E. Content for Student of Patliputra University

B.Sc Hons Zoology Part II Paper IV

Topic :- Types and functions of the Placenta in mammals

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Q. 19. What is Placenta? Give an account of the types and functions of the placenta in mammals:

Ans. In all viviparous animals, the development of the young one take place inside the uterous of the mother because the amount of stored yolk of egg does not remain sufficient for the development of an embryo which can lead an independent mode of existence, therefore, the development embryo has to depend on the mother in lesser or greater degree for nourishment, oxygen supply and other physiological assignments. Such embryos which develop inside the uterus of mother often get attached with uterin wall to draw necessary substance from the maternal (uterine) circulation by means of an organ called placenta. The term placenta applies to any type of organ built up maternal and foetal tissue jointly and which serves for the transport of nutrient substances from the tissues of the mother into those of the embryo. The placentae are not found exclusively in mammals but also appear in animals belonging to various groups of the animal kingdom such as in Peripatus (Protracheata), Salpa (Tunicata), Musrelus laevis (Elasmobranchia) and certain lizards (Reptilia). Placentae of mammals have following mode of origin, structure, type and physiology.

MODE OF ORIGIN AND TYPES OF MAMMALIAN PLACENTAE

A mammalian placenta, typically, is a structure produced by the opposition or fusion of the extra-embryonic membranes with the endometrium of uterus for the purpose of physiological exchange. It, therefore, follows that the placenta from the point of view of its origin, consists of two parts a foetal placenta, furnished by the extra-embryonic membranes and maternal placenta, furnished by the uterine

endometrium. Usually, the trophoblast cells of mammalian embryo remain specialized for interaction with the uterus.

Now, it would be obvious that while on the maternal side a single component the endometrium is involved; on the foetal side, one has to consider the prospective roles of four elements–amnion, cherion, yolk, sac and allantois. The first of these, the amnion, may be ruled out immediately, as is making no direct contribution to the placenta. This leaves the other three of which the chorion because of its most external position, is the membrane making immediate contact with the endometrium. But, we have seen in chick embryo that the chorion plays its role by way of a viscular supply, which it acquires from the allantois. In mammals, there are two possible sources of chorionic vascularization–the vitelline circulation provided by the yolk sac and allantoic circulation provided by the allantois. Thus, it can be said that in mammals, there exist two essentially different main types of placentae–the chorio vitelline placenta and the choric allantoic placenta.

A. CHORIO-VITELLINE PLACENTA

In some mammals, notably some marsupials (didelphys, Macropus), the allantois relatively small and never makes contact with the chorion; whereas the yolk sac becomes very large and gets fused broadly with the chorion. In these forms, the chorion gains it blood supply from the network of vitelline blood vessels of yolk sac. Such a placenta is called yolk sac placenta or chorio vitelline placenta. In such a foetal placenta the chorio vitelline never advances beyond a smooth membrane in close opposition with the vascular uterine lining, the endometrium.

B. CHORIO-ALLANTOIC PLACENTA

In some marsupials (e.g. Parameles, Dasyurus), and eutherians the yolk sac remains rudimentary and the allantois becomes well developed and vascularized to fuse with chorion and to furnish the latter the blood supply. Such a foetal placentates called chorioallantoic placenta. In this kind of placenta, the chorion is not smooth but bears root-like vascular processes, the villi, which grow out from the chorion into the adjacent maternal tissue. The chorio-allantoic placenta originates in the following fashion :

DEVELOPMENT OF CHORIO-ALLANTOIC PLACENTA

When a mammalian embryo enters the uterus, the zona pellucida, which previously surrounded it becomes dissolved and the embryo (blastocyst) is bathed by the uterine fluid. The fluid contains organic substances produced by the tubular glands of the uterine wall and voided into the lumen of the uterus. The early embryo may absorb some of these substances through its epithelium covering so long as a closer connection with the uterine wall has not been established. For its further development however, the embryo is completely dependent on substances supplied it from the tissue and the maternal tissues is essential. Nevertheless, it is found that the closeness of this connection between foetal and maternal tissues differs greatly within eutherian mammals. On the degree of intimacy of foetal and maternal tissues following three types of placenta may be recognised :

1. Non-deciduous Placenta or Semi-placenta : In most mammals the implantation is superficial, i.e;, the blastocyst lies in the cavity of the uterus in contact with the uterine wall. The contact may be made more intimate by the surface of the blastocyst by forming finger like outgrowths which penetrate into depressions in the wall of the uterus. Such outgrowths are initially formed by the trophoblast (i.e., the epithelial layer covering the blastocyst), but later on the connective tissue and blood vessels invade the outgrowths. These outgrowths are called chorionic villi, the blood vessels of chorionic villi are the braches of allantoic blood vessels in case of chorioa lantoic placenta. (In chorio-vitelline placenta, vitelline blood vessels give their branches to chorionic villi).

