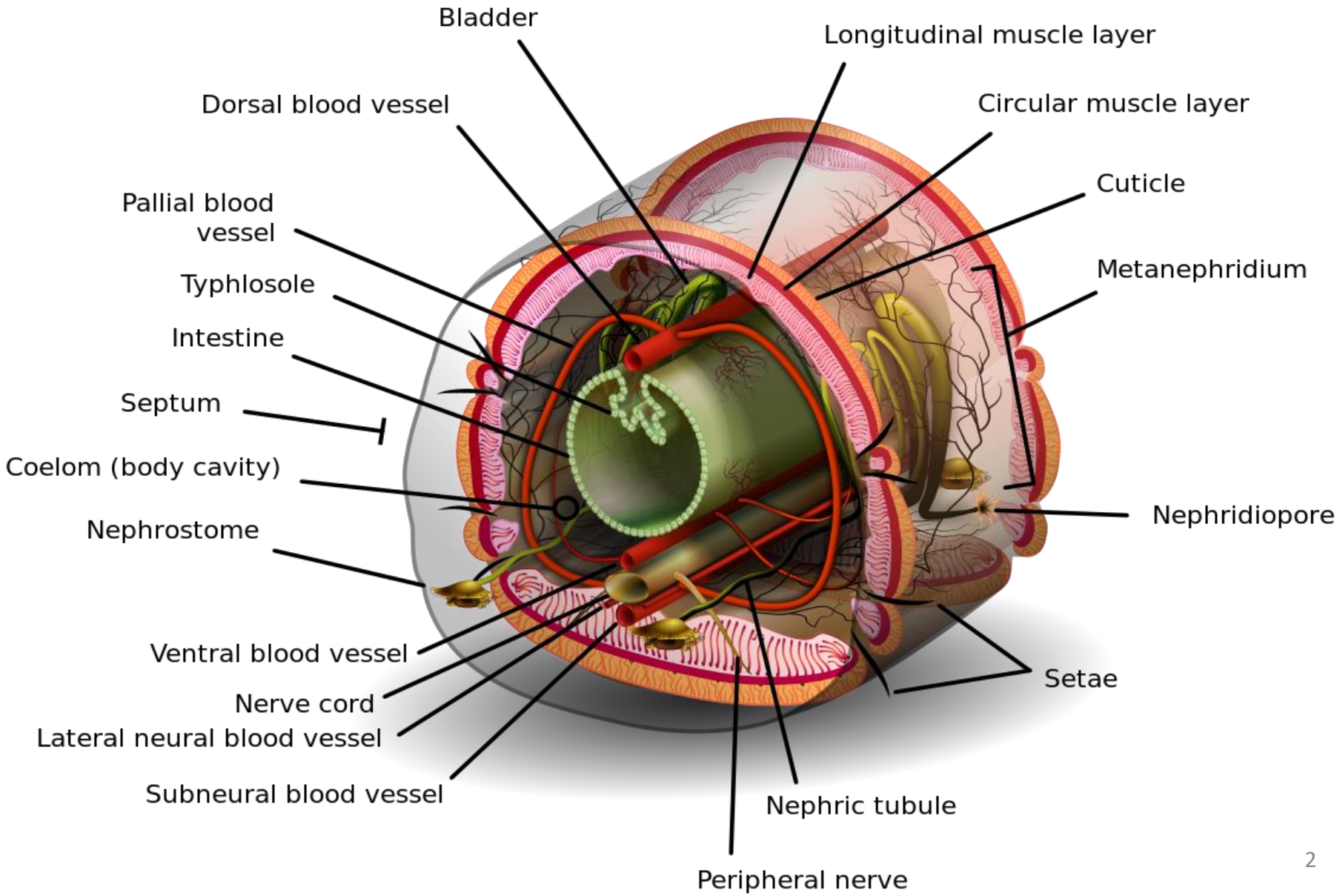
SEMESTER IIH-ZOOACOR03T

Zoology Honours

UNIT:1- Introduction to Coelomates

Coelom is the usually epithelium-lined space between the body wall and the digestive tract of metazoans above the lower worms. - Merriam-Webster Dicrtionary

