

Lecture - Week 3 Development

From Embryology

Placentation | Gastrulation | Notochord

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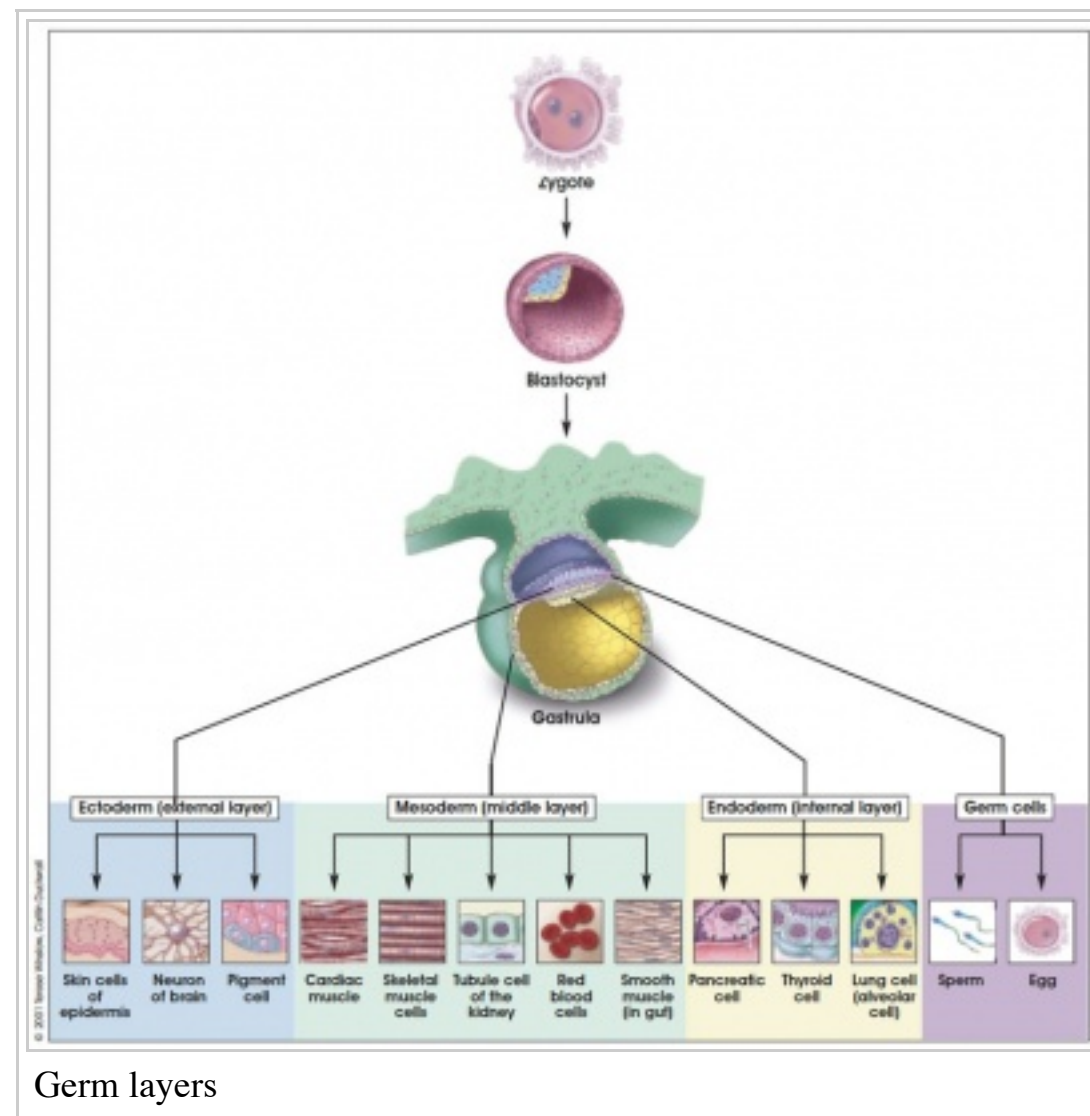
Introduction

In this lecture I will talk about week 3 of embryonic development. I will cover early placentation, gastrulation and embryonic folding.



