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Regional specializations in the syncytial trophoblast of early human placentas

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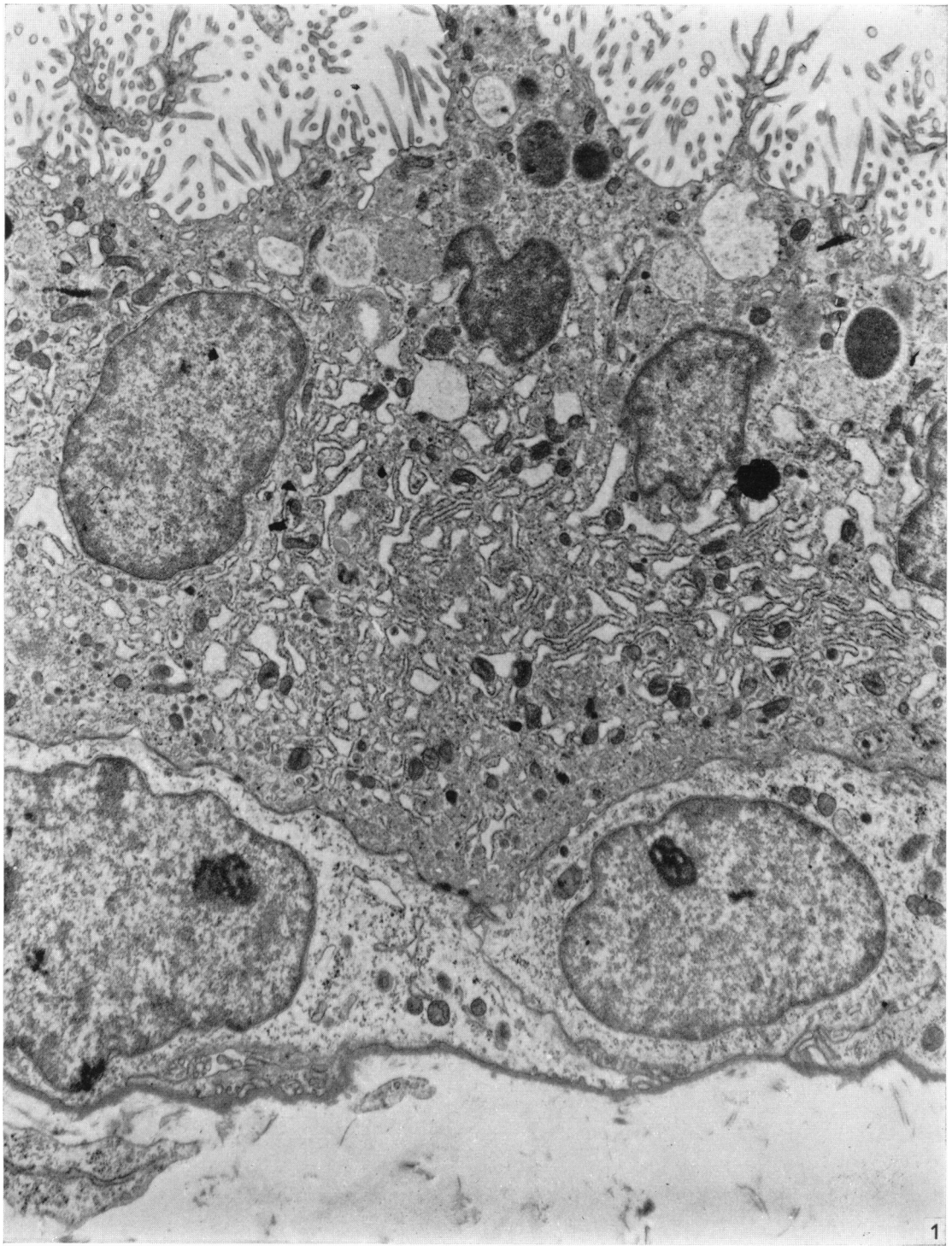
INTRODUCTION

Although there have been extensive studies of placental structure with both the light and electron microscope, only recently have concepts of regional specialization emerged. Perhaps because of Grosser's (1927) notions that placental barriers could be classified into an hierarchal series – the primate haemochorial arrangements being the simplest, most efficient and most advanced – placentologists have tended to emphasize the differences between species rather than to examine possible regional specializations of structure and function within a single species or in different parts of a single specimen. Nevertheless, many clues indicate that not all portions of the primate trophoblast have equal potentialities. Wislocki & Bennett (1943) noted an apparent maturation of function in the cytotrophoblastic shell and cell columns, a germinal, mitotic zone being located at the base of anchoring villi. They also found cytological evidence of increasing secretion in the cells above the basal zone. Variations in the brush border covering syncytiotrophoblast were interpreted by them as probably representing different functional states. Many investigators, observing that mitoses are absent in syncytial but present in cytotrophoblastic nuclei, have suggested that the Langhans layer is a germinal zone. This idea has received support from electron microscopic studies, but has not yet been accepted universally (Boyd & Hamilton, 1967). Some speculations have implicated the Langhans cells as producers of chorionic gonadotrophin (Wislocki & Bennett, 1943), but observations using immunofluorescent methods have placed this function in the syncytium (Midgley & Pierce, 1962; Hamishige & Arquilla, 1964). Histochemical evidence indicates that placental steroids are present in the syncytium (Dempsey & Wislocki, 1944). Structural specializations involving sprouts and buds, as well as regional thickening of the syncytium, have been noted by Boyd & Hamilton (1967) and by Dempsey, Lessey & Luse (1970). These and many other authors have described a complex brush border facing the intervillous space.

We have recently studied a series of young, healthy human placentas and observed surface modifications so extensive as to involve abolition of the syncytial microvilli and, indeed, even of the syncytium itself (Dempsey, *et al.* 1970). These specializations are so striking that we have attempted to gain a better understanding of their frequency by the use of scanning electron microscopy. The correlated observation on our specimens, using both scanning and transmission electron microscopes, have permitted us to define regional variations in the structure and function of human trophoblast.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MATERIALS AND METHODS

Our material consists of 34 specimens obtained by legal abortions in Yugoslavia, Sweden and Finland. Fragmented portions from early pregnancies (4–10 weeks of gestation) were obtained by curettage in Yugoslavia, whereas the Scandinavian specimens were from older embryos (8–20 weeks' gestation age) and were delivered intact by hysterotomy or hysterectomy. In one patient, pregnancy was terminated because of renal disease and in another after extensive radiotherapy of a cervical carcinoma. All other specimens were from pregnancies terminated for sociological or psychological reasons, although in one instance there was evidence of previous unsuccessful self-induced abortion.

The Yugoslav specimens were delivered directly upon a dry towel, immediately dissected and fixed in cold, buffered Dalton's fluid or 3 % 0·1 M cacodylate buffered glutaraldehyde. Those obtained in Scandinavia were placed upon crushed ice and transported to a laboratory where fixation was accomplished 15–60 min after delivery. For transmission microscopy, the glutaraldehyde-fixed specimens were post-osmicated, and both they and the Dalton-fixed portions were dehydrated in graded solutions of ethanol and transferred into toluene, in which they were brought to New York, where embedding in Araldite (Durcupan) was carried out. Sections were cut on Porter-Blum MT-1 microtomes, stained with lead citrate (Reynolds, 1963) and examined in an RCA EMU-3H electron microscope at initial magnifications of 2000–15000 diameters.

