

By. Priscilla Garcia

# *Plasmodium falciparum*

# Outline

- ❖ Taxonomy
- ❖ Historical Facts
- ❖ Plasmodium
- ❖ Plasmodium *falciparum*
  - ❖ Life cycle
  - ❖ Pathogenesis
  - ❖ Diagnosis
  - ❖ Treatments
- ❖ Case Studies
- ❖ Questionnaire
- ❖ Sources

# Taxonomy

Domain: Eukaryota

Phylum: Apicomplexia

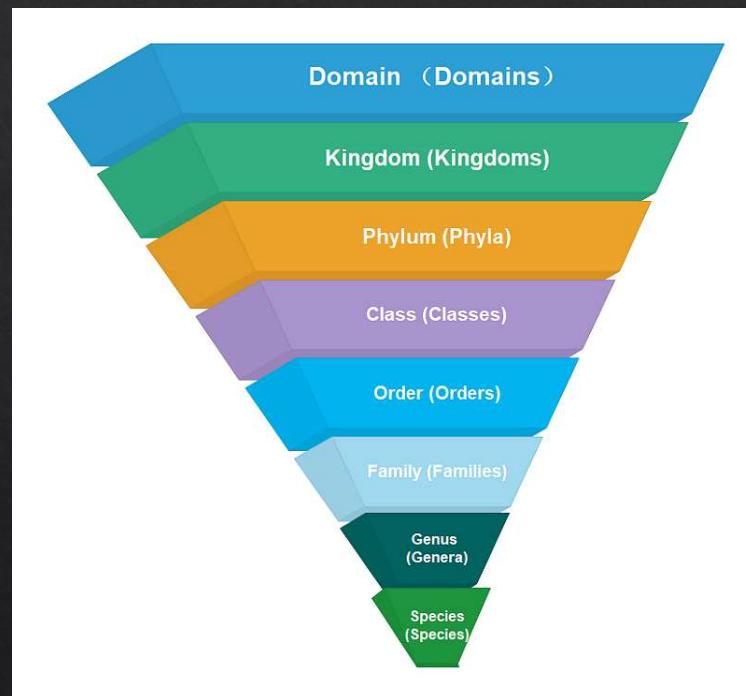
Class: Aconoidasida

Order: Haemosporida

Family: *Plasmodiidae*

Genus: *Plasmodium*

Species: *Plasmodium falciparum*



# History



1880



1897



1954

1980s

~2700 BC

~400

Malaria  
referenced in  
Chinese  
document

Malaria  
an  
unknown  
ally to the  
fall of  
Rome

Plasmodium  
first identified  
by French  
physician  
Alphonse  
Laveran

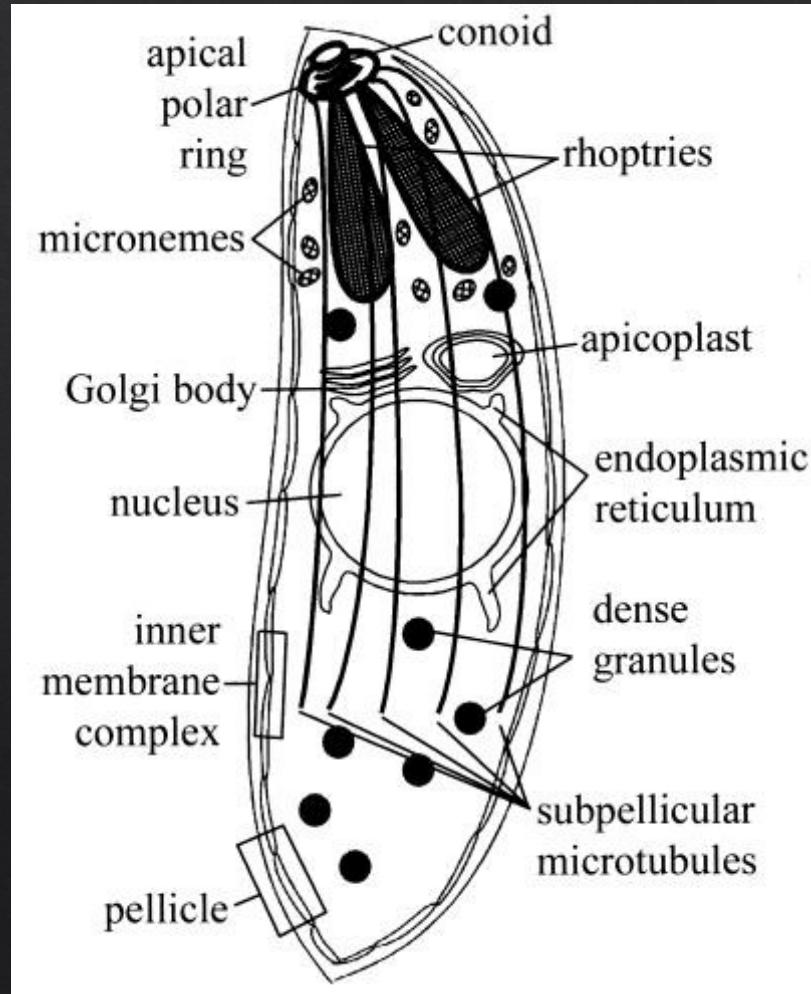
Ronald Ross  
discovered  
female  
mosquito  
vector  
anopheles

The International  
Commission on  
Zoological  
Nomenclature  
approved species  
name *Plasmodium*  
*falciparum*

Su, Xin-  
Zhuan &  
David  
Walliker  
Found that  
many genes  
were  
involved in  
antigenic  
variation

# Morphology: Plasmodium

- ❖ Apicomplexan: have an apical complex for penetration of cells
- ❖ Apical complex found in sporozoite & Merozoite stage
- ❖ Cytostome: ingests cytoplasm to form food vacuoles
- ❖ Subpellicular Microtubules: Structure support



# Morphology: Plasmodium

❖ **Plasmodium exists in several forms:**

❖ **Gamogony:** sexual phase in mosquito

❖ Formation of zygote occurs

❖ **Sporogony:** asexual phase in mosquito

❖ **Sporozoites** formed within oocyst

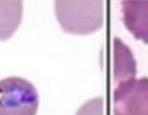
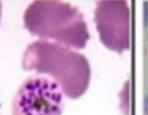
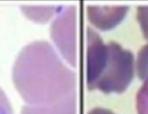
❖ Infective to humans

