UNIT IV

7 hr.

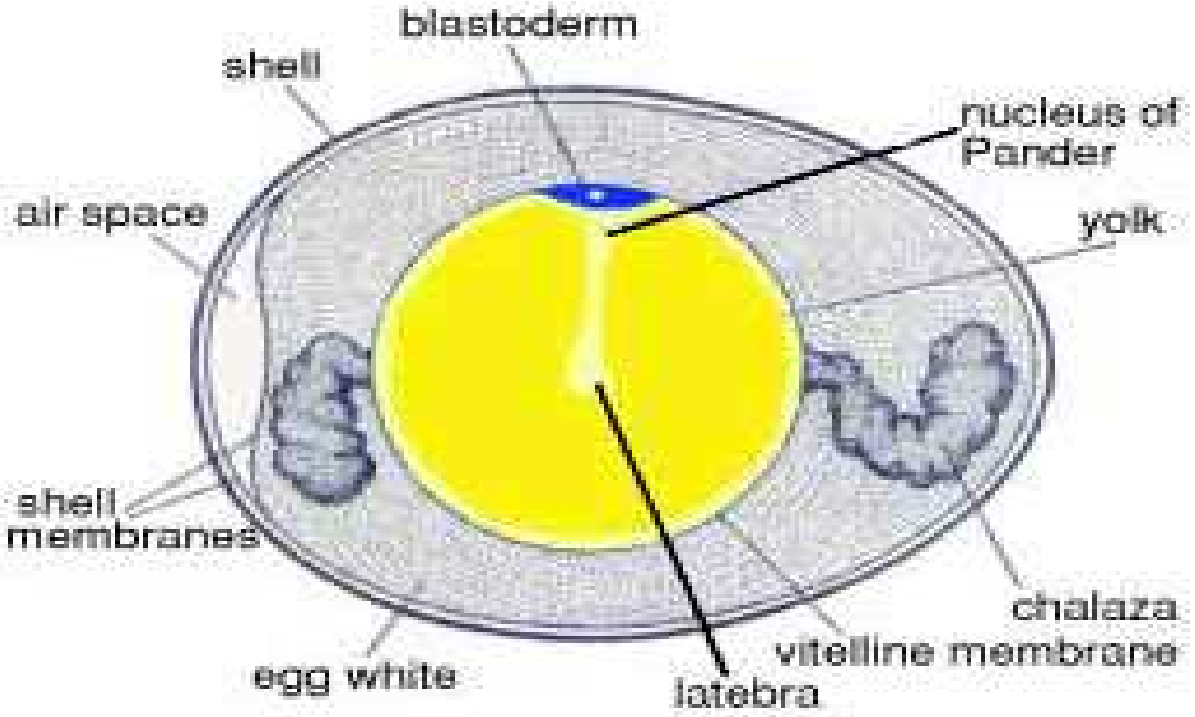
- **Development of chick:** Structure of hen's egg, cleavage, blastula, gastrulation – origin and development of primitive streak.

- **Fetal Membranes:** Development, structure and functions of amnion, horion, yolk sac and allantois.

- **Placenta:** Histological and morphological classification with examples. Placental hormones.

STRUCTURE OF HEN'S EGG

- Ovum is surrounded by a membrane called vitelline mebrane.
- Mass of white yolk at the centre – latebra
- The latebra is surrounded by a many concentric layers of yellow and white yolk.



- A strand white yolk runs upwards from the latebra. It is called the neck of latebra.
- It spreads on the upper surface of the ovum as a plate called the **nucleus of Pander.**
- On the nucleus of Pander rests a mass of disc- shaped cytoplasm with a nucleus. This is called the blastodisc.

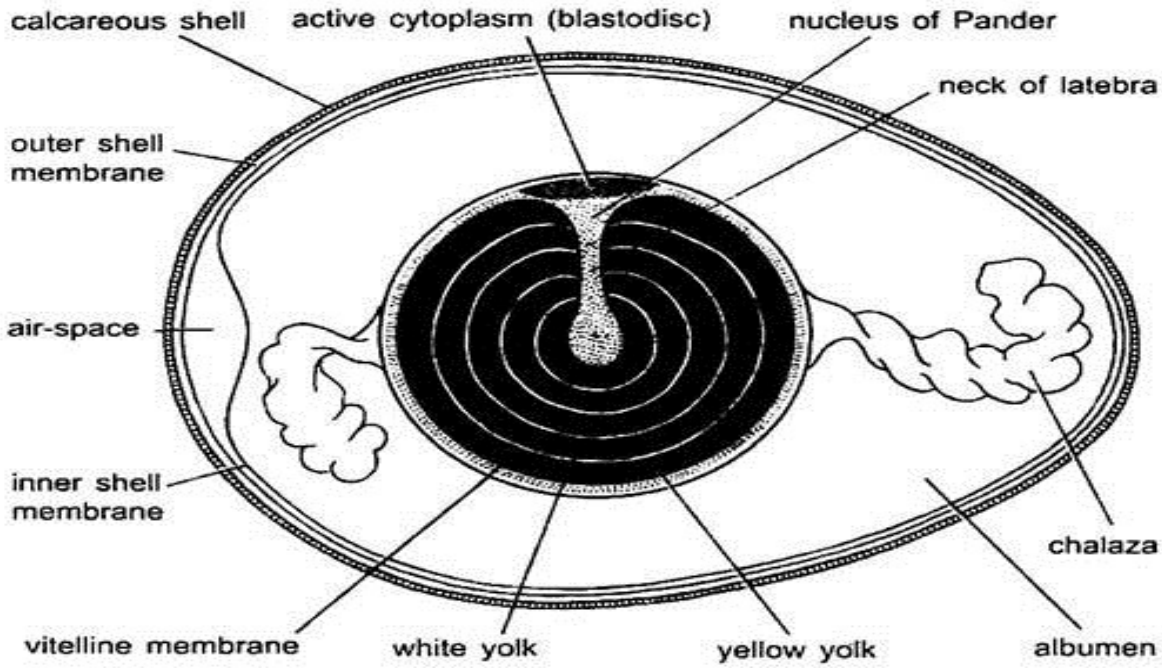


Fig. 38.1. Diagrammatic longitudinal section of a hen's egg.

- Blastodisc alone develop into the embryo proper – animal pole.
- As this passes down in to the oviduct, fertilization takes place and additional egg membranes are added.
- The vitelline membrane is surrounded by the albumin or the white of the egg.
- The albumen is formed of three layers, namely an inner less dense layer, a middle dense layer and an less dense layer.

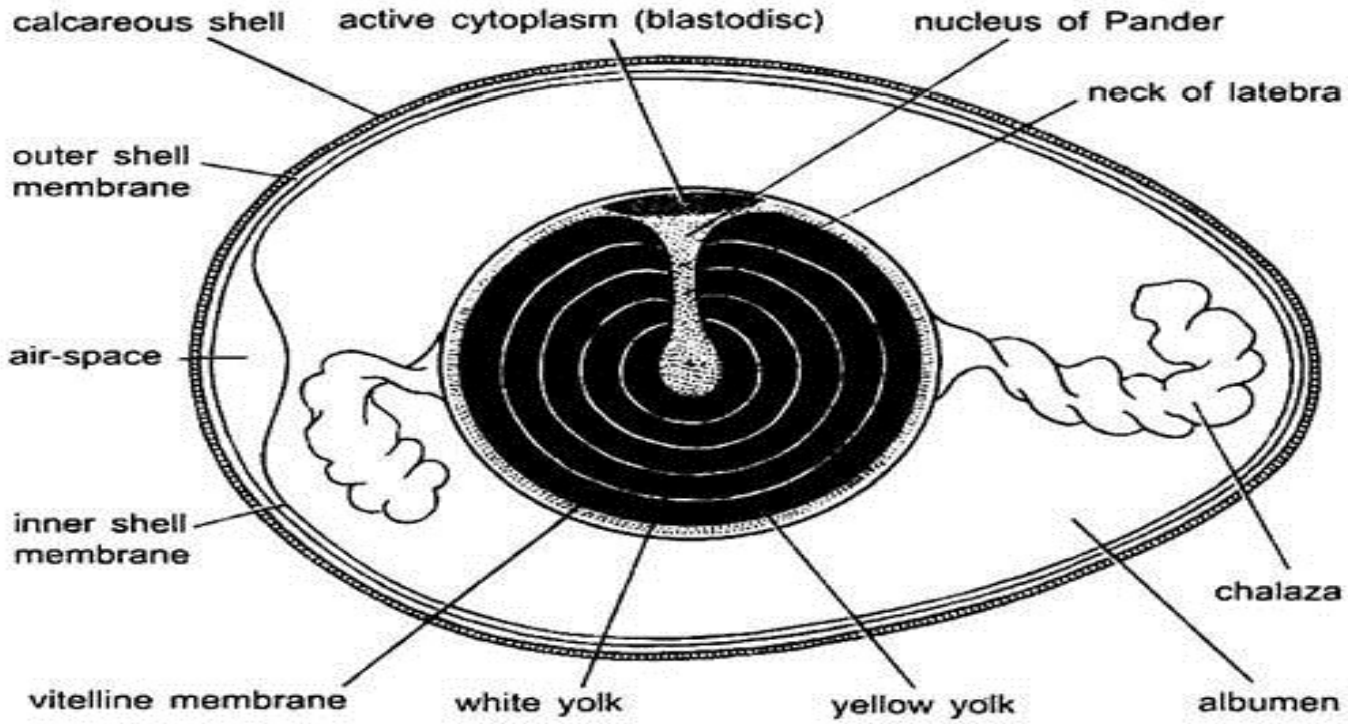


Fig. 38.1. Diagrammatic longitudinal section of a hen's egg.

- **Between the albumen and the vitelline membrane there is another membrane called chalaziferous membrane.**
- **At each end of the egg, this membrane is twisted into yards called chalazae.**
- **The chalazae keep the blastodisc up always in whatever position the egg is turned.**

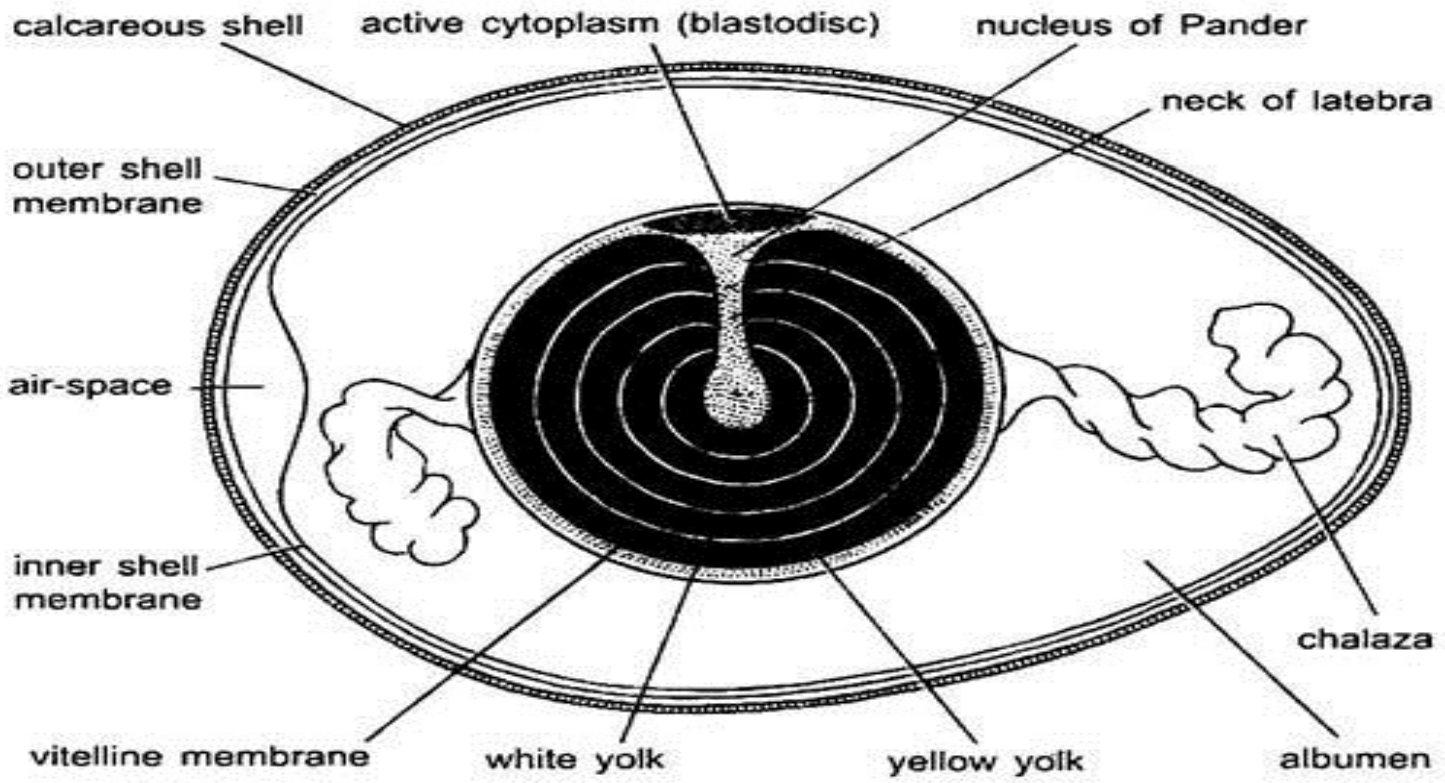
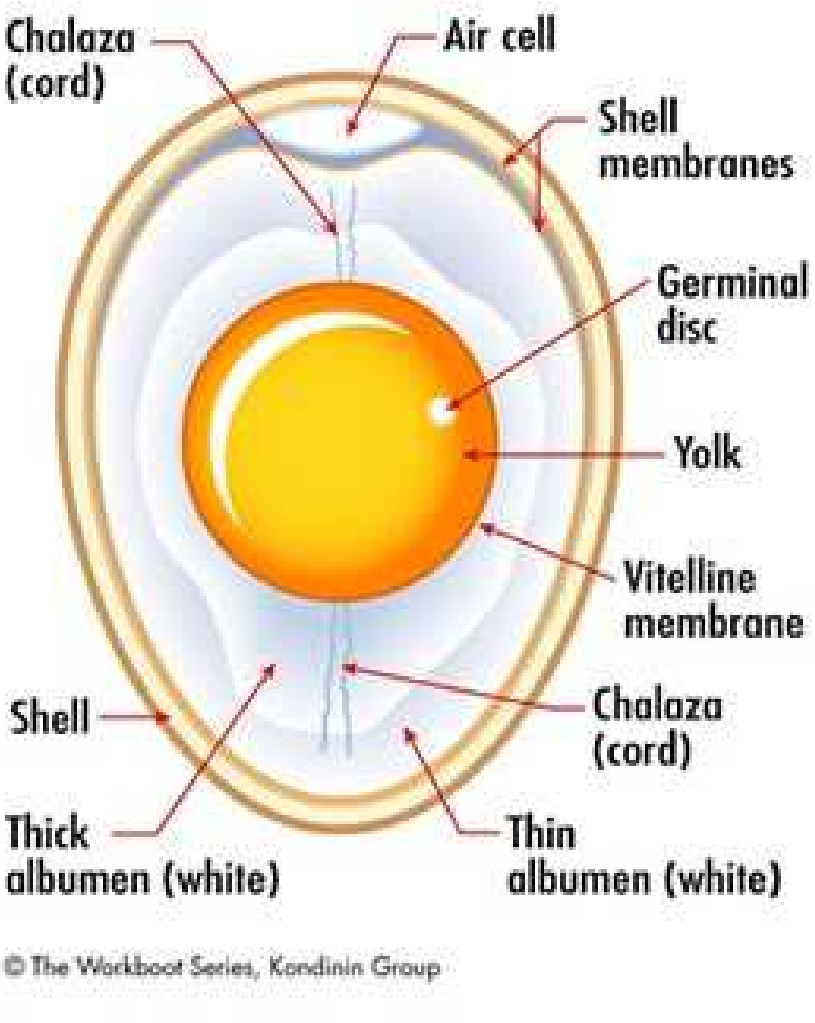


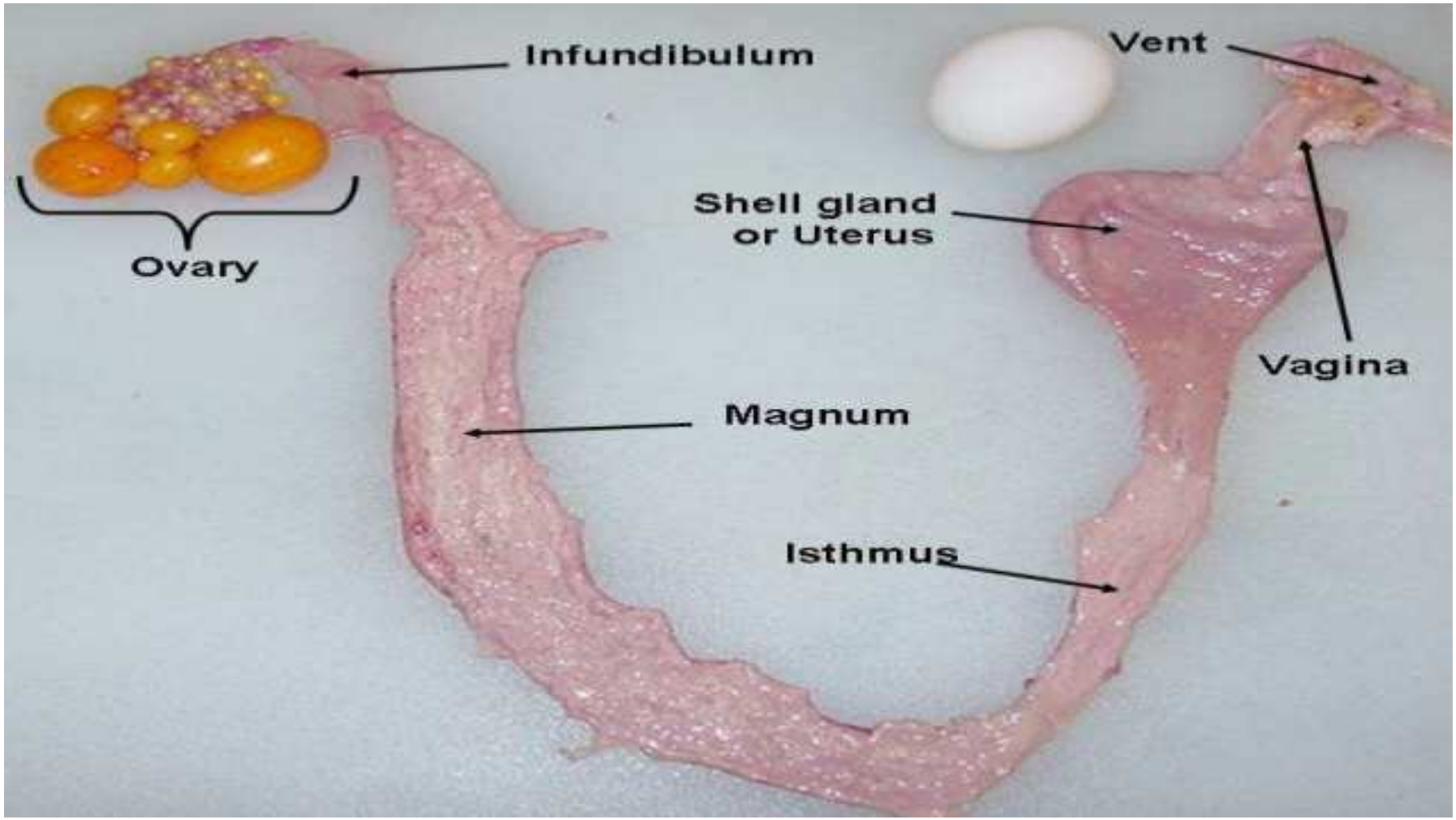
Fig. 38.1. Diagrammatic longitudinal section of a hen's egg.

