

Chapter 32

Introduction to Animals

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Chapter 32

Section 1 The Nature of Animals

Objectives

- **Identify** four important characteristics of animals.
- **List** two kinds of tissues found only in animals.
- **Explain** how the first animals may have evolved from unicellular organisms.
- **Identify** four features found only in chordates.
- **Identify** two functions of the body cavity.
- **List** the structural features that taxonomists use to classify animals.



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Section 1 The Nature of Animals

Characteristics

- **Animals** are multicellular heterotrophic organisms that lack cell walls.
- **Vertebrates** have a backbone.
- **Invertebrates** do not have a backbone.
 - Invertebrates account for more than 95 percent of all animal species alive today.



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Section 1 The Nature of Animals

Characteristics, *continued*

Multicellular Organization

- Each cell in an animal body depends on the presence and functioning of other cells.
- In all but the simplest animal phyla, there is **specialization** among cells.
- A **tissue** is a group of similar cells that perform a common function.
- **Organs** are composed of more than one type of tissue. Multicellularity and cell specialization have enabled organisms to adapt to many environments.



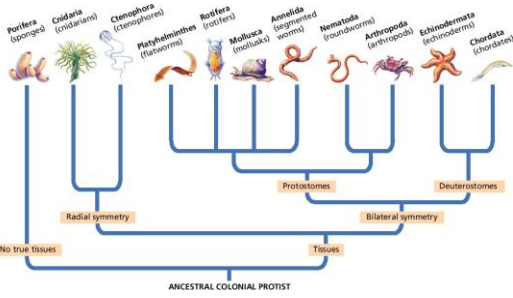
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Chapter 32

Section 1 The Nature of Animals

Evolutionary Relationships in the Animal Kingdom



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Section 1 The Nature of Animals

Characteristics, *continued*

Heterotrophy

- Animals are heterotrophic. They obtain complex organic molecules, usually by **ingestion**.

Sexual Reproduction

- Most animals can reproduce sexually, and some can also reproduce asexually.
- In sexual reproduction, two haploid gametes fuse to form a **zygote** that undergoes repeated mitotic divisions.
- The enlarging mass of dividing cells undergoes **differentiation**.

Movement

- Most animals move about in their environment.
- The ability to move results from the interrelationship of muscle tissue and nervous tissue, or **neurons**.

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Section 1 The Nature of Animals

Origin and Classification

- The first animals may have evolved from colonial protists.
- Taxonomists have grouped animals into several phyla by comparing their:
 - fossils
 - body symmetry
 - patterns of embryo development
 - macromolecules, such as rRNA

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Section 1 The Nature of Animals

Origin and Classification, *continued*

Invertebrates

- Invertebrate body plans range from:
 - lack of symmetry and lack of true tissues to:
 - bilateral symmetry and specialized parts

Chordates

- All **chordates** have, at some stage in life:
 - a **notochord**
 - a **dorsal nerve cord**
 - a postanal tail
 - pharyngeal pouches**

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Section 1 The Nature of Animals

Origins of Animal Tissues and Organs

Primary tissue layer	Gives rise to
Ectoderm	Outer layer of skin; nervous system; sense organs, such as eyes
Endoderm	Lining of digestive tract; respiratory system; urinary bladder; digestive organs; liver; many glands
Mesoderm	Most of the skeleton; muscles; circulatory system; reproductive organs; excretory organs

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Section 1 The Nature of Animals

Body Structure

Patterns of symmetry

- **Symmetry** is a body arrangement in which parts that lie on opposite sides of an axis are identical.
- Types of symmetry are:
 - no Symmetry (asymmetrical)
 - **radial symmetry**
 - **bilateral symmetry**, which includes:
 - a **dorsal** (back) side and a **ventral** (abdomen) side
 - an **anterior** (head) end and a **posterior** (tail) end
 - a right side and a left side
- Bilaterally symmetrical animals tend to exhibit **cephalization**.

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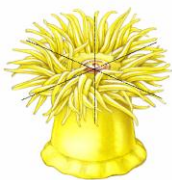
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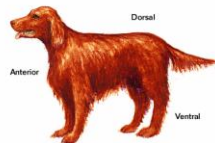
Radial and Bilateral Symmetries



Radial symmetry



Bilateral symmetry



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Body Structure, *continued*

Germ Layers

- **Germ layers** form in the embryos of all animals except sponges.
- The embryos of cnidarians and ctenophores have two germ layers.
- All other animals have three germ layers.