❖ **Schizogony:** asexual phase in humans

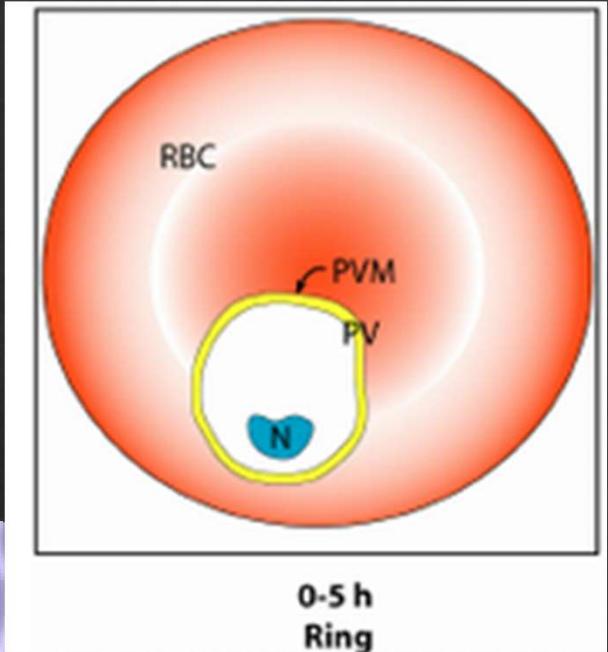
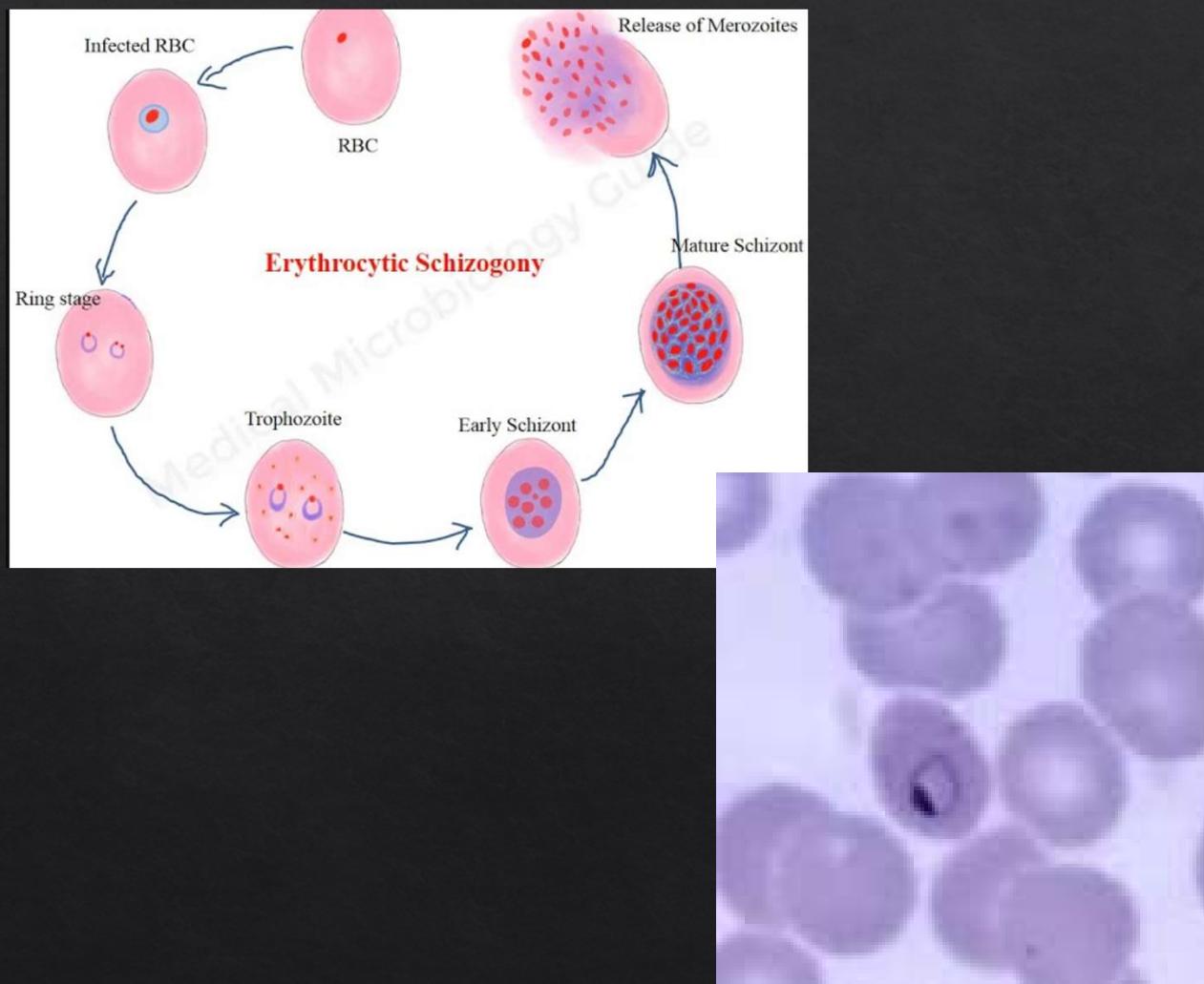
❖ **Merozoites** formed in liver cells and red blood cells