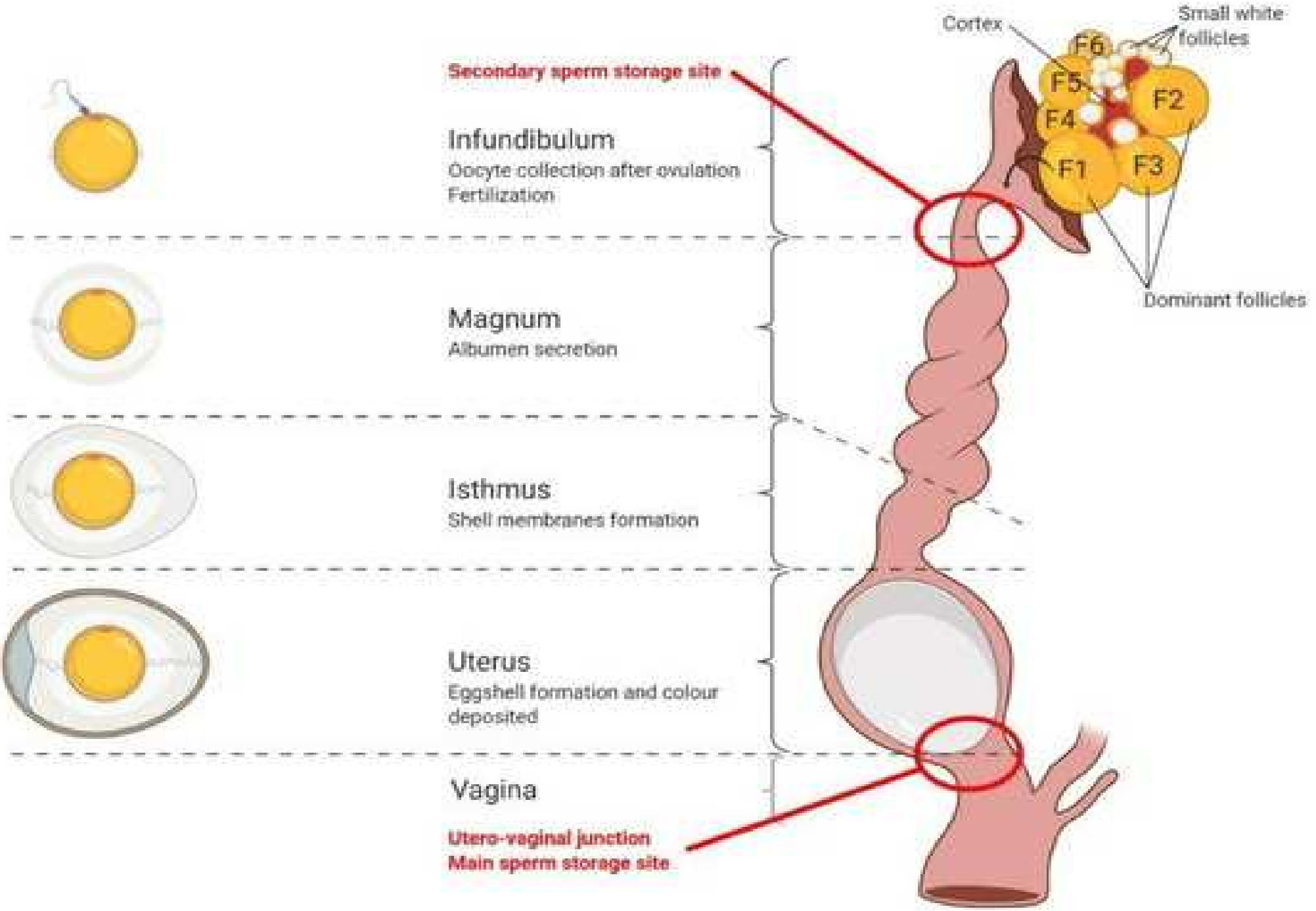
- The albumen is surrounded by a double-shell membrane.
- The two membrane is separated by an air space at the broad end of the egg.
- Since hen's egg is covered be a calcareous shell, it is called cleidoic egg.
- The egg contains large amount of yolk, it is called mesolecithal or macrolecithal or polylecithal egg.
- The yolk is oriented towards one pole, the egg is called telolecithal egg.

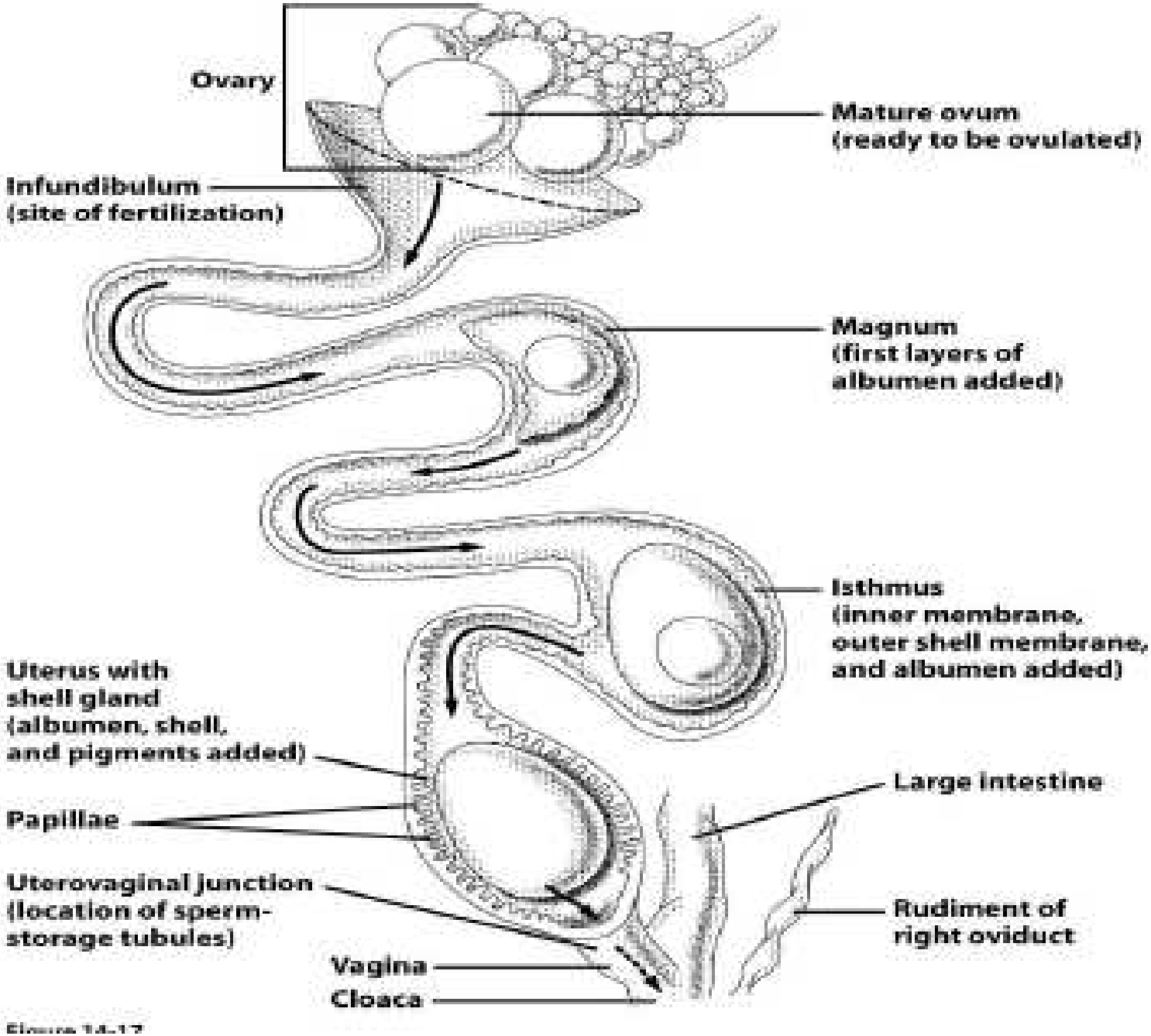


FERTILIZATION

- In birds, fertilization is internal.
- Polyspermy




Cortex
Small white follicles
F6
F5
F4
F2
F1
F3
Dominant follicles
Secondary sperm storage site
Infundibulum
Oocyte collection after ovulation
Fertilization
Magnum
Albumen secretion
Isthmus
Shell membranes formation
Uterus
Eggshell formation and colour deposited
Vagina
Utero-vaginal junction
Main sperm storage site


Ovary
Mature ovum
(ready to be ovulated)
Infundibulum
(site of fertilization)
Magnum
(first layers of
albumen added)
Isthmus
(inner membrane,
outer shell membrane,
and albumen added)
Uterus with
shell gland
(albumen, shell,
and pigments added)
Large intestine
Papillae
Uterovaginal junction
(location of sperm-
storage tubules)
Rudiment of
right oviduct
Vagina
Cloaca

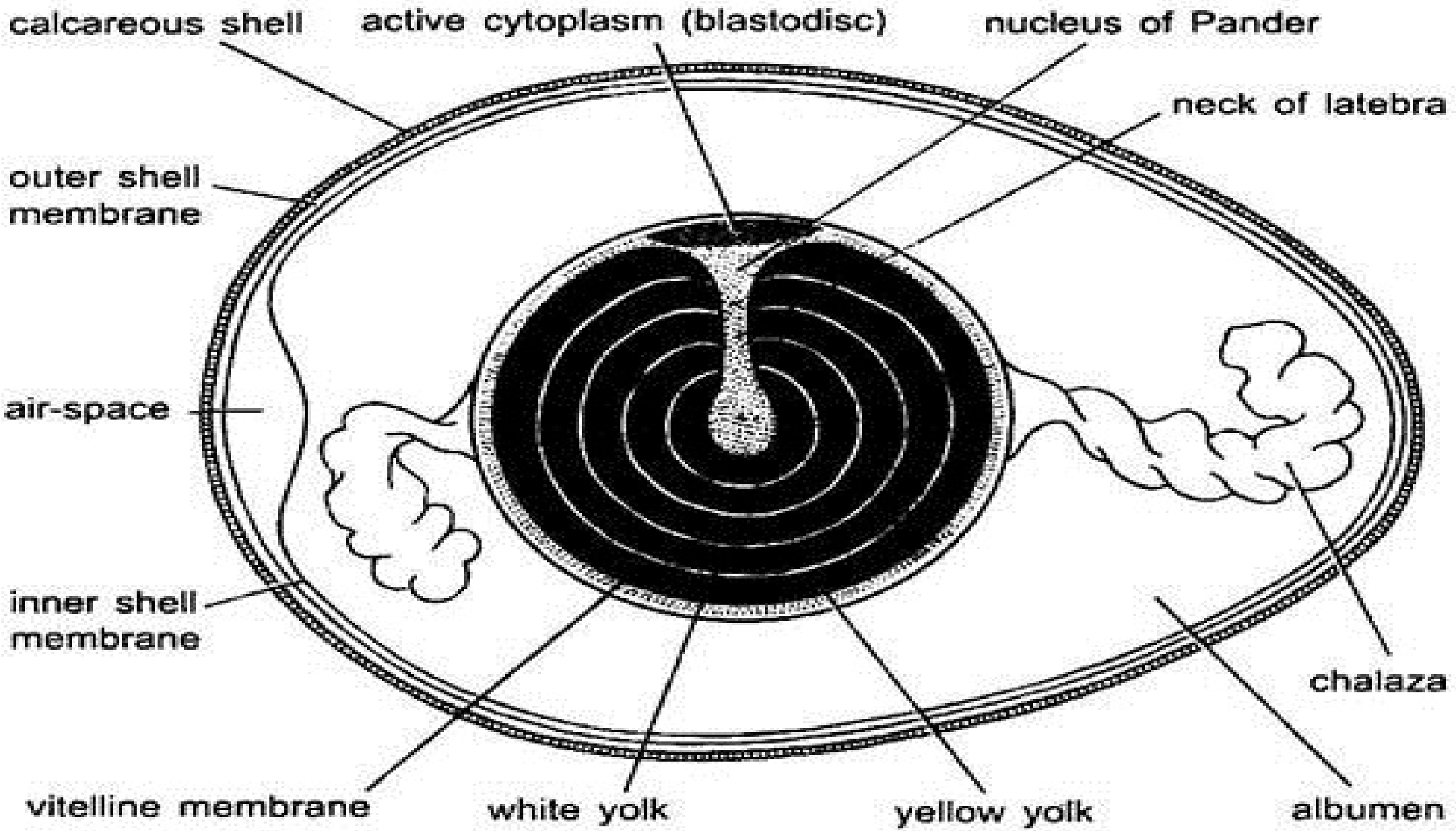
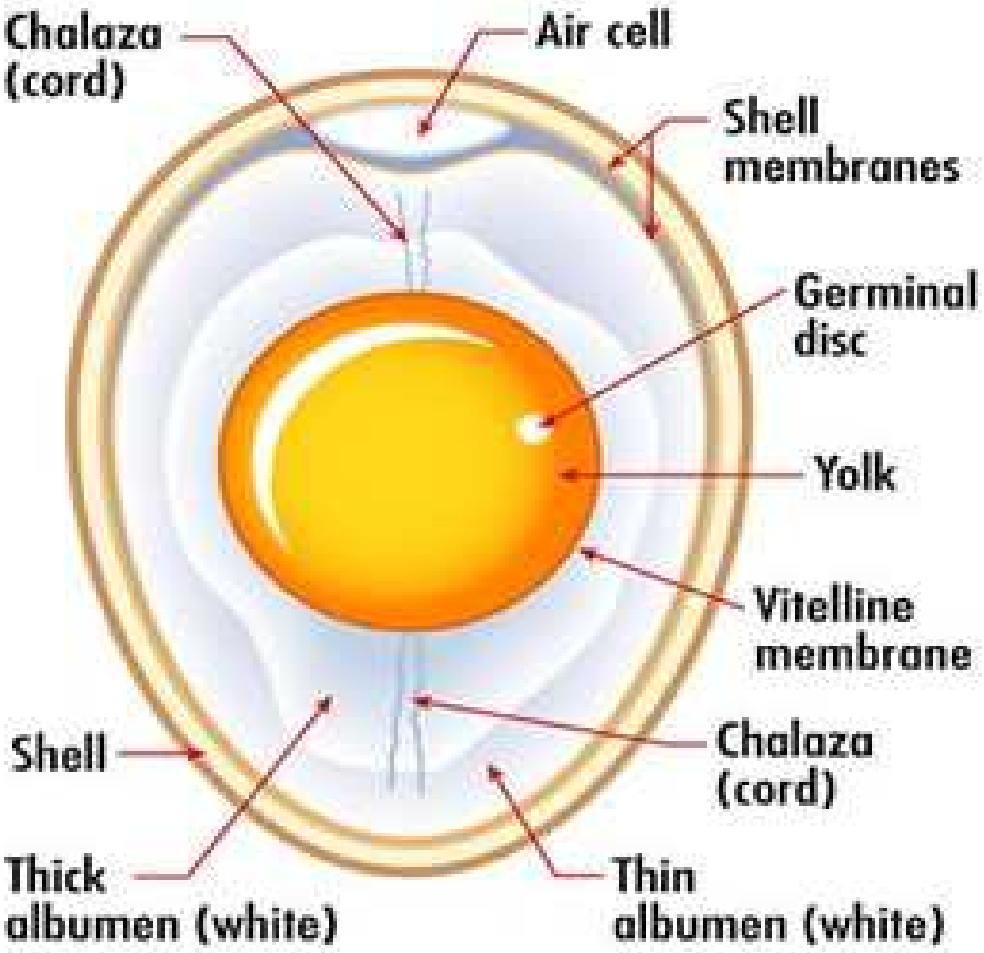


Fig. 38.1. Diagrammatic longitudinal section of a hen's egg.

