

## CLASSIFICATION OF ANIMAL KINGDOM

⇒ Two main branches of biology dealing with classification

### Taxonomy

→ includes identification, nomenclature & classification

### Systematics

→ includes systematic placing of organisms into taxa based on certain relationships b/w them

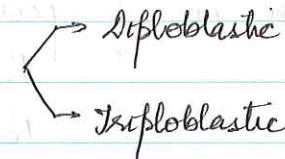
## Significance of Classification :-

- (i) help us gain evolutionary knowledge
- (ii) understanding connecting links b/w two groups of animals through transitory stages
- (iii) trace common ancestry
- (iv) adaptations can be studied
- (v) easy to study diversity of animals through a representative sample

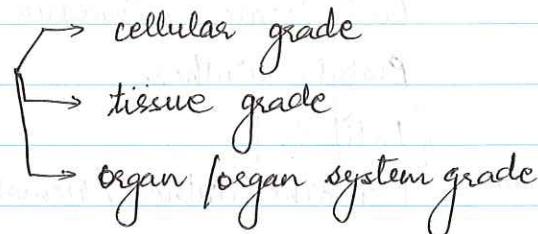
## Outline :-

⇒ Body plan or body structure made of classification

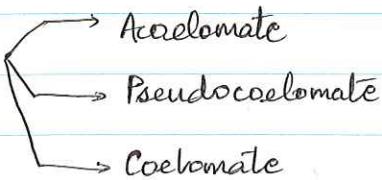
1) Based on no. of primary germ layers in embryo



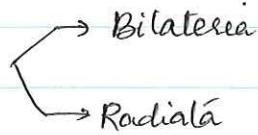
2) Based on division of labour

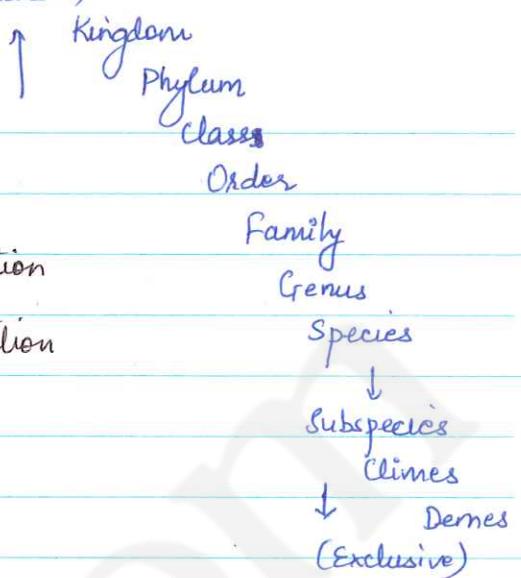
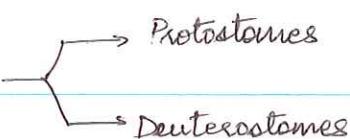


3) Based on body cavity

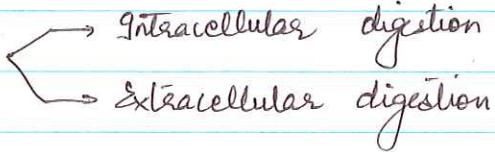


4) Based on body symmetry

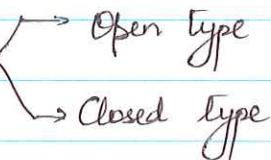




5) Based on fate of blastopore

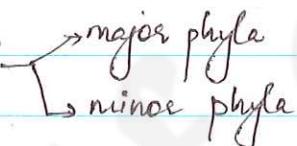


6) Based on circulation of blood



## Major & Minor Phyla

① Invertebrate phyla divided into



Division based on 2 factors :-

- No. of species or individuals in the phyla
- Participation in ecological communities

Based on no. of species, 11 major phyla

Protozoa

Porifera

Coelenterata / Cnidaria

Rhizarians

Rotifera

Nematheleuithes / Nematoda

Annelida

Mollusca

Arthropoda

Echinodermata

Ectoprocta

limited participation  
in ecological  
communities

so, MINOR PHyla

## Minor phyla

Mesozoa

Pentastomida

Ctenophora

Phoronida

Nemertinea

Ectoprocta

Acanthocephala

Brachiopoda

Entoprocta

Chaetognatha

Rotifera

Pogonophora

Gastropoda

Hemichordata

Kinorhyncha

Nematomorpha

Priapulida

Sipunculida

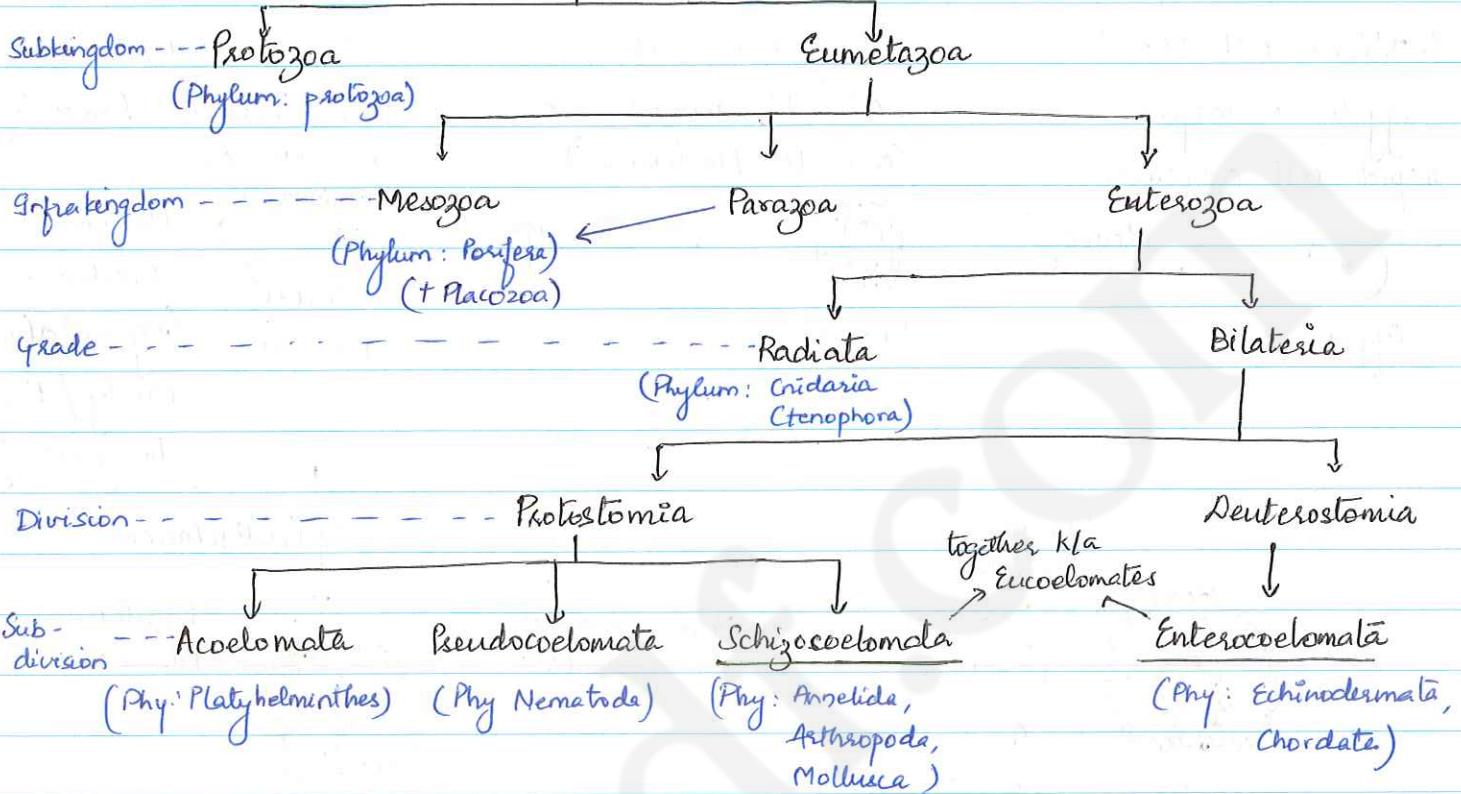
Echiurida

Jardigrada

Tardigrada

Oncophora

## DIVISIONS Kingdom - - - - - Animalia



## COELOM

- Evolutionary importance as it helped in efficient body design
- Space inside the body lined by mesodermal (peritonium) layer is k/a true body cavity or coelom
- It contains most visceral organs
- It is a secondary body cavity b/w 2 embryonic layers of mesoderm
- term coined by Ernst Haeckel

## Features of a true coelom :-

- secondary body cavity formed by splitting of mesoderm during embryonic development
- bounded on all sides by coelomic epithelium
- contains colourless coelomic fluid and excretory organs open to it
- reproductive organs arise from its walls

## Early stages of development :-

Fertilised cell k/a

zygote undergoes rapid cell divisions



Zygote

Cleavage

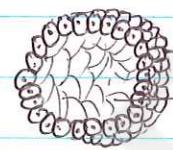
Compact mass of cells k/a morula  
(cells k/a blastomeres)



Morula

Cleavage

Forms a hollow ball called blastula lined by blastomeres



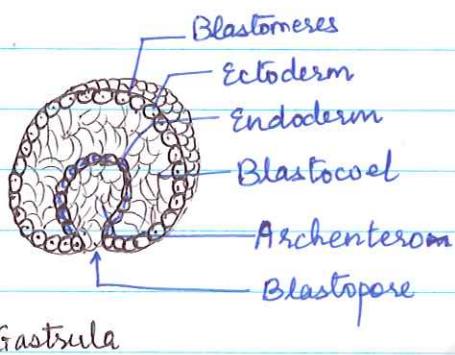
Blastula

Blastomeres

Blastocoel

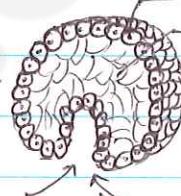
(segmentation cavity / 1° body cavity)

Gastrulation



Gastrula

Formation of gastrula



invagination at one end of blastula k/a gastrulation

- In a gastrula, the invagination of cells is lined by endoderm
- Invagination called archenteron or primitive gut
- Opening called blastopore
- Blastocoel is 1° body cavity lined by ectoderm

→ A third germ layer in triploblastic organisms called mesoderm that has loosely organized tissue called mesenchyme

→ In Acoelomates → blastocoel occupied by mesenchyme

→ In Pseudocoelomates → blastocoel partially filled with mesenchyme unoccupied portion exists as pseudocoelom

→ In Coelomates → blastocoel completely replaced by coelom

### Advantages of coelom :-

- Primitive diploblastic & triploblastic animals have only one major body cavity called digestive tract
- It limits body size, development & locomotion
- As size & weight increases, stress during locomotion increases & an effective circulatory system is required
- Thus, a body cavity becomes imperative

### Advantages are :-

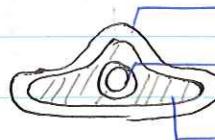
- (1) Coelom provides space for digestive tract organs to grow
- (2) Coelom provides space for gonads to grow (esp. breeding season)
- (3) Allows formation of a well defined circulatory system.
- (4) Coelomic fluid transports materials faster than diffusion
- (5) Generates hydrostatic force against which muscles can act

### TYPES OF ANIMALS BASED ON COELOM

#### (1) ACOELOMATES

- no coelomic cavity
- space around internal organs filled with parenchyma
- parenchyma restricts movement of internal organs
- only a gut, spongocoel or coelenteron exists and there is no other body cavity

e.g. Platyhelminthes, Coelenterates



Body cover derived from ectoderm

Gut derived from endoderm

Parenchyma derived from mesoderm

- #### (2) PSEUDOCOELOMATES
- coelom neither formed by mesoderm nor lined by mesodermal peritonium
  - internal organs lie freely in pseudocoelom.

e.g. Nematodes



Body covering derived from ectoderm  
Muscle layer from mesoderm  
Pseudocoelom  
Digestive tract from endoderm

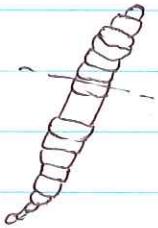
(3) COELOMATES - true body cavity derived from mesoderm and lined by mesodermal epithelium k/a peritoneum.  
aka

EUCOELOMATES

Outer wall of coelom  
Parietal / Somatic peritoneum      Inner wall of coelom  
Visceral / Splanchnic peritoneum

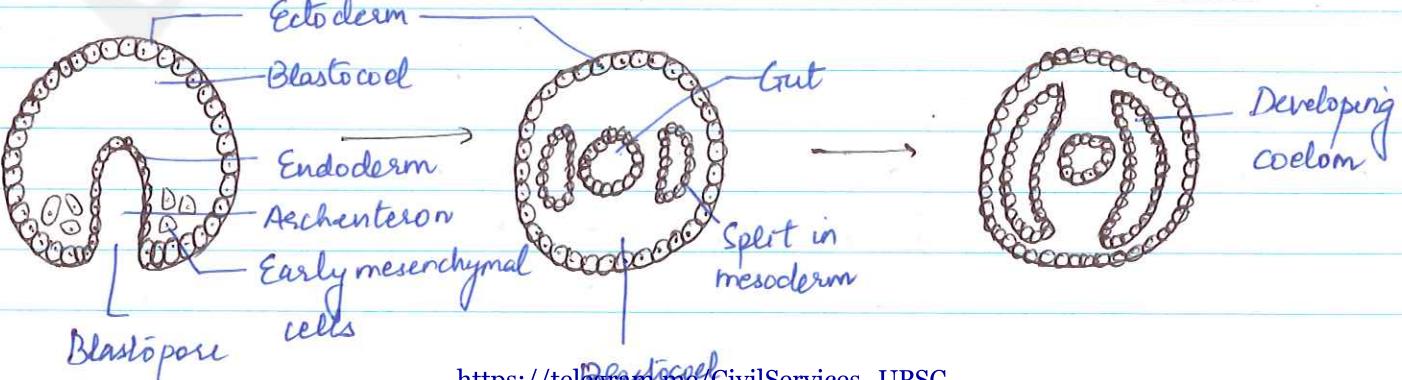
- animals have mesenteries which suspend the body organs within the coelom.

e.g. Annelids, Arthropods, Molluscs, Echinoderms, Chordates

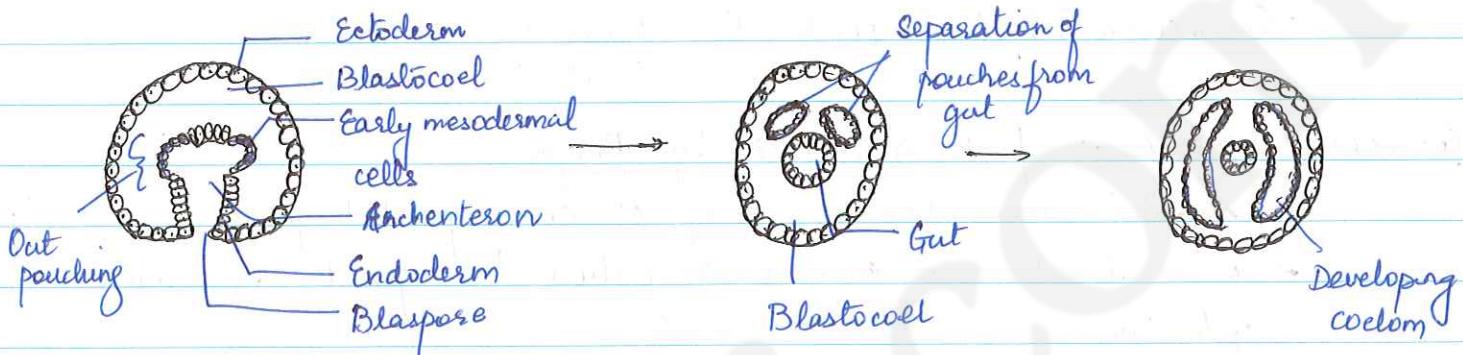


Body covering from ectoderm  
Coelom  
Parenchyma tissue derived from mesoderm  
Digestive tract from endoderm

(a) Schizocoelomates - coelomates where body cavity originates from splitting of mesodermal cells at the time of gastrulation  
- this method k/a schizocoelous method  
- e.g. annelids, arthropods, molluscs  
- schizocoelom may be blood filled k/a haemocoel eg arthropods, molluscs



- (b) Enterocoelomates - in most deuterostomes, coelom originates by out pouching of archenteron during gastrulation
- each pouch then expands and mesoderm lines the gut on inner side & body wall on outer side
  - method k/a enterocoelous



e.g. Echinodermata & Chordata

### THEORIES OF ORIGIN OF COELOM

- (1) SCHIZOCOEL THEORY → coelomates evolved from an ancestral acelomate like flatworms
- by hollowing out of parenchymal cells of mesenchyme
  - some of these cells formed the peritoneum
  - acelomate body plan is primary & ancestral to coelomate body plan
  - Thus, acelomate flatworms form basic group of evolution of bilateral animals
  - Schizocoel mode of coelom formation in annelids & molluscs supports this theory.

- (2) ENTEROCOEL THEORY → proposed by Lankester

- coelom evolved from gastric pouches of some cnidarian ancestors like anthozoans & siphonophores
- gastric pouches separated out from main gastric cavity to form

### coelomic pouches

- This theory proposes that all bilateral animals are basically coelomate and acelomate forms like flatworms are secondarily derived from coelomate ancestors by loss of cavity
- Enterocoelus mode supports this theory

### (3) GONOCOEL THEORY → first enunciated by Bergh

- regards coelom as the cavity of an expanded gonad
- origin based on common association b/w gonads & coelomic epithelium
- coelom initially arose in a segmented condition by enlargement & cavitation of gonads after release of gametes
- Drawbacks :- links origin of coelom with origin of metameric segmentation; so difficult to account for unsegmented coelomates
- no evidence that unsegmented coelomates originated from segmented ancestors
- no embryological support as gonads do not arise before coelom

### (4) NEPHROCOEL THEORY → proposed by Lankester

- coelom originated as expanded nephridia
- rejected as protonephridia in coelomates & echinoderms don't have excretory organs.

functions of coelom :- 1) protects & surrounds internal organs

- 2) provides hydrostatic skeleton to assist locomotion & maintains body shape
- 3) provides flexibility
- 4) removes excretory wastes
- 5) transport of gases & nutritive elements
- 6) keeps body wall moist for respiration
- 7) gamete maturation & embryo breeding site

## SYMMETRY

- arrangement of body parts in a balanced geometrical design, divisible into equal halves by planes of division is symmetry
- mainly derived by Ernst Haeckel

### Asymmetrical

→ animal that cannot be divided into equal halves by any plane passing through its centre

e.g. Porifera  
Amoeba

### Symmetrical

→ can be divided into equal halves by at least one plane passing through the centre of the body

## Types of symmetry

### 1. SPHERICAL SYMMETRY

- ball like body shape

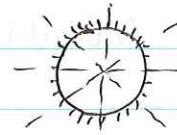
- all planes passing through the body will divide the organism into equal halves

- suited for rolling movements or floating

- sedentary lifestyles where food is available from all directions

- body organs or cilia all over the body in radial arrangement.

e.g. Volvox, Actinophrys

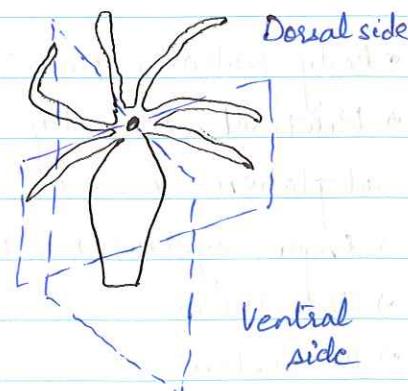


### 2. RADIAL SYMMETRY - in Coelenterates & Echinoderms

- body parts arranged along a longitudinal axis

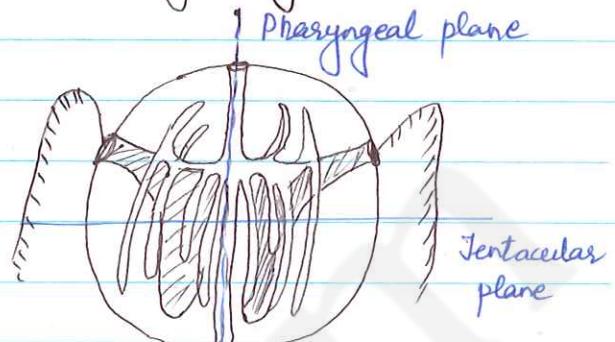
- suited for sessile existence where food is planktonic & available from all directions

- food capturing parts radially arranged



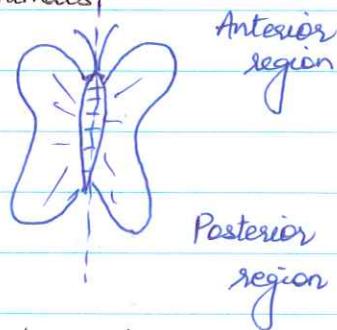
### 3. BIRADIAL SYMMETRY → mixture of radial & bilateral symmetry

- found in Ctenophores that float
- e.g. Pleurobrachia has oval body with 8 comb plates radially arranged
- comb plates used for swimming
- mouth, anal pore & statocysts arranged on antero-posterior axis
- pair of retractile tentacles bearing colloblasts for secreting sticky substance that captures food
- Tentacles - bilateral symmetry
- comb plates - radial symmetry



### 4. BILATERAL SYMMETRY - found in most higher animals,

- suited for animals that move in a definite direction
- sense organs & nervous system concentrate on anterior side k/a cephalisation.



