

Fish

# What are the Characteristics of Fish Development?

- Meroblastic
- Discoidal
- Transparent eggs
- Fertilization through micropyle
- Transcription (zygote genes) begins in mid-blastula (transition)
- Specification at late blastula (fate map)

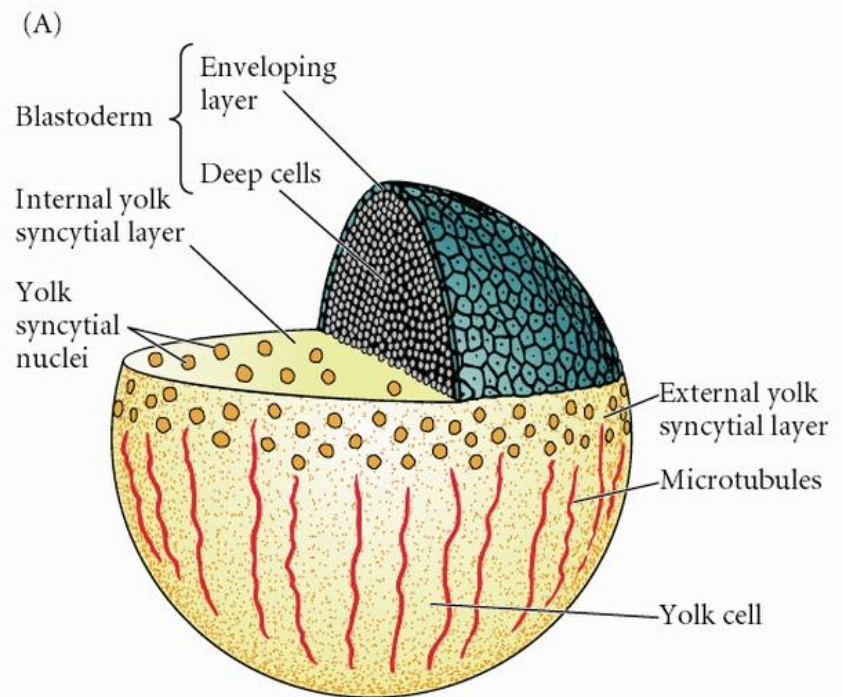
# What Good Are Transparent Embryos?

- GFP (green fluorescent protein) gene linked to other genes show where expressed in living cells

