



Malaria Challenge

Introduction to malaria

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What is malaria?



- Malaria is a life threatening disease which is transmitted to humans through the bites of infected female *Anopheles* mosquitoes.
- About 3.3 billion people – half of the world's population – are at risk of malaria.



Image: Hugh Sturrock, Wellcome Images

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Malaria is an infectious disease that is spread by mosquitoes, in particular female mosquitoes of the genus *Anopheles*. Malaria is a disease that is found in hundreds of different countries around the world and over 3 billion people are at risk from the disease.

What causes malaria?



- Malaria is caused by a single celled parasite called *Plasmodium*.
- There are four types of *Plasmodium* that infect humans:
 - *Plasmodium falciparum*
 - *Plasmodium vivax*
 - *Plasmodium malariae*
 - *Plasmodium ovale*

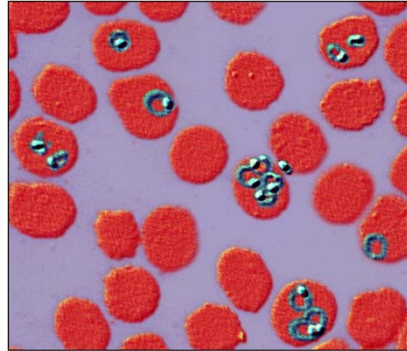


Image: CDC/Steven Glenn, Laboratory & Consultation Division

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Note this slide is animated

Malaria is caused by a eukaryotic protist, a single celled organism. The parasite belongs to a genus known as *Plasmodium*. The image shows a false coloured micrograph showing one of the life stages of the parasite (shown in blue) inside human red blood cells.

Four species of *Plasmodium* infect humans:

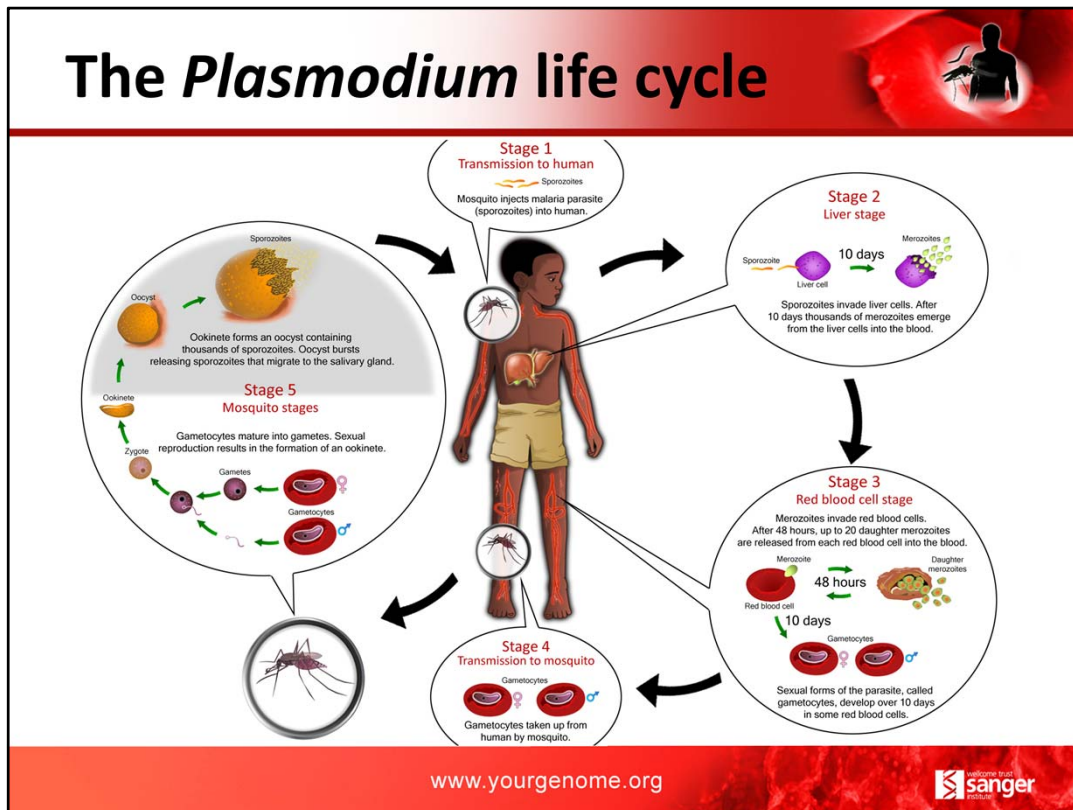
- *Plasmodium falciparum*
- *Plasmodium vivax*
- *Plasmodium malariae*
- *Plasmodium ovale*

Click once

Plasmodium falciparum and *Plasmodium vivax* are the parasites that cause the most cases of malaria worldwide. (Other two species are greyed out.)

