Charlynn Campbell_SRE Curriculum Draft
American Horror Story: Is a serial killer hiding in our homes?

Comment [BB1]: Missing: Cover page, title page, author's note, table of contents, lesson 1, student/teacher assessments, lesson summaries

Curriculum Summary
Is there a link between environmental pesticides, cytochrome P450, and breast cancer?

The purpose of this unit is twofold. First, to allow students to explore, and thus develop an understanding, and the ability to use, the processes of science. Second, to consider and evaluate whether or not practices that may cause harm to the natural environment also pose a risk to human health. The context for this exploration is environmental and human toxicology and the possible link between pesticide exposure and breast cancer. It is modeled after the work of Rola Zeidan of the University of Florida Vulpe Lab within the Center for Environmental and Human Toxicology. The unit will initially be designed for Advanced Placement Environmental Science and will follow a unit on pest control and pesticides. However, the unit could also fit easily into an advanced Biology or Anatomy and Physiology course. Much of the unit is student lead and teacher facilitated. As it is likely that every student has been impacted by breast cancer in one way or another, the unit will begin with a whole group discussion of their thoughts, perspective, and questions regarding breast cancer. Then, through a series of activities that will include brainstorming essential research questions, an exercise in how to read scientific papers with peer review, bioinformatics of cytochrome P450, and a bioassay, students will be able to evaluate and present results, make predictions (will justification), and propose questions for future research. The unit will include a pre- and post-test, a formative assessment in the form of a lab report/poster, and is expected to run seven 50-minute class sessions.

"Go as far as you can go, young scientists. The world needs you badly."
- E. O. Wilson

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Learning Standards and Performance Objectives
College Board Standards for Science Success
http://apcentral.collegeboard.com/apc/public/courses/teachers_corner/2128.html

Standard SP.1 Scientific Questions and Predictions
Asking scientific questions that an te tested empirically and structuring these questions to form testable predictions

Objectives
SP.1.1 Scientific Questions
- Students recognize, formulate, justify and revise scientific questions that can be addresses by science in order to construct explanations.

SP.1.2 Predictions
- Students make and justify predictions concerning natural phenomena. Predictions and justifications are based on observations of the world, on knowledge of the discipline and on empirical evidence.

Standard SP.2 Generation of Evidence
Collecting data to address scientific questions and to support predictions

Objectives
SP.2.1 Data Collection
- Students select and use appropriate measurement methods and techniques for gathering data, and systematically record and organize observations and measurements.

SP.2.2 Evaluating Data for Evidence
- Students determine which data from a speci c investigation can be used as evidence to address a scienti c question or to support a prediction or an explanation, and distinguish credible data from noncredible data in terms of quality.

Standard SP.3 Data Analysis
Searching for regularities and patterns in observations and measurements (i.e., data analysis)

Objectives
SP.3.1 Analyzing Data for Patterns
Students analyze data to discover patterns.

Standard SP.4 Evidence-Based Explanations and Models
Using evidence and science knowledge to construct scienti c explanations, models and representations

Objectives
SP.4.1 Constructing Explanations
Students construct explanations that are based on observations and measurements of the world, on empirical evidence and on reasoning grounded in the theories, principles and concepts of the discipline.

SP.4.2 Models and Representations
Students construct, use, re-express and revise models and representations of natural and designed objects, systems, phenomena and scienti c ideas in the appropriate context and in formulating their explanation.

SP.4.3 Evaluating Explanations
Students evaluate, compare and contrast explanations that are based on observations of the world, on empirical evidence and on reasoning grounded in the theories, principles and concepts of the discipline.

Standard SP.5 Quantitative Applications
Using mathematical reasoning and quantitative applications to interpret and analyze data to solve problems

Objectives

SP.5.1 Proportionality Between Variables
Students reason about relationships between variables (e.g., data, representations, uncertainty, samples) through the lens of ratios, rates, percentages, probability or proportional relationships when approaching or solving problems or when interpreting results or situations.

SP.5.2 Patterns of Bivariate Relationships
Students apply, analyze and create algebraic representations, relationships and patterns of linear functions, systems of linear inequalities, and one- or two-dimensional changes to solve problems, interpret situations and address scienti c questions.

Standard STS.1 Science, Technology and Society
A critical interdependence exists among science, technology and society.

Objectives

STS.1.1 Interdependence of Science and Technology
Students explain the interdependence of science and technology: how the ongoing development of technology relies on the advancements of science while scientific research relies on technological progress.

