BIO 221
Invertebrate Zoology I
Spring 2010

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http://www4.nau.edu/isopod

Lecture 13

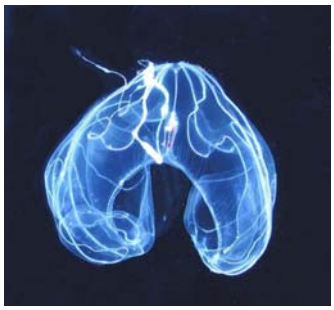
Evolution of Semelparity

2. If reproduction is favored at certain times and not others

a. e.g., for larval dispersal.

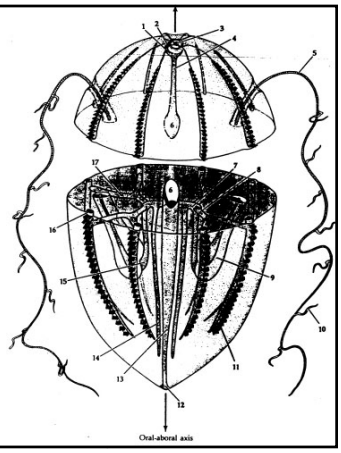
b. *And* if adult survivorship is low until next time,

c. *And* if fecundity is dependent on body size,



Evolution of Semelparity

d. may favor single explosive reproductive event.

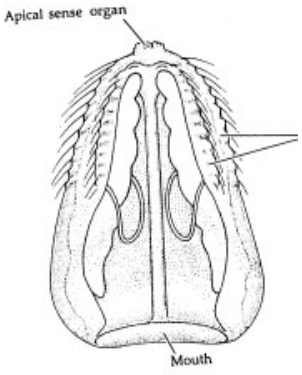


Ctenophoran Larvae

d. Larval stage is cydippid larva.

1. miniature adult with comb rows.

2. unique in animal kingdom.



Ctenophoran Larvae

e. Some evidence of relationship to trachyline hydrozoa indicated by larval stages of these animals.

7. Regeneration well-developed - permits asexual reproduction.

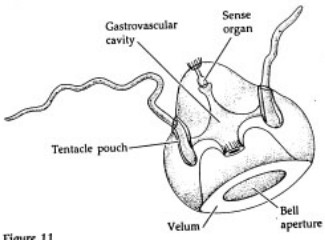


Figure 11

The aberrant trachyline medusa *Hydroctena*, which superficially resembles a ctenophore in its possession of an apical sensory structure and tentacular pouches. (After Hyman 1940.)

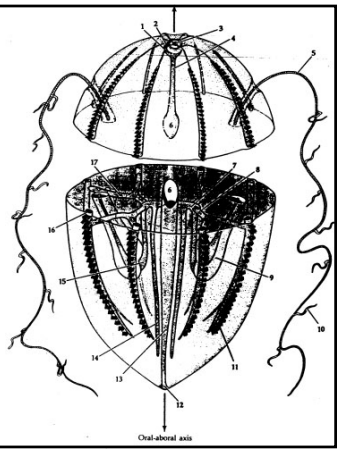
Important Groups

1. Two Classes:

a. Tentaculata - with tentacles; most ctenophores.

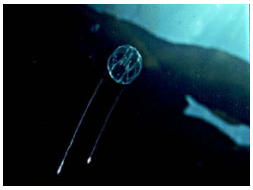
b. Nuda - without tentacles.

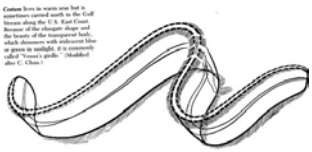
2. Brusca doesn't recognize these - systematics likely to be revised



Interesting Orders

1. Order Cydippida
   a. Globular, sea goosberries
   b. *Pleurobrachia*





Interesting Orders

2. Order Cestida
   a. Ribbon shaped, very transparent, beautiful
   b. *Cestum* - Venus' girdle; N. Atlantic, Mediterranean.

