
EXERCISE 23 PROTOCHORDATA (ACRANIA) : OBSERVATION AND CLASSIFICATION OF SPECIMENS

Structure

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23.1 INTRODUCTION

The last major group of the animal kingdom is Phylum Chordata. It is derived from two Greek words, “*chorde*” meaning a string or chord (referring to notochord) and “*ntn*” means bearing. The chord means stiff, rod-like structure along the back i.e. the *chorda dorsalis* or notochord (Gr., *noton*: back, *chorde*: string).

All the chordates possess three outstanding unique characteristics at some stage in their life history, i.e., a dorsal, hollow or tubular nerve cord, a longitudinal supporting stiff but flexible notochord and a series of pharyngeal gill-slits. A naked skin is hardly seen in chordates. (Some sort of structures like scales, feathers, hairs etc. are usually present)

Phylum Chordata has a superiority over other phyla, in possessing a living endoskeleton. This living endoskeleton permits greater freedom of movement and helps in growth.

The present laboratory exercise is based on Unit 1 (section 1.5 and subsection 1.5.1 and 1.5.2) of the LSE-10, theory course in which you studied Protochordates. Protochordates as you will recall retain three basic chordate characters and are considered most primitive chordates, Protochordates (Gr., *protos*: first; *chorde*: chord) are all marine, small, primitive or lower chordates, lacking a head, a skull or cranium, a vertebral column and jaws. This group is divided into 2 subphyla: (1) **Urochordata** and (2) Cephalochordata mainly on the basis of presence of notochord.

Protochordates have little economic value but they have great phylogenetic significance for the zoologists and that is why studies of Protochordata become very important. They show immense affinities and common origin with the living vertebrates.

Objectives

After performing this exercise you should be able to:

- identify and give the scientific and common names of specimens of *Herdmania* and *Doliolum* belonging to the Subphylum Urochordata, List characters justifying their classification and mention special features, if any.
- identify and give the scientific and common name of the specimen *Branchiostoma* belonging to Subphylum Cephalochordata. List characters justifying their classification and mention special features, if any.

- draw labelled diagram of each of the identified genera.
- mention the habitat, geographical location and economic importance, if any, of each of the identified genera.
- classify the identified Protochordates up to the level of classes.

23.2 MATERIAL REQUIRED

1. Preserved specimens of:
 - i) *Herdmania*
 - ii) *Branchiostoma* (Amphioxus)
 - iii) Slides of whole mounts of *Doliolum* and *Branchiostoma*
2. Laboratory manual
3. Practical Record File
4. Pen, Pencils, Eraser, Ruler

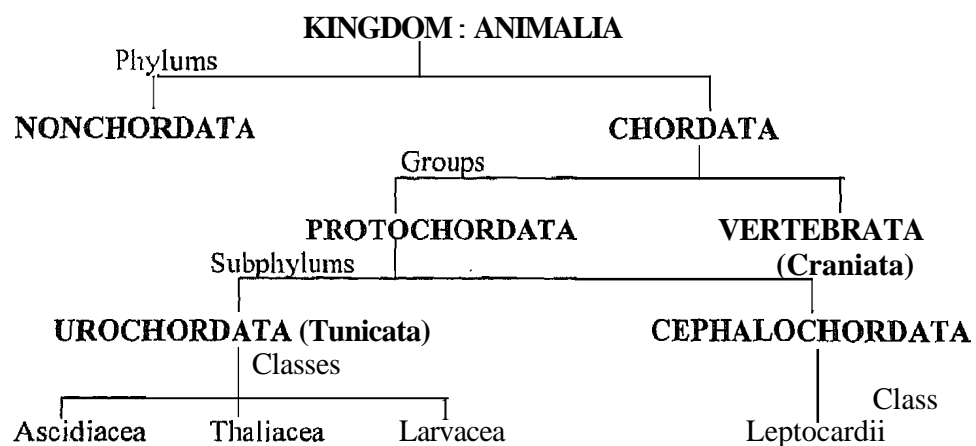
23.3 GENERAL CLASSIFICATION OF GROUP PROTOCHORDATA

Position of Protochordates in the Animal Kingdom

Classification and its Justification

Kingdom	Animalia	Animals, multicellular organisms with cells that lack a cell wall, many capable of movement or movement of some of their body parts or capable of movement at some time of their life cycle; heterotrophic nutrition.
Phylum	Chordata	Dorsal tubular nerve cord, notochord and paired gill-slits are present.
Group	Protochordata (Acrania)	Marine small forms; notochord is either found in the larval stage or as such persists throughout life; cranium, jaws and paired appendages absent.

