

Germinal layers and their derivatives

The following description gives an account of the respective organs formed by the three germ layers. Most of the organs are the product of combination of more than one than one germ layers.

Organs derived from ectoderm

1. Skin (epidermis) and their pigment cells.
2. Mucosal membrane of lips, cheek. gums, basal portion of mouth. some part of palate, nasal apertures.
3. Lower part of anal canal.
4. Glans penis.
5. Labia majora and outer part of labia minora.
6. Anterior epithelium of cornea, epithelium of conjunctiva. ciliary body and iris of eyes.
7. Outer face of tympanic membrane, epithelium of labyrinth.
8. Glands :
 - (i) Exocrine-
 - (A) Sweat glands
 - (B) Sebaceous glands
 - (C) Parotid glands
 - (D) Mammary glands
 - (E) Lacrimal glands ;
 - (ii) Endocrine-
 - (A) Hypophysis cerebri
 - (B) Adrenal medulla
9. Hairs, nails enamel of teeth
10. Lens of eyes.
11. Nervous system.

Derivatives of mesoderm

1. Connective tissues, superficial and deep fascia, ligaments, dermis of skin. (from dermatome)
2. Specialized connective tissues like adipose tissue, reticular tissues, bones, cartilages.
3. Teeth.
4. All muscles.
5. Heart. all blood vessels and blood cells.
6. Kidneys. ureters, urinary bladder, posterior urethra of female, upper glandular part of prostate.
7. Ovaries, uterine tubes.
8. Testes, epididymis, vas deferens and seminal vesicle, ejaculatory duct.
9. Pleural cavities, peritoneal cavity and pericardial cavity.
10. Joints.
11. Cornea, sclera, choroid ciliary body and iris related material.
12. Microglia, duramater etc.

Derivatives of endoderm

1. Epithelial part of mouth, some part of palate, tongue. tonsils, pharynx, oesophagus. stomach, small and large intestine. upper part of anal canal.
2. Pharyngo –tympanic tube, middle ear, inner face of tympanic membrane.
3. Respiratory tract.
4. Gall bladder, pancreatic duct.
5. Major portion of urinary bladder, complete urethra of female except posterior part, complete urethra of male except anterior and posterior part.

6. Whole inner part of vagina including inner face of labia minora.

7. Glands :

(i) Exocrin -

(A) Liver (B) Pancreas

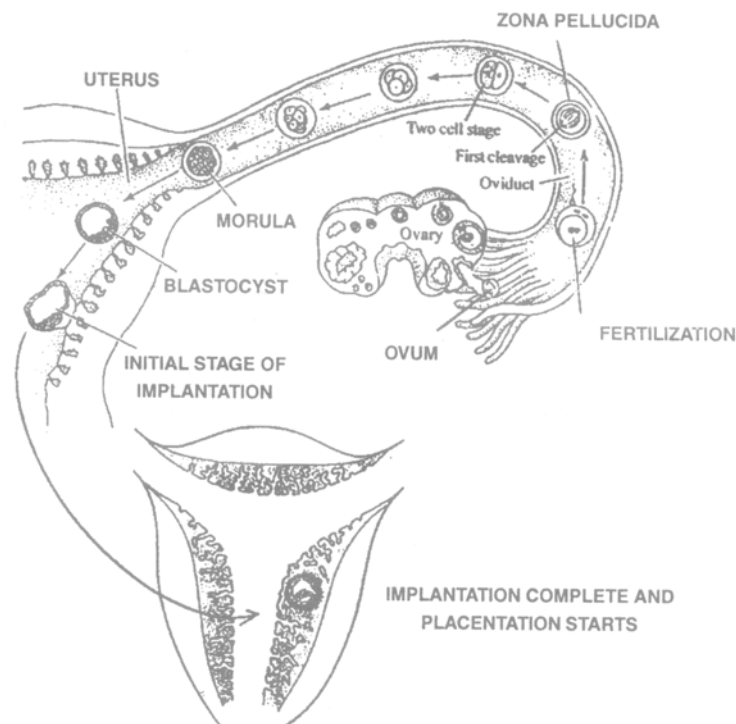
(ii) Endocrine-

(A) Thyroid (B) Parathyroid (C) Thymus (D) Islets of Langerhans

In addition to the above, the glands of gastrointestinal tract, major part of prostate ect. Are also formed by endoderm.

Implantation

The attachment of developing embryo to the appropriate body layer or surface to obtain nutrition is called implantation. This phenomenon is a common event in most mammals (except prototheria) in which embryo (blastocyst stage) after reaching in uterus attaches itself with the wall of the uterus. In other animals lilke fishes, reptiles, birds, prototherian mammals etc, this nutritive connection is established with the yolk present in egg. In higher mammals including men. the blastocys t on its contact with endometrium of uterus gets completely buried in the wall of the uterus.



