

# Parasite Classification

# **Aims of this chapter**

**This chapter provides an introduction to parasite classification and physiology.**

**To simplify the taxonomy, the major divisions involved in medical parasitology-specifically, intestinal and urogenital protozoa, blood and tissue protozoa, nematodes, trematodes, and cestodes have been addressed.**

# **Importance of parasites**

**Medical and veterinary parasitology is the study of invertebrate animals capable of causing disease in humans and other animals.**

**The global impact of parasitic infections and the number of parasite-associated deaths is staggering and must be of concern to all health care workers.**

**Increasingly, tourists, missionaries, Peace Corps volunteers, and others are visiting and working for extended periods in exotic, remote parts of the world.**

**Thus they are at risk for parasitic and other infections that are rare in the United States and other more developed countries.**

# Importance of parasites

Another source of infected patients is the ever-increasing number of refugees from developing countries.

Finally, the profound immunosuppression problems that accompany advances in medical therapy (e.g., organ transplantation), as well as those associated with persons infected with human immunodeficiency virus (HIV), place a growing number of individuals at risk for developing infections caused by certain parasites.

Given these considerations, clinicians and laboratory workers should be aware of the possibility of parasitic disease and should be trained in ordering, performing, and interpreting the appropriate laboratory tests to aid in the diagnosis and therapy.

# Estimated Worldwide Disease Burden of Parasitic Infections

Infection	Disease Burden in DALYs (thousands)	Deaths (thousands)*
Malaria	42,280	1,124
Lymphatic filariasis	5,644	0
Leishmaniasis	2,357	59
Hookworm	1,825	-
Schistosomiasis	1,760	15
Trichuriasis	1,649	-
African trypanosomiasis	1,598	50
Ascariasis	1,181	-
Onchocerciasis	987	0
Chagas Disease	649	13

\*Mortality data included where available.

Adapted from Edwards G, Krishna S: Pharmacokinetic and pharmaco-dynamic issues in the treatment of parasite infections. *Eur J Clin Microbiol Infect Dis* 23:233-242, 2004.

DALYs, disability-adjusted life years (the number of healthy years of life lost because of premature death and disability).

# **Classification and structure**

**The parasites of humans are classified within the kingdom Animalia and are separated into two subkingdoms, Protozoa and Metazoa.**

**Parasite classification takes into account the morphology of intracytoplasmic structures, such as the nucleus, the type of locomotive organelles, and the mode of reproduction.**

**The Protozoa are animals whose life functions occur in a single cell.**

**The Metazoa are multicellular animals in which life functions occur in cellular structures organized as tissue and organ systems**

# Protozoa

**Protozoa are simple microorganisms that range in size from 2 to 100  $\mu\text{m}$ .**

**Their protoplasm is enclosed by a cell membrane and contains numerous organelles, including a membrane-bound nucleus, an endoplasmic reticulum, food-storage granules, and contractile and digestive vacuoles. The nucleus contains clumped or dispersed chromatin and a central karyosome.**

**Organs of motility vary from simple cytoplasmic extrusions or pseudopods to more complex structures, such as flagella and cilia.**

# Protozoa

## 1- SARCOMASTIGOPHORA

**Phylum Sarcomastigophora consists of the amoebae (subphylum Sarcodina) and the flagellates (subphylum Mastigophora).**

**Locomotion of amoebae is accomplished by the extrusion of pseudopodia ("false feet"), whereas flagellates move by the lashing of their whiplike flagella. The number and position of flagella vary a great deal in different species.**

**In addition, specialized structures associated with the flagella may produce a characteristic morphologic appearance that may be useful in species identification.**



# Protozoa

## 2- CILIOPHORA

Phylum Ciliophora consists of the ciliates, which include a variety of free-living and symbiotic species.

Ciliate locomotion involves the coordinated movement of rows of hairlike structures, or cilia.

Cilia are structurally similar to flagella but are usually shorter and more numerous. Some ciliates are multinucleate.

The only ciliate parasite of humans, *Balantidium coli*, contains two nuclei: a large macronucleus and a small micronucleus.

