HELMINTHOLOGY

Helminths

- ✓ The helminthic parasites are multicellular, bilaterally symmetrical animals having three germ layers (triploblastic Metazoa).
- ✓ *Helminths* constitute a large assemblage of *worms* of comparatively simple and varied organization.
- ✓ Helminthes is derived from the Greek word *helmins* means *worms*.
- ✓ The term worm is not correct because it is applied to elongated invertebrates without appendages and with bilateral symmetry.
- ✓ In 18th Century all the worm-like animals were included in an old phylum- *Vermes* (Linnaneus, 1735).
- ✓ But this was a very heterogeneous group which included a highly diverse assemblage of forms.
- ✓ In the modem classification this group is divided into several independent phyla such as Platyhelminthes (Platyhelminths), Aschelminthes (Aschelminths), Annelida etc.
- ★ The term helminths is restricted to a few phyla of invertebrate animals, all of which are superficially worm like but they differ markedly in their morphology, life-history and bionomics.
- ★ The helminths of importance to human beings are divided into three main groups having the following peculiarities.

1. **Platyhelminthes or Platyhelminths or flat-worms.**
2. **Acanthocephala or Spiny headed worms**
3. **Aschelminthes or Nemathelminthes or round-worms.**

HELMINTHS		
Phylum PLATYHELMINTHES	Phylum NEMATHELMINTHES	Phylum ACANTHOCEPHALA

(Class Cestoidea & Trematoda)	(Class Nematoda)	
➢ Flattened, leaf-like or tape-like and segmented. ➢ Mostly hermaphrodite (monoecious). ➢ Alimentary canal incomplete or entirely lacking. ➢ Body cavity absent	➢ Elongated, cylindrical, unsegmented bodies. ➢ Sexes separate (dioecious). ➢ Alimentary canal complete. ➢ Body cavity present.	➢ Elongated, Unsegmented ➢ Sexes separate (Dioecious) ➢ Alimentary canal absent ➢ Pseudocoelomate

Table showing the differences between Cestodes, Trematodes, Acanthocephala and Nematodes

	Cestodes	Trematodes	Acanthocephala	Nematodes
Shape	Tape-like; segmented	Leaf-like; unsegmented	Unsegmented	Elongated, cylindrical; unsegmented
Sexes	Not separate, *i.e.*, hermaphrodite (monoecious)	Not separate (monoecious), except Schistosomes which are dioecious	Separate (Dioecious)	Separate (Dioecious)
"Head" end	Suckers, often with hooks	Suckers, no hooks	Invaginable proboscis, armed with recurved hooks	No suckers, no hooks. Well-developed buccal capsule in some species
Alimentary canal	Absent	Present but incomplete; no anus	Absent	Present and complete; anus present
Body cavity	Absent	Absent	Pseudocoelomate	Present

Phylum: Platyhelminthes (Platyhelminths):

♣ Term Platyhelminthes was proposed by Gegenbaur in 1859, means flatworms which refers to their characteristic contour of flattened

body.

- ♣ The term is derived from two Greek words – Platy = flat; helminthes = worms.
- ♣ The animals show low organization as they are without anus, skeletal, respiratory and circulatory systems.
- ♣ The body is filled with mesenchymal cells, which are mesodermal in origin.

General Characters

1. Bilateral symmetrical body, dorso-ventrally flattened.
2. Body generally shows anterior cephalization that is differentiation of anterior region into head.
3. Body generally worm like either long flat ribbon-shaped or leaf-like. The outline of body bizarre shape in trematodes and segmented tape like body in cestodes.
4. Most of the flat worms are of small to moderate dimensions to size varies from microscopic to the extreme elongation as much 10 to 15 meters.
5. General colour creamy white but on account of the presence of food the body may acquire colour. Some of the free-living flat worms are brilliantly coloured, often brown, black, gray etc.
6. Body with various types of attachment organs in the form of adhesive secretions, suckers, and hooks.
7. Body consists of three embryonic layers *viz*., ectoderm, mesoderm, endoderm.
8. In parasitic forms, the body is covered with a thick cuticle/tegument but free-living turbellarians are clothed with cellular or syncytial epidermis.
9. The exo- and endoskeleton are completely absent; therefore, the body is generally soft with hooks, spines, spicules and thorns.
10. Body space is filled with a mesenchyma that is parenchymatous tissue;

therefore, flat worms are *acoelomate* that is without coelom.

