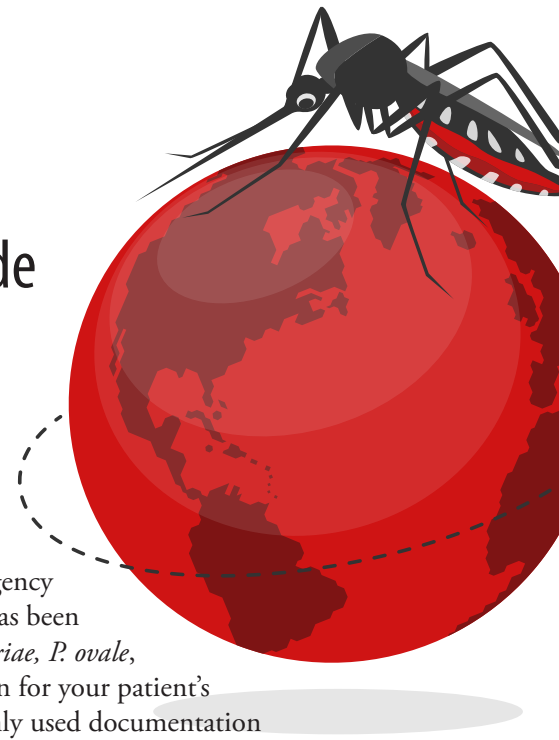


Buzz Off!

Malaria Treatment and Prevention Worldwide

by

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Activity Sheet for Case Study Doctor

You will be playing the role of a medical provider in an urgent care clinic or emergency room setting. You will be given the opportunity to meet and treat a patient who has been infected with malaria, a disease caused by the protozoa *Plasmodium vivax*, *P. malariae*, *P. ovale*, or, most commonly, *P. falciparum*. You will create standard medical documentation for your patient's visit using SOAP (subjective, objective, assessment, and plan), which is a commonly used documentation method among pharmacists and physicians.

Subjective

For the first part of SOAP, you will take a patient history. The patient's history will be a key tool in identifying the next step in your treatment plan and diagnosis.

1. Identify the patient's chief complaint by asking questions such as the following:
 - a. *What brought you in today?* (Malaria patients often complain of fever, chills, sweating, body aches, nausea and vomiting.)
 - b. *Which of your symptoms has been causing you the most discomfort/worry?* (Fever is often a severe symptom of malaria.)
2. Identify the onset of complaint (when) by asking one of these questions:
 - a. *When did these symptoms start?*
 - b. *How long have you been experiencing these symptoms?*
3. Identify the chronology of the chief complaint (worsening or improving since onset) by asking questions like:
 - a. *Have your symptoms been getting worse/better?*
 - b. *Do the symptoms come and go or are they constant?*
4. Identify the severity of symptoms.
 - a. *How severe is the pain on a scale of 1–10?*
 - b. *How severe are your symptoms?*
5. Has the patient sought medical treatment for these symptoms?
 - a. *Have you gone to see a doctor for this before?*
6. Find out if there is there any pertinent medical history.
 - a. *Are you pregnant?* (If applicable.)
 - b. *Do you have any pre-existing medical conditions?* (E.g., liver problems, kidney damage, heart disease, HIV, etc.)
7. Has the patient traveled to any high-risk areas (e.g., Central America, Central Africa, India, etc.)?
 - a. *Did you travel to any countries where malaria is common?*
 - b. *To your knowledge, were you bitten by a mosquito while there?*

- c. *Did you take anti-malaria drugs while there? If so, when did you begin them? And, were you compliant with the instructions given for the drug?*
8. Find out whether anyone else the patient often comes in contact with has similar symptoms.
 - a. *Is anybody else in your household sick with similar symptoms?*
 - b. *Has that person travelled with you? If no, has he/she seen a doctor about this and received a diagnosis?*

Objective

1. Obtain the patient's vital signs. These will include blood pressure, heart rate, temperature, etc. For the purposes of this role-play activity, the patient will have a fever of 103.0 °F. Assume other vitals are within normal range.
2. Obtain results from ordered diagnostics. You can order any of these tests that you deem necessary.
 - a. For malaria the most common test to detect the presence of the *Plasmodium* parasite is a microscopic analysis of a blood smear. A blood smear test can be performed using two methods: a thick smear (more protozoa are likely to be seen), or a thin smear (allows for identification of the type of *Plasmodium*).
 - b. A rapid diagnostic test is used to detect *Plasmodium* antigens.
 - c. A molecular PCR test utilizes PCR to identify the species of *Plasmodium* more precisely by detecting the genetic sequences.

