
TORTORA • FUNKE • CASE

Microbiology

AN INTRODUCTION

EIGHTH EDITION

Microbial Diseases of the Central Nervous System (Part II)

Lecture 2

PowerPoint® Lecture Slide Presentation prepared by Christine L. Case

Microbial Diseases of the CNS II

❖ Topics to be covered:

✓ ***Viral meningitis***

- *Non-polio enteroviruses*
- *Mumps virus*
- *Herpesviruses, (EBV, HSV, VZV)*
- *Measles virus*
- *Influenza virus*
- *Arboviruses, such as West Nile virus*
- *Lymphocytic choriomeningitis virus*

Microbial Diseases of the CNS II

❖ Topics to be covered:

✓ ***Viral encephalitis***

- *Prions and slow viruses*
- *Rabies*
- *Arboviruses*
- *Poliovirus and Enteroviruses*

✓ ***Other parasitic infections:***

- *Toxoplasmosis*
- *Malaria*
- *Hydatid disease*

Parasitic Infections

- 1. Toxoplasmosis



Toxoplasma gondii

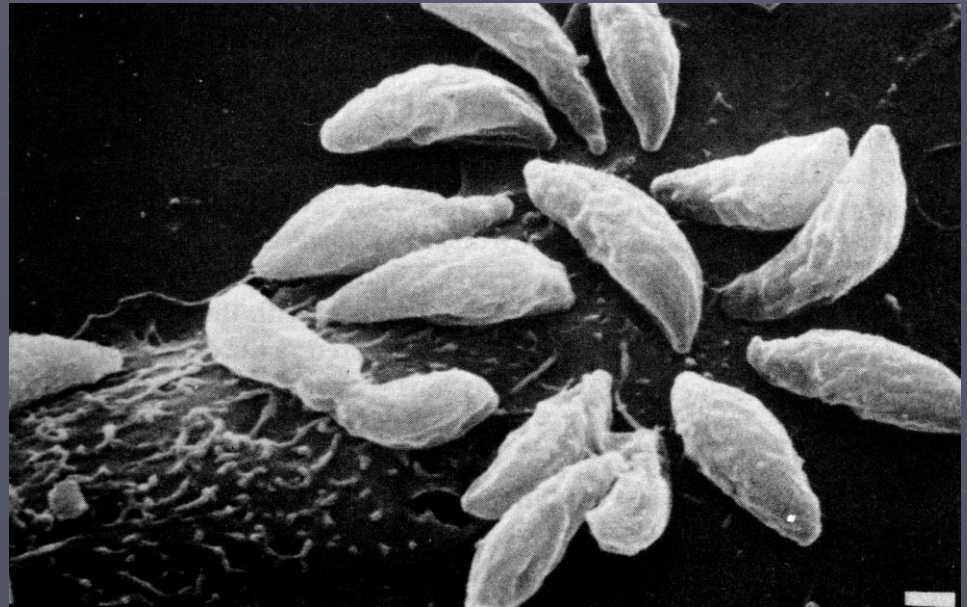
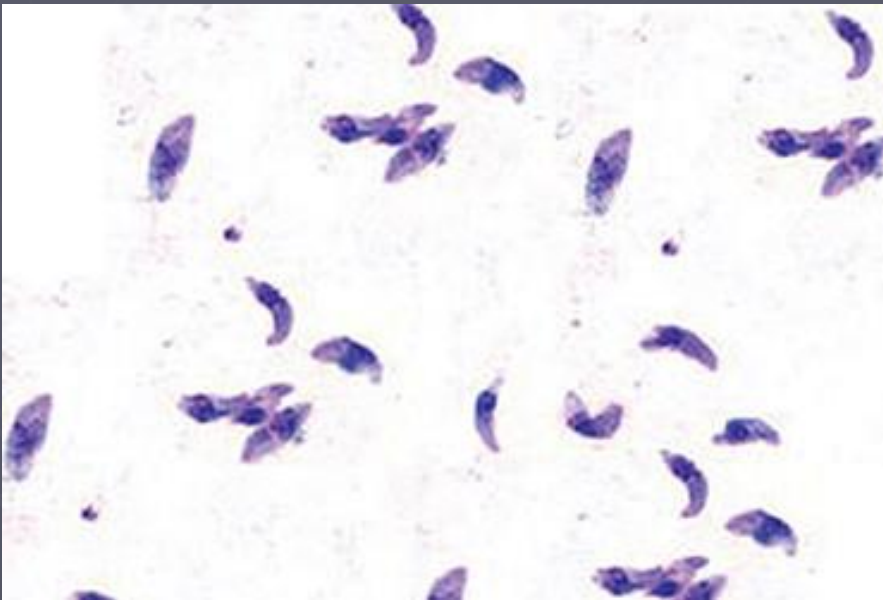
► **Epidemiology:**

Worldwide distribution. Definitive host is the cat.
5-50% of people in various regions are seropositive.

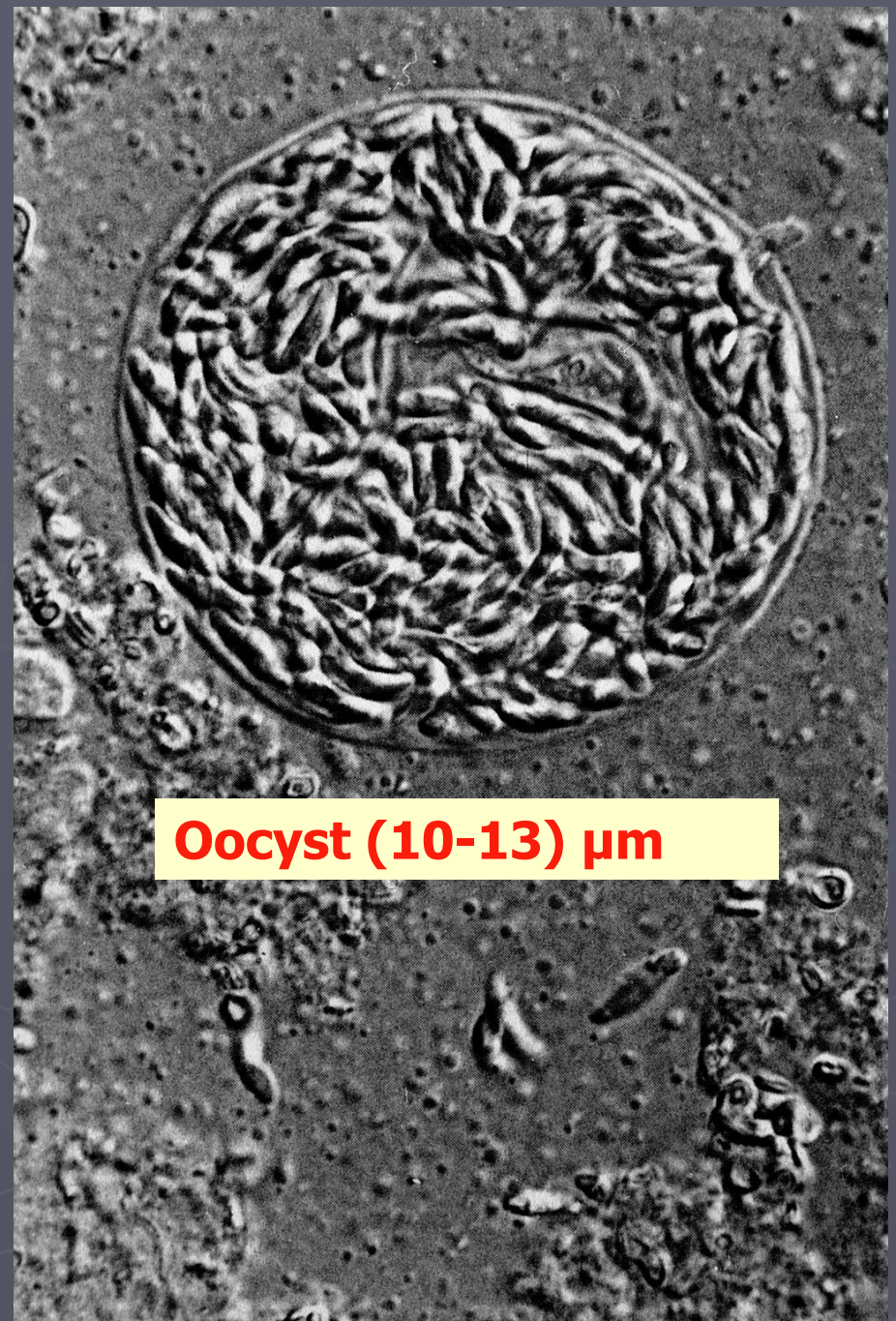
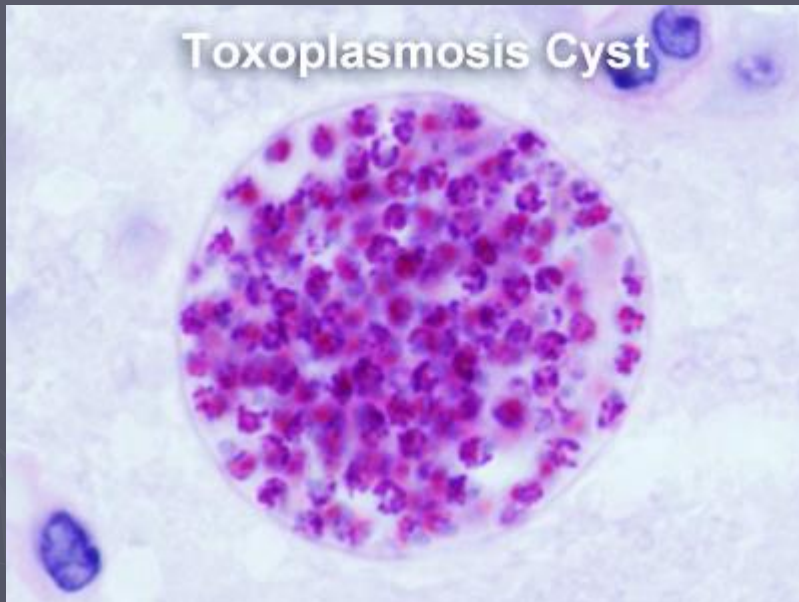
► **Mode of transmission:**

- Contaminated food/water
- Ingestion of raw or undercooked meat
- Unpasteurized goat milk
- Untreated drinking water
- Transplacental infection
- Organ transplant or blood transfusion (rare)

Morphology



Tachyzoite (intracellular parasite)



Clinical manifestations

- ▶ **Immunocompetent host:** Asymptomatic
- ▶ **Immunocompromised host:** Reactivation disease
- ▶ **Congenital infection:** Consequences depend upon the gestational age of the fetus. Spontaneous abortion, **CNS damage**, eye involvement



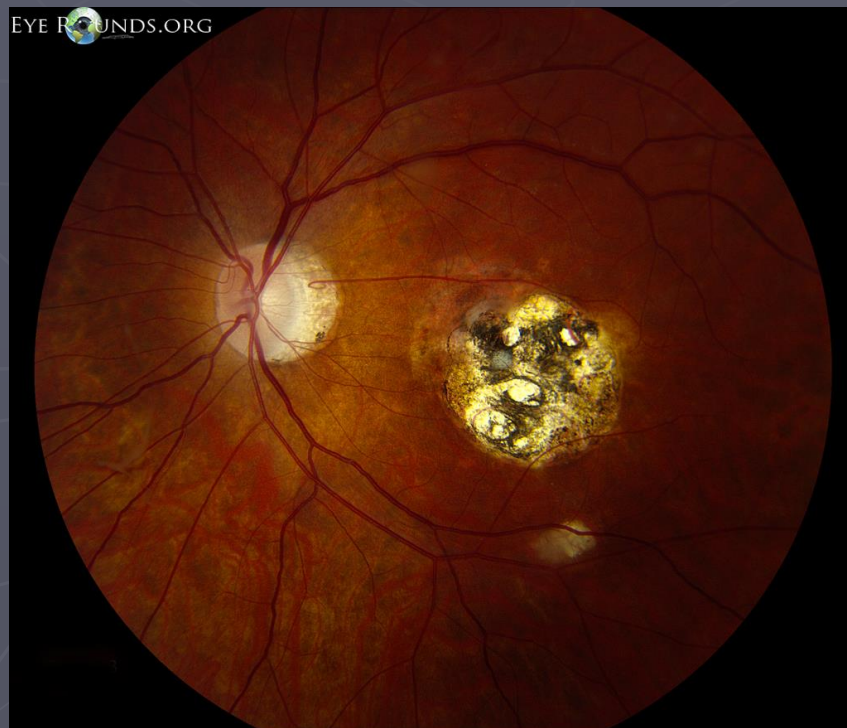
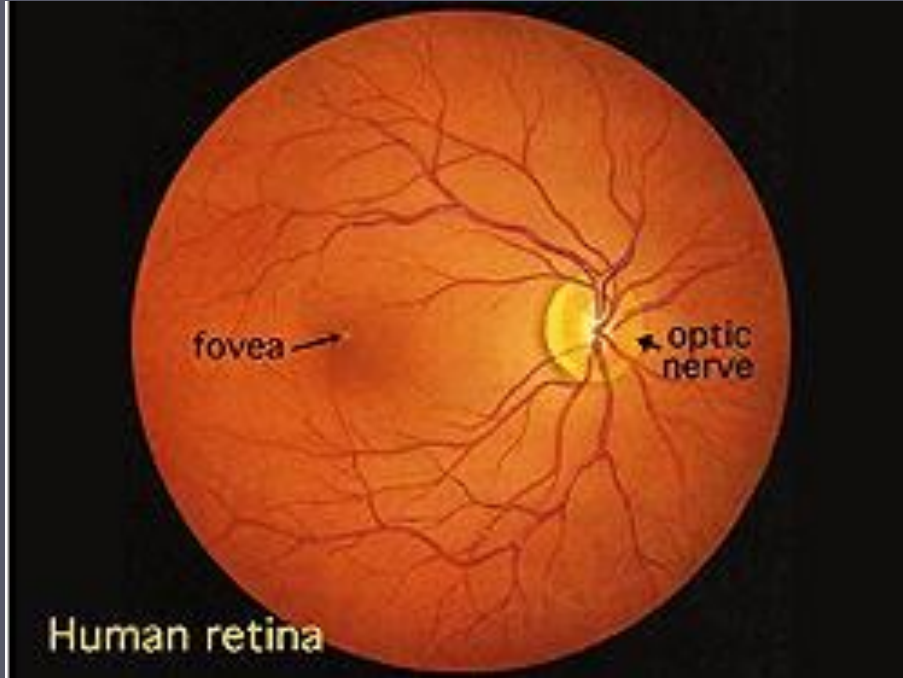
➤ **Toxoplasmosis may cause encephalitis.**

➤ **Symptoms may include:**

Confusion, poor coordination, muscle weakness, seizures and changes in alertness.

