

DEVELOPMENT

By Dr

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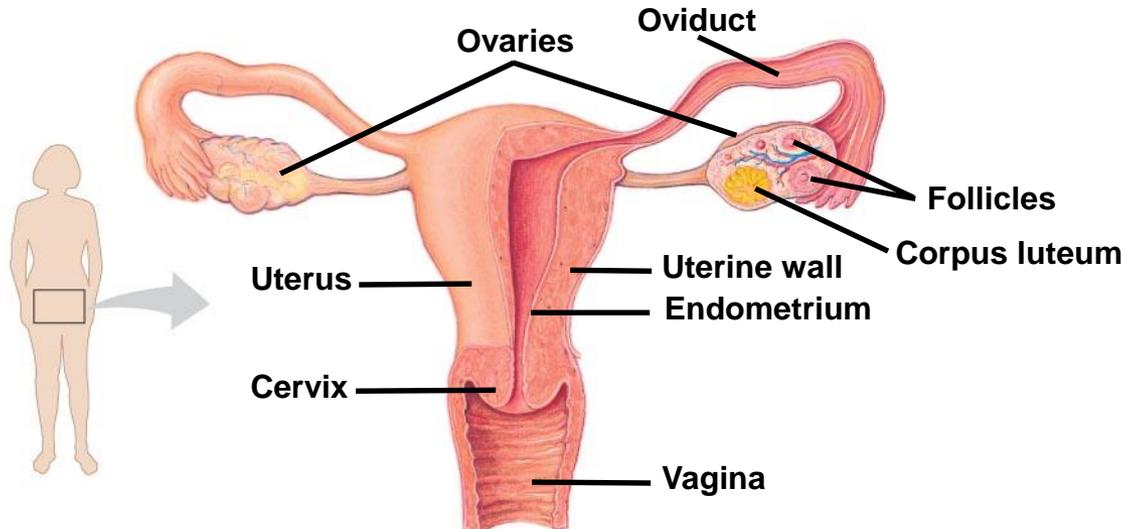
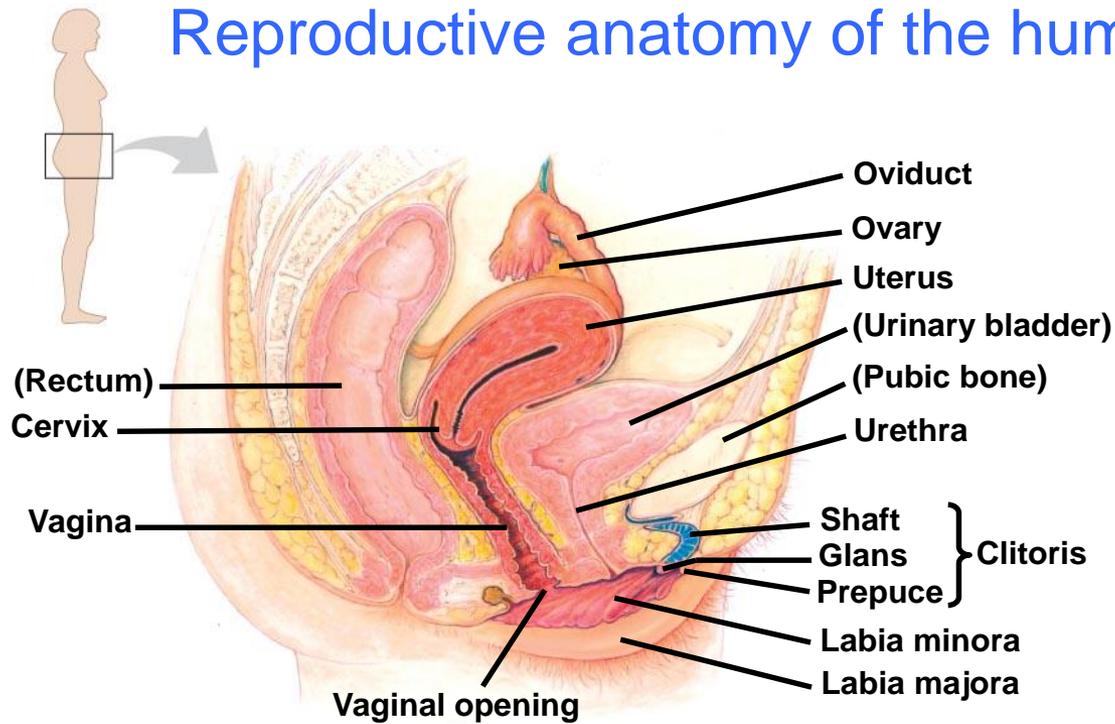
ILOs:

1. Identify reproductive anatomy of human female
2. Describe Ovulation
3. Identify reproductive anatomy of human male
4. Describe Spermatogenesis
5. Identify Structure of mature sperm
6. Define the process of fertilization.
7. Understanding the process of implantation.
8. Describe bilaminar & trilaminar disc.
9. Understand gastrulation and neurulation
10. Identify the derivatives of the germ layers.
11. Mastery the process of folding
12. Identify fetal membranes
13. Describe Further signs of fetal development

Embryo ; from the 2nd to the 8th week (end of 2nd month).

Foetus ; from the 9th week to birth

Reproductive anatomy of the human female



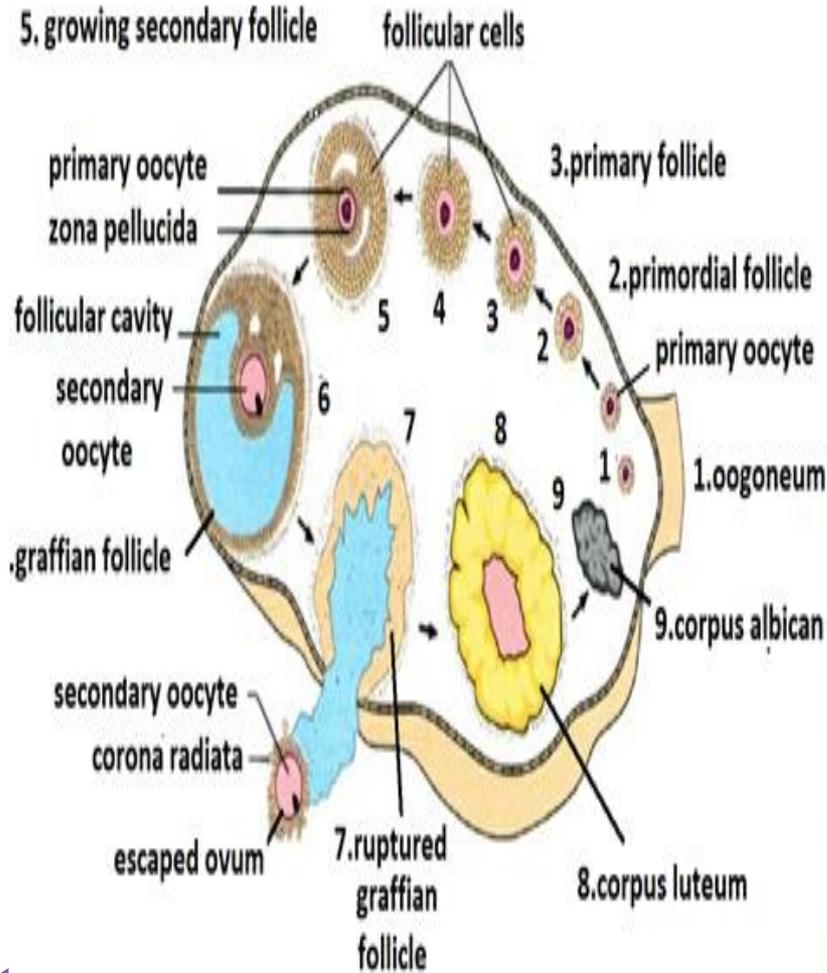
- The egg cell (ova) travels from the ovary to the uterus via an **oviduct** or **fallopian tube**.
- This is helped by:
 - 1- The sweeping movement of the fimbriae of the uterine tube which carry the ovum in a stream of peritoneal fluid.
 - 2- Activity of the cilia of uterine tube.
 - 3- Muscular contraction of the tubal wall.
- The uterus lining, the **endometrium**, has many blood vessels and it is the site of implantation of the growing embryo.

Ovaries = Female Gonads

- The female gonads, the ovaries, lie in the abdominal cavity.
- Each ovary contains many **follicles**, which are **egg chambers** consisting of a partially developed egg, called an **oocyte**, surrounded by support cells.
- Once a month, an oocyte develops into an ovum by the process of **oogenesis**.

4. secondary follicle

5. growing secondary follicle



- **Ovulation** expels an ova from the follicle.
- The remaining follicular tissue grows within the ovary, forming a mass called the **corpus luteum**.
- The corpus luteum secretes hormones that help to maintain pregnancy.
- If the ova is not fertilized the corpus luteum degenerates.

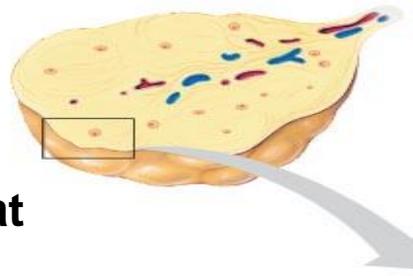
- **** If the ovum is fertilized:***
- **Corpus luteum will enlarge to form the corpus luteum of pregnancy, which will continue secreting progesterone .**
- **Its degeneration is prevented by chorionic gonadotrophins secreted by the chorion and placenta.**
- **Continuous secretion of progesterone during pregnancy will stop menstruation**

Gametogenesis

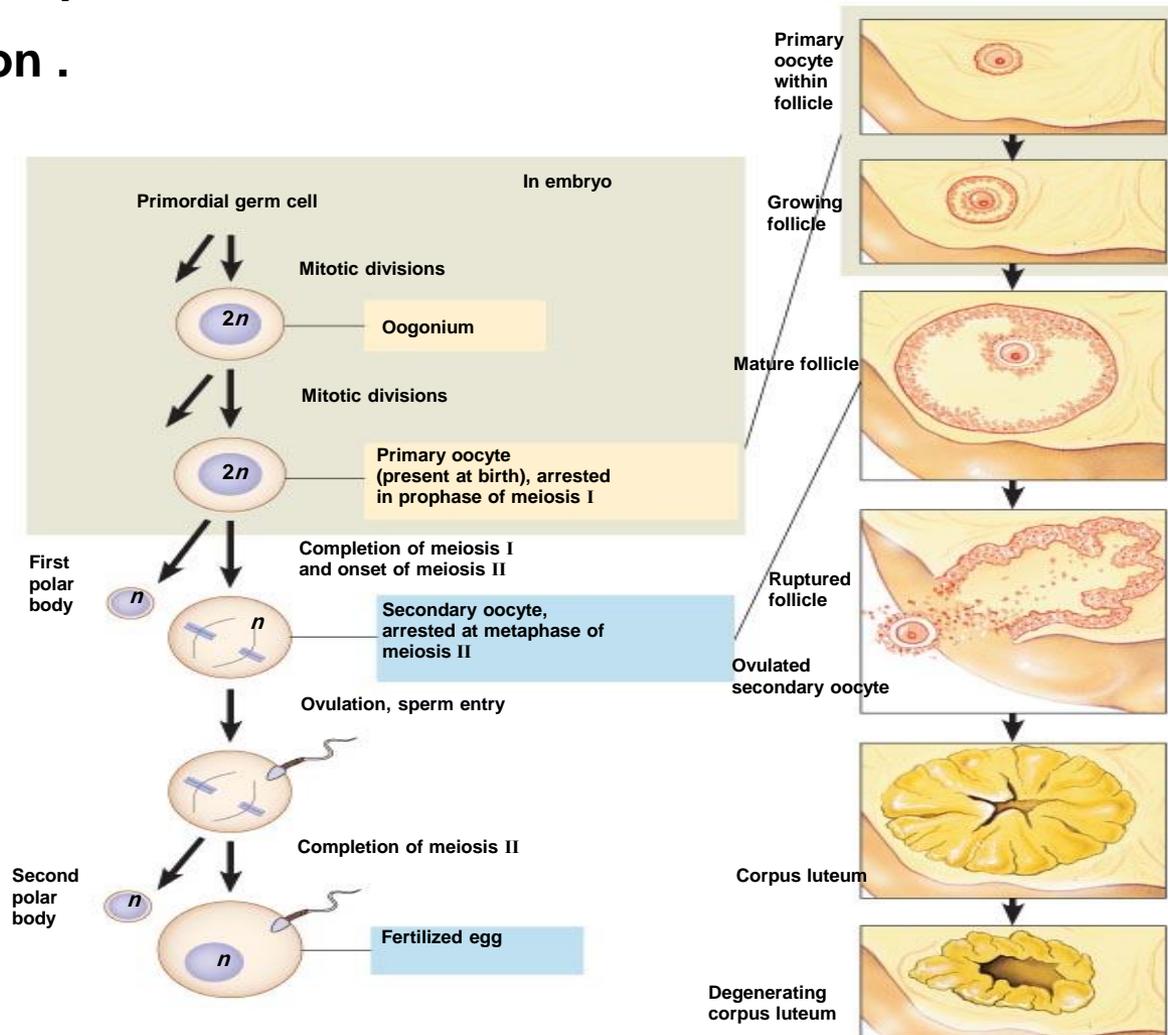
- It is the process of formation and development of mature germ cells i.e. gametes (sperm or ovum).
- In males , it is called *spermatogenesis*
- In females , it is called *oogenesis*.

Oogenesis

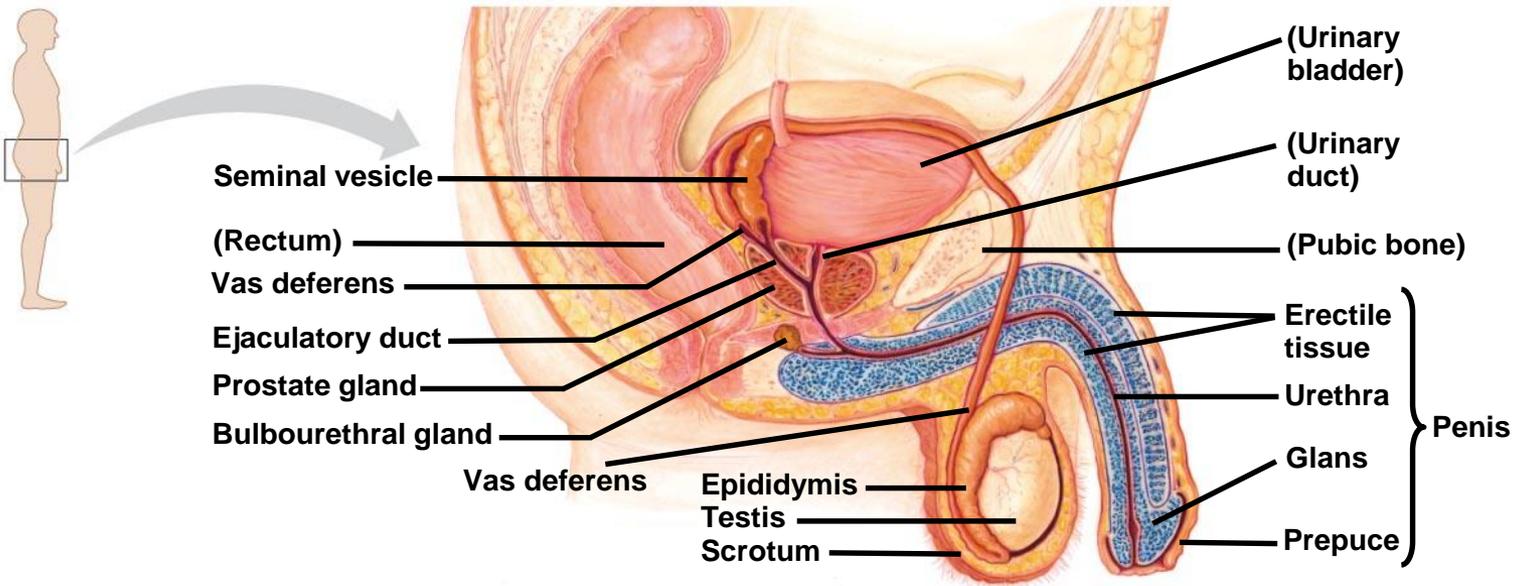
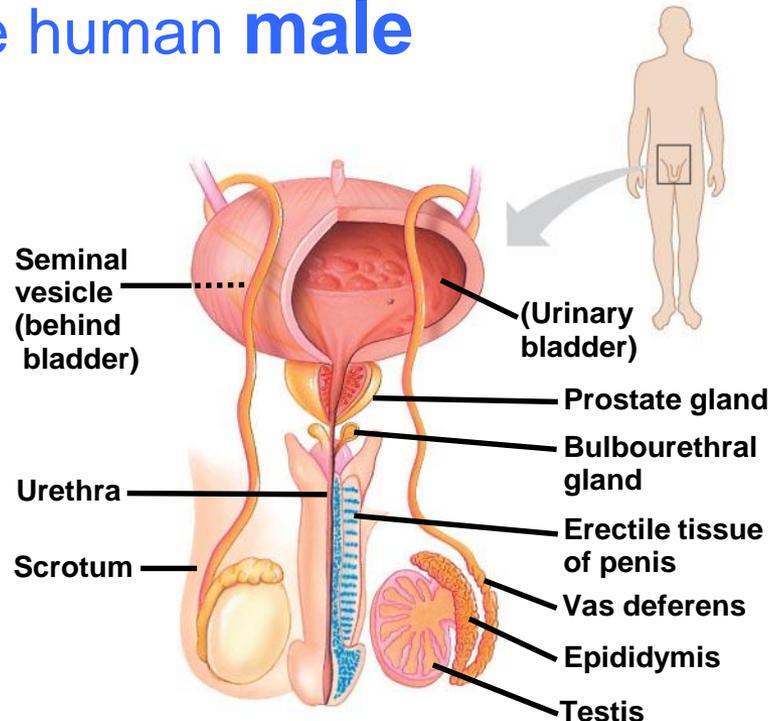
Ovary



Is the process of cell divisions that occurs in ovary to produce an ovum ready for fertilization .