- a single line passing through the longitudinal axis will divide the organism into mirror images
- have top (dorsal), bottom (ventral), left, right, anterior & posterior sides

### RADIATA

- ⇒ Body radially or biradially symmetrical
- ⇒ Bilateral symmetry a secondary adaptation in some
- ⇒ Organ systems not well marked
- ⇒ Diploblastic
- ⇒ No coelom

### BILATERIA

- ⇒ Bilaterally symmetrical
- ⇒ Radial symmetry a secondary adaptation in some
- ⇒ Organ systems well marked
- ⇒ Triploblastic
- ⇒ Acoelomate, pseudocoelomate or eucoelomates

☐ Tentacles with nematocysts	⇒ Tentacles without nematocysts
⇒ Comb plates present	⇒ Comb plates absent
⇒ Principal opening mouth	⇒ Principal openings mouth & anus
eg. Coelenterata + Echinodermata Ctenophora	eg. all other phyla

### THEORIES OF ORIGIN

→ Early metazoans were radially symmetrical & evolved to become bilateral owing to creeping habit to feed on detritus

#### 1. CTENOPHORE - POLYCLAD THEORY

- proposed by Kovalevsky & Lang
- polyclads evolved from ctenophore like ancestors

Ctenophores

free living, floating animals  
that show radial & biradial  
symmetry

→ Polyclads

like Notoplana & Leptoplana  
free living bottom dwelling  
turbellarians

- a ctenophore ancestor may have acquired bottom dwelling & crawling habits & gave rise to Polyclads
- some crawling ctenophores eg. Ctenoplana & Coeloplana

#### 2. CTENOPHORE - TROCHOPHORE THEORY

- establishes evolutionary links b/w larvae of Coelenterates, Ctenophores, Helminthes & Annelids

Planula larvae  
of Coelenterates

→ Cydippid larvae  
of Ctenophore

→ Müller's larvae  
of Polycladida

cylindrical / elongated  
body with cilia all  
over the body

ovoid with longitudinal  
ciliary bands radially  
arranged

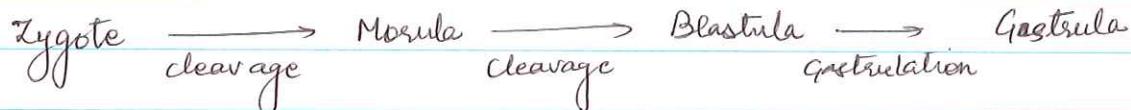
ciliary bands on swimming  
arms & apical tuft of cilia  
on anterior side

- Trochophore larva of Polychaeta resembles Müller's larva in having ciliary bands, apical tuft & ventral mouth.
- The theory considers larvae of acelomate bilateria as early stages of Trochophore.

### 3. PLANULOID - ACOELOMID THEORY

- proposed by Ludwig von Graff.
- primitive acelomate bilateria evolved from planuloid ancestor similar to planula larva of coelenterates.
- planuloid ancestor may have been free living, radially symmetrical, ciliated & with diffused nerve net.  
↓
- must have developed into a gastrula-like ancestor by formation of archenteron & adopted bottom crawling mode of living.  
↓
- creeping habit produced cephalization of nervous system towards anterior side  
↓
- mouth moved to ventral side as food was available at the bottom  
↓
- body became dorsoventrally flattened as in Turbellarians.

### BLASTOPORE



- Gastrula has pore called blastopore
- Incomplete blastopore eg. bird or mammal - ventral blastopore (primitive streak)

→ Blastopore gives rise to mouth or anus.

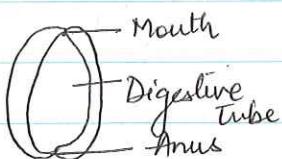
### PROTOSTOMES



Morula



Gastrula



Mouth

Digestive tube

Anus

→ means mouth is developed first

→ early divisions occur parallel to animal-vegetal axis of the zygote

- spiral cleavage

- determinate type cleavage as developmental fate of cells of embryo is determined by identity of parent cell

- if a cell removed from blastula other cells cannot compensate

- mouth arises from anterior margin of blastopore

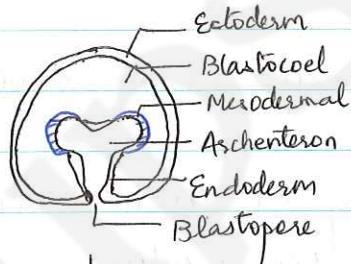
- coelom absent or pseudocoelom present

- larval form trochophore exhibits protostome characters

### DEUTEROSTOMES



Morula



Ectoderm

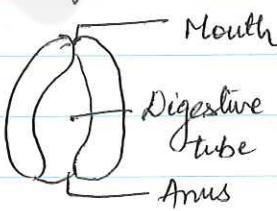
Blastocoel

Mesodermal

Archenteron

Endoderm

Blastopore



Mouth

Digestive tube

Anus

- means mouth second

- early divisions occur parallel or perpendicular to animal-vegetal axis of the zygote

- radial cleavage

- indeterminate type cleavage as developmental fate of embryo is not determined by identity of the parent cells

- if a cell removed from blastula other cells will compensate

- mouth arises anteriorly some distance away from blastopore

- coelom present (Enterocoel)

- larval forms - Tornaria & Bipinnaria exhibit deuterostomes characters

## PORIFERA

### CANAL SYSTEM

- Water circulatory system of sponges aka canal system
- Canal system aka aquiferous system

- ⇒ helps in a) food acquisition
- b) excretion
- c) respiratory gas exchange.
- d) transport of reproductive bodies

### TYPES OF CANAL SYSTEM

#### (a) ASCON TYPE - simplest type

- found in asconoid type of sponges  
eg. Leucosolenia.
- found in some developmental stages of all syconoid sponges

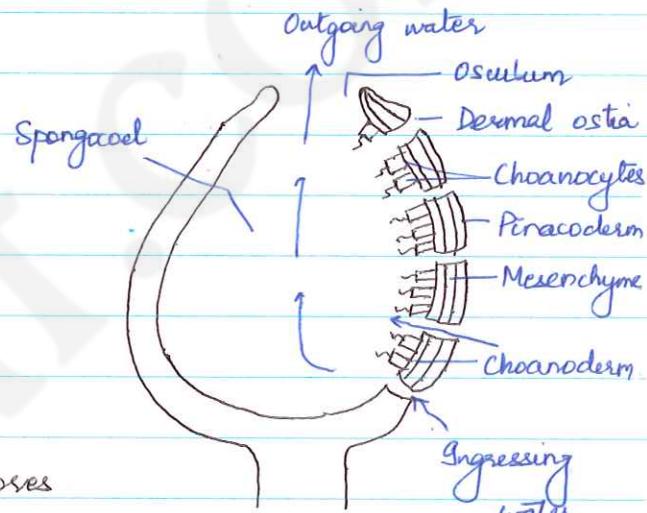
- body surface pierced by large no. of pores called dermal ostia
- ostia are intracellular spaces in tube like cells called porocytes.
- pores open radially into mesenchyme & directly into spongocoel

- spongocoel lined by flattened flagellate collar cells aka choanocytes
- opens into osculum fringed with monaxon spicules
- rate of water flow is slow as large spongocoel contains much water that cannot be pumped out through one osculum.

Ingressing water → Dermal ostia → Spongocoel → Osculum → Outside

#### (b) SYCON TYPE

- characteristic of syconoid sponges eg Sycon
- derived from asconoid type by horizontal folding of walls



→ embryonic development of Sypha shows asconoid pattern before converting to sponcoid pattern

⇒ Two types of canals - radial and incurrent canals

⇒ alternating with each other

⇒ both these canals open into body wall & interconnected by minute pores

⇒ Incurrent canals are non flagellated, dermal ostia open into them

⇒ Incurrent canals lined by pinacocytes, lead into radial canals through prosopyles.

⇒ Radial canals flagellated & lined by choanocytes, lead into spongocoel through apopyles.

⇒ Spongocoel lined by pinacocytes & non flagellated.

Ingressing water → Dermal ostia → Incurrent canal → Prosopyles → Radial canal → Apopyles → Spongocoel → Osculum → Outside

### (C) LEUCON TYPE

→ due to further folding of body wall of sponc type

→ e.g. Spongilla

→ radial symmetry lost due to complexity of canal system and symmetry is irregular

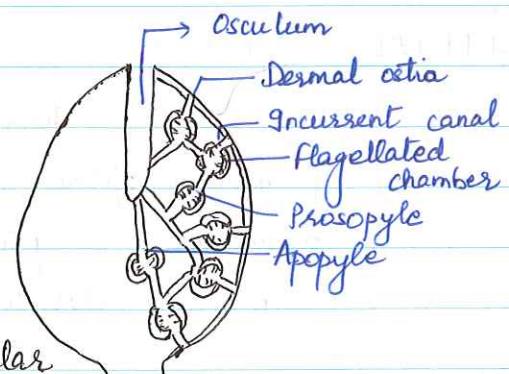
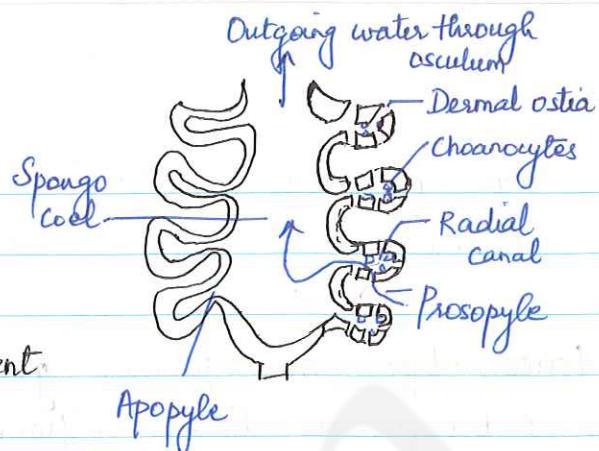
→ smaller flagellated chambers

→ lined by choanocytes & spherical in shape

→ all other spaces lined by pinacocytes

→ excurrent canals develop due to shrinkage & division of spongocoel

→ highly reduced spongocoel



Ingressing water → Dermal aesta → incurrent canal → Prosopyle → Flagellated chambers → Apopyles → Excurrent canal → Osculum → Outside

Leucon types has further grades :-

1. Eurypylous type - flagellated chambers directly communicate to excurrent canal through apopyles  
eg. Plankina

2. Aphodal type - apopyles drawn out as narrow canals called aphodas  
- aphodas connect flagellated chambers to excurrent canal  
eg. Geodia

3. Diplodal type - has aphodas  
- narrow tubes called prosodus between incurrent canal & flagellated chambers  
eg. spongilla

### SKELETAL SYSTEM

- all sponges have skeleton embedded in the mesenchyme
- spongin fibres or individual spicules or both
- supports & protects soft body parts
- provides classification into classes

### SPONGIN FIBRES scleroprotein

- organic, horny, elastic substance that resembles silk
- scleroprotein containing sulphur and related to collagen
- insoluble in water & resistant to protein digesting enzymes
- spongin fibres are fine threads consisting of a granular axial core externally surrounded by concentric layers of spongin

→ Contains sulphur & iodine

- ⇒ In class Desmospongia, spongin may be in the form of cement connecting siliceous spicules
- ⇒ It may be found as branching fibre with siliceous spicules embedded
- ⇒ In Keratosa, spicules are absent & only spongin may be present

Development of spongin :-

- ⇒ secreted by flask shaped mesenchyme cells k/a spongioblasts
- ⇒ during development, cells are present in rows and spongin rods secreted by them are fused together
- ⇒ later cells vacuolate and degenerate & only spongin is left

### SPICULES

- ⇒ microscopic crystalline structures that give sponges their form & rigidity
- ⇒ contain spines or rays that radiate from a point
- ⇒ secreted by amoebocytes k/a scleroblasts.

On basis of deposit of core organic matter :-

- ⇒ all spicules have a core of organic matter on which  $\text{CaCO}_3$  or colloidal silica is deposited

(a) Calcareous spicules - organic matter  $\text{CaCO}_3$  or calcite  
- typical in Class Calcarea

(b) Siliceous spicules - organic matter is colloidal silica  
- typical in Class Hexactinellida

On basis of size & function :-

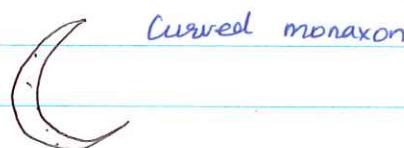
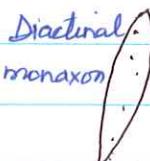
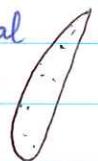
(a) Megascleres - large spicules that form the main skeleton of the sponge

(b) Microscleres - small spicules that occur interstitially

On the basis of no. of axes & rays:-

- (a) Monaxon - formed by growth along one axis  
 - may be straight or curved  
 - can be calcareous or siliceous

Monactinal monaxon



Monactinal

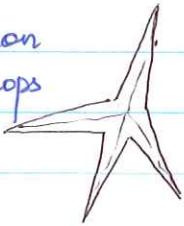
(growth in one direction)

Diactinal

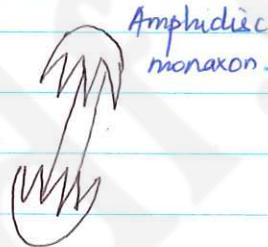
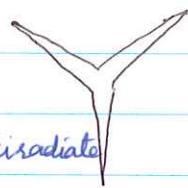
(growth in both the directions)

- (b) Tetragonon - four rays each pointing in a different direction  
 - one may be elongated to appear crown-like (eg - triaenes)  
 - all rays equal = calthrops

Tetragonon  
calthrops

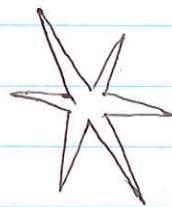


Triradiate



Triaene

- (c) Triaxon - 3 axes that cross one another at right angles to produce 6 rays  
 - aka hexactinal spicule  
 - typical of glass sponges of class Hexactinellida

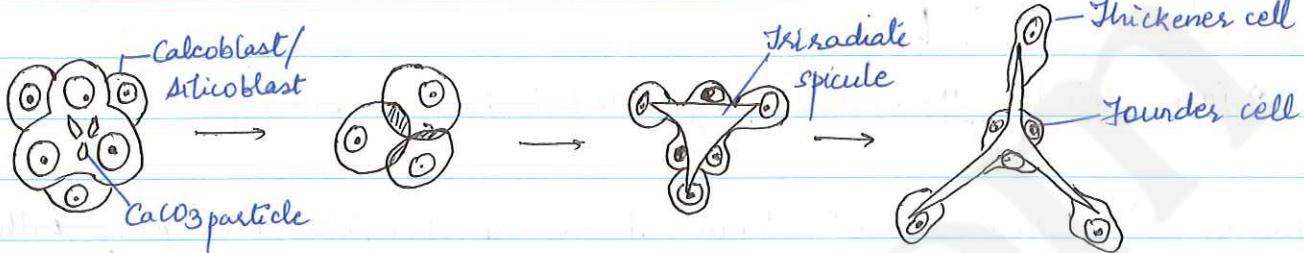
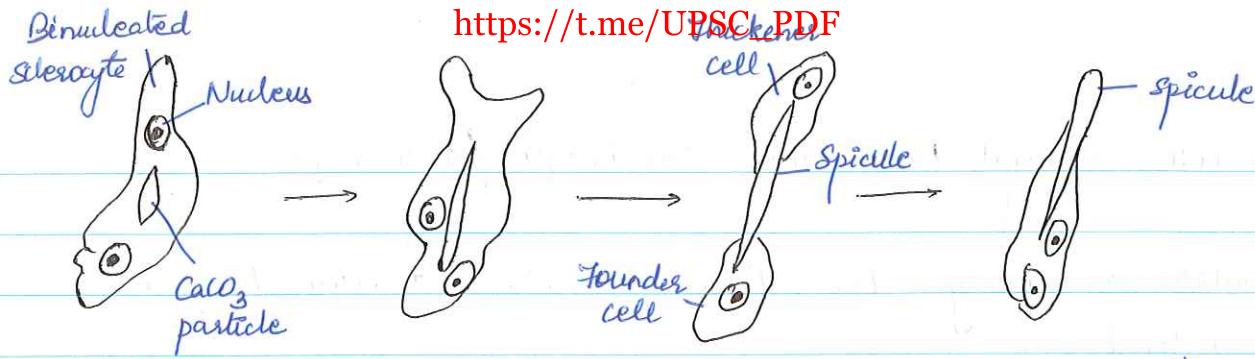


- (d) Polyaxon - spicules of several equal rays radiating from a central point  
 - star like appearance  
 - found along with microscleres



### Development of spicules

- calcareous spicules secreted by scleroblasts / sclerocytes
- sclerocytes derived from binucleated mesenchymal scleroblasts
- each ray is secreted by a pair of sclerocytes



Initiation starts with deposition of a  $\text{CaCO}_3$  particle b/w the two nuclei of binucleate mesenchymal cells

This particle grows drawing apart the nuclei and 2 sclerocytes are formed

Thickener cells lay down addition layer of  $\text{CaCO}_3$

secretes  $\text{CaCO}_3$  spicule = calloblast  
secretes siliceous spicule = silicoblast

Upon formation of spicule, both founder & thickener cell wander into the mesenchyme

### SEXUAL REPRODUCTION

- most sponges are bisexual or hermaphrodite, some unisexual
- cross fertilisation as a rule
- time of maturation of sperm & ova is different - protandry (sperm first) or protogyny (ova first)
- derived from amoebocytes /a archaeocytes
- sometimes may develop from choanocytes which undergo gametogenesis to form sperm & ova later.

### Spermatogenesis :-

- o sperm mother cell or spermatogonium are enlarged archaeocytes
- o spermatogonium covered by one or more flattened cover cell to form a spermatocyst.

