Mosquitoes, DNA, and Slavery

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OVERVIEW: The importance of mosquitoes in shaping the genetics of populations they feed on is often overlooked in history. Too often high school history courses focus on important individuals; war, conflicts, schisms, great inventions and various other themes, but rarely does social studies emphasize aspects of the world of entomology and parasitology. Seldom are students made cognizant of environmental influences that pathogens have in shaping the social biology of indigenous peoples and their cultures. The mosquitoes' role, perhaps, the chief culprit in this age-old saga, must be given greater status in social studies. Mosquitoes, with over two thousands distinct species, have long been major vectors used to spread deadly viruses, various parasites, such as malaria and yellow fever, completing the cycle of man verse pathogens. These pathogens have developed means and methods to use humans as sources of nutrition. Thus, by putting the human genome under continual siege, mosquitoes have played a tremendous role in altering cultural patterns, often determining where and how humanoids live. More importantly, they have caused mutations in their hosts' DNA as well.

RATIONALE:

Mosquitoes, along with other insect carriers of pathogens, have played vital roles in arresting and altering cultural development of many peoples especially Africans. Malaria, a chronic illness saps strength and vitality from its hosts. Malaria's persistency is a major cause of lassitude and lethargy amongst peoples in that it never permits the hosts to fully recover. Moreover, exposures to malaria infections over many eons have resulted in mutations and genetic abnormalities in the African gene pool.

One such genetic abnormality is the sickle cell gene that causes sickle anemia. The sickle cell gene is an important kind of genetic variant, one that was traded off to offer the mosquito's host relative immunity. Various types of protozoan such as Plasmodium vivax, Plasmodium ovale, Plasmodium malaria, and the vicious malaria caused by Plasmodium falciparum, are responsible for this genetic mutation. These agents have destroyed many Africans lives due to anemia and obstruction of the capillaries.

Africans have biologically surrendered elements of physical fitness for survival. It is this ability to survive these pathogens, malaria, yellow fever, dengue and other insect-borne scourges that helped to accelerate the need for slaves. After exterminating indigenous Indian populations, white, plantation owners began to depend on slaves captured and transported from Africa.

Africans, many of who had acquired immunity during childhood, withstood the on slough that befell whites. The Europeans paid a different kind of toll for their part in this tawdry affair, depopulation and deaths caused by inhumanity, slavery and it aftermath. They did not go unscathed, for the Africans possessed biological arsenals of lethal weapons that are the envy of germ warfare terrorists. These germs inflected illnesses, pain and destruction on the kidnappers.

These biological agents are, perhaps, responsible for more European deaths than any combination of wars or other forms of conquest. For example, according to the International Federation of Red Cross, three diseases alone, AIDS, tuberculosis and malaria, have killed an estimated 150 million people since 1945. The 23 million people killed in all the wars since 1945 pale in comparison to deaths caused by these diseases. European morbidity, caused by mosquito-borne pathogens, over time took untold deaths and caused dislocation, probably many more causalities than caused by slavery.

They came airborne from Africa, flying needles, loaded with lethal germs, to seek a kind of retribution against those who would despoil the motherland. From every corner of Africa, mosquitoes arrived in the Western Hemisphere and wrecked havoc the indigenous and European populations. This war, pathogens verse Europeans, continued well into the twentieth century, long after slavery was officially ended.

The presence of the Aedes Aegypti in the United States has had profound and disastrous consequences on the social, political and economic development. The common people of the south were long considered backward and diseased. These impressions were enhanced by the persistent presence of parasites.

Just like these same kinds of parasites sapped the vitality of Africans, so too, they sapped the strength of poor white rural southern peasants, rendering many of them listless, lethargic and ill tempered. The introduction of mosquito-born illnesses raged at will through these defenseless populations. They lack the essential immunities possessed by many Africans, deficiencies responsible for thousands upon thousands of deaths. This dichotomy contributed to the virulence of white hatred of the black races. It helped foster and

entrench negative attitudes that persist today. There was widespread belief that slaves were responsible for white misery. Nature has a way of leveling the playing field.