Reproductive anatomy of the human male

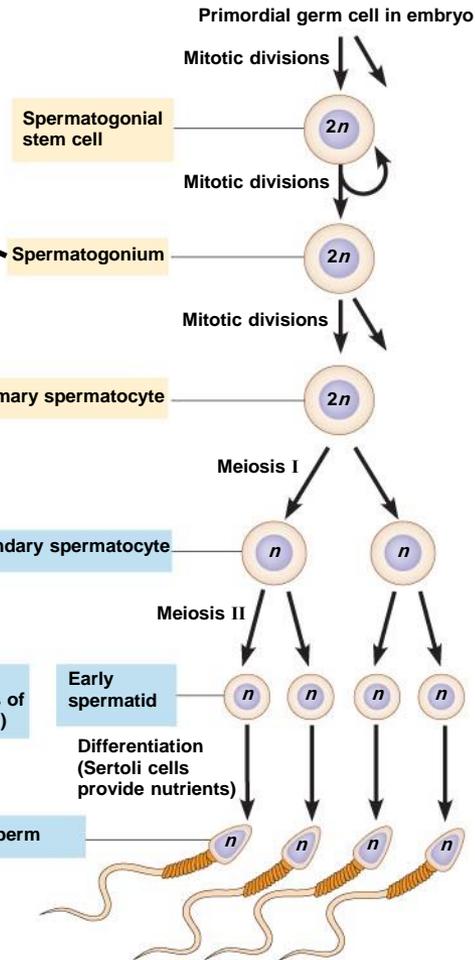
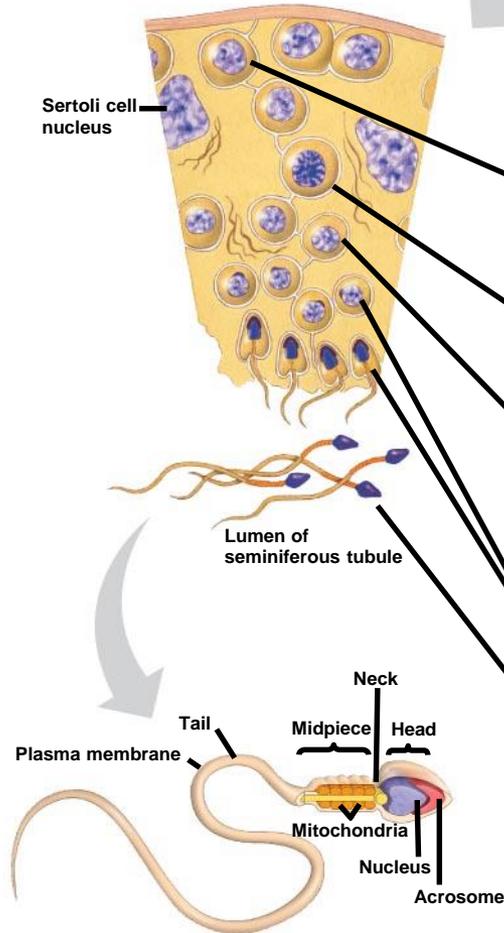
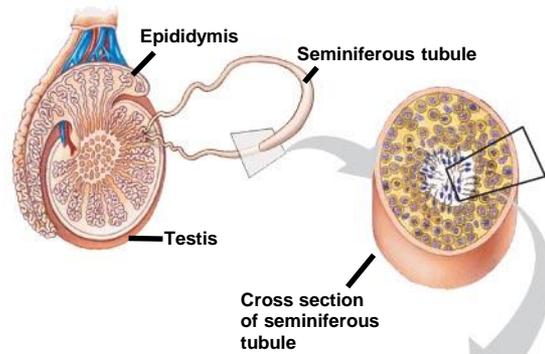


Testes = Male Gonads

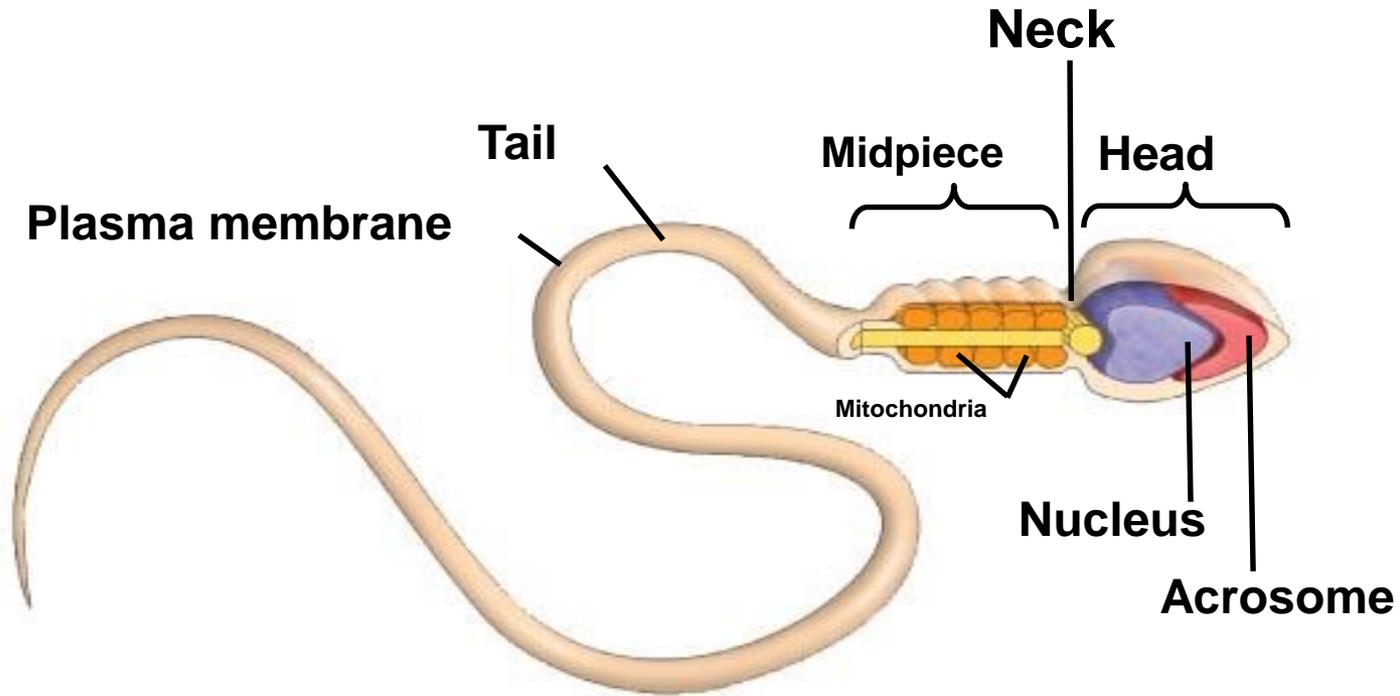
- The **testes** consist of highly coiled tubes surrounded by connective tissue. Sperm form in these **seminiferous tubules**. **Leydig cells** produce hormones and are scattered between the tubules.
- Production of normal sperm cannot occur at the body temperatures of most mammals. So the **testes** are held **outside** the **abdominal cavity** in the **scrotum**, where the **temperature is lower** than in the abdominal cavity.

Spermatogenesis

Is the process of cell division that takes place in seminiferous tubules of testis to produce sperms.



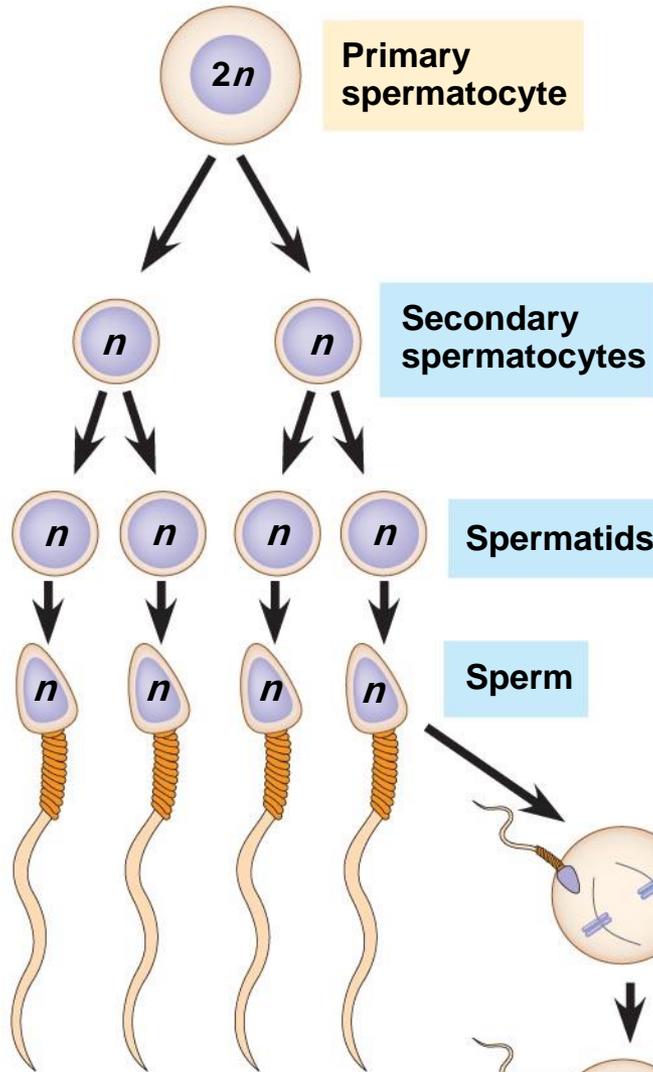
Mature sperm



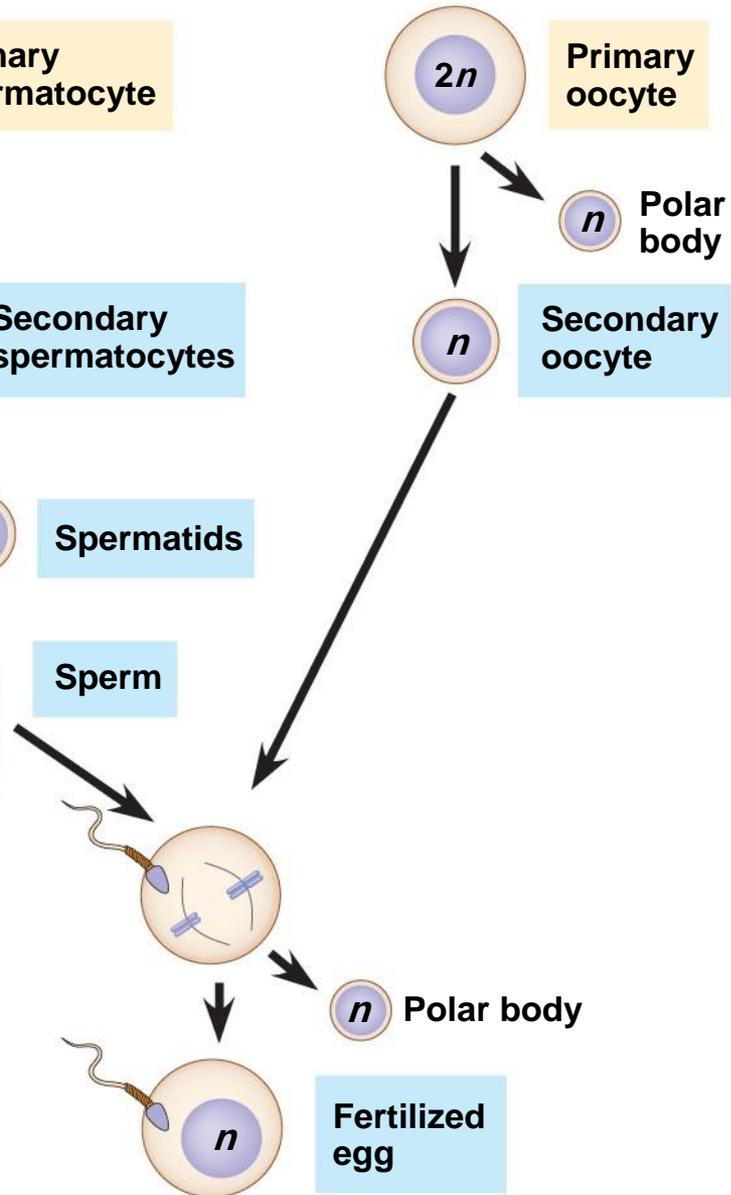
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Gametogenesis

Spermatogenesis



Oogenesis



Conception, Embryonic Development

- **Conception** = fertilization of an ova by a sperm, occurs in the fallopian tube.
- The resulting zygote begins to divide by mitosis in a process called cleavage.
- Division of cells gives rise to a blastocyst, a ball of cells with a cavity.

Beginning of Development

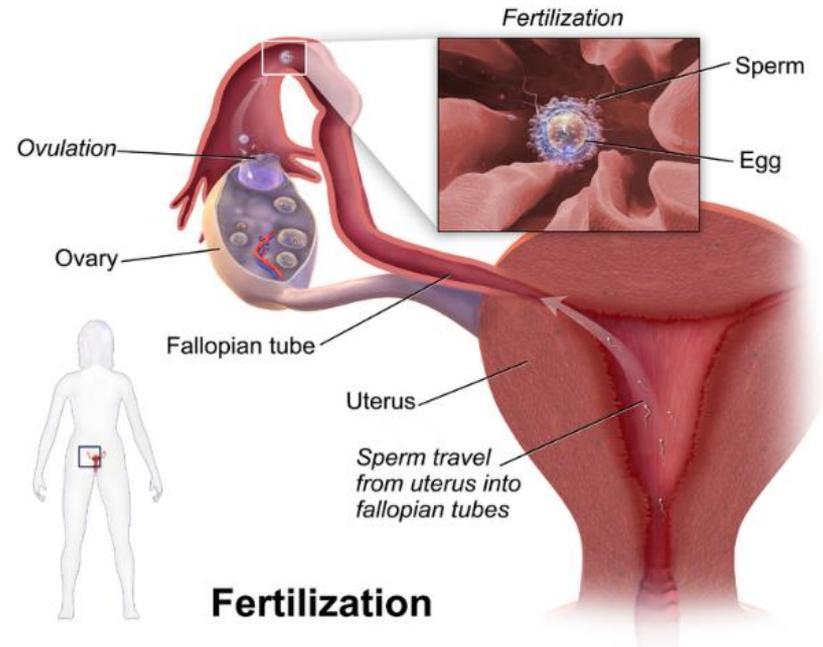
The First Week

1. Fertilization

- It is the union of the sperm with the ovum to form the zygote.
- Occurs in the **(ampulla)** *In the lateral third of the uterine tube.*



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Fertilization

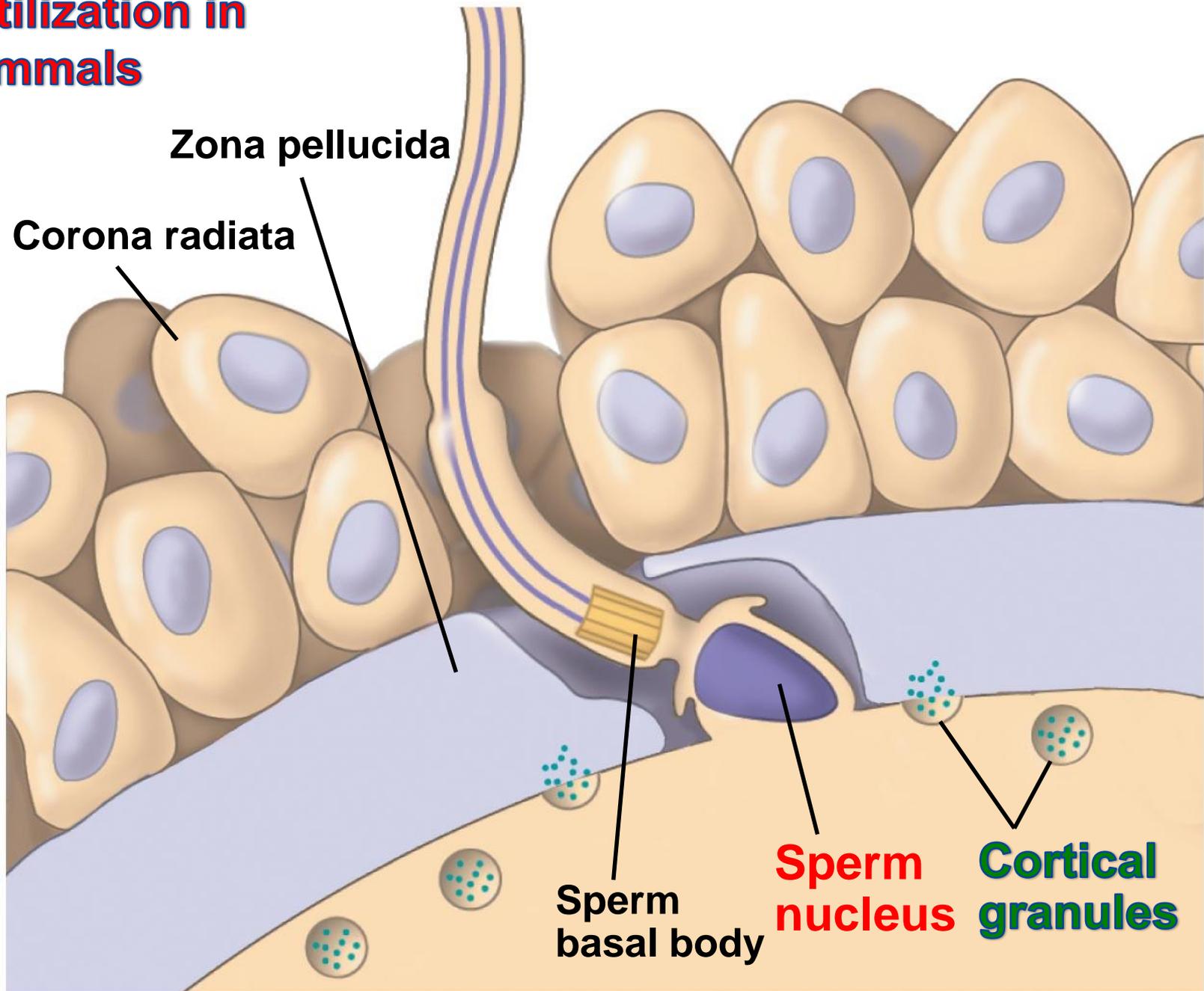
- The spermatozoa upon arrival in the female genital tract, are not capable of fertilizing the ovum. They must undergo:
- a- *Capacitation.*,
- b- *Acrosomal reaction.*
- **Capacitation**
- * It is the process by which freshly ejaculated sperm develops the capacity to fertilize an ovum.
- * Occurs normally in the female reproductive tract and takes about 7 hours .
- * Involves removal of the surface-coating proteins derived from the seminal fluid.

- **Acrosomal reaction:**
- * Occurs in the immediate vicinity of the oocyte under the influence of substances emanating from the corona radiata cells and the oocyte.
- * Morphologically multiple points of fusion can be observed between the plasma membrane and the outer acrosomal membrane of the sperm
- * These fusion points permit the release of the acrosomal contents needed for the sperm to penetrate the corona radiata and zona pellucida of the ovum.

Fertilization

- In human fertilization, the cortical reaction modifies the **zona pellucida**, the **extracellular matrix** of the **ova**, as a *slow block to polyspermy*.
- The first cell division occurs 12–36 hours after sperm binding.
- The diploid nucleus forms after this first division of the zygote.

Fertilization in mammals



Phases of Oocyte

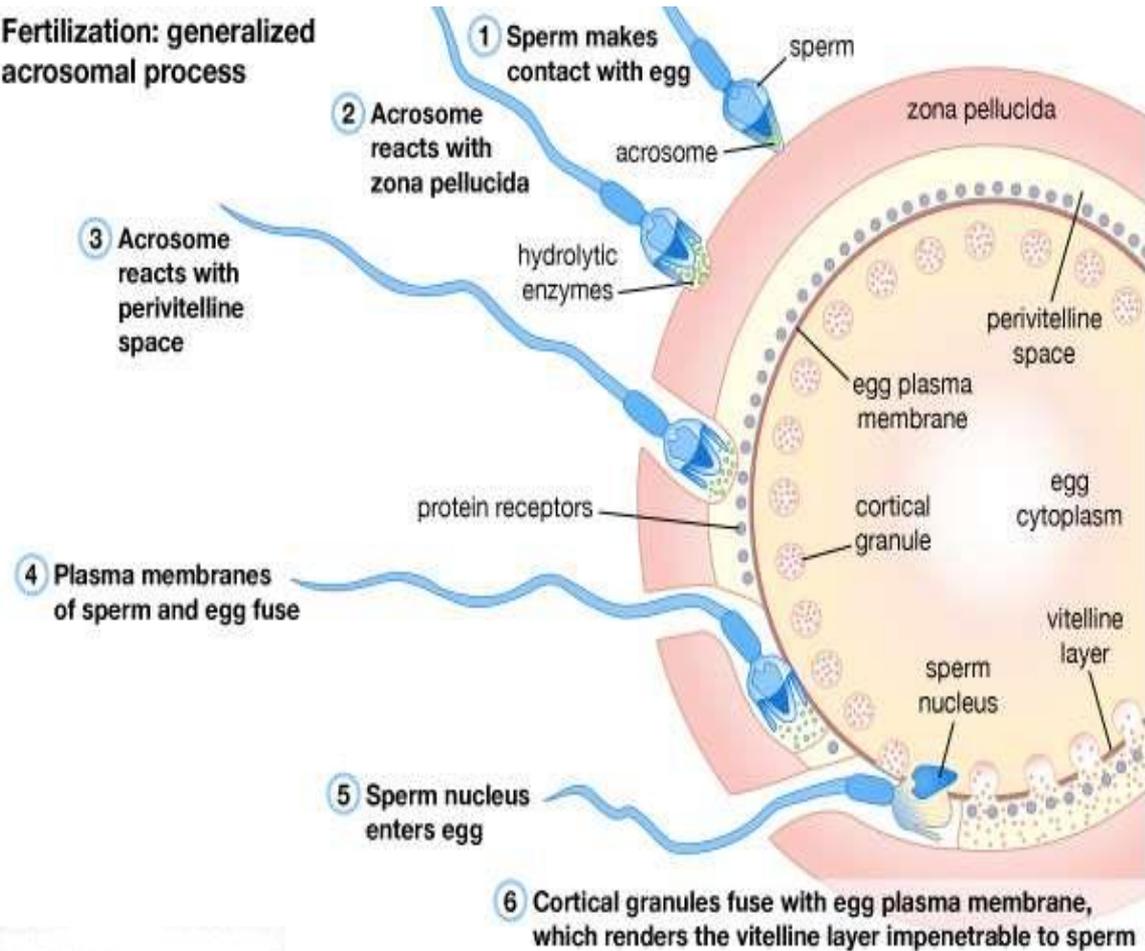
Penetration

1- Penetration of corona radiata.

