

The Fundamentals of Embryology

FERTILIZATION & IMPLANTATION AND TWINNING

أَوَّلًا يَذْكُرُ الْإِنْسَانَ أَنَّهُ خَلَقْتَهُ مِنْ قَبْلُ وَلَمْ
يَكُ شَيْئًا ﴿١٧﴾



Embryology
436



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OBJECTIVES:

By the end of the lecture, you should be able to:

- Identify **fertilization** and its sites
- List the phases of **fertilization**
- Describe **the results** of fertilization
- Describe formation of **blastocysts**
- Identify **implantation** and its sites
- Describe **the mechanism** of the implantation
- List the common sites of **ectopic pregnancies**

Fertilization

Fertilization: a male gamete (**sperm**) + a female gamete (**oocyte**) = a single cell called the (**ZYGOTE**).

It is a complex process which begins with a contact between the sperm & ovum and it ends up with intermingling (mixing) of the maternal and paternal chromosomes.

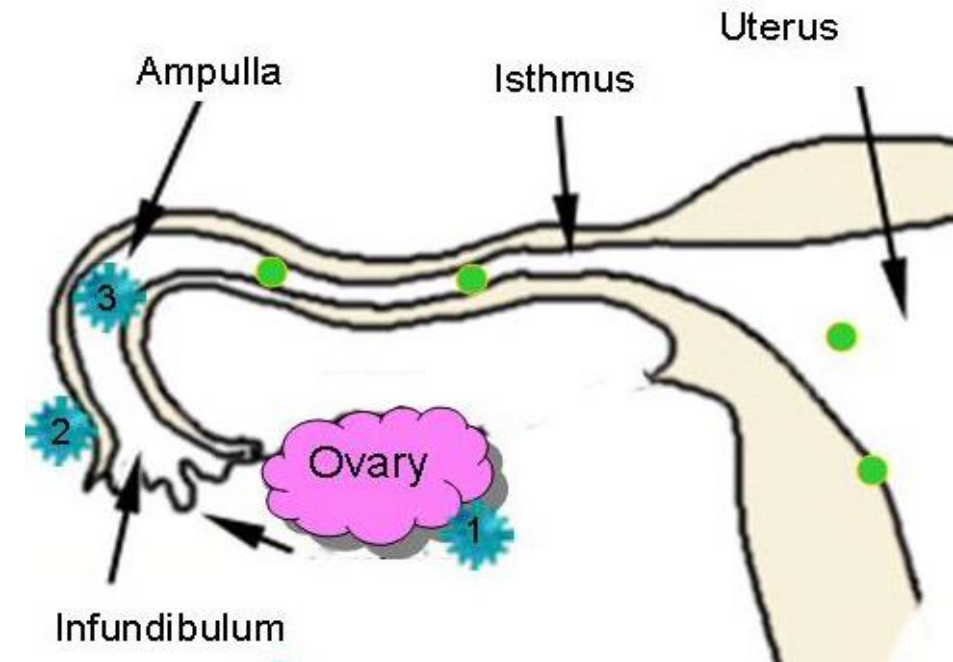
***Chemical signals** from the oocyte attracts the sperms.

Where Does Fertilization Normally Occur?

Usually in the **ampulla** (the widest part of the tube) of uterine tube.

Fertilization may occur in any other part of tube.

But it never occurs in the uterine cavity.



Phases of Fertilization

1-

Passage

Sperm pass through **corona radiata** by the effect of:

1-**hyaluronidase enzyme** secreted from the sperm

2-By movement of its **tail**

2-

Penetration

Penetration of the **zona pellucida** by **acrosine** (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 & formation of the female pronucleus.

