Phylum Brachiopoda

**Name:** Name means "arm" (brachio) + "foot" (pod).

**Chief characteristics:**

– Bivalved (two shells), each with bilateral symmetry. The plane of symmetry passes through the center of each shell or valve.

– The two valves differ in size and shape in most. Sometimes the larger valve will have an opening near the hinge line through which the pedicle extended in life.
Phylum Brachiopoda

Soft parts include a lophophore consisting of coiled tentacles with cilia. The lophophore circulates water between the two valves, distributing oxygen and flushing out carbon dioxide. Water movements caused by the lophophore also transport food particles toward the mouth.
**Mode of life:**

- Shallow marine environments.
- Generally attached to the sea floor.
- Inarticulate brachiopods are known to live in burrows in the sediment.
- Brachiopods are filter feeders.
Phylum Brachiopoda

• **Geologic range:**
  – Early Cambrian to Holocene.
  – Very abundant during Paleozoic.
  – A few species (belonging to only three families) remain today.
Inarticulate Brachiopods

- Primitive brachiopods with **phosphatic or chitinous valves**.
- No hinge. Spoon-shaped valves held together with muscles and soft parts.
- *Lingula* is a well known genus
- Geologic range:
  - Early Cambrian to Holocene
Articulate Brachiopods

- Calcareous valves attached together with a hinge consisting of teeth and sockets.

- Geologic range: Early Cambrian to Holocene

- Spiny brachiopods (called productids) are characteristic of Carboniferous and Permian.
Phylum Mollusca

- Clams, oysters, snails, slugs, *Nautilus*, squid, octopus, cuttlefish
- *Name*: Mollusca means "soft bodied."
Phylum Mollusca

• **Chief characteristics:**
  – Soft body enclosed within a calcium carbonate shell.
  – A few, like slugs and the octopus, have no shell.
  – Muscular part of body of clams and snails and some other groups of molluscs is called the foot.
Phylum Mollusca

• **Geologic range:** Cambrian to Holocene

• **Mode of life:** Marine, freshwater, or terrestrial.

• They may: swim, float or drift, burrow into mud or sand, bore into wood or rock, attach themselves to rocks, or crawl.
Types of Molluscs

1. Monoplacophorans (*Neopilina*)
2. Polyplacophorans or amphineurans (chitons)
3. Bivalves or pelecypods (clams, scallops)
4. Gastropods (snails and slugs)
5. Cephalopods (squid, octopus, *Nautilus*)
6. Scaphopods (tusk shells)
Class Bivalvia or Pelecypoda

- Clams, oysters, scallops, mussels, rudists
- **Chief characteristics:**
  - Skeleton consists of two calcareous valves connected by a hinge.
  - Bilateral symmetry; plane of symmetry passes between the two valves.
Class Bivalvia or Pelecypoda

- **Name:** Bivalvia means "two" (bi) + "shells" (valvia).
- **Geologic range:** Early Cambrian to Holocene
- **Mode of life:** Marine and freshwater. Many species are infaunal burrowers or borers, and others are epifaunal.
Class Gastropoda

• Snails and slugs
• **Chief characteristics:**
  – Asymmetrical, spiral-coiled calcareous shell.
• **Name:** means "stomach" (gastro) + "foot" (pod).
• **Geologic range:** Early Cambrian to Holocene.
• **Mode of life:** Marine, freshwater or terrestrial.
Class Cephalopoda

- Squid, octopus, *Nautilus*, cuttlefish
- *Name*: means "head" (kephale) + "foot" (pod).
- *Chief characteristics*:
  - Symmetrical cone-shaped shell with internal partitions called *septae*
  - Shell may be straight or coiled in a spiral which lies in a plane.
  - Smooth or contorted *sutures* visible on the outside of some fossils mark the place where septae join the outer shell.
Class Cephalopoda

