GENERAL EMBRYOLOGY

1ST WEEK OF DEVELOPMENT

FERTILIZATION

CLEAVAGE.

IMPLANTATION.

PLACENTA

BY
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OBJECTIVES

Cell Division – Mitosis & Meiosis
Gamatogenesis – spermatogenesis & Oogenesis
Female Sexual cycle
Ovarian cycle & Ovulation.
Endometrial cycle
Fertilization.
Zygote – Cleavage – Morula – Blastocyst - Trophoblast - Embryoblast.
Implantation.
Formation of germ disc
Placenta

- Embryology covers all stages of development from conception till the birth of fetus i.e. a period of approximately 37 weeks of intra uterine life.
  - It is divided into pre natal & post natal period.
  - Pre natal period i.e. the time before the birth is also called" intra uterine period". Pre natal period divided into following periods-
  - 1. Pre embryonic-from 14th day of menstrual cycle—end of 2 weeks.
  - 2. Embryonic period—first 2 months, from 2 weeks till 8 weeks of pregnancy.
  - 3. Fetal period- from 9th week till birth.

    Post natal period is divided into--
  - 1. Neonatal period- first 1 month after birth.
  - 2. Infancy- from 1 month till 1 year of life.
  - 3. Childhood or Paediatric period-from 1year till 12 years.
  - 4. Puberty—till puberty is attained, approximately 12-16 years
  - 4. Adolescence—3-4 years after puberty.
  - 5. Adulthood–18-20 years.

Gametes

- They are highly specialized sex cells which when they unite with each other produce zygote.
- Sperm is the male gamet.
- Oocyte is the female gamet.
- Sperm is formed in male gonad called testis.
- Oocyte is formed in female gonad called ovary.

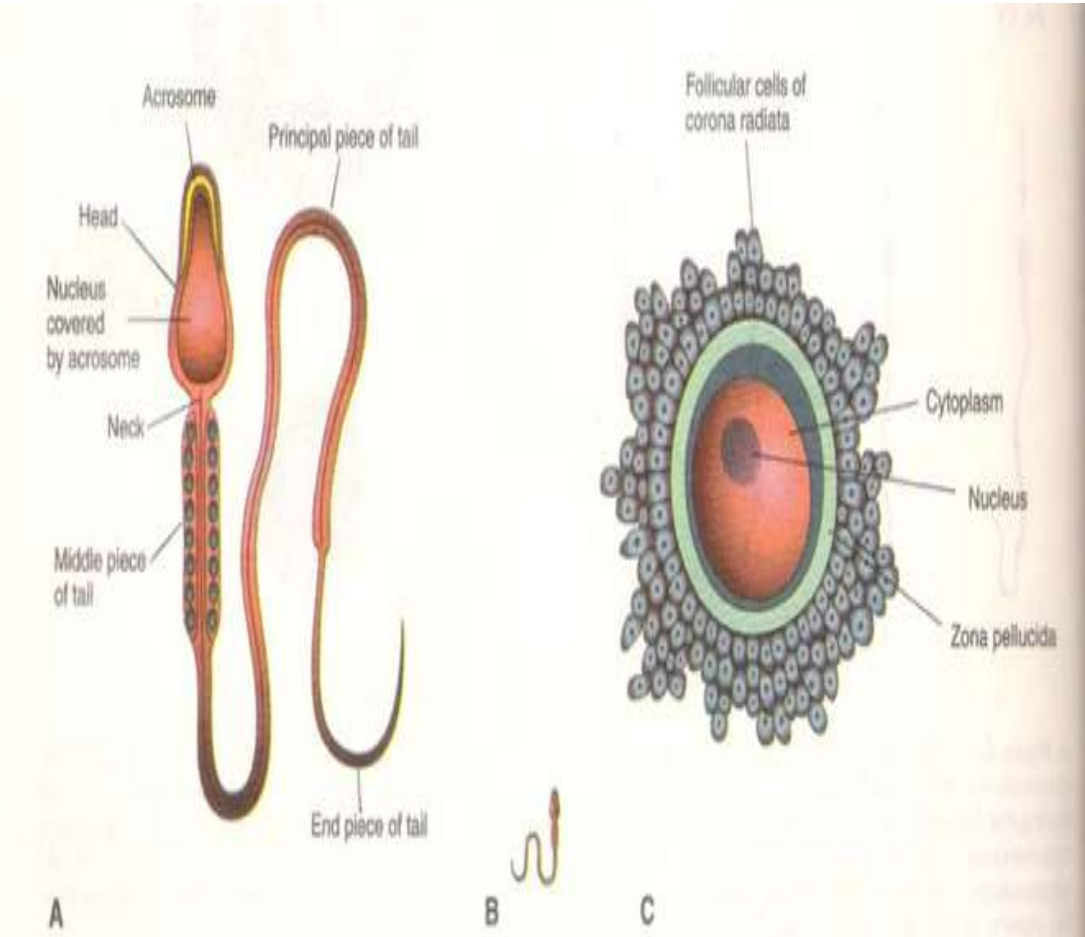


Figure 2–5. Male and female gametes (sex cells). *A*, Drawing showing the main parts of a human sperm (×1250). The head, composed mostly of the nucleus, is partly covered by the caplike acrosome, an organelle containing enzymes. The tail of the sperm consists of three regions: the middle piece, principal piece, and end piece. *B*, A sperm drawn to about the same scale as the oocyte. *C*, Drawing of a human secondary oocyte or ovum (×200), surrounded by the zona pellucida and corona radiata.

Mitosis & Meiosis

- Mitosis is the process by which cell nucleus divides to produce 2 daughter cells nuclei containing identical sets of chromosomes to the parent cells.
- Phases of mitosis
  - Prophase
  - Metaphase
  - Anaphase
  - Telophase

Meiosis is a form of nuclear division in which the chromosome number is halved from being diploid number (2n) to the haploid number(n).

Gametogenesis

- - Formation of male & female gametes from the primitive germ cells. It includes spermatogenesis & oogenesis.
- The process of sperm formation is called **spermatogenesis.**
- The process of oocyte formation is called **oogenesis.**
- Spermatogenesis & oogenesis together is called **gametogenesis.**

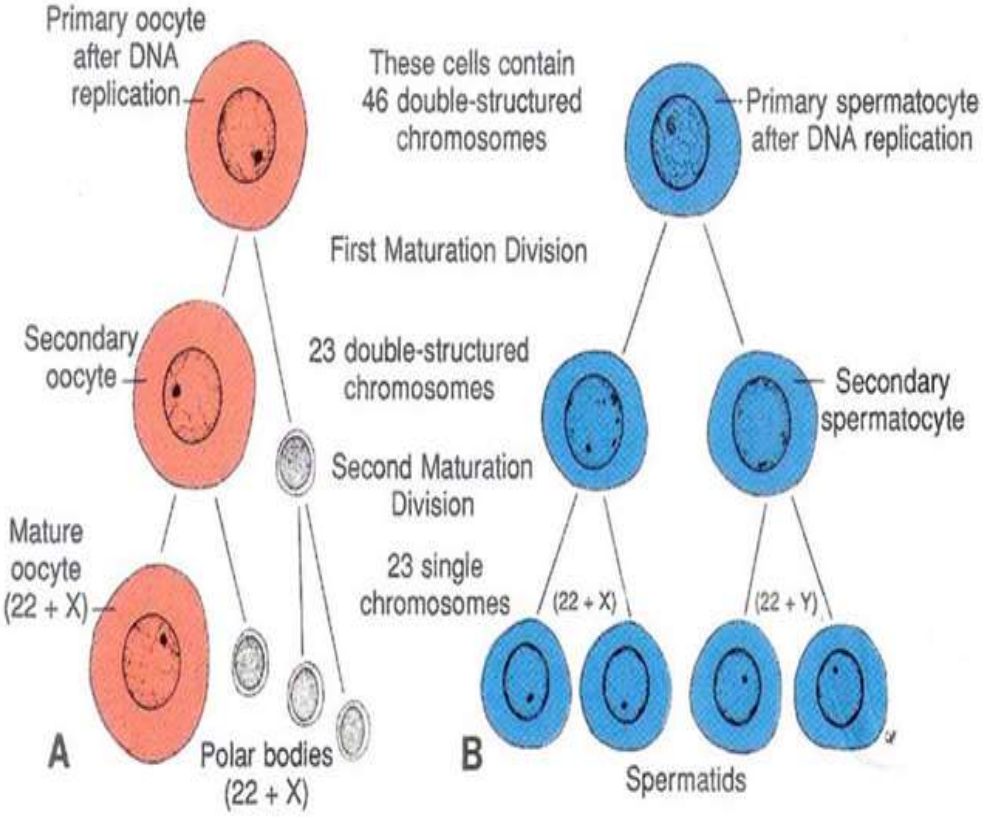


Figure 1.4. Events occurring during the first and second maturation divisions. **A.** The primitive female germ cell (primary oocyte) produces only one mature gamete, the mature oocyte. **B.** The primitive male germ cell (primary spermatocyte) produces four spermatids, all of which develop into spermatozoa.

Spermatogenesis – is the process of formation of spermatozoa from the primitive germ cells (spermatogonia).

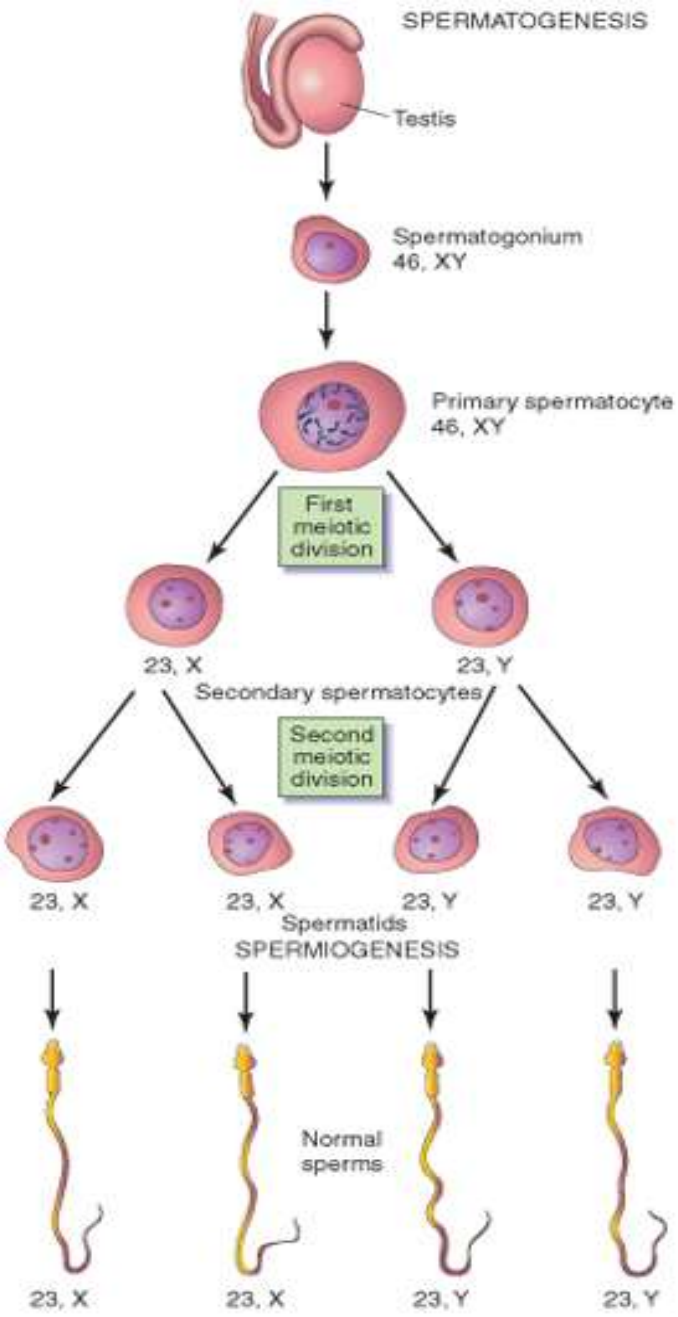
It takes place in the seminiferous tubules of testes.

It is controlled by testosterone.

It begins at puberty & continues up to the old age.

Duration – 64 days.

End result of spermatogenesis – in one cycle 4 motile sperms are formed from one primary spermatocyte which posses haploid no. of chromosomes.



Oogenesis – is a process of formation of ova from the primitive germ cells.

It takes place in the ovary & fallopian tube.

It begins in the intrauterine life & continues till menopause.

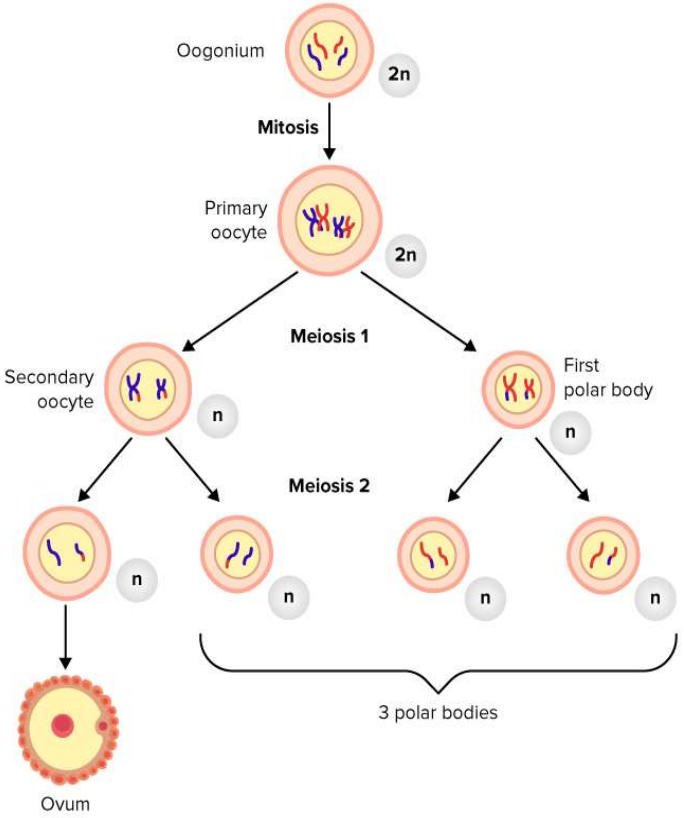
It takes 12-60 years to complete one cycle of oogenesis.

The cells present in the cortex of ovary are called oogenia. All oogenia are produced before birth.

The oogenia enlarge to form the primary oocyte.

Primary oocyte divides by first mitotic division into secondary oocyte & first polar body.

The secondary oocyte divides into ovum & secondary polar body.



Female sexual cycle

It is divided into 3 periods.

Birth to puberty- occurs between 12-14 yrs of age.

