Pila

Helix

Limax

Dentalium

Mytilus

Octopus

Unio

Chiton

Molluscans

Phylum Mollusca

- Mollusks are well defined as soft bodied animals
- Their name comes from the Latin word ***molluscus*** meaning soft.

Most mollusks are composed

of 4 basic parts:

foot - flat surface adapted for locomotion and usually contains the mouth and other feeding structures

mantle - covers most of the body and secretes the shell

shell - composed of calcium carbonate

visceral mass - contains the internal organ

General Characteristics

- Molluscs live in marine, freshwater, and terrestrial habitats.
- Body bilaterally symmetrical; unsegmented; often with a definitive head.
- Possess a muscular foot
- Possess a specialized tissue – Mantle
- Secretes the shell aids in Respiration, reproduction etc.

General Characteristics cont.

- Visceral mass contains all major organ systems
- Complex digestive system; rasping organ (radula)
- Open circulatory system
- Respiratory pigment is hemocyanin

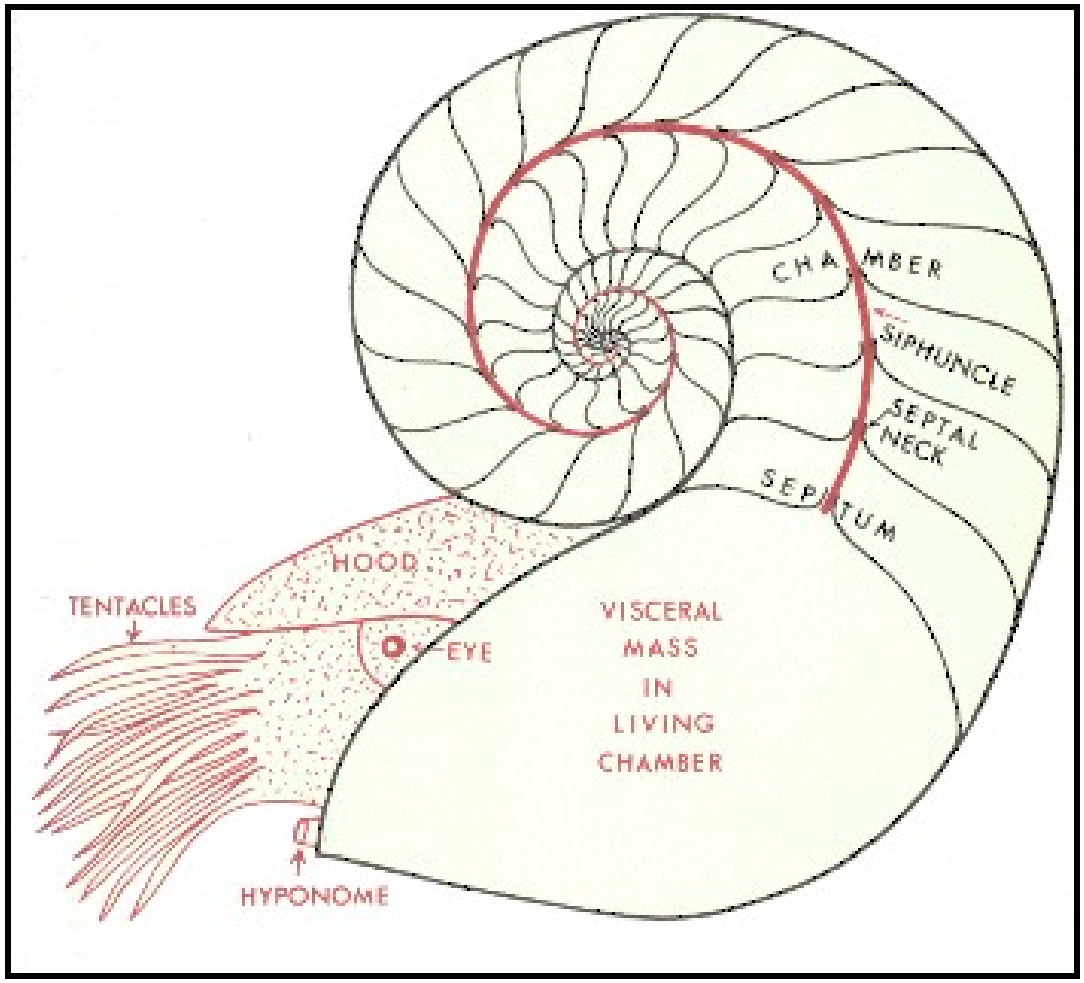
- Nervous system consists of paired ganglia
- Well developed sense organs (eyes in cepahlopods)
- Sexes are separate – larval stages in some (Veliger, Glochidium)

Classes of Mollusca

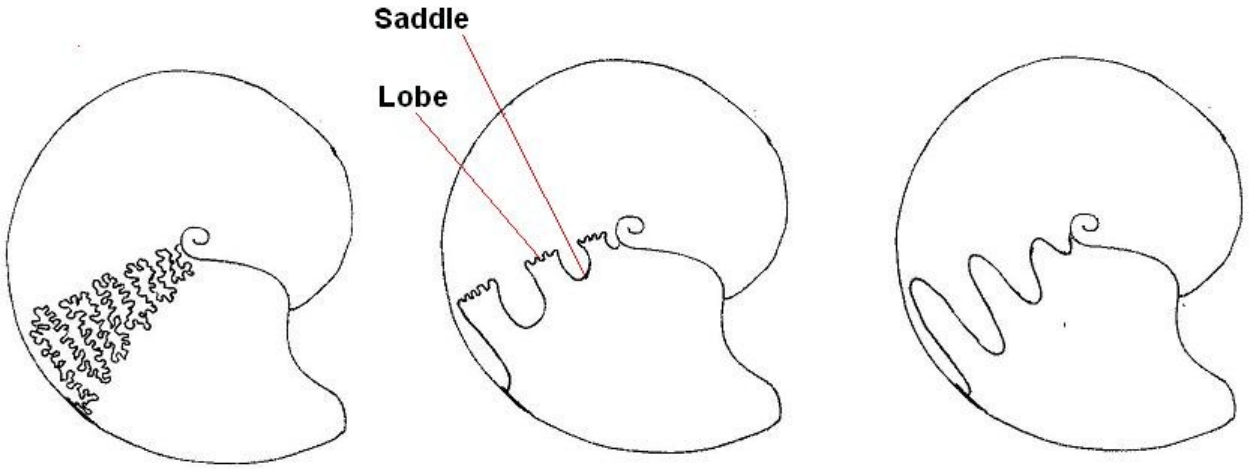
- Class Pelecepoda or Bivalvia (Clams, oysters)
- Class Gastropoda (snails, slugs)
- Class Cephalopoda (Squid, octopus)
- Class Polyplacophora (Chitons)
- Class Scaphopoda (Tusk shells)

Cephalopoda; (Cephalon=Head, +Poda=Foot)

- They are exclusively marine animals which started their life in Cambrian.
- Well known present day forms include cuttle fish, the squids and Nautilus while the extints type are Belemnite, Ammonites and Goniatites.
- Well developed head is present
- Univalve shells


CHAMBER
SIPHUNCLE
SEPTAL NECK
SEPTUM
HOOD
TENTACLES
EYE
VISCERAL MASS IN LIVING CHAMBER
HYPONOME

Comparison of Suture Lines



Ammonite

Ceriatite

Goniatite

Morphology

- The shell is conical and tube like structure
- Its pointed closed end is posterior and open end is anterior
- Animal grows from protoconch end to aperture end
- The Ventral surface is marked by the Hyponomic Sinus and the surface opposite to that is dorsal
- Apicad: It is the direction from a given point to Apex
- Discad: It is the direction from a given point to periphery.
- Centrad: It is the direction from a given point to center of the shell.
- The shell may be straight (Belemnite), curved (cyrtoceras) or coiled (Gonoatite)
- In most of the form coiling is in horizontal plane. i.e discoidal

Morphology

- But vertical coiling also present
- In spiral or coiled form the whorls are separate or just touching each other.
- The gap between two whorls are known as whorl gap
- The interior of the shell is divided into number of chambers by means thin transverse portion termed as septa.
- All the chambers size increase from protoconch to anterior end of the shell.
- Animal occupy the last chamber of the shell is called body chamber.
- Except body chamber all other chambers are filled with air to maintain the balance of the shell. Therefore it is called air chamber.

Morphology

- All the air chambers are traversed by a slender cord like siphuncle passing either through the centre of the shell or margin of the speta.
- The portion of the septa where siphuncle passes through septa is produced to form the septa neck.
- The septa neck may project towards the aperture (Prosiphonate)or it may project towards the protoconch (Retrosiphonate)
- The portion where the septum meets the external surface of the shell is termed as suture line.
- The suture is made up of ridges and depressions
- The ridges towards the aperture side is known as saddle and depression is known as lobes.

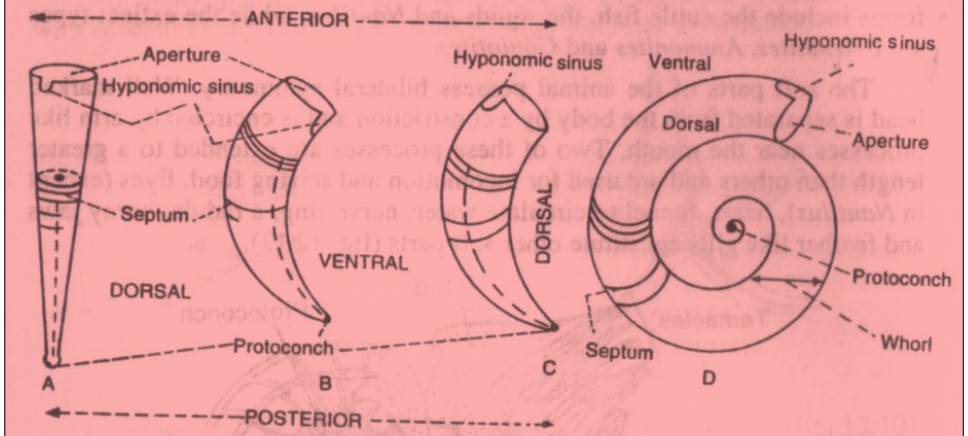


Fig. 12.13. Types of cephalopod shells.

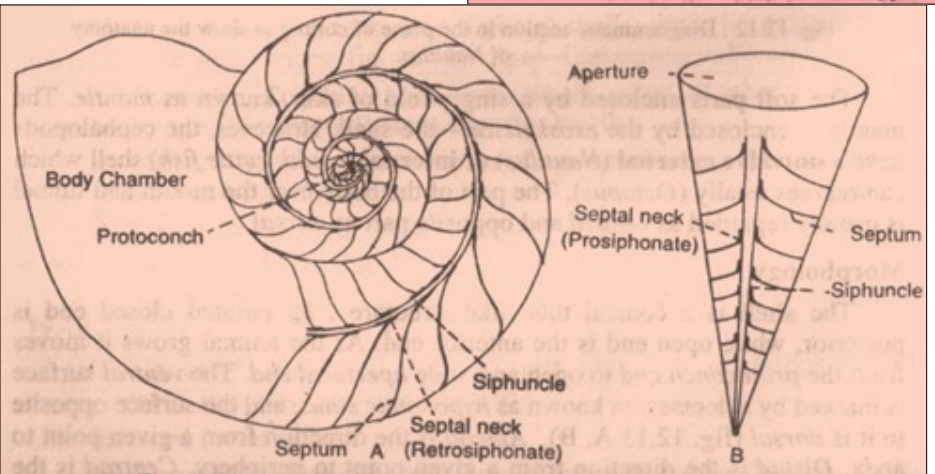


Fig. 12.14. Showing internal morphology of cephalopod shell — A ; Retrosiphonate and B; Prosiphonate conditions.

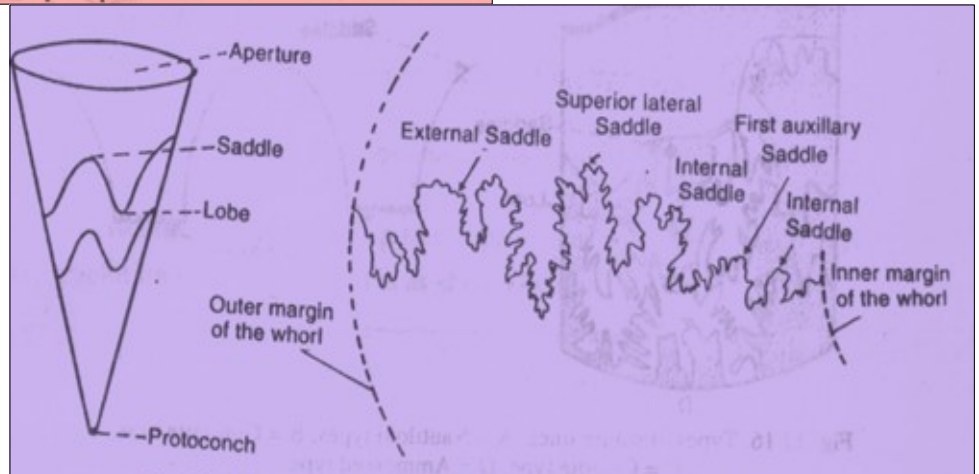


Fig. 12.15. Simple and complex suture lines in cephalopod shells.

Morphology

- Suture lines may be of four types
- 1. Simple straight or slightly undulating suture line is known as Orthoceratite or Nautiloid type. Orthoceras, Nautilus
- 2. Suture line with rounded saddle and angular lobes is known as Goniatite type. Goniatite
- 3. Suture line with rounded saddle and finely divided lobes is known as Ceratite type. Ceratite
- Suture line with highly divided saddle and lobs giving flower appearance is known as Ammonoid type. Phylloceras

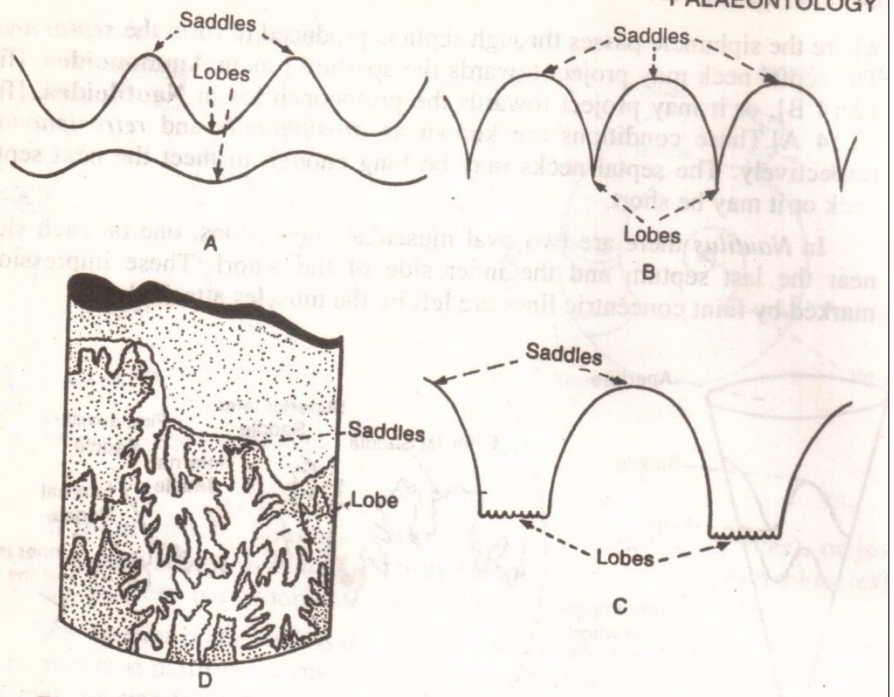


Fig. 12.16. Types of suture lines. A = Nautiloid types, B = Goniatite type, C = Ceratite type, D = Ammonoid type.

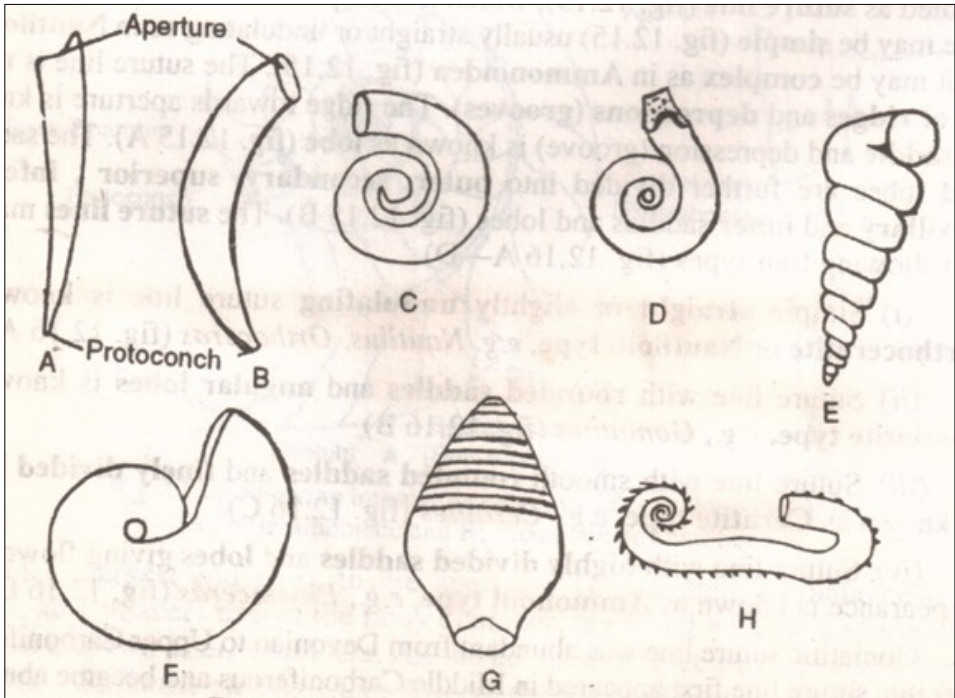


Fig. 12.17. Shapes of cephalopod shells.

