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*Plasmodium vivax (*Malaria parasite)

Knowledge source: A Textbook Of Biology and online website

Presented by: Puja Shrestha

Plasmodium vivax (Malaria parasite)

Systematic Position

Kingdom : Protista

Phylum : Protozoa

Class : Sporozoa

Genus : Plasmodium

Species : *vivax*

Habits and habitat:-

Plasmodium is an **intracellular** sporozoan parasite causing malaria in man. The parasite lives in the **RBC's and liver** cells of man and **alimentary canal** and **salivary glands** of female **Anopheles mosquito**.

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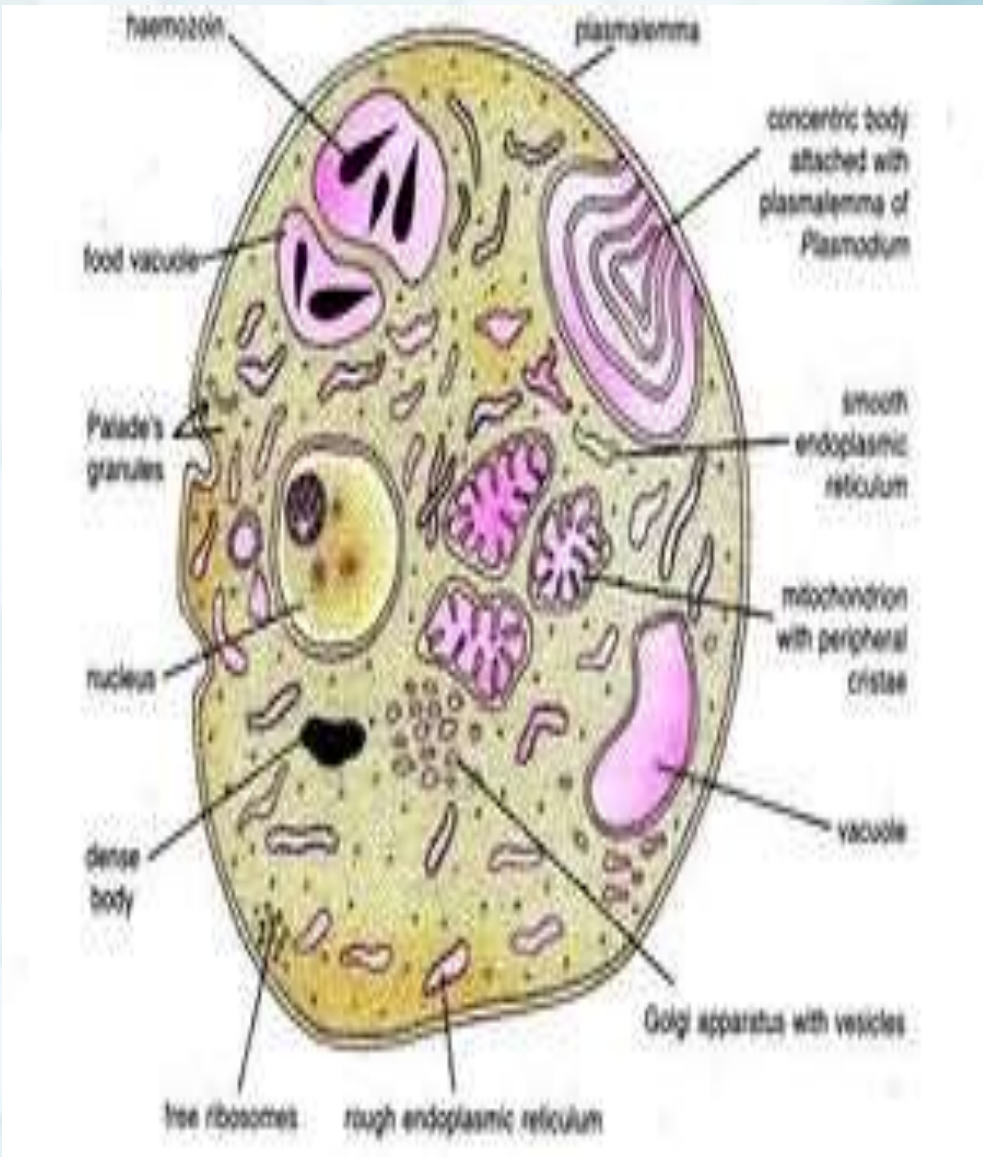
Body structure:

Structure:-

Structure of plasmodium is different stages of its life cycle. **Dimorphic parasite** viz. **Trophozoite and sporozoite.**

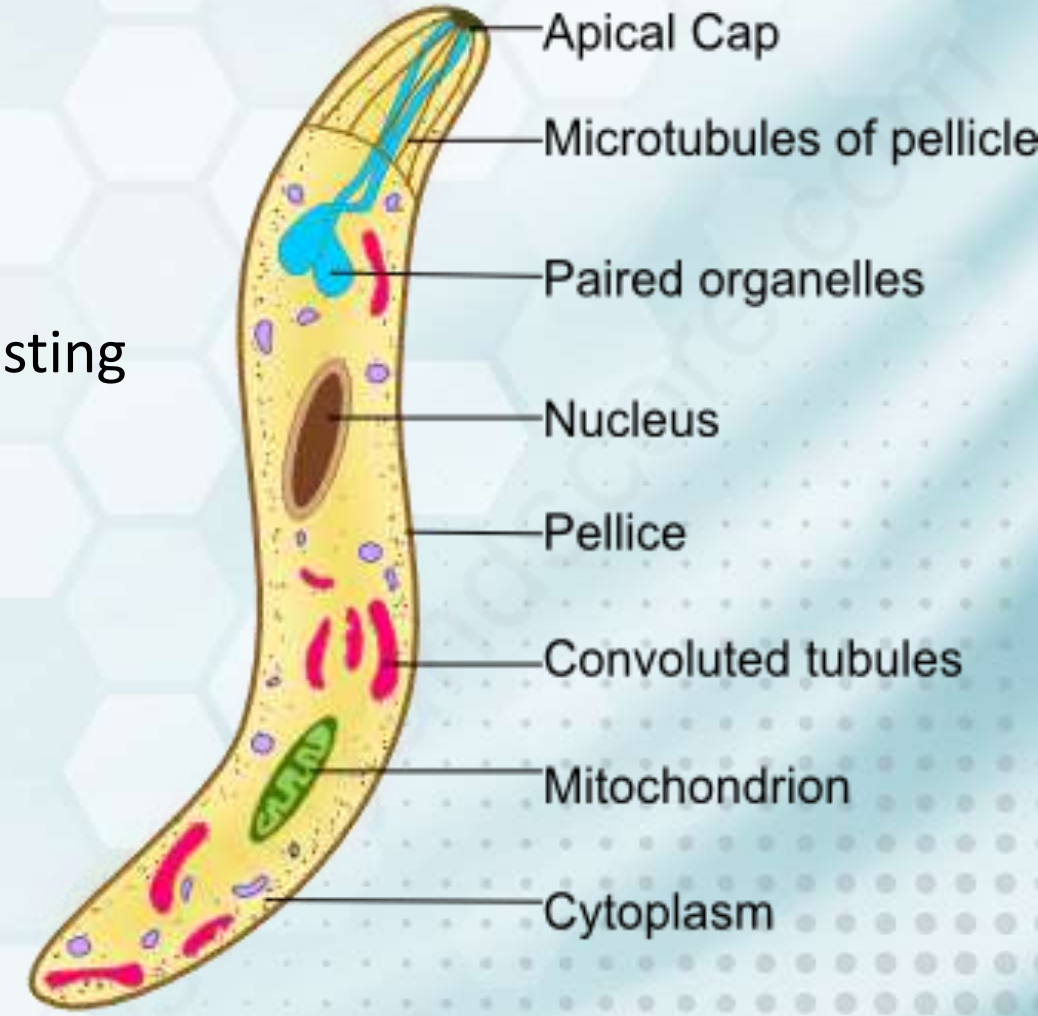
Trophozoite

- A fully grown **malarial parasite** is **amoeboid** and **uninucleated** structure known as **trophozoite**.
- surrounded by double layered **plasma lemma.**
- Cytoplasm contains **Palade's granules, endoplasmic reticulum made from smooth and rough vesicles, ribosome, mitochondria, golgi body and vacuoles** having **haemozoin,** contains nucleus having **nucleolus** and **granular nucleoplasm**.



