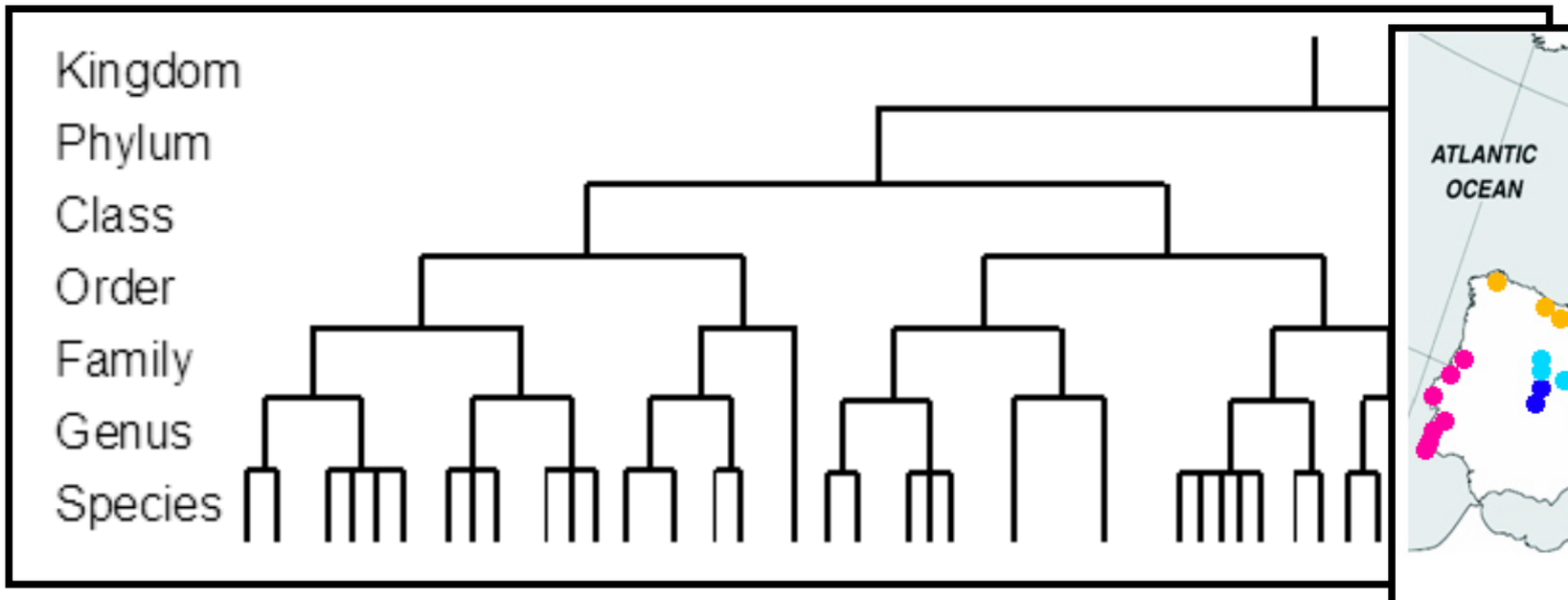
FISH310: Biology of Shellfishes

Lecture Slides #3
Phylogeny and Taxonomy

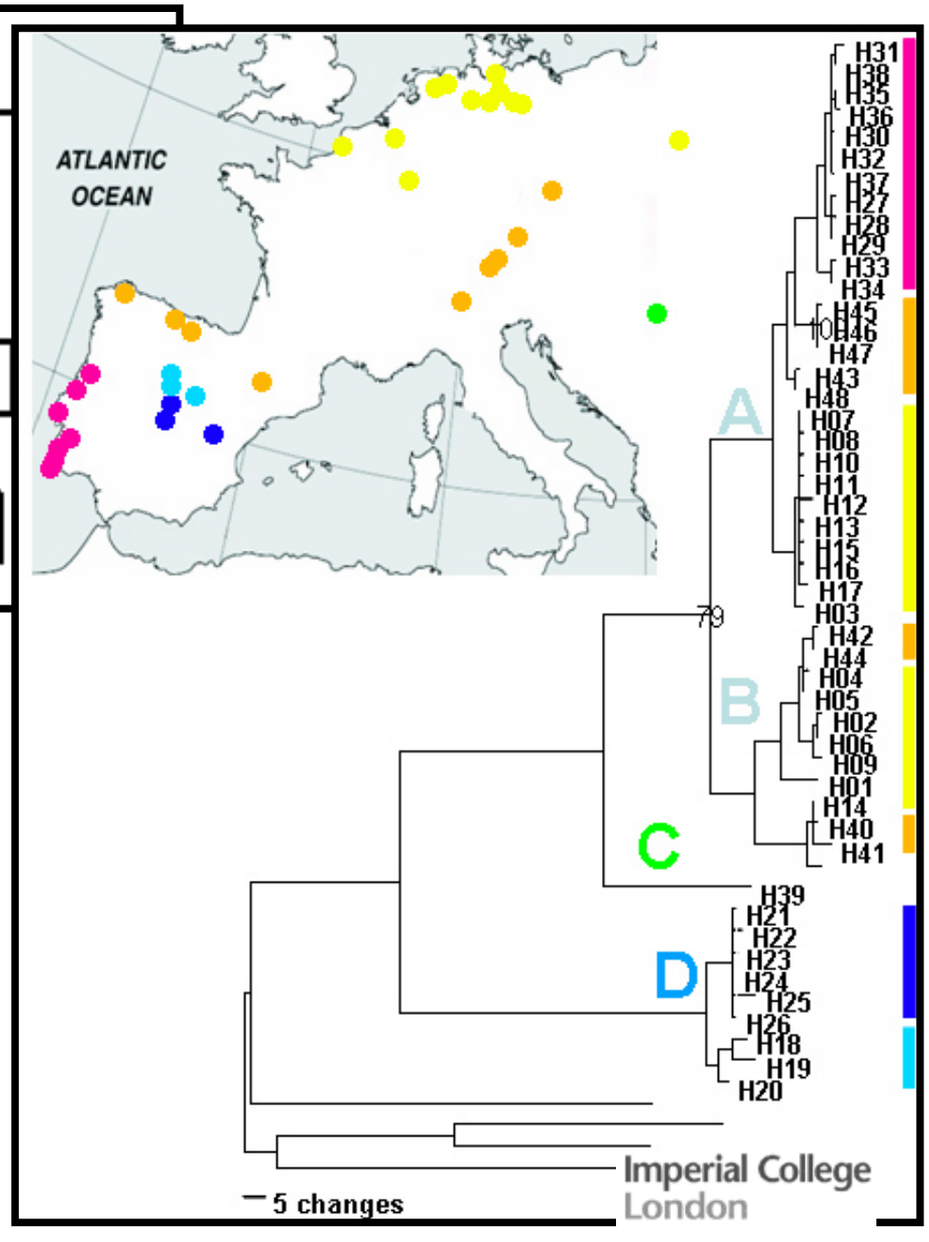
sorting organisms

How do we classify animals?

Taxonomy: naming



Systematics: working out relationships among organisms

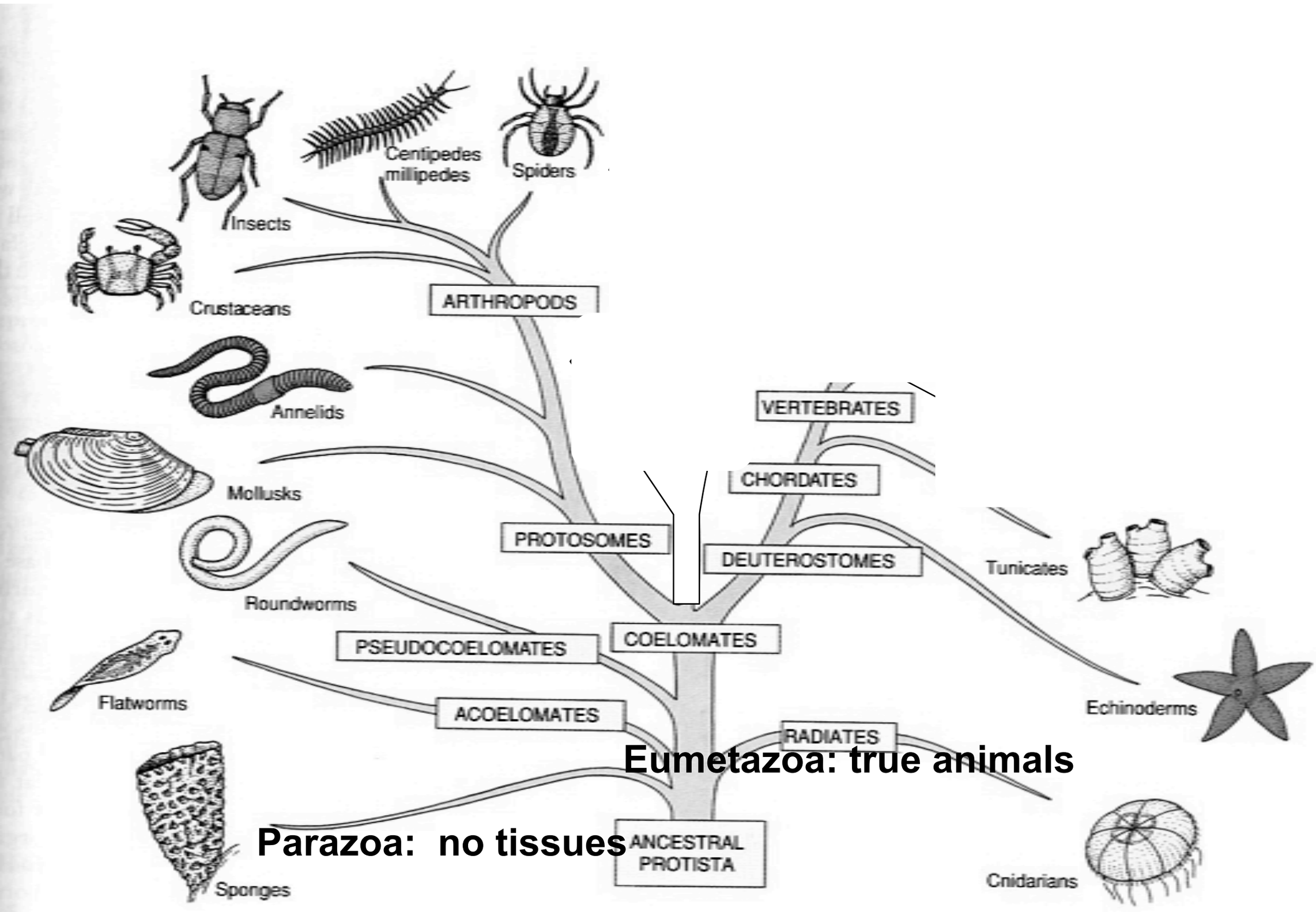


Disclaimer

Classification

- All classification schemes are, in part, artificial to impose order (need to start some where using some information)
  - Cell number:
    - Acellular, One cell (_____), or More than one cell (metazoa)
      - Metazoa: multicellular, usu 2N, develop from blastula
  - Body Symmetry
  - Developmental Pattern (Embryology)
  - Evolutionary Relationship

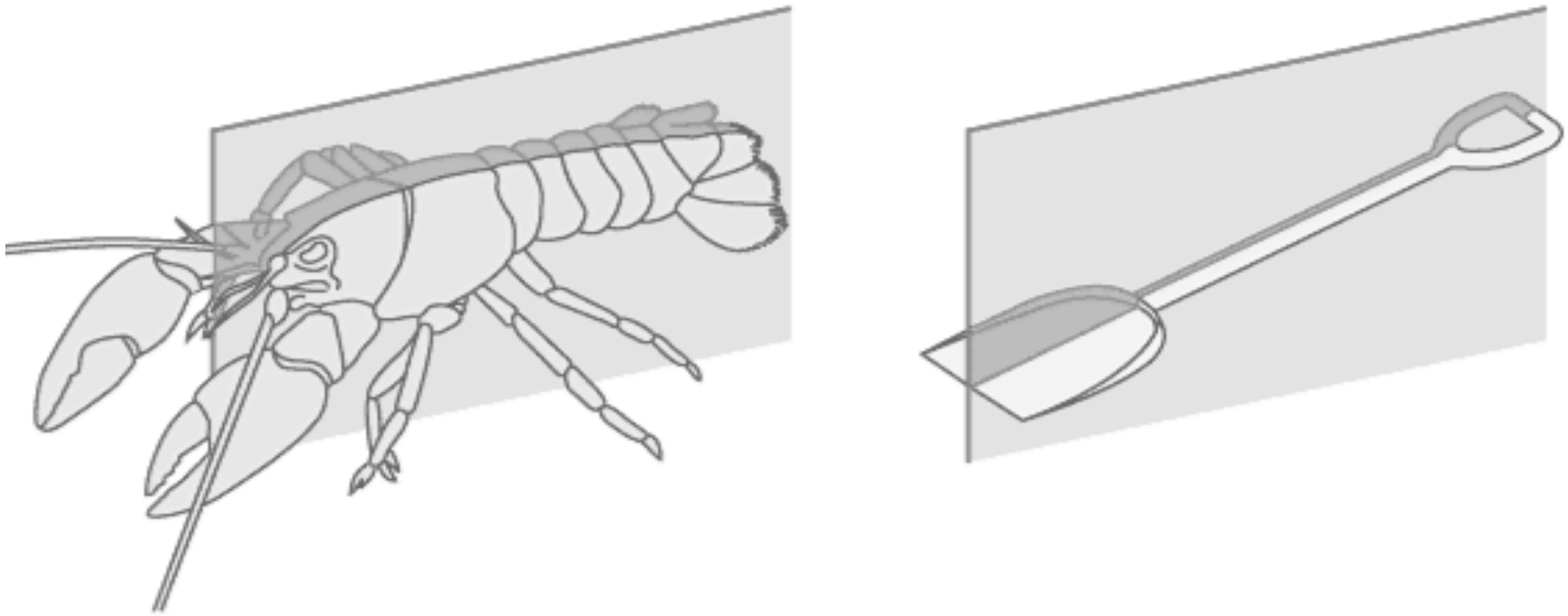
Animal Kingdom



Body Symmetry

- **Radial symmetry**
  - Phyla Cnidaria and Ctenophora
    - Known as Radiata
  - Any cut through center → 2 ~ "mirror" pieces
- **Bilateral symmetry**
  - Other phyla
    - Bilateria
  - Cut longitudinally to achieve mirror halves
  - D**orsal** and **ventral** sides
  - A**nterior** and **posterior** ends
    - Cephalization and central nervous system
  - Left and right sides