Puberty to menopause – occurs from 14-50 yrs of age.

Postmenopausal period – after 50yrs to rest of the life.

After puberty the female sexual cycle starts with repeats every 28 days.

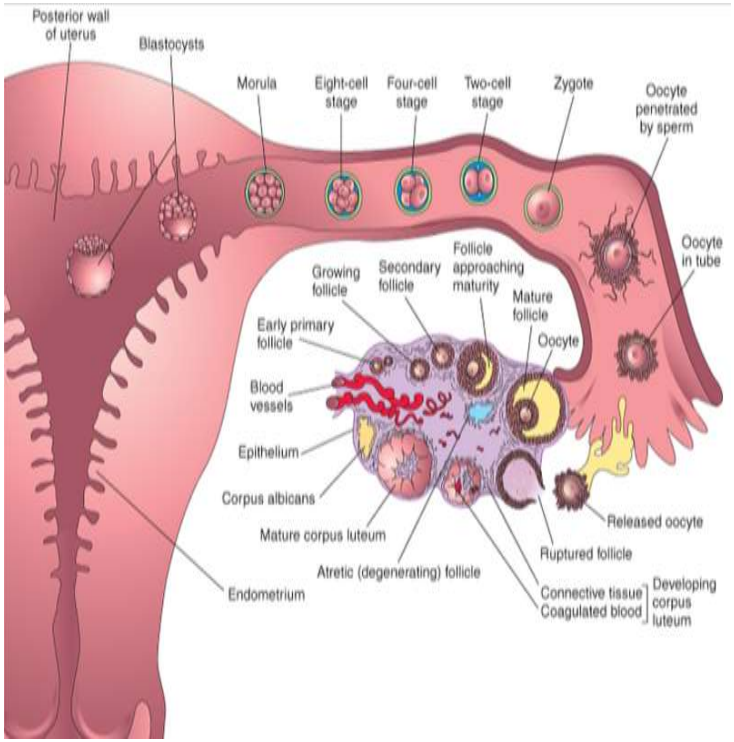
The occurrence of 1st menstrual cycle is called menarche.

The permanent stoppage of menstrual cycle is called menopause, which occurs at the age of 45-50 yrs.

The period between menarche to the menopause is called reproductive period.

Ovarian cycle.

- The ovarian cycle refers to the series of changes in the ovary during which the follicle matures, the ovum is shed, and the corpus luteum develops.
- Hypothalamus and pituitary gland control the ovarian cycle.
- Hypothalamus, control the pituitary gland .
- Pituitary gland releases the gonadotropins, follicle-stimulating hormone (FSH), and luteinizing hormone (LH).
- Follicles are stimulated to grow by FSH and to mature by FSH and LH.
- Primordial ,primary. secondary, preovualtory grraafian follicle.
- Ovulation occurs when concentrations of LH surge (flow) to high levels. LH also promotes development of the corpus luteum.



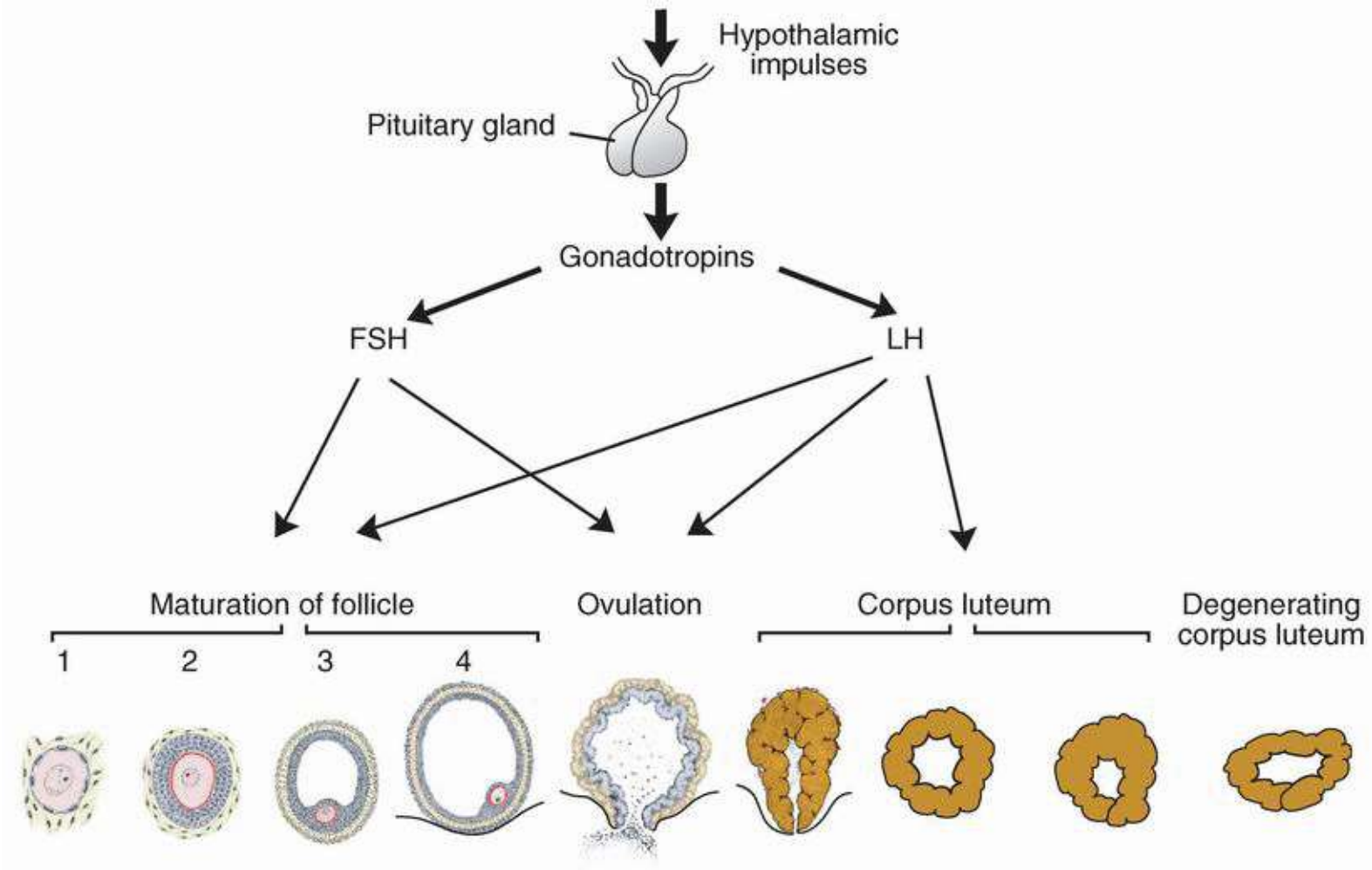
The no. of germs cells

- In intrauterine life there are 7 million germ cells.
- At birth there are 1 million oogenia.
- At puberty there are 40,000 oocyte.
- The women sheds about 500 secondary oocyte through out her life.
- At each ovulation 1 secondary oocyte is released.

Ovulation – the process of liberation of secondary oocyte from the ovary is called ovulation.

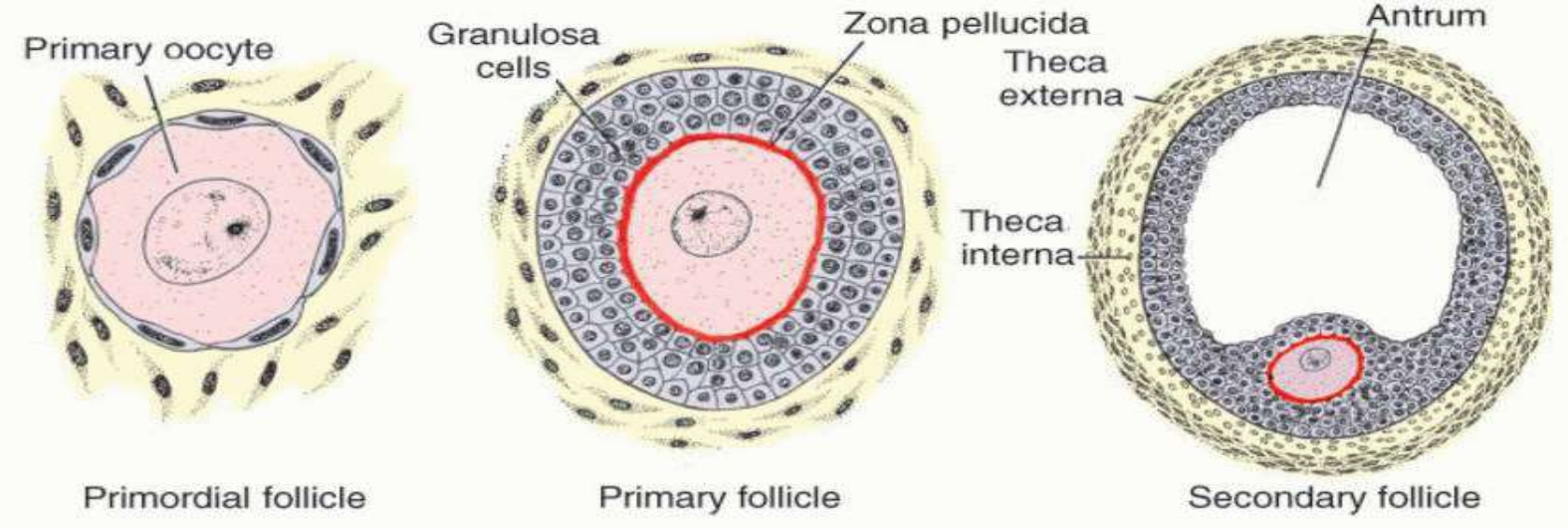
Time period – 14^{th} day prior to the next menstruation cycle.

Ovarian cycle.



Growing (Prolifration) of follicles.

- Primordial follicles, every day, some begin to grow and develop primary follicles.
- As the cycle progresses, FSH secretion stimulate primary follicles to begin development into secondary (antral, Graafian) follicles.
- During the last few days of maturation of secondary follicles,
- Estrogens is produced by follicular and thecal cells.
- Stimulate increased production of LH surge by the pituitary gland leads into ovulation



OVULATION AND CORPUS LUTEUM FORMATION.

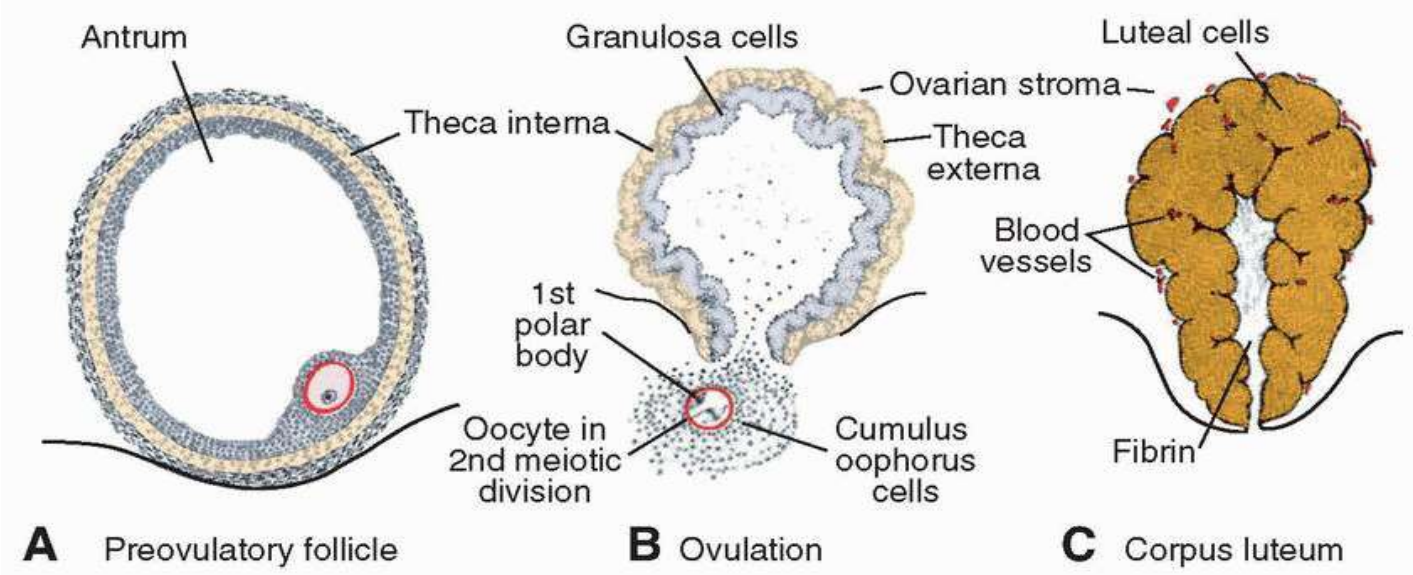
- **Ovulation**. Discharge of ovum from (grrafian follicle) ovary is known as ovulation.

The oocyte, in metaphase of meiosis II,

is discharged from the ovary

together with a large number

of **cumulus oophorus** cells.