Assessment

This will be your diagnosis for the patient's visit.

1. Based on your analysis of the patient's history, test results, etc., formulate a diagnosis of the patient. Does the patient have a *Plasmodium* spp. infection?
2. Explain the diagnosis to the patient using the diagnostic tests you ordered. For example, using the blood smear test, explain to the patient the difference between normal and pathogenic as you show him/her the results.

Plan

Document your plan to treat the patient. This will include a list of all the labs that were previously ordered, any medications that will be prescribed, any referrals given to the patient (to see a specialist), and any procedures performed. To treat malaria, choose which anti-malarial medication(s) below to use based upon the physical status of the patient along with the malaria drug-resistance status of the region where he/she contracted the disease. To determine this, look up the region's status through the CDC via its traveler's health website.

(*Note:* Countries are not required to submit malaria surveillance information to the CDC. However, the CDC regularly updates its database with information available from multiple sources and partners.)

1. Chloroquine is the cheapest and safest treatment. Prescribe 1000 mg once daily for two days, followed by 500 mg once daily for two to three weeks.
2. For drug-resistant malaria, artemisinin-based combination therapies (ACT) are used. Prescribe artemether and lumefantrine 1.5/9 mg/kg twice daily for three days.
3. If the patient is pregnant, prescribe quinine 8.3 mg/kg three times a day for seven days, and clindamycin 20 mg/kg/day for seven days.

Other supportive care is suggested for those suffering from malaria, such as hydration via IV fluids if the patient is dehydrated or antipyretics (anti-fever medicine) to help control fever (paracetamol).

Once you have completed these steps, you will have addressed the patient's main complaint, the cause of his/her symptoms, and developed a treatment plan to help the patient recover. As you record these steps you will create medical documentation that can be put in the patient's medical history to provide a complete history, should any future complications arise for the patient.

Activity Sheet for Case Study Patient

You will be playing the role of a patient who has contracted malaria from *Plasmodium falciparum*. You will be presenting to an urgent care clinic with moderate symptoms of malaria and will be seen by a medical provider. Remember, you are playing the role of a sick patient. Research how patients tend to present with malaria to help you make your role more convincing. Enjoy creating a unique patient with an interesting story.

Patient History and Symptoms

The provider will ask you about why you have come to the clinic. You should respond by reporting some of these symptoms:

- *Fever*: If the physician asks more, your fever started about a day and a half ago and it has not gone down at all. You have tried Tylenol and cold compresses but they have not helped.
- *Chills*: If the physician asks more, you have had chills for 10 hours or so.
- *Sweating*: If the physician asks more, ever since your chills started, you have been having cold sweats.
- *Body aches*: If the physician asks more, since your chills started, you have been extremely fatigued and experiencing body aches.
- *Nausea*: If the physician asks more, the nausea comes and goes and is not too strong.

Other information that you may provide if the physician asks:

- The physician will ask if you have travelled to an area that is at high risk for malaria. You should explain that you have travelled to one of the following areas: Central or South America, South East Asia, Central Africa, or India.
- If the physician asks if you were on anti-malarial medicine while traveling, state that you were not.
- You were bitten by mosquitoes a lot the first few days, so you bought bug spray with >30% DEET and used it for the rest of your trip.
- If you are asked about pre-existing medical conditions, you can decide if you have any and respond (pregnancy, heart disease, HIV, liver problems, etc.).

Section 1 – Activity

For this activity, there will be three rounds of an index card game. You will be assigned a flashcard listing a country and a prevention method. For the first round of the game, answer the questions below.

1. What country and prevention method were you assigned? _____
2. How well do you think the listed prevention method can prevent a person from contracting malaria in that country? Explain your answer.

Section 2 – Simulation

You will now participate in a class simulation demonstrating how effective your prevention method is in your assigned country. The teacher will ask those with a particular prevention method to raise their hand. Then the teacher will ask those with a red X to lower their hands. The teacher will reveal what the red X means.

As you discover how effective each of the methods are in each country, write down the total number of students in each group and the number of students in that group remaining without malaria in the table below. Calculate a percentage. Fill in the reasons for the efficacy of each prevention method present in each country in the table below as the teacher leads a class discussion.

