Contents

PLACOZOA

"Small multicellular hairy sticky flat things"

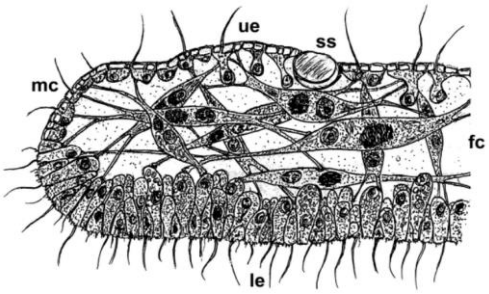
- Two species described in this phylum
  1. Trichoplax adharens
  2. Treptoplax reptans
- Smallest amount of DNA yet measured for any animal sequenced
- Few thousand cells
- 4-5 cell types
- Capable of moving over benthic substrate
- 7 distinct clades (identified by 16S ribosomal sequencing)
- Tropical/subtropical
- Calm, hard substrate e.g. rocky shores
- Pre-cambrian evolution
- Chemical deterrent defence → possess several proteins in known venoms and Hydroids paralyse or die when fed *Trichoplax*

BODY PLAN

- No obvious back or front
- Distinctive top and bottom: top = protective; bottom = nutritive
- Movement by cilia or contraction of fibre cell layer
- No muscles
- No nerve net (but encodes for neurotransmission machinery)
- No apparent ECM (but encodes for ECM adhesion proteins)
- Encodes for large number of transcription factors typically associated with cell differentiation

5 CELL TYPES

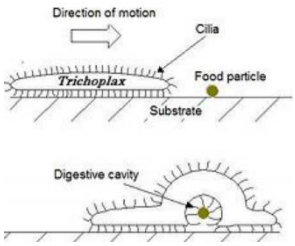
1. **COVER CELL** = flagellated T-cells, nucleus connected to each other through belt desmosomes
2. **CYLINDRICAL CELLS** = flagellated cells
3. **GLAND CELLS** = flagellated cells
4. **FIBER CELLS** = syncytial (fused cells) forming a three-dimensional structure between top and bottom (epithelioid)
5. **MARGINAL CELLS** = thick cord of pluripotent (can differentiate) small ovoid cells around entire margin of body



EPITHELOID = has desmosomes (junctions) but not a 'true' epithelium because no basal lamina

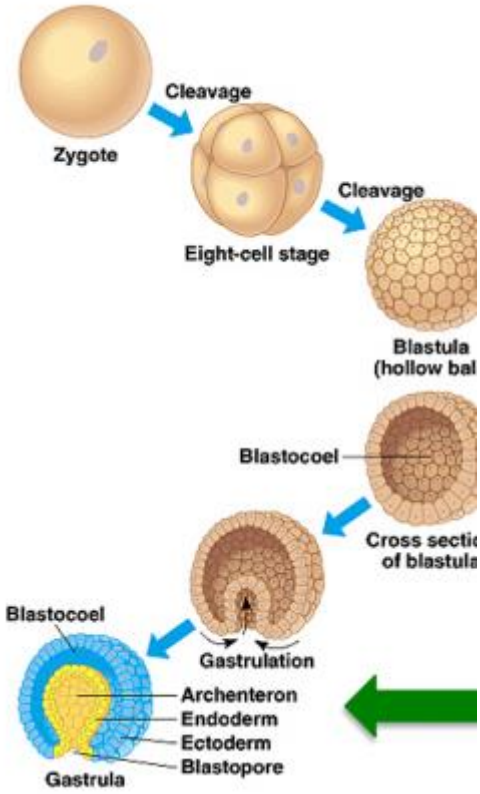
NOTE = number of desmosomes and therefore permeability differ between clade A and clade B (A>B)

FEEDING



- Feed with ventral surface producing digestive enzymes
- Extracellular digestion → ventral cells engulf already dissolved or broken down food via pinocytosis
- Can convert ventral surface into a sac to improve efficiency of digestion

REPRODUCTION



- Asexual reproduction – binary fission
- Sexual reproduction
  - All evidence based on lab cultures (limited)
  - Evidence of allele shuffling
  - At high animal density and low food:
    1. Oocytes derived from lower epidermis when parent starts to degenerate
    2. Fertilisation follows
    3. Membrane forms around egg and cleavage begins
    4. Early embryos released with death of parent
  - Haven't been able to determine whether gastrulation formation occur → therefore we don't know if lower epithelioid is derived from endodermal cells

FEEDING MODE OF LAST COMMON PLACAZOAN ANCESTOR?

