



M11 - Fungi & Parasites

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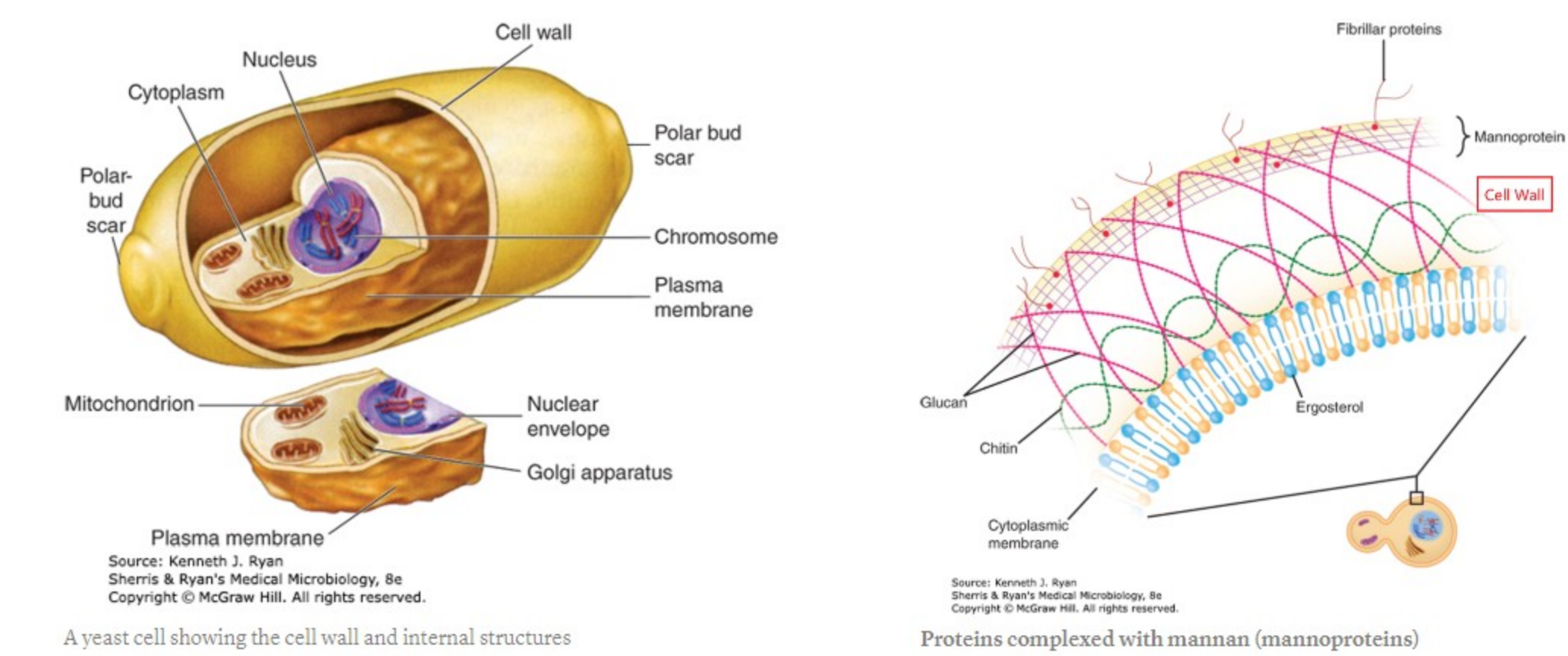
Learning Objectives

- Describe the basic classification and morphology of medically important fungi and parasites.
- List locally important examples of fungi and parasites causing human infections.
- Understand the types of infection caused by fungi and parasites.
- Describe the life cycle and vector for transmission of malaria parasites.