Pathology

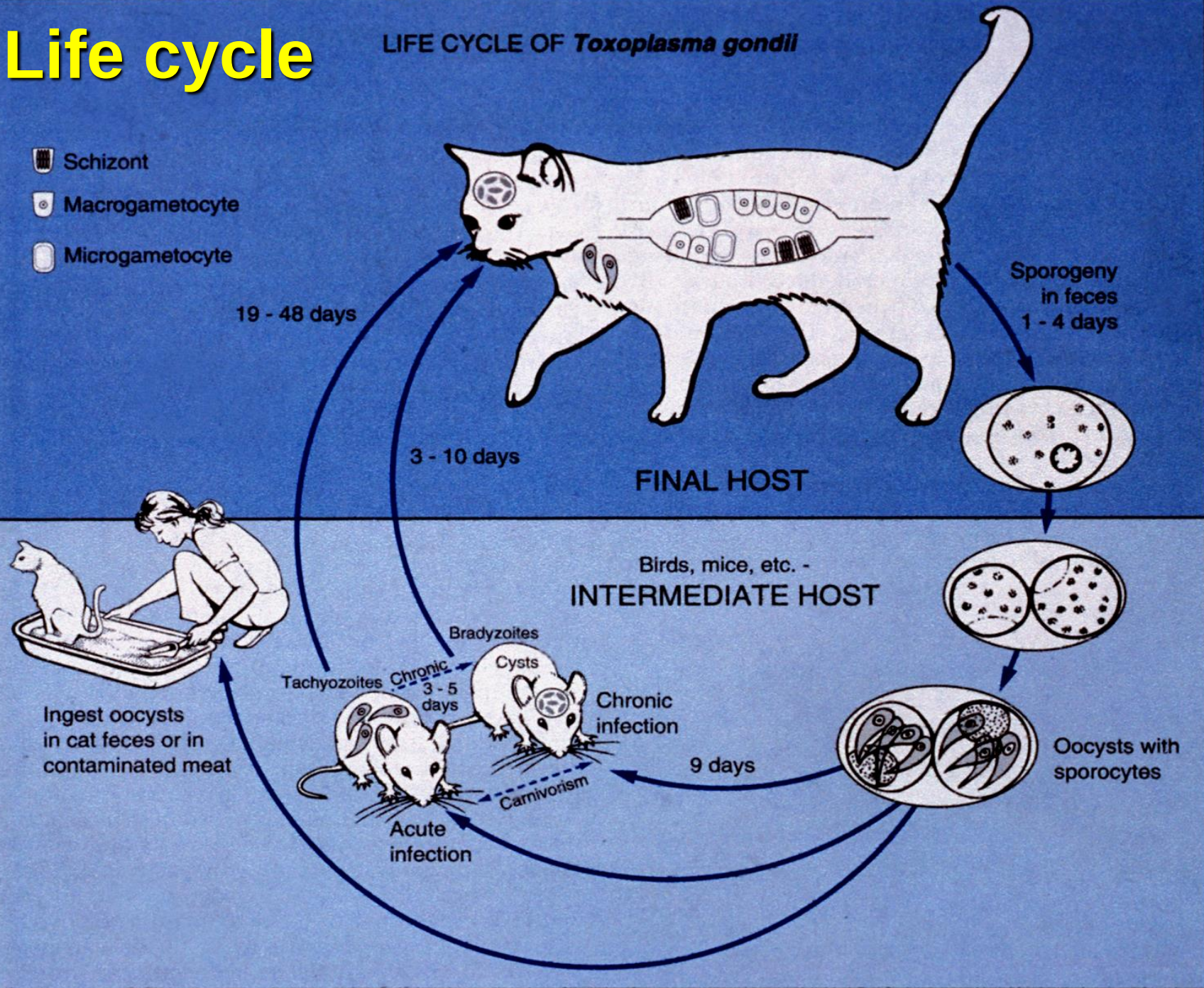
- ▶ Brain, lungs, liver, eyes are especially affected (**Toxoplasmic retinitis**)
- ▶ Cell-mediated immunity is important in suppressing signs of infection



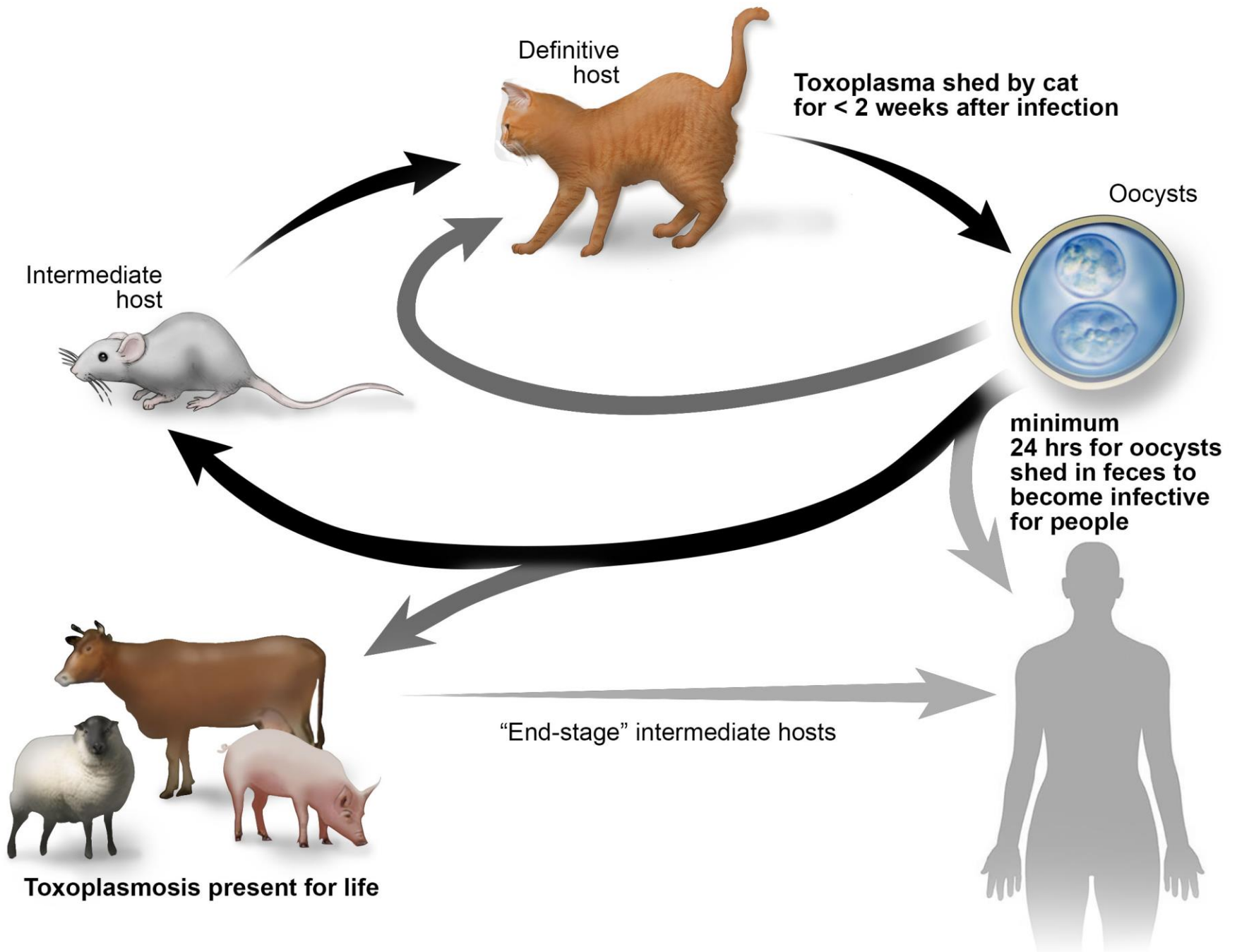
Life cycle

LIFE CYCLE OF *Toxoplasma gondii*

-  Schizont
-  Macrogametocyte
-  Microgametocyte

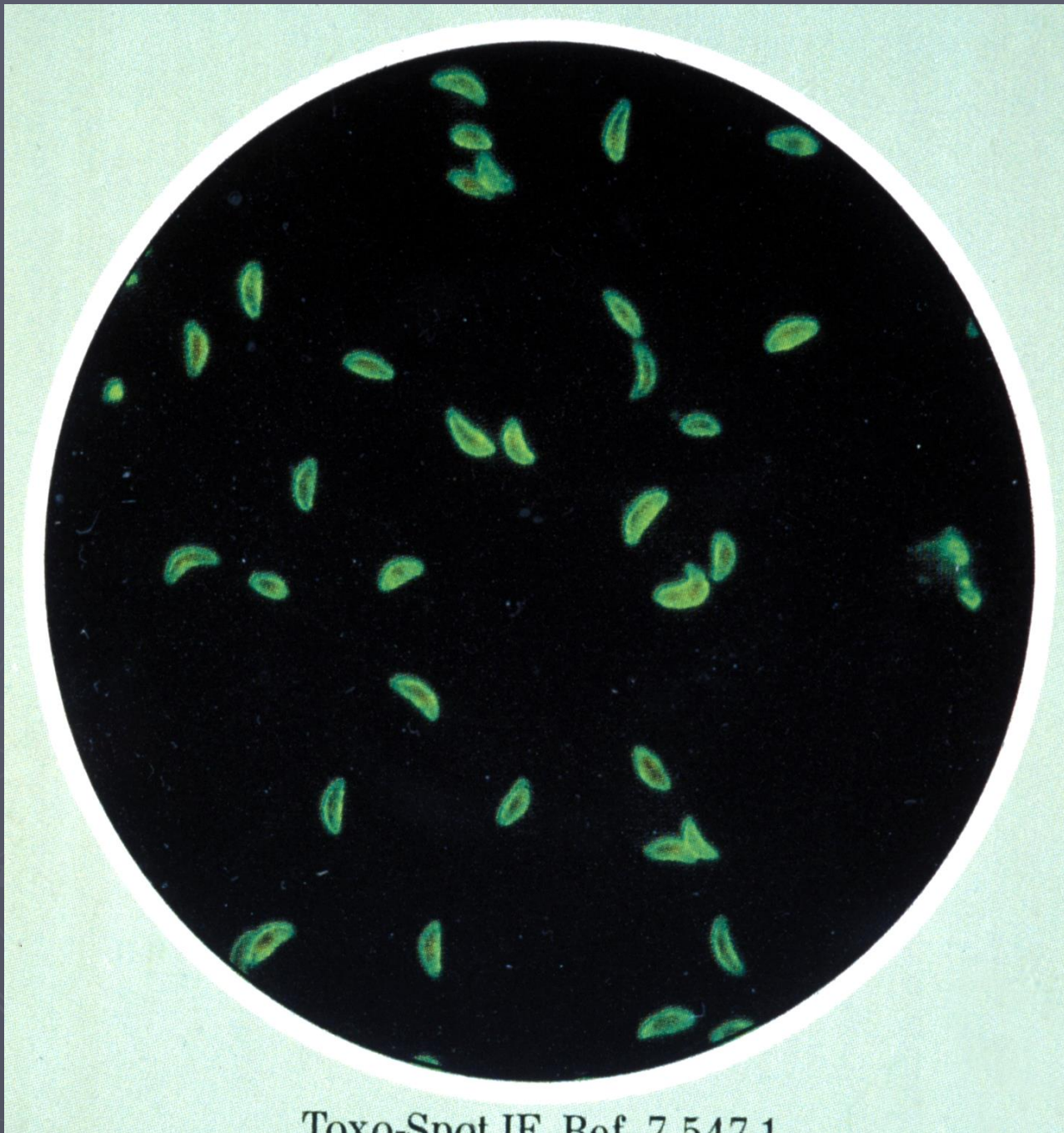


Life cycle of Toxoplasma



Laboratory diagnosis

- ▶ Diagnosed by enzyme immunoassay for **IgM antibody (acute)** or IgG antibody (chronic)
- ▶ **Banana-shaped trophs.** can be seen in Giemsa-stained blood smears during acute-phase infection from mice inoculated with patient samples



Toxo-Spot IF Ref. 7 547 1

Treatment

- ▶ No treatment is needed for healthy persons who are not pregnant.
- ▶ Combination of **sulfadiazine** and **pyrimethamine** for 3-4 weeks is recommended for **pregnant woman** with demonstrated acute infection.
- ▶ Also, persons with weakened immune systems.