For scanning microscopy, both glutaraldehyde and Dalton-fixed specimens were employed. Those fixed in glutaraldehyde alone were less satisfactory than were those also exposed to osmium. Presumably osmium tetroxide acts as a hardening agent, since after its use the syncytial microvilli do not collapse on to the syncytial surface. Some specimens were dehydrated in a freeze-dry apparatus, others were air-dried and still others were dried by evaporation from acetone or ethyl ether. Air-drying from water was unsuccessful, but excellent preparations were obtained both by freeze drying *in vacuo* and by evaporation of volatile solutions.

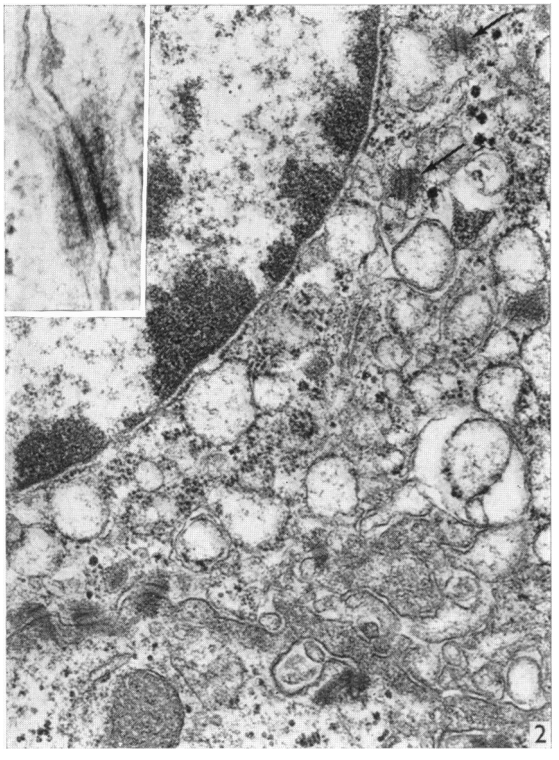
After drying, the specimens were mounted upon metal stubs and coated with thin layers of gold-palladium alloy in a Denton evaporator equipped with a rotating, wobbling specimen holder. The coated specimens were photographed at magnifications of 20–10000 diameters with a Cambridge Stereoscan electron microscope. These, and the negatives obtained by transmission microscopy, were enlarged photographically as desired.

Fig. 1. Section through the trophoblast from a 20 mm human embryo. The upper region, facing the intervillous space, has several protrusions and many branched and unbranched microvilli. Indenting the surface, invaginations connect with a canalicular system probably terminating in the small and large apical vacuoles. These structures, and small mitochondria, characterize the apical, *absorptive* zone. Beneath it, occupying approximately the middle third of the figure, is a region rich in rough endoplasmic reticulum. The cisternae are filled with an amorphous substance. The cisternae and the sparse but medium-sized mitochondria distinguish the middle, *secretory* zone. Still more basal, extending from the inferior poles of the nuclei to the margins of the Langhans cells is the basal *accrual* zone. It contains granular cytoplasm, moderately-sized mitochondria and other organelles resembling those of the cytotrophoblast. Dalton's fixation. × 8500.

OBSERVATIONS

Transmission electron microscopy

During the first trimester of gestation, the trophoblast exhibits a well-marked layering of structure. The apical surface of the syncytium characteristically exhibits microvilli, between which canals, leading to small and large coated vesicles, are frequent. This outer region we have chosen to call a zone of absorption. Beneath it, occupying typically the middle third of the syncytium, lies a region predominantly occupied by cisternae lined by rough endoplasmic reticulum. These cisternae are



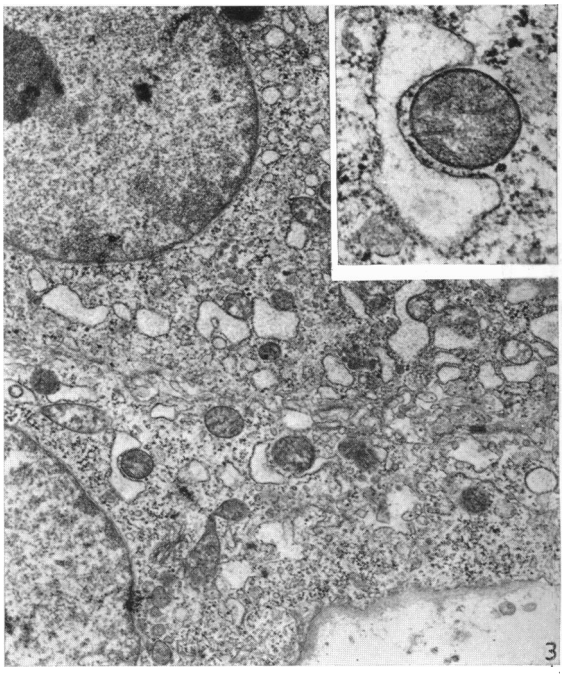


Fig. 2. Section through the margin of the syncytium above and a cytotrophoblastic cell of Langhans below. This embryo was fragmented, but the specimen was obtained 9 weeks after the last menstrual period. Numerous desmosomes attach the two trophoblastic elements together. A higher magnification of one such desmosome is shown in the insert. In the upper middle portion of the picture, the arrows point to two desmosomes apparently floating free in the syncytial cytoplasm. This appearance is compatible with the thought that syncytium is formed from confluence of cytotrophoblastic substance. Also compatible is the presence of dark granules of glycogen, often appearing in clusters, in both layers. Dalton's fixation. ×25000. Insert, ×75000.

Fig. 3. Section showing basal syncytium above, and cytotrophoblast below. The specimen was obtained 7 weeks after the last menstrual period. In both layers there is characteristic association between mitochondria and dilated cisternae of the endoplasmic reticulum. As shown in the enlarged insert, the ribosomes are abundant facing the mitochondrion and sparse elsewhere. Dalton's fixation. ×6000. Insert, ×22000.

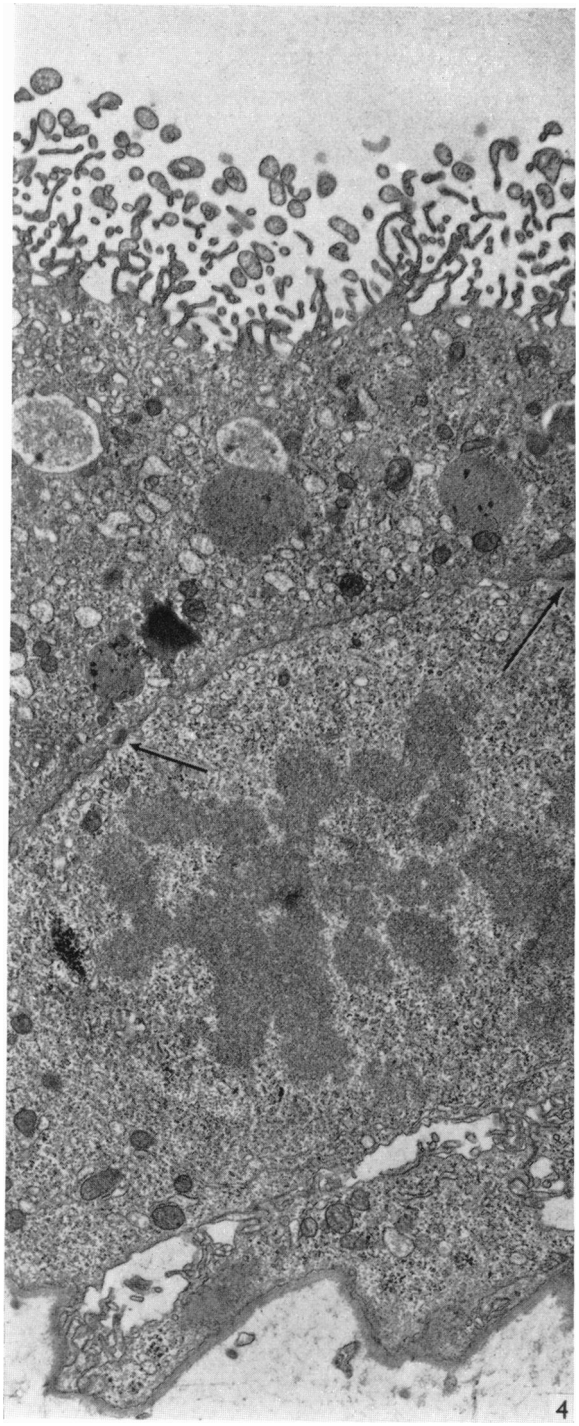
usually dilated by their contents of amorphous, flocculent substance. This middle region we have designated a zone of secretion. Still deeper, occupying approximately the basal third of the syncytium, is a region containing organelles similar to those of the cytotrophoblastic cells of Langhans. This basal region we have designated as a zone of accrual. These zones may be distinguished in Fig. 1. Underneath them, resting upon a thick basal lamina, are the cytotrophoblastic cells of Langhans.

