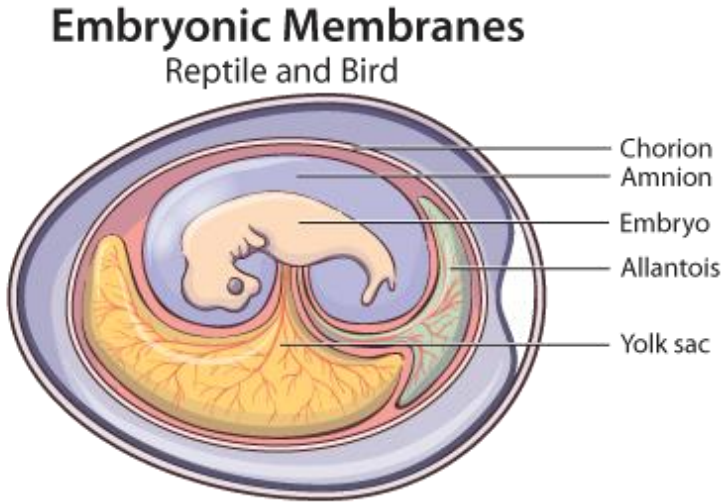
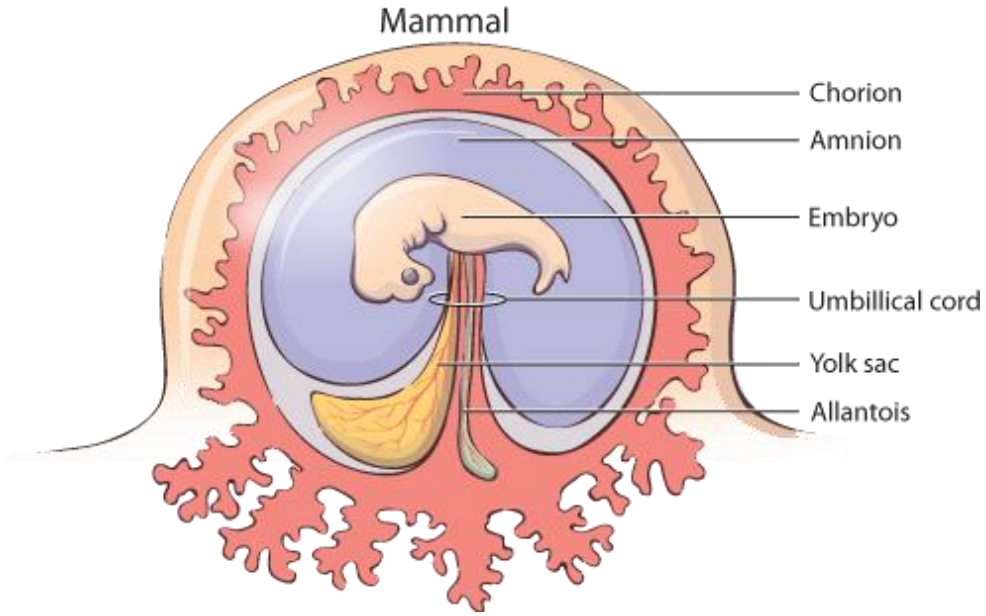
PLACENTA DEVELOPMENT IN MAMMALS

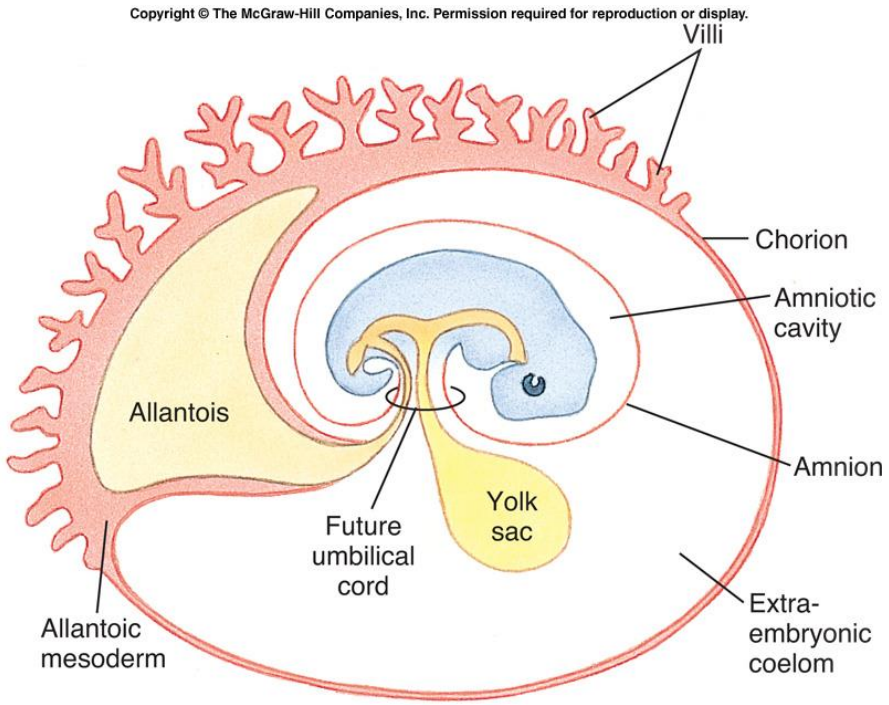


Unlike other vertebrates, including reptiles and birds, placental mammals develop membranes that form a **placenta** during pregnancy.