Shape of the Shells

- **Orthoceracone** – Shell is straight- e.g Orthoceras
- **Cyrtoceracone** – Shell is slightly curved – e.g Cytroceras
- **Gyroceracone** – Shell is loosely coiled – e.g Gyroceras
- **Tarphyceracone** – Shells shows complete coiling and the whorls arew in contact with each other/ e.g Tarphyceras
- **Lituiticone and Baulticone** shells exhibits partly coiled nature
- **Bervicone**- Shell exhibits cap like structure – e.g Berviceras

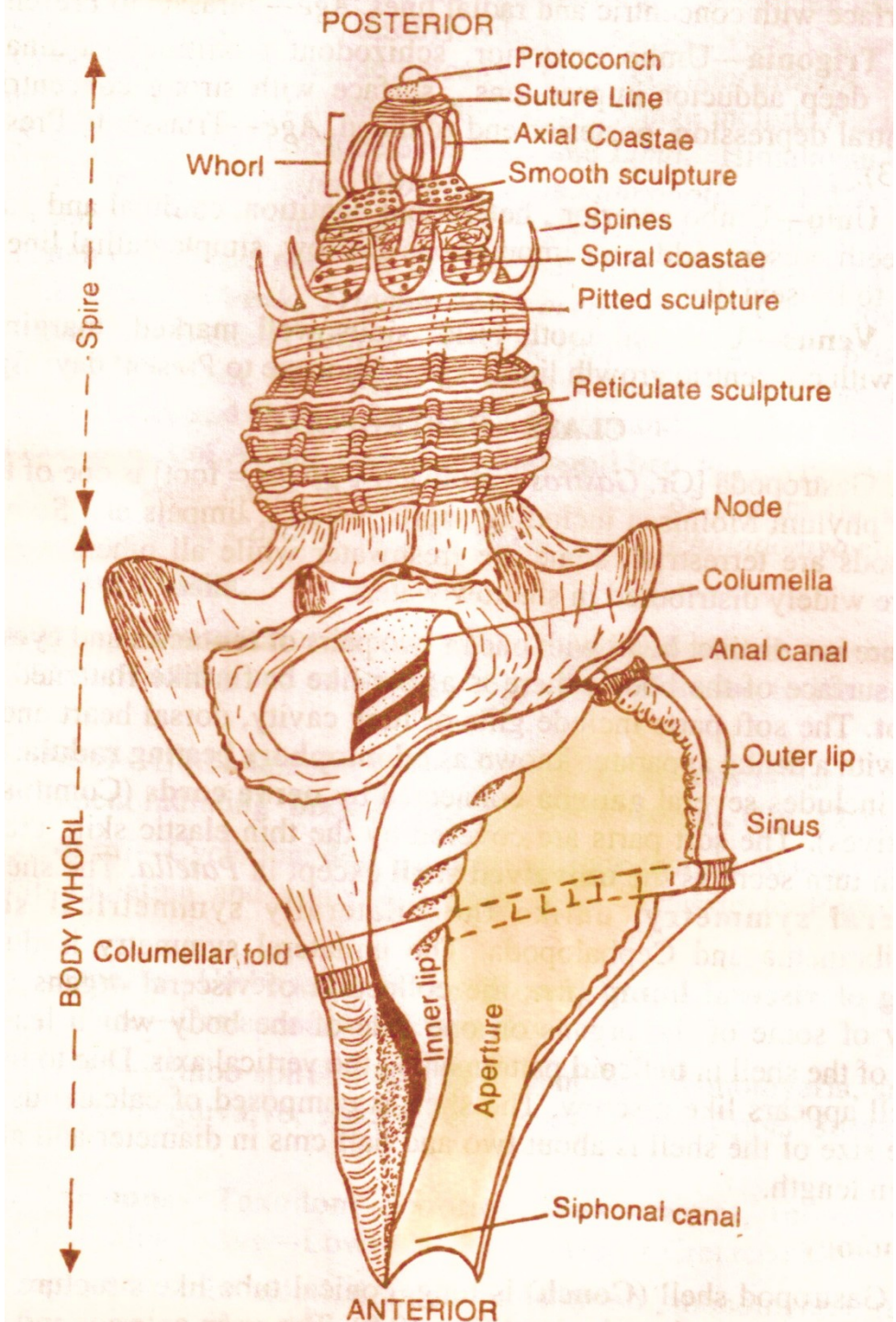
Class – Gastropoda

Gastro=Stomach+Podos=Foot

General Characteristics

- Body usually asymmetrical with a coiled shell (torsion)
- Some species lack shell and are not coiled
- **Head well-developed with pairs of eyes and tentacles.**
- **Radula present**
- Mantle modified into a lung or gill
- Foot large and flat

Gastropoda Morphology



- Gastropods found in terrestrial, freshwater and marine water.
- The shell has unilateral symmetry

Morphology

- It is long, conical and tube like structure
- Closed at one (Apex side) end and open at other end.
- The open anterior side is known as Aperture and the closed posterior end is known as Protoconch.
- The tube is coiled spirally into screw like structure and each coil is termed as Whorl.

- All the whorls except the last whorl constitute the Spire.
- The last whorl in which the animal lives is known as body whorl
- The whorls are separated by a slight depression which is known as Suture
- The coiling is mostly clock wise or Dextral and because of this aperture comes to the right hand side of the observer. E.g. Murex, conus
- In few cases like Physa, the coiling is anticlockwise or Sinistral giving rise to left sided aperture
- The sides of the spire converge towards each other near protoconch
- The angle between two sides of the spire is called spiral angle

- Ornamental elements of gastropods are Needles, spines, nodes, axial coastae, spiral coastae, pitted sculpture and smooth sculpture.
- Aperture of the shell may be covered by a plate known as **operculam**. Eg. Littorina
- The margin of the aperture is known as peristome. The outer part of the peristome is known as outer lip which is very simple and inner part of the peristome is known as inner lip.

- Inner part of the whorls collesce and form a central pillar like axis extending from apex to the base of the shell is called columella.
- Gastropods have different forms of shell which is based on spiral angle, number and shape of the whorl, size of the last whorl and whether it conceals the earlier whorls or not.

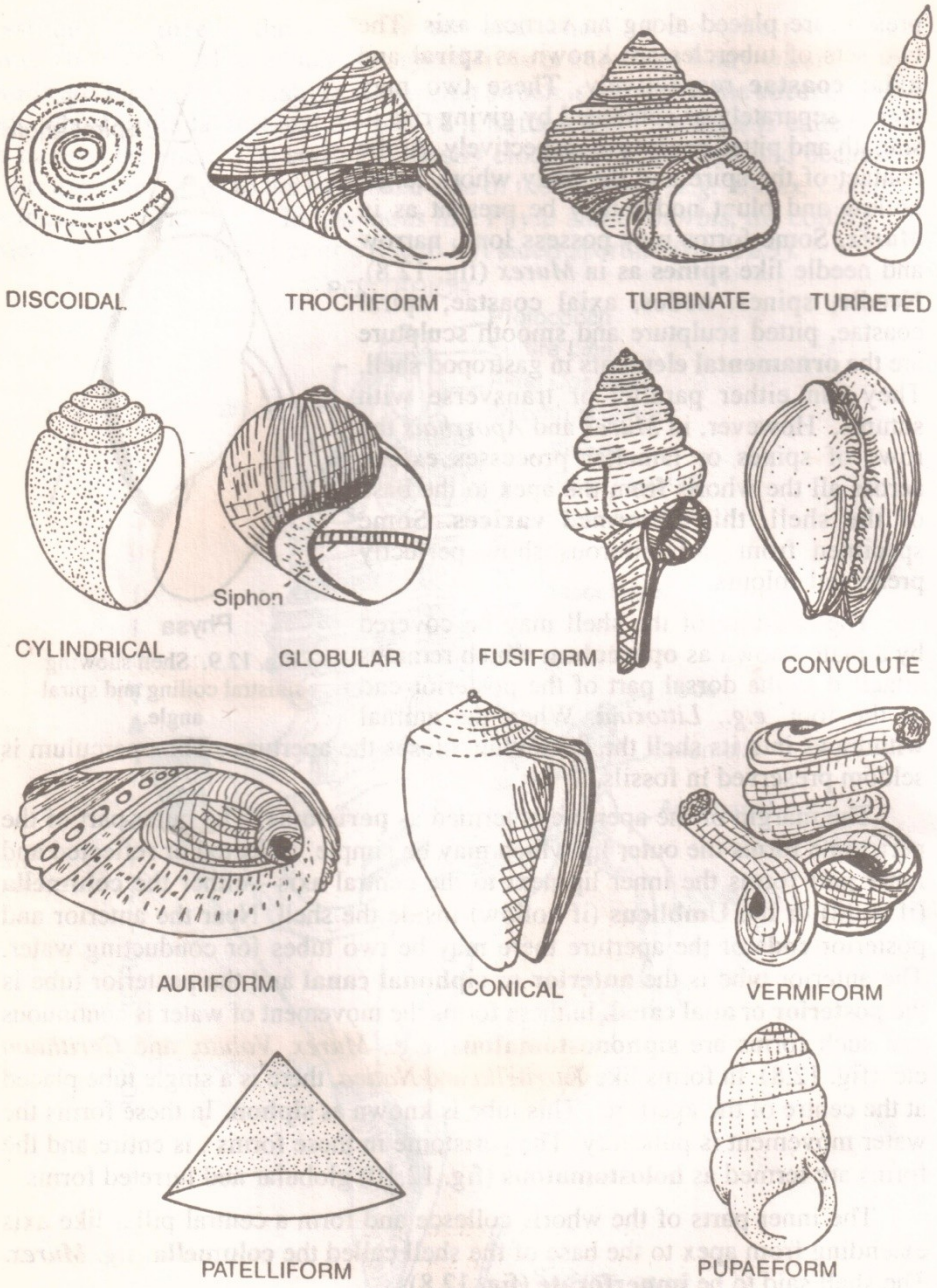
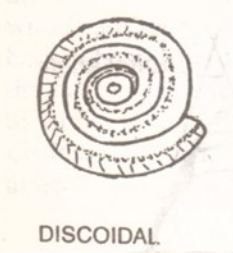
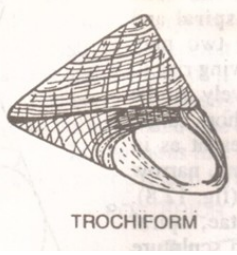
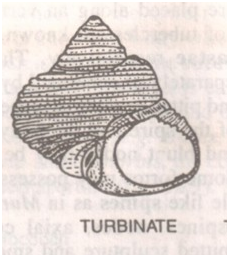


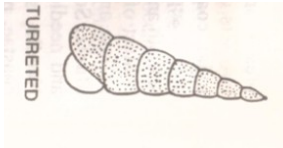
Fig. 12.10. Shapes of gastropod shells.

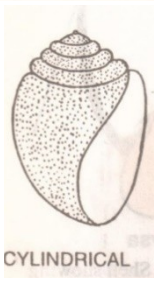
- Discoidal: The shell is planispirally coiled. The whorls are in one plane so that the entire arrangements can be seen.
- Trochiform: The spire is sharp and acute. The whorls in the spire increases in diameter gradually. The body whorls is small and the base of the shell is flat.
- Torbinate: Similar to Trochiform except the base which is convex.
- Turreted: The spire is long with numerous whorls. Apex is acute and sharp. The body whorl is very small.
- Cylindrical: After increase im the diameter of the spire, it remains constant or it may reduce near the base.
- Globular: The spire is very small and sharp. The body whorl is large and round with rounded aperture.



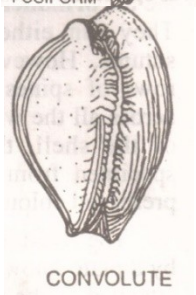


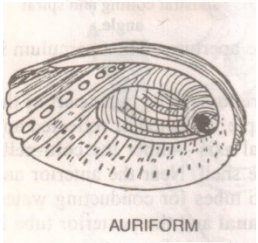


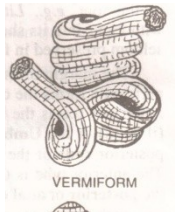


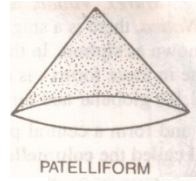


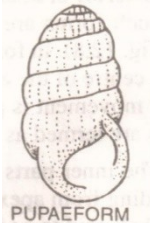
- Fusiform: The shell is spindle shaped. The body whorl is thick in the middle and tapering near the bottom and apex.
- Convolute: The last whorl of the shell covers all the previous whorls. The aperture, with crenulated outer lips is as long as shell.
- Auriform: The shell has very short spire and the aperture is very large.
- Conical: The spire is short. Apex is sharp, the body whorl is large and conical with parallel lips.
- Vermiform: The shell is warm like and twisted
- Patelliform: The apex is sharp and cap like shell
- Pupaeform: The apex is convex and rounded. All whorls are uniform in size and aperture is rounded.











Evolutionary Trend in Gastropod

EVOLUTIONARY TRENDS IN GASTROPODES

- The evolutionary trends in Gastropoda are both progressive and retrogressive.
- Uncoiled simple cap shaped shale started developing helicoids coiling; planispiral coiling was restricted to pelagic forms while helicoid coiling observed in benthonic forms.

PROGRESSIVE ADAPTATION DUE TO MODE OF LIFE IN GASTROPODA INCLUDE-

- 1. increase in tightness of coiling.
- 2. increase in evolution of the apex with respect to the last whorls,
- 3. development of discoidal shell,
- 4. increase in the size of the whorls,
- 5. development of trochiform and biconical shells,
- 6. development of fusiform shells,
- 7. modification around the aperture,
- 8. development of loss of ornamentation and
- 9. loss of operculum.

SOME IMPORTANT FOSSILS-

Clip slide

- **Dextral forms-**

1. ***Trochus***-Trochiform Shell, smooth spire, sharp apex.

Age-Triassic to present day.

Clip slide

2. ***Turbo***- Turbinate shell. Age-Jurassic to present day.

Clip slide

3. ***Turitella***-long, turreted shell, long spire, sharp apex, small body whorl. Age-cretaceous to present day.

Clip slide

5. ***Natica***- shell globular, small and sharp spire, large body whorl, round aperture umbllicus present. Age- Trias to present day.

6.**Cyprea**-convolute shell, outer whorl covers all other w
lips crenulated. Age-Eocene to present day.

Clip slide

Clip slide

7. ***Conus***-conical shell, short flat spire, long body whorl, lips parallel. Age-Upper cretaceous to present day.

Clip slide

8. ***Voluta***- short spire, cylindrical shell, long aperture. Age- Eocene to present day.

Clip slide

9.***Murex***- Shell with nodes, spine, large whorls, long aperture.
Age- Eocene to present day.

- **Sinistral forms-**

1. Plaorbis- discoidal shell.

Age – Jurassic to present day.

Clip slide

Clip slide

2.Physa- short spire, globular body whorl, helicoid coiling.
Age-Intertrappeans.

Geological Distribution

- Cambrian to Present day
- Oldest fossil is known as Scenella, Helicionella and Pelagiellia
- Appearance of 9 families in Ordovician, 8 in Silurian, 2 in Devonian, 1 in carboniferous and 3 in Permian took place.
- In Triassic period no gastropods were fully developed.
- Tertiary period was marked by abundance of opisthobranchia and non marine pulmonata.
- Heteropoda was common Miocene forms

Class - Bivalvia

- Bivalvia, in previous centuries referred to as the Lamellibranchiata and Pelecypoda.
- It is a class of marine and freshwater molluscs that have laterally compressed bodies enclosed by a shell consisting of two hinged parts.
- Bivalves have no head (Acephala), and they also lack a radula.

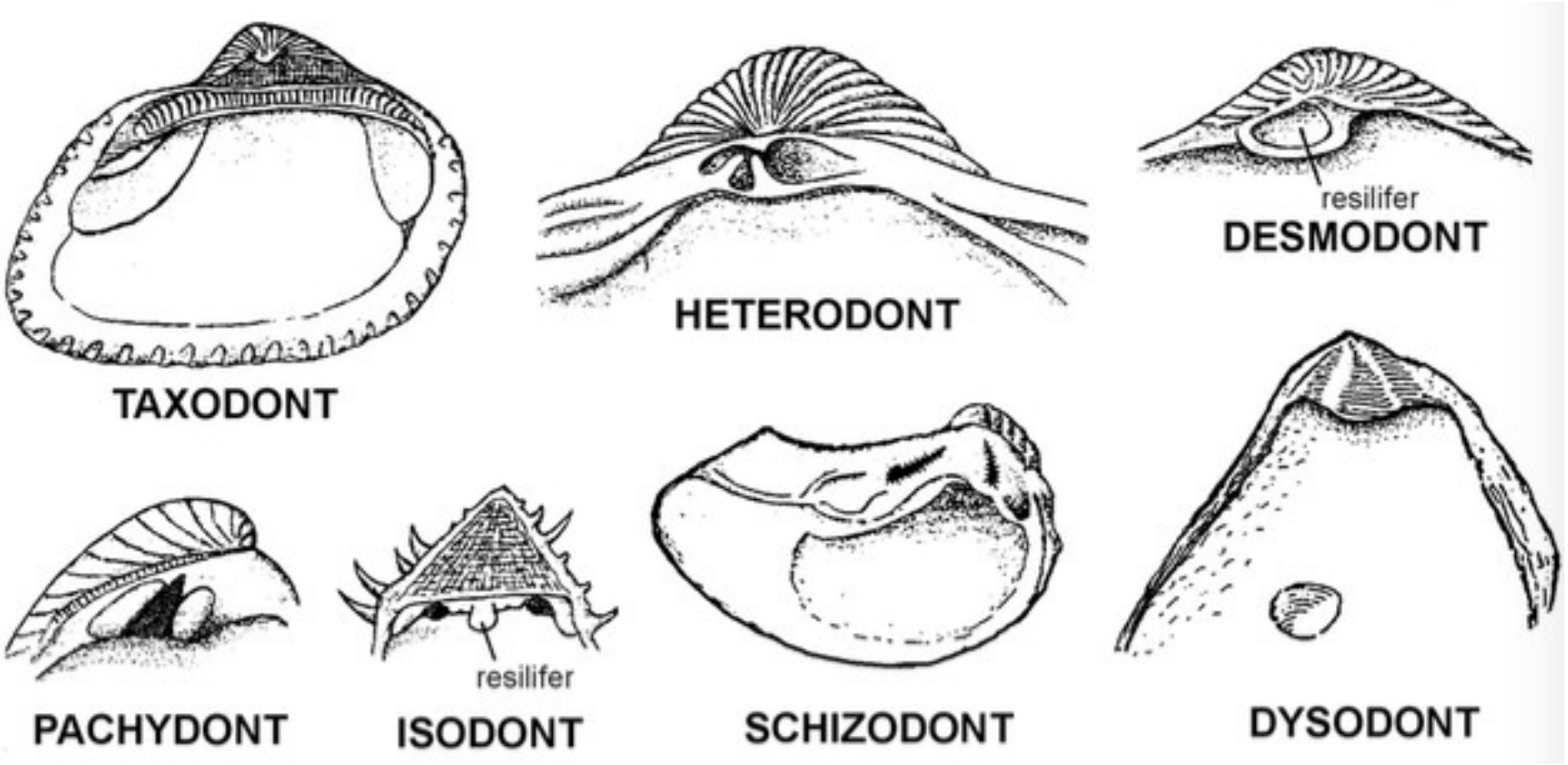
Clams, Mussels, Oysters, etc

- The shell of a bivalve is composed of calcium carbonate, and consists of two, usually similar, parts called valves.
- The margin near the hinge is called Dorsal and Opposite where the valve are open is called Ventral.
- Anterior which is located near the mouth, Posterior near the anus located.
- These are joined together along one edge (the hinge line) by a flexible ligament that, usually in conjunction with interlocking "teeth" on each of the valves, forms the hinge.

- The margin near the hinge is Dorsal and the opposite where the valve is open is called Ventral.
- The two valves are equal or inequal in size and each valve is generally inequilateral. But the genera Glycimeris has nearly equilateral. Ostrea is example for inequilateral valve.
- When the shell in inequilateral, the growth of the species direction is perpendicular to the hinge line.
- The apex of the genera is called umbo. These Umbones are sometime straight e.g Pectan, but generally curved towards anterior margin eg Trigonia, exogyra.

- In the interior of the valve various markings are noticed among which adductor is noticed in the form of round, oval and elongated shape in the Dimyaria.
- In monomyaria, it is in the centre of the valve.
- Adductor impressions are those produced by the muscles for the movement of foot
- Passing from one adductor impression to the other in each valve is linear depression caused by the attachment of the muscles of the mantle the shell and known as Pallial line

- This line passes evenly between the adductor impressions and parallel with the margin of valve.
- This type of line is called simple or entire. In some cases it bends inwards just before reaching the posterior adductor is called as Pallial Sinus.
- The Hinge is formed by the projections known as teeth, which alternate in the two halves, the teeth of one valve fitting to the depressions of other valve.
- The margin of the valve on which the teeth occurs in known as hinge line.
- It is generally curved but it is straight for Arca.


TAXODONT
HETERODONT
resilifer
DESMODONT
PACHYDONT
resilifer
ISODONT
SCHIZODONT
DYSODONT

Types of Hinge

Taxodant: The teeth are numerous and more or less similar in the form of size e.g Nucula.

Dysodant: They are developed from internal ribs at the margin of the valve. The hinge margin may be somewhat thickeened. Mylilus.

Isodant: There are two or three strong teeth of equal size which fit into the corresponding sockets in the other valves. E.g Spondulus

Schizodant: the teeth are few in number, thick and some time grooved e.g Trigonia

➢**Heterodont** The teeth are few in number and not all in uniform shape and size.

