

MALARIA

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Malaria is a mosquito-borne infectious disease caused by protozoan parasites of the genus *Plasmodium*. It is characterized by characterized clinically by periodic fever with chills, sweating, anemia, splenomegaly, and in severe cases, multi-organ dysfunction.

or

Malaria is an acute febrile protozoal infection of humans caused by parasites of the genus *Plasmodium*, transmitted by the bite of an infected female *Anopheles* mosquito.

Causative Organism

- Malaria is caused by protozoan parasites of the genus *Plasmodium*, mainly:
- *Plasmodium falciparum*, *Plasmodium vivax*, *Plasmodium ovale* and *Plasmodium malariae*

Vector

- The disease is transmitted by the bite of the infected female *Anopheles* mosquito, which acts as the definitive host and biological vector.
- Only the female mosquito transmits malaria because it feeds on human blood for egg development.

Mode of Transmission

1. Malaria is transmitted primarily through the inoculation of sporozoites into human blood during the bite of an infected female *Anopheles* mosquito.
- Less commonly, transmission may occur through:
 2. Blood transfusion
 3. Organ transplantation
 4. Sharing contaminated needles
 5. Transplacental transmission (congenital malaria)

PATHOGENESIS

Human (Asexual) Cycle – In the Human Host

1 Inoculation of Sporozoites

- Infection begins when an infected female *Anopheles* mosquito bites a human.
- Sporozoites are injected from the mosquito's salivary glands into the bloodstream.

2 Hepatic (Pre-erythrocytic) Stage

- Sporozoites rapidly reach the liver., invade hepatocytes (liver cells).
- Undergo asexual multiplication (schizogony/merogony).
- One sporozoite produces 10,000–30,000 merozoites.
- Infected liver cells rupture and release merozoites into circulation.
- In infections caused by: *Plasmodium vivax*, *Plasmodium ovale* Some forms remain dormant in the liver as hypnozoites, causing relapse weeks to months later.

3 Erythrocytic (Blood) Stage

- Merozoites invade red blood cells (RBCs).
- Inside RBCs they develop into: Ring form (early trophozoite, Trophozoite, Schizont
- The parasite multiplies (6–30 merozoites per RBC).
- RBC ruptures and releases merozoites.
- This cycle repeats every: 48 hours (most species), 72 hours in *Plasmodium malariae*
- Repeated RBC destruction causes: Fever with chills (periodic fever), Anemia
Splenomegaly
- Severe disease is commonly caused by *Plasmodium falciparum*.

4 Gametocyte Formation

- After several asexual cycles: Some parasites differentiate into male and female gametocytes.
- These sexual forms circulate in the blood.
- They are infective to mosquitoes.

B. Mosquito (Sexual) Cycle – In the Vector

5 Ingestion of Gametocytes

- When a female *Anopheles* mosquito bites an infected person, it ingests gametocytes.

6 Fertilization in Mosquito Gut

- In the mosquito midgut: Male gametocyte → microgamete, Female gametocyte → macrogamete
- Fusion forms a **zygote**.

7 Ookinete Formation

- Zygote elongates to form an **ookinete**, penetrates the gut wall.