❖ **Macro & Microgametocytes**

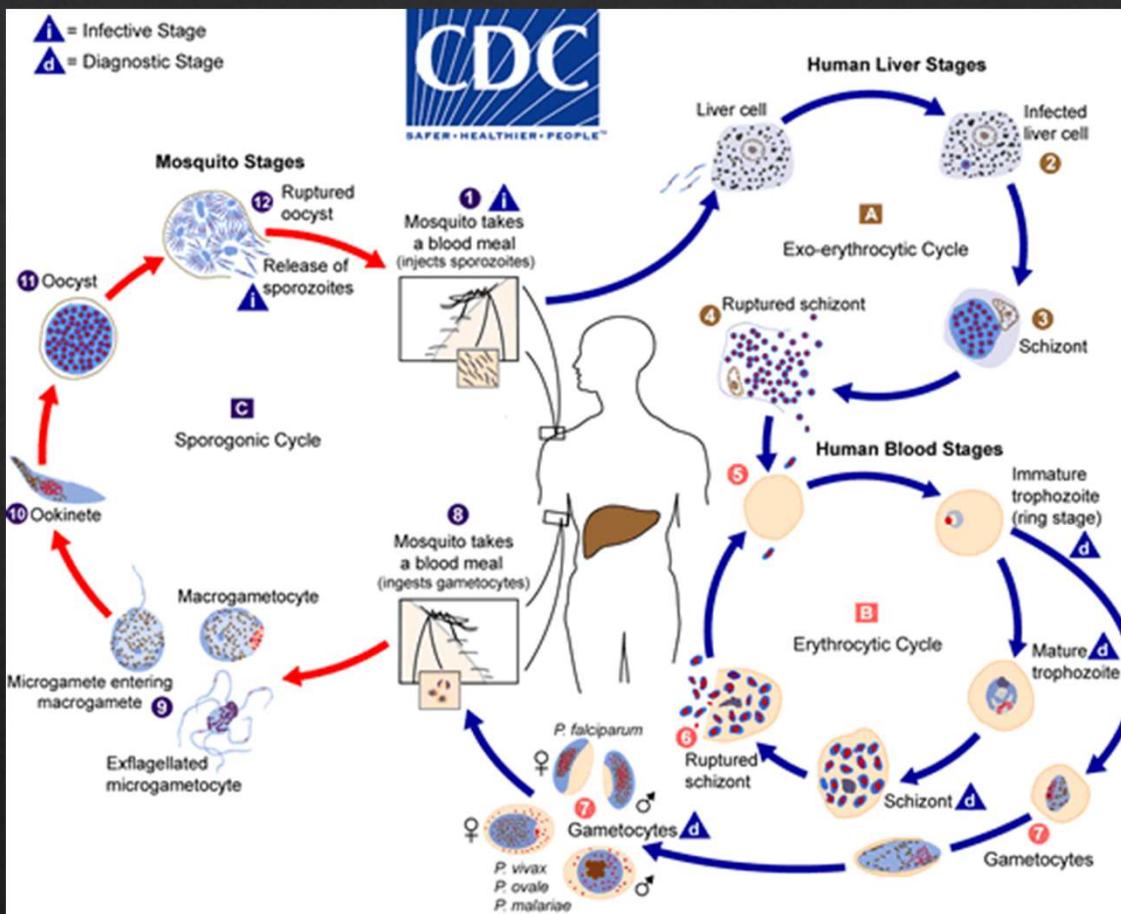
❖ Infective to mosquitos

Species \ Stages	Ring	Trophozoite	Schizont	Gametocyte
<i>P. falciparum</i>				
<i>P. vivax</i>				
<i>P. malariae</i>				
<i>P. ovale</i>				

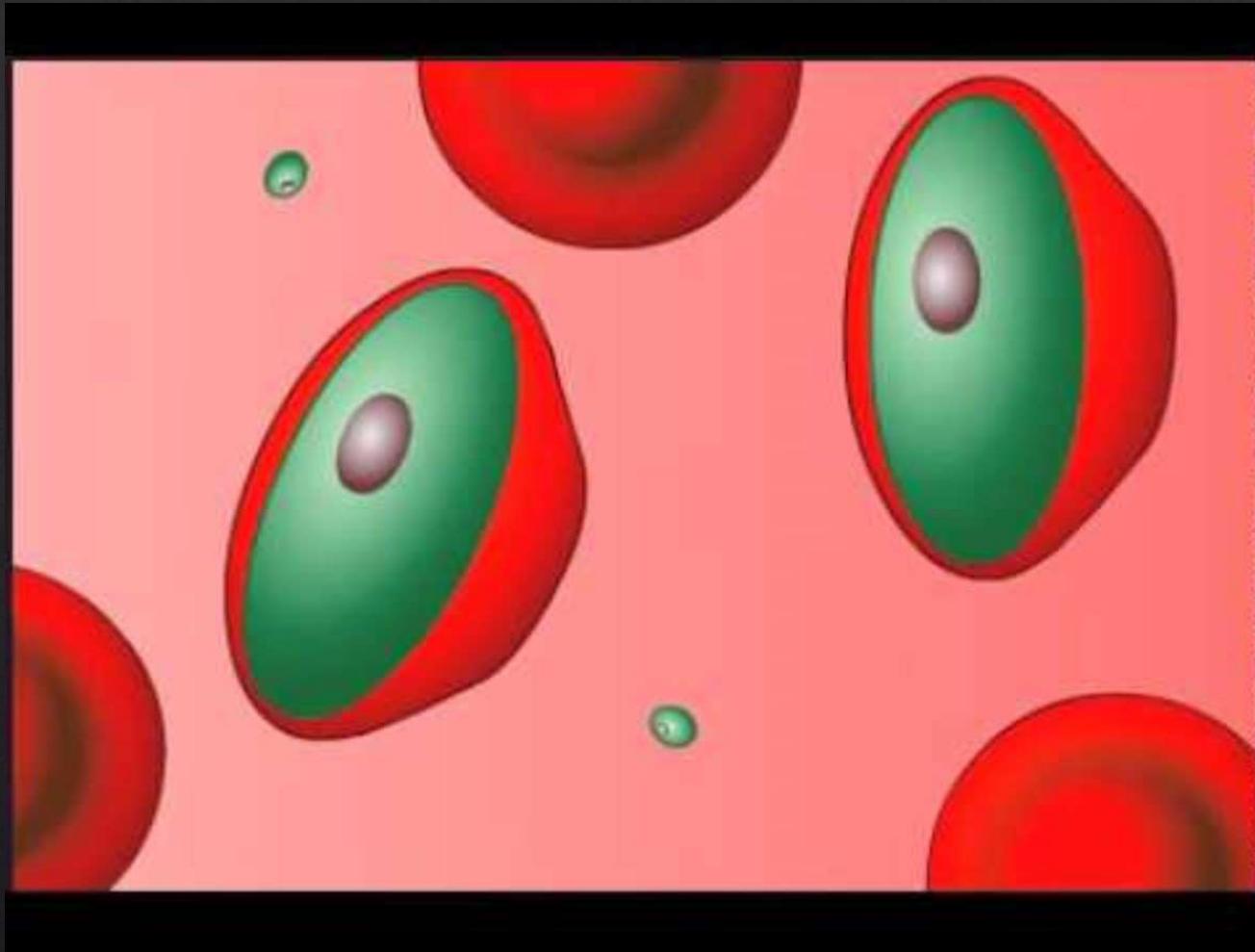
# Morphology: Erythrocytic Schizogony & Ring Stage



