XVI. *On the Placentation of the Apes, with a Comparison of the Structure of their Placenta with that of the Human Female.*

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[Plates 48 and 49.]

Contents.

The placenta in the Quadrumana has from time to time engaged the attention of anatomists.

John Hunter* seems to have been the first to describe and figure the placenta of a monkey, which had been shed in the ordinary course of parturition, after the birth of a single fœtus. The placenta was divided into two oblong contiguous lobes, and each lobe was made up of smaller lobes closely united together. Fissures were seen on the uterine surface of the placenta, in which were situated veins or sinuses that received the blood laterally from the lobes, and that passed through the decidua to enter the substance of the uterus. The substance of the placenta seemed to be "cellular" as in the human subject: an arrangement which allowed a communication to be kept up between different parts of each lobe, as well as between different lobes. Hunter recognised the chorion and amnion. The decidua was thicker than in the human subject. The allantois was absent. Hunter does not give the generic name of this monkey, but Professor Owen calls it *Macacus rhesus*, and in the "Catalogue

* 'Animal Œconomy, 1786.' Also in collected works by Palmer, vol. iv., p. 71, plates xxxv., xxxvi., and fig. 2, xxxiv. The uterine and fœtal surfaces of the same placenta are figured by Sir E. Home, 'Comparative Anatomy,' vol. iv., plates 167, 168. The description of the placenta of an Ape given in 'Les Œuvres de Vicq-d'Azyr,' vol. v., p. 318, 1805, is an almost verbatim translation of Hunter's description, though Hunter's name is not given as the authority.

of the Museum of the Royal College of Surgeons"* he points out that the filamentary fœtal villi include the capillary loops of the umbilical vessels; but instead of lying free in the alveolar cavities of the maternal placenta, they are connected or entangled with the fine cellular structure which receives the blood from the uterine arteries; the uterine veins have stronger and more definite coats than in the human placenta.

RUDOLPHI gave, in 1828, a short account, with figures, of the gravid uterus of an *Hapale jacchus*, in which were twin fœtuses.† The fœtal membranes consisted of a chorion, with an oval placenta and an amnion for each fœtus, but with no trace of an allantois. Each fœtus had an umbilical vesicle of about the same size as in the human embryo of the third month. The vesicle possessed a long peduncle containing delicate blood vessels, but no trace of an omphalo-mesenteric duct. The placenta was divided into a fœtal and a maternal part. RUDOLPHI also figured the placenta of a howling monkey (probably *Mycetes ursinus*), which consisted of a single oval lobe of greater thickness than the placenta of *Hapale*. In the fœtus not only of *Hapale* and *Mycetes*, but also of a Capucin monkey, two umbilical veins extended from the placenta up to the liver.

In 1845 M. BRESCHET published an elaborate memoir on the gestation of the Quadrumana,‡ in which he described and figured the fœtus and placenta in a species of *Hylobates*, in *Cercopithecus sabæus*, *Cynocephalus sphinx*, *Semnopithecus mitratus* and *nasicus*, *Mycetes seniculus*, and *Chrysothrix sciurea* (Saimiri). His description comprises an account of the form of the placenta, the presence of a decidua, the arrangement of the umbilical vessels, and the general disposition of the chorion and amnion in the several specimens. Some observations are also made on the appearance of the gravid uterus of *C. sabæus*. No allantois was present in any of the specimens, but in *sabæus* indications of an umbilical vesicle were seen at the junction of the cord with one of the lobes of the double placenta. No reference is made to the minute structure of the organ.

In the Chimpanzee the placenta is stated both by Professor OWEN§ and by Professor HUXLEY‖ to be single, and the latter anatomist says that in a specimen he examined, where the fœtus was $11\frac{1}{2}$ inches long, the placenta was simple, rounded, $3\frac{1}{2}$ inches in diameter, and 0·6 inch thick in the centre. The umbilical cord was inserted near one of its edges.

Professor ROLLESTON, in a memoir communicated to the Zoological Society,¶ gave an account of the examination of an injected placenta of *Macacus nemestrinus*, which had been preserved in spirit in the Oxford Museum for many years. He described

* Physiological Series, vol. v., p. 145, and 'Comp. Anat. of Vertebrates,' vol. iii., p. 746.

† Abhand. der Akad. der Wissensch. zu Berlin, 1828.

‡ Mémoires de l'Institut, Paris.

§ 'Comparative Anatomy of Vertebrates,' vol. iii., p. 747.

‖ 'Manual of the Anatomy of Vertebrated Animals,' p. 487, 1871.

¶ Trans. Zool. Soc., vol. v., 1863.

the uterine surface of the placenta as covered by a smooth continuous deciduous membrane, between which and the muscular coat were loose lamellæ, the deeper of which consisted of cells with large nuclei and tapering ends. A number of large blood vessels were seen amidst these lamellæ. The lamellated tissue represented the non-deciduous serotina. From the deciduous layer on the surface of the placenta processes of decidua passed into its substance. ROLLESTON obviously inclines to the view that the maternal vessels within the placenta formed a sinus system as in the human placenta. The fœtal villi were arborescent.

Signor ERCOLANI* has examined a placenta of *Cercopithecus sabæus* which had been preserved in alcohol. As he could not find any essential difference between its structure and that of the human placenta, he did not think it necessary to describe it, but states that the intra-placental lacunæ for the maternal blood are smaller than in the human placenta, and that manifest traces of decidua serotina are present on the uterine face of the organ, which are continued on to the fœtal villi, for which they form an external membrane.

KONDRATOWICZ has recently described† the uterus of a species of *Macacus*, in the last stage of pregnancy, preserved in the Museum at Warsaw. As it was not practicable to inject the placenta he gives no account of its structure, but he relates some facts bearing on the structure of the decidua vera. He states that the uterine mucous membrane is thickened, and he recognises on it an epithelium, which is blended with the chorionic epithelium. Subjacent to the uterine epithelium is a finely fibrous connective tissue with spindle cells and opaque yellow clumps of pigment; in the deeper layers the cells increase in number, become multipolar, and assume the character of large epithelial-like decidua cells. These cells, he says, seem to form the immediate boundaries of wide blood-containing spaces or canals. Deeper than these cells and next the muscular coat is a layer of delicate connective tissue, the trabeculæ of which bound large spaces lined by an epithelium formed of short hexagonal cylinders, with large nuclei. He regards these spaces as the expanded deeper ends of the utricular glands, the ducts of which have become obliterated. No gland-like spaces were recognised in the tissue between the placenta and the muscular coat of the uterus.

By the researches of the several investigators above referred to, observations on the form of the placenta in the Apes, on the presence of a decidua, on the absence of the sac of the allantois, on the absence or rudimentary condition of the umbilical vesicle, and on the arrangement of the amnion have gradually been accumulated.

* Sul processo formativo della porzione glandulare o materna della placenta. Mem. dell' Accad. delle Scienze di Bologna, 1870, p. 53.

† His memoir, entitled "Przyczynek do histologii ciężarnej macicy," is in the Pamietnik Towarzystwa Lekarskiego, Warszawa, Zezzyt iii. 1875, p. 259. As this memoir is in Polish, I have been unable to read it in the original, but owe my knowledge of its contents to an abstract by HOYER in HOFMANN and SCHWALBE'S "Jahresberichte," 1876.

To some extent, also, observations have been made on the minute structure of the placenta, so that by the common consent of anatomists the placenta in the Apes is regarded as approximating in many particulars, both of form and structure, to the human placenta. As the recorded observations have for the most part been made on specimens preserved often for many years in spirit of wine, many questions connected with the minute structure of the organ have either been left in doubt or not examined; more especially I may refer to the arrangement of the intra-placental decidua, the presence or absence of the utricular glands in the serotina, the relation of the maternal vascular system to the fœtal villi, and the general disposition of the intra-placental system of maternal blood spaces. As I felt that it was important to inquire into these matters on a fresh specimen, and with the aid of transparent injections and other modern histological appliances, I requested, some time ago, my friend Dr. JAMES MURIE to obtain for me, if possible, a monkey well advanced in pregnancy. This he very kindly succeeded in doing in the year 1876, and I have been able with the aid of this specimen not only to confirm many of the observations of my predecessors in this branch of investigation, but to ascertain a number of new facts in the structure of the monkey's placenta.

Gravid Uterus of Macacus cynomolgus.

The monkey obtained for me by Dr. MURIE was an adult *Macacus cynomolgus*, well advanced in pregnancy. After having been completely anæsthetized with chloroform it was killed by dividing the carotids and jugulars. As soon as respiration had ceased the abdominal cavity was opened into by a crucial incision, when the uterus was seen to occupy a large part of the abdominal cavity. It was broadly ovoid in shape, and ascended from the pelvis to within $2\frac{3}{4}$ inches from the xiphi-sternum. No portion of the small intestine was visible. The transverse colon appeared at the left side of the fundus uteri, and the cœcum projected immediately above the fundus. Both the cœcum and colon were covered by the great omentum, which contained bright yellow lobules of fat. Above the cœcum the pyloric end of the stomach occupied the epigastrium. No other abdominal viscus was visible until the uterus was pushed to one side.

The uterus was of a delicate bluish-grey colour mingled with pink. Slight changes in the contour of its anterior wall took place during about half an hour after the abdominal cavity was opened. Bulgings arose here and there which slowly subsided, to be succeeded by similar bulgings in adjacent parts of the wall. These movements were obviously due to slight movements of the fœtus within the uterine cavity.

From the sides of the uterus the broad ligaments passed to the postero-lateral walls of the abdomen. Large ovarian veins distended with fluid blood lay between their folds, and ramified on the wall of the uterus beneath the serous membrane. From the lower part of each antero-lateral aspect of the uterus a distinct ligamentum teres

passed downwards and forwards to the inguinal region. The Fallopian tube arose from the fundus in line with, but $1\frac{1}{4}$ inch above, the uterine attachment of the round ligament. The ovaries were attached by their ligaments to the fundus, posterior to the uterine ends of the Fallopian tubes. The right ovary was purplish coloured, and contained a corpus luteum; the left ovary was cream coloured, and with numerous semi-transparent specks on its surface. No appearance of an organ of ROSENMÜLLER was to be seen in either of the broad ligaments. The uterus diminished in size as it entered the pelvis and blended with the wall of the vagina. The body of the uterus was 5 inches long, the cervix uteri was $\frac{3}{4}$ inch, and the vagina $2\frac{1}{4}$ inches.

As one of the objects I had in view in the investigation of the structure of the placenta was to determine the relations of the fœtal and maternal vessels, I decided upon injecting both systems of vessels. With the object of doing this with as little disturbance of the parts as possible, without removing the uterus, I introduced a pipe into the abdominal aorta, and tied off the external iliac arteries so as to stop the flow of the injection into the lower limbs. I then made a mesial longitudinal incision through the anterior wall of the vagina, cervix uteri, and lower part of the body of the uterus. A colourless viscid mucous plug, which occupied the cervix, was removed, and the chorion opposite the os uteri internum was exposed. The depending part of the fœtal membranes was then cut through, when a gush of liquor amnii took place and the hairy breach of the fœtus was exposed. The finger being introduced into the uterine cavity, the umbilical cord was drawn down and injecting pipes introduced into the umbilical vein and one of the umbilical arteries. A simultaneous injection of the uterine and chorionic vessels was then made. My assistant, Mr. A. B. STIRLING, gently passed a red transparent injection through the aorta into the uterine arteries, whilst I threw at the same time a blue transparent injection into the umbilical vessels. It was unnecessary to inject specially the uterine veins, as the large veins in the broad ligaments became filled from the injection which had passed along the uterine arteries. When the injection had become set the incision was prolonged through the uterine wall to the fundus, and the fœtus was exposed.

The fœtus lay in the uterus with its breech in close relation to the os internum, and the head to the fundus; the back was directed to the left side of the body of the uterus, and the belly to the right (fig. 1). The head was bent forward, the chin being in contact with the front of the chest, and the snout resting between the hands. The thighs were flexed on the belly, and the legs on the back of the thighs. The ankles were flexed on the front of the legs, and the toes on the soles of the feet. The upper arms were close to the sides of the chest, the fore-arms slightly bent on the upper arms, the hands in the position of palmar flexion, and the fingers bent on the palms. The tail was curved forwards on the right side of the fœtus, so that its tip was in relation to the top of the head. The fœtus, a male, was covered with hair, and the nails were well developed. The upper and lower eyelids were firmly united together. From the snout to the root of the tail was $8\frac{1}{4}$ inches: the tail measured $7\frac{1}{4}$ inches in

length. The upper limb was 4 inches long, the lower limb 5 inches. The size and state of development of the fœtus confirmed the opinion I had formed during the life of the monkey that she was far advanced in pregnancy.

The umbilical cord was $4\frac{3}{4}$ inches long, and passed from the belly of the fœtus between the back of the left thigh and leg to the more anterior lobe of the placenta. The cord was then cut through and the fœtus removed, when the position and form of the placenta were seen. The placenta was divided into two distinct lobes; the one attached to the anterior, the other to the posterior wall of the uterus. The posterior lobe was almost circular in form; its vertical diameter being $3\frac{1}{2}$ inches, its transverse diameter 3 inches. Its upper border almost reached the summit of the fundus uteri, its lower border was $2\frac{1}{4}$ inches from the os internum. Its fœtal surface was traversed by shallow furrows which indicated a division into six lobelets. The anterior lobe was circular in form, its vertical and transverse diameters being alike 3 inches; the upper border did not approximate so closely to the fundus as that of the anterior lobe; the lower border was 1 inch from the os internum. The division of the anterior lobe into lobelets by superficial furrows was not so distinct as in the posterior lobe. The anterior and posterior lobes were separated from each other by intermediate smooth non-placental parts of the chorion, situated in relation to the lateral aspects of the uterus; the smooth part to the right was 1 inch in transverse diameter at its narrowest, whilst the smooth part to the left had a transverse diameter of 2 inches at its narrowest. The summit of the chorion at the fundus uteri, where it passed between the upper borders of the two placental lobes, was also smooth, and the most depending part of the chorion, in relation to the os internum, was smooth over a considerable area.

The umbilical cord joined the fœtal surface of the anterior placenta two inches from its upper border, and $1\frac{3}{4}$ inch from its left border. The umbilical vessels then branched, some of the branches entered the anterior placenta, but others ran with a tortuous course over its fœtal surface and across the intermediate smooth parts of the chorion, in relation both to the sides of the uterus and its fundus, to reach the posterior placenta. No vessels, however, ramified in the smooth chorion opposite the os internum. The ramifications of the blue injected fœtal vessels were very distinct on the fœtal surface of both placentæ, and the smaller vessels of the placental chorion were extremely tortuous. The substance of the anterior placenta contained a larger proportion of blue injected vessels than did that of the posterior, whilst the posterior placenta had a larger proportion of red injection in it than the anterior. This difference in the relative proportion of the two injections is capable of the following explanation. In injecting the vessels of the cord, the chief pressure was on the anterior placenta, for the cord directly joined it, and its fœtal vessels were therefore more completely filled with the blue fluid. But in injecting the uterine vessels through the aorta, the chief pressure had been on the posterior placenta, and therefore its maternal vascular spaces had been most completely filled with the red-coloured gelatine.