Introducing to Fungi

Characteristic of Fungi

Comparison of Mammalian cells



	Mammalian	Fungi
Cell Type	Eukaryotic	Eukaryotic [Nucleus, Mitochondria, ER] + Cell Wall - Saprophytes (腐生菌) - Commensal (共生菌) - Parasites (寄生虫)
Dominant membrane Sterol	Cholesterol	Ergosterol
DNA Content	Diploid nuclei	- Haploid - Diploid - Polyploid [in Stress] - Aneuploid [in Stress]
Cell Wall	Nil	- Cell wall mannan linked to surface proteins → Mannoprotein - Chitin and glucans → Rigidity
Metabolism	Heterotrophic metabolism	Heterotrophic metabolism
Reproduction	Sexual	- Asexual: Mitosis → Conidia - Sexual: Meiosis → Spores, with Specialized Structure In General: Spores, Budding, or Fission

Remark

- Aneuploid refers to an abnormal number of chromosomes in a cell.
- Heterotrophic metabolism uses available organic matter

Classification of Fungi

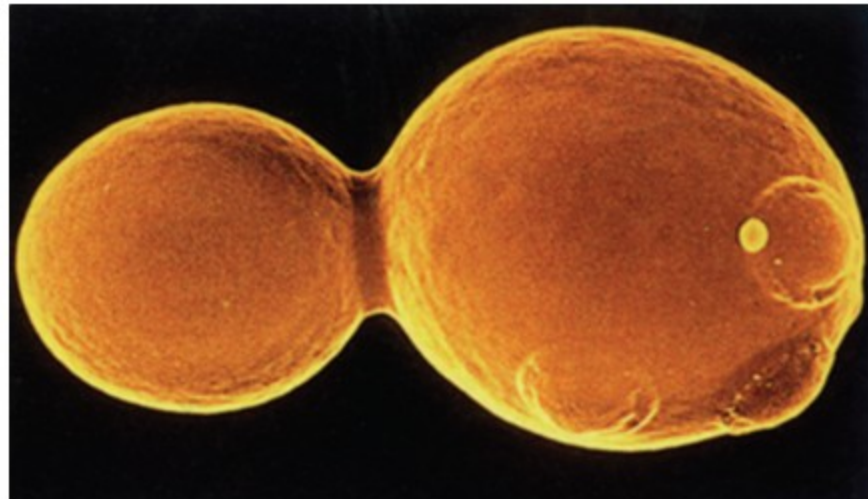
Molds - Elongated, Filamentous Hyphae



- Molds → Grow as: Hyphae** [filamentous, tube-like structures]
 - Structures: Hyphal septa (菌丝隔) — Cross-walls ⊥ Cell walls → Separate Hypha into Subunit cells.

	Septate Hyphae	Aseptate hyphae
Properties	Pores → Nutrients, Organelles, and Nuclei → Adj. cells.	Form septae that are very distant
Number of Nuclei	Multiple	Multiple

Yeasts - Single Cells



This oval yeast cell is budding to form a daughter cell. Scars from prior cell separations can be seen on other parts of the cell



Pseudohyphae from Candida Albicans

- Yeasts** [Round cellular]
 - Reproducing: Asexual budding → Constriction → Separation
- Pseudohyphae**
 - Elongated yeast cells growing end-to-end.
 - Distinguished by **Recurring bud-like constrictions** and **Less rigid cell walls**

Molds - More about Hyphae



- Vegetative mycelium:** a root in medium → Collecting Nutrients and Moisture.
- Aerial mycelium:** Reproductive Conidia / Spores

Dimorphic Fungi

Common Example of Dimorphic Fungi

Coccidioides immitis	Histoplasma capsulatum	Penicillium (Talaromyces) marneffei
灰酪球孢子菌	荚膜组织胞浆菌	培拉罗霉菌 / 马拉尼青霉菌

