

A close-up photograph of a sea anemone. The anemone has a thick, cylindrical body that is bright pink and covered in numerous small, white, circular spots. It has a large number of long, thin, pink tentacles that are slightly curved and extend upwards. The anemone is attached to a dark, textured rock surface. The background is dark and out of focus.

# **KINGDOM ANIMALIA**

## REMEMBER:

Look over your classification and taxonomy notes from AS2!

5 The budgerigar, *Melopsittacus undulatus*, is an Australian parakeet.

(a) Complete the table below to show the classification of the budgerigar.

Kingdom	
Phylum	Aves
	Psittaciformes
Order	Psittacidae
Family	Polytrichaceae
	<i>Melopsittacus</i>
Species	

# Features of the animal kingdom

multicellular

heterotrophs

locomotion

nervous co-ordination

growth occurs throughout the body

you need to know 4 phyla

cnidaria

platyhelminthes

ANNELIDS

chordates

there is an increase in complexity through the phyla

# Kingdom Animalia

## Features

- Eukaryotic cells lacking cell walls
- They have an internal cavity termed an **enteron** in which food is digested.
- All animals develop from an **embryonic stage known as a blastula** (ball of cells) which forms different **germ layers** (these give rise to the different tissues and organs).

# More features of the animal kingdom

- Animals are **multicellular, heterotrophs** – they are unable to make their own food and need a supply of organic food material.
- They are capable of **locomotion** and display some degree of **nervous co-ordination**.
- **Growth** occurs throughout the body.

# Differences in the phyla that make up the animal kingdom

- These are primarily differences in **feeding** and the **development of germ layers**
- They may possess a digestive cavity in which digestion takes place both in the cavity (extracellular) and in the cells lining the cavity (intracellular) or a through gut where digestion is completed extracellularly.
- They may possess two germ layers (diploblastic) or 3 germ layers (triploblastic); if triploblastic a coelom (body cavity) may develop.

**BODY**

**PATTERNS**



Symmetry

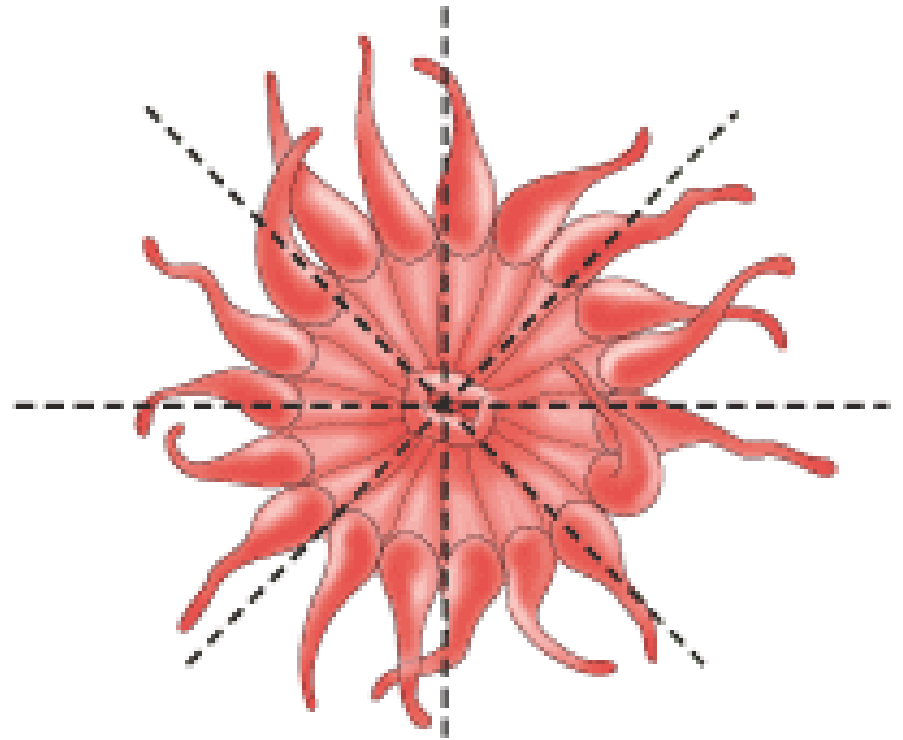
# Radial

symmetry around a central axis

e.g. Cnidarians



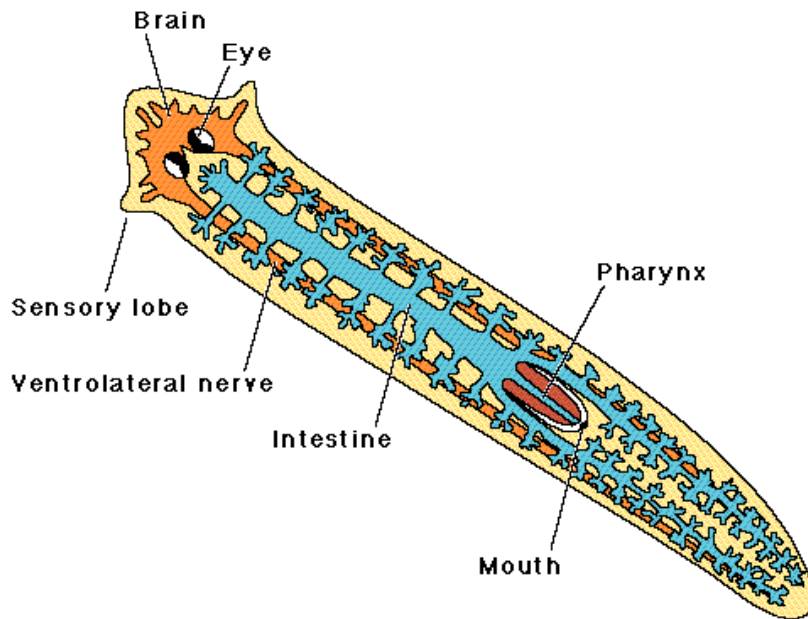
The sea anemone, a cnidarian, has radial symmetry.



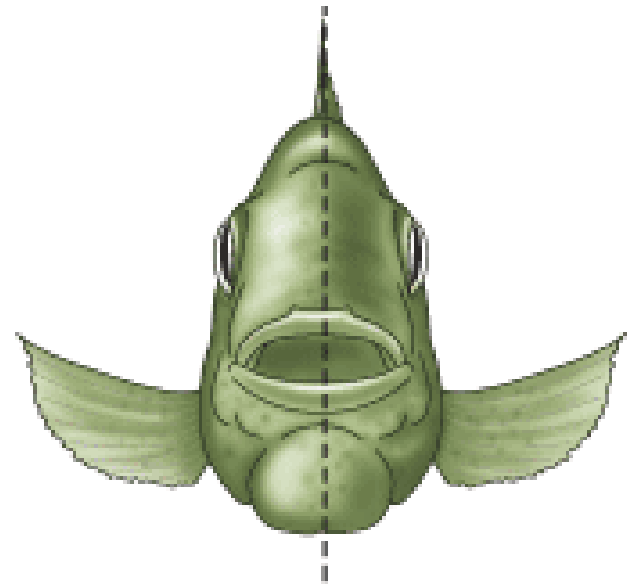
Any plane along the main body axis divides the animal into similar halves

# Bilateral

Body can be divided into 2 mirror image halves  
e.g. platyhelminthes and chordates



The fish, a vertebrate,  
has bilateral symmetry.



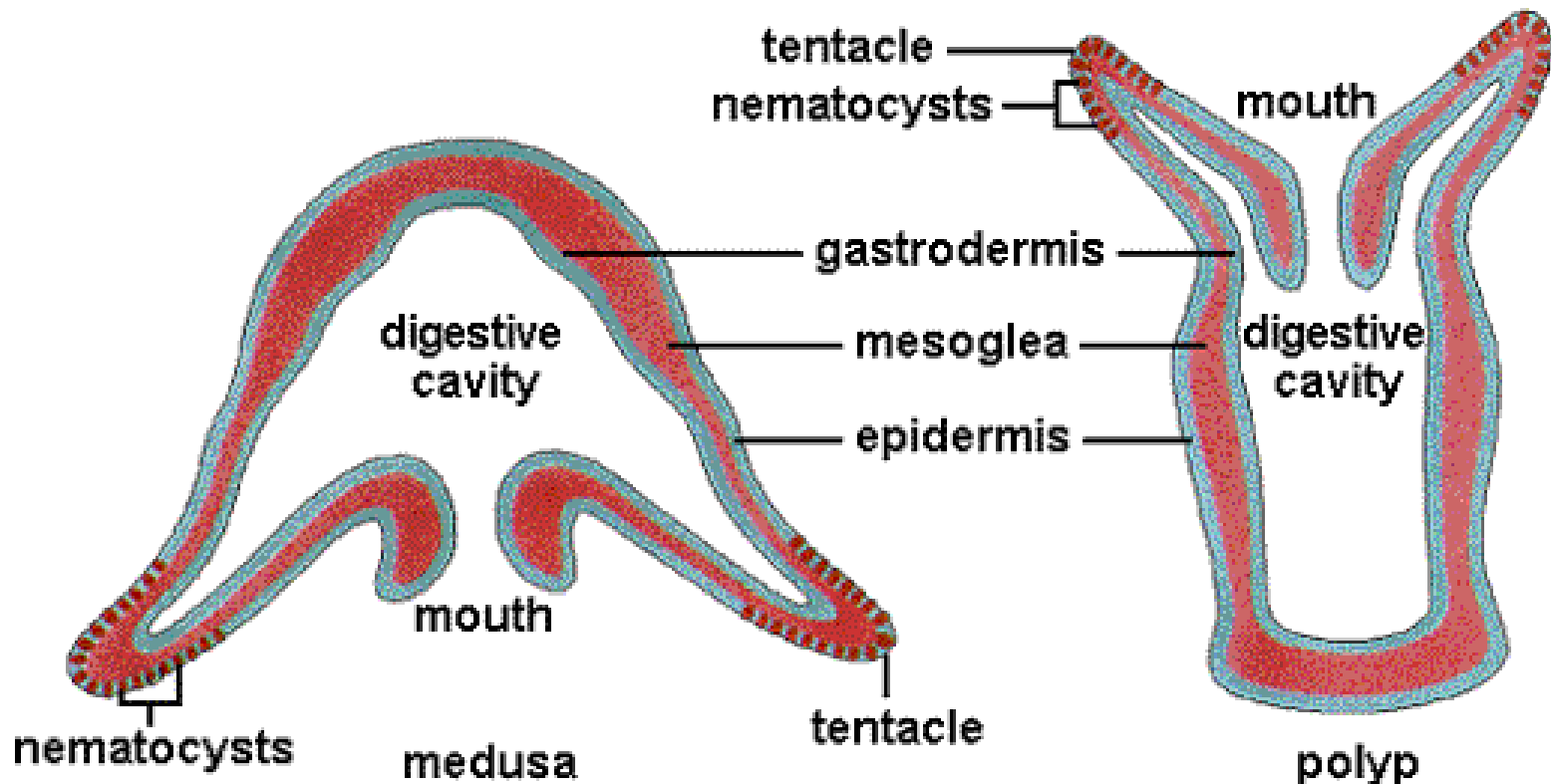
Only one plane divides the animal into  
similar, mirror- image halves.

Gut cavity

# Blind – only one opening

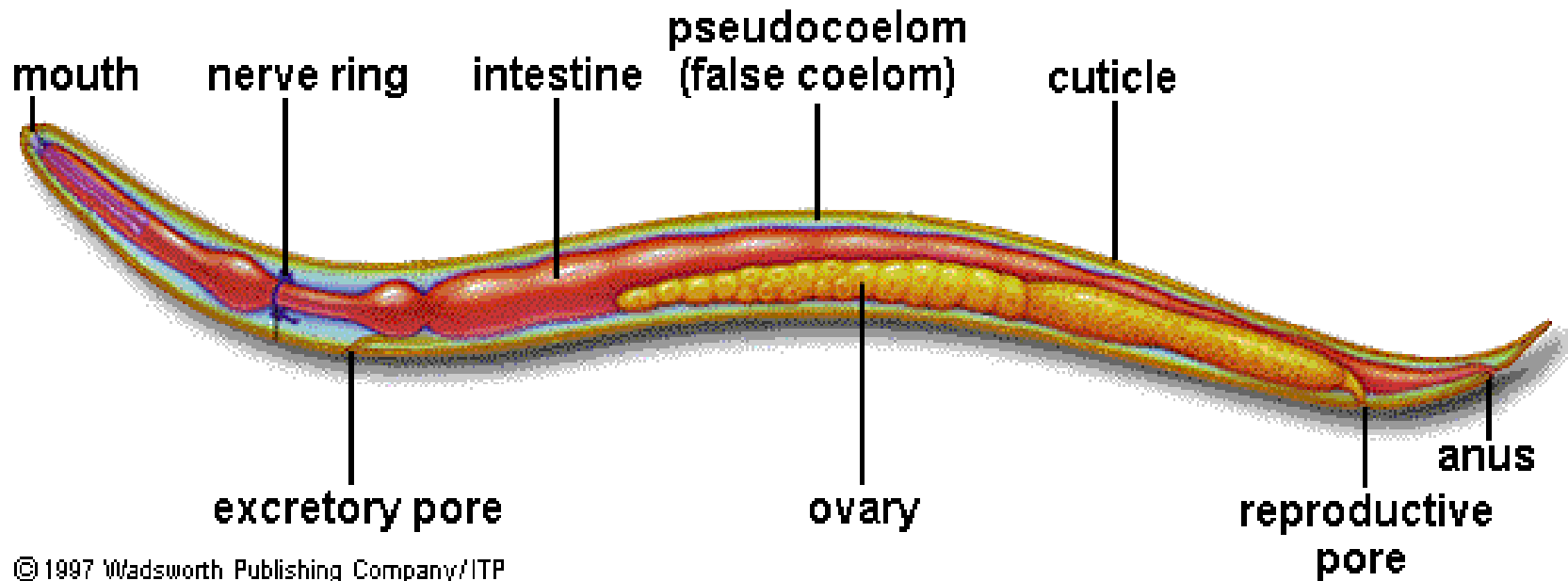
Entrance and exit to gut cavity through the same opening

e.g. cnidarians, platyhelminthes



# Complete – one way gut

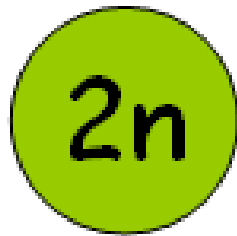
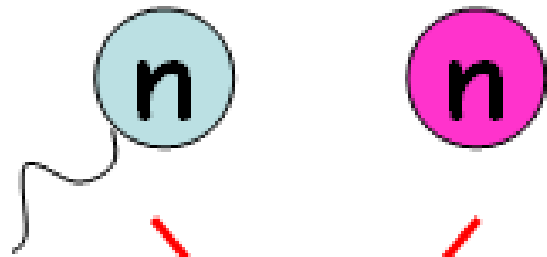
Mouth and anus  
e.g. annelids and chordates



