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 ancestory
(iv) adaptations can be studied
(v) easy to study diversity of animals through a representative sample

Outline :-

⇒ Body plan or body structure mode of classification

1) Based on no. of primary germ layers in embryo
   - → Diploblastic
   - → Triploblastic

2) Based on division of labour
   - → cellular grade
   - → tissue grade
   - → organ / organ system grade

3) Based on body cavity
   - → Acoelomate
   - → Pseudocoelomate
   - → Coelomate

4) Based on body symmetry
   - → Bilateria
   - → Radiata

(Inclusive)
↑
Kingdom
Phylum
Class
Order
Family
Genus
Species
↓
Subspecies
Clines
↓
Demes
(Exclusive)

5) Based on fate of blastopore → Protostomes / Deuterostomes

6) Based on gut / digestive tract → Intracellular digestion / Extracellular digestion

7) Based on circulation of blood → Open Type / Closed Type

Major & Minor Phyla

- Invertebrate phyla divided into → major phyla / minor phyla

- Division based on 2 factors :-
  (a) No. of species or individuals in the phyla
  (b) Participation in ecological communities

Based on no. of species, 11 major phyla

Protozoa
Porifera
Coelenterata / Cnidaria
Platyhelminthes
Rotifera
Nemathelminthes / Nematoda
Annelida
Mollusca
Arthropoda
Echinodermata
Ectoprocta

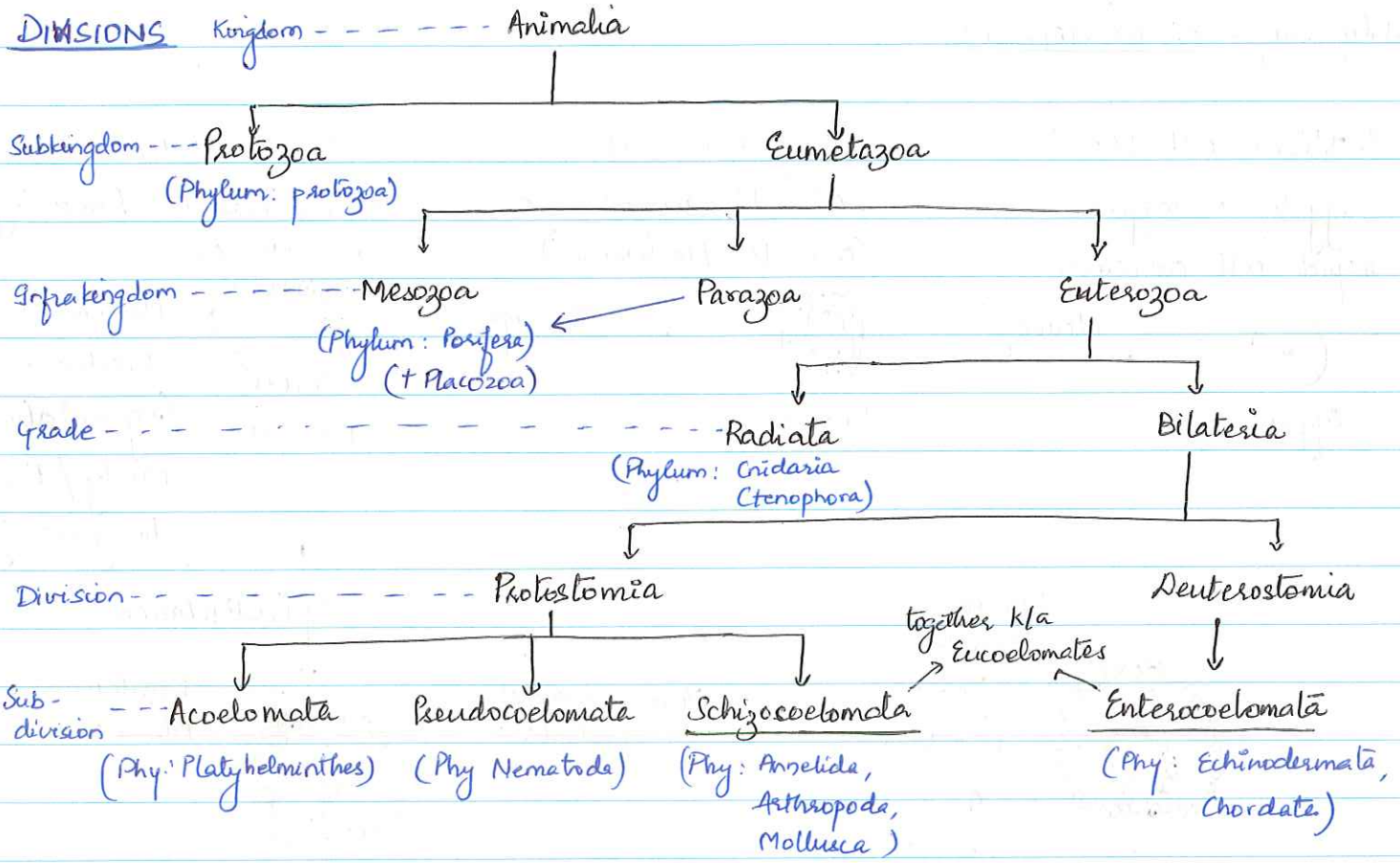
Limited participation in ecological communities → Rotifera, Ectoprocta

So, MINOR PHYLA

Minor phyla

Mesozoa	Pentastomida
Ctenophora	Phoronida
Nemertinea	Ectoprocta
Acanthocephala	
Entoprocta	Brachiopoda
Rotifera	Chaetognatha
Gastrotricha	Pogonophora
Kinorhyncha	Hemichordata
Nematomorpha	
Priapulida	
Sipunculida	
Echiurida	
Tardigrada	
Oncyophora	

DIVISIONS



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 :-

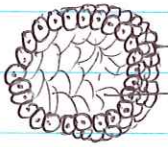
- → secondary body cavity formed by splitting of mesoderm during embryonic development
- → bounded on all sides by coelomic epithelium
- → contains colourless coelomic fluid and excretory organs open to it
- → reproductive organs arise from its walls

Early stages of development :-

Fertilised cell k/a zygote undergoes rapid cell divisions → Cleavage → Zygote

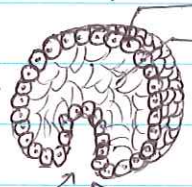
Compact mass of cells k/a morula (cells k/a blastomeres) → Cleavage → Morula

Forms a hollow ball called blastula lined by blastomeres



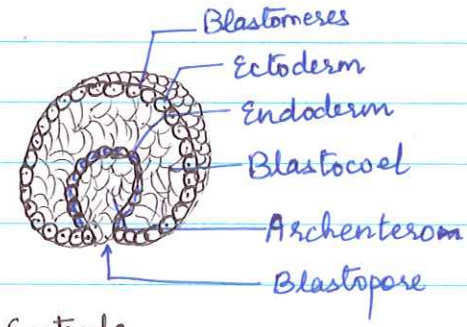
Blastula (segmentation cavity / 1° body cavity)

Gastrulation



invagination at one end of blastula k/a gastrulation

Formation of gastrula



Gastrula

→ 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

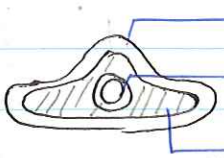
Advantages are :-

(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

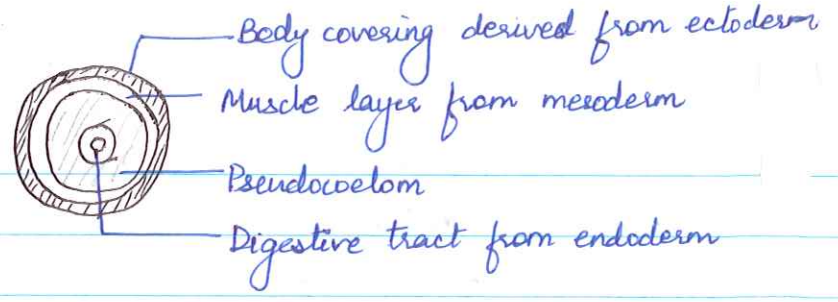
(1) ACOELOMATES - no coelomic cavity
- space around internal organs filled with parenchyma
- parenchyma restricts movement of internal organs
- only a gut, spongocoel or coelenteron exists and there is no other body cavity

eg. Platyhelminthes, Coelenterates



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

eg. Nematodes

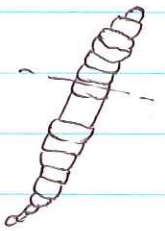


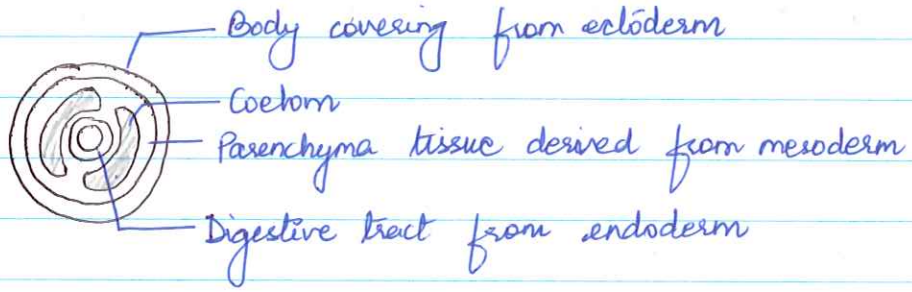
(3) COELOMATES - true body cavity derived from mesoderm and lined by mesodermal epithelium k/a peritoneum.
aka EUCOELOMATES

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

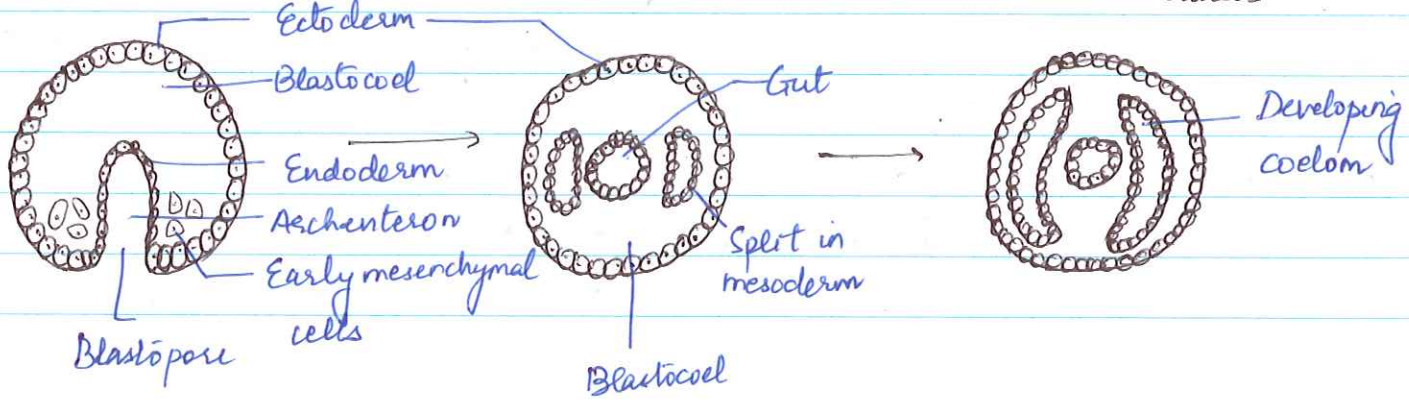
- animals have mesenteries which suspend the body organs within the coelom.