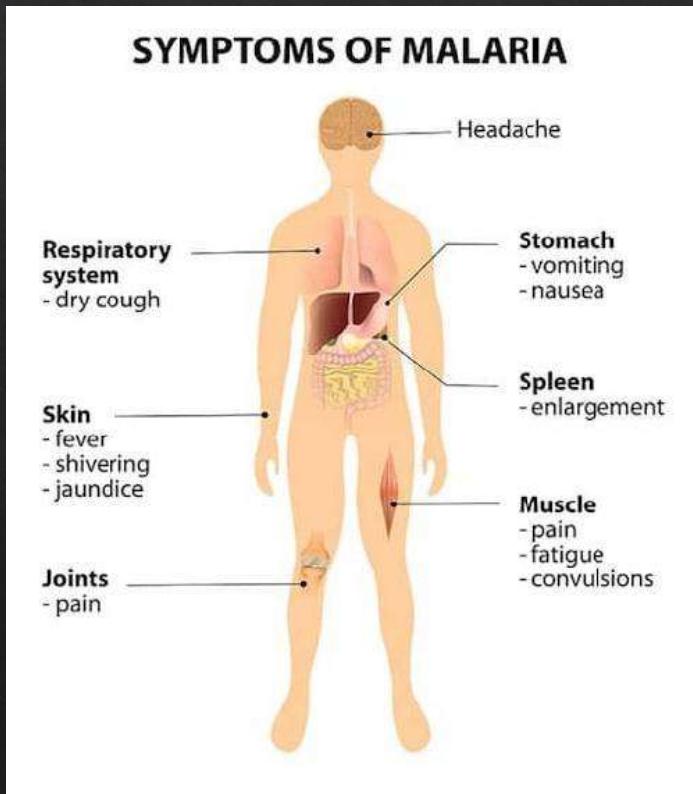
# Life Cycle



# Video Visual Of Life Cycle



# Pathogenesis



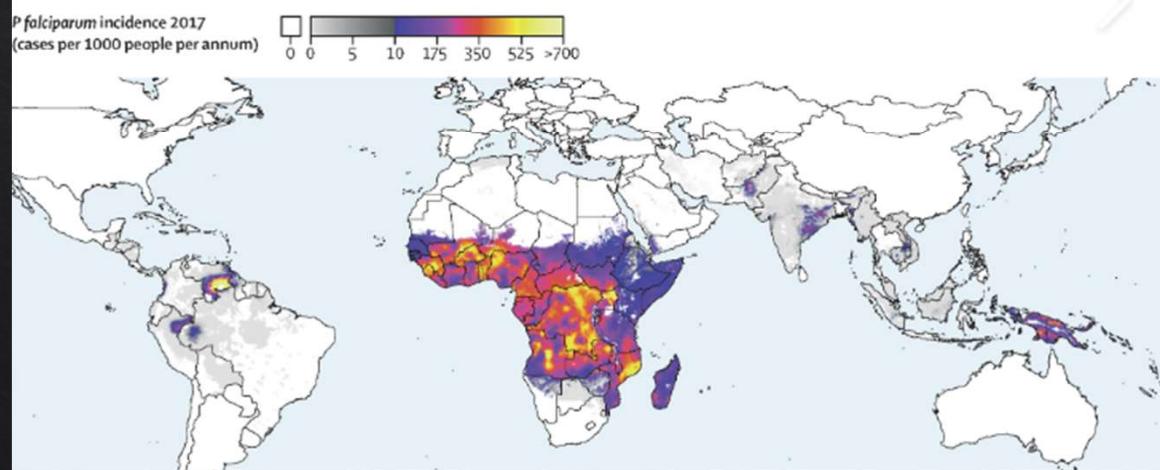
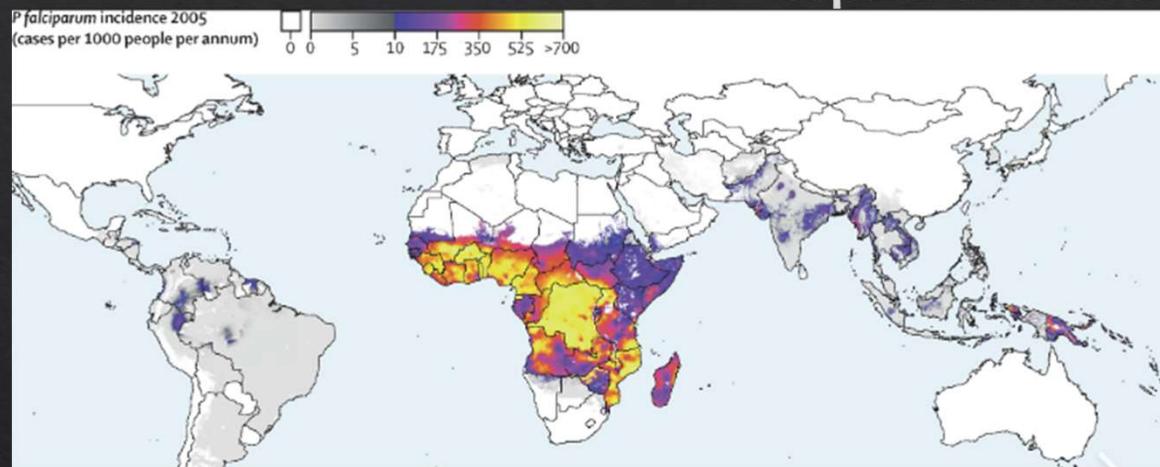
## Malignant Tertian Malaria

- ❖ Fevers occurring at 36-48hr intervals
- ❖ Anemia –can be fatal
  - High parasitemia
- ❖ Splenomegaly
- ❖ Anoxia of the vessels
- ❖ Cerebral Malaria caused by ischemia
- ❖ Black water fever
  - Excretion of excess hemoglobin in the urine
- ❖ Abortion
  - Blood sinuses blocked by parasitized cells

