

RHIZOPODS

Phylum: Protozoa

Subphylum: Sarcomastigophora

Superclass 1: Sarcodina = Rhizopodea

1. General Characteristics

Rhizopods move using **pseudopodia**.

Pseudopodia are temporary cytoplasmic extensions used for **locomotion and prey capture**.

- Some pseudopodia retract while others are formed.
- There are **4 types**:
 - Lobopodia
 - Filopodia
 - Reticulopodia
 - Axopodia

Lobopodia

- Rounded, finger-like extensions.
- Broad and short.
- Contain an **endoplasm** and an **ectoplasm** (peripheral).
- Found in:
 - **Polypodial amoebae**, which have several pseudopodia.
 - **Monopodial amoebae**, which have one pseudopodium.

Filopodia

- Found in **thecamoebians**, such as *Diffugia*.
- Thin or branched pseudopodia that always point toward one end of the cell.
- They are unable to **anastomose** (fuse with one another).

Reticulopodia

- Found in **foraminifers**.
- Thin and highly branched.
- They join together to form a **network**.
- Reticulopodia from several cells may also join together to form a **multicellular reticulum**, which acts as a net for trapping prey.
- Example: *Elphidium*.

Axopodia

- Cytoplasmic extensions arranged radially.

- Each axopodium is supported by an axial filament called an **axoneme**.
 - Found in **actinopods**.
-

Excretion and Osmoregulation

In amoebae, **contractile vacuoles** are formed by the progressive fusion of small vacuoles.

They then come into contact with the plasma membrane and release their contents outside the cell.

Nutrition

Rhizopods may be:

- **detritivores**, or
- **bacterivores**.

They live in environments rich in organic matter, such as:

- soil,
- aquatic environments,
- particularly freshwater.

Some are parasites of mammals and cause serious human diseases, such as **amoebiasis**.

Reproduction

Binary fission

The nucleus divides without division of the cytoplasm, producing a transient or resistant form.

Example: *Amoeba binucleata*.

Multiple fission

Occurs in **foraminifers**.

Sexual reproduction by autogamy

Autogamy is a type of **automictic reproduction** involving only one parent.

Although one individual gives rise to another individual, it is not considered multiplication.

It represents a form of **genetic rejuvenation** of the individual.

It occurs in some **foraminifers and heliozoans (actinopods)**.

Haplodiplobiontic Development Cycle

This cycle involves an alternation between **haploid and diploid phases**, which are equivalent in duration.

- Meiosis takes place at the end of the life of the diploid organism.
- The alternation of phases represents an **alternation of generations**.
- Example: *Elphidium crispum* (foraminifer).

The diploid generation consists of a **microspheric individual**, whereas the haploid generation consists of a **macrospheric individual**.

2. Classification

There are **2 classes**:

1. **Lobosea**
 2. **Granuloreticulosea**
-

Class 1: Lobosa

This class is divided into two subclasses based on the **presence or absence of a shell or theca** surrounding the individuals.

Two subclasses:

1. **Gymnamoeba**
2. **Thecamoeba**

1. Subclass: Gymnamoeba

Also called **naked amoebae**.

They are amoebae possessing **lobopodia**.

- **Order:** Amoebida
- **Family:** Amoebidae
- **Genus:** *Amoeba*

Examples

1. Non-pathogenic amoeba: ***Amoeba proteus***
 2. Commensal amoeba: ***Entamoeba coli***
 3. Pathogenic amoeba: ***Entamoeba histolytica***
-

Entamoeba histolytica

- Lives as a parasite in the cells of the **intestinal wall in humans**.
 - The name *histolytica* comes from the same roots as **histolysis**, meaning tissue destruction.
 - It phagocytoses **intestinal and blood cells**.
 - It causes **ulcerative complications**.
-

Amoeba proteus

Also called the **proteus amoeba**.

- A large freshwater amoeba, reaching up to **500 µm in length**.
 - Lives on the surface of mud in stagnant water and also in moist soils.
 - Feeds by **phagocytosis**; it is therefore a **heterotrophic phagotroph**.
 - It is a **polymorphic amoeba**.
 - It is spherical when contracted.
 - It elongates into a slug-like form when moving over a solid substrate.
 - It produces broad anterior pseudopodia.
 - Its posterior portion has only a cluster of small sticky and viscous projections forming the **collopodium**, which adheres to the substrate and aggregates and transports particles and prey.
 - At rest, it produces numerous short, unbranched pseudopodia in all directions.
 - Its cytoplasm contains large:
 - **digestive vacuoles**
 - **contractile vacuoles**
 - Digestive vacuoles are responsible for **phagocytosis**.
 - Contractile vacuoles regulate the organism's **osmotic pressure**.
 - Multiplication occurs through **mitosis**.
-

Subclass: Thecamoeba

These are amoebae with **lobed pseudopodia** surrounded by a **chitinous or siliceous shell**.