- **Geologic range**: Late Cambrian to Holocene
- **Mode of life**: Marine only; carnivorous (meat-eating) swimmers.
- **Types of Paleozoic cephalopods**:
  - Nautiloids
  - Ammonoids
  - Coleoids
Nautiloid Cephalopods

- The shells of nautiloid cephalopods have smoothly curved septa, which produce simple, straight or curved sutures.
- *Geologic range*: Cambrian to Holocene
Ammonoid Cephalopods

- Ammonoid cephalopods have complex, wrinkled, crenulated septa, which produce angular or dendritic sutures.
- **Geologic range**: Devonian to Cretaceous - all extinct.
Ammonoid Cephalopods

- There are three basic types of sutures in ammonoid shells:
  - **Goniatite** or **goniatitic** (septae have relatively simple, zig-zag undulations)
  - **Ceratite** or **ceratitic** (septae have smooth "hills" alternating with saw-toothed "valleys")
  - **Ammonite** or **ammonitic** (septae are complexly branching and tree-like or dendritic)
Types of Sutures in Cephalopods

- **Ammonitic**
  - Jurassic and Cretaceous
- **Ceratitic**
  - Late Permian to Triassic
- **Goniatitic**
  - Devonian to Permian
- **Nautiloid**
  - Cambrian to Recent
Subclass Coleoidea

- Belemnoids (belemnites)
  - *Geologic range*: Mississippian to Eocene - all extinct.
- Sepioids (cuttlefish)
  - *Geologic range*: Jurassic to Holocene
- Teuthoids (squid)
  - *Geologic range*: Jurassic to Holocene
- Octopods (octopus)
  - *Geologic range*: Cretaceous to Holocene
Order Belemnoidea - Belemnoids

- The belemnoids have an internal calcareous shell (which resembles a cigar in size, shape, and color) called a **rostrum**.
- The front part of this shell is chambered, as in the nautiloids and ammonoids.
- The rostrum is made of fibrous calcite, arranged in concentric layers.
Class Scaphopoda

- **Tusk shells or tooth shells**
- **Chief characteristics**: Curved tubular shells open at both ends.
- **Geologic range**: Ordovician to Holocene.
- **Mode of life**: Marine.
Phylum Arthropoda

- Insects, spiders, shrimp, crabs, lobsters, barnacles, ostracodes, trilobites, eurypterids
- *Name*: means "jointed" (arthro) + "foot" (pod).
- *Chief characteristics*:
  - Segmented body with a hard exterior skeleton composed of chitin (organic material).
  - Paired, jointed legs.
  - Highly developed nervous system and sensory organs.
Phylum Arthropoda

- **Geologic range**: Cambrian to Holocene
- **Mode of life**: Arthropods inhabit a wide range of environments. Most fossil forms are found in marine or freshwater sediments.
Paleozoic Arthropods and Their Geologic Ranges

- Trilobites - Cambrian to Permian
- Horseshoe crabs - Silurian to Holocene
- Eurypterids - Ordovician to Permian
- Arachnids - Late Silurian to Holocene
- Ostracodes - Cambrian to Holocene
- Onychophorans - Cambrian to Holocene
- Insects - Devonian to Holocene
Subphylum Trilobita - Trilobites

- **Chief characteristics:**
  - Body has three-lobes
  - Skeleton composed of *chitin*, with calcium carbonate
  - Body is divided into three segments:
    - Rigid head segment - *cephalon*
    - Jointed, flexible middle section - *thorax*
    - Rigid tail piece - *pygidium*
Subphylum Trilobita - Trilobites

- **Name**: Trilobite means "three" (tri) + "lobed" (lobus).
- **Geologic range**: Cambrian to Permian
- **Mode of life**: Exclusively marine. Most were bottom dwellers living in shallow shelf
Class Eurypterida - Eurypterids

- Extinct scorpion-like or lobster-like arthropods.
- Predators.
- Up to 10 ft long.
- *Geologic range*: Ordovician to Permian. Most are Silurian or Devonian.
Class Arachnida - Arachnids