# Protozoa

## 3- APICOMPLEXA

Phylum Apicomplexa organisms are often referred to as Sporozoa or Coccidia. These unicellular organisms have a system of organelles at their apical end that produces substances to help the organism penetrate host cells and thus become an intracellular parasite.

## 4- MICROSPORA

The Microspora are small intracellular parasites that differ significantly in structure from the Apicomplexa organisms.

These parasites are characterized by the structure of their spores, which have a complex, tubular extrusion mechanism (polar tubule) used to inject the infective material (sporoplasm) into host cells.

# Metazoa

The subkingdom Metazoa includes all animals that are not Protozoa.

## 1-HELMINTHS

The helminths are complex, multicellular organisms that are elongated and bilaterally symmetrical.

They are considerably larger than the protozoan parasites and generally are macroscopic, ranging in size from less than 1 mm to 1 m or larger.

The external surface of some worms is covered with a protective cuticle, which is acellular and may be smooth or possess ridges, spines, or tubercles.

# Metazoa

**The protective covering of flatworms is known as a tegument.**

**Often, helminths possess elaborate attachment structures such as hooks, suckers, teeth, or plates.**

**These structures are usually located anteriorly and may be useful in classifying and identifying the organisms.**

**Helminths typically have primitive nervous and excretory systems.**

**Some have alimentary tracts; however, none have a circulatory system.**

**The helminths are separated into two phyla, the Nematoda and the Platyhelminthes.**

# Metazoa

## 1-HELMINTHS

### A- Nematoda

**Phylum Nematoda consists of the roundworms, which have cylindrical bodies.**

**The sexes of roundworm are separate, and these organisms have a complete digestive system. The nematodes may be intestinal parasites or may infect the blood and tissue.**

# Metazoa

## 1-HELMINTHS

### B- Platyhelminthes

Phylum Platyhelminthes consists of the flatworms, which have flattened bodies that are leaflike or resemble ribbon segments.

Platyhelminthes can be further separated into classes trematodes and cestodes.

**B-1-Trematodes**, or flukes, have leaf-shaped bodies.

Most are hermaphroditic, with male and female sex organs in a single body. Their digestive systems are incomplete and only have saclike tubes. Their life cycle is complex; snails serve as first intermediate hosts, and other aquatic animals or plants serve as second intermediate hosts.

# Metazoa

## 1-HELMINTHS

### B- Platyhelminthes

**B-2- Cestodes**, or tapeworms, have bodies composed of ribbons of proglottids, or segments.

All are hermaphroditic, and all lack digestive systems, with nutrition being absorbed through the body walls.

The life cycles of some cestodes are simple and direct, whereas those of others are complex and require one or more intermediate hosts.

# Metazoa

## 2-ARTHROPODS

**Phylum Arthropoda is the largest group of animals in the kingdom Animalia.**

**Arthropods are complex, multicellular organisms that may be involved directly in causing invasive or superficial (infestation) disease processes or indirectly as intermediate hosts and vectors of many infectious agents, including protozoan and metazoan parasites.**

**In addition, envenomization by biting and stinging arthropods can result in adverse reactions in humans that range from local allergic and hypersensitivity reactions to severe anaphylactic shock and death. There are five major classes of arthropods.**



# Metazoa

## 2-ARTHROPODS

### 2-A-Chilopoda

Class Chilopoda consists of terrestrial forms, such as centipedes. These organisms are of medical importance because of their poisoning claws, which may produce a painful "bite."

### 2-B-Pentastomida

The pentastomids, or tongue worms, are bloodsucking endoparasites of reptiles, birds, and mammals. Adult pentastomids are white and cylindrical or flattened parasites that possess two distinct body regions: an anterior cephalothorax and an abdomen. Humans may serve as intermediate hosts for these parasites.

