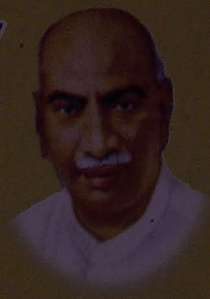




MADURAI KAMARAJ UNIVERSITY

(University with Potential for Excellence)

DIRECTORATE OF DISTANCE EDUCATION



B.Sc.

ZOOLOGY

First Year

PAPER - I

Invertebrata (Theory)

www.mkudde.org

5026

UZOO01

MADURAI KAMARAJ UNIVERSITY

(University with Potential for Excellence)

DIRECTORATE OF DISTANCE EDUCATION

Palkalai Nagar, Madurai – 625 021, India

Ph : 0452 – 2458471 (30 Lines) Fax : 0452 – 2458265

E-mail	: mkudde@mkudde.org
General grievances	: mkudde_grievances@gmail.com
UG Courses	: mkuddeug@gmail.com
PG Courses	: mkupg@gmail.com
MBA Courses	: mkuddembag@gmail.com
MCA Courses	: mkuddemcag@gmail.com
Education Courses	: mkuddeedu@gmail.com
Website	: www.mkudde.org
IVRS	: 0452 – 2459990
	: 0452 - 2459596

Student Support Service : 0452 – 2458419

DDE – Examinations

Fax : 0452 - 2458261

E-mail : mkuace@yahoo.com

Examn. Grievance Redress Cell : 0452 – 2458471 – Extn. 515

Reading Material Disclaimer

This reading material, developed by **Dr. C.Kandeepan & Mrs. R.V.Kalaimathi**, Arulmigu Palaniandavar College of Arts & Culture , Palani and reviewed by **Mrs.Raja Rajeswari, Associate Professor & Head**, Department Of Zoology, College, G.T.N Arts College ,Dindigul is an aid for the students of Directorate of Distance Education, Madurai Kamaraj University, to understand the course content. It is only for the registered students of DDE, MKU and is not for private circulation

©All copy rights & privileges are reserved



MADURAI KAMARAJ UNIVERSITY

(University with Potential for Excellence)

Madurai - 625 021.



DIRECTORATE OF DISTANCE EDUCATION

B.Sc.
(ZOOLOGY)
FIRST YEAR

PAPER - I
INVERTEBRATA
(THEORY)

www.mkudde.org

UZOO01
5026

Printed at Vinaya Note Book
Copies - 1000 First Print

MADURAI KAMARAJ UNIVERSITY

(University with Potential for Excellence)

Madurai - 625 021

DIRECTORATE OF DISTANCE EDUCATION



B.Sc.

(ZOOLOGY)

FIRST YEAR

PAPER - I

INVERTEBRATA

(THEORY)

www.mkude.org

U20001

5026

Printed at Vimala Note book
Copies - 1000 First Print

SYLLABUS

Paper I – Invertebrata (Theory)

- Unit – I** : Taxonomy: Units of Classification, Criteria of classification - types of Coelom, types of Symmetry, Binomial nomenclature. Classification up to class level, General characters of the following phyla with examples- i) Protozoa, ii) Porifera, iii) Coelenterata, iv) Platyhelminthes, v) Nematoda, vi) Annelida, vii) Arthropoda, viii) Mollusca, ix) Echinodermata
- Unit – II** : Protozoa: Type study –Paramecium- general organization, cyclosis, contractile vacuole and conjugation only. Life history, pathology and control of i) Plasmodium vivax and ii) Entamoeba histolytica. Porifera: Type study—Olynthus, general organization, histology, Spicules, reproduction and development only. Canal system in Sponges.
- Unit – III** : Coelenterata: Type study- Obelia; structure of obelia colony, Medusa, Nematocyst, reproduction and development (metagenesis) – Polymorphism in Coelenterata. Helminthes: Type study- Fasciola hepatica – external characters, digestive system, excretion, reproduction and development (life cycle). Structure, pathology and control measures of Ascaris and Wuchereria.
- Unit – IV** : Annelida: Type study—Earth worm, External morphology, setae, nephridia, nerves system and reproductive system – Metamerism in Annelids. Arthropoda: Type study-Marine Prawn – external morphology, appendages, digestive and excretory systems, reproductive system and development—Affinities of Peripatus.
- Unit V** : Mollusca: Type study- Pila – external morphology, digestive system, respiratory system, osphridium only. –Cephalopods as an advanced Mollusc. Echinodermata: Type study – Star fish, external morphology, pedicellaria, Water vascular system only. Larval forms of Echinodermata.

REFERENCE BOOKS:

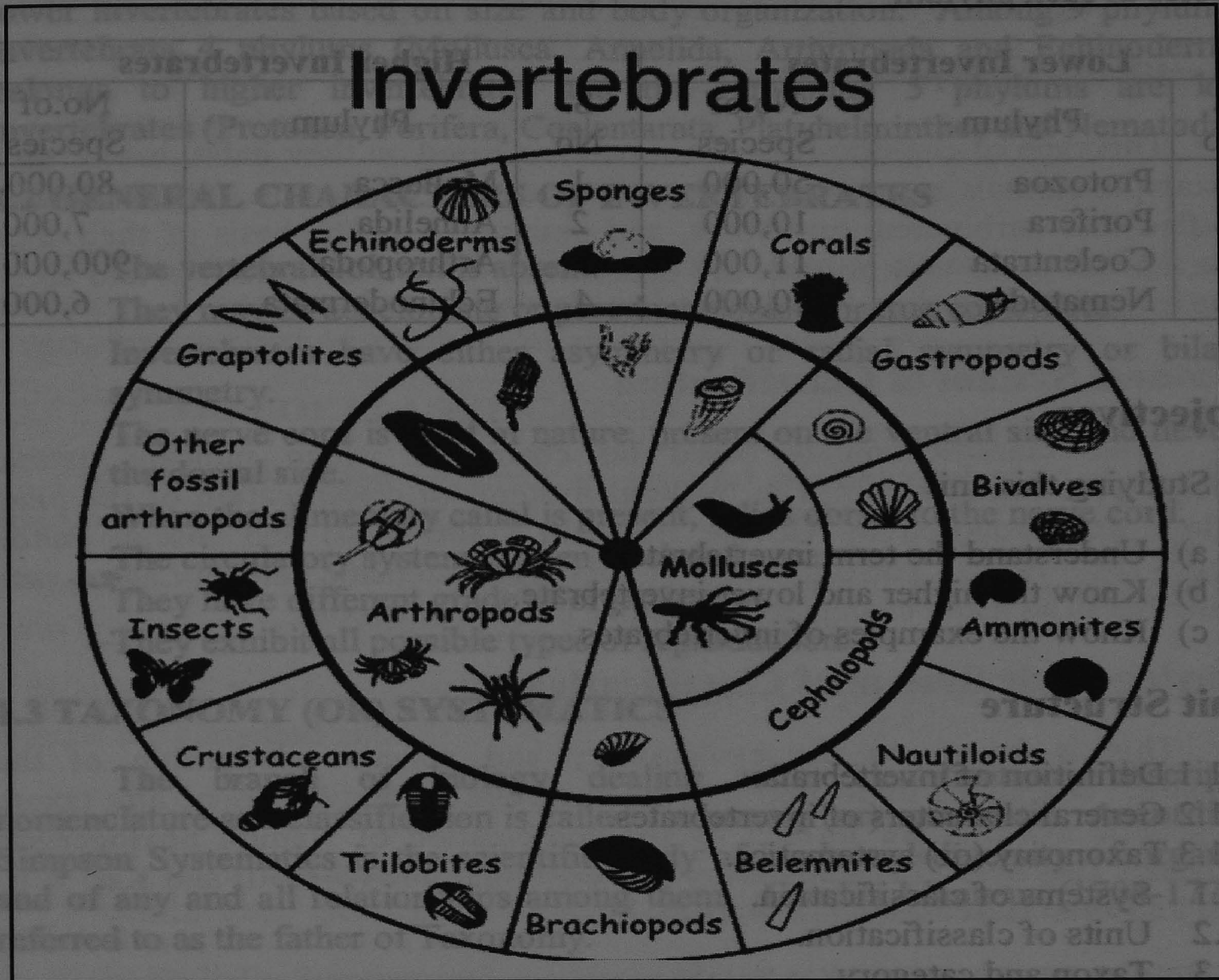
1. Invertebrate Zoology – **E.L. Jordon and P.S. Verma** (2005) S.Chand & co. New Delhi
2. Invertebrate Zoology – **P.S. Dhami and J.K. Dhami.** (2003) R.Cahnd & Co. New Delhi.
3. Invertebrate Zoology – **R.L.Kotpal,** (2005) Rastogi Publications, Meerat.
4. Text book of Invertebrata – **N.Arumugam et al.,** (2008) Saras Publications Nagerkovil.
5. A Manual of Zoology- **M.Ekambaranatha Iyer and T.N.Ananthakrishnan** (2003) Viswanathan Publications,

LESSON NO.	TITLE OF LESSON	PAGE NO.
1	Taxonomy – Classification upto class level	1-8
2	Phylum- Protozoa	9-34
3	Paramecium	35-50
4	Porifera – Olynthus	51-70
5	Coelenterata – Obelia (Seafur)	71-80
6	Platyhelminthes- Fasciola Hepatica	81-89
7	Aschelminthes- Ascaris Lumbricoides	90-92
8	Wuchereria Bancrofti	93-96
9	Annelida Type Study- Earthworm	97-104
10	Arthropoda – A Type Study-Prawn	105-138

Animals originated approximately 2 billion years ago. More than 2 million existing varieties of animals have been identified. Of these more than 12,72,000 are invertebrates and lower than 62,000 species are vertebrates. The animals which lack notochord or backbones are called invertebrates (e.g.) Amoeba, Hydra, Snails, Starfishes, insects etc. Vast and heterogeneous groups have been placed in the invertebrates. There is not even one positive character which is common to all invertebrates, and the differences between the groups are very large, each group of invertebrates has certain structural peculiarities, a special terminology and a distinct classification. Without a detail study of invertebrates, it is difficult to understand the secrets of life of animals on the whole, the invertebrates phyla are usually referred to as lower (five) and higher (four) invertebrates. The lower invertebrates are simple in body organization, and generally smaller in size. They are such as Protozoa, Porifera, Coelenterata (Cnidaria), Platyhelminthes and Nematoda. On the other hand, the higher invertebrates are generally larger in size and possess a complex body organization.

LESSON – 1

INTRODUCTION TO INVERTEBRATA



Animals originated approximately 600 million years ago. More than 2 million existing varieties of animals have been identified. Of these more than 12,72,000 are invertebrates and fewer than 62,000 species are vertebrates. The animals which lack notochord or backbones are called invertebrates (e.g.) Amoeba, Hydra, Snails, Starfishes, insects etc., Vast and heterogeneous groups have been placed in the invertebrates. There is not even one positive character which is common to all invertebrates, and the differences between the groups are very large, each group of invertebrates has certain structural peculiarities, a special terminology and a distinct classification. Without a detail study of invertebrates, it is difficult to understand the secrets of life of animals on the whole, the invertebrates phyla are usually referred to as lower (five) and higher (four) invertebrates. The lower invertebrates are simple in body organization, and generally smaller in size. They are such as Protozoa, Porifera, Coelentrata (Cnidaria), Platyhelminthes and Nematoda. On the other hand, the higher invertebrates are generally larger in size and possess a complex body organization.

The higher invertebrates include various phyla such as Mollusca, Annelida, Arthropoda and Echinodermata.

Table 1.1 Higher and Lower Invertebrate Phyla and approximate number of species in each phylum

Lower Invertebrates			Higher Invertebrates		
S. No	Phylum	No. of Species	S. No	Phylum	No. of Species
1.	Protozoa	50,000	1	Mollusca	80,000
2.	Porifera	10,000	2	Annelida	7,000
3.	Coelentrata	11,000	3	Arthropoda	900,000
4.	Nematoda	10,000	4.	Echinodermata	6,000

Objectives

By Studying this unit

- Understand the term invertebrata.
- Know the higher and lower invertebrate.
- Know the examples of invertebrates.

Unit Structure

- 1.1 Definition of invertebrata.
- 1.2 General characters of invertebrates.
- 1.3 Taxonomy (or) systematics.
 - 1.3.1 Systems of classification.
 - 1.3.2 Units of classification.
 - 1.3.3 Taxon and category.
 - 1.3.4 Criteria of classification.
 - 1.3.5 Binomial nomenclature.
- 1.4 Let us sum up.
- 1.5 Key words.
- 1.6 Books for further reading.
- 1.7 Questions/exercises.
- 1.8 Answer for cyp questions.

1.1 DEFINITION OF INVERTEBRATA

The organisms without backbone are called invertebrates. Examples: Paramecium, Starfish, Insects, Snails etc., They are classified into higher and lower invertebrates based on size and body organization. Among 9 phylums of invertebrata 4 phylums (Mollusca, Annelida, Arthropoda and Echinodermata) belongs to higher invertebrates and the remaining 5 phylums are lower invertebrates (Protozoa, Porifera, Coelentarata, Platyhelminthes and Nematoda).

1.2 GENERAL CHARACTERS OF INVERTEBRATES

The vertebral column is absent.

They may be acoelomate or pseudocoelomate or true coelomate.

Invertebrates have either asymmetry or radial symmetry or bilateral symmetry.

The nerve cord is solid in nature, present on the ventral side and never on the dorsal side.

When the alimentary canal is present, it lies dorsal to the nerve cord.

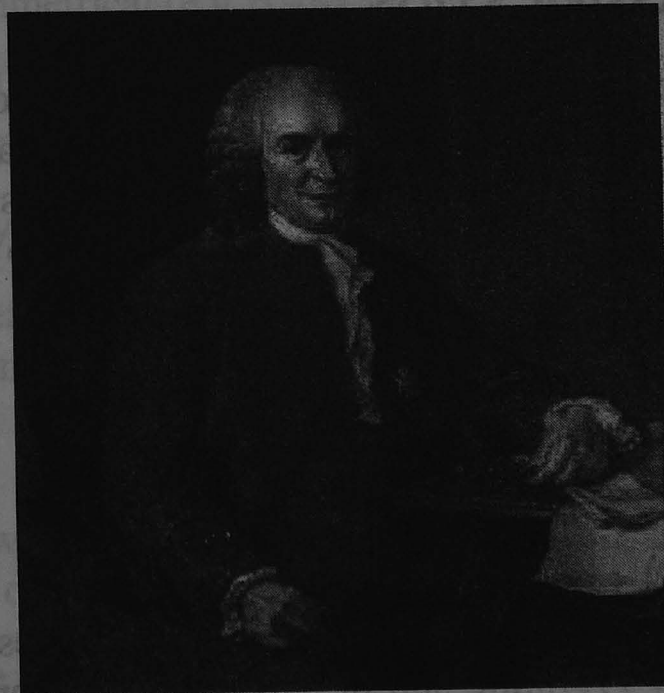
The circulatory system is open or closed type.

They have different grade of organization.

They exhibit all possible types of reproduction.

1.3 TAXONOMY (OR) SYSTEMATICS

The branch of biology dealing with identification, description, nomenclature and classification is called Taxonomy (or) systematic. According to Simpson Systematics is the scientific study of kinds and diversity of organisms and of any and all relationships among them. Carolus Linnaeus (1704-1778) is referred to as the father of Taxonomy.



Carolus Linnaeus

CHECK YOUR PROGRES

S

1. Define invertebrate

2. What is higher invertebrate

3. Give the example for lower invertebarat e

There are three types of classification. They are

1. Artificial System of classification.
2. Natural System of classification.
3. Phylogenetic System of classification.

1. Artificial System of Classification

This type of classification of animals are based on their habit, habitat etc., for example animals are classified into oviparous and viviparous. They are again classified into herbivores, carnivores, and omnivores on the basis of their food habits. In the same way animals are classified into aquatic, terrestrial and aerial on the basis of the places where they live (habitat).

2. Natural System of Classification

“This classification is based on characters which indicate natural relationships or similarity”. The ‘Natural System’ of classification of the plant kingdom was proposed by George Bentham (1800-1844) and Joseph Palton Hooker (1817-1911). The organisms of a natural systematic category agree with one another in so many characters due to one common ancestor.

3. Phylogenetic System of Classification

This is based on the evolutionary and genetic relationship of the organisms. It enables us to find out the ancestors or derivatives of any taxon. Phylogenetic systems are formed by the combination of Natural phylogenetic evidences. This system is adopted by Adolph Engler (1844-1930) and Karl A.E. Prantil and John Hutchinson (1884-1974).

1.3.2 UNITS OF CLASSIFICATION

All animals are placed in a very large group called Animal Kingdom or Animalia. The animal kingdom is split into large groups called phyla. The phyla are divided into small groups called classes. The classes are divided into still smaller groups called orders. The orders are divided into smaller groups called species.

Animal Kingdom

Phylum

Class

Order

Species

These are the main units of classification sometimes these main units are sub divided into subunits by Prefixing sub or super. For example, sub-phylum, sub-class, super class, sub-order, super-order etc.

Species is the smallest unit of classification. Species is defined as a group of genetically similar individuals which interbreed among themselves. So there is free gene flow between the members of a species.

1.3.3 TAXON AND CATEGORY

According to Simpson "A Taxon is a group of real organisms recognised as a formal unit at any level of a hierarchic classification".

Category

The group of animals are Taxa. Each Taxon is placed at some level in hierarchy. A category designates rank or level in a hierarchic classification. It is a class, the members of which are all the taxa assigned a given rank.

1.3.4 CRITERIA OF CLASSIFICATION

1. Grade of organization : Animals are grouped into unicellular and multicellular based on the number of cells.

2. Germ layers: The multicellular animals are classified into diploblastic (two germ layers) and triploblastic (three germ layers) animals.

3. Symmetry: It refers to the arrangement of body parts. Based on symmetry, animals are classified into

a) Assymetrical (e.g Amoeba)

In asymmetry, the body parts are irregularly arranged around the central axis. Such animals cannot be divided into two equal halves.

b) Radially Symmetrical (e.g Hydra)

In radial symmetry, the body can split in two equal halves by any plane passing through the central axis from top to bottom.

c) Bilaterally Symmetrical (e.g Earthworm)

In bilateral symmetry, the body can be split into two equal halves by only one plane.

4. COELOM

The space between the body wall and digestive tract is called coelom. Based on the nature of coelom, animals are classified into

a) Acoelomale – Animals without a coelom (eg. Tapeworm).

b) Psuedocoelomale – Animals with a false coelom (eg. Roundworm).

c) Eucoelomale – Animals with a true coelom (eg. Earthworm).

5. BODY TEMPERATURE

Animals are classified into two groups on the basis of their ability to regulate body temperature into

- a) Poikilothermic animals – whose body temperature varies with that of environment. (eg. Fish, frog).
- b) Homeothermic animals – whose body temperature always remains constant irrespective of changes in the surrounding (eg. Birds, man).

1.3.5 BINOMIAL NOMENCLATURE

In 1898, the international congress of Zoology organised an International Commission on Zoological Nomenclature to formulate a set of rules to frame a Nomenclature. It is a system of naming animals. According to this system, each animal is named by two words. The first word is called generic name, and the second word is called species name. The generic name starts with a capital letter and the species name starts with a small letter. Eg *Euglena viridis*. *Euglena* is the generic name and *viridis* is the species name.

Phylum	- Protozoa
Sub-Phylum	- Sarcomastigophora
Super Class	- Mastigophora
Class	- Phytomastigophora
Genus	- <i>Euglena</i>
Species	- <i>Viridis</i>

1.4 LET US SUM UP

Animals are classified into two groups namely Invertebrata and Vertebrata. The animals which lack a notochord are called invertebrates. The higher invertebrate phyla are 4 and lower invertebrates phyla are 5. The assembling of animals into groups based on their similarities is called classification or taxonomy. They are three classifications such as Natural, Artificial and Phylogenetic. Linnacus is referred to as the father of Taxonomy. He also discovered the Binomial Nomenclature in (1737). It is a system of naming animals with the generic name in the first word and species name as a second word. The criteria of classification is mainly based on grade of organization, germ layers, symmetry, coelom, body temperature etc.

1.5 KEY WORDS

Invertebrata	- Animals without backbone.
Taxonomy	- Taxon, Classification of animals, a group of animal.
Binomial	- Naming of animal by giving two names.

nomenclature

Phylogenetic

- System of clarification based on evolutionary and genetic relationship of the organism

Symmetry

- Arrangement of the structures in animal in relation to the central axis.

Coelom

- The cavity between the body wall and the alimentary canal.

1.6 BOOKS FOR FUTURE READING

1. Invertebrate Zoology-R.L.Kotpal(2005) Rastogipublications, Meerat
2. Chordate Zoology-. E.L. Jordan and Dr.P.S.Verma(2006) S.Chand & Co.NewDelhi
3. Text Book of Invertebrate- Dr.N.Arumugam Etal,(2008) Saras Publications, Nagerkovil.

1.7 QUESTIONS / EXERCISES

Part – A

1. Define Taxonomy.
2. What do you mean by Binomial Nomenclature.
3. Who is the father of Taxonomy?

Part – B

1. Write a short notes on lower and higher invertebrate phyla.
2. Briefly explain the types of classification.

Part – C

1. Enumerate the salient features of invertebrates.
2. Explain the criteria of classification of animals.
3. Who is the father of Taxonomy?

1.8 Answers for CYP questions.

1.8 ANSWER FOR CYP QUESTIONS

For Q.No.1 in Part A refer section No.1.3

For Q.No.2 in Part A refer section No.1.3.5

For Q.No.3 in Part A refer section No.1.3

For Q.No.1 in Part B refer section No.1.3

For Q.No.2 in Part B refer section No.1.3

For Q.No.1 in Part C refer section No.1.3

For Q.No.2 in Part C refer section No.1.2

For Q.No.3 in Part C refer section No.1.3.4

1.6 BOOKS FOR FUTURE READING

1. Invertebrate Zoology-R.L.Kopal(2002) Rastogi Publications, Meerut
2. Chordate Zoology- E.L. Jordan and D.P.S.Verma(2006) S.Chand & Co New Delhi
3. Text Book of Invertebrate- Dr.N.Aranganam Etal.(2008) Satya Publications, Nagerkovil

1.7 QUESTIONS & EXERCISES

Part - A

1. Define Taxonomy.
2. What do you mean by Binomial Nomenclature.
3. Who is the father of Taxonomy?

Part - B

1. Write a short notes on lower and higher invertebrate phyla.
2. Briefly explain the types of classification.

1.8 ANSWER FOR CYP QUESTIONS

For Q.No.1 in Part A refer section No.1.3

For Q.No.2 in Part A refer section No.1.3.2

For Q.No.3 in Part A refer section No.1.3

For Q.No.1 in Part B refer section No.1.3

LESSON – 2

INTRODUCTION TO PRESENT INVERTEBRATE PHYLA

Presently there are 30 invertebrata phyla, which are characterised by a unit of basic structural pattern in each of the phylum. This means in each phylum, though the members may differ in external features are constructed on the same ground plan in many respects. Evolutionary studies have confirmed that all the members of an individual phylum have been derived directly or indirectly from a common primitive ancestral type. Among 30 phyla, only nine phyla and their general characters are discussed in this lesson.

Objectives

By Studying this unit, the students will

- d) understand the present invertebrate phyla.
- e) know the difference between major and minor phyla.
- f) know the general characters of each phylum.

Unit Structure

- 2.1 Definition of phyla.
- 2.2 Classification of major and minor phyla.
- 2.3 Lower and higher invertebrate phyla.
- 2.4 General characters of phylum.
 - 2.4.1 General Characters of Phylum Protozoa.
 - 2.4.2 General Characters of Phylum Porifera.
 - 2.4.3 General Characters of Phylum Coelentrata.
 - 2.4.4 General Characters of Phylum Platyhelminthes.
 - 2.4.5 General Characters of Phylum Ashelminthes.
 - 2.4.6 General Characters of Phylum Annelida.
 - 2.4.7 General Characters of Phylum Arthropoda.
 - 2.4.8 General Characters of Phylum Mollusca.
 - 2.4.9 General Characters of Phylum Echinodermata.
- 2.5 Let us sum up.
- 2.6 Key words.
- 2.7 Books for further reading.
- 2.8 Questions/Exercise.
- 2.9 Answer for cyp Questions.

2.1 DEFINITION OF PHYLUM

The invertebrates are grouped into about 30 phyla on the basis of unity of basic structural pattern present in them.

2.2 CLASSIFICATION OF MAJOR AND MINOR PHYLA

The invertebrate phyla have been divided into major and minor phyla on the basis of two factors. (i) the number of species and individual. (ii) their participation in ecological communities. On the basis of the first factor 11 (eleven) phyla appear to be clearly major.

These are Protozoa, Porifera, Coelentrata, Platyhelminthes, Rotifera, Nematoda, Mollusca, Annelida, Arthropoda, Ectoprocta and Echinodermata. On the basis of second factor, if the phyla are represented in great majority of ecological communities, they would be regarded as major phyla. Whereas, the minor phyla form only a fraction of animal communities. On the basis the two phyla, Rotifera and Ectoprocta cannot be considered as major phyla due to their limited participation in animal communities.

2.3 LOWER AND HIGHER INVERTEBRATE PHYLA

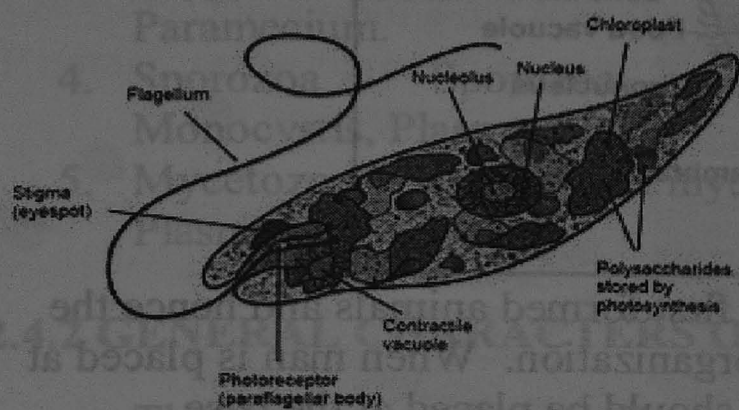
The lower invertebrate phyla are simple in body organization and generally small in size eg. Protozoa, Porifera, Coelentrata, Platyhelminthes and Nematoda. On the other hand higher invertebrates are larger in size and a complex body organization eg. Mollusca, Annelida, Arthropoda and Echinodermata.

2.4 GENERAL CHARACTERS OF PHYLUM

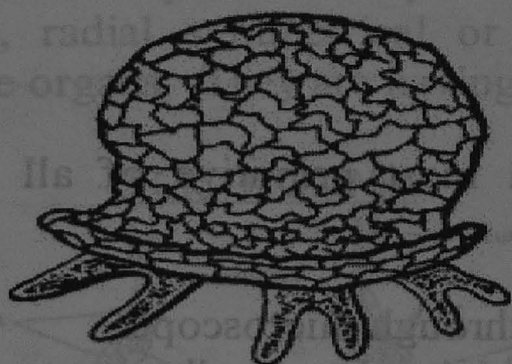
The general characters of invertebrates, like habitat, numerical strength, shape, size, symmetry, grade of organization, germ layers, segmentation, coelom, Intra as well as extracellular digestion mechanism, open as well as closed type circulatory system and varied modes of reproduction of different phylum will be discussed.

2.4.1 GENERAL CHARACTERS OF PHYLUM PROTOZOA

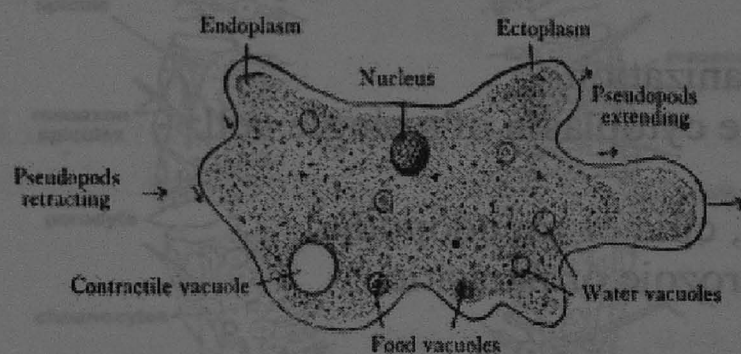
EUGLENA



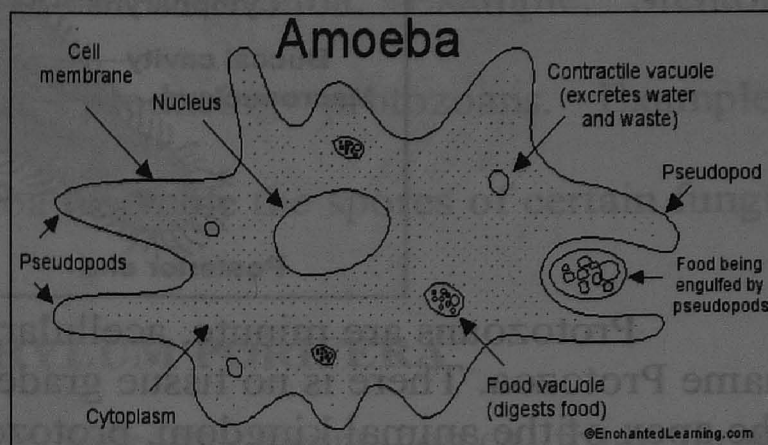
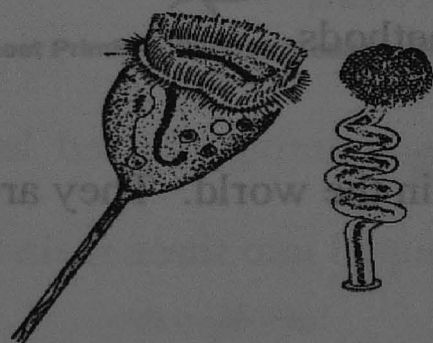
DIFFLUGIA



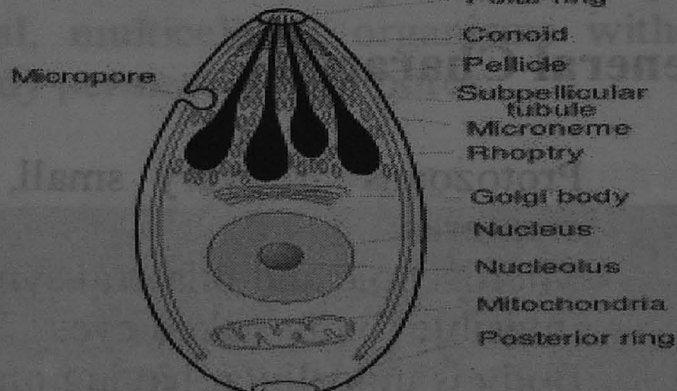
AMOEBA



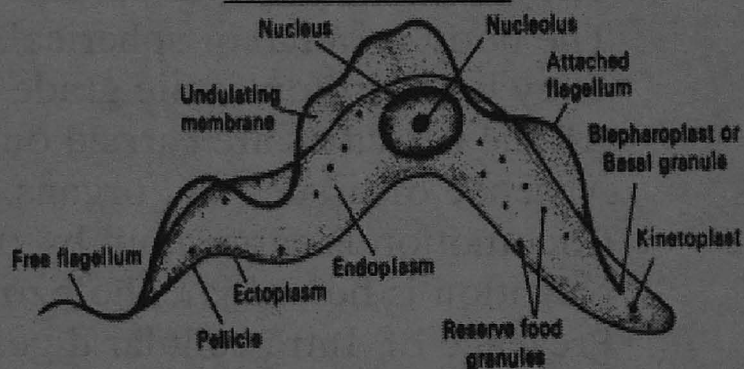
VERTICELLA



SPOROZOA

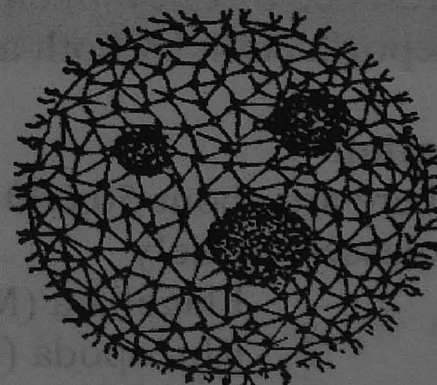


TRYPANANOMA

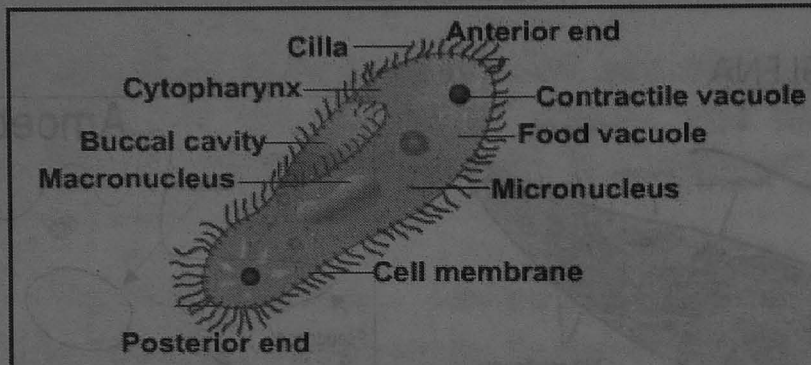


Trypanosoma gambiense

VOLVOX



PARAMECIUM



Protozoans are minute, acellular, the first formed animals and hence the name Protozoa. There is no tissue grade of organization. When man is placed at the apex of the animal kingdom, protozoans should be placed at the base.

General Characters

Protozoans are very small, simple and most primitive of all animal creatures.

Microscopic and bilateral symmetry

Invisible to our naked eyes. Visible only through microscope.

Body is unicellular having one or more nuclei and organelles.

They are free living or parasitic in nature symmetry is bilateral.

The body is radial or spherical.

They have protoplasmic grade of organization

All the activities are carried out by the cytoplasm of a single cell.

Absence of tissues and organs.

Locomotion is carried out by flagella, cilia or pseudopodia.

Nutrition is holophytic, holozoic, saprozoic or parasitic.

Presence of Intra cellular digestion.

Respiration and excretion occurs by diffusion.

In freshwater protozoans, contractile vacuoles used for osmo-regulation.

Presence of Encystment.

Reproduction by both asexual and sexual methods.

CHECK YOUR PROGRESS

1. What do you mean by major

phyla?

2.

Define minor

phyla.

3. Give

Classification

There are about 50,000 protozoans present in the world. They are grouped into five classes, namely

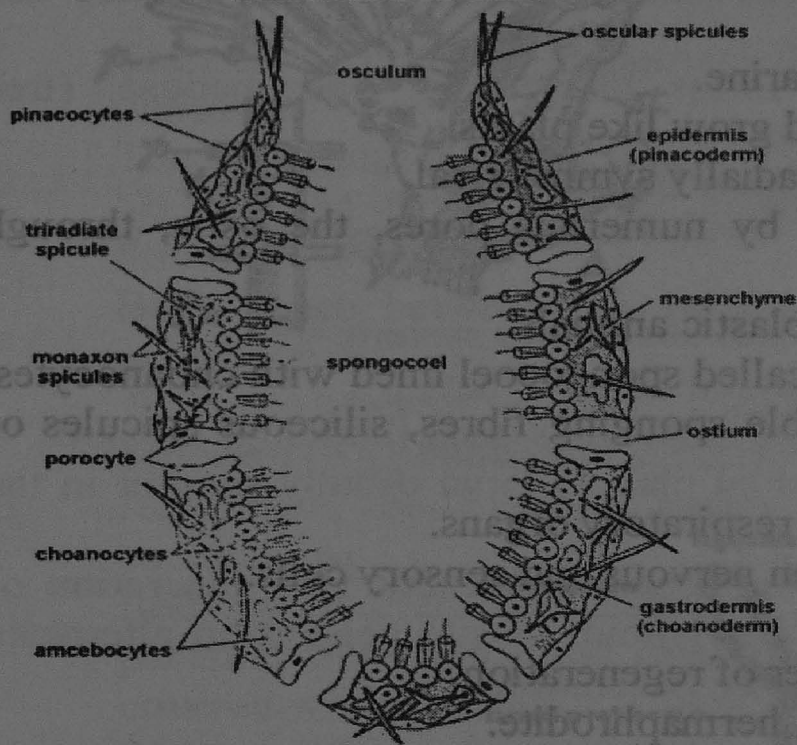
1. Flagellata (Mastigophora).
2. Rhizopoda (Sarcodina).
3. Ciliphora.
4. Sporozoa
5. Mycetozoa.

1. Flagellata (Mastigophora)–Protozoans having flagella. Example: Euglena, Noctiluca.
2. Rhizopoda – Protozoans with pseudopodia. Amoeba, Entamoeba
3. Ciliphora – Protozoans are provided with cilia. Example: Stentor, Paramecium.
4. Sporozoa – Sporozoa are spore producing protozoans. Example: Monocystis, Plasmodium.
5. Mycetozoa- The spores of mycetozoa resemble the spores of certain fungi. Plasmodiophora.

2.4.2 GENERAL CHARACTERS OF PHYLUM PORIFERA

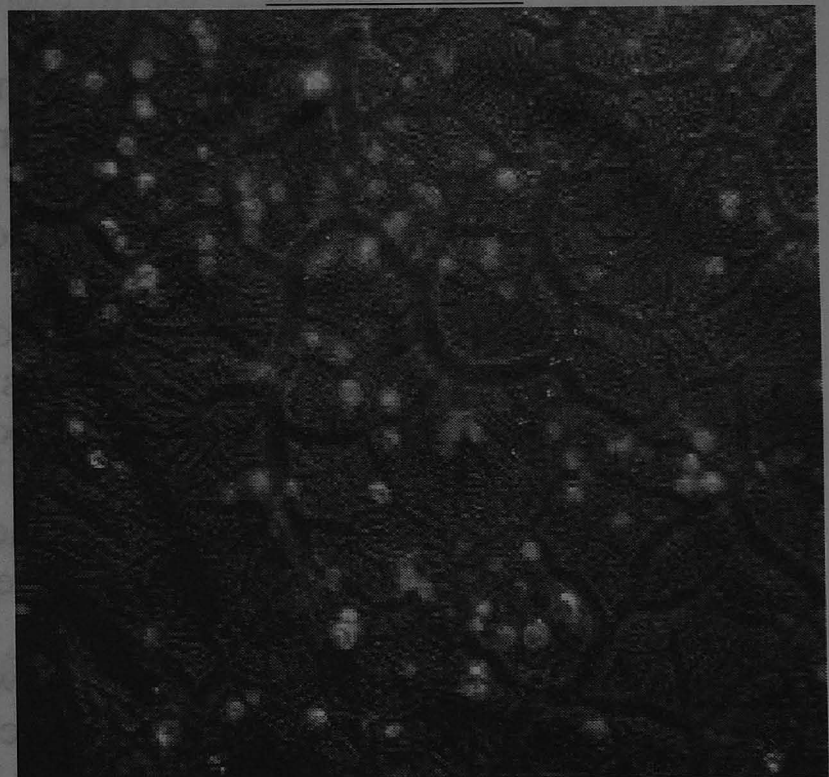
The name porifera (L.Porus=Pore; Ferro=to bear) comes from Grant (1836). The porifera may be characterised as sedentary, aquatic, solitary or clonal, radial symmetrical or asymmetrical, multicellular organisms without definite organs. They are having a porous body permeated with pores.

LECICOSOLENIA

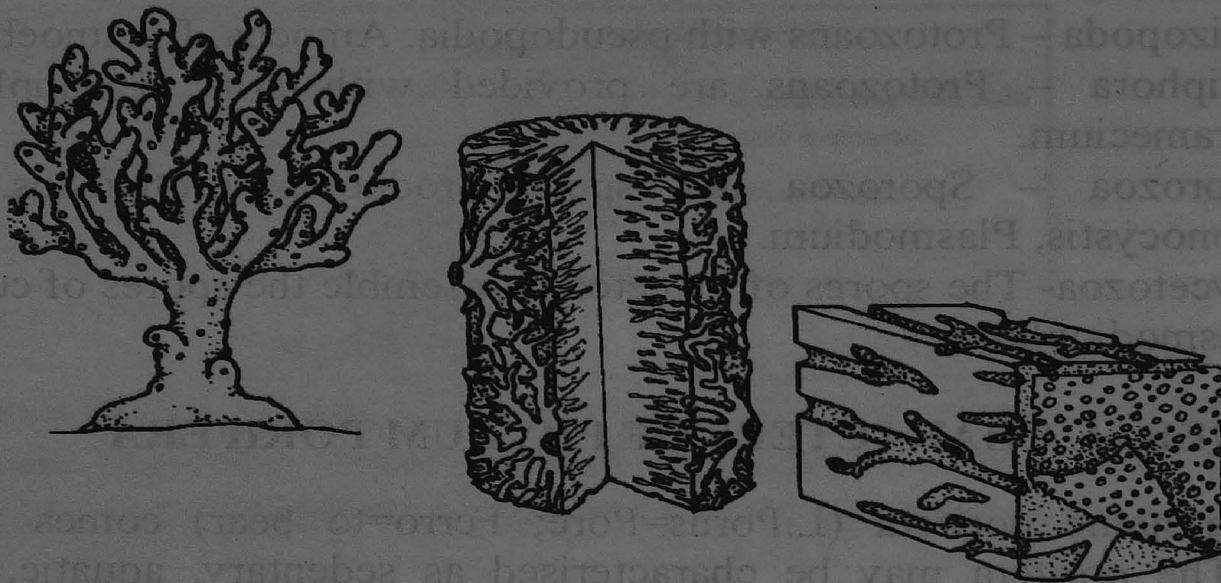


Most Primitive Sponge (*Leucosolenia*)

HYALONEMA



OSCARELLA



Livingstone, © BIODIDAC

General Characters

Porifera are all aquatic, mostly marine.

They are sterile and sedentary and grow like plants.

They are either asymmetrical or radially symmetrical.

The body surface is perforated by numerous pores, the ostia, through which a water current flows.

They are multicellular with diploblastic animals.

The interior space of the body is called spongocoel lined with choanocytes.

The sponges possess either flexible sponging fibres, siliceous spicules or calcarious spicules.

Absence of mouth, excretory and respiratory organs.

There is no differentiation between nervous and sensory cells.

The digestion is intra cellular.

The sponges possess greater power of regeneration.

The sponges are monoecious, i.e., hermaphrodite.

Asexual reproduction occurs by buds and gemmules.

Sexual reproduction occurs by ova and sperms.

Development is indirect through a free swimming ciliated larva called amphiblastula or parenchymula.

The organization of sponges have been grouped into three main types, viz, ascon type, sycon type and leuconoid type.

Classification

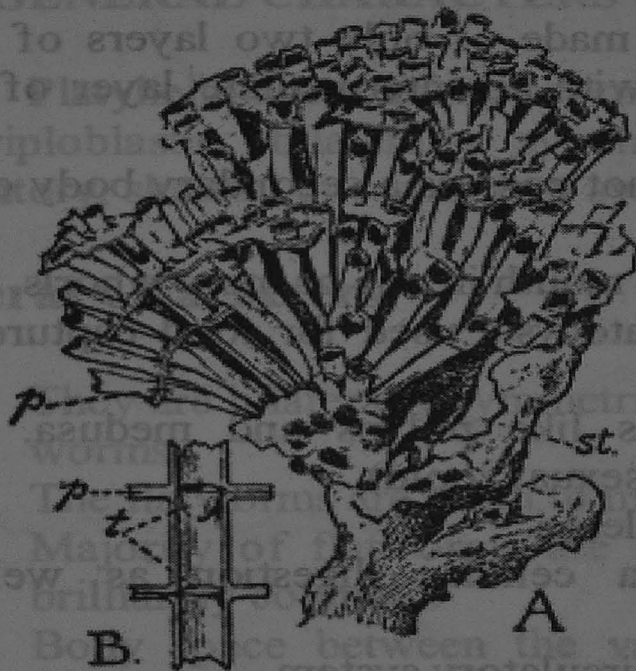
The classification of porifera is based on types of skeleton found in them by a modified form of Hyman's classification (1971). Phylum porifera is divided into three class based on the types of spicules.

1. Calcareo-calcispongiae (L. Calx=lime, Gr., sponges-sponge) They have skeleton of separate calcarious spicules. Example: Lecicosolenia.
2. Hexactinellida Skeleton is formed by six rayed triaxon with siliceous spicules. Example: Hyalonema.
3. Demospongiae (Gr. Dermos = Frame; Spongos= sponge) Skeleton either present or absent. When present it is formed of sponging fibres or sponging silicious spicules. Example: Oscarella.

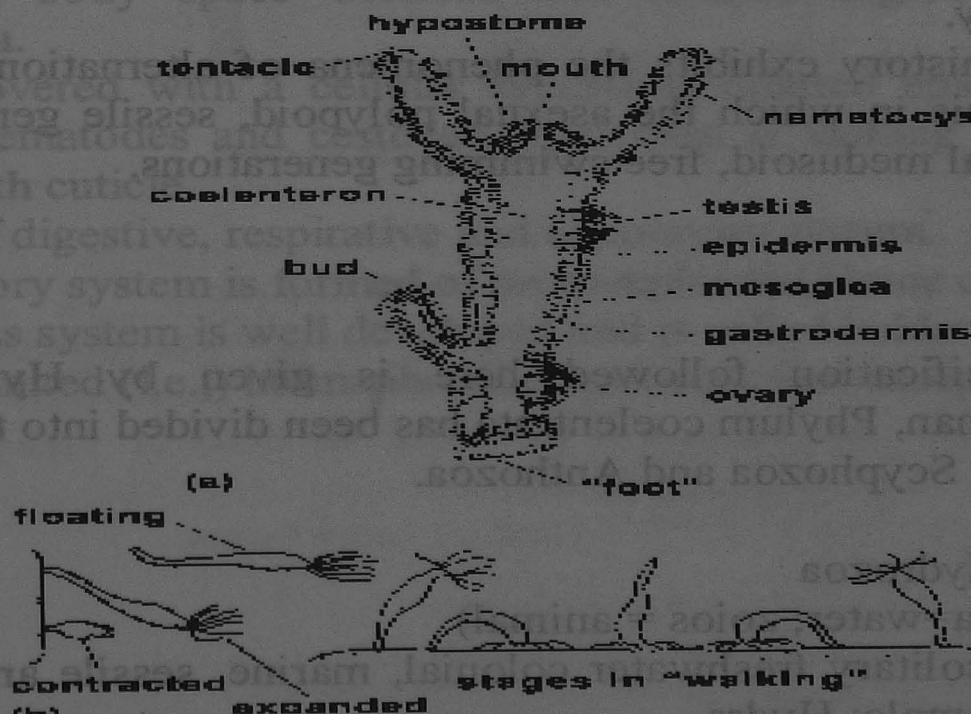
2.4.3 GENERAL CHARACTERS OF PHYLUM COELENTRATA

TUBIPORA

AURELIA



HYDRA



The coelentrata may be defined as "diploblastic metazoan with tissue grade of organization having nematocysts, and a single gastro vascular cavity or the coelenteron.

General Characters

They are multicellular animals with tissue grade of organization.

They are aquatic, mostly marine except hydra.

They are sedentary or free swimming and solitary or colonial.

The body is radially or biradially symmetrical with a central gastro vascular cavity.

They are diploblastic animals. It is made of only two layers of cells, namely the ectoderm and endoderm with an intermediate layer of non-cellular gelatinous mesogloea.

Acoelomate animals because they do not possess a secondary body cavity the coelom.

Short and slender tentacles encircle the mouth in one or more whorls.

The tentacles are provided with nematocysts used for food capture and defence.

They exhibit the polymorphic forms like polyps and medusa. (free swimming sexual zooid) (Sessile and asexual zooid).

Skeleton either exoskeleton or endoskeleton.

They are usually carnivorous extra cellular digestion as well as intracellular.

Absence of respiratory, excretory and circulatory system.

Nervous system is diffuse type, formed or nerve nets.

Reproduction is both by asexual (gametes) and sexual (budding) methods.

Development is indirect as a ciliated planula larva usually present in the life history.

The life history exhibits the phenomena of alternation of generation or metagenesis in which the asexual polypoid, sessile generation alternates with sexual medusoid, free swimming generations.

Classification

The classification followed here is given by Hyman, L.H(1940). According to Hyman, Phylum coelentrata has been divided into three classes, viz Hydrozoa, Scyphozoa and Anthozoa.

1. Class - I Hydrozoa

(Gr., Hydra=water; zoios = animal)

They are solitary freshwater colonial, marine, sessile and free swimming forms. Example: Hydra.

2. Class - II Scyphozoa

(Gr., Skyphos=cup; zoios = animal)

Scyphozoans are large jelly fishes or true medusae are exclusively marine.

Example: Aurelia.

3. Class - III Anthozoa

(Gr., Anthos=flower; zoios = animal)

Solitary or colonial exclusively marine, polypoid forms. Example: Tubipora.