eg. Annelids, Arthropods, Molluscs, Echinoderms, Chordates

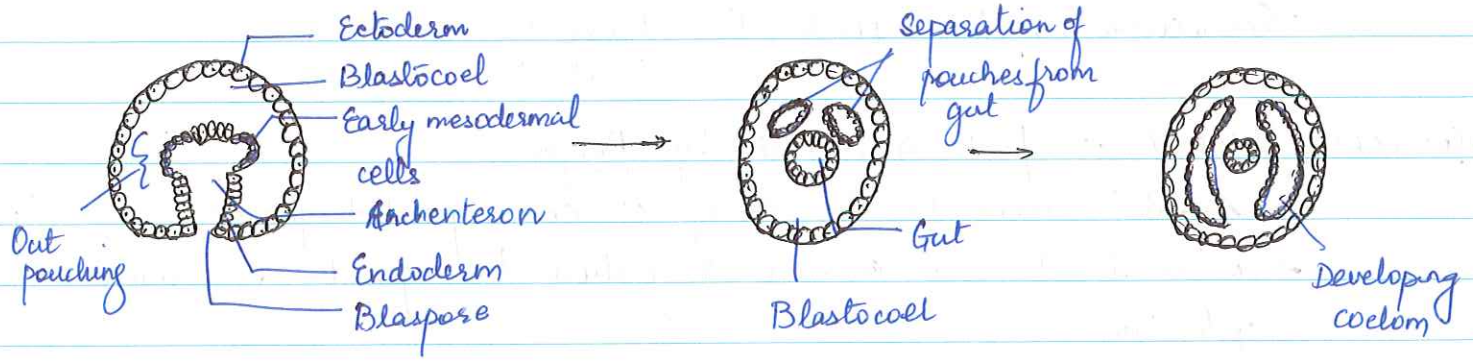




(a) Schizocoelomates - coelomates whose body cavity originates from splitting of mesodermal cells at the time of gastrulation
- this method k/a schizocoelous method
- eg. annelids, arthropods, molluscs
- schizocoelom may be blood filled k/a haemocoel eg arthopods molluscs



(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



- eg. Echinodermata & Chordata

THEORIES OF ORIGIN OF COELOM

(1) SCHIZOCOEL THEORY → Coelomates evolved from an ancestral acoelomate like flatworms
→ by hollowing out of parenchymal cells of mesenchyme
→ some of these cells formed the peritoneum
→ acoelomate body plan is primary & ancestral to coelomate body plan
→ Thus, acoelomate 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 & scyphozoans
→ gastric pouches separated out from main gastric cavity to form

coelomic pouches

→ This theory proposes that all bilateral animals are basically coelomate and acoelomate 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 do not 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 brooding site

SYMMETRY

→ arrangement of body parts in a balanced geometrical design, divisible into equal halves by planes of division is k/a symmetry
→ mainly desired by Ernst Haeckel.

Asymmetrical

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

eg: Porifera
Amoeba

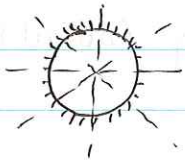
Symmetrical

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

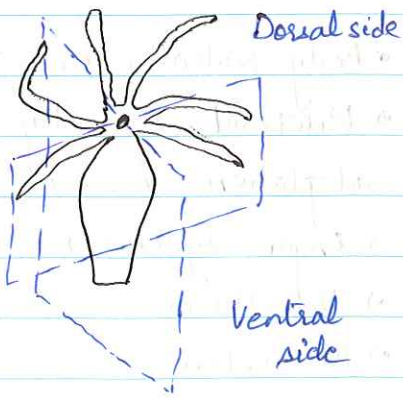
Types of symmetry

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

eg: Volvox, Actinophrys

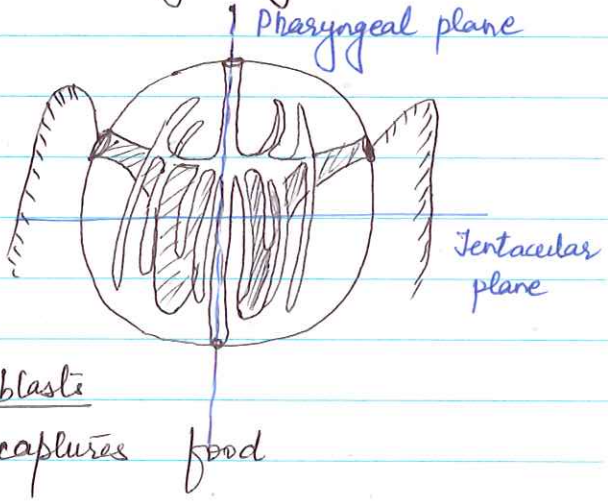


2. RADIAL SYMMETRY - in Coelenterates & Echinoderms
   - body parts arranged along a longitudinal axis
   - suited for sessile existence where food is planktonic & available from all directions
   - food capturing parts radially arranged



3. BIRADIAL SYMMETRY → mixture of radial & bilateral symmetry

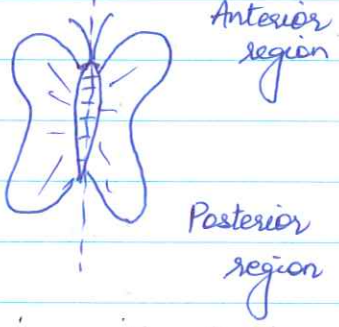
- found in Ctenophores that float
- eg Pleurobrachia has oval body with 8 comb plates radially arranged
- Comb plates used for swimming
- mouth, anal pore & statocysts arranged on antero-posterior axis
- pair of retractile tentacles bearing colloblasts for secreting sticky substance that captures food



- 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	BILATERIA
• Body radially or biradially symmetrical	⇒ Bilaterally symmetrical
• Bilateral symmetry a secondary adaptation in some	⇒ Radial symmetry a secondary adaptation in some
⇒ Organ systems not well marked	⇒ Organ systems well marked
• Diploblastic	⇒ Triploblastic
• No coelom	⇒ 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 ⟶ Polyclads

free living, floating animals that show radial & biradial symmetry

like Notoplana & Leptoplana free living bottom dwelling turbellarians

- a ctenophore ancestor may have acquired bottom dwelling & crawling habit & 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 ⟶	Muller'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 Muller's larva in having ciliary bands, apical tuft & ventral mouth.

→ The theory considers larvae of acoelomate bilateria as early stages of trochophore.

3. PLANULOID - ACOELOID THEORY

- proposed by Ludwig von Graff.

- primitive acoelomate 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

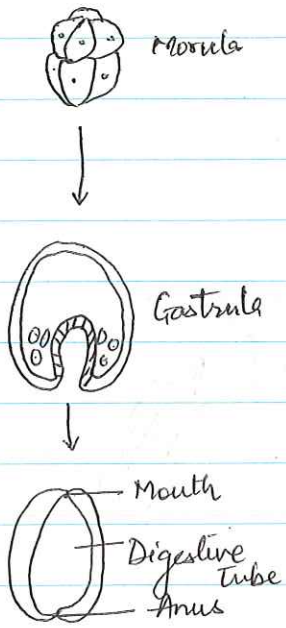
Zygote —cleavage→ Morula —Cleavage→ Blastula —Gastrulation→ Gastrula

→ Gastrula has pore called blastopore

→ Incomplete blastopore eg. bird or mammal - ventral blastopore (primitive streak)

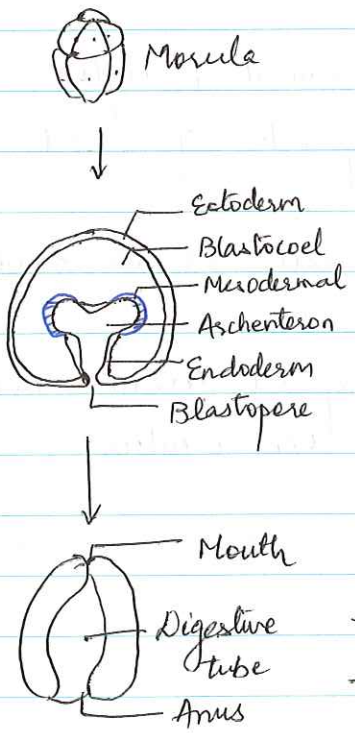
→ Blastopore gives rise to mouth or anus.

PROTOSTOMES



- → 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



- 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

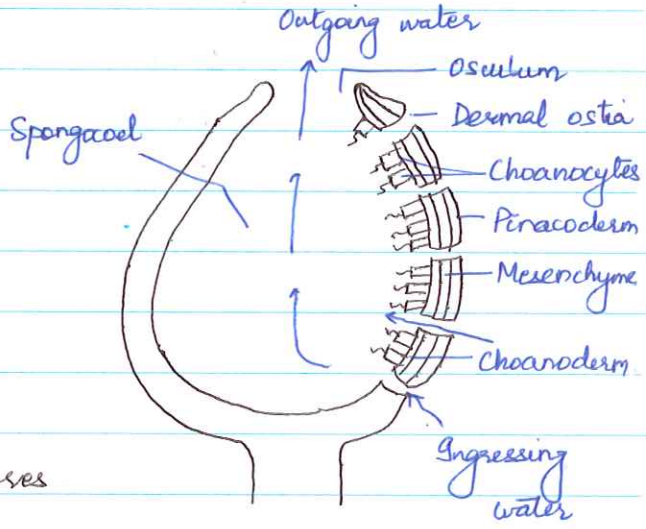
→ Water circulatory system of sponges k/a canal system
- Canal system aka aquiferous system

⇒ 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

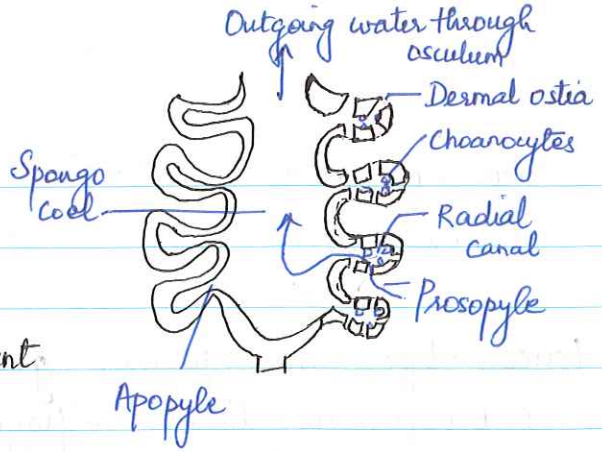


- body surface pierced by large no. of poses called dermal ostia
- ostia are intracellular spaces in tube like cells called porocytes.
- poses open radially into mesenchyme & directly into spongocoel.
- spongocoel lined by flattened flagellate collar cells k/a choanocytes
- opens into osculum fringed 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 syconoid pattern

⇒ Two types of canals - radial and incurrent canals ~~xxxx~~ 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

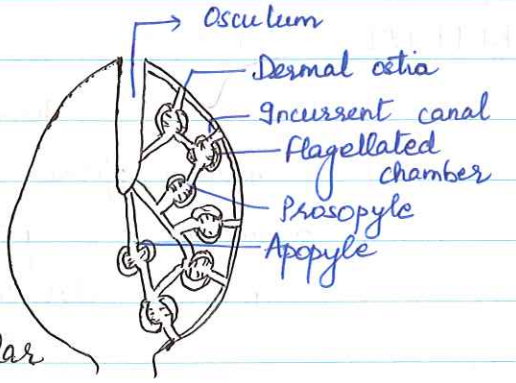
⇒ Incurrent canals lined by pinacocytes, lead into radial canals through prosopyles.

⇒ 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 sycon type

→ eg. 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 ostia → incurrent canal → Prosopyles → Flagellated chambers → Apopyles → Excurrent canals → 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 sclero protein

→ 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 sclerosblasts.