11. The digestive system is generally absent in tapeworms and acoela. But in other consists of mouth, pharynx and variously modified intestine.
12. Respiratory and circulatory systems are absent but some of the trematodes have system of tubes the so called *lymphatic system* of uncertain function.
13. The nervous system is of primitive type with missing of nervous tissue as *brain* in anterior-most region with several longitudinal ganglionated cords. Numerous transverse connections occur between the longitudinal cords. So the nervous system is generally ladder like.
14. Parasitic forms are without sensory organs but free-living forms are provided with sensory organs in the form of chemo- and tango-receptors, ciliated pits, statocysts and ocelli or eyes.
15. Excretory system well developed with *proto-nephridial tubules* having flame bulbs or cells. But acoela are without protonephridia.
16. Hermaphrodite, rarely with separate sex. The eggs are generally devoid of yolk but with yolk cells. Varieties of copulatory organs are present. Cross-fertilization and self-fertilization both are common.
17. Development direct *i.e.*, without larval stage or indirect with larval stages.
18. Life cycles complicated with succession of larval stages involving one to three intermediate hosts.
19. Asexual reproduction common among fresh water forms.
20. Parthenogenesis and Polyembryony common among trematodes and cestodes.
21. Endogenous and exogenous budding common in tapeworms.

Phylum Platyhelminthes is divided into three Classes

The classification followed here is from Hymen (1951)

I. **Turbellaria**
II. **Trematoda**
III. **Cestoidea (Cestoda)**

Class: Turbellaria

- ☆ Mostly free-living predators;
- ☆ in terrestrial, freshwater, and marine environments;
- ☆ body surface covered with discrete epithelial cells;
- ☆ no body cavity (coelom) present;
- ☆ bilaterally symmetrical;
- ☆ rhabdites present in most free-living species;
- ☆ osmoregulatory (excretory) system, if present, of the protonephric type involving flame cells (or bulbs);
- ☆ some species commensalistic, others parasitic on invertebrates, especially echinoderms and mollusks.

Order: Acoela
Order: Rhabdocoela
Order: Alloeocoela
Order: Tricladida
Order: Polycladida

Phylum: PLATYHELMINTHES (PLATYHELMINTHS)

CLASS TREMATODA:

- ✍ The trematodes are so named on account of their conspicuous suckers *(G. trematos*, pierced with holes).
- ✍ The species parasitising man belong to the digenetic trematodes.

General Characters of Trematodes

1. Body is usually unsegmented, dorso-ventrally flattened and leaf-like worms, called flukes.
2. Body is covered by thick tegument/cuticle and no cilia.
3. Epidermis absent. *Rhabdites* are absent.
4. They are ecto- or endoparasites
5. Size varies from 1 mm to several centimeters in length.
6. The organs of attachment are two strong muscular cup-shaped depressions, called *suckers*. The one, surrounding the mouth is called the *oral sucker* and the other, on the ventral surface of the body, is called the *ventral sucker* (acetabulum). Sometimes hooks are present.
7. Sexes are not separate, *i.e.*, each individual worm is a hermaphrodite (monoecious) except the Schistosomes which are unisexual.
8. Body cavity is absent.
9. The alimentary canal is present but incomplete. The anus is absent. The oesophagus bifurcates in front of the ventral sucker into a pair of blind intestinal caeca or crura which may be simple (as in *Clonorchis sinensis)* or branched (as in *Fasciola hepatica)* or may reunite to form a single caecum (as in *Schistosomes).*

10. In some cases there is a system of parenchymal vessels showing the presence of primitive circulatory system.
11. Excretory and nervous systems are present. Excretory system consists of "flame cells" and collecting tubules which open posteriorly, into the excretory pore. The pattern of flame cells provides the basis for species identification.
12. There are three pairs of longitudinal nerve cords.
13. Sense organs are poorly developed.
14. Reproductive system is highly developed and complete in each individual.
15. The genital organs lie between the two branches of the intestine.
16. Single ovary and many testes.
17. Cross fertilization takes place.
18. The worms are oviparous, since eggs are liberated.
19. Eggs are all operculated (except those of *Schistosomes)* and, can develop only in water. In a majority of cases they are immature when oviposited. Trematode eggs do not float in saturated solution of common salt.
20. Development direct or indirect.
21. Life-cycle simple or complicated with more than-one hosts.
22. There are about 6000 species in class Trematoda.