2.4.4 GENERAL CHARACTERS OF PHYLUM PLATYHELMINTHES

Platyhelminthes are flatworms (GK, Platys=Flat; helminth=worm). They are triploblastic, bilaterally symmetrical, acoelomate without definite anus, circulatory, skeletal or respiratory systems.

General Characters

They are bilaterally symmetrical, dorso ventrally flattened and triploblastic worms.

The flatworms are small to moderate in size from 10-15 meters.

Majority of flatworms are colourless some are brown, grey, black or brilliantly coloured.

Body space between the various organs is filled with a mesenchyme parenchyma.

Presence of great variety of adhesive secretions, organs of attachment and adhesion (e.g., hooks and suckers).

Acoelomate, body space between the various organs is filled with parenchyma.

Body is covered with a cellular syncytical ciliated epidermis, while in parasitic trematodes and cestodes, epidermis is lacking and the body is covered with cuticle.

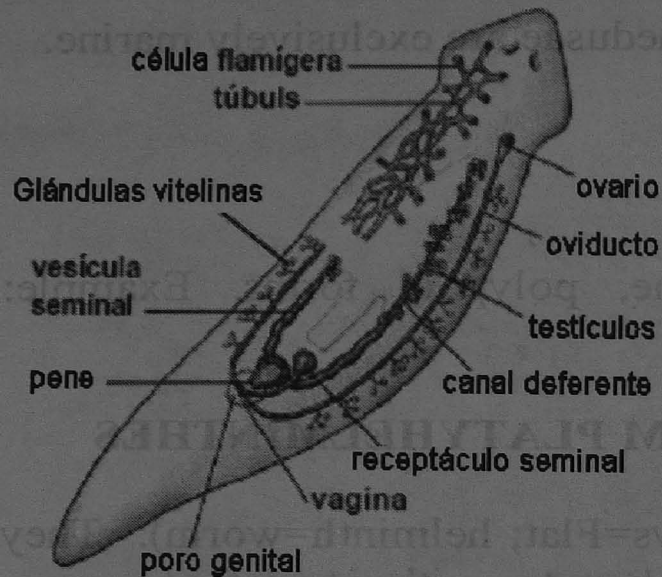
Absence of digestive, respirative and circulatory system.

The excretory system is formed of protonephridia(Flame cells).

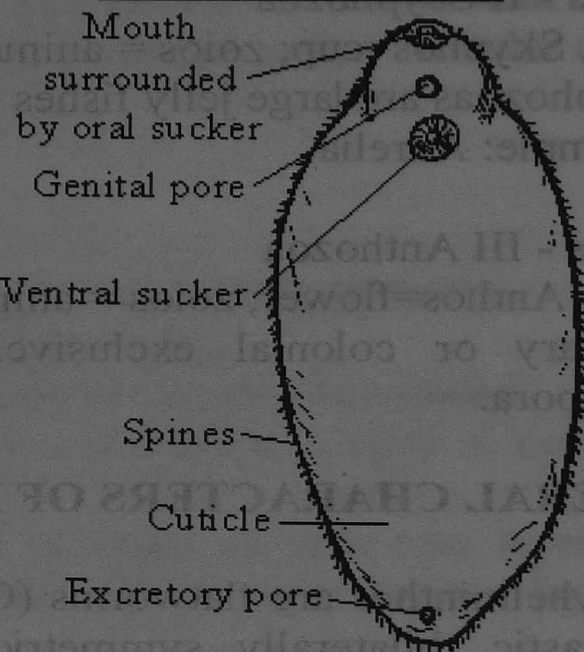
The nervous system is well developed and is called ladder type.

Sexes are united (i.e.,) hermaphrodite with very few exceptions.

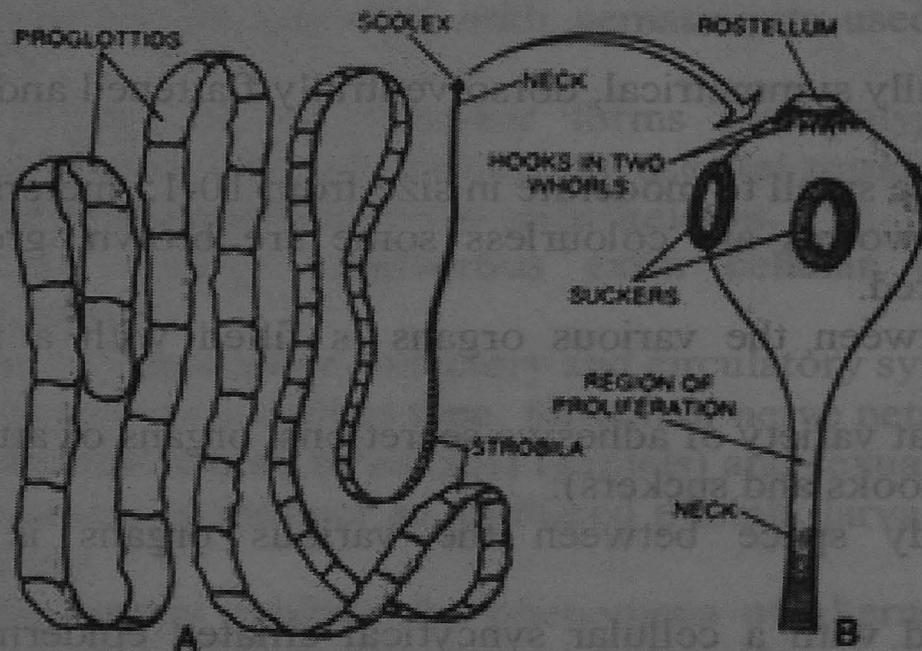
PLANARIA



FASCIOLA HEPATICA



TAENIA SOLIUM



Taenia solium : A. whole; B. its scolex

Reproductive system is highly evolved or complex.
 Asexual reproduction by fission in many freshwater turbellaria.
 Self or cross fertilization take place in them. Fertilization is internal.
 The flatworms are circular free living or ecto or endocommensals or parasites.
 Life cycle complicated involves one or more hosts.

Classification

The classification adopted here is from Hyman, L.H(1951) with certain modifications.

1. Class - I Turbellaria

(L., Turbella = a little string)

Mostly free living, flatworms, body segmented. Some are ectocommensals and endocommensals or parasitic. Eg: Planaria

2. Class - II Trematoda

(Gr., Tramatodes = having pores)

They are flukes either ectoparasitic or endoparasitic forms.

Example: Polystoma, Fasciola Hepatica

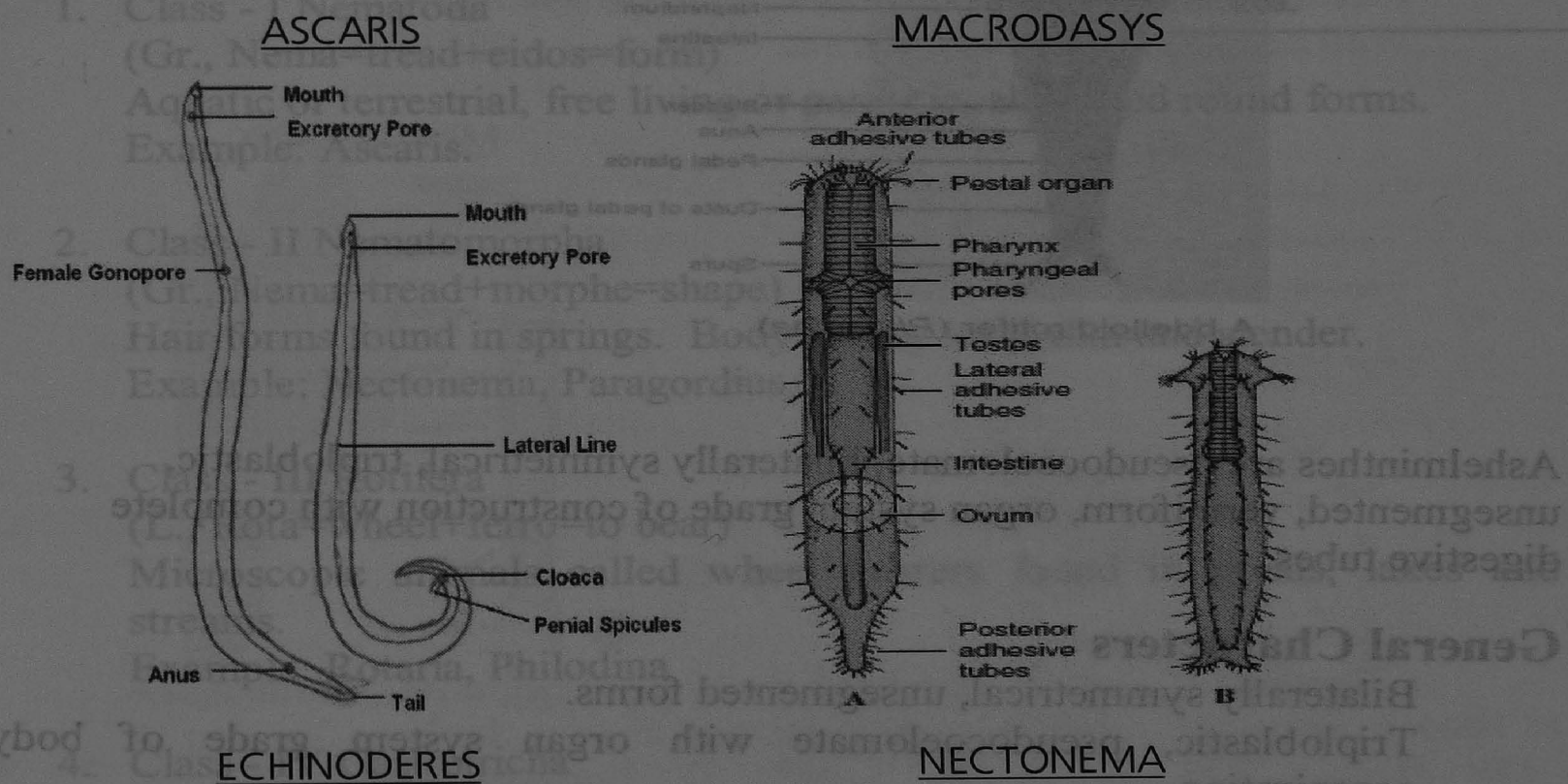
3. Class - III Cestoda

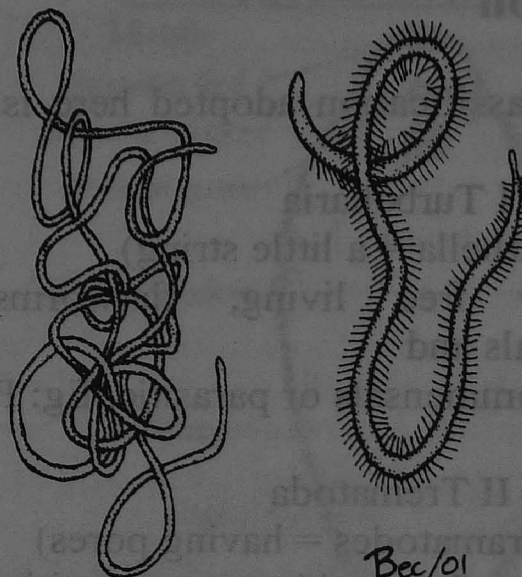
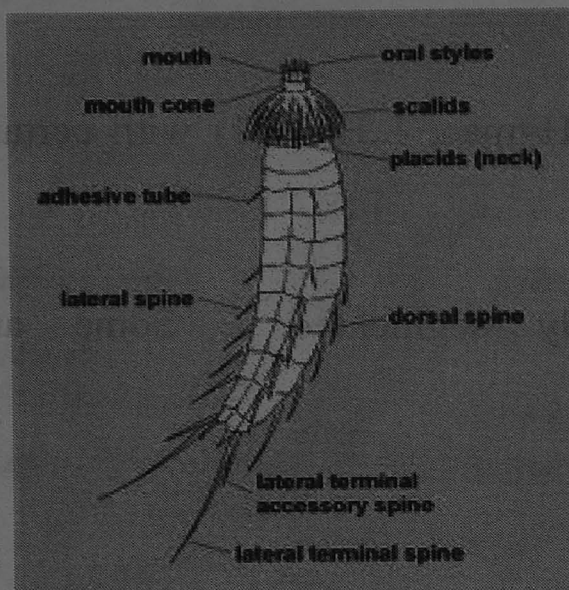
(Gr., Kestos = gridle+eidos = form)

They are tapeworms in the intestine of vertebrates.

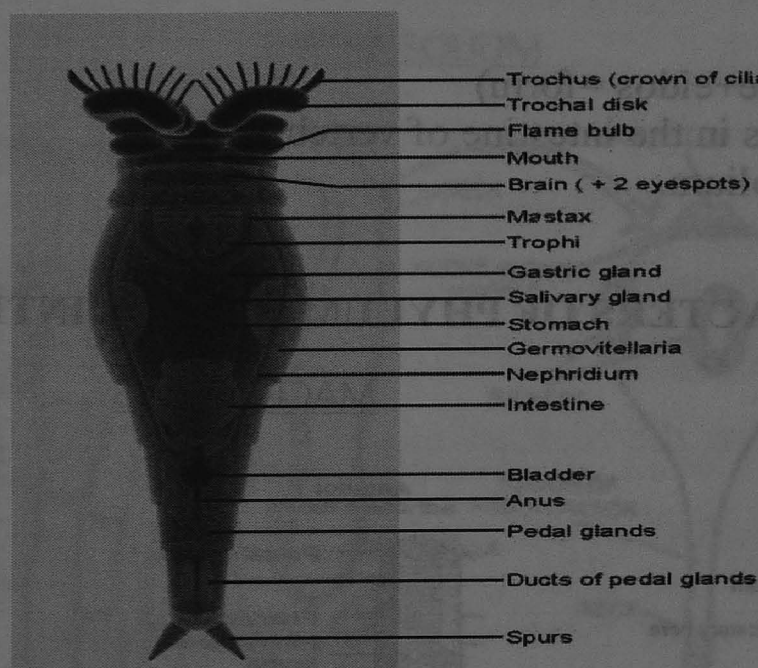
Example: Taenia solium.

2.4.5 GENERAL CHARACTERS OF PHYLUM ASHELMINTHES





PHILODINA



A bdelloid rotifer (*Philodina*)

Ashelminthes are pseudocoelomate, bilaterally symmetrical, triploblastic, unsegmented, vermiform, organ system grade of construction with complete digestive tubes.

General Characters

Bilaterally symmetrical, unsegmented forms.

Triploblastic, pseudocoelomate with organ system grade of body organization.

Very small, microscopic while others are few millimetres to a meter length.

The body is worm like cylindrical or flattened.

Presence of cuticle but the absence of cilia.

Alimentary canal is straight and complete with mouth, anus, pharynx muscular and highly specialised.

Absence of respiratory and circulatory system.

Excretory system contains a system of canals and protonephridia.

Presence of simple nervous system.

Sense organs are in the form of pils, papillae, bristles and eye spots.

Sexes separate (ie., dioecious and reproductive organs are very simple).

Absence of asexual reproduction.

Eggs shelled, cleavage derminate and spiral.

Life cycle is simple or complicated with no special larval stages.

Heterogeneous group inhabiting aquatic and terrestrial environment.

Classification

Ashleminthes is divided into 5 classes. They are

1. Nematoda
2. Nematomorpha
3. Rotifera
4. Gastrotricha
5. Kinorhyncha

CHECK YOUR PROGRESS

4. Define hermaphrodite.
5. What do you mean by metamerism?
6. What is indirect development?
7. Give the general characters of protozoa.

1. Class - I Nematoda

(Gr., Nema=tread+eidos=form)

Aquatic or terrestrial, free living or parasitic, elongated round forms.

Example: Ascaris.

2. Class - II Nematomorpha

(Gr., Nema=tread+morphe=shape)

Hair forms found in springs. Body is very long, thin and slender.

Example: Nectonema, Paragordius.

3. Class - III Rotifera

(L., Rota=wheel+ferro=to bear)

Microscopic animals called wheel bearers found in ponds, lakes and streams.

Example: Rotaria, Philodina

4. Class - IV Gastrotricha

(L., Gaster=stomach+trichos=hair)

Microscopic, marine and freshwater forms with cuticle bearing short spines.

Example: Macrodasys.

5. Class - V Kinorhyncha
(Gr., Kineo=more+rhynchos=beak)
Marine, microscopic and body forms.
Example: Echinoderes.

2.4.6 GENERAL CHARACTERS OF PHYLUM ANNELIDA

The phylum Annelids are true schizocoelous-coelom, bilaterally symmetrical, triploblastic, metamerically segmented worm like animals. e.g., Earthworm, leech.

General Characters

Annelids are bilaterally symmetrical, true coelomate animals.

They have organ system grade of organisation and triploblastic body wall.

They have a soft, elongated and cylindrical body.

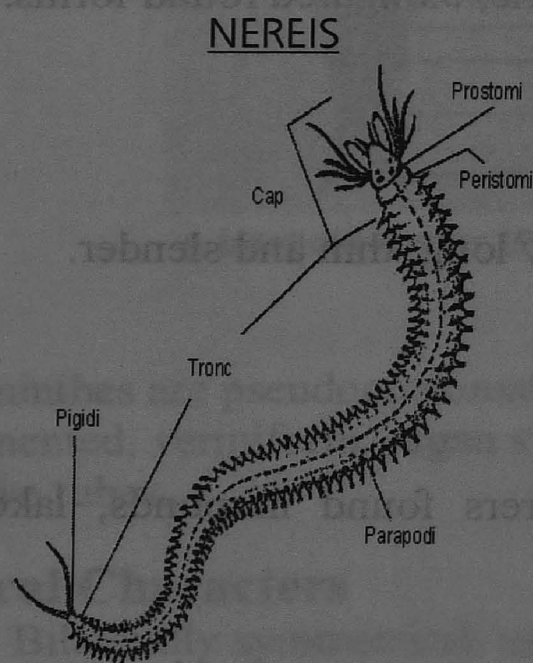
The anterior end has a head and a thick muscular body wall. So it is said to be dermomyocardic.

The body is covered by a thick cuticle and divided into a number of segments known as metamerism.

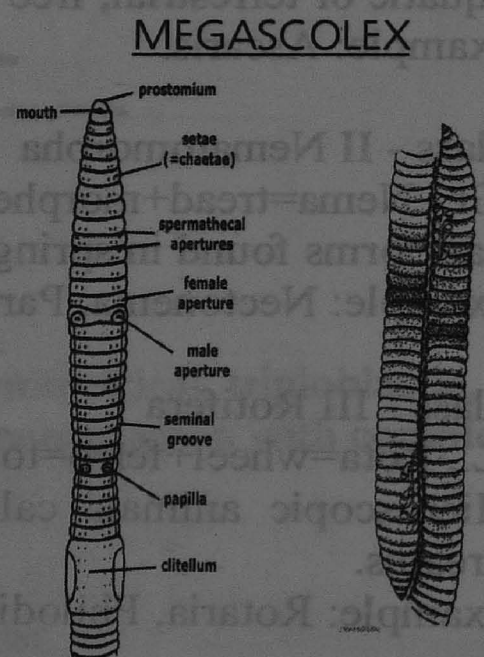
Setae are the locomotory organs.

Presence of a closed type of blood vascular system.

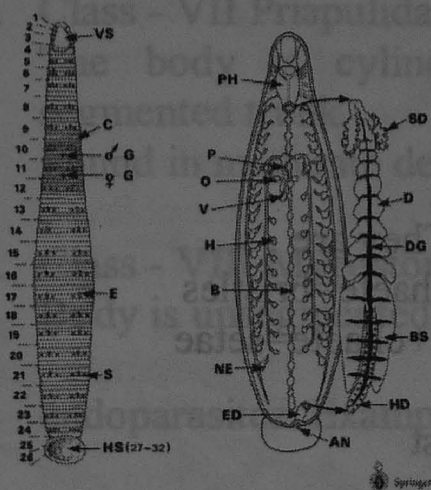
Well developed digestive system.



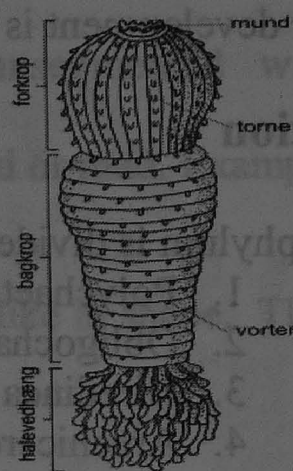
HIRUDO



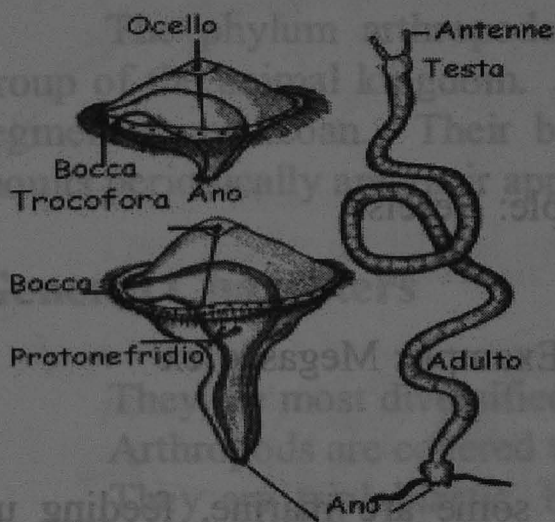
PRIAPULUS



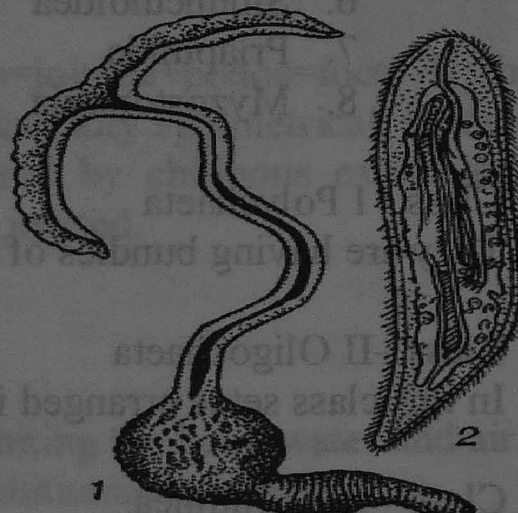
POLYGORIDUS



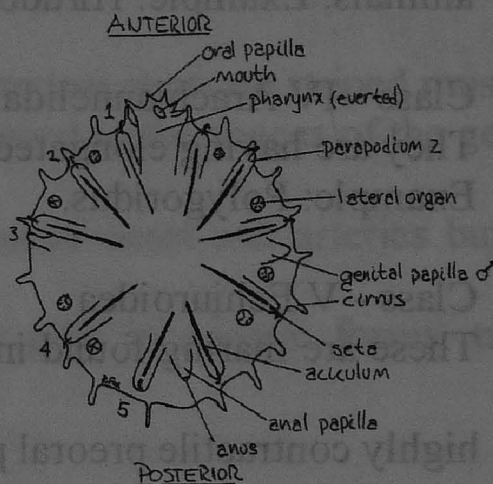
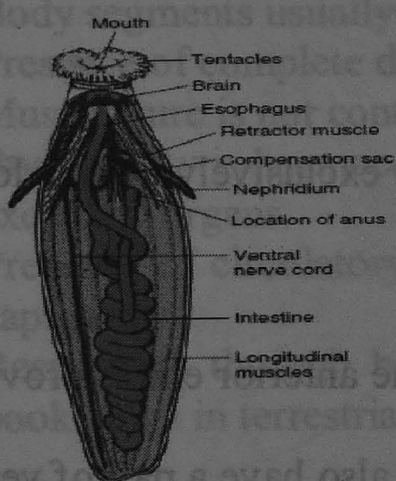
BONELLA



SIPUNCULOIDEA



MYZOTOMA



Asegmentally arranged nephridia is used for excretory system.

A pair of cerebral ganglia (brain) and a double ventral nerve cord is formed a nervous system.

Nervous system with a pair of cerebral ganglia, the brain and a double nerve cord having segmentally ganglia.

They are hermaphrodites (i.e) both sex organs are present in the same animal.

They have coelomoducts which are connection with nephridia

Regeneration is the important character in this phylum.

Their development is direct or indirect

Classification

This phylum is divided into eight classes. They are

1. Polychaeta – Gr., Poly=many+chaete=bristles
2. Obligochaeta – Gr., Oligos=few+chaete=setae
3. Hirudinea – L., Hirudo= a leech
4. Arachiceroidea – Gr., archi= first
5. Echiuroidea
6. Sipunculoidea
7. Priapulida
8. Myzostomaria

1. Class - I Polychaeta

They are having bundles of setae. Example: Nereis.

2. Class –II Oligochaeta

In this class setae arranged individually Example: Megascolex

3. Class - III Hirudinea

They are ectoparasitic and freshwater, some are marine, feeding upon fishes and other animals. Example: Hirudo

4. Class - IV Arachiannelida

They are having elongated worm like body exclusively marine forms. Example: Polygoridus.

5. Class - V Echiuroidea

These are mainly found in the mud and the anterior end is provided with a long highly contractile preoral proboscis. They also have a pair of ventral hooks setae.

Example: Bonellia.

6. Class - VI Sipunculoidea

Their body is elongated, yellowish or greyish in colour without segmentation. They are found in sand or boring in corals at the sea shore. Example: Sipunculus.

7. Class - VII Priapulida

The body is cylindrical, worm like unsegmented with superficial segmented trunk.

Found in moderate depths borrowing in sand or mud. Example: Pirapulus.

8. Class - VIII Myzostomaria

Body is unsegmented, flat and oval or disc like in shape. They live as ecto or endoparasites. Example: Myzostoma.

2.4.7 GENERAL CHARACTERS OF PHYLUM ARTHROPODA

The phylum arthropoda (Gr.,arthros=jointed+podos=foot) is the largest group of the animal kingdom. They are bilaterally symmetrical, meta merically segmented metazoan. Their body is covered by chitinous exoskeleton which moults periodically and their appendages are jointed.

General Characters

They are most diversified group inhabiting the land, water and air.

Arthropods are covered with a thick chitinous exo skeleton.

They are triploblastic, bilaterally semmetrical, metamerically segmented animals.

Body segments usually bear lateral and jointed appendages.

Presence of complete digestive system.

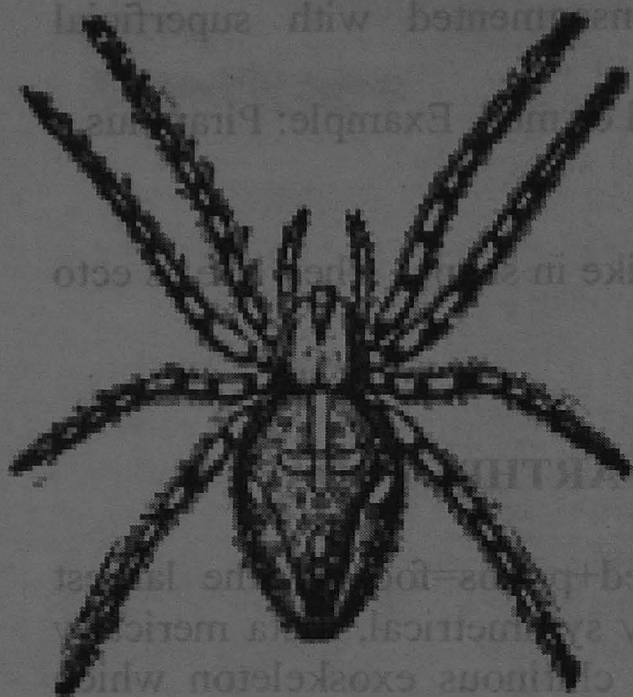
Musculature is not continuous, but comprises separate striped muscles.

Body cavity is haemocoel which is reduced to the spaces of the genital and excretory organs.

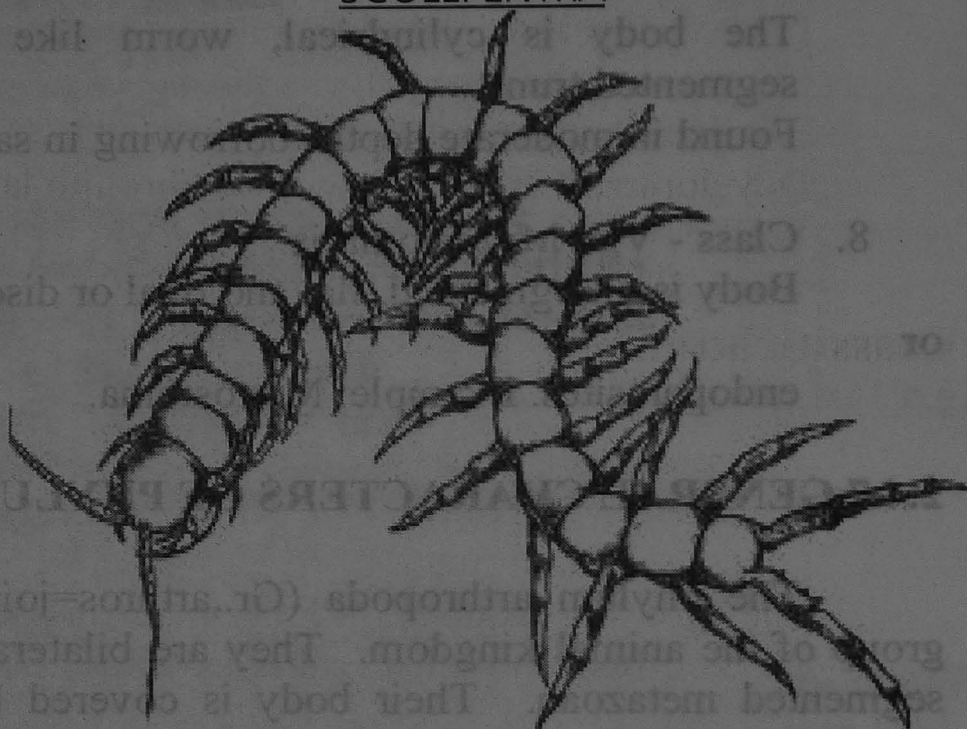
Presence of circulatory system with dorsal heart and arteries but without capillaries.

Respiration through body surface, by gills in aquatic forms, trachea or book lungs in terrestrial forms.

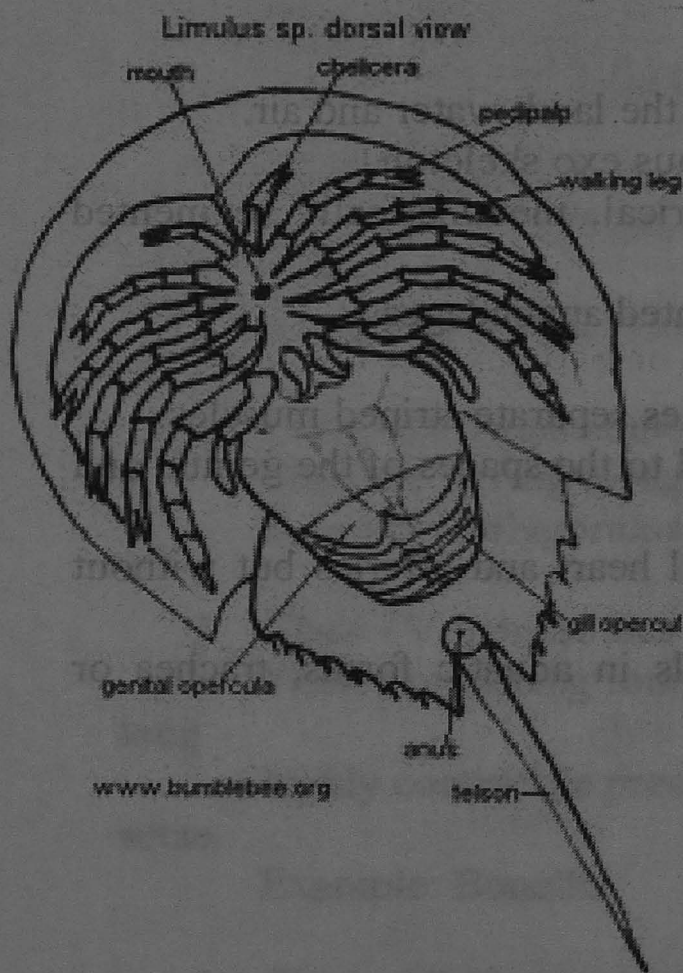
SPIDER



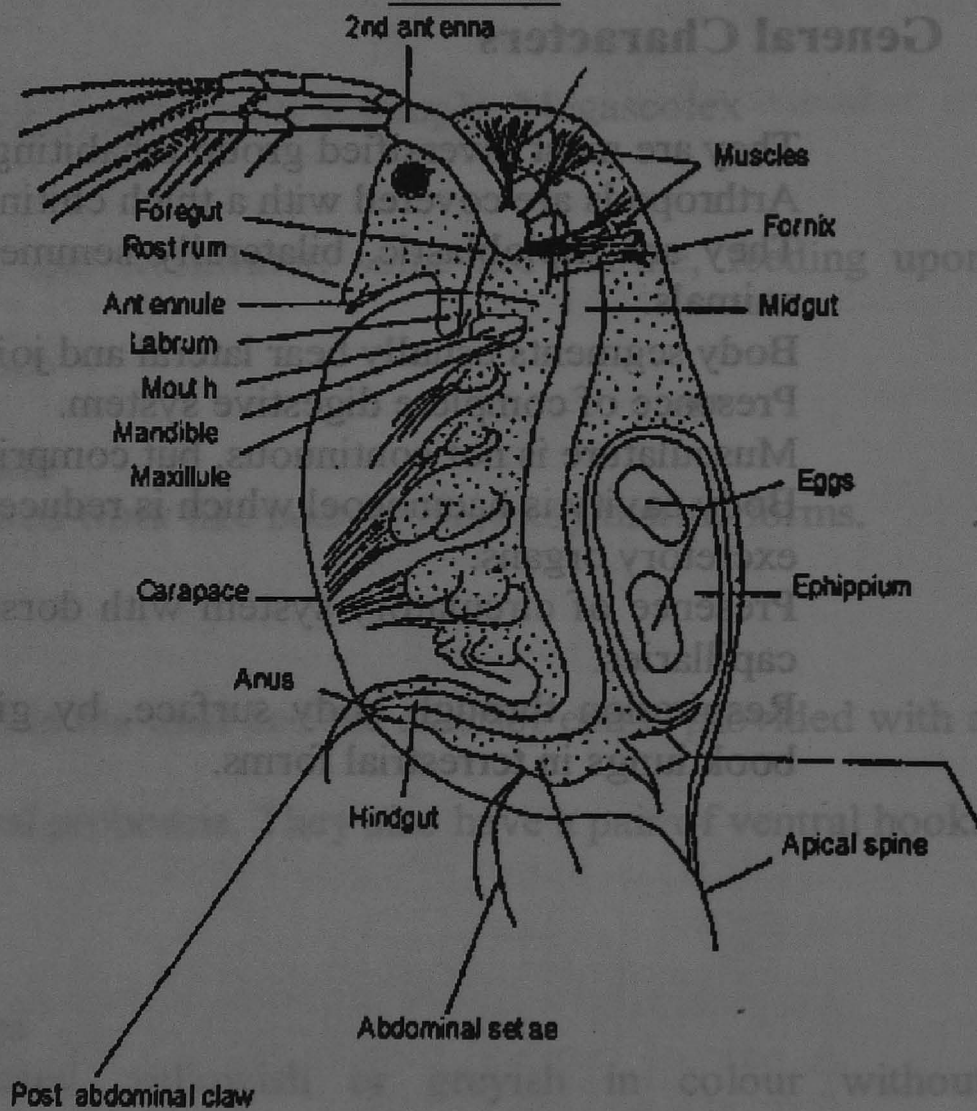
SCOLEPENTRA



LIMULUS



DAPHNIA



Absence of cilia in the whole body.
 Excretion is by malpighian tubules or green or coxal glands.
 Shows sexual dimorphism and sexes are separate.
 Fertilization is internal.
 Development is usually indirect through larval stages.
 Well developed parental care.

Classification

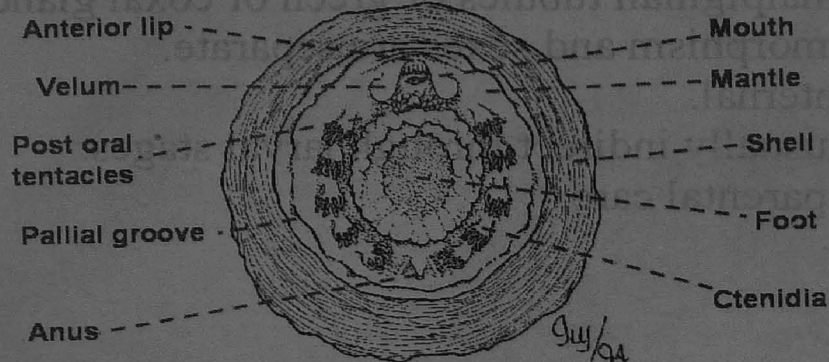
This phylum is classified into five classes

1. Class - I Merostomata
 They are only aquatic and marine arthropods. The abdominal appendages are modified into gills. Example: Limulus (king crab).
2. Class - II Arachnida
 They are air breathing, terrestrial arthropods. Example: Aranea (spiders).
3. Class - III Crustacea
 Their body is covered by chitinous cuticle. They are mainly aquatic, some are freshwater and few are parasitic forms. Example: Daphnia.
4. Class - IV Myriapoda
 These animals are terrestrial air breathing arthropods. Body is elongated with numerous segments, each bearing one or two pairs of legs. Example: Scolopendra.

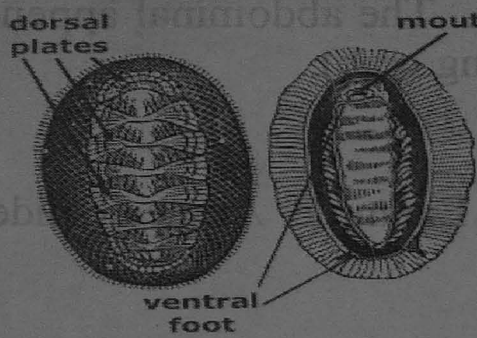
2.4.8 GENERAL CHARACTERS OF PHYLUM MOLLUSCA

Mollusca (L., Mollis=soft) comprise the second largest phylum of invertebrates in the number of species, over 80,000 living species about 351,000 fossil species are known. They are soft bodied, bilaterally symmetrical, unsegmented, coelomate animals.

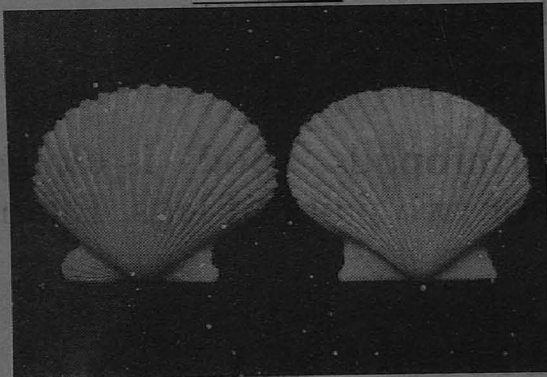
NEOPILINA



CHITON



PECTEN



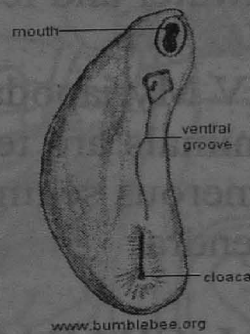
VIVIPARUS

G. Ghesquiere

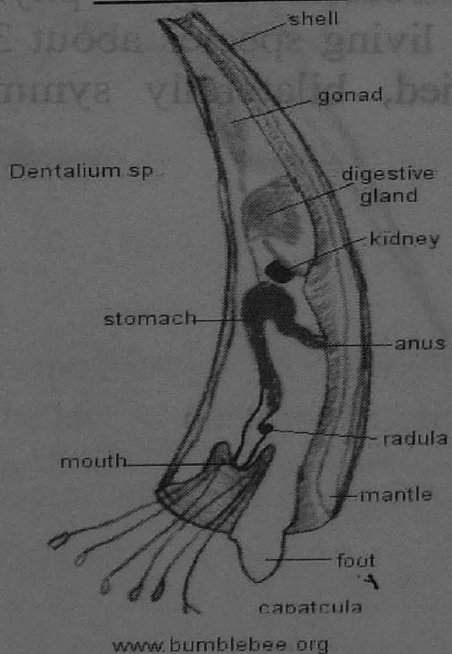


NEOMENIA

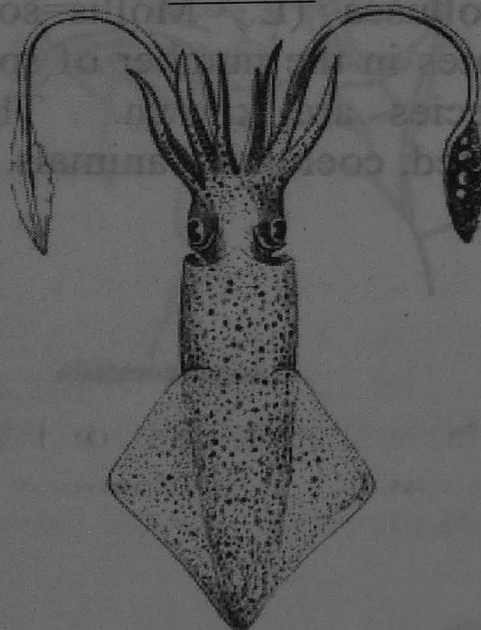
Neomenia sp.



DENTALIUM



LOLIGO



General Characters

They are essentially aquatic, mostly marine, few freshwater and some are terrestrial forms.

The body is covered with ciliated epidermis.

The body is soft, unsegmented, bilaterally symmetrical and consists of head, foot, mantle and visceral mass.

Body is protected by an exoskeletal calcareous shell of one or more pieces.

Presence of distinct head, bearing mouth, eyes, tentacles and other sense organs.

Ventral body wall is modified into a muscular flat or plough like surface, the foot which is used for creeping, burrowing and swimming.

Presence of simple digestive tract.

Circulatory system is open type.

Respiratory organs consist of numerous ctenidia provided with osphradium at the base. Lung is developed in terrestrial forms.

Haemocyanin is the respiratory pigment.

Excretory system consists of a pair of metanephridia.

Presence of well developed nervous system.

Sexes are separate (diecious) but some are hermaphroditic.

Fertilization is external or internal.

Development is either direct or indirect through trochophore stage called veliger larva.

Classification

This classification is adopted from Hyman, L.H.(1957) with certain (1965) modifications from Parker and Haswell (1965). The phylum is divided into 7 classes.

1. Class - I Aplacophora or Solenogasters

(Gr., a=not+plax=plate+pherein=bearing).

They are characterised by the absence of head, mantle, foot, shell and nephridia. Example: Neomenia.

2. Class - II Polyplacophora

(Gr., poly=many+plax=plate+pherein=bearing).

They are bilaterally symmetrical, dorsoventrally flattened molluscs. Example: Chiton.

3. Class -III Monoplacophora

(Gr., Monos=one+plax=plate+pherein=bearing).

Body is bilaterally symmetrical and segmented. Example: Neopilina.

4. Class - IV Gastropoda

(Gr., gaster=belly+pods=foot).

They are marine, freshwater, terrestrial and parasitic on echinoderms.

Example: Viviparus.

5. Class - V Scaphopoda

(Gr., scapha=boat+pods=foot).

They are bilaterally symmetrical, elongated and enclosed in a tusk like shell open at both ends. They are exclusively marine Example: Dentalium.

6. Class - VI Pelecypoda

(Gr., pelekys=hatchet+pods=foot).

Body is bilaterally symmetrical, aquatic mostly marine and some freshwater forms. Example: Pecten

7. Class - V Cephalopoda

(Gr., kephale=head+pods=foot).

Their body is bilaterally symmetrical with head and trunk. They are exclusively marine. Example : Loligo

Classification

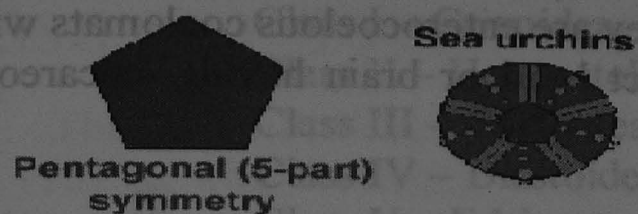
This classification is adopted from Hyman (1957) and Swell (1962). The classes are modified from Parker and Swell (1962). The classes are modified from Parker and Swell (1962).

1. Class - I Aplousophora or Solenogaster
(Gr., aplous=plate+phrein=bearing).
They are characterised by the absence of head, mantle, foot, shell and nephridia. Example: Neomenia.

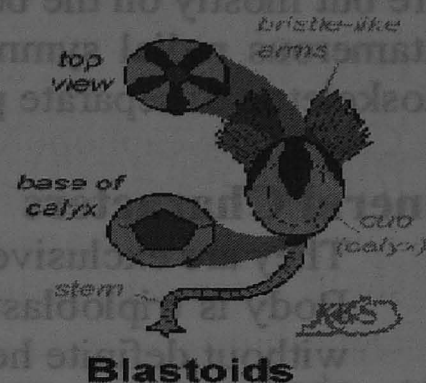
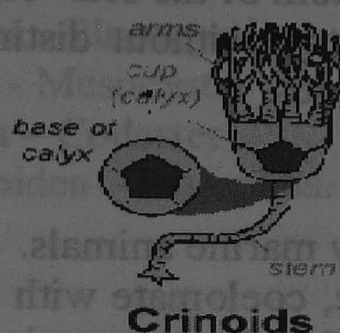
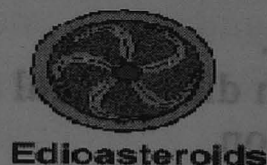
2. Class - II Polyplousophora
(Gr., poly=many+plax=plate+phrein=bearing).
They are bilaterally symmetrical, dorsoventrally flattened molluscs. Example: Chiton.

3. Class - III Monoplousophora
(Gr., Monos=one+plax=plate+phrein=bearing).
Body is bilaterally symmetrical and segmented. Example: Neopilina.

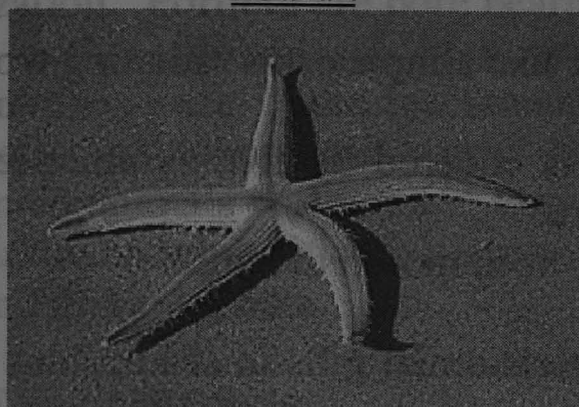
2.4.9 GENERAL CHARACTERS OF PHYLUM ECHINODERMATA



Sea urchins



LUIDIA

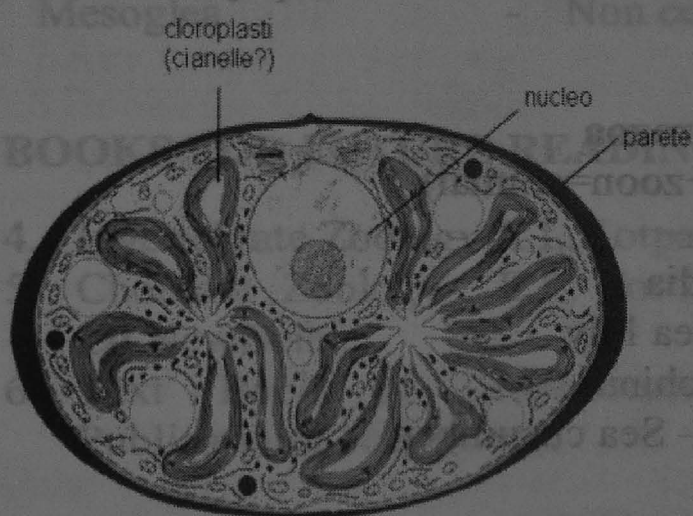
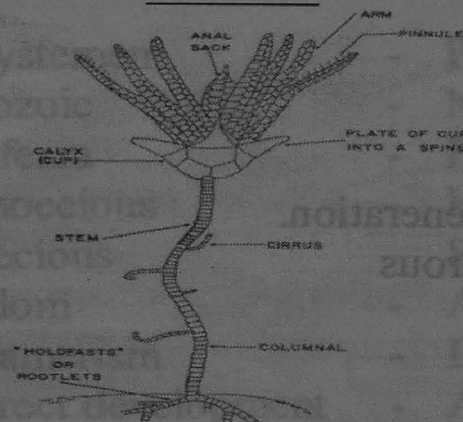
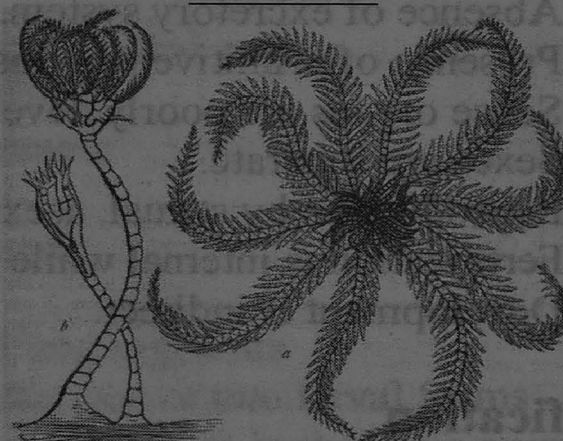


SEA LILLY

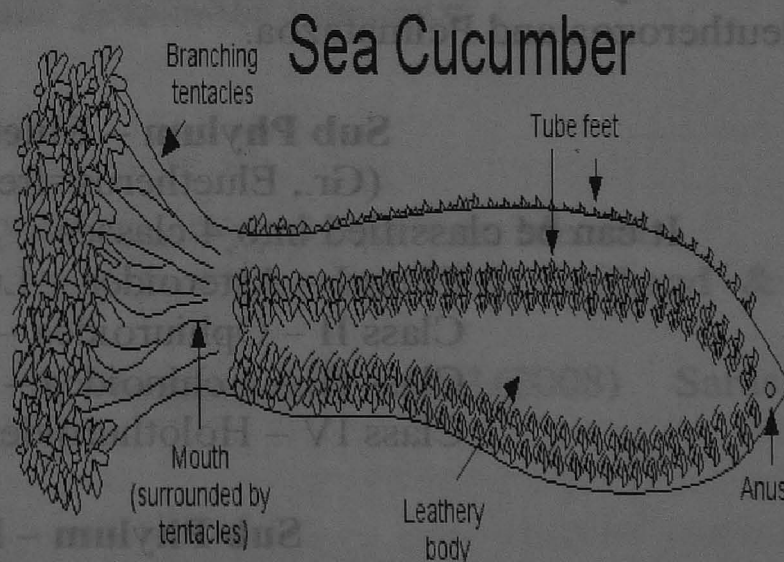
ECHINUS



ANTEDON



Glaucocystis



Sea Cucumber

©EnchantedLearning.com

The name Echinodermata (Gr.echinos=hedgehog + derma=skin) applied it only to echinoids. Echinodermata are exclusively marine animals living on the shore but mostly on the bottom of the sea. They are enterocoelous coelomats with pantamorous radial symmetry, without distinct head or brain having calcareous endoskeleton of separate plates.