8 Oocyst Formation

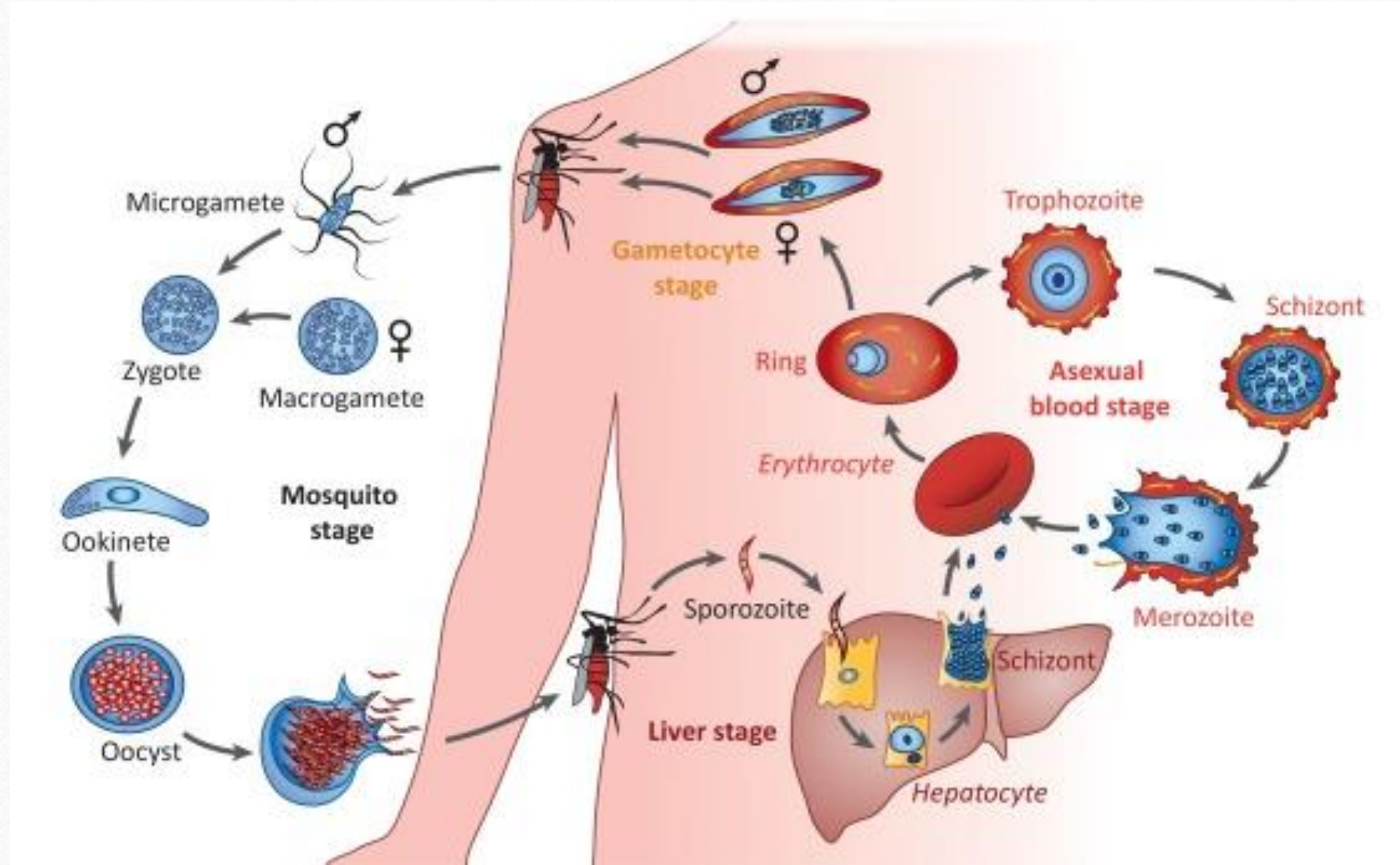
- Ookinete develops into an **oocyst** on the outer gut wall.
- Inside the oocyst, repeated asexual division occurs.

