

LIFE CYCLE OF AMPHIOXUS

**ALSO CALLED AS
LANCELET**

AMPHIOXUS

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.



- Lancelets serve as an intriguing comparison point for tracing how vertebrates have evolved and adapted. ... In 1836, Yarrel renamed the **genus** as **Amphioxus**(from the Greek: "pointed on both sides"), now considered an obsolete synonym of the **genus** Branchiostoma.

-

- **SYSTEMATIC POSITION**
- Phylum Chordata
- Sub Phylum Cephalochordata
- Class Cephalocorda
- Type Amphioxus
- Lancelet
- *Branchiostoma lanceolatum*

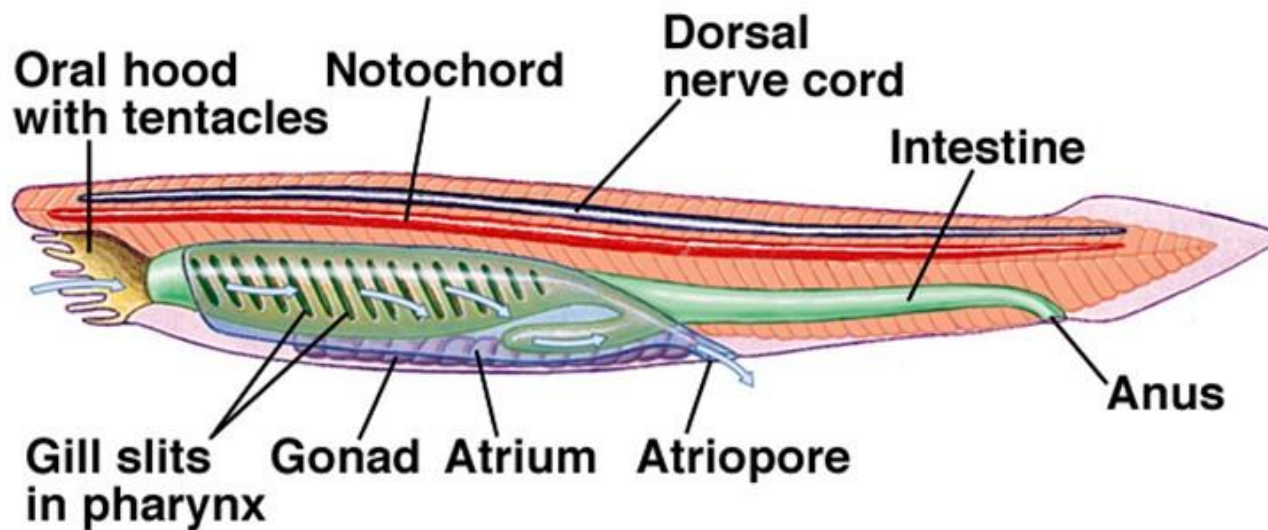
• GENERAL CHARACTERS OF AMPHIOXUS

- **Marine**, found in shallow water of the sandy coasts in tropical and temperate regions
- **Burrowing form** where anterior end protruding out, nocturnal
- Has a **transparent spindle like body, compressed, looks like lance**, pointed at both the ends hence called **lancelet**
- Body-anterior trunk having a **oral hood, mouth** at the anterior end above the mouth is the **rostrum**, 11 pairs of **oral tentacles/oral cirri** surrounding the mouth and posterior tail – 4.5 to 5 cms
- Anterior end protrudes in front – **rostrum** having a **dorsal fin, ventral fin and the caudal fin**

- Anus at the posterior end .presence of **metapleural folds,atriopore at the junction of metapleural** folds presence of " V" shaped blocks –**Myotomes**.
- Sexes are separate and sexual dimorphism is not distinct.**26pairs pairs of gonads** arranged in two rows one on each side of the body Gonoducts are absent and the gametes are released through the atriopore

Copyright © The McGraw-Hill Companies, Inc. Permission required for reproduction or display.

Lancelet Structure



- **REPRODUCTION IN AMPHIOXUS**

- Amphioxus is a Cephalochordate animal. Its Life history in the early stages shows resemblance with ascidians. HATSCHE'K WILSON ,CONKLIN' worked on the part of embryogenesis of Amphioxus. 'CONKLINS' work is more accurate and is recent

- The sexes are separate ,but apart from the reproductive organs there is no difference between the male and female
- The gonads occur at 26 pairs of pouches arranged metamERICALLY along the body wall They project into the atrium and largely fill its cavity The inner or mesial face of each pouch is covered by atrial epithelium which is pushed inwards by the growth of the gonads. Thus the gonads are present in a single layer of epithelium which is shown by the development which is coelomic Hence each gonad is surrounded by a closed coelomic sac.