General Characters

They are exclusively marine animals.

Body is triploblastic, coelomate with distinct oral and aboral surfaces and without definite head and segmentation.

They are of moderate to considerable size.

Presence of water vascular system.

Body shape rounded to cylindrical or star like simple arms radiating from a central disc.

Surface of the body is not smooth. It is covered by five symmetrically spaced radiating grooves called ambulacra.

Alimentary tract is coiled tube extending from mouth to anus.

Presence of circulatory system.

Respiration is by papulae in starfishes, peristomial gills in sea urchins and genital bursae in brittle stars.

Absence of excretory system.

Presence of primitive nervous system.

Sense organs are poorly developed.

Sexes are separate.

Reproduction by sexual, asexual and by regeneration.

Fertilization is internal while few are viviparous

Development is indirect.

Classification

Phylum Echinodermata is divided into two sub-phyla, namely Eleutherozoa and Pelmatazoa.

Sub Phylum – Eluethrozoa

(Gr., Eluetheros=free+zoon=animal)

It can be classified into 4 classes

Class I – Asteroidea – Luidia

Class II – Ophiuroidea – Sea lilly

Class III – Echinoidea – Echinus

Class IV – Holothuroidea – Sea cucumber.

Sub Phylum – Pelmatazoa

(G.r, Pelmatos=stalk+zoon=animal)

There are 5 classes in this phylum.

Class I – Crinoidea – Antedon

Class II – Heterostelea - Placocystis

Class III – Cystoidea - Mesocystis

Class IV – Blastoidea – Codaster

Class V – Edrioasteroidea – Isorophus.

2.5 LET US SUM UP

Protozoans are acellular organisms without any tissue grade of organization. Porifera are pore bearing organisms. Hydra is a radial symmetrical animal with a diploblastic body wall. Platyhelminthes are flat worms where Ashelminthes are pseudocoelomate vermiform animals. Annelides are metamerically segmented worm like animals. The phylum arthropods are segmented animals with jointed legs and chitinous exoskeleton. Mollusca are soft body animals, while star fish are calcareous coelomate organisms belong to the phylum Echinodermata.

2.6 KEY WORDS

Encystement	- Protective covering called cyst
Holozoic	- Nutrition solid food
Porifera	- Pore bearing animals
Monoecious	- Hermaphrodite
Dioecious	- Sexes are separate
Coelom	- A body cavity
Metamerism	- Body is divided into segments
Indirect development	- Adult formed after one or two larval forms
Hermaphrodite	- Both sex organs are present in the same animal
Mesoglea	- Non cellular gelatinous substance

2.7 BOOKS FOR FUTURE READING

4. Invertebrate Zoology-R.L.Kotpal(2005) Rastogipublications, Meerat
5. Chordate Zoology-. E.L. Jordan and Dr.P.S.Verma(2006) S.Chand & Co.NewDelhi
6. Text Book of Invertebrate- Dr.N.Arumugam Etal,(2008) Saras Publications, Nagerkovil.

2.8 QUESTIONS / EXERCISES

Part – A

1. Differentiate Major and Minor Phyla.
2. Define higher invertebrate phyla.
3. What do you mean by hermaphrodite?

Part – B

1. Write a short notes on Phylum Mollusca.
2. Explain the Phylum Porifera.

Part – C

1. Elaborately explain the General characters of Phylum Arthropoda .
2. Explain the general characters of Echinodermata.

2.9 ANSWER FOR CYP QUESTIONS

For Q.No.1 in Part A refer section No.1.2

For Q.No.2 in Part A refer section No.1.3

For Q.No.3 in Part A refer section No.1.4.4

For Q.No.1 in Part B refer section No.1.4.8

For Q.No.2 in Part B refer section No.1.4.2

For Q.No.1 in Part C refer section No.1.4.7

For Q.No.2 in Part C refer section No.1.4.9

2.7 BOOKS FOR FUTURE READING

4. Invertebrate Zoology-R.L.Koipal(2002) Parasitipublications, Meerut.
5. Chordate Zoology- E.L. Jordan and B.P.S.Verma(2006) S.Chand & Co New Delhi
6. Text Book of Invertebrate Zoology- B.N.Aranganam, Bial(2008) Saras Publications, Nagpur.

UNIT - II

LESSON – 3 TYPE STUDY - PARAMECIUM

The name Protozoa (Gr.Protos=First, Zoon=animal) comes from Gold Fuss (1818), who, however, used the name simply for the lower groups of zoophyta including protozoans, sponges, coelenterates, rotifers and bryozoans. It was von-siebold (1845), who recognising the unicellular nature of the protozoa, first used and defined the name protozoa in the present sense. Protozoa is a group of acellular organisms which have occupied all most all ecological habitats on earth.

Objectives

By Studying this unit, the students will

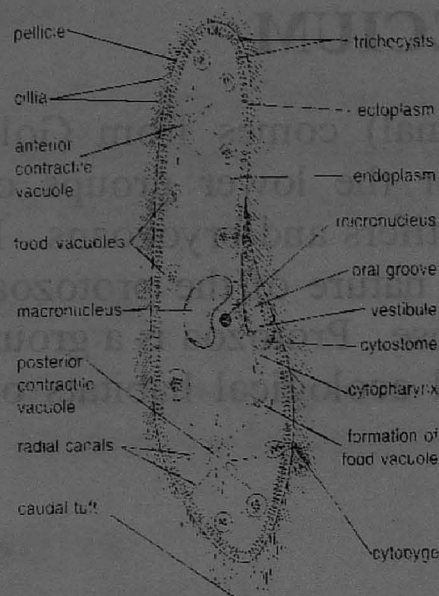
- g) understand the name protozoa.
- h) know the definition of protozoa.
- i) know the systematic position of paramecium.

Unit Structure

- 3.1 Definition.
- 3.2 Systematic position of paramecium.
- 3.3 A type study – paramecium.
 - 3.3.1 General organization.
 - 3.3.2 Cyclosis.
 - 3.3.3 Contractile vacuole.
 - 3.3.4 Conjugation.
- 3.4 Life History of Plasmodium Vivax.
- 3.5 Life History of Entamoeba Histolytica.
 - 3.5.1 Pathology.
 - 3.5.2 Control of Entamoeba.
- 3.6 Let us sum up.
- 3.7 Key words.
- 3.8 Books for further reading.
- 3.9 Questions/Exercise.
- 3.10 Answer for Questions.

3.1 DEFINITION

Paramecium (G.r, parameker, oblong, L.Caudatum) is a unicellular or acellular a typical ciliate protozoa. Ciliates are characterised by the presence of cilia as locomotor organelle, nuclear dimorphism and a unique type of sexual reproduction called conjugation.



3.2 SYSTEMATIC POSITION

Phylum : Protozoa

Sub Phylum : Ciliophora.

Class : Ciliata

Sub Class : Holotrichia

Order : Hymenostomatida

Genus : Paramecium

Species : Caudatum

3.3 TYPE STUDY – PARAMECIUM

3.3.1 GENERAL ORGANIZATION

Paramecium is commonly found in freshwater, ponds, pools, ditches, streams, lakes, reservoirs and rivers. It is specially found in abundance in stagnant ponds, rich in decaying matter, in organic infusions and in the sewage water. Paramecium is fresh living organisms and this species is worldwide in distribution and it is omnivorous in habit.

Structure : Size and shape

Paramecium Caudatum, visible to the naked eyes as a minute elongated body. It appears light grey or white measuring commonly between 170 to 290 microns in length and may attain a length upto 300 to 350 microns. It looks like the sole of a slipper or shoe, hence the animal is commonly known as slipper animalcule. The forward moving anterior part is slender with a blunt or rounded

end, while the posterior end is somewhat pointed or cone shaped. The widest part of the organism is just below the middle. The body of the animal is asymmetrical in form showing the well defined oral or ventral surface and an aboral or dorsal one.

Pellicle

The body is covered by a thin, double layered, elastic and firm pellicle made of gelatin. The pellicle holds the shape of the animal but is elastic enough to permit contractions.

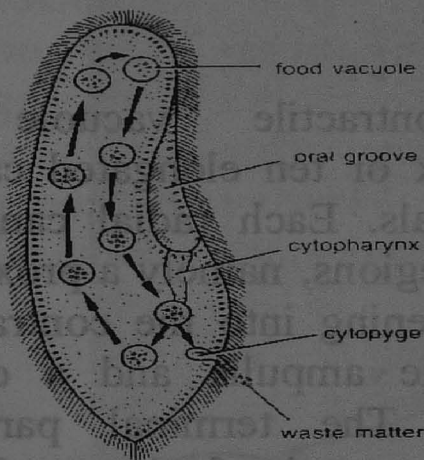
Cilia

The entire body is covered with numerous, small, hair like projections called cilia. Cilia occur in longitudinal rows all over the body. This condition is known as holotrichus in which the body cilia are equal.

Cytoplasm

The body of the paramecium is filled with a colloidal substance called cytoplasm. It is formed of two regions, namely ectoplasm and endoplasm. Ectoplasm is a denser fluid. It contains basal granules and trichocysts. The central part of the cytoplasm is called endoplasm which is less dense and contains a nucleus, contractile vacuoles and food vacuoles.

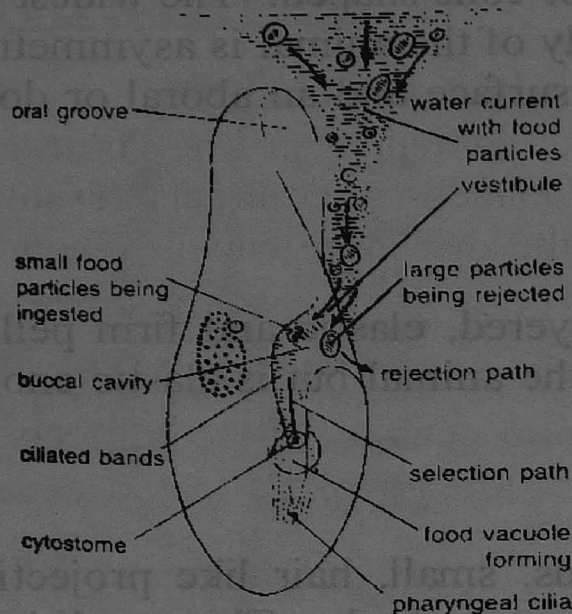
3.3.3 CYCLOSIS



Paramecium- Cvclosi

Paramecium feeds when it is at rest. It moves to a place where there is plenty of food. The cilia of the oral apparatus beat vigorously. This causes a water current. The water current along with food particles passes through the oral groove and vestibule. The cilia of the vestibule direct the food particle into the cytopharynx through the cytostome. The food particles are collected at the tip of the cytopharynx in a membranous vesicle. When sufficient

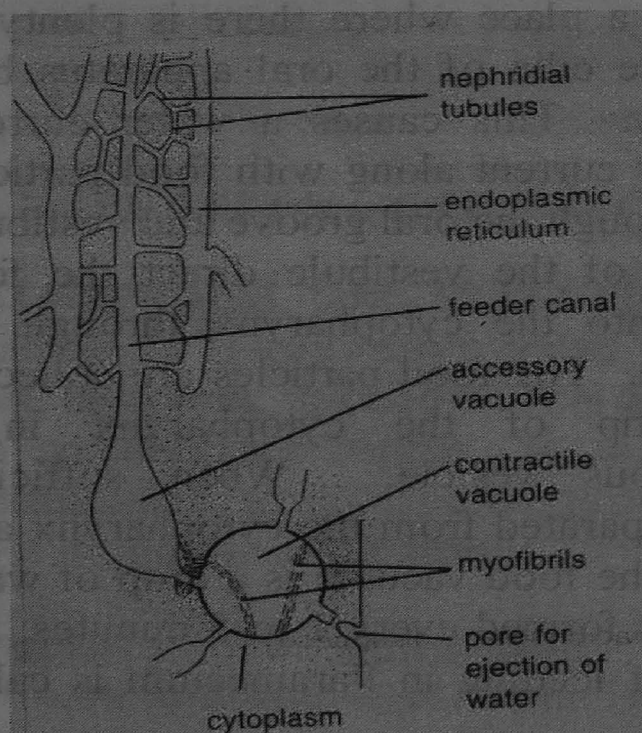
amount of food particles are collected, it is separated from the cytopharynx as a vesicle. This vesicle is called food vacuole. The food vacuole is a drop of water containing food particles. The food vacuole is formed every 1 to 5 minutes. As cilia are used for food collection the mode of feeding in Paramecium is called ciliary feeding.



Paramecium—Ciliary action creating vortex and drawing food particles into the oral groove with the water current.

3.3.3 CONTRACTILE VACUULES

Two contractile vacuules are found in Paramecium. They are located at each end of the body. They exhibit contraction (systole) and relaxation (diastole). Each contractile vacuule has a covering of thin, elastic and semi-permeable membrane. Each contractile vacuule opens to the outside on the dorsal side through a short discharge canal.



Contractile Apparatus

constant water content. Paramecium lives in fresh water. So the cytoplasm of the body is more concentrated than the fresh water. As a result fresh water

After separation from the cytopharynx, the food vacuole moves in the endoplasm in a definite direction. It moves backwards along the ventral side. After reaching the posterior end it moves forwards along the dorsal side. After reaching the anterior end, again it moves backwards along the ventral side. Finally it reaches the cytophyge. This cyclical movement of food vacuoles is called cyclosis. Cyclosis is caused by the streaming movement of cytoplasm. During cyclosis the food materials are killed, digested and absorbed. As digested food materials are absorbed into the cytoplasm during cyclosis, the size of the food vacuoles gradually decreases.

Each contractile vacuule is surrounded by six or ten elongated canals called radial canals. Each radial canal is formed of three regions, namely a proximal injector canal, opening into the contractile vacuule, a middle ampulla and a distal terminal part. The terminal part is connected with a network of minute tubules called nephridial canals ramifying the cytoplasm.

Functions : The contractile vacuule has two functions, namely osmoregulation and excretion.

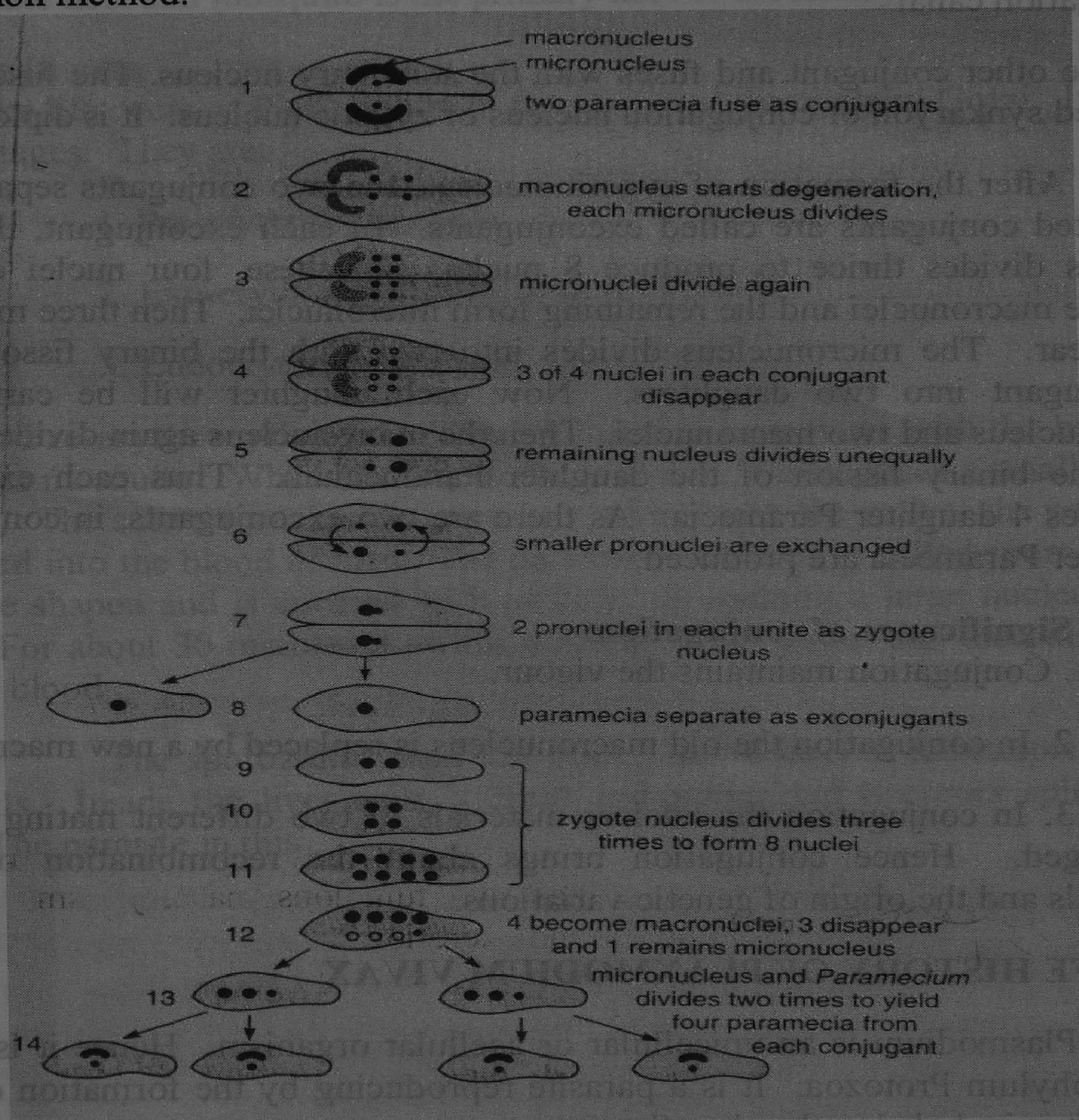
Osmoregulation: Osmoregulation is a process where the body maintains a constant water content. Paramecium lives in fresh water. So the cytoplasm of the body is more concentrated than the fresh water. As a result fresh water

continuously enters the body by endosmosis. This increases the water content of the body. This excess of water from the cytoplasm is collected by nephridial canals. They pour into the ampulla through the terminal part of the radial canal. When the ampulla is fully loaded, it discharges its contents into the contractile vacuole. When the contractile vacuole is fully loaded, it contracts (systole). During systole the water is expelled out through the discharge canal. Then the contractile vacuole relaxes (diastole). During diastole the contractile vacuole is gradually filled with water.

Excretion: The outgoing water also carries with it nitrogenous waste products.

3.3.4 CONJUGATION

Reproduction is a process by which the offsprings are produced by the parents. Paramecium exhibits asexual reproduction and sexual reproduction. The most common asexual reproduction exhibited by paramecium is binary fission. In sexual reproduction gametes are produced for the production of offspring by conjugation method.



Paramecium - Conjugation

Conjugation is the temporary union of two individuals for the exchange of nuclear materials. In conjugation two Paramecia of different mating types come closer and contact with their ventral surfaces. These paramecia are called conjugants. They stop feeding and their oral apparatus disappears. The pellicle and ectoplasm of the two individuals disappear at the point of contact. The conjugants are connected by a cytoplasmic bridge. This is referred to as conjugation canal.

The macronucleus has no role in conjugation. It simply breaks into fragments and is absorbed into the cytoplasm. The micronucleus divides twice, one of these divisions being reduction. As a result four haploid daughter nuclei are produced in each conjugant. Then three nuclei in each conjugant disappear. The remaining nucleus unequally divides into two nuclei called pronuclei or gametic nuclei. The large pronucleus is called stationary pronucleus or female pronucleus. The smaller pronucleus is called migratory pronucleus or male pronucleus. The migratory nucleus of each conjugant passes through the conjugation canal

into the other conjugant and fuses with the stationary nucleus. The fused nucleus is called synkaryon or conjugation nucleus or zygotic nucleus. It is diploid.

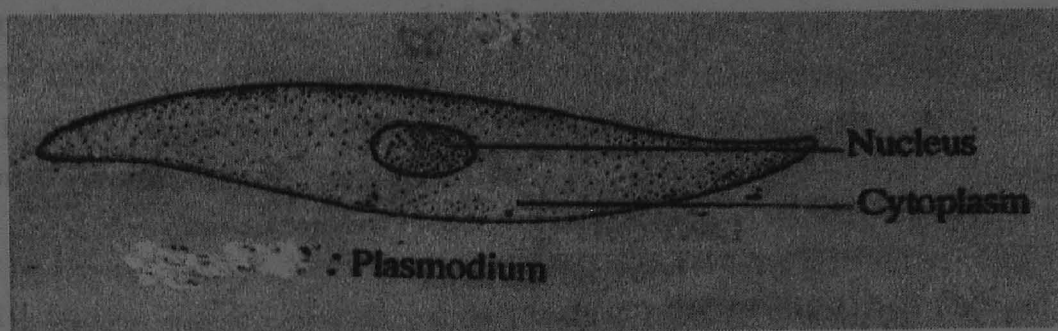
After the formation of zygotic nucleus, the two conjugants separate. The separated conjugants are called exconjugants. In each exconjugant, the zygotic nucleus divides thrice to produce 8 nuclei. Of these, four nuclei enlarge to become macronuclei and the remaining form micronuclei. Then three micronuclei disappear. The micronucleus divides into two with the binary fission or each exconjugant into two daughters. Now each daughter will be carrying one micronucleus and two macronuclei. Then the micronucleus again divides into two with the binary fission of the daughter Paramecium. Thus each exconjugant produces 4 daughter Paramecia. As there are two exconjugants, in conjugation 8 daughter Paramecia are produced.

Significance of conjugation:

1. Conjugation maintains the vigour.
2. In conjugation the old macronucleus is replaced by a new macronucleus.
3. In conjugation the nuclear materials of two different mating types are exchanged. Hence conjugation brings about the recombination of genetic materials and the origin of genetic variations.

3.4 LIFE HISTORY OF PLAXMODIUM VIVAX

Plasmodium is an unicellular or acellular organism. Hence it is included in the phylum Protozoa. It is a parasite reproducing by the formation of spores. Hence it is included in the class Sporozoa.



Habit and Habitat

It is an endoparasite living in the blood of man. It causes malaria in man. It is cosmopolitan in distribution.

Life Cycle

Plasmodium completes its life cycle in two hosts, namely man and the female *Anopheles* mosquito. Hence it is a digenic parasite. Man is the intermediate host and mosquito is the primary host or secondary host or vector.

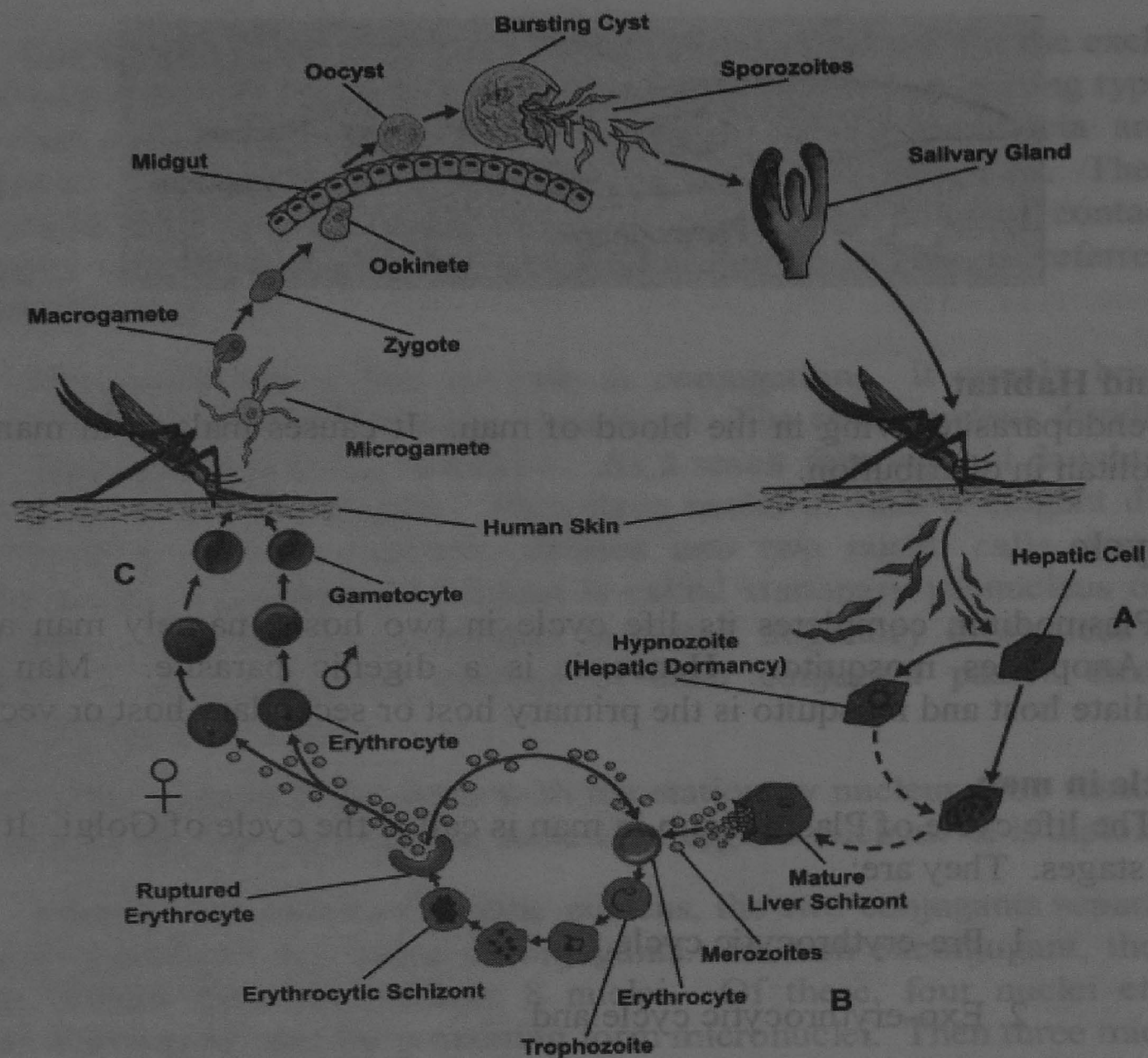
Life cycle in man

The life cycle of Plasmodium in man is called the cycle of Golgi. It occurs in three stages. They are:

1. Pre-erythrocytic cycle.
2. Exo-erythrocytic cycle and
3. Endoerythrocytic cycle.

1. Pre-erythrocytic cycle: The life cycle in man starts with the bite of an *Anopheles* mosquito. When a mosquito bites a man, it introduces a small amount of saliva. The saliva contains the parasite. Along with the saliva, the parasite is introduced into the blood of man. The parasite introduced is called sporozoite. It is spindle shaped and is covered with pellicle. It contains a large nucleus in the centre. For about 30 minutes it swims actively in the blood and then disappears from the blood.

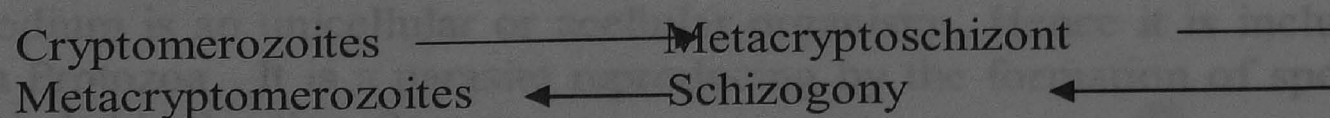
The sporozoite enter the liver. In the liver it penetrates into the liver cells. Inside the liver cells it feeds and grows and becomes spherical in shape. The parasite in this



stage is called cryptoschizont. The cryptoschizont undergoes a special kind of asexual reproduction called schizogony. During schizogony the nucleus of cryptoschizont of cytoplasm divided into 1000 daughter nuclei. This is followed by the division of the cytoplasm into about 1000 pieces. Each piece of cytoplasm encloses a single daughter nucleus. The resulting daughter cells are called cryptomerozoites. Cryptomerozoites are released into the liver by the rupture of liver cells.

Sporozoites → Cryptoschizont → Schizogony → Cryptomerozoite

2. Exo-erythrocytic cycle: Cryptomerozoites enter fresh liver cells. Here they grow and increase in size and become spherical in shape. The parasite in this stage is called metacryptoschizont. The metacryptoschizont undergoes schizogony resulting in thousands of daughter individuals called metacryptomerozoites. The metacryptomerozoites are released by the rupture of liver cells.



The pre-erythrocytic cycle and the exo-erythrocytic cycle are completed with 8 days. After this period the metacryptomerozoites, enter the blood. Until this time there will not be any symptom of malaria.

3. Erythrocytic cycle or endoerythrocytic cycle: This cycle occurs within the RBC. The metacryptomerozoite penetrates the RBC. Inside the RBC the parasite becomes rounded. This stage of the parasite is called trophozoite. It grows and increases in size. Then a small vacuole develops in the cytoplasm or trophozoites. This vacuoles gradually increases in its volume. As it increases in size, the nucleus is pushed towards one side. At this stage the parasite appears like a ring. Hence it is called signet ring. After sometime the vacuole disappears and the parasite develops many pseudopodia. At this time the parasite is in the amoeboid stage. It feeds on the contents of the RBC, The parasite secretes digestive enzymes which break the haemoglobin of RBC into haeme and globin. The haeme is converted into a toxic pigment called haemozoin which remains scattered in the cytoplasm of the parasite. When feeding stops, the pseudopodia disappear and the parasite becomes rounded. This stage of the parasite is called schizont. The schizont contains a single nucleus and haemozoin pigments in the cytoplasm. Then the schizont undergoes schizogony.

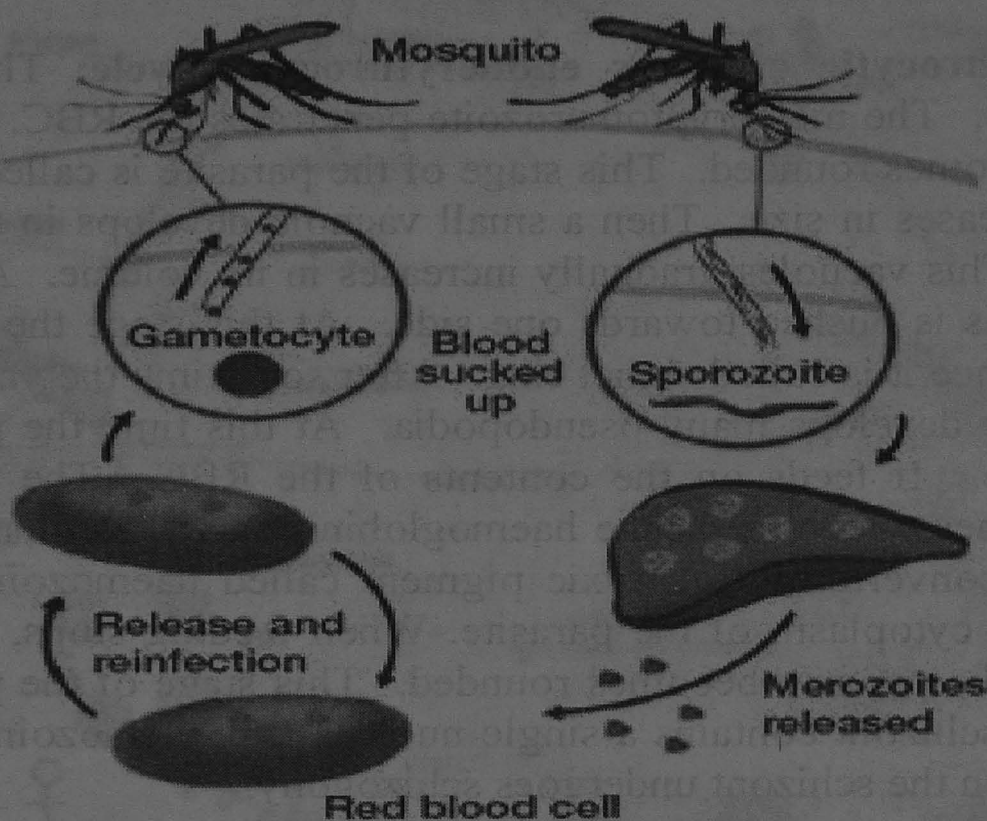
4. In schizogony the nucleus divides into 12 to 24 daughter nuclei. They come to occupy the periphery of the schizont. By this time the cytoplasm divides into as many fragments as there are nuclei. Each fragment of the cytoplasm encloses a single nucleus. The cytoplasm with the nucleus develops into the next stage of the parasite called merozoites. The merozoites are arranged more or less like the petals in a rose flower. Hence this stage is called rosette. The merozoites are released into the blood by the rupture of RBC. The erythrocytic cycle takes 48 hours (two days) for completion. The merozoites again attack fresh RBC and the cycle is repeated several times until almost all the RBCs are attacked.

After the several generations, the merozoites entering the RBC increase in size and become rounded. They are now called gametocytes. Some gametocytes are smaller in size and their nuclei are larger in size. These gametocytes are called male or microgametocytes. Others are larger in size but with smaller nuclei. These gametocytes are called female or megagametocytes. For further development the gametocytes must be taken into the body of the female *Anopheles* mosquito.

Life cycle in mosquito (Cycle of Ross)

The life cycle of *Plasmodium* in mosquito was first studied by Sir Ronald Ross. Hence this cycle is called the cycle of Ross. When the female *Anopheles* mosquito sucks the blood of man the gametocytes enter the gut. The RBCs are digested and the gametocytes are released. The Megagametocyte is reorganized and becomes a female gamete or megagamete.

THE MALARIA LIFE CYCLE



In microgametocyte the nucleus divides into 6 to 8 daughter nuclei. The daughter nuclei are arranged in the periphery of the gametocyte. The cytoplasm grows out into 6 to 8 long thin flagella like structures. Each nucleus moves into a flagellum-like structures. Each flagellum-like structure is now called a microgamete. The microgametes break off from the microgametocyte by violent movements. The formation of microgametes from microgametocyte is called exflagellation.

The microgametes exhibit gliding movement inside the lumen of the gut. The megagametocyte gives out a small cytoplasmic projection. It is called fertilization cone. When the microgamete comes into contact with the megagamete, it penetrates through the fertilization cone. Now the two gametes fuse together. This is called fertilization of syngamy. The resulting structure is called zygote or synkaryon.

The zygote is spherical in shape. It is diploid cell. It is non-motile. Soon it becomes elongated and spindle shaped; it exhibits gliding movement. At this stage the parasite is called an ookinete. The parasite penetrates the wall of the gut and comes to lie beneath the outer layer of the gut wall. Here it becomes spherical and secretes a cyst wall around it. Now the parasite is called oocyst. It grows by absorbing nutritive materials from the mosquito through the cyst wall. As a result it increases in size. The fully grown oocysts are seen as projections on the surface of the gut.

The oocyst now undergoes a special kind of sexual reproduction called sporogony. During sporogony the nucleus of oocyst divides into about 1000 daughter nuclei. The cytoplasm also becomes divided into about 1000 pieces. Each nucleus becomes encircled by a piece of cytoplasm. The resulting individuals are called sporozoites. Each sporozoite is spindle-shaped. They are released into the body cavity of the mosquito by the rupture of the oocyst and the outer layer of the gut wall. They then enter the salivary gland. For further development the sporozoites must be introduced into the blood of man. When a mosquito bite a man, it introduces a small amount of saliva to prevent the coagulation of blood. Along with the saliva the sporozoites are also introduced into the blood of man and the cycle is repeated.

MALARIA

It is a kind of fever caused by Plasmodium and transmitted by the female Anopheles mosquito. Malaria shows the following symptoms.

1. Loss of appetite.
2. Nausea
3. Constipation
4. Headache
5. Muscular pain and ache in joints
6. Shaking chillness
7. Sweating
8. Rise in body temperature as high as 106°F at an interval of 8 hours and
9. Anaemia

Control and Prevention of Malaria

Malaria can be controlled and prevented by the following methods.

1. Destruction of mosquito and its larva.
2. Spraying DDT in and around the houses.
3. Sterilization of mosquito.
4. Rearing the enemies of mosquito and its larvae like larvivorous fishes (stickle back, minnows and trouts), ducks, dragon, flies, etc. This method is called biological control.
5. Constructing mosquito proof houses.
6. Using mosquito nets.
7. Applying anti mosquito creams on the surface of the body.

Treatment

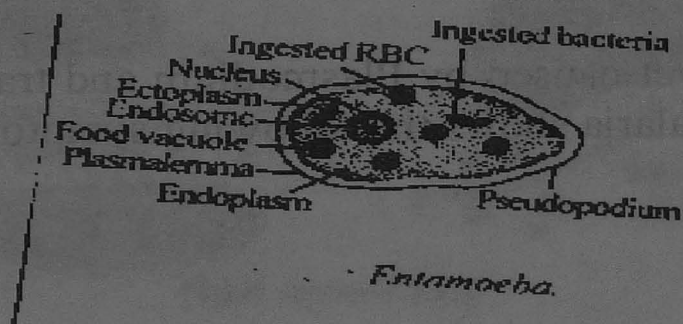
Malaria can be treated with the following drugs: Quinine, Daraprim, Chloroquine, Paludrine, Plasmoquine, etc.

CHECK YOUR PROGRESS

1. What are the symptoms of malaria?
2. Give an account of asexual cycle of *p. vivax* in man?
3. Who discovered the causative agent of malaria?
4. Define amoebiasis?
5. Which is called trophozoites?
6. Give the preventive measures of amoebiasis

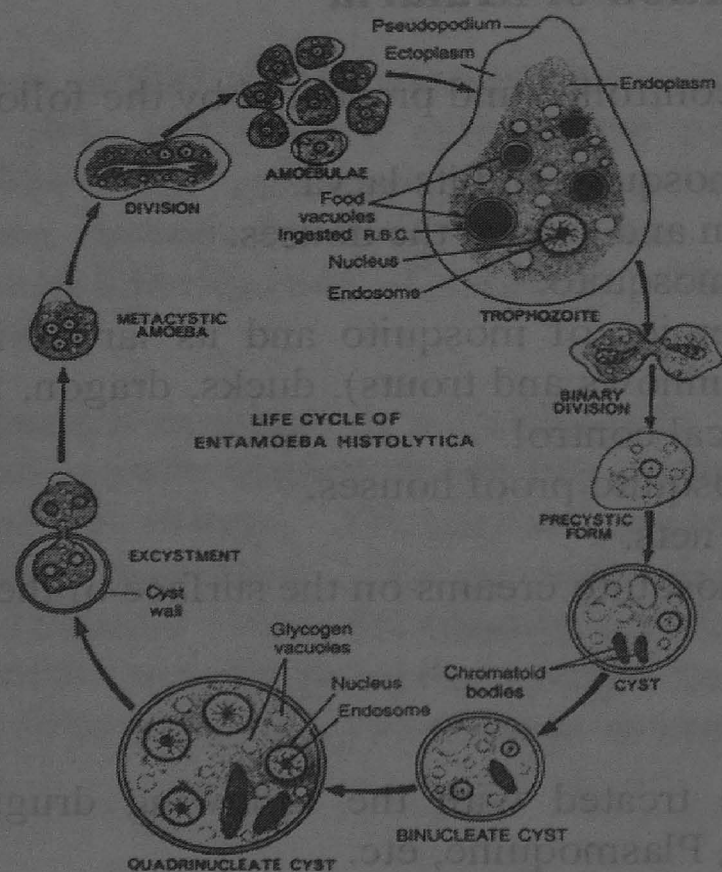
3.5 LIFE HISTORY OF ENTAMOEBA HISTOLYTICA

Entamoeba is an unicellular or acellular organism. Hence it is included in the phylum Protozoa. It has pseudopodium for locomotion. Hence it is included in the class Rhizopoda. It lives inside the large intestine of man. So it is an endoparasite. It causes a disease called amoebiasis or amoebic dysentery. Entamoeba is cosmopolitan in distribution. The fully grown and mature Entamoeba is called trophozoite. It looks like an Amoeba. The body is covered by plasmalemma. The plasmalemma encloses the cytoplasm. The cytoplasm has an outer ectoplasm and an inner endoplasm. The endoplasm contains a nucleus and food vacuoles. The food vacuoles contain ingested RBC, WBC, epithelial cells and so on. There is no contractile vacuole.



The nucleus is spherical in shape. It is surrounded by a nuclear membrane. In the centre of nucleus a spherical body is situated. It is called endosome or karyosome. It is surrounded by chromatin bodies. Entamoeba has a single pseudopodium. It is called monopodium. It is formed at the anterior end. Nutrition is holozoic. It feeds on bacteria, RBC, WBC and intestinal cells.

Life Cycle



Entamoeba histolytica : Reproductive and life history

Entamoeba is a protozoan parasite. It lives in the intestine of man. It is an endoparasite. It causes amoebiasis. Entamoeba completes its life cycle in only one host. Hence it is a monogenic parasite.

Binary Fission

The mature Entamoeba is called trophozoites. The trophozoite undergoes asexual reproduction by binary fission. During binary fission the nucleus divides into two daughter nuclei by mitosis. This is followed by the division of the cytoplasm into two pieces resulting in the formation of two daughter Entamoebae. Most of the daughter amoebae feed and grow into trophozoites. Others undergo a process called encystment.

Encystment

The Entamoeba loses its pseudopodium and becomes spherical. It secretes a thin tough and flexible membrane around itself. It is called cyst wall. Entamoeba with a cyst wall is called cyst. The process of formation of cyst is called encystment. The early cyst contains a single nucleus, a few rod-like chromatoid bodies and one or two glycogen granules. The glycogen granules and chromatoid bodies disappear as the age of the cyst increases.

In the beginning, the cyst contains only one nucleus. Hence the cyst is called uninucleated cyst. Soon the single nucleus divides into two by mitosis. At this stage the cyst contains two nuclei, hence the cyst is called the binucleate cyst. Then the two nuclei again divide by mitosis to produce four nuclei. Now the cyst contains four nuclei and hence it is called a tetranucleate cyst. Further development takes place inside the intestine of another man. The whole process of encystment occurs within a few hours.

Infection

The tetranucleate cyst is transmitted from one person to another through the following agents: 1. Contaminated food and 2. Contaminated water.

Excystment

The tetranucleate cyst enter the intestine of another man through contaminated food or waer. Here the cyst wall ruptures and the tetranucleate Amoeba comes out. The Amoeba then undergoes a special kind of multiple fission resulting in eight daughter Amoeba. The Amoebae enter the large intestine and grow into trophozoites.

Amoebiasis

The disease caused by *Entamoeba* in man is called amoebiasis or amoebic dysentery. Amoebiasis is characterized by the following symptoms:

1. *Entamoeba* feeds on the mucous epithelium. This causes ulcer in the intestine.
2. In the ulcer, blood vessels are damaged and hence blood oozes into the intestine.
3. The stool contains mucous and blood.
4. The stool becomes loose.
5. The patient defaecates frequently.
6. There is severe pain in the intestine.

Prevention

Infection by *Entamoeba* can be easily prevented by the following methods.

1. Before every meal, the hand should be properly washed and cleaned.
2. Finger nails should be closely cut.
3. Vegetables and other food stuffs should be properly cooked.
4. Drinking water should be well boiled.
5. Food stuff and water should be protected from house flies and other insects.

Treatment

Amoebiasis is a curable disease. It can be treated with the following drugs: Emetine, Dehydroemetine, Chloroquine, Diodoquine, Terramycin, Aureomycin and Erythromycin.

Other Species of *Entamoeba* in man

There are many species of *Entamoeba*. A few are ***Entamoeba coli***: it lives in the colon (intestine) of man and ***E. gingivalis***: It lives in the mouth between the teeth and gum.

3.6 LET US SUM UP

Paramecium is a unicellular, slipper animalcule included in the phylum Protozoa. Presence of two contractile vacuoles used for osmoregulation and excretion. The mode of nutrition is called holozoic carried out by the cyclosis process. *Paramecium* undergoes sexual conjugation process for the production of zoospores. *Plasmodium vivax* is an endoparasite living in the blood of man and causes a disease malaria. The another parasite *Entamoeba histolytica* lives in the intestine and causes a disease amoebiasis or amoebic dysentery.

3.7 KEY WORDS

Cytophyge	- Temporary opening
Holotrichous	- Uniform distribution of cilia
Kinetosome	- Cilium arises from a spherical body.
Pellicle	- Outer elastic covering.
Trichocyst	- Conical bag like structure of Paramecium
Osmoregulation	- Maintenance of constant water current
Systole	- Contraction of contractile vacuole
Diastole	- Relaxation of contractile vacuole.
Cyclosis	- Streaming movement of cytoplasm
Synkaryon	- Fused nucleus
Trophozoite	- The fully grown mature entamoeba
Encystment	- A thin, tough and flexible membrane around entamoeba
Ulcer	- Damaged blood vessels cause a bleeding
Infection	- Entry of microbe cause a disease.
Vector	- Disease causing organism
Primary host	- The higher organism in which the parasite completes its Life cycle.

3.8 BOOKS FOR FUTURE READING

7. Invertebrate Zoology-R.L.Kotpal(2005) Rastogipublications, Meerat
8. Chordate Zoology-. E.L. Jordan and Dr.P.S.Verma(2006) S.Chand & Co.NewDelhi
9. Text Book of Invertebrate- Dr.N.Arumugam etal,(2008) Saras Publications, Nagerkovil.

3.9 QUESTIONS / EXERCISES

Part – A

1. Which is called slipper animalcule? and why?
2. What do you mean by holotricus?
3. Define encystment.

Part – B

1. Give a short notes on contractile vacuule.
2. What are the symptoms of Malaria.

Part – C

1. Explain the conjugation process.
2. Describe the disease Amoebiasis.

3.10 ANSWER FOR CYP QUESTIONS

For Q.No.1 in Part A refer section No.1.3.1

For Q.No.2 in Part A refer section No.1.3.1

For Q.No.3 in Part A refer section No.1.5

For Q.No.1 in Part B refer section No.1.3.3

For Q.No.2 in Part B refer section No.1.4.1

For Q.No.1 in Part C refer section No.1.3.4

For Q.No.2 in Part C refer section No.1.5.1

LESSON – 4

PORIFERA TYPE STUDY - OLYNTHUS

The phylum Porifera includes pore-bearing, first multicellular animals. They are also called as sponges. They are all aquatic and have sedentary in habit. They are diploblastic and asymmetrical or radially symmetrical. The sponges possess an endoskeleton in the form of calcareous spicules. They reproduce their young ones either asexual (budding or gemmule) or sexual methods. They have greater power of regeneration. Development of the phylum is indirect or direct. The common larval forms are paranchymula, amphiblastula, etc., Example: Olynthus.

