The University of Burdwan
3-Year Degree/4-Year Honours in Zoology (NEP-CCFUP)
ZOOL1011 (Non-Chordates)

PORIFERA

CLASSIFICATION UPTO ORDER (HYMAN, 1940)

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Learning Objectives

- **Define** Porifera and understand their phylogenetic position as primitive metazoans
- **Identify** the general characteristics distinguishing sponges from other animals
- **Explain** the cellular grade of organisation and implications for sponge structure
- **Describe** the three main types of canal systems (ascon, sycon, leucon)
- **Classify** Porifera into three main classes:
  - Calcarea (Calcareous sponges)
  - Hexactinellida (Glass sponges)
  - Demospongiae (Horny sponges)
- **Differentiate** between orders within each class based on skeletal structures and body organisation

Quick Overview - Porifera at a Glance

Feature	Details
Definition	Multicellular, asymmetrical/radial, cellular grade, aquatic animals
Etymology	Porus (pore) + ferre (to bear) = Pore-bearers
Common Name	Sponges
Grade of Organisation	**Cellular** (not tissue grade)
Habitat	**Aquatic** - 98% marine, 2% freshwater
Living Species	~8,500 described species
Larval Type	Amphiblastula or Parenchymula

Evolutionary Status:

- Earliest diverging metazoan lineage
- Pre-Cambrian origin (~700-600 mya)
- Bridge between protists and true metazoans

Distinctive Features I - Body & Lifestyle

- **Sessile, Sedentary Existence**
  - Permanently attached to substrate
  - Rocks, coral, wood, shells, sediment
  - No adult locomotion whatsoever
  - Larvae only are motile (free-swimming)
- **Size Range**
  - **Microscopic** - barely visible to naked eye
  - **Typical** - 5-50 cm height
  - **Large** - up to 1-2 metres (Caribbean barrel sponges)
  - **Antarctic sponges** - up to several metres, 75% of benthic biomass
- **4. Brilliant Colouration**
  - **Pigment source:** Pigment granules in amoebocytes
  - **Colour patterns:**
    - **Dull:** Calcarea, Hexactinellida (white, grey, brown)
    - **Vivid:** Demospongiae (reds, yellows, oranges, purples, blues)
    - **Symbiotic:** Often harbour bacteria/algae providing colour

Shape Type	Examples	Lifestyle
Encrusting	Thin sheets on rocks/shells	Cryptic, protected
Tube/Cylindrical	Calcareous sponges	Increased surface area
Branching/Tree-like	Demosponges	Space occupation
Funnel-shaped	Glass sponges	Water channeling
Irregular/Massive	Many demosponges	Varied habitats

Distinctive Features II - Cellular Grade Organisation

- **What Does Cellular Grade Mean?**
  - **Cells are highly independent** - resemble protozoan colony more than true metazoan
  - **No true tissues** - cells not functionally integrated
  - **No organs or organ systems** - no brain, heart, digestion
  - **Limited cell types** - only 4-5 specialised types (vs. hundreds in higher animals)
  - **No embryonic germ layers** - this is diagnostic of sponges!
  - **No basement membranes** - unique absence (except Homoscleromorpha)
- **Implications:**
  - Maximum structural simplicity in multicellular animals
  - Cells can change function and position (high plasticity)
  - Regeneration from fragments extremely efficient
  - Totipotent archaeocytes bridge all cell types

Distinctive Features II - Cellular Grade Organisation

Three layered body wall

- **OUTER - Pinacoderm:**
  - Single layer of flat, polygonal **pinacocytes**
  - Protective epithelium
  - Can phagocytose small particles
  - No basement membrane
- **MIDDLE - Mesohyl:**
  - Gelatinous, non-living matrix
  - Contains amoeboid **amoebocytes**:
    - **Archaeocytes** - nutritive, totipotent
    - **Sclerocytes** - produce spicules
    - **Spongocytes** - produce spongin
    - **Lophocytes** - store nutrients
  - Skeletal elements embedded
- **INNER - Choanoderm:**
  - Single layer **flagellated choanocytes**
  - Microvilli collar around flagellum
  - Generate water currents
  - Capture food particles
  - Intracellular digestion site

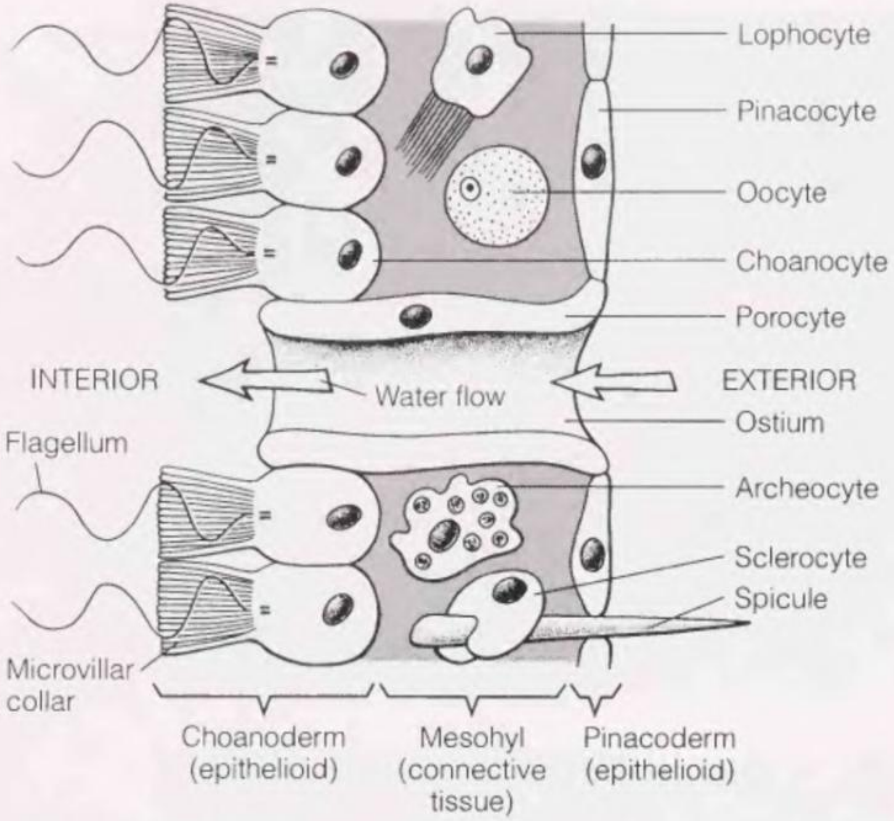


FIGURE 5-5 Porifera body wall: section through an asconoid sponge. *(Modified and redrawn from Rigby, J. K. 1987. Phylum Porifera. In Boardman, R. S., Cheetham, A. H., and Rowell, A. J. (Eds.): Fossil Invertebrates, Blackwell Science, Cambridge, MA. pp. 116–139.)*

