# *Malaria – Diagnosis and Treatment*

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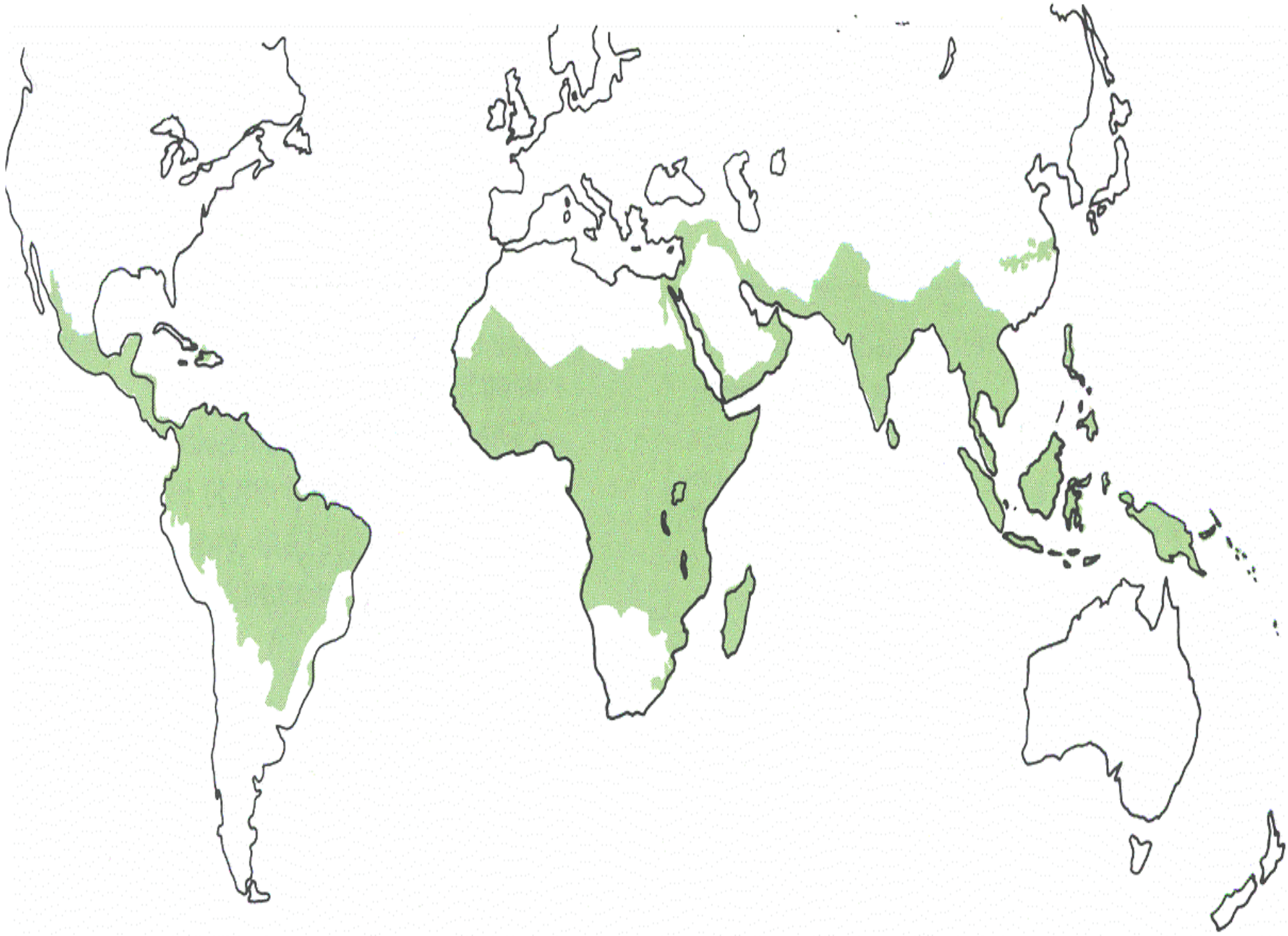
# Five species of human malaria

***Plasmodium falciparum***
***Plasmodium vivax***
***Plasmodium ovale***
***Plasmodium malariae***
***Plasmodium knowlesi***

**Curable and Preventable**

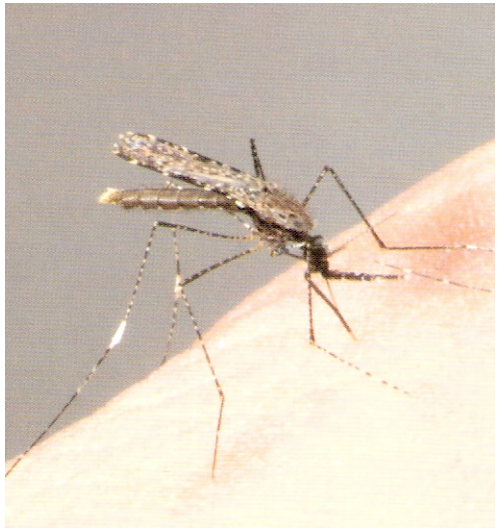
# MALARIA
# CURRENT WORLD STATUS

- **Malaria is the most important parasitic disease in the world.**
- **Forty percent of the world's population is at risk of malaria infection.**
- **Malaria incidence has increased during the last 2 decades, and it is now estimated that about 270 million people are infected annually, resulting in 2.7 million deaths.**
- **In patients with severe and complicated malaria, the mortality rate is between 20 and 50%**



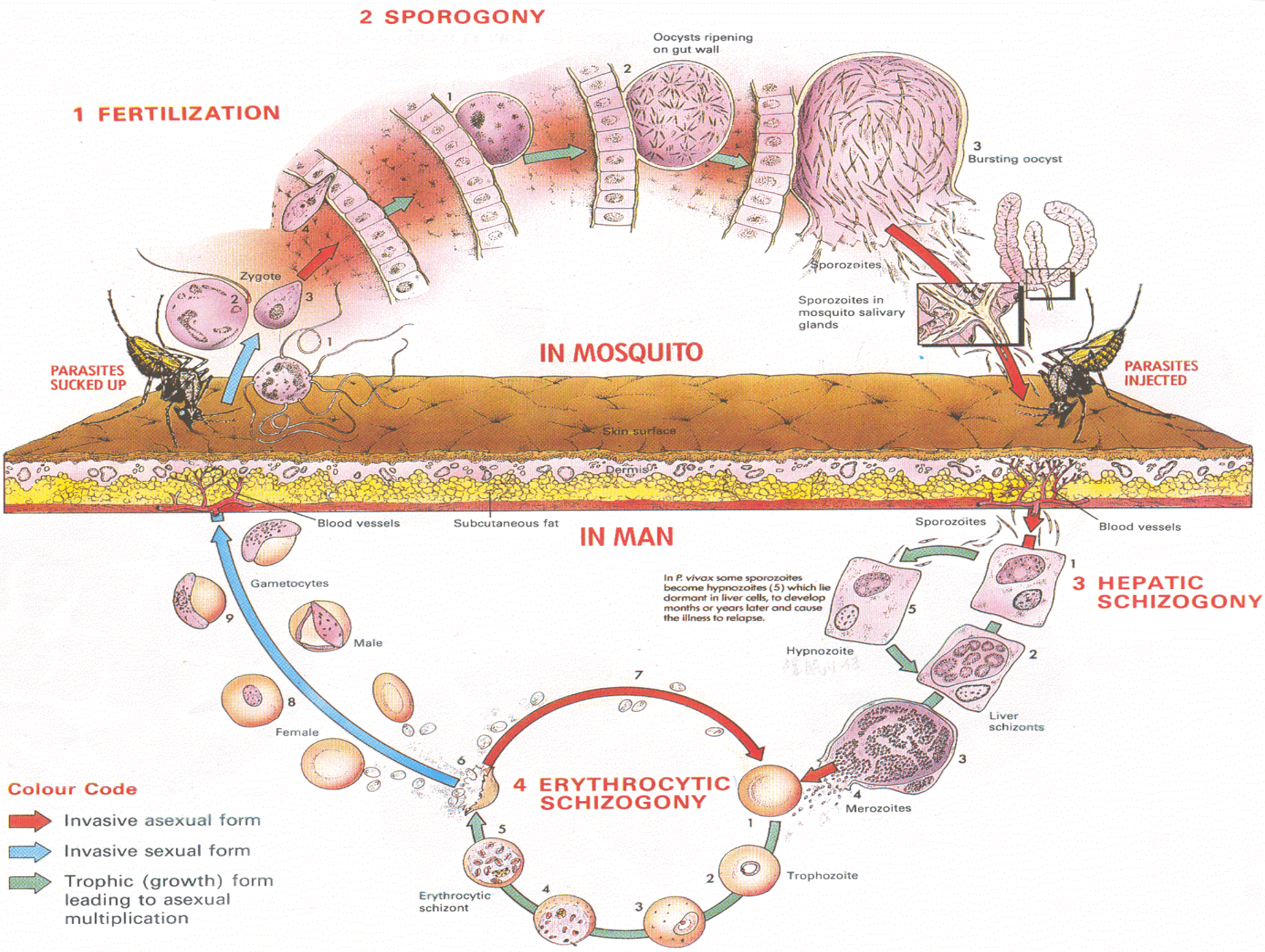
# MALARIA TRANSMISSION

- **Mosquito bites**
- **Blood transfusion**
- **Transplacental**
- **Iatrogenic**



# OUTCOME OF MOSQUITO MALARIA INFECTIOUS BITES IN SUB-SAHARAN AFRICA

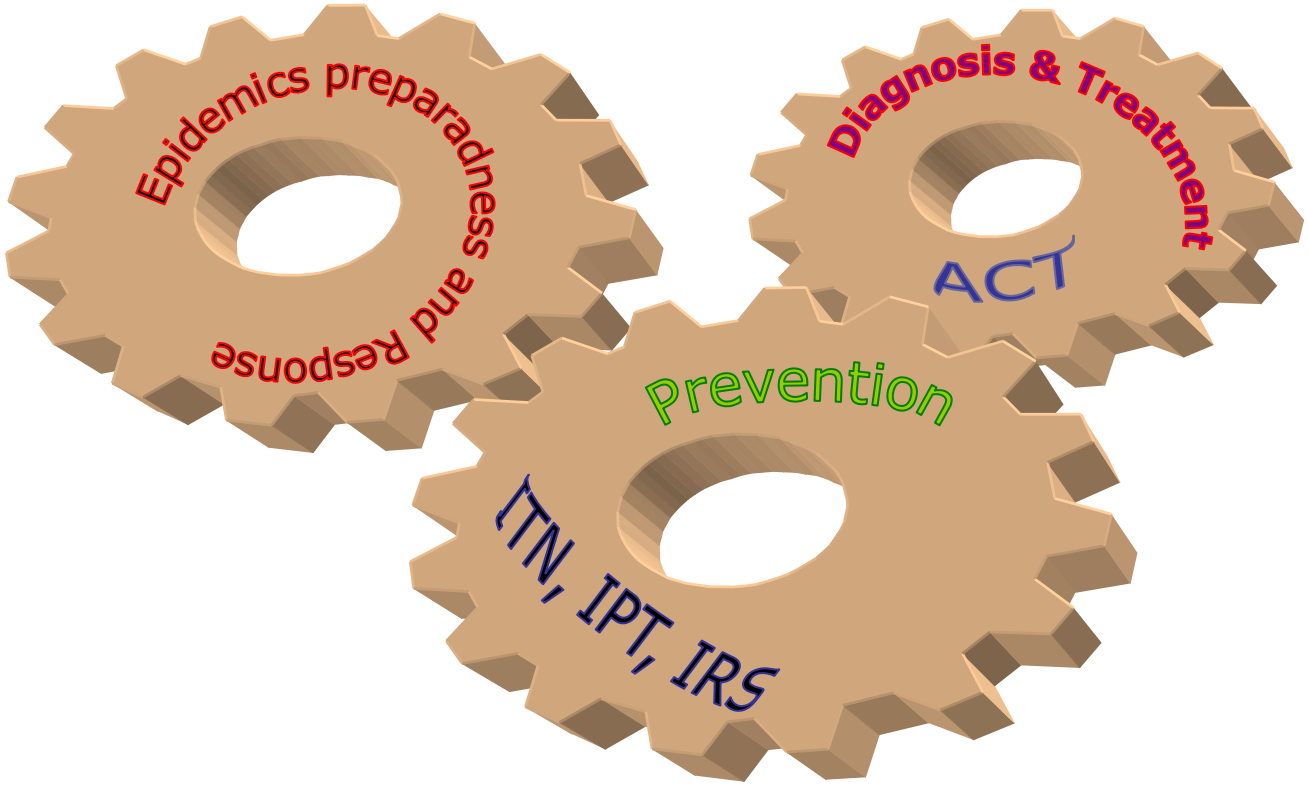
| • EVENT | • FREQUENCY |
| --- | --- |
| • Infectious bites | • 400 |
| • Patient infected | • 200 |
| • Clinical malaria | • 100 |
| • Severe malaria | • 2 |
| • Death | • 1 |


2 SPOROGONY
Oocysts ripening on gut wall
1 FERTILIZATION
3 Bursting oocyst
Zygote
Sporozoites
Sporozoites in mosquito salivary glands
IN MOSQUITO
PARASITES SUCKED UP
PARASITES INJECTED
Skin surface
Dermis
Blood vessels
Subcutaneous fat
IN MAN
Sporozoites
Blood vessels
In P. vivax some sporozoites become hypnozoites (5) which lie dormant in liver cells, to develop months or years later and cause the illness to relapse.
3 HEPATIC SCHIZOGONY
Hypnozoite
Liver schizonts
Gametocytes
Male
Female
4 ERYTHROCYTIC SCHIZOGONY
Merozoites
Trophozoite
Erythrocytic schizont
Colour Code
Invasive asexual form
Invasive sexual form
Trophic (growth) form leading to asexual multiplication

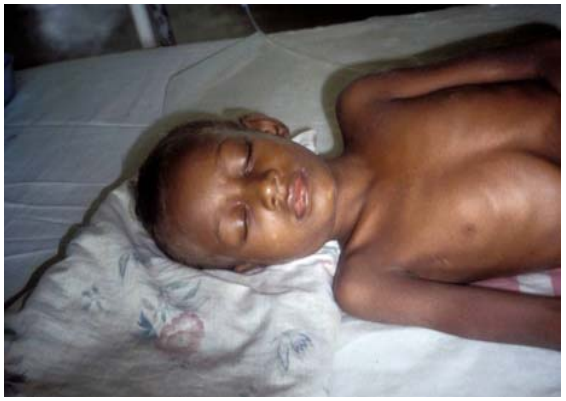
# BIOLOGICAL COMPARISON OF THE TYPES OF MALARIA

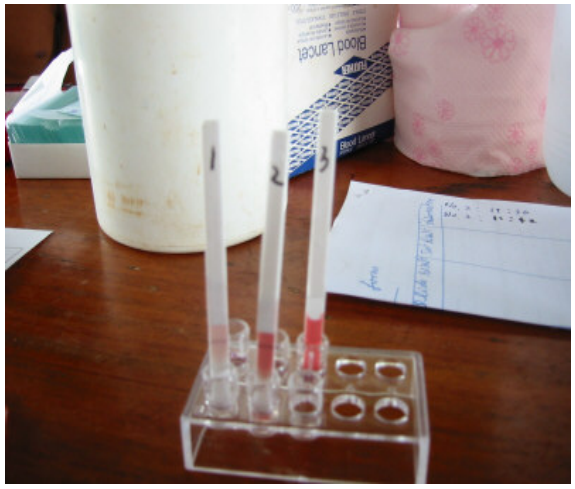
| Feature | Falciparum | Vivax | Ovale | Malariae |
|---|---|---|---|---|
| Exoerythrocyte (days) | 6-7 | 8 | 9 | 14-16 |
| Merozoites in schizont | 30,000 | 10,000 | 15,000 | 15,000 |
| Incubation period (days) | 12(8-25) | 14(8-27)<br>months-years | 15(9-17)<br>months-years | 15-30<br>months-years |
| Erythrocyte (hours) | 48 | 48 | 48 | 72 |
| Parasitemia (cum)<br>Percentage | 50,000-500,000<br>up to 2,500,000<br>up to 60% | 20,000-50,000<br><br><2% | 9,000-30,000<br><br><2% | 6,000-20,000<br><br><1% |
| Infected RBC | all stages | reticulocytes | reticulocytes | seniles |
| Relapse | no | yes | yes | no |
| Recrudescence | yes | no | no | yes? |

# Malaria Control Strategies



# Malaria Case Management






***"...Prompt accurate diagnosis and early treatment of malaria is the key to effective disease management."***

# CLINICAL MANIFESTATIONS

# MALARIA – COMMON SYMPTOMS
## NON-SPECIFIC

- **FEVER**
- **CHILLS**
- **HEADACHE**
- **NAUSEA, VOMITING**
- **DIARRHEA**
- **LOW BACK PAIN**
- **ARTHRALGIA, MYALGIA**
- **ANOREXIA**
- **FATIGUE**

