

# Malaria-1



# Objectives

- Basic understanding of malaria
  - Epidemiology
  - Symptoms
  - Diagnosis
  - Treatment
  - Prevention



# What Is It?

- A mosquito-borne infectious disease
- Protozoan parasites of the genus *Plasmodium*
- Transmitted only by Anopheles Mosquitoes
- Disease can be:
  - Acute
  - Chronic
- Four species:
  - *P falciparum*
  - *P vivax*
  - *P ovale*
  - *P malariae*



# Transmission

- ◆ Mosquito vector: *ANOPHELES*
- ◆ Transmission also possible through:
  1. Blood transfusion
  2. Contaminated needle
  3. Organ transplant
  4. Congenital



# Susceptibility

■ Universal susceptibility

■ No absolute immunity

■ Partial immunity in areas of high endemicity



# LIFE CYCLE

- Two hosts – vertebrate (Human)
  - Invertebrate (Mosquito-female anopheles)

Alteration of generation

Reproduce sexually (Sporogony)  
& asexually (Schizogony)

Alteration of host



# LIFE CYCLE : STAGES

## In Human

- Liver phase -  
Pre Erythrocytic Schizogony
- Erythrocytic Schizogony
- Gametogony
- Exo Erythrocytic  
Schizogony

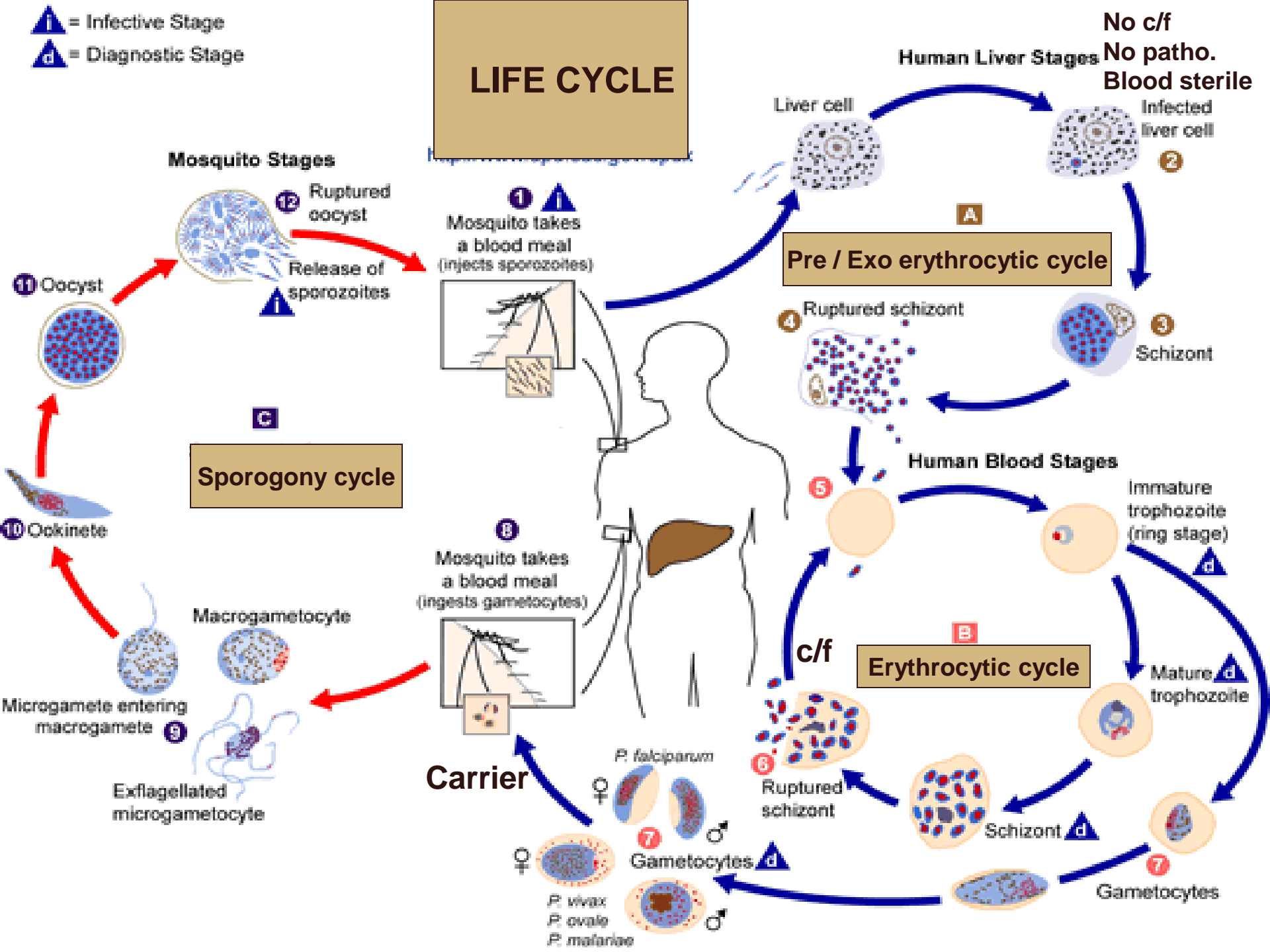
## In Mosquitoes

- Exflagellation &  
fertilization
- Zygote
- Oocyst
- Sporozoite



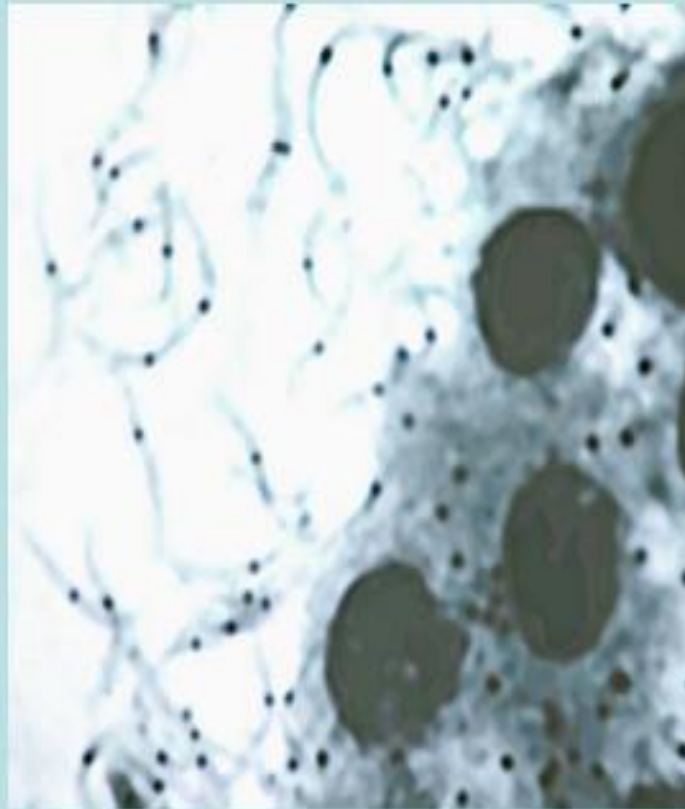
**i** = Infective Stage  
**d** = Diagnostic Stage