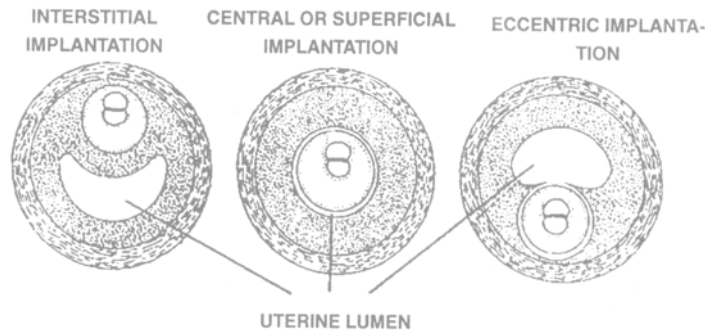
Mechanism of Implantation

In itally the oocyte after its release from ovary, comes into fallopian tube where the process of fertilization is completed. Just after fertilization, embryonic development starts and a blastocyst is formed after cleavage and morulation. In human being, the blastocyst gets attached with the uterine endometrium in about four days adhere with embryonic cells with the help of certain enzymes secreted by the cells of trophoblast. In human, the site of imphlantation is generally mid-dorsal or mid-ventral part of uterus. Implantation of blastocyst takes about 7-8 days after fertilization in human and by 12th day it is completely buried in the wall of the uterus. The place of entry through which the embryo enters into the wall. is completely closed by a fibrous and cellular plug. known as closin coaglum.

Types of Implantation

On the basis of the position of attachment in the uterus, implantation is of three types –

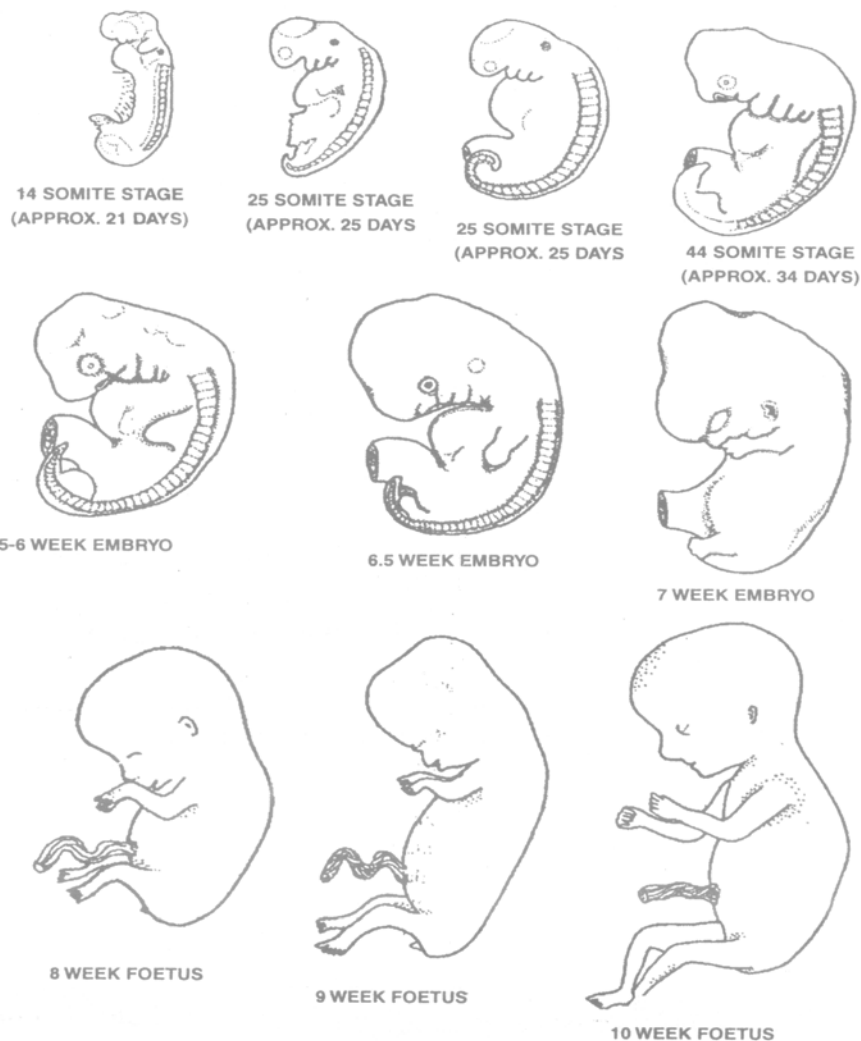
- Central or Superficial implantation-** In this type the blastocyst attaches superficially with the wall of uterus, and remains suspended in the lumen of the uterus. This type of implantation occurs in lower chordates, e. g. cow. Pig. dog etc.



- Interstitial implantation-** The blastocyst buries itself deeply inside the wall of uterus and is covered by the endometrial tissues lying under the epithelium. This type of implantation occurs in human beings.
- Eccentric implantation-** It occurs in rats, squirrels etc. In this type of implantation, the blastocyst settles in the folds of the epithelium of the uterus. After some time it is completely surrounded by these folds.