# Body layers

All animals develop from a **zygote** (fertilised egg) into a hollow ball of cells, the **blastula**. Groups of cells within this ball **differentiate** to form specific structures within an animals body

gametes



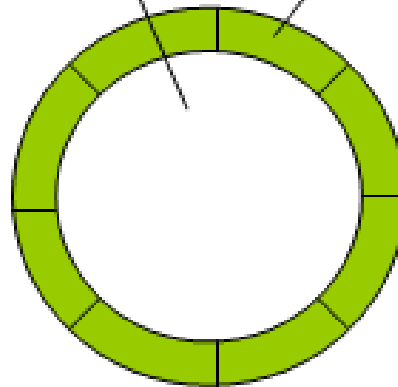
Zygote

mitosis



hollow cavity

cells



Blastula

mitosis  
&  
differentiation

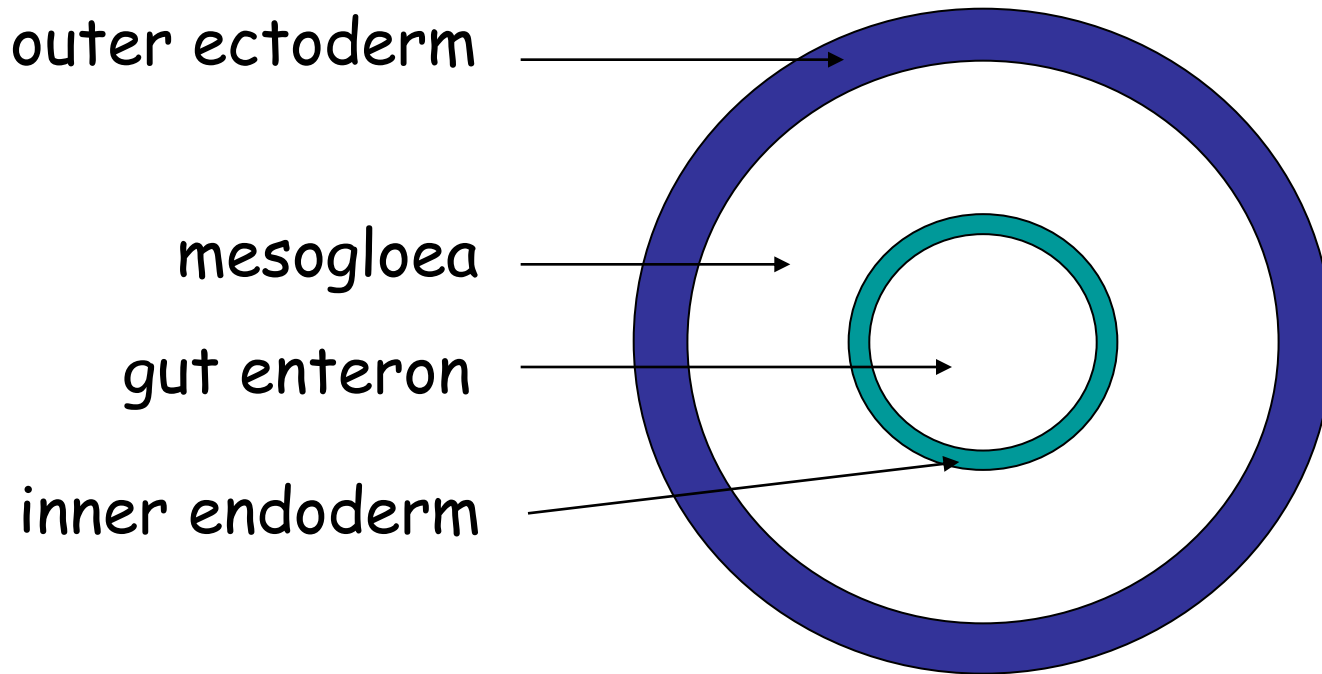


**Multicellular  
embryo**



# Diploblasts

Animals with 2 layers of tissues formed when an indent at one side of the blastula pushes a layer of cells into the hollow (e.g. cnidarians)

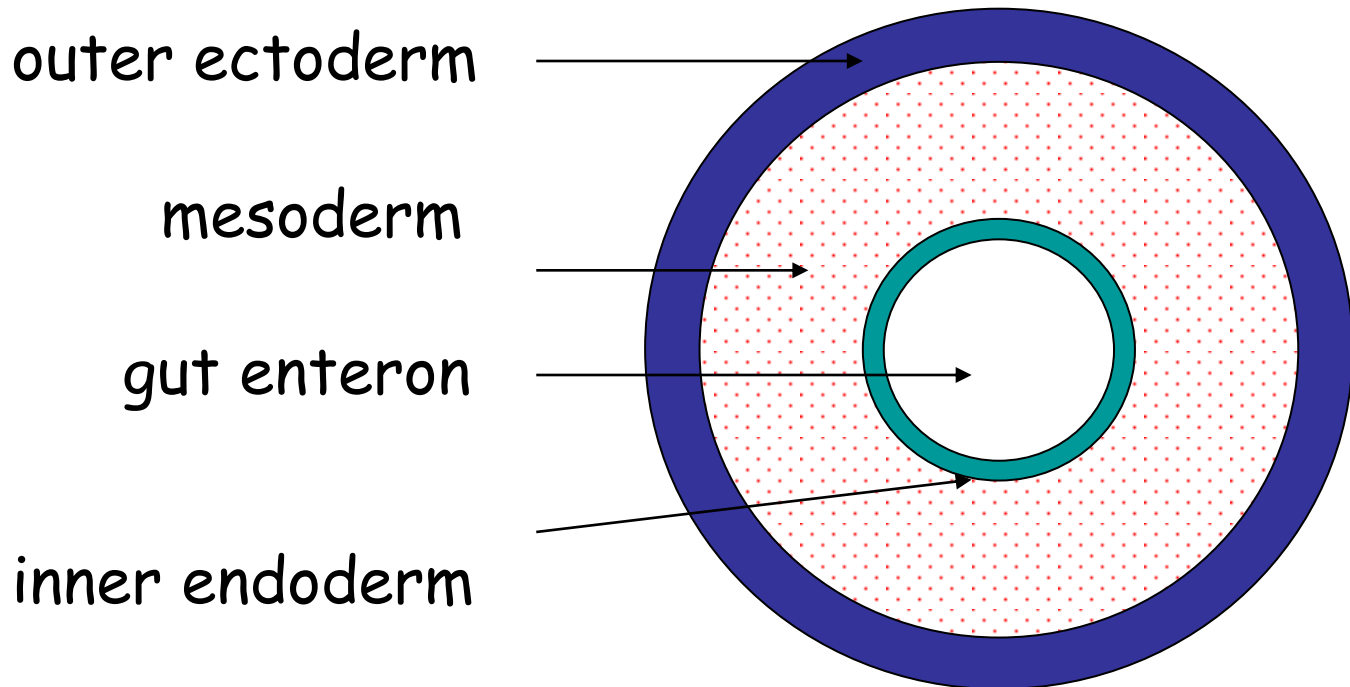


- **Ectodermis** found on the outside of the body develops into skin and the nervous system
- **Endodermis** forms the inner layer which develops into the digestive system and associated organs
- **Mesogloea** is a non-cellular layer containing fluids and dissolved substances

# Triploblasts

Layers formed in the same way as diploblasts but the mesogloea develops into a tissue layer called the **mesoderm**.

Mesoderm develops into the muscular system and other body tissues

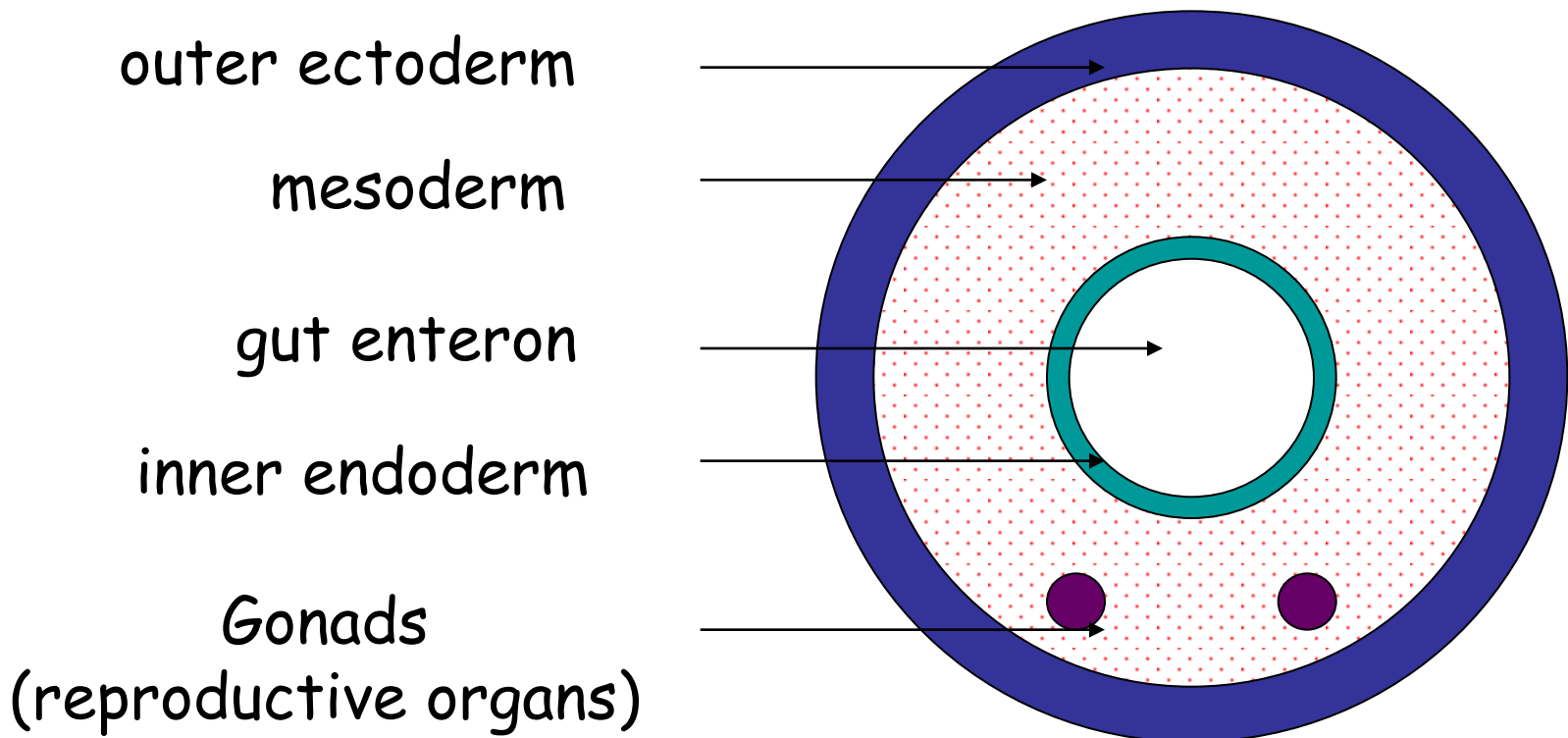


# Body cavities

only found in triploblasts

# Acoelomates

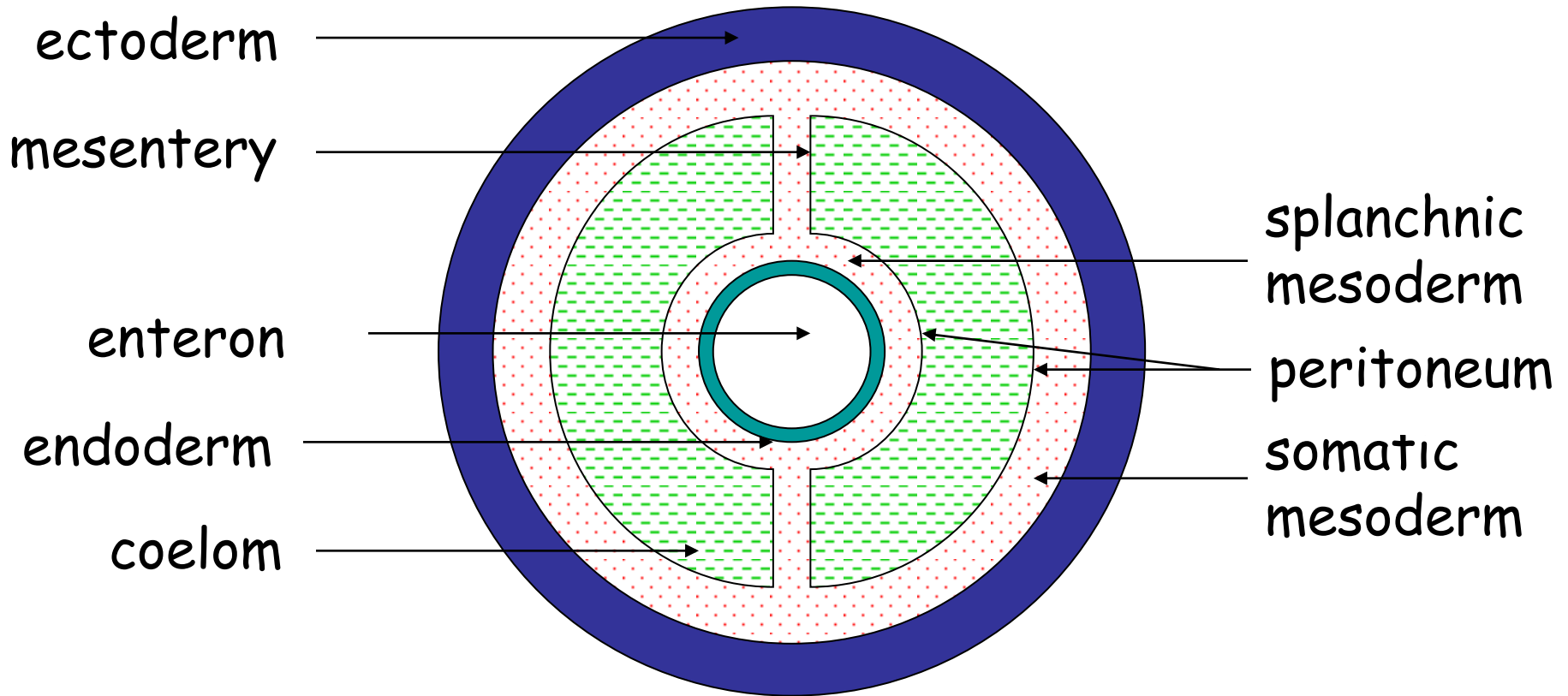
Mesoderm completely fills the space between  
the endoderm and ectoderm  
e.g. platyhelminthes



# Coelomates

The mesoderm splits as the embryo develops (e.g. annelids and chordates)

- **Somatic mesoderm** remains attached to the ectoderm
- **Splanchnic mesoderm** remains attached to the endoderm
- The split forms a fluid filled cavity called the **coelom**. The **coelomic fluid** is secreted by the mesodermal cells which form the **peritoneum**.



