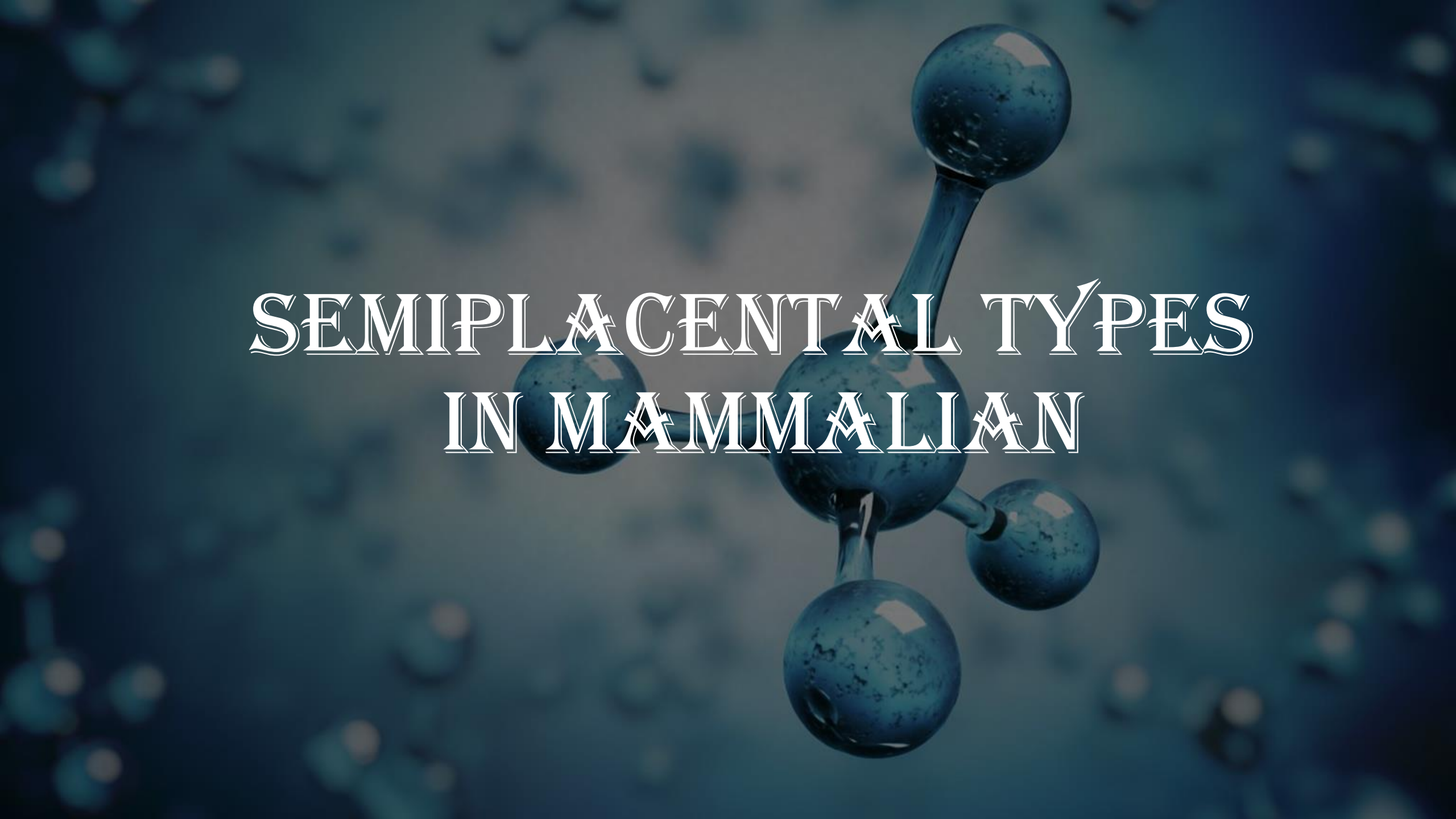


SEMIPLACENTAL TYPES IN MAMMALIAN

SEMIPLACENTAL TYPES IN MAMMALS

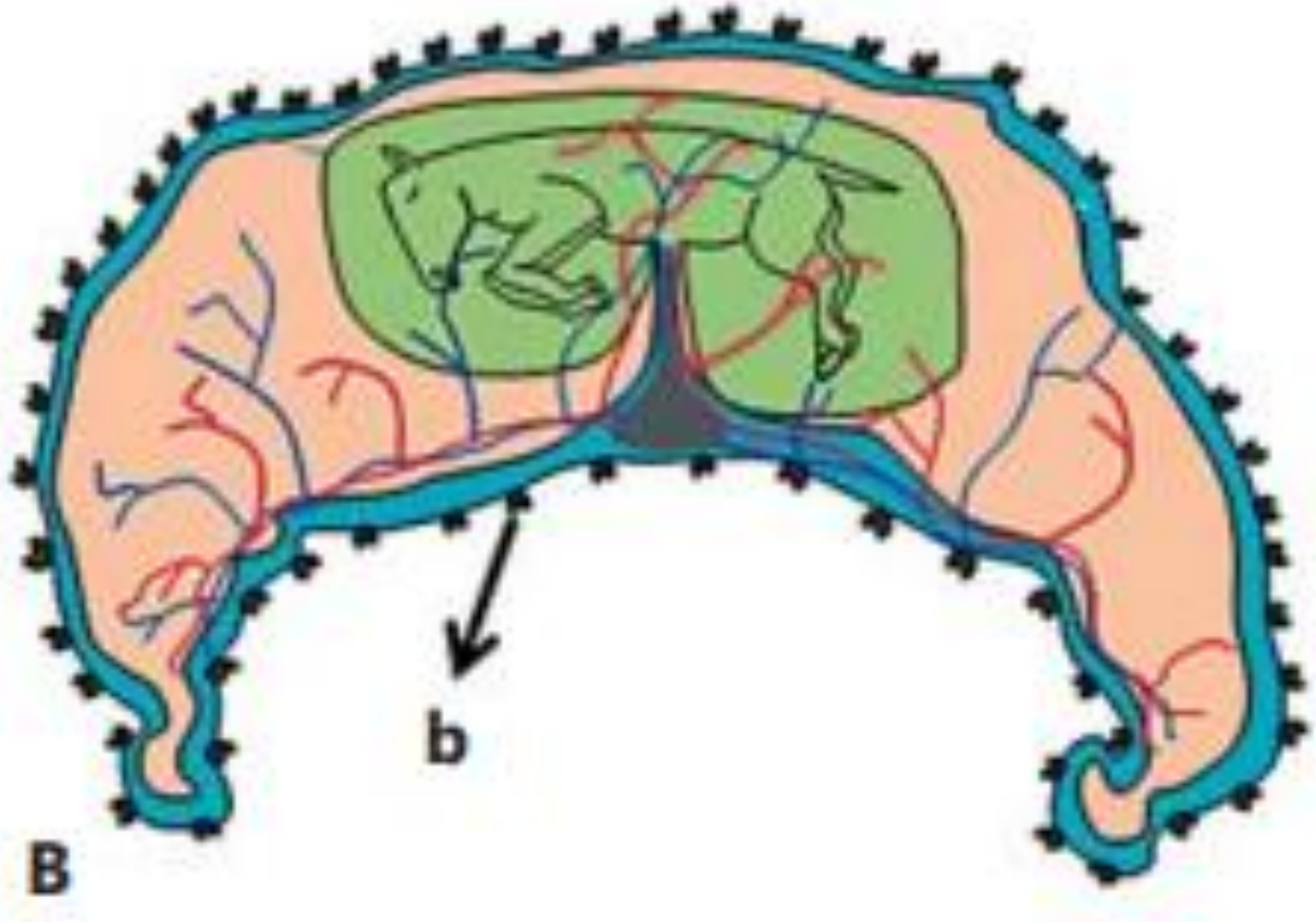
- Horses, pigs, and ruminants are the essential examples of semiplacental type, in other words, the placenta consists of all fetal layers and two or three maternal layers.