Interesting Orders

3. **Order Platyctenida**

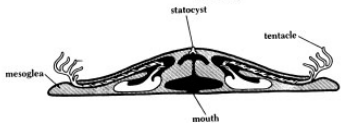
a. Flat, creeping forms - look amazingly like flatworms.

b. identifiable by tentacles.

c. *Coeloplana*

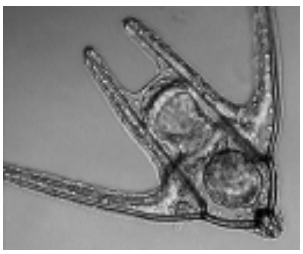
Flattened comb jelly, *Coeloplana*, as viewed from above. This animal is common on the coasts of Japan, where it creeps about on seaweeds and soft corals. (Modified after A. Krempf.)

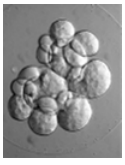
Diagrammatic section of *Coeloplana*. The body is flattened such that the mouth and sensory poles are relatively close together as compared with a more typical ctenophore like *Pleurobrachia*. (Modified after T. Komai.)



Invertebrate Embryology

We need to cover this information because developmental characteristics form such an important component of invertebrate systematics.





Ontogeny and Phylogeny

Ernst Haeckel (1834-1919)

1. Haeckel was correct to infer certain evolutionary relationships

from development.

a. Organisms don't "become" ancestral organisms during development.

b. But since development is conservative, similarities in these patterns

can provide clues to phylogenetic relationships.

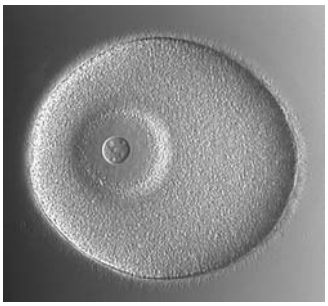
Invertebrate Ova

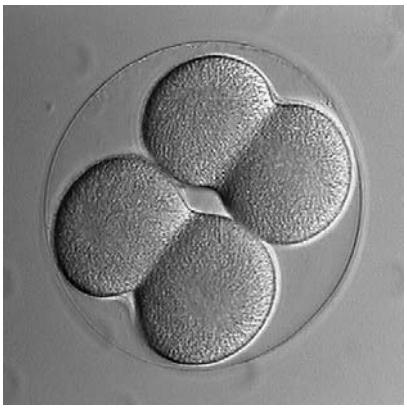
1. Most metazoans have at least some part of their life history that

includes production of sex cells.

2. Female produced cell is ovum

a. Contains nutritive material called yolk (deutoplasm)





The Amount of Yolk

Determines characteristics of cell division.

The Amount of Yolk

Classification scheme:

a. *isolecithal* - little yolk, evenly distributed.

b. *mesolecithal* - medium amt yolk - usually vertebrate.

c. *telolecithal* - lots of yolk, often permits recognition of tworegions (animal, vegetal).

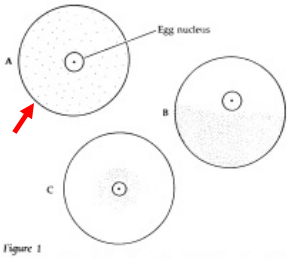


Figure 1

Types of ova. The stippling denotes the distribution and relative concentration of yolk within the cytoplasm. A, An isolecithal ovum has a small amount of yolk distributed evenly. B, The yolk in a telolecithal ovum is concentrated toward the vegetal pole. The amount of yolk in such eggs varies greatly. C, A centrolecithal ovum has yolk concentrated at the center of the cell.

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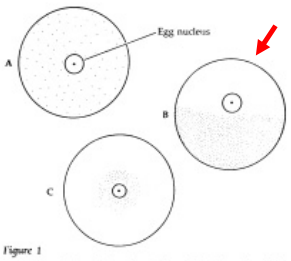

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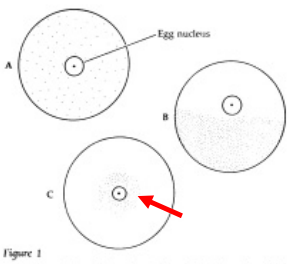
The Amount of Yolk

Classification scheme:

d. *centrolecithal* - like telolecithal, but yolk in middle of ovum.