OUTLINE CLASSIFICATION OF GROUP PROTOCHORDATA



23.4 SUBPHYLUM UROCHORDATA

Before you take up the type specimens of Subphylum Urochordata namely *Herdmania* and *Doliolum* for study, it will be desirable to recapitulate some of the general aspects of the subphylum. Urochordates are called sea squirts or ascidians. The subphylum Urochordata includes about 2000 species of sedentary tunicates, out of which nearly 95% are sea squirts. Besides this there are nearly 100 pelagic species. Urochordates are exclusively marine and cosmopolitan and are found in all seas and at all depths.

The subphylum Urochordata is divided into three classes: **Asciacea**, **Thaliacea** and **Larvacea**. For the detailed classification, you must refer to Unit-1 (Subsection 1.5.1) of Block 1 of LSE 10. In this exercise we have only given the features of those classes whose specimens you will study in the laboratory.

23.4.1 General Characters of Urochordata are as follows

- i) Mostly sedentary (fixed) but some are pelagic or free swimming.
- ii) Simple (solitary) or aggregated in groups, i.e., composite (colonial).
- iii) Their size varies from 0.25 to 250 mm with variance in body shape and hues.
- iv) Adults have degenerated bodies, which are saclike, unsegmented and without appendages.
- v) Tail is absent in adults.
- vi) Body is covered by a protective tunic or test, which is composed largely of **tunicine** (an organic base similar to cellulose) so these are also known as **tunicates**.
- vii) A terminal branchial aperture and a dorsal atrial aperture are usually present.
- viii) Notochord, a chordate feature is present only in the larval form and confined to the tail, hence the name Urochordata.
- ix) Dorsal tubular nerve cord is found only in larval stage.
- x) An endostyle, homologous with thyroid is present.
- xi) Tunicates are hermaphrodites.
- xii) Development is indirect as it includes a free-swimming tailed larva with basic chordate characters. Metamorphosis is retrogressive, whereby, many larval features (including the chordate characters) get degenerated or completely lost in adults.

23.4.2 Class Ascidiacea: Type specimen - *Herdmania*

Examine the specimen of *Herdmania pallida*. Also with the help of figure 23.1 note the following features:

- i) The bag-like body is laterally compressed and somewhat oblong or rectangular in shape.
(Fresh animals are pink as they possess superficial vascular ampullae in the test, a characteristic feature of ascidians.)
- ii) When the foot is present the body can be divided into two parts; body proper and root.
- iii) The test is a protective covering as well as an accessory respiratory organ, besides also being a receptor organ. It is soft, leathery and translucent.
- iv) The test is composed of clear gelatinous matrix, interfacing fibrils, corpuscles, nerve and other types of cells and calcareous spicules. Calcareous spicules are of two types: (i) megascleres and (ii) microscleres and form the endoskeleton of tunicates.
- v) The distal end of the body has two short, cylindrical projections called, the **branchial** and **atrial** siphons, guarded by branchial and atrial aperture.
- vi) The branchial siphon marks the anterior end and is wider and more outward than the atrial siphon.
- vii) The foot is entirely rough due to sand particles, pebbles, etc.
- viii) **Ascidian tadpole** larva is a very significant stage of *Herdmania* as it has the two most important diagnostic features of chordates i.e. a dorsal tubular nerve cord and a notochord (though restricted to the tail region only). The short-lived larva undergoes metamorphosis, losing its nervous system as well as the tail to become a **degenerated** adult.