On basis of deposit of core organic matter :-

- all spicules have a core of organic matter on which $CaCO_3$ or colloidal silica is deposited

(a) Calcareous spicules - organic matter $CaCO_3$ or calcite
- typical in Class Calcarea

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

On basis of size & function :-

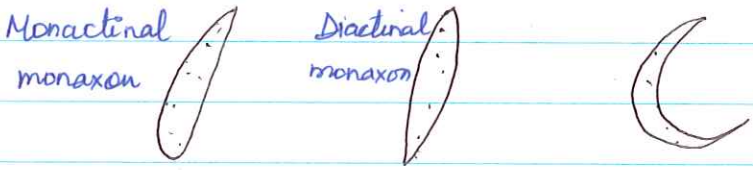
(a) Megascleres - large spicules that form the main skeleton of the sponge

(b) Microscleres - small spicules that occur interstitially

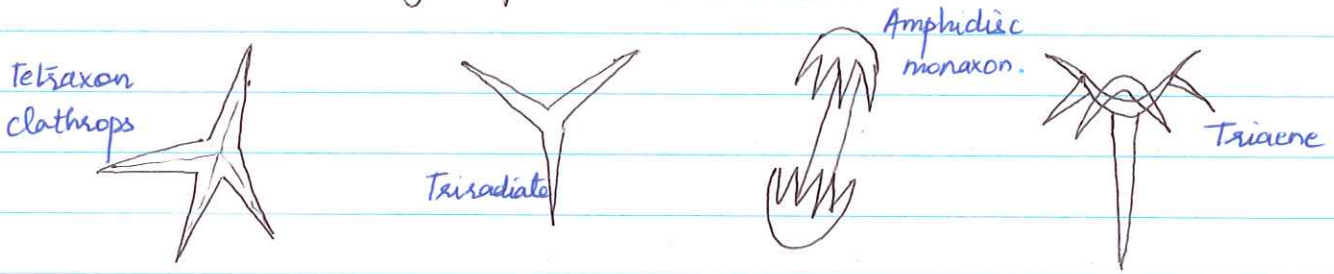
On the basis of no. of axes & rays :-

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

→ Monactinal (growth in one direction)
→ Diactinal (growth in both the directions)



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

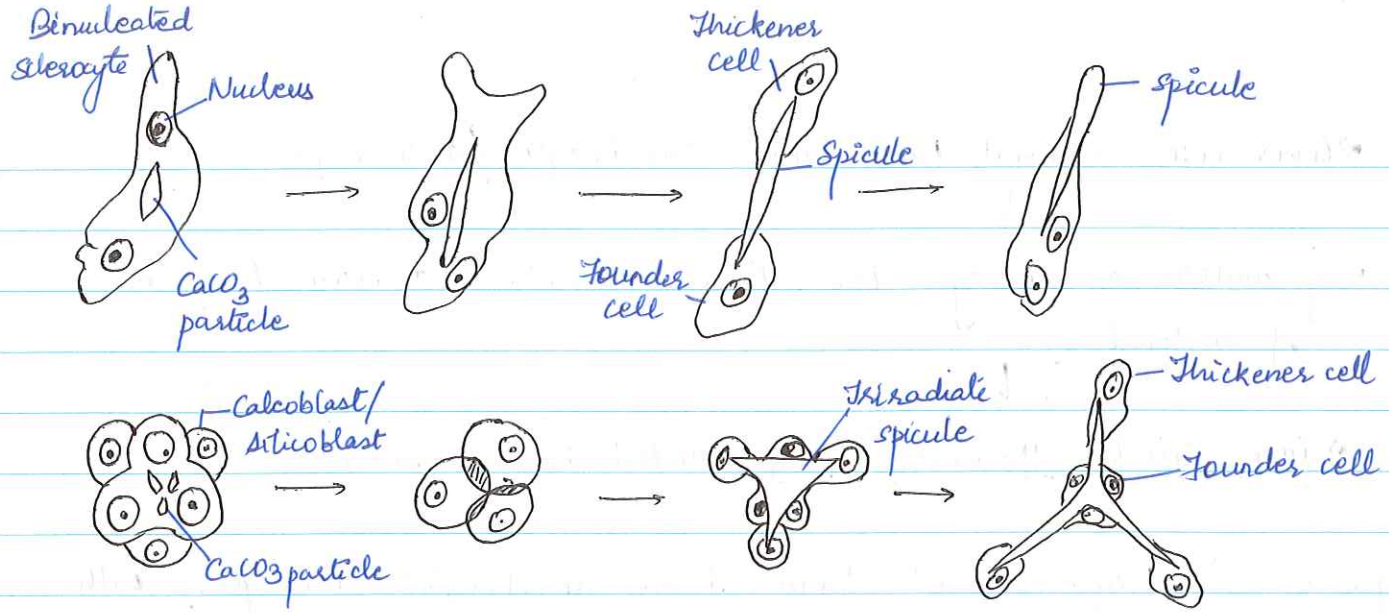


(c) Triaxon - 3 axes that cross one another at right angles to produce 6 rays
- aka hexactinal spicule
- typical of glass sponges of Class Hexactinellida

(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 sclerdblasts / sclerocytes
- sclerocytes derived from binucleated mesenchymal sclerdblasts
- each ray is secreted by a pair of sclerocytes



Initiation starts with deposition of a $CaCO_3$ particle b/w the two nuclei of binucleate mesenchymal cells → This particle grows drawing apart the nuclei and 2 sclerocytes are formed → Thickener cells lays down addition layer of $CaCO_3$

↓

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

secretes $CaCO_3$ spicule = calcoblast
secretes siliceous spicule = siliceoblast

SEXUAL REPRODUCTION

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

Spermatogenesis :-

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

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

Oogenesis :- Oocyte derived from large amoebocyte / archaeocytes with a distinct nucleus (totipotent cells)

OR

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 :- sperms 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

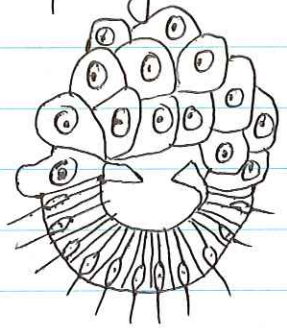
↓

Metamorphose and grow into adult sponges

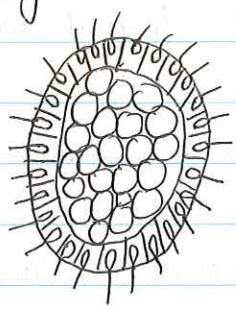
Types of larvae

(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

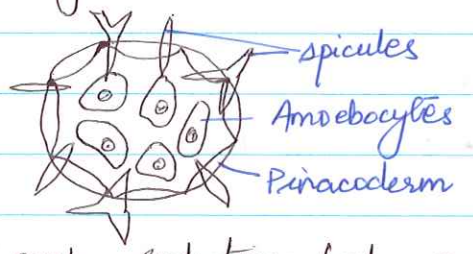
ASEXUAL REPRODUCTION

(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

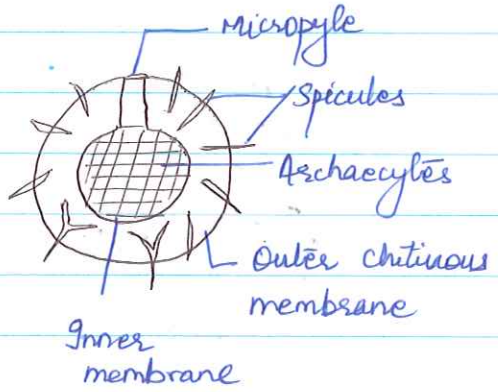
(b) FISSION - sponge hypertrophied over a limited area developing a line of weakness
- due to increase in size of cells rather than no. of cells
- along this weak line, splitting occurs & parts of parental sponge are thrown off

→ 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
kla 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

Porifera

Subclasses: Monaxonida (eg Spongilla) | Triactinellida (eg. Geodia) | Keratosa (eg. Euspongia)

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, urn or vase shaped
- colonial / solitary
- Trichimella 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
- Parenchymula larvae

eg. Spongilla

CNIDARIA

- diploblastic, radially symmetrical organisms with tissue grade org^{n}
- have defensive organs called cnidocytes
- have a gastrovascular cavity called coelenteron
- alternate b/w polyp & medusa phase
  - polyp: sessile, asexual
  - medusa: active, sexual
- marine or fresh water, solitary or colonial
- free living larva - planula
- fertilisation is external
- epidermis, gastrodermis & mesoglea
  - ↳ for swimming in medusoid form

Coelenterata

Hydrozoa	Scyphozoa	Anthozoa (Subclasses: Octocorallia, Hexacorallia)
» marine/freshwater	» marine only	» marine
» chiefly colonial	» medusa predominant	» solitary / colonial
» medusa may be absent	» No velum	» medusa absent
» Coelenteron undivided	» Mouth with 4 oral arms	» sedentary polypoid only
» acellular mesoglea	» Mesoglea cellular	» mouth oval with whorl of tentacles
» cnidocytes only on epidermis	» cnidocytes in epidermis & gastrodermis	» cnidocytes in epidermis & gastrodermis
» gonads in epidermis	» solitary or colonial	» gonads in gastrodermis
» polymorphic colonies	» show strobilation	
» Medusa has velum		
eg. Hydra, Obelia	eg. Aurelia	eg. Adamsia

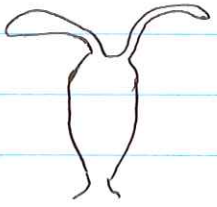
POLYMORPHISM

→ means phenomenon of occurence 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 motile
- marginal tentacles & mouth centrally located on lower concave surface



Origin of Polymorphism :-

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

↓

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 polypersons of Hydrozoa.

Patterns of Polymorphism :-

(a) Dimorphic :- simplest & most common with two zooids forms
→ exhibited by most hydrozoan colonies eg. Obelia, Tubularia

Gastrozooids - concerned with feeding, Aka hydranths

Gonozooids - concerned with asexual reproduction. Aka blastostyles

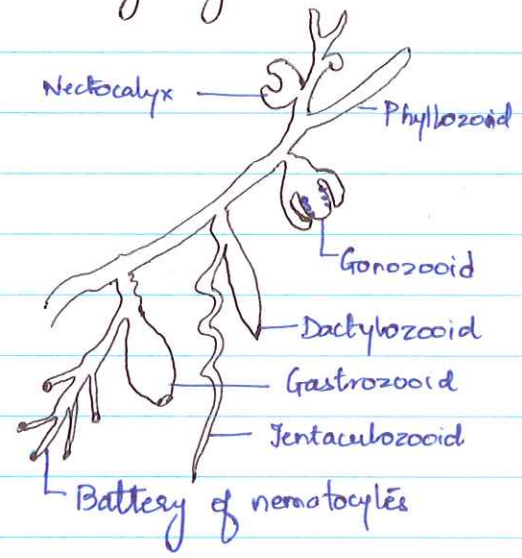
(b) Trimorphic :- 3 types of zooids → Gastrozooids (Hydranth)
→ Gonozooids (Blastostyles)
→ Dactylozooids

Dactylozooids - defensive structures with battery of nematocytes

(c) Polymorphic :- More than 3 types of zooid individuals eg: Hydractinia

⇒ Hydractinia has 5 types of zooids

a) Gastrozooids for feeding
b) Gonozooids for asexual reproduction
c) Dactylozooids for defense
d) Tentaculozooids for sensory function
e) Skeletozooids (spiny chitinous projections)

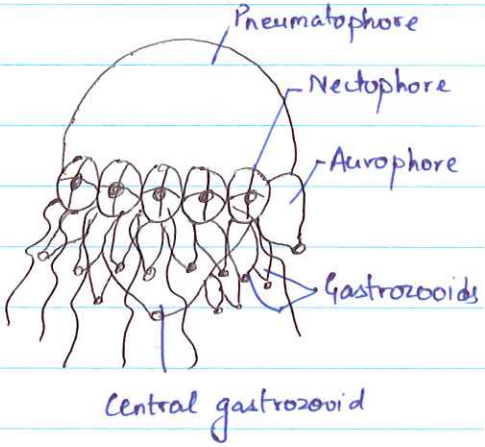


Modifications of polyp forms :-

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
Pneumatophore - Float-bladder like medusa. Filled with secreted gas
Phyllozooid - called as bract. Studded with nematocytes & help in protection
Gonophore - gonad zooid. Either ♂ or ♀



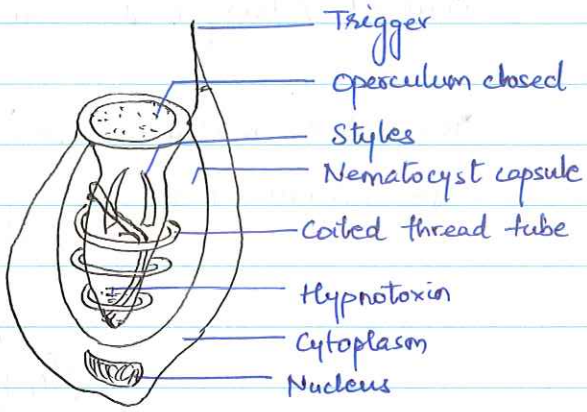
Polymorphism is important for division of labour

