Entomology + Parasitology

BGS233

(Theoretical Part)

First semester

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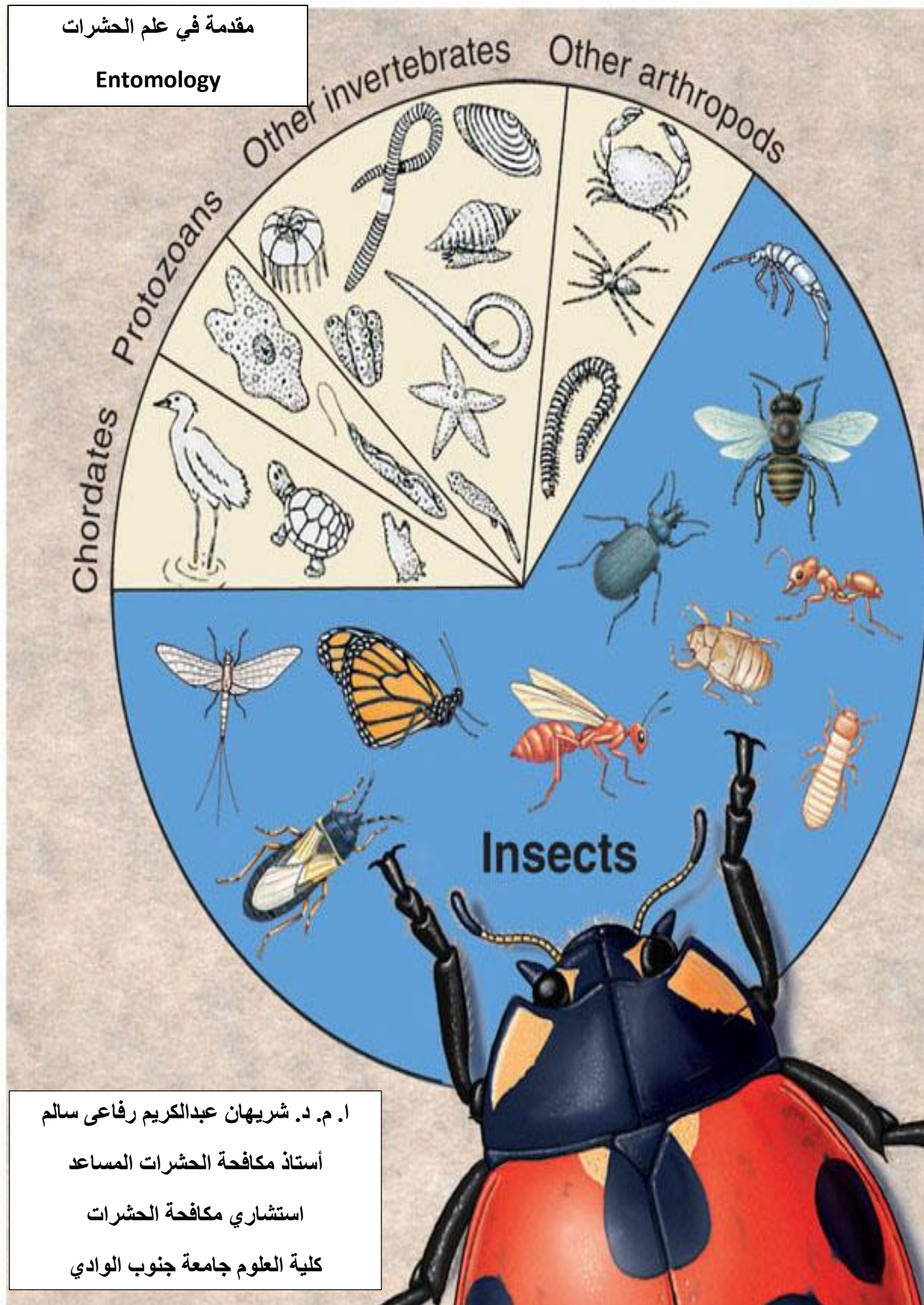
مقدمة في علم الحشرات

Entomology



ا. م. د. شريهان عبدالكريم رفاعى سالم

أستاذ مكافحة الحشرات المساعد

استشاري مكافحة الحشرات

كلية العلوم جامعة جنوب الوادي

What is Entomology?

The study of insects and their relationship to humans, the environment, and other organisms.

Why should we study insects?

لقد وردت مسميات وحكم الحشرات في الكتب المقدسة مثل القرآن الكريم في الآيات

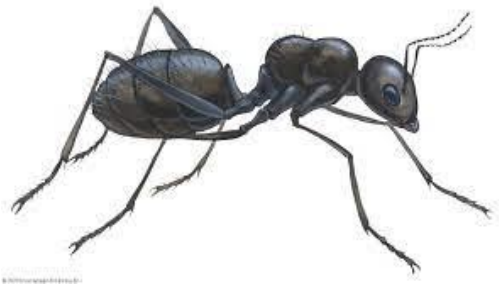
1- حكمة البعوض Mosquitoes

قال الله تعالى: ﴿ إِنَّ اللَّهَ لَا يَسْتَحْيِي أَن يَضْرِبَ مَثَلًا مَّا بَعُوضَةً فَمَا فَوْقَهَا ۚ فَأَمَّا الَّذِينَ آمَنُوا فَيَعْلَمُونَ أَنَّهُ الْحَقُّ مِن رَّبِّهِمْ ۖ وَأَمَّا الَّذِينَ كَفَرُوا فَيَقُولُونَ مَاذَا أَرَادَ اللَّهُ بِهَٰذَا مَثَلًا ۘ يُضِلُّ بِهِ كَثِيرًا وَيَهْدِي بِهِ كَثِيرًا ۚ وَمَا يُضِلُّ بِهِ إِلَّا الْفَاسِقِينَ﴾ البقرة: 26

2- قصة النمل True Ants

قال الله تعالى:

حَتَّىٰ إِذَا أَتَوْا عَلَىٰ وَادِ النَّمْلِ قَالَتْ نَمْلَةٌ يَا أَيُّهَا النَّمْلُ ادْخُلُوا مَسَاكِنَكُمْ لَا يَحْطِمَنَّكُمْ سُلَيْمَانُ وَجُنُودُهُ وَهُمْ لَا يَشْعُرُونَ (النمل:18)



3- سلوك النحل The Bees

قال الله تعالى:

"وَأَوْحَى رَبُّكَ إِلَى النَّحْلِ أَنِ اتَّخِذِي مِنَ الْجِبَالِ بُيُوتًا وَمِنَ الشَّجَرِ وَمِمَّا يَعْرِشُونَ * ثُمَّ كُلِي مِن كُلِّ الثَّمَرَاتِ فَاسْلُكِي سُبُلَ رَبِّكِ ذُلُلاً يَخْرُجُ مِن بُطُونِهَا شَرَابٌ مُّخْتَلِفٌ أَلْوَانُهُ فِيهِ شِفَاء لِلنَّاسِ إِنَّ فِي ذَلِكَ لآيَةً لِّقَوْمٍ يَتَفَكَّرُونَ" (النحل: 68، 69)

4- حكاية النمل الأبيض Termites- White Ants

قال الله تعالى:

﴿فَلَمَّا قَضَيْنَا عَلَيْهِ الْمَوْتَ مَا دَلَّهُمْ عَلَى مَوْتِهِ إِلَّا دَابَّةُ الْأَرْضِ تَأْكُلُ مِنْسَأَتَهُ فَلَمَّا خَرَّ تَبَيَّنَتِ الْجِنُّ أَنْ لَوْ كَانُوا يَعْلَمُونَ الْغَيْبَ مَا لَبِثُوا فِي الْعَذَابِ الْمُهِينِ﴾ سبأ: (14)

5- قوة الذباب House flies

قول الله تعالى (يَا أَيُّهَا النَّاسُ ضُرِبَ مَثَلٌ فَاسْتَمِعُوا لَهُ إِنَّ الَّذِينَ تَدْعُونَ مِنْ دُونِ اللَّهِ لَنْ يَخْلُقُوا ذُبَاباً وَلَوِ اجْتَمَعُوا لَهُ وَإِنْ يَسْلُبْهُمُ الذُّبَابُ شَيْئاً لا يَسْتَنْقِذُوهُ مِنْهُ ضَعُفَ الطَّالِبُ وَالْمَطْلُوبُ) (الحج:73).

6- عذاب الله بالجراد و القمل Locusts and Lice

﴿ فَأَرْسَلْنَا عَلَيْهِمُ الطُّوفَانَ وَالْجَرَادَ وَالْقُمَّلَ وَالضَّفَادِعَ وَالدَّمَ آيَاتٍ مُّفَصَّلَاتٍ فَاسْتَكْبَرُوا وَكَانُوا قَوْمًا مُّجْرِمِينَ﴾ (الأعراف: 133)

The Economic importance of insects:

A- Benefits

Pollination and food production

Insects play a key role in producing agricultural crops such as oilseed rape, field beans, apples and raspberries. 84% of crops grown in Europe rely on pollinators like bees, flies, wasps, beetles, butterflies, moths and even houseflies. Insect-pollinated plants attract insects with nectar to then carry pollen to other plants and fertilize them to create seeds and fruit.

Insects also contribute to human health and wellbeing directly through the production of honey, pollen, wax for food processing, propolis in food technology, and royal jelly as a dietary supplement and ingredient in food. Without insects, many foods would be off the menu, including onions, cabbage, broccoli, chillies, most tomatoes, coffee, cocoa, most fruits, sunflower and rapeseed oil. Fewer types and less quantity of food would be available. We would also need more synthetic fibres as pollination is necessary for cotton and flax for linen.

Biological control of more harmful insects

Some insects are predators that feed on other invertebrates that may cause harm to humans or human crops. Ladybirds for example are fantastic biocontrol for aphids that eat away at food producing plants. They also make quick meals of immature scale insects, mealybugs, mites and other soft-bodied insect pests as well as insect eggs. This is just one example for the importance of insects in an agricultural sense in particular.

Animal feed

Many birds, fish and mammals, including agricultural animals like cattle, have a diet consisting of invertebrates. Black soldier fly larvae, for example, are a natural source of methionine – an important nutrient for chickens, their natural diet consisting of mealworms, crickets, and earthworms all containing more essential amino acids than grain feed. This promotes better overall health and longevity. Insects have a huge importance in the natural food chain, as they are a primary food source for many other animals.

Recycling and waste clearance

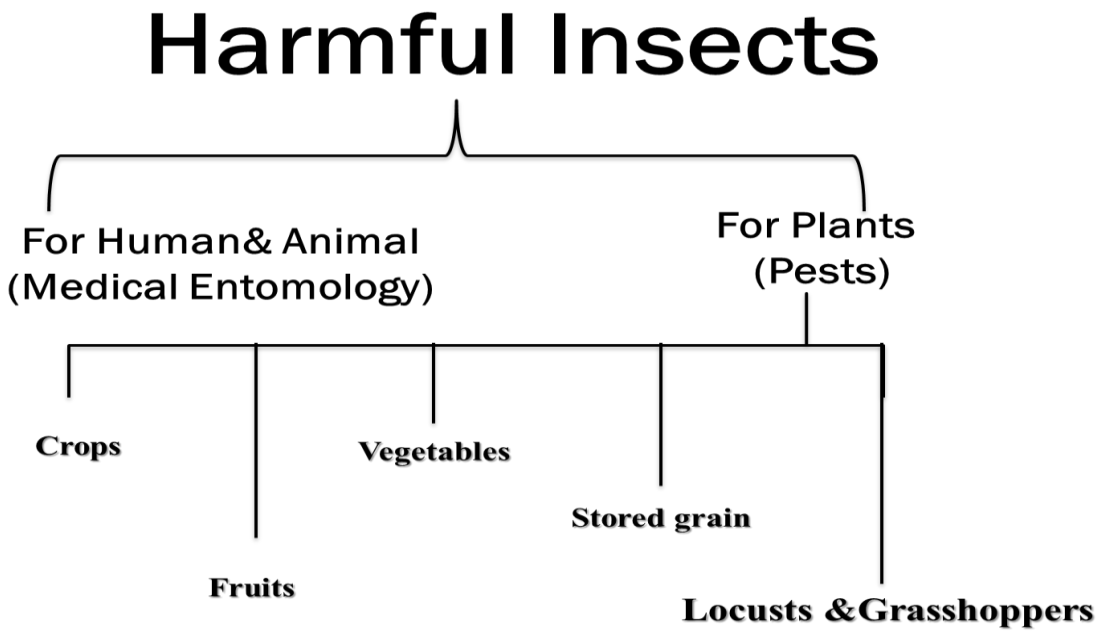
Lots of insects will eat and help to break down dead and decaying debris which can clog or infect soil and water streams. Their role in recycling is very important as this break down of waste helps create healthy, fertile soil.

Without insects to do this naturally, dead animals, plants and food waste would build up very quickly. Some flies are particularly beneficial in industry with their ability to convert organic waste into high-quality nutrients, as well as residue fertilizer for soil amendment.

Insect protein

In some parts of the world, insects are considered a delicacy and regular addition to one's everyday diet. Around two billion people around the world would consider them a very normal and an important ingredient in meal preparation as they are packed full of protein.

B- Dangers



Reasons for dominance:

There are several structural, morphological and physiological factors responsible for insect dominance. They are:

1. Capacity for flight
2. More adaptability
3. Smaller size
4. Presence of exoskeleton
5. Resistance to desiccation
6. Tracheal system of respiration
7. Higher reproductive potential

Taxonomy of Class: Insecta

Kingdom: Animalia
Phylum: Arthropoda
Class: Insecta

Insects are invertebrates grouped in the phylum **Arthropoda** (Arthro-joint, poda-foot). Characters of the Phylum Arthropoda are:

1. Segmented body

2. Segments grouped into 2 or 3 regions

3. Renewable chitinous exoskeleton

4. Grow by molting.

5. Bilateral symmetry of body.

6. Body cavity filled with blood and called as haemocoel.

7. Tubular alimentary canal with mouth and anus at anterior and posterior ends.

8. Dorsal heart with valve like ostia.

9. Dorsal brain with ventral nerve cord.

10. Striated muscles (with dark and light bands).

11. No cilia

12. Paired, segmented appendages.

Morphological Characters of Class: Insecta

*The insect integument is composed of the CUTICLE, EPIDERMIS, and the BASEMENT MEMBRANE.

Functions of the Integument

1 .Protection for internal organs.

2 .Skeleton for attachment of muscles.

3 .Give the insect its form.

4 .Give chemical and physical colors.

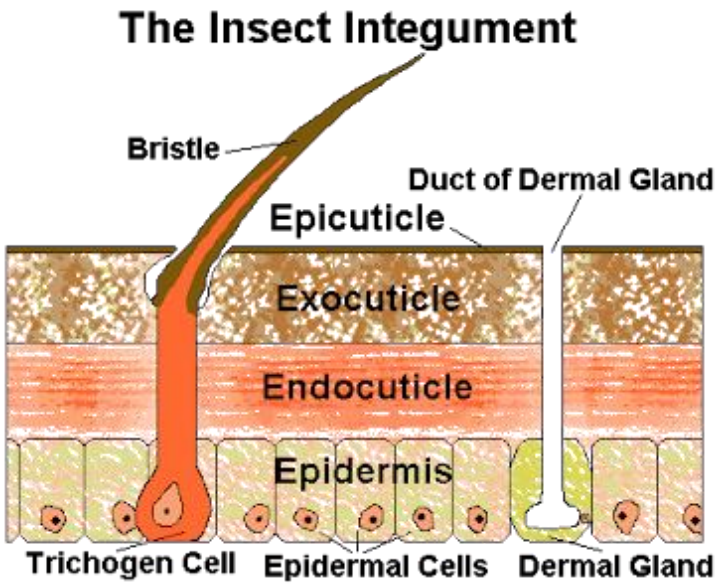
5 .Regulates water loss.

6 .Provides a metabolic reserve.

7 .Protects against entry of foreign materials such as pesticides.

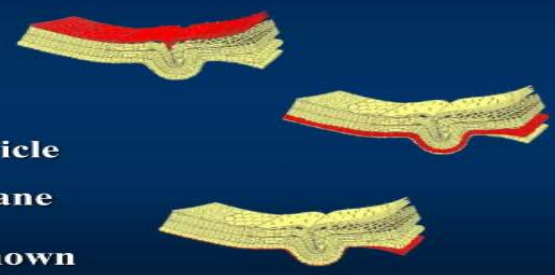
8 .Allows for modifications which provide sensory input, eyes, chemoreceptors, etc.

9. Allows for movement and most important, flight.



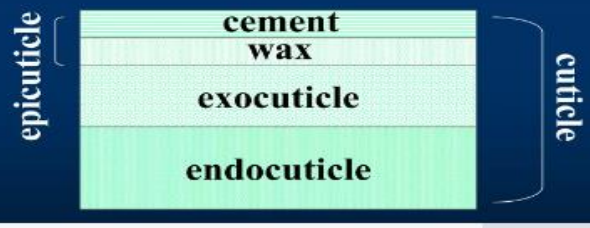
Components of the Exoskeleton

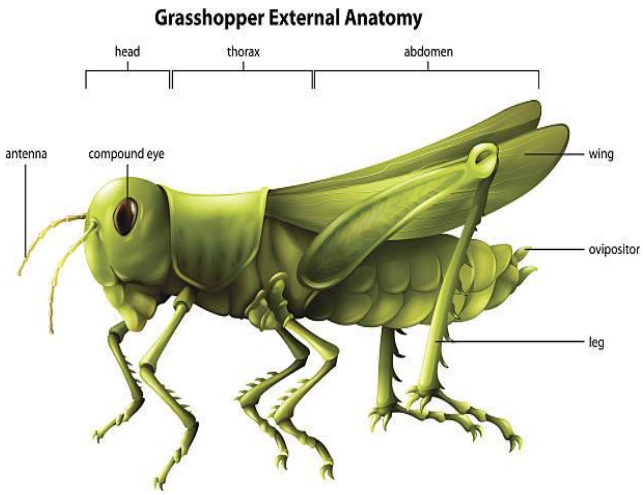
- Cuticle
  - non-living
- Epidermis
  - living
  - secretes the cuticle
- Basement membrane
  - non-living
  - function not known

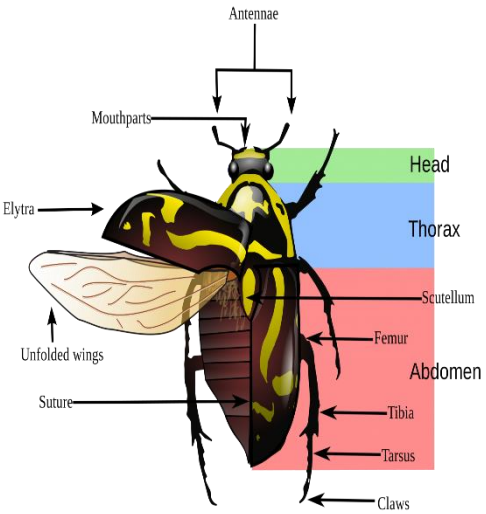


Cuticle

- Key contributor to the success of insects
  - barrier between living tissue/environment
  - restriction of water loss
  - abrasion protection







The Insect body regions

I- Head

II- Thorax

III- Abdomen

Head: In the adult insect, the head capsule appears unsegmented, though embryological studies show it to consist of six segments. The insect head contains

1. a pair of compound eyes(present or absent), simple eyes (ocelli)(present or absent).
2. mouth parts (labium, mandibles, maxillae, hypopharynx and labrum)
3. a pair of antennae.

Head appendages

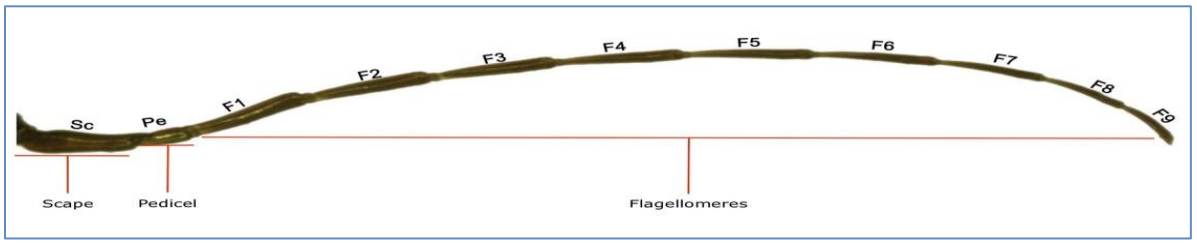
Insect Antennae

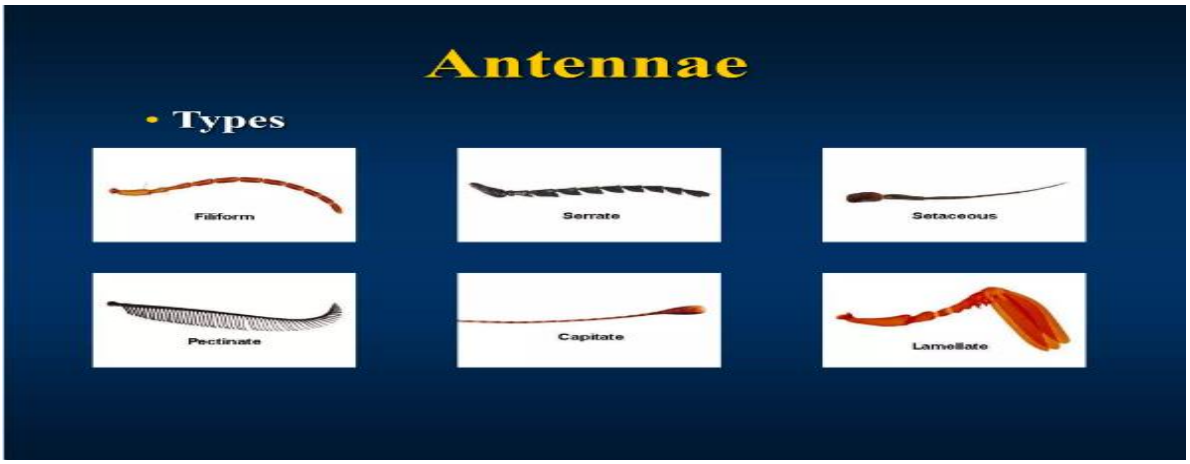
All insect antennae have three basic parts:

1-The scape is the first segment and is attached to the head of the insect inside a socket. This socket allows the insect to move and rotate the antenna easily.

2- The next segment is **the pedicel**. It contains muscle connections allowing the insect greater control over antennal movement.

3- The rest of the antenna is called **the flagellum** and is made up of many flagellomeres. These are small segments containing many specialised sensory cells.





Functions

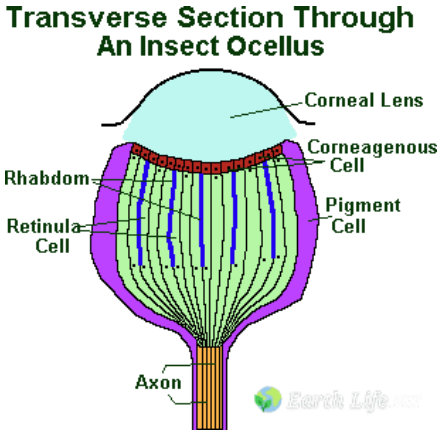
- Sense organ responding to touch, smell, odour, humidity, temperature & air currents or wind speed

Insect Eyes

Compound Eyes
Compound eyes are so named because the cornea is composed of a number of individual facets or lenses (called ommatidia), rather than a single lens as in ocelli (or our own eyes).

Ocelli (Simple Eyes)

Ocelli are present in most insects to some degree, though as with all aspects of insect anatomy there is a great deal of variety in form and even in relative function.

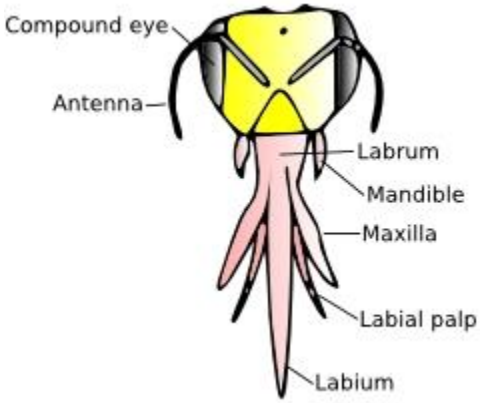


Insect Mouthparts

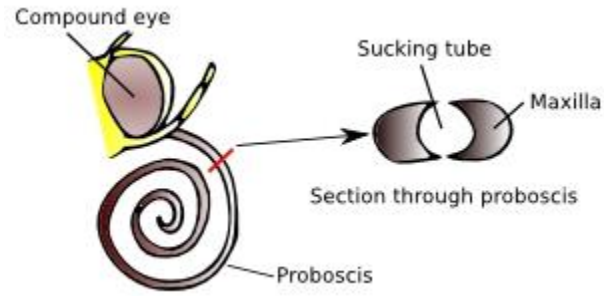
In the primitive form, the insect mouth articulates (moves) from side-to-side in a horizontal plane, rather than vertically as do ours. In those groups of insects that evolved later, the basic mouthparts shown below have become highly modified.

Mouthpart modifications

Honey bee - the mandibles are very small and suitable for moulding wax, the labium is curved downwards and inwards forming a tube used for sucking up nectar.

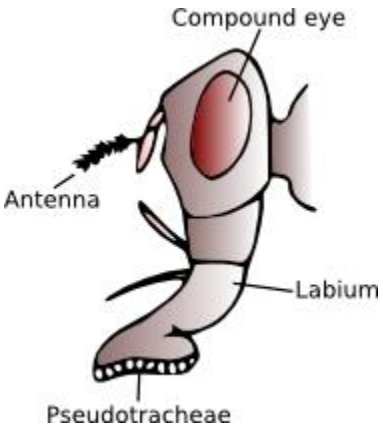


Butterflies and Moths - the mandibles have disappeared altogether. The maxillae are elongate, channelled along their surfaces and held together by hooks and spines to form a sucking tube. This proboscis may be very long, when not in use is carried coiled up like a watch spring under the head.



House-fly - the proboscis shows a capillary mechanism. The labium is elongated and forms two lobes at the tip. These lobes have a series of fine tubes (pseudotracheae). The hypopharynx runs down the proboscis and digestive juices pass down this onto the food. The food is made into a liquid by these juices. This liquid is then drawn up the pseudotracheae by capillary

action.



