THE BIOSPHERE, LITHOSPHERE, HYDROSPHERE and ATMOSPHERE

BSc. Part I Zoology (Hons) Paper II

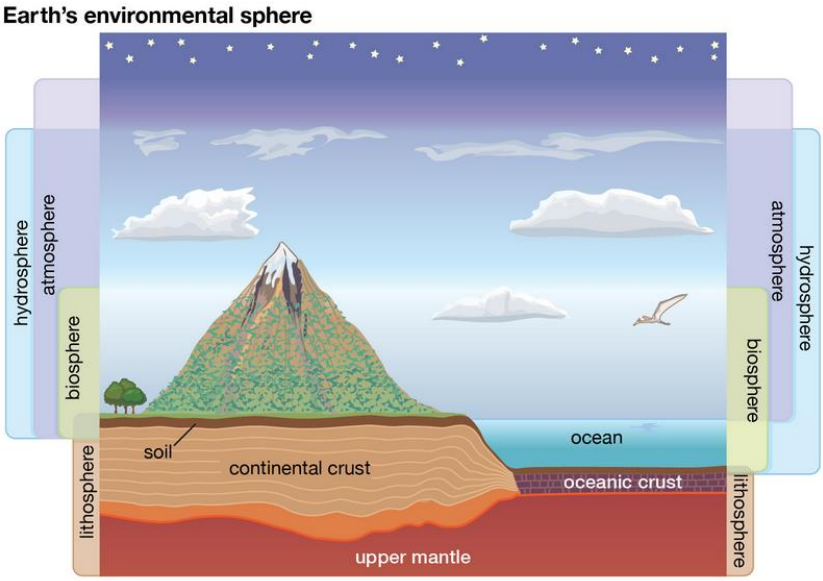
INTRODUCTION

The biosphere is the layer of the planet Earth where life exists. This layer ranges from heights of up to ten kilometers above sea level, used by some birds in flight, to depths of the ocean such as the Puerto Rico trench, at more than 8 kilometers deep. These are the extremes; however, in general the layer of the Earth containing life is thin: the upper atmosphere has little oxygen and very low temperatures, while ocean depths greater than 1000 m are dark and cold.

The development of the term is attributed to the English geologist Eduard Suess (1831-1914) and the Russian physicist Vladimir I. Vernadsky (1863-1945). The biosphere is one of the four layers that surround the Earth along with the lithosphere (rock), hydrosphere (water) and atmosphere (air) and it is the sum of all the ecosystems.

The biosphere is unique. So far, there has been no existence of life elsewhere in the universe. Life on Earth depends on the sun. Plants, some bacteria and protists, in the marvelous phenomenon of photosynthesis, capture energy, provided as sun light. The captured energy transforms carbon dioxide into organic compounds such as sugars and produces oxygen. The vast majority of species of animals, fungi, parasitic plants and many bacteria depend directly or indirectly on photosynthesis.

The area near the surface of the earth can be divided up into four inter-connected geo-spheres that make up the carbon cycle. The understanding of “sphere” in this situation means 'to surround or encompass'



The following help us understand the mean of the four spheres:

- **Litho**sphere - litho referring to rocks and minerals
- **Hydro**sphere - hydro referring to water
- **Bio**sphere - bio referring to life
- **Atmo**sphere - atmo referring to steam and vapor

LITHOSPHERE

It is believed the lithosphere evolved about 4.6 billion years ago. The lithosphere refers to the solid, rocky crust that covers the entire planet. This solid, rocky crust is composed of a number of different rocks that have been grouped into three categories based on how they are formed.

These three groups include:

- Metamorphic rocks – Metamorphic rocks are formed by heat and / or pressure from pre-existing rocks.
- Igneous rocks –the cooling of hot molten rock also known as magma forms igneous rocks. When the hot magma cools it begins to harden, meaning once it has fully cooled it creates what is known to be an igneous rock.
- Sedimentary rocks – sedimentary rocks are formed from pre-existing rocks. When rocks erode and mix with other dirt, clay and particles then settle together the mix together to form a sedimentary rock.