Click again

Plasmodium falciparum can cause serious complications and can be fatal if untreated. It is responsible for the most deaths due to malaria. (*Plasmodium vivax* is greyed out)



Note this slide is animated

Plasmodium has a complex life cycle. Part of it takes place inside a human host and part of it takes place inside a mosquito vector.

There are essentially five key stages to the *Plasmodium* life cycle:

1. The *Anopheles* mosquito bites a human injecting the *Plasmodium* parasite which enters the human's blood. At this stage the parasite is in a form known as a sporozoite, which is long and thin and is capable of moving in between and within cells.
2. The parasite travels in the blood until it reaches the liver. At this point the parasite recognises and invades liver cells where it remains for around 10 days. In the liver it undergoes a transformation into thousands of new parasites known as merozoites. These newly formed merozoites are released into the bloodstream.
3. The merozoites invade red blood cells and then reproduce. Each merozoite enters a red blood cell and once inside it grows and divides asexually to form up to 20 new merozoites. These burst out of the cell and invade neighbouring red blood cells. This whole process takes approximately 48 hours.
4. Some parasites do not form merozoites but develop into a sexual stage of the lifecycle called gametocytes. These are taken up by a mosquito when they feed on an infected human.
5. Once inside the mosquito's gut the gametocytes change into mature gametes (eggs and sperm) which fuse and develop into an ookinete. The ookinete burrows through the lining of the mosquito's gut wall where it forms an oocyst in which tens of thousands of sporozoites are formed. They burst out of the oocyst and travel to the salivary gland of the mosquito where the cycle begins again.

Click once

Stage 1 : Transmission to human

Click again

Stage 2: Liver stage

Click again

Stage 3: Red blood cell stage

Click again

Stage 4: Transmission to mosquito

Click again

Stage 5: Mosquito stages

Incidence facts



- 225 million cases of malaria worldwide and 781,000 deaths every year.
- A child dies of malaria every 30 seconds.
- Over 90% of malaria deaths are in Africa.
- 200,000 newborns die each year as a result of malaria.



Statistics: 2010 WHO Malaria Report and Malaria No More UK

Image: Bonnie Gillespie, Voices for a malaria free future

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According to the World Health Organization, there were 225 million cases of malaria worldwide and 781,000 deaths in 2009. Although this is a lot, these numbers have decreased from 233 million cases and nearly 1 million deaths in 2000.

The majority of malaria deaths are due to the *Plasmodium falciparum* parasite and are in children under the age of five in Africa.

Pregnant women are also vulnerable to malaria as they have lower natural immunity to the disease. If they are infected with malaria when pregnant this can have a serious impact on their unborn child. Pregnant women with malaria are susceptible to:

- placental infections (a build up of parasites in the placenta) that can lead to miscarriage
- death of newborns due to premature birth or low birth weight.

Who are affected?



Images: Bonnie Gillespie, Voices for a malaria free future, Courtney Dudley, JHU/ Voices for a Malaria Free Future, Cape Union Mart

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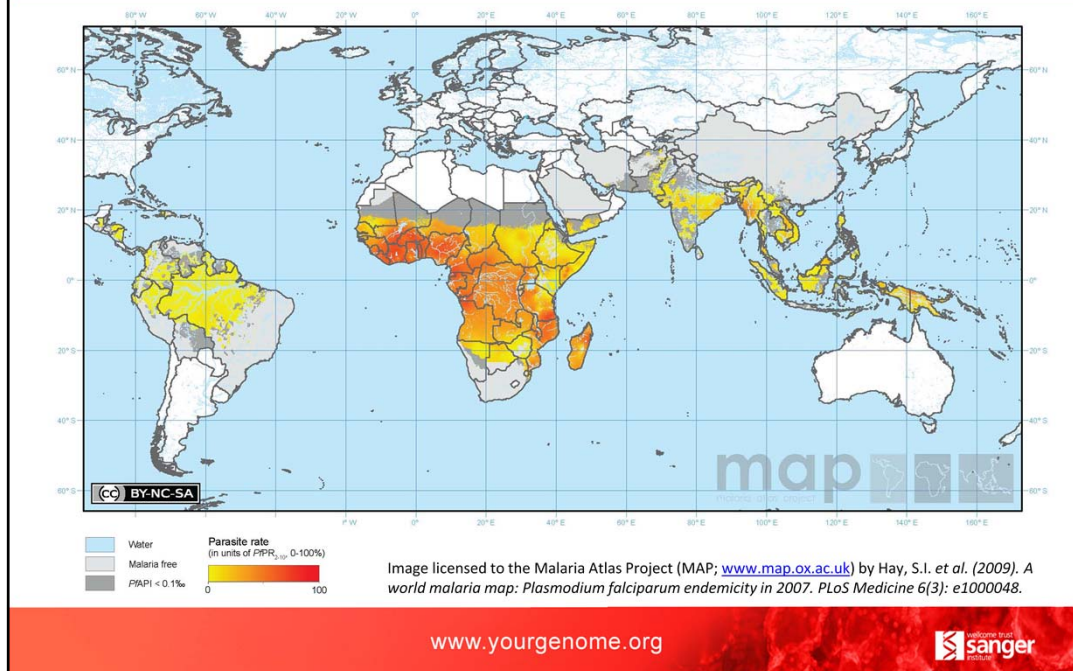