2- Penetration of zona pellucida.

3- Fusion of oocyte - sperm cell membranes.

Fertilization: generalized acrosomal process



Results of fertilization

- The zygote is formed
- Restoration of the diploid number of chromosomes (46)
- The hereditary characters derived from father and mother are determined and will be carried to the offsprings.
- The sex of the embryo is determined as follows:
 - * If a sperm with sex chromosome (X) unites with an ovum a female embryo (XX) will result.
 - * If a sperm with sex chromosome (Y) unites with an ovum a male embryo (XY) will result.
- So , the father is the only one responsible for the sex of his offsprings.
- Cleavage(segmentation) immediately follows fertilization.

Cleavage = Rapid Mitosis / No Mass change

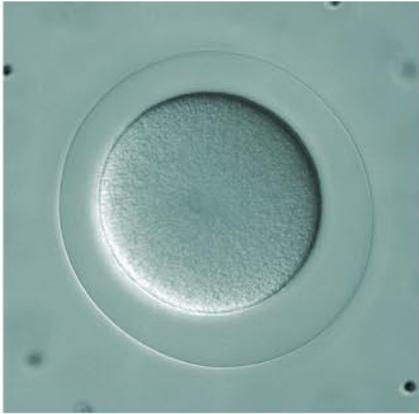
- Fertilization is followed by **cleavage**, a period of **rapid cell division without growth**.
- **Cleavage is the process that immediately follows fertilization in which there is a series of repeated mitotic divisions resulting in an increase in the number of cells.**

2- Cleavage

- This division occurs while the zygote is migrating through the fallopian tube to reach the uterus.
- Divisions occur inside the *zona pellucida* and so the cells become smaller with each further cleavage division.
- The 2 cell stage appears 30 hours after fertilization
- The 4 cell stage appears 40 hours after fertilization.
- The 16 cell stage resembles a mulberry and is called Morula.
- The morula reaches the uterine cavity 3-4 days after fertilization and spends a further, 3-4 days free in the upper part of uterus before implantation, which begins on the 7th day.

- **Cleavage**: A series of cell divisions that begin immediately after fertilization.
- **Morula**: After 3 days of cleavage. Is a solid ball of cells resembling a mulberry.
- **Blastocyst**: A hollow ball with an inner cavity known as the blastocoele.

Cleavage



(a) Fertilized egg



(b) Four-cell stage



(c) Early blastula



(d) Later blastula

- Once the blastocoele is formed,
- the blastula appears to consist of *two types of cells* :

1- Outer cell mass (trophoblasts):

A single layer of cells forming the wall . It proliferates rapidly and differentiates into two layers:

- a- *Cytotrophoblast* which is the original cellular layer
- b- *Syncytiotrophoblast* which is an outer multi-nucleated sheet of cells lying outside the cytotrophoblast.

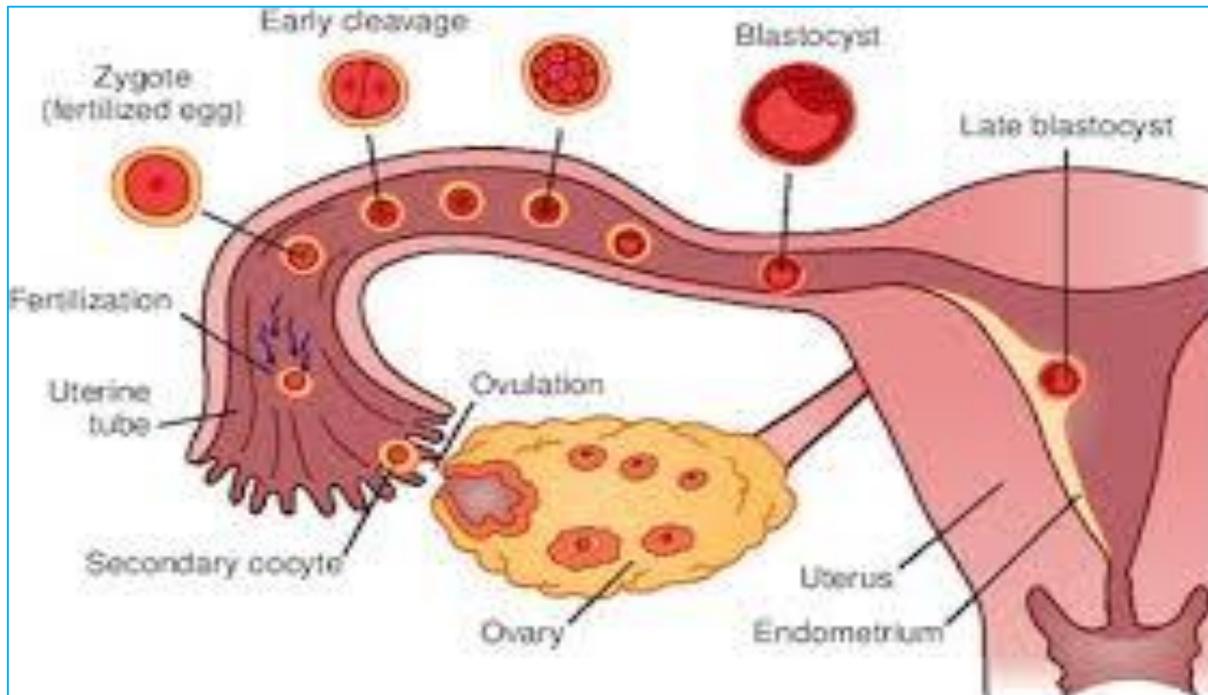
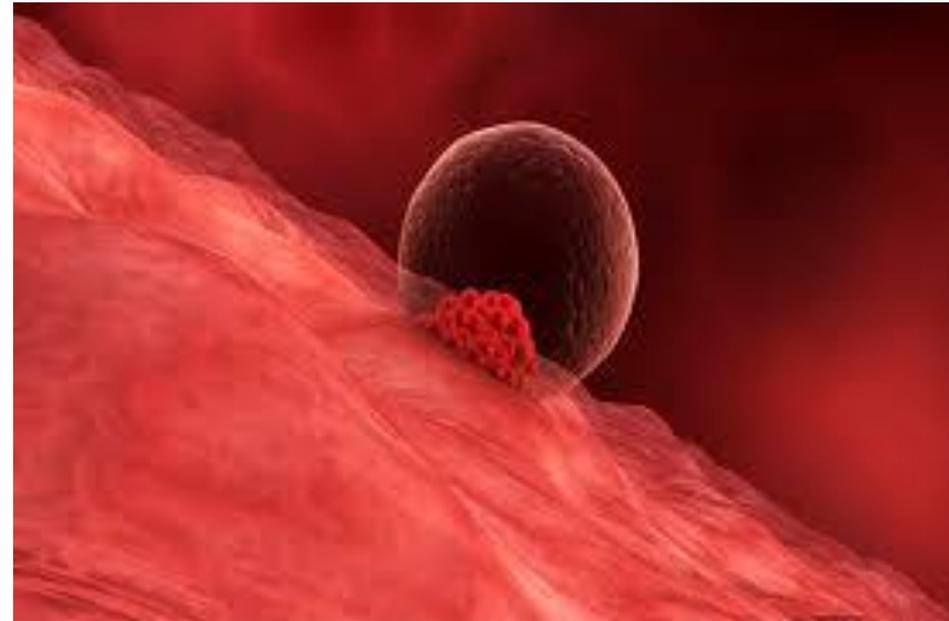
2- Inner cell mass (embryoblast) :

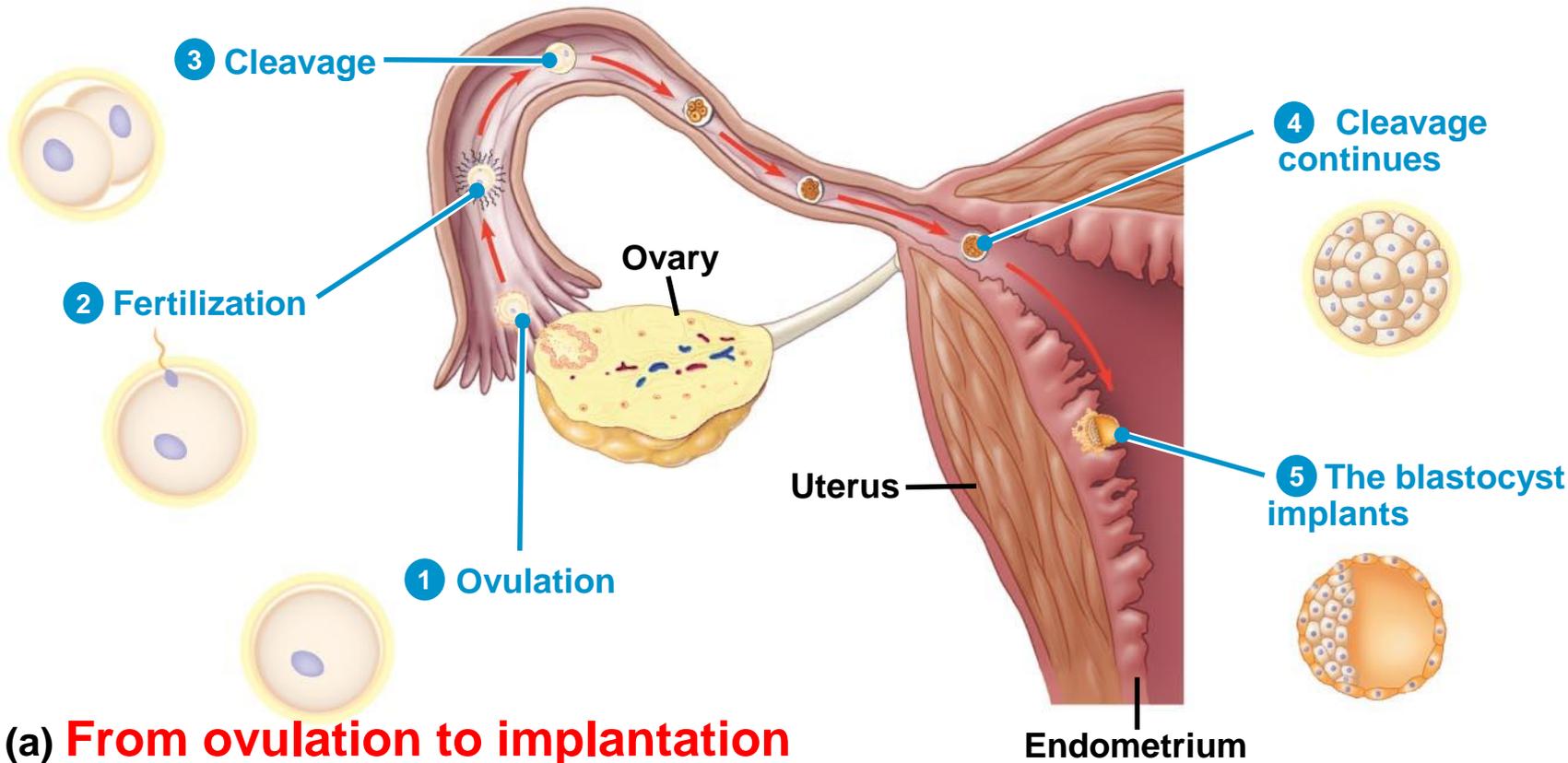
The remainder of the cells collect at one pole on the inner side of the blastocyst (embryonic part) and will form the embryo.

- **By the 7th day after fertilization, the human embryo becomes freely floating for 2 days in the uterine cavity ready to be implanted .**
- **As the pressure increases within the morula, the zona pellucida ruptures and disappears allowing implantation to begin.**
- **Contact with maternal tissue stimulates expansion of trophoblast**
- **Syncytiotrophoblast invades the endometrium .It appears to have invasive , ingestive and digestive functions thus eroding the endometrium**

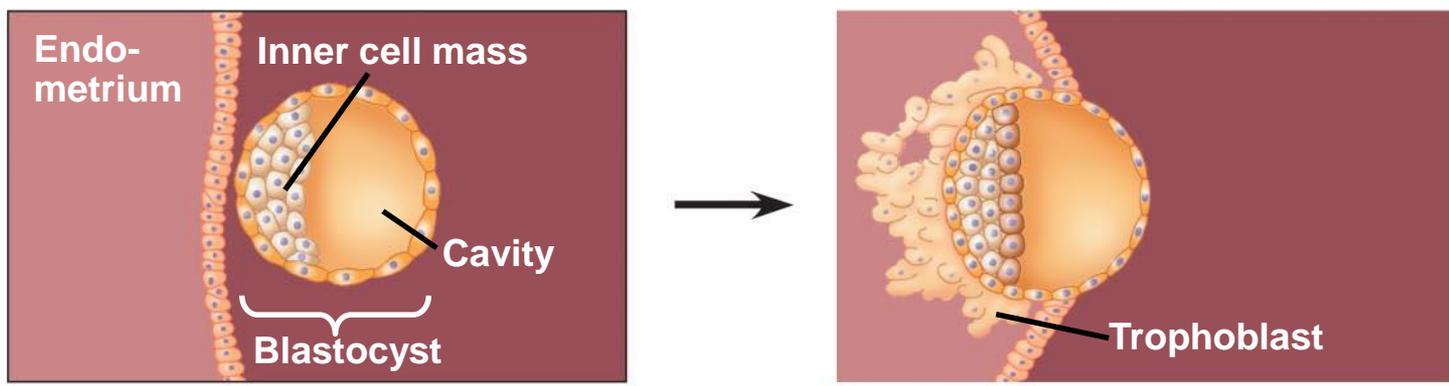
3. Implantation

➤ The process of attachment and invasion of uterine endometrium by the developing embryo (blastocyst).