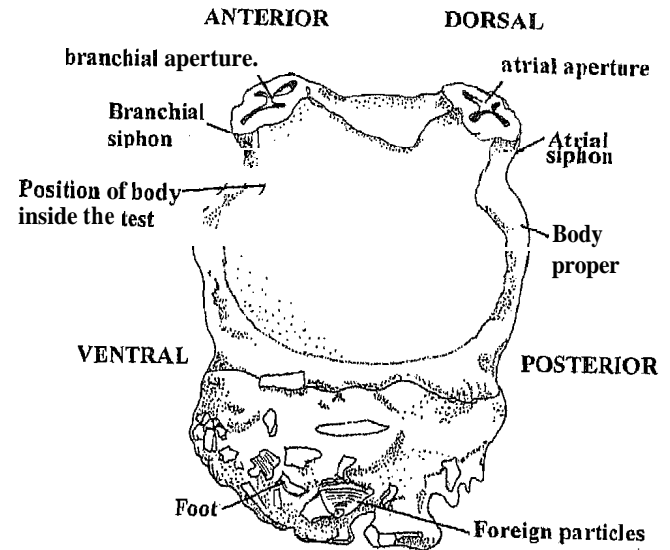


Fig. 23.1: External features of *Herdmania*.

Habit and Habitat

Herdmania is generally found at places having abundant polychaete fauna and chanks. *Herdmania* is solitary and marine. It remains embedded in sand or mud by means of a large, conical extended foot. A large number of organisms inhabit the test of *Herdmania*, some of these are attached to its surface, while others are more or less embedded within its substance.

It feeds on microscopic plants and animals. Sometimes, an individual becomes attached as a commensal to the shell of a living gastropod. This way it avails of better opportunities of food, oxygen and dispersal. The mollusc in turn is protected as the tunicate is unpalatable on account of its spicules.

Geographical Distribution

Herdmania is marine, found in all seas and at all depths, extending from the arctic to the tropics and from the littoral zone down to the abyssal depths of over 4 kilometers. *Herdmania* is common in Indian seas too. Twelve species are known, out of which four are found in Indian Ocean; these are *H. pallida*, *H. ceylonica*, *H. mauritiana* and *H. enurensis*.

Classification and its Justification

Kingdom	Animalia	Animals, multicellular organisms with cells that lack a cell wall, many capable of movement or movement of some of their body parts or capable of movement at some time of their life cycle; heterotrophic nutrition.
Phylum	Chordata	Dorsal tubular nerve cord, notochord and paired gill-slits are present.
Group	Protochordata (Acrania)	Marine small forms; notochord is either found in the larval stage or as such persists throughout life; cranium, jaws and paired appendages absent.
Subphylum	Urochordata	Free swimming tunicate larva, sessile adults, solitary or colonial; cuticular test containing tunicine.

Class	Ascidiaeae	Permanent well-developed test, persistent gill-slits; branchial-sac large and perforated by numerous gill-slits.
Genus	<i>Herdmania</i>	
Species	<i>pallida</i>	
Common name	Sea squirt	

Protochordata (Acrania) :
Observation and
Classification of Specimens

Features of Special Interest

Herdmania is called sea squirt because when disturbed in a living state, this animal emits jets of water simultaneously or independently through its branchial and atrial apertures. Larval stage is free-swimming but adults are sessile.

The foot: varies in character according to the nature of the substratum. If the substratum is fine sand, the foot has an oval shape and a smooth surface and the test is quite hard in consistency. But it is the other way, if the substratum consists of coarse and broken shell pieces.

23.4.3 Class Thaliacea: Type specimen – *Doliolum*

Doliolum occurs in two phases: a solitary sexual gonozoid which alternates with a colonial asexual gregaria or oozoid, thus, exhibiting an alternation of generations between two morphologically distinct phases in its life cycle.

Examine the specimens of *Doliolum* (Fig. 23.2) with a hand lens and under the microscope. Note down if the specimen given is a gonozoid (tailless) or asexual oozoid (tailed).

A. Sexual Gonozoid or Solitaria Phase (Fig. 23.2 a)

- i) The body is cask-shaped measuring 1 to 2 cm in length.
- ii) It is a solitary phase, where the animal has thin, transparent test and barrel shaped body.
- iii) The mantle is encircled by eight complete muscle bands, the first and last muscle bands act as sphincters, hence also, the name *Cyclomyaria* for its order **Doliolida**.
- iv) The mouth and atrial apertures are at opposite ends of the barrel.
- v) The propulsion occurs when contractions of muscles drive water through the posterior end.
- vi) Reproduction is specialized. The fertilized egg develops into a larva having a notochord and a tail, otherwise, its body is similar to that of adult.
- vii) The larva changes into an asexual oozoid.