The basal zone of the syncytium resembles the cytotrophoblast in three principal features. First, glycogen is often present, as individual granules or in clumps, in both regions (Fig. 2). It is much less frequently seen in the more superficial zones. Secondly, in both sites there is a characteristic relationship between dilated cisternae and mitochondria; this occurs regularly in Langhans cells and less frequently in the basal zone of syncytium (Fig. 3). Thirdly, cytotrophoblastic cells are attached to the syncytium by numerous small desmosomes; these are encountered not infrequently floating free in the cytoplasm of the basal syncytial zone (Fig. 2), a fact first observed by Enders (1965). In addition to these features, mitoses are fairly common in Langhans cells (Fig. 4), but have never been seen in syncytial nuclei.

Not unexpectedly, the three syncytial zones are often less clear cut than the outline above might suggest. The superficial zone especially varies greatly from the typical appearance, and the syncytial surface may be smooth, microvillous, lacy, or exhibit protrusions (Dempsey, *et al.* 1970). Where the lining of the intervillous space is smooth, the absorptive zone is largely lacking, and the cisternae characterizing the secretory zone are found close to the surface. Such smooth surfaces may be seen on syncytial sprouts (Fig. 5) or covering the ordinary portions of terminal villi. In the regions exhibiting a lacy appearance the absorptive zone is extremely well developed; so much so that the superficial half of the syncytium may consist of enclosed spaces often containing microvilli or remnants of them, together with entrapped maternal plasma (Fig. 6). The basal zone, too, may vary greatly. Its resemblance to the cytotrophoblast is greatest in early pregnancy, when also the largest number of mitoses may be observed in the Langhans cells. In older specimens, and especially in regions where the Langhans cells are depleted, so that the syncytium rests directly upon the basement membrane, the accrual zone may not be apparent at all, and the secretory zone occupies the entire middle and basal portion of the syncytium.

The mitochondria of the trophoblast differ distinctively in the various specialized regions. Those in the Langhans cells are characteristically larger and less numerous than those in the syncytium, and contain a pale matrix and relatively few, loosely spaced cristae. The syncytial mitochondria are small, and those in the middle and outer zones (secretory and absorptive) are slightly smaller than those located basally. Mitochondria are absent in the lacy or honeycombed regions, rare in the smooth areas, and exceedingly small in places where protrusions and large vacuoles are present.

Using the light microscope, placentologists have observed regions where syncytial masses, often containing several nuclei but lacking both Langhans cells and connective tissue cores, are attached to terminal villi. These structures have been termed 'syncytial sprouts' and are ordinarily interpreted as developing terminal villi (Boyd & Hamilton, 1967). They may have either well-developed microvilli, or a smooth surface. Not to be confused with them are structures protruding into the intervillous



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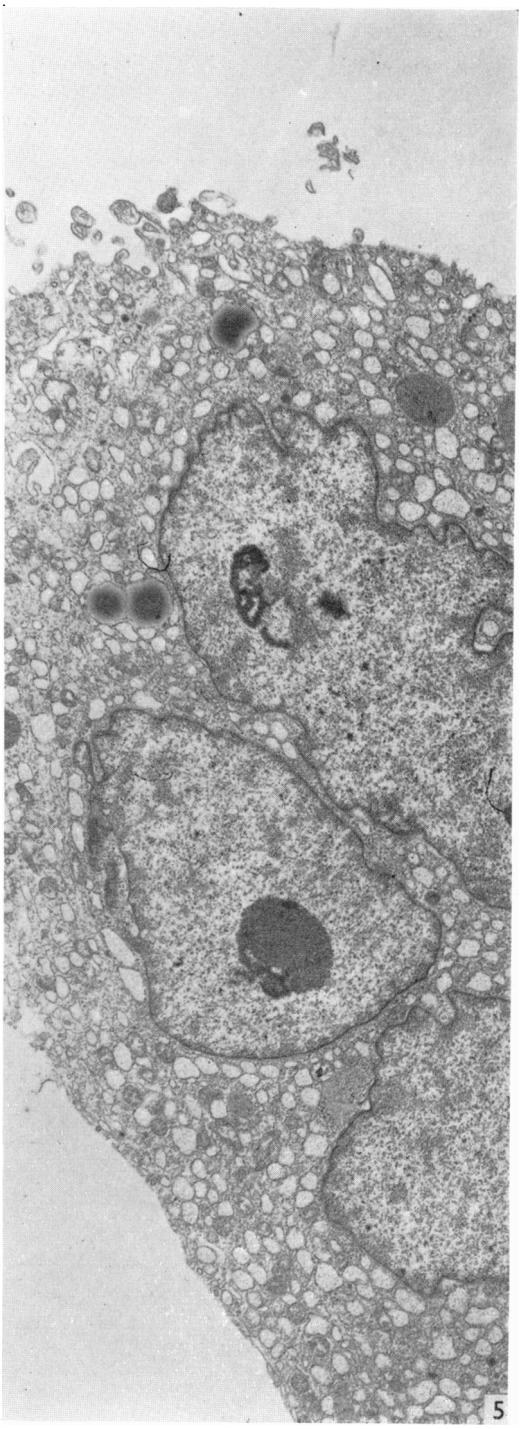

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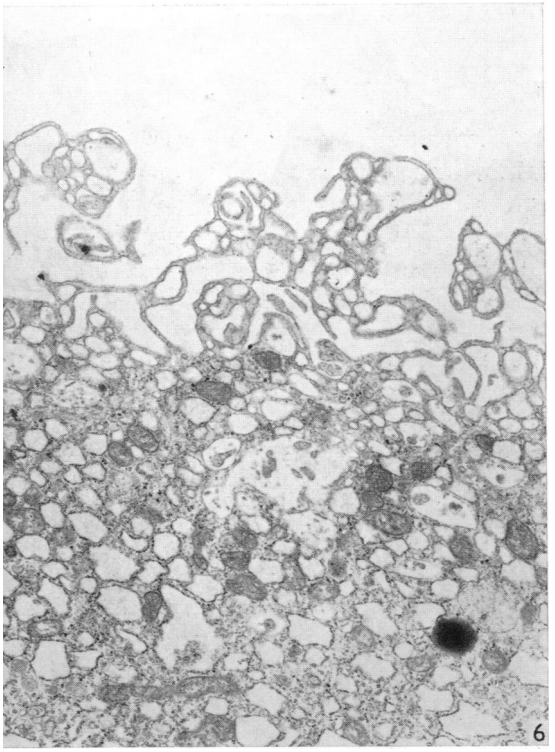
space and forming an extended base for microvilli. These structures, which have been called 'syncytial protrusions' or 'projections' (Dempsey *et al.*, 1970) seem not to have attracted much attention, although they are clearly visible in several pub-