- Fetal layers cannot keep in touch with any maternal blood vessels or maternal endothelium in semiplacental mammalian species. The animals with semiplacenta lack the decidual cells. Their placentas are referred to as the chorioallantoic type.

- Note: During the parturition, fetal and maternal layers can be separated from each other without any damage or devastation in semiplacental animals.

1. PLACENTATION IN PIGS

- Porcine embryos enter the uterus at the 4-cell to 8-cell stage 48 hours after ovulation. They remain near the tip of the uterine horn until about day six, after which they are moved to their sites of implantation. Intra-uterine migration may continue until the 11th day. During the pre-implantation period, the blastocyst changes from a spherical structure 0.5–2 mm in diameter on the ninth day, to an ovoid sac 5 cm long with a distinct embryonic disc evident by the 11th day. By day 13, the blastocyst is an elongated filamentous structure up to 100 cm in length. Because elongation of blastocysts is not synchronous, both spherical and elongated blastocysts may be found at the same stage of pregnancy. Irrespective of their length, blastocysts become regularly spaced in the uterine horns.
- Elongation of blastocysts is due to cellular reorganisation and remodelling of trophoblastic cells rather than hyperplasia, with minimal change in the size of the embryonic disc during this period. Changes in the blastocyst are attributed to growth factors released by the conceptus and uterine tissue. Endoderm from the primitive streak lines the trophoblastic cavity forming a bilaminar yolk sac. Mesoderm derived from the primitive streak occupies a position between the two layers and forms a trilaminar yolk sac, the embryonic component of a short-lived choriovitelline placenta. The extra-embryonic coelom expands rapidly into the trilaminar yolk sac and separates the endoderm from the trophoblast, thereby terminating the function of the choriovitelline placenta.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- Amniotic folds develop at about the 12th day and fuse by the 16th day, forming the inner amniotic and outer chorionic sacs. On the 15th day, the allantoic sac forms as an outgrowth of the hindgut and expands into the extra-embryonic coelom. By the 30th day, the allantois becomes anchor-shaped and expands towards both extremities of the chorionic sac. The allantois, which vascularises the chorion, does not expand to the tips of the chorionic sac and consequently the tips remain avascular. Shortly afterwards, the avascular ends of the chorionic sac become necrotic, a feature characteristic of porcine extra-embryonic membranes.

- The necrotic tips of chorionic sacs of adjacent embryos form an avascular zone which prevents inter-embryonic vascular anastomosis. Implantation, which is centric, is a gradual process beginning around the 12th day. The elongated blastocyst exhibits a slight dilatation in the region of the embryonic disc which ensures close apposition and adhesion of the trophoblast to the endometrium. As the extra-embryonic sacs expand and fill with fluid, the area of contact between maternal and embryonic tissue increases. Firm attachment is observed by the 18th day, with interdigitation of microvilli between embryonic and maternal epithelium. As most of the chorionic sac is apposed to the endometrium, this form of placentation is termed diffuse.

- In the sow, the chorioallantoic placenta is **diffuse, non-deciduate and epitheliochorial**. By the 13th day of development, the chorionic epithelium becomes apposed to the uterine mucosa, and follows the folding of the maternal epithelium. Adhesion gradually occurs between the maternal and foetal epithelium with the formation of microvilli resulting in an interdigitation of both tissues.

Description and histological classification of placentae of domestic animals, rodents and primates. Foetal layers are listed in accordance with their position relative to the maternal circulation.

Classification	Cows	Sheep	Pigs	Horses
Implantation				
Interstitial				
Eccentric				
Centric (superficial)	X	X	X	X
Placentation				
Chorioallantoic	X	X	X	X
• diffuse			X	X
• cotyledonary	X	X		
• zonary				
• discoid				
Deciduate (Conjoined)				
Non-deciduate (Apposed)	X	X	X	X
Epitheliochorial			X	X
Synepitheliochorial	X	X		
Endotheliochorial				
Haemochorial				

