XXIII. *Researches in Embryology. Third Series: A Contribution to the Physiology of Cells.* By Martin Barry, *M.D., F.R.S., F.R.S.E., Fellow of the Royal College of Physicians in Edinburgh.*

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THE "Second Series" of these Researches† traced certain changes in the mammiferous ovum consequent on fecundation. It is the object of the present communication to describe these changes more minutely, as seen by the aid of powerful lenses; and to make known a remarkable process of development thus discovered.

In order to obtain more exact results, my observations were still made on the same animal as before, namely, the Rabbit, in the expectation that, if these labours were successful, it would be comparatively easy to trace the changes in other Mammals.

By pursuing the method of obtaining and preserving ova from the Fallopian tube, which I recommended in my last paper, I have been enabled to find and examine 137 more of these delicate objects; and have thus had ample opportunity for confirming the principal facts therein stated. I have now procured in all 230 ova from the Fallopian tube. But being aware that repeated observations alone are not complete in researches of this nature, unless extended to the very earliest stages, I again specially directed my attention to the ovum still within the ovary, with a view to discover its state at the moment of fecundation, as well as immediately before and after.

(The measurements throughout this paper, as in former ones, are stated in fractions of a Paris line, and thus expressed ('''). As a simple mode of reducing this fraction into (what is very nearly) the equivalent fraction of an English inch, I recommend multiplying the denominator of the former by $11\frac{1}{4}$‡. The actual sizes of the ova are represented at the foot of each Plate. To admit of comparison in size, great care has been taken to preserve a fixed scale in the figures, as well for the contents of the ova as for the ova themselves; this being for the most part 100 diameters. In a few instances 50 diameters have been used; and for parts of ova, figured separately, 300 diameters. The Plates have been explained (par. 430.) with considerable minuteness, in order to admit of details being as much as possible avoided in the memoir.)

322. I am not aware that we hitherto possess any drawings of ova from the ovary, either as prepared for fecundation or showing its effects. In this memoir Plate XXII.

† Philosophical Transactions, 1839, Part II. p. 307.

‡ See the "Table of Measurements" (par. 429.).

has been devoted to the former, and Plate XXIII. to the latter object. In the upper row of figures of Plate XXIV. I have copied the only delineations published by others of ova from the Fallopian tube. The amount of information obtainable from these, will be seen on comparing with them eleven states of ova from the Fallopian tube, figured in my "Second Series†," and upwards of thirty more in the present paper‡.

323. It was stated in my last memoir § that the Purkinjean, or germinal vesicle, does not disappear at the period previously supposed; but that after fecundation it returns from the surface to the centre of the ovum. My later researches have not only established the fact now mentioned, but they also enable me, I believe from actual observation, to make known the destiny of this important object. These investigations realise the almost universal supposition that the germinal vesicle is the essential element of the ovum; but how far they realise any of the speculations of physiologists as to what becomes of it, will be seen on comparing the facts about to be recorded, with opinions quoted in the Appendix to this memoir.

The Doctrine of "Cells."

324. I formerly mentioned ‖ that SCHWANN ¶, basing his researches in the animal, upon the discoveries of SCHLEIDEN †† in the vegetable kingdom, had demonstrated that in development the same phenomena are exhibited in both; that he had shown animal tissues in general, like those of plants, to be reducible to modifications of vesicles or "cells;" and that the mode of origin of the cells is essentially the same in animals as SCHLEIDEN had discovered it to be in plants. SCHLEIDEN had found, that the membrane of each cell is formed at the surface of the object previously known as the nucleus of the cell; and in the nucleus he discovered a nucleolus. As the nucleolus, the nucleus, and the cell, are objects which must in future be considered of the first importance in the structure of organized beings; as they are constantly referred to in the following memoir; and as my observations on two of these objects do not, in all respects, accord with the experience of others, it is essential to state existing views regarding them. These will be found in the Appendix (par. 425.).

CHANGES IN THE OVARIAN OVUM PREPARATORY TO FECUNDATION.

(These are represented in Plate XXII. The ova there seen measured in diameter from $\frac{1}{15}'''$ to $\frac{1}{11}'''$.)

† *L. c.*, Plate VI.

‡ Plates XXIV., XXV., XXVI., XXVII.

§ "Second Series," *l. c.*, par. 133.

‖ "Second Series," *l. c.*, par. 358.