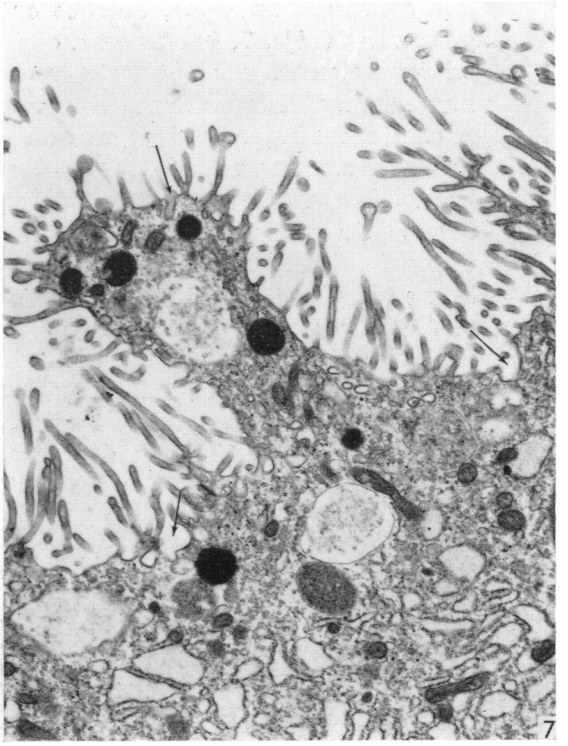


Fig. 6. Section through a villus from the specimen shown in Fig. 1. The lacy, honeycombed region occupies the top half of the figure whereas cisternae lined with rough endoplasmic reticulum are at the bottom. The vacuoles in the superficial region contain enclosed microvilli, as do also those formed by coalescence of the syncytial protrusions (Fig. 8). Dalton's fixation. × 6000.

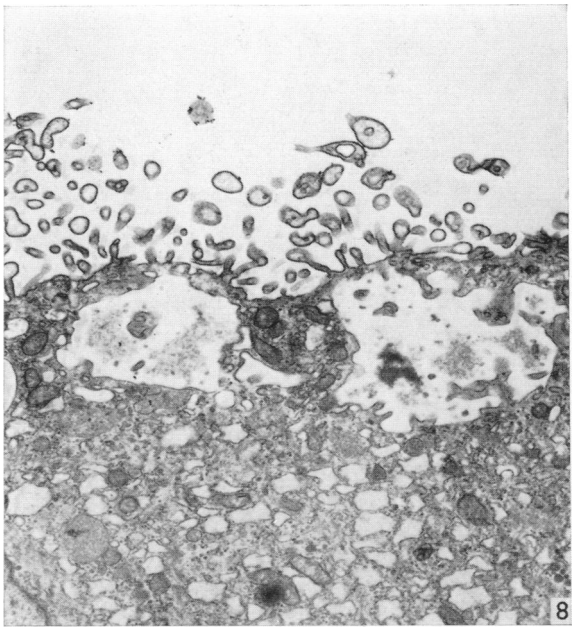
Fig. 7. Syncytial protrusion and microvilli from the absorptive zone of the placenta also illustrated in Fig. 1 (8 week's menstrual age). Straight and branched microvilli, some with expanded tips, are illustrated. Surface indentations are shown at the arrows. These seemingly communicate with an extensive system of canals and coated vesicles. Whether these in turn communicate with the large apical vesicles, which are common in or at the base of protrusions, is not clear (cf. Fig. 8). Lipid droplets may be seen in the protrusions and also elsewhere in the secretory and absorptive zones. Membrane-bound vesicles, some with dense and others with less opaque contents, are common in this zone; they probably represent lysosomes in different stages of formation. Dalton's fixation. × 8500.

Fig. 4. Section through the trophoblast from the same placenta illustrated in Fig. 2. A cell of Langhans containing a mitotic figure. During division it retains the desmosomes attaching it to the syncytium (arrows). Dalton's fixation. × 8500.

Fig. 5. Section through the tip of a syncytial sprout with a smooth surface. The specimen is the same as that illustrated in Fig. 3. Note the profusion of dilated cisternae, typical of the middle secretory zone as illustrated in Fig. 1. In many places these approach the surface closely. Lipid droplets, illustrated here and also in Fig. 7, are present in both the secretory and the absorptive zones. Dalton's fixation. × 8500.

lished photographs (Panigel, 1969; Luckett, 1970). They are most readily found in young placentas and are presumably the structures, to be described later, which are seen running as parallel ridges along the surface of the syncytium when it is examined with the scanning electron microscope. Their extensive investments of microvilli are often complexly branched, bulbous or fused with neighbouring microvilli. Such appearances (Figs. 7, 8) suggest a considerable mobility of the syncytial surface, perhaps accounting for the frequency with which large vesicles containing maternal plasma are associated with the protrusions.

Occasionally in our sections, well-defined clots are found in the intervillous space. These clots are not present in all the intervillous labyrinth, and most of our specimens were fixed so rapidly that clotting of the maternal blood is not complete. Moreover, in zones whose fibrin is adherent to the syncytium, sections through the clot and



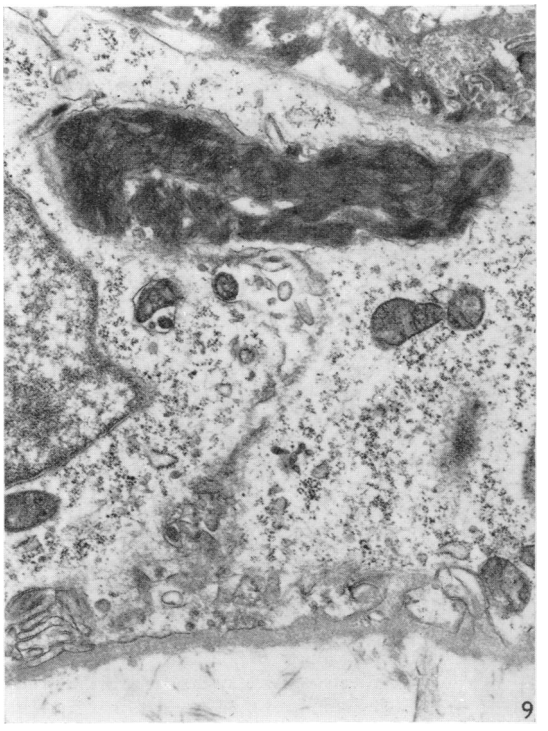


Fig. 8. Large apical vacuoles from a placenta of 7½ weeks' menstrual age. The indentations, profiles and protrusions into these vacuoles entirely resemble the indentations of the intervillous surface and its microvilli. The clumped detritus present in the vacuoles has a different appearance from the contents of the cisternae but more nearly resembles that of the membrane-bound dark bodies shown in Fig. 7. These branches are presumably formed by the fusion of branches from neighbouring syncytial protrusions, thus entrapping a portion of the intervillous space in its own lining. Dalton's fixation. × 8500.