Distinctive Features III - Water Circulation & Feeding

- **Port of Entry: OSTIA**
  - Numerous, minute openings on surface
  - Often guarded by **porocytes** (specialised cells)
  - Water enters with suspended particles
- **Central Chamber: SPONGOCOEL**
  - Single large internal cavity
  - Lined with choanocytes (simple ascon) or flattened cells (sycon)
  - Connected to exterior via ostia and osculum
- **Port of Exit: OSCULUM**
  - Single or multiple large openings
  - Protected by fringe of spicules
  - Expelled water carries waste
- **FEEDING - INTRACELLULAR DIGESTION**
  - **Unique Feature:** No mouth, no digestive tract!
  - Mode: Filter feeding (suspension feeders)
  - Size: 0.1-10 µm particles
  - Digestion: Inside amoebocytes (intracellular)
  - Efficiency: Can filter 50-100x their volume daily
  - Symbiosis: some harbour photosynthetic algae
- **Water Circulation Functions:**
  - Oxygen supply & CO_2 removal
  - Capture & ingestion of food
  - Waste removal (ammonia, metabolites)
  - Sperm distribution (reproduction)

Canal system

Ostia
(Inhalent Pores)

↓

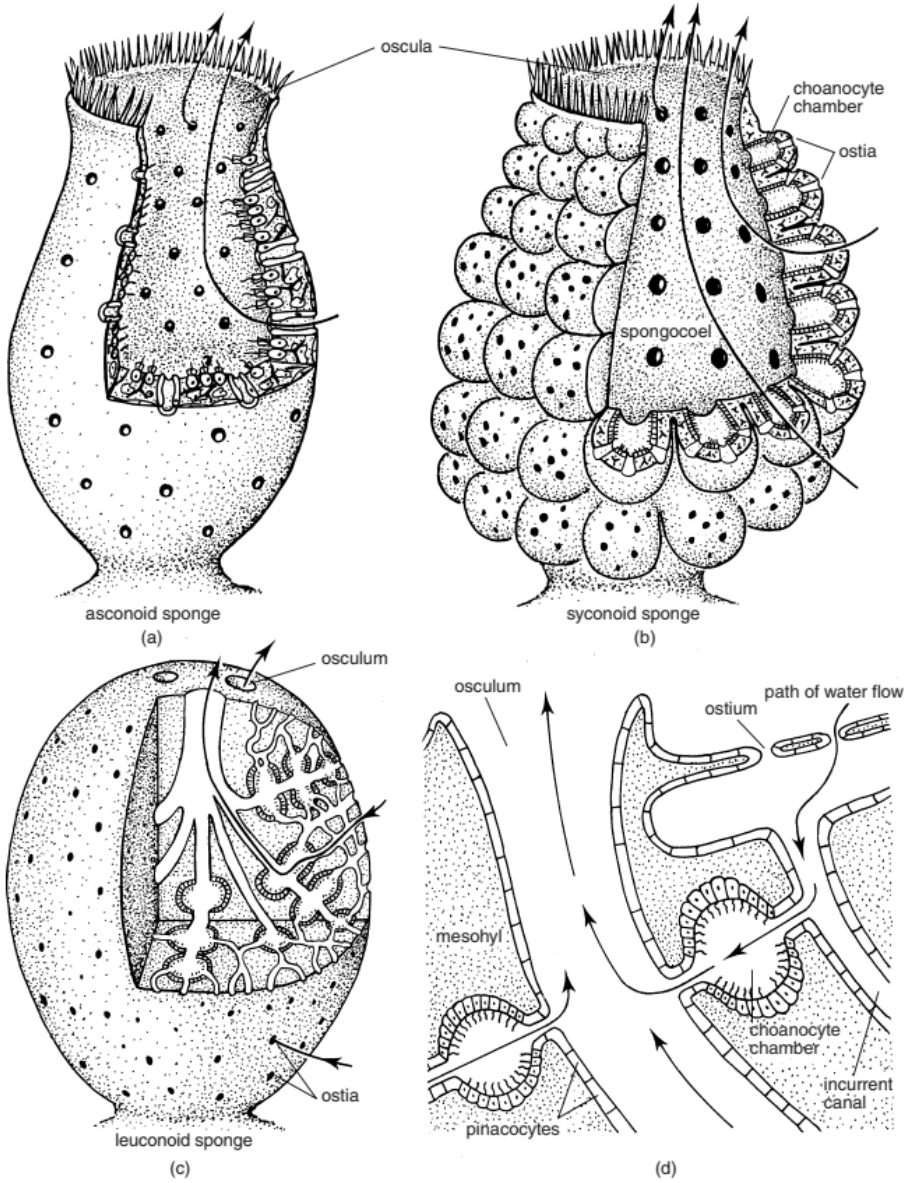
Canal System

↓

Choanocyte Chambers/Spongocoel

↓

Osculum
(Excurrent Opening)



Distinctive Features IV - Absence of Systems

System	Status	Function Replaced By
Nervous System	❌ None	Direct cell response
Muscular System	❌ Very limited	Water pressure, pinacocyte contraction
Digestive System	❌ None	Intracellular digestion by amoebocytes
Circulatory System	❌ None	Water circulation through aquiferous system
Excretory System	❌ None	Diffusion into water current
Respiratory System	❌ None	Diffusion directly into water

ABSENCE OF SPECIALISED SYSTEMS

The Sponge Paradox: Multicellular Yet Simple

Distinctive Features V - Reproduction

❖ASEXUAL REPRODUCTION:

❑Budding:

- Small bud forms on parent
- Eventually detaches & settles
- Forms independent clone
- **Gemmules** (Overwintering clusters):
- Protective envelope of cells
- Survives harsh conditions (freezing, drought)
- Germinates when conditions improve
- Characteristic of freshwater sponges (*Spongilla*)