CLASS TREMATODA IS DIVIDED INTO THREE SUB-CLASSES/ORDERS:

Subclass /Order 1 - Monogenea

Subclass /Order 2 - Aspidobothria

Subclass /Order 3 - Digenia

Order 1 - Monogenea

1. They are ectoparasites mostly in cold-blooded animals (fishes).
2. The life-cycle is simple and passed in one host only, *monogenetic*.
3. Oral sucker absent, when present is poorly developed.
4. A large disc-shaped structure, the *opisthaptor,* is found on the posterior end. It contains hooks and is lined with chitin.
5. Paired excretory pores are present in the anterior part of the body.
6. Male and female genital pores are separate.
7. One or two vaginae are present.
8. The uterus is small and contains few eggs.
9. Development is indirect through a larval stage called oncomiracidium.

Suborder: Monopisthocotylea	**Suborder: Polyopisthocotylea**
✍ Opisthaptor a single unit that may be subdivided into shallow loculi, usually developed directly from larval haptor; ✍ one to three pairs of large anchors usually present, commonly with minute marginal hooks; ✍ prohaptor glandular or with paired suckers or pseudosuckers; ✍ oral sucker absent; ✍ eyes often present; ✍ genitointestinal canal absent; ✍ eggs usually with polar filaments; ✍ seminal receptacle is enlargement of vagina.	☆ Complex opisthaptor commonly subdivided, with suckers, clamps, or anchors; ☆ larval haptor absent or reduced to pad supporting terminal anchors; ☆ marginal hooklets usually absent; ☆ mouth surrounded by sucker, or striated fringe, or with paired suckers inside buccal cavity; ☆ prohaptor usually without adhesive glands; ☆ eyes usually absent; ☆ genitointestinal canal usually present; ☆ intestine usually with two caeca, sometimes joined posteriorly; ☆ testes usually numerous; ☆ eggs usually with polar filaments; ☆ seminal receptacle present or absent.
Superfamily: Acanthocotyloidea Superfamily: Capsaloidea Superfamily: Gyrodactyloidea Superfamily: Udonelloidea	Superfamily: Avielloidea Superfamily: Diclidophoroidea Superfamily: Chimaericoloidea Superfamily: Diclybothrioidea Superfamily: Megalonocoidea Superfamily: Diplozooidea Superfamily: Microcotyloidea Superfamily: Polystomatoidea

Order 2 – Aspidobothrea

1. Endoparasite in the digestive tract of fishes and reptiles.
2. Oral sucker is absent.
3. The ventral sucker is divided by septa into many small parts. The hooks are absent in it.
4. Single excretory pore.
5. Only one testis is present.
6. Development direct, without alternation of hosts.

Family: Aspidogastridae (*Aspidogaster*)
Family: Stichocotylidae (*Stichocotyle*)
Family: Rugogastridae

Order 3 - Digenea

1. They are endoparasites in invertebrates and vertebrates.
2. Two to four hosts in the life cycle.
3. Two suckers, without hooks, mouth within anterior sucker.
4. There is only one excretory pore present in the posterior region of the body.
5. There is a common gonopore for male and female reproductive systems.
6. Vagina is absent.
7. Uterus is long branched with many eggs.
8. Their larval forms reproduce asexually before metamorphosis.