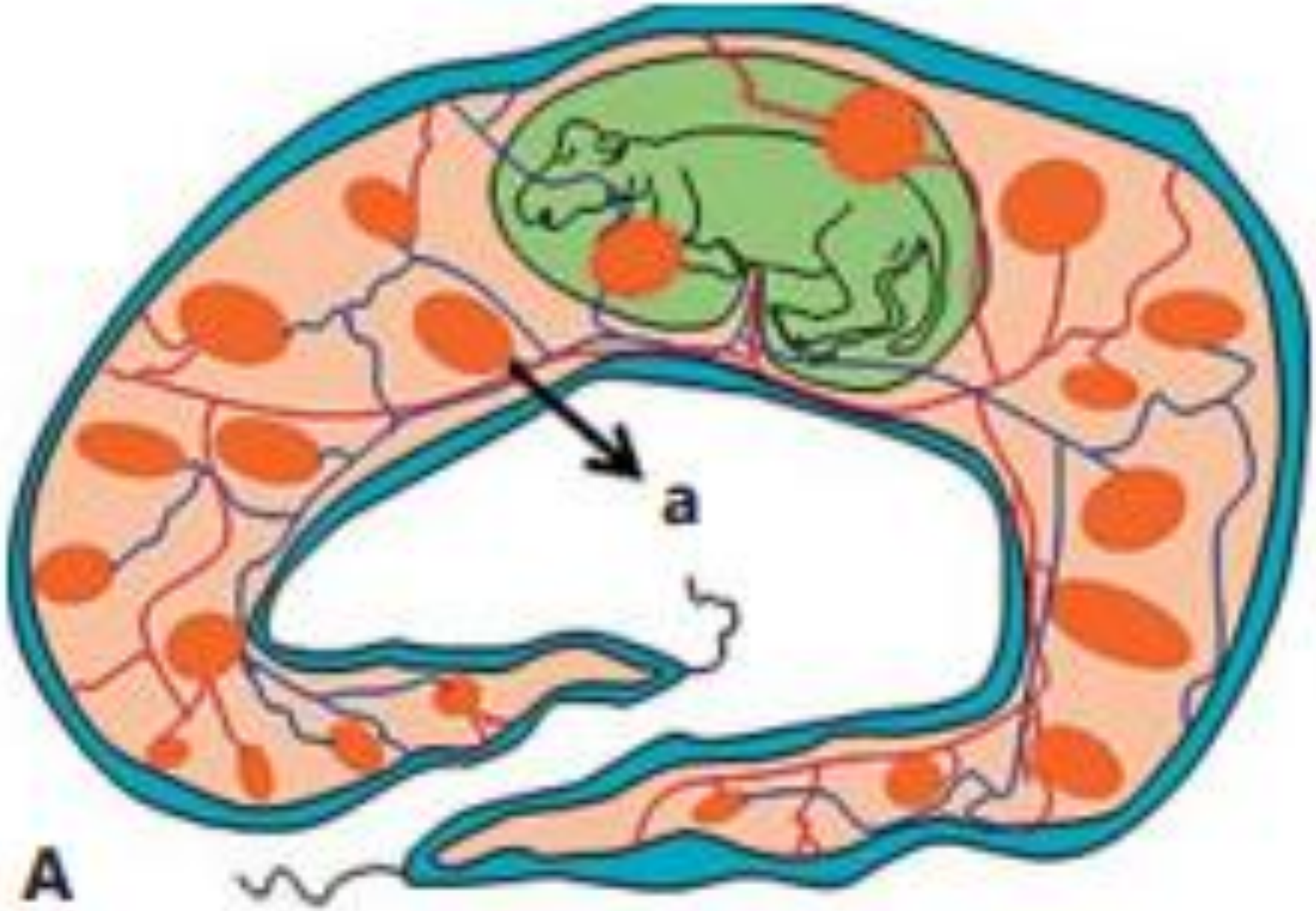
2. PLACENTATION IN CATTLE AND SHEEP

- In cattle and sheep, the zygote at the 8-cell stage enters the uterus on the third or fourth day post-ovulation. By the sixth day in sheep and the eighth day in cattle, the blastocyst has formed and emerges from its zona pellucida. In sheep the blastocyst, which has a spherical shape, is 1 mm in diameter. It elongates to 100 mm by the 14^{th} day of gestation. The bovine blastocyst elongates from approximately 2 mm on the 12th day to 100 mm by the 16th day. During this period of elongation, the embryonic disc, which is approximately 0.3 mm × 0.2 mm on the 14th day, undergoes little development. The elongating blastocyst extends into the non-pregnant horn on the 14th day in sheep and on the 18th day in cattle.