Microphagous = intracellular digestion of small particles through phagocytosis

Macrophagous = extracellular digestion of large particles followed by pinocytosis

SCENARIO 1

Last common ancestor = microphagous (lower epithelioid not derived from endoderm following gastrulation; Eumetazoa and Placozoa branched off from this)

SCENARIO 2 (most likely)

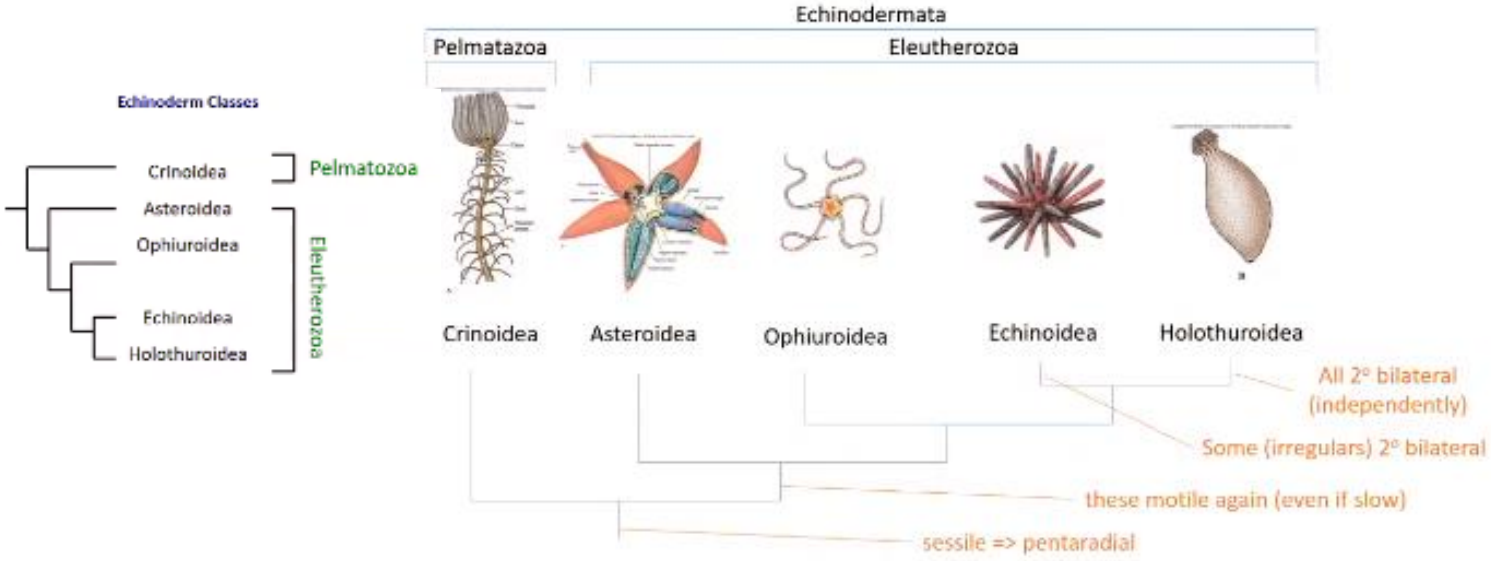
LCA = macrophagous via central sole; no gut (gut was later evolved in Eumetazoans) → evidence of this scenario in feeding traces on microbial mats (*Dickinsonia spp.* Suggests transition species from sponge to Placozoa)

SCENARIO 3

LCA = macrophagous via gut (gut was lost in modern Placozoa but kept by Eumetazoa)

- Asteroid metamorphosis – hydrocoel becomes the water vascular system in adult; change to pentaradial symmetry after settlement
- EVIDENCE OF BILATERIA: Ancestor echinoderm was found with bilateral symmetry; speculate that some became attached to the sea floor, becoming more sessile – radial symmetry is an advantage for sessile feeders to pentaradial symmetry evolved