Students understand how the evolution of various technologies (e.g., biotechnology, seismology, computational software, lasers) radically alters the practice of many science disciplines by affecting the quality and quantity of available data.

STS.1.2 Advantages and Disadvantages to Society
Students understand how science and technology together can be used for the bene t of society as well as their own lives (e.g., weather predictions, development of medications, creation of safety devices in cars), but that some technological capabilities (e.g., cloning, genetic recombination, nuclear energy studies, access to fossil fuels, chemical engineering) create ethical and economic dilemmas for society.

STS.1.3 Evaluating Online Information

Students recognize that the amount of information, as well as access to information, has exploded since the creation of the Internet. Online information should be judged using the same science practices and critical and skeptical views that reflect the way science is conducted and evaluated. Students also recognize the relationship between digital technology and the fact that social networking is a source of information generation and of the determination of "truths" in our current society. Students understand that this information presents a specific perspective that is not backed by research; therefore, the information and the perspective do not represent the empirical reality of science.

Standard ES.5 Humans and the Environment

Humans and the environment impact each other.

Objectives

ES.5.3 Humans' Impact on the Environment

Students understand that all human activities, including use of resources, have environmental consequences that occur over a range of spatial and temporal scales. Because of the complexity of Earth's systems and because of the occurrence of unintended consequences, a systems framework is commonly used to understand important environmental issues such as pollution, climate change or ecosystem disruption. A systems analysis guides scientific investigations, decision making and the identification of potential solutions to environmental issues.

Standard LS.1 Evolution

The diversity and unity of life can be explained by the process of evolution.

Objectives

LS.1.1 Evidence of Common Ancestry and Divergence

Students understand that an analysis over time of both the anatomical structures and the DNA compositions of organisms can be used to infer lines of descent back to a common ancestor.

LS.1.3 Genetic Variation Within Populations

Students understand that genetic variation within a population is essential for natural selection. Mutations, as well as random assortment of existing genes, can produce genetic variation in a population.

Standard LS.2 Cells as a System

Cells are a fundamental structural and functional unit of life.

Objectives

LS.2.1 Cell Function

Students understand that cells perform the essential functions of life, such as energy transfer and transformation, exchange of gas, disposal of waste, growth, reproduction, and interaction with the environment.

LS.2.2 Cell Structure

Students understand that cells have internal structures that carry out specialized life functions, and that these internal structures vary depending on a cell's function.

LS.2.3 Cell Growth and Repair

Students understand that cells of multicellular organisms repeatedly divide to make more

cells for growth and repair.

Standard LS.3 Interdependent Relationships
Interdependent relationships characterize biological ecosystems.

Objectives

LS.3.1 Living Systems and the Physical Environment
Students understand that in all ecosystems, living organisms interact with and depend on the physical (abiotic) conditions of their environment for survival.

LS.3.2 Interactions of Living Systems
Students understand that organisms in all ecosystems interact with and depend on each other, and that organisms with similar needs compete for limited resources.

LS.3.3 Ecosystem Stability
Students understand that a complex set of interactions within an ecosystem can maintain the number and types of organisms in an ecosystem that is relatively constant over long periods of time.

Standard LS.4 Matter and Energy
Biological systems utilize energy and molecular building blocks to carry out life's essential functions.

Objectives

LS.4.1 Matter Cycling
Students understand that matter is continuously recycled within the biological system and between the biological (biotic) and physical (abiotic) components of an ecosystem.

Standard LS.5 Information Transmission, Storage and Retrieval
Living systems have multiple mechanisms that are used to store, retrieve and transmit information.

Objectives

LS.5.2 Genetic Information Transmission
Students understand that during reproduction, genetic information (DNA) is transmitted between parent and offspring. In asexual reproduction the lone parent contributes DNA to the offspring, and in sexual reproduction both parents contribute DNA to the offspring.

LS.5.3 DNA to Trait
Students understand that genetic information (DNA) is used to produce proteins that largelydetermine the traits of an organism. These traits often result from the interactions and expression of many genes.

LS.5.4 Imperfect Transmission of Genetic Information
Students understand that there are various ways in which the transmission of genetic information can be imperfect, and that these imperfections may have positive, negative or no consequences to the organism.

LS.5.5 Nongenetic Information Transmission
Students understand that nongenetic transmission of information within and among organisms involves specialized molecules, cell structures and cell systems.