They live in **acidic freshwater environments**.

Examples

- *Diffugia pyriformis*
 - *Euglypha*
-

Diffugia pyriformis

In *Diffugia pyriformis*, the **pulling pseudopodium** extends through a centrifugal cytoplasmic flow.

- Once a pseudopodium adheres to the substrate, it serves as a point of support for the amoeba to move forward.

- It is then replaced by a new pseudopodium.
 - The old pseudopodium regresses.
 - The developing pseudopodium advances through a clearly visible cytoplasmic flow, revealed by the movement of organelles.
 - The pulling pseudopodium may sometimes “**bud**” a **secondary pseudopodium**, here at a right angle, indicating a change in the direction of migration.
-

Class 2: Granuloreticulosea

The order **Foraminifera (Foraminiferida)** is the most important group in this class, particularly from a **paleontological** point of view.

- They possess a complex **calcareous shell** perforated by openings through which slender pseudopodia emerge.
 - The shell is divided into several compartments and can reach **2–3 cm in diameter**.
 - They feed by phagocytosing:
 - diatoms (unicellular algae),
 - bacteria.
-

Foraminifera

The name **Foraminifera** comes from the Latin *foramen*, meaning “**opening**” or “**hole**.”

They are characterized by their shells, called **tests**, which are most often calcareous and generally **multilocular**, meaning they consist of several chambers.

These chambers remain connected to one another through their successive openings.

- Foraminifers develop by building **new chambers** onto their tests.
- These chambers are arranged according to a geometry specific to each species.
- The test is initially composed of organic material that gradually becomes mineralized.
- In some species, it may also contain aggregated **exogenous particles**, particularly in species living in sediments or at depth.
- The surface of the test may be:
 - smooth,
 - striated,
 - ribbed,
 - reticulated,
 - covered with tubercles,
 - or covered with spines.

Pseudopodia emerge through these openings and allow the organism to interact with its environment through:

- prey capture,
- feeding,
- locomotion.

Importance and Distribution of Foraminifera

Foraminifera have been extremely abundant for approximately **540 million years**.

- They appeared in the **Early Cambrian**.
- They developed from the **Triassic** onward.
- They have great ecological and scientific importance.
- They constitute one of the most abundant and diverse groups of fossils.

They mainly colonize **seafloors** and are therefore called **benthic foraminifera**.

A smaller fraction consists of **Globigerina**, which are less diverse and are generally **planktonic foraminifera** living at relatively shallow depths in the **euphotic zone**.

Their size generally ranges from **38 µm to 1 mm**, although some can reach several centimeters.

The maximum recorded size is **18 cm**.

Approximately **50,000 species** are currently recorded, including:

- **6,700–10,000 living species**
- approximately **40,000 fossil species**

Feeding

Their diet consists of:

- bacteria,
- algae,
- larvae of mollusks, echinoderms and crustaceans,
- various types of waste.

They adapt their diet to their environment.

Reproduction and Growth

Foraminifera have a complex reproductive cycle called the **haplo-diplophasic cycle**.

It involves alternation between:

- a **haploid mononucleate phase (gamogony)**,
- a **diploid multinucleate phase (schizogony)**.

The sexual phase (**gamogony**) is absent in some species.

Each foraminifer begins its life in a **single chamber**, forming a unilocular test.

The test becomes increasingly complex or develops additional chambers as the organism grows.

Each new chamber added is larger than the preceding one.

Consequently, some species can reach several centimeters in size after a certain age while remaining **unicellular organisms**.

Examples

- *Ammonia tepida* — living foraminifer, belonging to the group **Rotaliida**.
 - *Globigerina bulloides* — a planktonic foraminifer.
-

Superclass 2: Sarcodina = Actinopoda

There are **3 classes**:

1. **Acantharea = Acantharians**
 2. **Phacodarea = Radiolarians**
 3. **Heliozoa = Heliozoans**
-

Class 1: Radiolaria

They are also called **Phacodarea** or **radiozoans**.