The umbilical cord contained one large vein and two arteries, with a small quantity of the gelatinous tissue of WHARTON, but no trace of an allantois or umbilical vesicle could be seen. The umbilical vein after entering the abdomen ascended as an undivided vessel as far as the under surface of the liver. The pair of umbilical arteries passed as the hypogastric arteries to the posterior wall of the abdomen. Between the hypogastric arteries was a fibrous cord, the obliterated urachus, which extended from the apex of the bladder to the umbilicus. The cord was invested by the amnion and the fœtal surface of both the placental and non-placental parts of the chorion was lined, as in the human female, by this membrane. The surface of the amnion next the amniotic cavity was covered by a continuous layer of polygonal flattened epithelium cells, which were translucent and with faintly granulated protoplasm, but with the nucleus relatively large and distinct. These cells rested on a thin layer of delicate connective tissue.

The uterine ends of the Fallopian tubes opened at the sides of the uterus opposite the non-placental parts of the chorion situated between the two placentæ. The cavity of the uterus communicated with the canal of the cervix at a well-defined os internum, the lip of which formed a projecting ring around the os. The cervical canal was about $\frac{1}{2}$ inch long; its mucous membrane was elevated into folds, some of which were vertical, but others were directed obliquely, so as to form an arrangement somewhat like the arbor vitæ in the human cervix. The os externum was rounded and bounded by a distinct ring-like projecting lip. The vagina was $1\frac{3}{4}$ inch long; its mucosa was partly smooth and partly thrown into sinuous rugæ, some of which, near the os externum, were longitudinal, but the greater number were transverse.

Structure of the wall of the Uterus.

The wall of the uterus possessed an external serous coat as in the human female. The muscular coat was thin, and, relatively to the size of the uterus, much thinner than in the human uterus. In this respect the muscular coat resembled what is usually found in the mammalia where the impediments to parturition are not so great as in the human subject.

The uterine cavity was lined by a well-marked mucous membrane, which formed a layer homologous with the decidua vera, or uterina of the human gravid uterus. In the region near the internal os, the chorion could be raised from the mucous membrane by gentle traction, without doing much injury to the free surface of the mucosa. This surface was not smooth, but presented numerous shallow ridges and furrows, which for the most part ran transversely to the long axis of the uterus. At the internal os, however, the ridges were vertical and were continuous with, though not so prominent as, the longitudinal columns of the mucosa in the canal of the cervix uteri. In the region of the fundus uteri, the adhesion between the non-placental part of the chorion and the surface of the mucous membrane was much more intimate than near the os internum; so that on raising the chorion it was usual to peel off flakes

of the more superficial part of the mucous membrane along with it. If very great care was taken, the chorion could be separated from the mucous surface, which was then seen to present a ridge and furrowed appearance arranged much more irregularly than in the lower third of the uterus. The corresponding surface of the non-placental part of the chorion possessed multitudes of fine ridges which fitted into the furrows of the mucosa so closely as to make it difficult to strip off the chorion without removing a part of the mucous surface along with it. The close co-aptation of the chorion to the mucous membrane, even in the non-placental regions, was well seen in vertical sections through the wall of the uterus and fœtal membranes, in which the chorion followed the windings of the mucous surface and in close contact with its epithelial covering (fig. 2).

The uterine mucosa was covered by an epithelium which varied in character in different parts of the uterus. In the lower third or fourth of the cavity the cells had the characters of columnar epithelium. Their attached ends were either attenuated into a fine process, or truncated or occasionally bifurcated; at their free ends delicate processes, not unlike short cilia, were seen; but as this observation was made some time after death no movement was visible. The nuclei were nearer the attached than the free ends of the cells. A small proportion of these epithelial cells were swollen out, so as to have more the appearance of goblet epithelium. In the region of the fundus, and in the interval between the placental lobes, the epithelium was neither columnar nor ciliated. The cells were polygonal in form, and fitted together like the tiles of a pavement, but they were not such thin scales as one sees in the tessellated epithelium of the mouth. The nucleus was large, rounded or ovoid in form, and contained one or more nucleoli. In their general appearance these cells had a resemblance to the colossal cells of the human decidua.

The sub-epithelial tissue of the mucous membrane contained a considerable proportion of fusiform corpuscles closely crowded together, which were larger than the corpuscles of the sub-epithelial tissue in a specimen of the non-gravid uterus of a *Macacus*, with which they were compared. These corpuscles were not unfrequently elongated at their poles into slender filaments, though at other times the poles were short and stunted. Other cells were not fusiform, but polygonal, or even irregularly stellate. The protoplasm of the cells was dimly granulated, and the nuclei relatively large and elliptical in shape. Occasionally thin flakes of nucleated protoplasm were seen, in which the differentiation into definite cells could not be recognised. The abundance and variety in form of the cells in the sub-epithelial tissue gave one the impression of a texture in which a rapid cell growth had taken place. Bundles of white fibrous connective tissue were sparingly distributed in the sub-epithelial tissue, though a filamentous appearance, due to the filamentous poles of so many of the fusiform cells, was not uncommon. Parallel and next to the deep surface of the sub-epithelial tissue was a band, more or less distinct in different sections, which could sometimes be peeled off in a long stripe. This band contained spindle-shaped cells of

larger size than the fusiform corpuscles of the sub-epithelial tissue, and was, I believe, the layer of muscularis mucosæ (fig 2).

A search was then made for utricular glands in the non-placental part of the mucosa. I did not see the mouths of any glands opening on the free surface of the mucosa; but on tearing off thin portions of the membrane and magnifying them 100 diameters I occasionally saw an appearance of elongated tubes, situated in the deeper part of the membrane. The tubes were tortuous, and contained an epithelium, the cells of which were so granular and opaque that their form could not be definitely determined. The sub-epithelial tissue was very vascular, the capillary network having been injected from the aorta and uterine arteries. At the fundus uteri, where the adhesion between the chorion and mucous membrane was so close, the injected sub-epithelial tissue was often torn through and remained attached to the chorion, when that membrane was raised from its position.

In vertical sections through the mucosa numerous spaces were seen in the sub-epithelial tissue. Most of these were blood vessels divided either transversely, obliquely, or longitudinally, and they were either partially or wholly filled with injection. Other spaces, however, were occasionally present which were not vascular; some of these were elongated slits, others were more irregular in outline. KONDRATOWICZ has described spaces in the decidua vera of his specimen, lined by an epithelium of short columnar cells, which he regards as the deeper ends of the utricular glands. The spaces which I have observed had no epithelial lining, their wall being directly formed of the corpuscles of the sub-epithelial tissue. If these spaces were not gaps in the tissue, formed in the act of making the section, they were probably dilated utricular glands, the epithelium lining which had degenerated and disappeared. The sub-epithelial tissue of the mucosa, though not so compact as in a non-gravid uterus of a *Macacus* to be subsequently described, did not possess the loose, spongy character of the decidua serotina in this animal.

The muscularis mucosæ of the decidua vera was attached to the proper muscular coat of the uterus by a thin and lax layer of delicate submucous connective tissue.

No decidua reflexa could be seen as a distinct layer, for as already stated the chorion was closely adapted to the ridges and furrows of the mucous surface. The flakes of uterine tissue which were adherent to the chorion, when that membrane was stripped off, were the more superficial parts of the decidua vera—sometimes its epithelial layer alone, or at other times both epithelium and sub-epithelial tissue—and not a separate layer of decidua reflexa.

A thick layer of modified mucous membrane intervened between the placental lobes and the adjacent part of the wall of the uterus, and formed a decidua placentalis, homologous with the decidua serotina in the human uterus. The description of the decidua placentalis will be more appropriately considered along with the structure of the placenta.

Structure of the Placenta.

Each lobe of the placenta was half an inch thick at its centre, but was much thinner at the circumference of the disc. On making a section into its substance, it was seen to have a spongy appearance similar to the human placenta. Its fœtal surface was limited by the chorion; its uterine surface by a thick layer of modified uterine mucous membrane homologous with the decidua serotina of the human gravid uterus (fig. 5). The stems of the villi arose at intervals of from $\frac{1}{10}$th to $\frac{2}{10}$ths of an inch from each other. Each stem was, as a rule, so thick that it could be readily followed out with the naked eye or a simple lens, and be traced through the substance of the placenta to be attached to the hillock-like elevations of the decidua to be presently described. The stems were usually oblique in their direction, and it was not uncommon to see one, notwithstanding the branches which arose from it, reaching the decidua without experiencing any material diminution in size. In their course the stems of the villi gave off numerous branches, which divided and subdivided until they ended in the lateral and terminal bud-like offshoots of the villi (fig. 6). These buds varied in shape and size, some being elongated and cylindriform, whilst others were short and stunted, and it was by no means uncommon to find the latter arise in pairs. Branches of the umbilical vessels of considerable size, derived from the vessels in the chorion, were prolonged into the stems of the villi, and from them offshoots proceeded into the branches of the villi. The lateral and terminal buds contained a looped arrangement of capillaries. The loop might be single, or twisted so as to have a double coil, and the capillaries from one bud, more especially when the buds arose in pairs, might pass from one bud into the adjacent one. Sometimes the capillaries formed a network.

The placental chorion consisted of connective tissue distinctly fibrillated, and with fusiform connective tissue corpuscles. In many sections through it I observed rows of cells, arranged parallel to and at no great distance from the surface on which the amnion rested. These *intra-chorionic* cells did not form a continuous layer, but were found in patches (fig. 8). Sometimes they were in a single row, at others in two or more. They were elliptical, ovoid, rounded, or somewhat polygonal in form, with granulated protoplasm, and varied in size from a white blood corpuscle to about twice that size. The cells in each group were closely related to each other. They were quite distinct, both in position and appearance, from the amniotic epithelium. The fibrillated connective tissue was prolonged into the stems of the villi; but in the finer branches, and in the lateral and terminal buds, the tissue became so delicate that a differentiation into fibrillæ could not be recognised. A partially injected network of capillaries, continuous with the smaller tortuous umbilical vessels, was situated in the connective tissue of the chorion in the intervals between the origins of the stems of the villi, and formed an extra-villous capillary plexus.

The surface of the chorion next the interior of the placenta was covered by a strati-

fied arrangement of cells, which from their position may appropriately be called the *sub-chorionic* cells (figs. 7, 8). They formed a yellowish-white membrane, sufficiently thick to be seen with the naked eye and to be peeled off with a pair of forceps, which was continued over the whole surface of the chorion. I examined microscopically these sub-chorionic cells, both in vertical sections through the chorion and in preparations made by cutting away the stems of the villi and looking at the placental surface of the chorion. The layers of cells were not uniform in number, but varied from four or five to eight or ten, or even more. The cells in the most superficial layers were flattened and irregularly polygonal, and two or three times larger than the intra-chorionic cells just described. The cells in the deeper layers were elliptical, or even elongated into small spindles, not unlike in shape, but larger than, the fusiform corpuscles of the connective tissue of the chorion. In the more superficial cells the nucleus was very distinct, and in the whole the protoplasm was granulated. When seen in mass these cells had a yellowish colour, which contrasted with the white connective tissue of the chorion. They differed also very materially in appearance from the amniotic epithelium in relation to the opposite surface of the chorion. In some of the sections through the chorion the line of demarcation between the sub-chorionic cells and the proper tissue of the chorion seemed to be as definite as that between the cuticle and cutis in a section through the skin. But when thin sections were made and examined with a magnifying power of 350 diameters, the proper tissue of the chorion seemed to pass between the cells of the deeper layers, so as to give one the impression that they were derived from the chorion and were not cells superadded upon its free surface, but not arising from it.

The stems of the villi at their origin from the chorion were invested by a stratified arrangement of cells similar to, and continuous with, the sub-chorionic cells; and at the angle between the place of origin of the villus and the adjacent part of the chorion a great crowd of these cells was collected, for as many layers of cells enveloped the base of the villus as were situated on the immediately-adjacent part of the chorion. The layers diminished in number as the villous stem was traced farther away from the chorion. The cellular covering was also prolonged on to the larger branches of the villi, but with a considerable reduction in the number of layers. On the smaller branches of the villi, and on the terminal and lateral buds, the cellular covering of the villi was reduced to a single layer of somewhat flattened, though not squamous, cells, rectangular in outline and closely applied to each other by their margins.

The decidua placentalis or serotina formed a thick well-defined layer between each lobe of the placenta and the corresponding part of the muscular coat of the uterus. Opposite the intervals between the lobelets into which each lobe was divided, the modified mucous membrane was thicker than opposite the lobelets, and approached more closely to the chorion; and the villi which grew from the chorion, corresponding to these intervals, were much shorter than those entering into the substance of the lobelets. At the margin of the placental lobes the decidua serotina was directly

continuous with the decidua vera, and the spongy character of the serotina was prolonged into the vera immediately continuous with it.

When the placenta was carefully stripped off the uterus, the decidua placentalis split into two portions, the one adhered to the uterine surface of the placenta, the other remained on the uterus, and the latter was considerably thicker than the former. The separation into the two layers was effected by tearing through delicate bands and flakes of the decidual tissue, which were continuous with the septa between the loculi to be immediately described, in the uterine layer of the decidua serotina.

The layer of decidua which remained attached to the uterine surface of the placenta was thin, and of a fawn colour. Its placental surface was very irregular owing to numbers of hillock-like prolongations of its substance, which projected into the interior of the placenta in a manner not unlike that in which stalagmites project from the floor of a cavern (fig. 10). These hillocks were usually somewhat conical in form, and were set so closely together that narrow intervals only intervened between the bases of adjacent hillocks. The arrangement of the hillocks was examined both in vertical sections through the placental decidua and in preparations made by detaching the villi from the decidua and examining its placental surface. In both these modes of preparation the terminal parts of the stems of the villi were seen to be intimately attached to the hillocks of decidua; so close, indeed, was the union that some force had to be used to draw them asunder, and in the act of separation it was usual for either a portion of the decidua to be drawn away with the villus, or for a fragment of the villus to remain attached to the decidua. To carry out the comparison which I have already made, if the hillocks of decidua resemble stalagmites projecting from the floor of a cavern, the villi of the chorion are like stalactites depending from its roof, and the attachment of the villi to the decidua is due to the mutual growth and fusion of the two structures.

When examined microscopically this layer of the decidua placentalis was seen to be chiefly composed of irregularly polygonal, somewhat flattened cells, composed of a large and distinct nucleus surrounded by a granulated protoplasm. These cells had a stratified arrangement and a yellow colour when seen in mass. They closely resembled, both in appearance and arrangement, the superficial layers of sub-chorionic cells. Although, as a rule, the cells were compactly arranged in the several strata, they at times, in the deeper strata, were surrounded by a delicate, translucent, faintly fibrillated matrix, apparently an imperfectly differentiated connective tissue. Groups of fusiform cells were also occasionally seen.