Summary of developmental stages in human

Day 1	- Fertilization ; the diameter of fertilized egg is about 0.15 mm.
Day 2	- Two cell stage
Day 3	- 16 cell stage, morula
Day 4	- Entry of blastocyst in the lumen of uterus, disappearance of zona pellucida, diameter of blastocyst is about 0.3 mm.
7-8 days	- Partial entry of blastocyst inside the endometrium of uterus; implantation
Day 12	- Complete entry of blastocyst into endometrium, extra-embryonic mesoderm, amnion and yolk sac.
Day 14	- primitive streak formation.
Day 18	- Formation of 3-5 pairs of somites.
Day 19	- Neural groove, neural plate, notochordal plate, and 6-8 pair of somites formed.
Day 24	- Indication of the formation of head and tail region ; 21-23 pairs of somites formed, formation of heart continues at ventral side.
Day 28	- Heart starts beating. neural tube formed. 3 pairs of visceral arch 30-31 pairs of somites formed. Blood islands appear
Day 32	- 30-39 pairs of somites formed.
7 Weeks	- Jaws, fingers and external ears begin to appear. The C-R length (crown-rump length ; the length from head to the bottom of hips) is 19-20 mm
8 Weeks	- The embryo is completely surrounded by amnion, fingers and toes clearly visible, almost all organs formed with continuing development. at the end of 8th week the embryo appears like a little human, now called as foetus; C-R length is 28 to 30 mm.
5 months -	- Blood formation starts in bone marrow Decidua capsularis and parietalis connect together, hairs appear.



Embryonic development in human

9 months - placenta attains maximum size, nails on fingers appear. In the next 10 days the foetus is ready to be born as a little baby.

The above mentioned timing are approximate time periods. Some times, due to some reasons, certain babies are born before stipulated time. The babies born in 7th month may also survive as normal babies.

EXTRA EMBRYONIC MEMBRANES AND PLACENTA

Extra embryonic membranes

In chordates like reptiles, birds and prototherian mammals. Blastula is a disc shaped structure called as blastodisc. The cellular layer formed of blastomeres remains as blastoderm. The central part of blastoderm gives rise to embryo proper, while the peripheral portion does not take part in the formation of certain membranes called extra embryonic membranes. These extra embryonic membranes provide facilities for nutrition, respiration and excretion to embryo. Extra embryonic membranes are of four types-

1. Amnion
2. Chorion
3. Yolk sac
4. Allantois

1. Amnion – This group is characterized with the presence of amnion in the embryo of its members. For example members of class Reptilia, Aves and Mammalia.

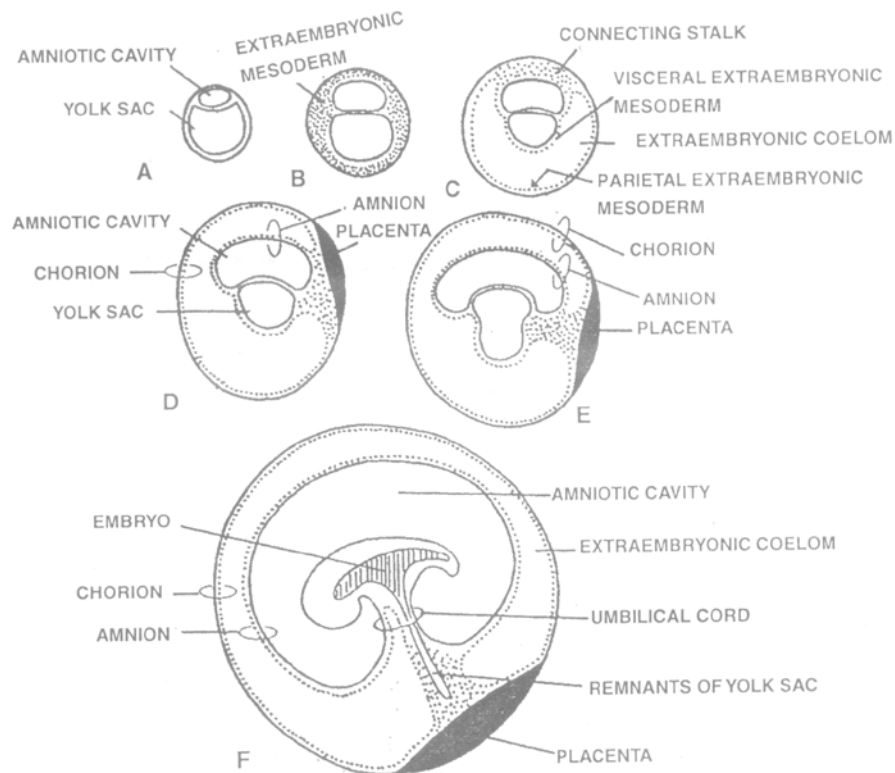
2. Anamniota- Animals of this group are devoid of amnion in their embryos. For example class cyclostomata, pisces and amphibia.

Extra embryonic membranes in human

The process of gastrulation in embryo results into the formation of endoderm of hypoblast, ectoderm or epiblast, amniotic cavity, yolk sac, extra embryonic parietal and visceral mesoderm, connecting stalk etc. Extra embryonic membranes are also formed during this process. Each extra embryonic membrane is derived from two layers.

