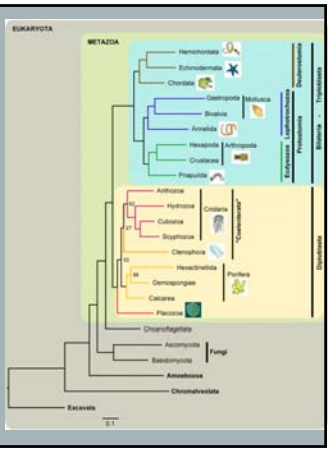
Major divisions of Animalia

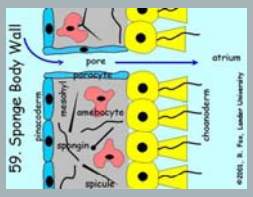
Parazoa vs. Eumetazoa
Radiata (Diploblasts) vs. Bilateria
Within the Bilateria
Protostomes and Deuterostomes

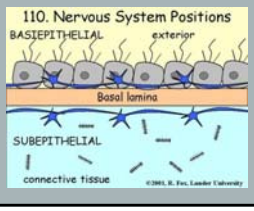


Major divisions of Animalia

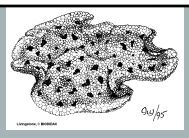
Parazoa vs. Eumetazoa
Tissue Organization

- Parazoa minimal tissue organization
  - Grind a sponge, it can reaggregate
  - No true epidermis
- Eumetazoa
  - tissues and organs present; nervous system with neurons
  - Epidermis regulates material passage to various compartments





Parazoa



Phylum Porifera

- Sponges– more later
- Probably more than one phylum, really

Phylum Placozoa

- Phylogenetic position is controversial-conflicting results from ribosomal and mtdna studies
  - often been seen as the "living ancestor" of animals
  - Is it a sister to all animals, bilaterians, or does it fit in the cnidarians?
- 1 species *Trichoplax adhaerens*
  - easily collected in tropical lagoons, but range not known
- Another was once reported but never seen again
  - 1st found in an aquarium
- Most simply organized multicellular animal known
  - only a few thousand cells & only 4 somatic cell types
- no symmetry, although has upper/lower (not true dorsoventrality)
  - a few fibric cells in between
- looks like pinkish, moving deposits in aquaria
- smallest amount of DNA ever measured for any animal.

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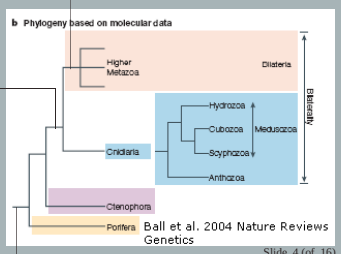
Parazoa

Phylum Placozoa

- Phylogenetic position is controversial-conflicting results from ribosomal and mtdna studies
  - often been seen as the "living ancestor" of animals (basal)
  - Is it a sister to all animals, bilaterians, or does it fit in the cnidarians?

sister to the bilaterians

sister to the Eumetazoa Srivastava et al Nature 2008. 104 nuclear genes found genes in *Trichoplax* associated with advanced cell types and processes



sister to all animals

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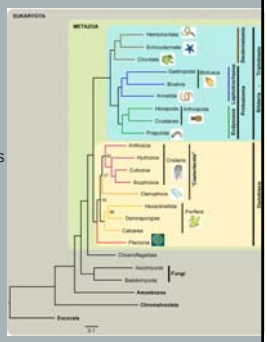
Parazoa

Phylum Placozoa

- Schierwater et al. PLOS 2009
- "Total Evidence" analysis
  - sum of morphological evidence, the secondary structure of mitochondrial ribosomal genes, and sequence data from mitochondrial and nuclear genes
  - *Bilateria* and *Diploblasts* are sister groups
  - *Placazoa* is basal to all diploblasts



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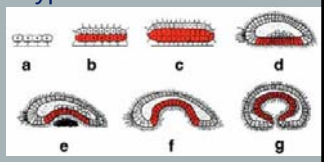
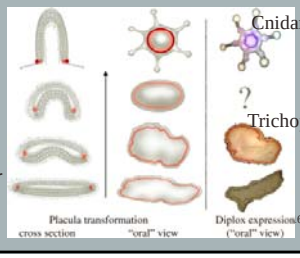
Placula hypothesis