Thorax

•consisting of three segments, Prothorax, Mesothorax and Metathorax

•Each possess a pair of legs and a pair of wings on meso and meta thoracic segment

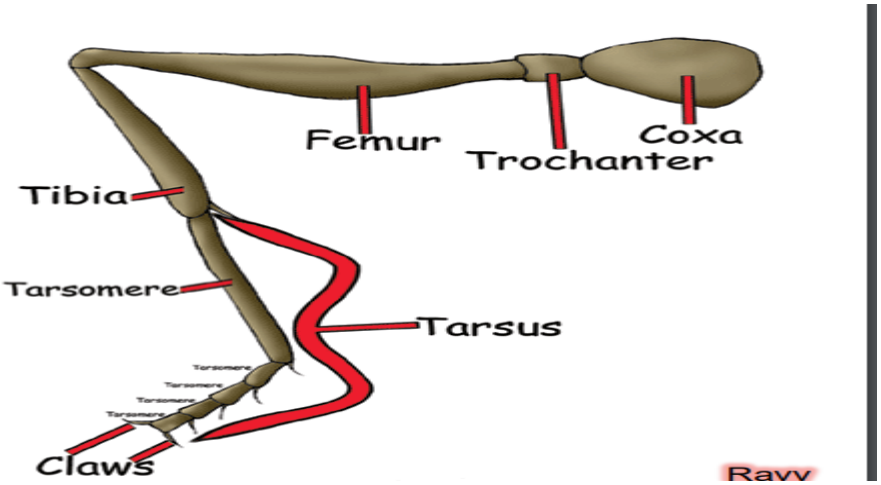
•Meso and meta thoracic segments together known as pterothorax

•Sclerite of dorsal region of thorax is tergum or notum

• ventral region is called sternum and lateral region is called pleuron

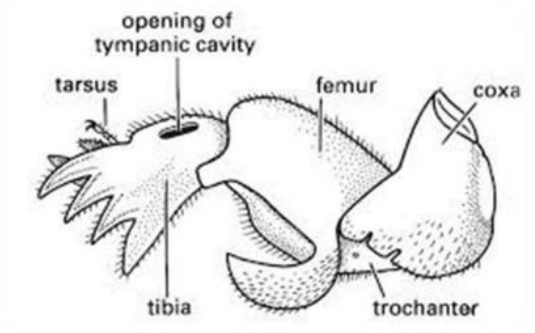
Insect Leg and its Modifications

All the three thoracic segments of an insect possess a pair of legs - hexapods and class insecta as hexapoda • Insect leg consists of 5 parts viz. Coxa, Trochanter, Femur, Tibia and Tarsus

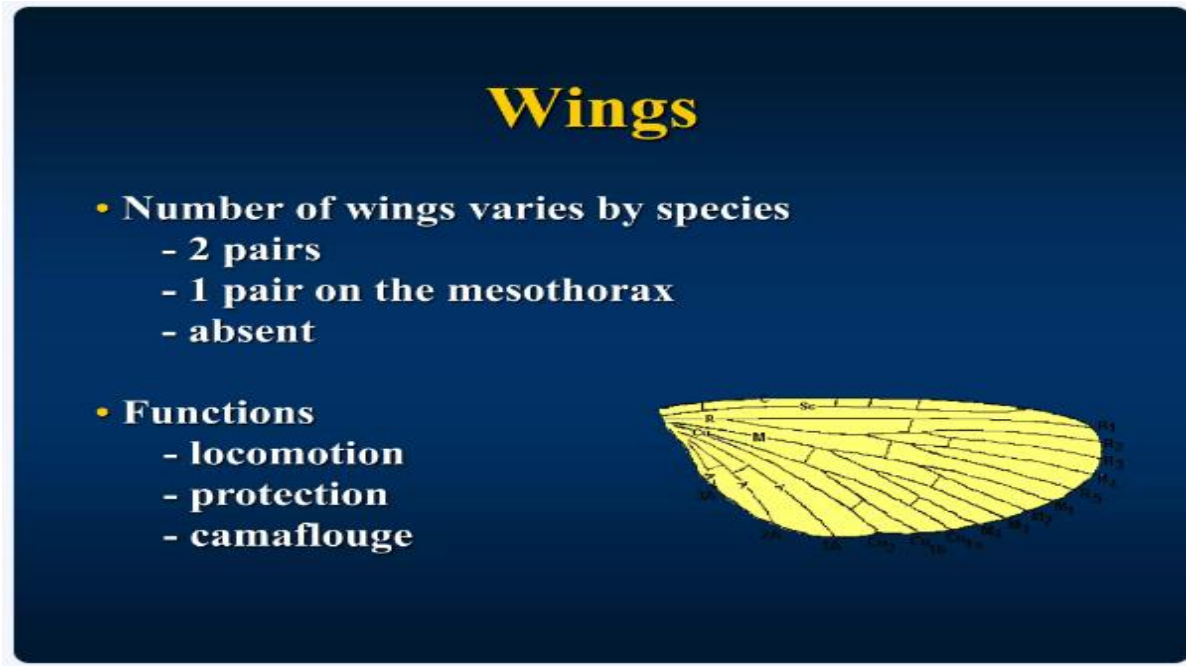


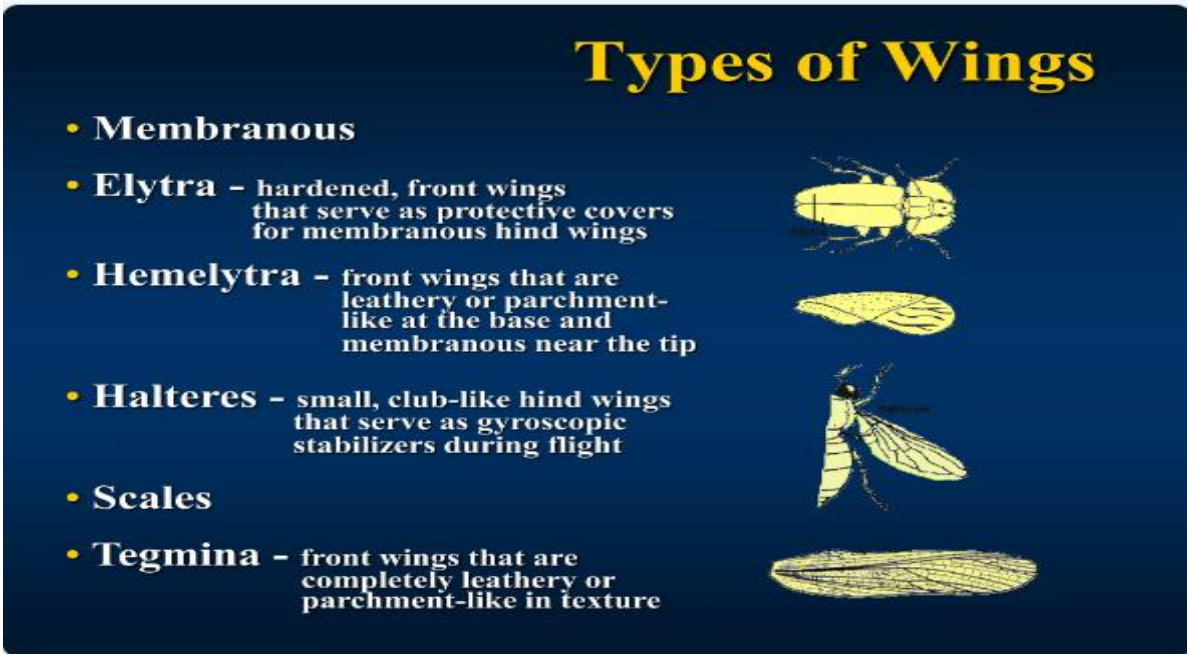
Modifications of Leg Type Leg

Type	Leg modified	Example	purpose	Modification
Cursorial	All legs	Blister beetle, wasp	Walking	All the legs uniformly well developed without any special modification
Ambulatory	All legs	Cockroach	Running	All legs are normal. coxa widely separated
Saltatorial	Hind legs	Grasshopper , gryllids	Leaping & jumping	Femur and tibia elongated
Fossorial	Front legs	Mole crickets, dung rollers	Digging	Tibia and tarsus short and broad with teeth like projections



Type	Leg modified	Example	purpose	Modification
Raptorial (grasping)	Front legs	Preying mantids	Preying	femur spinose and possess a central longitudinal groove. Tibia narrow, blade like spinose and fits into the groove of femur
Natatorial	Hind legs	Water beetle, water bugs	Swimming	Hind legs pad like. Tibia and tarsus short and broad having dense long marginal hairs.
Scansorial	All legs	Head louse	clinging	Tibia possess tibial thumb. Tarsus single segmented and pretarsus with a single long curved claw



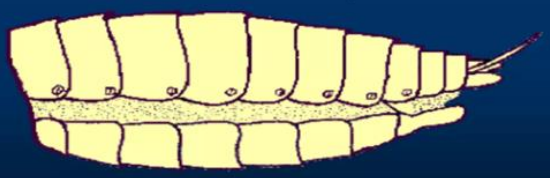


Abdomen:

The abdomen is the metabolic and reproductive centre, where digestion, excretion, and the sexual functions take place. Generally, abdomen consists of 11 segments. Posterior abdominal segments are modified for the purpose of mating and oviposition.

Abdomen

- Functions:
  - respiration
  - excretion
  - reproduction



Abdomen

- Spiracles
  - openings involved in respiration
  - located on each side of abdomen

- Cerci
  - sensory organs

- Ovipositor
  - egg-laying structure
  - stingers (modified ovipositor found in some females)

What is Metamorphosis?

Metamorphosis meaning the changing of one organism into another form typically soon after birth.

The transformative changes an insect passes through as it moves from one stage of its life cycle to the next is called metamorphosis.

Types of Metamorphosis

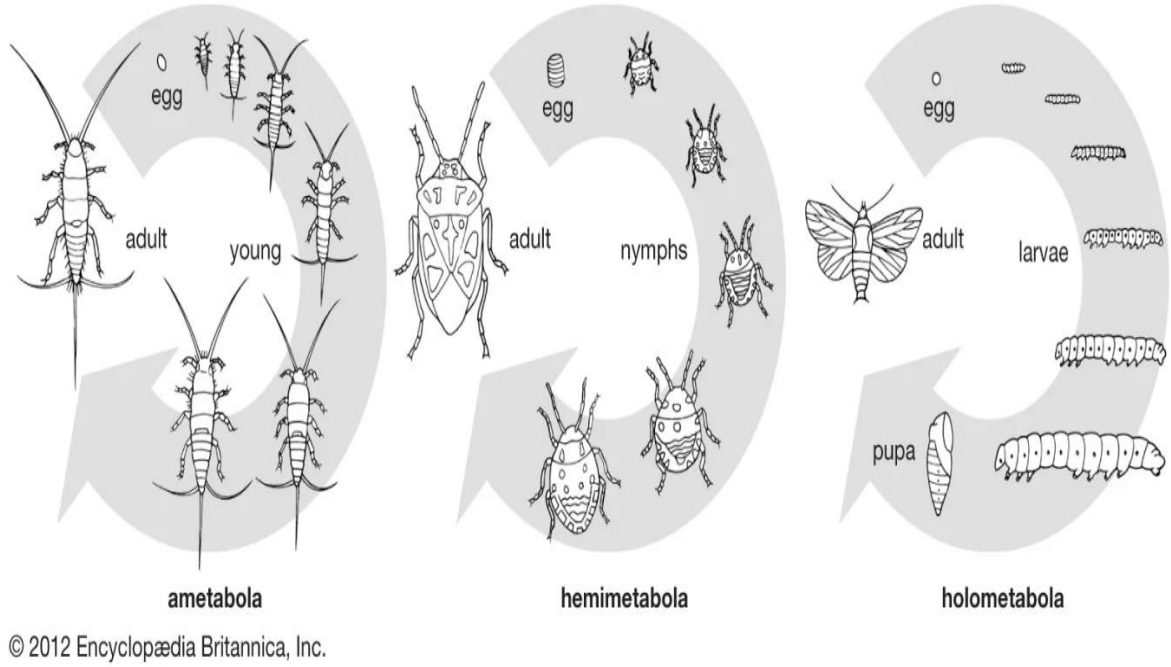
There are different types of metamorphosis that an animal can go through. The most common type of metamorphosis can be seen in insects. Insects are the most widely known group of animals to go through the process.

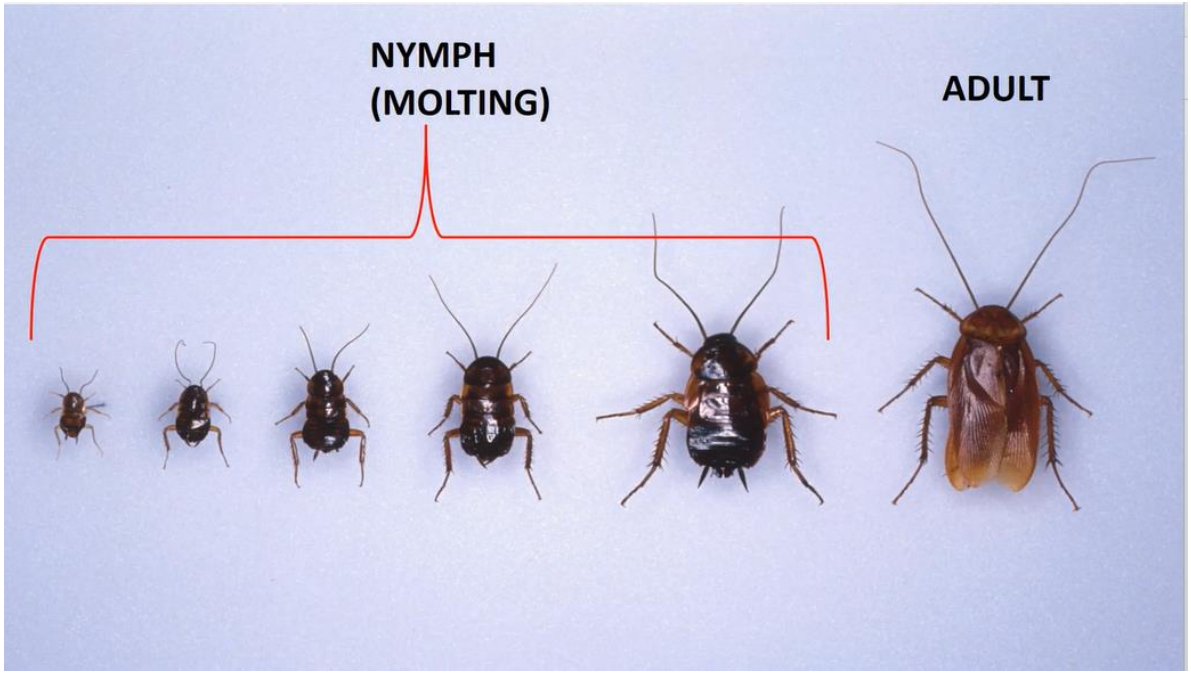
There are four types of metamorphosis in insects:

- Ametabolous
- Hemimetabolous
- Holometabolous
- Hypermetamorphosis
- **Ametabolous metamorphosis** is common in more primitive insects like silverfish and springtails. The animal hatches and then slowly gets bigger until it reaches the size of an adult.
- In insects, such as grasshoppers and termites, the process of **hemimetabolous (**incomplete metamorphosis) occurs. This is a three-step cycle of egg, nymph, and adult. After hatching from the egg, the nymph resembles a small version of the adult with few differences. It differs in color and dimension, and it will very slowly grow and undergo multiple molts. Its wings will continue to develop as it reaches its adult form.
- **Holometabolous metamorphosis** is also known as complete metamorphosis. During this process, the insect goes through the entire life cycle of **egg, larva, pupa, adult**. It is commonly seen in insects of

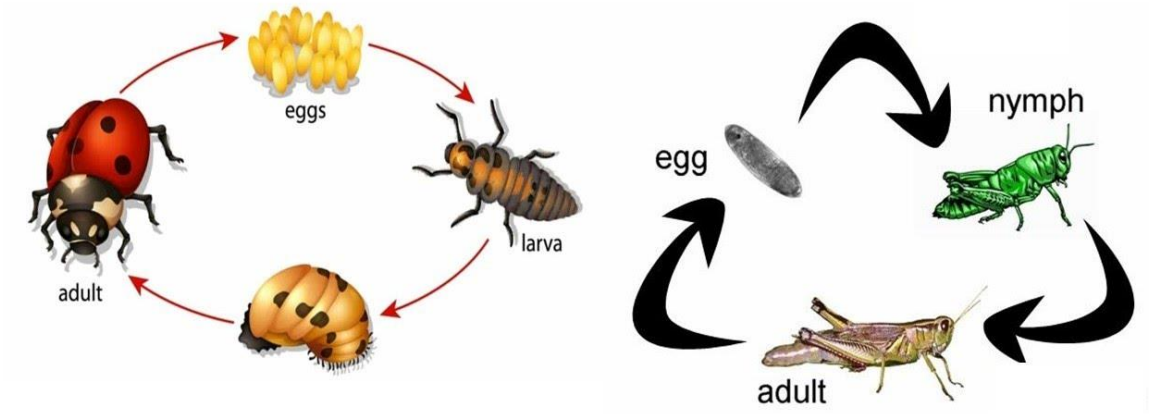
order Endopterygota that includes butterflies, bees, ants, flies and beetles. In this developmental life cycle, each stage animal differs from the next stage largely.

- **Hypermetetamorphosis** is a type of complete metamorphosis. In this type, there are multiple larval stages.





METAMORPHOSIS



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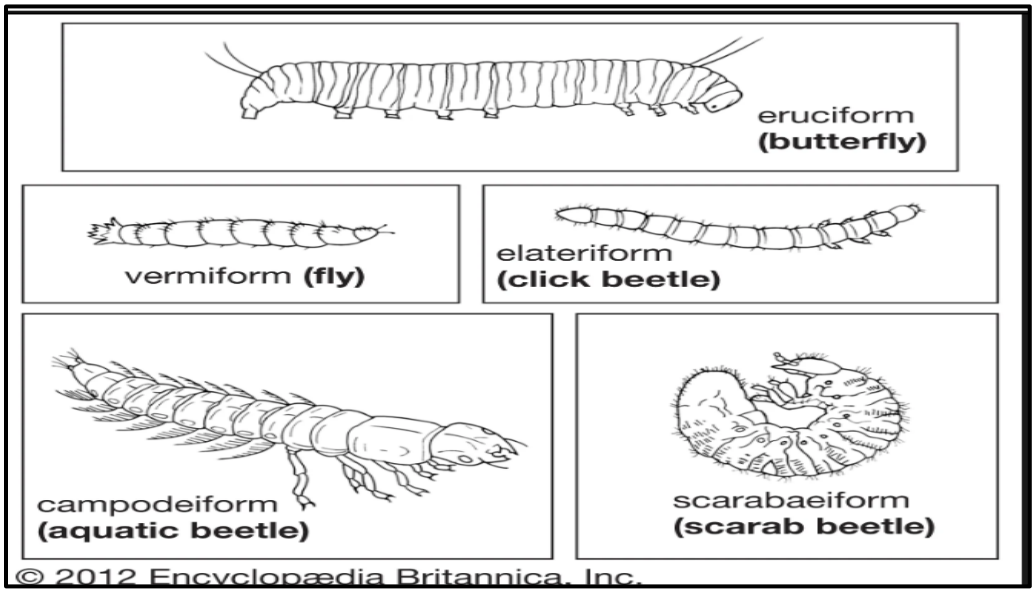
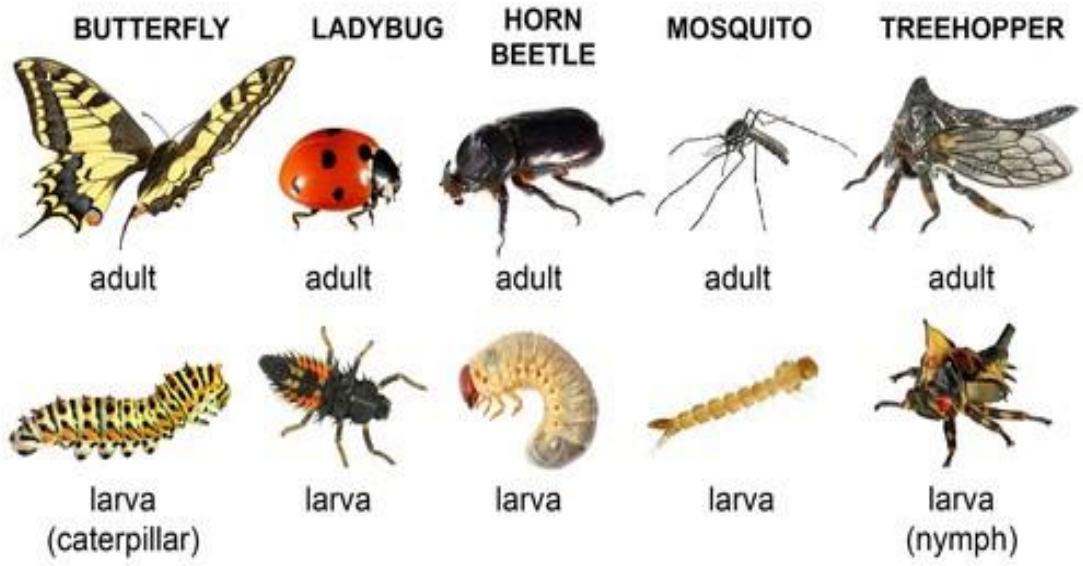
Developmental Stages

1. **Egg:** Egg is the first developmental stage of the insect life cycle. The egg is single celled which soon divides to form a larva before hatching. The egg stage is usually very short in insects or can sometimes last for months when the insect goes for hibernation to avoid extreme weather conditions.

2. Larva: Larva is the second stage of holometabolous life cycle. Sometimes, insects lay their eggs on food sources so that the larva can start feeding as soon as the egg hatches. The larva (plu: larvae) has simple eyes rather than compound eyes and possesses no wings or wing buds. Most of the larval stage is worm-like and mobile. On the basis of their body type, the larvae are of four types:

- Elateriform: wireworm-like, e.g., family Elateridae
- Eruciform: caterpillar-like, e.g., order Lepidoptera and Symphyta
- Scarabaeiform: grub-like along with a head capsule, e.g., family Scarabaeidae
- Vermiform: maggot-like, e.g., suborder Brachyceran
- Campodeiform: elongate, flattened with functional legs, e.g., *Campodea*

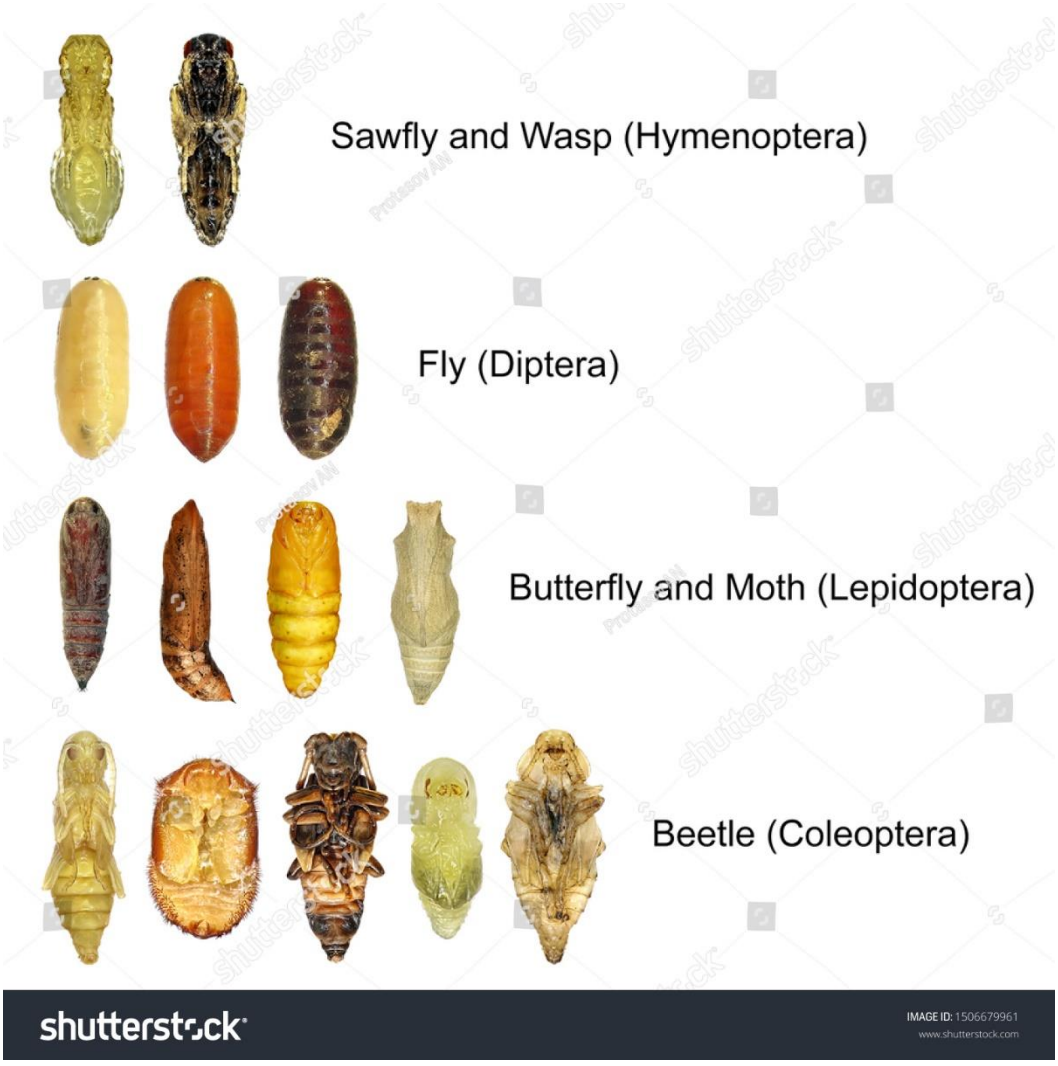




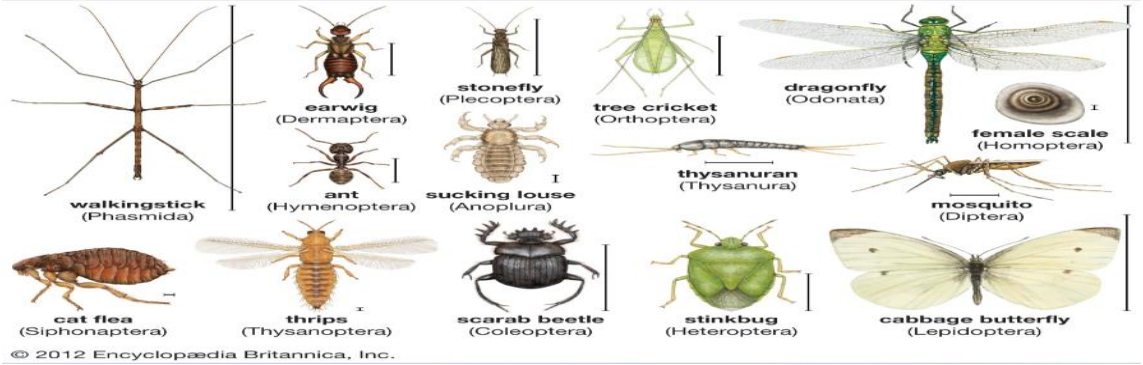
3. Pupa: The larva undergoes metamorphosis to enter the third developmental stage, i.e., pupa. They are inactive and non-feeding at this stage. Most of the organisms are immobile at this stage but some like mosquitoes are mobile. An organism prepares for pupation by knitting a cocoon made of silk or its own faeces for its protection. After reaching this stage, an organism's physiology and structure change drastically.