1. **Amnion**- it is formed by the layer of amniogenic cells present around the amniotic cavity and the extra embryonic mesoderm. Extra embryonic mesoderm layer surrounds the amnion. The connecting stalk is also attached with it. With a gradual increase in size the amnion covers the embryo from all sides. After about eight weeks of fertilization, amnion is completely incorporated into connecting stalk, which finally forms the umbilical cord. Embryo in this stage is called as fetus and remains hanging in amniotic fluid.

2. **Chorion** – It is formed by the extra embryonic parietal layer of mesoderm and the cells of trophoblast. After implantation of blastocyst, the trophoblast gives out several finger-like processes, the chorionic villi which get embedded into uterine endometrium. Mesoderm also contributes in the formation of these villi. After a period of four months these villi disappear from all parts except the connecting stalk where they grow rapidly and participate in the formation of placenta.



Formation of extraembryonic membranes in human

3. **Yolk sac**- yolk sac is formed by the cells of extra embryonic visceral mesoderm and endoderm. Initially the size of yolk sac is larger as compared to that of that of the embryo. About eight weeks after fertilization, the yolk is reduced in size and changes into a tubular structure. Ultimately a placenta is developed with the incorporation of yolk sac and mesodermal connection stalk with the amnion and chorion.

4. **Allantois** – it is a solid and cylindrical mass formed by embryonic mesoderm. A small cavity lined by endodermal cells develops in it. The mesoderm of allantois forms many small blood vessels in this region. These vessels connect the embryo with placenta and ensure nutritional and respiratory supply to embryo in human allantois does not function to store the excretory wastes as it does in reptiles and birds.

PLACENTA

The eggs of viviparous animals are unable to develop into their embryo outside the uterus independently. This is because of the very little or negligible amount of yolk present in these eggs, which can not fulfill the nutritional and other physiological demands of a developing embryo. Here the embryo depends upon maternal tissues for shelter, nutrition, respiration etc. These animals therefore, have developed adaptations, respiratory and other physiological requirements from mother's body. Placenta is found in all viviparous (except sub-class- prototheria; oviparous) animals.

Structure of Placenta

Placenta is not a simple membrane. It is made up of the tissues from two different sources- **Maternal tissue** – these include uterine epithelium, connective tissues and blood capillaries.

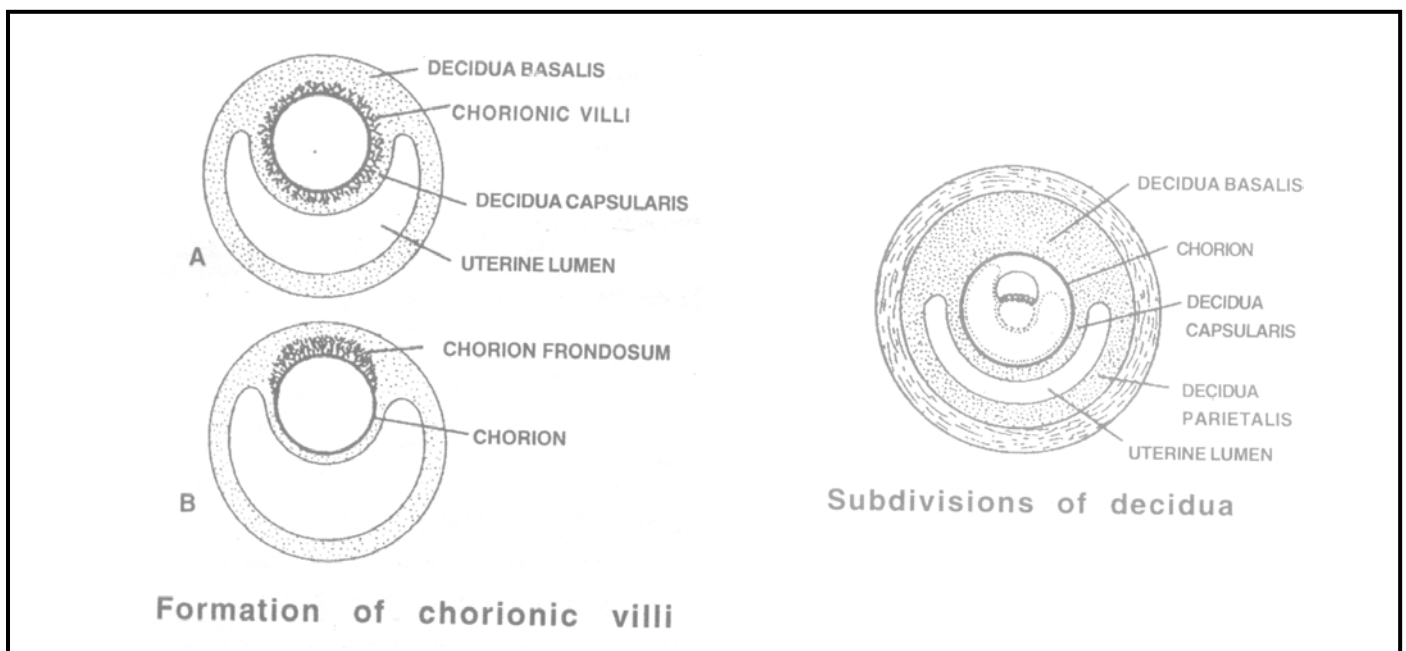
Embryonic tissue- these include extra embryonic membranes (mainly chorion). Yolk sac and allantois may also take part in placenta formation. Embryonic connective tissues and blood capillaries are also constituents of it.