(a) Radial symmetry



(b) Bilateral symmetry

Form and Life Style

- The symmetry of an animal generally fits its lifestyle
  - Sessile or planktonic organisms often have radial symmetry
    - Highest survival when meet the environment equally well from all sides
  - Actively moving animals have bilateral symmetry
    - Head end is usually first to encounter food, danger, and other stimuli

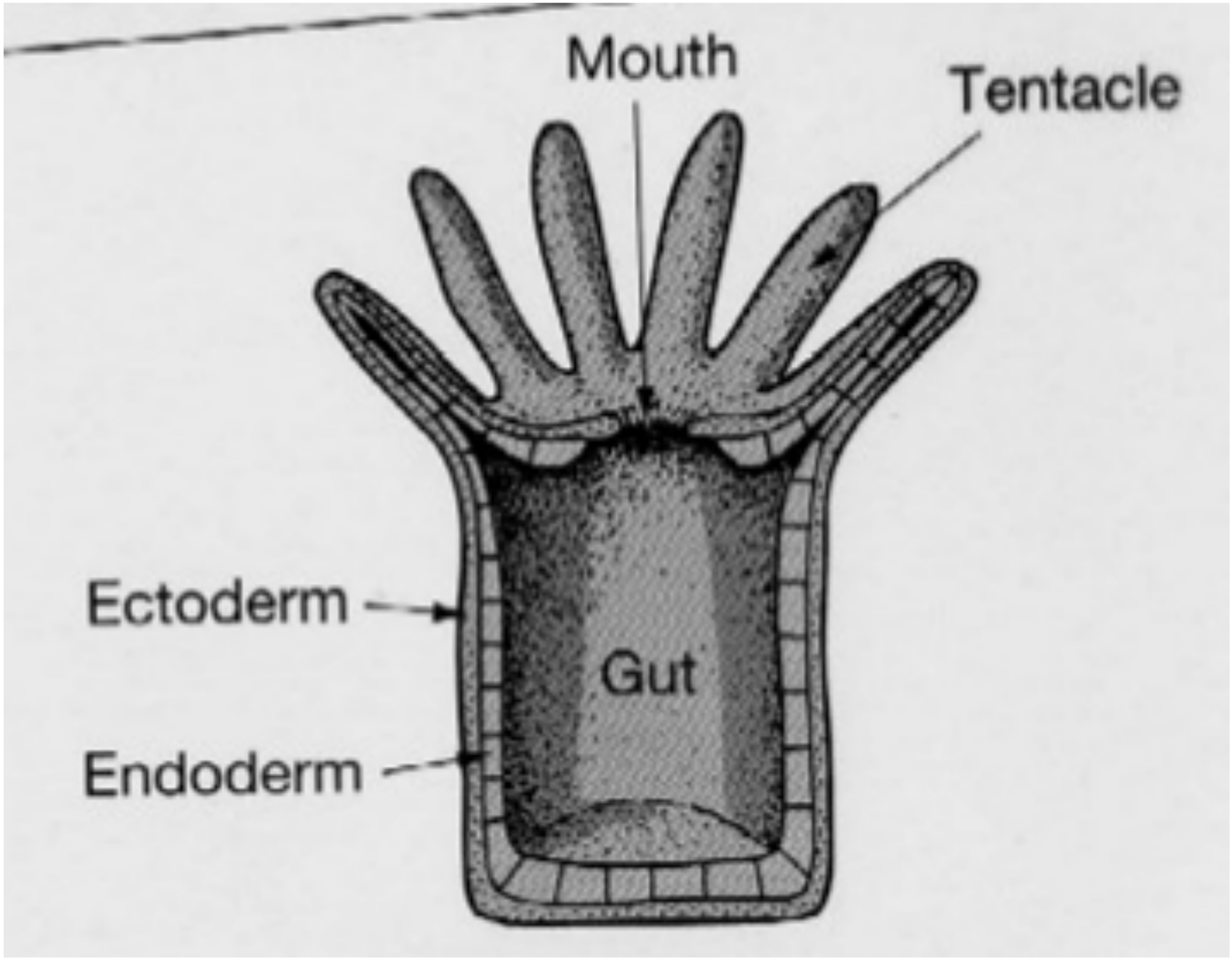
Developmental Pattern

- Metazoa divided into two groups based on number of **germ layers** formed during embryogenesis
  - differs between radiata and bilateria
    - Diploblastic
    - Triploblastic

Developmental Pattern..

- **Radiata** are **diploblastic:** two germ layers
  - **Ectoderm**, becomes the outer covering and, in some phyla, the central nervous system
  - **Endoderm** lines the developing digestive tube, or **archenteron**, becomes the lining of the digestive tract and organs derived from it, such as the liver and lungs of vertebrates

Diploblastic

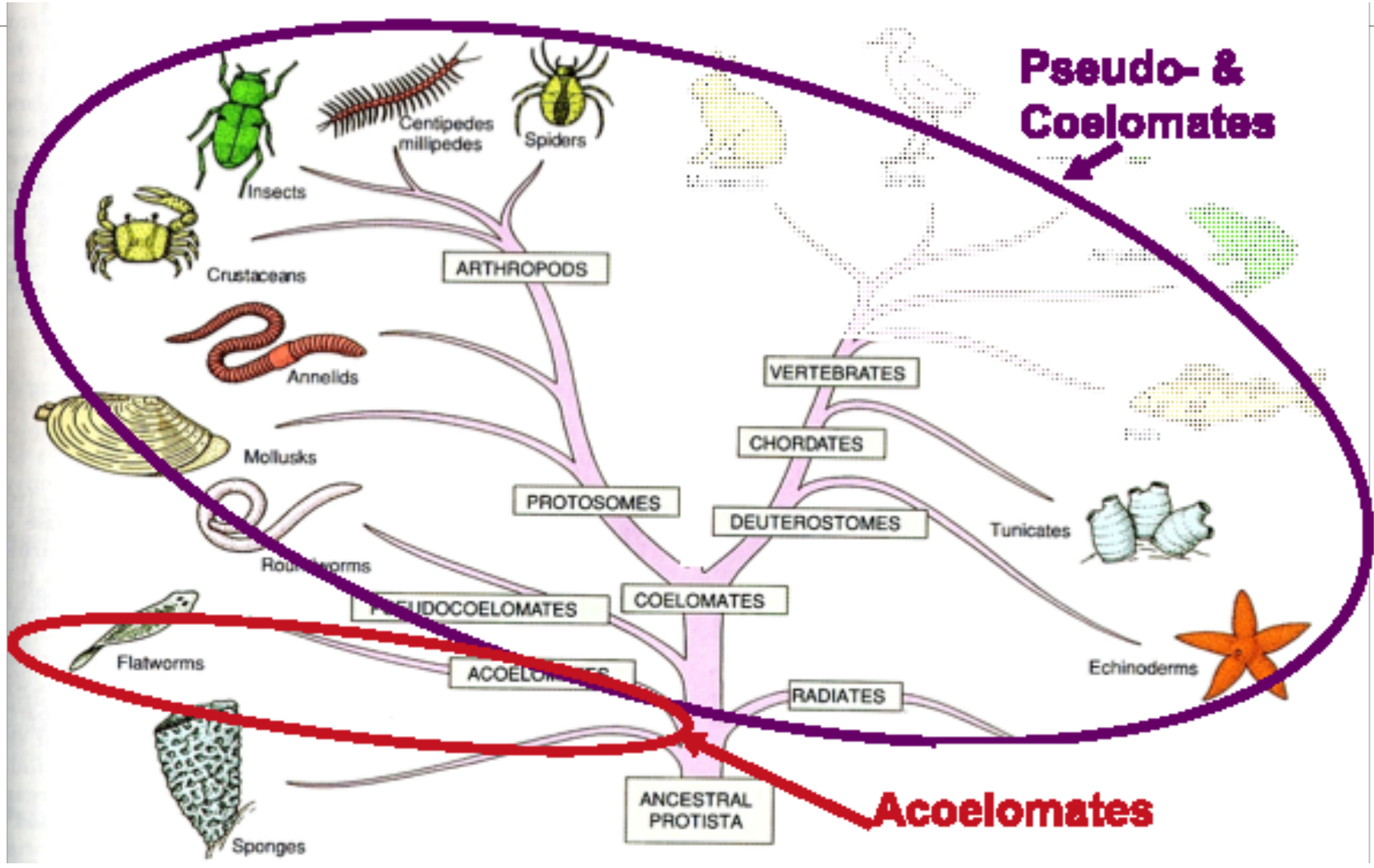


http://faculty.mccfl.edu/rizkf/OCE1001/Images/cnidaria1.jpg

Developmental Pattern….

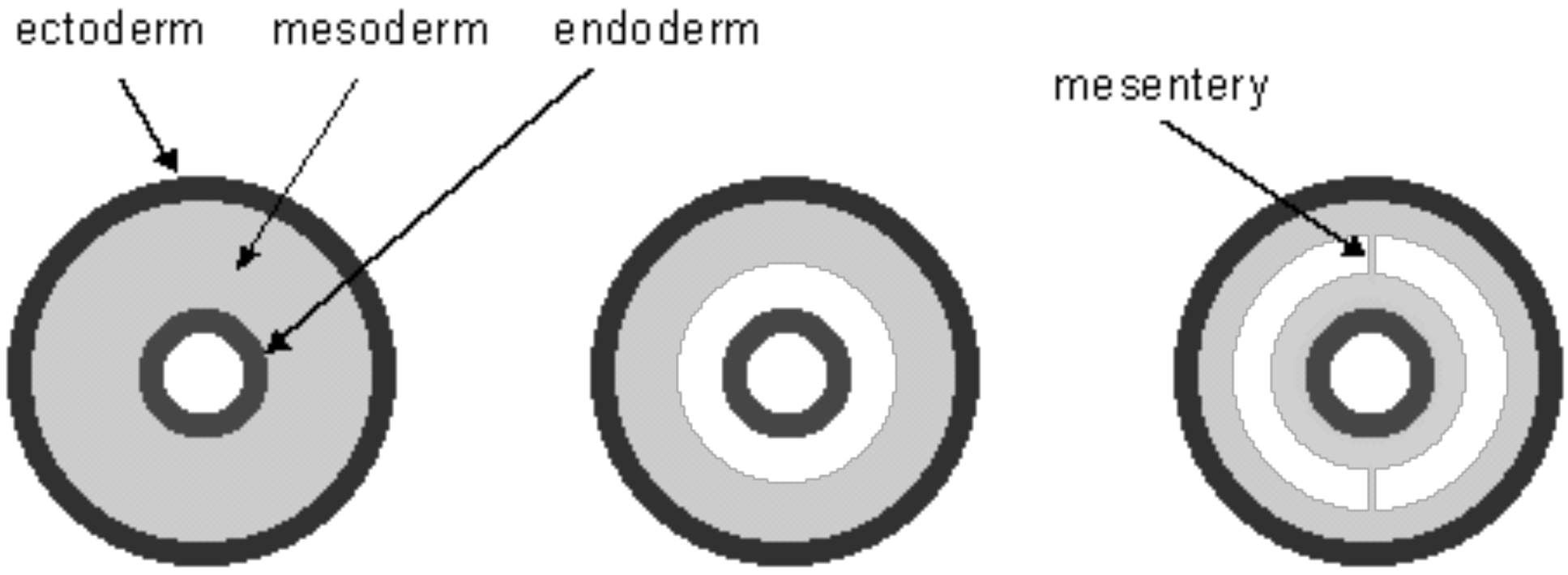
- **Bilateria** are **triploblastic**
  - The third germ layer, the **mesoderm,** lies between the endoderm and ectoderm
  - Mesoderm develops into the muscles and most other organs between the digestive tube and the outer covering of the animal

Triploblastic can* be classified into...



