FETAL MEMBRANES AND PLACENTATION

The term "fetal membranes" all extra-embryonal membranous structures involved in embryonal/fetal nutrition, excretion and protection They comprise the:

Yolk Sac

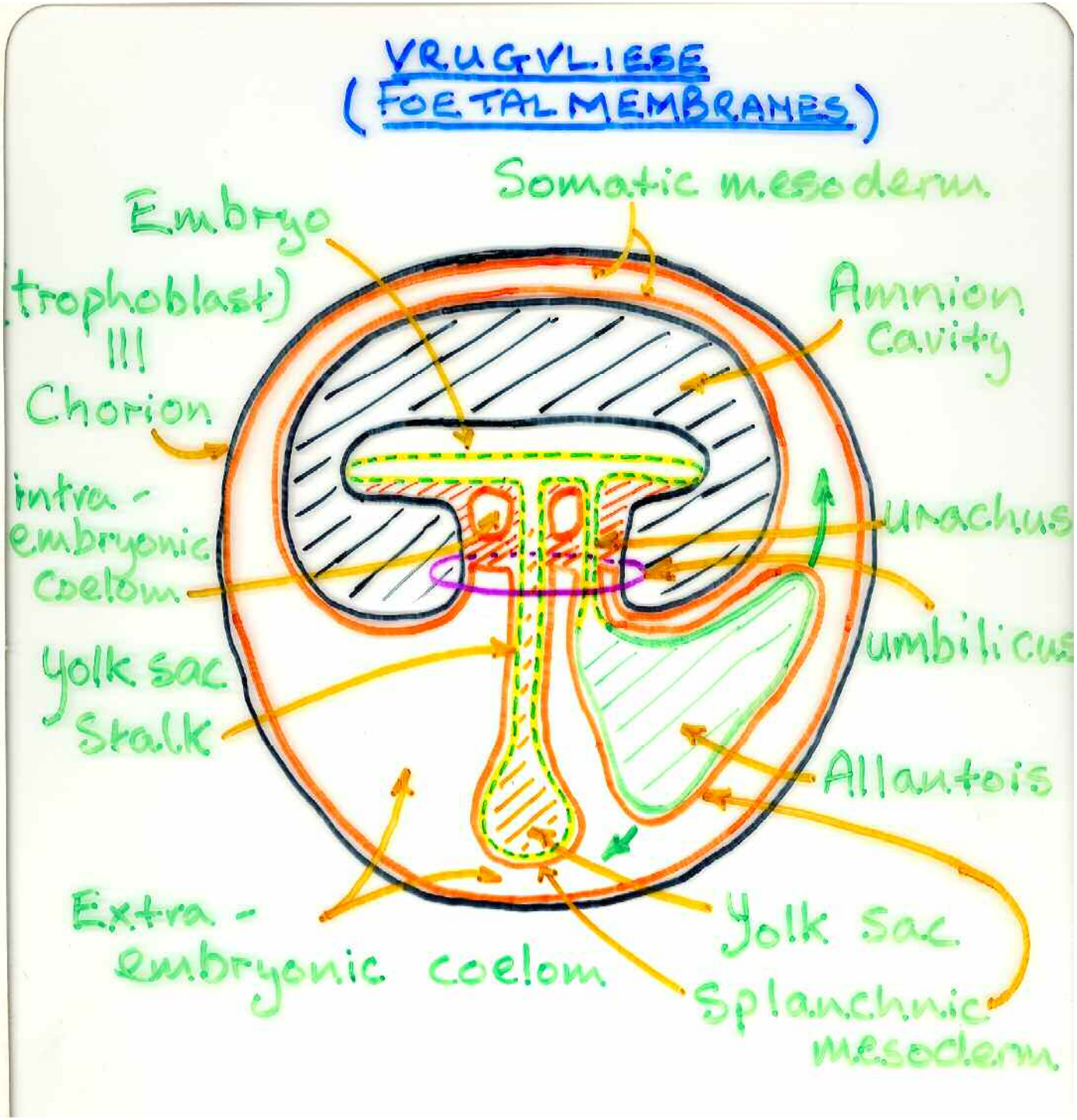
Amnion

Allantois

Chorion

Umbilical Cord

VRUGVLIESE
(FOETAL MEMBRANES)



Yolk Sac

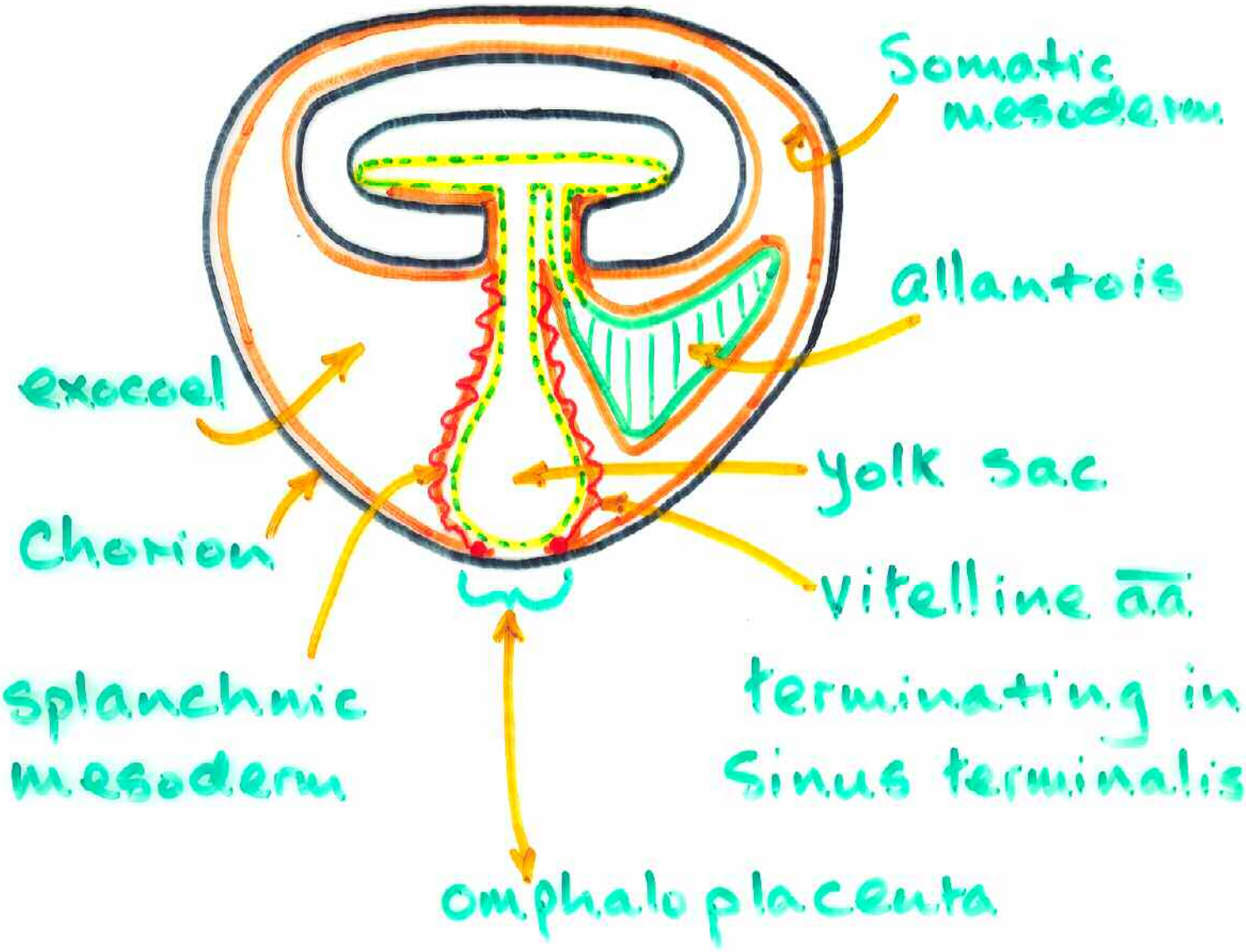
Originates during formation of the hypoblast.
Contains fluid with little or no nutritive value

Involved in:

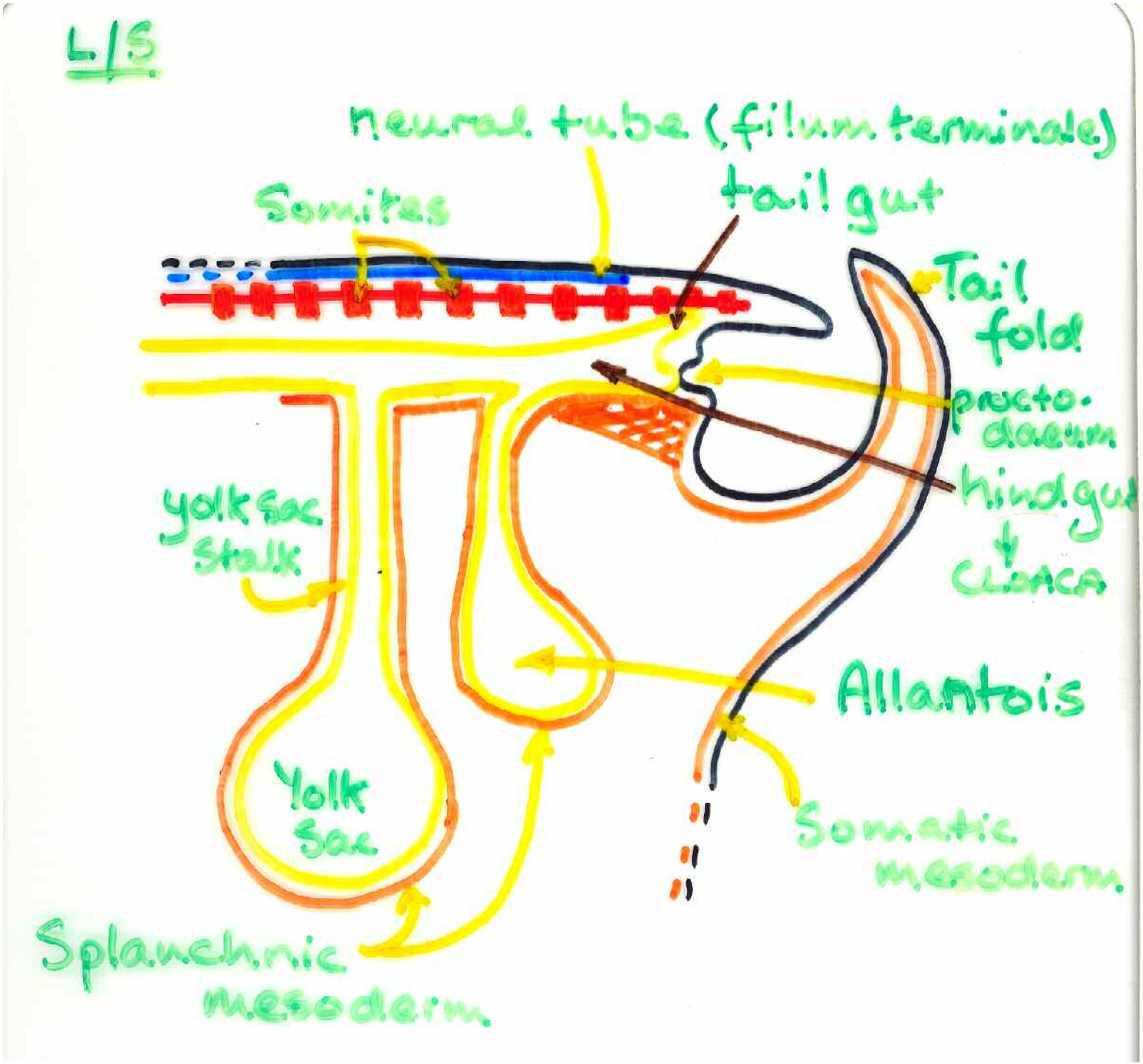
- **Formation of the primitive gut**
- **Early development of blood vessels and blood cells**
  (Vitelline arteries and veins)
- **Production of primitive germ (reproductive) cells**
- **Involved to a limited degree (horse and carnivores) in respiration and nutrition**