The hillocks of the decidua possessed a very similar structure. The greater part of their thickness was composed of a stratified arrangement of the irregularly polygonal, somewhat flattened, granulated and nucleated cells; but the axis of the hillock was not so richly cellular, but consisted mainly of delicately filamentous connective tissue containing fusiform corpuscles. The end of a villus attached to a hillock was completely surrounded by the stratified cells of the decidua, so that the villus was

imbedded for some distance in the hillock, and at times even extended close up to its base of origin (fig. 11). The extent to which the villus penetrated into the substance of the hillock was recognised, not only by its structural difference from the decidua, but by the passage of the branches of the umbilical vessels, filled with a blue injection and surrounded by the proper tissue of the villus, for a greater or less distance down the axis of the hillock. As the villus emerged from the apex of a hillock the strata of decidua cells which invested it diminished both in number and thickness, so that at a short distance from the hillock the cellular covering of the villus was reduced to the single layer of cells investing the placental villi.

Slender bands and thin membrane-like flakes were occasionally to be seen passing between and connecting together the free ends of the bud-like offshoots of the villi. These bands and flakes were continuous with the cellular investment of the villi. Sometimes a slender band, terminating in a pointed end, extended for a short distance from a bud, and apparently had been a connecting band which had been torn in two. These bands and flakes were most probably derived from the decidua.

The thick layer of the decidua serotina which remained attached to the wall of the uterus on stripping off the placenta presented a peculiar and very characteristic spongy or honey-combed appearance, owing to the numerous areolæ or loculi which it contained (fig. 5). The cavities of these loculi varied in size, some being so small as only to be capable of containing a small shot, whilst others could hold a common pea. The loculi were imperfectly separated from each other by thin semi-translucent septa, and the cavities of adjacent loculi freely communicated through gaps in the septa, bounded by a well defined and often falciform edge. The free surfaces of the septa were quite smooth.

When examined microscopically the walls of the loculi were seen to consist of a layer of cells on the free surface, and of a subjacent vascular connective tissue. The cells on the free surface had an epithelial-like arrangement, but they varied materially both in shape and size. The largest of the cells were as big as, or even larger than, the more superficial cells of the tessellated epithelial lining of the mouth, whilst others were not more than one-third or one-fourth that size (fig. 9). They were fitted together by their edges so as to form a continuous pavement. They had not, however, the irregular polygonal form of an ordinary squamous epithelium. The larger cells were often rounded along a part of the edge and indented, or with short processes at other parts; their protoplasm was very pellucid or faintly granulated, and the nuclei were of large size, often rounded in form, and so granulated that the nucleolus was usually obscured. Many of the smaller cells were flask-shaped or fusiform, with pellucid protoplasm and granulated elongated nuclei. At and near the falciform openings in the septa the cells were very much smaller than on the plane surface of a septum; in many cases they were not so large as the nuclei of the larger cells. Their shape was polygonal, their nuclei rounded or egg-shaped, and in many cases the nucleus was enveloped by only a thin layer of protoplasm. These

surface cells separated very readily from the subjacent tissue, which could be then examined. It was found to consist largely of elongated fusiform nucleated corpuscles, such as one is familiar with in the embryonic connective tissue, for they were bigger than the similar shaped corpuscles seen in the connective tissue of the adult; both in form and size they resembled the elongated cells of a spindle-celled sarcoma. Intermingled with the fusiform cells were spherical corpuscles like those of lymph, together with a small proportion of oval and elliptical corpuscles somewhat larger than those of spherical form. Occasionally thin flakes of protoplasm in which nuclei were imbedded, but where a differentiation into distinct cells had not taken place, were observed.

Blood vessels ramified in the septa between the loculi. They had been filled with the red injection and formed a capillary plexus, which was obviously concerned in the nutrition of the decidual tissue; many of these capillaries were of greater calibre than one usually finds in capillary networks.

But in addition to the vessels connected with the nutrition of the decidua, the serotina was traversed by veins and arteries passing to the placenta. The utero-placental veins passed obliquely through the uterine layer of the decidua serotina, and when they reached the placental layer they ran almost parallel to its outer surface, which was grooved for their lodgment. They could sometimes be followed in close contact with the placental layer for half an inch, or even a greater distance, and they were seen to branch two or more times. They were cylindriform vessels, smaller in size than the digital veins of the human hand; they possessed definite coats, which with a little care could be separated from the surrounding decidual tissue. When these vessels were carefully cut open, their smooth lining membrane was recognised, and they were seen to communicate with the interior of the placenta. The aperture of communication was crescentic in form, and was directed obliquely, so as to act like an imperfect valve. In the posterior lobe of the placenta, where the maternal system of vessels was more fully injected, the utero-placental veins were filled with the red injection, and when the placenta was gently squeezed, after a vein had been opened, the injection could be made to ooze out of the interior of the placenta through the crescentic opening into the vein.

The wall of the uterus did not contain a tortuous arrangement of the branches of the uterine arteries so characteristic of these vessels in the human gravid uterus, neither were curling arteries to be seen in the decidua serotina. This layer was, however, traversed by slender arteries, so fine indeed that it was difficult to isolate them from the surrounding decidua. They could be traced up to the placental layer of the decidua serotina when they tore through abruptly, so that their exact mode of entering the placenta could not be ascertained; but it seemed as if the supply of arterial blood to the maternal placenta was obtained through numbers of fine arteries which pierced the placental layer of the decidua at various points, and quite independently of each other.* The red injection of the maternal vessels had freely passed

* A more explicit description of the utero-placental arteries is given in the Appendix to this Memoir, pages 561, 562.

into the more posterior placental lobe, and had insinuated itself between the fœtal villi, where it formed a continuous network extending from the placental layer of the decidua to the stratified arrangement of sub-chorionic cells covering the placental surface of the chorion. This network of red injection was not contained in cylindriform tubes, so that it had no definite pattern, but exhibited an irregular anastomosing arrangement. In those parts of the lobe where the injection was most perfect, the stems, branches, lateral and terminal bud-like offshoots of the villi were seen to be surrounded by the red injection which was separated from the blue injection, occupying the umbilical vessels of the villi, by the cellular investment of the villi and by the more peripheral part of their delicate connective tissue. The spaces occupied by this network of red injection are, I believe, those through which the maternal blood flows in the living placenta. That they are not artificial channels produced in the act of injection is I consider established by their free communication with the utero-placental veins, and from the fact that they were filled with but a slight pressure on the piston of the injecting syringe. These spaces were not of uniform diameter; as a rule they were not equal to the transverse diameter of the villi, but sometimes they were of equal width, and occasionally even were wider than the villi. The width of the channels through which the injection, or the maternal blood, flowed would undoubtedly, within certain limits, vary with the pressure on the blood or injection contained in the maternal vessels. I could not satisfy myself that the spaces containing the red injection were enclosed by a definite membrane, continuous with the wall of the uterine arteries or veins, and separating the injection from the cellular investment of the villi. All that I saw was in favour of the view that the injection, and consequently the maternal blood in the living animal, was in direct contact with the cellular investment of the villi, the sub-chorionic cellular covering of the placental surface of the chorion, and the cellular surface of the placental layer of the decidua serotina. It is not unlikely, however, that at the relatively large crescentic openings of communication between the utero-placental veins and the spaces in the interior of the placenta, the lining membrane of the vein is prolonged for some distance along the placental surface of the placental layer of the decidua.

Comparison of the Placenta of the Ape with that of the Human Female.

In the course of my description of the gravid uterus and placenta of *Macacus cynomolgus* I have incidentally referred to some points of correspondence with, or difference from, the human gravid uterus and placenta, but it may not be uninteresting to make a more detailed comparison of the one with the other. More especially is it advisable to compare the minute structure of the organs, for up to this time satisfactory material for doing so has not been in the possession of anatomists. In the course of this comparison I shall refer to a number of original observations on the human gravid uterus and placenta, many of which, though incorporated in one of my

lectures on the Comparative Anatomy of the Placenta, delivered at the Royal College of Surgeons of England in June, 1876, have not otherwise been published.

Both in the *Macacus* and the human female the uterus is single and ovoid in form in its gravid condition. The gravid uteri of *Hapale jacchus* and *Cercopithecus sabæus* figured by RUDOLPHI and BRESCHET possessed a similar form, so that there can be little doubt that the pregnant uterus has this shape throughout the Quadrumana. In the Lemurs, on the other hand, the uterus is divided into two cornua, and though in the later stages of gestation the non-fecundated cornu becomes so compressed as to be scarcely visible on external examination, yet, as I have shown in a previous memoir,* when the uterus is opened it can be distinctly seen.

In the gravid uterus of the *Macacus*, when the abdominal cavity was opened, and the organ examined without disturbing its position, not only the round ligaments and Fallopian tubes were seen at the lateral borders of the anterior surface of the uterus, but the ovaries were also distinctly visible. In the human gravid uterus, again, these structures are situated more at the sides of the organ, so that to obtain a complete view of them the uterus must be drawn either forwards or to one side. From this difference in their relative position it would seem as if in the human female the growth and expansion during pregnancy of the anterior wall of the uterus was greater than in the Ape, so as to throw these structures more towards the sides of the organ.

In the *Macacus* the breech and not the head was the part of the fœtus which presented at the os uteri, and in JOHN HUNTER'S case also it is stated† that the young one was born with the hind parts first. Neither RUDOLPHI nor BRESCHET, though they describe the characters of the fœtus found in several gravid uteri which they examined, state the nature of the presentation. Observations have been therefore too scanty to enable one to say if the breech is the part which normally presents in the Apes, or if its presentation was exceptional in JOHN HUNTER'S and in my specimen.

The arrangement of the fœtal membranes in *Macacus* closely resembles that of the human placenta.

The division of the placenta into two distinct and separate lobes is in accordance with what has been seen by other observers to be the rule in the tailed Apes of the old world. In the tailless *Hylobates*, also, M. BRESCHET has figured a two-lobed placenta, but in the Anthropoid Chimpanzee the placenta is single. In the human placenta, as is well known, the placenta is also single, but cases have occasionally been seen in which the organ has been divided into two separate lobes. Professor HYRTL not only figures‡ two human placentæ where in each the division into two lobes is

* "On the Placentation of the Lemurs," Phil. Trans., 1876.

† Works, edited by PALMER, vol. iv., p. 72.

‡ 'Die Blutgefässe der Menschlichen Nachgeburt.' (Wien, 1870.) HYRTL also figures a human placenta almost completely divided into three lobes, and refers to cases where the division into a still greater number of lobes has been seen.

almost complete, but a specimen where they are completely separated. The umbilical vessels are directed to the edge of one of the lobes, but just before reaching it they give off branches which pass to the other lobe. HECKER * and J. MATTHEWS DUNCAN † have also referred to cases of bilobed human placentæ. In my specimen of *Macacus*, in the one figured by JOHN HUNTER, and in several of the placentæ figured by BRESCHET, the division into lobelets by furrows on the surface of the organ was also distinct.

The mucous lining of the non-placental part of the uterine cavity of *Macacus* obviously corresponded generally with the decidua vera of the human gravid uterus; but it differed from it in several points of structural detail. From the intimate adhesion which subsisted between the chorion and mucosa in the *Macacus* it was not easy to make a complete separation between the two surfaces, but when this was effected, the fine ridges and furrows described in a previous section of this memoir (p. 530) were observed.

In the human uterus the chorion and the free surface of the decidua are not so intimately adherent to each other as in the *Macacus*, although, as has been pointed out by various observers, at least in the later months of pregnancy adhesions do occur. I have seen in a human uterus at the fifth month the free surface of the decidua vera finely corrugated into numerous delicate convoluted folds, whilst thread-like prolongations of the chorion, apparently atrophied villi, were adherent to this surface. In another specimen, at the seventh month the outer surface of the chorion was closely adherent to the decidua lining the uterine cavity. When the chorion was stripped off, a well marked layer of decidua, the decidua reflexa, was attached to it, and a somewhat thicker layer remained on the uterine wall. To separate these from each other, flakes and threads of decidual tissue had to be torn through; but as the separation was not made precisely in the same plane throughout, it was clear that the decidua vera and reflexa had become blended together. After the separation had been made, the free surface of the vera was seen to be furrowed, and to these furrows ridges of the chorion were closely adapted. In a human uterus in the ninth month, whilst the chorion, with the decidua reflexa, was generally adherent over the whole extent of its outer surface to the vera, a smaller amount of traction was sufficient to draw them asunder. When the chorion and reflexa were removed, the surface of the vera was smooth and not corrugated.

Observations are wanting on the appearance of the decidua vera in the early stages of gestation in the monkey, but in the human female as early as the twelfth or thirteenth days of gestation REICHERT'S observations have shown ‡ that the free surface of this decidua was divided by furrows into "islands" which had an irregular

* 'Klinik der Geburtskunde.' Band II.

† 'Mechanism of Natural and Morbid Parturition,' Note, p. 313. Edinburgh, 1875.

‡ 'Beschreibung über frühzeitigen Menschlichen Frucht. Abhand. der König. Akad. der Wissenschaft.' Berlin, 1873.

polyhedral form. The free surface of these island-like areas was not quite smooth, but subdivided by minute furrows. The surface of the decidua was perforated by numerous apertures, much more distinctly seen in and near the furrows between the different islands than on the summit of the islands; these openings were the mouths of the utricular glands. In the beautiful drawings of the human gravid uterus from the twentieth to the twenty-fifth day, published by M. COSTE,* the division of the free surface of the decidua vera into islands is well displayed, as well as the orifices of the numerous utricular glands. In two human gravid uteri, at from the third to the fifth week, which I examined in June, 1876, similar appearances were seen. But I have also observed these characters in more advanced specimens. In a uterus at the fourth month the "islands" were very distinct, as well as the corrugated appearance of their surfaces. Numerous gland-mouths opened into and near the furrows between the islands. Along the fundus and sides of the uterine cavity the mouths of the glands were much more closely set in a given area than on the anterior and posterior surfaces, the orifices were transversely elongated, and the gland-tubes were short. In the specimen at the fifth month, already referred to (p. 539), the orifices of the glands were distinct, and also varied in number in different parts of the mucous surface; the division of the surface into island-like areas was no longer recognisable. In the uterus at the seventh month the islands had disappeared, but rounded orifices leading into shallow tubular depressions were scattered in varying numbers over different parts of the surface of the mucosa. In the specimen at the ninth month, the free surface of the decidua showed neither islands nor furrows, but numerous shallow pits opened on its free surface. The obliteration of the island-like areas and the intermediate furrows in the later months of pregnancy in the human uterus is doubtless due to the great distention of the organ, and the same cause has also converted the ducts of the tubular glands into the shallow pits I have just referred to.

In my *Macacus cynomolgus* at the stage of pregnancy at which the uterus was examined, no island-like areas or mouths of utricular glands were to be seen on the surface of the mucosa.