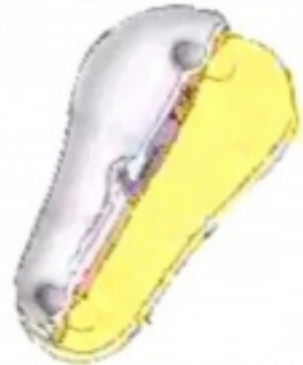
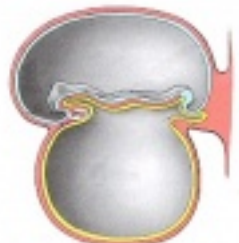

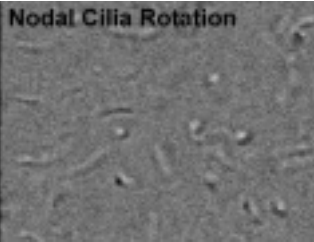

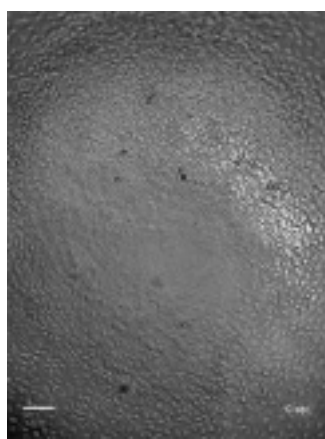
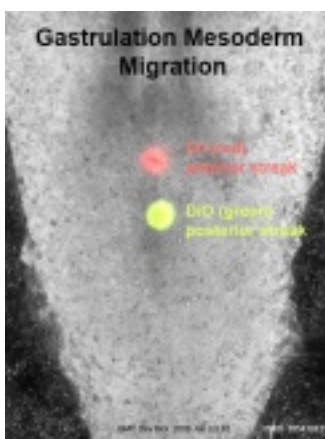
Objectives

- Understand the process early placentation, villi formation
- Understand broadly the events of week 3 of human development
- Understand the process of gastrulation
- Understand the process of axis formation
- Brief understanding of embryo folding




Lecture Resources



Movies [Collapse]

				
Week 3 Mesoderm Page Play	Week 3 Notochord Page Play	Week 3 Notochord Page Play	Week 3 Page Play	Amniotic Cavity Page Play
				
Nodal Cilia Page Play	Gastrulation ECM Page Play	Planar Movement Page Play	Mesoderm Move Page Play	

References [Collapse]

	Hill, M.A. (2014). <i>UNSW Embryology</i> (14th ed.) Retrieved August 11, 2014, from http://php.med.unsw.edu.au/embryology	<ul style="list-style-type: none"> Week 3 Gastrulation Implantation Placenta Development Lecture Archive: 2009 2010 2012 (http://embryology.med.unsw.edu.au/embryology/index.php?title=Lecture_-_Week_3_Development&oldid=97588) 2013
	Moore, K.L., Persaud, T.V.N. & Torchia, M.G. (2011). <i>The developing human: clinically oriented embryology</i> (9th ed.). Philadelphia: Saunders.	<p>The following chapter links only work with a UNSW connection.</p> <ul style="list-style-type: none"> Chapter 4 – Third Week of Human Development (http://er.library.unsw.edu.au/er/cgi-bin/eraccess.cgi?url=http://www.mdconsult.com/books/page.do?eid=4-u1.0-B978-1-4377-2002-0..00004-7&isbn=978-1-4377-2002-0&uniqId=330028653-2#4-u1.0-B978-1-4377-2002-0..00004-7)
	Schoenwolf, G.C., Bleyl, S.B., Brauer, P.R. & Francis-West, P.H. (2009). <i>Larsen's human embryology</i> (4th ed.). New York; Edinburgh: Churchill Livingstone.	<p>The following chapter links only work with a UNSW connection.</p> <ul style="list-style-type: none"> Chapter 3 - Third Week: Becoming Trilaminar and Establishing Body Axes (http://www.mdconsult.com/books/linkTo?type=bookPage&isbn=978-0-443-06811-9&eid=4-u1.0-B978-0-443-06811-9..10003-X)

ECHO360 Recording [Expand]