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Standard PS.2 Physical and Chemical Properties of Matter
Matter has mass and volume and can exist as a solid, liquid or gas. All pure substances have their own unique set of physical and chemical properties that can be used to identify them.

Objectives

PS.2.1 Properties of Matter
Students understand that pure substances are composed of matter that has de nable properties. Through macroscopic observation and measurement of these properties, students can describe and identify these substances.

PS.2.2 States of Matter
Students understand through observation that matter can exist in three common states: solid, liquid or gas. Students understand that these macroscopic observations serve as evidence of the concept that matter can exist as elements, compounds or mixtures.

PS.2.3 Particulate Nature of Matter
Students understand that matter is composed of atoms that can interact in different ways to form molecules and crystals. The structure, behavior and properties of matter can be explained by using models that depict particles in constant motion as well as the strength of the interacting forces among the particles

Standard PS.3 Conservation of Matter
Matter can be transformed by a change of state or by undergoing chemical reactions, but it can never be created or destroyed.

Objectives

PS.3.1 Conservation of Matter
Students understand that matter can neither be created nor destroyed during any interaction, including change of state or a change that takes place as a result of a chemical reaction.

PS.3.2 Physical and Chemical Changes of Matter
Students understand that chemical reactions produce new substances with new properties, whereas changes of state alter the appearance of a substance, not the identity of a substance.

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Charlynn_Assessments

Content Assessment

Name Date

Circle One: Pre-test Post-test

Part I: Objective Questions

_____ 1. What is toxicology? (Indicate the one best answer).
A. The field that studies the adverse effects on humans and animals.
B. The field that studies the adverse effects of chemicals on biological systems, including ecosystems.
C. The field that studies the adverse effects of chemicals and microorganisms.
D. The field that studies the risk-benefit balance of chemicals for living organisms.

_____ 2. Indicate which person is credited with initiating the contemporary environmental movement through their work and writings that warned of the harm to all natural systems from the misuse of chemical pesticides.
A. Aldo Leopold
B. John Muir
C. Rachel Carson
D. Rosalind Franklin

_____ 3. Indicate which chemicals played an important role in the history of modern toxicology (Indicate all that apply).
A. Mercury
B. Dioxins
C. DDT
D. Alcohol

4. When considering toxic substances, LD50 is a term that often appears. What do the letters "LD" represent in the term LD50? _____

For items 5-9, match each description with its corresponding term. The terms may be used only once.

Term	Description
_____ 5. risk assessment	A. Integrating hazard characteristics with exposure data.
_____ 6. hazard	B. The probability that an adverse effect will occur.
_____ 7. receptor	C. Integrating risk assessment with social, economic and political aspects.
_____ 8. risk	D. The molecular structure affected by a toxic agent.
_____ 9. risk management	E. A potential danger of a compound or a process.

_____ 10. What is true about the process of risk assessment? (Indicate the one best answer)
- A. Acute exposure and chronic exposure from a chemical result in effects on a similar target organ, but only at a single high or a repeated low dose of exposure, respectively.
- B. DNA can be a toxicological receptor.
- C. A dose response curve is important to establish the LD50 which is an important parameter in modern toxicological risk assessment.
- D. The LD50 is a constant parameter reflecting the acute toxicity of a chemical for different species.

_____ 11. Foreign compounds in an organism, such as drugs and toxins, are referred to as _____. (Indicate the one best answer)
- A. enzymes
- B. cytochromes
- C. xenobiotics
- D. amino acids

_____ 12. Which of the following statements is true regarding Cytochrome P450? (Indicate all that apply)
- A. a superfamily of mono-oxygenates
- B. detoxifies and solubilizes drugs and poisons by modifying them with oxygen
- C. found in all kingdoms of life
- D. contains heme

_____ 13. What are important cancer inducing factors? (Indicate all that apply).
- A. Environmental contaminants
- B. RNA viruses
- C. Ionizing radiation
- D. Pesticides
- E. Food additives
- F. Food colors
- G. Genetic factors

_____ 14. Not counting some kinds of skin cancer, breast cancer in the United States is (Indicate all that apply)
- A. …the most common cancer in women, no matter your race or ethnicity.
- B. …the most common cause of death from cancer among Hispanic women.
- C. …the second most common cause of death from cancer among white, black, and Asian/Pacific Islander women.
- D. …the third most common cause of death from cancer among American Indian/Alaska Native women.