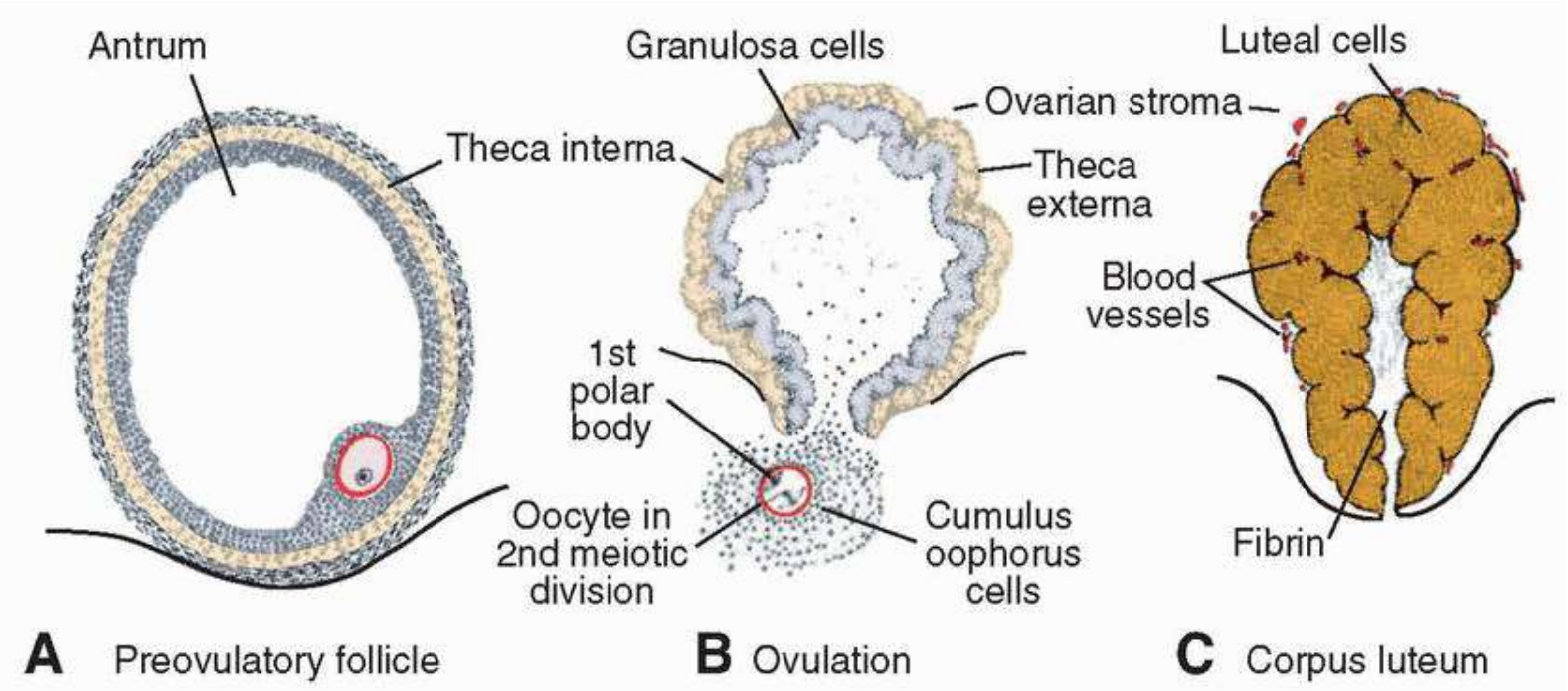
CORPUS LUTEUM FORMATION

Ruptured follicle together with theca folliculi after ovulation Forms corpus luteum

Secrete the hormone progesterone & estrogen.

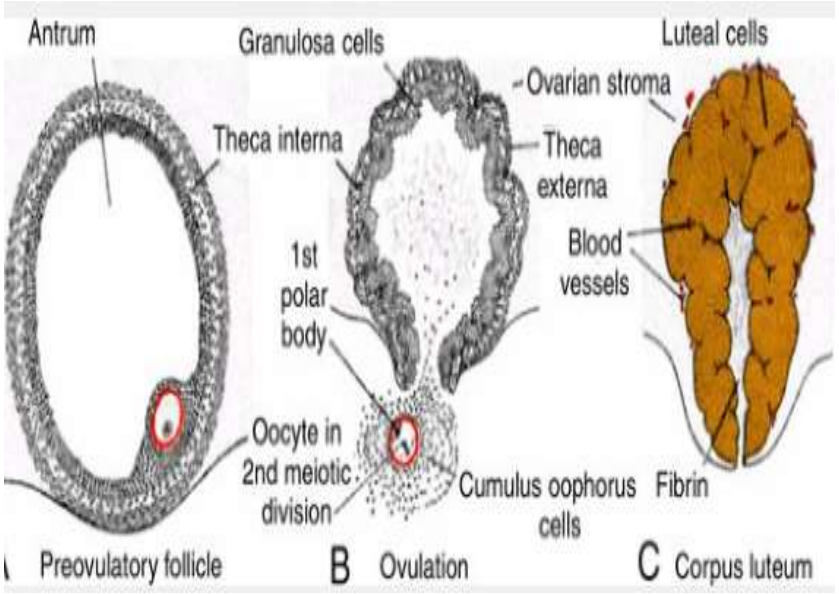
Corpus luteum. The corpus luteum, is formed by accumulation of lipid in granulosa & theca interna cells and fibrin.

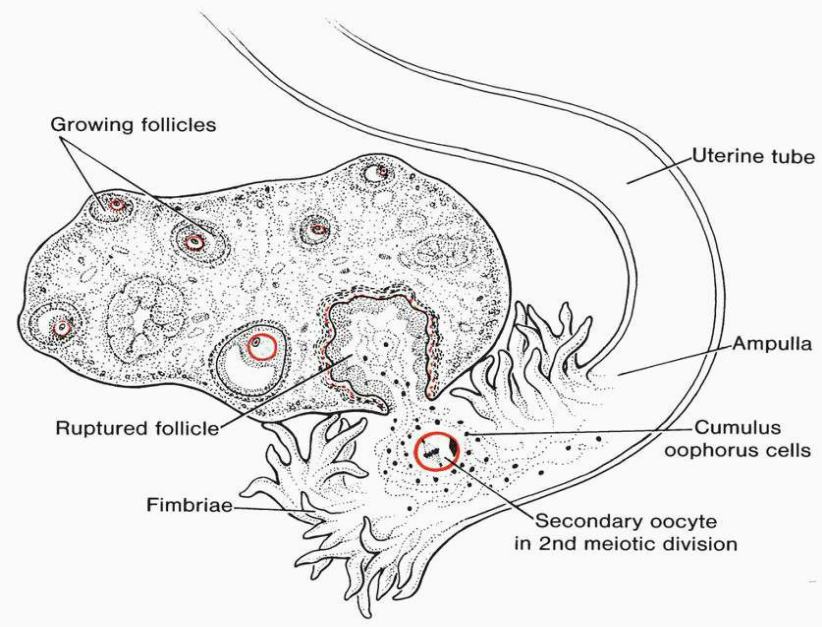
Follicular cells remaining inside the collapsed follicle differentiate into lutean cells.



Corpus luteum

- Oocyte- fertilized- corpus luteum-enlarges- corpus luteum of pregnancy
  - HCG secreted by syncytiotrophoblast prevent degeneration of corpus luteum
  - Secretes hormones to maintain the endometrium of uterus
  - Remains functional for first 20 weeks & later replace by hormone production by placenta
- Oocyte- not fertilized- corpus luteum involutes & degenerates 10-12 days after ovulation, forms white scar tissue in ovary k/a corpus albicans





Endometrial Cycle

It refers to the cyclic changes occurring in the endometrium during active reproductive period in females leading to recurrent monthly bleeding per vaginum.

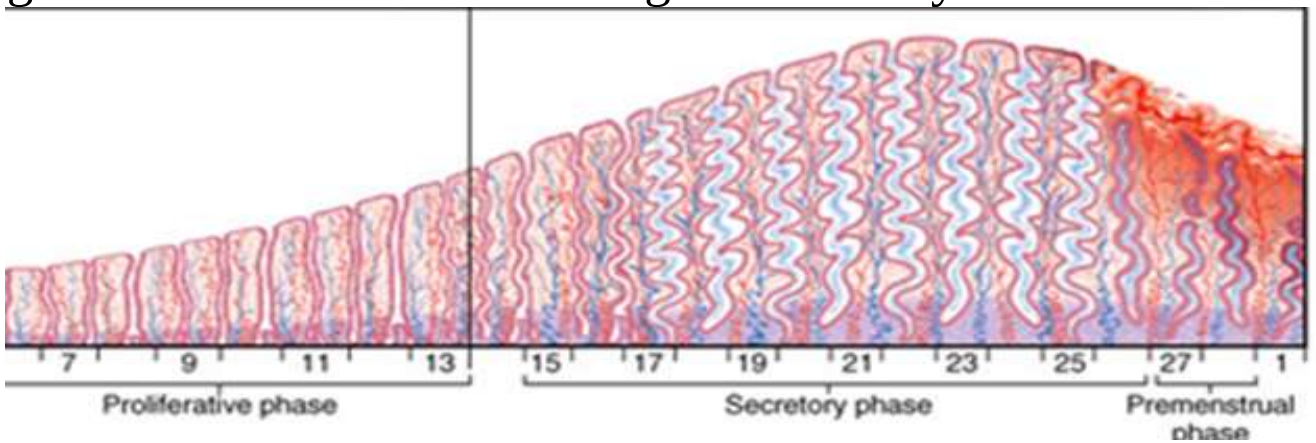
These cyclic changes are brought by the oestrogen & progestrone hormone.

Normally it is of 28 days.

Phases

1. Menstrual phase – 1st to 5th day.
2. Proliferative phase – 6th to 14th day
3. Secretory phase – 15th to 28th day.

Average amount of blood loss during menstrual cycle is 30ml.



Germinal period

- 1-3rd week of development

1st week:

- ✓ Begins at fertilization
- ✓ Cleavage division of zygote
- ✓ Formation of morula
- ✓ Blastocyst & its implantation

2nd week:

- ✓ Completion of implantation
- ✓ Differentiation of trophoblast
- ✓ Appearance of bilaminar disc
- ✓ Formation of amniotic cavity, primary yolk sac, chorionic cavity
- ✓ Formation of two layer of extraembryonic mesoderm

3rd week:

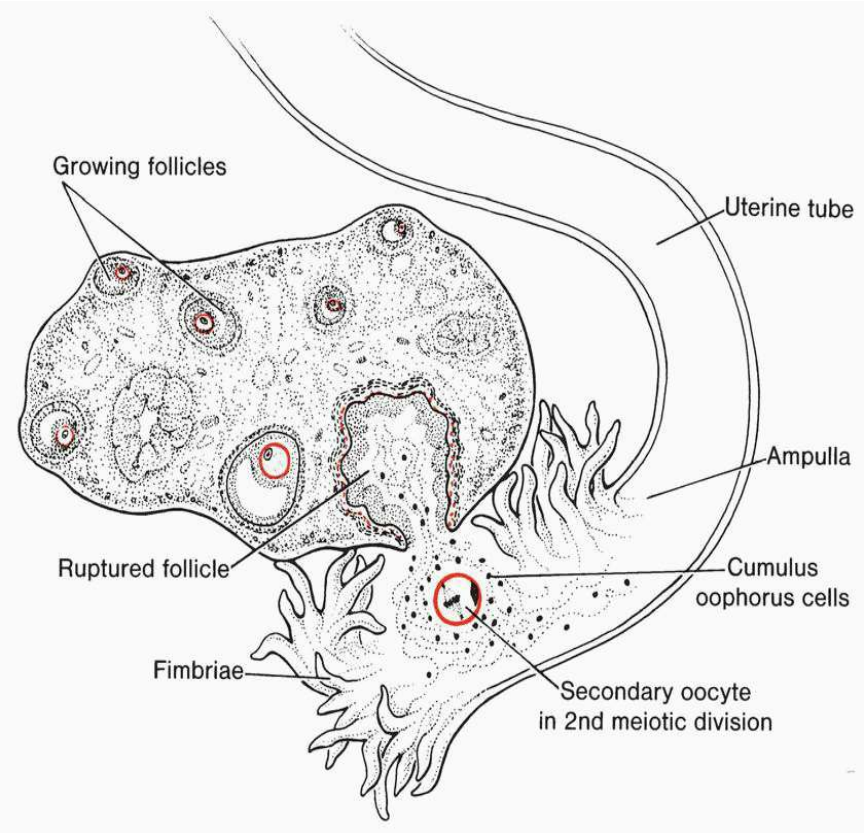
- ✓ Gastrulation
- ✓ Appearance of trilaminar germ disc
- ✓ Formation & fate of primitive streak
- ✓ Formation & fate of notochord
- ✓ Formation & fate of neural tube/ Neurulation
- ✓ Maturations of villi

Fertilization.

- Fertilization:

  is the process by which male and female gametes fuse with each other.

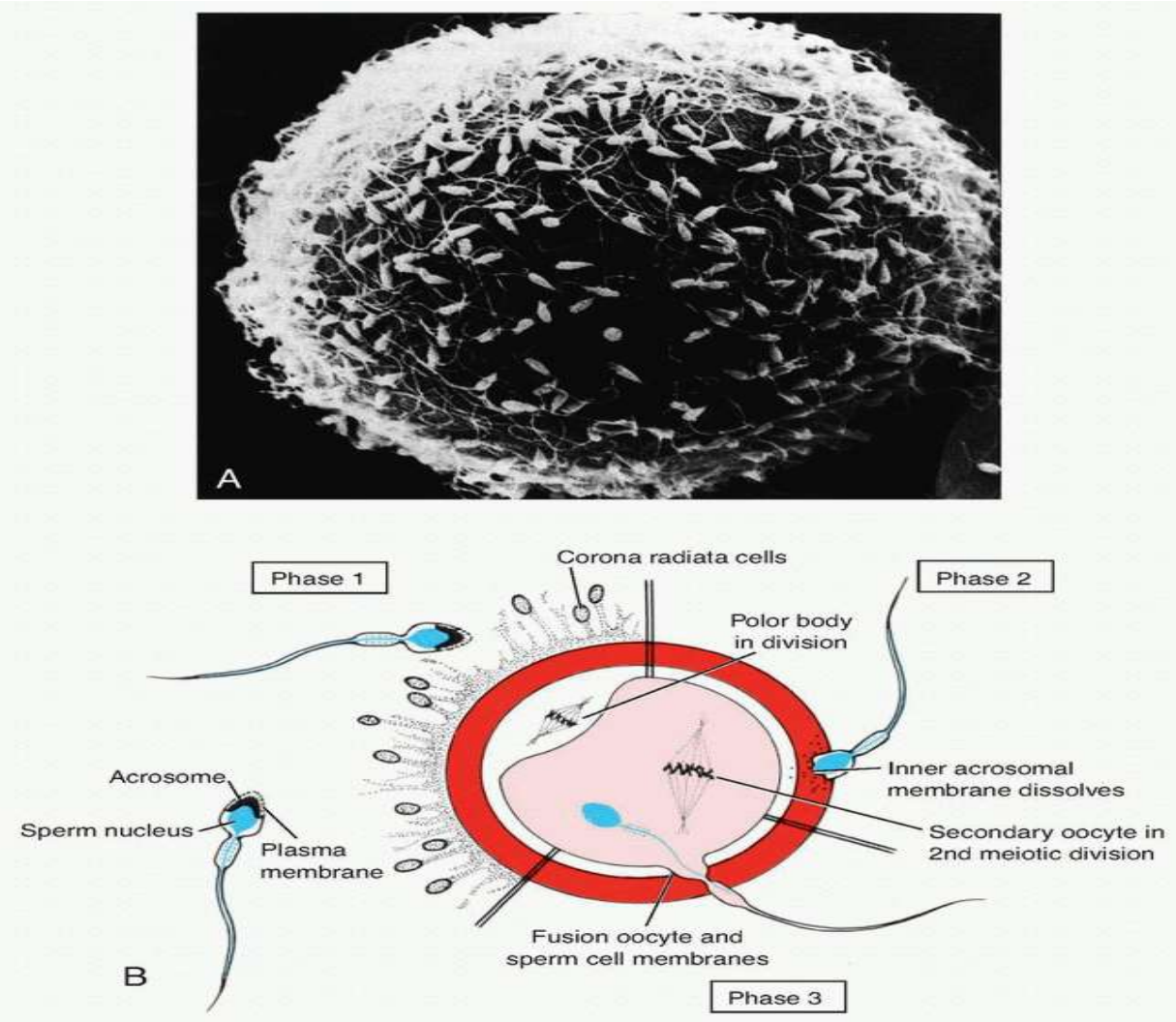
  This occurs in the ampullary region of the uterine tube.