# Function of the coelom

1. Acts as a **hydroskeleton**
2. Enables the body wall and alimentary canal to operate **independently**
3. Permits animals to become **larger**
4. Fluid may act as a circulatory medium for **transport** of food, waste materials and gases
5. Waste materials and excess fluids may be temporarily **stored** here
6. Provides **space** for enlargement of internal organs
7. Plays a role in the **osmoregulatory** activity of an organism



# Segmentation

In many coelomates the mesoderm and ectoderm divide to form a small fixed number of similar segments along the body, called **somites**.

Each segment has similar muscles, blood vessels and nerves.

**Specialised organs** e.g. reproductive are found only in some segments. The segments are separated by sheets of tissue called septa e.g. annelids.

Segmentation allows **independent movement of each part of the body**, permitting better burrowing activity and finer control of body movements.



# Metamerism

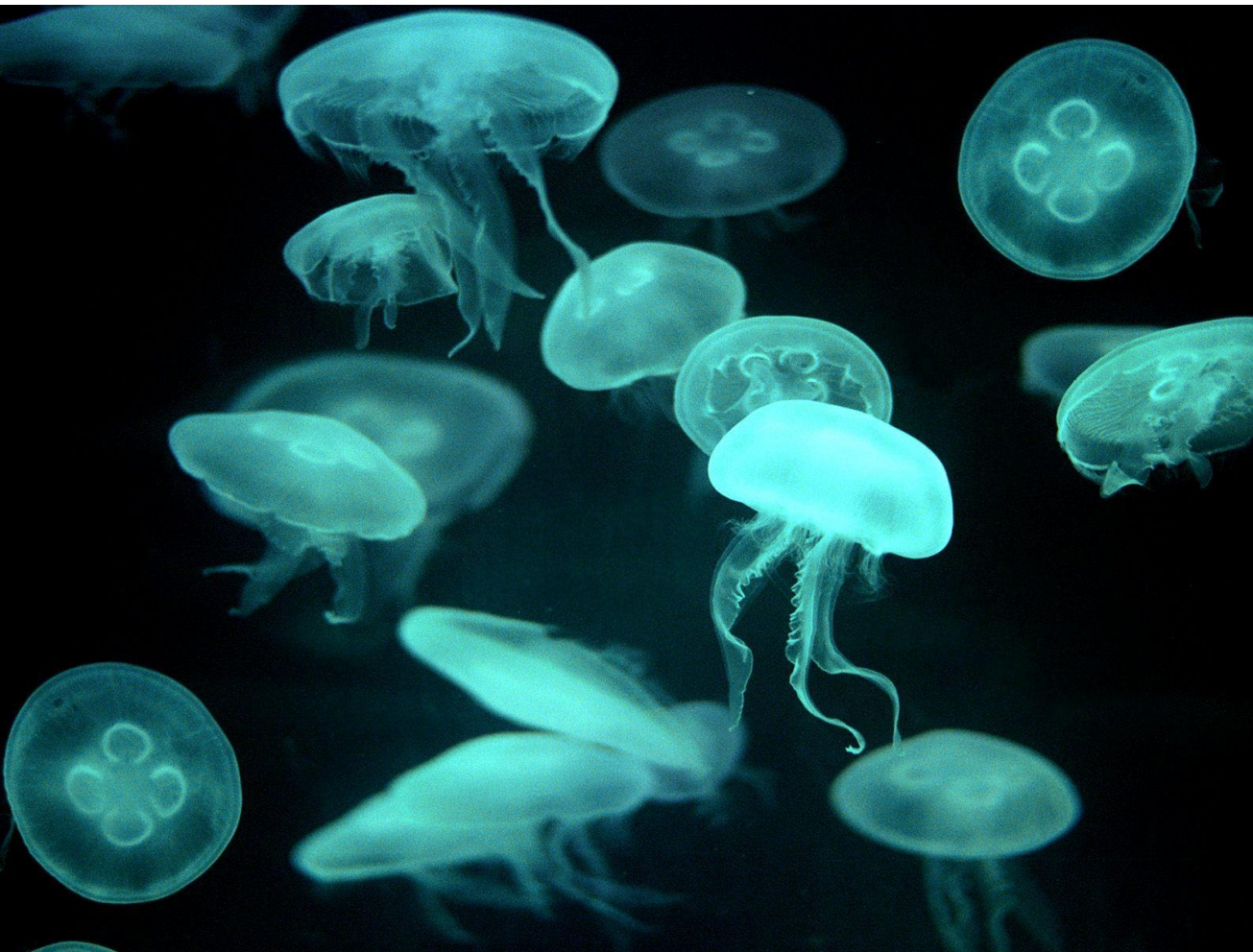
Metamerically segmented organisms e.g. annelids have structurally similar segments but these DO NOT FUNCTION INDEPENDENTLY OF OTHER SEGMENTS

Each segment has its own coelomic space with rudimentary organs such as excretory and nervous structures



# Kingdom Animalia

- **Phylum cnidaria (coelenterates)**



# PHYLUM CNIDARIA

## FORM

### DIPLOBLASTIC

**two body layers, ectoderm and endoderm,  
separated by non-cellular jelly layer, mesogloea**

### RADIAL SYMMETRY

### HYDROSTATIC SKELETON

**body supported by aqueous medium  
and hydrostatic skeleton formed by fluid filled enteron**

### little differentiation

**tissues rather than organs**

# PHYLUM CNIDARIA

## FEEDING

CNIDOCYSTS containing NEMATOBLASTS

**prey captured by use of stinging cells (cnidocysts)  
and conveyed to mouth by tentacles**

**blind gut**

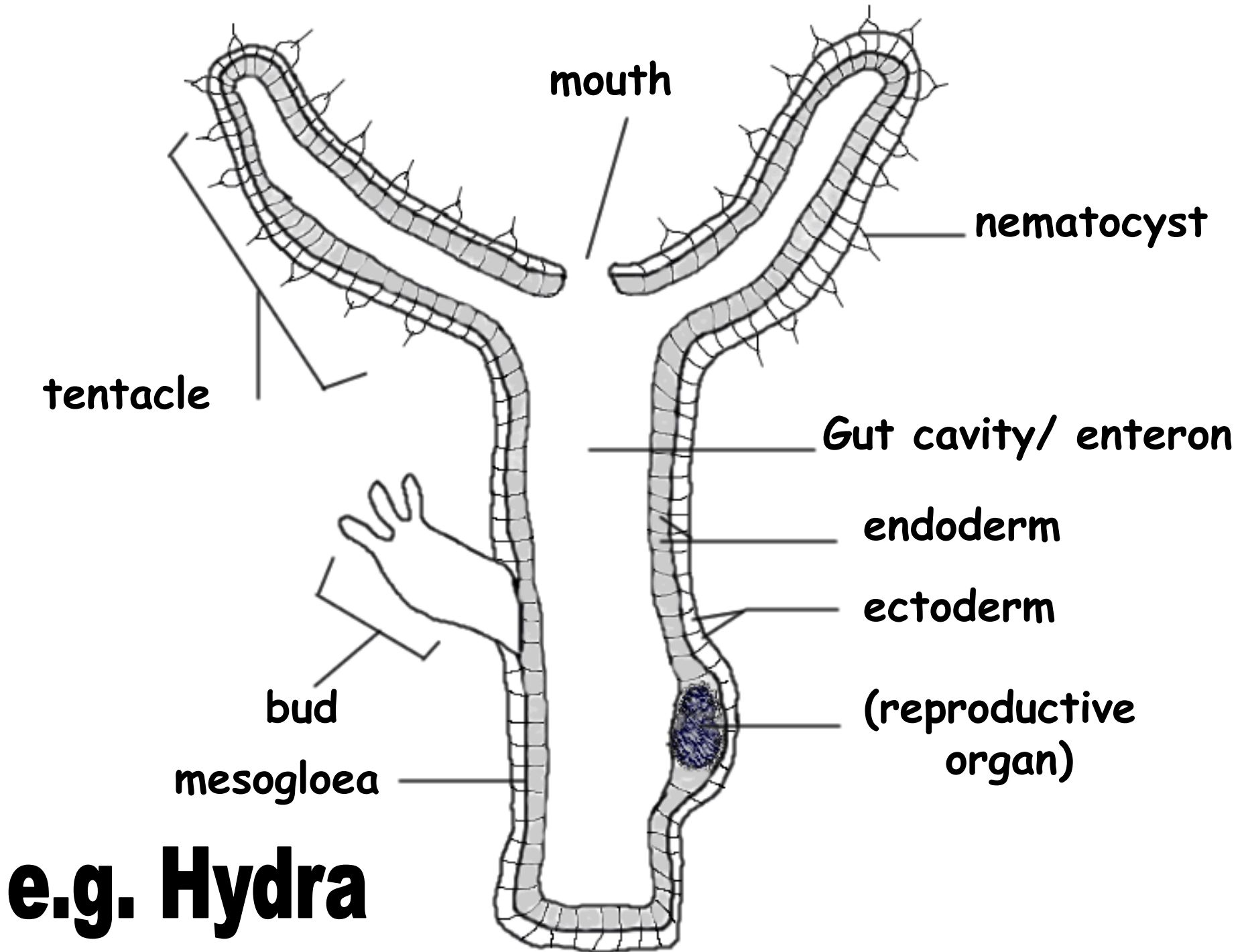
**single opening to the sac-like gut**

**digestion extracellular**

**initial digestion by extracellular secretions**

**products absorbed by endocytosis and**

**final phases are intracellular**





reproduction is asexual by budding





- These organisms show a **little differentiation**.
- They have a hollow gut or enteron and a body wall formed from 2 layers.
- The **enteron has only one entrance** termed the mouth which serves as the exit for undigested food.
- Hence they are referred to as **DIPLOBLASTIC** (2 layers of cells)
- A good example of this phylum are the *Hydra*.

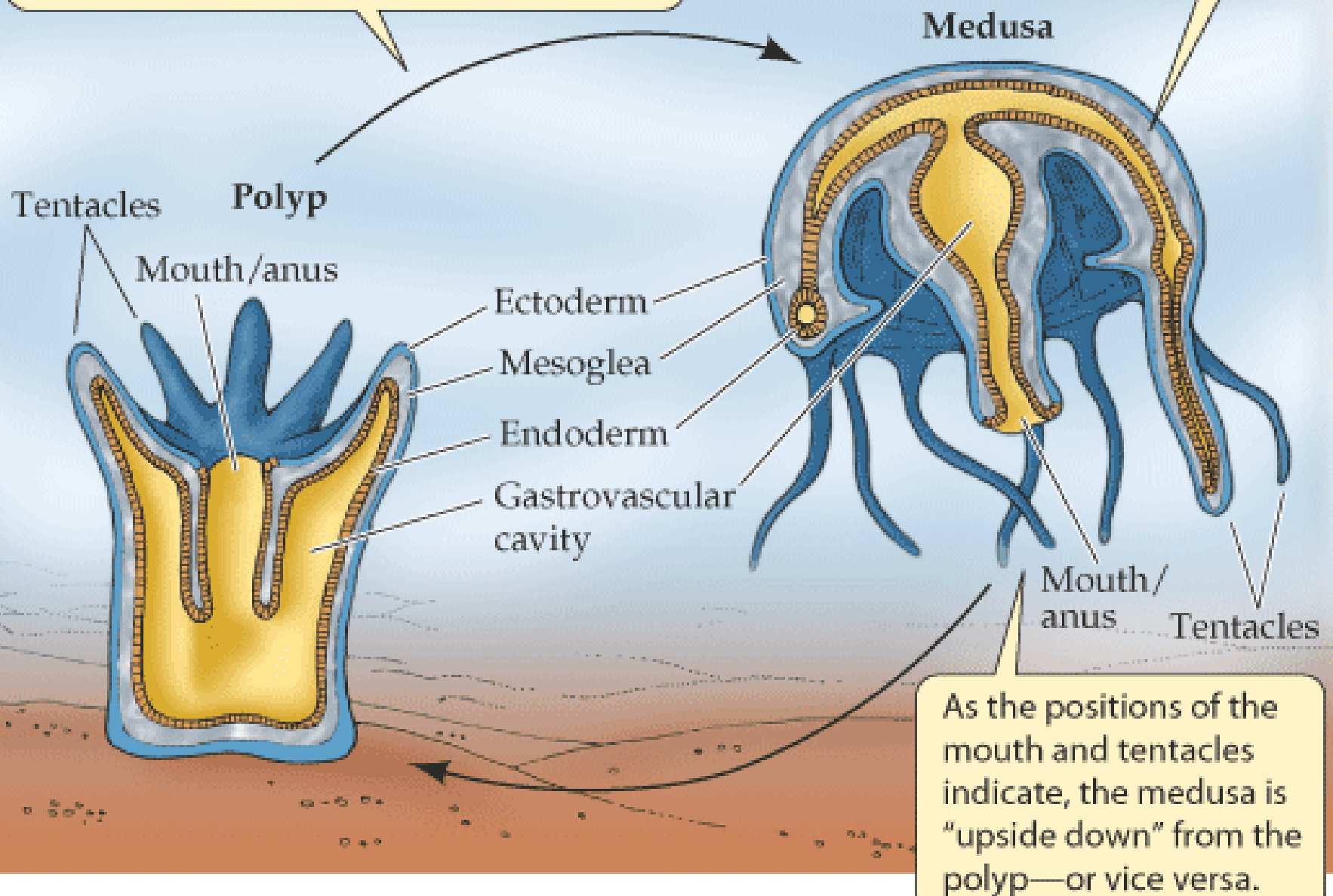


# Habitat -

- Aquatic organisms which are **mainly sessile** (i.e. do not move).
- **Some** members of this phylum have a **motile** stage in their life cycle, called a **medusa** (it is similar to a jelly-fish).
- The **sedentary** stage is called a **polyp**.

