FERTILIZATION AND IMPLANTATION

Objectives:

- Identify fertilization and its site
- List the phases of fertilization
- Describe the results of fertilization
- Describe the formation of blastocyst
- Identify implantation and its site
- Describe the mechanism of implantation
- Describe the formation of primary chorionic villi
- List the sites of ectopic pregnancy

Done by:

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Embryology 437

• Important • Extra • Notes

MED437
KING SAUD UNIVERSITY

Fertilization

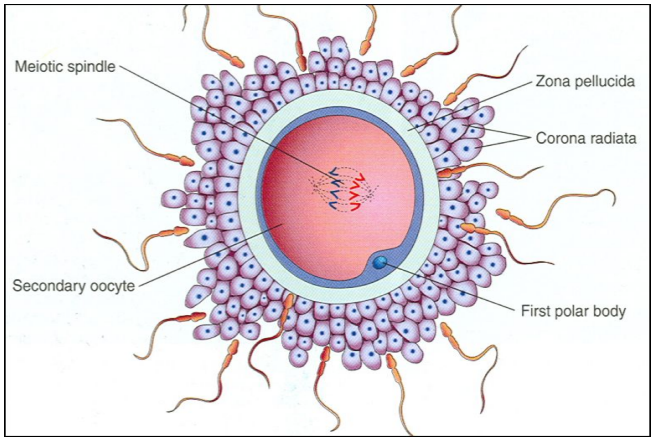
- **Fertilization:** It is the process during which a male gamete (sperm) unites with a female gamete (oocyte) to form a single cell (ZYGOTE)

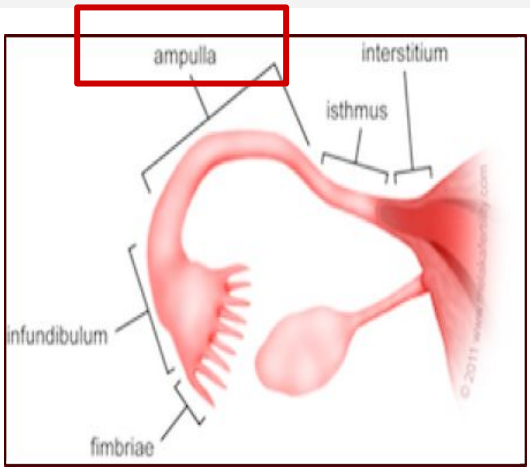
Another Definition:

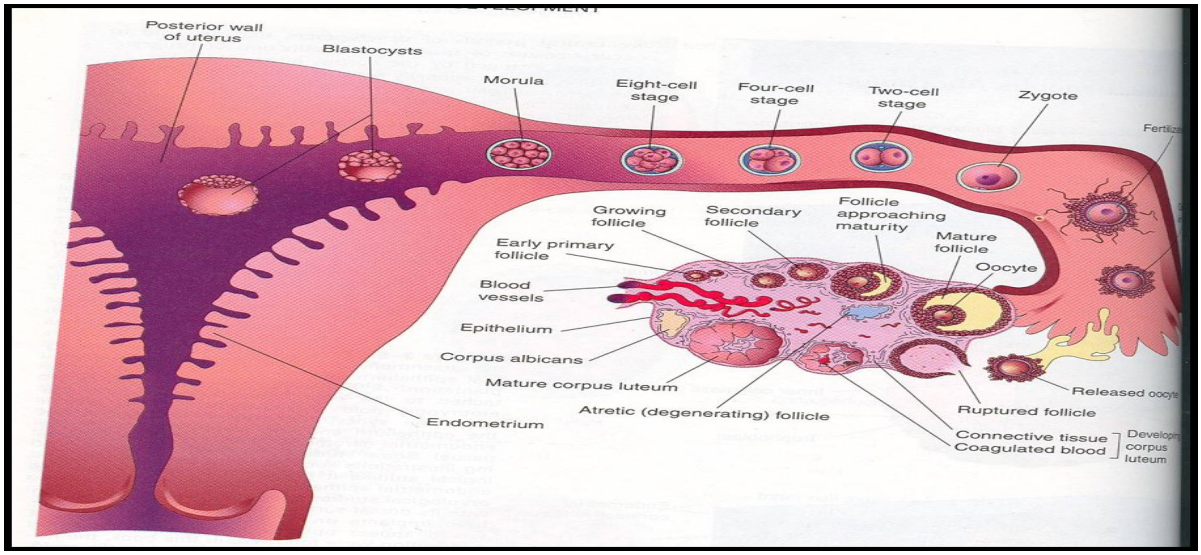
- It is a complex process
- It begins with a contact between sperm & ovum
- Ends up with intermingling (mixture) of the maternal and paternal chromosomes

Where does fertilization normally occur?