**Table 1. Signs and symptoms in European travelers and immigrants with falciparum malaria.**

| Sign or symptom | Immigrants ($n$ = 790) | European travelers ($n$ = 869) |
|---|---|---|
| Fever | 603 (76.3) | 704 (81) |
| Headache | 388 (49.1) | 432 (49.7) |
| Fatigue | 189 (23.9) | 302 (34.8) |
| Myalgia, arthralgia | 136 (17.2) | 202 (23.2) |
| Diarrhea | 77 (9.7) | 121 (13.9) |
| Vomiting | 96 (12.2) | 104 (11.9) |
| Respiratory complaints | 21 (2.7) | 30 (3.5) |
| Neurological complaints | 10 (1.3) | 22 (2.5) |
| Skin affections | 10 (1.3) | 11 (1.3) |
| Otitis | 56 (7.1) | 8 (0.9) |
| Other | 157 (19.9) | 153 (17.6) |
| None | 49 (6.2) | 0 |

**NOTE.** Data are no. (%) of patients. Multiple entries are possible.

**On average, up to 11,000 patients per year in European Union countries, with the number of patients with falciparum malaria estimated at about 8,000 per year**

**CID 34:572-576, 2002**

# Malaria stages of the disease

The cold stage

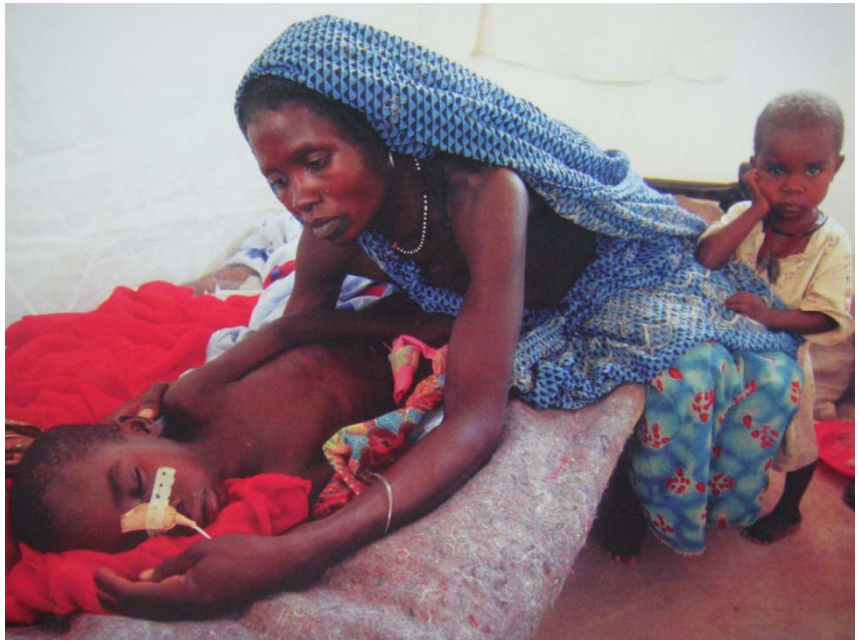
The hot stage

The sweating stage

# MALARIAL SYMPTOMS AND TYPICAL MIS-DIAGNOSIS

| Organs most affected | Main symptoms/signs | Typical mis-diagnosis |
|---|---|---|
| Gastrointestinal tract | Vomiting, diarrhea | Gastric flu, cholera, infectious diarrhea |
| Brain | Delirium, coma, convulsions | Encephalitis, meningitis, status epilepticus, hypoglycemic coma |
| Kidneys | Renal failure | Nephritis |
| Liver | Jaundice, fever | Bacterial and viral hepatitis |
| Lungs | Pulmonary edema | Pneumonia, heart failure |

# Severe malaria – cerebral malaria



# Severe Malaria

- **Clinical Manifestation:**
- **Impaired consciousness**
- **Respiratory distress (acidotic breathing)**
- **Multiple convulsions**
- **Circulatory collapse**
- **Pulmonary edema (radiological)**
- **Abnormal bleeding**
- **Jaundice**
- **Hemoglobinuria**

- **Laboratory Test:**
- **Severe anemia**
- **Hypoglycemia**
- **Acidosis**
- **Renal impairment**
- **Hyperlactatemia**
- **Hyperparasitemia**

# Parasitemia and clinical correlates

| Parasitemia | Parasites /μl | Remarks |
|---|---|---|
| 0.0001-0.0004% | 5-20 | Sensitivity of thick blood film |
| 0.002% | 100 | Patients may have symptoms below this level, where malaria is seasonal |
| 0.2% | 10,000 | Level above which immunes show symptoms |
| 2% | 100,000 | Maximum parasitemia of *P.v.* and *P.o.* |

# Parasitemia and clinical correlates

| Parasitemia | Parasites/µl | Remarks |
|---|---|---|
| 2-5% | 100,000-250,00 | Hyperparasitemia/severe malaria*, increased mortality |
| 10% | 500,000 | Exchange transfusion may be considered/ high mortality |

*WHO criteria for severe malaria are parasitemia > 100,000 /µl and severe anaemia (haemaglobin < 5 g/l).

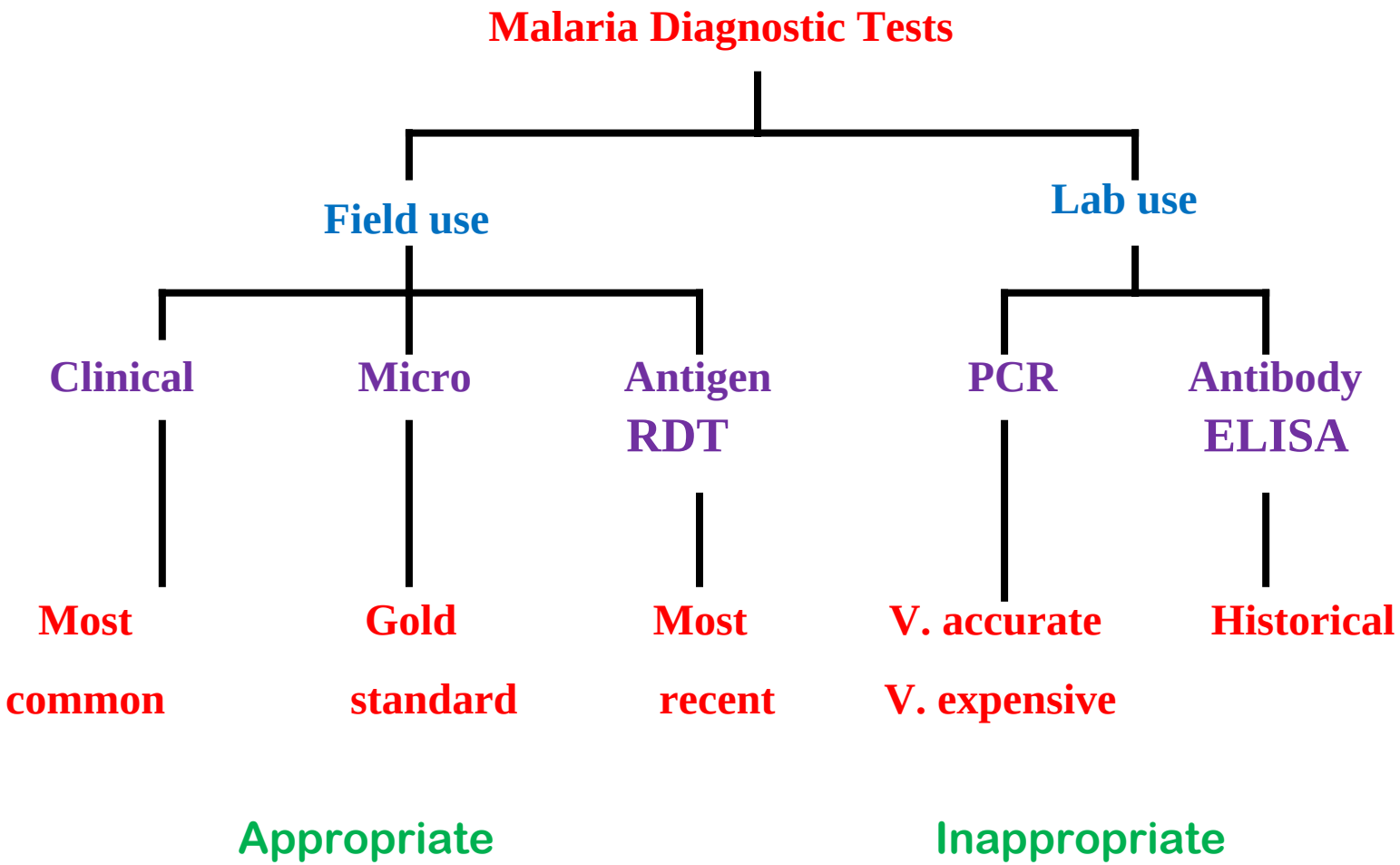
Prognosis is poor if > 20% parasites are pigment containing trophozoites and schizonts (more mature forms) and/or if > 5% of neutrophils contain visible pigment.

Hänscheid T. (1999) Diagnosis of malaria: a review of alternatives to conventional microscopy. *Clin Lab. Haem.* 21, 235-245.

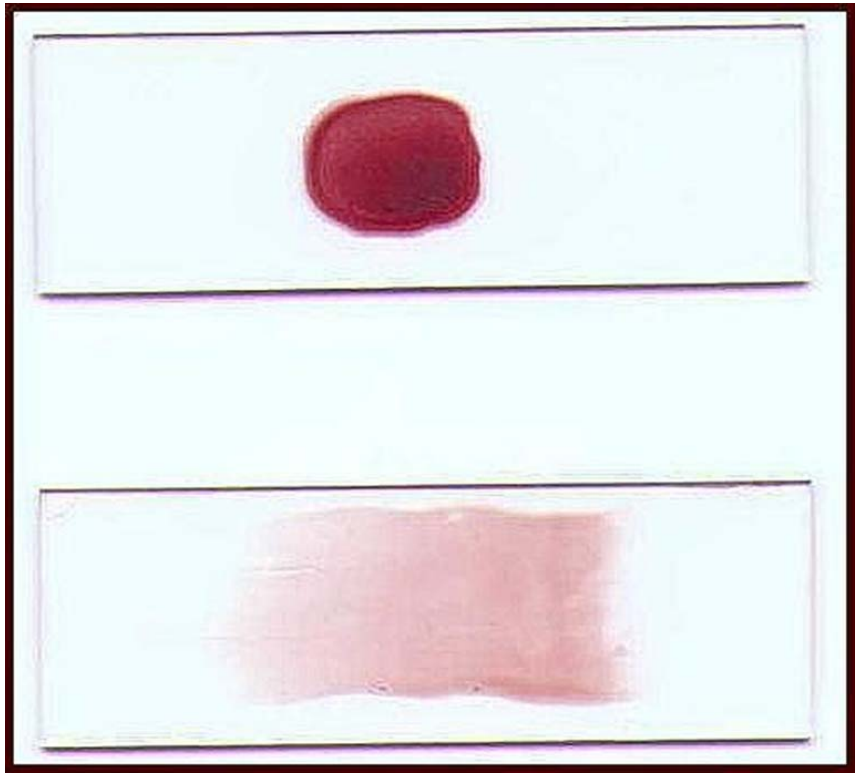
# Malaria Diagnosis

- Symptom-based (clinical) diagnosis
- Light microscopy
- Quantitative Buffy Coat (QBC) method
- Rapid diagnostic tests (antigen capture)
- Flow cytometery
- PCR-based molecular detection methods
- Loop-Mediated Isothermal Amplification

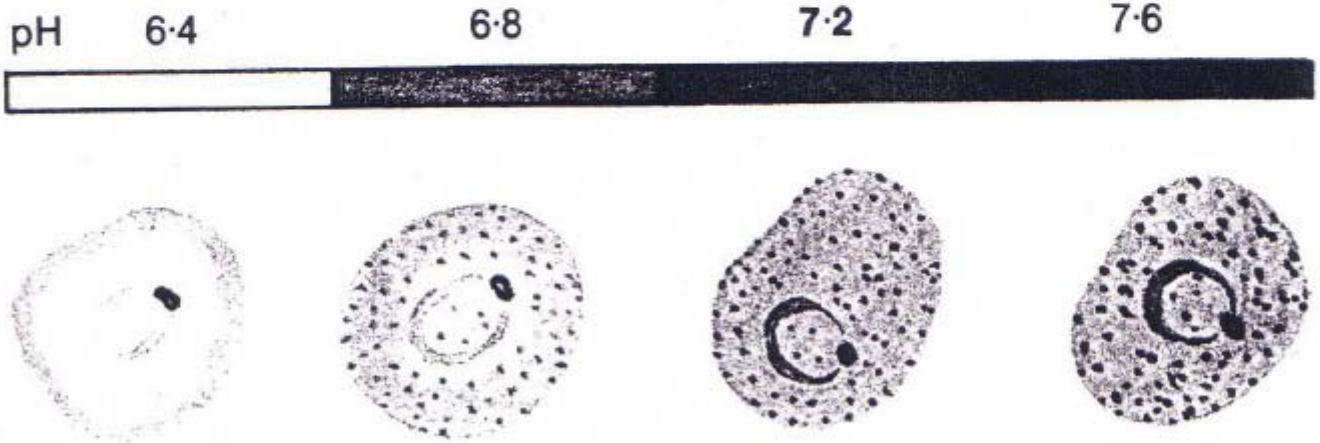
# Malaria diagnosis:



# Gold Standard Method



# pH 7.2

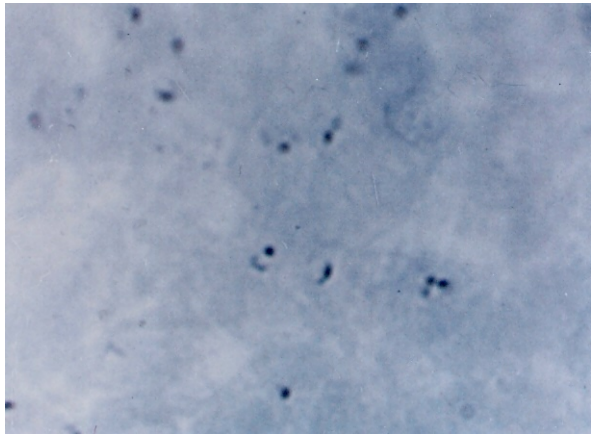


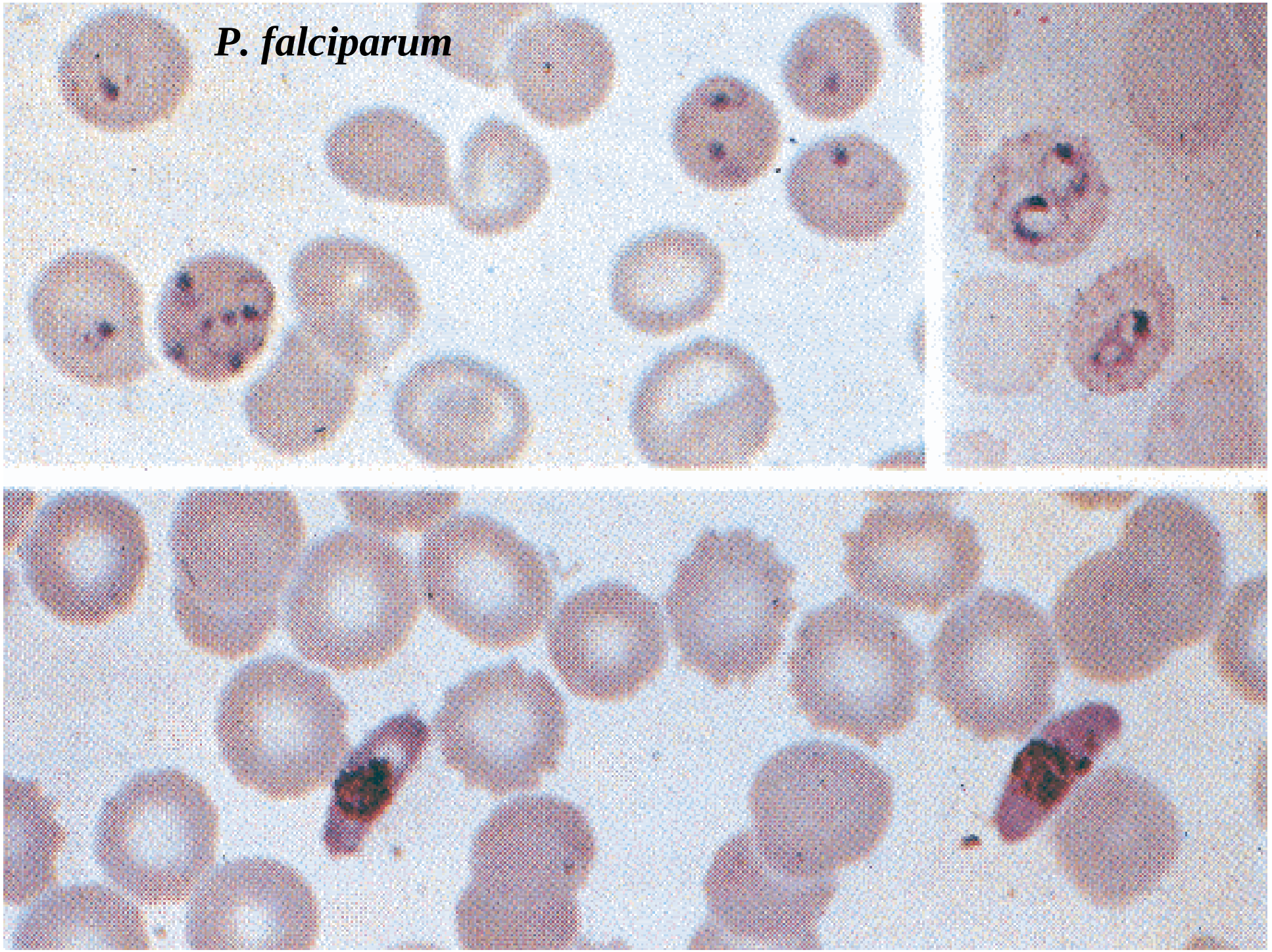

pH ET COLORATION

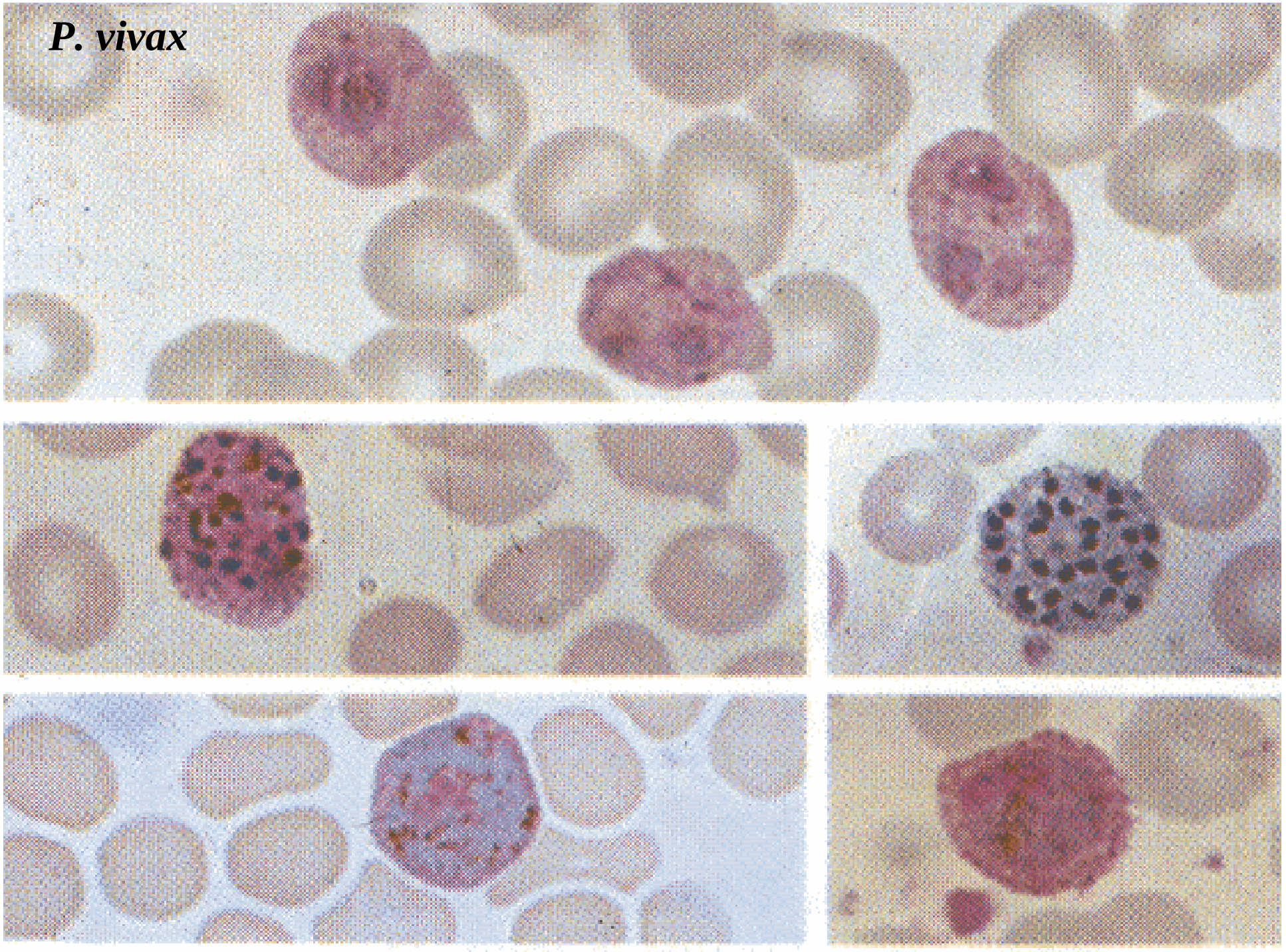
# Thick Blood Smear

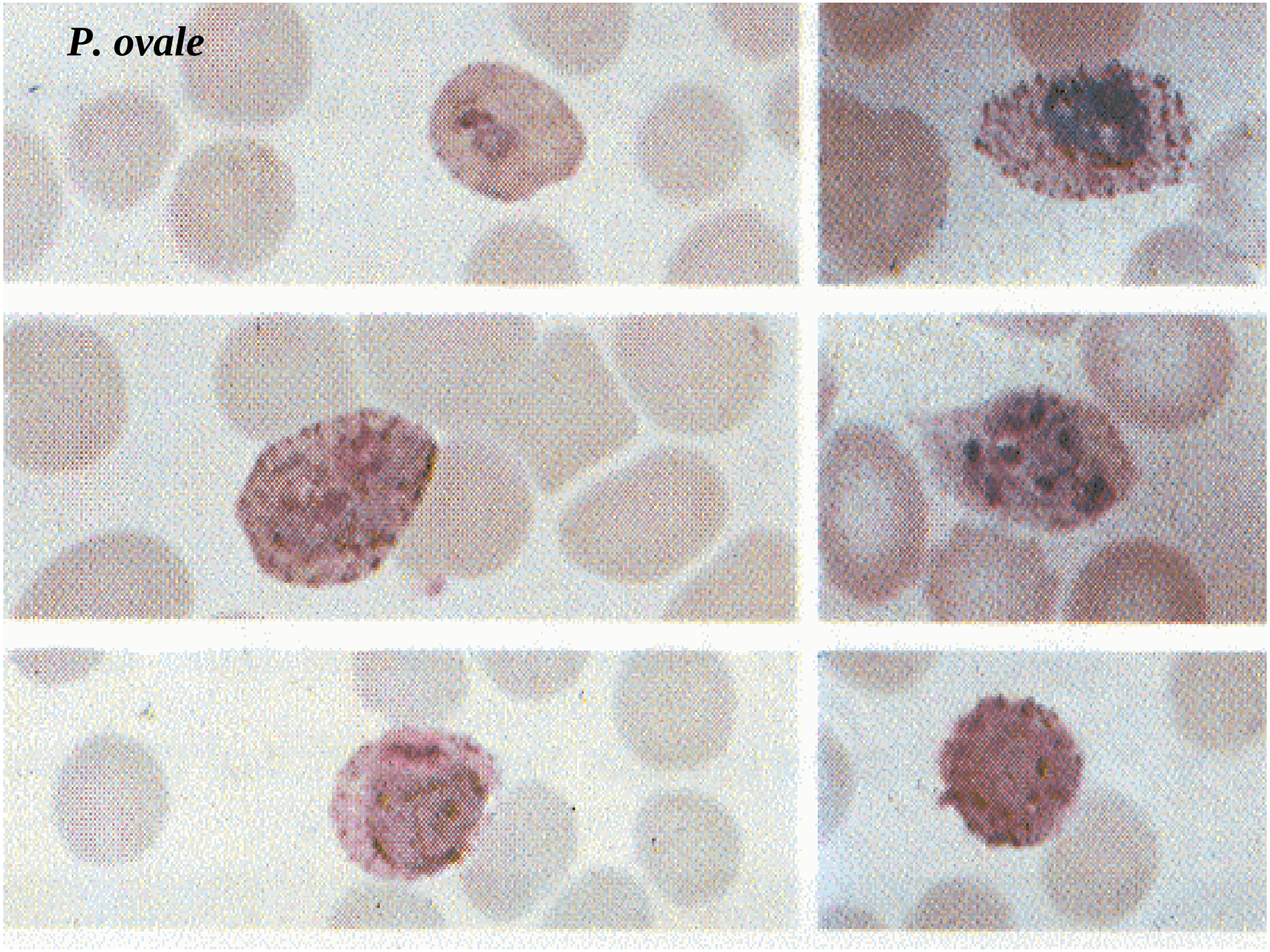
**Examination of a thick blood film should be the first step since this has the advantage of concentrating the parasites by 20 fold in comparison to a thin film, although the parasites may appear distorted making species identification difficult.**

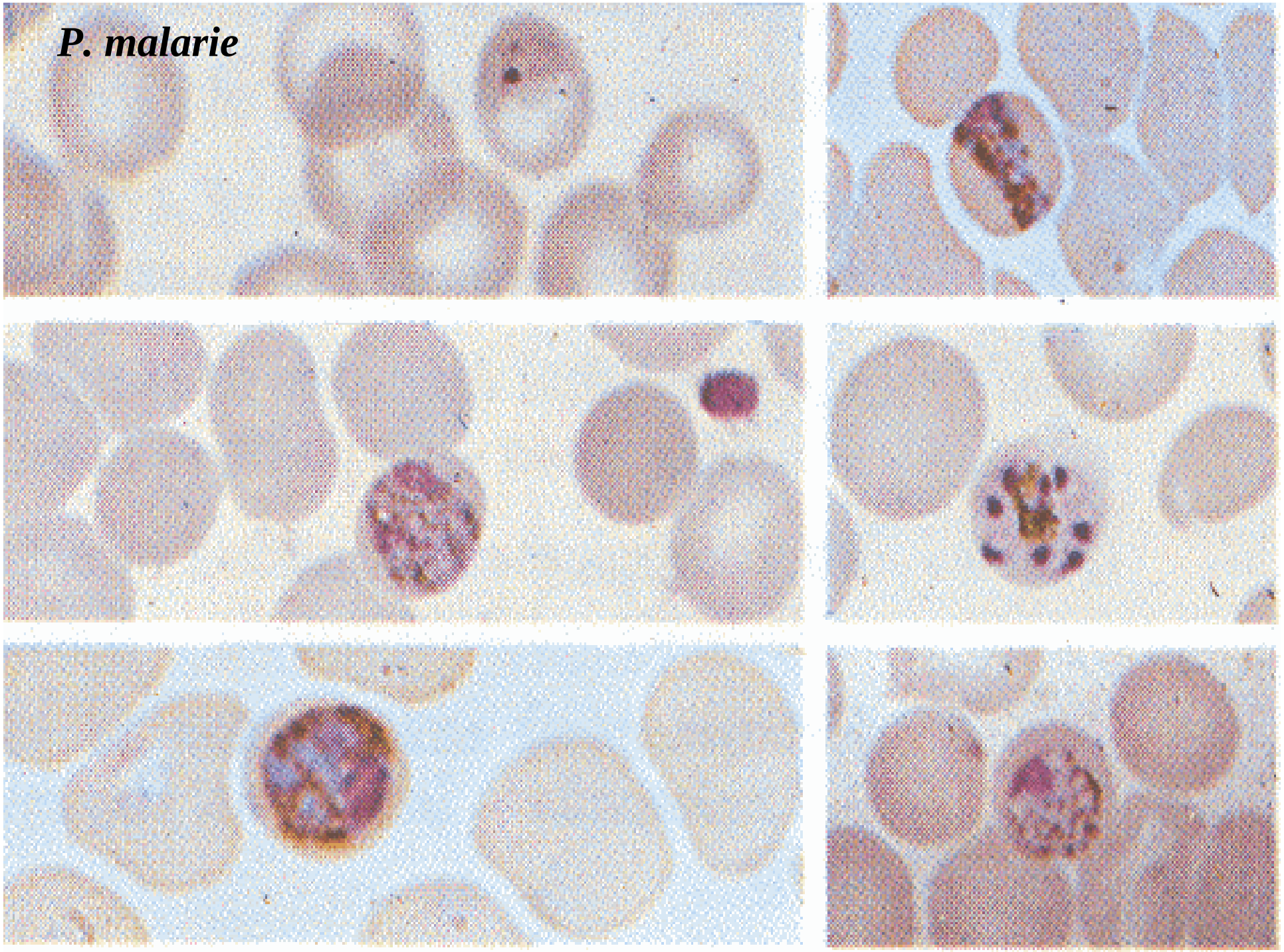
**If parasites are seen then the species should be confirmed by the examination of a thin film. Ideally blood should be collected when the patient's temperature is rising.**