The **placenta** allows nutrient uptake, waste elimination, and gas exchange via the mother's blood supply, fights against internal infection (placental **barrier**) and produces hormones to support pregnancy.

Placental development

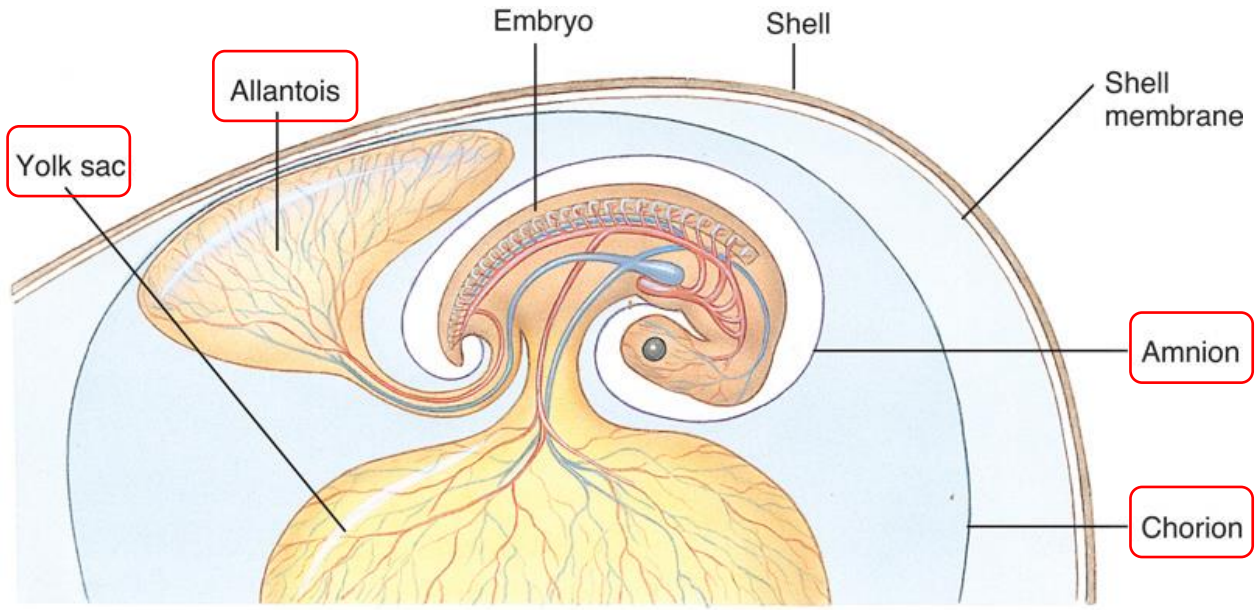


The placenta is a FETOMATERNAL organ composed of two different surfaces:

- The **maternal surface**, facing towards the outside. Derived from the endometrium.
- The **fetal surface**, facing towards the inside, or the fetus. Derived from the chorionic sac.

On the fetal surface, we can observe the **umbilical cord**, the link between the placenta and the fetus. Placenta and umbilical cord form a **transport system** for substances between mother and fetus.

In the mammalian organisms, the three germ layers give rise to the four **extraembryonic membranes** that surround the developing embryo



Amnion – fluid filled membranous sac that encloses the embryo. Protects embryo from shock.
Yolk sac – Source of stem cells that give rise to blood and lymphoid cells. Stem cells migrate to into the developing embryo
Allantois - storage of metabolic wastes during development. Contributes to the formation of the umbilical cord
Chorion - lies beneath the eggshell and encloses the embryo and other extraembryonic membrane. It forms most of the Placenta.

As embryo grows, the need for oxygen increases: Allantois and Chorion fuse to form a respiratory surface, the **chorioallantoic** membrane.

Placental functions

As the fetus is in full development, it requires a certain amount of gases and nutrients to help support its growth. Because the fetus is unable to do so on its own, the placenta provides these gases and nutrients throughout pregnancy.

During pregnancy, the placenta has **6** main roles to maintain good health and a good environment for the growing fetus:

- **1 Respiration**
- **2 Nutrition**
- **3 Excretion**
- **4 Protection**
- **5 Endocrine**
- **6 Immunity**

•1 Respiration

The fetus must obtain oxygen and excrete carbon dioxide through the placenta. Oxygen from the mother's blood passes into the fetal blood by simple diffusion; similarly the fetus gives off carbon dioxide into the maternal blood

•2 Nutrition

The fetus needs nutrients for growth and development. They are actively transferred from the maternal to the fetal blood through the walls of the villi

•3 Storage

Placenta metabolizes glucose, stores it in the form of glycogen and reconverts it to glucose as required. It can also store iron, fat and soluble vitamins.