- **AMPHIOXUS -ORGANISATION OF the GAMETES:**
- a) **SPERMATOOZOAN IN AMPHIOXUS:** The mature male sex cell called Spermatozoan .
- b) It is 15 to 20 in length. It shows three regions
- 1 . Head, 2. Middle piece and 3. Tail .
- On the head acrosome is present. Head shows a big nucleus. Around the nucleus thin sheet of Cytoplasm is present. It is called Manchetty. The middle piece is small and a long tail

OVA

- The unfertilised ovum or secondary oocyte of *Amphioxus* is 0.10 mm to 0.12 mm in diameter.
- It is microlecithal and isolecithal
- It is surrounded by a plasma membrane, which is further surrounded by a thin vitelline membrane of mucopolysaccharides
- Its nucleus is eccentric lying at the animal pole
- The egg undergoes its first maturation division before it leaves the ovary
- The animal pole is free from yolk and the cytoplasm towards the vegetal pole contains some yolk distributed evenly

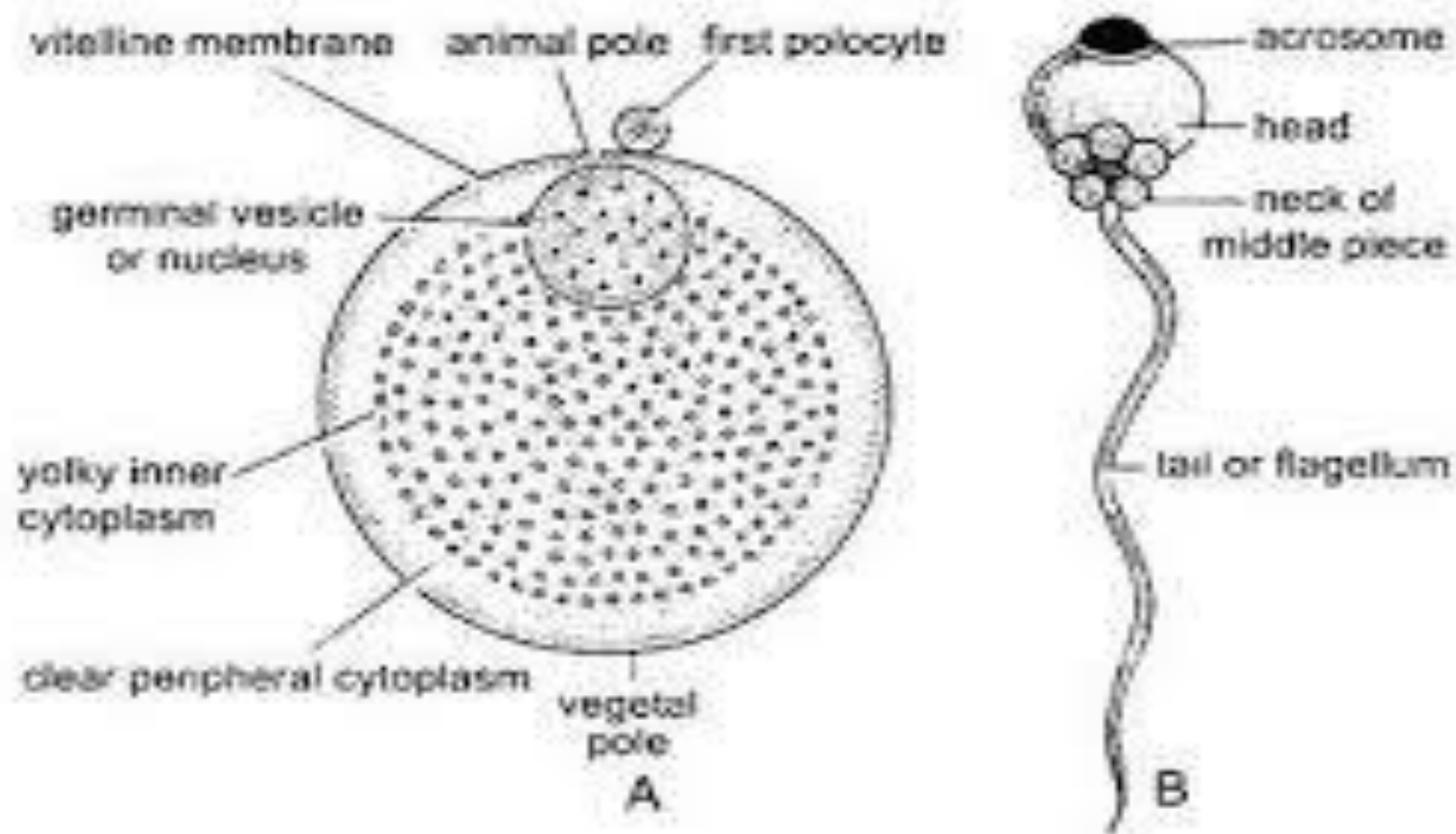
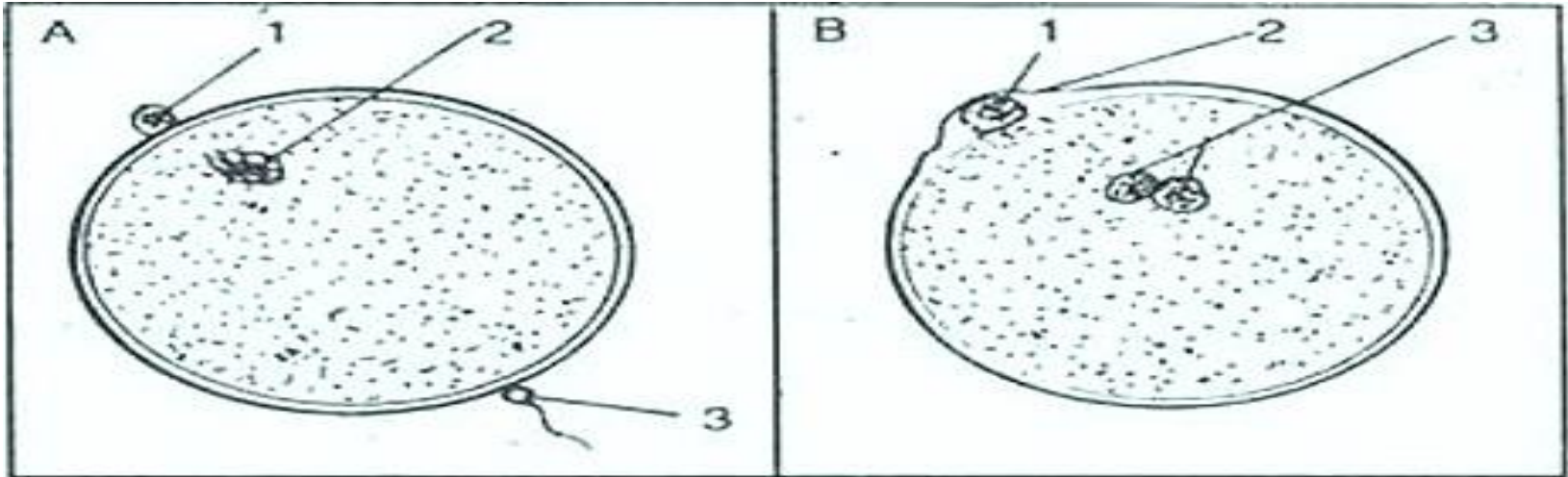


