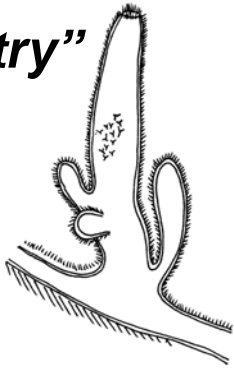


SYMMETRY and BODY AXES

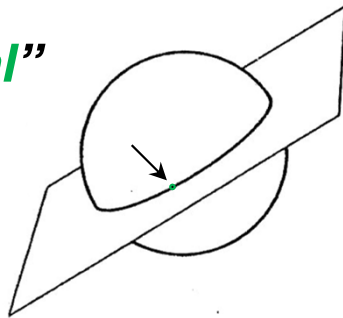
“asymmetry”

(no axes)
e.g. sponge



“spherical”

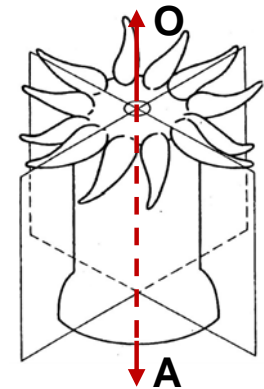
(no axes)
e.g. egg?



infinite planes of symmetry
through single point

“radial”

(one axis)
e.g. cnidarian

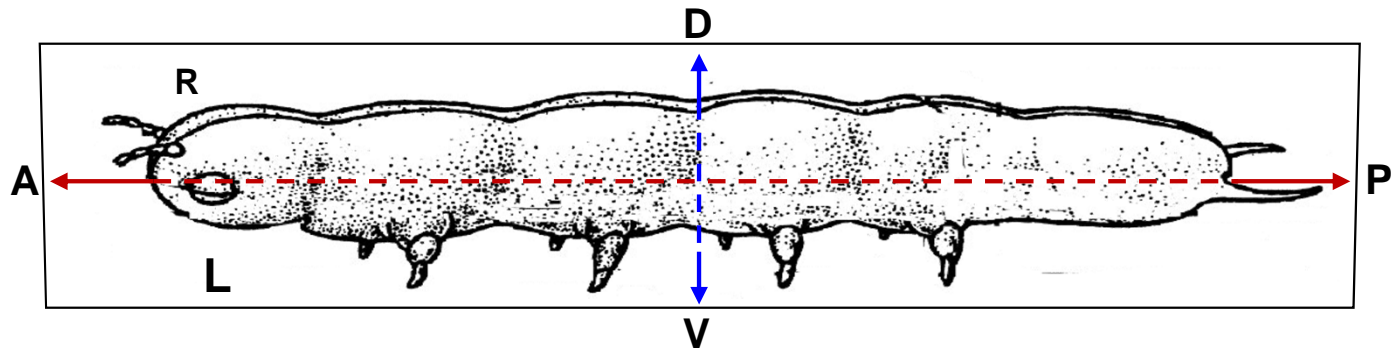


infinite planes of symmetry
through single line

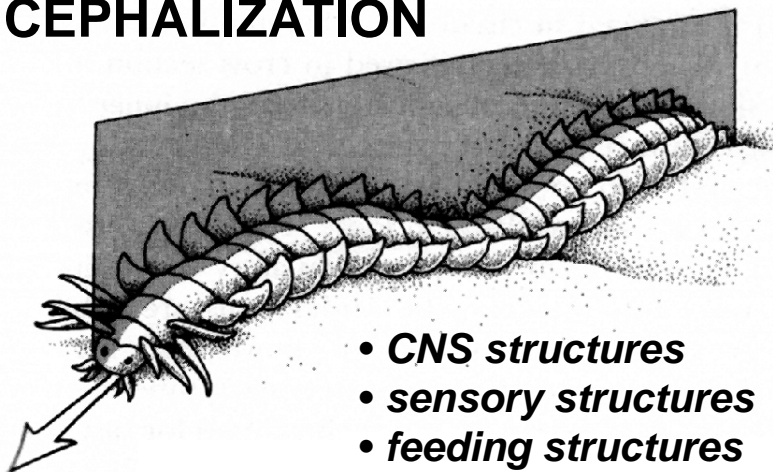
“bilateral”

(two axes)
e.g. worms

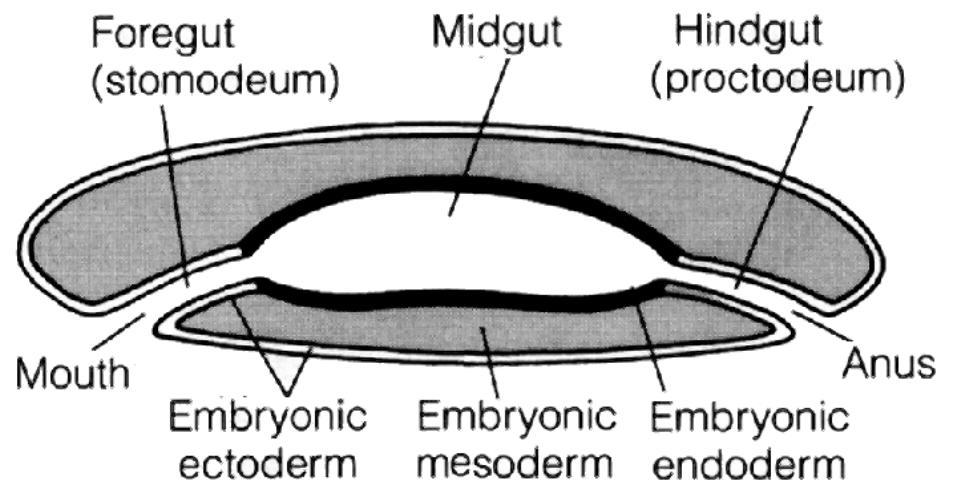
single plane of
symmetry



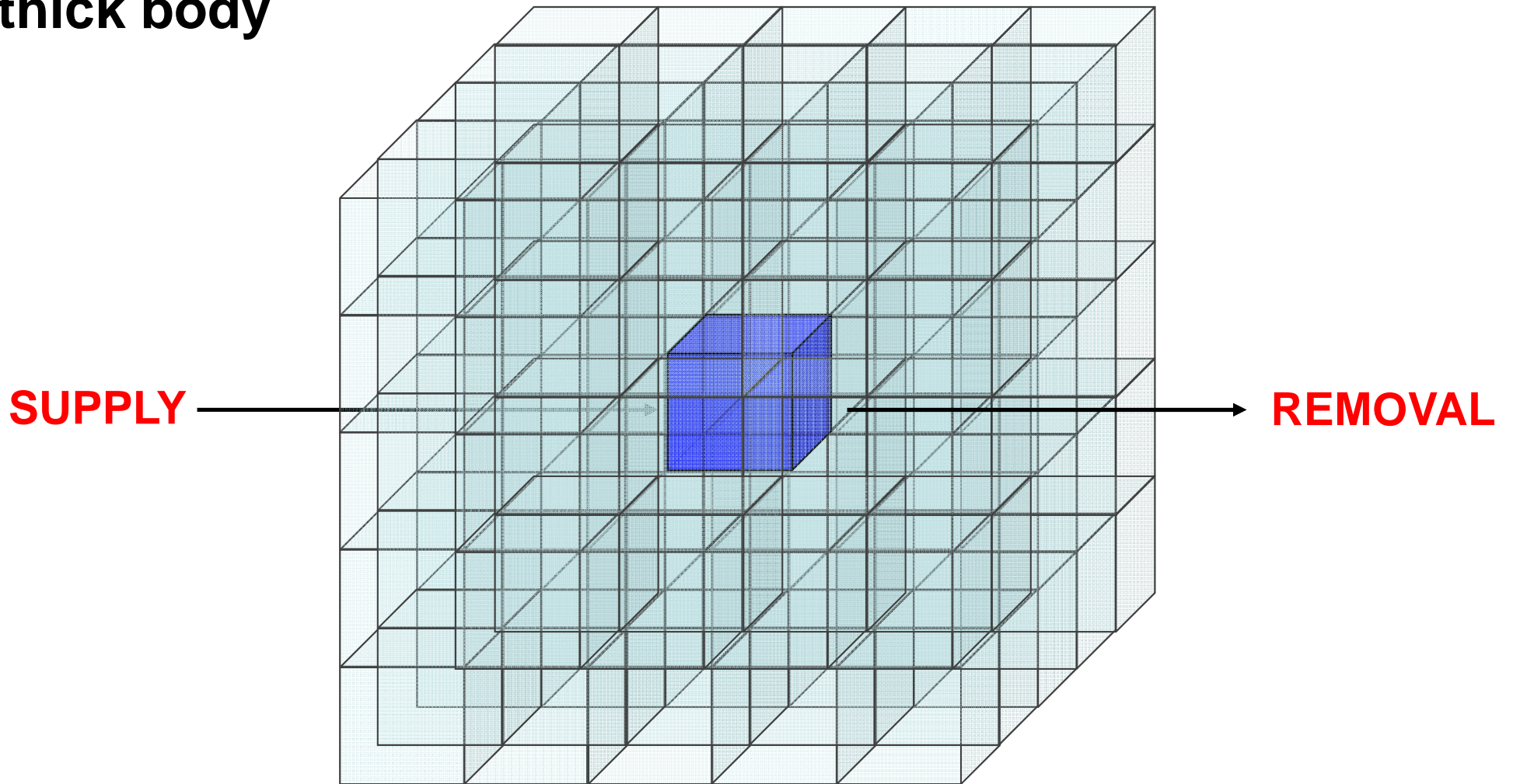
CEPHALIZATION



- CNS structures
- sensory structures
- feeding structures



Challenges to building a thick body

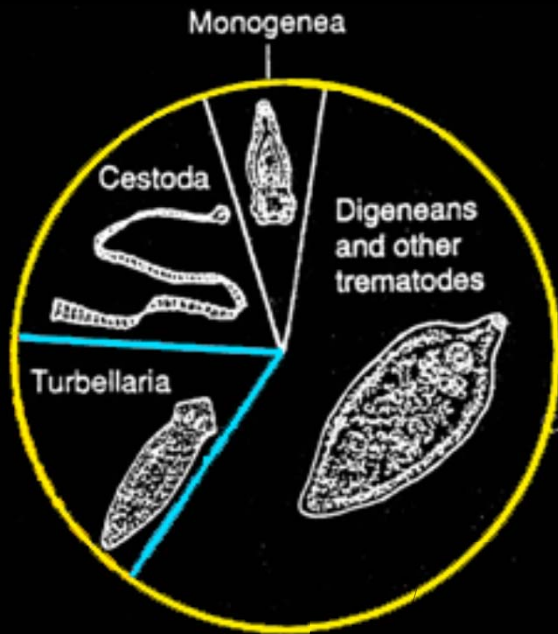


Scaling problem

$$\frac{\text{Surface area} \propto \text{length}^2}{\text{Volume} \propto \text{length}^3}$$

Solutions?

Ph. Platyhelminthes: Cl. Turbellaria



~~Acyels~~



“Rhabdocoels”



(+ 6-7 other orders...)