F/M HORSE

OMPHALOPLACENTA



L/S

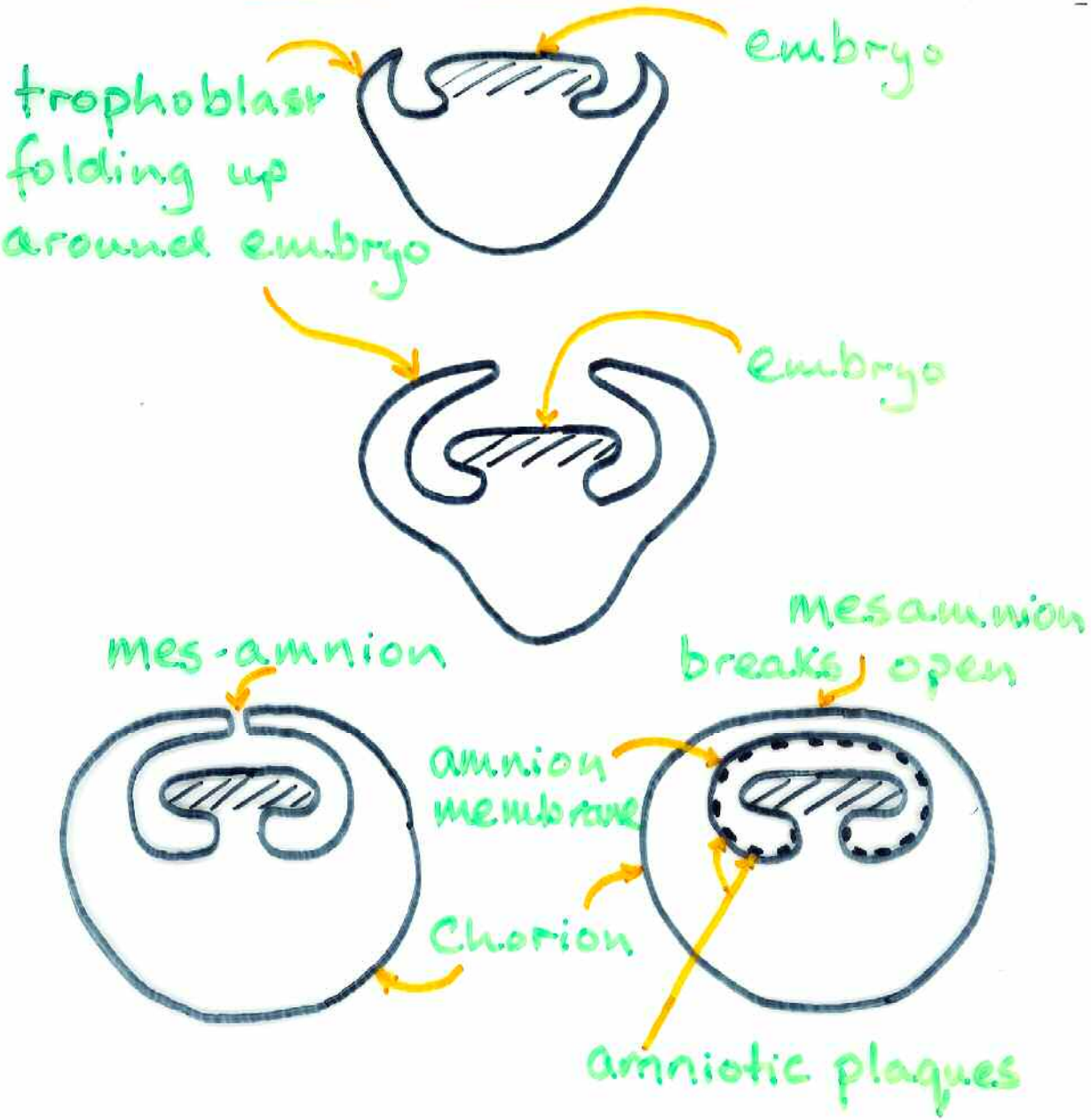

neural tube (filum terminale)
tail gut
Somites
Tail fold
procto-daeum
hind gut
CLOACA
yolk sac stalk
Allantois
Yolk Sac
Somatic mesoderm
Splanchnic mesoderm

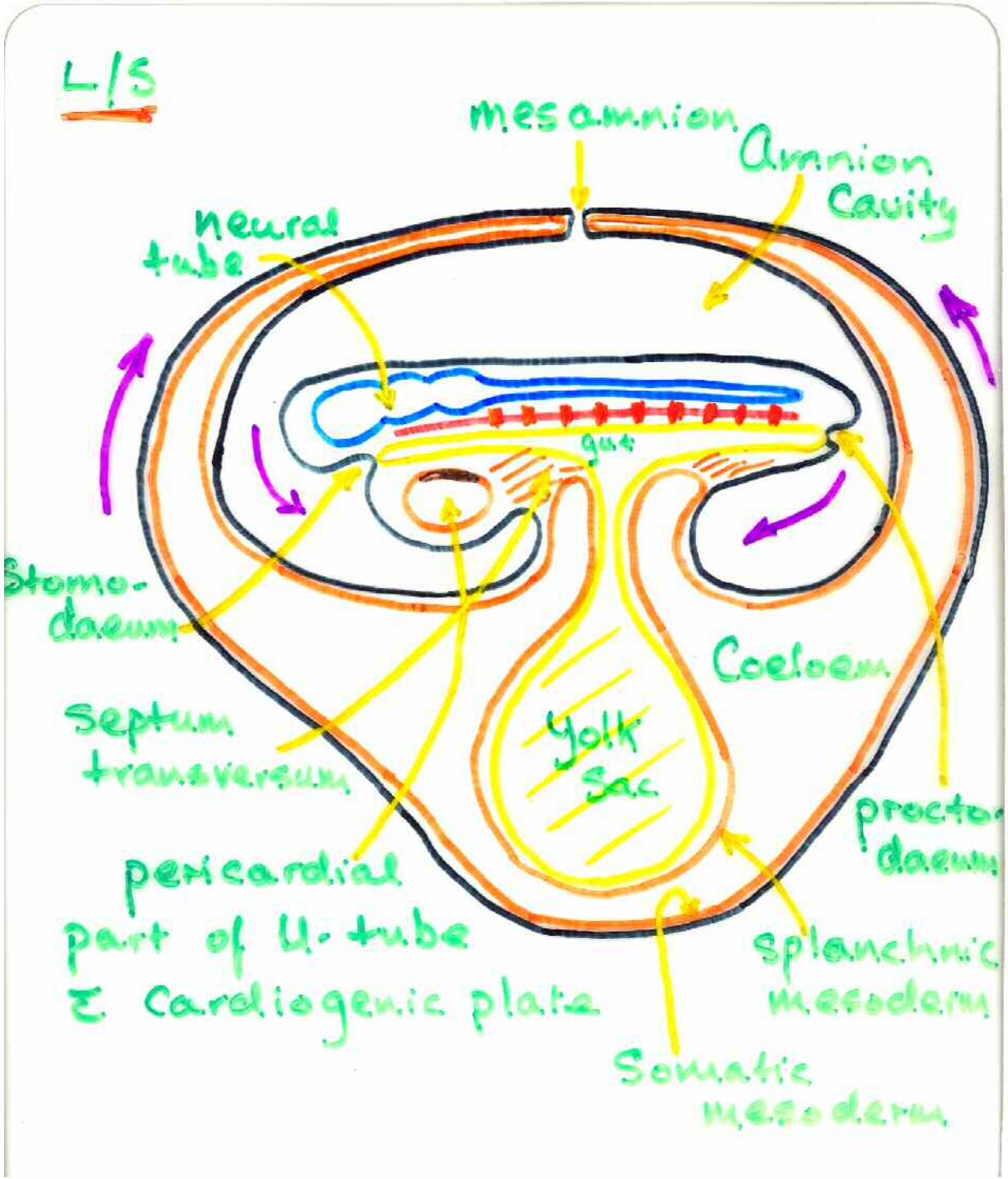
Amnion

Develops through formation of chorio-amniotic folds. Forms watery environment for embryo/fetus. Vascularised by the umbilical arteries and veins. Functions:

- **Shock-absorber and pressure equaliser**
- **Unhindered fetal movement and shape changes**
- **Prevents dessication of fetus**
- **Prevents adhesion between fetus and surrounding structures**
- **Limited uptake of fetal excreta**
- **Lubricant for birth canal during parturition**
- **Hydraulic dilator of birth canal**

AMNION FORMATION




L/S
mesamnion
Amnion Cavity
neural tube
gut
Stomo-daeum
Coeloem
Yolk Sac
septum transversum
pericardial part of U-tube & Cardiogenic plate
splanchnic mesoderm
Somatic mesoderm

Allantois

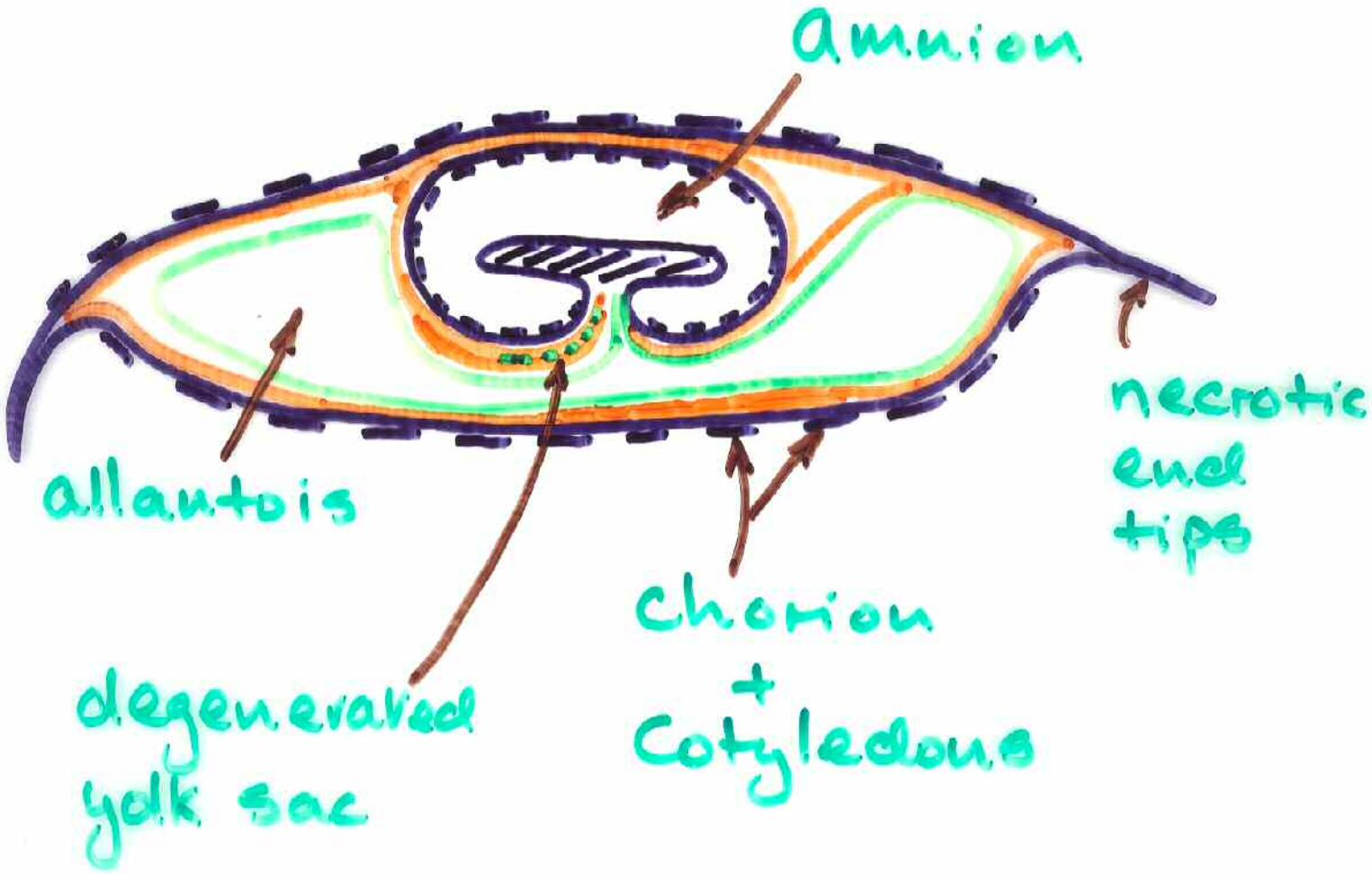
Endodermal evagination of the metenteron (hind gut). Vascularised by umbilical arteries and veins. Species differences regarding location. Functions:

- **Store urinary excreta / prevent contamination of amnion**
- **Responsible for nutrient absorption, respiratory gaseous exchange and excretion**
- **Proximal part of allantoic stalk (urachus) forms urinary bladder**