CLASSIFICATION OF TREMATODES (DIGENETIC)

Following zoological nomenclature, the trematodes infecting man may be classified as follows:

A. Systematic Classification of Trematodes

Phylum: **Platyhelminthes / Platyhelminths**
Class: **Trematoda**
Subclass: **Digenea**
Order: **Prosostomata**

sub-order: Strigeata	**sub-order: Amphistomata**	**sub-order: Distomata**
Superfamily: Schistosomatoidea	Superfamily: Paramphistomatoidea	SuperfamilyI: Fascioloidea Superfamily II: Opisthorchioidea Superfamily III: Troglotrematoidea

Superfamily	**Genus**	**Species**	**Habitat**	**Clinical manifestation**
Schistosomatoidea	*Schistosoma*	*S. haematobium*	Blood	Haematuria
		S. mansoni	Blood	Dysentery
		S. japonicum	Blood	Dysentery & Cirrhosis liver
Paramphistomatoidea	*Gastrodiscoides*	*G. hominis*	Large intestine	Mucous diarrhea
	Watsonius	*W. watsoni*	Small intestine	Diarrhoea
Fascioloidea	*Fasciola*	*F. hepatica*	Liver of sheep and man	Biliary colic
	Fasciolopsis	*F. baski*	Small intestine	Diarrhoea
Opisthorchioidea				
Family: Opisthorchidae	*Clonorchis*	*C. sinensis*	Liver	Jaundice
	Opisthorchis	*O. felineus*	Liver of cat, also man	Jaundice
Family Heterophyidae	*Heterophyes*	*H. heterophyes*	Small intestine	Diarrhoea
	Metagonimus	*M. yokogawai*	Small	Diarrhoea

			intestine	
Troglotrematoidea	*Paragonimus*	*P. westermani*	Lungs	Haemoptysis

B. According to the Habitat of Trematodes (Flukes)

1. **Intestinal Trematodes** (Intestinal flukes)
   (a) Small Intestine – *Fasciolopsis. buski, Heterophyes heterophyes, Metagonimus yokogawai, Watsonius watsoni*
   (b) Large Intestine – *Gastrodiscoides hominis*
2. **Hepatic Trematodes** (Liver flukes) – *Clonorchis sinensis, Opisthorchis felineus, Fasciola hepatica*
3. **Lung Trematodes** (Lung flukes) – *Paragonimus westermani*
4. **Blood Trematodes** (Blood flukes)
   (a) In the vesical venous plexus – *Schistosoma haematobium*
   (b) in the rectal venous plexus and portal venous system – *S. mansoni, S. japonicum*

CESTOIDEA: THE TAPEWORMS

- ♣ The Cestoidea constitutes another interesting group of parasitic flatworms.
- ♣ Members of this class possess all the characteristics of the phylum Platyhelminthes.
- ♣ In addition, they lack a mouth and digestive tract, and like the other parasitic platyhelminths, their body surfaces are covered with a tegumental layer.
- ♣ Many of the Cestoidea are true tapeworms of the subclass **Eucestoda**, whereas a smaller, less-known group belongs to the subclass **Cestodaria**.

Subclass: Cestodaria **The Unsegmented Tapeworms**	**Subclass: Eucestoda** ***The True Tapeworms***
☞ Monozoic flatworms; ☞ without mouth or digestive tract; ☞ body surface covered by syncytial tegument; ☞ with protonephritic osmoregulatory (excretory) system; ☞ monoecious, with one set of reproductive organs; ☞ with relatively well-developed paranchymal muscles; ☞ with or without suckers or rosette; ☞ lychophore larva with ten hooks; ☞ parasitic in primitive fish and tortoises.	☞ Polyzoic flatworms (except orders Caryophyllidea and Spathebothriidea); ☞ with one or more sets of reproductive organs per proglottid; ☞ scolex usually present; ☞ shelled embryo with six hooks; ☞ parasites of fish, amphibians, reptiles, birds and mammals
Order: Amphilinidea; Genera: *Amphilina*, *Gephyrolina*,	Order: Cyclophyllidea Family: Hymenolepidae (*Hymenolepis*) Family: Dioecocestidae (*Dioecocestus*) Family: Anoplocephalidae (*Moniezia*) Family: Taeniidae (*Echinococcus*, *taenia*) Family: Dilepididae (*Dipylidium*) Family: Mesocestoidae (*Mesocestoides*) Family: Davaineidae (*Cotugnia*, *Davainea*)
Order: Gyrocotylidea; Genera: *Gyrocotyle*, *Amphiptyches*	Order: Pseudophyllidea Family: Diphyllobothriidae (*Ligula*) Family: Haplobothriidae (*Haplobothrium*) Family: Bothriocephalidae (*Bothriocephalus*) Family: Ptychobothriidae (*Ptychobothrium*) Family: Amphiocotylidae (*Eubothrium*) Family: Triaenophoridae (*Triaenophorus*)
	Order: Proteocephalata Family: Proteocephalidae (*Ophiotaenia*)

