Raiganj Surendranath Mahavidyalaya

Department of Zoology

UG Semester I

DC2: Non Chordates II (Coelomates)

Unit I: Evolution of Coelom

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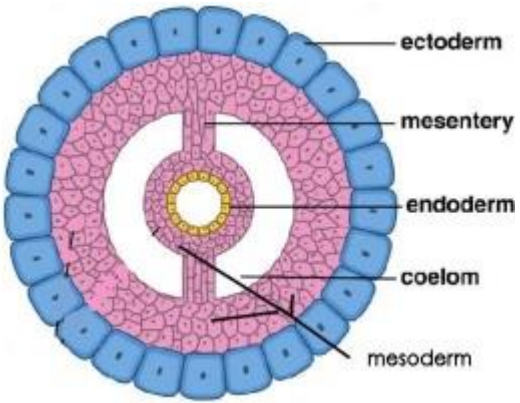
EVOLUTION OF COELOM

Definition: The coelom is the fluid-filled space inside the body of most animals in which is lodged the viscera and is surrounded by mesoderm on all its surfaces.



Features of Coelom:

1. Developmentally coelom arises as a split in the mesoderm which becomes bifurcated into two layers, a somatic layer lying next to the epidermis and a splanchnic layer around the endoderm.

2. Coelom becomes bounded on all sides by coelomic epithelium which secretes coelomic fluid.

3. The greater part of the coelom forms the perivisceral cavity or splanchnocoel.

4. In some higher animals part of the perivisceral cavity is kept separate to form restricted cavities.

5. The ancestral coelomate animals had segmentally arranged mesodermal pouches.

6. From these pouches gametes were formed by the process of proliferation of the epithelial lining.

7. Later on, these pouches became modified in structure and function.

Functions of Coelom and coelomic fluid

i. A coelom serves as a hydrostatic skeleton and a shock absorber.

ii. It can also support an immune system in the form of coelomocytes that may either be attached to the wall of the coelom or may float about in it freely.

iii. The coelom allows muscles to grow independently of the body wall — this feature can be seen in the digestive tract of tardigrades (water bears).

Definition: The fluid inside the coelom is known as coelomic fluid which is circulated by mesothelial cilia or by contraction of muscles in the body wall.

Functions:: The coelomic fluid mainly serves several functions: it acts as a hydroskeleton

i. it allows free movement and growth of internal organs

ii. it serves for transport of gases, nutrients and waste products around the body

iii. it allows storage of sperm and eggs during maturation; and it acts as a reservoir for waste.

Development of coelom:

During gastrulation stage, the developing digestive tube of an embryo forms as a blind pouch called the archenteron.

A. **Schizocoely:** In Protostomes, the coelom forms by a process known as schizocoely. The archenteron initially forms, and the mesoderm splits into two layers: the first attaches to the body wall or ectoderm, forming the parietal layer and the second surrounds the endoderm or alimentary canal forming the visceral layer. The space between the parietal layer and the visceral layer is known as the coelom or body cavity.

B. **Enterocoely:** In Deuterostomes, the coelom forms by enterocoely. The archenteron wall produces buds of mesoderm, and these mesodermal diverticula hollow to become the coelomic cavities. Deuterostomes are therefore known as enterocoelomates. Examples of deuterostome coelomates belong to three major clades:

chordates (vertebrates, tunicates, and lancelets), echinoderms (starfish, sea urchins, sea cucumbers), and hemichordates.