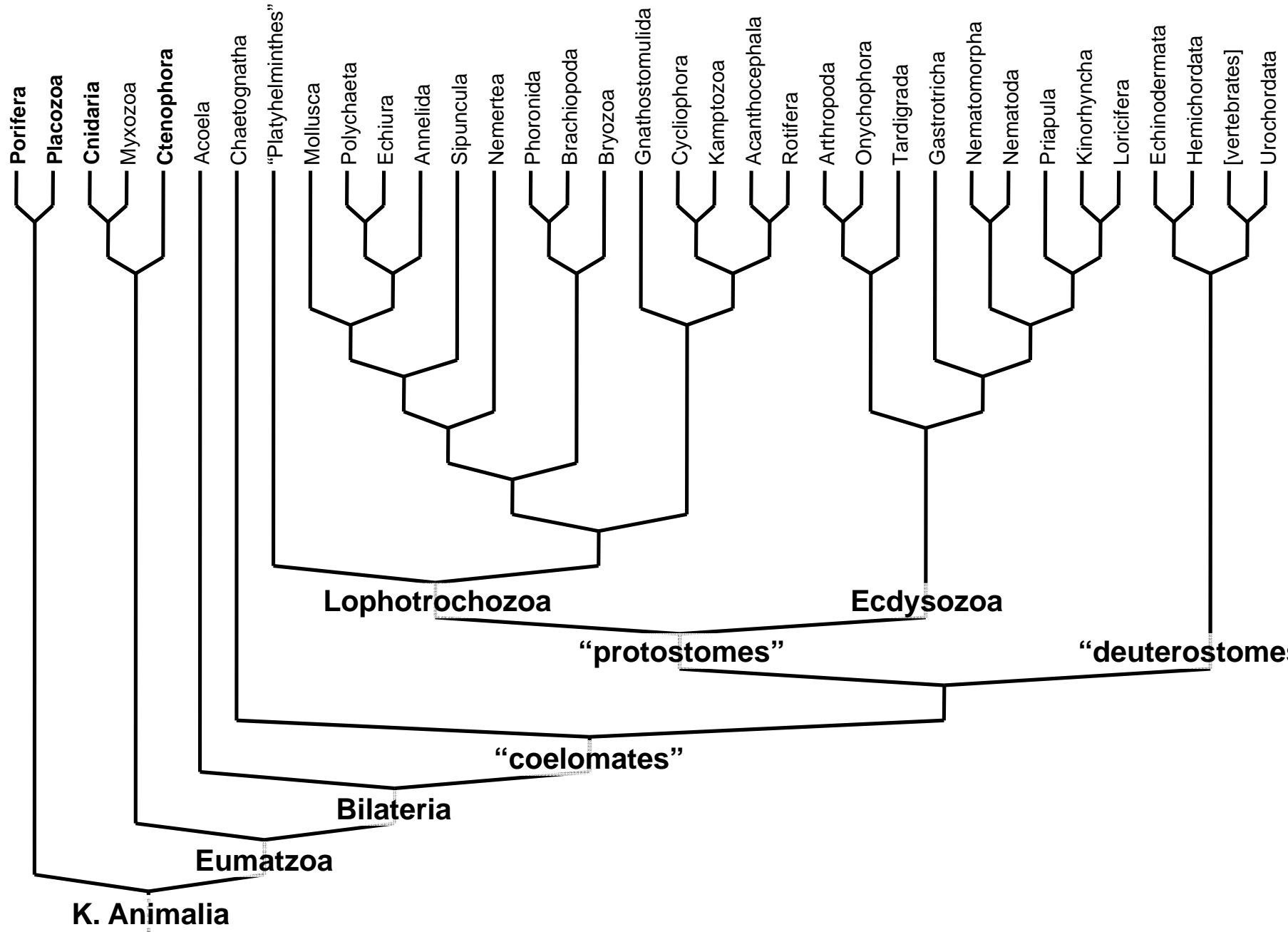
Triclads



Polyclads

Theme: limits of diffusion, size and complexity

[Choanoflagellates]



Porifera

Placozoa

Cnidaria

Myxozoa

Ctenophora

Acoela

Chaetognatha

"Platyhelminthes"

Mollusca

Polychaeta

Echiura

Annelida

Sipuncula

Nemertea

Phoronida

Brachiopoda

Bryozoa

Gnathostomulida

Cycliophora

Kamptozoa

Acanthocephala

Rotifera

Arthropoda

Onychophora

Tardigrada

Gastrotricha

Nematomorpha

Nematoda

Priapula

Kinorhyncha

Loricifera

Echinodermata

Hemichordata

[vertebrates]

Urochordata

Lophotrochozoa

Ecdysozoa

"protostomes"

"deuterostomes"

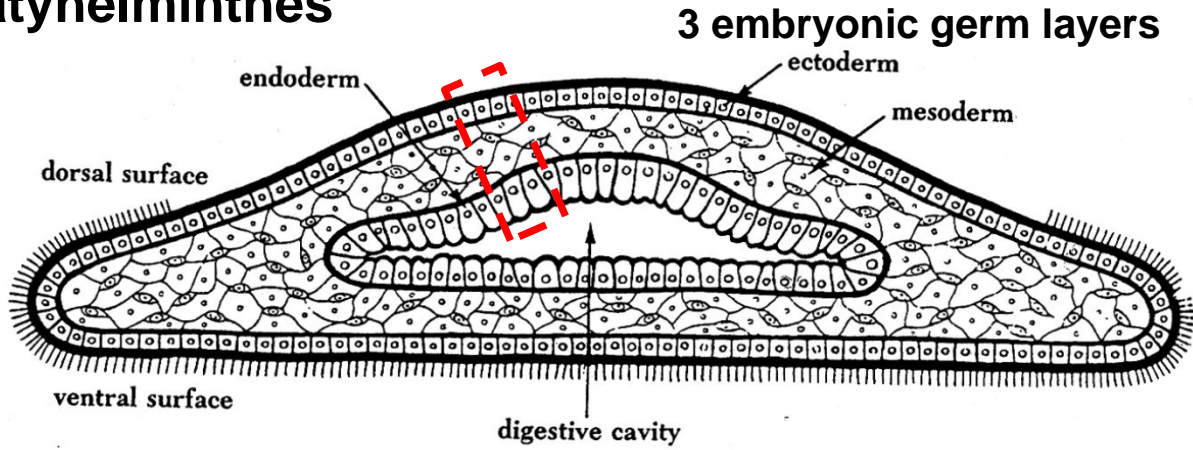
"coelomates"

Bilateria

Eumatzoa

K. Animalia

Ph. Platyhelminthes



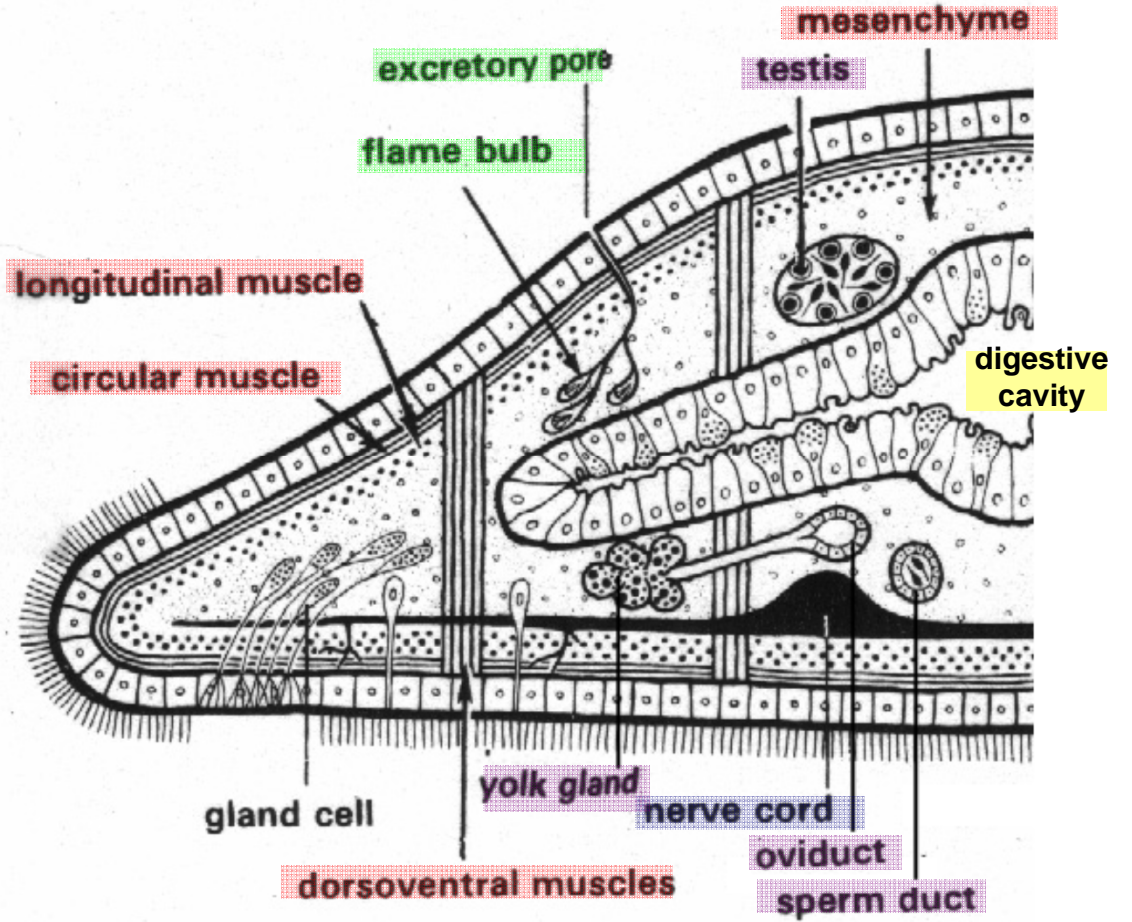
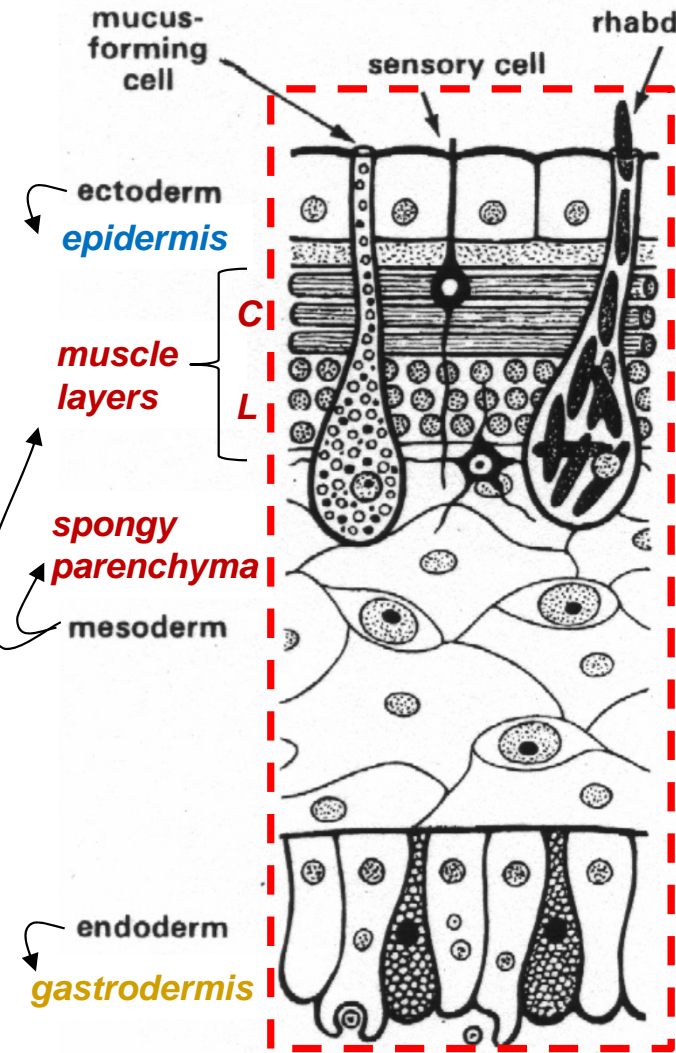
Mesoderm (muscle)