Table 1. Cameroon

	<i>Indoor Spraying</i>	<i>Bed Nets</i>	<i>Antimalarial Drugs</i>	<i>No Prevention</i>
<i>Total #:</i>				
<i>No malaria #:</i>				
<i>Percentage:</i>				
<i>Effective or not? Explain</i>				

Table 2. Brazil

	<i>Indoor Spraying</i>	<i>Bed Nets</i>	<i>Antimalarial Drugs</i>	<i>No Prevention</i>
<i>Total #:</i>				
<i>No malaria #:</i>				
<i>Percentage:</i>				
<i>Effective or not? Explain</i>				

Table 3. India

	<i>Indoor Spraying</i>	<i>Bed Nets</i>	<i>Antimalarial Drugs</i>	<i>No Prevention</i>
<i>Total #:</i>				
<i>No malaria #:</i>				
<i>Percentage:</i>				
<i>Effective or not? Explain</i>				

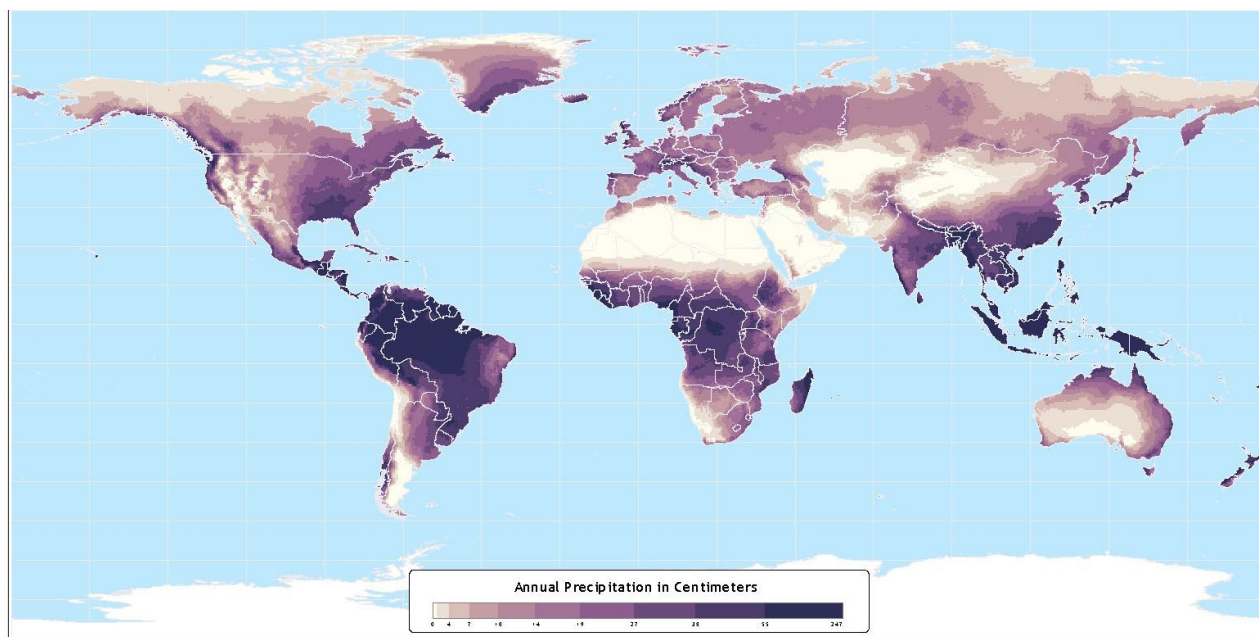
Table 4. Australia

	<i>Indoor Spraying</i>	<i>Bed Nets</i>	<i>Antimalarial Drugs</i>	<i>No Prevention</i>
<i>Total #:</i>				
<i>No malaria #:</i>				
<i>Percentage:</i>				
<i>Effective or not? Explain</i>				

Section 3 - Analysis

Work individually on these questions below.

1. Below is a map depicting the patterns of rainfall throughout each region. Is there any relationship between rainfall and regions affected by malaria? Explain.



Data taken from: CRU 0.5 Degree Dataset (New et al)

Atlas of the Biosphere

Center for Sustainability and the Global Environment
University of Wisconsin - Madison

Figure 1. Annual total precipitation. *Credit:* The Nelson Institute Center for Sustainability and the Global Environment, University of Wisconsin-Madison, <<https://nelson.wisc.edu/sage/data-and-models/atlas/maps.php?datasetid=34&includerelatedlinks=1&dataset=34>>.

