



Human Embryology-2

- ✓ Fertilization
- ✓ First Week of Life

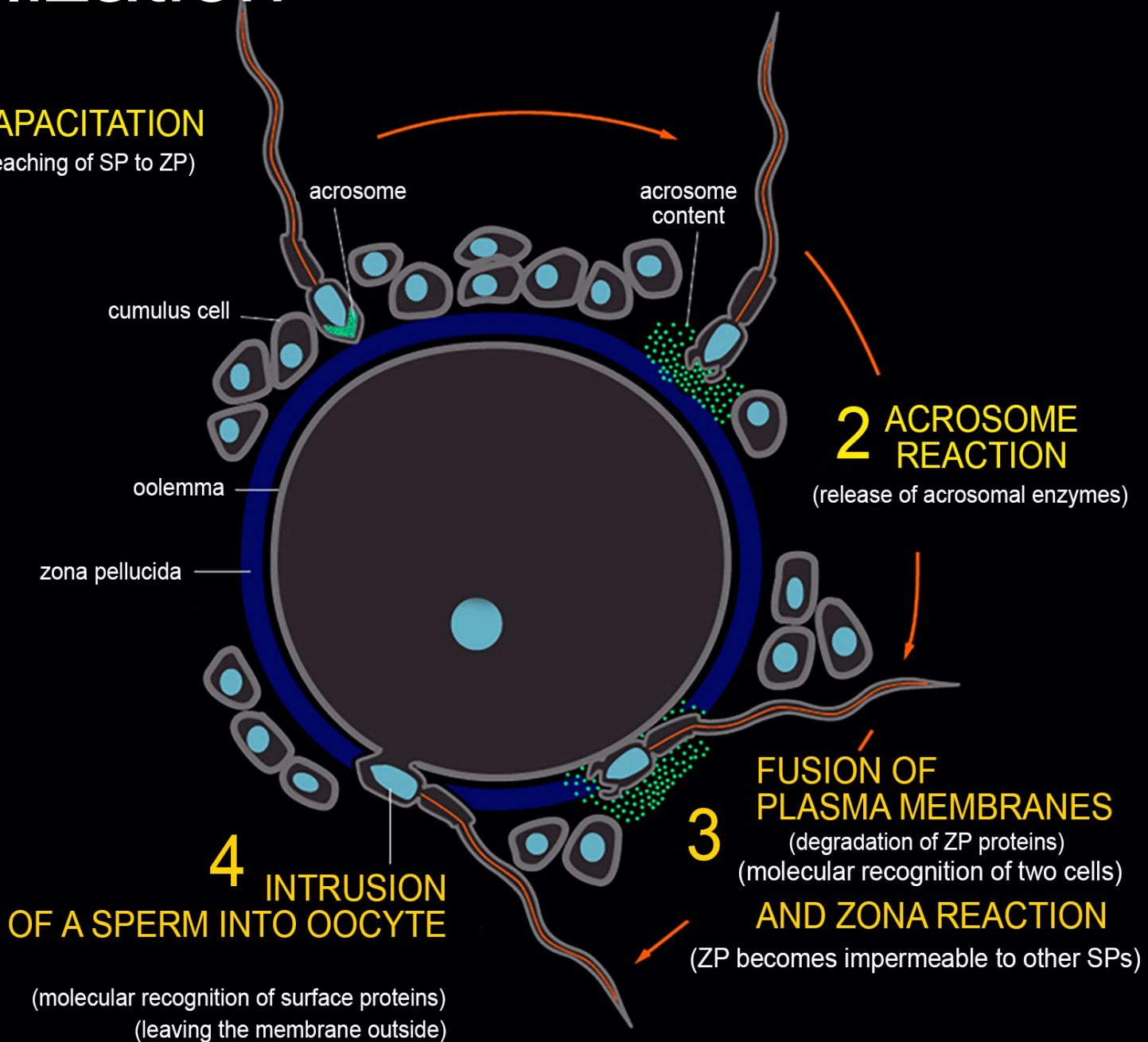
Prof. Alp CAN

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Fertilization

1 CAPACITATION (reaching of SP to ZP)



1. Capacitation

- It lasts 6-8 hours
- The plasma membrane proteins are degraded, and the head of sperm becomes naked
- This process is achieved by many sperms