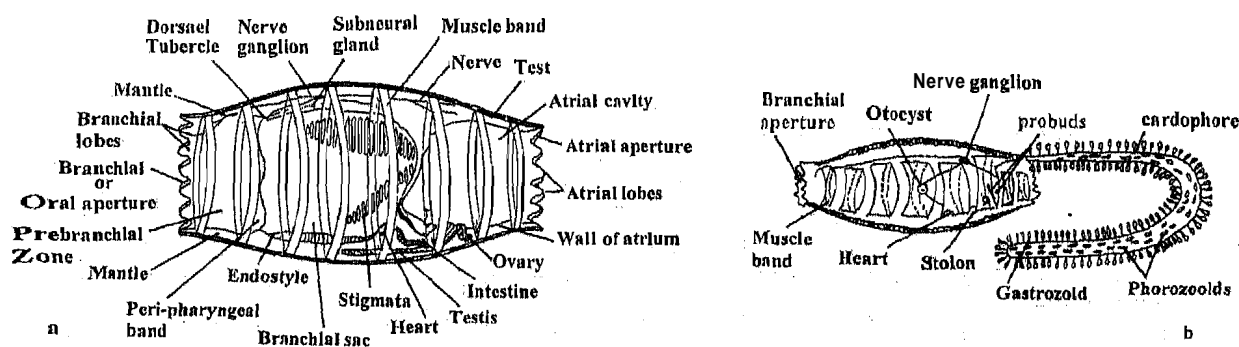


Fig. 23.2: *Doliolum*. a) Sexual form. b) Asexual form.

B. Asexual Oozoid or Gregaria Phase (Fig. 23.2 b)

- i) The postero-dorsal **cadophore** and ventral stolon formed in the larva increase as the tail aborts gradually.
- ii) There are nine complete muscle bands, which increase in thickness.
- iii) Retrogression occurs, whereby stigmata, endostyle, and alimentary canal degenerate.
- iv) The **probuds** are formed, which divide numerously and form three kinds of **zooids**.
 - (a) **Trophozooids** or gastrozooids – for nourishment and respiration of the colony. These do **not** undergo any further development.
 - (b) Phorozooids – act as nurses and become detached.
 - (c) **Gonozooids** – are fixed on the stalks of **phorozooids**, which form the sexual stage or adult.

Habit and Habitat

It is pelagic and free swimming.

Geographical Distribution

It is a thaliacean with cosmopolitan distribution. It is found in phytoplanktonic zone in tropical and sub-tropical seas. The species is common up to 200 m but nurse forms are also found from 3000 m.

Classification and its Justification

Kingdom	Animalia	Animals, multicellular organisms with cells that lack a cell wall, many capable of movement or movement of some of their body parts or capable of movement at some time of their life cycle; heterotrophic nutrition.
Phylum	Chordata	Dorsal tubular nerve cord, notochord and paired gill-slits are present.
Group	Protochordata (Acrania)	Marine small forms; notochord is either found in the larval stage or as such persists throughout life; cranium, jaws and paired appendages absent.
Subphylum	Urochordata	Free swimming tunicate larva, sessile adults, solitary or colonial; cuticular test containing tunicine.
Class	Thaliacea	Free swimming pelagic forms; single or colonial, transparent body; test is a permanent structure; muscular fibres of the body wall are arranged in ring-like bands; remarkable alternation of generations.
Genus	<i>Doliolum</i>	

23.5 SUBPHYLUM CEPHALOCHORDATA

The subphylum Cephalochordata includes only a single Class **Leptocardii** which has a single Family Brachiostomidae. There are only 2 genera, viz. *Branchiostoma* (*Amphioxus* : Gr. *amphi*-on both sides; *oxys*, sharp) with 8 species and *Asymmetrom* with 7 species. They are marine, solitary and small fish-like forms. The chordate characters are retained throughout life.