9 Sporozoite Formation

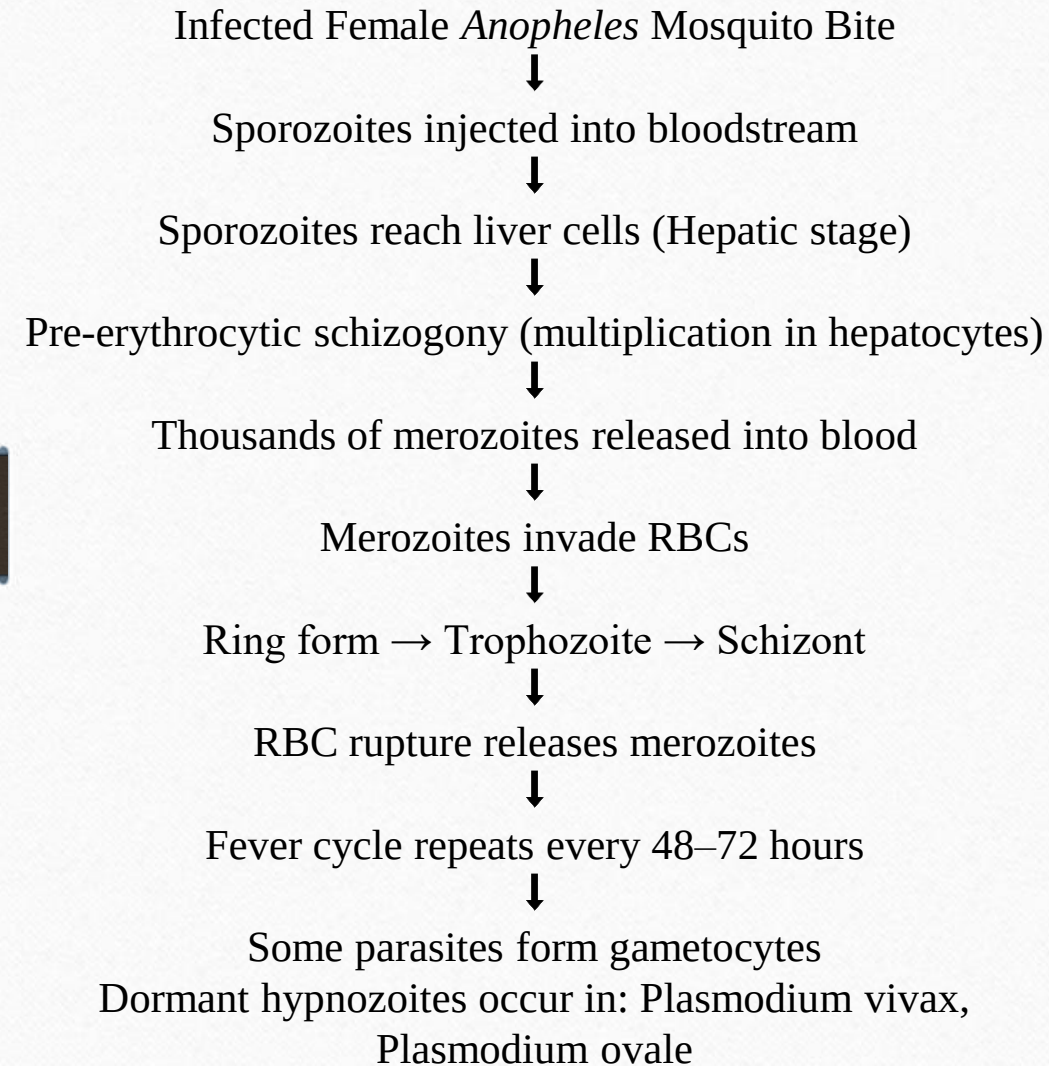
- Thousands of **sporozoites** are formed.
- They migrate to the mosquito's salivary glands.