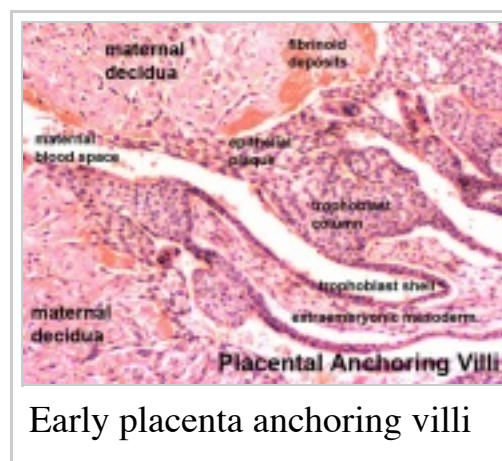
Early Placentation

The trophoblast layer has now differentiated into two morphologically distinct cellular layers.

- **Syncytiotrophoblasts** - form a multinucleated cytoplasmic mass by cytotrophoblast cell fusion and both invade the decidua and secrete hCG
- **Cytotrophoblasts** - form a cellular layer around the blastocyst, proliferates and extends behind syncytiotrophoblasts

Early Utero-Placental exchange

- transfer of nutrition from maternal lacunae filled with secretions from uterine glands and maternal blood from blood vessels.
- development of trophoblast villi extending into the uterine decidua.
- ongoing process with placental development (covered in future lecture)



Early placenta anchoring villi

There are three stages of villi development:

1. Primary Villi - cytotrophoblast
2. Secondary Villi - cytotrophoblast + extraembryonic mesoderm
3. Tertiary Villi - cytotrophoblast + extraembryonic mesoderm+ blood vessels

There are two main types of early villi:

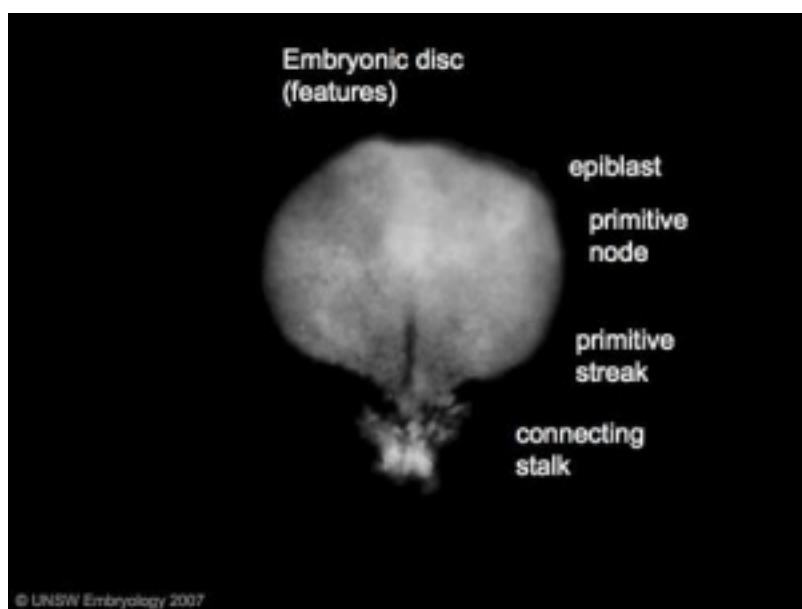
1. Anchoring villi - attached to decidua
2. Floating villi - not attached to decidua, floating in maternal lacunae.