Fig. 36.1. *Amphioxus*. A—Unfertilised ovum; B—Sperm.

Fertilisation in Amphioxus



A. Amphioxus:- Sperm unites with ovum

1. 1st polar body
2. Dividing nucleus
3. Sperm

B. Amphioxus :- Fertilization

1. 1st polar body
2. Fertilization membrane
3. Uniting nuclei.

- **B, EGG OR OVUM IN AMPHIOXUS** : The mature female sex cell is ovum. It is small and 0.12 mm in diameter. It is a **microlecithal egg**. The cytoplasm around the nucleus will show yolk. In the peripheral cytoplasm yolk is absent. It is granular and is called corticoplasm. The plasma membrane surrounds the cytoplasm. Around this is a mucopolysaccharide membrane is present. It is called vitelline membrane. In between these two layers perivitelline space is present. The nucleus is present towards the animal pole, where as the opposite pole is called vegetal pole. The vegetal pole becomes posterior dorsal side of the embryo. The Animal pole becomes antero-ventral side of the embryo. Hence a gradient polarity is established in the egg

- **FERTILISATION IN AMPHIOXUS** : fertilization is external taking place in the surrounding sea water where eggs and spermatozoa are shed As soon as the egg comes in contact with water the vitelline membrane will separate from the plasma membrane.
- The egg is surrounded by a number of sperms. One sperm will make its entry through the contents of the egg from the vegetal pole. At this time a number of changes take place in the corticoplasm. Now membranes are formed which unite with vitelline membrane It is called Fertilisation

- So that no other sperm can enter into the egg. The head and middle piece of the sperm will enter into ooplasm of the egg. The egg nucleus undergoes second maturation division . Second polar body is pushed into the perivitelline space . The sperm nucleus and middle piece will show 180° twist and move towards the egg nucleus. Both the nuclei will unite. Thus a zygote nucleus is formed
- The site of fusion is generally above the equator of the egg and slightly towards the side which will eventually be the posterior end of the embryo

- **FATEMAP OF FERTILISED EGG OF AMPHIOXUS :**

Conklin in 1932 studied the fate map of Amphioxus. In 1962 Tungtung described the egg of amphioxus 4 regions are clearly seen.