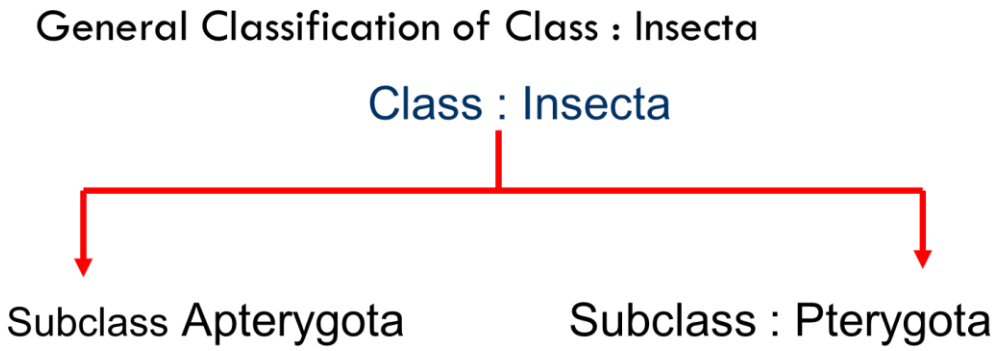
The pupae are of three kinds:

- Obtect: compact, legs and other appendages are closed
- Exarate: legs and other appendages are free and extended
- Coarctate: these pupae develop inside the larval skin



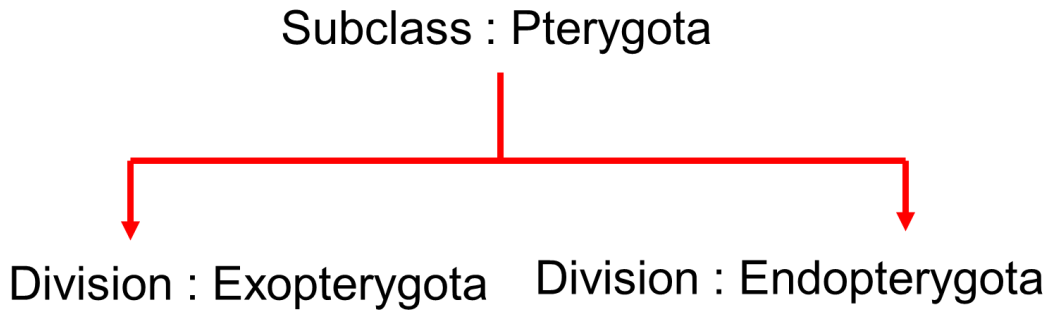
4. **adult**, is the final stage of holometabolous development. They have wings and reproductive organs. The majority of adults do not grow much after eclosion from pupa, some of them don't feed at all and focus primarily on mating and reproduction while some of them can still divide that is restricted to specific organs.





Sub class : Apterygota

1. Protura
2. Diplura
3. Thysanura
4. Collembola



Exopterygota : Incomplete metamorphosis
wings develop externally

Endopterygota : Complete metamorphosis
wing rudiments develop internally

Division 1 : Exopterygota

1- رتبة الرعاشات ODONATA

2- رتبة مستقيمة الاجنحة ORTHOPTERA

3- رتبة جلدية الاجنحة DERMAPTERA

4- ذباب مايو EPHEMEROPTERA

5- رتبة مطبقة الاجنحة PLECOPTERA

6- رتبة الحشرات العصوية والورقية PHASMIDA

7- رتبة امبية الاجنحة EMBIOPETRA

8- رتبة النمل الابيض ISOPTERA

9- رتبة الصراصير BLATTODEA

10- رتبة فرس النبى MANTODEA

11- رتبة قمل الكتب POSCOPETRA

12- رتبة القمل القارض MALLOPHAGA

13- رتبة القمل الماص SIPHONCULATA

14- رتبة نصفية الاجنحة HEMIPTERA

15- رتبة هدبية الاجنحة THYSANOPTERA

Division 2 : Endopterygota

1- رتبة شبكية الاجنحة NEUROPTERA

2- رتبة الذباب العقرب MECOPTERA

3- رتبة حرشفية الاجنحة LEPIDOPTERA

4- ذباب شعرية TRICHOPTERA

5- رتبة ثنائية الاجنحة DIPTERA

6- رتبة البراغيث SIPHONAPTERA

7- رتبة غشائية الاجنحة HYMENOPETRA

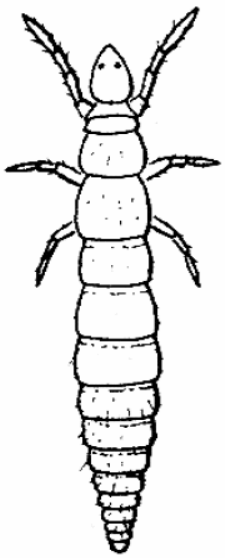
8- رتبة غمدية الاجنحة COLEOPTERA

General Characters of Order : Protura

1- Shape : Slender

2- Size : Small (1.5 mm)

3- Body is divided into :



a) Head : cone shaped

eyes : absent

antenna : absent

mouthparts ; chewing , well developed

Inside head

b) Thorax : wingless

3 similar pairs of thoracic legs

the 1st pair serve as tactile organs

c) Abdomen : 12 segments

1st 3 abdominal segments with paired styli

Order : Thysanura(Silverfish , Firebrats)

General characters of Order : Thysanura

1- Shape : Flattened wider body

styliform appendages

2- Size : Small to medium size (5-30 mm)

3- Body is divided into :

Head : eyes : absent or small

antenna : multisegmented

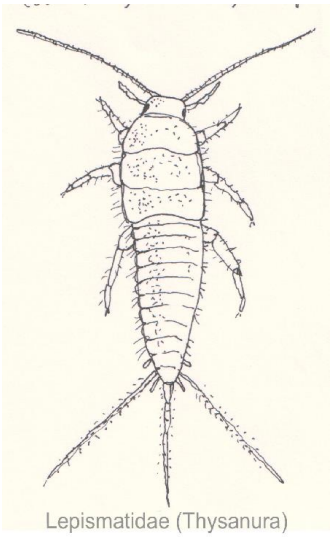
mouthprats: chewing

Thorax : wingless

legs : well developed

Abdomen :11 segments

has long cerci and along caudal filament



Lepismatidae (Thysanura)

Subclass: Pterygota

Division : Exopterygota

1-Order : *Odonata*

General Characters of order : Odonata

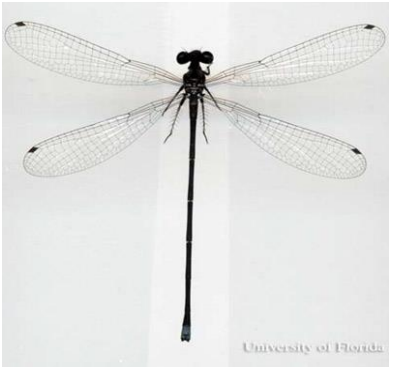
1-shape : This insects have beautiful colors.
2-size : medium to large.
3-Body is divided into :
a) Head :
-very mobile hypognathous head.
-Short filiform antenna.
-Mandibulate (chewing) mouth parts.
-Large compound eyes, 3 ocelli.
b)Thorax :
-Short and compact.
-Two pairs of nearly similar net-veined wings with pterostigmata. --In the hindwing, the inner margine is broader than the outer margine.
- Short walking legs

c) Abdomen :
- Elongated, slender with 10 segments.
- One segmented cerci work as catch organ in male.
- Male capulatory organs on second abdominal sternites (ventral side).
- Female genitalia on the last abdominal segment.

4- Metamorphosis :
- Incomplete metamorphosis.

5- Feeding :
Adult dragonflies and damselflies catch and eat insects while they are flying, including flies, wasps, moths, and beetles.

Naiads are voracious predators and feed mostly on other insects in water, but they also can be cannibals by feeding on other naiads of their own species. Some large naiads have been known to feed on small fish.



Dragon fly nymph

Damsel fly nymph

2-Order: Orthoptera

General Characters of Order Orthoptera

1- Size: Varies from less than 5mm to some cm.

2- Body is divided into:

- **Head:**

Eyes: large compound eyes and 3 ocelli (may present or absent).

Antenna: Length vary with species(sometimes filamentous, setaceous or multiarticulate)

Mouth parts: Mandibulated

- **Thorax:**

Prothorax: Large and covered by shield-like pronotum

Mesothorax: Small

Metathorax: Large

Wings: Two pairs of wings; the forewings or tegmina are narrower than hind wings and hardened at the base. They are held overlapping the abdomen at rest. The hind wings are membranous and held folded fan-like under the forewings when at rest.

Legs: Walking legs with saltatorial hind legs are elongated for jumping

Abdomen: about 8-9 segments and the three terminal abdominal segments are reduced. There is short unsegmented cerci. The female usually has well developed ovipositor.

3-Metamorphosis: They undergo incomplete (gradual) metamorphosis (having nymphs that look like small adults and no pupa).

Examples

Compound eyes in Desert Locust

Schistocerca gregaria

Common Field Cricket, *Gryllus domesticus*

3-Order: Blattodea (Cockroaches)

The cockroaches are fairly large, oval, flattened insects with long antennae. Legs are long and slender and adapted for running.

They have chewing mouthparts.

Wings can be well developed, short or lacking. If winged, forewings are leathery while the hindwings are membranous.

Metamorphosis is gradual, the life stages being the egg, nymph, and adult. Many live outdoors, but some species have adapted to live indoors and are considered to be serious household pests.


ALSANAFER

4-Order : Homoptera
(Cicadas, Hoppers, Psyllids, Whiteflies
Aphids & Scale Insects)

Characteristics of Homoptera:

1-All Homoptera are exclusively plant feeders and some species have been used in the biological control of weeds.

2- They have membranous or leathery wings, but it is possible to trace venation to the base.

3- Apterous forms are also present.

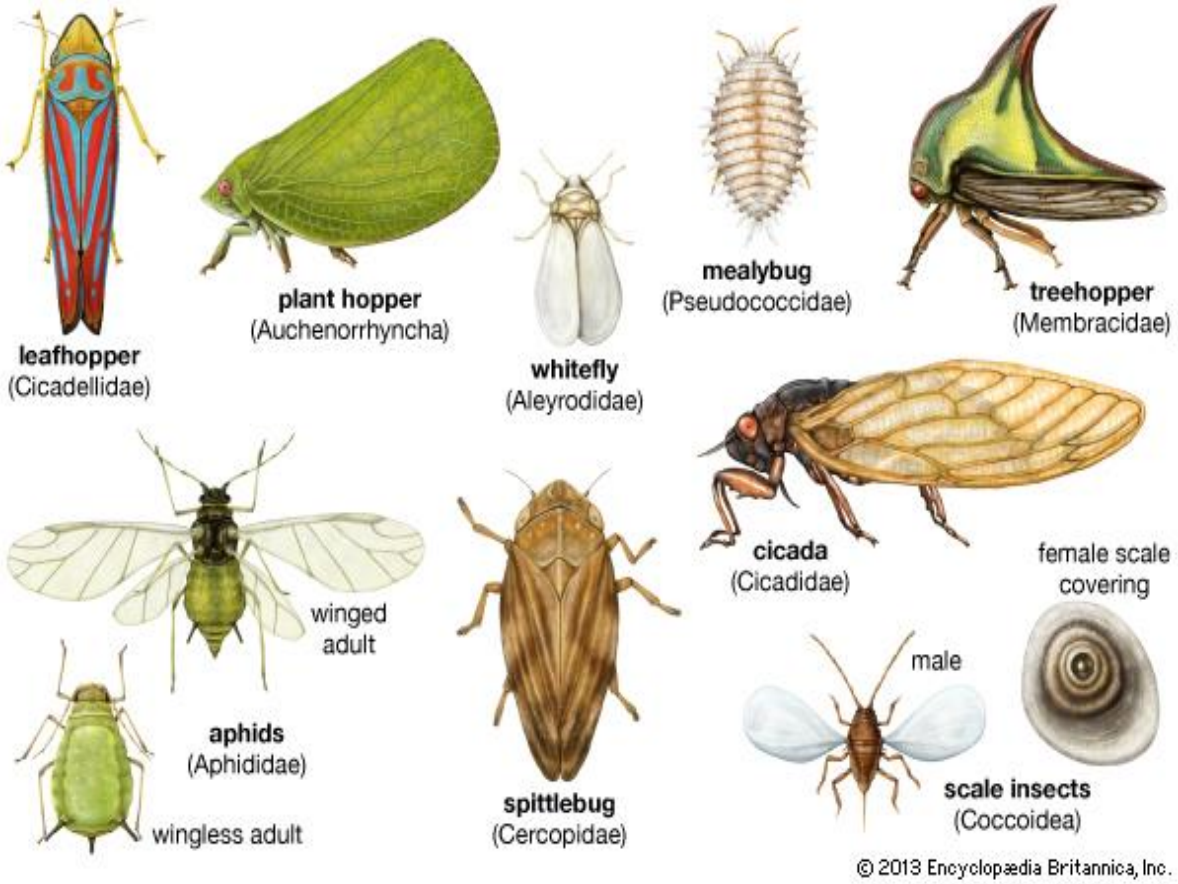
4- The mouthparts are beak-like and appear to arise from the front legs.

5- Two large groups of Homoptera are (1) the cicadas and leafhoppers, and (2) the aphids, scale insects and mealybugs.

6- The size ranges from very minute to larger forms.

7- There are a great variety of habits although they are all plant feeding.

8- The cicada has the longest life cycle of any insect, and there is a great diversity in dwelling places.



Division 2 : Endopterygota

1-Order : Lepidoptera

(Butterflies and moths)

General characteristics

1. 2 pairs of membranous wings that are covered in tiny scales . A few moths are wingless .
2. Large compound eyes .
3. One ocelli present above each eye .
4. Antennae present. Antennae are long and slender in female moths and generally feathery in male moths. Butterflies have clubbed antennae .
5. Mouthparts are formed into a sucking tube known as a haustellum .

Life History & Ecology

Lepidoptera (moths and butterflies) is the second largest order in the class Insecta. Nearly all lepidopteran larvae are called caterpillars. They have a well-developed head with chewing mouthparts. In addition to three pairs of legs on the thorax, they have two to eight pairs of fleshy abdominal prolegs that are structurally different from the thoracic legs. Most lepidopteran larvae are herbivores; some species eat foliage, some burrow into stems or roots, and some are leaf-miners.

Life Cycle

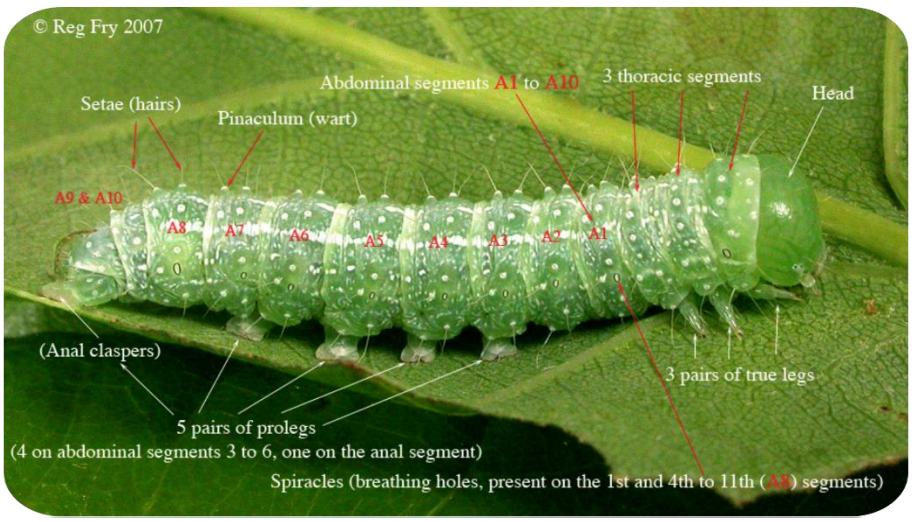
Moths and butterflies undergo a complete life cycle that includes four stages: egg, caterpillar (larvae), pupae and adult. The eggs are usually laid on or close

to the caterpillar's food plant either singularly or in groups. A female may lay only a few eggs or tens of thousands depending on the species, but several hundred is reasonably typical. After hatching caterpillars usually develop through 4 to 7 instars over a period of a few weeks up to a few months depending on the species, before pupating .

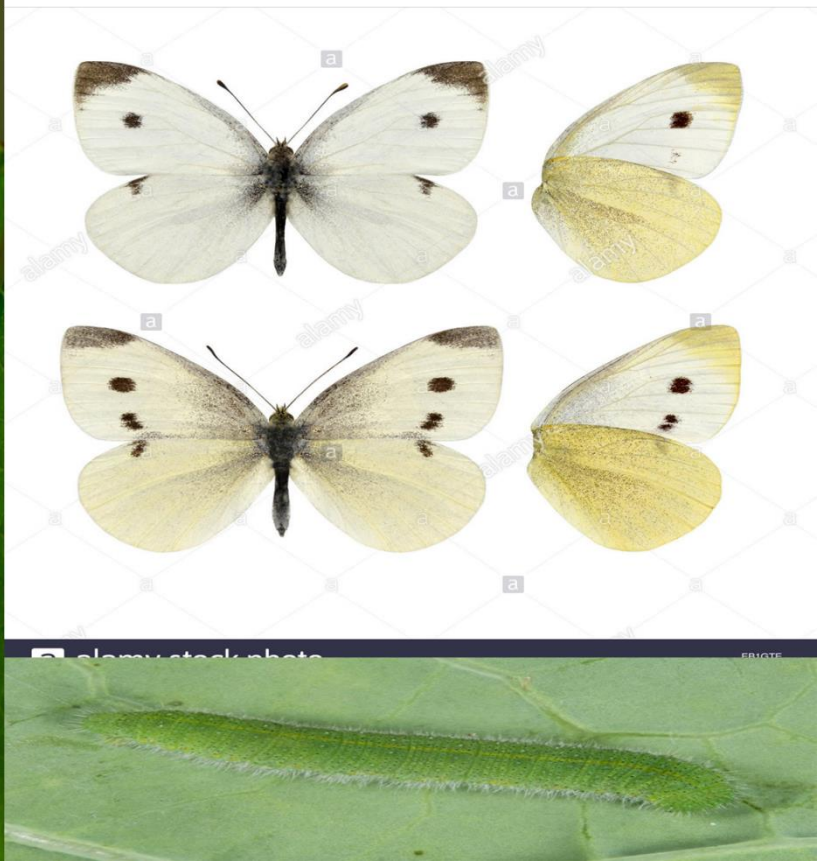
When ready to pupate caterpillars generally find a sheltered site to spin their cocoons. Some may pupate attached to vegetation, others in the soil or leaf litter or inside the wood they have been tunneling in. Many moths and butterflies have one or two generations each year while others may breed continuously. Other species such as the large wood-boring Cossidae may take up to five years to develop

Economic Importance

Although many Lepidoptera are valued for their beauty, and a few are useful in commerce (e.g., the silkworm, Bombyx mori), the larvae of these insects are probably more destructive to agricultural crops and forest trees than any other group of insects.




The Monarch
(Danaus plexippus)
MonarchButterflyGarden.net


alamy stock photo

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Agrotis ipsilon [MONA 10663]
AZ Pima Co 5800 ft Bear Canyon
Campground, Santa Catalina Mts,
MV lights. 5 May 2001. B. Walsh leg.

2-Order: Diptera

True Flies / Mosquitoes / Midges

General characteristics

1. Flies are well adapted for aerial movement, and typically have short bodies.
2. Flies have a mobile head with a distinct neck and have large compound eyes on the sides of the head, with three small ocelli on the top, and antennae, either long or short.
3. Mouthparts of sucking type. Often adapted to absorb liquids, sometimes piercing.
4. Only 1 pair of wings (on mesothorax). Hind wings are reduced to halters used for balance during flight.
5. Complete metamorphosis
6. Larvae are called maggots. Legless, wormlike larvae, often with a reduced head. Many larvae live in water. In plant feeding species the larvae often live within the plant tissues, leaf miners, stem or root borers.

Classification

Holometabola

complete development (egg, larva, pupa, adult)

The Diptera have been divided into three suborders:

- Nematocera (flies with multisegmented antennae)
- Brachycera (flies with stylate antennae)
- Cyclorrhapha (flies with aristate antennae)

In some newer classifications, Brachycera includes the Cyclorrhapha.

Major Families

Biting flies: In most cases, only the adult females take blood meals .

Culicidae (mosquitoes) -- may spread malaria, yellow fever, filariasis, and other diseases .

Tabanidae (horse flies / deer flies) -- may spread trypanosomiasis, and other diseases .

Simulidae (black flies) -- may spread leucocytozoon infections of poultry .

Psychodidae (moth flies) -- may spread leishmaniasis, sand fly fever, and other diseases .

Ceratopogonidae -- small but vicious biters that have been linked to the spread of several roundworm, protozoan, and viral pathogens in humans and other animals .

Muscidae (House flies) -- these are among the most cosmopolitan of all insects. Some species have biting mouthparts, others are scavengers. Diseases such as dysentery, cholera, and yaws may be transmitted on their feet and mouthparts**.**

Herbivores: larvae feed on plant tissues.

1. **Cecidomyiidae (gall midges)** -- some induce the formation of plant galls; others are scavengers, predators, or parasites.
2. **Tephritidae (fruit flies)** -- many species are agricultural pests; such as the apple maggot,
3. **Agromyzidae** -- most larvae are leaf miners, some are stem and seed borers. Several species are agricultural pests.
4. **Anthomyiidae -- many species are root or seed maggots.**

Scavengers: larvae feed in dung, carrion, garbage, or other organic matter.

1. **Drosophilidae** (fruit flies) -- feed on decaying fruit.
2. **Tipulidae** (crane flies) -- larvae live in soil or mud.

3. **Calliphoridae** (blow flies) -- larvae feed on garbage and carrion; includes the screwworm.

4. **Sarcophagidae** (flesh flies) -- larvae typically feed on carrion. Some species may cause human myiasis.

Muscoid fly

Hexapoda (including Insect) > Diptera > Muscidae

horse fly

Hexapoda (including Insecta) > Diptera > Tabanidae

Life Stages of the house fly

Economic Importance

The Diptera probably have a greater economic impact on humans than any other group of insects. Some flies are pests of agricultural plants, others transmit diseases to humans and domestic animals. On the other hand, many flies are beneficial -- particularly those that pollinate flowering plants, assist in the decomposition of organic matter, or serve as biocontrol agents of insect pests.

Parasitology

Concept of Parasitology

Definition: Parasitology is the scientific study of the interactions between host organisms and parasites.

Key Terms

Parasite:

- An organism that lives on or in a host and derives nutrients at the host's expense.
- It obtains food and shelter from the host.
- Can cause harm, potentially leading to the host's death.

Host:

- The organism that harbors the parasite.
- Experiences negative effects from the relationship and does not gain any benefits.

Parasitism:

A specific relationship where the parasite benefits while harming the host.

Types of Relationships Between Organisms

1. Mutualism:

Both organisms benefit and can survive independently.

Examples:

Flagellates and termites: Aid in cellulose digestion.

Birds and crocodiles: Birds clean teeth and receive food scraps.

Escherichia coli and humans: Bacteria assist in digestion and vitamin production.

2. Commensalism:

One organism benefits without affecting the other.

Examples:

Entamoeba coli in humans: Lives in the intestine without causing harm.

Remora fish and large fish: Gain protection and food without harming their hosts.

Parasitism:

The parasite benefits at the host's expense, causing harm.

Examples: Mosquitoes and humans: Feed on blood and may transmit diseases like malaria.

Types of Parasitism and Parasite Classification

1. Location of Parasitism:

- Ectoparasites: Live on the host's surface (e.g., lice, ticks).
- Endoparasites: Live inside the host's body (e.g., *Plasmodium*, parasitic worms).

2. Duration of Parasitism:

- Temporary parasites: Visit hosts for food (e.g., blood-sucking insects).
- Permanent parasites: Spend most of their life cycle as parasites (e.g., malaria-causing *Plasmodium*).

Types of Hosts

1. Definitive Host:

Harbors the adult parasite where sexual reproduction typically occurs.

Example: Humans as definitive hosts for tapeworms.

2. Intermediate Host:

Harbors the parasite during its larval or immature stages, often where asexual reproduction occurs.

Example: Snails as intermediate hosts for schistosome worms.

3. Reservoir Host:

Organisms that carry parasites and can infect humans.

Example: Monkeys as reservoir hosts for schistosomes.

4. Transport Host:

Carries the parasite without further development, aiding its transfer to the definitive host.

Example: Fish as transport hosts for tapeworm larvae.

5. Accidental Host:

Organisms that become infected by chance and are not typical hosts for the parasite.

Example: Humans as accidental hosts for animal parasites.

Sources of Parasitic Infection:

1. Soil:

Contains eggs and larvae of intestinal parasites that can persist for long periods.

2. Water:

May carry parasite eggs and larvae, such as cercariae, that can penetrate the skin.

3. Vegetables and Fruits:

Potential sources of infection if not properly washed.

4. Certain Animals:

Pigs transmit pork tapeworms; dogs can carry hydatid cysts.

Methods of Parasitic Infection Transmission

1. Digestive Tract:

Transmission occurs through contaminated food, drink, or substances.

2. Skin:

Parasites enter via larval or cercarial penetration.

