

# Lecture - Week 1 and 2 Development

From Embryology

Embryology - 10 Aug 2015    Translate [Expand]

Week 1 | Week 2 | Zygote | Morula | Blastocyst | Implantation

## Contents

- 1 Introduction
- 2 Objectives
- 3 Lecture Resources
- 4 Fertilization
  - 4.1 Fertilization - Spermatozoa
  - 4.2 Fertilization- Oocyte
- 5 Zygote Formation
- 6 Cleavage of Zygote
- 7 Morula
- 8 Blastocyst
  - 8.1 Blastula Cell Communication
  - 8.2 Blastocyst Hatching
- 9 Week 2 - Implantation
  - 9.1 Endometrial Receptivity
  - 9.2 Abnormal Implantation
- 10 Uterus
  - 10.1 Endometrial Layers
  - 10.2 Decidual Reaction
  - 10.3 Other Uterine Changes
  - 10.4 Decidua
  - 10.5 Uterus Abnormalities
- 11 Conceptus
  - 11.1 Bilaminar Embryoblast
  - 11.2 Bilaminar Trophoblast
- 12 Twinning
  - 12.1 Dizygotic Twinning
  - 12.2 Monoygotic Twinning

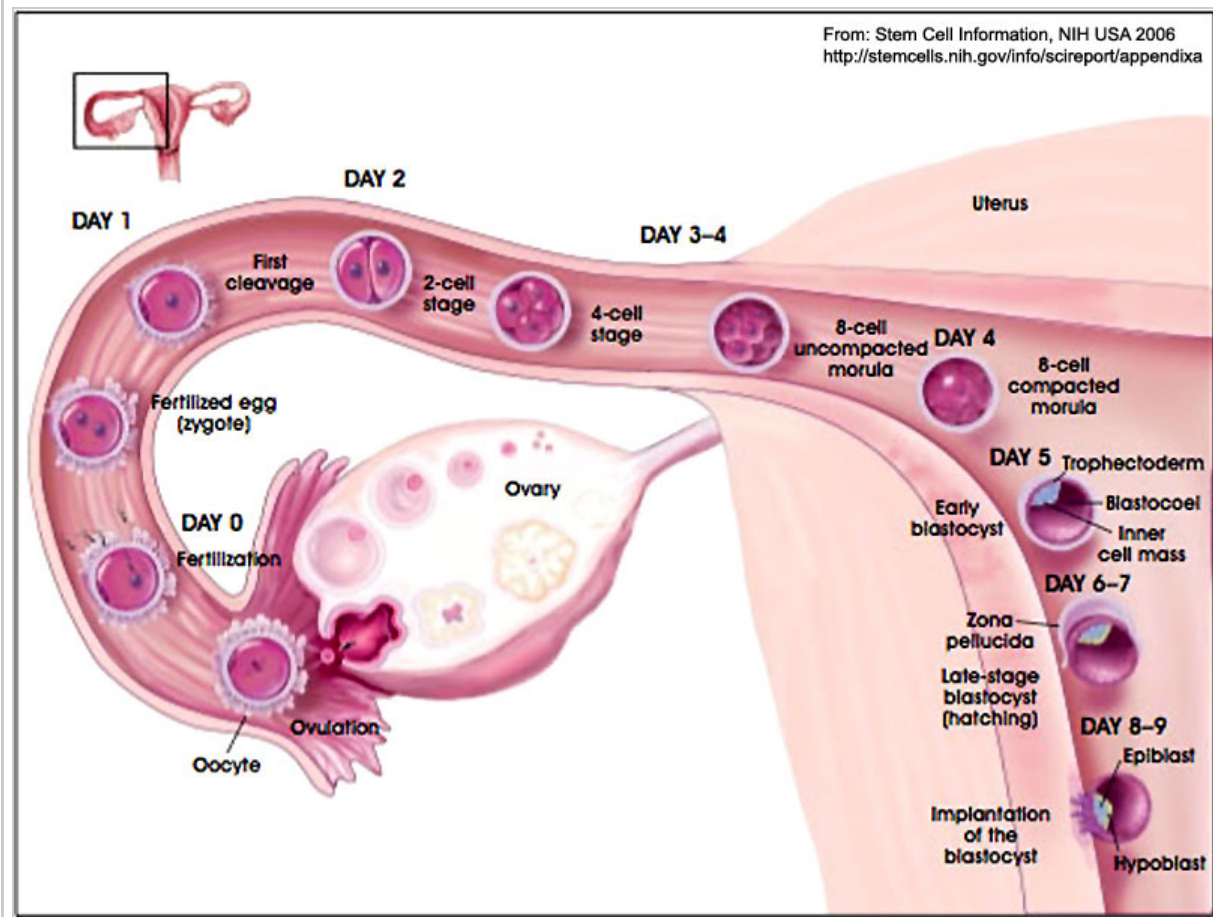
## Introduction

This lecture will discuss the first two weeks of human embryogenesis and describe the cleavage stages, blastocyst formation and hatching, and the generation of the bilaminar embryo. There will also be an introduction to the uterine changes at implantation, that will be covered in detail in the placentation lecture.

## Objectives

- Understand the events during week 1 of development (Zygote, Blastomeres, Morula, Blastocyst)
- Understand the events during week 2 of development (Trophoblast, Syncytiotrophoblast, Cytotrophoblast, Embryoblast, Implantation)
- Brief understanding of early placentation
- Brief understanding of maternal changes

## Lecture Resources



Week 1 and 2 Development (see Week 1 Movie)

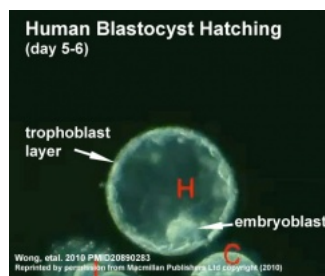
# Movies [Collapse]



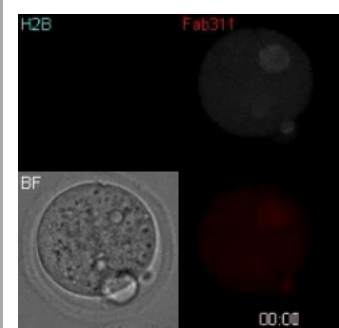
**Day 3 to 6**  
Page | Play



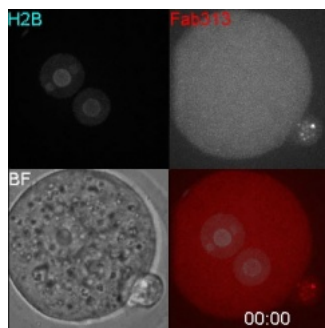
**Contractions**  
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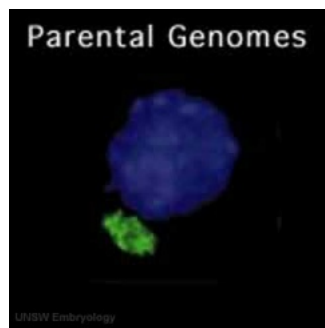
**Hatching**  
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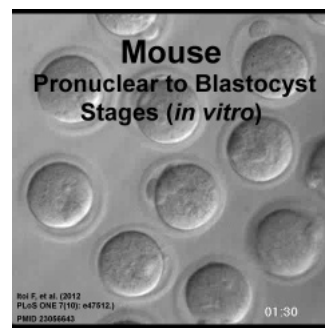
**Zygote Mitosis**  
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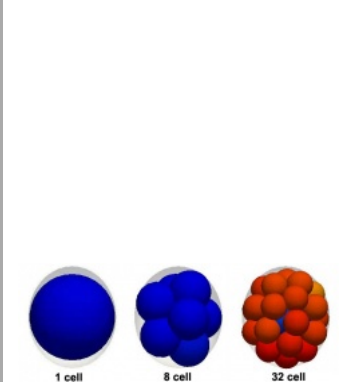
**Early Division**  
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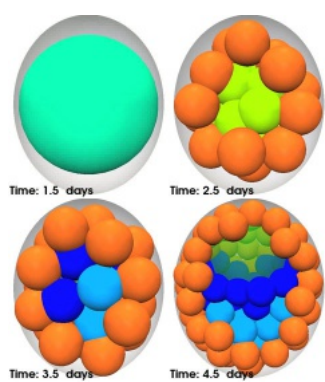
**Parental Genomes**  
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**Mouse Blastocyst**  
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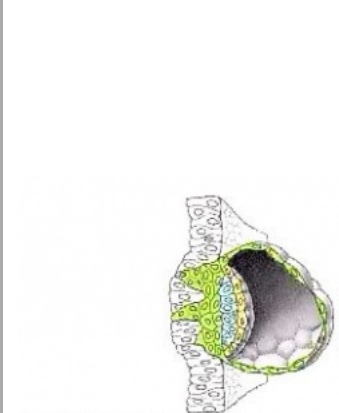


**Morula Model**  
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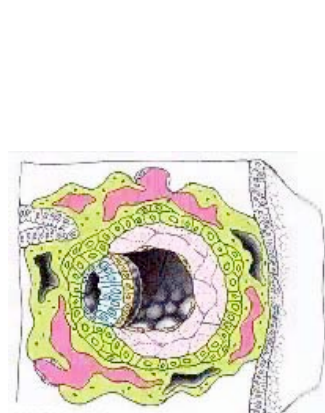


**Blastocyst Model**  
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## Week 2





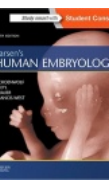
**Week 2 - Implant**  
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**Week 2 - Bilaminar**  
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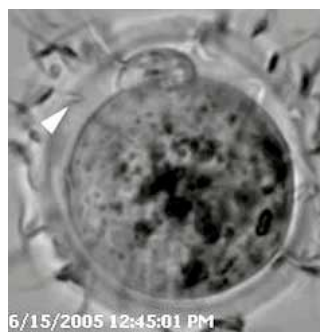
**Embryo 1.6mm**  
Page | Play

