group of four then shares with the class how their lists compared. If there is time you could do a class vote on whether the costs outweigh the risks.
Closure:
Place laboratory results up on overhead. Ask students what test would have been used, to see if they recall from earlier content that electrophoresis is one technique to identify specific genes.
Exit ticket: Rank your partner’s contribution according to the grading scale on the worksheet, and turn in the worksheet for a grade.
(questions are each worth 1 point maximum)

**Scenario:** A Family Disease

Jenny’s grandmother died of Huntington’s disease. Her parents never talked much about her grandmother’s illness. It was like a “family secret” that nobody wanted to talk about. Now that Jenny is 18 years old, her mother wants her to see a doctor so she can get a genetic test for Huntington’s disease. Jenny doesn’t understand why her mother insists that she get the genetic test.

Jenny is very worried. She did not realize that she might get Huntington’s (HD) disease from her grandmother. She wonders how she could get HD when her parents don’t have any of the symptoms that her grandmother had.

Jenny did a bit of research on the Internet. Here is what she found out about Huntington’s disease.

**Huntington’s Disease**

Huntington’s disease (HD) is an inherited disease that gradually destroys cells in certain areas of the brain. The loss of brain cells causes symptoms that include uncontrolled movements, loss of intellectual ability, and emotional disturbance.

HD is an inherited disease caused by a defective dominant gene that may be passed from parent to child. A person who inherits one HD gene will eventually develop the symptoms of Huntington’s disease. The symptoms of the disease typically begin at about age 40, but this varies from individual to individual.

The illness is progressive (gets worse with time). Some early symptoms of HD are mood swings, depression, irritability; along with trouble driving, learning new things, remembering facts, or making decisions. As the disease progresses, patients develop uncontrolled body movements that become progressively worse.

At this time, there is no cure for HD. Physicians can prescribe medications to help control the emotional and movement problems associated with HD. These medications have side effects and do not slow or stop the progression of the disease. Persons with HD usually live about 20 years after first showing symptoms.

A genetic test for the HD gene, along with a complete medical history and other medical tests, helps physicians diagnose HD. The genetic test may also be used to determine if a person with a family history of HD has inherited the dominant gene and is likely to develop the symptoms of HD later in life.
1. List three symptoms of HD (Huntington’s disease).

2. What causes the symptoms of HD?

3. Jenny’s father doesn’t have any symptoms of HD. Does this mean that he does not have the defective gene that causes HD?

4. Why might a person who doesn’t have symptoms of Huntington’s disease consider genetic testing?

5. Many people with a family history of Huntington’s disease spend years thinking about whether or not to get the genetic test. Would you want to have a gene test that told you whether or not you had the gene for Huntington’s disease? Explain why or why not.

6. If you were Jenny, list three questions you would have about Huntington’s disease and genetic testing?

(source end)
Secret partner evaluation (4 points maximum)
Partner’s name ___________________________
Circle how well they worked with partner:

12- Poorly
13- Some, but not quite satisfactory
14- Satisfactory, but not excellent
15- Excellent

Copy of teacher answers (attached)
**Genetic Testing PBL: day 1 worksheet**
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**Scenario: A Family Disease**

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Jenny did a bit of research on the Internet. Here is what she found out about Huntington’s disease.

### Huntington’s Disease

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At this time, there is no cure for HD. Physicians can prescribe medications to help control the emotional and movement problems associated with HD. These medications have side effects and do not slow or stop the progression of the disease. Persons with HD usually live about 20 years after first showing symptoms.

A genetic test for the HD gene, along with a complete medical history and other medical tests, helps physicians diagnose HD. The genetic test may also be used to determine if a person with a
family history of HD has inherited the dominant gene and is likely to develop the symptoms of HD later in life.

1. List three symptoms of HD (Huntington’s disease).

*Uncontrolled movements, loss of intellectual ability, and emotional disturbance.*

2. What causes the symptoms of HD?

*The loss of cells in certain brain regions OR a defective dominant gene.*

3. Jenny’s father doesn’t have any symptoms of HD. Does this mean that he does not have the defective gene that causes HD?

*No. The symptoms of HD may appear later in life—typically at about age 40.*

4. Why might a person who doesn’t have symptoms of Huntington’s disease consider genetic testing?

*To see if they have the defective gene that will cause them to develop the symptoms of HD later in life.*

5. Many people with a family history of Huntington’s disease spend years thinking about whether or not to get the genetic test. Would you want to have a gene test that told you whether or not you had the gene for Huntington’s disease? Explain why or why not.

*Student answers will vary. The purpose for this question is to help students understand that people may chose to get, or not get, genetic testing done.*

6. If you were Jenny, list three questions you would have about Huntington’s disease and genetic testing?

*Student answers will vary. If time permits, encourage students to discuss their questions and/or to do further research to find the answers to their questions*
Genetic Testing and Huntington’s disease
Student Research evaluation form (12 points maximum)
“If you were Jenny, what question would you have about Huntington’s disease and genetic testing?”

Use the following research websites to answer your question:

Huntington’s Disease: Hope Through Research

Your Genes Your Health: Huntington’s Disease
http://www.ygyh.org/hd/whatisit.htm  Be sure to click on the headings in the bar on the left!

The Huntington’s Disease Outreach Project for Education
http://www.stanford.edu/group/hopes/  Be sure to click on the bars at the top of the page!