At the time of birth, when parturition (the separation of the foetus and its membranes from the mother's body) occurs, the chorionic villi are simply drawn out from the depressions in the wall of the uterus, and thus maternal foetal tissue are separated without further damage to the uterine wall and no bleeding occurs. This type of placenta is called non-deciduate or non-deciduous placenta and is found in pigs, cattle and some other mammals. Further, the chorionic villi of a non-deciduate placenta, because lie in apposition with the endometrium, but do not fuse with it, so such a placenta is also called semiplacenta.

2. Deciduous Placenta or Placenta Vera– In other mammals, however, the degree of intimacy between maternal and foetal tissues becomes further increased. The wall of the uterus becomes croded to various degress through the action of the trophoblast and the embryonic tissues penetrate into the uterine wall establishing a more intimate contact and and faciliating the passage of substances from the mother to the foetus and from the foetus to the mother. Here because the chorinoic villi fuse with the eroded uterine mucosa, such placenta is called placenta vers (true placenta). At the end of pregnancy the uterine wall is no longer intact and when the foetus with its membranes including the chorian is removed, more or less extensive haemorhhage from the uterine wall ensues (i.e. at birth, when placenta is discharged, the uterine lining also tears away with some bleeding). Such a type of placenta found in higher eutherian mammals is called deciduous placenta.

3. Contra-deciduate Placenta– In Parameles and Talpa (mole), some-what modified type of deciduate placenta occurs, which is called Contra deciduate placenta. In such case not only there is a loss of maternal tissue but also of the foetal portion of the placenta, both of which absorbed in site by maternal leucocytes.

Classification of Mammalian Placentae :

Mammalian placentae have been classified as follows-

(A) Classification of Placentae According to the Mode of Implantation : In general, following types of implantation may be distinguished, although transitional conditions occur-

(i) Superficial Implantation : Growth of the chorionic sac brings into contact with the lining of the main uterine cavity. This type of implantation is also called central implantation, e.g. ungulates carnivores monkey.

(ii) Eccentric Implantation : The chorionic sac lies for a time in a fold or pocket which losses off from the main cavity, e.g., beaver, rat, squirrel.

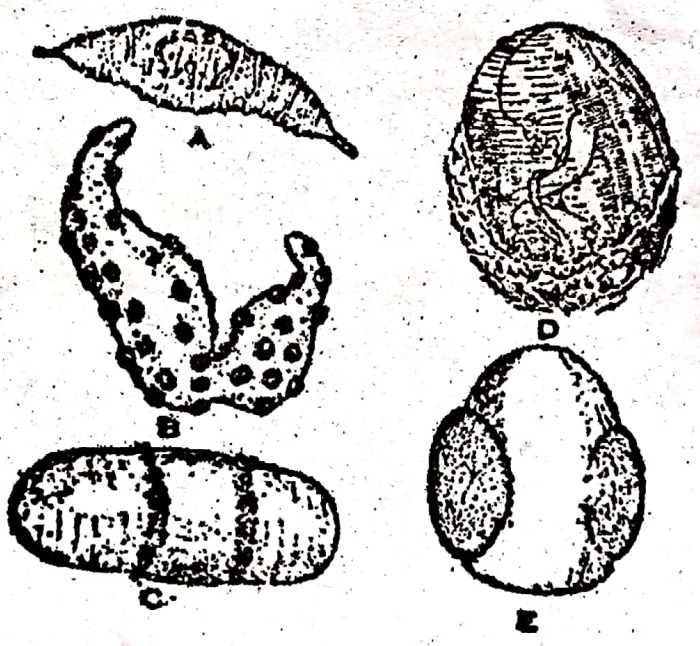
(iii) Interstitial Implantation : The chorionic sac penetrates into the substance of the uterine lining, e.g., hedgehog, guinea pig, some bats, ape and man.

B. CLASSIFICATION OF PLACENTAE ACCORDING TO THE DISTRIBUTION OF VILLI ON CHORION

In different mammals the pattern of distribution of villi varies from species and accordingly following kinds of placentae have been recognised.