 <p>Hill, M.A. (2015). <i>UNSW Embryology</i> (15th ed.) Retrieved August 10, 2015, from <a href="https://embryology.med.unsw.edu.au">https://embryology.med.unsw.edu.au</a></p>	<ul style="list-style-type: none"> <li>Menstrual Cycle   Week 1   Week 2   Implantation</li> <li>Lecture Archive: 2009   2010   2011 (<a href="http://embryology.med.unsw.edu.au/embryology/index.php?title=Lecture_-_Week_1_and_2_Development&amp;oldid=61429">http://embryology.med.unsw.edu.au/embryology/index.php?title=Lecture_-_Week_1_and_2_Development&amp;oldid=61429</a>)   2012 (<a href="http://embryology.med.unsw.edu.au/embryology/index.php?title=Lecture_-_Week_1_and_2_Development&amp;oldid=97577">http://embryology.med.unsw.edu.au/embryology/index.php?title=Lecture_-_Week_1_and_2_Development&amp;oldid=97577</a>)   2013   2014</li> </ul>
 <p>Moore, K.L., Persaud, T.V.N. &amp; Torchia, M.G. (2011). <i>The developing human: clinically oriented embryology</i> (9th ed.). Philadelphia: Saunders.</p>	<p>The following chapter links only work with a UNSW connection.</p> <ul style="list-style-type: none"> <li>First Week of Human Development (<a href="http://www.unsw.eblib.com.wwwproxy0.library.unsw.edu.au/patron/Read.aspx?p=1430154&amp;pg=35">http://www.unsw.eblib.com.wwwproxy0.library.unsw.edu.au/patron/Read.aspx?p=1430154&amp;pg=35</a>)</li> <li>Second Week of Human Development (<a href="http://www.unsw.eblib.com.wwwproxy0.library.unsw.edu.au/patron/Read.aspx?p=1430154&amp;pg=63">http://www.unsw.eblib.com.wwwproxy0.library.unsw.edu.au/patron/Read.aspx?p=1430154&amp;pg=63</a>)</li> </ul>
 <p>Schoenwolf, G.C., Bleyl, S.B., Brauer, P.R., Francis-West, P.H. &amp; Philippa H. (2015). <i>Larsen's human embryology</i> (5th ed.). New York; Edinburgh: Churchill Livingstone.</p>	<p>The following chapter links only work with a UNSW connection.</p> <ul style="list-style-type: none"> <li>Chapter 1 - Gametogenesis, Fertilization, and First Week (<a href="https://login.wwwproxy0.library.unsw.edu.au/login?url=http://www.unsw.eblib.com/patron/FullRecord.aspx?p=2074524">https://login.wwwproxy0.library.unsw.edu.au/login?url=http://www.unsw.eblib.com/patron/FullRecord.aspx?p=2074524</a>)</li> </ul>

ECHO360 Recording[Expand]

## Fertilization

- Fertilization usually occurs in first 1/3 of oviduct.
- Fertilization can also occur outside oviduct, associated with In Vitro Fertilization (IVF, GIFT, ZIFT...) and ectopic pregnancy.
- The majority of fertilized eggs do not go on to form an embryo.

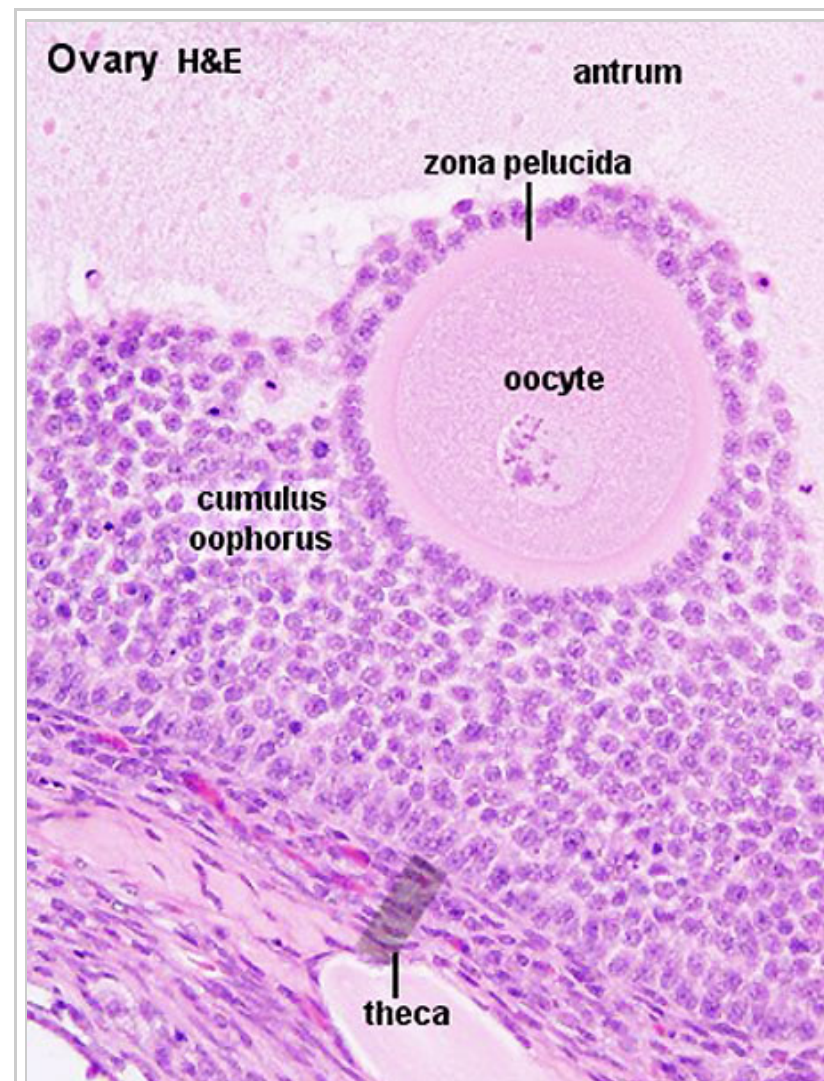


6/15/2005 12:45:01 PM  
**Mouse Fertilisation**

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## Fertilization - Spermatozoa

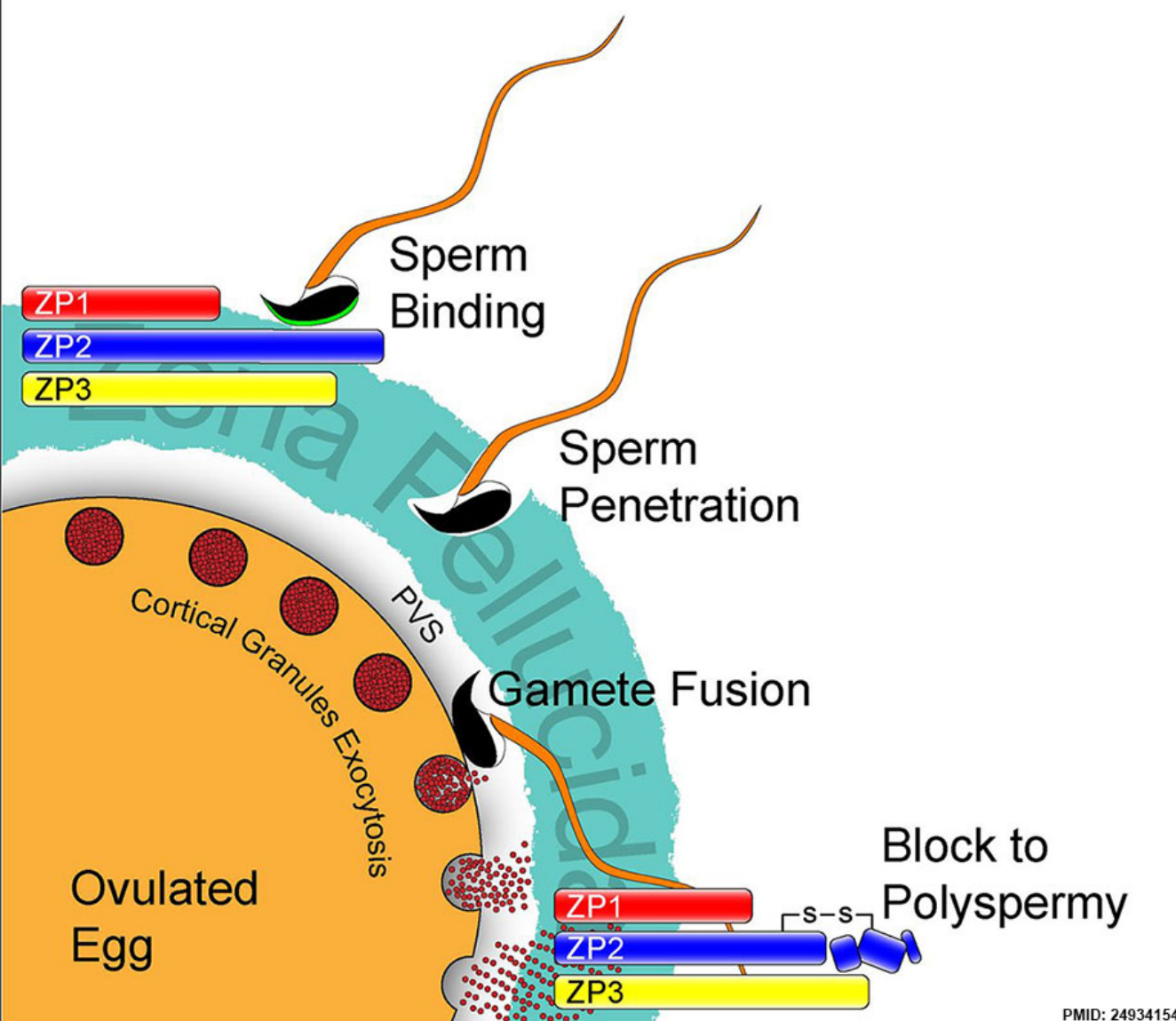
- Sperm Binding** - zona pellucida protein ZP3 acts as receptor for sperm
- Acrosome Reaction** - exocytosis of acrosome contents (Calcium mediated) MBoC - Figure 20-31. The acrosome reaction that occurs when a mammalian sperm fertilizes an egg (<http://www.ncbi.nlm.nih.gov/books/bv.fcgi?rid=mboc4.figgrp.3741>)
  - enzymes to digest the zona pellucida, exposes sperm surface proteins to bind ZP2
- Membrane Fusion** - between spermatozoa and oocyte, allows spermatozoa nuclei passage into oocyte cytoplasm