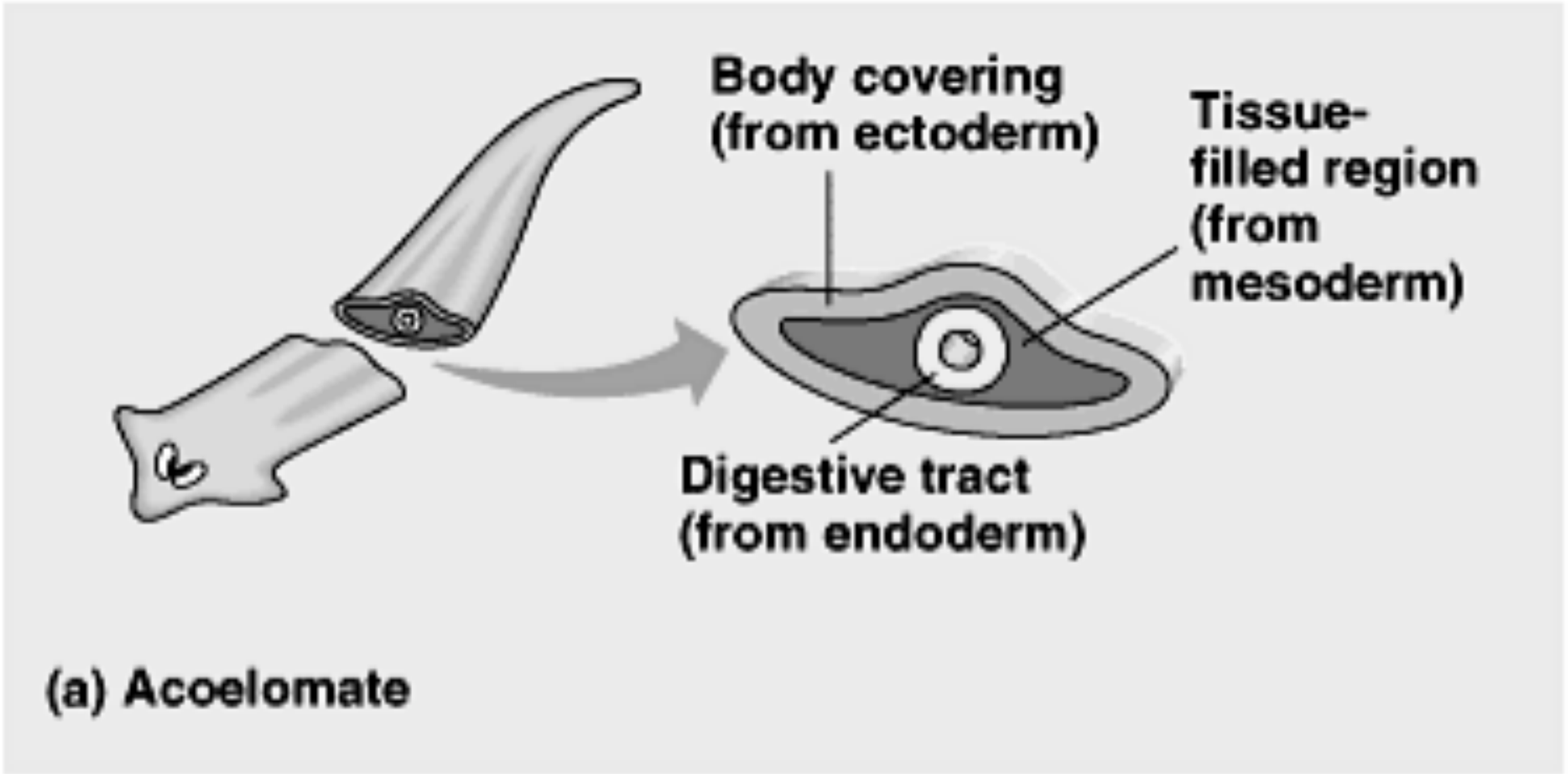
Body Cavity – To be or not to be?

- Coelom (true body cavity)
  - Presence resulted in production of a hydrostatic skeleton, an antagonist for circular and longitudinal muscles
    - Organs arise from mesoderm: mesenteries connect inner and outer mesoderm layers and suspend organs in the coelom → bigger, more complex animals -like us ☺

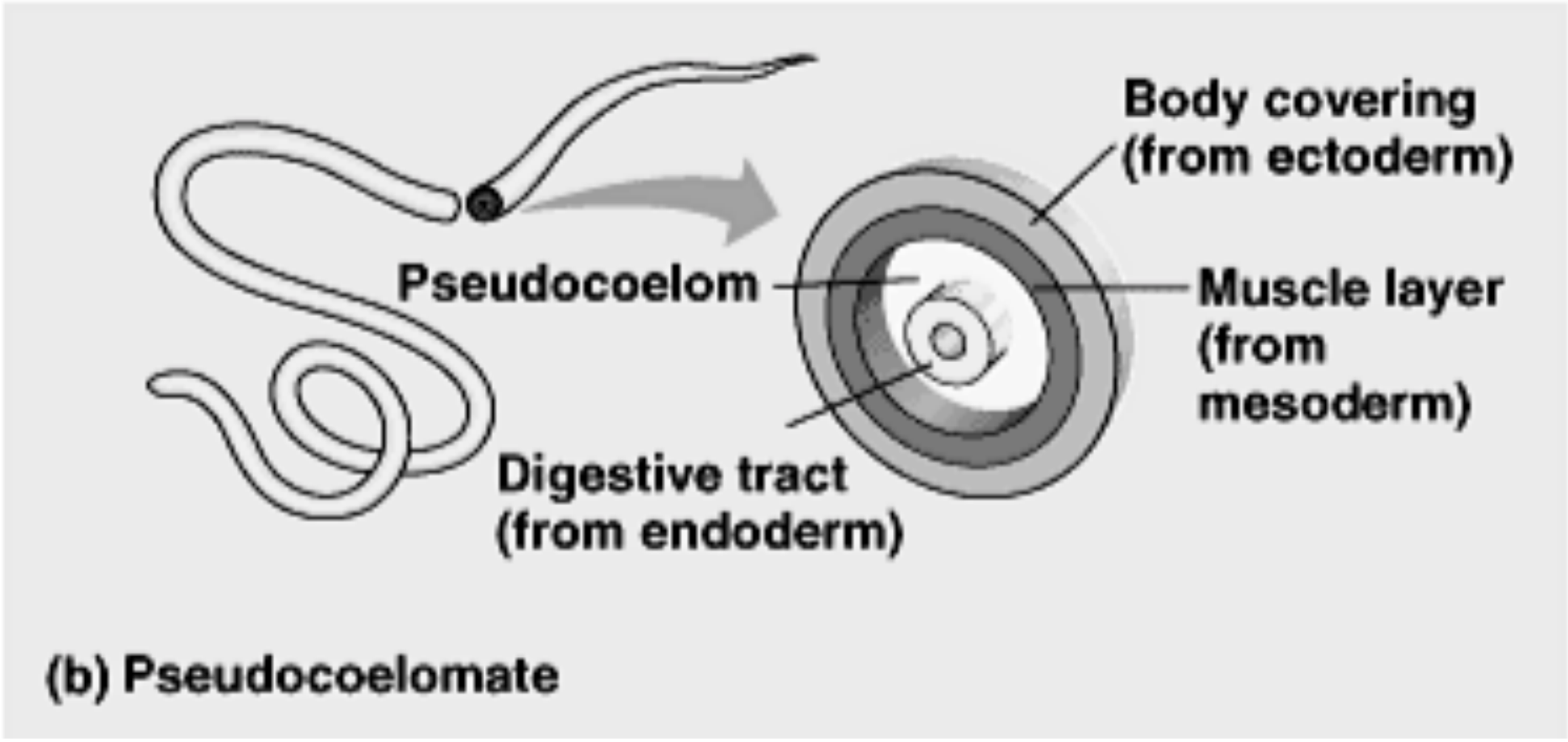


Text Figure

Acoelomate


Body covering
(from ectoderm)
Tissue-
filled region
(from
mesoderm)
Digestive tract
(from endoderm)
(a) Acoelomate

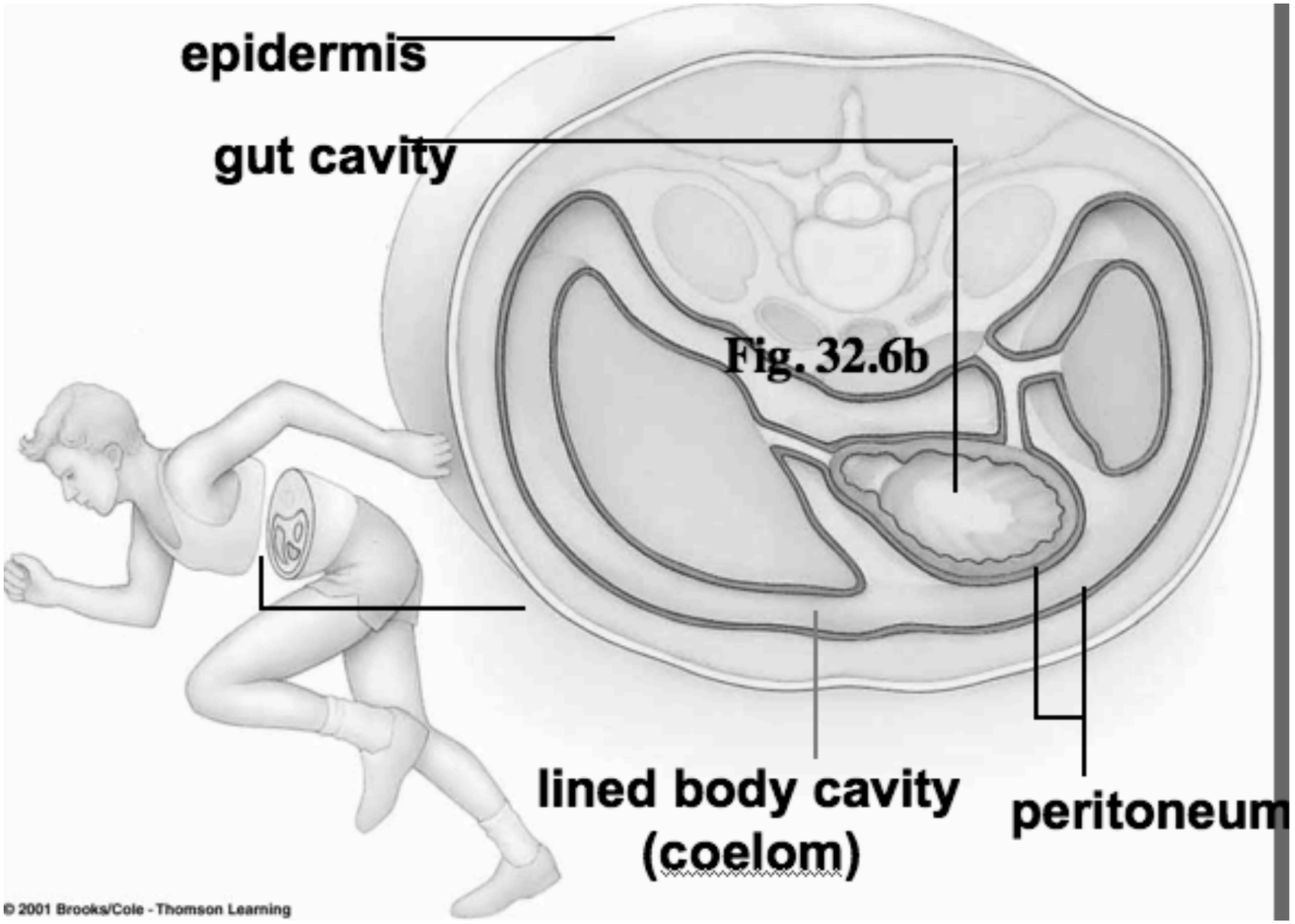
Pseudocoelomate



Body cavity (coelom), not completely lined by mesoderm, and derived from blastocoel

Coelomate

- Organisms with a true **coelom**, a fluid-filled body cavity completely lined by mesoderm