Parasitic Infections

- **2. Malaria**



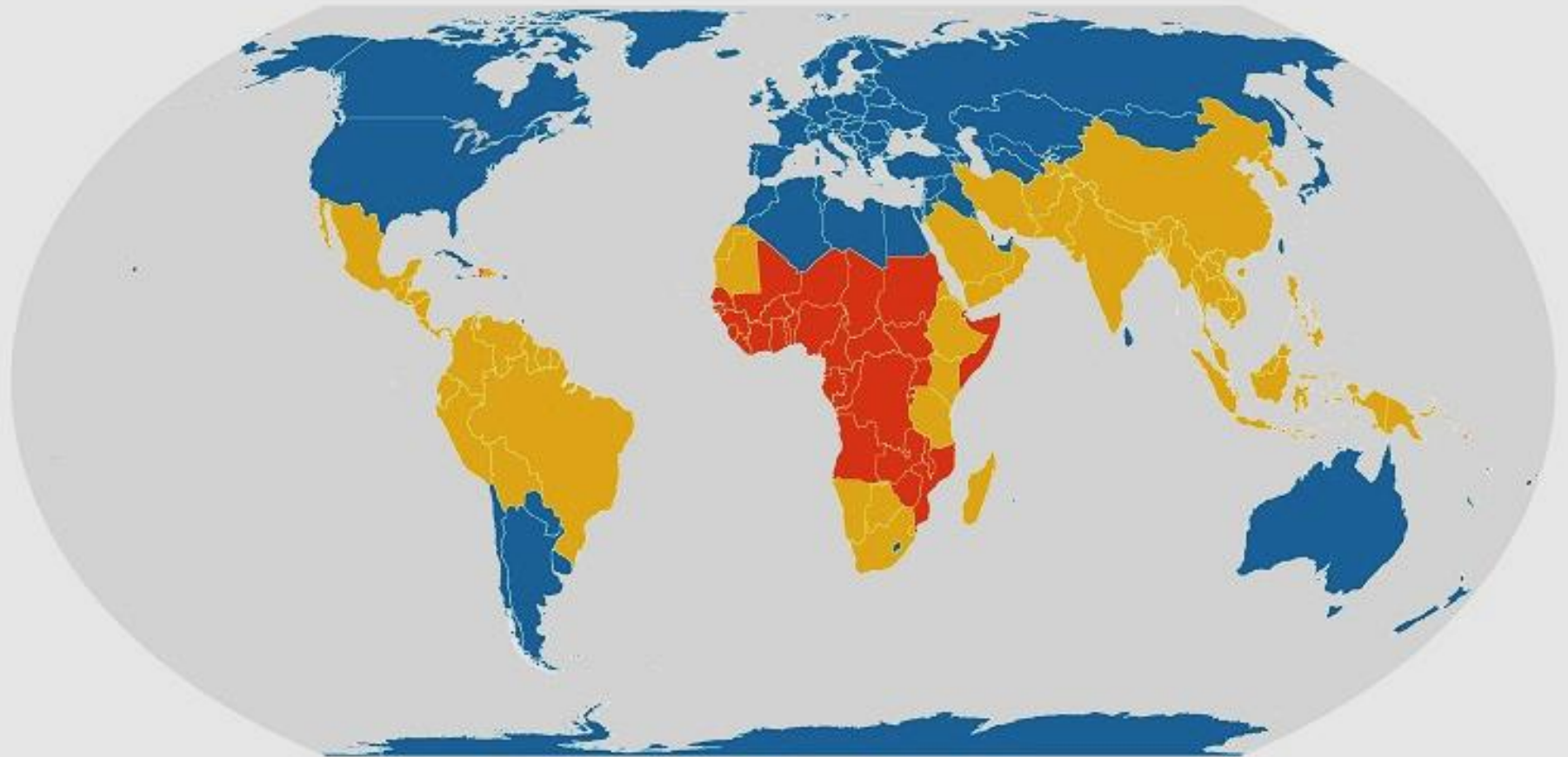
Malaria

- ▶ *Plasmodium* species: *P. falciparum*, *P. vivax*, *P. malariae*, *P. ovale*
- ▶ In addition, *P. knowlesi*, a type of malaria that naturally infects macaques in Southeast Asia, also infects humans ("*zoonotic*" malaria).
- ▶ Humans are the intermediate host for *Plasmodium*; the mosquito is the definitive host

Key facts

- In 2021, nearly **half of the world's** population was at risk of malaria.
- That year, there were an estimated **247 million cases** of malaria worldwide.
- The estimated number of **malaria deaths** stood at **619 000** in 2021.
- The WHO African Region carries a disproportionately high share of the global malaria burden.
- In 2021, the Region was home to **95% of malaria cases and 96% of malaria deaths**.
- **Children under 5** accounted for about **80%** of all malaria deaths in the Region.

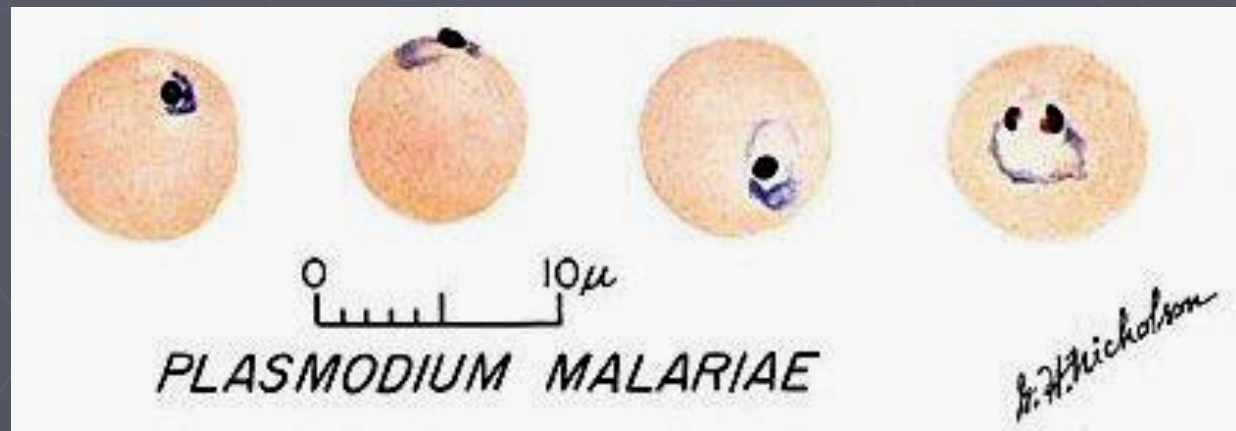
Epidemiology

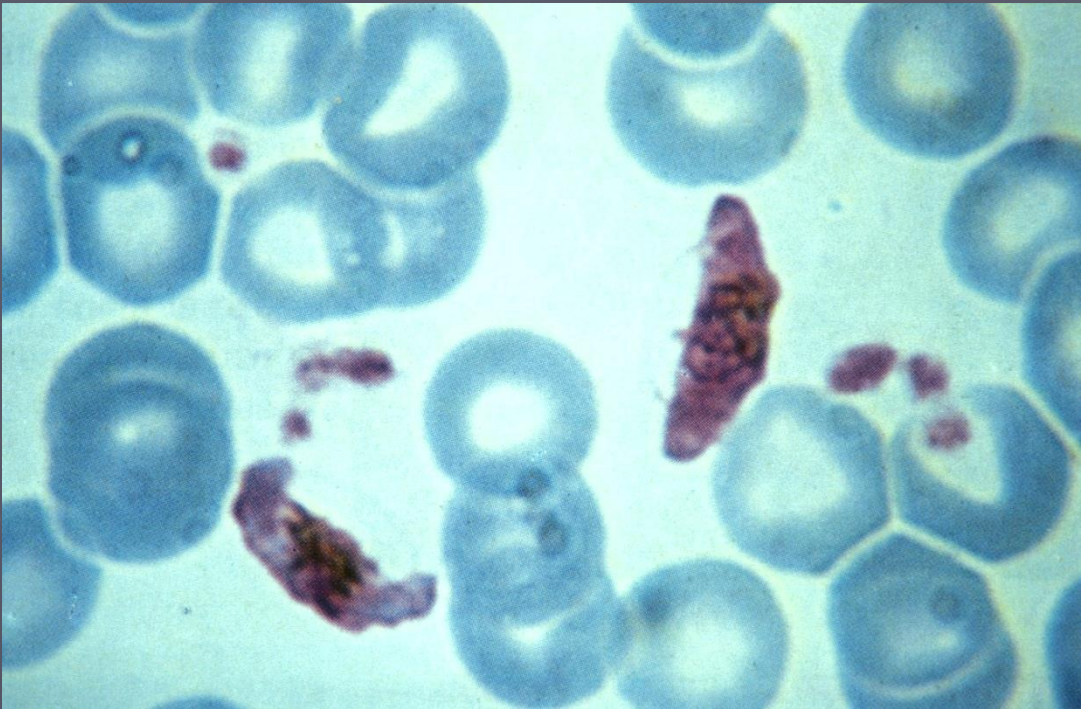
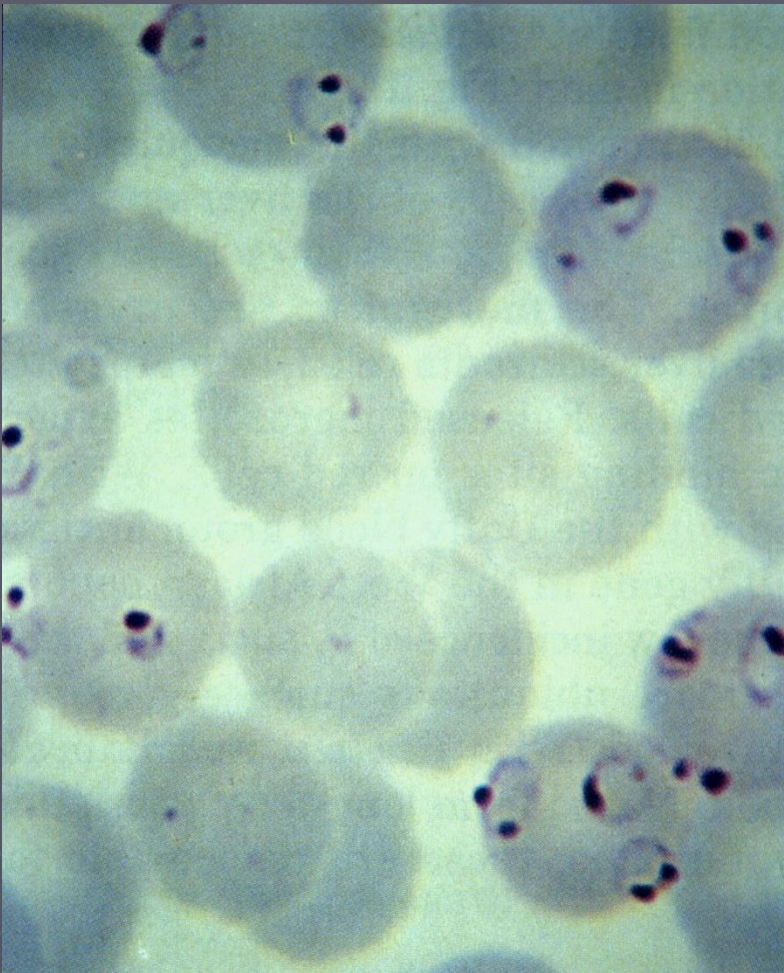


- Malaria transmission is not known to occur
- Malaria transmission occurs in some places
- Malaria transmission occurs throughout

Morphology

- ▶ Trophozoite (1-2 μm)
- ▶ Sexual forms (gametocytes)