Excretory

Nervous

Reproductive

Digestive



Muscle

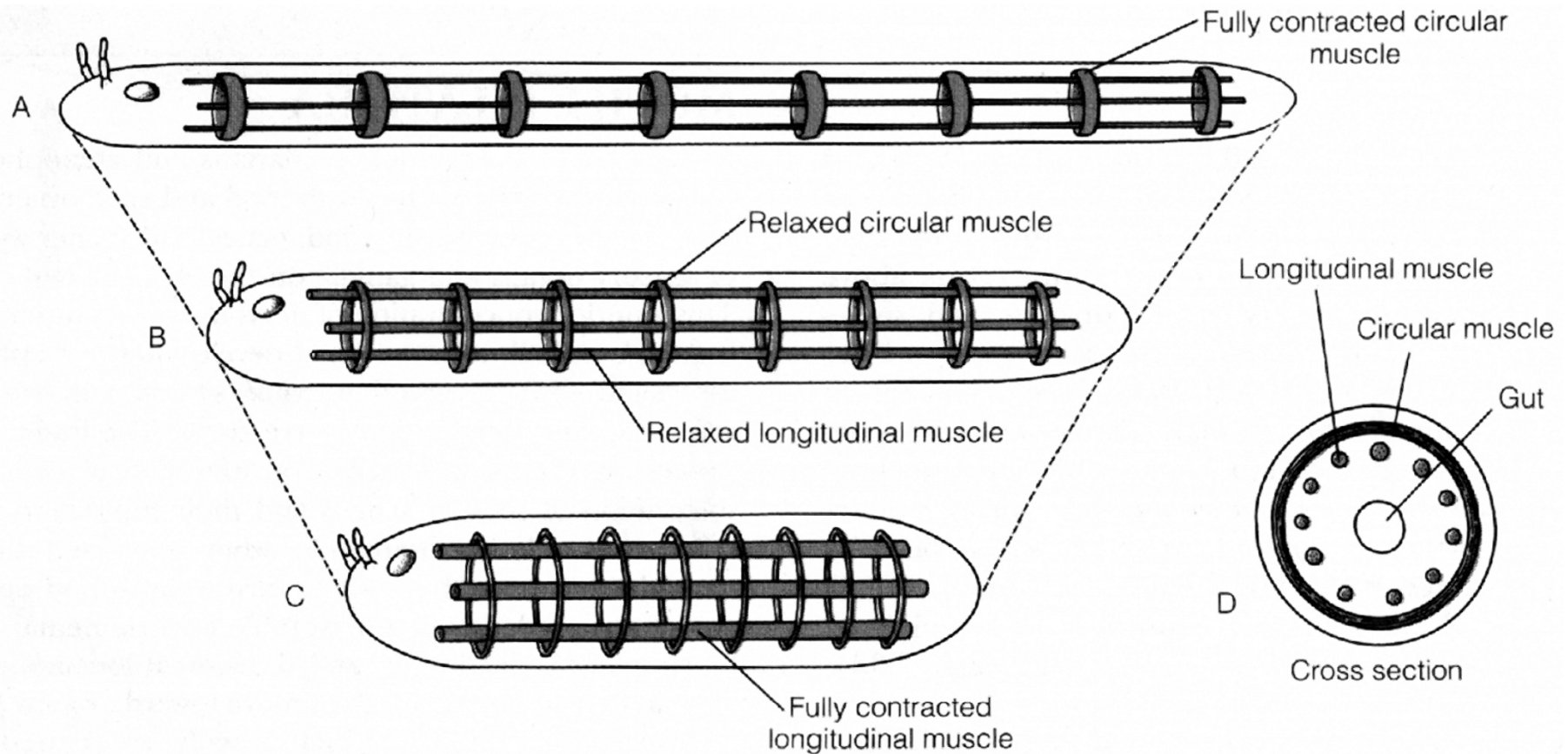
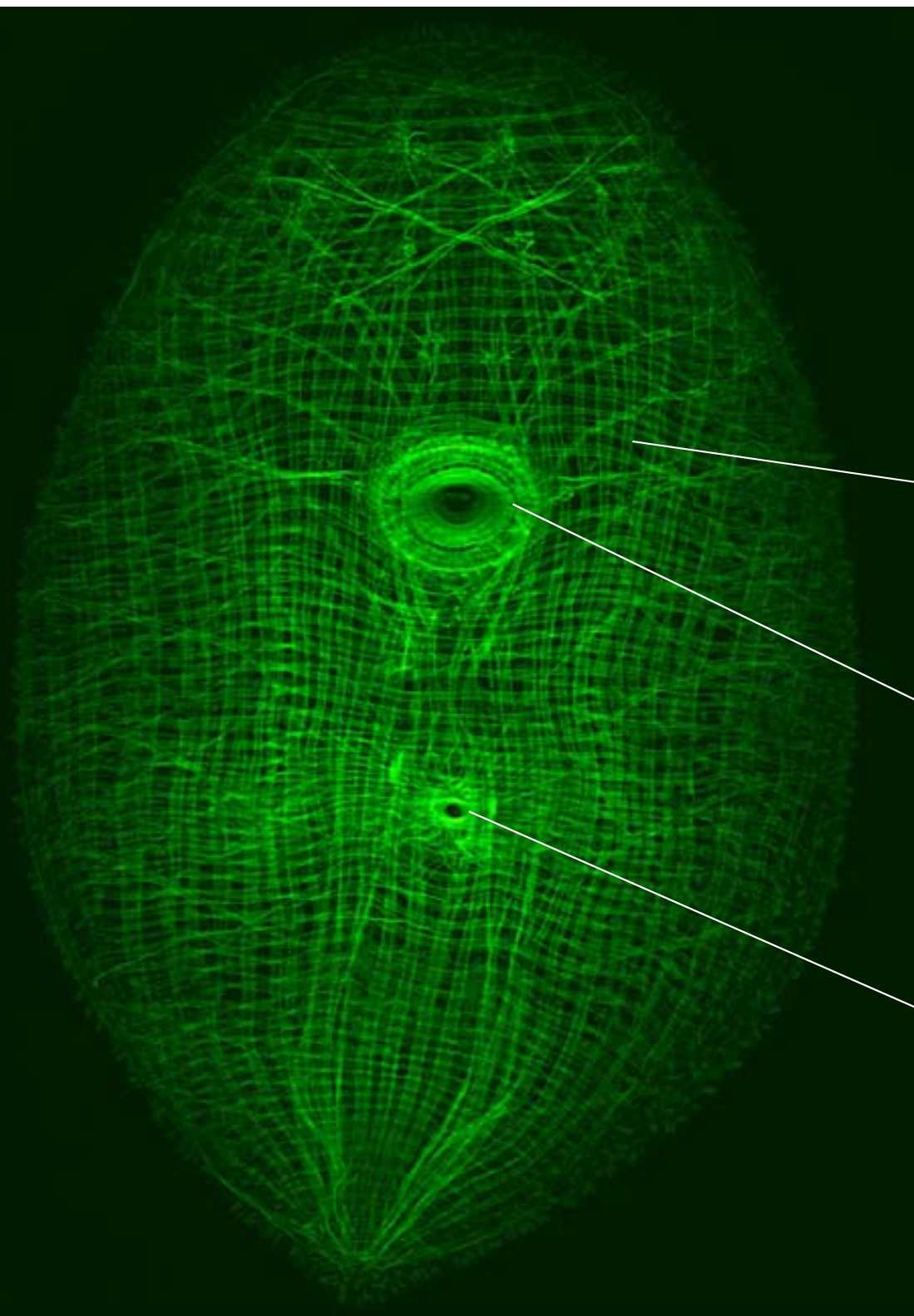


FIGURE 9-5 Bilateria: body-wall musculature. The basic arrangement of body-wall muscles in soft-bodied bilateral animals, as shown in **B** and the cross section (**D**), is an outer circular and an inner longitudinal musculature. These two layers have antagonistic actions: Contraction of the circular musculature causes elongation of the body (**A**), whereas contraction of the longitudinal musculature causes shortening (**C**). Longitudinal muscles alone allow the animal to bend and turn. The circular body wall muscles typically are positioned outside of the longitudinal muscles because the effectiveness of their action (elongation or peristalsis) depends on compression of the bodily tissues, including the longitudinal musculature.