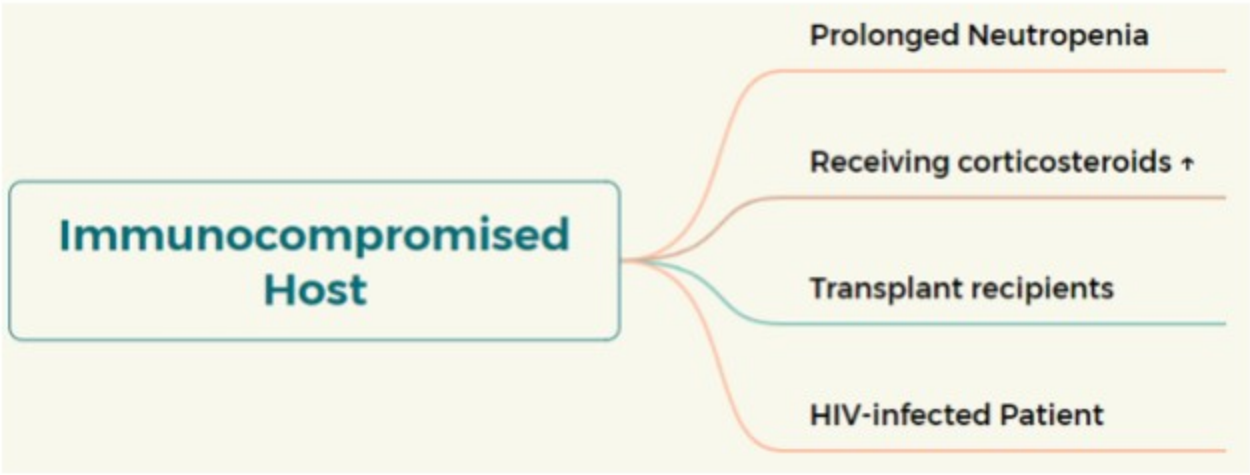
- In Hong Kong, **Penicillium (Talaromyces) marneffei** is common.

Some fungi can transition: **Yeast-like ↔ Hyphal morphologies.**
∴ Shape is directly related to pathogenesis → Different microenvironments.

Introducing to Fungus Diseases

▼ Fungus Diseases & Immunocompromised Host

What is “Immunocompromised Host”



▼ Text Version

- Prolonged neutropenia
- Defects in cellular immunity
 - receiving high-dose corticosteroids
 - transplant recipients
 - HIV-infected Patient

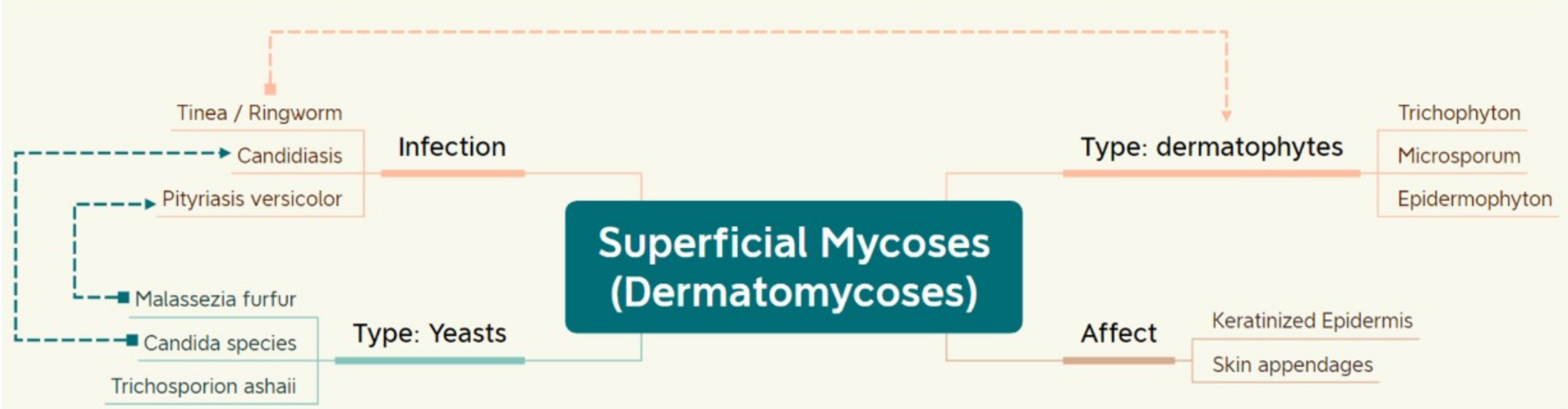
↑ Immunocompromised hosts

- Hospital
 - Broad-spectrum antibiotic therapy → More Immunocompromised Hosts
 - Breaches in cutaneous and mucosal integrity due to indwelling medical devices
 - Defects in host immune mechanisms
- Community settings.