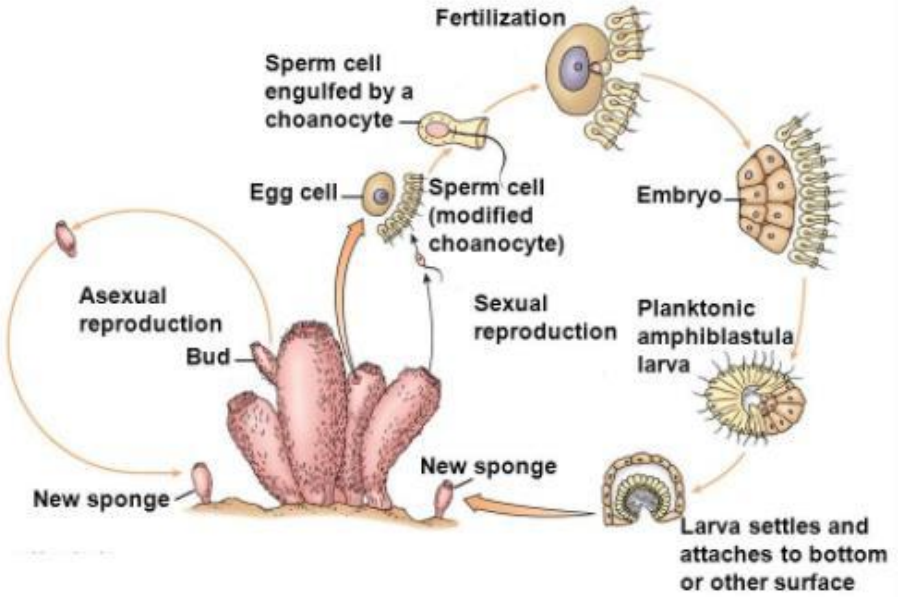
❑Fragmentation:

- Sponge breaks apart
- Each fragment regenerates
- Exceptional regeneration ability

❖SEXUAL REPRODUCTION:

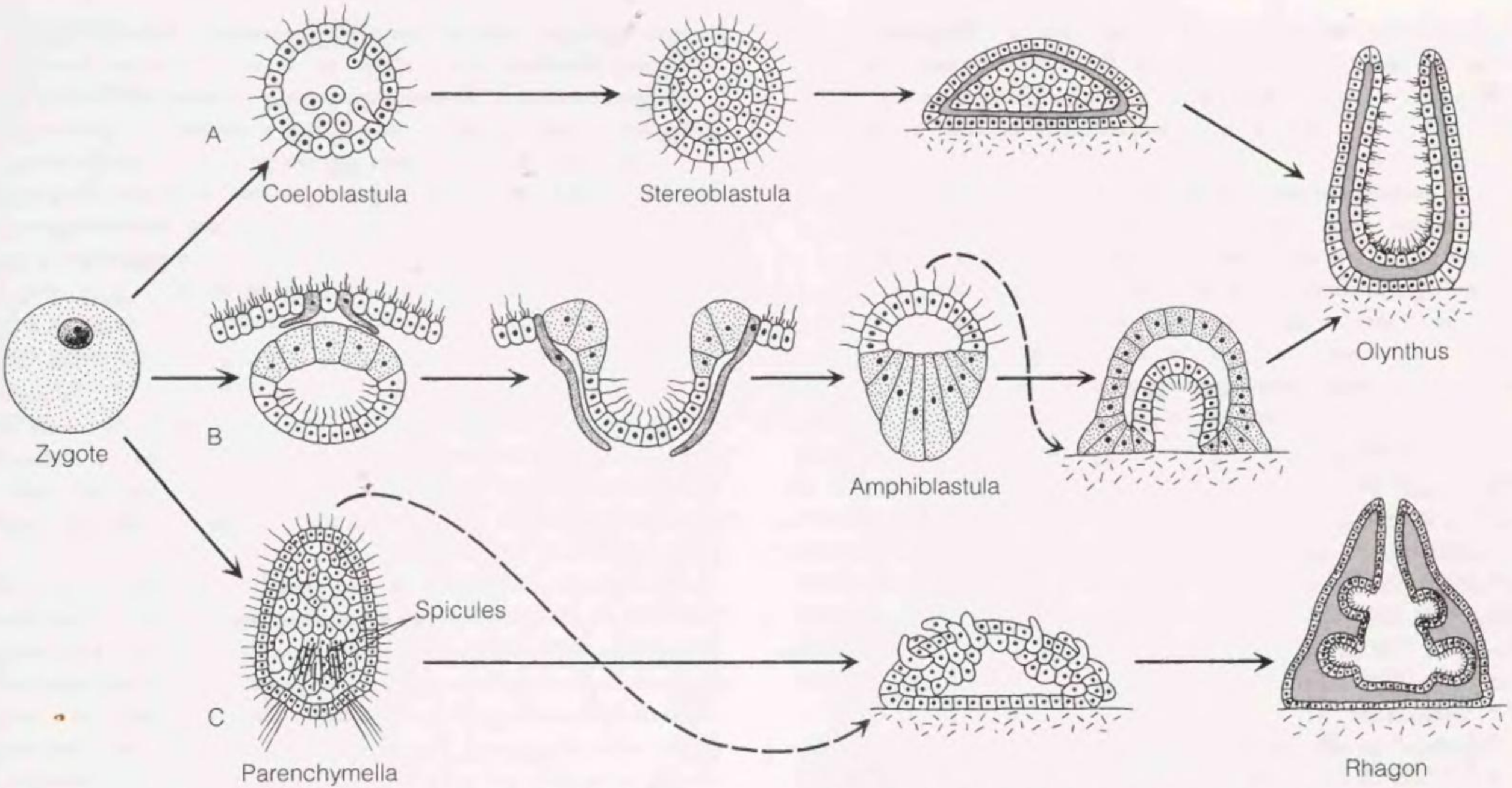
❑Characteristics:

- **Monoecious** - most are hermaphrodites (both sexes)
- **Sperm & ova** - develop from amoebocytes
- **Sperm release** - into water column
- **Fertilisation** - internal (choanocytes capture sperm)
- **Development** - indirect through larvae



Larval Types

- **Coeloblastula:** Hollow sphere with inward-pointing flagella that undergoes inversion to become stereoblastula. Found in Calcarea (Homocoela: *Clathrina* - Lattice Sponge, *Leucosolenia* - White Tube Sponge).
- **Stereoblastula:** Solid larva with exterior flagellated cells produced from coeloblastula inversion; released into plankton for settlement and metamorphosis. Found in Calcarea (intermediate developmental stages in *Clathrina* and *Leucosolenia*).
- **Amphiblastula:** Hollow ball with two distinct cell types (anterior non-flagellated granular cells and posterior flagellated band); undergoes complex metamorphosis with inversion. Found in Calcarea (Heterocoela: *Grantia compressa* - Purse Sponge, *Sycon ciliatum* - Urn Sponge, *Leucosolenia*).
- **Parenchymula:** Solid prefabricated juvenile with uniformly flagellated exterior and differentiated interior (sclerocytes, collencytes, pinacocytes, choanocytes). Found in Demospongiae (~90% of sponges: *Spongilla lacustris* - Freshwater Green Sponge, *Halichondria panicea* - Breadcrumb Sponge).
- **Trichimella:** Solid larva with distinctive band of flagellated cells around equatorial region only; anterior and posterior surfaces non-flagellated. Found in Hexactinellida (glass sponges: *Euplectella aspergillum* - Venus' Flower Basket, *Hyalonema* - Glass Rope Sponge).


