Chapter 32:
An Overview of Animal Diversity

1. General Features of Animals
2. The History of Animals
1. General Features of Animals
General Characteristics of Animals

- animals are multicellular eukaryotic heterotrophs that ingest their food and digest it internally
- animals have tissues that develop from embryonic germ layers
  - tissues are groups of similar cells that act as a functional unit
- nerve & muscle tissue are derived characters of animals
Animal cells lack cell walls and can adopt a wide variety of specific cell fates (e.g., muscle, nerve, kidney, liver cells).
Animal Body Plans

Almost all animal species have symmetrical body plans:

- some animal groups are characterized by body plans with radial symmetry
- most animal groups exhibit bilateral symmetry

Animal body plans are dependent on the Hox genes, a set of genes unique to the Animal Kingdom.
Most animals reproduce sexually with the diploid phase of the life cycle being dominant.

Following fertilization, early animal development unfolds in the characteristic stages shown here.

**CLEAVAGE** – rapid cell division without cell growth

**GASTRULATION** – reorganization of cells to produce the germ layers
The Germ Layers

Through the process of gastrulation, 2 or 3 germ layers are produced from which the overall body plan and all body structures develop.

- species that are **diploblastic** have only 2 germ layers – ectoderm and endoderm
- **triploblastic** species produce all 3 germ layers

**ECTODERM** – outermost germ layer that gives rise to the nervous system and external structures

**ENDODERM** – innermost germ layer that gives rise to the digestive structures

**MESODERM** – middle germ layer that gives rise to structures not derived from ectoderm or endoderm
Body Cavities

Most triploblastic animal species have body cavity separate from the gut called a **coelom** associated with mesodermal tissues.

- **coelomates** have a coelom completely surrounded by mesodermal tissue
• **pseudocoelomates** have a coelom bordered on the interior by endoderm

• **acoelomates** are triploblastic animals do not have a coelom
## Protostome vs Deuterostome Development

- **in PROSTOSTOMES**, the **blastopore** becomes the mouth, cleavage is **spiral** & determinate.

- **in DEUTEROSTOMES**, the **blastopore** becomes the anus (a second opening becomes the mouth), cleavage is **radial** & indeterminate.

<table>
<thead>
<tr>
<th>Protostome development (examples: molluscs, annelids)</th>
<th>Deuterostome development (examples: echinoderms, chordates)</th>
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<tbody>
<tr>
<td><strong>(a) Cleavage</strong></td>
<td><strong>Eight-cell stage</strong></td>
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<td></td>
<td><strong>Spiral and determinate</strong></td>
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<td></td>
<td><strong>Radial and indeterminate</strong></td>
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<td><strong>(b) Coelom formation</strong></td>
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<td></td>
<td><strong>Blastopore</strong></td>
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<td></td>
<td><strong>Mesoderm</strong></td>
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<td></td>
<td><strong>Solid masses of mesoderm split and form coelom.</strong></td>
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<td></td>
<td><strong>Archenteron</strong></td>
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<tr>
<td></td>
<td><strong>Coelom</strong></td>
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<td></td>
<td><strong>Folds of archenteron form coelom.</strong></td>
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<td></td>
<td><strong>Anus</strong></td>
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<td></td>
<td><strong>Digestive tube</strong></td>
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<tr>
<td><strong>(c) Fate of the blastopore</strong></td>
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<td></td>
<td><strong>Mouth develops from blastopore.</strong></td>
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<td><strong>Anus develops from blastopore.</strong></td>
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**Key**
- Ectoderm
- Mesoderm
- Endoderm
2. The History of Animals
Phylogeny of the Animal Kingdom

Metazoa

Eumetazoa

Bilateria (most animals)

Porifera (basal animals)

Ctenophora

Cnidaria

Acoela (basal bilaterians)

Deuterostomia

Lophotrochozoa

Ecdysozoa

True tissues

Bilateral symmetry

Three germ layers
Steps in the Origin of Multicellular Animals

Protists called choanoflagellates are the closest living relatives to animals.

- Individual choanoflagellate
- Collar cell (choanocyte)
- Choanoflagellates
- Sponges
- Other animals

Other Eukaryotes

Animals
Genes involved in cell-cell adherence such as *cadherin* that are unique to animals were key to multicellularity.
### History of Animals Spans Over 500 Million Years

<table>
<thead>
<tr>
<th>Era</th>
<th>Millions of Years Ago (mya)</th>
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<tbody>
<tr>
<td>Neoproterozoic</td>
<td>1,000</td>
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<tr>
<td>Paleozoic</td>
<td>542</td>
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<tr>
<td>Mesozoic</td>
<td>251</td>
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<tr>
<td>Cenozoic</td>
<td>65.5</td>
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<table>
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<tr>
<th>Event</th>
<th>Timeframe (mya)</th>
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<tr>
<td>560 mya: Ediacaran animals</td>
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</tr>
<tr>
<td>535−525 mya: Cambrian explosion</td>
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<tr>
<td>365 mya: Early land animals</td>
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- **Neoproterozoic**: 1,000 mya
- **Paleozoic**: 542 mya
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- **Cenozoic**: 65.5 mya

- **560 mya**: Ediacaran animals
- **535−525 mya**: Cambrian explosion
- **365 mya**: Early land animals
- **Origin and diversification of dinosaurs**: 251 mya
- **Diversification of mammals**: 65.5 mya
Ediacaran animals were largely sessile and are some of the earliest animals in the fossil record.
The Paleozoic Era (542 to 251 mya)

The Cambrian explosion (535 to 525 mya) refers to a period when the ancestors of most major animal groups first appear in the fossil record.

- most have bilateral symmetry and complete “one way” digestive tracts
- hypothesized to be due to increased $O_2$ and evolution of the $Hox$ genes
375 million year old fossils of *Tiktaalik roseae* are the earliest evidence of the vertebrate transition from water to land.

- has characteristics of both fish & amphibians
Mesozoic Era (251 to 65.5 mya)

Dinosaurs were the dominant land vertebrates.

- the first mammals in the fossil record
- the first evidence of coral reef ecosystems
- end of this era coincides with an asteroid impact and mass extinctions
Cenozoic Era (65.5 mya to present)

- mammals increased in size and variety to occupy niches vacated by mass extinction and become the dominant land vertebrates
The Diversification of Animals

- **ANCESTRAL PROTIST**
  - Metazoa
    - Eumetazoa
      - Bilateria
        - Deuterostomia
          - Porifera
            - Ctenophora
          - Cnidaria
          - Acoela
          - Hemichordata
          - Echinodermata
          - Chordata
            - Platyhelminthes
          - Rotifera
          - Ectoprocta
          - Brachiopoda
          - Mollusca
          - Annelida
          - Nematoda
          - Arthropoda
          - Lophotrochozoa
          - Ecdysozoa

- **Metazoa**
  - 770 million years ago
  - 680 million years ago
  - 670 million years ago