# Pathogenesis

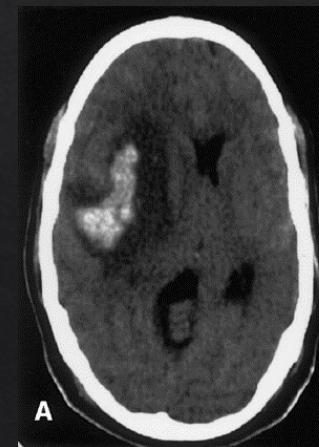
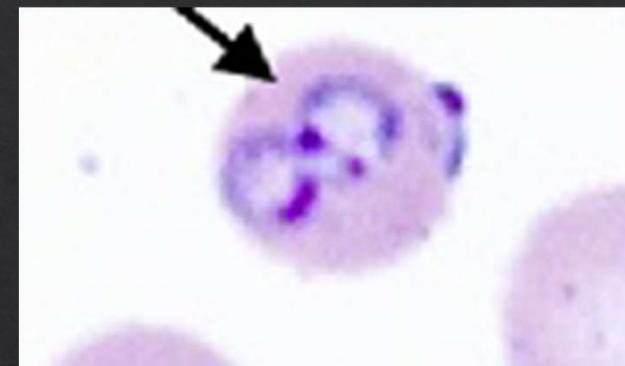


# Epidemiology



# Diagnosis

- ❖ Microscopy of thick and thin blood smears of diagnostic stages
- ❖ PCR tests by blood samples
- ❖ CT scans
- ❖ Rapid Diagnostic Tests
  - ❖ Detects specific malaria antigens in blood



# Treatments

- ❖ Treatment:
- ❖ Chloroquine phosphate, doxycycline, artesunate, and many more
- ❖ Quinine is no longer used due to its association with **blackwater fever.**

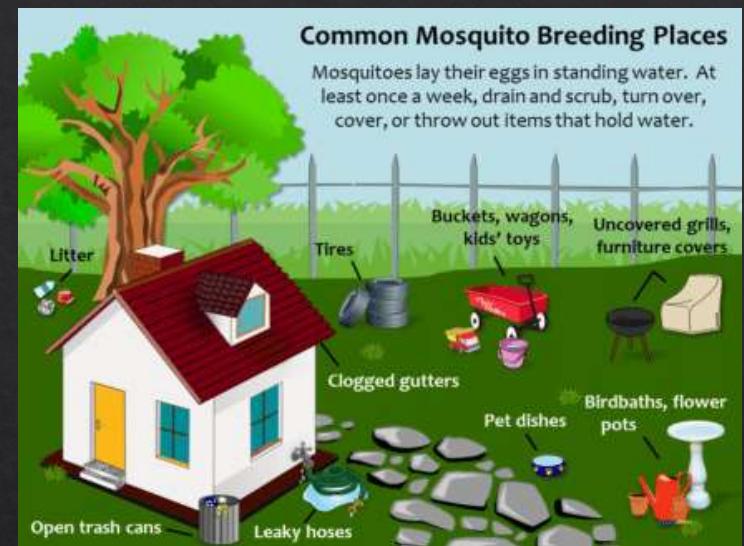
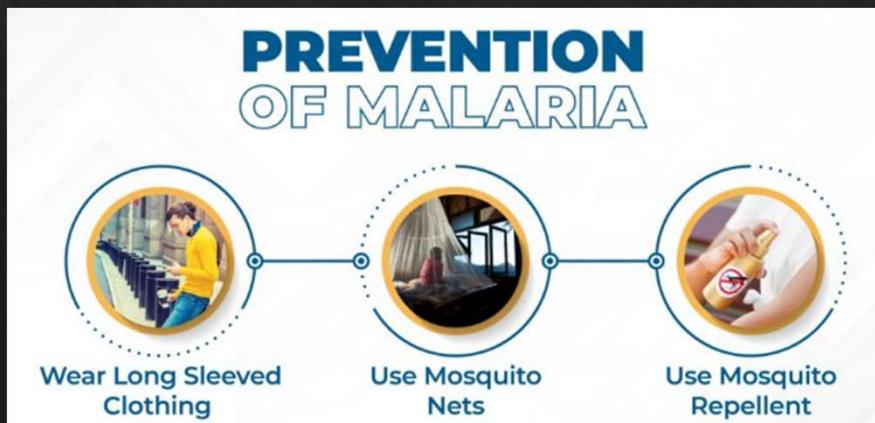