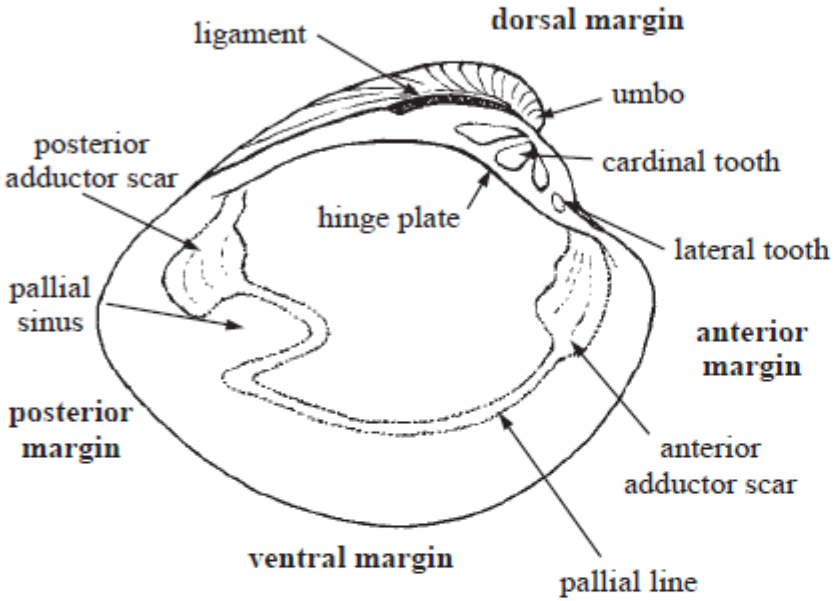
➢ The teeth which is immediately under the umbo is known as **cardinal teeth**. Others are known as **laterals**

➢**Desmodont:** True teeth and a hinge plate are absent or ridges are developed in the hinge margins, e.g Peluromya

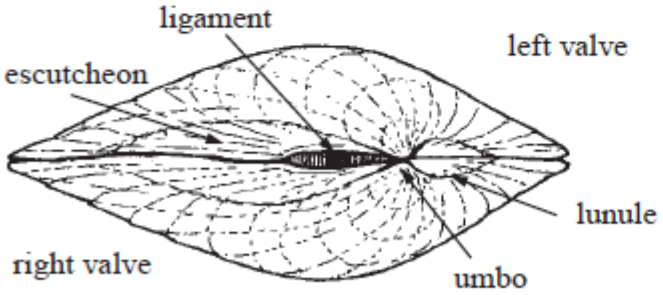
- The valves of lamellibranchs opened and closed by the help of ligament (muscles), internal and external ligaments.
- External ligaments placed in the hinge margin usually from posterior to umbo. It extends both front and back of the umbones
- Internal ligaments noticed with in the hinge plate so that when the valves are closed, it is compressed and relax by the animals order.

- The length of the lamellibranchs shell measured from the anterior to posterior margins. Width is measured from Umbo to Ventral margins. Thickness is from one valve to another at right angle to the lines of length and breadth

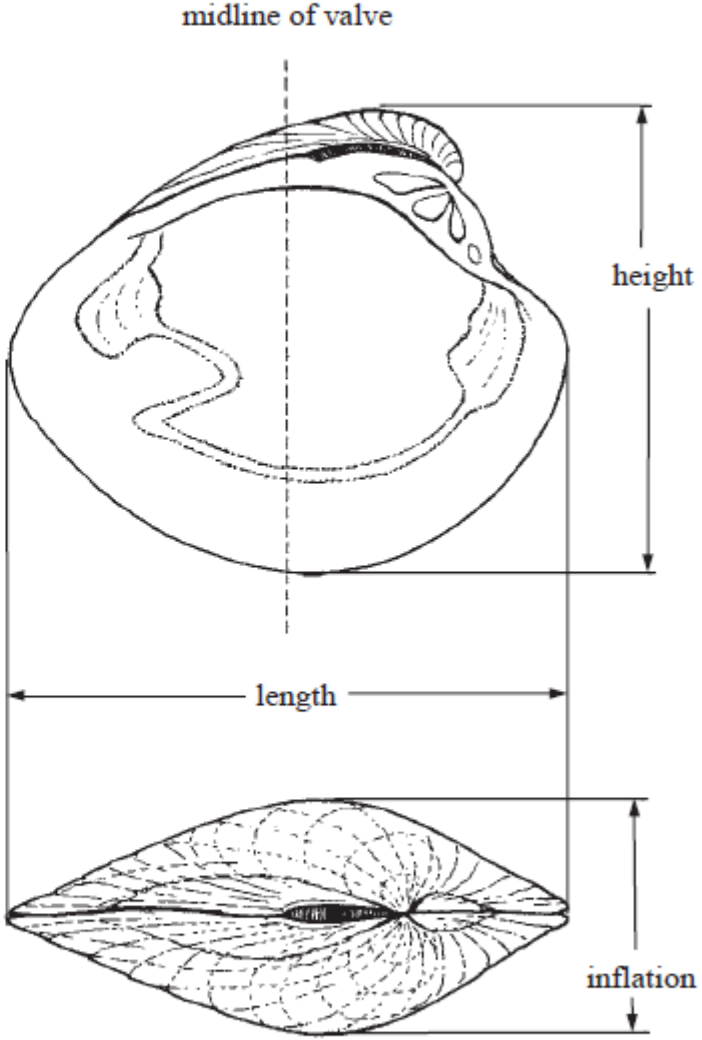
TECHNICAL TERMS AND MEASUREMENTS



interior of left valve



dorsal view of entire shell



The shell can be closed by means of adductor muscles which passes from interrior of one valve to another valve. In many genera there are two aductor which is called **Dimyariya**. **Monomyaria** posses only one aductor (Oyster)

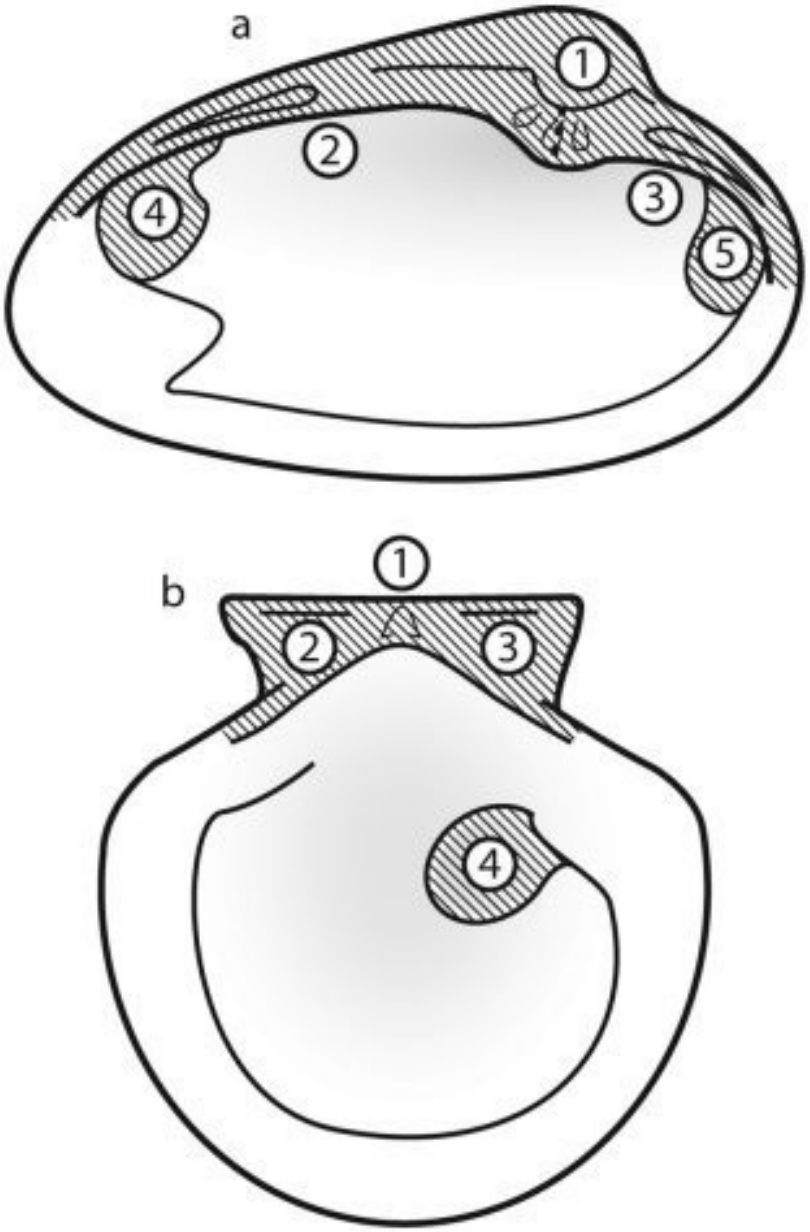
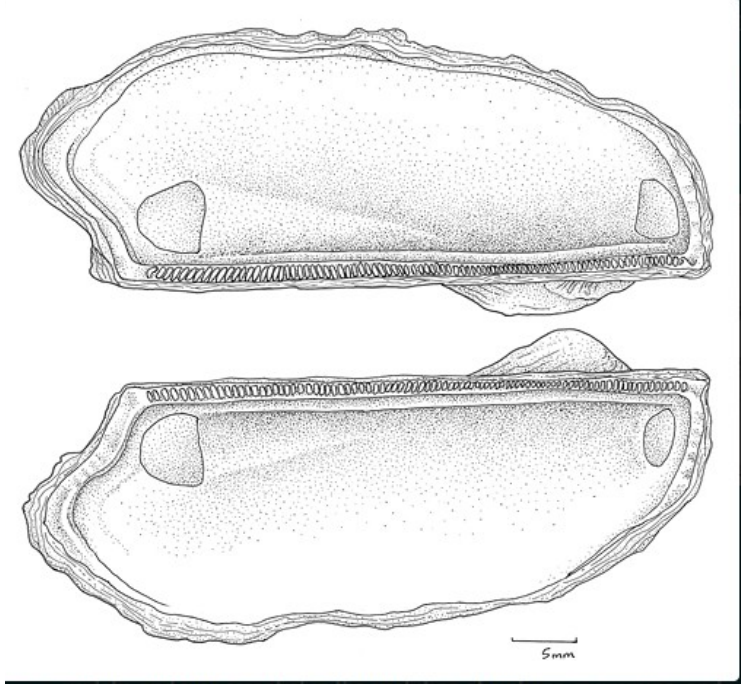
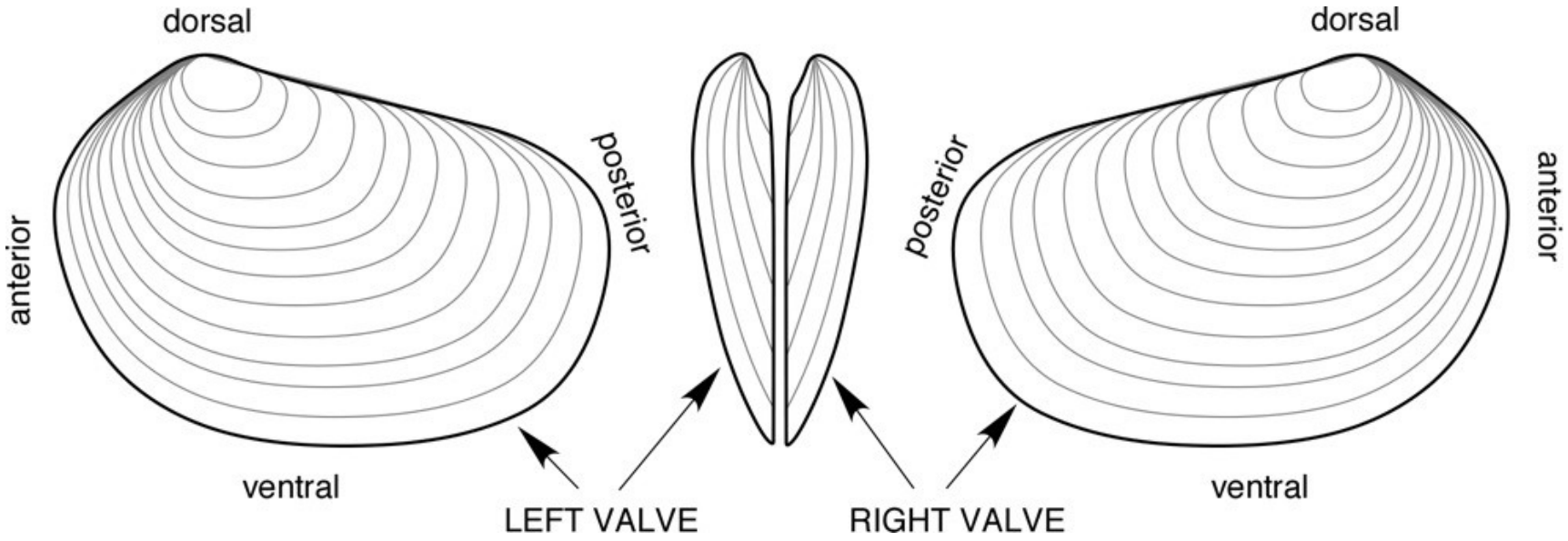


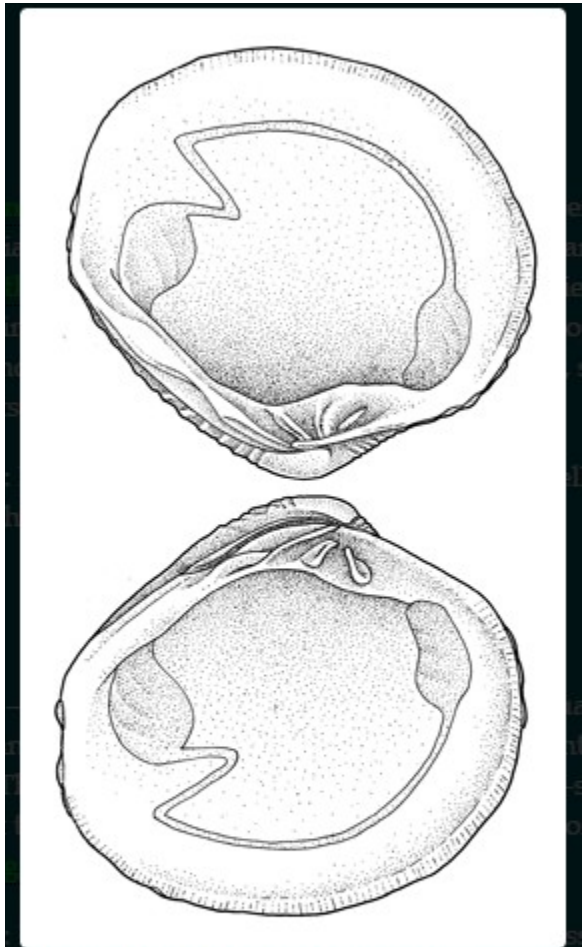
Fig. 8. Bivalve NRE (1 = umbo; 2 = posterior hinge; 3 = anterior hinge; 4 = posterior adductor muscle scar; 5 = anterior adductor muscle scar). Note the presence of only a single adductor muscle scar on the monomyarian shell valve of b.

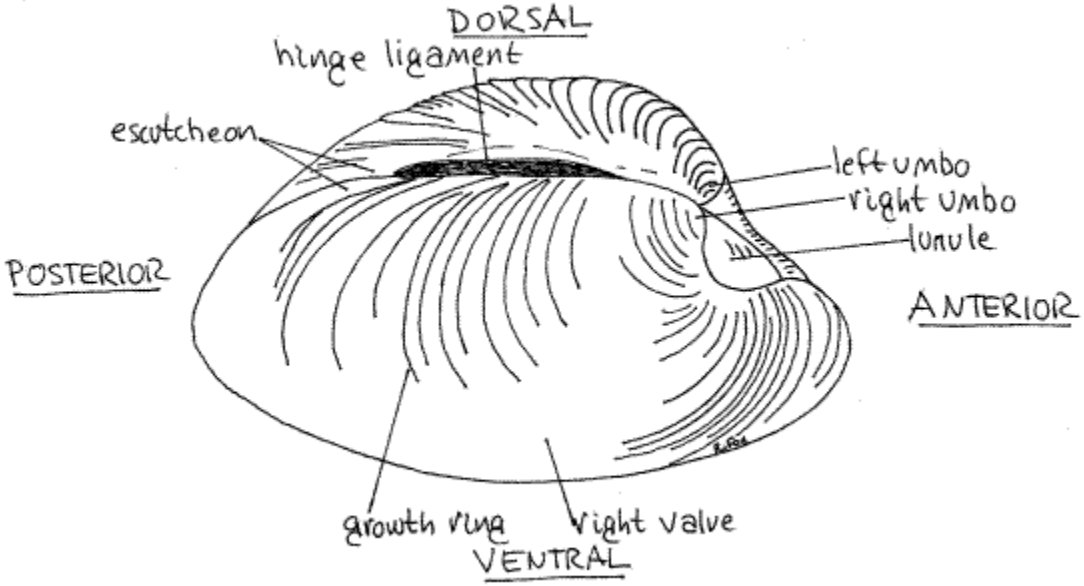
Different Types of Umbo noticed in the Bivalve.