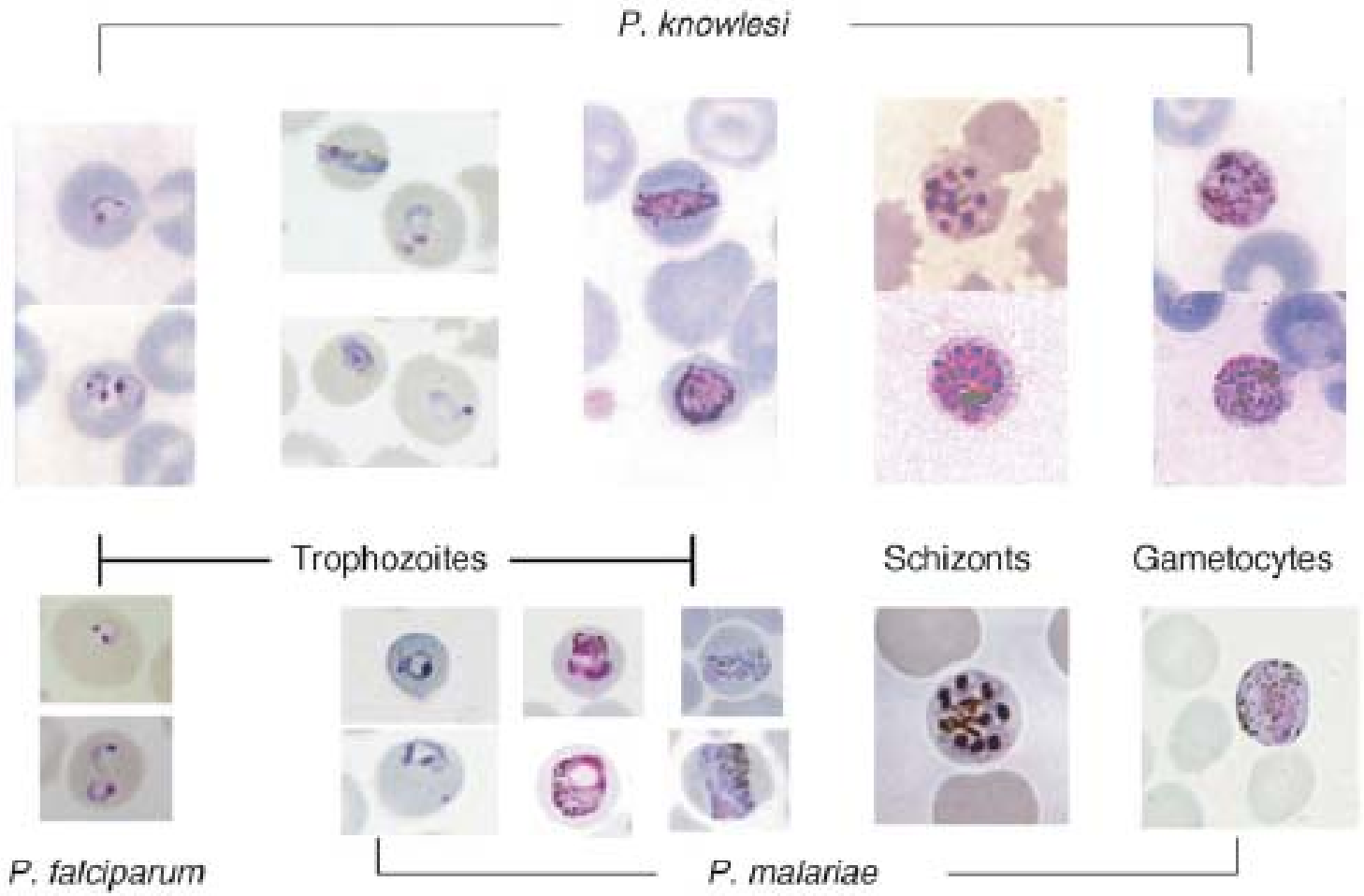



P. falciparum


*P. vivax*

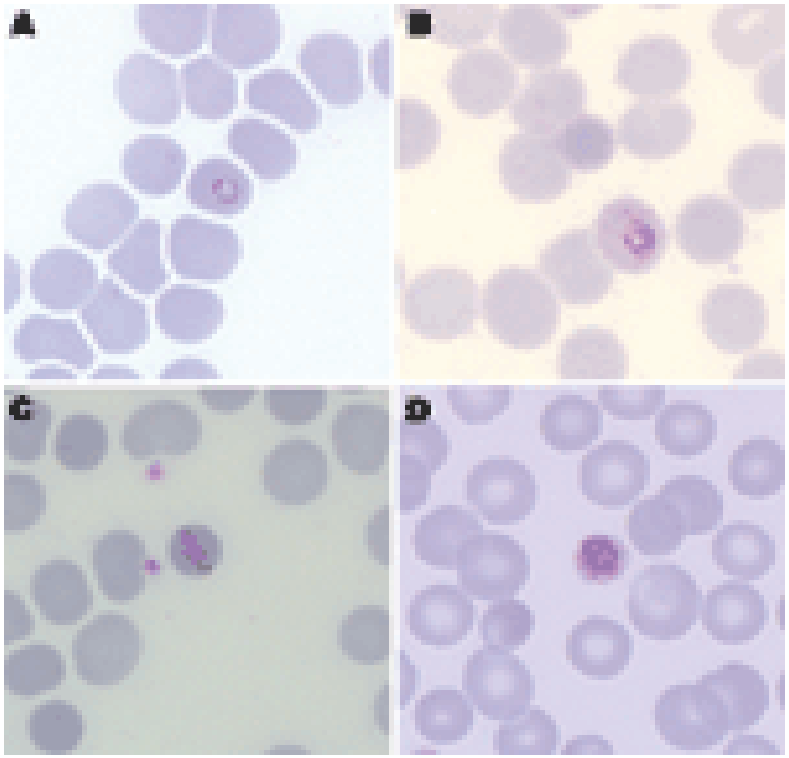

*P. ovale*


*P. malarie*

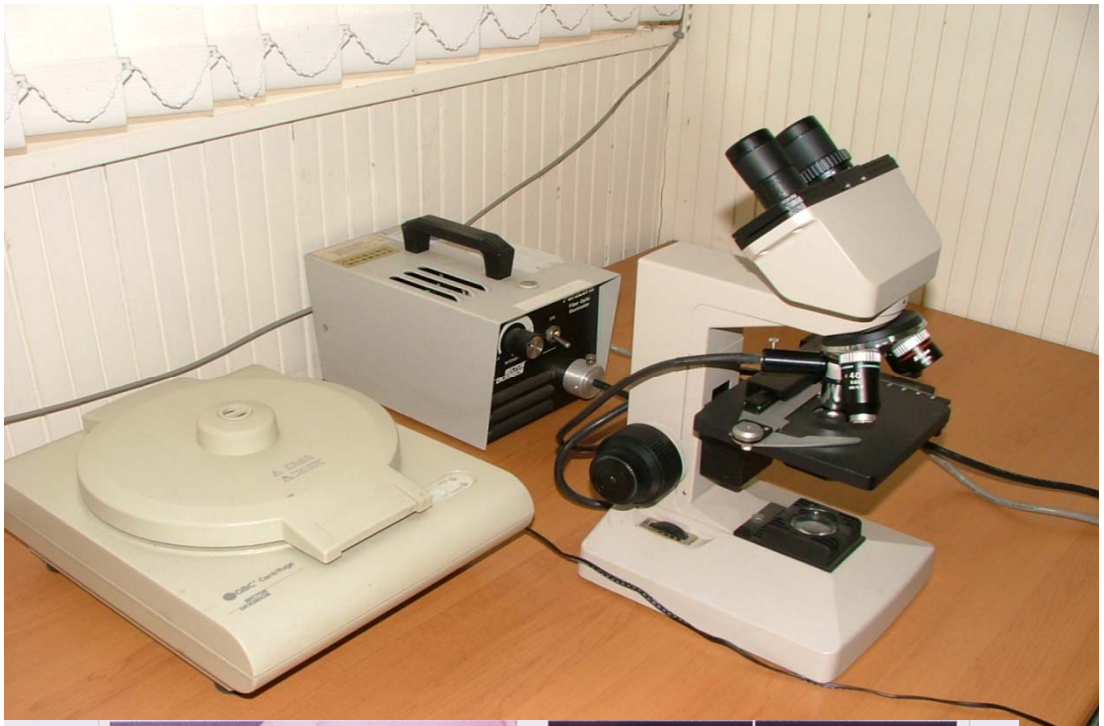

P. knowlesi
Trophozoites
Schizonts
Gametocytes
P. falciparum
P. malariae
TRENDS in Parasitology

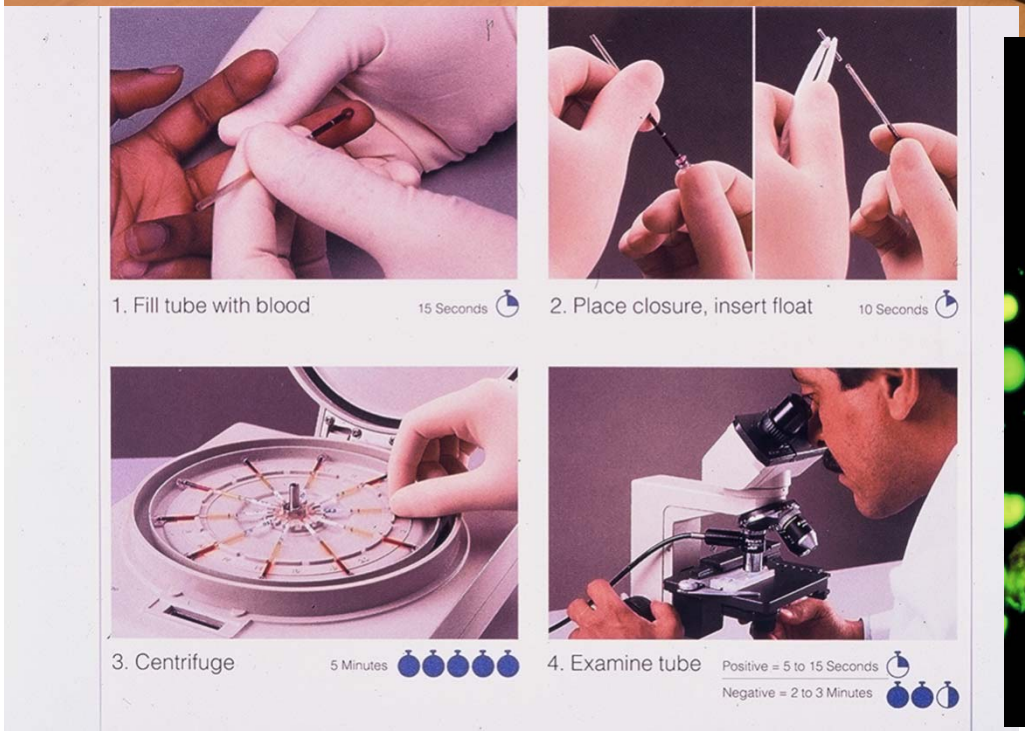
# A new species of malaria – *P. knowlesi*

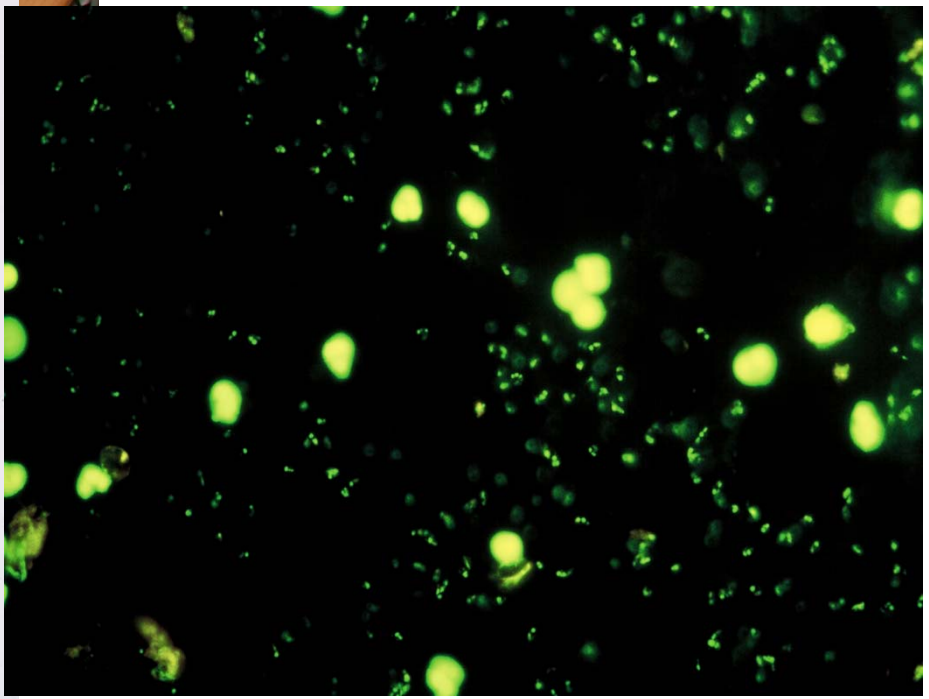
| Aspects | Characteristics |
|---|---|
| Morphology ring | *Diff P.falciparum* |
| Morphology mature trophozoite | *Diff P. malariae* |
| Clinical | *Diff P. falciparum* |
| Phylogenetic | *Diff P. vivax* |
| Liver stage | Absence of hypnozoite forms |
| Asexual cycle | 24 hrs |
| Treatment | Chloroquine |



# Quantitative Buffy Coat (QBC)





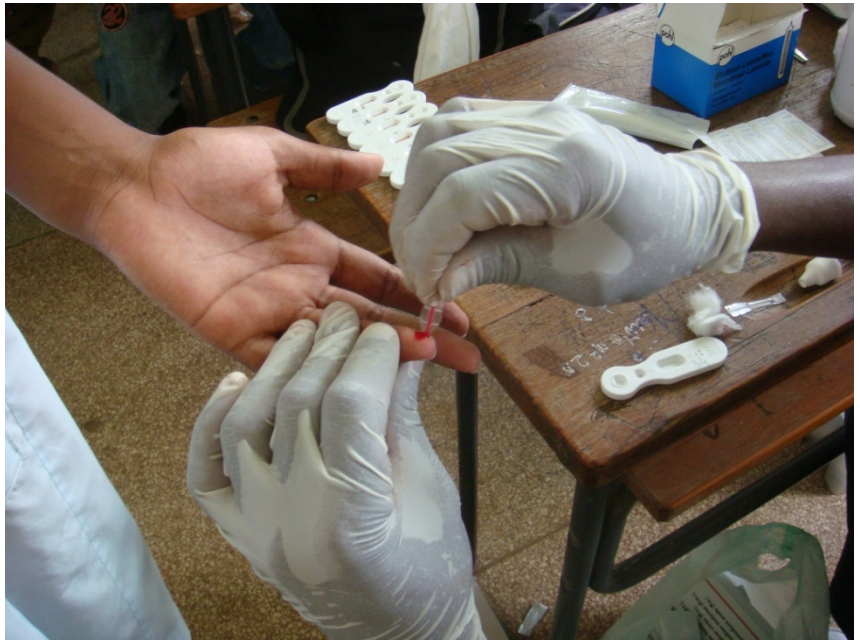
# Quantitative Buffy Coat (QBC ®)

- Fluorescent microscopy after centrifugation
- AO-coated capillary is filled with 50-100 µl blood
- Parasites concentrate below the granulocyte layer in tube
- May be slightly more sensitive than light microscopy but some reports of 55-84%

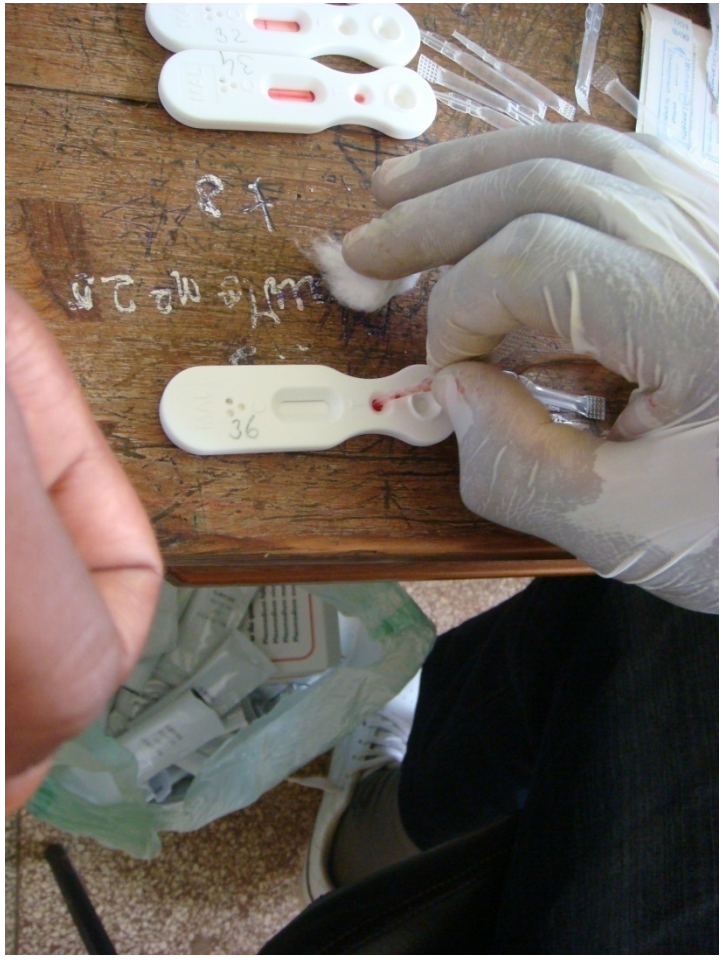
# Quantitative Buffy Coat (QBC ®)

- Useful for screening large numbers of samples
- Quick, saves time
- Requires centrifuge, special stains
- 3 main disadvantages
  - Species identification and quantification difficult
  - High cost of capillaries and equipment
  - Can’t store capillaries for later reference