DEFENSE STRUCTURES

- body wall of coelentrates 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~~ interstitial cells of epidermis
- These move to the tentacles through mesoglea by amoeboid movements 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)
- One 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



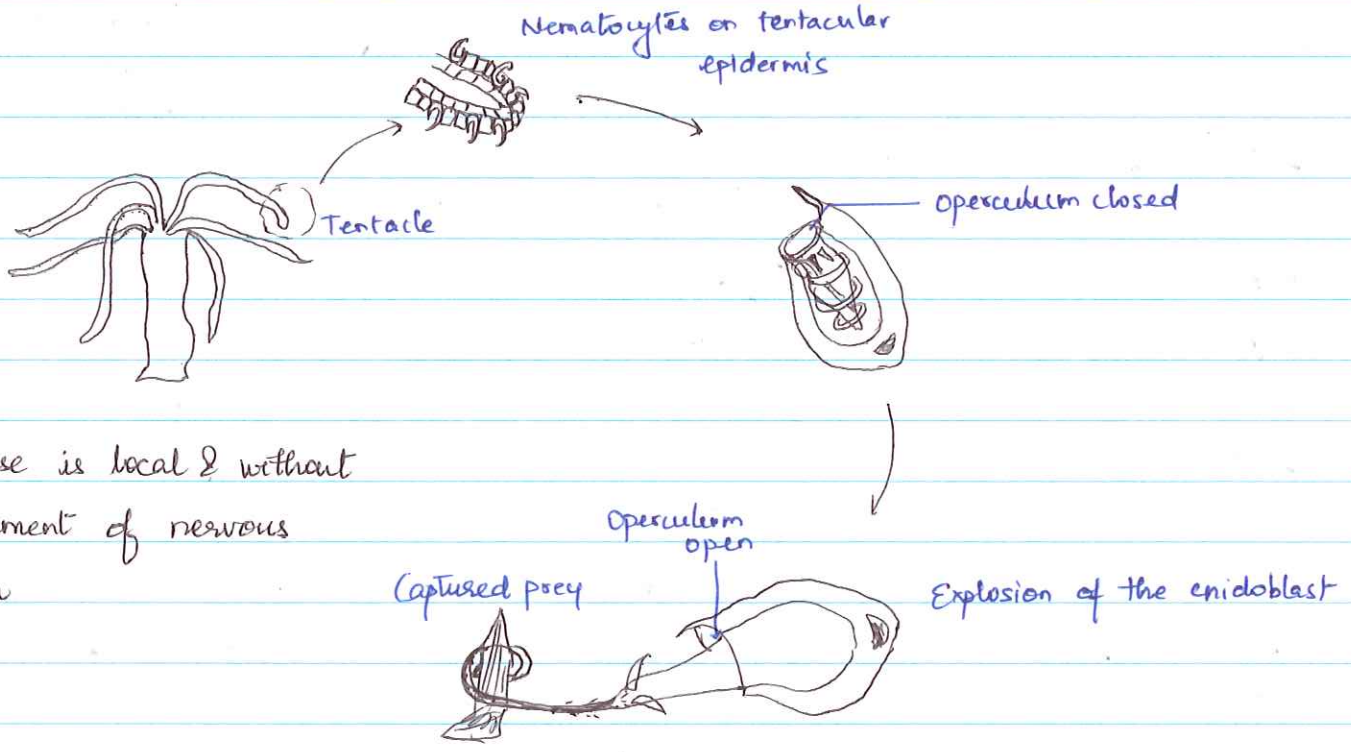
Distribution of nematocytes :-

- 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 nematocyte are enclosed in a single large epithelio muscle cell

Mechanism of defense :-

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

Thus, both mechanical similations (contact of food) and chemical simulations (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.

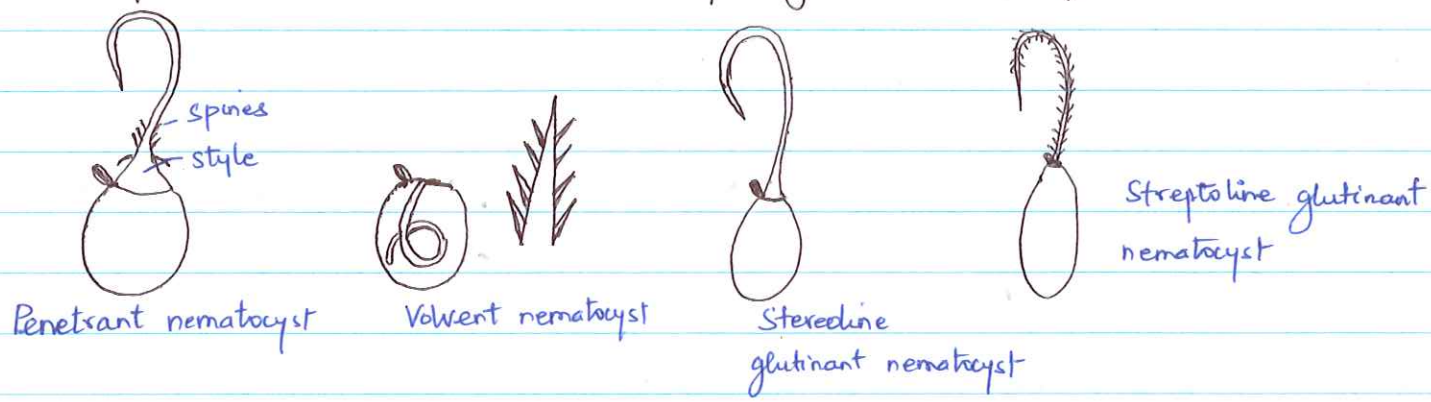
(a) Penetrant nematocyst :- very large and occupy almost entire space of the nematocytes
- Very long thread tube with barbs & barbules
- when ejected, penetrates the victim's body and discharges hypnotoxin into it to paralyse or kill it

(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
- donot have a shaft
- discharge is a straight unarmed thread tube open at the tip
- useful for attachment & anchorage

(d) Streptoline glutinant nematocyst :- oval or cylindrical

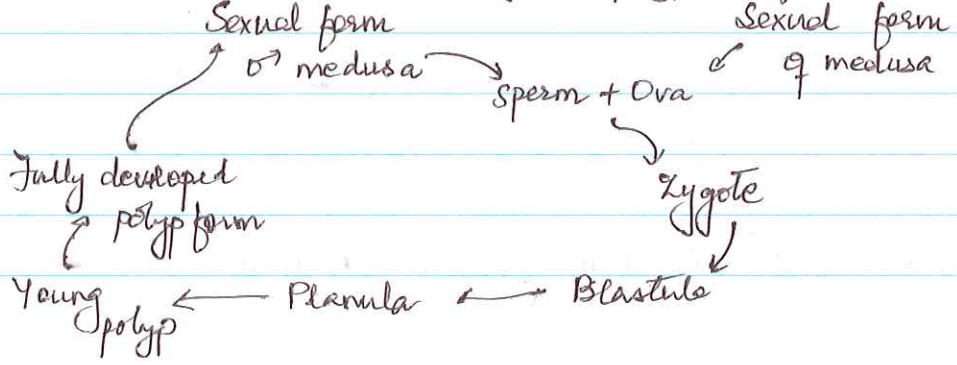
- thread tube is long with a narrow shaft
- bears spiral row of small spines
- helps in attachment or in impeding movement of small animals



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
  - polyp → reproduces asexually
  - medusa → 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 (dioecious; separate ♂ & ♀). These are fertilised, externally or internally, to produce a zygote that grows into a planula larva and ultimately a polyploid form



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

Differences b/w polyp & medusa forms

POLYP	MEDUSA
Fixed and sedentary; rarely free form	Free swimming or pelagic
Body cylindrical & elongated	Body umbrella shaped
Base attached to substratum exposing the manubrium upwards	Base always above hanging manubrium downwards
Tentacles usually 24	Tentacles 16 in young medusa & numerous in adult
Mesoglea poorly developed	Mesoglea well developed
Velum absent	Velum present around umbrella margin
Mouth circular without oral lobes	Mouth rectangular with oral lobes
Gastrovascular cavity simple without radial & circular canals	4 Radial canals and one circular canal
Sense organs absent	Sense organs called statocysts present along margin of tentacles
Asexual - no gonads	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 ($CaCO_3$) 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 :- -small about 10 mm long & 1-3 mm in diameter
- 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 siphonoglyphs
- 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 $CaCO_3$ secreted by stony corals

→ Also consists of coralline algae and foraminiferans (Protozoans)

→ Corals need warm shallow waters with Temp. above 20°C

→ Corals therefore found only at Indo-Pacific, Central Western Pacific and Carribean regions

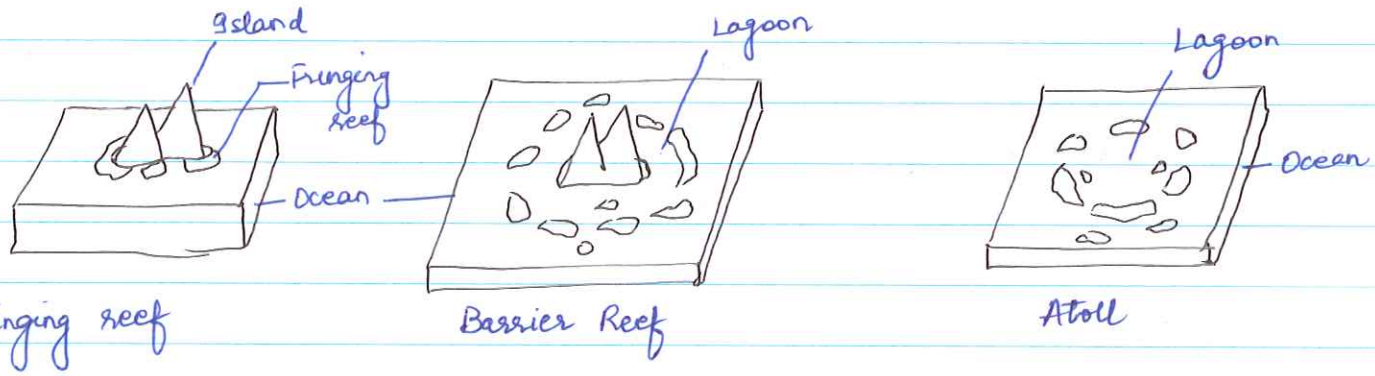
→ Depending upon their formation, of 3 kinds :-

(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 ~ $\frac{1}{2}$ - 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 encircling 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

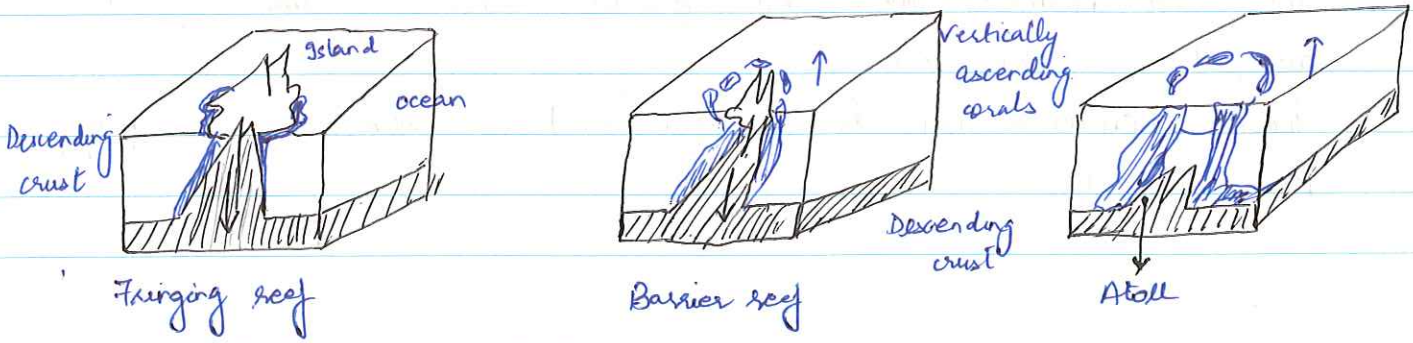
- put forth by Darwin
- all known coral reefs are found in regions where subsidence of land has taken place
- Initially, corals grew as fringing reefs on sloping shores of an island in a shallow tropical sea
- → Subsidence of islands commenced and reef turned into a barrier reef
- → Island finally became 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 80 m
- 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 hydrotheca