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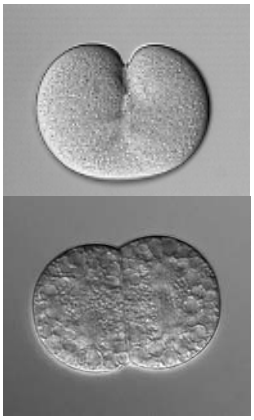
Cleavage

1. After fertilization zygote must go from unicellular to multicellular state.

2. Divisions are called cleavage because,

a. Cell size is reduced - reduction division.

b. No growth between cell divisions.



Cleavage

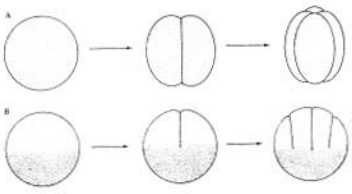
The resulting cells are known as *blastomeres*.

Types of Cleavage

a. *Holoblastic* - whole cell divides (isolecithal)

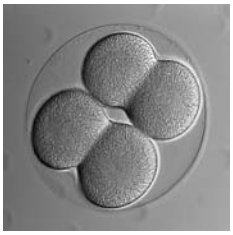
b. *Meroblastic* - incomplete division (telolecithal)

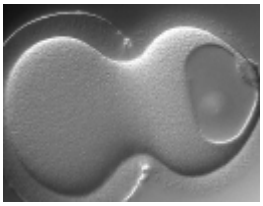
c. *Superficial* - cells divide only on surface (centrolecithal)

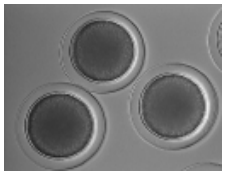


Blastomeres

d. blastomeres vary in size depending on type of cleavage and amount of yolk present in ovum.







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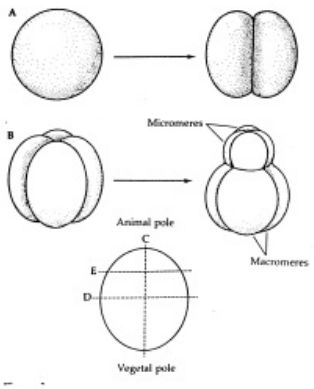
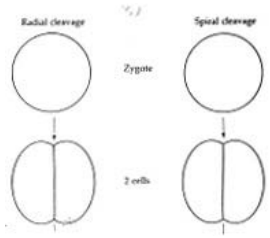


Directions of Cleavage Planes and Blastomere Fate

Two types of cleavage:

Radial

Spiral



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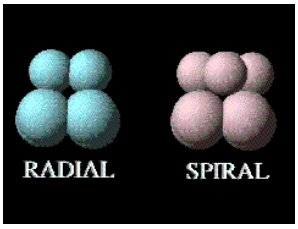
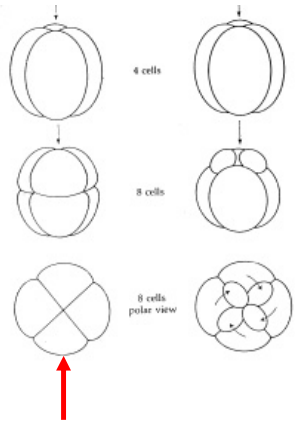


Directions of Cleavage planes and Blastomere Fate

a. Radial Cleavage

1. Cell divisions occur along latitudinal or longitudinal axes.

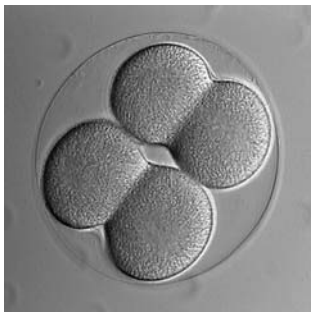


Radial Cleavage

3. Developmental fate of cells is *indeterminate*.

a. Cells can be separated and develop into complete organisms.

b. Vertebrate zygotes are like this.