# *Malaria rapid diagnostic test*



# *Malaria rapid diagnostic test*

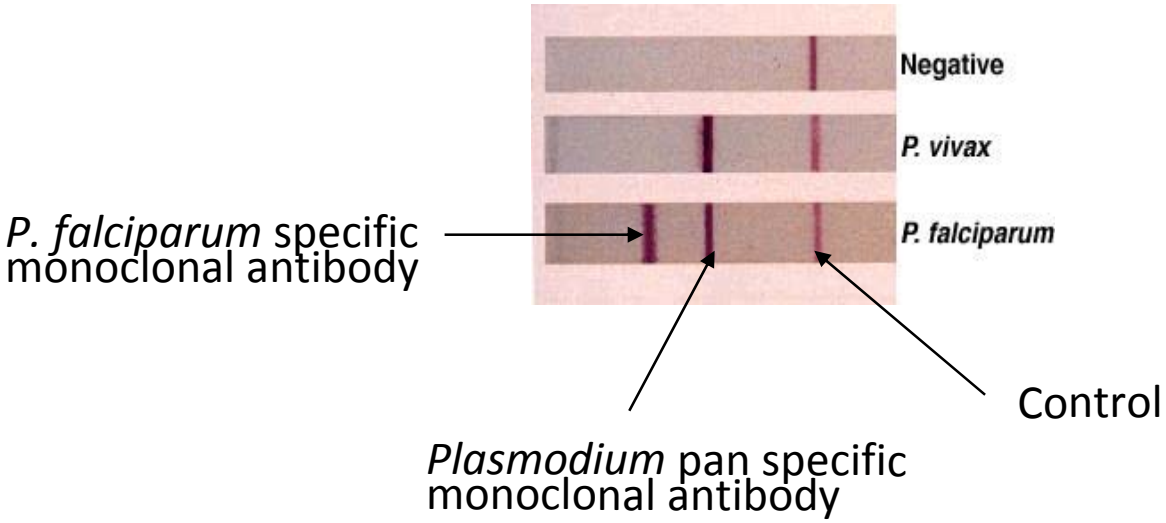


# Rapid Diagnostic Test (ICT)

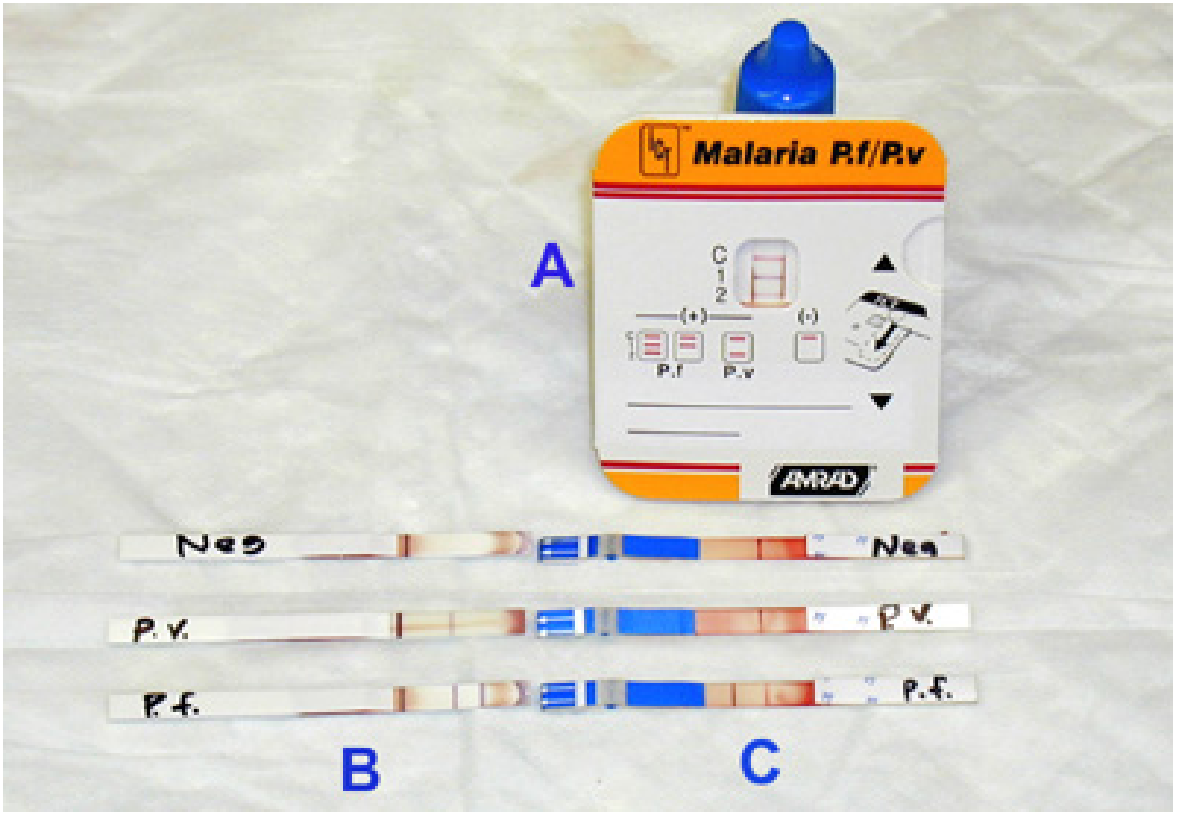
# Antigen Detection

## Malaria Immunochromatographic Dipstick

OptiMAL Assay



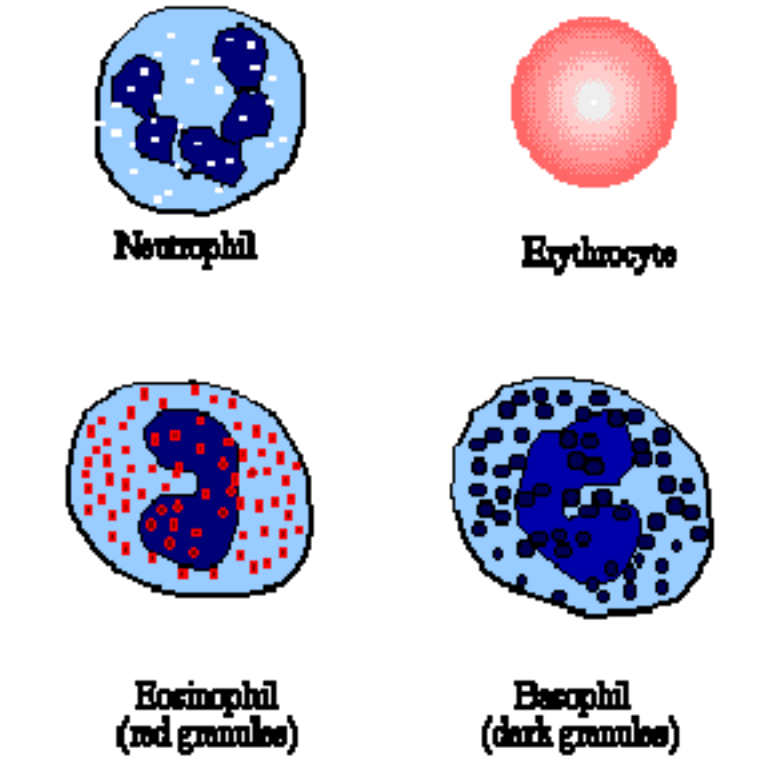
# Detection of *Plasmodium* antigens




**A: HRP-2 (histidine-rich protein 2) (ICT)**
**B: pLDH (parasite lactate dehydrogenase)(Flow)**
**C: HRP-2 (histidine-rich protein 2) (PATH)**


NOW® Malaria
For the qualitative detection of Plasmodium vivax (P.v.), Plasmodium falciparum (P.f.), Plasmodium malariae (P.m.) and Plasmodium ovale (P.o.) antigens
binax
NOW® Malaria
For the qualitative detection of Plasmodium vivax (P.v.), Plasmodium falciparum (P.f.), Plasmodium ovale (P.o.) antigens
binax
binax
NOW® Malaria
Procedure Card for sample addition using a capillary
1 Using an EDTA capillary tube, collect blood from either a finger or heel prick.
2 SLOWLY add blood to cover the entire purple sample pad.
IMPORTANT:

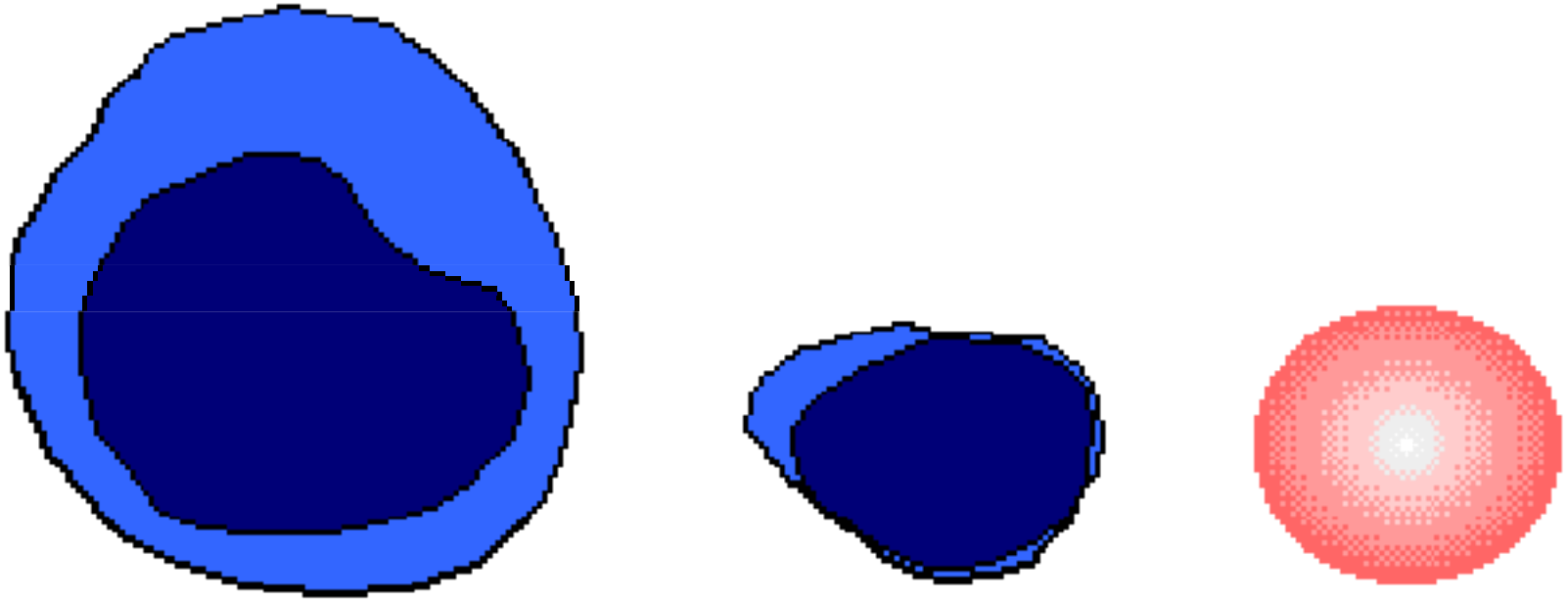
# Flowcytometry




Typical granulocytes (with erythrocyte for size comparison)

- **Cell size**
- **Cellular granularity**

# Agranulocytes




Typical agranulocytes (with erythrocyte for size comparison)

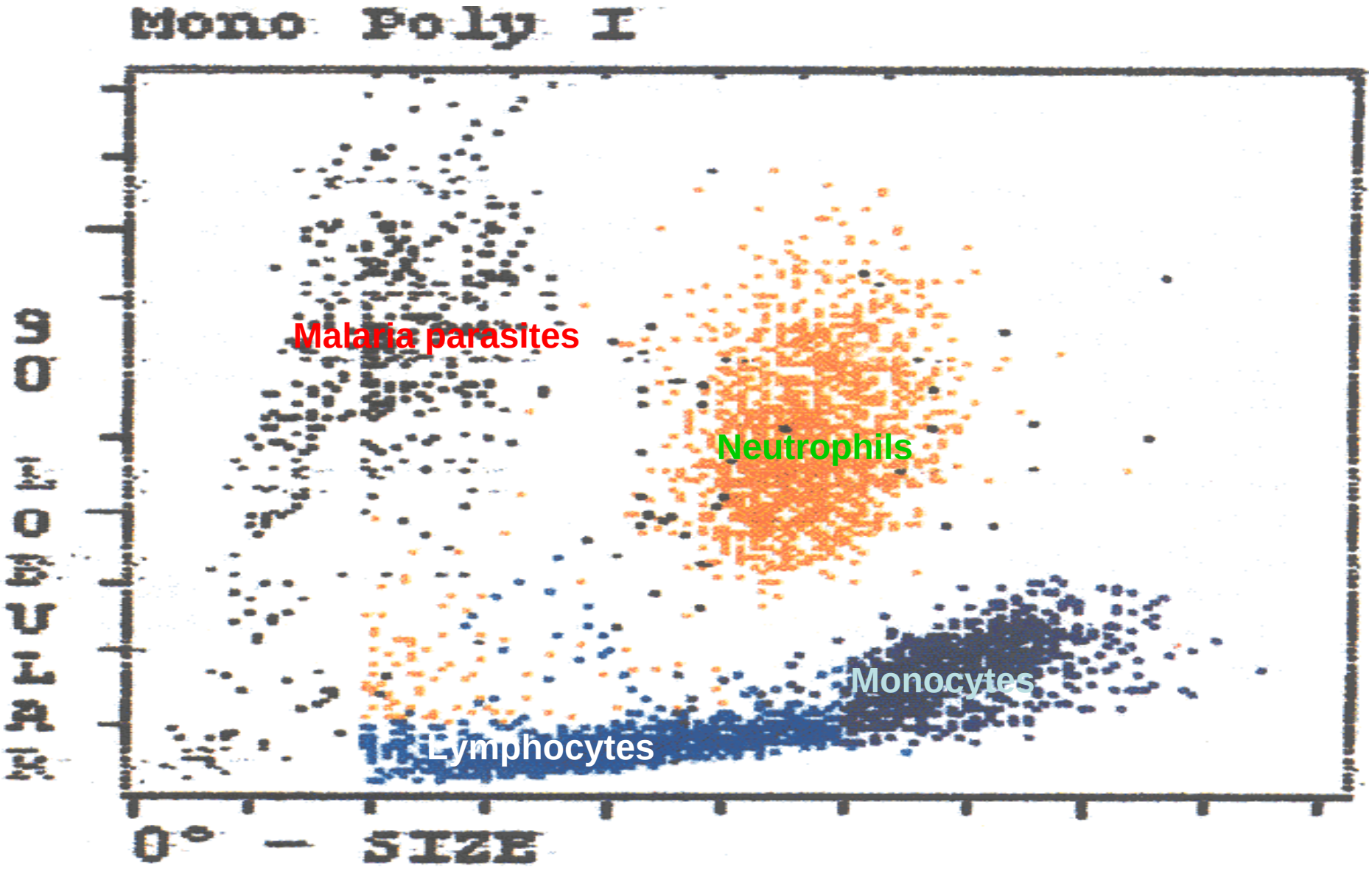
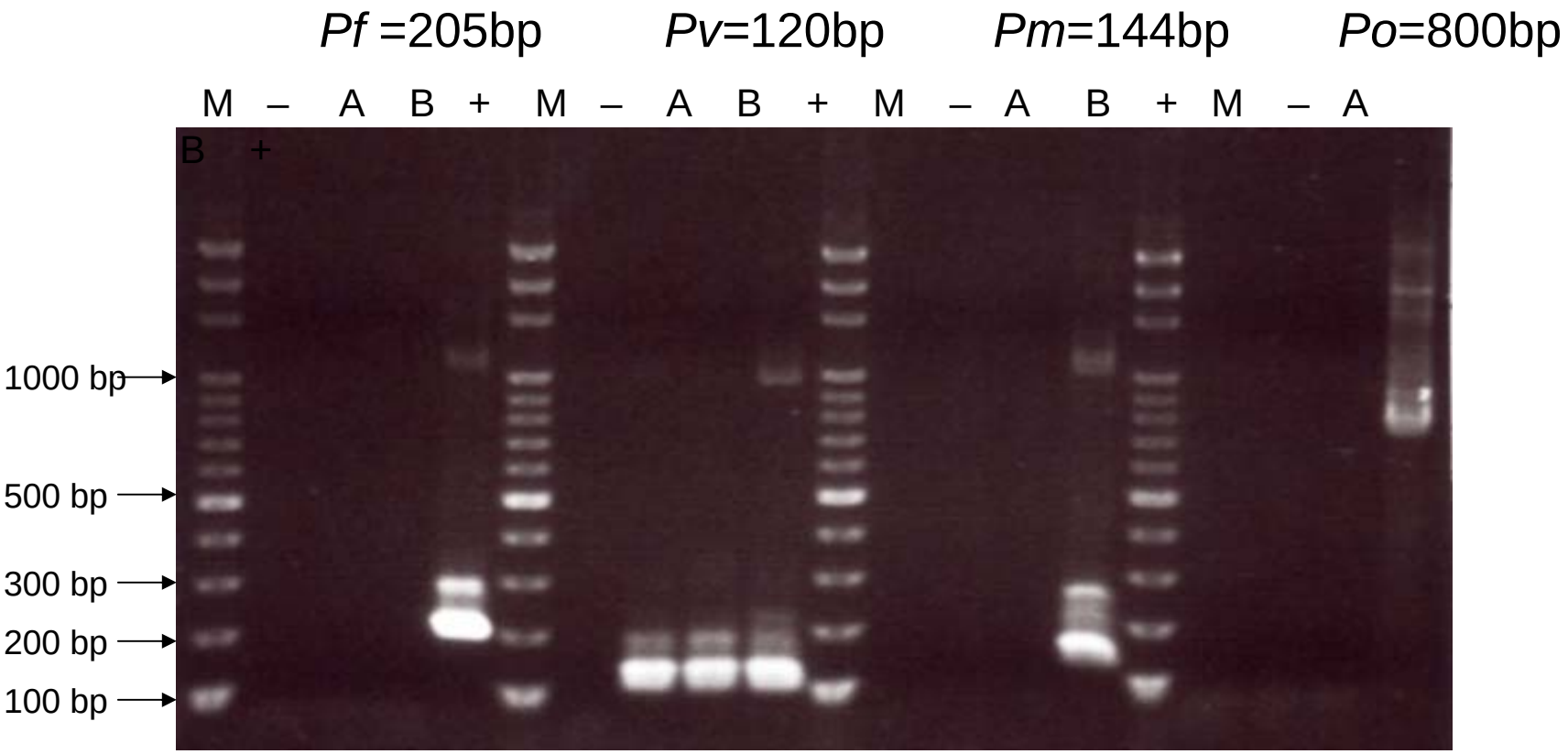



**Figure 1.** Scattergram generated by an automated blood-cell analyzer. Orange points, neutrophils; blue points, lymphocytes; purple points, monocytes.