- By the 22nd day, the bovine blastocyst extends to the tip of the contralateral horn. In sheep, the allantois commences to grow into the extra-embryonic coelom on the 16th day and the amniotic folds fuse on the 17th day. In cattle, the amniotic folds fuse on the 18th day and the allantois is evident by the 19th day. At this stage in cattle and sheep, the allantois becomes anchor-shaped and extends to the tips of the chorionic sac. As the tips of adjacent chorionic sacs overlap, vascular anastomosis between adjoining extraembryonic membranes occurs in 90% of bovine twins. In sheep, the incidence of comparable vascular anastomoses is low.

- The chorioallantoic placenta of cattle and sheep is **cotyledonary, non-deciduate and synepitheliochorial**. The endometrium of cattle and sheep is composed of caruncles and inter-caruncular areas. The caruncles of non-pregnant cattle are small, raised, non-glandular areas approximately 0.5–1 cm in diameter.

- During the oestrous cycle, they become more prominent and in pregnancy they reach a diameter of up to 10 cm. The number of caruncles ranges from 80 to 140 in cows and 80 to 100 in ewes. Bovine caruncles have a convex surface with a distinct stalk, whereas ovine caruncles are concave with broad attachments.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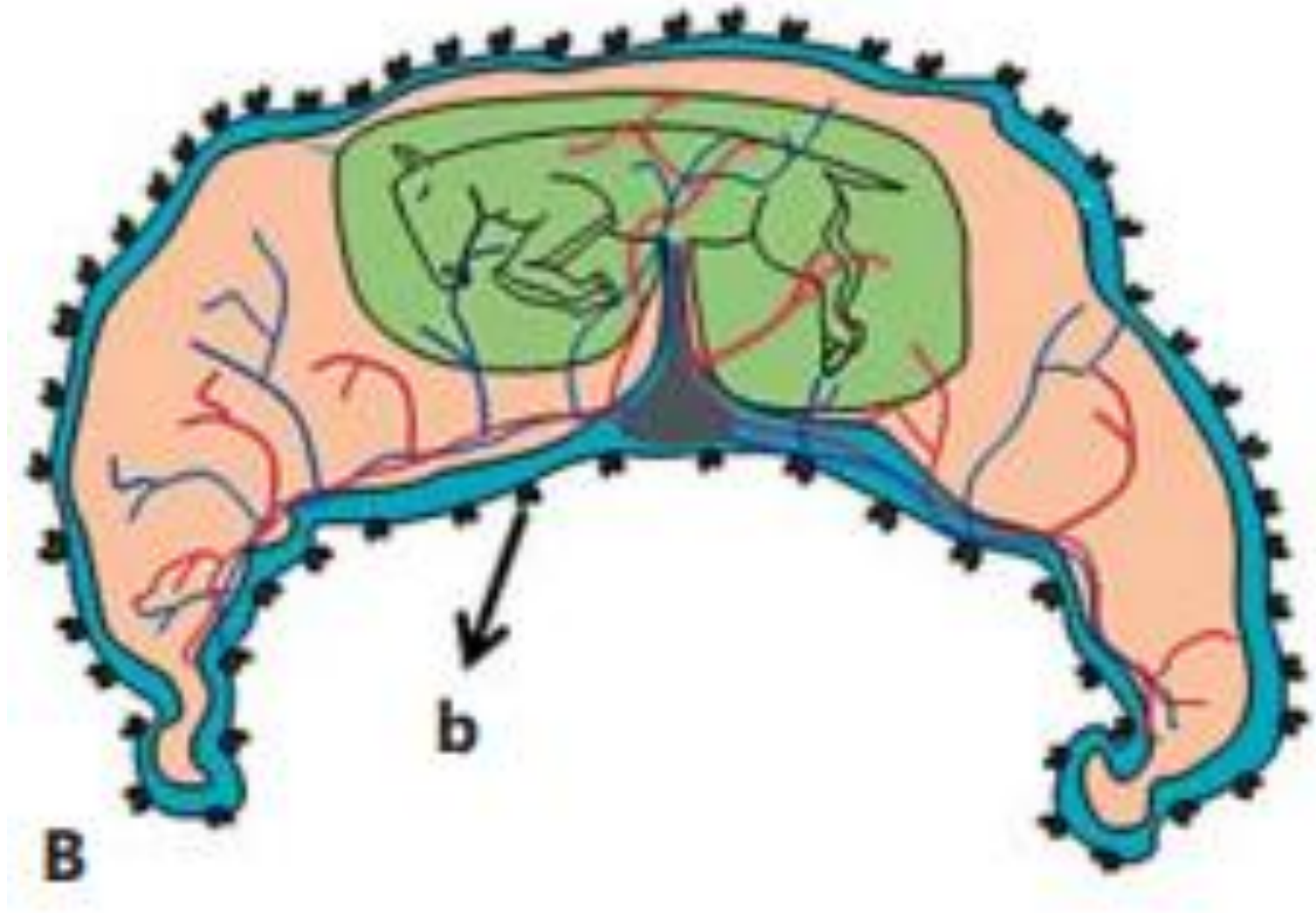
Description and histological classification of placentae of domestic animals, rodents and primates. Foetal layers are listed in accordance with their position relative to the maternal circulation.