OBJECTIVES:

This project is designed to demonstrate how and why mosquitoes play major roles in developing African biological existence, resistance, more specifically, genetic adaptations. Adaptation engendered by endemic persistence of insect vectored germs. Pupils are to extrapolate data collected and do research to draw conclusions about the importance of African acquired immunity to mosquitoes caused illnesses. Finally, students will be directed towards examining how ecology and entomology have played a significant role in shaping the history of slavery.

Moreover, African relative acquired immunity to the virulent potency of these germs, significantly contributed to their exploitation as slave labor, and maybe partly responsible for their limited ability to defend themselves against the horrors of slavery. Equally important, students need to explore the fact that Africans were not the only ones to receive a raw deal being enslaved. Just as many Africans died, in this vulgar, sordid display of capitalism, so did thousands upon thousands Europeans, from pathogenic agents brought over mainly from Africa. This part of the transaction is rarely explored in the classroom. This curriculum serves to demonstrate that many different races suffered from this repulsive exchange.

A tangential aspect of this study will explore, in a general way, how changes in ecology and entomology have significantly affected events throughout recorded history from ancient Rome to present day Africa. Students will explore how mosquito-borne parasites changed and altered important historical events.

STRATEGIES: Students will used a multifaceted approach to achieving the expressed objectives:

1. Study of African ecology.
2. Examine the life cycle of mosquitoes

3. Interplay between mosquitoes vector diseases and slavery.

4. Discussion of the relationship between entomology, parasitology and epidemiology.

5. Malaria and genetic mutation, sickle cell anemia.

6. Malaria and yellow fever, social, political and biological effects on America's south.

7. Use of JAVA Epidemiology Program to simulate an epidemics.

8. Research paper:

How has malaria or yellow fever influence some significant historical events?

a. Building of the Panama Canal

b. Revolution in Haiti

c. Spanish American War

d. Creation of the Tennessee Valley Authority

e. Impact on the Civil War

f. Industrial development of the South.

g. War World II The United States verse Japan in the Pacific

h. The collapse of the Roman Empire

i. Impact on the slave trade in the United States

j. Building of the Suez Canal

Students receive the same tired and worn out analysis of slavery and it aftermath. Rarely is social biology interconnected with political and social forces to exemplify a unified picture of this period in American history. Here is an opportunity to do bench marked cross curriculum lessons that marries history, mathematics and biology. Students will determine causes and effects of mosquito-borne diseases, including but not limited to dengue, hemorrhagic fever, encephalitis, malaria, and yellow fever, they will be able to see clearly how the pathogens played significant roles in shaping of the people of Africa and the Americas.

ECOLOGY: Study of the ecology of Africa, Caribbean, and the American South will be explore on Microsoft: Virtual Globe.

DNA MUTATIONS: Students will explore the DNA mutations, genetic changes unique to Africans. (Some Europeans who inhabit the Mediterranean Sea areas have developed mutated genes influence by malaria too.) Mutations brought on by the persistent threats of malaria and other non-contagious pathogens. In doing so, they will then explore the trade off between mutation and acquired immunity vs. non-mutation and susceptibility to parasites.

Moreover, they will learn some general aspects about genetics, mutation, vectors and probabilities. Perhaps, they will study the lifecycle of mosquitoes, characteristics, blood feeding, development, food, hatching, impregnation, larvae, pupa stage, territories and transmission.

An example of genetic mutation will be placed on sickle cell gene. In biology class students will be given an in-depth look at PCR (Polymerase Chain Reaction). Or in social student class students will be given a cursory look at PCR. Students will understand how to detect the presence of the sickle cell gene.