- Usually in the **ampulla** of **uterine tube**
- Ampulla is the longest and widest part of the tube
- Fertilization may occur in any other part of tube.
- **Never** occurs in the **uterine cavity**
- Chemical signal from oocyte attracts the sperms
- Peristaltic movement of the tube from **medial to lateral**



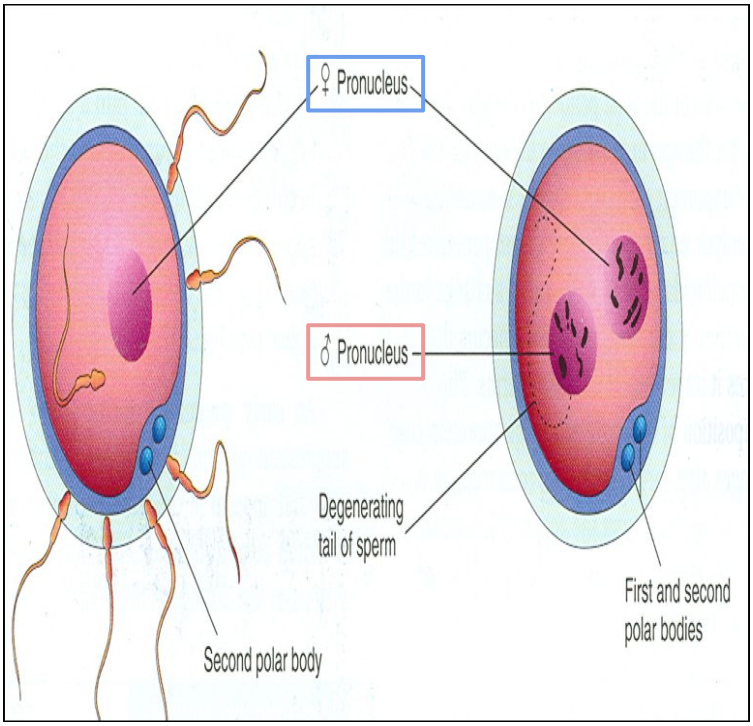


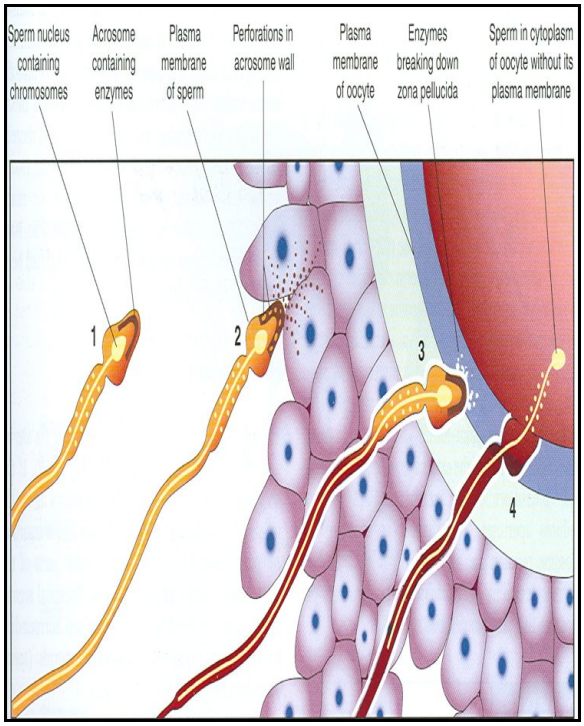


Phases of Fertilization

Important!

1- Passage	Sperm pass through the cells of **corona radiata** by the effect of: 1. **hyaluronidase** enzyme secreted from the acrosome of the sperm 2. By **movement of its tail**
2- Penetration	Penetration of the **zona pellucida** by **acrosine E** (substance secreted from acrosomal cap)
3- Fusion	Fusion of the **plasma membranes** of the oocyte and the sperm
4- Completion	Completion of the **second meiotic** division of the oocyte which was arrested at **metaphase**
5- Formation	Formation of the **female** pronucleus
6- Formation	Formation of **male** pronucleus
7- Union	Union of the **2 pronuleii**