Few observations have as yet been recorded on the glands in the non-gravid uteri of the Apes. In 1873 I described† these structures in the uterus of *Ateles gricescens*, and in my lectures on the 'Comparative Anatomy of the Placenta'‡ I made some general observations on the utricular glands in some other genera of Apes, but did not give a detailed description of them, an omission which I now supply.

I have specially examined the non-gravid uteri of *Macacus rufescens*, *Semnopithecus entellus*, and young specimens of a *Hylobates agilis*, and a Chimpanzee, in order to determine the characters of the mucous membrane in the unimpregnated uterus, and the mode of arrangement of the utricular glands. In all these specimens the mucous

* 'Histoire du Développement des Corps Organisés.' 1847.

† On the "Placentation of the Sloths," Trans. Roy. Soc. Edinburgh, vol. xxvii.

‡ First series, p. 28. Edinburgh, 1876.

membrane formed a definite layer lining the uterine cavity. By its deep surface it was closely united to the subjacent muscular tissue. Its free surface was covered by a single layer of columnar epithelial cells; these cells were much shorter than the columnar cells covering the surface of the intestinal or respiratory mucous membrane; their nuclei were relatively large, and the cells themselves were not unlike in appearance the germ-epithelium corpuscles one sees on the surface of a young ovary. I am unable to say if the cells were ciliated at their free ends, as the uteri had been preserved in spirit for some time before they came into my possession;* but there can be little doubt that in the Apes, as in the uteri of other mammals, the cellular covering of the mucosa is a ciliated epithelium.

The sub-epithelial connective tissue of the mucosa was vascular, and contained a great abundance of corpuscles. Although the corpuscles were diffused throughout the whole thickness of the tissue, yet they were in some places relatively more numerous than in others. In *Macacus*, for example, they were more closely crowded immediately subjacent to the epithelium than in the deeper parts of the mucosa, and, in many of the sections through the mucosa of this and the other specimens, rows of corpuscles lay almost vertical to the free surface, as if following the course of the larger blood vessels. In the *Macacus*, *Hylobates*, and Chimpanzee, the mucous membrane was thrown into broad folds separated by shallow furrows, but in *Semnopithecus* the free surface of the mucosa was almost plane.

The glands were not uniform either in arrangement or relative numbers in these genera of Apes. In the young Chimpanzee they seemed to be absent in the substance of the broad folds of the mucosa, but to be situated at the sides and bottom of the furrows which separated these folds from each other. In these localities vertical sections through the mucous membrane exhibited transverse and oblique sections through tubular glands, but it was only seldom that the gland tube could be followed to its opening on the surface. As the divided gland tubes were always seen to be collected together in clusters, it is probable that the tube was tortuous and perhaps branched, so that a vertical section passed through various parts of its length. The deeper parts of the glands lay in close proximity to the muscular coat and distinct fasciculi, apparently continuous with the muscular bundles, passed between them. In the young *Hylobates* the glands were more numerous, and more equally distributed throughout the mucosa than in the Chimpanzee. In vertical sections through the membrane they were often divided both obliquely and transversely, so that their course was oblique to the surface and probably tortuous, and it was only seldom that the opening of a gland on the surface could be seen. In *Macacus rufescens* tubular glands were arranged as in the Chimpanzee in the neighbourhood of the furrows which separated the longitudinal folds of the mucosa from each other. A tubular appearance was also seen in the folds themselves; but from the absence of an

* These uteri were obtained from animals that had died in the Zoological Gardens, and were kindly given to me by Professor A. H. Garrod.

epithelial lining (which may perhaps have been shed) I could not say definitely that these were gland tubes.

In *Semnopithecus* the glands were very distinct and uniformly distributed throughout the mucosa. For some distance from the surface the tubes passed almost vertically into the substance of the mucosa, so that they were divided longitudinally in the sections. The gland tube was constricted into a comparatively narrow neck near its mouth, below which it dilated and assumed a flask-shaped form. In the deeper parts of the mucosa the glands were more tortuous and branched, and the sections through the tubes were oblique and transverse.

In all the specimens the glands were lined by a columnar epithelium, resembling in its characters the epithelium covering the free surface of the mucosa. The cells did not occupy the whole transverse diameter of the tube, but left a central lumen. I am unable to say if these cells were ciliated, as has been observed by ALLEN THOMSON * and LEYDIG † in the epithelial lining of the uterine glands in the pig, and by LOTT ‡ in the cow, sheep, rabbit, mouse, and bat.

In the non-gravid human uterus the utricular glands are elongated and even slightly tortuous tubes, which extend from the free surface of the mucosa in an oblique direction throughout its substance, and reach by their closed ends the muscularis mucosæ. They branch occasionally in their course, and sometimes two neighbouring glands join to form a short duct, which opens by a single aperture on the free surface of the mucosa. They are lined by a columnar § epithelium, which FRIEDLÄNDER and JOHN WILLIAMS || have observed to be ciliated, and which resembles the epithelium covering the free surface of the mucosa itself.

That great changes take place in the mucous membrane of the human uterus during pregnancy is well known to anatomists. Not only is the surface epithelium, but the subjacent tissue and the utricular glands are modified in an important manner. The changes in the glands and inter-glandular tissue were studied many years ago by E. H. WEBER,¶ Dr. SHARPEY,** and the late Professor GOODSIR,†† more especially in the early stages of gestation. Of late years renewed attention has been given to the condition of the glands, particularly in the later stages of gestation, and important observations have been recorded by FRIEDLÄNDER,‡‡ KÖLLIKER,§§ KUNDRAT and ENGELMANN,||| LANGHANS¶¶ and LEOPOLD.***

* QUAIN'S 'Anatomy,' 8th edition, vol. ii., p. 466.

† MÜLLER'S 'Archiv,' 1852, p. 375. ‡ STRICKER'S 'Handbuch:' Article, "Uterus."

§ 'Physiologisch-Anatomische Untersuchungen über den Uterus,' Leipzig, 1870.

|| "The Structure of the Mucous Membrane of the Uterus," Obstetrical Journal, 1875.

¶ WEBER'S edition of HILDEBRANDT'S 'Anatomie,' vol. iv.

** BALY'S translation of MÜLLER'S 'Physiology.'

†† 'Anatomical and Pathological Observations,' Edinburgh, 1845, and 'Anatomical Memoirs,' 1868.

‡‡ *Op. cit.* §§ 'Entwicklungsgeschichte,' 1st edition, 1861; 2nd edition, 1876.

||| STRICKER'S 'Med. Jahrb.,' 1873. ¶¶ 'Archiv. für Anat. und Phys.,' 1877, p. 188.

*** "Studien über die Uterus-schleimhaut," 'Archiv. für Gynäkologie,' 1877.

The decidua vera in the human uterus is thicker than the mucous membrane of the unimpregnated uterus, and this thickening is always considerably greater in the earlier than in the later months of pregnancy. The superficial part of the membrane is comparatively compact, whilst the deeper part possesses a looser and more spongy character. The ciliated columnar cells, which form the epithelial covering of the free surface of the non-gravid membrane, disappear. The glands become expanded, and though they retain for a time their elongated tubular form, yet in the later months of pregnancy, in correlation with the growth of the ovum and the expansion of the uterine wall, they are so altered that the evidence of their presence is so much obscured that they are recognised with difficulty.

The human gravid uterus at the fifth month, with its contained placenta, closely approximates in size to the gravid uterus of the *Macacus cynomolgus*, which forms the special subject of this Memoir; and it may not be without interest to compare the structure of the human decidua vera at this stage of gestation with that of the *Macacus*. The human decidua vera consisted of a superficial compact and of a deeper spongy layer (figs. 3, 4). The compact layer was composed of a laminated arrangement of irregularly polygonal and somewhat flattened cells with distinct nuclei. The cells were closely crowded together, and the protoplasm in many was elongated into angular processes. It is not unlikely that the stratified cells of this compact layer were derived from and represented in the vera, the epithelium of the non-gravid mucosa, though they widely differed from the ciliated and columnar cells of the unimpregnated uterus. In this respect the epithelial covering of the vera in the human uterus differs in a material manner from what I have described in the gravid *Macacus*, in which animal it retains in the lower part of the uterus its columnar and ciliated character, though in the region of the fundus it forms a single layer of polygonal cells arranged in a pavement-like manner.

In vertical sections through this layer in the human decidua short tubes were traced from the orifices opening on its surface; they passed almost vertically through its thickness, but I did not see them communicate with the spaces of the subjacent spongy layer (fig. 3). In horizontal sections through the compact layer the tubes were transversely divided, and they were seen to be circular or elliptical in form. Occasionally two tubes were close together, but more usually they were separated from each other by considerable intervals occupied by the proper cellular constituents of the compact layer. These tubes had no special epithelial lining, but their walls were formed by the cells of the compact layer. Notwithstanding the absence of an epithelial lining, I have no doubt that these tubes were the ducts of the utricular glands which had become much more dilated than in the non-gravid condition.

Subjacent to the compact layer was the spongy layer of the mucosa, the more superficial part of which had the appearance of an imperfectly differentiated connective tissue, in which were numbers of elongated fusiform corpuscles, swollen out somewhat at the body of the cell, where a large elongated nucleus was situated.

These corpuscles were arranged very definitely in rows, with their long axes parallel to the surface of the decidua; sometimes the rows of cells were close together, but at other times not only the different rows, but the cells in the same row were separated by an imperfectly differentiated connective tissue. These cells were not aggregated into bundles, but the outline of each cell was distinct. In their form and appearance they bore a close resemblance to the fusiform corpuscles of involuntary muscular tissue (fig. 4).

The spongy tissue was several times thicker than the compact layer, and owed its loose or spongy character to the numerous spaces in it. Some of these spaces were undoubtedly sections through blood vessels, for they contained a red injection which had been thrown into the vessels from the uterine arteries. Others again, and these the most numerous, were seen on section to be, in some instances, elongated spaces, in others spaces varying in shape and size, which were arranged in several tiers, irregularly superimposed over each other, and were evidently non-vascular. These spaces were separated from each other by trabeculæ, which were sometimes broad bands of tissue, but at other times slender bars. Fusiform corpuscles, similar to those immediately subjacent to the compact layer of the mucosa, entered into the formation of most of the trabeculæ, and in some instances constituted their chief constituent, but at other times irregularly polygonal, and somewhat flattened cells with rounded nuclei were the predominant structures in the trabeculæ. I saw no appearance of an epithelial lining to these spaces.

We may now inquire into the nature of the non-vascular spaces in the spongy tissue. They were obviously natural spaces in the mucosa, and not produced in the act of making the section.

Friedländer, Kölliker, and the other observers above referred to, regard the decidua vera as retaining its glands throughout the whole period of gestation in the human uterus, which by becoming greatly widened and convoluted give rise to the spongy character of the vera I have just described. The epithelium, they say, also degenerates and disappears from many parts of the widened glands, the disappearance taking place in those parts of the glands which lie nearest the surface, but in the deeper spaces of the spongy layer patches of columnar or cubical cells have been seen by Kölliker and Leopold up to the end of pregnancy. I was not so fortunate as to see an epithelial lining, either complete or partial to the gland spaces, in my specimen at the fifth month, or in uteri at later stages of gestation; and there can, I think, be little doubt, though we may regard the spaces as produced by the great dilatation of tubular glands, yet that the degeneration and loss of their epithelial contents must have impaired if not destroyed, at least in the later stages of gestation, their function as secreting organs.

In the decidua vera of the *Macacus* the glands had also become modified from the non-gravid condition. If the spaces referred to in the descriptive part of this memoir (p. 531) were glands, then their epithelium had disappeared, and the tortuous tubes

with an opaque epithelium, also referred to, were so sparing in number that they were very seldom seen. As the uterine glands in the non-gravid *Semnopithecus* are much more numerous and more distinct than in the non-gravid *Macacus*, it is possible that in the former animal they may during gestation undergo a smaller amount of change both in form and structure. The spongy character of the decidua vera in the human uterus was much more pronounced than in the uterus of *Macacus cynomolgus*. I am unable to say if the decidua vera is shed in parturition in the *Macacus* or remains on the surface of the muscular coat.

In the absence of any information of the early stages of gestation in the Apes, it is not possible to say with certainty that the impregnated ovum is in the early weeks of pregnancy shut off from the general cavity of the uterus, and confined in a special ovigerous chamber by the development of a periovular decidua, the decidua reflexa, like that of the human female. M. BRESCHET, in his figures of the placenta and membranes within the gravid uterus of the two specimens of *Cercopithecus sabæus* which he described, has represented the decidua as divided in some places into two layers, as if one were the vera and the other the reflexa. Professor OWEN, in his description of the shed placenta of *Macacus rhesus*, states* that portions of the deciduous membrane remain attached to the outer surface of the placenta and chorion. Dr. ROLLESTON† was unable to say, from the condition of his specimen, if the decidua reflexa was as complete as BRESCHET had described and figured.

From the observations of these anatomists it would seem that, in their judgment, the Apes possess a decidua reflexa, although the demonstration of its arrangement does not appear to have been very complete in any of the specimens. Still, from the general similarity, both in form and structure, of the placenta in the Ape and the human female, there is every probability that a reflexa grows around the young ovum of the Ape, as it does in the human uterus. My dissection, however, proves that in the later stages of gestation, the chorion and uterine decidua have become so intimately attached to each other, that the demonstration of the decidua reflexa as a distinct layer is not possible; and during parturition, if the chorion had carried away, on its outer surface, a covering of decidua, it would have been difficult to say if that covering were reflexa or vera. This, however, is no proof that a reflexa did not at one time exist as a definite layer, for, as I have already stated, even in the human uterus, in the later months of pregnancy, the chorion, with its covering of reflexa, becomes closely attached to the corresponding surface of the vera. Moreover, the reflexa cannot, as was at one time supposed, be regarded as an exclusively human structure; for, as I have elsewhere shown,‡ it exists as a definite layer on the surface of the non-placental part of the chorion of the two-toed Sloth, *Cholopus Hoffmanni*.

Both in the human placenta and in that not only of *M. cynomolgus* but of the other monkeys described by previous anatomists, a well-defined and even tolerably thick

* "Catalogue of the Museum of the Royal College of Surgeons," Physiological Series, vol. v., p. 145.

† Trans. Zool. Soc., vol. v., 1863.

‡ Trans. Roy. Soc. Edinburgh, 1873, p. 77.

layer of decidua serotina intervened between the placenta and the muscular coat of the uterus; and in the Apes the serotina was proportionally thicker than in the human female. In both, the serotina can be divided into two strata, the one comparatively thin and immediately related to the placenta, the other considerably thicker and in relation to the muscular coat of the uterus. The thin stratum is, without question, shed along with the placenta during parturition; whilst the thicker stratum, either altogether or in great part, probably remains on the placental area of the uterus. One of the most prominent characters of the thicker stratum in *Macacus cynomolgus* was its loose spongy appearance, due to the numerous areolæ or loculi which it contained; and in the separation of the placenta there can be little doubt that the septa between those loculi which lie next to the thinner and proper placental layer are torn through. M. Breschet has figured,* but not described, in a vertical section through the placenta of *Cercopithecus sabæus*, a series of spaces; but the small scale to which the figure is drawn makes it somewhat difficult to say if these spaces are intended to represent spaces within the placenta, or loculi in the serotina similar to those present in *M. cynomolgus*. Dr. Rolleston, in his account of the placenta of *Macacus nemestrinus*,† described numerous loose lamellæ as intervening between the placenta and the muscular coat of the uterus, the deeper of which had a horizontal direction, whilst those nearer the placenta were vertical. I have little doubt that these lamellæ were the septa between a system of loculi, similar to those I saw in *M. cynomolgus*.