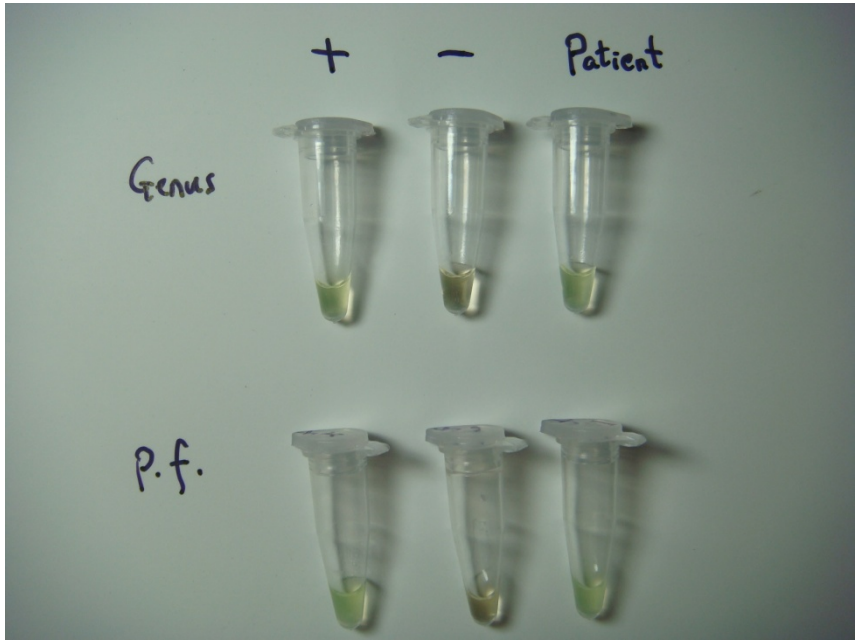
**High sensitivity of detection of human malaria parasites by the use of nested PCR** ***Mol Biochem Parasitol 61: 315-20, 1993***

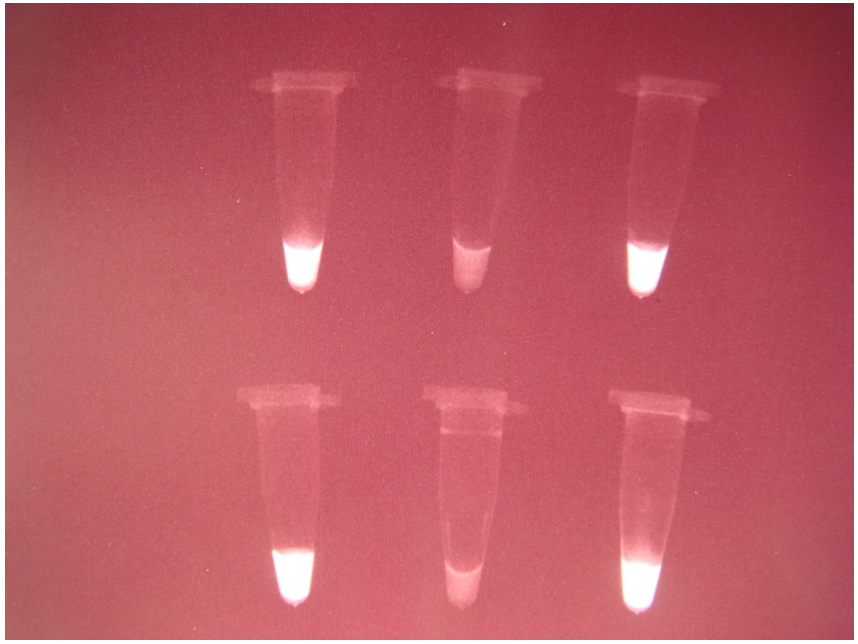



**M:100 bp DNA ladder －: negative control ＋: positive control**

**Samples A and B**

# Loop-Mediated Isothermal Amplification for Malaria Diagnosis



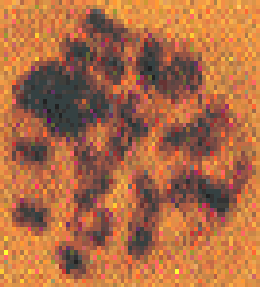



# DIAGNOSTIC MALARIA

| METHOD | SENSITIVITY |
| --- | --- |
| Blood thin film | 100/ul (parasitemia 0.002%) |
| Blood thick film | 10-20/ul |
| Quantitative buffy coat | <10/ul |
| Antibody test | ? |
| Antigen capture test | 50/ul |
| PCR | <1/ul |

# Diagnosis

| | Clinical dx | Microscopy | RDTs |
|---|---|---|---|
| Sensitivity | 85% | 60-95% | 85-95% |
| Specificity | 40% | 75-95% | 95% |
| Infrastructure needed | Minimal | High | Moderate |
| Skill needed | Minimal | High | Moderate |
| Cost | $0 | $0.10-0.40 | $0.70-1.00 |
| Current use | High | Moderate | Minimal |

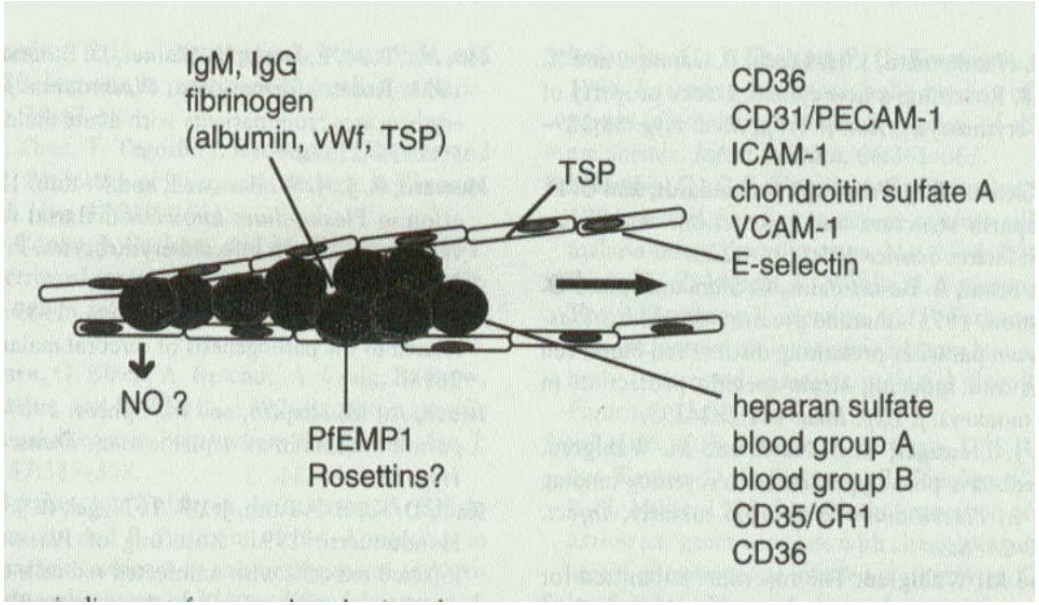


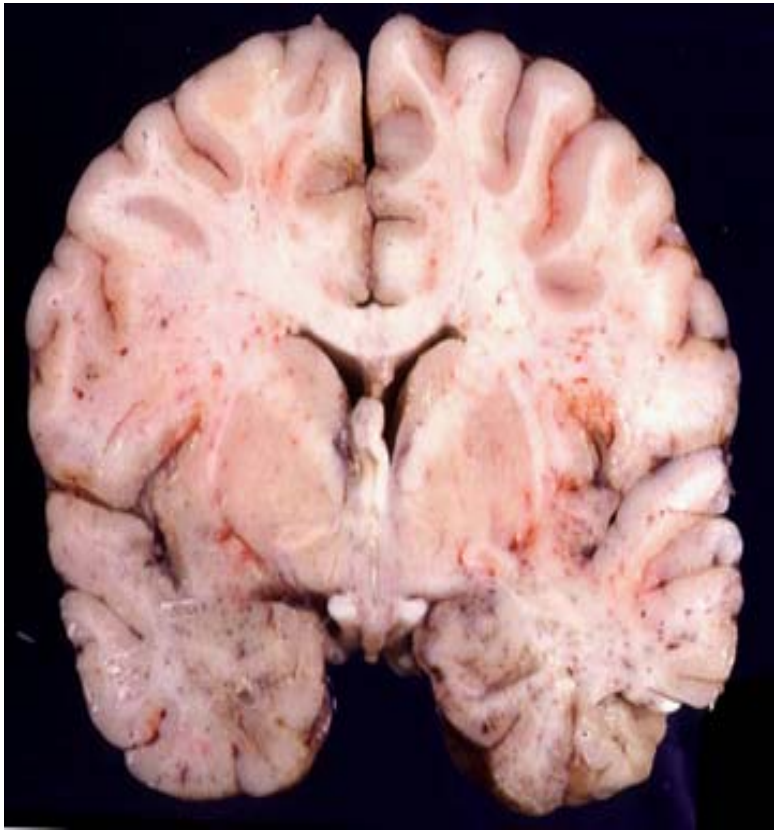
# IMMUNE RESPONSE AND PATHOGENESIS

# PATHOGENESIS OF MALARIA

- **INVASION OF RED CELLS: The entire process of invasionis completed within 30 seconds. In falciparum malaria the EBA 175 and/or MSP-1 appear to interact with the red cell sialoglycoproteins (glycophorins), whereas in vivax malaria, the red cell Duffy antigen on the uninfected RBC is involved.**
- **CYTOADHERENCE: The process (sequestration) whereby mature infected cells (PfEMP-1) specifically bind to endothelial cells (CD36, ICAM-1, VCAM-1, E-selectin, thombospondin, chondroitin sulfate A) in postcapillary venules, preventing destroy through the spleen; localized at sites of reduced oxygen tension favoring parasite growth; and facilitating the invasion of uninfected RBC.**
- **ROSETTING: RBC containing the more mature stages of parasite (PfEMP-1) bind uninfected RBC to their surface (CR1), may involve microcirculatory obstruction.**
- **PARASITE TOXINS AND CYTOKINE: Both GPI-anchored parasite molecules and hemozoin-associated protein are favored candidates. Such malaria toxins lead to the release of TNF-a amd IL-1, responsible for fever and other clinical symptoms and signs.**

# *Cerebral Malaria*

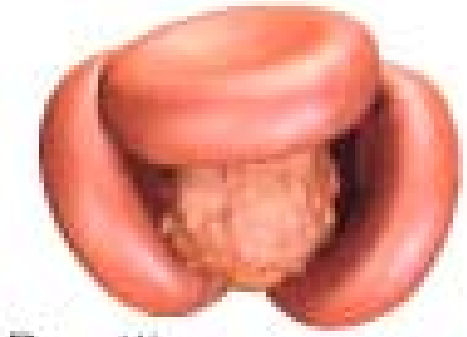


**1. High cytokine levels could be toxic on their own.**

**2. High levels of cytokine also enhance the second process thought to be responsible for cerebral malaria: sequestration of infected RBCs**

# Sequestration & cytoadherence



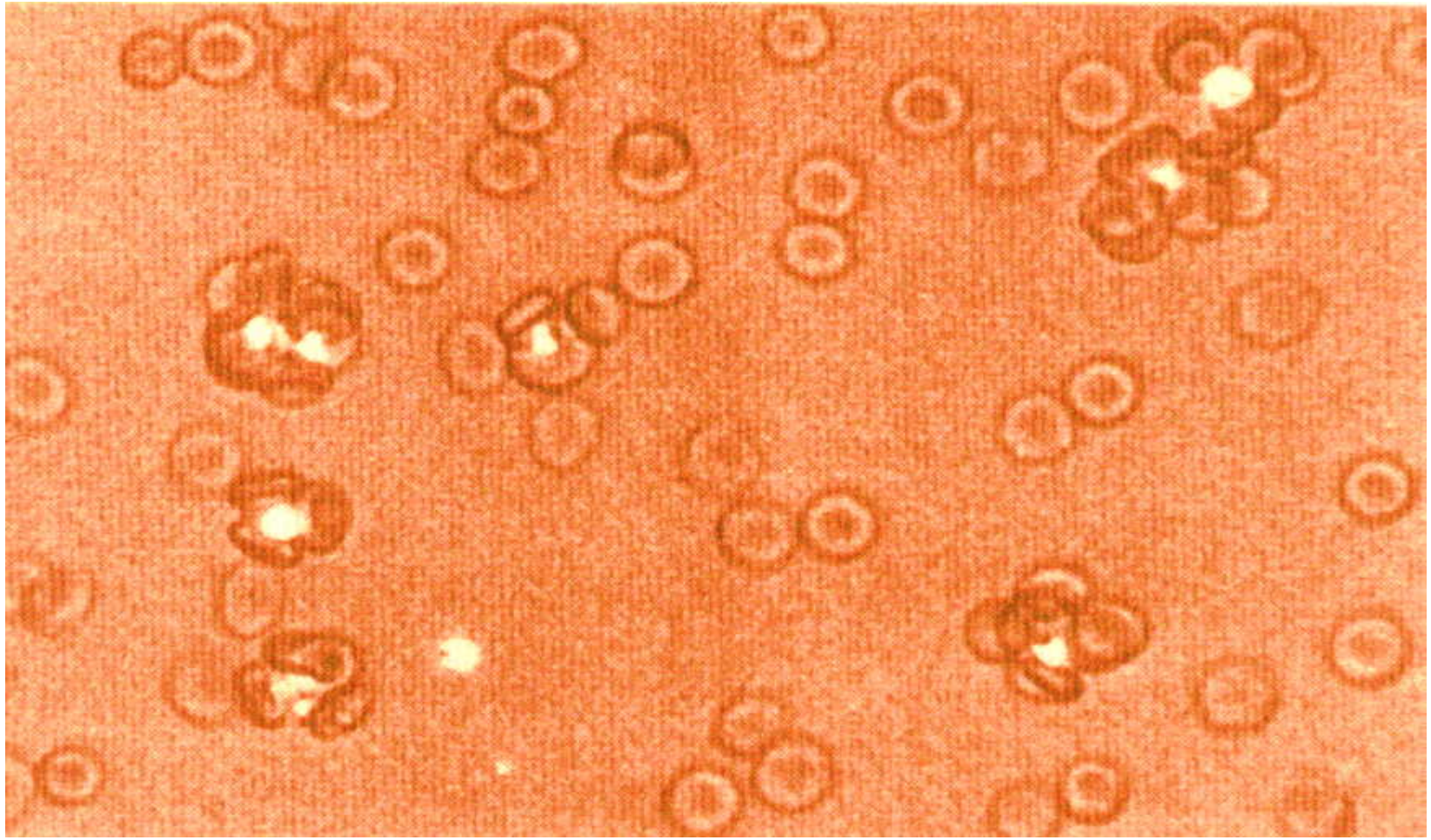
Rosetting

Clumping

**Rosetting (adhesion of infected RBCs to other RBCs) and clumping (adhesion between infected cells) was first observed in in vitro culture**

**Rosetting was also found in 50% of field isolates and correlated strongly with the severity of the observed disease**

# Rosetting of *P. falciparum in vitro*



# RELAPSE OR RECRUDESCENCE?

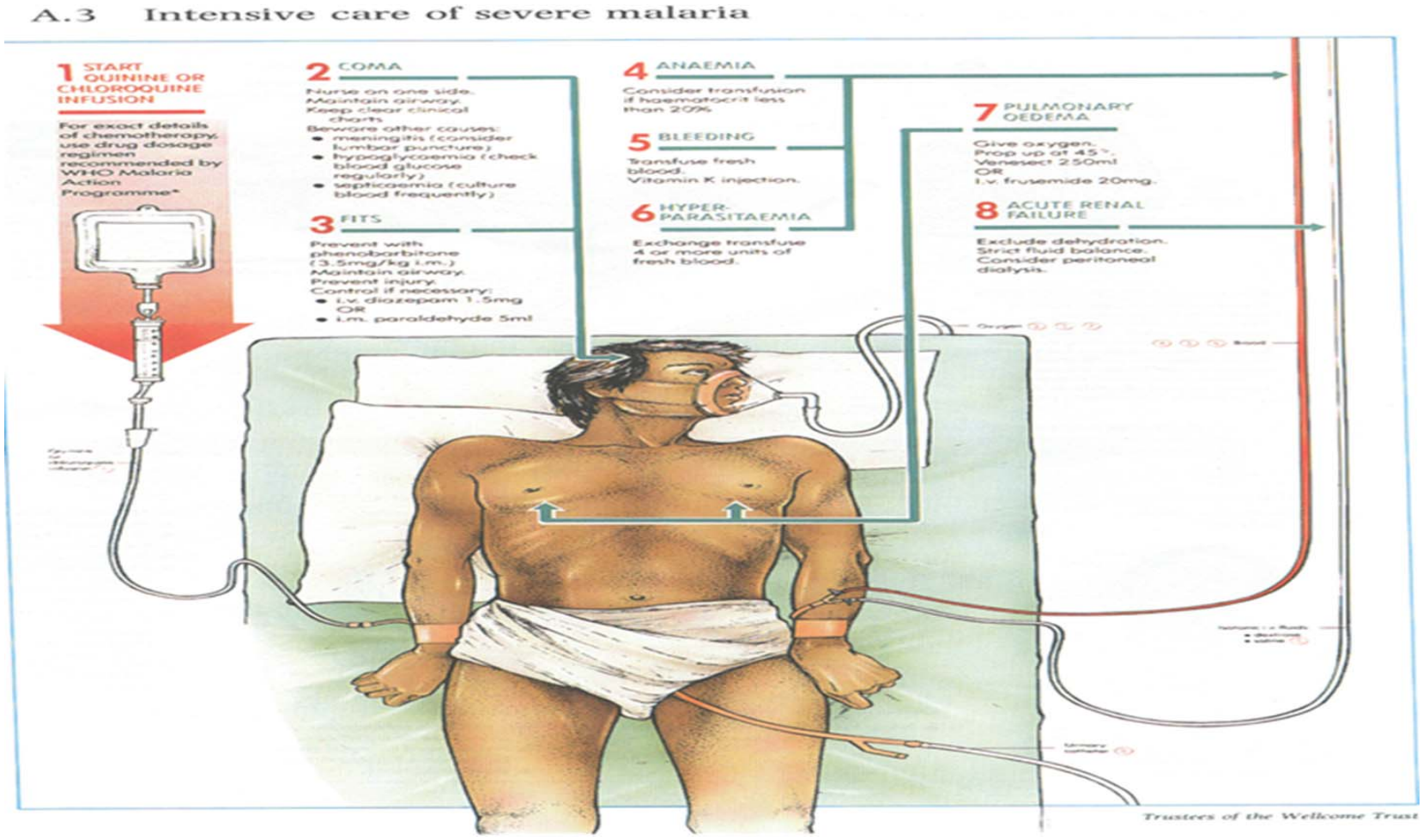
| Phenomenon | Relapse | Recrudescence |
|---|---|---|
| Malaria species | *P. vivax*<br>*P. ovale* | *P. falciparum*<br>*P. malariae*? |
| Mechanisms | Hypnozoite<br>(exo-erythrocytic) | Sequestration<br>(endothelial cytoadherence) |
| Duration | months - years | weeks - months |
| Clinical setting | Eradication by primaquine | Antigen variation<br>Drug resistance? |