23.5.1 General Characters

1. The name Cephalochordata is derived from the fact that the notochord extends forward inside rostrum even beyond the so-called brain. The subphylum comprises a few, small and marine fish-like protochordates.

2. Cephalochordates are marine, widely distributed in shallow waters.
3. These are mostly sedentary.
4. Body is small, slender and transparent.
5. Paired appendages are lacking. Median fins are present.
6. Exoskeleton is absent and muscles are dorso-lateral, which are segmented into **myotomes**.

23.5.2 Class Leptocardii: Type specimen – Branchiostoma (Amphioxus)

Examine the specimen of *Branchiostoma lanceolatum* (whole mount and/or museum specimen) and note with the help of figure 23.3 the following features:

- i) Both the ends of the body of Amphioxus (Fig. 23.3) are sharp and pointed so that it looks like a lance (a weapon, sharp at both ends) and hence is commonly called as 'lancelet'.

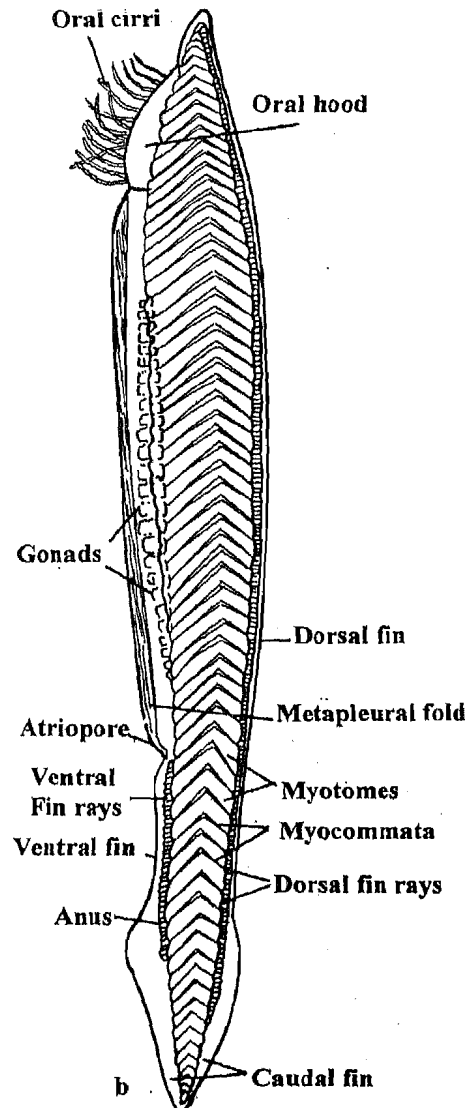
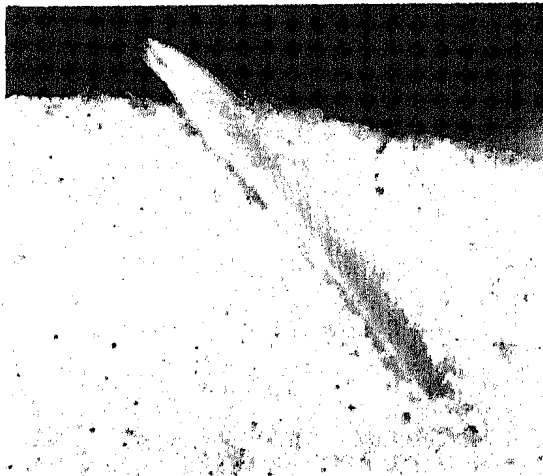


Fig. 23.3: *Branchiostoma (Amphioxus)*. a) Seen lying in its normal position, partly buried in sand (Note the v-shaped myomeres used in swimming to new sites and burrowings. b) Drawing of *Amphioxus*.

- ii) Body is laterally compressed and streamlined, which is an adaptation for burrowing as well as swimming.
- iii) The posterior end is more tapering and pointed than the anterior end.
- iv) The trunk bears three openings, **mouth, atriopore** and **anus**. The entire body can be divided into (i) Cephalic (ii) Abdominal and (iii) Atrial regions.
- v) Anteriorly, there is a tentaculated **oral hood**, which is formed by the dorsal and lateral projections of the body.