- Scorpions, spiders, ticks, and mites
- Scorpions are the oldest arachnids with a fossil record.
- Scorpions had evolved by Late Silurian. The earliest ones appear to have lived in the water, because their fossils have gills.
- Scorpions, spiders, and mites are found in Devonian rocks.
- Geologic range: Late Silurian to Holocene.
Class Ostracoda - Ostracodes

- The ostracodes are mainly microscopic in size.
- Tiny bivalved shell encasing a shrimp-like creature.
- Geologic range: Cambrian to Holocene.
- Mode of life: Both marine and freshwater.
The insects are among the most diverse living group on Earth, but they are rarely found as fossils.

Body is divided into three parts, head, thorax, and abdomen.

Thorax has six legs.

The earliest insects were wingless.

Winged insects appeared by Pennsylvanian.

Geologic range: Middle Devonian to Holocene.
Phylum Echinodermata

• Starfish, sea urchins, sand dollars, crinoids, blastoids, and others
• Name: Echinodermata means "spiny" (echinos) + "skin" (derma).
Phylum Echinodermata

- **Chief characteristics**: Calcite skeleton with five-part symmetry, superimposed on primitive bilateral symmetry.
- Echinoderms have a water vascular system with water in a system of tubes within the body.
- **Tube feet** are soft, movable parts of the water vascular system which project from the body and are used in locomotion, feeding, respiration, and sensory perception.
Phylum Echinodermata

• Geologic range: Cambrian to Holocene.
• Mode of life: Exclusively marine. Some are attached to the sea floor by a stem with "roots" called holdfasts; others are free-moving bottom dwellers.
• Similarity of embryos between echinoderms and chordates suggests that they may be derived from a common ancestral form.
Class Crinoidea - Crinoids

- Crinoids are animals which resemble flowers.
- They consist of a calyx with arms, atop a stem of calcite disks called columnals.
- The crinoid is attached to the sea floor by root-like holdfasts.
- Some living crinoids are swimmers, and not attached.
- Over 1000 genera are known.
Crinoids

- **Geologic range:** Middle Cambrian to Holocene.
- Especially abundant during Mississippian.
Class Blastoidea - Blastoids

- Blastoids are extinct animals with an armless bud-like calyx on a stem.
- About 95 genera are known.
- A common genus is *Pentremites*.
- Geologic range: Ordovician to Permian - all extinct.
Class Asteroidea - Starfish

- Starfish are star-shaped echinoderms with five arms.
- About 430 genera are known.
- Geologic range: Ordovician to Holocene.
Class Ophiuroidea – Brittle Stars

- Brittle stars have 5 arms, like starfish, but the arms are thin and serpent-like.
- About 325 genera are known.
- Geologic range: Ordovician to Holocene.
Class Echininoddea

- Sand dollars and sea urchins
- Echinoids are disk-shaped, biscuit-shaped, or globular.
- Viewed from above, they may be circular or somewhat irregular in shape, but with a five-part symmetry.
- About 765 genera are known.
- Geologic range: Ordovician to Holocene.
Phylum Hemichordata
Class Graptolithina - Graptolites

- **Name**: Graptolite means "write" (grapto) + "stone" (lithos), because they resemble pencil marks on rock.
Graptolites

**Chief characteristics:**

- Organic (chitinous) skeletons consisting of rows or lines of small tubes or cups, called **thecae**.
- Tubes or cups branch off a main cord or tube called a stem or **stipe**.
- Stipes may consist of one, two, or many branches.
- Entire colony called a **rhabdosome**.
- A filament at the lower end of the rhabdosome is called a **nema**.
Graptolites

- Most graptolites are found flattened and carbonized in black shales and mudstones.
- *Geologic range:* Cambrian to Mississippian. (Most abundant during Ordovician and Silurian.)
- Some living organisms which may be surviving descendants (living fossils) have been recovered in 1989 in the South Pacific and later in Bermuda.
- *Mode of Life:* Planktonic (colonies attached to floats).