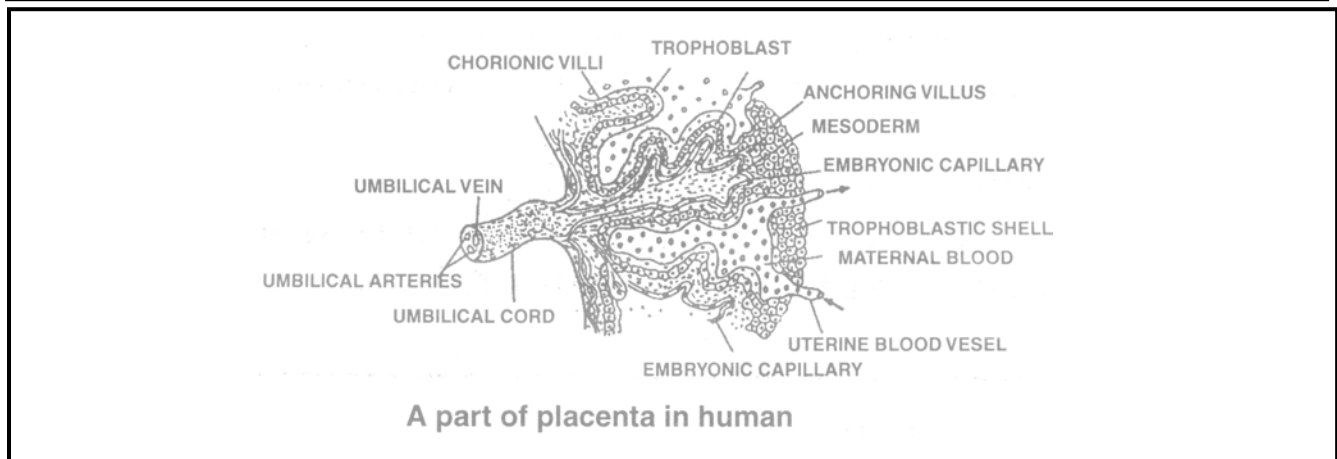
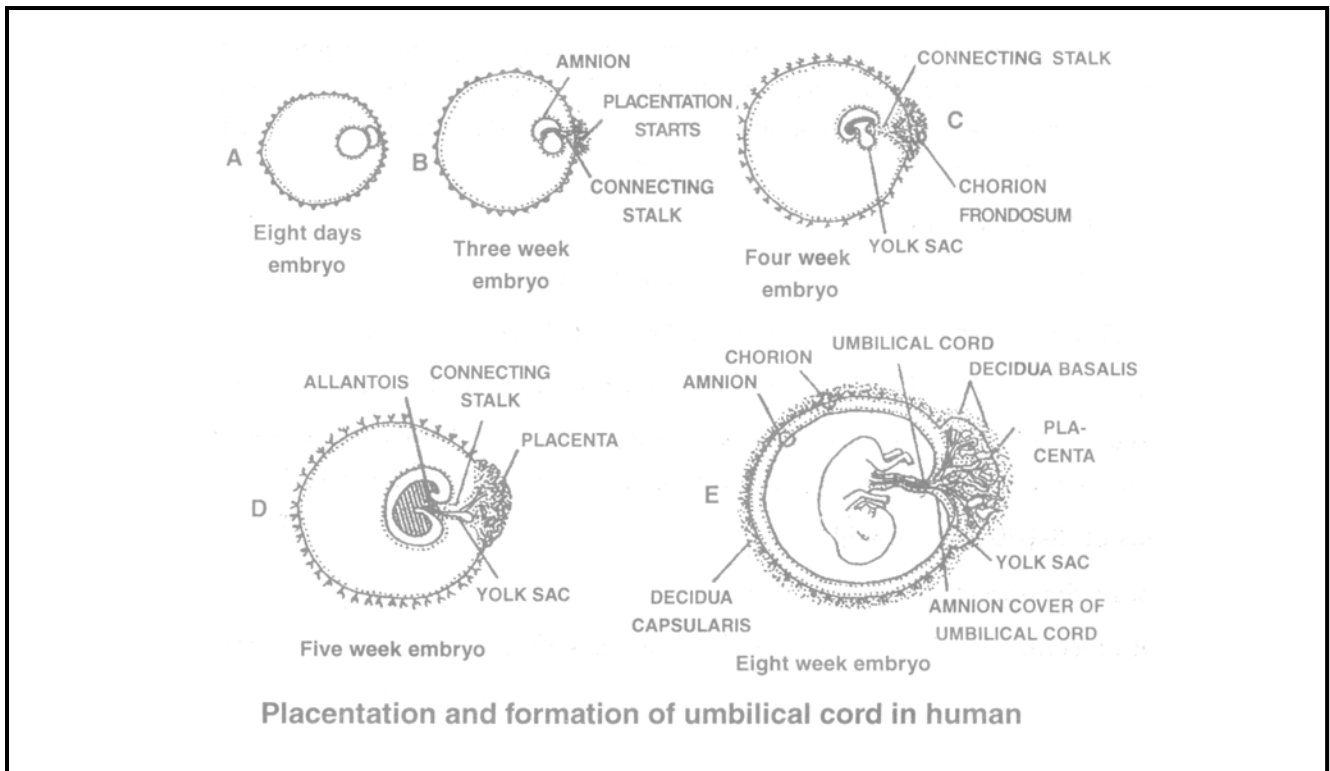
On the basis of extra embryonic membranes, the placenta is of three types.