3. Direct Contact:

Infections can spread through physical contact, as seen in leishmaniasis.

4. Blood:

Transmitted via insect vectors, such as mosquitoes.

5. Respiratory System:

Parasites can be inhaled through spores or contaminated particles.

6. Reproductive System:

Some parasites are transmitted through sexual contact.

Effects of Parasites on Hosts

1. Nutrient Theft:

Parasites extract nutrients, especially when present in large numbers.

2. Tissue Damage:

Significant harm to host tissues occurs due to parasitic activity.

3. Mechanical Disturbances:

Blockages can occur in lymphatic vessels or bile ducts.

4. Inflammation:

Parasite eggs (e.g., schistosomes) can cause bladder inflammation.

5. Facilitation of Microorganism Entry:

Parasites may create openings for microorganisms via skin penetration.

6. Toxin Release:

Parasites can release toxins that negatively impact the host.

Effects of Hosts on Parasites

1. Suitable Environment:

Hosts provide a warm, moist environment conducive to parasite growth.

2. Nutrient Supply:

Parasites obtain essential nutrients from hosts, supporting their survival and growth.

3. Life Cycle Stimulation:

Some parasites rely on hosts to complete their life cycle stages.

4. Immune Response:

The host's immune system can reduce parasite populations or eliminate them.

5. Behavioral Changes in Parasites:

Hosts may influence parasite behaviors, including feeding habits and preferred habitats.

Preventive Measures Against Parasitic Infections

1. Personal Hygiene:

Regular handwashing and avoiding contact with contaminated surfaces.

2. Avoid Contaminated Water:

Drink clean water and avoid swimming in polluted sources.

3. Wash Fruits and Vegetables:

Thoroughly wash produce before consumption.

4. Proper Cooking:

Cook food adequately to kill parasites and their eggs.

5. Limit Animal Contact:

Reduce exposure to sick or contaminated animals.

6. Vaccinate Pets:

Ensure pets receive necessary vaccinations and regular veterinary care.

7. Community Education:

Promote awareness of parasite transmission and prevention strategies.

Diagnostic Methods for Parasitic Infections

1. Laboratory Tests:

Analyze stool, urine, or blood samples to detect parasites or their eggs.

2. Imaging Tests:

Utilize X-rays, ultrasound, or MRI to locate parasites within tissues.

3. Allergy Tests:

Assess the body's response to parasite antigens.

4. Endoscopy:

Perform internal examinations of intestines or other organs to find parasites.

5. Fluid Analysis:

Examine body fluids, such as cerebrospinal or lymph fluid, for parasite detection.

6. Medical History:

Collect information on symptoms and potential parasite exposure.

Protozoa

Introduction:

Protozoa are considered the simplest animals, characterized by their bodies being composed of only a single cell. Despite their structural simplicity, this cell is capable of performing all vital functions such as nutrition, respiration, movement, growth, and reproduction. These unicellular organisms can be divided into various groups based on their lifestyle or mode of movement.

General Characteristics of Protozoa:

- Size: Most protozoa are microscopic and can only be seen with a microscope, but some larger species can be observed with the naked eye.
- Cellular Structure: They consist of a single cell containing internal organelles capable of carrying out integrated vital functions such as nutrition, respiration, and reproduction. Therefore, it is preferable to refer to them as "acellular" organisms rather than "unicellular."
- Lifestyle:

Protozoa are divided into two types:

• Free-living: They inhabit fresh or saltwater environments and rely on themselves to obtain food.

• Parasitic: These depend on another living organism to obtain their food. Parasites are further divided into:

O Ectoparasites: Live on the external surface of the host.

O Endoparasites: Live inside the host's body.

- Diseases:

Some parasitic protozoa cause serious diseases in humans, such as amoebic dysentery (*Entamoeba histolytica*) and malaria (*Plasmodium*).

- Cytoskeleton:

The body consists of protoplasm surrounded by a thin membrane known as the plasma membrane. In some species, it is covered by a non-living rigid outer layer called the pellicle.

- Diseases:

Some parasitic protozoa cause serious diseases in humans, such as amoebic dysentery (*Entamoeba histolytica*) and malaria (*Plasmodium*).

- Movement:

Protozoa move using pseudopodia, flagella, or cilia, while some species lack movement structures entirely.

- Respiration and Excretion:

Respiration: Aerobic respiration occurs through simple diffusion across the body surface.

Excretion: Waste is also removed through diffusion across the body surface.

- Reproduction:

Asexual: Occurs through binary or multiple fission.

Sexual: Involves the formation of gametes.

- Encystment:

Under unfavorable conditions, protozoa surround themselves with a cyst to protect themselves.

Classification of Protozoa

- Classification Based on Movement:

1. Class Sarcodina: Move using pseudopodia, e.g., *Entamoeba*.

2. Class Mastigophora: Move using flagella, e.g., *Trypanosoma*.

3. Class Ciliophora: Move using cilia, e.g., *Balantidium coli*.

4. Class Sporozoa: Lack specialized movement structures and are characterized by a spore-forming stage, e.g., *Plasmodium*.

- Classification Based on Parasitic Location:

1. Intestinal protozoa

2. Blood protozoa

3. Urinogenital protozoa.

Class: Sarcodina

Introduction:

This class includes amoeba species that live within the digestive tracts of both vertebrates and invertebrates. Most of them coexist with their hosts without causing harm, except for the pathogenic species Entamoeba histolytica, which causes amoebic dysentery.

Entamoeba histolytica:

This amoeba is found worldwide and is responsible for causing amoebic dysentery. It resides in the large intestines of humans and other animals, where it attacks the mucous tissues. Entamoeba histolytica goes through two main stages:

• Trophozoite Stage: Feeds on red blood cells and attacks intestinal tissues.

• Cyst Stage: The parasite transforms into a cyst to protect itself and is excreted in the feces, allowing it to be transmitted to another host.

- Habitat:

Entamoeba histolytica resides in the large intestines of humans.

- Hosts:

- Definitive host: Humans.
- Reservoir hosts: Cats, dogs, and monkeys.
- Infective Stage:

The quadrinucleate (mature) cyst.

- Mode of Infection:

Infection occurs through the consumption of water or food contaminated with the infective cyst stage.

- Life Cycle of the Parasite:
- Cyst Stage: The quadrinucleate cyst enters the body through the mouth via contaminated food or water. Once it reaches the small intestine, it divides and releases trophozoites.
- Trophozoite Stage: The trophozoite is the active form of the parasite that settles in the large intestine, feeding on intestinal tissues and causing significant damage. The trophozoites may also invade blood vessels and spread to other organs, such as the liver.
- Encystation: After the trophozoite stage, the parasite transforms back into a cyst, which is excreted with the feces. The life cycle continues if the cysts are ingested by a new host.
- Symptoms of the Disease:

❖ Intestinal Symptoms:

- Abdominal pain accompanied by cramps.

- Watery or bloody diarrhea, which is a characteristic symptom of intestinal amoebiasis.
- General fatigue and weakness.

❖ Systemic Symptoms (Outside the Intestines or Extraintestinal):

If the parasite spreads to other organs, such as the liver, the patient may experience fever, pain in the upper right abdomen (due to liver abscesses), and weight loss.

- Diagnosis of Infection:

❖ Stool Examination: The most common method, where cysts or trophozoites are searched for using a microscope.

❖ Molecular Tests: Such as polymerase chain reaction (PCR), used to detect the parasite's genetic material, especially in chronic infections.

❖ Serological Tests: Used to detect antibodies in cases of extraintestinal infections, such as liver abscesses.

- Treatment of the Disease:

- Antiparasitic Medications: Several well-known drugs are used to treat active trophozoites within the intestines and other parts of the body, as well as cysts remaining in the intestines, to prevent reinfection.

- Surgical Intervention: In cases of liver abscesses, surgery may be necessary to drain the abscesses in conjunction with drug treatment.

- Symptoms of the Disease:

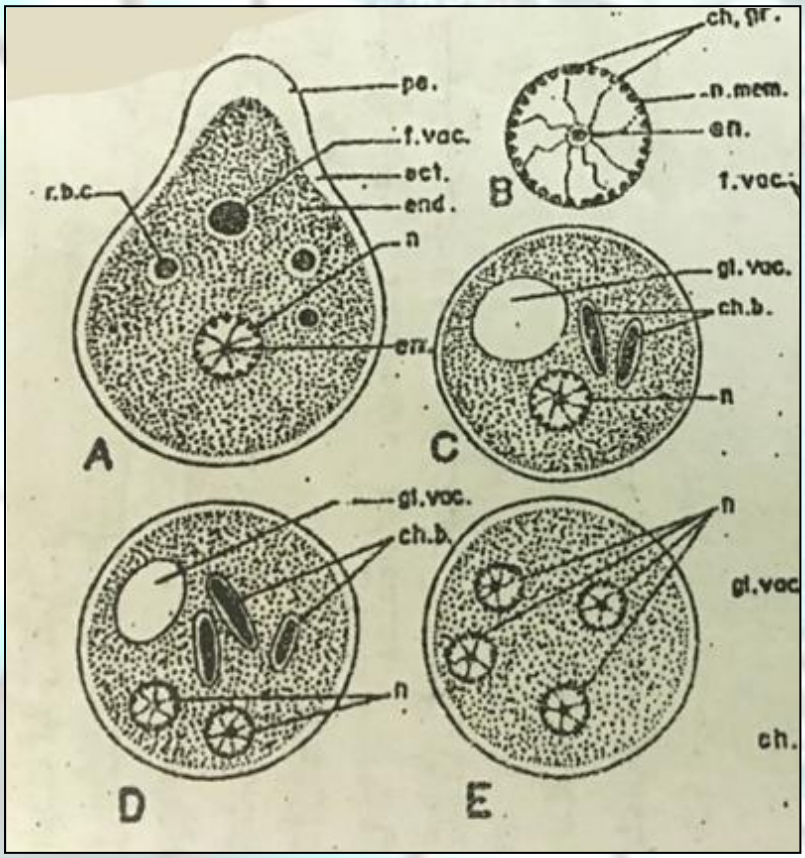
- Preventive Measures Against Parasitic Infection:

- Personal Hygiene Practices: Washing hands with soap and clean water after using the bathroom and before eating.

- Water Treatment: Drinking treated or boiled water and avoiding unsafe water in endemic areas.

- Safe Food Preparation: Thoroughly washing fruits and vegetables and cooking food well to kill microorganisms.

- Health Education: Raising awareness about personal hygiene and water treatment to reduce infection, especially in areas with poor sanitation conditions.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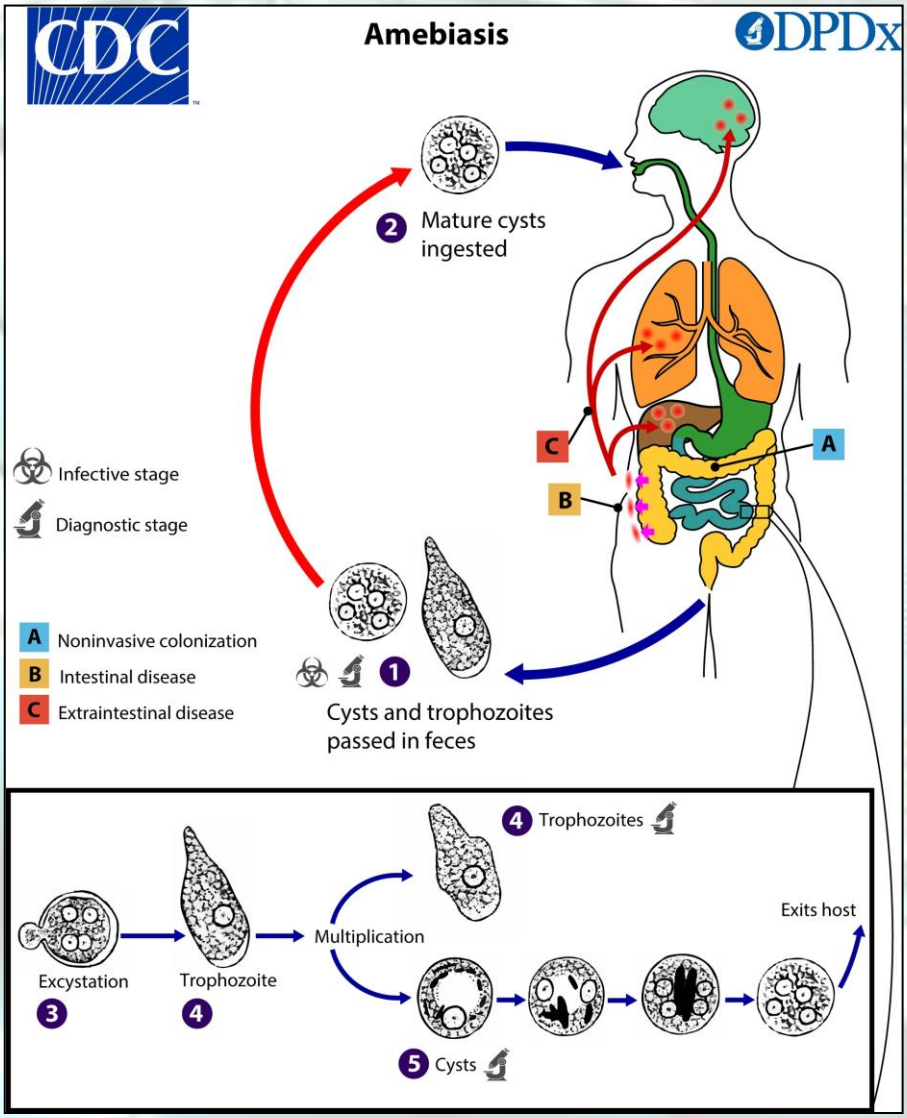

CDC
Amebiasis
DPDx
2 Mature cysts ingested
Infective stage
Diagnostic stage
A Noninvasive colonization
B Intestinal disease
C Extraintestinal disease
1 Cysts and trophozoites passed in feces
A
B
C
4 Trophozoites
Exits host
Multiplication
Excystation
3
Trophozoite
4
5 Cysts

Class: Mastigophora

Introduction:

Flagellates include a group of protozoans that move using flagella, typically possessing one or more flagella. This class is divided into two main groups: blood flagellates and intestinal flagellates (some of which inhabit the mouth or urinogenital system).

Trypanosoma:

These are small flagellates that parasitize humans and some mammals, residing in the digestive system and salivary glands of blood-sucking insects. They cause serious diseases such as sleeping sickness and Chagas disease.

Species of *Trypanosoma* that Affect Humans:

1. *Trypanosoma brucei gambiense*
2. *Trypanosoma brucei rhodesiense*
3. *Trypanosoma cruzi*

1. *Trypanosoma brucei gambiense*:

- Geographic Distribution: Found in West Africa.
- Transmission: Spread by the tsetse fly, causing sleeping sickness (African trypanosomiasis).
- Infection Process: The infection is transmitted through the fly's bite, where the Trypanosoma

moves to the insect's digestive system and then to the salivary glands before being transmitted to humans.

2. *Trypanosoma brucei rhodesiense*:

- Geographic Distribution: Found in East Africa.
- Transmission: Also transmitted by the tsetse fly, it causes sleeping sickness, but symptoms are more severe and can lead to death if left untreated.

3. *Trypanosoma cruzi*:

- Geographic Distribution: Found in South and Central America.
- Transmission: Spread by the triatomine bug, causing Chagas disease.
- Infection Process: Transmission occurs through contamination of wounds with feces from the infected insect.
- Habitat:

Trypanosomes live in the blood of mammalian hosts.

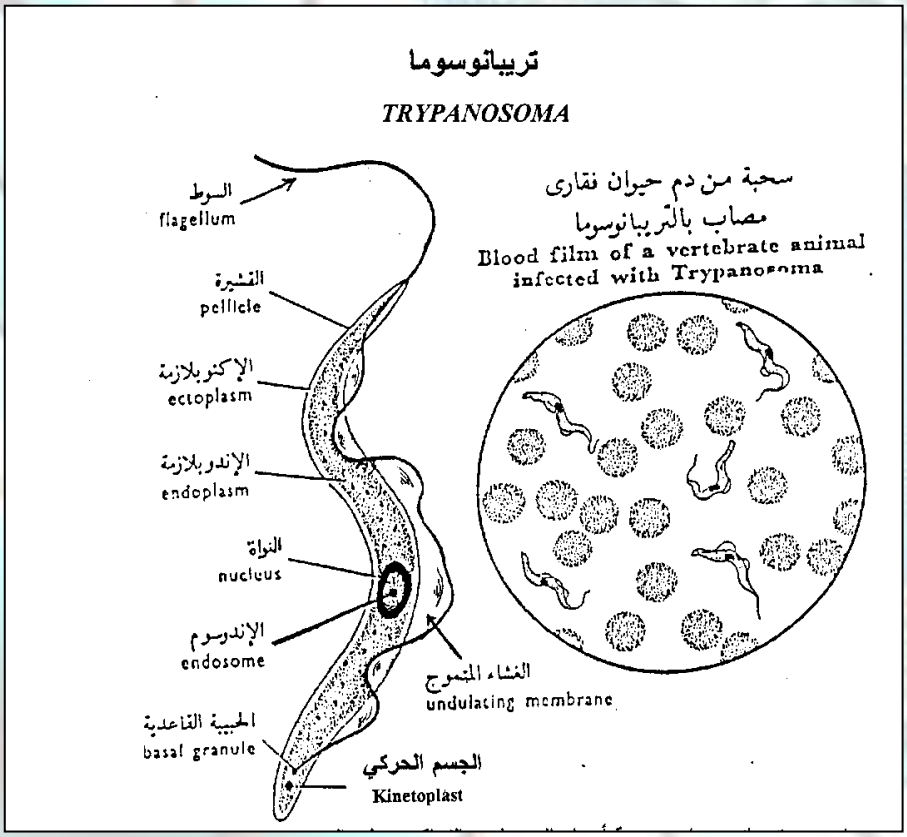
Hosts:

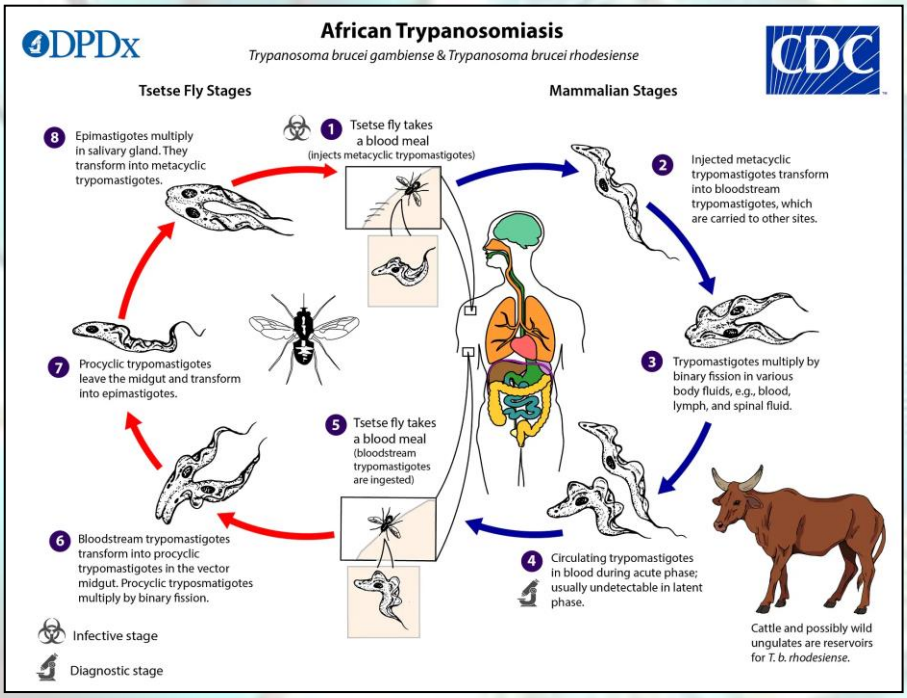
- Definitive host: Mammals (such as humans and animals).
- Vectors: Insects (such as the tsetse fly or winged bug).

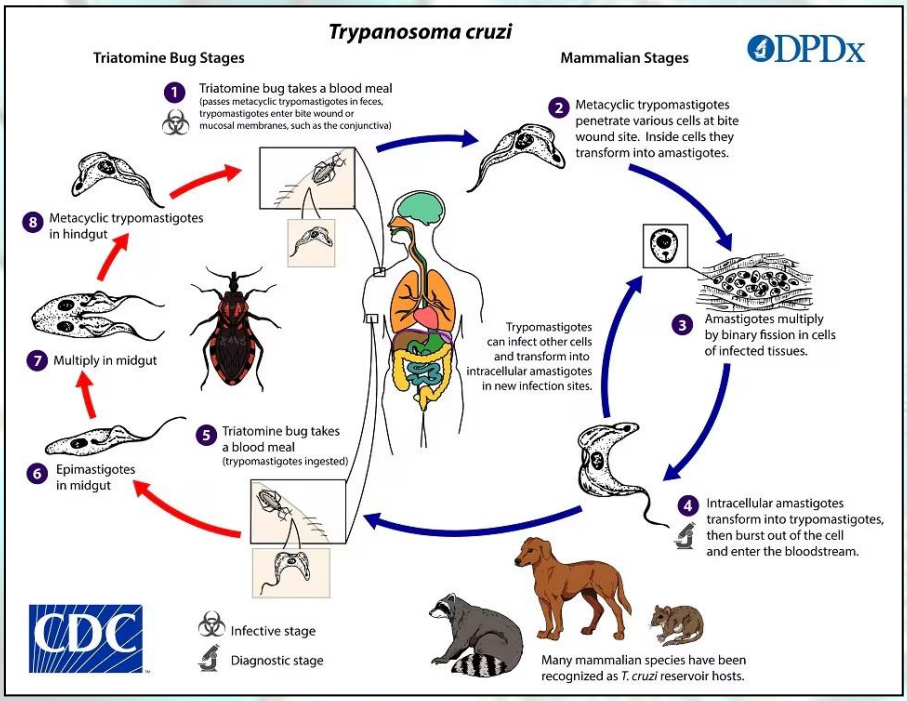
- Infective Stage:

Metacyclic trypomastigote stage.

- Mode of infection: Infection occurs through the bite of the insect vector carrying the infectious stages of the final host.
- Life cycle: When the insect bites the final host, the parasites are transferred to the blood where they multiply and cause symptoms. The cycle is transmitted from the host to the insect when the insect bites the infected host.
- Symptoms: In the case of sleeping sickness: fever, headache, fatigue, swollen lymph nodes, and deterioration of neurological functions. In the case of Chagas disease: fever, heart enlargement, digestive problems.
- Diagnosis: The infection is diagnosed by examining blood under a microscope or through antibody testing.
- Precautions necessary for prevention: Avoid infested areas, use insect repellent, and improve living conditions to reduce exposure to vector insects.


تريبانوسوما
TRYPANOSOMA
السوط
flagellum
القشيرة
pellicle
الإكتوبلازمة
ectoplasm
الإندوبلازمة
endoplasm
النواة
nucleus
الإندوسوم
endosome
الحبيبة القاعدية
basal granule
الجسم الحركي
Kinetoplast
الغشاء المتموج
undulating membrane
سحبة من دم حيوان فقارى
مصاب بالتربيانوسوما
Blood film of a vertebrate animal
infected with Trypanosoma


DPDx
African Trypanosomiasis
Trypanosoma brucei gambiense & Trypanosoma brucei rhodesiense
CDC
Tsetse Fly Stages
Mammalian Stages
1 Tsetse fly takes a blood meal (injects metacyclic trypomastigotes)
2 Injected metacyclic trypomastigotes transform into bloodstream trypomastigotes, which are carried to other sites.
3 Trypomastigotes multiply by binary fission in various body fluids, e.g., blood, lymph, and spinal fluid.
4 Circulating trypomastigotes in blood during acute phase; usually undetectable in latent phase.
5 Tsetse fly takes a blood meal (bloodstream trypomastigotes are ingested)
6 Bloodstream trypomastigotes transform into procyclic trypomastigotes in the vector midgut. Procyclic tryposmatigotes multiply by binary fission.
7 Procyclic trypomastigotes leave the midgut and transform into epimastigotes.
8 Epimastigotes multiply in salivary gland. They transform into metacyclic trypomastigotes.
Cattle and possibly wild ungulates are reservoirs for T. b. rhodesiense.
Infective stage
Diagnostic stage


Trypanosoma cruzi
Triatomine Bug Stages
Mammalian Stages
DPDx
1 Triatomine bug takes a blood meal
(passes metacyclic trypomastigotes in feces, trypomastigotes enter bite wound or mucosal membranes, such as the conjunctiva)
2 Metacyclic trypomastigotes penetrate various cells at bite wound site. Inside cells they transform into amastigotes.
3 Amastigotes multiply by binary fission in cells of infected tissues.
4 Intracellular amastigotes transform into trypomastigotes, then burst out of the cell and enter the bloodstream.
5 Triatomine bug takes a blood meal
(trypomastigotes ingested)
6 Epimastigotes in midgut
7 Multiply in midgut
8 Metacyclic trypomastigotes in hindgut
Trypomastigotes can infect other cells and transform into intracellular amastigotes in new infection sites.
CDC
Infective stage
Diagnostic stage
Many mammalian species have been recognized as T. cruzi reservoir hosts.

Helminthology is the scientific study of worms, particularly parasitic worms that infect humans and various animals. Numerous types of worms exist on Earth, each distinguished by its unique characteristics, especially its biological traits and modes of infection in humans. Our focus in this study is on two important phyla of worms:

1. **Phylum Platyhelminthes (Flatworms)**
2. **Phylum Aschelminthes (Nematodes)**

Phylum Platyhelminthes (Flatworms)

This phylum includes triploblastic, acoelomate animals with a flattened body, from which they derive their name. Flatworms are characterized by the following features:

1. Bilaterally symmetrical and dorsoventrally flattened body.
2. The body is covered with a cuticle lined internally by a muscle layer.
3. Equipped with suckers for attachment to host organs.
4. Lack a body cavity, as their bodies are filled with a spongy tissue called parenchyma.
5. Most are hermaphrodites, except for schistosomes.
6. Reproductive openings are found on the ventral surface or sides.

7. They have an excretory system consisting of branched tubules ending in flame cells.
8. The nervous system consists of a brain and longitudinal nerve cords on either side of the body.
9. No circulatory system; digested food is distributed by endodermal cells.
10. They lack a respiratory system, exchanging gases through their cell surface.
11. The digestive tract, if present, is simple with only a mouth opening, and no anus.