Antral Follicle and Oocyte



Intracytoplasmic sperm insemination (ART)

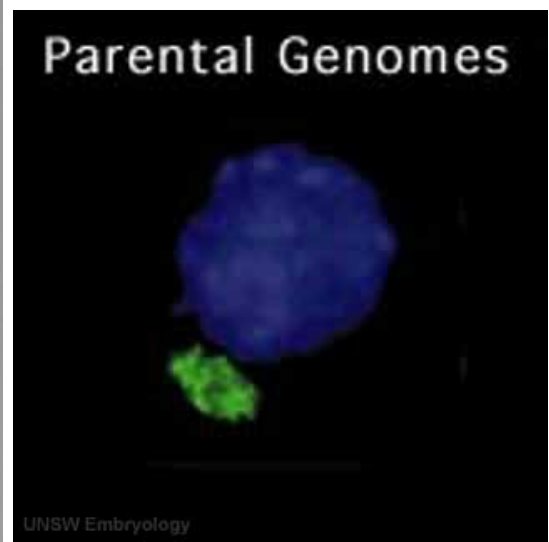
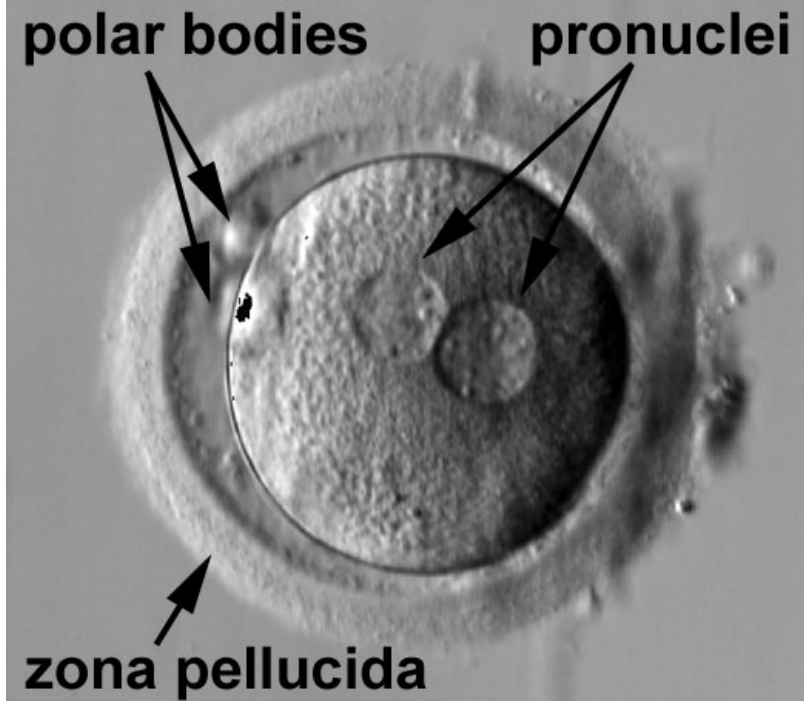
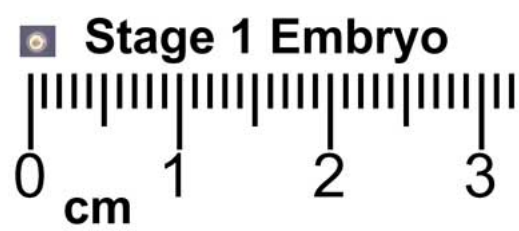


## Fertilization- Oocyte

- **Membrane Depolarization** - caused by sperm membrane fusion, primary block to polyspermy
- **Cortical Reaction** - IP<sub>3</sub> pathway elevates intracellular Calcium, exocytosis of cortical granules MBoC - Figure 20-32. How the cortical reaction in a mouse egg is thought to prevent additional sperm from entering the egg (<http://www.ncbi.nlm.nih.gov/books/bv.fcgi?rid=mboc4.figgrp.3743>)
  - enzyme alters ZP3 so it will no longer bind sperm plasma membrane
- **Meiosis 2** - completion of 2nd meiotic division
  - forms second polar body (a third polar body may be formed by meiotic division of the first polar body)

## Zygote Formation

- zygote (Carnegie stage 1) is the first diploid cell formed following fertilisation.
- male and female pronuclei, 2 nuclei approach each other and nuclear membranes break down.
- DNA replicates, first mitotic division
- sperm contributes centriole which organizes mitotic spindle



**Pronuclear Fusion and Parental Genomes Movies[Expand]**

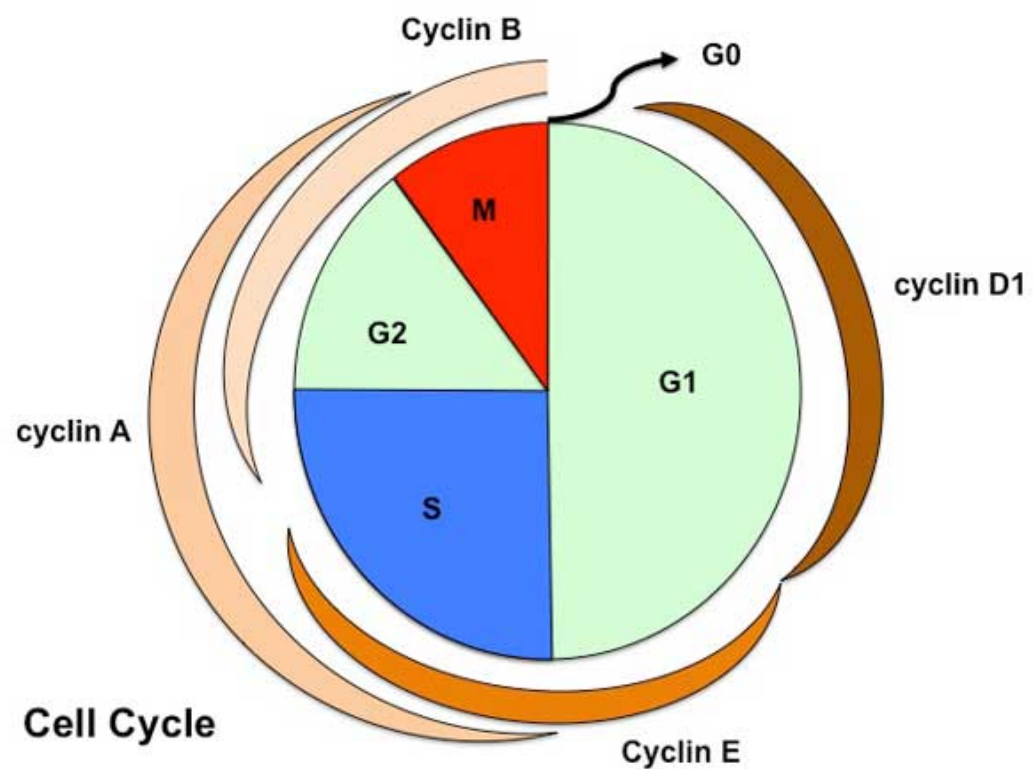
*Conceptus* - the term refers to all material derived from this fertilised zygote, includes both the embryo and the non-embryonic tissues (placenta, fetal membranes).

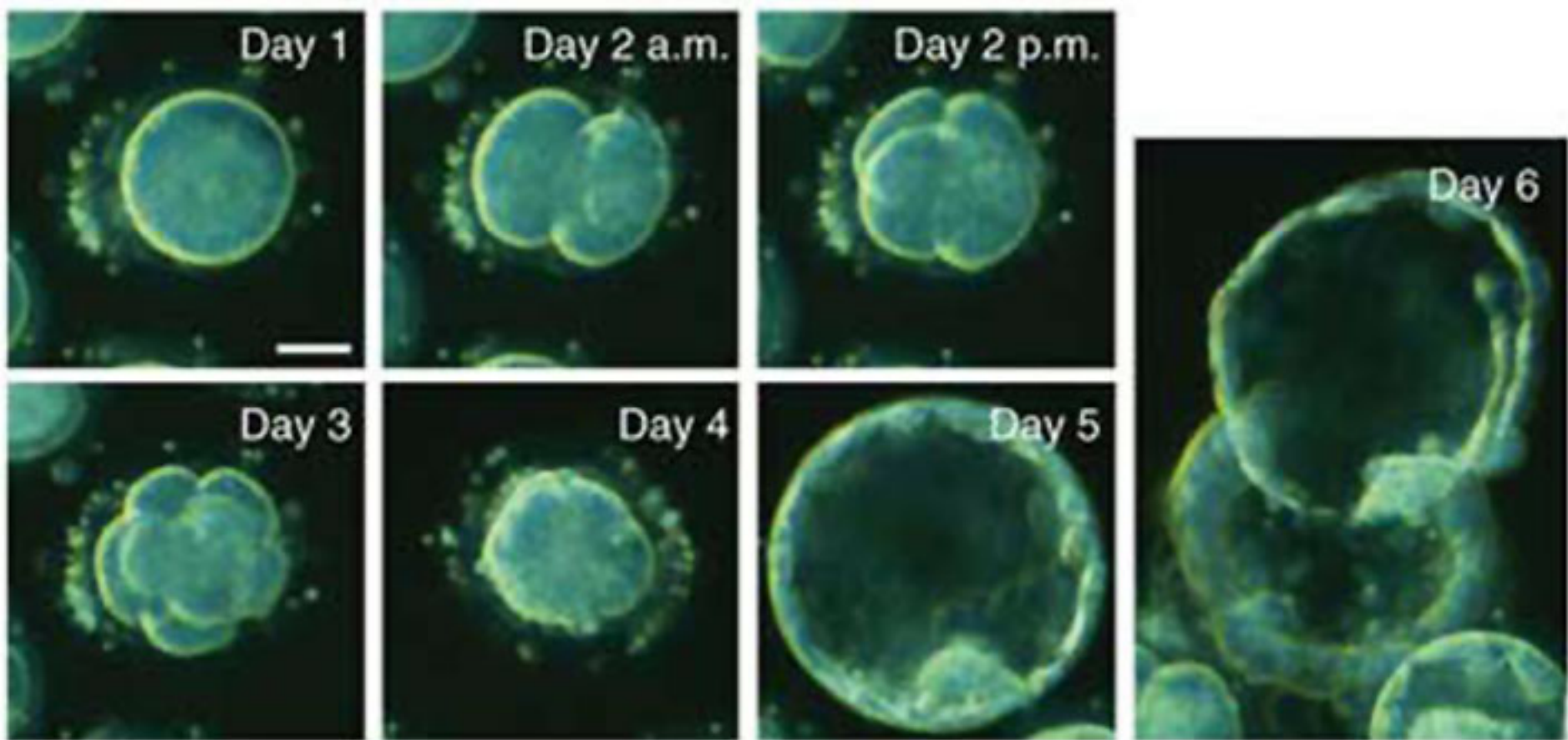
**Links:** Fertilization | Carnegie stage 1