_____ 15. Lambda-cyhalothrin, a synthetic pyrethroid, is a common ingredient found in many insecticides. Pyrethroids work by… (Indicate the one best answer)
- A. …disrupting the normal function of the nervous system.
- B. …causing endocrine disruption.
- C. …attacking the respiratory system.
- D. …binding to calcium channels in cardiac tissue.

_____ 16. What is true about toxicogenomics? (Indicate all that apply).
- A. Toxicogenomics studies use DNA microarray techniques.
- B. Toxicogenomics studies describe the effects of chemical compound on DNA.
- C. Toxicogenomics studies are an invitro approach that can replace invivo animal studies for toxicity.
- D. Toxicogenomics studies use real-time RT-PCR to validate mRNA expression patterns.
- E. Toxicogenomics studies use real-time PCR to quantify protein expression.

_____ 17. What is true about RT-PCR? (Indicate all that apply).
A. RT stands for Reverse Transcription.
B. RT stands for Real-Time.
C. When measured real-time the original amount of cDNA can be calculated from the number of amplification cycles it takes to reach a threshold amplification cycles it takes to reach a threshold level for detectable DNA-associated fluorescence.
D. It quantifies the amount of a mRNA.
E. It quantifies the amount of DNA.

_____ 18. What is the best description for the benchmark dose?
(Indicate the one best answer).
A. A dose that can be interpreted as a NOAEL but is defined in a better way.
B. The dose that results in a defined, for example 10%, response.
C. The dose that defines the sensitivity of a part of the population.
D. A dose that defines the margin of safety, taking the statistical uncertainty into account.

Part II: Free Response Question

You are a scientist working in a Human and Environmental Toxicology research lab. Identify and describe the steps of the scientific process you would utilize to help you design an experiment for your research investigation.

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Charlynn_Assessments

TEACHER ANSWER KEY

Content Assessment

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Answers will vary

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LESSON TWO: BREAST CANCER JOURNAL CLUB - PIECES OF A PUZZLE (ADAPTED FROM THE POMPE PREDICAMENT WITH PERMISSION FROM AUTHOR JULIE BOKER_CPET)

KEY QUESTION(S): How do you read a scientific journal article for understanding?

OVERALL TIME ESTIMATE:

- Advanced Preparation: 90 minutes including reading articles
- Student Procedure:
  - Day 1: 45 minutes
  - Day 2: 45 minutes
  - Day 3: 30 minutes

LEARNING STYLES: Visual and auditory

VOCABULARY:

Peer-review is the act of having another writer read what you have written and respond in terms of its effectiveness. This reader attempts to identify the writing's strengths and weaknesses, particularly how sound the science is, and then suggests strategies for revising it. The hope is that not only will the specific piece of writing be improved, but that future writing attempts will also be more successful. Peer-review happens with all types of writing, at any stage of the process, and with all levels of writers.

LESSON SUMMARY: Using a reading guide, students work in pairs to read a journal article and share their interpretations during a whole class activity. After completing the introductory reading activity, students utilize a reading guide to work independently to read and identify key information before sharing their understanding with others in a small group. If time allows, students translate their paper into a poster to share with classmates during a gallery walk and subsequent poster presentation.

STUDENT LEARNING OBJECTIVES:

The student will be able to...

1. Identify key developments in the etiology of Breast Cancer
2. Identify key developments in the genotoxicity of pesticides
3. Improve scientific literacy by reading primary sources
4. Read a scientific paper for understanding
5. Recognize that science is ever growing and building on previous discoveries
6. Conclude that research takes place around the globe and through publishing, discoveries are shared

STANDARDS:

TBD

MATERIALS:

- Copies of *Guide to Reading Scientific Papers*, one per student
- Copies of *Guide to Reading Scientific Papers Worksheet*, one per student
- Copies of introductory journal article, one per student or student pair
- Copies of journal articles (choose three to five articles for the class and make multiple copies of each, allowing one per student)

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BACKGROUND INFORMATION: Breast cancer is the most common cause of cancer related deaths in women. It has long been known that environmental chemicals are one of the risk factors in the development of breast cancer. Although its etiology remains unknown, environmental, genetic, nutritional and hormonal factors contribute to breast cancer risk. A substantial proportion of breast cancers have been proposed to be of environmental origin.

Students need to be scientifically literate, and part of that effort includes their use and familiarity with primary sources of information, namely articles peer-reviewed and published in scientific journals. Many high school and undergraduate students are intimidated by these articles because they approach them in the wrong manner. They are not novels to be consumed at one time. They are jargon-filled texts that are often presented in a dry and painful manner. Students are bogged down by the vocabulary and the methods, so they can't focus on the bigger, important ideas of the paper, the "take-home message". Small, manageable doses of primary literature in a guided manner will allow students to gain comfort using and understanding original research articles.