This phylum contains two classes:

1. **Class Trematoda (Flukes)**: These are parasitic flatworms with a leaf-like shape.
2. **Class Cestoda (Tapeworms)**: These are parasitic flatworms with a ribbon-like shape.

Class Trematoda (Flukes)

Order Digenea

This class is characterized by the following traits:

1. Flattened, unsegmented, leaf-like parasites.
2. Lacking cilia except in their larval stages.
3. Adult worms live inside their hosts, parasitizing humans, vertebrates, and birds.

4. Indirect embryonic development, with adults parasitizing the final host and larval stages parasitizing an intermediate host.
5. Lacking hooks.
6. Equipped with flame cells in their excretory system, with an excretory pore near the posterior end of the body.
7. The skin may have scales or spines.
8. The body has an oral sucker and a ventral sucker, sometimes also a genital sucker.
9. The muscular system consists of circular and longitudinal muscles, with dorsoventral muscles called oblique muscles.
10. The digestive system starts with a mouth, followed by an esophagus lined with a pharynx. In some species, like *Fasciola gigantica*, the pharynx surrounds the esophagus, while in *Heterophyes heterophyes*, a part of the esophagus called the prepharynx is located in front of the pharynx. In schistosomes, the pharynx is absent, and the esophagus is equipped with glands. The esophagus bifurcates into two intestinal caeca that may remain separate (as in *Heterophyes*) or fuse (as in schistosomes) to form a single intestinal sac. In some species, like *Fasciola*, the intestines branch into secondary and tertiary divisions.

11. The nervous system consists of two ganglia surrounding the esophagus, from which three pairs of nerve fibers extend to the anterior end and another three to the posterior end. Trematodes have no sensory organs except for eyespots (eye spots) in the larval stages.

12. The excretory system consists of flame cells, each composed of a broad cytoplasmic portion with a nucleus and a cavity filled with constantly moving cilia, resembling a candle flame. These flame cells lead to excretory tubules, which converge into larger excretory ducts, ultimately leading to an excretory bladder.

13. These worms respire anaerobically, breaking down organic matter, particularly glycogen, into carbon dioxide and fatty acids, releasing energy for the worm's vital functions.

14. Most trematodes are hermaphrodites (except schistosomes, which have separate sexes). The reproductive system is highly developed, producing large numbers of eggs.

The male reproductive system consists of two or more testes, each with an efferent duct. The shape and number of testes vary by species. For example, the testes of *Fasciola* are branched, while those of *Heterophyes* are oval and unbranched, and *Schistosoma* has oval or circular testes, numbering four or more. The efferent ducts join to form a single

vas deferens, which expands into a seminal vesicle that may be divided into two chambers. The vesicle leads to a muscular cirrus (male copulatory organ), which is housed in the genital atrium. During mating, the cirrus extends outside the genital opening.

The female reproductive system consists of an ovary, which may be branched (as in *Fasciola*), oval to pear-shaped (as in *Schistosoma*), or oval to circular (as in *Heterophyes*), and is located anterior to the testes. The ovary leads to an oviduct that carries eggs to the uterus, where they accumulate before being released. The eggs have an outer covering similar to bird eggs, which protects them until a larval stage called a miracidium develops in aquatic environments.

Medical Importance of Trematodes

Trematodes have significant medical importance. Many species transmit diseases and infections to humans and animals. For example, *Schistosoma* species are linked to schistosomiasis, which affects the bladder and urinary tract, while *Fasciola* species cause liver infections, leading to fascioliasis, a disease resulting from consuming contaminated food with larvae.

Treatment typically requires medical intervention, including antiparasitic medications, while prevention involves maintaining personal hygiene and avoiding contaminated water.

Blood Flukes

Family Schistosomatidae

Characteristics of this family include:

1. Separate sexes (dioecious).
2. Lack of a pharynx.
3. A short esophagus that bifurcates into two intestinal caeca, which later fuse.
4. The male is shorter and wider than the female and has a gynaecomorphic canal (a fold on both sides of the male's body).
5. Multiple testes (three or more), without a cirrus.
6. The female is slender and long, with an oval ovary, and the vitelline glands occupy a large area, extending from the ovary to the posterior end of the body.
7. The egg lacks an operculum.
8. Equipped with two suckers located near the anterior end.
9. These worms live in blood vessels.

Schistosoma

Schistosoma was discovered in Egypt in 1851 by Theodor Bilharz. However, its presence was known to ancient Egyptians as evidenced by schistosome eggs found in mummies from the 20th dynasty (1200 BC). In 1907, Sambon distinguished between two types of

schistosomes: urinary and intestinal. Schistosomiasis remains a major public health concern in Egypt.

Schistosoma haematobium (Urinary Schistosomiasis)

This parasite is distributed throughout the country, with adult worms residing in the blood vessels surrounding the urinary bladder and the pelvic veins. Occasionally, they may also be found in portal veins or other blood vessels. These worms feed on blood and are dioecious.

Male Characteristics:

1. Short and wide, measuring 1 to 1.5 cm in length and 1 cm in width.
2. The body consists of an anterior cylindrical part and a posterior flattened section that folds on both sides to form a gynaecomorphic canal, which holds the female during copulation and egg-laying.
3. The skin has small projections.
4. The worm attaches itself using two suckers: the anterior sucker is long and contains the mouth, while the posterior sucker is round with a neck. The suckers are lined with fine spines for attachment to the host.

Female Characteristics:

1. The female is relatively slender and long, measuring about 2 cm in length and 1/4 mm in width.
2. The skin is smooth.

Digestive System: The mouth leads directly to a short esophagus surrounded by several glandular cells called esophageal glands. The esophagus branches in front of the ventral sucker into two intestinal branches known as intestinal caeca, which extend posteriorly on both sides of the body and unite at the end of the middle third of the body to form a single intestinal caecum. This extends to the posterior end of the body. Schistosoma feeds on the host's blood, digesting and absorbing it, but does not completely digest hemoglobin, leaving behind dark brown pigments known as schistosoma pigments.

Respiration: Schistosoma lacks specialized respiratory organs and undergoes anaerobic respiration. However, during larval migration to the host's lungs, it briefly undergoes aerobic respiration.

Excretory and Nervous Systems: These systems resemble those of the liver fluke.

Reproductive System: The male reproductive system consists of 3-5 testes arranged in a single line. Sperm passes from each testis through efferent ducts into a vas deferens, which leads to a pear-shaped seminal vesicle, opening directly into the male

genital pore behind the ventral sucker. The female reproductive system is more complex than the male's. It consists of an oval or pear-shaped ovary located anterior to the union of the intestinal caeca. A posterior oviduct leads from the ovary and opens into the egg preparation area. The egg preparation area is surrounded by Mehlis' gland and opens into the yolk duct from the vitelline glands. From the egg preparation area, a straight uterus containing 20-30 eggs leads forward to the female genital opening. The vitelline glands consist of yolk cells scattered along the sides of the main intestinal caecum, and there is no Laurer's canal.

Life Cycle: When it's time to lay eggs, the male holds the female in the gynecophoral canal. Sperm is released from the male genital pore into the gynecophoral canal and migrates to the female's reproductive system through the female genital pore until it reaches the egg preparation area. Meanwhile, an ovum from the female's ovary travels to the oviduct and into the egg preparation area, where fertilization occurs. The fertilized egg is surrounded by several yolk cells, thickened by a chitinous shell, and then exits through the female genital opening. The male continues carrying the female in the gynecophoral canal against the bloodstream to blood vessels leading to the bladder. At the end of the vein, the female separates from the male and moves alone to tiny venules to lay her eggs sequentially. The egg is oval, measuring between 120-160 microns in length and 40-60 microns in width, laid one by one with the

spine facing backward (in the direction of blood flow). As the female moves slightly backward, another egg is laid. When she retreats, the blood vessels that were dilated by her presence constrict again. The female continues laying eggs until the venules are full, then moves to other venules to continue laying.

Through the contractions of venules and the secretions from cephalic glands in the miracidium inside the egg, the surrounding cells dissolve, allowing the egg to break through the bladder wall and into its cavity, from where it exits with urine. The eggs cause damage to the blood vessels, allowing blood to leak out along with the eggs.

Eggs are excreted in urine, especially at the end of urination. When released, the egg contains a fully developed miracidium. The time it takes for the egg to develop into a mature miracidium after being laid is sufficient for the embryo to fully mature.

Sometimes, eggs travel with the blood to the heart and may deposit in the brain, liver, and other locations, leading to severe complications.

When the egg reaches freshwater canals or ditches, it hatches, releasing the next stage, the miracidium. Hatching occurs when the urine is diluted by about five times its volume in canal water. Eggs hatch in waters where the salt concentration is higher than 0.04%. Various factors influence hatching, such as water being hypotonic compared to the fluids inside the miracidium, neutral or slightly alkaline water, an

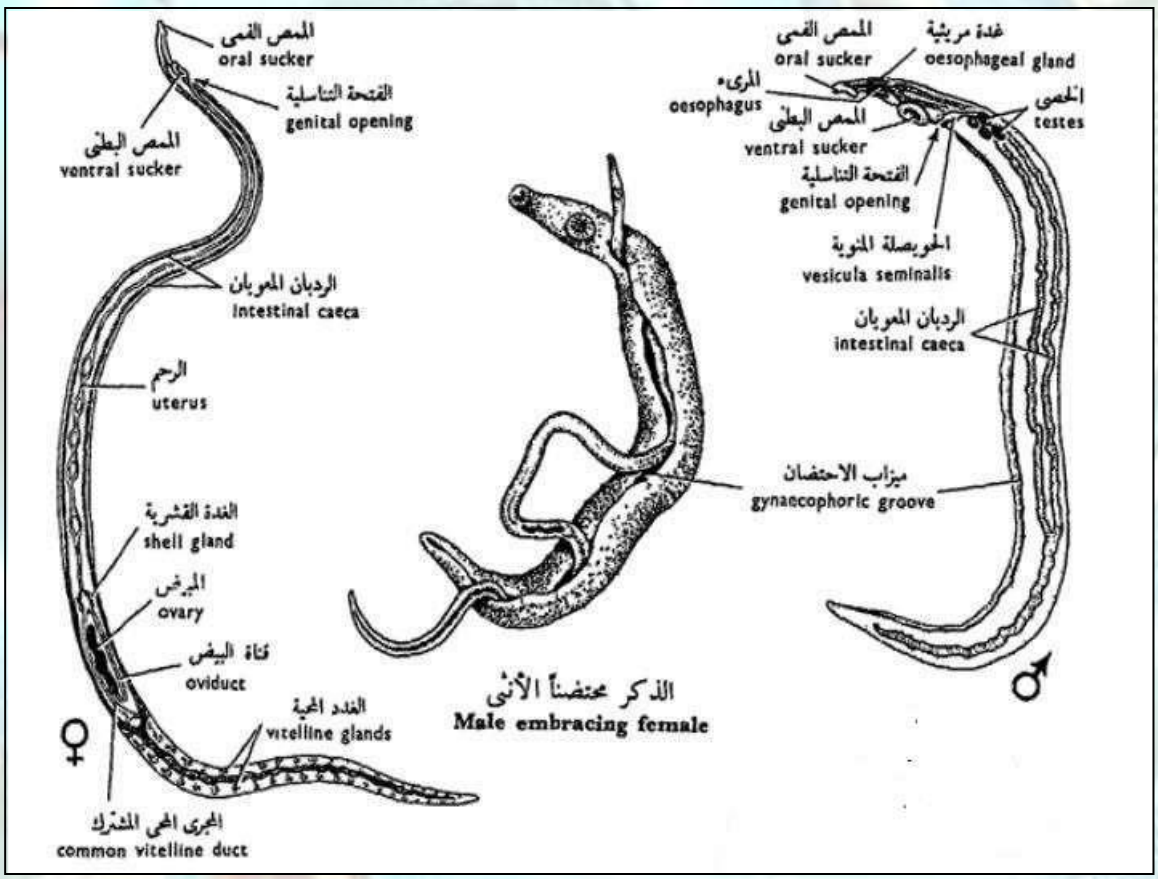
appropriate temperature of around 26°C, and the presence of light. Eggs can survive in cold water for over 30 days, but dryness negatively affects them. The eggs absorb water and swell, activating the embryo inside, which causes the egg to split lengthwise, releasing the miracidium into the water.

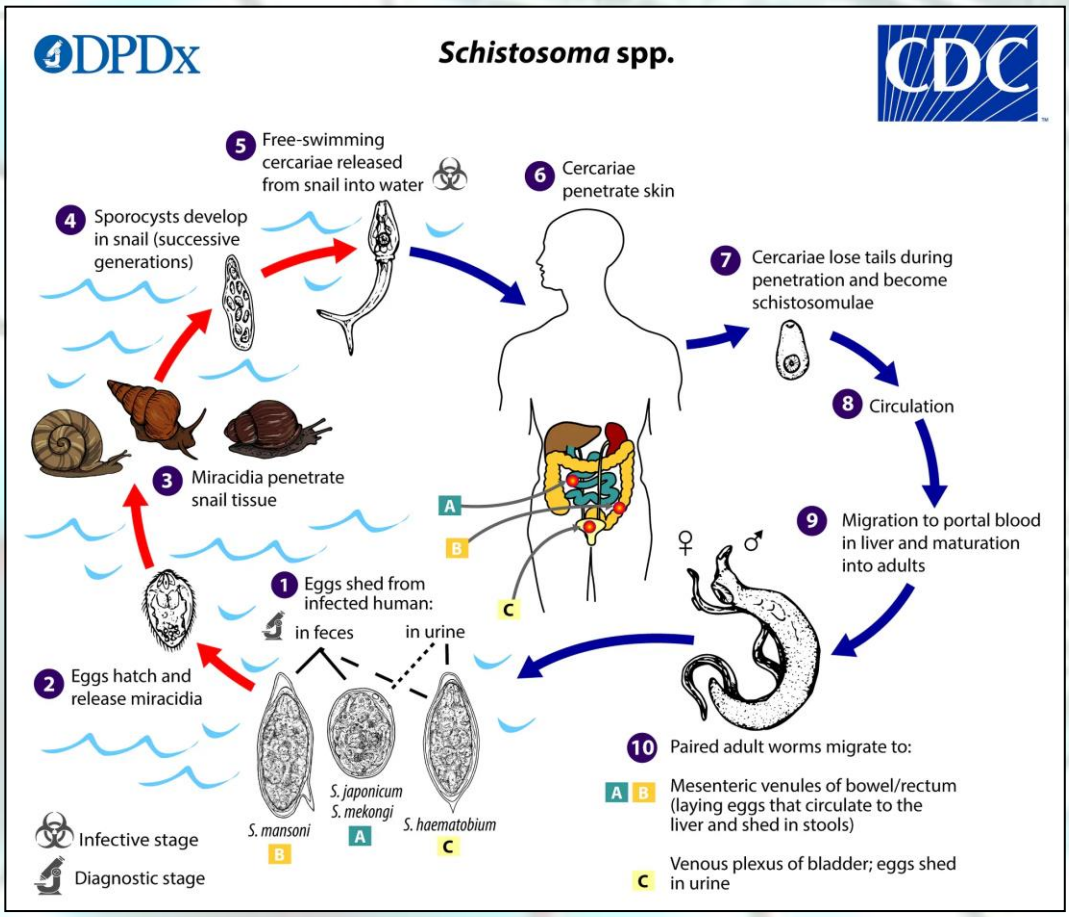
Schistosoma miracidium lacks eye spots and is sexually specific. It becomes active in water, searching for its intermediate host, the snail (Bulinus truncatus), which lives throughout Egypt. This snail, with a left-handed spiral opening, inhabits freshwater streams at canal bends, where aquatic plants grow that hide the snails. The miracidium attaches to the snail using an adhesive organ and penetrates the snail's sensory antennae, producing infectious cellulose tissues. Once attached, it enters the snail and begins transforming into the next stage, the cercaria. Within the snail, the miracidium loses its digestive tract and other systems, elongates, and divides into multiple branches. This reproductive type involves cell division, with reproductive cells appearing before maturation, known as hepatic cells. After cercaria maturation, they become free cercariae, awaiting the presence of a host to jump onto. Upon release from the snail, cercariae survive in water for up to 48 hours. If they do not find a host within this time, they die.

When cercariae approach the host's skin, they penetrate and enter the bloodstream, appearing alive in the blood. They settle in blood capillaries, then

migrate to nearby blood vessels until they reach the vessels surrounding the bladder. After about 7-8 weeks of entering the host, the worms mature into adults and begin mating.

Impact of Schistosomiasis: Schistosomiasis is a serious infectious disease, causing devastating effects on public health and the environment. Infection can lead to severe complications affecting the liver, bladder, and urinary tract, which can significantly impact the patient's quality of life.




DPDx
Schistosoma spp.
CDC
5 Free-swimming cercariae released from snail into water
6 Cercariae penetrate skin
4 Sporocysts develop in snail (successive generations)
7 Cercariae lose tails during penetration and become schistosomulae
8 Circulation
3 Miracidia penetrate snail tissue
9 Migration to portal blood in liver and maturation into adults
A
B
C
1 Eggs shed from infected human:
in feces
in urine
2 Eggs hatch and release miracidia
S. mansoni
B
S. japonicum
S. mekongi
A
S. haematobium
C
10 Paired adult worms migrate to:
A B Mesenteric venules of bowel/rectum (laying eggs that circulate to the liver and shed in stools)
C Venous plexus of bladder; eggs shed in urine
Infective stage
Diagnostic stage

Class Cestoda (Tapeworms)

General Characteristics:

1. **Body Shape:** Tapeworms are ribbon-like in appearance, rarely round.
2. **Lifestyle:** Most of these worms are internal parasites, commonly residing in the intestines.
3. **Digestive System:** Tapeworms lack a digestive system. They absorb digested nutrients directly from the host's intestines through their body surface via diffusion. They possess attachment organs like sucking grooves (bothria) in some species (e.g., the broad tapeworm) or suckers in others, and some have a muscular organ called a rostellum.
4. **Body Structure:** The body consists of three parts: the head (scolex) at the front, the neck, and the segments or proglottids. The neck is the worm's growth region.
5. **Scolex (Head):** Characterized by the presence of four suckers, sometimes accompanied by a rostellum with hooks in certain species.
6. **Neck Region:** The neck may be long (as in fish tapeworms) or short (as in beef or pork tapeworms).
7. **Proglottids (Segments):** Each segment is called a proglottid, varying in shape. The proglottids near the neck are immature, followed

by mature proglottids containing complete reproductive organs, and finally gravid proglottids filled with eggs.

8. **Number of Proglottids:** The number of proglottids can range from 3-4 in Echinococcus granulosus to 4,000 in the broad fish tapeworm (Diphyllobothrium latum).

9. **Shape of Proglottids:** The shape of the proglottids varies by species; for instance, the broad fish tapeworm has square or broad proglottids, while gravid proglottids are more rectangular.

10. **External Structure:** These worms lack a cellular epidermis or external cilia. A flexible cuticle followed by an external muscular layer forms the body covering.

11. **Nervous System:** Composed of nerve cords and two lateral nerve chains in the proglottids.

12. **Excretory System:** Made up of flame cells and paired excretory canals within the proglottids, connected by a transverse canal at the posterior end.

13. **Reproductive System:** All tapeworms are hermaphroditic, with each proglottid containing a complete set of reproductive organs. Male organs include numerous testes (up to 400),

while the female system has ovaries and an oviduct leading to the uterus.

14. **Health Impact:** Tapeworms cause localized inflammation, severe diarrhea, and may block the intestines when present in large numbers. They absorb vast amounts of nutrients, causing the host to feel extreme hunger, while toxins secreted by the worms may lead to digestive and neurological issues.

Growth and Development of Tapeworms:

1. **Fertilization:** Fertilization can be either self-fertilization within the same proglottid or cross-fertilization between proglottids of the same or different worms.

2. **Egg Formation:** Eggs form in the ovaries, move to the uterus, and are excreted with feces. Tapeworm eggs contain a few yolk granules surrounded by a thin shell.

3. **Embryo:** The embryo has six hooks and is known as a hexacanth embryo. When the eggs are ingested by an intermediate host, the embryo breaks free, penetrates the intestinal wall, and develops into a larval stage.

Beef Tapeworm (Taenia saginata): One of the most widespread tapeworms in Egypt and Syria, the beef tapeworm lives in the human small intestine. It attaches to the intestinal wall using four suckers on its head. Without a digestive system, it absorbs pre-

digested nutrients from the surrounding intestines. The body length ranges from 7 to 15 meters, sometimes exceeding 25 meters, while its larval stage exists as a cyst in cattle muscles.

Body Structure of Taenia saginata:

1. **Scolex (Head):** Small, about the size of a pinhead, measuring 1.5-2 mm in diameter, with four suckers for attachment.
2. **Neck:** Thin and thread-like, it's the worm's growth area, where new proglottids form throughout its life.
3. **Strobila (Body Segments):** Consists of 1,000-2,000 segments. Proglottids near the neck are small and undeveloped, growing larger toward the rear, with mature proglottids reaching lengths of 12-15 mm.

Digestive System: Lacking a digestive system, the worm absorbs nutrients through its entire body surface while living in the intestinal environment.

Respiration: Primarily anaerobic respiration, though some speculate that oxygen-rich areas in the intestinal mucus layer allow for some aerobic respiration through the body surface.

Excretory System: Composed of epithelial cells leading to excretory tubes that open into main excretory canals.

Nervous System: Includes a mass of cerebral ganglia located in the scolex, with nerve fibers extending to the suckers and other organs.

Reproductive System: As hermaphrodites, each mature proglottid contains both male and female reproductive organs. Each segment functions as an individual unit, with numerous small testes forming the male system, while the female system includes a bilobed ovary.

Life Cycle: Self-fertilization or cross-fertilization occurs between different proglottids of the same worm. Gravid proglottids are expelled with feces, containing small, round eggs measuring 20-40 microns in diameter. If ingested by intermediate hosts (like cattle), the eggs develop into cysts within the muscles. When undercooked beef is consumed, the cysts are ingested and the tapeworm grows, absorbing the host's nutrients.

Symptoms and Health Effects:

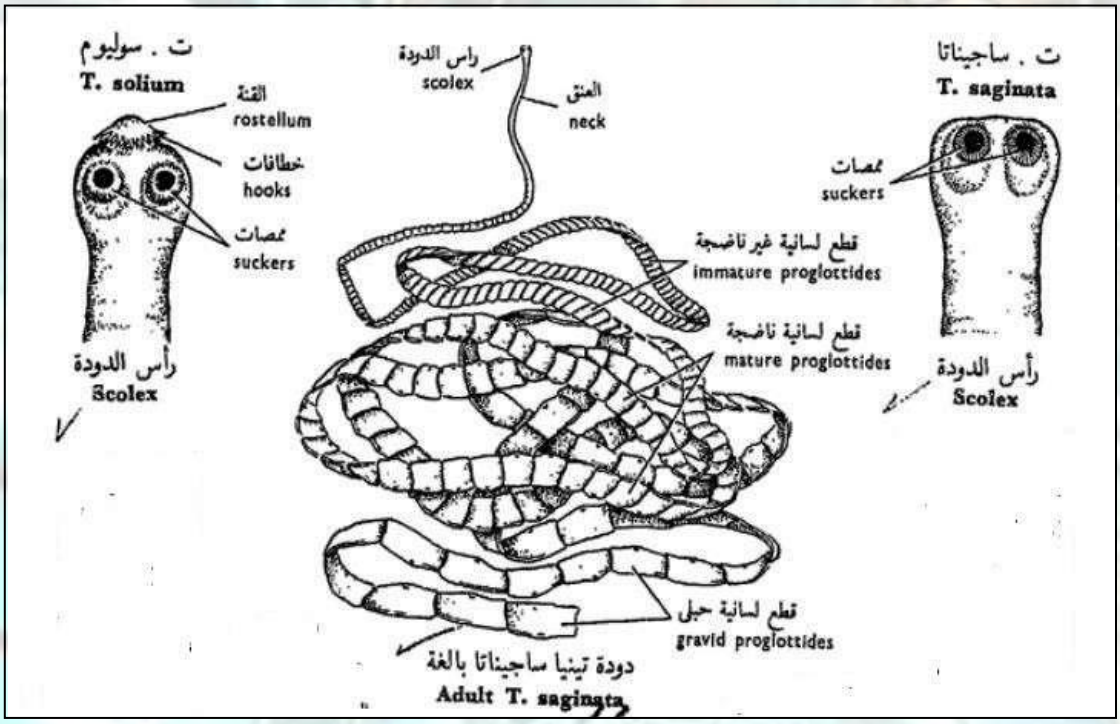
1. **Hunger Sensations:** Due to nutrient absorption, leading to weakness and weight loss.
2. **Intestinal Blockage:** Tapeworms may cause bowel obstruction due to their large size.
3. **Neurological Disorders:** Result from toxins secreted by the worm.
4. **Abdominal Pain and Diarrhea.**

5. **Increased White Blood Cells.**
6. **Tissue Reactions:** Especially when cysts form in vital organs.

Diagnosis: Infection is diagnosed by identifying the characteristic eggs and gravid proglottids in stool samples.

Prevention and Control:

1. Inspecting slaughtered animals in abattoirs.
2. Thoroughly cooking meat.
3. Avoiding meat from uncertified slaughterhouses.
4. Destroying infected meat.
5. Avoiding defecation in open areas.
6. Treating infected individuals to reduce sources of infection.