- Cover cells derived from other amoebocytes / archacocytes
- Spermatogonia undergo two - three maturation division to form spermatocytes
- Give rise to spermatozoa. (rounded head & tail)

Oogenesis :- Oocyte derived from large amoebocyte / archacocytes with a distinct nucleus

OR

totipotent cells

from choanocytes

Oocyte moves like amoebocytes engulfing other cells

Engulfed cells act as nursing cells for oocyte

Undergoes maturation division to form ovum which lies in the wall of radial canal or spongocoel for capturing sperm

Fertilisation :- Sperm released from osculum

reach the other sponge through ostia

choanocytes act as nurse cells and transport the sperm to ova which lie in the flagellated choanoderm

Internal cross-fertilization occurs

Development :- Early development occurs in the maternal sponge

Larval stage is free swimming & have flagella

Move out of maternal sponge, find suitable substratum

↓  
Metamorphose and grow into adult sponges

### Types of larvae

(a) Amphiblastula :- hollow, oval & large, characteristic of calcareous sponges

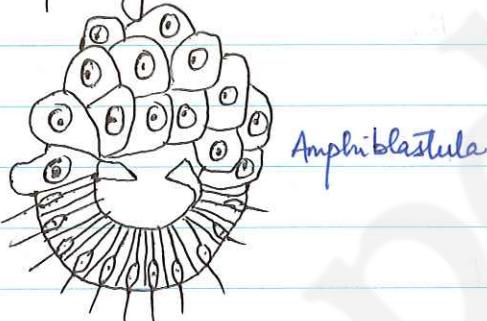
→ anterior half bears flagella

→ posterior half free of flagella

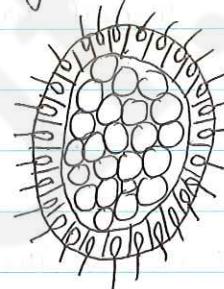
(b) Parenchymula :- solid, oval & flattened

→ characteristic of calcareous, desmospongia & hexactinellida

→ completely covered with flagella



Amphiblastula



Parenchymula

### ASEXUAL REPRODUCTION

(a) Budding - no. of individuals in a colony may increase or new colonies formed

- a bud arises at the base or attached end

- it is because of buldging of pinacoderm

- bud breaks off an osculum at distal end, grows in size and becomes an adult individual

(b) Fission - sponge hypertrophied over a limited area developing a line of weakness

- due to increase in size of cells rather than no. of cells

- along this weak line, splitting occurs & parts of parental sponge are thrown off

- the fragments grow and break off an osculum
- these adults form a colony by budding

(c) REDUCTION BODIES - highly unusual

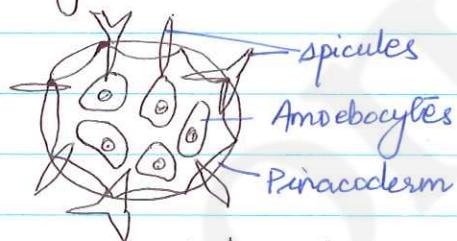
- some sponges get disintegrated during adverse conditions

- it leaves behind small rounded balls

↳ reduction bodies

- each reduction body contains amoebocytes covered by pinacoderm

- upon return of favorable conditions, each reduction body can grow into a new individual



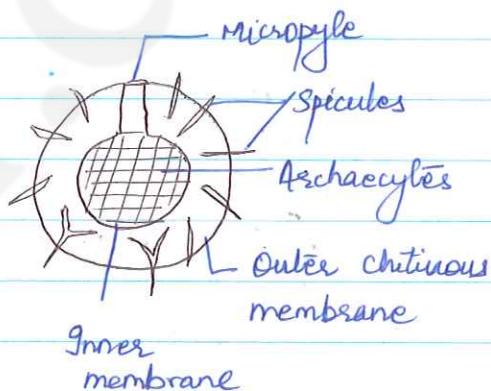
(d) GEMMULES - internal buds formed within the

sponge body

- typical in all freshwater & some marine forms

- get detached when parent is decayed

- can get through unfavorable conditions



- gemmules contain internal mass of food laden archaeocytes surrounded by chitinous double membrane

- outer membrane strengthened by amphidisc monaxons or spicules

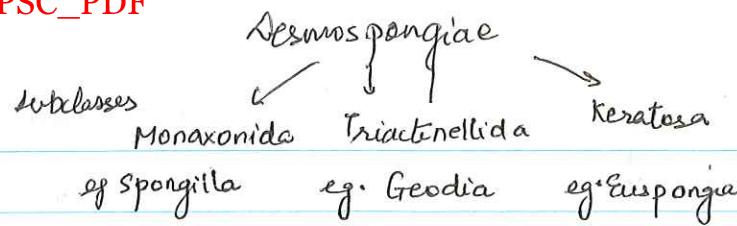
- In fresh water sponges, sponges disintegrate during autumn leaving behind gemmules

- These gemmules grow when favorable conditions appear  
↓

living content escapes through micropylar opening & forms new sponge

This sponge forms spermatozoa & ova. Thus showing alternation of generations

CLASSIFICATION OF PORIFERA



Calcarea

- ⇒ small
- ⇒ marine & shallow water
- ⇒ calcareous spicules
- ⇒ cylindrical / vase like
- ⇒ colonial / solitary
- ⇒ may be asconoid, syconoid or leuconoid
- ⇒ Amphiblastula or Coeloblastula larva
- eg. *Scypha*

Hexactinellida

- ⇒ glass sponges
- ⇒ moderate size
- ⇒ marine deep water
- ⇒ triaxon spicules
- ⇒ cup, wreath or vase shaped
- ⇒ colonial (solitary)
- ⇒ Trichemella larva
- eg. *Euplectella*

Desmospongiae

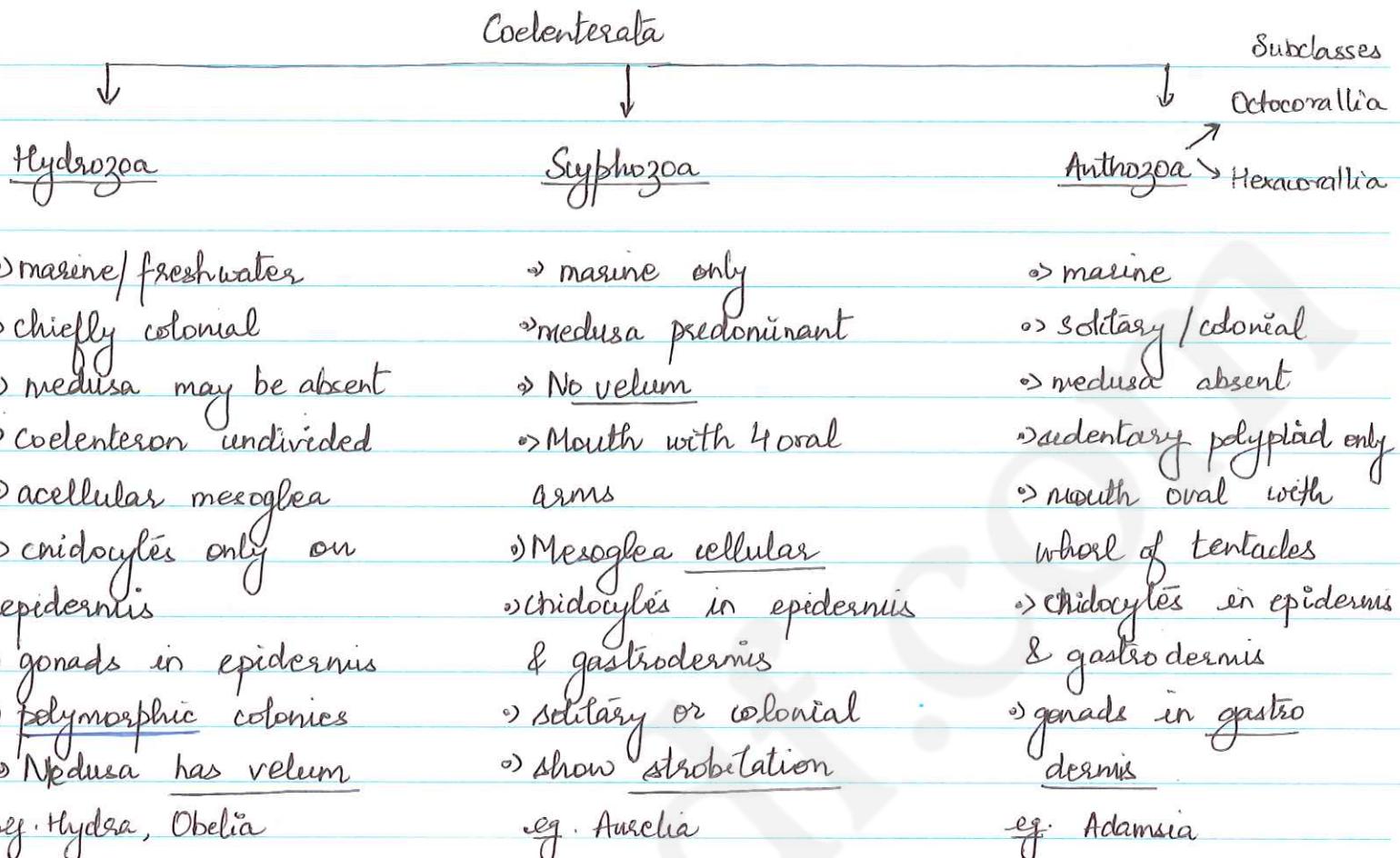
- ⇒ large sized
- ⇒ marine & fresh water forms
- ⇒ siliceous spicules or spongin fibres or both or none (keratosa)
- ⇒ vase/cup/cushion shaped
- ⇒ solitary / colonial
- ⇒ leuconoid
- ⇒ Parycymula larva
- eg. *Spongilla*

CNIDARIA

- ⇒ diploblastic, radially symmetrical organisms with tissue grade org<sup>n</sup>
- ⇒ have defensive organs called cnidocytes
- ⇒ have a gastrovascular cavity called coelenteron.
- ⇒ alternate b/w polyp & medusa phase

sessile, asexual      active, sexual

- ⇒ marine or fresh water, solitary or colonial
- ⇒ free living larva - planula
- ⇒ fertilisation is external
- ⇒ epidermis, gastrodermis & mesoglea for swimming in medusoid form



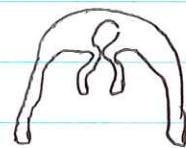
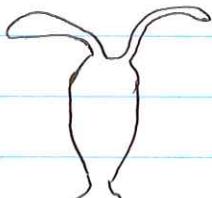
## POLYMORPHISM

- means phenomenon of occurrence of same species of the organism in more than one form with different functions
- guarantees well organized division of labour
- in a cnidarian colony, different individuals united as a colony

Two forms involved :-

(a) POLYPS - tubular, sessile & mouth surrounded by tentacles  
- attached to substratum by a pedal disc

(b) MEDUSAE - umbrella, bowl-shaped and mobile  
- marginal tentacles & mouth centrally located, on lower concave surface



## Origin of Polymorphism :-

Theory 1 :- ancestral coelenterate was hydra-like polyp that arose from gastroca

↓  
gave rise to hydroid colony through asexual budding

some polyp forms modified into medusa for sexual & pelagic lifestyle

Theory 2 :- ancestral coelenterate was medusoid that arose from metagastrea by developing tentacles

↓  
Tentacles of this medusoid form multiplied & shifted to become zooids

↓

Thus polyp is a persistent larval stage while medusa is completely evolved coelenterate

Theory 3 :- various zooids of siphonophorans are merely organs that have attained grade of polymorphic individuals

↓

Polyorgans of Siphonophora become poly persons of Hydrozoa

## Patterns of Polymorphism :-

(a) Dimorphic :- simplest & most common with two zooids forms

→ exhibited by most hydrozoan colonies e.g. Obelia, Tubularia

Gastrozooids - concerned with feeding. Aka hydranths

Gonozooids - concerned with asexual reproduction. Aka blastostyles

(b) Trimorphic :- 3 types of zooids

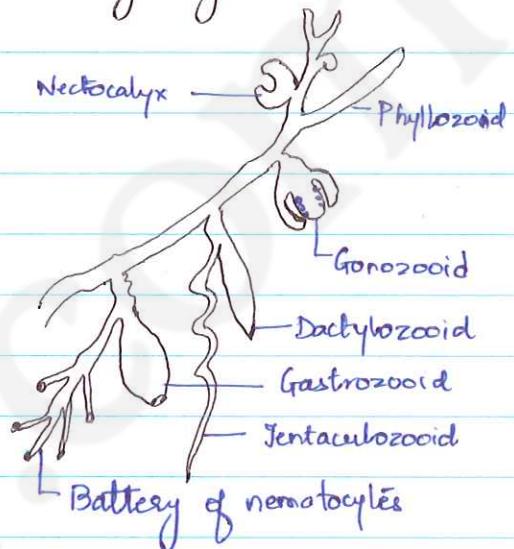
- Gastrozooids (Hydranth)
- Genozooids (Blastostyles)
- Dactylozooids

Dactylozooids - defensive structures with battery of nematocytes

(c) Polymorphic :- More than 3 types of zooid individuals e.g. Hydractinia

→ Hydractinia has 5 types of zooids

- Gastrozooids for feeding
- Genozooids for asexual reproduction
- Dactylozooids for defense
- Tentaculozooids for sensory function
- Skeletozooids (spiny chitinous projections)



### Modifications of polyp forms :-

Gastrozooids - mouth & a long tentacle for feeding (Feeding polyp)

Dactylozooid - no mouth but basal long tentacle (Protective polyp)

Gonozooid - produces sexual medusa form asexually (Reproductive polyp)

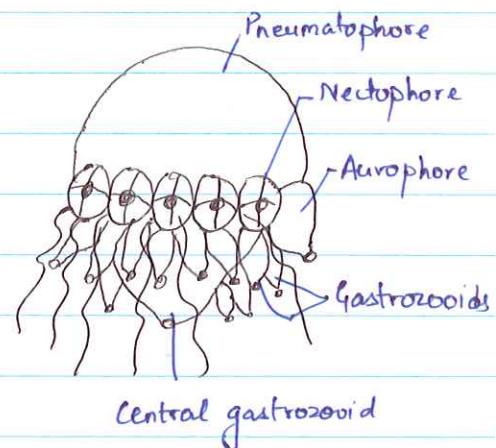
### Modifications of medusa forms :-

Nectophore - Swimming zooid . Muscular bell without tentacles

Pneumatoaphore - float-bladder like medusa . Filled with secreted gas

Phyllozooid - called as bract . Studded with nematocytes & help in protection

Genophore - gonad zooid . Either ♂ or ♀



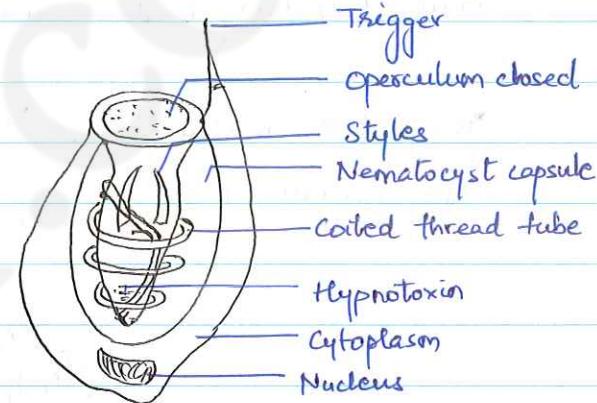
Polymorphism is important for division of labour

## DEFENSE STRUCTURES

- body wall of coelenterates contains defense organs called stinging cells or nematocytes or cnidocytes (hence the name Cnidaria)
- actually cell organelles found in cnidocytes or cnidoblast cells
- develop only from modified intercellular cells of epidermis
- interstitial
- These move to the tentacles through mesoglea by amoeboid movement when fully developed.

### Structure of cnidoblast :-

- oval or rounded cell with basal nucleus
- inside the nematocyte / cnidoblast, an oval or pyriform bladder k/a stinging capsule or nematocyst is present
- nematocyst contains tiny bulb made of chitin
- bulb filled with poisonous fluid or hypnotoxin (mixture of proteins & phenols)
- The end of the bulb is extended as a narrow, long, hollow tube like filament & is coiled around the bulb = Thread tube
- Base of the thread tube is swollen to form a shaft
- Inside the shaft - 3 large spines called barbs and 3 spiral rows of minute spines called barbules
- Shaft externally covered by a lid called operculum
- outer end of cnidoblast projects beyond the epidermis as a pointed hair like cnidocil or trigger
- central core of trigger has fibres in 9+2 pattern
- cytoplasm of cnidoblast contains contractile muscle fibrils
- other organelles like ER, golgi, ribosomes, mitochondria are present



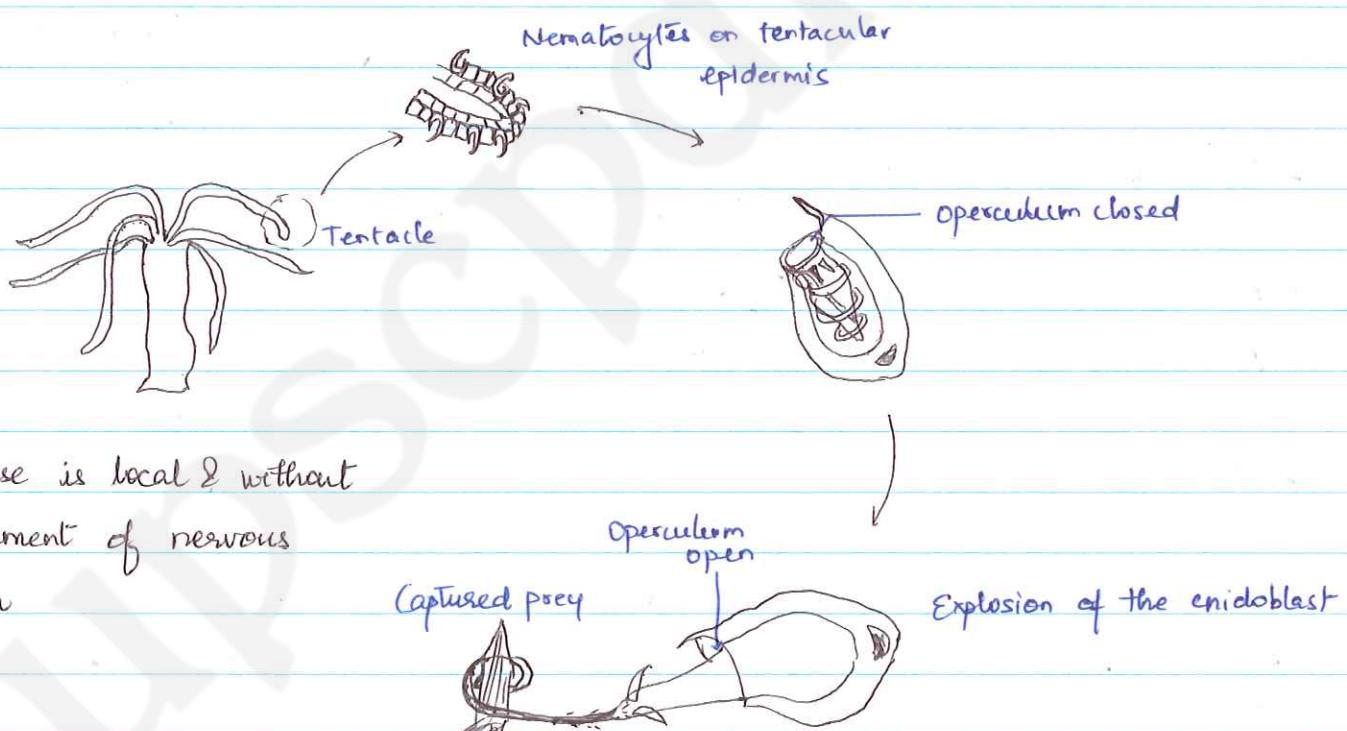
## Distribution of nematocytes :-

- scattered individually throughout the epidermis
- absent on the basal disc
- abundant in the oral region and on the tentacles
- a nematocyst battery contains 2 large nematocytes with 10-12 small nematocytes - all these nematocysts are enclosed in a single large epithelial muscle cell

## Mechanism of defense :-

Cnidocil / trigger is stimulated by both food & touch (not any one alone)

Thus, both mechanical stimulations (contact of food) and chemical stimulations (approaching prey) are involved in action of nematocytes



Response is local & without involvement of nervous system

Wall of nematocyst capsule is fully impermeable to water normally but becomes permeable during discharge

Water rapidly taken inside the capsule & osmotic pressure increases

Operculum forced open and coiled thread tube turns inside out  
↓

Nematocyst explodes to the outside  
↓

Barbs & barbules unfold to the outside

→ Thread tube once discharged cannot be withdrawn. Cnidocytes now cannot be used, are migrated to the gastrovascular cavity & digested  
↓

Exploded cnidocytes replaced in 48 hours.