ADVANCE PREPARATION:

Implementation note: Determine size of groups for journal discussions and choose papers accordingly. For a class of 32 students, if the journal clubs (groups) are 8 students each you will need to select 4 papers and make 8 copies of each. The usual standard is to keep groups as small as possible. In this situation however, a group of 6-8 students discussing a paper would be fine and could encourage discussion and generate more ideas. If you opt for smaller groups of 4, you will need to select (and read!) 8 papers.

- Make copies of *Guide to Reading Scientific Papers*, one per student
- Select and copy journal articles (choose three to five articles for the class, depending on how large the groups will be, and make multiple copies of each, allowing one per student). Most research journals have restricted access. Suggested articles are listed in the resources below.
- Read the selected articles.

IMPLEMENTATION NOTES:

This activity is intended to build on the discoveries presented in the previous brainstorm and research lesson. It also provides background information for the cytotoxicity and genotoxicity lab investigation later in the unit. As written, three class days are devoted to this activity, stressing the importance of communicating science. Students need to know where to find primary sources of scientific literature as well as how to read and present the information for understanding. Due to the new field of genotoxicity, there is limited literature relating to the potential link between pesticide exposure and breast cancer etiology.

It also assumes students are not familiar with reading science journal articles so it models the steps of reading and discussing a paper as the first part of the lesson. For advanced and/or experienced students, you may elect to skip the day one component and begin with assigning students papers to read for homework and discuss in small groups the following day.

For classes accustomed to the use of blogs or other social media outlets, this lesson would be well suited for discussion to take place outside of the classroom. In this situation, you may wish to assign the entire class a paper one night and ask them to respond to a blog post or wiki prompt. They could repeat this process for multiple papers throughout the unit. The poster and gallery walk could also be held virtually through the use of blogs.

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PROCEDURE AND DISCUSSION QUESTIONS WITH TIME ESTIMATES:
Day One (45 minutes)

1. (5 minutes) Introduce the importance of publishing scientific findings. Tell the students that in science, information is primarily shared with others through writing papers that are reviewed by other scientists for accuracy and clarity (peer-review). These publications are the primary means to share new findings with others across the world and allow researchers to build on prior findings to make new discoveries. It is important for scientists to be good written and oral communicators.
2. (5 minutes) Give each student a copy of *Guide to Reading Scientific Papers*. Instruct the students to read the *Guide* silently.
3. While students are reading, provide a copy of the first article to each student or student pair.
4. Project the first article (feel free to select a different article)
   ANTICANCER RESEARCH 27: 4443-4450 (2007)
   RNA Expression of Cytochrome P450 in Breast Cancer Patients
   RADKA VACLAVIKOVA1, MILUSE HUBACKOVA1,4, JANA STRIBRNA-SARMANOVA1, ROMAN KODET2, MARCELA MRHALOVA2, JAN NOVOTNY3, IVAN GUT1 and PAVEL SOUCEK1http://ar.iiarjournals.org/content/27/6C/4443.long
5. (5 minutes) Review the *Guide to Reading Scientific Papers* with them, stressing which sections students should read a bit more carefully (abstract, introduction), and which can be skimmed or skipped (methods/materials). Use the projected article to indicate these sections. Direct their attention to the questions at the bottom to focus their reading. You may wish to have students highlight or underline the answers on the article.
6. (15 minutes) Ask the student pairs to work together to read the article and formulate a summary. Encourage them to use the *Guide to Reading Scientific Papers*. Point out that to read a paper for full comprehension, it takes longer, but this is a beginning exercise to get them acquainted with scientific papers.
7. (10 minutes) Call on student pairs to give a summary of each key section (abstract, introduction, results, and conclusions). The *Teachers Page: Discussing Science Journals* provides a teacher's guide for this discussion. Ask other students to add to the summary that has already been given, asking them if they thought there were other important aspects. Prompt them with the questions below:
   1. What was the purpose of the study?
   2. What questions were asked?
   3. What were the final answers?
   4. What was unique about the study?
   5. What is the next step?

8. (5 minutes) Distribute a copy of one paper to each student. Choose 3-5 papers so there will be multiple students reading the same paper.
9. Instruct the students to follow the same procedure they just did as a class tonight for homework, using the *Guide to Reading Scientific Papers* and completing the *Guide to Reading Scientific Papers Worksheet*. Tell them to be prepared to share their paper in small groups tomorrow.