▼ Classification of Fungus Diseases

Superficial Mycoses	Subcutaneous Mycoses	Deep / Systemic Mycoses
- Immunocompetent - Immunocompromise	Nil	- Usually Immunocompromise

▼ Superficial Mycoses



▼ Text version

- Superficial mycoses (dermatomycoses) → Keratinized epidermis & skin appendages.
 - Infection called tinea or ringworm, Candidiasis, Pityriasis versicolor
 - Dermatophytes
 - Trichophyton
 - Microsporum
 - Epidermophyton
 - Yeasts
 - Candida species
 - Trichosporion ashaii
 - Malassezia furfur.

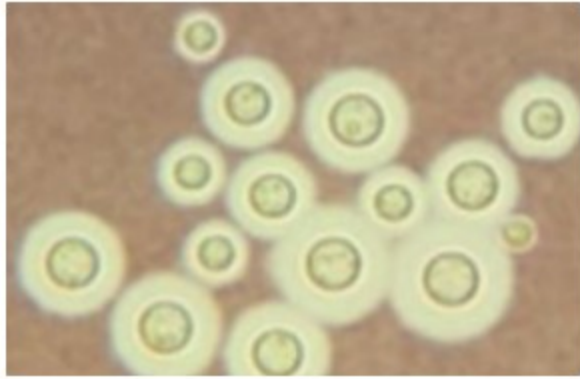
Diagnosing

- Clinical suspicion
- Radiological suspicion
- Microscopy
- Fungal culture
- Antigens of fungi in blood or body fluids (e.g. cryptococcal antigen)
- Histopathology
- Nucleic acid amplification

Systemic mycoses

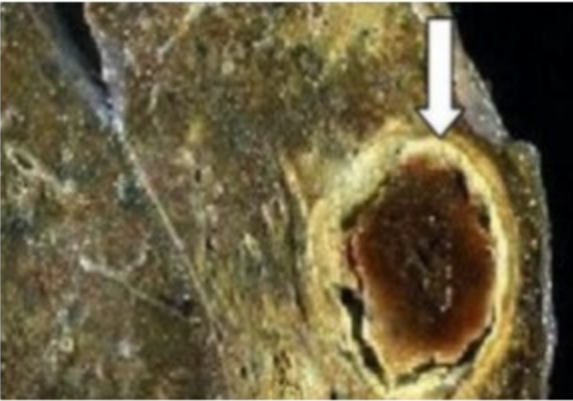
Infection	Pathogens	Nosocomial Infection
Fungaemia	Various fungi - usually yeasts such as Candida	- Catheter-related infections - Intra-abdominal Infection
Systemic candidiasis	Candida	-
Cryptococcosis	Cryptococcus neoformans	-
Aspergillosis	Aspergillus	-
Talaromycosis (penicilliosis)	Talaromyces (Penicillium) marneffei	-

Cryptococcosis



- Pathogen:
 - Cryptococcus neoformans.
- Targets:
 - Most Immunocompromise.
 - Some Immunocompetent
- Diseases:
 - Pneumonia
 - Lung nodules
 - Cryptococcal Meningitis (Related to AID)

Aspergillosis



- Pathogen:
 - Aspergillus fumigatus [Septate Hyphae]
 - Aspergillus flavus
- Target:
 - Most Immunocompromise
 - Bone marrow, Lung, Heart-lung transplant recipients
- Diseases:
 - Pneumonia