The lithosphere includes a various number of different landforms such as mountains, valleys, rocks, minerals and soil. The lithosphere is constantly changing due to forces and pressures such as the sun, wind, ice, water and chemical changes.

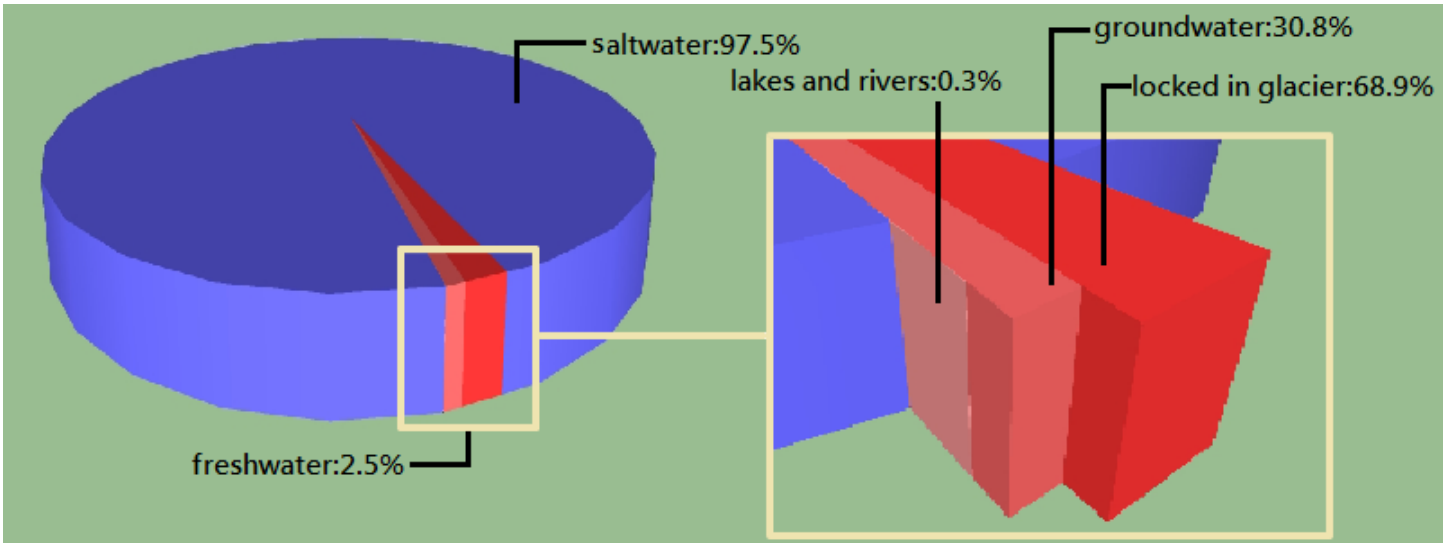
The earth's surface is composed into two types of lithospheres. These are known as the oceanic and continental lithospheres.

1. The oceanic lithosphere includes the uppermost layers of mantle, which is topped with a thin yet heavy oceanic crust. This is where the hydrosphere and lithosphere meet.
2. The continental lithosphere include the uppermost layers of mantle, which is topped with a thick yet light continental crust. This is where the atmosphere, biosphere and hydrosphere meet the lithosphere.

HYDROSPHERE

The hydrosphere refers to the most important resource that is water. The hydrosphere includes all forms of water in the Earth's environment. The forms of water include things such as the ocean, lakes, rivers, snow and glaciers, water underneath the earth's surface and even the water vapor that is found in the atmosphere. The hydrosphere is always in motion as seen through the movement and flow of water in rivers, streams and the ocean (beach). Plant and animal organisms rely on the hydrosphere for their survival, as water is essential. The hydrosphere is also home to many plants and animals and it believed that the hydrosphere covers approximately 70% of the earth's surface.

