



What to do about Malaria?

Written by Casey Noll

MALARIA is a DISEASE that causes high fevers and flu-like symptoms. While malaria is not always fatal, the CDC estimates that 627,000 people died of malaria in 2020. Now we've identified a PROBLEM, let's talk about what we could do to SOLVE it.

SPELL: PROBLEM, SOLVE, DISEASE

_____ is a disease that causes high fevers and flu-like symptoms MALARIA

Name another disease that has similar symptoms to malaria.

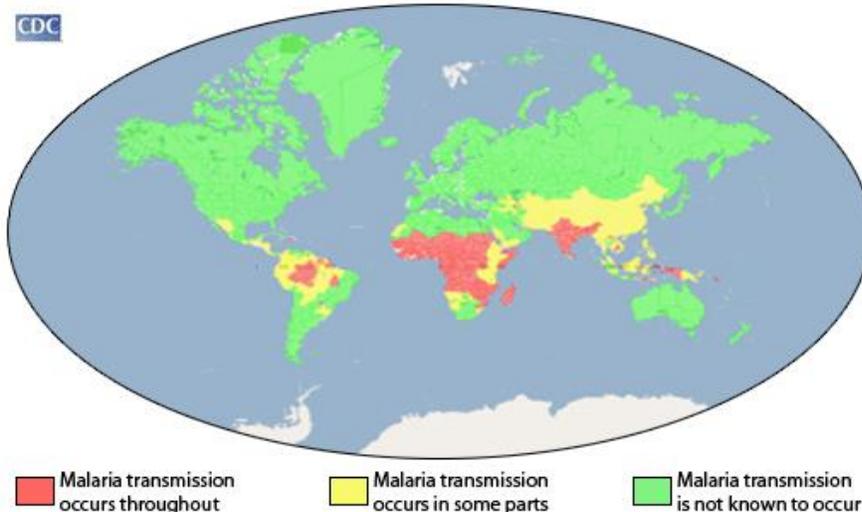
How many people were estimated to have died of malaria in 2020? 627000, SIX HUNDRED AND TWENTY SEVEN THOUSAND

The first step to solving any problem is to learn more about it. Here's some useful information:

Malaria is PREVALENT in parts of the world with TROPICAL CLIMATES, mostly in SUB-SAHARAN AFRICA, and a little bit in Central & South America, and parts of Asia. Malaria is not prevalent in the United States, Canada, Australia, or Europe.

Photo Credit: CDC Website

SPELL: PREVALENT, CLIMATE, WORLD _____



Question Type Key

KNOWN - SEMI OPEN - PRIOR KNOWLEDGE - MATH - OPEN - VAKT



What climate does malaria tend to be in? TROPICAL

Name one of the areas with malaria: SUB- SAHARAN AFRICA, CENTRAL AMERICA, SOUTH AMERICA, ASIA

Name one of the areas without malaria: UNITED STATES, CANADA, AUSTRALIA, EUROPE

Do you have any interest in visiting other parts of the world? If so, where? Point to Africa on the map

Malaria is a disease caused by a few different species of PARASITES. These parasites are all in the same genus, *PLASMODIUM*, although not all *Plasmodium* carry malaria. *Plasmodium* are microscopic and range in size from 1 to 20 MICRONS in diameter (125,000 microns = 1 inch). This is why malaria is only in tropical regions: the plasmodium needs warm temperatures and humidity to complete its life cycle.

SPELL: DIAMETER, TEMPERATURE, PARASITES

The parasites that carry malaria are all in what genus? PLASMODIUM

The plasmodium requires certain conditions to complete its _____ LIFE CYCLE

How big are *Plasmodium*? 1-20 MICRONS

How many microns are in an inch? 125,000 MICRONS

Can you think of something else that requires a specific set of conditions to survive?

The plasmodium parasites are carried by mosquitoes in the genus *ANOPHELES*. All mosquitoes are in the family *CULICIDAE*, but there are different genres of mosquito. When an *Anopheles* mosquito carries the *Plasmodium* parasite, and goes to bite a human for a blood meal, the mosquito INADVERTENTLY leaves behind some plasmodium in the human's bloodstream, which is what causes that human to get sick with malaria.

SPELL: INADVERTENTLY, GENUS, FAMILY

The Mosquito leaves behind some plasmodium in the human's _____

BLOODSTREAM

All mosquitoes are members of the family _____ *CULICIDAE* Mosquitoes that

Question Type Key

KNOWN - SEMI OPEN - PRIOR KNOWLEDGE - MATH - OPEN - VAKT

2



carry the malaria parasite are all in the genus _____ ANOPHELES

What is your relationship with mosquitoes?