Body Cavities

- Most animals have some type of body cavity.
- The body cavity aids in movement of the body and transport of nutrients and wastes among cells.

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Body Structure, *continued*

Body Structure and Relatedness

- Biologists use similarities in body plans and patterns of development to help them classify animals and hypothesize about the evolutionary history of animals.
- Multicellularity and a limited degree of cell specialization characterize the sponges. Sponges have no organized body shape and no true tissues.
- True tissues in two layers are found in the cnidarians and the ctenophores.
- True tissues in three layers and bilateral symmetry characterize all of the other animal phyla.



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Section 1 The Nature of Animals

The Animal Body: An Evolutionary Journey

Phylum	Body Features	Typical organism
Porifera	Multicellularity	Sponge
Cnidaria	Radial symmetry Extracellular digestion Specialized tissues	Hydra
Platyhelminthes	Internal organs Bilateral symmetry Cephalization	Liver Fluke
Nematoda	Body cavity	Nematode
Mollusca	Ceolom	Snail
Annelida	Segmentation	Earthworm
Arthropoda	Jointed appendages Exoskeleton	Wasp
Echinodermata	Deuterostome Development Endoskeleton	Sea Star
Chordata	Notochord	Lancelet

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Section 2 Invertebrates and Vertebrates

Objectives

- **Compare** symmetry, segmentation, and body support in invertebrates and vertebrates.
- **Describe** the differences in the respiratory and circulatory systems of invertebrates and vertebrates.
- **Compare** the digestive, excretory, and nervous systems of invertebrates and vertebrates.
- **Contrast** reproduction and development in invertebrates and vertebrates.



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Section 2 Invertebrates and Vertebrates

Invertebrate Characteristics

- Adult invertebrates show a tremendous amount of morphological diversity.
- Invertebrates may be characterized in terms of their:
 - Symmetry
 - Segmentation
 - Support of the Body
 - Respiratory and Circulatory Systems
 - Digestive and Excretory Systems
 - Nervous System
 - Reproduction and Development



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Invertebrate Characteristics, *continued*

Symmetry

- Most invertebrates display either radial or bilateral symmetry.
- Radial symmetry allows an animal to receive stimuli from all directions.
- Bilateral symmetry is an adaptation to a more motile lifestyle.
- Bilateral symmetry allows for cephalization, which is present in varying degrees in different animals.



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Invertebrate Characteristics, *continued*

Segmentation

- **Segmentation** in animals refers to a body composed of a series of repeating similar units.
- Segmentation is in its simplest form when each unit of the body is very similar to the next one.
- In more complex forms, segments may look different and have different functions.



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Invertebrate Characteristics, *continued*

Support of the Body

- Invertebrate bodies have diverse means of support.
- Some have a simple skeleton that supports their soft tissue.
- Some are supported by the pressure of their fluid-filled body cavity.
- Some have an **exoskeleton**—a rigid outer covering that protects their soft tissues.



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Invertebrate Characteristics, *continued*

Respiratory and Circulatory Systems

- Gas exchange occurs either directly across the body covering or through internal **gills**.
- In most animals, the circulatory system moves blood or a similar fluid through the body to transport oxygen and nutrients to cells, and carbon dioxide and wastes away from cells.
- Animals may have one of the following:
 - no circulatory system
 - an **open circulatory system**
 - a **closed circulatory system**



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Invertebrate Characteristics, *continued*

Digestive and Excretory Systems

- Invertebrates may have one of the following:
 - no digestive system (digestion occurs within individual cells)
 - a simple central chamber with one opening
 - a digestive tract, or gut, running through their body
- In some animals, food is broken down and absorbed in the **gut**.
- Wastes, especially ammonia (NH_3), are either:
 - dissolved and excreted directly, or
 - filtered from the body cavity by specialized structures and converted to less toxic substances.



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Invertebrate Characteristics, *continued*

Nervous System

- The extraordinary degree of diversity among invertebrates is reflected in their nervous systems.
- Invertebrate nervous systems range from simple, with no neurons, to complex, with a high degree of cephalization and a complex brain.
- The phylum Mollusca exhibits the progression of cephalization and the evolution of the brain.
 - The most highly cephalized mollusk is the octopus.