Hippomanes are formed

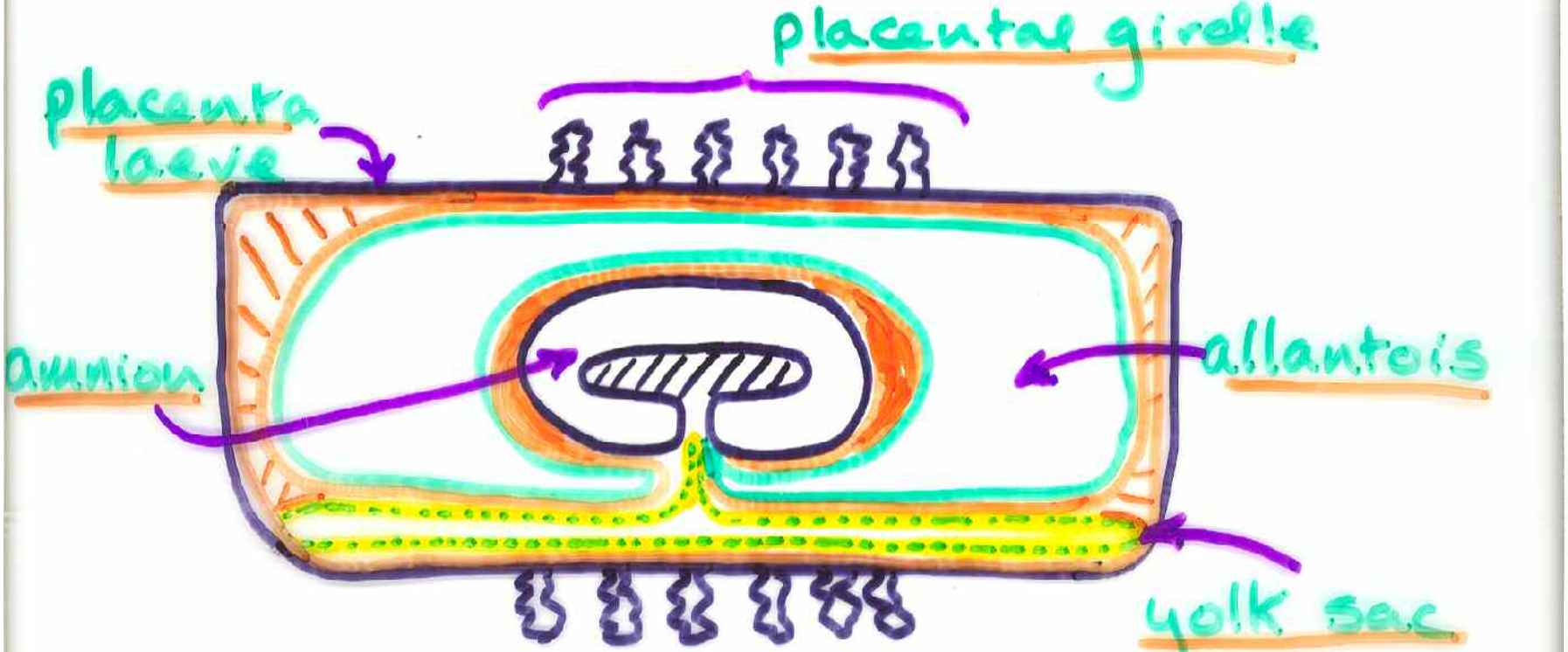
F/M IN RUMINANTS

Arrangement of foetal membranes at birth



F/M CARNIVORS

Arrangement F/M at BIRTH



Chorion

Develops through formation of chorio-amniotic folds.

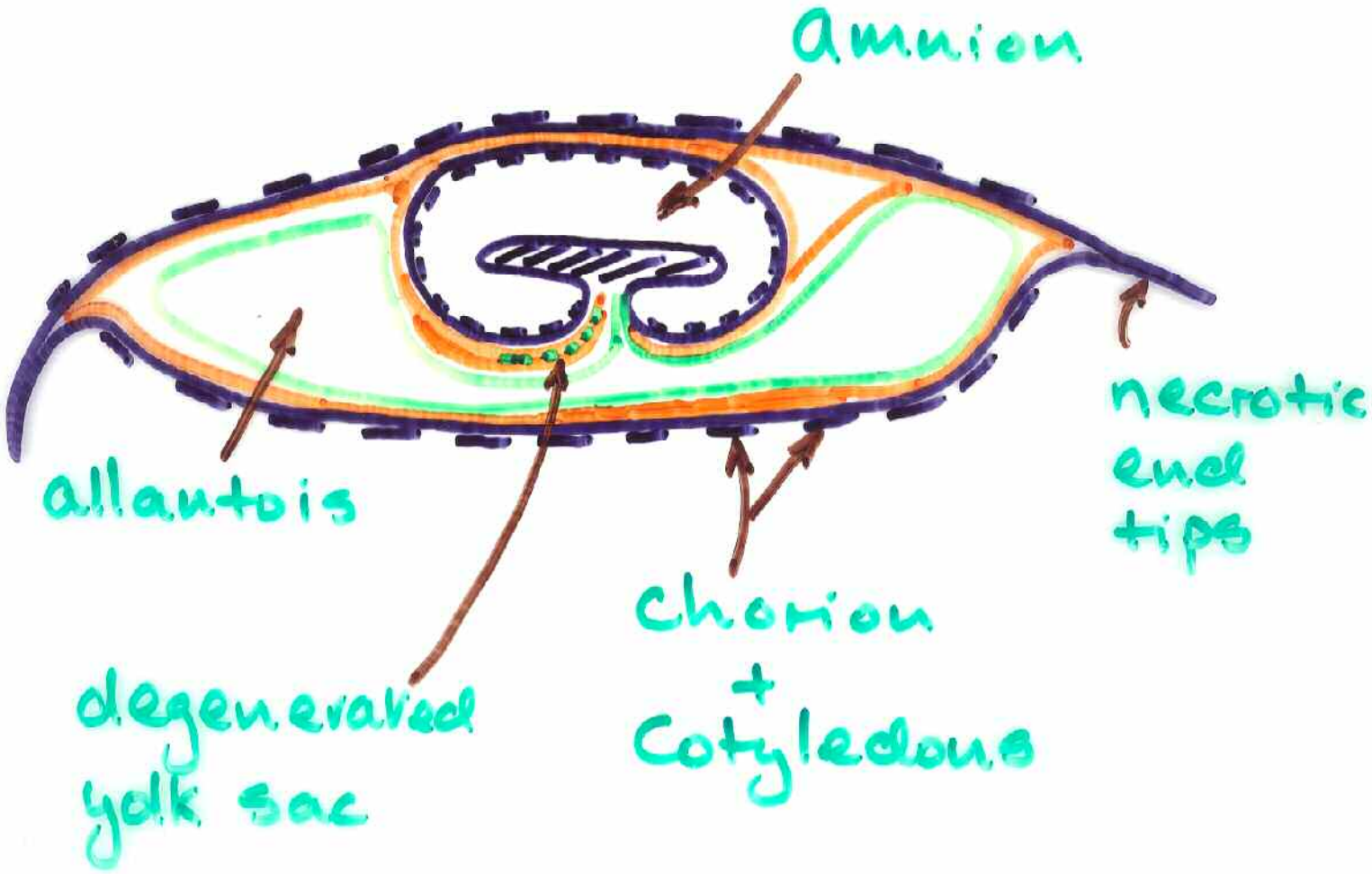
Lined by somatic mesoderm vascularised by umbilical arteries from the allantois. Chorion fuses with the allantois (all species) and with the amnion (ruminants and pig)

By virtue of its contact with female endometrium it is involved in the uptake of nutrients (embryotrophic nutrition). Depending on intimacy of fetal/maternal contact nutrition can be histotrophic or hemotrophic

Surface of chorion is modified (species differences) to fulfill its function

F/M IN RUMINANTS

Arrangement of foetal membranes at birth



F/M CARNIVORS

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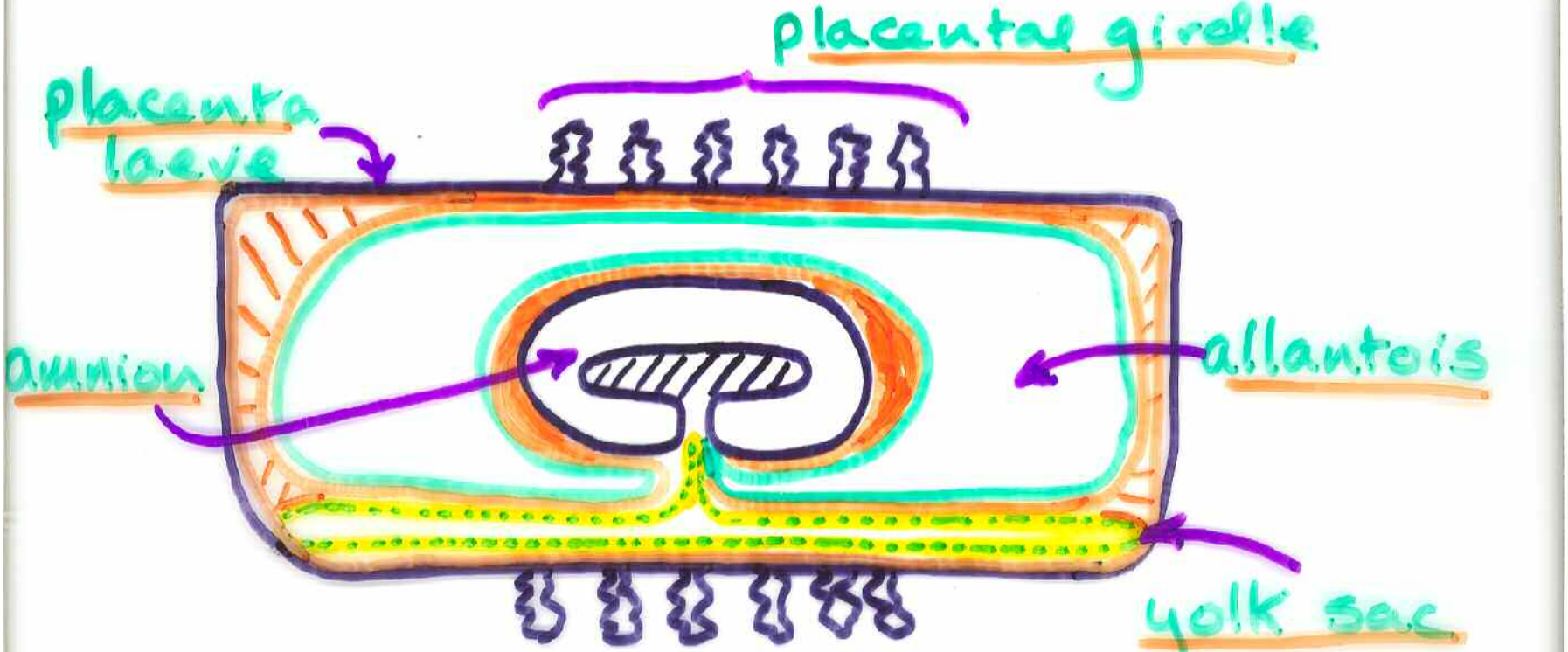


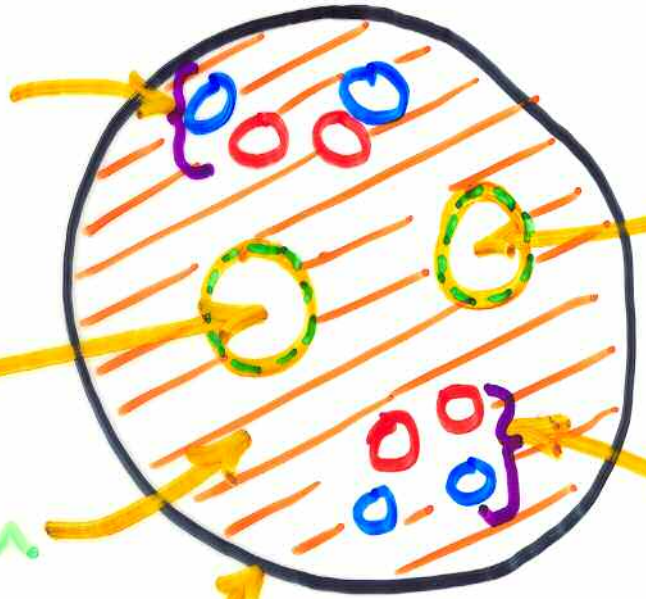
Umbilical cord

Connection between fetus and fetal membranes

Composed of mucous connective tissue covered by short region of fetal skin and amniotic epithelium

Contains vitelline duct (yolk sac stalk) with Aa. and Vv. vitellinae and allantoic duct (urachus) with Aa. And Vv. umbilicalis

Cross Section



umbilical
a.a. + v.v

urachus

mesoderm

ectoderm

yolk sac stalk

vitelline
a.a. + v.v

PLACENTA

The term placenta refers to the area or areas where the contact between the fetal chorion and the maternal endometrium is made more intimate by means of interdigitating villi.