1. Diffuse Placenta : In some mammals (e.g. ungulates, pig, saw, mare, horse, lemur etc.) the chorionic villi remain scattered all over the surface of the chorion and their placentae are correspondingly expensive. Such placentae are called diffuse placentae.

2. Cotyledonary Placenta : In a cotyledonary placenta, the villi are found in groups or patches, while the rest of the chorion surface remains smooth. The resettes or patches of villi are called cotyledons, and the placenta of this types is found in ruminants (cudchewing) ungulates such as, cattle, sheep and deer.



3. Zonary Placenta : In a zonary placenta, the villi are developed in the form of belt or girdle-like band around the middle of their blastocyst or chorionic sac, which is more or less elliptical in shape. Such a placenta occurs in carnivores (e.g. cats, dogs etc.) Raccon has incomplete zonary placenta.

4. Discoidal Placenta : In insectivores, bats, rodents mouse, rat, rabbit, main and anthropoid apes, the chorion is at first of all covered with villi, but the villi continue developing only on one side, the side turned away from the lumen of the uterus, while on the other parts of

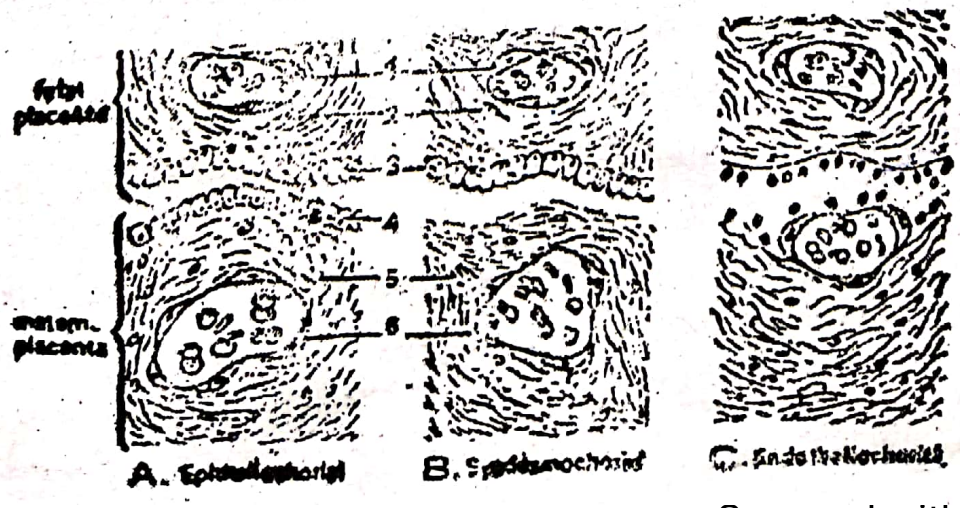
the chorion the villi are reduced. The functional placenta therefore, has shape of a disc and because this placenta has a single disc shaped villous area is called monodiscoidal placenta.

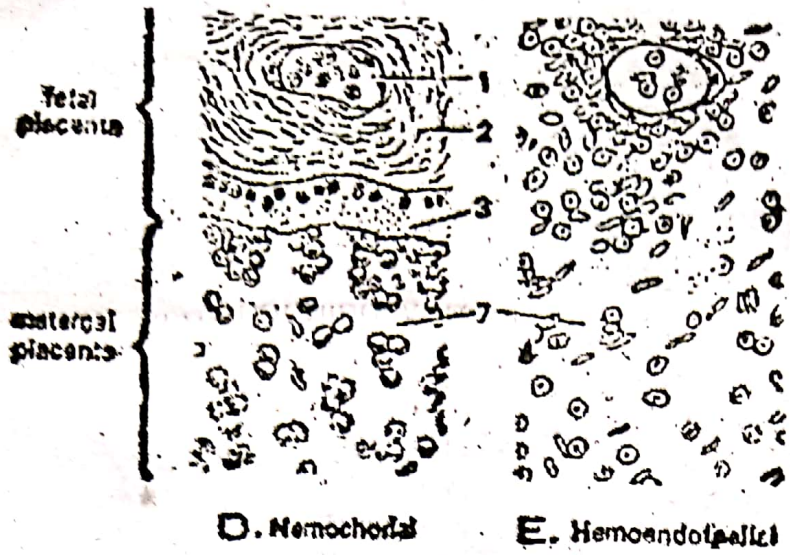
In the monkey, the placenta consists of two disc, shaped villous areas and such a placenta is called bidiscodial placenta.