	Order: Tetraphyllidea Family: Oncobothriidae (*Calliobothrium*) Family: Phyllobothridae (*Phyllobothrium*)
	Order: Trypanorhyncha Family: Lacistorhynchidae (*Lacistorhynchus*) Family: Oncobothriidae (*Acanthobothrium*) Family: Hepatoxylidae (*Hepatoxylon*) Family: Tentaculariidae (*Nybelinia*)
	Order: Lecanicephalidea Family: Lecanicephalidae (*Lecanicephalum*) Family: Tetragonocephalidae (*Tetragonocephalum*)
	Order: Caryophyllidea Family: Caryophyllaeidae (*Archigetes*)
	Order: Aporidea Family: Nematoparataeniidae (*Gastrotaenia*)
	Order: Spathebothriidea Family: Diplocotylidae (*Didymobothrium*)
	Order: Diphyllidea Family: Echinobothriidae (*Echinobothrium*) Family: Ditrachybothriidae (*Ditrachybothrium*)
	Order: Nippotaeniidea
	Order: Litobothridea

Phylum: ***PLATYHELMINTHES***
Class: **CESTOIDEA**
Subclass: **CESTODA**

CLASS III CESTODA

1. They are found as endoparasites in the intestine of vertebrates and are called *tapeworms.*
2. Body is flat, elongate and ribbon-like, measures from 1 mID to 10 metres in length.
3. Body is without epidermis, rhabdites, cilia but a cuticle is present.
4. Body is usually divided into a scolex or head, neck and few to many proglottids.
5. Scolex is provided with hooks or suckers or both.
6. Scolex is followed by neck which forms new *'proglottids'* by transverse budding called *strobilization.*
7. Mouth and digestive tract are absent.
8. Excretory system consists of proto nephridia with flame-cells.
9. Nervous system consists of ganglionated nerve ring in scolex and two pairs of lateral nerve cords in proglottids.
10. Each proglottid contains one or two sets of male and female reproductive organs. Thus they are hermaphrodite.
11. Several testes in the form of follicles and single-lobed ovary.
12. Uterus presents a great variety of structures.
13. Fertilization internal and self.
14. Life-cycle is complicated with hooked embryo, and is passed in more than one host.

General Characters of Cestodes:

1. The majority of cestodes are long, segmented and tape-like, hence called tape-worms. They are flattened dorsoventrally.
2. Sizes vary from a few millimetres to several metres.
3. Adult worms are found in the intestinal canal of man and animal.
4. “Head” is provided with suckers (slit-like or cup-like) and sometimes with hooks, which serve as organs of attachment.
5. There are three regions in an adult worm: (i) a “head” (scolex), (ii) a “neck” and (iii) a strobila (a body or trunk) consisting of a series of segments (proglottides).
6. Sexes are not separate, i.e., each individual worm is a hermaphrodite.
7. Body cavity is absent.

8. Alimentary canal is entirely absent.
9. Excretory and nervous systems are present.
10. Reproductive system is highly developed and complete in each segment. According to the maturity of reproductive organs three types of segments of the strobila can be recognised from the front backwards:
    a) Immature: Male and female organs not differentiated.
    b) Mature: Male and female organs have become differentiated (male organs appear first).
    c) Gravid: Uteri are filled with eggs (other organs atrophied or disappeared).

Class Cestoda has about 3400 species.