Types of nematocysts :- close to 30 different types but constant in a particular species

(a) Penetrant nematocyst :- very large and occupy almost entire space of the nematocytes

- Very long thread tube with barbs & barbules
- when ejected, penetrates the victim's body and discharges hypnotoxin into it to paralyze or kill it

(b) Volvent nematocyst :- small & pear shaped

- contain short, thick, spineless elastic threads tube forming a single loop

- when discharged, tightly coils around the prey

(c) Stereoline glutinant nematocyst :- oval or elongated

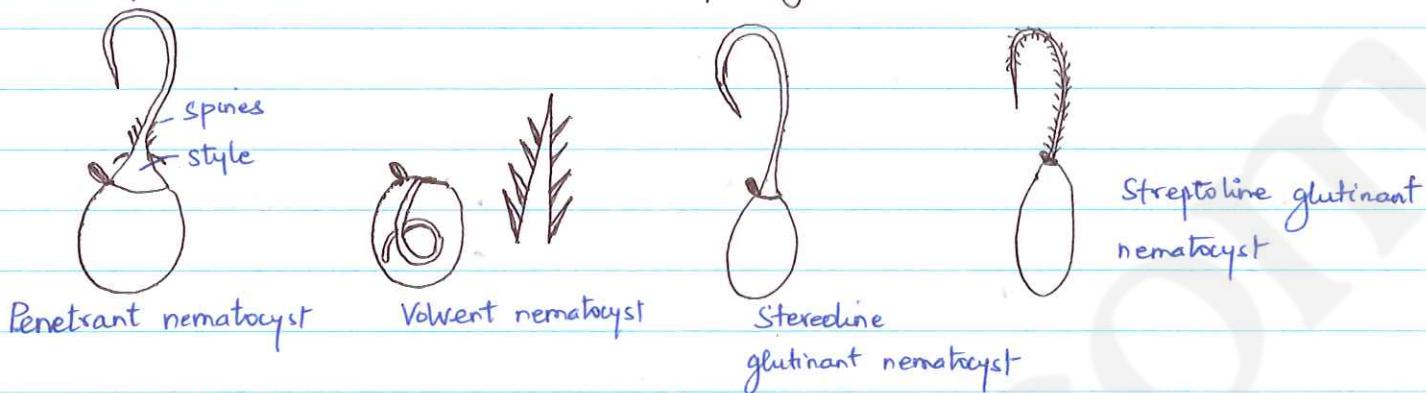
- do not have a shaft

- discharge is a straight unarmed thread tube open at the tip

- useful for attachment & anchorage

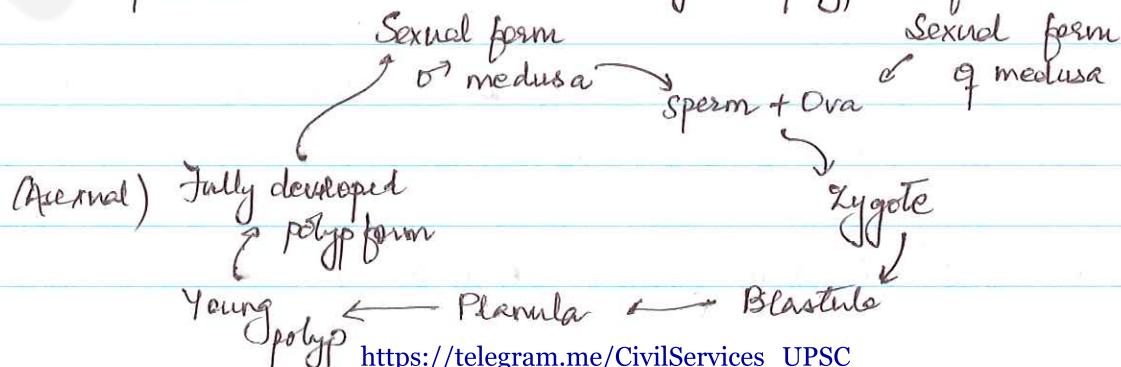
(d) Sterepoline glutinant nematocyst :- oval or cylindrical

- thread tube is long with a narrow shaft
- bears spiral row of small spines
- helps in attachment or in impeding movement of small animals



## METAGENESIS

- ⇒ Alternation of generation is k/a metagenesis
- ⇒ It is a phenomenon wherein, in the life of an organism, a diploid asexual phase and a haploid sexual phase regularly alternate with one another.
- ⇒ This type of true alternation of generations is present in plants like mosses & ferns.
- ⇒ In Coelenterates, 2 types of individuals exist - polyp & medusa
- ↳ reproduces asexually
- ↳ reproduces sexually
- ⇒ A tubular, cylindrical polyp form that is sessile reproduces by budding and gives rise to medusoid form
- ⇒ In medusa, the sperm and ova are produced (differences - separate ♂ & ♀)  
These are fertilised, externally or internally, to produce a zygote that grows into a planula larva and ultimately a polyploid form



- ① Metagenesis a characteristic of Hydrozoa class.
- ② In Scyphozoa, medusa dominant & polyp reduced
- ③ In Anthozoa, medusa is absent and polyploid stage has become sexual.

### Differences b/w polyp & medusa forms

#### POLYP

- ① Fixed and sedentary; rarely free form
- ② Body cylindrical & elongated
- ③ Base attached to substratum exposing the manubrium upwards
- ④ Tentacles usually 9-14
- ⑤ Mesoglea poorly developed
- ⑥ Velum absent
- ⑦ Mouth circular without oral lobes
- ⑧ Gastrovascular cavity simple without radial & circular canals
- ⑨ Sense organs absent
- ⑩ Asexual - no gonads

#### MEDUSA

- ① Free swimming or pelagic
- ② Body umbrella shaped
- ③ Base always above hanging manubrium downwards
- ④ Tentacles 16 in young medusa & numerous in adult
- ⑤ Mesoglea well developed
- ⑥ Velum present around umbrella margin
- ⑦ Mouth rectangular with oral lobes
- ⑧ 4 Radial canals and one circular canal
- ⑨ Sense organs called statocysts present along margin of tentacles
- ⑩ 4 gonads present on radial canals

### Similarities :-

- 1) Radially symmetrical
- 2) Diploblastic - ectoderm & endoderm
- 3) Homologous mouth
- 4) Exumbrellar surface corresponds base of polyp
- 5) Stomach, radial & circular canals correspond to gastrovascular cavity of polyp
- 6) Both forms carnivorous
- 7) Digestion intra & extracellular
- 8) Gastrodermis lines the gastrovascular cavity

## CORAL REEFS

- ↳ coral animals are marine, colonial polyploid Coelenterates (no medusa form)
- ↳ Calcareous ( $\text{CaCO}_3$ ) horny skeleton secreted by the coral animals is commonly k/a coral
- ↳ Some corals grow into massive solid structures and form branched colonies
- ↳ coral animals belong to class Anthozoa usually or class Hydrozoa.

### Structure of a coral polyp :-

- some can grow upto 25 cm
- basal disc is absent as it is surrounded by calcareous exoskeleton
- oral disc bears numerous tentacles in several rows
- pharynx short with no ciphonoglyphs
- mesenteries restricted to upper part
- muscles not well developed
- living polyps found only on surface layers of the coral mass
- feeding both raptorial & suspension type

### Structure of coral skeleton :-

- skeleton of a solitary coral k/a corallite
- skeleton is calcareous structure secreted by the epidermis
- in colonial forms, corallites are individual polyps which fuse to form skeletal mass called corallum
- each corallite
  - stony cup with a basal plate
  - wall of the cup called theca
  - cavity of the cup contains vertically radiating ridges called sclerosepta
  - inner end of sclerosepta fused to form irregular central skeletal mass or columella

### Formation of coral skeleton:-

- ⇒ In all coral polyps, sexual reproduction takes place by fusion of gametes  
↓
- ⇒ Zygote develops into a free swimming ciliated planula larva  
↓
- ⇒ Gets attached to substratum & metamorphoses to a young coral polyp  
↓
- ⇒ Reproduces by budding to form a colony  
↓
- ⇒ Polyp begins to secrete a skeletal sediment called prototheca by ectoderm  
↓
- ⇒ Radial folds develop and secrete sclerosepta  
↓
- ⇒ At the same time, a rim built around polyp at thecal wall  
Further skeletal material added into gaps b/w sclerosepta  
↓
- ⇒ By budding of new polyps, colony grows in size along margins & surface
- Structural differences & variations due to differences in pattern of budding

### KINDS OF CORAL REEFS

- Continuous budding of coral polyps creates massive structures called coral reefs.
- A coral reef is a ridge of limestone, upper surface of which is near the sea surface.
- Formed of  $\text{CaCO}_3$  secreted by stony corals.
- Also consists of coralline algae and foraminiferans (Protozoans).
- Corals need warm shallow waters with Temp. above  $20^\circ\text{C}$ .
- Corals therefore found only at Gonto-Pacific, central Western Pacific, and Caribbean regions.

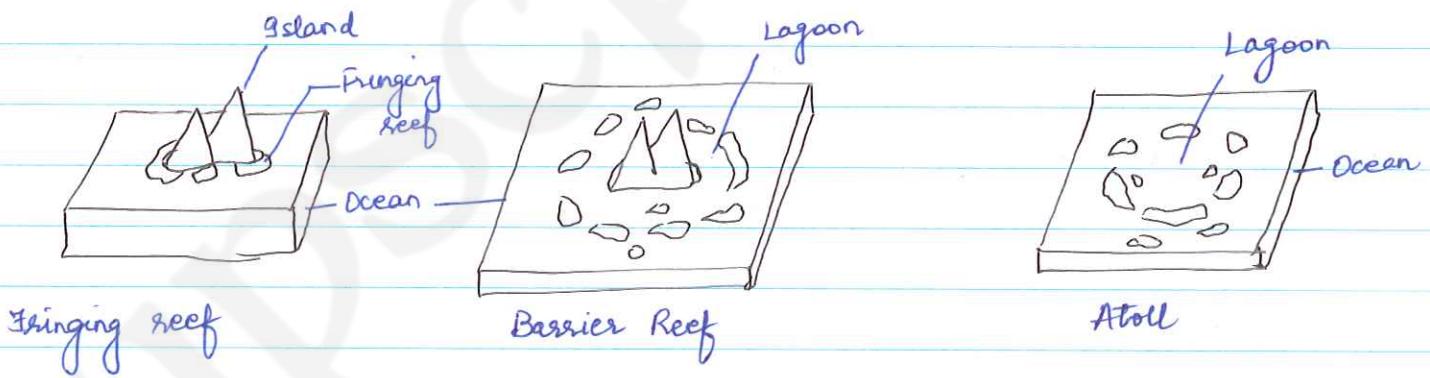
→ Depending upon their formation, of 3 kinds :-

(a) FRINGING REEFS

- corals reefs situated close to some volcanic islands or continents
- may extend to a distance of a quarter mile from the shore
- most active zone of coral growth facing the sea
- seaward zone k/a edge or front
- shallow water channel 50 - 100 m wide lies b/w reef edge & shore
- during low tides, water channel recedes to expose flat bottom surface called REEF FLAT
- reef flat composed of sand, mud, dead & living corals & other animals

(b) BARRIER REEFS

- similar to fringing reefs but at a greater distance from the shore
- stretch of water separating reef and the shore  $\approx \frac{1}{2}$  - 10 miles
- This stretch is k/a Lagoon
- lagoons are deep & suitable for navigation



(c) ATOLLS

- aka coral islands or lagoon islands
- ring like or horse shoe shaped enclosing a lagoon
- lagoon may be complete or broken into a number of navigable channels
- outer side of the reef slopes off into the ocean

## THEORIES OF FORMATION

### (a) SUBSIDENCE THEORY

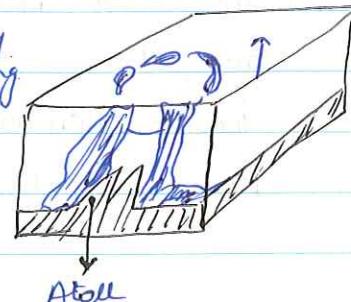
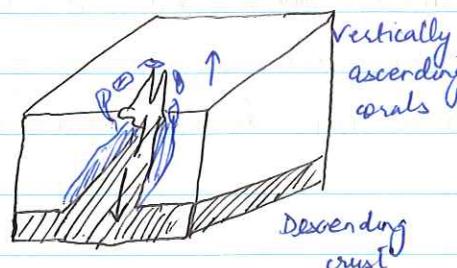
- put forth by Darwin
- all known coral reefs are found in regions where subsidence of land has taken place
- initially, corals grew as fringing reefs on sloping shores of an island in a shallow tropical sea
- Subsidence of islands commenced and reef turned into a barrier reef
- Island finally became smaller & disappeared beneath the ocean leaving atoll & lagoon.

### (b) THEORY OF SEA BOTTOM RISE

- propounded by John Murray
- corals grow on the highest peaks of the ocean bottom
- deposition of sediments brings them to an optimum level for coral growth
- barrier reefs & atolls produced by the better growth of corals on edges of coral deposition & solution of inner coral rock

### (c) GLACIATION CONTROL THEORY

- propounded by Penck & Daly
- during glacial period, formation of ice caps lowered the level of ocean by 60-70 m
- Subsequently, temp. rose & ice melted
- corals began to grow on the flat surface of the ocean bottom and kept pace with rising ocean level forming reefs.



## IMPORTANCE

- 1) highly favorable sites for accumulation of oil
- 2) Nicknamed 'rainforests of the ocean' due to biodiversity
- 3) home to plants and animals. Sometimes human inhabited
- 4) Decorative value eg. Corallum rubrum
- 5) Medicinal value eg. red coral & organ pipe coral used in indigenous medicine system in south India
- 6) Chunks of corals belonging to Porite species used as building material
- 7) Raw material for preparation of lime, mortar & cement
- 8) natural barriers against waves, tsunamis, hurricanes
- 9) nursery ground for commercially important fishes
- 10) tourist attraction

## DESTRUCTION OF CORAL REEFS

### 1) REEF BLEACHING

- water conditions cause corals to expel the photosynthetic alga that provide them their colour.
- can be due to increase in water temperatures

### 2) POISON FISHING

- Used to capture fishes and coral dwelling marine animals
- fishes can metabolise cyanide and are temporarily stunned to be captured for ornamental purposes
- corals cannot metabolize cyanide & die in the cloud of poison

### 3) WATER POLLUTION

- reefs are harmed when oil, fertilisers, animal & human waste is dumped into the area
- these chemicals can be harmful and cut sunlight availability from the reef

#### 4) SEDIMENTATION

- construction and mining can create silt & soil run off
- particles can cut off sunlight and nutrients to corals

#### 5) CARELESS TOURISM

- Touching by divers, snorkelers can kill coral reefs
- Boating & fishing also causes damage
- can be protected by declaring marine protected areas
- initiatives like Coral Reef Watch use satellite data to monitor sea surface temperature to avoid bleaching

### OBELIA

- cosmopolitan in distribution except high-Arctic and Antarctic seas
- sedentary, marine & colonial form upto depth of 80m
- Class Hydrozoa
- aka sea fur; hydroid colony is delicate, semi-transparent & whitish to light brown in colour.
- Sympodial colony growth
- vertical branches called hydrocaulus & root like branches called hydrorhiza.
- hydrocauli branches in alternate manner
- ultimate branch terminates into a hydranth or polyp
- in older polyps, cylindrical reproductive zooids are placed k/a blastostyles or gonangia
- dimorphic colony
- turns trimorphic when medusoid form produced

### Polyp or hydranth (Nutritive Zooids)

- aka gastrozooid or trophozooid

- yellow in colour, radially symmetrical & cylindrical (hydra like)
  - specialised for capture, ingestion & digestion of food
  - basal end not closed but connected to a stalk with hydrocaulus
  - body wall composed of ectoderm, mesoglea & endoderm
  - mouth at the apex of hypostome surrounded by tentacles
  - ectoderm is thin
  - nematocytes only on tentacles
  - middle structureless layer mesoglea has a nerve net
  - nutritive muscular cells possess flagella at their inner ends
- 
- living sac - coenosarc surrounded by chitinous perisarc
  - perisarc covers hydranth forming conical protective covering called hydrorhiza

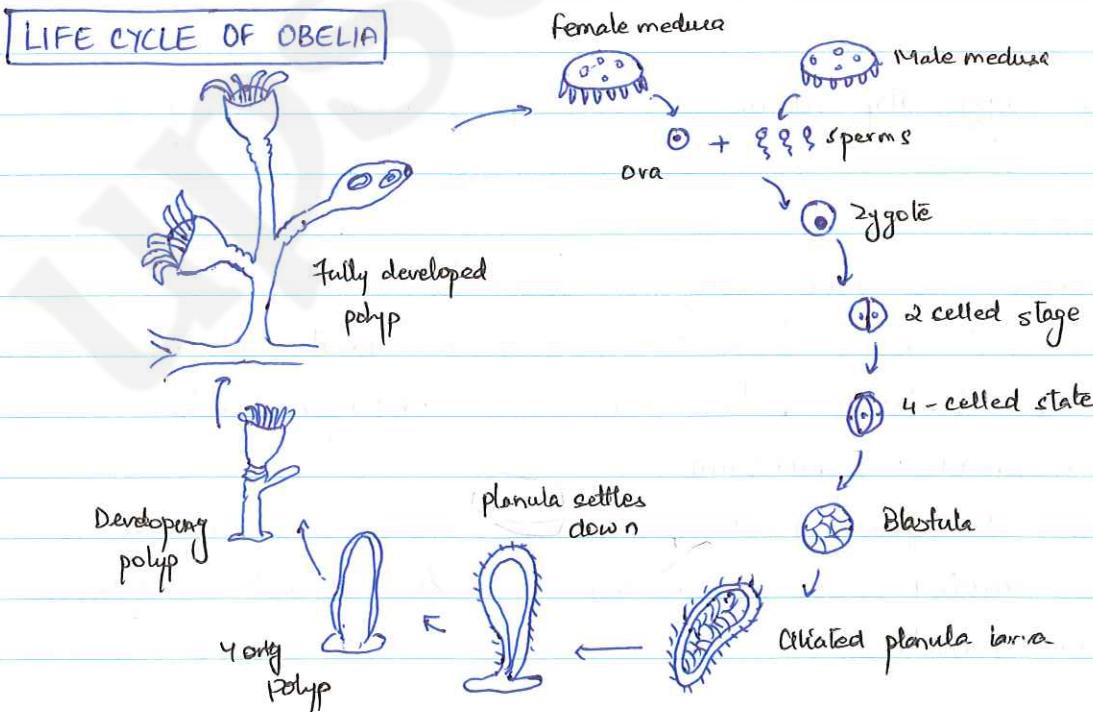
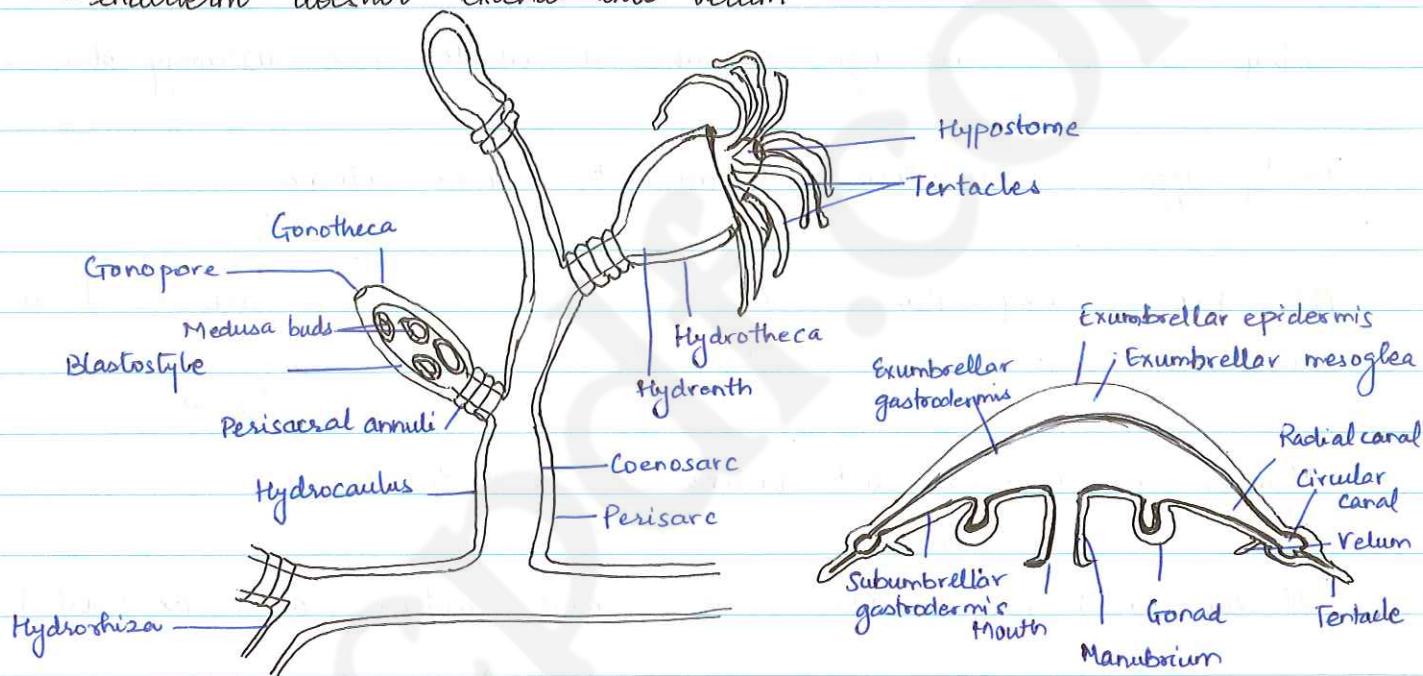
### Blastostyle (Reproductive zooids)