ENTOMOLOGY: Another phrase of this curriculum will put emphasis on the importance of the study of entomology. An understanding of study insects is necessary in understanding their impact in shaping history. There are numerous accounts about the role of insects in shaping and altering historical events. Some entomological influenced events the teacher may want students elaborate on are:

a. Egypt: Biblical history: fly and locust

b. Europe: Bubonic: flea.

c. Utah: Mormons and Locust

d. China: Famine and Locust

e. Africa: Cattle: Tsetse Fly

f. Brazil: Killer Bees

g. Brazil: Fire Ants

EPIDEMIOLOGY: Students will learned the dynamics of epidemiology and the way and style epidemics influence history. To this end students will visit web pages for the Center for Disease Control and the National Archive to learn the parameters of the nature of epidemics in southern United States.

For example students will study the role yellow fever and malaria epidemics played in Haitian independence. The Haitian victory over the French had a profound influence on American slaves and their owners. Slaves, they derived hope, white owners, they tightened their grip on slave movement looking for early warning signs of resistance.

Pupils can examine how mosquitoes played a role in the Louisiana Purchase. One of the principle reasons Napoleon Bonaparte sold the Louisiana Territory was due in large part to the persistence of malaria and yellow fever. Epidemics that French troops encountered in Haiti.

Equally important, students should examine how malaria and yellow fever epidemics, along with myriad of other disease, decimated the Native American and acerbated their demise.

Malaria and yellow fever epidemics played a major role in the causalities and morbidity rate in the Civil War. Students will examine ephemera such as handbills, postcards and letters issued by soldiers during the Civil War describing the effects of these epidemics. They will determine whether the effects of these diseases on combatants altered the course of the war. This information can be obtained on the World Wide Web, type in malaria or American Civil War

ACTIVITY #1: This unit is designed to introduce students to the basic aspects of malaria, a tropical disease that wrecks physical and emotional havoc on many of the world poorest people. Students will study malaria as an endemic, persistent insect bore disease.

This unit is crafted and structured to help students apply and relate epidemiological consequences of malaria to aspects of the salve trade. This data will help them to realize and appreciate the magnitude of this infection on

passed generations, as well as, its effects on present day populations. To achieve this students will examine major aspects of malaria as reported in the World Health Organization's web site.

World Health Organization Publications

a. Basic Laboratory Methods in Medical Parasitology

b. Basic Malaria Microscopy

c. Bench Aids for Diagnosis of Malaria

d. Entomological Field Techniques for Malaria Control

e. Global Strategy for Malaria Control

f. Malaria: A Manual for Community Health Workers

g. Malaria Vaccine Development

h. Vector Control for Malaria and Other Mosquito-borne Diseases

i. WHO Expert Committee on Malaria, Twentieth Report

Students can write a synopsis of one of these publications and report their findings to the class.

The basic causation of the disease will be explored in depth. Special attention will be given to how and why these parasitic organisms evolved to use humans as a ready source of nutrients. An evolutionary process that interconnects parasites, mosquitoes and humans in a cycle that benefits the parasites and mosquitoes but is quite devastating to humans, especially to those in tropical areas. Since there are four species of plasmodium, a single cell parasite, students will examine the most virulent of these protozoans. Just how and why these microscopic organisms find their way into the guts of mosquitoes and eventually use humans as hosts for procreation? Is this another example of evolutionary specie jump from protozoan to insect to animal and finally to humans?

TOPOGRAPHY: In determining the range and prevalence of malaria, students will have an opportunity to apply their geographical and topographical knowledge. They will strategize how geography helps to determine climatical conditions. They will determine how these conditions are enhanced and altered by humans, exacerbating the spread of malaria. All these factors influence the prevalence and spread of malaria.

SYMPTOMS: A through review of symptoms and attended illnesses can help students to infer the physical, mental and psychological effects on the parasite's on its hosts. These inferences will be analogized to the conditions surrounding slavery. Since malaria is a chronic disease, symptoms appear and reappear upward of six times a year. This reoccurrence results in serve mental and physical disabilities. At the onset of malaria, the host will experience shivering, pain in joints, vomiting, convulsions, coma, anemia and ultimately death.