Now that we have some more information, let’s look at possible solutions.

Chemical Solutions: Pharmaceuticals and Pesticides

There are several ANTIMALARIAL medications currently on the market. Antimalarials can be used to treat malaria or prevent it. These MEDICATIONS are often recommended to travelers who are visiting a country where malaria is a concern. While these medications can be very effective and life-saving, since Plasmodium are living things, they can EVOLVE and become resistant to antimalarial drugs, so new ones are constantly being developed to keep up. The other downside of this solution is that some of the antimalarials have unpleasant potential side-effects.

SPELL: ANTIMALARIAL, MEDICATIONS, DEVELOPED Living things can ___ and become resistant to things EVOLVE Antimalarials can have unpleasant _____ SIDE EFFECTS Antimalarials can be used to ___ malaria TREAT, PREVENT What’s another example of a medication?

“PESTICIDES” is a general term used to mean a chemical that kills a “pest”. INSECTICIDES are pesticides that are deadly to insects, including mosquitoes. Insecticides can be used to eliminate the mosquitoes in an area, so that the people living there don’t get malaria. In the 1970s, pesticides were one of the main tools used to ERADICATE (to get rid of entirely) malaria in EUROPE, along with antimalarial medications. However, some insecticides, especially the powerful ones that can eradicate mosquitoes in an area, have been shown to cause adverse health effects in humans and other animals.

SPELL: EUROPE, ELIMINATE, ADVERSE
___ is a term for a chemical that kills any pest PESTICIDE
___ is a term for a chemical that kills insects INSECTICIDE
Pesticides were used to ___ malaria in Europe ERADICATE
Some pesticides cause _____ HEALTH PROBLEMS, ADVERSE HEALTH EFFECTS
When was malaria eradicated in europe? THE 1970S
Name something you’d like to eradicate.

Question Type Key

KNOWN - SEMI OPEN - PRIOR KNOWLEDGE - MATH - OPEN - VAKT

Biological Solutions: Evolution and Genetic Modification

SICKLE CELL is a genetic condition in humans that likely evolved in response to malaria. Normally, our RED BLOOD CELLS are shaped like little round disks. When someone has sickle cell, some or all of their red blood cells take on a sickle shape. These sickle shaped blood cells are not good at holding oxygen and nutrients, and the person's body will recognise the unhealthy cell and destroy it quickly. Sickle cell can cause major problems for the person who has it; they can get extreme fatigue and exhaustion from ANEMIA, which is when you don't have enough red blood cells carrying oxygen around your body. People with sickle cell can also suffer blood clots, because the sickle-shape can get caught on other sickle cells and form a clump of cells.

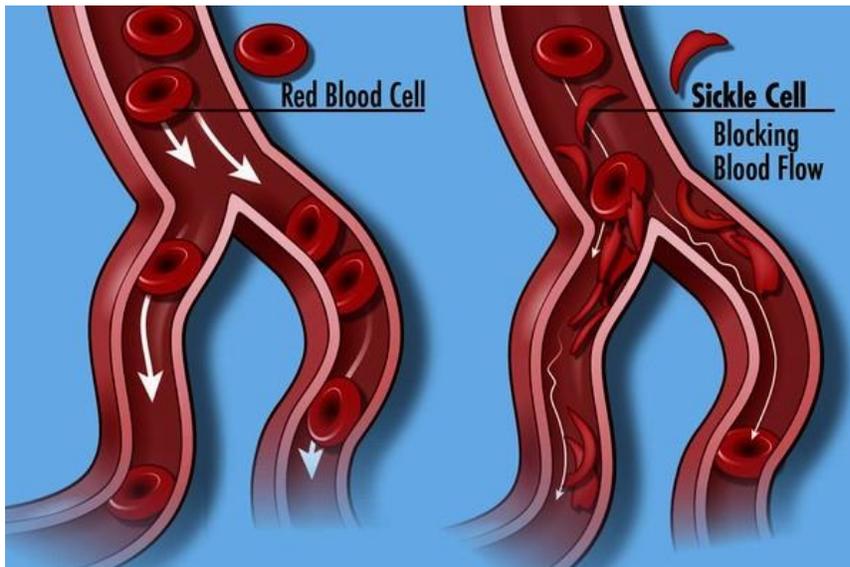


Photo Credit: Medline Plus

SPELL: OXYGEN, NUTRIENTS, RECOGNISE

_____ is the genetic condition I just discussed SICKLE CELL

_____ are usually shaped like little round disks RED BLOOD CELLS People with sickle cell may suffer from _____ ANEMIA, EXHAUSTION, FATIGUE, BLOOD CLOTS

