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#### AN ANALYTICAL CHEMIST, A BIOCHEMIST, AN ANIMAL SCIENTIST, AND AN ONCOLOGIST WALK INTO A LAB...NO JOKE

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# SCIENTISTS, OVARIAN CANCER, AND THE SEARCH FOR BIOMARKERS

Scientists are fighting cancer on many different fronts. These battlegrounds range from trying to determine causes and genetic predispositions/factors, to finding or creating effective treatments, to elucidating meaningful diagnostic techniques and tools.

With all of the diagnostic tools available to doctors and scientists - MRIs, PET scans, CT scan, etc. - it may be hard to believe that determining whether someone has cancer or not is difficult, but it is indeed the case. This is in part because imaging tools are not nearly as clear as most laypeople think, but also because cancer is far more differentiated that many people realize. Cancer is different from type to type (liver cancer vs. lung cancer), between subtypes (there are several types of ovarian cancer), and from case to case. To address the difficulties in

diagnosing any disease, cancers included, scientists try to determine biomarkers. Biomarkers are chemicals that occur naturally in living sys-



Similarities between human ovaries and hen ovaries are among reasons that the hen is used as an animal model for

tems that vary depending on the health of the organism. A diseased organism may produce more or less of a particular compound that can be measured. In many cases these biomarkers can also be used to determine the efficacy of treatments.

Finding these biomarkers, though, can also prove difficult. They do not necessary exist in the same amount in each person or each animal, so they have to be studied in particular individuals over time. Studying people in this way is not usually feasible – in part because most people will not want to be part of this kind of investigation, and in part because scientists do not know which people to study (i.e. who will get the disease). This leads to the importance of finding useful animal models. Of course, the use of animal models also has its own set of issues.

## SPECIALIZATION & COLLABORATION IN SCIENTIFIC INVESTIGATIONS

As our knowledge has progressed and our technological tools have become more advanced, scientists have had to specialize more and more. There are too many skills and a predominance of information that prevent an individual person from being an effective "generalist" anymore. Hence, we have analytical chemists and molecular biologists (and even specialization within those fields). Real world problems, though, do not follow these boundaries. Therefore these specialists need to bring their expertise together to address them. They each have roles, but they must work together as a team and communicate effectively in order to conduct meaningful investigations.

### **TEAM DESCRIPTION**

Your investigation team will be composed of an analytical chemist (a measurement scientist), a biochemist, an animal scientist, and an oncologist. These scientists must work together to solve real world problems, just like you will have to work together to fulfill the expectations of this project. The team will have topics to research together and products related to them to generate. The description of these team requirements follows on the next two pages.

Additionally, each team member will have several individual avenues that they are required to investigate and several products that they will have to con-

struct.

The descriptions of the individual requirements of team members fulfilling different roles are given on pages 4-7.

Ultimately, the team members will be asked to bring both full-team aspects and individual aspects together to assemble and submit a unified team project.

As part of the final grade for the project, team members will submit a self and peer review, so please keep that in mind and make sure that you fulfill all the duties of a true team member.

The team will also submit a Works Consulted & Cited page for the team requirements.

#### TEAM REQUIREMENT #1: HISTORY OF MASS SPECTROMETRY

The first part of the team requirement is an investigation of the history of mass spectrometry. The person filling the role of the Analytical Chemist (see page 4) will be compiling more research on the types, techniques, and uses of mass spectrometry today, but the team will collectively conduct research into how it developed over time (and see how it connects to several topics that we have previously discussed in class).

Questions to be addressed (and do not feel limited to these) include: 1) Who developed it first and when?, 2) How did it originally work and how has that changed over time?, 3) How was it used and how did that change over time? Product: After conducting the necessary research, the team will create an infographic that effectively and communicates all of the pertinent information.

Infographic production tools are listed on page 8 and grading criteria are given on the project rubrics handout.



science fried art. 2013.