ت . سوليوم
T. solium
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hooks
ممصات
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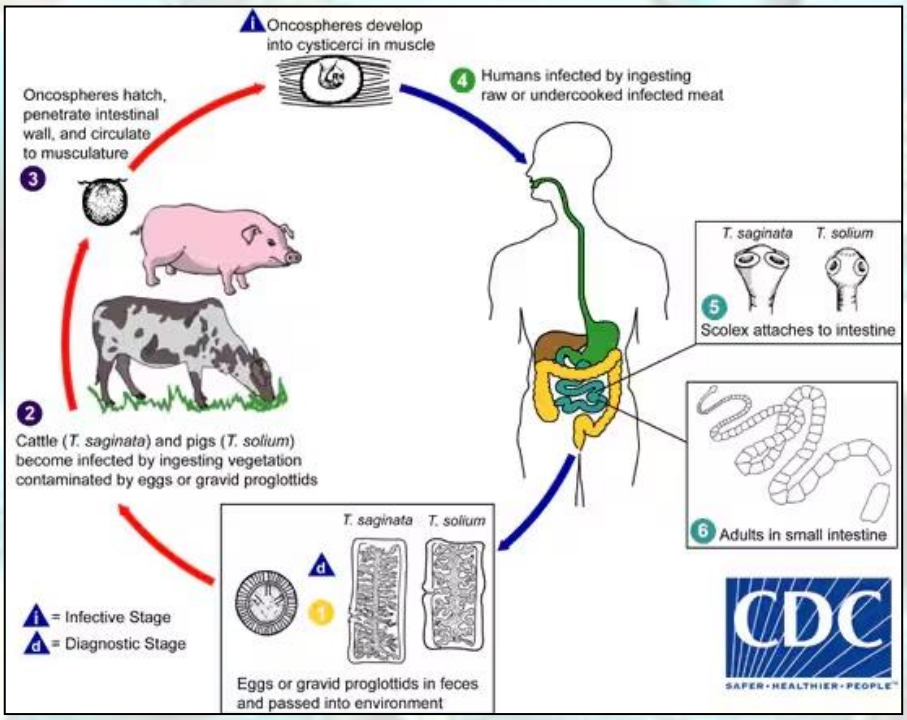
رأس الدودة
Scolex
راس الدودة
scolex
العنق
neck
قطع لسانية غير ناضجة
immature proglottides
قطع لسانية ناضجة
mature proglottides
قطع لسانية حبلى
gravid proglottides
دودة تينيا ساجيناتا بالغة
Adult T. saginata
ت . ساجيناتا
T. saginata
ممصات
suckers
رأس الدودة
Scolex


1 Oncospheres develop into cysticerci in muscle
2 Cattle (T. saginata) and pigs (T. solium) become infected by ingesting vegetation contaminated by eggs or gravid proglottids
3 Oncospheres hatch, penetrate intestinal wall, and circulate to musculature
4 Humans infected by ingesting raw or undercooked infected meat
5 Scolex attaches to intestine
6 Adults in small intestine
T. saginata
T. solium
i = Infective Stage
d = Diagnostic Stage
Eggs or gravid proglottids in feces and passed into environment
CDC
SAFER·HEALTHIER·PEOPLE

Phylum Aschelminthes

The organisms in this phylum are characterized by the following features:

1. They are triploblastic animals with a pseudocoelom.
2. They are unsegmented, bilaterally symmetrical animals.
3. The body is covered by a thick cuticle without ciliary coverings.
4. The sexes are separate, and the reproductive system is simple, with males and females differing in appearance.
5. They have a digestive system consisting of a long tube starting with the mouth, followed by the esophagus, intestines, and ending at the anus.
6. They lack circulatory and respiratory systems.
7. The nervous system consists of a front-end neural mass with nerves extending to various parts of the body.
8. Some live freely, while others are parasitic.

Class Nematoda

The nematodes exhibit the following features:

1. They are cylindrical animals, rounded at the front and tapered at the rear.
2. Their length ranges from less than 1 millimeter to over a meter.
3. The sexes are separate, with males being smaller than females and typically having a bent posterior.
4. The body is covered by a cuticle marked with fine lines, with sensory papillae visible on the surface.
5. Attachment organs include hooks, teeth, or papillae.
6. The posterior end may have papillae, spicules, or fan-like copulatory bursa.
7. The body wall consists of:
    - An outer non-cellular layer.
    - A subcuticular epithelial layer.
    - A layer of muscle cells.
8. The digestive system is a simple tube starting at the mouth and ending at the anus, which opens ventrally near the posterior end. The mouth may be surrounded by lips or papillae or contain teeth, leading into a buccal cavity, followed by a muscular esophagus with a triradiate lumen, which varies in structure among different species.

- It may be simple and cylindrical as in *Ancylostoma*, or divided into two parts, as in *Enterobius*, or have a distinct anterior muscular and posterior glandular part as seen in filarial worms.

9. The intestine consists of a long tube with a single layer of epithelial cells and a connective tissue base, leading to the rectum or hindgut, which is cuticle-lined. The anus is located before the end of the worm, and the tail is the part between the anus and the tip of the worm.

10. The nervous system consists of a circumoesophageal ring with nerve cords extending both anteriorly and posteriorly.

11. There is no circulatory system, but the body fluids contain oxyhemoglobin to aid in respiration.

12. The excretory system consists of two lateral canals running along the body, which open to a single excretory pore ventrally near the head, without flame cells.

13. The reproductive organs are tubular, with the male reproductive system consisting of a single testis leading to the vas deferens, seminal vesicle, and ejaculatory duct, which joins the digestive tract at the cloaca. Males also often have chitinous spicules to assist in copulation. The female reproductive system consists of paired ovaries, oviducts, seminal

receptacles, and two uteri that unite to form a short vagina opening ventrally.

Family Ascaridae

The distinguishing features of this family include:

1. Large worms with three prominent lips, one dorsal and two ventrolateral, each with sensory papillae.
2. The male's tail is curved ventrally.
3. The esophagus is typically cylindrical.
4. The male reproductive system includes spicules.
5. The female reproductive opening is located on the anterior part of the body.
6. They produce large numbers of eggs, each with a thick shell and mucous layer.

Ascaris lumbricoides

Ascaris lumbricoides is one of the most widespread nematodes, living in the small intestine of humans, monkeys, pigs, and other animals. It is common worldwide, especially in warm, humid climates. The adult worms are whitish-yellow and sexually dimorphic. Males measure 15-25 cm in length, while females range from 25-35 cm. The male has a

characteristic curved posterior with copulatory spicules. The digestive system starts with a mouth surrounded by three lips, followed by an esophagus, midgut, and hindgut, with the anus located near the posterior end.

Life Cycle of Ascaris lumbricoides

1. **Infection:**
   Humans ingest *Ascaris* eggs through contaminated food or water.
2. **Hatching:**
   The eggs hatch in the small intestine, releasing larvae.
3. **Migration:**
   The larvae penetrate the intestinal wall, enter the bloodstream, and travel to the lungs.
4. **Pharyngeal migration:**
   From the lungs, the larvae move up the throat and are swallowed again, returning to the intestines.
5. **Maturation:**
   The larvae mature into adult worms in the intestines within 2-3 months and start producing eggs, completing the cycle.

Symptoms and Health Effects

Mild infections may be asymptomatic, but severe cases can cause:

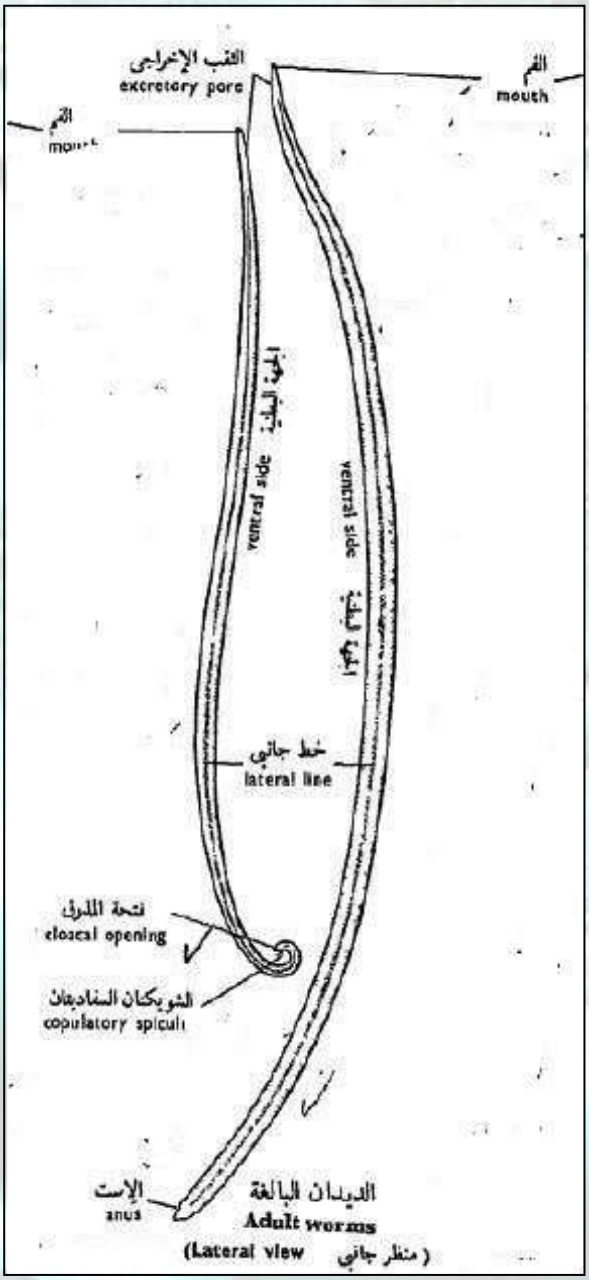
- Abdominal pain
- Nausea and vomiting
- Weight loss
- Diarrhea
  Complications can include intestinal blockage or respiratory difficulties when larvae migrate to the lungs.

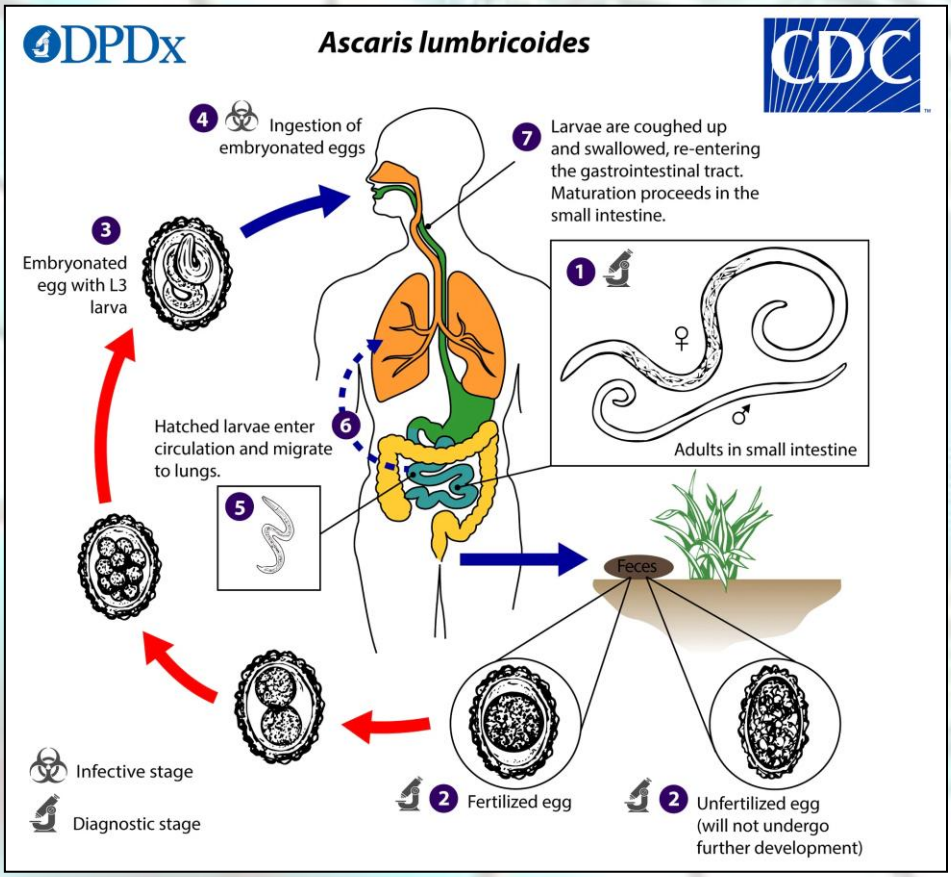
Diagnosis and Treatment

Infections are diagnosed through stool analysis for eggs and imaging techniques like X-rays. Treatment involves anti-parasitic medications such as mebendazole or albendazole, with complete courses to ensure eradication of the worms.

Prevention

- Practicing good hygiene, including handwashing before meals and after using the toilet
- Proper sanitation to avoid contamination


الثقب الإخراجي
excretory pore
الفم
mouth
الفم
mouth
الجهة البطنية
ventral side
ventral side
الجهة البطنية
خط جانبي
lateral line
فتحة المذرق
cloacal opening
الشويكان السنادبان
copulatory spicula
الإست
anus
الديدان البالغة
Adult worms
(Lateral view منظر جانبي)


DPDx
Ascaris lumbricoides
CDC
4 Ingestion of embryonated eggs
7 Larvae are coughed up and swallowed, re-entering the gastrointestinal tract. Maturation proceeds in the small intestine.
3 Embryonated egg with L3 larva
1
Adults in small intestine
Hatched larvae enter circulation and migrate to lungs.
6
5
Feces
Infective stage
Diagnostic stage
2 Fertilized egg
2 Unfertilized egg (will not undergo further development)

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Noble, E. R., & Noble, G. A. (1989). Parasitology: The Biology of Animal Parasites (6th ed.). Lea & Febiger.

Roberts, L. S., & Janovy, J. (2013). Foundations of Parasitology (9th ed.). McGraw-Hill Education.

Entomology + Parasitology

BGS233

(Practical Part)

First semester

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Faculty of Science

Zoology Department

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Division: Basic - Science

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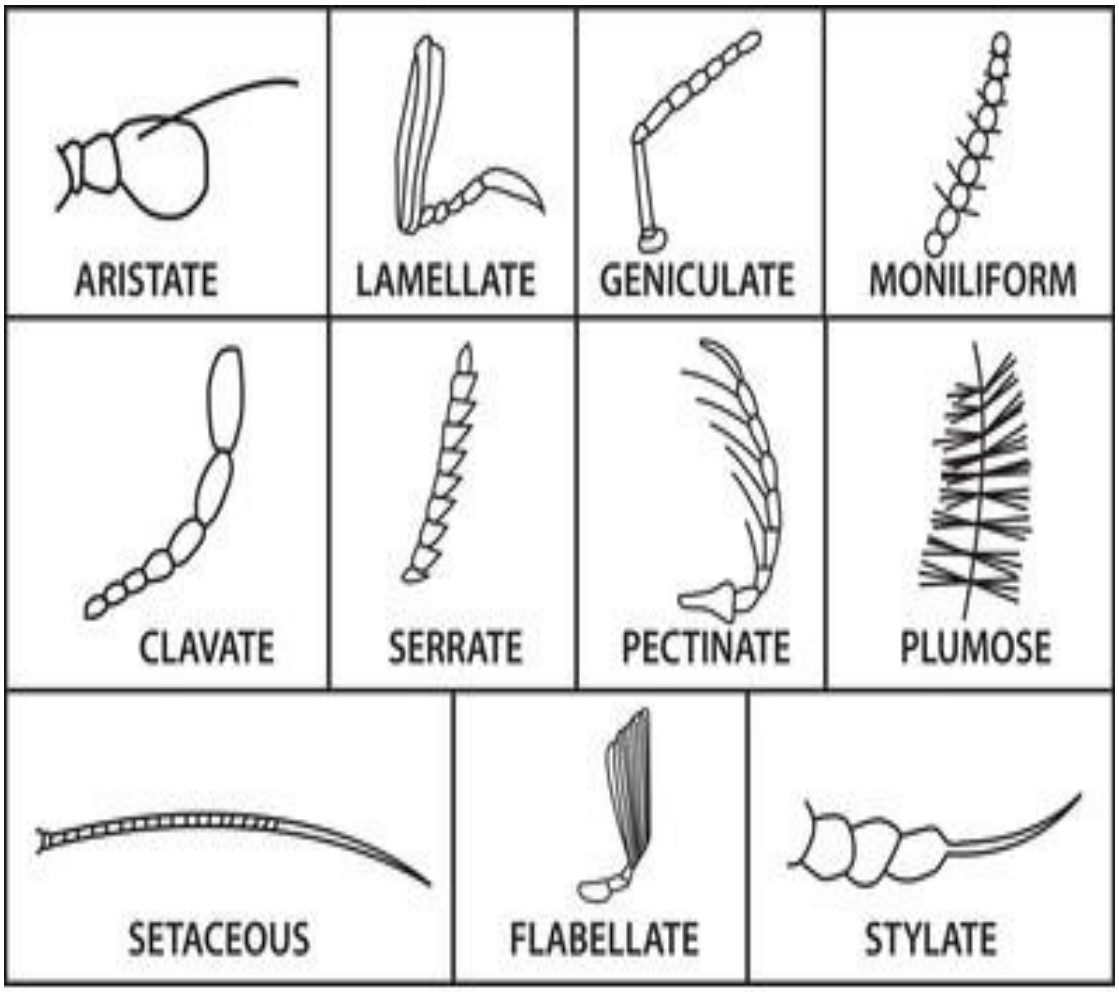
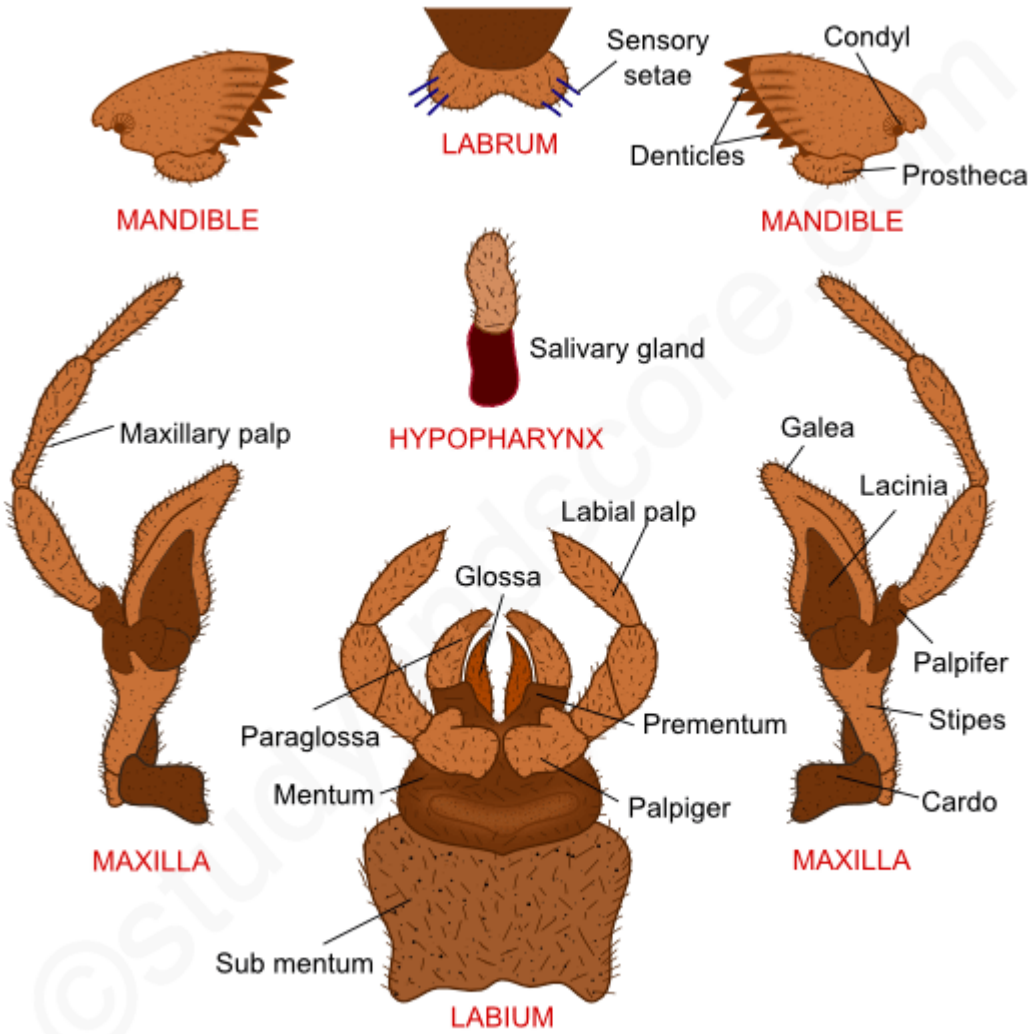
2024-2025

