

## Kingdom Animalia - Invertebrates

### Defining Animals

Characteristics of animals include:

1. Animals are multicellular, heterotrophic eukaryotes.
2. Animals generally store their carbohydrate reserves as glycogen
3. Animal cells lack cell walls
4. Animals are unique in that they possess special tissues that are responsible for impulse conduction (nervous tissue) and movement (muscle tissue).
5. Most animals reproduce sexually, with the diploid stage dominating the life cycle

### Trends in Animal Evolution

There were 5 major anatomical and physiological trends (innovations) during animal evolution

1. The first trend was a shift from a body plan called **radial symmetry** to a body plan referred to as **bilateral symmetry**
2. Along with this first trend came a second trend called **cephalization**, or the development of a distinct head, which has associated with it a brain and various kinds of sensory structures
3. In the third trend, invertebrate animals evolved away from a simple sac-like body with a single opening at one end to a more complex, elongated body containing a tube called the "gut" with openings at both ends
4. The fourth trend was away from a tube enclosed in solid tissue and toward suspension of the tube in a fluid filled space  
This cushioned the 'gut' and allowed for the development of more complex internal organs
5. A fifth trend was toward **segmentation** - the development of a series of body units, each containing similar sets of muscles, blood vessels, nerves. etc.  
Segmentation allowed animals to develop specialized body parts, such as legs, wings, and antennae

## Major Events in Animal Evolution

### A. The Parazoa-Eumetazoa Split

1. *Parazoa* ("beside the animal") - animals that lack true tissues
2. *Eumetazoa* - animals with well defined tissue layers

### B. The Radiata-Bilateria Split

The eumetazoa are divided into 2 major branches depending on the type of body symmetry (=body plan or organization) that evolved.

1. Some organisms exhibit **radial symmetry**, and are called the **Radiata**
2. Other eumetazoa exhibit **bilateral symmetry**, and are called the **Bilateria**

Another difference in body plan actually defines the Radiata-Bilateria split better than symmetry

Early in the development of all embryos except sponges, the embryo becomes layered through the process of gastrulation

As a general rule, these layers, called **germ layers**, form the various tissues and organs of the body as development progresses

1. *Ectoderm* - covering the surface of the embryo

Gives rise to the outer covering of the animal (= epidermis) and in some phyla the nervous system.

2. *Endoderm* - inner most germ layer; lines the primitive gut

Gives rise to the lining of the digestive tract and its outpocketings, such as the liver and lungs of vertebrates

Note:

The animal groups that make up the Radiata (e.g. Cnidarians and ctenophores) produce only these germ layers and are said to be **diploblastic**

All other eumetazoa, the Bilateria, are **triploblastic** and produce a third germ layer

3. *Mesoderm* - germ layer between the ectoderm and the endoderm

Gives rise to muscles and to most other organs.

### C. The Acoelomate-Coelomate Split

Among the bilaterally symmetrical animals with 3 germ layers, further development of the embryo leads to organisms with one of three types of body cavities:

**1. Acoelomates** - animals with solid bodies - that is, there is no body cavity between the gut (endoderm) and the outer body wall.  
e.g. Platyhelminthes or flatworms

The other 2 body plans are called a *tube within a tube body plan*, with a fluid filled sac separating the gut from the outer body wall.

There is a second important difference between acoelomates and animals having a body cavity: animals with a body cavity have some sort of blood vascular system - blood is circulated through a network of spaces or vessels

**2.** If the cavity is not completely lined with mesodermal tissue the organisms are said to be **Pseudocoelomates**.

And the body cavity is called a **pseudocoelom**.

**3. Eucoelomates** are animals that have a fluid filled body cavity that is completely lined with tissue that is derived from the mesoderm.

This kind of body cavity is called the **coelom**.

### D. The Protostome-Deuterostome Split

Those organisms that are coelomates, can be divided into 2 distinct groups: **protostomes** and **deuterostomes**.

They are distinguished based upon fundamental differences in early development, including cleavage, fate of the blastopore, coelom formation

#### **1. Cleavage:**

a. Protostomes - Spiral, determinate cleavage

b. Deuterostomes - Radial, indeterminate cleavage

## **2. Blastopore Fate**

- a. Protostomes - blastopore becomes the mouth  
Protostome means "first mouth"
- b. Deuterostomes - blastopore becomes the anus  
Deuterostome means "second mouth"

## **3. Coelom Formation**

- a. Protostomes - coelom formation is called **schizocoelous development**  
Coelom forms by splitting of mesoderm
- b. Deuterostomes - coelom formation is called **enterocoelous development**  
Coelom forms as outpockets from the endoderm

## **The Animal Phylogenetic Tree**

The relationships between the animal phyla (N=35) continues to be debated

Many ideas about relationships have been based on morphological data sets; however, molecular data has also made significant contributions to our understanding of relationships within the group

There are two major phylogenetic hypotheses regarding animal evolution: one is based largely on morphological and developmental data; the other is based primarily on molecular sequence data

### **Points of Agreement between the Two Hypotheses**

1. All animals share a common ancestor
2. Sponges are basal animals
3. Eumetazoa is a clade of animals with true tissues
4. Most animal phyla are members of the Bilateria clade
5. Vertebrates and some other phyla belong to the Deuterstomia clade

### **Points of Disagreement**

The morphologically-based tree divides the bilaterians into two clades: deuterstomes and protostomes

But, several recent molecular studies have generally assigned two sister taxa to the protostomes rather than one: 1) the **ectdysozoans** and 2) the **lophotrochozoans**