•4 Excretion

The main substance exctreted from the fetus is carbon dioxide. Bilirubin will also be excreted as red blood cells are replaced relatively frequently

•5 Protection

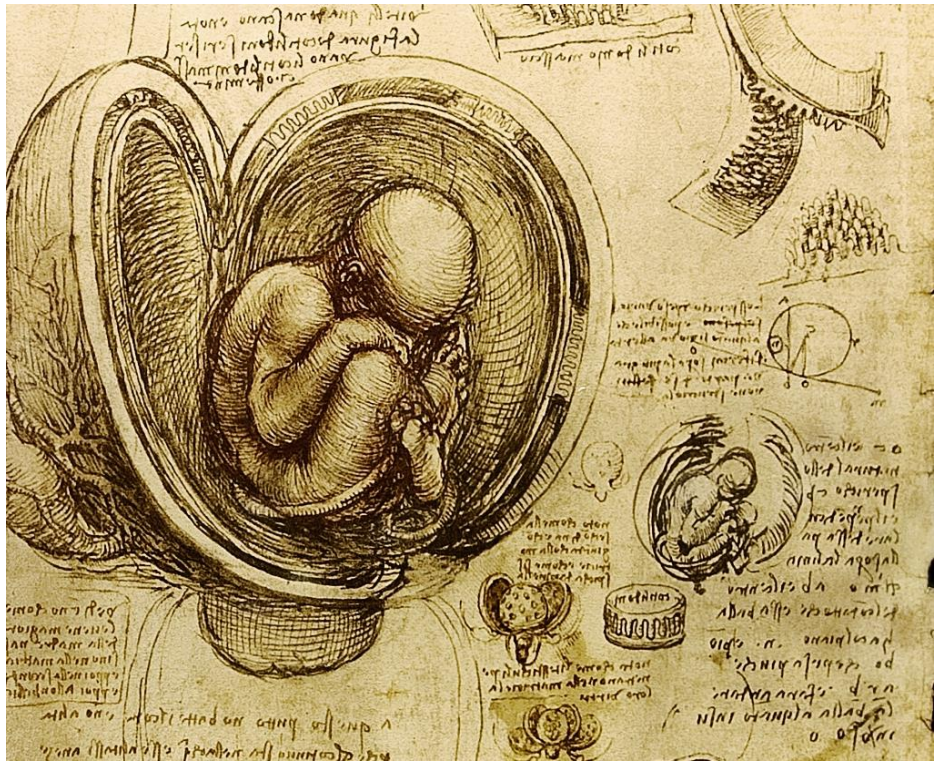
The placenta provides a limited barrier to infection. However, substances including alcohol, some chemicals and several types of viruses, such as human cytomegalovirus and rubella are not filtered out. These substances can cross the placental barrier freely and may cause congenital abnormalities

•6 Endocrine

Oestrogens are growth stimulating hormones, which are secreted throughout pregnancy. They are produced by the placenta as the activity of the corpus luteum declines, the fetus providing the placenta with the vital precursor for their production

Placenta: **definition** and classification

The placenta is a “vascular organ in most mammals that provide connection between the fetus to the uterus of the mother. It mediates the metabolic exchanges of the developing individual through an intimate association of embryonic tissues and of certain uterine tissues, serving the functions of nutrition, respiration, and excretion.”