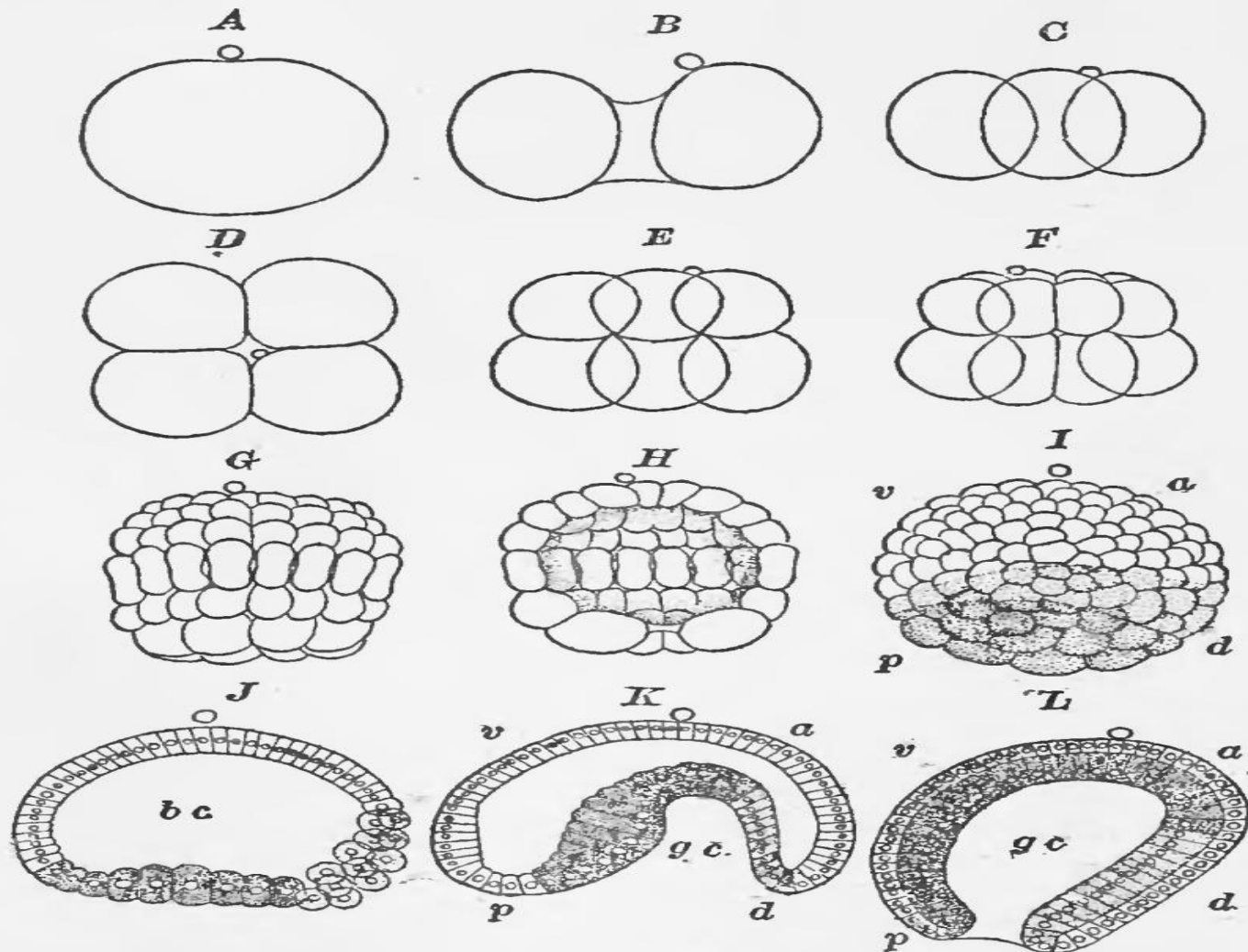
1 . Clear cytoplasm occupying the animal pole will mainly become epiderm& ectoderm .

2 . The granular yolky cytoplasm near the vegetal pole will become endoderm

3 The crescent shaped cytoplasm of the posterior side will become mesoderm .

4. Opposite to this mesodermal crescent another crescent is present which becomes presumptive nervous system. The lower part will develop into notochord

Development in Amphioxus Segmentation of oosperm D, the four celled stage ,G. vertical section upto H, k- vertical section of the blastula and lastly formation of gastrula.



Development

- After maturation as in the fig.above and fertilization in the surrounding sea water
- The membrane separate from the developing egg, leaving a wide space around it. Segmentation is complete, there being very little yolk. It begins by a sagittal cleft dividing the egg into two (B), and is followed by second cleft, also meridional, at right angles to the first (D)
- Next , an approximately equatorial cleavage takes place, and now the embryo consists of eight cells (E), of which the four belonging to the upper hemisphere,diguished by the presence of the polar bodies are similar than the lower four

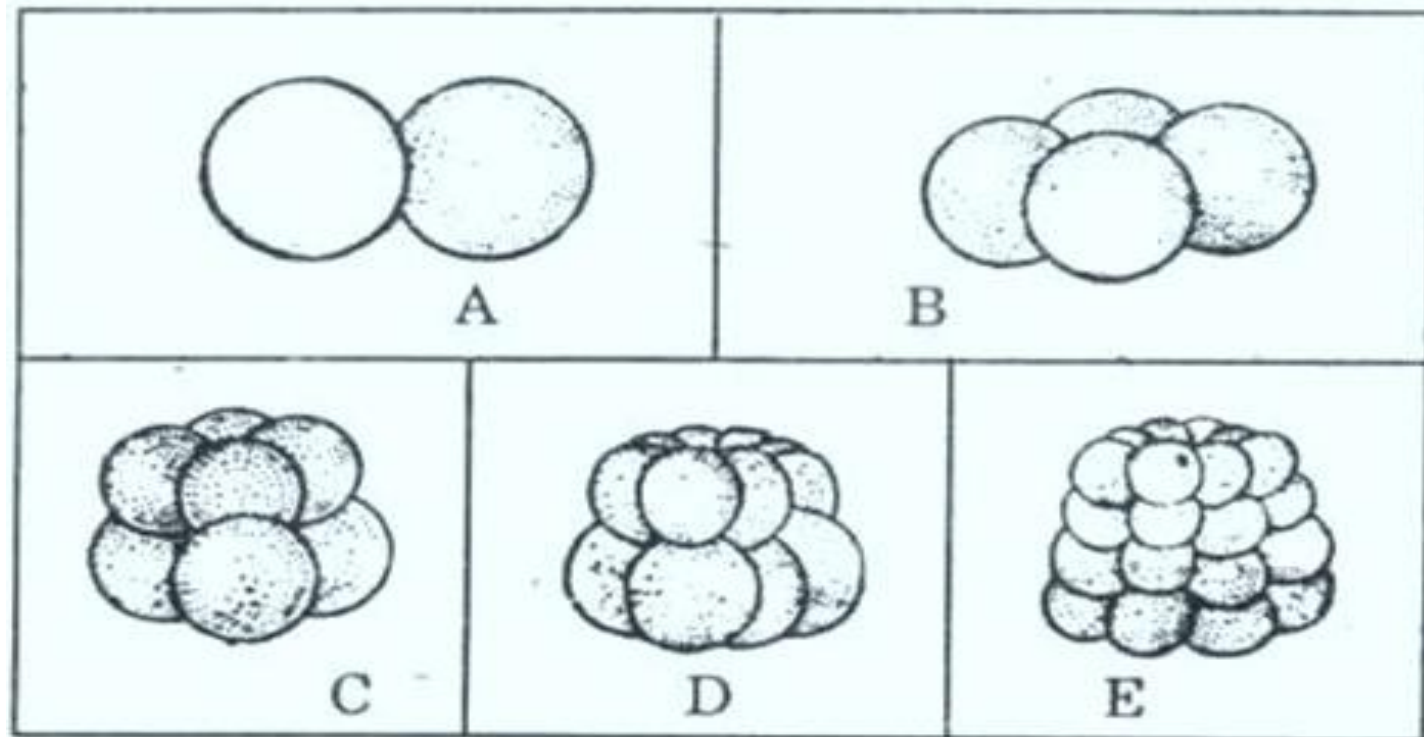
- **First Cleavage** : After 1 1/2 hours* of fertilisation meridional cleavage will take place. It is from anterior end to posterior end (The median axis of the egg is from Animal pole to vegetal pole). The result of this cleavage is two equal blastomeres are formed.
Second Cleavage : It is also meridional but it is at right angles to the first one. Because of this cleavage 4 equal blastomeres are formed.
Third & Fourth Cleavage: It is in double plane. Both are, in meridional way extending from animal pole to vegetal pole. 8 micromeres and 8 macromeres are resulted