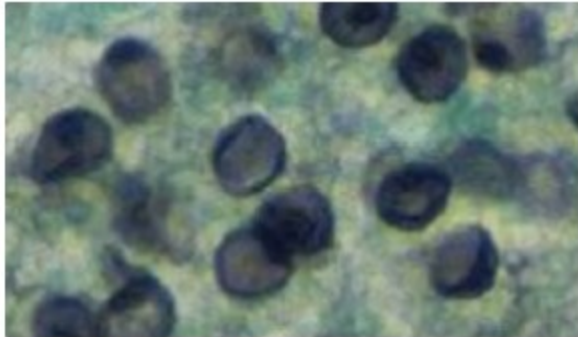
Talaromycosis



AIDS- defining illness

- Pathogen [Opportunistic pathogen]:
 - Talaromyces (Penicillium) marneffei [Dimorphic]
- Target:
 - Immunocompromised patient
 - Endemic in Southeast Asia.
- Diseases:
 - Skin lesions or ulcers
 - Enlarged lymph nodes

Pneumocystosis



AIDS- defining illness

- Pathogen:
 - Pneumocystis jirovecii.
- Route:
 - Spread by inhalation.
- Location:
 - Respiratory tract [Asymptomatically]
- Target:
 - Immunocompromised hosts.
- Diagnosis - Cannot Cultured:
 - Methenamine silver stain of the bronchoalveolar lavage. 支气管肺泡灌洗
 - × Expectorated sputum

▼ Introducing to Parasites

Basic Definition:

- Parasitism: any reciprocal association in which a species depends upon another for its existence.
寄生关系：任何相互依赖的关联，其中一种物种依赖另一种物种的存在。
- Parasite: the species that derives all the benefit from the association.
寄生虫：从这种关联中获益的物种。
- Host: the harboring species.
宿主：提供庇护的物种。
 - Definitive host: harbours the adult or sexual stages of the parasite.
最终宿主：寄生虫的成虫或性阶段。
 - Intermediate host: harbours the intermediate or larval stages of the parasite.
中间宿主：寄生虫的中间阶段或幼虫阶段。

▼ Diagnosis

- Direct microscopy, staining, or tissue sections
- Serology [血清检验]
- Culture of a small number of protozoa.
- Nucleic acid amplification.

▼ Treatment

- Supportive treatment
- Specific anti-parasitic agents (May develop Resistance)



▼ Classification of parasites

Protozoa	Nematodes	Trematodes	Cestodes	Arthropods
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▼ Arthropods

Ectoparasites	Insects (6 legs in the adult stage)	Arachnids (8 legs in the adult stage)
Lice	Mosquitoes	Spiders
Fleas	Flies	Scorpions
Maggots	Bugs	Ticks
Sarcoptes scabiei (scabies mite)		Mites

▼ Trematodes - Helminths



Flukes

	Examples
Liver flukes	Clonorchis (Opisthorchis) sinensis Fasciola hepatica
Intestinal flukes	Fasciolopsis buski
Lung flukes	Paragonimus westermani
Blood flukes	Schistosoma

▼ Cestodes - Helminths

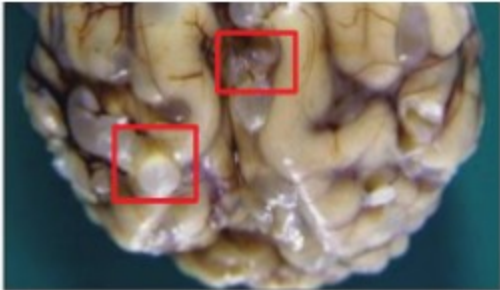
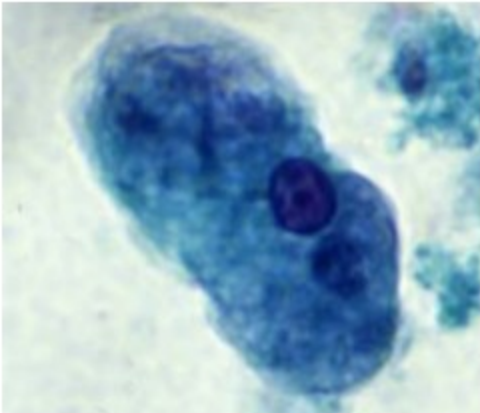


Figure 4: Pathology of cysticercosis (A) Cerebral cysticercosis in a pig brain.