Body cavity functions and advantages

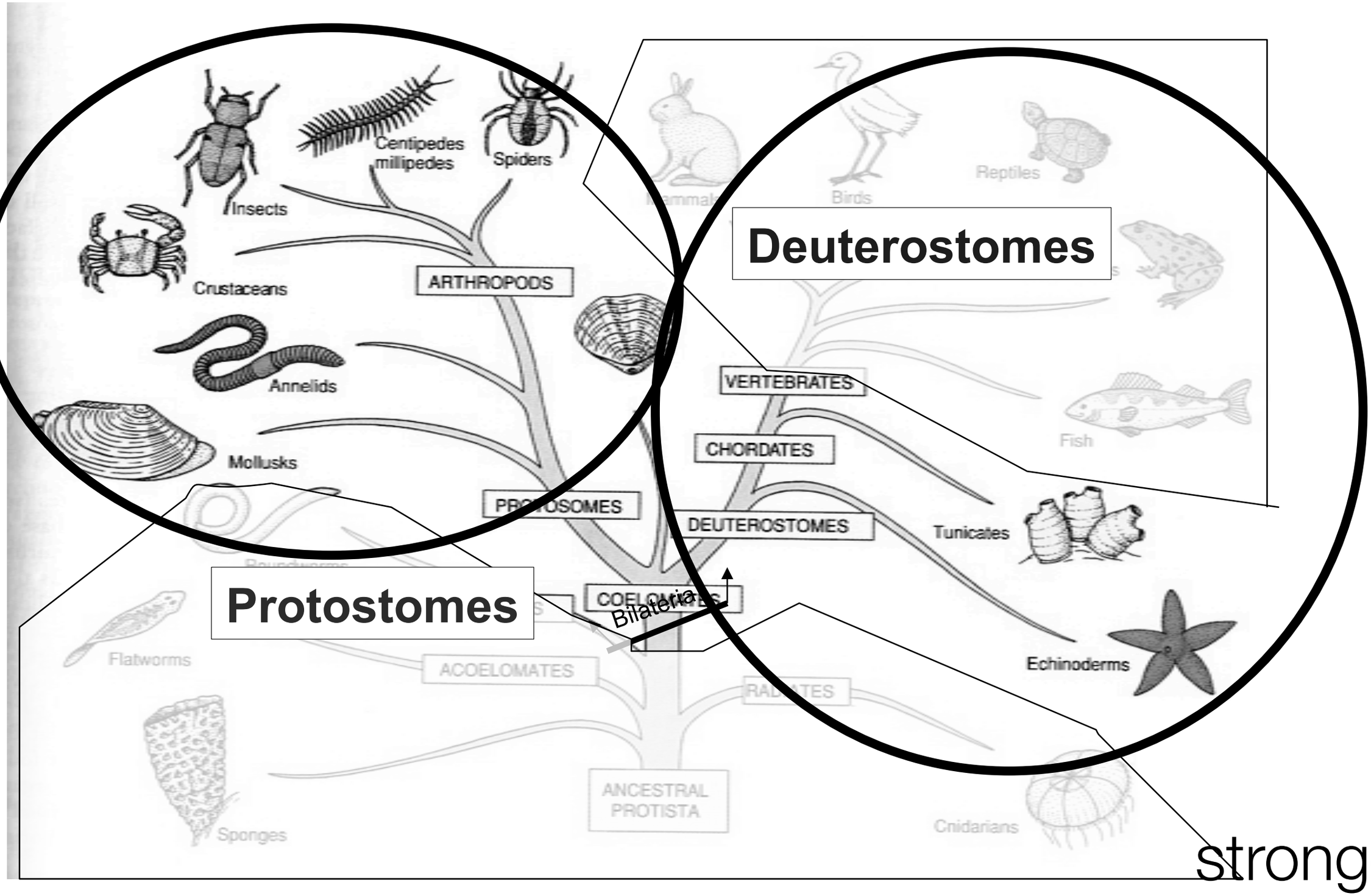
- Fluid cushions the internal organs, helping to prevent internal injury
- Essentially non-compressible fluid can function as a **hydrostatic skeleton** against which muscles can work → more effective movement
- Presence of the cavity enables the internal organs to grow and move independently of the outer body wall
- Evolution of larger body size

What this tells us about evolutionary relationship is ***uncertain***

acoelomate might not be primitive

Classification – Developmental Pattern

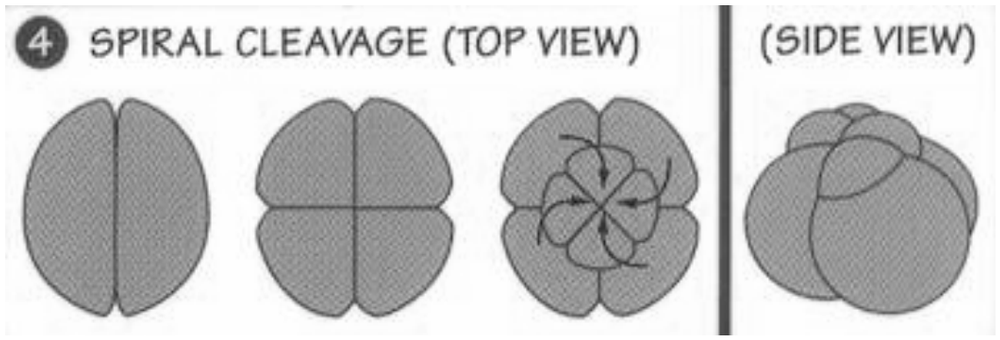
Divide coelomates further into:



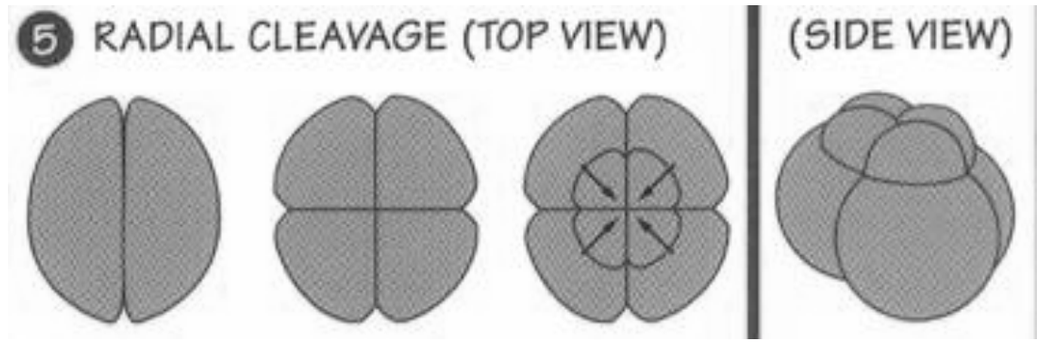
Classification – Developmental Pattern

- The coelomate phyla are divided into two categories or taxa **based on differences in their developmental cleavage pattern**, **coelom formation, and blastopore fate**
  - **Protostomes**: Molluscs, annelids, arthropods, and several other phyla
  - **Deuterostomes**: echinoderms, chordates, and some other phyla

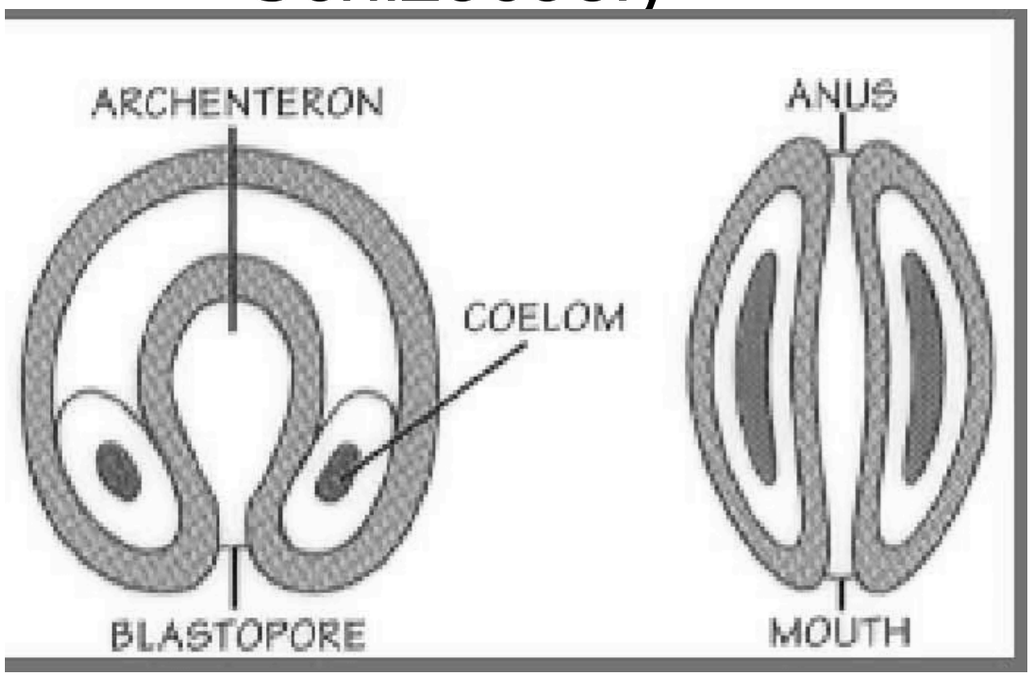
- PROTOSTOMES
  - Spiral Cleavage



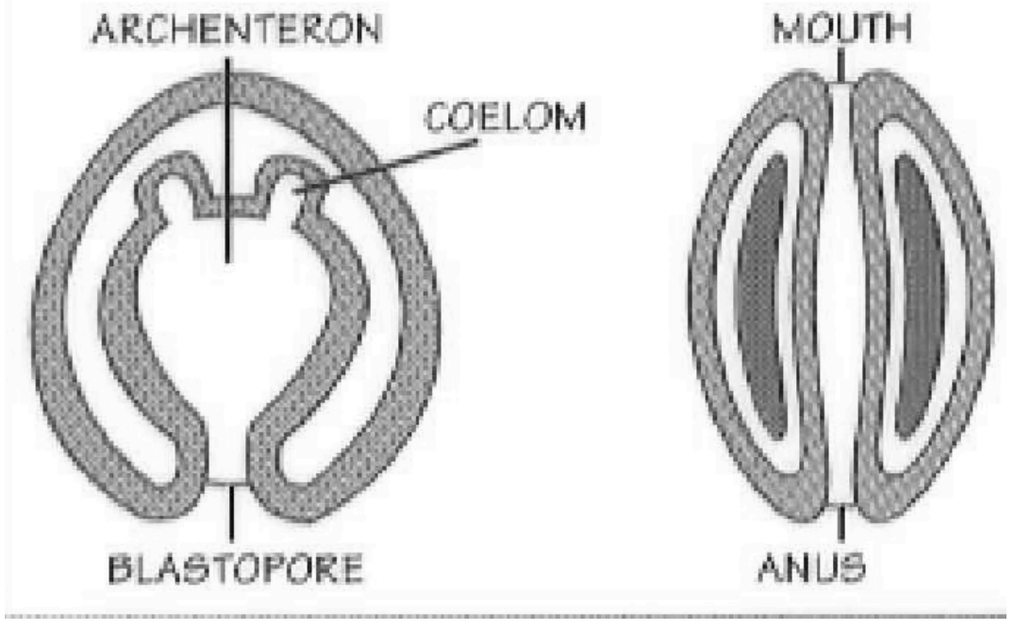
- DEUTEROSTOMES
  - Radial Cleavage



- PROTOSTOMES
  - Spiral Cleavage
  - Schizocoely



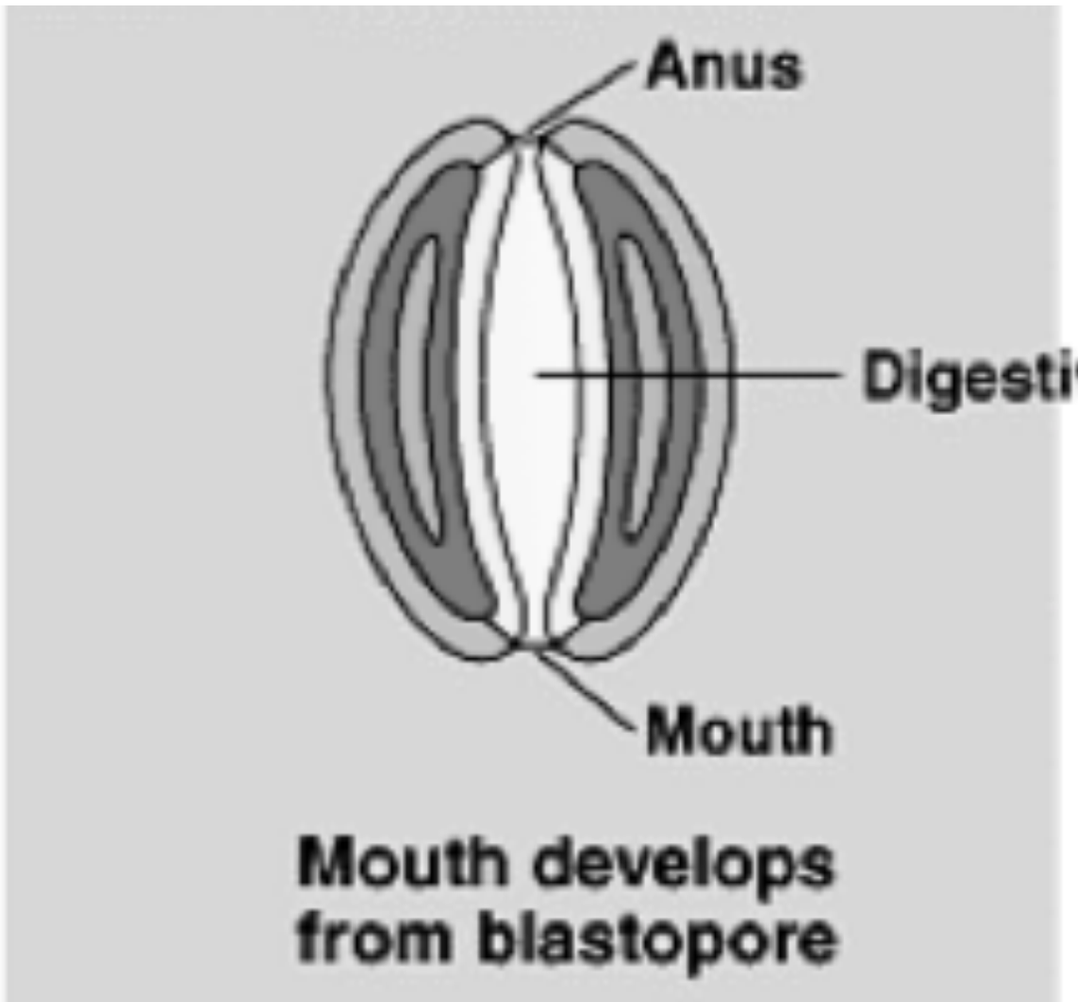
- DEUTEROSTOMES
  - Radial Cleavage
  - Enterocoely

