

## **Phylum Arthropoda**

### **Similarities between Annelids and Arthropods**

Arthropods are metameric and the segments have appendages

Their nervous system is to that of annelids

Some biologists have speculated that the early arthropods may have resembled the **Onychophora**

*Onychophorans are Annelid-like:*

Segmented, but segments have unjointed appendages

Similar to annelids in structure of the body wall,

Possess segmentally arranged nephridia

Possess pigment-cup ocelli like annelids

*Onychophorans are Arthropod-like:*

Reduced coelom, open circulatory system, trachea; soft cuticle composed of chitin

Members of the **phylum Tardigrada** or “water bears” also have shared features of annelids and arthropods

*Annelid-like features:*

Unjointed (8) legs; annelid-type nervous system

*Arthropod-like features:*

Presence of a cuticle (nonchitinous) that is periodically molted, similar attachment of muscle fibers to the exoskeleton

The arthropods evolved along four main lines, which most zoologists recognize as subphyla

1. Trilobitomorpha - extinct trilobites
2. Chelicerata - horseshoe crabs, spiders, ticks, mites, and some extinct groups
3. Crustacea - crabs, lobsters, shrimps, barnacles
4. Uniramia - insects, centipedes, millipedes

## The Arthropod Exoskeleton

Epidermis secretes an external skeleton called the **exoskeleton** or **cuticle**

Functions/advantages:

- provides strong support
- provides rigid levers that muscles can attach to and pull against
- offers protection
- serves as a barrier to prevent internal tissues from drying out; important because many arthropods live on land
- serves as a barrier to prevent infection

The outer surface of the cuticle is called the **epicuticle**

The thicker portion is called the **procuticle**, with an **exocuticle** and the **endocuticle**

In the exocuticle the glycoprotein chains are cross linked - **tanning**

In order to grow the arthropod must shed its exoskeleton, and secrete a new and larger one - **molting** or **ecdysis**.

## Jointed Appendages

The exoskeleton is divided into a number of plates and numerous cylinders around the appendages

At the junction point between plates and cylinders, the arthropod exoskeleton remains thin and flexible = the *joints*,

The word arthropod means "jointed foot" and arthropods are said to have **jointed appendages**.

The coelom has become reduced in arthropods when compared to the annelids and this is probably related to the importance of muscles rather than a hydrostatic skeleton in locomotion

## Specialized Arthropod Segments: Reduction in Metamerism

The arthropods evolved modified groups of segments

The fusion of groups of segments into functional groups is called **tagmatization**

In so doing, various appendages on segments became specialized for functions other than locomotion

## **Arthropod Respiratory Advances**

Special respiratory structures allow the arthropods to metabolize more efficiently and thus move rapidly

Many aquatic arthropods (crabs and lobsters) have gills, which are typically modifications of appendages or outgrowths of the body wall

Gas exchange in terrestrial arthropods accomplished by invaginations of the integument

Insects have **tracheae**; spiders have **book lungs**

## **Acute Senses**

Arthropods have a well-developed nervous system that is of the same overall design as the annelids.

The head usually bears various kinds of sense organs with extreme sensitivity

Many arthropods have **compound eyes** - eyes that are composed of many visual units called **facets (ommatidia)**

Some eyes are simple eyes with only a few photoreceptors; however, they are capable of forming crude images

## **Other Arthropod Characteristics**

### *Digestive System*

The arthropod gut differs from most other animals

It is divided into 3 main regions: foregut, midgut, and hindgut

### *Internal Transport and Excretion*

Arthropods have an open circulatory system

Many crustaceans possess an excretory organ called the green gland (antennal gland), which filters fluid from the blood

Most insects and spiders have a excretory system called **malpighian tubules**

### *Reproduction*

Sexes are separate

Fertilization is external in aquatic forms, internal among the terrestrial forms

## Arthropod Diversity

### Subphylum Chelicerata

Lack antennae

Body is composed of two regions the **cephalothorax** and **abdomen**

Cephalothorax is usually covered dorsally by a structure called the **carapace**

They possess six pairs of appendages: first pair are **chelicerae**; second pair are **pedipalps**

The four additional pairs of appendages are walking legs

There are no abdominal appendages

Some have compound eyes, but most have simple eyes that are capable of forming crude images.