Chromosomes In The Zygote

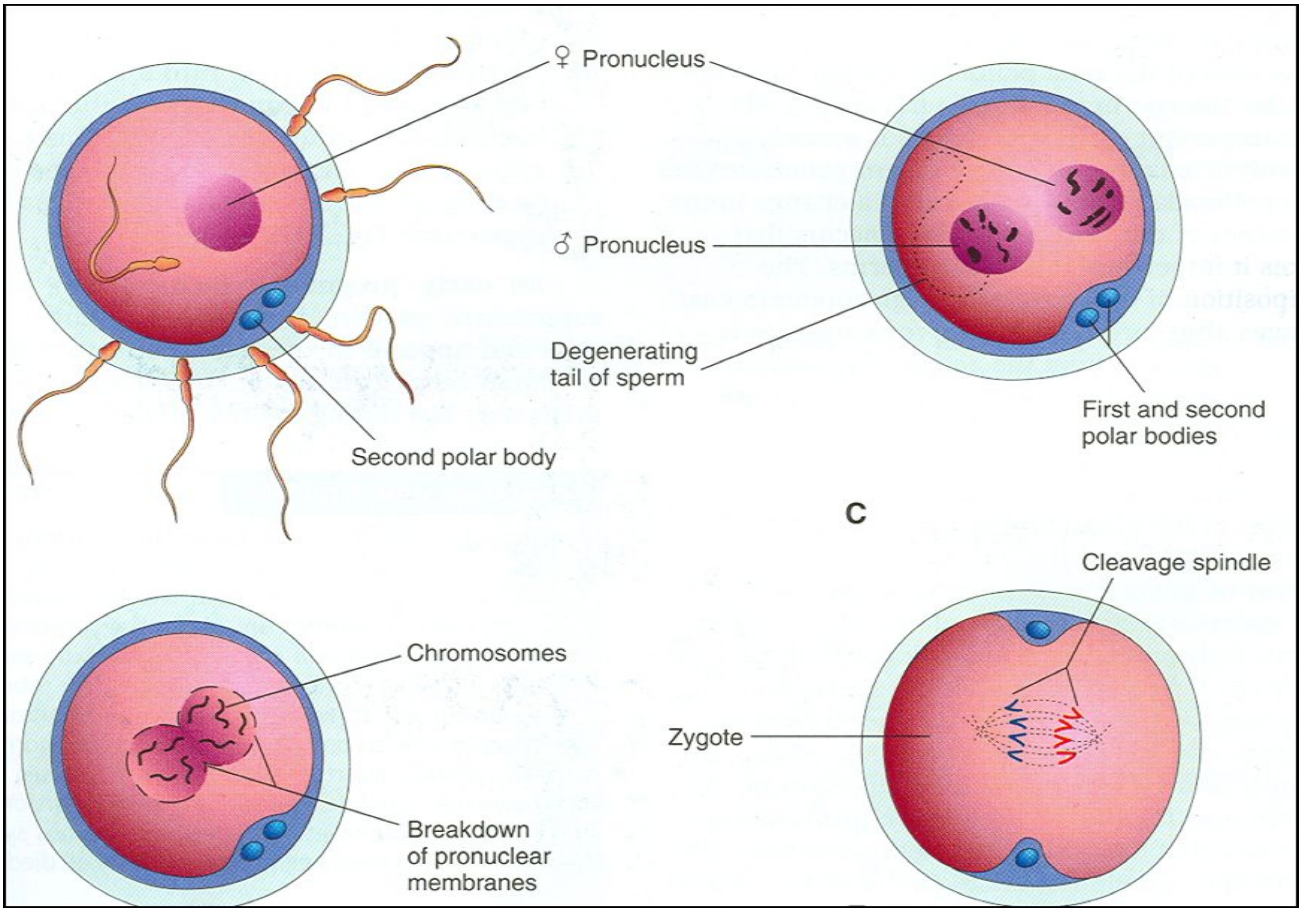
- **Zygote** is genetically unique
- Half of its chromosomes comes from the father and the other half comes from the mother
- New combination is formed which is different from either of the parents
- This mechanism forms **biparental inheritance** and leads to variation of the human species

❖ Sex of the Embryo:

- Embryo's chromosomal sex is determined **at the time of fertilization** by genetic studies
- Sex is determined by the type of sperm (X or Y) that fertilizes the oocyte
- So, it is the **father** whose gamete decides the sex

❖ Zonal reaction:

- It is a change in properties of zona pellucida that makes it **impermeable** to other sperms.



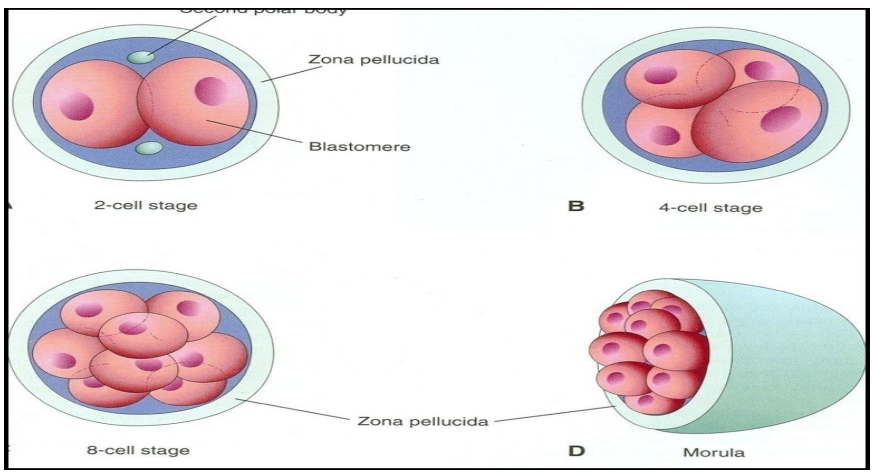
Important!