Objectives

By Studying this unit, the students will

- understand the phylum porifera (pore bearing organisms)
- know the first multicellular organism.
- know the special characters of phylum (gemmule, spicules and canal system)

Unit Structure

4.1 Definition of Porifera.

4.2 Systematic position.

4.2.1 General organization.

4.2.2 Histology.

4.2.3 Spicules.

4.2.4 Reproduction.

4.2.5 Development.

4.2.6 Canal system in sponges.

4.3 Let us sum up.

4.4 Key words.

4.5 Books for further reading.

4.6 Questions/Exercise.

4.7 Answer for Questions.

4.1 DEFINITION PORIFERA

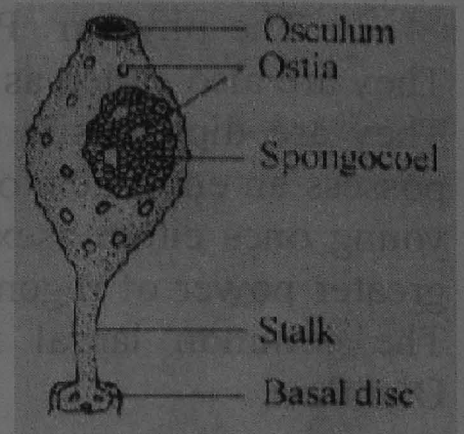
The porifera may be defined as asymmetrical or radially symmetrical multicellular pore bearing organisms with cellular grade of organization and with a characteristic skeleton made of calcareous spicules, siliceous spicules or horny fibres of sponging.

4.2 SYSTEMATIC POSITION OLYNTHUS (Clathrina)

Phylum : Porifera

Class : Calcarea

Order : Homocoeta

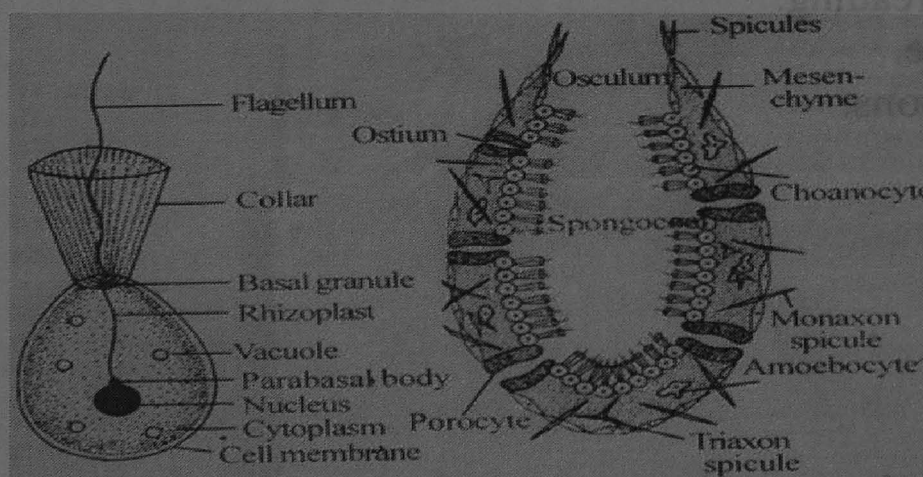


Olynthus

4.2.1 GENERAL ORGANIZATION

Olynthus is a sponge. It is also called Clathrina. The body contains numerous pores. Hence it is included in the phylum Porifera. It has spicules made of calcium carbonate. Hence it is included in the class Calcarea. It is a very simple type of sponge. It resembles the asconoid type of sponge. But it is in a primitive stage. It is radially symmetrical. The body is cylindrical with a vase-like body.

It is attached to the substratum by one end and the other end is free. The attached end has a stalk and a basal disc for attachment. The free end has a large opening called osculum. The body encloses a large cavity called spongocoel. The body wall has many pores called ostia. Water enters the spongocoel through ostia and goes out through the osculum. The body wall is composed of an outer layer of epidermis, an inner choanoderm and a middle layer of mesogloea. The choanoderm is composed of choanocytes. A choanocyte is a flagellated collar cell. It consists of a cell body and a collar. The collar encloses a flagellum. The collar is funnel-shaped. The flagellum arises from the basal granule. The choanocyte does two functions, namely feeding and creating water current.



A Choanocyte

LS of Olynthus

The epidermis is made up to a row of flat cells called pinacocytes. The mesogloea is a gelatinous mass containing two main types of cells, namely scleroblasts and amoebocytes. The scleroblasts are the spicule forming cells. The amoebocytes have pseudopodia and they freely wander about. The amoebocytes are doing different functions. The ostia are intracellular as there are perforations through cells called porocytes present in the epidermis. The mesenchyme contains spicules. They are of three types, namely, monaxons, triaxon and tetraxon. Olynthus also occurs in the developmental stages of calcareous sponges such as Sycon. In Sycon, the gastrula develops into an Olynthus stage. This stage persists only for a short time and then it develops into the adult Sycon.

4.2.2 HISTOLOGY

All sponges are diploblastic. The body wall is composed of two layers, the epidermis or pinacoderm and the endoderm or choanoderm, with an intermediate mesenchyme. The cells are simple and modified for various functions.

Pinacoderm

The surface epithelium consists of large flat polygonal epithelial cells called pinacocytes. Each pinacocyte consists of a thickened central bulge with a nucleus. Pinacocytes are highly contractile and they can reduce or increase the surface area of the sponge. In Ascon type of sponge the ostia are intracellular openings through the porocytes. Porocytes are the modified pinacocytes. Porocytes are tubular cell reaching from the epidermis to the spongocoel pierced by a central canal. They are highly contractile. They effect the closure of the pore by extending a thin cytoplasmic membrane called the porediaphragm.

Choanoderm

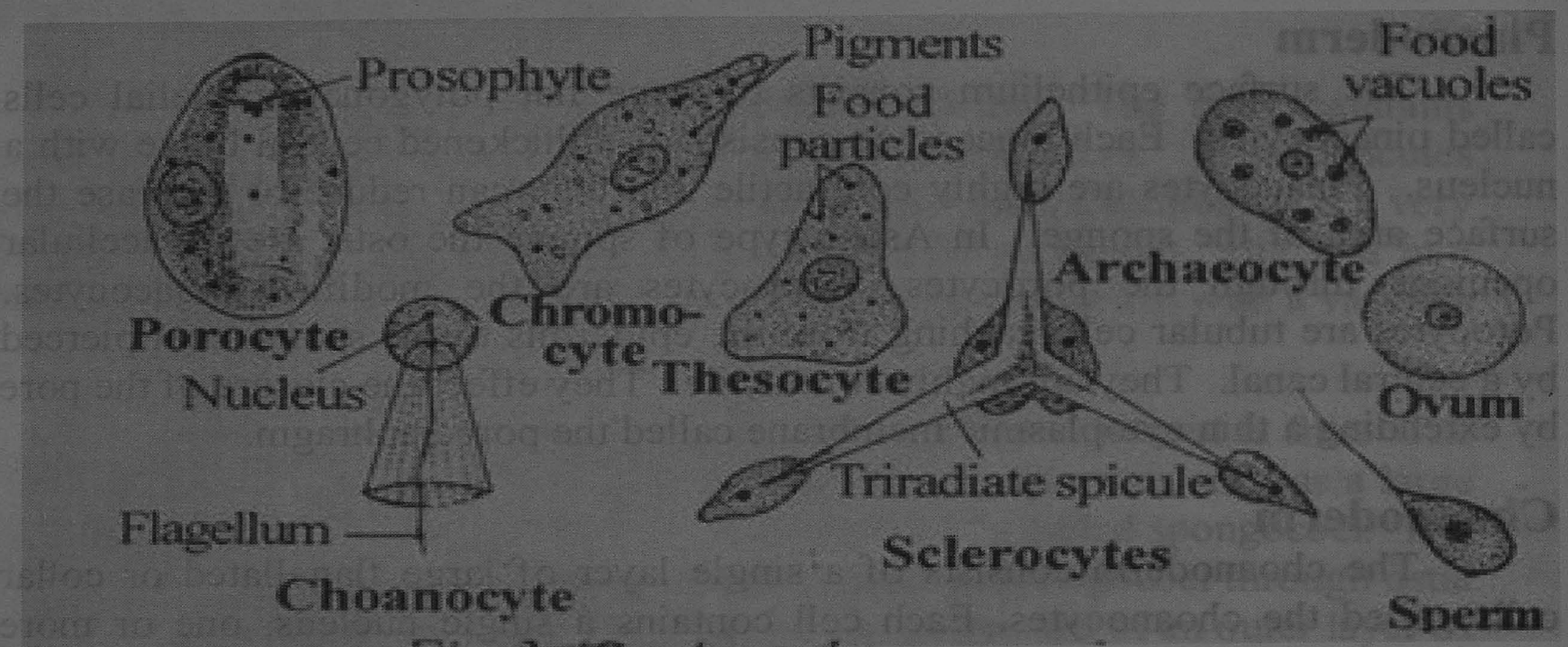
The choanoderm consists of a single layer of large flagellated or collar cells called the choanocytes. Each cell contains a single nucleus, one or more contractile vacuoles, food vacuoles and reserve food particles. Its inner end is prolonged into a long whip-like flagellum. The flagellum is surrounded at its base by a thin transparent and highly contractile funnel like collar. The flagellum arises from the basal granules.

Mesenchyme

Mesenchyme is present between the epithelium and choanoderm. It is composed of a gelatinous matrix called mesogloea, in which free amoeboid cells called amoebocytes are present. The mesenchyme is termed collenchymas when the cells are few and much mesogloea are present. When there are more cells with less amount of mesogloea the mesenchyme is called parenchyma.

The amoebocytes differ in size, shape of pseudopodia and kind of inclusions of different species. A few kinds of amoebocytes are as follows:

1. **Collencytes:** The amoebocytes with slender branching pseudopodia are called collencytes. They often unite into a syncytial network.
2. **Chromocytes:** These are pigmented amoebocytes with lobose pseudopodia.
3. **Thesocytes:** These are cells filled with reserve food materials.
4. **Trophocytes:** These are nourishing cells, they digest the food and distribute it.
5. **Scleroblasts:** These manufacture the spicules. According to the nature of the products they are known as calcoblasts, silicoblasts or spongioblasts.



Amoebocytes of sponges

6. **Archaeocytes:** These are large reserve cells. They have blunt pseudopodia and large nucleus with nucleolus. These are undifferentiated embryonic cells. They give rise to the sex cells, namely the ova and sperms. They play an important role in regeneration. Cells which can convert into any other kinds of cells within an animal are called totipotent.

7. **Gland cells:** These are attached to the surface by long strands and presumably secrete lime.

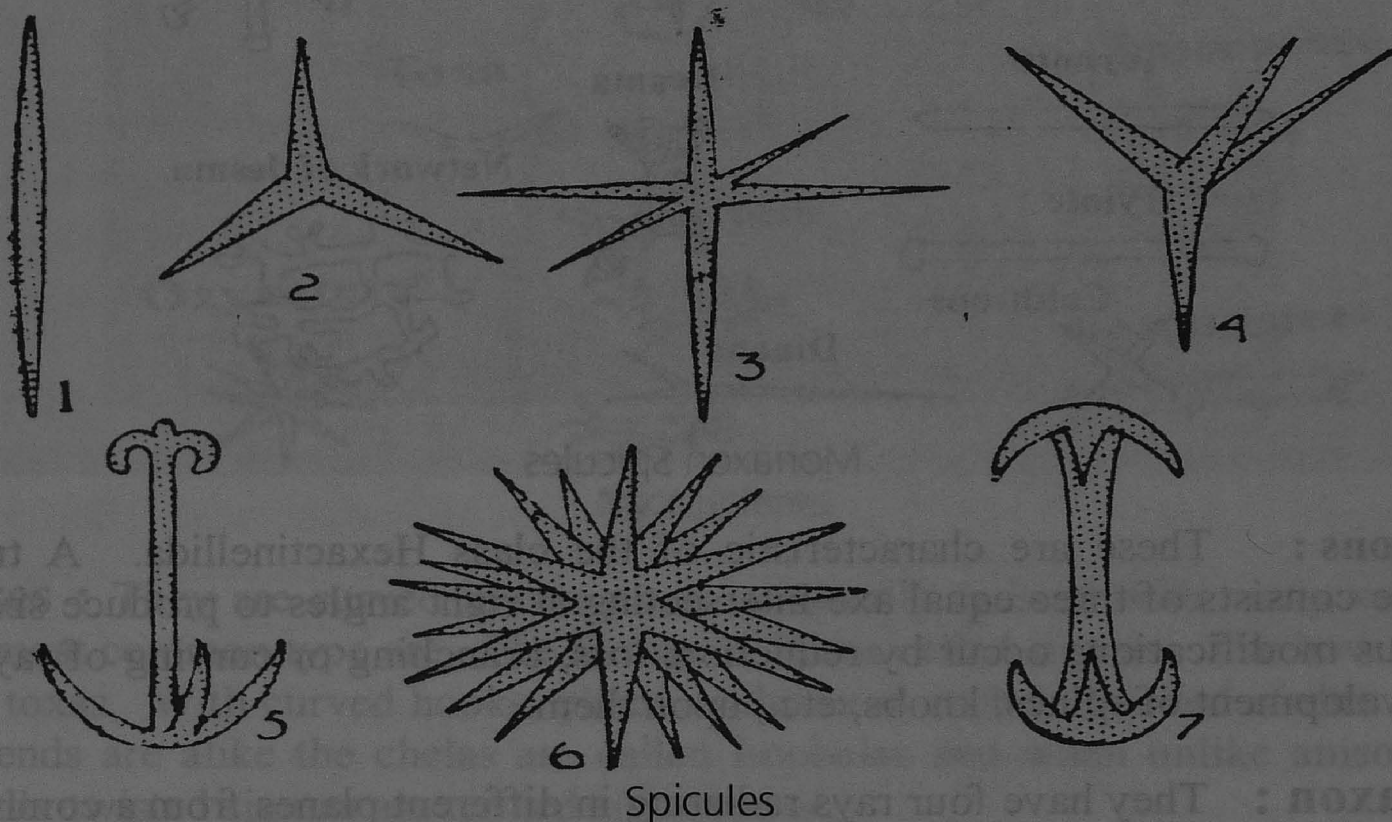
8. **Germ cells:** The gametes of sponges, differentiate from amoebocytes. In some cases they may arise from choanocytes.

9. **Myocytes:** These are fusiform contractile cells. They resemble the smooth muscles of other invertebrates. They are arranged circularly to form sphincters at osculum and other openings which can be opened or closed by them.

10. Phagocytes: These cells engulf excreta and damaged tissue.

4.2.3 SPICULES

The skeleton is one of the most important features of sponges. It provides support and protection to the sponge body. It is also a most useful diagnostic characteristic for classifying the sponges. It consists of spicules or sponging or both. Spicules or sclerites are crystalline structures and consists of rays or spines radiating from a point. They may be calcareous or siliceous. Both have a core or organic material around which is deposited either calcium carbonate or silica. Traces of other materials like manganese, zinc, copper, etc., also occur. The spicules are classified into large macroscleres and smaller microscleres according to their size.

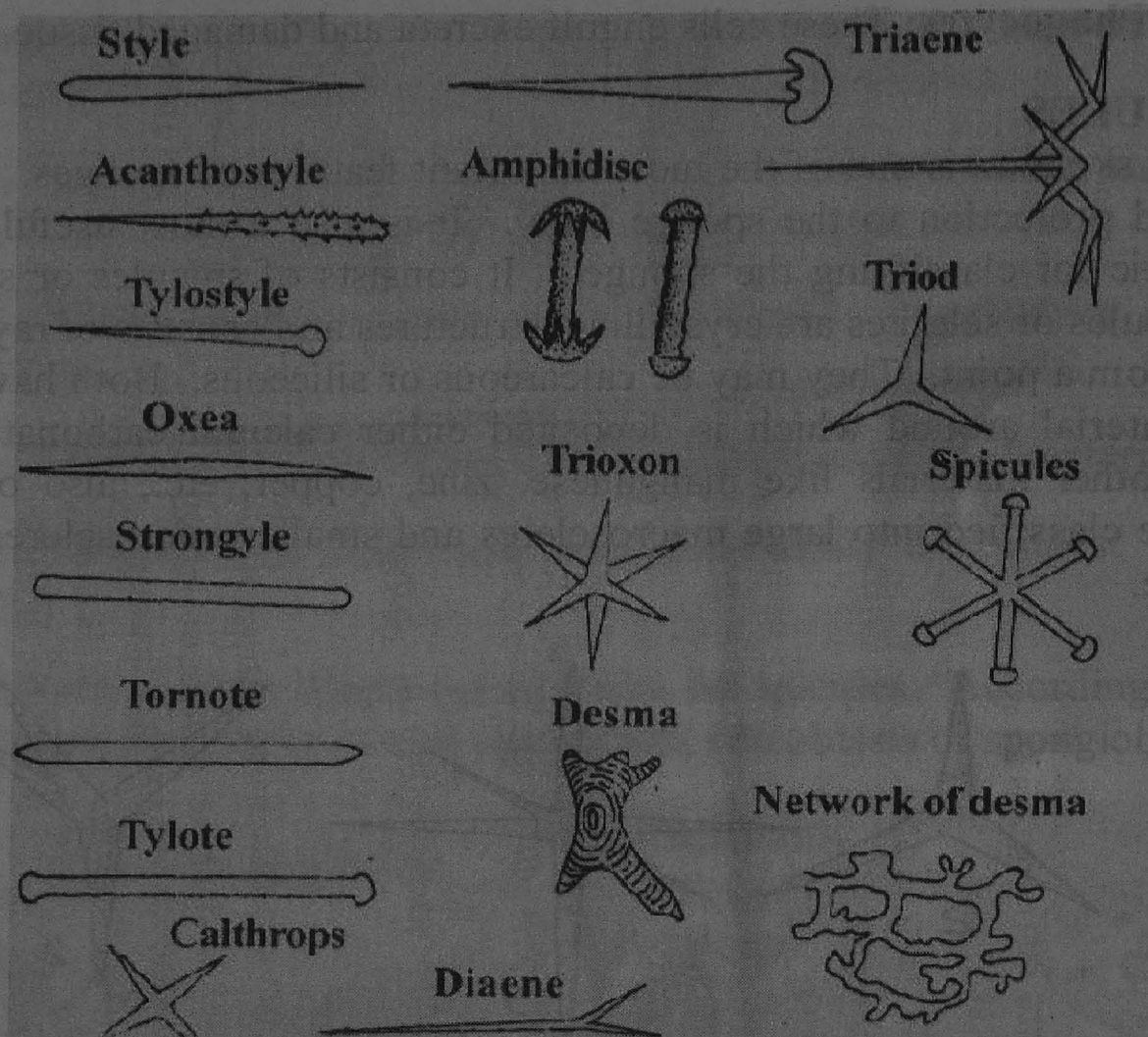


MACROSCLERES

The macroscleres make up the supporting frame work of the sponge, whereas the microscleres occur throughout the mesenchyme. According to the shape, the macroscleres can be divided into the following types:

Monaxons

They are simple rod-like to needle-like-spicules formed by growth in one or both directions along a single axis. When growth has occurred in one direction only, the spicule is called monactinal monaxon or style. Styles are typically rounded at one end and pointed at the other end. Styles in which the broad end is knobbed are called tylostyles; those covered with thorny processes are named acanthostyles. When growth proceeds in both directions the spicules are known as diactinal monaxons or rhabds. Rhabds pointed at both the ends are known as oxeas, lance shaped at each end are termed tornotes, round at the end are strongyles; and knobbed at each end are called tylotes.



Monaxon Spicules

Triaxons : These are characteristic of the class Hexactinellida. A triaxon spicule consists of three equal axes intersecting at right angles to produce six rays. Various modifications occur by reduction, loss, branching or curving of rays and by development of spines, knobs, etc., upon them.

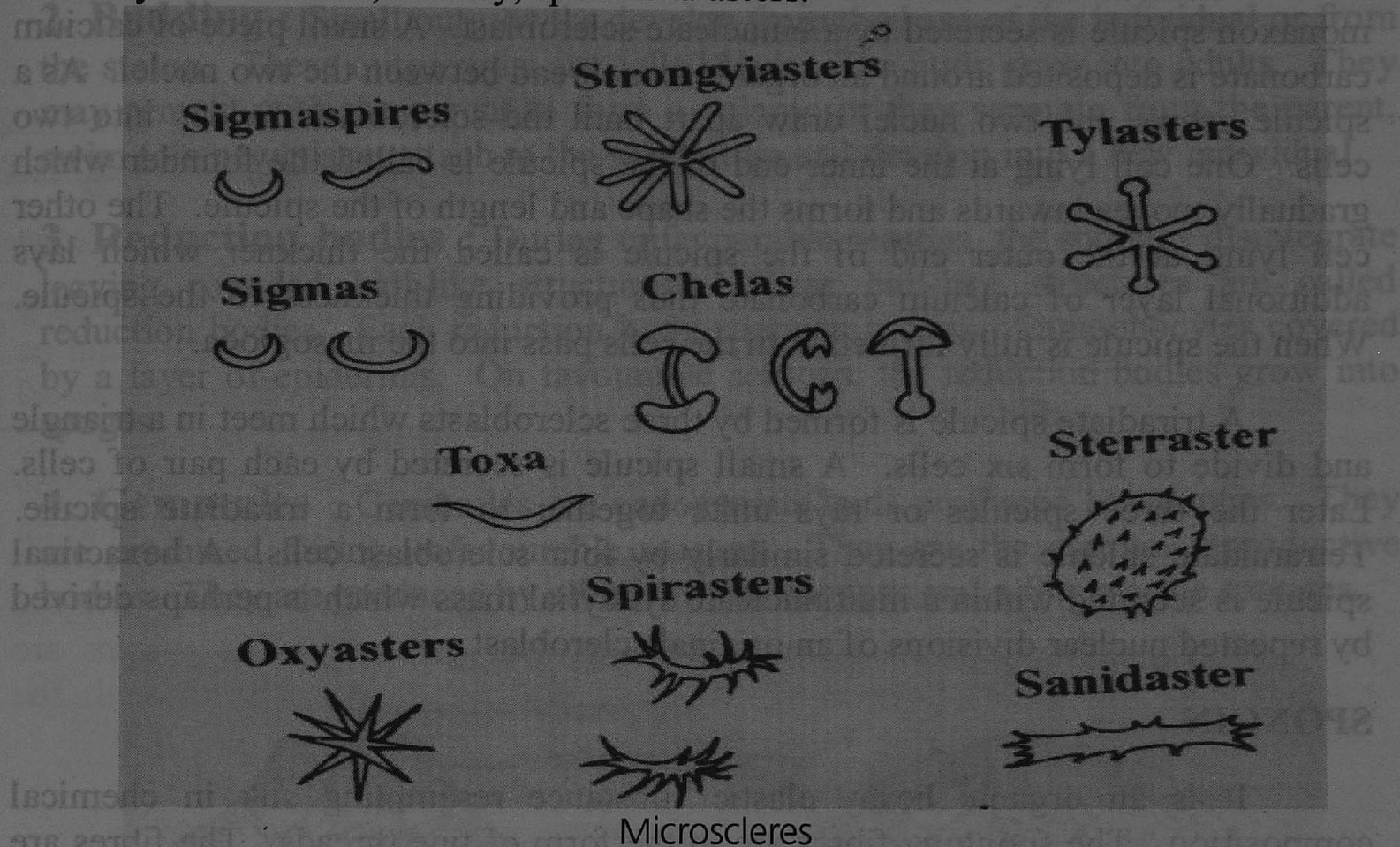
Tetragon : They have four rays radiating in different planes from a common point. When all the four rays are more or less equal, the spicule is called calthrops. When a single ray is elongated, bearing a crown of three smaller rays, it is called triaenes. Loss of one smaller ray results into a diaene. If the elongated ray bears a disc at both ends it is called an amphidisc spicule. Loss of the elongated ray results into a triradiate spicule called triod.

Polyaxons : They have several axes proceeding from the centre.

Spheres : These are rounded spicules in which the growth is concentric around a central point.

Desma : These are modified macroscleres formed by the deposition of silica in irregular layers upon an ordinary monaxon triradiate or tetragon spicule. These are usually united into a network called lithistid.

MICROSCLERES : They occur in the mesenchyme and sometimes project into the canal. So they are also known as the auxillary or flesh spicules. These are mainly of two kinds, namely, spires and asters.



Spires : They are curved in one plane or spirally twisted with many varieties. The most common type are, The C-shaped forms called sigmas, The bow shaped ones toxas, With curved hooks, plates or flukes at each end called chelas. When two ends are alike the chelas are called isochelas and when unlike anisochelas. Spirally twisted sigmas are termed sigmaspires.

Asters : These are multiactinate microscleres. The polyaxon types in which actins proceed from a centre are called euasters. There are two types of asters one with small centres and long rays and other with large centres and short rays. Among the small centred forms are oxyasters with pointed rays, strongyasters with rounded ends and tylasters, with knobbed rays. Large centred forms include spherasters, with definite rays and sterrasters with rays reduced to small projections from a spherical surface. Among monaxons, short spring asters are known as streptasters. The spirally twisted streptasters are called spirasters. The rod-shaped ones are called the sanidasters. The streptasters with a few spines from a very short axis are known as plesioasters. When the spines are at both the ends these are called amphiasters.

DEVELOPMENT OF SPICULES

The cells that secrete the spicules are known as scleroblasts. A calcareous monaxon spicule is secreted by a binucleate scleroblast. A small piece of calcium carbonate is deposited around an organic axis thread between the two nuclei. As a spicule grows, the two nuclei draw apart until the scleroblast divides into two cells. One cell lying at the inner end of the spicule is called the founder which gradually moves inwards and forms the shape and length of the spicule. The other cell lying at the outer end of the spicule is called the thickener which lays additional layer of calcium carbonate thus providing thickness to the spicule. When the spicule is fully formed both the cells pass into the mesogloea.

A triradiate spicule is formed by three scleroblasts which meet in a triangle and divide to form six cells. A small spicule is secreted by each pair of cells. Later the three spicules or rays unite together to form a triradiate spicule. Tetraradiate spicule is secreted similarly by four scleroblast cells. A hexactinal spicule is secreted within a multinucleate syncytial mass which is perhaps derived by repeated nuclear divisions of an original scleroblast.

SPONGIN

It is an organic horny elastic substance resembling silk in chemical composition. The sponging fibres are in the form of fine threads. The fibres are secreted by flask-shaped mesenchyme cells called spongioblasts, which after secreting the sponging, become vacuolated and finally degenerate.

Spongin occurs in various forms in demospongia. In some Monaxonida spongin occurs as a cement connecting together the siliceous spicules. In some other Monaxonida, it is found in the form of branching fibres in which siliceous spicules are embedded. In keratosa the spicules are absent and the spongin alone forms a continuous, elastic fibrous frame work of the body.

4.2.4 REPRODUCTION

The production of young ones is called reproduction. Sponges reproduce asexually and sexually.

ASEXUAL REPRODUCTION

Production of young ones without the involvement of gametes is called asexual reproduction. It takes place by four methods, namely

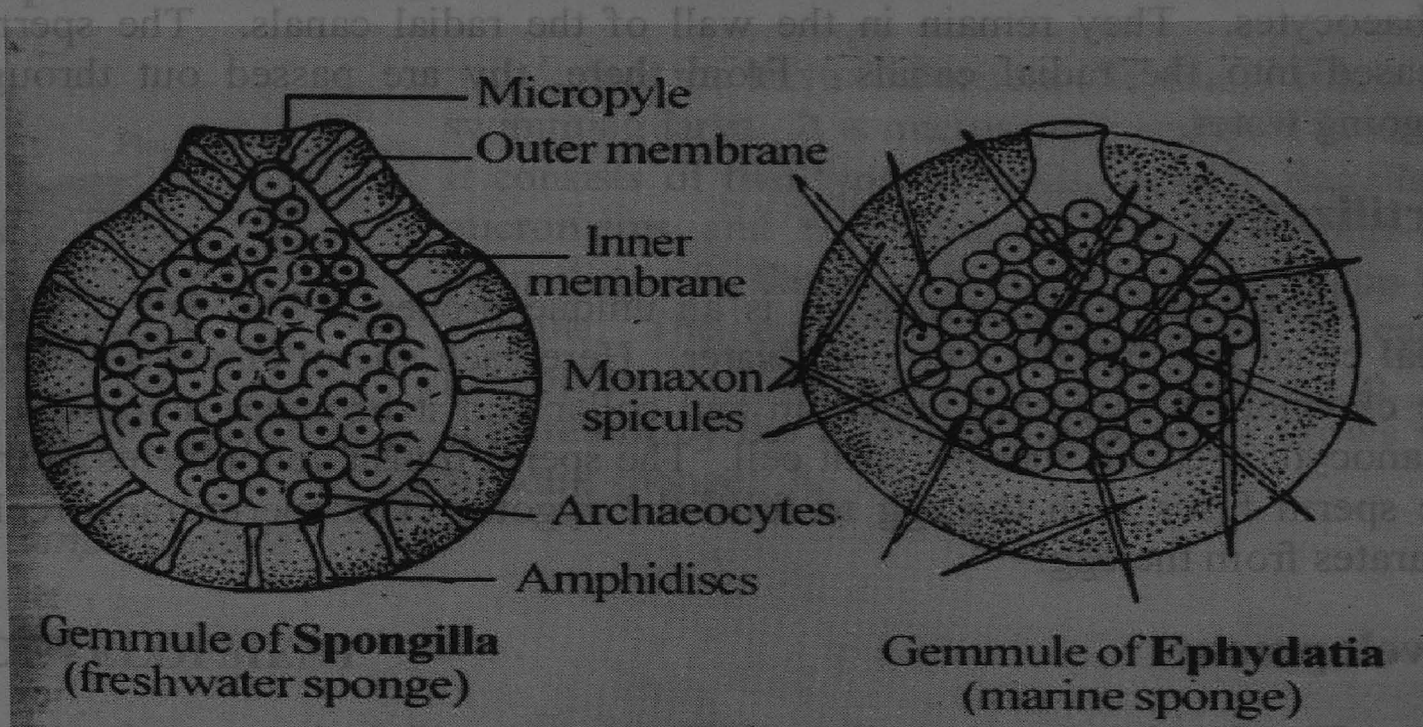
1. Fragmentation.
2. Budding.
3. Reduction bodies and
4. Gemmules

1. Fragmentation : Large sponges break into small pieces and each piece grows into an entire sponge.

2. Budding : Small outgrowths develop from the base of the individual or from the stolon. These outgrowths are called buds. The buds grow into adults. They may remain with the parent to form a colony; or they separate from the parent, swim to a new place, attach to the substratum and develop into a new individual.

3. Reduction bodies : During unfavourable seasons, the sponges disintegrate leaving rounded ball-like structures. These ball-like structures are called reduction bodies. Each reduction body contains a mass of amoebocytes covered by a layer of epidermis. On favourable seasons, the reduction bodies grow into sponges.

4. Gemmules : Gemmules are endogenous buds produced by sponges. They are produced during unfavourable seasons. They are the asexual reproductive bodies. They are produced by all freshwater sponges and a few marine sponges.



Gemmules of sponges

The gemmule has the following features:

1. It is spherical in shape.
2. It is covered by two membranes, namely an outer membrane and inner membrane.
3. Numerous spicules are situated between the two membranes. In marine-gemmules the spicules are monaxon and in the freshwater gemmules the spicules are amphidiscs.
4. The interior of gemmule is filled with a mass of archaeocytes.
5. The archaeocytes are loaded with food particles.

6. The mature gemmule has an opening called micropyte.
7. Gemmules are resistant to external factors such as freezing and drying.
8. On favourable seasons each gemmule grows into a sponge.
9. Gemmules help in the dispersal of sponges.

Significance of gemmules

Gemmules has three significances:

1. It is a means of asexual reproduction.
2. It helps the sponge to tide over the unfavourable seasons.
3. It helps the dispersal of sponges.

CHECK YOUR PROGRESS

1. Define choanocyte?
2. What do you mean by spicules?
3. What is amphiblastula?
4. What is the function of canal system?
5. Define leucon canal system?

SEXUAL REPRODUCTION

The production of young ones with the involvement of gametes is called sexual reproduction. It occurs in all sponges. The eggs develop from the archaeocytes. They remain in the wall of the radial canals. The sperms are released into the radial canals. From there, they are passed out through the outgoing water.

Fertilization

Fertilization is internal. It is a unique process. The sperms enter the radial canal through the incoming water. Here each sperm enters a choanocyte. The choanocyte loses the flagellum and collar and it becomes amoeboid. This choanocyte is called sperm-transit cell. The sperm-transit cell adheres to the egg. The sperm fuses with the egg to form the zygote. The sperm-transit cell now separates from the egg.

Development

The development is indirect. The zygote undergoes segmentation. The segmentation is called cleavage. The cleavage is holoblastic and unequal. Cleavage leads to the formation of blastula. The blastula develops into a parenchymula larva or amphiblastula larva before developing into the adult.

1. Parenchymula larva

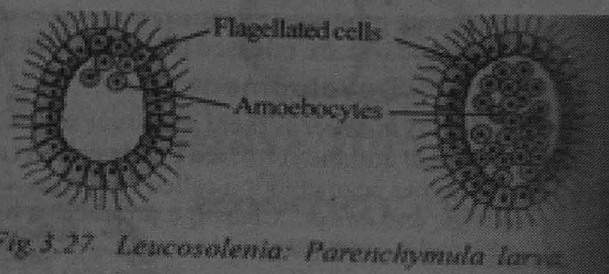
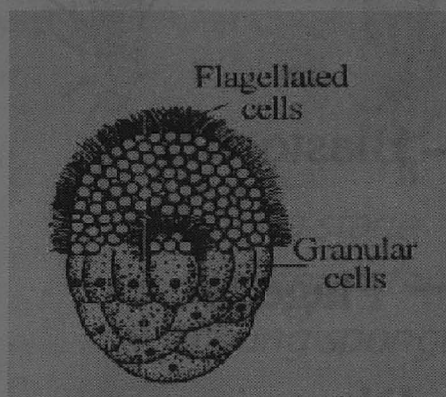


Fig 3.27. *Leucosolenia*: Parenchymula larva

It is the larva of Porifera (*Leucosolenia*). It is a free-swimming larva. It is microscopic and oval in shape. It consists of an outer layer of flagellated cells and an inner mass of amoebocytes. After a short free-swimming life, it is attached to the substratum. The amoebocytes migrate to the exterior and spread out to form the ectoderm and mesenchyme. The flagellated cells get enclosed by the ectoderm and become the choanoderm. The ostia and an osculum develop and the larva grows into an adult sponge.

2. Amphiblastula larva



Amphiblastula

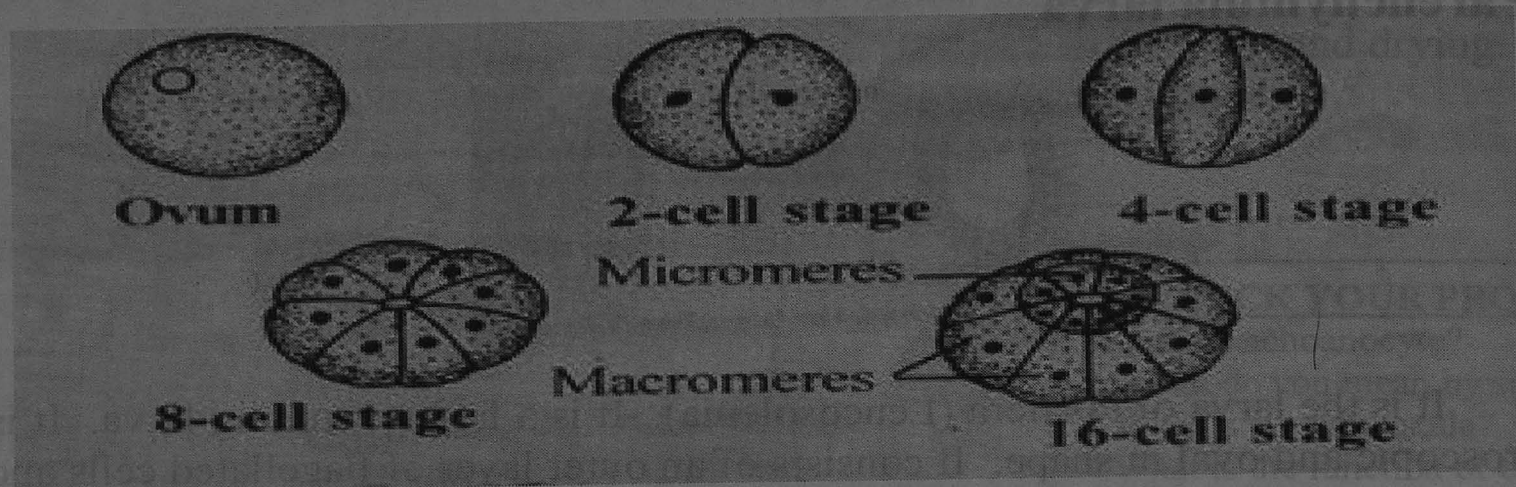
It is the larva of Porifera (*Scypha*). It is a free swimming larva. It is microscopic and oval in shape. It consists of two types of cells, namely flagellated micromeres and macromeres. After a short-free swimming life, the larva is converted into a cup-like gastrula. The opening of the gastrula is called blastopore. The gastrula is attached to the substratum by the blastoporal end and it grows into an adult sponge.

4.2.5 DEVELOPMENT

Development is indirect as there are larval stages in the life history. Fertilization is external. The fertilized egg is called zygote.

CLEAVAGE

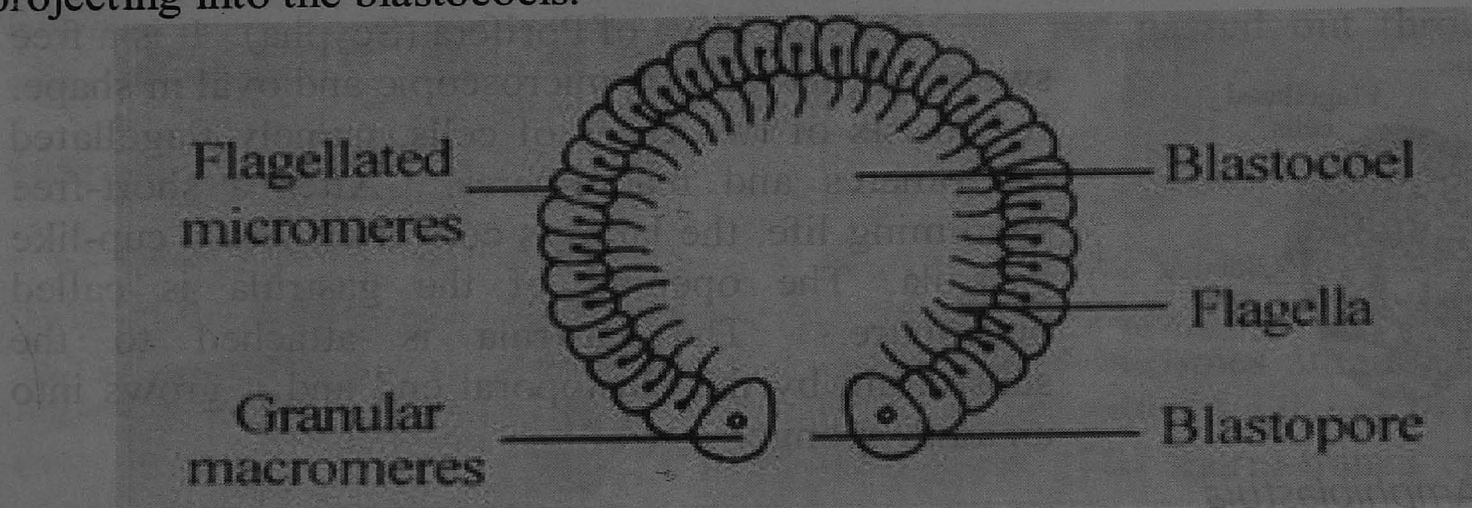
The zygote undergoes segmentation called cleavage. Cleavage is holoblastic and unequal. The first three divisions produce eight equal blastomeres. The fourth division is unequal producing eight small cells called micromeres and eight large cells called macromeres. The micromeres are destined to develop into the choanoderm and the macromeres are destined to develop into the ectoderm. The macromeres divide slowly but the micromeres divide faster. Cleavage leads to the formation of an embryonic stage called stomolastula.



Scypha - Cleavage

Stomoblastula

It is spherical in shape. It is formed of two types of cells, namely rounded granular cells called macromeres and elongated cells called micromeres. There is a cavity inside called blastocoel. It opens to the outside by mouth located in the centre of macromeres. The micromeres contain flagella on their inner side projecting into the blastocoel.



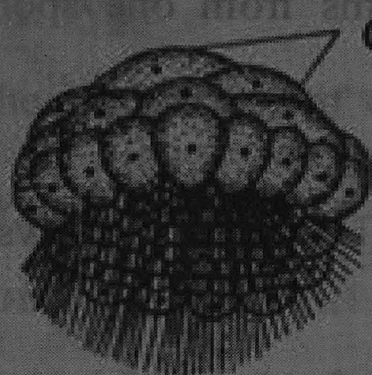
Stomoblastula

Amphiblastula

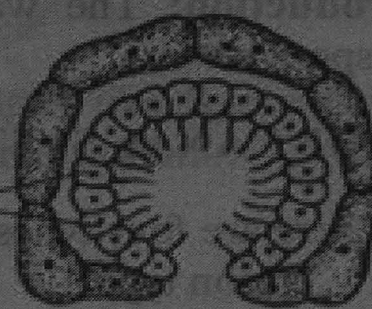
It develops from stomoblastula. The stomoblastula undergoes a process of inversion in which the embryo turns inside out through its mouth bringing the flagellated cells outside. Amphiblastula is a free swimming larva. It is oval in shape. One half of the larva is formed of small elongated flagellated cells and the other half is formed of large rounded granular cells.

Gastrula

Soon the amphiblastula larva undergoes gastrulation. During gastrulation, the flagellated cells invaginate and the larva is transformed into a double walled cup. The opening of the cup is called blastopore. The non-flagellated cells become the ectoderm and the flagellated cells become the choanoderm. The cavity lined by the choanoderm is called archenteron.



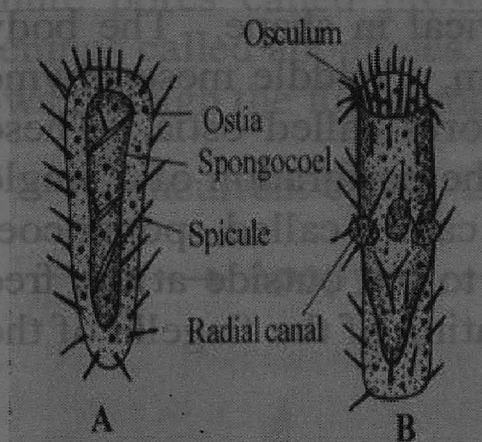
Entire



Section

Scypha - Gastrula

Metamorphosis



Scypha stage

A. Olynthus stage

B. Young sponges

The gastrula is attached to the substratum with the blastoporal end. It elongates into a cylinder. The free end develops an opening called osculum. Small openings called ostia develop on the surface of the cylinder. The mesogloea is secreted between the ectoderm and choanoderm. Now the schypa looks like and Ascon sponge and this stage is called Olynthus stage. The adult Schypa develops from the Olynthus stage by the pushing out of the wall to become radial canals. The choanocytes shifts into the radial canals.

4.2.6 CANAL SYSTEM IN SPONGES

The body of the sponges is traversed by numerous canals opening to the outside by many minute pores. These canals and pores of sponges constitute the canal system.

FUNCTIONS OF CANAL SYSTEM

The canal system creates a water current to flow in and out of the sponges continuously. This water current has the following functions:

1. **Respiration** : The cells absorb O_2 from the water current and gives out CO_2 .
2. **Nutrition**: The water current brings in food particles.
3. **Excretion**: Nitrogenous wastes products are faces and washed out by the water current.

4. Reproduction: The water current carries the sperms from one sponge to another sponge.

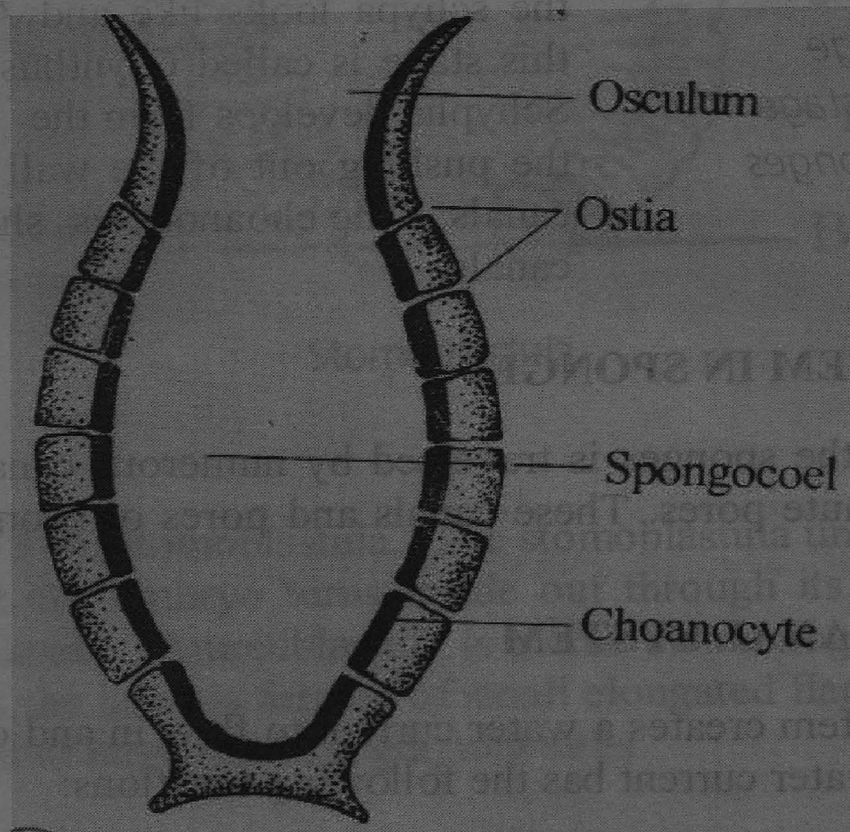
TYPES OF CANAL SYSTEM

There are four types of canal system in sponges. They are as follows:

1. Ascon type
2. Sycon type
3. Rhagon type and
4. Leucon type.

1. Ascon type

It is the simplest type of canal system. It is exhibited by sponges like *Olynthus* and *Leucosolenia*. These animals are cylindrical in shape. The body wall is formed of three layers, namely an outer ectoderm, a middle mesenchyme and an inner choanocytes. The wall contains many pores called ostia. These pores are intracellular because each pore is formed by the perforation of a single cell called porocyte. All the ostia open into a central cavity called spongocoel which is lined by choanocytes. The spongocoel opens to the outside at the free end by a large circular opening called osculum. The beating of the flagella of the choanocytes creates a water current.



