# OBSERVATIONS ON THE FULL-TERM FOETAL MEMBRANES OF THREE MEMBERS OF THE CAMELIDAE (*CAMELUS DROMEDARIUS* L., *CAMELUS BACTRIANUS* L. AND *LAMA GLAMA* L.)

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Our knowledge of the placentae in the Camelidae is largely based on the macroscopic examination, made many years ago, of a small number of specimens, and on more recent unillustrated statements of other workers. Savi (1843) was the first to note that the foetal placenta in the dromedary was diffuse in nature, as in the mare, and not cotyledonary, as in other ruminants. He described the thick chorionic membrane in the dromedary as being covered with short shrub-like tendrils or villi, in which arteriovenous connexions sometimes occurred. He considered, on these and other taxonomic points, that camels were more related to Pachyderms than to Ruminants. Owen (1868), Milne-Edwards (1870), Turner (1875), and Beddard (1902) have noted the diffuse nature of the placenta in the Camelidae, and Turner also recorded the presence of polar bare areas. Grosser (1927) and Mossman (1937), apparently basing their opinions on the accounts of Owen and Beddard, classified the placenta in the Bactrian camel as undoubtedly epithelio-chorial in type. Barmintsev (1938, 1939), and Boshaev (1938) gave tables on the gestation period, mating and oestrous cycles for both the Arabian (*Camelus dromedarius* L.) and the Bactrian camel but did not describe their foetal membranes. Barclay, Franklin & Pritchard (1944) figured a transverse section of the umbilical cord of a dromedary foetus of unknown age, illustrating the allantoic duct, the remains of the yolk-sac, and amniotic pustules; and Amoroso (1952), and Harvey (1959), referred to, but did not illustrate, the epithelio-chorial nature of the placenta of camels. In the absence of recent descriptions of the membranes a description of the full-term foetal membranes of three members of the Camelidae, together with illustrations of their macro-, and microscopic appearances is of interest.

## MATERIALS AND METHODS

The material on which the present account is based consisted of the foetal membranes obtained immediately after delivery from an Arabian camel (*C. dromedarius* L.) following a gestation period of 417 days from the last day of mating; and those from a Bactarian camel (*C. bactrianus* L.) and a llama (*Lama glama* L.) obtained about 24 hr. after delivery of normal full-term calves. All three calves were singleton females, and all thrived after birth. The specimens of Bactrian and llama placentae were damaged after delivery, but the general form and histological appearances could be determined.

Small portions of the dromedary chorion, and all that part of the amnion which was born with the calf, were fixed in 10% formol-saline, or absolute alcohol, immediately after the birth of the calf and membranes. Further samples of the chorion, amnion and allantois were taken after the membranes had been examined and photographed, and fixed in 10% formol-saline some 2 hr. after delivery. The two other specimens were cleansed with water and photographed before similar samples were removed and fixed in 10% formol-saline or Bouin's solution. Specimens from the three animals were dehydrated, embedded in paraffin, cut at 6, 8, or 10 $\mu$, and stained with Harris's haematoxylin and eosin, Weigert's iron haematoxylin and van Gieson's connective tissue stain, Mallory's or Masson's trichrome stain, Feulgen and Wilder's silver impregnation methods. Frozen sections of formalin fixed material were stained for lipides with Sudan IV. A dye coupling method (Burstone, 1958) was used to demonstrate the presence of alkaline phosphatase.

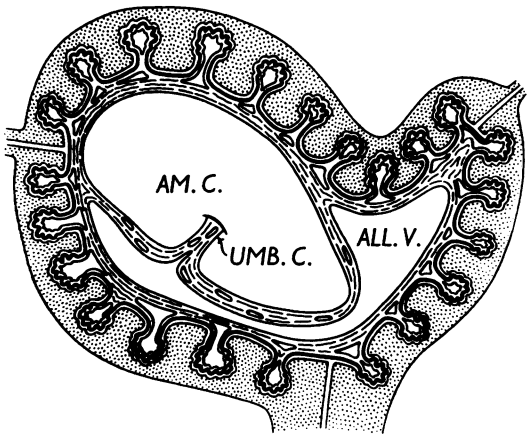
## DESCRIPTION

### *The Arabian camel* (Camelus dromedarius *L.*). *Macroscopic and microscopic appearances*

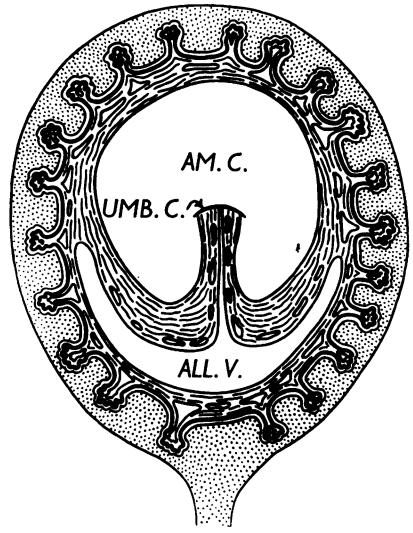
The membranes externally were bright red in colour during delivery, but smooth white inner structures were visible through tears in the chorion. The chorion formed a crescentic sac (Pl. 1, fig. 1) ruptured irregularly near the mid-point of its lesser curve. It measured 10 ft. 7 in. along the greater and 8 ft. 3 in. along the lesser curve when spread out flat on the ground. The two horns of the sac were of unequal size, the larger measuring 20 and 38 in. circumferentially, and the smaller 19 and 28 in. at distances of 1 ft and 3 ft. respectively from the apices. The umbilical cord after rupture measured about 5 in. from the navel to its free end, and another 12 in. to its rather indefinite ending on the membranes. The amnion covered most of this part of the cord. Two umbilical arteries and two veins were present in the cord, and distally were distributed over the whole inner surface of the chorion, each main artery or vein being distributed in general to one half of the chorion. The outer surface of the chorion was covered with small red tufted villous processes (Pl. 1, fig. 2) which varied in height and size, and also in density of distribution. Several areas, mainly near the antimesometric aspect of the larger horn, and near the pole of the lesser horn, were relatively bare of villous tufts, but under a low-power magnifier small sessile elevations could be seen scattered sparsely over these areas. In other areas relatively small tufts were surrounded by larger ones, but typical areolae such as those of the horse or pig, were not seen. The chorionic tufts measured up to 3 mm. in height, and were attached by constricted stalks to the chorion. Distally the surface of each tuft was plicated into numerous folds and did not form finger-like villi such as are seen in the mare's placenta. Small white masses were also present on the edges of some folds. The amnion, most of which had been delivered with the calf, was adherent in part to the chorion forming a chorio-amnion; it also formed an allanto-amnion which was lightly vascularized near the umbilical region (Pl. 2, fig. 7). Small amniotic pustules, measuring up to 1 cm. in diameter, and fine bristle-like horns up to 15 mm. in length were present, being most noticeable close to the umbilical cord (Pl. 2, figs. 8, 9). The allantois, which also was torn,

excluded the amnion almost completely from the lesser horn and from the lesser curve of the chorionic sac where the main branches of the umbilical vessels lay. A soft brown lamellated hippomane measuring $65 \times 32 \times 17$ mm. and weighing 18 g. was found in the allantoic cavity.