Fig. 9. Area from the placenta shown in Fig. 1 (8 weeks menstrual age), in which a clot of fibrous fibrin has completely replaced the syncytium. Along the upper margin of the figure it can be seen resting upon two adjacent cytotrophoblastic cells. A large mass of fibrin occupies a space between these cells, and smaller amounts, shown by the increased density between the cells, have dissected all the way down to the basement membrane. Dalton's fixation. × 15500.

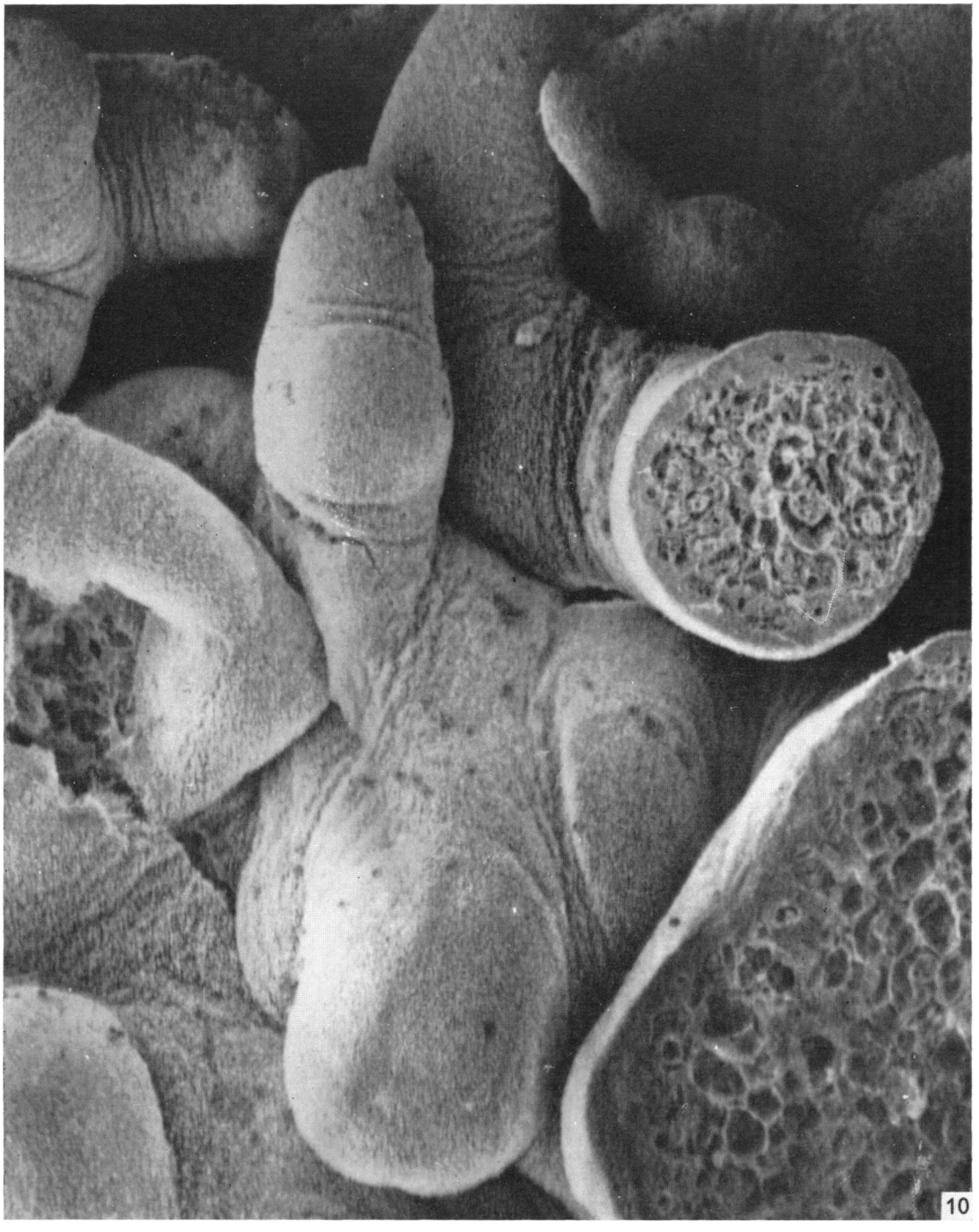
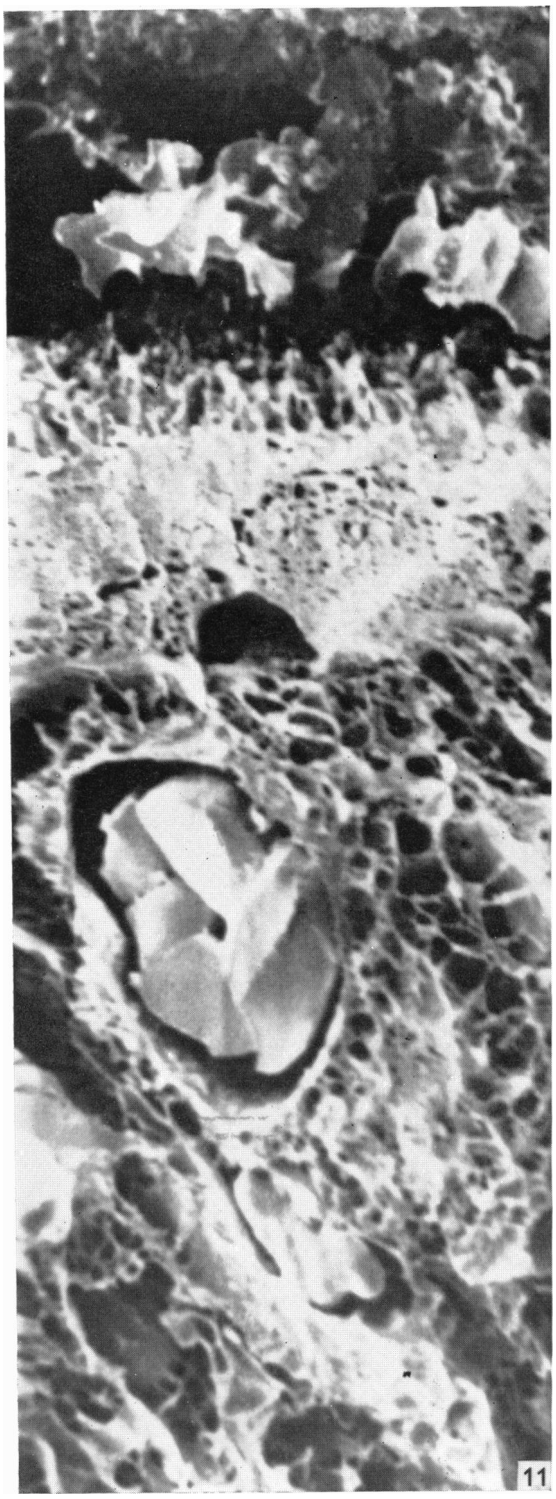