C. CLASSIFICATION OF PLACENTA ACCORDING TO THE HISTOLOGY

On histological basis, following types of mammalian placentae have been recognised-

1. Epithelio-chorial placenta–The epithelio-chorial type placenta is most primitive type placenta and it is found in marsupials, ungulates (pig, saw, cattle etc.) and lemurs. In such a case, no fewer than six tissues or membrance lie between the foetal and maternal blood streams, therefore, the molecules of nutrients and oxygen, for instance, in going from the mother to foetus would pass through in this order–(1) the endothelium of the maternal blood vessel; (2) endomaterial connective tissue (messenchyme); (3) uterine epithelium; (4) the ectoderm of the chorion or chorioic epithelium; (5) chorionic connective tissue (foetal mesenchyme); and (6) the endothelium of foetal blood. Because, the immediate contact of the two halves of the placenta involves chorionic epitheliochorial uterine epithelium, this type of placenta is called epithelio-chorial placenta. The villi of an epithelio-chorial placenta push in the wall of uterus and later lie in the pocket like depressions of the uterine wall.





2. Syndesmo Chrsoal Placenta : In the reminant ungulates (cattle, sheep), the foetal and maternal components are fused so intimately as to result in a destruction of the uterine epithelium, thus, bringing the chorion into contact with the connective tissue of the uterine mucosa. Only five barriers, therefore, the between the two, (viz., foetal and uterine blood streams). This type of placenta is called syndesmo-chorial placenta.

3. Endothelio Chorial Placenta : In carnivores (dogs, cats, bears; etc.) the uterine mucosa is reduced and the chorionic eipthelium comes in contact with the endothelial wall of the maternal (uterine) blood vessels. In such a case, therefore, there lies only four barriers between the foetal and maternal blood steams. This type of placenta is called endothelio chorial placenta.

4. Haemo-chorial Placenta : In the haemo-chorial placenta of primates, insectivores moles, shrews, and chiropterans (bats), a reduction of the barriers to three occurs. In such case, the endothelial walls of maternal (uterine) blood vessel also disappear and the chorionic epithelium is bathed directly in maternal blood. Actualy, the chorionic villi are surrounded by spaces (sinuses) devoid of endothelial lining, into maternal blood enters through the arteries of the uterus and from which the blood flows into the uterine vein.

5. Haemo-endothelial Placenta : In haemo-endothelial placenta of higher rodents (rat, ruginea pig, rabbit), the number of barriers between

the maternal and foetal blood steams is reduced to just two in them, the chorionic villi loss their epithelial and mesenchymal layer to such a degree that in most places, the essentially bare endothelial lining of their blood vessel along separates the foetal blood from the maternal sinuses.

Functions of Placenta : In all histological type of placentae, there exists a placental barrier which may include two to six kinds of tissues. Due to the placental barrier, the blood of foetus and mother is never blended. Physiolo-gically, the placental barrier is like a ultrafilter or semipermeable membrane. Accordingly, there is a relationship between placental transmission and molecular size, smaller molecules passing more readily through placental barrier than the larger ones. This means that water, oxygen, carbon dioxide, soluble organic materials as chloride and phosphates of sodium, potassium and magnesium and soluble organic substances as monosaccharides, hormones, vitamins and urea by diffusion. Macromolecules of poly-saccharides, lipids and proteins may be absorbed tropoblast cells by pinacocytosis.

The antibodies, which have developed in the blood of mother who has acquired immunity to certain diseases, such as diptheria, scarlet fever, small pox and measles, are passed to the foetus, which thus, becomes passively immunized and unsusceptible to these illnesses in the first period after birth. Certain pathogenic organisms and viruses can penetrate through the placental barrier and can infect the foetus if the mother is infected by those pathogens. This is known to happen with syphilis, small pox, chicken pox, measles, and rubella or German measles.

May drugs used medically may penetrate the placental barrier and some times cause most adverse effects on the embryo. Thus it is believed by women in early pregnancy (25 to 44 days), caused very extensive deficiencies in the development of limbs, the alimentary (non-performation of the anus) and the heart.

Besides, acting as to and from passge for maternal and foetal biochemical molecules, the plcenta stores materials such as fat, glycogen and iron; participates in the metabolism of proteins, and its

also acts like endocrine gland. Like an endocrine gland it secretes may hormones such as estradiol, progeserone, chorionic gonadotropin and placental lactogen in human female and most palcental mammals. In some animals such as rabbit, the placenta is a significant sources of the relaxen, which is a protein hormone for the relaxation of the pelvic ligaments of facilitate the birth of the young.