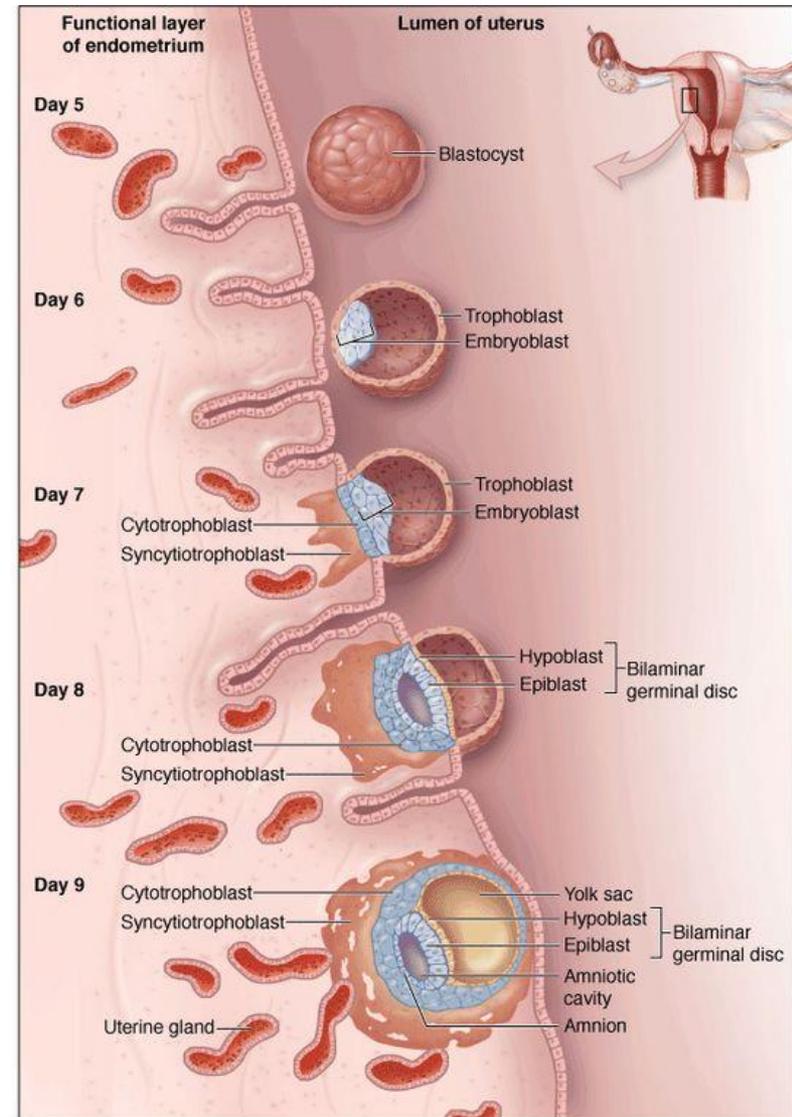
(a) From ovulation to implantation



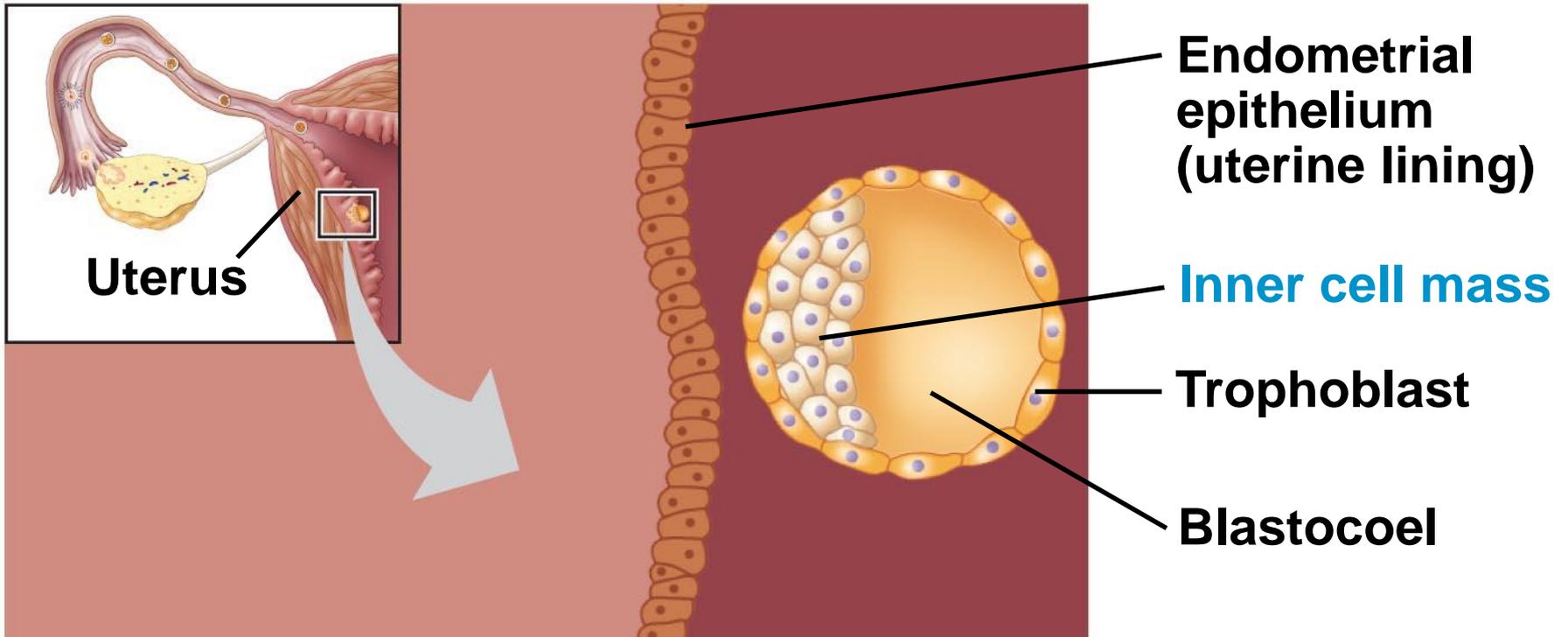
(b) Implantation of blastocyst

Implantation

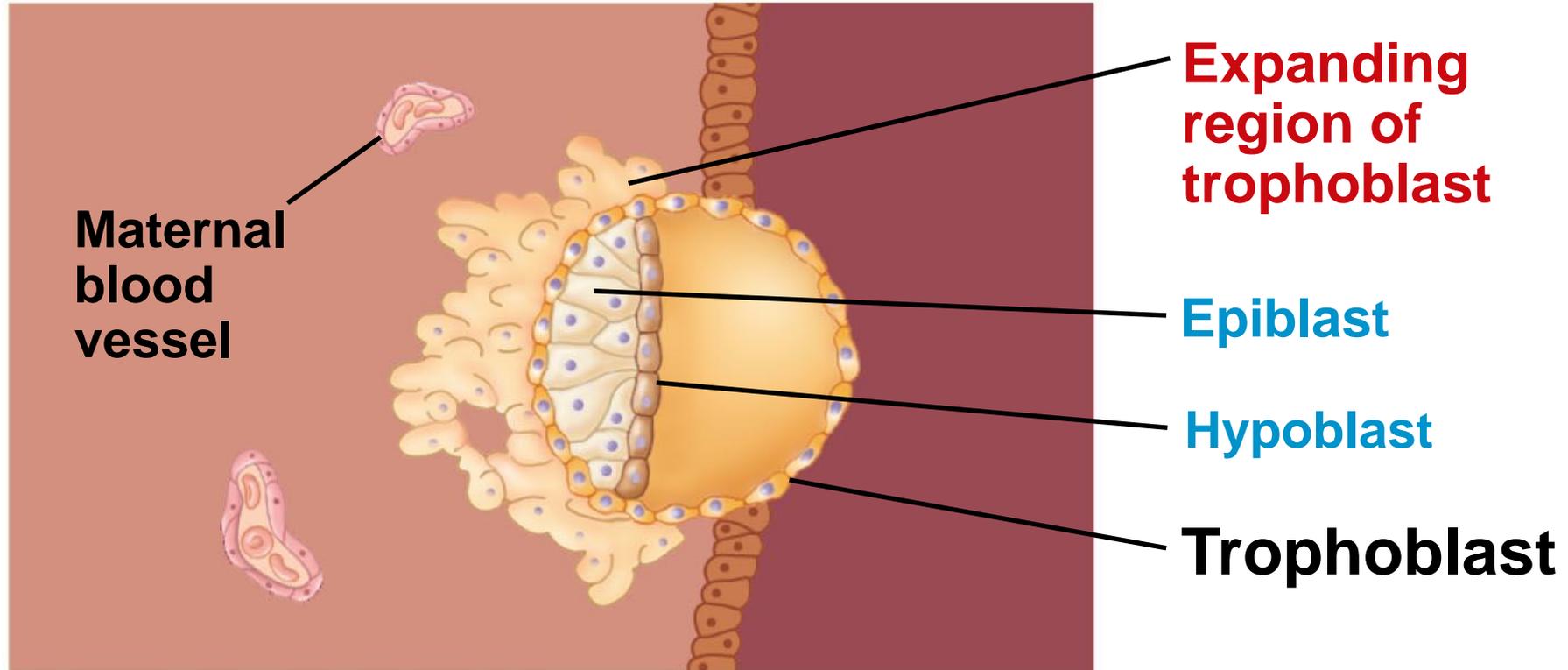
- Occurs by the 7th day after fertilization.
- occurs normally at the upper part of the posterior wall of the uterus near the fundus.



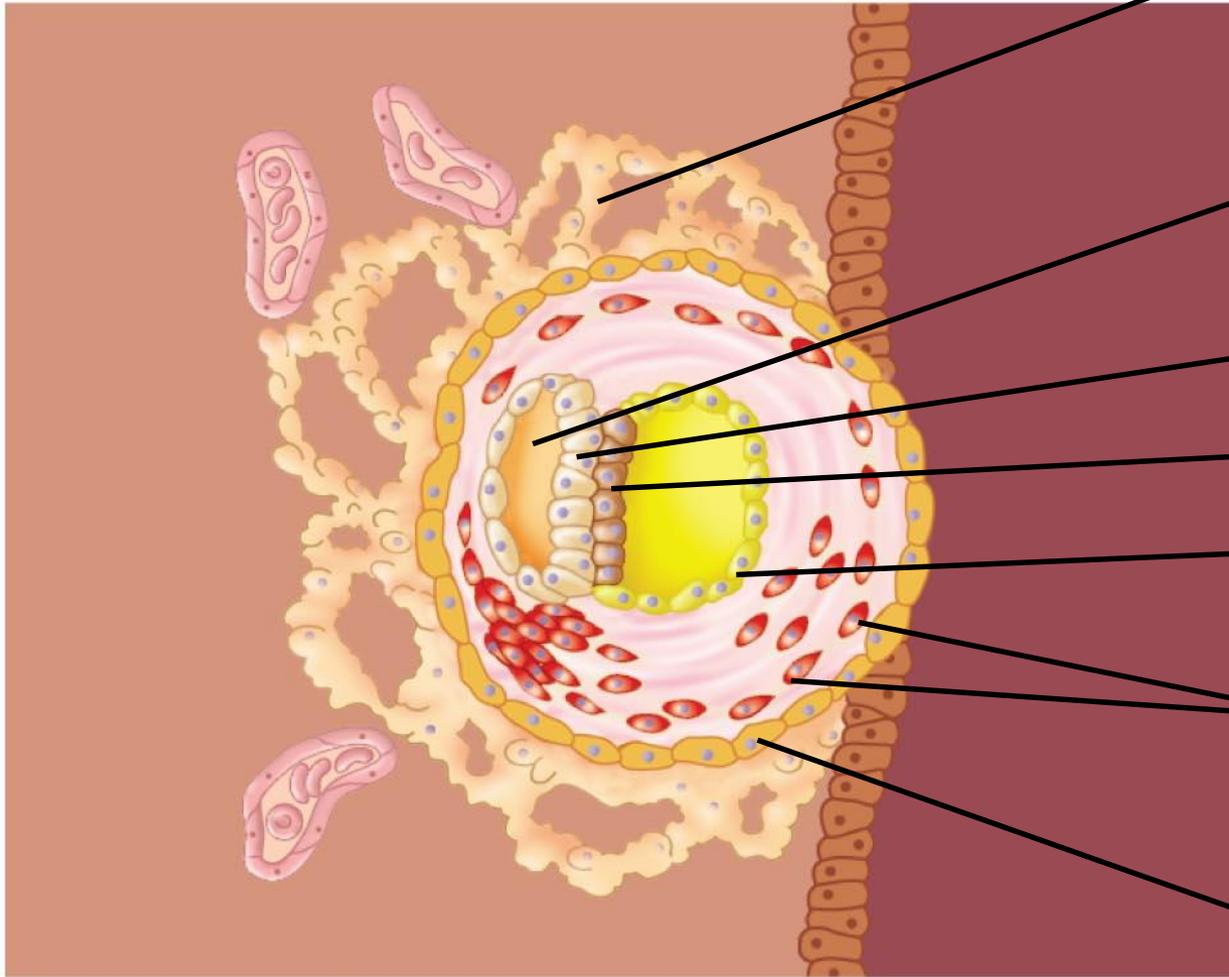
Early embryonic development of a human



Early embryonic development of a human



Early embryonic development of a human



Expanding region of **trophoblast**

Amniotic cavity

Epiblast

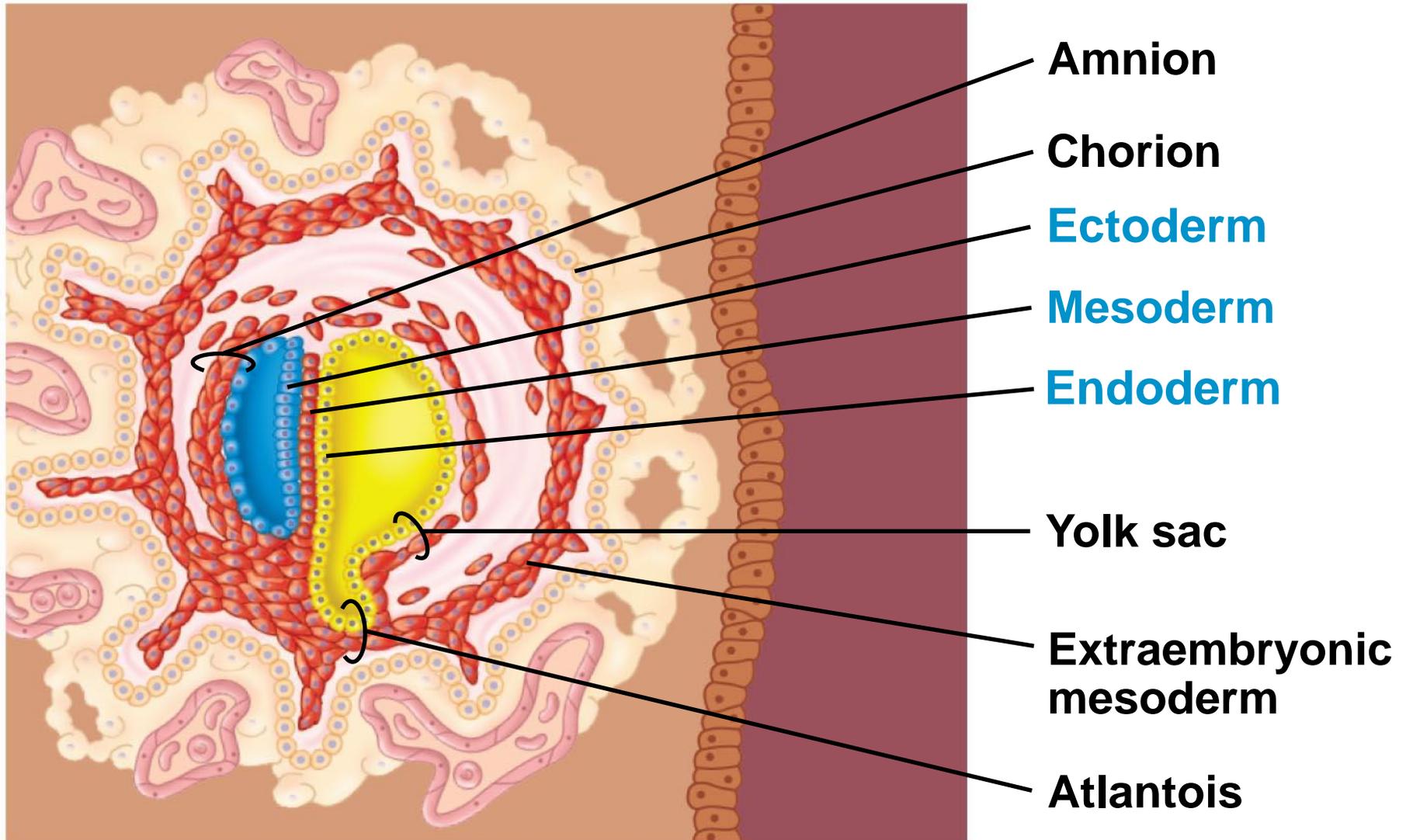
Hypoblast

Yolk sac (from hypoblast)

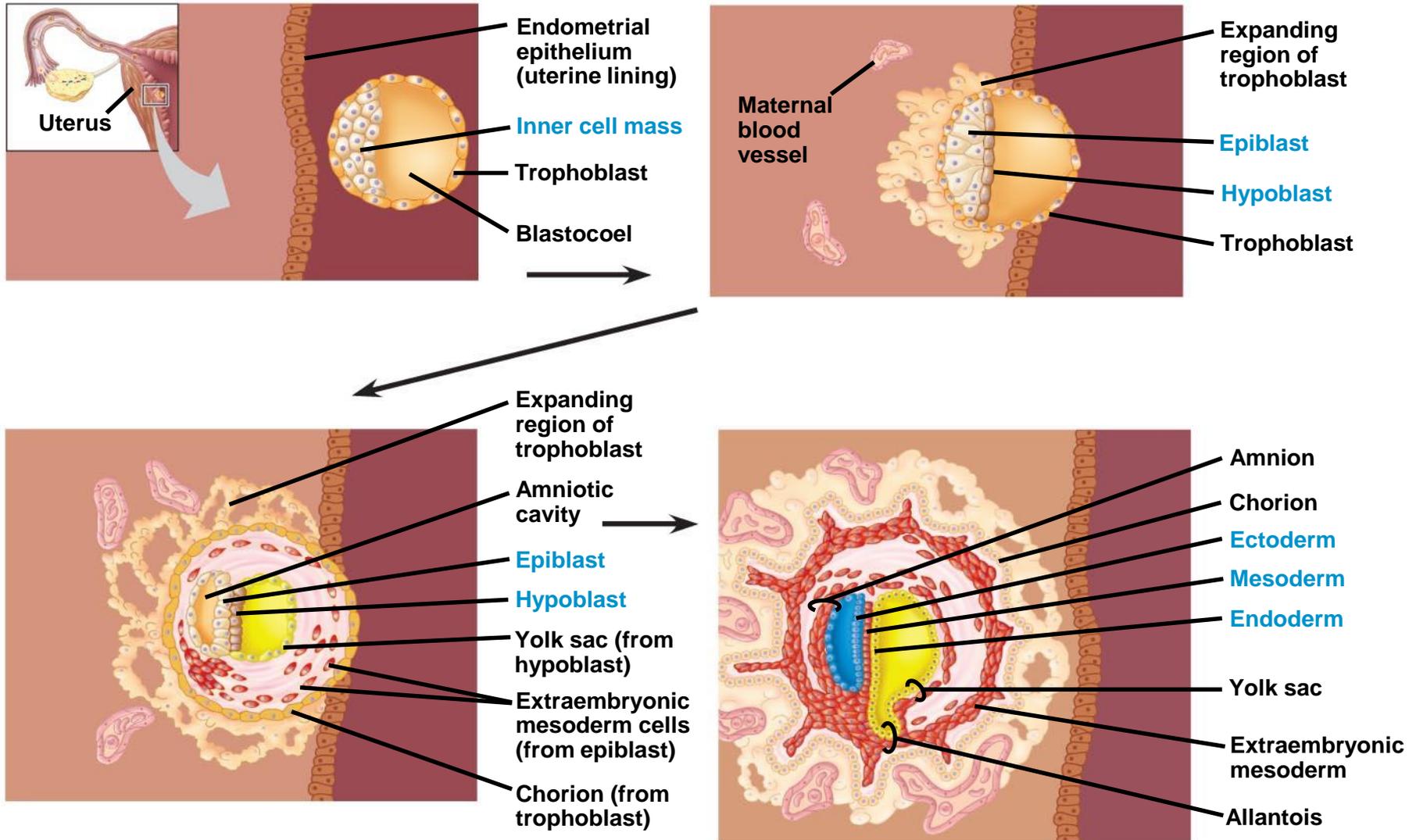
Extraembryonic mesoderm cells (from epiblast)

Chorion (from trophoblast)

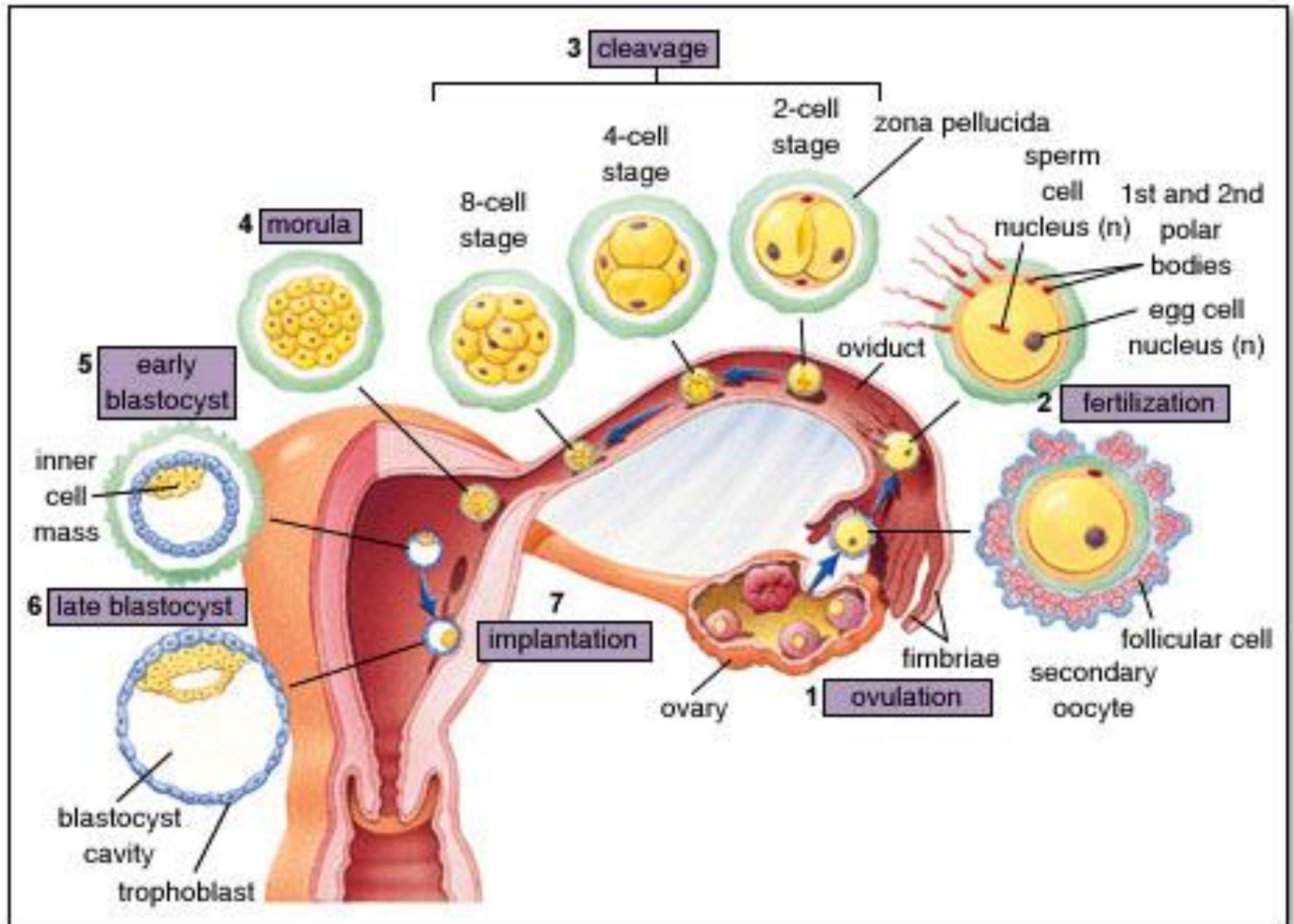
Early embryonic development of a human



Four stages in early embryonic development of a human

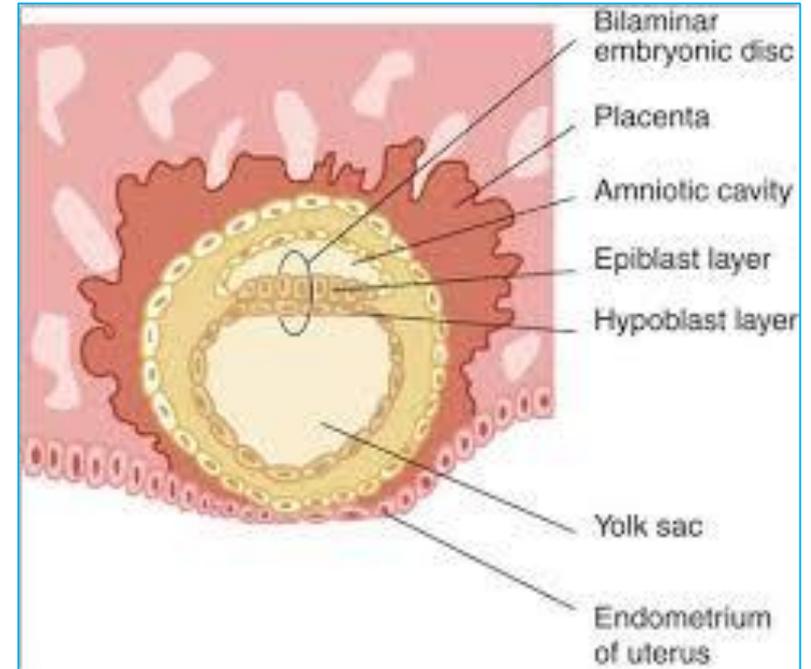


Sequences of First Week events



Second Week Bilaminar embryo

- Occurs during the 2nd week of development.
- the inner cell mass differentiate into 2 cell layers:
 1. Epiblast; dorsal columnar cells.
 2. Hypoblast; ventral cubical cells.