1. **Yolk sac placenta** - It is formed by yolk sac and uterine epithelium. For example. Elasmobranchs (Sharks), Mustelus etc.
2. **Chorio- vitelline placenta** – It is formed by chorion and yolk sac combinedly. Hence it is called as choriovitelline placenta. For example. Didelphis. Macropus and other metatherian mammals.
3. **Chorio- allantoic placenta** - This type of placenta is formed by embryonic chorion and allantoic membranes. It is also referred to as a true placenta. It is found in eutherian mammals.

Chorio- allantoic placenta in mammals.

1. In this type of placenta, allantoic mesoderm and the mesoderm of umbilical cord jointly form the blood vessels of umbilical cord. The endodermal part of the allantois remains as a very small cavity.
2. To obtain nutrition from maternal blood several fingerlike processes or villi are formed by chorion which penetrate deeply into the crypts of uterus. Initially the villi are scattered over the whole surface of chorion but later they become restricted in the decidua basalis region. The chorionic villi on the remaining surface disappear shortly. The part of chorion, which helps in placenta formation is known as chorionic fronsom.





Classification of Placenta

On the basis of different characters, the placenta are classified in following manner-

1. On the basis of intimacy

After implantation, the wall of uterus is as decidua, instead of endometrium. The part of decidua where placenta is formed is called **decidua basalis** whereas, the part separating the embryo from lumen of uterus is called **decidua capsularis**. The remaining part of lumen of uterus is called **decidua parietalis**. Decidua also comes out from uterus at the time parturition. On the basis of intimacy between embryo and uterin wall the placenta is callssified into three classes -

- (i) **None-deciduate or Semi palcenta** - In this type of placenta, there is no close and rigid associations between embryo and the wall of uterus. Hence, at the time of parturition, these is no bleeding as the chorionic villi are easily pulled out from the crypts of uterus. For example, cow, buffalo, horse, pig.
- (ii) **Contra - deciduate placenta** - There is a close association between embryonic and maternal tissue. However at parturition, the damages maternal and ebyonic tissues along with the part of palcenta remain inside the uterus which are absorbed in situ by leucocytes. For example - Parameles, Talpa etc.

(iii) **Deciduate placenta** - This type of placenta is found in human, dog, here etc. It is characterized with a very close association between chorionic villi and uterine wall. At the time of birth, the mucosal covering of the uterus is also damaged and discarded outside. This results in an extensive bleeding at child birth. This placenta is known as a true placenta.

2. On the basis of implanation

Three types of placenta are found on the basis of implantation.

- (i) **Superficial** - When the placenta is situated in the lumen of uterus. For example, Paramoeba, pig, cow, cat etc.
- (ii) **Eccentric** : The placenta is situated in the fold or pocket of the cavity of uterus. For example - rat, Squirrel etc.
- (iii) **Interstitial** - This type of placenta is found in man, guinea pig, apes etc. The chorionic sac (placenta) penetrates deep inside the wall of uterus. Hence, the association between embryo and maternal part becomes very close