- develop when hydrocaulus has reached its full development
- fewer as compared to hydranths
- mouth and tentacles absent ; gastrovascular cavity reduced
- distal end closed and forms a flattened disc
- covered by perisarc called gonotheca
- reproduce asexually to produce medusa buds or gonophores
- buds develop into medusae
- when fully developed, blastostyle ruptures at distal end & medusae swim away

### Medusae

- small, transparent, solitary, free swimming & umbrella shaped
- inner concave surface sub-umbrella & outer convex surface k/a exumbrellar surface
- quadrangular projection called manubrium hangs from the subumbrellar surface ; mouth - square shaped located at tip of manubrium

- mouth leads to gastral cavity or enteric cavity placed at the centre
- from this cavity, four radial canals radiate
- these open into a circular canal running around edge of umbrella
- edge of medusa has a sudimentary fold on the inner side Velum
- margin of umbrella has tentacles - 16 in young medusa  
- increase thereafter
- ectoderm covers both exumbrellar & subumbrellar surface
- endoderm does not extend into velum



⇒ Sperm & ova released in water by rupture of gonad



External fertilization in water & zygote formed



Zygote undergoes equal & holoblastic cleavage



Blastula formed and solid so called stereo gastrula or solid gastrula



Embryo set free from egg membrane as ciliated free swimming planula larva



Cavity appears in endoderm cell mass that form entosco



After free swimming, planula loses cilia & settles down, attaches to a substrate and undergoes metamorphosis



} Hydrula

Attached or proximal end wedges as basal disc



At the distal end, a dilation is formed, tentacles arise as short buds



Narrow portion becomes hypostome and aperture (mouth) formed

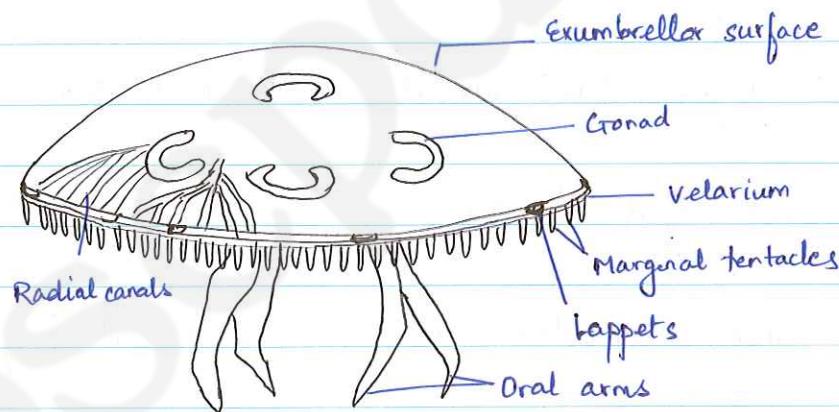


Young hydranth repeatedly divides by budding to form a colony

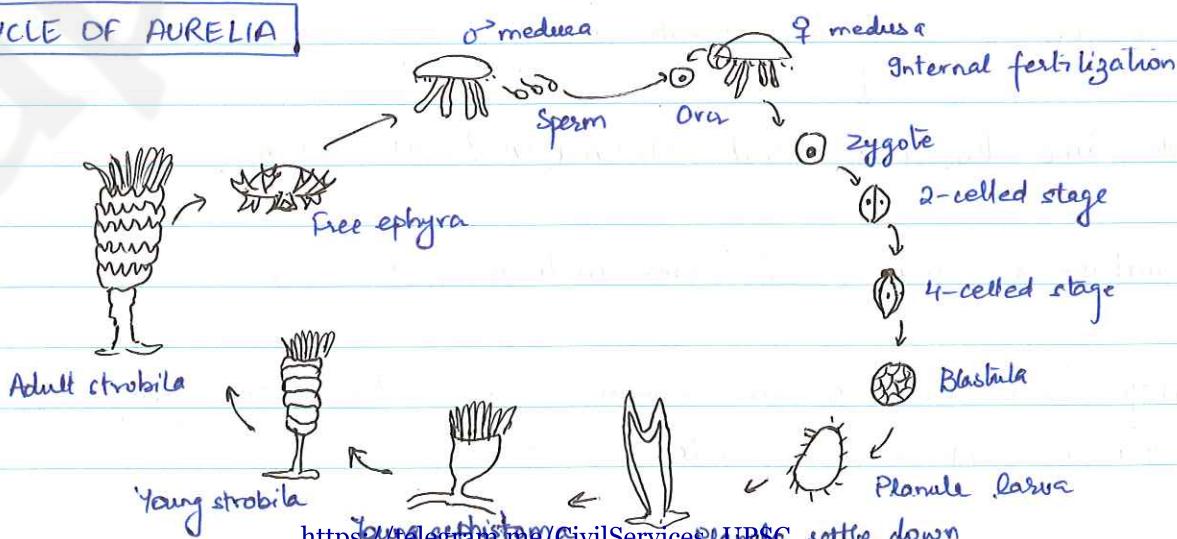
## AURELIA

- cosmopolitan ; known as moon jelly or jelly fish
- soft umbrella shaped body transparent & bluish white in color
- gonads reddish or pinkish & horseshoe shaped ; clearly visible
- short and inconspicuous manubrium
- from each corner of square mouth, oral arms hang downwards
- oral arms have ciliated grooves leading into the mouth & edges of grooves contain nematocytes

- Radii along oral arms called per radii
- Midway b/w 2 per radii - inter radius is present
- B/w each per radius & inter radius - a radius is present
- Each inter radius bears a circular aperture on subumbrellar surface called sub genital pit
- Just above sub genital pit, gonads are present
- Circular margin of umbrella broken into 8 lobes & 8 notches
- Each notch has 2 leaflike processes called as marginal lappets
- B/w the lappets, a secretory organ called Rhopalium or tentaculocyst is present
- Numerous thread like tentacles having batteries of nematocysts
- marginal bearing lappets and tentacles has a thin flexible flap like velarium
- Velarium does not have gastrodermal canals so called pseudovelum



### LIFE CYCLE OF AURELIA



Sperms reach the ova either in stomach or female or in oral arms



Gills or oral arms serve for temporary brooding



Zygote undergoes holoblastic divisions to form solid morula



Morula converts to blastula with fluid filled cavity called blastocoel



2-layer gastrula developed by invagination (inner endoderm & outer ectoderm)



Blastopore of gastrula not completely closed



Embryo elongates, outer cells become ciliated & blastopore closed



Ciliated free swimming planula larva formed



Settles down and attaches from aboral end to substratum



Cilia lost and mouth opens at the oral end



Larva elongates and metamorphoses into trumpet shaped polyp



Tentacles develop around mouth. Mouth elongates and becomes square in outline & short manubrium develops



Looks like hydra & called HYDRATUBA / SCYPHISTOMA



In autumn & winter, scyphistoma undergoes strobilation



Develops series of ring like transverse constrictions that gradually deepen to give an appearance of pile of discs



Scyphistoma now called strobila and each disc called ephyra larva  
Ephyrae connected with one another by muscular strands  
↓

As ephyrae grow, muscular strands break one by one & ephyrae are pinched off  
↓

Ephyrae has tetramerous symmetry  
with edge having 8 bifid lobes  
with 8 oral indentations  
↓

→ Polydisc strobilation  
(when food abundant)  
→ Monodisc strobilation  
(limited food & high temp)

Distal ends are notched to form pair of lappets that are sensory in nature  
↓

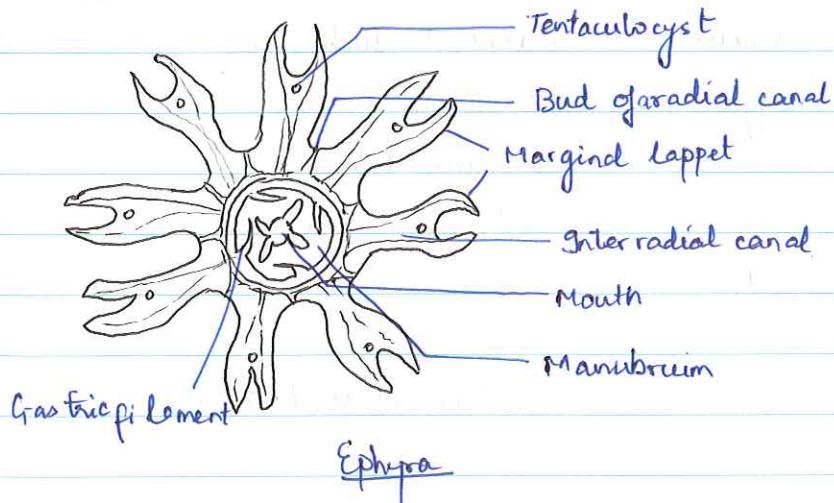
space b/w lappets has a tentacle which is the future tentaculocyst  
↓

Ephyra swims actively & feeds on small organisms  
↓

Meongea increases enormously and 2 layers of endoderm fuse to form gastrodermal lamella except in regions of gastrovascular canals.  
↓

Numerous marginal tentacles and 4 oral arms formed  
↓

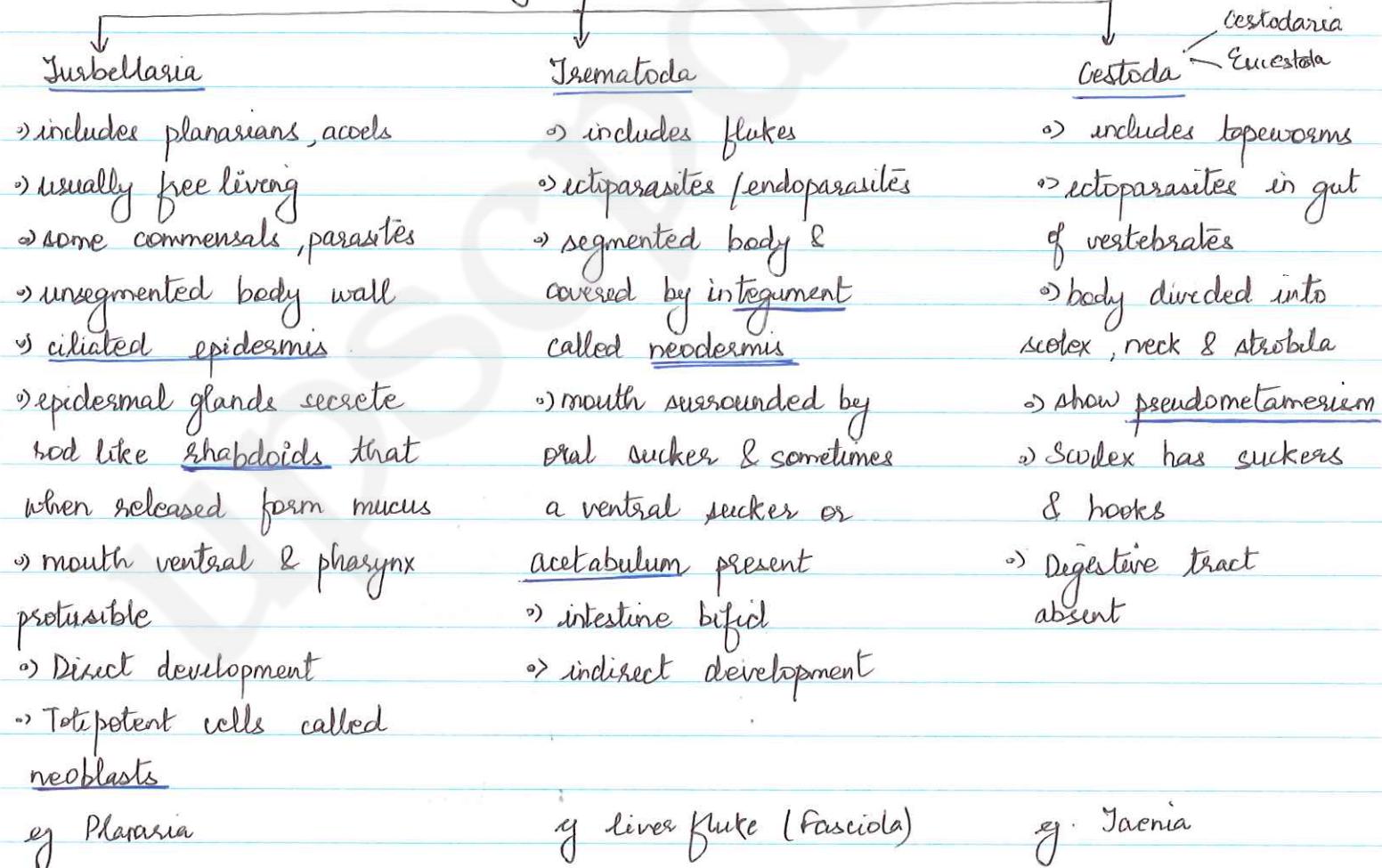
Medusa form reached.



## PLATYHELMINTHES

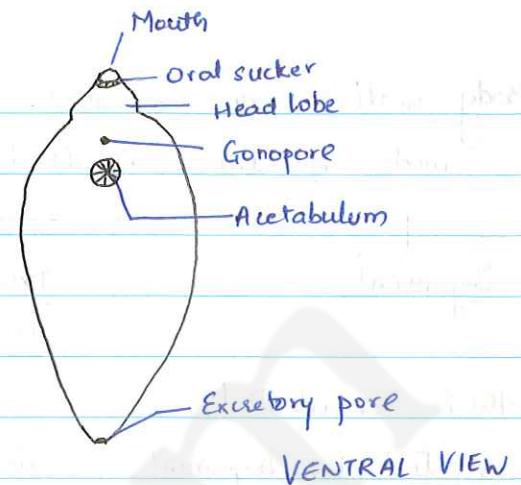
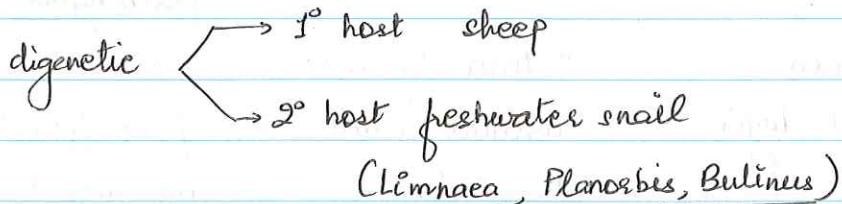
- includes flatworms like Planarians, flukes & tapeworms
- triploblastic and acelomate
- evolution of triploblastic condition & bilateral symmetry coincide with evolution of organs & organ systems, cephalization and centralisation of nervous system
- mostly parasitic, some marine forms are free living
- connective tissue b/w gut & body wall called parenchyma
- Incomplete digestive system w/o anus
- Cerebral ganglia constitute the brain. Longitudinal nerve cords joined by transverse commissures at regular intervals
- mostly hermaphrodite with internal fertilisation

### Platyhelminthes



## FASCIOLA

- Fasciola hepatica a digenetic trematode
- endoparasite in bile passages of liver & sheep
- completes part of its life cycle in snail.



Morphology :- soft, fleshy, dorsoventrally flattened, leaf like body  
 → anterior end is broad & rounded ; posterior end is bluntly rounded & narrower  
 → pinkish in colour with brownish margins ; transparent body wall

Structure :- Head lobe / Cephalic cone broad anterior region with mouth at its tip

Suckers → anterior or oral sucker is cup shaped & surrounds the mouth  
 muscular & muscles radiate from the mouth to the periphery  
 sectorial region & helps in ingestion & adhesion

posterior sucker or ventral sucker is saucer shaped  
 lies mid-ventrally w/o aperture & called acetabulum

Apertures

- mouth terminal at the tip of oral cone
- common genital aperture / gonopore lies midventrally a little in front of acetabulum
- excretory pore at the posterior end midventrally
- opening of Laurer's canal appears temporarily during breeding season, on dorsal side

Body wall :- non ciliated, lacks a cellular epidermis and adapted to parasitic mode of life. Multi-layered

↓  
Tegument

↓  
Basement membrane

↓  
Musculature

↓  
Mesenchyme or parenchyma

- ⇒ thick, non-ciliated
- ⇒ secreted by Tegument secreting cells
- ⇒ has spines directed backward for anchorage & locomotion

- ⇒ a non-distinct layer

- ⇒ three layered
  - circular muscles
  - longitudinal
  - oblique / diagonal

- ⇒ packing material
- ⇒ fluid filled
- ⇒ uninucleate / binucleate cells

Digestive organs :- Incomplete w/o anus

- a) Mouth with oral sucker
- b) Short pharynx which is muscular & has pharyngeal glands
- c) Oesophagus joining intestine
- d) Bifid intestine running along lateral sides & end blindly
  - highly branched into caeca or diverticula

- ⇒ Oral sucker & pharynx provide suctorial ingestion
- ⇒ Extracellular digestion - digestive enzymes present
- ⇒ No circulatory system - digested food diffuses into mesenchyme
- ⇒ Food stored as glycogen & fats in mesenchyme & muscles

- ⇒ Respiration - anaerobic or anoxysymbiotic
  - glycogen breaks by anaerobic glycolysis to form  $\text{CO}_2$  & lactic acid

Excretory / Protonephridial system :-

- greatly branched excretory ducts & flame cells
- flame cells have pseudopodial processes
- excretory trunks → excretory canal → excretory pore

⇒ Nervous System :- a pair of cerebral ganglia surrounded by nerve ring  
- 3 pairs of longitudinal nerve cords