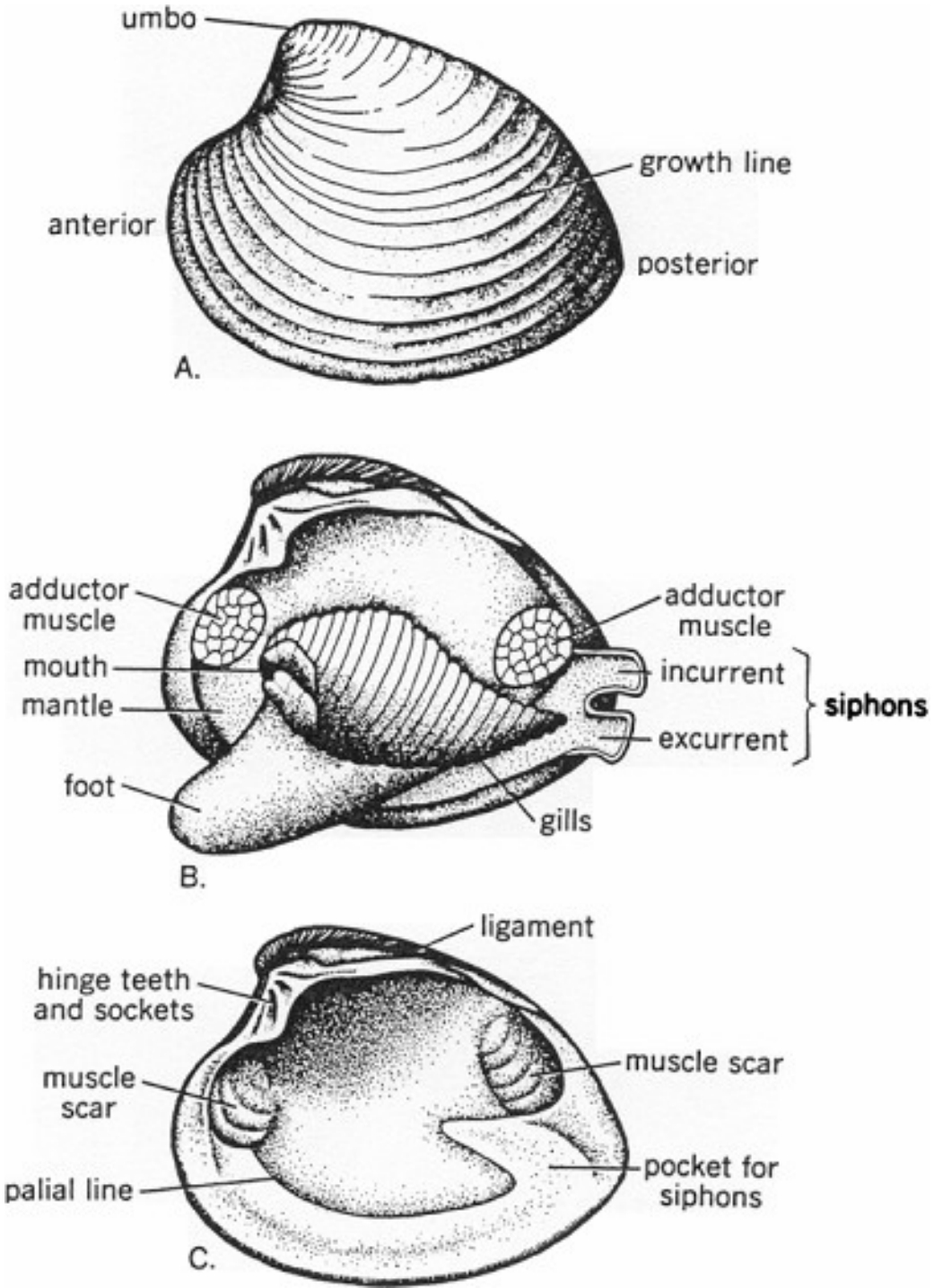
- Umbo pointing towards anterior side is called **Prosogyre or Prosocline**. Ex. Arca
- Umbo pointing towards Posterior side is called **Opisthogyre or Opisthocline**. Ex Trigonia
- Umbo pointing towards each other side is called **Orthogyre or Acline.** Ex Pectan
- Umbo curving towards the centre is called **Spiral** Ex. Exogyra


5mm

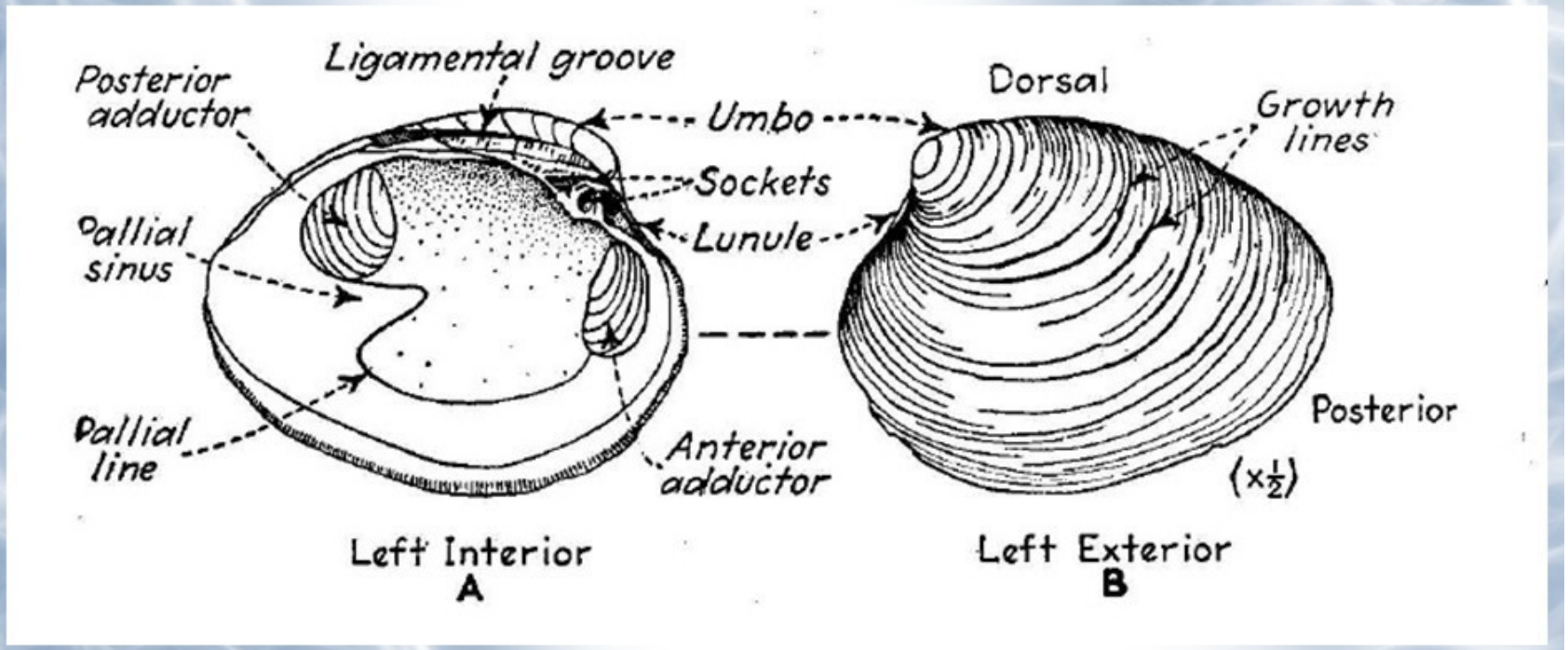

dorsal
anterior
posterior
ventral
LEFT VALVE
RIGHT VALVE
dorsal
posterior
anterior
ventral




DORSAL
hinge ligament
escutcheon
left umbo
right umbo
lunule
POSTERIOR
ANTERIOR
growth ring
right valve
VENTRAL


umbo
growth line
anterior
posterior
A.
adductor muscle
adductor muscle
mouth
incurrent
siphons
mantle
excurrent
foot
gills
B.
ligament
hinge teeth and sockets
muscle scar
muscle scar
palial line
pocket for siphons
C.

Morphology


Ligamental groove
Posterior adductor
Umbo
Dorsal
Growth lines
Sockets
Lunule
Pallial sinus
Pallial line
Anterior adductor
Posterior
(x½)
Left Interior
A
Left Exterior
B

Phyllum – Brachiopoda

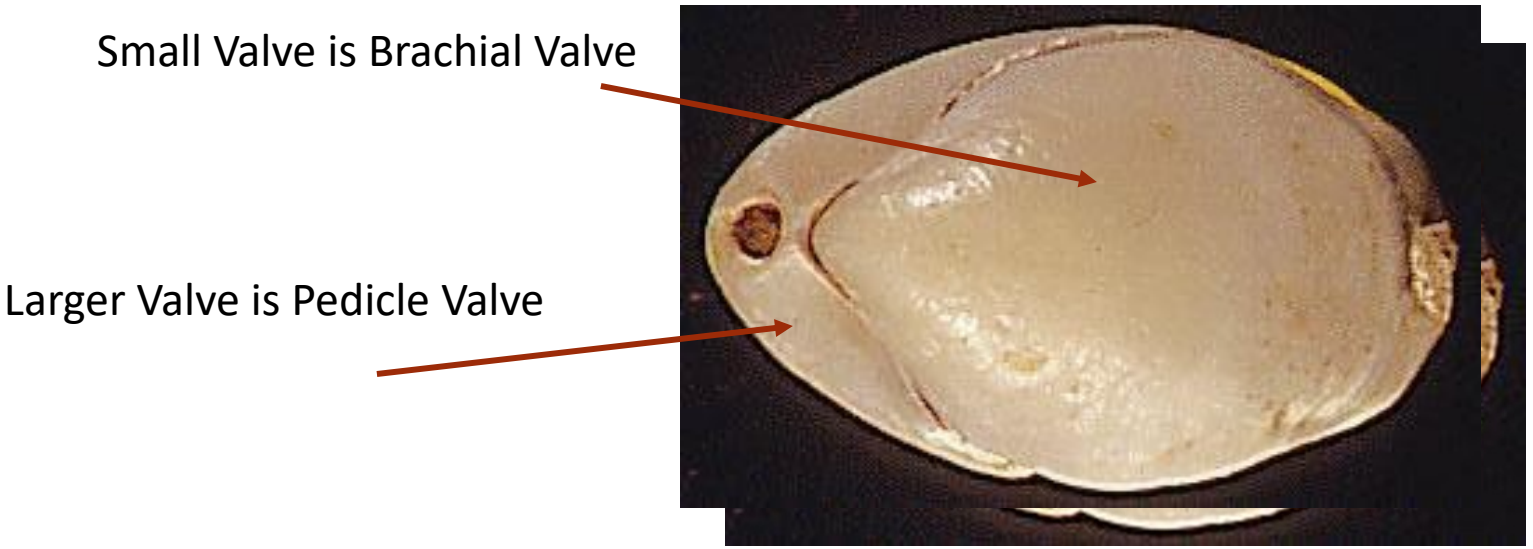
Brachion = Arm + Podos = Foot

General Characteristics

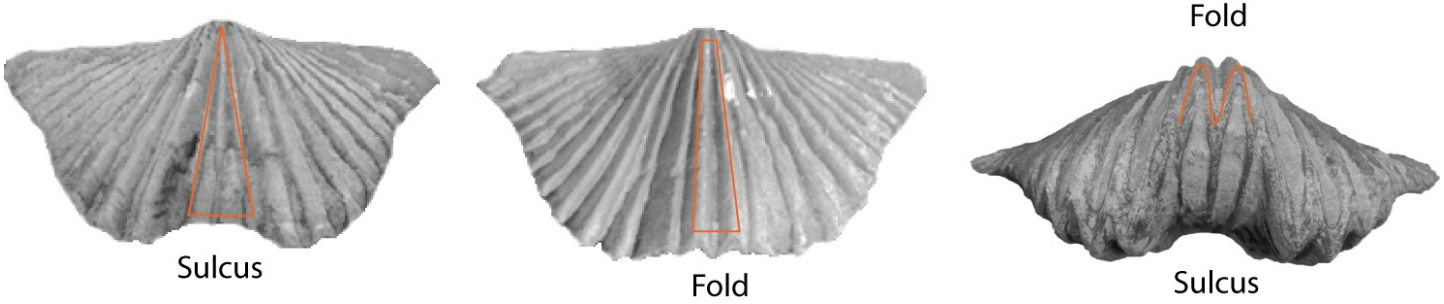
- It is one of the most important group of invertebrates.
- They are exclusively marine form
- Their fossils occurs in most of the stratigraphic horizon (Paleozoic) and have abundant in past.
- Classes: Articulata and Inarticulata
- Inarticulata subdivided into two orders namely Atremata (A-Absent+Tremata-Opening) and Neotrenata, Neo means young.
- Articulate has three orders, 1. Paleotremata, 2.Protremata, and 3. Telotremata.

Morphology

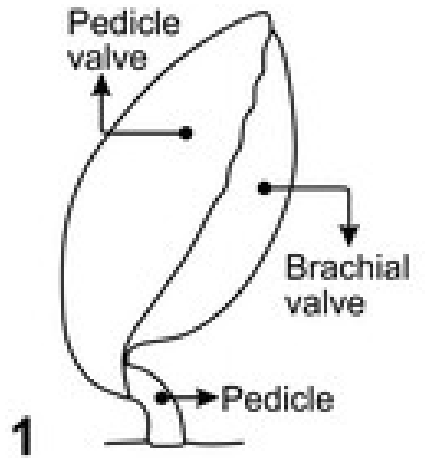
- They have 2 VALVES (shells) that totally enclose the soft parts.
- The average size is 20 - 70 mm but can range up to 370 mm.
- The valves can open and are hinged at one end; muscles open and close the shell.
- The two valves are different in size (as opposed to bivalves).



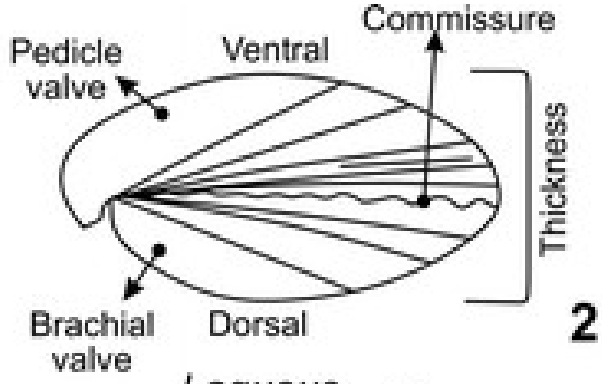
- ***Dorsal Valve*:** Also called the *brachial valve*; smaller valve of the brachiopod; the lophophore attaches to this valve
- ***Ventral Valve***: Also called the *pedicle valve*; larger valve of the brachiopod; pedicle attaches to this valve
- ***Beak***: Pointed portion(s) at the posterior end of the brachiopod
- ***Commissure:*** The edge of the shell along its line of closure between valves
- ***Fold:*** Elevation of a brachiopod valve along the midline, accompanied by a depression (sulcus) on the other valve



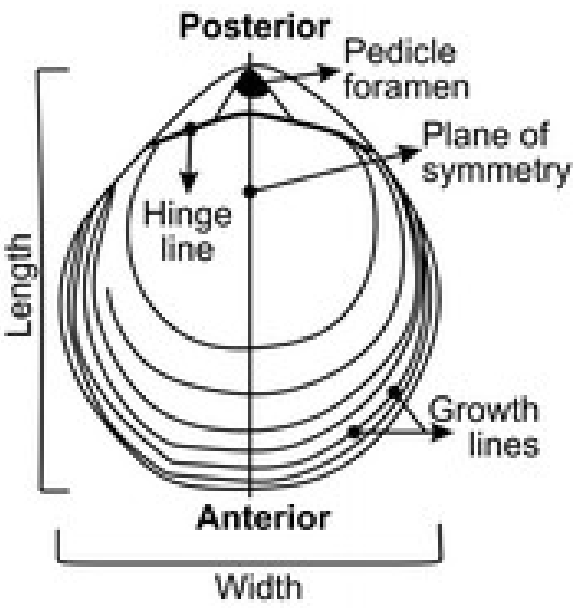
- **Sulcus**: Depression of a brachiopod valve along the midline, accompanied by an elevation (fold) on the other valve
- **Pedicle Foramen**: Subcircular to circular opening in the ventral valve through which the pedicle penetrates
- **Growth Line**: Concentric markings that run from the beak to the commissure
- **Plication**: Major undulation (waves) on the shell surface; particularly visible along the commissure



1

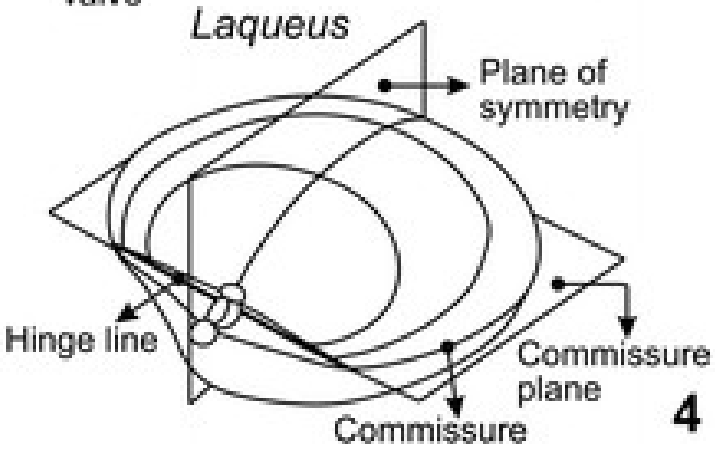


2

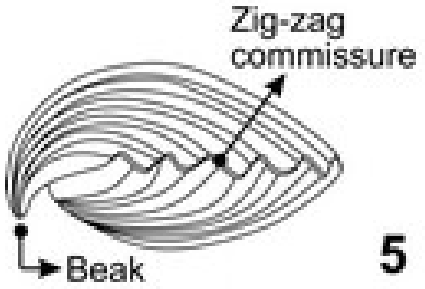


Laqueus
(Brachial valve)