The class is divided into two Orders:

Order I: Pseudophyllidea; Order II: Cyclophyllidea

General characters of Pseudophyllidean Cestodes:

1. Large worms consisting of a long chain of segments.
2. "Head" has in place of Suckers two slit-like sucking grooves called *bothria.*
3. Vitelline glands are scattered widely in the parenchyma and consist of many acini.
4. Genital pores are on the ventral surface of the segment and not marginal. There are three genital orifices in each segment, one male orifice (the opening of vas deferens) and two female orifices (the openings of the vagina and the uterus).
5. Uterus opens to the exterior through which eggs come out.
6. Eggs are operculated and can develop only in water. They are immature when oviposited. The oncosphere gives rise to ciliated embryo.
7. Larval development proceeds in two intermediate hosts. The first larval stage is called *procercoid* and the second larval stage is called *plerocercoid.*
8. *Examples: Diphyllobothrium latum (Linnaeus, 1758) Luhe, 1910.*

General Characters of Cyclophyllidean Cestodes

1. Large or small worms consisting of chains of segments.
2. "Head" is quadrate in outline with four cup-like round suckers at each of the four angles. An apical rostellum in the centre armed with hooklets may be present.
3. Vitelline glands are concentrated into a single mass behind the ovary near the posterior margin of each segment.
4. The common genital pore is marginal, i.e., on the lateral side of each segment.

5. There is no uterine opening for the exit of eggs from the gravid uterus. The eggs can only escape by the disintegration or rupture of ripe segments. In Taeniidae, Dilepididae ripe segments are detached from the main body and passed in the faeces.
6. Eggs are not operculated and can develop only in the intermediate host. They are fully embryonated when detached from the segment. The oncosphere is never a ciliated embryo.
7. Larval development proceeds in one intermediate host.
8. Examples: *Taenia, Echinococcus, Multiceps, Hymenolepis, Dipylidium*.

Difference between a Pseudophyllidean Cestode and a Cyclophyllidean Cestode

Characteristic	Pseudophyllidean Cestode	Cyclophyllidean Cestode
Head	Bears 2 slit-like grooves	Bears 4 cup-like suckers
Uterus	No branching; the convoluted uterine tube assumes the form of a rosette	Branching may or may not be present
Uterine pore	Present	Absent
Common Genital Pore	Ventral in the middle line	Lateral
Eggs	Operculated; give rise to ciliated larvae	Not operculated; do not give rise to ciliated larvae

Classification of Cestodes Infecting Man

(A) According to Habitat

I. Pseudophyllidean Cestodes: Possessing false or slit-like grooves (bothria)

(1) Adult worms in Intestine

Genus *Diphyllobothrium: D. latum* (fish tapeworm)

(2) Larval Stages (Plerocercoid) in Man

(i) *Sparganum mansoni*

(ii) *Sparganum proliferum*

II. Cyclophyllidean Cestodes: Possessing cup-like and round suckers (acetabula)

(1) Adult worms in Intestine

(i) Genus *Taenia: T. saginata* (beef tapeworm), *T. solium* (pork tapeworm)

(ii) Genus *hymenolepis*: *H. nana* (dwarf tapeworm), *H. diminuta* (rat tapeworm)

(iii) Genus *Dipylidium*: *D. caninum* (double-pored dog tapeworm)

(2) Larval stages in Man

(i) Genus *Echinococcus*: Hydatid cyst of *E. granulosus* (dog tapeworm), *E. multilocularis*

(ii) Genus *Taenia*: *Cysticercus cellulosae* of *T. solium*

(iii) Genus *Multiceps*: *Coenurus cerebralis* of *M. multiceps* and *Coenurus glomeratus* of *M. glomeratus*