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Invertebrate Characteristics, *continued*

Reproduction and Development

- Invertebrates are capable of sexual reproduction, and many can also reproduce asexually.
- Some invertebrates are **hermaphrodites**.
- Two patterns of invertebrate development occur :
 - **Indirect development** has an intermediate stage called a **larva** (plural, larvae).
 - **Direct development** has no larval stage.



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Vertebrate Characteristics

- Vertebrates are chordates that have a backbone.
- Classes of vertebrates include fishes, amphibians, reptiles, birds, and mammals.
- All vertebrate classes except fishes spend part or all of their life on land.
- Many characteristics of terrestrial vertebrates are adaptations to life on land and fall into two broad categories:
 - support of the body, and
 - conservation of water.



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Section 2 Invertebrates and Vertebrates

Vertebrate Characteristics, *continued*

Segmentation and Support of the Body

- Vertebrates segmentation is evident in the ribs and the **vertebrae** of vertebrates.
- As terrestrial vertebrates evolved from aquatic vertebrates, their limbs and associated muscles evolved to give the animals better support and greater mobility.
- Vertebrates have an **endoskeleton** that grows as the animal grows.



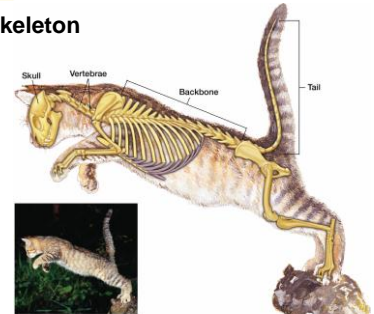
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Section 2 Invertebrates and Vertebrates

Vertebrate Skeleton



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Vertebrate Characteristics, *continued*

Body Coverings

- The outer covering of an animal is called the **integument**.
- The integuments of fishes and most amphibians are adapted only to moist environments.
- The integuments of most terrestrial vertebrates are adapted to the dry conditions of a terrestrial environment.
- Integuments serve other purposes such as respiration, protection, or insulation.



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Section 2 Invertebrates and Vertebrates

Vertebrate Characteristics, *continued*

Respiratory and Circulatory Systems

- Gas exchange occurs in the gills of aquatic vertebrates.
- **Lungs** evolved in terrestrial vertebrates.
- Vertebrates have a closed circulatory system with a multichambered heart.
- In some vertebrates, the multichambered heart has separate chambers and is thus more efficient.



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Open and Closed Circulatory Systems



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Vertebrate Characteristics, *continued*

Digestive and Excretory Systems

- Digestion occurs in the gut.
- In many vertebrates, the gut is very long and folded.
- Most vertebrates must expel wastes while conserving water.
- Most vertebrates convert ammonia to less toxic substances.
- In most vertebrates, **kidneys** filter wastes from the blood while regulating water levels in the body.

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Vertebrate Characteristics, *continued*

Nervous System

- Vertebrates have highly organized brains, and the control of specific functions occurs in specific centers in the brain.
- The structure and function of the nervous system vary among vertebrate classes.
- Fishes have limited neural circuitry devoted to simple decision making.
- Many mammals display complex and flexible behavior.

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Vertebrate Characteristics, *continued*

Reproduction and Development

- In most fish and amphibian species, eggs and sperm are released directly into the water, where fertilization takes place.
- In reptiles, birds, and mammals, the egg and sperm unite within the body of the female.
- The fertilized eggs of many fishes, amphibians, reptiles, and birds develop outside the body. The embryo is nourished by the egg yolk and protected by jellylike layers or a shell.
- Most mammals give birth to live offspring. Embryos develop in the female's body, nourished by the mother's blood supply until the young are born.
- Most vertebrates undergo direct development.

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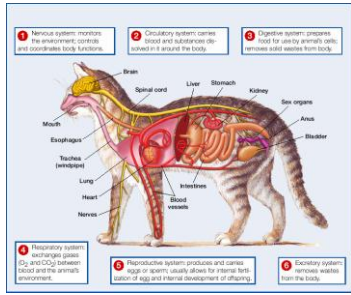
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Section 2 Invertebrates and Vertebrates

Major Vertebrate Organ Systems



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Section 3 Fertilization and Development

Objectives

- **List** the steps of fertilization and development through gastrulation.
- **List** two body parts formed from each germ layer.
- **Identify** the three different body cavity structures of animals.
- **Name** the categories of animals that undergo spiral cleavage and radial cleavage.
- **Contrast** the two processes of coelom formation.