Low-power microscopical examination of the external surface of the chorion, and sections transverse and tangential to its surface demonstrated clearly that the villous tufts were folded and not branched (Pl. 1, fig. 2; Pl. 3, figs. 15, 16). The plicated villous tufts were quite different in appearance from the fine finger-like processes radiating from a central core which are found in the placentae of the mare, pony and donkey. They consisted of a central mesenchymal core covered by a thin layer of trophoblast, the cell walls of which were difficult to define. Large masses of syncytiotrophoblast were also present, and frequently projected from the apices of




Text-fig. 1




Text-fig. 2

Text-fig. 1 . Diagrammatic representation of the probable arrangement of the foetal membranes of the Camelidae at full term. Compound crypts in the uterine wall (stippled) lined by intact uterine epithelium enclose the diffusely scattered plicated villous tufts of the chorion forming a diffuse epithelio-chorial placenta. The relatively small allantoic vesicle excludes the amnion from the smaller pole of the chorion, but the amnion obliterates the allantoic cavity in large part, and may form a true amnio-chorion.

Text-fig. 2. Schematic diagram of a transverse section through the pregnant horn of the uterus. Abbreviations: *ALL.V.*, allantoic vesicle; *AM.C.*, amniotic cavity; *UMB.C.*, umbilical cord.

the villous folds. These masses may represent the white structures visible on surface inspection of the chorion. Areas of well defined tall columnar-celled cytotrophoblast were also present (Pl. 3, fig. 17) basally and may represent the normal cryptal trophoblast, such as is seen in the pig (Amoroso, 1955), or specialized areas for direct absorption of material from the uterine lumen as described by Hamilton, Harrison & Young (1960) in the Cervidae. A rich interlacing network of capillary vessels was present superficially, which on section was found to be intra-epithelial in position

(Pl. 3, figs. 18–20). A subepithelial plexus was also present, and the larger vessels lying looped in the mesenchymal core were connected to the plexuses at frequent intervals. Intra-epithelial capillaries were absent from the areas of columnar cytotrophoblast. A short piece of the umbilical cord, fixed between ligatures while still distended with blood, measured 2·5 × 1·8 cm. in cross-section and contained two umbilical arteries, two umbilical veins, the patent remains of the allantoic duct, and a number of small vasa propria embedded in loose mesenchyme and covered by the amnion (Pl. 2, fig. 12). The umbilical veins were slightly larger than the arteries and resembled them in having muscular walls interlaced by elastic tissue and a lining of low cuboidal endothelium. The allantoic duct was lined by tall columnar cells, which rested on a basal layer of small cuboidal cells. External to this was a connective tissue layer 0·13–0·2 mm. thick, and then a layer of longitudinally running smooth muscle some 0·4–0·5 mm. thick. Capillary vessels at right angles to the long axis of the duct penetrated the connective tissue zone as far as the epithelium. The remains of a small highly vascular yolk-sac were found under the amniotic covering of another part of the umbilical cord. It was lined with cuboidal cells which in many places were heaped up into projecting masses. The vitelline vessels ran longitudinally along the main axis of the sac. The amnion was lined with a single layer of flattened epithelial cells which formed low cornified plaques or became columnar in the larger pustules. Foci of cell degeneration were present in the latter, and occasionally epithelial 'pearls' were formed. The allantoic hippomane consisted of a mass of degenerated cells, some giant cells with well-stained nuclear masses, small intact groups of epithelial cells, and a few small cysts, all bound together by layers of fibrinous material. The probable *in situ* relationships of the foetal membranes and the uterus are represented diagrammatically in Text-figs. 1 and 2.

*The Bactrian camel* (Camelus bactrianus *L.*) *and the llama* (Lama glama *L.*)

The foetal membranes of the Bactrian camel (Pl. 1, figs. 3, 4) and of the llama (Pl. 1, figs. 5, 6) resembled those of the Arabian camel (*C. dromedarius* L.) in their general form and appearances, but they were smaller and less bulky. The fresh weights of the present specimens were not recorded, but that of the dromedary was distinctly heavier than that of the Bactrian camel. The dromedary chorion felt slightly shicker than that of the Bactrian camel. The llama membranes were light and fine as compared with those of the camels. The measurements of the present specimens are compared in Table 1 with those of a Bactrian camel and a llama from the London Zoological Gardens made by Hill (1959). There is a general agreement on the order of the measurements except for the length of the greater curve of the Bactrian chorion. Differences in placing the membranes for measurement, and damage to the membranes probably account for this discrepancy. It will be seen that Hill also noted areas of dense villous concentrations in addition to bare areas on the surface of the chorions. He did not record the presence of hippomanes. The bare areas of the present Bactrian chorion were situated over part of the greater curvature of the intact horn (the other horn was badly damaged), but in the llama a well defined bare area about 3 cm. wide ran along the lesser curve from one pole of the chorion almost to the other, in addition to the areas of relative bareness at the smaller pole and over the greater curve and side walls of the chorion. The linear

bare area (Pl. 1, fig. 6) was related to the underlying main chorionic blood vessels which ran towards the poles from the slightly eccentrically placed umbilical cord. Definite polar bare areas were not seen at all six cornua, nor were bare areas seen which could be related to the probable positions of the internal os uteri. The vascularity of the bare areas in all three specimens was relatively poor as compared with that of areas of dense villous concentration. These latter areas were particularly noticeable on the llama chorion, where small circular areas devoid of villi were in some places surrounded by large tufts resembling areolae (Pl. 2, fig. 11). A somewhat similar condition was also found on parts of the Bactrian chorion (Pl. 2, fig. 10).