2. Notice that the Southeast region of the United States of America has very high annual rainfall and tropical climate. According to the relationship between rainfall and malaria that you predicted above, do you think there used to be a history of malaria there in the past? Why is there not a problem today? What societal, climatological, and species migration changes must occur for the region to have a problem with malaria once again? Think about the socioeconomic and political impacts on malaria as you answer this question.

3. Below is a map depicting insecticide resistance for each region we discussed. Conclude any reasons why the indoor spraying may have different effectiveness in each region. Again, think about the socioeconomic impacts on malaria as you answer this question.

Mosquito Insecticide Resistance Map

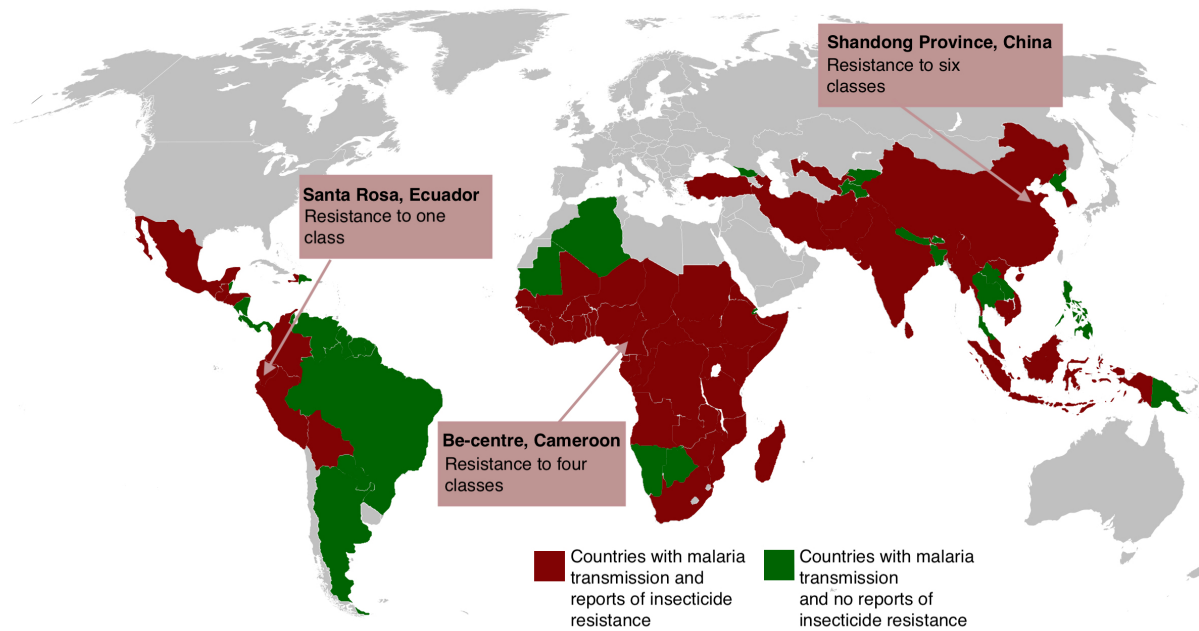
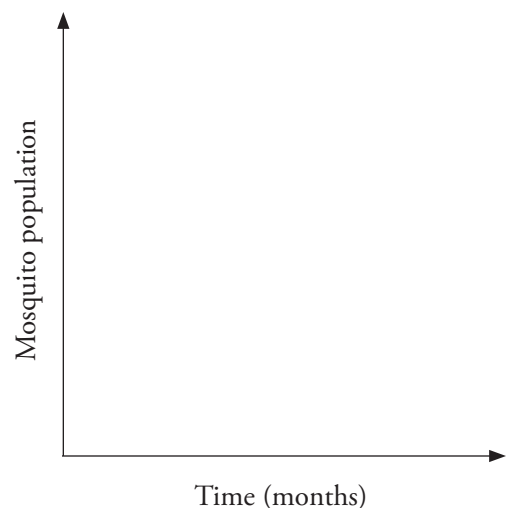
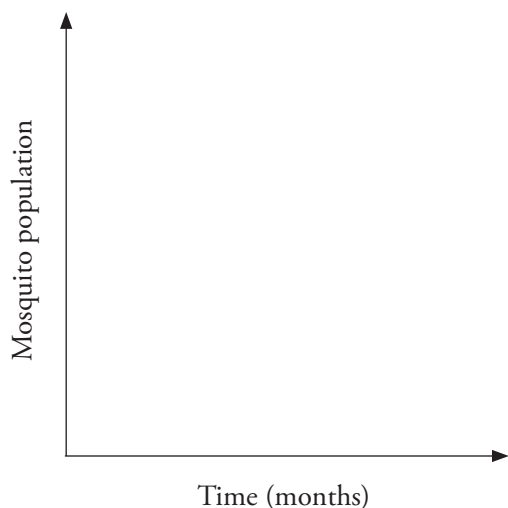