2. Acrosome Reaction

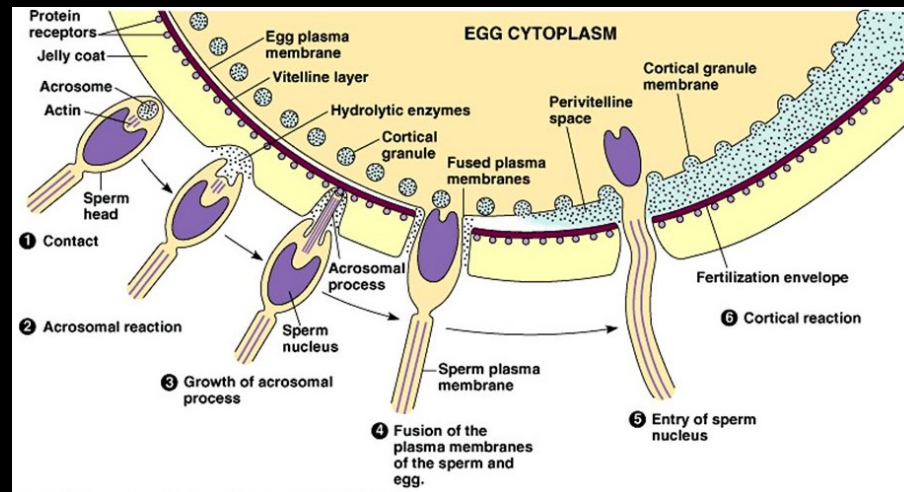
- AC reveals few SPs to pass through ZP
- Mainly ZP-3 is degraded
- At the end of AC, SPs (more than one) touch the oolemma

Some acrosomal proteins in mammals	
Acid proteinase	β -galactosidase
Acrosin	β -glucuronidase
Aryl amidase	Hyaluronidase
Collagenase	Phospholipase-C
Esterase	Proacrosin

3. Fusion of Plasma Membranes & Zona (Cortical) Reaction

- When SPs touch oolemma, a rise in Ca^+ occurs in oocyte (parthenogenetic stimulation)
- Cortical granules release lysosomal enzymes
- Released (exocytosed) enzymes degrade oolemmal receptors
- This reaction inhibits other SPs to recognize oolemma, therefore only one SP can penetrate the oolemma

Polyspermy
block



Fusion of SP-Oocyte Membranes (Izumo-Juno Interaction)

Izumo; (on sperm surface) (member of Ig super family); 2005

The immunoglobulin superfamily protein Izumo is required for sperm to fuse with eggs

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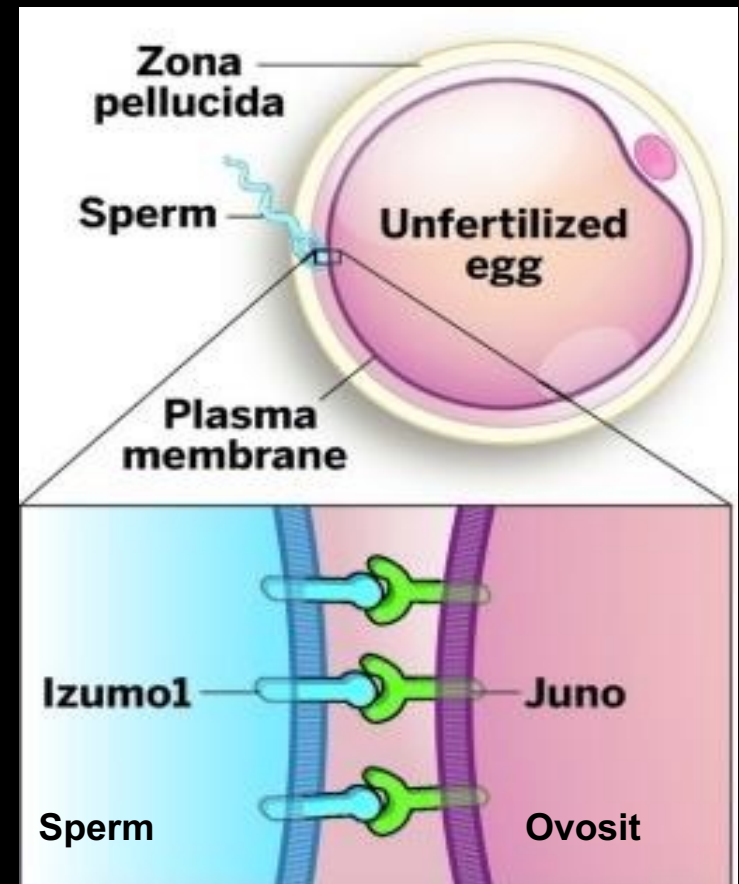
Nature 434; 234-38, 2005