Ascon type of canal system

The water flows in the following route:

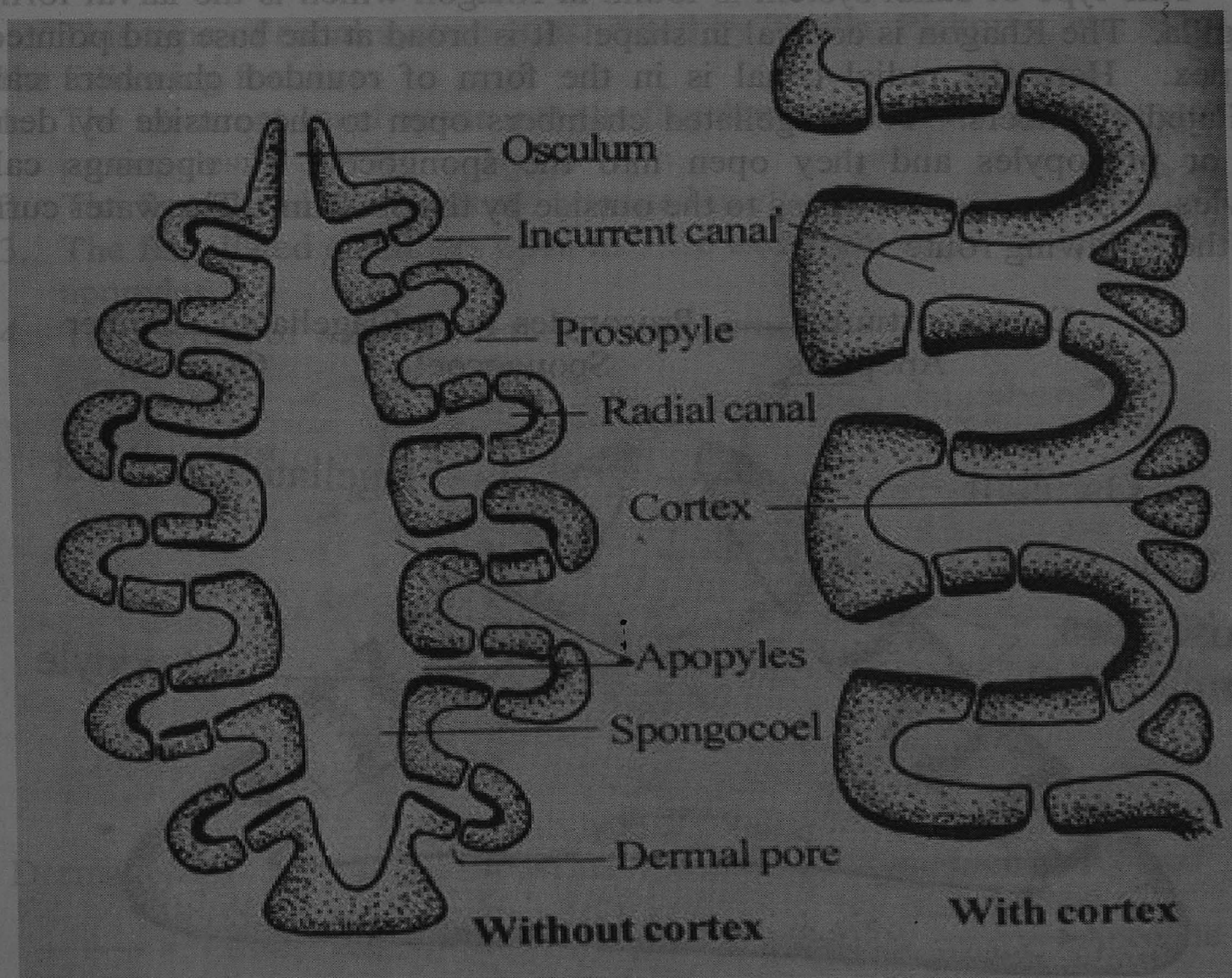
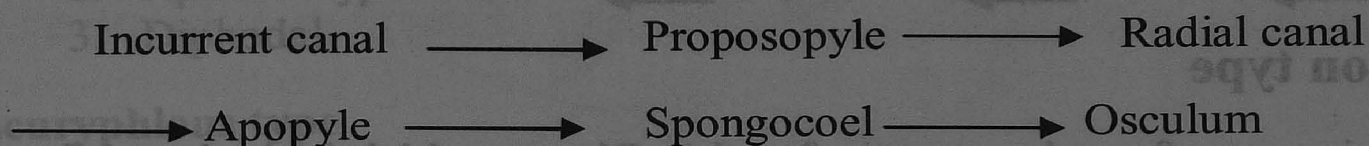
Ostia → Spongocoel → Osculum

2. Sycon type

The sycon type of canal system is seen in sponges like Sycon(Grantia), Sycetta, etc. There are two types of sycon type of canal system. They are 1. Sycon type without cortex and 2. Sycon with cortex.

1. Sycon type without cortex

It is found in Sycetta. It is derived from the ascon type by the development of many finger-like, outgrowths on the surface. These finger like outgrowths are called canals. These canals are lined with choanocytes. But the spongocoel is lined with ectoderm. Between the radial canals there is another canal called incurrent canal. The incurrent canals open into the radial canals by minute pores called prosopyles. The radial canals open into spongocoel by openings called apophyles. The spongocoel opens out by the osculum. The water flows through the following route:



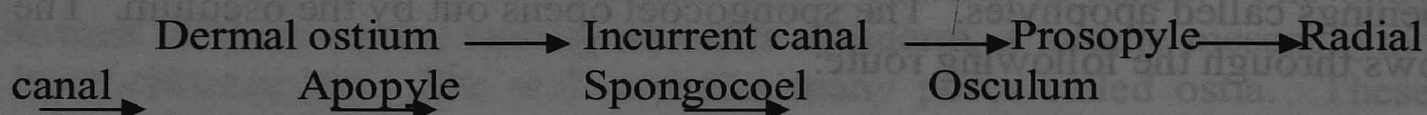
Sycon type of canal system

2. Sycon type with cortex

This type is found in Sycon (Scypha or Grantia). In addition to the previous type it has four additional features. They are as follows:

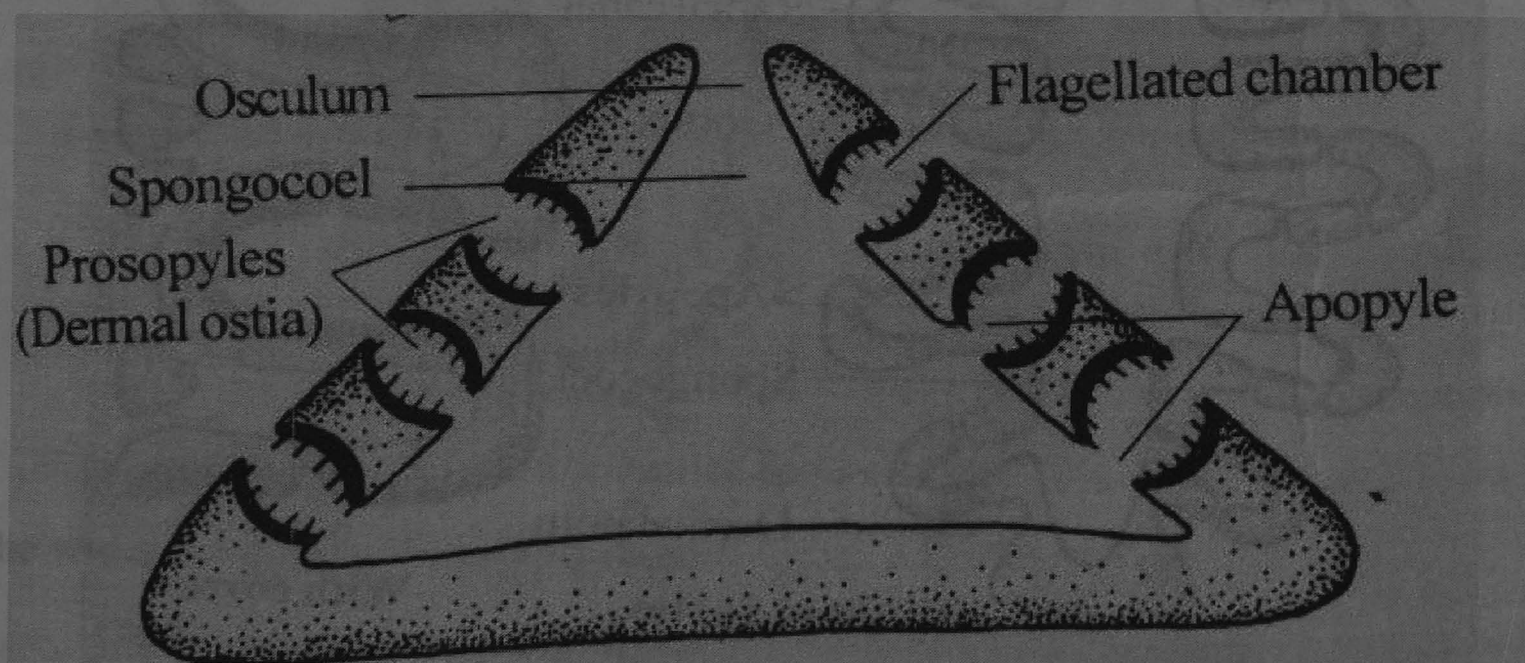
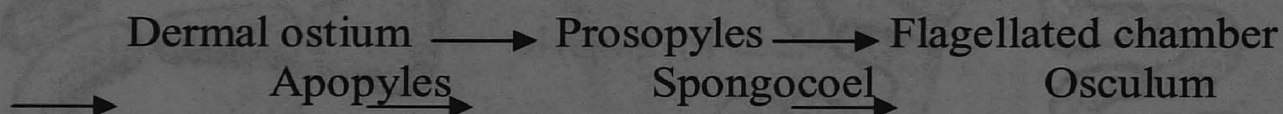
1. The epidermis and mesenchyme spread over the outer surface so as to form a cortex.
2. The free end of the incurrent canals open to the outside by minute pores called dermal ostia.
3. The incurrent canal opens into the radial canal by openings called prosopytes.
4. The radial canal opens into the spongocoel by openings called apopyles.

In this type the water current flows through the following route:



3. Rhagon type

This type of canal system is found in Rhagon which is the larval form of Spongilla. The Rhagon is conical in shape. It is broad at the base and pointed at the apex. Here the radial canal is in the form of rounded chambers called flagellated chambers. The flagellated chambers open to the outside by dermal ostia or prosopyles and they open into the spongocoel by openings called apopyles. The spongocoel opens to the outside by the osculum. The water current takes the following route:



Rhagon type of canal system

4. Leucon type

The leucon type of canal system is derived from the Rhagon type. The leucon type has the following advanced characters:

1. The dermal ostia open into subdermal spaces.
2. The subdermal space open into incurrent canals.
3. The incurrent canals open into flagellated chambers.
4. Choanocytes are located only in flagellated chambers.
5. The flagellated chambers leads into excurrent canals.
6. The excurrent canals open into spongocoel.
7. The spongocoel opens to the outside by an osculum.

CHECK YOUR PROGRESS

1. Define fragmentation?
2. What is budding?
3. Define pinacoderm?
4. What is trophocytes?
5. What is microscleres?

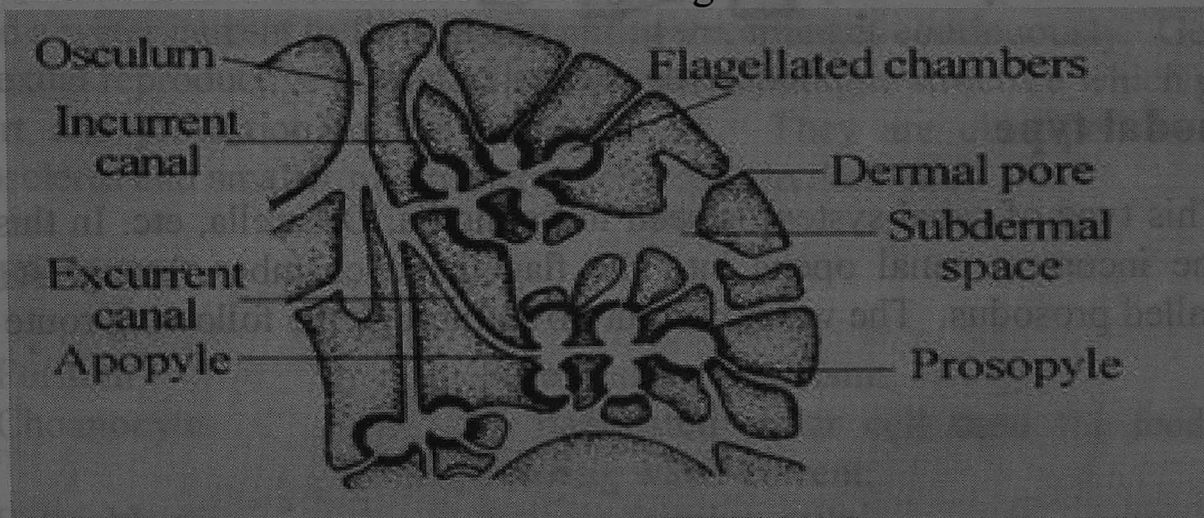
There are three kinds of leucon type of canal system namely:

1. Euryphulous type
2. Aphodal type and
3. Diphodal

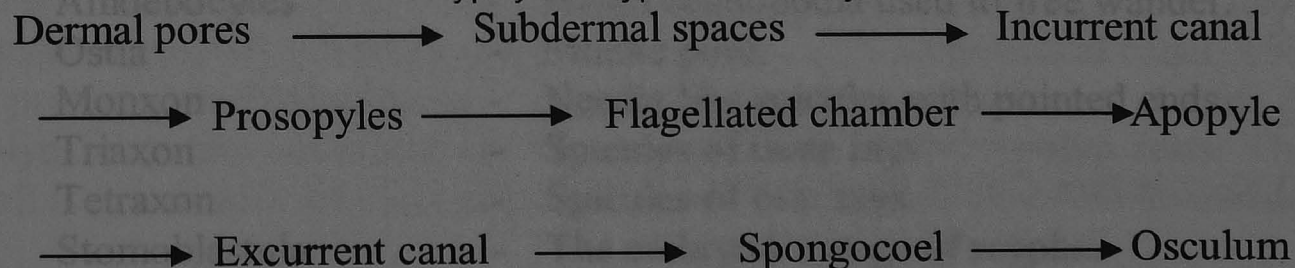
1. Ecuryphlous type

This type of canal system is exhibited by Tetilla, Plakortis, etc. This type has the following features:

1. The incurrent canal opens into the flagellated chambers by openings called prosopyles.
2. The flagellated chambers are arranged in clusters.
3. The flagellated chambers open into the excurrent canal by openings called apopyles.
4. The current of water takes the following route:



Euryphylous type of canal system

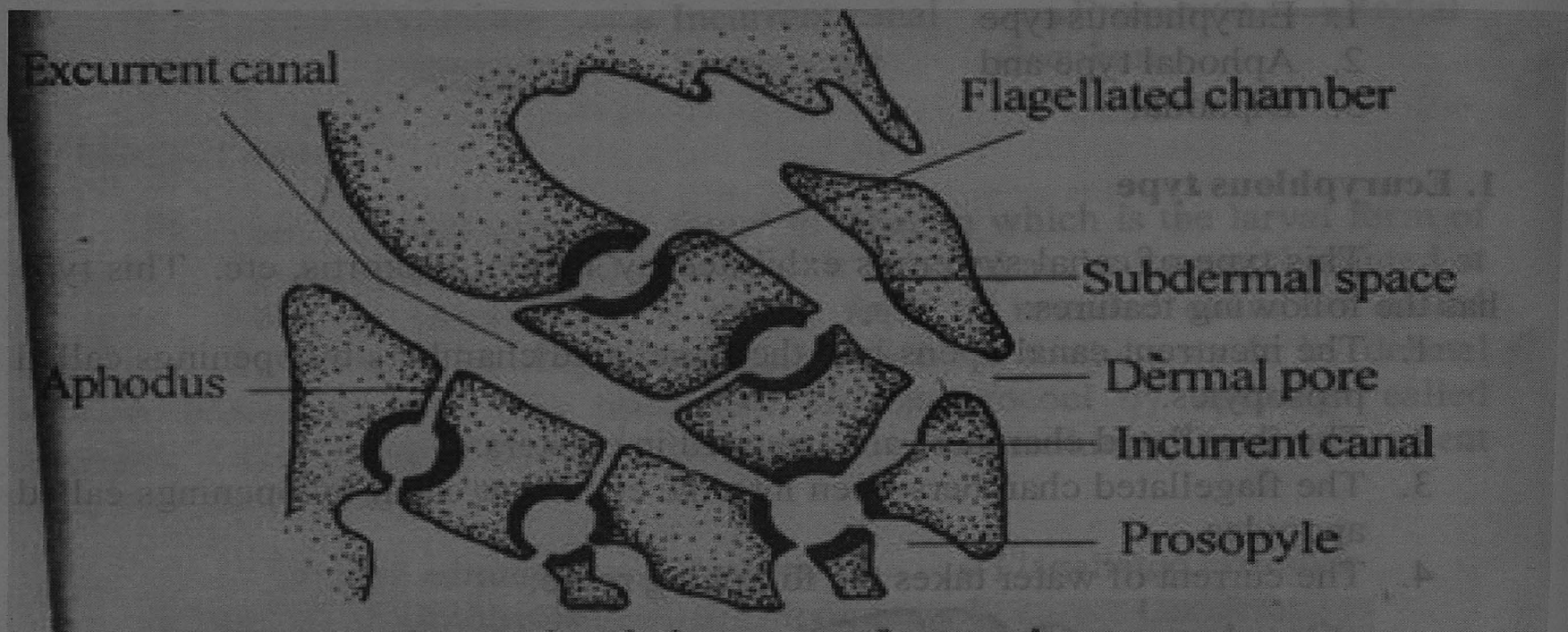


2. Aphodal type

The aphodal type of canal system is seen in *Geodia* and *Stelletta*. It has the following salient features:

1. Flagellated chamber opens into the excurrent canal through a canal called aphodus.
2. The water current takes the following route:

Dermal ostia → Subdermal spaces → Incurrent canal
 → Prosopyles → Flagellated chamber → Aphodus
 → Excurrent canal → Spongocoel → Osculum

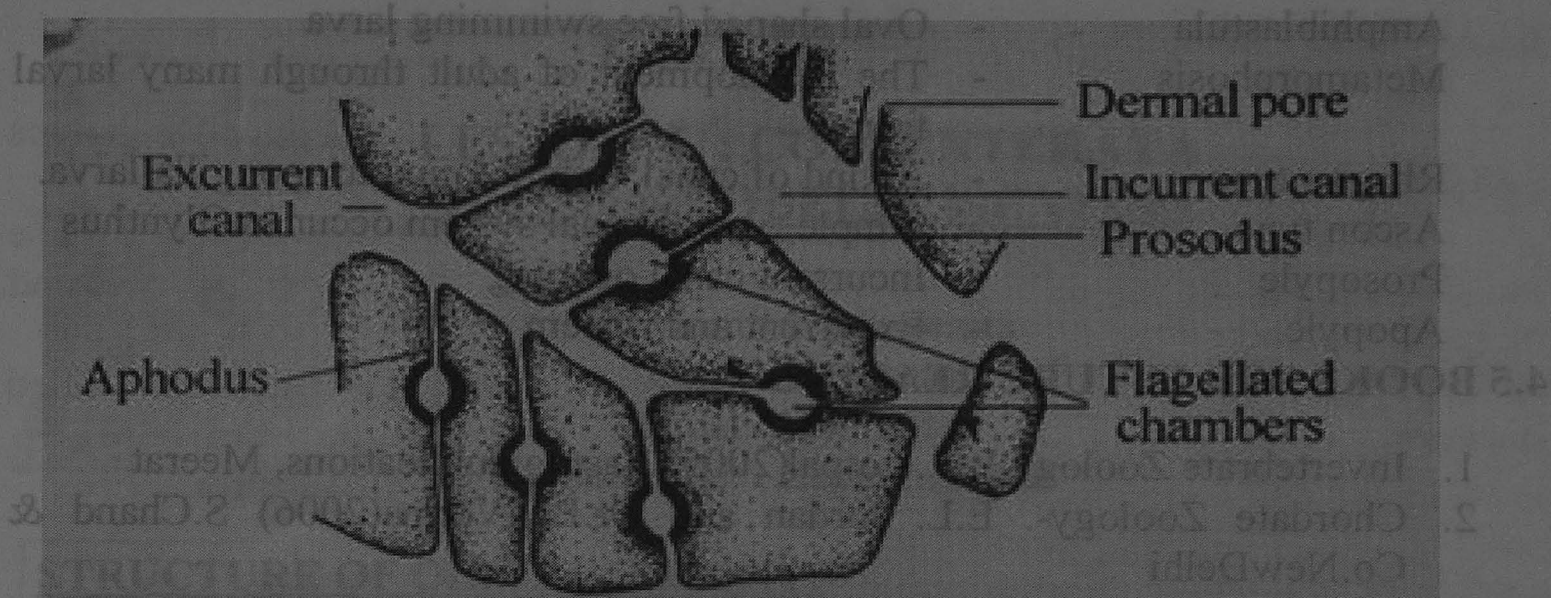


Aphodal type of canal system

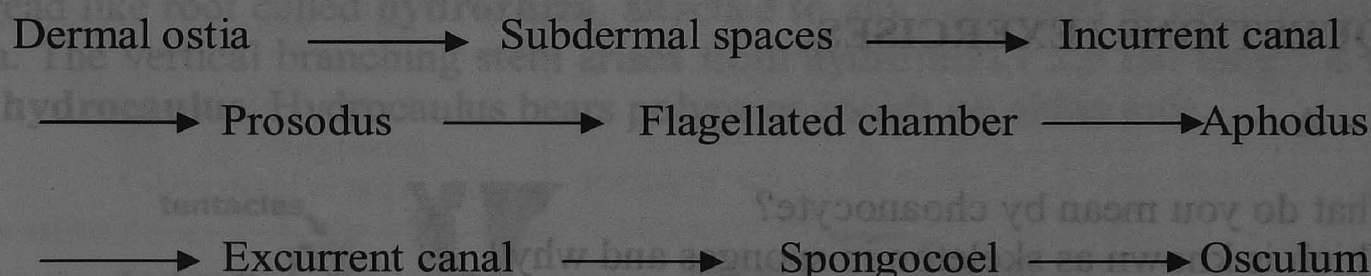
3. Diphodal type

This type of canal system is seen in *Spongilla*, *Oscarella*, etc. In this type the incurrent canal opens into the flagellated chamber through a canal called prosodus. The water current flows through the following route

Dermal pores → Subdermal spaces → Incurrent canal
 → Prosopyle → Flagellated chamber → Aphodus
 → Excurrent canal → Spongocoel → Osculum



Dipodal type of canal system



4.3 LET US SUM UP

Porifera are pore bearing organisms. Olynthus is a very simple type of sponge. Presence of choanocyte does two main functions, namely feeding and creating water current. The mesogloea secrete two main types of cells scleroblasts and amoebocytes. Scleroblasts produce spicules and amoebocyte have pseudopodia. Canal system in sponges are very peculiar phenomenon which created a water current to flow in and out of the sponges continuously. Gemmules are asexual reproductive bodies. Spicules are crystalline structure which provides support and protection to the spongy body. They are classified into larger macroscleres and smaller microscleres according to their size.

4.4 KEY WORDS

Porifera	- Pore bearing organisms
Choanocyte	- A flagellated collar cell used for feeding and creating water current.
Scleroblast	- Spicule forming cells.
Amoebocytes	- Have pseudopodia used to free wander.
Ostia	- Minute pore.
Monaxon	- Needle like spicules with pointed ends.
Triaxon	- Spicules of three rays.
Tetragon	- Spicules of four rays.
Stomoblastula	- The embryonic stage of scypha.

Amphiblastula
Metamorphosis

- Oval shaped free swimming larva
- The development of adult through many larval forms.
- A kind of canal system found in spongilla larva.
- Simple type of canal system occur in Olynthus
- Incurrent canal opening
- Excurrent and system

Rhagon type
Ascon type
Prosopyle
Apopyle

4.5 BOOKS FOR FUTURE READING

1. Invertebrate Zoology-R.L.Kotpal(2005) Rastogipublications, Meerat
2. Chordate Zoology-. E.L. Jordan and Dr.P.S.Verma(2006) S.Chand & Co.NewDelhi
3. Text Book of Invertebrate- Dr.N.Arumugam Etal,(2008) Saras Publications, Nagerkovil.

4.6 QUESTIONS / EXERCISES

Part – A

1. What do you mean by choanocyte?
2. Which is known as skeleton in sponges and why?
3. What is the important role of canal system in sponges?

Part – B

1. Write a short note of spicules.
2. Describe canal system in sponges.

Part – C

1. Explain the reproduction and development of sponges.
2. Write the General organization of sponges.

4.7 ANSWER FOR CYP QUESTIONS

For Q.No.1 in Part A refer section No.1.2.1

For Q.No.2 in Part A refer section No.1.2.3

For Q.No.3 in Part A refer section No.1.2.6

For Q.No.1 in Part B refer section No.1.2.3

For Q.No.2 in Part B refer section No.1.2.6

For Q.No.1 in Part C refer section No.1.2.5

For Q.No.2 in Part C refer section No.1.2.1

UNIT III

LESSON -5 : COELENTERATA

Type study : OBELIA [SEAFUR]

Phylum : Coelenterata

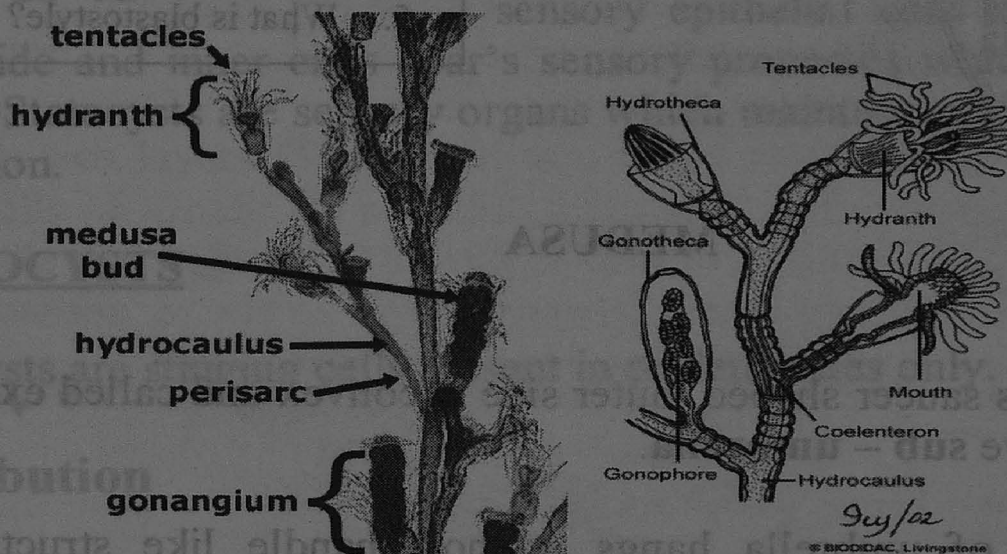
Class : Hydrozoa

Order : Hydroidea

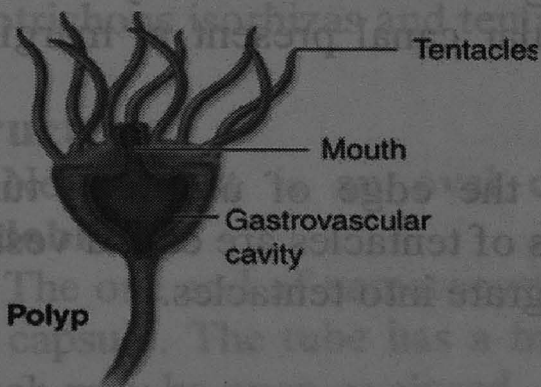
Sub order : Leptomedusae

STRUCTURE OF OBELIA COLONY:

Obelia is a marine, branched colony. Each colony consists of horizontal thread like root called **hydrorhiza**, attached to any substrates at the bottom of the sea. The vertical branching stem arises from hydrorhiza (2.5 cm long) is known as **hydrocaulus**. Hydrocaulus bears polyps or zooids on either side.



POLYPS:



Each polyp has a stem and terminal head called a **hydranth**. The hydranths are feeding polyps as they capture minute animals and larvae for food. The proximal end of polyps continues with **hydrocaulus**. The distal end of polyp has conical elevation called **hypostome** or **manubrium**. Hypostome is surrounded by about 24 tentacles in a circle and bears mouth in the centre. Polyp has gastro vascular cavity or **coelenteron** inside. One end opens outside by mouth and other end gets connected with **coenosacral** canal. The polyp is protected in **hydrotheca**, which is continuation of **perisarc**. At the base of polyps ring like structures are present called shelf where polyp rests. The body wall is diploblastic of outer **ectoderm**, inner **endoderm** and a middle **mesoglea**.

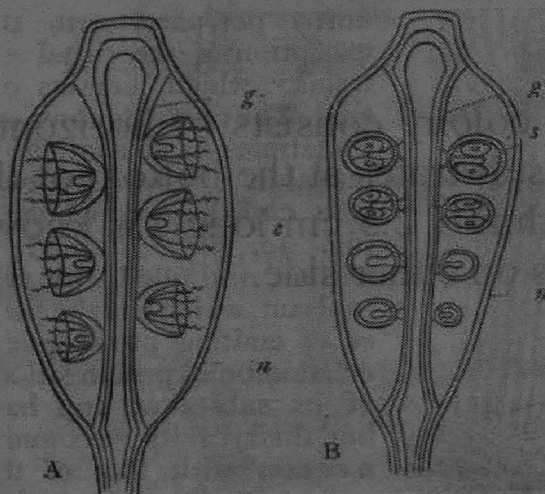
BLASTOSTYLE :

At the base of hydrocarlus in the axil of polyp are reproductive polyps called **blastostyle** they are also called as reproductive or gonozooids.

They are cylindrical tubular zooids with no mouth and tentacles. The perisac forms a sac like structure called **gonotheca** which opens at its distal end by **gonopores**.

It reproduces asexually by budding and develops button like zooids called **medusa**.

The blastostyle with medusa and gonotheca is called **gonangium**.



Check your progress

1. What is medusa?
2. What is hydrorhiza?
3. Under which phylum obelia comes?
4. What do you mean by gonangium?
5. What is blastostyle?

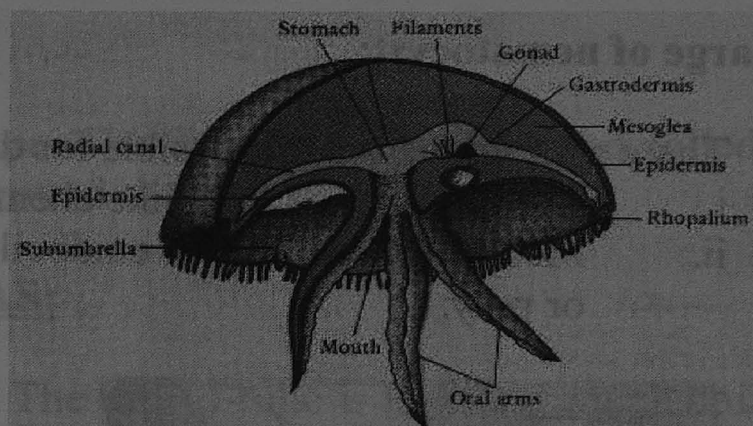
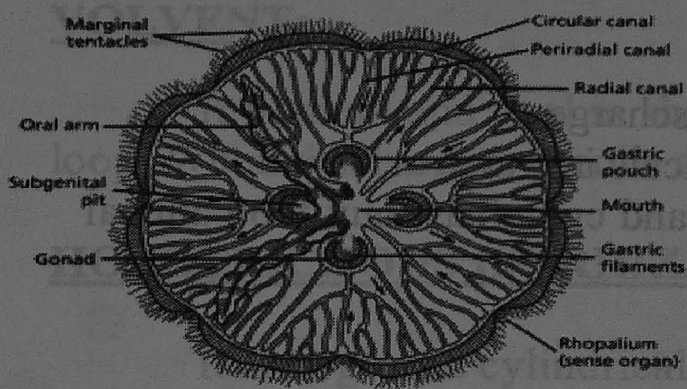
MEDUSA

STRUCTURE:

The medusa is saucer shaped, outer side is convex and called **ex-umbrella** and inner side concave **sub – umbrella**.

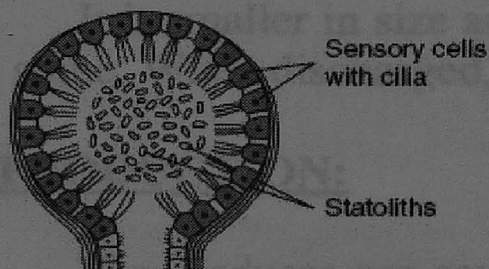
From centre of umbrella hangs a short handle like structure called **manubrium**. At its apex, there is a square mouth surrounded by four **oral lobes**. Mouth leads into gastro vascular cavity. From the gastro vascular cavity arise four radial canals. The radial canals open into a circular canal present at margin of medusa.

The margin of umbrella bears tentacles, the edge of umbrella turned inwards as a fold called **velum**. The basal swellings of tentacles are called **vesicles** or **bulbs**. **Nematocysts** are formed in bulbs and migrate into tentacles.



STATOCYST:

The medusa has eight marginal sense organs called **statocysts** lying at regular intervals. Each statocyst has large sac filled with a fluid containing large calcareous particle called **statolith** or **otolith**.



cells outside and inner ends bear's sensory processes which made contact with lithocyte. Statocysts are sensory organs which maintain equilibrium and muscular coordination.

The statolith is secreted and surrounded by a cell called **lithocyte**. The wall of sac has sensory epithelial cells connected with nerve

NEMATOCYSTS

Nematocysts are stinging cells present in coelenterates only.

I. Distribution

Nematocyst is present more on the tentacles and body but absent from basal disc. Hypostome has only holotrichous isorhiza, body has stenoteles and holotrichous isorhizas and tentacles have all type of nematocyst.

Structure

Nematocyst is an oval capsule situated inside a specialized cell called **cnidoblast**.

The one end of nematocyst (capsule) is produced into **tube** lying coiled inside the capsule. The tube has a basal swelling called **butt** and a long coiled **thread** which may be open or closed.

Inside the tube spines are present. The large spines present at the base of thread is called **barb**. The three rows of **small spines** are called **barbules**. The base of thread is covered by a lid called **operculum**. There is small hair like structures present on the side of the lid called **cnidocil** or **trigger**.

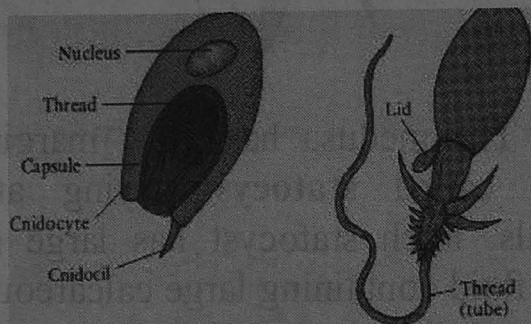
III. Discharge of nematocyst:

There are two factors responsible for discharge.

- The presence of lipid like chemicals in water
- Mechanical contact of cnidocil and cnidoblast buy food animal or prey.

Check your progress

1. Name the different types of neamotocyst
2. what is cnidoblast?
3. What is butt?
4. What do you mean by barbles?
5. What is planula?



TYPES : Nematocysts are classified into four types.

They are as follows:

1. Penetrant
2. Volvent
3. Holotrichous isorhizas
4. Atrichous isorhizas

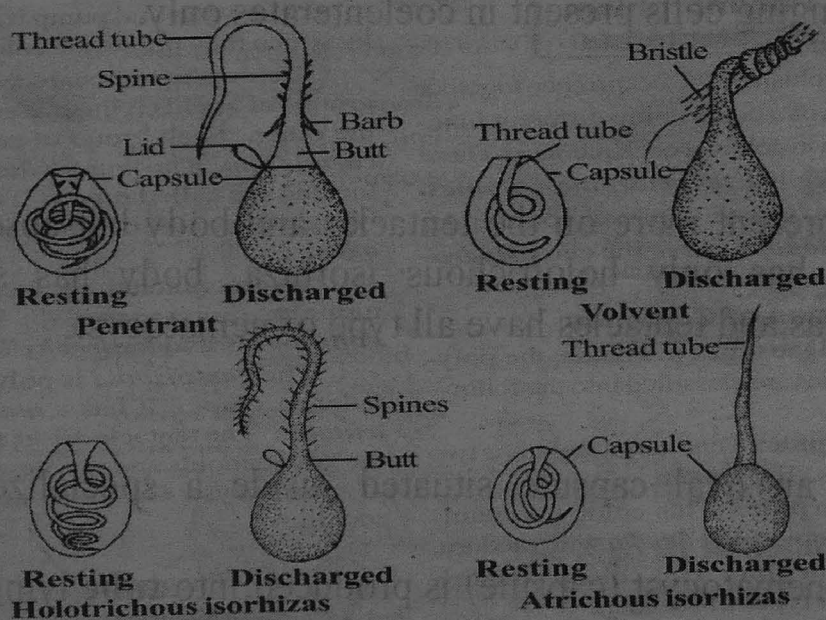


Fig.5.78: Types of nematocysts.

PENETRANT:

It is large in size and oval in shape. The thread tube is long, opens at the tip and is much coiled.

The butt has three **barbs** and three rows of **spines**. When discharged, it penetrates the body of the prey and injects the hypnotoxin.

VOLVENT:

It is small and oval in shape. The thread tube is short and coiled in a single loop. When discharged, it coils around the bristles of the prey.

HOLOTRICHOUS ISORHIZAS:

It is large and cylindrical. The thread-tube is long and much coiled. It has a narrow butt and a spiral row of spines. When discharged, it becomes coiled.

ATRICHOUS ISORHIZAS:

It is smaller in size and oval in shape. The thread-tube is long without butt and spine. When discharged, it remains straight.

REPRODUCTION:

The medusas are sexual or reproductive zooids possessing gonads. Sexes are separate. Each medusae has four testis or ovaries in sub umbrella just below the radial canals. A gonad has outer ectoderm, inner endoderm with mesoglea between two layers. The gonad is a small diverticulum of the radial canal. The germ cells of Obelia do not arise from gonads; they arise from interstitial cells of blastosyle and migrate into medusa then through radial canals. Then they take up their position in ectoderm of gonads, the green cells mature here and gonads rupture and release spermatozoa and ova are discharged externally into water.

LIFE HISTORY:

FERTILISATION

Fertilization usually takes places in open sea water where the gametes are set free.

DEVELOPMENT:

The zygote undergoes complete and equal cleavage to form a single-layered blastula. Its outer cell layer becomes the ectoderm and inner cell mass the endoderm. The gastrula elongates and its outer layer of ectoderm cells becomes ciliated, and now it is called planula.

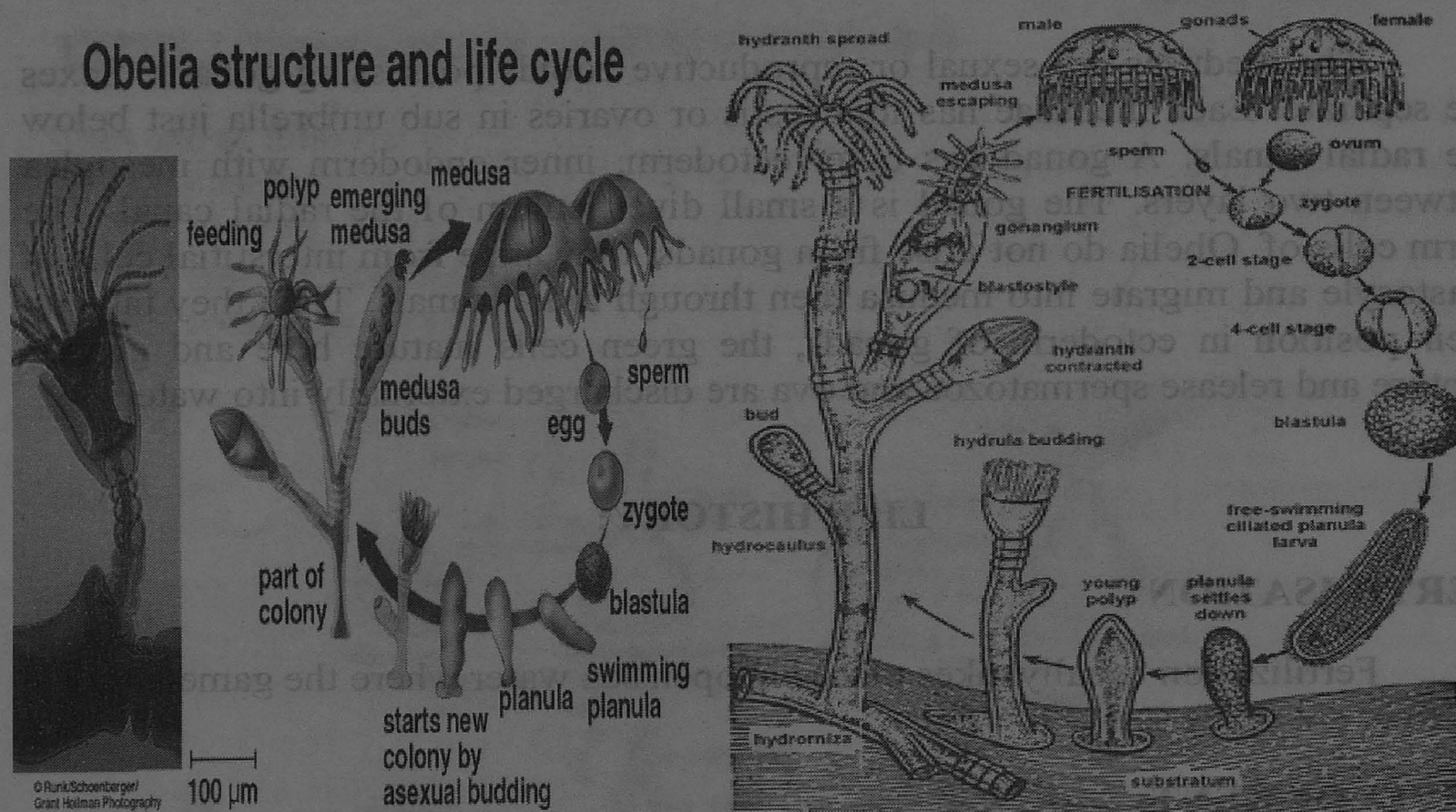
The planula is a two-layered larva having an outer ciliated ectodermal cells and an inner layer of endodermal cells planula after a short free-swimming existence settles on some solid object by its broader end. The free end forms a manubrium with a mouth and circlet of tentacles. Thus, a simple polyp or hydrula is formed, from which an obelia colony is developed by budding.

ALTERNATION OF GENERATIONS AND METAGENESIS:

It is clearly evident from the life history of *Obelia* that there is an alternation of polypoid and medusoid generations. The polypoid generation is asexual reproduction occurs by budding. The medusa gives rise to gametes, which after fertilization develop into a polypoid colony from which medusa are produced again by budding. Thus, an asexual polypoid generation alternates with a sexual medusoid generation. The term alternation of generations means that the individual exists in two distinct form. Which alternate each other regularly in the life history. One individual possesses the power to reproduce the other by asexual reproduction, which again by sexual reproduction gives rise to the next generation.

There is a regular alternation between fixed polypoid and free-swimming medusoid phases, both of them being diploid. Such an alternation of generations between two diploid phases is known as metagenesis.

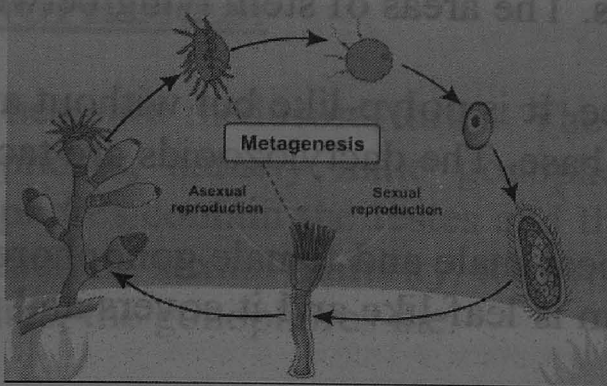
Obelia structure and life cycle



METAGENESIS

In the life cycle of *Obelia*, there are asexual reproduction and sexual reproduction. The *Obelia* colony reproduces medusa asexually by budding. Medusa reproduces *Obelia* colony by sexual reproduction. Thus it appears that there is alternation of generations in *Obelia*.

In *Obelia*, a diploid asexual generation (*Obelia* colony) alternates with another diploid sexual generation (medusa). This phenomenon is called **metagenesis**.



POLYMORPHISM IN COELENTERATA

Based on the type of zooids, the polymorphic colonies are classified into the following types:

- i. **DIMORPHIC**: This colony contains two types of zooids. Eg. obelia.
- ii. **TRIMORPHIC**: This colony contains three types of zooids. Eg. obelia with medusa.
- iii. **POLYMORPHIC**: This colony contains more than three types of Zooids.

The following coelenterates exhibit polymorphisms are Obelia, Halistemma, Velella, Physalia, Porpita.

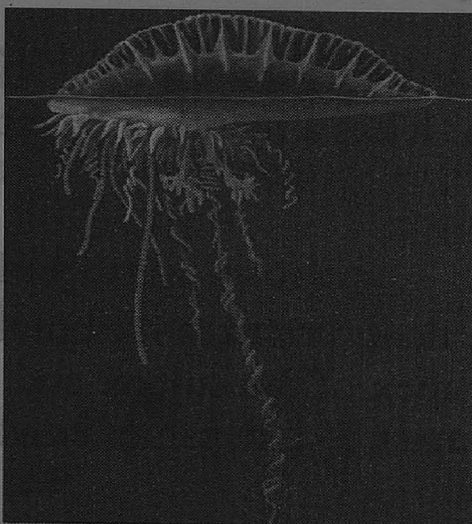


Fig: Physalia

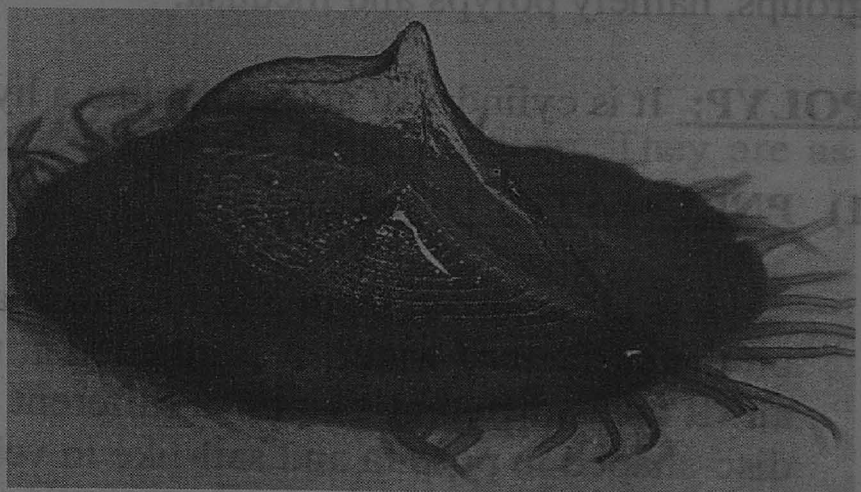


Fig: Velella

A TYPICAL POLYMORPHIC COLONY-HALISTEMMA:

Halistemma is a typical polymorphic colony. It is a marine free-swimming colony. The colony consists of a long slender stem and many zooids.

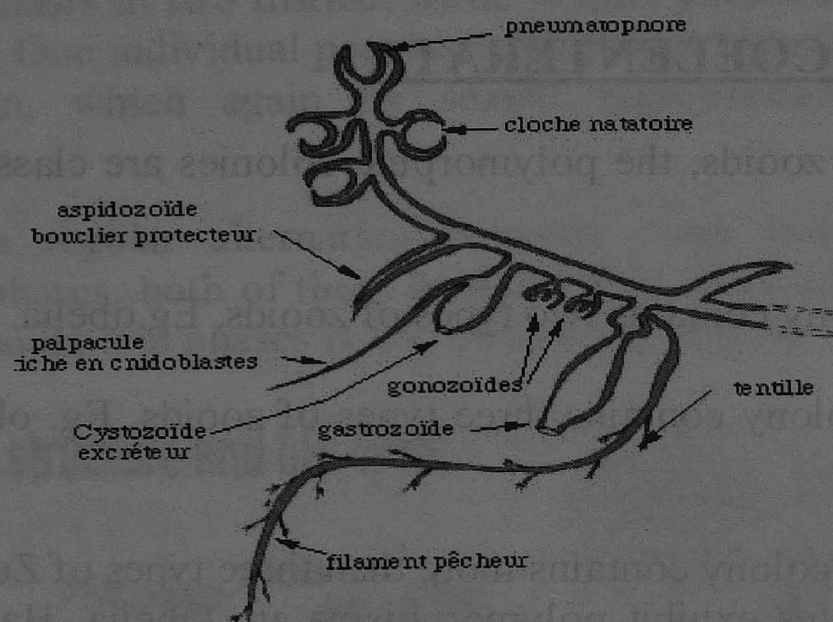
The upper end of the stem has an air-filled bulb-like structure called float or pneumatophore. It functions as a float. Below the float, the stem bears, a number of bell-like zooids called **nectocalyces** or **swimming bells**.

Below the nectocalyces, the stem bears groups of zooids lying in a series one behind the other. Each group of zooids is called a **cormidium**. The points

where cormidia are located are called **nodes**. The areas of stem lying between two cormidia are called **internodes**.

The dactylozooids is tubular in shape. It is polyp-like but without a mouth. A long unbranched tentacle arises from its base. The dactylozooids are tactile and defensive in function.

Gonozooids lie in groups and they bear male and female gonophores. They are reproductive in function. Hydrophyllium is leaf-like and it covers and protects the zooids of a cormidium.



Check your progress

1. Name the different types of zooids
2. Quotes some examples showing polymorphism
3. What is pneumatophore?
4. Define cormidium.

TYPES OF ZOOIDS: All the zooids of a polymorphic colony fall into two groups, namely polyps and medusa.

POLYP: It is cylindrical and looks like a hydra. It has a mouth and tentacles.

1) **PNEUMATOPHORE:**

It is a medusoid form and functions as a float. It makes the colony floating on the surface of water. It is situated at the apex of the colony and filled with air. It takes different shapes in different animals. It is cup-like in *Halistemma*, disc-shaped in *porpita* and sail-like in *velella*.

2) **NECTOCALYCES:**

These are medusoid forms. They are bell-shaped with mouth and tentacles. The musculature is well developed for locomotion of the colony. Hence they are called swimming bells. Eg. *Halistemma*.