Sporozoite:

- **Infective stage** with 10-15 mm in size
- Are uninucleated, motile with sickle-shaped body, consisting of pellicle, cytoplasm and nucleus.
- Microtubules present in apical region helps in wriggling movements.



Hosts:-

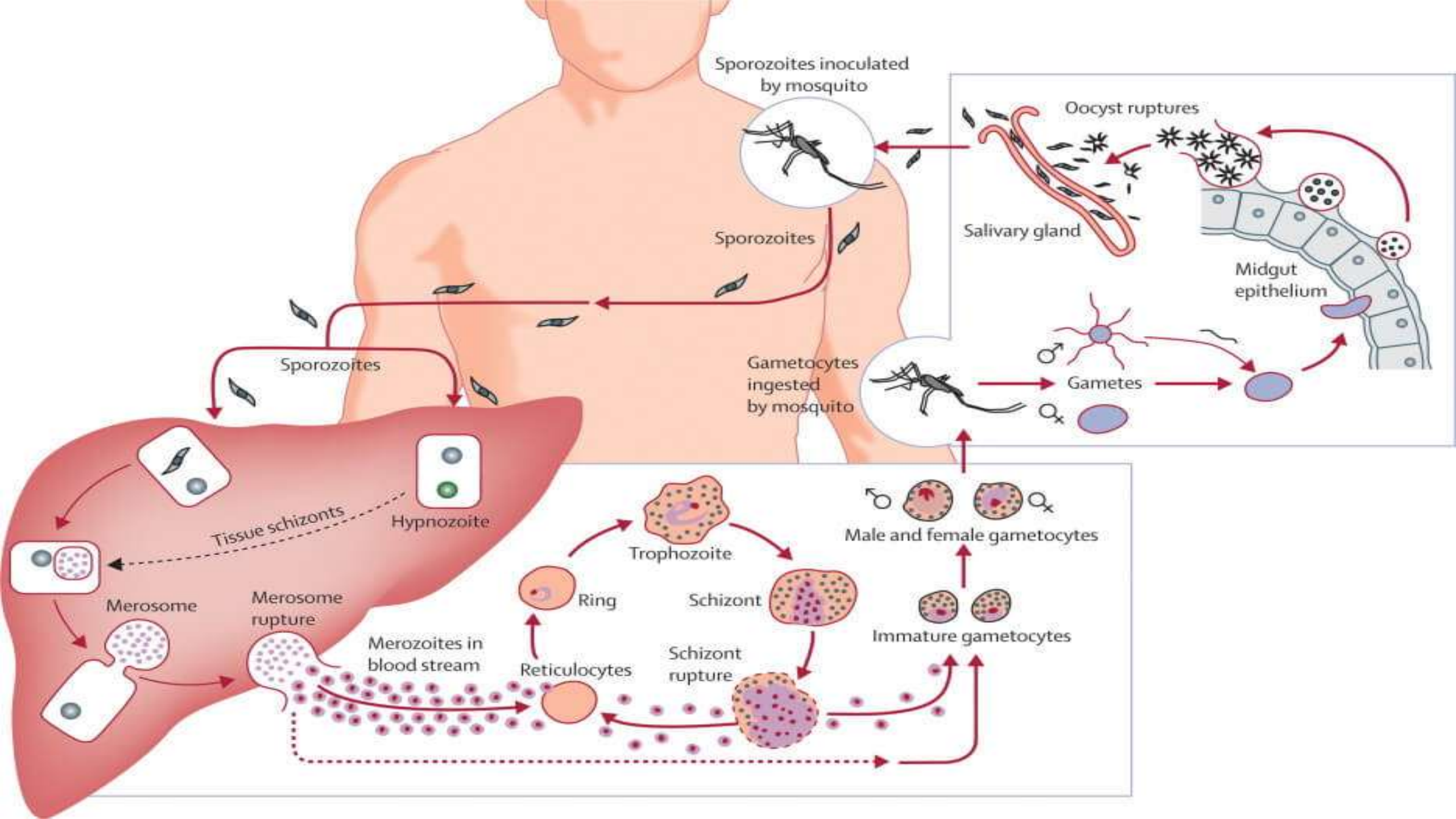
- Plasmodium completes its lifecycle in two hosts **(digenetic)**: Man and female Anopheles mosquito.
- Malaria parasites transmitted by mosquito bite are remarkably efficient in establishing human infections.
- The infection process requires roughly **30 minutes** and is highly complex as **quiescent (inert)sporozoites** injected with mosquito saliva must be rapidly activated in the skin, migrate through the body, and infect the liver.