## Cleavage of Zygote

**Zygote Division Movie[Expand]**

- cleavage of zygote forms 2 blastomeres and is also cleavage with no cytoplasm synthesis.
  - special "embryonic" cell cycle **S** phases and **M** phases alternate without any intervening **G1** or **G2** phases (MSMSMSMS, adult MG1SG2) therefore individual cell volume decreases.
- cell division is initially synchronous, then asynchronously
- cell division becomes slower (centre cells, larger) and faster in peripheral cells
- zona pellucid still intact (division occurs within the ZP)

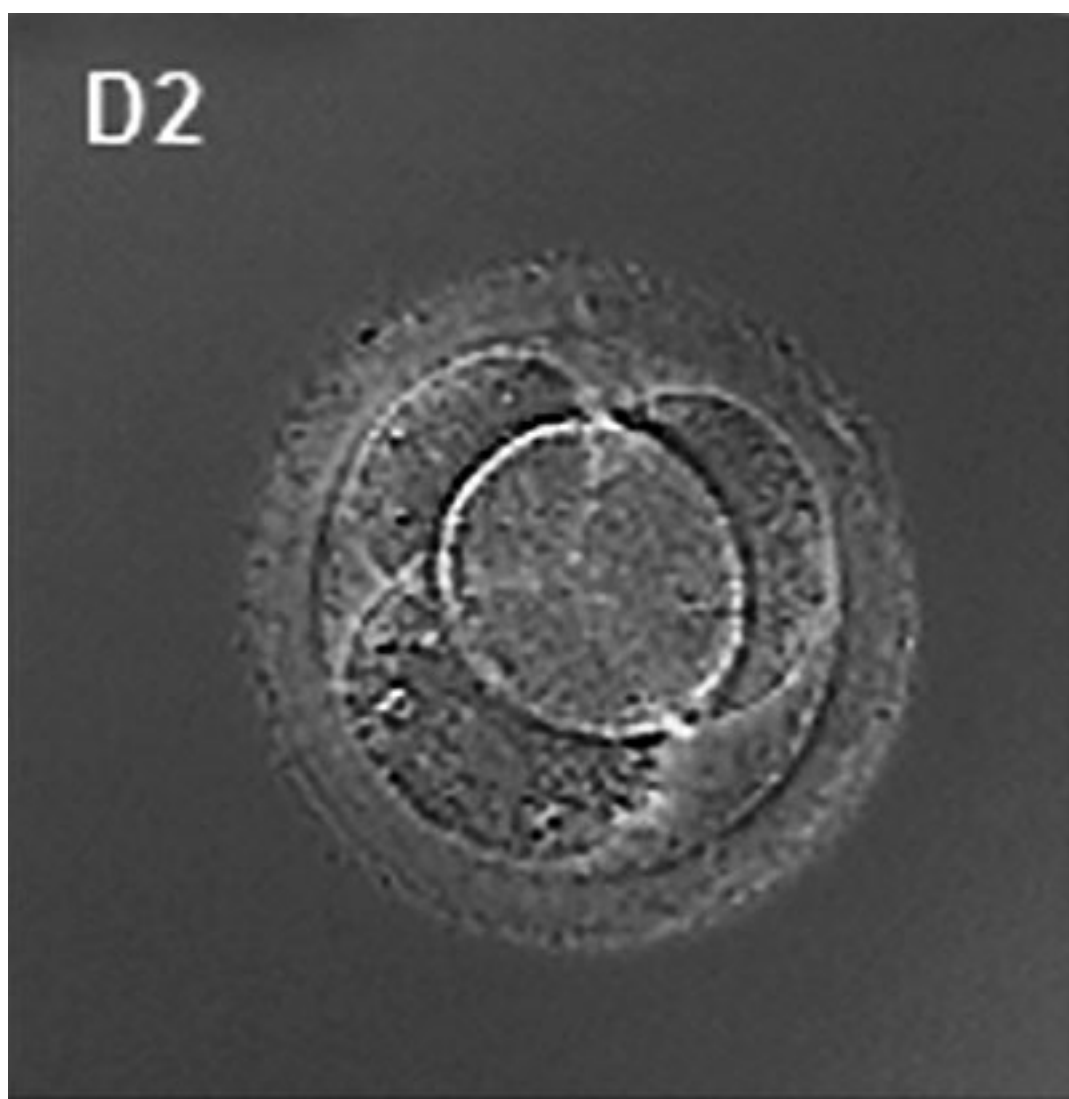




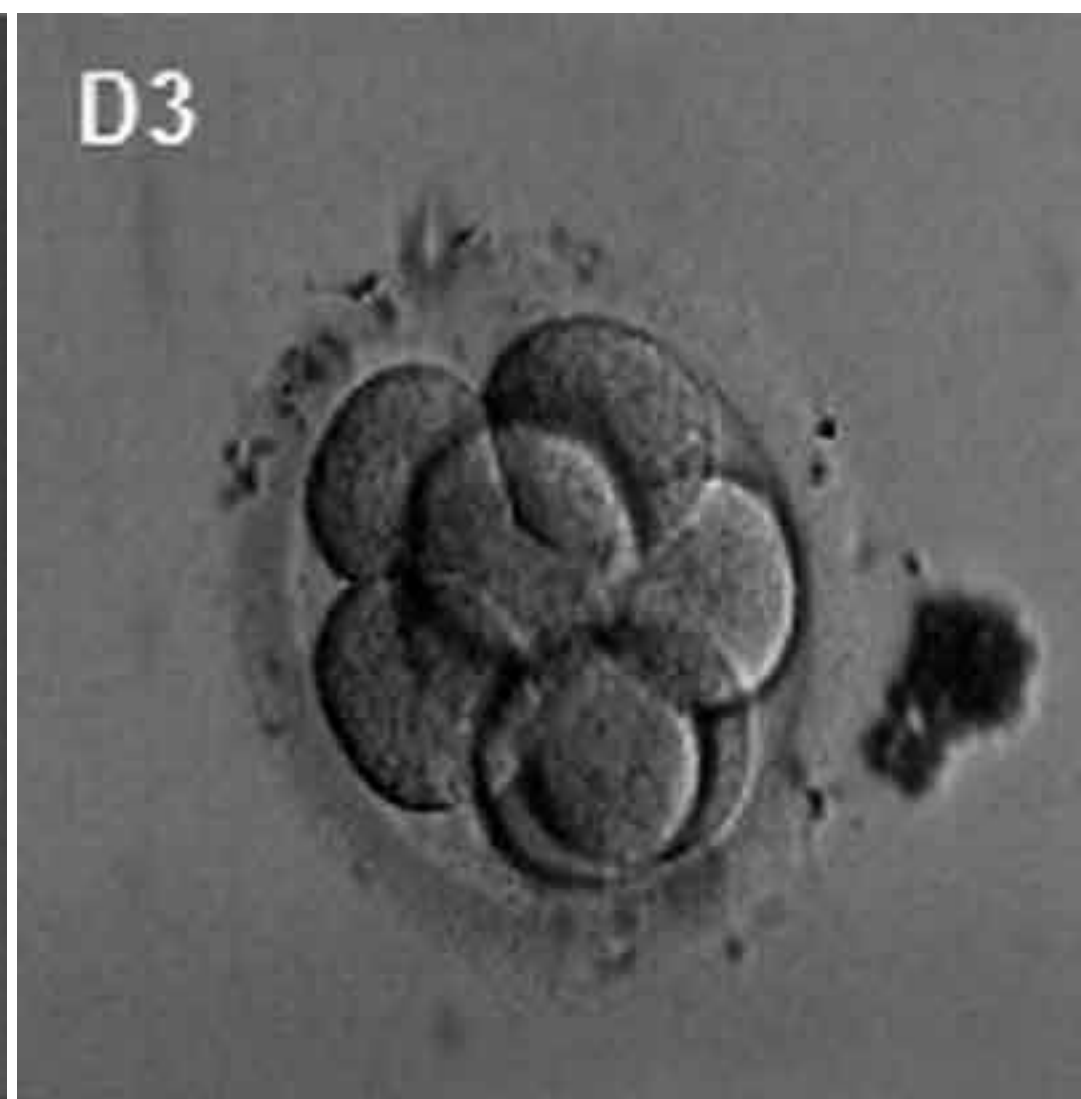
Human Zygote to Blastocyst Development (day 1 to 6)