Classification	Cows	Sheep	Pigs	Horses
Implantation				
Interstitial				
Eccentric				
Centric (superficial)	X	X	X	X
Placentation				
Chorioallantoic	X	X	X	X
• diffuse			X	X
• cotyledonary	X	X		
• zonary				
• discoid				
Deciduate (Conjoined)				
Non-deciduate (Apposed)	X	X	X	X
Epitheliochorial			X	X
Synepitheliochorial	X	X		
Endotheliochorial				
Haemochorial				

3. PLACENTATION IN HORSES

The equine zygote enters the uterus at the morula stage between the fifth and sixth day after ovulation. A unique feature of reproduction in the mare is that only fertilised ova enter the uterus; unfertilised ova are retained in the uterine tubes. A possible mechanism whereby the developing embryo enters the uterus relates to secretion of appreciable quantities of prostaglandin E2 by the morula, which acts locally, relaxing the circular muscle of the uterine tube thereby facilitating its entry into the uterus. By the sixth day, the blastocyst becomes enclosed by a thin acellular membrane or capsule of trophoblastic origin composed of glycoprotein molecules.

At the eighth day, the blastocyst is approximately 0.5 mm in diameter and the zona pellucida is lost. The capsule, which expands with the blastocyst, persists up to the 20th day of gestation and may prevent attachment of the blastocyst to the endometrium during the period of intra-uterine migration.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- The chorioallantoic membrane is apposed to the endometrium by the 17th day of gestation. The area of attachment is at first confined to a girdle of chorionic villi adjacent to the yolk sac. This discrete white annular band, referred to as the chorionic girdle, occupies a position at the boundary of the chorioallantois and the trilaminar yolk sac, a position it continues to occupy until the 40th day of gestation. Around the 25th day, the width of the girdle is approximately 1 mm, at 27 days it is approximately 3 mm, and at 34 days it is approximately 7 mm. By 40 days, it is diffuse and fragmented. At first the chorionic epithelium is in contact with the uterine epithelium only in the region of the chorionic girdle.

- Later, when the allantois fuses with the chorion forming the chorioallantoic membrane, the area of attachment remote from the girdle increases until the entire chorioallantoic membrane becomes attached to the endometrium. The attachment at first is in the form of a simple diffuse apposition of foetal and maternal tissue similar to that in pigs. Between the seventh and eighth weeks of gestation, villi develop on the chorioallantoic membrane which fit into crypts in the endometrium. Initially, the villi have a simple structure. Later, secondary and tertiary villi are formed from the primary villi up to the fourth month of pregnancy. The villi and their corresponding crypts form microscopic inverted dome-like structures referred to as microcotyledons.