Links: Development Animation - Implantation

Gastrulation

Embryonic Disc

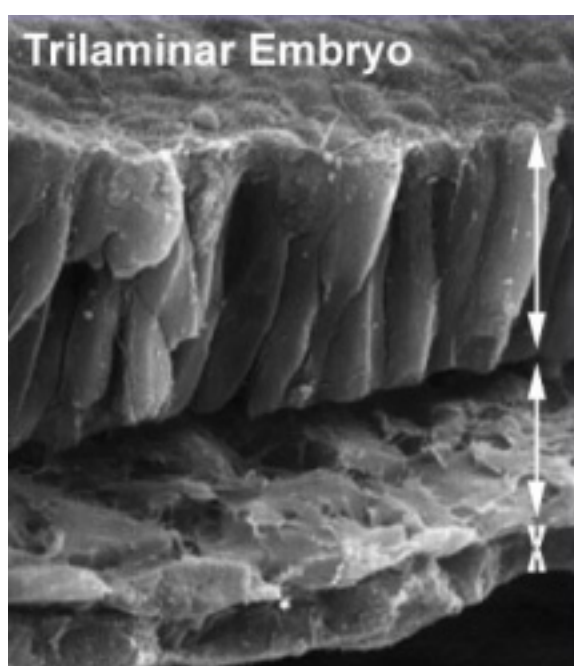
- Gastrulation, (Greek = belly) means the formation of gut.
- used in a more looser sense to describe the formation of the trilaminar embryo.
- **Epiblast layer** - consists of totipotential cells forming all 3 embryo layers (germ layers) that form the entire embryo.
 - Historically, gastrulation was one of the earliest observable morphological event occurring in the frog embryo.
 - Currently, the molecular and physical mechanisms that regulate patterning and migration during this key event are being investigated in several different animal models.
 - In humans, it is proposed that similar mechanisms regulate gastrulation to those found in other vertebrates.



Week 3 Mesoderm

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Embryonic Disc showing primitive streak



Ectoderm

Mesoderm

Endoderm

(Image: K Sulik)

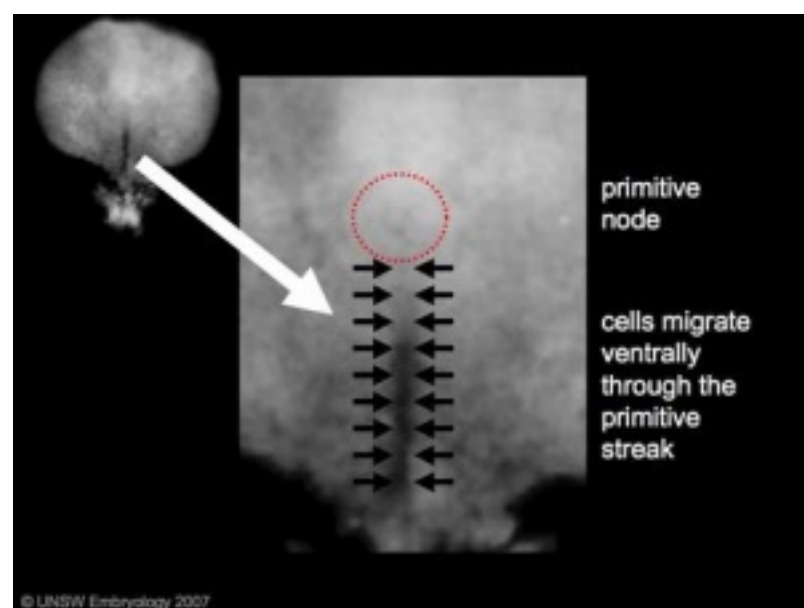
1. **Ectoderm** (epithelium) - forms the central and peripheral nervous system, parts of the sensory systems, and the epithelium of the skin.
2. **Mesoderm** (connective tissue) - forms the body connective tissues: blood, bone, muscle, connective tissue skin, gastrointestinal and respiratory tracts.
3. **Endoderm** (epithelium) - forms gastrointestinal tract organs and the epithelium of the gastrointestinal and respiratory tracts.

This is a very simplified explanation of the 3 layer contributions, many body tissues have contributions from all 3 origins.

Primitive Streak

The primitive streak is the visible feature which represents the site of cell migration to form the additional layers.

- Midline of embryonic disc running between the primitive node to near the edge of the disc at the caudal end (near the connecting stalk).
- Region of cell migration from the epiblast layer forming sequentially the two germ cell layers (endoderm and mesoderm).
- Cells that do not migrate form the ectoderm.



