

## The Origami Embryo: A model of early organogenesis.

Instructions for folding your own embryo.

You will need: colored paper

2 sheets of blue ("ectoderm": most dorsal layer)

4 sheets of pink ("mesoderm")

2 sheets of yellow ("endoderm": layer adjacent to yolk)

Scotch tape

Stapler and staples

notochord representative (pencil)

allantois representative (a balloon, imagination)

### 1. Gastrulate

Assemble three germ layers.

Each layer must be fairly wide, since folding will take up a lot of surface. The embryo provides the surface partially by growth--your paper won't grow, so you have to start big.

Overlap blue sheets slightly at their short ends and tape.

Overlap yellow sheets slightly and tape.

Between the blue and yellow sheets, place 2 layers of pink on each side leaving a 3/4 inch gap at the midline.

Staple the sheets together at each side of the midline, stapling through the most medial edge of the pink sheet.

Remember throughout these manipulations that the most lateral edges of your sheets have ends: in the embryo, these ends extend all around the yolk to form complete spheres.

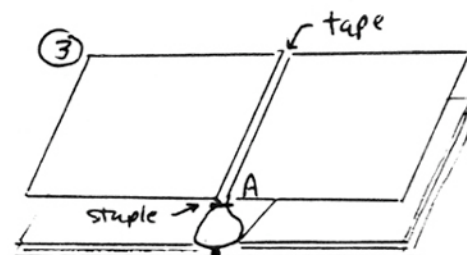
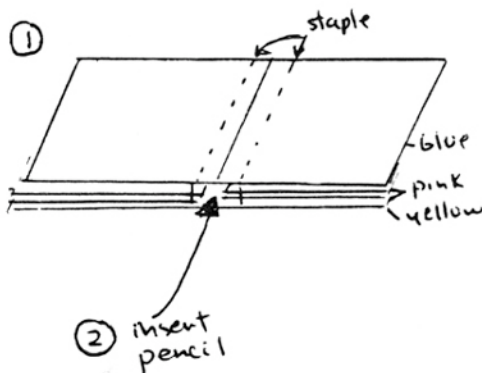
### 2. Induce CNS: Primary induction

Push a pencil between the two lines of staples.

This procedure represents the migration of Hensen's node:

The pencil represents the notochord laid down by Hensen's node.

Mark the end where you inserted the pencil anterior (A). Tape the pencil in place.



### 3. Neurulate

Fold the blue paper up to make a tube about 1 inch in diameter.

Staple the neural folds together, representing fusion of the neural folds.

From the ectodermal side, tape the folds together at the midline, representing fusion of the ectoderm.

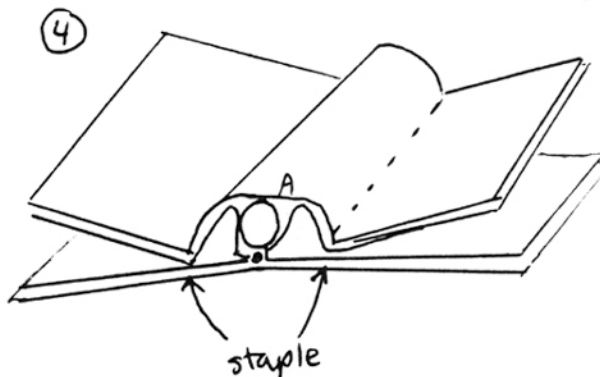
### 4. Form mesodermal primordia

Pinch all four sheets together 1-2 inches lateral to the neural tube and staple from anterior to posterior.

The two pink layers medial to the staples are the epithelial somites.

The staples go through the intermediate mesoderm.

The two sheets of pink extending laterally on each side are the somatic mesoderm (dorsal--toward ectoderm) and splanchnic mesoderm (ventral--toward endoderm).

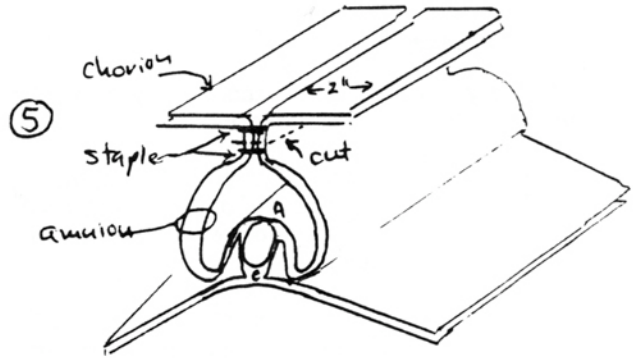


**5. Form the amnion and the chorion**

Fold the ectoderm and somatic mesoderm upwards  
 Staple these two sheets together  
 with two parallel lines of staples  
 about 2 inches from the end of the sheets.

Cut between the line of staples,  
 releasing the chorion from the amnion.

The chorion you made is small. In the embryo,  
 this layer would have extended all around the  
 yolk. You made the chorion small so the origami  
 embryo would have a large enough amnion to  
 make body walls later. Pay particular attention to  
 the relative positions of ectoderm and somatic  
 mesoderm: i.e., which is inside the amnion?  
 Which is toward the egg shell?



**6. Form the gut and yolk stalk.**

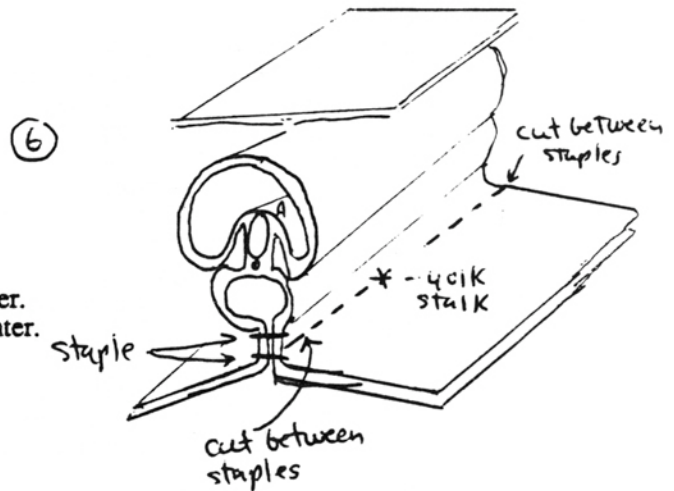
Fold down the splanchnopleure (yellow endoderm  
 and pink splanchnic mesoderm)  
 to form a tube 1 inch in diameter.

Staple two parallel lines from anterior to near the center.  
 Staple two parallel lines from posterior to near the center.  
 Cut between the stapled lines

from the anterior and from the posterior,  
 but do not completely sever the sheets.

Leave the sheets attached at the center.

The attached region is the yolk stalk where  
 the inside of the gut is open to the inside of  
 the yolk sac.



⑦ attach allantois at \*, above

**7. Form the allantois**

Attach your balloon to the yolk stalk.

The balloon represents an outpocketing  
 of the gut at the yolk stalk.

Ask yourself: which color would be on the  
 outer surface of the allantois, blue (ectoderm)  
 or pink (mesoderm). Why?

⑧

**8. Form the lateral body walls**

Bring the amnion down around the gut.

Staple in two lines except at the yolk stalk.

Cut between the two lines  
 except at the yolk stalk.

This procedure separates the amnion from the  
 lateral body walls and leaves the embryo  
 floating within the amniotic sac.

