History of Science: Historic Controversy Case Study (Argumentation) Model
Student Name: Margaret A. Lambert
Subject: Biology
Topic: Germ Theory
Grade Level: 9-10th

Duration: 4 90-minute periods

Essential Questions: What is Germ Theory? Who are the scientists responsible for developing this theory? What information led them to the conclusions that they drew?

Virginia Standards of Learning (SOLs):
BIO.1 The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which: b) hypotheses are formulated based on direct observations and information from scientific literature; l) alternative scientific explanations and models are recognized and analyzed; and m) current applications of biological concepts are used.

BIO.4 The student will investigate and understand life functions of Archaea, Bacteria and Eukarya.

Key concepts include a) comparison of their metabolic activities; b) maintenance of homeostasis; c) how the structures and functions vary among and within the Eukarya kingdoms of protists, fungi, plants, and animals, including humans; d) human health issues, human anatomy, and body systems; e) how viruses compare with organisms; and f) evidence supporting the germ theory of infectious disease.

Objectives
Students will know:
-Multiple different theories for how diseases have spread have existed throughout time, including the Humoral and Miasma.
-The microscope allows scientists to see bacteria and microbes for the first time in the 1700s, which allowed the connection between disease and microscopic organisms to be made.
-Germ Theory, as supported by the work of Louis Pasteur, Robert Koch, and John Snow, took the place of all prior theories of disease spread due to the exactness with which it was able to explain the transfer of a pathogen via microscopic means.

Students will be able to understand:
-Human understanding about the spread of disease has evolved and become more exact over time.
-Humans create multiple theories to explain the same phenomena depending on their culture, religion, and societal environment.
-Theories must be backed up by repeatable results in order to become a tried and true scientific theory.

Students will be able to do:
-Parse out the important pieces of a theory on the spread of disease.
-Create a poster demonstrating their understanding of a disease theory.
-Reason like a historical scientist to explain a theory.
-Record a podcast and explain why Germ Theory united and eclipsed prior theories.

Background Information:

This three-day lesson will come in the middle of the year. Students will have already been exposed to cells and The Cell Theory and it can be assumed that they have used compound microscopes before in class. The way this lesson fits into the overall arc of the year is that it works to couch the knowledge that students have in terms of the historical period during which this knowledge evolved. Students will be asked to brainstorm what they know about how disease is spread and then they will be asked to forget about that and travel back in time to reason like ancient citizens of either Greece or Europe. They will have to read through scenario cards and reason like the citizens of those times to create theories of how disease is spread. Day One: The class will be split in half to do the initial research and they will write up their findings in a poster format. They will have a full day of researching one theory (either the Miasma or Humoral Theory). Day Two: The class will take turns presenting their theories to the other half of the class. Day Three: The teacher will present one more unifying theory—*Germ Theory*—which has now replaced both of the other theories. As a fun culminating activity, the students will be asked to write out a script and record a "medical history" podcast of the theory they researched. The class will host a "live radio show" during which they will listen to examples from all of the conflicting theories and recap on the lesson as a whole.

In this lesson, students will be asked to reason like ancient scientists, either from the philosophical Ancient Grecian who believed in the Humoral theory of ailment or the Middle Ages-Victorian Age Europeans who believed in "bad air" and the Miasma. Cultural beliefs regarding disease were influenced by the religious culture and the political climate of the time. In Ancient Greece, where the highly regarded men were both religious and philosophical, it is not a long jump to see how a philosophy such as the Humoral theory, that says humans have four internal and oppositionary forces: blood, phlegm, black bile, and yellow bile. Four was a very strong number in earth-bound cultures being tied in to the cardinal directions, night and day, the sun and moon, hot and cold, wet and dry. There are many instances of pairs of duality existing in ancient Greek tales of the triumphs and follies of the gods and goddesses. Similarly, in English villages, where underground sanitation and piping systems didn't exist, and raw sewage was often throw out onto nearby public streets, it was common for people to be exposed to numerous foul smells, making the jump to the Miasma theory not too far fetched.