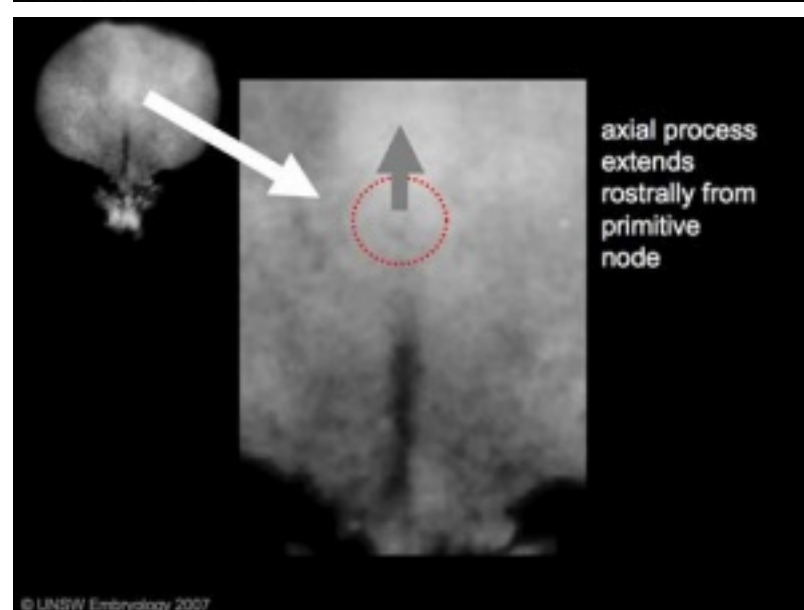
Primitive Node

- (Hensen's node) region in the middle of the early embryonic disc epiblast from which the primitive streak extends caudally (tail).
 - nodal cilia establish the embryo left/right axis
 - axial process extends from the nodal epiblast



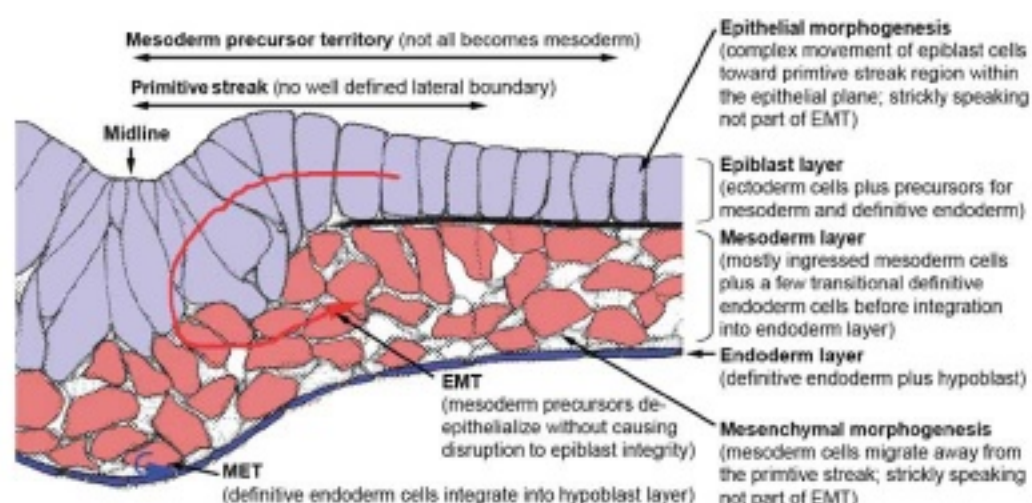
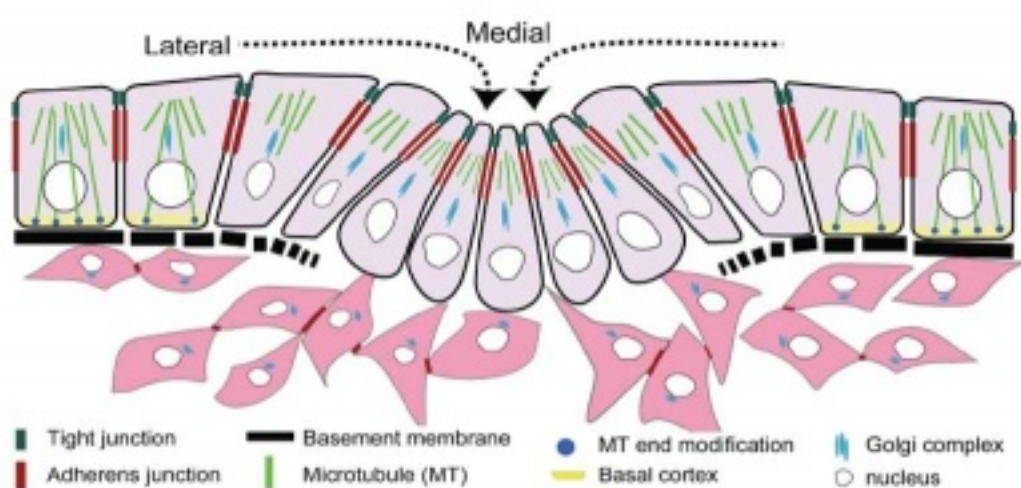
Nodal Cilia