Structure of hen's egg

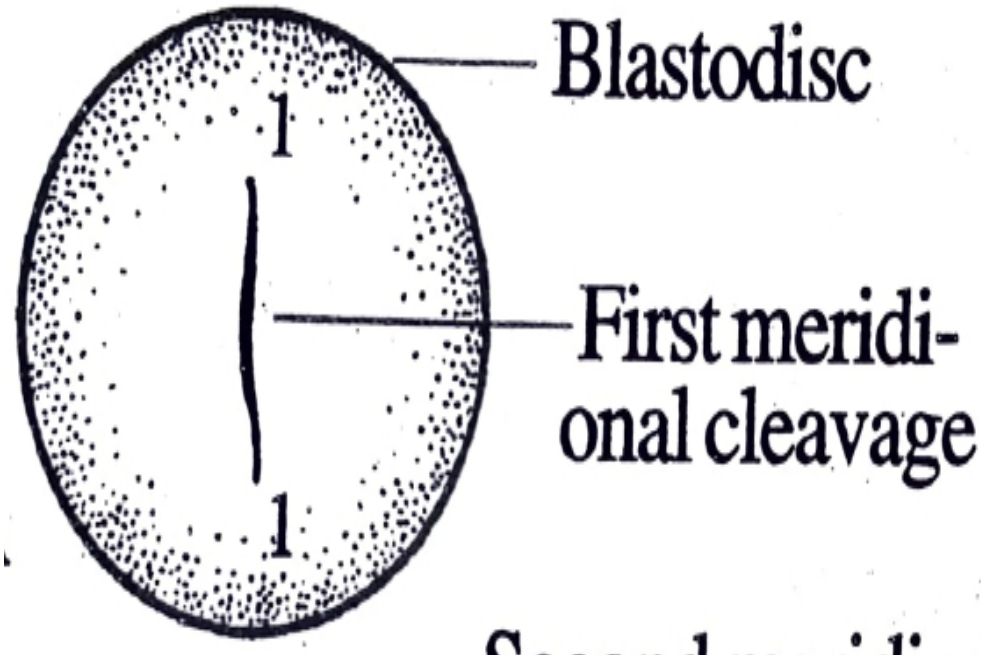


Development of chick- cleavage

- Cleavage is the successive mitotic division of the zygote into continuously diminishing sized cells and result in blastula.
- Cleavage is restricted to blastodisc and the yolk remains uncleaved. Such cleavage is called meroblastic or discoidal cleavage.
- The central part of blastodisc is whitish and circular. It is surrounded by a darker marginal zone known as the periblast, which merges with the underlying white yolk.

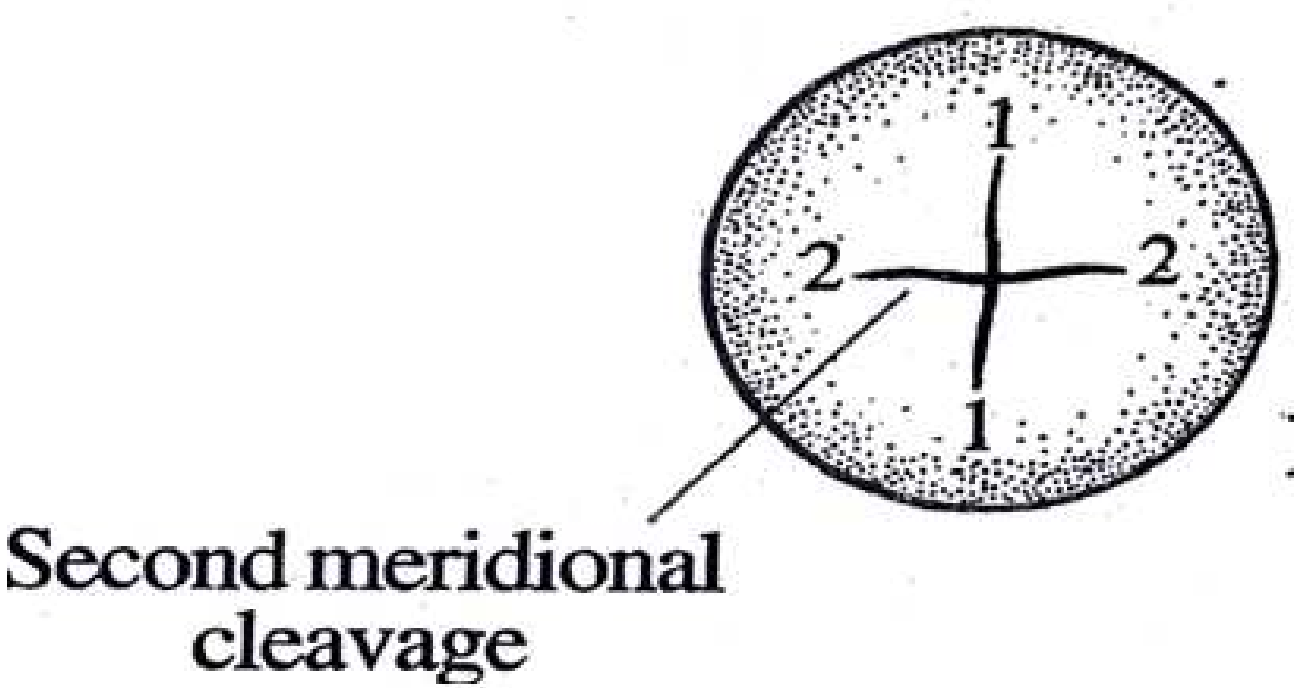
Chick Cleavage- I

- After five hours of fertilization the first cleavage will appear. It is confined to the centre of blastodisc.
- It is meridional in plane.
- It cannot completely divide the blastodisc.
- Blastomeres are not formed



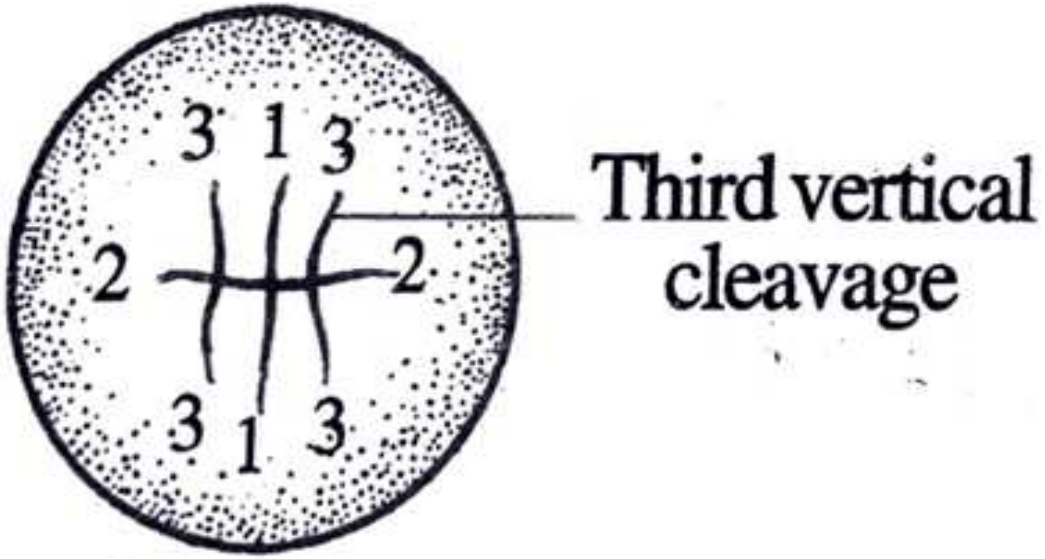
Chick Cleavage- II

- Second cleavage plane is also meridional.
- It takes place at right angles to first cleavage.
- Even because of second cleavage clear blastomeres are not formed.



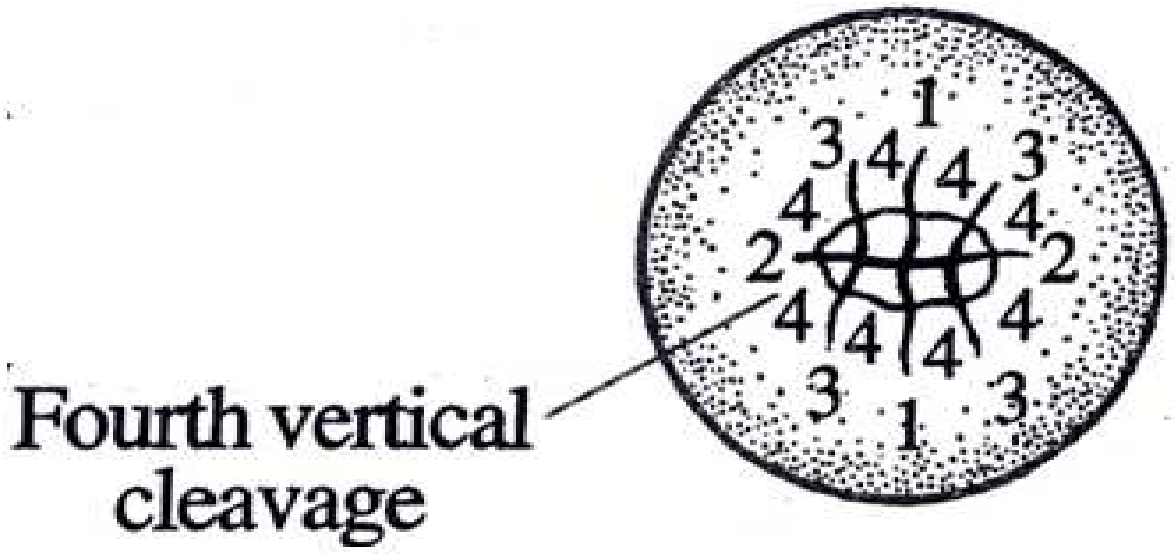
Chick Cleavage- III

- The third cleavage consists of two furrows lying at right angle to the seemed one.
- It is vertical and parallel to the first division.
- It is in the two sides of first division.
- As a result of this division eight blastomeres are formed.
- But they do not show boundaries.



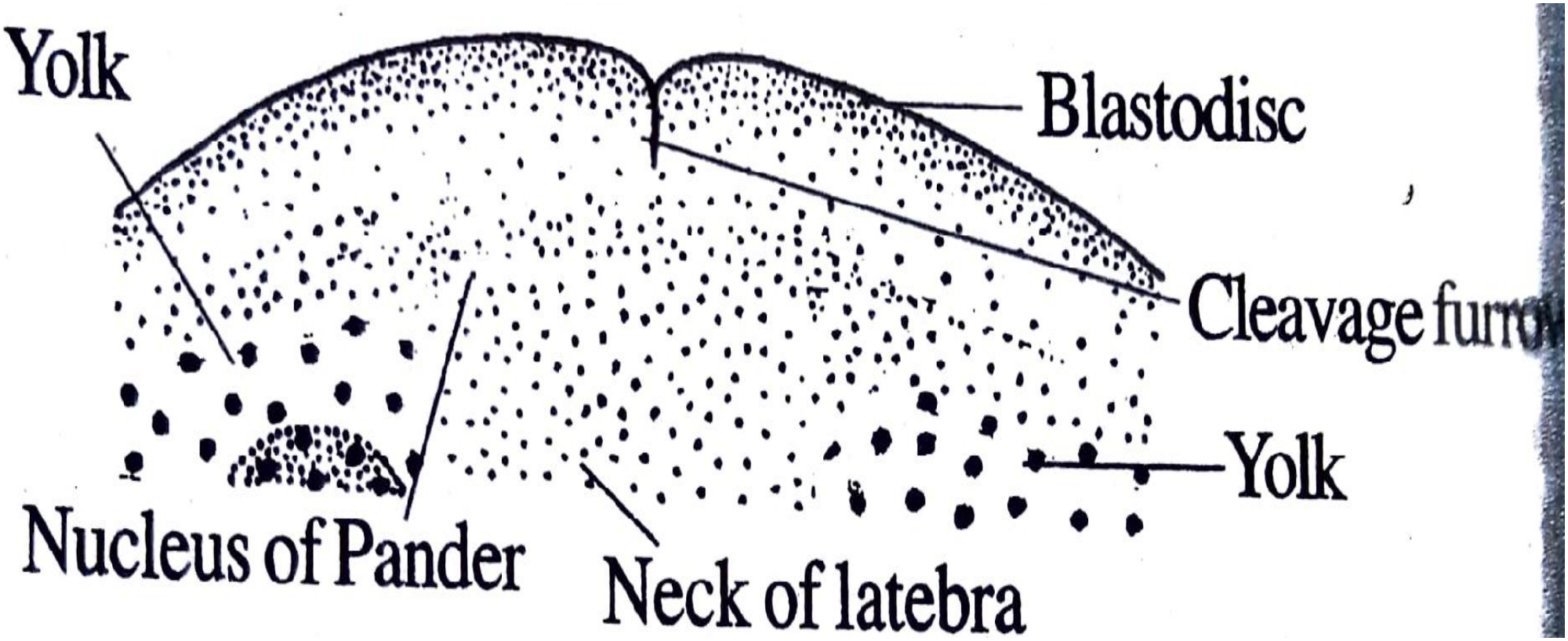
Chick Cleavage- IV

- The fourth cleavage takes place in such a way that eight central blastomeres and eight peripheral blastomeres (marginal blastomeres) will form.
- Only at this stage of division definite cells are formed.
- The central eight cells are completely separated from yolk.



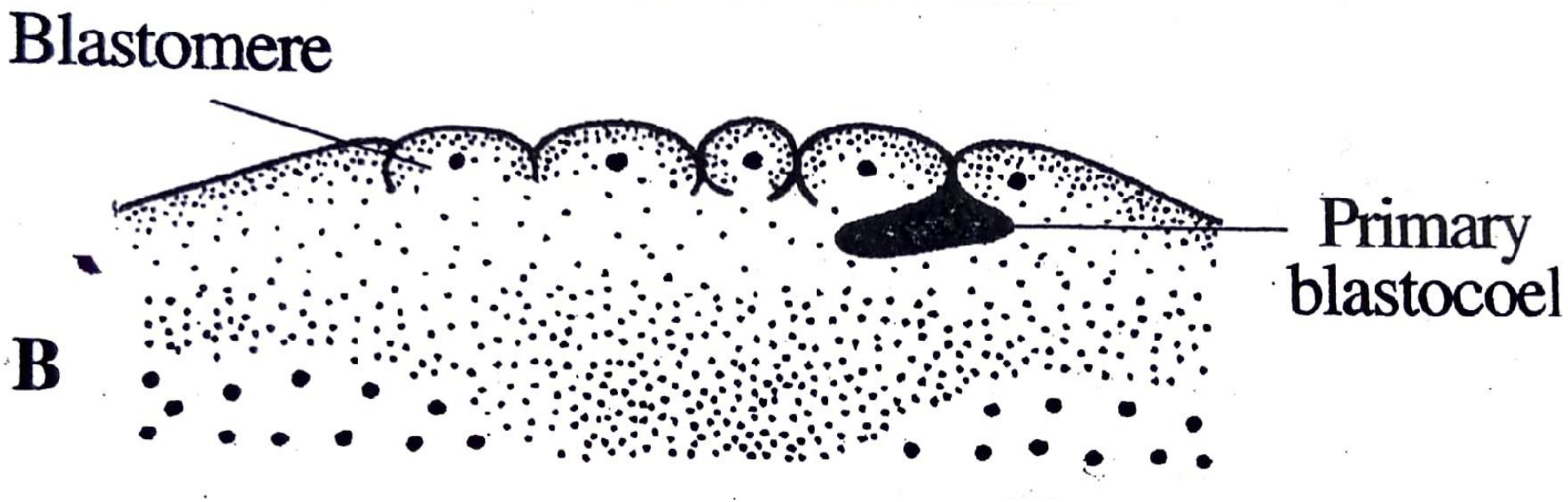
Blastoderm

- After fourth cleavage the cleavages are irregular and a blastoderm is formed.
- The cleaving blastodisc is called blastoderm.