Coelom


Bladder
Longitudinal muscle layer
Dorsal blood vessel
Circular muscle layer
Cuticle
Pallial blood vessel
Metanephridium
Typhlosole
Intestine
Septum
Coelom (body cavity)
Nephridiopore
Nephrostome
Ventral blood vessel
Setae
Nerve cord
Lateral neural blood vessel
Subneural blood vessel
Nephric tubule
Peripheral nerve

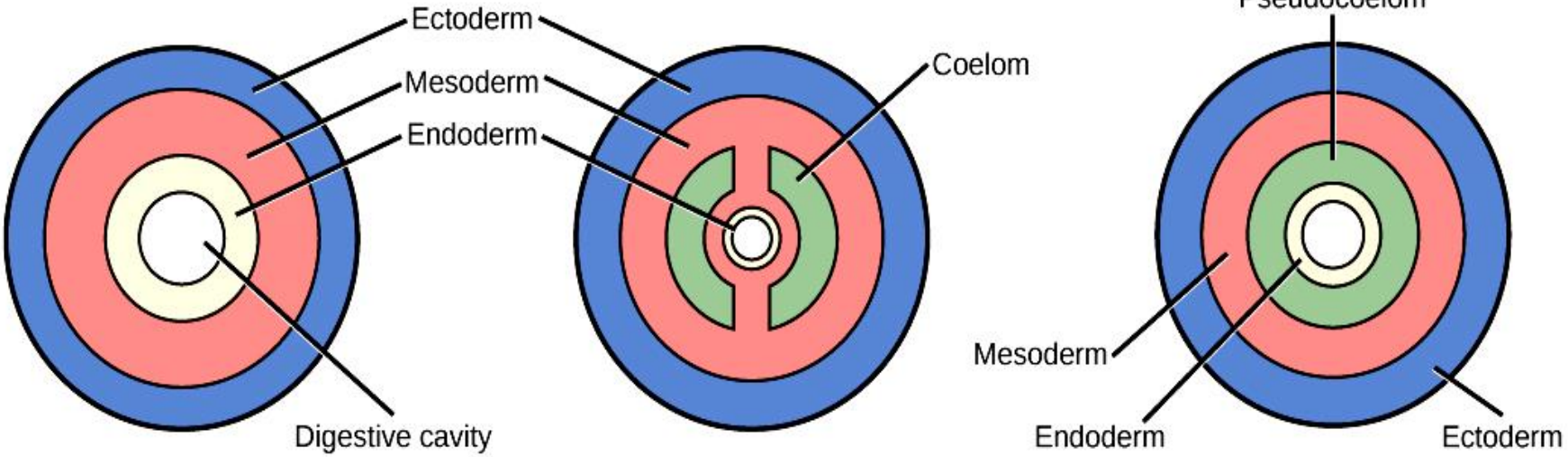
Coelom may be defined as a body cavity lined by epithelium derived from embryonic mesoderm.
Coelomic cavity is independent of adjacent connective tissue and gut compartment.
Organs form inside a coelom can freely move, grow and develop independently of body wall while the coelomic fluid **as potential 'shock-absorber' cousions, protects them from hydrostatic shock and provides function of circulation with specialization of aconnective tissue called the blood-vascular system, reproduction and excretion.** The transport system in all bilateralians are with coelom .
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.
Coelom becomes bounded on all sides by coelomic epithelium which secretes coelomic fluid.
The **greater part of the coelom** forms the perivisceral cavity or **splanchnocoel**.
Animals having a coelom are known as **coelomates.**

- **In vertebrates:** Also in **humans**,all mammalian embryoes develop true coelomic cavity; the **intra-embryonic coelom**-often contracted to the term of **mammalian coelomic cavity** which is lined by **somatic sphlanic lateral plate mesoderm** and **extra-embryonic coelom**- lined by **extraembryonic mesoderm** termed as **chorionic cavity**.**Large cavities enclosing the viscera,lungs, and heart are all coeloms**. The epithelial linings of the vertebrate coelom is a thin, noncontractile layer, called **peritonium,** which separates **the coelomic fluid from the underlying retroperitonial muscle and connective tissue.** Sub-dividing coelomic cavity to compartment as pericardial cavity or pericardium where heart simplyfies the discussion for the anatomy of complex animals.But few invertebrate coelomates actually have a vertebrate-like peritonium.
- **In Invertebrates:** the simplest and probably most primitive coelom, like that of segmented worms, **annelids**, and acorn worms, **hemichordates**; is lined by a simple epithelium composed largely of myoepithelial cells. The single epithelium simultaneously the body musculature and the coelomic lining. Coelom may be paired and arranged in a longitudinal series with vertical partition **mesentery** and longitudinally **septum** for specialization accuracy, as **genital coeloms** with gonads (**echinoderms,hemichordates**) and enclose **hearts as pericardia** (**molluscs, urochordates)** and vascular dominant form in **arthropods as heamocoel**.