## **2-ARTHROPODS**

### **2-C-Crustacea**

**Class Crustacea consists of familiar aquatic forms, such as crabs, crayfish, shrimp, and copepods.**

**Several are involved as intermediate hosts in life cycles of various intestinal or blood and tissue helminths.**

### **2-D-Arachnida**

**Class Arachnida consists of familiar terrestrial forms, such as mites, ticks, spiders, and scorpions.**

**Unlike insects, these animals have no wings or antennae, and adults have four pairs of legs, as opposed to three pairs for insects.**

**Of medical importance are those serving as vectors for microbial diseases (mites and ticks) or as venomous animals that bite (spiders) or sting (scorpions).**

# Metazoa

## 2-ARTHROPODS

### 2-E-Insecta

**Class Insecta consists of familiar aquatic and terrestrial forms, such as mosquitoes, flies, midges, fleas, lice, bugs, wasps, and ants.**

**Wings and antennae are present, and adult forms have three pairs of legs.**

**Of medical importance are the many insects that serve as vectors for microbial diseases (mosquitoes, fleas, flies, lice, and bugs) or as venomous animals that sting (bees, wasps, and ants).**

# Medically Important Parasites (Kingdom Animalia)

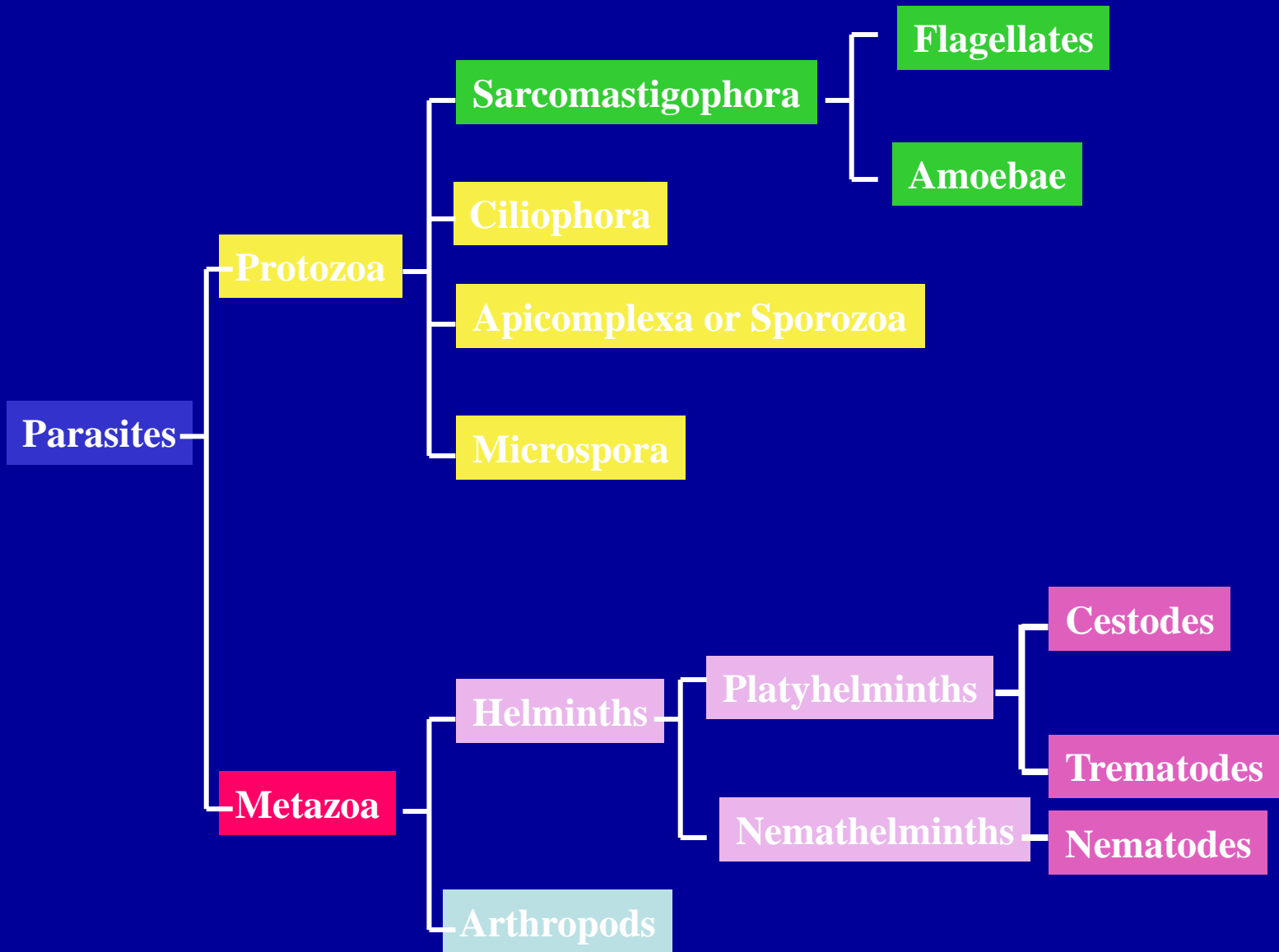
Subkingdom	Phylum	Organisms
<b>Protozoa</b>	Sarcomastigophora	Ameba, flagellates
	Ciliophora	Ciliates
	Apicomplexa	Sporozoa, Coccidia
	Microspora	Microsporidia
<b>Metazoa</b>	Nematoda	Roundworms
	Platyhelminthes	Flatworms
	Trematodes	Flukes
	Cestodes	Tapeworms
	Arthropoda	
	Chilopoda	Centipedes
	Pentastomida	Tongue worms
	Crustacea	Crabs, crayfish, shrimp, copepods
	Arachnida	Mites, ticks, spiders, scorpions
Insecta	Mosquitoes, flies, lice, fleas, wasps, ants, beetles, moths, roaches, true bugs	