Results of Fertilization:

1. Stimulates the penetrated oocyte to complete its **2nd meiotic division**
2. Restores the normal **diploid** number of chromosomes
3. Determines the sex of the embryo
4. Initiates cleavage (**cell division**) of the zygote

Cleavage of Zygote:

- It begins about **30 hours** after fertilization
- It is the repeated mitotic divisions of the zygote
- Normally occurs in the uterine tube
- Rapid increase in the number of the cells.
- These smaller embryonic cells are now called, **Blastomeres**
- Zygote divides from one cell into **2, then 4, then 8, then 16 cells**
- Zygote lies within the thick zona pellucida during cleavage
- Zygote migrates in the uterine tube during cleavage from lateral end to medial end
- Under the microscope, the zona pellucida is a thick translucent membrane



Morula

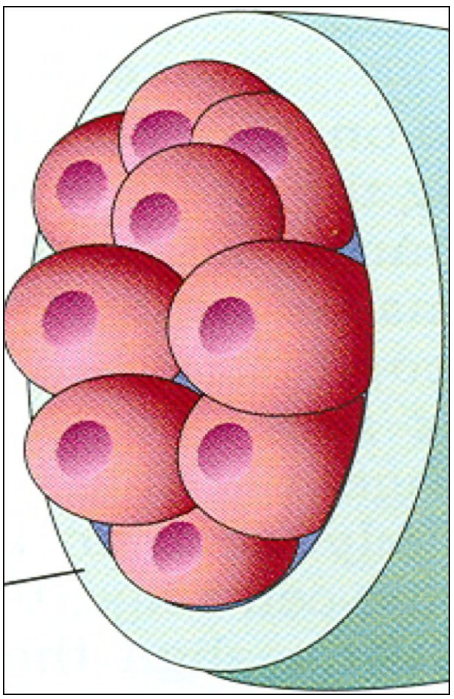
- When there are **16-32 blastomeres** the developing human is called **MORULA**
- The Morula reaches the uterine cavity at this stage
- The spherical Morula is formed about **3 days** after fertilization
- It resembles mulberry or blackberry

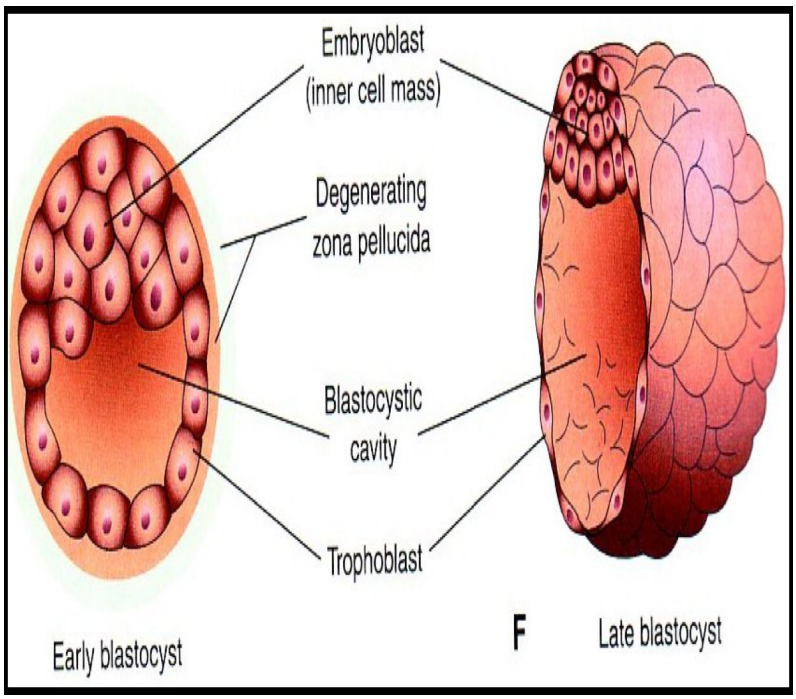
❖ Mechanism of blastocyst formation:

- The Morula reaches the uterine cavity by the **4th day** after fertilization and remains free for one or two days
- Fluid passes from uterine cavity to the Morula
- Now the morula called **blastocyst** its cavity is called **blastocystic cavity** or blastocele, its cells divided into Embryoblast & Trophoblast.