There are two components:

***Pars fetalis* (chorion, yolk sac, allantois, amnion)**

***Pars uterina* (endometrium of uterus)**

CLASSIFICATION OF PLACENTAS

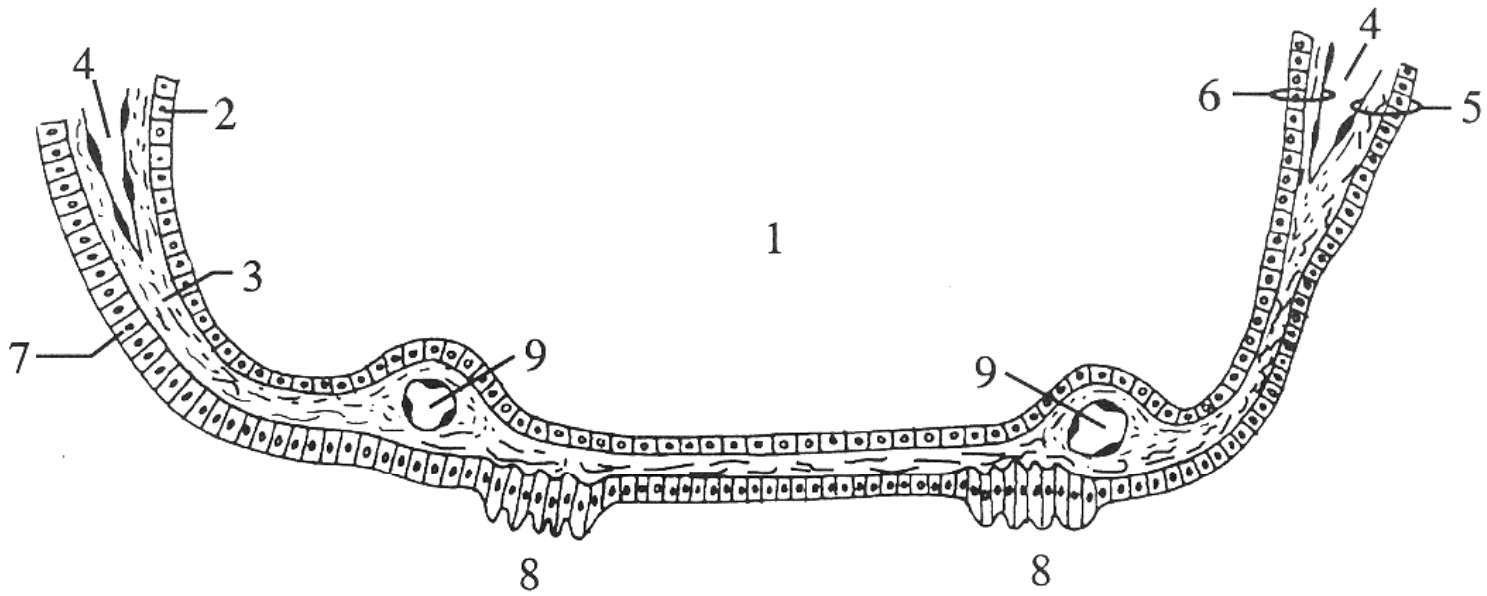
According to the fetal membranes forming the *Pars fetalis*

a. *Placenta vitellina (*bilaminar / trilaminar*)*

b. *Placenta choriovitellina*

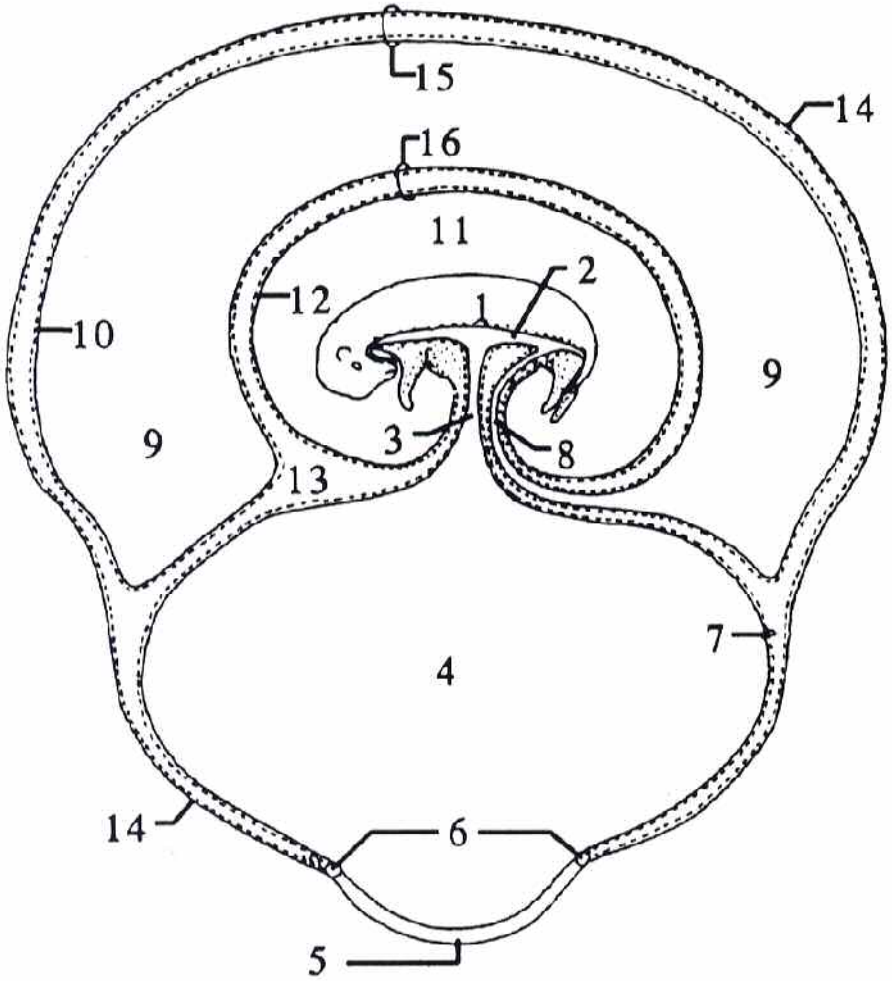
c. *Placenta chorioallantoica*

d. *Placenta chorioamniotica*



1. Yolk sac
2. Extra-embryonic endoderm
3. Extra-embryonic mesoderm
4. Exocoelom
5. Somatopleure
6. Splanchnopleure
7. Chorion
8. Primitive chorionic villi
9. *Sinus terminalis*

Fig. 2.19 Equine *Placenta choriovitellina* (transverse section, schematic)

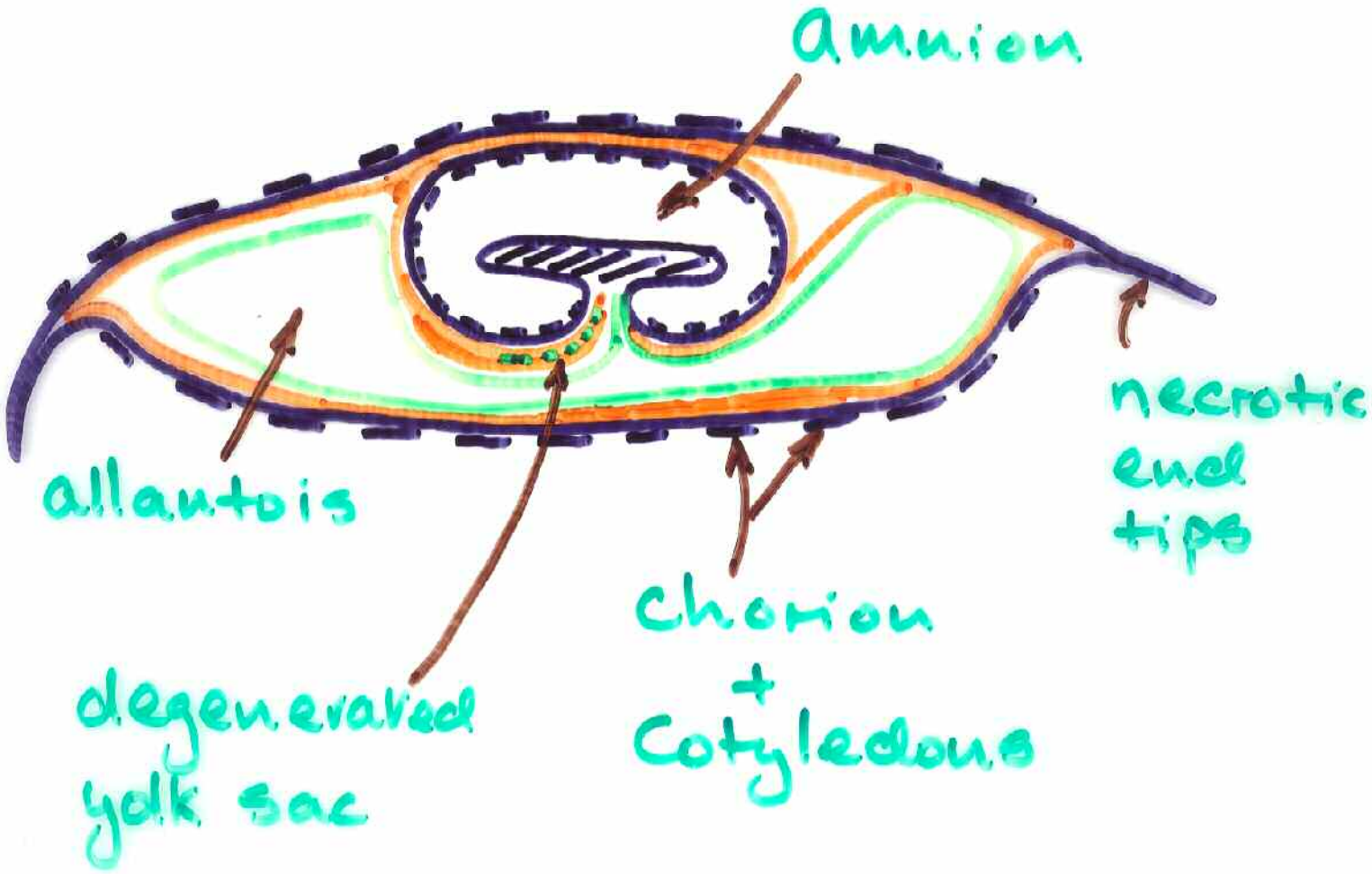


1. Embryo
2. Primitive gut
3. Vitelline duct
4. Yolk sac
5. Choriovitelline placenta
6. *Sinus terminalis*
7. Vascularized splanchnopleure
8. Allantoic duct
9. Allantoic sac
10. Allantois
11. Amniotic sac
12. Amnion
13. Exocoelom
14. Chorion
15. Allantochorion
16. Allantoamnion

Fig. 2.20 Equine conceptus at day 34 (longitudinal section, schematic)

F/M IN RUMINANTS

Arrangement of foetal membranes at birth



CLASSIFICATION OF PLACENTAS

According to the degree of maternal tissue loss

a. *Placenta adeciduata* (minimal/no loss of maternal tissue - horse, ruminant, pig)

b. *Placenta deciduata* (substantial maternal tissue loss - carnivores)