ECOLOGY: Equally important, transmission of malaria is easily avoided. On the other hand it is easily spread due to a complex interaction of climate; geography, rain and man made induced ecological and environmental changes.

This area of study is an important juncture to spin off into discussions about environmental, social, political and climatical changes such as global warming and the El Nino effect on the spread of the mosquito.

Global warming is proving to be a lode for the dissemination of pathogen carrying mosquitoes. Just a few degrees in warm temperature can increase their range. Malaria has spread into areas where previously it did not exist or was eradicated including areas in proximity of the United States.

Moreover, increased international travel, regional conflicts, refugees, growing immigration from tropical countries to new unaffected sites has added to the problem of increase in mosquitoes borne diseases. Epidemiologists have coined the term "airline induced malaria" as name for the spread of mosquitoes in this fashion.

ECONOMICS:

In countries where malaria is endemic, the economic consequences of this disease are severely profound. Students should be made particularly aware of how these consequences aid in the underdevelopment of third world countries. Teacher should assist students in applying the degenerating aspects of malaria to economic consequences. One result is lost labor production. Cost of treatment, prevention and lost income accounts for 1 to 5 percent GDP.

In Africa most of the population live in rural areas and depend on agricultural activity to grow food and earn needed income. Their income is already marginal at best. Since most agricultural activity occurs during the rainy season farmers are increasingly exposed to infection. Surely, the economic results are that many poor people are made even poorer since they are limited in their ability and willingness to plant and/or tend crops. Several studies suggest that malaria affected families cleared only 40 per cent of land for crops compared with healthy families. Direct cost of malaria to Sub Sahara countries exceeds 2 billion dollars. (1997 estimates . . . . I believed these estimates are extremely low.)

COGNITION:

Perhaps, once students understand the interaction between malaria and cognition they may extrapolate this data and apply it to the effects on slaves. Slaves were under continuous parasitic stress by innumerable insect borne pathogens. The cumulative effects of this parasitic onslaught, surely, had its long-term effects on intellectual stamina and acuity. Even today school children that suffer from chronic illnesses are routinely absent from school impairing their learning ability.

Children are the main target of malaria since it kills one child every 30 second resulting in the death of 3,000 children under five years of age. Presently the death toll far exceeds the mortality rate of AIDS. Children are often chronic victims and average 6 bouts a year fatally afflicting children dies less than 72 hours after development symptoms. These implications are especially are especially important in analyzing the salve trade. Malaria drains vital nutrients from its hosts impairing their physical and intellectual development.

ACITIVTY: #2

Have students ponder whether chronic physical impairment results in lethargy and lassitude. How did lethargy impaired the ability of Africans to resist slave traders?

Added to the above situation, malaria causes severe anemia especially during pregnancy and accounts for a major factor in contribution to maternal deaths in endemic regions. Equally important, pregnant mother, who have malaria and are HIV positive are more likely to pass on their HIV status to their unborn child. Today, malaria is one of the five major causes of under five-child mortality. Imagine the impact of malaria and yellow fever during the time of slavery.

These notes represent the first stage of understanding the impact on malaria on contemporary societies. These facts are designed to give the students a working base of knowledge to apply to the slave trade in particular and history in general.

ECOSYSTEM:

Students will examine how the spread of malaria is closely aliened to the ecosystem. They will explore changes in the African and American ecosystem that exacerbated the spread of malaria.

How did the first Africans survive and flourish despite exposure to the lethal falciparum malaria?

Perhaps prehistoric Africans survival was based on the yet undisturbed high forest ecosystem in which some Africans lived and the relative small size of their pre-agricultural, nomadic, hunter-gather bands. The anpheline mosquito was to become the chief vector of malaria in Africa. In early time these mosquitoes were not in abundance.

Their relative scarcity was due in large part to the high forest which provided fewer breeding sites. The small groups of hunter-gathers were also anti malarial. The numbers were sufficiently small so that there would be few malaria carriers to circulate infection through the mosquitoes.