❖ Blastocyst:

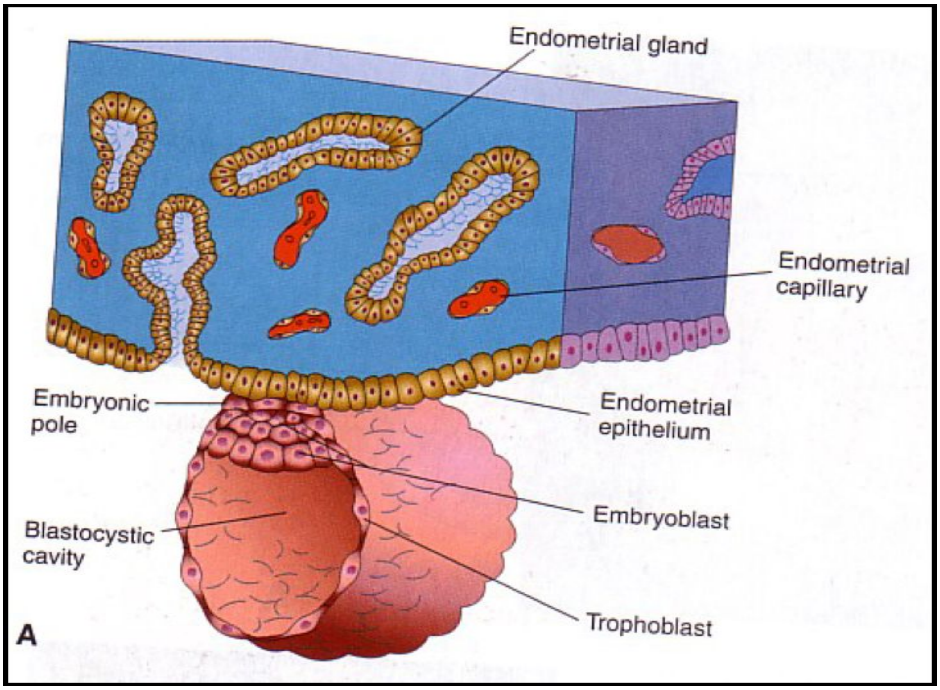
- A cavity appears within the morula dividing its cells into 2 groups:
  1.Outer cell layer called trophoblast.
  2.Inner cell layer (mass) called Embryoblast attached to one of the poles of the blastocyst
- The cavity is called **blastocystic cavity** or **blastocele**





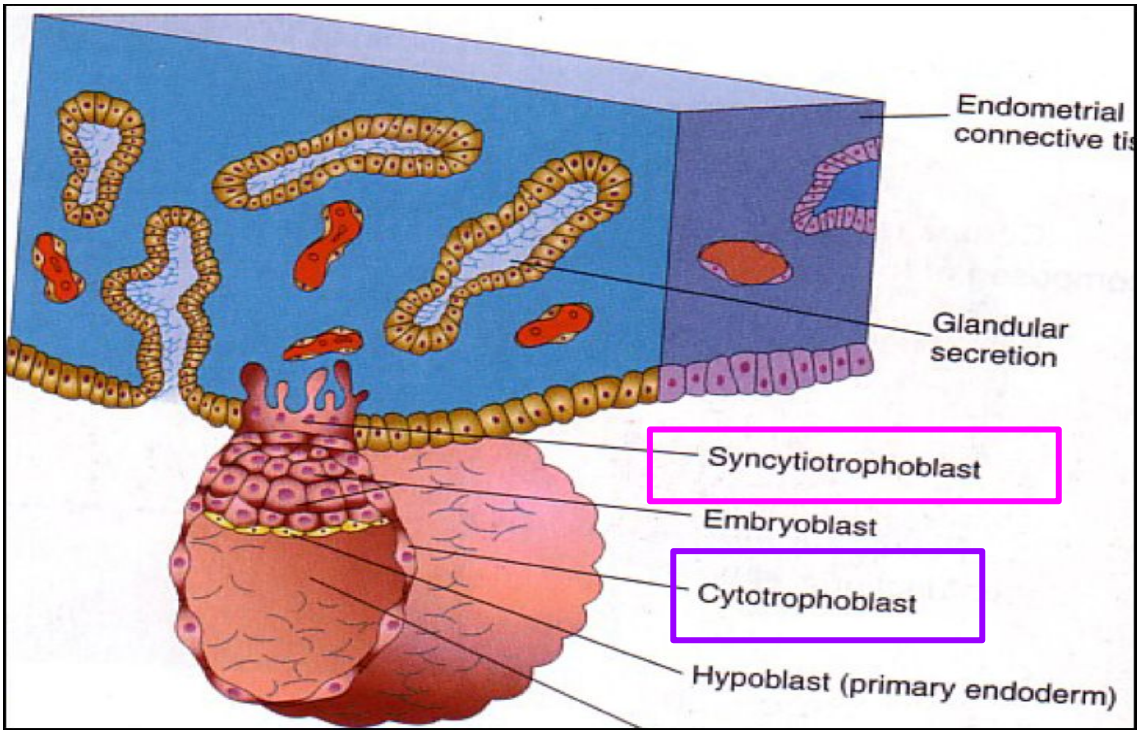
Implantation

Implantation	
Definition	➢ It is the process by which the Blastocyst penetrates the superficial (Compact) layer of the endometrium of the uterus
Time	➢ It begins about the **6th** day after fertilization ➢ It is completed by the **11th** or **12th** day
Site	➢ The normal site of implantation is the **posterior wall of the body of the uterus near the fundus**