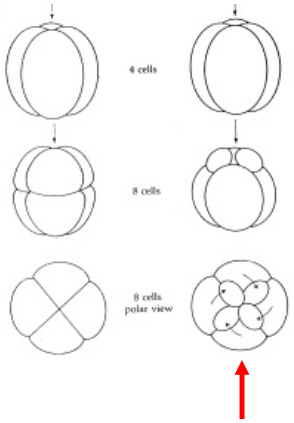
Spiral Cleavage

1. Cell divisions are longitudinal for first two divisions.

2. Then mitotic axes are transverse.

a. this causes blastomeres to appear to rotate.

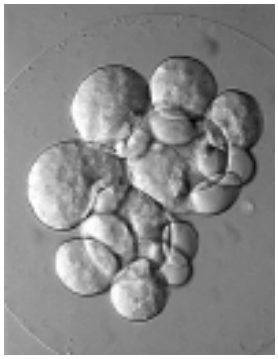
b. usually *dextropic*; then *levotropic*; alternates to 64 cells.

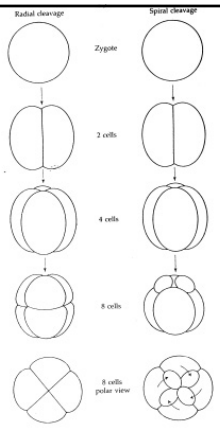


Spiral Cleavage

3. Developmental fate of cells is determinate.

4. After cleavage, you get a ball of cells.





Blastulation

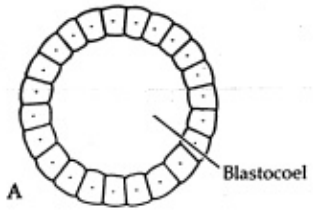
1. A ball of cells produced by cleavage.

2. Often similar in organization to colonial algae- the source of the Colonial Theory for Metazoan Evolution (Haeckel 1874).

Types of Blastulae

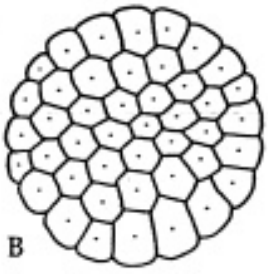
Different taxa have different types of blastulae.

a. *Coeloblastula* - has a blastocoel.



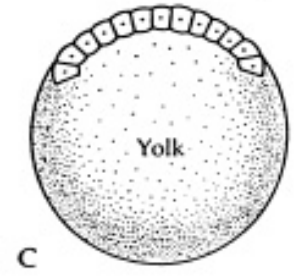
Types of Blastulae

b. *Stereoblastula* - solid mass of cells.



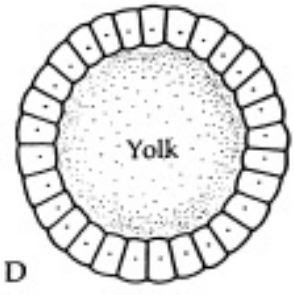
Types of Blastulae

c. *Discoblastula* - cells on top of yolk mass.



Types of Blastulae

d. *Periblastula* cells surrounding yolk.



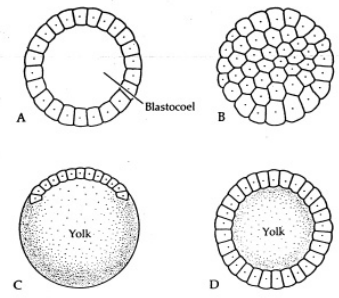


Figure 6

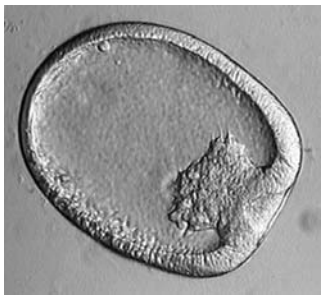
Types of blastulae. These diagrams represent sections along the animal–vegetal axis. A, Coeloblastula. The blastomeres form a hollow sphere with a wall one cell layer thick. B, Stereoblastula. Cleavage results in a solid ball of blastomeres. C, Discoblastula. Cleavage has produced a cap of blastomeres that lies at the animal pole, above a solid mass of yolk. D, Periblastula. Blastomeres form a single cell layer enclosing an inner yolky mass.