**Links:** Carnegie stage 2 |

## Morula



Human Embryo (day 2)



Human Embryo (day 3)

- about **day 4** is a solid ball of 16-20 cells with peripheral cells flattened against zona pellucida
- compaction occurs forming a cavity and leading to the next blastocyst stage

**Links:** Figure 8.19. Changes in DNA methylation during mammalian development (<http://www.ncbi.nlm.nih.gov/books/bv.fcgi?&rid=hmg.figgrp.928>)

## Blastocyst

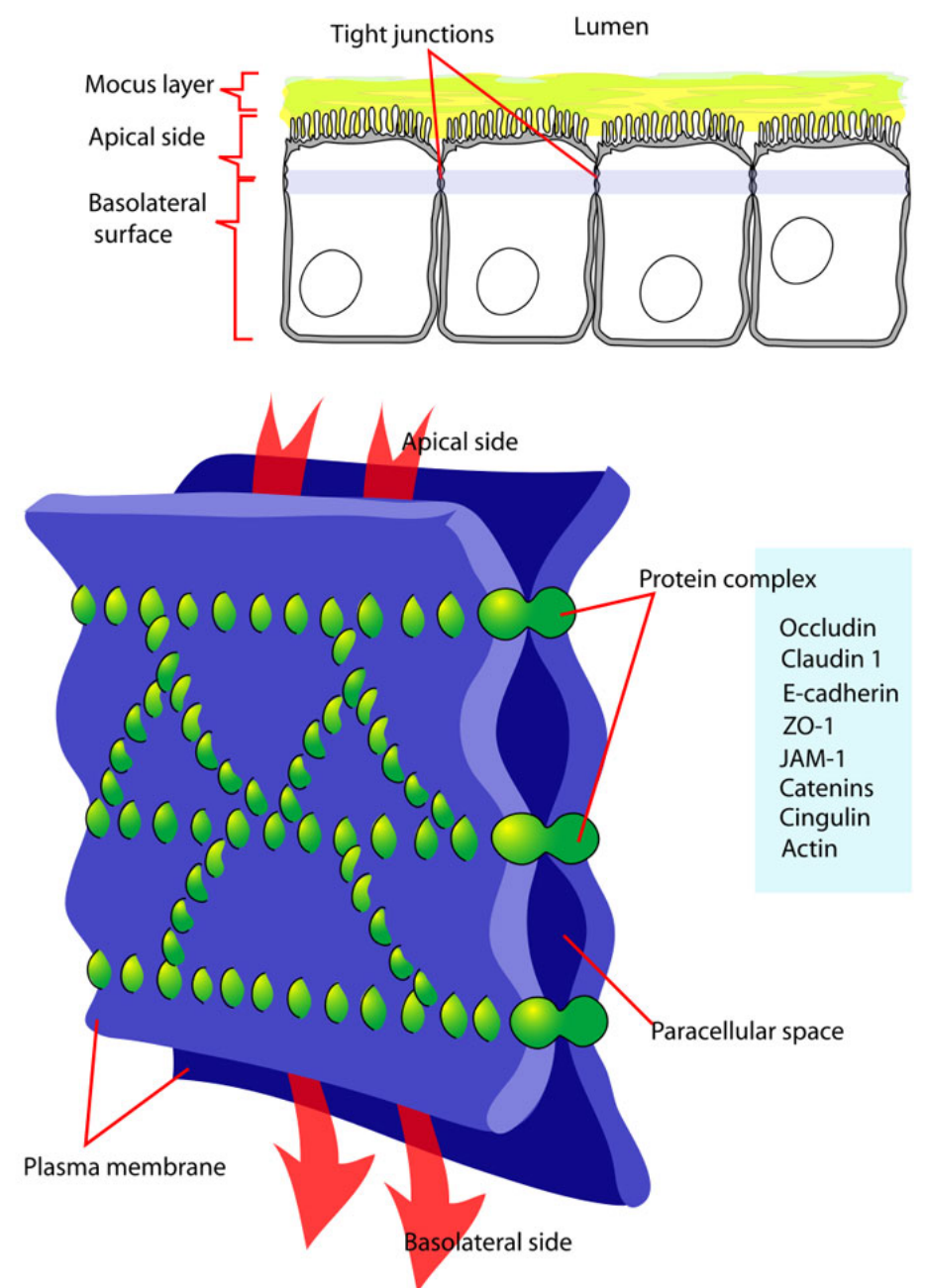
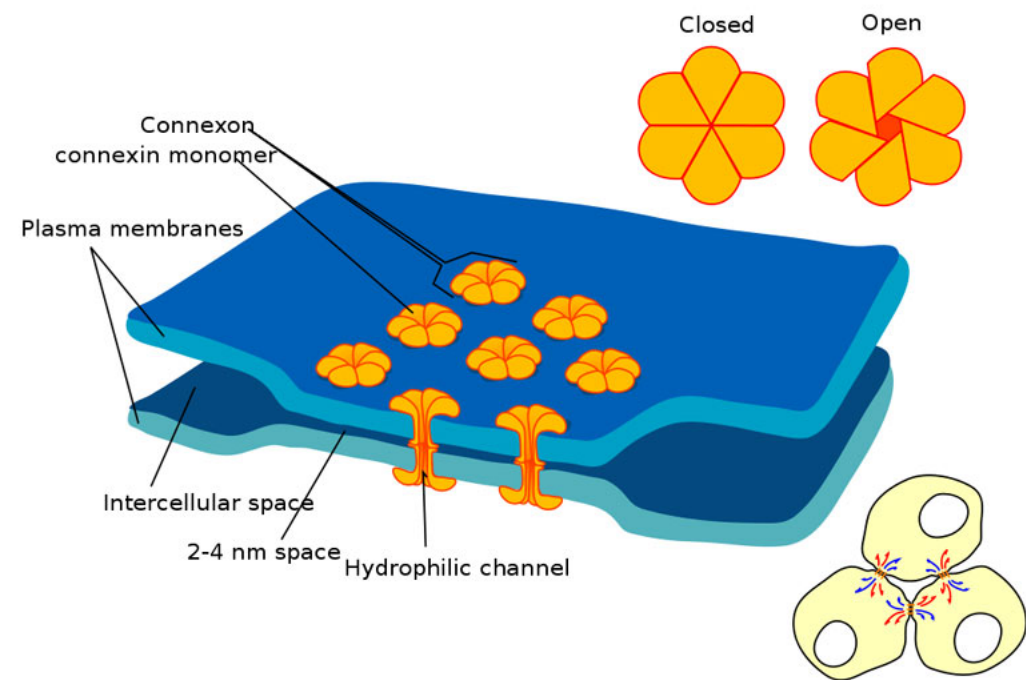
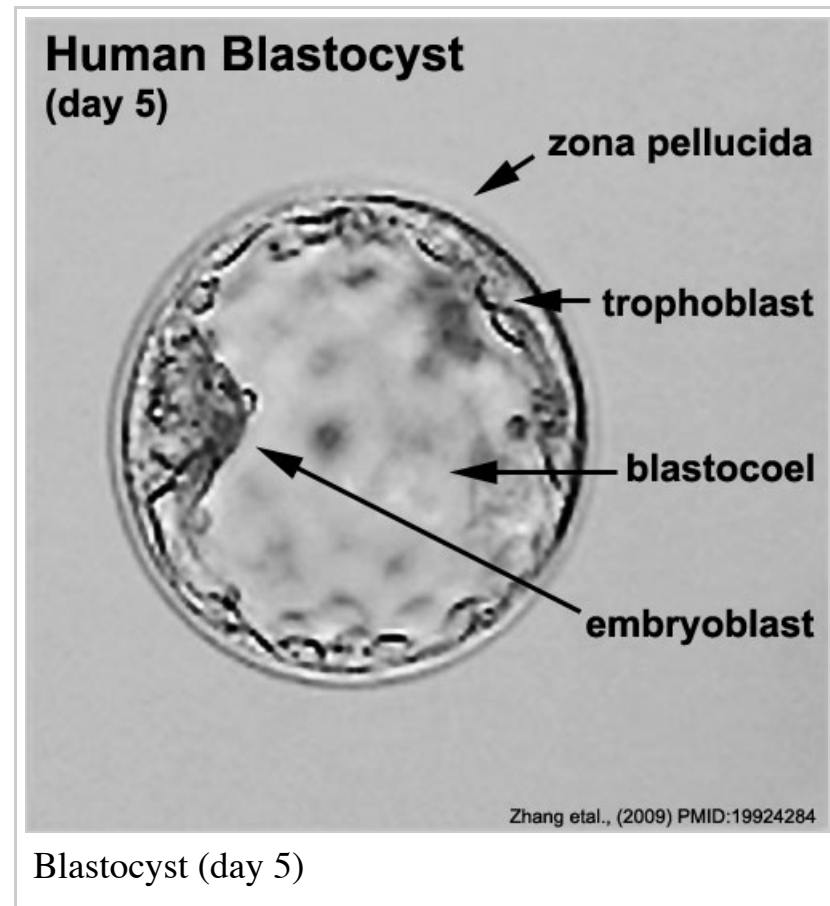
- about **day 5** have 2 identifiable cell types and a fluid-filled cavity (blastocoel)
  - outer cell layer - **trophoblast**, peripheral flattened cells, forms the placenta and placental membranes
  - inner cell mass - **embryoblast**, mass of rounder cells located on one wall of the blastocoel, forms entire embryo

[Human Blastocyst Movies\[Expand\]](#)

## Blastula Cell Communication

Two forms of cellular junctions

- gap junctions**, allow electrically couple cells of epithelium surrounding a fluid-filled cavity
- tight junctions**, close to outer surface create a seal, isolates interior of embryo from external medium