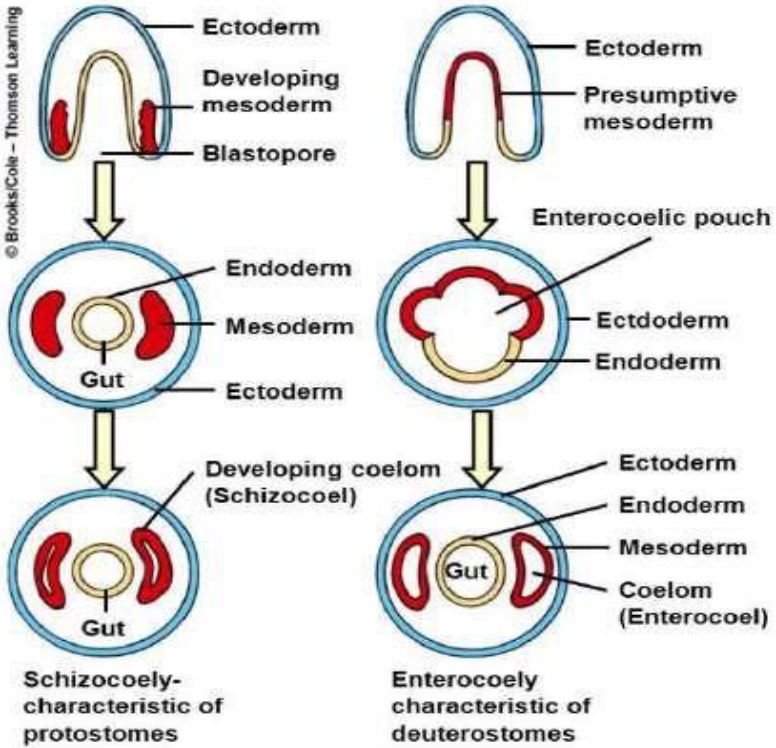


Table 5.3 : Differences between Protostomia and Deuterostomia

Characters	Protostomia	Deuterostomia
Blastopore gives rise to	Mouth	Anus
Formation of coelom	Schizocoel	Enterocoel
Cleavage type	Spiral determinate	Radial indeterminate
Larval type	Trochophore larva	Pluteus larva
Mesoderm formation	From 4d cells	From other cells

Types of Coelom:

There are three types of coelom, such as:

(i) Acoelom

(ii) Pseudocoelom

(iii) Coelom or Eucoelom.

(i) Acoelom:

It means 'without a coelom' or fluid-filled cavity is absent. The space between the gut and body wall is filled by a kind of densely packed connective tissue derived from both ectoderm and endomesoderm (entomesoderm), called parenchyme. Animals are without a body cavity in triplooblastic animals, called acoelomates and the group is referred to as acoelomata.

Examples:

Gnathostomulida, Platyhelminthes and Nemertea, Gastrotricha, Kinorhyncha.

(ii) Pseudocoelom:

It means 'false cavity'. The fluid-filled body cavity lying between the gut and outer body wall musculature and generally formed by persistence of em-bryonic blastocoel is called pseudocoel. The term 'pseudocoelom' usually refers to the space which does not develop from embryonic mesoderm and not lined by coelomic epithelium derived from the mesoderm. The body cavity is bounded externally by the fibrous processes of the longitudinal muscle cells (mesoderm) and internally by the intestine (endoderm).

The pseudocoelomic fluid acts as a hydrostatic skeleton to maintain body shape and circulate nutrients. Animals that contain a pseudocoel are called pseudo- coelmates or pseudocoelomate animals. Pseudocoelomate animals are also referred to as haemocoelomate or blastocoelomate animals (Brusca and Brusca, 2003).

Examples:

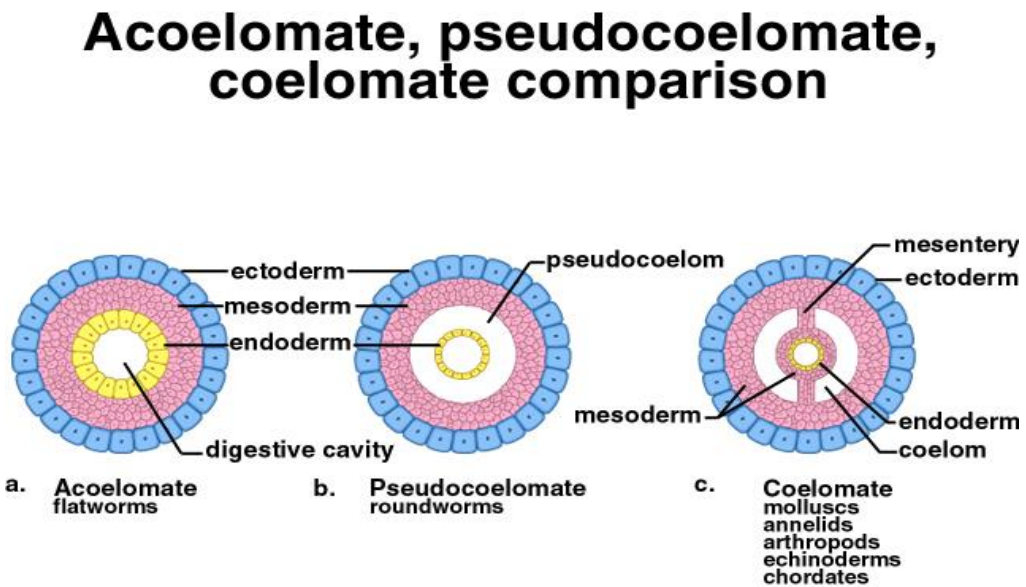
Rotifera, Nematoda, Nematomorpha, Loricifera. In small free-living nematodes, the pseudocoel is small or non-existent but may be voluminous in large-sized nematodes. The pseudocoel in Nematomorphos contains stellate mesenchymal cells. In rotifers, a spacious fluid-filled pseudocoel occurs beneath the body wall and surrounds the gut and other internal organs.