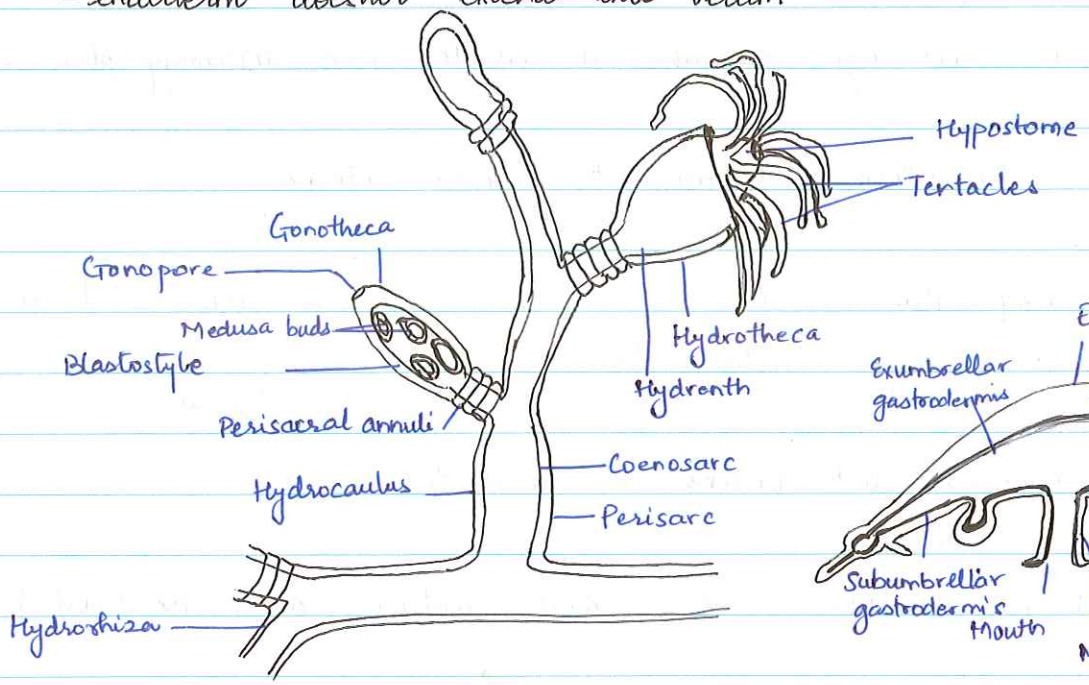
Blastostyle (Reproductive zooids)

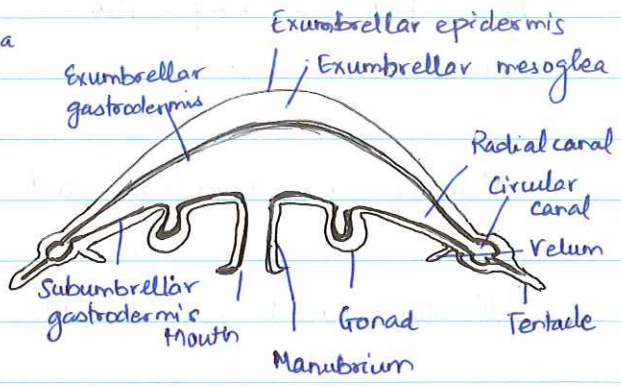
- develop when hydrocaulus has reached its full development
- fewer as compared to hydranths
- mouth and tentacles absent; gastrovascular cavity reduced
- distal end closed and forms a flattened disc
- covered by perisarc called gonotheca
- reproduce asexually to produce medusa buds or gonophores
- buds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

Medusae

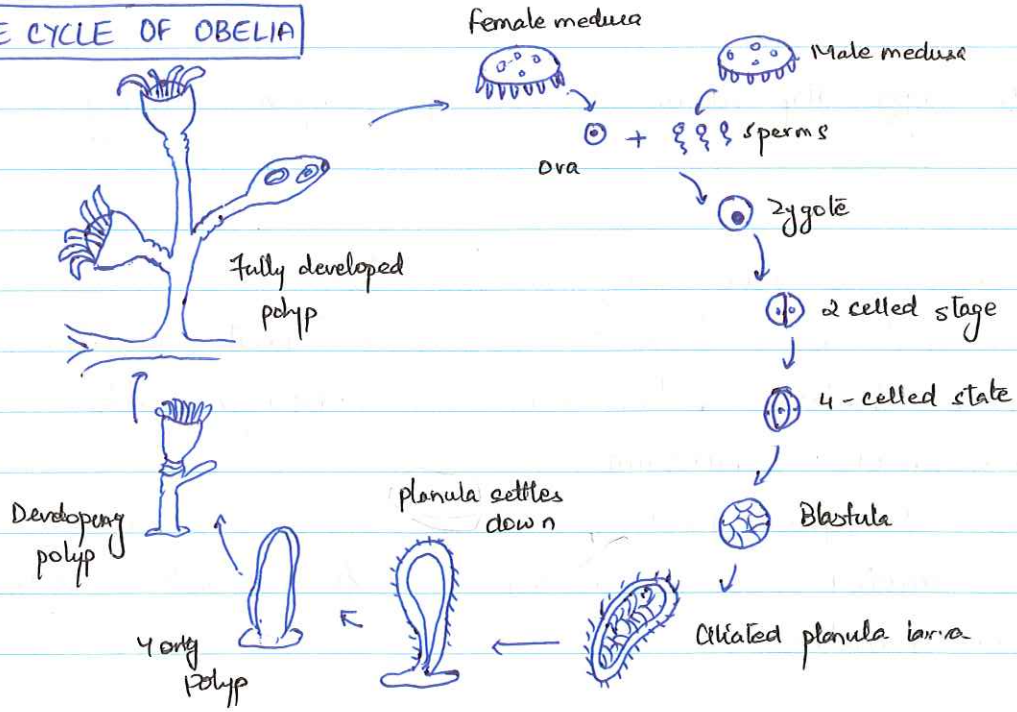
- small, transparent, solitary, free swimming & umbrella shaped
- inner concave surface sub-umbrella & outer convex surface k/a exumbrellar surface
- quadrangular projection called manubrium hangs from the subumbrellar surface; mouth - square shaped located at tip of manubrium

- 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 rudimentary fold on the inner side k/a VELUM
- margin of umbrella has tentacles - 16 in young medusa
  - increase thereafter
- ectoderm covers both exumbrellar & subumbrellar surface
- endoderm does not extend into velum





LIFE CYCLE OF OBELIA



⇒ 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 enteron

↓

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

↓

Attached or proximal end wedens as basal disc } Hydrula

↓

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

↓

Narrow portion becomes hypostome and apesture (mouth) formed

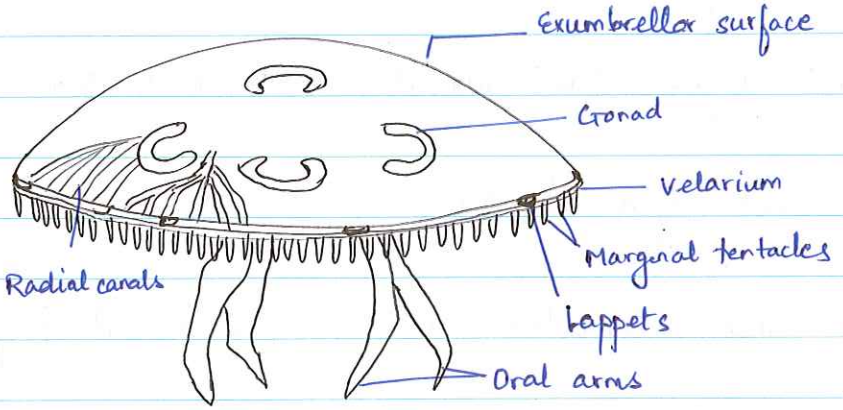
↓

Young hydranth repeatedly divides by budding to form a colony

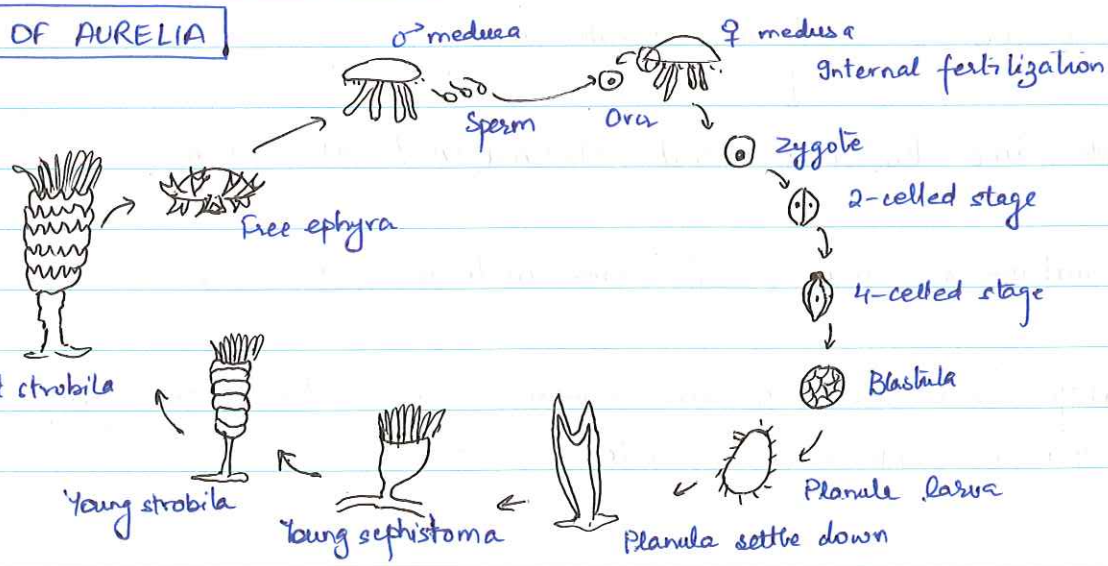
AURELIA

- 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 rhophalium or tentaculocyst is present
- numerous thread like tentacles having batteries of nematocysts
- marginal bearing lappets and tentacles has a thin flexible flap k/a velarium
- Velarium donot have gastrodermal canals so called pseudovelum



LIFE CYCLE OF AURELIA



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

↓

Frills 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 autum & 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 broken one by one & ephyrae are pinched off

↓

Ephyrae has tetramerous symmetry with edge having 8 bifid lobes with 8 aradial indentations

- Polydise strobilation (when food abundant)
- Monodise 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

↓

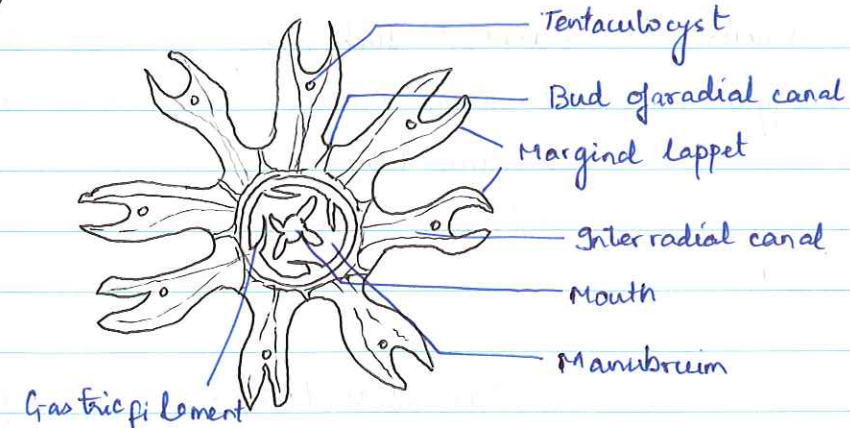
Mesoglea increases enormously and 2 layers of endoderm fuse to form gastrodermal lamella except in regions of gastrovascular canals.