Placenta: definition and **classification**

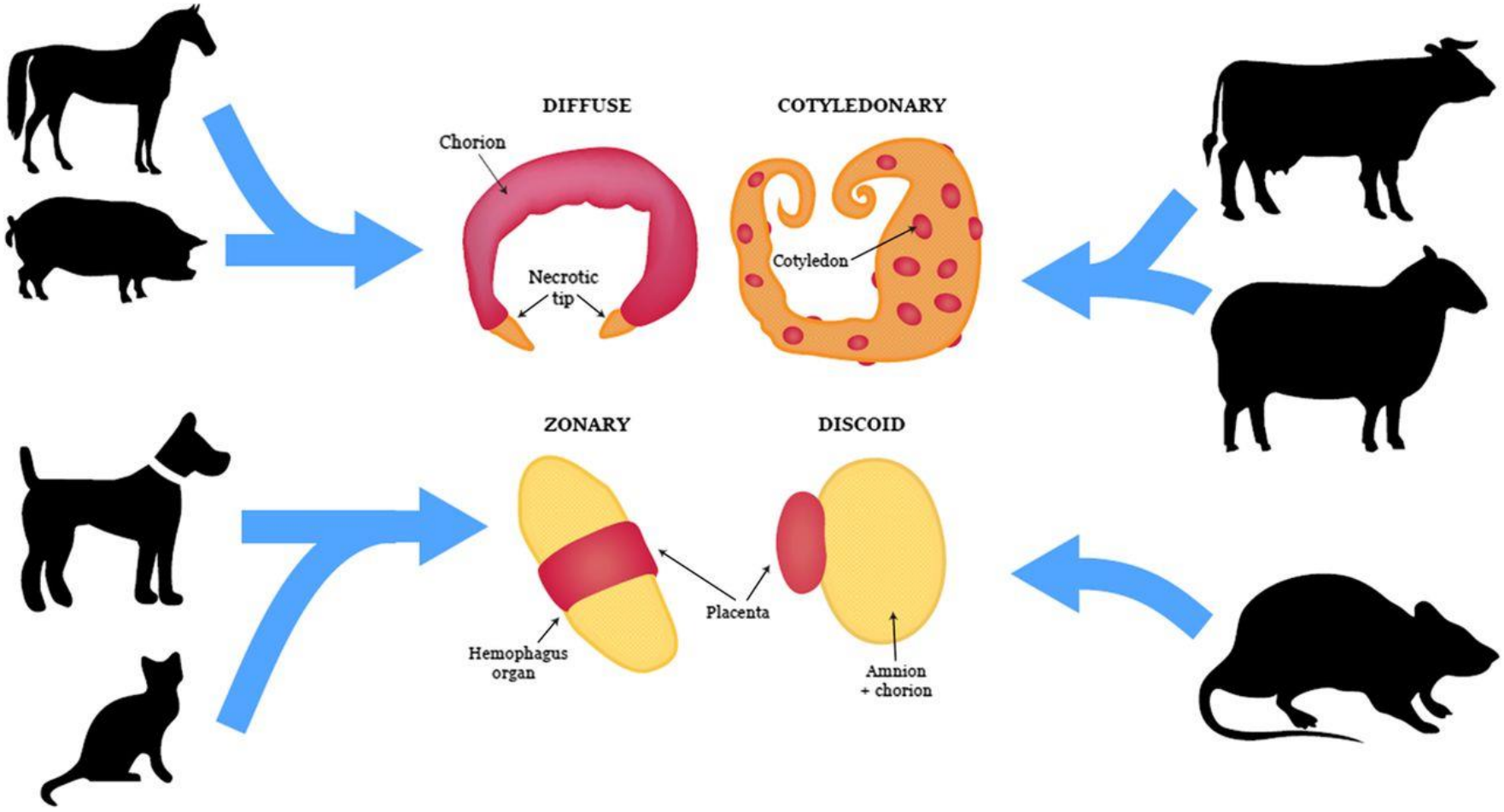
The placentas of all eutherian (placental) mammals provide common structural and functional features, but there are differences among species in gross and microscopic structure of the placenta.

Two characteristics are particularly divergent and form bases for classification of placental types:

-The **gross shape** of the placenta and the distribution of **contact sites** between fetal membranes and endometrium.

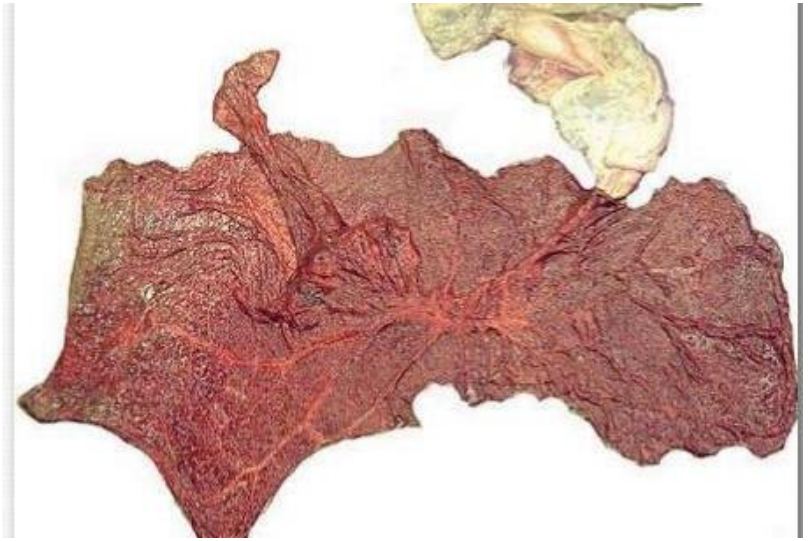
-The **number of layers** of tissue between maternal and fetal vascular systems.

Gross anatomical classification of placentas is based on the pattern of contact between chorion and endometrium



Gross anatomical classification of placentas is based on the pattern of contact between chorion and endometrium

DIFFUSE (horse, pigs)
Uniform distribution of chorionic villi over contact surface



COTYLEDONARY (ruminants)
Villi restricted to defined area. The fetal portions of this type of placenta are called **cotyledons**, the maternal contact sites (**caruncles**), and the cotyledon-caruncle complex a **placentome**

Gross anatomical classification of placentas is based on the pattern of contact between chorion and endometrium

ZONARY (dogs, cats)
circle of chorionic villi around the middle of chorionic sac. The placenta takes the form of a complete or incomplete band of tissues surrounding the fetus

DISCOIDAL (humans, rodents)
Disc-shaped area on chorionic sac. Part of the chorion remains smooth, while the other part interacts with the endometrium to form the placenta.