- vi) Anteriorly free ventro – lateral edges or margins called the oral hood have 10 to 11 pairs of slender, stiff and ciliated oral or buccal cirri. Buccal cirri bears sensory papillae too.
- vii) The paired fins are absent in Branchiostoma but longitudinal, unpaired median fin can be recognised.
 - A dorsal fin in the form of a fold of skin extends along the whole surface.
 - A caudal fin is present around the tail whereas, ventral fin runs mid-ventrally in the posterior part of the body from caudal fin to the **atriopore**.
 - Dorsal and ventral fins (or ridges) are supported by small rectangular stiffeners called fin-ray boxes. There is one row of such boxes in the dorsal fin and a double row (right and left) in the ventral fin, caudal fin has no stiffeners.
- viii) Two metapleural folds, which are hollow and membranous run longitudinally along the ventro-lateral margins from oral hood to atriopore.
- ix) On each lateral side of the body are a series of <-shaped **myotomes** or muscle bands, which are visible through the transparent body wall of the animal.

(This animal wonderfully depicts the four distinctive hall marks of the Phylum Chordata, dorsal tubular nerve cord, a notochord, gill-slits for filter feeding and a post anal tail for propulsion. It is considered an animal of classical Zoology as it represents a combination of primitive, specialized and degenerate features.)

Economic Importance

In China and Japan, this animal is sold in bulk as food.

Habit and Habitat

Branchiostoma leads a double mode of life. For most of the time, it remains buried in the sand in an upright condition with only the anterior end protruding above the sand (Fig. 23.3 a). At night or dusk, it comes out of the sand and swims actively by lateral undulating movements of its body caused by muscles.

It swims vertically in water. When disturbed it jumps out of its burrow, swims a short distance, drives back into sand keeping the head downwards and makes a U-turn inside, so that the anterior end comes up again above the sand.

It feeds on planktonic microorganisms brought along with a respiratory-cum-food water current, which constantly enters the mouth. Thus, the mode of feeding is ciliary like those of Urochordates.

The notochord that extends in front of mid-brain is a peculiarity not found in other chordates.

Geographical Distribution

It is cosmopolitan in distribution and is reported from different oceans of the world. It is more common in warmer seas, such as, Mediterranean and especially abundant near the coasts of United States, British Seas and even as far north as the coast of Norway.

These animals are collected in large numbers off the coasts of China and Japan, . The species common on the Indian sea coasts are *B. indicum*, *B. pelagicum*, *B. caribaeum* and *B. lanceolatus (lanceolatum)*.

Classification and its Justification

Kingdom	Animalia	Animals, multicellular organisms with cells that lack a cell wall, many capable of movement or movement of some of their body parts or capable of movement at some time of their life cycle; heterotrophic nutrition.
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Phylum	Chordata	Dorsal tubular nerve cord, notochord and paired gill-slits are present.
Group	Protochordata (Acrania)	Marine small forms; notochord is either found in the larval stage or as such persists throughout life; cranium, jaws and paired appendages absent.
Subphylum	Cephalochordata	Solitary forms; nervous and blood vascular system in general pattern to higher chordates, notochord extends throughout the length of the body and persists throughout life.
Class	Leptocardii	Lancets; small fish-shaped chordates; metameric; body supported by well developed notochord; no vertebrae; no brain; no anterior array of sense organs; jawless filter feeders; mouth surrounds by an oral hood.
Genus	<i>Branchiostoma</i> (<i>Amphioxus</i>)	
Common name	Lancelet	

**Protochordata (Acrania):
Observation and
Classification of Specimens**

23.8 TERMINAL QUESTIONS

1. Why is *Herdmania* called a tunicate?
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2. Name the two external openings of *Herdmania*.
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3. What are the bright red patches on the test of a sea squirt?
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4. What are the two forms of *Doliolum*?
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5. What are the two characters of solitaria phase of *Doliolum*?
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6. What is the common name of *Branchiostoma*? Why is it so called?
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7. How is lancelet easily identified?

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8. Give one main difference between fishes and *Branchiostoma* pertaining to fins.

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9. List two major chordate characters found in *Branchiostoma*.

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(2).....

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