CLASSIFICATION OF PLACENTAS

According to the area/s for hemotrophic nutrition (location of villi)

a. *Semiplacenta diffusa* (*incompleta*) - horse, pig

b. *Semiplacenta cotyledonaria* - ruminants

c. *Placenta zonaria* - carnivores

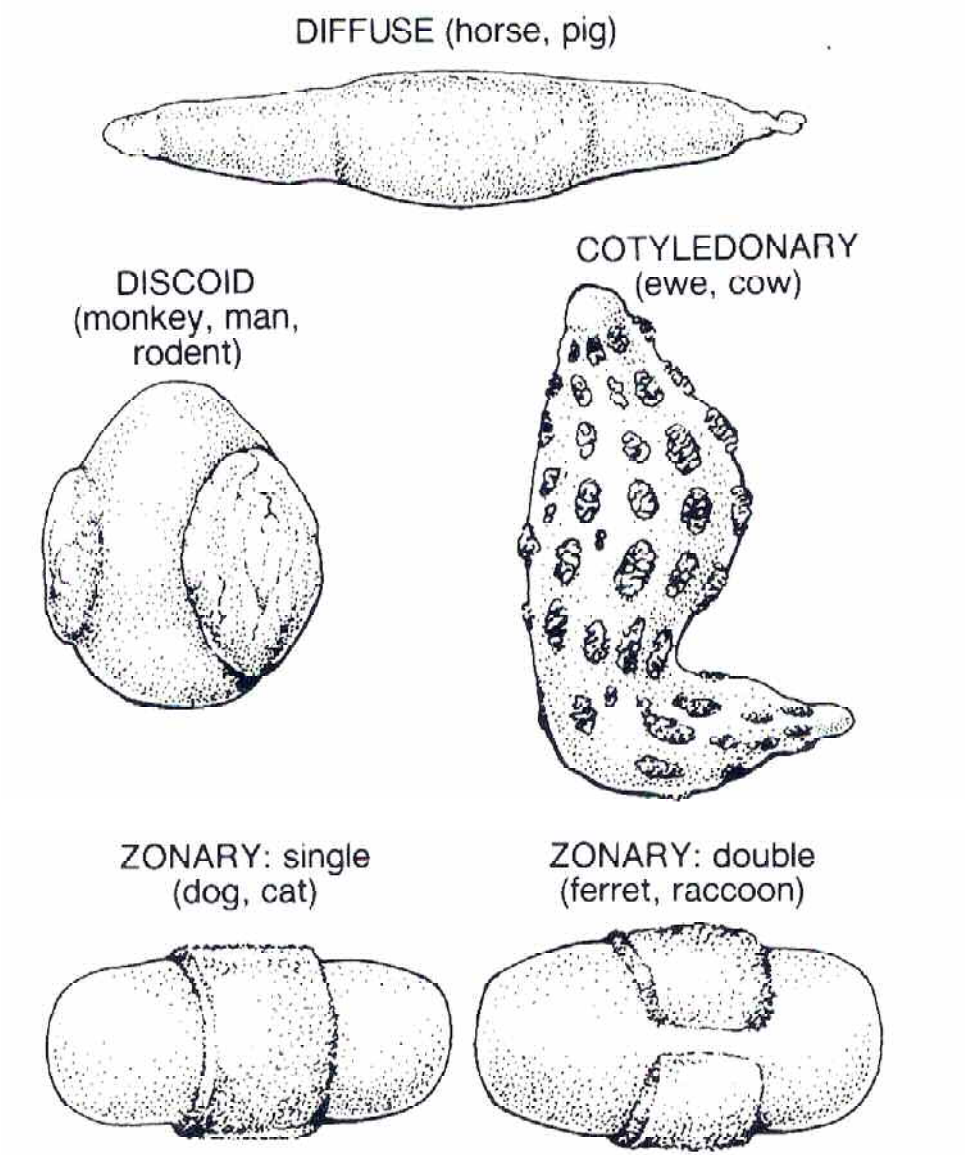


Figure 3.4. Classification of placentas according to the shape and distribution of attachment sites between extraembryonic and maternal tissues. (Redrawn after WJ Hamilton, JD Boyd and HW Mossman, 1962.)

CLASSIFICATION OF PLACENTAS

According to the histological structure of the placenta

a. *Placenta epitheliochorialis* (Fetal chorion lies against maternal (uterine) epithelium

b. *Placenta endotheliochorialis* (Modified fetal chorionic cells form syntrophoblast around maternal capillaries)

EQUINE

Gestation Period

In the mare 334-343 days (48-49 weeks or 11 months). In the jenny 360 days (52 weeks or 12 months)

Placenta

Classified as being trilaminar vitelline (initially), choriovitelline (later), chorioallantoic (finally), adeciduate, incompletely diffuse and epithelio-chorial

Equine yolk sac

Involved in prolonged period of histotrophic nutrition

(5 - 6 weeks) - Due to late feto-maternal attachment

Vitelline circulation established by week 3. Consists of arterial terminal sinus formed by two vitelline arteries (right one soon regresses). Drained by two vitelline veins.

At 3 weeks yolk sac has pale yellow colour and fine, parallel blood vessels. After about 7 weeks the choriovitelline placenta regresses.

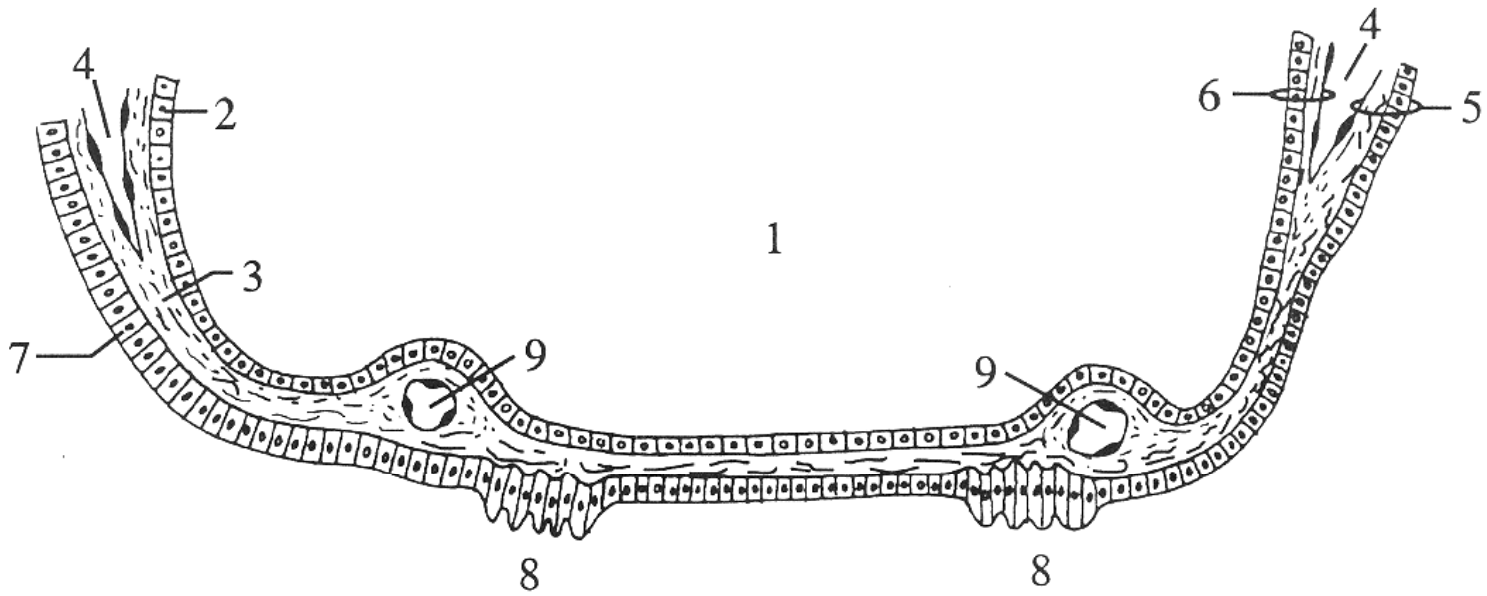


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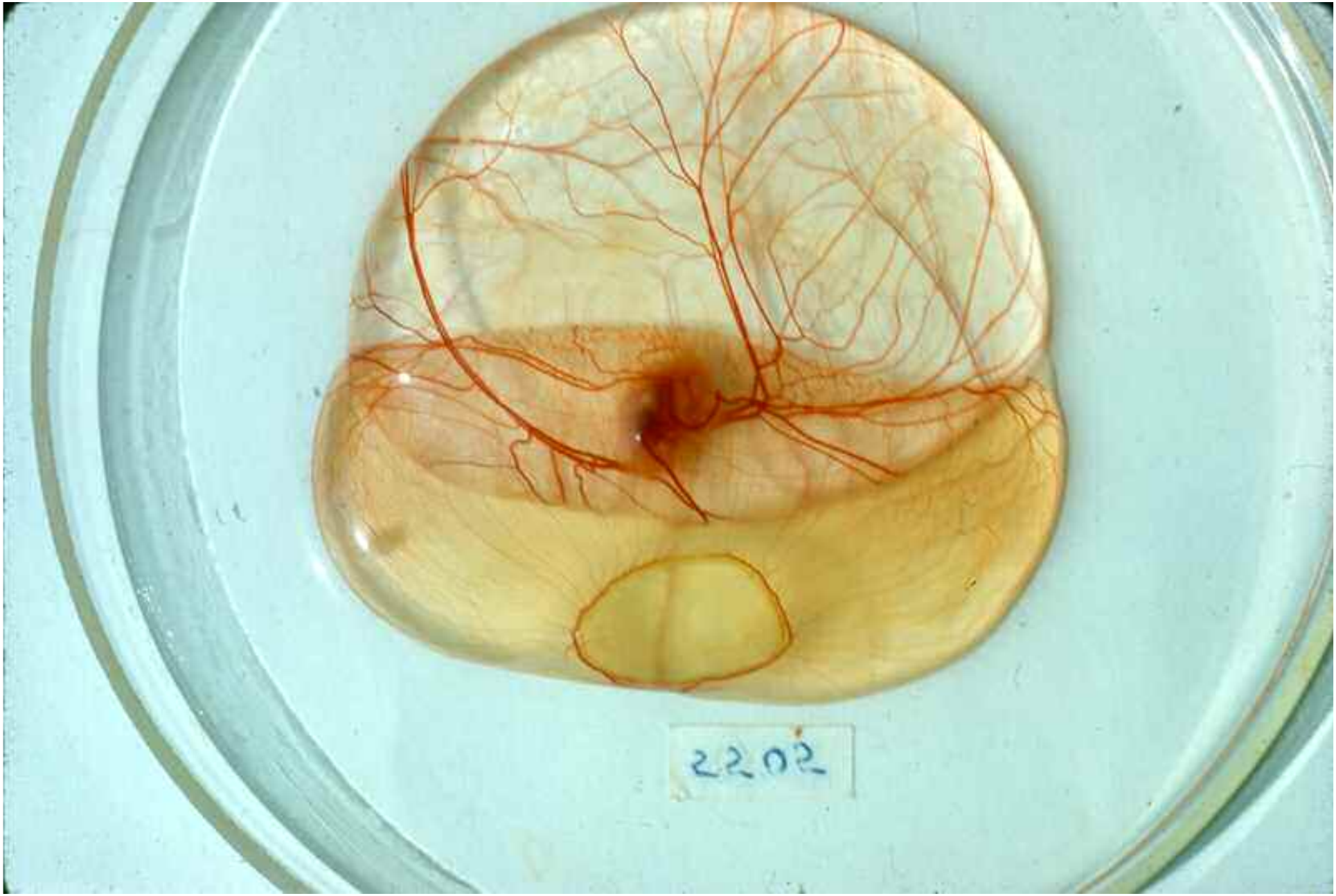
Fig. 2.19 Equine *Placenta choriovitellina* (transverse section, schematic)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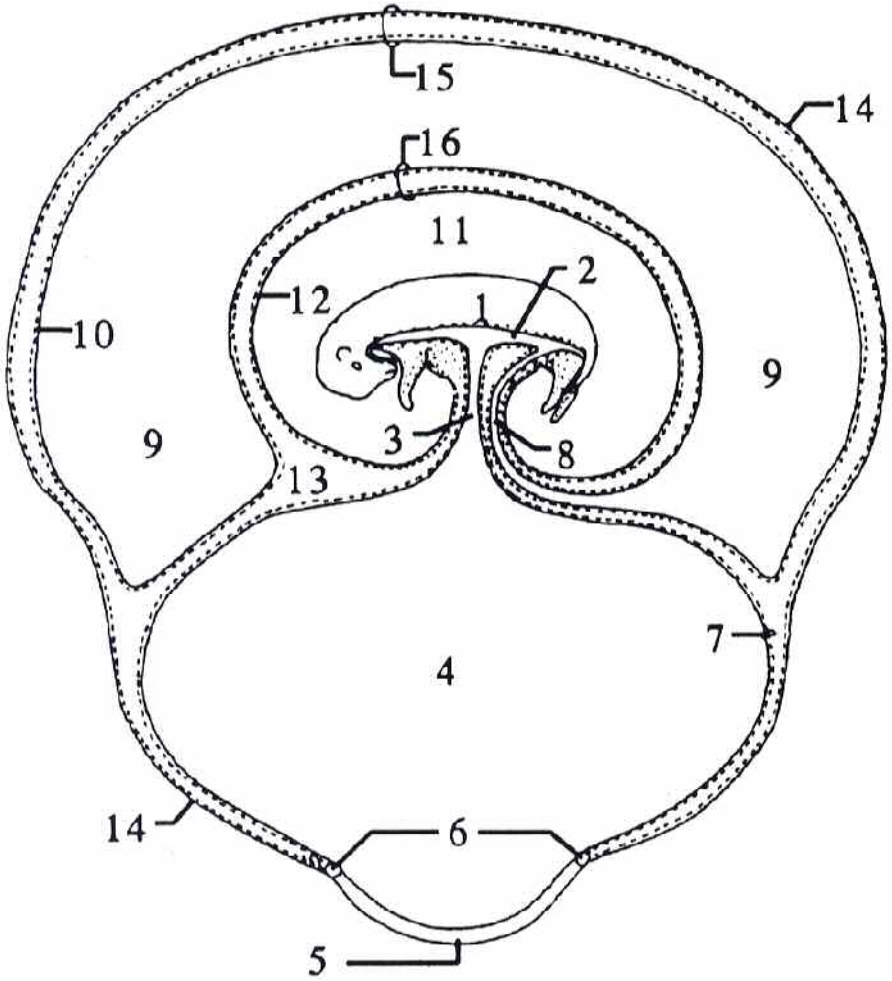
Equine amnion

Completely formed by week 3

Initially small amount of amniotic fluid (1 ml) - gradually increases in volume to 3-6 litres at parturition

Amniotic plaques develop from about week 10

Amniotic fluid is colourless, viscous, slightly alkaline. Consists of water (99%), some albumin, creatine and glucose. Also some mucus, fetal hoof epidermis, kidney and intestinal excreta eg. Urea and meconium



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16. Allantoamnion

Fig. 2.20 Equine conceptus at day 34 (longitudinal section, schematic)

Equine allantois

Develops from about week 3. Evagination of hindgut. Grows between amnion and chorion on right side of embryo. Expands to form dome over amniotic cavity and fills rest of exocoelom. Impeded by choriovitelline placenta. Splanchnic mesoderm containing umbilical Aa. and Vv. vascularises somatic mesoderm of amnion and chorion.