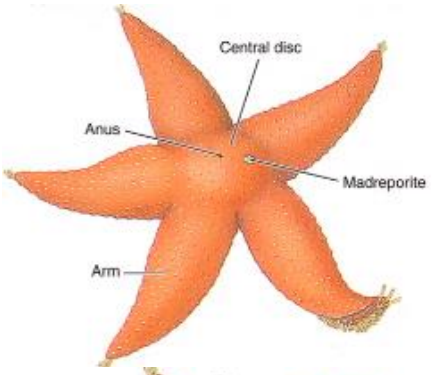
    - Plematozoa – mouth faces upward
    - Eleutherozoa – mouth faces downward



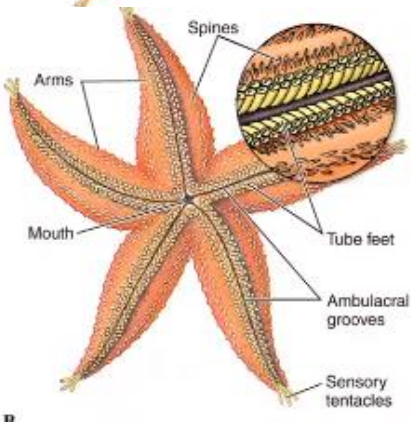
KEY CHARACTERISTICS OF ECHINODERMS

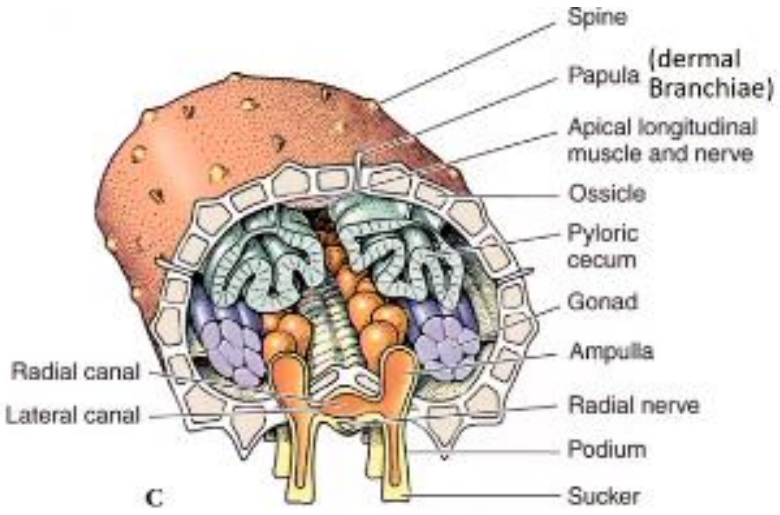
- **Adults pentaradial symmetry**
- **No distinct brain**
- **Spiny endoskeleton plates – network of calcareous ossicles connected together by <u>catch collagen</u> – goes from solid (locked ossicles) to liquid allowing sea star arms up and down (can hold posture for long time with little energy)**
- **Water vascular system – develops as part of the coelom**
- **All marine – no distinct osmoregulatory organ; not capable of living in freshwater**
- **Dermal branchiae – papule; skin gills for respiration and N waste excretion**
- **Pedicellarie – jaw-like projections on outside of body surface**
- **3 compartments in adult coelom**
    - **True coelom = fluid filled, contains amebocytes, ciliated lining for circulation, bathes oragns, dermal branchiae projected from here**
    - **Hydrocoel – locomotion**
    - **Haemocoel – (perihemal channels) not well developed in sea stars, enclosed within part of the true coelom, up nutrient transferred from digestive organs to gonads and podia**
- **Pedicellaria – spines arise to a greater or lesser extent from the dermal ossicles**
    - **Muscle controlled**
    - **Pincers, pliers – clean skin from parasite**
    - **Food collection**