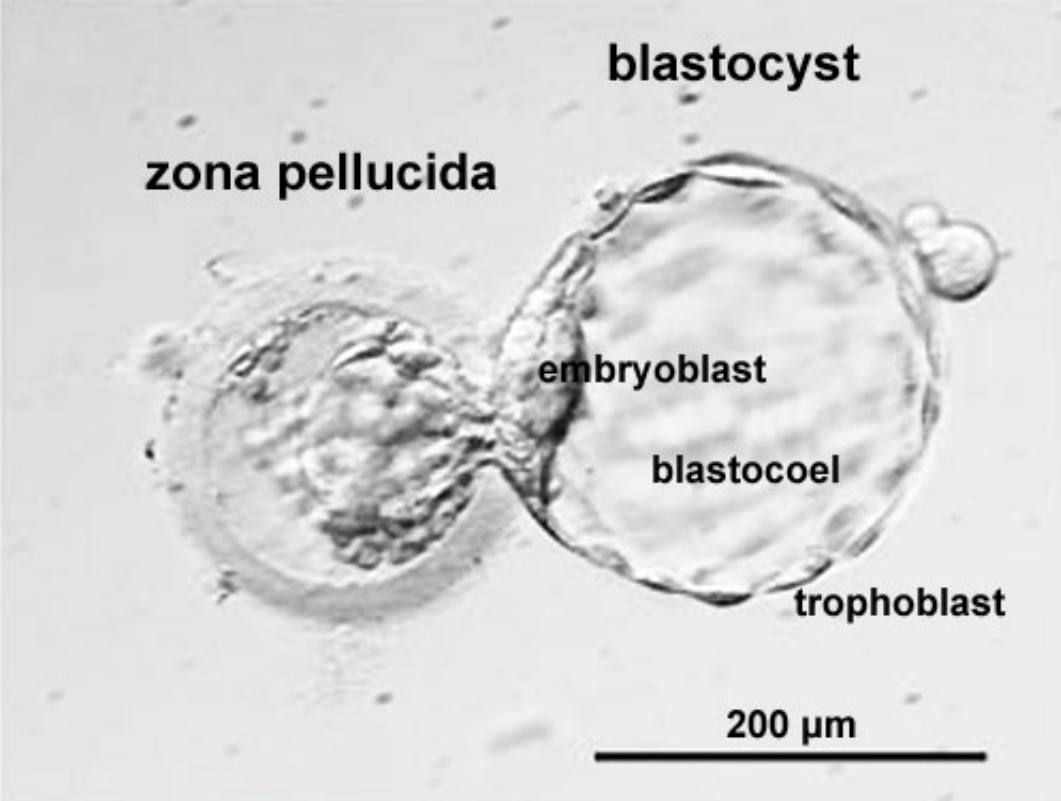
Gap junctions

Tight junctions

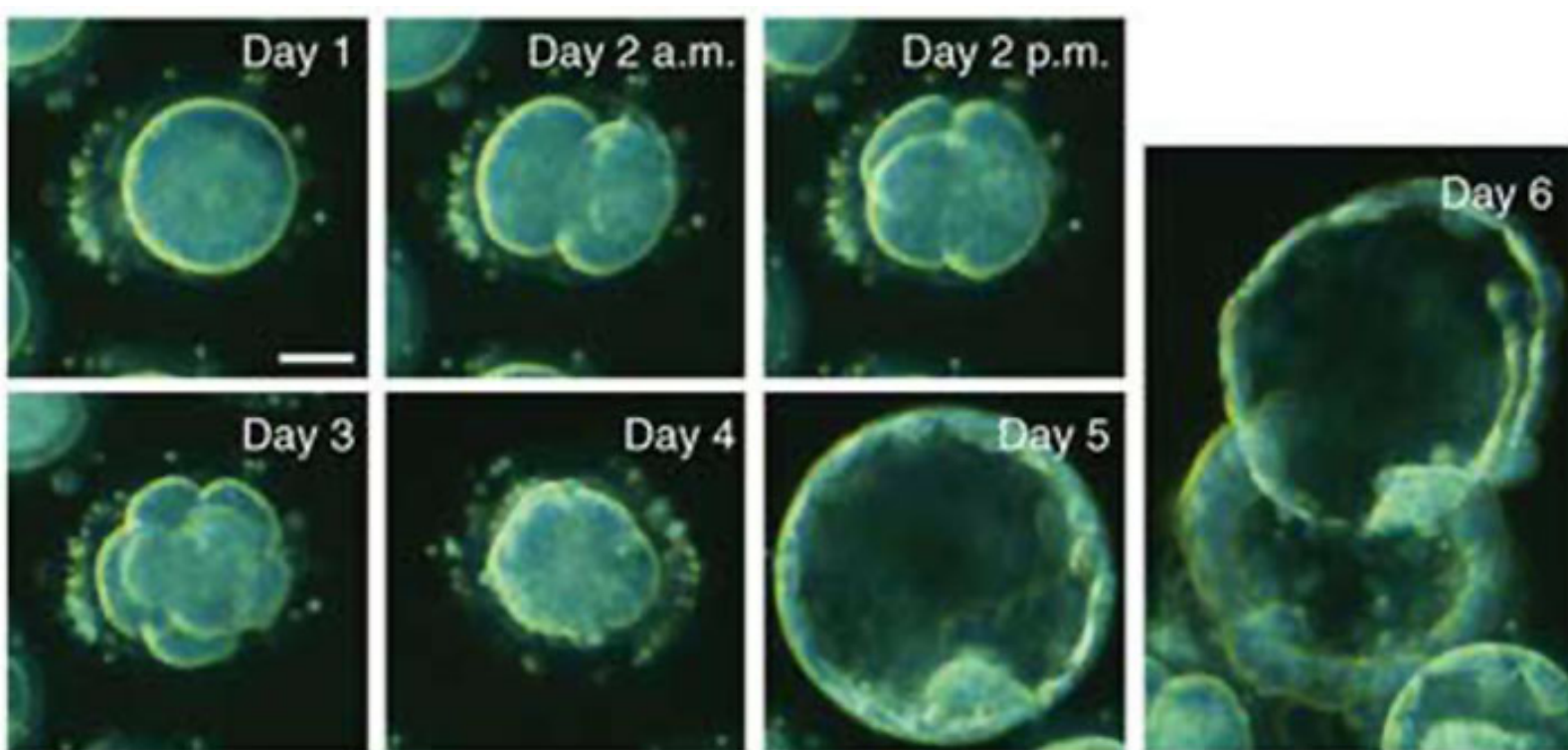
## Blastocyst Hatching

[Human Blastocyst Hatching Movie\[Expand\]](#)





**Blastocyst Hatching** - zona pellucida lost, ZP has sperm entry site, and entire ZP broken down by uterine secretions and possibly blastula secretions. **Uterine Glands** - secretions required for blastocyst motility and nutrition



**Links:** Carnegie stage 3 | Figure 21-69. The blastula (<http://www.ncbi.nlm.nih.gov/books/NBK26863/figure/A3927>)

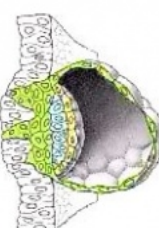
## Week 2 - Implantation

### Implantation Movie[Expand]

The second week of human development is concerned with the process of implantation and the differentiation of the blastocyst into early embryonic and placental forming structures.

- implantation commences about **day 6 to 7**
- **Adplantation** - begins with initial adhesion to the uterine epithelium
  - blastocyst then slows in motility, "rolls" on surface, aligns with the inner cell mass closest to the epithelium and stops
- **Implantation** - migration of the blastocyst into the uterine epithelium, process complete by about **day 9**
  - interaction between trophoblast cells and endometrial epithelium (apoptosis and decidualization)
- **coagulation plug** - left where the blastocyst has entered the uterine wall **day 12**

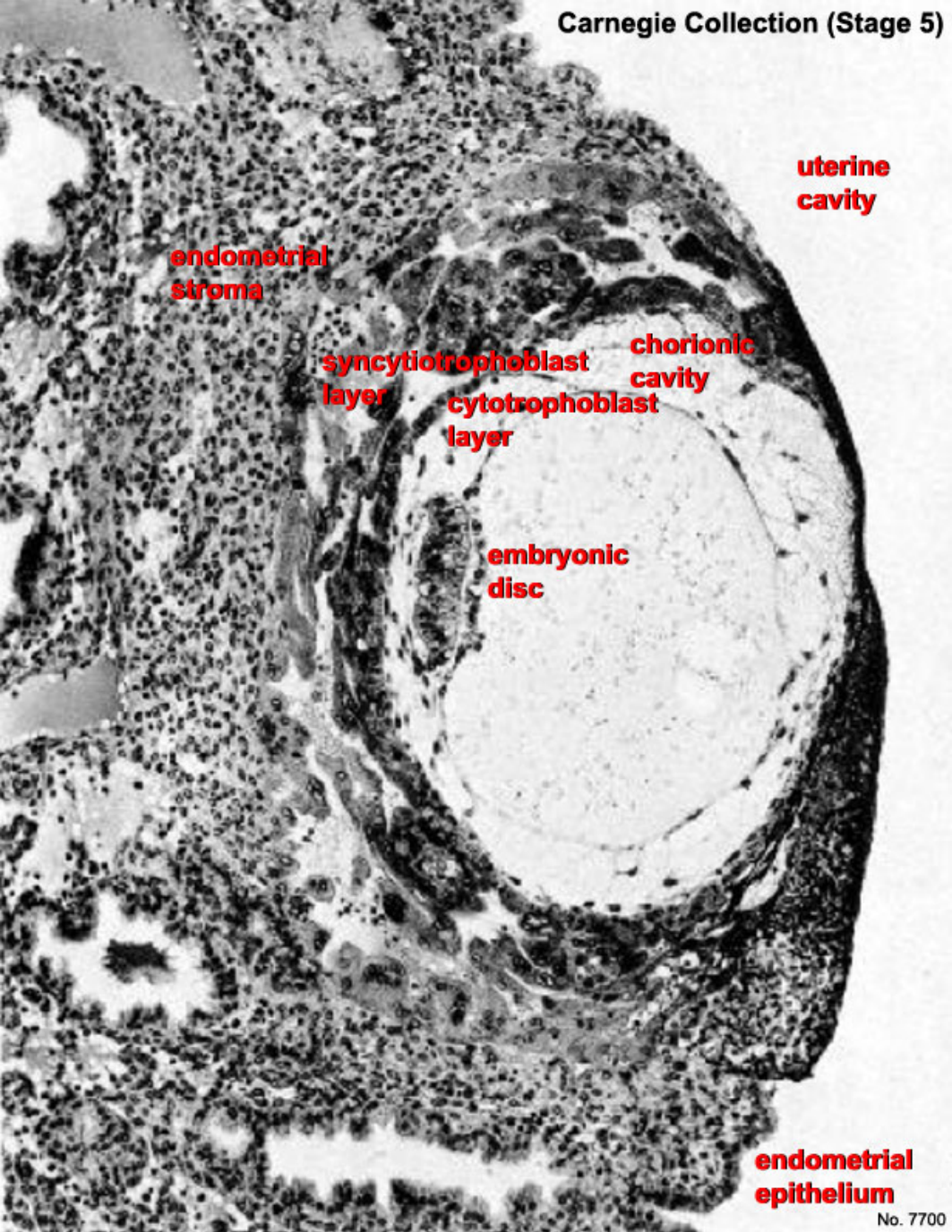
**Normal Implantation Sites** - in uterine wall superior, posterior, lateral