5-

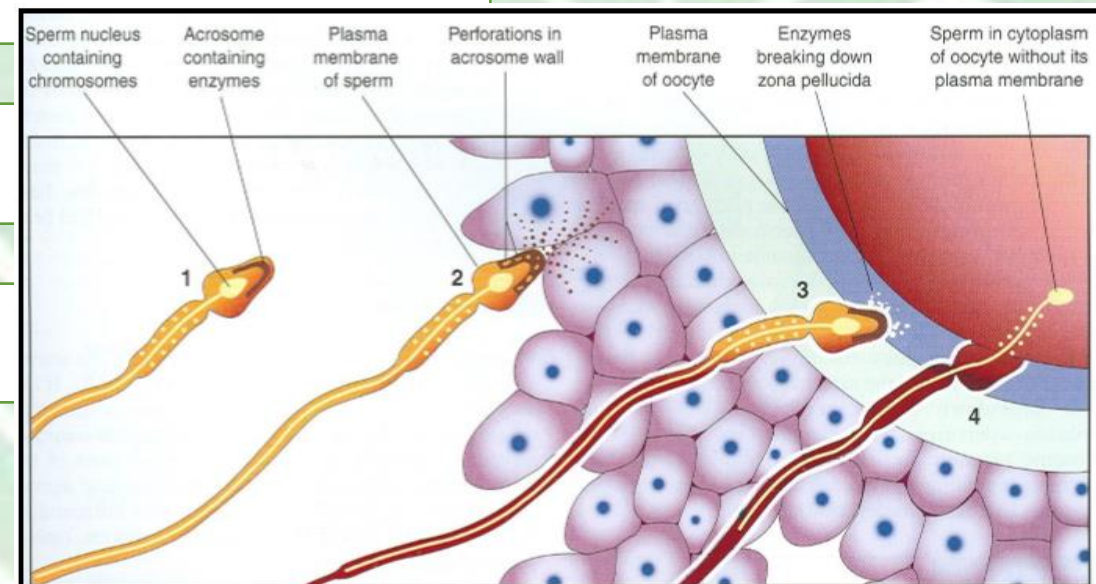
Formation

Formation of the **female pronucleus** and **male pronucleus**

6-

Union

Union of the **2 pronuclei**



Chromosomes

Zygote: is genetically a unique structure.

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 parent.

This mechanism forms biparental inheritance and leads to **variation of the human species**.

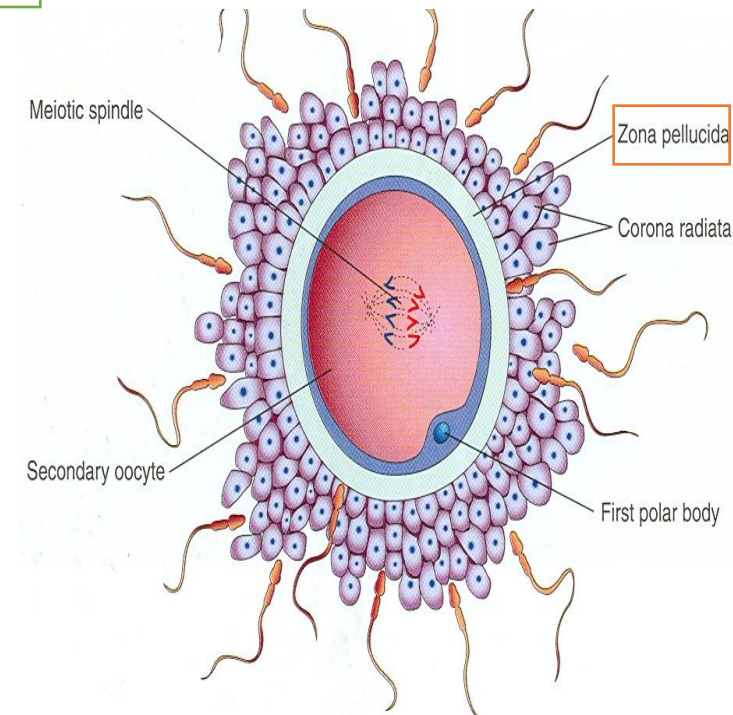
Sex of the Embryo

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 (X or X).

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. (it happens when a sperm gets inside the oocyte, so there is no need to another one. Zona pellucida prevents the other sperms to get in).



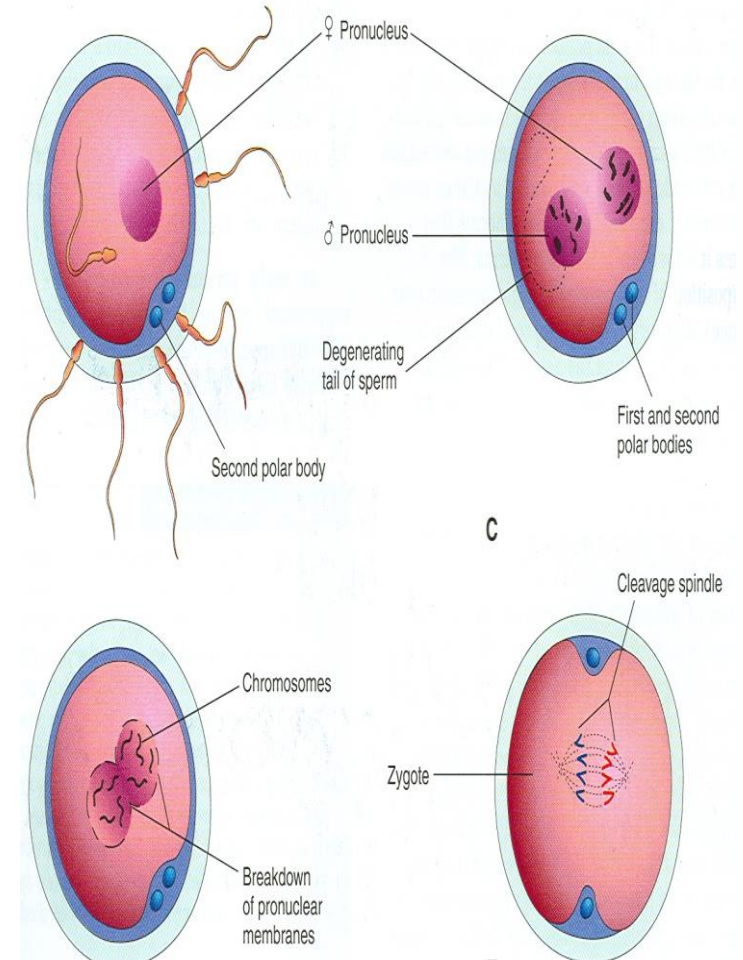
Results of fertilization:

1. Stimulates the penetrated oocyte to **complete its 2nd meiotic division** which was arrested at metaphase.

2. **Restores the normal diploid number of chromosomes.** (23 of the sperm and the same of the oocyte = 46)

3. **Determines the sex of the embryo.**

4. Initiates **cleavage of the zygote** (cell division).



Cleavage of Zygote

Now once we knew that the zygote is about a single cell formed of the union of 2 pronuclei (the paternal pronucleus and the maternal pronucleus)

This single cell will undergo a multiple “mitotic” division to form (*Blastomeres*).

After **30 hours** of fertilization , the cleavage begins.

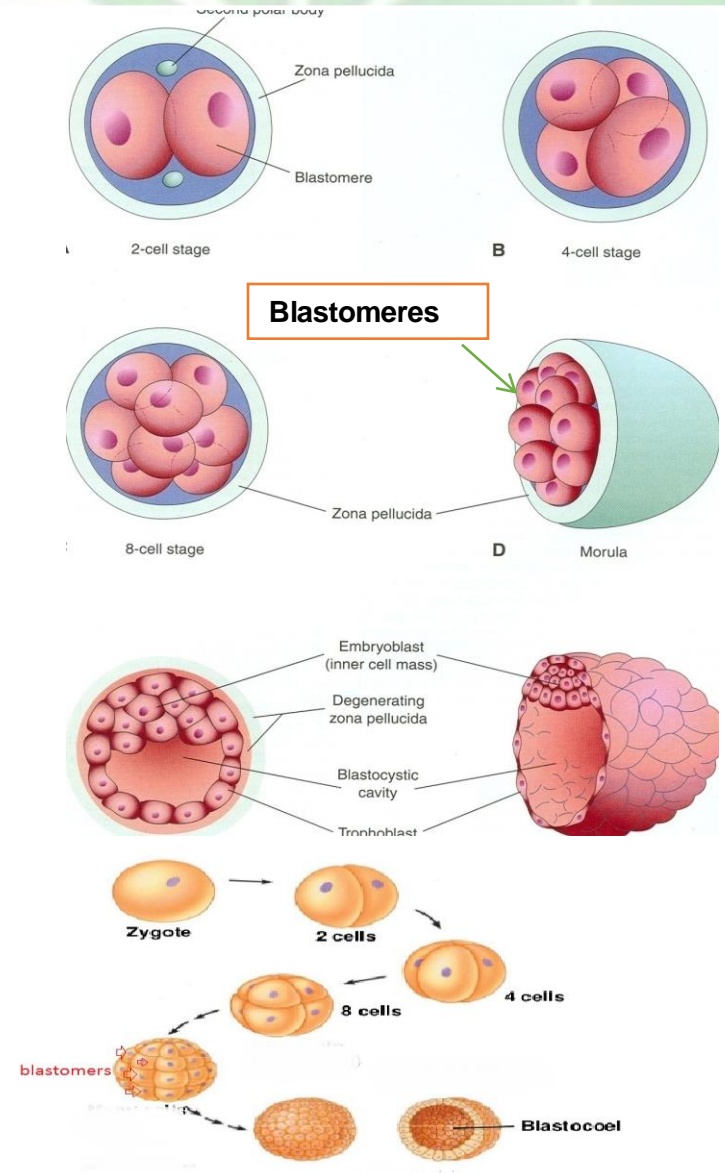
So, **Cleavage of Zygote** : is the repeated **mitotic** divisions of the zygote which **normally occurs in the uterine tube**.

