Introduction to the Animal Kingdom

Distinguishing Characteristics of Animals:

(1) Animals are multicellular, heterotrophic eukaryotes.
- They must take in preformed organic molecules through **ingestion**, eating other organisms or organic material that is decomposing.

(2) Animal cells lack cell walls that provide structural supports for plants and fungi.
- The multicellular bodies of animals are held together with the extracellular proteins, especially ***collagen***.

(3) Animals have two unique types of tissues: nervous tissue for impulse conduction and muscle tissue for movement.

(4) Most animals reproduce sexually, with the diploid stage usually dominating the life cycle.
- In most species, a small flagellated sperm fertilizes a larger, nonmotile egg.
- The zygote undergoes **cleavage**, a succession mitotic cell divisions, leading to the formation of a multicellular, hollow ball of cells called the **blastula**.
- During **gastrulation**, part of the embryo folds inward, forming the blind pouch characteristic of the **gastrula**.
  - This produces two tissue layers: the endoderm as the inner layer and the ectoderm as the outer layer.
- Some animals develop directly through transient stages into adults, but others have distinct larval stages.
  - The **larva** is a sexually immature stage that is morphologically distinct from the adult, usually eats different foods, and may live in a different habitat from the adult.
- Animal larvae eventually undergo **metamorphosis**, transforming the animal into an adult.

Animal Evolution

- Most systematists now agree that the animal kingdom is monophyletic.
  - If we could trace all the animals lineages back to their origin, they would converge on a common ancestor.
- That ancestor was most likely a colonial flagellated protist that lived over 700 million years ago in the Precambrian era.
- The traditional view of relationships among animal phyla are based mainly on key characteristics of body plans and embryonic development.
- Each major branch represents a **grade**, which is defined by certain body-plan features shared by the animals belonging to that branch.
- The major grades are distinguished by structural changes at four deep branches.

(1) The first branch point splits the **Parazoa** which lack true tissues from the **Eumetazoa** which have true tissues.
- The parazoans, phylum Porifera or sponges, represent an early branch of the animal kingdom.

(2) The eumetazoans are divided into two major branches, partly based on body symmetry.
- Members of the phylum Cnidaria (hydras, jellies, sea anemones and their relatives) and phylum Ctenophora (comb jellies) have **radial symmetry** and are known collectively as the **Radiata**.
- The other major branch, the **Bilateria**, has bilateral symmetry with a **dorsal** and **ventral** side, an **anterior** and **posterior** end, and a left and right side.

- Linked with bilateral symmetry is **cephalization**, an evolutionary trend toward the concentration of sensory equipment on the anterior end.
  - Cephalization also includes the development of a central nervous system concentrated in the head and extending toward the tail as a longitudinal nerve cord.
- The symmetry of an animal generally fits its lifestyle.
  - Many radial animals are sessile or planktonic and need to meet the environment equally well from all sides.
  - Animals that move actively are bilateral, such that the head end is usually first to encounter food, danger, and other stimuli.
- The basic organization of **germ layers**, concentric layers of embryonic tissue that form various tissues and organs, differs between radiata and bilateria.
- The radiata are said to be **diploblastic** because they have two germ layers.
  - The **ectoderm**, covering the surface of the embryo, give rise to the outer covering and, in some phyla, the central nervous system.
  - The **endoderm**, the innermost layer, lines the developing digestive tube, or **archenteron**, and gives rise to the lining of the digestive tract and the organs derived from it, such as the liver and lungs of vertebrates.
- The bilateria are **triploblastic**.
  - The third germ layer, the **mesoderm** lies between the endoderm and ectoderm.
  - The mesoderm develops into the muscles and most other organs between the digestive tube and the outer covering of the animal.

(3) The Bilateria can be divided by the presence or absence of a **body cavity** (a fluid-filled space separating the digestive tract from the outer body wall) and by the structure the body cavity.

- **Acoelomates** (the phylum Platyhelminthes) have a solid body and lack a body cavity.
- In some organisms, there is a body cavity, but it is not completely lined by mesoderm.
  - This is termed a **pseudocoelom**.
  - These **pseudocoelomates** include the rotifers (phylum Rotifera) and the roundworms (phylum Nematoda).
- **Coelomates** are organisms with a true **coelom**, a fluid-filled body cavity completely lined by mesoderm.
  - The inner and outer layers of tissue that surround the cavity connect dorsally and ventrally to form mesenteries, which suspend the internal organs.
- A body cavity has many functions.
  - Its fluid cushions the internal organs, helping to prevent internal injury.
  - The noncompressible fluid of the body cavity can function as a hydrostatic skeleton against which muscles can work.
  - The present of the cavity enables the internal organs to grow and move independently of the outer body wall.

(4) The coelomate phyla are divided into two grades based on differences in their development.

- The mollusks, annelids, arthropods, and several other phyla belong to the **protostomes**, while echinoderms, chordates, and some other phyla belong to the **deuterostomes**.
- These differences center on cleavage pattern, coelom formation, and blastopore fate.

- Many protostomes undergo **spiral cleavage**, in which planes of cell division are diagonal to the vertical axis of the embryo.
    - Some protostomes also show **determinate cleavage** where the fate of each embryonic cell is determined early in development.
- The zygotes of many deuterostomes undergo **radial cleavage** in which the cleavage planes are parallel or perpendicular to the vertical egg axis.
    - Most deuterostomes show **indeterminate cleavage** whereby each cell in the early embryo retains the capacity to develop into a complete embryo.
- Coelom formation begins in the gastrula stage.
    - As the archenteron forms in a protostome, solid masses of mesoderm split to form the coelomic cavities, called **schizocoelous** development.
    - In deuterostomes, mesoderm buds off from the wall of the archenteron and hollows to become the coelomic cavities, called **enterocoelous** development.
- The third difference centers on the fate of the **blastopore**, the opening of the archenteron.
    - In many protosomes, the blastopore develops into the mouth and a second opening at the opposite end of the gastrula develops into the anus.
    - In deuterostomes, the blastopore usually develops into the anus and the mouth is derived from the secondary opening.