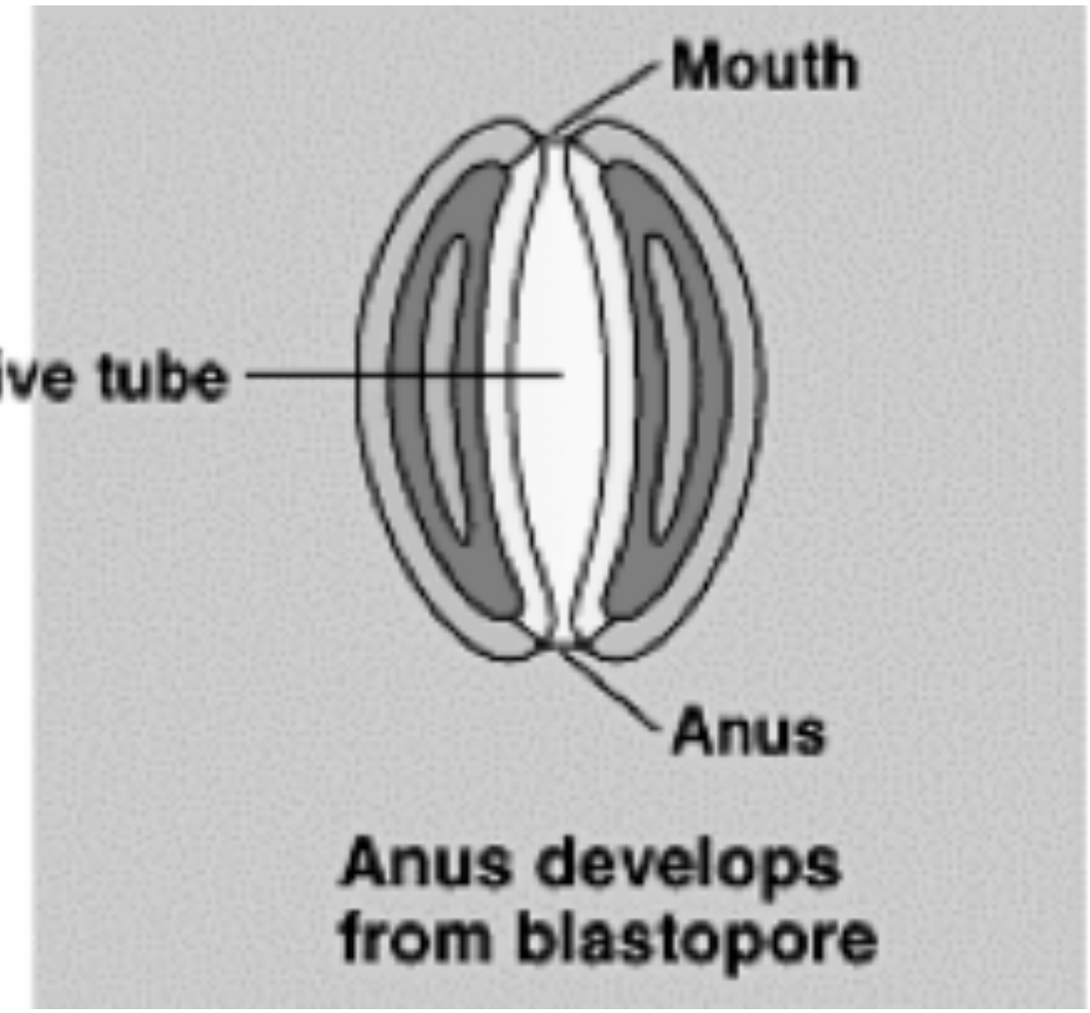


•**Schizocoelous development** (Protostomes): As archenteron forms solid masses of mesoderm, originating from 1 cell at 64 cell stage, split to form coelomic cavities

•**Enterocoelous development** (Deuterostomes): Mesoderm buds from wall of archenteron and hollows to become coelomic cavities

- PROTOSTOMES
  - Spiral Cleavage
  - Schizocoely
  - Determinant Development
  - Blastophore fate = mouth
- DEUTEROSTOMES
  - Radial Cleavage
  - Enterocoely
  - Indeterminate Development
  - Blastophore fate = anus





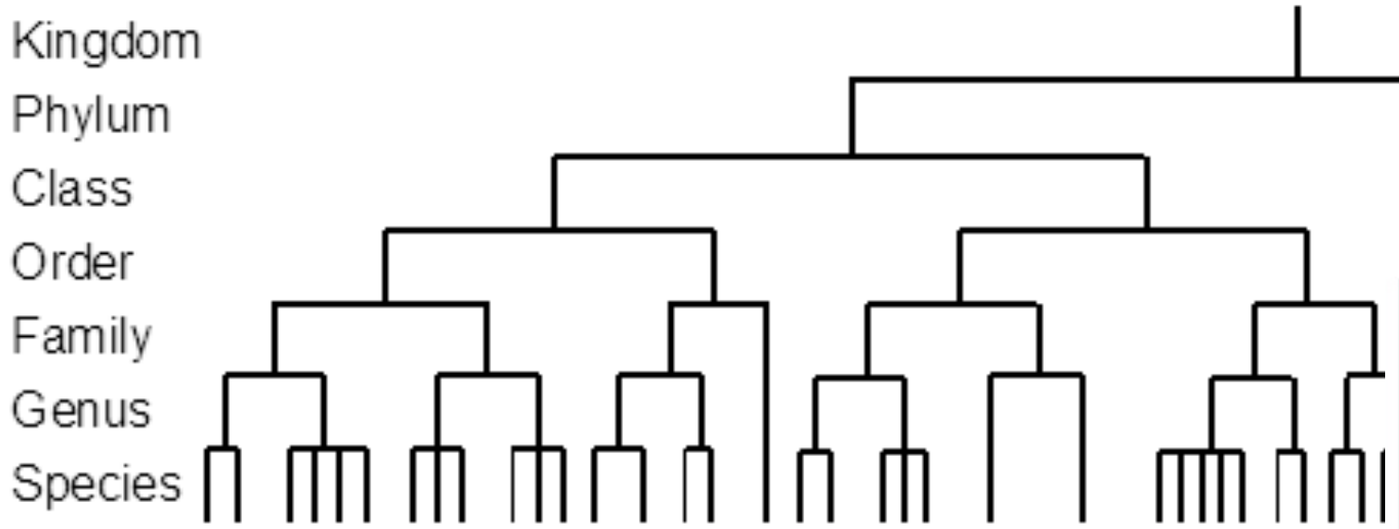
Classification via embryonic developmental patterns (protostome vs deuterostome) has held up to molecular scrutiny

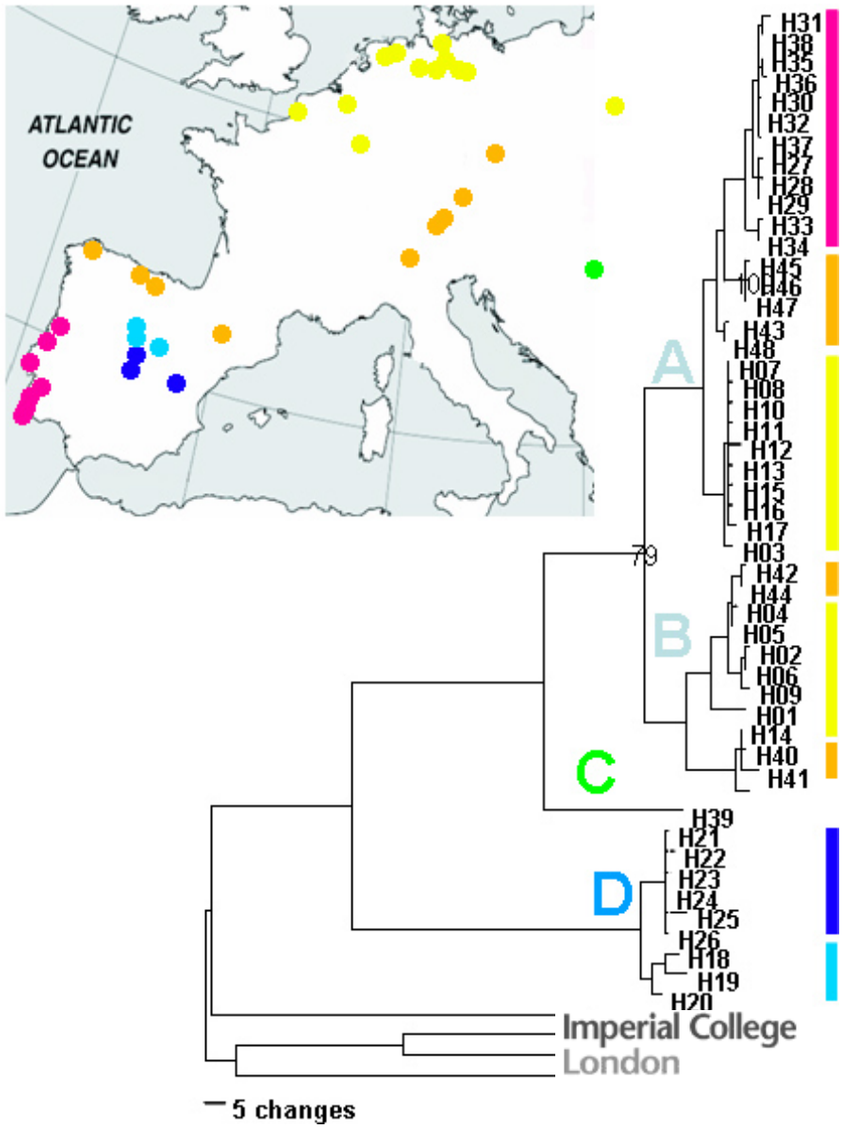
- However not all members share all characteristics:
  - Flat worms acoelomate but share rest of characteristics with protostomes
  - Crabs, insects and squid lack spiral or radial cleavage yet grouped as though cleavage patterns evolved from spiral ancestry

Summary of Evolutionary Trends

	Symmetry	Gut	Coelom	Embryonic Germ Layers
Sponges	asymmetrical	no gut		none
Cnidarians	radial	saclike		2, (tissues, no organs)
Flatworms	bilateral	saclike	Acoelomate	3, (tissues and organs)
Roundworms	bilateral	complete	Pseudocoelomate	
Mollusks **Annelids** **Arthropods** **Echinoderms** **Chordates**	bilateral	complete	Coelomate	

How do we classify animals?
Evolutionary Relationships





- **Linnean system** - hierarchical system of taxa so within each taxon each group is more closely related than to those between taxa and evolved from single common ancestor within each taxon

Science of describing, categorising, and naming organisms

Systematics and Taxonomy

- The traditional view of relationships among animal phyla are based mainly on key characteristics of body plans and embryonic development
- Each major branch represents a **clade**, which is defined by certain body-plan features shared by the animals belonging to that branch

  - Dichotomous Key
    - Method for species identification offering two (or more) alternatives at each juncture. This choice determines next step

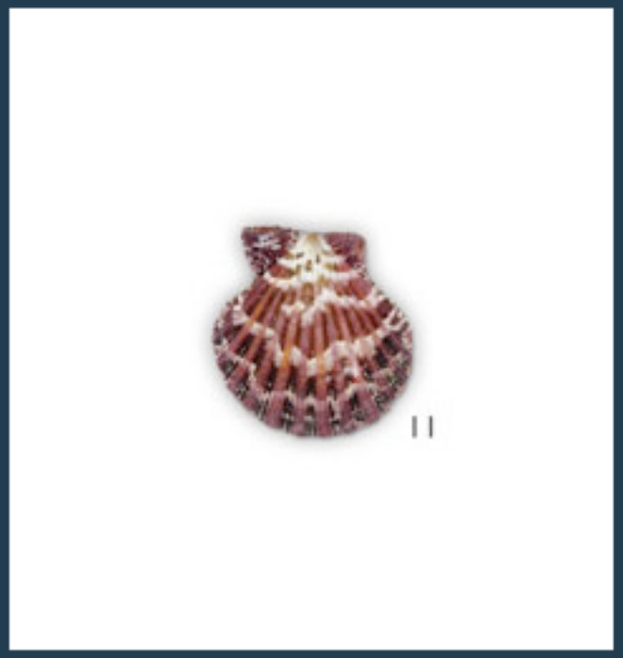
Biodiversity and Evolutionary Trees

Differs?