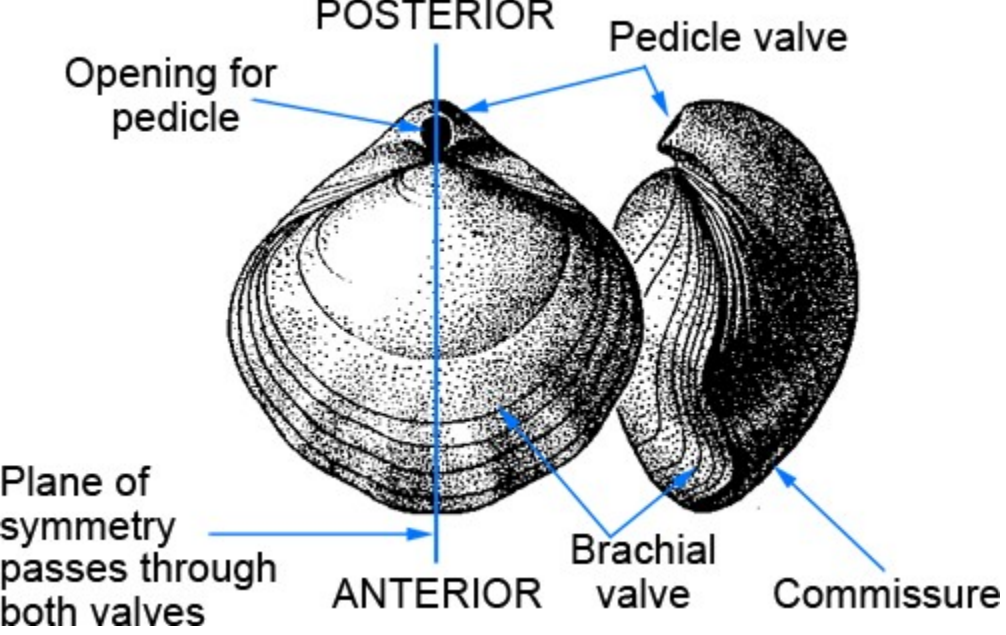
3

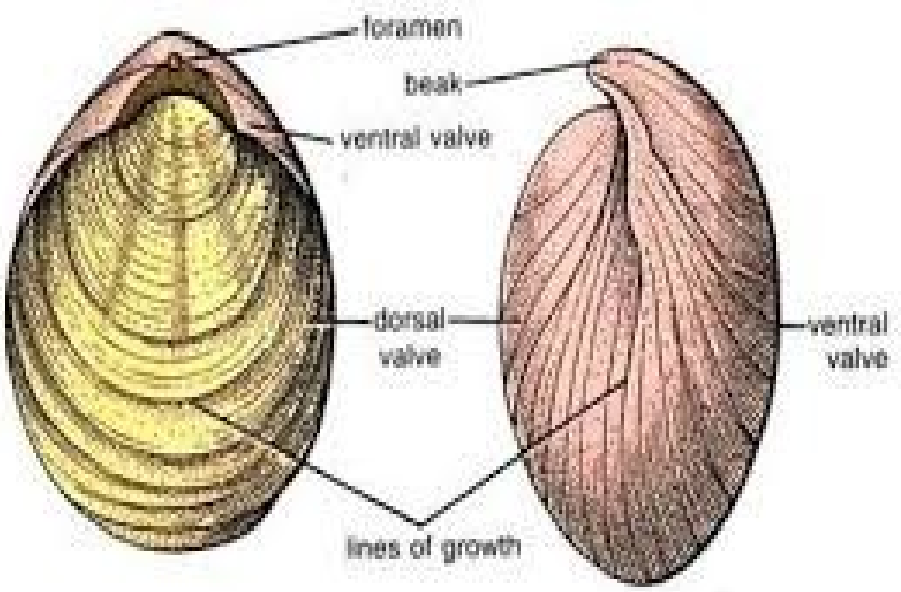


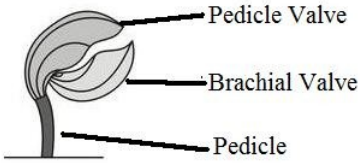
4



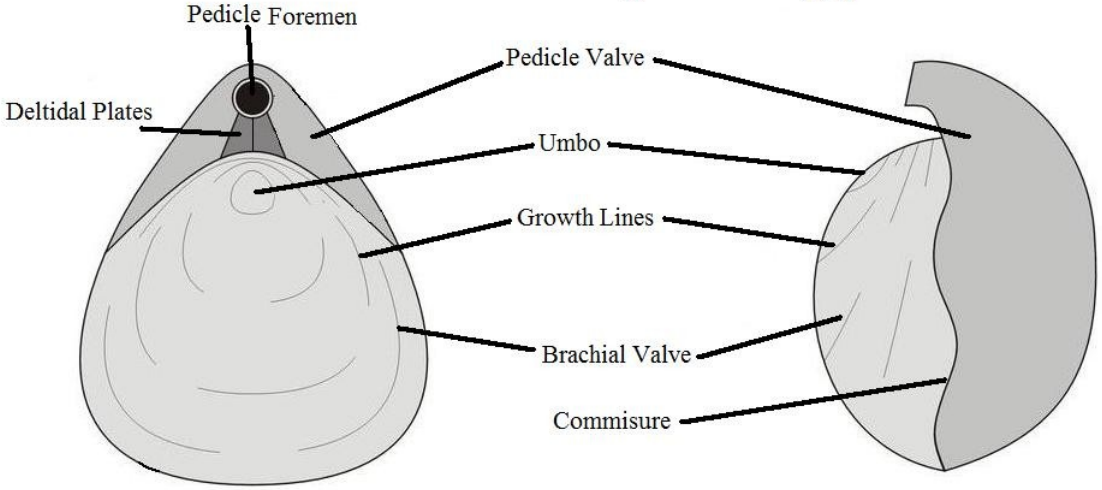
5

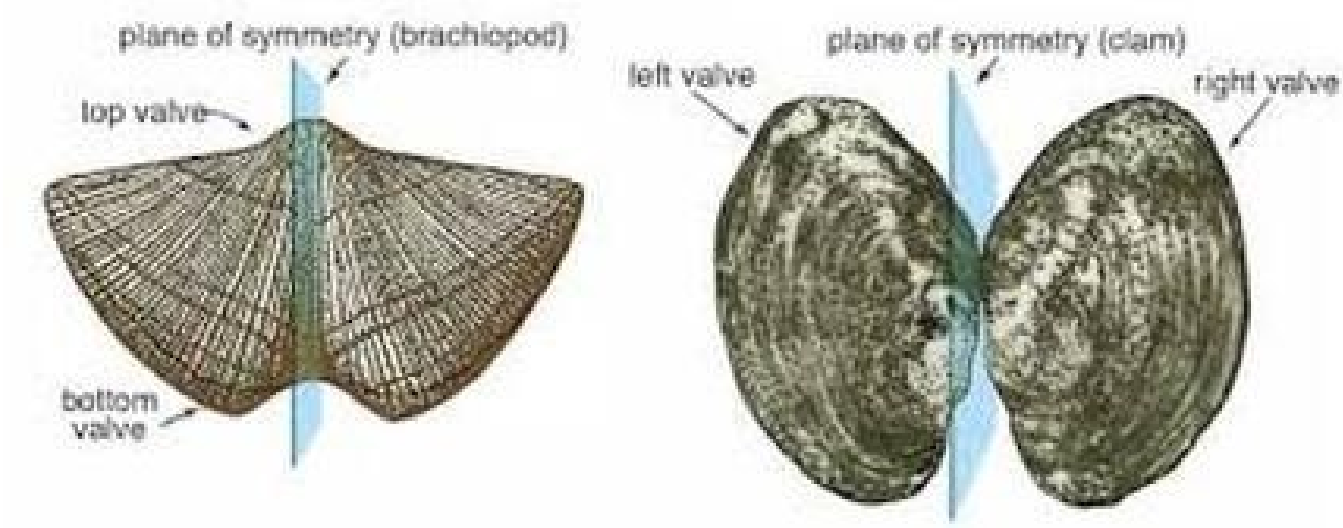






Brachiopod Morphology




plane of symmetry (brachiopod)
top valve
bottom valve
plane of symmetry (clam)
left valve
right valve

Morphology

- Often the pedicle valve has a small circular opening (FORAMEN) at the end through which a type of foot extends called the PEDICLE
- Brachiopoda comprises heart like organ, pedicle, nerve ring digestive system and arm which are called **lopophore.**
- Lopophore occur in pair are used for gathering food.
- All the soft parts are enclosed by a thin skin which is known as **mantle**.
- The space between the mantle of the two sides are known as mantle cavity or mantle chamber.
- The **valves are equilateral** and the **shell is inequivalve** but in the case of Lamellibranchia **inequilateral** valves and **equivalved** shells

Morphology

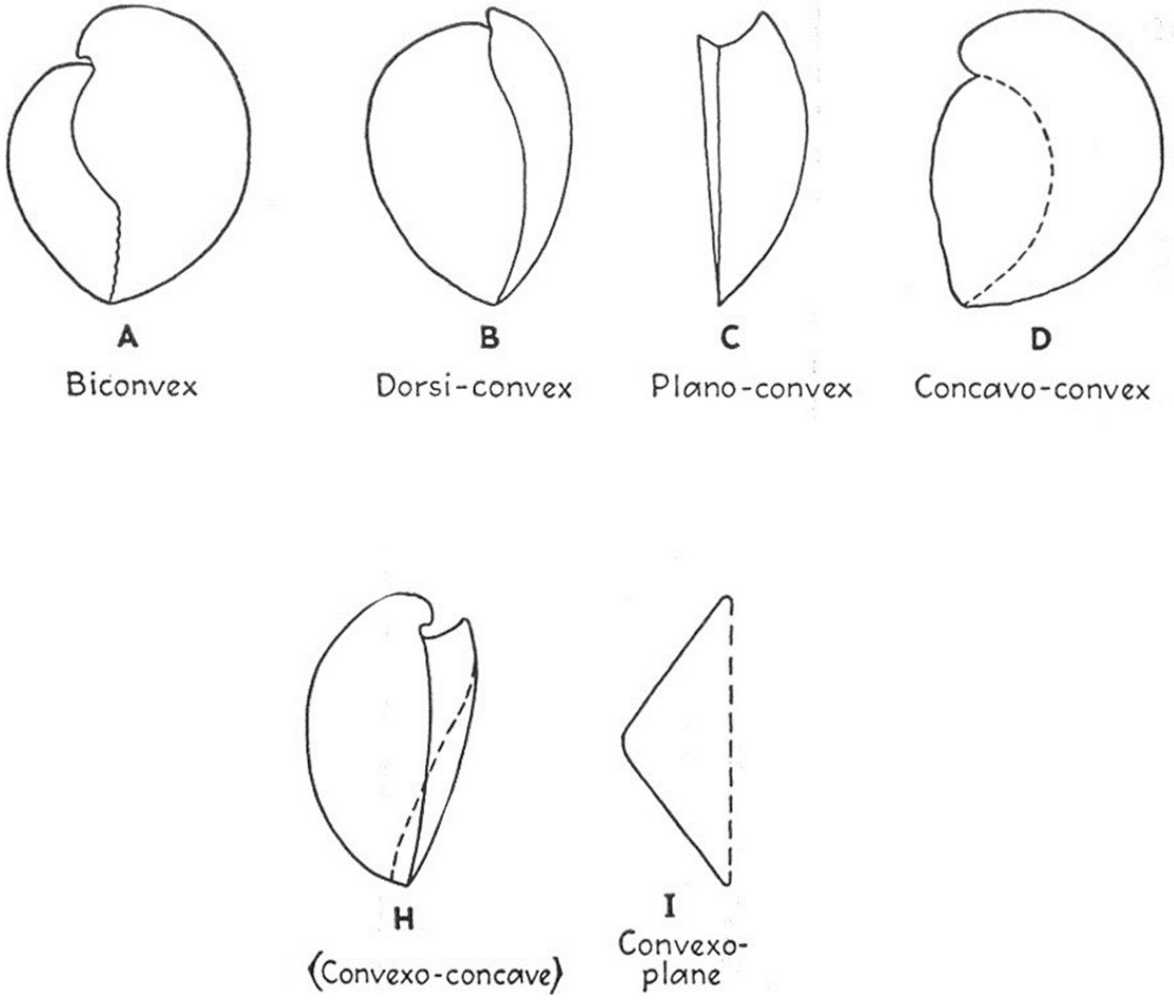
- Smaller valve is dorsal and larger valve is ventral.
- Since the Brachia is attached to the dorsal valve it is also known as **brachial valve** and likewise pedicle comes out through the ventral valve, so it is also known as **pedicle valve**.
- **The posterior** – terminal part of both the valves which comprises beak or umbo.
- The ventral umbo is more prominent than the dorsal.
- The side opposite to umbo is **anterior**
- The two valves are joined at a margin on the posterior side which is known as **hinge line**.
- Hinge line may be long and straight or short and curved.

Morphology

- In certain species like Spirifer between the hinge line and umbo, there may be a triangular area which is known as **Cardinal area, hinge area** or area.
- The area can be in one valve or it can be seen in both valve like Orthis.
- Hinge consist of teeth (Ventral valve) and sockets (dorsal valve). All those form with dental system are grouped under the class of **Articulata**.
- In certain forms, the valves are held together by means of muscles and mantle which are placed under **Inarticulata**. Ex. Lingula
- The valves are opened and closed by divaricator (diductor) and adductor muscles.
- The places of attachment of these muscles are known as **muscle impression. In Articulata,** 5 or 6 pairs of musles present and in Inarticulata, it is very complex.

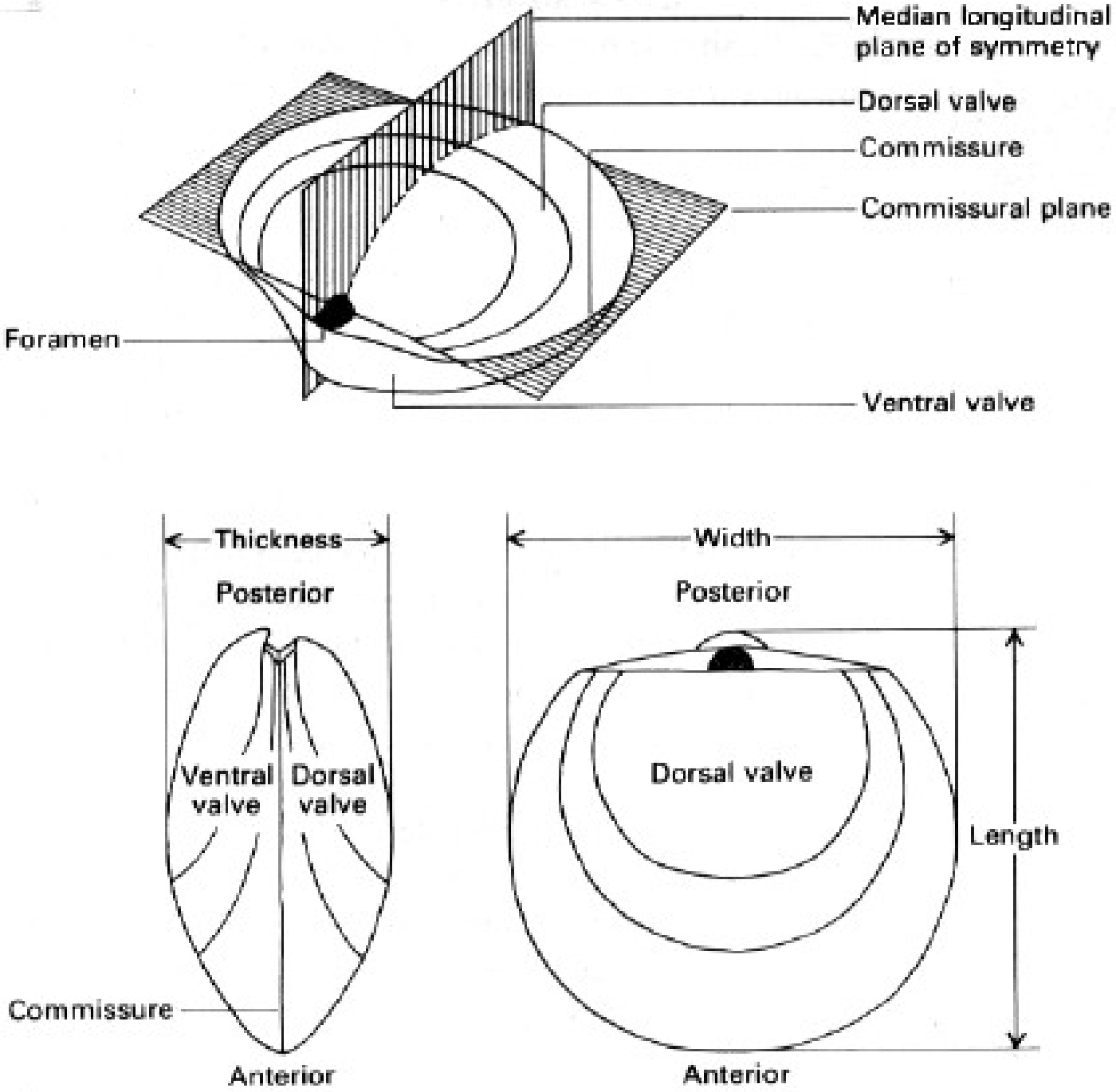
The Shapes of Valves

- Biconvex
- Dorsiconvex
- Planoconvex
- Cancavo-convex
- Convexoplane
- Convexo-concave



The Shapes of Valves

- The shell may be **Spiriferid** in which the hinge line is straight and the width is more than the length. Ears are present. Ex Spirifer
- The shell may be **Megathyroid** where the hinge line is straight and the length is slightly more than the width. Ex Megathyris
- It may be **Terebratulid** where the small hinge line is highly curved and the length is more. Ex Terebratula
    - Length is measure from Umbo to anterior side
    - Perpendicular to length, width is measured
    - Thickness is measured from Thickness of one valve to other valve


Median longitudinal plane of symmetry
Dorsal valve
Commissure
Commissural plane
Foramen
Ventral valve
Thickness
Posterior
Ventral valve
Dorsal valve
Commissure
Anterior
Width
Posterior
Dorsal valve
Length
Anterior

The Shapes of Valves

- The external surface of the shell may be concentric or radiating.
- One valve may have Plica (Ridge) and another may have Sulcus (Depression)

- These are called **ornamentation** of brachiopod

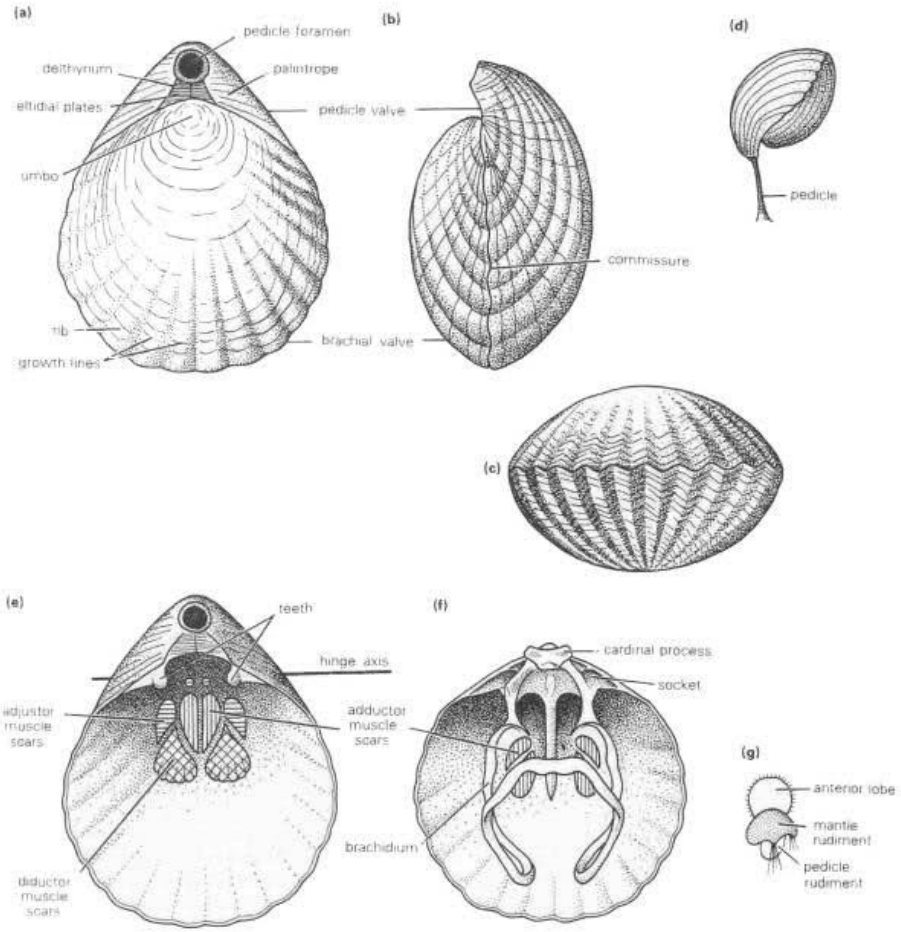
Shell Shape & Symmetry	Bivalves – Bilaterally about a plane between two valves. Two identical valves. Brachiopods – Bilaterally about a plane from umbo to anterior margin. Pedicle valve is larger.
Composition of Shell	Bivalves – Calcareous and partly organic in 3 layers. Brachiopods – Calcareous.
Shell Size	Bivalves – A few mm to 1m (giant clam) Brachiopods – Generally 2–10cm
Opening and Closing Mechanisms	Bivalves – A pair of adductor muscles contract to keep valves closed (leave scars at anterior and posterior). When muscles relax, external ligament pulls them open. Brachiopods – Adductor muscles contract to close valves (pair of scars in pedicle valve, 2 in brachial) – Didcutor muscles contract to open valves (run from cardinal process to floor of pedicle valve)

Umbos	Bivalves – Lies in front of the ligament in both valves. Brachiopods – Lies in top portion of both valves.
Growth Lies	Bivalves & Brachiopods – Concentric markings parallel to the edge of the shell.
Ribs	Bivalves – Radial markings forming from fine lines to coarse ribs and grooves. Brachiopods – Radiating lines from the umbo.

Foot	Bivalves – Found at posterior end, used for movement and digging. Brachiopods – None.
Pedicle	Bivalves – None Brachiopods – Some have pedicle for attachment to rocks.
Orientation of Valves	Bivalves – Right and left valves hinged by ligament on dorsal surface. Umbo points towards anterior. Brachiopods – Pedicle valve (ventral) is larger, projecting beyond brachial valve (dorsal) at posterior.

Pallial Line and Sinus	Bivalves – Clearly seen around margin of shell. Brachiopods – None
Respiration & Feeding	Bivalves – Use gills Brachiopods – Lophophore attached by brachial supports.
Teeth and Socket	Bivalves – Dentition along hinge plate; cardinal teeth below umbo, with lateral teeth either side (hetrodont only) Brachiopods – Two teeth within hinge apparatus of pedicle valve, two sockets in brachial valve (articulate only).