Table 1. *Measurements and other data on the foetal membranes of the present specimens compared with those on two specimens from London made by Dr W. C. O. Hill (personal communication)*

| | Present specimens | | | London specimens | |
|---|---|---|---|---|---|
| | Arabian camel | Bactrian camel | Llama | Bactrian camel | Llama |
| Chorion | | | | | |
| Length of lesser curve (in.) | 99 | 68 | 48 | 75 | 49½ |
| Length of greater curve (in.) | 127 | 89 | 86 | 148 | 78 |
| Maximum girth (in.) | 38 | 49 | 24 | 50 | 21 |
| Length of umbilical cord (in.) | 18 | — | — | 27 | — |
| Bare areas on chorion | Yes | Yes | Yes | Yes | Yes |
| Heavy villous concentrations on chorion | Yes | Yes | Yes | — | Yes |
| Hippomanes | Yes | — | Yes | — | — |

The macro- and microscopic appearances of the villous tufts of the Bactrian camel (Pl. 4, figs. 21–26) and of the llama (Pl. 5, figs. 27–32) were very similar to those of the dromedary (Pl. 3, figs. 15–20). The tufts were plicated, highly vascular with intra-epithelial capillaries in areas of low trophoblast, had areas of tall columnar-celled cytotrophoblast basally, and masses of syncytiotrophoblast elsewhere. Amniotic pustles were also present, and the allantoic lining, particularly in the llama, was ridged internally (Pl. 5, figs. 28, 29). A soft brown hippomane measuring $38 \times 25 \times 12$ mm. was found in the amniotic cavity of the llama (Pl. 2, fig. 14). It had the same laminated structure as that of the dromedary, and similar microscopial appearances on section.

*Special staining techniques.* All three placentae showed fine red granules of lipide material scattered throughout the epithelial cells and underlying mesenchyme of the chorion, when stained with Sudan IV. The phosphatase reaction (in dromedary and llama only) produced a marked red stain in the coagulum superficial to the trophoblast, but phosphatase could be detected within any cell layer. A heavy reticulin response was produced by the vessel walls by Wilder's silver impregnation method, and the capillary plexuses were well demonstrated.

## DISCUSSION

The mascoscopic appearances of all three placentae are essentially similar, and the arrangement of the amniotic and allantoic membranes also appears to be the same in the three forms. The presence of the diffusely scattered plicated villous tufts

arranged in areas of varying density of distribution is also similar, except that in the llama a more definite bare area was present along the lesser curve of the chorion than was seen in the other two forms. The relative paucity of small blood vessels in the 'bare' or almost 'bare' areas agrees with the observations of Wislocki (1933) who found that the avillous areas of the mare's placenta were associated with relatively avascular zones of the chorion. Mossman (1937), however, considered that such avillous areas were due to the chorion failing to make contact with the uterine mucosa over these areas. The two views do not seem to be mutually exclusive. Hellegers (1960) and Meschia, Prystowsky, Hellegers, Huckabee, Metcalfe & Barron, (1960) have examined llama placentae *in situ* and found that they were epithelio-chorial in type. These investigators deny the view expressed by Prystowsky (1960) that the llama placenta is haemo-endothelial in type. The microscopical findings of the present investigation confirm the presence of the trophoblast layer of the llama chorion. The intact trophoblast with intra-epithelial foetal capillaries, basally situated columnar cytotrophoblast, and syncytiotrophoblast masses elsewhere, as seen in the three camelid placentae, are so similar in appearance to those of the pig and horse at full-term, that it is virtually certain that all three placentae are epithelio-chorial in type. The observations of Turner (1876) indicate that the inter-cotyledonary villi in the giraffe placenta are similar in general morphology to those of the Camelidae, and Mossman (1937) described diffuse patches of small villi between the cotyledons in the chorio-allantoic placenta of the giraffe. It is evident then that the giraffe placenta occupies an intermediate position in its morphology between the pure diffuse placenta of the Camelidae, and of the small musk deer (Owen, 1866–68), and the pure cotyledonary placenta of most ruminants. The observations of Savi (1843) on the foetal placenta of the dromedary have been fully confirmed, and it is shown that his description of the diffusely distributed shrub-like villi could also be applied to the villous tufts of the Bactrian camel and the llama. The great differences between these placentae and those of other ruminants must be taken into consideration as Savi did, when considering the taxonomic position of the Camelidae, and it is surprising to find that this had been done so many years before Mossman (1937) wrote his classical paper. The presence of laminated deposits in the allantois of the dromedary similar to those found in the mare had been noted by Owen (1866–68). Amoroso (1952) records that these bodies occur in the amniotic or allantoic fluids of the horse, cow, sheep and pig. and the present author has found them in the amniotic fluid of the goat (*Capra hircus* L.). The presence of such a body in the amniotic cavity of the llama had not previously been reported. The intra-epithelial position of the capillary network in the chorion and the loops of larger vessels in the cores of the villous tufts which supply the surface vessels are so arranged that 'counterflow' of the foetal and maternal blood streams could take place. Such a 'counterflow', together with the thinness of the tissue layer separating the foetal blood stream from the surface of the chorion, would make the placenta a very efficient organ for foetal-maternal exchanges.

*Note.* Since going to press the author's attention has been drawn to the article by A. N. Fahmy and M. T. El-Garby (*Gaz. Egypt Soc. Gynaec. Obstet.*, 1959, 9/1) describing the dromedary placenta as non-cotyledonous, epithelio-chorial and with intra-epithelial capillaries.

SUMMARY

1. The full-term foetal chorions of the dromedary, Bactrian camel and llama have been described.

2. The chorion of each is crescentic in shape and diffusely covered by plicated villous tufts, except in irregularly arranged bare areas which may be polar in position.

3. The villous tufts have constricted bases, and bunched and folded extremities. A thin layer of trophoblast containing a profuse intra-epithelial capillary network covers the chorion, except in some basal areas where tall columnar cytotrophoblast is present. Small syncytiotrophoblastic masses are scattered over the surface of the chorion.

4. The allantoic vesicles are relatively small as compared with the amniotic vesicles but in the dromedary excludes the amnion from the distal end of the smaller chorionic cornua.

5. The amnion is large and forms an allanto-amnion which may be partially vascularized. An amnio-chorion appears to be present in the dromedary and probably also in the other species. Small flat amniotic pustules with occasional fine hair-like horns are present in the dromedary. The pustules in the other forms were less conspicuous and without horns.