Tapeworms

Tapeworms	Examples
Intestinal tapeworms	Taenia solium Taenia saginata Diphyllobothrium latum
Tissue tapeworms	Taenia solium → Cysticercosis Echinococcus granulosus → hydatid disease

▼ Protozoa



Unicellular organisms.

Blood and tissue protozoa	Lumen-dwelling protozoa (gut, genital tract)
Plasmodium spp.	Entamoeba histolytica
Trypanosoma spp.	Giardia lamblia
Leishmania spp.	Trichomonas vaginalis
Toxoplasma gondii	

▼ Nematodes - Helminths



Round worms.

Intestinal nematodes	Blood and tissue nematodes
Ascaris lumbricoides	Wuchereria bancrofti - Filariae
Hookworms	Brugia malayi - Filariae
Enterobius vermicularis (pinworms)	Trichinella spiralis
Trichuris trichiura	
Strongyloides stercoralis	

▼ More about Malaria

Epidemiology

Species	Distribution	Remarks
Plasmodium vivax	Worldwide	Common
Plasmodium falciparum	Generally in the tropics	Common
Plasmodium malariae	Usually sporadic	
Plasmodium ovale	West Africa, some South Pacific islands	
Plasmodium knowlesi	Southeast Asia. A simian (monkey) malaria usually found in jungles.	

- ▼ Remarks:
- About 95% of all cases of malaria are due to P. vivax and P. falciparum.

Life Cycle of Malaria parasites

The life cycle of malaria parasites involves both the mosquito vector and the human host. Here is a brief overview of the life cycle:

- Mosquito Stage:**
 - The parasites undergo sexual reproduction within the mosquito, forming male and female gametocytes.
- Exflagellation:**
 - Inside the mosquito's midgut, the male gametocytes are releasing microgametes.
- Fertilization:**
 - The microgametes fertilize the female gametocytes, forming zygotes.
- Ookinete Formation:**
 - The zygotes develop into motile ookinetes, which penetrate the mosquito's midgut wall.
- Oocyst Formation:**
 - The ookinetes transform into oocysts, where they multiply and develop.
- Oocyst Rupture:**
 - The mature oocysts rupture, releasing thousands of sporozoites into the mosquito's body cavity.
- Salivary Glands:**
 - The sporozoites migrate to the salivary glands of the mosquito.
- Human Stage:**
 - When an infected mosquito bites a human, sporozoites are injected into the bloodstream.
- Liver Stage:**
 - The sporozoites invade hepatocytes (liver cells) and develop into liver-stage parasites called schizonts.
- Blood Stage:**
 - After a period of development in the liver, the schizonts rupture, releasing merozoites into the bloodstream.
- Erythrocyte Invasion:**
 - The merozoites invade red blood cells (erythrocytes) and develop into ring-stage parasites.
- Multiplication and Release:**
 - The ring-stage parasites multiply inside the red blood cells, causing them to rupture and release more merozoites.
- Clinical Symptoms:**
 - The release of merozoites is associated with the clinical symptoms of malaria, including fever and chills.
- Gametocyte Formation:**
 - Some of the parasites develop into sexual-stage gametocytes, which can be taken up by mosquitoes during a blood meal.

Transmission

- Female Anopheles mosquitoes
- Blood transfusion, transplantation.
- Contaminated needles, medications, medical instruments.
- Congenital - 先天的.

Diagnosis

- History: travel history, chemoprophylaxis taken, transfusion.
- Specimens: Peripheral blood, anticoagulated with EDTA.
- Standard method: thick and thin blood films stained with Giemsa stain
 - Remember: one set of negative blood smear does not rule out malaria.
- Detection of plasmodial antigens in blood.
- Nucleic acid amplification