Figure 2. Mosquito insecticide resistance. Credit: Based on Dai *et al.*, 2015; Mandeng *et al.*, 2019; Maxmen, 2012; WHO, *n.d.*

4. Due to many mosquito breeding reservoirs commonly found around many clustered homes in endemic areas, there is a need for outdoor control in addition to indoor control. The outdoor attractive toxic sugar bait (ATSB) is a method that takes advantage of a mosquito’s sugar consumption behavior. Make a prediction as to the effects of ATSB on a female mosquito population over half a year. Then, graph your prediction in a simulated mosquito population versus time plot below (left). Then, make a prediction on the effects of outdoor ATSB when combined with indoor long-lasting insecticidal nets (LLINs). Graph it below (right) in the same manner.



5. Below is a map depicting antimalarial drug resistance for each region we discussed. Based upon the differences in parasite, vector, and host genetic pools in each region, discuss why antimalarial drug resistance occurs earlier in some regions but later in others. Then, discuss how it contributes to the drug effectiveness present in those regions. Briefly explain what happens to drug resistance when different mosquito species interact.

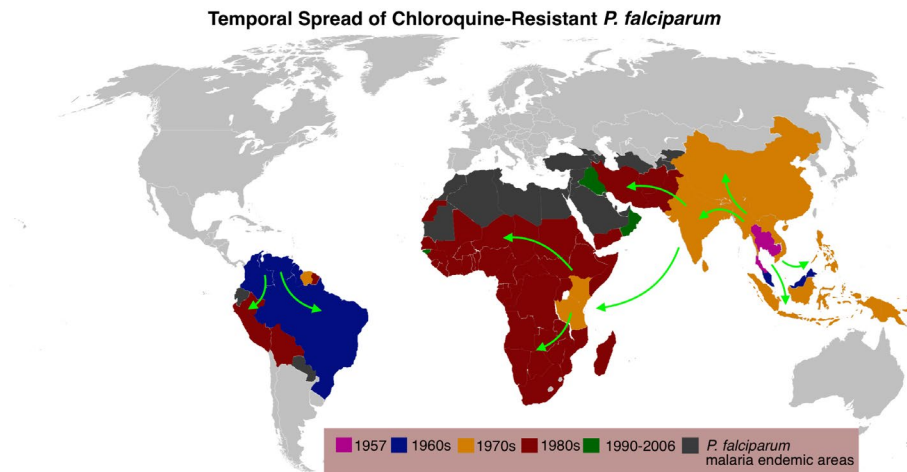


Figure 3. Spread of chloroquine-resistant *P. falciparum* over time. Credit: Based on Dai *et al.*, 2015.

Section 4 – Conclusion

6. The map below represents the magnitude of malaria in each region we discussed. Using the above information you obtained, explain why the incidence of malaria is higher in some regions, but lower in other regions.