6. The umbilical cords contained two arteries, two veins, the remains of the allantoic duct and numerous vasa propria.

7. A small highly vascular yolk-sac vesicle was found in the amniotic part of the umbilical cord of the dromedary only.

8. An allantoic hippomane was found in the dromedary and an amniotic hippomane in the llama.

9. The microscopic appearances of the three chorions indicate that the placenta in all three forms is epithelio-chorial in nature.

10. It is suggested that the anatomical arrangement of the chorionic villous vessels is such that 'counterflow' between the foetal and maternal blood streams could occur, and that the placenta, at term, is a very efficient organ for foetal-maternal exchanges.

The author wishes to express his thanks to Mr Alec McLean, M.R.C.V.S., City Veterinarian, Belfast, and Mr R. Chipperfield of Chipperfields Circus and Zoo Ltd., for their great help in obtaining the material on which this research was carried out; to Mr G. Bryans for his technical assistance, and to the Northern Ireland Hospitals Authority for a grant towards the cost of the photography and Queen's University, Belfast for a grant towards the cost of publication.

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## EXPLANATION OF PLATES

### PLATE 1

The gross appearances of the foetal membranes of the Arabian camel (*C. dromedarius* L.), the Bactrian camel (*C. bactrianus* L.), and the llama (*Lama glama* L.) are shown on the left of the plate, while close-up views of the surfaces of the three forms are shown on the right. All illustrations have been taken from Kodachrome transparencies made before the membranes were fixed.

**Fig. 1.** The foetal membranes of a full-term female calf of the Arabian camel (*C. dromedarius* L.). The two horns of the crescentic chorion are close together at the top left corner of the picture, and the umbilical cord and amnion appear as white structures at the lower right corner, as they protrude through the hole in the chorion caused by the birth of the calf. A 12 in. rule is shown. $\times \frac{1}{14}$ approx.

**Fig. 2.** Surface view of the dromedary chorion showing the closely spaced plicated placental tufts. $\times 7$ approx.

**Fig. 3.** The foetal membranes of a full-term female calf of the Bactrian camel (*C. bactrianus* L.). The crescentic form of the membranes can be seen although the chorion has been extensively torn. The umbilical cord above, which is about 18 in. long, leads down to the torn amnion which appears as a bright white structure (lower left), and the inner aspect of the allantochorion (lower right). The external surface of the chorion is shown on either side of the umbilical cord. A 12 in. rule is shown. $\times \frac{1}{14}$ approx.

**Fig. 4.** A low-power view of the surface of the chorion of the Bactrian camel showing the closely packed plicated placental tufts. Scale in mm. $\times 0{\cdot}9$.

Fig. 5. The foetal membranes of a full-term female llama calf (*Lama glama* L.). The crescentic form of the membranes is well illustrated here, as also is the inequality of the two cornuae of the chorion. The umbilical cord, which here is about 6 in. long, leads down to the amnion (left centre) to the left of which large branches of the umbilical vessels can be see on the inner aspect of the allanto-chorion. The narrow white area on the right side of the lesser curve of the chorion is devoid of villous tufts. A 12 in. rule is shown. $\times\frac{1}{11}$.

Fig. 6. Surface view of the bare area on the lesser curve of the llama chorion. There is an absence of the plicated chorionic tufts over the main placental vessels which lie under the white lines in the centre of the picture. The tufts increase gradually in size as the distance from the bare area increases. Scale in mm. $\times 1{\cdot}1$.

PLATE 2

Figures numbered 9, 10, 11, 13 and 14 are from Kodachrome transparencies made while the membranes were fresh.

Fig. 7. The allanto-amnion of the dromedary by transmitted light showing part of the vascular network, present near the umbilical cord. $\times 1{\cdot}3$.

Fig. 8. Transverse section of a typical amniotic pustule from the dromedary. $\times 15$.

Fig. 9. The amnion of the dromedary in the umbilical cord region has numerous low ectodermal plaques or pustules on its surface. Scale in mm. $\times 1{\cdot}5$.

Fig. 10. Surface view of the Bactrian chorion showing areas of large densely clustered villous tufts and other lighter areas of small tufts. $\times 0{\cdot}7$.

Fig. 11. The chorion of the llama viewed by transmitted light. The villi in the darker areas are large and closely packed while those in the light area are small and few in number. $\times 3{\cdot}3$ approx.

Fig. 12. Transverse section of the umbilical cord of the dromedary showing two arteries above, and a patent allantoic duct between two umbilical veins below. Numerous small vasa propria are also present. $\times 3{\cdot}3$.

Fig. 13. Profile view of the chorionic tufts of the llama chorion showing their plicated nature. $\times 10$ approx.

Fig. 14. The amniotic cavity of the llama was found to contain a dark flattened ovoid hippomane which is seen in the centre of the picture partially covered by the cut edge of the allanto-amnion. Scale in mm. $\times 0{\cdot}5$.

PLATE 3

Photomicrographs of the full-term foetal placenta of the Arabian camel (*C. dromedarius* L.).

Fig. 15. Low-power view of a transverse section through the allanto-chorion of the dromedary. Part of the narrow base of a chorionic villous tuft is seen attached to the chorionic plate, but the majority of the tufts have been cut peripherally. The plicated nature of the tufts is clearly illustrated. The allantois shows as a faint marginal line below. Higher power views of the areas enclosed by the rectangles are shown in figs. 17 and 19. $\times 29$.

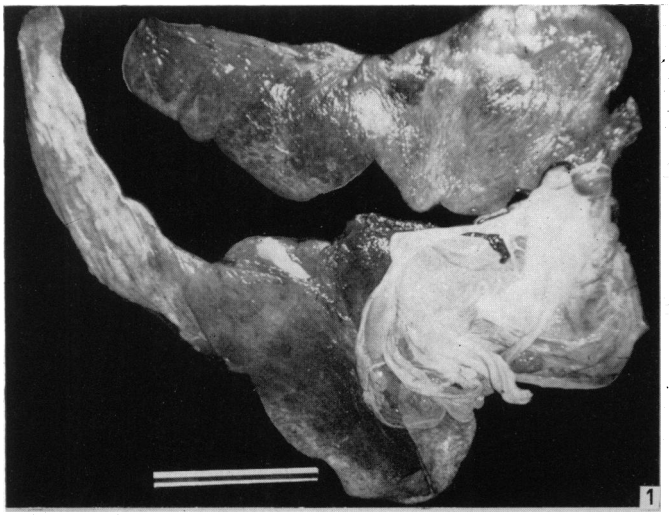
Fig. 16. Tangential section through the chorionic tufts of the dromedary placenta. The star-shaped appearances of the tufts as seen in this view confirm that the tufts are plicated. $\times 29$.