Flatworm: *Pseudobiceros bedfordi*

Annelid: *Glycera*

Nematode: *Heterodera glycines*



(a) **Acoelomate** (flatworms)

(b) **Eucoelomate** (annelids, mollusks, arthropods, echinoderms, chordates)

(c) **Pseudocoelomate** (roundworms)

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 triploblastic animals, called **acoelomates** and the group is referred to as acoelomata. The coelom can be used for diffusion of gases and metabolites. As surface area to the volume ratio is large enough to allow absorption of nutrients and gas exchange while diffusion has been done along due to dorsoventral flattening.

Examples: Gnathostomulida, Platyhelminthes and Nemertea, Gastrotricha, Kinorhyncha.

Eucoelom or true coelom

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**- the oviducts and the excretory ducts. The coelomic fluid contains **amoeboid cells or amoebocytes**. The animals containing such a body cavity or coelom, called **eucoelomates**.

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

Pseudocoelom may be defined as the fluid-filled false body cavity occupies the space between the body wall and gut in a few phyla of protostomes, chiefly in aschelminthes.

- Pseudocoel lacks an epithelial lining like a blood space.
- A heart and vascular system absent in pseudocoeol.
- Diffusion and osmosis regulates the circulation of nutrients and removal of waste materials.
- Lack of skeleton: Hydrostatic pressure gives the body a supportive framework that act as a skeleton
- No segmentation is observed.
- They are mostly parasites in almost every stages of life; some are also free-living.
- The body cavity is bounded externally by the fibrous processes of the longitudinal muscle cells (mesoderm) and internally by the intestine (endoderm).
- Body wall- Epidermis and muscle often synsitial, usually covered by a cuticle.
- Examples include: Rotifera,, Acanthocephala (spine headed worms) , Aschelminthes, Entoprocta, Priapulida.

Relative Development of Coelomic and Vascular Compartments: Haemocoel and Coelomic fluids

- Among echinoderms, the coelomic compartments are not highly specialized for locomotion and skeletal support but have largely superseded the blood-vascular system for internal transport.
- **Haemocoel may be defined as a expansion of the blood filled cavity displaces the coelom and appropriates from it the functions of circulation with hydrostatic support**. Example: **Arthropods and Molluscs**; both have evolved rigid framework skeletons such as shells and exoskeletons.
- As in these cases, the role of the coelom in **hydrostatic support is diminished**, and **the blood-vascular system** and the other dominant connective tissues are **expanded to dominate the middle layer of the body**.
- The coelom generally persists, howevere, though much reduced in size, as gonadal cavities, pericardial cavities, or as specialized cavities for the receipt of primary urine from blood, often called **coelomosacs**.
- Invertebrate coelomic fluids has not been well-analyzed as blood but in general contains water, ions, low-molecular weight solutes and cells. **Circulatory cells** which **may or may not contain respiratory proteins or developing germ cells**; named as **Coelomocytes**.

Significance of Coelom: As a secondary body cavity after developed primary body cavity or blastocoel, coelom has its great significance.

- *The coelomic fluid content facilitates smooth transportation of particles or materials in solution.*
- *Coelom affords flexibility to the body and extends room for the movement of the gut which remains suspended.*
- *Gonads which develop from coelomic epithelium are housed in the cavity of the coelom. So also are the nephridial tubules, which connect the coelom to the exterior and in some cases allow the passage of eggs and sperms.*
- *The coelom filled with incompressible coelomic fluid acts as a hydrostatic skeleton and helps in locomotion.*

Evolution of coelom

An advanced in animal organization, no less important than the development of a mesoderm and internal musculature, is the appearance within the mesoderm of the cavity known as the coelom, as defined as a cavity arises within the endomesoderm and is therefore covered on its outer surface by the somatic mesoderm and on its inner surface by the splanchnic mesoderm; as secondary body cavity after primary cavity or blastocoel, the question of the evolutionary origin of the coelom has been much debated, but there is a lack of definite information, and conclusions can only be reached by inference.

