Unit 23 · Plasmodium vivax

ANSWER KEY · FOR TEACHERS

Full marks 35

Give the marks for the points in the marking scheme; an answer in other words that says the same is right.

1 Key words

1. digenetic
2. vector
3. sporozoite
4. schizogony
5. hemozoin
6. hypnozoites
7. exflagellation
8. ookinete

K · 4

Each carries 0.5 mark.

2 Label the diagram

1. apical cap
2. paired organelles
3. nucleus
4. pellicle
5. convoluted tubules
6. mitochondrion

K · 3

Each carries 0.5 mark.

3 Multiple choice

i. **d.** female *Anopheles* — K · 1

Only the **female** *Anopheles* carries *Plasmodium*. Males don't bite, and *Culex* mosquitoes carry other diseases (such as filariasis and Japanese encephalitis), not human malaria.

ii. **d.** liver cells — K · 1

Pre-erythrocytic means "before the red cells": the first schizogony is in **liver cells**.

iii. **c.** bursting of RBCs and release of merozoites with hemozoin — U · 1

The attack comes when RBCs **burst together**, releasing merozoites, hemozoin and other parasite substances, to which the body reacts with fever.

iv. **c.** zygote — U · 1

Only the **zygote** is diploid. Meiosis follows at once (it is complete by the time the zygote has become an ookinete), so every later stage is haploid, as are the stages in the person.

v. **c.** gametocytes – zygote – ookinete – oocyst – sporozoite — A · 1

It starts with the **gametocytes** sucked up by the mosquito and ends with **sporozoites** in its salivary glands.

4 Very short answers

a. MARKING SCHEME — K · 1

✓ The sexual phase passes in the mosquito.

b. MARKING SCHEME — K · 1

✓ Bite to the first parasites in the blood, about 8 days.

c. MARKING SCHEME — U · 1

✓ The saliva has anticoagulants that stop the blood clotting.

Science Playground, Katunje, Bhaktapur
Book a class visit: https://science-playground.com/booking

5 Short answers

a. MARKING SCHEME U · 2

- ✓ No: the form described is the trophozoite (the feeding stage in the RBC, round or amoeboid, with a vacuole).
- ✓ A sporozoite is slender and sickle-shaped, pointed at both ends, with no vacuole: the infective stage.

b. MARKING SCHEME U · 2

- ✓ The erythrocytic cycle, ending in the RBCs bursting, takes 48 hours, so the fever comes every 48 hours.
- ✓ Counting the fever day as day one, the next is on the third day (*tertius*, third).

c. MARKING SCHEME A · 2

- ✓ Hypnozoites resting in liver cells woke up (chloroquine clears only the blood stages): a relapse.
- ✓ Primaquine kills the hypnozoites.

d. MARKING SCHEME U · 3

- ✓ Any one difference, e.g. benign tertian against malignant tertian (high death rate).
- ✓ Any second, e.g. hypnozoites and relapses against none.
- ✓ Any third, e.g. enlarged RBC with Schüffner's dots against not enlarged with Maurer's dots, or round against crescent gametocytes.

6 Long answers

a. ANSWER U · 4

Erythrocytic schizogony is the asexual multiplication of *Plasmodium* inside **red blood cells**.

i. **Young trophozoite**: a merozoite enters an RBC, feeds, and becomes rounded with a vacuole.
ii. **Signet ring**: a large central vacuole pushes the nucleus and cytoplasm to the edge, like a ring with a gem. The parasite digests hemoglobin, using the globin and storing the heme as **hemozoin** (malaria pigment).
iii. **Amoeboid stage**: the trophozoite grows and puts out pseudopodia; **Schüffner's dots** appear in the RBC, which becomes enlarged and pale.
iv. **Schizont**: the trophozoite becomes large and round; its nucleus divides by mitosis into 12–24 nuclei.
v. **Rosette stage**: each nucleus with cytoplasm becomes a merozoite, arranged round the edge with the hemozoin in the middle, like a rose.
vi. The RBC **bursts**, releasing merozoites and hemozoin (the attack of fever); the merozoites infect fresh RBCs. One cycle takes **48 hours** in *P. vivax*.

After several cycles some merozoites become **gametocytes** instead.

MARKING SCHEME

- ✓ Asexual multiplication of *Plasmodium* inside RBCs; a merozoite becomes a young trophozoite, then the signet ring (central vacuole, hemoglobin digested, heme stored as hemozoin).
- ✓ Amoeboid stage: pseudopodia, Schüffner's dots, RBC enlarged and pale.
- ✓ Schizont: nucleus divides into 12–24; merozoites round the edge, the rosette stage.
- ✓ The RBC bursts (the fever), merozoites infect fresh RBCs; one cycle in 48 hours; some merozoites become gametocytes.

Science Playground, Katunje, Bhaktapur
Book a class visit: https://science-playground.com/booking

b. ANSWER A · 4

The mosquito sucks up gametocytes with the blood of a patient; they survive her digestion. In her stomach each **microgametocyte** exflagellates (set off by the fall in temperature), giving eight flagellum-like male gametes, and each **macrogametocyte** becomes a non-motile female gamete. One male gamete enters the female gamete at its **receptive cone** and they fuse (**syngamy**) into a diploid **zygote**, which lengthens into a motile **ookinete**. The ookinete passes through the stomach wall and encysts under its outer layer as an **oocyst**. Inside, by **sporogony**, the haploid nuclei (after meiosis) divide many times by mitosis and the cytoplasm splits into about **10,000 sporozoites**. The oocyst bursts and the sporozoites travel through the hemocoel to the **salivary glands**.

MARKING SCHEME

- ✓ Gametocytes sucked up survive; gametogony: exflagellation gives eight male gametes, the macrogametocyte a female gamete.
- ✓ Fertilization (syngamy) at the receptive cone gives a diploid zygote, which becomes a motile ookinete.
- ✓ The ookinete encysts under the outer layer of the stomach wall as an oocyst.
- ✓ Sporogony (mitoses after meiosis) gives about 10,000 sporozoites, which reach the salivary glands.

7 Think

ANSWER HA · 3

The development in the mosquito, from the blood meal to sporozoites in the salivary glands, takes about 9–18 days, longer in cool weather, so malaria spreads only where it stays warm long enough: in Nepal the Terai and the low valleys, not the hills and mountains. The **Terai family** is right to worry more. Measures: sleep under insecticide-treated bed nets; spray the inside walls of houses; drain or cover stagnant water and remove containers that hold rainwater; get every fever tested quickly and take the full course of medicine.

MARKING SCHEME

- ✓ The cycle in the mosquito needs about 9–18 days of warmth (slower in the cold).
- ✓ So the Terai family, where it is warm enough, is right to worry more.
- ✓ Any two measures, e.g. treated bed nets, indoor spraying, removing stagnant water, quick testing and treatment.

8 Activity: Malaria at the health post (Activity 8.4)

(not marked)

WHAT STUDENTS SHOULD FIND

The health post tests a drop of blood from a finger, by a **rapid diagnostic test** (a strip that shows the parasite's proteins in 15–20 minutes) or a **blood smear** under the microscope. Testing and treatment are free in Nepal's government health facilities. Most cases in Nepal now are **imported**, caught by people working or traveling abroad, most of them in India. If a local female *Anopheles* bites such a patient before treatment, she can pick up gametocytes and pass the parasite on, so every imported case must be found and treated quickly.

Marks by level	Knowledge	Understanding	Application	Higher ability	Total
Marks	11	14	7	3	**35**

Science Playground, Katunje, Bhaktapur
Book a class visit: https://science-playground.com/booking