Juno; (on oocyte surface) (folic acid receptor 4); 2014

Juno is the egg Izumo receptor and is essential for mammalian fertilization

Enrica Bianchi¹, Brendan Doe², David Goulding³ & Gavin J. Wright¹

Fertilization occurs when sperm and egg recognize each other and fuse to form a new, genetically distinct organism. The molecular basis of sperm-egg recognition is unknown, but is likely to require interactions between receptor proteins displayed on their surface. Izumol is an essential sperm cell-surface protein, but its receptor on the egg has not been described. Here we identify folate receptor 4 (Folr4) as the receptor for Izumol on the mouse egg, and propose to rename it Juno. We show that the Izumol-Juno interaction is conserved within several mammalian species, including humans. Female mice lacking Juno are infertile and Juno-deficient eggs do not fuse with normal sperm. Rapid shedding of Juno from the oolemma after fertilization suggests a mechanism for the membrane block to polyspermy, ensuring eggs normally fuse with just a single sperm. Our discovery of an essential receptor pair at the nexus of conception provides opportunities for the rational development of new fertility treatments and contraceptives. Nature 508; 483-87, 2014



How Meiotic Division Progress When a Sperm Enters Ooplasm

The inhibitory effect of MIS disappears (oocyte resumes meiosis-II)

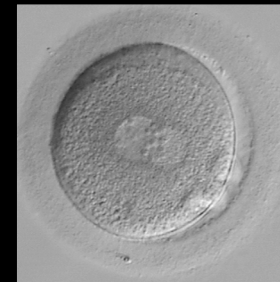
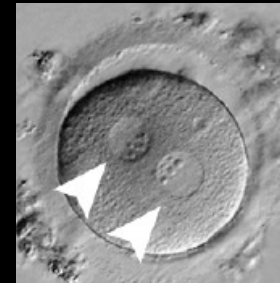
↓
2nd Polar Body is expelled

↓
Chromosomes decondens into chromatin, and nuclear envelope reorganize

↓
Pronuclei form

↓
Syngamy

↓
ZYGOTE



Spermatozoa can live in fertile cervical mucus for up to **5 days**.
An oocyte can live up to **24 hours** after ovulation.

Chance of Pregnancy in Days Near Ovulation

Time	Chance of Pregnancy (%)
5 days before ovulation	10
4 days before ovulation	16
3 days before ovulation	14
2 days before ovulation	27
1 day before ovulation	31
Day of ovulation	33
Day after ovulation	0

Pronuclei Formation

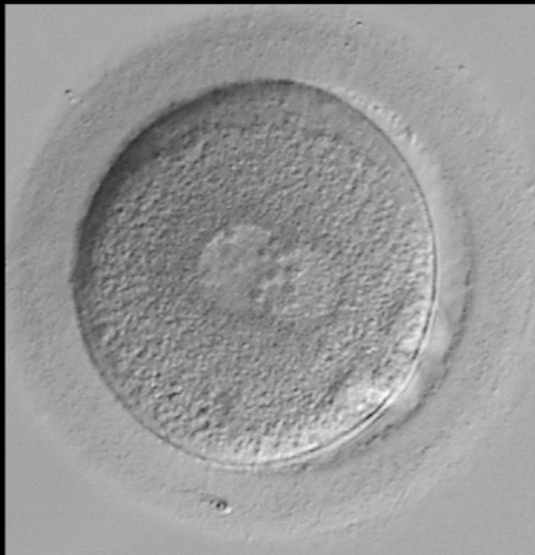
Male pronuclei forms in 3 stages

- Disassembly of sperm nuclear membrane
- Expansion of sperm chromatin in the ooplasm
- Chromatin condenses as chromosomes and a pronuclear envelope assembles