3) **HYDROPHYLLIUM:**

It is a medusoid form. It is leaf-like and serves a cover to protect the other zooids of the colony. Eg. *Halistemma*.

4) GONOPHORES:

These are medusoid forms. They contain gonads. There are two types of gonophores, namely male gonophores and female gonophores. The male gonophores contain the testes and the female gonophores contain the ovaries. On reaching sexual maturity, they release sperms and ova. After the release of gametes, the gonophores die.

5) GASTROZOODIS:

It is a polyp. It is nutritive in function with a mouth and large gastrocoel. It has a long tentacle bearing lateral branches called tentilla. Which ends in a coil of nematocysts. Eg. Halistemma.

6) DACTYLOZOOID:

It is protective in function. It looks like a gastrozoid but it has no mouth. A coiled tentacle arises from the base. The tentacle is unbranched. Eg. Halistemma.

7) GONAZOODIS:

These are reproductive zooids called blastostyles. It produces medusae by budding. Eg.. Physalia.

ORIGIN OF POLYMORPHISM:

There are two theories explaining the origin polymorphism. They are as follows:

- i. Polyorgan theory
- ii. Polyperson theory.

i. POLYORGAN THEORY:

This theory was proposed BY Huxley, Eschscholtz and Metshnikoff. According to the theory the different zooids of a colony are really the organs of a single medusoid individual.

ii. POLYPERSON THEORY: This theory was proposed by Leuckert, vogt and Gegenbaur. It states that the various zooids of the colony are only the modified polyps which have the power to produce the medusae.

Key words:

Distal - situated away from the centre of the body or from the point of attachment

Feed on - derive regular nourishment from (a particular substance)

Elevation - being raised to a higher level

Sac - a hollow, flexible structure resembling a bag

Reproduce - produce a copy of its own

Migrate - move from one part of something to another

saucer - a shallow dish, typically having a circular indentation in the centre, on which a cup is placed

Gonads - an organ that produces gametes; a testis or ovary

Arise - come into being; originate

Rupture - break or burst suddenly

Diploid - (of a cell or nucleus) containing two complete sets of chromosomes

Haploid - (of a cell or nucleus) having a single set of unpaired chromosomes

asexual reproduction - not involving the fusion of gametes

Polymorphism - the occurrence of different forms among the members of a population or colony

Diverticulum - a blind tube leading from a cavity or passage

Question and exercises: Part A

1. What is nematocyst?
2. What is polymorphism?
3. What is meant by zooids? Write about different kinds of zooids found in Obelia.

Part B

1. Write a note on planula
2. Write short notes on metagenesis and alteration of generations, respectively.
3. Draw labelled diagrams
 - i. Obelia colony
 - ii. Medusa of Obelia
4. Give an account on nematocyst

Part C

1. Describe in detail the structure of an Obelia colony and give an account of its life history
2. Give an account of the various types of zooids found on the Obelia colony
3. Write an essay on polymorphism in coelenterates.

LESSON -6 : PLATYHELMINTHES

Type study: Fasciola hepatica

Phylum: Platyhelminthes

Class: Trematoda

Order: Digenia

EXTERNAL FEATURES: Fasciola hepatica is an endoparasite lives in bile duct of sheep and liver of vertebrates.

SHAPE SIZE & COLOUR:

It has a thin dorsoventrally flattened leaf like elongated oval body. It measures about 25-30 mm in length & 4-12mm in breadth. Its anterior end is rounded while it is somewhat blunt and pointed posteriorly. It is usually pinkish in color but appear brownish due to ingestion of bile juice of the host.

EXTENAL MORPHOLOGY:

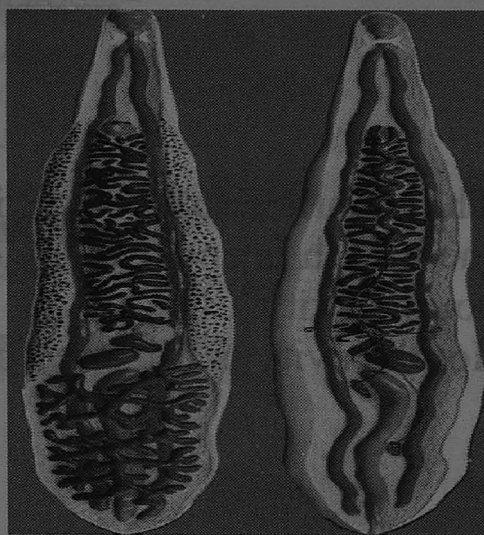
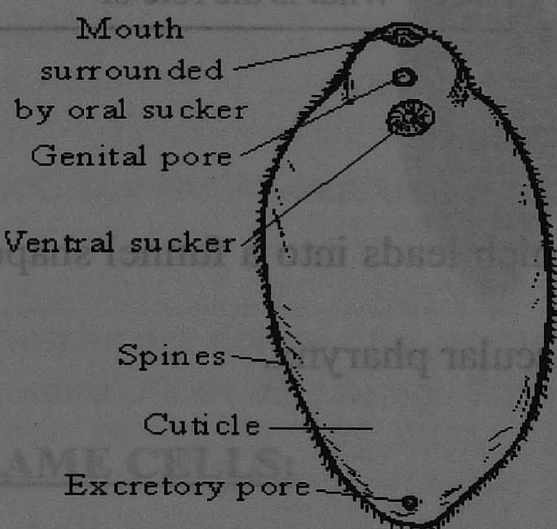


Fig : ventral and dorsal view

The anterior end of the body is conical and called as **oral cone** or **head lobe**.

HEAD LOBE:

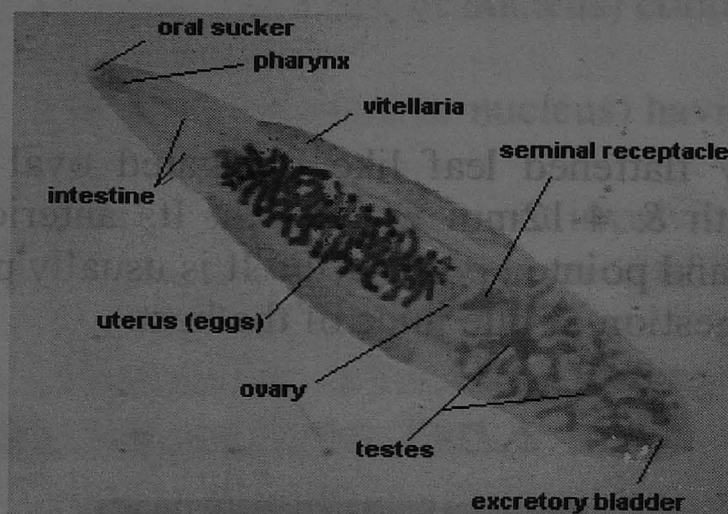
The head lobe at its tip bears somewhat triangular aperture called **mouth**. It has two muscular suckers, **oral sucker** at anterior end encircling the mouth and a large **ventral sucker** or **acetabulum** situated behind the oral sucker midventrally. The suckers are cup like muscular organ used for attachment to the host by vacuum.

In addition to mouth aperture, another two permanent apertures are present on the body.

- 1) Genital aperture or gonopore is situated mid-ventrally in front of ventral sucker.
- 2) Excretory pore located at posterior end of the body.

A temporary aperture called **Laurer's canal** appears during breeding season on dorsal surface just anterior to middle of the body.

DIGESTIVE SYSTEM : The digestive system is very simple. It is formed of mouth, pharynx, oesophagus and the intestine.



Check your progress

1. What is flame cells?
2. Where does Fasciola hepatica lives?
3. What does liver fluke feed on?
4. What is Laurer's canal?
5. What is the role of

MOUTH:

- i. The mouth is sub-ventral in position.
- ii. The mouth is enclosed by oral sucker which leads into a funnel shaped mouth cavity.
- iii. Mouth cavity is followed by a round muscular pharynx.

PHARYNX :

- i. It has thick walls.
- ii. It is surrounded by pharyngeal glands.
- iii. It has a small lumen which leads into a oesophagus

OESOPHAGUS:

- i. It is short & narrow
- ii. It is followed by intestine.

INTESTINE:

- i) The intestine is divided into two branches called as **intestinal caeca** or **crura**.
- ii) Each intestinal caeca runs upto the posterior ends blindly.
- iii) Each caeca gives out number of branches called diverticula.

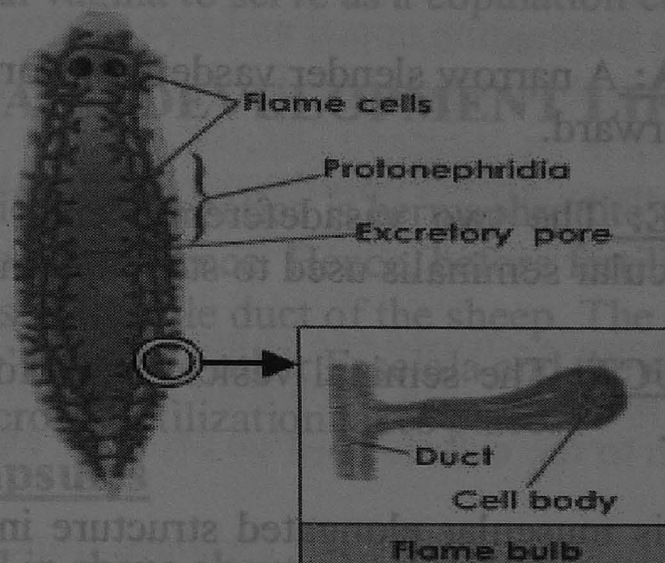
ANUS: It is absent.

FOOD, FEEDING, DIGESTION:

- i) The liver fluke feeds on blood and bile juice of the host.
- ii) The oral sucker and pharynx serves as sucktoreal organ.
- iii) Digestion is extra cellular and occurs in intestine
- iv) The digested food material is distributed by diverticula to all part of the body along parenchyma.
- v) The undigestible remains of the food will be ejected though the mouth.

EXCRETORY SYSTEM:

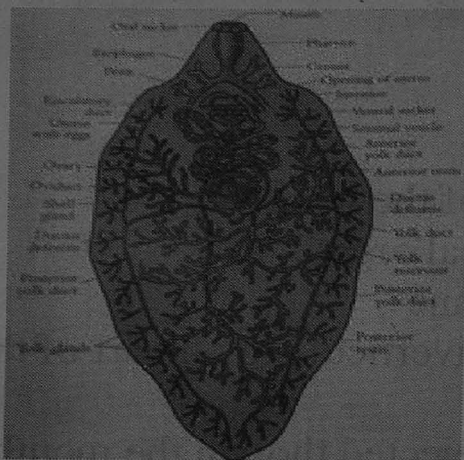
The excretory system is concerned with excretion and osmoregulation. The excretory system consists of large number of flame cells or protonephridia, connected with a system of excretory ducts.



FLAME CELLS:

- i) The flame cells are modified mesenchyme cells.
- ii) They are bulb like bodies present throughout the mesenchyme.
- iii) Each flame cell is formed of single cells.
- iv) It has thin elastic walls with a nucleus and cavity.
- v) The cavity has many long cilia arising from basal granules.
- vi) The surface of flame cells is produced into pseudopodia.
- vii) In living condition the cell vibrate like a flickering flame, hence the name flame cells.

REPRODUCTIVE SYSTEM: Fasciola hepatica is hermaphrodite where both male and female reproductive organs are present in the same animal. But usually cross fertilization takes places. It contain well developed complicated reproductive organ.



Check your progress

1. What is hermaphrodite?
2. What is vasa deferentia?
3. How many rings are present in miracidium larva?

MALE REPRODUCTIVE SYSTEM: The male reproductive system consists of testes, vasa deferentia, seminal vesicle, ejaculatory duct, cirrus or penis, prostate glands and genital atrium.

TESTES: They are tubular and highly branched; two in number, placed one behind other in the posterior middle part of the body.

VASA DEFERENTIA: A narrow slender vasdeferens or spermduct arise from each testes run forward.

SEMINAL VESICLE: The two vasadeferentia enter to form a bag like seminal vesicle or vesicular seminalis used to store sperms.

EJACULATORY DUCT: The seminal vesicle leads to narrow curved duct called ejaculatory duct.

CIRRUS: The cirrus is muscular elongated structure into which ejaculatory duct opens. The cirrus (penis) opens by male genital aperture in to a common genital atrium.

PROSTATE GLAND: The ejaculatory duct is surrounded by many prostate glands. Its secretion keeps in fine movement of sperm during copulation.

FEMALE REPRODUCTIVE SYSTEM: The female reproductive system consists of ovary, oviduct, uterus, vitelline glands, mehli's glands and laurer's canal.

OVARY: The ovary is single tubular highly branched. It is situated anterior to testes at right side.

OVIDUCT: All branches of ovary opens into short narrow tubes called oviduct. It runs forward and opens in to vitelline duct.

UTERUS: At the junction of oviduct and vitelline duct arise a large duct called uterus, which form shelled eggs.

VITELLINE GLANDS: Behind the testes are many follicles called vitelline glands, yolk glands. The vitelline glands opens by small ducts called longitudinal vitelline duct on each side. The two longitudinal ducts connected by transverse vitelline duct. The transverse vitelline duct has swollen yolk reservoir and the ducts run inward to form a median vitelline duct and it runs forward to join the oviduct.

MEHLI'S GLANDS: A mass of unicellular glands are formed situated along junction of median vitelline duct, oviduct and uterus. The secretions of these glands lubricate the passage of eggs into uterus and also activate sperm and harden the egg shell.

LAURER'S CANAL: From oviduct arises a narrow canal called laurer's canal runs vertically upwards. It opens on dorsal slide temporarily during breeding season and acts a vestigial vagina to serve as a copulation canal.

REPRODUCTION AND DEVELOPMENT LIFE HISTORY

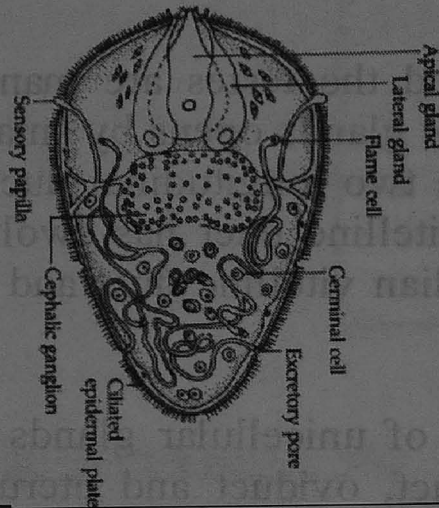
Copulation and fertilization: *F. hepatica* is hermaphrodite; even then **cross-fertilization** is of common occurrence. Hence, before fertilization **copulation** occurs; copulation occurs in the bile duct of the sheep. The cirrus of one *Fasciola* is inserted into the laurer's canal of other *Fasciola* and the sperms are deposited into the oviduct, so that cross-fertilization takes place.

Formation of egg capsules

The eggs are oval in shape about 130 to 150 microns in length and 63 to 90 microns in width. The eggs are fertilized in the oviduct. The fertilized eggs receive **yolk cells** from vitelline glands and they get enclosed in a **chitinous shell**. The shell has an **operculum or lid**. The complete 'eggs' are called **capsules** which are large in size and they pass into the uterus where they start their development. Capsules come out of the gonopore into the bile duct of the sheep; they reach the intestine and are passed out along with the faeces. The capsules which fall in water or damp places will develop.

Development: Development starts in the uterus and the fertilized egg divides into a small **propagatory cell** and a larger **somatic cell**. The propagatory cell divides into two cells, one of which forms the **endoderm** and **mesoderm** of the larva. In two weeks time, small ciliated **miracidium larva** is formed and it comes out of the shell by forcing the operculum.

Miracidium larva

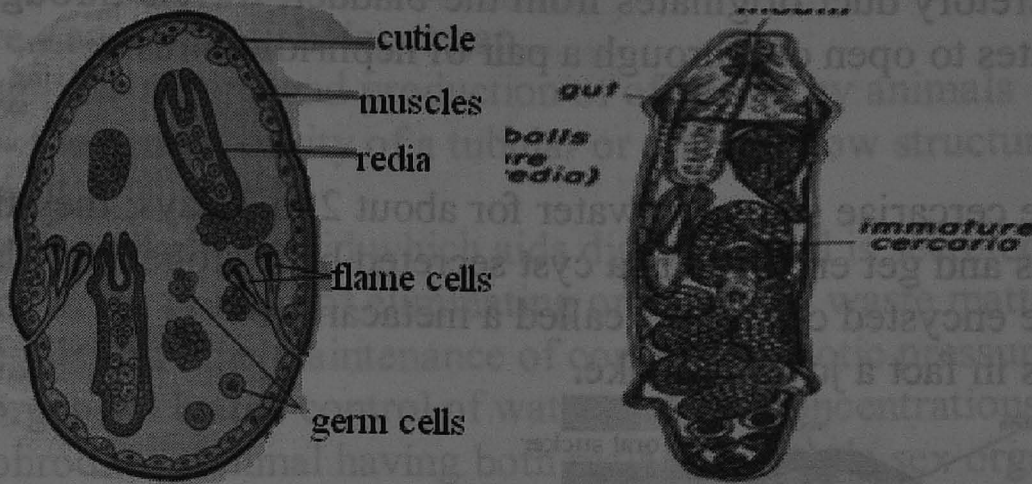


1. Miracidium larva is a minute, oval and elongated, free-swimming stage. It is covered with 18 to 21 flat ciliated epidermal cells lying in five rings.
2. The **first ring** is made of six plates (two dorsal, two lateral and two ventral). **Second ring** has six plates (three dorsal and three ventral).
3. **Third ring** has three plates (one dorsal and two ventro-lateral). **Fourth ring** has four plates (two right and two left). **Fifth ring** has two plates (one left and one right)
4. Anteriorly it has a conical **apical papilla** attached to glandular sac called **apical gland**. On each side of the apical gland is a bag-like **penetration gland**.
5. There are two pigmented x-shaped **eye spots** and a **nervous system**.
6. There is a pair of **protonephridia**, each with two **flame cells**.
7. The flame cells open to the exterior by two separate **excretory pores** or nephridiopores.
8. When it comes in contact with the snail *Limnaea truncatula*, the miracidium penetrates into the body of the snail.
9. It reaches the digestive gland of the snail and gets transformed into another larva called **sporocyst**.

Sporocyst

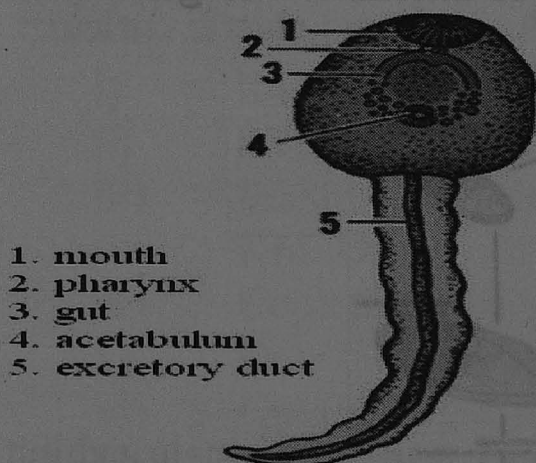
1. The sporocyst is an elongated germinal sac about 0.7 mm long and covered with a thin cuticle
2. The glands, nerve tissue, apical papilla and eye spots of miracidium disappear.
3. Sporocyst has a pair of protonephridia each with two flame cells, it has germ cells and germ balls
4. The sporocyst moves about in the host tissues and its germ cells develop into a third type of larva called redia.
5. A sporocyst forms 5 to 8 rediae.

Redia:



1. The Redia is elongated about 1.3 mm to 1.6 mm in length with two ventral processes called lappets near the posterior end and a birth pore near the anterior end
2. Body wall has cuticle just in front of the birth pore, a muscular circular ridge called the collar used for locomotion.
3. Redia has an anterior mouth, pharynx in which numerous pharyngeal glands open, sac-like intestine and there is a pair of protonephridia with two pairs of flame cells.
4. Its cavity has germ cells and germ balls
5. The germ cells during summer develop into daughter redia, in winter they produce the fourth larval stage, the cercaria larva.
6. Each redia forms about 14 to 20 cercariae.

Cercaria



1. mouth
2. pharynx
3. gut
4. acetabulum
5. excretory duct

Check your progress

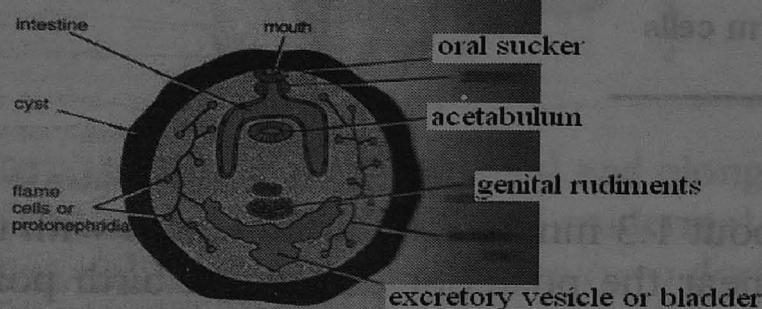
1. From which larva cercaria develops.
2. What is sporocyst?
3. What is the function of cystogenous glands?
4. What is metagenesis?
5. What is metacercaria?

1. The Cercaria has an oval body simple long tail covered by cuticle.
2. Below the cuticle are muscles and cystogenous glands.
3. There are two suckers namely oral and ventral sucker.
4. It has an alimentary canal consisting of mouth, buccal cavity, pharynx, oesophagus and a bifurcated intestine.

5. There is an excretory bladder with a pair of protonephridial canals with a number of flame cells.
6. An excretory duct originates from the bladder, travels through the tail and bifurcates to open out through a pair of nephridiopores.

Metacercaria

1. The cercariae swims in water for about 2 to 3 days; they then lose their tails and get enclosed in a cyst secreted by cystogenous glands.
2. The encysted cercaria is called a metacaria.
3. It is in fact a juvenile fluke.

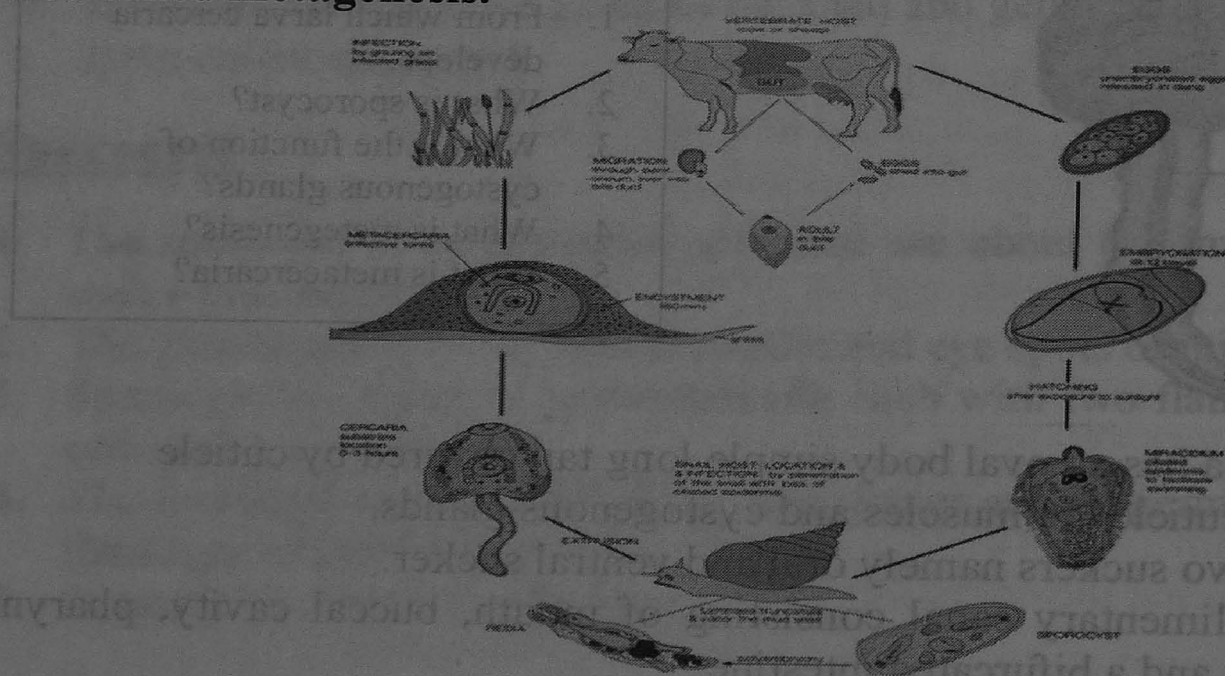


Infection

When a sheep eats the grass containing metacercaria, the larva enters the intestine. The cyst wall dissolves and the larva penetrates the wall of the intestine and enters the coelom. From the coelom it gets into the liver and grows into an adult fluke.

Alternation of generations

The life history of liver fluke shows and alternation of generations. Miracidium larva is produced by sexual reproduction. Redia and cercaria are developed by parthenogenesis from the germ cell. Thus sexual reproduction alternates with parthenogenetic generation. This type of alternation of generation is also called **metagenesis**.



Keywords:

- Dorsal - upper side or back of an animal
- Ventral - underside of an animal
- Aperture - an opening, hole, or gap
- Breeding - the mating and production of offspring by animals
- Lumen - the central cavity of a tubular or other hollow structure in an organism or cell
- Bile - brown alkaline fluid which aids digestion and is secreted by the liver
- Excretion - the process of eliminating or expelling waste matter
- Osmoregulation - the maintenance of constant osmotic pressure in the fluids of an organism by the control of water and salt concentrations
- Hermaphrodite - animal having both male and female sex organs
- Fertilization - the fusion of male and female gametes to form a zygote

Question and exercises

Part – A

1. What is miracidium?
2. What is flame cell?
3. What is hermaphrodite?

Part – B

1. Describe the Digestive system of Fasciola?
2. How does excretion take place in Fasciola hepatica?
3. Describe the structure of Fasciola hepatica

Part – C

1. Describe the reproductive system of Fasciola hepatica
2. Explain the life history of Fasciola hepatica with the help of diagrams.

LESSON -7 : ASCHELMINTHES ASCARIS LUMBRICOIDES

Phylum – Aschelminthes

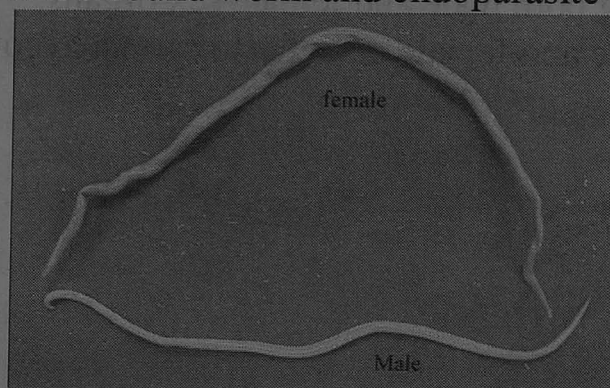
Class – Nematoda

Subclass – Phasmidia

Order – Ascaroidea

EXTERNAL STRUCTURE

It is a round worm and endoparasite living in the intestine of man.



SHAPE AND SIZE: *Ascaris lumbricoides* is elongated cylindrical and tapering at both ends the female is 20-41 cm long and 4-6 mm in diameter. But the males are smaller 15-31 cm and 2-4 mm in diameter.

COLOURATION: Nematodes have no colour, the external cuticle is whitish or yellowish but *Ascaris* has a definite reddish tint due to consumption of haemoglobin.

MORPHOLOGY : The body is covered with smooth tough and elastic cuticle. The body is long cylindrical and has four longitudinal epidermal chords visible externally.

- i. One narrow mid dorsal chord
- ii. One mid ventral chord
- iii. Two thick lateral chords

Ascaris exhibits sexual dimorphism. The anterior end of male and female exhibits the same structure.

The mouth is situated at the anterior end and bounded by three lips or labia: one elliptical mid dorsal and two oval latero ventral in position papillae. Each lateroventral lip has one double sensory papillae.

Check your progress

1. Under which phylum does *Ascaris* belong.
2. Name the epidermal chord present in *Ascaris*.
3. What is pneumonia?
4. What is diarrhea?

The anus is located at the posterior end in female; but male has cloaca, from which two spicules or penial setae project. In male, near the cloaca about 50 pairs of pre anal papillae and 5 pairs of post anal papillae are present ventrally which are concerned with copulation. In female there is a genital aperture called vulva or gonopore on ventral side. An excretory pore is present mid ventrally.

PATHOGENESIS:

Ascaris cause a disease called ascariasis. As many as 500 to 5000 adult ascaris may be present in a single host they may cause the following symptoms.

- i. Abdominal discomforts, diarrhoea .
- ii. Vomiting, weakness anaemia.
- iii. As they wander in the gut they may enter bile or pancreatic ducts and cause damage enteritis and peritonitis.
- iv. When it damages lungs it cause pneumonia.
- v. As they wander into nose, they produce toxins which irritate mucous membrane of gut and prevent digestion of proteins cause general nervousness.
- vi. In children they dull mental capacity and causes stunted growth.

TREATMENT:

- i. A mixture of oil of chenopodium and tetra chlorocycline is an effective drug for ascaris eradication.
- ii. 1gm of hexylresorcinol in a gelatinous capsule can be used with fasting for 1hrs with treatment and after 4hrs followed by purgative removes 95% of ascaris.

INFECTION OF ASCARIS IS PREVENTED BY THE FOLLOWING METHODS:

- i) Keep good sanitary conditions
- ii) Avoid pollution of soil with human faces.
- iii) Washing the fruits & vegetables thoroughly with mild solution of KMnO_4 .
- iv) Cook the food, properly.
- v) Don't use raw vegetables & nuts.
- vi) Cut the finger nails regularly.
- vii) Wash the hands properly with some antiseptic soap before touching edibles or eatables.

Keywords:

Symptom - a physical or mental feature which is regarded as indicating a condition of disease

Diseases - a disorder of structure or function in a human

Helminth - a parasitic worm

Diarrhoea - a condition in which faeces are discharged from the bowels frequently and in a liquid form

Pneumonia - lung inflammation

Appendicitis - a serious medical condition in which the appendix becomes inflamed and painful

Purgative - strongly laxative in effect

Antiseptic - preventing the growth of disease-causing microorganisms

Question and exercises

Part – A

1. What kind of parasite is ascaris and it is the causal organism of which disease?
2. Which medicines are used for the treatment of ascariasis?

Part – B

1. Describe the external structure of *Ascaris lumbricoides* with a neat labeled diagram.

Part – C

1. Write an account on the aspects of pathogenicity, therapy and prophylaxis with reference to ascaris.

INFECTION OF ASCARIS IS PREVENTED BY THE FOLLOWING

METHODS:

- i) Keep good sanitary conditions
- ii) Avoid pollution of soil with human faeces
- iii) Washing the fruits & vegetables thoroughly with mild solution of KMnO_4
- iv) Cook the food properly
- v) Don't use raw vegetables & nuts
- vi) Cut the finger nails regularly
- vii) Wash the hands properly with some antiseptic soap before touching edibles or catables

Keywords:

Helminth - a parasitic worm
Diseases - a disorder of structure or function in a human
indicating a condition of disease
Symptom - a physical or mental feature which is regarded as
aided or earth by behavior

LESSON - 8

WUCHERERIA BANCROFTI

1. The incubation period is 6-12 months
2. Lymphopharyngitis
3. Fever
4. Elephantiasis of genitals, legs
5. Considerable disability
6. Reversible lymphoedema
7. Eosinophilia

(Filarial worm)

Phylum – Aschelminthes

Class – Nematoda

Subclass-Phasmodia

Order-Filarioidea

External morphology:

Habit and habitat

Wuchereria bancrofti is a dreadful **endoparasite** of man; adults harbouring the lymphatic vessels and lymph nodes. Its life history is **digenetic**, as it involves a secondary host, the bloodsucking insects, i.e., the female mosquitoes of the genus *Culex*, *Aedes* or *Anopheles*;

Structure

The **adult worms** are long, hair-like, transparent and often creamy-white in colour. They are filiform in shape having tapering ends; the head end terminating in a slightly rounded swelling. **Sexes** are separate and **sexual dimorphism** is distinct. The **male worm** measures 2.5 to 4 cm in length and 0.1 mm in diameter having a ventrally curved tail-end with a number of genital papillae and two unequal **corpulutory spicules**.

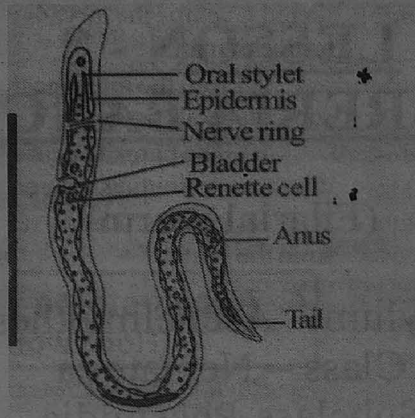
The **female** worm measures 8 to 10 cm in length and .2 to .3 mm in diameter having a narrow and abruptly pointed tail. The female genital pore or vulva is located ventrally in the pharyngeal region and is characteristically provided with a pyriform **ovijector**. The male and female worms remain coiled together. Its **mouth** is simple without lips, **pharynx** is divisible into an anterior muscular and a posterior glandular parts.

The **microfilariae** are very active and can move with and against the blood stream. They have colourless and transparent bodies with blunt anterior ends and rather pointed tails. Structures from anterior end are future mouth or oral stylet, nerve ring band, nephridiopore, reticulate cells and a dark colored inner mass and four cells of future anus.

Digenetic – an organism living in two hosts.

Pathogenesis - the manner of development of a disease.

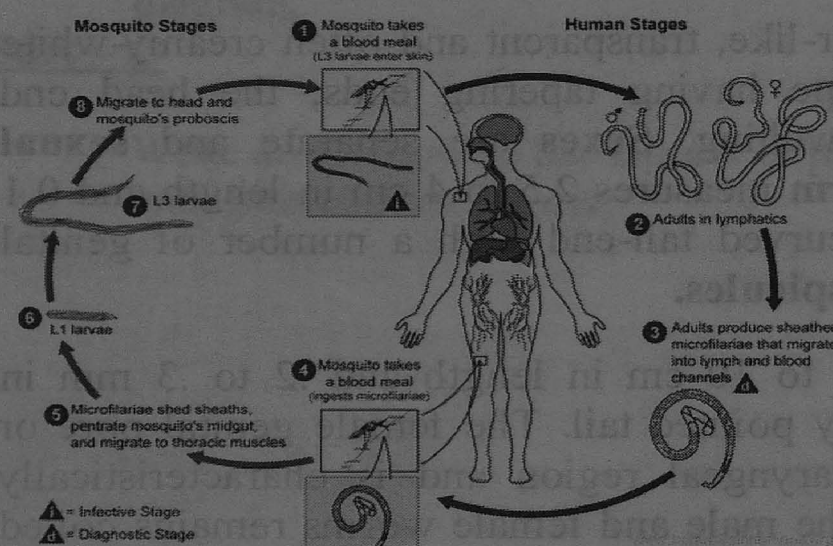
Obstruction - prevents passage or blockage.



PATHOGENECITY : The pathogenic effects seen during filariasis are caused by living or dead adult worms. Light infection does not cause serious effects it causes filarial fever, head ache and mental depression.

MODE OF TRANSMISSION:

This disease is transmitted by Culex mosquito when it bites a man containing the larva enters the guts of mosquito. In the gut larva moults twice and becomes another larva called filariform larva which penetrates the gut and migrates to muscles of mosquito and reaches the mouth parts.



Check your progress

1. what is lymphoedema?
2. which mosquito is responsible for the transmission of elephantiasis?
3. Name two symptoms of filariasis.
4. What is the name of the chemical used to treat elephantiasis?

When it bites another man the larva enters the blood of man from blood, it goes to lymph vessel and block the vessels and glands causing lymphatic obstruction where the lymph can't get back to circulatory system.

So accumulation of lymph occurs in the affected organ (legs, arms, scrotum & mammae) are enlarged & become swollen. This condition is called **lymphoedema**.

When they inject lymph node it causes **lymphadenitis**. However sometimes the affected organ enlarges producing a tumour like ugly look this condition is called **elephantiasis** or filariasis.

Symptoms of filariasis:

1. The incubation period is 5-18 months
2. Lymphopharyngitis
3. Fever
4. Elephantiasis of genitals, legs and arms
5. Considerable disability
6. Reversible lymphoderma
7. Eosinophila



Fig: A photo of an infected individual with elephantiasis

Control measures

1. Treatment of all people in endemic areas with **diethylcarbamazine** capable of killing larvae and some adults.
2. Consumption of salt mixed with diethyl carbamazine to prevent infestations.
3. Killing of mosquito larvae by spraying insecticides to reduce vectors.
4. Use of mosquito nets, propellants and others to escape from mosquito bites.
5. Setting up of underground drainage system to avoid mosquito breeding.

Keywords:

Sexual dimorphism - distinct difference in size or appearance between the sexes of an animal

Digenetic – an organism living in two hosts.

Pathogenesis - the manner of development of a disease

Obstruction - prevents passage or blockage

Lymph - fluid exuding from a sore or inflamed tissue

Tumour - a swelling of a part of the body

Questions and exercises:

Part - A

1. Write down the classification of Wuchereria.
2. Why Wuchereria is said to be digenetic?

Part - B

1. Give an account on external features of Wuchereria bancrofti.

Part - C

1. Give an account of the pathogenecity and control measures of Wuchereria bancrofti.

Control measures

1. Treatment of all people in endemic areas with diethylcarbamazine capable of killing larvae and some adults.
2. Consumption of salt mixed with diethyl carbamazine to prevent it, blood infections. he holds out strong evidence that salt mixed with diethyl carbamazine is a good way.
3. Killing of mosquito larvae by spraying insecticides to reduce vectors.
4. Use of mosquito nets, repellents and other to escape from mosquito bites.
5. Setting up of underground drainage system to avoid mosquito breeding.

Keywords:

Sexual dimorphism - distinct difference in size or appearance between the sexes of an animal.
Digenetic - an organism living in two hosts.
Pathogenesis - the manner of development of a disease.
Obstruction - prevents passage or blockage.

UNIT - IV

LESSON – 9 : ANNELIDA TYPE STUDY - EARTHWORM

PHERETIMA POSTUMA (The Indian Earthworm)

The earthworms are metamerically segmented borrowers. They are found in the decaying organic matters. The rainy season is the most favourable time for the earthworms, during this season, they live in the superficial soil of the earth and they are often seen crawling on the surface in abundance. They are nocturnal in habit. They breed during rainy season. They are cold blooded or poikilothermal animals. The presence of earthworm is inferred by their castings as a small round pellets lying separately near the burrows, like a little heaps. The natural life span of earthworms varies from three and a half years to ten years. Earthworms are farmer's friend because they are 'Natural Ploughman'.

Objectives

By Studying this unit, the students will

- j) Understand the systematic position of earthworm.
- k) know the favourable season and castings.
- l) know the life span of earthworm.

Unit Structure

9.1 Definition of Annelida.

9.2 A type study – earthworm.

9.2.1 Systematic position.

9.2.2 External morphology.

9.2.3 Setae.

9.2.4 Nephridia

9.2.5 Nervous system.

9.2.6 Reproductive system.

9.2.7 Metamerism.

9.3 Let us sum up.

9.4 Key words.

9.5 Books for further reading.

9.6 Questions/Exercise.

9.7 Answer for Questions.

9.1 DEFINITION OF ANNELIDA

Annelida (L., Annellus = little ring or F., anneler=to arrange in rings) are triploblastic bilaterally symmetrical, coelomate and segmented metazoa.

9.2 A TYPE STUDY – EARTHWORM

9.2.1 SYSTEMATIC POSITION

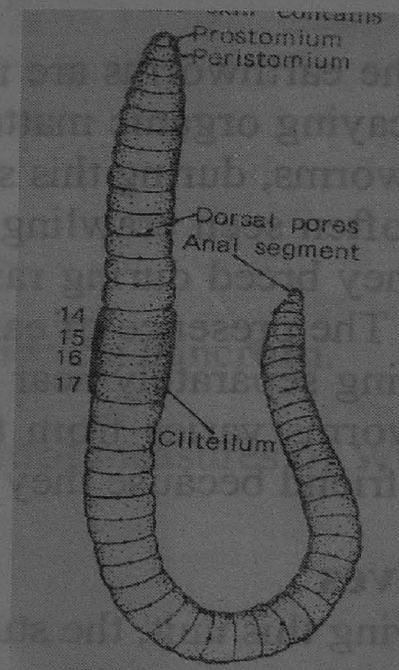
Phylum : Annelida

Class : Oligochatea

Order : Opisthopora

Genus : Pheretima

Species : Posthuma

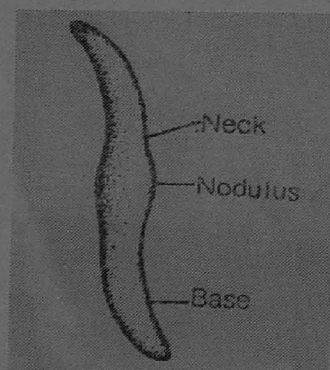


Earthworm

9.2.2 EXTERNAL MORPHOLOGY

Shape and Size: Pheretima posthuma has long, elongated, cylindrical narrow body. The anterior end is tapering while the posterior end is blunt. The mature earthworm may attain the size upto 150mm in length and 3-5mm in wide. The earthworm is glistening dark brown in colour due to the presence of a pigment porphyrin. The first segment is called peristomium. It bears mouth. Anteriorly the peristomium has a prostomium. The last segment is called anal segment or pygidium. In the adult earthworm the four segments from the 14th to 17th segments are swollen to ring like structure called clitellum. Clitellum has many glandular cells, which secrete egg case. The clitellum divides the body into three regions namely anterior preclitellar region (segment 1st to 13th), the middle clitellar region (segment 14th, 15th and 16th) and the posterior post clitellar region (it starts from 17th segment upto the segment of the body).

9.2.3 SETAE



Setae

In all the segments of the body except the first, last and clitellum, the skin contains a numerous bristle like structure called cltinuous setae are projected backwardly. Each seta arises from a setigerous sac of the skin and is a pale yellow curved S-shaped pointed rod like with the swollen middle part called nodulus. The setae help in locomotion by holding the earth since they are directed backwards. The movement of setae is controlled by a

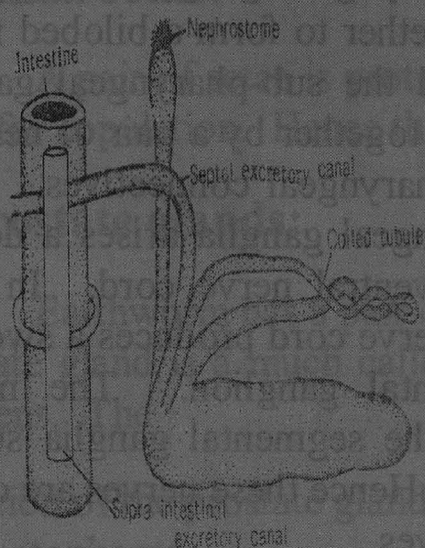
special type of muscle. The setae can be moved in any direction and extended or withdrawn at the will of the earthworm.

9.2.4 NEPHRIDIA

The excretory organs of earthworms are symmetrically arranged slender coiled tubules called nephridia. One end of the duct opens into the coelom by a funnel like opening called nephrostome and the other end opens to the outside by the nephridiopore. This type of nephridium is called metanephridium. Earthworm has three types of nephridia. They are as follows.

1. Meganephridium (or) septal nephridia.
2. Micronephridium (or) integumentary nephridia.
3. Pharyngeal nephridia.

1. Meganephridia

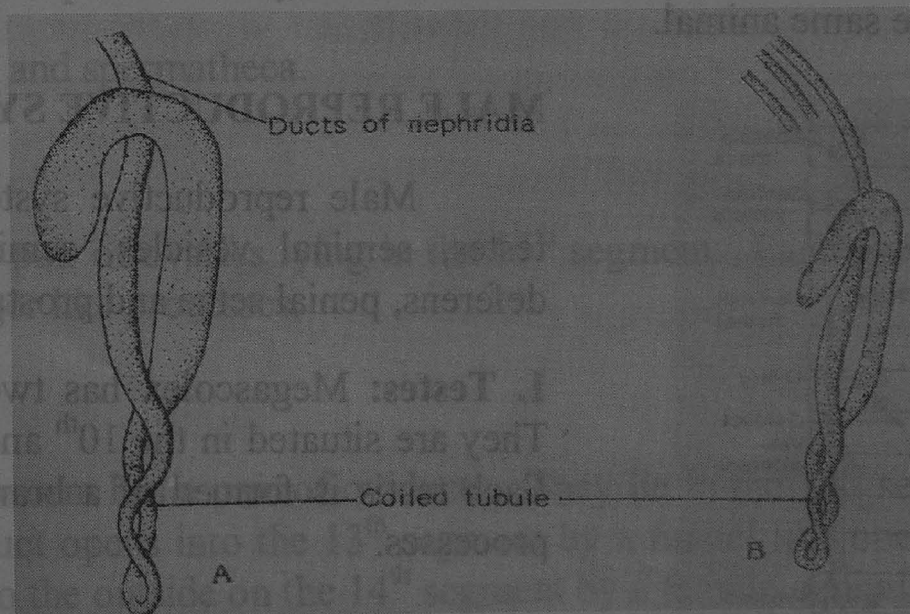


Meganephridium

They are arranged from 19th segment, on pair in each segment. It has a nephrostome which leads into a coiled tube from which arises a narrow duct called the septal excretory canal. It opens into a median canal called supra intestinal excretory canal lying above the intestine. The supra intestinal excretory canal communicates with the intestine by paired tubes in each segment.

2. Micronephridia : They are minute finger shaped tubules, arranged, behind the 14th segment. Each tube opens to the outside by a separate nephridiopore. They have no nephrostome.

These are also called integumentary or exonephric nephridia.



A – Micronephridium B – Pharyngeal nephridium

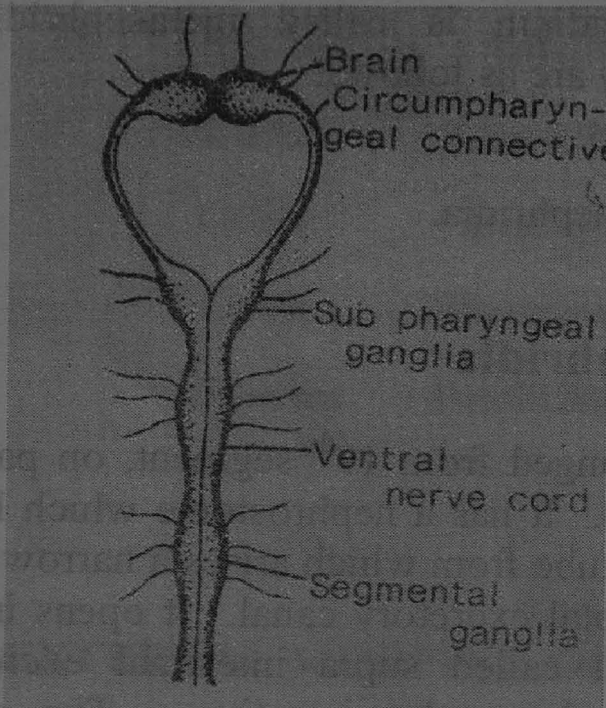
CHECK YOUR PROGRESS

1. What is clitellum?
2. What do you mean by nephridia?
3. What is the use of spermathecae?
4. Where is the fertilization takes place?
5. What is the use of clitellum?

3. Pharyngeal nephridia

These are paired tufts arranged on either side of the alimentary canal from 5th to 9th segment. These ducts run in separate bundles and open into the oesophagus. Nephrostome is absent.

9.2.5 NERVOUS SYSTEM

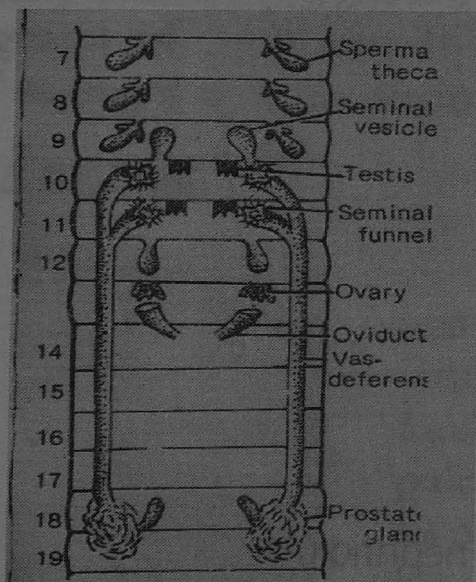


Nervous system

The nervous system has a brain. The brain is formed of two ganglia called cerebral ganglia. The two ganglia are fused together to form a bilobed mass. They are situated above the pharynx. Hence they are also called suprapharyngeal ganglia. Below the pharynx there is another pair of ganglia called sub-pharyngeal ganglia. They are also fused together to form a bilobed mass. The brain and the sub-pharyngeal ganglia are connected together by a pair of nervous called circumpharyngeal connectives. From the sub-pharyngeal ganglia arises a double nerve called ventral nerve cord. In each segment the nerve cord produces a swelling called segmental ganglion. The nerves arising from the segmental ganglia supply the segments. Hence these nerves are called segmental nerves.