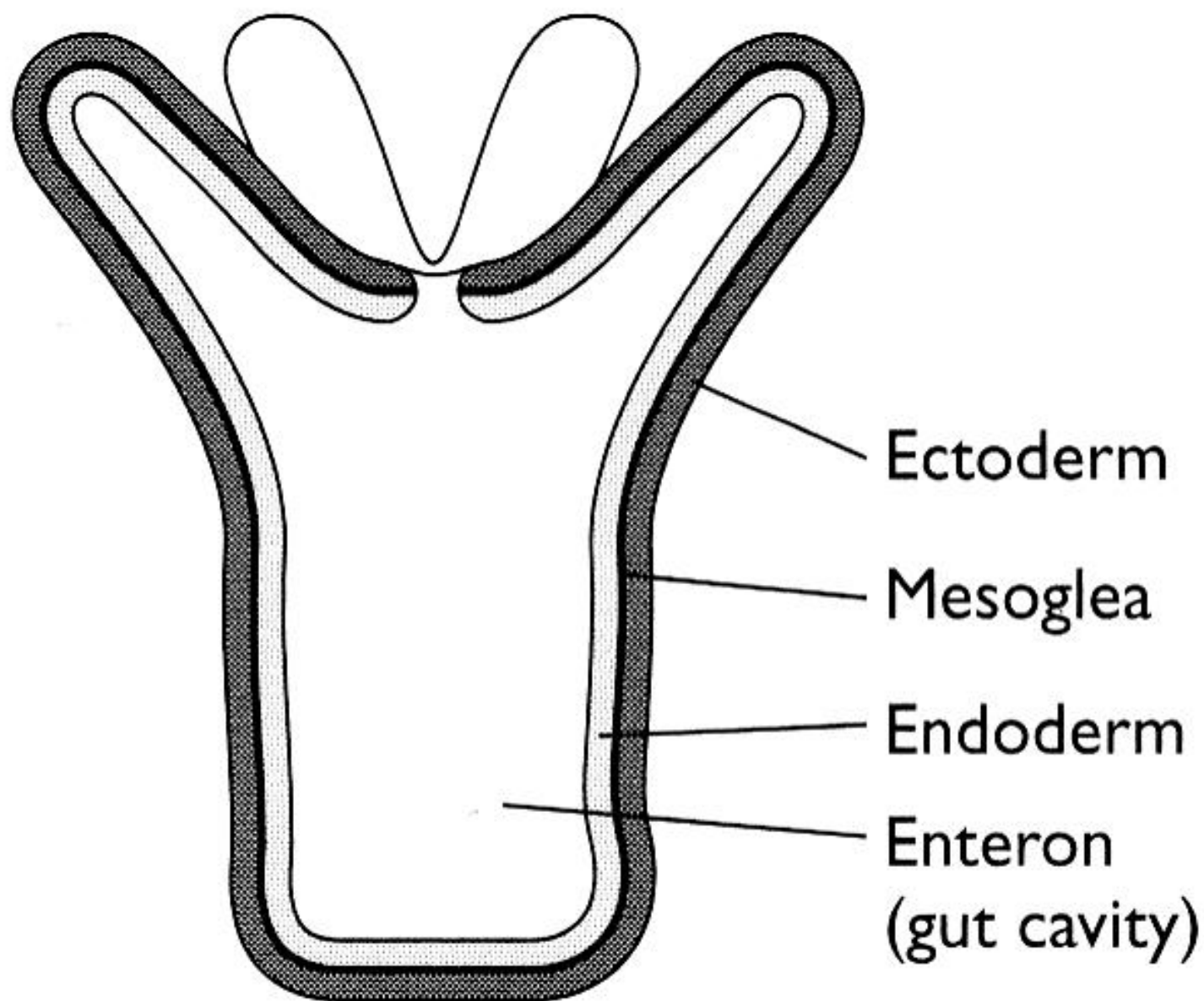
During the life cycle of many cnidarians, the usually sessile, asexual polyp alternates with the free-swimming, sexual medusa.

The mesoglea is a jellylike layer with few cells.



# Structure -

- Hydra are **diploblastic** and **radially symmetrical**.
- They have two layers in their body wall, (the outer ectoderm layer and the inner endoderm separated by a non-cellular jelly-like layer – the **mesoglea**).
- The majority of the cells in the ecto and endoderm are **muscle tail cells**,
- arranged transversely in the endoderm (contraction = long thin body) and
- longitudinally in the ectoderm (contraction = body shortening).



***Figure 41 The body structure of Hydra***

# Nervous system –

- The nervous system is formed from a network of neurones, i.e. there is **no CNS**.
- Receptors are sense cells – restricted to the ectoderm and concentrated on the tentacles and around the mouth.
- After stimulation of a sensory cell, the impulse is slowly transmitted in all directions.
- Distance the impulse travels varies with the strength of stimulation.
- **Conduction is slow due to the large number of synapses.**
- Initially a localised response is produced but prolonged stimulation may involve the whole body.

# Ectoderm-

- Outer layer of epidermis.
- Some of the cells in this layer can be **stimulated by nerves in the mesoglea.**
- When these cells contract the *Hydra* can alter its shape.
- The ectoderm also contains the stinging cells (**cnidocysts** – cnidoblasts, nematoblasts)
- When triggered these explosively penetrate the prey and inject poison, paralysing and holding the prey prior to ingestion.

# Mesoglea -

- A jelly-like layer **containing nerve fibres which connect the ectoderm and the endoderm.**
- (Compare this level of innervation to the sponge which has no nerve or sense cells. In the sponge all cells are sensitive but transmit impulses only to cells around them. Therefore it is insensitive to change and reacts slowly).



# Endoderm -

- - inner layer or **gastrodermis**.
- This layer lines the enteron or digestive cavity.
- It possesses **ciliated cells** which break up food (by the beating of the cilia).
- Food is then engulfed by the formation of **pseudopodia**.
- Digestion occurs **INSIDE the cells**.
- **Nerve cells** in this layer are sensitive to the environment of the enteron.

# Support -

- The *Hydra* is supported by its **aqueous environment**.
- However it also gains support from the pressure of fluid in the enteron.
- This acts like a **hydroskeleton**.

# Nutrition -

- *Hydra* feed on small aquatic
- animals, e.g. *Cyclops* and
- *Daphnia* (the water flea). →



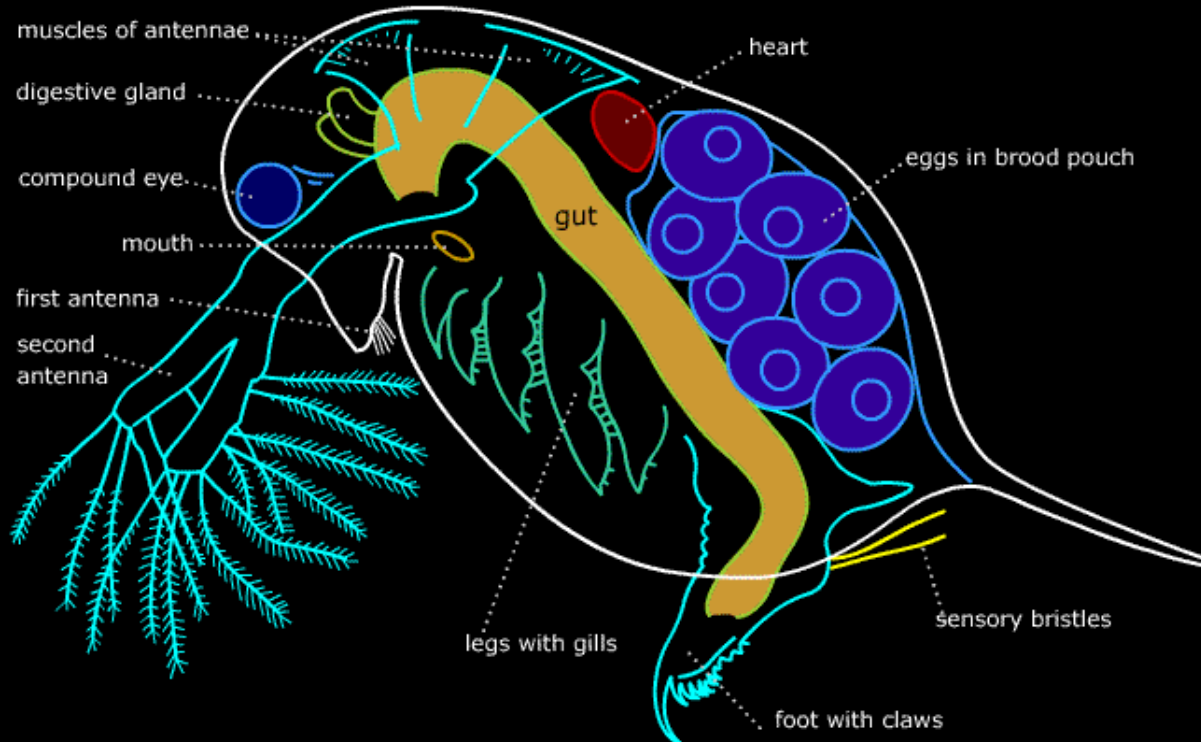
- The poison cells (cnidocytes) (its poison tube with barb shoots out) immobilise the prey and the co-ordinated movement of the tentacles push prey into the enteron via the mouth.
- **Endodermal cells** secrete digestive enzymes which begin to digest the surface of the prey extracellularly but digestion is completed **intracellularly**, following **endocytosis**.
- Undigested food is discharged through the mouth.

# Water flea anatomy – reveal true image:

<http://microscopy-uk.org.uk/mag/indexmag.html?http://microscopy-uk.org.uk/mag/artmar02/fleanatomy.html>

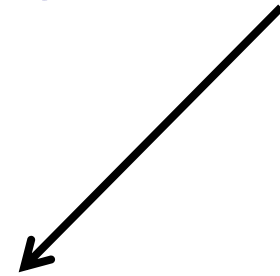
- by Wim van Egmond, The Netherlands

This is a mouse-over image of *Daphnia longispina*, a common water-flea. Use the underlying image to examine its main anatomical features!



# Reproduction -

- **Sexual reproduction** occurs at the end of favourable seasons as conditions deteriorate.
- **Asexual reproduction occurs by budding.**