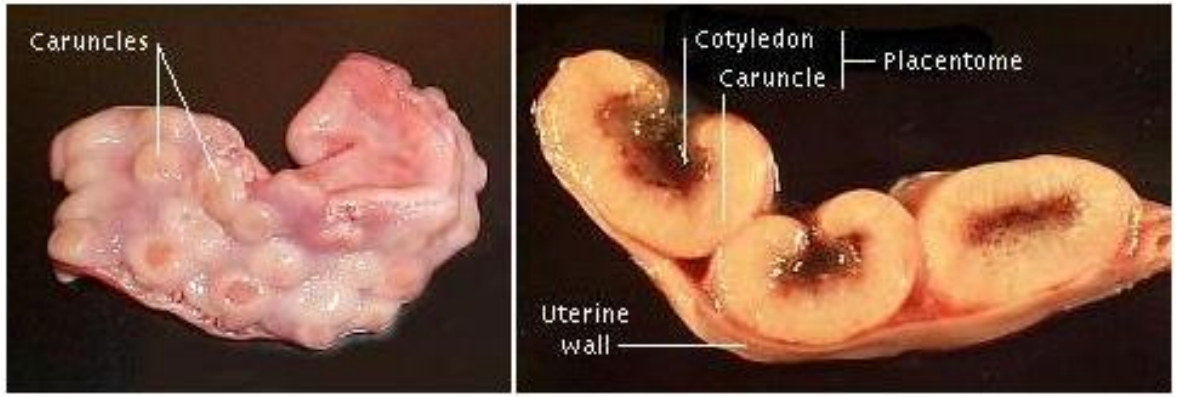
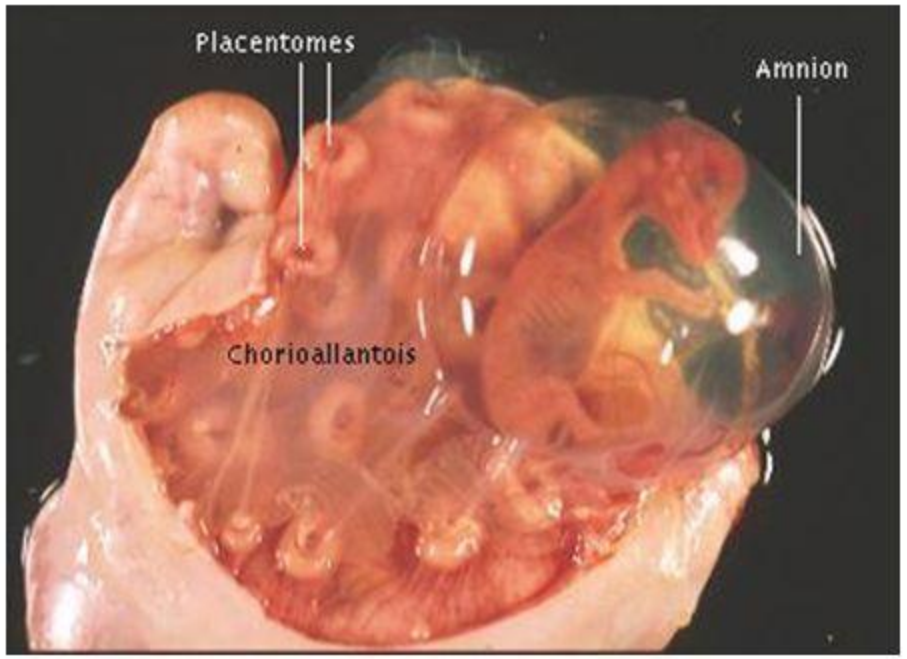
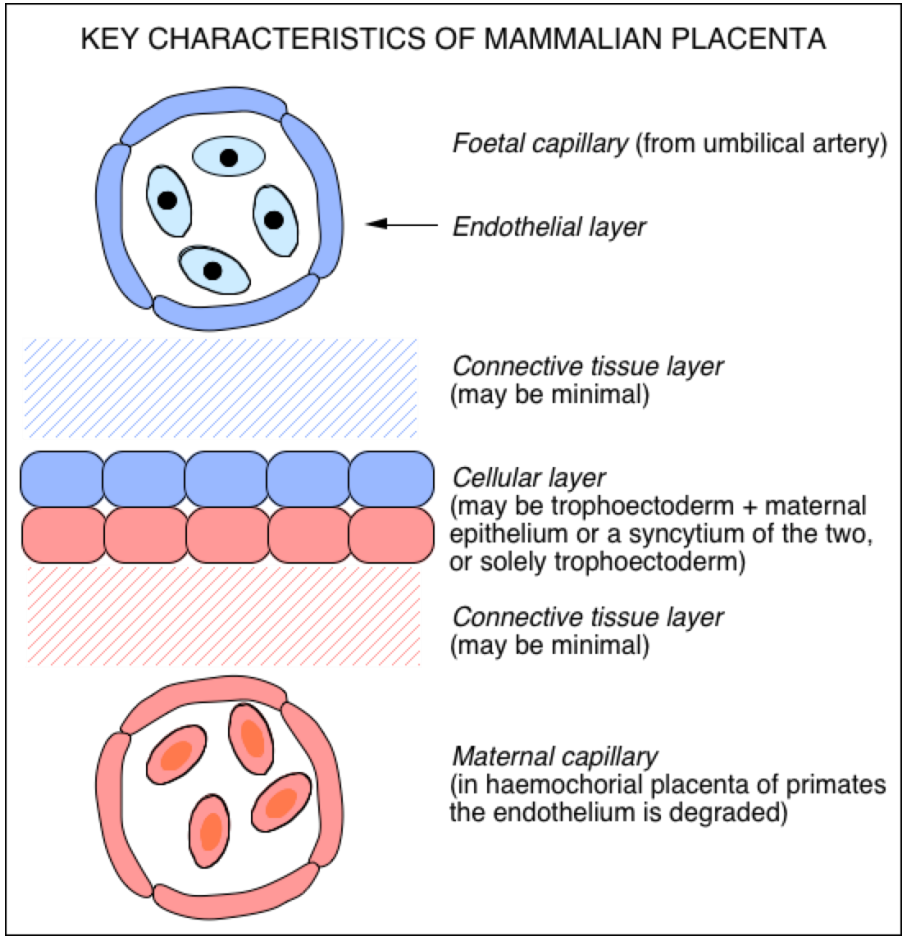