**Rhabdocoel turbellarian
phalloidin stain (L-actin of
body wall **musculature**)**



**longitudinal and
circumferential
(circular) muscles**

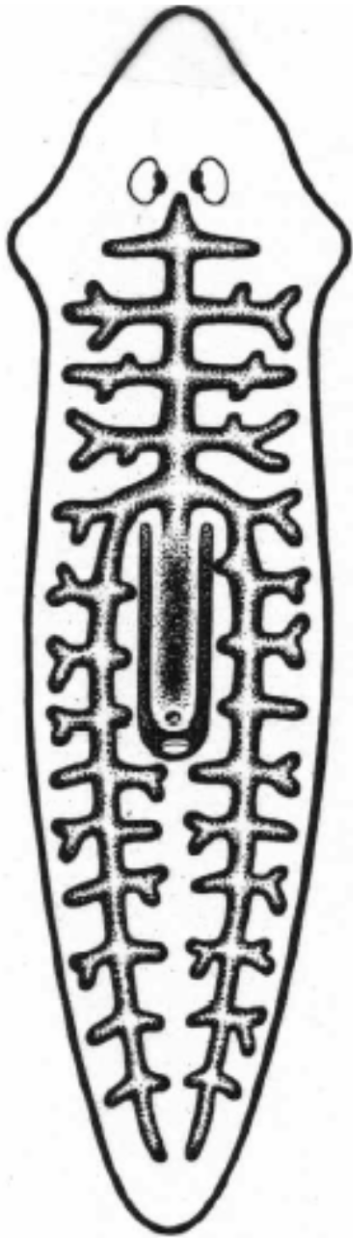
**bulbous, muscular
pharynx**

genital pore

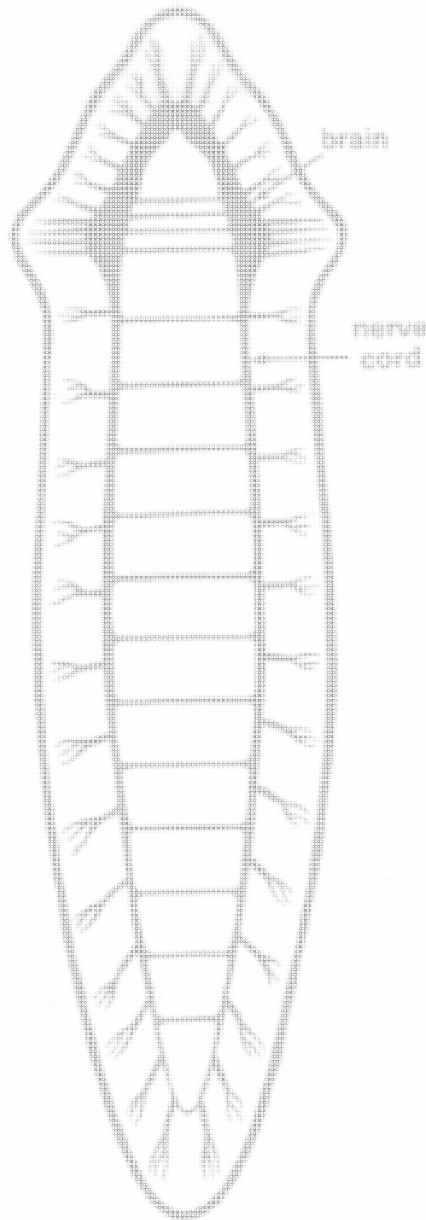


Polyclads swimming with undulatory body waves

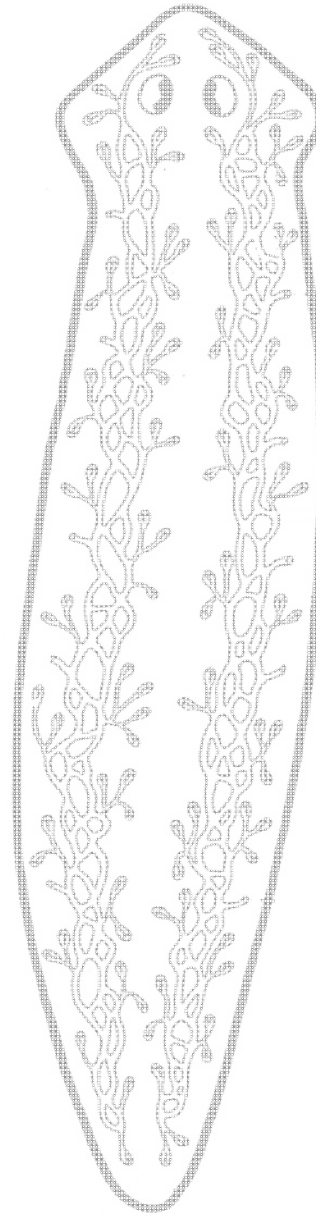




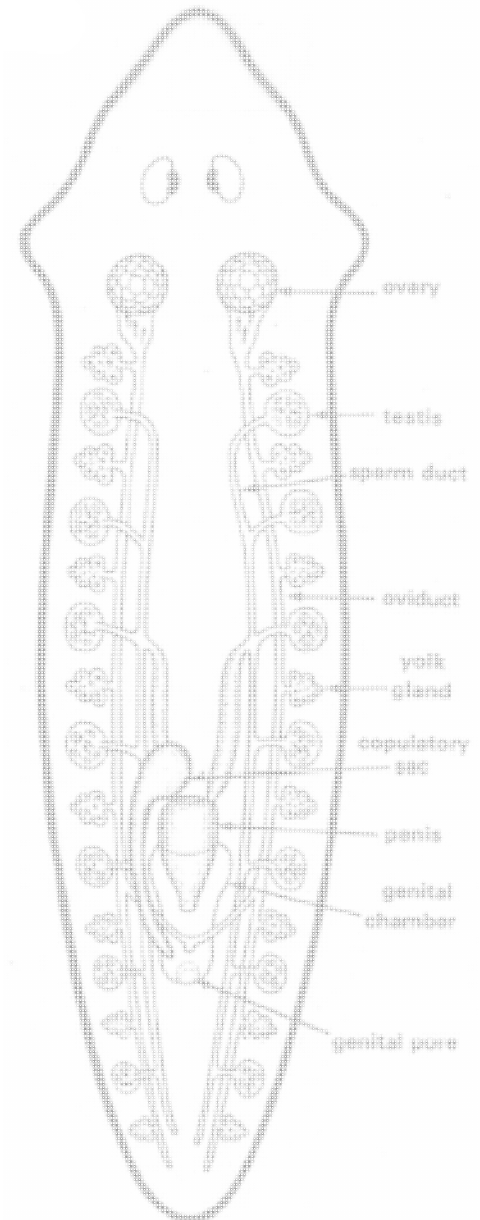
Digestive



Nervous



Excretory



Reproductive

Turbellarians are often predatory specialists



ascidian

polyclads feeding

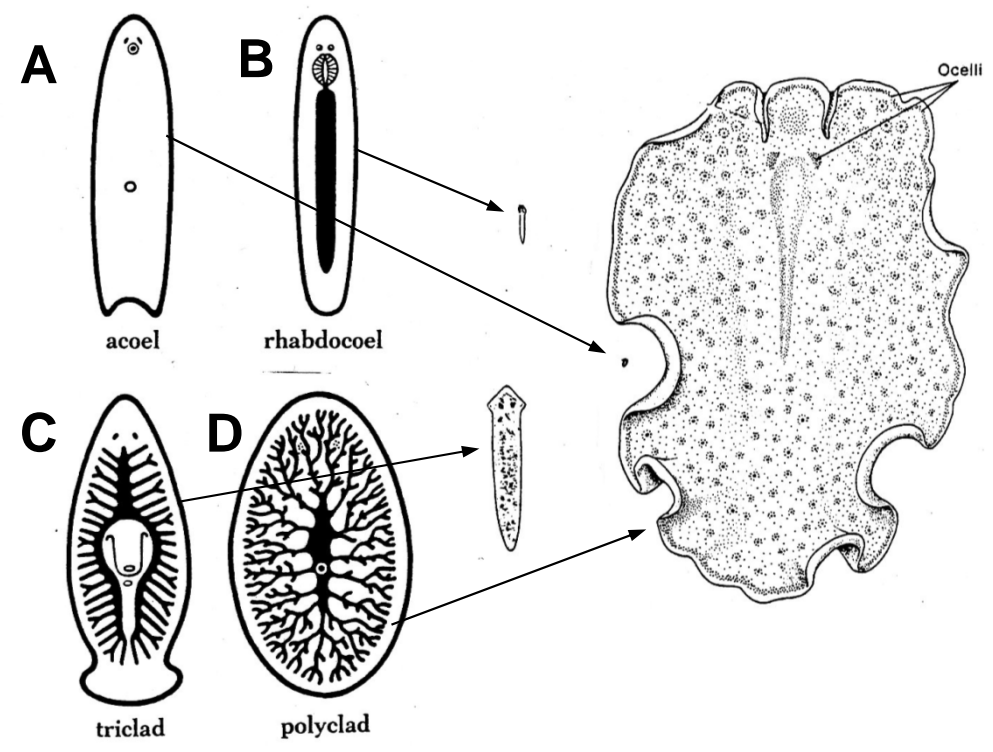
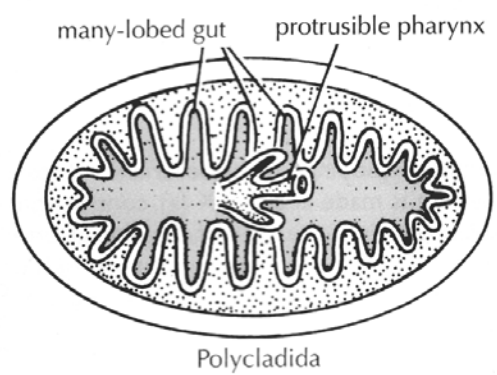
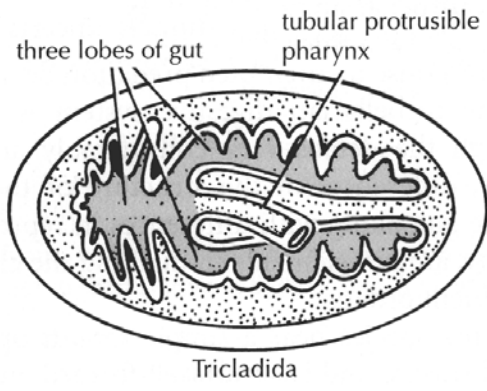
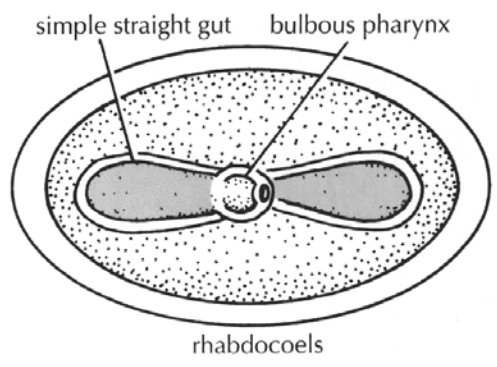
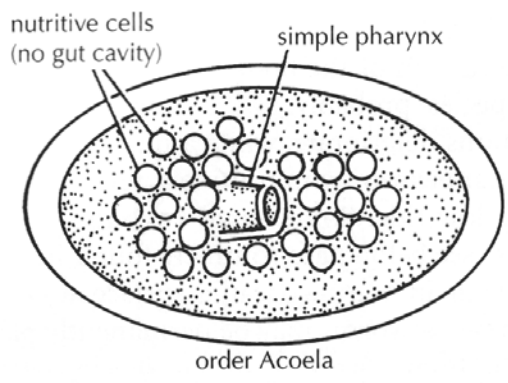
bryozoans