10 Transmission to Another Human

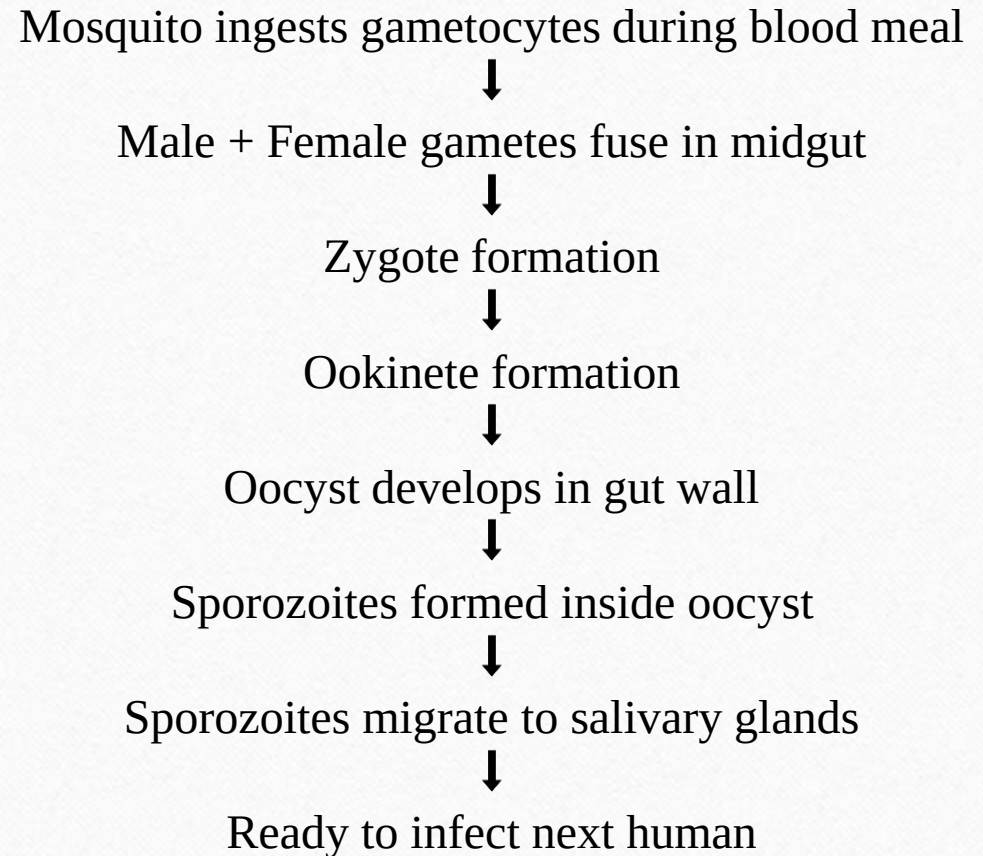
- During the next blood meal, sporozoites are injected into a new human host.



A. Human Host (Asexual Cycle)



B. Mosquito (Sexual Cycle)



When to Suspect Malaria

Malaria should be suspected in:

1. Any patient with intermittent fever in endemic areas
2. Patients with recent travel history to endemic regions
3. Fever with chills without obvious source
4. However, malaria can mimic many infections, so other causes should be ruled out if the patient has:
 1. Running nose and cough (respiratory infection)
 2. Diarrhea or dysentery
 3. Burning micturition (UTI)
 4. Skin rash or abscess
 5. Painful joint swelling
 6. Ear discharge
 7. Lymphadenopathy

Clinical Presentation of Malaria

Malaria presents with a wide spectrum of manifestations ranging from mild febrile illness to life-threatening complications.

The severity depends on the species involved, parasite load, immunity of the patient, and timeliness of treatment.

Severe disease is most commonly associated with *Plasmodium falciparum*.

Uncomplicated (Classical) Malaria: Prodromal Symptoms

These occur before the typical fever pattern:

1. Headache
2. Malaise
3. Myalgia
4. Arthralgia
5. Anorexia
6. Nausea and vomiting

Classical Malarial Paroxysm (Intermittent Fever)

The fever typically occurs in cycles (every 48–72 hours depending on species) and has three stages:

1. Cold Stage

Sudden onset of chills
Rigors (shivering)
Feeling extremely cold

2. Hot Stage

High fever (often 39–41°C)
Flushed face
Headache
Restlessness

3. Sweating Stage

Profuse sweating
Temperature falls
Weakness and fatigue

General Physical Findings

Pallor (due to anemia)
Splenomegaly
Mild hepatomegaly
Tachycardia

Severe (Complicated) Malaria:

Seen mainly in infection with *Plasmodium falciparum*.