UNSW Embryology

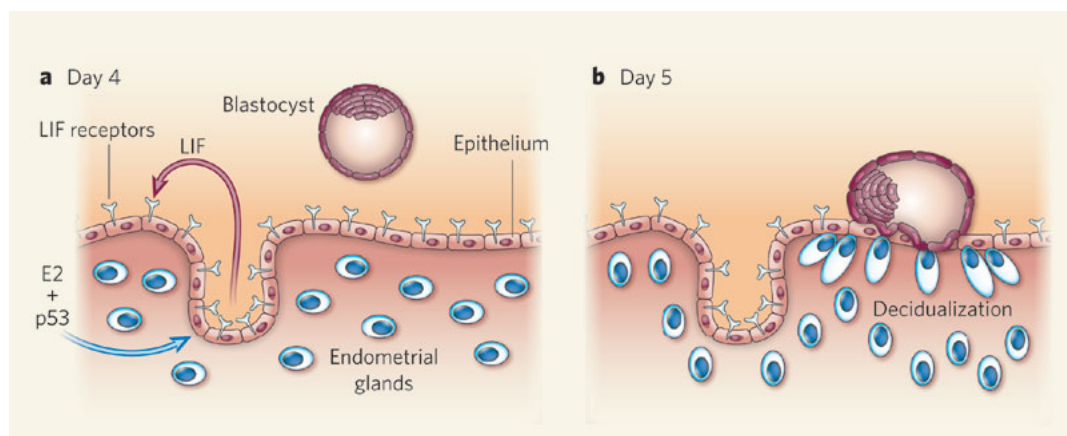
**Week 2 -  
Implant**

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## Endometrial Receptivity

- In humans, receptivity occurs 6 days after the post-ovulatory progesterone surge and lasts about 2 to 4 days.
  - Similar "receptivity window" in other species (rat day 5 and mouse day 4.5).
- Many studies have looked into identifying markers for this receptivity period both to optimise and to block this process.



## Abnormal Implantation

## Ectopic Ultrasound Movie



[Click Here](#) to play on mobile device

Abnormal implantation sites or Ectopic Pregnancy occurs if implantation is in uterine tube or outside the uterus.

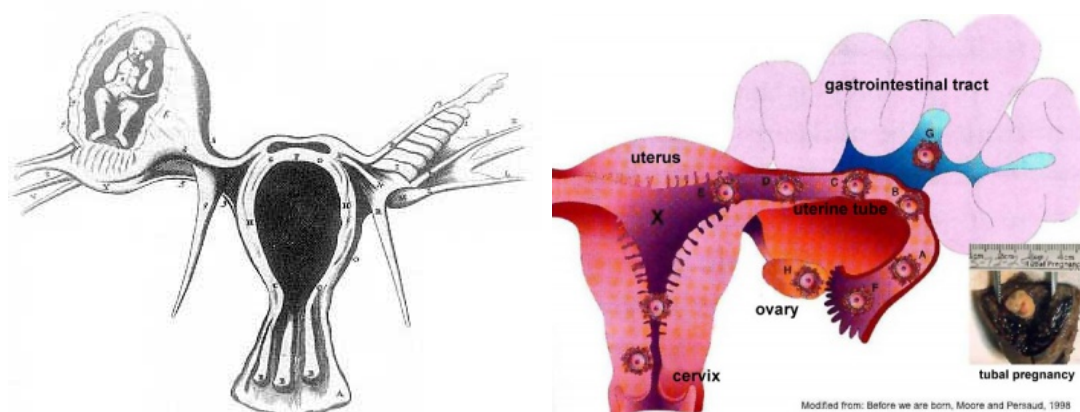
- sites - external surface of uterus, ovary, bowel, gastrointestinal tract, mesentery, peritoneal wall
- If not spontaneous then, embryo has to be removed surgically

**Tubal pregnancy** - 94% of ectopic pregnancies

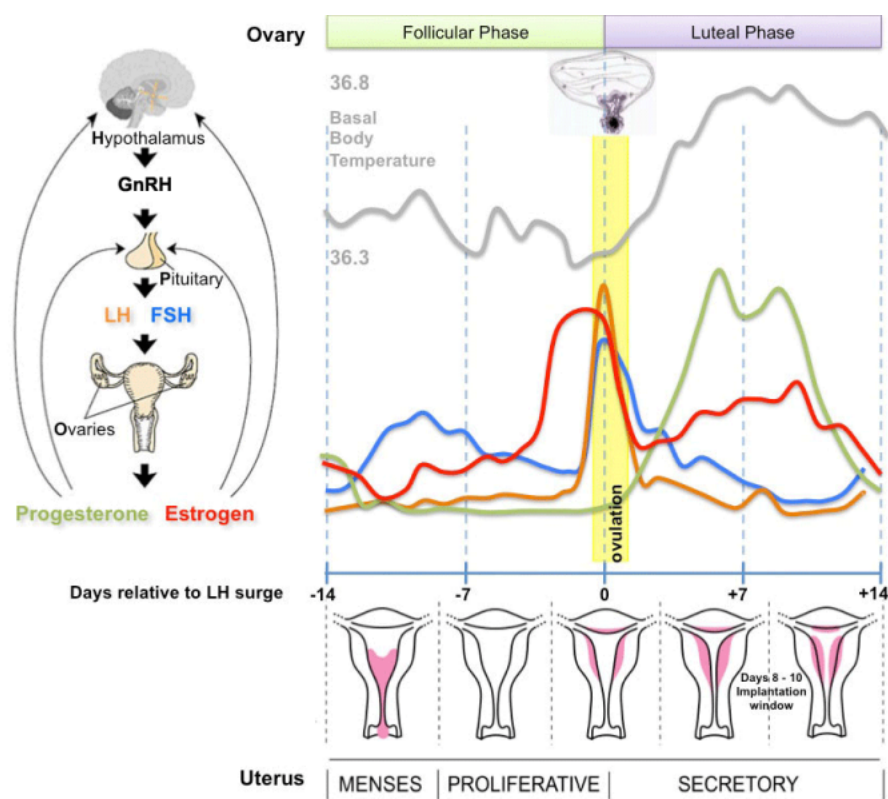
- if uterine epithelium is damaged (scarring, pelvic inflammatory disease)
- if zona pellucida is lost too early, allows premature tubal implantation
- embryo may develop through early stages, can erode through the uterine horn and reattach within the peritoneal cavity