Attempt to explain evolution of metazoans from protists

Flagellated protozoans unite to form a plate-like metazoan organism. The one-layered protist form (a) evolves to the two-layered "placula" (b,c). Cells of the upper layer form the ectoderm, while cells of the lower layer (orange) adopt a feeding function and later invaginate to form the entoderm (d-g)





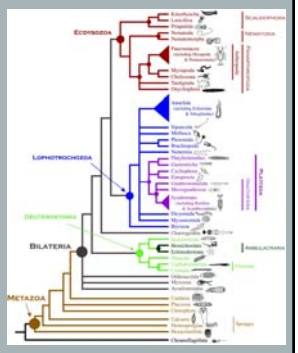
Slide 6)

Eumetazoa

Innovations:

1) true epithelia
   - permit establishment of regulated compartments
   - control passage of materials
   - chemical environment can be controlled
2) bodies with definite axes
   - e.g. anterior-posterior or oral-aboral
3) tissues and cells with greater differentiation

   muscle and nervous tissues present
4) gut
5) often with large, complex, motile bodies



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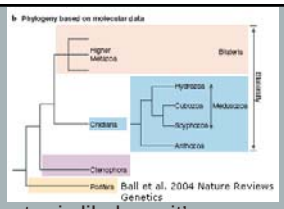
Radiata



Radial symmetry as a character is likely on it's way out – other molecular/developmental characters would replace

Cnidaria: hydras, jellies, sea anemones, and coral animals

Ctenophora: Comb jellies

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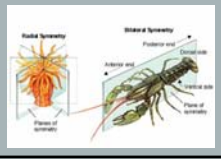
Eumetazoa

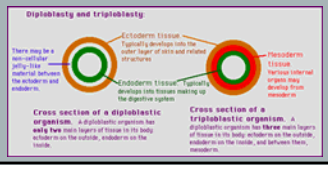
Diploblasty versus Triploblasty

- number of tissue layers forming during gastrulation
- Diploblast:
  - epidermis derived from ectoderm
  - gastrodermis derived from endoderm
- triploblastic: three embryonic tissues (germ layers:)
  - ectoderm: outer layer - skin and nervous tissue
  - endoderm: inner layer - lines digestive tract
  - mesoderm: middle layer - muscles, bones, circulatory system, organs

Parazoa and Eumetazoa:Radiata are diploblasts (maybe??)

- It's looking like ctenophores and cnidarians might have mesoderm





Bilateria: Protostomes vs. Deuterostomes

Protostomes:

- Lophotrochozoa and ecdysozoa

Deuterostomes:

- echinoderms, chordates, hemichordates

Developmental differences distinguish the two groups

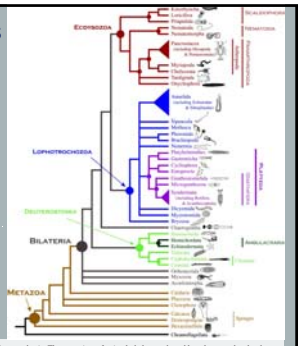
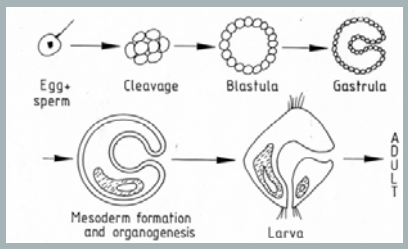


Figure 2 Modern synthesis. The new view of animal phylogeny based largely on molecular data. This figure is intended to be slightly conservative in nature, as poorly resolved issues are shown as polytomies. Brown is Metazoa, gray is Bilateria, green is Deuterostomia, dark green is Ambulacraria, red is Ecdysozoa, blue is Lophotrochozoa, magenta is Platyzoa, and black is nonmetazoan. Nested clades of one color may be inside a more inclusive clade of another color. For example, Echinodermata is dark green because it is within Ambulacraria, but it is also a deuterostome (green), bilaterian (gray), and metazoan (brown). Note that Siboglinidae is the preferred name for the pogonophoran/vestimentiferan lineage, and the position of Orthonectida as a basal bilaterian needs confirmation. Filled circles correspond to labeled nodes. Dashed vertical lines indicate groups that are not monophyletic.