Why These Symptoms Occur

1. **Fever** → Due to synchronized rupture of infected RBCs
2. **Anemia** → RBC destruction
3. **Splenomegaly** → Increased clearance of infected RBCs
4. **Cerebral malaria** → Sequestration of infected RBCs in brain capillaries

Neurological

- Altered sensorium
- Seizures
- Coma (Cerebral malaria)

Hematological

- Severe anemia
- Hemoglobinuria
- Splenomegaly

Metabolic

- Hypoglycemia
- Metabolic acidosis

Renal

- Acute renal failure
- Reduced urine output

Respiratory

- Acute pulmonary edema
- Respiratory distress

Diagnosis of Malaria

Early and accurate diagnosis is essential to prevent complications and reduce mortality.

1. Laboratory Diagnosis A. Peripheral Blood Smear (Gold Standard): Two types of smears:

1. Thick smear

More sensitive

Detects presence of parasites

2. Thin smear

Identifies species

Assesses parasite density

Species commonly detected:

1. *Plasmodium falciparum*
2. *Plasmodium vivax*
3. *Plasmodium ovale*
4. *Plasmodium malariae*

2. Rapid Diagnostic Tests (RDTs)

- Detect specific malaria antigens in blood
- Results within 15–20 minutes
- Useful in remote areas
- Cannot quantify parasite load

3. Polymerase Chain Reaction (PCR)

- Highly sensitive and specific
- Detects low-level parasitemia
- Used mainly in research/reference laboratories

4. Supportive Laboratory Findings

- Anemia
- Thrombocytopenia
- Elevated bilirubin
- Hypoglycemia
- Elevated creatinine (in severe cases)

5. Diagnosis of Severe Malaria

- Severe malaria is diagnosed when:
 - Peripheral smear shows parasitemia
AND
- There is evidence of organ dysfunction (coma, severe anemia, renal failure, acidosis, etc.)
- Severe disease is most commonly caused by *Plasmodium falciparum*.

Management of Malaria

Management of malaria depends on:

1. Species of *Plasmodium*
2. Severity (uncomplicated or severe)
3. Drug resistance pattern
4. Patient group (pregnancy, children, travellers)

Treatment of Uncomplicated Malaria

Type of Malaria	Drug of Choice	Dose & Duration	Important Points
Chloroquine-sensitive malaria	Chloroquine	Total 25 mg/kg over 3 days (Adult: 600 mg base initially, 300 mg after 6 hrs, then 300 mg daily × 2 days)	Only in sensitive areas
Chloroquine-resistant falciparum malaria	Artemisinin-based Combination Therapy (ACT) - Artesunate + Amodiaquine	Artesunate 4 mg/kg/day + Amodiaquine 10 mg/kg/day *3-day regimen	Artemisinin should NOT be used as monotherapy

WHO Recommended ACT Options

ACT Regimen	Dose	Duration
Artemether + Lumefantrine	6-dose regimen	3 days
Artesunate + Amodiaquine	Artesunate 4 mg/kg/day + Amodiaquine 10 mg/kg/day	3 days
Artesunate + Mefloquine	Artesunate 4 mg/kg/day + Mefloquine 8.3 mg/kg/day	3 days
Artesunate + Sulfadoxine-Pyrimethamine	Artesunate 4 mg/kg/day × 3 days + Single dose SP (25/1.25 mg/kg)	3 days
Dihydroartemisinin + Piperaquine	DHA 4 mg/kg/day + Piperaquine 18 mg/kg/day	3 days

Second-Line Treatment

Regimen	Dose	Duration
Artesunate + Doxycycline / Tetracycline / Clindamycin	Artesunate 2 mg/kg/day + partner drug	7 days
Quinine + Doxycycline / Tetracycline / Clindamycin	Standard quinine dose + partner drug	7 days

Treatment in Special Populations

A. Pregnant Women

Trimester	Recommended Treatment
First trimester	Quinine + Clindamycin × 7 days
If failure	Artesunate + Clindamycin × 7 days
Second & Third trimester	ACT OR Artesunate + Clindamycin OR Quinine + Clindamycin