1. Primary or definitive host:

Female *Anopheles* mosquito is the primary host of Plasmodium in which it completes its **sexual life cycle**.

2. Secondary or Intermediate host:

Man is the secondary host of plasmodium in which it completes its asexual life cycle.


Sporozoites inoculated by mosquito
Oocyst ruptures
Salivary gland
Midgut epithelium
Sporozoites
Sporozoites
Gametocytes ingested by mosquito
Gametes
Tissue schizonts
Hypnozoite
Merosome
Merosome rupture
Merozoites in blood stream
Ring
Trophozoite
Schizont
Schizont rupture
Reticulocytes
Male and female gametocytes
Immature gametocytes

The lifecycle of Plasmodium can be divided into three phases:

1. **Asexual schizogony**
2. **Sexual gamogony**
3. **Asexual sporogony**

ASEXUAL CYCLE OF Plasmodium, IN HUMAN

Infective form of Plasmodium is known as **sporozoites**. Sporozoites are **11-12µ** long slender, **uni-nucleated,s**ickle-shaped structure present in the salivary glands of infected mosquito. When an infected female Anopheles mosquito bites a healthy man, a large number of **sporozoites** enter into the **blood stream** of man. Within half an hour, sporozoites enter the liver cells and undergo asexual multiplication called **schizogony.**

1. **Asexual Schizogony**:-

Schizogony is the asexual phase of reproduction of Plasmodium. It takes place in liver cells and RBC's of man. Schizogony can be divided into following phases:

a) Pre-erythrocytic schizogony
b) Exo-erythrocytic schizogony
c) Erythrocytic schizogony
d) Post- erythrocytic schizogony

ASEXUAL LIFECYCLE OF PLASMODIUM

Sporozoites in the salivary gland of the female Anopheles mosquito will go into the bloodstream and primarily infect the liver cells

STAGE OF INFECTION

Hepatic cell → Schizont → Cryptozoites → Cryptomerozoites

PRE ERYTHROCYTIC SCHIZOGONY

Megagametocryptozoites will infect the liver cells

New hepatic cell → Schizont → Metacryptozoites

EXO ERYTHROCYTIC SCHIZOGONY

Micrometacryptozoites will infect the RBCs

Trophozoite → Singlet ring → Amoeboid → Merozoites → Schuffner cells → Haemozoin → Microgamete, Macrogamete

ERYTHROCYTIC SCHIZOGONY

a. Pre-erythrocytic schizogony:

In the **liver cells**, sporozoites grow to form a large and spherical **schizont**. Schizont divides by **multiple fission** and forms many **cryptozoites**. They may either pass into the blood circulation to start **erythrocytic schizogony** or enter fresh liver cells to start **Exo-erythrocytic schizogony**. Pre-erythrocytic schizogony takes **8 days** to complete.

b. Exo-erythrocytic schizogony:

After re-entering fresh liver cell each cryptozoites divides to form many **metacryptozoites** that enter the RBC'S to start erythrocytic schizogony.

c.Erythrocytic schizogony:-

As stated above, the **erythrocytic schizogony** begins when the **RBC's of blood** are attacked either by **pre-erythrocytic cryptozoites** or by **exo-erythrocytic micro-metacryptozoites**. It takes normally in 8 to 12 days after above 2 phases. Stages of erythrocytic schizogony are:

i. Trophozoite Stage:-

The **merozoites** (cryptozoites and micro- metacryptozoites) after entering into the blood stream, feed on erythrocytes, become rounded and modify into **trophozoite**.

ii. Signet Ring Stage:-

As the merozoites grow, a **vacuole appears** in the center and the nucleus is pushed to one side. It gives a ring like appearance and known as **signet ring stage**.