The Disease Question: Unit Plan Outline			
Classes	**Year(s)**	**Historical Description**	**Class Problem**
1st 90 minute period **Half the Class**	**12th-9th centuries BC, Ancient Greece**	**Humor Theory of Disease Spread**	**Activity 1:** Have students free write for 5 minutes responding to the prompt, "How is disease spread? Name all the ways you can think of." **Think-Pair-Share** Responses to above questions **Activity 2: Humoral Cards** Students are given a set of images of the "humors" and are asked to brainstorm a theory about how disease spread occurs based on the cards. **Activity 3: Scenario Cards** Students are given a scenario that they are back in Ancient Greece. They are all physicians talking together who are working on treating patients who are suffering from very different ailments. They are given some key beliefs of the time that they must use to defend whatever decision they come to about what the cause of disease spread could be. Students will work in their base group tables to discuss and come to an idea together. (See Ancient Greece Scenario Cards Below)**I still need to create the cards.** **Activity 4: Humoral Theory Poster** Students will create a poster highlighting what the Humoral Theory of disease spread is. They should be prepared to present their findings to the other group the next class period. They will be allowed to consult historical readings given to them by the teacher only (See Reference and Resource section). **Humoral – http://ocp.hul.harvard.edu/contagion/humoraltheory.html** **https://www.nlm.nih.gov/exhibition/emotions/balance.html** **The Hippocratic Corpus -** **http://exhibits.hsl.virginia.edu/antiqua/humoral/**

1st 90 minute period **Half the Class**	**1500's-1800's, Europe**	**Miasma Theory of Disease Spread**	**Activity 1:** Have students free write for 5 minutes responding to the prompt, "How is disease spread? Name all the ways you can think of." **Think-Pair-Share** Responses to above questions **Activity 2: Smog Cards** Give base groups the smog cards (page one only) and have them discuss at their tables what the images share in common and what that has to do with disease spread. **Activity 3: Black Death Scenario Cards** Students are given a scenario that they are back in the Middle Ages in Europe during the bubonic plague aka Black Death years of 1346-1353. They are trying to decide where the healthiest place is to go to stay healthy. They are given some key beliefs of the time that they must use to defend whatever decision they come to. Students will work in their base group tables to discuss and come to an idea together. (See Bubonic Plague Scenario Card Below) **Activity 4: Miasma Theory Poster** Students will create a poster highlighting what the Miasma Theory of disease spread is. They should be prepared to present their findings to the other group the next class period. They will be allowed to consult historical readings given to them by the teacher only. (See Reference and Resource section). **Miasma - https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1121911/ http://www.carlsterner.com/research/files/History_of_Miasmic_Theory_2007.pdf**
2nd 90 minute period **Full Class**	**Late 1800's Europe**	**Germ Theory** Louis Pasteur, John Snow, Robert Koch	**Activity 1:** The teacher will do a direct instruction lesson on Germ Theory, showing images of bacteria and explaining the historic significance of these images. There will be a brief review of the Cell Theory and the scientists who helped us learn more about cells. Students will take notes. **Activity 2:** Students will use compound microscopes to focus on images of microbes: yeast, bacteria, etc. Students will record in their lab notebooks, which they will have already set up earlier in the year.

3rd 90 minute period **Full Class**		**Putting it All Together into Podcasts**	**Activity 1:** Have students listen to sample medical history podcasts from **SawBones, http://www.maximumfun.org/shows/sawbones** and highlight the important components: factual, humorous, witty, short. **Activity 2:** Students write up a script for their Medical History Podcast recording following the criteria that: 1) All three theories of disease spread are mentioned, 2) The students highlight which theory they researched, as well as give an explanation for how Germ Theory eventually took over as the accepted belief in our modern day. Students will edit and swap scripts and act as editor for someone else in their base groups. Students will record and submit the final version of their podcast to the teacher. The teacher will have a "live radio show" and will choose volunteer podcasts to play for the class on the last day of this lesson.

Materials/Resources:
-white boards for presentations
-computers for research
-scenario cards
-recording device (computer) for podcasts

Safety: No concerns.