Rapid (high speed) increase in the number of the cells that divided from the single cell (Zygote) to a sequence of 2 cells, then 4,8 and 16.... And so on.

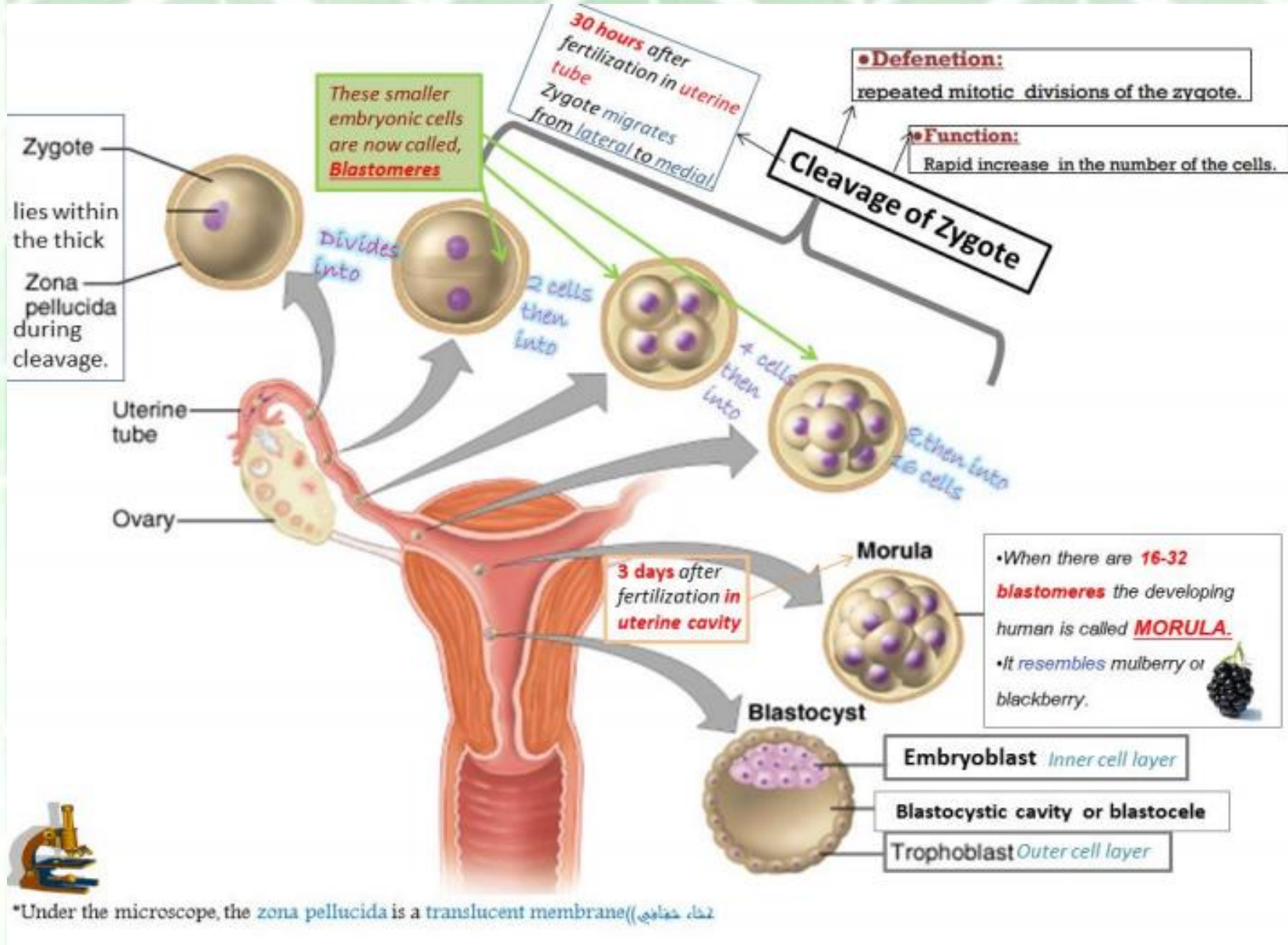
These smaller embryonic cells are now called: **Blastomeres**.

During cleavage, these cells will be surrounded by thick **zona pellucida** , which is translucent (شفاف) membrane under the microscope.

Zygote migrates (travels) in the uterine tube during cleavage from its lateral end to its medial end. (until it reaches the uterine cavity).



Summary



Morula

When there are **16 - 32** blastomeres the developing human is called **MORULA**.

The **Morula** reaches the uterine cavity at this stage.