# LIFE CYCLE





Sporozoites of malaria in infected  
mosquito stomach preparation

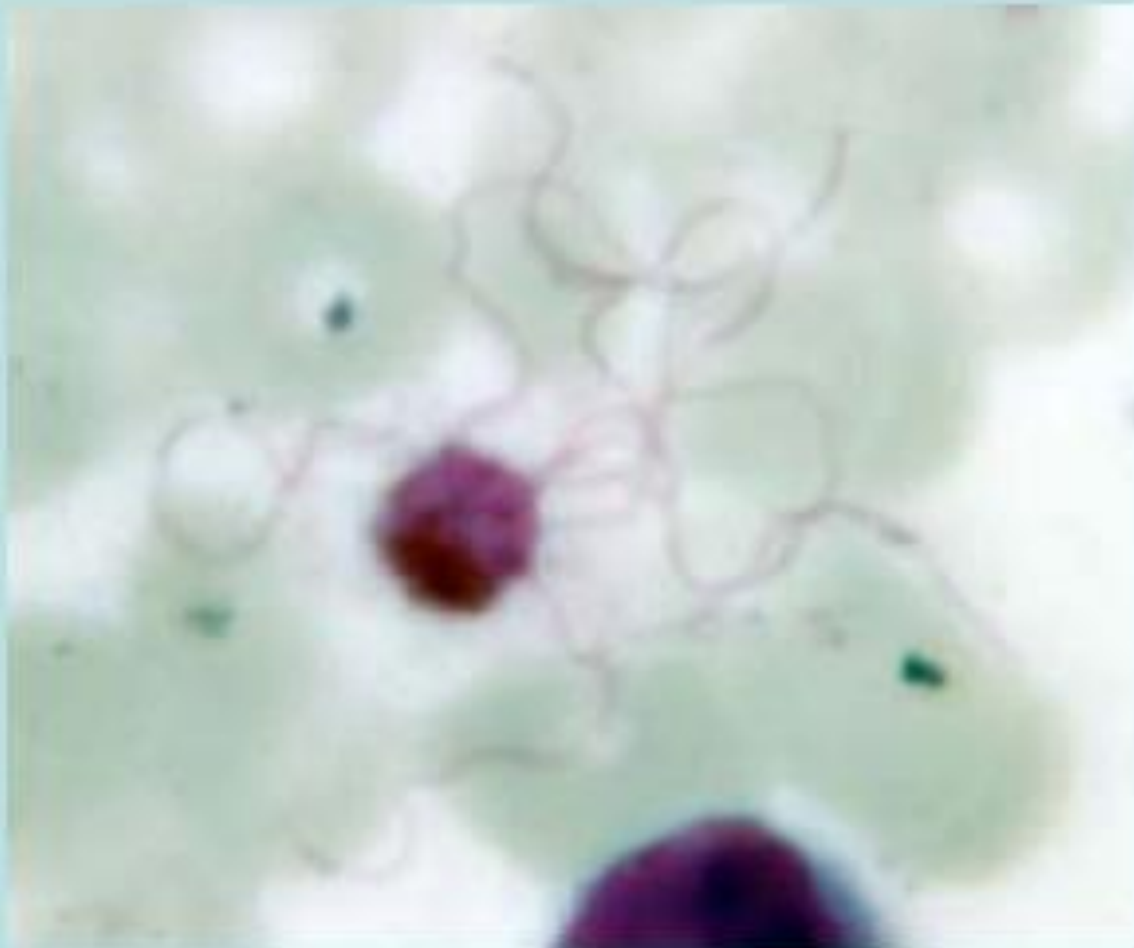


Light micrograph



SEM Photo: Photolab

Ex-flagellation of the microgametocyte  
of a malaria parasite in mosquito stomach



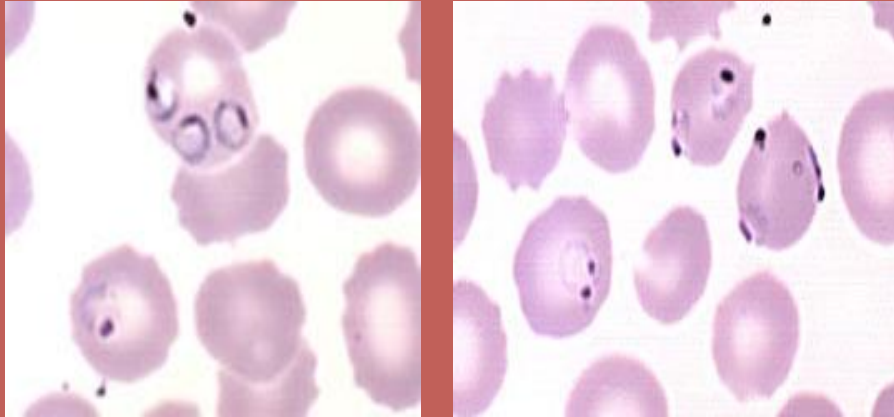
# Comparison of the P.vivax & P.falciparum