3. On the basis of distribution of villi

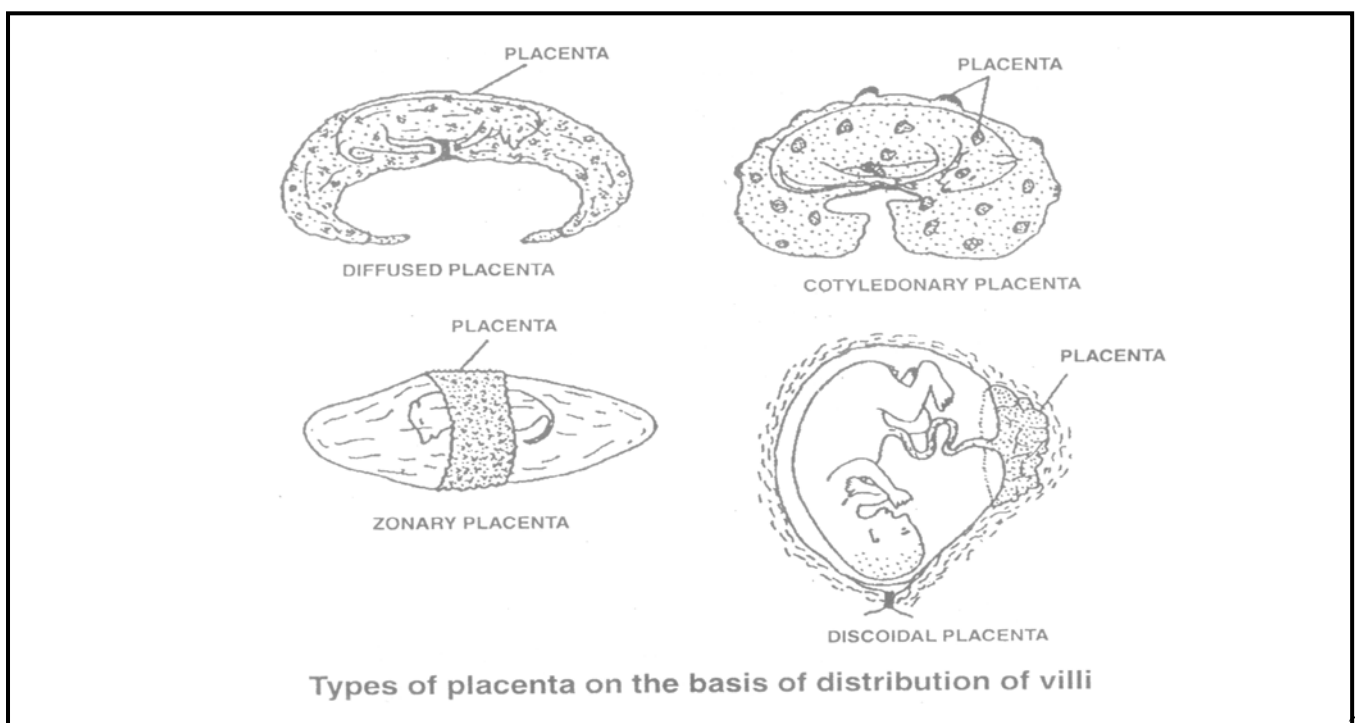
]

On this basis, the placenta are of four types.

- (i) **Diffused placenta** - The villi are scattered on the whole surface of placenta. For example pig, horse, lemur etc.
- (ii) **Cotyledonary placenta** - The villi are distributed in small isolated groups on the chorionic surface. These groups of villi are called as cotyledons. For examples, cow, buffalo, sheep, deer etc.
- (iii) **Zonary placenta** - This type of placentae have the villi distributed in a belt shaped zone which is large sized and circular.

Zonary placenta is of two types -

- (a) Complete zonary placenta - The belt of villi is complete and ring shaped in it. For example dog, cat, lion etc.
- (b) Incomplete zonary placenta - The belt of villi is incomplete in it. For example racoon.



(iv) **Discoidal placenta** : In this type of placenta, whole of the chorionic surface is covered by villi in initial stage, but the villi disappear later from most area except the region of implantation, that is only a disc like region is left with villi. Discoidal placenta is also of two types -

(a) Mono discoidal placenta - The villi are present only on dorsal surface in a single circular disc like area. For example - human, hare etc.

(b) Bi discoidal placenta - If the villi are distributed in two disc like areas, the placenta is called as bidiscoidal, e. g. monkey.