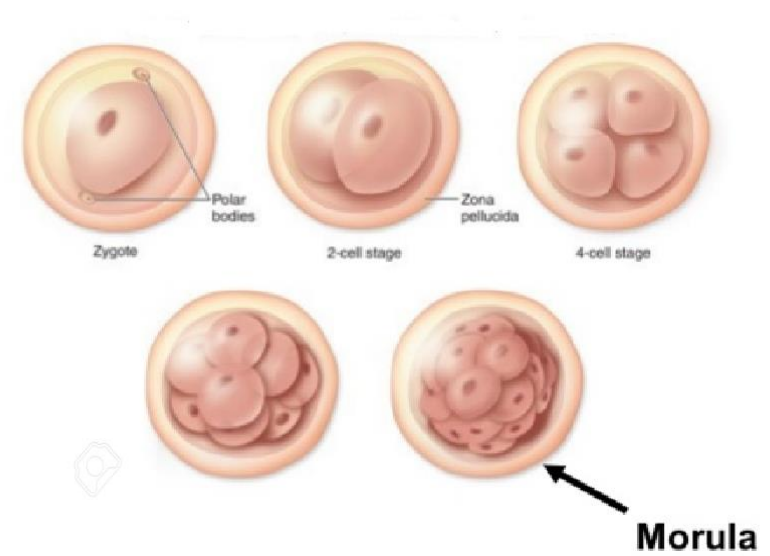
Spherical **Morula** is formed about the **3rd** day after fertilization. It resembles mulberry or blackberry and it reaches the uterine cavity by the **4th** day.

Blastocyst

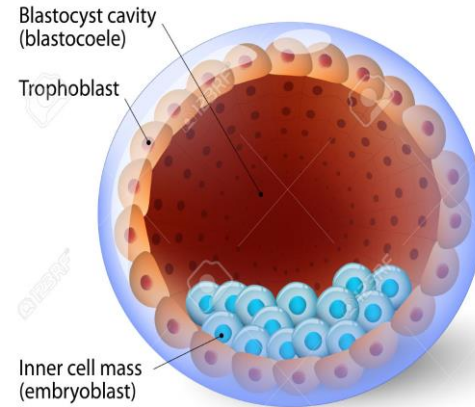
A **cavity** appears within the morula dividing its cells into 2 groups:

- 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 **blastocoele**.



BLASTOCYST



IMPLANTATION

Definition: It is the process by which the **Blastocyst** penetrates the **superficial** (compact) layer of the **endometrium** of the uterus.

Site: The normal site of implantation is the posterior wall of the body of the uterus near the fundus.

Time: It **begins** about the 6th day after fertilization.

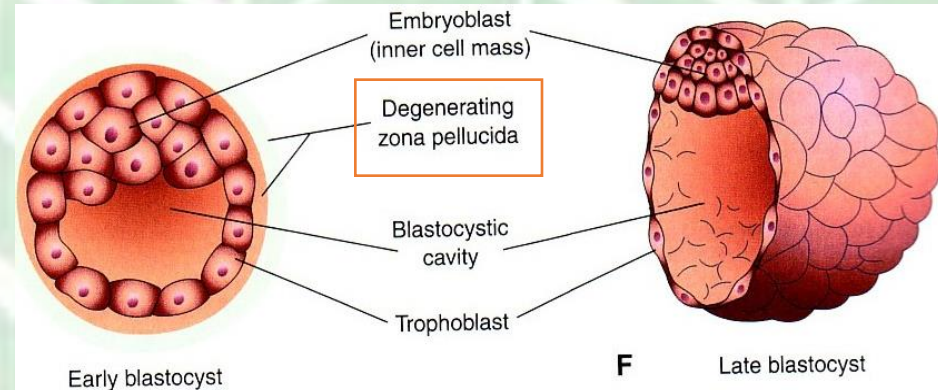
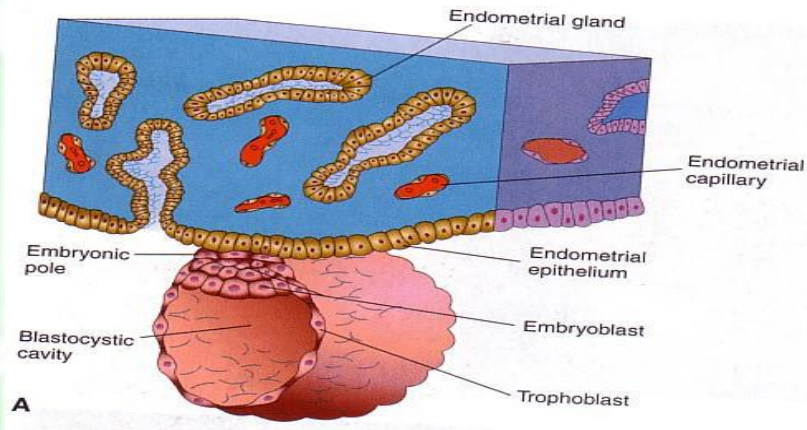
It is **completed** by the 11th or 12th day

Mechanism:

*The Morula reaches the uterine cavity by the 4th day after fertilization and it remains free within the uterine cavity for one or two days.

