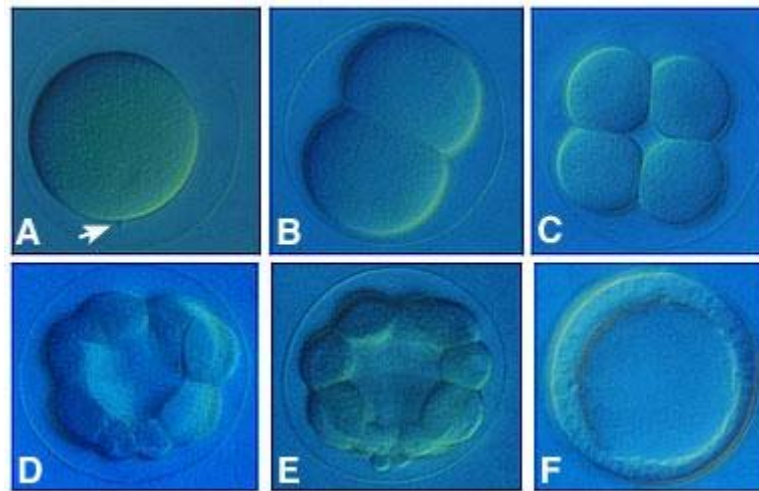


# Introduction to Sea Urchin Development

Most introductory biology textbooks will cover aspects of sea urchin development and you might want to read that portion of your old textbook. The key topics used in *Genomics*, *Proteomics* & *Bioinformatics* are blastula and gastrula formation. Let's take a quick look so you will understand the timing and terminology under investigation in Eric Davidson's lab where he has uncovered the genomic circuitry of a single gene.

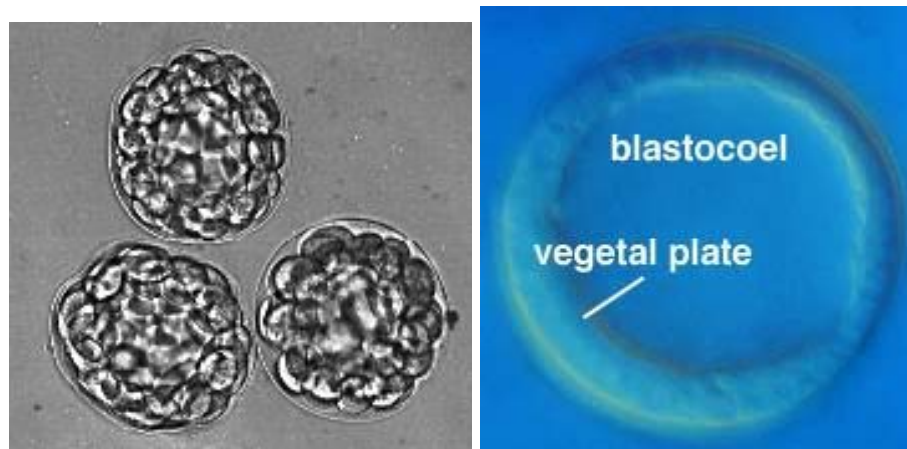
## Cleavage Stage Embryos



**Figure 1.** *L. variegatus* zygotes, viewed from the side. **A.** 1-cell zygote. The fertilization envelope is visible as a large "halo" around the embryo. The arrow points to the site of sperm penetration. **B.** 2-cell **C.** 8-cell **D.** 16-cell **E.** 32-cell **F.** Hatched blastula. (from [worms.zoology.wisc.edu/urchins/SUcleavage\\_stages.html](http://worms.zoology.wisc.edu/urchins/SUcleavage_stages.html))

[Click here to see Quicktime movie of cleavage.](#)

## Blastula Stage

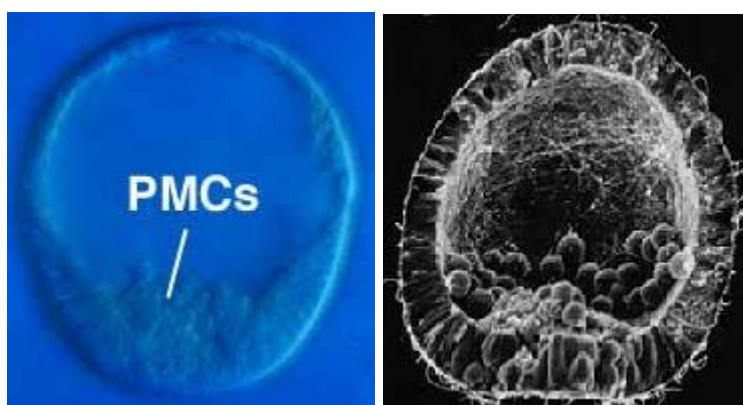


**Figure 2. Left:** Unhatched blastulae. **Right:** A *L. variegatus* hatched blastula, showing the thickened vegetal plate and obvious blastocoel. (from [worms.zoology.wisc.edu/urchins/SUcleavage\\_blastula.html](http://worms.zoology.wisc.edu/urchins/SUcleavage_blastula.html))