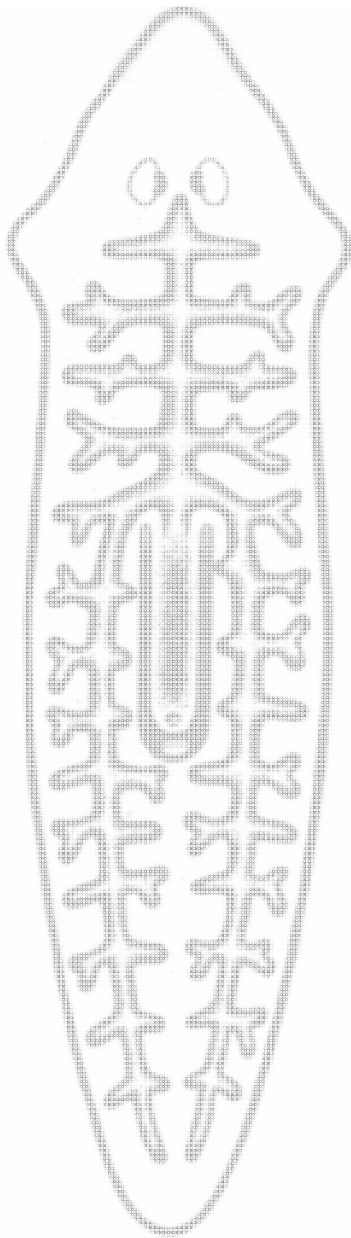


planarian feeding on a midge

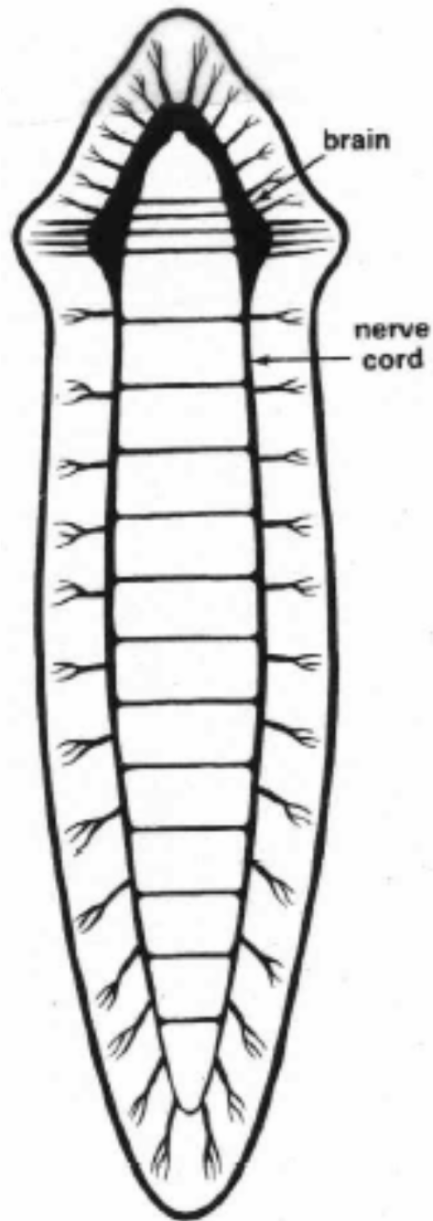


Digestive

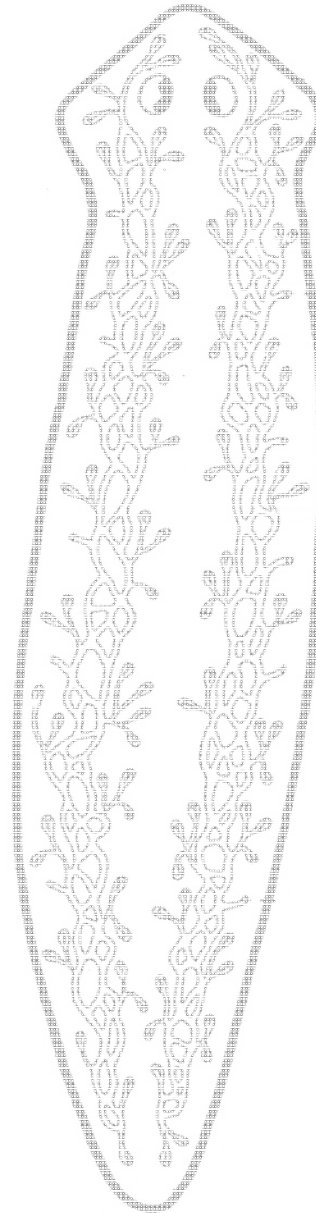




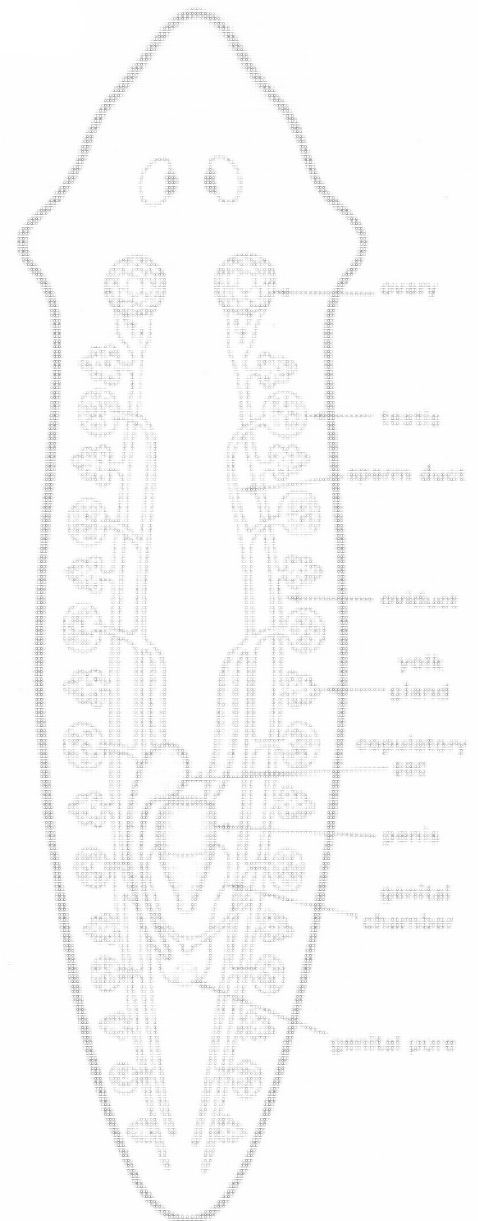
Digestive



Nervous

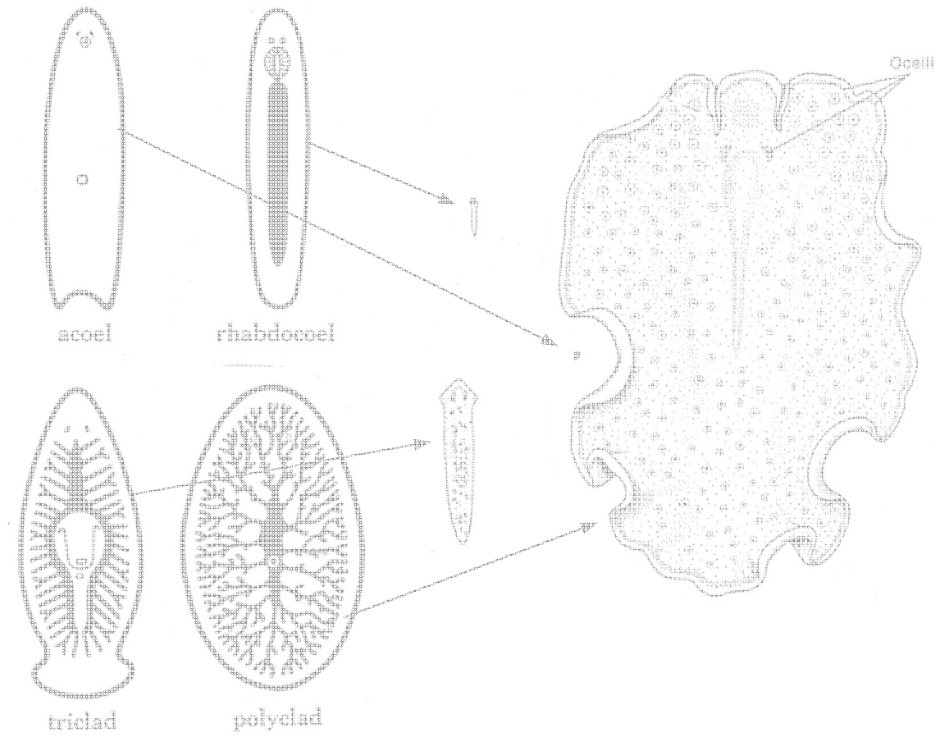
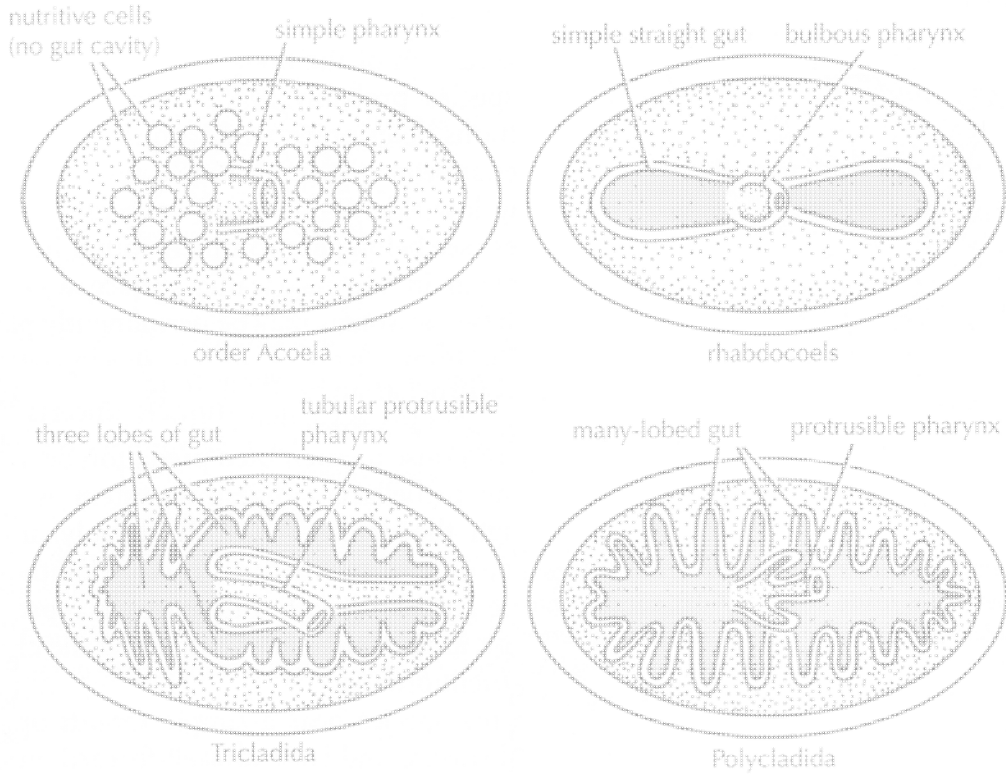


Excretory

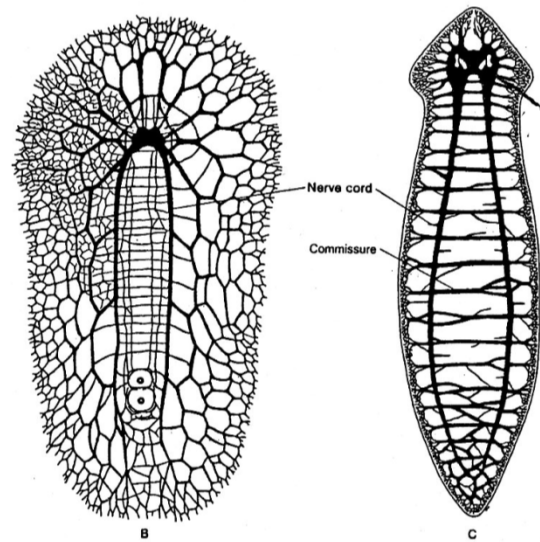
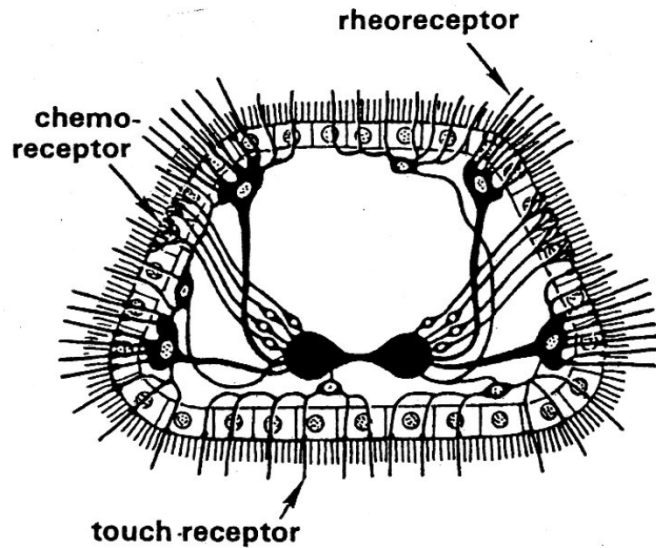


Reproductive

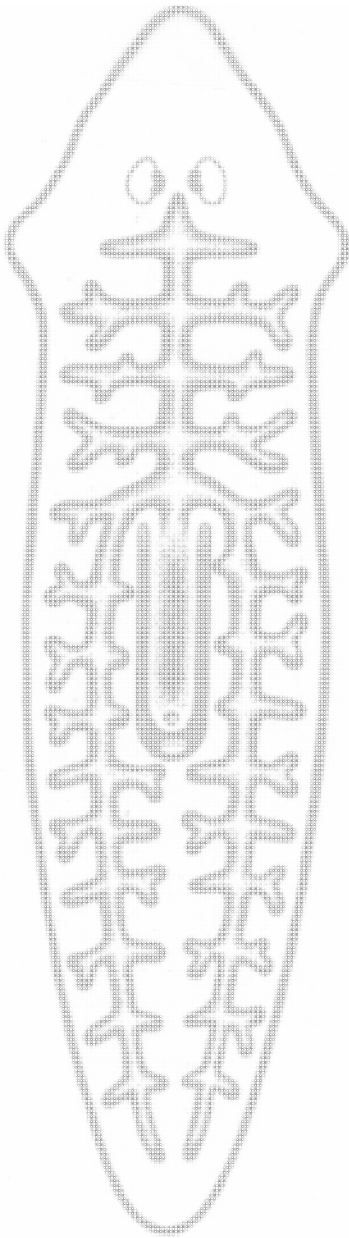
Digestive



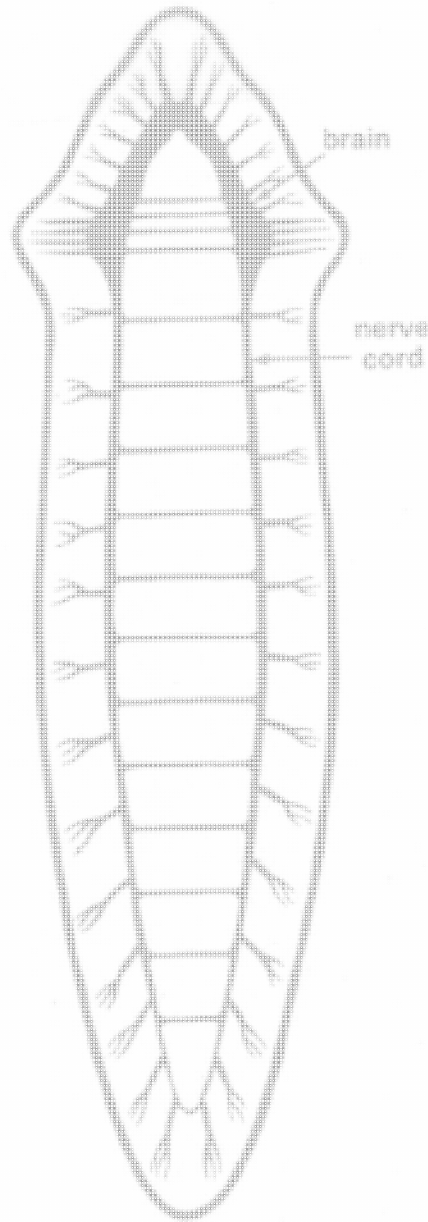
Nervous



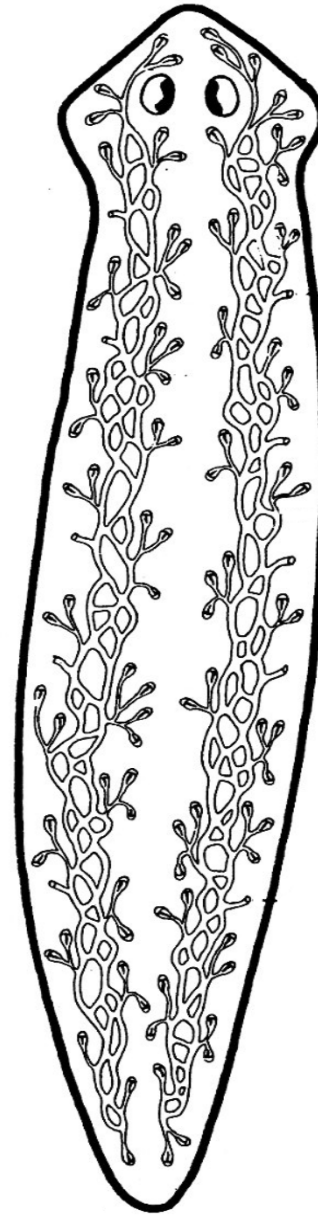
The netlike arrangement of peripheral nerves is clear in polyclads (B, ventral nervous system) and triclads (C), but in triclads a regular series of transverse commissures imparts a segmental pattern on the nervous system.