- In the mare, the chorioallantoic placenta is **diffuse, non-deciduate and epitheliochorial.**

Description and histological classification of placentae of domestic animals, rodents and primates. Foetal layers are listed in accordance with their position relative to the maternal circulation.

Classification	Cows	Sheep	Pigs	Horses
Implantation				
Interstitial				
Eccentric				
Centric (superficial)	X	X	X	X
Placentation				
Chorioallantoic	X	X	X	X
• diffuse			X	X
• cotyledonary	X	X		
• zonary				
• discoid				
Deciduate (Conjoined)				
Non-deciduate (Apposed)	X	X	X	X
Epitheliochorial			X	X
Synepitheliochorial	X	X		
Endotheliochorial				
Haemochorial				

ENDOMETRIAL CUPS

- A distinguishing feature of equine placentation is the formation of ulcer-like structures termed endometrial cups, which develop in the endometrium in the region of the chorionic girdle. These cups, which develop at approximately the 35th day of gestation and reach diameters from 2 mm to 5 cm, atrophy around the 120th day. Close to the 35th day of gestation, columnar epithelial cells of the chorionic girdle penetrate and destroy the endometrial epithelium. After they migrate through the basement membrane into the endometrial stroma, these cells lose their migratory ability and develop into large epithelioid cells referred to as endometrial cup cells. These cells, which are polyhedral in shape with pale-staining foamy cytoplasm, are up to 100 μm in their cross-sectional dimensions. Their nuclei are ovoid with prominent nucleoli. Many of these cells are binucleate. Endometrial cups, which are first macroscopically evident at about the 40th day, appear as discrete, pale, slightly raised plaques in the endometrium.

- The cups continue to enlarge and become crater-like due to continuing growth at their periphery with accompanying central necrosis. After the 80th day, the endometrial cup cells become increasingly pale and necrotic. Hypertrophied endometrial glands discharge their copious secretion into the crater-like depressions of endometrial cups, which are covered by the chorioallantoic membrane. Endometrial cup cells have been shown by *in vitro* and *in vivo* experiments to be the principal source of equine chorionic gonadotrophin (eCG), formerly known as pregnant mare serum gonadotrophin (PMSG).

- The concentration of eCG in maternal serum rises rapidly from the 40th day of gestation reaching a level of 40–200 i.u./ml between the 50th and 70th days. Thereafter, levels decline steadily and become undetectable by the 120th day of gestation. The presence of eCG in the serum of mares during this period forms the basis of a pregnancy test. As endometrial cup cells are of foetal origin, they are foreign to the mare and, accordingly, induce a maternal immunological response which results in lymphocytic infiltration of the uterine stroma. Invasion by cytotoxic T lymphocytes which destroy endometrial cup cells, together with the production of antibodies directed against paternal antigens on the cup cells, correlates with the cessation of eCG secretion around the 120th day of gestation.

- Once endometrial cups are formed, subsequent termination of pregnancy, either surgically or as a consequence of abortion, does not alter the continued development and subsequent regression of endometrial cups. Mares in which pregnancy has been terminated during the time when endometrial cups are present do not revert to oestrus until the cups have regressed and eCG levels have disappeared. Even after termination of pregnancy, the continued secretion of eCG by endometrial cup cells can give a positive reaction in a pregnancy diagnostic test based on detection of eCG in the serum.

Description and histological classification of placentae of domestic animals and humans. The foetal layers are listed in accordance with their position relative to the maternal circulation.

		Placental layers					
		Maternal layers			Foetal layers		
Species	Type of placentation	Endothelium	Connective tissue	Epithelium	Epithelium	Connective tissue	Endothelium
Pigs	Epitheliochorial	Present	Present	Present	Present	Present	Present
Horses	Epitheliochorial	Present	Present	Present	Present	Present	Present
Cattle	Synepitheliochorial	Present	Present	Absent	Present	Present	Present
Sheep	Synepitheliochorial	Present	Present	Absent	Present	Present	Present
Goats	Synepitheliochorial	Present	Present	Absent	Present	Present	Present

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