# Kingdom Animalia

- **Phylum Platyhelminthes**  
**(Flatworms)**



BIODIDAC © J. Houseman, Univ. d'Ottawa



# PHYLUM PLATYHELMINTHES

## FORM

TRIPLOBLASTIC

**ectoderm, mesoderm, endoderm**

ACOELOMATE

**no body cavity**

BILATERAL SYMMETRY



# PHYLUM PLATYHELMINTHES

## FORM

### TISSUE DIFFERENTIATION

**well differentiated organ systems e.g. for digestion**

**no specialised skeletal system**

**but advancement of non-cellular mesogloea found in cnidarians**

**into cellular mesoderm that provides support**

**so organism retains shape at all times**

**unlike jelly like cnidaria**

# PHYLUM PLATYHELMINTHES

## FORM

flattened dorso-ventrally

**large SA:VOL for gas exchange by diffusion only**

**DEFINITE anterior/posterior**

# PHYLUM PLATYHELMINTHES

## FEEDING

**DIFFERENTIATION IN FEEDING HABITS**  
**from detritivores to active predators**

**blind gut**

**with primitive digestive system**  
**gut branches to deliver nutrients to all cells**

# PHYLUM PLATYHELMINTHES

## FEEDING

digestion extracellular

**prey taken into gut through pharynx,  
enzymes partly digest food,  
most digestion completed intracellularly**

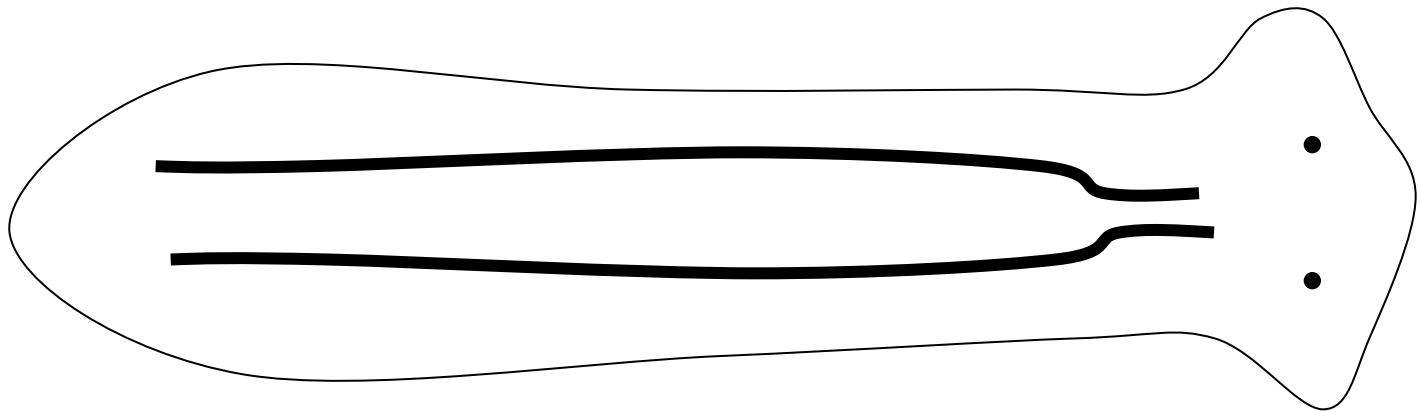
**e.g. planaria**

**branched gut**

**simple eye**

**posterior**

**anterior**



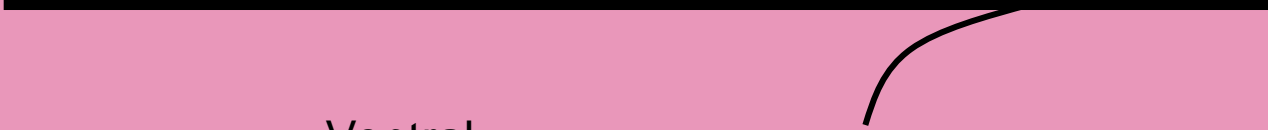
Dorsal  
(back)  
surface

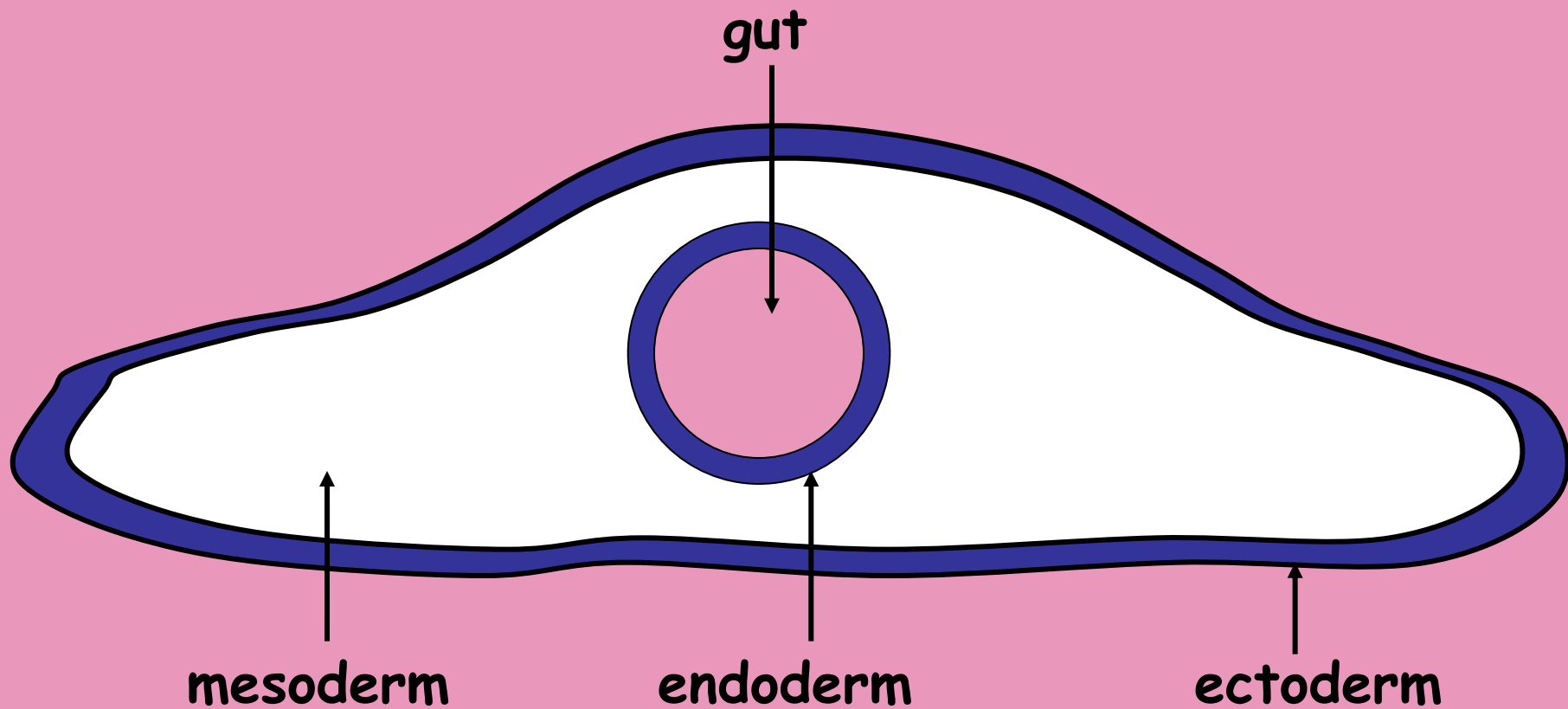
posterior

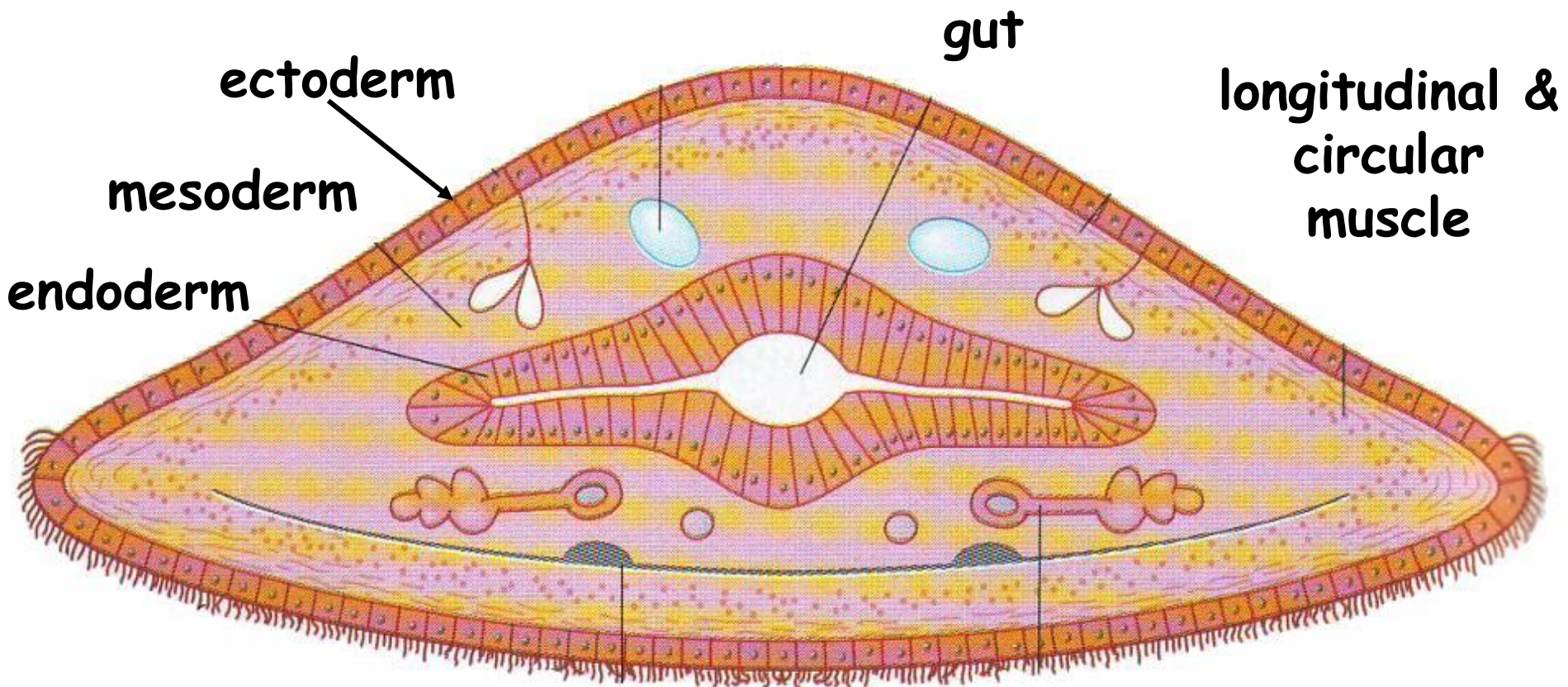
anterior

Ventral  
(front)  
surface

Pharynx  
(mouth)





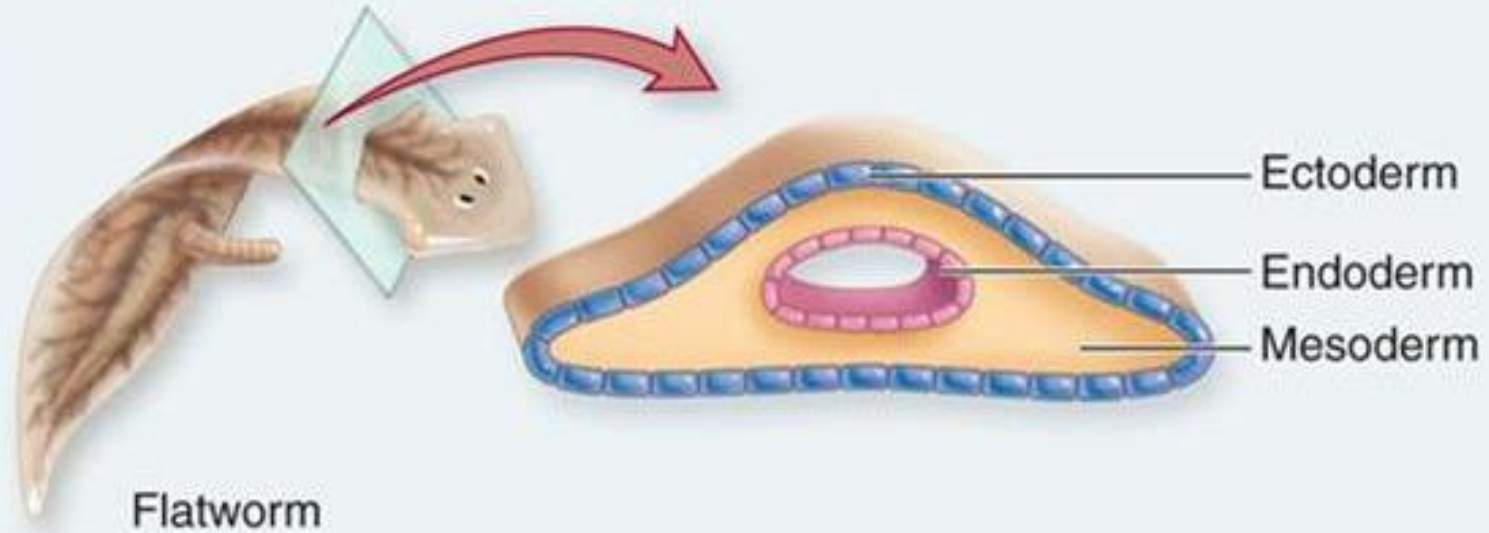


**Cilia on ventral surface  
for movement**

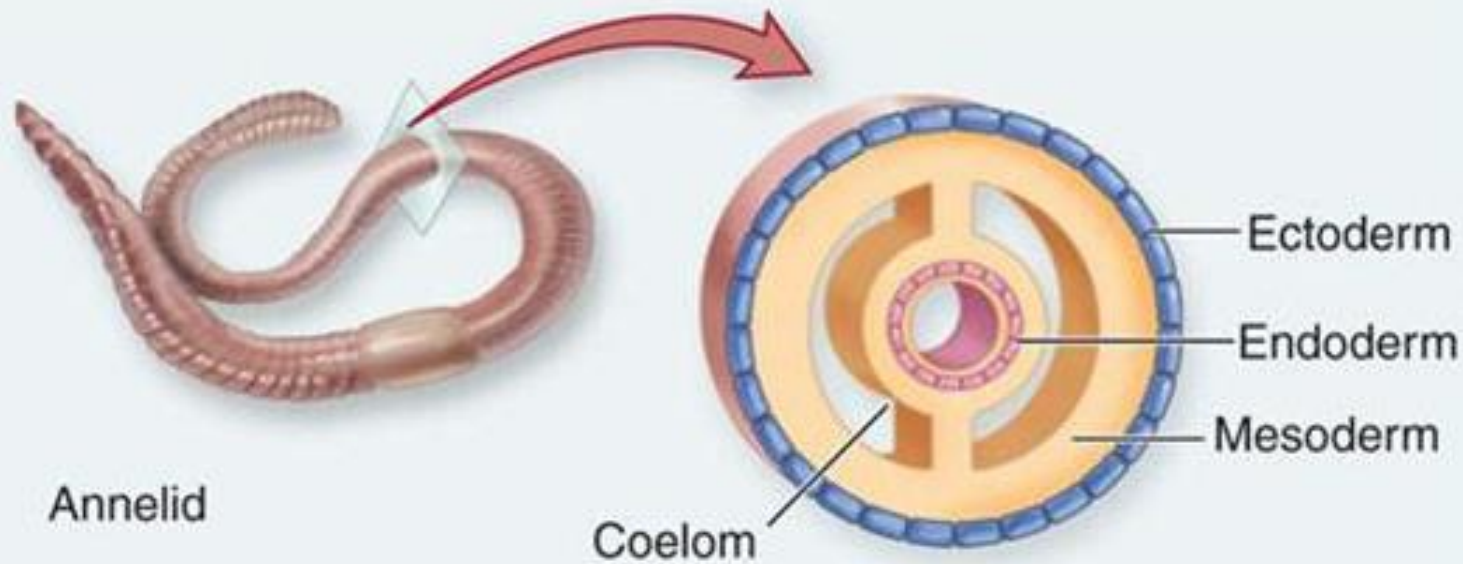


**Comparing  
acoelmates  
(platyhelmi-  
nthes) with  
coelomates  
(annelids)**

**Acoelomate**



**Coelomate**



- Organisms in this phylum are **triploblastic** - **having ectoderm, mesoderm and endoderm.**
- They are **acoelomate** (don't have a coelom) – the **mesoderm acts as a hydroskeleton**, completely filling the space between the endoderm and ectoderm.
- They exhibit **differentiation.**
- They are **dorso-ventrally flattened** and as a result have a **large SA to Vol. ratio.**

- The phylum Platyhelminthes contains the turbalaria, an example is the flatworm *Planaria*.
- Planarian flatworms are bilaterally symmetrical and unsegmented.



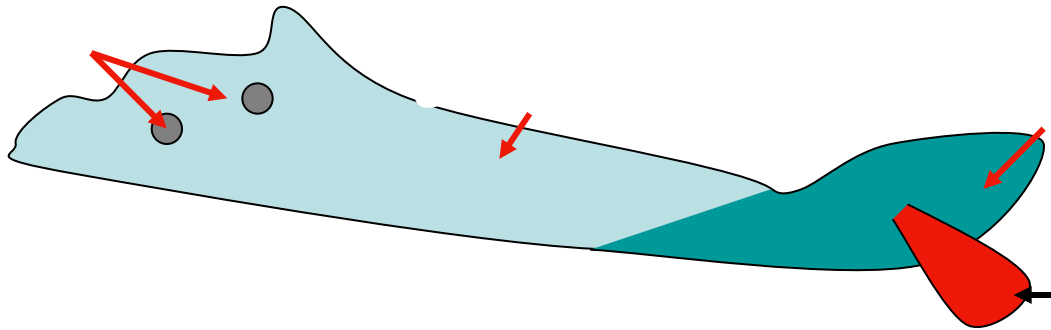
# Habitat

- They can be found in practically every pond, stream and canal and spend most of daylight hours concealed under stones or among weeds, **emerging at night to search for food.**

# Structure

- There are three body layers present:-
- Ectoderm – posses **cilia** which allow the organism to move. It contains 2 layers of muscle (running in opposite directions) which enable the worm to **swim** and cells which secrete **slime**.
- Mesoderm – a **true layer of connective tissue** containing **secretory glands**. It fills the spaces between internal organs.
- Endoderm- forms the **lining of the gut**.