Day Two (45 minutes)

1. Present students with the following quick write prompt as a bell ringer:
   A. In three complete sentences, summarize the journal article you read last night.
   B. List one thing you learned.
   C. List one question you still have.
2. Allow students 5 minutes to complete the prompt. Collect the writings.

3. (15 minutes) Ask students to gather in groups according to the paper they read. Allow the students to self-sort. Instruct them that within the group, they should share their understanding of the paper, discuss anything they didn't understand, and decide on the important points using the questions in the *Guide* as prompts. This is similar to a journal club in a research setting.
4. (10 minutes) After the students have had the opportunity to discuss their paper, they will now make a poster using the five questions from their reading guide to share with the class during a gallery walk. ***Implementation note****: Instead of posters and a gallery walk, student could do a modified jigsaw, forming groups with members from different papers. Each should share with the new group the summary and important points from their individual paper. Allow 20 minutes for the groups to assemble and share. Have them complete an exit slip during the last 5 minutes asking them to state one thing they learned and one thing they still have a question about.*

5. (15 minutes) Have groups affix their poster to the wall when completed. Students should move around the room and read the other posters. Give them post-it notes and ask them to generate at least one question and place it next to the corresponding poster (similar to an exit slip). It cannot be the same question someone else has already posted. (If wanting to use for assessment purposes, students should include their name on the back of the post-it.)
6. Teacher homework: review the quick writes and make note of any reoccurring questions or concerns expressed by the students. Review the post-it note exit slips and make note of thoughtful questions to make sure to address the following day. As the student groups are presenting to the class, prompt them with the questions and provide wrap-up for each poster after the students are finished to clarify any misunderstandings.

Day Three (45 minutes)

1. As students enter, they should visit their poster and read the questions their classmates posted.
2. (5 minutes) Encourage student groups to discuss the questions posed and decide on a main speaker for the group to present the paper abstract; the additional members of the group should each answer one of the questions posed by their classmates.
3. (5-10 minutes) Allow the first group 3-5 minutes to present their paper/poster to the class and answer questions. (The number of questions answered may vary based on complexity of the answer and classroom engagement.) Help to clarify concepts and correct any misconceptions. The questions might be beyond the scope of knowledge for the students, so it is critical that the teacher is ready to assist with answering, correcting, or encouraging students to investigate further to find the answer.
4. (20 minutes) Repeat with the remaining groups.
5. (10 minutes) When all groups have presented, engage in a whole class discussion about the findings of the papers, focusing the students' attention on the following:
    a. Did it build on previous work?
    b. Where does it fit in our timeline from lesson 2?
    c. Key finding(s)

6. (5 minutes) Help the students understand that science is an ever-growing body of knowledge. Only by sharing results can forward progress be made.

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ASSESSMENT SUGGESTIONS:

- Homework and/or quickwrite collected
- Participation grades for the exit slip and paper/poster presentation.

EXTENSION:
ACTIVITY:

- Students compose an essay or poster to inform the general public of Pompe disease or another orphan disease.
- After students have completed the entire activity, have them read the following editorial: (Link TBD)
- Based on what they have learned so far, do they agree with the author? Is there bias in her comments? Is it acceptable for the author to present her opinion in an editorial piece?

RESOURCES/REFERENCES:

- How to read scientific papers: http://hampshire.edu/~apmNS/design/RESOURCES/HOW_READ.html
- Nice list of research tools including how to read a research article and citations. https://pantherfile.uwm.edu/ajpetto/www/Research_tools.htm
- The National Institute of Health has an extensive list of publications with abstracts and links to full articles. The suggested articles below can be found on their site: (TBD)
- There are additional articles in the References section at the end of this curriculum (as well as full citations for the links below) that would be excellent for students to read and discuss. Unfortunately, access is limited.

TEACHER PAGE: DISCUSSING A SCIENCE JOURNAL ARTICLE
(sample - replace with TBD….)
Disease severity in children and adults with Pompe disease related to age and disease duration
http://amdapompe.ehclients.com/downloads/publications/Hagemans_Neurology_280605.pdf

Feel free to use any article. This one was selected to model because it is short and not very complicated, which will allow students to focus on the main parts and how to read an article rather than be burdened with jargon and methods during the introduction.