Name something else that can cause fatigue

Name something else that can cause blood clots

Question Type Key

KNOWN - SEMI OPEN - PRIOR KNOWLEDGE - MATH - OPEN - VAKT



For Practitioner Use Only!
2022 I-ASC All Rights Reserved





However, if you live in a country where malaria is a serious problem, having sickle cell might save your life! Plasmodium like to live part of their life inside HEALTHY red blood cells. When a plasmodium tries to live in a sickle cell, it is DEPRIVED of nutrients, and it is quickly destroyed along with the red blood cell. This is likely why this genetic condition is found in people who DESCEND from tropical areas where malaria is or was once a major problem. It can be a blessing and a curse.

SPELL: GENETIC, DESTROYED, CONDITION

Sickle cell is found in people who ___ from tropical areas DESCEND Plasmodium are ___ of nutrients in sickle cells DEPRIVED

Plasmodium do well when they live in ___ red blood cells HEALTHY, DISK-SHAPED, NORMAL

What is something you would consider a blessing and a curse?

We humans don't truly have the ability to control evolution yet, but we now have TECHNOLOGY that allows us to do GENETIC MODIFICATION. GMOS, or GENETICALLY MODIFIED ORGANISMS, are living things that have DNA that was altered in a lab, usually before the organism was born.

SPELL: GMOS, GENETIC MODIFICATION, ALTERED

GMO stands for ___ GENETICALLY MODIFIED ORGANISM

We have ___ that allows us to make GMOs TECHNOLOGY

When making GMOS, the DNA is usually altered ___ the organism is born BEFORE

What have you heard about GMOS before?

Researchers have developed a genetically modified mosquito that carries a LETHAL gene, meaning a gene that kills the organism it's a part of. The lethal gene is on an X CHROMOSOME. Just like humans, male mosquitoes usually have XY chromosomes, and female mosquitoes usually have XX chromosomes. Some genes are what we call "RECESSIVE X-linked Genes." Recessive means that the gene can be easily overpowered by a DOMINANT gene, and x-linked means that the gene is on the X chromosome.

SPELL: CHROMOSOME, DOMINANT, RESEARCHERS

___ genes can be overpowered by dominant genes RECESSIVE

Question Type Key

KNOWN - SEMI OPEN - PRIOR KNOWLEDGE - MATH - OPEN - VAKT

5



For Practitioner Use Only!
2022 I-ASC All Rights Reserved





_____ are genes on the X chromosome X-LINKED

The GMO mosquito described carries a _____ gene LETHAL

Do you believe it is ethical to genetically modify a mosquito? What about other organisms? (plants, animals, fungi, bacteria?)

So what scientists did was they made a female mosquito with a recessive lethal gene on one of her X-chromosomes, and a dominant gene

on her other X-chromosome that would not kill her. Since the dominant gene overpowers the recessive gene, she lived! They made several more of these GM mosquitoes and released them into controlled areas where there were many wild mosquitoes.

What happened was that the GM mosquitoes MATED with the wild mosquitoes, and the lethal gene got INCORPORATED into the next GENERATION of mosquitoes. Any males that were born with the lethal gene died, but females that had just one copy of the lethal gene lived, and continued to pass on the lethal gene to the next generation.

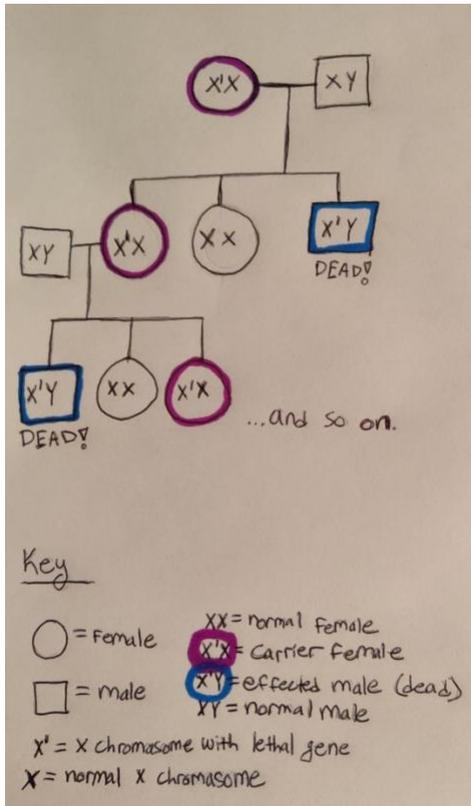
SPELL: INCORPORATED, LIVED, WILD

GM Mosquitoes _____ with wild mosquitoes MATED

The lethal gene was incorporated into the next _____ GENERATION Males with the lethal gene _____ DIED

What do you think the impacts of methods like this could be?