Nomadic people don't stay in one place long enough to infect the local mosquitoes. Basically, as long as Africans remained in small mobile groups they could avoid the virulence of malaria. About two thousands years ago, Africans started to put more demands on the environment, created permanent settlement, started an agricultural way of life, in short, they helped to create the conditions for malarial to emerge to become a life threatening pestilence. Yams, taros, bananas, coconuts arrived from Asia and adopted by Africans. Fields supplanted the forests, plots and domesticated plants created ecological wet holes in forest ideal for the breeding of mosquitoes. The female mosquitoes had become domesticated like cattle and plants and were now apart of the village ecosystem. The mosquito greater presence added another reason for the Africans to migrated and developed infusions of protective genes.

SICKLE CELL GENE:

It is believed that aboriginal Veddoids from Asia brought the sickle cell gene to Africa from India. The gene was coded for the manufacture of an abnormal from of hemoglobin the working constituents of red blood cells.

This was the sickle cell gene. In it's purest form, the double dose of the gene inherited from both parents causes eventual death from progressive sickle cell anemia. Students will now study the sickle cell trait, which affords Africans some immunity to malaria. Their ability to withstand the most severe ravages of malaria contributed substantially exploitation as slave labor.

PROTECTIVE TRAIT:

Sickle cell in its dilute form in an individual, who inherits abnormal hemoglobin gene from one parent, is protective against the full pathogenic force of falciparium malaria. This is the "sickle cell trait." Children with sickle cell trait are as susceptible to infection as plasmodium falciparum as children with normal hemoglobin, but the parasite does not flourish in the sickle cell trait erythrocyte; the attack is attenuated, and the child survives to eventually become an adult protected by an acquired immunity.

The sickle cell confers “balanced deaths” to those without the trait. It permits the survival of the group; the cost of that surviving a high death rate from malignant malaria in children with normal cell hemoglobin, and death from sickle cell anemia of the children with the double does of the gene. The sickle cell gene not only permitted community survival, but also by ensuring a continuous supply of “carriers” of the parasite also established the skein of malaria transmission in Africa that remains unbroken.

ACTIVITY #3:

To understand fully genetic magnitude of the sickle cell trait have students log on to:

www.emory.edu/PEDS/SICKLE

The Georgia Comprehensive Sickle Cell Center at Grady Health System, Atlanta, GA

Students are complete the following exercise:

1. What is Sickle Cell Disease?
2. What makes the red cell sickle?
3. How do you get sickle cell?
4. Is Sickle Cell only in African Americans?
5. How can I be tested?
6. Newborn Screening
7. Are there different types of sickle cell disease?
8. Where can I get more information?

   Sickle Cell Disease Association of America 1-800421-8945

ACTIVITY: #4 Students will make and work with DNA probability charts to study the chances of inheriting the sickle cell trait.

ACTIVITY: #5 Equally important, students will explore and study how the sickle trait, acquired immunity, could have been beneficial to slaves and their owners.

MOSQUITOE BORNE DISEASES CROSS THE ATLANTIC

OVERVIEW: This segment will examine the consequences of mosquitoes borne diseases on slavery and the development of the southern part of the United States. One aspect of this segment is to do map work to demonstrate where many of the slaves originated and the topography associated with their environment.

OBJECTIVES: Students will study the topography of Africa, especially areas where slaves originated. They will note sea routes of slaves ships and ports of entry in the Americas. They will examine the impact of mosquitoes borne diseases on indigenous inhabitant of the Americas.

MATERIALS: Two maps are required: Africa and world map, geography text, Microsoft Virtual Globe, hole puncture, colored construction paper.