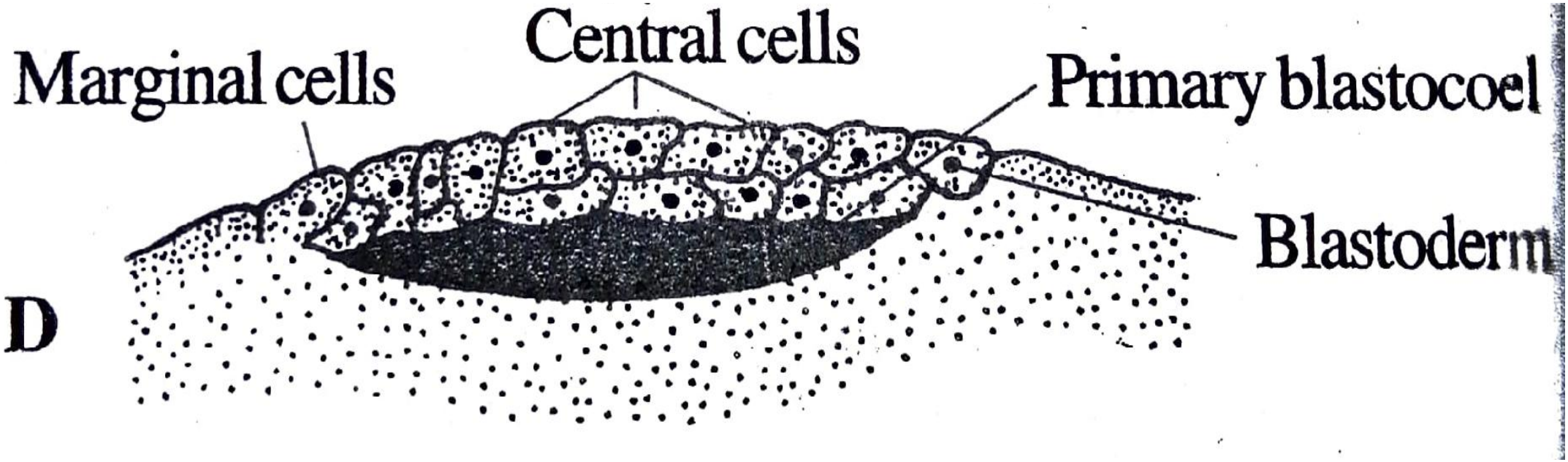
Primary blastocoel

- A horizontal cleft appears below the central cells.
- This cleft cuts off a single superficial layer of central cells from the undivided cytoplasm beneath.
- A fluid then begins to collect between this layer of cells and the cytoplasm→ Establishes a shallow space called primary blastocoel or segmentation cavity or sub-germinal cavity.



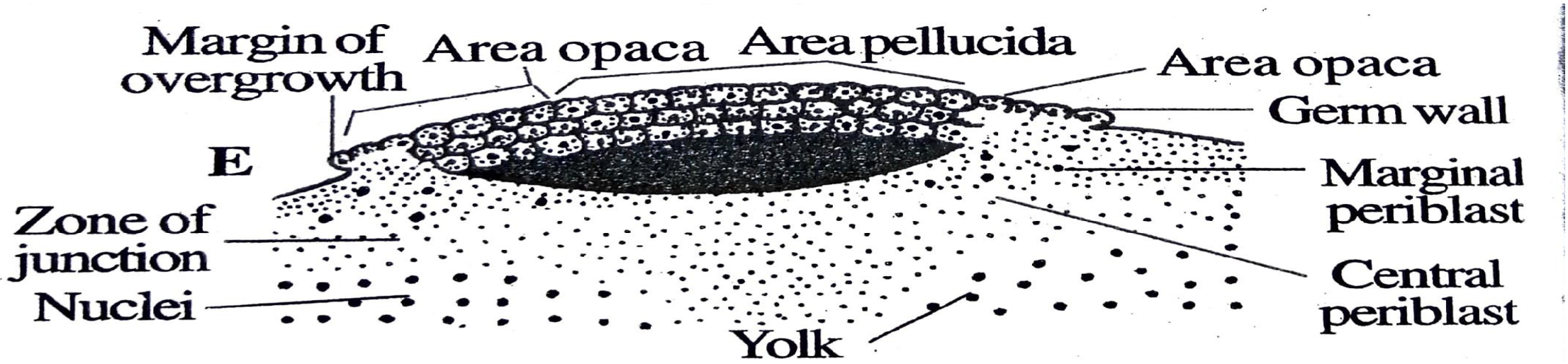
Horizontal cleavage

- As the primary blastocoel is being formed, a single layer of central cells is formed above the cavity.
- Then a horizontal cleavage furrow appears among the central cells.
- This cleavage furrow is parallel to the surface. → As a result, the single layer of central cells is converted into two layer above the primary blastocoel.



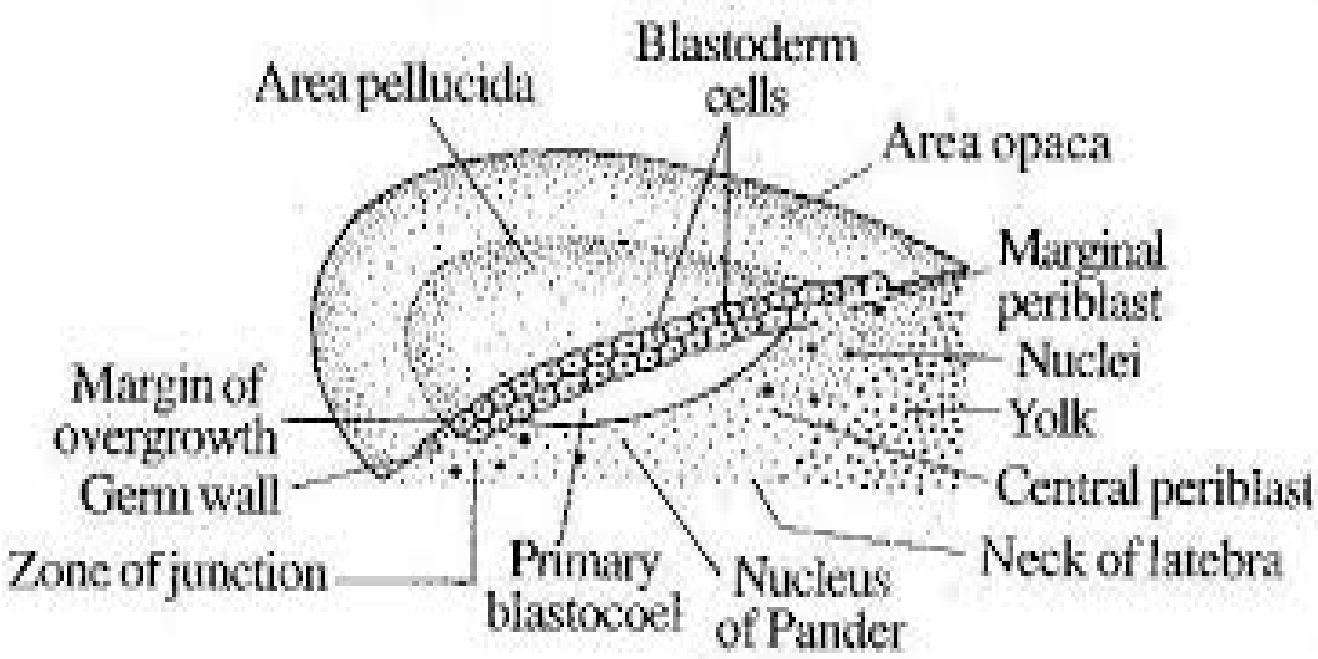
Periblast tissue

- As cleavage proceeds, some of the nuclei from the dividing blastoderm area enter the uncleaved portion of the cytoplasm located around and below the enlarging primary blastocoel.
- These nuclei arrange themselves here and there in the cytoplasm. This mass of cytoplasm is converted into a syncytial mass.
- This syncytial cytoplasm is called periblastic tissue. It is made up of two general areas, namely peripheral periblast and central periblast.
- The peripheral periblast lies around the margin of the blastderm and central periblast lies beneath the rim of the primary blastocoel.

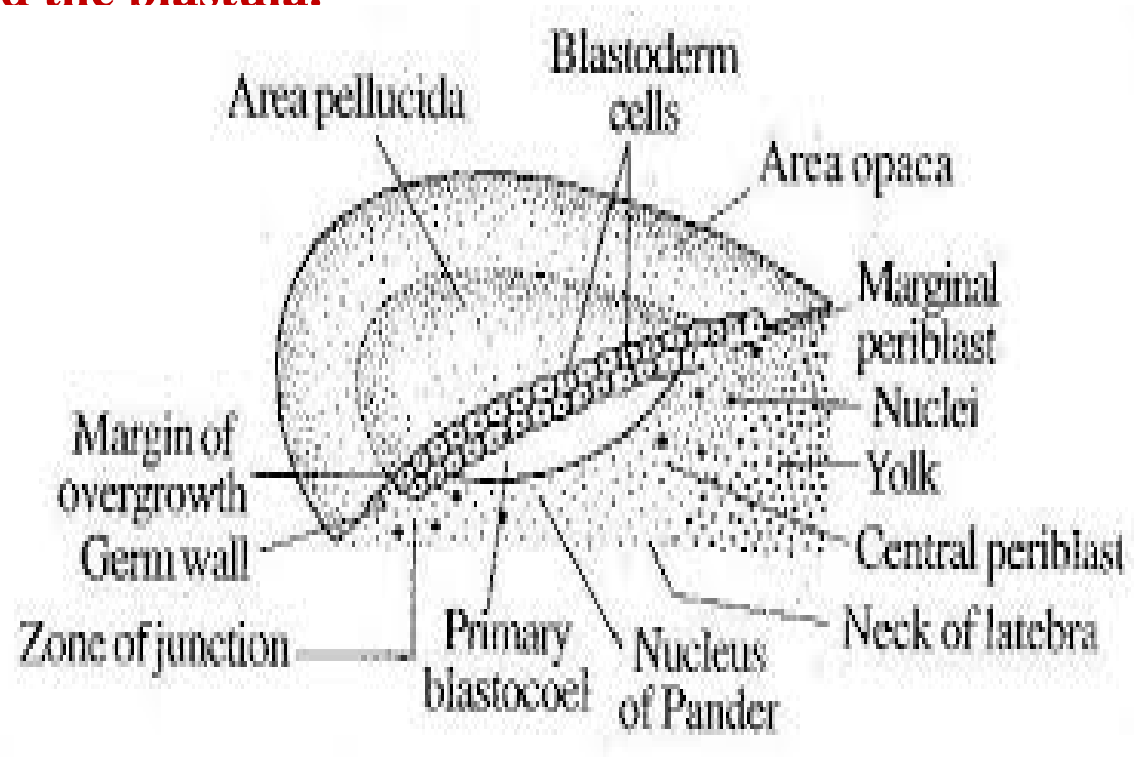


Chick development - BLASTULATION

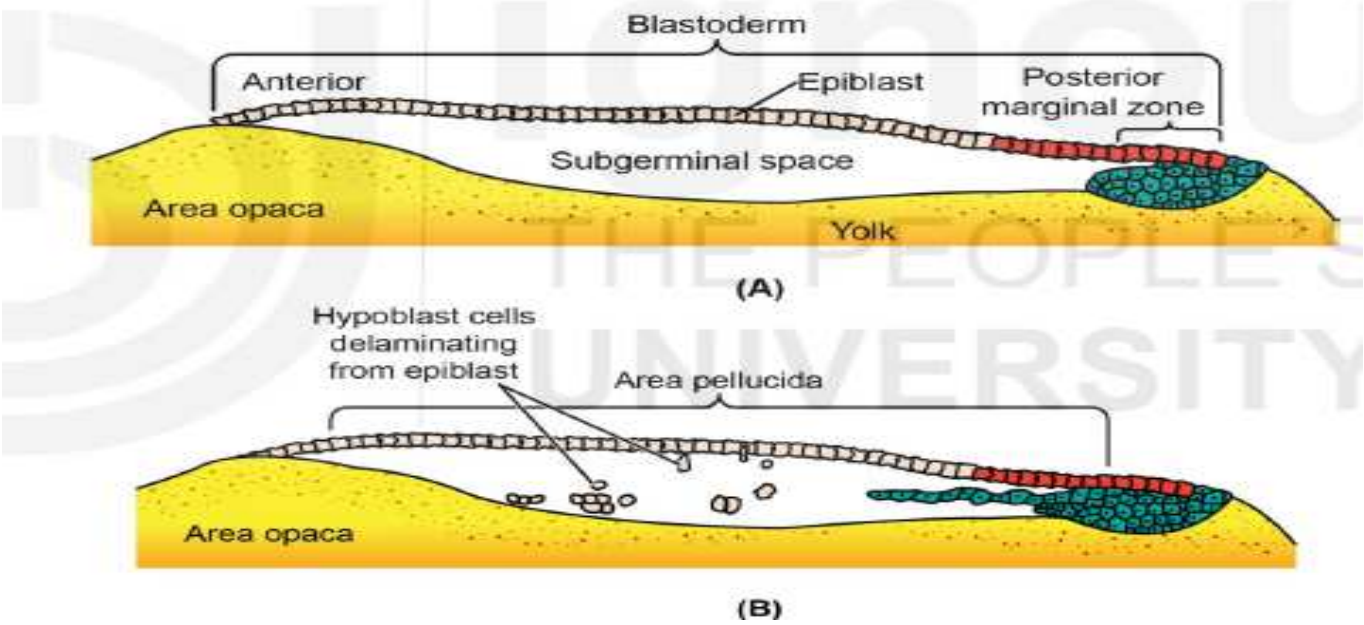
- **Blastula is an embryonic stage formed by cleavage. The blastula of chick is discoidal in → Discoblastula.**
- **Discoblastula consists central mass of cells called blastoderm. Below the blastoderm, there is a cavity called primary blastocoel or segmentation cavity.**
- **The primary blastocoel is located in the central part of the blastula. As a result, the central part of the blastoderm is free from the yolk and the peripheral part is closely adhering to the yolk.**



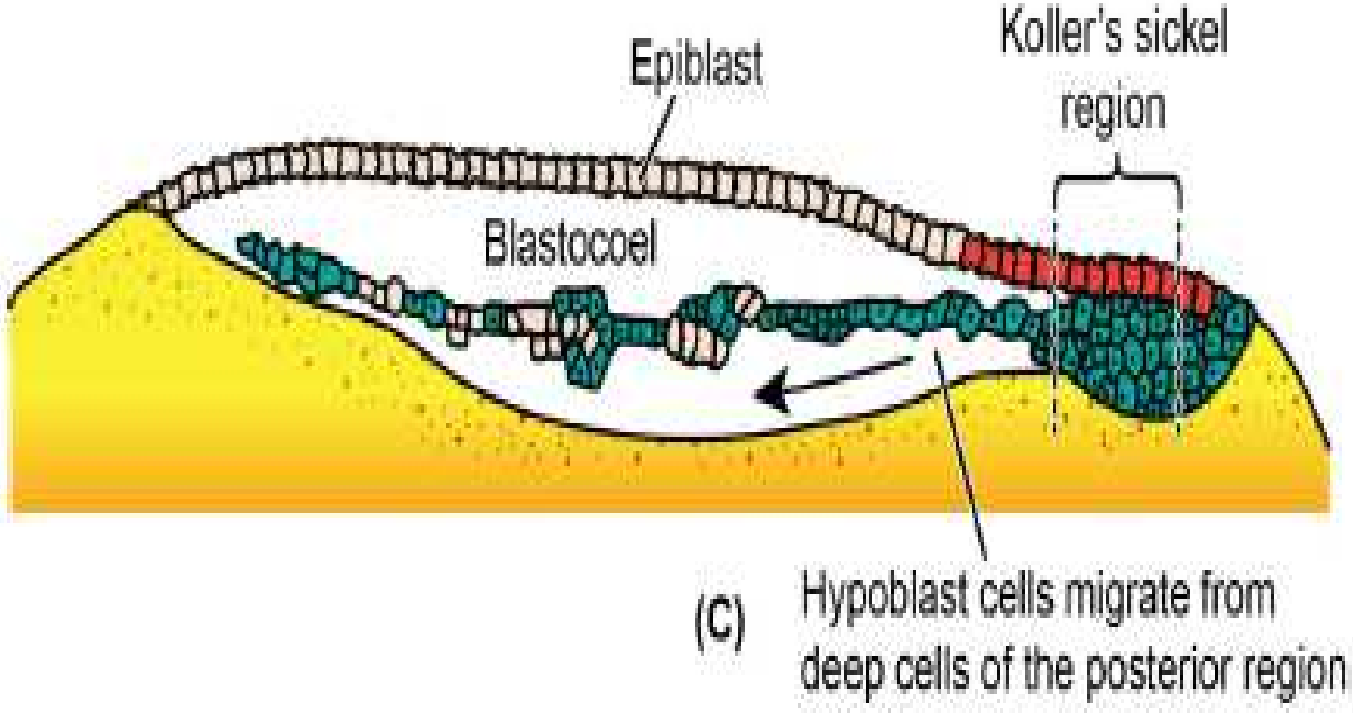
- **The central transparent part of the blastoderm is called Area Pellucida and peripheral opaque region is called Area opaca.**
- **The Area Pellucida gives rise to embryonic tissue and Area Opaca gives rise to extra embryonic tissue.**
- **Between the area pellucida and area opaca is a thin layer of cells which is known as marginal zone. The embryo is now called the blastula.**