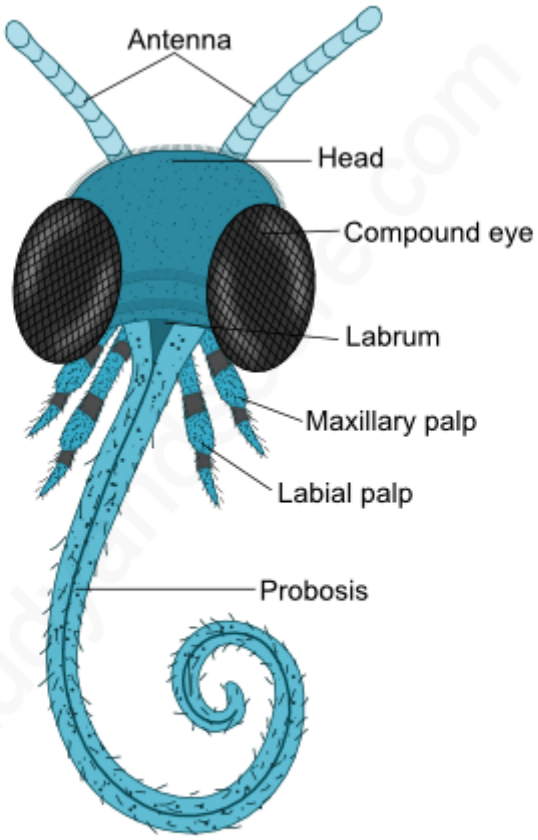
Types of antennae



Types of Mouth Parts

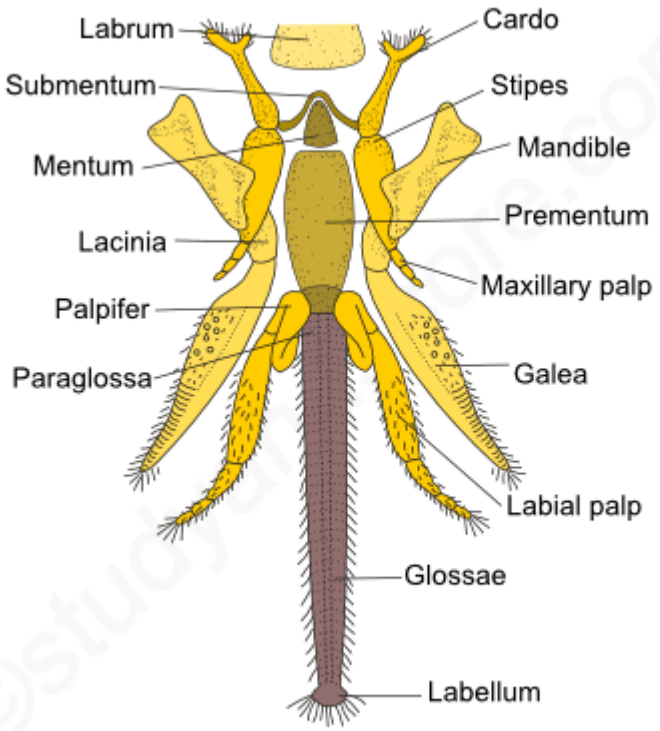


MOUTHPARTS OF COCKROACH - BITING AND CHEWING TYPE

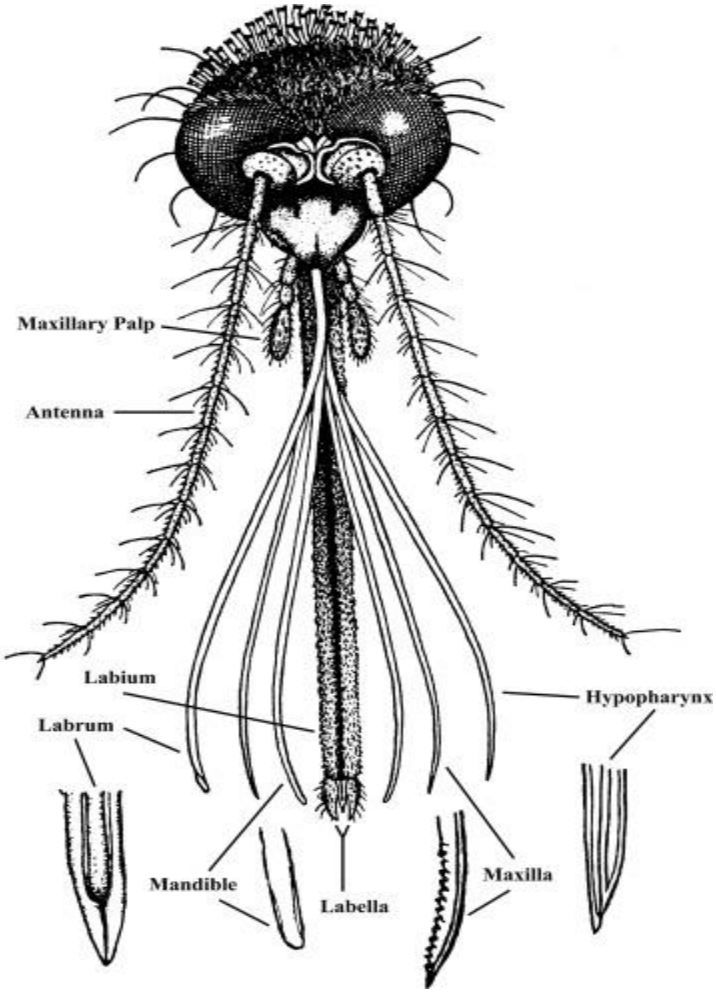


MOUTHPARTS OF BUTTERFLY - SIPHONING TYPE

Siphoning-sucking mouthparts: Process of feeding

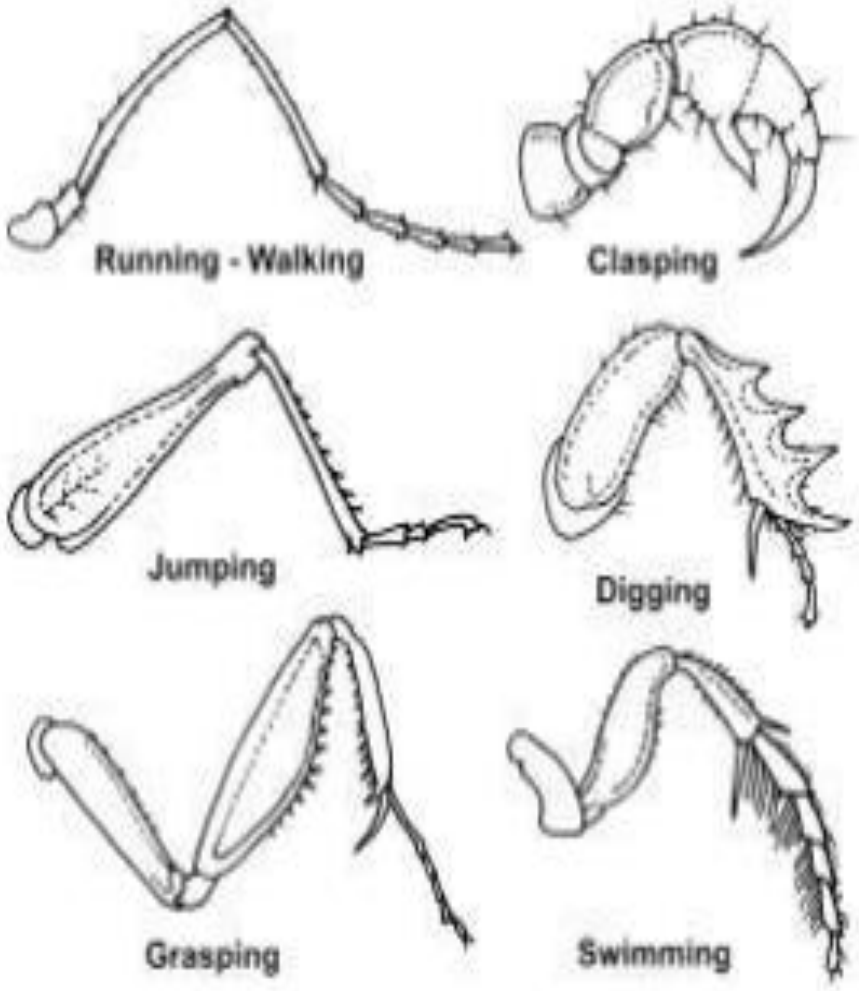


MOUTHPARTS OF HONEY BEE - CHEWING & LAPPING TYPE

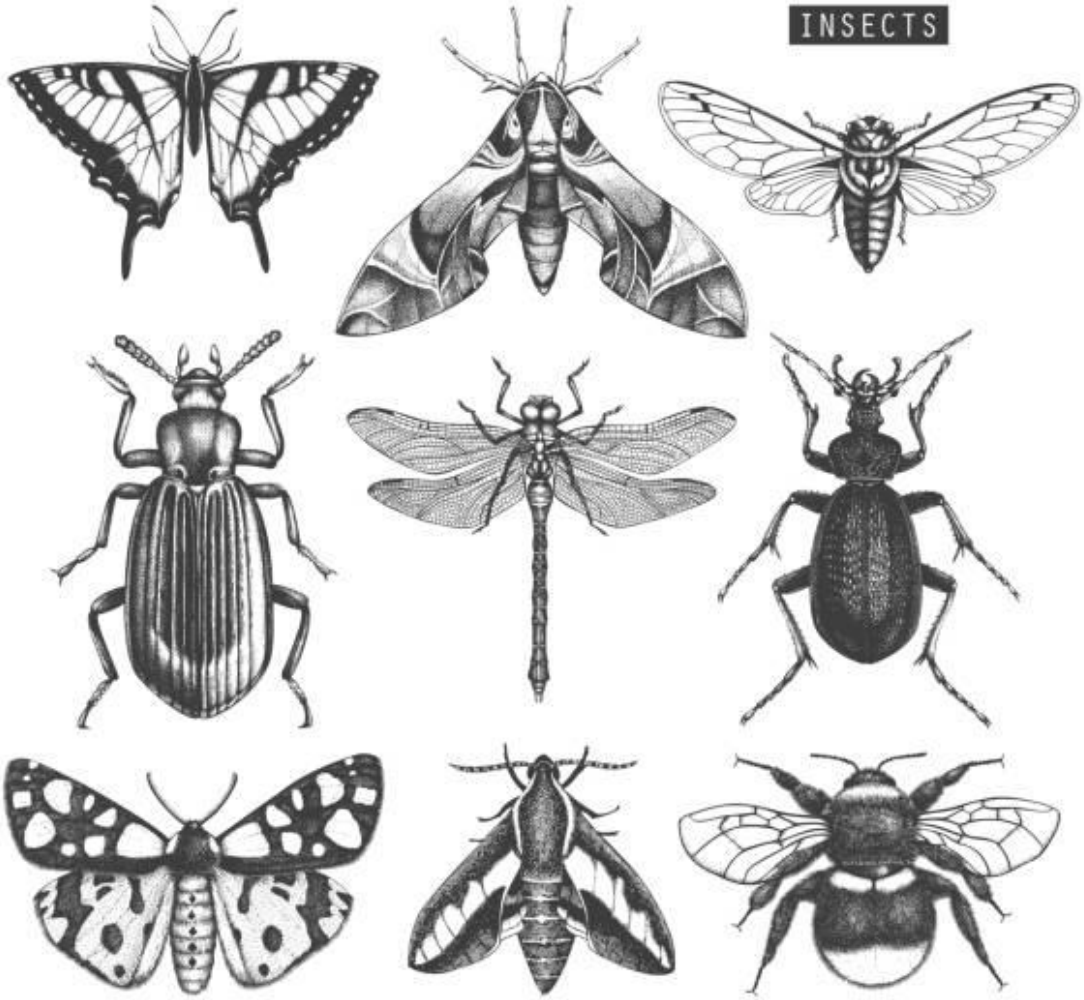


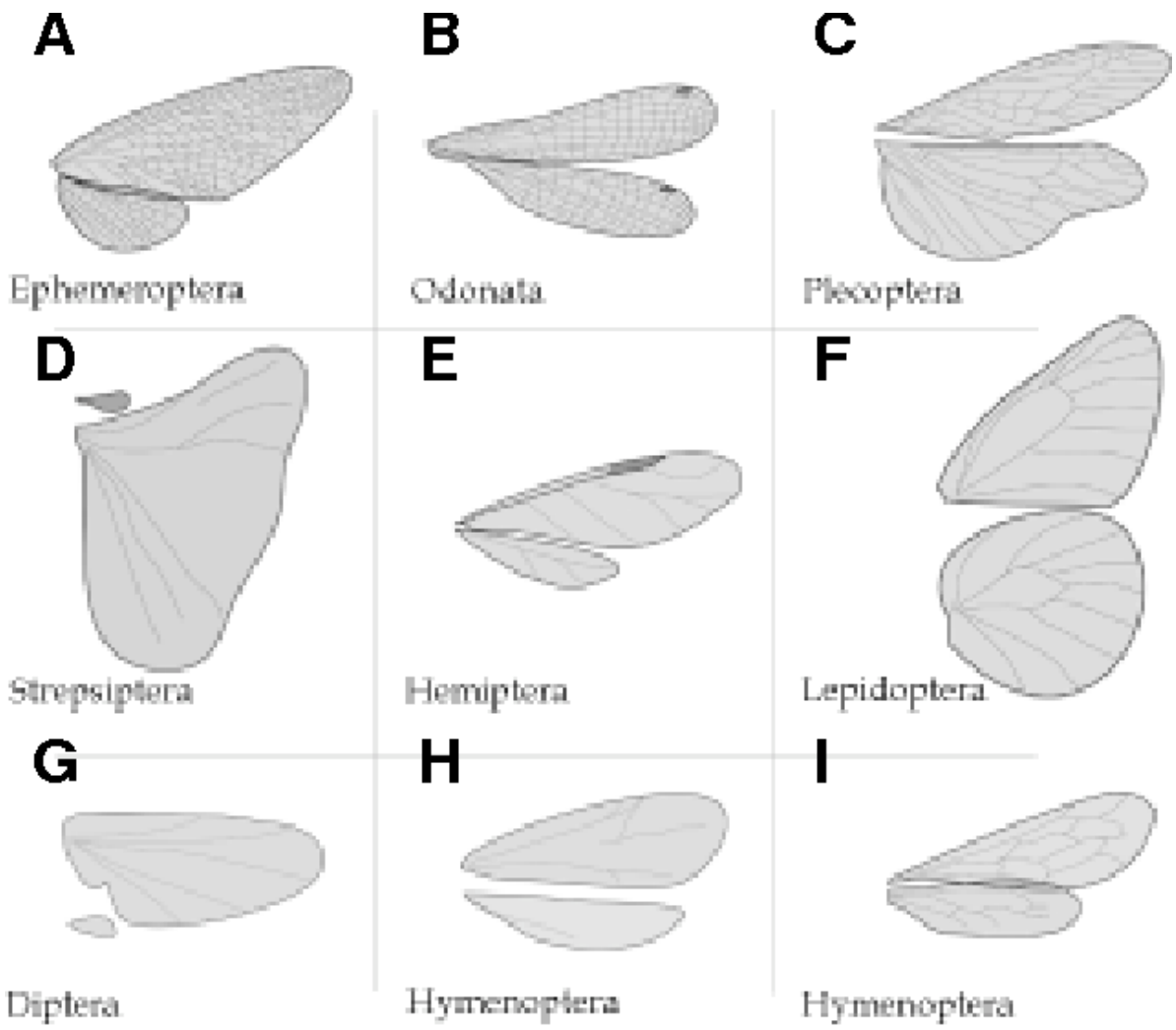
MOUTHPARTS OF MOSQUITO - PIERCING & CHEWING TYPE

Types of insect legs



Types of wings




A
Ephemeroptera
B
Odonata
C
Plecoptera
D
Strepsiptera
E
Hemiptera
F
Lepidoptera
G
Diptera
H
Hymenoptera
I
Hymenoptera

Class : Insecta

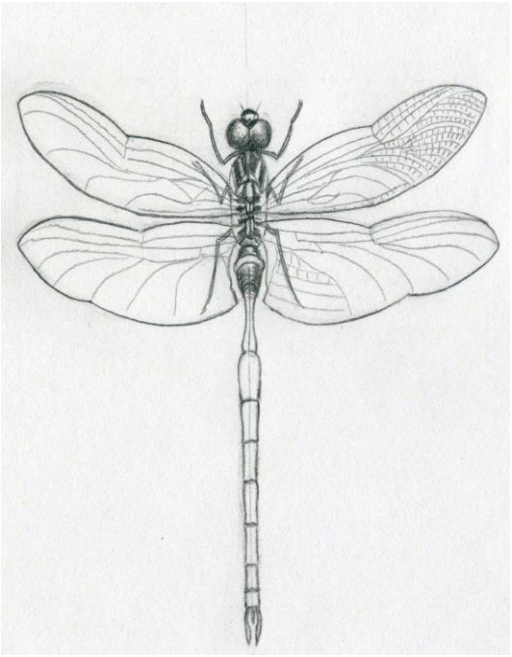
Subclass : Pterygota

Division : Exopterygota

Order : Odonata

Family : Libellulidae

e. g. : <u>Crocothemis</u> <u>erythraea الرعاش الكبير**</u>**



Class : Insecta

Subclass : Pterygota

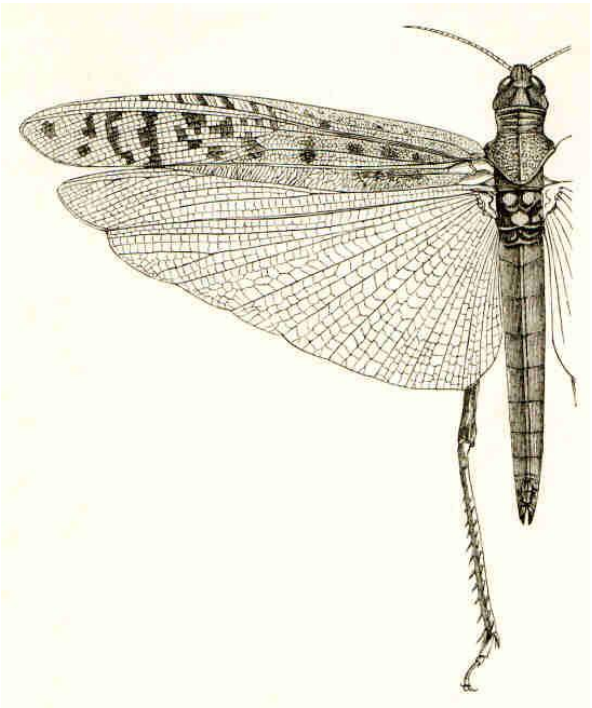
Division : Exopterygota

Order : Orthoptera

Suborder : Caelifera

Family : Acrididae

e. g. : <u>Schistocerca</u> <u>gregaria</u> الجراد الصحراوى



Class : Insecta

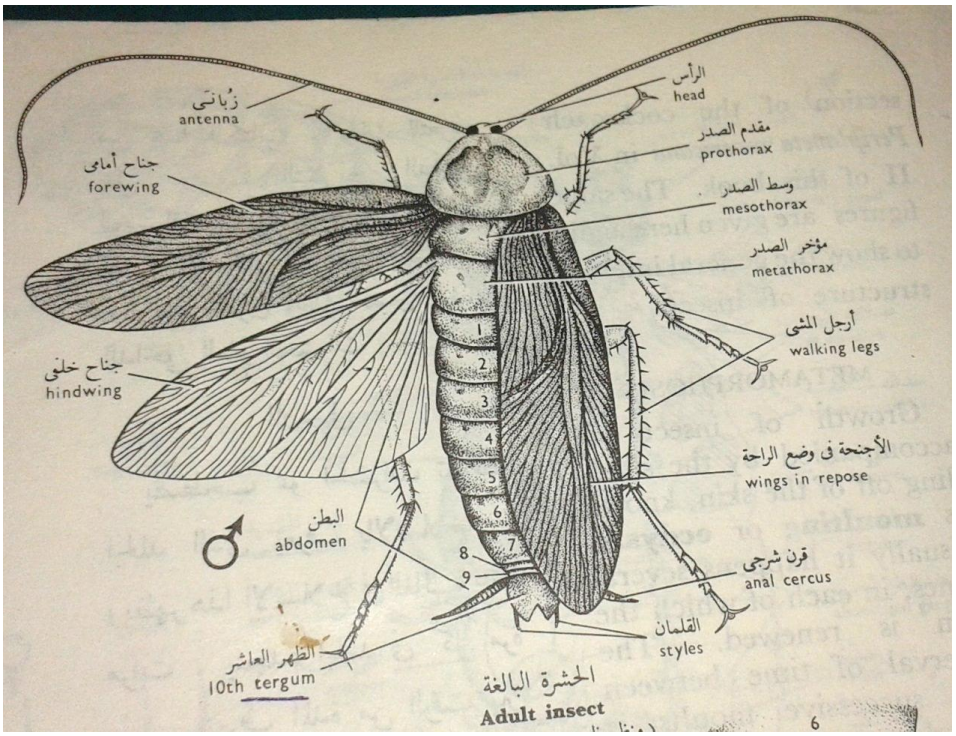
Subclass : Pterygota

Division : Exopterygota

Order : Blattodea

Family : Blattidae

e. g. : <u>Periplaneta</u> <u>americana **الصرصور الامريكى**



Class : Insecta

Subclass : Pterygota

Division : Endopterygota

Order : Lepidoptera

Suborder : Heterocera

Family : Geometridae

e. g. : Spodoptera littoralis دودة ورق القطن

Class : Insecta

Subclass : Pterygota

Division : Endopterygota

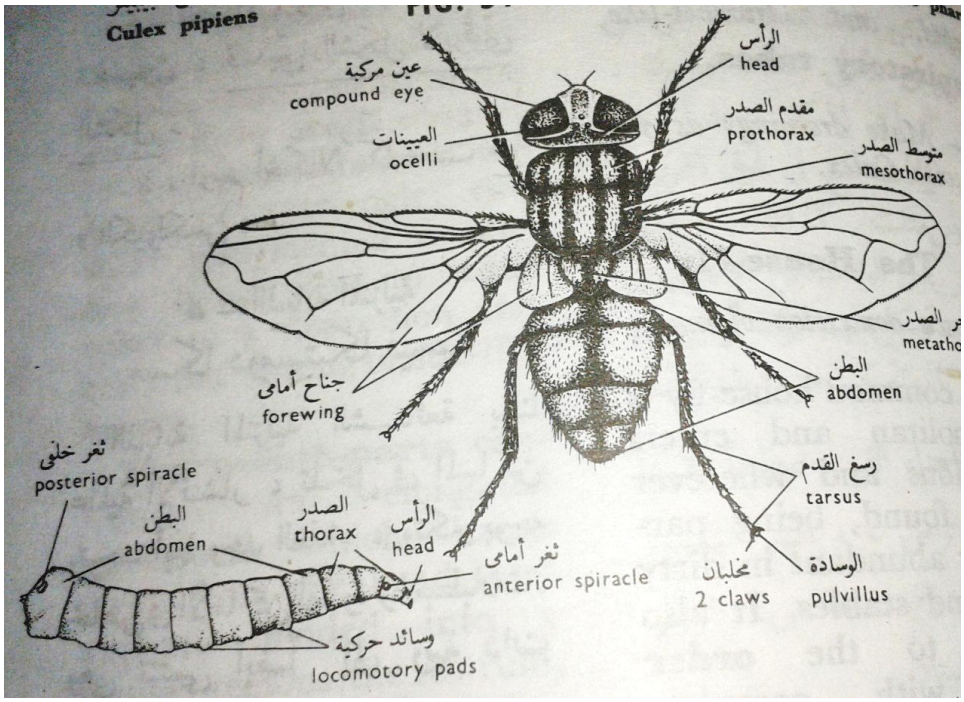
Order : Diptera

Suborder : Brachycera

Division : Cyclorrhapha

Family : Muscidae

e. g. : <u>Musca</u> <u>domestica **الذبابة المنزلية**



Class : Insecta

Subclass : Pterygota

Division : Endopterygota

Order : Hymenoptera

Suborder : Apocrita

Family : Vespidae

e. g. : Vespa orientalis دبور البلح

Class : Insecta

Subclass : Pterygota

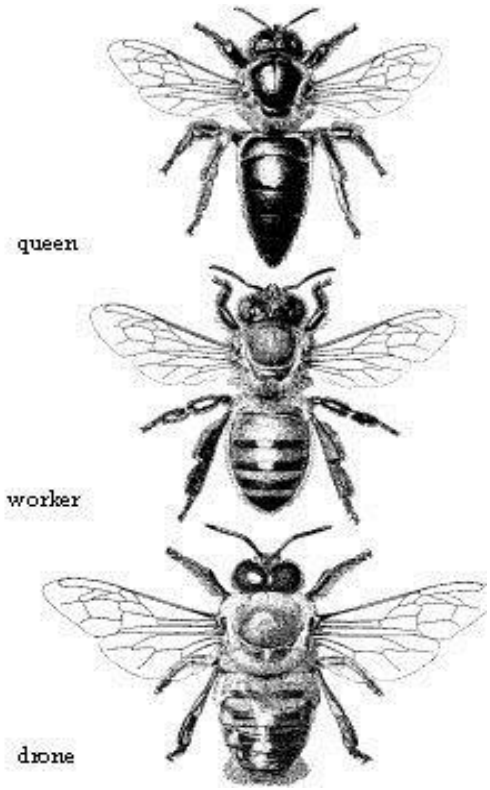
Division : Endopterygota

Order : Hymenoptera

Suborder : Apocrita

Family : Apidae

e. g. : Apis mellifera نحل العسل



Parasitology

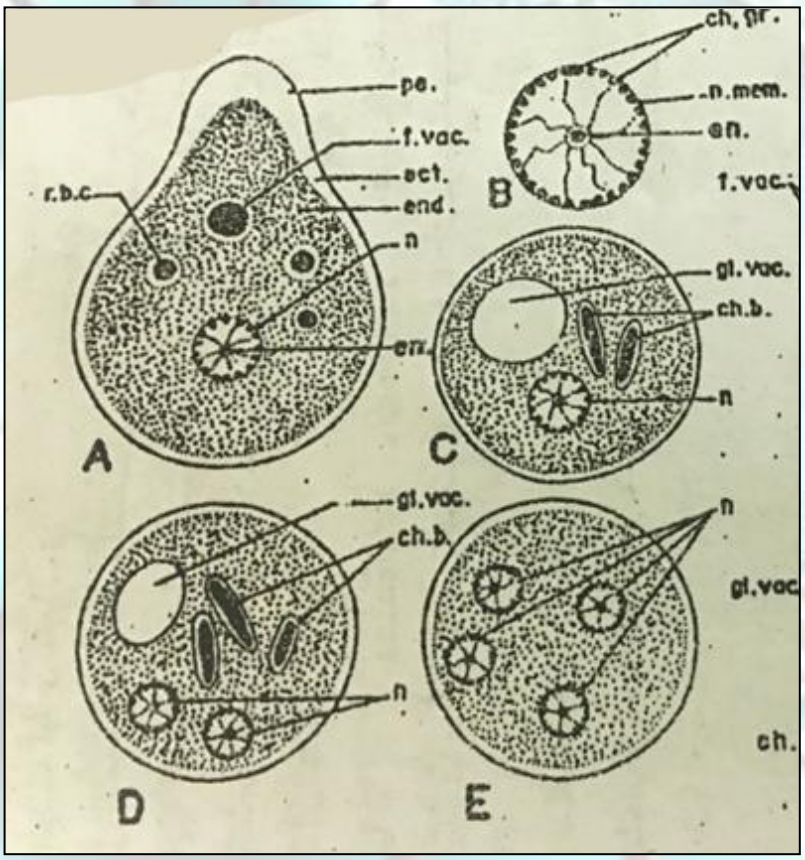
Kingdom: Animalia

Subkingdom: Protozoa

Phylum: Protozoa

Class: Sarcodina

e.g.: ***Entamoeba histolytica***



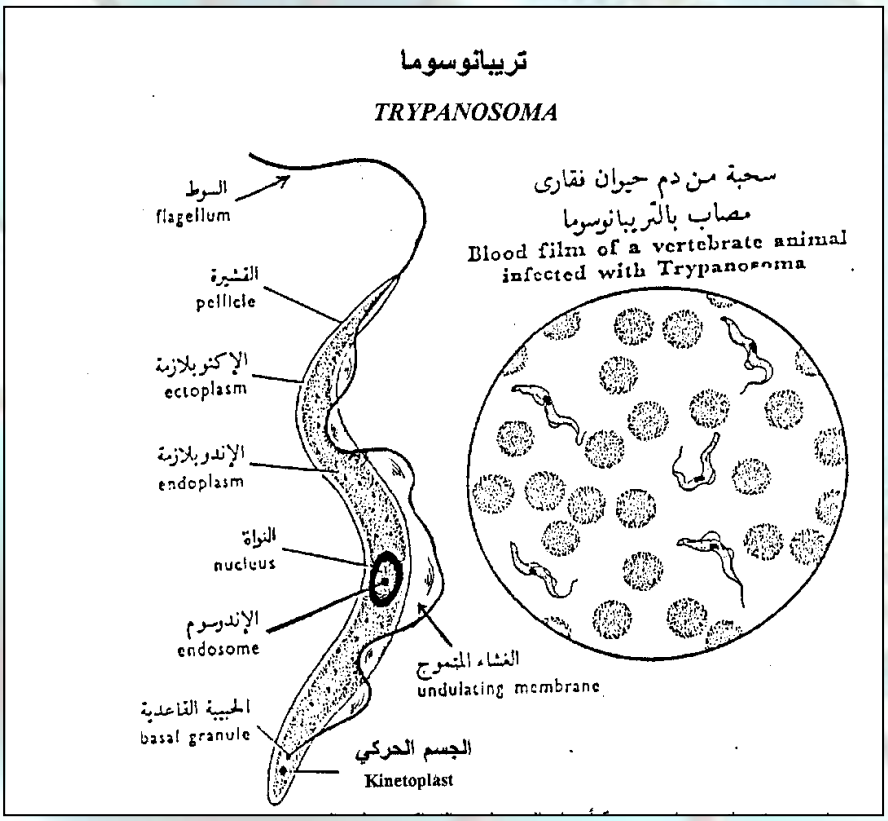
Kingdom: Animalia

Subkingdom: Protozoa

Phylum: Protozoa

Class: Mastigophora

e.g.: *Trypanosoma* sp.