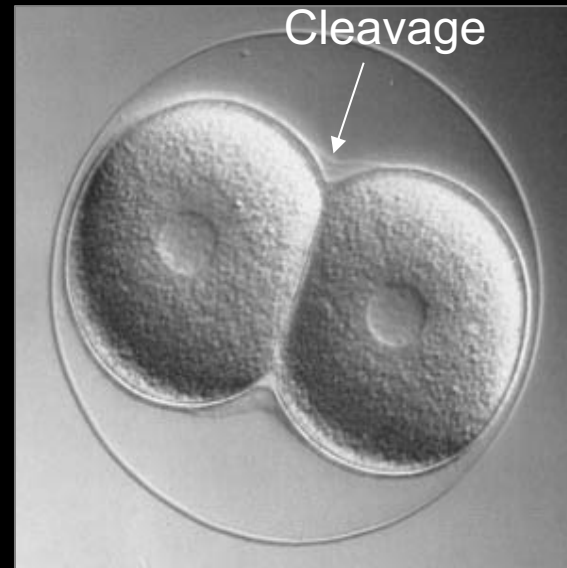
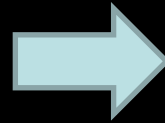


By the Process of Fertilization

- Diploid chromosome number is reassembled
- Sex is determined (XX or XY)
- Life starts with the first cell division (cleavage)