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Links: Development Animation - Mesoderm | Gastrulation

Epithelial to Mesenchymal Transition



Chicken Gastrulation An amicable separation: Chick's way of doing EMT. Nakaya Y, Sheng G. Cell Adh Migr. 2009 Apr;3(2):160-3. Epub 2009 Apr 10. PMID: 19262172

Chicken Gastrulation An amicable separation: Chick's way of doing EMT. Nakaya Y, Sheng G. Cell Adh Migr. 2009 Apr;3(2):160-3. Epub 2009 Apr 10. PMID: 19262172

- **Epithelial cells** (organised cellular layer) which lose their organisation and migrate/proliferate as a mesenchymal cells (disorganised cellular layers) are said to have undergone an Epithelial Mesenchymal Transition (EMT).
- **Mesenchymal cells** have an embryonic connective tissue-like cellular arrangement
 - cells that have undergone this process may at a later time and under specific signaling conditions undergo the opposite process, mesenchyme to epithelia.
- In development, this process can be repeated several times during tissue differentiation.

This process occurs at the primitive streak where epiblast cells undergo an epithelial to mesenchymal transition in order to delaminate and migrate.

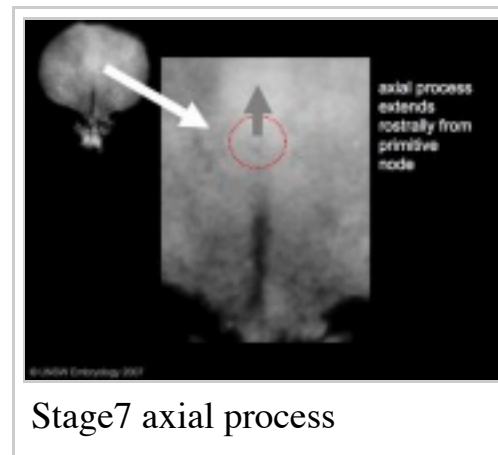
MH - there are a number of common cellular changes that occur during embryonic development at different times and in different tissues, which we can classify into "developmental mechanisms".

Notochord

- The notochord is a structure which has an early **mechanical role** in embryonic disc folding and a major **signaling role**

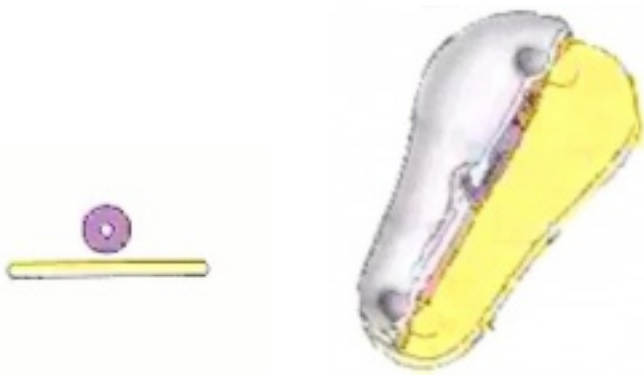
in patterning surrounding embryonic tissue development.

- A developmental feature not present in the adult anatomy.
- This signaling role patterns many different tissues (neural plate, neural tube, somites, endodermal organs).
- Has own sequence of development from a primitive axial process
 - **axial process** an initial epiblast hollow epithelial tube which extends in the midline from the primitive pit, cranially in the embryonic disc (toward the oral membrane).
 - **neuroenteric canal** is a transient communication between the amniotic cavity and the yolk sac cavity formed by the axial process.
 - **notochordal plate** forms from the axial process merging with the endoderm layer.
 - **notochord** forms from the notochordal plate which then separates back into the mesoderm layer as a solid column of cells lying in the midline of the embryonic disc and running rostro-caudally (head to tail).
- An alternate name for the notochord is "axial mesoderm".