A
Coeloblastula
Stereoblastula
Olynthus
Zygote
B
Amphiblastula
Spicules
C
Parenchymella
Rhagon

Distinctive Features VI – Regeneration and Totipotency

- **Experimental Evidence:**
  - Sponge pushed through fine mesh → cells separate
  - Separated cells → reaggregate → reform sponge
  - Shows cells are **totipotent** (can become any type needed)
  - Archaeocytes are key totipotent cell type
- **Lifespan:**
  - Temperate zones: 1-5 years
  - Tropical & deep-sea species: 200+ years
  - Some Antarctic calcified sponges: ~5,000 years!

Distinctive Features VII – Canal system

Feature	Ascon	Sycon	Leucon
Body Wall	Thin, unfolded	Thick, pleated	Extensively folded
Choanocyte Location	Spongocoel wall	Radial canals	Flagellated chambers
Spongocoel Lining	Choanocytes	Flattened cells	Flattened cells
Typical Size	<1-5 cm	5-7 cm	10-100+ cm
Filtration Rate	Low	Moderate	Very high
Evolution	Most primitive	Intermediate	Most advanced
Primary Examples	Leucosolenia, Clathrina, Ascyssa	Scypha/Sycon, Grantia, Leucandra	Most Demospongiae; some Calcarea; some Hexactinellida

Evolutionary Significance:
Progressive increase in surface area & choanocyte number = larger body size & greater feeding efficiency

Distinctive Features VII – Skeleton

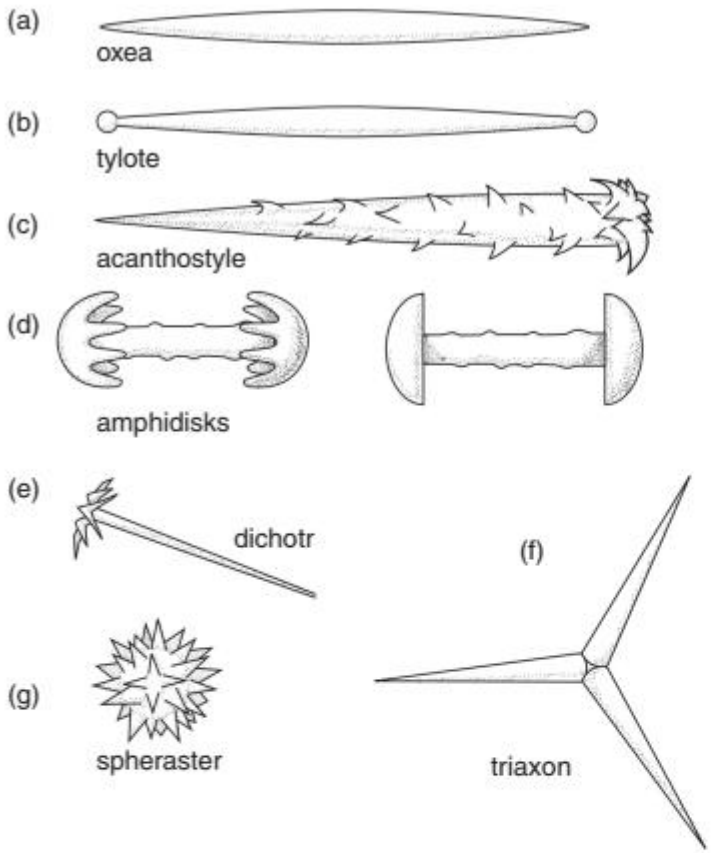
The nature of the skeleton is the PRIMARY basis for classifying Porifera into classes

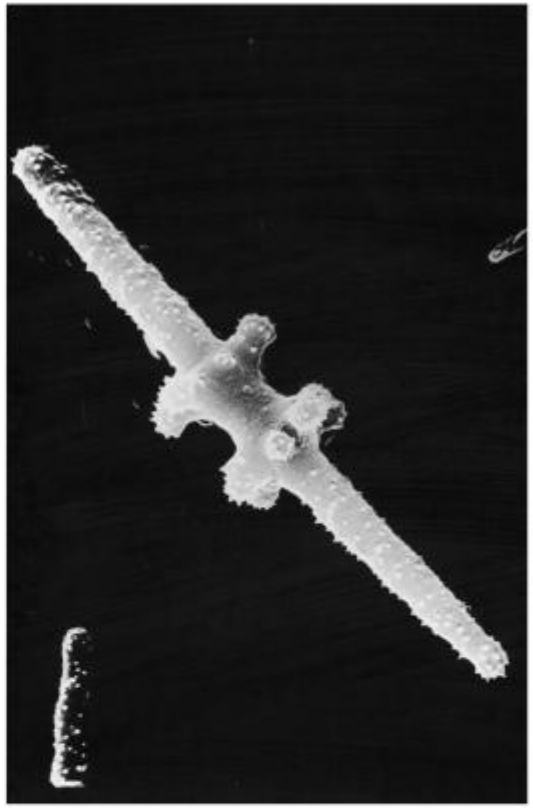
KEY DIAGNOSTIC FEATURE:

- **Skeleton type determines class assignment**
  - Spicule morphology studied under microscope
  - Distinct forms in each class
  - **Detailed morphological classification covered in separate PPT**

Skeletal Type	Composition	Class	Characteristics
Calcareous	$CaCO_3$ spicules	Calcarea	Small sponges, marine, shallow
Siliceous	SiO_2 spicules	Hexactinellida, Demospongiae	Variable size, all depths
Spongin	Organic protein fibres	DEMOSPONGIAE (Keratosa)	Medium size, tropical waters

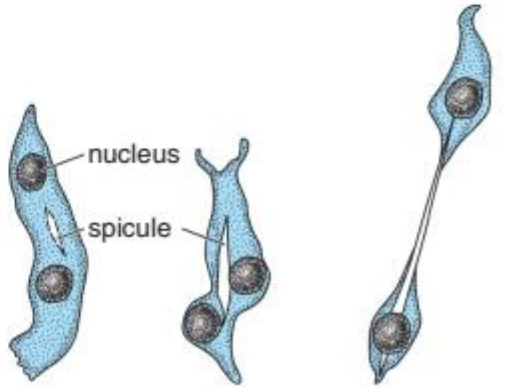
(a–g) Representative sponge spicule morphologies. (i) Scanning electron micrographs of sponge spicules. (h) Small aphiaster from *Alectona wallichii*. (i) Fusiform amphiaster from *Alectona wallichii*. (j–l) The production of a sponge spicule by a binucleate sclerocyte. The spicule is initiated between the two nuclei. After the spicule is completed, the cells will wander off into the mesoglea.