Image shows caruncles in an incised non-pregnant sheep uterus (left) and cross sections through placentomes from a midgestation sheep pregnancy (right).



The image shows an incised uterus from a pregnant sheep, roughly 50 days of gestation. The numerous button-shaped structures are placentomes. The slightly milky- looking membrane covering and between placentomes is the chorioallantois. The fetus is clearly visible inside the amnion.

Histological classification of placentas is based on the degree of removal of the maternal layers (number of layers)



There are 3 layers of fetal extraembryonic membranes in the chorioallantoic placenta of all mammals, all of which are components of the mature placenta:

1.Endothelium lining allantoic capillaries
2.Connective tissue
3.Chorionic epithelium, the outermost layer of fetal membranes

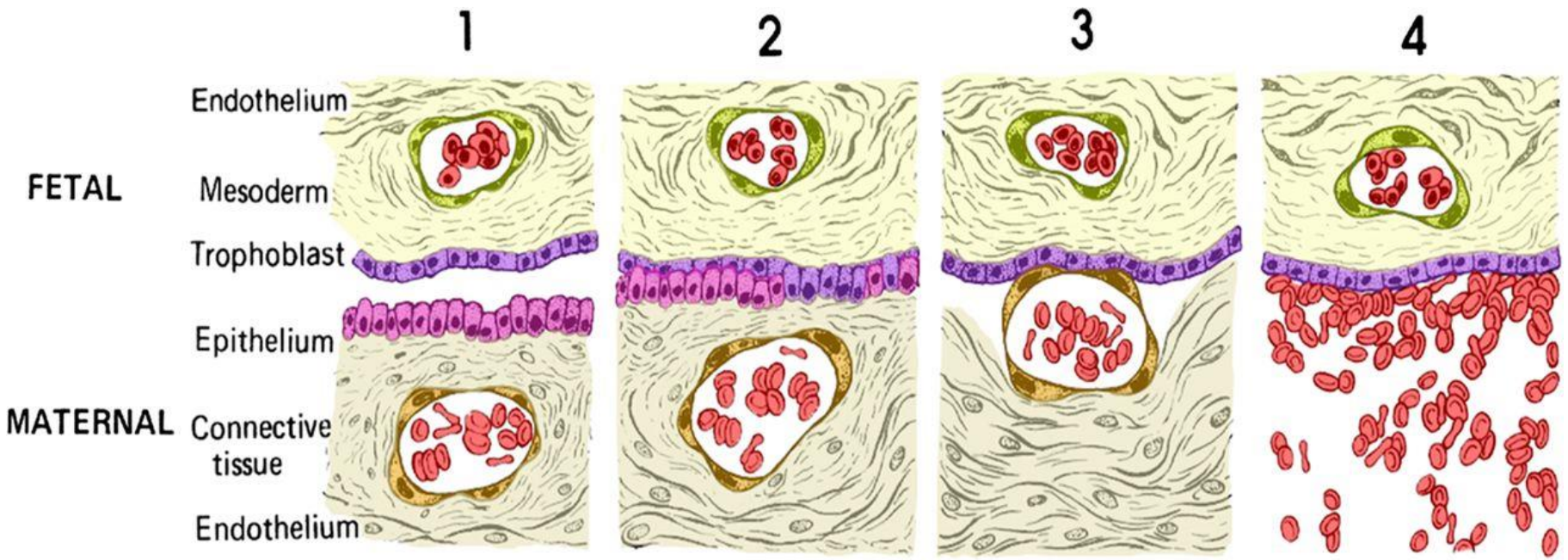
There are also 3 layers on the maternal side, but the number of these layers which are retained varies greatly among species.