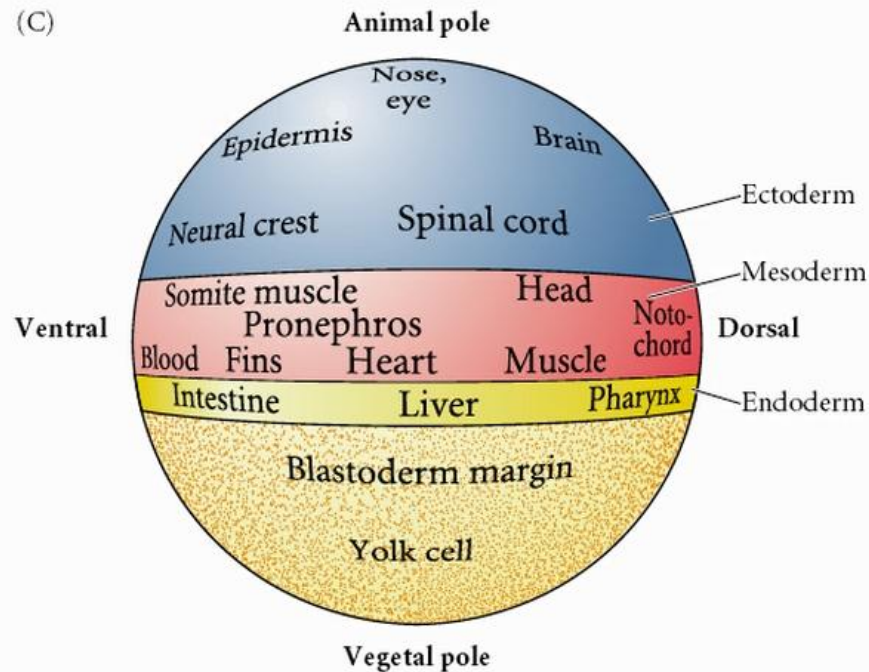


# Fish Blastula

- Deep cells become embryo
- EVL is protective
- YSL



# Zebrafish Fate Map of Deep Cells



# Blastula to Neurula

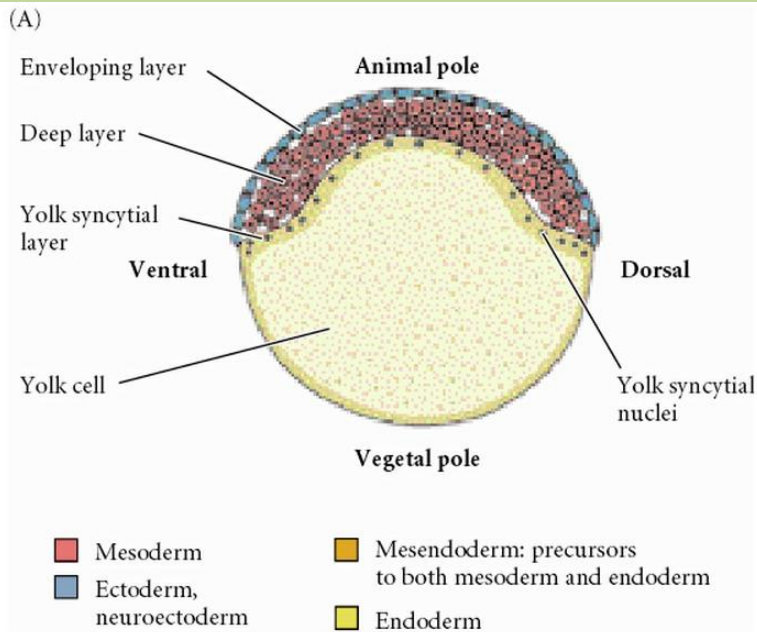
- Epiboly of blastoderm over yolk
  - force provided by syncitial layer
    - progresses via microtubules
    - pulls deep cells with it
  - thicker end (→ embryonic shield) → dorsal side
  - dorsal mesoderm forms chordamesoderm → notochord
  - neural cells go to midline → keel

# Zebrafish Development: Time Lapse Films



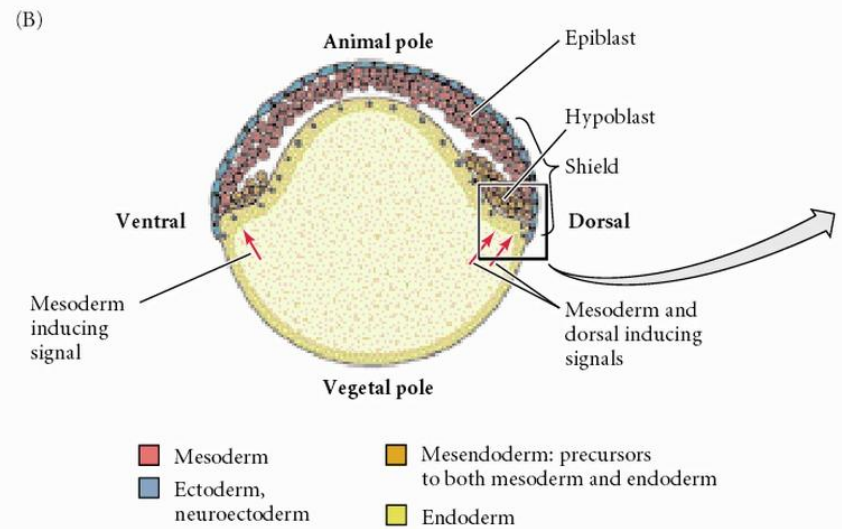
Fish Cleav.mov

# Zebrafish Gastrulation I



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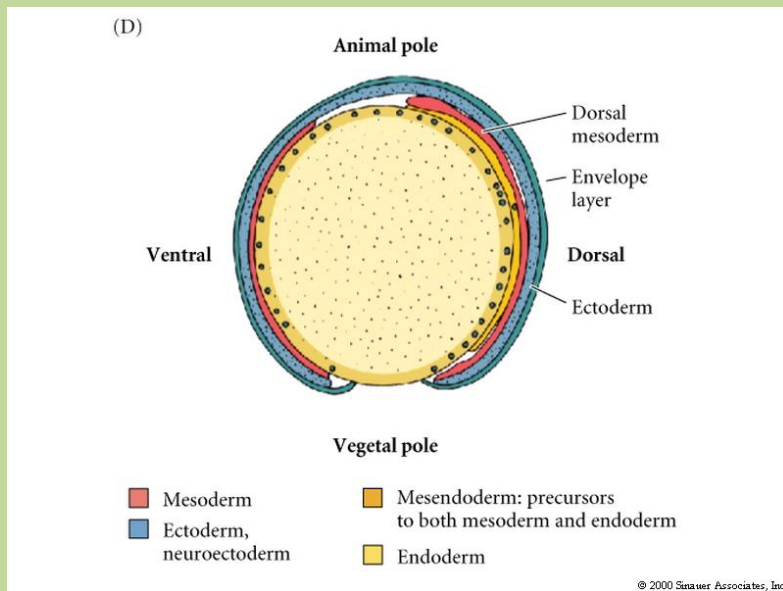