↓

Numerous marginal tentacles and 4 oral arms formed

↓

Medusa form reached.



Ephyra

PLATYHELMINTHES

- includes flatworms like Planarians, flukes & tapeworms
- triploblastic and acoelomate
- 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

Turbellaria

- includes planarians, acoels
- usually free living
- some commensals, parasites
- unsegmented body wall
- ciliated epidermis
- epidermal glands secrete rod like rhabdoids that when released form mucus
- mouth ventral & pharynx protrusible
- Direct development
- Totipotent cells called neoblasts

eg Planaria

Trematoda

- includes flukes
- ectoparasites / endoparasites
- segmented body & covered by integument called neodermis
- mouth surrounded by oral sucker & sometimes a ventral sucker or acetabulum present
- intestine bifid
- indirect development

eg liver fluke (Fasciola)

Cestoda

Cestodaria
Eucestoda

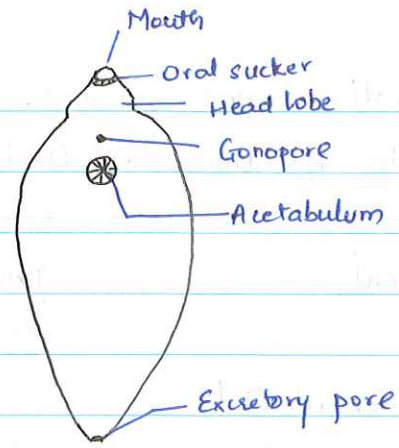
- includes tapeworms
- ectoparasites in gut of vertebrates
- body divided into scolex, neck & strobila
- show pseudometamerism
- Scolex has suckers & hooks
- Digestive tract absent

eg. Taenia

FASCIOLA

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

digenetic → 1° host sheep
→ 2° host freshwater snail (Limnaea, Planorbis, Bulinus)



VENTRAL VIEW

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

Basement membrane
- » a non-distinct layer

Musculature
- » three layered
  - circular muscles
  - longitudinal
  - oblique / diagonal

Mesenchyme or parenchyma
- » 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 anoxybiotic
- glycogen breaks by anaerobic glycolysis to form CO_2 & lactic acid

» **Excretory / Protonephridial system :-**
- greatly branched excretory ducts & flame cells
- flame cells have pseudopodial processes
- excretory trunks → excretory canal → excretory pore

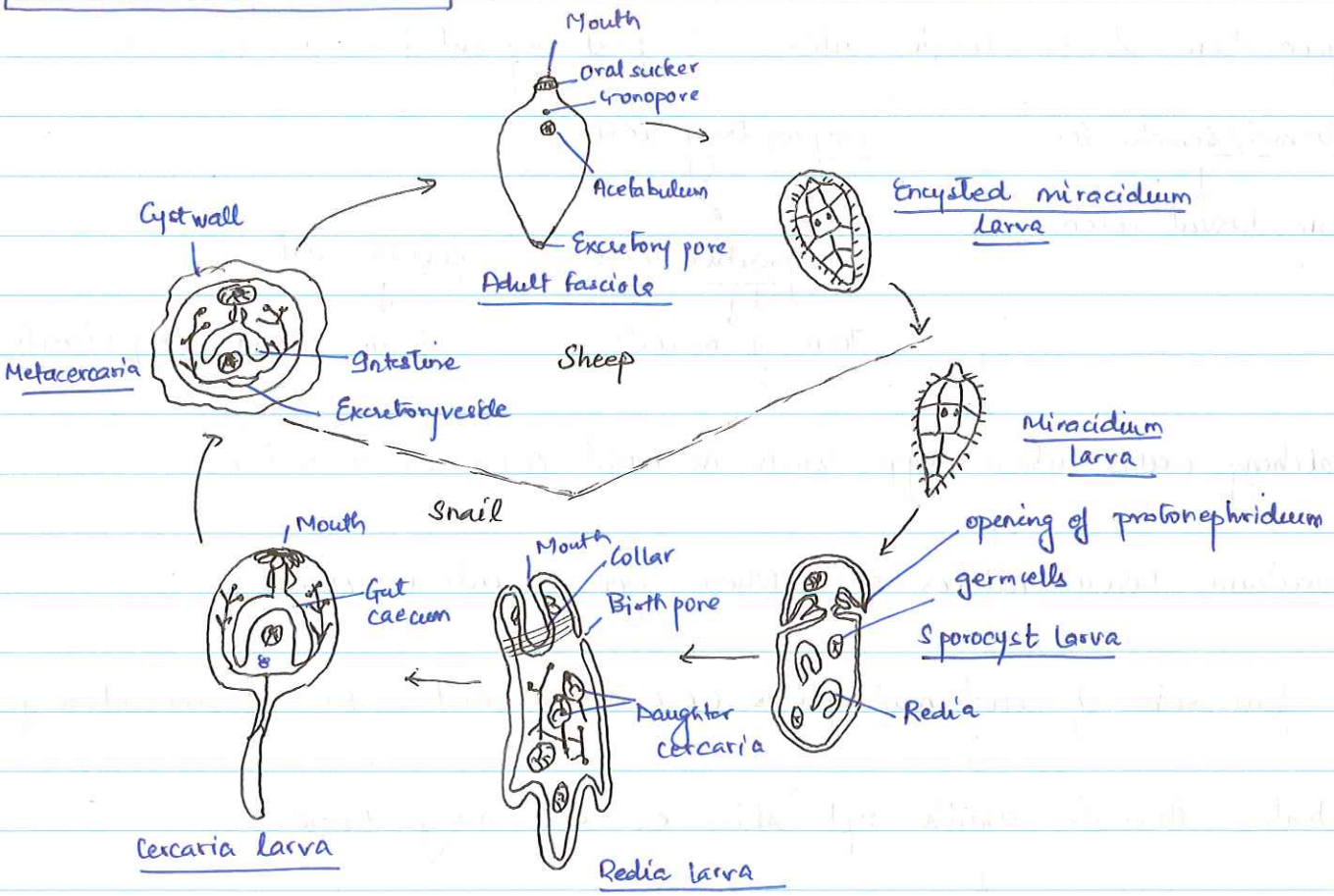
⇒ **Nervous System :-** a pair of cerebral ganglia surrounded by nerve ring
- 3 pair of longitudinal nerve cords

⇒ **Reproductive system :-** hermaphrodite but cross fertilisation a rule

♂ reproductive system
- testes
- vas deferntia
- seminal vesicle
- ejaculatory duct
- cirrus (penis) & cirrus sac

♀ reproductive system
- ovary
- oviduct
- ootype
- uterus
- Mehil's glands
- Vitelline glands & ducts
- Laurer'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 fertilised in uterus or ootype

↓

Fertilised cells deposited with yolk cells produced by vitelline glands & 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

Propagatory cell → 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 five rows of epidermal plates (6, 6, 3, 4, 2) and a pair of penetration glands

↓ Swims 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

↓

Unecellular cystogenous glands form a cyst around larva to form metacercaria

↓

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

↓

Swims 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 enter definite host when sheep grazes 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. MORHOLOGICAL 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 locomotary organs
5. Incomplete digestive system & suctorial ingestion
6. Highly branched intestine
7. Anaerobic respiration as free O_2 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 (~ 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 fasciolepsis. Causes hepatitis & inflammation of bile duets
- calcification of bile passages can cause formation of gall stone causing damage to the liver called liver rot

acute liver rot

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

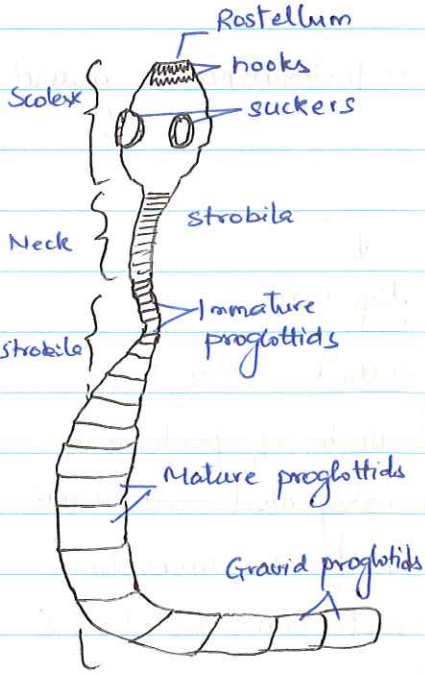
chronic liver rot

- 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 & dysentry

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.

Body parts

Head or scolex

Proximal Rostellar part
- conical retractile part
- 2 rows of 28 chitinuous hooks

Distal 4-sided part
- 4 cupshaped suckers

attachment / holdfast part

Neck
- unsegmented
- new segments bud off from this region

Strobila
- composed of linear series of 800 - 1000 sets of reproductive organs
- linear repetition of genitalia is termed as PROGLOTTISATION
- each segment k/a PROGLOTTID

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 - apolysis.

Body wall

Tegument
- thick & resistant
- made of proteins & impregnated with $CaCO_3$
- helps in absorption, protection, excretion & osmoregulation

Basement membrane

Musculature
- circular muscles
- longitudinal muscles

Parenchyma or mesenchymal cells

- Digestive system absent
- Excretory system - flame cells, - caudal vesicle
  - 4 lateral excretory vessels
  - transverse canals

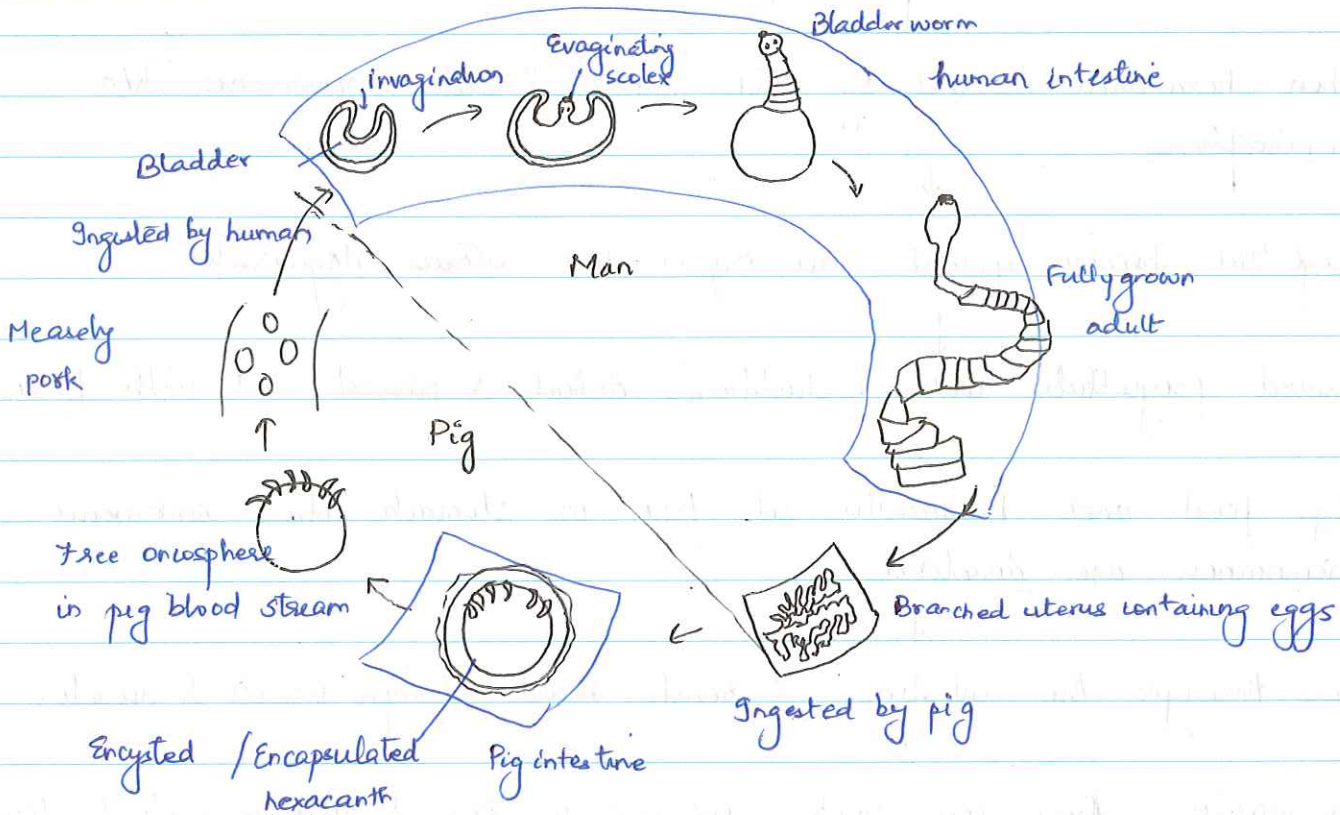
♂ reproductive system

- testes
- vasa efferentia
- vasa deferens
- cirrus and cirrus sac

♀ reproductive system

- ovaries
- oviduct
- ootype
- uterus
- vagina
- Mehil's gland
- Vitelline gland
- Seminal receptacle