# Biologic, Morphologic, and Physiologic Characteristics of Pathogenic Parasites

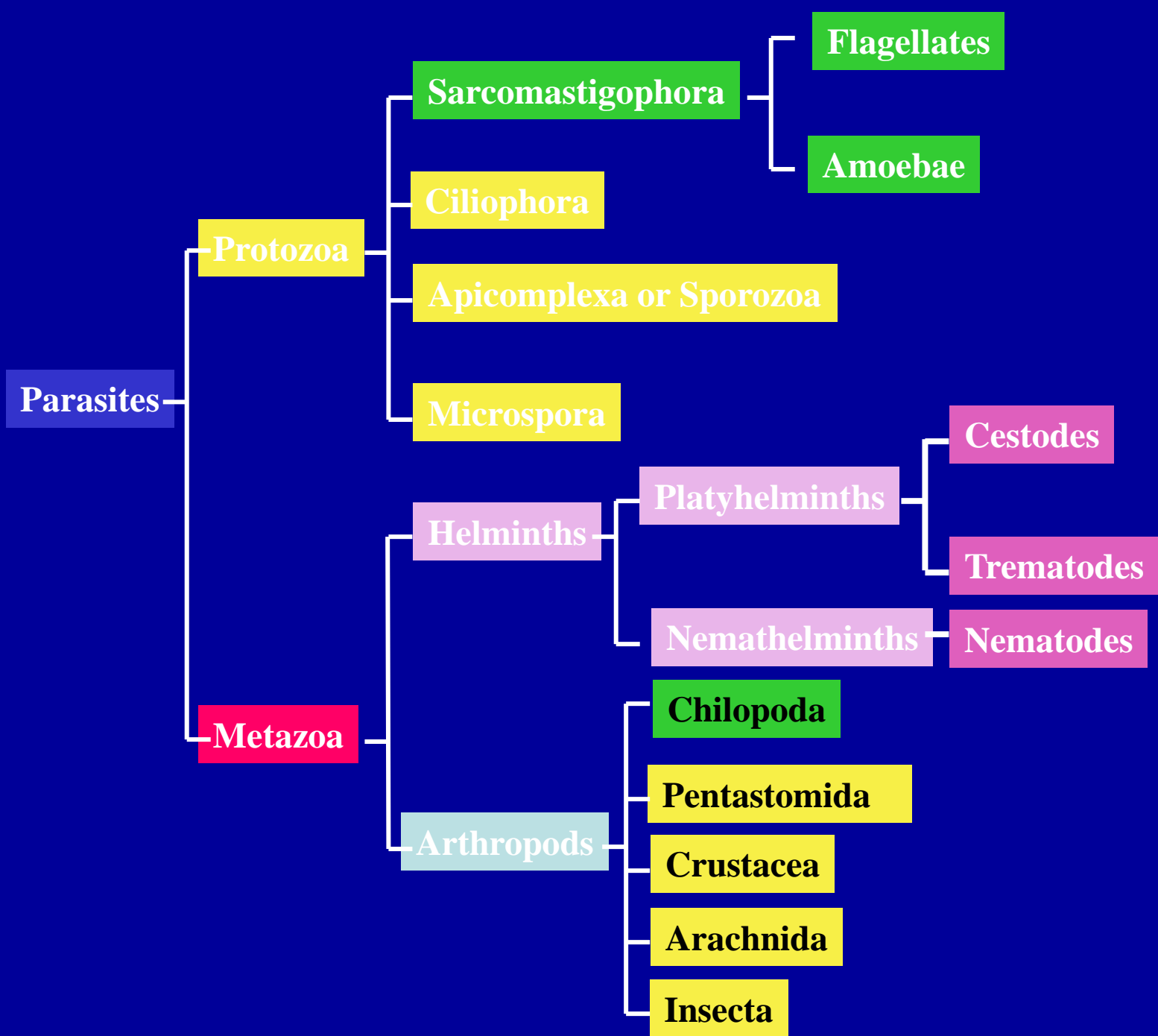
Organism Class	Morphology	Reproduction	Organelles of Locomotion	Respiration	Nutrition
<b><i>Protozoa</i></b>					
Amoeba	Unicellular; cyst and trophozoite forms	Binary fission	Pseudopods	Facultative anaerobe	Assimilation by pinocytosis or phagocytosis
Flagellates	Unicellular; cyst and trophozoite forms; possibly intracellular	Binary fission	Flagella	Facultative anaerobe	Simple diffusion or ingestion via cytostome, pinocytosis, or phagocytosis
Ciliates	Unicellular; cysts and trophozoite	Binary fission or conjugation	Cilia	Facultative anaerobe	Ingestion via cytostome, food vacuole
Coccidia	Unicellular, frequently intracellular; multiple forms, including trophozoites, sporozoites, cysts (oocysts), gametes	Schizogony and sporogony	None	Facultative anaerobe	Simple diffusion
Microsporidia	Obligate intracellular forms; small, simple cells and spores	Binary fission, schizogony and sporogony	None	Facultative anaerobe	Simple diffusion