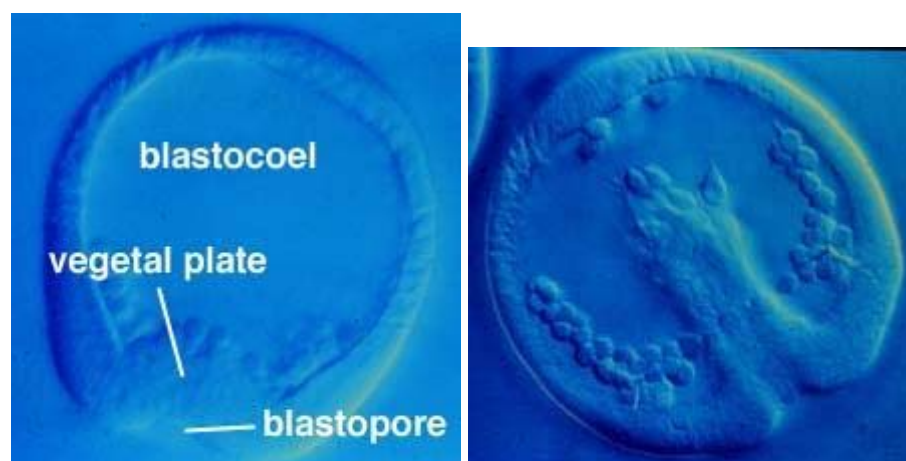
[Click here to see animated gif](#)

[Click here to see a 3D animated gif](#)

## Gastrula Stage

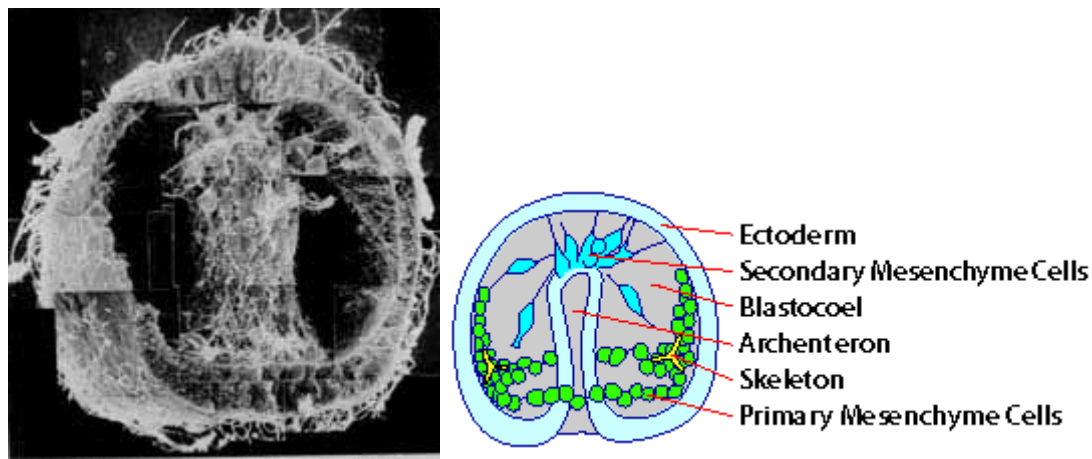


**Figure 3. Left:** *L. variegatus* mesenchyme blastula, viewed from the side, showing ingressing primary, or skeletogenic, mesenchyme cells (PMCs). **Right:** A *L. variegatus* mesenchyme blastula processed for scanning electron microscopy and fractured through the vegetal plate to show the process of ingression (from [worms.zoology.wisc.edu/urchins/SUgast\\_ingression.html](http://worms.zoology.wisc.edu/urchins/SUgast_ingression.html))