LIFE HISTORY OF TAENIA



Digenetic organism but <u>self fertilisation</u> occurs as a rule

↓

Cirrus of the same segment inserted into the vagina of same segment

↓

Sperms stored in <u>seminal receptacle</u>

↓

In ootype, zygote associated with a large yolk cell or <u>vitelline cell</u> and enclosed in a <u>chorionic membrane</u>

↓

Capsulated eggs collected in uterus and undergo further development

↓

Zygote undergoes holoblastic & unequal cleavage

- Megamere → outer embryonic membrane
- embryonic cell
  - mesomeres → shell outside morula
  - micromeres → morula

↓

Morula's posterior end develops 6 chitinuous hooks (called hexacanth)

↓

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

↓

Proglottid become gravid & all organs but uterus degenerate

↓

Gravid proglottids with onchospheres detach & passed out with faeces

↓

Pigs feed and hexacanths set free in stomach whose embryonic membranes are dissolved

↓

Bore 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 proscolex evaginates

↓

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

↓

Forms measely 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. Simulates host's gut to secrete mucous 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, vomitting, indigestion, eosinophilia

b. Cysticercosis :- caused by infection through onchospheres
- scolex causes injury to intestine causing reverse peristalsis

↓

gravid proglottids pushed into the stomach - retro infection / auto infection

↓

infection of non-pork eaters through water - hetero infection

↓

reach voluntary muscles and form cysticercus 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: ~~Trichinella~~ Desmoscolex

Phasmida

- Mostly parasitic
- Both phasmids & amphids
- Amphids pore like
- Excretory system well-developed
- Poorly developed mesenterial tissues
- no caudal adhesive glands

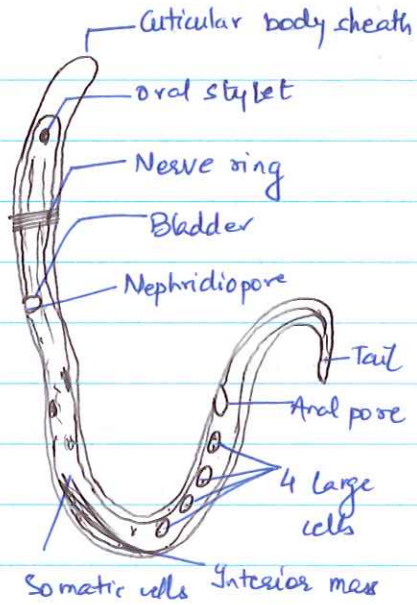
eg Ascaris, Wuchereria

WUCHERERIA

- Wuchereria bancrofti commonly k/a filarial worm
- endoparasitic nematode in lymph vessels & nodes in man
- usually in tropical regions but cosmopolitan
- digenetic life cycle

1° host — man

2° host — Anopheles / Culex / Aedes mosquito



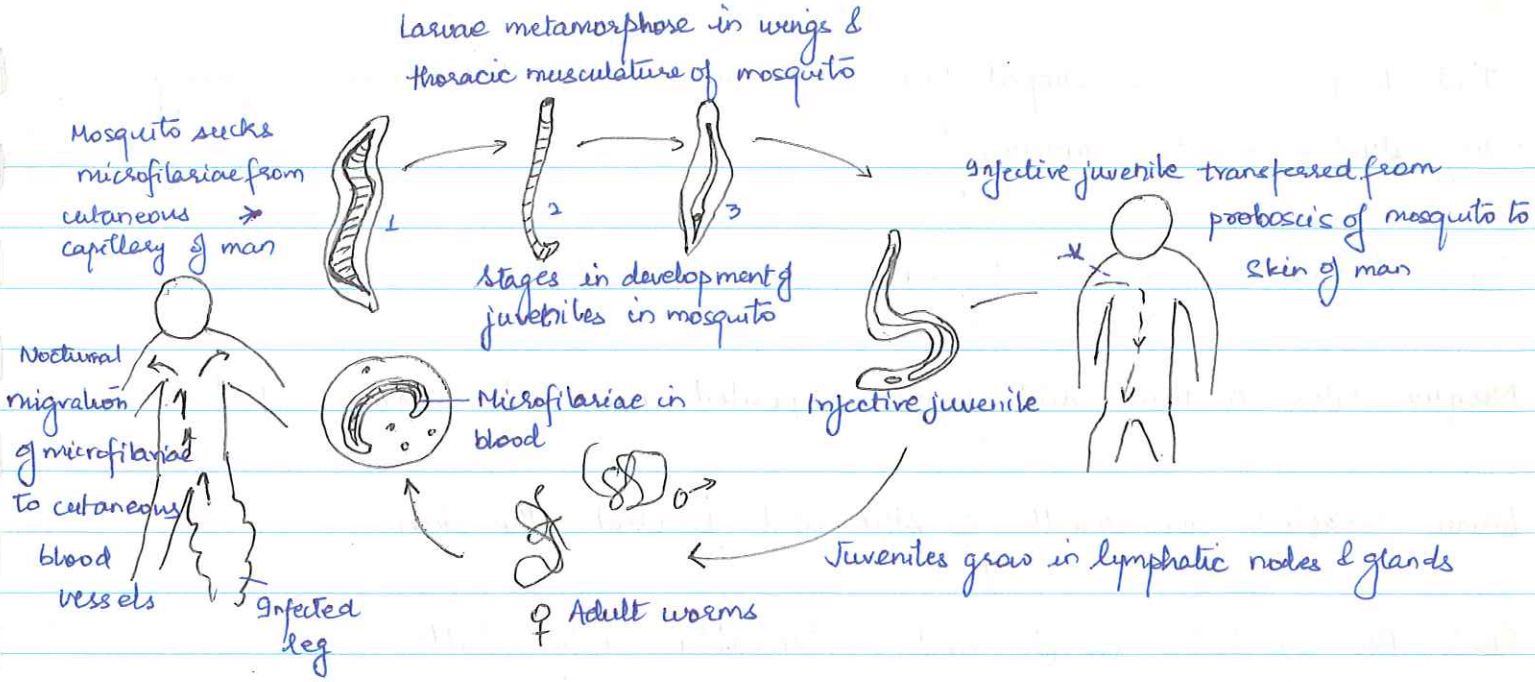
- Adults are unisexual & dioecious (sexual dimorphism)
- Filiform worms with tapering ends
- Creamish white, smooth, semitransparent body
- Locomotory organs absent

♂	♀
- shorter	- longer
- sharply curved posterior end	- straight & blunt posterior
- contains copulatory spicules, caudal alae & genital papillae	- Absent
- Genital pore at posterior end	- Genital pore in pharyngeal region

Microfilariae

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

- Filarial worm is viviparous or ovoviviparous.



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

↓

Numerous juveniles called microfilariae released through viviparity or ovoviviparity

↓

Microfilariae discharged into lymph vessels

↓

Enter blood vessels and swim with active movements

↓

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

↓ live for 7o days

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 1o 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

↓

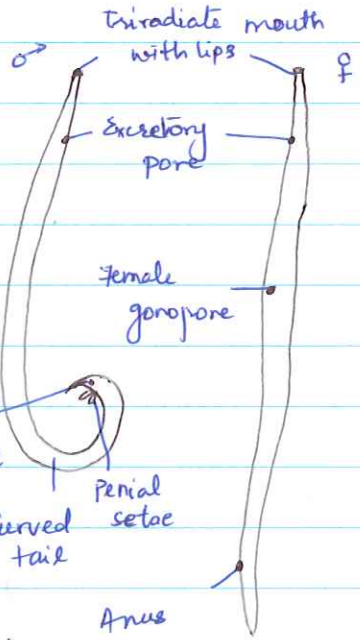
Become sexually mature in 5-18 months and start a new generation of microfilariae

Pathogenic Symptoms :-

a) Obstruct lymph vessels and cause deposition of metabolites
b) Initiate proliferation of endothelial cells and lead to inflammatory thickening
c) Periodic fever attacks
d) Tumour like solid growth called elephentiasis.

ASCARIS

- Ascaris lumbricoides aka roundworm
- gastrointestinal 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 pseudosegmented appearance



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

mid dorsal ← | mid ventral ↓ | → 2 lateral

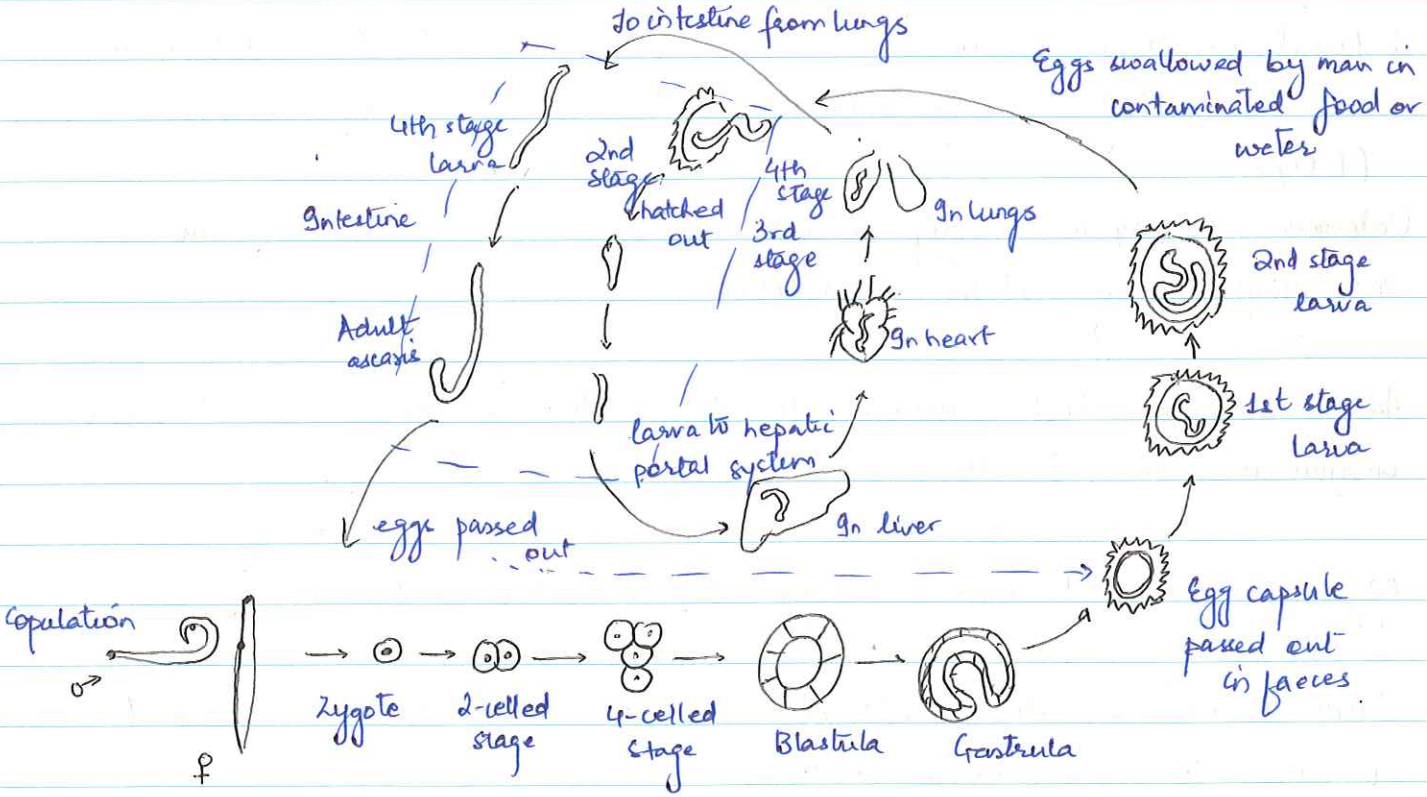
- trisadiate mouth guarded by 3 broad lips or labia (absent in Wuchereria)

♂
- cloaca at the posterior end
common aperture for digestive & 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 <u>longitudinal muscles</u> only

» Body cavity k/a <u>pseudocoelom</u> because :-
a) not lined by coelomic epithelium or peritoneum
b) no relation to excretory & reproductive organs
c) developed from blastocoel.