(i)

(h)



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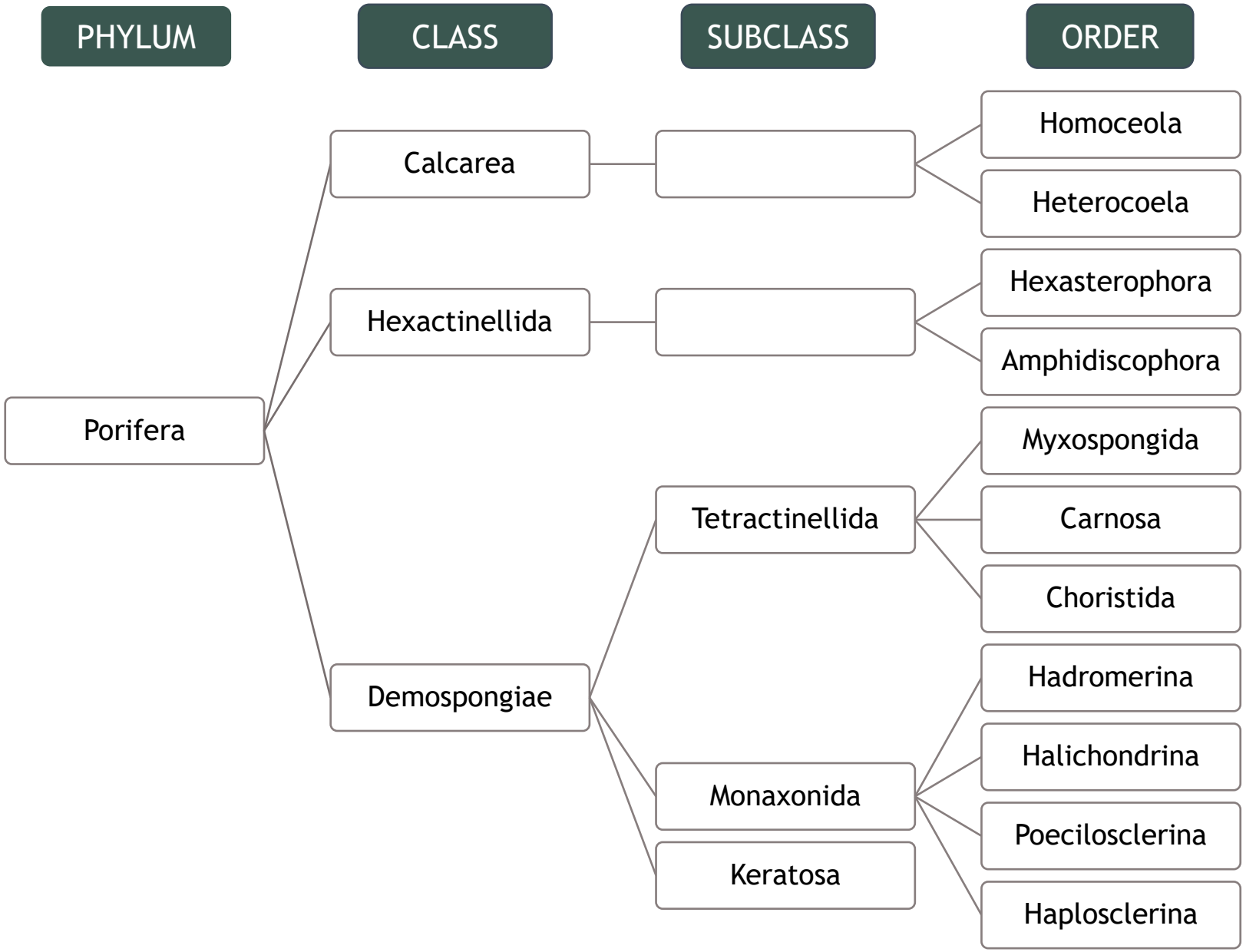


Classification System - Hyman (1940)

Primarily on **skeleton type, canal system type, and associated characteristics**

CLASS CALCAREA - Calcareous Sponges

Etymology:
Calcarea = Latin *calcarius* = **limy** OR Latin *calx* = **lime/chalk**
Meaning: Sponges with **calcium carbonate (chalk-like) skeleton**

Feature	Detail
Skeleton	Free calcareous spicules (87% $CaCO_3$, 7% $MgCO_3$) - NOT fused
Habitat	**Exclusively marine, shallow coastal waters** (<100 metres)
Substratum	Require **hard substratum** for attachment
Size	Small-sized sponges (~10 cm height or less)
Body Shape	**Cylindrical or vase-like**
Osculum	Narrow, terminally placed with oscular fringe
Choanocytes	Comparatively **large collared cells**
Spicules	**Monaxon, triaxon, or tetraxon** forms
Spicule Differentiation	May be differentiated into **megascleres and microscleres**
Canal System	**Asconoid, syconoid, AND/OR leuconoid**
Unique Feature	**ONLY CLASS containing asconoid canal system**
Larva	Amphiblastula type
Species Count	~400-500 described species

ORDER 1: HOMOCOELA (Asconoid Forms)

- **Etymology:**
  - **Homo-** = Greek *homos* = **same, uniform, similar**
  - **-coela** = Greek *koile* = **cavity, hollow chamber**
  - **Meaning: "Uniform cavity sponges"** - simple, undifferentiated spongocoel
- **Defining Features:**
  - Asconoid
  - Radially symmetrical
  - Small body size
  - Most primitive sponges
- **Representative Examples:**
  - *Clathrina* - delicate, net-like colonies
  - *Leucosolenia* - simple, tube-like, often branched

Clathrina

Leucosolenia

ORDER 2: HETEROCOELA (Syconoid/Leuconoid Forms)

- **Etymology:**
  - **Hetero-** = Greek *heteros* = **different, other, varied**
  - **-coela** = Greek *koile* = **cavity, hollow chamber**
  - **Meaning: "Different/complex cavity sponges"** - differentiated cavity system with radial canals
- **Defining Features:**
  - **Syconoid OR leuconoid sponges** (more advanced than Homocoela)
  - **Comparatively large bodies** (larger than Homocoela)
  - **Thick body wall** - folded internally
  - **Only radial canals are lined by choanocytes, Spongocoel lined by flattened endoderm cells**
  - Better filtration efficiency than Homocoela