9.2.6 REPRODUCTIVE SYSTEM

Earthworms are hermaphrodites. The male and female sex organs are present in the same animal.



Reproductive System

MALE REPRODUCTIVE SYSTEM

Male reproductive system is formed of testes, seminal vesicles, seminal funnel, vas-deferens, penial setae and prostate glands.

1. Testes: Megasclex has two pairs of testes. They are situated in the 10th and 11th segments. Each testis is formed of a branch of finger-like processes.

2. Seminal vesicles:

Earthworm has two pairs of seminal vesicles. They lie in the 9th and 12th segments. The spermatozoa develop in the seminal vesicles.

3. Seminal funnels:

There are two pairs of seminal funnels. They are located in the 10th and 11th segments. Each seminal funnel has a ciliated opening into the coelom.

4. Vas deferens

Earthworm has two vas deferentia. They start from the 10th segment. Anteriorly each vas deferens get connected with the two seminal funnels. The two vas deferentia open to the outside on the ventral side of the 18th segment by a pair of male genital apertures.

5. Penial setae:

A pair of setae is protruding through each male genital aperture. They are used for copulation. Hence they are called penial setae.

6. Prostate glands:

Earthworm has a pair of prostate glands situated in the 18th segment. Each prostate gland is a much called tube. It opens to the outside along with the vas deferens. The

secretion of the prostate glands helps to cement the spermatozoa into budles called spermatophores.

FEMALE REPRODUCTIVE SYSTEM

The female reproductive system is formed of ovaries, oviducts and spermatheca.

1. Ovaries:

There is a pair of ovaries lying in the 13th segment. Each ovary is formed of a bunch of finger like processes.

2. Oviducts:

The earthworm has a pair of oviducts. They lie in the 14th segment. One end of each oviduct opens into the 13th segment by a funnel like opening and the other end opens to the outside on the 14th segment by a female genital aperture.

CHECK YOUR PROGRESS

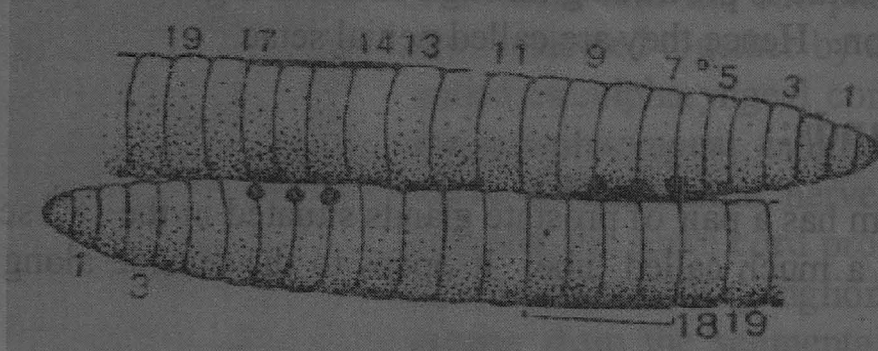
1. In which segment the ovary is situated?
2. Which segment is used for the mouth?
3. What is the function of septal nephridia?
4. What is the name of body cavity?
5. Which is called as "Natural Ploughman"?

3. Spermatheca:

There are three pairs of saclike structure called spermatheca. They are located from the segments and 8 and 9 one pair in each segment. They open to the exterior on the ventral side between segments 6 and 7, 7 and 8 and 9. Each spermatheca has an elongated ampulla and a pair of diverticula. The spermatheca serves to store spermatozoa.

COPULATION

Copulation takes place between two earthworms. During copulation the earthworms attach themselves by their ventral surface and they face opposite each other. The male genital pores of one earthworm come to lie exactly against the spermathecal openings of the other earthworm. Spermatozoa are liberated into the spermathecae. When one pair of spermatheca is full, the worms shift a little forward or backward, so that all the spermathecae are located with spermatozoa. After copulation the earthworms separate.



Copulation

The clitellar glands secrete a membranous bag around the clitellar segments. This bag hardens to form the egg case called cocoon. Ova and albumen are released into the cocoon. The earthworm wriggles out of the cocoon backwards. When spermathecal region passes through the cocoon the spermatozoa are squeezed out into the cocoon. When the worm has come out of cocoon, the openings of the cocoon are closed.

In earthworm fertilization is external. It occurs inside the cocoon. The development is direct. The cocoon contains many eggs. But one or two eggs develop into earthworms. The remaining eggs are used as food for the developing embryo. The young earthworm comes out by the rupture of the cocoon.

9.2.7 METAMERISM

The body of earthworm consists of about 100-120 small ring segments or somites or metameres. It exhibits true segmentation. In other words the whole surface of the body is divided into many ring like segments by a distinct series of annular grooves or furrows representing the external segmentation. Similarly the

interior of the body is divided by intersegmental septa or coelosepta into small chambers representing internal segmentation. However, all the segments of the body are alike except the first segment (peristomium) and the last segment (anal segment or pygidium).

9.3 LET US SUM UP

Earthworm is metamerically segmented worm included in the phylum Annelida. They are detritus feeders. The body is divided into 100 to 120 segments called metameres. The skin contains bristle like setae used for locomotion. Excretion is carried out by coiled ducts nephridia. The nervous system has a brain. Earthworms are hermaphrodites. Copulation takes place between two earthworms and their fertilization is external.

9.4 KEY WORDS

Metameres	- Segments
Peristomium	- The first segment bears mouth
Pygidium	- The last anal segment
Prostomium	- A fleshy lobe of peristomium
Setae	- Bristle like structure used for locomotion
Nephridia	- Excretion is carried out by coiled ducts
Hermaphrodite	- Both sexes are present in the same animal
Copulation	- Sexual contact between male and female worms
External fertilization	- Occurs inside the cocoon

9.5 BOOKS FOR FUTURE READING

4. Invertebrate Zoology-E.L.Jordon and P.S.Verma (2005) S.Chand and Co, NewDelhi.
5. A manual of Zoology – M.Kambarnath Iyer and T.N.Ananthakrishnan (203) Viswanathan publications, Chennai.
6. Invertebrate Zoology-R.L.Kotpal(2005) Rastogi publications, Meerat.
7. Text Book of Invertebrate- Dr.N.Arumugam et.al,(2008) Saras Publications, Nagerkovil.

9.6 QUESTIONS / EXERCISES

Part – A

1. Define annelida.
2. Give a systematic position of earthworm.
3. Differentiate peristomium from prostomium.

Part – B

1. Write a short notes on setae.
2. Give a brief account on nephridia.

Part – C

1. Explain the external morphology of earthworm
2. Explain the reproductive system of earthworm

9.7 ANSWER FOR THE QUESTIONS

For Q.No.1 in Part A refer section No.1.1

For Q.No.2 in Part A refer section No.1.2.1

For Q.No.3 in Part A refer section No.1.2.2

For Q.No.1 in Part B refer section No.1.2.3

For Q.No.2 in Part B refer section No.1.2.4

For Q.No.1 in Part C refer section No.1.2.2

For Q.No.2 in Part C refer section No.1.2.6

9.8 BOOKS FOR FUTURE READING

1. Invertebrate Zoology - E.L. Jordan and P.S. Verma (2005) S.Chand and Co.
2. Invertebrate Zoology - R.L. Kopal (2005) Rastogi Publications, Meerut.
3. Text Book of Invertebrate Zoology - Dr.N.Aravamudan et al. (2008) Saras Publications, Nagercoil.
4. Invertebrate Zoology - M.Kamath and T.N. Ananthakrishnan (2003) Viswanathan Publications, Chennai.
5. Invertebrate Zoology - M.Kamath and T.N. Ananthakrishnan (2003) Viswanathan Publications, Chennai.
6. Invertebrate Zoology - R.L. Kopal (2005) Rastogi Publications, Meerut.

9.9 QUESTIONS / EXERCISES

1. Define the term 'Invertebrate'.
2. Give a systematic position of earthworm.
3. Differentiate between the following:

UNIT V

LESSON – 10 : ARTHROPODA – A TYPE STUDY - PRAWN

Arthropoda are segmented animals with jointed legs, bilaterally symmetrical and metamerically segmented metazoan. Phylum Arthropoda have undergone an adaptive radiation for aerial, aquatic, terrestrial and parasitic environments filling every conceivable ecological niche. It is the largest phylum comprising about 80% of the known species. The metanurus are specialised structures and their number is generally fixed. Arthropoda have evolved from annelids or at least from some common ancestor.

Objectives

By Studying this unit, the students will

- a) understand the phylum Arthropoda.
- b) know the ancestor of Arthropoda.
- c) know the status of the phylum.

Unit Structure

- 10.1 Definition of Arthropoda.
- 10.2 Systematic position.
- 10.3 Type Study of Prawn.
 - 10.3.1 External morphology.
 - 10.3.2 Appendages.
 - 10.3.3 Digestive system
 - 10.3.4 Excretory system
 - 10.3.5 Reproductive system and development.
 - 10.3.6 Affinities of peripatus.
- 10.4 Let us sum up.
- 10.5 Key words.
- 10.6 Books for further reading.
- 10.7 Questions/Exercise.
- 10.8 Answer for Questions.

10.1 DEFINITION OF ARTHROPODA

The phylum arthropoda (Gr., arthros=jointed + podos = foot) is the largest group of the animal kingdom. They are triploblastic, segmented, bilaterally symmetrical, jointed appendages with the organ system grade of organization.

10.2. SYSTEMATIC POSITION OF PRAWN

Phylum : Arthropoda

Class : Crustacea

Order : Decapoda

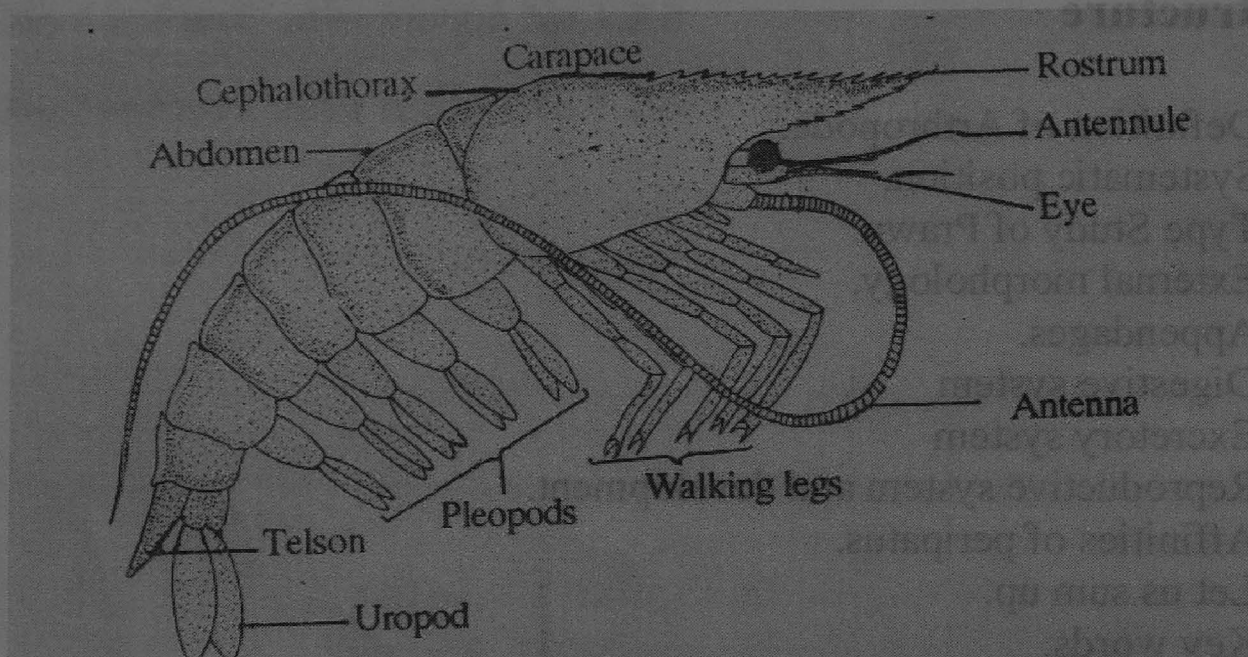
Genus : Penaeus

10.3 TYPE STUDY OF PRAWN

10.3.1 EXTERNAL MORPHOLOGY

Habit, Habitat and shape

Penaeus is marine animal. It can swim in the water and crawl on the bottom of the sea. It is omnivorous in habit. Prawn is elongated and spindle-shaped. The body has a characteristic bend in the middle of the body. Prawn has two stalked compound eyes. They are located beneath the rostrum.

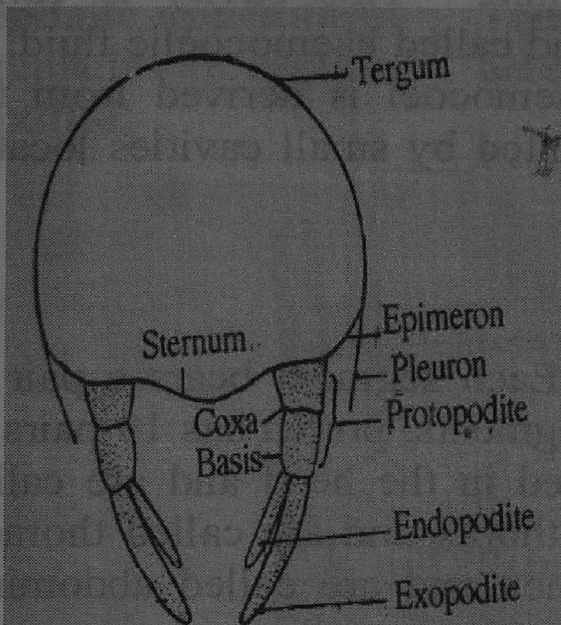


Penaeus - Prawn

Segmentation

The body is segmented and it is formed of 19 segments. It has two main regions, namely the anterior cephalothorax and posterior abdomen. The cephalothorax is formed of 13 segments and the abdomen is formed of 6 segments. The segments in cephalothorax are fused together but in the abdomen the segments are free and distinct. The cephalothorax is formed by the fusion of two regions, namely the head and the thorax. The head is formed of 5 segments and the thorax is formed of 8 segments. Each segment bears a pair of appendages on its ventral side. As prawn has 19 segments, there are 19 pairs of appendages. The last segment bears a conical projection called telson.

Exoskeleton



Prawn - Exoskeleton.

The body and the appendages are covered by chitin. The chitin is very hard and it forms a well developed exoskeleton. It protects the body. In each segment the exoskeleton has a dorsal piece called tergum and a ventral piece called sternum. The terga of the anterior 13 segments (cephalothorax) fuse together to form a broad plate called carapace or dorsal shield. Anteriorly the carapace is produced into a median spine called rostrum. It is serrated. The carapace is attached to the body on the dorsal side, but it is free on the lateral sides. Thus on either side of the thorax, the carapace hangs down as a flap called branchiostegite or gill-cover. The space lying between the

branchiostegite and the body is called gill chamber or branchial chamber.

The terga of the adjacent abdominal segments are connected by thin, flexible membranes called arthrodial membranes. These membranes facilitate movements between the segments. Ventrally the tergum extends downwards on either side as a membrane called pleuron. The appendage of each segment is connected with the pleuron by a small plate called epimeron.

External apertures

1. **Mouth:** The mouth lies ventrally in between the mandibles.
2. **Anus:** The anus lies ventrally on a small elevation at the base of the telson.
3. **Genital apertures:** The genital apertures are paired. The male genital apertures lie at the base of the last pair of walking legs. The female genital apertures lie at the base of the third pair of legs.
4. **Excretory apertures:** The excretory apertures are also paired and they lie at the coxa of antenna.
5. **Statocyst openings:** There is a pair of statocysts lying one at the base of each antennules. The statocysts open externally through statocystic openings located in the precoxa.

Body cavity: The space between the body wall and the alimentary canal is not a true coelom, because it lacks coelomic epithelium. This cavity is called haemocoel, because it is filled with a blood-like fluid called haemocoelic fluid. It contains corpuscles like those in blood. The haemocoel is derived from the embryonic blastocoel. The true coelom is represented by small cavities located around the gonads.

10.3.2 APPENTAGES

Prawn has jointed biramous appendages. Each segment bears a pair of appendages on the ventral side. As there are 19 segments, prawn has 19 pairs of appendages. Of these 19 pairs, 5 pairs are located in the head and are called cephalic appendages, 8 pairs are presented in the thorax and are called thoracic appendages and 6 pairs are present in the abdomen and are called abdominal appendages. The appendages are named as follows:

The 1st appendage is called antennule

The 2nd appendage is called antena

The 3rd appendage is called mandible

The 4th and 5th are called I & II maxillae

The 6th, 7th & 8th are called I, II & III maxillipedes

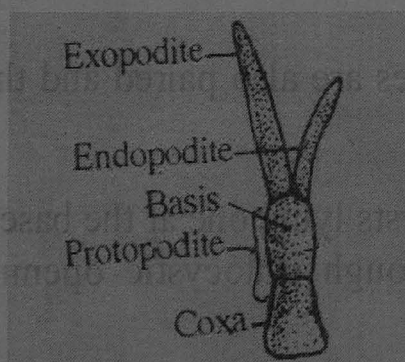
The 9th to 13th are called I to V walking legs

The 14th to 18th are called pleopods

The 19th are called uropods

Each appendage is formed of many segments called podomeres. The appendages do various functions like the sensory function, feeding, locomotion, respiration, copulation, etc. Each appendage is specialised to do a particular function. The appendages are variously modified according to their function. Even though the appendages do different functions, they are all constructed on a similar fundamental pattern.

A typical appendage



A typical appendage

An abdominal appendage can be taken as a model in studying the structures of the appendages of prawn. It consists of a basal region, called protopodite made up of two segments or podomeres, namely coxa and basis. The segment by which the appendage is attached to the body is called coxa and the distal segment is known as basis. The basis bears two fingers-like processes. They are the exopodite and the endopodite. The

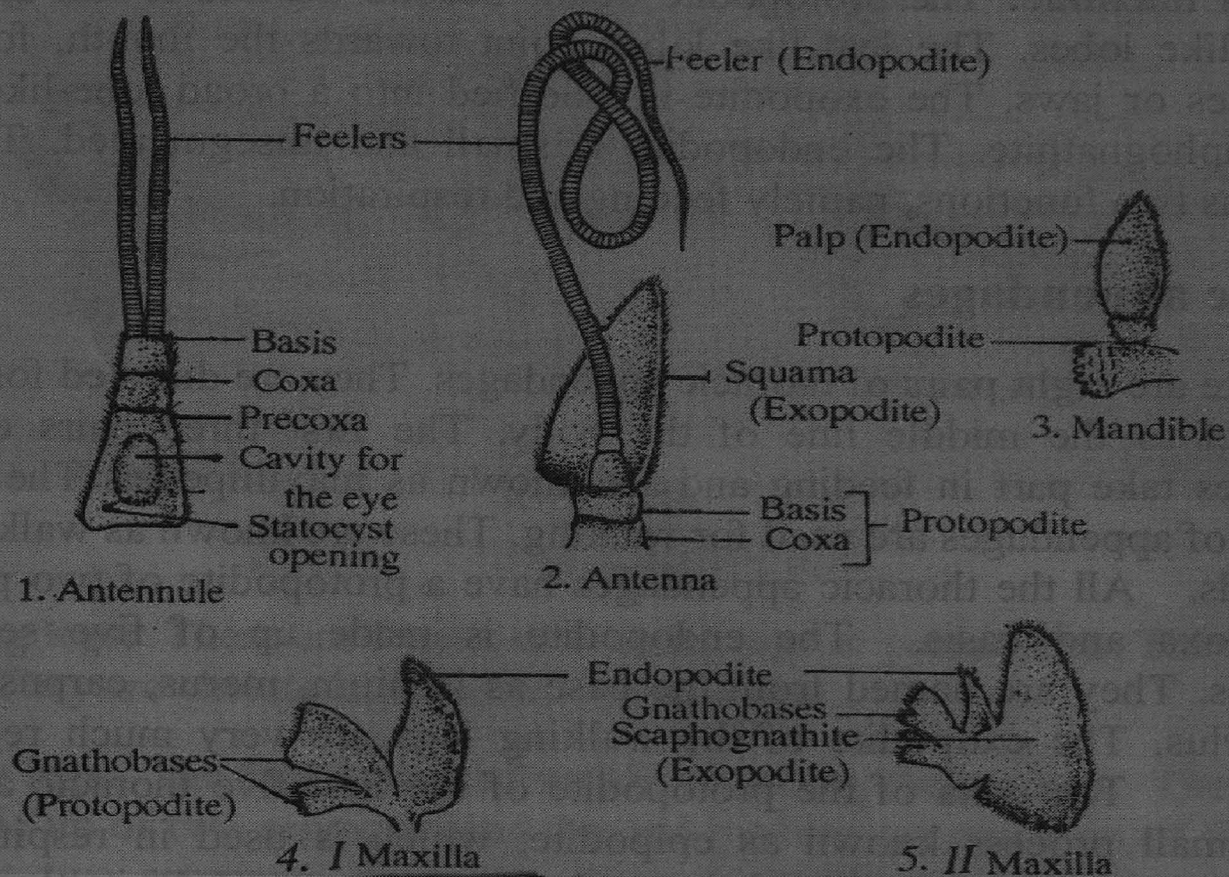
exopodite is larger than the endopodite and it lies outwardly. The endopodite is

CHECK YOUR PROGRESS

1. What are the two main parts of prawn?
2. How many cephalic appendages are in prawn?
3. What is the use of second maxillae?
4. Which are the non-chelate legs?
5. What is the petasma?

smaller in size and lies internal to the exopodite. This type of appendage is called biramous, because it is formed of two finger – like processes.

Cephalic appendages : There are five pairs of cephalic appendages. They are antennules (I antennae), antennae (II antennae), mandibles, I maxillae and II maxillae.



Cephalic appendages

1. Antennules or first antennae: They lie below the eye stalks. Each antennule has a protopodite made up of three podomeres, namely precoxa, coxa and basis. The precoxa is hallow and it contains a cavity for the eye and an opening for the statocyst. The endopodite and the exopodite are made up of many segments which are modified into two short flagella or feelers. The antennules are sensory in function serving as tactile organs. The antennules contain statocysts or the organs of balancing.

2. Antennae or second antennae: They are situated behind the antennules. The protodite of the antenna has two segments, namely coxa and basis. The endopodite is modified into a long, multi jointed filament called feeler. The exdopodite is broad plate called squame. The antennae serve as tactile organs.

3. Mandibles: The mandibles lie on either side of the mouth. Each mandible has a protopodite and the protopodite has calcified teeth. The endopodite is a double segmented process known as palp. There is no exopodite. The mandibles are mastigatory in function. While biting, the mandibles move from side to side and not up and down.

4. First maxillae or maxillulae: These are small appendages. Each maxilla consists of a protopodite of two flattened leaf-like lobes, called gnathobases (Gnathos = Jaws). Gnathobases are covered with minute setose hairs. The endopodite of each maxilla is slender and is made up of two segments. The exopodite is absent. The first maxilla is used to pass food to the mouth.

5. Second maxillae: The protopodite of the second maxilla is flat and cut into four leaf-like lobes. The leaf-like lobes point towards the mouth, forming the gnathobases or jaws. The exopodite is modified into a broad lobe-like structure called scaphognathite. The endopodite is small and unsegmented. The second maxilla has two functions, namely feeding and respiration.

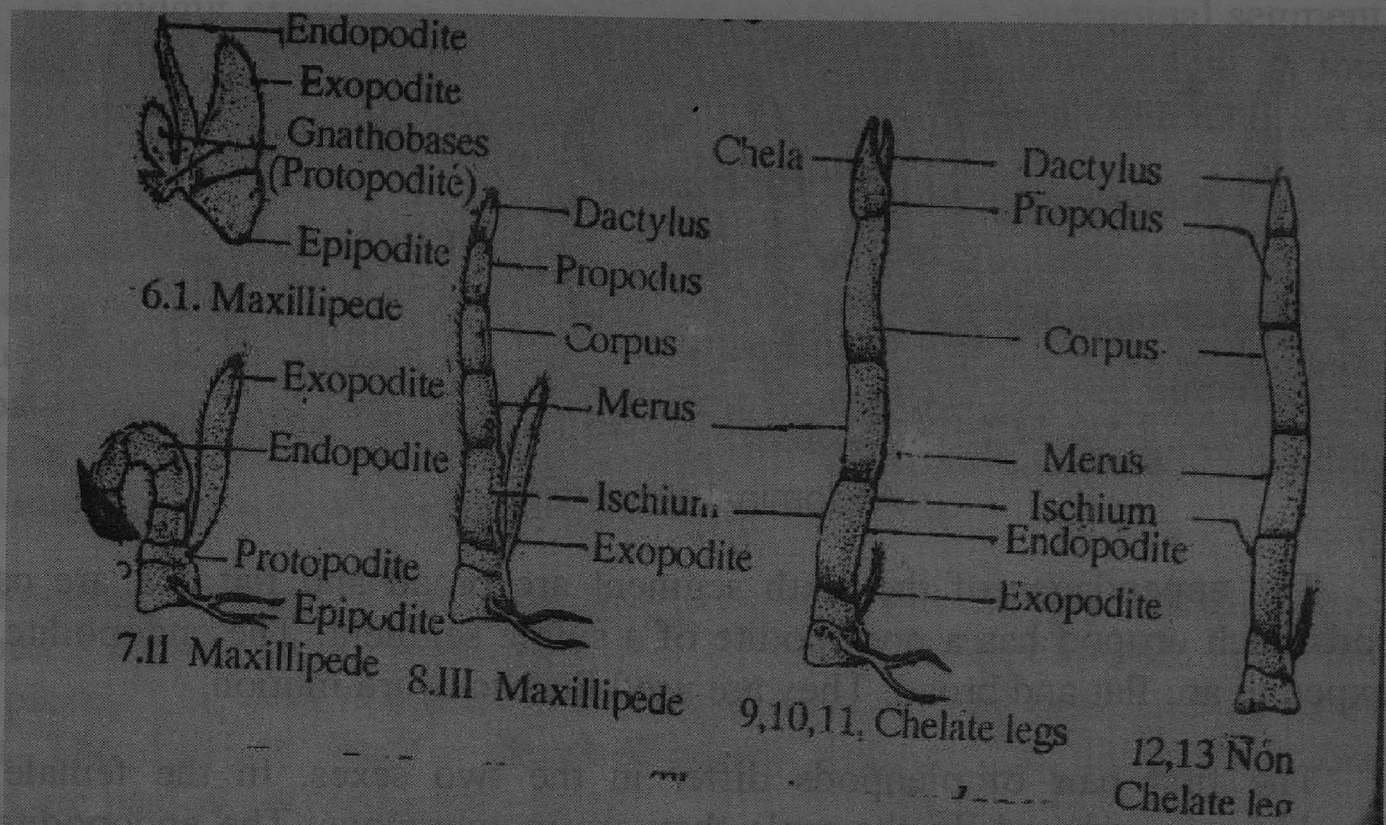
Thoracic appendages

There are eight pairs of thoracic appendages. They are directed forwards and lie parallel to the middle line of the body. The first three pairs of thoracic appendages take part in feeding and are known as maxillipedes. The remaining five pairs of appendages are used for walking. These are known as walking legs or peraeopods. All the thoracic appendages have a protopodite of two podomeres, namely coxa and basis. The endopodite is made up of five segments or podomeres. They are named from the base as ischium, merus, carpus, propodus and dactylus. The exopodite of the walking legs are very much reduced into filaments. The coxa of the protopodite of the first five thoracic appendages bears a small process known as epipodite, which is used in respiration. The epipodite of the first maxillipedes are flattened lobes, while in the remaining appendages the epipodites are y-shaped.

I. Maxillipedes: The protopodite is flattened and incompletely divided into three lobes, called gnathobases which are covered with setose hairs. The exopodite and epipodite are flattened lobes.

II. Maxillipedes: The protopodites are divided into two segments as in the typical appendages. The endopodites are segmented and curved like a question mark. Epipodites are Y-shaped. The exopodites are annulated.

III. Maxillipedes: These are exactly like II maxillipedes except in one feature; the endopodite is straight and not like a question mark.



Thoracic appendages

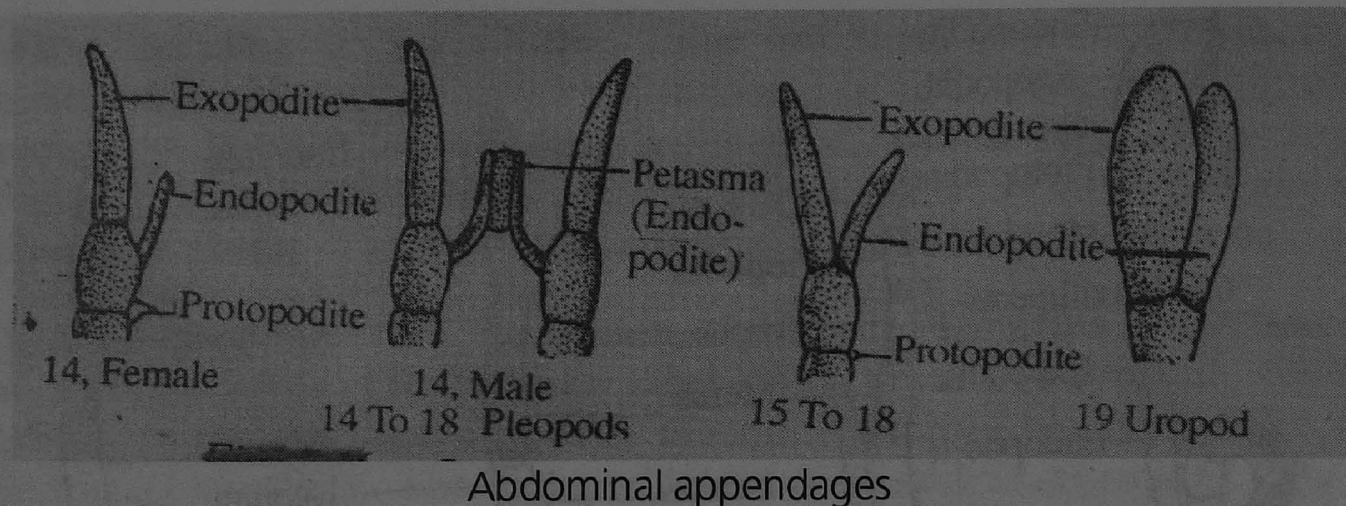
Walking legs: These are 5 pairs of walking legs or peraeopods. They are of two types. They are chelate legs and non-chelate legs.

Chelate legs: The first 3 pairs of walking legs are chelate legs. The protopodites are made up of two segments and the endopodites are made up of five segments. The last two segments, the propodus and the dactylus of the endopodite are arranged in such a way that the two segments work against each other like the blades of a pair of forceps. This type of articulation is called chela. They are used to grasp the food and to pass it into the mouth. The epipodites are present in all the 3 chelate legs and are Y – shaped.

Non-chelate legs: The last two pairs of walking legs lack the chela. So they are called non-chelate legs. The segments of the endopodite are arranged in a linear order. The epipodites are absent.

Abdominal appendages

The abdomen bears six pairs of abdominal appendages. They are called pleopods or swimmerets. They appendages from the second to the fifth abdominal segments are like the typical appendage described above.

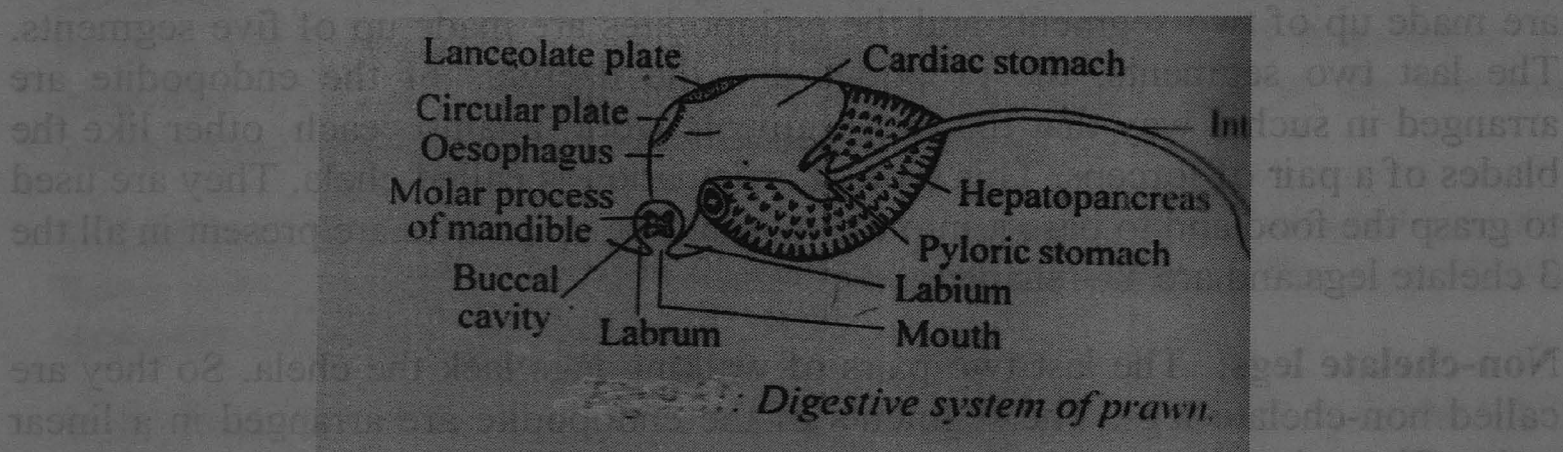


The appendages of the sixth segment are broad and flat and are called uropods. Each uropod has a protopodite of a single segment. The endopodite and the expodite are flat and broad. They are used for backward motion.

The first pair of pleopods differ in the two sexes. In the female the endopodites are reduced. In the male they are membranous. The endopodites of the two sides unite to form a copulatory organ called petasma.

10.3.3 DIGESTIVE SYSTEM

The digestive system consists of the alimentary canal and the associated digestive glands.



Alimentary Canal: The alimentary canal is formed of the foregut, the midgut and the hind gut. The foregut is formed of mouth, the buccal cavity, the oesophagus and the stomach. The foregut and the hind gut are lined with chitin.

The mouth lies in between the mandibles. It leads into the buccal cavity. The buccal cavity is followed by the oesophagus which is short and runs vertically from the buccal cavity to the stomach. The stomach consists of an anterior large cardiac stomach, and a posterior small pyloric stomach. The floor of the cardiac stomach has many folds. They bear setae and spicules. The roof of the cardiac stomach has many calcareous, stout denticles which constitute the gastric mill or gastric armature. The denticles are called gastric mill because they are used in grinding food. The pyloric stomach has narrow lumen and is followed by the

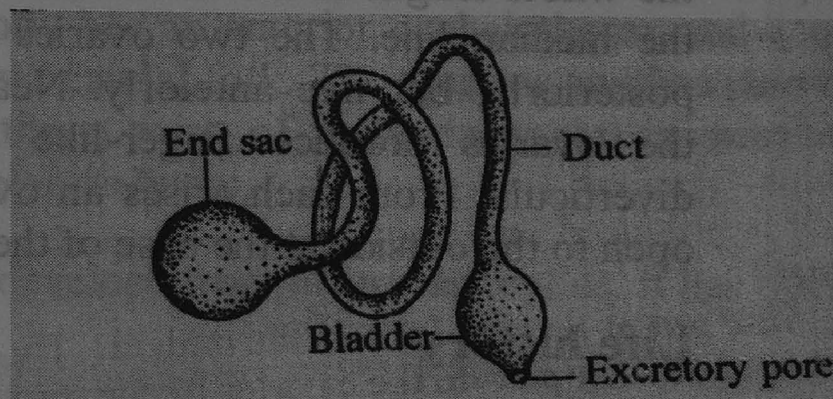
midgut. The midgut extends as a straight tube up to the sixth abdominal segment. The chitinous lining of the pyloric stomach is produced into the midgut as four lappets or valvulae. The hind gut or rectum follows the midgut. The hind gut is very short. It opens to the exterior by the anus.

Digestive glands: The stomach is surrounded by a large gland called hepatopancreas. It is formed of numerous tubules. The tubules join to form two large ducts called hepatopancreatic ducts. They open into the pyloric stomach. The hepatopancreas has three functions: a) It secretes digestive enzymes like the pancreas of vertebrates. b) It stores glycogen, fat and calcium and c) It exhibits intracellular digestion by absorbing food from the stomach.

Feeding: *Penaeus* is an omnivorous animal. The chelate legs and third maxillipedes capture and convey the food to the mouth. The mandibles cut it into smaller pieces. The food is further ground in the gastric mill and digested in the stomach. The digested food is absorbed in the midgut. The undigested food materials are passed out through the anus.

10.3.4 EXCRETORY SYSTEM

The excretory system is formed of a pair of antennary glands or green glands. They are located in the coxa of antenna and hence their name antennary glands. They are green in colour and hence called green glands. Each green gland has a coiled excretory duct with an end sac at one end a bladder at the other end. The bladder opens out one by the excretory pore. The entire gland is kept inside the coxa of the antenna.



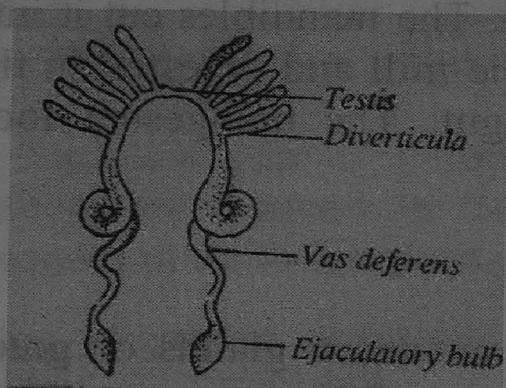
Green Gland

The nitrogenous waste is collected by the end sac. The excretory fluid passes through the coiled duct from the end sac and accumulates in the bladder. In the coiled duct the useful materials are absorbed into the blood. The fluid collected in the bladder is called urine and it is expelled out through the excretory pore. The green gland also does the function of osmoregulation. It pumps out the excess of water from the body.

10.3.5 REPRODUCTIVE SYSTEM

The two sexes are separate. Prawns exhibit sexual dimorphism. The two sexes can be identified by two morphological structures, namely petasma and thelycum. The petasma is a copulatory organ present only in the male. It is a membranous structure formed by the fusion of the endopodites of the first abdominal appendages. The thelycum is present only in the female. It is a sac-like outgrowth from the sternum of the last thoracic segment. The male deposits the spermatophores in the cavity of the thelycum.

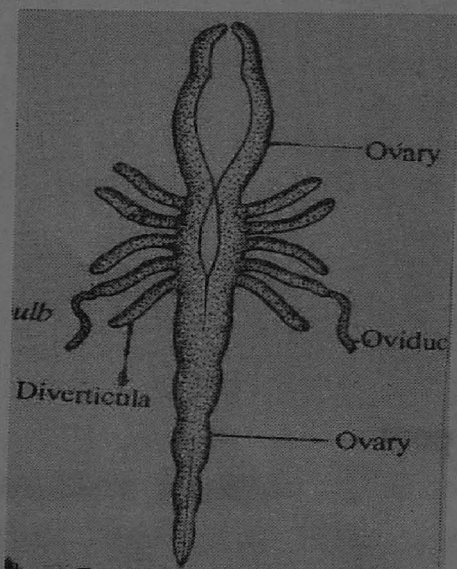
Male reproductive system



Male Reproductive System

The male has pair of tubular testes located in the thorax in either side of the middle line. The two testes are fused together anteriorly. Each testis has many finger-like outgrowths called caecal diverticula. Posteriorly, the testis leads into a vasdeferens. The terminal end of the vasdeferens becomes dilated into an ejaculatory bulb. The ejaculatory bulb opens to the outside by the male genital pore at the base of the last walking leg.

Female reproductive system



Female Reproductive

The female has a pair of long ovaries extending the whole length of the thorax and the abdomen along the median line. The two ovaries are fused together posteriorly, but free anteriorly. Near the anterior end the ovaries produce finger-like outgrowths called diverticula. From each arises an oviduct. The oviduct open to the outside at the base of the third walking leg.

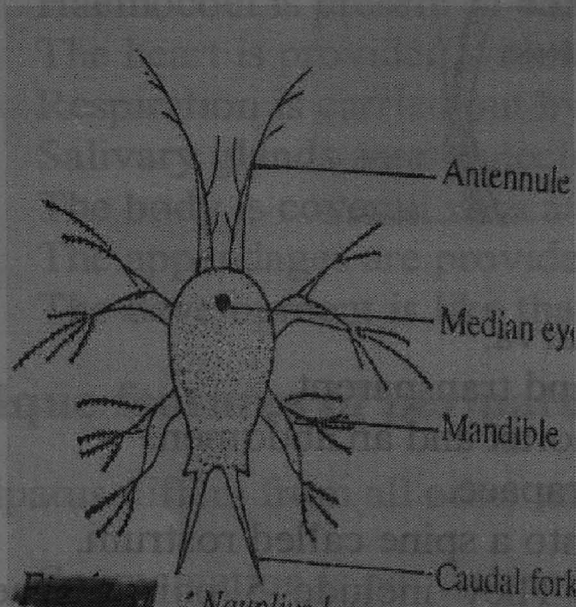
Life history

The male deposits the spermatophores (bundles of sperms) in the thelycum of the female. As the egg passes out from the female, it is fertilized; hence fertilization is external.

In *Penaeus* development is indirect. The fertilized egg hatches into a larve called nauplius. The nauplius is followed by a series of larval forms, namely metanauplius, protozoea, zoea and mysis. Finally the mysis larva is transformed into prawn.

1. Nauplius: The larva hatched from the egg is called nauplius larva. It has the following features:

1. It is free swimming pelagic larva.
2. It is minute and microscopic
3. It is oval in shape; the anterior end is broad and the posterior end is narrow.
4. The body has three regions, namely the anterior head, the middle trunk and the posterior anal region.



Nauplius Larva

5. The head has a simple median eye on the dorsal side.

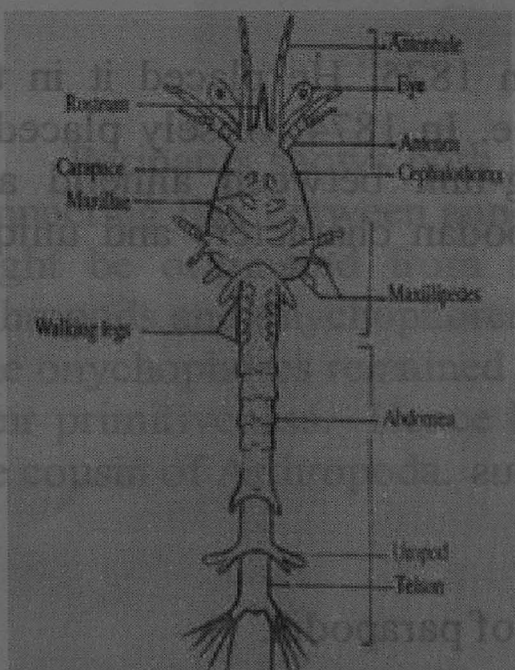
6. It has 3 pairs of appendages. They develop into the first 3 pairs of appendages of adult prawn. The first pair of appendages is uniramous and is called antennules. The second and the third pairs of appendages are biramous and are called mandible. The mandible has no teeth.

7. The posterior end has a caudal fork.

8. The nauplius larva grows and undergoes several moults and finally develops into the next larva called metanauplius.

2. Metanauplius : It is the second larva of *Penaeus*. It develops from the nauplius. The body has an anterior cephalothorax and a posterior abdomen. The abdomen ends in a caudal fork. The anterior end has pair of frontal sense organs. The larva has three pairs of appendages as in nauplius and the next four appendages develop as buds.

3. Zoea : Zoea develops from the metanauplius. It has the following features:

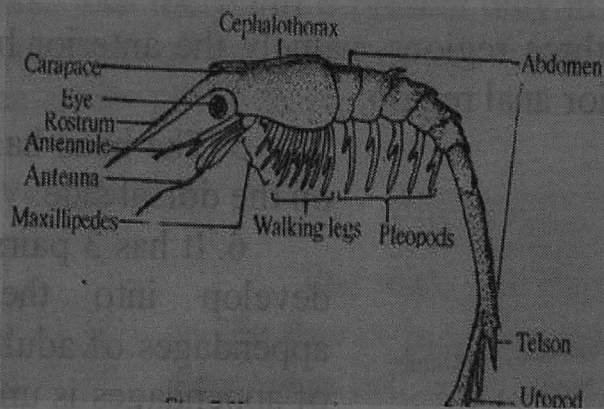


Zoea

1. It is a free swimming pelagic larva.
2. It is minute and microscopic.
3. The body is divisible into an anterior cephalothorax and a posterior abdomen.
4. The cephalothorax is covered by carapace.
5. Anteriorly the carapace is produced into a median spine called rostrum.
6. It has a pair of stalked compound eyes.
7. All the 5 cephalic appendages are well developed.

8. In the thorax the 3 pairs of maxillipedes are slightly developed and the remaining 5 pairs of walking legs are in the form of buds.
9. The abdomen has 6 segments. The last segment ends in a forked telson. The abdomen is without appendages.

4. Mysis



Mysis

1. The mysis larva develops from zoea larva.
2. It is elongated, laterally compressed and transparent.
3. The body is divisible into a cephalothorax and an abdomen.
4. The cephalothorax is covered by a carapace.
5. Anteriorly the carapace is produced into a spine called rostrum.
6. All the appendages are developed. They include 5 pairs of cephalic appendages, 8 pairs of thoracic appendages and 6 pairs of abdominal appendages.
7. The thoracic legs are used for swimming.
8. The abdomen ends in a telson.
9. The eyes are stalked and compound.
10. The mysis larva looks like the adult Mysis and hence the name. The larval mysis differs from the adult Mysis in the absence of a brood pouch beneath the thorax and a pair of statocysts.

CHECK YOUR PROGRESS

1. Penaeus belongs to which type of animal?
2. What is the role of green gland?
3. What you mean by nauplius?
4. Define zoea?
5. Peripatus looks like what?

10.3.6 AFFINITIES OF PERIPATUS

Peripatus was first described by Guelding in 1825. He placed it in the phylum Mollusca because of its slug-like appearance. In 1874 Mosely placed it under the phylum Arthropoda. It is a connecting-link between annelid and arthropoda. It exhibits annelidan characters, arthropodan characters and unique characters of its own.

1. Annelidan Characters

1. The segmentation is more or less homonomous
2. The body is vermiform
3. The body wall is dermomuscular.
4. The legs are hollow and unjointed like those of parapodia.

5. The eyes are simple.
6. The nephridia are segmentally arranged.
7. Genital ducts are ciliated.
8. Alimentary canal is straight.

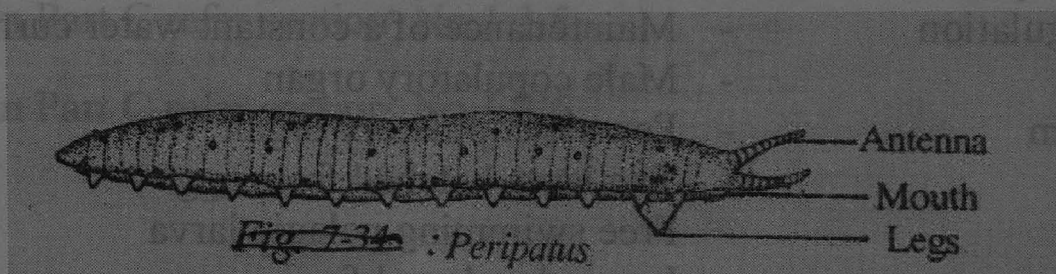
2. Arthropodan Characters

1. The antennae are jointed and are similar to those of arthropoda.
2. The jaws are the modified appendages.
3. Haemocoel is present in both the groups.
4. The heart is provided with lateral ostia.
5. Respiration is carried out by the tracheal system.
6. Salivary glands are connected with the digestive system.
7. The body is covered with a chitinous cuticle.
8. The appendages are provided with claws.
9. The development is like that of arthropods.

3. Unique features of peripatus

Peripatus differs from all other animals in the following features:

1. Segmentation is not distinct.
2. The stigmata are arranged in a scattered pattern.
3. The nervous system is ladder-like and without segmental ganglia.
4. The skin is soft, velvety with many transverse wrinkles and numerous papillae.
5. There is only one pair of jaws.



Peripatus shows both annelidan and arthropodan characters. So it forms a connecting link between annelida and arthropoda. It gives an idea that arthropods might be originated from an annelidlike ancestor. Now, it is believed that arthropods and onychophores were originated separately from a common ancestor. The onychophores remained as a blind offshoot and they survive till today with all their primitiveness. Hence Peripatus is not the ancestor of Arthropoda; but it is the cousin of Arthropoda.