	<b>P. vivax</b>	<b>P. falciparum</b>
<b>Pre erythrocytic schizogony</b>	<ul style="list-style-type: none"> <li>- One cycle (8 days)</li> <li>- Schizont (42µm)</li> <li>-12,000 merozoites</li> </ul>	<ul style="list-style-type: none"> <li>- One cycle (6 days)</li> <li>- Schizont (60x30 µm)</li> <li>- 40,000 merozoites</li> </ul>
<b>Erythrocytic schizogony</b>	<ul style="list-style-type: none"> <li>- 48 hours</li> <li>- clinical attack of malaria</li> </ul>	<ul style="list-style-type: none"> <li>- 36-48 hours</li> <li>- clinical attack of malaria</li> </ul>
<b>Exo Erythrocytic schizogony</b>	<ul style="list-style-type: none"> <li>- Present (not &gt; 3 years)</li> <li>- Relapse can occur</li> </ul>	<ul style="list-style-type: none"> <li>- <u>Absent</u></li> <li>- Relapses do not occur</li> <li>- Recrudescence occurs</li> </ul>
<b>A single infection</b>	<ul style="list-style-type: none"> <li>- Lasts up to 3 years</li> </ul>	<ul style="list-style-type: none"> <li>- Lasts up to 1 month but maximum of 1 year</li> </ul>