(B) Systematic Classification

Genus	Species	Definitive Host	Intermediate Host	Stage found in Man
Order I. Pseudophyllidea; Superfamily Bothriocephaloidea; Family Diphyllobothriidae				
Diphyllobothrium	*D. latum*	Man, Dog, Cat	Cyclops & Fish	Adult worm
	D. mansoni	Dog, Cat	Frog, Snake, Man	Larval stage
Order II. Cyclophyllidea; Superfamily Taenioidea, Family Taeniidae				
Taenia	*T. saginata*	Man	Cow	Adult worm
	T. solium	Man	Pig, Man	Adult; Larval stage occasionally
Echinococcus	*E. granulosus*	Dog, Wolf, Jackal	Sheep, Cattle, Pig, Man	Larval stage
	E. multilocularis	Fox, Dingo, Dog, Wolf	Field Mouse, Tundra vole, Man	Larval stage
	M. multiceps	Dog	Sheep, Goat, Cattle, Man	Larval stage
Order II. Cyclophyllidea; Superfamily Taenioidea, Family Hymenolepididae				
Hymenolepis	*H. nana*	Man, Rat	Not required	Adult and larval stages in Intestine
	H. diminuta	Rat (Man)	Rat flea	Adult worm
Order II. Cyclophyllidea; Superfamily Taenioidea, Family Dilepididae				
Dipylidium	*D. caninum*	Dog, Cat (Man)	Dog flea	Adult worm

General Characters of Acanthocephala (Spiny headed worms):

1. Pseudocoelomate, endoparasites
2. Protrusible proboscis, armed with recurved hooks
3. Hooks and spines also present on other parts of the body
4. The anterior part of the body is divided into the presoma, comprising the proboscis and the unarmed neck
5. The trunk or body contains the rest of the organs
6. Sexes are separate
7. No larval reproduction
8. Digestive tract absent; all food absorbed through the surface of the body
9. Parasites of the intestinal tracts of fish, reptiles, birds and less often mammals in the wild.

CLASSIFICATION OF ACANTHOCEPHALA

The group Acanthocephala includes about 650 species recorded from all over the world. Petrachenke (1958) – Russia and Yamaguti (1963) – Japan, gave the group the rank of a class under the phylum Nematyhelminthes. However, van Cleave (1948), has raised the group to the rank of phylum. The latter view is supported by Hyman and Crompton. According to van Cleave (1936), the phylum Acanthocephala is divided into three orders

Recent reviews of the classification are those of Amin (1985, 1987) and Khatoon & Bilqees (1991). Three classes are generally recognized namely the Archiacanthocephala, Palaecanthocephala and the Eoacanthocephala. Amin (1987) has recommended that a new class – Polyacanthocephala should be created to accommodate the family Polyacanthorhynchidae.

Class 1: Archiacanthocephala	Class 2: Palaeacanthocephala	Class 3: Eoacanthocephala
Main longitudinal lacunar canals dorsal and ventral or dorsal only; few hypodermal nuclei; giant nuclei in lemnisci and cement glands; two ligament sacs persist in	Main longitudinal lacunar canals lateral; hypodermal nuclei fragmented, numerous, occasionally restricted to anterior half of trunk; nuclei of lemnisci and cement	Main longitudinal lacunar canals dorsal and ventral, often no larger in diameter than irregular transverse commissures; hypodermal nuclei few, large, sometimes

females; protonephridia present in one family (Oligacanthorhynchidae); pyriform cement glands separate; eggs oval, usually thick shelled; parasites of birds and mammals; intermediate hosts are insects or myriapods	glands fragmented; spines present on trunk of some species; single ligament sac of female does not persist throughout life; protonephridia absent; cement glands separate, tubular to spheroid; eggs oval to elongate, sometimes with polar thickenings of second membrane; parasites of fish, amphibians, reptiles, birds and mammals.	amoeboid; proboscis receptacle single walled; proboscis inverter muscle pierces posterior end of receptacle; brain near anterior or middle of receptacle; nuclei of lemnisci few and large; two persistent ligament sacs in female; protonephridia absent; cement gland single, syncytial, with several nuclei, and with cement reservoir appended eggs variously shaped; parasites of fish, amphibians, and reptiles
Order 1: Moniliformida; Family: Moniliformidae; Genus: *Moniliformis*	**Order 1**: Echinorhychida; Family: Rhadinorhynchidae; Genus: *Rhadinorhynchus*. Family: Gorgorhynchidae; Genus: *Aspersentis*. Family: Pomphorhynchidae: Genus: *Pomphorhynchus*.	**Order 1**: Gyracanthocephalida; Family: Quadrigyridae; Genus: *Quadrigyrus*. Family: Pallisentidae; Genus: *Pallisentis.*
Order 2: Gigantorhynchida; Family: Gigantorhynchidae; Genus: *Gigantorhynchus* Family: Pachysentidae; Genus: *Oncicola*	**Order 2**: Polymorphida; Family: Polymorphidae; Genus: *Polymorphus*. Family: Echinorhynchidae; Genus: *Echinorhynchus*.	**Order 2**: Neoechinorhynchida; Family: Neoechinorhynchidae; Genus: *Neoechinorhynchus*. Family: Tenuisentidae; Genus: *Tenuisentis.*
Order 3: Oligacanthorhynchida; Family: Oligacanthorhychidae; Genus: *Oligacanthorhynchus*		
Order 4: Apororhynchida		