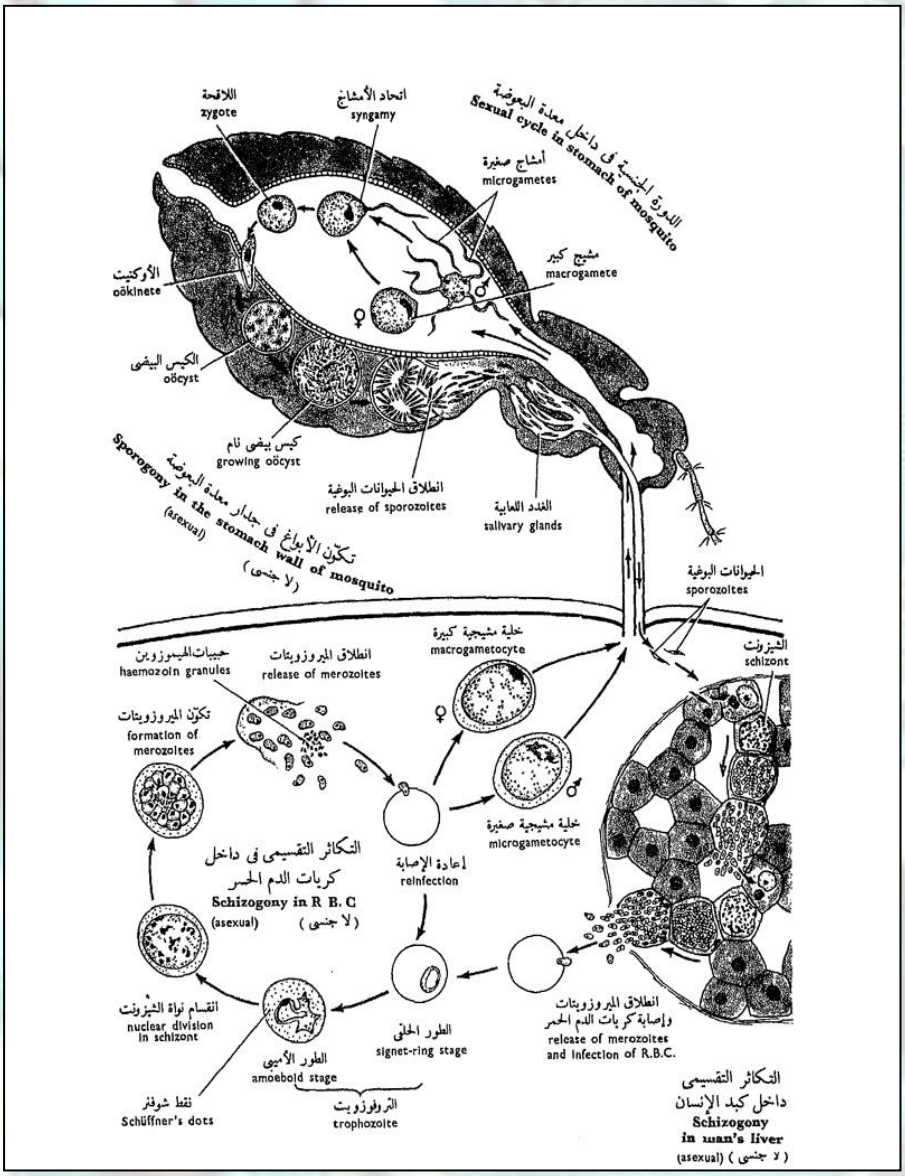
Kingdom: Animalia

Subkingdom: Protozoa

Phylum: Protozoa

Class: Sporozoa

e.g.: ***Plasmodium malariae***



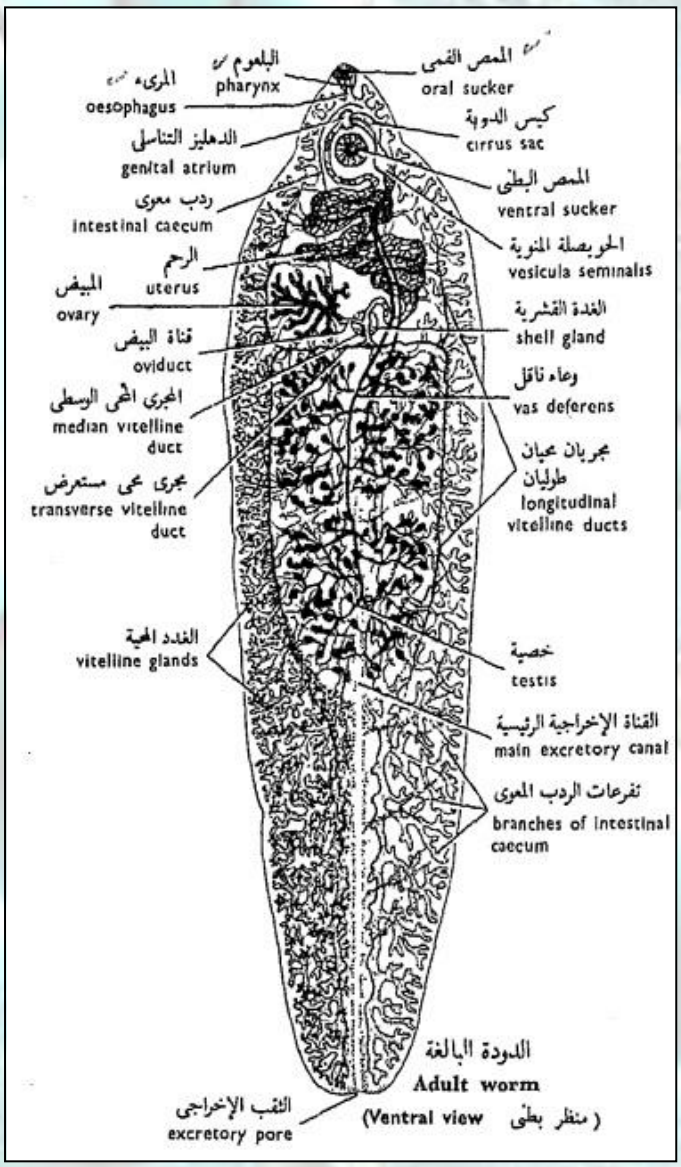
Kingdom: Animalia

Subkingdom: Metazoa

Phylum: Platyhelminthes

Class: Trematoda

e.g.: ***Fasciola gigantica***



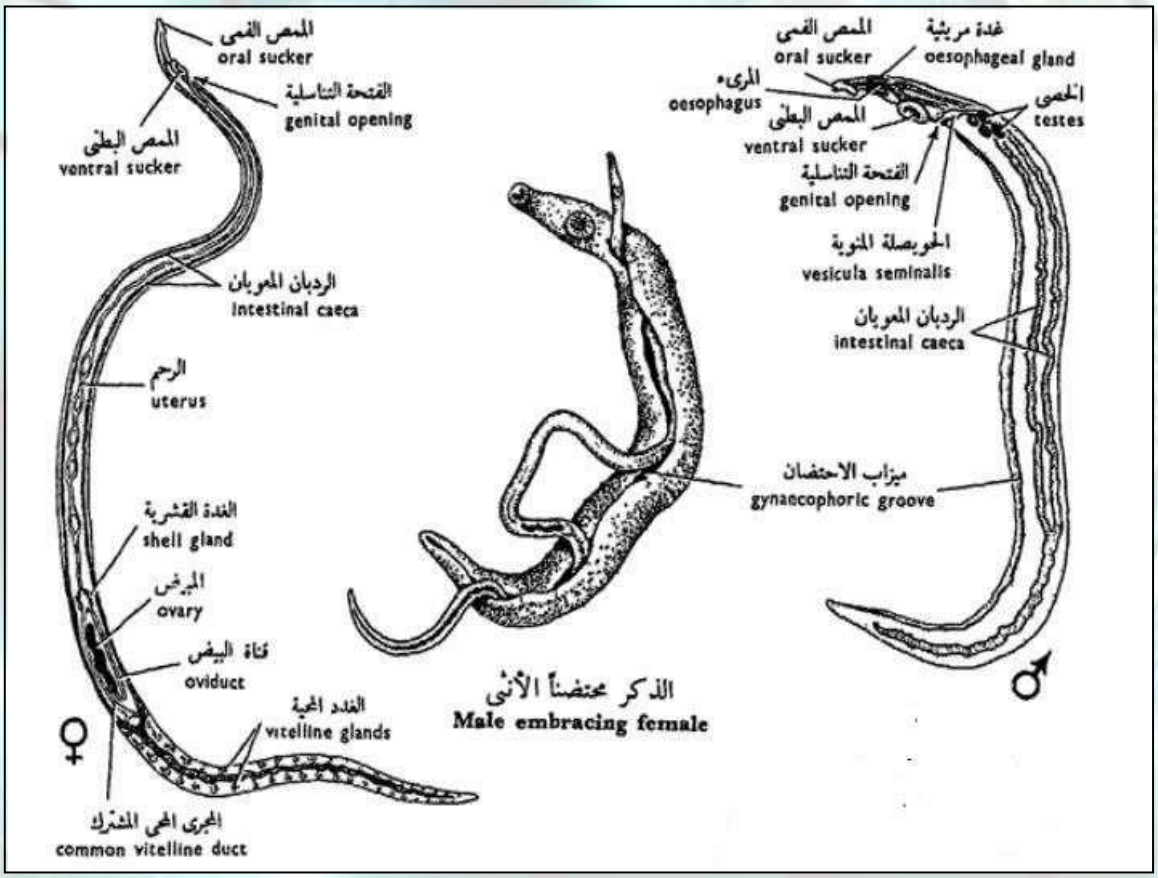
Kingdom: Animalia

Subkingdom: Metazoa

Phylum: Platyhelminthes

Class: Trematoda

e.g.: ***Schistosoma haematobium***



Kingdom: Animalia

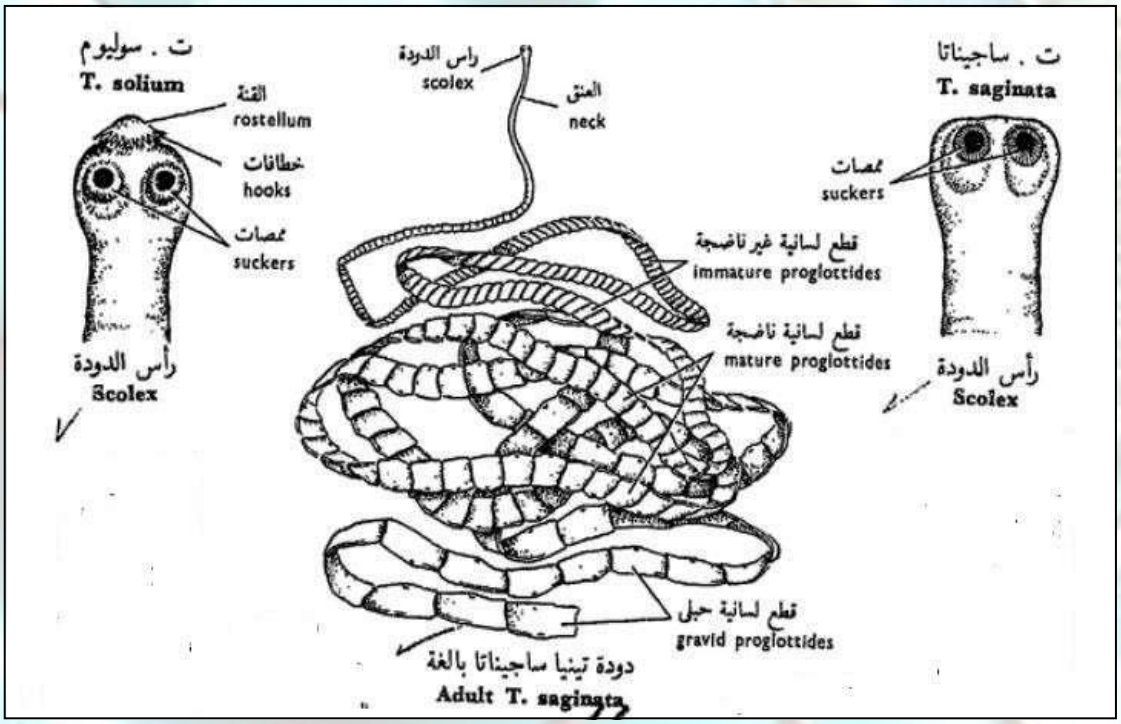
Subkingdom: Metazoa

Phylum: Platyhelminthes

Class: Cestoda

e.g.: ***Taenia saginata***

e.g.: ***Taenia solium***



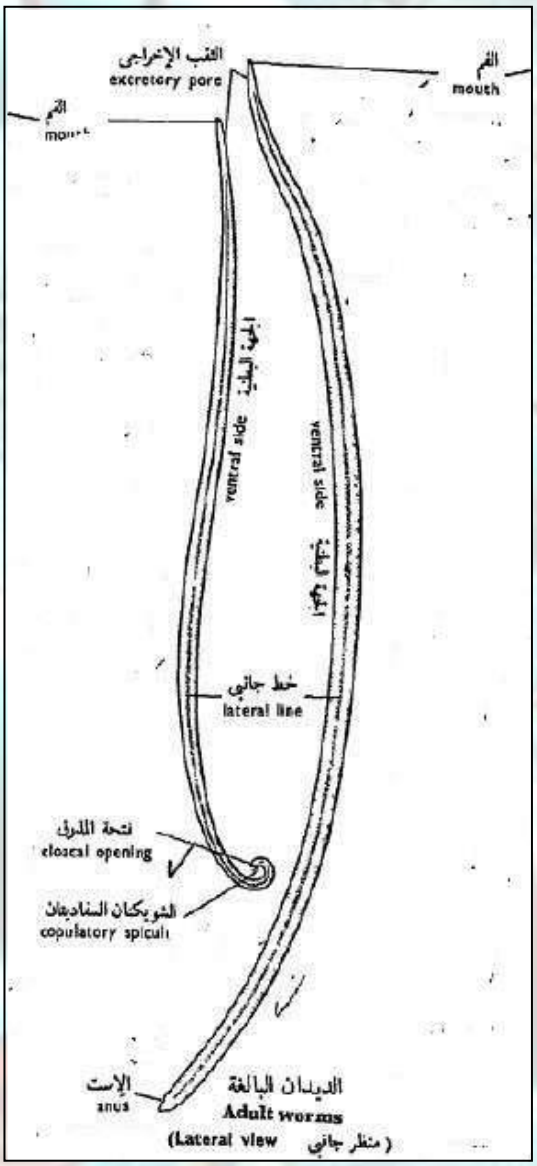
Kingdom: Animalia

Subkingdom: Metazoa

Phylum: Aschelminthes

Class: Nematoda

e.g.: ***Ascaris vitulorum***



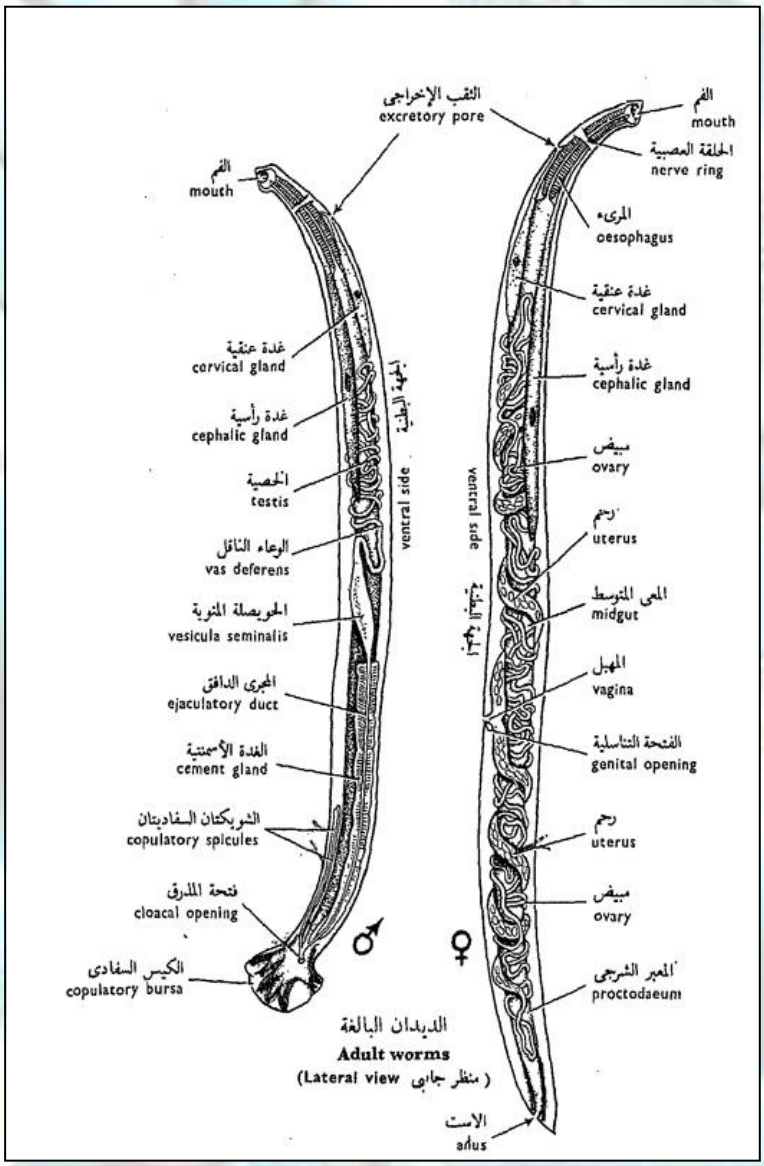
Kingdom: Animalia

Subkingdom: Metazoa

Phylum: Aschelminthes

Class: Nematoda

e.g.: ***Ancylostoma duodenale***



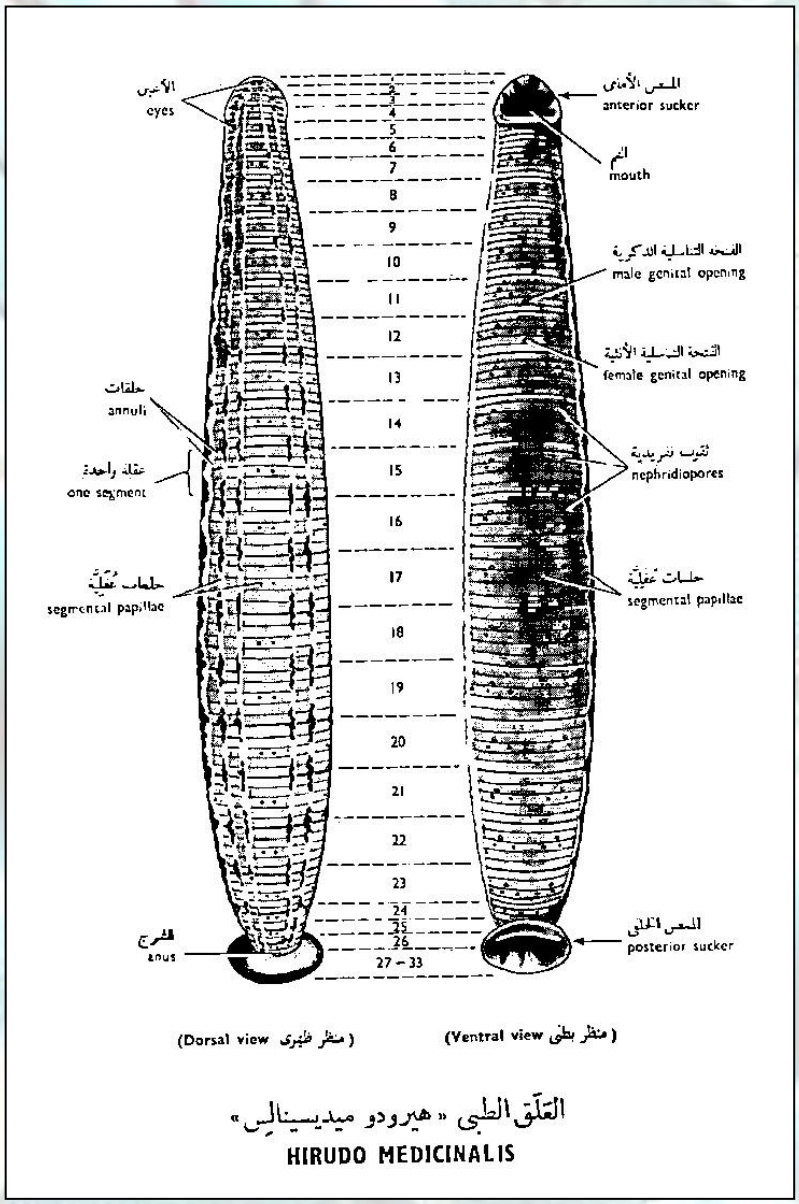
Kingdom: Animalia

Subkingdom: Metazoa

Phylum: Annelida

Class: Hirudinea

e.g.: ***Hirudo medicinalis***



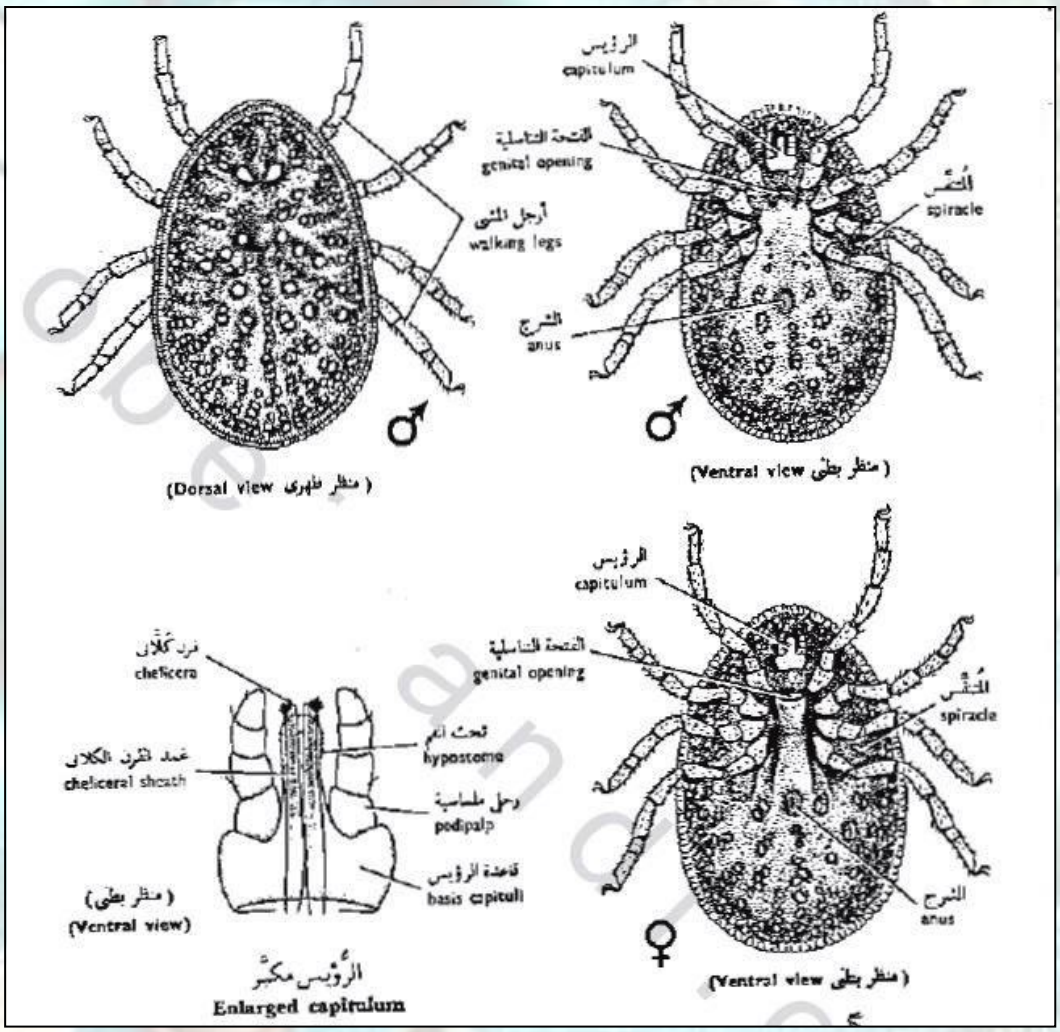
Kingdom: Animalia

Subkingdom: Metazoa

Phylum: Arthropoda

Class: Arachnida

e.g.: ***Argas persicus***



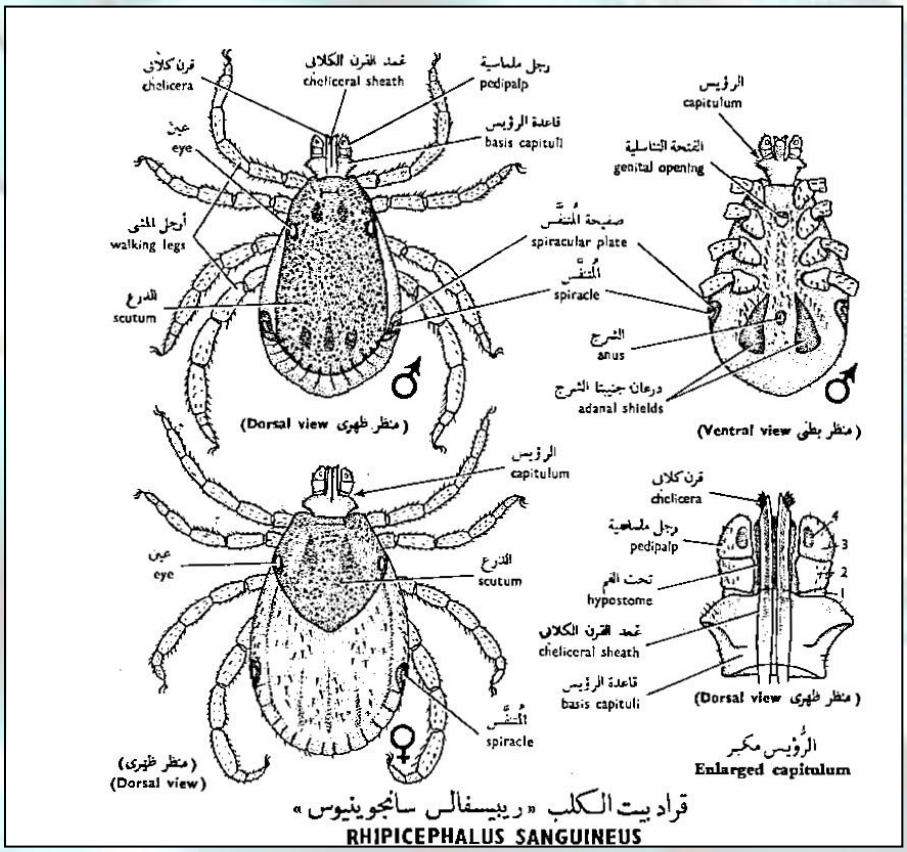
Kingdom: Animalia

Subkingdom: Metazoa

Phylum: Arthropoda

Class: Arachnida

e.g.: ***Rhipicephalus sanguineus***



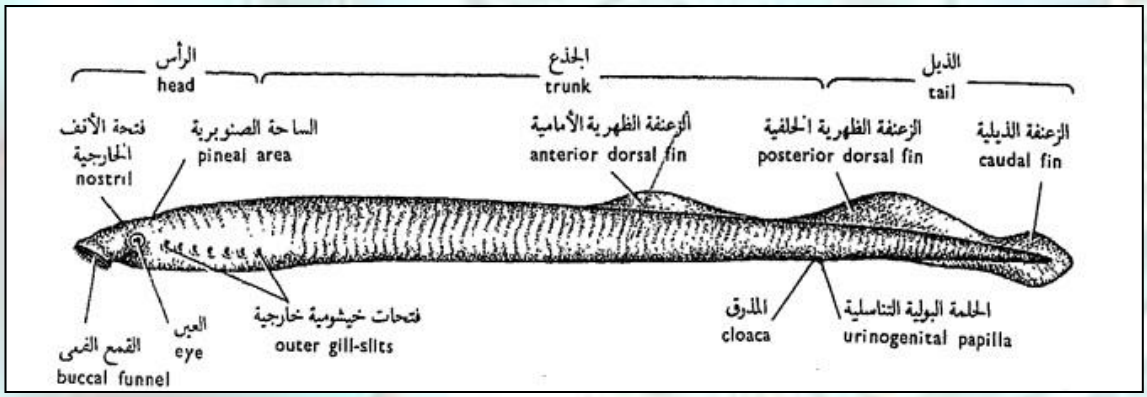
Kingdom: Animalia

Subkingdom: Metazoa

Phylum: Chordata

Class: Cyclostomata

e.g.: ***Petromyzon fluviatilis***



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بيولوجية الحيوان العملية باللغتين العربية والإنجليزية (الجزء الثاني) : للدكتور أحمد حماد الحسيني والدكتور إميل شنودة دميان ، القاهرة (مصر): دار المعارف 1969.