Choose one of the following answers

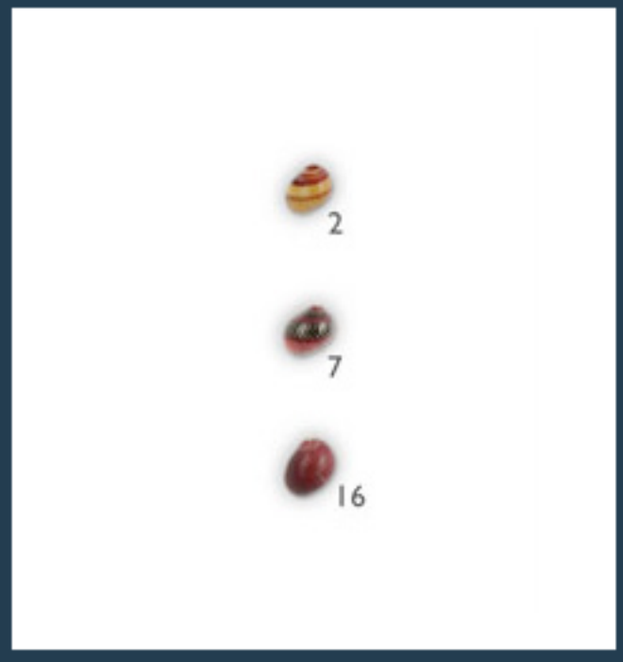
A)

B)

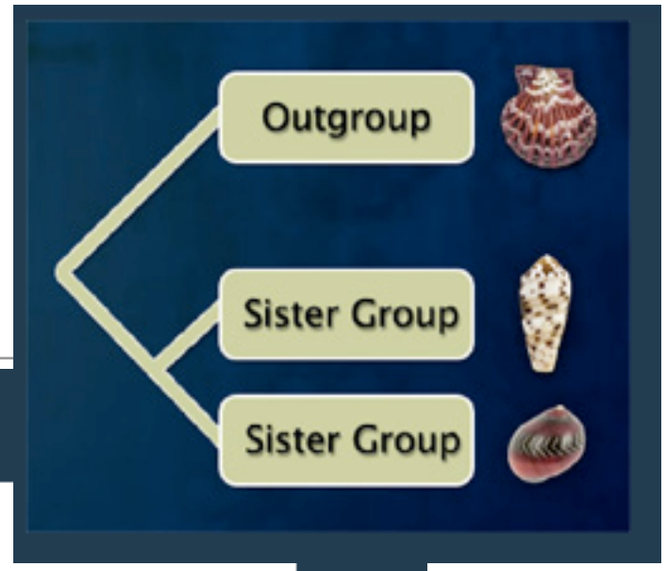


C)

D)



Differs?



Choose one of the following answers

A)

B)

C)

D)

Find the Second Outgroup

Nineteen shells remain.

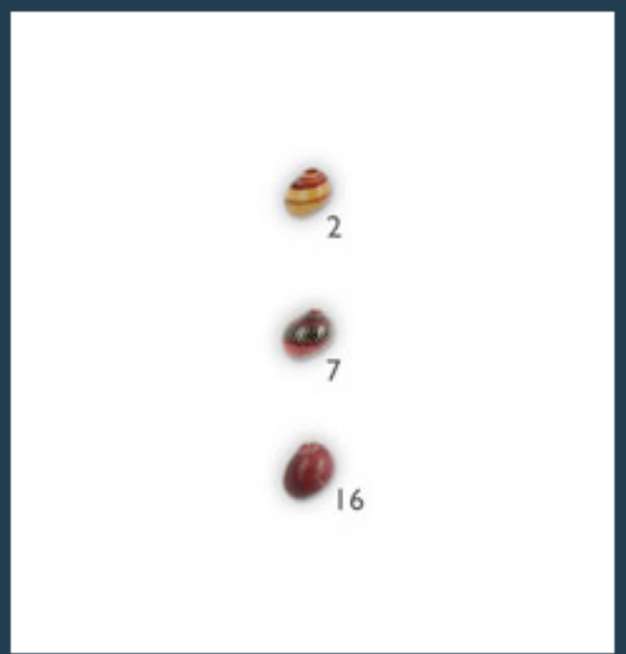
Find the Second Outgroup

Nineteen shells remain.

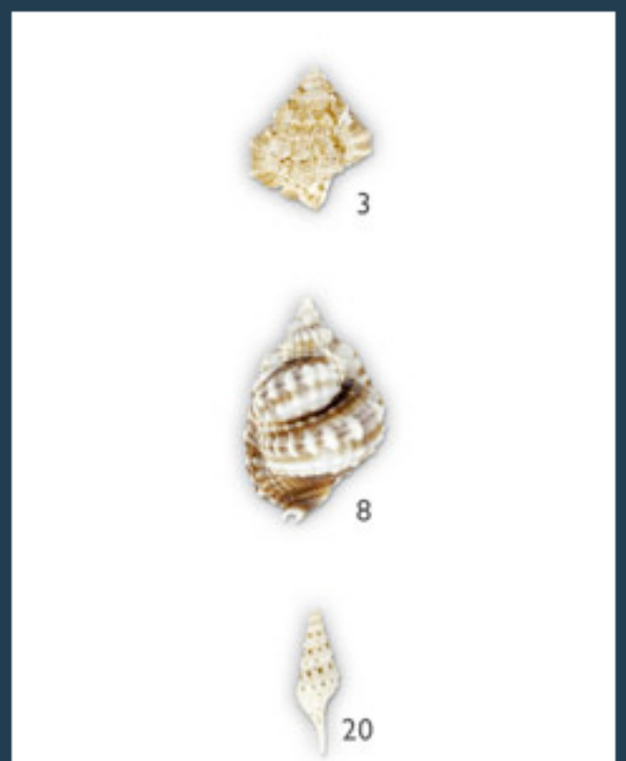
A)

B)

C)

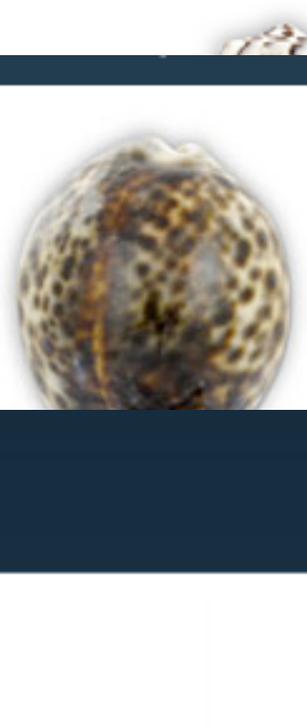


D)



Find the Second Outgroup

Nineteen shells remain.



● A)

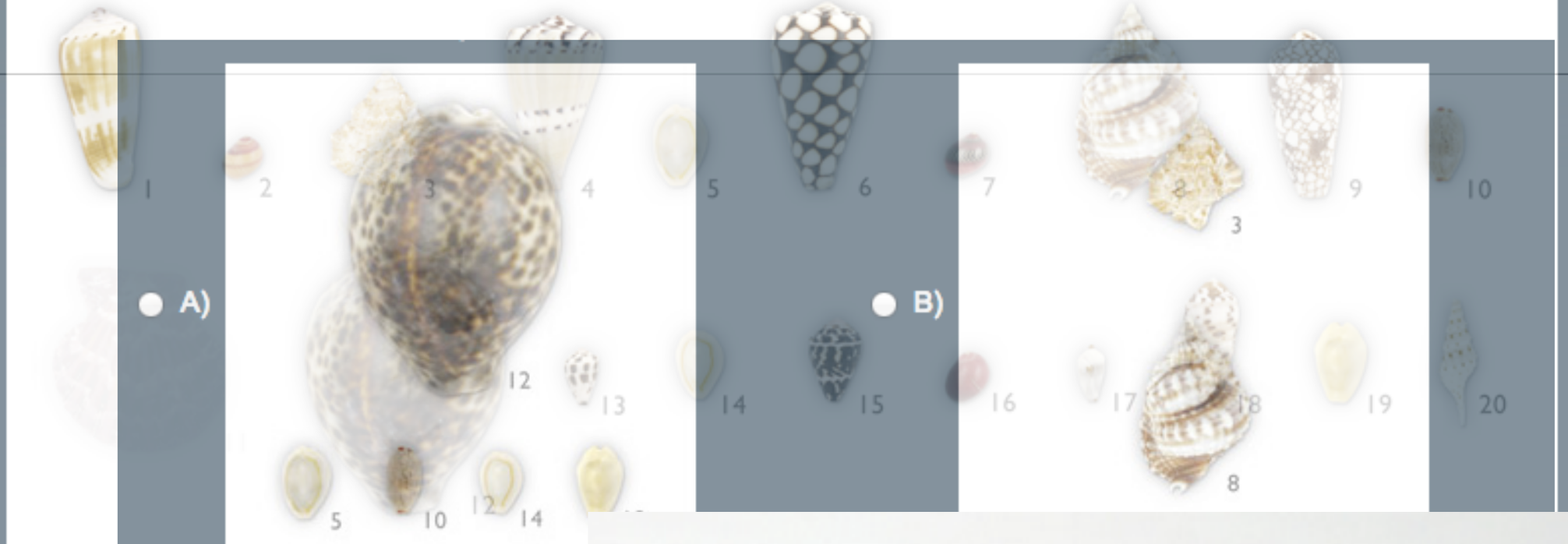
● B)

Nerites

● D)

Find the Second Outgroup

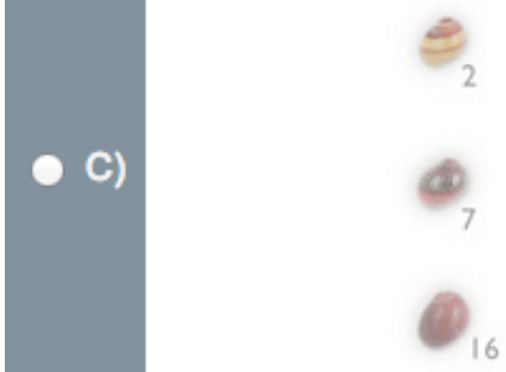
Nineteen shells remain.