Bottom
Top
Two dissimilar valves
Brachiopod
"sea shells"
in life
Top
Bottom
Two similar valves
in life
Pelecypod
"sea shells"

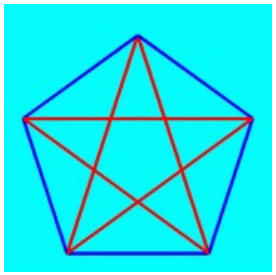

(a)
pedicle foramen
delthyrium
palintrope
ellidial plates
pedicle valve
umbo
rib
growth lines
brachial valve
(b)
commissure
(c)
(d)
pedicle
(e)
teeth
hinge axis
adjustor muscle scars
adductor muscle scars
deductor muscle scars
(f)
cardinal process
socket
brachidium
(g)
anterior lobe
mantle rudiment
pedicle rudiment

Phylum Echinodermata

Class Echinoidea

(Echinos= Spines+derma=skin+ ata=characterized by)

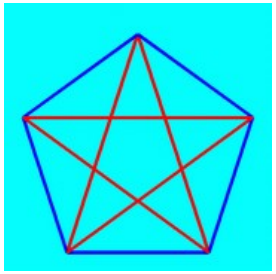
- General
  - Echinodermata is exclusively marine and include star fish, brittle star, sea lilies, sea cucumber and sea urchins.
  - The possess **pentamerous** radial or more or less primitive bilateral symmetry.
  - The Skin is covered by calcareous plates. Network of rods and spines



- General
  - The spaces in the network of rods are filled with calcite.
  - These animals have some water vascular system which may combines food gathering and locomotion.
  - Mc Kerrow in 1978, classified this phylum into four subphyla. Homalozoa, Crinozoa, Astreozoa and Echinozoa which includes class Echinoidea

CLASS- ECHINOIDEA (Echinos=Spines+oidea=Test)

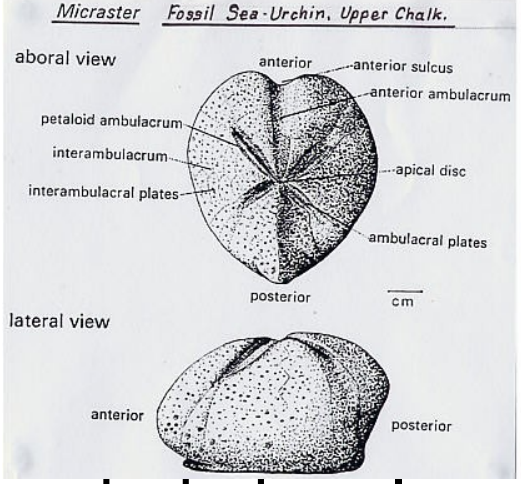
- General
  - Exclusively marine bottom dwelling animals.
  - They may be spherical, globular, discoidal or heart shaped.
  - The soft parts are enclosed inside the calcareous shell known as test.
  - The test is covered with spines on the external surface.



CLASS- ECHINOIDEA

- Morphology
  - The Test, which may be spherical, globular, discoidal or heart shaped.
  - It has two poles, viz Oral pole and Aboral pole
  - Maximum diameter of the Test is known as Ambitus
  - Mouth is located at the Ventral side (Oral pole)
  - Anus is located at the dorsal side (Aboral pole)
  - When mouth and anus are centrally placed at the opposite poles of the test are called Regular Echinoids Rx.. Cidaris

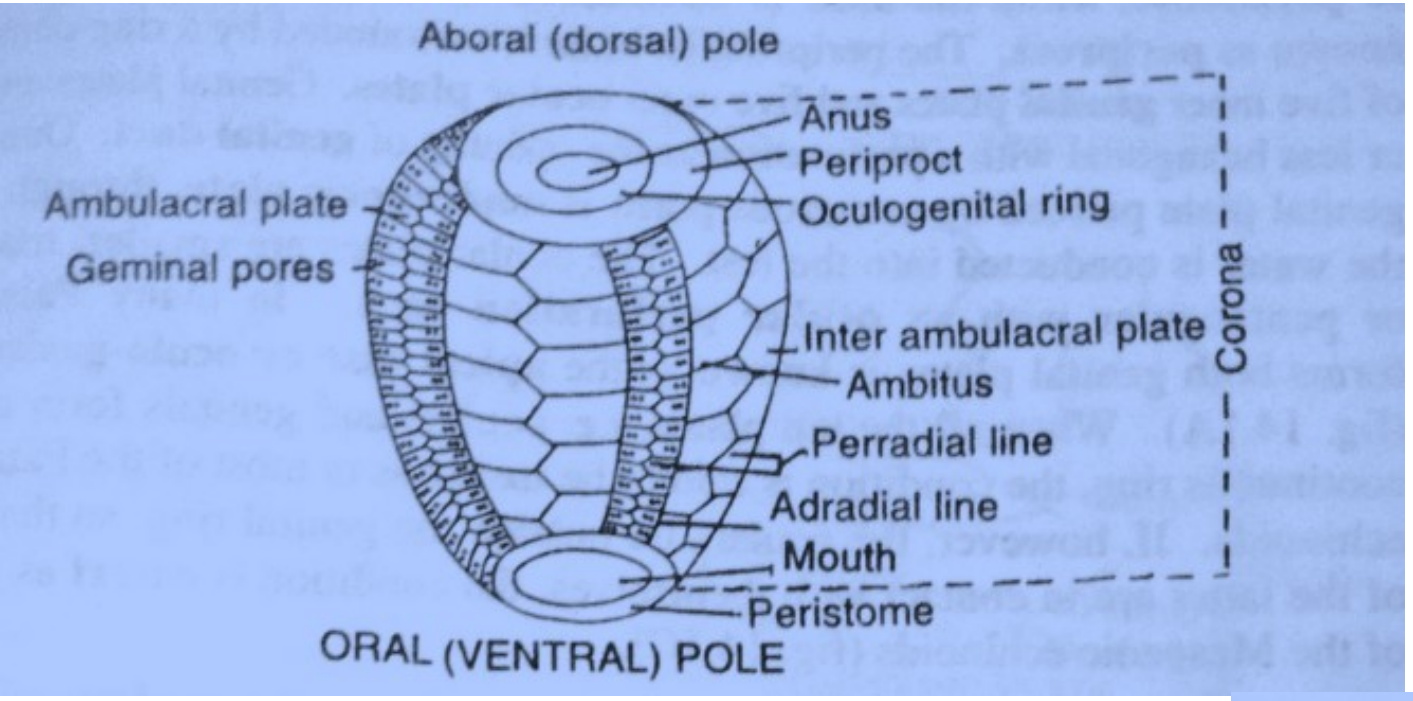
CLASS- ECHINOIDEA

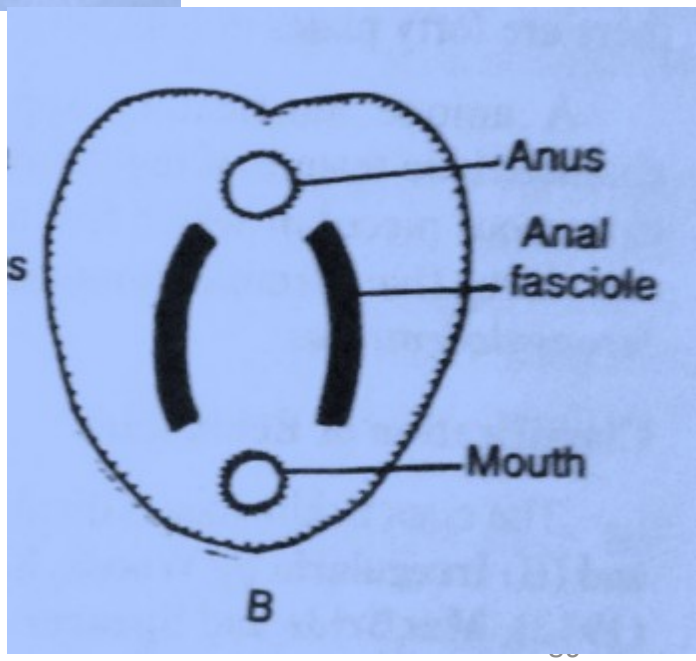


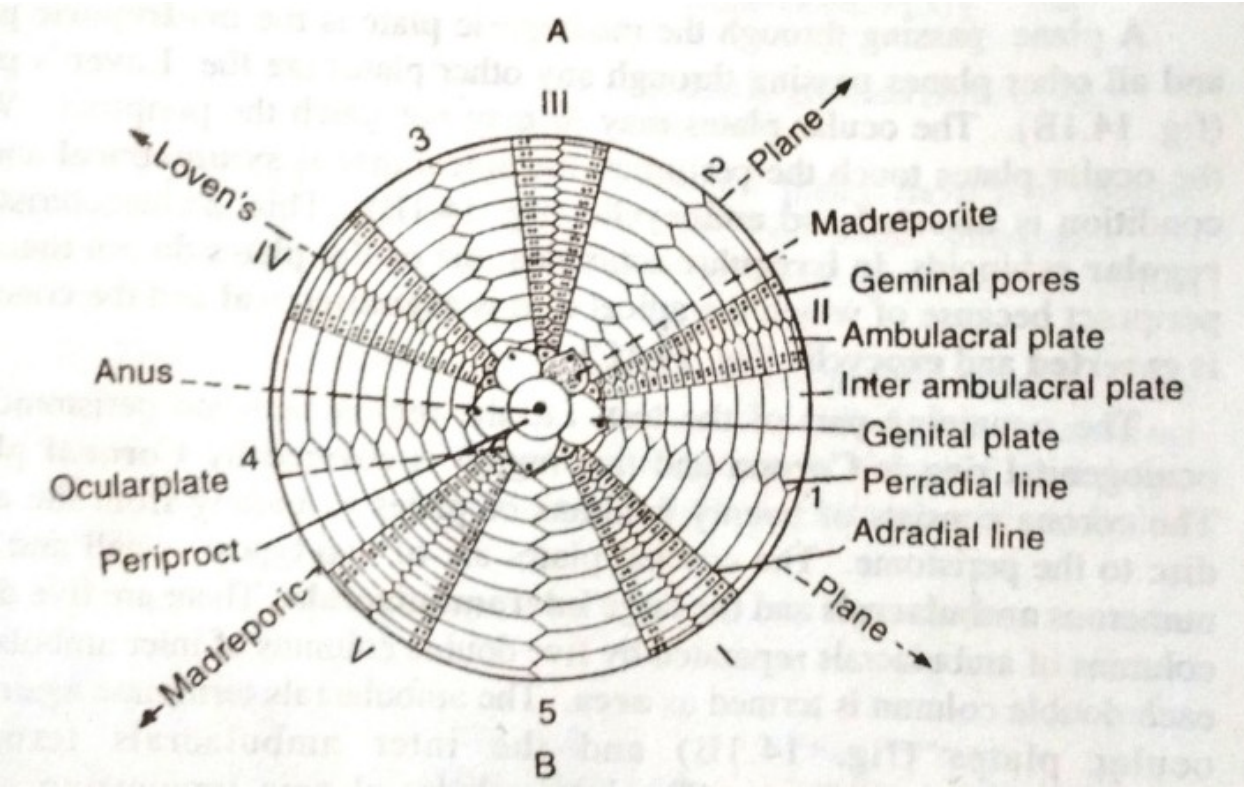
- Morphology
  - Irregular Echinoids: Anus is always located aboral end and the mouth is often eccentric towards posterior and anterior of aboral axis. Ex Micraster
  - The mouth is covered by a ring of calcareous plates is known as Peristome.
  - The Anus is surrounded by a ring of calcareous plate is known as Periproct.
  - The Periproct is surrounded by 5 inner Genital Plate and 5 outer Ocular Plate,

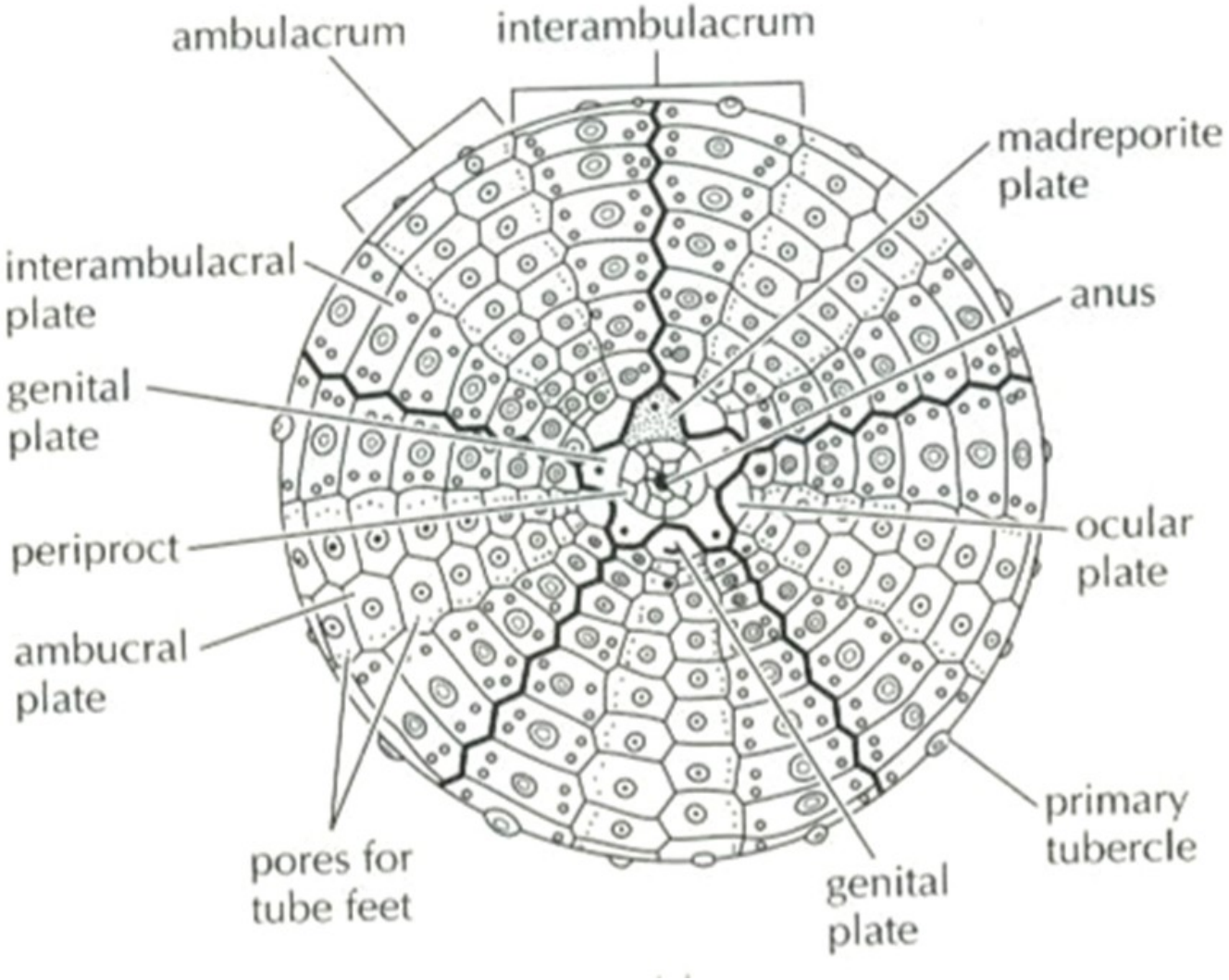
CLASS- ECHINOIDEA

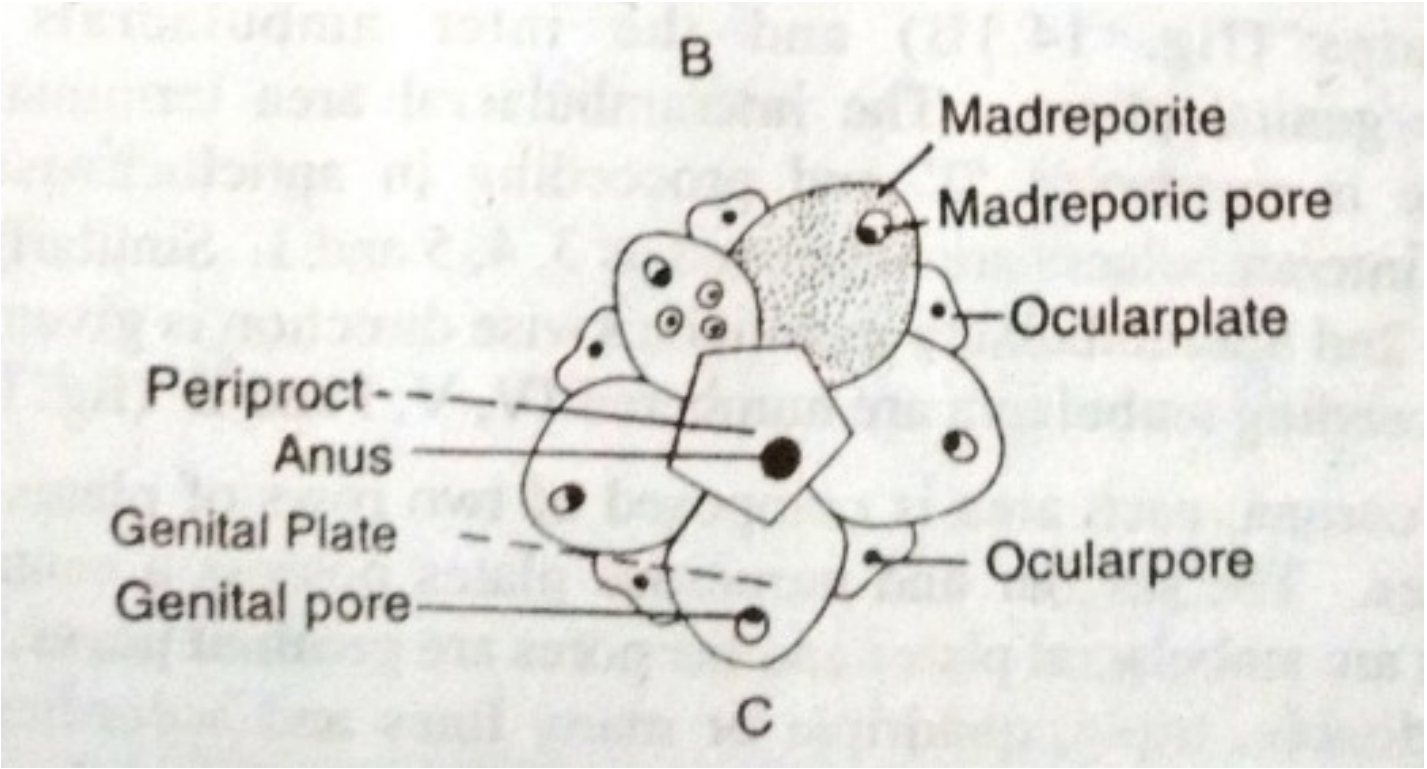
- Morphology
  - One of the genetal plates is pierced by numerous pores is known as Madreporic Plate.
  - The ocular plate may touch or may not touch the periproct. When it touches, the apical disc is symmetrical.
  - The region between peristome and oculogenital ring is called Corona. This region is covered by Coronal Plate


Aboral (dorsal) pole
Anus
Periproct
Oculogenital ring
Ambulacral plate
Geminal pores
Inter ambulacral plate
Ambitus
Corona
Perradial line
Adradial line
Mouth
Peristome
ORAL (VENTRAL) POLE


Anus
Anal
fasciole
Mouth
B


A
III
3
2
Plane
Loven's
IV
Madreporite
Geminal pores
II
Ambulacral plate
Anus
Inter ambulacral plate
Genital plate
4
Ocularplate
Perradial line
1
Periproct
Adradial line
Madreporic
V
I
Plane
5
B


ambulacrum
interambulacrum
madreporite plate
interambulacral plate
anus
genital plate
ocular plate
periproct
ambucral plate
primary tubercle
pores for tube feet
genital plate


B
Madreporite
Madreporic pore
Ocularplate
Periproct
Anus
Genital Plate
Genital pore
Ocularpore
C

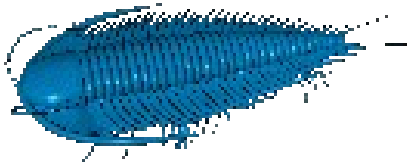
Phylum Arthropoda

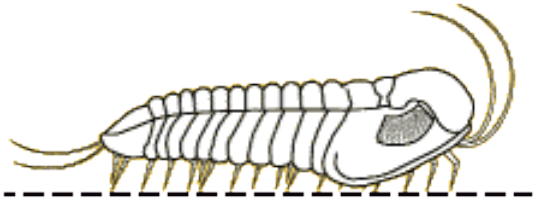
Class Trilobita

General

- They are highly organized, active, marine, fresh water, terrestrial and aerial invertebrates.
- Age of Cambrian to recent
- Arlegsthro=Jointed, + Poda=foot.
- They have elongated, segmented body and jointed legs.
- They are bilaterally symmetrical animals with mouth and anus at opposite end.
- Arthropoda is the largest phylum including about 9,00,000 species forming 80% of the animal kingdom.
- This phylum classified into subphyla and several orders based on the nature of body segmentation.
- Trilobita forms an important class in the subphyla trilobitomorpha