B. Lactating Women

Can receive ACT

Avoid: Primaquine & Tetracycline

C. Infants & Young Children

ACT is first-line

Ensure accurate dosing

Rectal artesunate may be used if unable to swallow

D. Travelers (Non-endemic Countries)

Drug Options	Duration
Atovaquone + Proguanil	3 days
Artemether + Lumefantrine	3 days
Dihydroartemisinin + Piperaquine	3 days
Quinine + Doxycycline / Clindamycin	7 days

Treatment of Severe / Complicated Malaria

- ✓ Admit in ICU
- ✓ Treat complications aggressively
- ✓ Start treatment immediately (do not delay for lab confirmation if strongly suspected)

Aspect	Treatment
First-line drug	IV Artesunate (preferred drug)
Dose of IV Artesunate	2.4 mg/kg IV at 0 hr, 12 hr, 24 hr, then once daily
Alternative (if artesunate unavailable)	IV Quinine (with cardiac monitoring)
After patient improves & can take oral drugs	Complete full course of oral ACT (Artemisinin-based Combination Therapy)
Management of hypoglycemia	IV 25–50% dextrose
Management of seizures	IV diazepam / lorazepam
Management of severe anemia	Blood transfusion
Fluid management	Careful IV fluids (avoid overload)
Renal failure	Dialysis if required
Monitoring	Vital signs, blood glucose, parasite count, urine output

Patient Education and Counselling in Malaria

Proper patient education helps in preventing infection, ensuring treatment success, and reducing reinfection.

1 About the Disease

Patients should be informed that:

1. Malaria is caused by *Plasmodium* parasites transmitted by the bite of an infected female *Anopheles* mosquito.
2. Common symptoms include fever with chills, sweating, headache, body pain, nausea, and weakness.
3. Severe malaria can affect the brain, kidneys, and lungs
4. Early diagnosis and complete treatment prevent complications.
5. Relapse can occur in infections caused by *Plasmodium vivax* and *Plasmodium ovale* due to dormant liver forms.
6. Advise patients to seek medical care immediately if fever develops after travel to endemic areas.

Counselling About Medications

1. Purpose of Medication

1. To kill malaria parasites in the blood.
2. To prevent relapse (if primaquine is prescribed).

2. Dose and Duration

1. Take medicines exactly as prescribed.
2. Complete the full course even if symptoms improve.
3. Artemisinin-based combinations must be taken for full 3 days.

3. Missed Dose Advice

1. Take the missed dose as soon as remembered.
2. Do NOT double the dose if it is close to the next dose.

4. Possible Side Effects

1. Nausea, vomiting
2. Dizziness
3. Abdominal discomfort
4. Mild headache
5. If severe side effects occur (persistent vomiting, rash, breathing difficulty), seek medical help.

5. Special Advice

1. Take medication with food if advised (improves absorption).
2. Avoid alcohol during treatment.
3. Inform doctor about pregnancy or other illnesses.

Prophylaxis Advice for Travellers: Travellers to endemic areas should:

1. Start prophylactic medication before travel (as prescribed).
2. Continue during stay and for recommended period after return.
3. Seek medical attention if fever develops even after returning home.

Lifestyle Modifications

- ✓ Use long-sleeved clothing and full-length pants
- ✓ Apply mosquito repellent creams or sprays (especially at night)
- ✓ Use insecticide-treated bed nets
- ✓ Use mosquito coils or vaporizers
- ✓ Sleep in screened or air-conditioned rooms

Special Focus on Mosquito Control (Community Level)

a. Environmental Control

- ✓ Avoid water stagnation (drain stagnant water weekly)
- ✓ Cover water storage containers
- ✓ Dispose of unused tires, cans, coconut shells
- ✓ Maintain clean surroundings

b. Household Control

- ✓ Install window and door screens
- ✓ Use larvicidal agents if recommended
- ✓ Participate in community spraying programs

Preventing Reinfection and Spread

- ✓ Do not delay treatment if symptoms reappear
- ✓ Encourage family members with fever to get tested
- ✓ Follow government malaria control programs
- ✓ Promote awareness in community