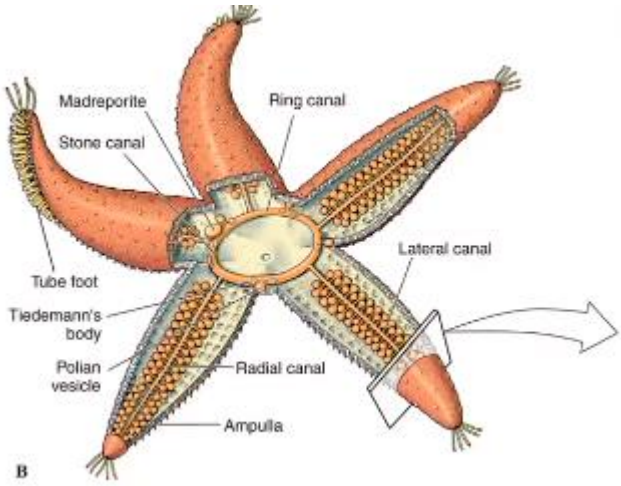
CLASS ASTEROIDEA – sea stars/star fish



- Inconspicuous anus (upper side is aboral)
- Conspicuous madreporite – external opening to water
- Typically, 5 arms but may have more
- Regeneration of individual arms & clones
  - Difficult to kill
  - Injecting CaCl into coelom is used to control crown of thorns starfish
- Oral side – sensory tentacles on end of each arm
  - Ocellus
  - Ambulacral grooves – lines with spines
  - Ines with tube feet or podia – locomotion, feeding & resp
- Spines = project from ossicles lying within connective catch collagen
- Dermal branchiae = papulae; delicate extensions of the coelom into seawater for respiration and excretion (respiration via diffusion into coelom; excretion by diffusion out via these papulae)
- Coelomocytes = transport wastes to tube feet
- Pyloric caecum = an extension of the digestive system