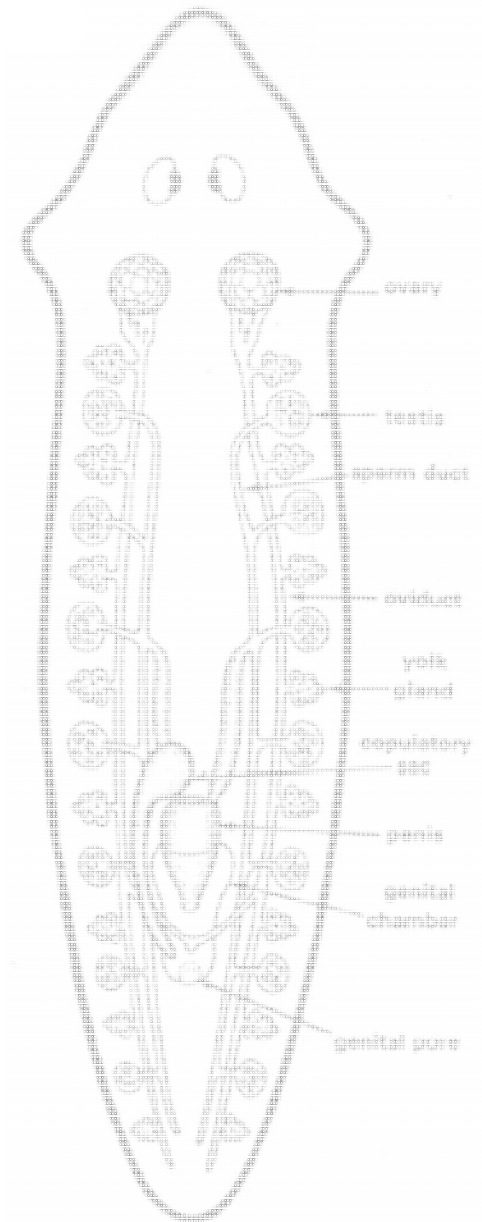
Digestive



Nervous

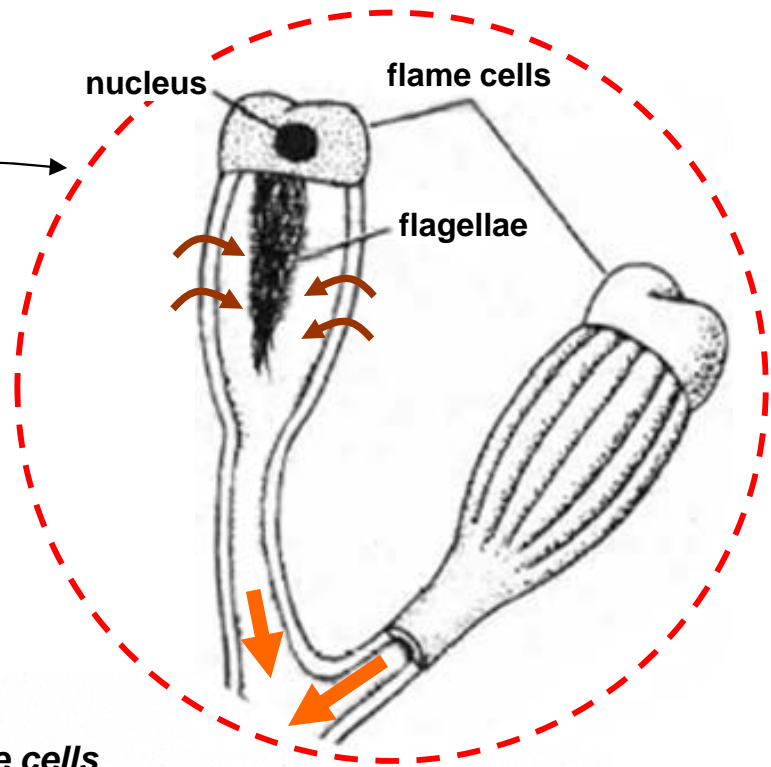
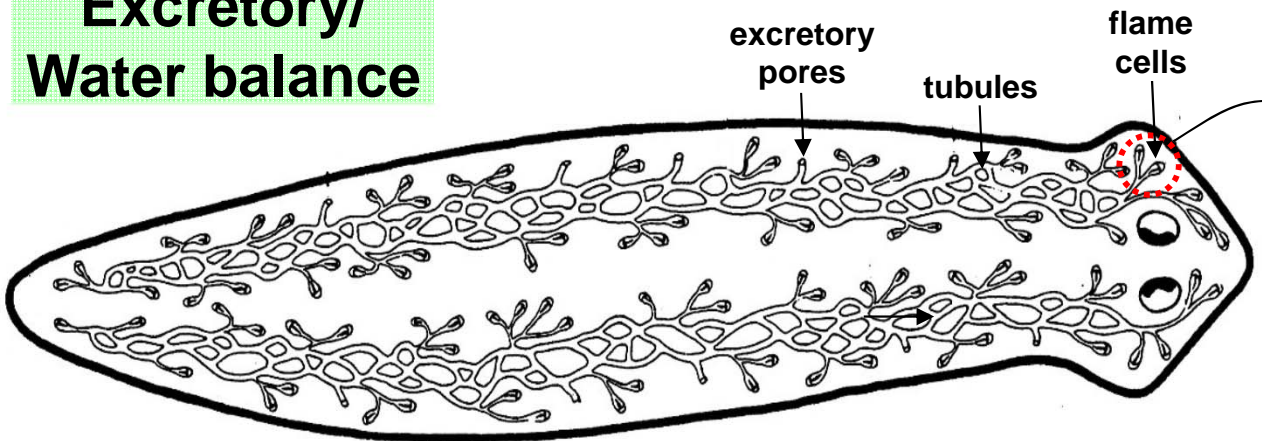


Excretory



Reproductive

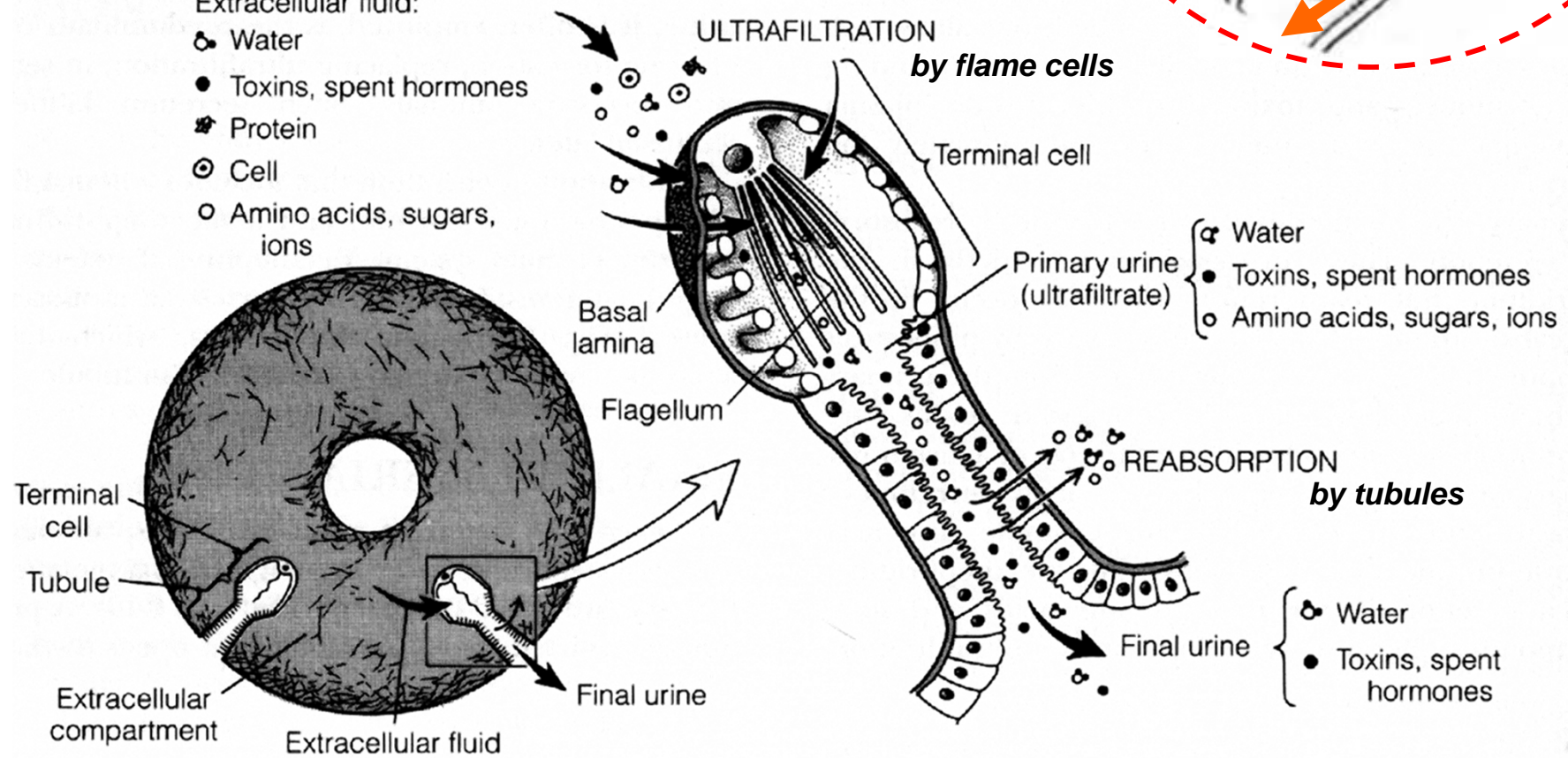
Excretory/ Water balance

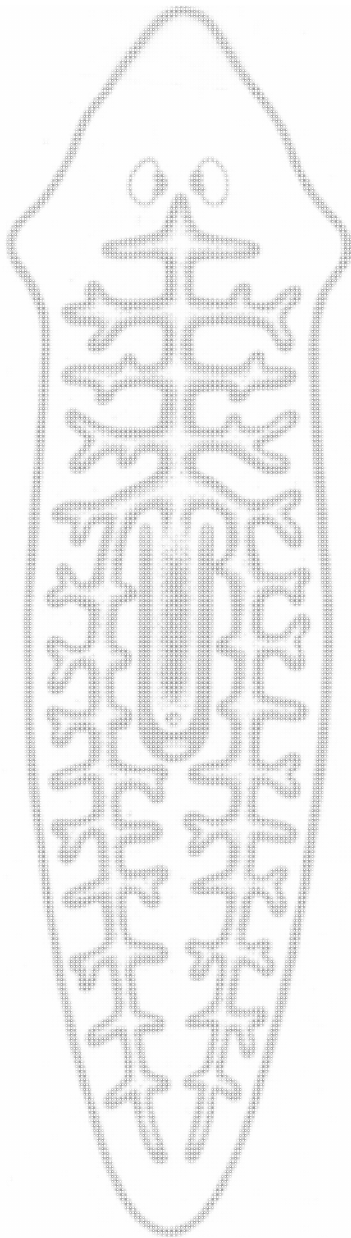


Protonephridial system

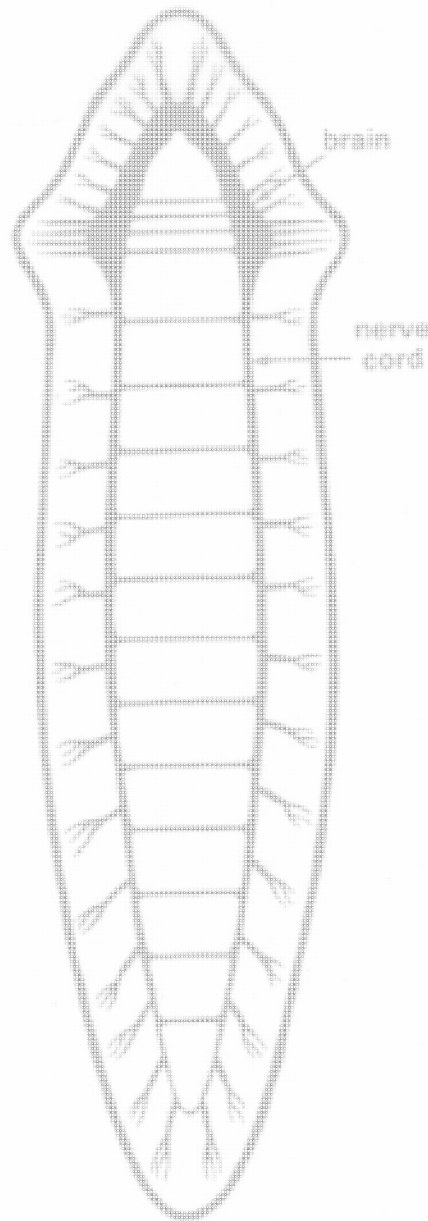
Extracellular fluid:

- Water
- Toxins, spent hormones
- ✱ Protein
- ⊙ Cell
- Amino acids, sugars, ions