Water distribution in the hydrosphere:

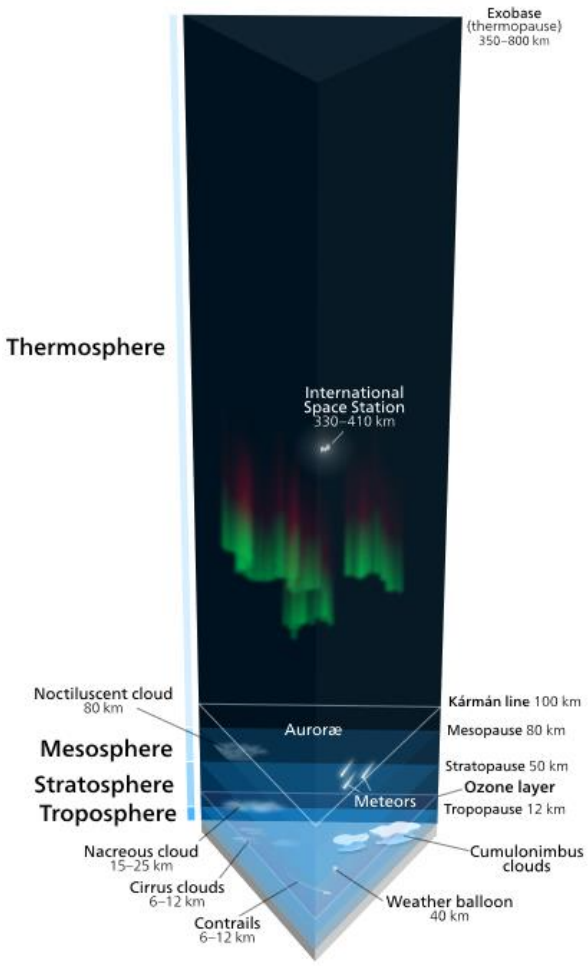


BIOSPHERE

The biosphere is composed of all living organisms, including; plants and animals. It is believed that all life exists in the biosphere. Most of the living organisms are found from up to three meters below ground to thirty meters above it and also in the to 200 meters of the ocean and seas. The biosphere could not survive if it was not for the other spheres, as all organisms need water from the hydrosphere, minerals for the lithosphere and gases from the atmosphere. Energy flow is essential to maintain the structure of organisms by the splitting of phosphate bonds.

ATMOSPHERE

The atmosphere refers to the air that surrounds the earth. The atmosphere is always in motion and constantly changing. It is believed that there are about 14 different gases that make up the atmosphere. The atmosphere is also responsible for the weather as the weather occurs within the lower atmosphere.
The bottom layer of the atmosphere is known as the troposphere. The troposphere is where the weather happens. It is the warmest near the Earth because of the heat rising from the earth's surface but it becomes colder with altitude. This layer is separated from the next by what is known as tropopause. The tropopause is the point at which temperatures will begin to change due to the increase of altitude.
Above the tropopause is the stratosphere. The stratosphere is where there large concentration of ozone gas is found. Ozone gasses are essential as they absorb a large percent of radiant solar energy, protecting the earth from harmful ultra violet rays also known as UV.
The coldest of spheres is known as the mesosphere this is where the water vapor often freezes to create clouds that are purely made of ice. The mesosphere is separated from the thermosphere by the mesopause.
The topmost layer is known as the thermosphere, this is where many satellites circle the earth. Due to the thin air and proximity of the sun, the temperatures in the thermosphere tend to rapidly increase and decrease.