TEAM REQUIREMENT #2: POLARITY VS. NON-POLARITY AND HYDROPHILICITY VS. HYDROPHOBICITY

One topic related to this research that we have discussed in class is polarity and non-polarity (and related to this hydrophilicity and hydrophobicity). As a team you will have to familiarize yourselves further with these concepts. Product: Once the team is familiar and comfortable with the ideas, they will create a cartoon or comic strip to illustrate the concepts (an example is provided to the left). Additionally, there will be a one-two paragraph explanation of how the cartoon/comic strip illustrates the concepts. It is strongly suggested that the team uses one of the cartoon/comic strip production tools listed on page 8 to make the product, but hand-drawn ones will also be accepted as long as they meet the criteria.

Grading criteria are given on the project rubrics handout.

"Teamwork divides the tasks and multiplies the success."

~Anonymous

#### TEAM REQUIREMENT #3: LONGITUDINAL STUDIES

There are many types of investigations and studies. One type is basic research—for the most part what you are doing during this project. Another type is called a longitudinal study.

Longitudinal studies are generally associated with social science studies but they can be applicable and important in the natural sciences as well.

Product: After researching what longitudinal studies are and identifying the important aspects of them, the team will devise two different longitudinal studies. One will be a study on the students of the class and one will be designed as a study on the people at the school. We will most likely NOT be actually conducting these studies - the designs are to ensure understanding of the methodology involved, so be creative (and yet appropriate)!

The designed studies must have discussions of methodologies in both cases – discuss what is being studied, why it is being studies, how it is being studied (along with controls and other scientifically appropriate ideas).

Communities Shared Group Collaboration Part Leadership Knowledge Work Communication Technology Improvement Help Training Analysis Individual Problem Scientific Project Skills Solve Tools

Grading criteria are given on the project rubrics handout.

#### TEAM REQUIREMENT #4: ETHICAL CONSIDERATIONS OF ANIMAL STUDIES

The team member filling the role of the Animal Scientist (see page 6) will be investigating in more depth what animal models are and how they are selected. For this requirement, as a team, you will focus more on the ethical considerations related to the study of animals. This is a complex topic and in many cases is presented by members of the media in a way that elicits strong emotional and visceral responses. These responses are not inherently bad, but sometimes emotions cloud our ability to see the complex nature of such issues. You will determine the major ethical ideas pertinent to all sides of this issue. Product: Once you have determined the pertinent ethical ideas you will write a script for a 5-7 minute debate about the topic. You can include a moderator as part of the debate, if you wish. Then you will act in and film the debate. You will submit the script and the video as your products for this requirement.

Grading criteria are given on the project rubrics handout.

"Individual commitment to a group effort — that is what makes a team work, a company work, a society work, a civilization work." ~Vince Lombardi



#### TEAM REQUIREMENT #5: COLLABORATION BETWEEN SCIENTISTS

As a team you will discuss how each scientist has an important role to play in the endeavor to better diagnose cancer, and you will also figure out the challenges of working in this type of group. You should address these questions (*at least*): 1) How do these different scientists communicate with each other and why might that be difficult? 2) Does there need to be a leader and, if so, who should be the leader? 3) What other issues might teams of experts from different fields experience while working together?, 4) What other specialists would be helpful to have on this team?

Product: The team will create an illustration (like the gears in the diagram (to the right) - that shows how different scientists each have the own important role, but also how they have to work together to make the scientific process work. (You cannot use gears as your illustration since that was the example).

You will also produce a short writeup answering the questions above and discussing how your illustration illuminates the separate roles and the interconnectedness of the scientists.

Grading criteria are given on the project rubrics handout.



# ANALYTICAL CHEMIST

The student filling the role of the analytical chemist (sometimes these chemists refer to themselves as "measurement scientists") will investigate what analytical chemistry is as a field of study and the major objectives of the field as a whole.

The student will research the techniques of analytical chemistry most related to this overall investigation (mass spectrometry and liquid chromatography), but they will also explore other analytical chemistry techniques that might be pertinent to this or other research. After completing the pertinent research the student filling this role will make a Tellagami animation illustrating the main focus of an analytical chemist. This student will also write a 3-4 page paper addressing the questions given below as well as anything else they find important and appropriate related to the topic. The student will also produce a "free choice" illustration on the topic and also provide a Work Cited page that has at least 5 different resources.



Analytical Chemists in the Wild West

## **QUESTIONS TO ADDRESS**

"Measure what is measurable, and make measurable what is not so."

