Metazoan Phylogeny

c.f. Brusca and Brusca 2004

“Higher Protostomes”
“Higher Protostomes”

Sipuncula
Mollusca
Echiura
Annelida
Arthropoda
Tardigrada
Onychophora

Synapomorphies: Articulata

8. Engrailed (en) controls segmentation during development.
30. "Brain" with mushroom bodies.
36. Teloblastic growth.

Hox Genes
A cluster of regulatory genes, the Hox genes, control segment identity in arthropods, and comparisons of the sequences and functions of Hox genes can reveal evolutionary relationships.
**Hox Genes**

Hox genes specify positional identity not a specific structure.
Different species of embryos interpret the values differently.

**Mushroom Bodies**

Paired structures associated with olfaction and memory (Corpora pedunculata).

**Teloblastic Growth in Trilobites**
Synapomorphies:
Onychophora +

17. Ecdysis mediated by ecdysone.
57(1). "Mixocoel" present - semi-open circulation.
90(0). Eyes not compound.

<table>
<thead>
<tr>
<th>Estimated numbers of described living species</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amelida</td>
</tr>
<tr>
<td>Onychophora</td>
</tr>
<tr>
<td>Tardigrada</td>
</tr>
<tr>
<td>Arthropoda, Crustacea</td>
</tr>
<tr>
<td>Arthropoda, Hexapoda</td>
</tr>
<tr>
<td>Arthropoda, Myriapoda</td>
</tr>
<tr>
<td>Arthropoda, Cheliceratiomorphes</td>
</tr>
<tr>
<td>Arthropoda, Tilleuliomorpha</td>
</tr>
<tr>
<td>(all extinct)</td>
</tr>
</tbody>
</table>
55(1). Cerebral ganglia organized in 3 parts: proto-, deutero-, trito-.
76. Gut encapsulates food in peritrophic membrane.
### Characteristics of the Phylum Arthropoda

1. Internal, implantable gonadotropes
2. Body segmented, with clearly demarcated body regions: head, thorax, and abdomen
3. Appendages: various modifications of the appendages of the trunk segments
4. Segmentation: often well-defined in the trunk, sometimes less obvious in the head
5. Circulatory system: often well-developed, including a heart and blood vessels
6. Nervous system: complex, with a brain and ganglia
7. Reproduction: often internal, with eggs or young attached to the parental body
8. Dry exoskeleton for protection and support
9. Sexual dimorphism: often present
10. Locomotion: often rapid, with the use of walking legs, swimming, or flying
11. Sensory organs: often well-developed, including eyes, antennae, and chemosensory structures
12. Development: often direct, with larvae similar to the adults, or indirect, with a pupal stage
13. Resistance to environmental changes: often high, with adaptations for various habitats
14. Evolutionary history: diverse, with a long history of diversification

#### Table: Characteristics of Selected Arthropod Groups

<table>
<thead>
<tr>
<th>Arthropod Group</th>
<th>Estimated Number of Species</th>
<th>With Telodorsal Segmentation</th>
<th>Reproduction and Development</th>
<th>With Exoskeleton</th>
<th>Eyes and Appendages</th>
<th>Reference</th>
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</thead>
<tbody>
<tr>
<td>Arachnida</td>
<td>65,000</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Well-developed</td>
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<tr>
<td>Mysidacea</td>
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<td>Yes</td>
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<td>Reduced or absent</td>
<td>Reference</td>
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<tr>
<td>Arthropoda</td>
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<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Reduced or absent</td>
<td>Reference</td>
</tr>
<tr>
<td>Chilopoda</td>
<td>50,000</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Reduced or absent</td>
<td>Reference</td>
</tr>
<tr>
<td>Chilopoda, Hexapoda</td>
<td>50,000</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>Reduced or absent</td>
<td>Reference</td>
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<tr>
<td>Chilopoda, Chilopoda, Hexapoda</td>
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<td>Yes</td>
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<td>Chilopoda, Hexapoda, Chilopoda, Hexapoda</td>
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</tr>
</tbody>
</table>
1. Bilateral, triploblastic protostomes
2. Body segmented, both internally and externally; segments arise by teloblastic growth (showing en gene expression)

3. Minimally, body divided into head (cephalon) and trunk regions; commonly with further regional body specialization or tagmosis; typically with a head shield or carapace

4. Head with labrum (or clypeolabrum) (showing Dil gene expression) and with nonsegmental acron; engrailed (en) gene expression suggests that acron and first true head segment develop as single morphological unit
5. Cuticle forms well developed exoskeleton, generally with thick sclerotized plates (sclerites) consisting of dorsal tergites, lateral pleurites, and ventral sternites; cuticle of exoskeleton consists of chitin and protein (including resilin), with varying degrees of calcification; without collagen.

6. Each true body segment primitively with a pair of segmented (jointed), ventrally attached appendages, showing a great range of specialization among the various taxa; appendages composed of a proximal protopod and a distal telopod (both multiarticulate); protopodal articles may bear medial endites or lateral exites.