Fig. 10. Scanning electron micrograph of the labyrinth of a 10-week human placenta. The specimen was fixed in glutaraldehyde, frozen in isopropane chilled to the temperature of liquid nitrogen, dehydrated in vacuo in a freeze-dry apparatus, and coated with a thin layer of gold-palladium in a vacuum evaporator. The specimen illustrates terminal villi which attached maternal erythrocytes, and a syncytial sprout or bud. Frozen-dried specimens are fragile; two fractured villi exhibit their trophoblastic rim and spongy connective tissue core. × 200.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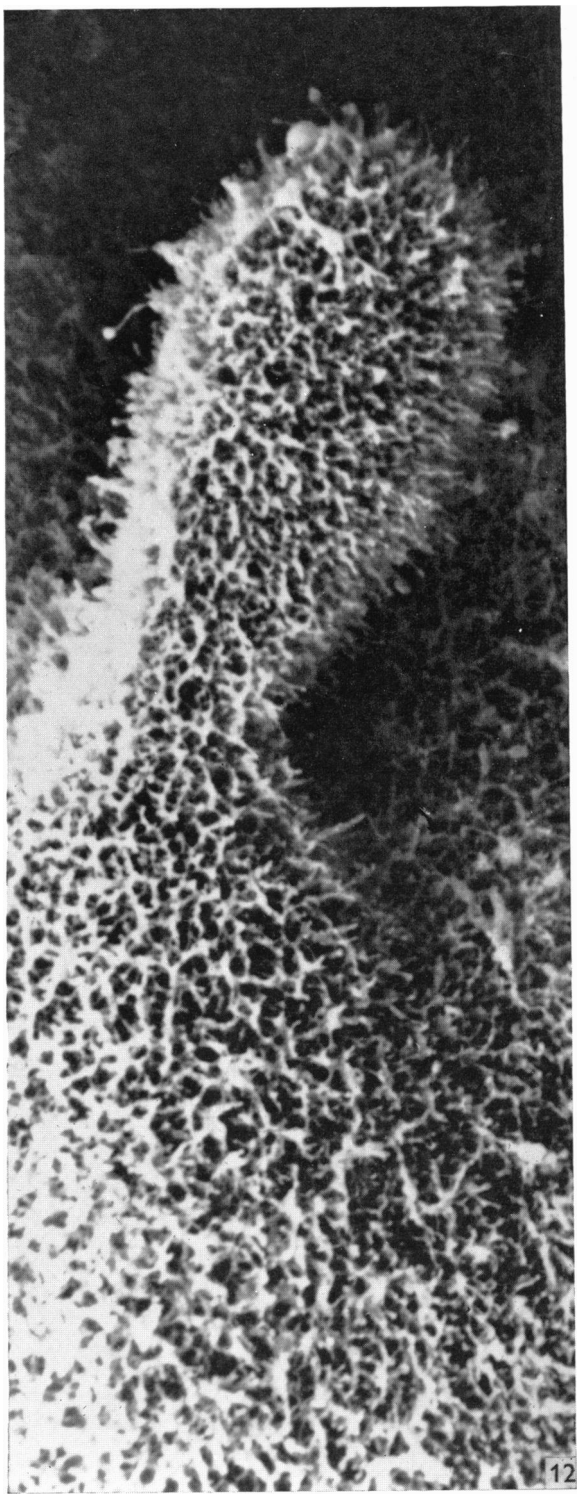
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adjacent villi frequently exhibit clusters of maternal leucocytes and fibrin inclusions deep within the syncytium, extending even to the basement membrane of the trophoblast. These areas are so frequent, and the damage to the syncytium so extensive, that Dempsey *et al.* (1970) suggested they might well account for the access of certain large molecules to the foetal circulation. A section through such an area is illustrated in Fig. 9.

Scanning electron microscopy

With low-power magnification, the relationships of the terminal villi and syncytial sprouts to the intervillous space are well seen (Fig. 10). Here and there, dark, circular structures adhere to the syncytium. These prove, on higher magnification, to be isolated maternal erythrocytes. After freeze-drying, the villi are quite fragile and often fracture during the preparative procedures. The surfaces of such fractures are reminiscent of sections, and in them, one can discern a rim of syncytio- and cytotrophoblast, the former often with an irregular surface. Both layers surround an inner core of spongy connective tissue and blood vessels (Fig. 11).

With higher magnification, the syncytium exhibits a textured surface because of its microvilli, protrusions and other specializations. When the specimen is oriented so that the view appears to be straight down, the villi appear to have porous surfaces. This is at least partly the result of the matted arrangement of the microvilli, which present a spongy feltwork to the scanning beam. However, careful examination of the photographs, especially at the margins of villi, clearly shows that many of the delicate extensions are individual finger-like processes. They are extremely varied in size and shape, some projecting several microns into the maternal plasma, some fusing or interdigitating with others and some ending in bulbous enlargements resembling tethered balloons (Figs. 12, 13).

With moderate magnification, arrays of parallel elevations may occasionally be distinguished. The size and frequency of these long, parallel ridges suggest that they may be the equivalents of the projections or protrusions as seen in sections (Fig. 14). When examined with higher magnifications, not too much detail can be distinguished in our preparations, because of the delicacy and fragility of the microvilli, and their propensity for matting together. Further description is therefore hazardous. We have seen, on the margins of villi, protrusions inclined toward and touching one another or fusing into a lacy mesh to enclose droplets of maternal plasma. Such appearances are quite like those seen in sections.

One is impressed, in viewing scanning micrographs, by the numbers of maternal erythrocytes which adhere to the villous surfaces. Considering the looseness of the villous meshwork in early gestation, and considering also the degree to which our

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Fig. 11. Higher magnification of a fractured villus from an 11-week-old human placenta. At this magnification, microvilli can be seen projecting into the intervillous space which contains fibrin and maternal erythrocytes. Beneath the microvilli, the syncytium and outlines of two Langhans cells can be seen. Just under the trophoblast, a foetal capillary and a somewhat larger vessel, containing distorted foetal red cells, are present. Preparation as described for Fig. 10. ×4000.

Fig. 12. Surface view of a terminal villus and a syncytial sprout from an 11-week-old human placenta. Straight and bulbous microvilli project into the intervillous space. In many places, the microvilli are matted in appearance. ×4000.