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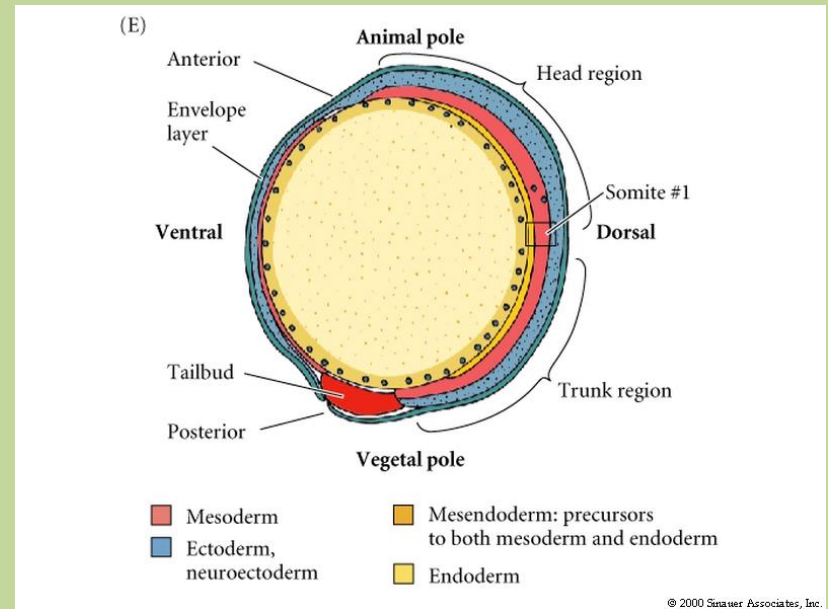
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# Zebrafish Gastrulation II

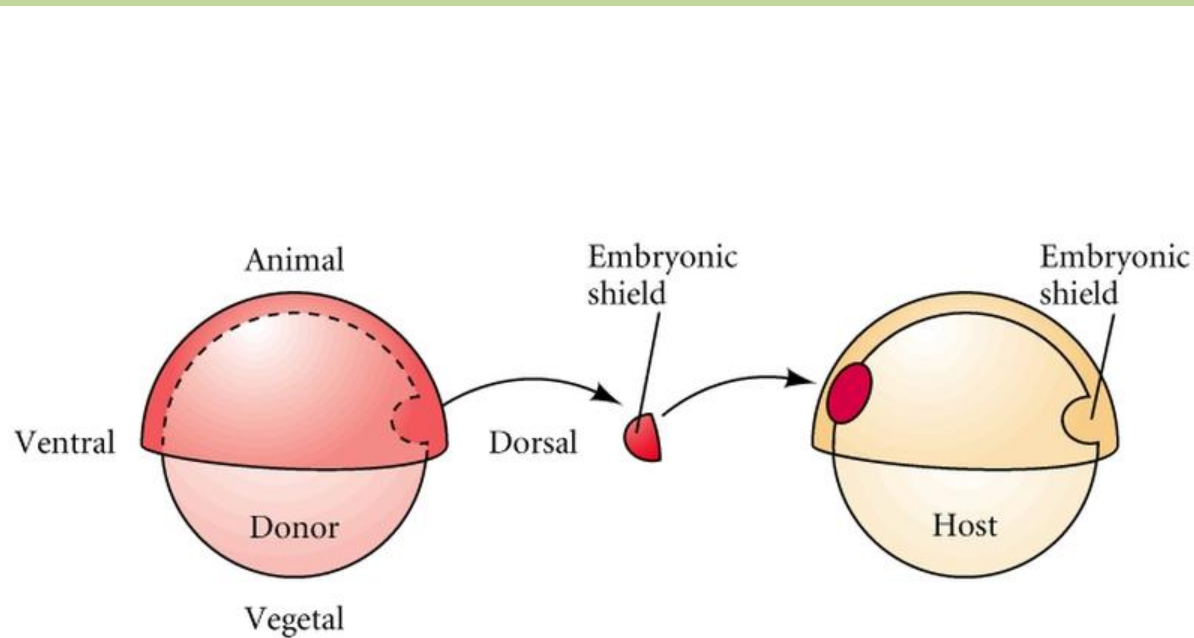


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# The Fish Organizer



Transplantation induces secondary axis

# What are the Signals for DV Axis Formation?

- Dorsal-ventral
  - from embryonic shield induction
  - signals like amphibians
  - ectoderm + **BMP2B** → epidermis
  - chordamesoderm → **chordino** (chordin)
    - blocks BMP allowing neural development
  - other extracellular regulators