In human uteri at various stages of gestation, the spongy appearance of the stratum of the serotina next the muscular coat of the uterus has been described by several anatomists. Friedländer, Kundrat and Engelmann, Kölliker and Leopold, have all recognised it, and the stratum has been regarded as homologous with the spongy layer of the decidua vera. My attention has also been directed to this matter, and I shall now describe the more important characters that I have observed.

In two human gravid uteri, from the third to the fifth week,‡ the decidua serotina was irregularly sinuous on its free surface, as is so well delineated by M. Coste in his figures of this structure in the early stages of pregnancy. It was nearly two-tenths of an inch in thickness, and when vertical sections were made through it was seen to consist of a more compact superficial, and of a deeper spongy part. The superficial compact portion consisted of two strata. The stratum next the ovigerous chamber had a folded or laminated appearance, but its minute structure was not well defined. It seemed to consist of an indefinite fibrillated material, which did not colour with hæmatoxylin. Scattered through this material, and somewhat more numerous in the more advanced of the two specimens, were a few corpuscles having the size and form

* Memoir already cited, plates 3 and 4, fig. 5.

† Memoir already cited, p. 300.

‡ For the opportunity of examining one of these specimens, from the Museum of St. George's Hospital, I am indebted to Dr. Robert J. Lee; the other, a somewhat more advanced specimen, in the Museum of Guy's Hospital, Drs. Pye-Smith and Hilton Fagge kindly gave me permission to examine.

of blood corpuscles; and in the less advanced specimen some irregularly-shaped cells, three or four times larger than blood corpuscles and with distinct nuclei, were occasionally seen. The obscure anatomical characters of this stratum made it difficult to give an opinion on its nature. From its position on the free surface of the serotina, it might be regarded as the coagulated secretion of the utricular glands, but the presence of blood corpuscles in it is against such a supposition, and would lead one to think that it was coagulated blood. But the paucity of the corpuscles was such as to throw doubts upon this interpretation.

Immediately subjacent to, and in part commingled with, this stratum, was the deeper stratum of the compact layer. It was almost entirely composed of cells, the nuclei of which were brilliantly stained with hæmatoxylin, so that it contrasted in colour with the superficial stratum. A large proportion of the cells were fusiform, and contained elliptical or oval, or at times elongated, nuclei. They were, for the most part, arranged with their long axes perpendicular to the free surface of the serotina. Intermingled with the fusiform cells were rounded and nucleated lymphoid corpuscles, which in some localities were more numerous than in others; also a proportion of irregularly-shaped cells, three or four times larger than white blood corpuscles.

The deeper spongy part of the human serotina was thicker than the compact stratum. It owed its spongy appearance to the numerous areolæ it contained, the larger of which were visible to the naked eye. The areolæ varied in form, being in the vertical sections circular or ovoid, or considerably elongated or triangular, or with a greater number than three sides. Sometimes they were closely crowded together, and separated by slender thread-like bands of decidual tissue, but at other times they were further asunder, and broad bands of the tissue intervened. This tissue was continuous with the deeper stratum of the compact layer of the serotina, and, like it, consisted of variously formed cells; but the fusiform corpuscles, more especially in the more slender septa between the areolæ, were more attenuated than in the compact layer. Throughout the serotina the cells were embedded in an indistinctly fibrillated matrix.

The edge of the cut surface of many of the areolæ directed towards the enclosed space was often quite sharp and distinct, as if bounded by a definite coat, but at other times the outline was ragged and wanting in precision, and thin flakes of cells projected from the wall into the areola. Some of the smaller areolæ having a circular outline were unquestionably divided arteries and veins, for they possessed distinct coats and contained red blood corpuscles. But blood corpuscles were also contained in a number of the spaces possessing an elongated triangular, or even more than three-sided form, so that from the nature of their contents they were clearly also divided and dilated blood vessels. The corpuscles were at times so abundant as quite to fill the areolæ, but at other times they only occupied a portion of the space. These larger areolæ did not possess laminated walls, but the decidual tissue formed their

apparent boundary, though it is possible that they may have had an endothelial lining. They were obviously colossal capillaries dilated into small sinuses. But in many of the areolæ, cells were intermingled with the red blood corpuscles, the nuclei of which were stained with hæmatoxylin like the proper decidual cells. Some of these cells were white blood corpuscles, others of a more irregular shape were larger than white corpuscles, whilst others were spindle-shaped cells. They were so intermingled with the red corpuscles that they did not seem as if they had got accidentally amongst them in the act of making the section, but rather as if they had formed a portion of the contents of the sinus-like capillary, and it may have been developed from the white blood corpuscles. Many areolæ which contained no blood corpuscles resembled in size, form, and general appearance those in which these corpuscles were situated, and without doubt must be regarded as blood sinuses, out of which the corpuscles had dropped in the process of preparing the section for microscopic examination.

But these blood spaces, though the most numerous, were not the only spaces to be seen in the sections; for in the deeper part of the spongy tissue I occasionally saw sections through tubular structures which possessed a more or less perfect lining of columnar epithelium. Sometimes the cells were in position on the wall, but at other times they were loose in the lumen of the tube. There could be no doubt that these tubes were the utricular glands of the placental area; and on the free surface of the serotina some rounded openings were seen, which were in all probability the mouths of the glands.

In the human placenta at the fifth month the decidua serotina consisted of a compact cellular layer next the placenta, and of a deeper and thicker spongy layer. The spongy character of the latter was due to numerous areolæ, which were irregular in form as in the earlier stages just described, but considerably larger. They were separated from each other by bands of decidual tissue, and though it is possible that some of these areolæ were dilated utricular glands, a large number were unquestionably the dilated blood sinuses of the decidua serotina, for they contained a red injection which had been passed into the uterine vessels. In the human placenta in the ninth month the serotina also consisted of a compact cellular and a spongy layer. It is quite certain that almost the whole, if not the whole, of the spaces in the spongy layer at this stage were dilated blood sinuses, for not only did they contain a red injection passed into them from the uterine vessels, but several of those which lay next the placenta had perforations in their walls through which the placental villi projected into the cavity of the sinus, and the sinus communicated with the maternal blood space in the interior of the placenta. I have obtained no satisfactory evidence of the persistence of the utricular glands in the placental area of the human uterus at and near the full time; and in this respect my observations are more in accordance with those of Kölliker than with those of Friedländer, Kundrat and Engelmann, Langhans and Leopold, who have described enlarged but compressed glands containing epithelium as persisting in the placental area up to the separation of the placenta.

Should this be so, they must be very sparing in numbers. My observations on the structure of the spongy layer of the serotina even in the early weeks of pregnancy show that the blood sinuses of the decidua constitute a greatly preponderating proportion of the areolæ of the spongy layer: much more so than LEOPOLD'S observations would lead one to believe. The employment of injections of the uterine vessels in the examination of the decidua in the later months of pregnancy enables one to state with certainty that here also the blood sinuses are the dominating, if not the sole, factors in the constitution of the areolæ.

In *Macacus cynomolgus* the areolæ so abundantly present in the spongy layer of the serotina were obviously not blood sinuses. They did not contain any injection, although the injection had filled not only the vessels in the muscular coat of the uterus, the capillaries, and other vessels of the decidua, but had occupied the maternal blood spaces in the interior of the placenta. In the *Macacus* the veins of the decidua do not expand into elongated sinuses as in the human placenta, but retain the form of cylindrical tubes, and possess definite walls which can be isolated by dissection from the surrounding decidual tissue. The arteries also which penetrate the decidua in their course to the placenta do not in the *Macacus* possess the form of the curling arteries of the human placenta. The areolæ in *Macacus* may probably therefore represent the dilated glands in the placental area of the decidua, although their epithelial lining had lost its glandular character and had assumed for the most part a squamous form.

But the placental part of the decidua was not limited to the layer which lies between the placenta and the muscular coat of the uterus. Both in the human placenta and in that of the Ape, processes of the decidua were prolonged into the interior of the organ. In the human placenta these processes have been referred to, and in some instances imperfectly figured by several observers, as VAN DER KOLK,* ECKER,† PRIESTLEY,‡ and KÖLLIKER.§ In a paper published in 1872 ‖ I described and figured in the human placenta at the full term, bands of the decidua extending from the placental layer of the serotina up to the chorion, and separating the lobes or cotyledons of the placenta from each other. I named these bands the primary or inter-cotyledonary decidual dissepiments. Their junction with the chorion was readily seen near the margin of the placenta, and is represented in the plate appended to my paper; but nearer the middle of the organ the junction could not always be traced. I also observed that these dissepiments could be split into two layers, one remaining attached to each cotyledon, and between these layers a utero-placental vein was not unfrequently situated. Smaller prolongations passing into the

* 'Waarnemingen over het Maaksel van de Menschelijke Placenta,' 1851.

† 'Icones Physiologicæ,' 1852–1859.

‡ 'Lectures on the Gravid Uterus,' 1860.

§ 'Entwicklungsgeschichte,' 1st edition, p. 145, 1861.

‖ 'Journal of Anatomy and Physiology,' vol. vii., p. 133, plate 5.

interior of the cotyledons for a greater or less distance, but not reaching the chorion, were also described as secondary or intra-cotyledonary dissepiments. Since that time I have examined the intra-placental prolongations of the decidua in younger placentæ. In the placenta at the fifth month the arrangement was very instructive. Not only did very definite bands of decidua separate the lobes of the placenta from each other, but numerous intra-cotyledonary or secondary dissepiments passed into each lobe, both from the general surface of the serotina and from the surface of the inter-cotyledonary dissepiments. From these secondary dissepiments numerous still more delicate off-shoots branched off in the intervals between the villi of the chorion, where they formed a network in the interspaces of which the villi were contained. Hence the whole interior of the placenta was traversed by prolongations of the decidua serotina, which formed an intervillous network of trabeculæ. The dissepiments had the characteristic structure of the compact layer of the decidua; but the intervillous off-shoots, though they contained the large decidua cells close to where they arose from the dissepiments, yet were made up in great part of a delicately fibrillated connective tissue in which scattered corpuscles were imbedded.

Kölliker, in the second edition of his 'Entwicklungsgeschichte' (p. 336, 1876), has recently described these inter-cotyledonary dissepiments by the name of septa placentæ, and his observations on these bands of decidua closely correspond with those I had previously made on the mature placenta. The surface of the decidua, which is directed to the interior of the human placenta, is not therefore a plane surface, but presents an irregularly uneven appearance from the numerous intra-cotyledonary dissepiments which project from it.

In the *Macacus nemestrinus* described by Rolleston, processes of maternal tissue were followed into the placenta. In *M. cynomolgus* the placental surface of the decidua serotina was uneven from the numerous hillock-like elevations which in the description of the organ (p. 534) I have compared with stalagmites: these correspond to the intra-cotyledonary dissepiments of the human placenta. In the *Cynomolgus*, however, though the division into cotyledons is marked by furrows on the chorionic surface of the organ, and though there is a special thickening of the decidua opposite the borders of contiguous lobelets, yet the decidua does not send prolongations between the lobelets up to the surface of the chorion, like the inter-cotyledonary dissepiments of the human placenta. Hence the intra-placental maternal blood spaces in *Macacus* form throughout the interior of the organ a more continuous anastomosing cavernous arrangement than in the human placenta.

The presence of the definite arrangement of stratified cells on the placental surface of the chorion of *M. cynomolgus*, which I have named the sub-chorionic cells, is of particular interest in connexion with some observations made during the last six years on the structure of the human placenta. In 1872 Winkler described and figured diagrammatically,* by the name of *Schlussplatte*, a layer extending over the entire

* "Zur Kenntniss der Menschlichen Placenta," 'Archiv für Gynäkologie,' iv., 238.

extent of the placental surface of the human chorion, consisting of homogeneous intercellular substance with cells scattered in it. This layer also, he stated, invested the stems of the villi, but was not prolonged on to their finer branches. From its arrangement he regarded it as bounding the maternal blood spaces on the fœtal side of the placenta, and as formed of maternal tissue. This structure has recently been investigated by KÖLLIKER, who named it "decidua subchorialis."* Though recognising that the placental surface of the chorion presented throughout a peculiar lamellated structure, KÖLLIKER was unable to trace the decidua subchorialis for more than a short distance from the border of the placenta; neither was he able to see that it gave a covering to the stems of the villi, except to those which arose from the chorion in close proximity to the placental border. Throughout the placenta generally he states that the maternal blood spaces had on their fœtal aspect no other boundary than the chorion itself. LEOPOLD, in his memoir on the human placenta already referred to, says† that his observations correspond with those of KÖLLIKER. But a different view of the nature of this structure has been advanced by LANGHANS.‡ He recognises that about the middle of pregnancy a layer of cells is developed. At first the cells are small in size, but subsequently present a great resemblance to decidual tissue, though in his opinion they do not belong to the decidua. For he states that they are formed between the vascular fibrillar stroma of the chorion and its epithelial covering, and are probably derived from the vascular layer of the chorion itself. He names the structure the "cell layer of the chorion frondosum," employing a term which implies no opinion of the origin of the cells. In most cases the layer is not of equal thickness throughout, but the cells lie in groups, between which a homogeneous intercellular substance is situated, which is directly continuous with the fibrillar tissue of the chorion. At a later stage of placental growth he states that this cell layer becomes converted into canalised fibrine, for after the dissolution of the chorionic epithelium in the last months of pregnancy a deposition from the maternal blood takes place, and the lamellated layer of the chorion frondosum is formed. This cellular and lamellated layer bounds the space within the placenta in which the maternal blood is contained, and it is penetrated by the chorionic villi which project into that blood space.

My attention has also been directed to the placental surface of the chorion in the human placenta. In the placenta in the fifth month this surface was covered by a single layer of cells, which had the aspect of the chorionic epithelium. They were, however, to all appearance in process of degeneration, for they were infiltrated with fine granular particles. In a placenta in the seventh month, although this surface of the chorion was obscured by masses of blood corpuscles, and by a granulated material of indefinite structure, which might have been fibrine, here and there patches of cells

* 'Entwicklungsgeschichte,' ed. 1876, p. 337.

† *Op. cit.*, p. 52.