- Planaria are generally black in colour and measure up to 15mm in length.
- The body of the planarian is broader at the front than at the back where it is roundly tapered and extremely flattened.



- They have a pair of anteriorly placed eyes on the dorsal surface, and a mouth on the posterior end of the ventral surface.
- **During feeding the pharynx protrudes through the mouth.**

# Support

- There is no special means of support but the **mesoderm acts to help support** the body.

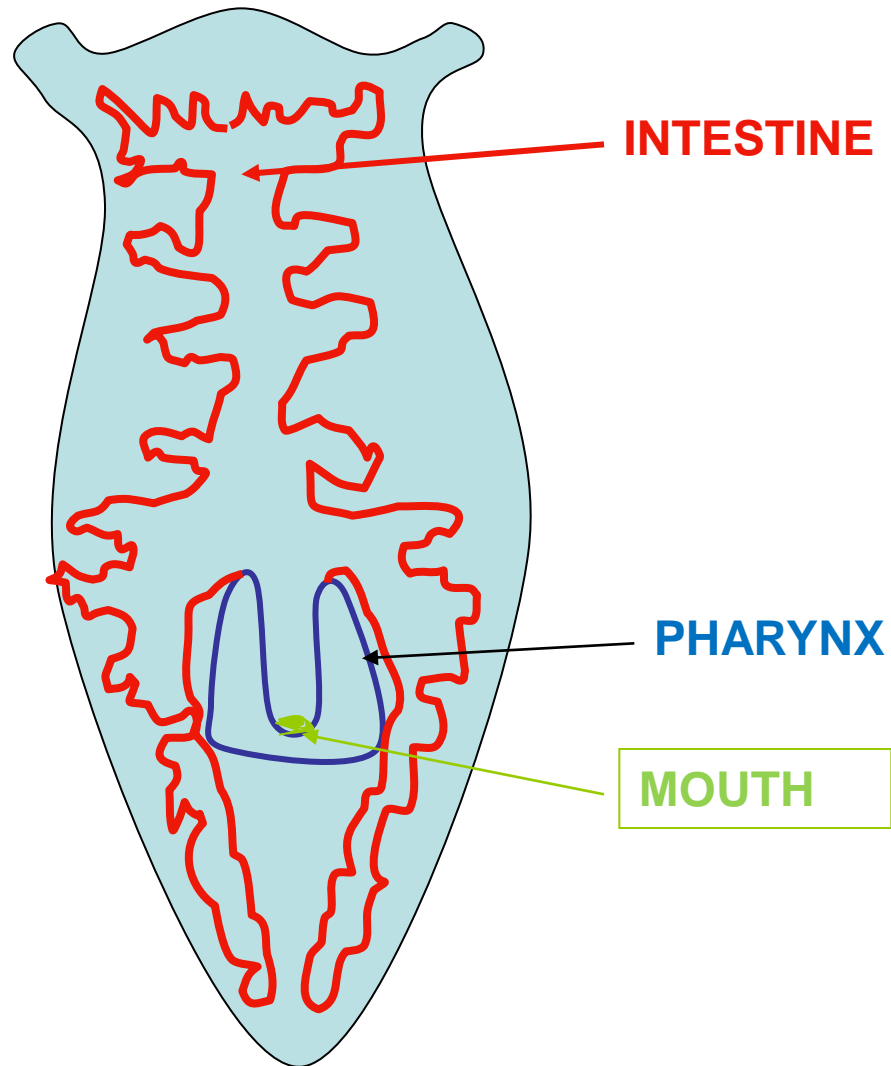
# Nutrition

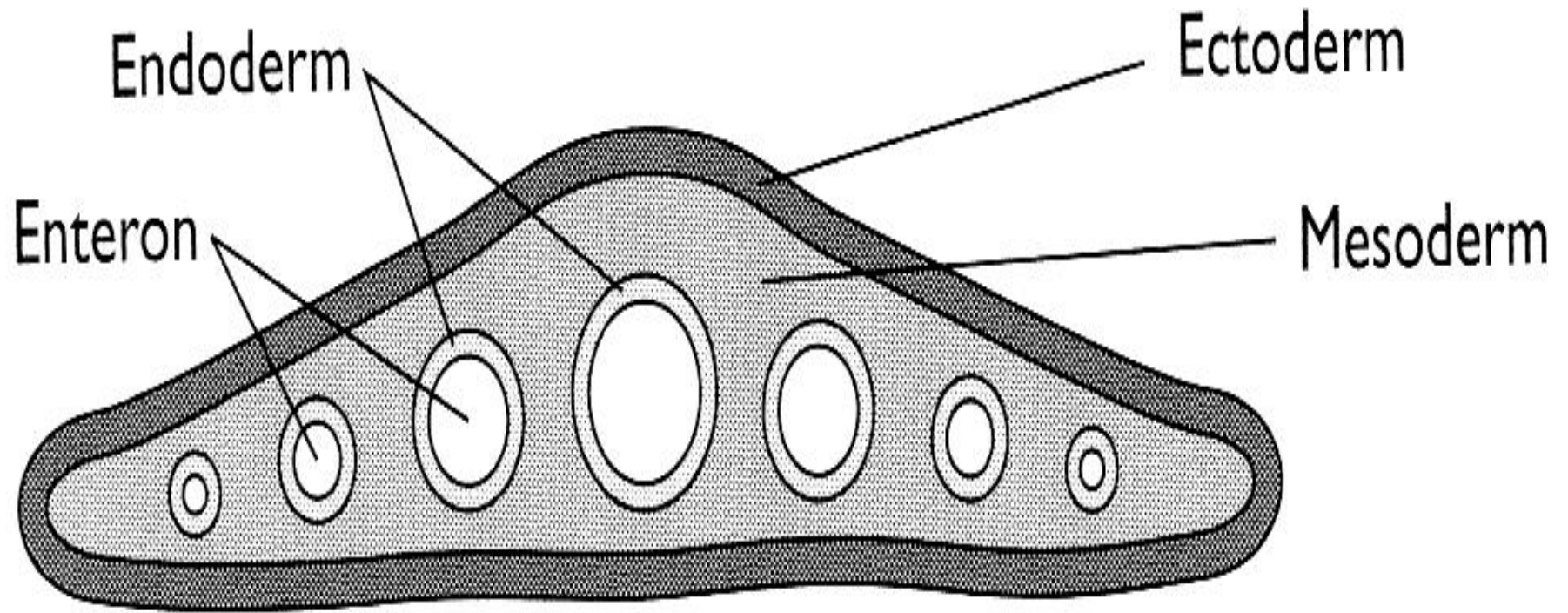
- Planaria are normally **detritivores** but **some** are active predators feeding **on small worms**, crustaceans and on the dead bodies of larger animals.
- The mouth, on the ventral side of the posterior of the worm leads first to a short buccal cavity and then a large, muscular and thick-walled **pharynx**.
- The pharynx leads to the **intestine** which can be located in the middle region of the body.



- The intestine divides into three **branches**:-
- One proceeds forward to the head and ends behind the eyes
- The other two lead left and right around the pharynx sac and then back toward the posterior end.
- From each branch come numerous **blind-ended sub-branches (or caecae)**, giving the gut a very large surface area.
- As a result of the branched gut and flattened shape, **no cell in the body is very far from either the gut or the permeable ectoderm.** Therefore flatworms lack a circulatory system

# VENTRAL VIEW





***Figure 42 The body structure of a planarian***

- Planaria have **no anus**. The mouth is the only opening to the gut.
- They have cilia and secrete mucus which aids a gliding movement
- When feeding on small prey, the planarian creeps onto it, entangling it in slime and engulfing it in the **everted pharynx**.
- When food is larger, the pharynx exudes a digestive fluid onto it and breaks it up into small pieces by a continual pumping action.

- Digestion is **partly extracellular by exudation of enzymes but is completed intracellularly by lysosomes**, after ingestion of smaller particles by endocytosis.
- From here the soluble food passes by diffusion to the rest of the body.
- Undigested foods are ejected through the mouth.

# Other information

- **Excretion and osmoregulation** – is by means of a specialised excretory system within the mesoderm which uses **highly specialised flame cells**.
- **Reproduction** – Planarians are **hermaphrodites** (having both male and female reproductive organs) **but** their reproductive system is extremely complex to **avoid self-fertilisation**.

- Platyhelminthes also contains the classes Trematoda and Cestoda which are major groups of parasites responsible for many human and animal infestations, e.g. liver fluke (Trematode) and pork tapeworm (Cestode).
- Planaria belong to the class Turbellaria.