Grading scale:

16- Very little
17- Some, but not quite satisfactory
18- Satisfactory, but not excellent
19- Excellent

Task :

1) Answer your research question in a 200 to 400 word essay on the back of this form. It should address the following criteria:

_______ Is the explanation sufficient (i.e., it explains everything it needs to)?
_______ Is the explanation coherent (i.e., rational, sound, and free from contradictions)?
_______ Did they use enough evidence to support their ideas (i.e., they used more than one piece of evidence, and all their ideas are supported by evidence)?

2) Response to peer research: 4 complete sentences per essay, 1 point per essay

a) Essay Author ___________________
What did this essay make you think about?
What are the strengths of this essay?

b) Essay Author ___________________
What did this essay make you think about?

What are the strengths of this essay?

c) Essay Author ___________________
What did this essay make you think about?

What are the strengths of this essay?
d) Essay Author __________________

What did this essay make you think about?

What are the strengths of this essay?
(Questions are each worth 1 point maximum)

Family history: (note that Jenny’s paternal grandmother’s father did not have the disease, either.)

Jenny knows that the defective (H) gene that causes Huntington’s disease is a dominant gene. If a person has one defective (H) gene, that person will have Huntington’s disease. Jenny hopes that she got two normal genes!

Jenny’s father refuses to be tested to see if he has the dominant gene that causes Huntington’s disease. She wonders if she should get the genetic test. She also wonders if her brother (Jeremy) or other members of her family should consider getting tested to see if they have the defective (H) gene.

The genetic counselor asked questions about Jenny’s family and recorded the information to create a pedigree chart. Jenny explains that none of her mother’s relatives have Huntington’s disease. But, her grandmother (her father’s mother) and two of her aunts (her father’s sisters) have Huntington’s disease. Here is the pedigree chart that the genetic counselor created to represent Jenny’s father’s family.
Jenny’s Chances:

When Jenny asks what her chances of getting Huntington’s disease are, her family doctor suggests that she talk with a genetic counselor. Genetic counselors are trained specialists who help people understand the information about genetic diseases that run in their families.

You and your partner are going to play the role of her genetic counselor. In the pedigree chart, fill in the H and h alleles for the family line that ends with Jenny and her brother (0.5 point each).

1) So, Jenny’s first question is “What is the chance that my Dad got the Huntington’s disease gene from my grandmother?” To assist you in answering this, use the pedigree chart.

2) If Jenny’s father has the Huntington’s disease gene, what are the chances that Jenny will develop Huntington’s disease when she gets older?

3) If Jenny’s father does not have the Huntington’s disease gene, what are the chances that Jenny will develop Huntington’s disease when she gets older?
**Jenny’s Choices:**
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Jenny thought that the genetic counselor would tell her to get the genetic test. But, the genetic counselor explained that genetic counselors don’t tell people what to do. They are trained to help people think about how getting tested, or not getting tested, might affect their future and their family.

The genetic counselor explains that it is important that Jenny NOT rush into getting a genetic test! Before Jenny makes a decision, she needs to understand what kinds of choices she has and what the consequences of these choices might be. Jenny should understand why some people decide to have genetic testing done and why other people decide to NOT get a genetic test. The genetic counselor encourages Jenny to talk with her father and her brother (Jeremy) about genetic testing.

1. Read the conversation below. As you read, use two different colors to underline (or highlight) the parts of the conversation that indicate:
   • reasons for getting genetic tests—one color
   • reasons for not getting genetic tests—a second color

   *Hint: This is more fun if you can get three people to be readers and play the roles of Jenny, Dad, and Jeremy.*

   **Jenny:** Mom is really pressuring us to get tested, but we’re really having trouble deciding about this genetic testing.
   **Dad:** Remember it’s not your mother’s choice or my choice. It’s one you and your brother need to make.
   **Jeremy:** Dad, I don’t want to upset you, but we really need to understand why you never got tested. It’s important to hear your side of things before I make my decision.
   **Dad:** It’s tough to explain. When the doctors figured out your grandmother had Huntington’s disease, there wasn’t any way to test for the HD gene. Once scientists developed the genetic test for the HD gene, I’m not sure why I didn’t get tested.
   **Jenny:** But didn’t you want to know whether you had the gene or not?
   **Dad:** Your mother used to tell me I hid from the problem, hoping it would go away. She wanted me to face the future and plan for it. But I didn’t think I could handle knowing.
Laboratory Report:
Huntington's Disease Gene Testing

Patient: Jenny Lanahan
Results: (number of bands) 1
Analysis: (circle one)
- Two Huntington's disease genes - HH
- Two normal genes - hh
- One Huntington's disease gene and one normal gene - Hh
Likelihood that patient will develop symptoms of Huntington's disease? (circle one)

Likely  Uncertain  Not likely

Patient: Jeremy Lanahan
Results: (number of bands) 2
Analysis: (circle one)
- Two Huntington's disease genes - HH
- Two normal genes - hh
- One Huntington's disease gene and one normal gene - Hh
Likelihood that patient will develop symptoms of Huntington's disease? (circle one)

Likely  Uncertain  Not likely

Patient: James Lanahan (Dad)
Test Results: (number of bands) 2
Analysis: (circle one)
- Two Huntington's disease genes - HH
- Two normal genes - hh
- One Huntington's disease gene and one normal gene - Hh
Likelihood that patient will develop symptoms of Huntington's disease? (circle one)

Likely  Uncertain  Not likely

(source end)
References