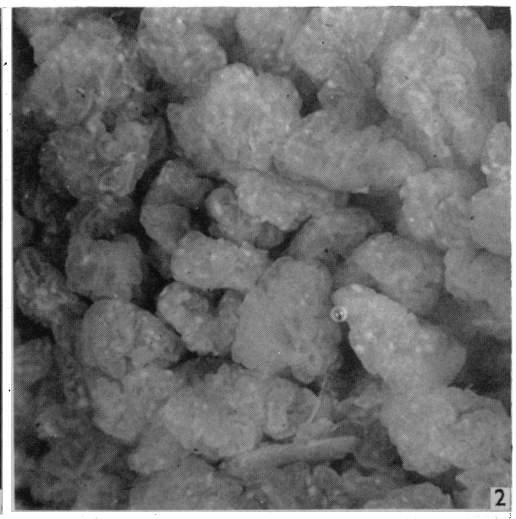
Fig. 17. Medium-power view of the area in the lower right rectangle of Fig. 15. Areas of columnar cytotrophoblast are situated basally in the region of the chorionic plate. $\times 140$.

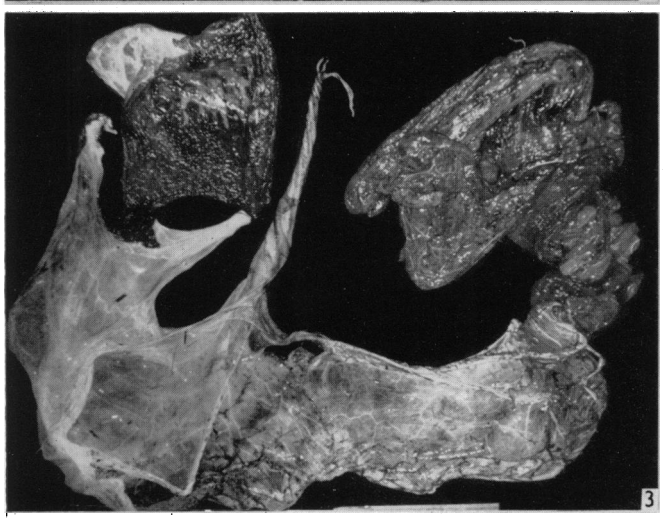
Fig. 18. High-power view of T.S. of the dromedary chorion showing a large hour-glass shaped intra-epithelial foetal capillary within the trophoblast layer. $\times 1400$.

Fig. 19. Medium-power view of the upper left rectangle of fig. 15. The peripheral trophoblast is low, the cell walls are indistinct, and many intra-epithelial capillaries are present in it. A capillary is seen running from the mesenchymal core of the tuft to the edge of the tuft. A high-power view of this vessel is shown in fig. 20 below. Syncytial masses of trophoblast are also present. $\times 140$.

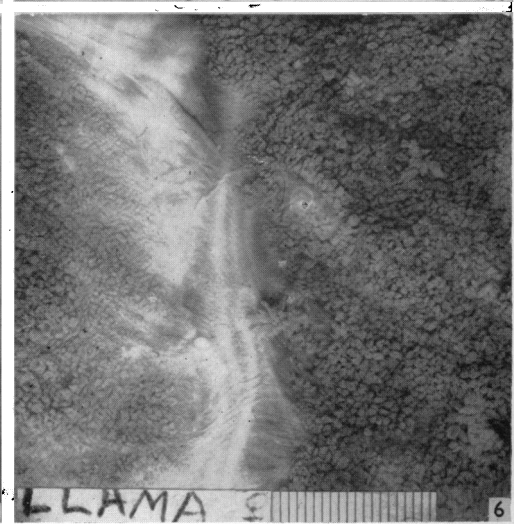
Fig. 20. High-power view of the area in the rectangle in fig. 19. The foetal capillary is running diagonally up and to the right where it divides into two as it enters the trophoblast layer. Elongated oval red blood cells can be seen within its lumen. $\times 1400$.