Allantoic fluid initially colourless - become slightly opaque. Consists mainly of water, some albumin, glucose, lipids, lactic acid, various phosphates.

Hippomanes occur - Brown to olive green in colour

Volume at parturition is 8 - 15 liters

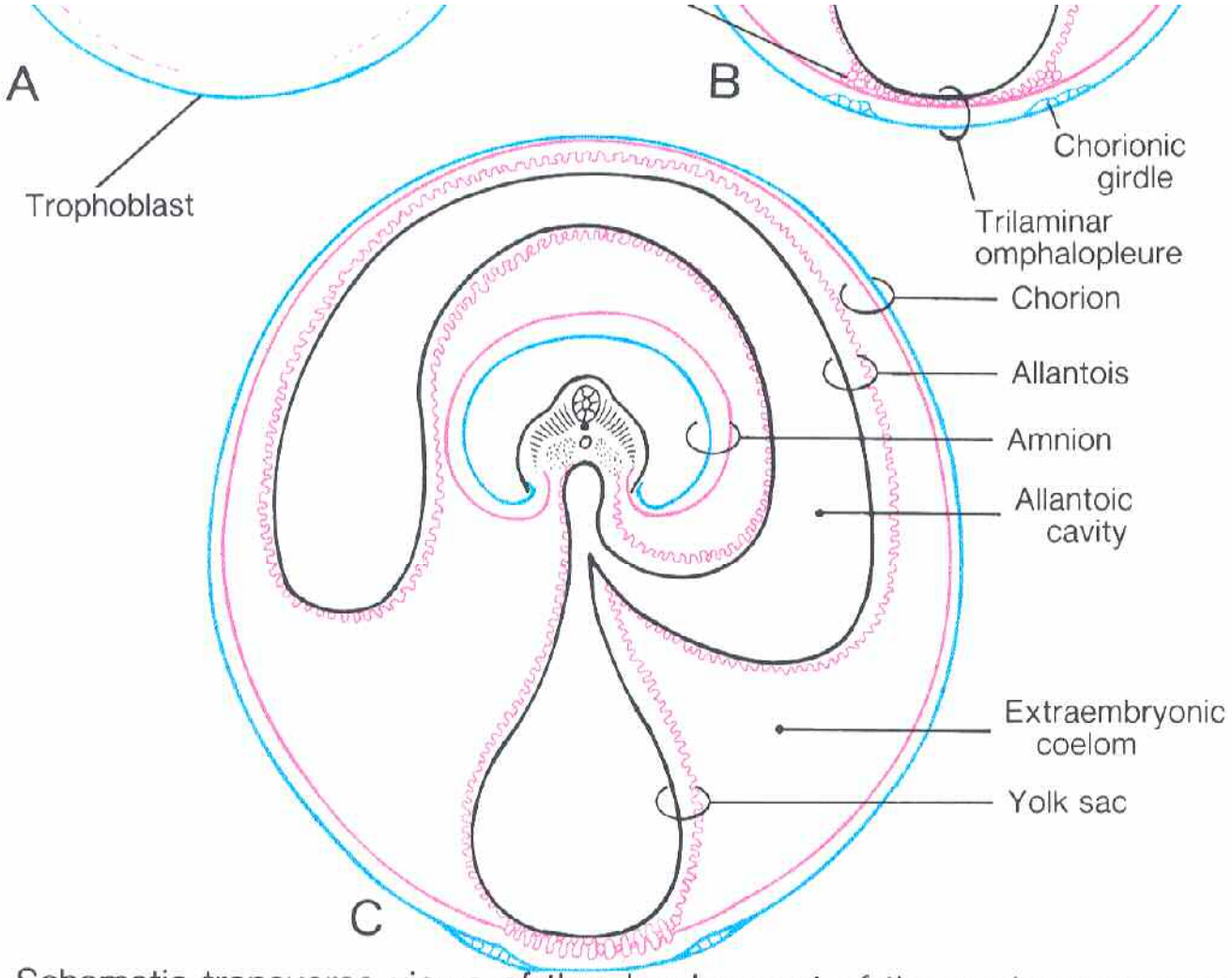
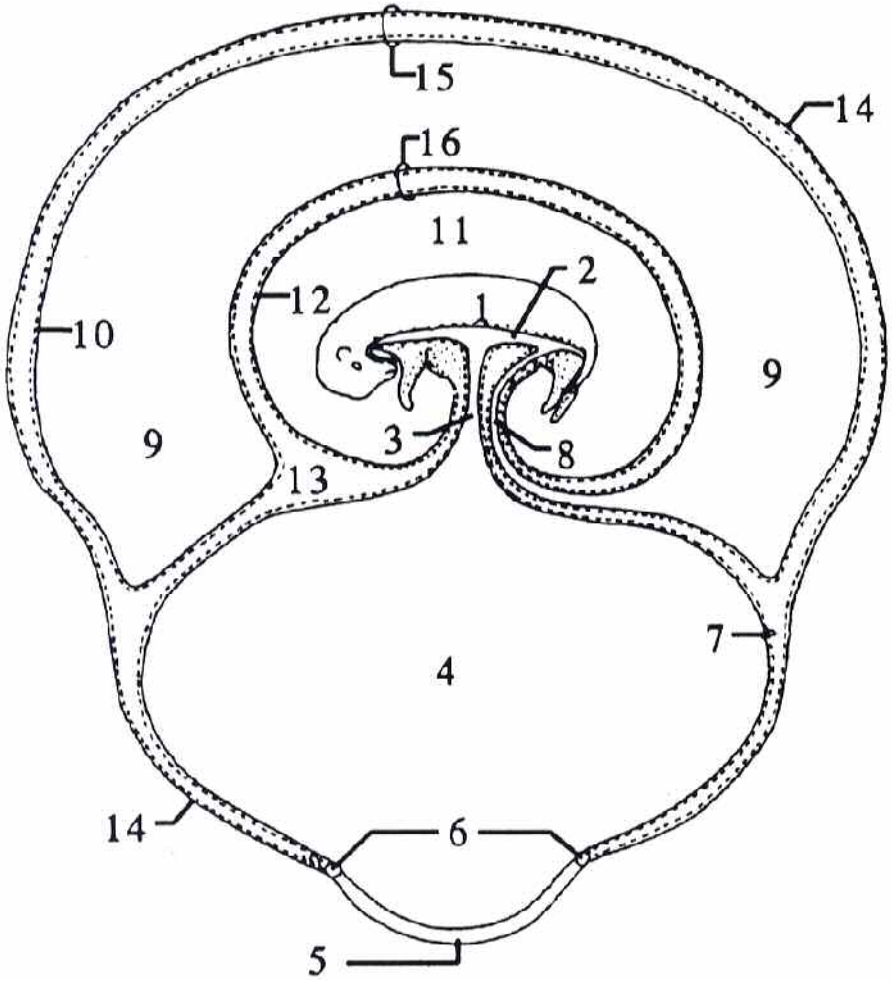


Figure 3.6. Schematic transverse views of the development of the equine extraembryonic membranes at *A*, 15 days; *B*, 18 days; and *C*, 30 days of gestation. Note the persistent attachment of the yolk sac to the abembryonic chorion.



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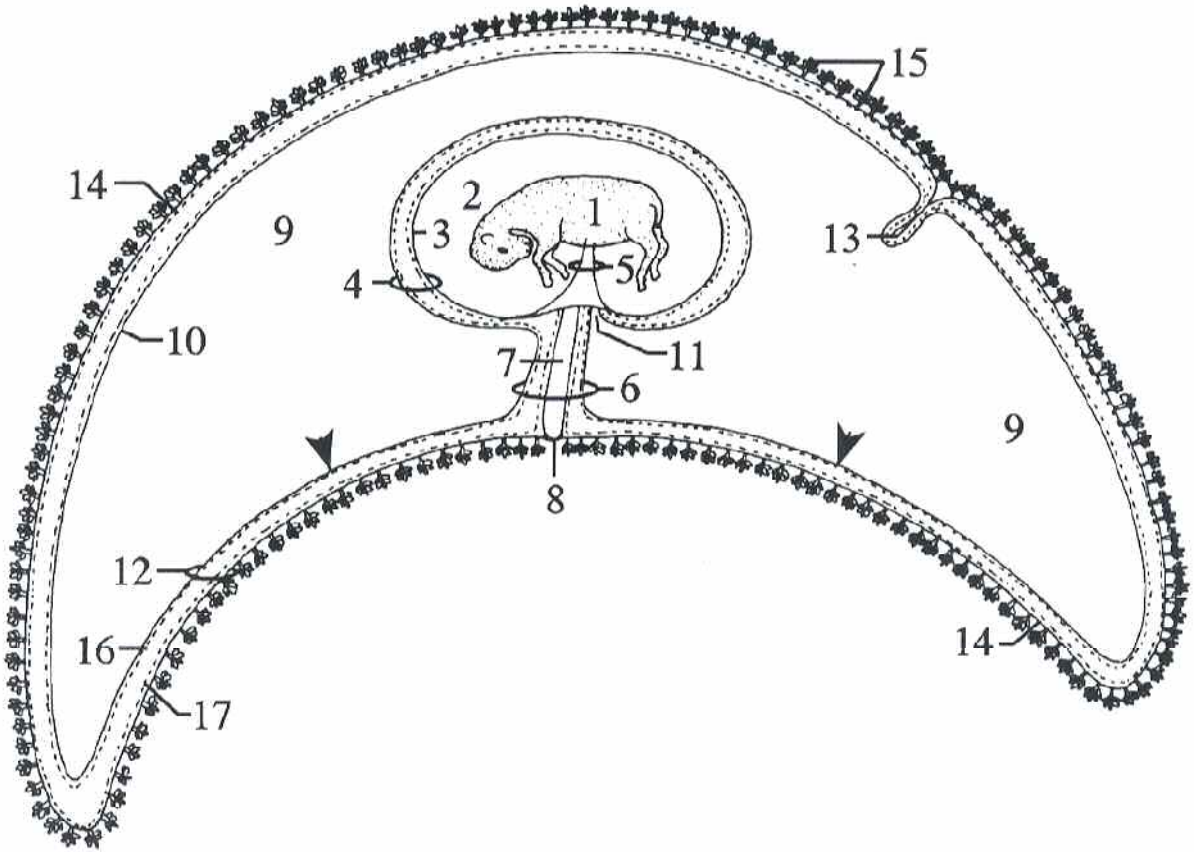

1. Fetus
2. Amniotic sac
3. Amnion
4. Allantoamnion
5. Umbilical cord (amniotic)
6. Umbilical cord (allantoic)
7. Yolk sac
8. Choriovitelline placenta
9. Allantoic sac
10. Allantois
11. Allantoic duct
12. Allantochorion
13. Allantochorionic pouch - NB position incorrect.
14. Chorion
15. Microcotyledons
16. Splanchnic mesoderm
17. Somatic mesoderm

Fig. 2.22 Equine conceptus at day 75 (schematic)

Arrowheads indicate correct position of allantochorionic pouches

Equine chorion

Involvement in embryotrophic nutrition

Chorionic villi develop from about day 40 except opposite the cervix, uterine (Fallopian) tubes and uterine glands.