Animal embryogenesis - the basics



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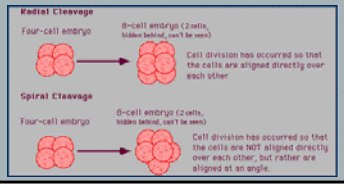
Willmer 1990 p103

Bilateria: Protostomes vs. Deuterostomes

Cleavage

- spiral vs. radial
  - Protostome: spiral: as embryo goes from a 4 to 8-cell, the cells divide at slight angles to one another, so that the none of the 4 cells in one plane of the eight-cell stage is directly over a cell in the other plane.
  - Deutero: radial: each cell in the top four cell plane is directly over one other cell in the bottom plane.



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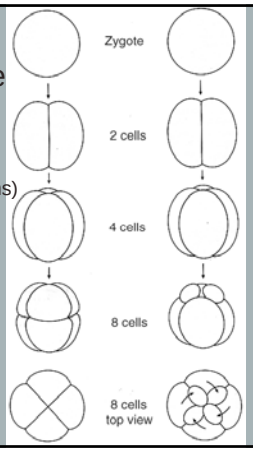
Radial cleavage

Found in many deuterostomes (e.g. echinoderms)

Daughter cells align in rows



Spiral cleavage

Found in many protostomes (e.g. annelids molluscs)

Daughter cells bud off at an angle to the body axis

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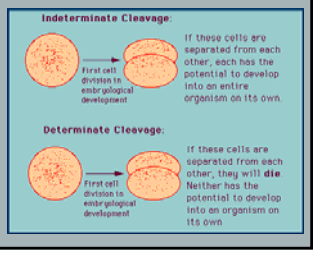
Protostomy vs. Deuterostomy

Cleavage

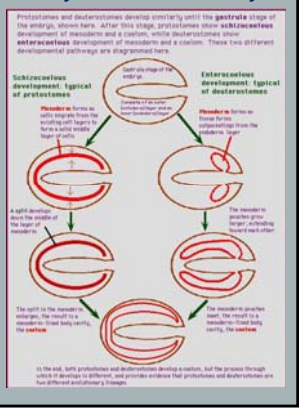
- determinate (proto) vs. indeterminate (deutero)
- determinate: protostomes after the intitial cell division the fate of the resulting daughter cells is determined -- can only develop into specific tissues, not whole organisms.
- Indeterminate: each daughter cell can dev. into entire organism.
- Sometimes this occurs;
  - identical twins



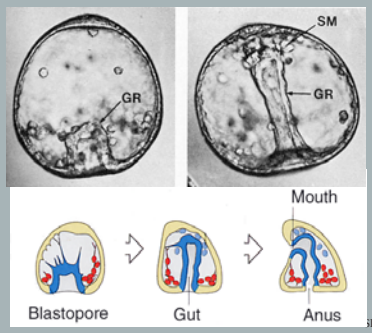
Protostomy vs. Deuterostomy

schizocoely (proto) vs, enterocoely (deutero)

- coelom
  - body cavity, within which internal organs can develop
  - completely lined with tissue of mesodermal origin.
  - S: the mesoderm, and coelom, initially develop from a solid block of mesoderm tissue that develops a split down the middle
  - E: The mesoderm, and coelom, from outpocketing of the primitive digestive tract (the archenteron)
- blastopore fate
  - Protostome=mouth, Deuterostome=anus

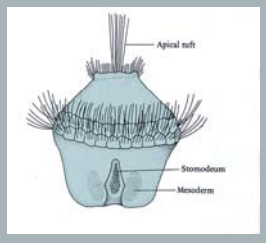


Mouth formation in a deuterostome (Echinoderm, sea urchin)

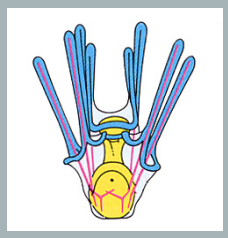


Sources: Gilbert and Raunio 1997, fig 16.11; Wolpert 1998 fig 6.19

Larval forms of protostomes and deuterostomes



Trochophore larva of Mollusc (marine snail)



Pluteus larva of Echinoderm (sea urchin)