- **Fifth Cleavage'**: It is latitudinal. It is in double plane. 32 celled stage is reached.

Sixth Cleavage: These divisions are approximately meridional. 64 blastomere are formed.

After the cleavage it is difficult to follow the cleavage pattern

Cleavage': The fertilised egg will become a multicellular structure only because of cleavage. The cleavage is initiated by the holoblastic division and approximately equal further.



Amphioxus - Cleavage

A. 1st Cleavage

B. 2nd Cleavage

C. 3rd Cleavage

D. 4th Cleavage

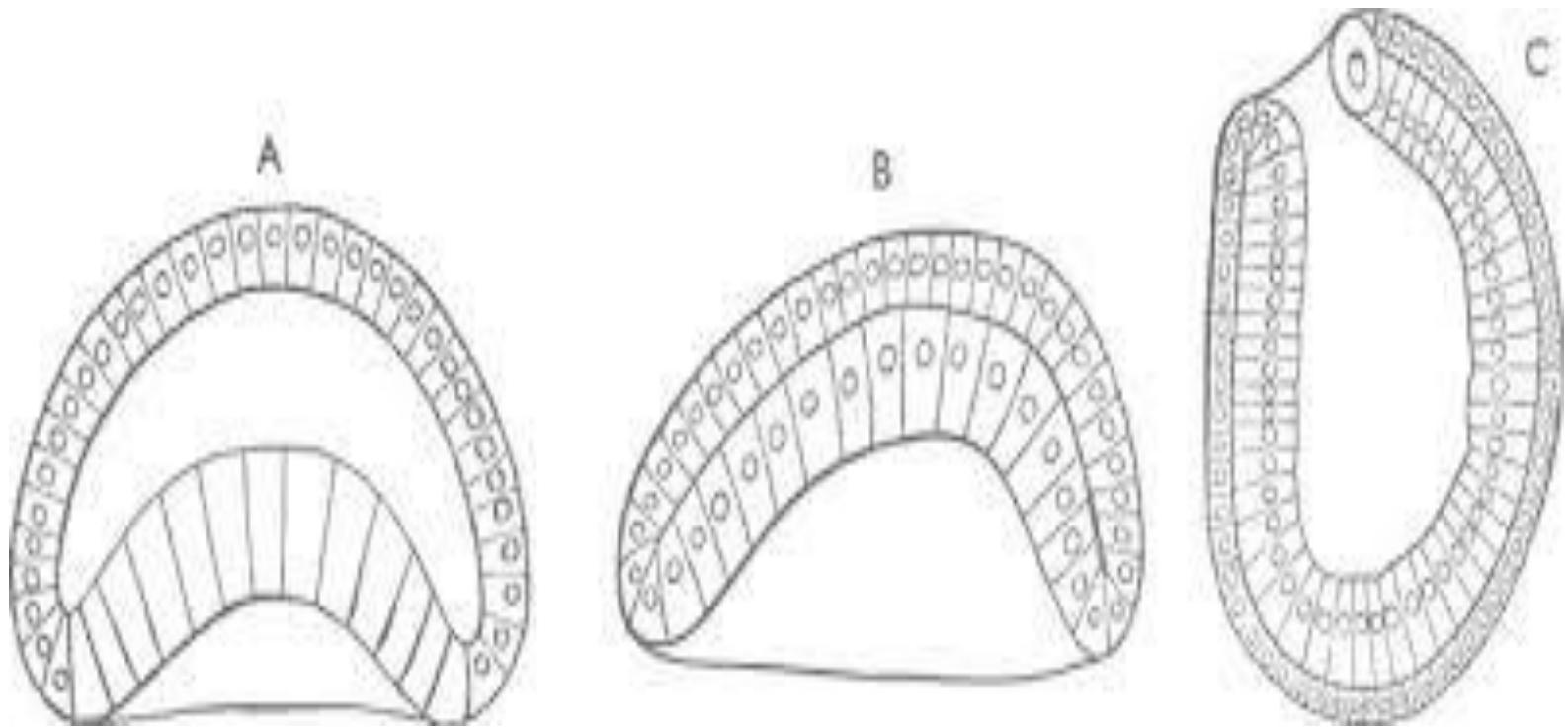
E. 5th Cleavage

- **BLASTULATION IN AMPHIOXUS** : From the 7th cleavage onwards irregular cleavages will occur. The cells of the vegetal pole will divide slowly where as the cells of the animal pole will divide in a quick way. Because of this blastomeres of the animal pole will be small and blastomeres towards vegetal pole will be bigger. The cells are loosely packed. It is called Morula. Then in the centre of the cell mass a jelly substance appear. It will push the blastomeres outside. Hence a single layered blastula is formed. It includes a fluid filled cavity called blastocoel. This is called blastula stage. The blastocoel appears at the 4 celled stage as the cells are round and then do not unite.