Mechanism of Implantation

- Zona pellucida degenerates & disappears by the 5th day to allows the blastocyst to increase in size and penetrates the endometrium
- The embryoblast projects into the blastocystic cavity, while the trophoblast forms the wall of the blastocyst
- By 6th day the blastocyst adheres to the endometrium (beginning of implantation)
- By 7th day, Trophoblast differentiated into 2 layers:
  1- Cytotrophoblast, inner layer, mitotically active.
  2- Syncytiotrophoblast (outer multinucleated cytoplasmic mass, with indistinct cell boundary)
- By 8th day the blastocyst is superficially embedded in the compact layer of the endometrium.



Cont ...

- Endometrial cells undergo a process called apoptosis (programmed cell death) to facilitates invasion of endometrium by the Syncytiotrophoblast
- Syncytiotrophoblast engulf these degenerated cells for nutrition of the embryo
- Blood-filled Lacunae appear in the Syncytiotrophoblast which communicate forming a network by the **10th or 11th day**
- Syncytiotrophoblast erodes the endothelial lining of the maternal capillaries which known as sinusoids. Now blood of maternal capillaries reaches the lacunae so, Uteroplacental circulation is established by **11th or 12th day**

Implantation:

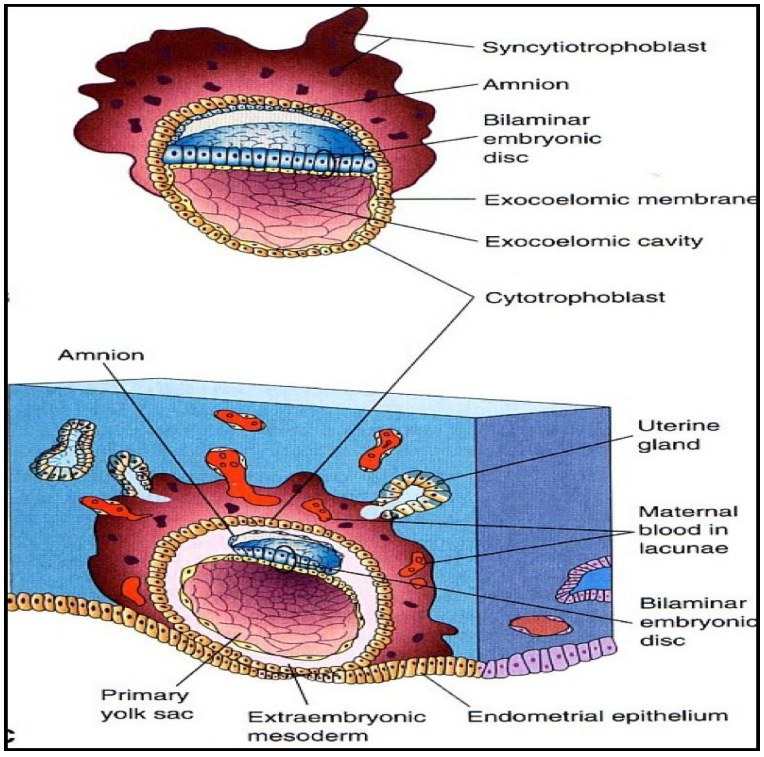
can be detected by:

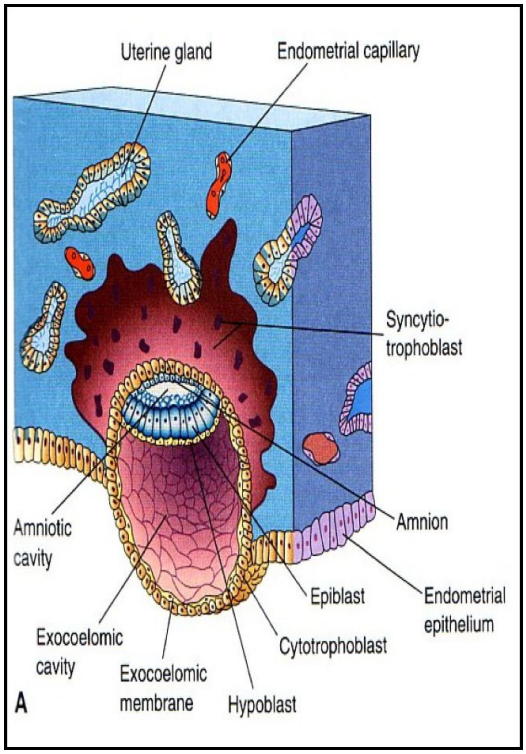
1.**Ultrasonography**

2.**hCG** (human chorionic gonadotropin which is secreted by the Syncytiotrophoblast) about the end of **2nd week**