# Kingdom Animalia

- **Phylum Annelida**



# PHYLUM ANNELIDA

FORM

TRIPLOBLASTIC

**ectoderm, mesoderm, endoderm**

COELOMATE

**body cavity in mesoderm contains**

**well differentiated digestive and other organ systems**

**first animal to have a body cavity**

**and true tissue differentiation**

**showing increasing complexity**

# PHYLUM ANNELIDA

## FORM

**BILATERAL SYMMETRY**

**typically long and thin**

**HYDROSTATIC SKELETON**

**gives support, provided by fluid in the coelom**

**METAMERIC SEGMENTATION**

**body divided into similar segments  
which provide a hydrostatic skeleton for movement,  
not just support**

# PHYLUM ANNELIDA

FORM

## CEPHALISATION

**nervous tissue concentrated in head as simple brain**

## CHAETAE

**important in movement**

**DEFINITE anterior/posterior**

# Earthworm - Lumbricus terrestris - video

<http://www.arkive.org/earthworm/lumbricus-terrestris/video-01.html>

# PHYLUM ANNELIDA

## FEEDING

### DIGESTION EXTRACELLULAR

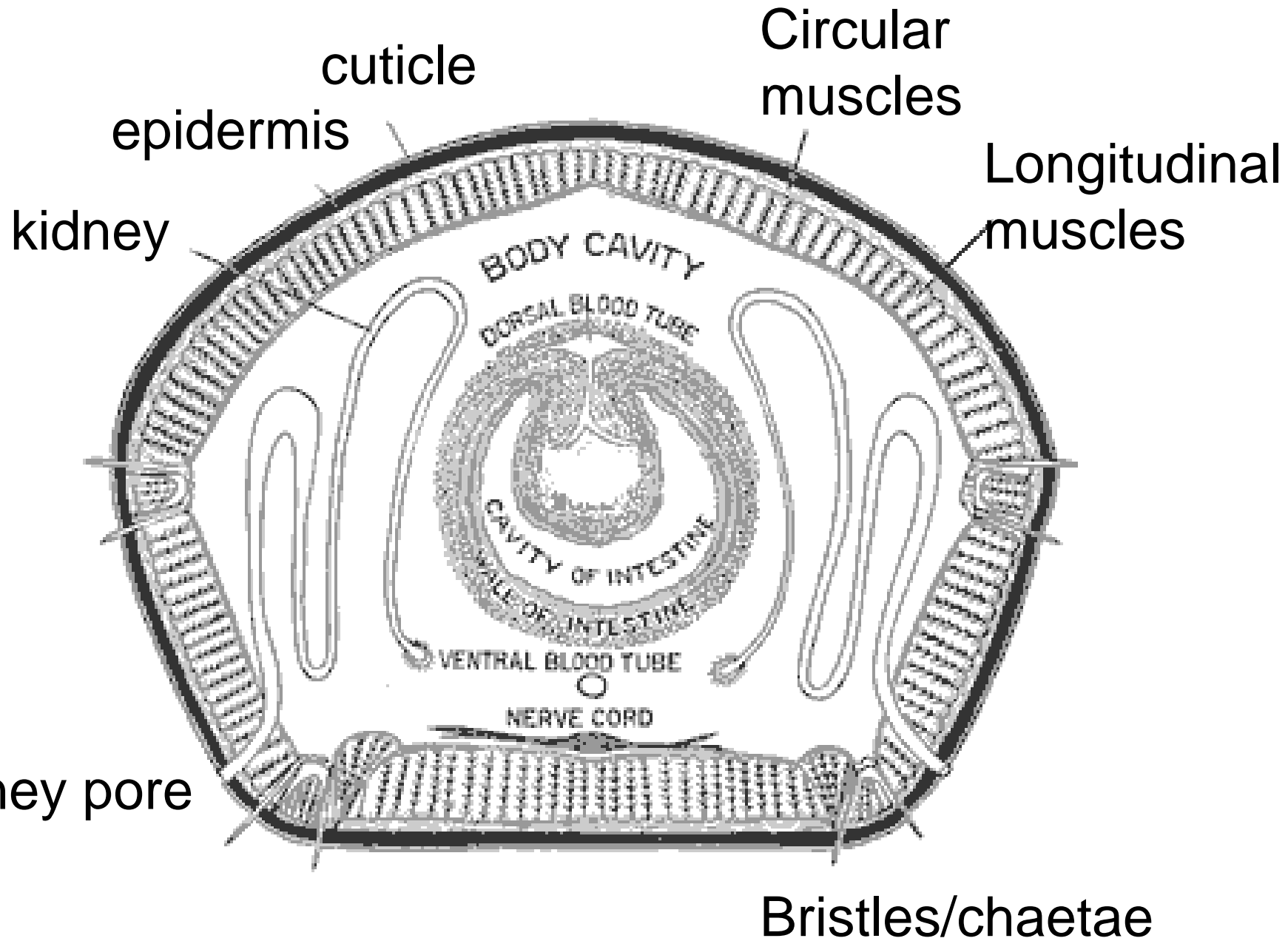
**detritivores**

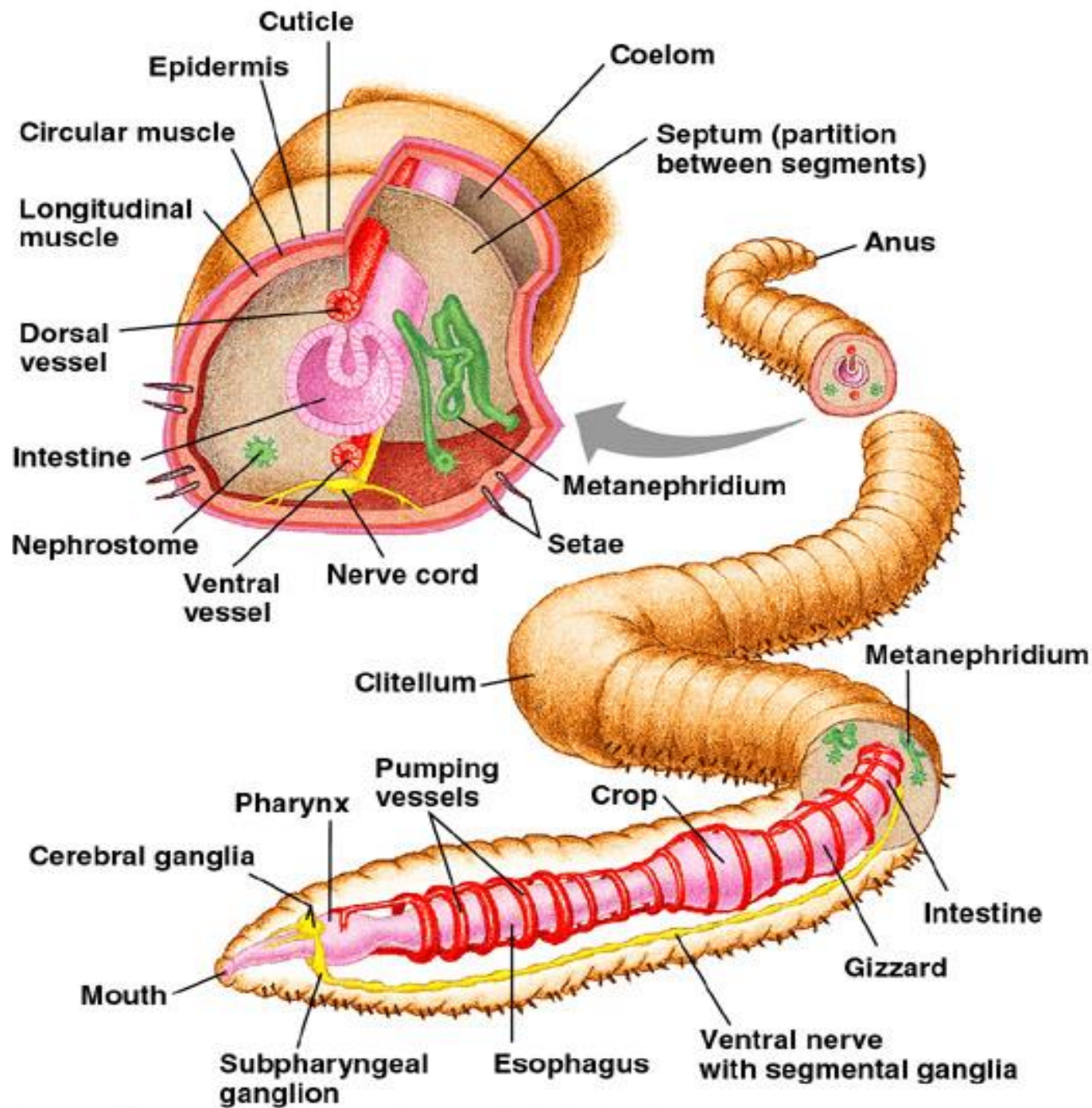
**gut has mouth and anus**

**and shows regional specialisation**

**nutrients distributed by a well developed circulatory system**

e.g. earthworm



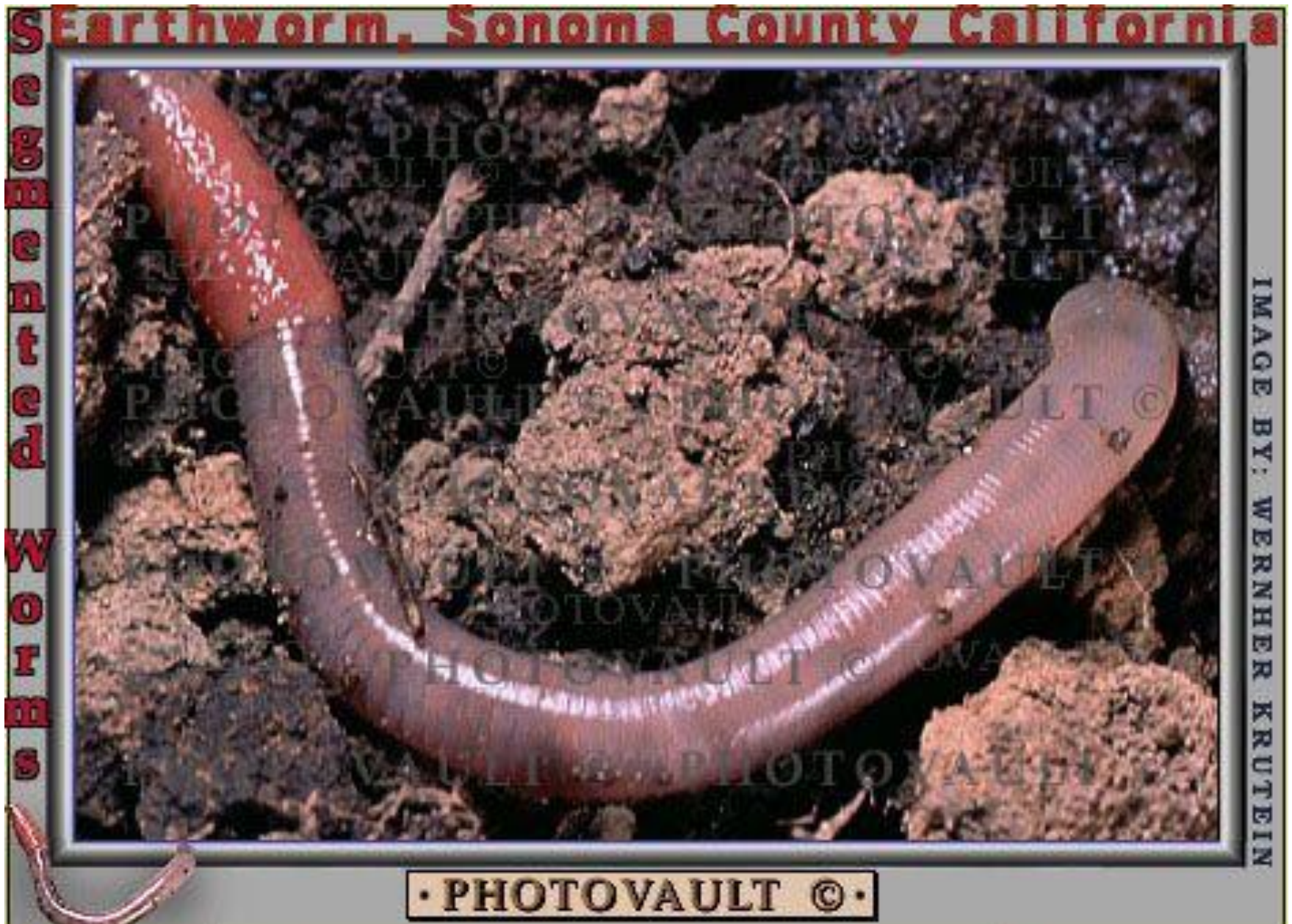


# The Segmented Worms

- These are **triploblastic**, **coelomate** with well developed tissue **differentiation**.
- The body is divided into segments both externally and internally (**metamerically** segmented)
- There are three classes:-
  1. **Polychaeta** – usually marine
  2. **Hirudinea** – leaches
  3. **Oligochaetae** – includes the earthworm.



# *Lumbricus terrestris* – the earthworm

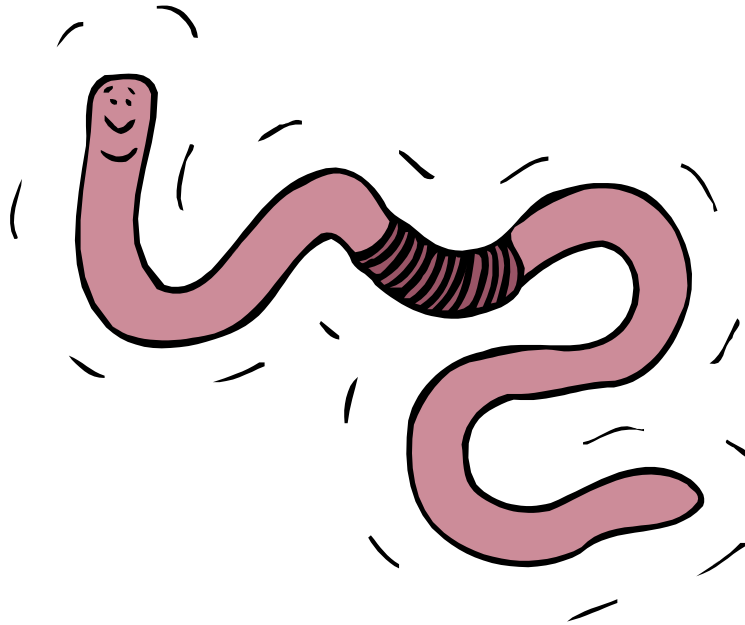


# Structure -

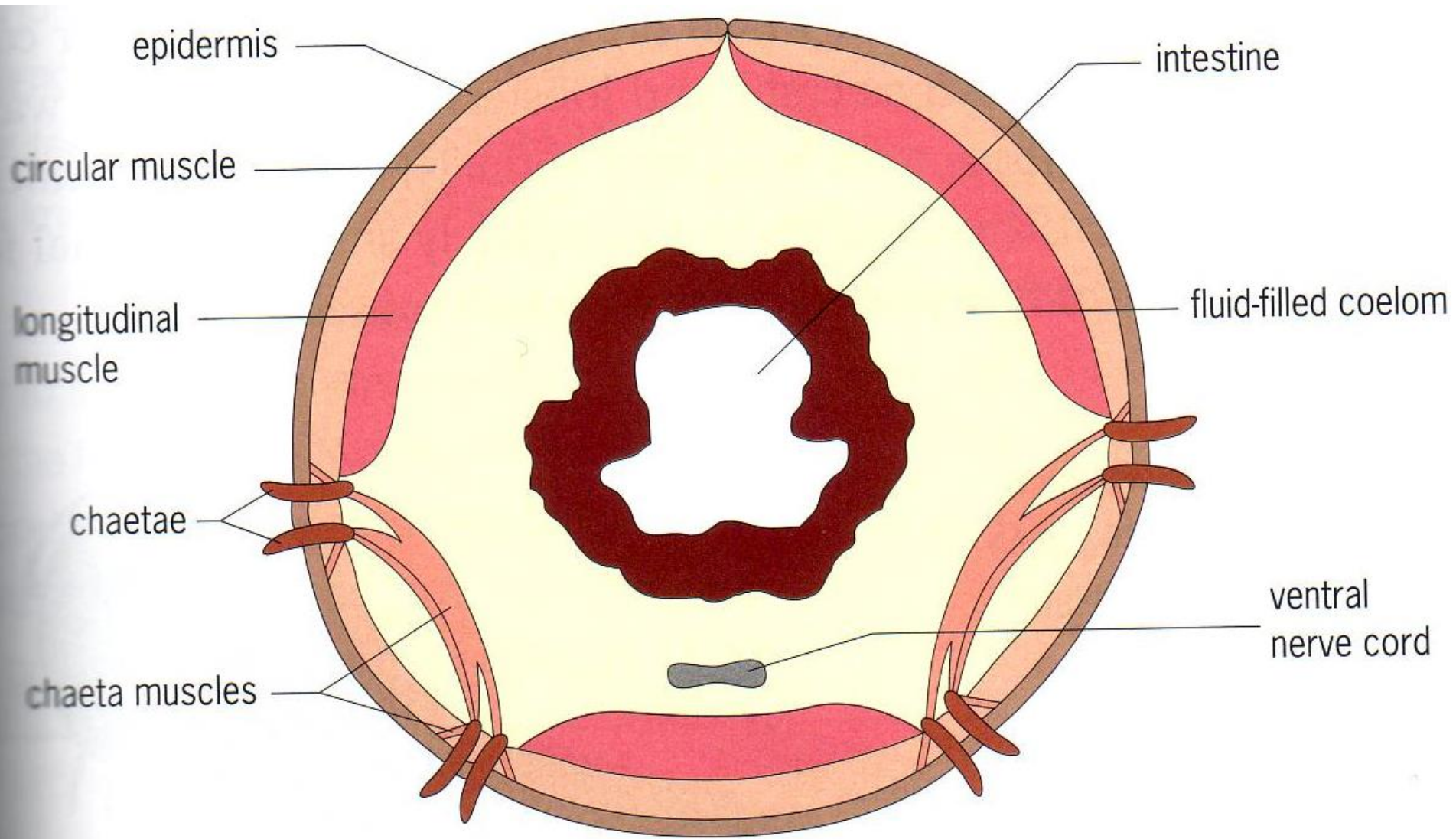
- There are three body layers – the ectoderm, the mesoderm (containing the coelom) and the endoderm.
- Within the coelom lies the well-differentiated digestive system and other systems.
- The body is bilaterally symmetrical, metamerically segmented and typically is long and thin.
- They have a through (one way) gut with both a mouth and an anus

- The earthworm has approximately 150 segments, a head end (prostomium) and a terminal part (pygidium).
- A hydrostatic skeleton with fluid contained in independent compartments allows muscles to work in different parts of the body in turn.
- The fluid is held in the coelom and each 'compartment' is separated by muscular septa (dividing walls)

- Earthworms are burrowing animals that need sustained and powerful locomotion.
- They can locomote because their muscles, attached to the body wall, pull against the fixed volume of fluid in the coelom.
- As they are long and thin they can move easily.







- The ectoderm is composed of:-
- a cuticle, a thin fibrous layer that is secreted by the epidermis and resists dessication
- The epidermis
- Blocks of longitudinal muscle and rings of circular muscle that are antagonistic ( and each segment of the earthworm's body is controlled separately).
- Chaetae – 4 pairs per segment which help anchor the worm.