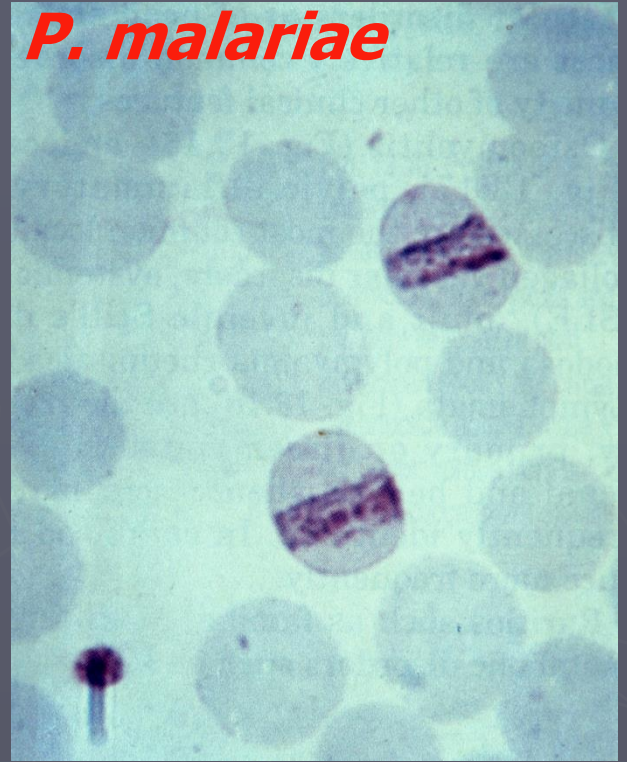


P. falciparum

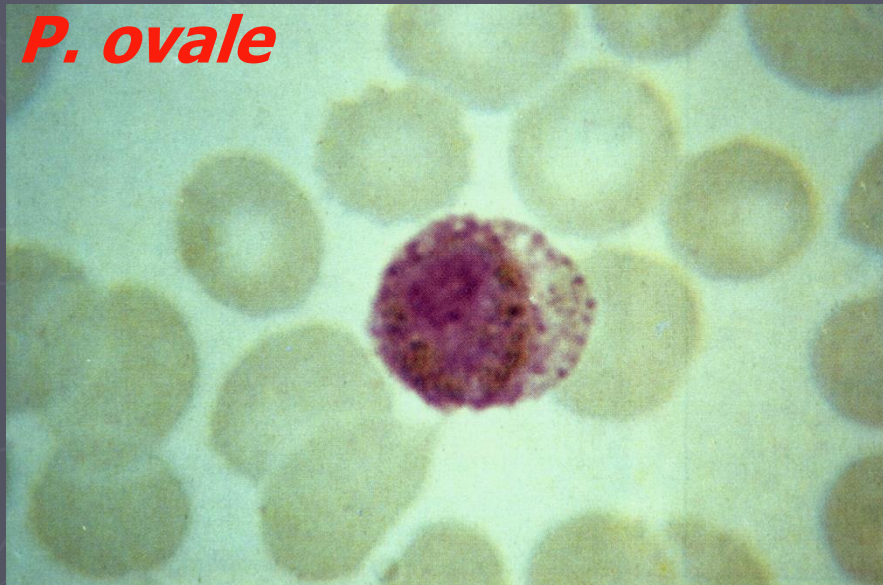
P. vivax

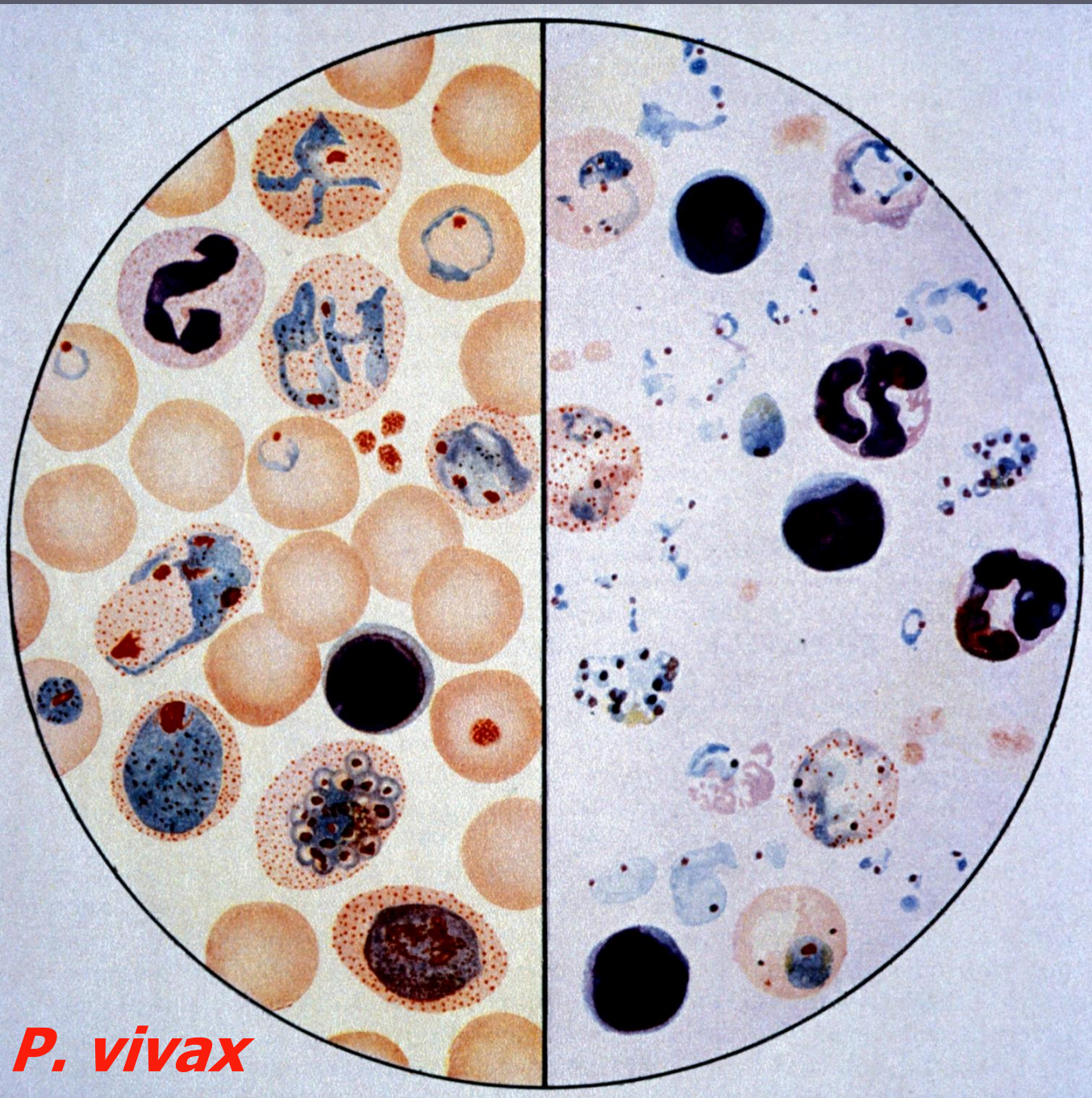


P. malariae

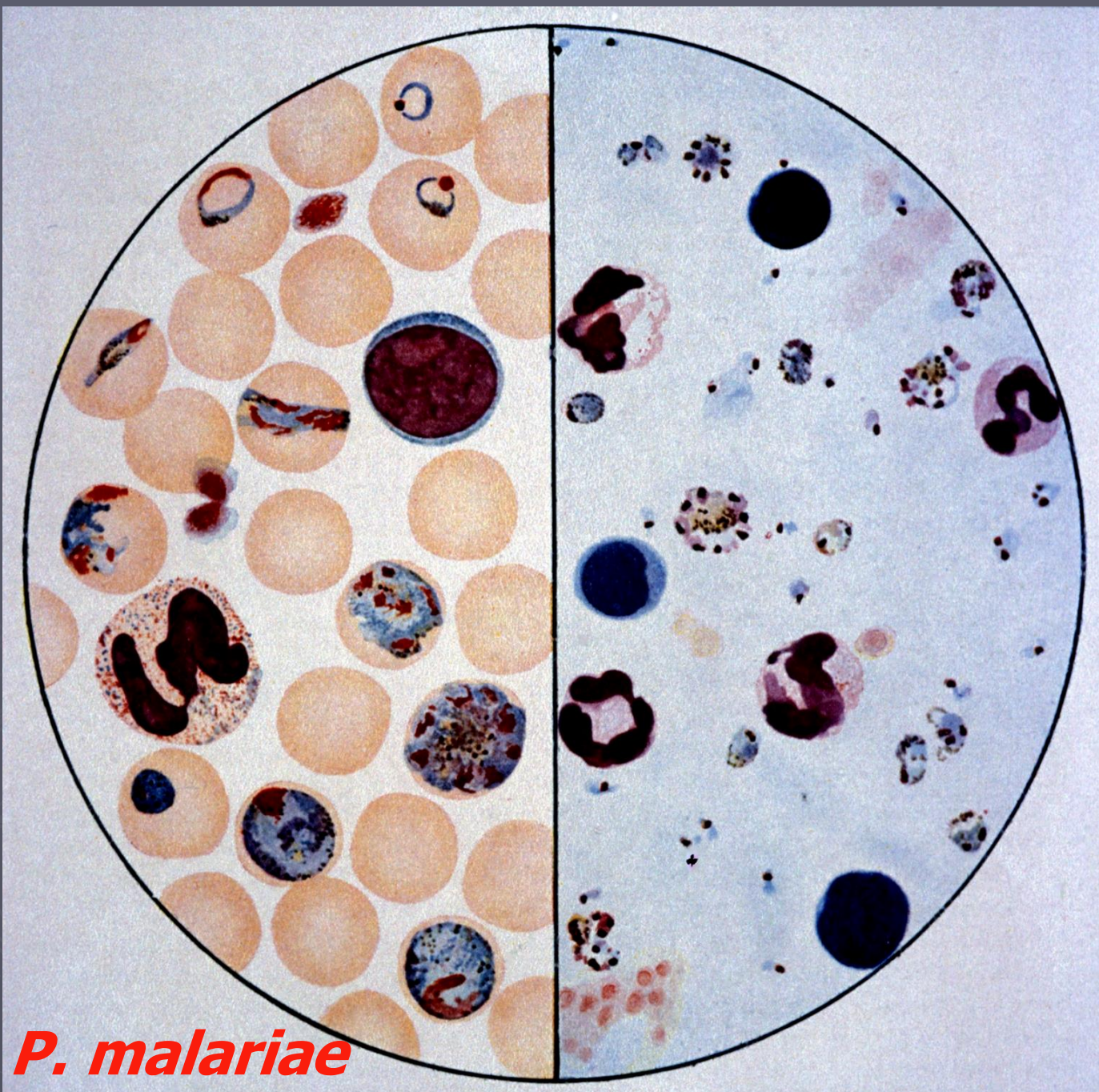


P. ovale

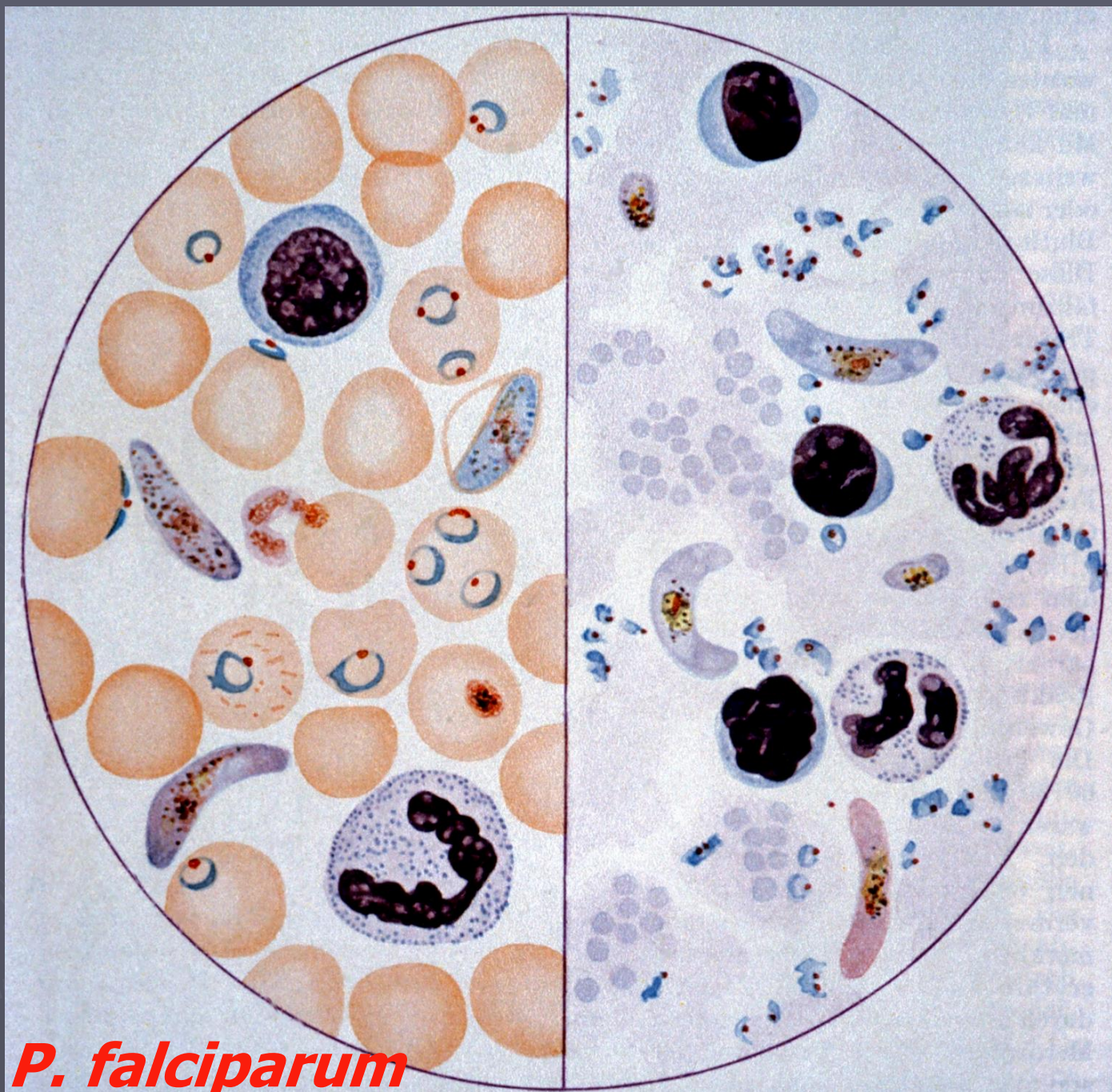




P. vivax



P. malariae



P. falciparum

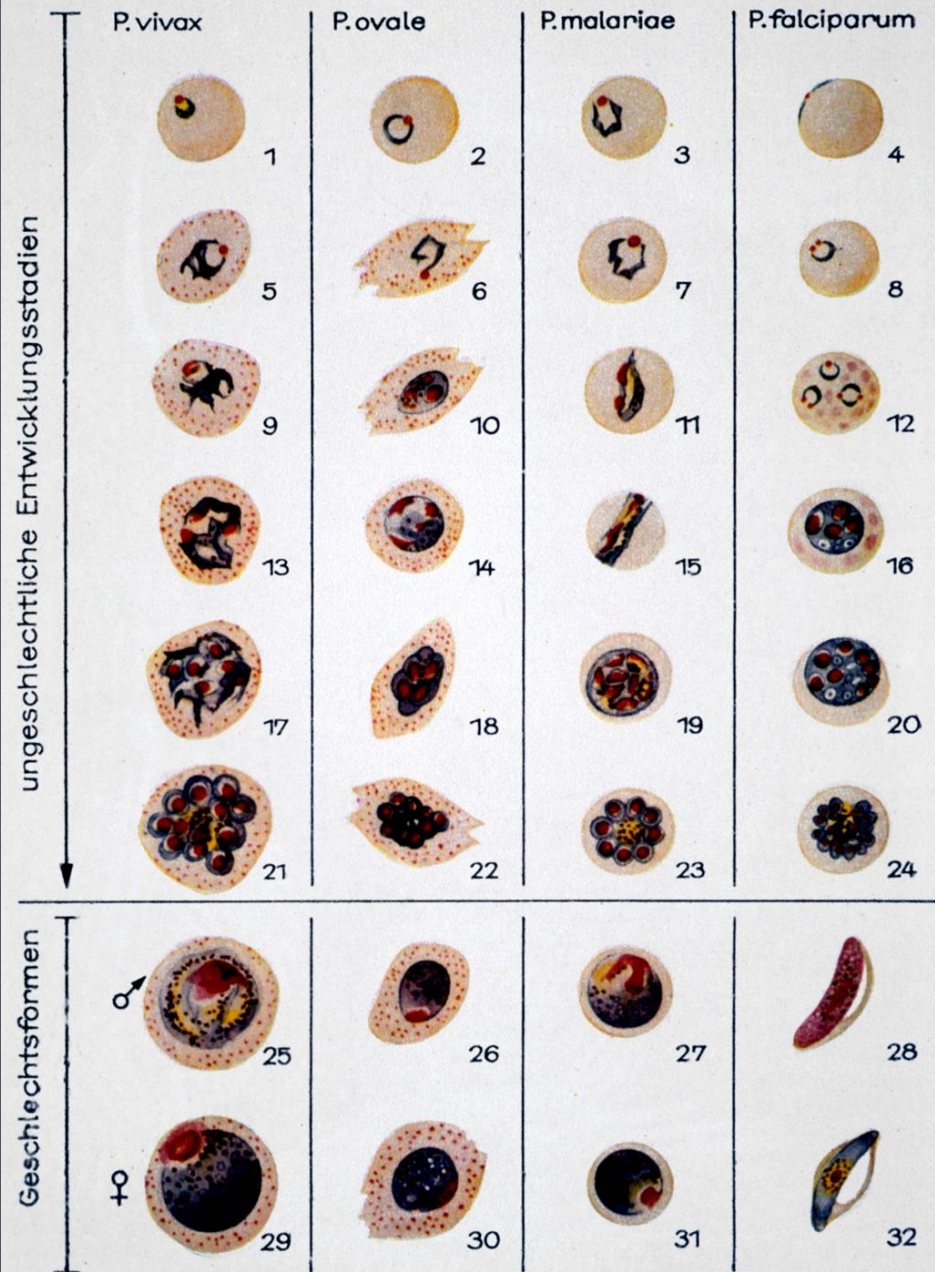


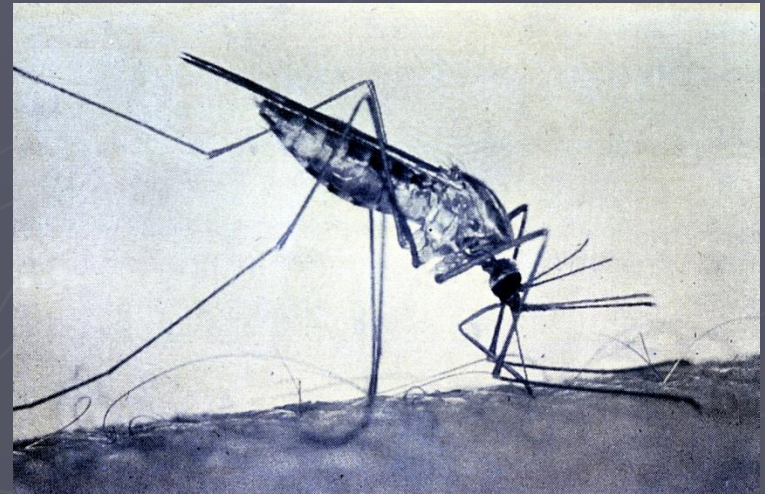