Home Pregnancy Test:

(HCG can measured in both the blood and urine to determine if a woman is pregnant)





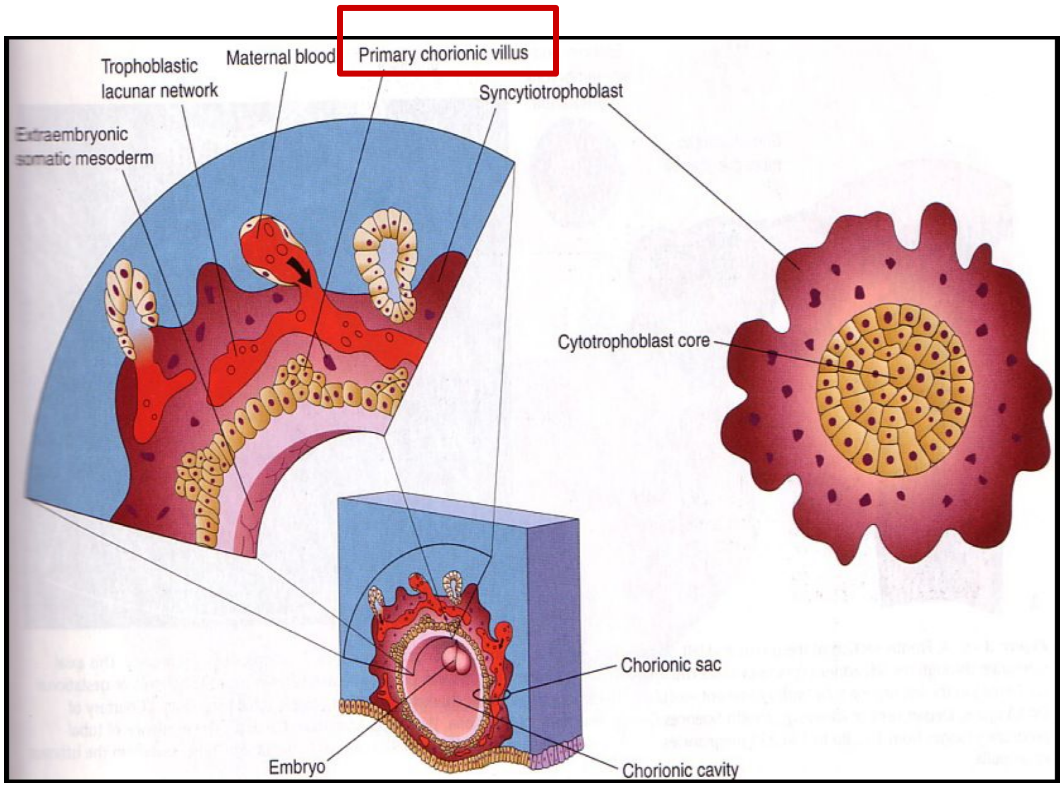
Early Pregnancy Factor (EPF)

- Is an immunosuppressant protein.
- Secreted by trophoblast cells
- Appears in maternal serum within **24-48 hrs**, after implantation
- It is the basis for EPT (Early pregnancy test) in the first **10 days** of development

Formation of The Chorionic villi

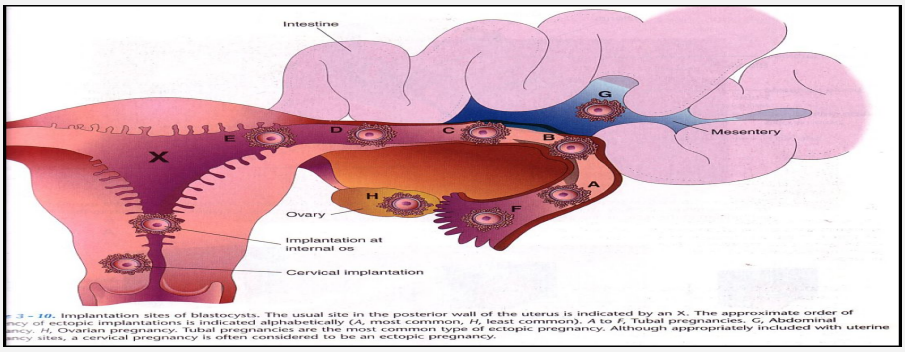
Primary chorionic villi:

- By the **13th day** Proliferation of Cytotrophoblast cells produce extension inside the Syncytiotrophoblast to form the **primary chorionic villi**