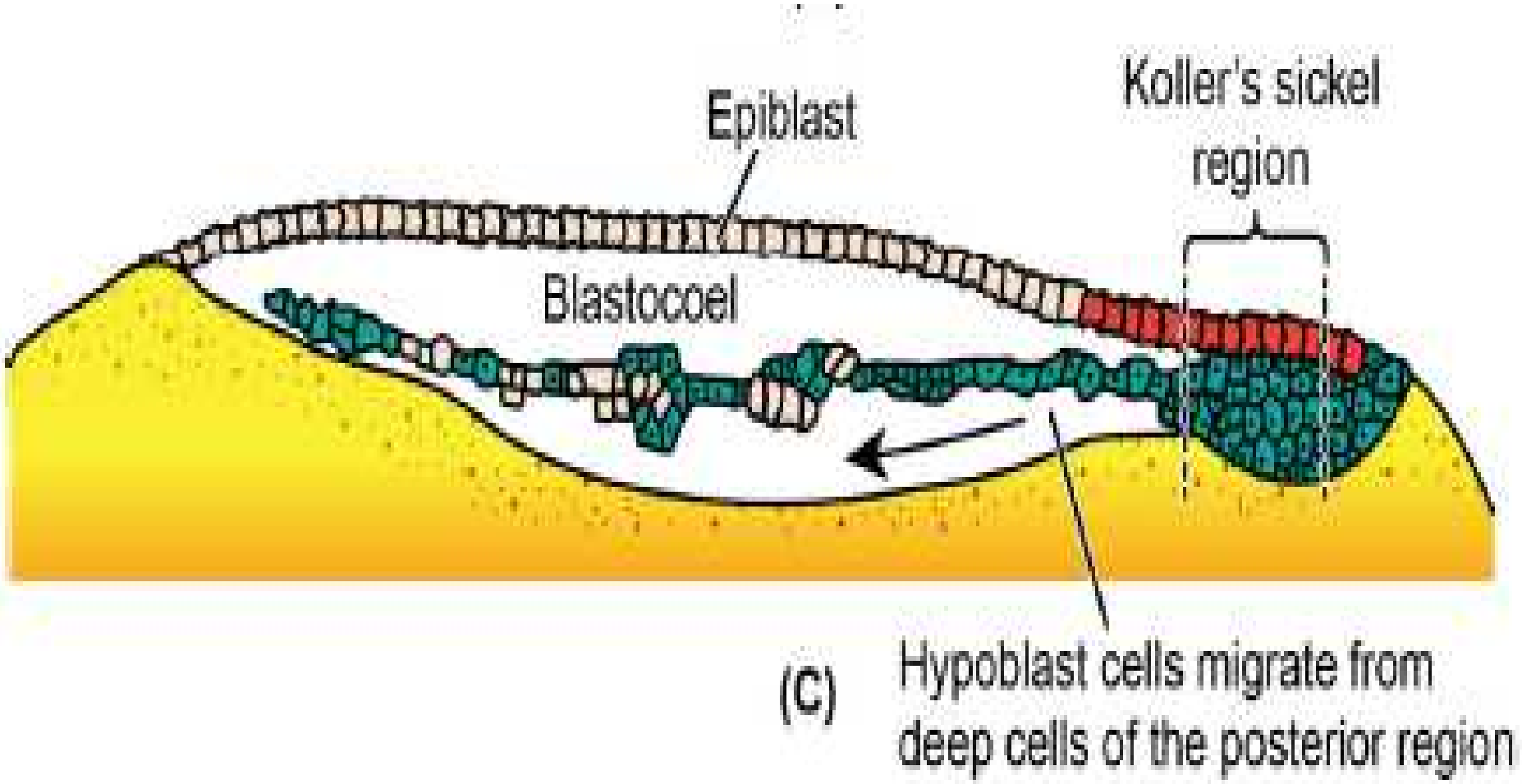
- **At blastula stage the embryo reaches the uterus.**
- **The egg is laid by the female about the time the blastula is formed. At the time of laying, the blastoderm is composed of 20,000 to 60,000cells. Most of the cells of the area pellucida remain at the surface, forming an "upper layer" called the epiblast.**
- **Shortly before the egg is laid some cells delaminate from the epiblast and ingress into the subgerminal cavity in clusters forming the primary hypoblast.**



- At the same time a sheet of cells begins to delaminate and migrates from the posterior edge of the area pellucida under the surface.
- These delaminated cells at the posterior edge of area pellucida gradually link up with each other and with the primary hypoblast, to form a continuous layer of flattened cells, which lie over the yolk on the floor of the subgerminal cavity. This layer is called as **secondary hypoblast or endoblast.**



- **The upper layer of the blastoderm is the epiblast containing ectoderm and mesoderm cells. Hypoblast is exclusively composed of endoderm cells.**



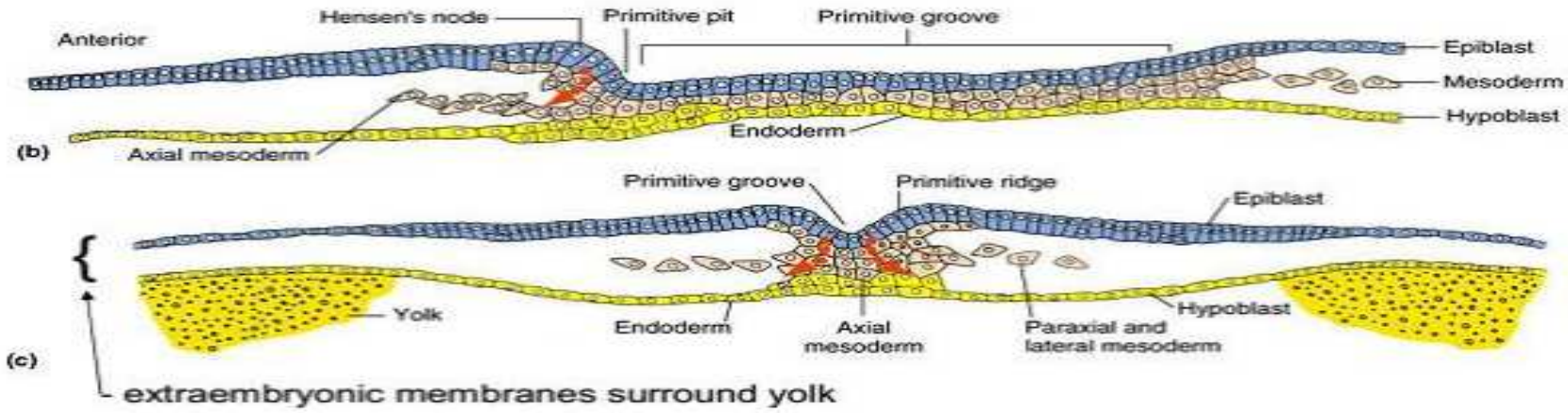
Development of chick- Gastrulation

- Gastrulation is a prolonged process initiated soon after the beginning of incubation after laying of the egg and is completed in about 4 days.
- The gastrulation is the conversion of blastula into gastrula by morphogenetic movement.
- It is preceded by some pre-gastrular movements of certain cells resulting in their separation from the blastoderm and formation of a lower layer called the hypoblast.
- Cells that remains at the upper layers of the blastoderm constitute the epiblast.

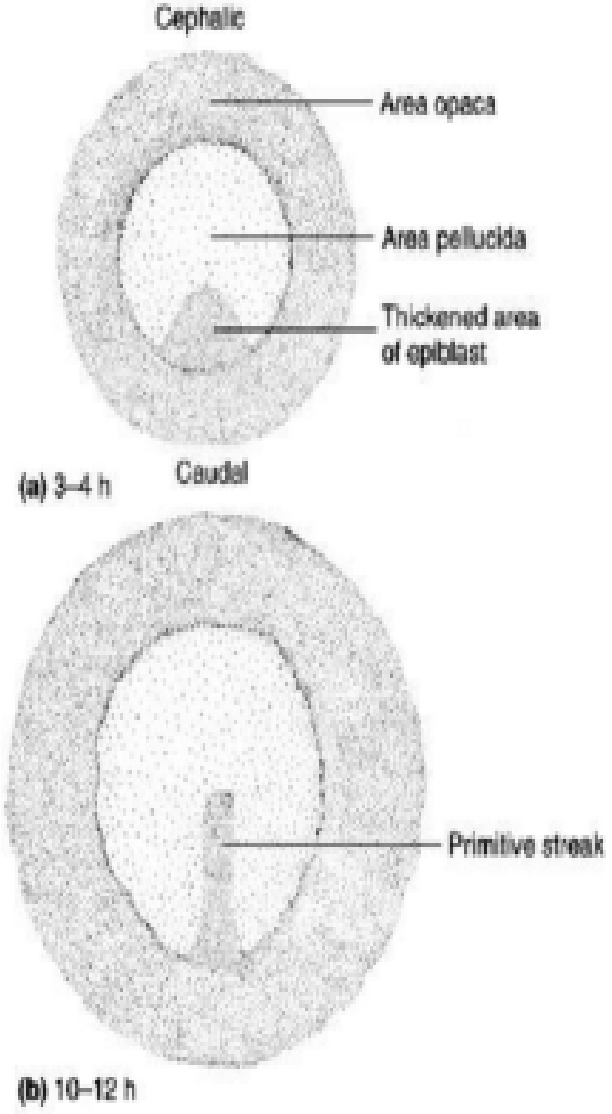
- Morphogenetic movement results in the formation of the germ layers namely, ectoderm, mesoderm and endoderm.
- Gastrulation takes place by convergence, involution, divergence and elongation.
- The process of gastrulation is a complicated process and is expressed as primitive streak.
- The formation of primitive streak takes place at about 18 hours.

Development of chick - origin and development of primitive streak

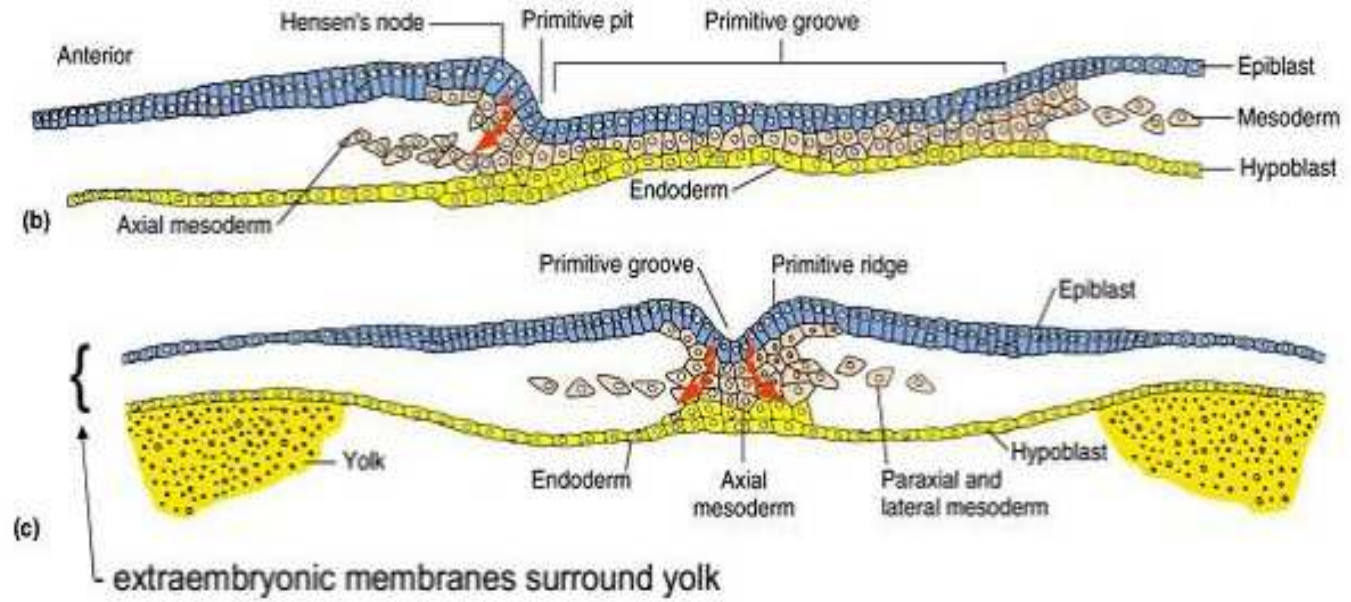
- The **primitive streak** formed on the epiblast surface during the first 10-18 hours of incubation at 37.5-385°C.
- The primitive streak can be considered as the equivalent of an elongated blastopore lip of amphibian embryos.
- It forms as a result of convergence of epiblast cells to the dorsal midline of the blastoderm.



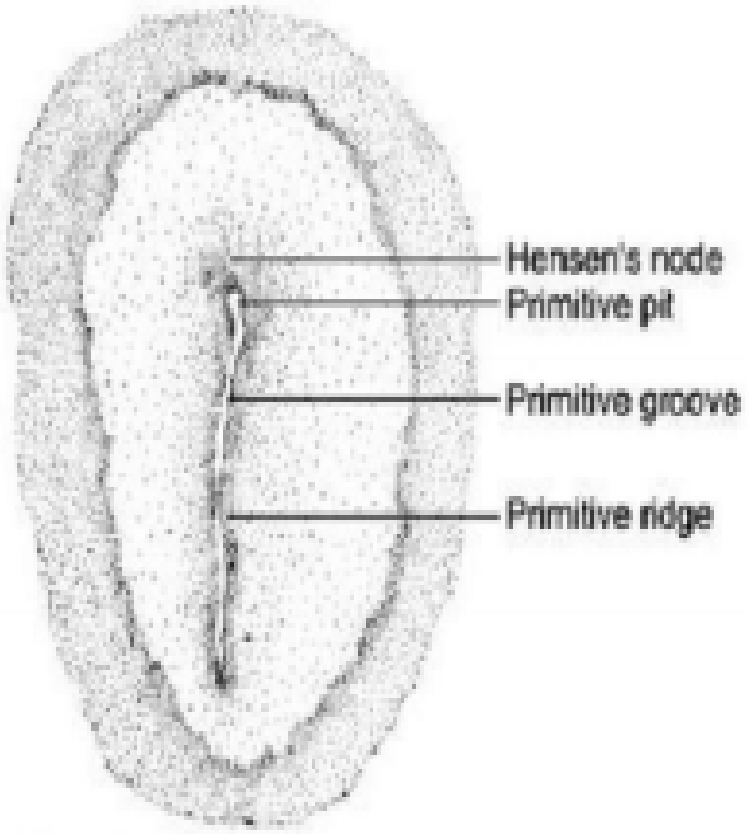
- There is a great tendency to form blastopore due to heavy yolk it is not possible.
- This tendency makes the prospective mesoderm material to push along the mid anterior side.
- This results in the formation of primitive streak. Material from the posterior lateral side reaches the streak, undergo involution and diverge on the same side.



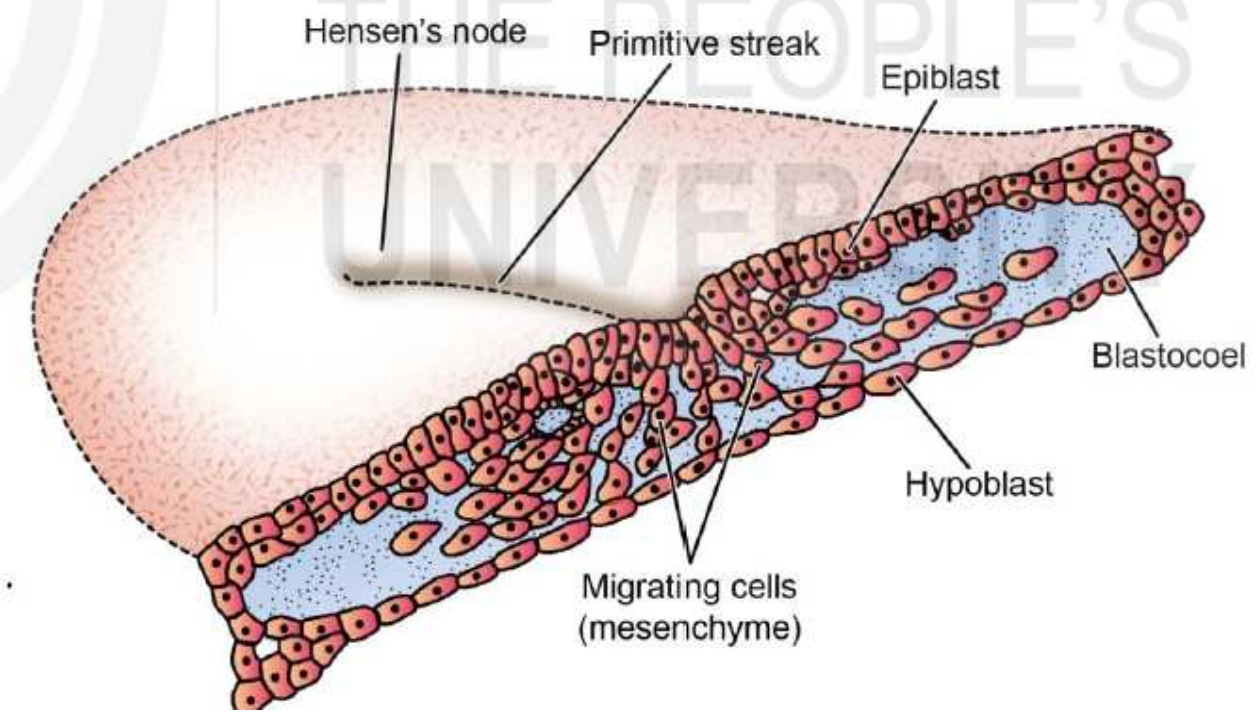
- Primitive streak is a structural expression of gastrulation.
- Fully formed primitive streak consists of a primitive groove and primitive folds on its either side
- Primitive streak is homologous to the blastopore lip then the primitive groove is homologous to the amphibian blastopore.
- Continued convergence of more and more lateral mesoderm results in the anterior elongation of the primitive streak.



- In addition to convergence another kind of movement viz., forward streaming and stretching takes place.
- Circular area pellucid now assumes pear shape. In this way short primitive streak becomes definitive primitive streak.