The parasite ingests **haemoglobin** and decomposes it into **protein and haematin**. Protein is use as food whereas unused haematin **forms toxic**. Yellowish brown malarial pigment, haemozoin.

iii. Amoeboid Stage: –

As the signet ring parasite grows, **vacuole disappears** and the parasite becomes amoeboid in appearance, thrusting out pseudopodial processes. This stage is called amoeboid stage. At this stage **RBC develops numerous granules,** the **Schuffner's granules.**

iv. Schizont Stage:-

Parasite grows in size, becomes rounded and almost completely fills the RBC called **Schizont**.

v. Rosette Stage:-

The nucleus of schizont divides by multiple fission to form **6 to 24 daughter nuclei**. These nuclei arrange at the periphery, while the **toxic haemozoin** granules accumulate at the center of RBC. It appears as a flower rose, so called rosette stage.

Nuclei of rosette stage are surrounded by a **little cytoplasm** and are developed into merozoites. With the rupture of the RBC, these merozoites are liberated into the **blood plasma** along with toxic **haemozoin**. These normally attack fresh **RBC's to repeat the erythrocytic** cycle or may change into **gametocytes**. One complete erythrocytic cycle takes **48 hours** in *Plasmodium vivax.*

d. Post-erythrocytic schizogony:-

Sometimes, **some merozoites produced in erythrocytic schizogony** reach the liver cells and undergo schizogony development in liver cells. This is called **post-erythrocytic schizogony**.

SEXUAL CYCLE OF Plasmodium in MAN

2. Sexual Gamogony:-

Formulation of gametocytes:

After **many generations in about 4-5 is the blood** some merozoites increase in size to form two types of gametocytes**; larger macro (9-10µ),** less numerous and contain large nucleus. **Micro gametocytes** are smaller (10-12µ), more numerous and contain smaller nucleus.

SEXUAL CYCLE OF Plasmodium IN MOSQUITO

When a female Anopheles sucks the blood of a malaria patient, the **gametocytes** reach the stomach of mosquito and formation of gametes take palace as follows:

a. Gametogenesis (gemetogony) :

Process of formulation of gametes (male and female gametes).

i. Formulation of male gametes:

The nucleus of microgametocyte divides to **form 6-8 daughter nuclei**. The cytoplasm gives out same number of flagella like projections and daughter nuclei **enter each projection**. These projections separate from the cytoplasm and form **6-8 haploid microgamete or male gametes**. This process of formation of microgamete is **called exflagellation.**

ii. Formation of female gamete:-

The mega gametocyte undergoes some reorganization to form a **single haploid mega gamete** or female gamete which is ready for fertilization.