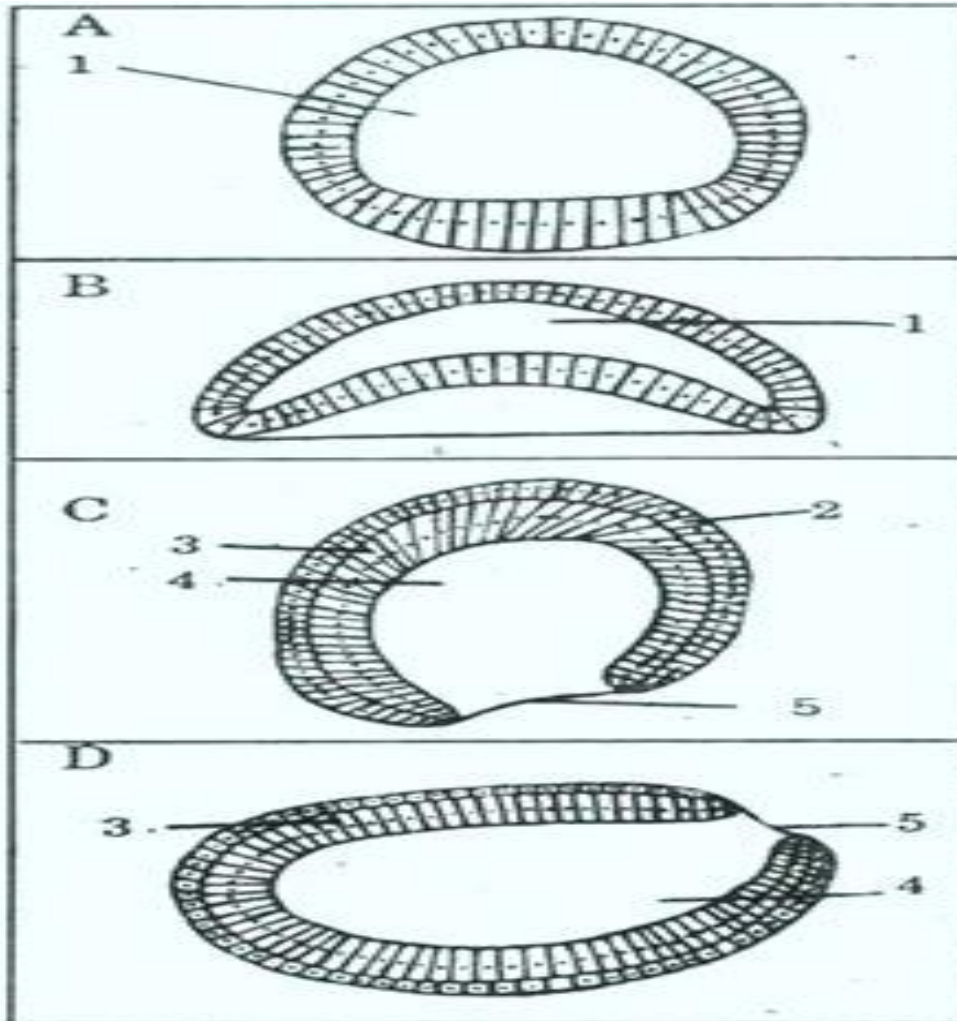
- Thus apertures at the poles lead into a central cavity. Further meridional and latitudinal divisions takes place and the embryo becomes a **blastula**.(I,K).
- It now encloses a spacious blastocoels
- The cells on its lower pole (megameres) are larger than the closer approximation of the cells

- Invagination takes place due to the rapid multiplication of the micromeres. The lower pole of the blastula is gradually pushed in until the whole lower hemisphere is in complete contact with the upper hemisphere and the blastocoel is obliterated.
- Thus Gastrula is formed

Three stages in the formation of the gastrula



DEVELOPMENT OF AMPHIOXUS



A, B, C, D - Amphioxus
-Gastrulation

A) Amphioxus - Blastula
1) Blastocoel

B) Amphioxus - Invagination
1) Blastocoel

C) & D) Amphioxus - Gastrula

2) Ectoderm

3) Endoderm

4) Archenteron

5) Blastopore

The gastrula takes place by the following ways. 1) Invagination, 2) Involution, and 3) Epiboly.