Assessment: Students will be assessed based on the quality of their group discussions (teacher will circulate) and the answers to their given scenario cards that they will fill out as a team. Students will also be assessed based on the accuracy and details on their posters and their ability to explain the theories while presenting to their classmates. Students will also have to write up a script for a Medical History podcast about the evolution of thought in around how disease is spread. Students must mention all three of the theories in the lesson: Humoral, Miasma, and Germ theory. They should make it interesting and entertaining. They can listen to examples of good quality medical history podcasts here: SawBones, http://www.maximumfun.org/shows/sawbones.

Closure: The teacher will recap the main tenets of each theory and students will opt to play their recorded medical history podcasts for the class.

Accommodations for individual differences:
Students will have a choice at the end of this unit about what they'd like to create their poster projects about. They will get to choose the direction of their investigation.

Behavioral and organizational strategies:
Students will be sorted into some heterogeneous and some homogeneous groups in various days to allow for multiple aptitudes to come through. The teacher will always reserve the right to shift a group, as needed.

Resources/References:

Historic Writings for Students to Use in Research:

Humoral – http://ocp.hul.harvard.edu/contagion/humoraltheory.html

https://www.nlm.nih.gov/exhibition/emotions/balance.html

The Hippocratic Corpus - http://exhibits.hsl.virginia.edu/antiqua/humoral/

Miasma - https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1121911/
http://www.carlsterner.com/research/files/History_of_Miasmic_Theory_2007.pdf

The Burdens of Disease: Epidemics and Human Response in Western History
By J. N. Hays
https://books.google.com/books?id=AJReBNnOoL8C&pg=PA11&lpg=PA11&dq=humoral+theory+writings&source=bl&ots=VCEVRLIcgO&sig=RdB5Rn3DTw3MKtk8BbB7jwpg5ko&hl=en&sa=X&ved=0ahUKEwjznOvI_JjTAhVD5SYKHVX1AD4Q6AEIgQEwEw#v=onepage&q=humoral%20theory%20writings&f=false

Other Resources:

Online Encyclopedia – Miasma - http://www.sciencemuseum.org.uk/broughttolife/techniques/miasmatheory

Online Encyclopedia – Germ Theory - http://science.jrank.org/pages/3035/Germ-Theory.html

BigPictureEduation – The History of Germ Theory –
https://bigpictureeducation.com/history-germ-theory

Science Museum Brought to Life – Germ Theory -
http://www.sciencemuseum.org.uk/broughttolife/techniques/germtheory

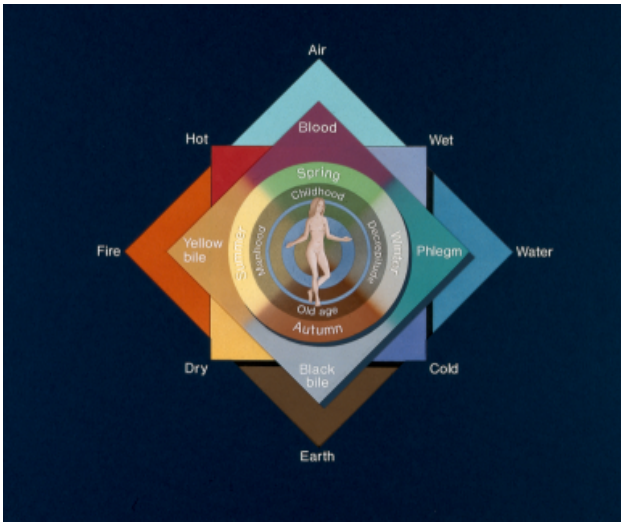
Science Museum Brought to Life – Humoral Theory -
http://www.sciencemuseum.org.uk/broughttolife/techniques/humours

Malaria and Miasma Theory History – Engaging Etymology - https://www.youtube.com/watch?v=2ypHJM98Ehc

Cynical Cypher Explained -
https://www.youtube.com/watch?annotation_id=annotation_667910245&feature=iv&src_vid=2ypHJM98Ehc&v=EM1EV8RdnJA