● A)

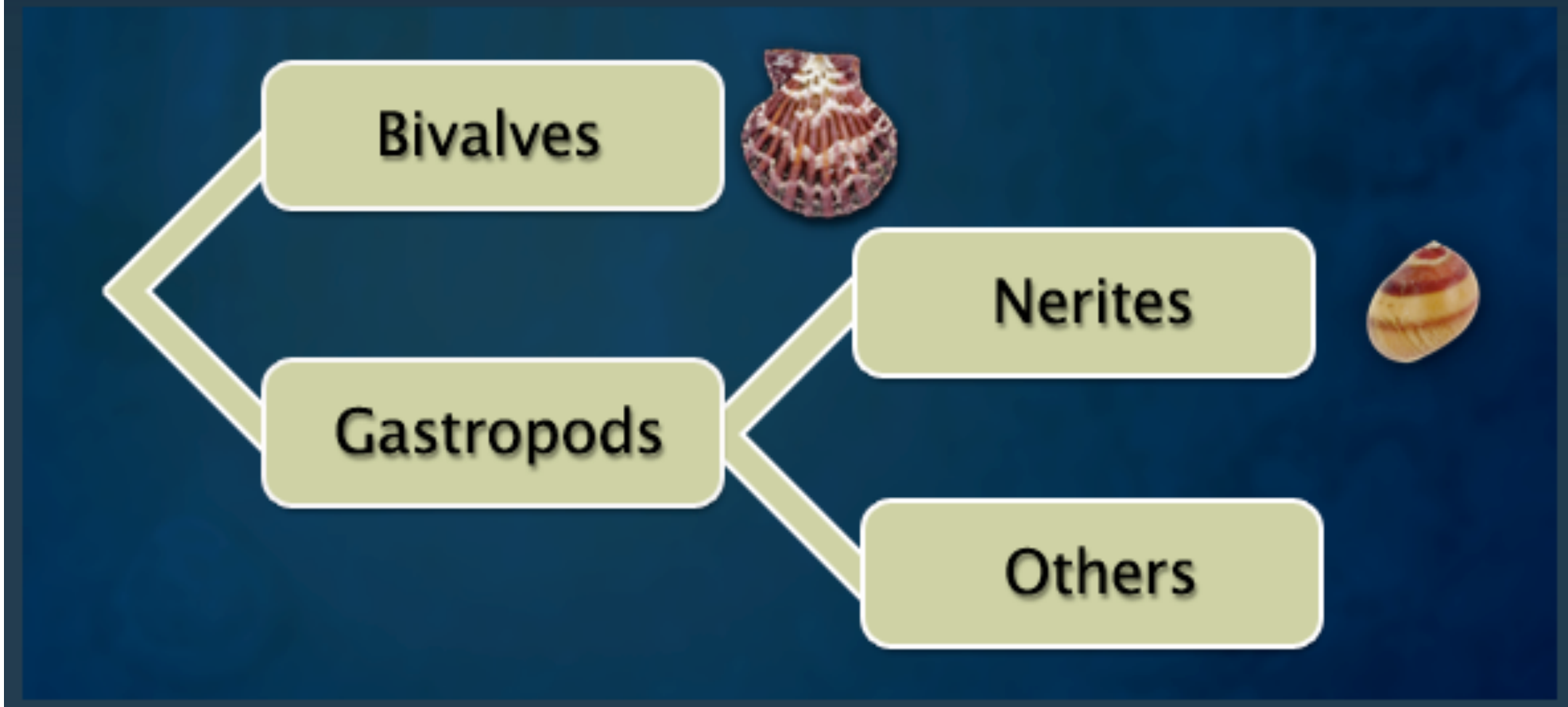
● B)

● C)



Sorting the Remaining Gastropods

So far, we have generated the following tree:



Similiar- Cone Snails

Similiar- Cone Snails

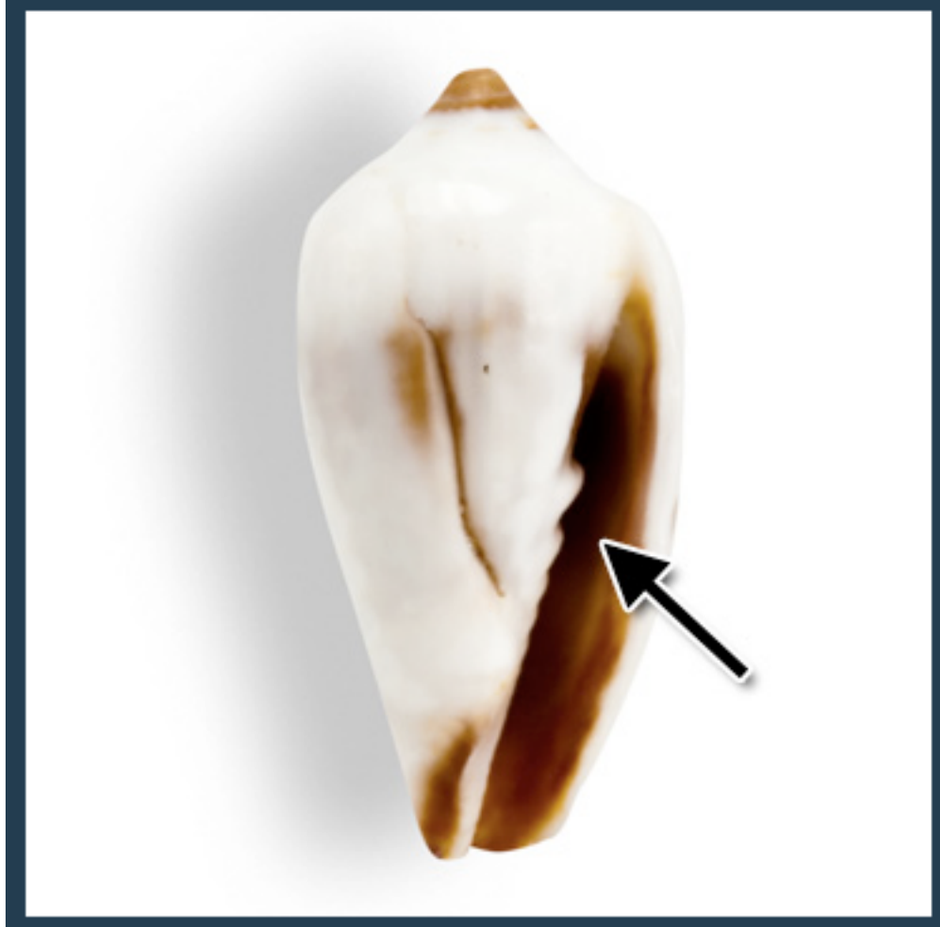
A B C

Similiar- Cone Snails

The correct answer is B. The cone snails belong to the taxonomic family Conidae.

Similiar- Cone Snails

Shell 17 is tricky. Although it is cone-shaped, it is from a different gastropod group called Miter shells. It can be differentiated by ridges in the shell opening.



Closest Sister Group to Conidae

Closest Sister Group to Conidae

Choose one of the following answers

A)

3

B)

8

C)

17

D)

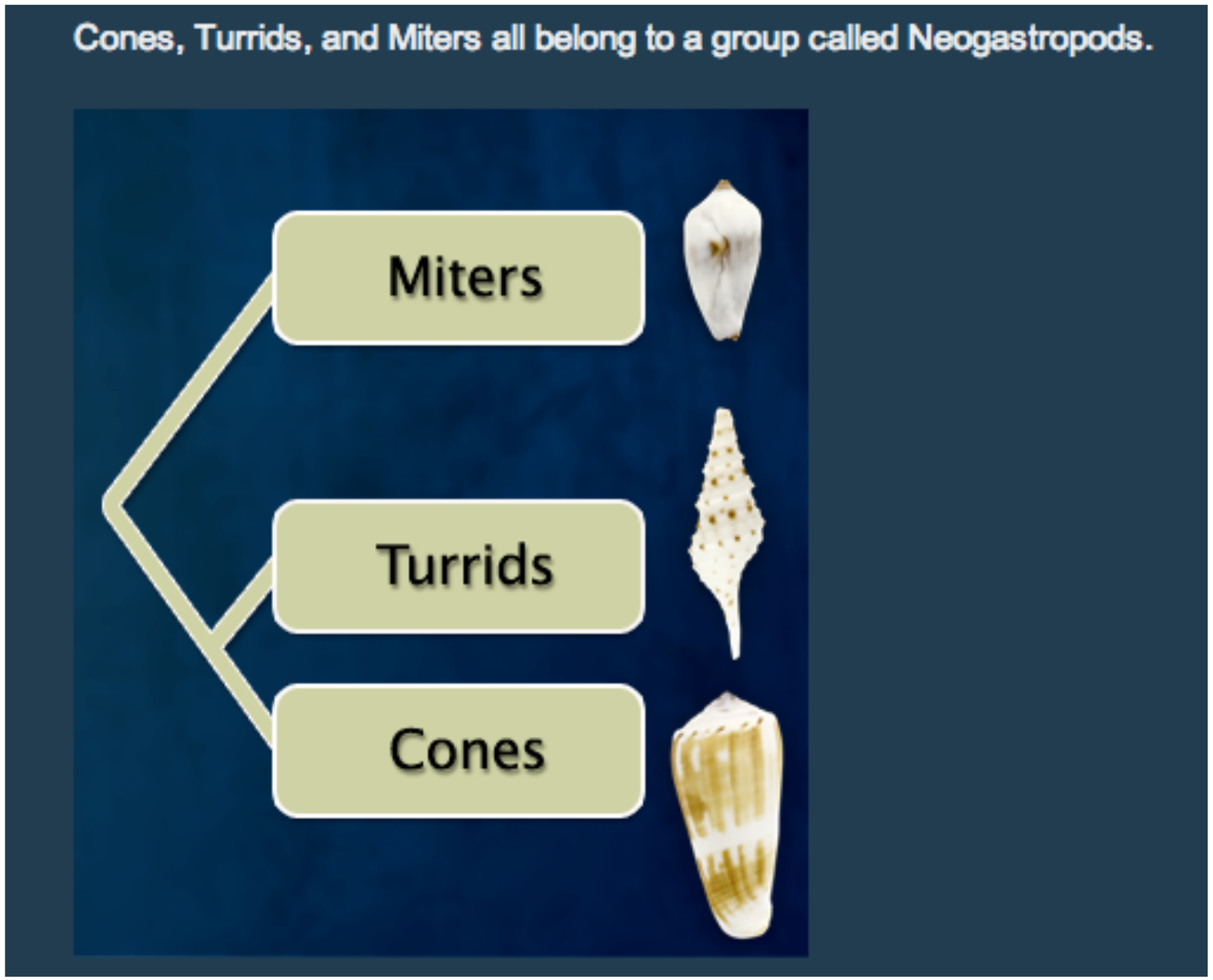
20

Closest Sister Group to Conidae

Neogastropods

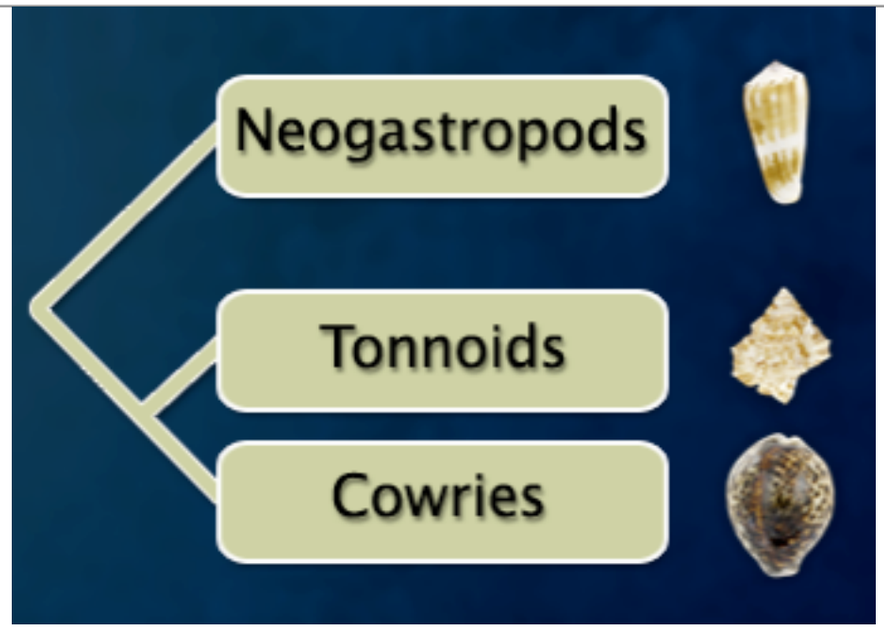
The correct answer is D, a Turrid shell.

You may have chosen C, the miter shell, based purely on shape. But Turrids and Cones are both venomous, and are thought to have evolved the venom system after their lineage had split off from the Miters.