This is a method that has been used to eradicate mosquitoes in LOCALIZED areas, as it slowly diminishes the population with each generation. Some people are concerned that using tactics like this will lead to the EXTINCTION of the mosquito, and could possibly disrupt food webs and ECOSYSTEMS. However, it is heavily debated whether or not mosquitoes are truly a crucial part of any ecosystem.

SPELL: DEBATE, CRUCIAL, DIMINISHES

This method has been used in _____ areas LOCALIZED

People are concerned this will lead to the ___ of the mosquito EXTINCTION Some are concerned this will disrupt _____ ECOSYSTEMS, FOOD WEBS Should this method be used in areas with malaria?

Natural Solutions: Dietary and Behavioral

“DIETARY” just means “related to what we eat or drink”. There used to be a dietary solution to malaria: TONIC WATER! Tonic water contains something called “QUININE,” which has antimalarial properties. It was once recommended to drink



tonic water to prevent malaria. Quinine has also been used in much higher CONCENTRATIONS in antimalarial drugs. Unfortunately, quinine is one of the antimalarials that the parasite has become resistant to. The quinine resistance began by random MUTATION of the plasmodium's genes in 3 different places: South America, Southeast Asia, and Oceania. The gene allowed the plasmodium to survive quinine, and therefore to live long enough to create offspring that also carry that resistance gene, and now almost all areas with malaria have quinine resistant malaria. So tonic water doesn't work anymore.

SPELL: TONIC WATER, CONCENTRATIONS, SURVIVE Tonic water contains _____ QUININE

___ means related to what we eat or drink DIETARY Quinine resistance began by random ___ MUTATION

Name one of the places where quinine resistance first evolved. SOUTH AMERICA, SOUTHEAST ASIA, OCEANIA

Can you think of another example of an evolved trait?

"BEHAVIORAL changes," or things that we choose to do differently, are still on the table though: people who live in countries with malaria often use MOSQUITO NETS, especially around their bed at night. It can also be effective to wear long pants and long sleeves in these places, to give mosquitoes fewer places to bite. It's also important not to make "mosquito homes" near your home: mosquitoes like wet places, so keep your home and yard dry if you can. And of course, avoid places with lots of mosquitoes!

Ultimately, there's still debate on the best way to approach this problem, as well as many other problems in the world. The best answer is probably a COMBINATION of many solutions, many of which are probably not even mentioned in this lesson.

SPELL: COMBINATION, AVOID, DIFFERENTLY

People in countries with malaria use ___ around their bed MOSQUITO NETS

Are you interested in learning more about any of the topics covered in this lesson? If so, which topic or topics interest you?

Question Type Key

KNOWN - SEMI OPEN - PRIOR KNOWLEDGE - MATH - OPEN - VAKT

8



For Practitioner Use Only!
2022 I-ASC All Rights Reserved





Make a venn diagram of these 3 types of approaches, and place specific actions where you think they belong.

Creative Writing

Based on what you know now, how would you approach the malaria problem? Are there any interventions that you think are better than others?

Pick a problem you would like to solve. What interventions would you like to try in order to solve it? Explain your approach.



Casey Noll is an S2C Practitioner in Training, former science teacher, and a total science nerd. She holds a degree in biotechnology from James Madison University and currently practices S2C in the DC area.

Sources:

<https://www.cdc.gov/>

[https://www.ncbi.nlm.nih.gov/books/NBK234327/#:~:text=The%20Parasite&text=Depending%20on%20the%20developmental%20stage,approximately%20125%2C000%20of%20an%20inch\).](https://www.ncbi.nlm.nih.gov/books/NBK234327/#:~:text=The%20Parasite&text=Depending%20on%20the%20developmental%20stage,approximately%20125%2C000%20of%20an%20inch).)

<https://pubmed.ncbi.nlm.nih.gov/9683896/>

<https://www.sciencedirect.com/science/article/pii/S1198743X16301203#:~:text=Malaria%20was%20eradicated%20from%20Europe,and%20immigrant>

<https://www.mayoclinic.org/diseases-conditions/sickle-cell-anemia/symptoms-causes/syc-20355876>

<https://medlineplus.gov/genetics/condition/sickle-cell-disease/>

Question Type Key

KNOWN - SEMI OPEN - PRIOR KNOWLEDGE - MATH - OPEN - VAKT



For Practitioner Use Only!
2022 I-ASC All Rights Reserved