Disease – A Crash Course in World History – John Green
https://www.youtube.com/watch?v=1PLBmUVYYeg
Recent Paris Smog Article - https://www.citylab.com/transportation/2017/03/the-cars-that-ate-paris/520710/

Humoral Theory

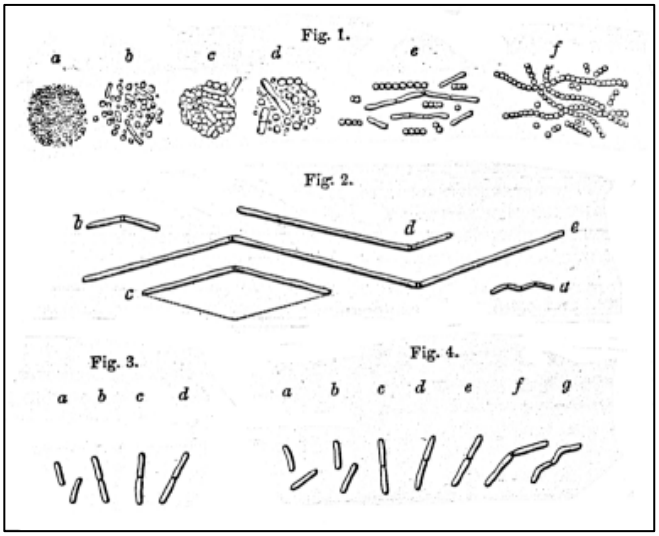


The four humors and their corresponding qualities.

Miasma Theory


The thick evil air of infection hovering over a city.

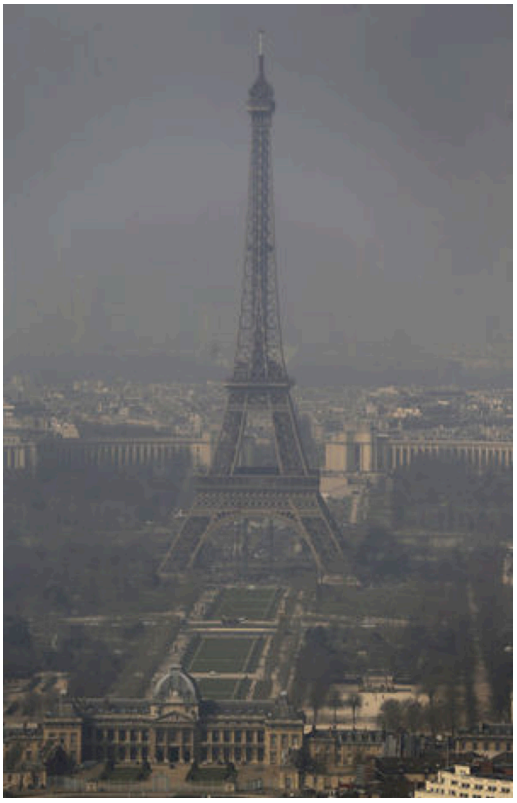
Germ Theory



The atmospheric germ theory, from a lecture given to the Royal College of Surgeons in Edinburgh, 1868.

These images have something to do with a theory of disease spread. What do you think that theory is?

A Glasgow, Scotland street, 1868.



Paris, France. 2014.