⇒ Reproductive system :- hermaphrodite but cross fertilisation a rule

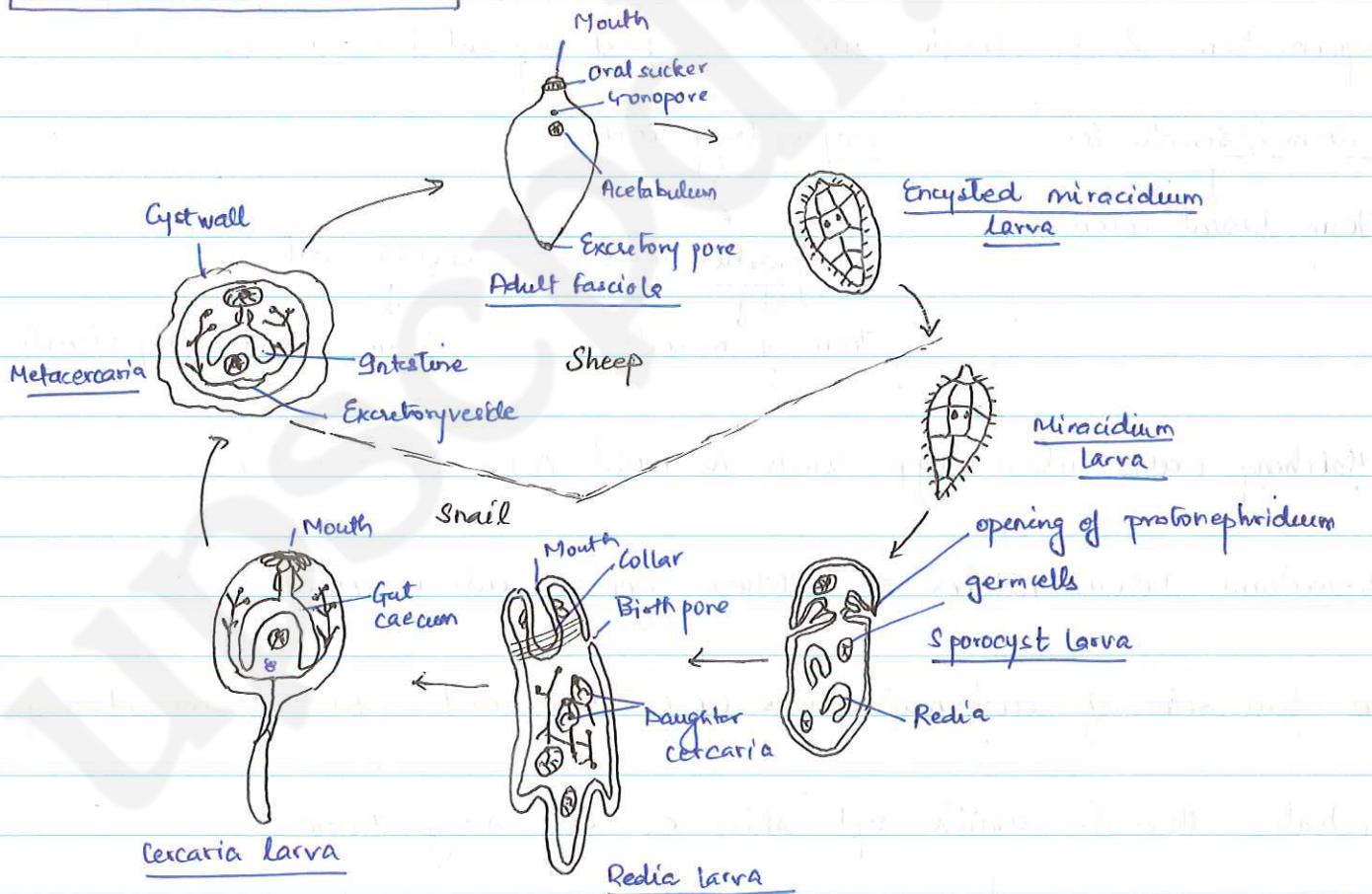
♂ reproductive system

- testes
- vas deferentia
- seminal vesicle
- ejaculatory duct
- coccus (penis) & coccus sac

♀ reproductive system

- ovary
- oviduct
- ootype
- uterus
- Mehl's glands
- Vitelline glands & ducts
- Lauder's canal

### LIFE CYCLE OF FASCIOLA



Copulation of two flukes inside the bile duct of host's body



Cirrus inserted into Laurer's canal & sperms ejaculated



Eggs fertilized in uterus or ootype



Fertilised cells deposited with yolk cells produced by vitelline gland & covered by chitinous egg capsule



Eggs formed are operculate



Eggs carried to the intestine and passed out with faeces



Segmentation starts inside uterus & first segmentation is unequal



Ectodermal/somatic cell



Form larval ectoderm

Propagatory cell



Propagative cells

↓  
Form germ cells

Somatic cells



Form larval body structures

Hatching occurs when eggs reach a moist area or in water



Miracidium larva hatches out when egg operculum opens



Has fine rows of epidermal plates (6, 6, 3, 4, 2) and a pair of penetration glands

↓ Survival and lives for 24 hours only

Penetrates through snail's soft skin or respiratory tissue



Miracidium throws off cilia, loses apical gland, penetration gland, brain & eyespots inside lymph vessels or pulmonary chambers of snail



Sporocyst larva formed with all layers of miracidium body except ciliated epithelium



Germ cells inside sporocyst undergo repeated divisions to form redia larvae



Redia larva comes out by rupture of sporocyst that now has an opening called birthpore



Germ balls inside redia give rise to daughter redia in summer & cercaria larvae in autumn months



Cercaria larva with a flattened heart shaped body & long contractile tail. Body covered by thin cuticle & backwardly directed spines



Unicellular cystogenous glands form a cyst around larva to form metacercaria



Upon maturation, cercaria leave the redia through birthpore & wriggles out of snail body



Stones for sometime & settle on blades of aquatic weed. Sheds off the tail & cyst formed



In metacercaria, cystogenous glands disappear & flame cells increase in no.



Metacercaria enters definite host when sheep graze on aquatic weed and reaches digestive tract



Cyst dissolves by host's digestive juices & fluke comes out. Reaches the bile system & starts its existence.

## PARASITIC ADAPTATIONS OF FASCIOLA

### A. MORPHOLOGICAL ADAPTATIONS

1. flattened leaf like body to allow movement through narrow bile ducts
2. Oral sucker & acetabulum for attachment to host
3. Very simple external organisation without head, trunk or tail

### B. ANATOMICAL MODIFICATIONS

1. Thick cuticle to protect against action of chemicals in host body
2. Spicules in skin
3. Thickening of cuticle in oral & ventral region to form suckers
4. No locomotory organs
5. Incomplete digestive system & suctorial ingestion
6. Highly branched intestine
7. Anaerobic respiration as free O<sub>2</sub> not available
8. No circulatory system
9. Highly developed excretory system
10. Poorly developed nervous system & no sense organs (not needed)
11. Extensively developed reproductive system
12. Hermaphrodite nature

### C. PHYSIOLOGICAL ADAPTATIONS

1. Adapted to osmotic concentration of bile
2. Osmoregulation not needed

### D. MODIFICATIONS IN LIFE HISTORY

1. Production of large no. of eggs ( $\sim 10$  mn)
2. Operculated eggs to prevent damage
3. Digenetic lifecycle to ensure dispersion
4. Multiple larval forms & polyembryony / paedogenesis
5. Free swimming miracidium larva to ensure dispersal

## PATHOLOGICAL SYMPTOMS

- disease caused called fasciolopsis. Causes hepatitis & inflammation of bile ducts

- calcification of bile passages can cause formation of gall stone causing damage to the liver called liver rot

### acute liver rot

- ⇒ sleep becomes sluggish
- ⇒ abdominal pain
- ⇒ loss of weight
- ⇒ enlargement of liver
- ⇒ death in few days

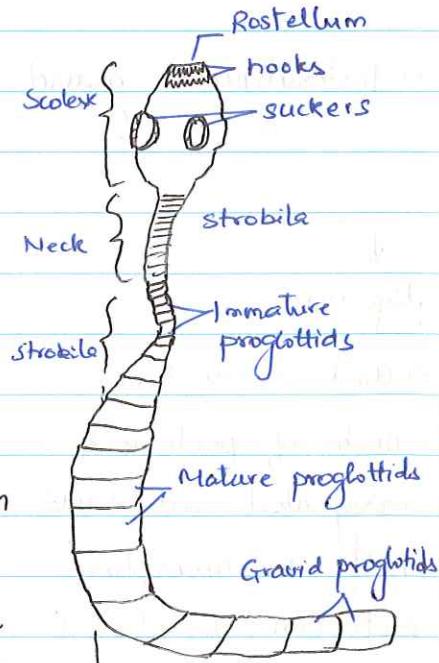
### chronic liver rot

- ⇒ by slow and successive entry of cercaria
- ⇒ anaemia & weight loss
- ⇒ watery swelling in jaws
- ⇒ death in few months.

Liverfluke in man can cause anaemia, occlusion of bile passages, body pain, cough & dysentery

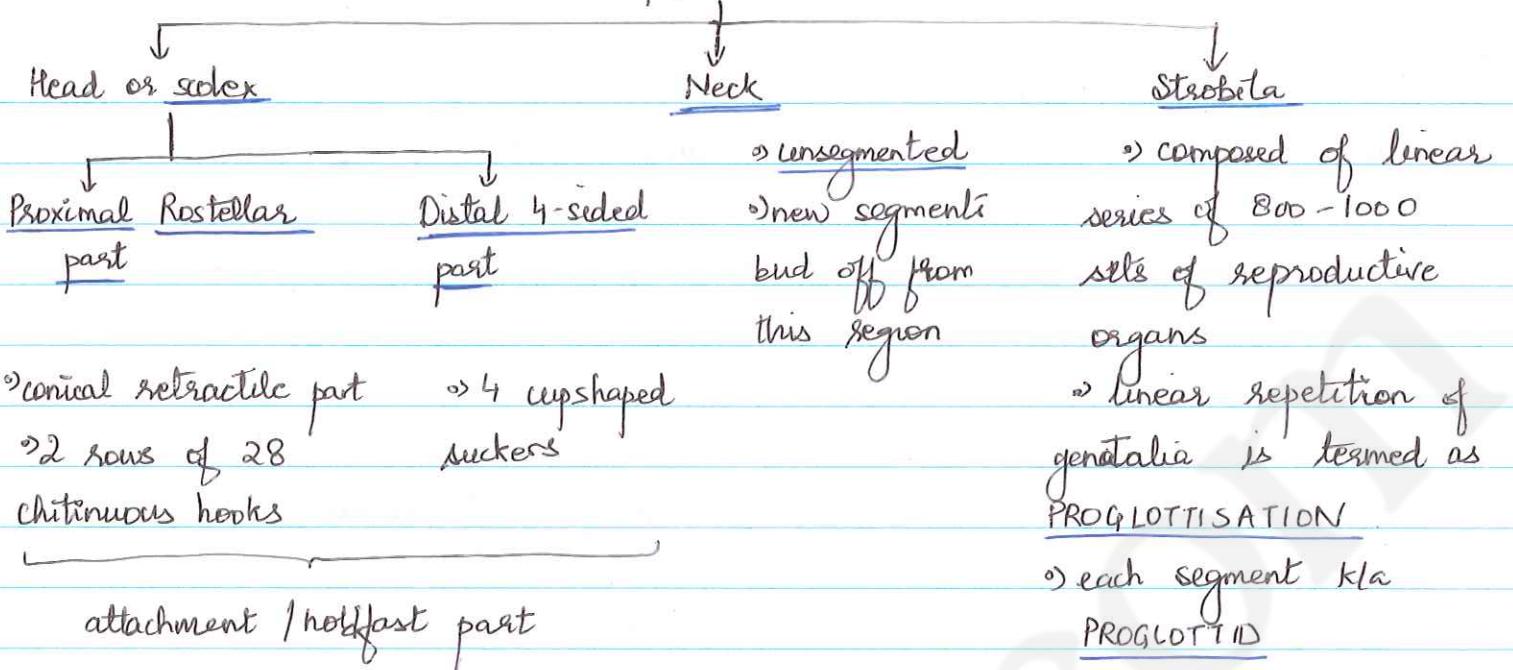
## TAENIA

- ⇒ Taenia solium is intestinal parasite of man
- ⇒ Class Cestoda, digenetic life cycle
  - man
  - pig

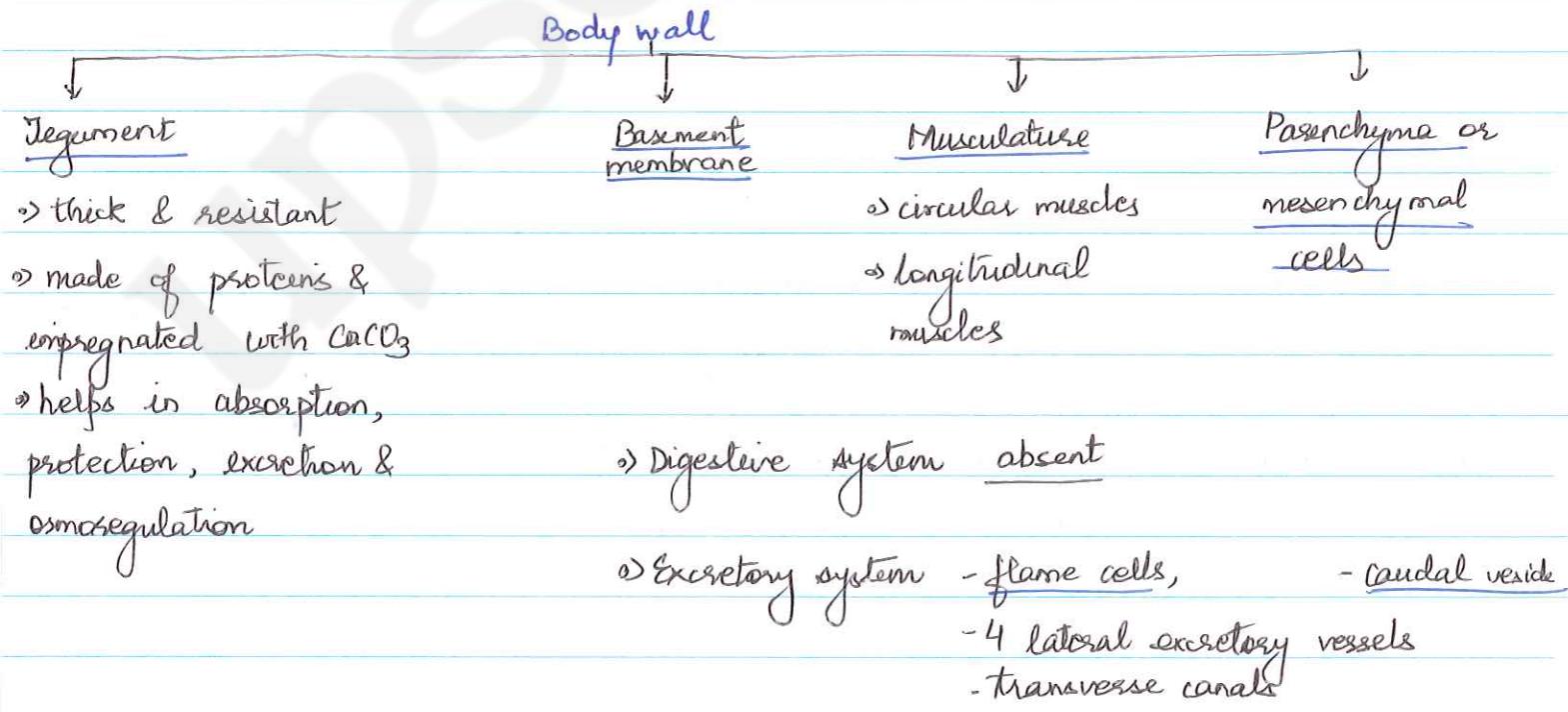


### Morphological features :-

- ⇒ elongated body, dorsoventrally flattened, ribbon like
- ⇒ linear series of almost similar segments
- ⇒ opaque white body but may be grey, yellow or cream
- ⇒ Body divided into head/scolex, neck and body/strobila
- ⇒ May attain a length of 3-5 m.



- Immature proglottids
- newly formed & undifferentiated
  - first 200
  - reproductive organs absent or underdeveloped
- Mature or reproductive proglottid
- next 400-600
  - sexually mature
- Gravid or ripe proglottids
- last 200
  - filled with developing embryos
- Posteriormost gravid proglottids detach & expelled with faeces - apolyse.



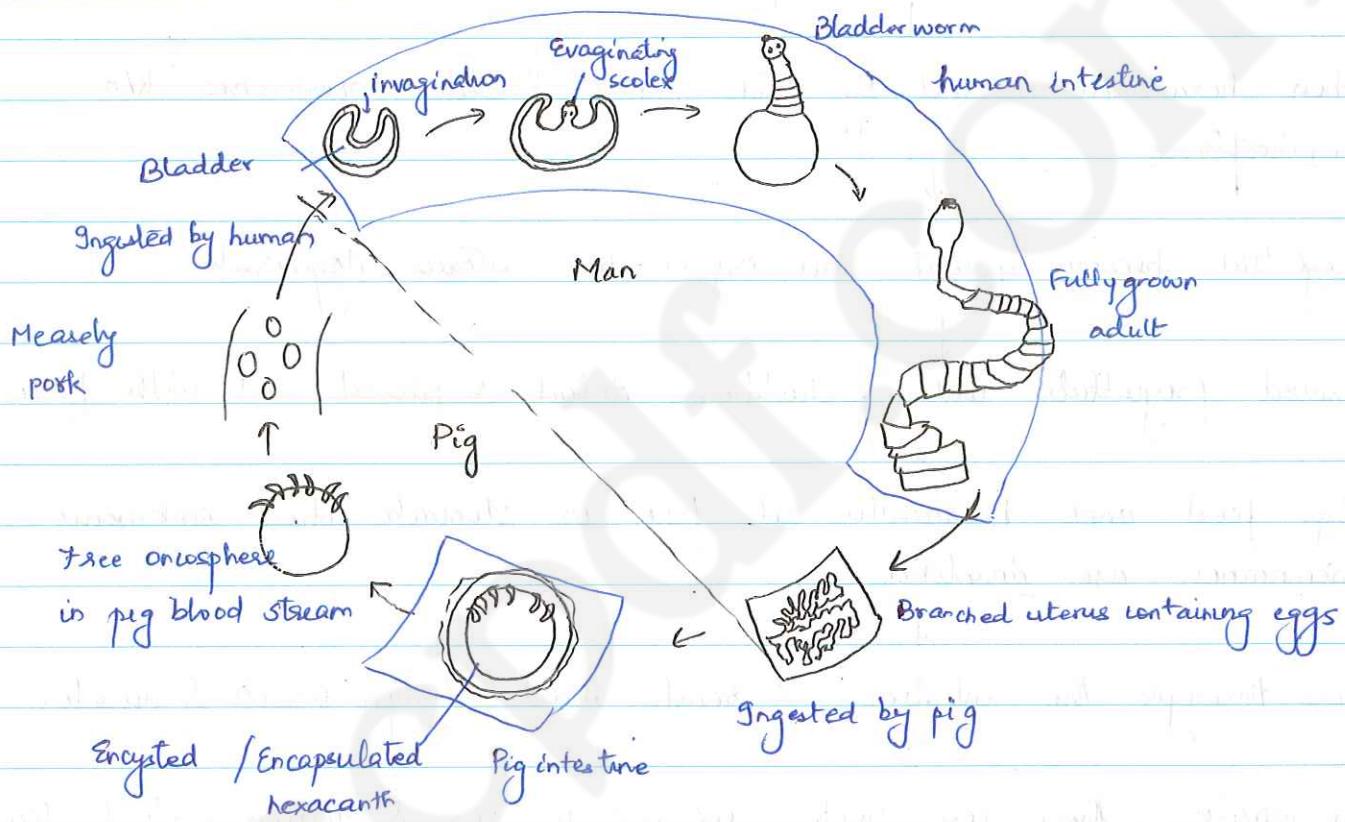
## ♂ reproductive system

- testes
- vasa efferentia
- vasa deferens
- vesicula and cæcum sac

## ♀ reproductive system

- ovaries
- oviduct
- ectotype
- uterus
- vagina
- Mehl's gland
- Vitelline gland
- Seminal receptacle