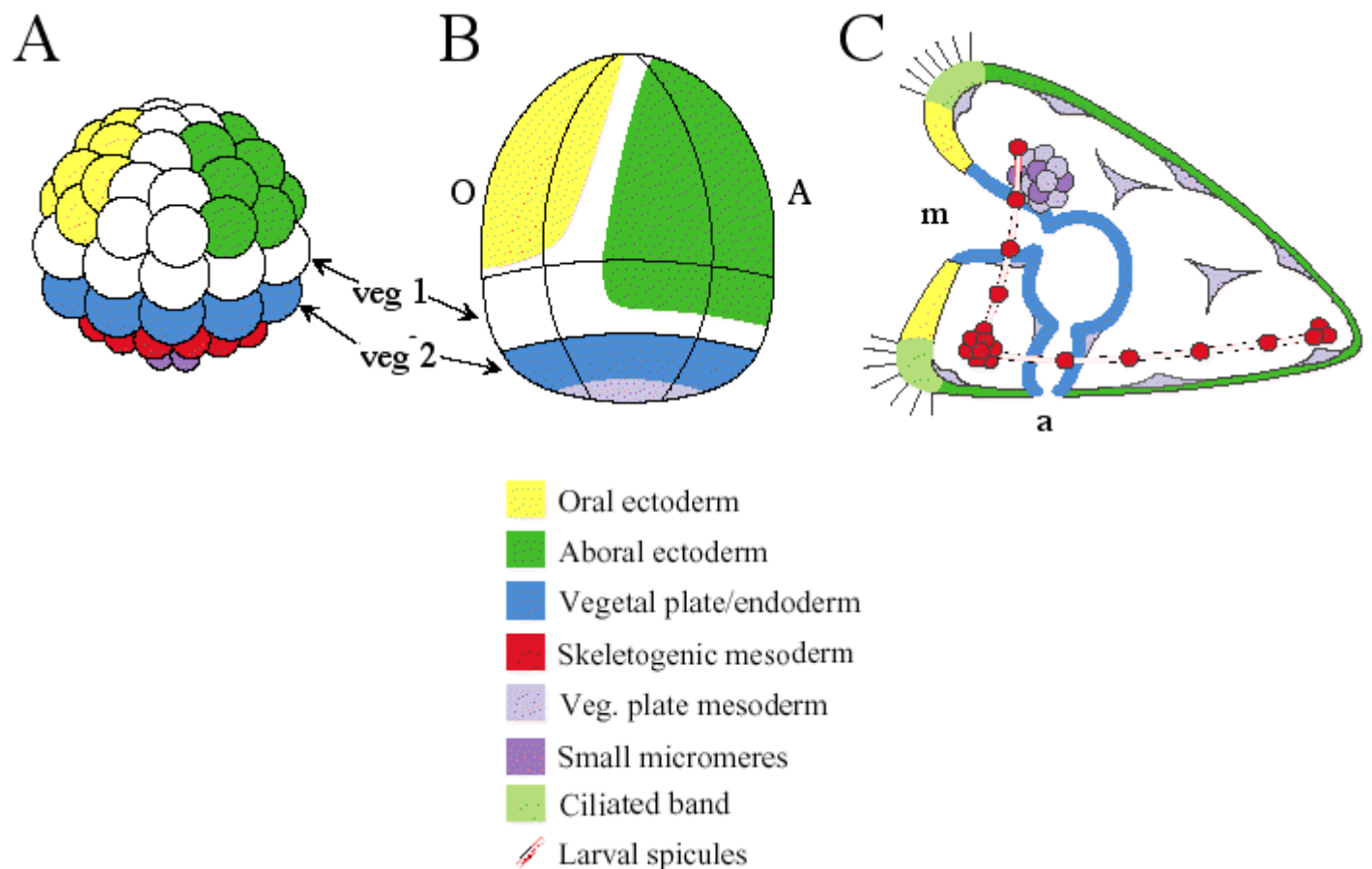
**Figure 4. Left:** *L. variegatus* early gastrula, viewed from the side. (from [worms.zoology.wisc.edu/urchins/SUgast\\_primary.html](http://worms.zoology.wisc.edu/urchins/SUgast_primary.html)) **Right:** *L. variegatus* late gastrula, viewed from the ventral (oral) side. (from [worms.zoology.wisc.edu/urchins/SUgast\\_intro.html](http://worms.zoology.wisc.edu/urchins/SUgast_intro.html))

[See a really good animated gif of gastrulation.](#)



**Figure 5. Left:** *L. variegatus* late gastrula processed for scanning electron microscopy. **Right:** Cartoon of sea urchin gastrula with some key parts labeled. (from [www.luc.edu/depts/biology/dev/seargas.htm](http://www.luc.edu/depts/biology/dev/seargas.htm))