(iii) Coelom or Eucoelom:

It is a true coelom lying between the gut and outer body wall musculature and lined by coelomic epithelium derived from the embryonic mesoderm. It is a mesodermal origin and opens to the exterior through the coelomoducts, e.g., the oviducts and the excretory ducts. The coelomic fluid contains amoeboid cells or amoebocytes. The animals containing such a body cavity or coelom, called coelomates.

Examples:

Sipuncula, Echiura, Priapulida, Mollusca, Annelida, Arthropoda, Onychophora, Phoronida, Brachiopoda, Bryozoa, Echinodermata, Chaetognatha, Hemichordata and Chordata.



Origin and Evolution of Coelom:

The evolutionary origin of the coelom is uncertain. Initially two theories were proposed :

A. **The acoelomate theory:** which states that coelom evolved from an acoelomate ancestor.

B. **The enterocoel theory**: which states that coelom evolved from gastric pouches of cnidarian ancestors. This is supported by research on flatworms and small worms recently discovered in marine fauna.

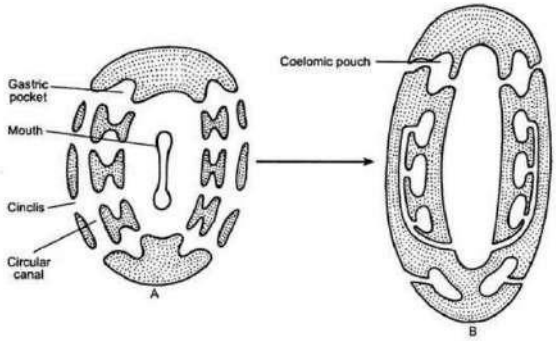
Later, Clark (1964) discussed four different theories to regarding origin and evolution of Coelom.

A. **Enterocoel theory—** First proposed by Lankester in 1877, supported by Lang (1881), Sedgwick (1884)

B. **Gonocoel theory -** (HatSchek, 1877, 1878), Bergh (1885), Meyer (1890), Goodrich (1946)

C. **Nephrocoel theory -** (Lankester, 1874, Snodgrass, 1938)

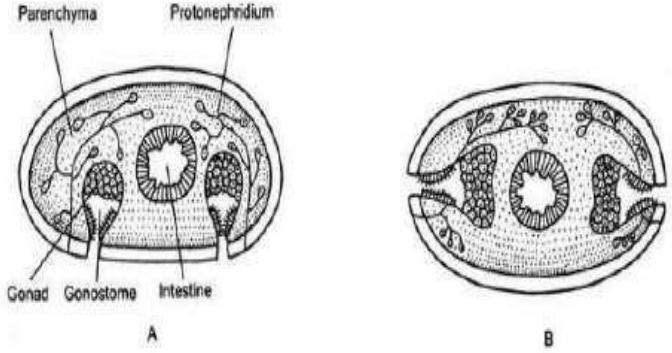
D. **Schizocoel theory -** (Clark, 1964)



A. Enterocoel theory: This theory argues that the coelom evolved from the gastric pouches of some cnidarians ancestors such as anthozoans or scyphozoans. These gastric pouches separated out from the main gastric cavity to form the coelomic pouches.

- This theory proposes that all bilateral animals are basically coelomate and that acoelomate forms like flatworms are secondarily derived from coelomate

ancestors by the loss of the cavity. The enterocoelous mode of coelom formation in the embryogeny of echinoderms, hemichordates and chordates is the main supporting evidence of this theory.



B. Gonocoel theory: It regards the coelom as the cavity of an expanded gonad and its origin is based on the common association between the gonads and the coelomic epithelium. Bergh believed that coelom initially arose in a segmented condition by enlargement and cavitation of the gonads after the release of gametes. One of the main drawbacks of this theory is

that it closely links the origin of coelom with the origin of metameric segmentation and hence it is difficult to account for the unsegmented coelomates. There is no evidence that the unsegmented coelomates have originated from the segmented ancestors. This theory has no embryological support because gonads do not arise before the coelom.

C. **Nephrocoel theory:** Proposed by Lankester in 1874. The coelom originated as an expanded nephridia. This theory however, was never taken seriously because protonephridia has been described in coelomates and also excretory organs are absent in some coelomates like echinoderms.

D. **Schizocoel theory:** According to this theory, the coelomates evolved from an ancestral acoelomate like flatworms by hollowing out of the parenchymal cells of the mesenchyme. Some of these cells formed the peritoneum. According to this theory, the acoelomate body plan is primary and ancestral to the coelomate plan.

- The acoelomate flatworms, thus, form the basic group in the evolution of bilateral animals. The schizocoel mode of coelom formation in the embryonic development of annelids and molluscs would claim as supporting evidence of this theory.