## LIFE HISTORY OF TAENIA



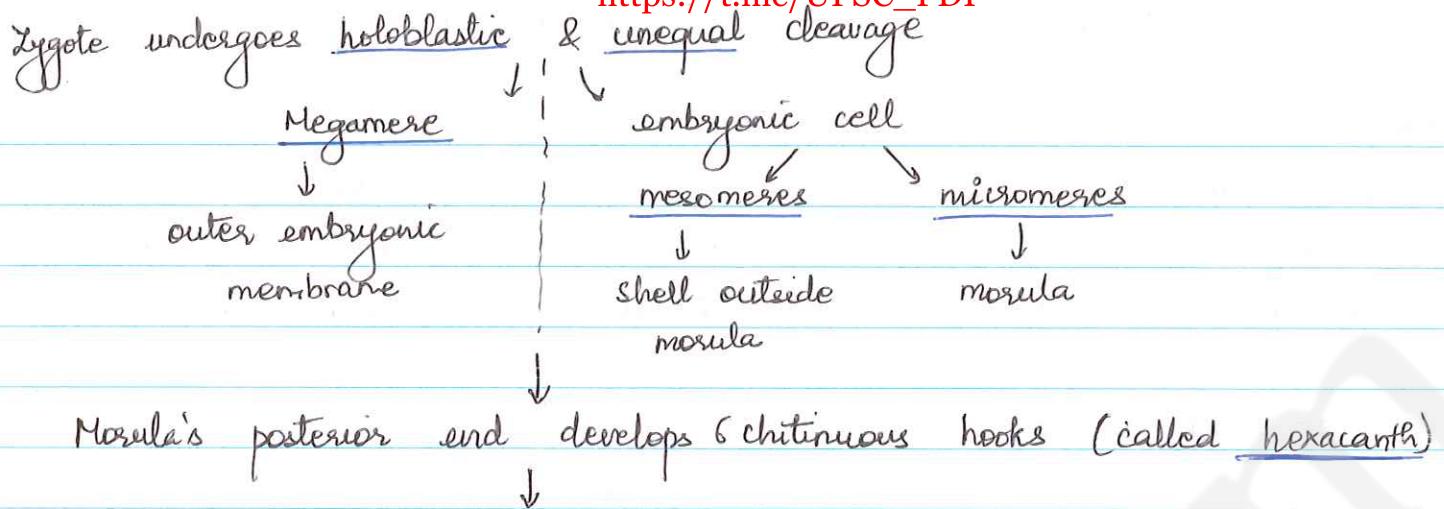
Digenetic organism but self fertilisation occurs as a rule

↓  
Cursors of the same segment inserted into the vagina of same segment

↓  
Sperms stored in seminal receptacle

↓  
In ectotype, zygote associated with a large yolk cell or vitelline cell and enclosed in a chorionic membrane

↓  
Capsulated eggs collected in uterus and undergo further development



When hexacanth covered by thick inner & outer membranes k/a oncosphere

Proglottid become gravid & all organs but uterus degenerate

Gravid proglottids with oncospheres detach & passed out with faeces

Pigs feed and hexacanthe set free in stomach where embryonic membranes are dissolved

Move through the intestine & reach heart, lymph vessels & muscles

In muscles, they lose hooks, increase in size & develop central fluid filled space called bladder

Invagination occurs and a proscotlex evaginates

hooks & suckers exposed to the exterior k/a cysticercus larva

Forms measly dots in pork and infect man when eaten

Cysticerci take firm hold in intestine, bladder thrown off & budding of proglottids starts

## PARASITIC ADAPTATIONS IN TAENIA

### A. MORPHOLOGICAL ADAPTATIONS

1. Flattened or ribbon like body wall
2. Anterior end of scolex has suckers & hooks for holdfast
3. Animal grows throughout life
4. Large no. of hermaphrodite segments

### B. ANATOMICAL MODIFICATIONS

1. Thick and resistant cuticle made of insoluble proteins to protect against action of host's digestive juices
2. Absence of alimentary canal as pre digested food available
3. excretory system developed & performs osmoregulation
4. Anaerobic Respiration
5. Sense organs absent except tangoreceptors
6. Degraded nervous system except region of attachment
7. Large no. of reproductive proglottids
8. Self fertilisation and highly branched ovary to produce large no. of eggs

### C. PHYSIOLOGICAL ADAPTATIONS

1. Adapted to take liquid food
2. Maintains osmotic pressure
3. Energy obtained by anaerobic glycolysis
4. Secretes antienzymes against host's digestive enzymes to protect
5. Stimulates host's gut to secrete mucus that forms a protective layer around it

### D. LIFE CYCLE CHANGES

1. Hermaphrodite & self fertilisation
2. Enormous fertility with each proglottid producing 30000-40000 eggs
3. Digenetic life cycle for dispersal

## PATHOLOGICAL SYMPTOMS

a. Taeniasis :- pain in abdomen, anaemia, giddiness, obstruction to passage of food, vomiting, indigestion, eosinophilia

b. Cysticercosis :- caused by infection through oncospheres

- scolex causes injury to intestine causing reverse peristalsis

↓  
gravid proglottids pushed into the stomach - retroinfection / autoinfection

↓

infection of non-pork eaters through water - heteroinfection

↓

reach voluntary muscles and form cysticercosis larvae

↓  
form cysts in heart, brain, eye, muscles, liver

Necrosis of brain & disintegration of living cells

↓

Epilepsy, convulsions, giddiness, local paralysis, headache

## NEMATODA

- ⇒ non segmented, triploblastic, roundworms / pinworms or threadworms
- ⇒ largest phylum of pseudocoelomate groups
- ⇒ free living → marine or freshwater & microscopic ; terrestrial
- ⇒ parasitic → much larger
- ⇒ locomotory cilia absent ; gastrodermis has ciliated cells
- ⇒ pseudocoelom not lined by peritoneum ; pseudocoelomic fluid helps in circulation and acts as hydrostatic skeleton
- ⇒ complicated digestive system . Digestion intra - & extra-cellular
- ⇒ Sense organs include papillae, amphids & phasmids

### Amphids (Anterior)

mechano-sensory / chemo-sensory

### Phasmids (Posterior)

chemosensory / excretory / Secretory

- ⇒ Unisexual with internal fertilization
- ⇒ Show - Eutely - cell division (except in gonads) ends near the end of embryonic development .
- Adult has constant no. of cells and grows by increase in cell size

## Nematoda

### Aphasmida

- ⇒ free living
- ⇒ amphids occur in various shapes
- ⇒ phasmids are absent
- ⇒ no excretory system
- ⇒ mesenterial tissue well developed
- ⇒ possess caudal adhesive glands

eg. Fishinella Desmoscolex

### Phasmida

- ⇒ Mostly parasitic
- ⇒ Both phasmids & amphids
- ⇒ Amphids pose like
- ⇒ Excretory system well-developed
- ⇒ Poorly developed mesenterial tissue
- ⇒ no caudal adhesive glands

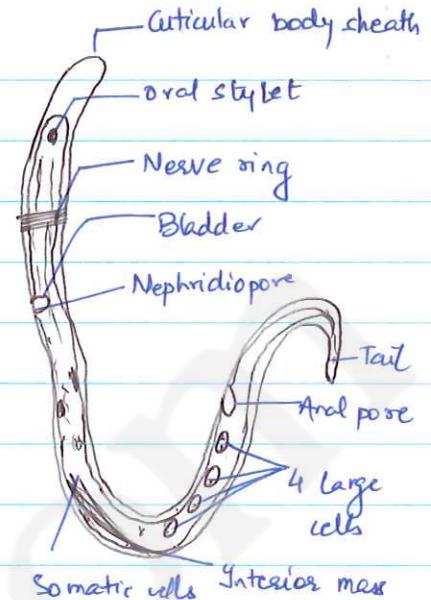
eg. Ascaris, Wuchereria

## WUCHERERIA

- » Wuchereria bancrofti commonly known as filarial worm
- » endoparasitic nematode in lymph vessels & nodes in man
- » usually in tropical regions but cosmopolitan
- » digenetic life cycle

1<sup>st</sup> host  
man

→ 2<sup>nd</sup> host  
Anopheles / Culicx / Aedes  
mosquito



- » Adults are unisexual & dioecious (sexual dimorphism)

### Microfilariae

- » Filiform worms with tapering ends

- » Creamish white, smooth, semitransparent body

- » Locomotory organs absent

♂

- shorter
- sharply curved posterior end
- contains copulatory spicules, caudal alae & genital papillae
- Genital pore at posterior end

♀

- longer
- straight & blunt posterior
- Absent

- Genital pore in pharyngeal region

- » Microfilariae are microscopic and surrounded by a delicate cuticular sheath

- » contains rudiments of adult organs / structures

- » Body wall formed of single epithelial layer

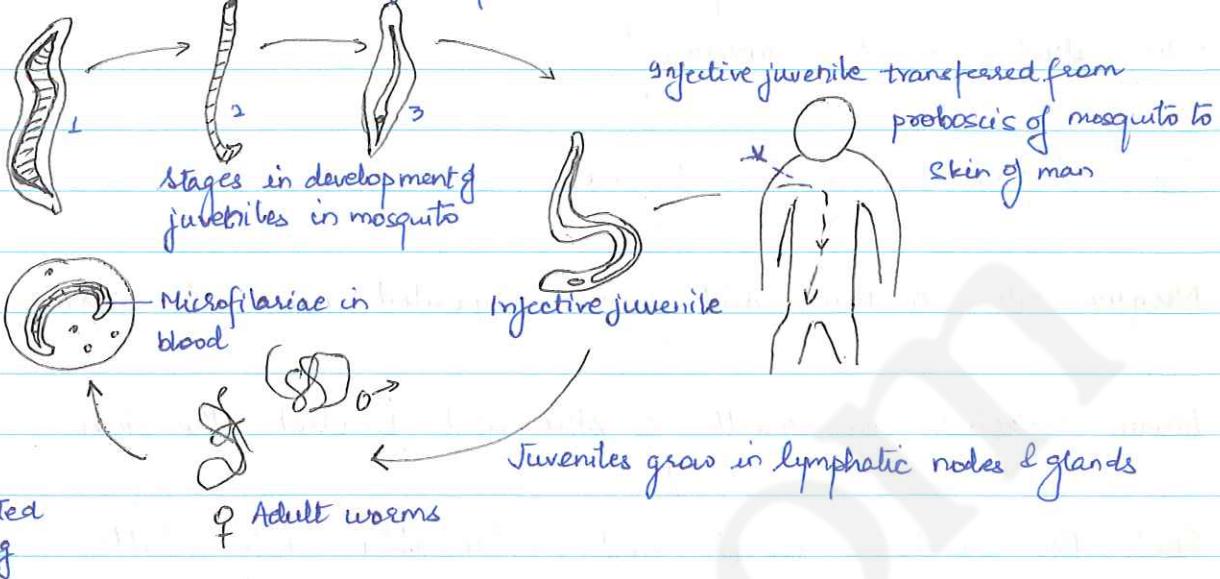
- » Rudiments of below structures available:-

- 1) Future mouth or oral stylet
- 2) Nerve ring band
- 3) Nephridiopore & bladder
- 4) Inner cell mass

- 5) Reticular cell (excretory organs)
- 6) 4 large cells
- 7) Anal pore

- » Filarial worm is viviparous or ovoviparous.

Mosquito sucks microfilariae from cutaneous capillary of man



Copulation occurs when both sexually mature ♂ & ♀ present in same lymphatic gland

Numerous juveniles called microfilariae released through oviparity or ooviparity

Microfilariae discharged into lymph vessels

Enter blood vessels and swim with active movements

In blood, microfilariae show diurnal rhythm. During day time, reside in deep seated thoracic blood vessels but migrate to superficial peripheral blood vessels at night.

Sucked by ♀ Culex or Aedes mosquito

Inside mosquito stomach, sheath is lost and microfilariae penetrate the stomach wall & migrate to the thoracic muscles or wings

Undergo 2 moults in 10 days to reach third stage larvae or infective juvenile stage

[First to plump sausage shaped larva → then an elongated larva & finally a long slender infective juvenile]



Infective juvenile migrates to mosquito labium



Mosquito bites a man and larvae deposited near skin through proboscis



Larvae attracted by warmth of skin and penetrate the skin



Reach the lymphatic vessels and metamorphose into adults



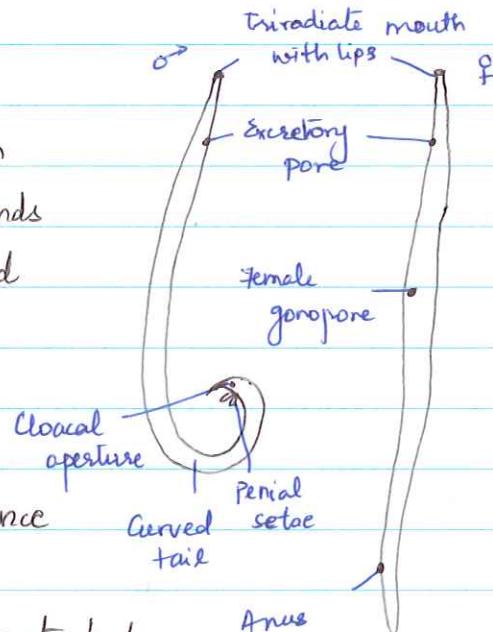
Become sexually mature in 5-18 months and start a new generation of microfilariae

### Pathogenic symptoms :-

- Obstruct lymph vessels and cause deposition of metabolites
- Initiate proliferation of endothelial cells and lead to inflammatory thickening
- Periodic fever attacks
- Tumour like solid growth called elephantiasis.

### ASCARIS

- Ascaris lumbricoides aka roundworm
- gastro-intestinal parasite in man & cosmopolitan
- elongated cylindrical body tapering at both ends
- anterior end more slender than posterior end
- unisexual
- dioecious with sexual dimorphism
- body covered with cuticle with minute striations to impart pseudo-segmented appearance

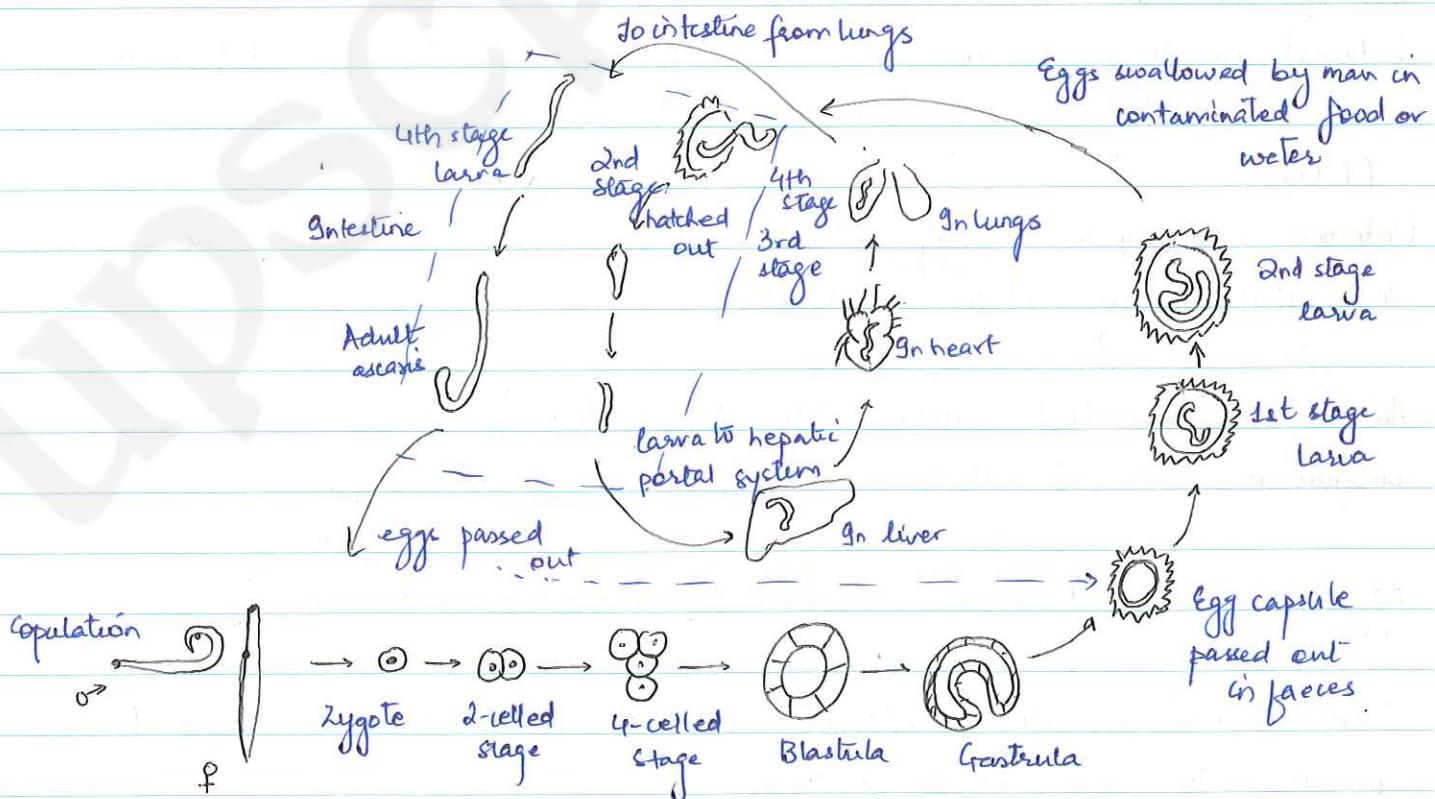


- light yellow to light pink with semi-transparent body
- along entire body length, 4 longitudinal streaks

mid dorsal      mid ventral      2 lateral

- triradiate mouth guarded by 3 broad lips or labia (absent in Wuchereria)
- ♂
- cloaca at the posterior end
- common aperture for digestion & genital tubes
- chitinous spicules called pineal setae
- genital papillae for copulation
- anus at posterior end guarded by lips
- genital pore (gonopore/vagina)
- vagina receives sperm from chitinous spicules k/a pineal setae
- Body wall made up of thick, transparent cuticle which is permeable to salts & products of metabolism
- Cuticle secretes anti-enzymes to neutralize host's digestive enzymes.
- Only one layer of longitudinal muscles only
- ⇒ Body cavity k/a pseudocoelom because :-

  - not lined by coelomic epithelium or peritoneum
  - no relation to excretory & reproductive organs
  - developed from blastocoel



Copulation takes place inside man's small intestine. Penial setae open the vallva & transfer sperms to vagina

Sperms reach the proximal end of uterus and fertilization occurs

Glycogen of the egg migrates to the surface & forms a chitinous shell.  
Fat globules form a thin lipid layer below the shell

Uterine wall secretes a hard waxy coat on the elliptical egg

Determinate and apical cleavage occurs

16 celled blastula with cavity called blastocoel

Gastrulation leads to formation of gastrula

Grows in size to form an active juvenile with an alimentary canal, nerve ring & larval excretory system

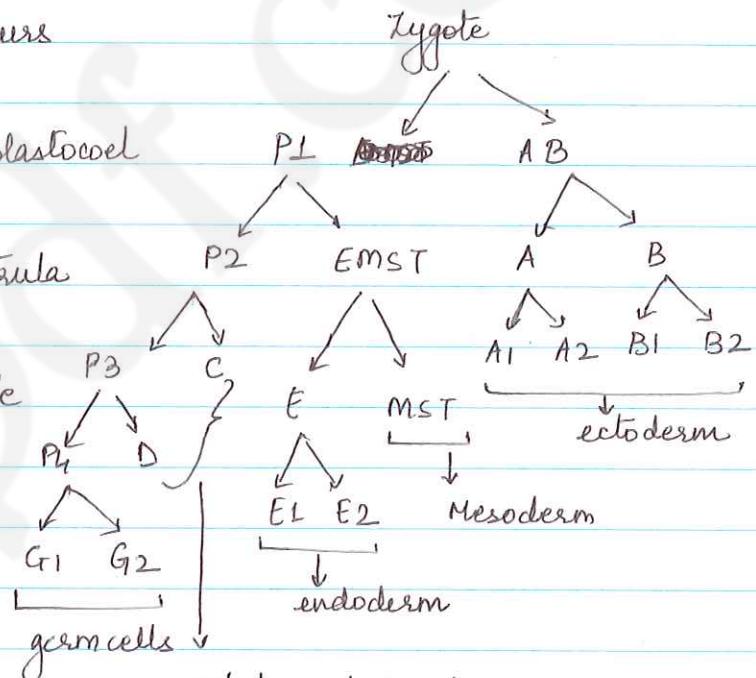
(Rhabditiform larva)