Scypha – Urn Sponge

Grantia

Leucandra

Comparative tables: Calcarea orders

Feature	HOMOCOELA	HETEROCOELA
Canal Type	Asconoid (simplest)	Syconoid/Leuconoid (more complex)
Body Size	Very small	Larger (up to 10 cm)
Body Wall	Thin, unfolded	Thick, folded
Choanocyte Location	Line spongocoel	Line radial canals
Spongocoel Lining	Choanocytes	Flattened endoderm
Filtration Efficiency	Low	High
Complexity	Primitive, simple	More advanced
Commonality	Rare	More common
Examples	*Clathrina, Leucosolenia*	*Scypha, Grantia, Leucandra*

CLASS HEXACTINELLIDA - Glass Sponges

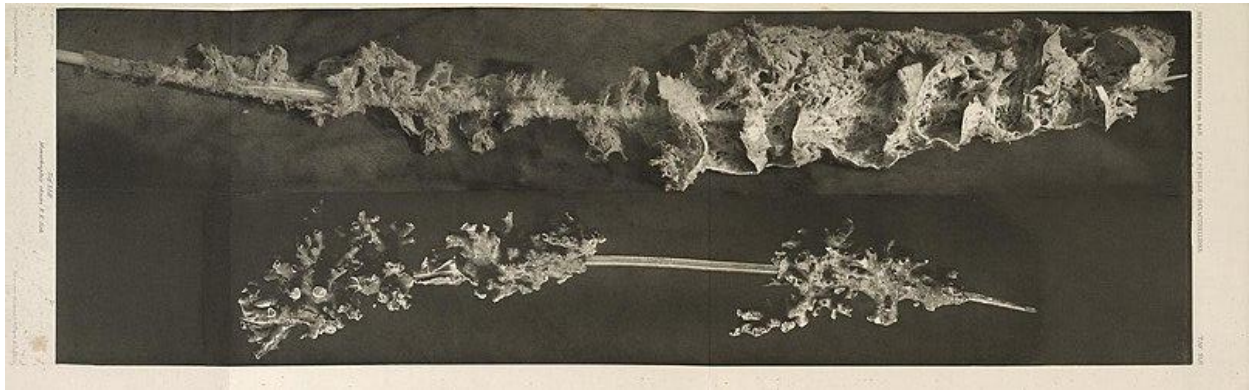
- **Etymology:**
  - **Hex-** = Greek *hex* = **six**
  - **-actis/-actine** = Greek *aktis* = **ray, spoke, needle**
  - **-ell-** = Latin = **diminutive ending**
  - **Meaning**: Literally **"little six-rayed spicules"** - sponges with six-rayed siliceous spicules
- **Also Called:**
  - **Glass Sponges** = Greek *hyaleos* = **glassy, transparent** (appearance)
  - **Triaxonida** = Greek *treis* (three) + *axon* (axle) - three-axial spicules

Feature	Detail
Skeleton	Six-rayed triaxon siliceous spicules (or modifications)
Spicule Arrangement	Separate OR united into networks (fused lattice)
Chemical Composition	SiO_2 86%, water 9%, inorganic elements 3%, spiculin protein 2%
Spicule Differentiation	Megascleres and microscleres ALWAYS distinguished
Outer Layer	NO cellular dermal epithelium - syncytial (multinucleate) - UNIQUE
Choanocytes	Restricted to finger-like chambers (simple or folded) - NOT lining spongocoel
Spongocoel	Encloses interior, opens by wide osculum
Canal System	Syconoid or leuconoid type (NO asconoid)
Size	Large: 10-30 cm average, can reach 1 metre
Body Shape	Cup, vase, urn, or foot-like
Habitat	Exclusively deep-sea (200-1000 metres depth)
Sediment	Can grow in firm and soft sediments
Fossils	Abundant since Palaeozoic (Cambrian/Ordovician)
Common Name	Glass Sponges
Larva	Trichimella type
Species Count	~400 extant species

Order: HEXASTEROPHORA

- **Etymology:**
  - **Hexaster-** = Greek *hex* (six) + Greek *aster* = **star**
  - **-o-** = connecting vowel
  - **-phora** = Greek *pherein* = **to bear, to carry**
  - **Meaning: "Bearers of six-rayed stars"** - sponges that **possess hexaster spicules** (star-shaped microscleres)
- **Key Diagnostic Features:**
  - **Spicules are hexasters** (star-like, 6-rayed forms)
  - **Amphidiscs completely ABSENT** - DIAGNOSTIC
  - **Radial canals or flagellated chambers are simple** (not complex)
  - **Arranged radially in sponge wall**
  - **NOT attached by root tufts**
  - **Commonly attached to hard objects** (rocks, coral)
  - Often **prized museum specimens**

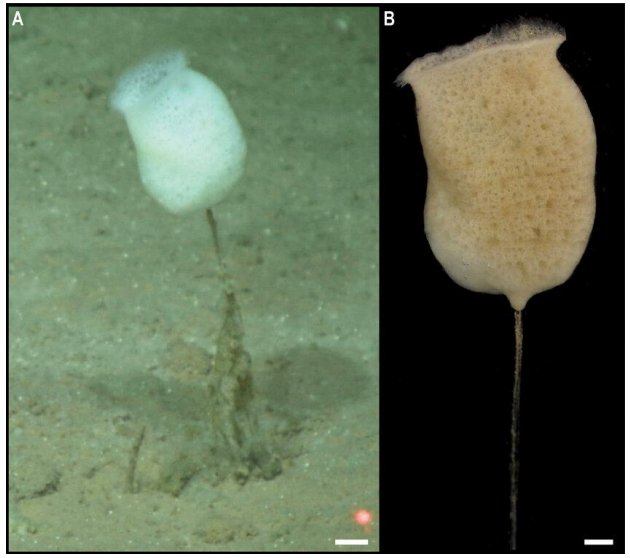
Euplectella aspergillum - Venus Flower Basket