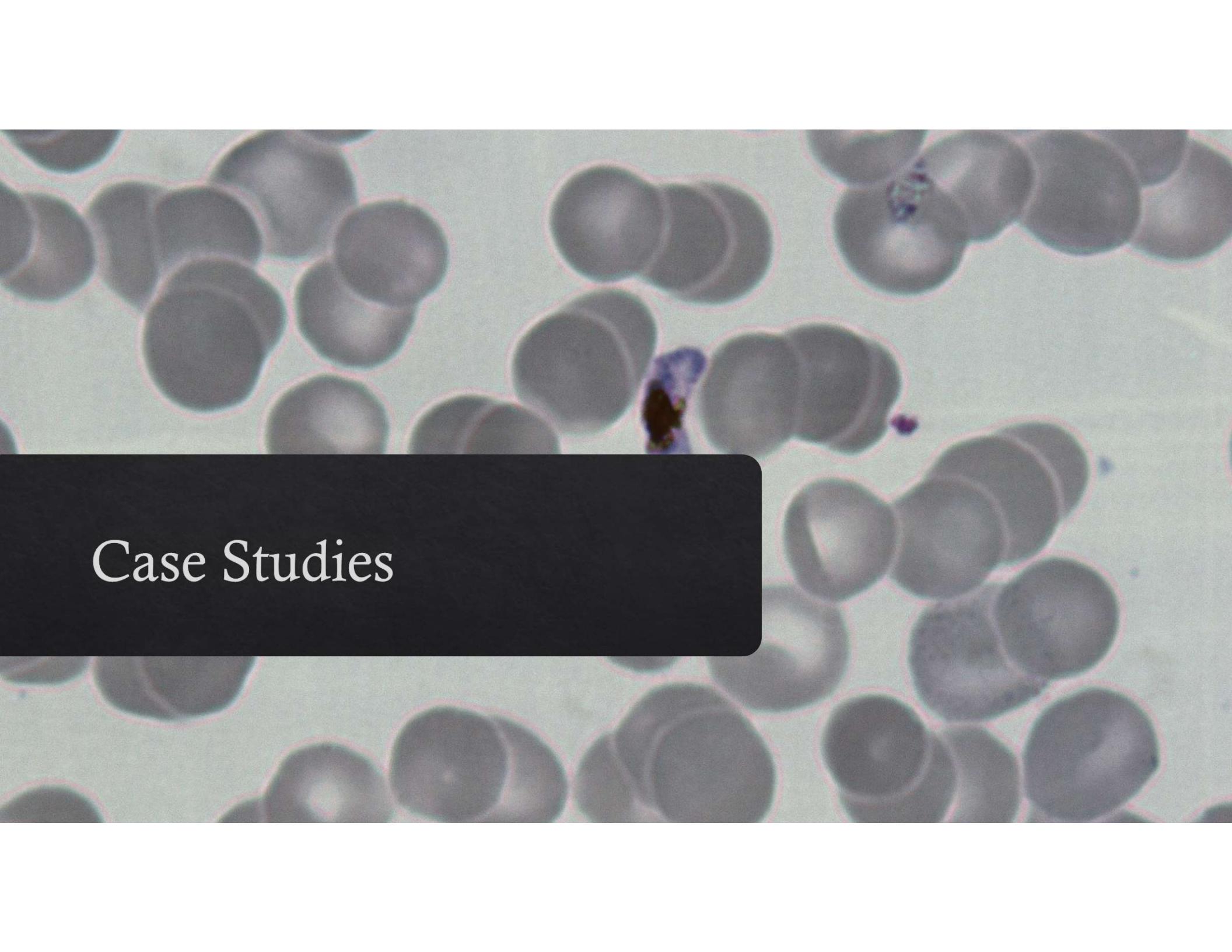
# Prevention/Control

- ❖ Taking medications before visiting endemic areas

## Control:

- ❖ Control of malaria via anti mosquito measures such as spraying, destroying breeding areas.



A microscopic image showing a dense population of dark, circular blood cells against a light blue background. A single cell in the center contains a prominent purple-stained nucleus. A large, solid black rectangular box is positioned in the lower-left quadrant of the image.

# Case Studies

# Case Study 1 (2014)

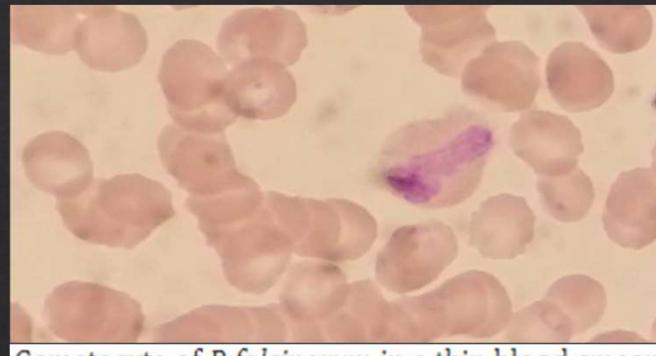
- ❖ Patient Background
  - ❖ 25-year-old male
  - ❖ From Bursa, Turkey.
  - ❖ previous 14 month stay in Tanzania
- ❖ Symptoms
  - ❖ Fever of 38.3 C and constant chills for 3 days



# Day 1 of Tests

## Tests/Diagnosis

- ❖ Physical examination –
- ❖ Mild sensitivity of upper right quadrant of abdomen
- ❖ CBC Tests:
  - ❖ WBC of 3230/ $\mu\text{L}$
  - ❖ Platelets: 26,800/ $\mu\text{L}$
  - ❖ Hemoglobin (Hb): 14.3 g/dl
- ❖ Microscopy
- ❖ -Staining of thick and thin blood smears
- ❖ Diagnosis of *P. falciparum*



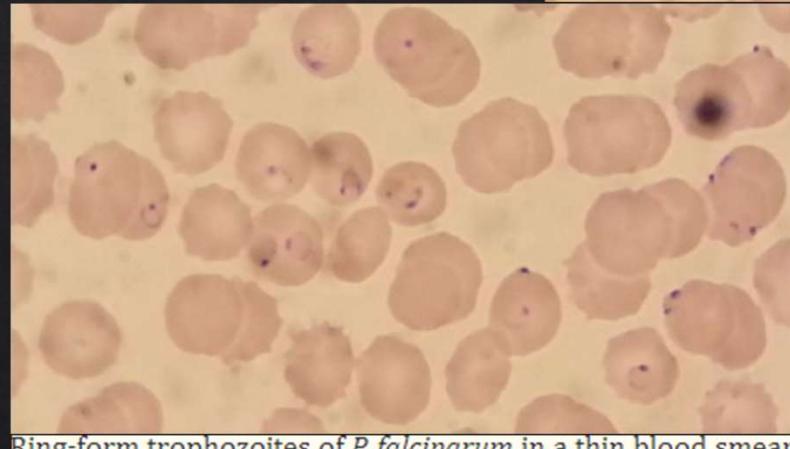
Gametocyte of *P. falciparum* in a thin blood smear

Normal CBC Ranges:

WBC: 4,500-11,000  $\mu\text{L}$

Platelet: 150,000-400,000 $\mu\text{L}$

Hemoglobin: 14-17.5 g/dl

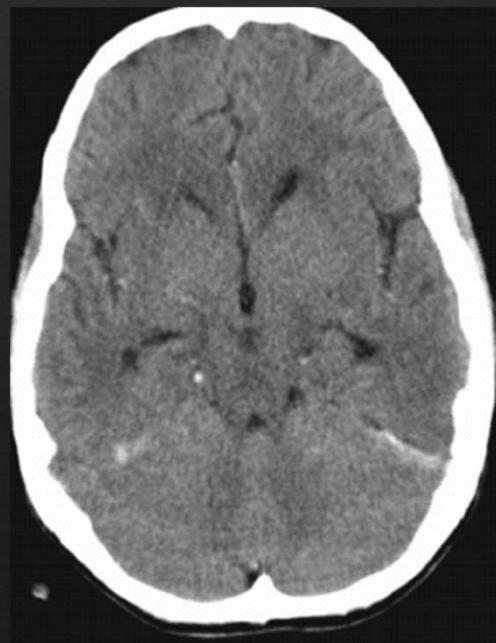


Ring-form trophozoites of *P. falciparum* in a thin blood smear

## Day 2

### 1st Treatment/Outcome:

- ❖ intravenous artemisinin (2.4 mg/kg)
- ❖ Patient suffered seizure
  - ❖ treated with IV diazepam
- ❖ Tests/Diagnosis
- ❖ CT scans of the brain performed
- ❖ Diagnosis of **cerebral malaria**