The three potential maternal layers in a placenta are:

1.Endothelium lining endometrial blood vessels
2.Connective tissue of the endometrium
3.Endometrial epithelial cells

Maternal endometrial epithelium intact (Pig; Horse)

Removal of endometrial epithelium and connective tissue (Dog; Cat)



Epithelio–chorial

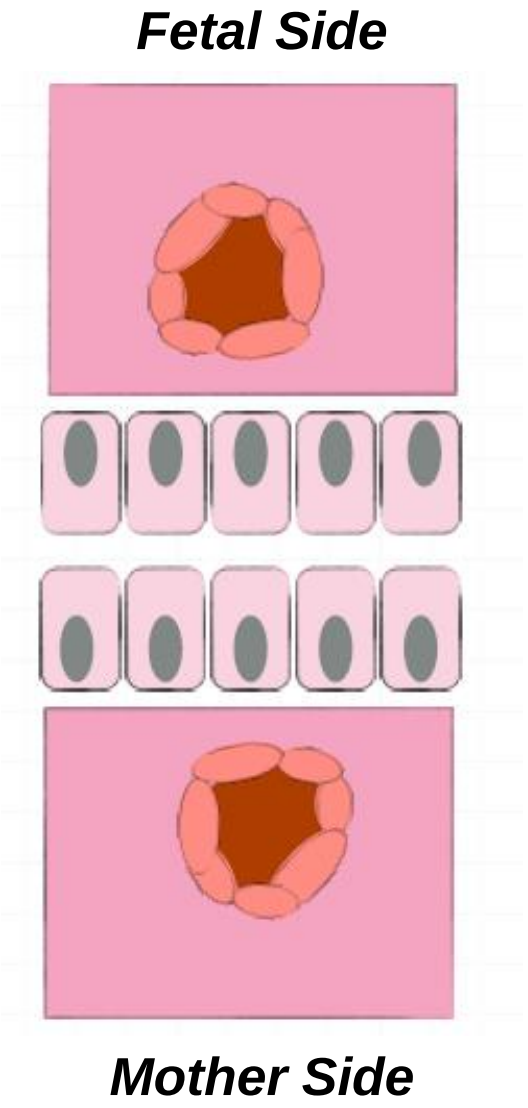
Synepithelio–chorial

Endothelio–chorial

Hemo–chorial

Syncytium of maternal epithelium and chorion (Ruminants)

Removal of maternal endothelium (Human; Rodent)

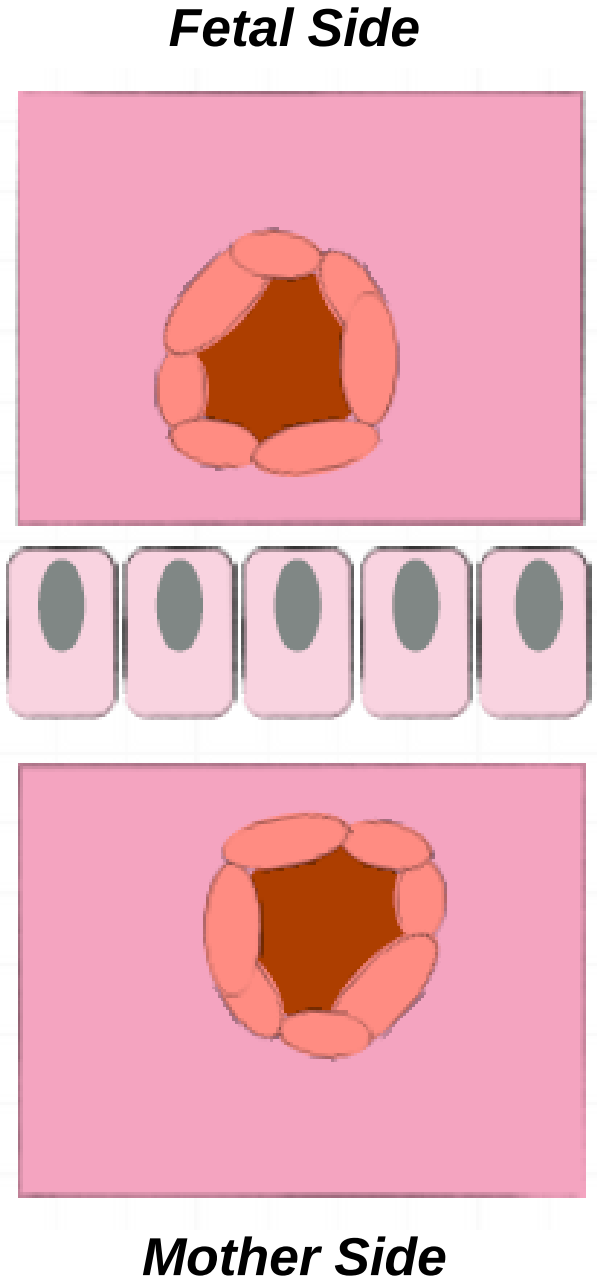


1.epitheliochorial placentation

Chorionic villi, growing into the apertures of uterine glands (epithelium).