THE THREE PHASES OF OOCYTE PENETRATION.

- **Phase 1,** spermatozoa pass through the corona radiata barrier.
- **Phase 2,** one or more spermatozoa penetrate the zona pellucida.
- **Phase 3,** One spermatozoon penetrates the oocyte membrane while losing its own plasma membrane.

PENETRATION OF SPERM.



Capacitation.

- Capacitation is a period of conditioning (refining) in the female reproductive tract

  that in the human occurs in approximately 7 hours.

- During this time, a glycoprotein coat and seminal plasma proteins are removed from the plasma membrane that overlies the acrosomal region of the spermatozoa.

- Only capacitated sperm can pass through the corona cells and undergo the acrosome reaction.

ACROSOMAL REACTION.

Release of acrosomal enzymes (acrosin) allows sperm to penetrate the zona pelucida, thereby coming in contact with the plasma membrane of the oocyte.

FERTILIZATION

❖Main result of fertilization:

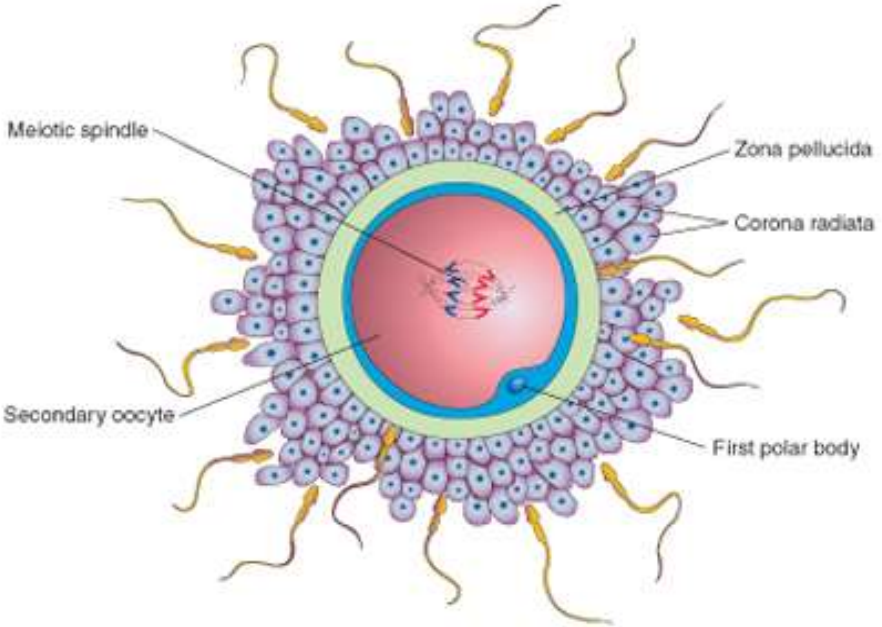
a. Restoration of the diploid number of chromosomes(46) in the zygote:

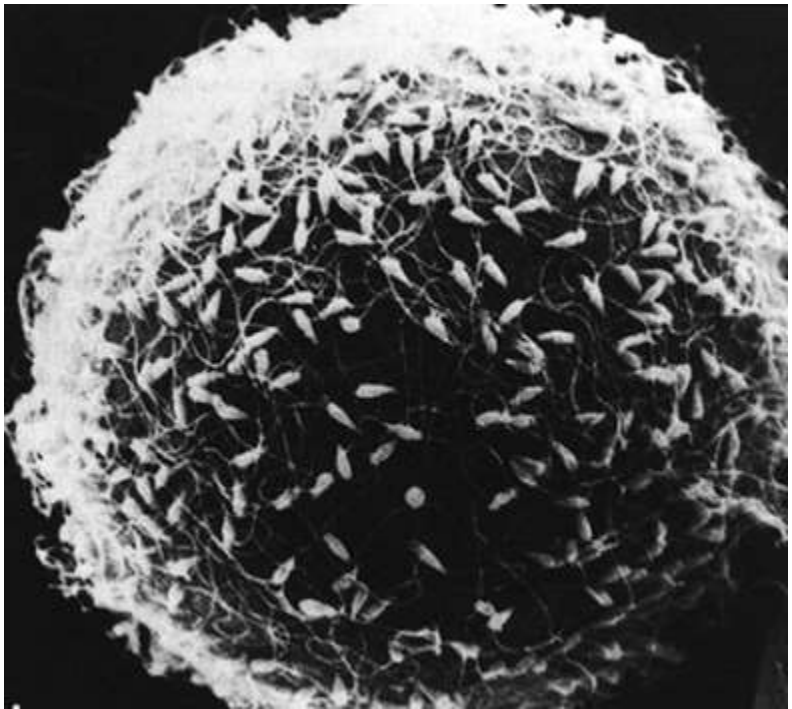
- ✓ Half from the father and half from the mother

b. Determination of the sex of the new individual:

- ✓ X-carrying sperm produces a female (XX) embryo
- ✓Y-carrying sperm produces a male (XY) embryo

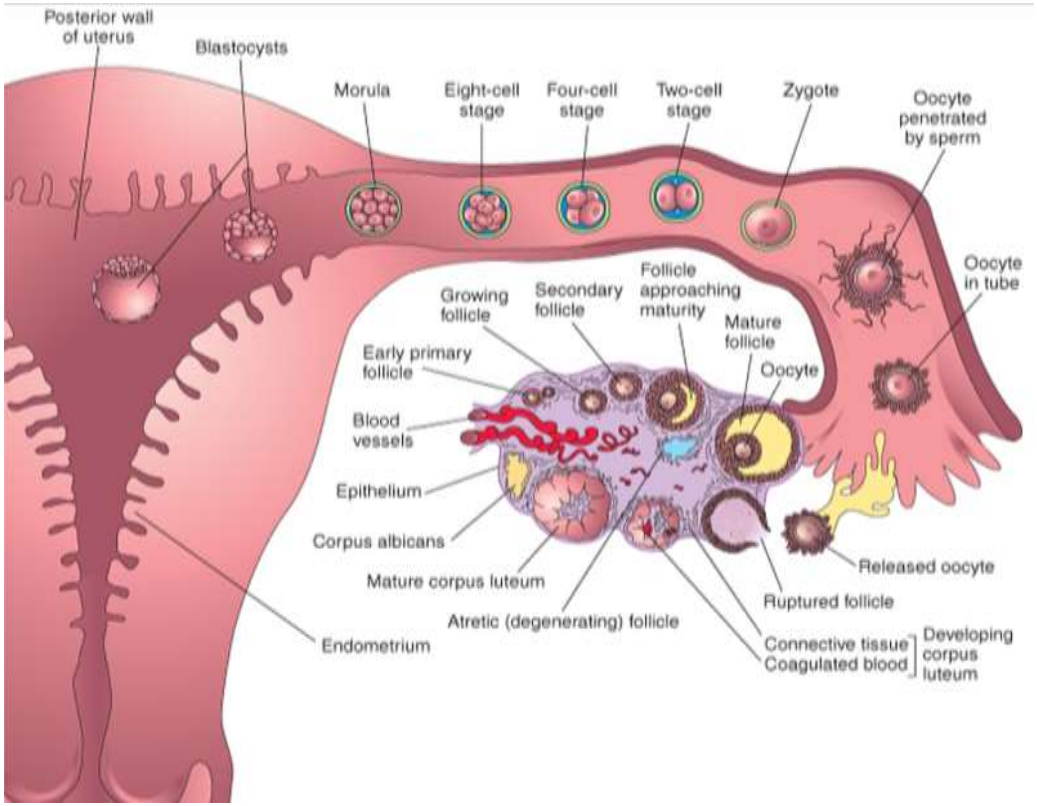
c. Initiation of cleavage of the zygote





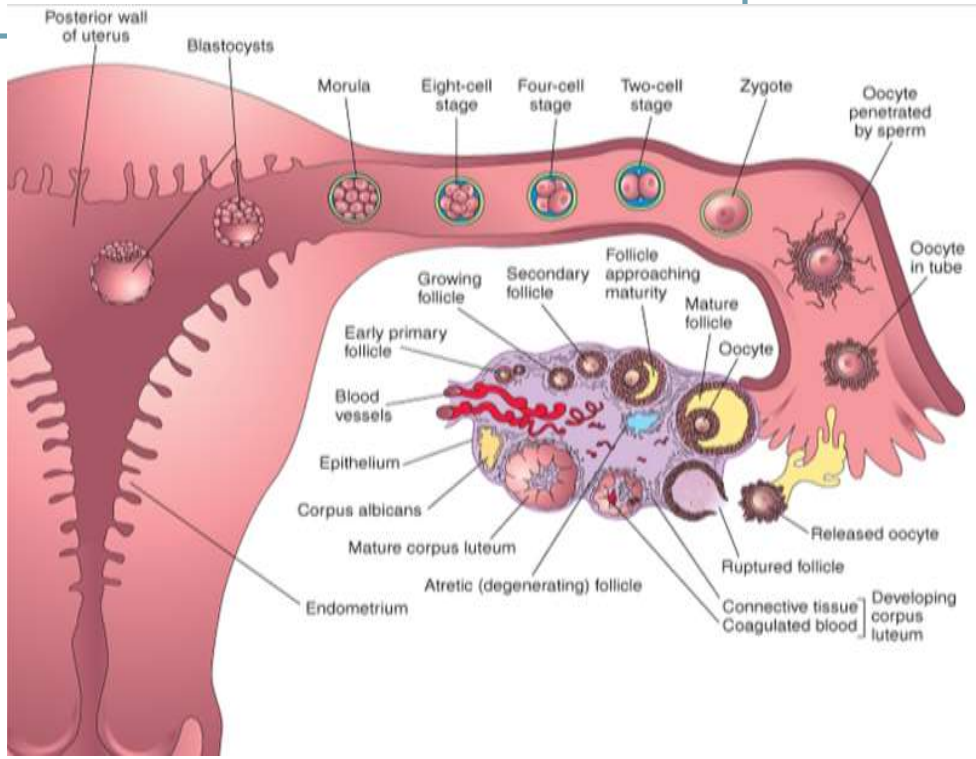
CLEAVAGE

- Once the zygote has reached the two-cell stage, it undergoes a series of mitotic divisions, increasing the numbers of cells. These cells, which become smaller with each cleavage division, are known as blastomeres.



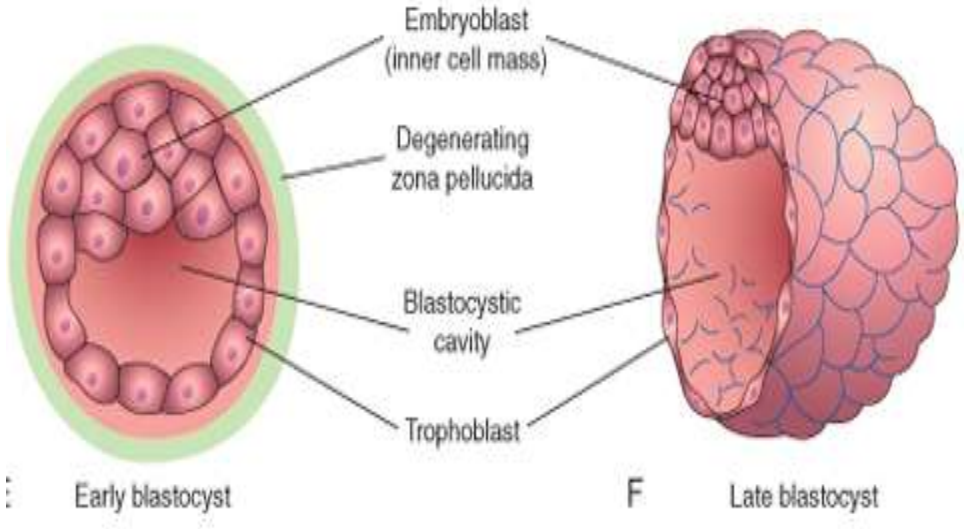
Formation of Morula

Approximately 3 days after fertilization, cells of the compacted embryo divide again to form a 16-cell morula



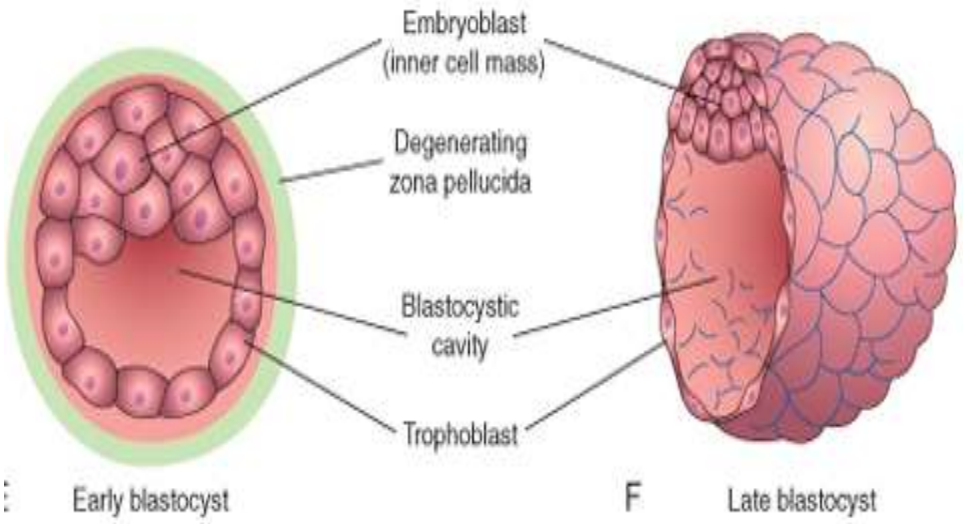
Cells of morula grouped into:

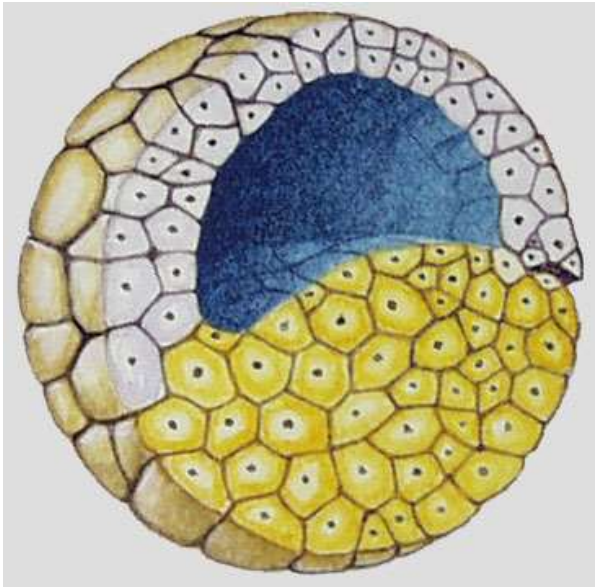
- ✓**Inner part: inner cell mass k/a embryoblasts**
- ✓**Outer part/periphery: outer cell mass k/a trophoblasts**



Blastocyst.