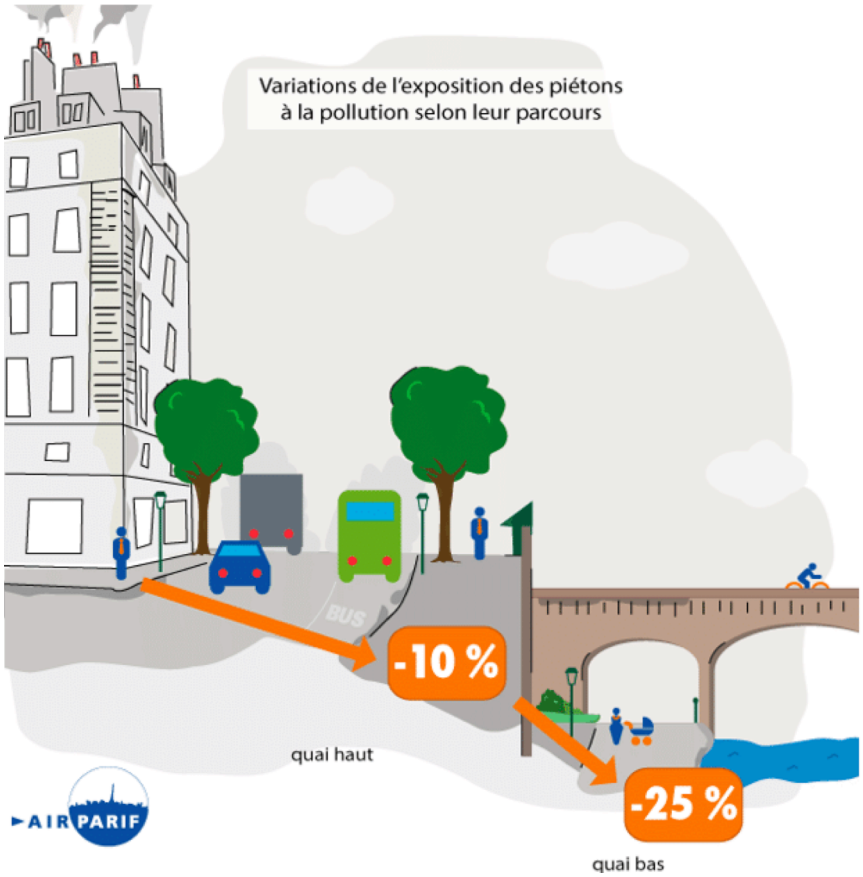
Rio de Janeiro, Brazil.

Hong Kong, China.

I'll give you a clue… those pedestrians aren't holding their hands over their mouths because that last guy farted…. Why else do you think they would be covering their nose and mouths?

San Francisco, California, as seen from Oakland.

Smog is a fog or haze combined with smoke and other atmospheric pollutants. Cities create polluted air from car, trains, buses, airplanes, factories, and heating of homes among other factors. All of the particles released into the air hangs over the city, such as in the photos above in San Francisco, California. Because polluted air is denser than non-polluted air, ground exposure, such as pedestrians get, is more toxic than exposure higher in the air. Just look at this image of the roads above the River Seine in Paris and below. The pollution on the river walkway is 15 times more polluted than the road above. Medical experts from the Middle Ages (1500's) to the 1800's believed in a theory of disease spread called the **Miasma Theory.**



According to the **Miasma Theory**, diseases were caused by the presence in the air of a miasma, a poisonous vapor in which were suspended particles of decaying matter that was characterized by its foul smell. The theory originated in the Middle Ages and endured for several centuries.

The killer disease, malaria is named - from the Italian *mala* 'bad' and *aria* 'air' – which is evidence of its suspected miasmic origins.

In 19th-century England the **Miasma Theory** made sense to the sanitary reformers. Rapid industrialization and urbanization had created many poor, filthy and foul-smelling city neighborhoods that tended to be the focal points of disease and epidemics. By improving the housing, sanitation and general cleanliness of these existing areas, levels of disease were seen to fall, an observation that lent weight to the theory.

The **Germ Theory** of disease emerged in the second half of the 1800s and gradually replaced **Miasma Theory**. Although it had been disproved and rejected, the miasma theory's existence was not without its merits. By removing the causes of bad smells, reformers often inadvertently removed bacteria, the real cause of many diseases.

Bubonic Plague Years Scenario

The year is 1347 and you are all residents of Paris, France. You have heard through others that many people in Paris are getting sick from an unknown disease. No one in your family has gotten sick yet and you'd like to keep it that way. You are holding a family meeting to try to decide where you should go and what measures you should take to all stay healthy.

Your Families Beliefs About Disease:

- Disease is avoidable.
- Disease comes from "bad air" which holds dangerous evil things that get into your body and kill you from the inside out.
- You have heard that people who live near the River Seine and the factory areas are getting sick.
- You know of a whole block of residents who are ill.

Discuss with your family what your options are and decide on what your plan is. Have one person write out your "survival plan" and be ready to share with the group.