‡ *Op. cit.*, p. 256.

could be seen, which in size and shape resembled those seen in a placenta in the ninth month. In the last month of pregnancy a definite layer of cells was seen on the placental surface of the chorion, not limited, as KÖLLIKER has stated, to the marginal lobes, but extending generally over its whole surface. These cells were polygonal in shape and in contact with each other by their edges, so that they formed a definite layer. Their nuclei were relatively large, the protoplasm granulated; and in size, shape, and appearance they closely resembled the large cells of the compact layer of the decidua placentalis. In their position and general characters they were like the sub-chorionic cells of the *Macacus*, but instead of possessing as in that animal a stratified arrangement so as to form a membrane thick enough to be seen with the naked eye, they formed, so far as my observations have gone, apparently only a single layer of cells.

There are difficulties in the way of giving a satisfactory account of the mode of origin of the sub-chorionic cells in the human placenta. Their position and characters point to one or other of three sources—modified chorionic epithelium, intra-chorionic cells, or from the decidua serotina. I do not think it likely that they can be modified chorionic epithelium, for they not only differ so much from the cells of that epithelium in appearance and size, but, from LANGHANS'S observations and my own, there is every reason to believe that the chorionic epithelium degenerates and disappears in the human placenta about the middle of pregnancy.

Many facts and arguments are advanced by LANGHANS in favour of their origin in the human placenta, where alone he has studied them, from the vascular layer of the chorion, and I must refer to his memoir* for a full discussion of the subject. Here, however, I may state that before his memoir was published I had observed in *Macacus cynomolgus*, in addition to and quite distinct from the sub-chorionic cells, rows of intra-chorionic cells having a granulated protoplasm, such as one finds in the cells of the decidua, which had obviously originated within the chorion (p. 532). These intra-chorionic cells, however, did not form a continuous layer, but were broken up into groups, separated from each other by fibrillated connective tissue, and situated near the amniotic surface.

The sub-chorionic cells in *Macacus* had a different arrangement, not only from the intra-chorionic cells, but from the sub-chorionic cells as described in the human placenta by LANGHANS, or as seen by myself. They were not broken up into groups or patches, but possessed a continuous stratified arrangement over the whole placental surface of the chorion, and invested the stems of the villi so that the fibrillar structure of the chorion was excluded from forming the boundary of the intra-placental maternal blood spaces. The fact that between the deeper layers of these cells the proper tissue of the chorion seemed to penetrate, points to the origin of these deeper layers at least from the chorion, and to their homology with the intra-chorionic cells. The great resemblance between the more superficial layers of these cells and the cells

* 'Archiv für Anat. und Phys.,' 1877, p. 256.

of the decidua was so very striking, that when I first examined them I was of opinion that they were decidua cells covering the placental surface of the chorion, investing the stems of the villi and forming a decidua sub-chorialis, which walled in with maternal tissue the maternal blood space at its chorionic boundary. If this view be accepted then the more superficial of the sub-chorionic cells would have a different origin from those of the deeper layers. Though several arguments might be advanced in favour of such a conclusion, yet as through want of material I have only had the opportunity of studying these sub-chorionic cells in one particular stage of development of the placenta in *Macacus*, I do not definitely commit myself to the theory of the decidual origin of the superficial layers of cells. The more so as the corresponding though not precisely similar arrangement of cells in the human placenta does not apparently exist in the earlier half of placental development, which one would be disposed to say it ought to have done if it had been derived from the decidua.

But whilst there is a difficulty in definitely assigning a decidual origin to the sub-chorionic cells, and to the cells enveloping the stems of the villi as they arise from the chorion, there can be no doubt that the stratified arrangement of cells surrounding the villi at their attachment to the hillock-like elevations of the decidua are derived from the decidua, for they can be traced in direct continuity with it.*

The layer of cells enveloping the lateral and terminal buds and the smaller branches of the villi in the *Macacus* closely resembles the corresponding layer of cells on the villi of the human placenta, and consists of somewhat flattened though not squamous cells, rectangular in outline, and closely applied to each other by their margins so as to form a continuous layer. These cells were apparently first described and figured by Mr. DALRYMPLE† in the human placenta, and since that time have attracted the attention of all who have studied the minute structure of the villi. As regards their homology there is, however, a difference of opinion. By most observers they are regarded as an epithelial layer continuous with the general epithelial covering of the chorion, and belonging therefore to the fœtal part of the placenta. In opposition,

* When this Memoir was presented to the Royal Society, I had not had the opportunity of reading Signor ERCOLANI's latest and very important memoir, 'Sull' unità del Tipo Anatomico della Placenta nei Mammiferi e nell' Umana specie' (Bologna, 1877), a copy of which he has with great courtesy presented to me. In this memoir Signor ERCOLANI gives a diagrammatic representation (Taf. v., figs. 15, 16) of the embedding in the human placenta of the end of a fœtal villus in a heap of decidual cells, similar to what I have described and figured in *Macacus* (Plate 49, figs. 10, 11). He also speaks most decidedly in support of the decidual origin of the sub-chorionic cells of the human placenta. On theoretical grounds I would also support this view of their origin, but I have hesitated in the text definitely to assign this mode of origin to these cells, as, through the want of specimens in successive stages of development, I have not been able to trace their mode of origin.

† Medico-Chirurgical Transactions, 1842, vol. xxv., p. 21. Mr. DALRYMPLE speaks of them as nucleated cells, resembling an irregular epithelium. E. H. WEBER had previously figured the villi as possessing a pellucid margin, but had not recognised that this pellucid border was cellular. See his drawing in WAGNER'S 'Icones Physiologicæ,' and the copies of the figure in R. WAGNER'S 'Physiology,' translated by Dr. WILLIS, 1842, fig. cxix.; and Dr. BALY'S translation of MÜLLER'S 'Physiology,' fig. 231.

however, to this view, it may be stated that the chorionic epithelium apparently degenerates and disappears in the later months of pregnancy, whilst this layer of cells persists throughout the whole period of gestation. The late Professor GOODSIR, in his memoir "On the Structure of the Human Placenta,"* described them as derived from the decidua, and as belonging therefore to the maternal part of the placenta. The observations made from time to time, and quite independently of each other, by Signor ERCOLANI and by myself on the minute structure of the placenta in numerous mammals, have proved that there is interposed between the maternal blood and the fœtal villi a layer of cells derived from the uterine mucous membrane, and belonging therefore to the maternal placenta. The cellular covering of the villi in the human placenta and in that of the *Macacus* has a similar relation on the one hand to the maternal blood, and on the other to the tissue of the villus and to the capillary terminations of the umbilical vessels, which the epithelial cells of the maternal part of the placenta in the diffused, cotyledonary, and zonary forms of placenta have to the maternal and fœtal blood vessels. On this ground, therefore, they might be regarded as homologous with each other.

In order, however, to prove the derivation of the cellular covering of the human villi from the decidua, it would be necessary to trace a prolongation of the decidua around them. In the more advanced of the two early human gravid uteri I have already described (p. 546), I found that the villi were adherent both to the decidua serotina and to the inner surface of the decidua reflexa, from both of which delicate prolongations passed between the villi, so that the fixing and interblending of the two structures seemed to be due to a coincident growth of the villi and of the decidua. It is probable, therefore, that at this early stage of placental development the villi may become ensheathed by the cell structures of the decidua. In the placenta of the fifth month, as I have described at p. 550, the interlocking of the fœtal villi with trabecular prolongations of the decidua was distinctly recognised. Even in the fully-formed placenta the attachment of the terminal parts of the villi to the placental surface of the decidua shows how intimate is the relation of the one structure to the other. I have no observations to offer on the early stages of development of the placenta in *Macacus*, but from the similarity in appearance and arrangement of the cellular covering of the villi to that in the human placenta there can be no doubt that it has a similar origin. Should the more superficial layers of the sub-chorionic cells be derived from the decidua, then an additional argument may be urged in support of the decidual origin of the cellular covering of the villi.

Both in the *Macacus* and in the human female the stems of the villi arose from the placental surface of the chorion, separated from each other by intervals which in the *Macacus* were from one-tenth to two-tenths of an inch, and in the human placenta from two-tenths to three-tenths. In the *Macacus*, the stems, though giving off nume-

* 'Anatomical and Pathological Observations,' Edinburgh, 1845. 'Anatomical Memoirs,' Edinburgh, 1868.

rous branches, yet diminished but slightly in thickness in their passage to the decidua; but in the human placenta they divided much more completely into branches, and these branches, with their finer offshoots, reached the decidua. In both, the villi were adherent to the decidua, and at the points of adhesion were imbedded in that structure. In the *Macacus*, however, the adhesion seemed to be firmer than in the human placenta, and the decidual cells were prolonged for a greater distance over the villi. The villi are, therefore, in both placentæ attached both at their chorionic and decidual ends, so that numerous checks are interposed to the too great separation of the chorion and the placental decidua from each other, such as might arise if the blood were poured too rapidly into the intra-placental maternal blood spaces, and the villi were floating free. In the human placenta, where on account of its greater magnitude an additional check may be needed, it is supplied by the passage of the inter-cotyledonary dissepiments through the placenta to the chorion.

The relatively large interval between the stems of the villi gives room for the ramifications of the numerous branches of the villi with their lateral and terminal bud-like offshoots. In both the human placenta and that of the *Macacus* the buds closely resembled each other both in form and size, and, in both, the capillary terminations of the umbilical arteries had a similar arrangement in loops and coils within the buds. In both, an extra-villous network of capillaries was situated in the placental part of the chorion in the intervals between the bases of origin of the stems of the villi. This extra-villous network corresponded in its position to the extra-villous capillary network, which I have elsewhere described, in the diffused and cotyledonary forms of placenta.* In neither, however, did I observe an extension of the capillary network into the non-placental parts of the chorion such as occurs in the zonary placenta; but the non-placental part of the chorion of *Macacus* was traversed by the branches of the umbilical arteries and vein, which passed between the placental lobes.

Both in the human placenta and in that of the *Macacus* an intra-placental system of spaces for the circulation of the maternal blood was present. These spaces formed an irregular but freely communicating anastomosis interposed between the villi. They were bounded on the chorionic aspect by the sub-chorionic cells; on the decidual aspect by the decidua placentalis; whilst the spaces between the villi were bounded by the villi themselves with their cellular covering. In the human placenta the curling arteries pass in so tortuous a manner through the placental decidua that they are followed with difficulty. If they previously be injected from the uterine arteries, in specimens where the placenta is attached to the wall of the uterus, they can, with the aid of a lens, be followed through the decidua. The delicate coat of the artery can be slit up with a needle, and the plug of injection can be followed into the interior of the placenta. Another way of observing their mode of opening into the placenta is to cut off the portion of decidua placentalis in which a curling artery is situated, to remove the villi attached to its placental aspect, and then to examine

* Lectures on the Comparative Anatomy of the Placenta, already cited.

that aspect with a good lens, when the mouth of the artery can be seen to open obliquely on the inner surface of the decidua placentalis. In the *Macacus*, owing to the placental arteries being so much smaller in size, and not exhibiting a characteristic curling appearance, it was difficult to distinguish them from the arteries of supply of the decidua placentalis, and their exact mode of communication with the interior of the placenta was not satisfactorily ascertained.*

In the human placenta, the utero-placental veins form sinus-like dilatations, not only in the serotina occupying the placental area, but in the inter-cotyledonary dissepiments and at the margin of the placenta. These sinuses communicate with the interior of the placenta by cribriform apertures in their walls, through which it is not uncommon to see the placental villi project into the sinus. In the *Macacus*, the corresponding veins are not dilated into sinuses, but preserve, as already pointed out, their cylindrical tubular form.

Both the utero-placental veins and the curling arteries of the human placenta possess a smooth inner surface, due to the presence of an endothelial lining. From the freedom of their communication with the intra-placental maternal blood spaces one would expect that a prolongation of this endothelial lining for a greater or less distance into the placenta would take place. Although such a prolongation is denied by many observers, yet I have occasionally seen an appearance of a lamella on the villi distinct from and external to their epithelial covering, which layer I have interpreted as derived from and representing the endothelial wall of the maternal vessels,† though without committing myself to the statement that it was universally present. LANGHANS has since given a description of an endothelial-like membrane on the placental surface of the decidua serotina in placentæ in the fourth and seventh months, though he cannot speak with the same confidence of its existence in the placenta at the full time. LEOPOLD, though unable to detect an endothelial covering on the villi, has seen it on the placental surface of the decidua between the place of attachment of the villi to that structure. From the free communication of the curling arteries and utero-placental veins with the interior of the placenta, and from the prolongation of their endothelial lining for some distance at least into the organ as a wall for the intra-placental blood spaces, there can be no doubt that these spaces represent maternal blood vessels. They are, I believe, greatly dilated blood capillaries, the endothelial wall of which is in part preserved, though to a large extent it apparently disappears, so that the villi with their cellular covering lie in the maternal blood spaces, which have assumed a cavernous character. That the maternal blood capillaries, even at a very early period in the development of the decidua placentalis, become dilated into sinuses I have already pointed out (p. 548) in my description of the decidua serotina in human uteri from the third to the fifth week of gestation.

I am unable to state if the endothelial lining of the uterine vessels in *M. cynomolgus*

* See the Appendix for a more explicit statement on this point.

† "On the Placentation of the Sloths," Trans. Roy. Soc. Edinburgh, vol. xxxii., p. 99, 1873.

is prolonged into the interior of the placenta, as the injection of the organ interfered with the use of the nitrate of silver reaction. I could not in this specimen obtain any evidence of a layer on the villi external to their cellular covering, but I may refer to a previous observation* on the structure of the villi in the placenta of the *M. nemestrinus* in the Oxford Museum, in which a layer of apparently flattened cells seemed to be situated external to the proper cellular covering of the villus. But whether an endothelial prolongation of the lining of the maternal vessels be present or not within the placenta, there can I think be no doubt that the inter-villous spaces in *Macacus* are of the same nature as the corresponding spaces in the human placenta. Should, as is most probable, the cellular covering of the villi be derived from the decidua, then in the human placenta and in the *Macacus*, as in the other placental mammals, a layer of cells, derived from the epithelium of the uterine mucous membrane, would be interposed between the maternal blood and the capillary terminations of the fœtal vessels.

The stage of development of the placenta in the *Macacus* was too advanced to enable me to determine if the villi of the chorion had had any relation to the utricular glands.

The comparison that I have now made between the gravid uterus and placenta in *Macacus cynomolgus* and the human female proves that they correspond in the form of the uterus and in the arrangement of the fœtal membranes, and that they both possess a discoid placenta, which in the *Macacus* is divided into two lobes, but is undivided in the human placenta. In the arrangement and relative position of the constituent parts of the placenta they also correspond, and although some differences of detail in the characters of some of the structures occur, yet in the main features of construction, makroscopic as well as microscopic, they have a close resemblance to each other. I have little doubt, if a detailed examination of the placenta in the other genera of Apes were made, that a similar resemblance in structure would be found.

Explanation of Plates.

PLATE 48.

Fig. 1. A view of the interior of the gravid uterus of *Macacus cynomolgus*, obtained by making a longitudinal incision through the anterior wall. The fœtus is shown undisturbed in its position.

v. Vagina.

c. Cervix uteri. About one-third less than nature. (Page 527.)