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

↓

Sperms reach the proximal end of uteri and fertilization occurs

↓

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

↓

Uterine wall secretes a hard wavy coat on the elliptical egg

↓

Determinate and spiral 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)

(7 days)

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

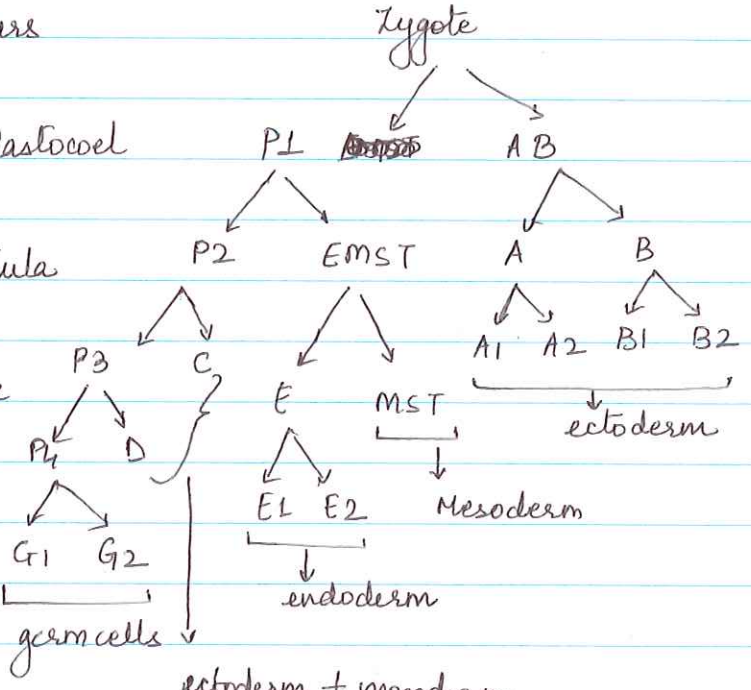
↓

egg shell dissolved and 2nd stage larva hatches out

↓

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

↓



Remains 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 dimentary canal with muscular pharynx for suctorial function
5) No circulatory system (absorption, distribution & transport through pseudocoelomic fluid)
6) ~~Advanced~~ Absence of sensory organs and nervous system poorly developed
7) Highly fertile ; a ♀ lays ~27 mn eggs a day
8) Eggs / Zygote 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 irritation 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, blister worms
→ Triploblastic, bilaterally symmetrical, schizocoelomates
→ Protostomes and exhibit metamesic 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 additions of new segments from teloblastic growth zone located in front of pygidium

- Body wall consists of fibrous collagenous cuticle, epidermis, dermis, musculature and peritoneum
→ Chitinuous 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 ~~skin~~ 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 systems consists of circumpharyngeal nerve ring and a ganglionated double ventral nerve cord

Annelida

Polychaeta | Oligochaeta | Hirudenia | Archiannellida

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
- Trocophore larva

eg. Nereis

Class Oligochaeta :- (few hair)

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

eg. Pheretima

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 cocoons
- eg Hirudinaria

Class Archiannellida :-

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

eg. Dinophilus

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 used only when organs of mesodermal origin are so arranged.
» Primary segmental 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 mesenteries 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 highes animals is incomplete because of

division of labours.

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

3. TRUE & PSEUDOMETAMERISM

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

True metamerism	Pseudo metamerism
No. of segments constant for each species. No new segments added except in asexual reproduction	No. of segments grows throughout life by addition
Growth by elongation of pre-existing segments	Growth by addition of segments
All segments of same age & at same stage of development	Proglottids vary from one another in age & degree of development
All segments integrated & are functionally dependant on each other	Proglottids independant & self contained
Helps in individuality of the organism & locomotion	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, metamerism initially developed secondarily as a result of repetition of body parts like blood vessels, coelom, nerves, 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, metamesic segmentation 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 & metacoel led to unsegmented coelomates like molluscs
→ Subdivision of metacoel produced primary segments leading to development of segmented Annelids.
→ This theory is based on phylogenic assumption that all bilateral

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

4. Locomotory Theory :-

→ Proposed by Clark

→ This theory proposes that metamerism evolved as an adaptation to locomotion of different kinds

→ It evolved independantly in chordates for locomotion which was previously carried out by undulation of body in primitive aquatic invertebrates

→ Annelid metamerism probably evolved for burrowing

→ Metamerism 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, cirri & 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, Glycera

2. Pelagic polychaetes

- Aka planktonic polychaetes
- Adapted to live in open sea & semitransparent in appearance
- Swim near sea surface where danger 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 cirri that carry tangoreceptors 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 movements
- 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, Glycera.

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. Chaetopterus

(d) Calcareous tubes :-

- tubes made up of calcium
- two large glands under collar folds secrete $CaCO_3$
- eg. Serpula

Acc. to mode of nutrition

1. Raptorial feeders
   - aka carnivorous feeders
   - include crawling, burrowing & tubiculous (most) & all pelagic polychaetes
   - feed on small invertebrates
   - capture the food by an eversible 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 extensile 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

e.

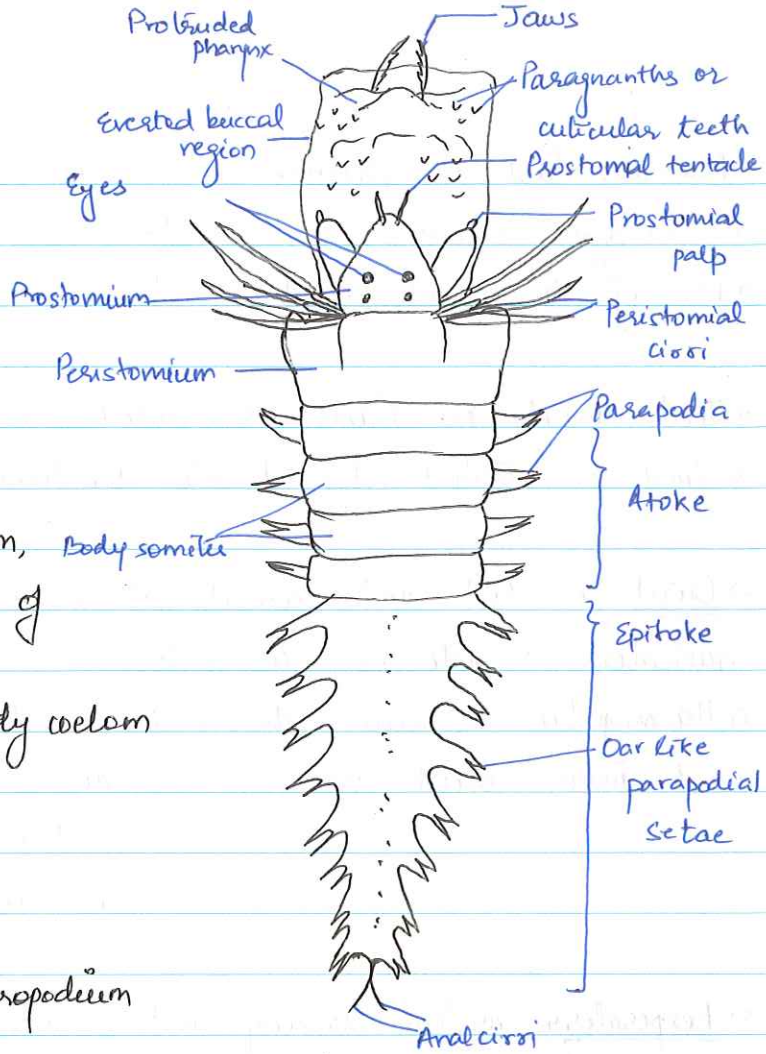
3- Filter feeders

» donot have a proboscis
» head provided with long bifinnate filaments called radides with a ciliated groove running along the oral surface
» Radides used in food collection

eg. 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 ciliary groove

eg. 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 U shaped tubes, may show filter feeding
- Each trunk segment except prostomium, peristomium & pygidium carries a pair of dorsoventrally flattened parapodia
- Parapodial cavity continuous with body coelom
- Biramous parapodia
  - Basal part
  - 2 lobes
    - Notopodium
    - Neuropodium
- 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)	Midgut (Mesenteron)	Hindgut (Proctodaeum)
- buccal cavity	- oesophagus	- rectum
- pharynx	- stomach	- lined by ectoderm & cuticle
- lined by ectoderm & cuticle	- lined by endoderm	

- Mouth lies ventral to prostomium & bordered by peristomium
- Anterior part of buccopharyngeal cavity forms an eversible proboscis
- The cuticular lining is thickened to form denticles

- Posterior part of pharynx has a pair of large, chitinuous, 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 cirri

- 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 cirri – tactile
  - 2 pairs of eyes

- Sexes are separate. Species that show Heteronereis 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 phase

↓

Changes to sexual Heteronereis post maturation
posterior part filled with gametes called epitoke } Phenomenon
anterior non sexual part without gametes atoke } EPITOKY

↓

Releases gametes & external fertilisation occurs

↓

Undero spiral & determinate cleavage

↓

Unequal size cells called stomatoblasts are produced < megameres / micromeres.
and embryo at this stage is k/a stereoblastula

↓

Epibolic gastrulation by spreading of micromeres over endoderm & somatoblasts

↓

Trochophore larva hatches

↓

Converts to adult Nereis.

TROCHOPHORE LARVA

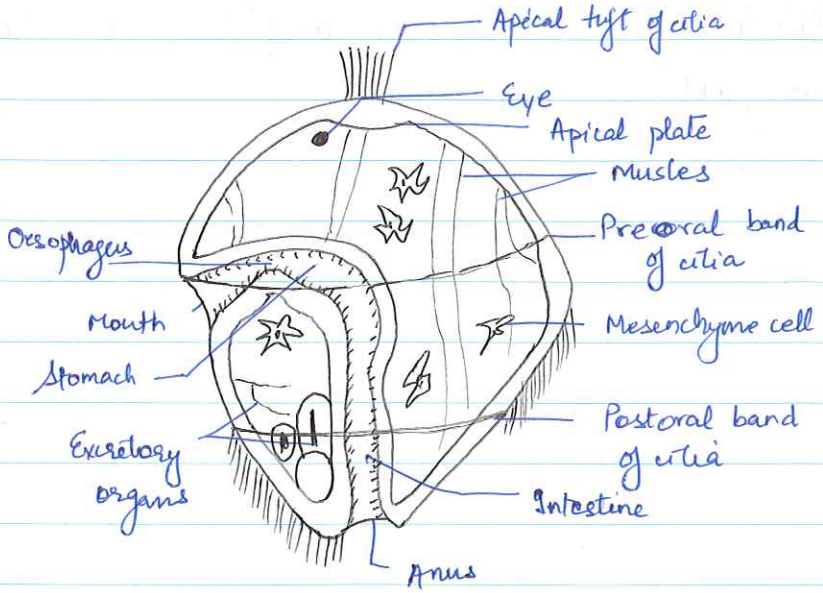
» Top of presumptive head differentiates into apical plate

↓

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 postrochophore or nectochaete

- 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 ~~larva~~ adult grows by adding few segments in front of pygidium