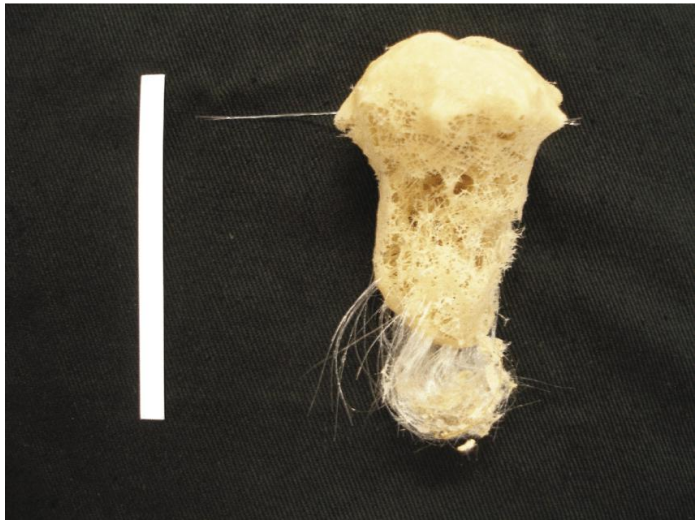
Monoraphis chuni

ORDER 2: AMPHIDISCOPHORA

- **Etymology:**
  - **Amphi-** = Greek *amphi* = **both, around, on both sides**
  - **-disc-** = Greek *diskos* = **disc, plate, disk-like structure**
  - **-phora** = Greek *pherein* = **to bear, to carry**
  - **Meaning: "Bearers of disc-like structures"** - sponges that **possess amphidisc spicules** (disc-shaped with rays from both ends)
- **Key Diagnostic Features:**
  - **Spicules are amphidiscs** (disc-shaped with rays)
  - **Hexasters completely ABSENT** - DIAGNOSTIC
  - **Attached to substratum by distinctive root tufts**
  - Root tufts: **Clustered siliceous spicules** acting as anchors
  - **Inhabit soft sediment** (mud/sand) on deep-sea floor
  - **Can extend several metres** from root tip to sponge body
  - **Adaptation for anchoring** in unstable substrates



Hyalonema - Glass Rope Sponge



Pheronema - Bowl Sponge

Comparative Table: Hexactinellida Orders

Feature	HEXASTEROPHORA	AMPHIDISCOPHORA
Etymology	Hexaster (6-rayed star) + phora (bearing)	Amphidisc (both-sided disc) + phora (bearing)
Spicule Type	Hexasters	Amphidiscs
Root Tufts	ABSENT	PRESENT - diagnostic
Attachment	Direct to hard objects	Via root tufts in soft sediment
Habitat	Hard substrate (rock/coral)	Soft sediment (mud/sand)
Body Morphology	Cylindrical, curved	Cup, vase-shaped
Examples	Euplectella (Venus' Flower Basket)	Hyalonema (Glass Rope Sponge)
Special Features	Symbiotic shrimp relationship	Extended root system

CLASS DEMOSPONGIAE - Overview & Representatives

- **Etymology:**
  - **Demos-** = Greek *demos* = **common people, the masses** (as opposed to aristocracy)
  - **-spongiae** = Greek *sponggia* = **sponge**
  - **Meaning:** Literally **"Common/People's sponges"** - most abundant and diverse sponges (~90% of all living species)

Feature	Detail
Skeleton	**Absent OR siliceous spicules OR spongin fibres OR combination**
Siliceous Spicules	**NEVER triaxon (6-rayed)** - only monaxon/tetraxon forms
Spicule Differentiation	**Generally differentiated into megascleres and microscleres**
Canal System	**EXCLUSIVELY leuconoid type** - DIAGNOSTIC FEATURE
Flagellated Chambers	**Small and rounded**
Habitat	**Mostly marine BUT includes freshwater forms** - UNIQUE among sponges
Freshwater Forms	**Possess contractile vacuoles** for water elimination
Colouration	**Brilliant colouration** in most species (pigment in amoebocytes)
Larva	**Parenchymula type** (not amphiblastula)
Size	Variable, often very large - **largest body sizes**
Body Shapes	**Irregular:** massive, encrusting, branching, funnel-shaped, fan-like
Depth Range	**Shallow water to great depths**
Species Count	**~7,500 living species (~90% of all sponges!)**
Distribution	**Worldwide, all depths**

SUBCLASS I: TETRACTINELLIDA

- **Etymology:**
  - **Tetra-** = Greek *tetras* = **four**
  - **-actin-** = Greek *aktis* = **ray, needle, spoke**
  - **-ellida** = Latin/Greek diminutive class suffix
  - **Meaning**: Literally **"bearing little four-rayed spicules"** - characterized by tetraxon (4-rayed) spicules
- **Diagnostic Features:**
  - **Tetraxon (4-rayed) siliceous spicules** present
  - **Spongin fibres typically absent**
  - Spicules **sometimes completely absent** (Myxospongida)
  - Body: **Rounded, flattened, or cushion-like** - usually without branches
  - **Shallow water forms**
  - **Canal system: leuconoid type**

ORDER 1: MYXOSPONGIDA

- **Etymology:**
  - **Myxo-** = Greek *myxa* = **mucus, slime, snot**
  - **-spongida** = sponge order
  - **Meaning: "Mucus/gelatinous sponges"** - soft, jelly-like (no skeletal support)
- **Diagnostic Features:**
  - **Extremely simple structure** - most primitive demosponges
  - **Skeleton and spicules completely absent** - NO skeletal elements
  - **No supporting framework**
  - **Structure simple and undifferentiated**

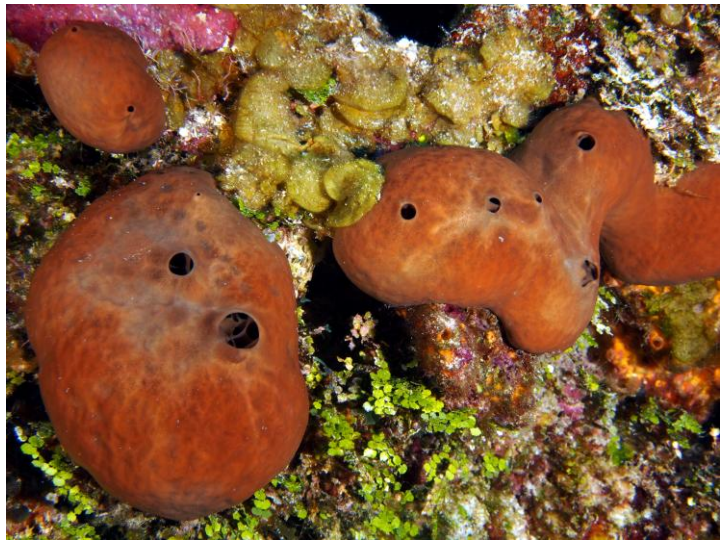
Oscarella

Haliscara

ORDER 2: CARNOSA

- **Etymology (Carnosa):**
  - **Carno-** = Latin *carnis* = **flesh, meat**
  - **-sa** = Latin possessive ending
  - **Meaning: "Fleshy sponges"** - soft, flesh-like composition
  - **Alternative names:**
  - **Homosclerophora** = Greek *homo* (same) + *sclero* (hard) = "uniform hardness"
  - **Microsclerophora** = Greek *micro* (small) + *sclero* (hard) = "small hard parts"
- **Diagnostic Features:**
  - **Simple structure**
  - **Megascleres and microscleres NOT distinctly separable** - NOT differentiated
    Spicules similar in size throughout skeleton
  - **Asters may be present** as microscleres
  - **No clear megaclere/microsclere distinction** - DIAGNOSTIC