2nd week development

Bilaminar embryonic disc

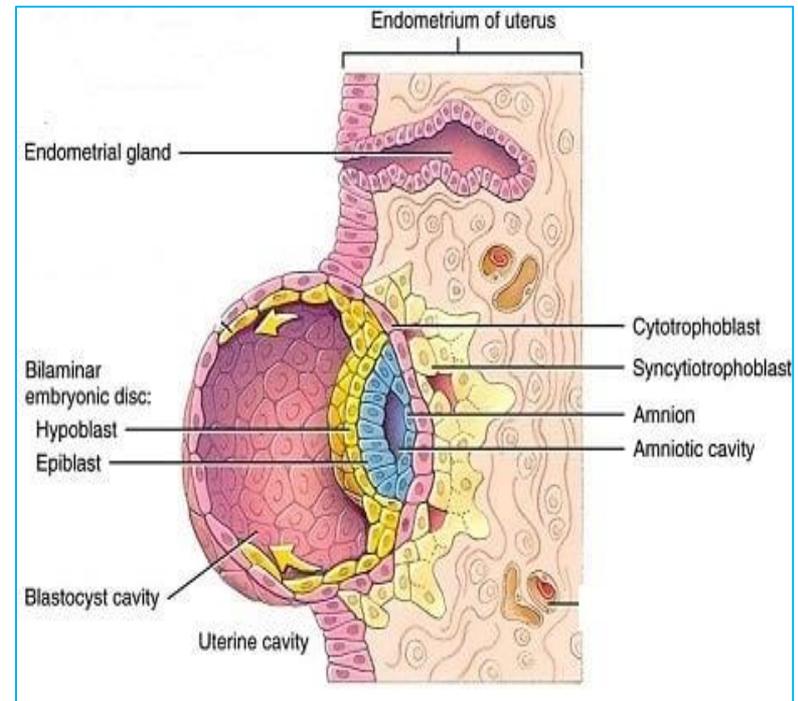
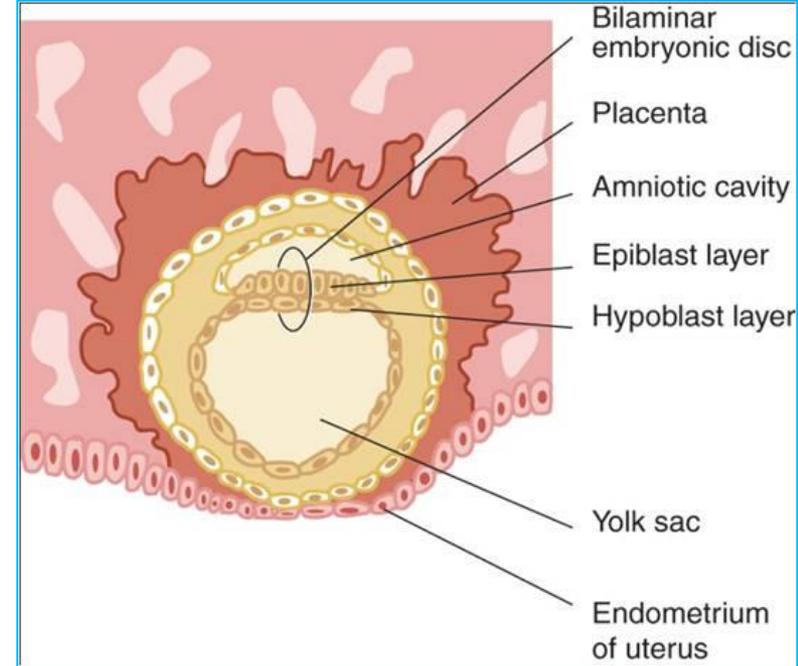
The **bilaminar disc (two-layers)** - this will give rise to all the tissues and organs of the body

The embryonic disc is formed of **two layers**: (derived from the embryoblast).

- Epiblast
- Hypoblast

Two cavities (balloons)

- primitive Yolk sac
- amniotic cavity.



By the end of 2nd week:

The embryo has the form of a flat, bilaminar disc, ovoid in shape.

Formation of two cavities:

- Amnioblasts (derived from the epiblast) separate and form the amniotic cavity.
- Cells from the hypoblast form the exocoelomic cavity or primitive yolk sac

The *prechordal plate*, formed from fusion of epiblast and hypoblast cells, is the site of the future mouth.

In a localized area of the hypoblast, form a thickened circle area, the *prechordal plate*.

2nd week of development: The week of twos_WHY?

✓ Trophoblast ↗ cytotrophoblast

↳ syncytiotrophoblast

✓ Embryoblast ↗ hypoblast

↳ epiblast

✓ Extraembryonic mesoderm ↗ somatopleure

↳ splanchnopleure

✓ Cavities ↗ amniotic

↳ primitive yolk sac

The embryonic disk 3rd week

□ During this time gastrulation takes place; this is the process by which the 3 primary germ layers are produced:

1. Ectoderm

2. Mesoderm

3. Endoderm.

□ It begins with the formation of the primitive streak within the epiblast.

➤ *Ectoderm forms neuroectoderm and neural crest cells.*

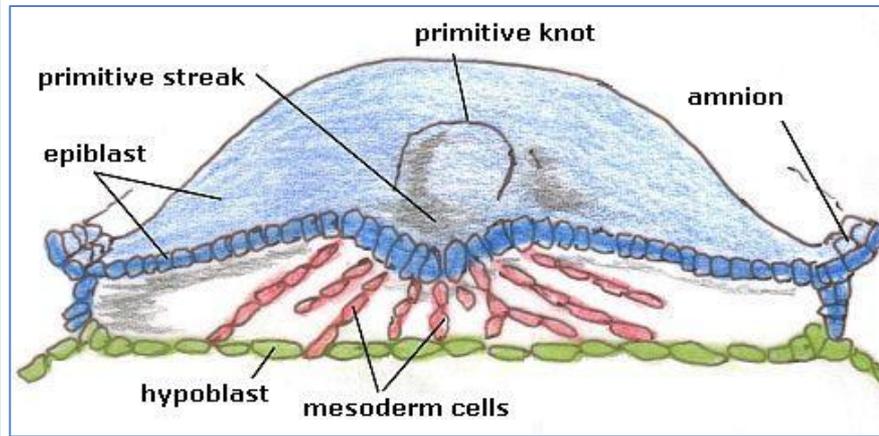
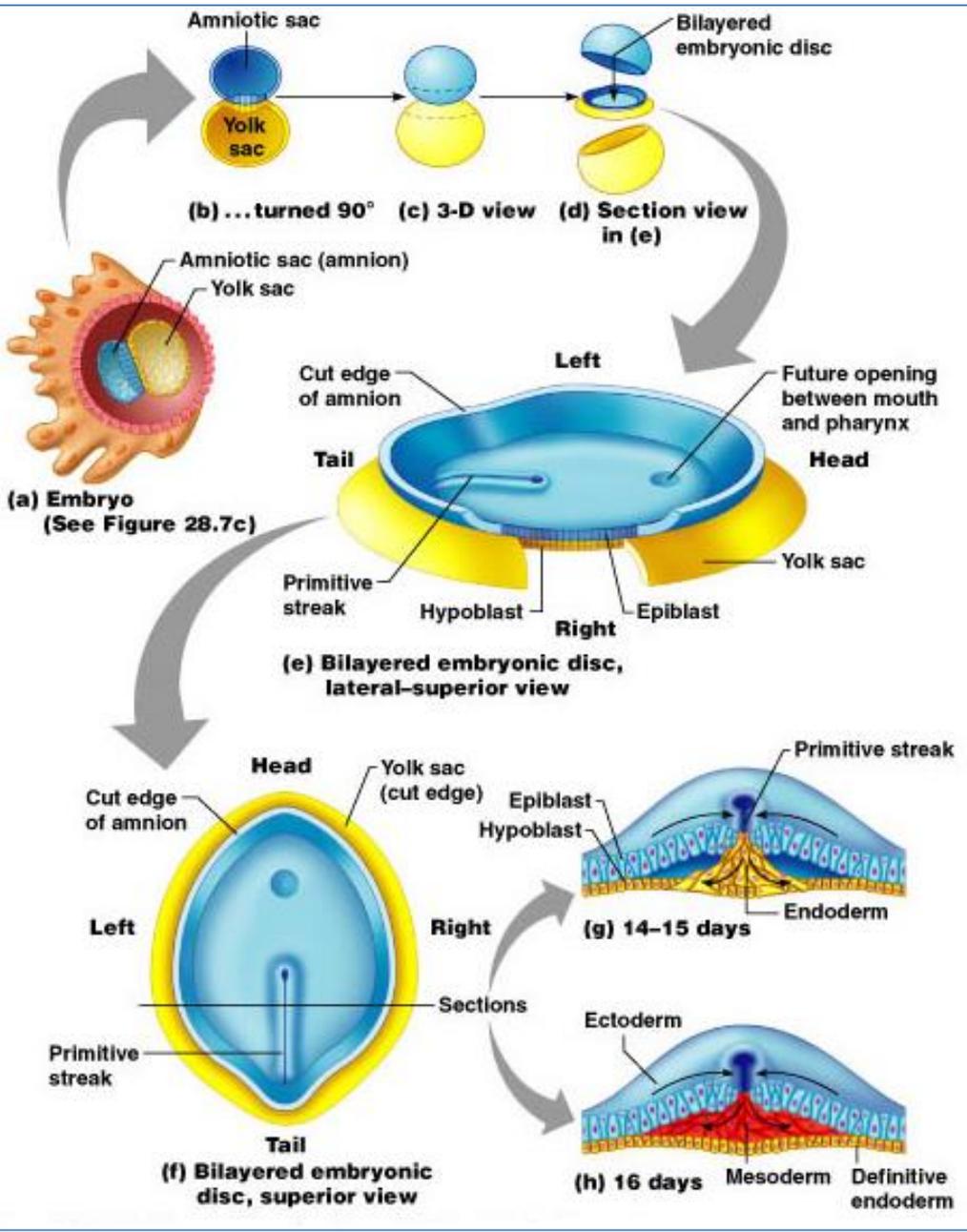
➤ *Mesoderm forms* paraxial mesoderm, intermediate mesoderm, and lateral mesoderm.

Formation of the Trilaminar Embryo

The Third Week

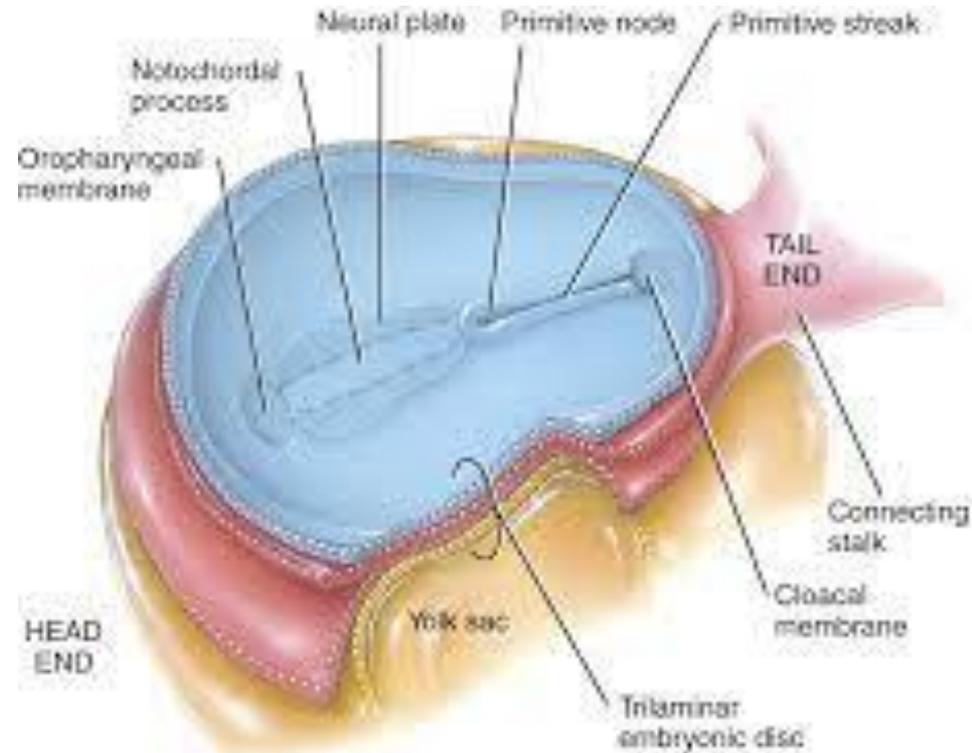
Gastrulation

- Gastrulation is the process by which the *bilaminar* embryonic disc is converted into a *trilaminar* embryonic disc.
- It begins by the 14th day and end about the 19th day.
- Daughter cells of the dividing epiblast detach themselves from the neighboring cells and *migrate* inwardly to form a loose layer called mesoblast between the epiblast and hypoblast.
- Some of these mesoblast cells spread laterally , cranially and along the middle line to form a layer between the epiblast and hypoblast known as intraembryonic mesoderm.



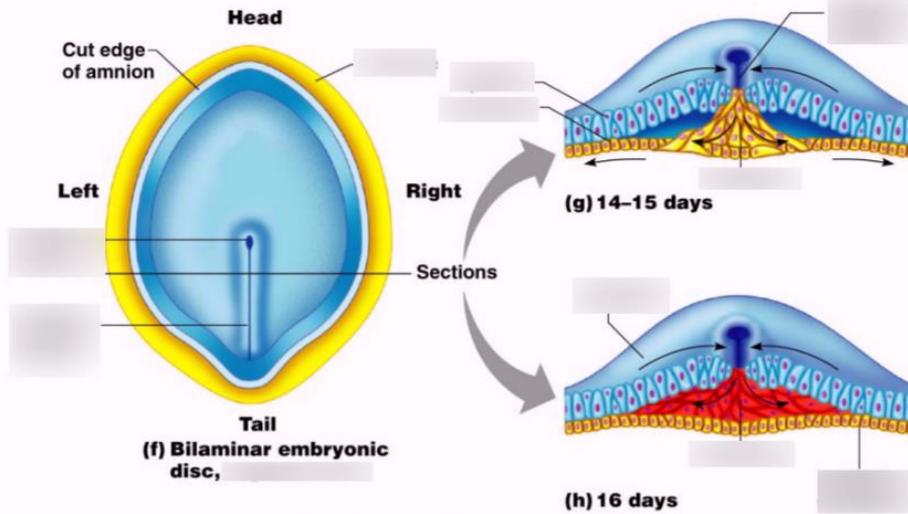
What are the embryonic changes occurring during 3rd week of intrauterine life ?

1. Formation of primitive streak , notochord
2. Gastrulation and creation of the third germ layer (intra-embryonic mesoderm) from the epiblast cells.
3. Formation of neural tube from the epiblast cells.
4. Formation of neural crest cells (N.C.C.).
5. Differentiation of intra-embryonic mesoderm (para-axial, intermediate & lateral).
6. Derivatives of all germ layers.