By day 60 chorionic villi interlock (interdigitate) with uterine villi.

From day 100 chorionic villi branch and fuse to form micro-cotyledons which fit into crypts (hollows) in the endometrium (superficial layer of the uterus). Fully developed by day 150. Involved in hemotrophic nutrition.

Areas of chorion between microcotyledons involved in histotrophic nutrition. Uterine gland secretions important for this function.

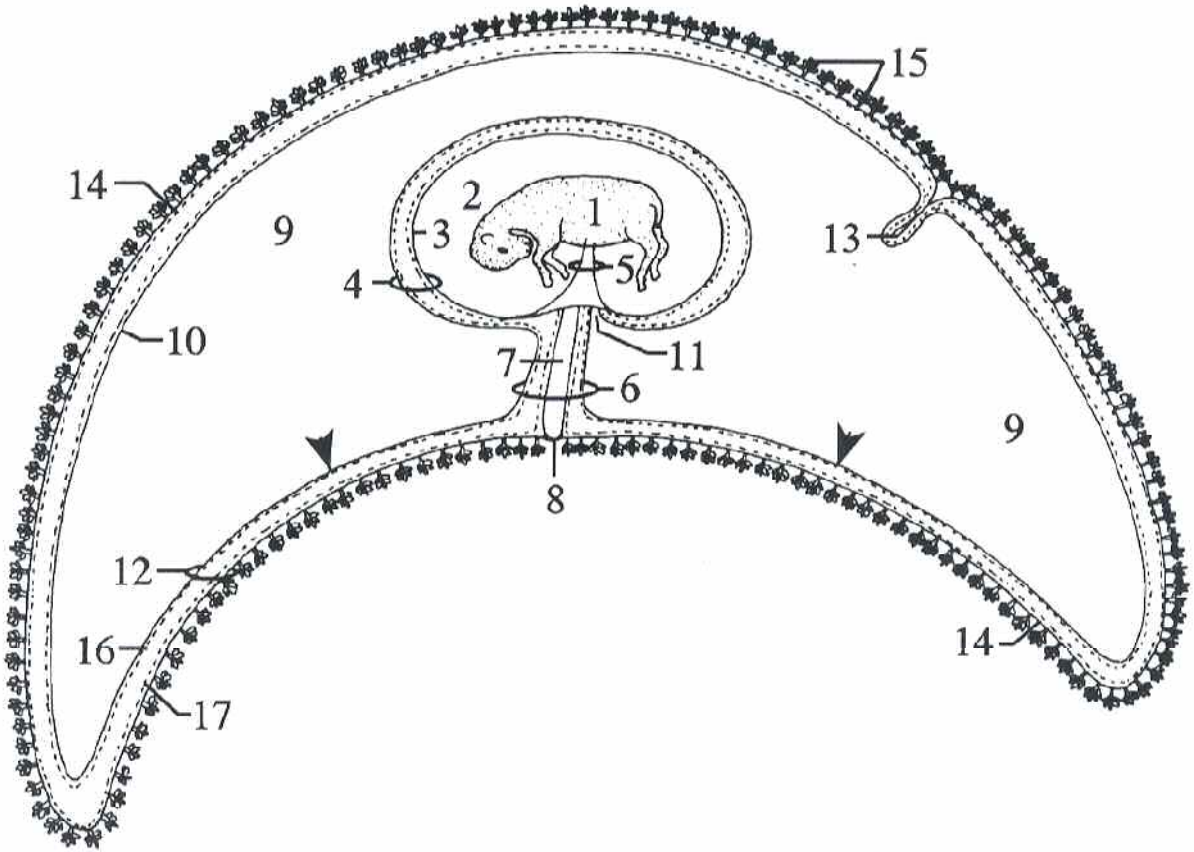

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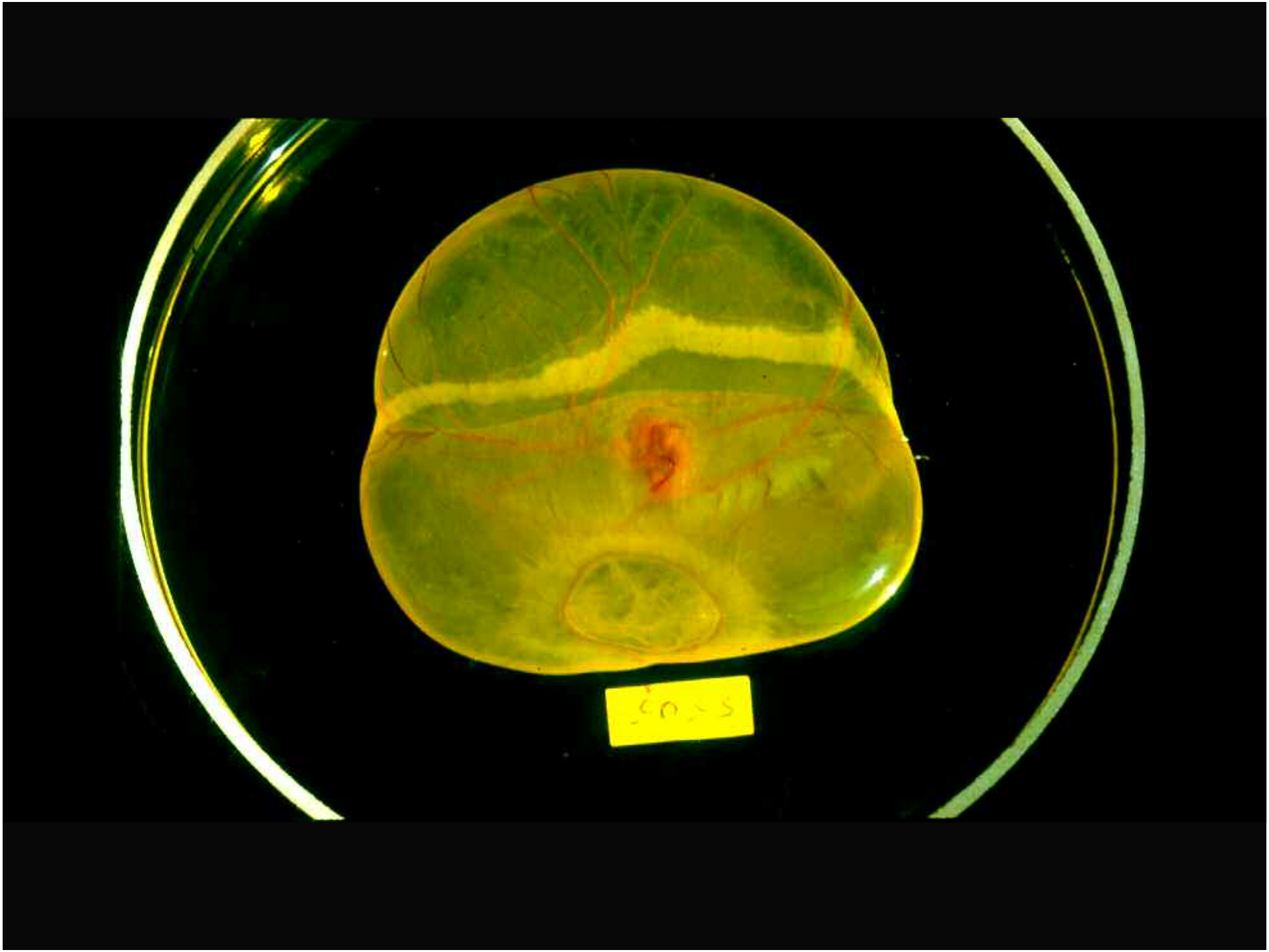
Fig. 2.22 Equine conceptus at day 75 (schematic)

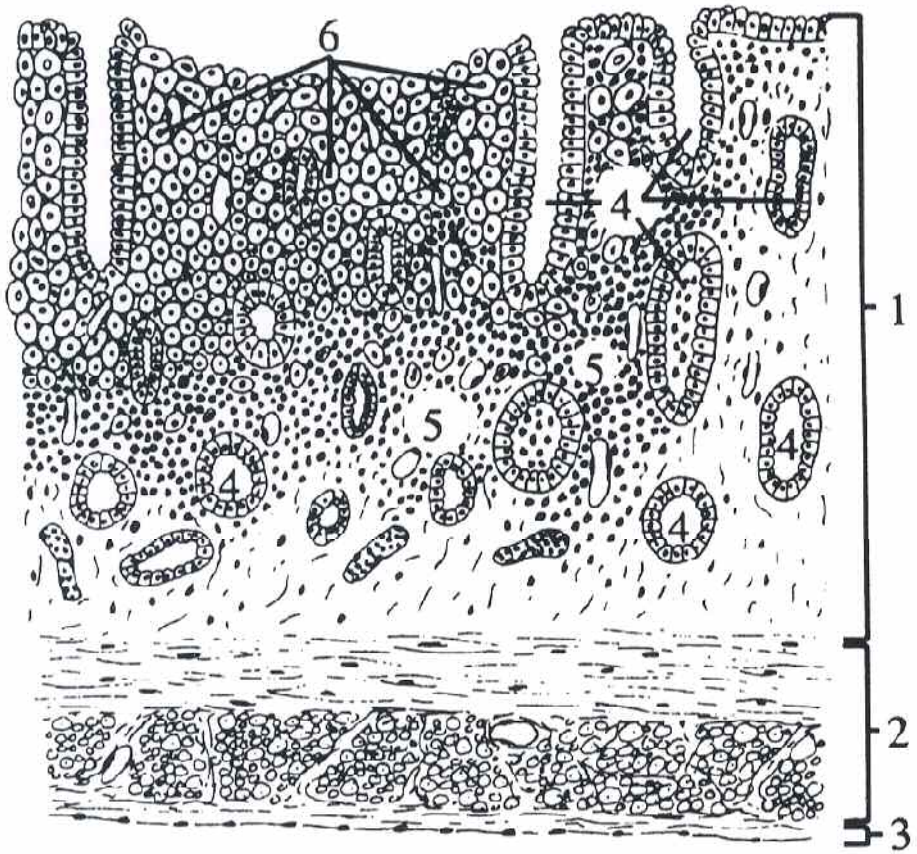
Arrowheads indicate correct position of allantochorionic pouches

Equine chorion

Endometrial cup formation

By day 25 a band of villi (the chorionic girdle) forms on the border between the vitelline and umbilical chorionic circulations (ie. Point of contact between allantois and yolk sac). Cells from this region (established at day 40) migrate and attach to uterine epithelium. Invade interstitial tissue of endometrium and establish colonies of large oval cells – endometrial cups. Cells produce chorionic gonadotrophins (pregnant mare serum gonadotrophins – PMSG)





1. Endometrium
2. Myometrium
3. Perimetrium
4. Uterine glands
5. Lymphocytes, plasma cells & eosinophils
6. Chorionic girdle cells

Fig. 2.22 Equine endometrial cup (histological section)

Equine chorion

Endometrial cup formation

When maximum development of the cups is achieved by day 80, leukocytes (plasma cells, lymphocytes, eosinophils) isolate and begin to destroy them (they disappear at about days 120 – 140). Necrotic cell masses are ejected from endometrium and serve as histotroph.

A jenny (female donkey) only develops cups if carrying a mule fetus ie mated to a stallion. A mare always develops cups except when carrying a hinny ie mated to a jack (male donkey) – seldom viable.