Plakina



Plakortis

ORDER 3: CHORISTIDA

- **Etymology:**
  - **Chorist-** = *Greek choristos* = **separated, distinct, differentiated**
  - **-ida** = order name suffix
  - **Meaning: "Separated/differentiated sponges"** - distinct spicule types separated into megascleres and microscleres
- **Diagnostic Features:**
  - **Long-shafted triacnes present** (3-pronged megascleres)
  - **Megascleres and microscleres distinctly differentiated** - DIAGNOSTIC
    Clear separation between spicule types
  - **Microscleres include asters and/or sigmas**

Geodia – Leathery Barrel Sponge

Ancorina

Craniella

SUBCLASS II: MONAXONIDA

- **Etymology:**
  - **Monax-** = Greek *monos* (single) + Greek *axon* = **an axle, axis**
  - **-onida** = subclass name suffix
  - **Meaning: "Single-axled/uniaxial sponges"** - megascleres grow along one axis only
- **Diagnostic Features:**
  - **Megascleres are monaxonial** (single axis - NOT 4-rayed like tetraxons)
  - **Spongin may or may not be present**
  - **Spicules distinguished into megascleres and microscleres**
  - **Highly variable body forms** - rounded, branching, elongated, stalked, funnel, fan-shaped
  - **Most diverse subclass** - abundant worldwide
  - **Shallow and deep-water forms**
  - **Includes freshwater species** - MAJOR GROUP for freshwater adaptation
  - **Canal system: leuconoid type**

ORDER 1: HADROMERINA (Astromonaxonellida)

- **Etymology:**
  - **Hadro-** = Greek *hadros* = **thick, strong, robust**
  - **-merina** = order suffix (possibly from Greek *merion* = part)
  - **Meaning: "Thick-spicule-bearing"** - robust skeletal organization
  - **Alternative:** Astro- (star) + monaxon + ell (diminutive) = "star-bearing monaxons"
- **Diagnostic Features:**
  - **Megascleres mostly tylostyles** (monaxons with broad, knobbed end)
  - **Microscleres when present are asters** (star-shaped) – DIAGNOSTIC
  - **Spongin fibres completely absent** - NO organic fibres
  - Simple skeletal organization

Cliona – Boring sponge / Sulphur sponge

Poterion – Neptune's Goblet

ORDER 2: HALICHONDRINA

- **Etymology:**
  - **Hali-** = *Greek hals* = **salt, sea, marine**
  - **-chondrina/-chondrida** = *Greek chondros* = **cartilage, grain, granule**
  - **Meaning: "Sea-grain sponges"** or **"marine cartilage sponges"** - marine habitat with granular composition
- **Diagnostic Features:**
  - **Megascleres ALWAYS of more than one kind** - at least 2 types present
  - **Both monactines and diactines present** - DIAGNOSTIC
  - **Microscleres typically absent** (though may occasionally be present)
  - **Spongin fibres present BUT scanty** - very little spongin
  - Relatively simple skeletal arrangement

Halichondria – Breadcrumb sponge

ORDER 3: POECILOSCLERINA

- **Etymology:**
  - **Poecilos** = *Greek poikilos* = **varied, variable, diverse, motley**
  - **-scler-** = *Greek sclero* = **hard, hardness**
  - **-ina/-ida** = order name suffix
  - **Meaning: "Varied-hard-parts sponges"** or **"diverse-skeletal sponges"** - highly diverse spicule types and arrangements
- **Diagnostic Features:**
  - **Megascleres usually of two or more kinds** - multiple spicule types
  - **Megascleres are localized in distribution** - specific placement patterns
  - **Reticulate skeleton** (net-like arrangement of spicules)
  - **United by spongin** - spongin connects spicules
  - **Echinating spicules often present** (protruding forms)
  - **Microscleres include sigmas, chelas, and toxas** (curved/hook-shaped types)
  - **Complex skeletal organization** - most intricate

Myxilla

Microciona

ORDER 4: HAPLOSCLERINA

- **Etymology:**
  - **Haplo-** = *Greek haploos* = **simple, single, unduplicated, plain**
  - **-scler-** = *Greek sclero* = **hard, hardness**
  - **-ina/-ida** = order name suffix
  - **Meaning: "Simple-hard-parts sponges"** or **"uniform-skeletal sponges"** - monomorphic (all same type) megascleres
- **Diagnostic Features:**
  - **Megascleres are ALWAYS diactinal** (growth at both ends, two-rayed)
  - **Megascleres of only ONE kind** (monomorphic) – DIAGNOSTIC
  - **Megascleres NOT localized** - distributed throughout skeleton
  - **Microscleres may or may not be present**
  - **Spongin fibres usually present** (often abundant)
  - **INCLUDES FRESHWATER SPECIES** - most important group for freshwater adaptation
  - **Most diverse order for freshwater forms**
  - Often **branching or finger-like body shapes**
  - **Most successful and widespread monaxonid order**

ORDER 4: HAPLOSCLERINA

Haliclona – Finger sponge

Chalina – Mermaid's glove

Ephydatia – Freshwater sponge

Spongilla – Freshwater sponge

SUBCLASS III: KERATOSA

- **Etymology:**
  - **Kerat-** = *Greek keras* = **horn, horny substance**
  - **-osa** = Latin possessive ending = **composed of, resembling, possessing**
  - **Meaning:** Literally **"horny sponges"** or **"horn-like sponges"** - skeleton resembles horn
- **Diagnostic Features:**
  - **Skeleton composed EXCLUSIVELY of spongin fibres** - DIAGNOSTIC FEATURE
  - **Siliceous spicules completely absent** - NO spicules present
  - **Network of spongin fibres** forms supporting framework
  - Body: **Rounded and massive** with prominent oscula
  - **Conspicuous oscula on surface** - often visible
  - **Found in shallow warm waters** - tropical and subtropical regions
  - **ALL MARINE** - no freshwater keratose sponges
  - **Commercially most important** - primary bath sponge source
  - **Fine, flexible texture** due to pure spongin composition
  - **Golden-yellow to brown colouration**
  - **Economic value** - harvested for human use

SUBCLASS III: KERATOSA

Euspongia officianlis – Bath Sponge

Phyllospongia – Leaf-shaped Sponge

Hippospongia – Horse Sponge