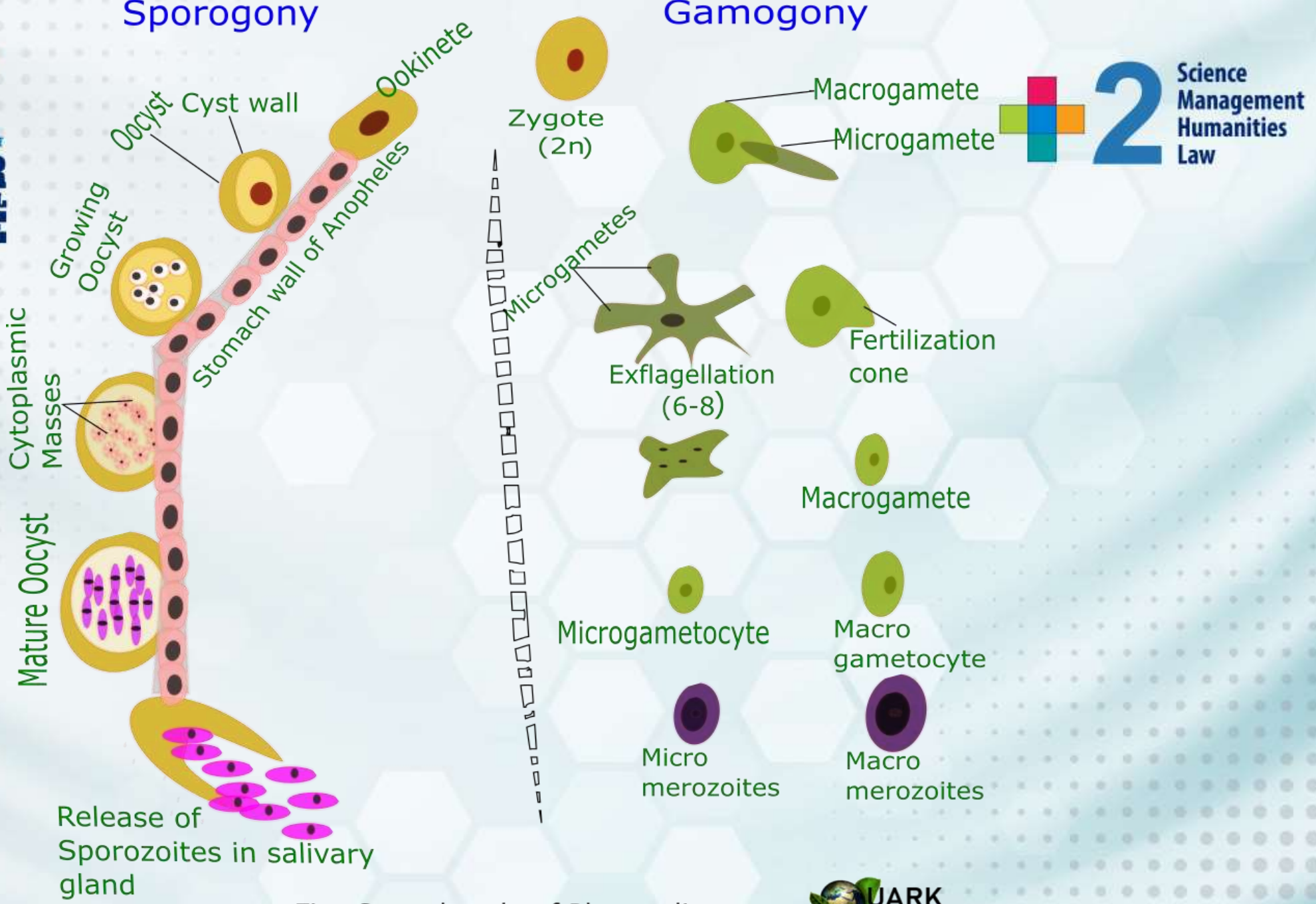


Fig: Sexual cycle of Plasmodium

b. Fertilization:

The male gamete enters the female gamete through the fertilization cone formed at female gamete and form diploid **zygote or synkaryon**. Fusion is **anisogamous**. (Anisogamy is a form of sexual reproduction that **involves the union or fusion of two gametes that differ in size** and/or form.)

3. Asexual sporogony

c. Ookinete stage:

The zygote remains inactive for **sometimes and then elongates** into a worm like **Ookinete or vermicule**, which is **motile.** The **Ookinete penetrates the stomach wall** and comes to lie below its **outer epithelial layer.**

d. Oocyst stage:

The Ookinete gets enclosed in a **cyst**. The encysted zygote is called **Oocyst**. The **Oocyte** absorbs nourishment and grows in size.

The nucleus of Oocyte divides repeatedly to form a large number **of haploid daughter nuclei**. At the same time, the cytoplasm develops v**acuoles** and gives numerous **cytoplasmic masses**. The daughter nuclei pass into each **cytoplasmic mass** and develop into slender **sickle-shaped sporozoites** are formed in each Oocyte. This phase of asexual multiplication is known as **sporogony.**

Lastly, the **Oocyte** brusts and sporozoites are liberated into the **haemolymph** of the mosquito. They spread throughout the **haemolymph** and eventually reach the salivary glands and enter the duct of the **hypopharyx**. The mosquito is now becomes **infective** and sporozoites get **inoculated or injected** the human blood when the mosquito bites. The cycle is repeated.

Incubation period:

The period between infection and the appearance of first symptoms is called incubation period. It is about **10-14 days in Plasmodium vivax.**

Pre-patent period:

The duration between the initial sporozoites infection and the first **appearance of parasites in the blood** is called as pre-patient period**. It is about 8 days in Plasmodium vivax.**

Symptoms of malaria

- Mouth becomes dry, nausea and loss of appetite

. Headache, muscular pain and joint pain

- Chill, fever (106° F) and sweating all **every 48 hours.**
- Chill to sweating lasts **for 8-10 hours.**
- Liver and spleen become enlarged.
- Due to loss of RBC's **anaemia is** caused.

Malaria can be controlled by four ways

1. Destruction of vector
2. Prevention of infection(prophylaxis)
3. Treatment of patient(**Quinine; Paludrine** kills almost all stages of parasite. **Daraprim** (single dose of 25 mg) is the most effective drug.)
4. Public awareness

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