Stage7 axial process

MH - Much of our knowledge of this structure comes from the study of animal models of development.



Week 3 Notochord

Week 3 Notochord

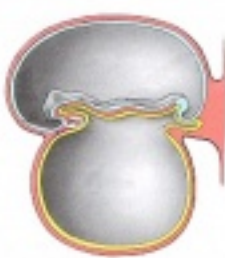
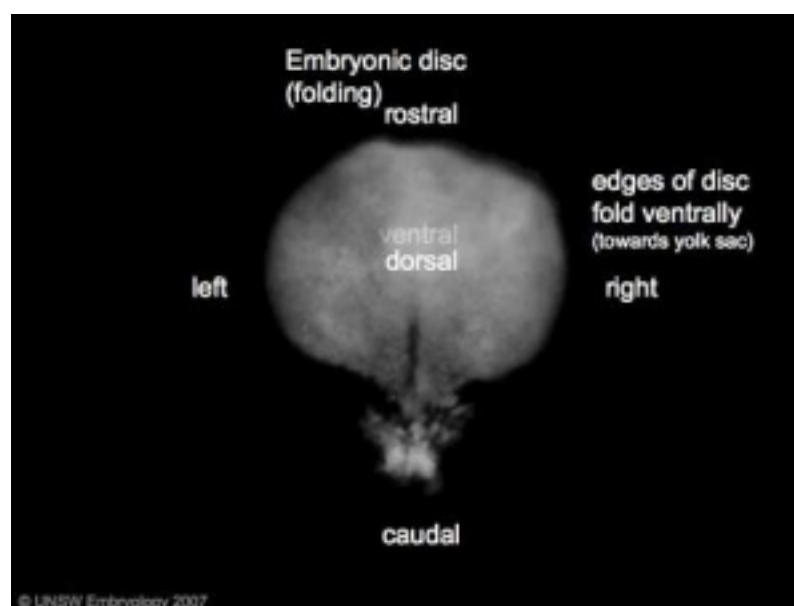
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Links: Notochord Movie | Mesoderm

Embryo Folding

- **embryonic disc** now has 3 germ layers (ectoderm, mesoderm, endoderm)
- this flat 3 layer disc then begins to fold ventrally at the edges
- eventually forming a "hollow tube" of these 3 germ layers