Abb. 115 Malaria plasmodien im Blutausschlag (Giemsa-Färbung). 1-4 junge Ringformen (ohne

Mode of transmission

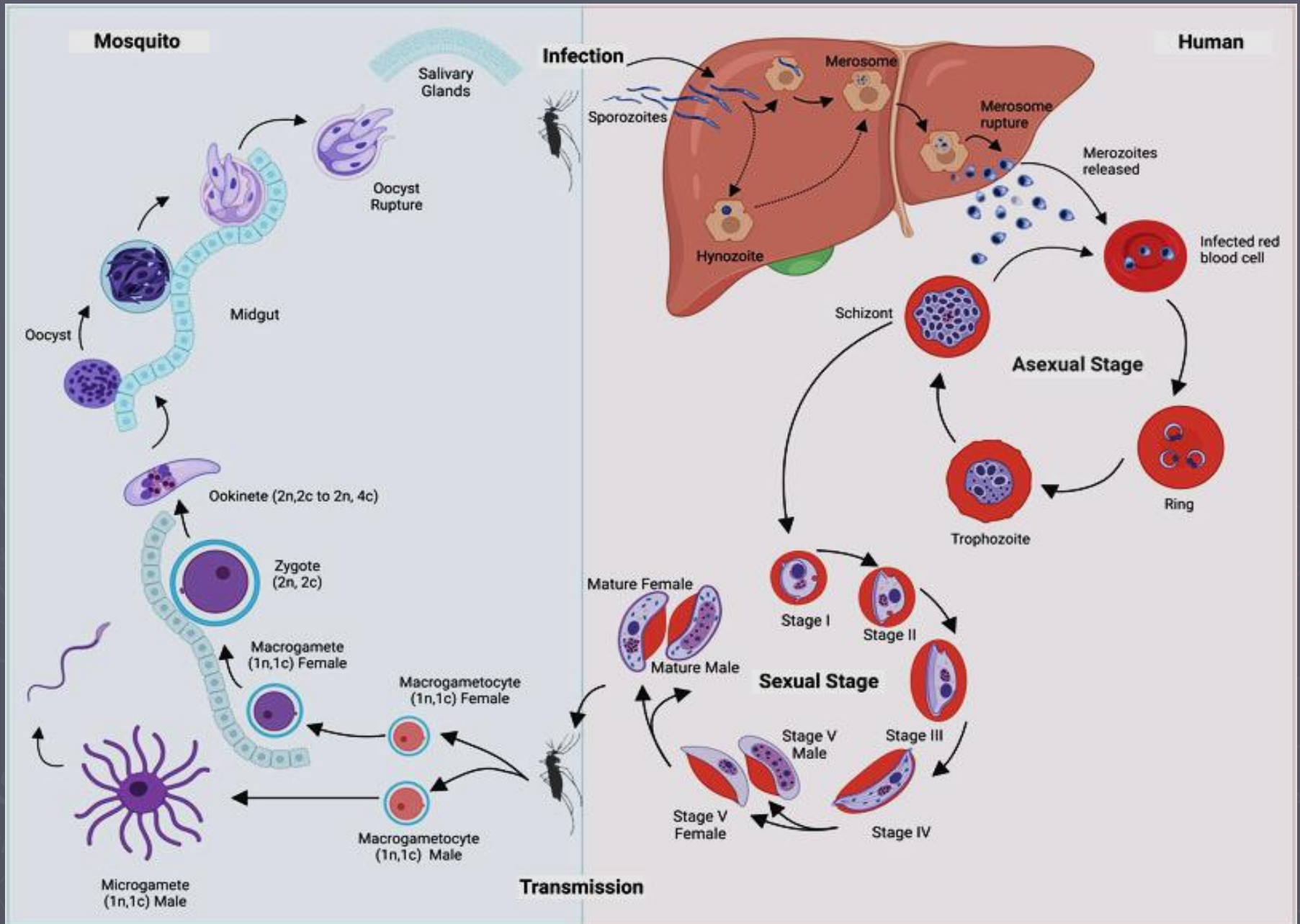
- Zoonotic transmission via female *Anopheles* mosquito, or (rarely) by inoculation of infected blood



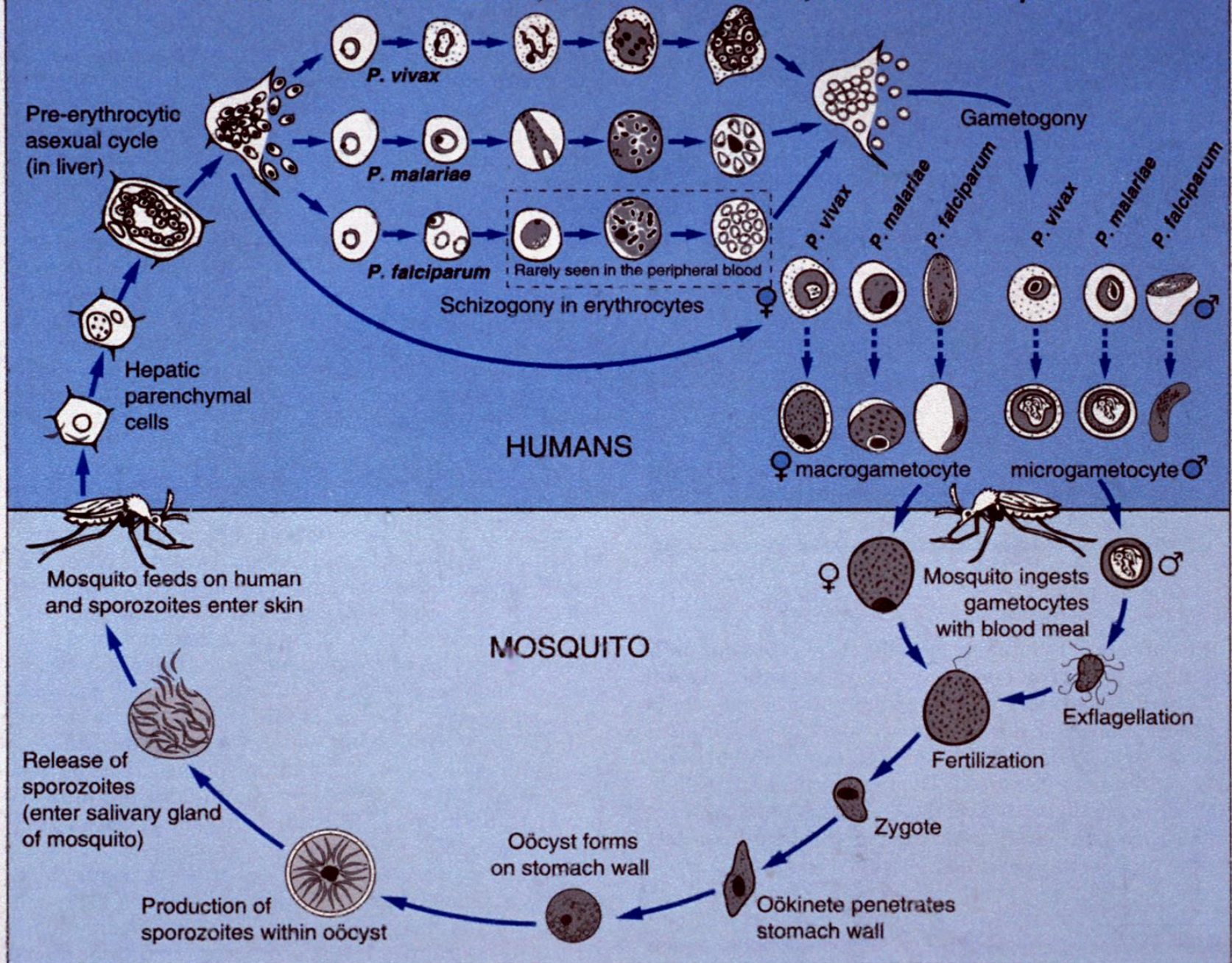
Figure 2: South American species of malarial mosquito (*Anopheles albimanus*) feeding from human arm.