Cerebral brain CT scan



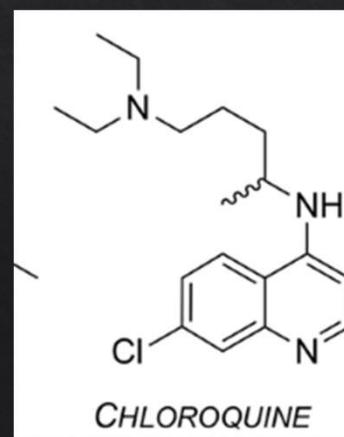
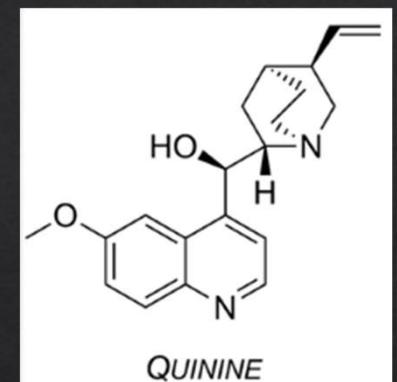
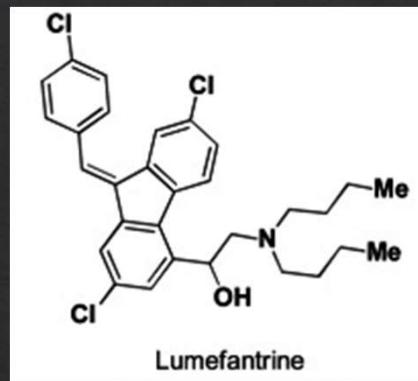
Normal brain CT scan

## Treatment

- ◊ Intravenous mannitol for 6 days
- ◊ Intravenous artemisinin 1.2mg/kg 2x per day for 10 days
- ◊ Artesunate & lumefantrine through feeding tube for 3 days
- ◊ 14th day anti malarial treatment replaced with quinine and doxycycline

Outcome:

After 25 more days was released  
No more parasitic infection



# Case Study 2

## Patient Background

- ❖ 16-year old Sri Lankan boy
- ❖ Has beta thalassemia major
- ❖ co-morbidity of blood transfusion-induced cardiomyopathy
- ❖ splenectomy in 2010
- ❖ Receives blood transfusions monthly
- ❖ Last transfusion on April 21<sup>st</sup> 2021
- ❖ No history of travel overseas

## Symptoms

- ❖ Developed fever 13 days after last blood transfusion. Fever of 37.8 C
- ❖ General practitioner diagnosed fever
- ❖ Was treated with anti-pyretics
- ❖ Fever did not change, patient admitted to general hospital on May 9<sup>th</sup>

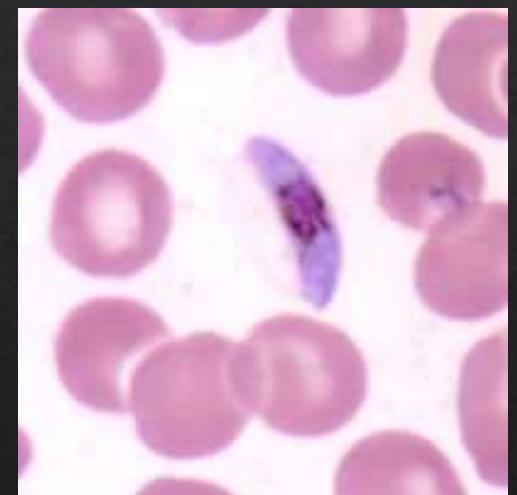


## Test/Diagnosis

### Microscopy

- ❖ Parasite density of 51,315/ $\mu\text{l}$  of asexual parasites and gametocytes
- ❖ CBC test shows low levels of hemoglobin (5.4 mg/dl)
- ❖ Confirms *P. falciparum*
- ❖ PCR test confirms *P. falciparum*

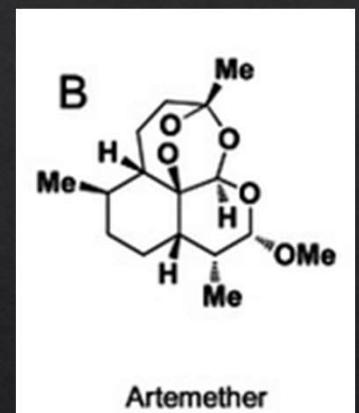
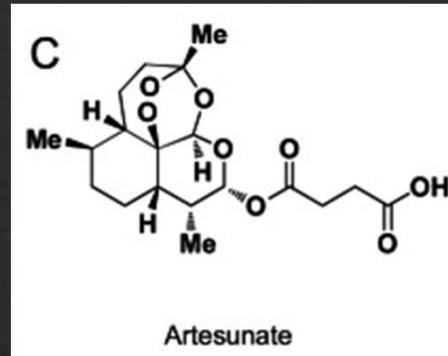
Normal level of  
Hemoglobin:  
14-17.5 g/dl