Characters of Urochordata:

These animals are known as 'sea squirt'. The life-history of urochordates passes through a dramatic change. Their chordate characters are more pronounced during larval period. While in adults they are more like invertebrates than chordates. Therefore, the characters are described in two heads — larval characters and adult characters

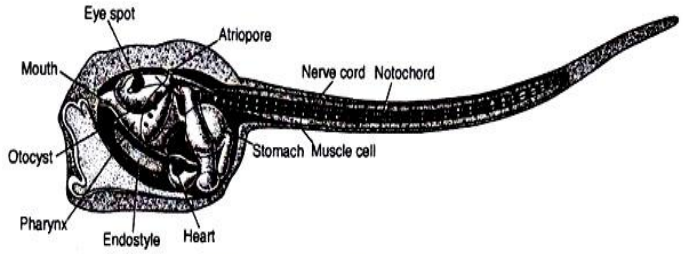


Fig. 1.4 : A diagramatic longitudinal sectional view of an ascidian larva

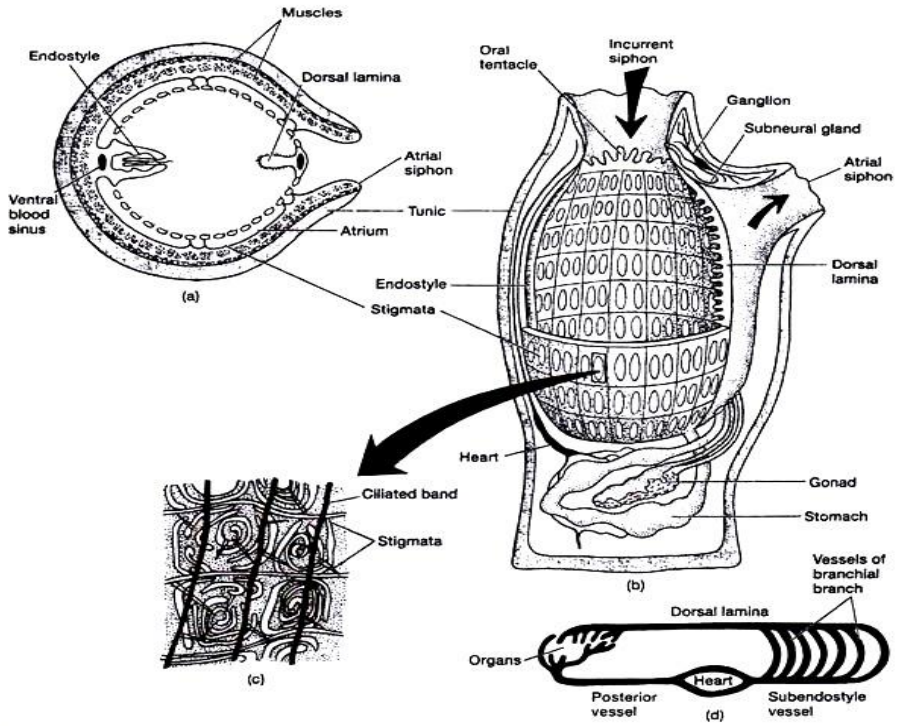


Fig. 1.5 : (a) Schematic cross-sectional view of an ascidia. (b) One side of the body opened to show internal strucures. (c) Structure of several highly subdivided pharyngeal gill slits. (d) Flow diagram of urochordate circulation

Larval characters of Urochordates:

1. Elongated larva of Urochordata is known as ascidian tadpole larva.
2. Adult emerges from the larva by the process of metamorphosis.
3. Notochord restricted at the caudal end, hence name Urochordata.
4. Dorsal hollow nerve chord spreads end to end.

5. Pharyngeal gill slits are present.
6. Highly active post anal tail is prominent.

Adult characters of Urochordata:

1. The body of the adult is covered by a tunic (hence named Tunicata).
2. The tunic is composed of a protein tunicin and a polysaccharide similar to plant cellulose.
3. Adults are sessile and attached to the substratum of the sea.
4. Incurrent branchial siphon, and ex-current atrial siphon, form entrance and exit portals for the water that circulates through the body.
5. Branchial siphon opens into a branchial basket, i.e. pharynx.
6. Tiny finger-like sensory tentacles encircle the incurrent siphon to examine the incoming water and prevent large particles from entering.
7. These are hermaphrodite animals; reproduce both sexually and asexually.