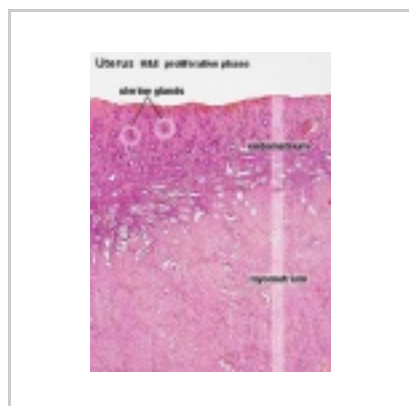
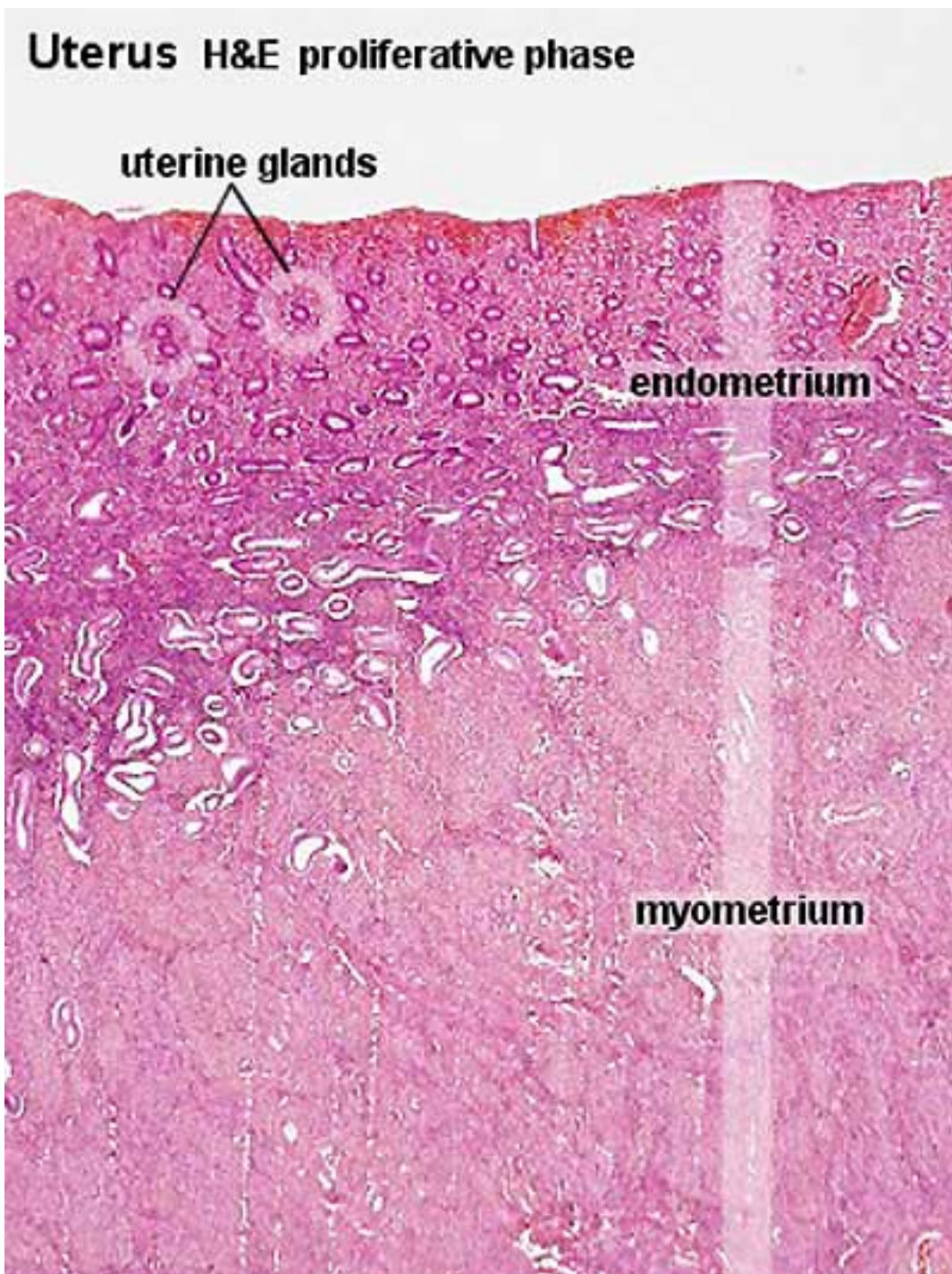
Ectopic tubal pregnancy



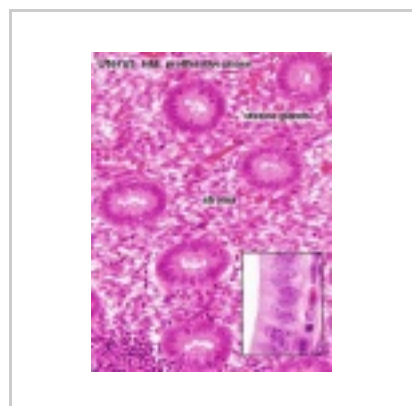
# Uterus



- Endometrium - 3 layers in secretory phase of menstrual cycle: compact, spongy, basal
- Myometrium - muscular layer outside endometrium, contracts in parturition
- Perimetrium - tunica serosa of the uterus continuous with the peritoneal wall



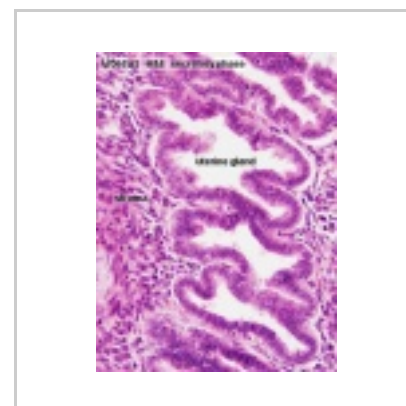
Uterus proliferative phase



Uterine gland proliferative phase



Uterus secretory phase



Uterine gland secretory phase

## Endometrial Layers

- Compact - implantation occurs in this layer, dense stromal cells, uterine gland necks, capillaries of spiral arteries
- Spongy - swollen stromal cells, uterine gland bodies, spiral arteries
- Basal - not lost during menstruation or childbirth, own blood supply

## Decidual Reaction

- transformation of endometrial stromal cells
- occurs initially at site of implantation and includes both cellular and matrix changes
- reaction spreads throughout entire uterus, not at cervix
- deposition of fibrinoid and glycogen and epithelial plaque formation (at anchoring villi)
- presence of decidual cells are indicative of pregnancy

## Other Uterine Changes

- **Cervix** - at mouth of uterus, secretes mucus (CMP), forms a plug/barrier, mechanical and antibacterial
- **Vascular** - increased number of blood vessels

## Decidua

The endometrium becomes the decidua and forms 3 distinct anatomical regions (at approx 3 weeks)

- Decidua Basalis at implantation site
- Decidua Capsularis enclosing the conceptus
- Decidua Parietalis the remainder of uterus
  - Decidua Capsularis and Parietalis fuse eventually fuse and uterine cavity is lost by 12 weeks

## Uterus Abnormalities

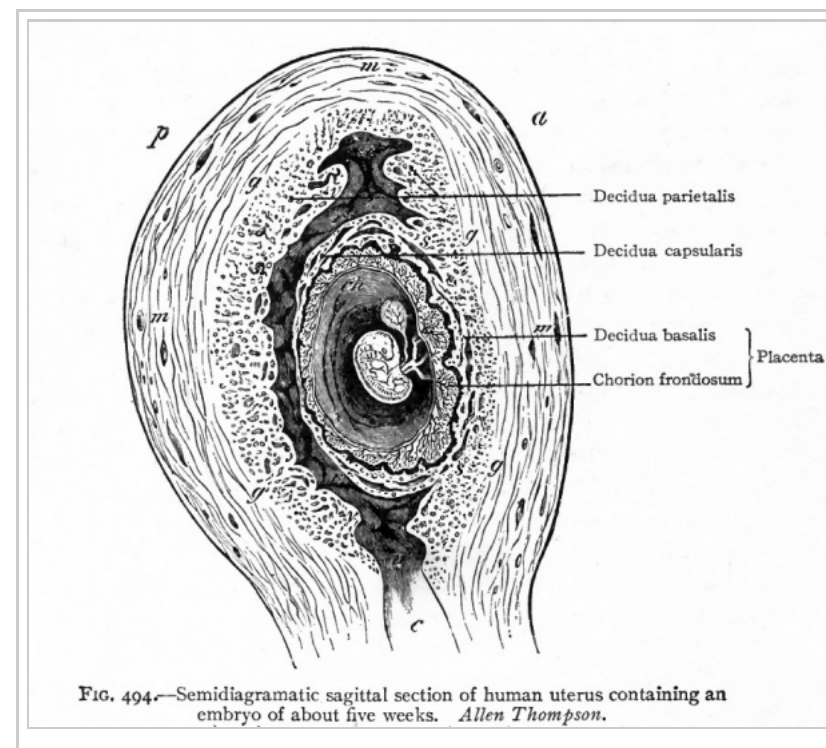
**Endometriosis** endometrial tissue located in other regions of the uterus or other tissues. This misplaced tissue develops into growths or lesions

which respond to the menstrual cycle hormonal changes in the same way that the tissue of the uterine lining does; each month the tissue builds up, breaks down, and sheds.

## Conceptus

### Bilaminar Embryoblast

- about **day 8 to 9**
- The outer trophoblast and inner embryoblast layers now both differentiate to form two distinct cellular layers.
- The trophoblast layer forms the **syncytiotrophoblast** and **cytotrophoblast** layers.
- The embryoblast (inner cell mass) forms the **epiblast** and **hypoblast** layers.
  - **Epiblast** - will form the 3 germ layers.
  - **Hypoblast** - transient layer replaced by endoderm.
- This early stage of embryo development is referred to as the **bilaminar embryo**.



Movie - Week 2 Bilaminar Embryo

### Bilaminar Trophoblast

Two trophoblast layers Cytotrophoblast and Syncytiotrophoblast.

**Cytotrophoblasts** - form a continuous cellular layer that covers the developing placental villi.

### Syncytiotrophoblasts

- **secrete proteolytic enzymes**, enzymes break down extracellular matrix around cells
- Allow passage of blastocyst into endometrial wall, totally surround the blastocyst
- generate spaces that fill with maternal blood- lacunae
- **secrete Human Chorionic Gonadotropin (hCG)**, hormone, maintains decidua and Corpus Luteum, basis of pregnancy diagnostic test, present in urine is diagnostic of pregnancy
  - levels peak at 8 to 10 weeks of pregnancy, then decline and are lower for rest of pregnancy



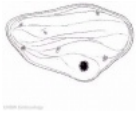

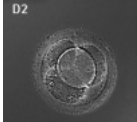
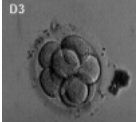
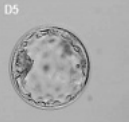
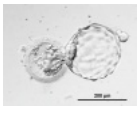
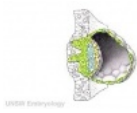
Event	Ovulation	fertilization	First cell division	Morula	Early blastocyst	Late blastocyst Hatching	Implantation starts	X inactivation
								
<b>Monoygotic</b>		Diamniotic			Diamniotic			Monoamniotic
<b>Twin Type</b>		Dichorionic			Monochorionic			Conjoined

Table based upon recent Twinning Review.<sup>[1]</sup>

1. ↑ Judith G Hall **Twinning**. Lancet: 2003, 362(9385);735-43 PMID: 12957099

**Links:** Twinning | Australian Twin Registry (<http://www.twins.org.au/index.php?page=31>)

Now watch the Week 1 overview.

[Week 1 Movie\[Expand\]](#)

**2015 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 | ANAT2341 2015 Students | Student Sharing | Moodle page (<http://moodle.telt.unsw.edu.au/course/view.php?id=15814>)

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