Ectopic Implantation (Pregnancy)

- **The usual site of implantation is the posterior wall of the body of uterus (X)**
- Tubal pregnancy is the **most common type** of ectopic pregnancy (A)
- Ovarian pregnancy is the **least common type** of ectopic pregnancy (H)



3 - 10. Implantation sites of blastocysts. The usual site in the posterior wall of the uterus is indicated by an X. The approximate order of ncy of ectopic implantations is indicated alphabetically (*A*, most common, *H*, least common). *A* to *F*, Tubal pregnancies. *G*, Abdominal ancy. *H*, Ovarian pregnancy. Tubal pregnancies are the most common type of ectopic pregnancy. Although appropriately included with uterine ncy sites, a cervical pregnancy is often considered to be an ectopic pregnancy.

❖ Ectopic Pregnancy:

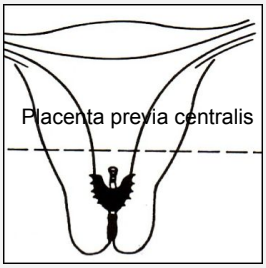
- It means implantation outside the uterine cavity
- 95 to 97% of ectopic pregnancies occurs in the uterine tube
- Most are in the **ampulla** & **isthmus**

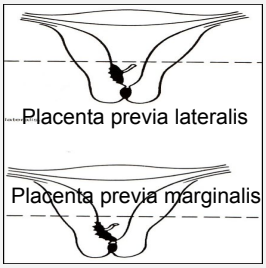
❖ Placenta previa:

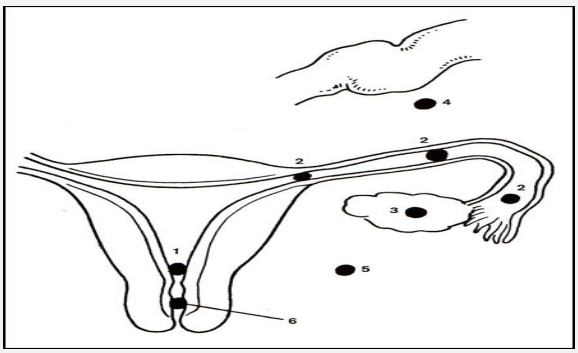
- Implantation occurs in the lower uterine segment

❖ Ectopic Pregnancy:

1. Placenta Previa
2. Tubal
3. Ovarian
4. Abdominal
5. Pelvic
6. Cervical







Summary

DATE	EVENT
within 24--48 hrs after implantation in blood	immunosuppressant protein Appears in maternal serum
30 hours after	Cleavage of Zygote
3 days after fertilization by	Spherical Morula is formed
the 4th day after fertilization	The Morula reaches the uterine cavity and remains free for one or two days
the 5th day	the Zona pellucida degenerates
It begins about the 6th day after fertilization	Blastocyst begins implantation
By 7th day	Trophoblast differentiated into 2 layers (Cytotrophoblast Syncytiotrophoblast)
By 8th day	the blastocyst is superficially embedded in the compact layer of the endometrium
by the 10th or 11th day	Blood-filled Lacunae appear in the Syncytiotrophoblast which communicate forming a lacunar network

Summary

DATE	EVENT
EPT (Early pregnancy test)	in the first 10 days of development
by 11th or 12th day	Uteroplacental circulation is established and the Implantation completed
about the end of 2nd week	human chorionic gonadotrophin hormone is secreted by the syncytiotrophoblast
By the 13th day	Proliferation of Cytotrophoblast cells produce extension inside the Syncytiotrophoblast to form the (primary chorionic villi)

EVENT	SITE
Fertilization	Ampulla
Cleavage of Zygote	uterine tube
implantation	posterior wall of the body of the uterus near the fundus

MCQ's

1. Which of the following is the most common Site of fertilization:		2. Trophoblast differentiated into 2 layers by:	
A.	Isthmus of fallopian tube	A.	7th day
B.	Ampulla of Fallopian tube	B.	5th day
C.	Placenta	C.	6th day
D.	infundibulum of Fallopian tube	D.	4th day
3. Cleavage of Zygote Begins After ... Hours of fertilization		4. The Morula reaches the uterine cavity by the .. day after fertilization	
A.	10 Hours	A.	3rd
B.	15 hours	B.	4th
C.	20 hours	C.	5th
D.	30 hours	D.	2nd
5. When does Implantation begins		6. Blastocyst is formed of an Outer cell layer called ... and Inner cell layer called ...	
A.	The 4th day after fertilization	A.	trophoblast – Embryoblast
B.	The 5th day after fertilization	B.	Embryoblast – trophoblast
C.	The 6th day after fertilization	C.	Cytotrophoblast -Syncytiotrophoblast

Q	1	2	3	4	5	6
Answers	B	A	D	B	C	A