~Galileo Galilei

1. What is an analytical chemist? What is the primary focus of analytical chemistry?

2. What is mass spectrometry? How does it work?

3. What are the different types of mass spectrometry available currently? How are they different?

4. What is chromatography?

5. What is liquid chromatography and how is it used in tandem with mass spectrometry?

6. What other techniques are common to analytical chemistry? 7. What role(s) does the analytical chemist play in this overall investigation?



## **PRODUCTS & REQUIREMENTS**

1. Make a Tellagami animation that illustrates the main points of what an analytical chemist does. It should have a background that is appropriate for an analytical chemist.

> 2. A 3-4 page paper discussing the answers to the given questions (above) and anything else deemed appropriate.

3. An illustration (student choice – can be a drawing, a Venn diagram, a graphic organizer, or any other meaningful illustration) demonstrating the role and importance of the role of the analytical chemist.

4. A Works Cited page with at least 5 different resources.



Consult the project rubrics handout for more specific information on requirements, grading expectations, and deadlines.



# BIOCHEMIST

The student filling the role of the biochemist will investigate what biochemistry is as a field of study and the major objectives of the field as a whole.

The student will research the goals and methods that makes up the field of biochemistry and what techniques are most frequently employed by biochemists.

The student will focus on glycans (since they are central to this investigation) but also investigate genomics and proteomics.



After completing the pertinent research the student filling this role will make a Tellagami animation illustrating the main focus of a biochemist. This student will also write a 3-4 page paper addressing the questions given below as well as anything else they find important and appropriate related to the topic. The student will also produce a "free choice" illustration on the topic and also provide a Work Cited page that has at least 5 different resources.

## **QUESTIONS TO ADDRESS**

1. What is a biochemist? What is the primary focus of biochemistry?

2. What are some chemical processes that are particularly important in biological systems?

3. What is genomics? What are the major applications of the study of genomics?

4. What is proteomics? What are the major applications of the study of proteomics?

5. What are glycans and glycomics? What are the major applications of the study of glycomics?

6. What are certain types of biochemical substances more challenging to study than others? 7. What role(s) does the biochemist play in this overall investigation?



"Very few scientists acquainted with the chemistry of biological systems at the molecular level can avoid being inspired."

~Donald Cram

## **PRODUCTS & REQUIREMENTS**

1. Make a Tellagami animation that illustrates the main points of what a biochemist does. It should have a background that is appropriate for a biochemist.

2. A 3-4 page paper discussing the answers to the given questions (above) and anything else deemed appropriate.

# TRUST ME I'M A BIDCHEMIST

3. An illustration (student choice – can be a drawing, a Venn diagram, a graphic organizer, or any other meaningful illustration) demonstrating the role and importance of the role of the biochemist. 4. A Works Cited page with at least 5 different sources.

Consult the project rubrics handout for more specific information on requirements, grading expectations, and deadlines.



# ANIMAL SCIENTIST

The student filling the role of the animal scientist will investigate what animal science is as a field of study and the major objectives of the field as a whole.

Animal science is not the same as veterinary science (although many veterinarians get their undergraduate degrees in animal science), so the student filling this role needs to distinguish between the two fields and concentrate on animal science.

The student will investigate how different animals are



chosen for different experiments and why. The student will also investigate how the animals are cared for during experiments and what happens to them after experiments.

After completing the pertinent research the student filling this role will make a Tellagami animation illustrating the main focus of an animal scientist. This student will also write a 3-4 page paper addressing the questions given below as well as anything else they find important and appropriate related to the topic. The student will also produce a "free choice" illustration on the topic and also provide a Work Cited page that has at least 5 different resources.

"Some people talk to animals. Not many listen though. That's the problem." ~ A.A. Milne

STAND BACK

I'M GOING TO TRY

SCIENCE

## **QUESTIONS TO ADDRESS**

1. What is an animal scientist? What is the primary focus of animal science?

2. What is an animal model and how are appropriate ones selected? Why were chickens chose for this particular investigation?

3. What are knockout mice (and other knockout species)?

4. How are knockout species made and for what purpose?

5. How are animals in experiments cared for?

6. How do animal scientists use controls in their experiments?

7. What role(s) does the animal scientist play in this overall investigation?



Not what is really meant by knockout mice.