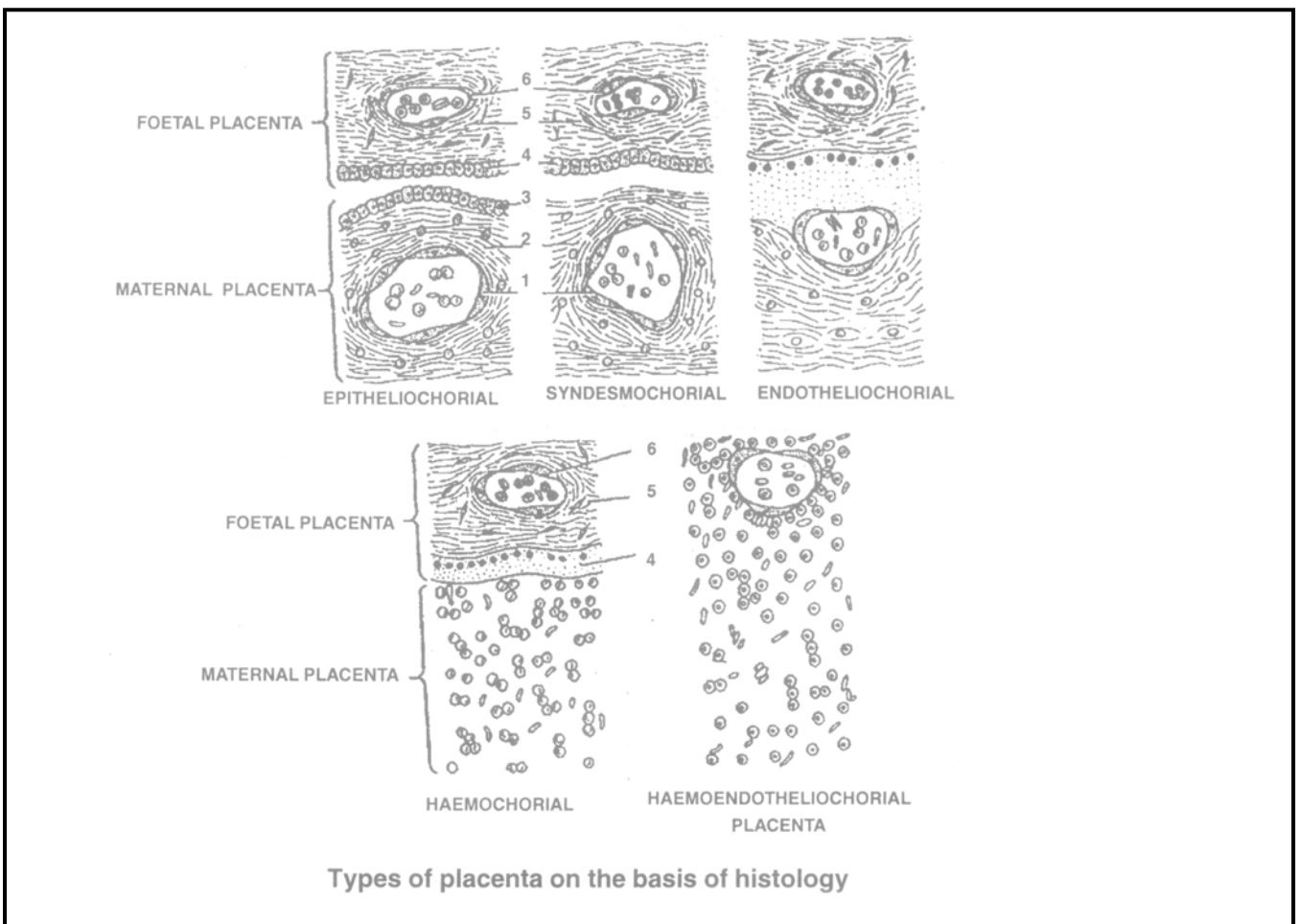
4. On the basis of histology

The blood of maternal embryonic do not mix together through placenta. The blood circulations of the two sides are kept separated by one or more layers described below -

- 1. Maternal endothelium
 - 2. Uterine connective tissue
 - 3. Uterine epithelium
- } Maternal layers

- 4. Trophoblast/Chorion
 - 5. Chorionic connective tissue
 - 6. Endothelium of embryonic blood vessels
- } Foetal layers

The transportation of various materials takes place by diffusion through these six layers. The intimacy between maternal and embryonic tissues in different mammals is determined by the presence or absence of these layers in placenta. Therefore, on the basis of presence of above layers, the placenta is of five types.



1. **Epitheliochorial** - It is the most primitive type of placenta in which all the six layers, mentioned earlier, remain intact. For example, pig, horse etc.
2. **Syndemochorial** - In this type of placenta the uterine epithelium is eroded by chorionic villi, so only two maternal layers remain functional. Therefore, along with three foetal layers, total five layers are present in this placenta. For example sheep, goat, cow etc.
3. **Endotheliochorial** - Here uterine connective tissue layer is also damaged along with uterine epithelial layer. Therefore only four layers (3 foetal and one maternal) are found in this placenta eg. dog, cat, etc.
4. **Haemochorial** - All the three maternal layers are penetrated in this placenta. The chorionic epithelium comes in direct contact with uterine blood sinusoids. For example - man, monkey, bat etc.
5. **Haemoendotheliochorial/Haemoendothelial** : is is the most typical placenta in which the trophoblastic epithelium of embryo is also eroded along with all three maternal layers. The foetal capillaries are in direct contact with maternal blood. For example rat, guinea pig, rabbit etc.

Hormones of Human Placenta

The placenta of human mainly secretes two steroid hormones like estradiol and progesterone, and two protein hormones like human chorionic gonadotropin HCG and human placental somatomammotropin HCS. Large amount of HCG hormone is secreted during early pregnancy, from the placenta. Because of this reason its quantity increases in the urine of pregnant lady. On the basis of this fact, pregnancy test is performed. The above hormones are also held responsible for keeping the corpus luteum active, protection of embryo, prevention of abortion and growth of mammary glands.

Function of placenta

1. Exchange of important materials between foetal and maternal blood.
2. The essential materials are exchanged by diffusion, pinocytosis or active transport.
3. The small molecules like O₂, CO₂, H₂O etc. and other inorganic substances like chlorides, phosphates, sodium, potassium, magnesium etc. are also diffused through placenta.
4. Large molecules like lipids, polysaccharides, carbohydrates, proteins etc. are obtained by pinocytosis process.
5. The nutritional substances are supplied to embryo from the mother through placenta.
6. Placenta also serves as a respiratory medium for exchange of O₂ and CO₂ between embryo and mother.
7. The nitrogenous and metabolic wastes from foetus are released into the blood of mother by diffusion through placenta.
8. The antibodies for measles, chickenpox, polio etc. present in the blood of mother reach the embryo through placenta.
9. Pathogenic viruses may also enter in embryo through placenta.
10. If a female takes some harmful chemicals, liquor, drugs etc. during pregnancy, these may cross the placenta and on reaching into foetus may cause deformity during organogenesis (eg. Thalidomide).
11. Placenta itself secretes some hormones like progesterone, estrogen, lactogen HCG, HCS etc.
12. Progesterone, maintains and supports the foetus during the whole pregnancy period. At the time parturition, relaxin is secreted by placenta which lubricates, and widens the birth canal to facilitate child birth.