Gastrulation

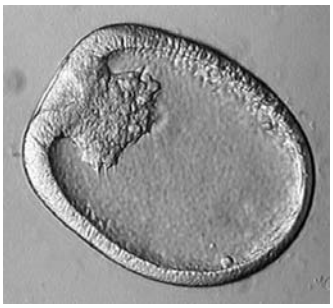
1.Formation of germ layers is a process called *Gastrulation*.

a. Outer layer – *ectoderm*

1. Forms skin, nerves, upper, lower digestive tract.
2. Occasionally gonadal tissue.



Gastrulation



b. Inner layer - *endoderm* (entoderm).

1. Gut, glandular tissues, lymphatic.
2. Occasionally gonadal.

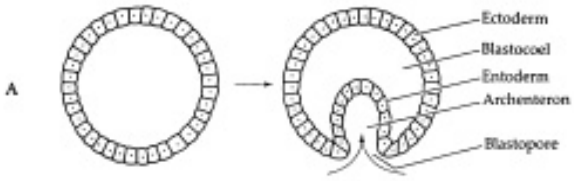
Gastrulation

c. Middle layer (formed later) – *mesoderm*.

1. Muscle, support, blood, viscera
2. Everything else.

Types of Gastrulation

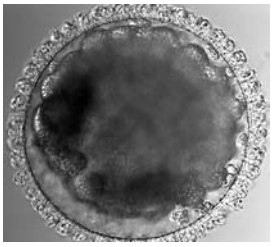
a. Invagination - forms archenteron, blastopore.

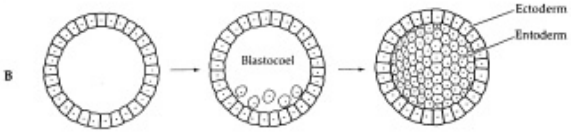


Types of Gastrulation

b. Ingression - cell migrate inward.

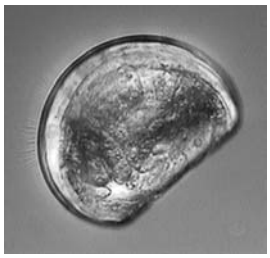
1. unipolar
2. multipolar.

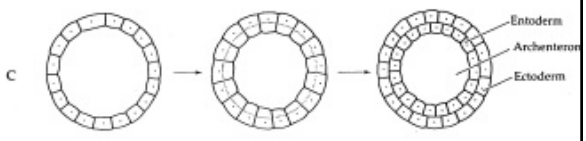




Types of Gastrulation

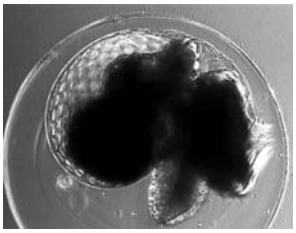
c. Delamination - mass of cells split apart.

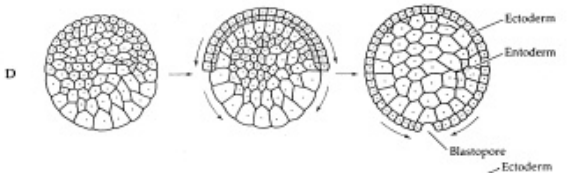




Types of Gastrulation

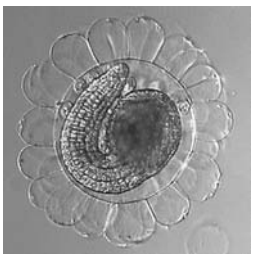
d. *Epiboly* - in stereoblastula; animal pole overgrows vegetal pole.

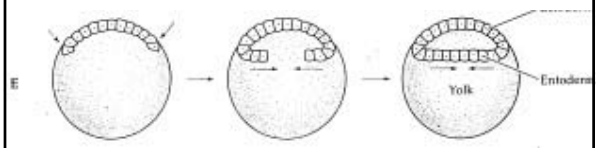




Types of Gastrulation

e. *Involution* - in discoblastula; cells turn under.