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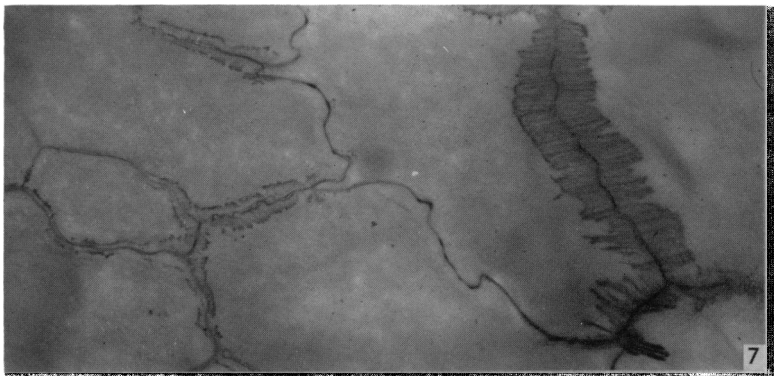
(*Facing p.* 208)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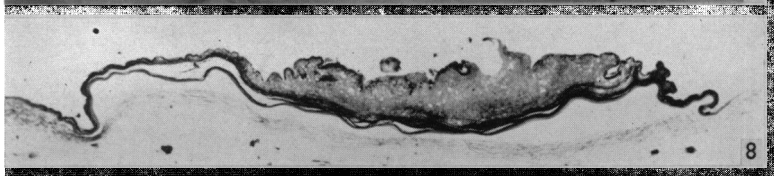
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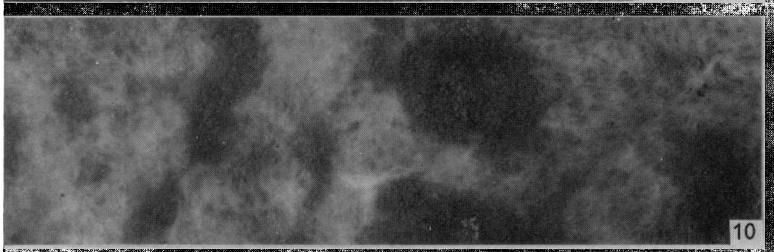
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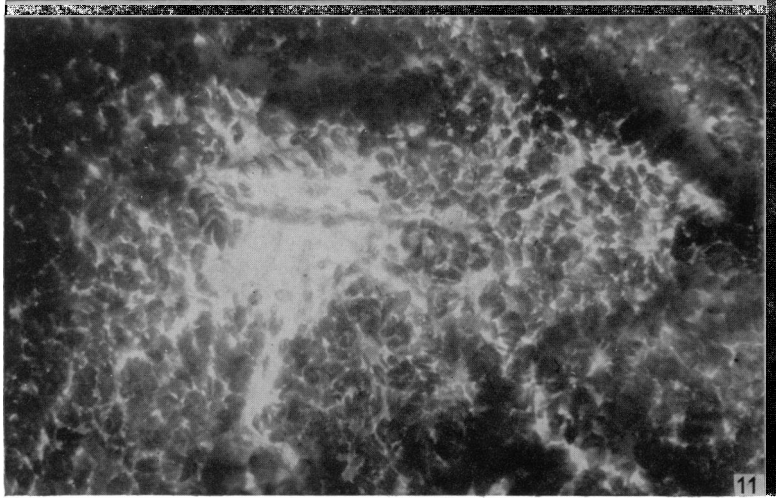
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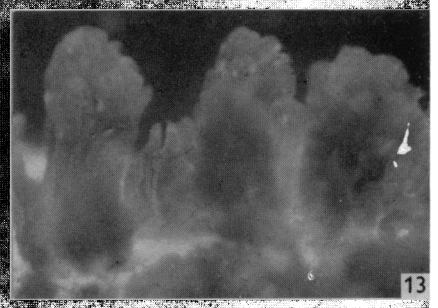
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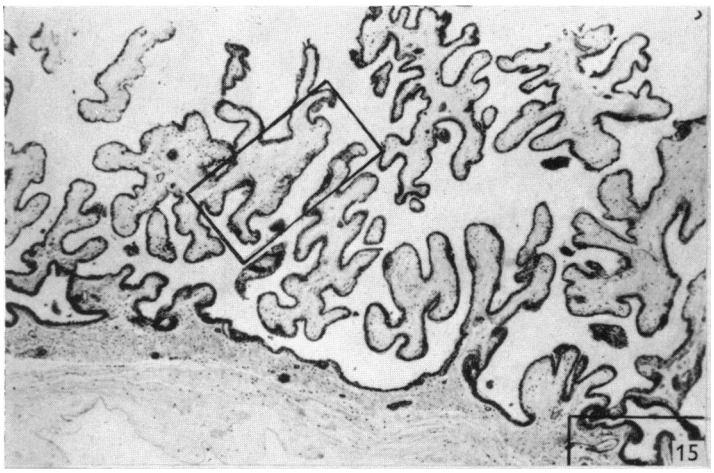
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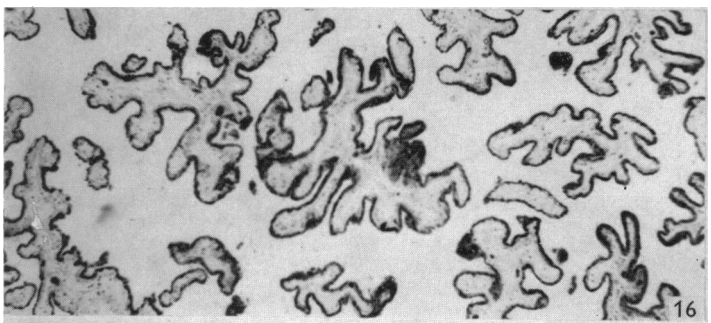
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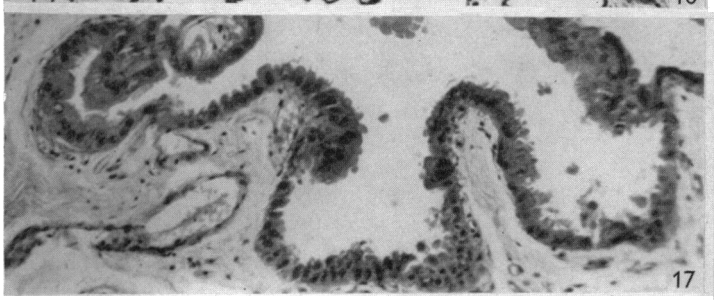
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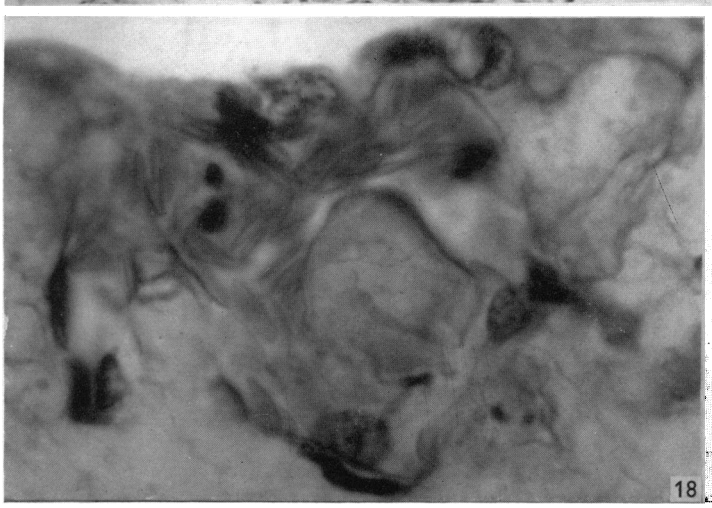
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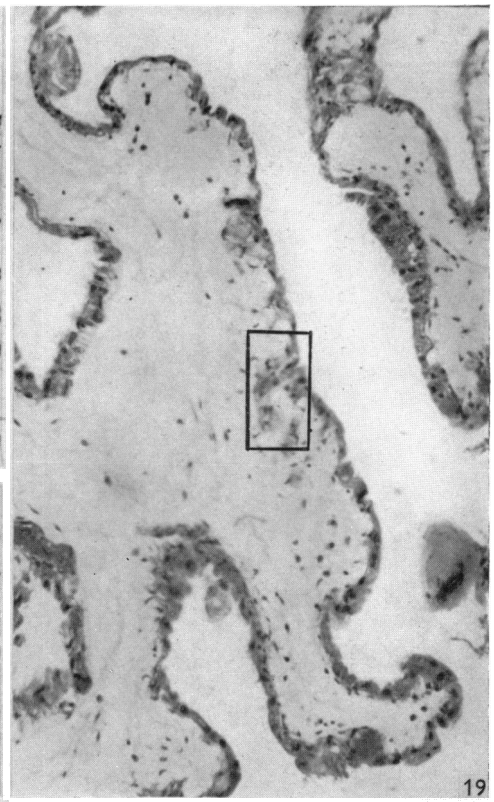
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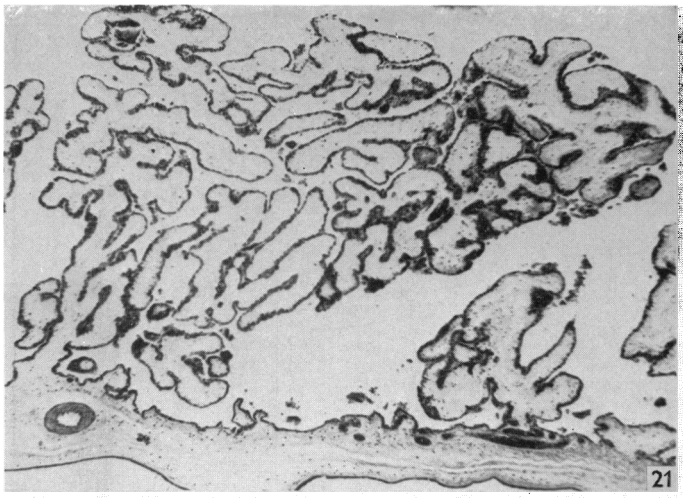
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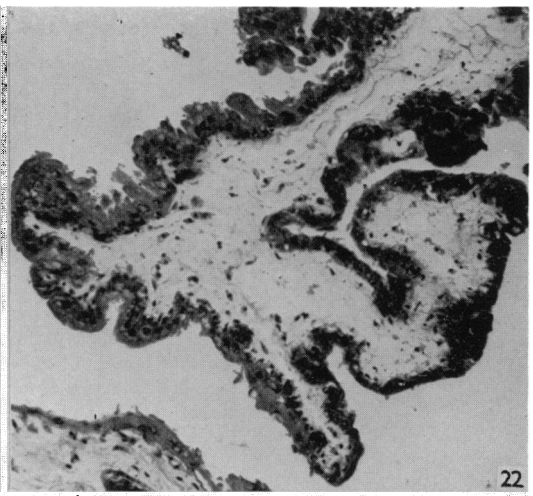
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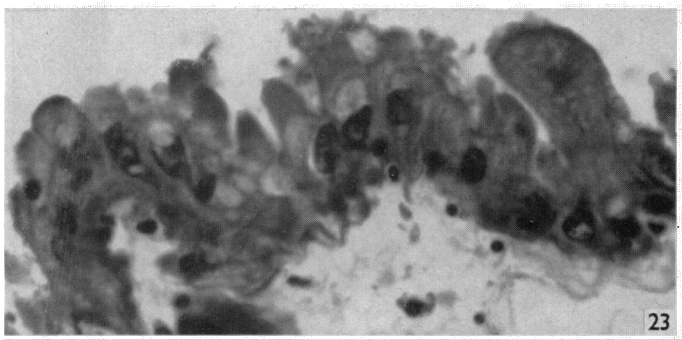
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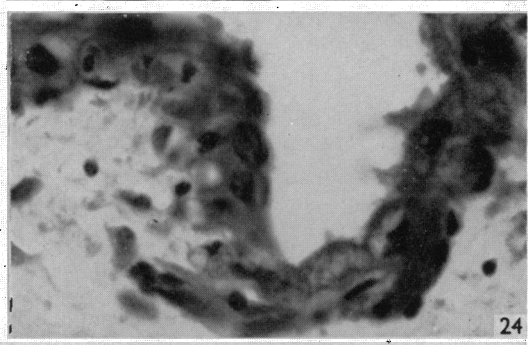
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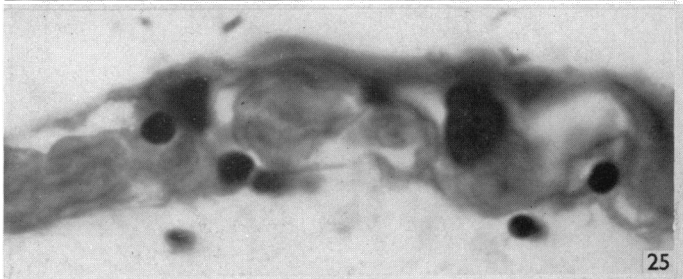
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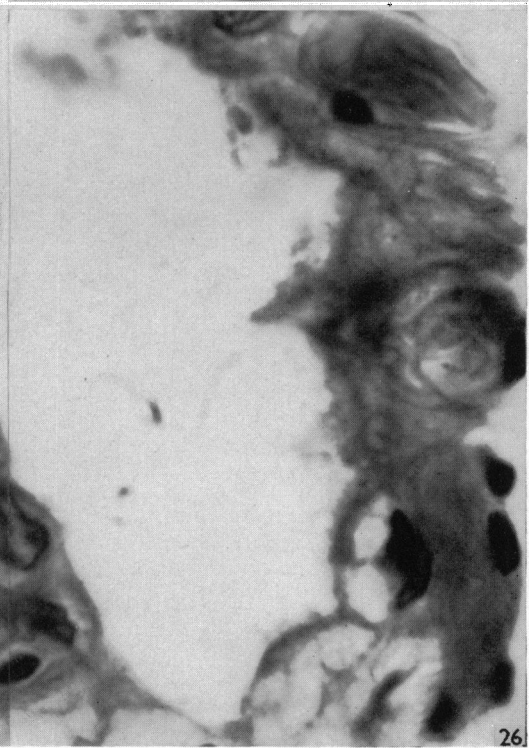
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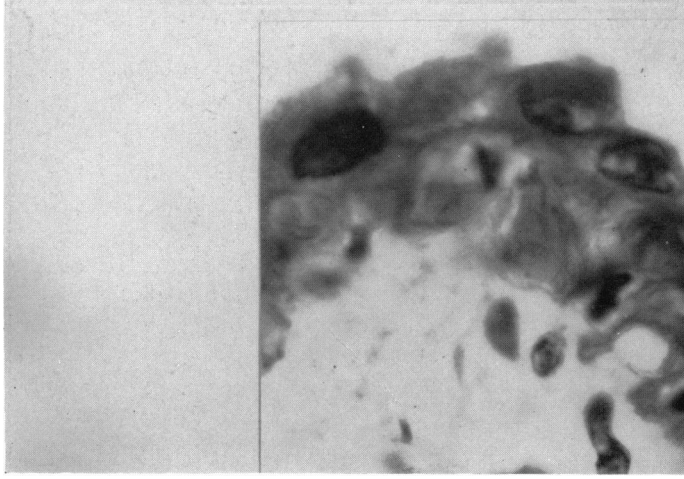