- morula enters the uterine cavity,
- fluid begins to penetrate through the zona pellucida into the intercellular spaces of the inner cell mass.
- Gradually, single cavity is formed, the blastocele,
- At this time, the embryo is a **Blastocyst**.
- Cells of the inner cell mass, now called the embryoblast,
- outer cell mass, trophoblast





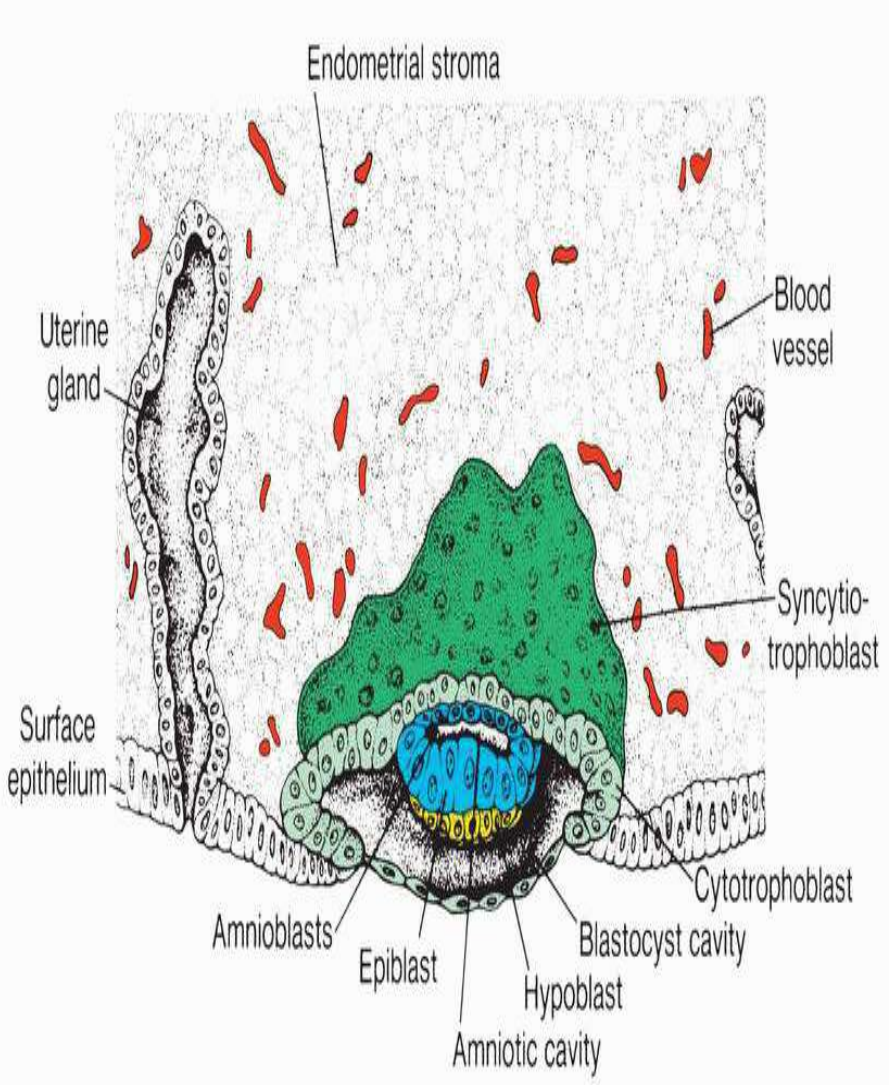
IMPLANTATION.

- Penetration of the blactocyst in the endometrium is known as Implantation.

6-7 days after fertilization

Common site:

Posterior wall and Funds of uterus.

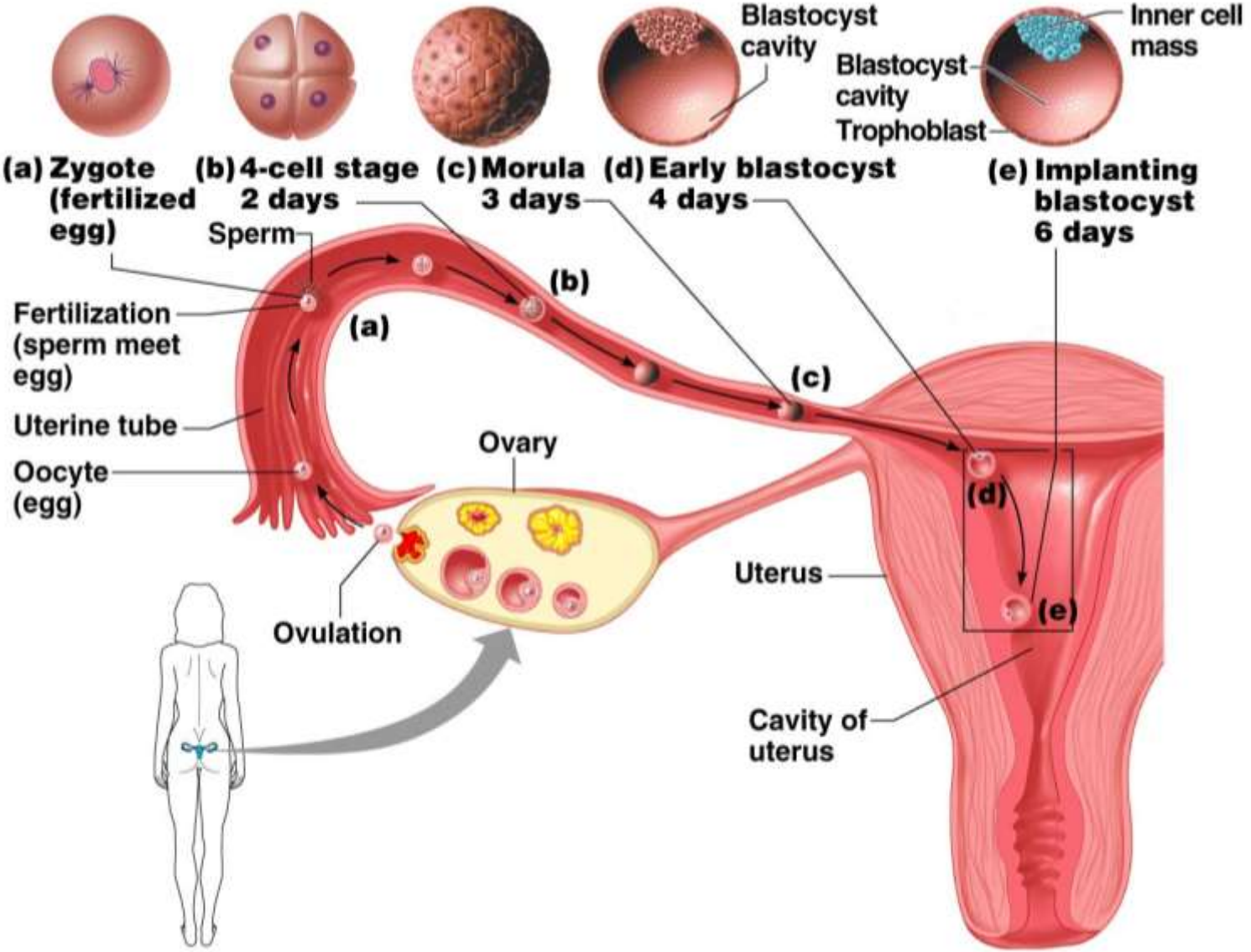


Week 1 – from zygote to blastocyst

- **Fertilization.(Conception)** – in lateral third of uterine tube
  - **Zygote** (fertilized oocyte) moves toward the uterus
  - **Blastomeres** – daughter cells formed from zygote
- **Morula** – **solid** cluster of 12–16 blastomeres
  - "Mulberry"
- **Blastocyst** – Cyst . fluid-filled structure – ~ approximately 60 cells

Fertilization and the Events of the

First 6 Days of Development



Second week of Development

- Blastocyst- Embryoblast and Trophoblast
- 8th day bilaminar disc form 2 layers: Epiblast and Hypoblast
- Formation of primitive streak
- Trophoblast- cytotrophoblast & syncytiotrophoblast
- Amnion and amniontic cavity
- Formation of primary & secondary yolk sac.

Formation of germ disc

Gastrulation – formation of 3 germ layers.

Ectoderm, mesoderm & Endoderm

Derivatives of Germinal layer

A. Ectoderm

1 skin & appendages – Epidermis, hair, nails.

2. Mucous membrane of oral cavity, nasal cavity, & paranasal sinuses.

3. Eye & Ear

4. Exocrine glands - , sweat glands, sebaceous gland, salivary glands, mammary glands, lacrimal gland, pitutary gland.

5. Neural tube - gives rise to CNS, retina, cranial & sensory nerves & ganglia.

B. Mesoderm & its derivatives

1. Myotomes – skeletal muscles of limb.
2. Dermatomes – dermis of skin.
3. Sclerotomes – gives skeleton except cranium.
4. Urinary organs – kidneys, bladder, urethra, prostate.
5. Reproductive organs – testes, epididymis, ductus deferens, seminal vesicles, ejaculatory duct in males & ovaries, uterus, uterine tubes & vagina in females.
6. Superficial & deep fascia, ligaments, tendons & aponeurosis, cartilage , blood vessels, lymph vessels.

Endoderm & its derivatives

1. Lining epithelium of Gastrointestinal tract, Respiratory tract, Genitourinary tract.
2. Formation of primitive gut.

Foregut - gives rise to floor of the mouth, pharynx, tongue, palatine tonsil, auditory tubes, middle ear etc.

Oesophagus, Stomach, upper half duodenum, Liver, pancreas, gall bladder.

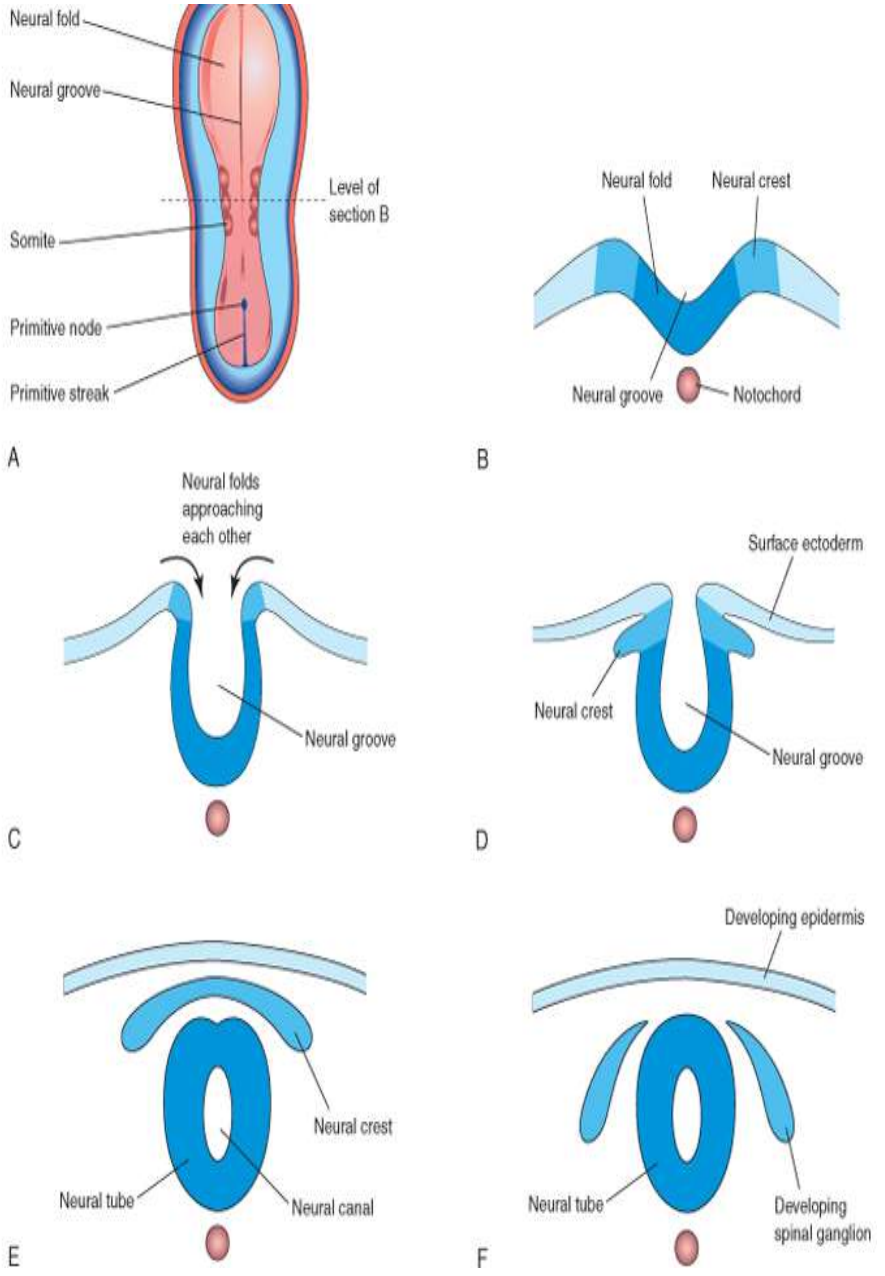
Midgut – distal part of duodenum, jejunum & ileum, caecum, appendix, ascending colon, right 2/3rd of transverse colon.

Hindgut – left 1/3rd of transverse colon, Descending colon Sigmoid colon, Rectum, Upper part of anal canal, mesentries.