Things to point out:

1. Read the title: (TBD)
2. Note the journal: (TBD). This is a peer-reviewed and highly respected journal.
3. Multiple authors contributed, indicating collaboration among many individuals. In this case, the funding for the project and the main research lab is indicated by the last name listed, Van der Ploeg.
4. In the bottom left, note the institutions represented, who funded the project, and potential conflict of interest. This information is telling regarding any bias that might be apparent or inadvertent.
5. Also, note the date the paper was originally received: Dec. 21, 2004. This is the date it was submitted to the journal. After going through peer review, suggested modifications are sent to the authors for the

chance to revise. The revision is then either approved or denied publishing. In this case, it was accepted on March 23, 2005 and appeared in print in June, 2005.

6. The layout of papers differ. Each journal has its own way of arranging the text on the page, as well as specific sections they do or don't want included.

Use the reading guide with the students, calling attention to each section and highlighting key points.

The **Abstract** provides a nice summary of the paper. (Adapt following to reflect selected BC/pesticide article)

- This one is particularly short, reflective of a short paper. 255 individuals with Pompe completed a survey to gather information about the natural course of the disease.

The **Introduction** gives a history of the topic and discusses what others have found. It also poses the research question(s).

- The author devotes the first paragraph to a description of Pompe. This provides background. They then discuss what the current treatment available is – ERT is just in clinical trials (this is why it is important to note the date). The authors want to help determine the ideal time to administer the treatment, so they need to understand the natural course of the disease, particularly for individuals with late-onset.

Methods and Materials are most meaningful to those in the field who might want to repeat the research or to help clarify results. Skip this section, but note that as you become more experienced with reading primary sources, it can be helpful to return to this section to better understand some of the results and discussion.

- Interesting how tiny the font is for the methods section in this journal, indicating this section is really for those that need to know all the details of carrying out the experiment. Not necessary for our students to understand the paper.

Results are just that. There is no discussion or explanation. They are worth a glance, particularly if any tables are included that summarize the findings neatly. Just a skim of this section will suffice.

- Font size is increased a bit, but not as large as the introduction or conclusions. There are a lot of percentages given, and description of the figures. It does give some nice descriptions of the symptoms and pathologies affected individuals reported, and the age of onset.

The **Discussion/Conclusion** is where the author explains what happened. In this section, the questions should be answered. This is usually where the author reflects on the work and its meaning in relation to other findings and to the field in general.

- General findings are discussed such as disease severity increases with duration. This is a progressive disease, so not unexpected. It wasn't correlated with age however, supporting the diverse set of symptoms that present at all ages. Other than the classic infantile form, all other forms are heterogeneous. They do point out the subset of children who were affected very young, as presenting more severe symptoms earlier and consistently: those who are respirator dependent, are likely to be wheelchair dependent. There concluding remarks suggest ERT should be started as early as possible, before "irreversible damage has occurred" such as muscle weakness requiring a wheelchair or respiratory assistance.

Add your own interpretations to these:

- What was the purpose of the study? Compile and analyze data about the natural course of Pompe disease (how does it progress in individuals not on enzyme replacement therapy?)

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- What questions were asked? Is there a relation between age of onset, duration, and symptom severity?
- What were the final answers? Only in those presenting symptoms very young is there an expected course; all others present a mix of symptoms.
- What was unique about the study? Surveyed 255 patients, quite a large sample size for a disease so rare, to record the natural history of the disease with one standard questionnaire. Rather than piecing bits of case reports together for the literature, they were able to standardize the questions and therefore the results.
- What is the next step? Compare to the next generation who receives ERT. Does ERT make a difference in severity and duration? Can those who present symptoms early, be treated with enzyme replacement therapy and delay serious symptoms? For how long?

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STUDENT PAGE: GUIDE TO READING SCIENTIFIC PAPERS

Scientific papers can be daunting, full of details and language that is unfamiliar. Scientific papers are best read and considered in small, manageable pieces. Unless you plan to repeat the experiment, you really just need to get the general idea of the questions and answers along with the big idea of the paper. As you become more comfortable with reading journal articles, you will naturally read for more depth and content. When starting out however, the key is knowing what to read, what to skim, and what to skip. Yes. There are parts of a paper that you can skip.

The paper is divided into sections, based generally on the scientific method. Most research papers contain the following sections: Abstract, Introduction, Methods/Materials, Results, Discussion, sometimes Conclusions, and References.