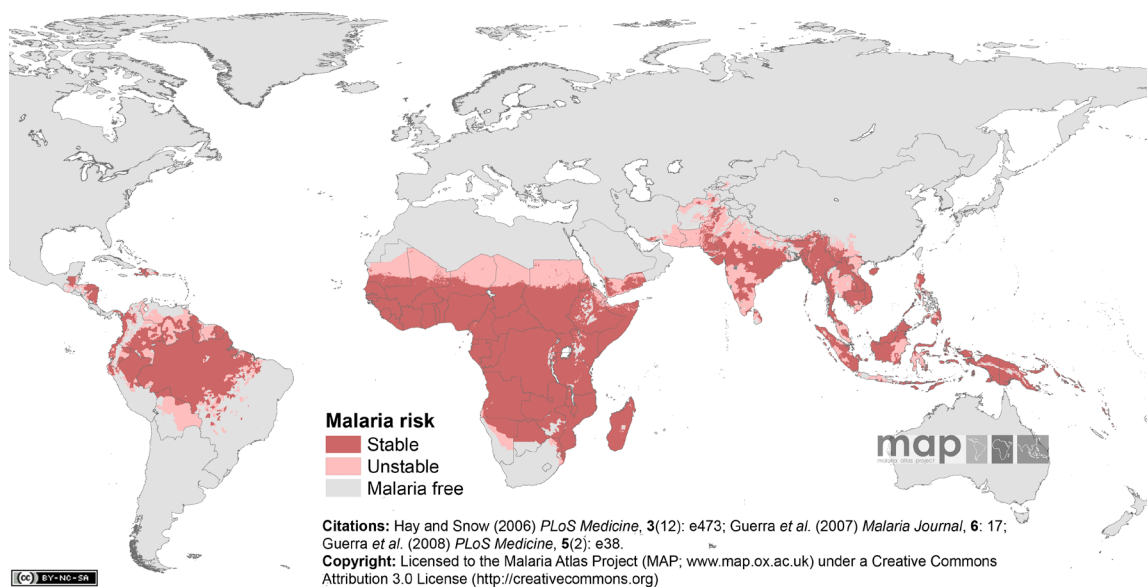


Figure 4. Malaria risk (2008). Credit: The Malaria Atlas Project, cc by 3.0, <<https://malariaatlas.org/>>.

7. Can you think of any preventative solutions for malaria in the regions we discussed?

References

- Dai, Y., *et al.* 2015. Development of insecticide resistance in malaria vector *Anopheles sinensis* populations from Shandong province in China. *Malaria Journal* 14:62. <<https://doi.org/10.1186/s12936-015-0592-8>>.
- Mandeng, S.E., *et al.* 2019. Spatial and temporal development of deltamethrin resistance in malaria vectors of the *Anopheles gambiae* complex from North Cameroon. *PLoS One* 14(2):e0212024. <<https://doi.org/10.1371/journal.pone.0212024>>.
- Maxmen, A. 2012. Malaria surge feared: the WHO releases action plan to tackle the spread of insecticide-resistant mosquitoes. *Nature* 485(293). <<https://doi.org/10.1038/485293a>>.
- World Health Organization. *n.d.* Malaria threats map: vector insecticide resistance. [Webpage]. <<https://apps.who.int/malaria/maps/threats/>>.

Homework Assignment

Answer the following questions below in groups of two to three. Assign group members so that there are one or two researchers and one recorder. The researchers should present their research to the group for discussion. The recorder should record the discussion and read the answers back to make sure all the relevant information is recorded. Here are a few resources to help guide you through the questions:

- The Centers for Disease Control and Prevention. *n.d.* [Webpage]. <<https://www.cdc.gov/malaria/about/biology/index.html>>
- The Society for General Microbiology. 2012. *Malaria: A Global Challenge*. <<https://microbiologysociety.org/publication/education-outreach-resources/malaria-a-global-challenge.html>>.

Questions

1. How is malaria transmitted?
2. How can you get malaria if you haven't been bitten by a mosquito?
3. How can you get malaria if you are already taking drugs to prevent malaria?
4. If a patient is taking drugs to prevent malaria, does the patient need to do anything else to remain safe? Why or why not?
5. Describe what happens when an uninfected mosquito bites a person infected with malaria. How does the malaria reproduce in the mosquito?
6. Look at the following stages of *Plasmodium* spp. (from the protozoan life cycle) and decide if they are found solely in the human host, in the mosquito, or if they are found in both.
 - Sporozoite
 - Merozoite
 - Daughter merozoite
 - Male and female gametocyte
 - Zygote
 - Oocyte
7. Why is a malarial infection so dangerous during pregnancy?
8. Why doesn't our immune system protect us from malaria? What mechanisms has the protozoan evolved to evade the human immune system?
9. Why does a mosquito regurgitate when it bites and how does that enhance an infection of malaria in humans?
10. A person can avoid getting malaria by taking medications or by wearing protective clothing and using insect repellent. How can a community reduce the incidence of malaria?
11. Why has sickle cell anemia not been eradicated by natural selection if it is genetic and can be deadly?
12. Why does malaria cause the de-oxygenation of hemoglobin?