Undergoes moulting within egg to form 2nd stage larva which is infective

As no secondary host, humans infected due to ingestion of eggs through contaminated food & water

egg shell dissolved and 2nd stage larva hatches out

Bore through intestinal epithelium through active thrashing movement & migrates to liver, heart & lungs



Remain in lungs for few days and grows in size

Ruptures through capillaries to reach alveoli and undergoes moulting to form 3rd stage

Undergoes moulting to form 4th stage larva

Migrates to pharynx and enters the gut when coughed or swallowed back

Undergoes final moulting to become adult & matures in 8-10 weeks

### Parasitic Adaptations :-

- 1) Thick & resistant cuticle with anti digestive enzymes secreted to counter host's enzymes
- 2) Locomotory organs to counter peristaltic movements
- 3) Anaerobic respiration & low metabolic rate
- 4) Very simple alimentary canal with muscular pharynx for oesophageal function
- 5) No circulatory system (absorption, distribution & transport through pseudocoelomic fluid)
- 6) Absence of sensory organs and nervous system poorly developed
- 7) Highly fertile ; a ♀ lays ~27 mn eggs a day
- 8) Eggs / Egg shells covered in thick protective membranes

### Pathological Symptoms :-

- 1) Disease k/a ascariasis through contaminated food & water
- 2) Larvae can cause haemorrhages
- 3) Fever, eosinophilia, leucocytosis, anaemia
- 4) Adult causes enteritis and cause inflammation of gall bladder, bile duct or appendix
- 5) Can cause desitation of intestinal mucous membrane to produce convulsions, delirium, coma & nervousness
- 6) Interferes with protein digestion & causes protein deficiency
- 7) Stunted growth in children

## ANNELIDA

- Includes earthworms, leeches, blitter worms
- Triploblastic, bilaterally symmetrical, schizocoelomates
- Protostomes and exhibit metameric segmentation
- Cephalization is more pronounced with distinct head bearing eyes, tentacles, etc.
- Homonomous segmentation i.e. body is divided into linear series of similar segments separated externally by intersegmental grooves & internally by intersegmental septa

- Body divided into 3 regions
  - Prostomium
  - Trunk
  - Pygidium
- Trunk consists of longitudinal series of similar segments.
- Growth due to addition of new segments from telo blastic growth zone located in front of pygidium
- Body wall consists of fibrous collagenous cuticle, epidermis, dermis, musculature and peritoneum
- Chitinous bristles project out from epidermis - called setae
- Each segment has a pair of schizocoelous body cavities separated by dorsal & ventral mesenteries.
- Coelomic fluid acts as hydrostatic skeleton
- Alimentary canal straight muscular type with digestive glands
- Exchange of respiratory gases through ~~the~~ skin or gills (modified parapodia in some polychaetes)
- Closed type blood vascular system
- Excretory organs are segmentally arranged metanephridia. They open into coelom by nephrostome exterior by nephridiopore
- Nervous system consists of circum pharyngeal nerve ring and a ganglionated double ventral nerve cord

↓  
Polychaeta

↓  
Oligochaeta

↓  
Hirudinea

↓  
Archianellida

Class Polychaeta :- (many hair)

- ⇒ Commonly k/a bristle worms
  - ⇒ Chiefly marine some fresh water
  - ⇒ External & internal segmentation
  - ⇒ Distinct head with palps, eyes & tentacles
  - ⇒ Numerous setae on lateral parapodia
  - ⇒ Bundled setae
  - ⇒ Clitellum absent
  - ⇒ Sexes separate
  - ⇒ Gonads in most segments.
  - ⇒ Gonads absent in some species
  - ⇒ Gametes shed into coelom & spawn through metanephridia
  - ⇒ External fertilization
  - ⇒ Trochophore larva
- eg. *Nereis*

Class Hirudinea :- (leeches)

- ⇒ Mostly freshwater
- ⇒ Blood sucking ectoparasites / carnivorous
- ⇒ Fixed no. of segments = 33
- ⇒ Segments externally divided into ANNULI
- ⇒ No appendages, parapodia or setae
- ⇒ Both ends have suckers (locomotory)
- ⇒ Coelom reduced due to nutrient storing botryoidal tissue
- ⇒ Gonads confined to few segments
- ⇒ Internal fertilization, direct within coelom
- ⇒ eg *Hirudinaria*

Class Oligochaeta :- (few hair)

- ⇒ Includes earthworms and some marine & freshwater forms
  - ⇒ External & internal segmentation
  - ⇒ No appendages or parapodia
  - ⇒ Head without appendages
  - ⇒ Few setae imbedded in skin
  - ⇒ Clitellum develops on sexual maturity
  - ⇒ Glandular clitellum for cocoon formation
  - ⇒ Hermaprodites with testes anterior to ovaries
  - ⇒ Gonads confined to few segments
  - ⇒ External & direct fertilization
  - ⇒ Gonoducts present
- eg. *Pheretima*

Class Archianellida :-

- ⇒ small marine worms
  - ⇒ segmentation chiefly internal
  - ⇒ No parapodia or setae
  - ⇒ Sexes usually separate
  - ⇒ Development includes trochophore larva
- eg. *Dipophilus*

## Metamerism

- ⇒ METAMERISM is the condition when general segmentation of bilateral animals involves longitudinal division of the body into linear segments / sections.
- ⇒ Each segment k/a as metamere or somite or segment
- ⇒ Each segment has repeats of some or all units of organs
- ⇒ Metamerism need only when organs of mesodermal origin are so arranged.
- ⇒ Primary segmented divisions are body wall musculature and coelom. This in turn imposes a corresponding metamerism on associated systems
- ⇒ Longitudinal structures like gut, main blood vessels and nerves extend through the entire body length
- ⇒ Gonads repeated in all or few segments.

## Types of metamerism

### 1. EXTERNAL & INTERNAL METAMERISM

- ⇒ In most Annelids, metamerism conspicuous both externally & internally
- ⇒ Eg. Pheretima posthuma numerous repeated body segments  
Coelom segmentally divided into compartments by intersegmental transverse membranes called septa  
Only digestive tract extends through every segment unsegmented.
- ⇒ In Arthropods, metamerism chiefly external
- ⇒ Humans & vertebrates show internal metamerism of nerves, blood vessels

### 2. COMPLETE & INCOMPLETE METAMERISM

- ⇒ Complete metamerism affects all body systems
- ⇒ In this segmentation, metameres are homonomous and each metamere has segmental blood vessels, nerve cells, coelomoducts & nephridia
- ⇒ eg. homonomous metamerism in Annelida
- ⇒ Metamerism in Arthropods and other higher animals is incomplete because of

division of labour.

- Metameres of different regions of the body vary considerably k/a heteronomous metamorphism
- Larval & embryonic stages of Arthropods and other vertebrates show complete metamorphism

### 3. TRUE & PSEUDOMETAMERISM

- True segments in Annelids developed during embryonic development
- Pseudo metameric in tapeworms are superficial and due to strobilation
- Proglottids are not true segments rather complete reproductive individuals

#### True metamorphism

- No. of segments constant for each species. No new segments added except in asexual reproduction

Growth by elongation of pre-existing segments

- All segments of same age & at same stage of development
- All segments integrated & are functionally dependant on each other
- Help in individuality of the organism & locomotion

#### Pseudo metamorphism

- No. of segments grows throughout life by addition

Growth by addition of segments

- Proglottids vary from one another in age & degree of development
- Proglottids independent & self contained

Each proglottid a self sufficient reproductive unit

### THEORIES OF ORIGIN

#### 1. Pseudometamerism Theory :-

- Proposed by Hymen & Goodrich
- Explains pseudometamerism that occurs in Cestodes like Tapeworms
- Acc. to this theory, metameres initially developed secondarily as a result of repetition of body parts like blood vessels, coelom, nervous, etc.

- Later, a segmented condition arose due to formation of cross striations / partitions so that each segment receives a part of each system.
- This process of formation of cross partitions after basic segmentation is seen in Annelids during development of somites in larval & adult stages.
- Acc to this theory, pseudo segmentation is an adaptation for undulating movement.

## 2. Fission Theory :-

- Proposed by Perrier
- Acc to this theory, metamerism resulted when some non-segmented ancestors divided repeatedly by transverse fission or asexual budding to produce a chain of individuals.
- Later these subindividuals integrated morphologically & physiologically into one complex individual.
- Thus, a segmented animal is a chain of completely coordinated sub-individuals.
- Such process occurs in Annelids & Platyhelminthes.

## 3. Cyclomerism Theory :-

- Proposed by Sedgwick
- Acc to this theory, metamerism in chordates evolved for better arrangement of organs in coelom.
- This theory assumes that coelom originated in some ancestral radiate actinozoan coelenterates through separation of four gastric pouches from the central digestive cavity.
- Initial division of two pouches resulted in 3 pairs of coelomic cavity namely protocoel, mesocoel & metacoel.
- Later, loss of protocoel & mesocoel led to unsegmented coelomates like molluscs.
- Subdivision of metacoel produced primary segments leading to development of segmented Annelids.
- This theory is based on phylogenetic assumption that all bilateral

metazoans were originally segmented & coelomate & those acelomate unsegmented groups like Platyhelminthes lost these characters later.

#### 4. Locomotory Theory :-

- Proposed by Clark
- This theory proposes that metamorphism evolved as an adaptation to locomotion of different kinds
- It evolved independently in chordates for locomotion which was previously carried out by undulation of body in primitive aquatic invertebrates
- Annelid metamorphism probably evolved for burrowing
- Metamorphism allowed myotomes or muscle bundles and nerves to be arranged segmentally for better coordination of undulatory body movement

#### Significance :-

1. Provides effective locomotion through coordination of segments
2. Fluid filled coelomic compartments provide hydrostatic skeleton through differential turgor pressure
3. Allows division of labour eg. clitellum

#### MODES OF LIFE OF POLYCHAETES

- Polychaeta is the largest class of Phylum Annelida
- Shows adaptive diversity

#### Acc. to habitat :-

##### 1. Crawling polychaetes

- Marine, freely moving animals that crawl on sea bottom
- Head bears sense organs such as eyes, tentacles, antenna, cilia & palps
- Locomotory organs or parapodia are large and with setae
- Parapodia can be retracted & protruded in various directions for crawling among rocks & stones
- Sense organs on prostomium & peristomium are well developed

- ⇒ Body segments generally similar  
eg. Nereis, Glyceria

## 2. Pelagic polychaetes

- ⇒ Aka planktonic polychaetes
- ⇒ Adapted to live in open sea & semitransparent in appearance
- ⇒ Swim near sea surface where dangers of predators & solar radiation is excessive
- ⇒ Semitransparent body imparts near invisibility
- ⇒ Some have large eyes while some have none
- ⇒ Parapodia are small & locomotion by lateral undulation of body
- ⇒ Large cilia that carry taste receptors to locate food.
- eg. Vanadis, Tomopteris

## 3. Burrowing Polychaetes

- ⇒ Adapted for burrowing in sand
- ⇒ Body elongated; prostomium reduced or absent
- ⇒ Eyes, tentacles and palps are absent
- ⇒ Parapodia reduced
- ⇒ Move through the substratum through peristaltic movement
- ⇒ Well developed circular muscles for assisting in locomotion
- ⇒ Effective septa compartment for division of coelomic fluid that acts as hydrostatic skeleton
- ⇒ Setae help to anchor against burrow wall
- ⇒ Spend most of the time inside burrows & come out only for catching prey
- eg. Arenicola, Glyceria

## 4. Tubicolous Polychaetes

- ⇒ Live in temporary or permanent self secreted tubes
- ⇒ Tubes act as protective covering
- ⇒ Further divided as follows on basis of tube types

(a) Mucus lined burrows :-

- ⇒ some polychaetes make mucus-lined burrows in sand & mud
  - ⇒ have well developed prostomium, sense organs & parapodia
  - ⇒ carnivorous & extend out from tube opening to catch prey
- eg. *Eunice*

(b) Shell & sand grained tubes :-

- ⇒ usually straight tubes built vertically in sand & mud
  - ⇒ composed of sand grains & shell cemented together with mucus
- eg. *Diopatra*

(c) Parchment tubes :-

- ⇒ membranous u-shaped tubes
  - ⇒ sometimes covered by sand grains & shells
- eg. *Chactoplerus*

(d) Calcareous tubes :-

- ⇒ tubes made up of calcium
- ⇒ two large glands under collar folds secrete  $\text{CaCO}_3$
- ⇒ eg. *Serpula*

Acc. to mode of nutrition

1. Raptorial feeders

- ⇒ aka carnivorous feeders
  - ⇒ include crawling, burrowing & tubicolous (most) & all pelagic polychaetes
  - ⇒ feed on small invertebrates
  - ⇒ capture the food by an versible pharynx or proboscis
- eg. *Nereis*

2. Detritus feeders

- ⇒ usually sedentary polychaetes

→ feed on sea bottom or dead organic matter

(a) Direct deposit feeders :-

- directly swallow mud & sand as they burrow through it
- organic matter is digested and sand egested as castings
- include burrowing & tube-dwelling species

(b) Indirect deposit feeders :-

- lack proboscis
- have highly extensive ciliated grooved tentacles secreting mucus
- small food particles moving down the groove accumulate at the base of tentacles and are moved inside by wiping tentacles on the lips
- use palps to collect suspended detritus
- etc

3. Filter feeders

- do not have a proboscis
- head provided with long bipinnate filaments called radicles with a ciliated groove running along the oral surface
- Radicles used in food collection

e.g. *Chaetopterus* lives in U-shaped parchment tube has fans on some segments.

The beating of fans produces water current which enters the tube from anterior end and flows out of posterior end

Food particles are filtered out in a mucous bag which ends in a ciliated cup.

Food is rolled in a ball & passed forward to the mouth along the ularian groove

e.g. *Arenicola* sucks through the proboscis to form a funnel shaped depression at the tube mouth. Sand with food percolates through funnel

## NEREIS

⇒ Nereis is a carnivorous (raptorial) polychaete

⇒ Marine & bottom dwelling

⇒ While living in V shaped tubes, may show filter feeding

⇒ Each trunk segment except prostomium, body somite peristomium & pygidium carries a pair of dorsoventrally flattened parapodia

⇒ Parapodial cavity continuous with body coelom

⇒ Bisegmental parapodia

Basal part

2 lobes

Notopodium

Neuropodium

Prostomium

Peristomium

Prostomial palp

Peristomial cilia

Parapodia

Atoke

Epitoke

Oar like parapodial setae

Anal cirri

⇒ 2 tentacular processes, one on each lobe of a parapodium

⇒ Bundle of setae fans out from each parapodium

⇒ Setae are fine, stiff and chitinous bristles that help in locomotion

⇒ Alimentary canal is straight tube suspended in body cavity by dorsal mesentery & intersegmental septa

Foregut (Stomodaeum)

- buccal cavity
- pharynx
- lined by ectoderm & cuticle

Midgut (Mesenteron)

- oesophagus
- stomach
- lined by endoderm

Hindgut (Proctodaeum)

- rectum
- lined by ectoderm & cuticle

⇒ Mouth lies ventral to prostomium & bordered by peristomium

⇒ Anterior part of buccopharyngeal cavity forms an evesible proboscis

⇒ The cuticular lining is thickened to form denticles

- ⇒ Posterior part of pharynx has a pair of large, chitinous, movable jaws
- ⇒ Oesophagus occupies 5 segments behind the pharynx.
- ⇒ Pair of long unbranched glandular oesophageal caecae.
- ⇒ Feeds mainly on clams so called clam worm.
- ⇒ Food is tested by tactile prostomial palps and peristomial cilli
- ⇒ Blood is red and consists of a fluid plasma & numerous amoeboid, nucleated & colorless corpuscles.
- ⇒ Haemoglobin remains dissolved in plasma.
- ⇒ 3 main blood vessels
  - dorsal vessel (from posterior to anterior end)
  - ventral vessel (from anterior to posterior end)
  - neural vessel
- ⇒ Respiratory system lacking and exchange of gases takes place through general body surface.
- ⇒ Excretory organs include a series of paired segmentally arranged coiled tubes having ciliated lumen - called nephridia
- ⇒ Present in each body somite except first few anterior & posterior segments
- ⇒ Receptor organs:
  - pair of prostomial tentacles - tactile function
  - pair of " palps - tactile
  - pair of nuchal organs - chemoreceptors
  - 4 pairs of peristomial cilli - tactile
  - 2 pairs of eyes .
- ⇒ Sexes are separate. Species that show heterogenetic phase may show slight sexual dimorphism
- ⇒ Gonads are temporary and develop during reproductive season as mass of reproductive cells from coelomic epithelium

- Gonoducts are absent and gonads release genital products either through nephridia or temporary rupture of body wall.
- Fertilisation is external.

Asexual *Nereis* please



Changes to sexual Heteronereis post maturation

posterior part filled with gametes called epitoke

anterior non sexual part without gametes atoke

phenomenon  
EPITOKY



Releases gametes & external fertilisation occurs



Undergo spiral & determinate cleavage



Unequal size cells called stomatoblasts are produced

megameres

and embryo at this stage is k/a stereoblastula

micromeres



Epibolic gastrulation by spreading of micromeres over endoderm & somatoblasts



Trochophore larva hatches



converts to adult *Nereis*

#### TROCHOPHORE LARVA

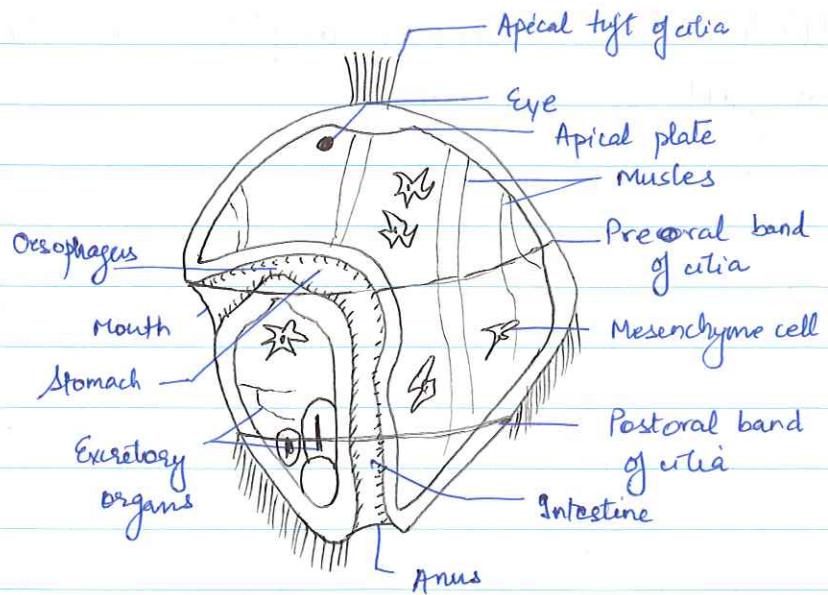
- Top of presumptive head differentiates into apical plate



differentiates into cerebral ganglia and a tuft of cilia



Tuft of cilia behind apical plate - prototroch



- Trochophore is minute, transparent, unsegmented pear shaped larva
- Bound by thick ectoderm
- Preoral band just in front of mouth - prototroch
- Postoral band - metatroch
- Larva lacks coelom but possesses a spacious blastocoel b/w alimentary canal & ectoderm
- A pair of protonephridia & muscles are found.
- Free swimming trochophore occurs in only a few polychaetes. In Nereis it is passed inside the egg membrane
- Larva hatches out in sea water by rupturing egg's vitelline membrane. It is k/a posttrochophore or neotrochae
- During metamorphosis, ciliated bands disappear & preoral part forms the prostomium of adult. Postoral part constricts into segments & elongates which develop parapodia & bristles.  
↓

First segment forms prostomium & last pygidium .  
↓

Ciliated bands disappear completely and ~~body~~ <sup>adult</sup> grows by adding few segments in front of pygidium