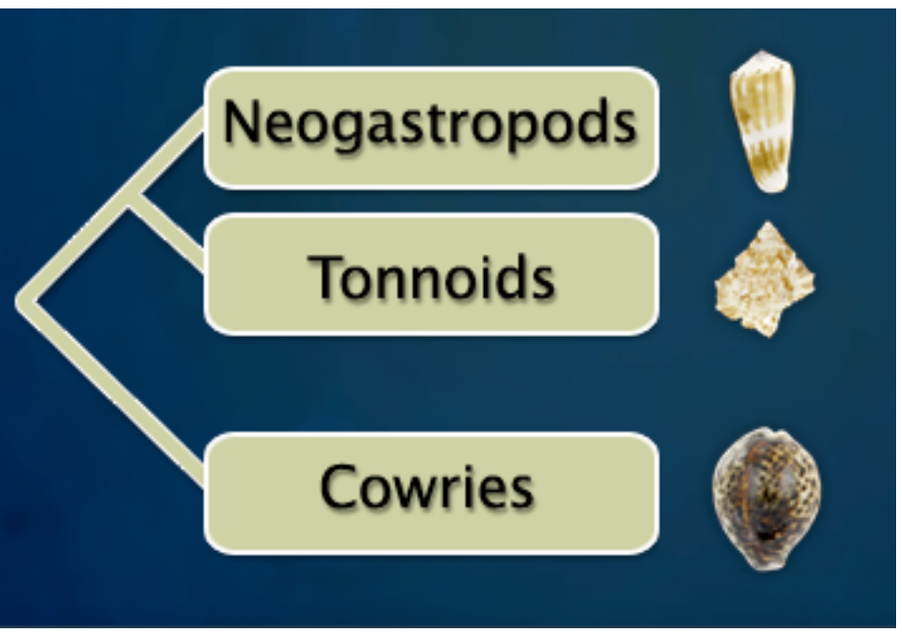

Cones, Turrids, and Miters all belong to a group called Neogastropods.
Miters
Turrids
Cones

Placing the Tonnoids

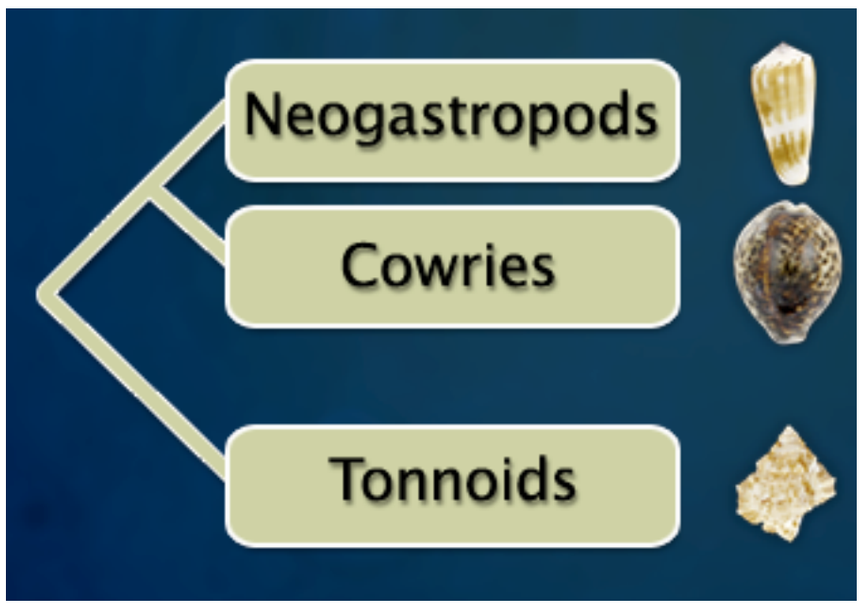
B


Neogastropods
Tonnoids
Cowries

A


Neogastropods
Tonnoids
Cowries

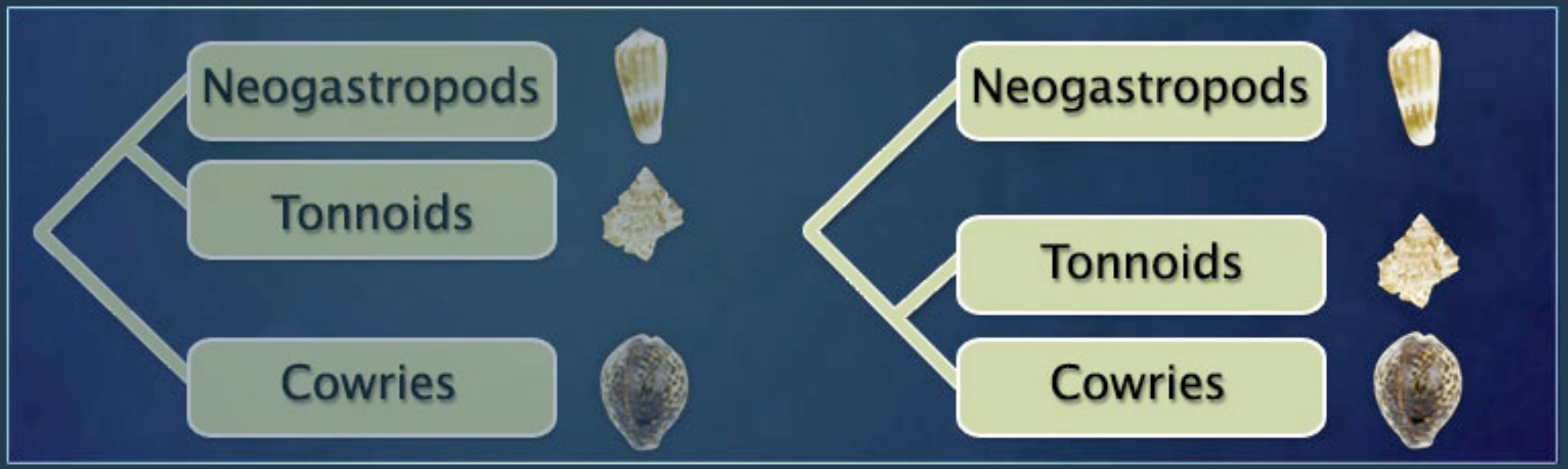
C

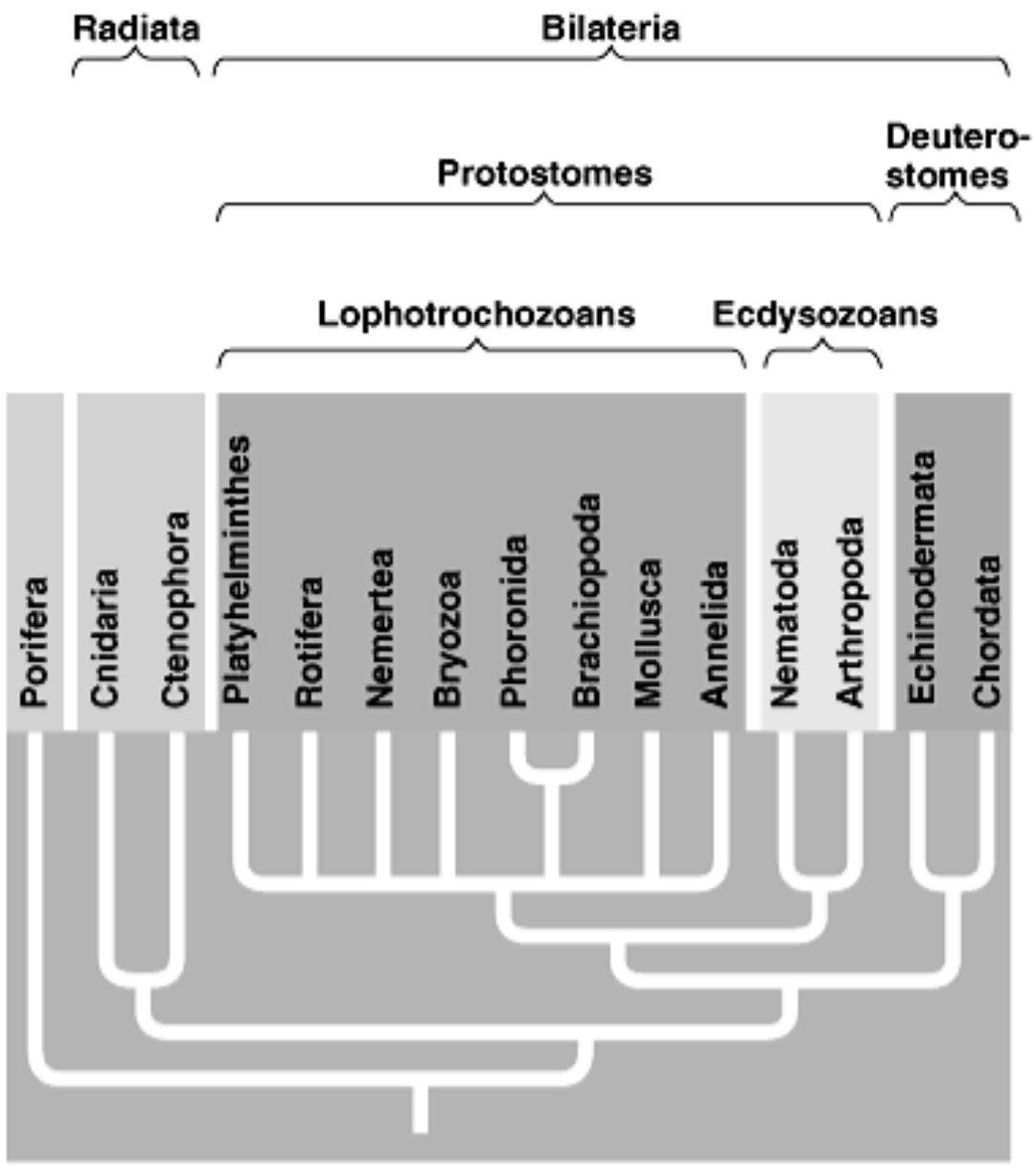

Neogastropods
Cowries
Tonnoids

Taxonomic Schemes Get Revised

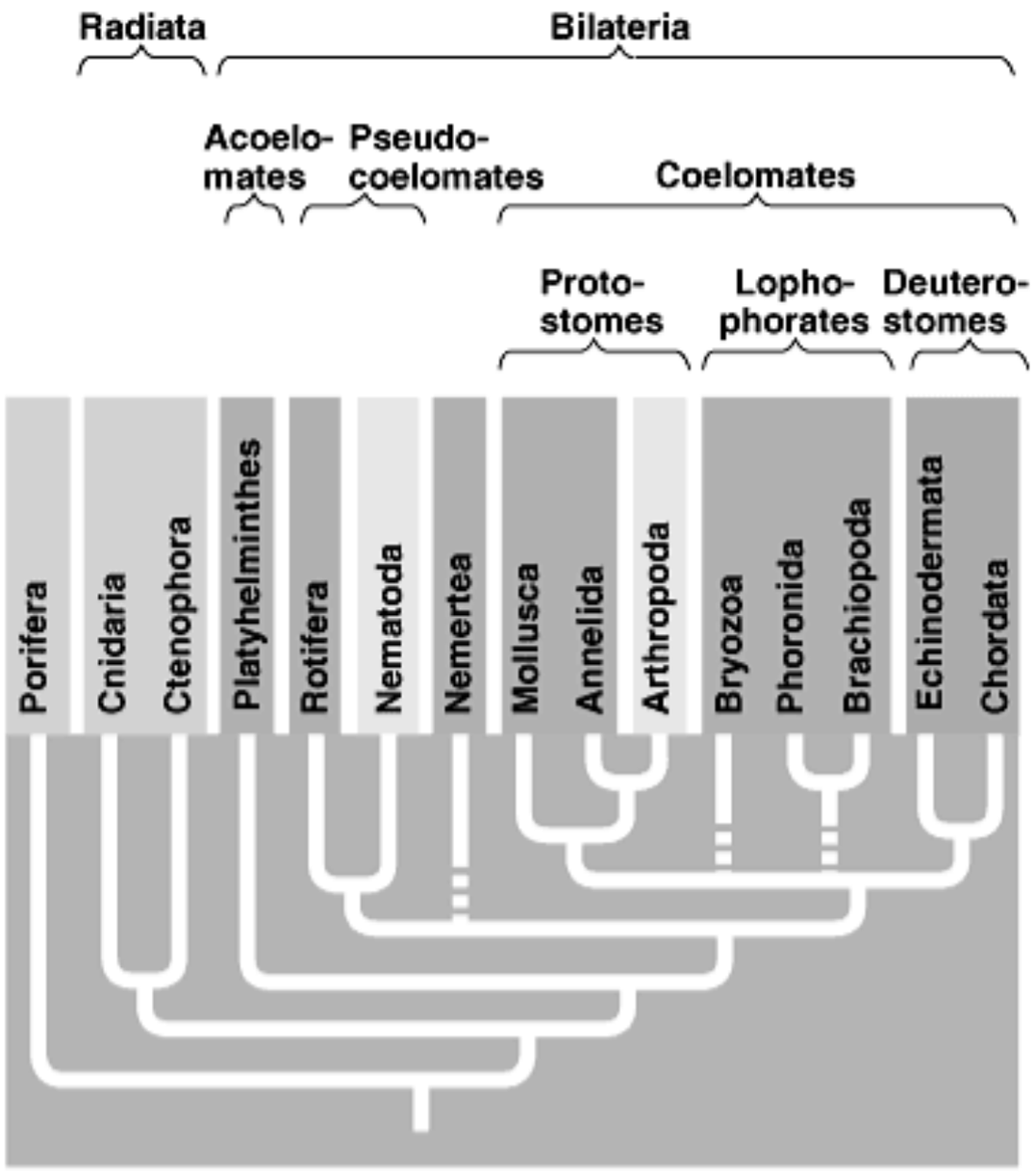
Professional taxonomists disagree on the place of the Tonnoids in the molluscan tree. Some considered them closely related to Neogastropods (answer A), while others grouped Tonnoids with a group that includes the Cowries (B).

A recently published paper concludes that they are more closely related to the Cowries than to the Neogastropods. (B)





(a) Tree based on molecular comparisons



(b) Tree based on body-plan grades

Taxonomy - Flow Chart

Cell Number?: Acellular (0 cells), unicellular (1 cell) or multicellular (≥2 cells)

Tissues?

Eumetazoa (true tissues)

Parazoa (no true tissues)

Porifera

Body Symmetry?

Radiata

Bilateria

Developmental Pattern?

Diploblastic

Triploblastic

Acoelomate: Playthelmenthes

Cnidaria and Ctenophores

Coelomate and pseudocoelomate

Protostome

Deuterostome

Mollusc, Annelid, Arthropods, etc

Echinoderms, Chordates, us ☺

Don't forget the molecular data!