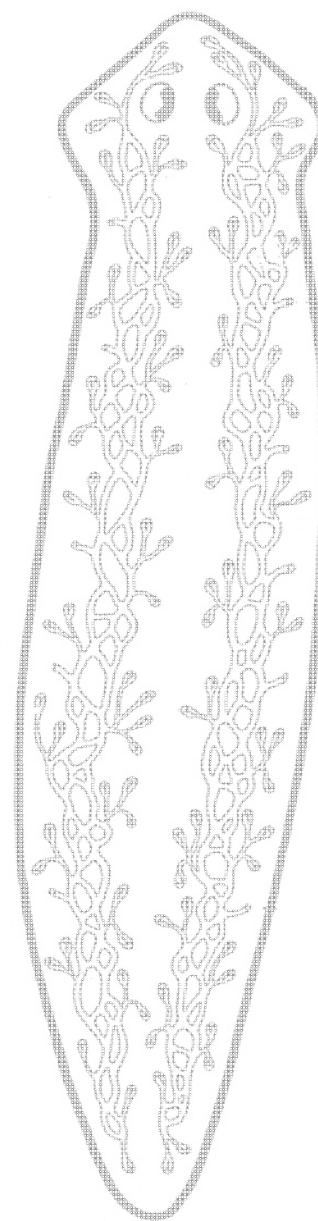




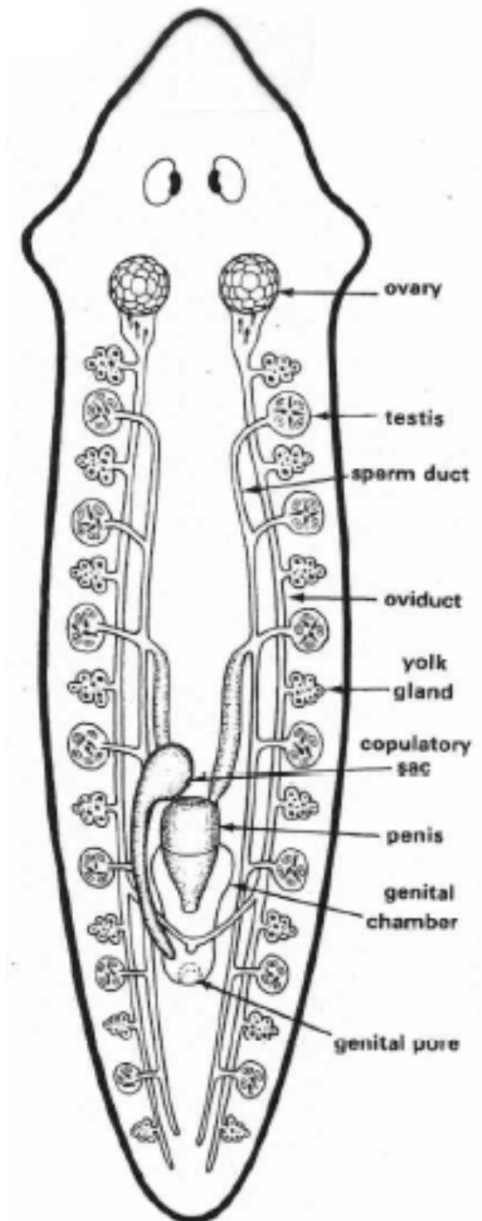
Digestive



Nervous



Excretory

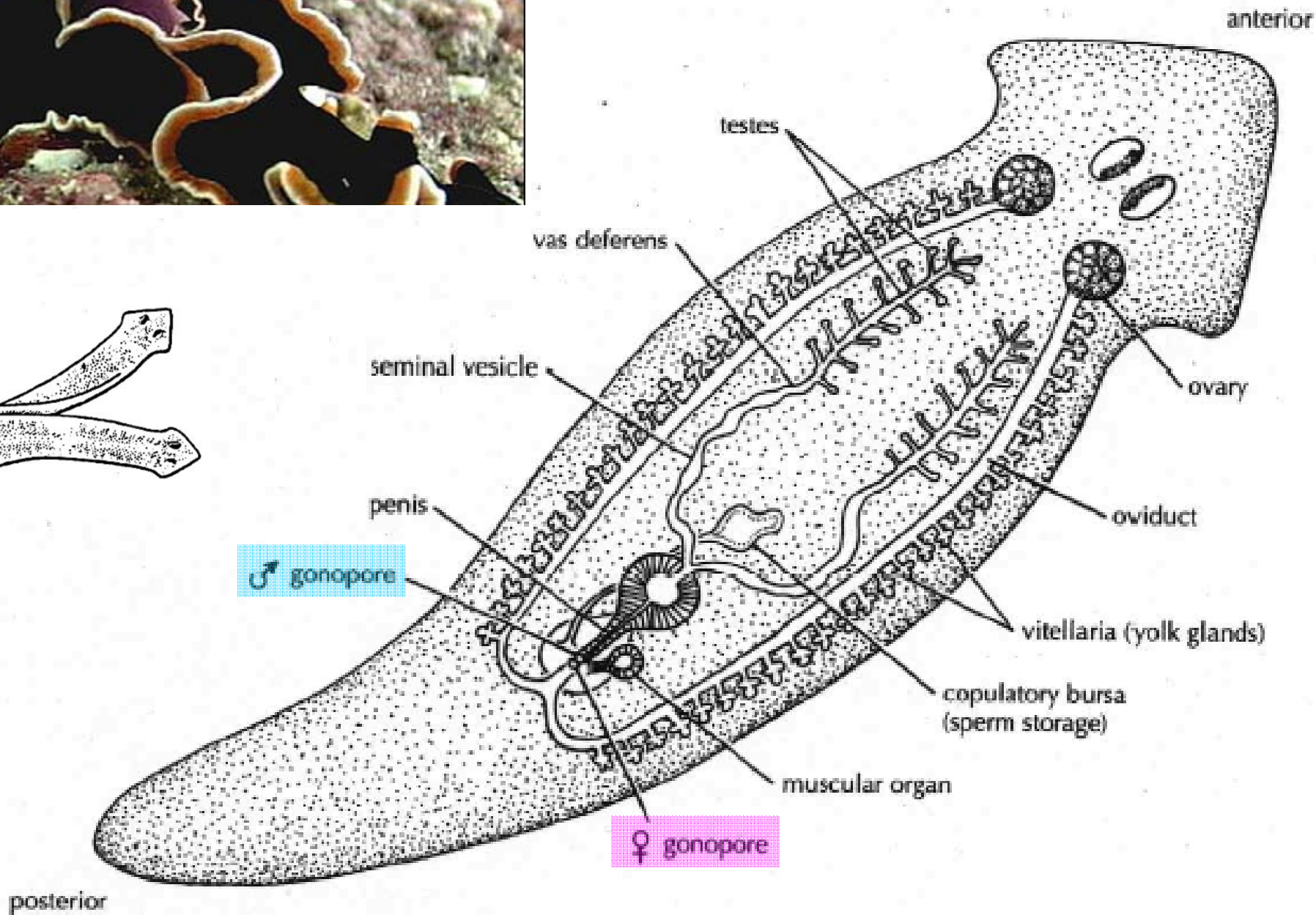
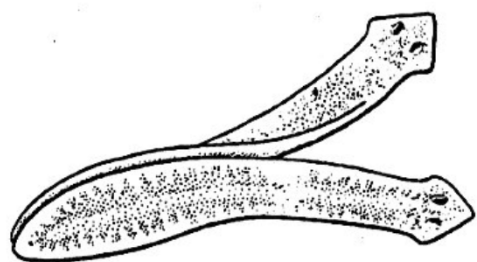


Reproductive

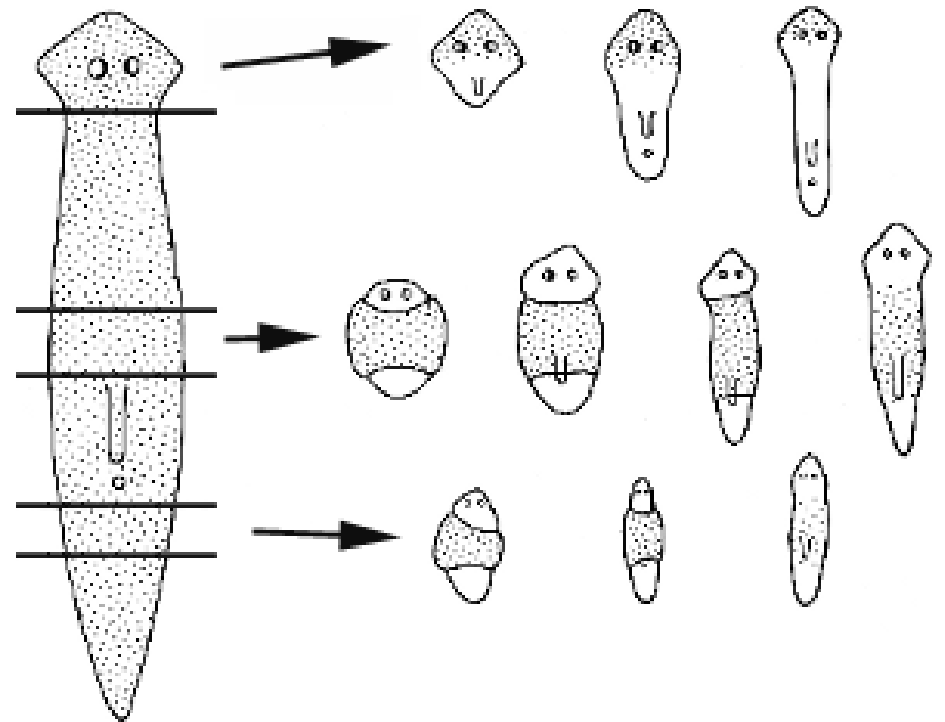


http://www.pbs.org/kcet/shapeoflife/episodes/hunt_explo2.html
<http://www.youtube.com/watch?v=5fx-YgcP8Gg> (0:43)
<http://www.youtube.com/watch?v=S0c3NyupRuY&NR=1> (0:35)

“Penis-fencing”