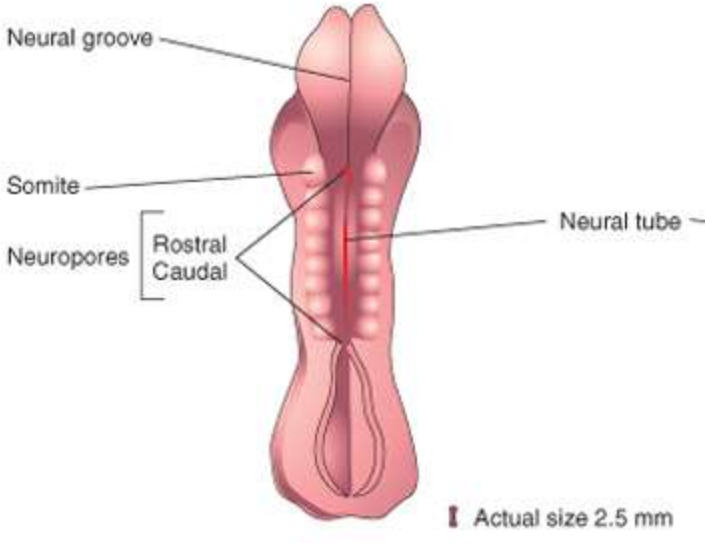
3rd week of Development

Formation of neural tube& its fate:

- ✓ Process is known as neurulation
- ✓ Induction by notochord & paraxial mesoderm convert the ectoderm into neuroectoderm/neural plate
- ✓ Lateral edges of neural plate elevate to form neural folds
- ✓ Depressed mid region forms the neural groove
- ✓ Neural folds approach each other in the midline & fuse
- ✓ Fusion begins at cervical region(5th somite)
- ✓ Fusion proceeds cranially & caudally
- ✓ Neural tube is formed

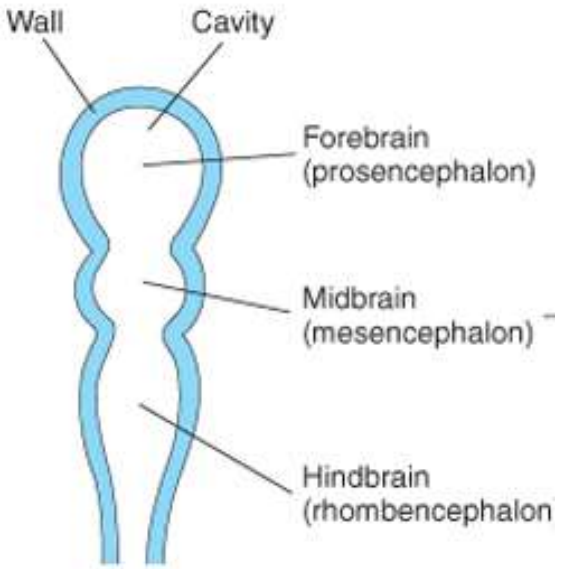


- Neural tube communicate with amniotic cavity via cranial/anterior & caudal/posterior neuropores
- Closure of cranial neuropore– day 25/ 18-20 somite stage
- Closure of caudal neuropore– day 27/ 25 somite stage
- Neurulation is complete



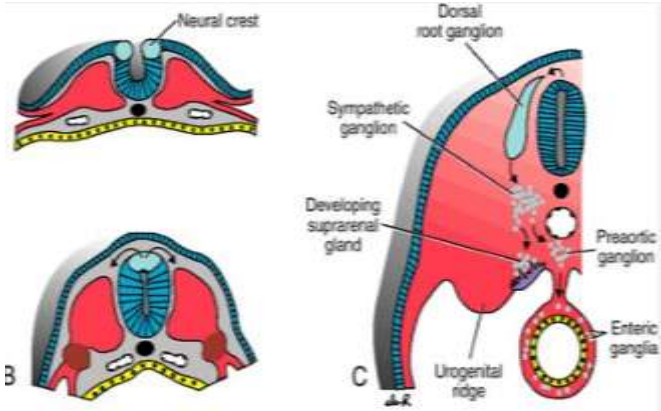
Fate :

- Cranial part forms number of dilations – forebrain, midbrain, hindbrain vesicles - different part of brain
- Caudal part– narrow tubular– spinal cord



Neural crest cells:

- As the neural folds elevate and fuse, cells at the lateral border/crest dissociate
- Enters into the mesoderm
- **Derivatives:**
  - Connective tissue and bones of the face & skull
  - C cells of thyroid gland
  - Odontoblast
  - Dermis in the face and neck
  - Spinal ganglia, sympathetic chain & preaortic ganglia, Cranial nerve ganglia, Parasympathetic ganglia of GIT
  - Adrenal medulla
  - Schwann cells, Glial cells
  - Meninges
  - Melanocytes
  - Smooth muscle cell to blood vessels of the face.

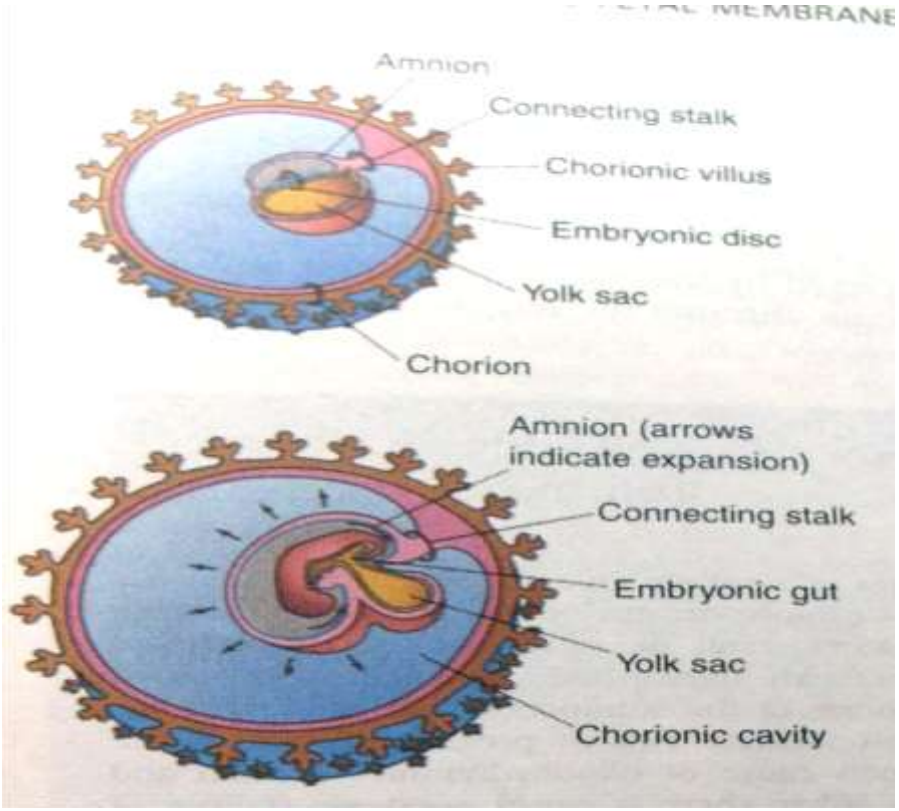


Fetal membranes

- They are—
- Amnion
- Chorion
- Yolk sac
- Decidua
- Placenta
- Connecting stalk &
- Umbilical cord

- Are those parts developed from trophoblast.
- They are delivered after the birth of fetus. Hence are also called “after birth”.
- They are shed off after fetus is born, so they are deciduate.
- Functions are– protection, nutrition, hormone production ,respiration & excretion

- Amnion- the inner membrane that surrounds the embryo.
- Choroin surrounds the embryo, amnion and other membranes.
- Chorion=syncytio trophoblast+cytotrophoblast+ somatopleuric extraembryonic mesoderm (SEM).
- Forms at the time of implantation.
- Forms finger like processes called villi.
- They develop into primary, secondary & tertiary villi.
- Yolk Sac- membraneous sac attached to the embryo.



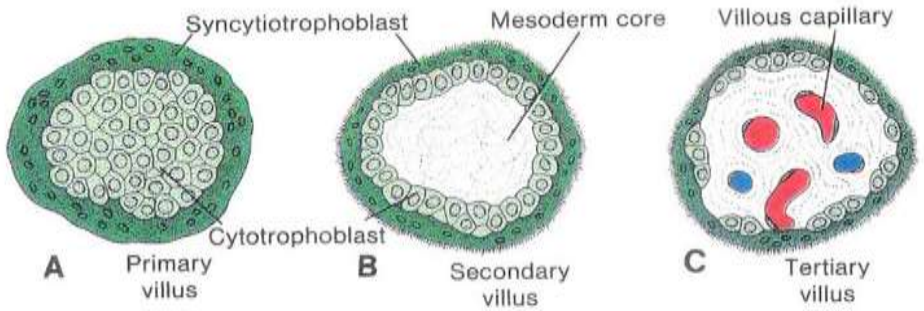
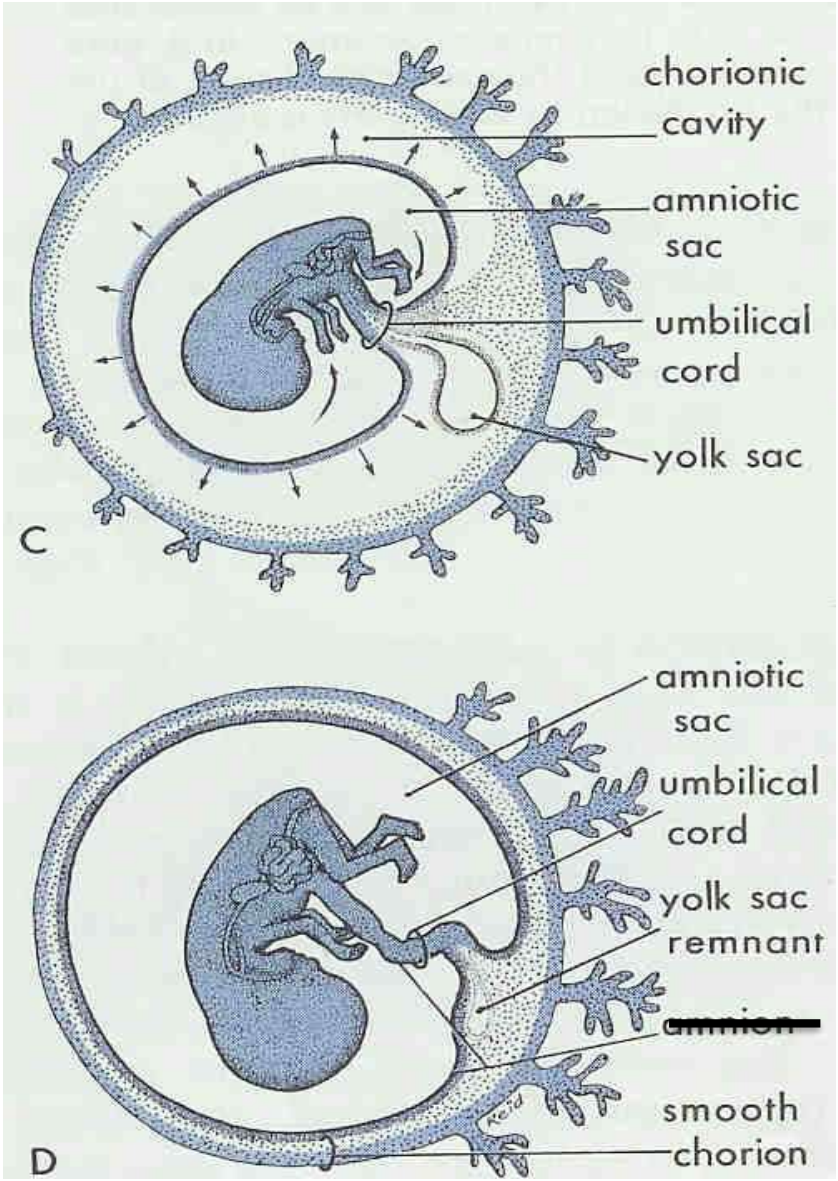


Figure 4.15. Development of a villus. **A.** Transverse section of a primary villus showing a core of cytotrophoblastic cells covered by a layer of syncytium. **B.** Transverse section of a secondary villus with a core of mesoderm covered by a single layer of cytotrophoblastic cells, which in turn is covered by syncytium. **C.** Mesoderm of the villus showing a number of capillaries and venules.

Chorion

- **Fate** –
- Chorion frondosum forms fetal part of placenta
- As amniotic cavity enlarges, amnion fuses with chorion laeve & forms amnio-chorionic membrane.
- This is a thin membrane & is attached to the margins of placenta.
- Is delivered along with placenta after the birth of fetus



Placenta

Placenta is a temporary organ formed during pregnancy.

It forms an important circulatory link between the mother & the feotus.

Formation –

Maternal part of placenta - derived from decidua.

Foetal part of placenta – derived from chorion.

A fully formed placenta is a disc-shaped structure, has a diameter of 15-20 cm & weight about 500 gm.

After birth of the baby, the placenta is shed off along with decidua.

Functions

— exchange of gases between foetal & maternal blood.

- Exchange of nutrients & metabolic wate products between foetus and the mother.
- It transfers maternal Ab to the foetus.

It synthesizes the hormones

- HCG
- - progestrone
- - oestrogen

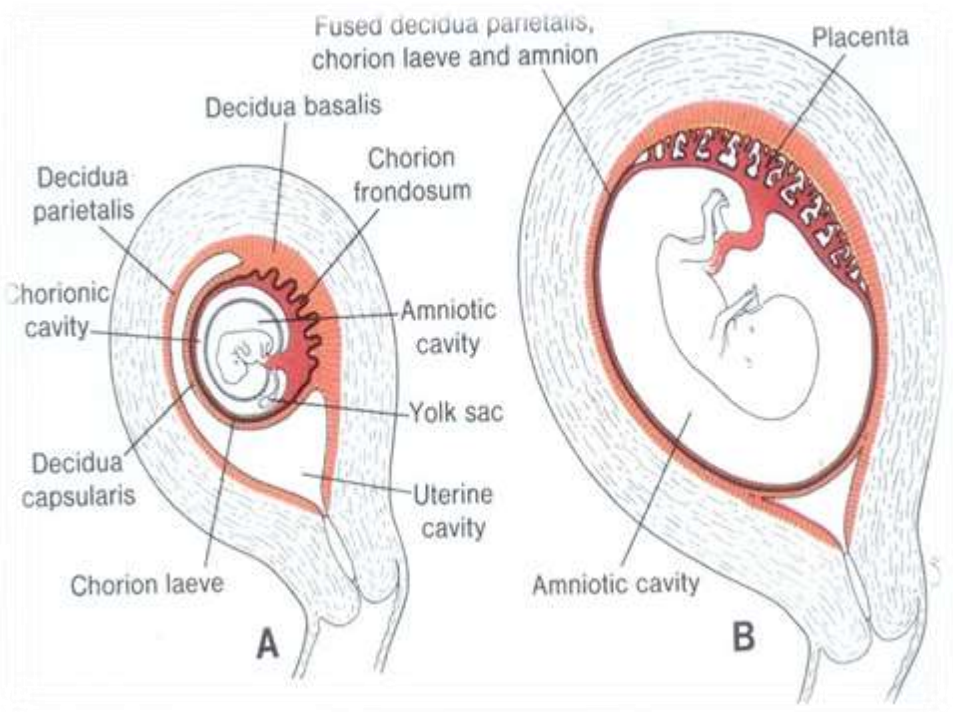
It connects the foetus to the mother.