- As gastrulation begins the mitotic activity in the primitive ectoderm cells will increase. Whereas the endodermal blastomeres will not show mitotic activity. Because of this the endodermal cells of the vegetal pole will show invagination. In the beginning of the gastrulation the endodermal cells become plate like. This will show an inward or invagination, in the blastocoel. It gives way for the development of archenteron..

- When the invagination is carried on the blastocoel becomes obliterated. The embryo becomes cup shaped structures with two layer of cells. The opening is called blastopore. On the dorsal lip of archenteron notochordal cells are present

- **INVOLUTION IN AMPHIOXUS** : The notochordal cells should roll to the middle of the root of the archenteron. In the same way the mesodermal cells present on the ventral lip of the blastopore should roll inside. The movement of cell & inside is called involution.

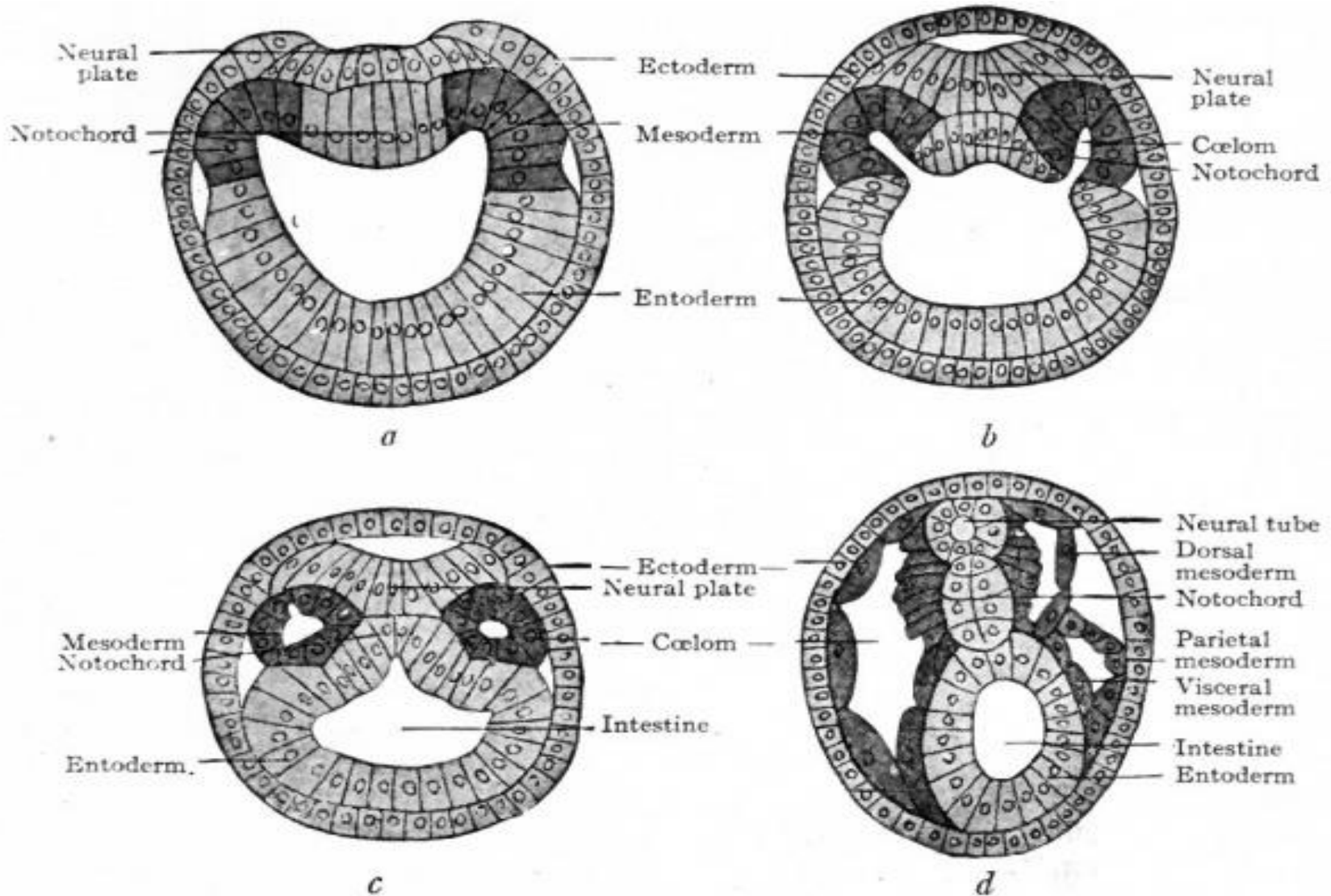
- **EPIBOLY IN AMPHIOXUS** : As the changes are taking place, the ectodermal cells of the animal pole will divide rapidly and they grow over the blastopore. This process is called epiboly. When the mesodermal crescent cells and notochordal crescent cells are totally shifted inside the lips of the blastopore will contract and the blastopore becomes very small. The two layered gastrula is formed. The outer ectoderm and inner endoderm with mesodermal notochordal crescent (cells) and central archenteron.