Scheme of Classification of Subphylum Urochordata:

Berrill (1950), Marshall and Williams (1964), Ruppert and Barres (1994), Anderson (1998) and Pechenik (2000) have divided the Urochordata into different Classes and orders. Barrington (1967, 1979), Young (1981), Kent and Miller (1997) and Kardong (1998, 2002) have divided the Urochordata into three classes only (Ascidiacea, Thaliacea and Larvacea) and these classes do not pertain any order.

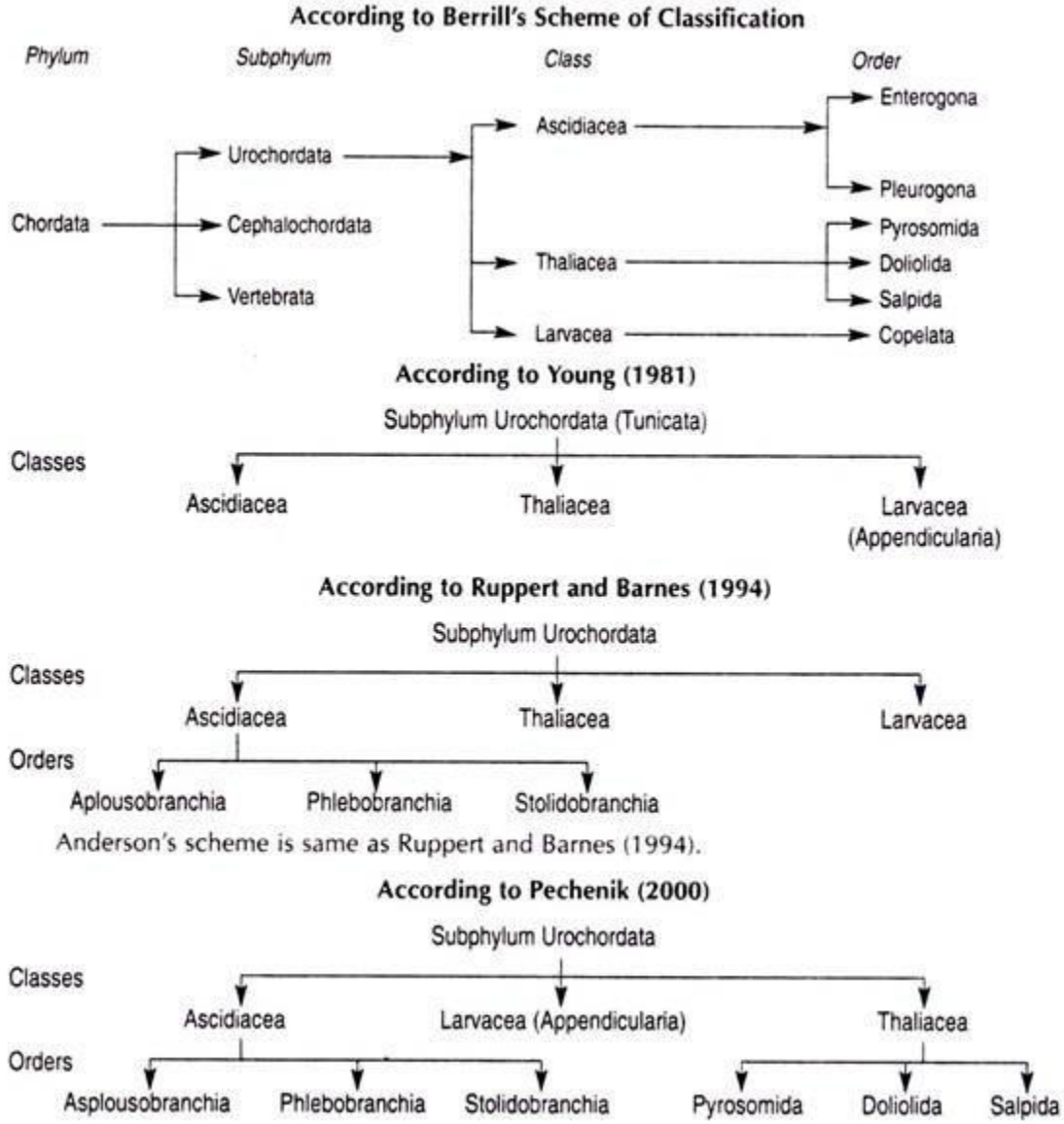
The outline classification of Urochordata according to Berrill (1950), Young (1981), Ruppert and Barnes (1994), Anderson (1998) and Pechenik (2000) has been given here in summarized form.