- Diameter: **0.1–0.2 mm**
- They produce complex **mineral skeletons**.
- They generally possess a central capsule dividing the cell into two parts:
 - **endoplasm**
 - **ectoplasm**
- The mineral skeleton is generally composed of **silica**.
- They occur as **zooplankton** in all the world's oceans.
- As zooplankton, radiolarians are mainly **heterotrophic**, but many possess photosynthetic **endosymbionts** and are therefore considered **mixotrophic**.
- The skeletal remains of some radiolarians constitute a large part of the ocean floor in the form of **siliceous ooze**.

Because of their rapid evolution as species and their complex skeletons, radiolarians are important **diagnostic fossils** dating back to the **Cambrian**.

They generally live as isolated individuals, although some colonial forms exist in which each individual retains its own functional identity.

They are characterized by a **central capsule** that physically separates the ectoplasm from the endoplasm.

They generally live in the **deep ocean**, below the depth at which calcium carbonate is redissolved.

They have existed throughout geological time, from the **Cambrian to the present**.

Some common radiolarians

- *Challengeron wyvillei*
- *Hexacontium asteracanthion*
- *Thalassicola pellucida*

Marine sediment microfossils

They may contain:

- radiolarians (spheres),
- sponge spicules (small “spines”),
- planktonic foraminifers (small white shells),
- benthic foraminifers (large white shell in the center and small yellow shells made of aggregated sand grains).

Average diameter of the spheres: approximately **0.5 mm**.

Class 2: Acantharia

- Actinopods that produce fine, **radially arranged pseudopodia**.
- Their test is essentially composed of **celestine** (organic matter and strontium sulfate).
- Their cytoplasm consists of:
 - a central, granular and multinucleate **endoplasm**,
 - a peripheral **ectoplasm** producing pseudopodia that bear symbiotic algae called **zooxanthellae**.

Their skeleton is always present and is formed by **10 perfectly symmetrical diametrical spicules**.

There are **20 spicules fused at the center of the cell**, from which they originate.

At the points where the spicules emerge, they are all of equal length.

Bundles of contractile **myonemes** are inserted there, forming a highly developed **hydrostatic apparatus** that allows the organism to float or dive.

Cellular diagram of Acantharia

1. Axopodium
2. Radial radicle
3. Filopodia
4. Ectoplasmic cortex
5. Myoneme
6. Mitochondrion
7. Endoplasm
8. Ribosome
9. Zooxanthella
10. Vacuoles

11. Microtubules
 12. Ectoplasm
 13. Central capsule membrane
 14. Golgi apparatus
 15. Digestive vacuoles
 16. Nuclei
-

Class 3: Heliozoa

They constitute a group of **actinopods** that is now known to be **polyphyletic**.

These species possess:

- a **silicate skeleton** (SiO_2), or
- a **chitinoid skeleton**, which is similar to chitin and carbohydrate in nature.

A phylogenetic study proposed a **monophyletic phylum of heliozoans**, centered around the **Centrohelida**.

The heliozoans owe their name to the German biologist **Ernst Haeckel (1834–1919)**, who classified them in 1866 separately from acantharians and radiolarians.

They share with these groups cytoplasmic extensions called **axopodia** and a **mineral skeleton**.

Characteristics

Their feeding takes place with the help of **exopodia**, cytoplasmic extensions that release digestive enzymes before the prey is phagocytosed.

They owe their name to their characteristic structure, which resembles the shape of the **sun**.

Indeed, from a single spherical cell forming the body of the organism, radial cytoplasmic projections emerge: the **axopodia**.

Some forms possess shells composed of grains of sand or similar small particles, while others have a **siliceous skeleton**.

Body structure

The body consists of:

- **Ectoplasm:** has a vacuolated texture.
- **Endoplasm:** very dense and contains numerous inclusions, including one or more nuclei.

They live:

- in marine environments,
- in freshwater.

They are part of the **plankton**.

They often live in **sympiosis with unicellular algae** present in their cytoplasm, such as:

- chlorellae,
- Xanthophyceae.

Some forms are **attached to a substrate**.

Phylogenetic Classification and Taxonomy

Phylogenetic classification

The group is now considered **polyphyletic**.

Some heliozoans are closely related to **radiolarians**.

Taxonomy

Classes

- **Centrohelea** Kuhn, 1926
- **Nucleohelea** Kuhn, 1926

Unclassified genera

- *Rhumbleria*
- *Asterocoelum*
- *Myriophrys*
- *Belonocystis*
- *Monobia*
- *Chondropus*
- *Actinophrys*

Example: *Actinophrys* sp.