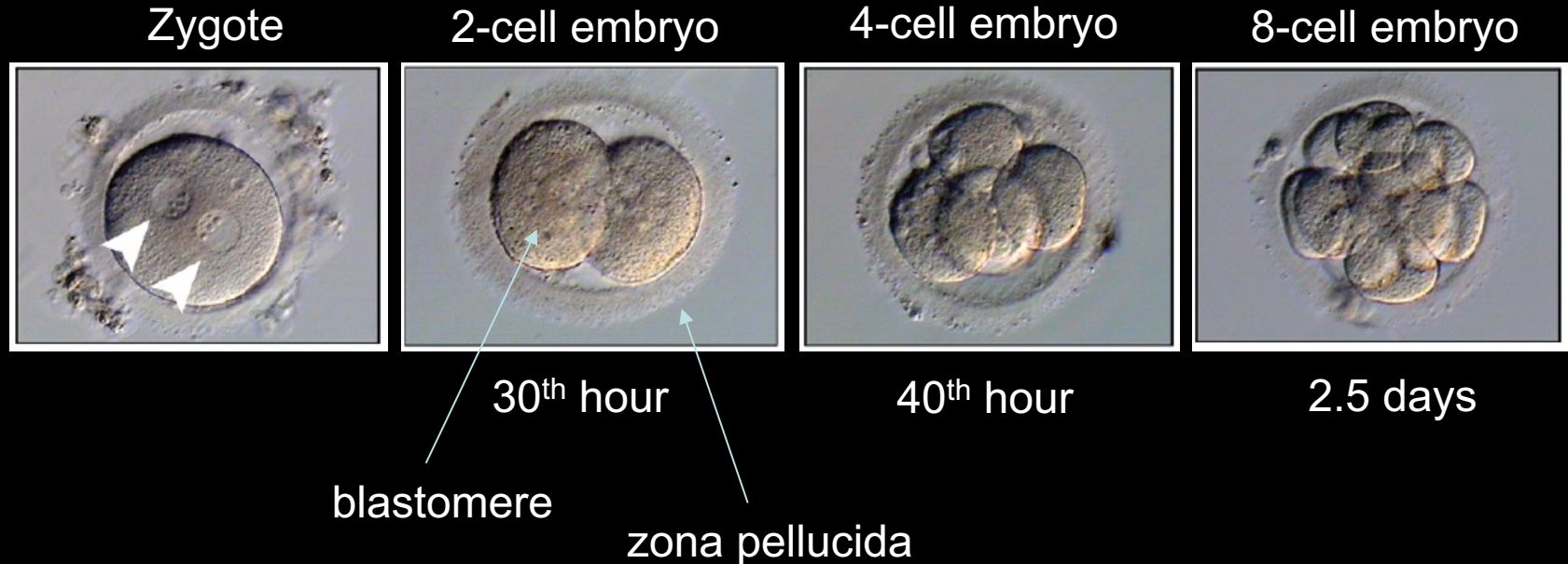


Zygote



2-cell embryo

First Week of In Utero Development (Preimplantation Period)



Embryonic gene activation (EGA) starts at 2-4-cell stage. Imprinting mechanisms represses some genes to express only paternal genome for extraembryonic tissues; whereas maternal genome is expressed in embryonic tissues.