We follow in this text book Marshall and Wiliam's (1964) scheme of classification.

Classification in Outline:

Subphylum. Urochordata Herdman, 1910 or Tunicata Lamarck, 1816 [Gk. Oura, the tail, or L. Tunicatus, clothed with the tunic]. Approx. – 1400 species

This subphylum is divided into three classes — Ascidiacea, Thaliacea and Larvacea.



A. Class — Ascidiacea:

General characters:

1. Comprises mostly brightly coloured marine animals.
2. Some species are solitary, others are colonial.
3. Adults are sessile, but larvae are planktonic and do not feed.
4. Adults having sac-like body, covered by tunic.
5. Most of the chordate characters that were present during larval period disappear during metamorphosis into adult.In adult, nervous system transforms into a nerve ganglion.
6. **Examples:** Ascidia, Ciona, Herdmania .

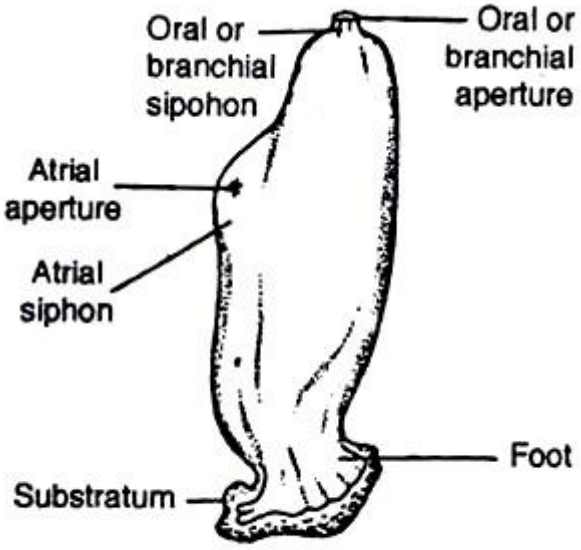


Fig. 1.8 : External organisation of adult *Ascidia*

B. Class — Thaliacea:

General Characters:

1. These are free-living pelagic urochordates.
2. The tunic is transparent and thin.////
3. They possess encircling circumferential bands of muscles within the walls of the test.
4. Incurrent and ex-current siphons are present at opposite end of the body.
5. A few pharyngeal gill slits are present.
6. In the life-cycle polymorphism and clear alternation of generations are evident.
7. **Examples:** Salpa , Doliolum .