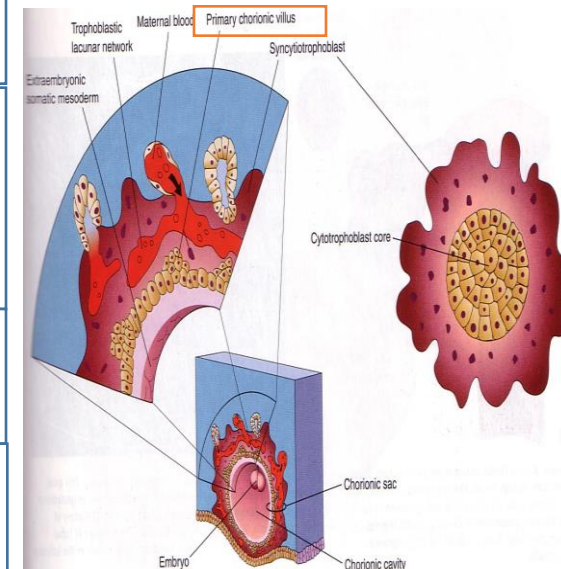
*Fluid passes from uterine cavity to the Morula.

*Now the Morula is called **Blastocyst**, its cavity is called **blastocystic** cavity or **blastocoele**, and its cells divided into Embryoblast & Trophoblast.



Summary

5 th Day	<ul style="list-style-type: none"> • Zona pellucida degenerates & disappears to allow the Blastocyst to increase in size and penetrate the endometrium. • The Embryoblast projects into the blastocystic cavity, while the trophoblast forms the wall of the blastocyst.
6 th Day	<ul style="list-style-type: none"> • Blastocyst begins implantation & adheres to the endometrium. • Penetration results from proteolytic enzymes e.g.(cox-2) produced by the trophoblast
7 th Day	<ul style="list-style-type: none"> • Trophoblast is differentiated into • A- Cytotrophblast: inner layer, mitotically active. • B- Syncytiotrophblast: outer multinucleated mass with indistinct cell boundary.
8 th Day	<ul style="list-style-type: none"> • Blastocyst is superficially embedded in the compact layer of the endometrium.
10 th or 11 th Day	<ul style="list-style-type: none"> • Syncytiotrophblast erodes the endothelial lining of the maternal capillaries which is known as sinusoids. • Blood Filled Lacunae appear in the Syncytiotrophblast which communicate forming a network.
11 th or 12 th Day	<ul style="list-style-type: none"> • Blood of maternal capillaries reaches the lacunae so Uteroplacental circulation begins.
13 th Day	<p><i>Proliferation</i> of Cytotrophblast cells produce extension inside the Syncytiotrophblast to form the primary chorionic villi.</p>



Endometrial cells undergo a process called **apoptosis** (programmed cell death) to facilitate invasion of endometrium by the **Syncytiotrophoblast**.