Organism Class	Morphology	Reproduction	Organelles of Locomotion	Respiration	Nutrition
<b><i>Helminths</i></b>					
Nematodes	Multicellular; round, smooth, spindle shaped, tubular alimentary tract; possibility of teeth or plates for attachment	Separate sexes	No single organelle; active muscular motility	Adults: usually anaerobic; larvae: possibly aerobic	Ingestion or absorption of body fluids, tissue, or digestive contents
Trematodes	Multicellular; leaf shaped with oral and ventral suckers; blind alimentary tract	Hermaphroditic(Schistosoma group has separate sexes)	No single organelle; muscle-directed motility	Adults: usually anaerobic	Ingestion or absorption of body fluids, tissue, or digestive contents
Cestodes	Multicellular; head with segmented body (proglottids); lack of alimentary tract; head equipped with hooks and/or suckers for attachment	Hermaphroditic	No single organelle; usually, attachment to mucosa, possible muscular motility (proglottids)	Adults: usually anaerobic	Absorption of nutrients from intestine

Organism Class	Morphology	Reproduction	Organelles of Locomotion	Respiration	Nutrition
<b>Arthropods</b>					
Chilopoda	Elongated; many legs; distinctive head and trunk; poisoning claws on first segment	Separate sexes	Legs	Aerobic	Carnivore
Pentastomida	Wormlike; cylindrical, or flattened; two distinct body regions; digestive and reproductive organs; lack of circulatory and respiratory systems	Separate sexes	Muscle-directed motility	Aerobic	Ingestion of body fluids and tissue
Crustacea	Hard external carapace; one pair of maxillae; five pairs of biramous legs	Separate sexes	Legs	Aerobic	Ingestion of body fluids and tissue, carnivorous
Arachnida	Body divided into cephalothorax and abdomen; eight legs and poisoning fangs	Separate sexes	Legs	Aerobic	Carnivore
Insecta	Body: head, thorax, and abdomen; one pair of antennae; three pairs of appendages, up to two pairs of wings	Separate sexes	Legs, wings	Aerobic	Ingestion of fluids and tissues







**Parasites**