# A-P and L-R Axes

- A-P axis set in oocyte
  - anterior = animal cap
  - stabilizes at gastrulation
  - two centers
    - anterior neural cells
    - posterior mesodermal cells
- L-R
  - nodal-related protein (**nr-2**)

# What Induces Shield Mesoderm?

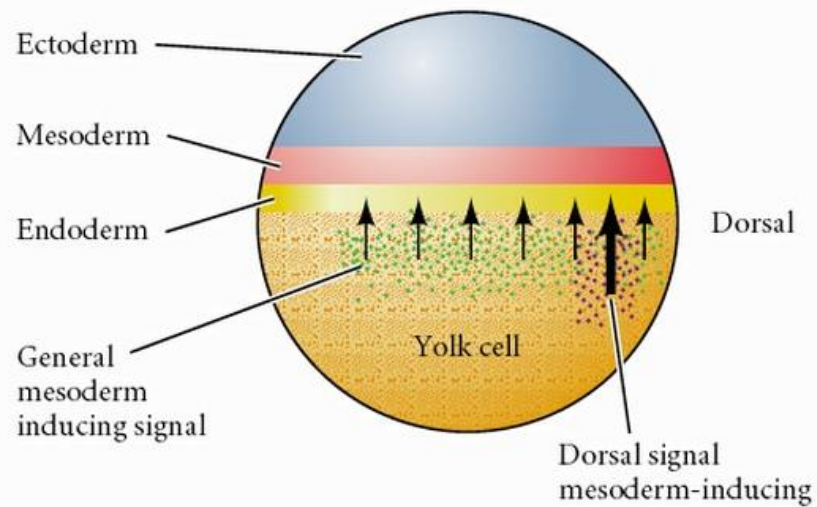
- Nuclei of YSL under future embryonic shield accumulate  $\beta$ -catenin
- Activates *squint* and *bozozok* (like *nodal* and *siamois*)
- Bozozok
  - represses *bmp2B* and *wnt8* ventralizing genes
  - suppresses *vegal*

# Induction of Shield

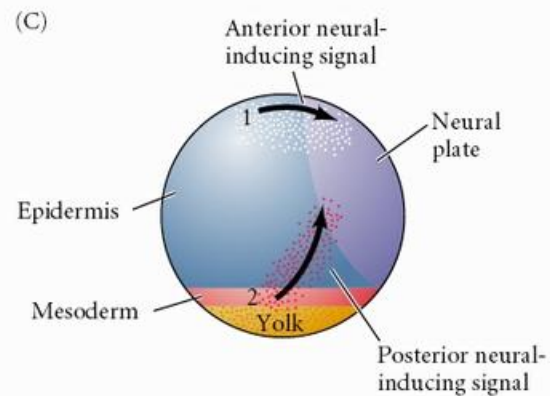
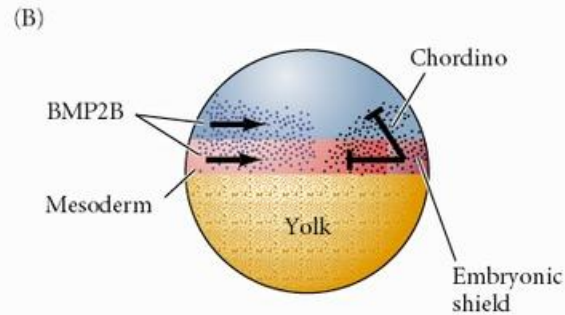
- *Squint* and *bozozak*
  - activate *chordino*
  - activate *goosecoid*, *noggin*, *dickkopf* of neural ectoderm that block *wnt* and *bmp*
- Again similar to *Xenopus*
  - Conservation of signals and pathways

# Zebrafish Axis Formation

(A)



# Zebrafish Axis Formation





# Are Developmental Signals Conserved in Vertebrates?

- $\beta$ -catenin
- Veg factors
- Bmp and Wnt antagonism
- Chordino = chordin
- Noggin
- Dickkopf
- Bozozok = siamois
- Goosecoid

# Conservation of Signals: Vertebrate-Invertebrate Dorsal-Ventral Reversed