# Treatment/Outcome

## Treatment/outcome

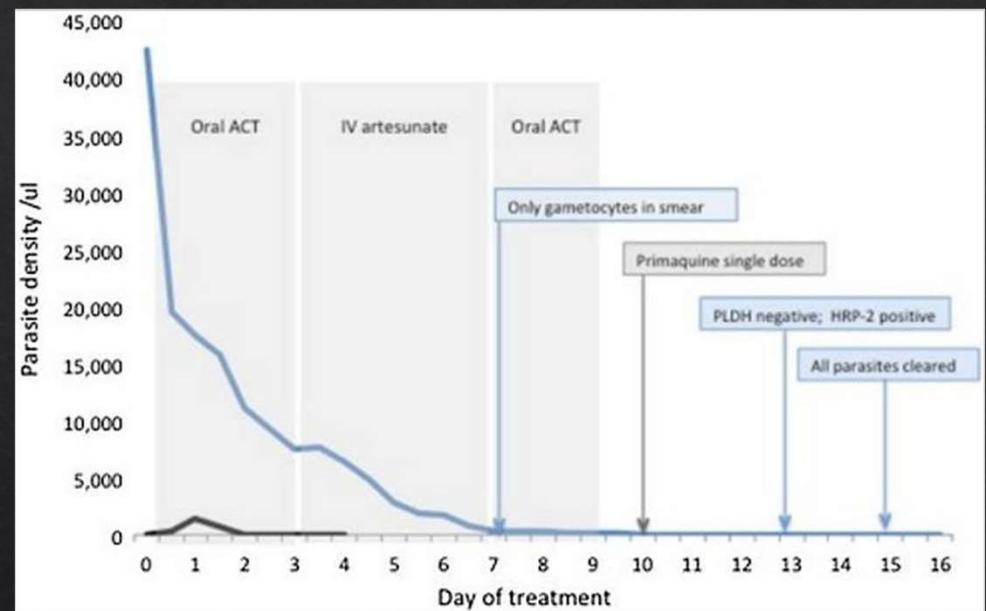
- ❖ artemether-lumefantrine for 3 days
- ❖ Parasite density decreased 7147 parasites/ $\mu$ l
- ❖ Patients' health deteriorated
- ❖ Blood pressure below normal
- ❖ Irregular fevers
- ❖ Intravenous artesunate 2.4mg/kg for 3 days
- ❖ 3-day course of oral artemether-lumefantrine after
- ❖ 7<sup>th</sup> day no presence of asexual parasites
- ❖ 15<sup>th</sup> day patient completely cleared of gametocytes



Outcome:  
Discharged by day 17, parasite free

# Case Study 2 Cause?

- ❖ Blood donor traced
- ❖ Member of armed forces
- ❖ Spent 16 months in Sudan during 2019-2020
- ❖ Found to have low density of *P. falciparum*
- ❖ Normal Hb of 15.2 g/dl.



# Case Study 3

## Patient Background

- ❖ 31-year-old woman, African American in Pennsylvania
- ❖ History of latent tuberculosis with 3-month therapy
- ❖ History of **malaria infection** 10 years ago in Liberia, treated with medication (unknown)
- ❖ Has not traveled since leaving Liberia in 2014
- ❖ Does not participate in outdoor activities
- ❖ No sick people in her life
- ❖ Is a caretaker

## Symptoms presented on Aug 2021

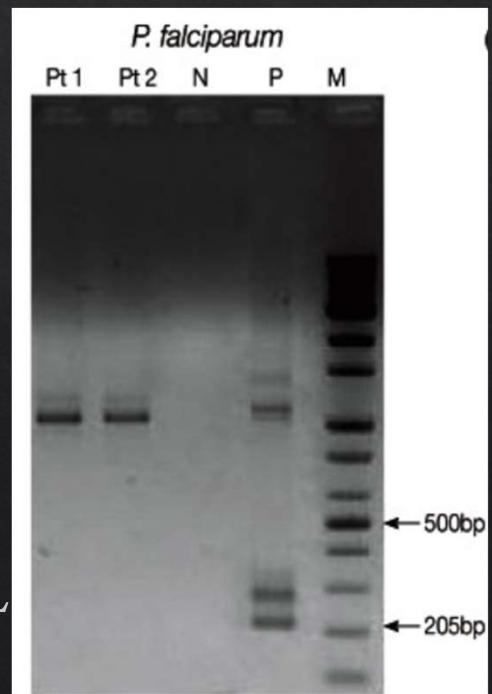
- ❖ Abdominal pain
- ❖ Headache
- ❖ 4-5 days of fever
- ❖ Previously had 2 episodes of nausea & vomiting



# Tests/Diagnosis

## Tests

- ❖ Physical examination:
- ❖ CBC test:
- ❖ WBC lower than normal range  $3.2 \times 10^9/L$
- ❖ Hemoglobin lower than normal range (9.4 g/dL)
- ❖  $43 \times 10^9/L$  Platelet count much lower-than-normal range
- ❖ Blood Smear indicates parasitic elements
- ❖ Ultrasound reveals moderate splenomegaly
- ❖ PCR test confirms diagnosis of *P. falciparum*



Normal CBC Ranges:

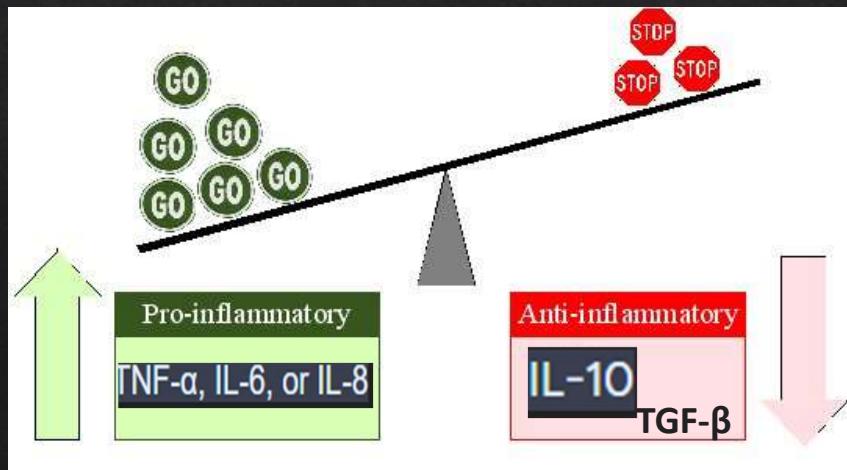
WBC: 4,500-11,000  $\mu L$

Platelet: 150,000-400,000  $\mu L$

Hemoglobin: 14-17.5 g/dl

# Treatment/Outcome

- ❖ Medicine
- ❖ Given 300mg of primaquine for 14 days in hospital
- ❖ Follow up
- ❖ 1 week later resolution of all symptoms



- ❖ Patient pattern:
- ❖ The combination of malaria and latent tuberculosis have a balance between the production of inflammatory and anti-inflammatory cytokines
- ❖ This can produce immunological protection against severe malaria

# Question 1

In case 2 why do you think treatment took longer for our patient than the blood donor (3 days) despite him having the infection longer?

## Question 2

In case study 3 would we consider this a case of relapse? Why?

# References

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