Pregnant women and children under the age of five are most vulnerable to malaria infections. This is because they have a lower natural immunity to the disease compared to others in the community.

Adults can also be affected by malaria, however if they have lived in the same area for a long period of time they are likely to build up some immunity to the parasite. This does not mean that they are not infected but may mean they have less severe symptoms.

People who travel from malaria free areas to malaria endemic areas are also at risk of contracting the disease. Holiday makers and immigrant workers can be vulnerable to infections as they have no immunity to the disease. Drugs are available that can be given to these people to kill the parasite if they become infected.

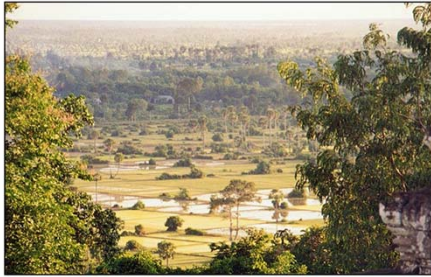
Where is malaria a problem?



This map shows areas where *Plasmodium falciparum* is endemic around the world. You can see that the highest levels of malaria are between the Tropics of Cancer and Capricorn.

Malaria is a disease of the developing world affecting people in some of the poorest countries, especially in sub-Saharan Africa. It is considered a disease of poverty but is also a major cause of poverty .

Why these areas?



Images: Manfred Werner, Courtney Dudley, JHU/Voices for a Malaria Free Future, Muhammad Mahdi Karim micro2macro.net, Julian Rayner

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These are images from four regions where malaria is found: Cambodia in South East Asia (top left), Dar Es Salaam, Tanzania, Africa (top right) Shanty town in India, (bottom left), a remote rural village in Peru, South America (bottom right).

Question to the students: *Why do you think these areas have high levels of malaria? What do they have in common?*

- Warm climate (over 19-20 °C) and heavy rainfall. Long rainy seasons can form areas of standing water which are ideal mosquito breeding grounds.
- Poor housing and sanitation facilities. The houses in these areas don't always have windows or mesh screens to prevent mosquitoes and other biting insects entering the house.
- Some are in rural areas, in close proximity to forest (except Dar es Salaam in Tanzania) which provides ideal habitats for some mosquito species.

Why is malaria a problem?



- Malaria has a significant economic impact on countries with high levels of malaria transmission.
- In affected countries the disease accounts for:
 - 40% of public health drug expenditure
 - 30-50% of in patient hospital admissions
 - up to 60% of outpatient health clinic visits



Statistics: 2010 WHO Malaria Report

Image: Bonnie Gillespie, Voices for a Malaria Free Future

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Malaria causes significant economic losses, and can decrease gross domestic product (GDP) by as much as 1.3% in countries with high levels of transmission. It is estimated that malaria-related health expenditure and lost productivity costs Africa's economy over \$8 billion per year. It also deters foreign investment, tourism and trade. These sustained annual economic losses have resulted in substantial differences in GDP between countries with and without malaria, particularly in Africa.

Malaria disproportionately affects poor people who cannot afford treatment or have limited access to health care. This traps families and communities in a vicious cycle of poverty and disease which they are unable to break away from.

How do you diagnose malaria?



- Malaria can be diagnosed by microscopy and rapid diagnostic tests (RDTs).
- Microscopy uses a blood smear to identify whether parasites are present in the patient.
- RDTs are quick tests that use a drop of blood from the finger tip to identify whether parasites are present in the patient.