### *Chelicerate Diversity*

#### Class Meristomata

Marine chelicerates known from the Ordovician (400 mya)

Have a large dorsal carapace that bears compound eyes

Possess the chelicerae, pedipalps and 4 pair of walking legs; all but the last pair are **chelate**

The abdomen terminates in a long tail called the **telson**

The underside of the abdomen has a series of gill plates called **book gills**

#### Class Arachnida

Among spiders, the cephalothorax and abdomen shows no external segmentation; these tagma are joined by a narrow **pedicel**

Respiration is accomplished via book lungs, tracheae, or both

Usually have 8 simple eyes

Many species have evolved poison glands associated with the chelicerae

Many of the spiders and mites are capable of producing **silk** via silk glands; open to the exterior part of the abdomen through opening called **spinnerets**

Most spiders are predaceous and have all kinds of sensory hairs (mechanoreception) and relatively well-developed eyes for motion detection

Prey capture among the spiders can take on one of two forms: **cursorial predators** and **web building spiders**

## SubPhylum Crustacea

Differ from other arthropods because they possess 2 pair of antennae  
First pair is homologous to those of insects, but the second pair is unique to the crustaceans

The head usually bears a pair of compound eyes and 3 pairs of mouthparts for grinding, chewing or filtering, including a pair of **mandibles**, and 2 pairs of **maxillae**

The trunk varies considerably among the various classes  
Primitively, the first three pairs of thoracic segments are **maxillipeds**; they, along with the maxillae function in food handling  
Also, there are usually 5 pairs of appendages strengthened for walking and protection (**chelipeds**, pincer-like claws)

The abdomen is also highly variable, but it is primitively a large structure  
In the groups that have a well-developed abdomen there are usually six pairs of appendages  
Five pairs of structures called **simmerets (=pleopods)**  
The last pair of abdominal structures is called **uropods**, these are wide and together with the terminal **telson** they form a tail fan than can serve as rudders during locomotion

Primitively many of the appendages of the crustaceans are **biramous**, two-branched  
There is an outer **exopod** and an inner **endopod**

They usually have an extremely hardened exoskeleton, which is impregnated with calcium carbonate

The exoskeleton forms a protective shell called the **carapace**

The primitive larva of the crustaceans is called the **nauplius larva**

## SubPhylum Uniramia

All uniramia possess a single pair of antennae

The first pair of feeding appendages are mandibles and there are one or 2 pairs of maxillae

Number of legs vary from 3 pair to many pairs; they are unbranched or **uniramous**

### Class Chilopoda (Centipedes)

Serial segmented, flattened body and each segment has a pair of jointed appendages

Active predators, killing their prey with **poison claws**, which are modified legs on first segment

### Class Diplopoda (Millipedes)

Serially segmented, rounded body with 2 smaller pairs of legs per segment

Slow moving

Feed on decaying plants

### Class Insecta

Body is divided into 3 parts: the head, thorax and the abdomen.

On the head: a pair of antennae, a pair of compound eyes, and several sets of simple eyes

Mouthparts: a pair of mandibles, and two pairs of maxillae

Primitively, one pair of maxillae are fused together to form a lower lip - **labium**

There is an upper lip - **labrum** - formed from an extension of the head

Mouthparts are highly modified depending on the group you are discussing

Mosquitoes have pointed mouthparts for piercing and sucking; grasshoppers have

mouthparts that are well adapted for chewing; butterflies for siphoning; flies for sponging

The thorax is composed of 3 segments and each one has a pair of legs

The last two have a pair of wings

Exceptions include: **halteres** of Diptera, wingless fleas, males ants (and females during certain periods)

The wings of insects are modified portions of the exoskeleton

The 1st pair is usually tough and leathery and fold over the inner pair for protection.

The segmented abdomen does not have appendages

However, the terminal portions do harbor the reproductive structures

Most insects undergo **metamorphosis** (=a change in form) during their development.

**1. Incomplete Metamorphosis (Hemimetabolous)**

Early developmental stages are very similar to the adults  
Thus development is egg ----> nymph ----> adult

**2. Complete Metamorphosis (Holometabolous)**

Each of the developmental stages is structurally and functionally very different  
Common among flies, beetles, and butterflies  
Egg ----> larva ----> pupa ----> adult

**Learn the insect orders on pages 245-246**