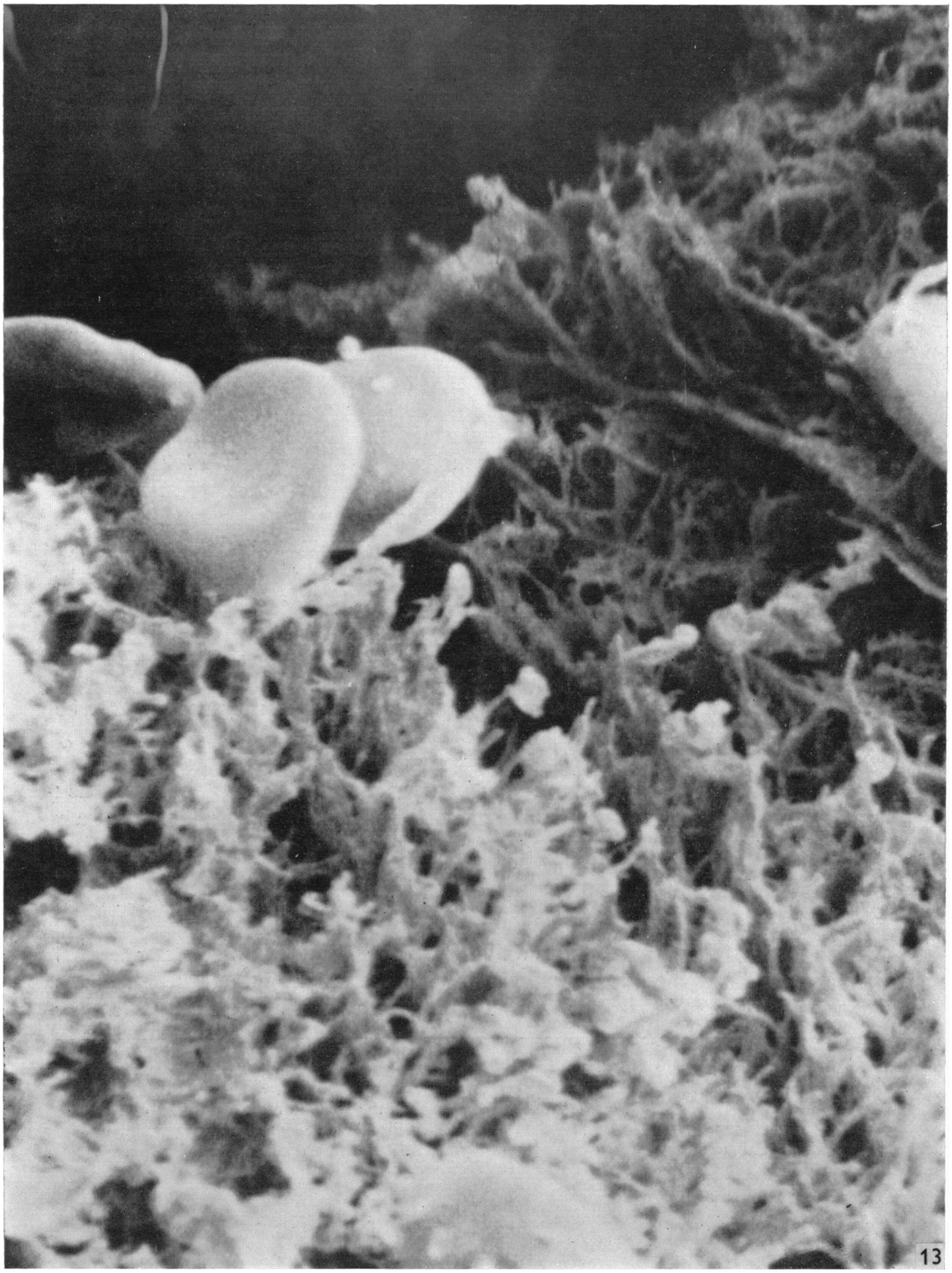

Fig. 13. Higher magnification of a region similar to that shown in Fig. 12. The matted appearance of microvilli is illustrated. Maternal red cells, some with attached globules, are attached to the microvilli. Running obliquely across the field are two parallel rows which may represent the syncytial protrusions. × 8000.

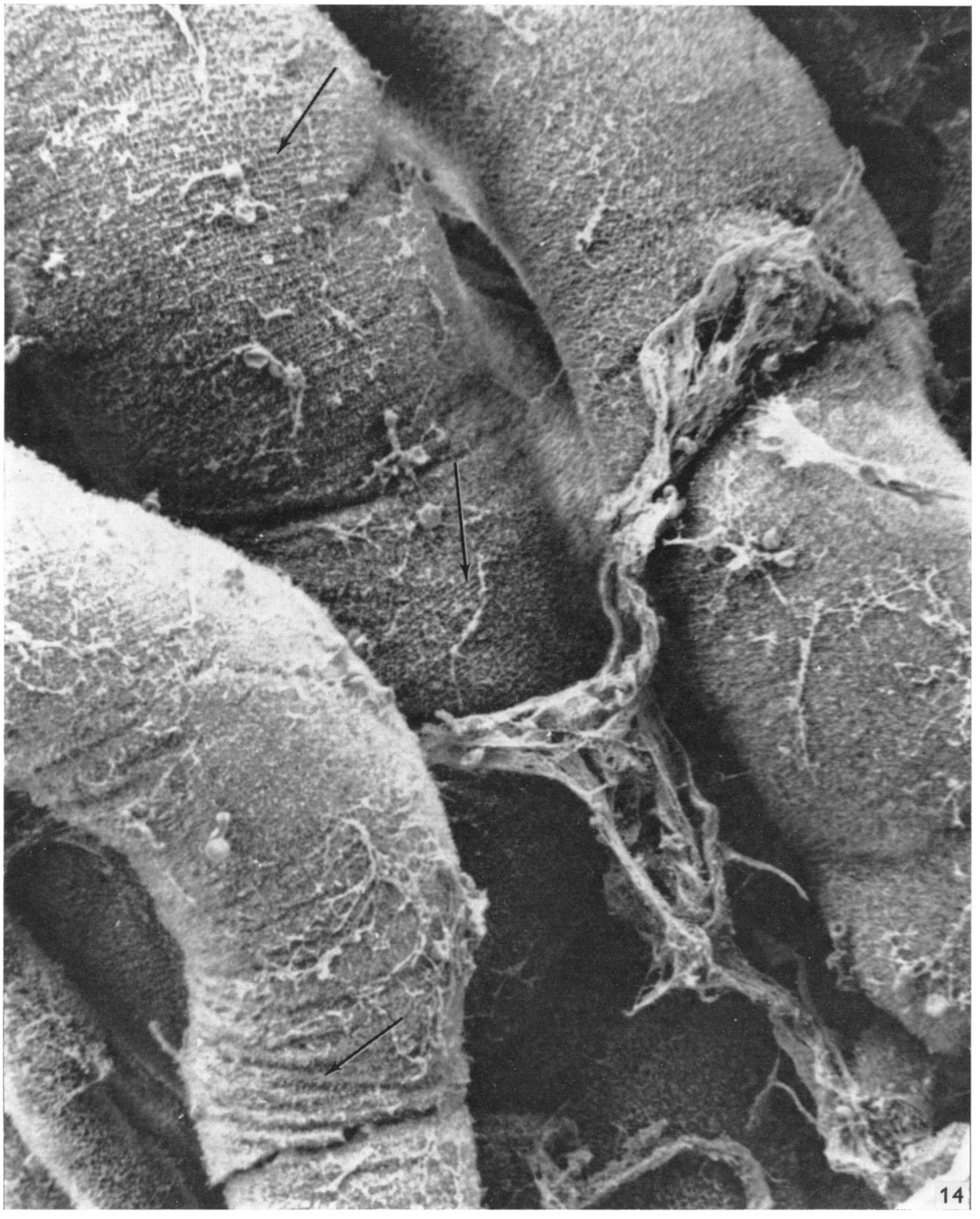

Fig. 14. Placental labyrinth from a specimen of 10 weeks menstrual age. Fibrous clots of fibrin are numerous and often have maternal erythrocytes attached to them. At the arrows, parallel ridges, probably representing syncytial protrusions, are evident. × 800.

tissues for scanning microscopy were washed in glutaraldehyde during transportation back to our laboratory, it is surprising that individual and clumped red cells are still present in the intervillous space. Closer examination reveals that small spherical bodies are often attached to the erythrocytes; these bodies have the shape and appearance of maternal platelets, although they could also be the detached bulbous ends of trophoblastic microvilli (Fig. 13). Of greater interest, however, are the frequent clumps, strands and masses of fibrous material, presumably fibrin, attached to the surfaces of villi and often containing numerous entrapped red cells. Where they attach, they seem to distort the syncytium so that pits or fossae may often be seen at the margins of the clumps (Fig. 13). Transmission electron micrographs through such regions reveal frank gaps in the covering of the villi, so that a loose meshwork of fibrin entirely replaces the trophoblast (Fig. 9).