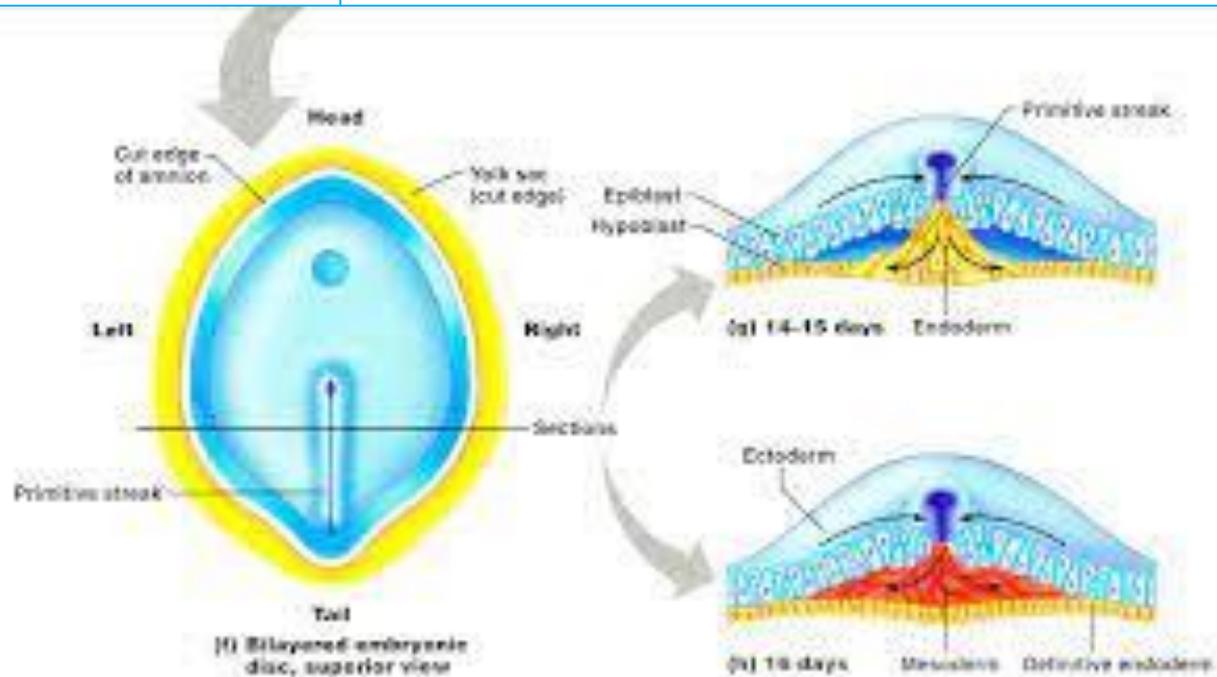


(a) Dorsal and partial sectional views of trilaminar embryonic disc, about 16 days after fertilization

Formation of Trilaminar Embryo

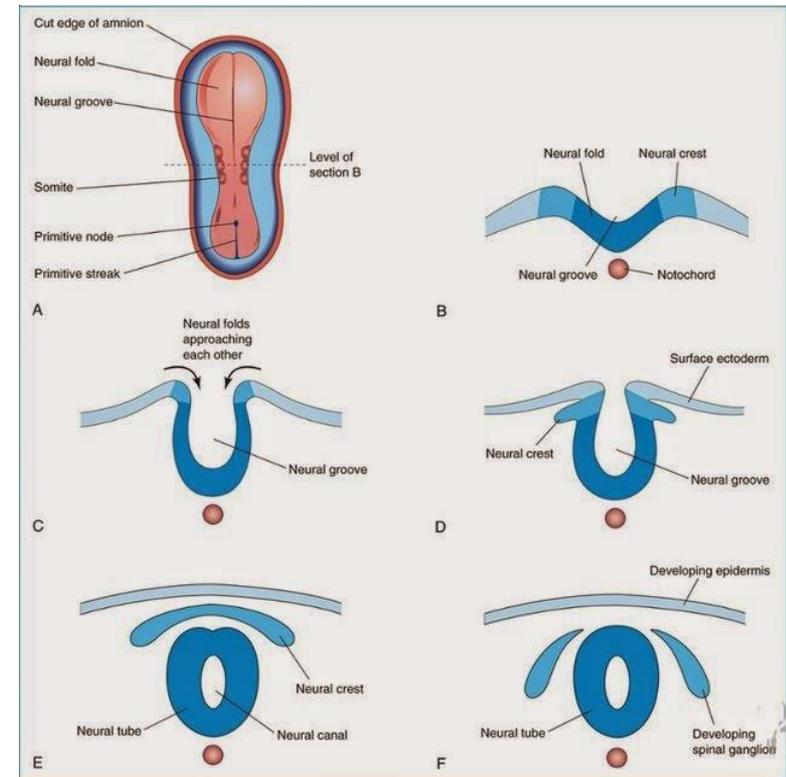
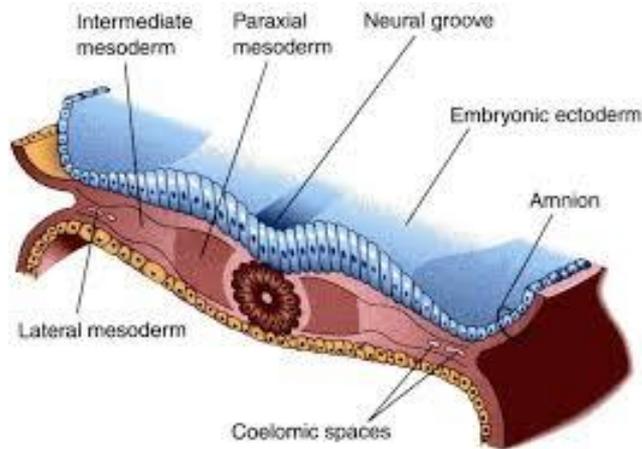


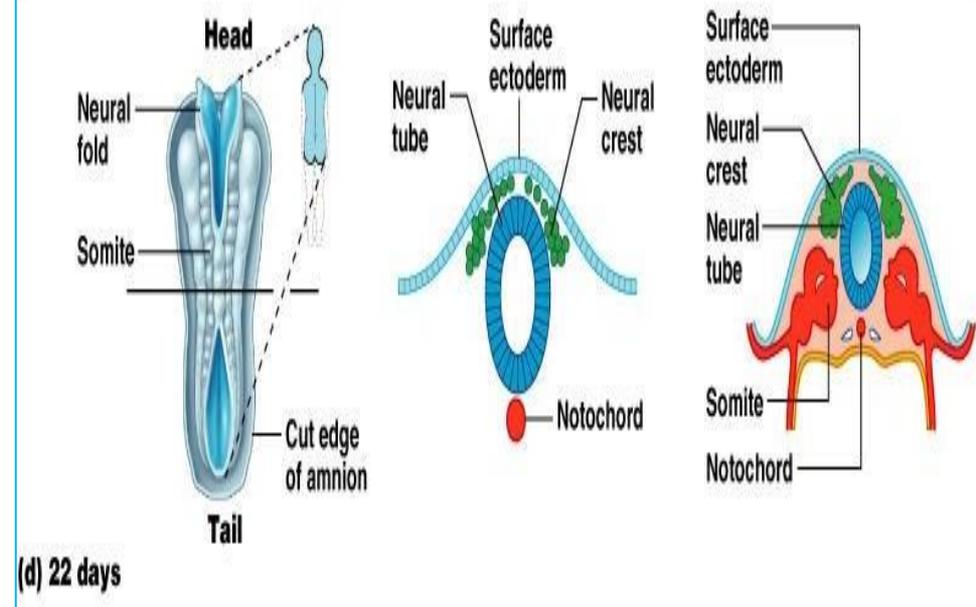
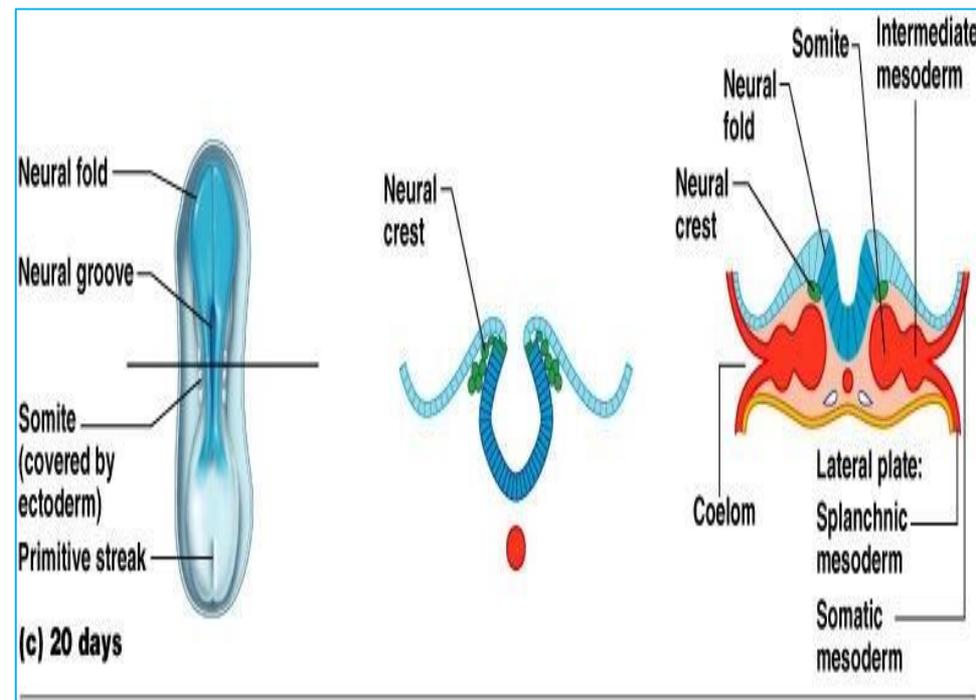
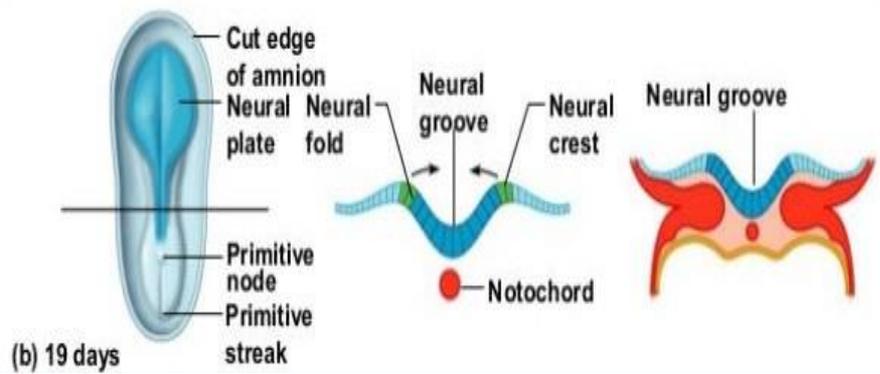
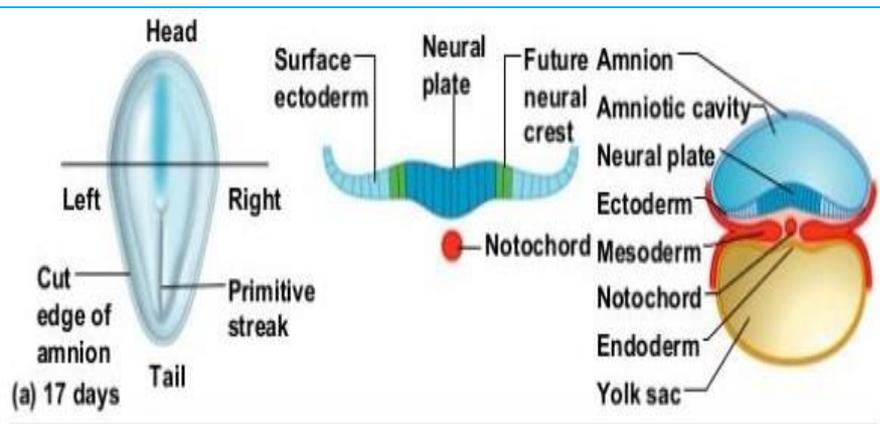
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Neurulation

- It is the formation of the neural tube.
- The cranial part of the tube forms the brain while the caudal part forms the spinal cord.





Neurulation:

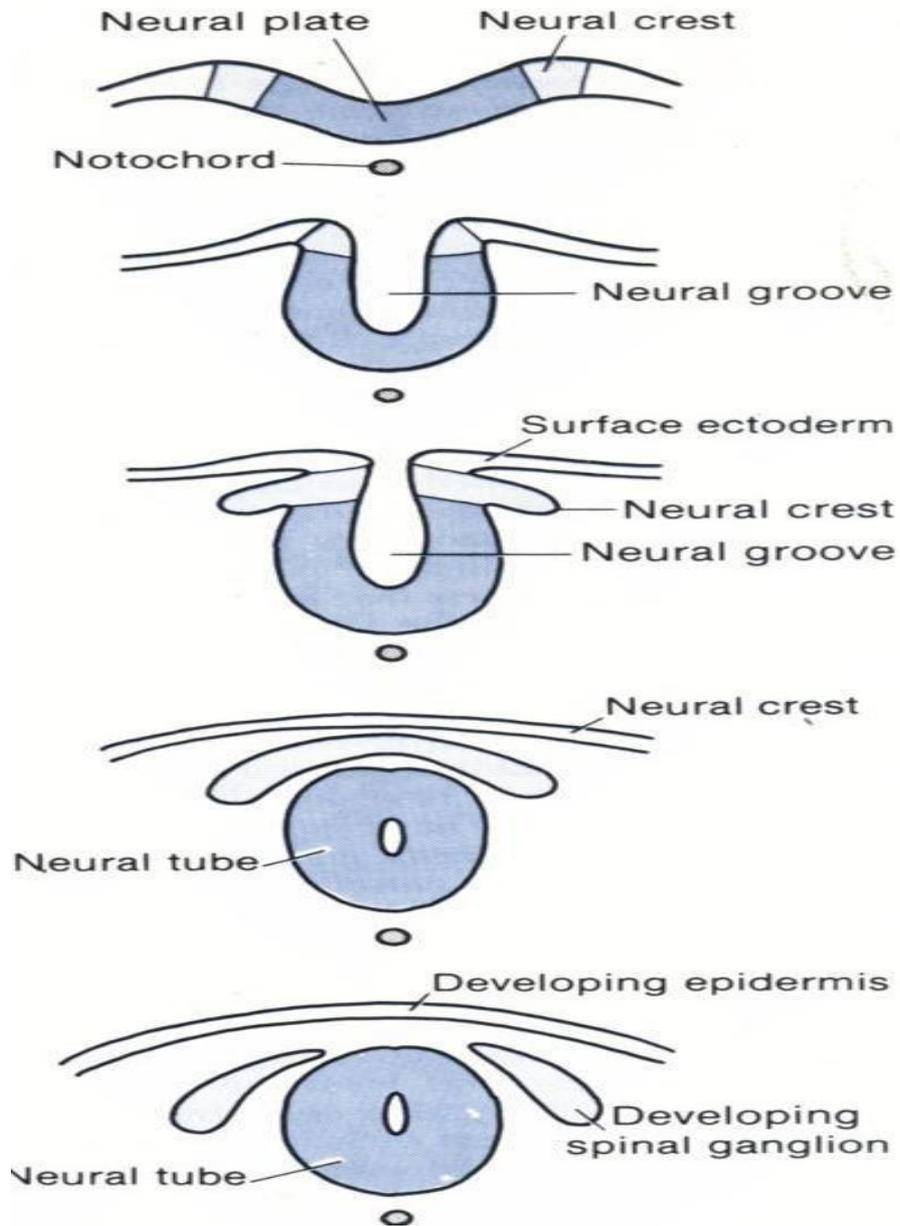
Onset of appearance: 19th day after fertilization.

Steps of Formation:

1. Overgrowth of the ectodermal cells overlying the notochord results in condensation and thickening of this part and formation of **neural plate**.
2. Raising of the edges of neural plates leads to formation of the **neural folds** and **neural groove**.
1. Fusion of the edges of the neural folds results in formation of **neural tube** that lies dorsal to the notochord.

Functions:

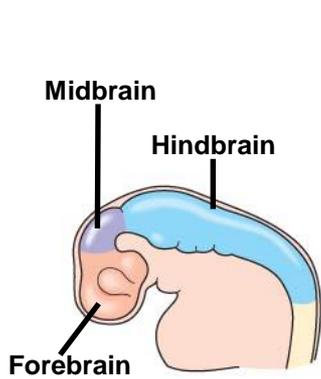
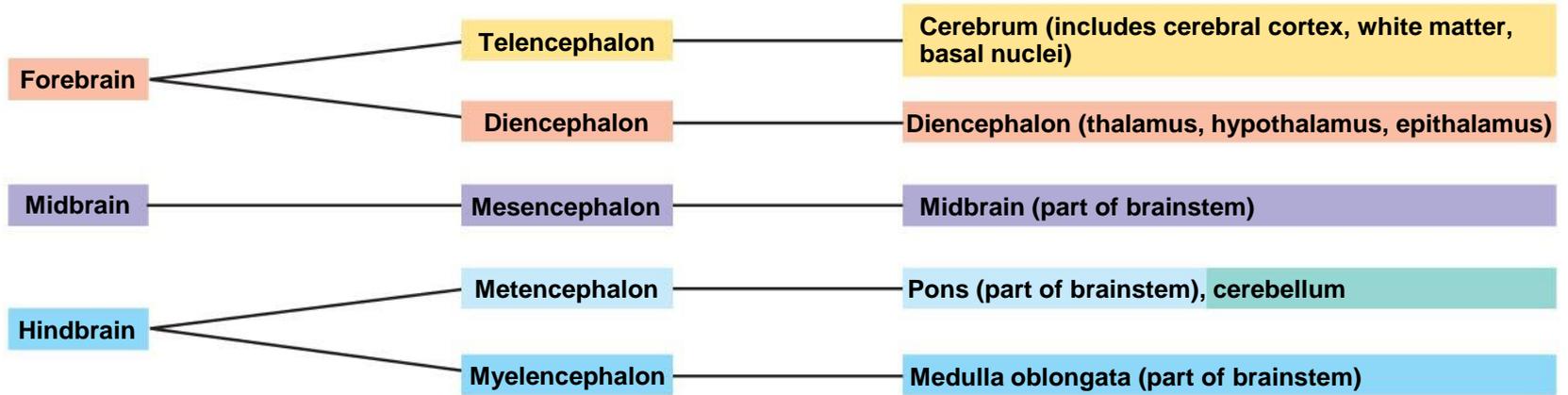
- ❖ Its cranial part forms the **brain**.
- ❖ Its caudal part forms the **spinal cord**. **Fate:**



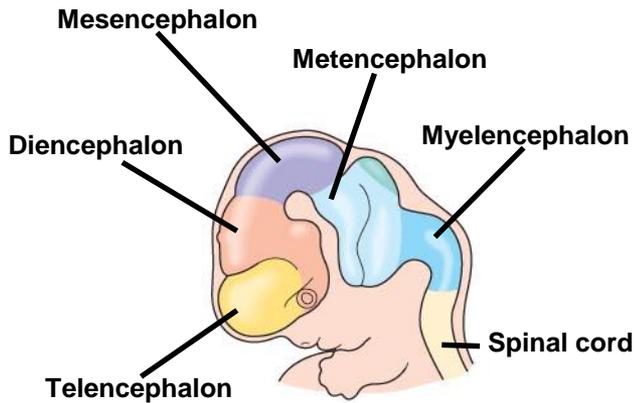
Development of human brain

- ✓ **The neural tube is at first a simple tube.**
- **Later, its cranial end shows constrictions and becomes divided into 3 vesicles:**
 - ✓ **Forebrain**
 - ✓ **midbrain**
 - ✓ **hindbrain.**
- **By the fifth week of human embryonic development, five brain regions have formed from the three embryonic vesicles.**