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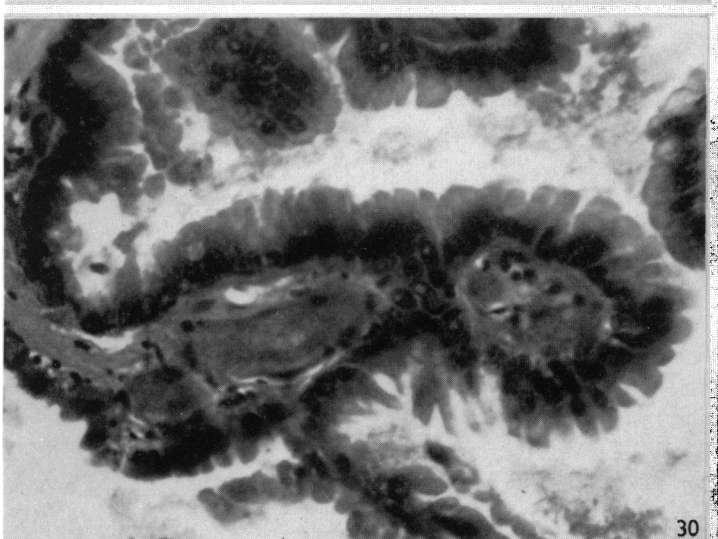
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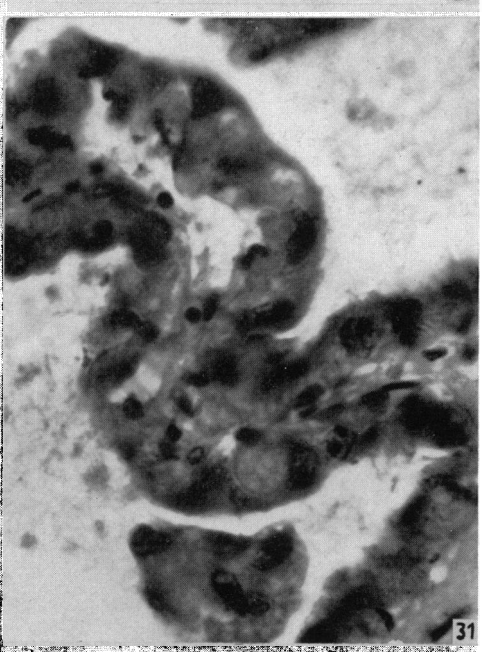
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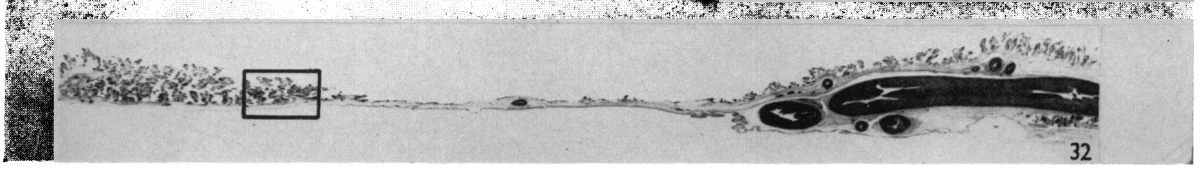
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PLATE 4