# Nutrition -

- Earthworms are **detritivores** – feeding on organic matter and saprotrophic fungi and bacteria found in decaying matter.
- Food is drawn into the mouth (segment 1) by a muscular pharynx (segments 4-5)
- Mucus is secreted to aid the passage of soil and food.
- Most digestion occurs extracellularly in the intestine whose surface is increased by a longitudinal fold (**typhlosole**) in segments 20-149.
- Undigested remains of the food are egested from the anus and deposited on the surface of the ground as worm casts.

- Regional specialisation of the gut occurs:-
- Mouth – segment 1
- Pharynx – segments 4-5
- Crop – segments 14-16 (food is stored here)
- Gizzard – segments 17-19 (food is ground down here)
- Typhlosole – segments 20-149
- Anus – segment 150
- Nutrients are absorbed in to the blood





## **Circulation –**

- 5 pairs of hearts surround the oesophagus and are connected to dorsal and ventral blood vessels.

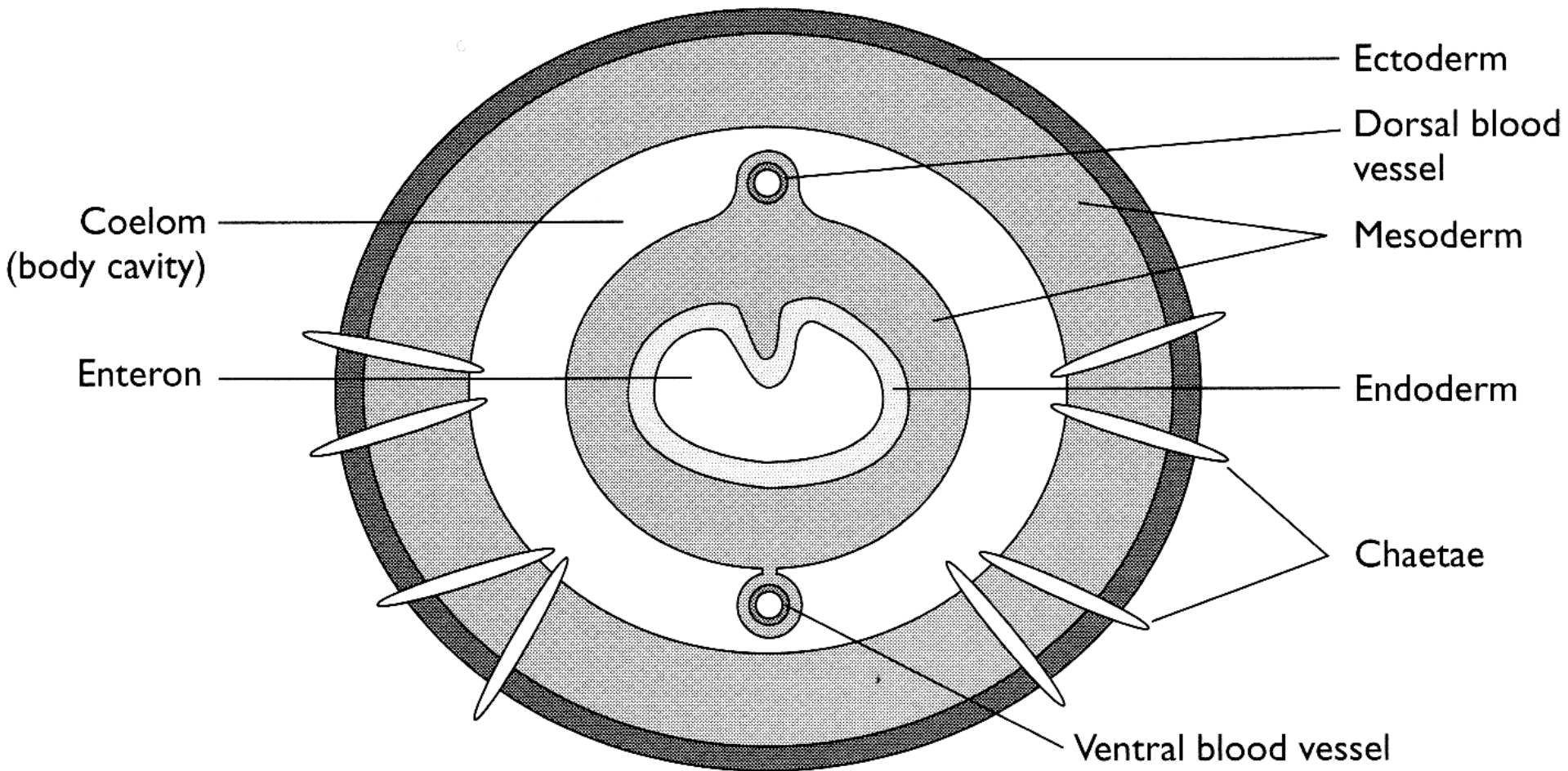
## **Gaseous exchange –**

- Occurs through the skin
- Blood capillaries containing haemoglobin come near to the surface of the skin.
- Water loss during gas exchange is a potential threat.

# Nervous system –

- CNS composed of a ventral nerve cord and a ganglion in each segment, from which 3 nerves innervate the body wall and gut.
- At the anterior end there is a 'brain'.
- The earthworm shows the early stages of **CEPHALISATION**.
- Sense organs consist of cells or small groups of cells.
  - Moves away from light or touch
  - Moves towards moisture.

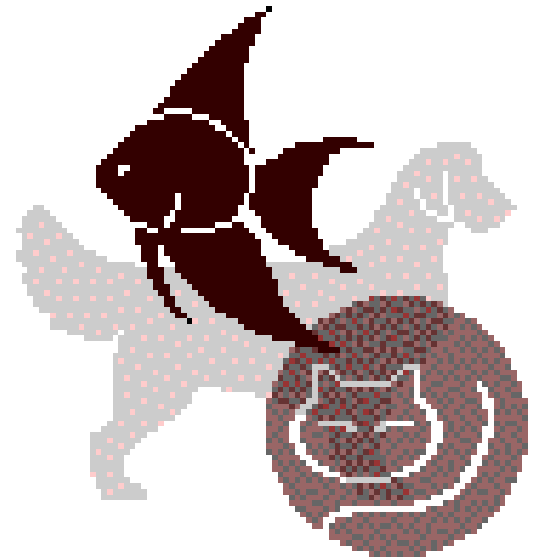




***Figure 43 The body structure of an earthworm***

# Kingdom Animalia

- **Phylum Chordata (The chordates)**



# PHYLUM CHORDATA

## FORM

**TRIPLOBLASTIC**

**ectoderm, mesoderm, endoderm**

**COELOMATE**

**body cavity in mesoderm contains**

**VARIETY OF SYSTEMS due to COMPLEX TISSUE DIFFERENTIATION**

**including well differentiated digestive, reproductive,  
circulatory and excretory systems**

# PHYLUM CHORDATA

## FORM

BILATERAL SYMMETRY

SEGMENTED BODY

SEGMENTAL MUSCLE BLOCKS

# PHYLUM CHORDATA

FORM

## SKELETON

**consisting of an internal  
jointed system of calcified bones**

## NOTOCHORD

**defining feature of the skeleton,  
a stiff dorsal rod or spinal column  
which gives body structure and therefore  
a true back and front  
unlike cnidaria**

# PHYLUM CHORDATA

FORM

POST-ANAL TAIL





# Carnegie Stages of Human Development

Dr Mark Hill, Cell Biology Lab, School of Medical Sciences (Anatomy), UNSW



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## FETAL DEVELOPMENT

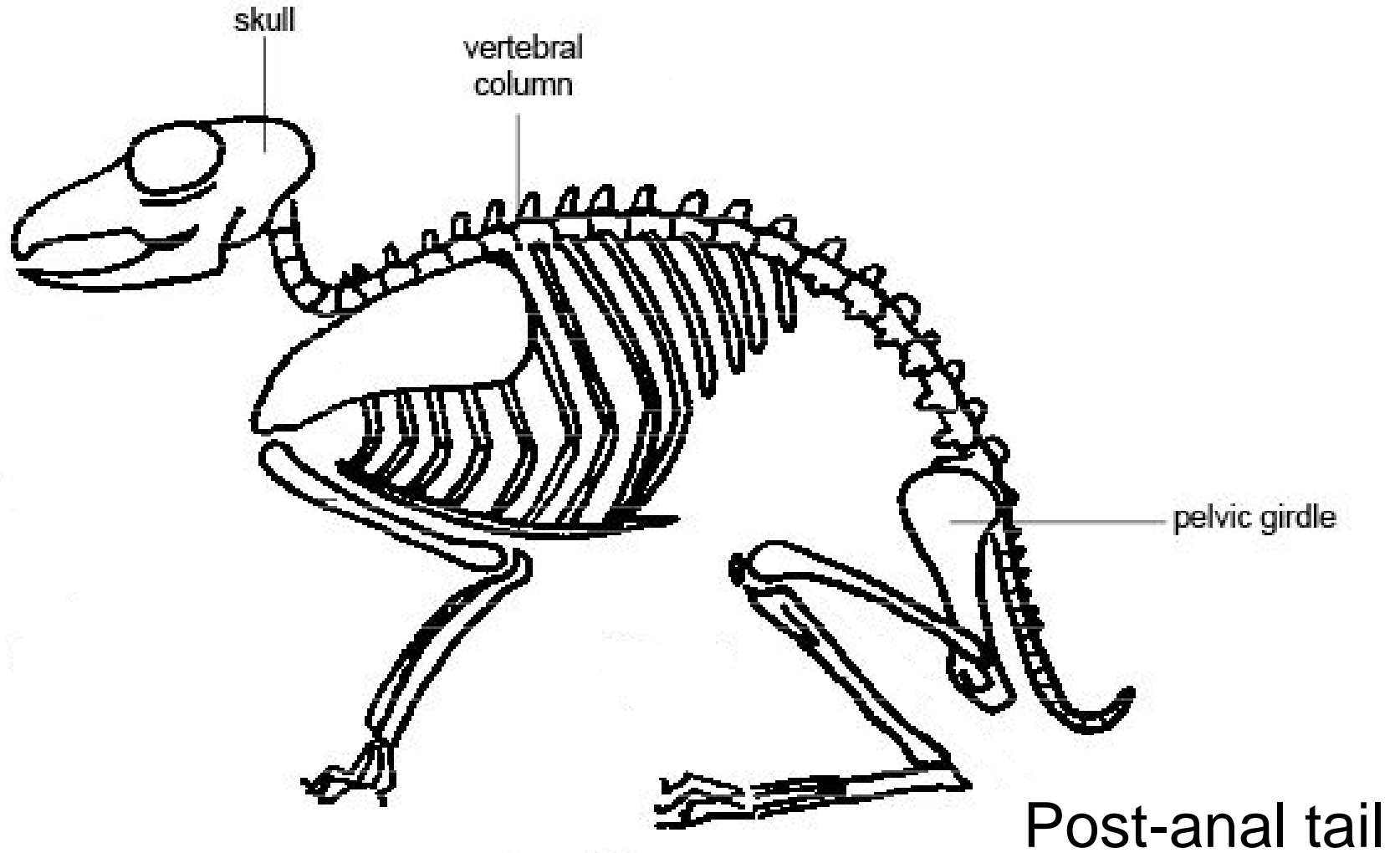
*From zygote to full term.*

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e.g. rabbit or mouse



# PHYLUM CHORDATA

## FEEDING

### VARIATION IN FEEDING HABITS

**differentiation in systems and complexity in body form  
enables chordates to be  
active predators, omnivores or herbivores**

# PHYLUM CHORDATA

## FEEDING

### COMPLETE GUT

**with mouth and anus and  
well developed specialised regions**

### EXTRACELLULAR DIGESTION

**in the spaces within the digestive system  
e.g. stomach, duodenum**

- They are triploblastic, coelomates with an internal skeleton.
- They possess ectoderm, endoderm and mesoderm, the last of which contains a coelom.
- Digestive, reproductive, circulatory and excretory systems are well differentiated (found inside the coelom).
- They are bilaterally symmetrical.
- One way gut
- Post anal tail
- Vertebral column
- Skeletons consist of internal joints of **calcified bone**.
- So the chordates are vertebrates- fish, amphibians, reptiles, birds and mammals

# **5 characteristics that they possess at some point in their life:-**

1. Tubular, hollow, dorsal nerve cord.
2. Dorsal, flexible supporting rod – notochord.
3. Post anal tail.
4. Gill slits in the throat
5. Blood circulation which flows down the body dorsally and up ventrally.

# Subphylum Vertebrata

## **Class Mammalia –**

- Skin is covered in hair
- Body cavity (thorax and abdomen) is divided by a muscular diaphragm
- Body temperature is maintained by internal regulation
- Sweat glands in skin aid cooling
- Fertilisation is internal
- When young are born they are fed on milk from mammary glands.



## ***There are various subclasses –***

**Monotrema** – primitive egg-laying mammals, e.g. duck-billed platypus

**Marsupialia** – young are born at an immature stage and migrate to a pouch on the mother's body. Development is completed in the pouch.

**Eutheria** (true mammals) – eggs develop in the uterus and are nurtured by the maternal blood circulation via the placenta.

# Nutrition

- Mammals may be active predators, omnivores or herbivores.
- The gut has both a mouth and an anus and well-developed specialised regions within it (cf. stomach, ileum, duodenum e.t.c.).
- Digestion occurs **extracellularly**.
- Products of digestion are absorbed and distributed by a well-developed circulatory system.

# **Evolutionary trends in the kingdom Animalia**

In the animal kingdom there are the following evolutionary trends:

- from radial symmetry, which suits sessile organisms, to bilateral symmetry, which is a consequence of directional movement (also producing an anterior and posterior end, and a ventral and dorsal surface)
- from a diploblastic to a triploblastic condition, with the mesoderm forming a variety of new tissues
- from a sac-like gut cavity (enteron) to a one-way through gut, providing the conditions for more efficient feeding and digestion
- towards the coelomate condition, providing a body cavity in which organs can grow while fluid cushions them from damage
- towards the development of an internal blood transport system, necessitated by the appearance of the coelom (outer tissues separated from inner tissues), an increase in size and the possession of an impermeable outer covering, which is better adapted to a terrestrial existence

## **Practical work**

Study appropriate living and preserved specimens, prepared slides and photographs.