- Thus the gastrula has an outer layer of ciliated **ectoderm** cells, in which mid dorsally or cells of **neural plate and** ventro-laterally or cells of **epidermal ectoderm**, the inner cells of the gastrula have a mid –dorsal strip of **notochord** cells, on the two sides of which are **mesoderm** cells, and the lateral and ventral inner cells are **endoderm**

Fate of germ cells

The ectoderm will give rise to epidermis, nervous system and receptors. Endoderm will form the alimentary canal and mid gut diverticulum . Mesoderm will form muscles, connective tissue and germ cells

Four stages in the development of the notochord, nervous system and mesoderm



Formation of notochord nervous system and mesoderm

- The cells which were invaginated from the dorsal lip of the blastopore lie in the mid-dorsal roof of the archenteron.
- They evaginate dorsally at the anterior end of embryo and become separated from the endoderm
- This evagination of notochordal material also continuous caudally and ultimately forms a solid, cylindrical cord of cells which is called the notochord .It lies below the neural tube and between the mesodermal somites.
- It extends in the entire length of the body.
- A notochordal sheath of fibrous connective tissue will eventually surrounds the notochord

- While the central nervous system is thus being formed the wall of the archenteron develops dorso-laterally a pair of longitudinal folds develops(A & B)
- The cavities in these continues with the archenteron the transverse folds appears and divide the longitudinal folds into segments with the result that the archenteron comes to have appended to it dorso-laterally a paired series offshoots to become **coelomic pouches** arranged metamERICALLY .In this way segmentation is established
- At this period the embryo ruptures its containing membrane and begins free existence

- Now the coelomic pouches separate from the archenteron and forms series of closed **coelomic sacs or somites** , lying between ectoderm and endoderm from the wall of these sacs the **mesoderm** is derived .Their cavities unite and becomes the coelom
- While the coelomic sacs are in course of formation a median groove appears along the wall of the archenteron (fig C & D). It deepens so that its inner wall unite to become solid rod the **notochord** , which lies immediately beneath the nerve – tube
- New coelomic pouches are formed in regular order from before backwards, the embryo at the same time elongates and becomes laterally compressed and pointed
- At the anterior end the **mouth** appears on the left side of the body as a small aperture, which soon increases in size
- On the ventral surface another small aperture the **first gill-slit** makes its appearance and soon shifts over to the right side.

- Now it forms a direct communication between the pharynx and the exterior.
- The anterior end of the **alimentary canal** has meanwhile grown out into a pair of pouches which will be in the form of closed sacs
- Of these the right gives rise to the coelom of the head, and the left to a depression called the **preoral pit** which opens on the exterior and from which the groove of Hatschek and the wheel organ are formed afterwards. The preoral pit also gives **Hatschek's nephridium** a narrow ciliated tube which opens into the anterior part of the pharynx and runs forwards to terminate blindly in the roof of the oral hood. It disappears completely in the adult.

On the floor of the archenteron in the neighbourhood of the mouth a depression appears and give rise to a structure known as the **clup-shaped gland**, which may be a modified gill-cleft.

- Posteriorly the neurenteric canal closes and the anus appears
- In the mesoderm separate paired somites are arranged metamERICALLY in the dorsal region of the embryo these increase in size and extent both upwards and downwards forming **a somatic layer and a splanchnic layer**
- On the ventral surface of the notochord a horizontal partition is formed in each coelomic pouch separating it into a dorsal **myotome** and ventral portion called **lateral plate mesoderm** and its cavity forms a segment of the coelom

- Now the larva increase in size and becomes very long and narrow, with a pointed anterior end and a provisional caudal fin posteriorly
- As growth proceeds new segments are added behind . The notochord grows forwards to the anterior end of the snout, and the eye-spot and olfactory pit appears
- The later is a ectodermal pit which communicates with the neurocoel by the opening called neuropore
- The mouth attains a relatively immense size and remain on the left side additional gill-slits arise behind
- As growth proceeds the first or ventral series gradually travels over to the left side producing a symmetrical arrangement and at the same time the slit and the last five of the first or definitely left series close up and disappear

- While the development of the gill-slits is proceeding the formation of **atrium** takes place
- Paired longitudinal ridges, the metapleural folds appear on the ventral side of the body behind the gill-slits and gradually extend forwards dorsally
- Alimentary canal is formed immediately below the ventral body wall This canal is the commencement of the atrium
- The posterior opening remains as the atriopore, but the anterior opening becomes gradually shifted forwards as the fusion of the subatrial ridges proceeds . Finally it is completely closed. In this the gill-slit come to open not directly on the exterior, but into a cavity formed by the union of paired ridges of the body-wall and therefore lined by ectoderm

- The mouth gradually passes to the ventral surface and undergoes a relative diminution in size
- A fold of integument develops round it and forms the oral hood which is probably a **stomodaeum**
- The endostyle appears on the right of the pharynx and is at first rod-shaped, then V-shaped.
- Ultimately the limbs of the V unite in the middle ventral line
- The gill-slits increase in number and become more vertically elongated. The provisional caudal fin disappears .
- The gonads arise from the outer and ventral regions of the protovertebrae in the form of pouches, which gradually assume the permanent forms