Life cycle



LIFE CYCLE OF *Plasmodium vivax*, *Plasmodium malariae*, *Plasmodium falciparum*



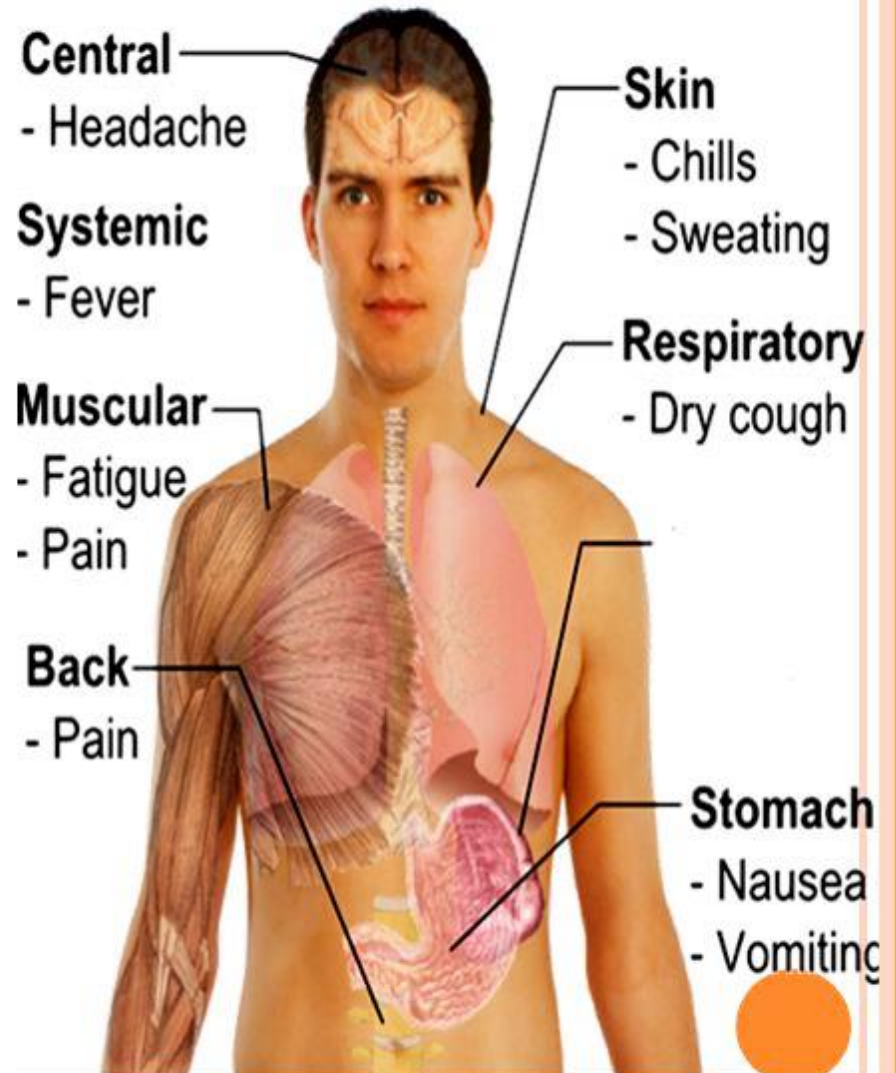
Clinical manifestations

- ▶ Abrupt onset fever (variable by of *Plasmodium* species)
 - *P. falciparum* (malignant tertian malaria)
 - *P. vivax* (benign tertian malaria)
 - *P. ovale* (ovale tertian malaria)
 - *P. malariae* (quartan malaria)
- ▶ Symptoms also vary with the species but include chills, drenching sweats, anemia and splenomegaly

- ▶ *P. vivax* & *P. ovale* produce latent infection in the liver (relapses).
- ▶ *P. malariae*: quartan fever pattern 72h (every 4th day).
- ▶ Falciparum malaria causes **severe CNS manifestations** and can be life-threatening (80%).

Clinical Features

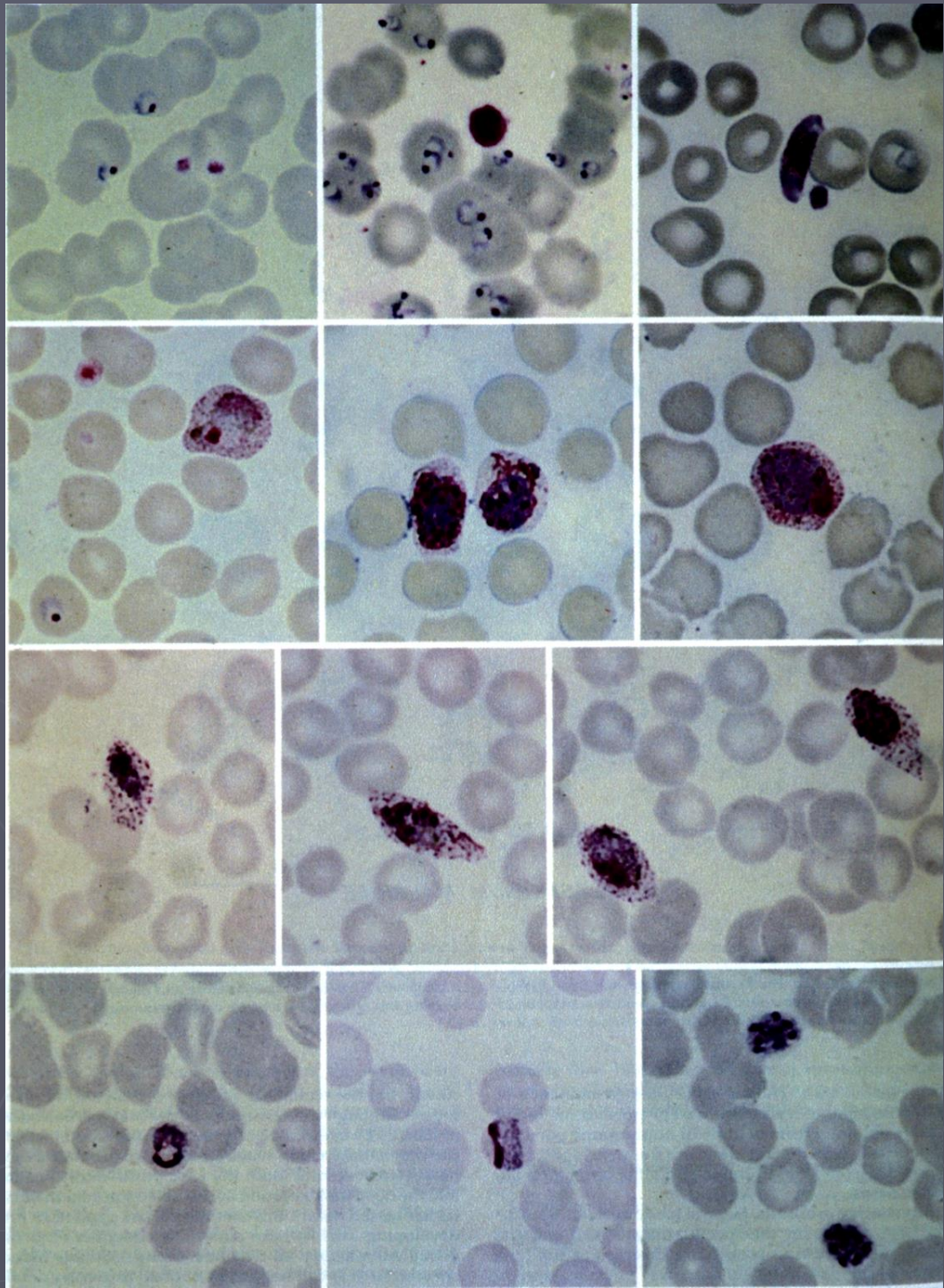
- ✦ Acute falciparum malaria is potentially fatal.
- ✦ Symptoms of malaria.



Pathology and Immunology

- ▶ RBCs destruction, both due to parasite lysis and splenic sequestering
- ▶ Abs are against merozoites & schizonts
- ▶ RES (Macrophages): infected RBCs
- ▶ Abs-coated merozoites
- ▶ cell mediated immunity

Diagnosis



Treatment & control

- ▶ Quinine derivatives as quinine sulphate, chloroquine, meflaquine and primaquine
- ▶ Prophylaxis: Eliminates bloodstream forms before other cells are infected



Parasitic Infections

- 3. Hydatid disease (Cystic echinococcosis, CE)



*A case **fatality rate of 1.94%** and a **mortality rate of 3.1** per 100.000 inhabitants were registered (PLOS One. 2014)*

Echinococcus granulosus & *E. multilocularis* (hydatid)

- ▶ Common in Asia, Australia, Eastern Africa
- ▶ The incidence is ~ (1-2 /1000) population
- ▶ About 2-3 millions human echinococcal infections occur each year worldwide,
- ▶ Hydatid disease accounts for about 95% of those infections.
- ▶ The smallest of all tapeworms (3-9 mm long)
- ▶ With only 3 proglottids



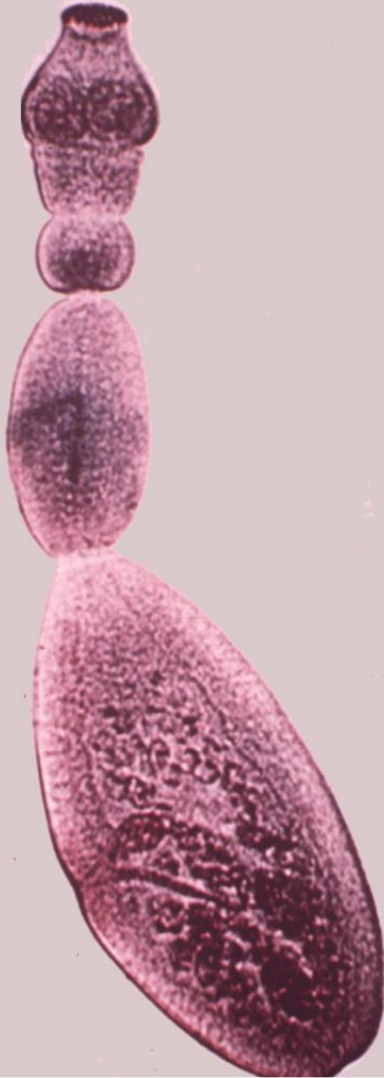
Echinococcus granulosus



adultes Stadium

- im Darm von Karnivoren
- 2,5 - 6 mm lang
- 3 - 4 Proglottiden

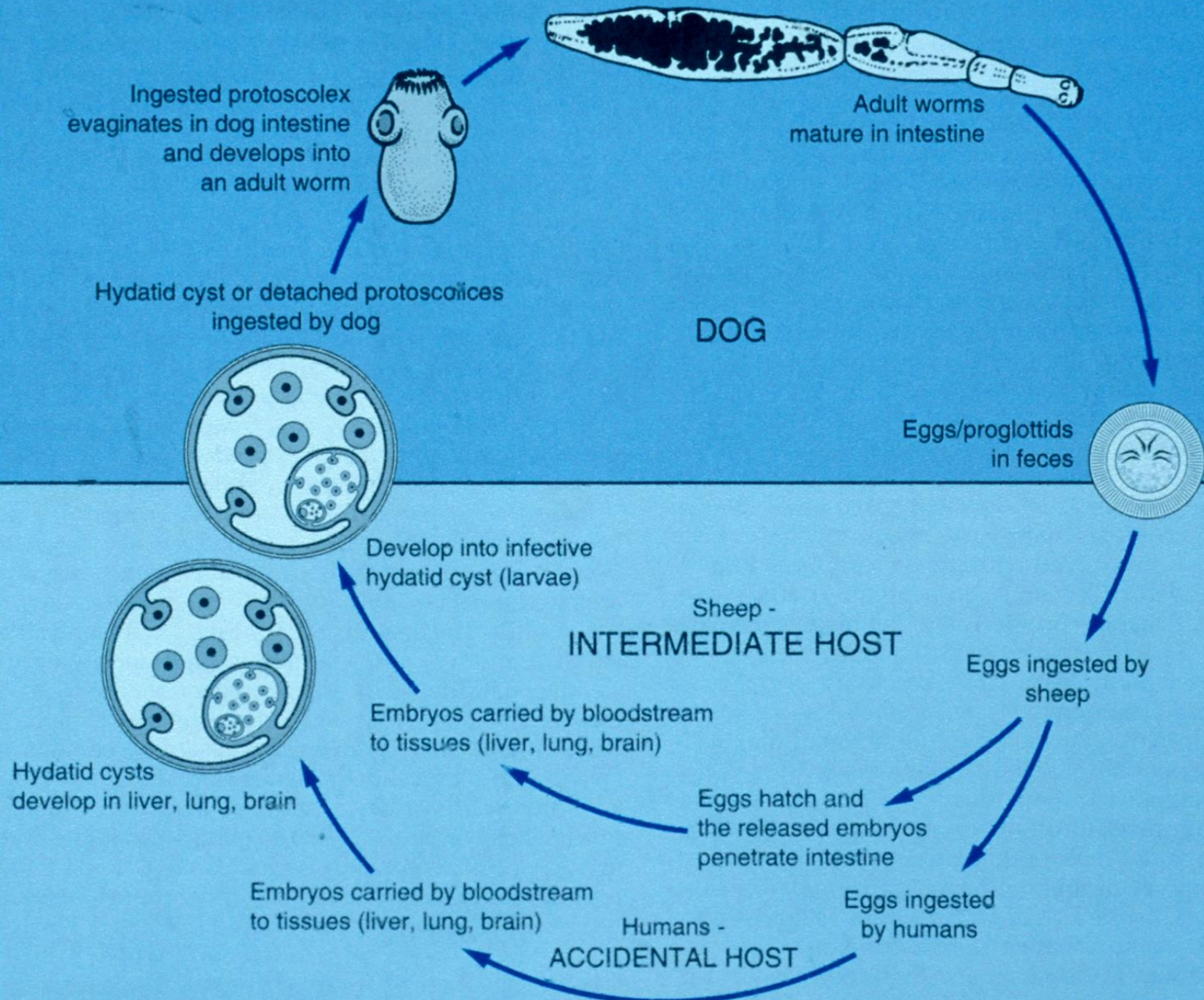
Echinococcus granulosus (hydatid) morphology