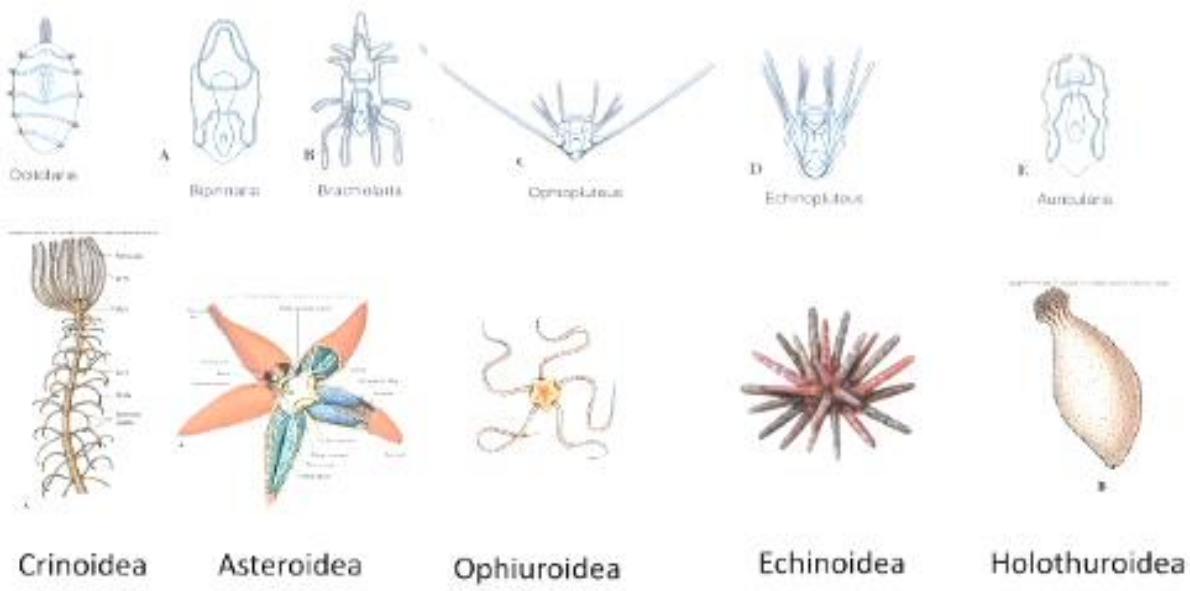




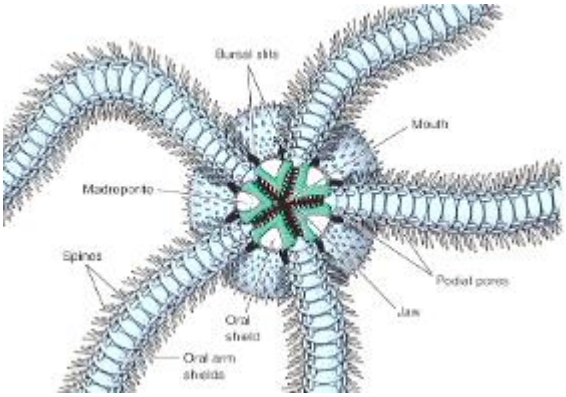
- Water vascular system
  - Part of coelom that develop from hydrocoel
  - Ring canal, radial canals, lateral canals, ampullae and tube feet
  - Hydraulic system for extending, retracting and generally controlled tube feet (coordinated by the radial nerves)
  - Madreporite = hydraulic fluid pressure/volume regulator
  - Ampullae = localised (coelomic) fluid reservoirs; muscular contraction sends fluid into feet; longitudinal muscle in feet contract to shorten them (forces fluid back into ampullae) → radial nerve coordinates foot movement
- Digestive and haemal systems
  - Large cardiac stomach is eversible
  - Digestion mainly extracellular – within stomach cavity

- Most body fluid circulation is likely to occur though the various parts of the ciliated coelom
- Haemal system enclosed in a third coelomic compartment – function unclear – absorbed nutrients appear here after feeding and are transported to gonads and podia

Types of echinoderm larvae – class specific



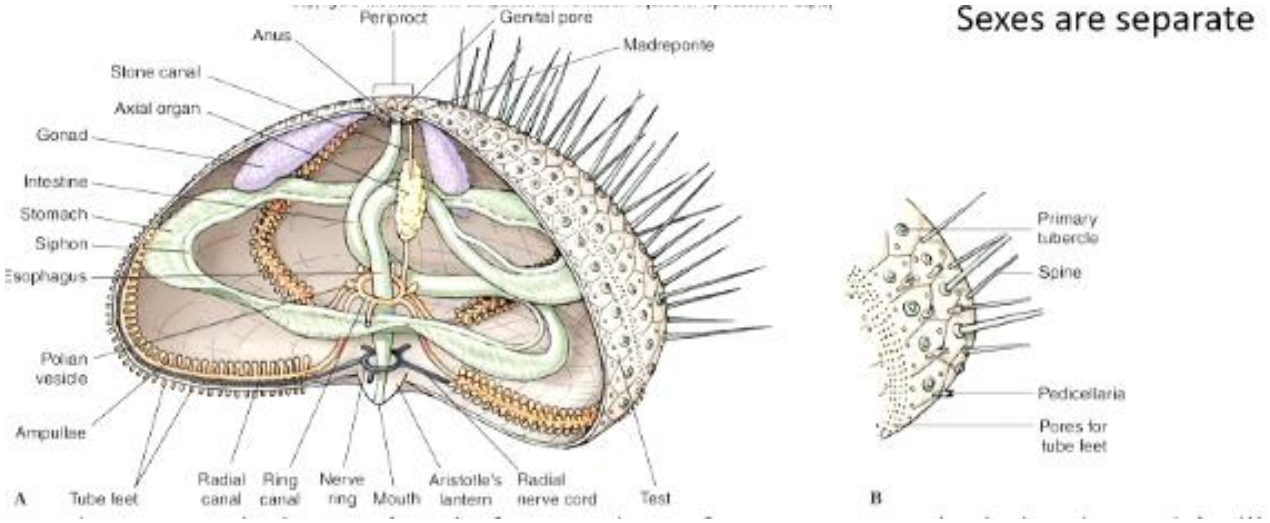
CLASS OPIUROIDEA – brittle stars and sea baskets