Photomicrographs of the full-term foetal placenta of the Bactrian camel (*C. bactrianus* L.).

Fig. 21. Low-power view of a T.S. of the allanto-chorion of the Bactrian camel. The bushy plicated villous tuft is attached on the left by a narrow stem to the chorionic plate. Numerous blood vessels are present in the mesenchyme between the basal trophoblast and the dark line of the allantoic lining below. × 29.

Fig. 22. Part of a villous tuft from the Bactrian placenta showing tall columnar celled cytotrophoblast (left), and masses of syncytio-trophoblast (right). The chorionic plate is below and to the left. × 132.

Fig. 23. Medium-power view of the columnar cytotrophoblast seen in fig. 22. The nuclei of the trophoblast are basally situated, and the more superficial cytoplasm is vacuolated. Intra-epithelial capillaries do not occur in such areas of cytotrophoblast. × 624.

Fig. 24. Medium-power view of the Bactrian chorion showing many intra-epithelial capillaries in the low trophoblast layer. × 624.

Fig. 25. High-power view of an area of the Bactrian chorion showing large capillaries lying within the thickness of the trophoblast. × 1400.

Fig. 26. High-power view of the same area as seen in fig. 24. The blood filled foetal capillaries on the left are deep to the trophoblastic nuclei, those on the right are more superficially placed and those at the lowest part of the figure are next to the surface of the trophoblast. × 1400.

PLATE 5

Photomicrographs of the full-term foetal placenta of the llama (*Lama glama* L.).

Fig. 27. Low-power view of a T.S. from the edge of the bare area of the chorion (see fig. 32 below and Pl. 1, fig. 6). The villous tufts have the same plicated appearance as those of the Arabian and Bactrian camels (compare with Pl. 3, fig. 15 and Pl. 4, fig. 21). The allantoic epithelial lining is below. × 29.

Fig. 28. Low-power view of a T.S. from an area of large densely massed villous tufts from the same placenta. An albuminous coagulum surrounds the free surfaces of the chorion and it was in such a coagulum that a positive phosphatase reaction was obtained. Compare with fig. 27 above. × 29.

Fig. 29. Medium power view of a large tuft from the llama chorion. The trophoblast covering the folds of the tuft is low and contains many intra-epithelial capillaries. The allantois, which is markedly folded, is lined with a flattened epithelium. × 133.

Fig. 30. High power view of avascular tall columnar cytotrophoblast of the llama chorion. A syncytial mass can be seen above. × 624.

Fig. 31. High-power view of intra-epithelial capillaries in the low trophoblast covering an adjacent villous fold. A syncytial mass is present at the bottom of the figure. × 624.

Fig. 32. Low-power view of a section across the long axis of the bare area of the llama placenta (see Pl. 1, fig. 6 and 27 above). Villous tufts are absent in the centre, and the main allantoic vessels are on the right. × 10.