Asexual reproduction and regeneration

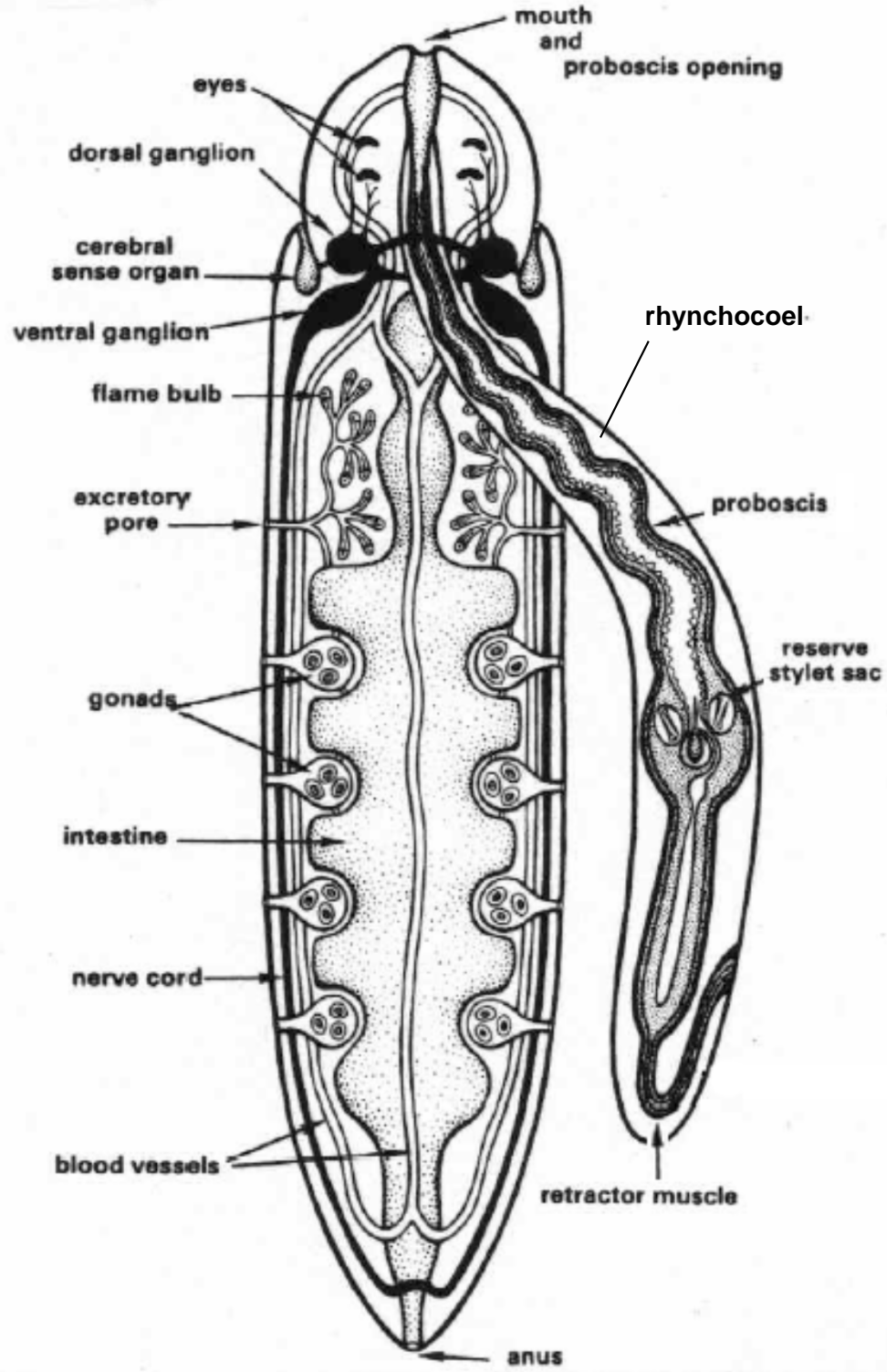
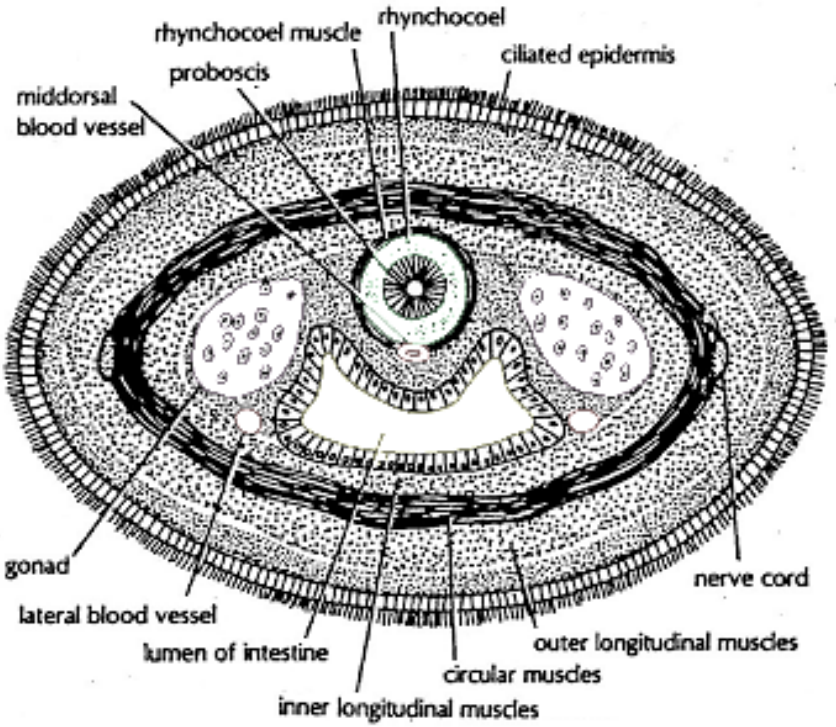
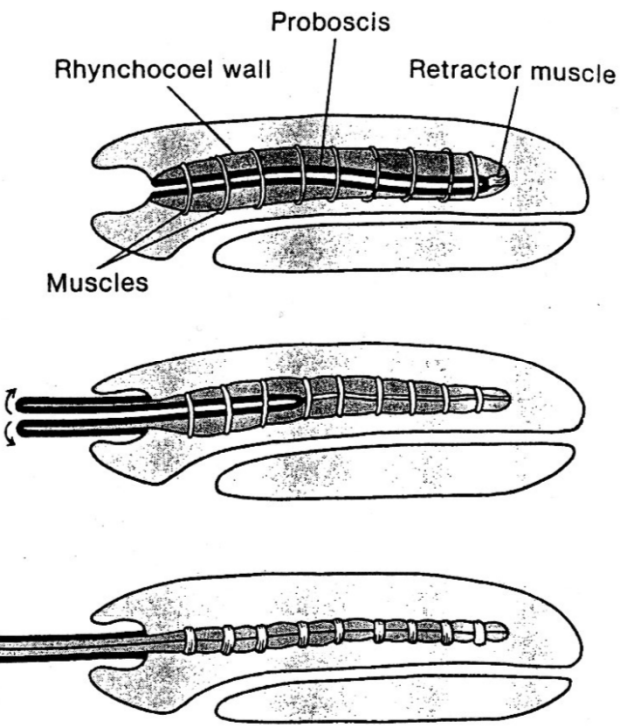
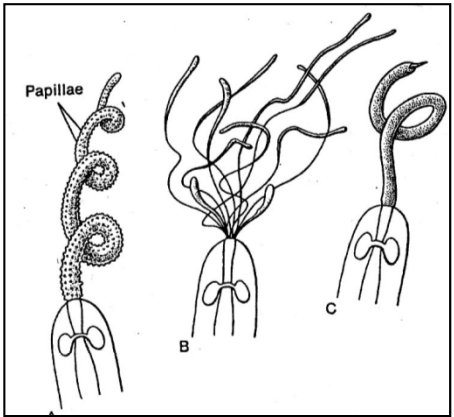


Ph. Nemertea (Ribbon Worms)

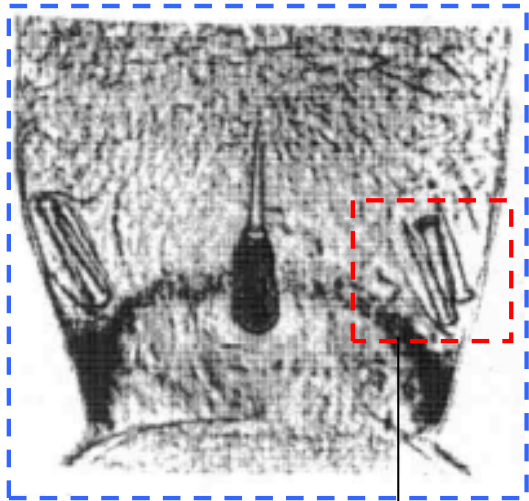


Themes: efficiency of a 1-way gut; novel structures

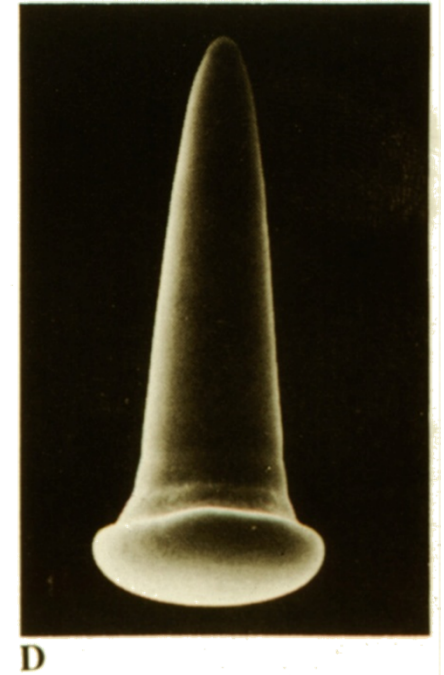
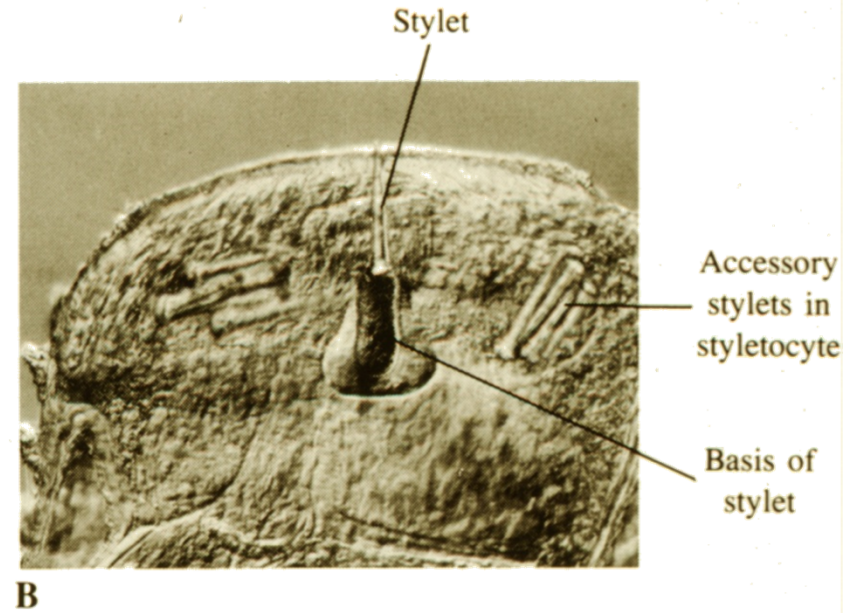
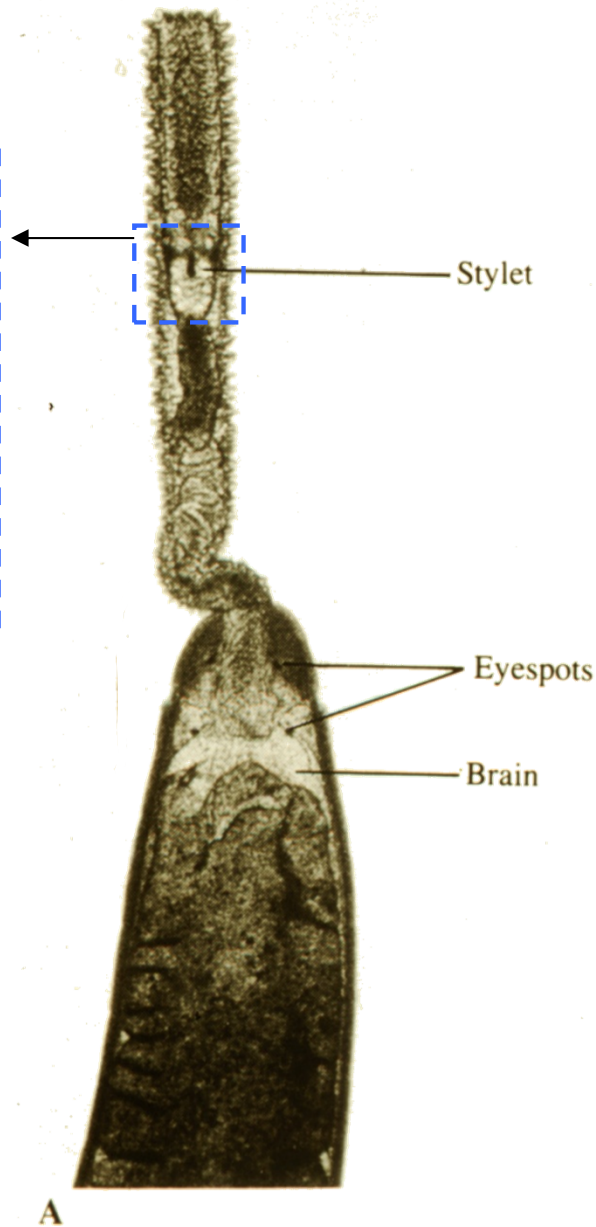
Ph. Nemertea: internal anatomy



nemertea = “unerring”



<http://vimeo.com/13829966>



© Norbert Wu

**Nemertean
are voracious predators
with well-developed
chemical senses**

scyphozoan
medusa

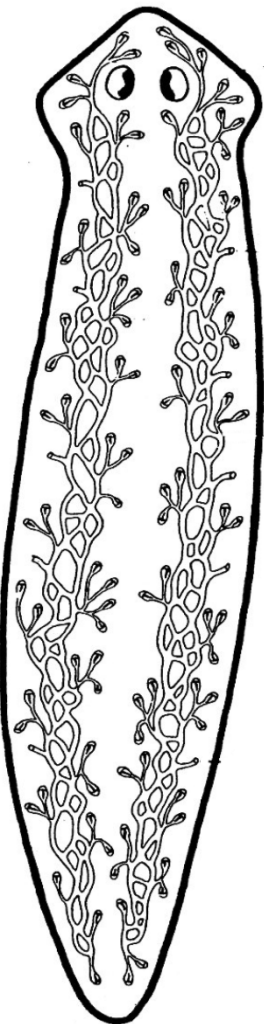
fish eggs



© M Dale Stokes

Excretory systems

Excretion in platyhelminths
protonephridial system



Excretion in nemerteans
protonephridial system
coupled to circulatory system