Equine chorion

Twins

Generally dizygotic (from separate zygotes). One fetus usually dies

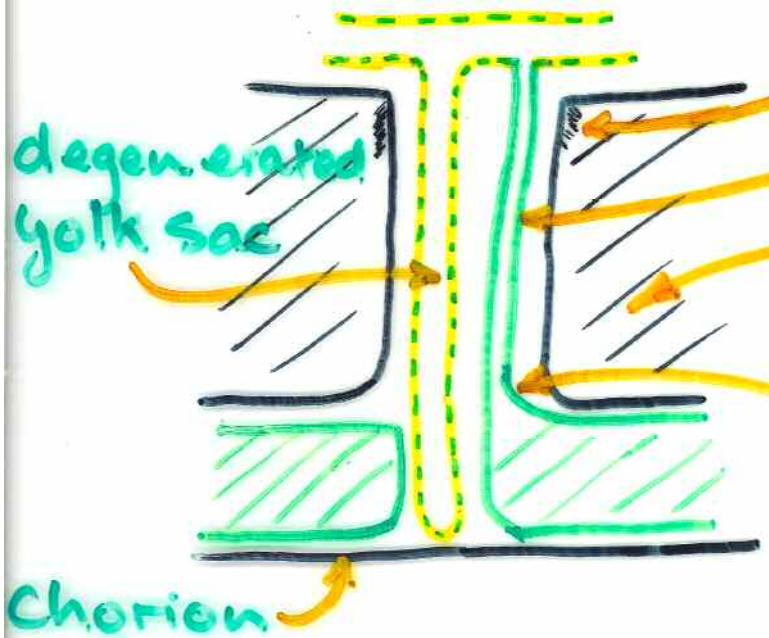
Chorionic sacs lie against each other. No villi formed at contact area

In some instances the sacs fuse and vascular anastomoses (fusion of blood vessels) form. In the case of heterozygous twins blood cell chimerism results. Due to anastomoses only forming during late pregnancy, development of the genital system is not affected. NB! Compare later with heterozygous bovine twins

Equine

UMBILICAL CORD:

1 m. long 2/3 of which is covered by amnion sac



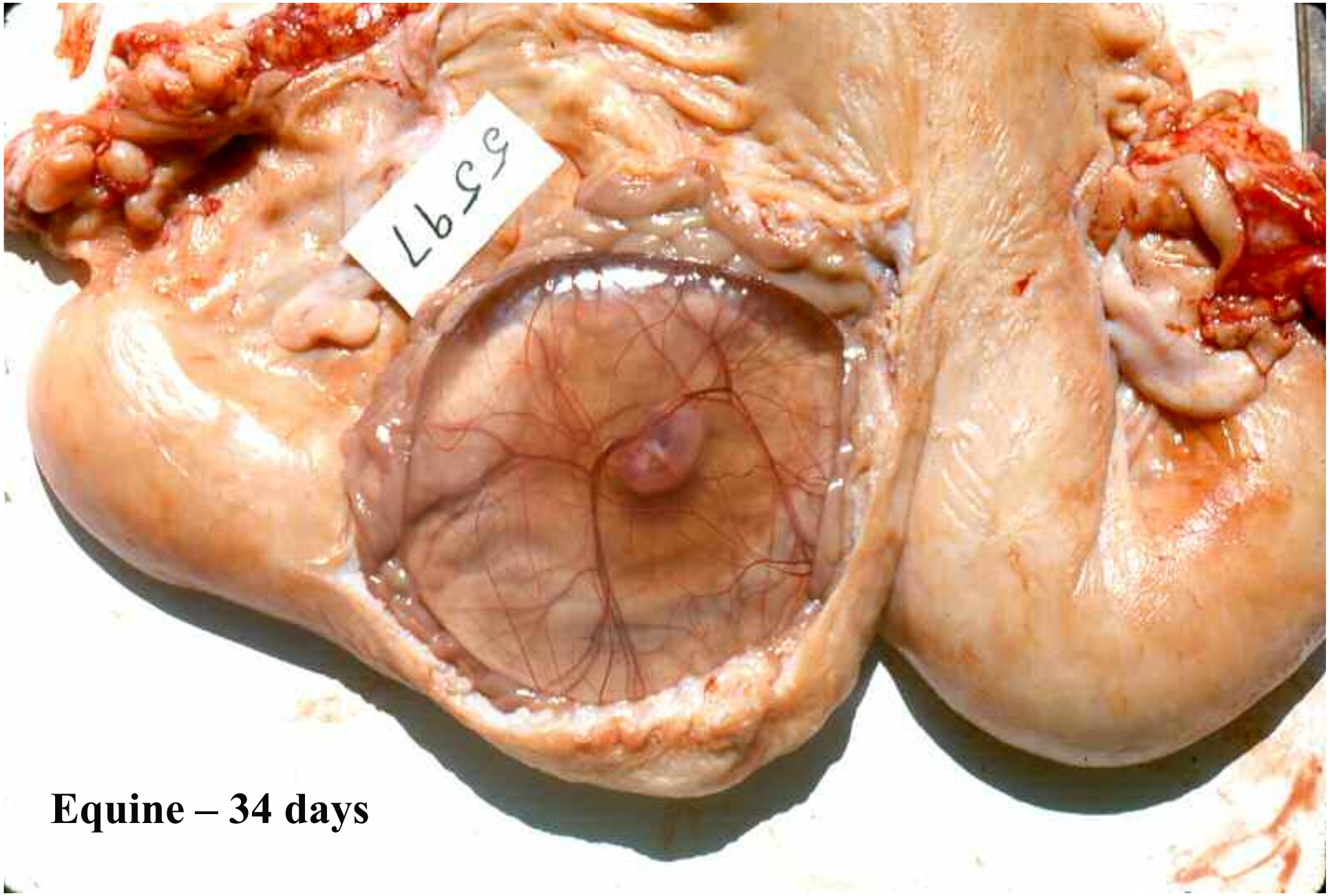
foetal hair line

urachus

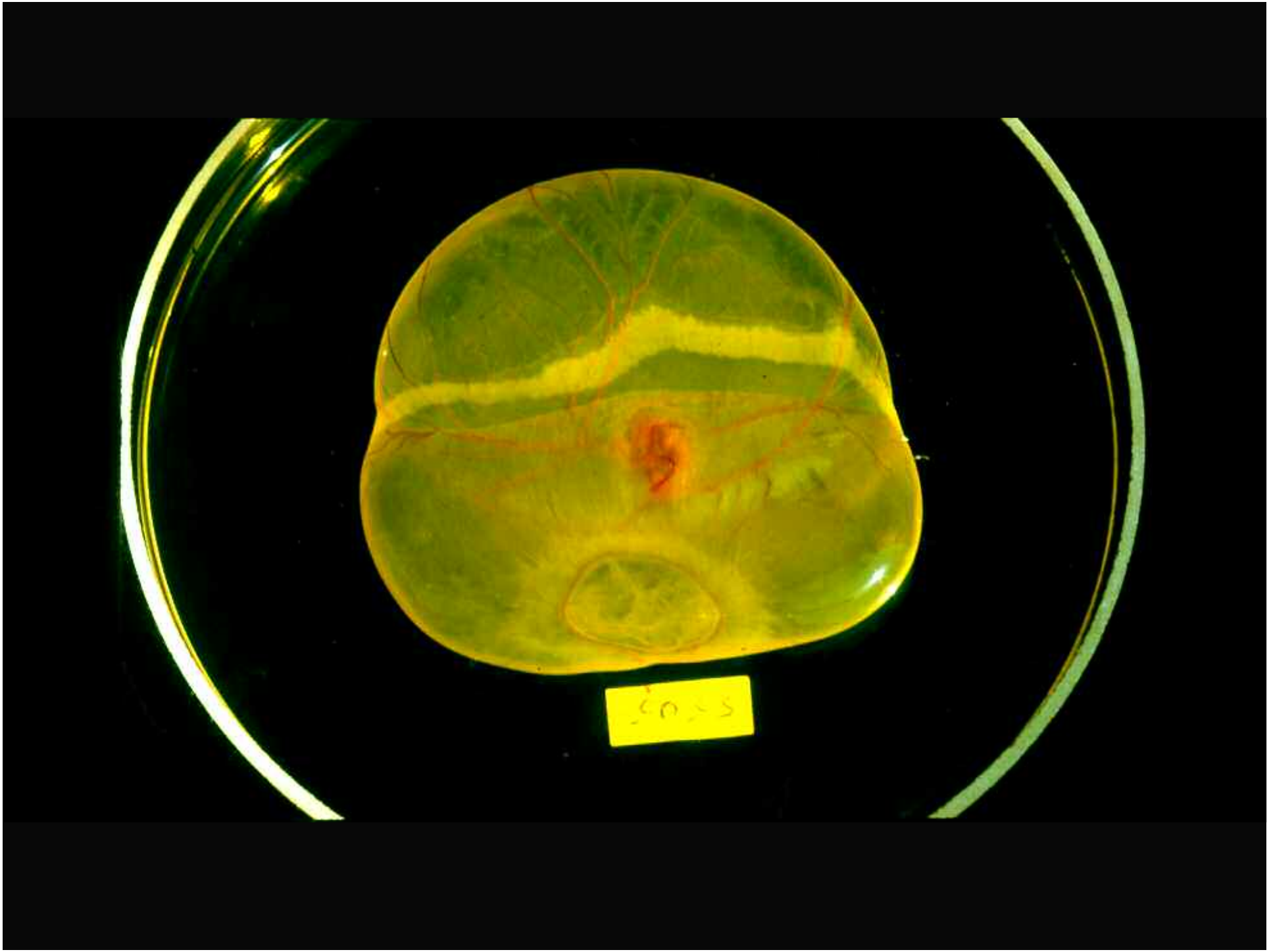
amnion

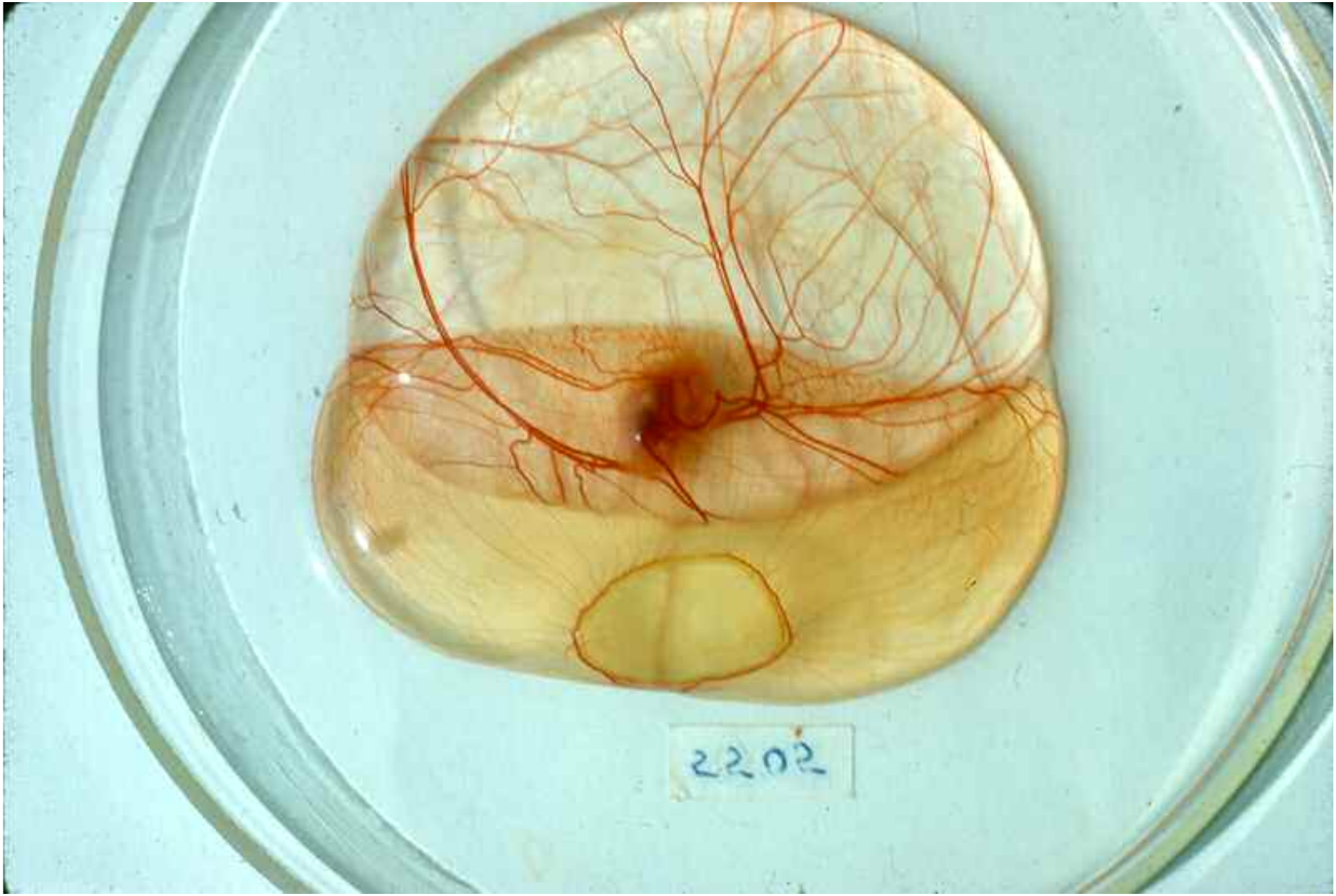
L + R umbilical veins fuse ± at junction of allantois & amnion: L vein remains

Umbilical cord breaks due to FOETAL WEIGHT: ± 1-2 cm below foetal hair line.



Equine – 34 days

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Equine – 23 days