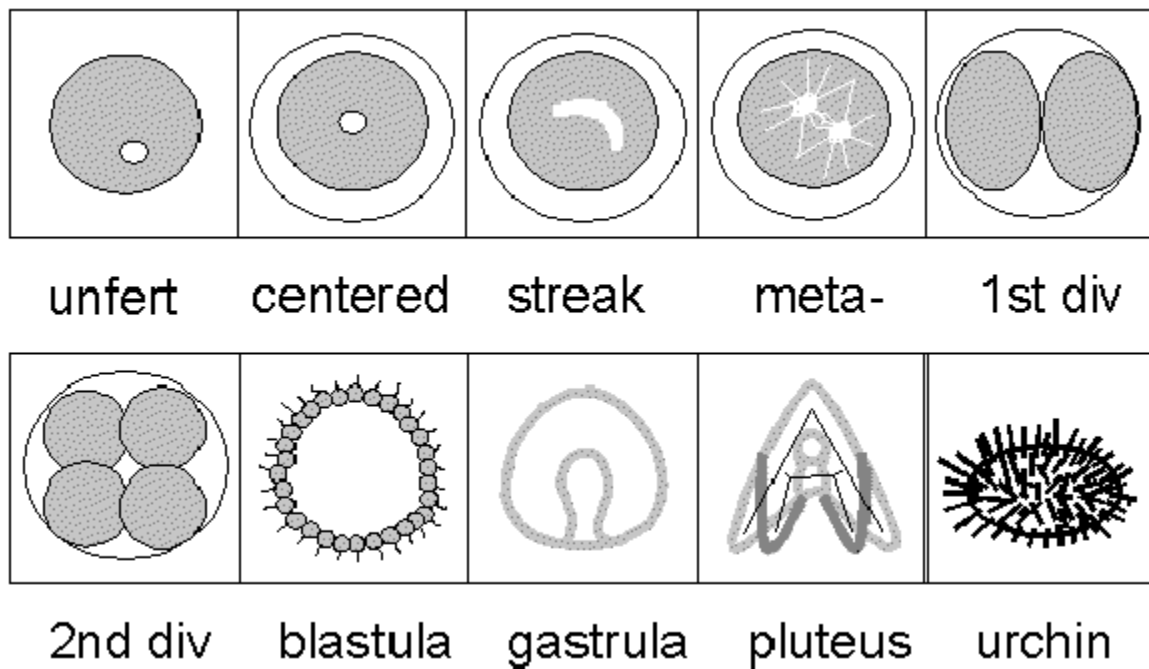
### Overview of Development and Cell Fate Maps



**Figure 6.** Developmental stages and fate maps of sea urchin *S. purpuratus* embryogenesis. (A) 60-cell stage embryo undergoing rapid cell division. Eight large micromeres (shown in red) will become mesenchymal cells destined to form the future skeleton. Beneath them are the four small micromeres (shown in purple). Though their progeny will contribute exclusively to the coelomic

pouches, their actual state of specification at 6th cleavage is not known. The eight blastomeres of the veg2 ring are also specified and their progeny will express vegetal plate marker genes. The veg1 domain, here shown in white, is not yet specified, since later its progeny will be allocated into one of three different fates, nor are the lateral ectodermal domains on either side of the embryo (white arch of cells over the top) yet specified. Some progeny of these blastomeres will form the boundary regions between oral (yellow) and aboral (green) ectoderm. The polar clones of the aboral ectoderm territory are already specified, and these clones will soon begin to express aboral markers. The polar clones of the oral ectoderm territory may also be specified. **(B)** External lateral view of 24 hour old blastula composed of about 500 cells. Regions where specifications have still not yet occurred are shown in white. **(C)** Lateral view of final state of specification in early pluteus-stage larva, about 1500 cells (65 hours post-fertilization). (with permission from Eric Davidson; from Davidson et al. 1998. *Development*. Vol. 125: 3269 - 3290. Figure 2 on page 3271)

### Timing of Sea Urchin Development



species	nuclei fuse and center	centro-some streak	metaphase	1st division	2 nd division	blastula	gastrula	pluteus
pictus 18C	20'	50'	80'	90'	2.5 hrs	24 hrs	2 days	5 days
purp 12C	30'	60'	90'	120'	3 hrs	24 hrs	2 days	5 days

(with permission from SUE <<http://www.stanford.edu/group/Urchin/dev.htm>>)

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## Web Resources about Sea Urchin Development

[Movie of Cleavage](#)

[2D Animated GIF of development to pluteus-stage larva.](#)

Two 3D Animated GIFs of development to pluteus-stage larva.

- <http://www.stanford.edu/group/Urchin/3D.html>
- <http://www.stanford.edu/group/Urchin/gastro.htm>

[Interactive Fate Map for Cells after Six Rounds of Division](#)

[Tutorial on Cleavage/Blastula Stage Sea Urchins](#)

[Tutorial on Gastrula Stage Sea Urchins](#)

[Images and Explanation of How Cells Invaginate During Gastrulation](#)

[Movie of Elongating Archenteron](#)

[Overview of Entire Sea Urchin Life History](#)

[Sea Urchin Development \(SUE\) comprehensive web site](#)

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