Images: Bonnie Gillespie and Jen Warren, Voices for a Malaria Free Future

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Note this slide is animated

Early diagnosis and treatment of malaria reduces disease and prevents deaths. It also contributes to reducing malaria transmission. There are two ways malaria can be diagnosed: Microscopy and rapid diagnostic tests (RDTs).

Click once

Microscopy - a blood sample is taken from the patient and is looked at under the microscope. If parasites are visible within the blood smear they are diagnosed as having malaria.

Question to the students: *What are the limitations of microscopy?*

The key limitation is that this method of diagnosis can only be used in laboratories where there is electricity and trained medical staff.

Click again

The second method of diagnosis is RDTs.

RDTs are quick tests that use a drop of blood from the finger tip to identify if the patient has malaria. The tests are sensitive to antigens (proteins that are produced by the parasite) that bind with a dye to form a coloured strip (a bit like a pregnancy test) to indicate whether there are parasites in the blood. The image shows a test and you can see two strips, one is the control strip and the other indicates a positive result.

An RDT takes just 15 minutes and can be used in rural communities by trained community workers, making this a valuable and life saving diagnostic tool.

How do you treat malaria?



- Malaria can be treated with anti-malarial drugs.
 - WHO recommends artemisinin combination therapies (ACTs) to treat *Plasmodium falciparum* infections.
 - Drugs such as chloroquine and primaquine are recommended for *Plasmodium vivax* malaria.



Image: Bonnie Gillespie, Voices for a malaria free future

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Anti-malarial drugs kill the parasite but do not prevent the patient from being re-infected. Early and effective treatment of malaria with anti-malarial drugs can shorten the duration of the infection and prevent further complications which could be fatal.

In many countries, anti-malarial drugs can be purchased over the counter without prescription from doctors or medical practitioners. This can lead to inappropriate use of the drugs, for example, if someone has a fever they may take anti-malarial drugs when malaria is not the cause of the fever. This uncontrolled use of single drug therapies, such as chloroquine, in the past has led to parasites developing drug resistance. This causes great problems as the drugs available to patients are ineffective and cannot be prescribed to treat the disease.

A new compound known as artemisinin was found to be effective against malaria in the 1990s. It is now used in combination with other drugs particularly to deal with *Plasmodium falciparum* infections. Artemisinin is recommended as first line treatment for malaria by the World Health Organization.

How do you prevent malaria?



- Key methods to prevent malaria transmission are:
 - Long lasting insecticide impregnated nets (LLINs)
 - Insecticide-treated nets (ITNs)
 - Indoor residual spraying
 - Mosquito repellents
 - Preventative drug treatments



Image: p_skov_vestergaard_frandsen

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Protection against mosquito bites and controlling vector populations are effective methods of preventing malaria transmission. Vector control in particular works to reduce malaria transmission at a community level and can significantly reduce transmission from very high levels to close to zero. For individuals, personal protection against mosquito bites through the use of bed nets and insect repellents is the first line of defense to prevent malaria.

Insecticide-treated nets (ITNs) and long lasting insecticide impregnated nets (LLINs) offer both a physical and chemical barrier to mosquitoes.

LLINs are the preferred form of insecticide treated nets for public health distribution programmes and recommended by the World Health Organization as they can be effective for 3-5 years.

Indoor residual spraying (IRS) with insecticides is an extremely effective way to rapidly reduce malaria transmission. It can be effective for 3-6 months, depending on the insecticide used and the type of surface on which it is sprayed. DDT can be effective for 9-12 months in some cases.

Drugs can also be used to prevent malaria. For travellers, malaria can be prevented through chemoprophylaxis, taking drugs that suppress the blood stage of malaria infections, thereby preventing malaria disease.

Pregnant women are also offered anti-malarial drugs during their pregnancy. This is known as *Intermittent Preventive Treatment in pregnancy (IPTp)*. This practice aims to reduce the possible complications during pregnancy such as severe anaemia and placental infections which can threaten the life of the mother and child.

The activity



The *Malaria Challenge* is a multimedia resource which can provide you with information on the lifecycle of the malaria parasite and how the disease can be treated and prevented. It includes videos, animations and interviews with malaria researchers to give an insight into the many different issues surrounding this topic. This information can be used to find out more about malaria and enable students to take part in a discussion based activity.