Blastopore Formation

a. This is an important part of earlier classification schemes based on developmental characteristics.

b. Fate of blastopore differs among two major lines of animals.

1. Blastopore becomes mouth - *Protostomes*

2. Blastopore becomes anus - *Deuterostomes*

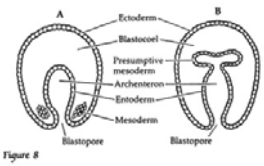
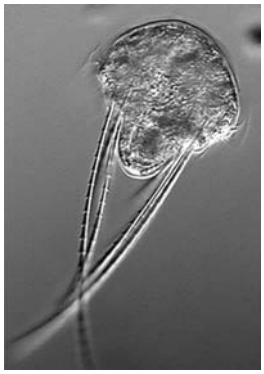


Figure 8

Methods of mesoderm formation in late gastrulae (frontal sections). A, Mesoderm formed from derivatives of a mesentoblast. B, Mesoderm formed by archenteric pouching.

Mesoderm and Coelom Formation

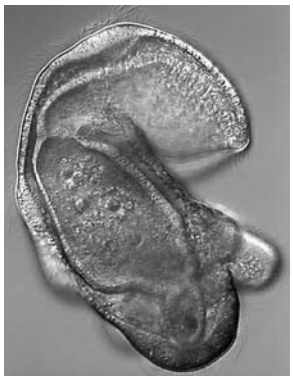


1. Mesoderm is derived from different sources in different taxa.

2. An important aspect of development.

a. Third germ layer - represents an advance in structural organization.

Mesoderm

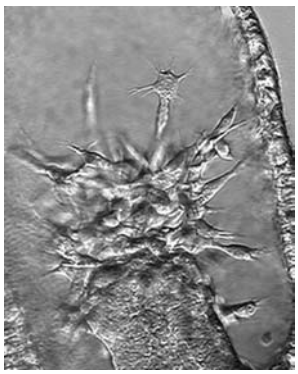


Source of this layer is associated with type and complexity of

coelom

- the internal body cavity.

Coelom



1. Involved in structural support.

2. Provides space for organs, movement, gametes.

c. Patterns of formation are important in tracing phylogenies.

Sources of Mesoderm

3. In general, mesoderm sources are:

a. Protostomes: from mesentoblast - endodermal cells near anus.

b. Deterostomes: form enteric pouches.

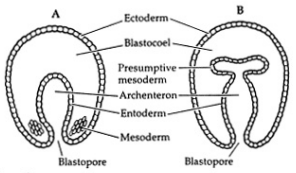


Figure 8

Methods of mesoderm formation in late gastrulae (frontal sections). A, Mesoderm formed from derivatives of a mesentoblast. B, Mesoderm formed by archenteric pouching.

Coelom Formation

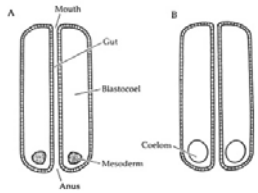
Protostomes

1. Mesoderm arises from vegetal cell (4d).

2. Arises near future anus.

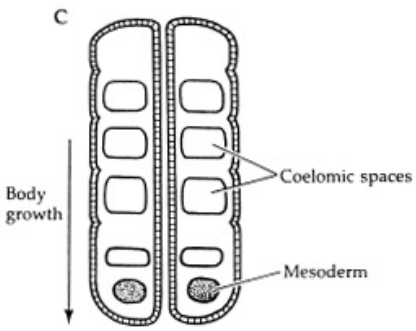
3. Forms two masses that later delaminate to form coelom.

a. Mesoderm spreads out to form musculature and mesenteries.



Coelom Formation

5. Mesodermal splitting to form coelom is called *schizocoely*.



Coelom Formation

Deuterostomes

1. Mesoderm from enterocoelic pouches.
2. Secondary schizocoely may occur.
3. Process proceeds the same as before.
4. Mesodermal formation from pouches is enterocoely.