- Four main theories have been proposed since the evolution of coelom is uncertain.
- **1. Enterocoel theory 2. Schizocoel theory 3. Gonocoel theory and 4. Nephrocoel theory**
- As Hyman points out in her analysis of these several theories, none is wholly free from difficulties.

Enterocoel (Gr. enteron= gut) theory— First proposed by Lankester in 1877, supported by Lang (1881), Sedgwick (1884):

This theory states that the coelom may have originated by evagination as pouch-like structures in the wall of embryonic archenteron.

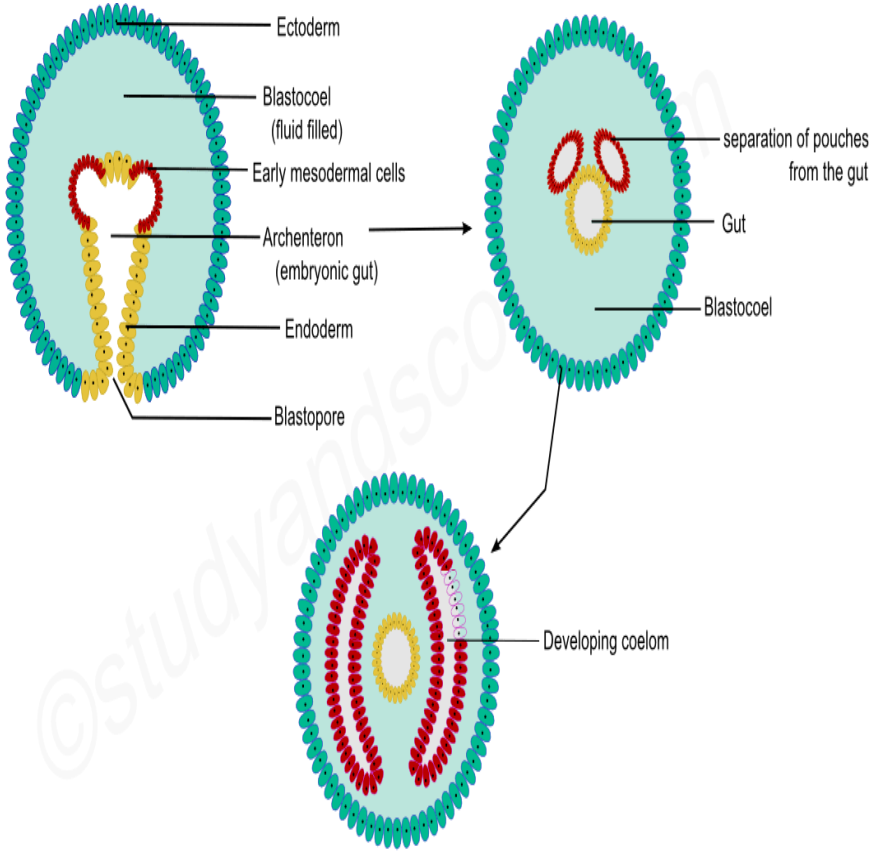
This type of coelom formation occurs in many existing enterocoelous animals- Echinoderms, Hemichordates and Chordates.

This concept was proposed by Lankester in 1877. Sedgwick (1884) suggested that the gastric pouches of Anthozoans (Cnidaria) became separated from the main gastric cavity (gastrovascular cavity) and were transformed into coelomic pouches.

According to this theory all bilateral animals are basically coelomate and acoelomate form secondarily derived from coelomate ancestors by loss of cavity. The enterocoelom mode of coelom formation in the embryogeny of echinoderms,hemichordates and chordates is the main supporting evidence of this theory.

This theory never gained much importance because it is difficult to postulate functional steps that have led to a change from coelomate to acoelomate and from bilateral to radial symmetry. In contrast, the ancestral position of flatworms among the bilaterism and the primitive nature of the acoelomate bodyplan has been widely accepted. Moreover, the gastric pouches occur in the more advanced Cnidarians such as Anthozoans and Schyphozoans which are not suitable for ancestral types. Also the enterocoel theory with origin of metameric segmentation,an association serve restriction on this theory.