DISCUSSION

Although there have been many studies on the ultrastructure of human placentas since the original reports by Dempsey & Wislocki (1953) and Boyd & Hughes (1954), little attention has been given to regional specializations. Wislocki & Dempsey (1955) and others (for references, see Boyd & Hamilton, 1967) noted regional variations in the thickness of the syncytium, and discussed the relations of syncytial 'sprouts', 'buds', 'knots' and 'proliferation nodes' to the formation of new villi. It has been suggested that regions of the syncytium having a well-developed brush border may have absorptive functions different from those which occur across the thinned out 'epithelial plates' covering the capillaries in placentas near term (Boyd & Hamilton, 1967; Wislocki & Bennett, 1943). The characteristic groupings of organelles in the surface, middle and basal zones of the syncytium (Dempsey & Zergollern, 1969), and their modifications with progress of gestation and in different portions of the placenta have not been emphasized previously. What slight evidence there is in the literature, however, supports our suggestions that the outer zone is absorptive, the middle is secretory and the basal zone one of accrual of cytoplasmic material. Thus Ashley (1965) has shown that when term placentas are incubated in solutions containing ferritin or thorium, they accumulate these substances in apical canals or vacuoles, and Muir (1966) has demonstrated phagocytosis of iron-dextran by the apical syncytium of term placentas. The accretion of basal cytoplasm from Langhans cells is generally accepted (Enders, 1965; Boyd & Hamilton, 1967), and this conclusion is supported by the observations reported in this paper. Immunofluorescent methods have yielded evidence that gonadotrophins are present in the syncytium (Midgley & Pierce, 1962; Hamashige & Arquilla, 1964). The initial speculations implicating cytotrophoblast as the site of origin of placental gonadotrophins (Wislocki & Bennett, 1943) were based upon methods much less specific than the immunofluorescence procedures now available. One of the observations originally advanced was that basophilia and protein production are related, hence gonadotrophins logically might be formed in the basophilic cells of the cytotrophoblastic shell, islands and columns (Wislocki, Dempsey & Fawcett, 1948). The syncytium is also strongly basophilic in the middle zone (Dempsey & Wislocki, 1945) and our recent description of the cisternae in that region is better in accord with a

secretory activity than is any known appearance of the cytotrophoblast. We must concur, therefore, with current hypotheses that the protein hormones of the placenta are most likely formed in the middle zones of the syncytium, especially in the first and second trimesters of pregnancy.

The irregular appearance of the primate syncytium under the light microscope has been stressed by Wislocki & Bennett (1943). To the speculations of earlier investigators that differences might characterize 'implantation' from 'resorptive' syncytium (Grosser, 1927), they added the suggestion that the plastic, pleomorphic variations in structure of the syncytium might reflect amoeboid, dynamic variations in function in different locations and at different times during gestation. In general, this suggestion has been well received (cf. Boyd & Hamilton, 1967). Only slight attention has been paid to such regional variations in studies utilizing electron microscopy. Boyd & Hamilton (1967) summarize the available literature and remark merely that the microvilli vary in length, and that in older placentas there may be regions in which they are essentially absent. They also mention regions exhibiting a honeycomb appearance and state that in the outer portions of the syncytiotrophoblast the cisternae of the endoplasmic reticulum often possess small microvilli projecting into their lumina. The smooth regions they describe are not confined to late generation, but are readily observed in our specimens from the first trimester (Dempsey, *et al.* 1970). The honeycomb appearance they mention is presumably similar to that which we have chosen to call 'lacy' (*loc. cit.*), but we cannot agree with their statement that microvilli project into the cisternae of the endoplasmic reticulum. Rather, we suggest that they failed to distinguish between the superficial vacuoles enclosed by confluence of syncytial streamers of protrusions and the deeper-lying cisternae of the endoplasmic reticulum (Figs. 6, 7). Several characteristics differentiate these two structures – the vacuoles lack the ribosomes of the rough endoplasmic reticulum, the precipitated contents are different in the cisternae and vacuoles, and the vacuoles contain microvilli which the cisternae lack.

An appearance which distinguishes regions rich in protrusions from those with other surfaces is the size and number of mitochondria. The protrusions may occur as rather regular serrations (Fig. 14; cf. also Dempsey *et al.* 1970; Luckett, 1970) or as isolated eruptions from the surface of a syncytial sprout. The sprout might be regarded as a larger and more differentiated version of the protrusion. However, the sprout contains all of the organelles of the syncytial layer – nuclei, cisternae, vacuoles, lipid droplets, mitochondria, etc. – whereas the protrusions never contain either nuclei or cisternae. We are inclined, therefore, to regard the protrusion as a pseudopodial eruption of the outer absorptive zone whereas the sprout probably results from a more passive streaming movement of the entire syncytium. In any event, numerous and tiny mitochondria are present in the protrusions but never in the slender microvilli which they support. The mitochondria in the sprouts are appropriate to the region in which they occur – sparse and medium-sized in secretory regions rich in cisternae and absent in the lacy honeycombed areas. The smallest mitochondria are at or below the resolving power of light microscopes, some circular profiles having diameters as low as 0·2–0·4 μm. We have previously seen such small mitochondria only in the smallest processes of cells in the central nervous system.

In the areas in which fibrin has replaced the syncytium, only a loosely organized

clot separates maternal blood from the basement membrane of the foetal villus (Dempsey *et al.* 1970). To the extent that the syncytium is thus replaced, the haemochorial human placenta is transformed, in places, into a type which might be called haemosyndesmic. That is, only the foetal connective tissue and endothelium separate the two blood streams in these regions. Indeed, if the basement membranes of the villus and the foetal capillary touch and fuse, the relationship could even be called haemoendothelial. The destruction of syncytium in such regions is well known from light microscopy, but it has been thought to represent degeneration of a villus, and, therefore to have a mainly pathological significance (Lister, 1969). Our observations indicate that localized areas of this kind are a common occurrence, even in early pregnancy, and that they occur in otherwise normal villi.

Scanning microscopy, which permits examination of much larger surface areas than can be sampled by transmission microscopy, provides evidence of the frequency with which clots adhere to the syncytium, whereas sections through such areas demonstrate the degree to which the syncytium is damaged. Together, they show that considerable portions of the placenta may not have a trophoblastic barrier interposed between the maternal and foetal circulations.

Our scanning electron micrographs also demonstrate that the placenta presents a variety of surface configurations. The profuse microvilli, seen by all electron microscopists who have examined human specimens, have been described variously as straight, branching, with bulbous tips, extending from a regular syncytial base or from protuberances which may or may not fuse into apical vacuoles with enclosed microvilli. Many of these pleomorphic forms have now been observed by scanning microscopy. Since these specimens have not been embedded or sectioned, the bulbous tips of microvilli cannot be artefacts due to these procedures. These and other variations in surface appearance confirm similar variations seen in transmission microscopy, and thus give greater credence to the results obtained with both methods.

SUMMARY

Early human placentas, ranging from 4 to 20 weeks' gestation age, have been examined by transmission and by scanning electron microscopy. Regional specializations occur in the syncytiotrophoblast, which may exhibit a smooth, microvillous, or lacy surface. Trophoblastic sprouts or buds contain all the organelles of the syncytium, but protrusions never have nuclei and microvilli lack mitochondria.

Syncytiotrophoblast typically has an outer absorptive zone facing the intervillous space, a middle secretory zone in which cisternae lined by rough endoplasmic reticulum is the predominant feature, and a basal accrual zone, the organelles of which closely resemble those of Langhans cells. Each of these typical zones may be extensively modified in localized regions. Fibrin clots adherent to the trophoblast often replace it entirely so that no cellular barrier exists between the basement membrane of the villus and the maternal blood.

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