Compaction



12-16-cell stage
Morula



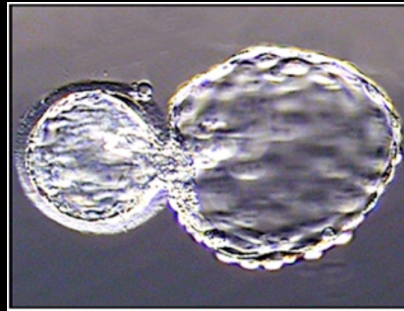
3rd day

Blastocyst



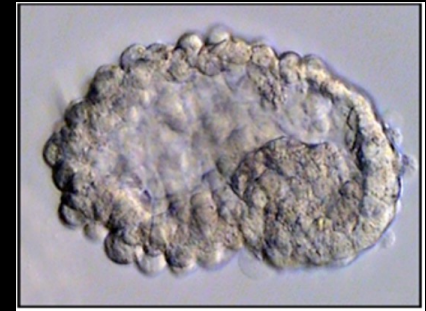
4,5th day

Hatching



5th day

Preimplantation
Blastocyst



5,5-6th day

Fluid influx in
uterine tubes

Entry to uterus

Osmotic balance in
Inner cell mass

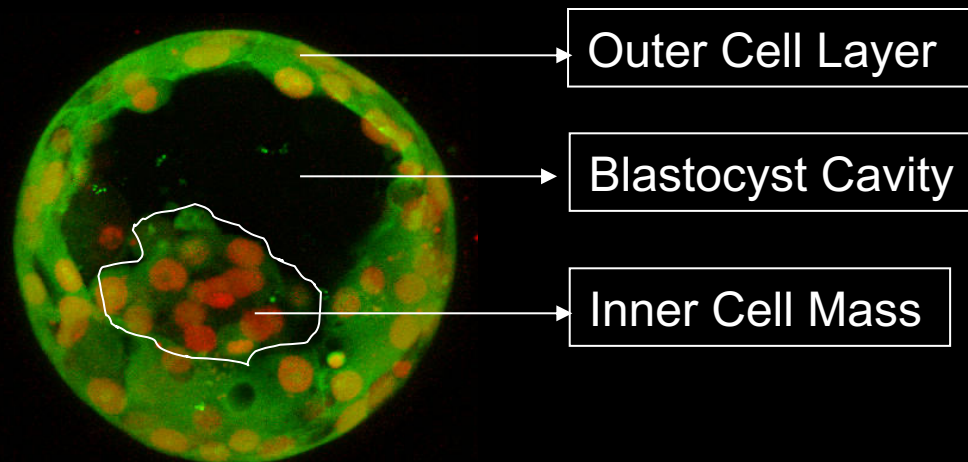


Compaction

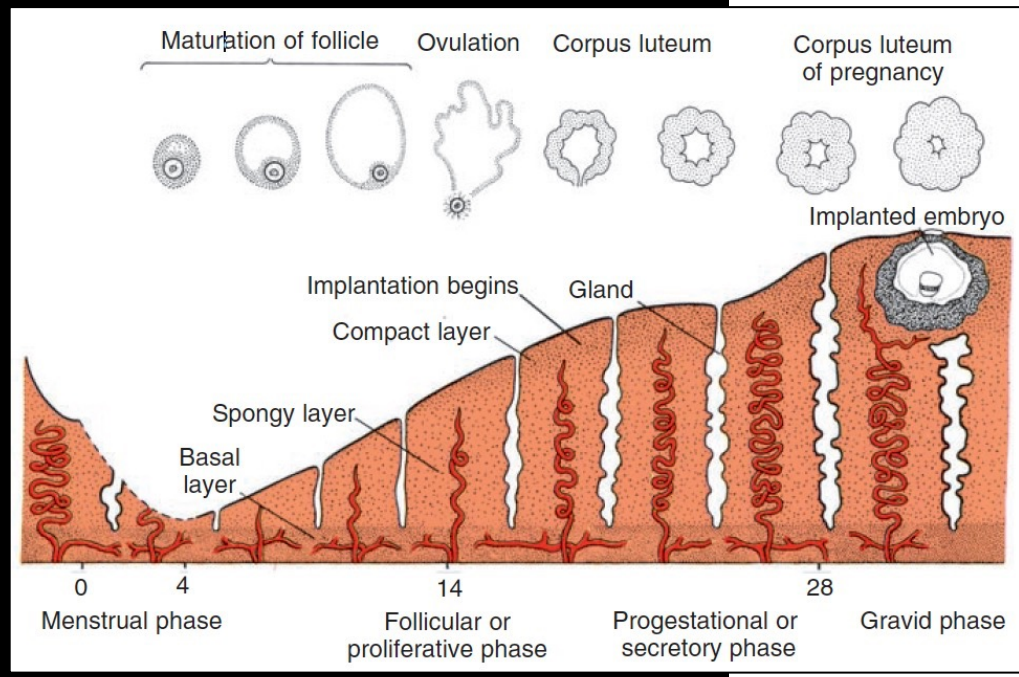
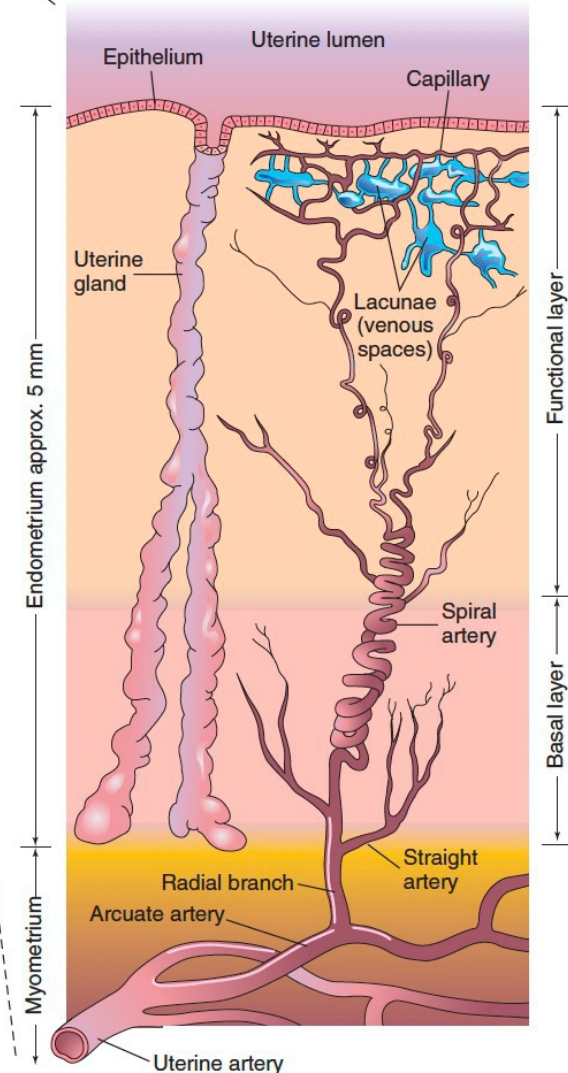
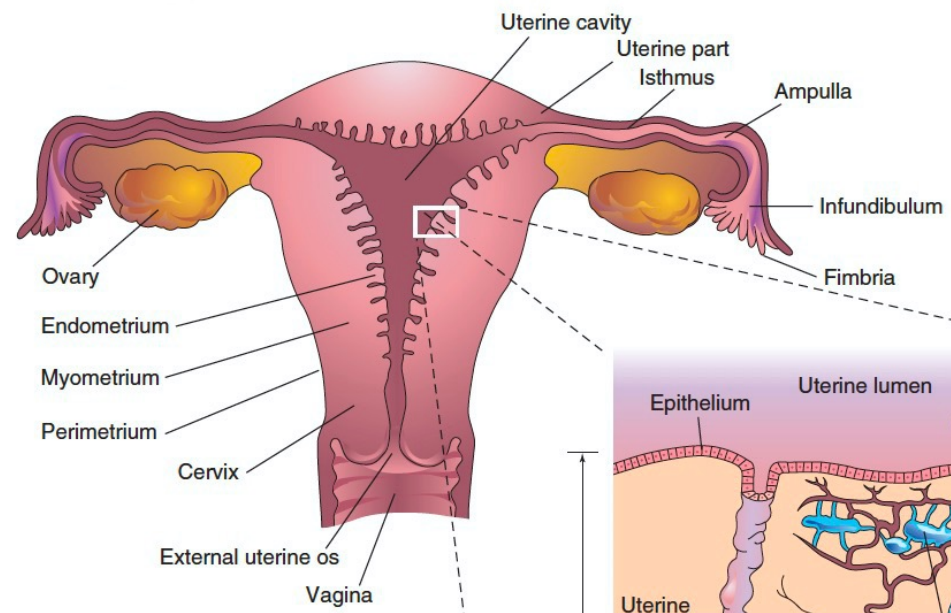
- Starts at 8-cell stage
- An inner cavity forms, intercellular junctions are built between blastomeres (*zonula occludens and nexus*) by the synthesis of E-cadherin
- Blastomeres begin to polarize (outer-inner)
- Ends with the formation of morula