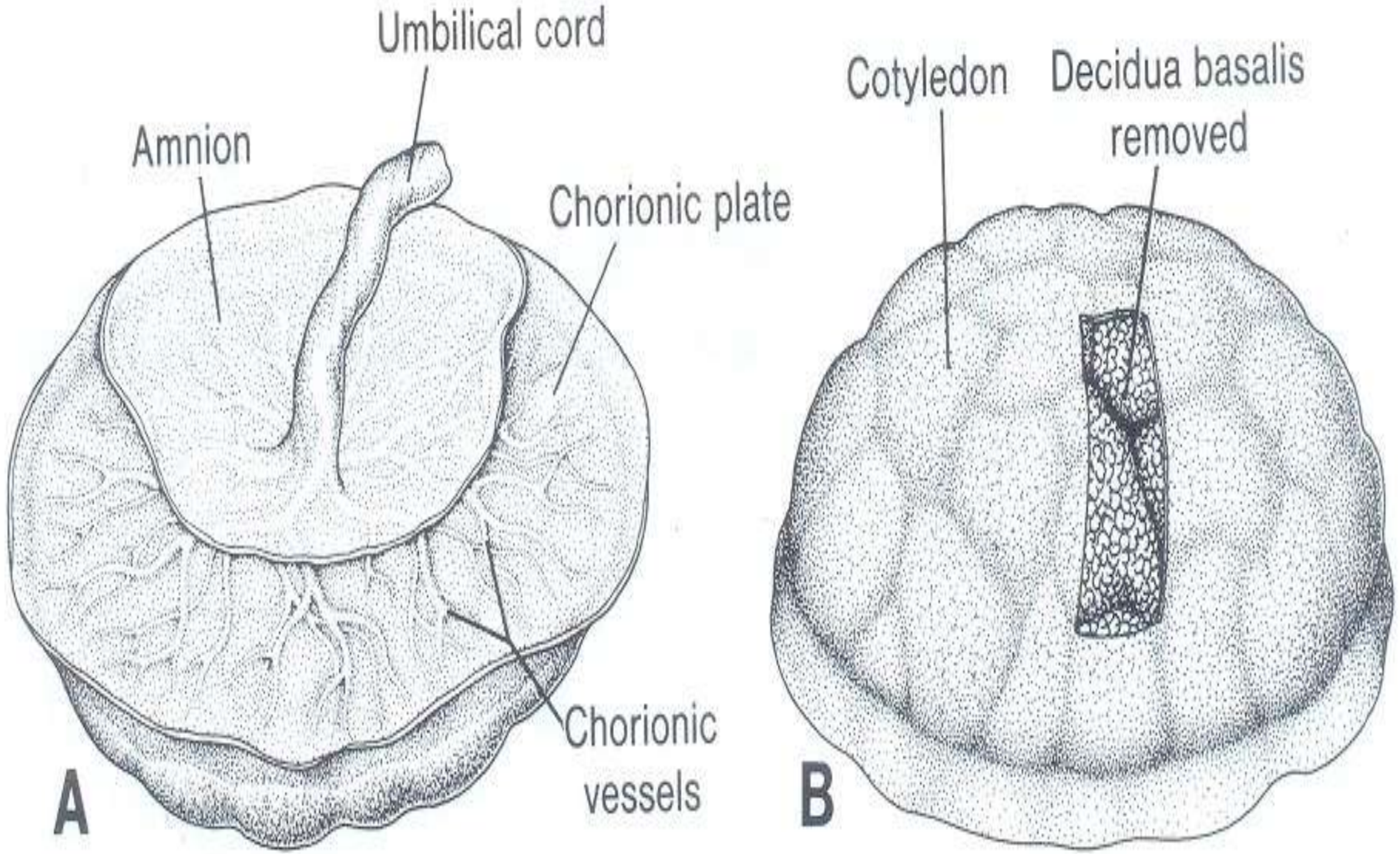
FORMATION OF PLACENTA

DECIDUA.

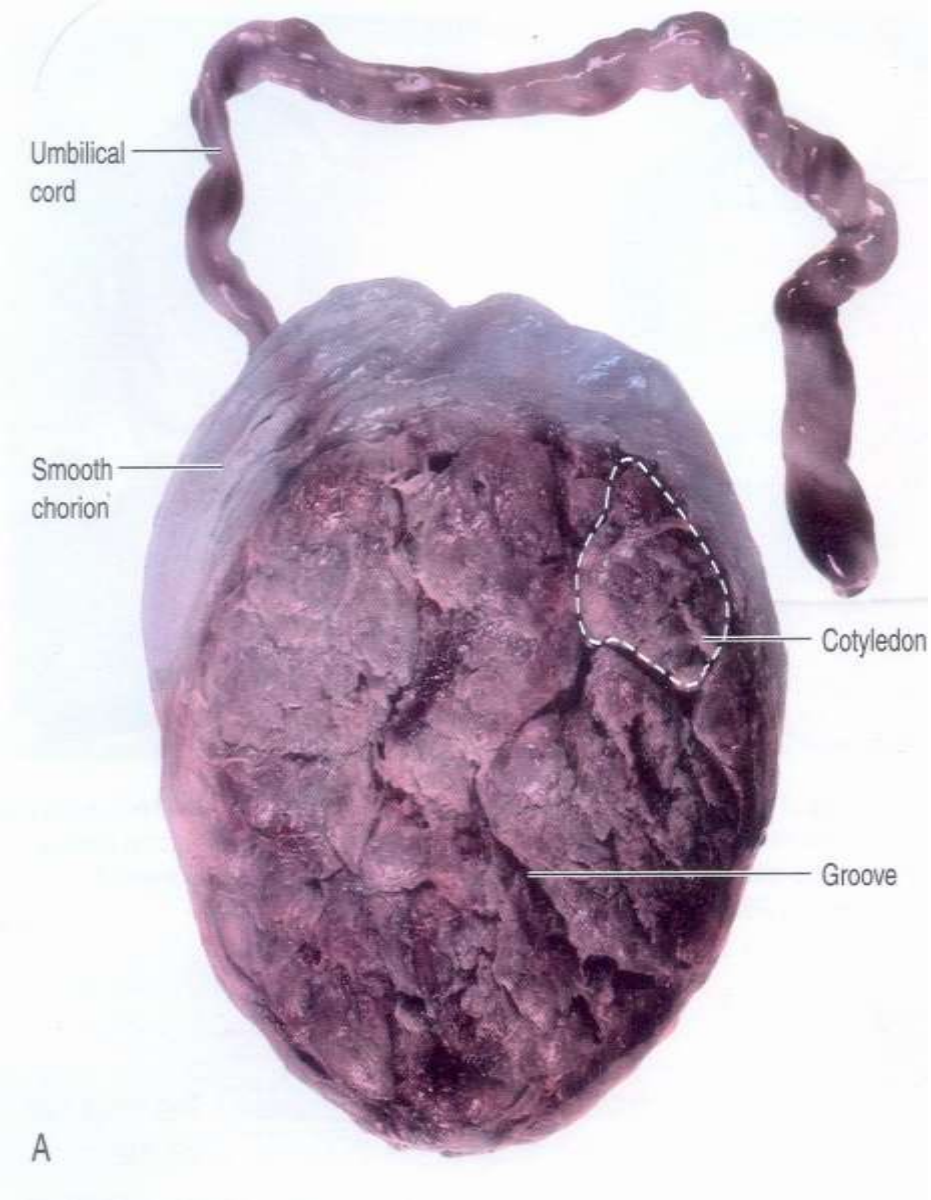
- After the implantation of the embryo , the uterine endometrium is called as the DECIDUA.
- It refers to the GRAVID ENDOMETRIUM , the functional layer of the endometrium.
- The 3 regions of decidua in relation to the implantation site are :-

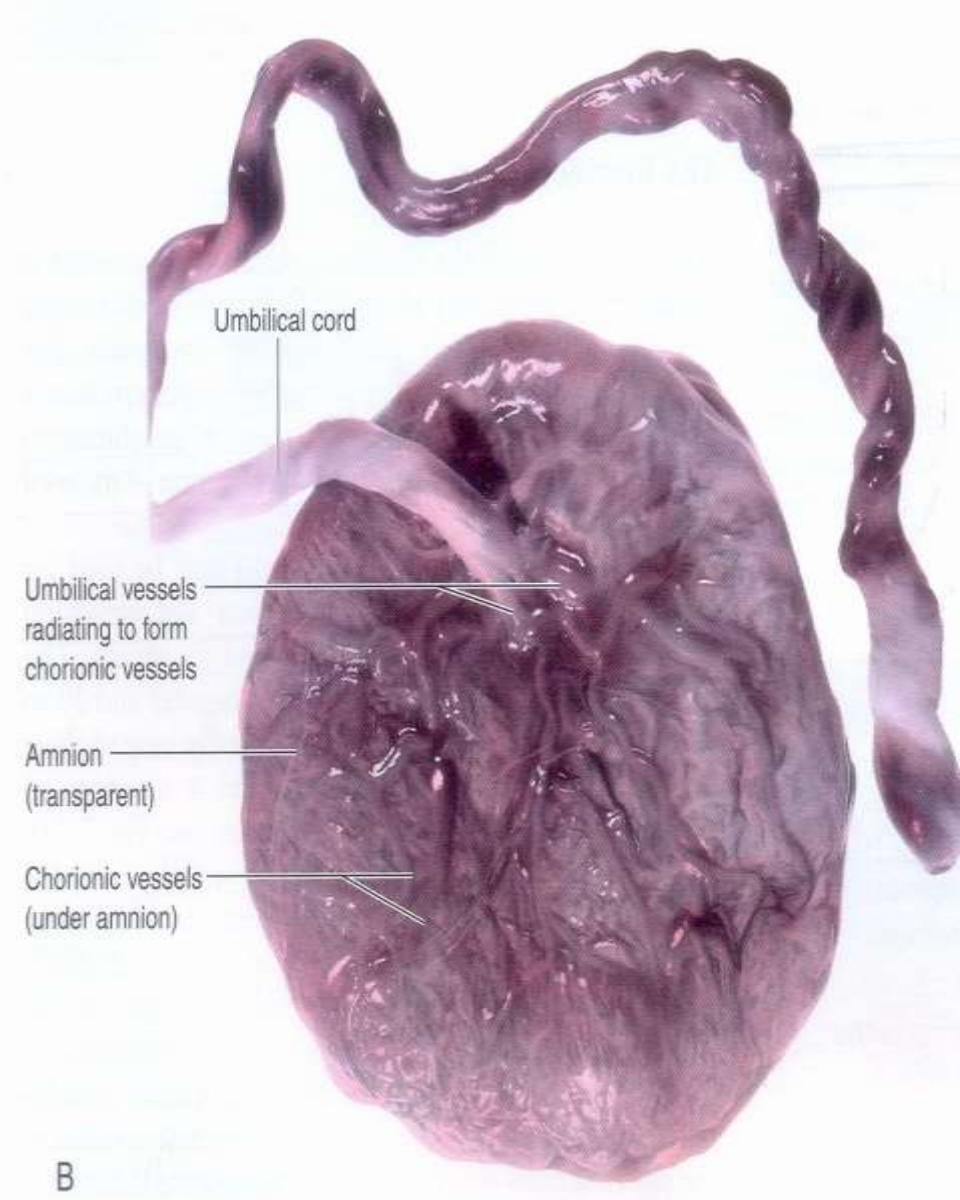
1) Decidua basalis.
2) Decidua capsularis.
3) Decidua parietalis.





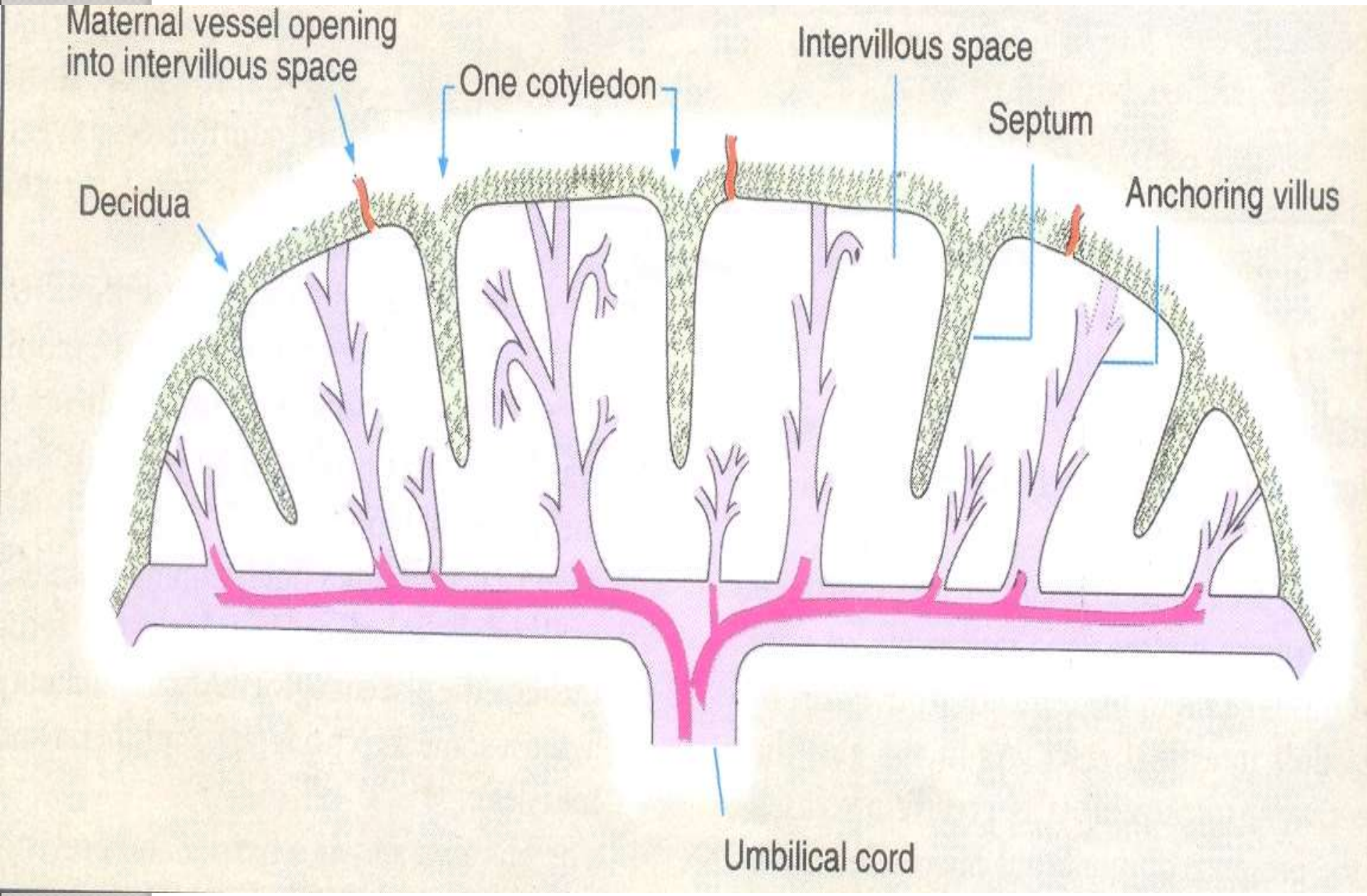
FETAL AND MATERNAL SURFACES.