* Cited in the Memoir "On the Placentation of the Sloths," p. 97.

Fig. 2. Vertical section through the non-placental part of the chorion, the decidua vera, and the muscular wall of the same uterus, the section being made near the os internum. × 300.

am. The cells of the amnion, partly shown in profile and partly with their flat surfaces.

ch. The chorion. Two ridge-like elevations of which may be seen fitting into furrows of the decidua vera.

ee. Columnar epithelium covering the decidua vera.

se. The sub-epithelial cell-tissue of the decidua, the darkly-shaded spots in which represent sections through divided blood-vessels.

s. A space in the sub-epithelial tissue.

mm. Layer of muscularis mucosæ.

sm. Submucous areolar coat.

m. Muscular coat of the uterus, divided into two layers and exhibiting sections through divided blood vessels. (Page 530.)

Fig. 3. Vertical section through the decidua vera of the human uterus at the fifth month. × 20.

e. The compact cellular layer which represents in its position the epithelium ; in it are the depressions of tubular glands.

se. The more superficial part of the spongy layer immediately subjacent to the compact cellular layer.

sp. The deeper and more characteristically spongy part of the spongy layer. (Page 543.)

Fig. 4. Vertical section through a portion of the same human decidua vera. × 300.

e. The stratified cells of the compact layer, representing in their superficial position the epithelium.

se. The subjacent spongy layer in which are situated rows of fusiform cells, which have a general resemblance to the cells of non-striped muscle.

s. A space in this tissue. (Page 544.)

PLATE 49.

Fig. 5. A vertical section through the uterine wall and placenta of *Macacus cynomolgus*. Natural size.

ch. The placental chorion and umbilical cord.

u. The muscular wall of the uterus.

s. The spongy layer of the decidua serotina.

c. The compact layer of the decidua serotina. From the placental surface of the chorion the stems of the villi may be seen to pass

through the placenta to reach the compact layer of the decidua. The blue colour is intended to indicate the blue injection in the blood vessels of the chorionic villi. (Page 532.)

Fig. 6. A portion of the chorion, with the stems of two of the villi arising from it dissected out of the placenta of *Macacus cynomolgus*. The uniformity in size of the stems throughout their length, and the numerous branches to which they give origin are represented. The blue colour is intended to show the blood vessels magnified. (Page 532.)

Fig. 7. Vertical section through the placental chorion and a small part of the stem of a villus from the same placenta. × 20.

am. The layer of amnion.

ch. The chorion containing divided blood vessels.

sch. The layer of sub-chorionic cells prolonged on the stem of the villus. (Page 533.)

Fig. 8. Vertical section through a portion of the chorion of the same placenta. × 350.

am. Amnion.

ch. Chorion.

ich. Intra-chorionic cells.

sch. Sub-chorionic cells. (Page 532.)

Fig. 9. A portion of one of the septa between the areolæ in the spongy layer of the decidua serotina of *Macacus cynomolgus*. × 350.

e. The epithelial cells with their large nuclei. At *se* the epithelium has been shed and the subjacent fusiform corpuscles and lymphoid cells of the sub-epithelial tissue are exposed. The darkly-shaded tube is a blood capillary situated in the sub-epithelial tissue.

Fig. 10. Vertical section through the uterine wall and decidua serotina of the same animal. × 65.

m. Muscular coat containing divided blood vessels.

s. Decidua serotina containing areolæ.

aa. Hillock-like elevations of the serotina projecting into the interior of the placenta.

v. A villus with its contained blood vessel, injected blue, penetrating into the interior of a large hillock of decidua. (Page 534.)

Fig. 11. A section through the compact layer of the decidua serotina and a view of one of the hillock-like prolongations of the same placenta. × 350.

s. Compact layer of decidua serotina.

a. A hillock-like prolongation. The cellular structure of both is shown, and some isolated cells are represented detached from the serotina. The pale blue colour, *v*, shows the injection in the vessels of the stem of a villus embedded in and surrounded by the decidual cells of the hillock, and from it some idea may be formed of the extent

to which the villus penetrates into the hillock. The darker blue colour is in the capillaries of terminal villi adherent to the surface of the decidual hillock, and apparently continuous with the villus embedded in the hillock. The layer of cells, *cc.*, which envelopes the smaller terminal villi, is shown.

Of the drawings from nature from which these figures are taken, fig. 9 is by myself; for fig. 5 I am indebted to Mr. J. D. Dunlop; fig. 6 to Alfred H. Young, M.B.; fig. 1 to Dr. J. Halliday Scott; and the remainder to John Haycraft, M.B.

Appendix.

(November 30, 1878.)

During the month of October I received, through the courtesy of Professor A. H. Garrod, the placentæ of two other monkeys, the examination of which has enabled me to clear up one or two points which I was obliged to leave in doubt in my memoir, and to add some additional particulars.

The one placenta was obtained on October 4th from a *Cercocebus fuliginosus*, which had been impregnated by a *Macacus cynomolgus* living with it in the same cage. The *Cercocebus* had been well advanced in pregnancy, and had met with her death by falling from the topmost bar in one of the lofty cages in the gardens of the Zoological Society of London. The other placenta was shed during parturition on October 14th, along with a living fœtus, by a *Cynocephalus mormon*, which had been impregnated by the same *Macacus cynomolgus*.

The placenta of the Sooty Mangeby was contained in the cavity of the uterus, but the fœtus had been removed before it came into my possession, and a note had not been taken of its position in the uterus. The placenta consisted of two lobes, unequal in size. The larger, 3 inches in diameter and almost circular, was adherent to the posterior wall of the uterus; the smaller, $2\frac{1}{2}$ inches in one diameter by 2 inches in another, had been adherent to the anterior wall, but along with the surrounding chorion had become detached from it. The two lobes were separated from each other by a broad band of intermediate chorion, in which the vessels ramified that passed from one lobe to another. The cord was attached to the centre of the larger lobe. From the lower edge of this lobe to the region of the os uteri the chorion was closely adherent to the inner surface of the uterus.

The placenta of the female *Cynocephalus* was single, almost circular in form, and measured $3\frac{1}{2}$ inches in diameter. All the membranes had been preserved, and no trace of a smaller subordinate lobe was to be seen. The cord joined the placenta near its middle. The presence of only a single placental lobe in *Cynocephalus mormon* is of

interest in connexion with an observation made by M. BRESCHET on the placenta in *Cynocephalus sphynx.** M. BRESCHET states that in his specimen the placenta appeared to be single, but, influenced apparently by the idea that the placenta was double in the Monkeys of the old world, and single only in those of the new world, he thought that from the torn condition of the membranes a smaller subordinate lobe had been destroyed by the mother. It is probable, however, that in M. BRESCHET'S specimen, as was certainly so in my own, only a single placenta was present. Hence it would appear that in the Baboons, as in the Chimpanzee, the placenta consists of only a single lobe, so that the opinion which was at one time entertained that the Apes of the old world could be distinguished from those of the new by the invariable presence of a bi-lobed and not a single-lobed placenta is not borne out by more extended inquiry.

Both in the placenta of *Cercocebus* and *Cynocephalus*, as in the previously described *Macacus cynomolgus*, the placenta was divided by furrows into lobelets. The uterine surface of the shed placenta of *Cynocephalus* was covered by a well-defined layer of decidua, which was ragged on its uterine surface, owing, doubtless, to the tearing through of the thin walls between the loculi, similar to those I have described in *Macacus*. Several utero-placental veins, which had been torn across, lay in grooves in the placental decidua, usually in the furrows between the lobelets and opened by obliquely directed mouths into the interior of the placenta, the villi within which could be seen through the venous orifices. Those villi which were placed next the edge of the mouth of the vessel were adherent to its wall, so that a provision existed which would admit of a prolongation of the endothelial wall of the vessel on to the villus. When the placenta had been steeped in spirit, a quantity of the fluid had soaked into its interior, and could by gentle pressure be squeezed out through the mouths of the utero-placental veins, which proved that a free communication existed between these vessels and the interior of the placenta. The torn veins closely resembled those figured by JOHN HUNTER on the uterine surface of the shed placenta of his *Macacus rhesus*.

But in addition to the vessels that I have described as veins, I saw other vessels attached to the uterine surface of the placenta of *Cynocephalus*, which I believe to be the utero-placental arteries. They were smaller in size than the veins, but yet sufficiently large to enable me to pass a pig's bristle into the lumen. One in particular was traced for about an inch, extending with a slightly wavy course in close contact with the uterine surface of the organ. Another could be traced for half an inch covered over by a thin pellicle of decidua to open into the placenta about the middle of a lobelet.

The detached lobe of the placenta of the Sooty Mangeby had also its uterine surface covered by decidua, and a thick layer of decidua, showing numerous loculi, was left on the placental area of the uterus, and in both the torn-across mouths of utero-

* 'Mémoires de l'Institut,' 1845, p. 452.

placental veins could be seen. It is clear, therefore, from this specimen, as well as from the appearance presented by the placenta of the Baboon, that, when the placenta is separated, a portion of the decidua remains attached to the wall of the uterus, and that another portion peels off with the placenta; hence, to use the terms employed by Dr. ROLLESTON, there is both a deciduous and a non-deciduous serotina.

As it was desirable to make quite certain that the vessels I have described in the whole series of placentæ as utero-placental veins, were veins and not arteries, I directed my assistant, Mr. A. B. STIRLING, to pass a red injection into the uterine arteries of *Cercocebus fuliginosus* and a blue injection into the uterine veins, so as to inject the vessels belonging to the attached lobe of the placenta, and enable me readily to discriminate the one set of vessels from the other. I then found on carefully detaching the lobe from the placental area of the uterus that the vessels corresponding to those which I have throughout this Memoir described as utero-placental veins contained the blue injection, so that the accuracy of my interpretation of their venous nature was thus established. But entering this same placenta were several vessels, which contained a red injection, and may therefore be fairly regarded as utero-placental arteries. Though smaller than the utero-placental veins, they were yet large enough to admit a pig's bristle, and when slit open were seen to have a distinct orifice into the placenta, through which the fœtal villi could be seen. Hence it is probable that the fine arteries, which I saw in the decidua serotina of *Macacus cynomolgus* (p. 536), were not for the placenta, but for the supply of the decidual tissue.

By means, therefore, of these two placentæ I have been able to establish much more definitely than in the placenta of *Macacus cynomolgus* the distinction between the utero-placental arteries and veins, and to show that each kind of vessel has a free communication with the interior of the placenta, so as to provide for a free circulation of blood throughout the interior of the organ.

In tearing away the non-placental chorion of *Cercocebus* from the wall of the uterus, I observed a number of very tortuous arteries, filled with red injection, passing from the uterine wall to that layer of the decidua which remained attached to the chorion. These vessels were so slender as to appear to the naked eye not larger than fine threads.

The outer surface of the chorion of the shed placenta of *Cynocephalus* was irregularly covered by a thin flocculent membrane, which was, as a rule, closely adherent to the chorion, though in places it was flocculent and partially separated from it. In its structure it consisted for the most part of white fibrous connective tissue, in which many fusiform corpuscles were situated. Occasional patches of polygonal cells, set together after the manner of an epithelium, were also seen. This membrane obviously represented the decidue reflexa of previous writers on this subject; but for the reasons I have already advanced (p. 545), it is difficult to say how far the membrane was a decidua vera or a decidua reflexa.

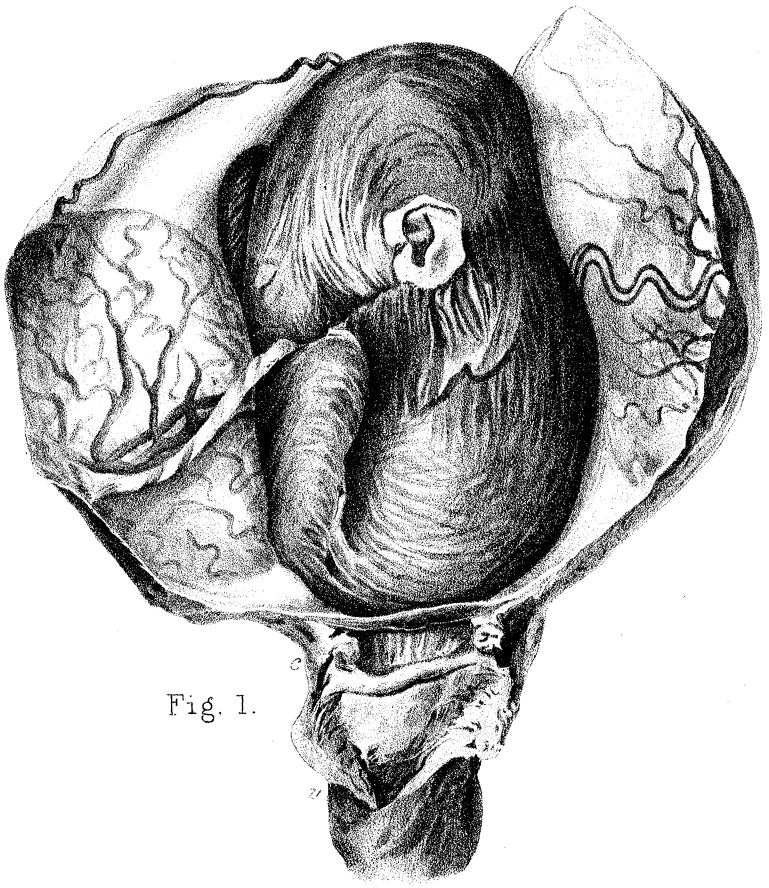

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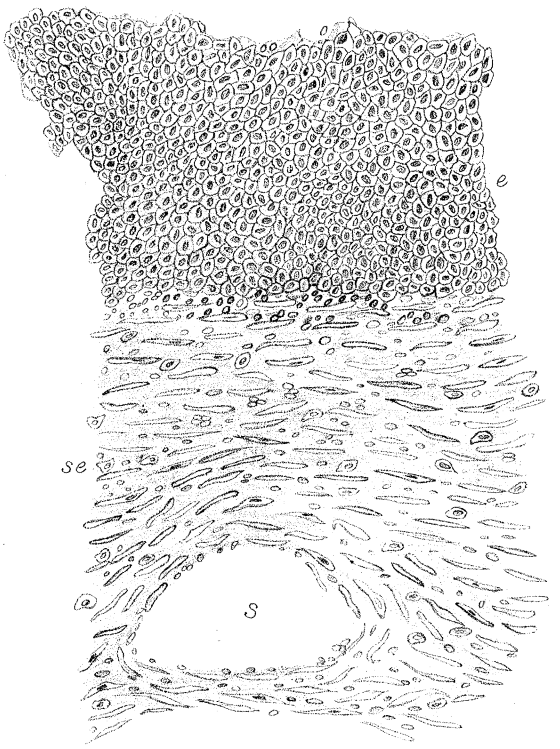
Fig. 4.