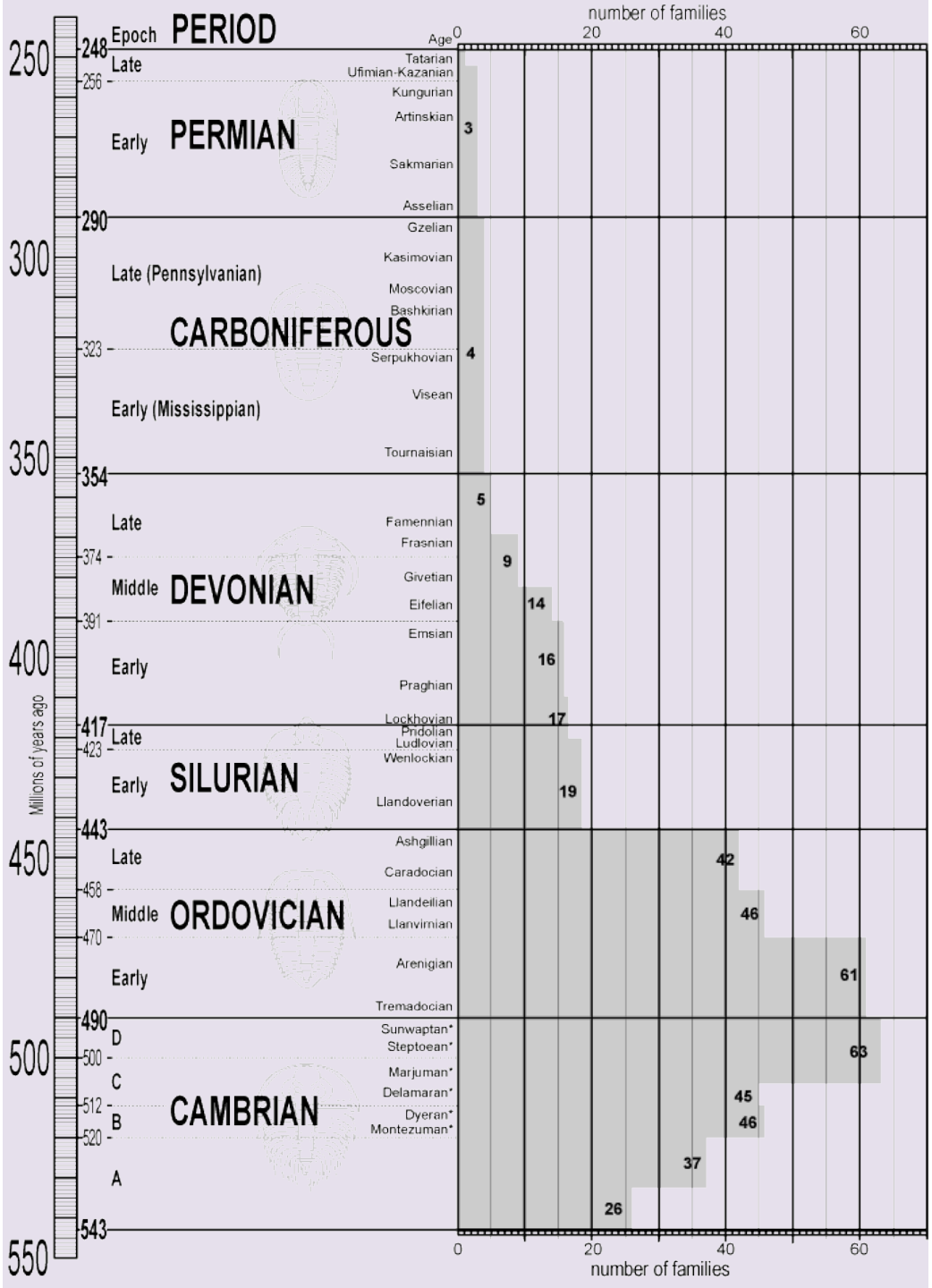
Trilobites





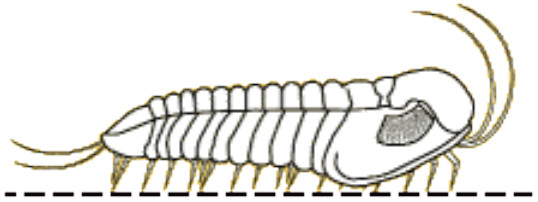
Class Trilobita:

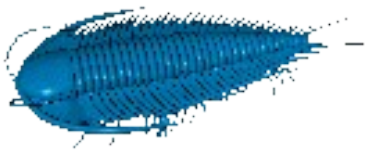
- **Highly evolved extinct form of phylum Arthropoda.**
- **Their life span is restricted to Paleozoic Era only.**
- **Trilobites first evolved in the Lower Cambrian and became extinct by the end of the Permian.**
- **They are most common during the Cambrian, Ordovician and Silurian.**
- **Therefore they have no modern equivalents and an understanding of their soft parts has to be based on modern day arthropods that show some similarity i.e. crustaceans.**
- **They are marine animals.**
- **They were benthic animals which swimmed along the bottom of the ocean floor and fed on small organisms and debris in the bottom mud.**


number of families
Epoch
PERIOD
Age
0
20
40
60
250
300
350
400
450
500
550
Millions of years ago
248
256
290
323
354
374
391
417
423
443
458
470
490
500
512
520
543
Late
Early
PERMIAN
Tatarian
Ufimian-Kazanian
Kungurian
Artinskian
Sakmarian
Asselian
3
Late (Pennsylvanian)
CARBONIFEROUS
Gzelian
Kasimovian
Moscovian
Bashkirian
Serpukhovian
4
Early (Mississippian)
Visean
Tournaisian
5
Late
Middle
DEVONIAN
Early
Famennian
Frasnian
Givetian
Eifelian
Emsian
Praghian
Lochkovian
9
14
16
17
Late
Early
SILURIAN
Pridolian
Ludlovian
Wenlockian
Llandoverian
19
Late
Middle
Early
ORDOVICIAN
Ashgillian
Caradocian
Llandeilian
Llanvirnian
Arenigian
Tremadocian
42
46
61
D
C
B
A
CAMBRIAN
Sunwaptan*
Steptoean*
Marjuman*
Delamaran*
Dyeran*
Montezuman*
63
45
46
37
26
number of families

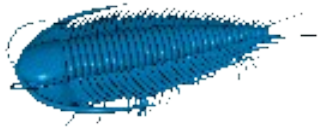
Trilobites: Specification 1

- **In particular you need to know about: Morphology:**
  - Cephalon
  - Thorax
  - Pygidium
  - Glabella
  - compound eyes
  - facial suture
  - Spines
  - shape of exoskeleton
  - nature and position of legs, gills and mouth.



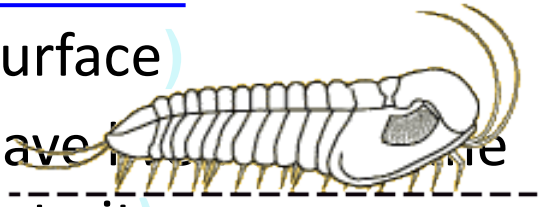


Trilobites: Specification 2

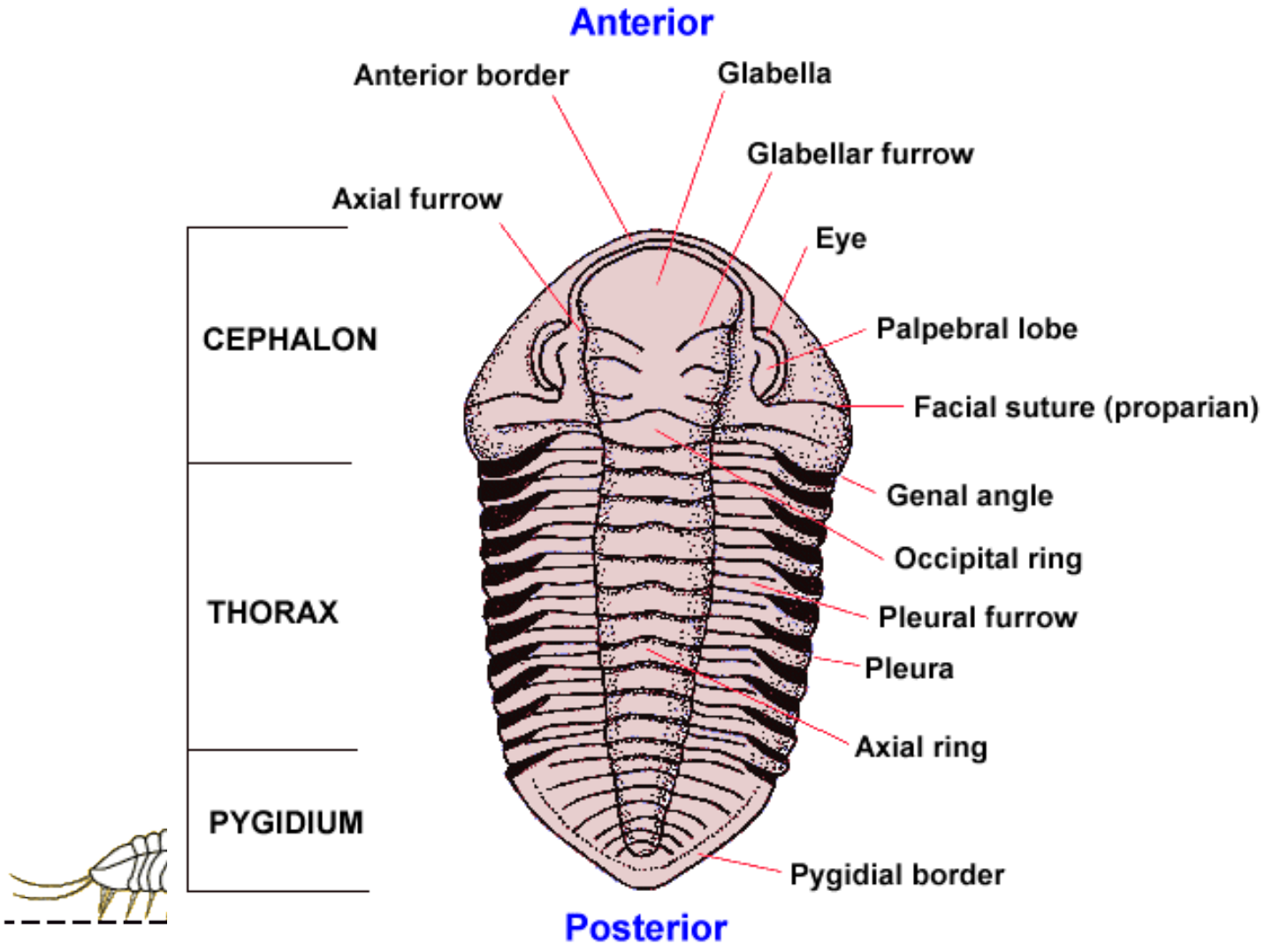


- **In addition to the morphology you also need to know about: Palaeoenvironments and mode of life**

  - **Nektonic (**swim and migrate freely, e.g., adult fishes, whales, **)**
  - **Pelagic (** neither close to the bottom of ocean nor near the shore**)**
  - **benthonic (**the lowest level of a body of water such as an ocean or a lake, including the sediment surface**)**
  - **infaunal modes of life. (**They would have lived in the sediment on the sea floor by burrowing into it**)**



Trilobites:


Anterior
Anterior border
Glabella
Glabellar furrow
Axial furrow
Eye
CEPHALON
Palpebral lobe
Facial suture (proparian)
Genal angle
THORAX
Occipital ring
Pleural furrow
Pleura
Axial ring
PYGIDIUM
Pygidial border
Posterior

Morphology

- **They are segmented animals and have a chitinous exoskeleton.**
- **They have a bilateral symmetry i.e. either side is symmetrical.**
- **They have jointed limbs with an identical pair on the either side of the body.**

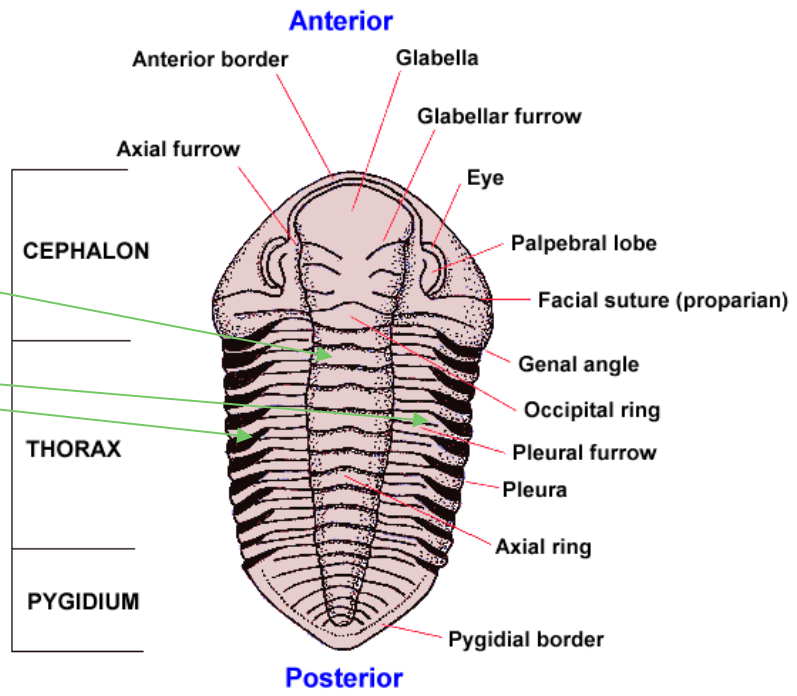
- **The body can be divided into segments:**

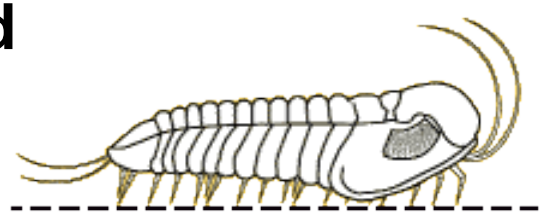
Laterally:

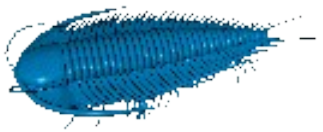
- **A central or axial segment.**
- **Bounded by two lateral segments.**

Transversely into three regions:

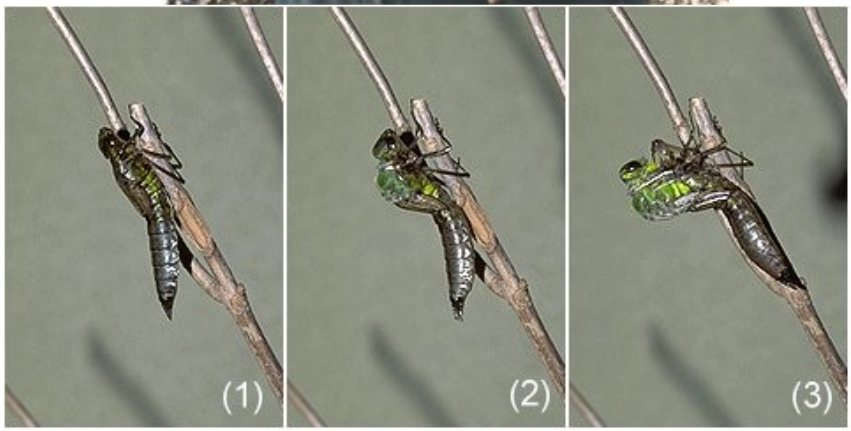
- **Cephalon - "head" area.**
- **Thorax - "body" with hinged segments.**
- **Pygidium - "tail" with fused segments.**



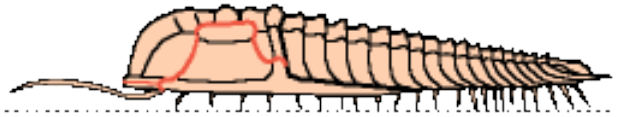


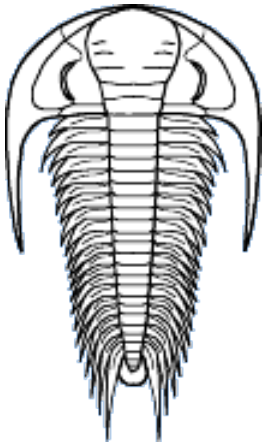


- **Trilobites tend to be fairly small being 5 - 8 cm long on average although extremes do occur from 5 mm to 70 cm.**
- **Because they had a rigid exoskeleton growth caused problems.**
- **How did they grow?**
- **They shed their exoskeletons for a larger by a process called "ecdysis".**

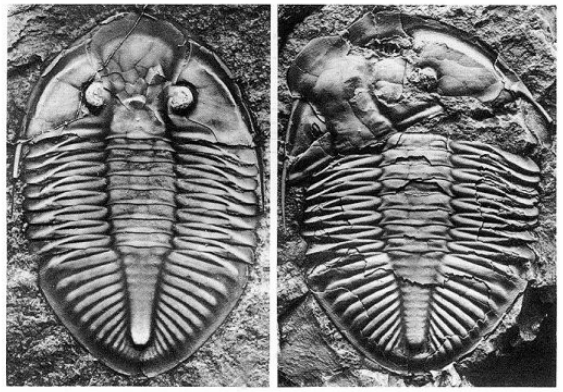


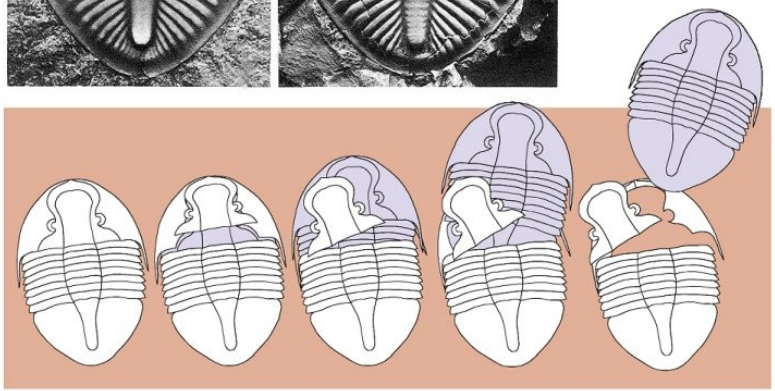
Ecdysis





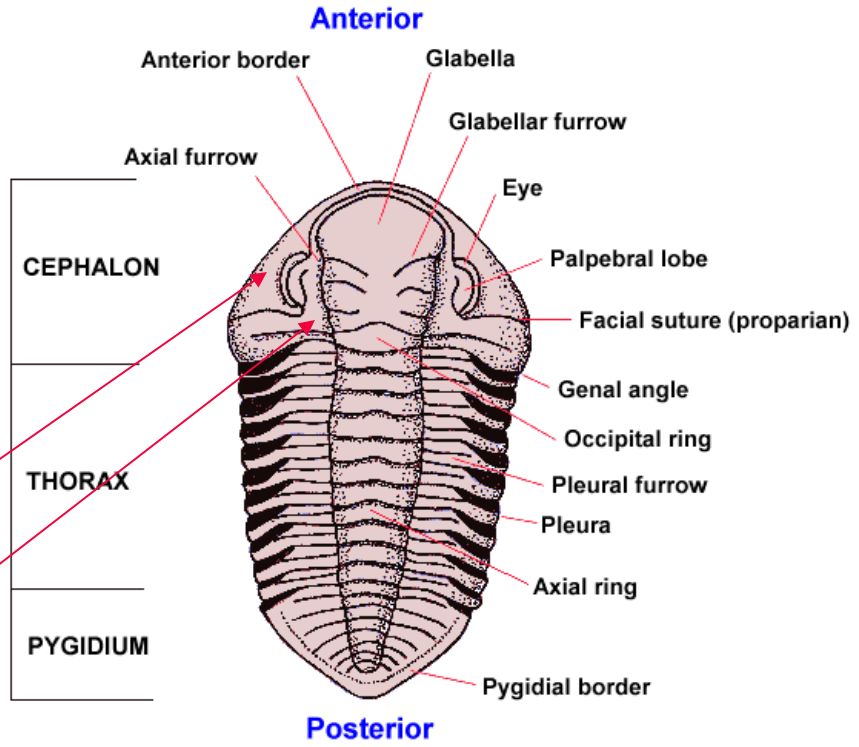
- **The animation depicts a *Paradoxides* trilobite molting (right is the animal in top view).**
- **In the animation, the facial sutures (red) split, opening the cephalon.**
- **This provides an exit for the molting trilobite (purple) from its old exoskeleton (orange).**