CASE MANAGEMENT

# COMMON ERRORS IN THE TREATMENT OF MALARIA

- **Initial blood smear is negative and not repeated**
- **Drug of choice is not readily available**
- **Lack of high index of suspicion of malaria due to**
  1. **Presentation with fever and GI symptoms**
  2. **Failure to take an adequate travel history**
  3. **Lack of knowledge about the incubation period of malaria**

# Malaria is preventable and curable but can be fatal if delay



# ASSESSMENT OF MALARIA SEVERITY

- **MILD: Parasitemia < 2% and temperature <39C and patient ambulant, and no complications***
- **SEVERE: Parasitemia > 2% or schizonts** or temperature > 39C or patient non-ambulant, or complications***

***Complications = cerebral involvement, severe anemia, renal failure, pulmonary edema, hypoglycemia, hypovolemia, bleeding, DIC, acidosis, jaundice, et al.**

****The presence of schizonts or pre-schizonts on the film may mean:**

**(1) The peripheral parasitemia is unrepresentative of the total parasite burden due to sequestration**

**(2) A further cycle of replication is imminent**

# Principles of Treatment

**Treatment of malaria depends on the following factors:**

- **Type of infection**
- **Severity of infection**
- **Status of the patients**
- **Associated conditions/diseases**

# Aims of Treatment

| Aims | Causation | Therapy | Drugs |
|---|---|---|---|
| To alleviate symptoms | Symptoms are caused by blood forms of the parasites | Blood schizonticidal drugs | Chloroquine, quinine, PS, artemisinin |
| To prevent relapses | Releases are due to hypnozoites of *P. vivax/P. ovale* | Tissue schizonticidal drugs | Primaquine |
| To prevent spread | Spread is through the gametocytes | Gemetocytocidal drugs | Primaquine for *P. faciparum*, chloroquine for all other<br>Artemisinin |

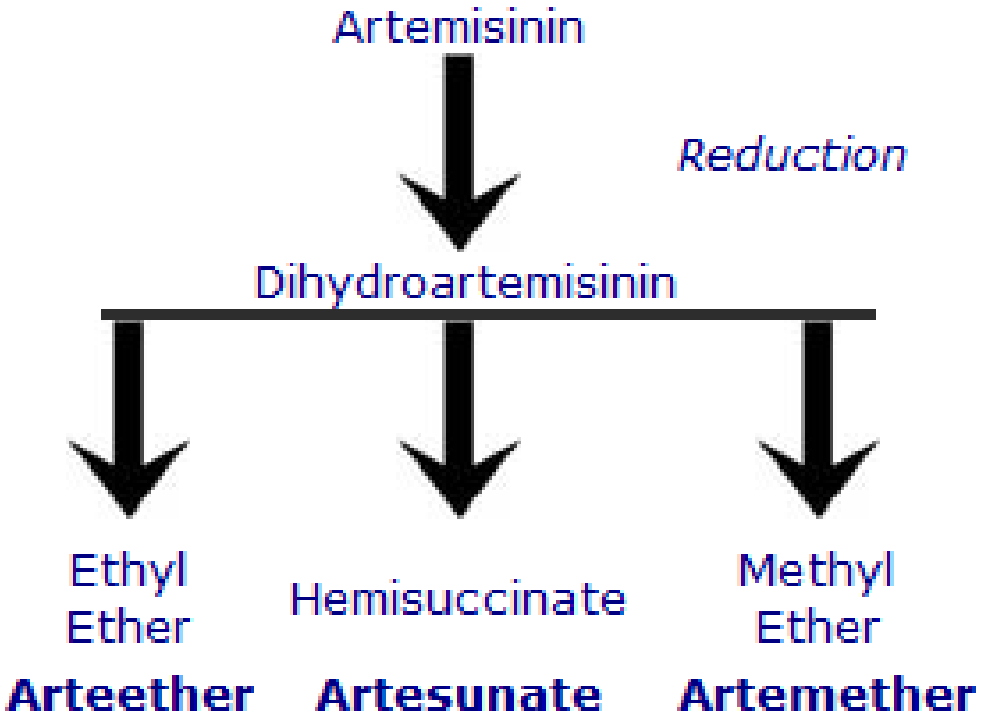
# Common Antimalaria Drugs

- **Chloroquine**
- **Sulfadoxine-pyrimethamine (Fansidar®)**
- **Mefloquine (Lariam®)**
- **Atovaquone-proguanil (Malarone®)**
- **Quinine**
- **Doxycycline**
- **Artemisinin-based combination therapy (ACT)**

# CINCHONA TREE

# *Artemisia annua* - *artemisinin*

## The Artemisinin Derivatives



# Artemisinin treatment by dose but never monotherapy

| Drug | Artemether | Arteether | Artesunate |
|---|---|---|---|
| Oral for mild cases | 4 mg/kg (1st day), followed by 2 mg/kg for 6 days | Nil | 4 mg/kg (1st day), followed by 2 mg/kg for 6 days |
| Parenteral for severe cases | 3.2 mg/kg (1st day, IM), followed by 1.6 mg/kg for 6 days | 3 mg/kg (IM) for 3 days | 2.4 mg/kg (IV), q12 hr, for 24 hrs, followed by qd for 6 days |

# Artesunate in hepatic or renal failure

- **Artesunate dosages need not be changed because of hepatic or renal failure or concomitant or previous therapy with other medications, including previous therapy with mefloquine, quinine, or quinidine.**
- **There are no known interactions between artesunate and other drugs.**
- **WHO does not recommend artemisinin is applied for monotherapy.**

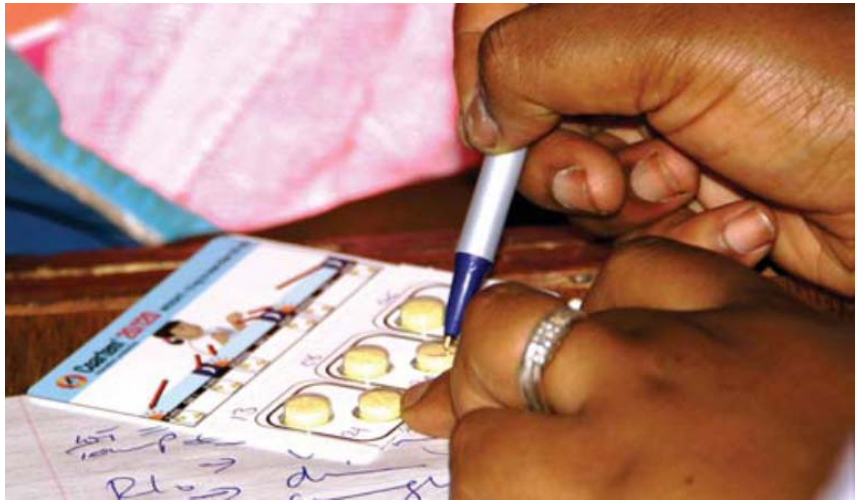
# Artemisinin-based combination therapy (ACT)

- 1) Coartem®: artemether (20 mg) + lumefantrine (120 mg) per tablet
- 2) Winthrop®: artesunate (100 mg) + amodiaquine (270 mg) per tablet
- 3) Artequick®: artemisinin (80 mg) + piperaquine
- (400 mg) + primaquine (4 mg) per tablet
- 4) artesunate plus sulfadoxine/pyrimethamine (in areas where SP efficacy remains high)
- 5) artesunate plus mefloquine (in areas with low to moderate transmission)
-

# Choosing antimalarials: cost

| | |
|---|---|
| • Chloroquine | $0.11 |
| • SP (Fansidar) | $0.14 |
| • Quinine | $1.27 |
| • Mefloquine | $2.55 |
| • Artemether-lumefantrine | $9.12/2.40/1.80 |
| • Artemether-SP | $2.40 |
| • A-P (Malarone) | $48.00 |

# ACT treatment



**Uncomplicated malaria**

- **For those body weight > 5 Kg – Coartem® (artemether + lumefantrine)**
- **For those body weight < 5 Kg – Winthrop® (artesunate + amodiaquine )**

**Pregnant women**

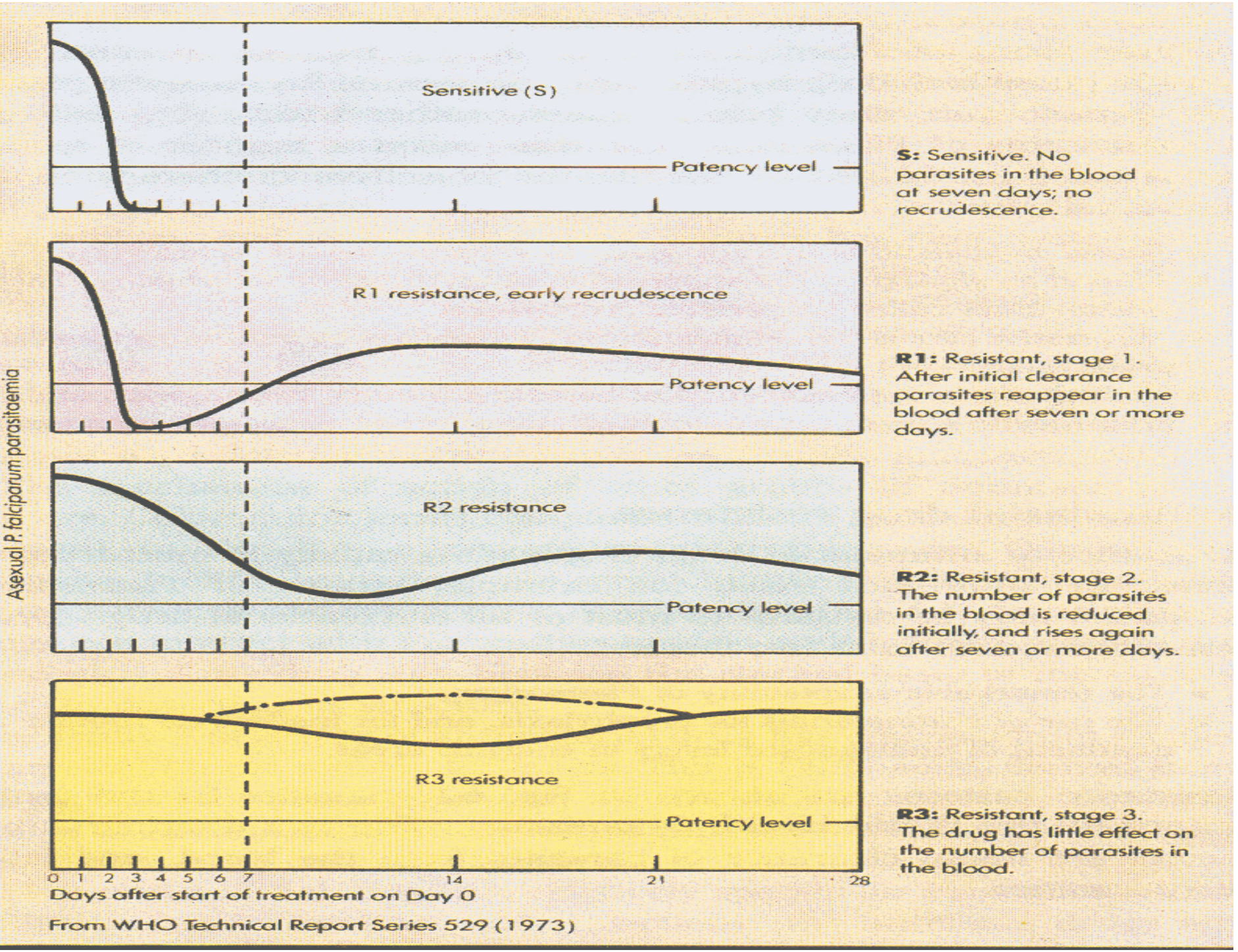
- **1st trimester – quinine**
- **2nd and 2rd trimesters – Winthrop® (artesunate + amodiaquine )**

# TREATMENT OF MILD MALARIA

- **Oral treatment unless patient is vomiting, in which case treat as in severe malaria**
- **ACT regimens**
- **Quinine 10 mg salt/kg (max 600 mg) 8 hourly, reduce to a 12 hourly regimen if develops severe cinchonism (tinnitus & deafness)**
- **When the patient is better and the parasitemia has cleared, give ONE of the following as a SECOND drug:**
- **Fansidar 3 tablets stat (1 tablet per 20 kg): avoid if a history of sensitivity to sulphonomides and avoid in pregnancy;**
- **Doxycycline 100 mg/day x 14 days (not in pregnancy); or tetracycline 250 mg/day x 7 days (not in pregnancy)**

# TREATMENT OF SEVERE MALARIA

- **Quinine dihydrochloride iv 10 mg/kg (max 600 mg) in 250 ml of normal saline over 4 hr, maintenance dose every 8-12 hr x 10 days**
- **A loading dose of iv quinine 20 mg/kg (max 1400 mg) over 4 hr should be given if the patient fulfils WHO criteria for severe disease**
- **Patients who have received a treatment dose of mefloquine within 3 days should not have a loading dose of quinine, and quinine should be used with caution because of risk of arrhythmia**
- **12-hr interval iv quinine usually sufficient, but may be given 8-hr**
- **Check quinine level immediately before 4$^{th}$ dose**
- **Quinine dihydrochloride im into the anterior thigh: dilute in normal saline to 60 mg/ml, give half the dose into each thigh**
- **Convert to oral quinine 8 hourly when patient is better and can reliably take orally**
- **Stop quinine and give second drug once parasitemia has cleared**
- **Artesunate IV**




**S:** Sensitive. No parasites in the blood at seven days; no recrudescence.

**R1:** Resistant, stage 1. After initial clearance parasites reappear in the blood after seven or more days.

**R2:** Resistant, stage 2. The number of parasites in the blood is reduced initially, and rises again after seven or more days.