Coelonteric pouches serve to increase digestive efficiency through specialization of cells while their mesenteries help to regulate the water content of hydrostatic skeleton . These advantages will be lost if the pouches seperated off as separate coelomic cavity.



ENTEROCOELOMATE

Ex: Phylum Echinodermata and Chordata

Schizocoel (Gr. Schizon= to split) theory (Clark, 1964):

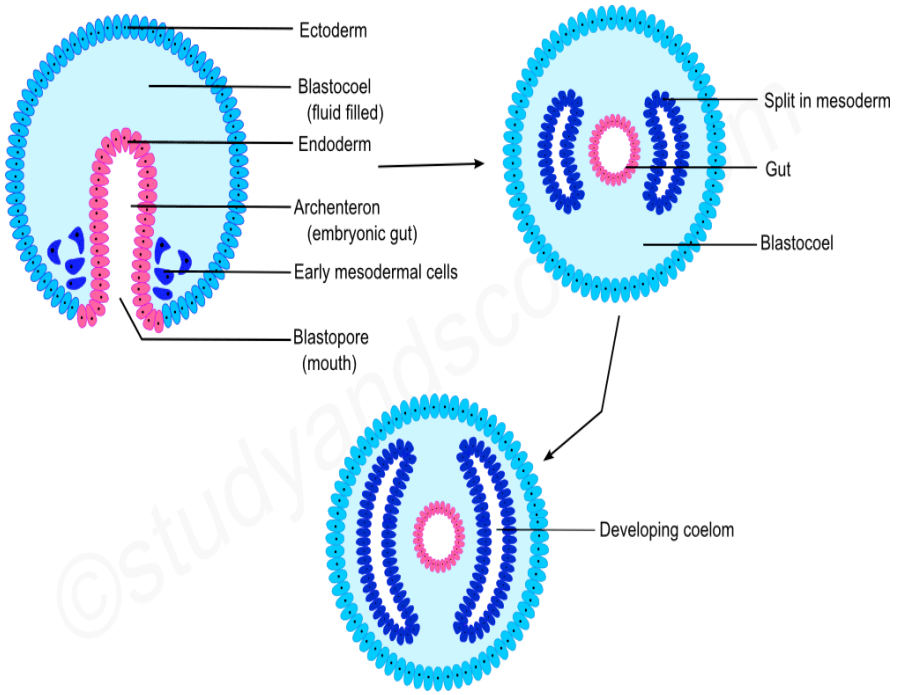
The theory states that the coelom could have evolved by the splitting of mesodermal plates.

This type of coelom formation occus in schizocoelic animals such as- Annelids, Arthropods and molluscs.

This theory is at first sight more plausible than either of the preceding theories, yet it has received little support.

According to this theory, the coelomates evolve from an ancestral acoelomate, like flateworms, by hollowing out of the parenchymal cells of the mesenchyme. Some of these cells would from the peritonium.

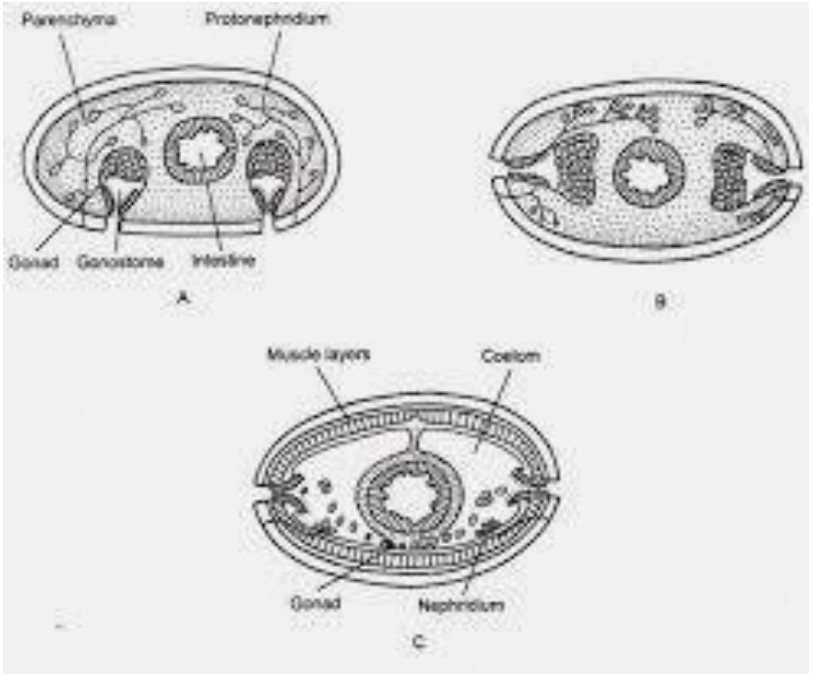
Also to this theory, the acoelomate body plan is primarily on ancestral to the coelomate plan. The acoelomate flatworms thus form the basic group in the evolution of bilateral animals. The schizocoel mode of coelom formation in the embryonic development of annelids and molluscs would claim as supporting evidence of this theory. However, the evolution of coelom is not related to gonads or endodermal pouches of lower forms.