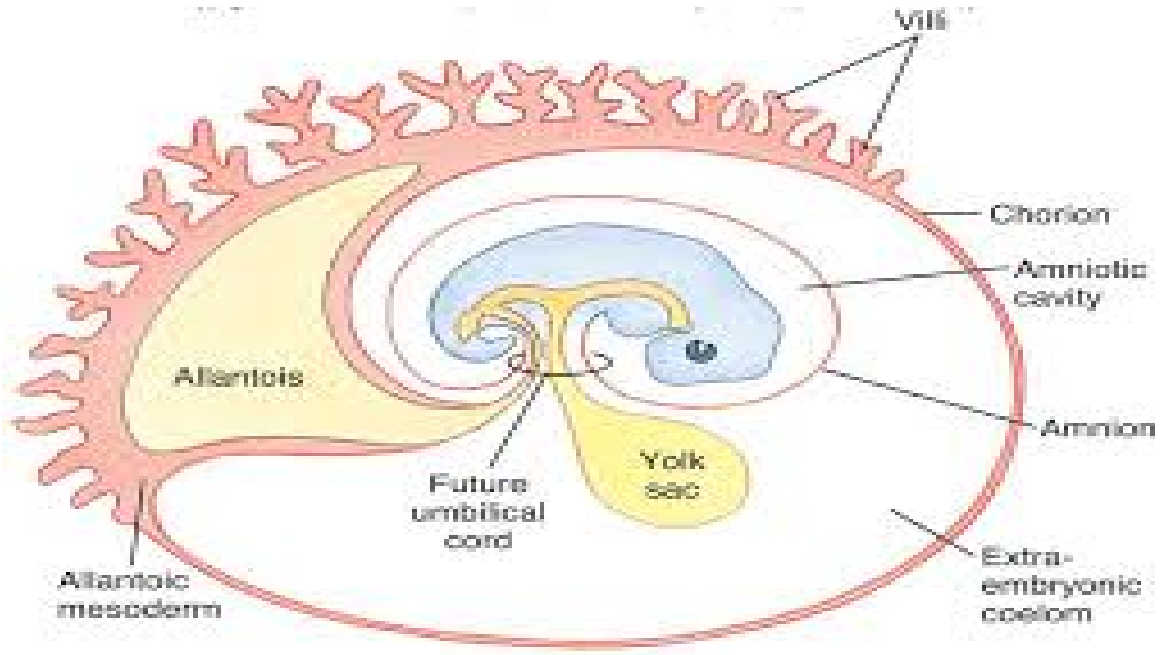


- The primitive streak extends anteriorly upon about three fourth the length of area pellucida where it ends in a deep pit called **Hensen's Node** with thick borders.
- Hensen’s node is the functional equivalent of the dorsal lip of the amphibian organizer.
- Posterior end of the primitive streak is comparable to the ventral region of the blastopore which forms future anus.



FOETAL MEMBRANES

- The embryos are covered and protected by a set of membranes called foetal membranes.
- These membranes are developed from the tissue lying outside the embryo. Hence they are also called extra-embryonic membranes.
- The main function of the foetal membranes are to provide protection, nutrition, respiration and excretion to the embryo.
- All the foetal membranes disappear before or immediately after hatching.
- Types of foetal membranes
  - **CHORION**
  - **AMNION**
  - **ALLANTOIS**
  - **YOLK SAC**



DEVELOPMENT OF FOETAL MEMBRANES

- These membranes will develop from blastoderm cells.
- The central part of blastoderm will give embryo proper
- The marginal blastoderm will give extra embryonic membranes.
- Amnion and chorion will develop from somatopleurae, yolk sac and allontois, will develop from splanchnopleurae.

AMNION

- Amnion is a foetal membrane or extra embryonic membrane that covers foetus.
- The animals developing an amnion are called amniota.

Eg: Reptiles, birds and mammals

- The animals which do not develop an amnion are called anamniota. Eg: Fishes, amphians etc.

- Composed of two layer → an outer somatic mesoderm and inner ectoderm.
- It encloses the a cavity filled with amniotic fluid.
- The amnion is connected to the embryo on the ventral side by a stalk called somatic umblicus.

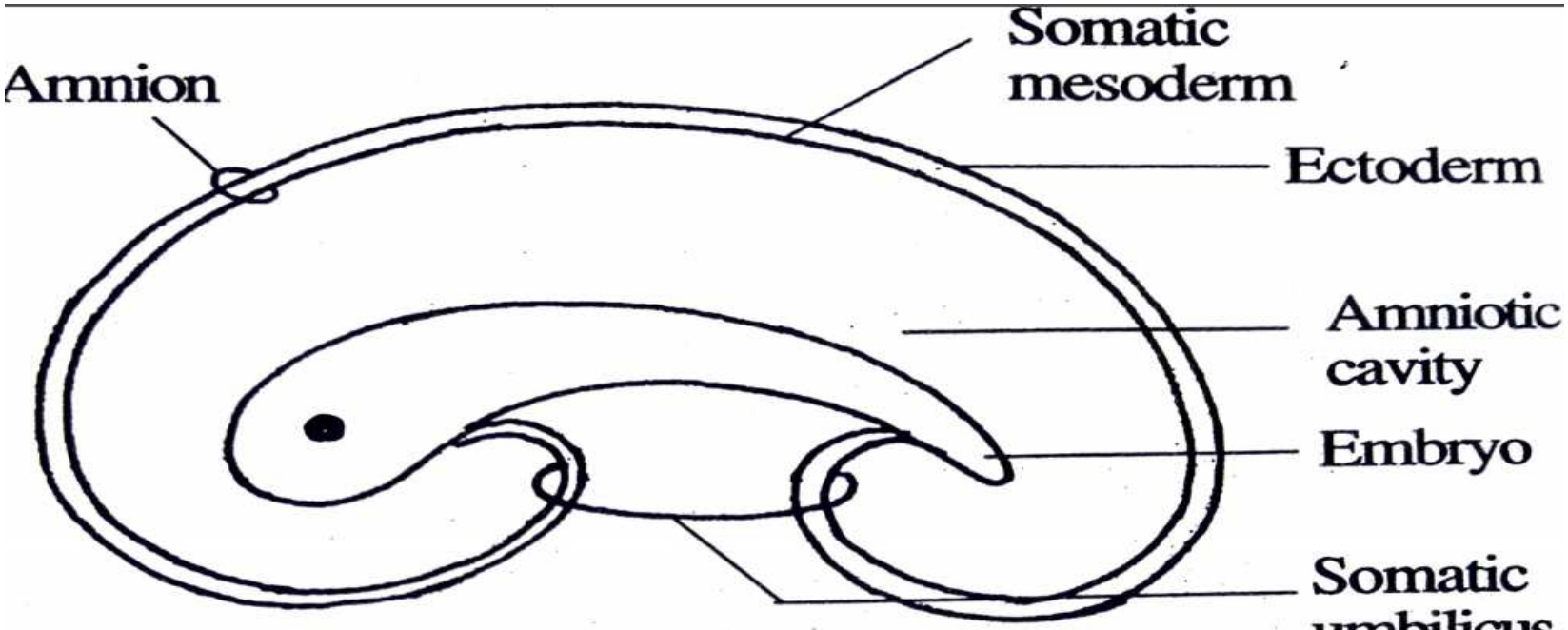


Fig.21.3: Amnion.

DEVELOPMENT OF AMNION

- Amnion develops from somatopleure. During development, the somatopleure develops certain folding called amniotic folds.
- The amniotic folds develop into amnion.
- Amnion ruptures at the time of hatching.

FUNCTION OF AMNION:

1. The amniotic fluid provides a liquid medium for the embryo.
2. It is called the artificial swimming pool of the embryo.
3. The amniotic fluid functions as a shock absorber.
4. It prevents the adhesion of the embryo to the shell.

CHORION

- It is also called serosa.
- It surrounds the entire embryo and lies outside. It lies close to the shell.
- It s made up of two layers, namely an outer ectoderm and inner somatic mesoderm.
- The cavity enclosed by the chorion is called extra-embryonic coelom.
- The chorion develops from somatopleure containing an outer ectoderm and inner somatic mesoderm.
- Chorion ruptures at the time of hatching.
- **Function:** Helps in respiration and protection

ALLANTOIS

- It develops from splanchnopleure.
- It is attached to the hindgut by a narrow stalk called allantoic stalk.
- Allantois is supplied by a allantoic arteries and a single allantoic vein.
- In later stage splanchnic mesoderm of allantois and somatic mesoderm of chorion fuse together to form a chorio-allantoic membrane.
- Allantois ruptures at the time of hatching.

Function:

- It is excretory in function→ collects the excretory products from the embryo.
- It helps in respiration.
- It absorbs calcium from the shell. This helps to rupture of the shell at the time of hatching.

YOLK SAC

- Yolk sac encloses the yolk.
- It is made up of an inner endoderm and outer splanchano mesoderm. It develops from splanchnopleure.
- It is attached to the midgut by a narrow stalk called yolk stalk.
- It opens into the midgut by an yolk duct.
- The endoderm of yolk sac has many finger-like folds called yolk sac septa.
- The yolk sac gradually decreases in size as the yolk is consumed.

The yolk sac provides nutrition for the embryo.

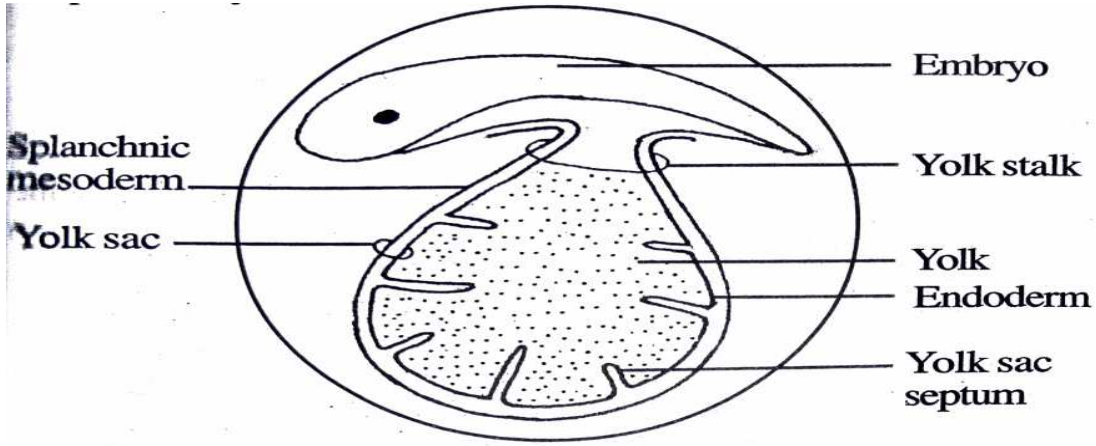


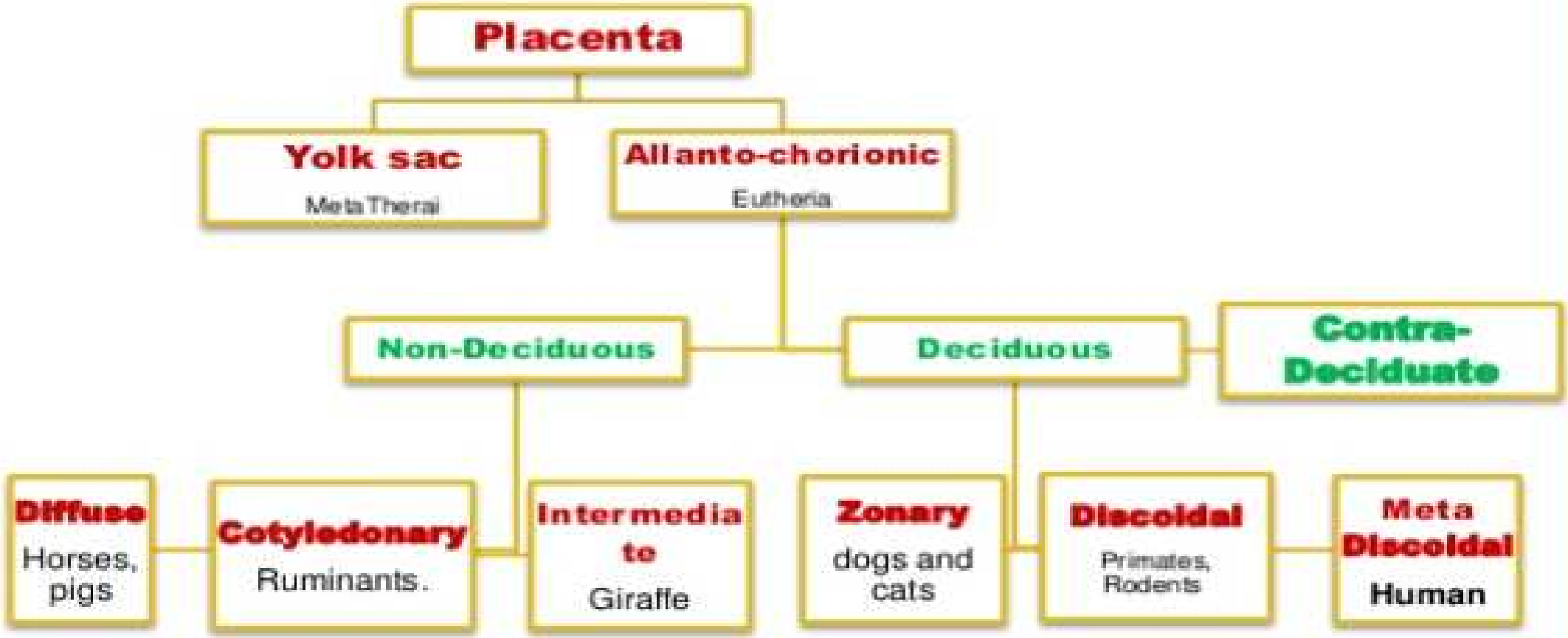
Fig.21.4: Yolk sac.

PLACENTA

- It is a special kind of tissue that connects between the mother and the foetus, formed by the inner lining of uterus and the foetal membranes → Found in mammals
- It is formed by the contributions of embryonic and maternal tissue. The process of formation of placenta is called placentation
- It serves mainly for the transport of nutrients and oxygen from the mother to the foetus.
- Forms a placental barrier and prevents the direct mixing of foetal and maternal blood cells.

CLASSIFICATION OF PLACENTA

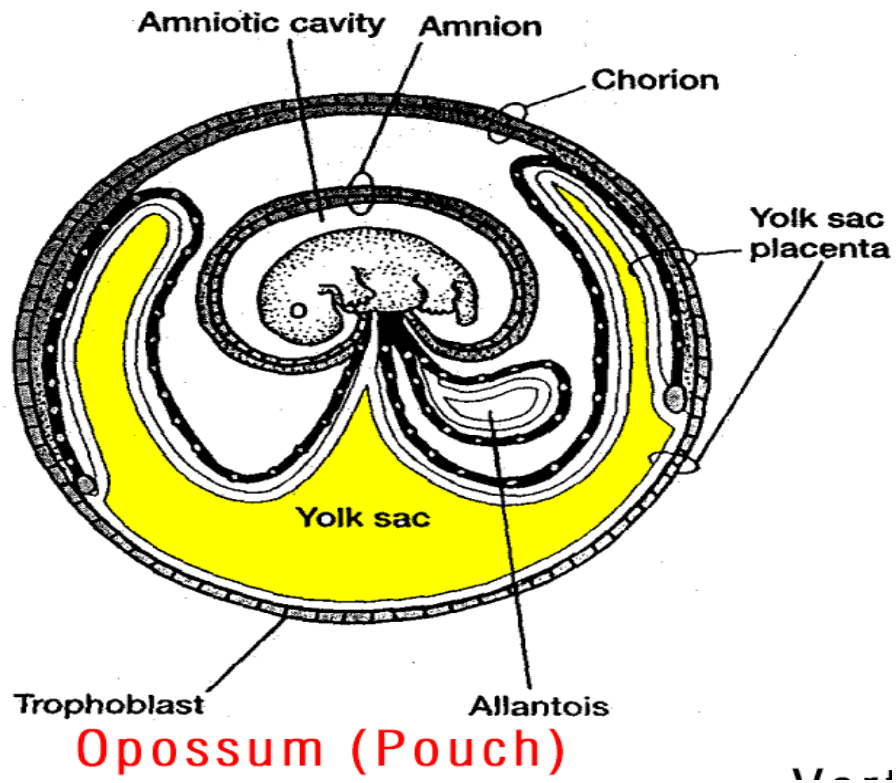
On the basis of origin of Villi



CLASSIFICATION OF PLACENTA BASED ON THE TYPE OF FOETAL MEMBRANES INVOLVED

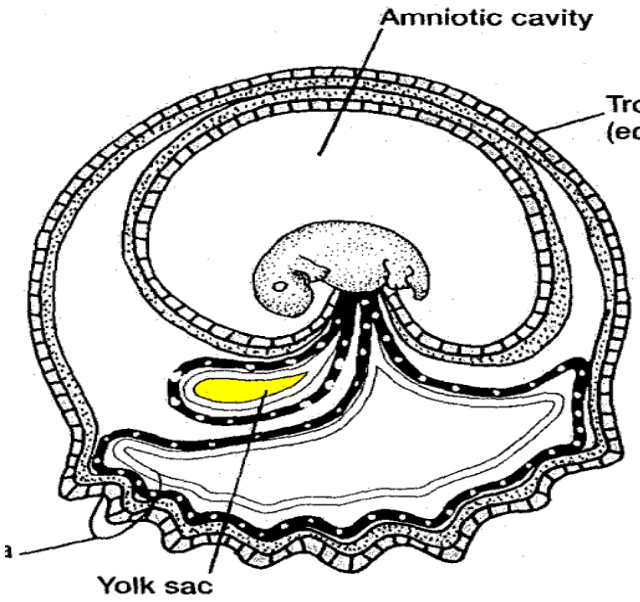
YOLK SAC PLACENTA

- Yolk sac placenta is formed by yolk sac and chorion. It is also called chorio-vitelline placenta or yolk sac placenta.
- Ex – Marsupials like Opossum



• CHORIO ALLANTOIC PLACENTA

- Chorio- allantoic placenta is formed of chorion and allantois. The allantois is so large that it comes in contact with the chorion.
- The allantois and chorion fuse together to form a membrane called chorio-allantoic membrane. This membrane is well vascularized by the allantoic arteries and veins.
- Ex- Eutherian mammals like Man, cow , dog etc.,



Mammal (Eutherian)