- Comparing to asteroids
  - Arms sharply distinguished from central disc
  - Lack pedicellariae and papulae
  - Ambulacral grooves closed – covered by ossicles
  - Bursae connect to outside via bursal (genital) slits at the bases to arms
  - Water circulates across bursae for respiratory exchange
  - Gonads associated with bursae release gametes into the bursae and out through bursal slits
  - Some have light detectors on ossicles
  - Simple saccular stomach – no intestine or anus; visceral organs confined to disc
  - Madeporite on oral end not aboral
  - Tube feet lack suckers – used for feeding more than locomotion; move food to mouth
  - Tube feet lack ampullae – extend by muscles alone
  - Locomotion by muscle movement not tube feet
  - 5 moveable plates act as jaws
- Brittle stars = feed on seafloor, grazing, detritus feeding, predators, scavengers
- Basket stars = filter feeders

CLASS ECHINOIDEA – sea urchins

- Similar to asteroids
    - Retain pentaradial symmetry in regular echinoids – 5 ambulacral grooves
    - Spines – stiff and moveable on ball and socket joints
    - Pedicellaria – some with venome gland
    - Oral surface bearing the tube feet has extended to the aboral side, so the abulacral grooves converge on periproct
    - Dermal ossicles expanded into closely fitted plates forming an endoskeletal test (shell)
    - Ambulacral groove marked by rows of holes in the test & are closed
    - Podia connect to ampulla through these pore – two pores per ampulla unit
    - Move tube feet with help of spines



- Feeding
    - Grazers
    - Inside test is a coiled digestive system; longer than that in asteroids
    - Ciliated siphon allows water to bypass the stomach – maintaining concentration of food passing into intestine
    - 5 teeth attached to a complex chewing mechanism (ARISTOTLE'S LANTERN) unique to regular urchin and sea dollars
- Irregular sea urchins: sand dollars and heart urchins
    - Secondarily bilaterally symmetrical
    - Change in shape allows more efficient access to water and oxygen within sediments and burrows
    - Live buried in sediment – degree of faltering correlated with grain size of sediment
    - Move by movement of spines rather than tube feet

CLASS HOLOTHUROIDEA – sea cucumbers

- Retain elements of pentaradial body plant – 5 ambulacral modified grooces
- Secondarily bilateral with extended oral-aboral axid
- Elongated body
- Dermal ossicles much reduces – soft bodies

FISH LOCOMOTION

Properties of water

- Universal solvent – mix of gases, solutes, ions etc
- Thermally stable and constant relative to air
- **Density – 800x density of air**
- **High viscosity - 15x air**
- **Incompressible**
- Low oxygen concentration 1/20 of air, <10ml oxygen per litre
- Rate of diffusion for oxygen 300,000x slower than air
- CO_2 highly soluble in water
- NH_3 (NH_4^+) highly soluble in water

Advantages

1. Increased buoyancy with greater density
2. Generate force against medium (an incompressible fluid)
3. Reduce effect of gravity

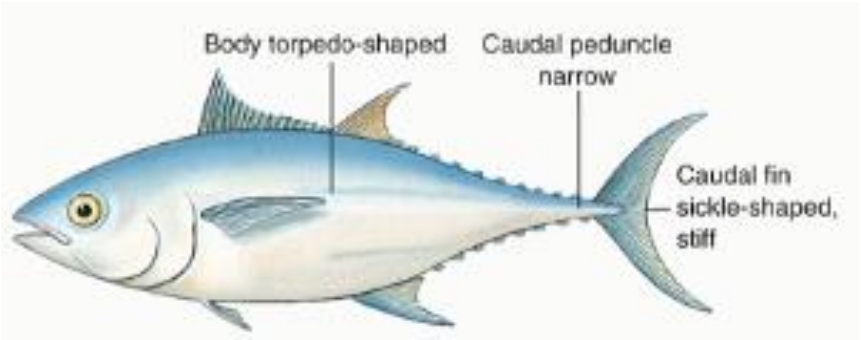
Disadvantages

1. Increased drag with increase in viscosity
2. Greater effort/energy required to swim through water

Body form

Reduce drag; increase swimming speed

- Streamlining
- Scales and mucus
- Fusiform body shape



The machinery

- Axial musculature – skeletal muscle
- Segment muscle blocks – myotomes
  W shape
  Spiral pattern of muscle fibres
- Sheets of collagenous tissue – myosepta (which attach to vertebral column)
  (Muscle fibres do not attach directly onto vertebral column)