NEMATA (OR NEMATODA): THE ROUNDWORMS

- The relationship of the nematodes or roundworms to other organisms remains uncertain even after 100 years of debate.
- Some consider these organisms to constitute an independent phylum, the **Nemata (or Nematoda)**,
- whereas others include these worms, along with the Rotifera, Gastrotricha, Kinorhyncha, and Nematomorpha, in the phylum **Aschelminthes**.
- In another scheme, the nematodes, along with the Nematomorpha, are considered classes of phylum **Nemathelminthes**.
- The most popular view at this time appears to consider the nematodes as representing a distinct phylum and is being designated the Nemata.

Phylum: Nemathelminthes (Aschelminthes)

Class: Nematoda

General Characters:

1. The nematodes are unsegmented worms without any appendage. They are elongated and cylindrical or filiform in appearance; both ends are often pointed.
2. The *sizes* show a great variation, the smallest (T. spiralis and S. Stercoralis) measures less than 5 mm and the largest *(D. medinensis) measures up to 1 metre*.
3. The *body* is covered with a tough cuticle.
4. The worm possesses a *body cavity* in which the various organs, such as the digestive and genital systems, float. Excretory and nervous systems are rudimentary.
5. The *alimentary canal* is complete, consisting of an oral aperture, mouth cavity, oesophagus, intestine and a subterminal anus. The mouth cavity, when present, may have teeth or cutting plates; in other cases where the mouth cavity is absent, the oral aperture is directly continuous with the oesophagus.
6. The nematodes of man are all diecious helminths, i.e., the sexes are separate. The male is generally smaller than the female and its posterior end is curved or coiled ventrally.

Classification of Nematodse

(A) According to Habitat of Adult Worms

I. Intestinal	II. Somatic (Inside the Tissues & Organs)
1. Small Intestine only *Ascaris lumbricoides* (common roundworm) *Ancylostoma duodenale* (The old World hook-worm) *Necator americanus* (American hookworm) *Strongyloides stercoralis* *Trichinella spiralis* (Trichina worm) *Capillaria philippinensis* **2. Caecum and Vermiform Appendix** *Enterobius vermicularis* (Threadworm or pinworm) *Trichuris trichiura* (Whipworm)	1. **Lymphatic System** *Wucheraria bancrofti* *Brugia malayi* **2. Subcutaneous Tissues** *Loa loa* (African eye worm) *Onchocerca volvulua* *Dracunculus medinensis* (Guinea worm) **3. Lungs** *Strongyloides stercoralis* **4. Mesentery** *Dipetalonema perstans* *Mansonella ozzardi* **5. Conjunctiva** – *Loa loa*

(B) Systematic Classification of Nematodes

Class: Nematoda

Subclass	Order	Superfamily	Genus	Species
Aphasmidia (No caudal chemo-receptors)	Enoplida	Trichinelloides	*Trichinella* *Trichuris* *Capillaria*	*T. spiralis* *T. trichiura* *C. philippinensis*
Phasmidia (Having caudal chemo-receptors)	Spirurida	Filarioidea	*Wuchereria* *Brugia* *Onchocerca* *Dipetalonema* *Mansonella* *Dirofilaria* *Loa*	*W. bancrofti* *B. malayi* *O. volvulus* *D. perstans* *D. streptocerca* *M. ozzardi* *D. conjunctivae* *D. immitis* *L. loa*
		Dracunculoidea	*Dracunculus*	*D. medinensis*
		Spiruroidea	*Gnathostoma*	*G. spinigerum*