10.4 LET US SUM UP:

Penaus is a marine animal, the body is segmented and it is formed of 19 segments. The body and the appendages are covered by chitin and forms a well developed exoskeleton. Prawn has jointed biramous appendages of three types. They are cephalic appendages, thoracic appendages and abdominal appendages. Excretion is by green glands or Malpighian tubules. Respiration in by gills or trachea or book lungs. The male deposits the spermatophores in the thelycum of the female. As the egg passes out from the female, it is fertilized, hence Fertilization is external ducts. In penalus development is indirect: The fertilized egg hatched into a larva called nauplius which is follow by a series of larval forms, namely metanauplius, protozoea, zoea and mysis.

10.5 KEY WORDS

Cephalothorax	- The union of two regions namely the head, and the thorax.
Telson	- The last segment bears a conical projection
Pleuton	- Membrane of tergum
Epimerson	- A small plate connecting appendage of segment with pleuron
Endopodite	- Finger like process
Exopodite	- Small 'Y' shaped process used for respiration
Epipodite	- Union of foregut, midgut and hind gut
Alimentary canal	- Maintenance of a constant water current
Osmoregulation	- Male copulatory organ
Petasma	- Female copulatory organ
Thelycum	- The larva hatched from egg
Naplium	- Free swimming pelagic larva
Zoea	- Larva developed from zoea
Mysis	- The covering of cephalothorax
Carapace	

10.6 BOOKS FOR FUTURE READING

1. Invertebrate Zoology-E.L.Jordon and P.S.Verma (2005) S.Chand and Co, NewDelhi.
2. A manual of Zoology – M.Kambarnath Iyer and T.N.Ananthakrishnan (203) Viswanathan publications, Chennai.
3. Invertebrate Zoology-R.L.Kotpal(2005) Rastogipublications, Meerat.
4. Text Book of Invertebrate- Dr.N.Arumugam et.al,(2008) Saras Publications, Nagerkovil.

10.7 QUESTIONS / EXERCISES

Part – A

1. Define Mandibles
2. Give the external apertures of prawn.
3. Differentiate antennules from antennae.

Part – B

1. Write a short note on digestive system of prawn.
2. Give a brief notes on male reproductive system.

Part – C

1. Explain the life history of prawn.
2. Explain the affinities of peripatus.

10.8 ANSWER FOR THE QUESTIONS

For Q.No.1 in Part A refer section No.1.3.2

For Q.No.2 in Part A refer section No.1.3.2

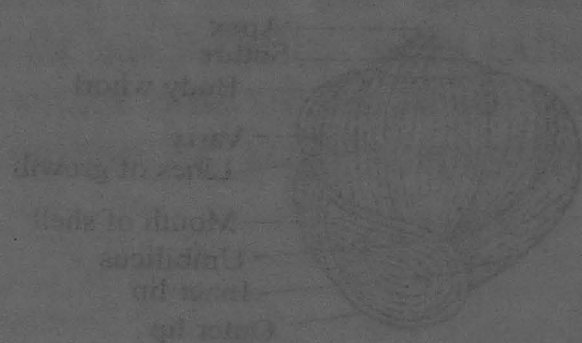
For Q.No.3 in Part A refer section No.1.3.2

For Q.No.1 in Part B refer section No.1.3.3

For Q.No.2 in Part B refer section No.1.3.4

For Q.No.1 in Part C refer section No.1.3.5

For Q.No.2 in Part C refer section No.1.3.6



Operculum:

The outer surface has number of rings of growth around the nucleus. The inner surface has an elliptical boss for attachment of muscles and boss is surrounded by a groove.

DIGESTIVE SYSTEM

Microscopic structure of shell:

- The shell consists of 3 layers namely
- i. Outer most pigment periostracum, made of concholin
 - ii. Middle prismatic layer made of calcareous plates runs vertically
 - iii. Innermost nacreous layer made of calcareous plates running longitudinally
- iv. Inside the shell is the mantle which secretes the shell
1. Tubular salivary gland
 2. A Pair of Salivary Glands
 3. A Large Digestive Gland

MOLLUSCA PILA GLOBOSA

Phylum : Mollusca

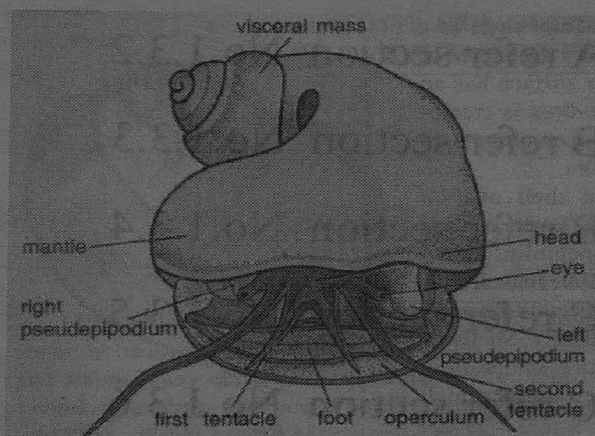
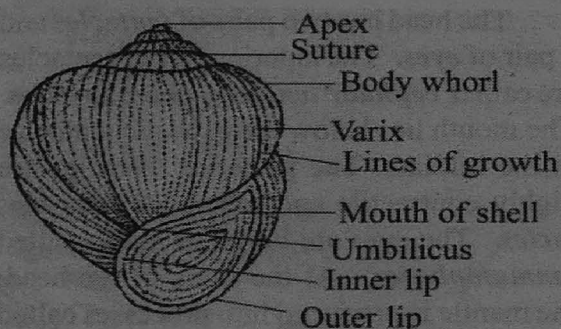
Class : Gastropoda

Order : Pectinibranchia

External features:

Shell:

The soft body of the Pila is covered by shell spirally coiled around a central axis. The top of the shell is called **apex**. It contains smallest and oldest whorl. Below the apex is **spire** consist of several large coils followed by **penultimate** whorl and body whorl which enclosed the most of the body. The lines between the whorls are called **sutures**. The body whorl has a large mouth and margin of mouth is called **peristome** the shell is spiraled clockwise or right handed or **dextral**. The outer margin of the mouth is called **outer lip** and the inner margin is called **columellar lip**. In the centre of the shell runs a vertical axis or **columella**, around which the whorls of shell are coiled. The columella is hollow and the opening to the exterior is known as **umbilicus**. The mouth of shell is covered by calcareous **operculum**.



Check your progress

1. The mouth of shell is covered by
2. To which phylum pila belongs to?
3. What is sutures?
4. What is periostracum?

Operculum:

Its outer surface has number of rings of growth around the nucleus. The inner surface has an elliptical boss for attachment of muscles and boss is surrounded by a **groove**.

Microscopic structure of shell:

The shell consists of 3 layers namely

- i. Outer most pigment periostracum, made of concholin
- ii. Middle prismatic layer made of calcareous plates runs vertically
- iii. Innermost nacreous large made of calcareous plates running longitudinally
- iv. Inside the shell is the mantle which secretes the shell

Body : The body consists of a head, foot, and visceral mass.

- i. **Head:** There is a distinct head produced into a **snout**. The head bears two pairs of **tentacles** the first tentacles are small called **labial palps**. Behind them is second pair of long tentacles called **true tentacles**. Behind the tentacles, the head has a pair of eye borne on stalks **ommatophores**.
- ii. **Foot:** Below head is large triangular muscular foot, apex pointing backwards used for creeping. The foot is formed of two regions namely an anterior **propodium** and posterior **metapodium**.

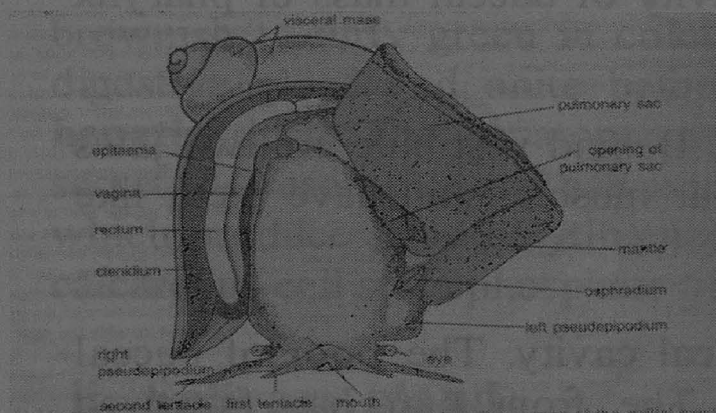
The head and foot together form head foot complex which is connected to visceral mass by a small neck

iii. Visceral mass:

Above head foot complex is a visceral mass forming the main part of the body, which is spirally coiled like a shell.

Mantle:

The mantle or **pallium** covers the visceral mass, form a hood over the animal when it is withdrawn. Over the edge of mantle is thick and has **shell glands** above this is **supra marginal groove** the mantle has 2 fleshy lobes called **nuchallobes** or **pseudopodia** which are joined on either side of the head. The left pseudopodium form a long tubular respiratory siphon for aerial respiration, while the right pseudopodium is less developed.



Check your progress

1. What is the other name for mantle?
2. What are labial palps?

DIGESTIVE SYSTEM

The digestive system comprises

1. Tubular alimentary Canal
2. A Pair of Salivary Glands
3. A Large Digestive Gland

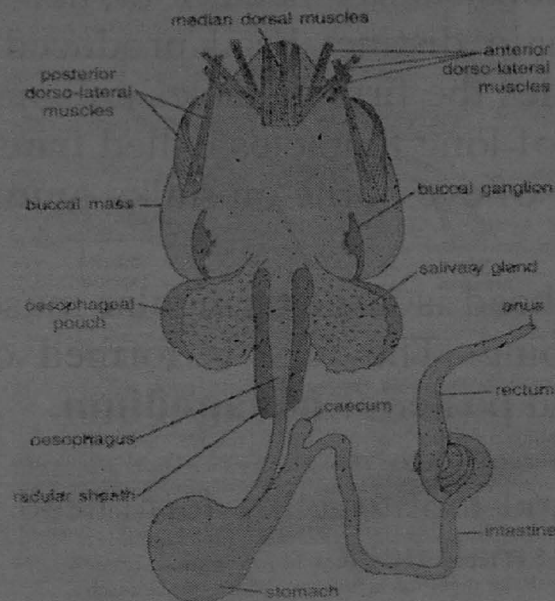
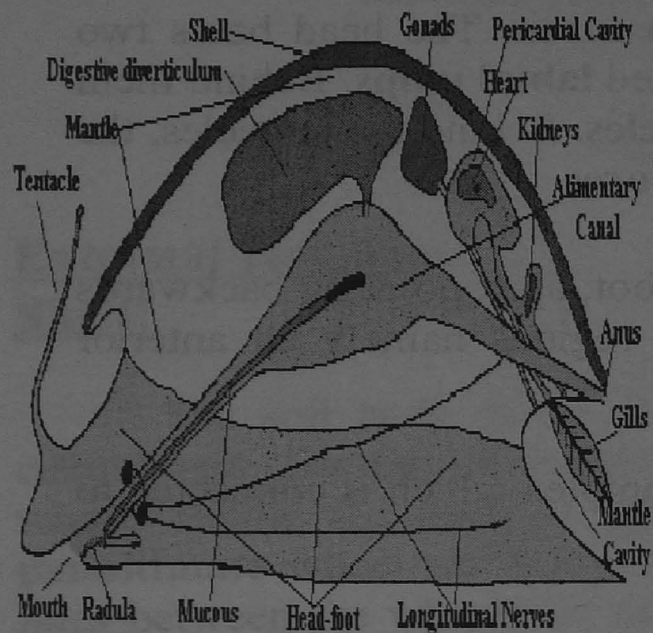


Fig. 60.7. *Pila globosa*. Alimentary canal.

Alimentary canal:

Alimentary canal's distinguished into three regions namely

1. The foregut or stomadaeum
2. Midgut or mesenteron
3. Hindgut or proctodaeum

Foregut: Foregut includes mouth, buccal mass & oesophagus

- i. **Mouth** :The mouth is a narrow vertical slit lying below anterior tentacles.
- ii. **Buccal mass** The mouth leads to a large cavity of buccal mass or pharynx having thick walls with many set of muscles.

The anterior part of buccal mass is **vestibule**. Behind vestibule are two jaws hanging from roof of buccal mass. The jaws bear muscles and have teeth like projections.

Buccal Cavity: Behind the jaws is large buccal cavity. The floor of buccal cavity is large elevation called **odontophore**. The front part has furrowed **subradular organ**. The odontophore has protractor and retractor muscles and two pairs of cartilages.

Radula: Behind odontophore is bag like **radular sac**. The radular sac has transverse rows of cells called **odontoblasts**. Inside the radular sac is a radula. Radula is made of many transverse rows of horny teeth. Each row has seven teeth two marginal, one lateral tooth on each side and central tooth in middle thus giving a formula 2,1,1,1,2.

Oesophagus: The buccal mass leads into long narrow **oesophagus**. There are two round **oesophageal pouches** lying near the anterior end. Oesophageal pouches serves as a temporary storage organ of food and digestion begins here.

Midgut: The midgut includes stomach and intestine.

i. **Stomach :** The stomach begins on the left side just below the pericardium of the visceral mass. It is a rectangular sac of dark red in colour having broad U-shaped internal cavity. The stomach has two chambers namely **cardiac chamber** and **pyloric chamber**.

Cardiac chamber is round in appearance and posses longitudinal folds on its inner surface which oesophagus opens. The pyloric chamber is tubular and has transverse folds on its inner surface. A small rounded caecum arises from pyloric region

ii. **Intestine:** From the pyloric chamber arises an Intestine which is long and coiled.

Hindgut:The **rectum** is a thick walled tube. It enters the mantle cavity and passes downwards to open by an anus on the right of the head.

Digestive glands: Pila has two types of digestive glands. They are **salivary glands** and **hepatopancreas**.

i. **Hepatopancreas**

It is somewhat triangular plate or cone which is spirally coiled. The gland is brownish to dirty green in colour and soft. Two ducts arise from two lobes of digestive gland and unite before reaching stomach by a common duct called **hepatic duct**. The hepatopancreas is formed of three kinds of cells namely secretory, resorptive and calcareous cells. The secretory cells secretes an enzyme which produce a proteolytic enzyme helps in digestion of cellulose pulp and the calcareous cell store phosphate of lime.

ii. **Salivary gland:**

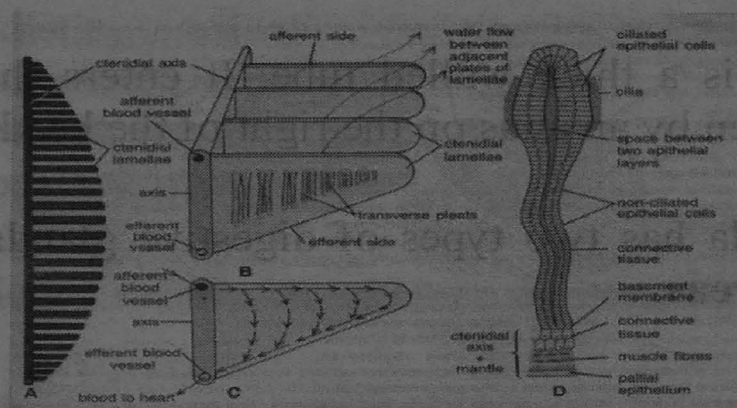
Pila has a pair of salivary glands on the sides of oesophageal pouches. From each gland arises a salivary duct which opens into the buccal cavity. The salivary secretion contains mucous and enzymes

RESPIRATORY SYSTEM

The respiratory organ consists of a single ctenidium or gill, a pulmonary sac or lung and a pair of nuchal lobes.

1. Ctenidium or gill

The ctenidium or gill is the organ of aquatic respiration. The ctenidium is situated on dorso-lateral wall of branchial chamber of the mantle cavity. It is composed of long series of thin triangular leaflets or **lamellae** lying parallel to each other. It has an axis called **ctenidial axis** provided with an afferent blood vessel and efferent blood vessel. All the gill lamellae are not same size, largest in the middle and gradually smaller towards the end such a gill is called **monopectinate gill**. Each lamella bears **pleats** or **ridges** on both anterior and posterior surface gradually decreasing in size from base of lamella to its apex. Each lamella has a smaller right side receiving blood from afferent vessel called **afferent side** and a longer left side from which blood goes to efferent vessel called **efferent side**.



2. Pulmonary sac or lung

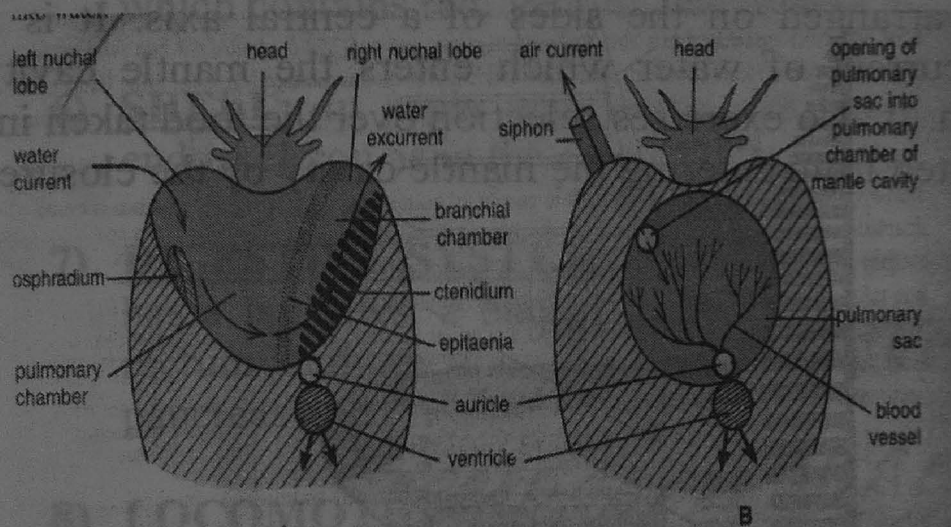
The pulmonary sac or lung is a closed cavity like a bag which hangs from dorsal wall of mantle. The dorsal wall of this sac is densely pigmented while ventral wall is creamy white. The wall of the sac is richly supplied with blood vessels. The pulmonary sac communicates with the pulmonary chamber or branchial cavity by an aperture known as **pneumostome**.

3. Nuchal lobes:

The right and left pseudopodia or nuchal lobes are fleshy and highly contractile processes of mantle present on either side of the head. They form elongated funnels or siphons during respiration for the entry or exit of water.

Mechanism of aquatic respiration

There are two types of respiration in *Pila* which are as follows



Check your progress

1. Name the two types of respiration in *pila*.
2. What are nuchal lobes?
3. What is ctenidium?

i. Aquatic respiration:

True aquatic respiration takes place when the snail lies at the bottom of a pond or lying suspended in mid-water. At this time the head and foot is fully extended and the two nuchal lobes increase in size. The left lobe takes the form of a distinct gutter in which a current of water flows. In aquatic respiration a current of water enters the left lobe, comes in contact with the osphradium which tests the nature of the water. It enters the mantle cavity and passes over the epitaenia into the branchial chamber to bathe the ctenidium, then the current passes out through the right nuchal lobe. The ctenidium takes in oxygen from the current of water and gives out carbon dioxide which diffuses into water.

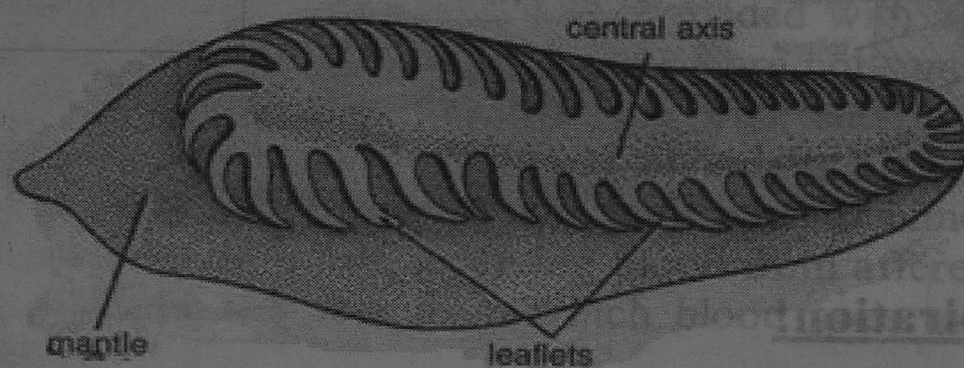
ii. Aerial respiration:

The pulmonary sac or lung is used in aerial respiration in two ways. When the snail comes to the surface of water its left nuchal lobe projects as a tube above the water and air is drawn into it, the air goes to the pulmonary chamber and then into the lung. The branchial chamber being shut off by the epitaenia pressing against the mantle. When the snail comes on land it takes in air directly into its lung through the mantle cavity and no siphon is formed by the left nuchal lobe. In both type of aerial respiration and relaxations walls, When the muscles contract the floor of the lung gets arched increasing its cavity and air is drawn into the lung, when the muscles relax the cavity of the lung decreases and air is expelled. The blood vessels in the lung take in oxygen from the air and give out carbon dioxide.

SENSE ORGAN OSPHRADIUM

Osphradium hangs from the mantle near the left pseudopodium. It is oval with 22 to 28 fleshy leaflets arranged on the sides of a central axis. It is a chemoreceptor and tests the current of water which enters the mantle cavity through the left pseudopodium. It also exercises selection over the food taken in.

The foul water is prevented from entering the mantle cavity by the closure of the left nuchal lobe.



CEPHALOPODS AS AN ADVANCED MOLLUSCS

Among Mollusca, cephalopoda form a highly specialized and advanced group. They possess certain characters which are similar to those of chordates. The advanced characters of cephalopods are following.



Fig : sepia



Fig: Octopus

1) **MORPHOLOGY:** Cephalopods have look of vertebrates.

2) **HEAD:** The head is large, globular and bears two large eyes, tentacles, a mouth and a funnel.

3) **EYES:** The head bears two large eyes like vertebrates; their eyes possess an orbit, a sclerotic coat, a retina, the rods, a cornea, a lens, an iris, a ciliary body, the aqueous humour, the vitreous humour.

- 4) **FINS:** Like the fishes, cephalopods have fins.
- 5) **COLOUR-CHANGE:** The skins of cephalopods have chromatophores which contains red, yellow, and orange pigments.
- 6) **SHELL:** In sepia and loligo, the shell is internal. It forms a sort of endoskeleton as in the case of vertebrates.
- 7) **DIGESTIVE SYSTEM:** The digestive system is well developed and it has a lip, jaws, a buccal cavity, an esophagus, a stomach, an intestine, a rectum and an anus like vertebrates. They have salivary glands, the pancreas and the liver.
- 8) **LOCOMOTION:** Sepia and Loligo can swim with the help of their fins.
- 9) **INK GLANDS:** Sepia have ink gland, when attacked by an enemy, it liberates the ink into the water producing a smoke-screen from the spot by jet propulsion.
- 10) **NERVOUS SYSTEM:** Nervous system of cephalopods has a well developed brain like vertebrates.
- 11) **CIRCULATORY SYSTEM:** Cephalopods possess a closed type circulatory system and arteries and veins are circulatory by capillaries. They have two types of hearts, namely an arterial heart and a venous heart.
- 12) **EXCRETION:** The excretion is carried out by the kidney and the excretory product is in the form of guanine.
- 13) **REPRODUCTION:** The sexes are separate and exhibit clear sexual dimorphism.
- 14) **COPULATION:** Copulation in cephalopods is a specialized type. The male has a hectocotylized arm. This arm is inserted into his mantle cavity and deposits them in the funnel of the female for safety.
- 15) **DEVELOPMENT:** Fertilization is internal. The fertilized egg is enclosed in a capsule and the eggs are made into bunches and are attached to seaweeds.

The eggs hatch into the young ones resembling the adults. Hence the development is direct as in the case of vertebrates.

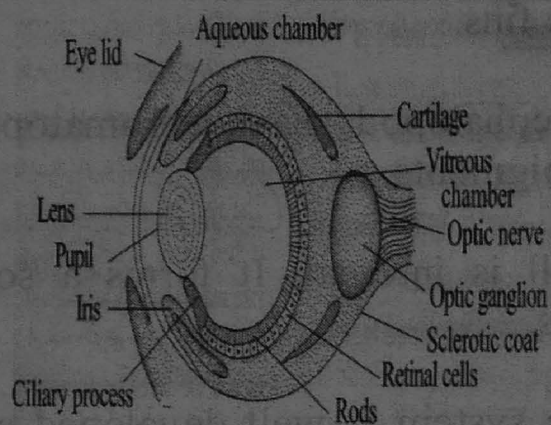


Fig : Eye of septia

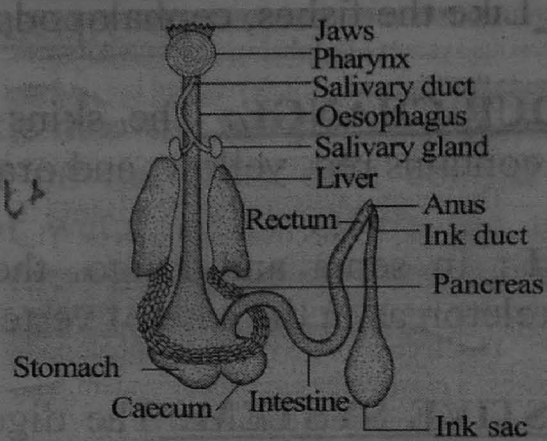


Fig : digestive system of sepia

KEYWORDS

Whorl - each of the turns or convolutions in the shell

Dextra - whorls rising to the right and coiling in an anticlockwise direction

Coiled - a length of something wound in a joined sequence of concentric rings

Snout - the projecting nose and mouth of an animal, especially a mammal

Palp - elongated segmented appendages near the mouth

Tentacle - a slender, flexible limb around the mouth bearing sense organs

Mantle - a fold of skin enclosing the viscera

Visceral - the internal organs in the main cavities of the body, especially those in the abdomen

Groove - a long, narrow cut or depression

Cavity - an empty space

Cartilage - firm, flexible connective tissue

Protractor muscles - a muscle serving to extend a part of the body

Retractor muscles - a muscle serving to contract a part of the body

Pouch - a small flexible bag

Gland - an organ in the animal body which secretes particular chemical substances

Aquatic - animal growing or living in or near water

Questions and Excerices

Part – A

1. Which type of respiration occurs in pila?
2. Classify pila.

Part – B

1. What is monopectinate gill?
2. What is radula? What is the function of radula?
3. Draw labelled diagram to show the organs of pallial complex
4. Write short notes on Osphradium

Part – C

1. Describe external features of pila globosa
2. Describe the digestive system of pila globosa
3. Give an account of the respiratory organs and mode of respiration of pila globosa.
4. Cephalopods are advanced moluscs-discuss.

3) Spines:

The entire aboral surface is covered with numerous short, blunt, spinous processes called spines. On the oral surface, in the centre of the central disc is an apertural opening called the mouth. It is pentagonal aperture with five angles, each directed towards an arm. It is surrounded by a soft membrane called the peristome which is guarded by five groups of oral spines or mouth papillae.

Between the ossicles are numerous small pores. From each dermal pore projects out a very small, club-shaped, branched, filamentous projection called the dermal branch. From each angle of the mouth radiates a narrow groove called the ambulacral groove which runs all along the middle of oral surface of each arm.

5) Pedicellariae:

Entire aboral surface is covered by many small, pincer-like structures called pedicellariae. Each ambulacral groove contains four rows of tube feet or podia. The tube feet are soft, thin walled, tubular, retractile structures provided with terminal discs or suckers.

Check your progress

1. What is pila?
2. What is bivalve?
3. What is gastropod?
4. Define pedicellariae.
5. What is the function of suckers?

ECHINODERMATA

SYSTEMATIC POSITION:

Phylum – Echinodermata.
Subphylum – Eleutherozoa .
Class – Asteroidea.
Order – Forcipulate.
Genus - Asterias .

EXTERNAL FEATURES:

SHAPE, SIZE AND COLOUR:

Asterias has a radially symmetrical and pentamerous body. The body consists of a central, pentagonal central disc from which radiate out five elongated, tapering, symmetrical spaced projections, the rays or arms.

The color varies, having shades of yellow, orange, brown and purple. The body has two surfaces, the upper convex and much darker side is called the aboral or abactinal surface.

The lower surface is flat; less pigmented and is called the oral or actinal surface. The axes occupied by the arms are known as radii the regions of the central disc between the arms are inter-radii. A well defined head is entirely absent.

ORAL SURFACE:

The side of the body, which flat remains towards the substratum and contains the mouth or oral opening colour is called oral or actinal surface.

1) Mouth:

On the oral surface, in the centre of the central disc is an aperture. It is a pentagonal aperture with five angles, each directed towards an arm. It is surrounded by a soft membrane called the peristome membrane or peristome which is guarded by five groups of oral spines or mouth papillae.

2) Ambulacral grooves:

From each angle of the mouth radiates a narrow groove called the ambulacral groove which runs all along the middle of oral surface of each arm.

3) Tube feet or podia:

Each ambulacral groove contains four rows of tube feet or podia. The tube feet are soft, thin walled, tubular, retractile structures provided with terminal discs or suckers.

4) Ambulacral spines:

Each ambulacral groove is bordered and guarded laterally by 2 or 3 rows of movable calcareous ambulacral spines, which are capable of closing over the groove.

5) Sense organs:

Sense organs included five unpaired terminal tentacles and five unpaired eye spots.

ABORAL SURFACE:

The side of the body which remains directed upward or towards the upper surface is convex and called aboral surface.

The aboral surface bears following structures:

1) Anus:

A minute circular aperture, called the anus, is situated close to the center of the central disc of aboral surface.

2) Madreporite:

At the aboral surface of the central disc occurs a flat, sub-circular, asymmetrical and grooved plate called between the bases of two of the five arms. The two arms having madreporite between their bases are collectively referred to as a bivium and the other three arms as a trivium.

3) Spines:

The entire aboral surface is covered with numerous short, stout, blunt, calcareous spines or tubercles.

4) Papulae or gills:

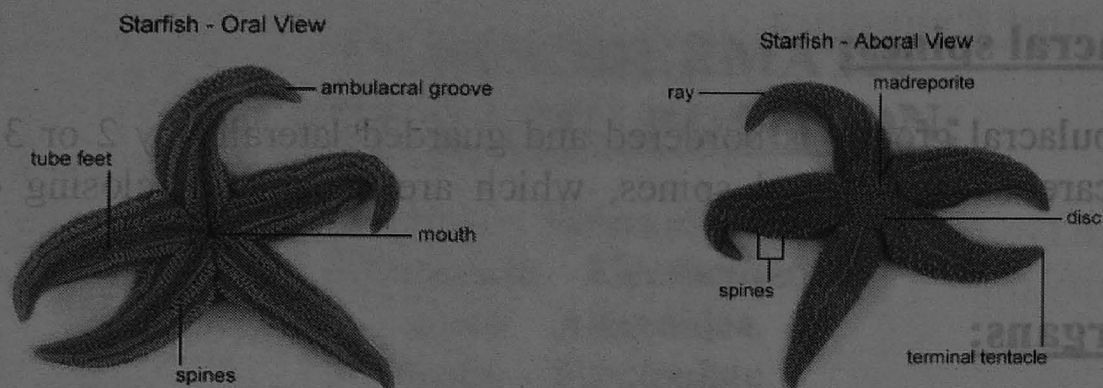
Between the ossicles of integument are present a large number of minute dermal pores. From each dermal pore projects out a very small, delicate, tubular membranous projection called the dermal branchina or gill or papilla.

5) Pedicellariae:

Entire aboral surface is covered by many whitish modified spine-like tiny pincers or jaws called pedicellariae. Pedicellariae having three calcareous pieces and a stalk are called forcipulated pendunculate pedicellariae.

Check your progress

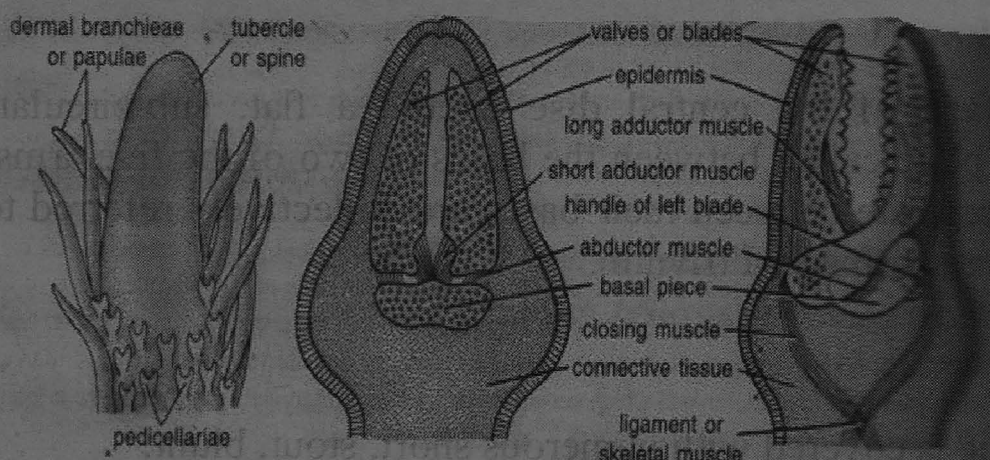
1. What is papulae?
2. what is bivium.
3. what is Ambulacral grooves?
4. Define pedicellariae.
5. What is the role of adductor muscles?



PEDICELLARIAE: Entire aboral surface is covered by many whitish modified spine-like tiny pincers or jaws called pedicellariae. Pedicellariae having three calcareous pieces and a stalk are called forcipulated pendunculate pedicellariae.

- i. Straight type
- ii. Crossed type

Straight type pedunculate pedicellariae: These types of pedicellariae are simple. Two jaws are straight and attached basally to the basal piece. When closed they remain parallel meet throughout their length. The two jaws work like the blades of a forceps with the help of three pairs of muscles namely **adductor muscles** for closing the jaws and pair of **abductor muscles** for opening them.



Crossed type pedunculate pedicellariae:

In this type of pedicellariae, the basal ends of the two jaws cross each other. The jaws are also operated by two pairs of **adductor muscles** and pair of **abductor muscles**. It helps to keep clean body surface from debris and organisms like sponges and coelenterates setting on the body.

Other types:

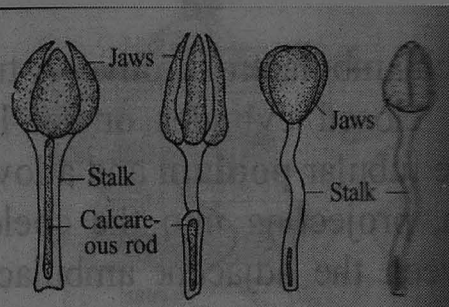
Gemmiform pedicellariae:

The blades of this type are long, tapering and curved. There is a pair of poison glands used to paralyze the prey organisms

Tridentate pedicellariae: The blades of this type are long and triangular with few teeth and capture small organisms.

Utrifoliate pedicellariae: They have leaf-like blades without teeth used for cleaning the body surface.

Ophiocephalous type: It has broad blades with small teeth used to seize the larger prey.



Water vascular (ambulacral) system: The water vascular system is a modified part of coelom. It consists of a system of seawater filled canals having corpuscles. It plays most vital role in the locomotion of the animal and comprises madreporite, stone canal, ring canal, radical canal, Tiedemann's feet.

Madreporite: The madreporite is a rounded calcareous plate occurring on the aboral surface of the central disc in inter-radial position. Its surface bears a number of radiating, **narrows**, straight or wavy grooves or **furrows**. Each furrow contains many minute pores at its bottom which leads into a very short, fine, tubular **pore canal**. There may be about 200 pores and pore-canals. The pore-canals unite to form the **collecting canals** which open into an ampulla

Stone canal: The ampulla opens into a S-shaped **stone canal**. The stone canal extends (orally) and opens into a ring canal, around the mouth. The wall of stone canal are supported by series of calcareous ring. In young asterias, the stone canal remains a simple tube but in adult lumen of stone canal has prominent **ridge** with two spirally rolled **lamella**. During its course, the stone canal is ensheathed by a wide, thin-walled tubular coelomic sac, called **axial sinus**.

Ring canal: The ring canal or water ring is located to the inner side of the peristomial ring of ossicles directly above to the hyponeural ring sinus. It is wide and pentagonal or five sided.

Tiedemann's bodies. : The ring canal gives out inter-radially nine small, yellowish rounded glandular bodies called **Tiedemann's bodies**.

Check your progress

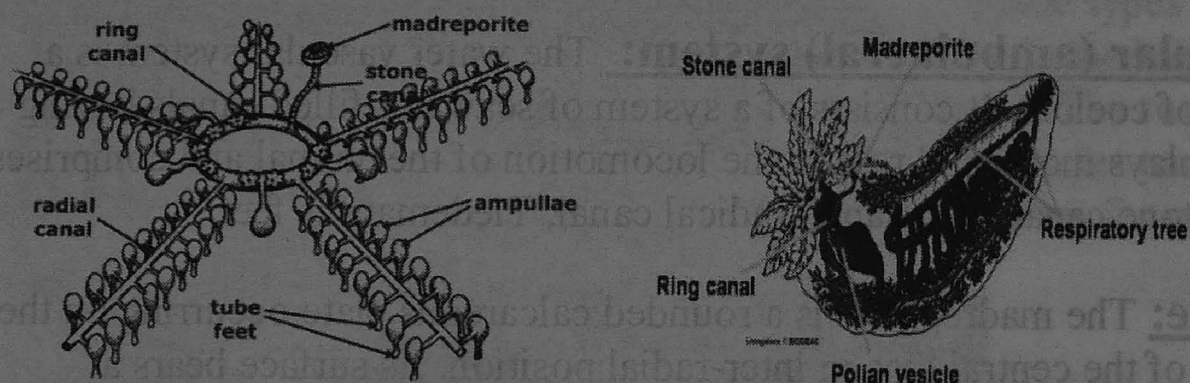
1. The ampulla opens into a S-shaped _____
2. What are lateral or podial canals ?
3. What is Tiedemann's bodies?
4. What is the another name of ponial canals?

Polian vesicles: The ring canal gives off on its inner side in the inter-radial position. One, two or four, little, pear-shaped, thin-walled, contractile bladders or reservoirs with long necks called **polian vesicles**.

Radial canal : From its outer surface the ring canal gives off a radial water canal into each arm.

Lateral canals. : In each arm, the radial canal gives out two series of short, narrow, transverse branches called **lateral** or **podial canals**.

Tube feet : There are four rows of tube feet in each ambulacral groove. A tube foot or podium is a hollow, elastic, thin-walled, closed cylinder or sac-like structure having an upper sac-like **ampulla**, a middle tubular **podium** and a lower disc-like **sucker**. The ampulla lies within the arm, projecting into the coelom above the **ambulacral pore** which is a gap between the adjacent ambulacral ossicles for the passage of the podium.



LARVAL FORMS OF ECHINODERMATES:

In echinoderms, the development may be direct or indirect. Direct development is living in Arctic and Antarctic waters. In

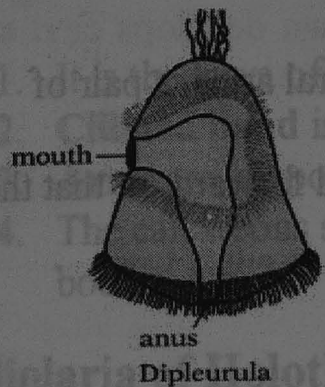
- 1) Dipleurula larva
- 2) Bipinnaria larva
- 3) Brachiolaria larva
- 4) Ophiopluteus
- 5) Echinopluteus
- 6) Auricularia larva
- 7) Doliolaria of holothuroides(pupa)
- 8) Doliolaria of crinoidea
- 9) Pentacrinoid larva.

DIPLEURULA LARVA

This larva develops from the gastrula.

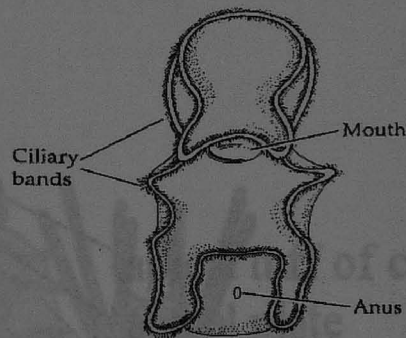
Salient features:

- 1) Dipleurula is the fundamental larva of all echinoderms.
- 2) It is microscopic.



- 3) It has a gut formed of the mouth, the oesophagus, the intestine, the stomach and the anus.
- 4) It has two ciliary bands, namely a perioral band around the mouth and an adoral band inside the mouth.
- 5) It feeds on diatoms and the dipleurula develops into the bipinnaria larva.

BIPINNARIA LARVA:



- 1) It is minute and microscopic and swims freely on the surface of the water.
- 2) It has a straight alimentary canal with a mouth at the anterior end and an anus at the posterior end.
- 3) The body has a number of outgrowths called arms. The arms are covered by ciliated bands which used for locomotion. It has two unpaired arms and 5 pairs of paired arms.

BRACHIOLARIA LARVA:

1. It is the third larva of starfish.
2. The bipinnaria larva, after a short free swimming life, is transformed into the brachiolaria larva.

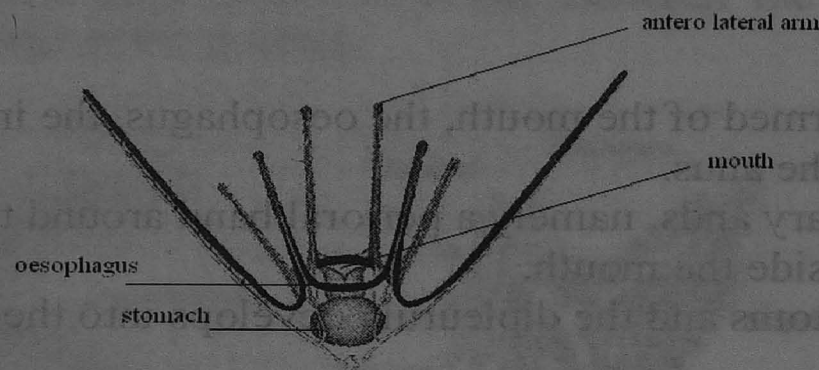
Check your points

1. Name the different larval forms of echinoderms.
2. What are the salient features of bipinnaria larva

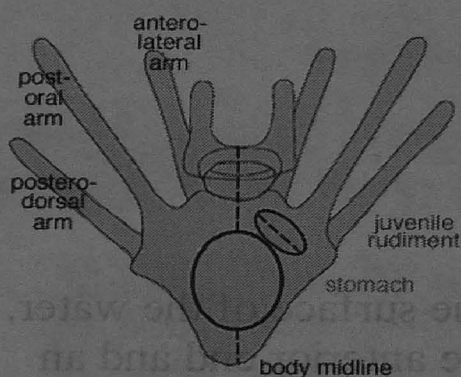
3. The preoral region of this larva has three processes called brachiolar arms.
4. Arms are tipped with suckers
5. It swims and feed like a bipinnaria.

OPHIOPLUTEUS:

- 1) It is the larva of ophiuroidea.
- 2) The preoral lobe is small.
- 3) The ciliated band is single
- 4) The larva has a pair of pre oral arms , a pair of post oral arms, a pair of postero dorsal arms and a pair of postero lateral arms.
- 5) The postero lateral arms are always longer and directed forward, so that the larva appears like a "V".

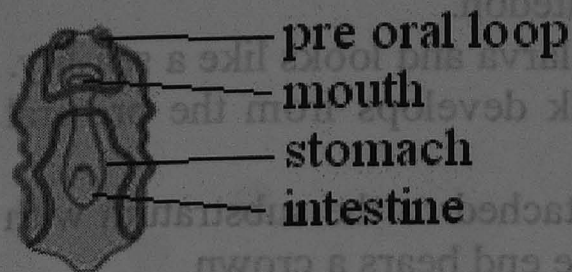


ECHINOPLUTEUS:



- 1) It is the larva of echinoidea.
- 2) it has a small pre-oral lobe and a single ciliary band.
- 3) The larva is provided with a pair of preoral arms, and a pair of post oral arms, a pair of antero lateral arms, a pair of antero dorsal arms.
- 4) The postero lateral arms are very short directed backwards.

Auricularia larva



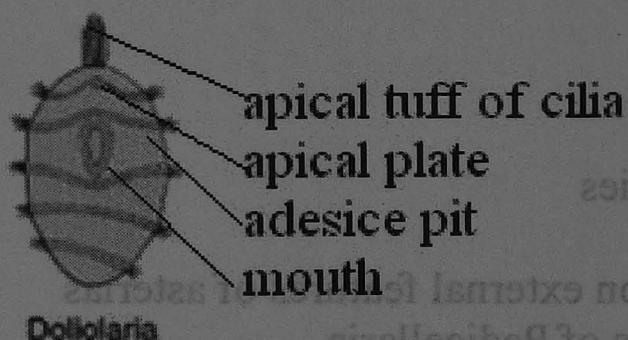
Auricularia

1. It is the larva of **holothuroidea** which has a well developed **pre-oral**.
2. **Ciliated band** is single.
3. **Arms** are supported not by calcareous rods
4. The calcareous structures are in the form of wheels, spheres, star-shaped bodies, etc.

Doliolaria of Holothuroidea (Pupa)

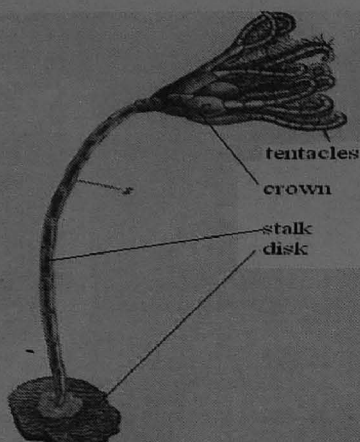
1. In Holothuroidea (sea – cucumber), the auricularia larva develops into doliolaria larva.
2. It is a free-swimming larva called pupa and It is **barrel-shaped**.
3. The calcareous skeleton is in the form of spheres and the ciliated bands are broken into pieces.
4. Metamorphosis begins during free swimming life. After metamorphosis, the larva sinks into the bottom to become the adult.

Doliolaria of Crinoidea



Doliolaria

1. It is the larva of antedon.
2. It is a free – swimming larva and bilaterally symmetrical.
3. It is barrel shaped and has four or five ciliary bands.
4. At the anterior end the ectoderm thickens to form an apical plate which bears a tuft of cilia called **apical sensory tuft**.
5. An **adhesive pit** is present between the first and second ciliary bands is used for attachment.
6. A mouth is located between the second and third ciliary bands.



Pentacrinoid larva

1. It is the second larva of antedon.
2. It develops from Doliolaria larva and looks like a sea-lily.
3. It has a stalk and the stalk develops from the pre-oral lobe of Doliolaria.
4. One end of the stalk is attached to the substratum with the help of a disc and the free end bears a crown.
5. The crown consists of a central mouth surrounded with the help of a circle of tentacles and the crown develops cirri and breaks off from the stalk as a free living antedon.

Keywords:

Arm - a flexible limb of an invertebrate animal

Autotomy - the casting off of a part of the body

Disc - the central part of the body

Groove - a long, narrow cut or depression

Spines - hard, pointed defensive projection

Water vascular system - a network of water vessels in the body, the tube feet being operated by hydraulic pressure within the vessels

Ridge - a narrow raised band on a surface

Vesicles - a small fluid-filled bladder or sac

Pore - a minute opening in a surface

Larva - an immature form of other animals

Question and exercises:

Part A

1. Tube feet
2. Madreporite
3. Pedicellaria
4. Tiedemann's bodies

Part - B

1. Give an account on external features of asterias
2. Describe the types of Pedicellaria

Part - C

1. Describe the Water vascular (ambulacral) system in asterias
2. Write an essay on the larval forms of echinoderms

Reference books

1. INVERTEBRATE ZOOLOGY by E.L.JORDAN and Dr.P.S.VERMA
2. A TEXT BOOK OF INVERTEBRATES by N.C. NAIR, S.LEELAVATHY, N.SOUNDARAPANDIAN, T.MURUGAN, N.ARUMUGAM

MADURAI KAMARAJ UNIVERSITY

(University with Potential for Excellence)

DIRECTORATE OF DISTANCE EDUCATION

Palkalai Nagar, Madurai - 625 021 India

Ph : 0452-2458471 (30 Lines) Fax : 0452-2458265

E-mail	: mkudde@mkudde.org
General grievances	: mkuddegrievance@gmail.com
UG Courses	: mkuddeug@gmail.com
PG Course	: mkuddepg@gmail.com
MBA Course	: mkuddembag@gmail.com
MCA Course	: mkuddemcag@gmail.com
Education Courses	: mkuddeedu@gmail.com
Website	: www.mkudde.org
IVRS	: 0452 - 2459990
	: 0452 - 2459596

Student Support Service : 0452 - 2458418

DDE - Examinations

Fax No. : 0452 - 2458261

E-mail : mkuace@yahoo.com

Examn., Grievance Redress Cell: 0452-2458471-Extn.515