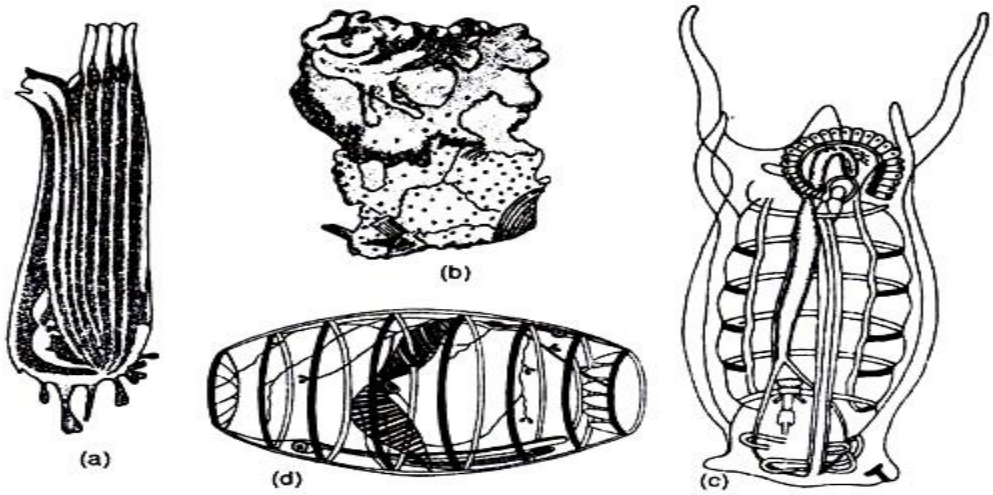


Fig. 1.6 : Some members of Urochordata : (a) *Ciona*, (b) *Herdmania*, (c) *Salpa* and (d) *Doliolum*

C. Class — Larvacea/Appendicularia:

General characters:

1. These are tiny marine planktonic urochordates found worldwide.
2. Larvacea received their name because the adults retain larval characteristics similar in some way to the ascidian tadpole with its tail and trunk. The general resemblance of adult larvaceans to ascidian tadpoles suggests that larvaceans may be neotenous form.
3. They produce a remarkable feeding apparatus (house) that consists of three components: screens, filters and expanded gelatinous matrix. Disturbed or actively feeding larvaceans abandon their old house and builds a new one.
4. The trunk holds major body organs.
5. The tail is thin and flat.
6. Muscle bands act on notochord to produce movement.
7. A tubular nerve cord is present.
8. All species, except one, are monoecious, and most of these are protandrous.
9. **Examples:** Oikopleura, Appendicularia.