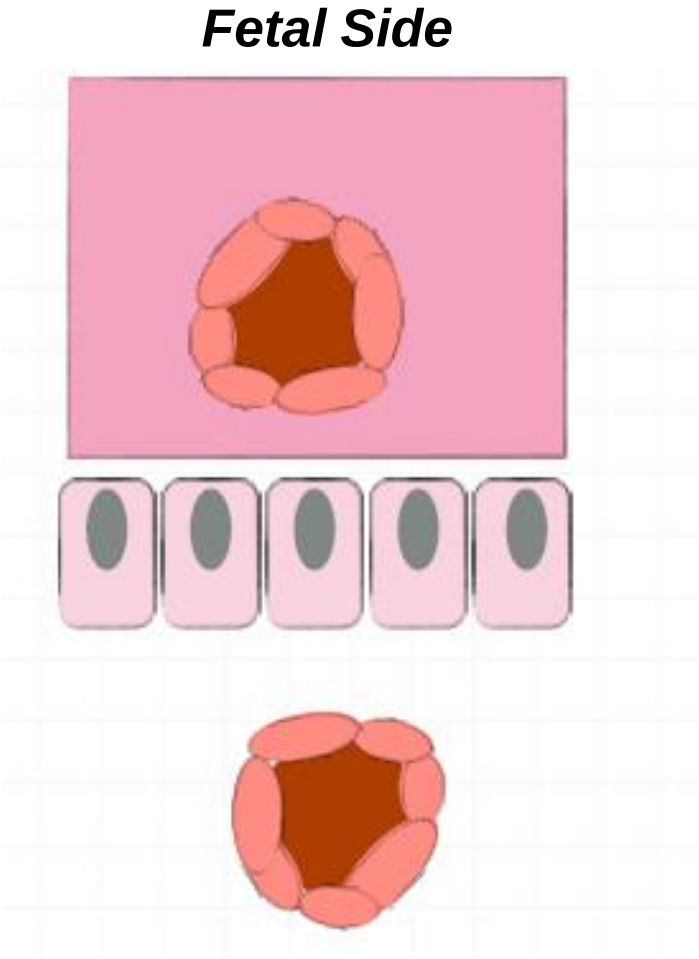
(e.g. horses, whales, lower primates)

(Ruminants)



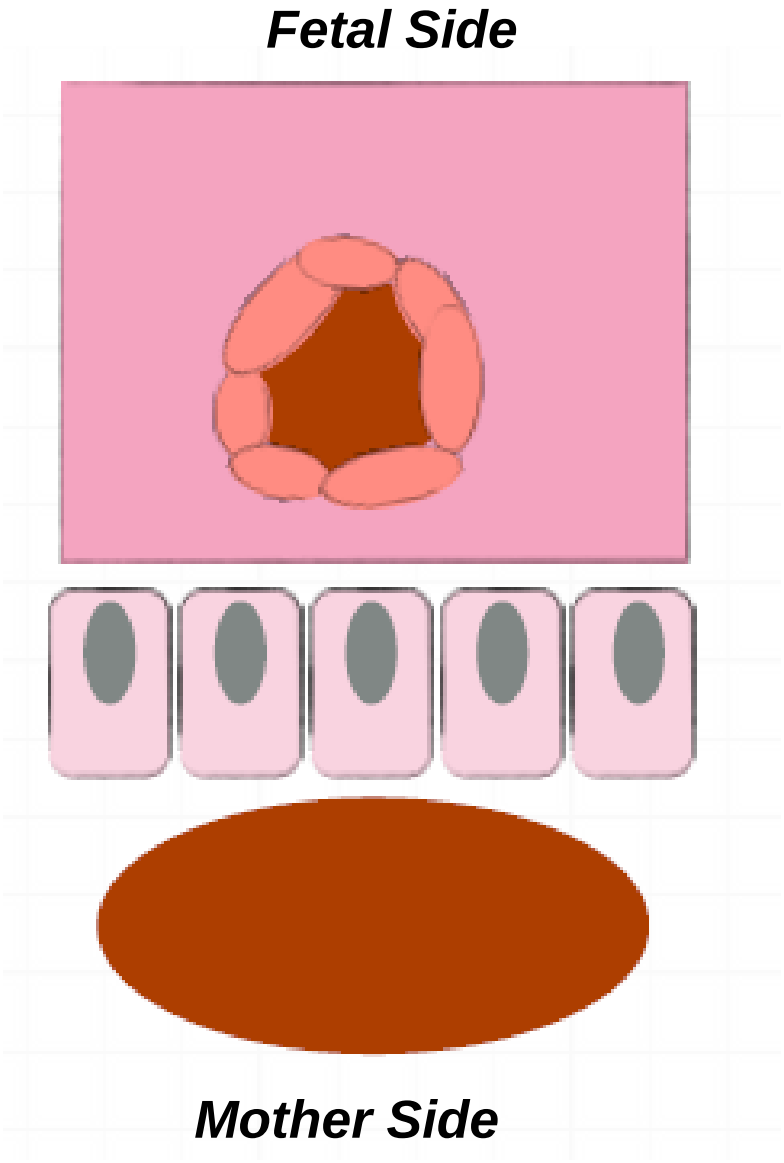
Synepitheliochorial placentation

Syncytium of maternal endometral epithelium and chorion



Endotheliochorial placentation

In this type of placentation, the chorionic villi are in contact with the endothelium of maternal blood vessels. (e.g. in most carnivores like cats and dogs)



Hemochorial placentation
(e.g. in higher order primates, including humans, and also in rabbits, guinea pigs, mice, and rats). The haemochorial placenta shows the intimate juxtaposition of foetal and maternal blood allowing efficient exchange.