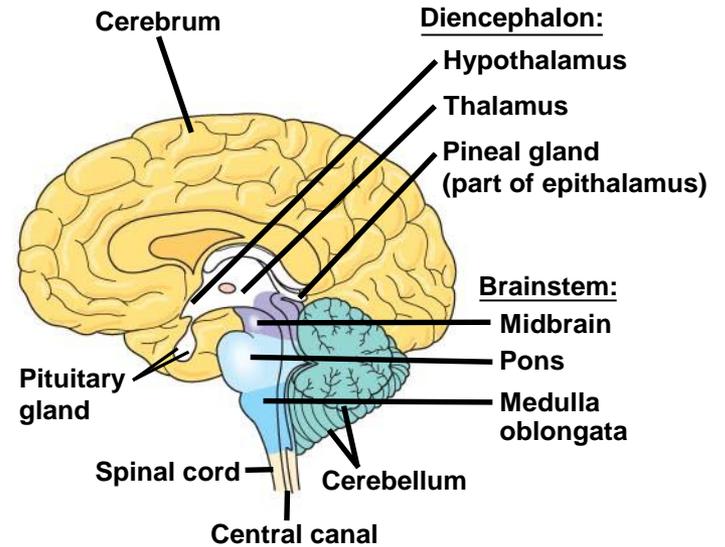
Development of the human brain



(a) Embryo at 1 month

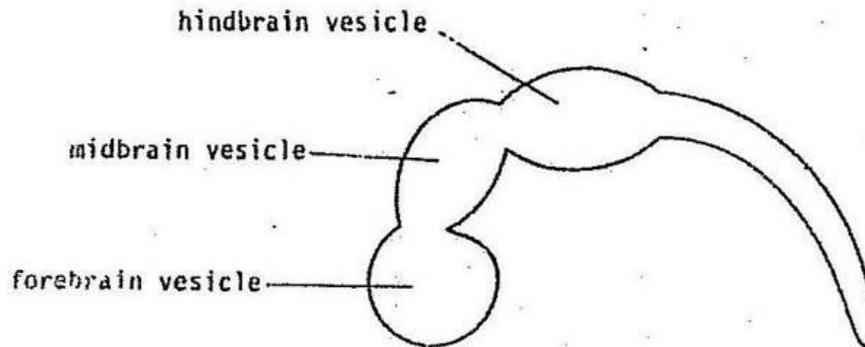
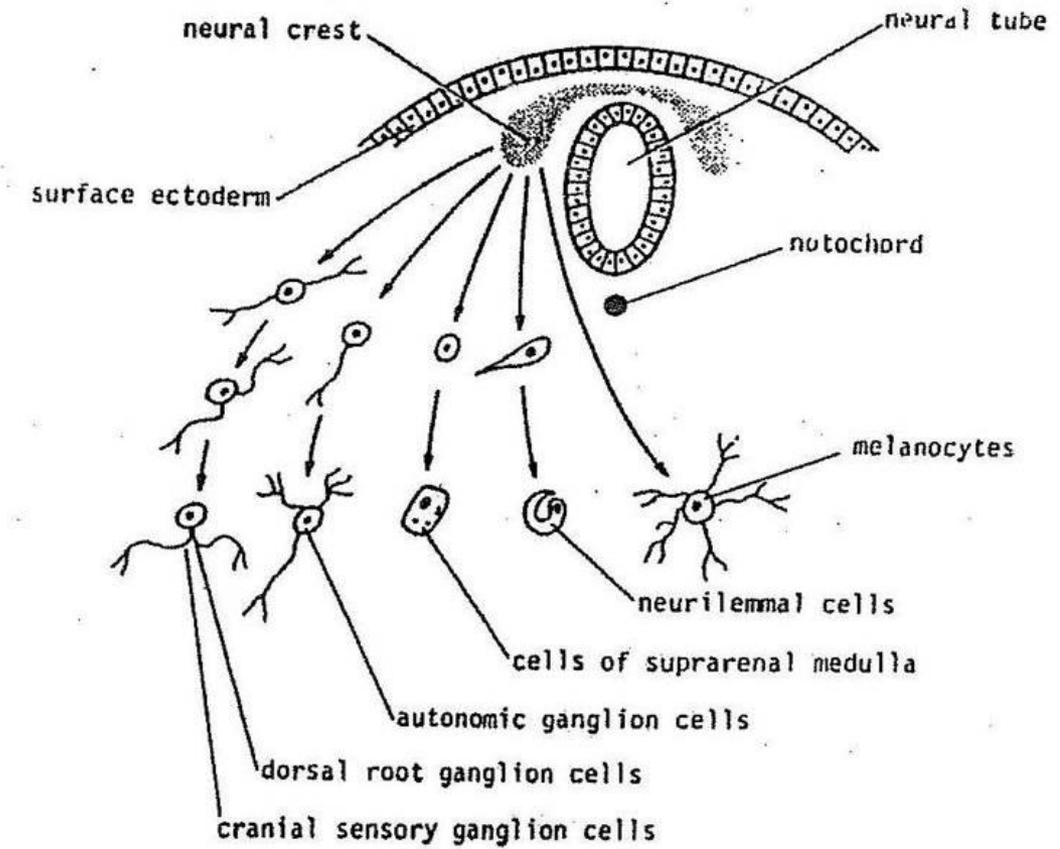


(b) Embryo at 5 weeks



(c) Adult

Derivatives of the neural crest

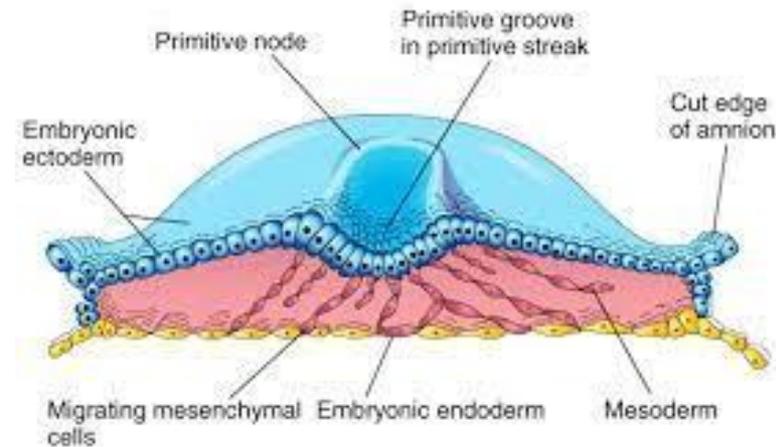


Differentiation of trilaminar germ disc (4th –8th weeks)

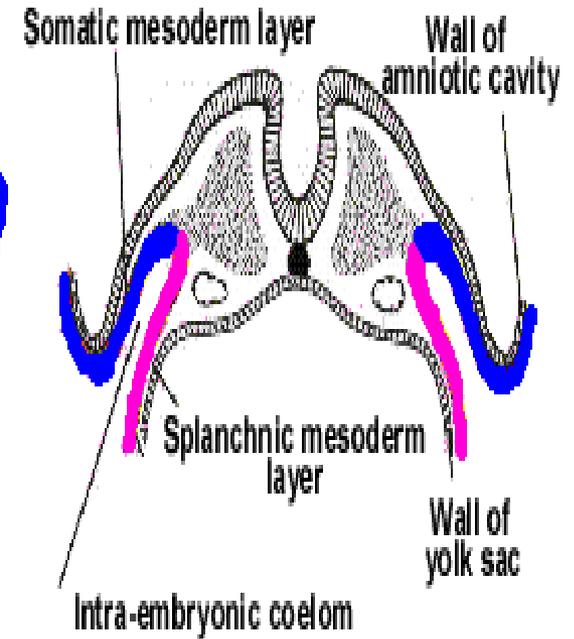
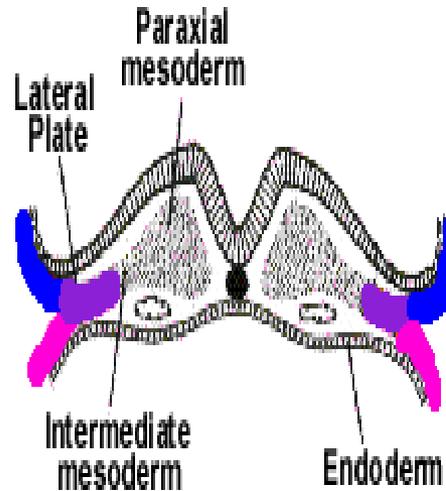
- Differentiation: same cells which are primordial and immature differentiate into different cells which have specific structure and function
- ---Induction: some tissues affect the differentiation, and determine the differentiating orientation of another tissue

• Development of 2ry mesoderm

- The secondary mesoderm is formed during 3rd week as a result of proliferation of cells of:
 - The primitive streak and
 - The primitive node



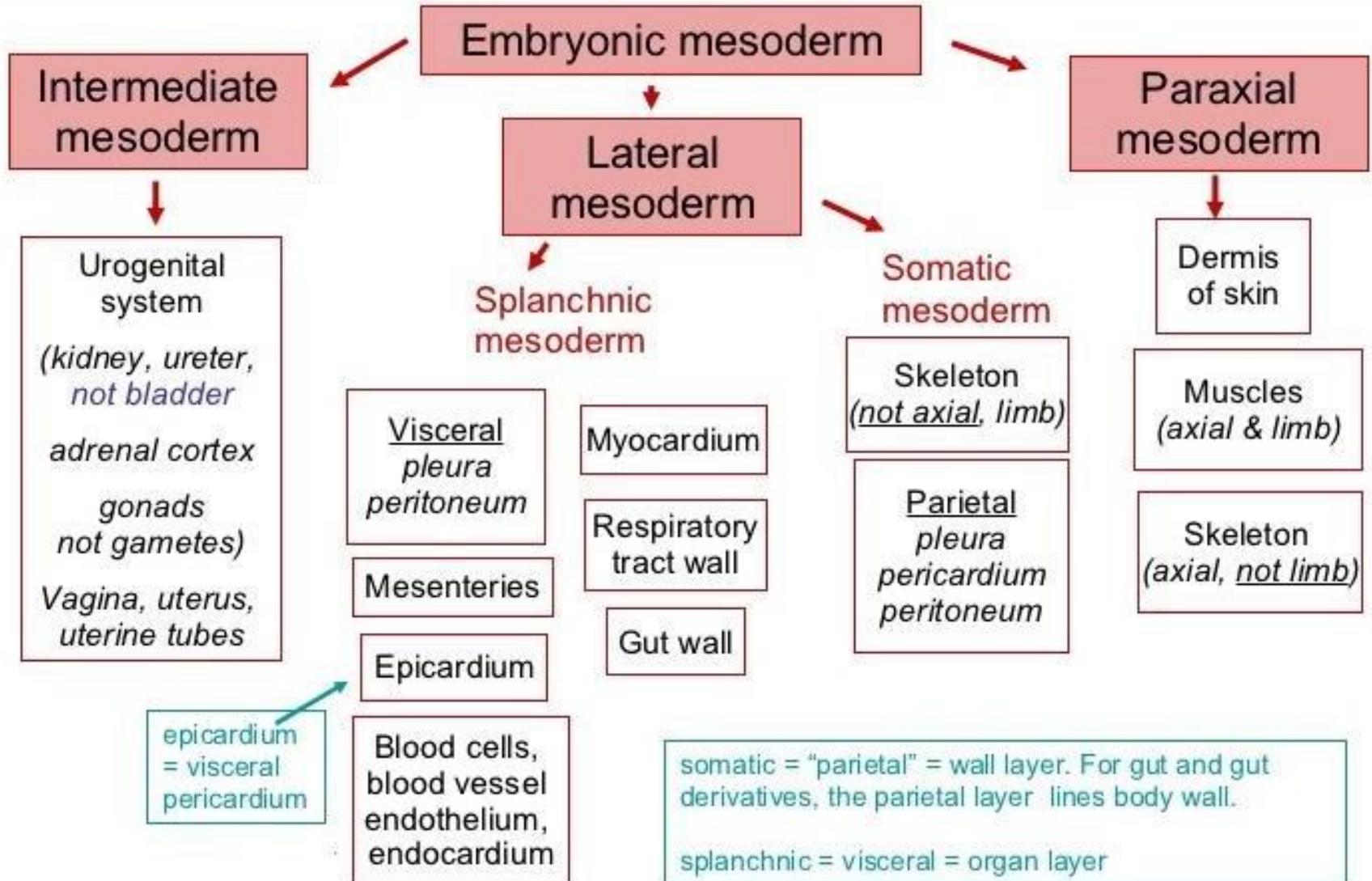
- In the 17 days embryo mesoderm appears as a sheet of loose tissue formed of several cell layers that lie between the endodermal and ectodermal germ layers.
- Two longitudinal grooves appear in the intraembryonic mesoderm, one on each side of the middle line.
- This groove divides the intraembryonic mesoderm into 3 parts:
 - Paraxial mesoderm:
 - - Lies medial to the groove parallel to the notochord.
 - Intermediate mesoderm:
 - - Also called (Intermediate cell mass or nephrogenic cord).
 - - Lies in the floor of the groove.
 - Lateral plate: Lies lateral to the groove.



Ectoderm derivatives

- The central nervous system;
- The peripheral nervous system;
- The sensory epithelium of the ear, nose and eye;
- The epidermis, hair and nails; and
- The subcutaneous, mammary and pituitary gland;
- The enamel of teeth.

Postnatal derivatives of embryonic mesoderm



Adult derivatives of the three embryonic germ layers

ECTODERM

- Epidermis of skin and its derivatives (including sweat glands, hair follicles)
- Epithelial lining of mouth and anus
- Cornea and lens of eye
- Nervous system
- Sensory receptors in epidermis
- Adrenal medulla
- Tooth enamel
- Epithelium of pineal and pituitary glands

MESODERM

- Notochord
- Skeletal system
- Muscular system
- Muscular layer of stomach and intestine
- Excretory system
- Circulatory and lymphatic systems
- Reproductive system (except germ cells)
- Dermis of skin
- Lining of body cavity
- Adrenal cortex

ENDODERM

- Epithelial lining of digestive tract
- Epithelial lining of respiratory system
- Lining of urethra, urinary bladder, and reproductive system
- Liver
- Pancreas
- Thymus
- Thyroid and parathyroid glands

Embryonic period

- Extension:

From the 4th to the 8th week of pregnancy.

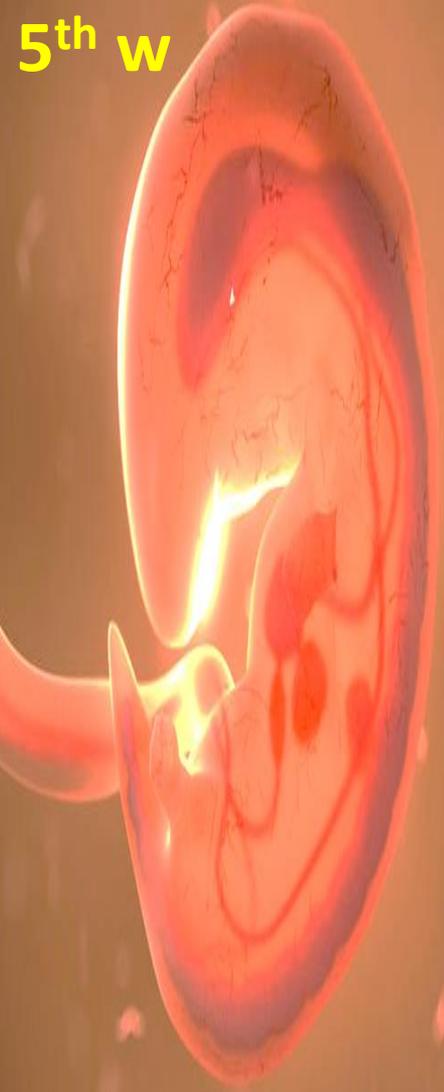
- During this 5 weeks all the major external and internal structures of the human embryo develop (it is the period of embryogenesis or organogenesis).
- As the organs develop ,the shape of the embryo changes due to folding of the embryonic disc.
- Exposure of the embryo to any teratogens or irradiations during this period may cause major congenital malformations.

Embryonic period

4th w



5th w



6th w

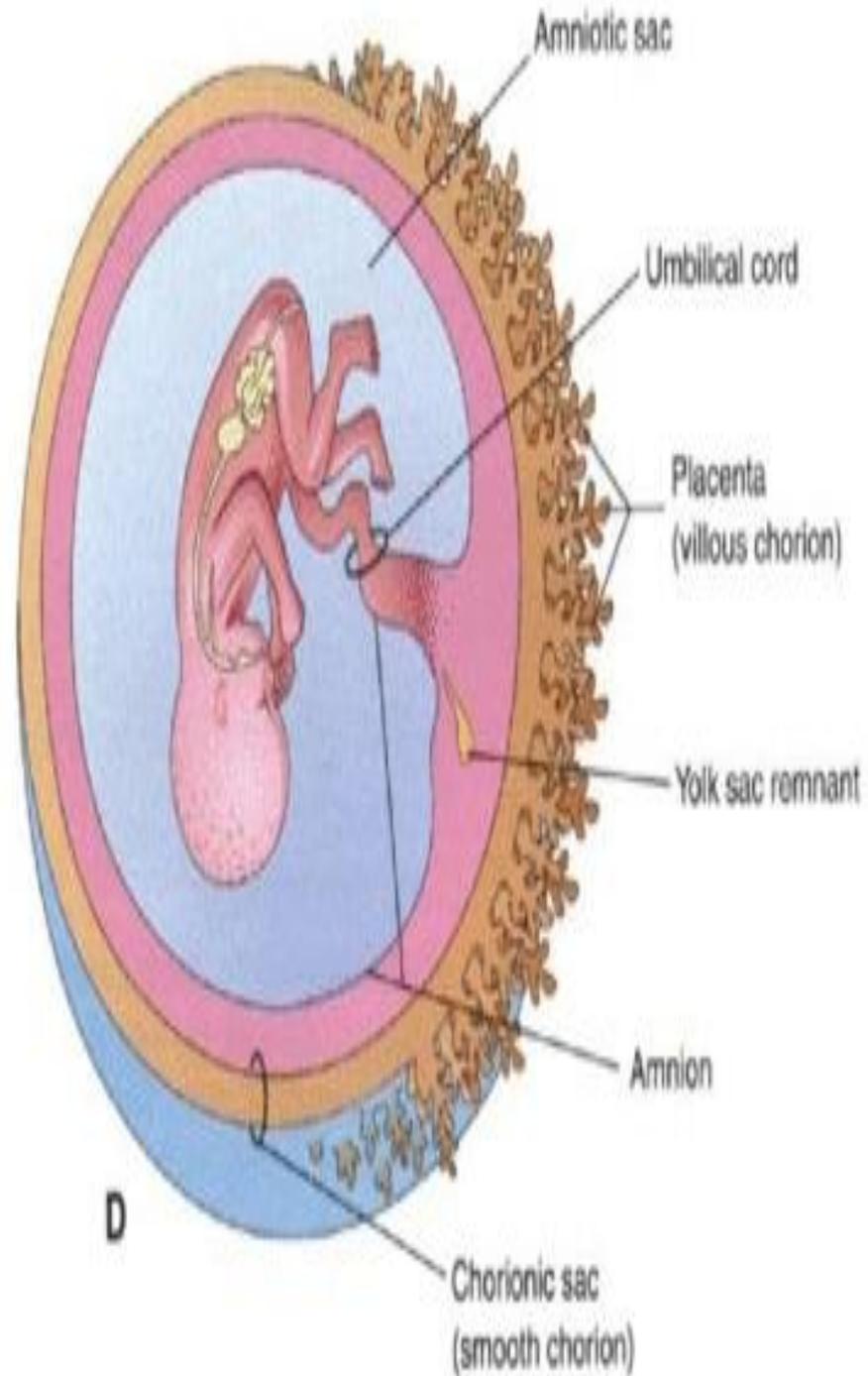
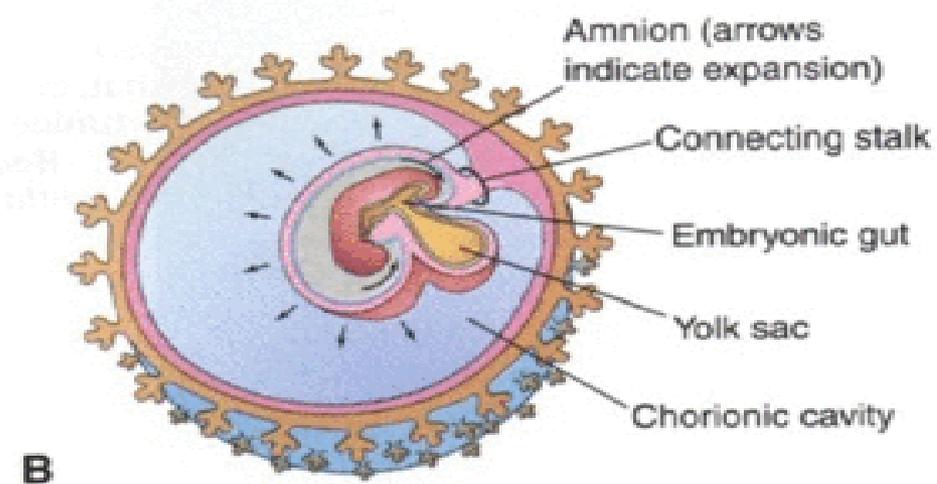
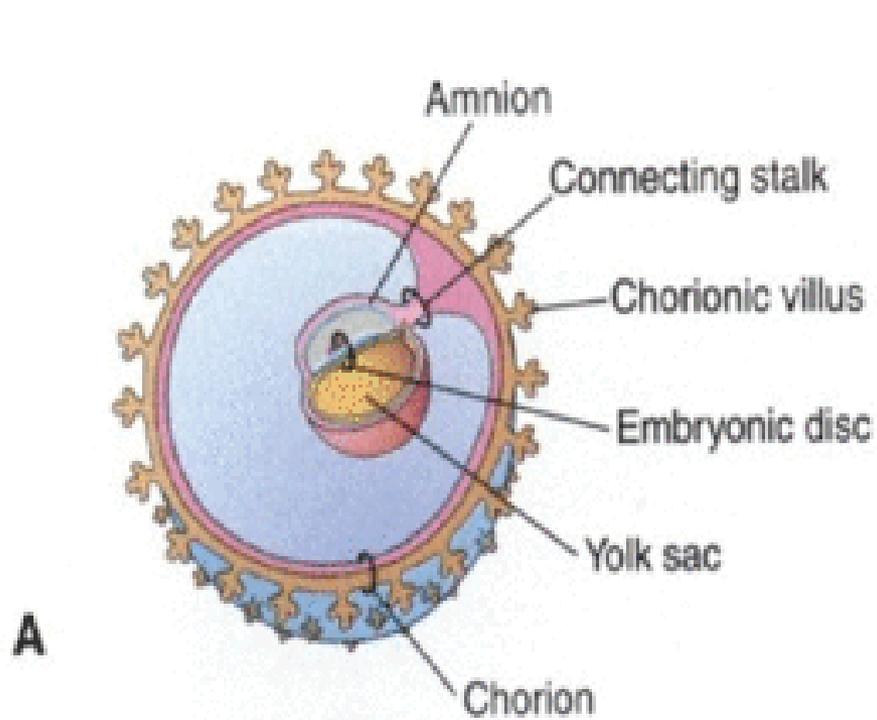


8th w



Amniote ExtraEmbryonic Membranes (Fetal Membranes)

- During amniote development, four **extraembryonic membranes** form around the embryo:
 - **The chorion** *outermost membrane* / functions in gas exchange. Shares in formation of placenta.
 - **The amnion** encloses the *amniotic fluid*. *Surrounds the developing foetus*.
 - **The yolk sac** encloses the yolk. Shares in formation of gut.
 - **The allantois** A sac of endoderm and mesoderm which form a constituent of the umbilical cord. **Its functions are:**
 - ✓ Blood formation occurs in its wall during the 3rd to 5th week.
 - ✓ The allantoic vessels will become the umbilical vessels.