The **Abstract** provides a nice summary of the paper. It might have some unknown words or numbers, but it gives the overall flavor of the paper. It should be read and then re-read at the end.

The **Introduction** gives a history of the topic and discusses what others have found. It also poses the research question(s).

Methods and Materials are most meaningful to those in the field who might want to repeat the research or to help clarify results. Skip this section, but note that as you become more experienced with reading primary sources, it can be helpful to return to this section to better understand some of the results and discussion.

Results are just that. There is no discussion or explanation. They are worth a glance, particularly if any tables are included that summarize the findings neatly. Just a skim of this section will suffice.

The **Discussion/Conclusion** is where the author explains what happened. In this section, the questions should be answered. This is usually where the author reflects on the work and its meaning in relation to other findings and to the field in general.

Re-read the Abstract. Does it make more sense now? It should tie everything together.

Vocabulary. You may need to look words up if you can't figure them out using context clues. You can miss a really important point of the paper if you don't understand the language.

In summary:

- Absolutely read the Abstract, Introduction, Discussion, and then the Abstract again.
- Skim the results.
- Skip the methods/materials.

In the end, you want to be able to answer the following questions with some confidence:

- What was the purpose of the study?
- What questions were asked?
- What were the final answers?
- What was unique about the study?
- What is the next step?

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STUDENT PAGE: GUIDE TO READING SCIENTIFIC PAPERS WORKSHEET

Name: _____

Paper name: _____

1. What was the purpose of the study?

2. What questions were asked?

3. What were the final answers?

4. What was unique about the study?

5. What is the next step?

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LESSON THREE: Inquiry-Based Lab Investigation
Title: (TBD) Yeast-based cytotoxicity and genotoxicity assay of lambda-Cyhalothrin

VOCABULARY:

Assay

Chromatography - A process for separating complex liquid mixtures of proteins or other molecules by passing a liquid mixture over a column containing a solid matrix. The properties of the matrix can be tailored to allow for the selective separation of one kind of molecule from another. Properties include solubility, molecular size, and charge.

Cytotoxicity

Genotoxicity

LESSON SUMMARY: Modeling contemporary research techniques in conjunction with a commercially available kit from Bio-Rad, students step through the process of an assay that measures general toxicity as well as any DNA damage as a result of exposure to genotoxic agents.

STUDENT LEARNING OBJECTIVES: (TBD)

STANDARDS: (TBD)

Lesson: (Specific protocol still to be determined but will likely incorporate a yeast-based cytotoxicity and genotoxicity assay along with an adaptation from a bacterial model to a yeast-based model of the Bio-Rad Green Fluorescent Protein Chromatography Kit, http://www.bio-rad.com/webroot/web/pdf/lse/literature/4006099.pdf)

RESOURCES/REFERENCES: (***Revise format with correct style guide***)

American Association for the Advancement of Science (AAAS), ScienceLinks, Toxicology 1: Toxicology and Living Systems, http://sciencenetlinks.com/lessons/toxicology-1-toxicology-and-living-systems/

American Association for the Advancement of Science (AAAS), ScienceLinks, Toxicology 2: Finding the Toxic Dose, http://sciencenetlinks.com/lessons/toxicology-2-finding-the-toxic-dose/

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American Association for the Advancement of Science (AAAS), ScienceLinks, Toxicology 3: Toxicology and Human Health, http://sciencenetlinks.com/lessons/toxicology-3-toxicology-and-human-health/

Andrew W. Knight,a Patrick O. Keenan,b Nicholas J. Goddard,a Peter R. Fieldena and Richard M. Walmsleyb , *A yeast-based cytotoxicity and genotoxicity assay for environmental monitoring using novel portable instrumentation, J. Environ*. Monit., 2004,6, 71-79

Bio-Rad. *Green Fluorescent Protein Chromatography Kit*. http://www.bio-rad.com/en-us/product/green-fluorescent-protein-chromatography-kit?pcp_loc=catprod

National Institutes of Health National Library of Medicine Specialized Information Services. Household Products Database. https://householdproducts.nlm.nih.gov/cgi-bin/household/brands?tbl=brands&id=19020309

National Institutes of Health National Library of Medicine Specialized Information Services. Household Products Database. https://householdproducts.nlm.nih.gov/cgi-bin/household/brands?tbl=chem&id=2452

National Pesticide Information Center. *Lambda-cyhalothrin General Fact Sheet*. http://npic.orst.edu/factsheets/archive/l_cyhalotech.pdf

Zeidan, Rola. Vulpe Lab