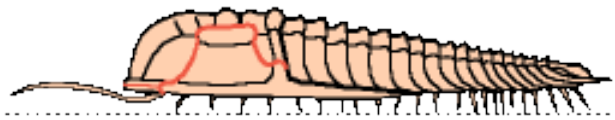




Cephalon

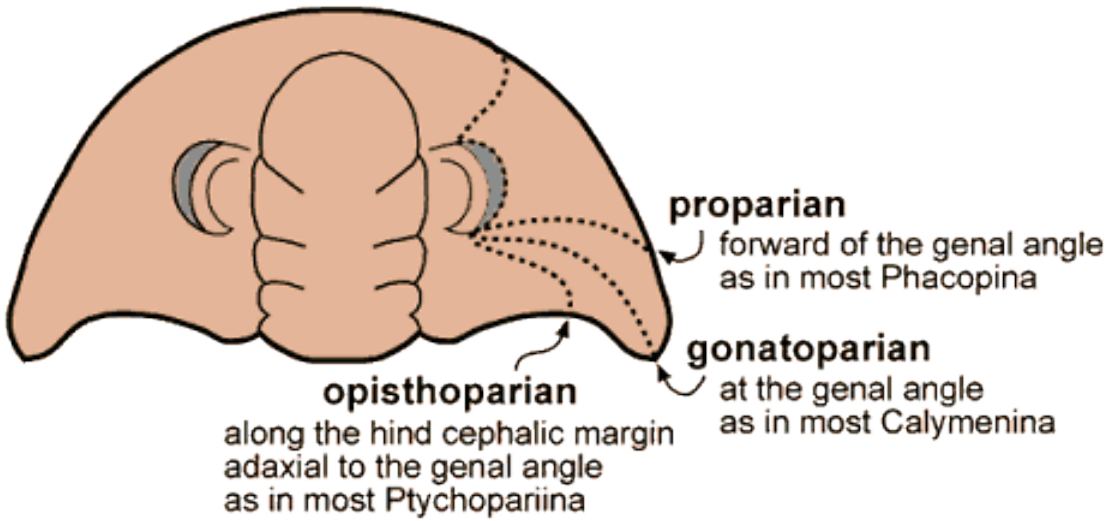
- **This is the head shield, which consists of a central region GLABELLA, or axial region.**
- **The glabella is usually convex but does vary in size and shape in different species.**
- **The FACIAL SUTURE is the line along which the skeleton is cracked to allow ecdysis, it divides the cheeks into 2 areas:**
- **FIXED CHEEK: That part which stays attached to the glabella.**
- **FREE CHEEK: That part which becomes separated during ecdysis.**



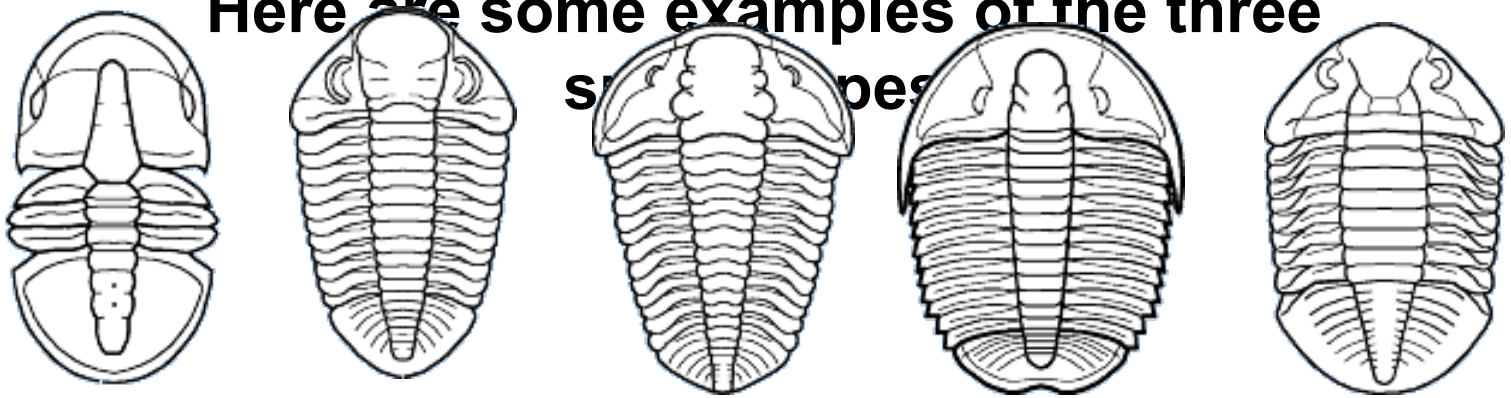


The three main types of facial sutures

are defined by where the suture ends, relative to the genal angle:



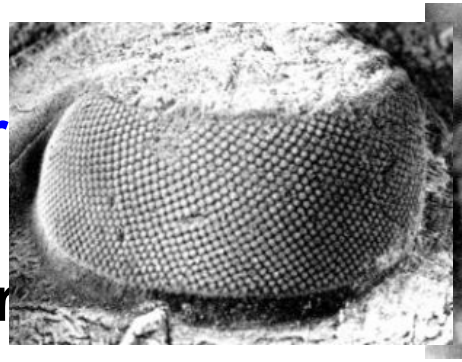
Here are some examples of the three s[illegible]pes

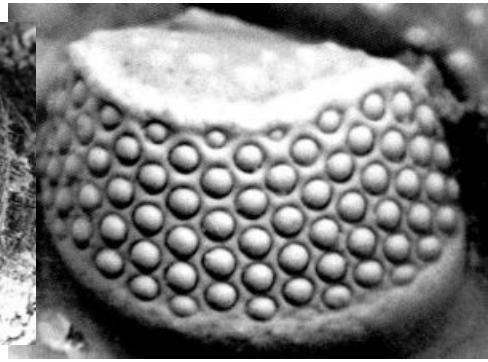


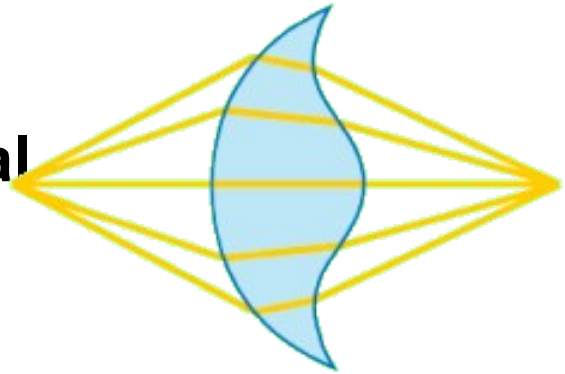
Eodiscina (proparian) | Phacopina (proparian) | Calymenina (gonatoparian) | Ptychopariina (opisthoparian) | Asaphida (opisthoparian)

Trilobite Eyes

- Trilobites developed one of the first advanced visual systems in the animal kingdom.
- The majority of trilobites bore a pair of compound eyes (made up of many lensed units).
- Compound eyes in living arthropods such as insects are very sensitive to motion, and probably allowed predator detection in trilobites.
- They typically occupied the outer edges of the cephalon (free cheeks) on either side of the glabella, adjacent to the facial sutures.



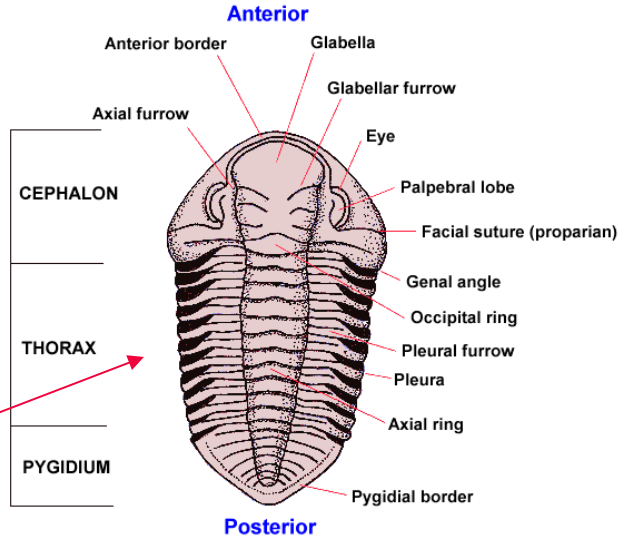


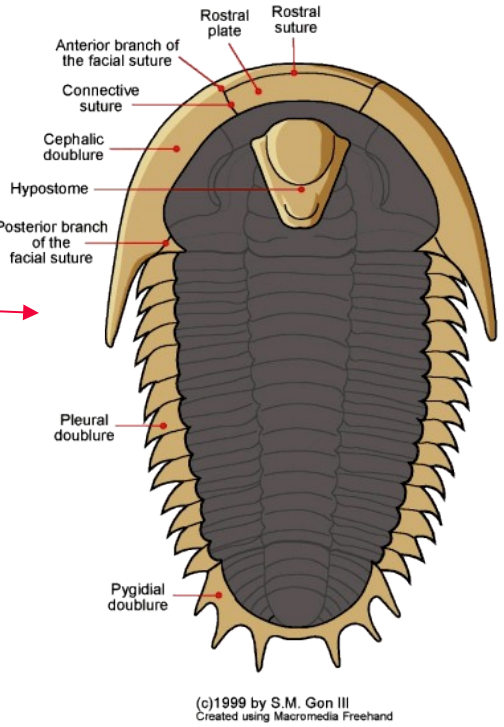


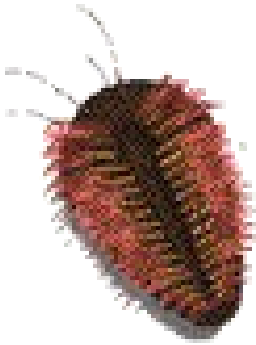
- Some trilobites have spines, which extend backwards, from the cephalon: GENAL SPINES.
- Glabella end = ANTERIOR
- Pygidium end = POSTERIOR

Top side of the cephalon = DORSAL.

- Bottom of cephalon = VENTRAL.
- On the ventral side are some small plates, one the HYPOSTOME protects the mouth. See page 150 Black.

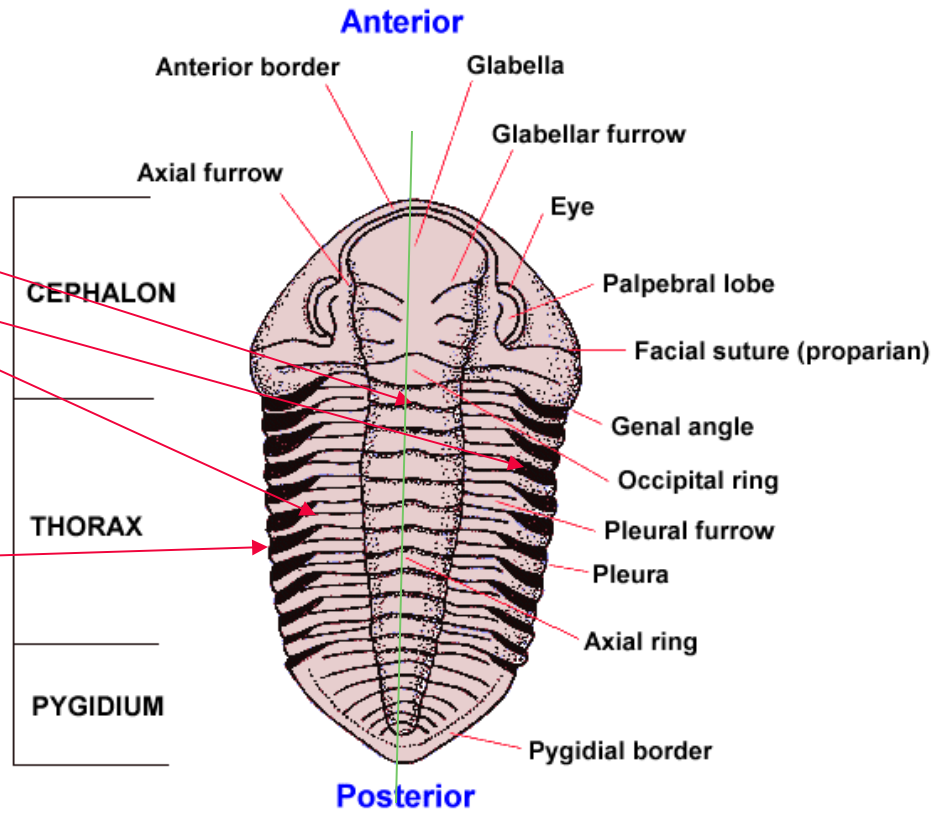




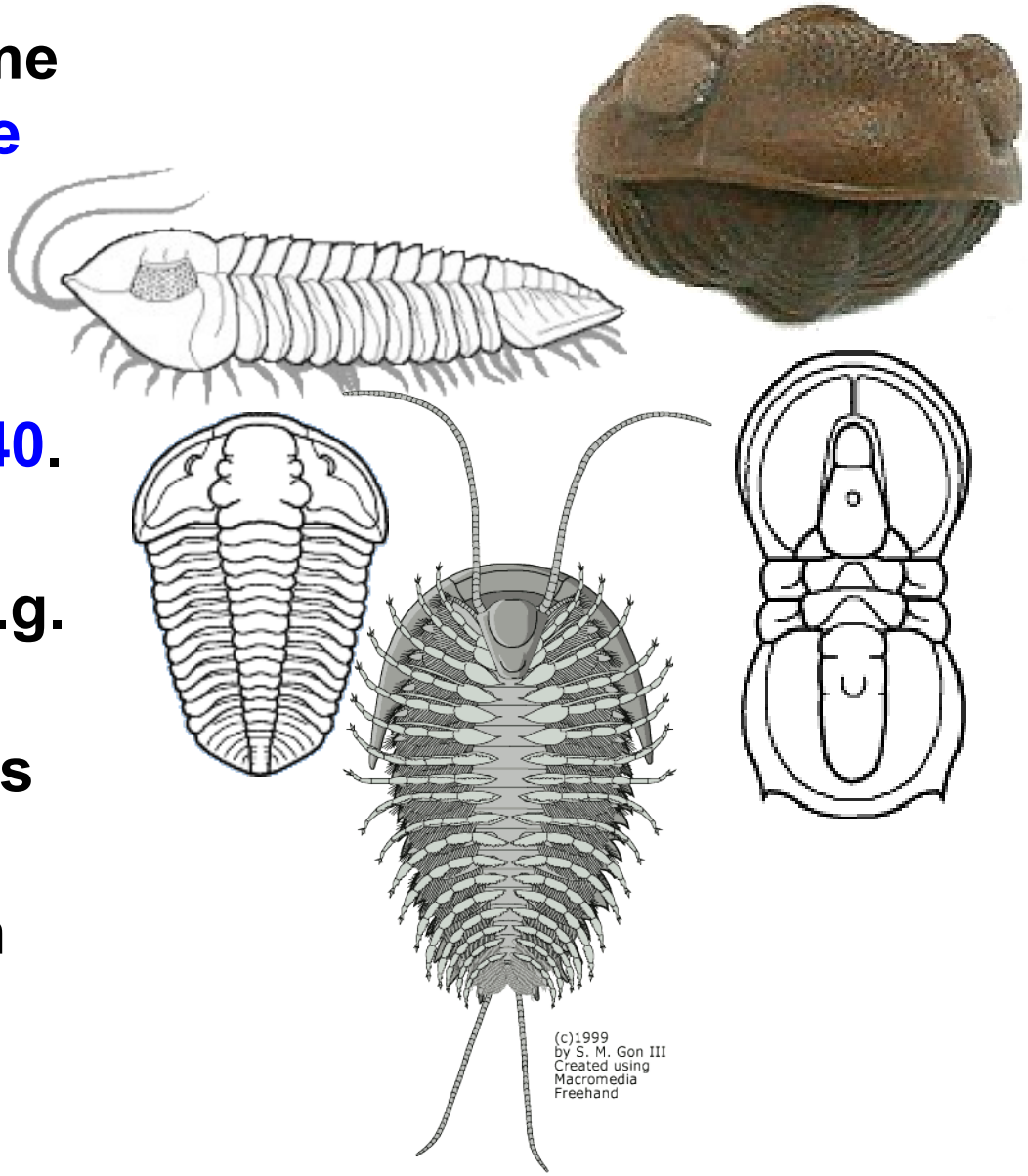


Thorax

- **Trilobites can be divided into three from side to side.**
- **It has a central axis separated from the 2 lateral regions by the AXIAL FURROW.**
- **Each segment of the lateral area has PLEURA.**
- **The thorax contains segments, which are jointed and able to move independently.**

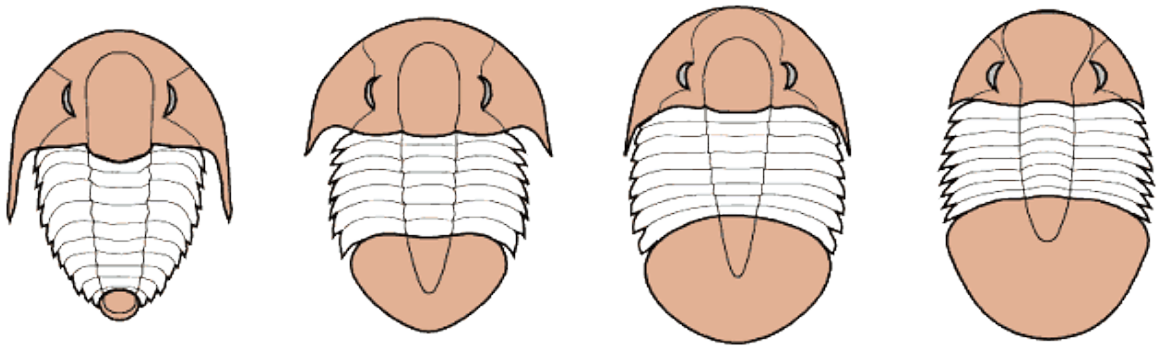


- This flexibility allows some trilobites to roll up to give protection to the softer under part.
- The number of these segments varies e.g. 2 - 40.
- However, in any Genera the number is constant e.g. 13 in Calymene.
- Underneath each pleura is a jointed limb and a gill.
- These are in pairs one on each side of the body.



Pigidium

- **This is a semicircular or triangular shield.**
- **These have a number of fused segments, which varies from 2 - 30 but cannot move independently.**
- **the pygidium (tail piece) can range from extremely small (much smaller than the cephalon) to larger than the cephalon. There are four general categories of pygidium relative size, shown below:**



micropygous

pygidium much smaller than cephalon

subisopygous

pygidium subequal to cephalon

isopygous

pygidium equal to cephalon

macropygous

pygidium larger than cephalon

Trilobite Modes of Life

- Most trilobites are **benthonic** and crawl around on the seabed.
- Sometimes they spread their weight by using spines or some plough through the soft sediment.
- Some even bury themselves.
- A few trilobites are **pelagic** and were streamlined enough to be able to swim close to the sea floor.
- They usually lived on the continental shelf where there is abundant life = shallow enough to have some light to stimulate the food chain.