- Changes occur in the mother:
 - Growth of the placenta
 - Cessation of ovulation and the menstrual cycle
 - Breast enlargement
 - Nausea is also very common.

Human fetal development



(a) 5 weeks



(b) 14 weeks



(c) 20 weeks



(a) 5 weeks



(b) 14 weeks



(c) 20 weeks

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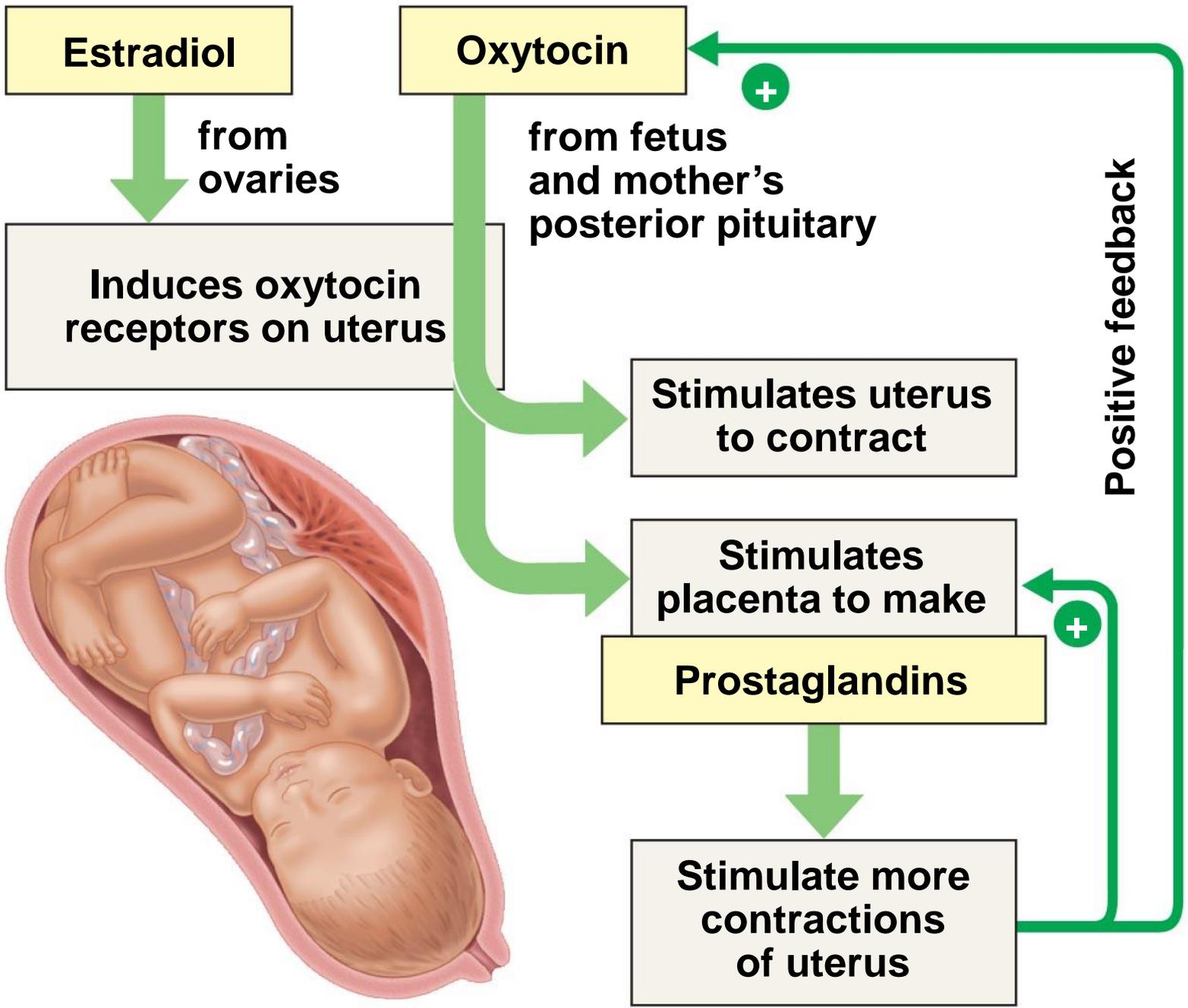
Second Trimester

- During the second trimester:
 - The fetus grows and is very active
 - The mother may feel fetal movements
 - The uterus grows enough for the pregnancy to become obvious.

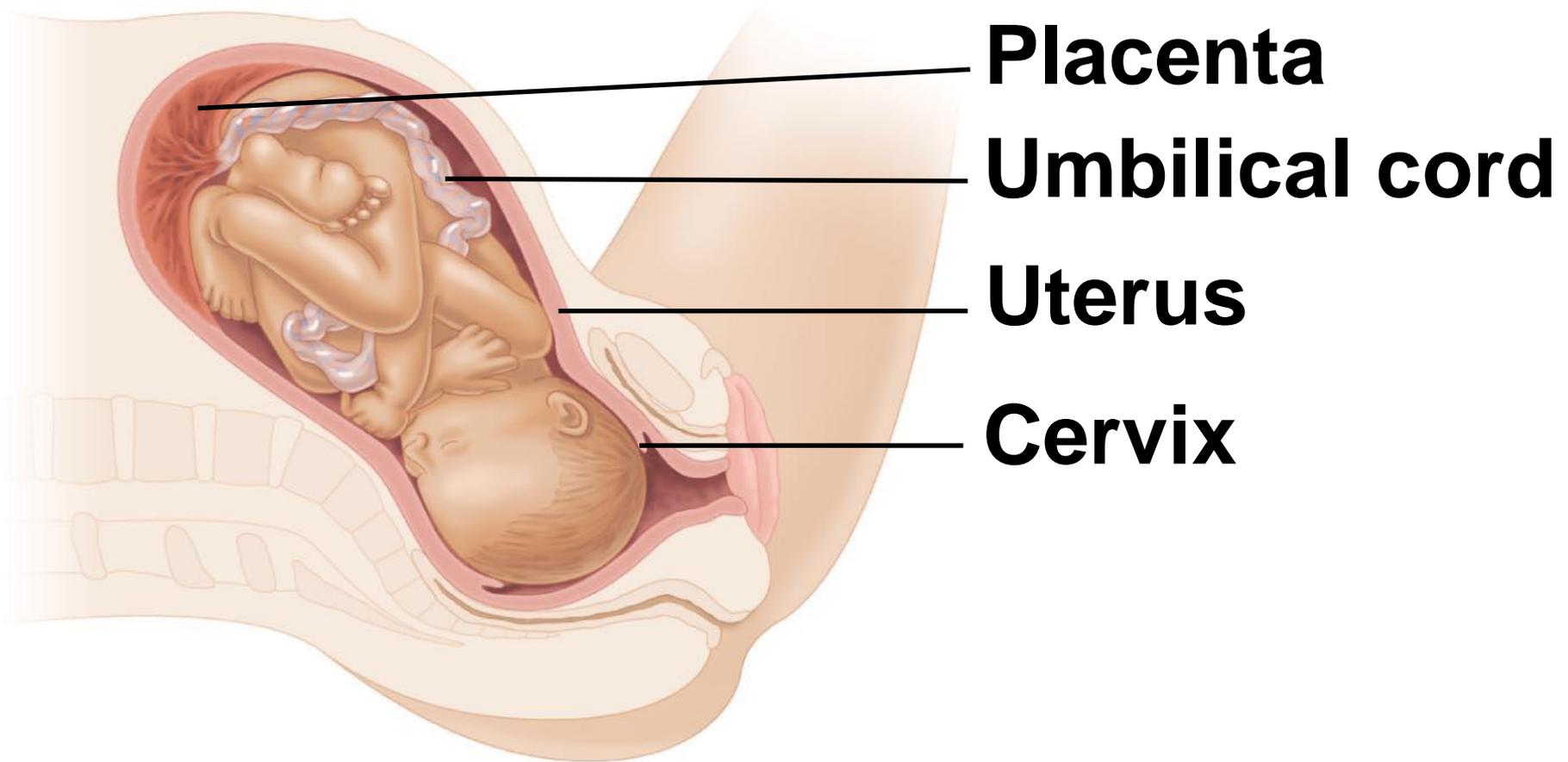
Third Trimester

- During the third trimester, the fetus grows and fills the space within the embryonic membranes.
- A complex interplay of local regulators and hormones induces and regulates **labor**, the process by which childbirth occurs.

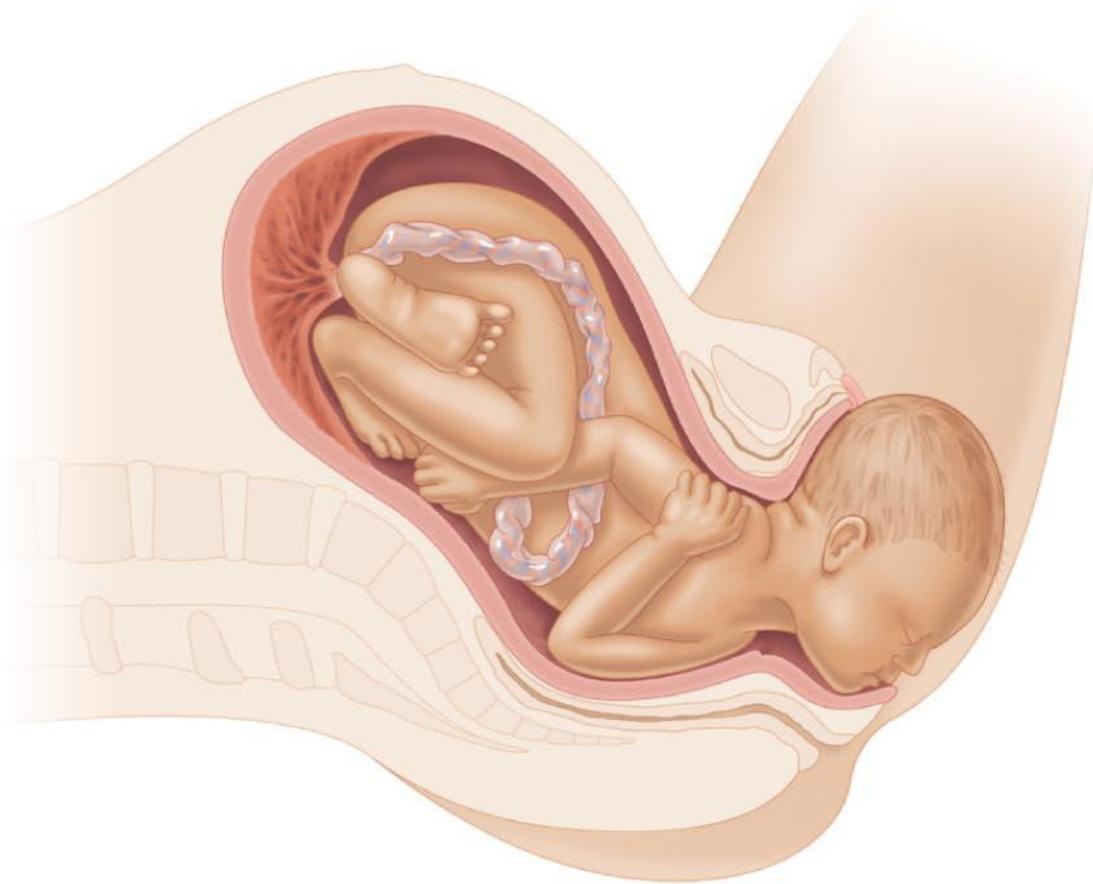
Labor



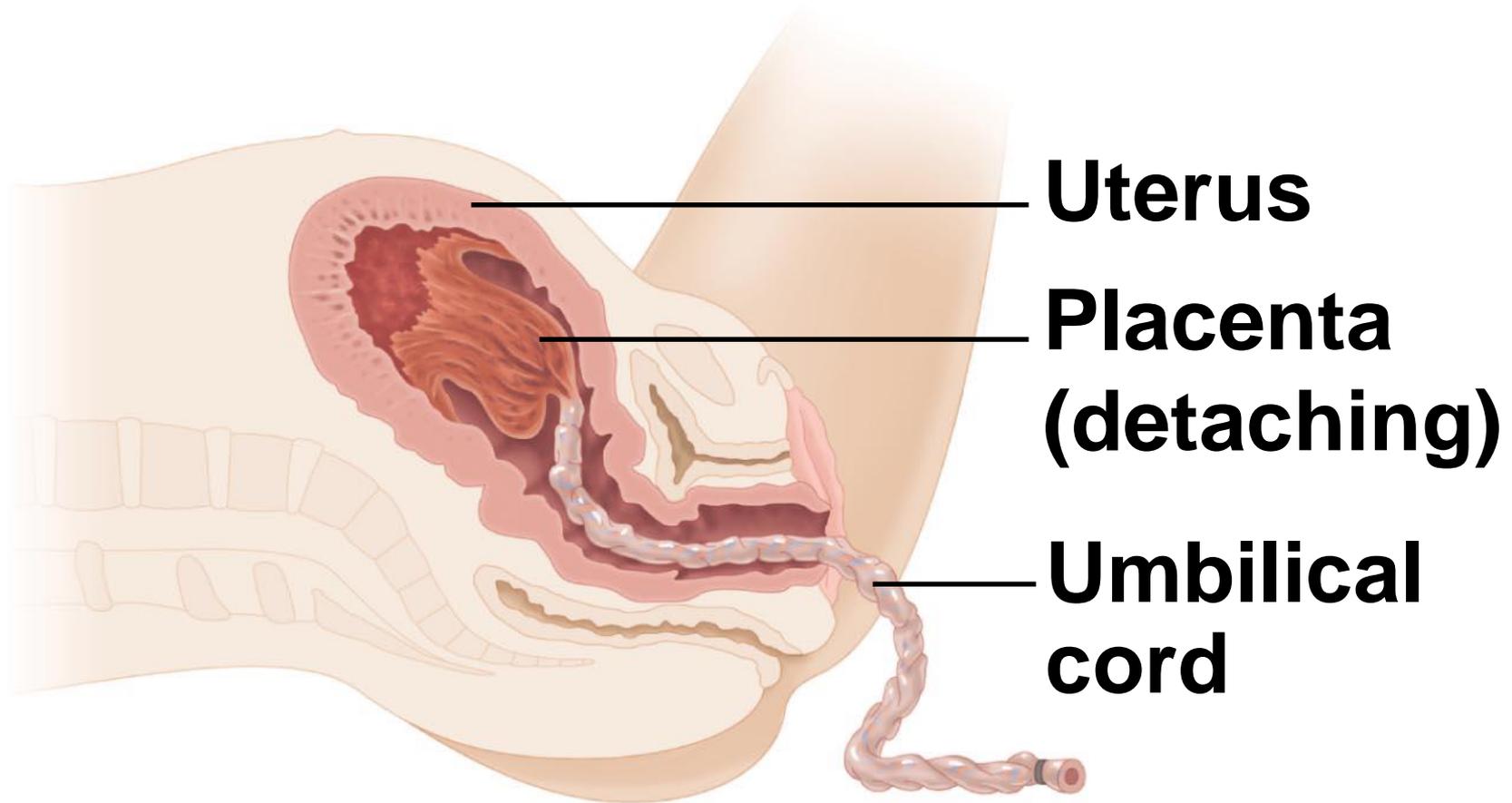
The three stages of labor



1 Dilatation of the cervix

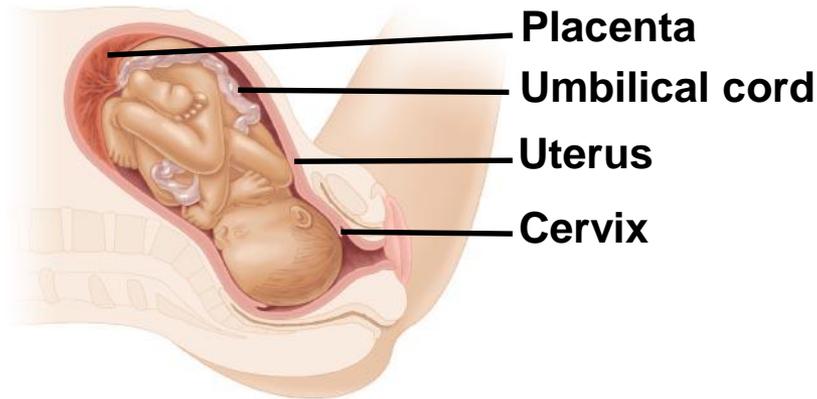


2 Expulsion: delivery of the infant



3 Delivery of the placenta

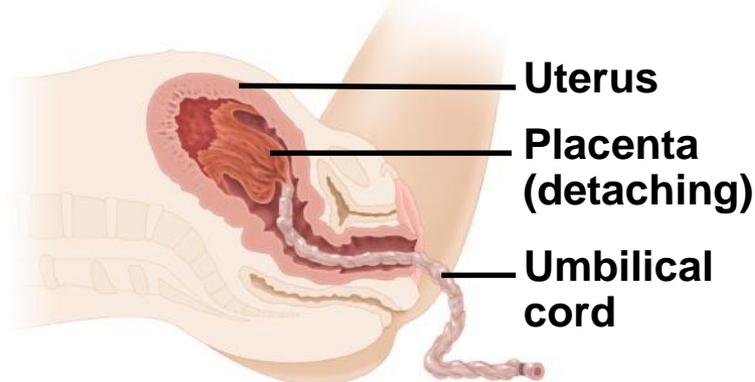
The three stages of labor



1 Dilation of the cervix



2 Expulsion: delivery of the infant



3 Delivery of the placenta

- **Birth**, or **parturition**, is brought about by a series of strong, **rhythmic uterine contractions**.
- First the baby is delivered, and then the placenta.
- **Lactation** = **the production of milk**. This is unique to mammals.



Thank You