**Differential features of  
P. vivax & P. falciparum  
In  
Erythrocytic phase**



# Trophozoite : Ring form



**P. falciparum**

■ Rings: double chromatin dots; **accolé** forms; **1.25-1.5  $\mu\text{m}$**

■ multiple infections in same red cell

■ No enlargement of RBC

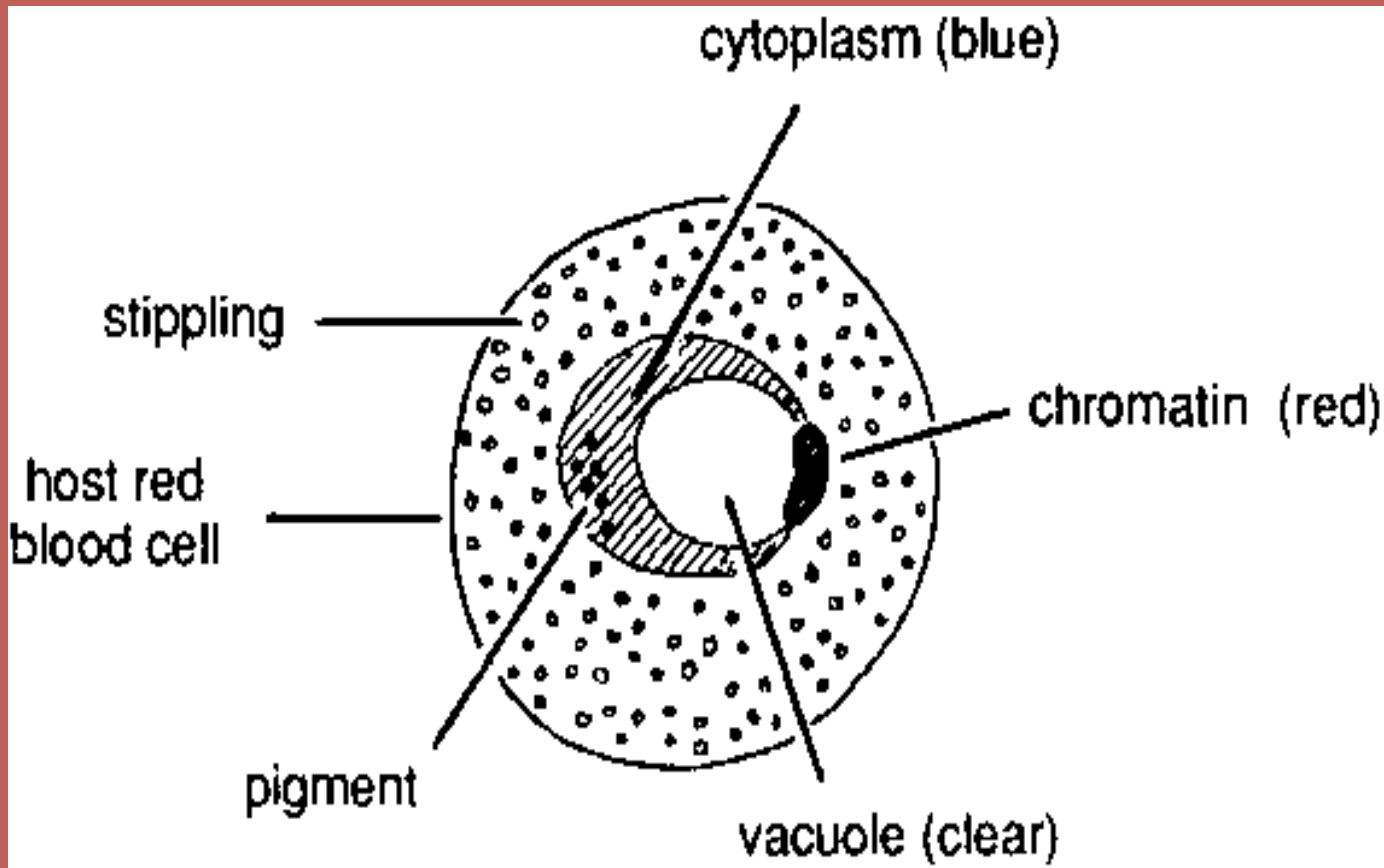


**P. vivax**

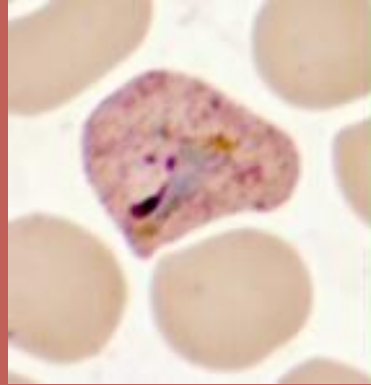
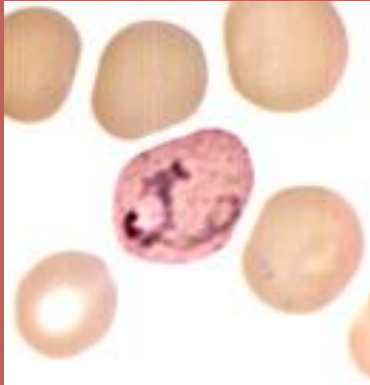
■ **2.5-3  $\mu\text{m}$**

■ Occupying **1/3 rd** of cytoplasm

■ Enlargement of RBC



# Trophozoite : Growing form



**P. vivax**

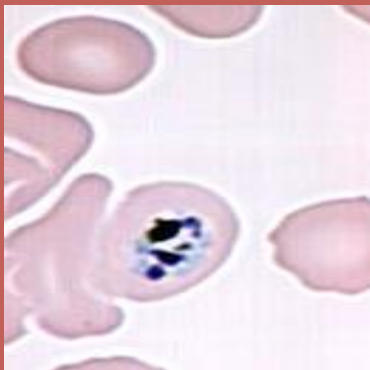
**Irregular with a vacuole**

**Actively amoeboid**

**deforms the RBC**

**Yellowish brown pigment**

**Schuffner's dots**



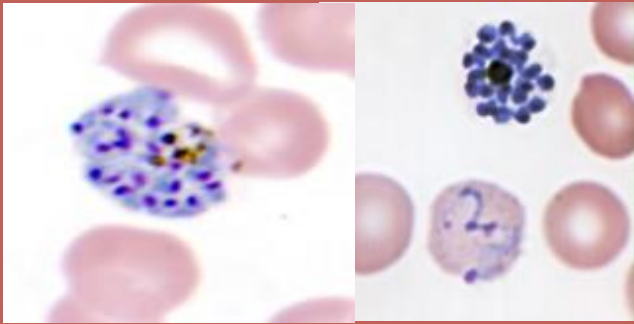
**P. falciparum**

**Compact (rarely seen in peripheral blood)**

**Dark brown or black pigment**

**Maurer's dots/ clefts**

# Schizonts



**P. vivax**

9-10  $\mu\text{m}$ , regular.