Slaves were taken from the west coast of Africa. Principally, they were transported from Nigeria, Ghana, Guineas, Angola, Ivory Coast Senegal, Gambia, Sierra Leone, Cameron, Gabon, Togo, and Benin. Their destinations were the major slave ports of the Americas including Savannah, New Orleans, Charleston, Cuba, Dominican Republic, Haiti, Jamaica, Barbados, Guyana, Suriname, Cartagena, Belem and Rio de Janeiro, Brazil.

The habitats of West Africa were mainly equatorial rain forests, jungles and savannas. Much of these habitats were altered and changed. First by Africans, due to subsistent burn and slash agriculture The forest was cleared and made way for increased domestication mosquitoes.

Increasingly, European incursions into equatorial Africa exacerbated the spread of malaria and yellow fever. In additional to environmental changes noted above, other changes were achieved by massive ecological-alterations such as cleared forests for the purpose of rice cultivation and logging. Rice growing required swamp like-conditions. Logging helped to create ponds in the cleared landscape. Irrigation of all sorts enhanced the spread and domestication of mosquitoes. Mining activities also must be added as a factor in the degradation of the tropical environment. More importantly, the importation of man made vessels capable of holding water helped to offer different types of breeding places for mosquitoes. These containers littered the African landscape.

ACTIVITY: #6

Students label the African countries where many slaves were captured. They are to key in the topography of the countries involved. They are to note how the disruption of the African ecosystem could exacerbate the spread of disease carrying insects. Students are to examine topographical maps or log on to Microsoft Virtual Globe to obtain topographical information and label map of Africa. Have students to create keys for all map work.

ACITIVTY: #7

Students label world map to include the ports of call where slaves disembarked. They are to draw lines from the Africa countries to the receiving countries noting above the line the estimate number of slaves captured and transported. Punch holes in various colored construction papers to create dots. Use dots to indicate slaves' places/countries of origins. Place dots on the world map and on African continent to designate tribal location. Place matching colored dots at sites in Western Hemisphere where slaves were sold. Have students draw lines connect the dots.

Life abroad slave ships suggest that mosquitoes bred and flourished in water barrels abroad the ships. Ships had ready supplies of fresh water. This water sat long enough for mosquitoes to

breed and complete a life cycles. Mosquitoes had captive blood supplies to feed. Many people abroad were infected with malaria and yellow fever.

JAVA EPIDEMIOLOGY:

Log on to http://darkwing.uoregon.edu/bsl/epidemiology/overview.html

JAVA Epidemiology is a computer program designed to simulate the spread of disease in a population. The JAVA program manipulates the following values to simulate and see how population characteristics change through time. Students can investigate major issues in population biology and public health. They can apply these findings to historical trends such as:

1. population death rates
2. birth rates
3. time infected individuals are infectious
4. probability of disease transmission
5. initial population characteristic

The Java program, epidemiology, allows student to alter population characteristics and immediately see the effect of the changes. Students can organize, explore, and keep track of the spread of the disease.

ACTIVITY: #8

Students are to create an infected slave, one with malaria or yellow fever. They are to sell the slave in an American port and following him to a plantation. The slave is to infect local people.

Using the JAVA epidemiology program, students are to write how these infections affected local populations. They are to postulate and simulate situations that will result in epidemics.

Students will come to realize that malaria and yellow is also American diseases. The United States had acute problems with these two diseases from colonial times until 1940. One of the first military expenditures of the Continental Congress was for $300 to buy quinine to protect General Washington's troops. During the Civil War one half of the white troops and for fifths of the black soldiers of the Union Army got malaria annually.

Yellow fever and malaria epidemics in America's south have received extensive coverage by historians. During the early years of malaria and yellow fever epidemics political and government officials try to keep it presence quite but the disease spreads inexorably; people fee in panic; too little is done too late; hundreds or thousands die.

ACTIVITY: #9

Students may investigate these epidemics by logging onto the National Archive Web Sites and Library of Congress's America's Library.