MATERNAL SURFACE.

FETAL SURFACE.



FULLY FORMED PLACENTA.

STRUCTURE OF PLACENTA.

- ✓ **The placenta consists of : -**

1. Chorionic plate on the fetal side.
2. Basal plate on the maternal side.
3. Stem villi extending between the plates.
4. And intervillous space between the stem villi filled with maternal blood vessel

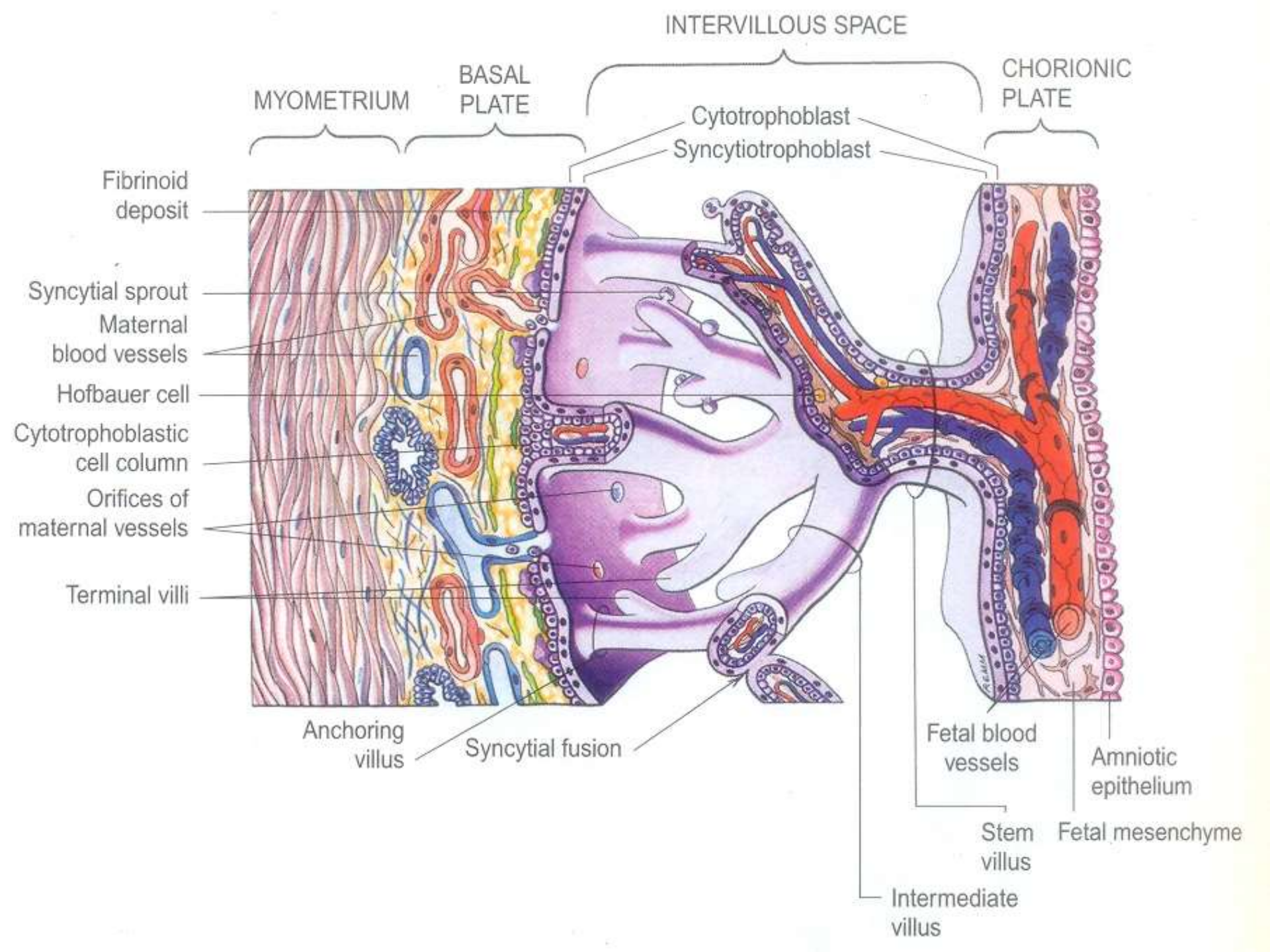
.

- ✓ *Chorionic plate* is composed of the following structures :-

1. Primary mesoderm containing branches of umbilical vessels.
2. Cytotrophoblast.
3. Syncytiotrophoblast.

- ✓ *Basal plate* consists of the following structures :-

1. Stratum spongiousm of decidua basalis containing maternal blood vessels.
2. Outer layer of Syncytiotrophoblast (Nitabuch's layer)which undergoes fibriniod degeneration.
3. outer shell of cytotropoblast.
4. Inner layer of Syncytiotrophoblast


INTERVILLOUS SPACE
MYOMETRIUM
BASAL PLATE
CHORIONIC PLATE
Cytotrophoblast
Syncytiotrophoblast
Fibrinoid deposit
Syncytial sprout
Maternal blood vessels
Hofbauer cell
Cytotrophoblastic cell column
Orifices of maternal vessels
Terminal villi
Anchoring villus
Syncytial fusion
Fetal blood vessels
Amniotic epithelium
Stem villus
Fetal mesenchyme
Intermediate villus

PLACENTAL BARRIER OR PLACENTAL MEMBRANE.

✓It consists of tissues which intervene between fetal blood in the chorionic villi and maternal blood in intervillus space.

✓It consists of the following layers :-

1. The endothelium of fetal blood vessels , and its basement membrane .
2. Surrounding mesoderm
3. Cytotrophoblast and its basement membrane.
4. Syncytiotrophoblast.

✓ Two layers :-

1. Endothelium of fetal capillaries resting on basement membrane
2. Syncytiotrophoblast which represents numerous microvilli.

Anomalies of the Placenta

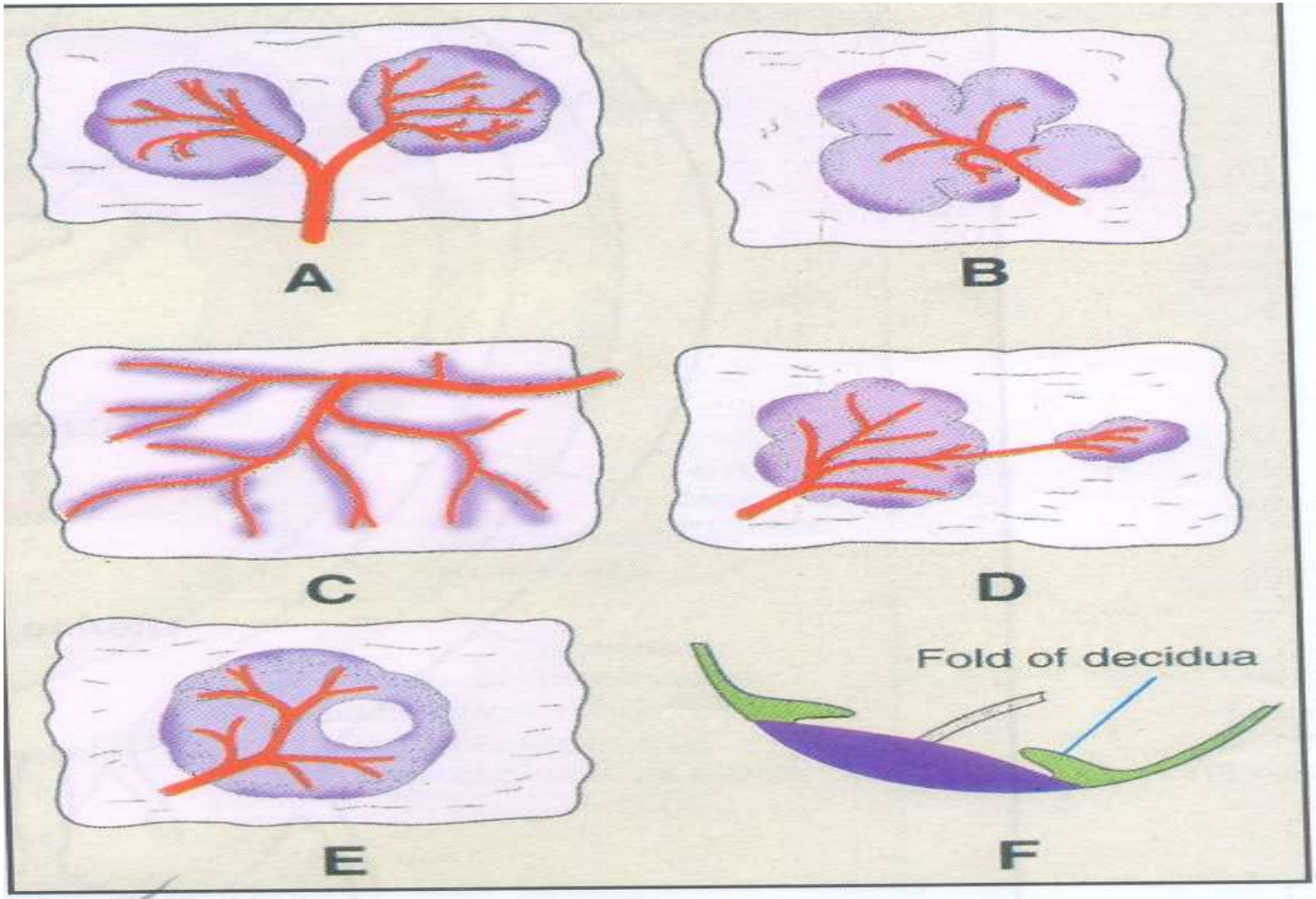


Fig. 6.24 Anomalies of placenta: (A) Bidiscoidal; (B) Lobed, (C) Diffuse, (D) Placenta succenturiata, (E) Fenestrated placenta, (F) Circumvallate placenta.

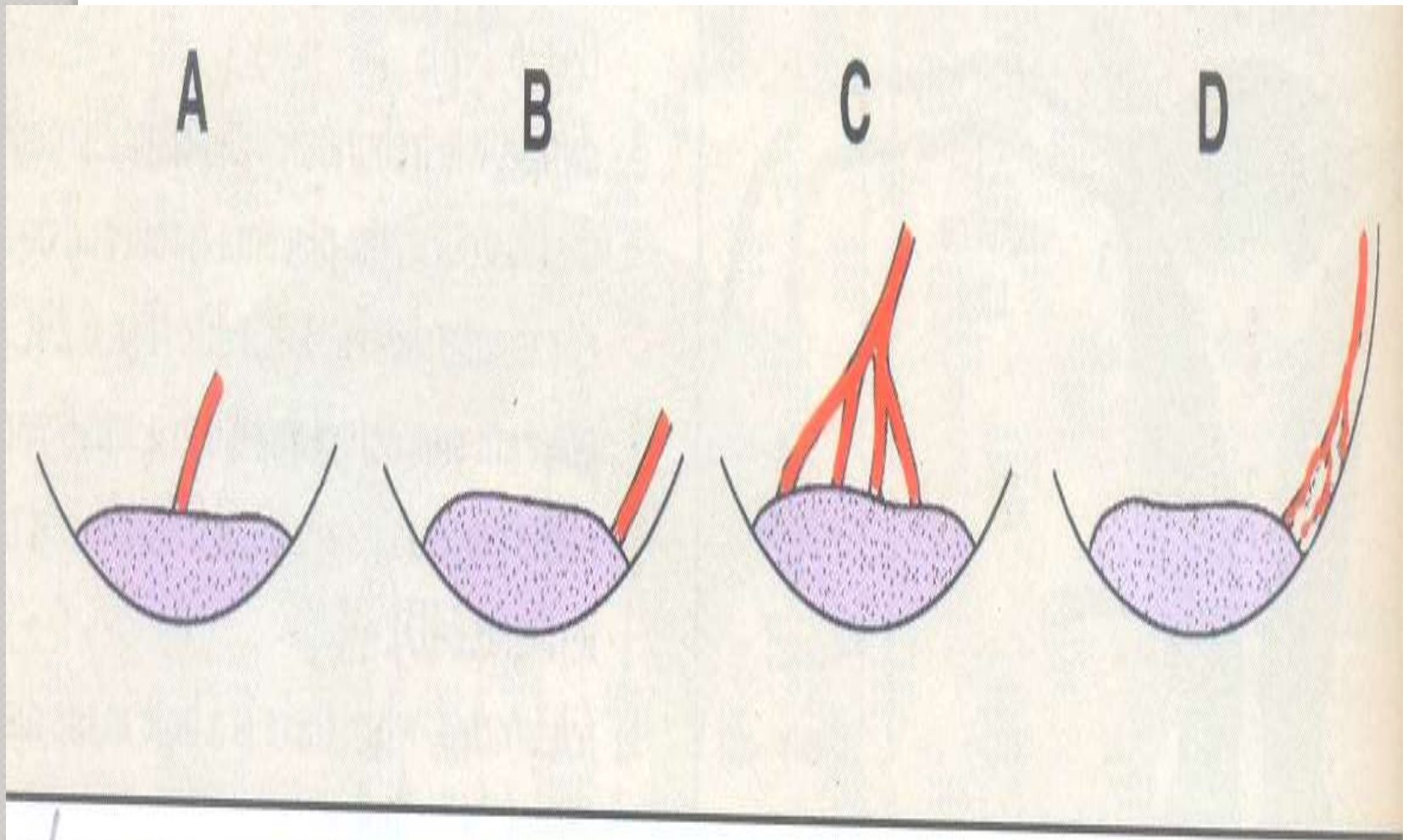


Fig. 6.25 Variations in attachment of umbilical cord to placenta: (A) Normal, (B) Marginal, (C) Furcate, (D) Velamentous insertion.

Three types of placenta previa

Low marginal implantation: A small placental edge can be felt through the internal os.

Partial placenta previa: The placenta partially caps the internal os.

Total placenta previa: The internal os is covered entirely.

THANK YOU