**R3:** Resistant, stage 3. The drug has little effect on the number of parasites in the blood.

From WHO Technical Report Series 529 (1973)

# PREVENTION OF MALARIA

- Lack of a suitable malaria vaccine
- Integrated malaria control programme
- Insect repellents for personal protection
- Chemoprophylaxis
  - Nonimmune travelers to an area where malaria is endemic
  - Pregnant women
  - Children with sickle cell anemia

# Integrated malaria control

- Long-lasting insecticide-treated nets (LLINs)
- Indoor residual spraying (IRS)
- Larviciding
- Intermittent preventive treatment (IPT)
- Artemisinin-based Combination Therapy (ACT)
- Health education

# Rolling Back Malaria 擊退瘧疾

# Long-lasting insecticide-treated nets (LLINs)


# Intermittent Preventive Treatment (IPT)
# Fansidar (Pyrimethamine/sulfadoxine)

# MALARIA


Marcos Boulos - USP

# Mosquito attractants

- Dark Clothing
- Carbon Dioxide (you exhale CO2)
- Lactic Acid (in perspiration fluid)
- Floral or Fruity Fragrances (perfumes)
- Skin Temperature
- Moisture (perspiration)

# Biting times – important for long-term travel

***An. gambiae* (Africa) –**

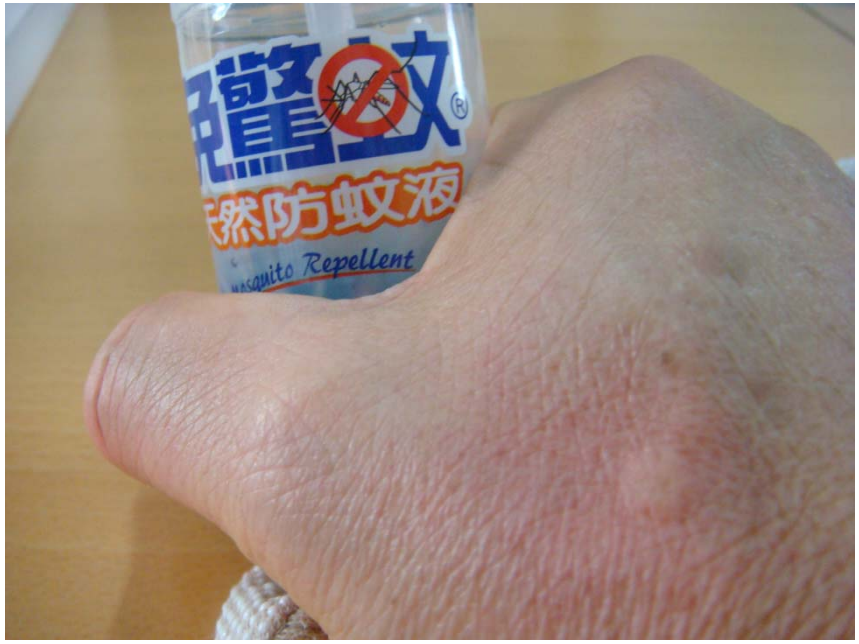
- **late night indoor feeder – peaks at 22:00 and 02:00 – nets (LLINs) ideal**

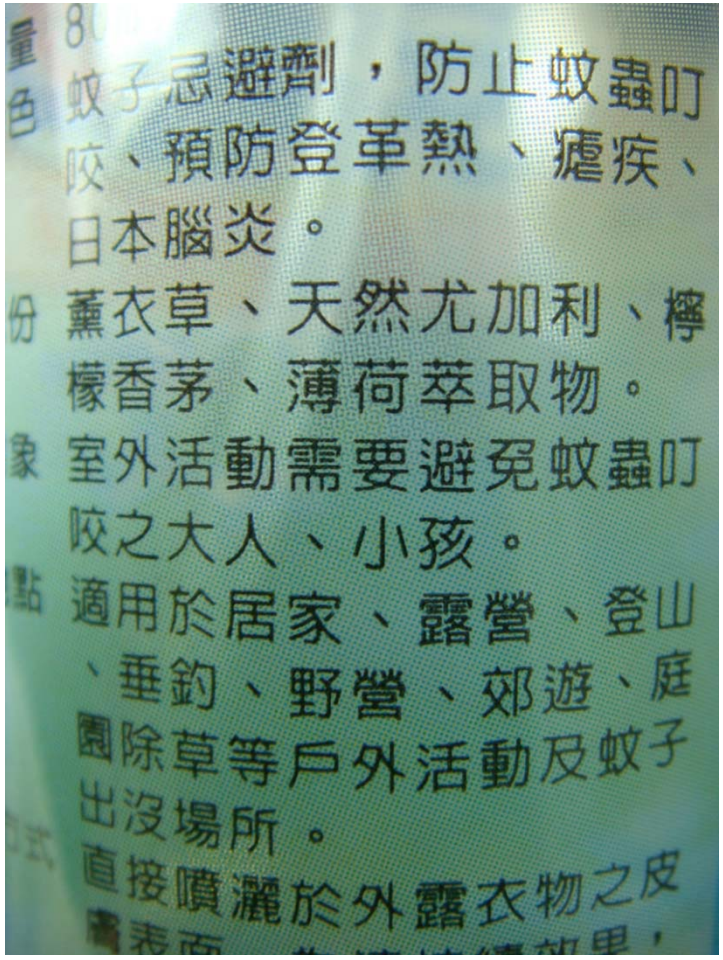
***An. darlingi* (Amazon) –**

- **early evening biting – peaks at 20:00 and 22:00 – repellents essential**

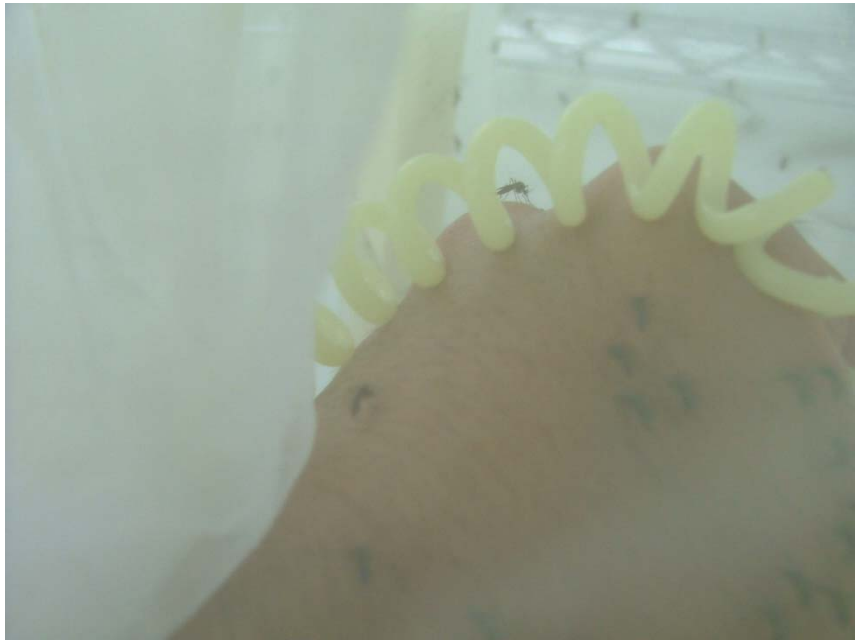
# Choosing the right insect repellent

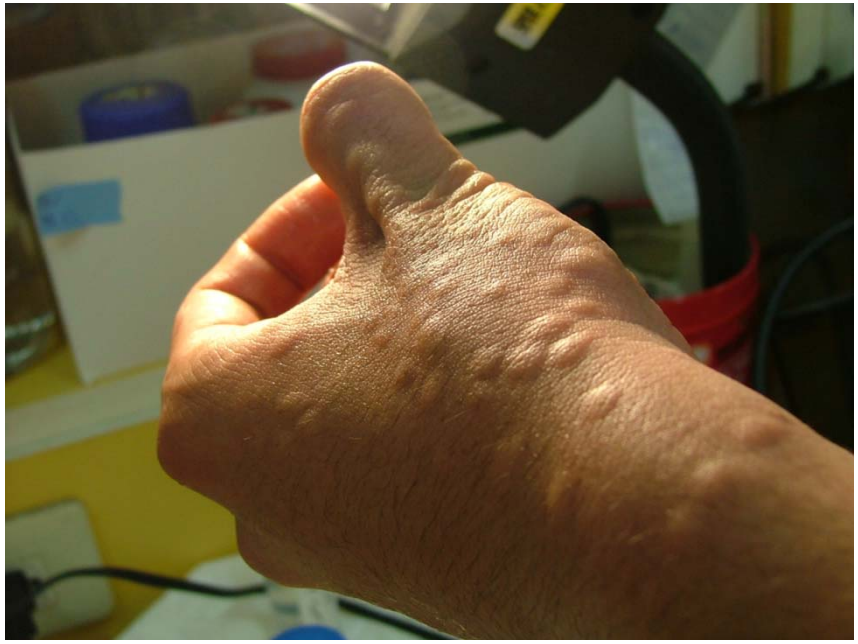

# 天然防蚊液 －香草萃取複方 － 無效



# 香茅防蚊環　－





# Mosquito repellent (DEET)


# HOW TO AVOID MOSQUITO BITES

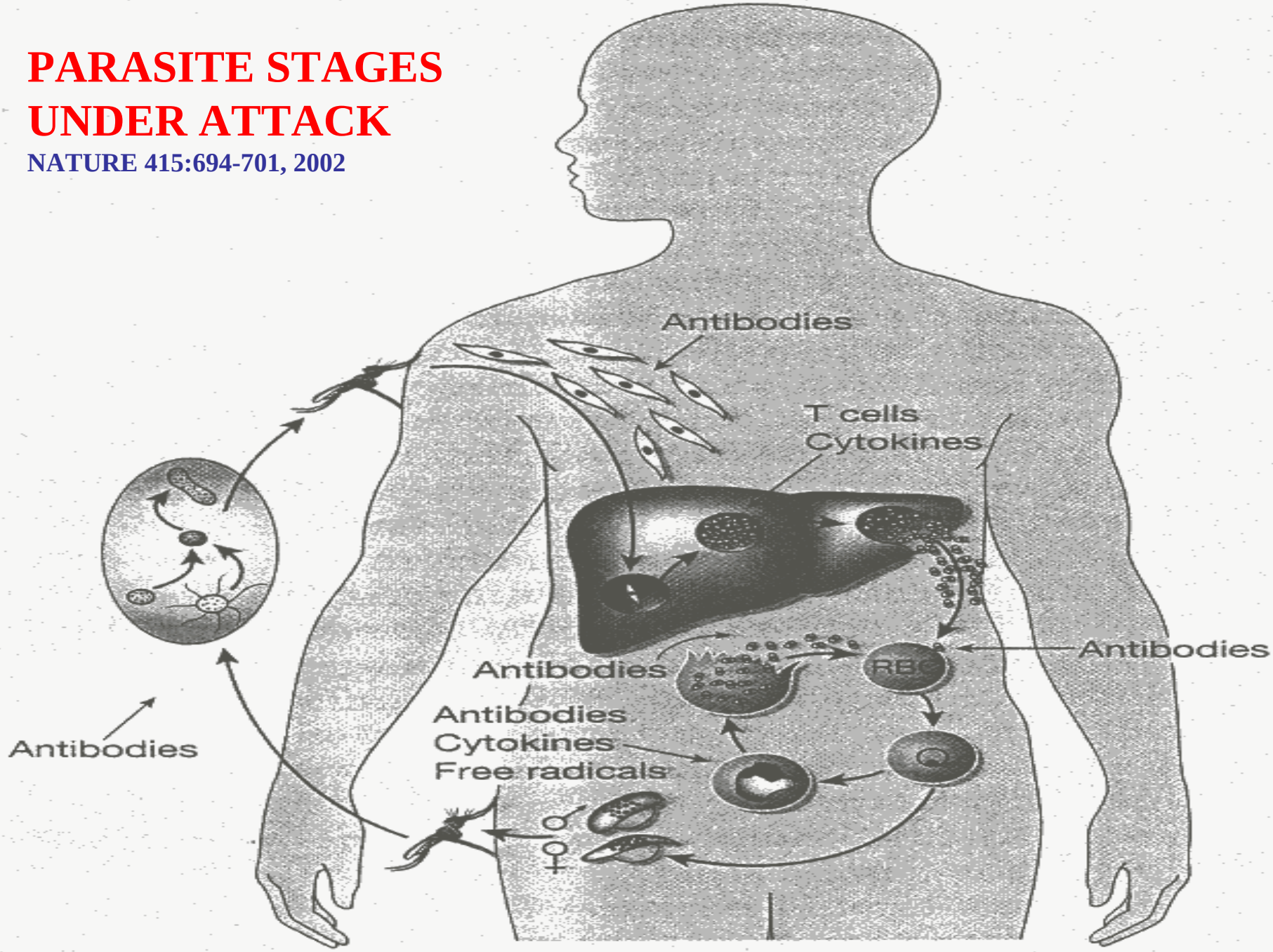
- **Apply insect repellent (containing 20-35% N,N-diethyl-m-toluamide) to exposed skin.**
- **Wear long-sleeved clothing and long pants if you are outdoors at night.**
- **Use a mosquito net (treating with permethrin) over the bed if your bedroom is not air-conditioned or screened.**
- **Spray an insecticide or repellent on clothing, as mosquitoes may bite through thin clothing.**
- **Spray permethrin or a similar insecticide in your bedroom before going to bed.**

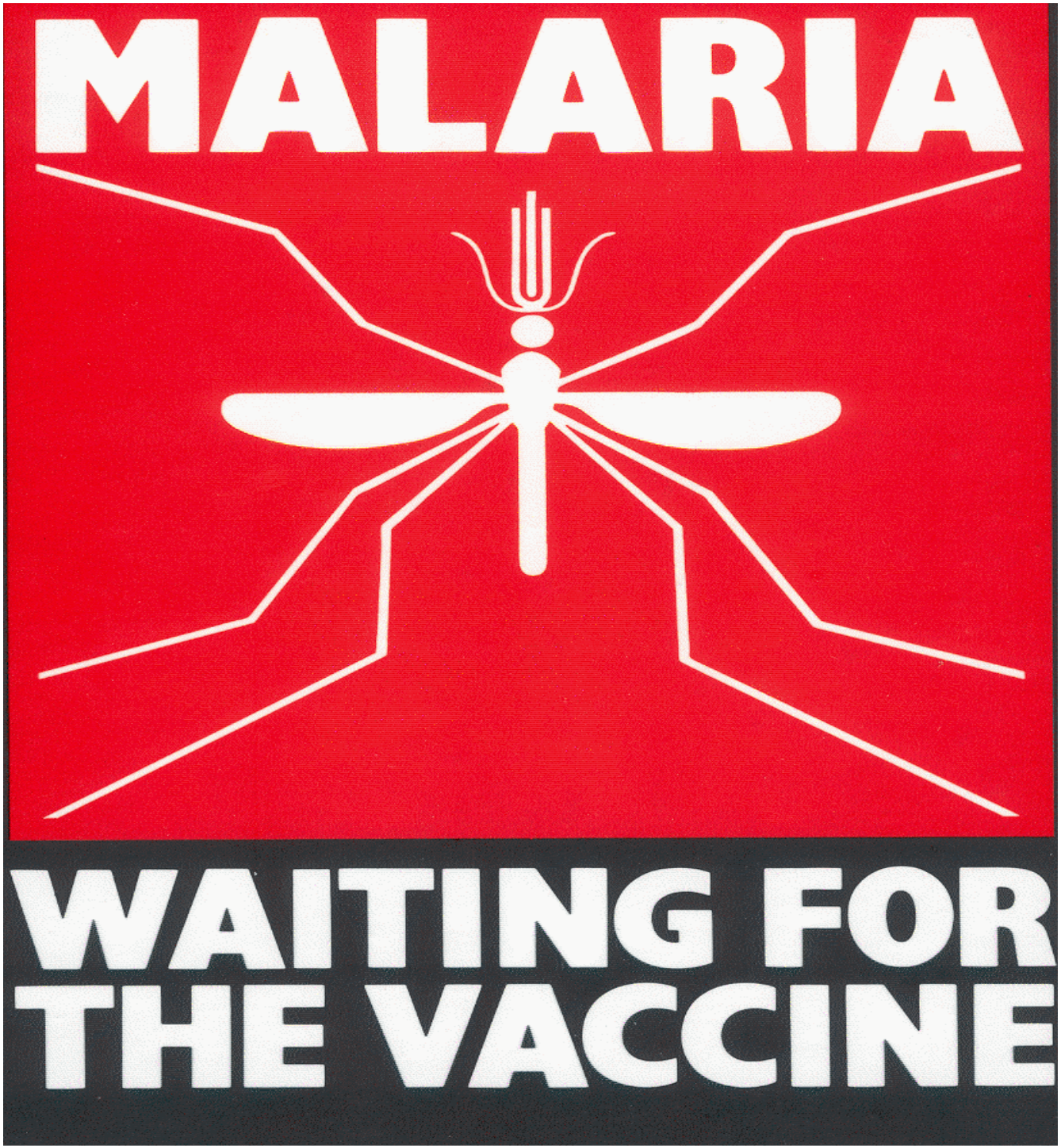
# MALARIA CHEMOPROPHYLACTIC DRUG DOSAGE

| Drug (trade name) | Packaging | Adult dose | Child dose |
|---|---|---|---|
| Atovaquone-proguanil (Malarone) | One tablet containg Atovaquone 250 mg + proquanil 100 mg | 1 tablet/day | 11-20 kg: ¼ tablet<br>21-30 kg: ½ tablet<br>31-40 kg: ¾ tablet<br>> 40 kg: adult dose |
| Chloroquine phosphate (Aralen) | 150 mg base | 300 mg base/week | 5 mg base/kg/week |
| Doxycycline (Vibramycin) | 100 mg | 100 mg/day | 2mg/kg/day; not for children < 8 yrs old |
| Mefloquine (Lariam) | 250 mg base | 250 mg base/week | 5 mg base/kg/week |
| Primaquine | 15 mg base | 15 mg base/day for 14 days | 0.3 mg base/day for 14 days |
| Proguanil (Paludrine) | 100 mg | 200 mg/day | 4 mg/kg/day |

# PARASITE STAGES UNDER ATTACK

**NATURE 415:694-701, 2002**




MALARIA
WAITING FOR
THE VACCINE

# Can malaria be eliminated?

| Comparison | 2000s | 1950s |
|---|---|---|
| Aim | Elimination | Eradication |
| Strategies | Integrated | Limited |
| IRS | Pyrethroid | DDT |
| Bednets | LLINs | None |
| Pregnancy /children | IPT | None |
| Diagnosis | Blood films/RDT/PCR | Blood films |
| Treatment | ACT | Chloroquine |
| Chemoprophylatic | Mefloquine/Malarone | Chloroquine |
| Vaccine | Partial protection? | None |