SCHIZOCOELOMATE
Ex: Phylum Annelida, Arthropoda and Mollusca

Gonocoel (Gr. Gonos= genitals) theory (HatSchek, 1877, 1878), Bergh (1885), Meyer (1890), Goodrich (1946):

The origin of coelom in favour of gonocoel theory is that first coelomic cavities arose from the mesodermally derived expanded gonadal cavities and the cavities persisted after the release of gametes. For example, the gonads of tricladid flatworms are arranged in a linear order and the segmental coelom of annelida may have developed from this tricladid .



Bergh believed that coelom initially arouse in a segmented condition by enlargment and casitation of the gonads after the release of gametes.

One of the most favoured theory of four has its favourable points in the fact that describes that some acoelomate nemertines pass through a stage in which they possess a series of gonads with large and sometimes empty cavities; it is possible to visualize the further enlargement of these into the spacious coelomic cavities of annelids.

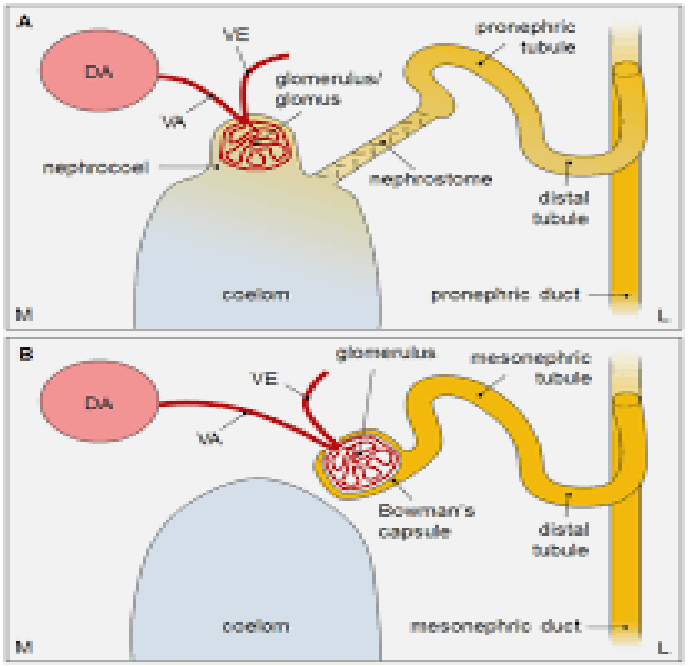
In this respect, however, it fails to explain why the germ cells often make their first appearance in regions other than the coelomic wall, and only reach this after considerable passage through the body.

Another support is to derive the coelom from serially repeated gonads is to imply that its origin was closely connected with the establishment of metamerism. Clearly this entirely fails to account for the existence of many unsegmented coelomate groups.

Nephrocoel (Gr. Nephros= relating to kidney) theory (Lankester, 1874, Snodgrass, 1938):

The theory states that the coelom originated from the expanded nephridia of flatworms. The chief objection of this theory is that the protonephridia have not recorded in all coelomates, even the echinoderms do not have excretory organs.

This theory is only of historical interest proposed first by Lankester .



This theory has never been taken seriously because protonephridia described in coelomates and also excretory organs are ab sent in some coelomates like echinoderms.

At that time of proposal, theory received few supporeters but when the relationship between nephridia and coelomoducts had still to be clarified.