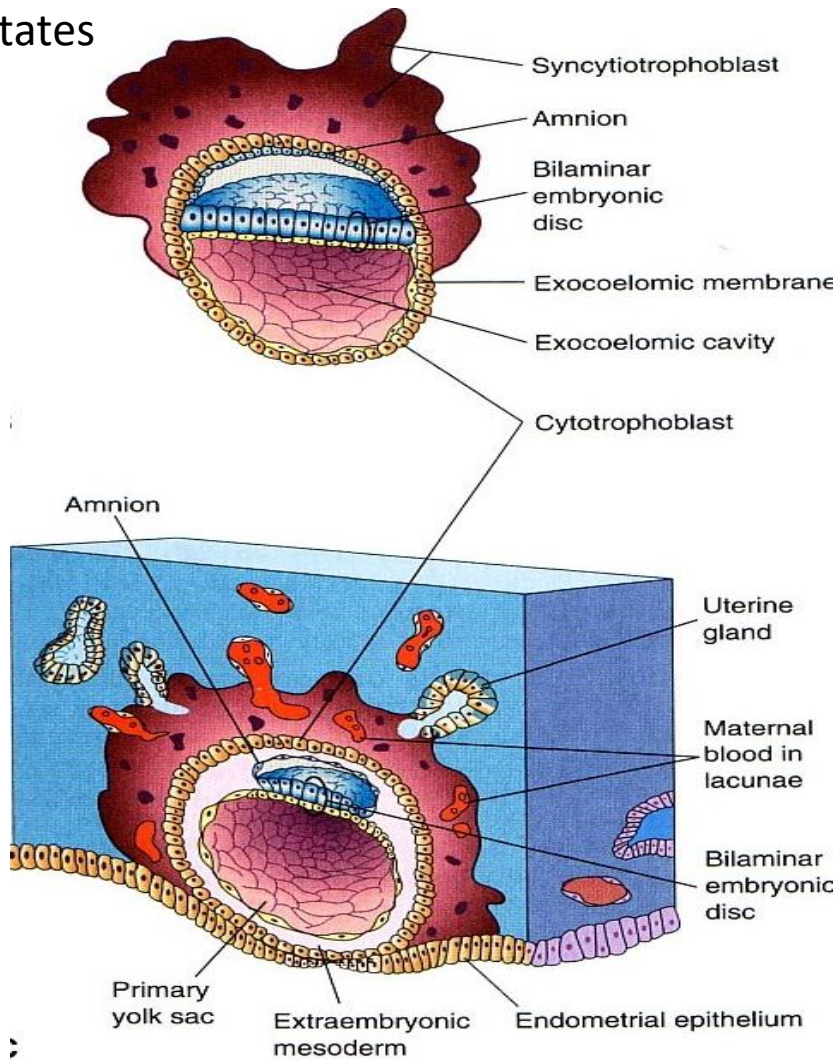
The **syncytiotrophoblast engulf** these degenerated cells for nutrition of the embryo.

Implantation can be detected by:

- 1- Ultrasonography.
- 2- hCG (human chorionic gonadotrophin) a hormone which is secreted by the Syncytiotrophoblast about the end of 2nd week. (excreted in the mother's urine)

Early Pregnancy Factor

The early pregnancy factor is an **immunosuppressant protein** which is **secreted** by **trophoblast cells** and it 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.



Ectopic Implantation (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**.

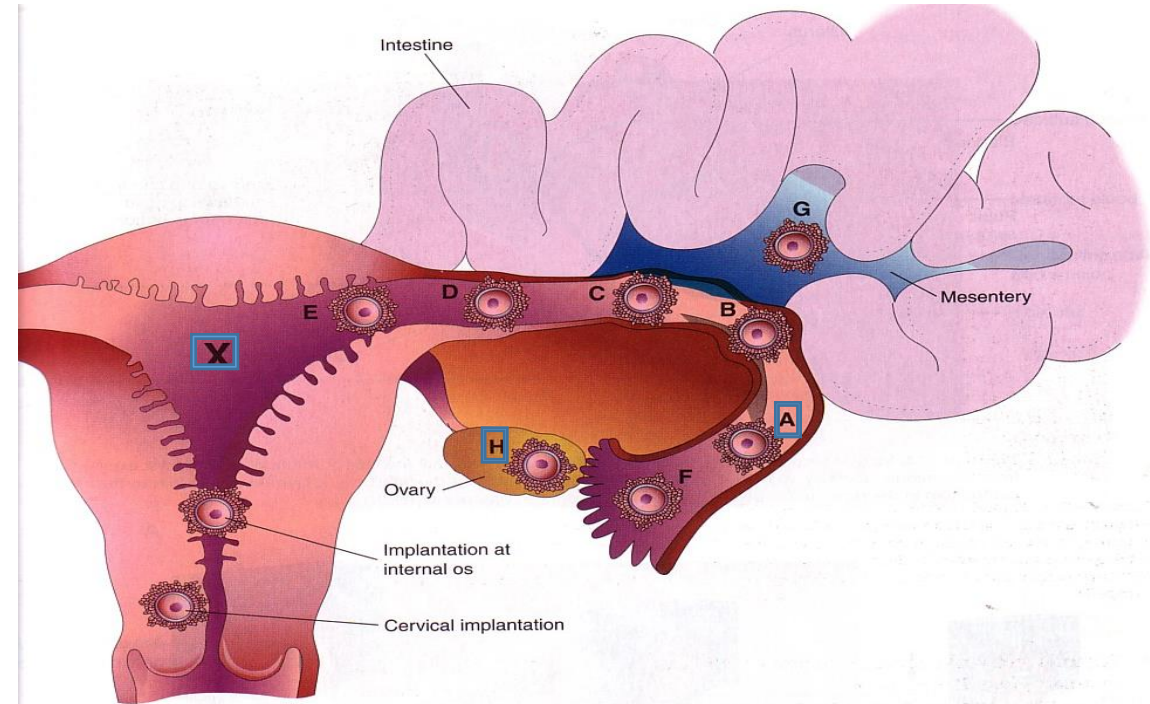
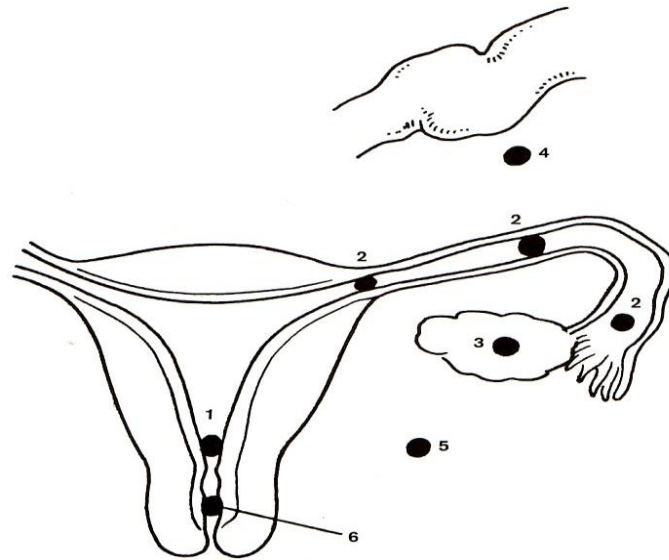