ACTIVITY: #10

Use JAVA epidemiological program to have students to create a log to indicate the epidemiological and or statistical processes of either yellow fever or malaria infections. (Activity #10 is a continuation of Activity #8)

1. Indicate time between cycles involved in laying mosquitoes eggs, development larvae and development of grown mosquitoes.

2. Record date of contact between mosquitoes and infected carrier slaves.

3. Record processes in which mosquitoes acquired pathogens from carrier slaves.

4. Students are to note date and time from point of mosquito's contract with infected humans to pathogenic activity inside mosquito's guts.

5. Record time from point of mosquito's injection of pathogens in human to apparent symptoms.

6. Record apparent symptoms.

7. Date and time of arrival in port to be sold and date of sale.

8. Indicate place and date of slave arrival on plantation.

Students must assume no acquired immunity amongst the white populations in the slave ship's ports of call. Some of the local population will acquire partial immunity after the first major epidemic. They must come to inhabit localities with acute chronic malaria transmission (holoendemicity) in order to survive.

ACTIVITY# 11

Students are to create a panorama on a four to six feet by two feet of craft paper of their study of mosquitoes, DNA and slavery. Any and all of the results of the above activities can be included in the panorama such as the following:

1. Draw or paste labeled map of Africa and the Americas.
2. Sea routes of slave ships.
3. Ports of call of slave ships.
4. Representation of condition on slave ships.
5. Draw, trace or photos of mosquitoes identify characteristics.
6. Chronology of the spread of disease.
7. Results of JAVA epidemiology Program
8. Statistics
9. Evidence of symptoms of malaria or yellow fever.
10. Color and creativity should be stressed.

COMMUNICATIONS STANDARDS

Pittsburgh Public Schools

1. All students use effective research and information management skills, including locating primary and secondary sources of information with traditional and emerging library technologies.

2. All students read and use a variety of methods to make sense of various kinds of complex texts.

All students respond orally and in writing to information and ideas gained by reading narrative and informational texts and use the information and ideas to make decisions and solve problems.

4. All students write for a variety of purposes, including narrating, informing, and persuading, in all subject areas.

5. All students analyze and make critical judgments about all forms of communication, separating fact from opinion, recognizing propaganda, stereotypes, and statements of bias, recognizing inconsistencies and judging the validity of evidence.

6. All students exchange information orally, including understanding and giving spoken instructions, asking and answering questions appropriately, and promoting effective group communications.

7. All students listen to and understand complex oral message and identify the purpose, stricture, and use.

8. All students compose and make oral presentations for each academic area of study that are designed to persuade, inform, or describe.

9. All students communicate appropriately in business, work, and other applied situations.

MATHEMATICS STANDARDS

Pittsburgh Public Schools

1. All students use numbers, number systems, and equivalent forms (including numbers, words, objects and graphics) to represent theoretical and practical situations.

2. All students compute, measure, and estimate to solve theoretical and practical problems, using appropriate tools, including modern technology such as calculators and computers.

3. All students apply the concepts of patterns, functions and relations to solve theoretical and practical problems.

4. All students formulate and solve problem and communicate the mathematical processes used and the reasons for using them.

6. All students evaluate, infer, and draw appropriate conclusions from charts, tables and graphs, showing the relations between data and real-world situations

7. All students make decisions and predications based upon the collections, organizations, analysis and interpretation of statistical and the application of probability.

Bibliography

An examination of the following texts, pamphlets, article and web sites will assist educators in understand and implementing the activities described in this curriculum, Mosquitoes, DNA and Slavery.

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Web Sites

www.Jimmunol.org

www. Info.sciencedirect.com

www.wehi.edu.au/MalBB. Genome Mapping Data

www.nara.gov Archival Information Locator

www.java.epidemiology.org. University of Oregon Web www.genpat,uu.se/anthropology (Mitochondrial DNA Clarifies Human Evolution)

www.monmouth.edu/mpalladi (Internet Resource for Biology Students)

www.ncbi.nlm.gov/genome/guide/

www.nlc.america'slibrary.gov. (Library of Congress Web Site)