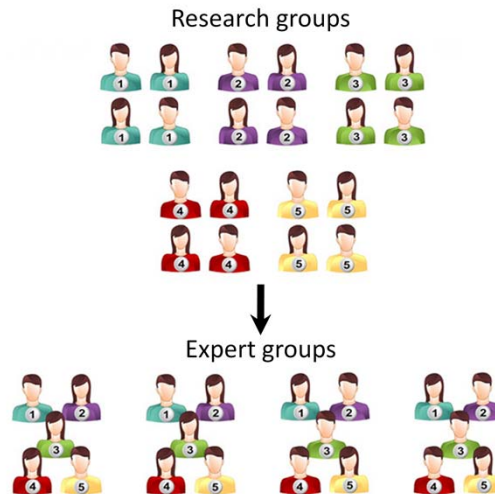
Use the following slide(s) to introduce the discussion activity you have decided to run. *Hide the two slides that are not relevant to the activity that you decide to run, e.g. if you are running the Big Debate, hide slides 15 and 16.*

Activity 1: The big debate



Can malaria be eliminated?

- In your groups discuss the stage of the life cycle you've been allocated and the interventions that target it.
- Form "expert" groups to discuss the best methods to eradicate malaria.
- Feedback your thoughts to the class.



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Note this slide is animated

In this activity each group will randomly select a stage of the malaria life cycle.

All members of the group must research the particular lifecycle stage they have been allocated using the *Malaria Challenge resource*. You should identify the stage's relevance in the disease lifecycle and the prevention interventions that specifically target it.

Then as a group discuss the advantages and disadvantages of the prevention interventions and how effective they could be at eradicating malaria.

By the end of this discussion each member of the group should be clear on the issues surrounding the malaria stage and its prevention interventions. They are now "experts" and should have each completed a worksheet with key points from the group discussions.

The next stage is to form new groups with an "expert" from each malaria stage. In these newly formed groups each person will take it in turns to put forward their thoughts and findings on their particular stage of the malaria lifecycle. After this, as a group, put together an argument for the three best methods or techniques to eradicate malaria which the spokesperson(s) will present to the rest of the class.

Click once

Form "expert" groups to discuss the best methods to eradicate malaria.

Click again

Feedback your thoughts to the class.

Activity 2: Funding decisions



Who and what should get funding?

- Your charity has raised £20 million to fund malaria programmes around the world.
- In your groups discuss each of the funding proposals and decide which of these should receive funding.
- Complete your group worksheets and feed back your decisions to the class.

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Before starting the discussion the group should nominate the following roles:

- **Spokesperson(s):** the person or persons who will speak on behalf of the group during the feedback session
- **Scribe:** the person responsible for taking notes on all the discussion and completing the group worksheet
- **Financier:** the person responsible for doing the calculations and ensuring that the available funds are correctly allocated and the group doesn't overspend!

The first stage of the discussion process is to consider funding principles, a set of considerations or guidelines to help the group in their decision making. Ideas for funding principles include:

- Should you only fund projects in malaria endemic countries?
- Should the project have to use innovative technology?
- Will the project have a large scale impact?
- Should a project you fund further advances in the understanding of malaria?
- Should a project you fund further advances in the treatment of malaria?

As a group discuss each of the funding applications in turn, discussing their advantages and disadvantages. Once a decision has been made place the card in a yes, no or maybe pile. The scribe should complete the group worksheet with the assistance of the financier.

Note: They do not have to spend all of the money. If they do not think all of the projects should receive funding, then they can leave surplus funds.

Once they have completed their worksheet, the spokesperson should prepare to feed back their decisions to the rest of the class with explanations as to why they chose those particular projects.

Activity 3: Malaria management



- In groups discuss the best strategy for reducing malaria transmission for your allocated scenario:
 - Cambodia
 - Uganda
 - Tanzania
 - Brazil
- Complete your group's worksheet and present your strategy to the class.
- **Remember:** only three initiatives per strategy are allowed so identify your main priorities.

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In this activity the students will be playing the role of malaria programme managers for a community in a malaria endemic area. These regions are Cambodia, Uganda, Tanzania and Brazil.

In groups they must assess the situation facing their allocated community and propose a strategy that will work towards eliminating malaria from the region.

The groups must present their proposal to the rest of the class and summarise their reasons for suggesting this strategy.

Discussion guidelines



- Speak for yourself and not for others.
- Allow others to finish before you speak. Listen well.
- Ask questions as well as making statements.
- Explain what you think and feel.
- Respect differences in opinion – the world would be a boring place if everyone thought the same.
- Share your life experiences and knowledge – they are valuable.

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These discussion guidelines apply to all of the activities, make sure these guidelines are followed during the activity. Everyone should contribute to the discussion and no one should be excluded.