Completely fills an enlarged RBC

Merozoites 12-24, arranged in an irregular grape like structure



**P. falciparum**

4.5-5  $\mu\text{m}$ , fills 2/3 rd of RBC

8-24 merozoites

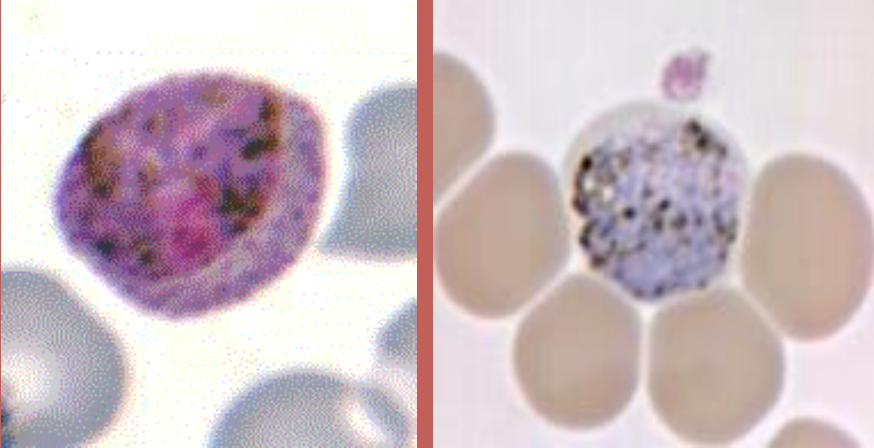
Rarely seen in peripheral blood



# Gametocyte

**Spherical or globular**

**Much larger than RBC**



**P. vivax**



**P. falciparum**

**mature (M) & immature (I) forms**

**Crescentic, larger than RBC**






# Method of transmission

- ✓ 1. Inoculation
- 2. Sporozoite induced malaria
- 3. Trophozoite induced malaria
  - Transfusion malaria
  - Congenital malaria
  - Malaria in drug addicts
- 4. Therapeutic malaria



# *Plasmodium* Species

## *P. Falciparum*

-  Most severe and prevalent
-  Malignant tertian malaria
-  40-60% of cases
-  Widespread CHLOROQUINE resistance
-  Infects RBCs of all ages—Heavy parasitaemia



# Plasmodium Species




## P. vivax

-  30-40% of cases
-  Benign tertian malaria
-  INFECTS YOUNG RBCs: LESS SEVERE THAN FALCIPARUM

## P. ovale

-  Benign tertian malaria
-  INFECTS YOUNG RBCs

## P. malariae

-  Benign quartan malaria
-  Can persist SUBCLINICALLY for extended periods of time
-  INFECTS OLD RBCs



# Incubation Period

 <i>P. Falciparum</i>	12 days
 <i>P. Vivax</i>	14 days*
 <i>P. Ovale</i>	14 days*
 <i>P. Malariae</i>	30 days

\* May be 8 - 10 months or longer for some strains



# Acute Symptoms

- Classical cyclic paroxysm:
  - Cold stage: chills and shaking
  - Hot stage: warm, headache, vomiting
  - Sweating stage: weakness
  - Feel well for period of time, then cycle repeats itself

## Clinical signs

- Anemia (Microcytic/hypochromic normocytic)
- Splenomegaly



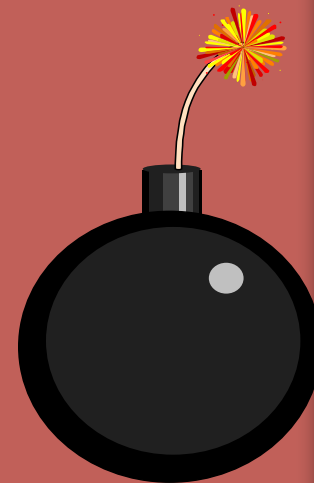
# Pathogenesis

- RBC destruction
- Immune complexes and mediators
- Capillary permeability
- Tissue hypoxia