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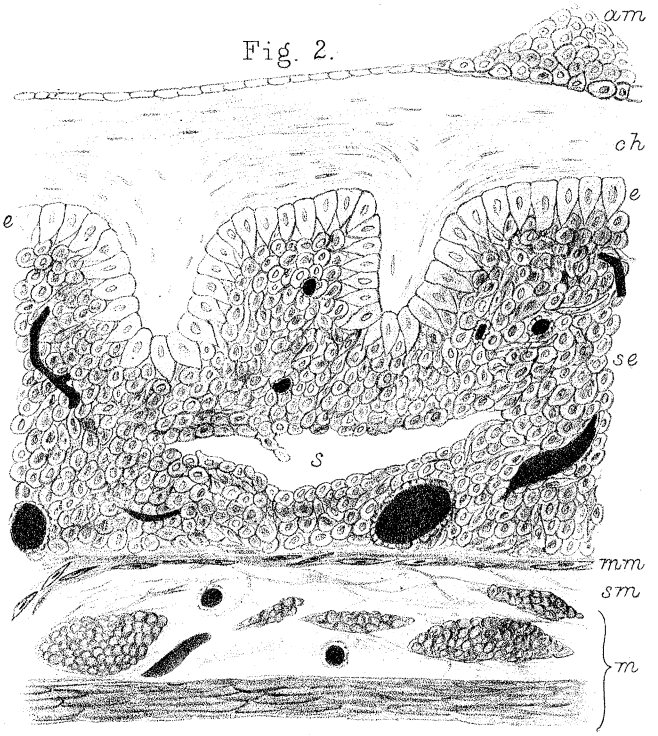

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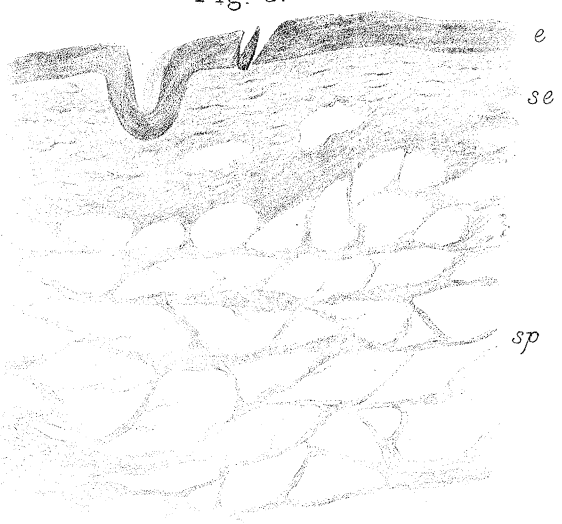

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Fig. 6.

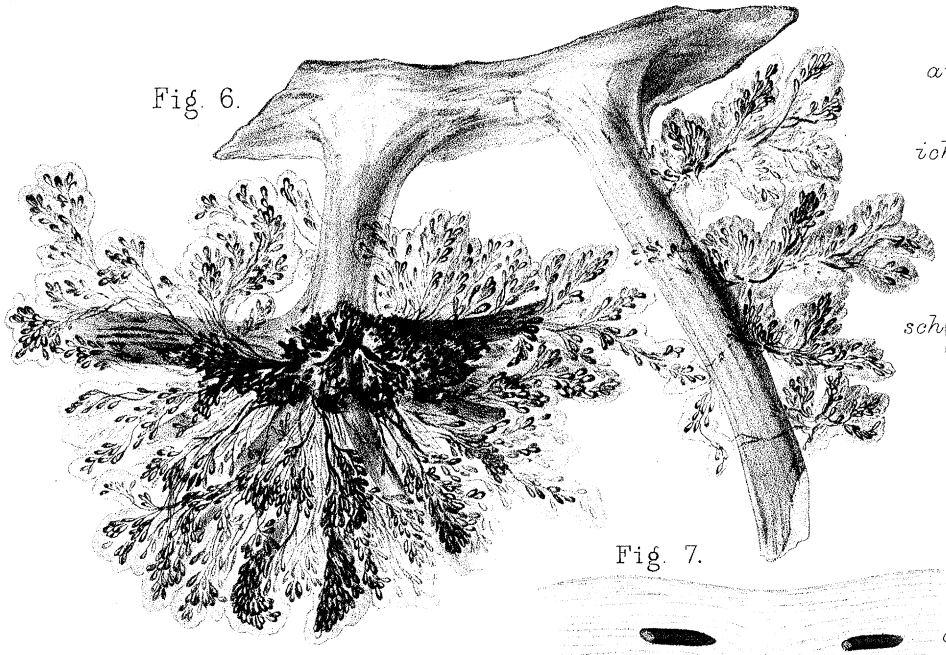


Fig. 8.

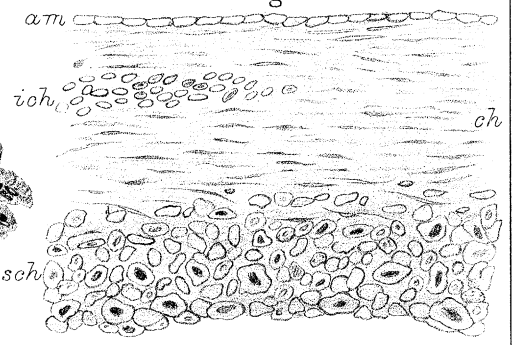


Fig. 7.

Fig. 10.

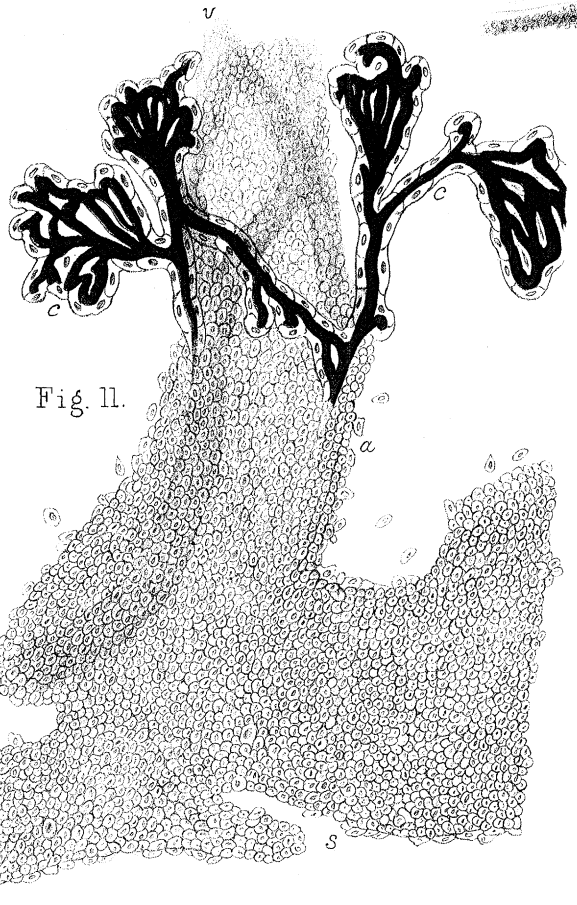


Fig. 11.

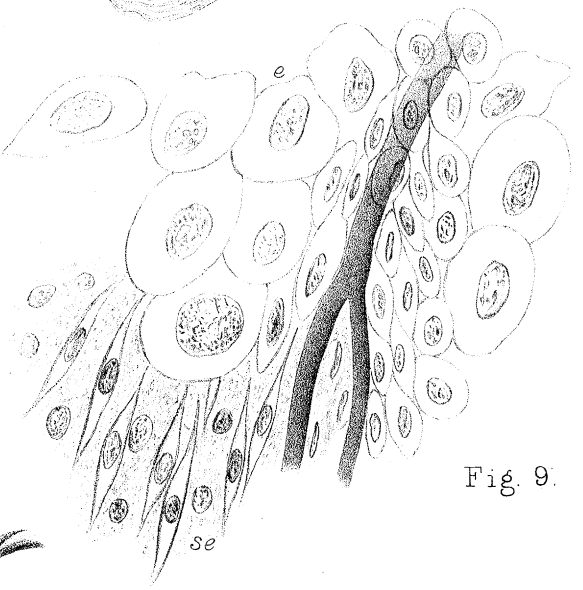
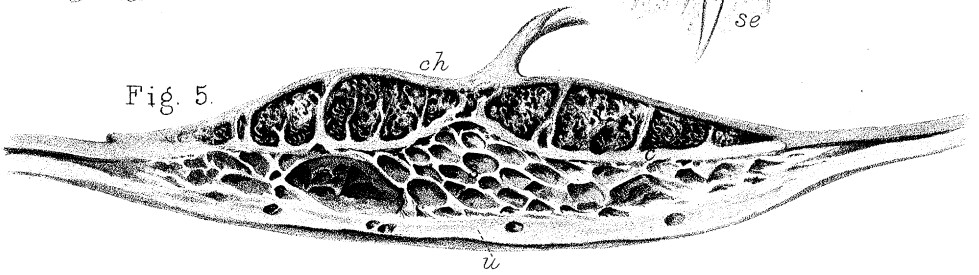


Fig. 9.

Fig. 5.



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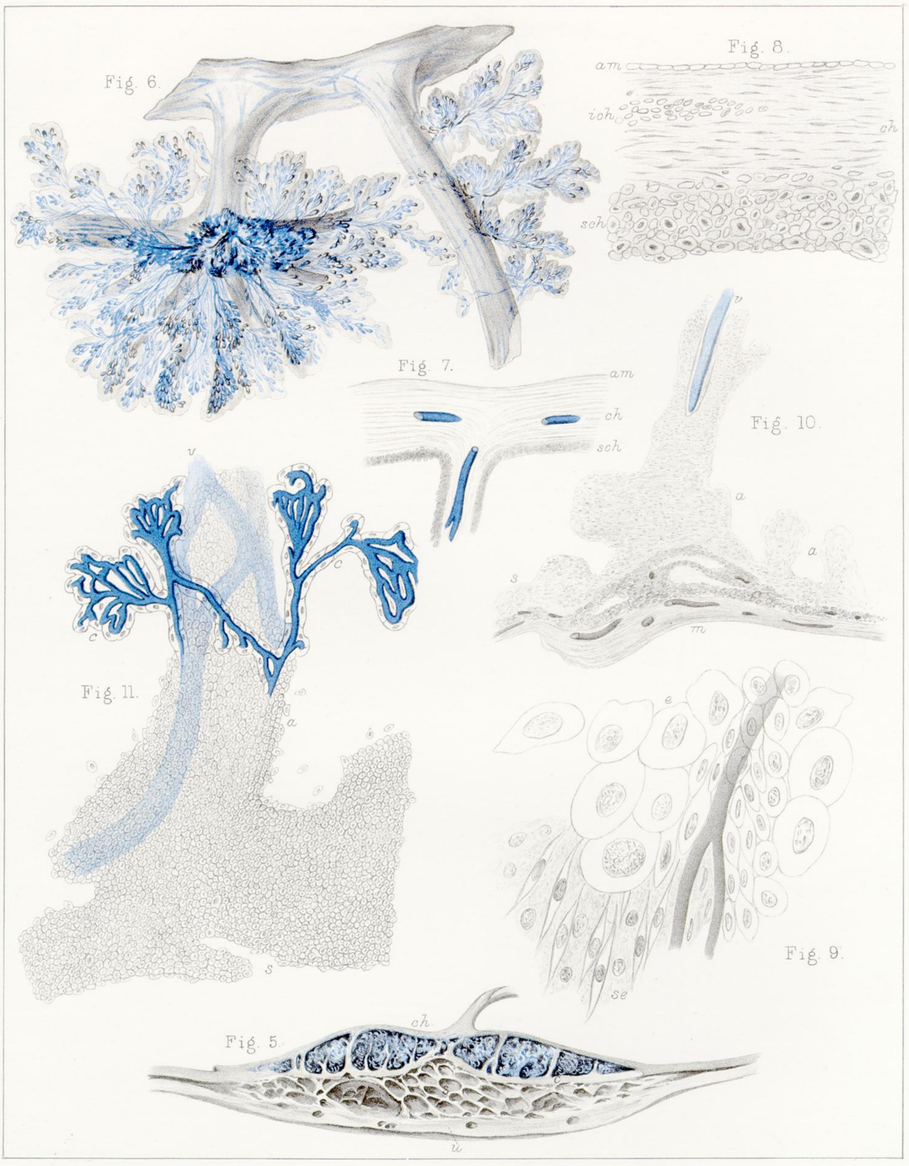

PLATE 49.

Fig. 5. A vertical section through the uterine wall and placenta of *Macacus cynomolgus*. Natural size.

ch. The placental chorion and umbilical cord.

u. The muscular wall of the uterus.

s. The spongy layer of the decidua serotina.

c. The compact layer of the decidua serotina. From the placental surface of the chorion the stems of the villi may be seen to pass through the placenta to reach the compact layer of the decidua. The blue colour is intended to indicate the blue injection in the blood vessels of the chorionic villi. (Page 532.)

Fig. 6. A portion of the chorion, with the stems of two of the villi arising from it dissected out of the placenta of *Macacus cynomolgus*. The uniformity in size of the stems throughout their length, and the numerous branches to which they give origin are represented. The blue colour is intended to show the blood vessels magnified. (Page 532.)

Fig. 7. Vertical section through the placental chorion and a small part of the stem of a villus from the same placenta. × 20.

am. The layer of amnion.

ch. The chorion containing divided blood vessels.

sch. The layer of sub-chorionic cells prolonged on the stem of the villus. (Page 533.)

Fig. 8. Vertical section through a portion of the chorion of the same placenta. × 350.

am. Amnion.

ch. Chorion.

ich. Intra-chorionic cells.

sch. Sub-chorionic cells. (Page 532.)

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e. The epithelial cells with their large nuclei. At *se* the epithelium has been shed and the subjacent fusiform corpuscles and lymphoid cells of the sub-epithelial tissue are exposed. The darkly-shaded tube is a blood capillary situated in the sub-epithelial tissue.

Fig. 10. Vertical section through the uterine wall and decidua serotina of the same animal. × 65.

m. Muscular coat containing divided blood vessels.

s. Decidua serotina containing areolæ.

aa. Hillock-like elevations of the serotina projecting into the interior of the placenta.

v. A villus with its contained blood vessel, injected blue, penetrating into the interior of a large hillock of decidua. (Page 534.)

Fig. 11. A section through the compact layer of the decidua serotina and a view of one of the hillock-like prolongations of the same placenta. × 350.

s. Compact layer of decidua serotina.

a. A hillock-like prolongation. The cellular structure of both is shown, and some isolated cells are represented detached from the serotina. The pale blue colour, *v*, shows the injection in the vessels of the stem of a villus embedded in and surrounded by the decidual cells of the hillock, and from it some idea may be formed of the extent to which the villus penetrates into the hillock. The darker blue colour is in the capillaries of terminal villi adherent to the surface of the decidual hillock, and apparently continuous with the villus embedded in the hillock. The layer of cells, *cc.*, which envelopes the smaller terminal villi, is shown.