Fig 3-10. Implantation sites of blastocysts. The usual site in the posterior wall of the uterus is indicated by an X. The approximate order of frequency of ectopic implantations is indicated alphabetically (A, most common, H, least common). A to F, Tubal pregnancies. G, Abdominal pregnancy. H, Ovarian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

Ectopic Pregnancy:

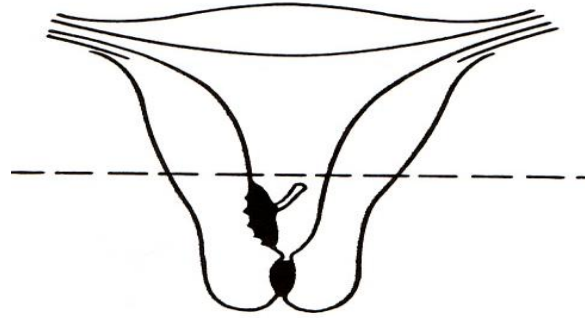
- 1- Placenta Previa.
- 2- Tubal.
- 3- Ovarian.
- 4- Abdominal.
- 5- Pelvic.
- 6- Cervical. عنقي



The usual site of implantation is the **posterior wall of the body of uterus (X)**.

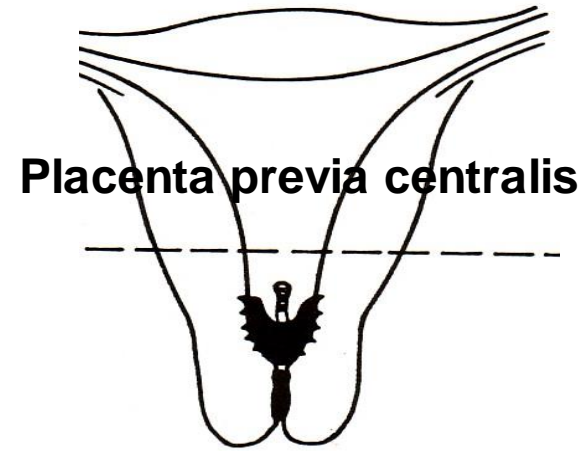
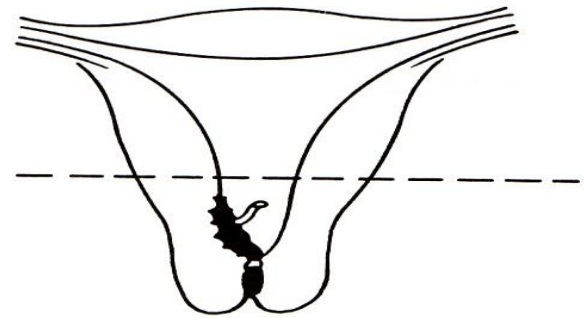
Tubal pregnancy is the **most common type of ectopic pregnancy (A)**.
Ovarian pregnancy is the **least common type of ectopic pregnancy (H)**.

Ectopic Implantation (pregnancy) cont'd



Placenta previa lateralis

Placenta previa marginalis



Placenta previa centralis

Credits

Team members:

Maha ALGhamdi

Laila Mathkour

Ghadah Almazrou

Rana Almanaa

Haneen Alsubki

Nada Alyousef

Ghadah Alothaim

Khalid Alhusainan

Abdulrahman Alrasheed

Jehad Alsadhan

Abdulrahman Alharbi

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