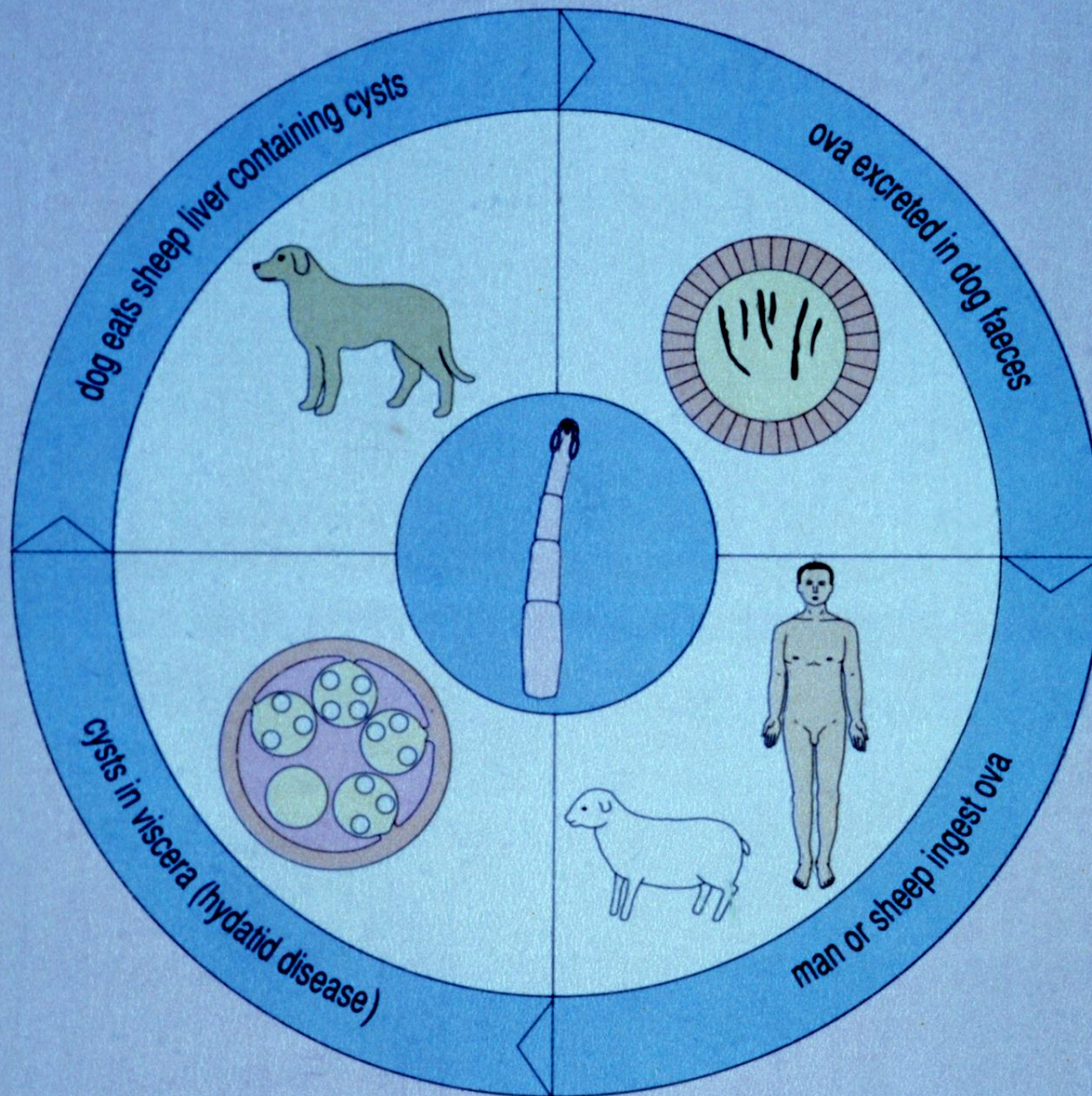


- ▶ Definitive hosts are **dogs** or other **canids**
- ▶ Intermediate host (**sheep**, goat, swine, cattle, horses, camel)
- ▶ For *E. multilocularis*, definitive host are **foxes**
- ▶ Intermediate host are small **rodents**

LIFE CYCLE OF *Echinococcus granulosus*, *Echinococcus multilocularis*



Cycle of Hydatid Infection



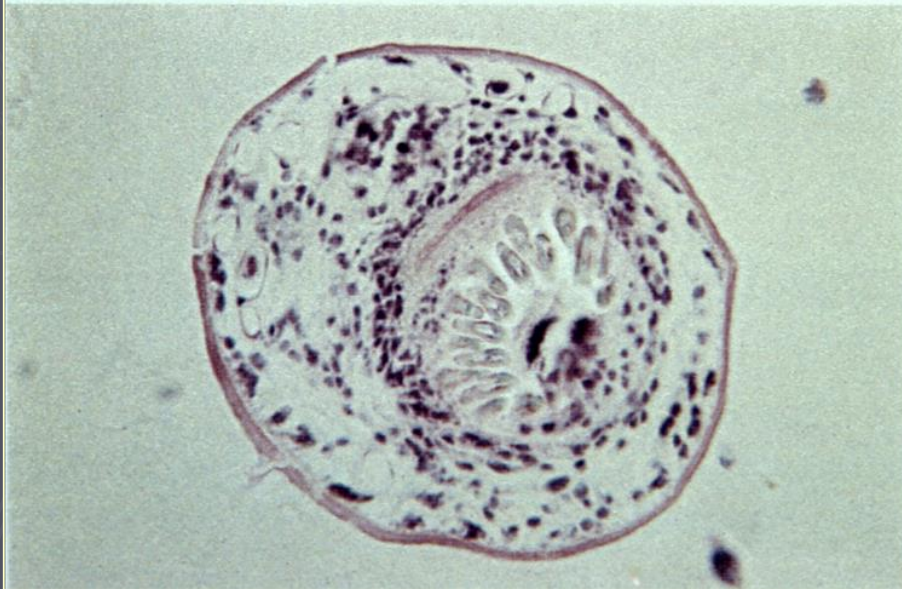
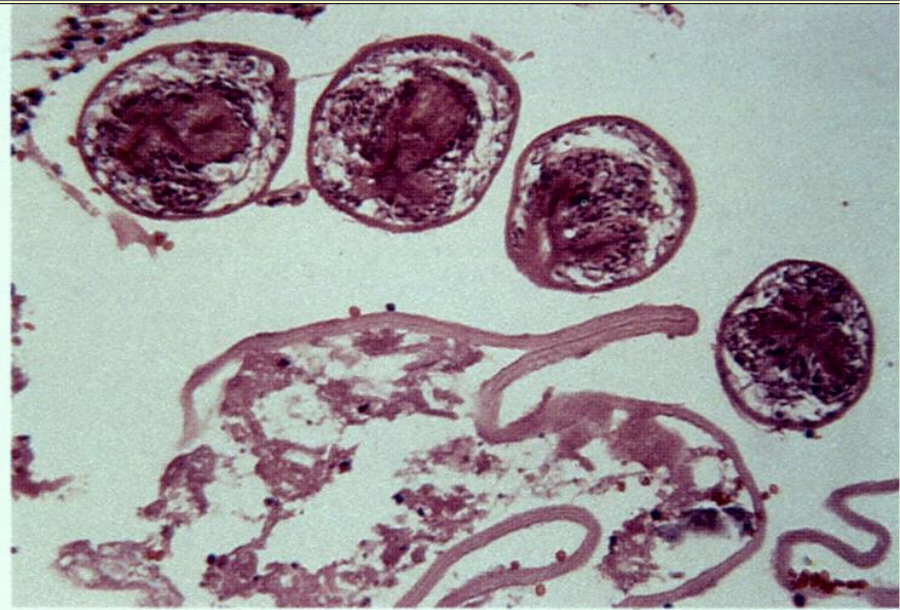
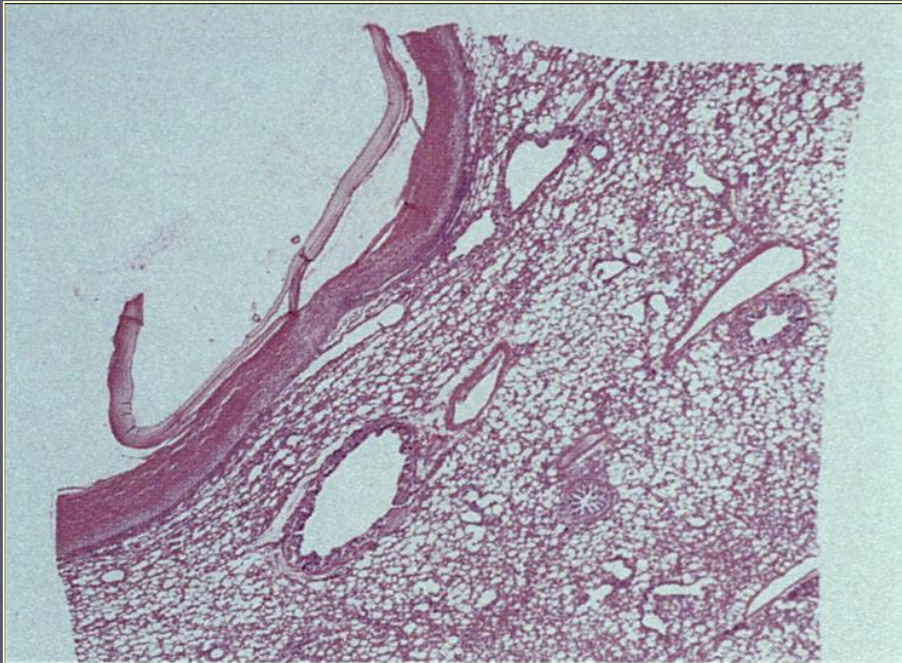
Symptoms

- ▶ Depend upon the location of the cyst:
- ▶ Liver cysts cause obstructive jaundice
- ▶ Peribronchial cysts (pulmonary abscesses)
- ▶ Brain cysts (intracranial pressure)
- ▶ Kidney cysts cause renal dysfunction
- ▶ The contents of a cyst may produce anaphylactic responses

Symptoms

- ▶ Hydatid cysts have a few characteristics that make them appear differently than simple liver cysts in imaging scans, including:
 - Collapsed cyst inside the cyst wall.
 - Multilayered cyst wall.
 - Thick or calcified cyst wall.

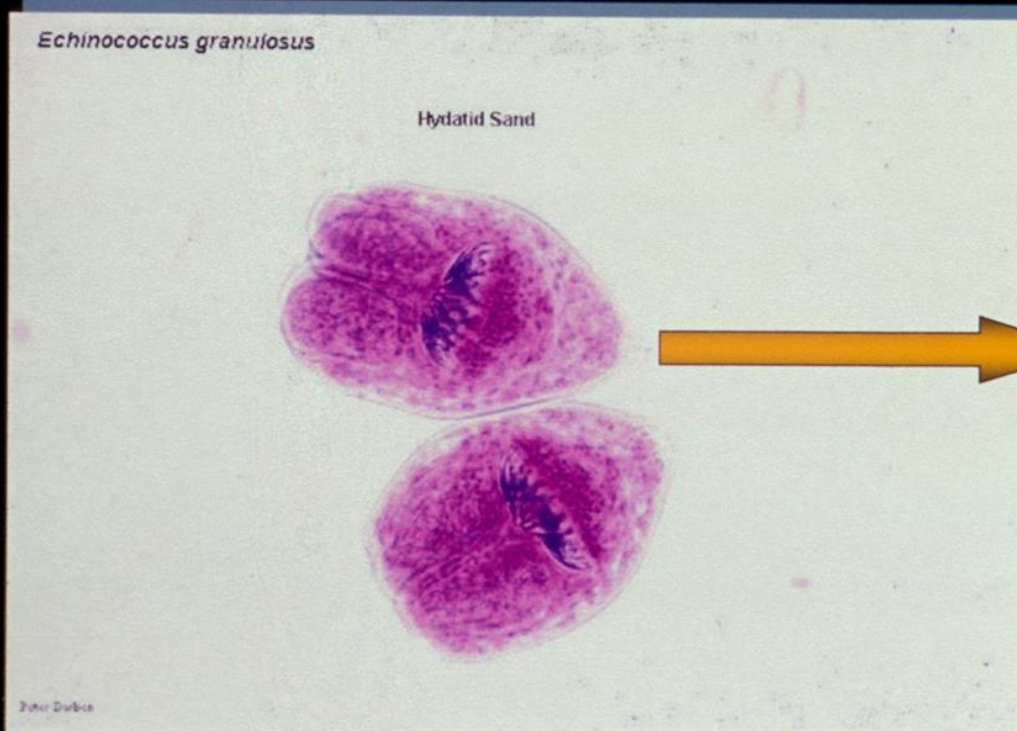




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Echinococcus granulosus (Hundebandwurm)



Endwirt

- Hund
- Fuchs u.a. Karnivoren

Zwischenwirt

- Schaf
- andere Wiederkäuer
- Pferd
- Schwein
- **Mensch!**

Protoscolices („Köpfchen“)

Echinococcus granulosus



Hydatide

- bis kindskopfgroß
- glatte Oberfläche
- mit wasserheller Flüssigkeit
- im Inneren Brutkapseln mit den Protoscolices