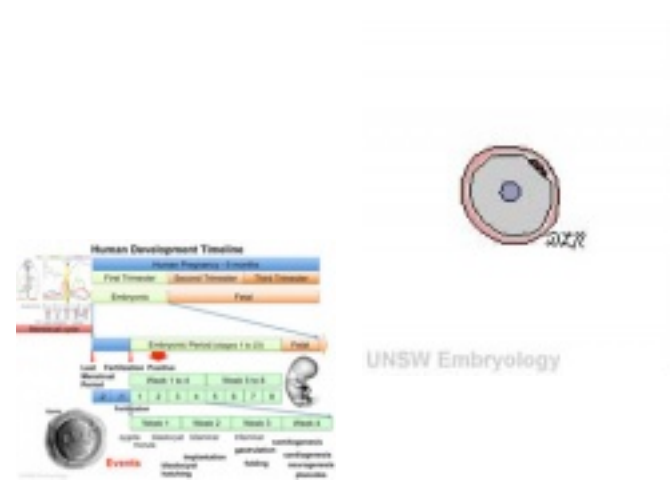
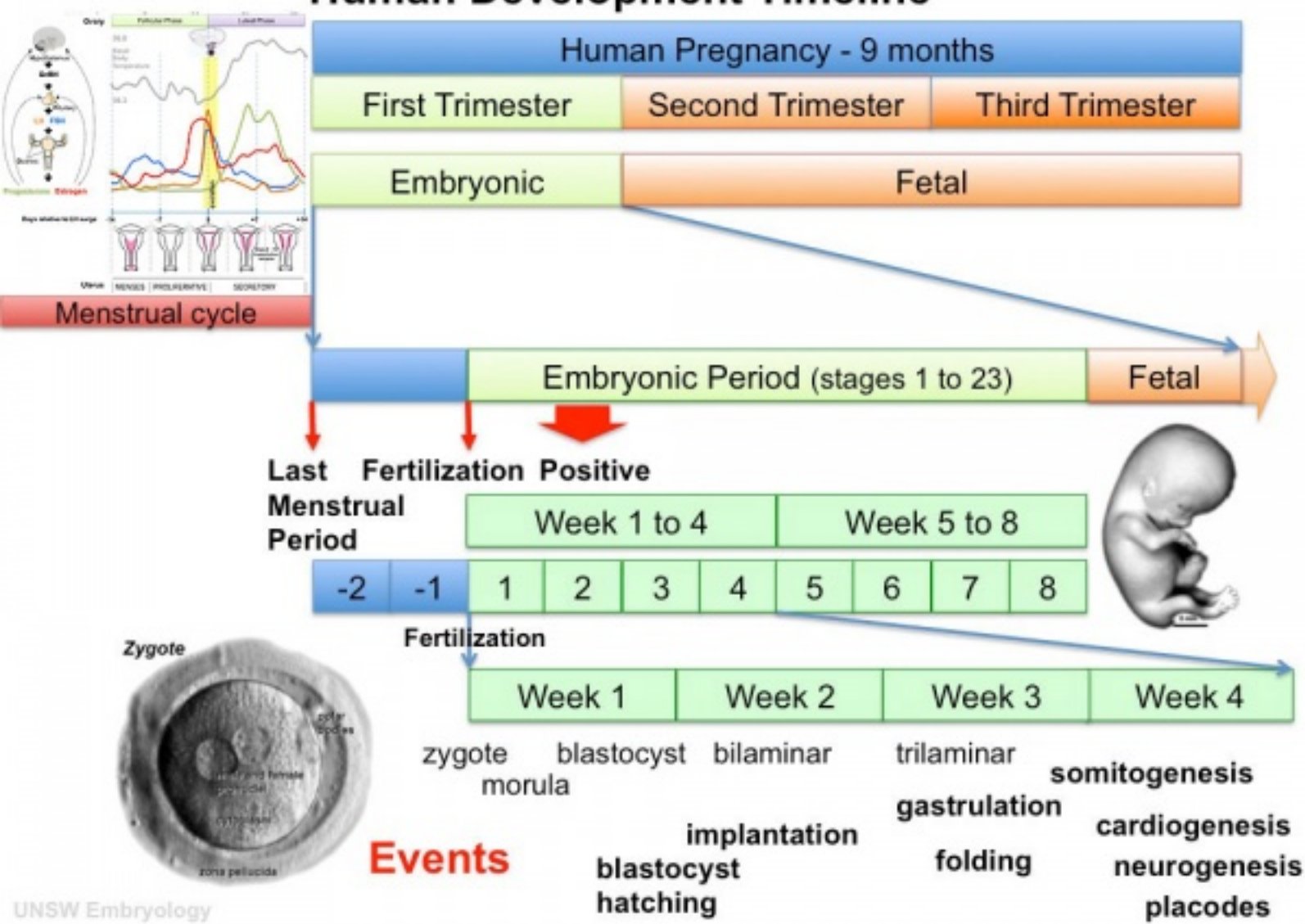
Week 3

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Embryonic Disc Folding - all edges of the embryonic disc will fold ventrally, forming a rostro-caudal "C" shaped tube.

Timeline

Human Development Timeline



Next: Lab 2 - Fertilization/Week 1 and 2

Human Timeline
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Human Development
Page | Play

2014 Course: Week 2 Lecture 1 Lecture 2 Lab 1 | **Week 3** Lecture 3 **Lecture 4** Lab 2 | **Week 4** Lecture 5 Lecture 6 Lab 3 | **Week 5** Lecture 7 Lecture 8 Lab 4 | **Week 6** Lecture 9 Lecture 10 Lab 5 | **Week 7** Lecture 11 Lecture 12 Lab 6 | **Week 8** Lecture 13 Lecture 14 | Lab 7 | **Week 9** Lecture 15 Lecture 16 Lab 8 | **Week 10** Lecture 17 Lecture 18 Lab 9 | **Week 11** Lecture 19 Lecture 20 Lab 10 | **Week 12** Lecture 21 Lecture 22 Lab 11 | **Week 13** Lecture 23 Lecture 24 Lab 12 | Moodle (<http://moodle.telt.unsw.edu.au/course/view.php?id=9262>)

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