# Complicated Malaria

- Hyperparasitemia: (>3%)
- Hypoglycemia: (<60 mg/dl)
- Severe anemia
- Renal failure
- Hyponatremia
- Cerebral malaria
- Prolonged hypothermia
- High output vomiting or diarrhea
- Pregnancy





# Pernicious (malignant) malaria

Caused by *P. falciparum* (Fatal condition)

>5% RBCs are infected

- Obstruction to blood flow to organs
- Alteration on RBC membrane

 Cerebral malaria

 Algid malaria

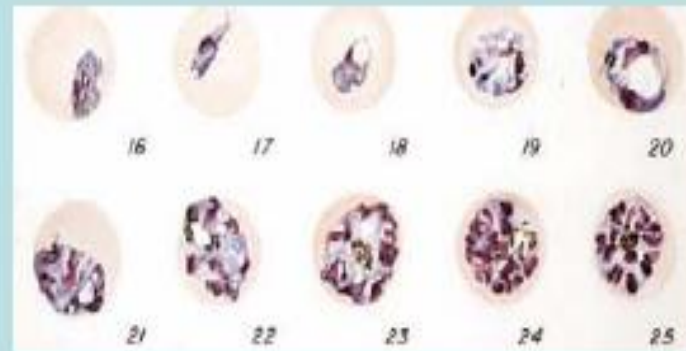
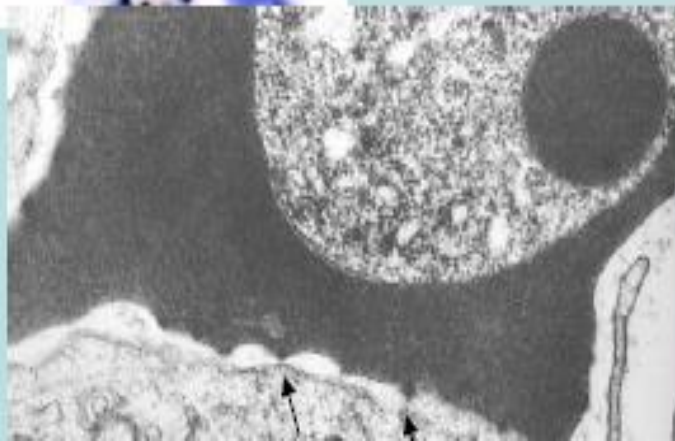
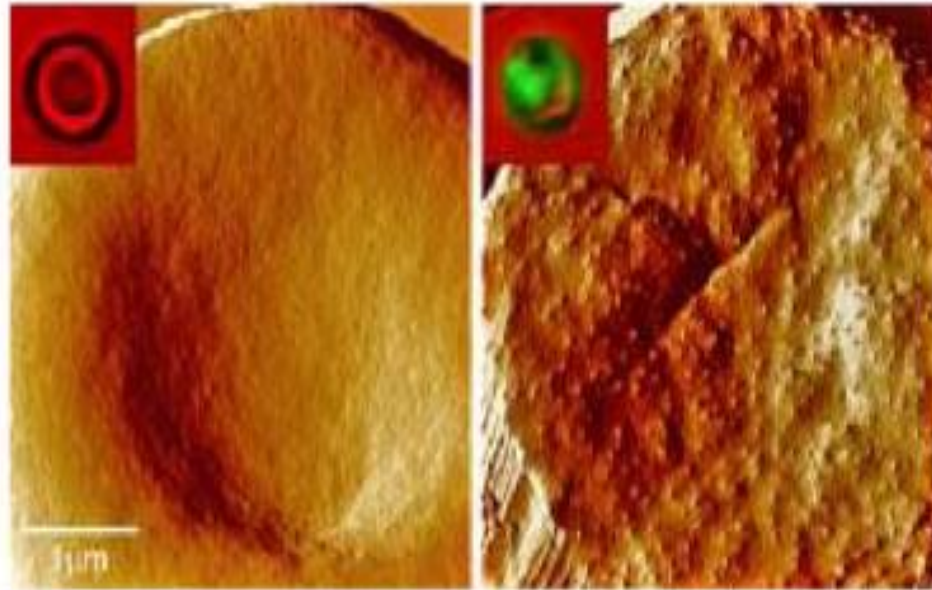
 Septicaemic malaria