Echinococcus granulosus

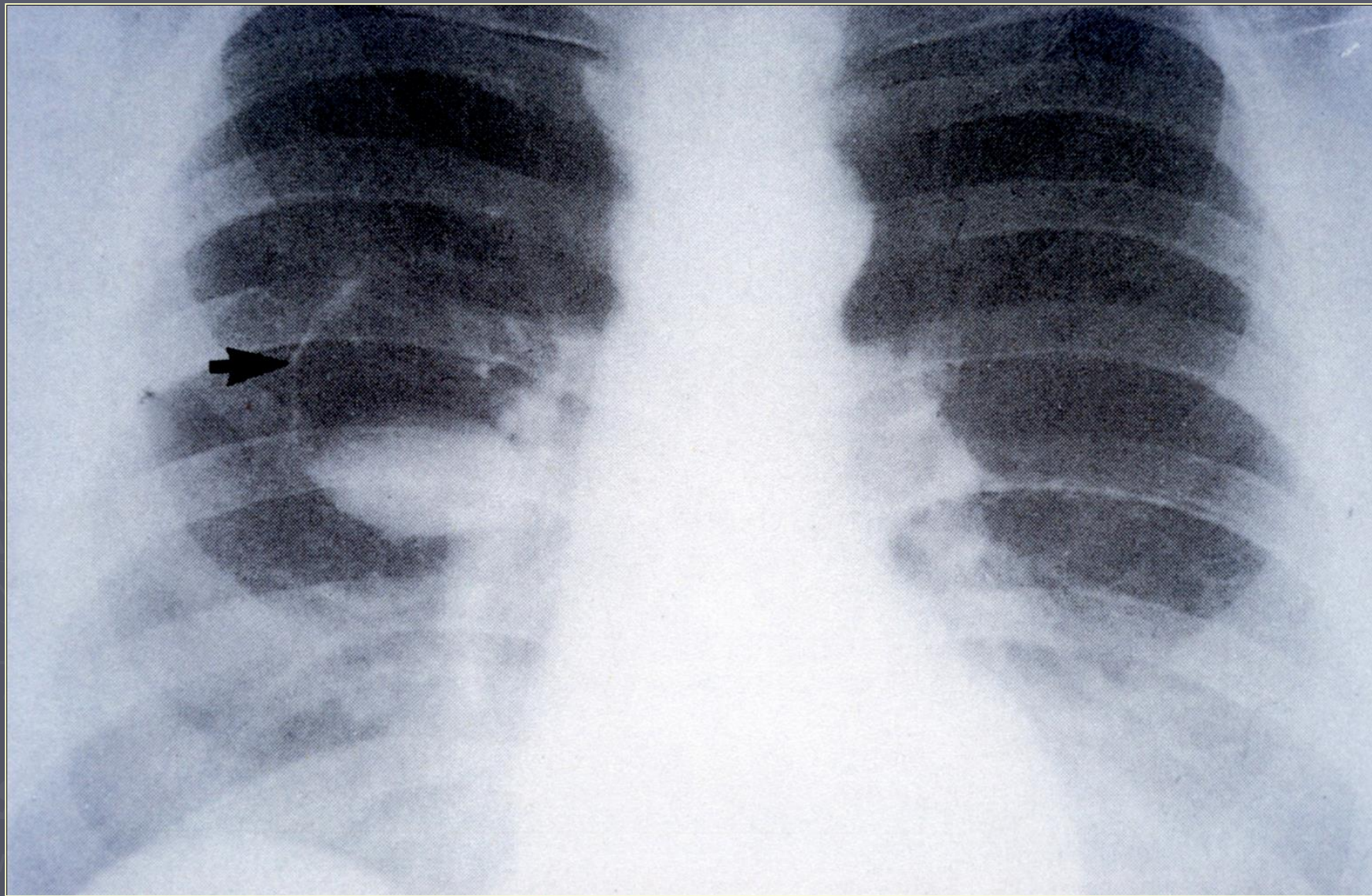


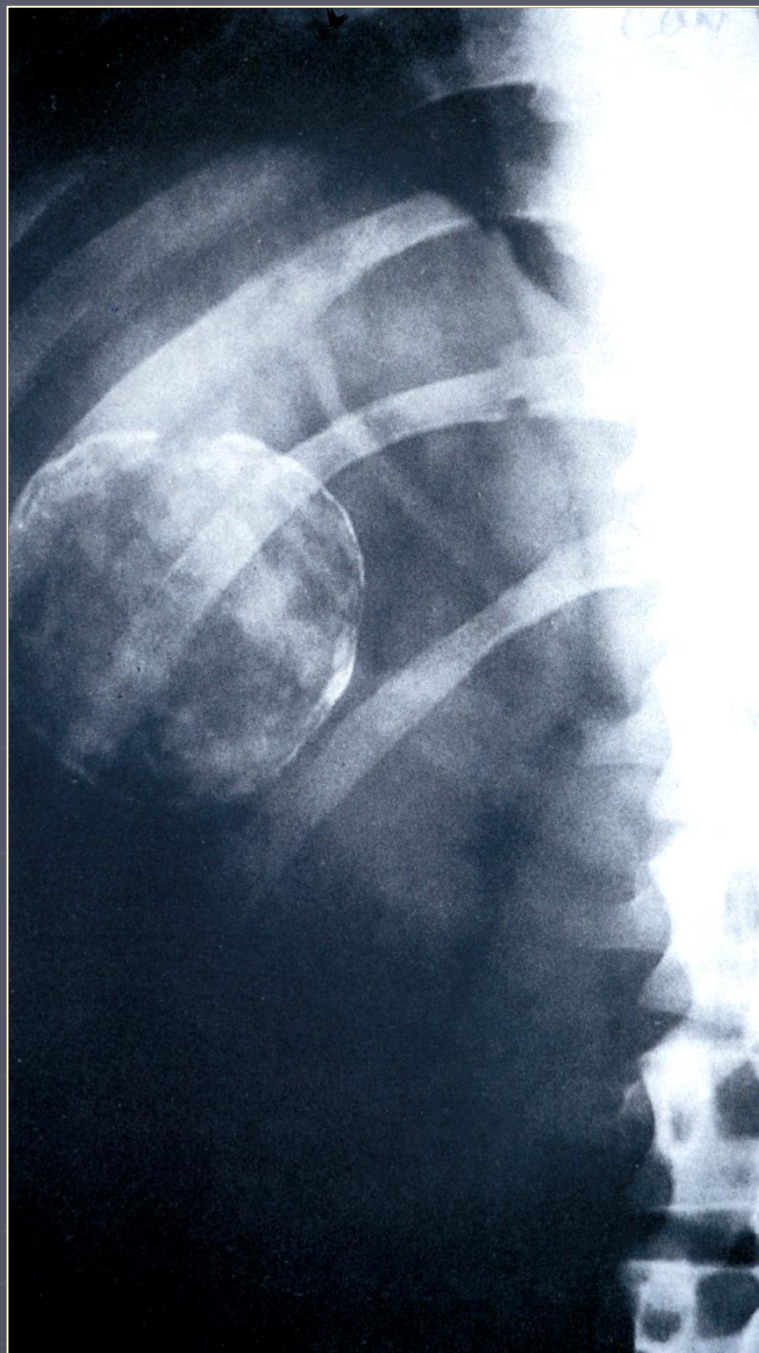
Hydatide

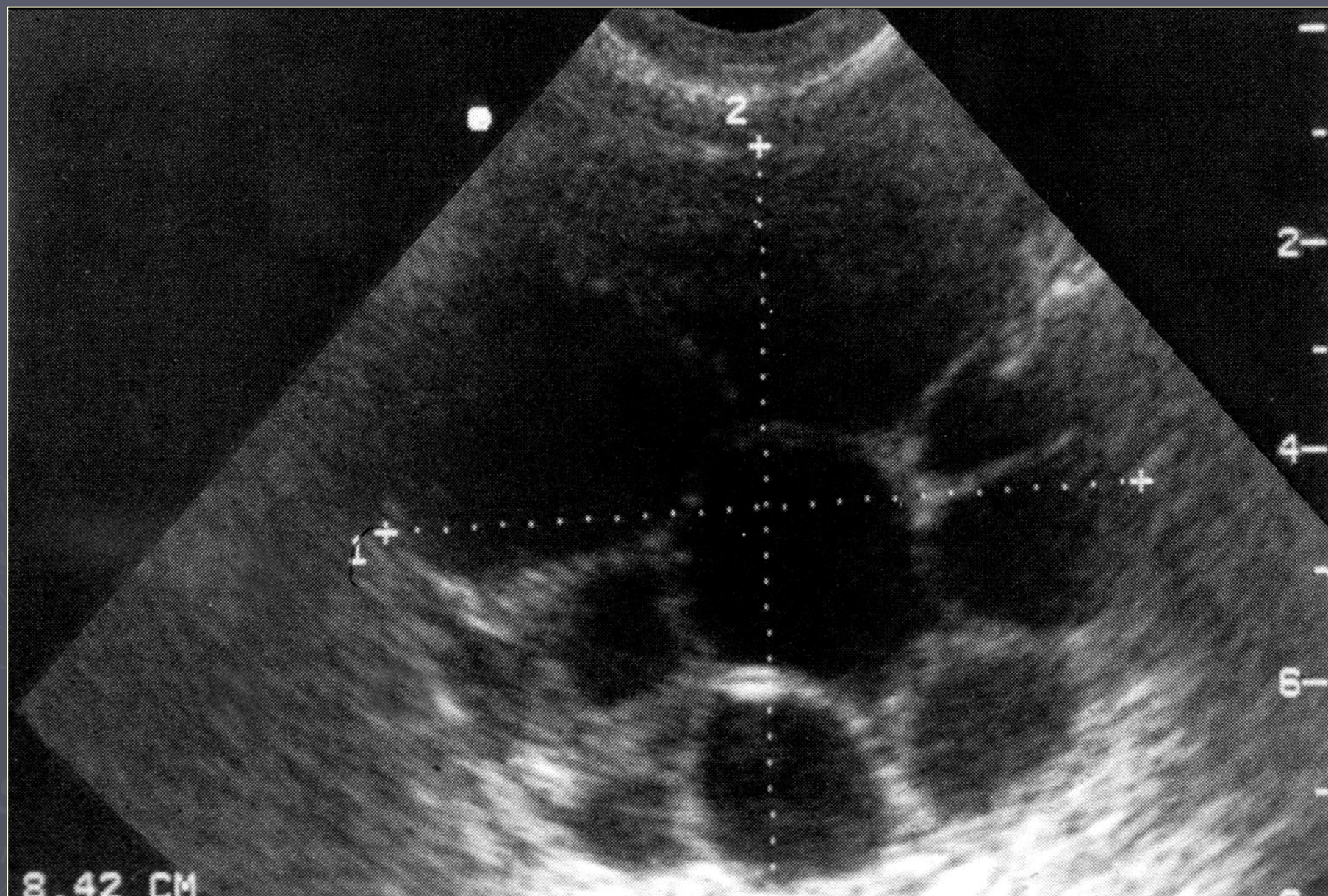
**histologischer
Schnitt**

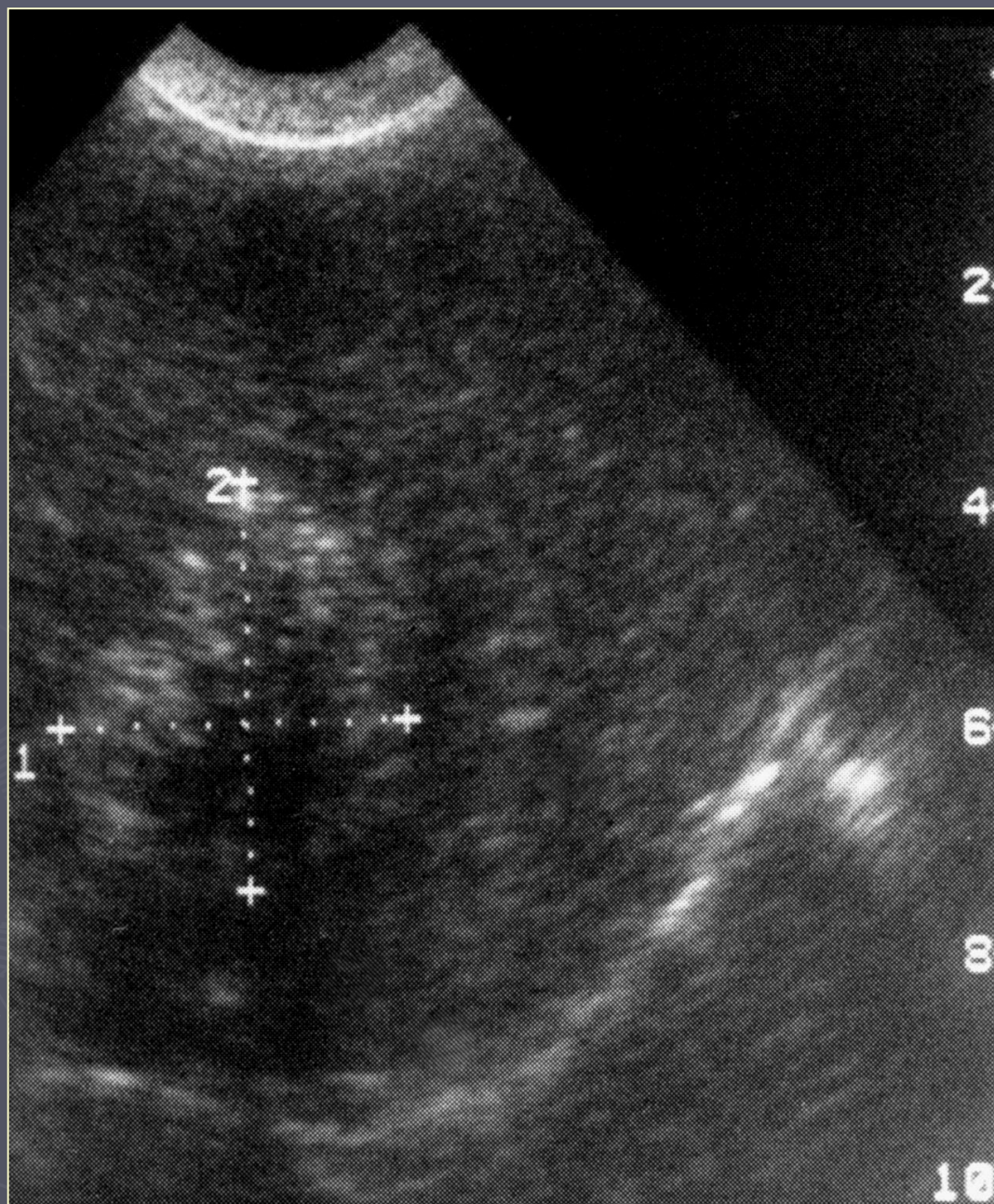
Diagnosis

- ▶ **Clinical symptoms of a slow-growing tumor**
- ▶ **Eosinophilia**
- ▶ **Intradermal (Casoni) test**
- ▶ **X-rays**
- ▶ **ELISA or IHA tests**









Cerebral hydatid disease

Presentation:

History of severe headache with 1 month of duration and episodes of vomiting in African patient.

Patient Data:

Age: 8

Gender: Male



Well-circumscribed roundish cystic lesion

Treatment & control

- ▶ Surgical removal of cyst
- ▶ Inactivation of hydatid sand (*Hypertonic saline*)
- ▶ High dose of **Mebendazole** results in some success