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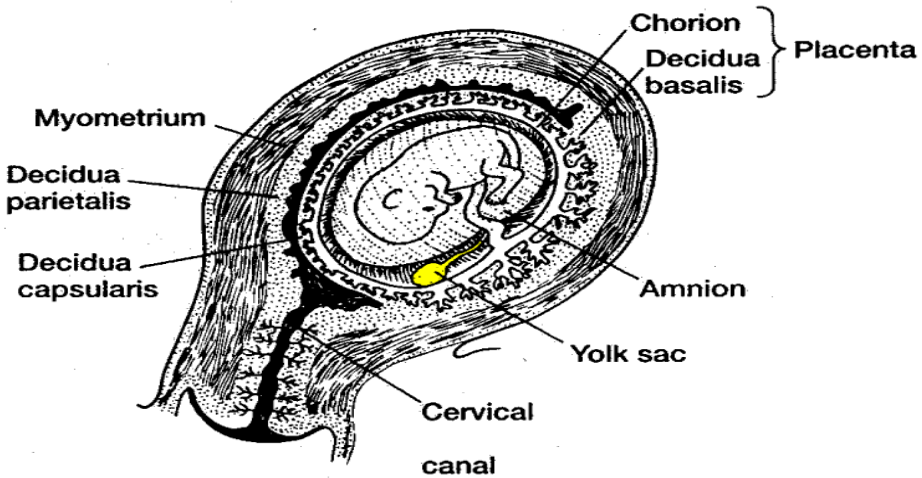
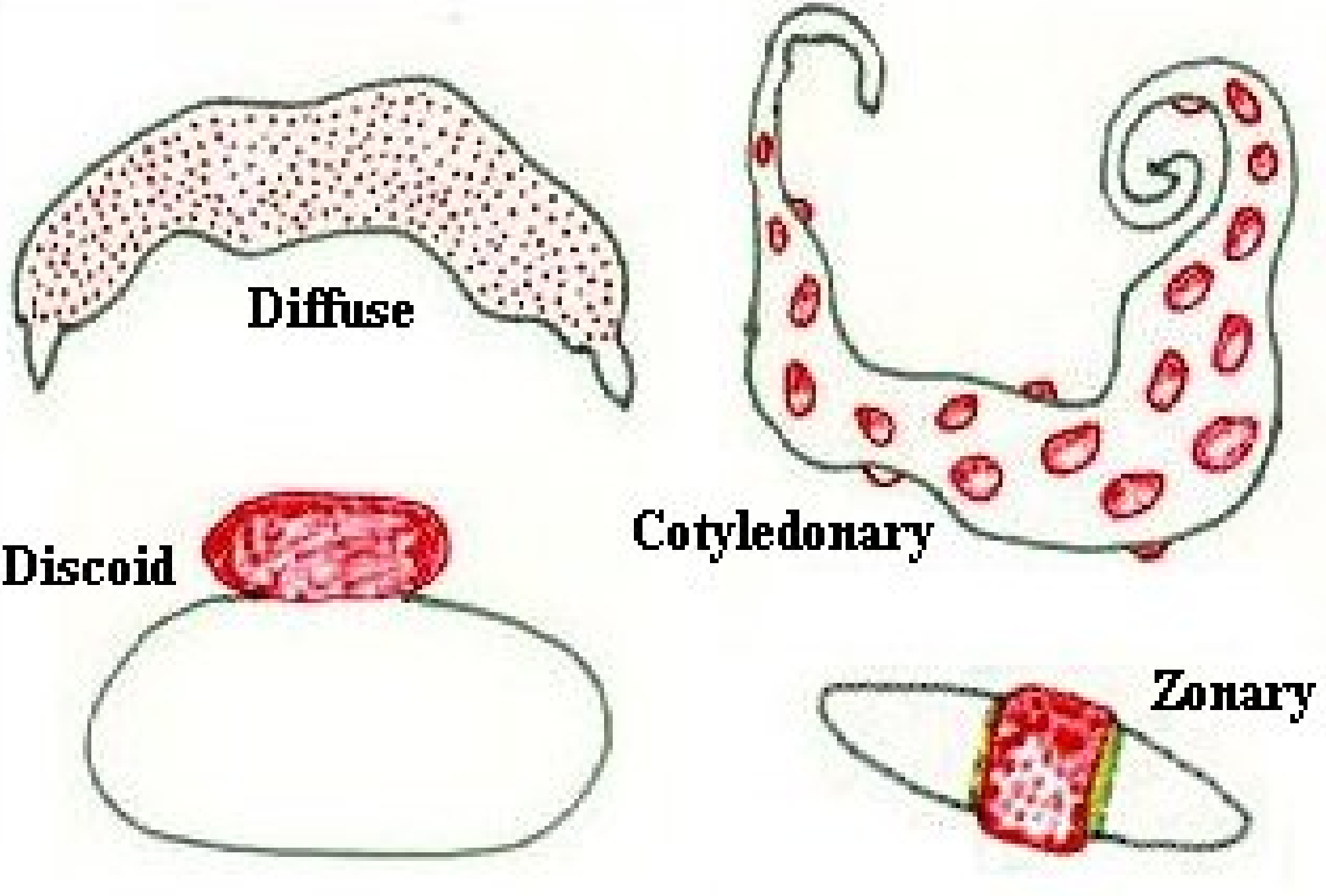


Human (eutherian)

CLASSIFICATION OF PLACENTA BASED ON THE DISTRIBUTION OF VILLI

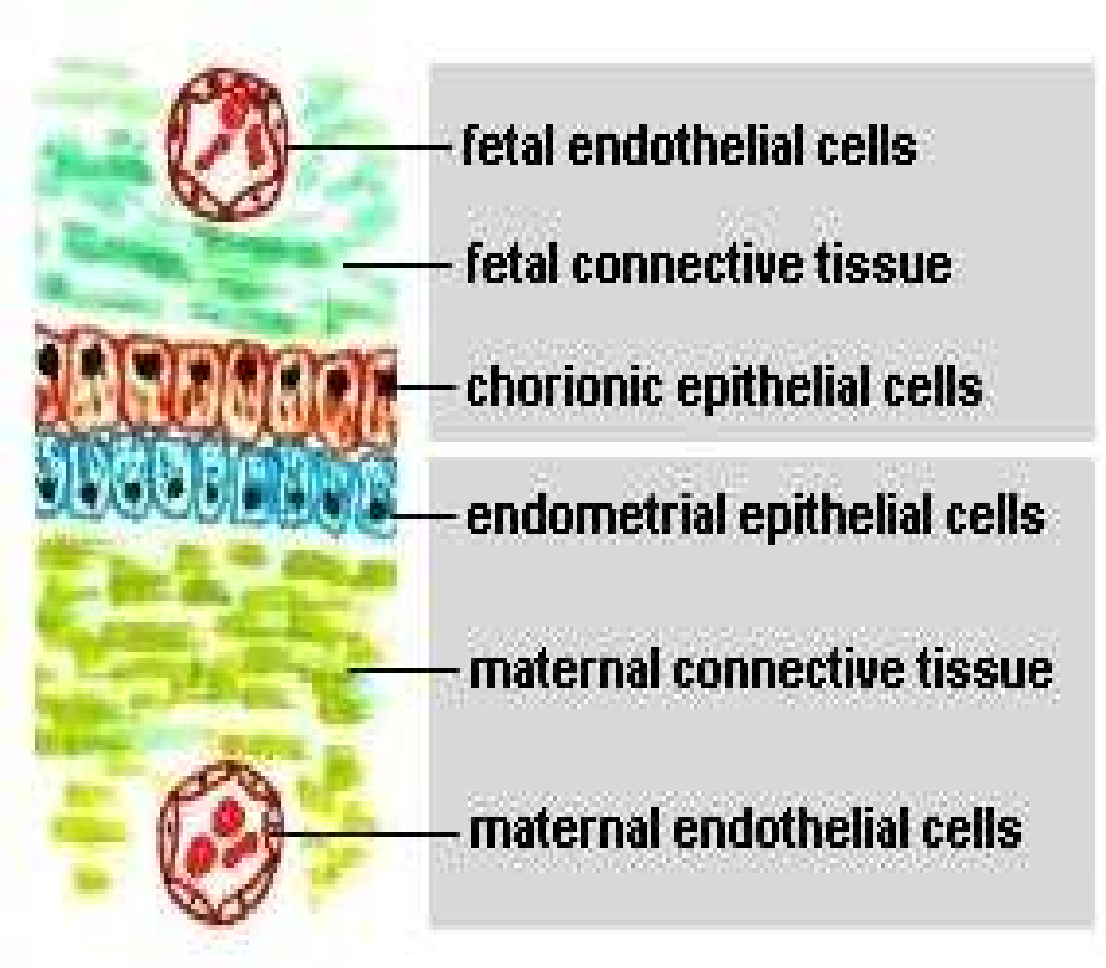
- The chorio- allantoic placenta, is classified into six types based on the distribution of villi on the surface of chorion.
  - Diffuse placenta – pig & horse
  - Cotyledonary placenta – sheep, cow & deer
  - Intermediate placenta- Camel & giraffe
  - Zonary placenta- Elephant, dog cat etc.
  - Discoidal placenta – Rat &Rabbit
  - Metadiscoidal placenta

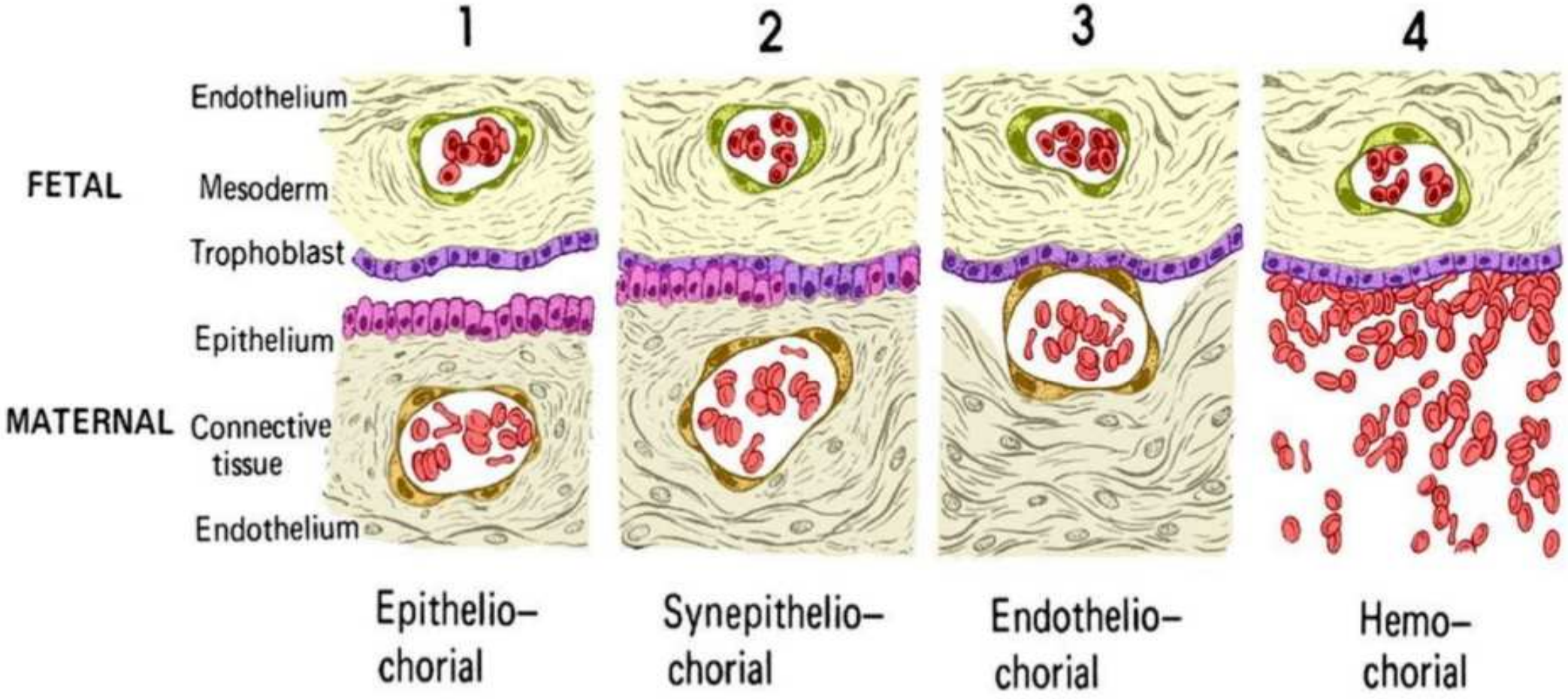
    1. Monodiscoidal – Man
    2. Bidiscoidal - Monkey


Diffuse
Cotyledonary
Discoid
Zonary

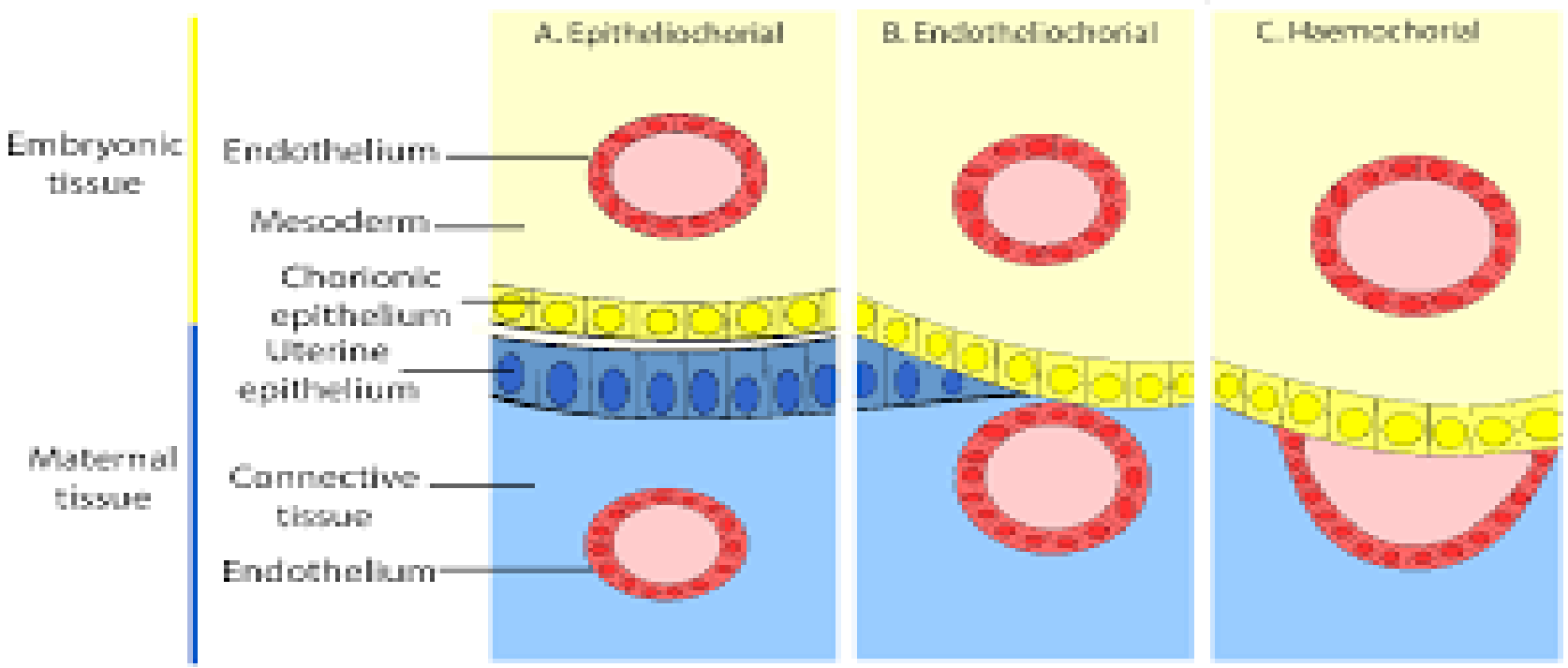
Classification of placenta based on the type of tissues involved - Histology

- Based on the tissue layer involved in the placenta.