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Section 3 Fertilization and Development

Fertilization and Early Development

- In animals, **fertilization** is the union of haploid female and male gametes to form a single diploid zygote.

Gametes

- In most animals, the sperm cell is specialized for movement.
- The egg is typically large, with a store of cytoplasm and yolk.

Fertilization

- The sperm's cell membrane fuses with the egg's cell membrane.
- The nucleus of the sperm enters the cytoplasm of the egg.
- The nuclei merge to form the diploid nucleus of the zygote.
- Replication of DNA begins, and cell division follows.

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Section 3 Fertilization and Development

Fertilization and Early Development, *continued*

Cleavage and Blastula Formation

- **Cleavage** is the series of mitotic cell divisions that follows fertilization.
- As cleavage progresses, the divisions rapidly increase the number of cells and yield smaller individual cells.
- In most species, cleavage produces a raspberry-shaped mass of 16 to 64 cells.
- Then, the mass becomes a hollow ball of cells called a **blastula**.
 - The hollow cavity is the **blastocoel**.

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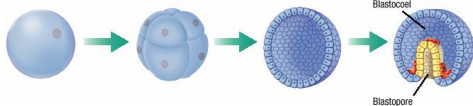
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Section 3 Fertilization and Development

Cleavage and Blastula Formation



- Zygote** The fertilized egg is diploid and will divide by mitosis.
- Eight-Cell Stage** Eight cells arise from three divisions of the zygote.
- Blastula** Continued cell division produces a hollow ball of cells. This figure is a cross section of a blastula.
- Gastrula** One side of the blastula collapses inward and forms a pouch.

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Section 3 Fertilization and Development

Fertilization and Early Development, *continued*

Gastrulation and Organogenesis

- In **gastrulation**, the blastula folds inward upon itself and transforms into a multilayered embryo called the **gastrula**.
- As the folding continues, the embryo enlarges, and the **archenteron**, or primitive gut, develops.
 - The open end of the archenteron is the **blastopore**.
- The outer germ layer is the **ectoderm**.
- The inner germ layer is the **endoderm**.
- In most phyla, a third layer, **the mesoderm**, forms between the endoderm and the ectoderm.
- Each of the germ layers develops into certain organs in a process called **organogenesis**.

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Section 3 Fertilization and Development

Patterns of Development

- The distinct patterns of development in different animal phyla are clues to their phylogenetic history.

Types of Body Cavities

- Acoelomates** do not have a body cavity.
- A cavity that is not completely lined by mesoderm is called a **pseudocoelom**.
- In **coelomates**, mesoderm lines the body cavity, supports the endodermic gut, and forms the attachment for the organs in the coelom.

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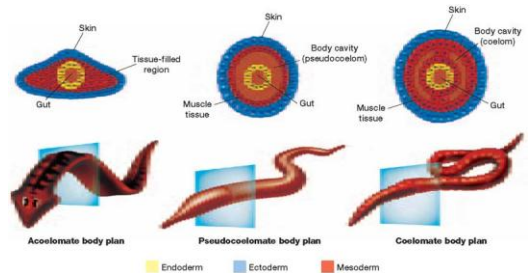
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Section 3 Fertilization and Development

Three Body Plans of Symmetrical Animals



Endoderm Ectoderm Mesoderm

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Patterns of Development, *continued*

Cleavage and Blastopore Fate

- There are two distinct patterns of development in coelomates:
 - In **protostomes**, the blastopore develops into a mouth, and a second opening forms at the other end of the archenteron, forming an anus.
 - Many protostomes undergo spiral cleavage.
 - Protostomes have determinate cleavage.
 - In **deuterostomes**, the blastopore develops into an anus, and a second opening at the other end of the archenteron becomes the mouth.
 - Most deuterostomes undergo radial cleavage.
 - Deuterostomes have indeterminate cleavage.

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Patterns of Development, *continued*

Coelom Formation

- Two patterns of coelom formation occur:
 - Protostomes exhibit **schizocoely**, or “split body cavity.”
 - Deuterostomes exhibit **enterocoely**, or “gut body cavity.”
- In both patterns, mesodermal cells spread out to completely line the coelom, and the blastocoel disappears.
- Thus, in both protostomes and deuterostomes, mesoderm lines the interior of the outer body wall and surrounds the gut.

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