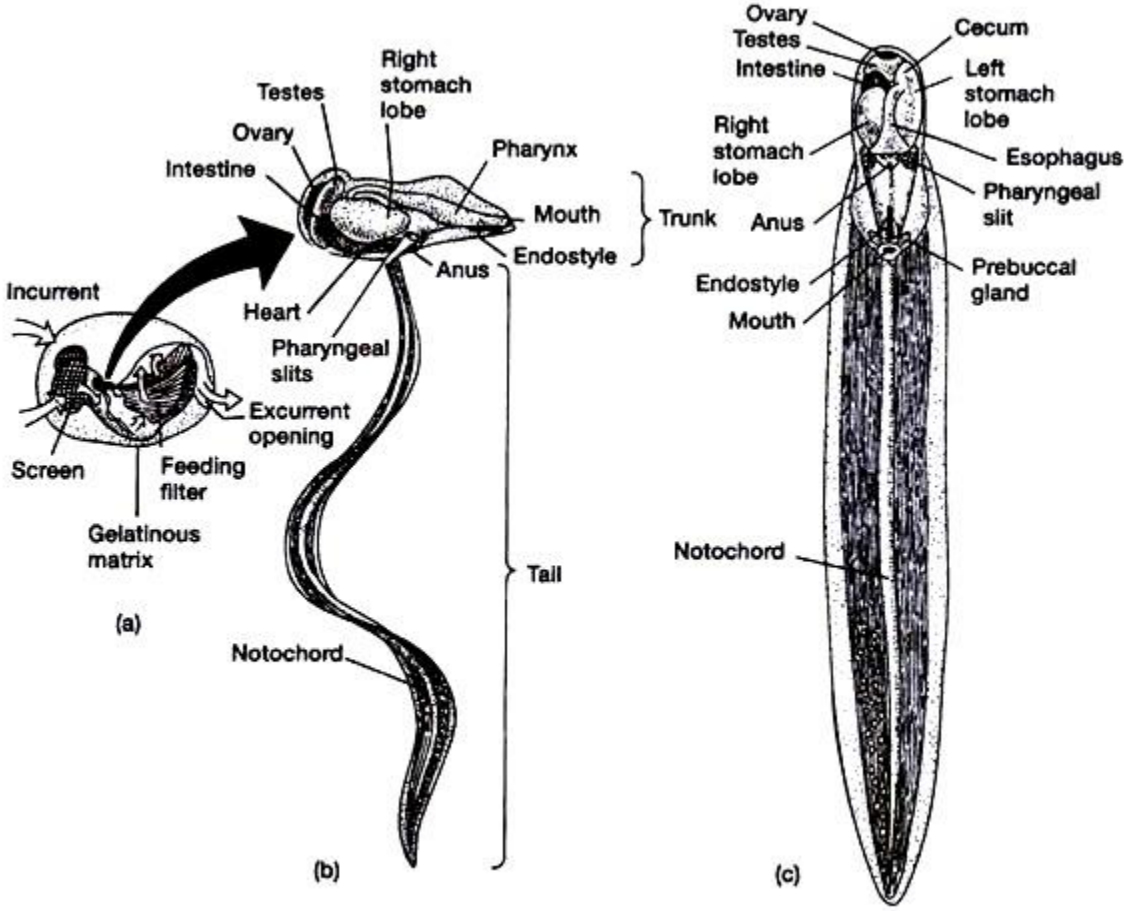


Fig. 1.7 : *Oikopleura* : (a) within its gelatinous house, (b) and (c) Free floating forms

Affinities of Urochordata with Non-Chordates:

Similarities:

1. Food collection similar to s
2. pongec, mussels and lophophores.
3. Typhlosole in the intestine.
4. Presence of larval eye and oocytes.
5. Budding leading to a chain of new zooids.
6. Formation of colony.

Dissimilarities:

1. Fish-like tadpole larva.
2. Absence of pharyngeal gill slits.

Affinities of Urochordata with Hemichordata:

Similarities

1. Structure of pharynx.
2. Development of the central part of the nervous system.

Dissimilarities:

1. Absence of endostyle helping in food collection in Hemichordata.

Affinities of Urochordata with Cephalochordate:

Similarities:

Tadpole larva and Branchiostoma: (Adult and larval structures):

1. Body shape.
2. Presence of dorsal and ventral fins.
3. Presence of velum and velar tentacles.
4. Filter feeders.
5. Cleavage and gastrulation.
6. Mode of development of notochord and nervous system.
7. Presence of notochord.
8. Similar atrial complex with endostyle, pharyngeal groove and epipharyngeal bands.

Affinities of Urochordata with Chordates:

Similarities:

1. Tadpole larva possesses major basic features of chordates.
2. Presence of gill slits.

3. Presence of notochord.
4. Dorsal, tubular, hollow nerve cord.

Affinities with vertebrates:

1. Tadpole larva similar to fish larva.
2. Feeding mechanism similar to Ammocoete larva and some larval amphibians.
3. Nasal glands similar to hypophysis.
4. Gonadotrophin stimulates ascidian neural gland.

Scientists are unanimous that Urochordata occupies a position in the lower rung of the hierarchy of Chordata, but they are divided in ascertaining the exact pathway of their origin.

Some suggest that the development of sexual maturity along with other complexities in the larval form led to the elimination of ancestral adult phases and the degenerated forms are the descendants of ancestors having all chordate features.

Others hold that they were lowly organized forms, which never reached the level of the simplest form of chordates. A third group believes that the appendicular larva is a primitive one giving rise to a stationary adult having degenerated vertebrate characters.

Another view is that the doliolids (urochordates) have undergone neoteny to produce present day urochordates. Regarding the interrelationship within the urochordates, it is believed that larvacea is most primitive. Thaliacea developed from fixed forms close to ancestral compound ascidians, which gave rise to Pyrosomida.