1
2
3
4
Endothelium
FETAL
Mesoderm
Trophoblast
Epithelium
MATERNAL
Connective tissue
Endothelium
Epithelio–chorial
Synepithelio–chorial
Endothelio–chorial
Hemo–chorial

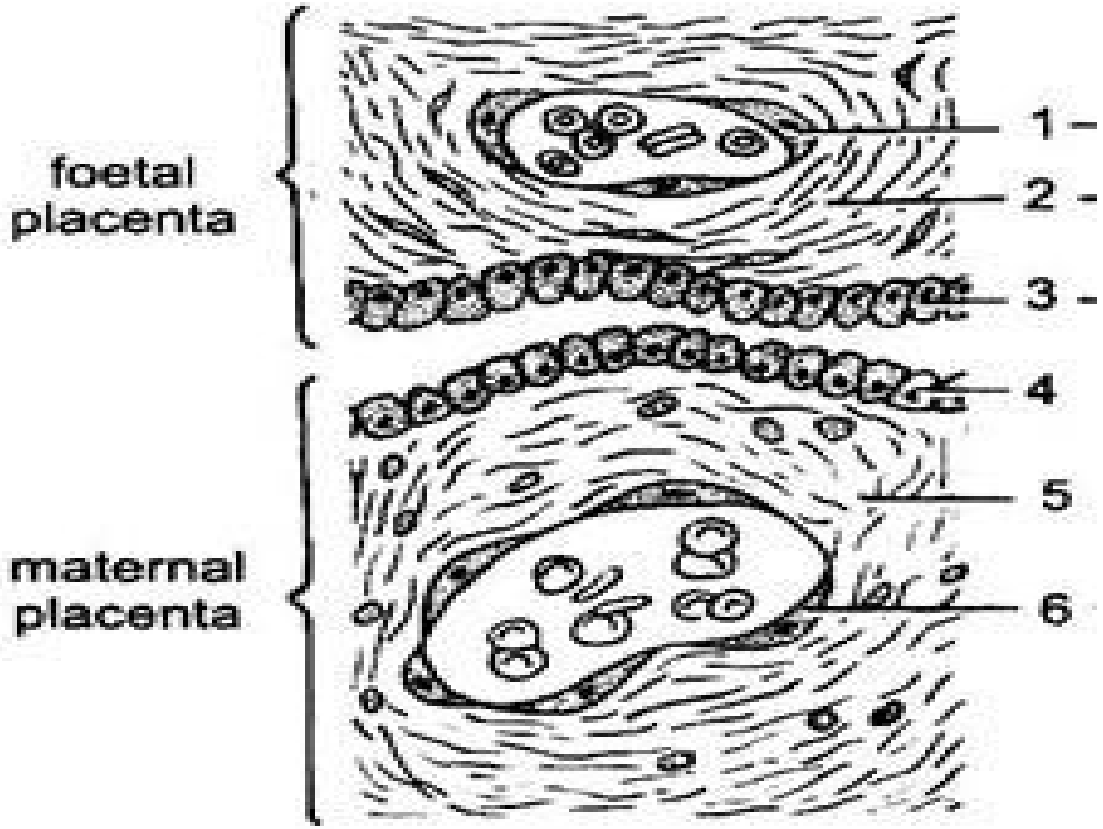
- The placenta is classified into five type
  - Epitheliochorial placenta
  - Syndesmochorial placenta
  - Endotheliochorial placenta
  - Haemochorial placenta
  - Haemoendothelial placenta



EPITHELIOCHORIAL PLACENTA

- In epitheliochorial placenta, the uterine epithelium of the mother makes contact with the chorion of the embryo.
- It is the simplest type of placenta. The villi of the chorion dip into the crypts of the uterine wall. It is chorio- allantoic placenta.
- This type of placenta is provided with 6 types of tissues.
  - **Maternal endothelium**
  - **Maternal connective tissue**
  - **Maternal uterine epithelium**
  - **Chorion**
  - **Foetal connective tissue**
  - **Foetal endothelium**

  Egg; Pig, Horse etc



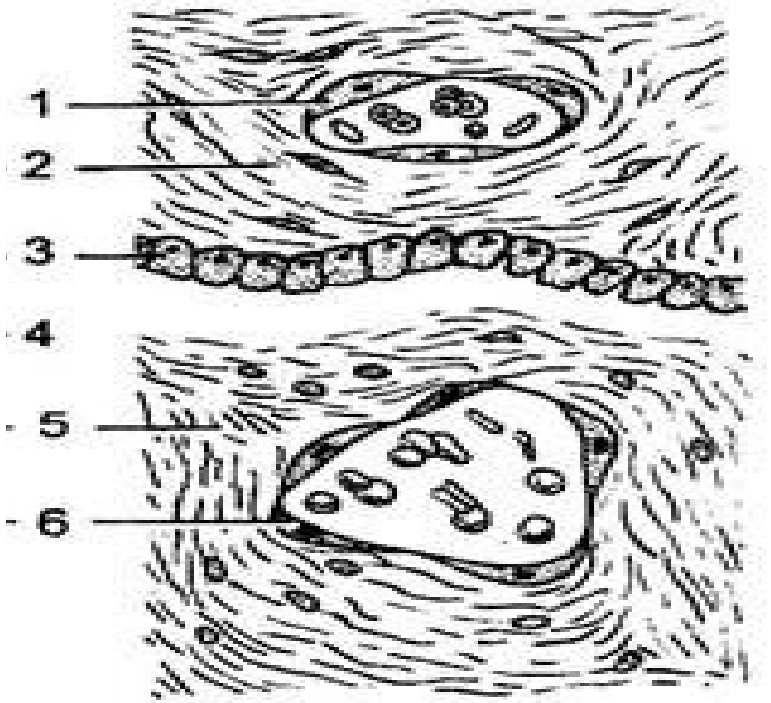
A – Epitheliochorial

Mammalian placental types arranged in a series to show the progressive elimination of barriers between the maternal and foetal circulation. 1. Endothelium of foetal blood vessel; 2. Chorionic connective tissue; 3. Chorionic epthelium; 4. Uterine epithelium; 5. Endometrial connective tissue (mucosa); 6. Endothelium of maternal blood vessel; 7. Maternal blood pool.

SYNDESMOCHORIAL PLACENTA

- In syndesmochorial placenta, the maternal connective tissue (syndesmous) makes contact with the chorion.
- In this type of placenta the uterine epithelium is eroded.
- Nutrients pass through maternal edothelium, maternal connective tissue, chorion, foetal connective tissue, foetal endothelium.

Eg; sheep

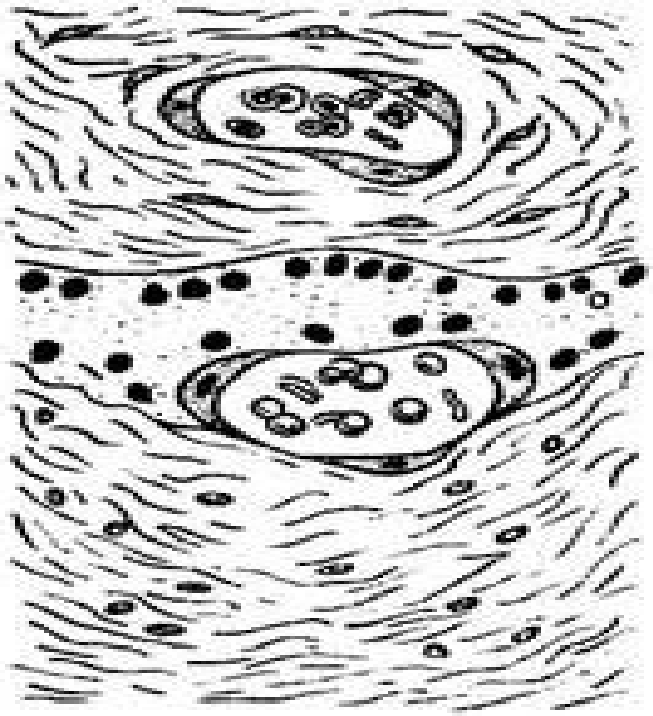


B – Syndesmochorial

ENDOTHELIOCHORIAL PLACENTA

- In endotheliochorial placenta, the endothelium of the mother makes direct contact with the chorion.
- The **uterine epithelium and maternal connective tissue are eroded.**

Eg: Dogs and cats etc.,

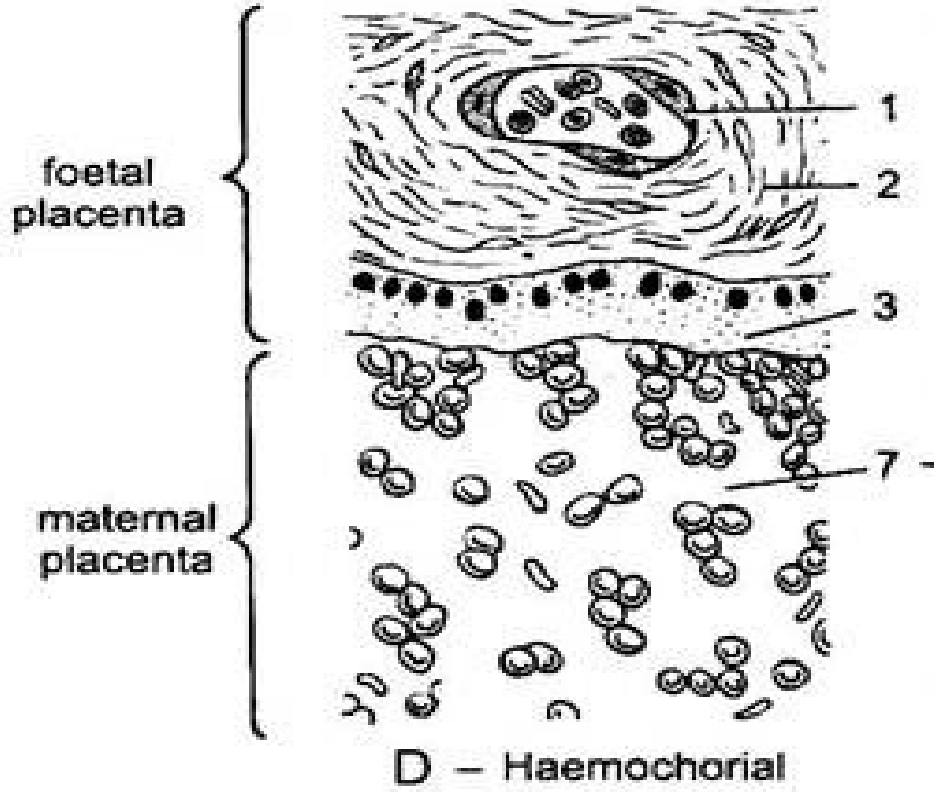


C – Endotheliochorial

HAEMOCHORIAL PLACENTA

- In haemochorial placenta, the chorion of the embryo directly dip into the maternal blood sinuses.
- **The uterine epithelium, maternal connective tissue and the maternal endothelium are eroded.**
- Thus the chorionic villi directly dip into the maternal blood sinuses.

Eg; Man, Monkey and bats etc.

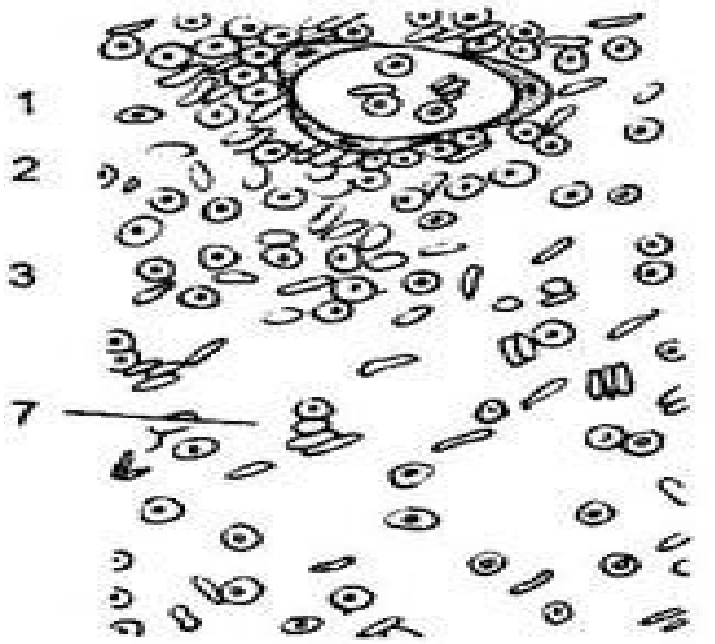


D – Haemochorial

HAEMOENDOTHELIAL PLACENTA

- Foetal blood vessels dip into maternal blood pools.
- The uterine epithelium, the maternal connective tissue, maternal endothelium and the chorion are eroded.
- The maternal blood has only one barriers, the foetal endothelium to reach the embryo.

Eg; Rabbit and Rat etc,



E – Haemoendothelial

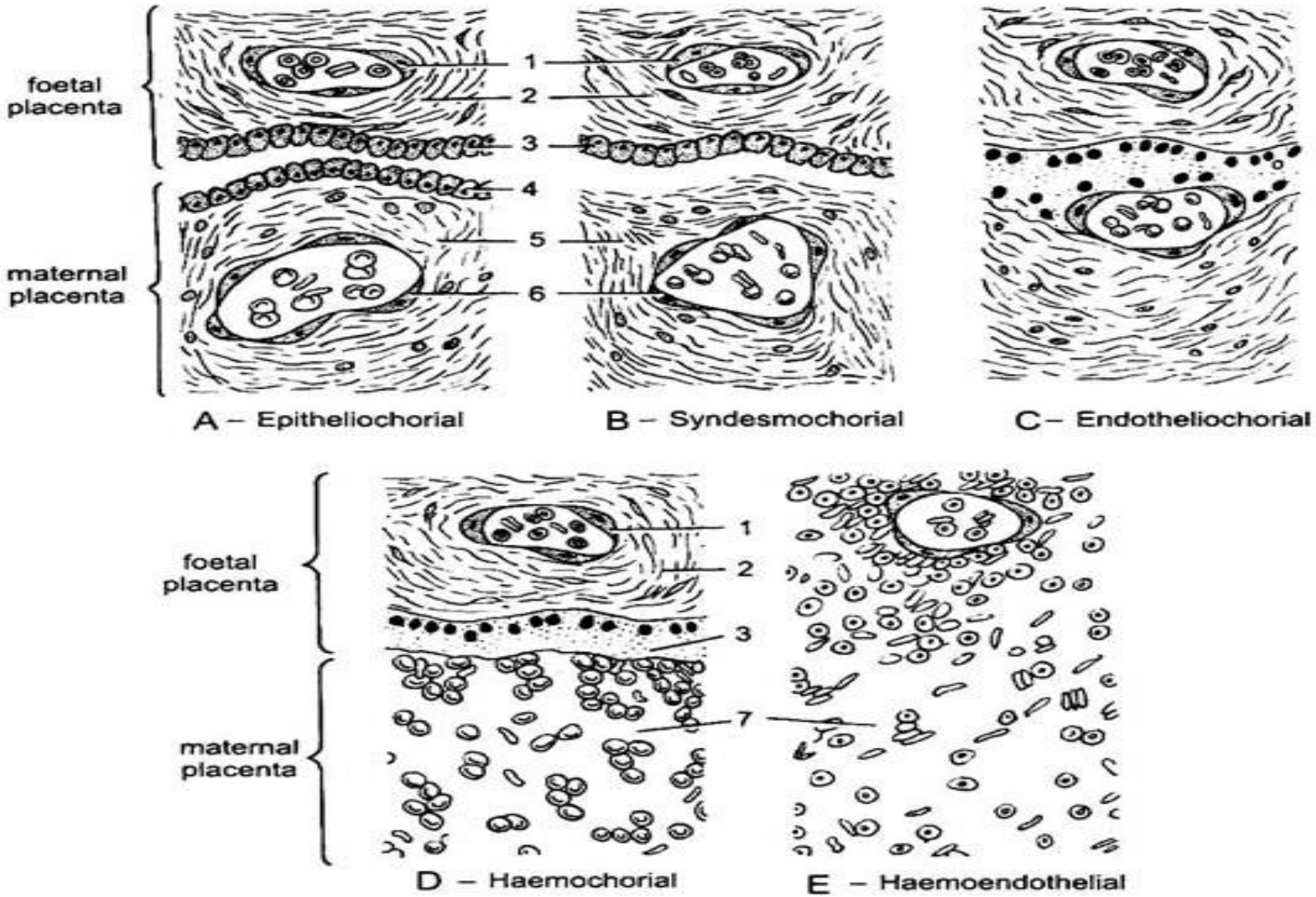


Fig. 40.3. Mammalian placental types arranged in a series to show the progressive elimination of barriers between the maternal and foetal circulation. 1. Endothelium of foetal blood vessel; 2. Chorionic connective tissue; 3. Chorionic epthelium; 4. Uterine epithelium; 5. Endometrial connective tissue (mucosa); 6. Endothelium of maternal blood vessel; 7. Maternal blood pool.

Placental hormones

- Placenta of mammals acts temporarily as an endocrine organ.
- Secretes a various of hormones
- Example: In rat on twelfth day of the pregnancy, placenta secretes the hormone, rat chorionic mammoluteotrophin - which is responsible for the maintenance of the corpora lutea and later progesterone (which is responsible for pregnancy to continue to term).
- Horse placenta secretes the pregnant mare serum gonadotrophin (PMSG), a luteotrophic hormone, in addition to progesterones and oestrogens.
- In some animals, such as rabbit, the placenta does not seem to secrete any hormone.

Placental hormones

Human placenta produces a variety of protein and steroid hormones

Protein hormones:

1. **Human chorionic gonadotrophin (HCG);**
2. **Human placental lactogen (HPL);**
3. **Human chorionic thyrotrophin**
4. **Human chorionic corticotrophin**
5. **Relaxin**

Steroid hormones :

1.Oestrogens

2.Progesterones

Human Chorionic Gonadotropin

- hCG is a glycoprotein that contains galactose and hexosamine produced by the syncytiotrophoblast
- hCG is primarily luteinizing and luteotropic and has little FSH activity
- It maintenance of corpus luteum till 6 week of pregnancy.
- It stimulate the leyding cells of the male fetus to produce testosterone.

Human Chorionic Somatotropin (hCS)

Secreted by the placenta at about the fifth week of pregnancy.

- Decreases insulin sensitivity → decreased utilization of glucose in the mother → making larger quantities of glucose available to the fetus.

- Promotes the release of free fatty acids from the fat stores of the mother, → provides alternative source of energy for the mother's metabolism during pregnancy.

Relaxin

- Relaxin hormone is produced by the placenta in very small amounts.
- It causes the relaxation of the symphysis and sacroiliac joints during pregnancy and also reduces the tension of cervix.

Estrogen

- Causes enlargement of the mother's uterus
- Causes enlargement of the mother's breasts and growth of the breast ductal structure
- Causes enlargement of the mother's female external genitalia.
- The estrogens also relax the pelvic ligaments of the mother, so that the sacroiliac joints become relatively limber and the symphysis pubis becomes elastic during parturition.

Progesterone

- Progesterone helps in the maintenance of pregnancy and prevents premature parturition.
- In fact, progesterone stops the menstruation and the release of ovum from the ovary until the pregnancy.