Normal RBC

Atomic force microscopy of knobs

In situ RBCs  
with *P. falciparum*



Stages of *P. falciparum* with knobs

# Cerebral malaria

- Commonest cause of death in malignant malaria
- Sticky RBC knobs
- High TNF level – vascular endothelial adhesiveness  
- direct CNS effect
- Poor deformability of infected RBCs
- Increased endothelial permeability

# Algid malaria

- Circulatory collapse
- Severe abdominal pain, vomiting, diarrhoea
- Mucosal & sub mucosal capillaries packed with parasitized RBCs



# Septicaemic malaria

- High degree of parasitaemia
- Acute lung injury
- Alveolar capillaries & coronary blood vessels are congested & filled with parasitized RBCs



# Blackwater fever

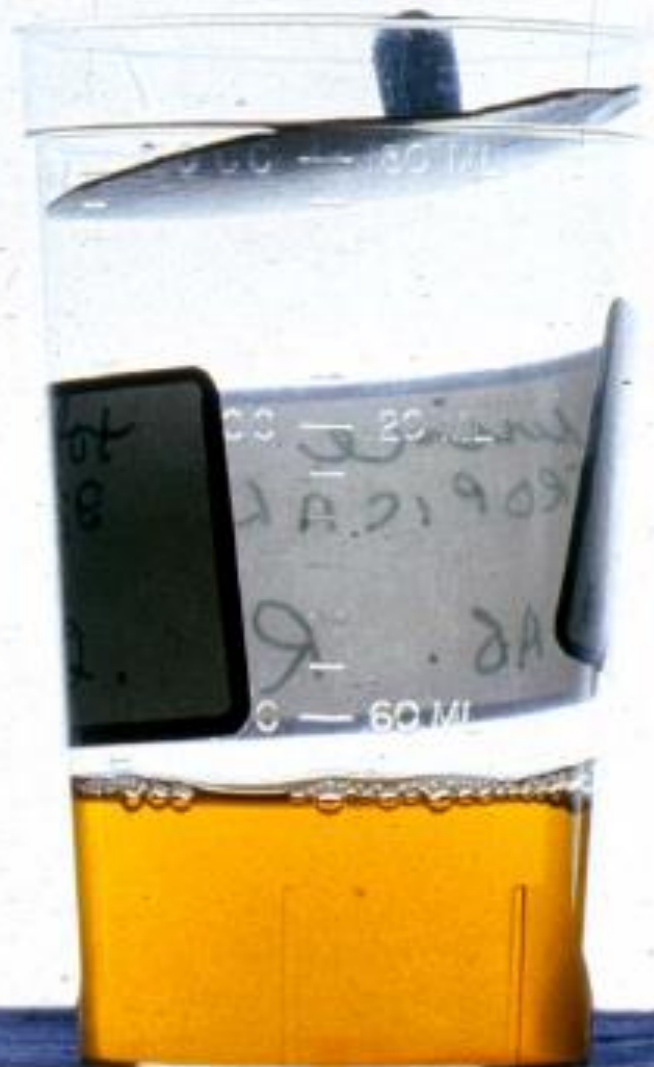
- Malarial haemoglobinuria is some time associated with falciparum malaria, particularly in patients who have experienced repeated infections & inadequate quinine therapy
- Auto antibodies against RBCs

↓  
I/V haemolysis

- Parasites are not detected in blood during & just after the attack but may reappear after an week of acute attack

- Fever with rigor, aching pain in loins, bilious vomiting, icterus, haemoglobinuria, circulatory collapse, ARF.
- Urine – red to dark red (port-wine / cola)
  - acidic







# Genetically determined conditions conferring protection against death from malaria

- Sickle-cell trait
- Ovalocytosis
- Absence of Duffy blood group antigen
- G6PD deficiency