Formation of Blastocyst

- As the Morula come close to the uterine cavity uterine secretory fluid influxes into the forming blastocyst through zona pellucida
- Thereby blastocyst cavity is formed filled with fluid. This formation is called blastocyst.
- Inner Cell Mass → Embryoblast (forms embryo itself)
- Outer Cell Layer → Trophoblast (forms placenta)

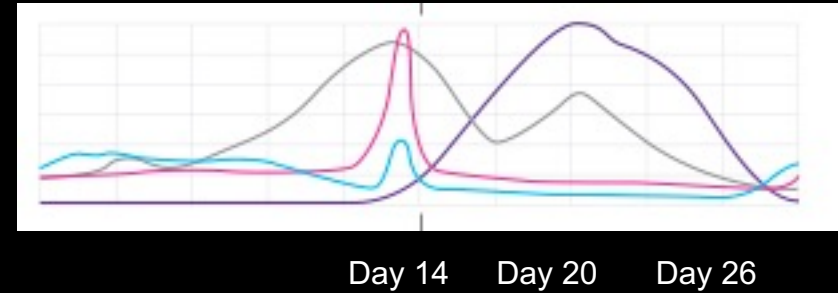


Endometrium (Receptive tissue for the developing embryo)



Histological Components of Endometrium

- Surface epithelium
- Secretory glands
- Stroma (decidualization)
- Specialized vascular bed



Secretory Products

- Fibronectin, laminin, entactin
- Type I, III, IV, V, VII collagen
- BMP-2, BMP-7, FGF-2, Wnt-4
- Growth factors (HB-EGF-like GF)

How is a Pregnancy Predicted?

- Human Chorionic Gonadotropin (hCG)
 - It is produced by the syncytiotrophoblast cell
 - hCG can be detected in blood (serum) (5 mIU/mL) or urine (> 10 mIU/mL) after implantation around 6-12 days after fertilization
 - Blood hCG test can detect pregnancy earlier than urine, even before a period has been missed.
 - Urine test will typically show positive around four weeks after the last menstrual period (LMP)