## **PRODUCTS & REQUIREMENTS**



1. Make a Tellagami animation that illustrates the main points of what an animal scientist does. It should have a background that is appropriate for an animal scientist.

2. A 3-4 page paper discussing the answers to the given questions (above) and anything else deemed appropriate. 3. An illustration (student choice – can be a drawing, a Venn diagram, a graphic organizer, or any other meaningful illustration) demonstrating the role and importance of the role of the animal scientist.

4. A Works Cited page with at least 5 resources.



Consult the project rubrics handout for more specific information on requirements, grading expectations, and deadlines.

# ONCOLOGIST

The student filling the role of the oncologist will investigate what oncology is as a field of study and the major objectives of the field as a whole.

Oncologists are actually medical doctors, so they are a bit different than the other roles in this project. They might be seen as being on the "front lines," but there is research just as important going on behind the scenes as well.

The student investigating this role will look into facets of oncology, but will also have to research into some epidemiological issues as well (epidemiology is branch of medicine that deals with the incidence, distribution, and possible control of diseases).

After completing the pertinent research the student filling this role will make a Tellagami animation illustrating the main focus of an oncologist. This student will also write a 3 -4 page paper addressing the questions given below as well as anything else they find important and appropriate related to the topic.



The student will also produce a "free choice" illustration on the topic and also provide a Work Cited page that has at least 5 different resources.

## **QUESTIONS TO ADDRESS**



1. What is an oncologist? What is the primary focus of oncology?

2. What is cancer?

3. What are some major different types of cancer? What are some important statistics related to these different types?

4. How are cancers detected and diagnosed?

5. What are some treatments for cancers? What do these treatments actually do?

6. What are the different stages of cancer and what is the importance of designating stages?

7. What role(s) does the oncologist play in this overall investigation?



"When someone has cancer, the whole family and everyone who loves them does too."

~Terri Clark

# PRODUCTS & REQUIREMENTS



1. Make a Tellagami animation that illustrates the main points of what an oncologist does. It should have a background that is appropriate for an oncologist. 2. A 3-4 page paper discussing the answers to the given questions (above) and anything else deemed appropriate.

3. An illustration (student choice – can be a drawing, a Venn diagram, a graphic organizer, or any other meaningful illustration) demonstrating the role and importance of the role of the oncologist. 4. A Works Cited page with at least 5 resources.

Consult the project rubrics handout for more specific information on requirements, grading expectations, and deadlines.



Integration of Sciences

**Statistics on Ovarian Cancer** 

Estimated New Cases in 2014	21,980
% of All New Cancer Cases	1.3%
Estimated Deaths in 2014	14,270
% of All Cancer Deaths	2.4%

http://seer.cancer.gov/statfacts/htm I/ovary.html

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## STUDENT REFLECTIONS & SELF AND PEER EVALUATIONS

The last part of your project will be a reflection. You will write a 1-2 page (double-spaced) paper about the experience of working on the project. Make sure to *at least* address the following questions: 1) What was



the most interesting thing that you learned during the experience? Why? 2) What was the most important thing that you learned? Why was it the most important? 3) What was the most difficult aspect of the project? Why? 4) What was the easiest aspect of the project? Why? 5) What would you like to investigate and learn more about? Why? 6) What could be done to improve the project/experience? Why would that be an improvement? You can also make comments beyond these questions.

After the completion of the project you will also get a chance to assess your own performance and the contributions of the other team members. This evaluation score will be incorporated into the grades for the project.

# TOOLS TO USE

#### Infographic Tools for the History of Mass Spectrometry:

- http://piktochart.com/
- http://infogr.am/
- http://create.visual.ly/

#### Cartoon/Comic Strip Tools for Polarity/Non-Polarity Product:

- http://www.toondoo.com/
- http://www.readwritethink.org/files/resources/interactives/comic/
- http://www.makebeliefscomix.com/Comix/

#### Tellagami Animation for the Individual Roles:

 https://tellagami.com/ (you will have to download the app on an apple product or google product to use it—ask the teacher if you need a device)



This is not what we are aiming for here.