¶ Mikroskopische Untersuchungen über die Uebereinstimmungen in der Struktur und dem Wachsthum der Thiere und Pflanzen, 1839.

†† Beiträge zur Phytogenesis, MÜLLER's Archiv, 1838. Heft II. p. 137.

Preparatory Changes in the Germinal Vesicle and Germinal Spot.

325. The germinal vesicle (*c*) does not "burst," "dissolve away," or "become flattened," on or before the fecundation of the ovum, as hitherto supposed. It ceases to be pellucid; and this perhaps is one cause of the mistaken views regarding it. But another cause is possibly a less transparent state assumed by the surrounding substance; and a third is doubtless the almost entire absence of observations on mammiferous ova at this period.

326. The germinal vesicle fills with cells, and these become filled with the foundations of other cells; so that the germinal vesicle is gradually rendered nearly opake (Plate XXII. fig. 164. *c.*). The mode in which this alteration takes place, is the following; and it is one which, if confirmed by future observation, must modify the views recently advanced on the mode of origin, the nature, the properties, and the destination of the nucleus in the physiology of cells. Some minute details are unavoidable; but their introduction here will save future repetition.

327. The germinal spot (*b*) is known to present in some instances a dark central point†. I find that such a point always makes its appearance at a certain period; that it enlarges, resembles a dark globule or ring, and contains a cavity filled with fluid, which is exceedingly pellucid. That which originally constituted the germinal spot assumes the appearance of incipient cells‡ (Plate XXII. fig. 156. *b.*). These, enlarging, gradually come to occupy the whole of the interior of the germinal vesicle, except that part from which they rose. In the ovum, fig. 157, that which had been a dark point presented a finely granular appearance, with a central pellucid cavity. In a subsequent condition (fig. 159.), the part corresponding to that just referred to, as finely granular, had distended, and presented a layer of incipient cells; while in its interior there had arisen another object having a finely granular appearance, and likewise a central cavity. In the more advanced ovum of figs. 160 and 161, the germinal vesicle contained no less than four concentric layers, arisen in the order just mentioned, and surrounding a pellucid central space, which was exceedingly minute. The germinal vesicle in the ovum, fig. 162, presented an appearance of the same kind, but seemed to be in a condition yet more advanced. Besides three concentric layers of cells, a space was seen in the interior (included by the dotted line, fig. 163.); and in this space were two other concentric layers of cells, in a still more incipient state,—these also surrounding a pellucid centre§.

† R. Wagner, Prodromus Historiæ Generationis, 1836. Schwann, *l. c.*, p. 54.

‡ My friend R. Wagner with reference to the ova of squamous Amphibia and cartilaginous Fishes, remarks, "Also where the germinal spot is single only, and in riper ova, there are sometimes found to arise granulations, in the form of minute scattered globules on the inner surface of the germinal vesicle, whereupon the original larger and opaker germinal spot becomes less distinct and disappears." (Lehrbuch der Physiologie, Erste Abtheilung, p. 33, 1839. Prodromus, &c., figs. 24. and 27.) This eminent observer appears also to have seen the external portion of the germinal spot in the mammiferous ovum undergoing the change I have above described (Lehrbuch, &c., Tab. II. fig. viii.), though the nature of that change remained concealed.

§ The changes above described, as taking place in the germinal spot, may assist to explain its altered ap-

328. As the foundations of new cells successively make their appearance in the interior of the altered germinal spot, the pellucid central cavity in the latter presents changes in its size, and sometimes is scarcely or not at all to be discerned (compare in Plate XXII. figs. 161 and 166.), whence I conclude that the foundations of new cells in question, have their origin in the pellucid fluid of that central cavity. This remark applies to all the nuclei referred to in this memoir; and I apprehend it will be found, in connection with what has been stated in the preceding paragraph, that the nature and the varying appearance of the nucleolus of Dr. SCHLEIDEN may be thus explained.

329. Each of the objects in the germinal vesicle (*c*) which I have called cells or incipient cells, presents with more or less distinctness, an interior indicating the operation there of a process essentially the same (see Plate XXIII. fig. 169.) as that which gives origin to the concentric layers, in one of which the object itself is contained.

330. The germinal vesicle passes from the globular into a flattened form †. In the ovum, Plate XXII. fig 158, it resembled in its form the crystalline lens of the eye (fig. 159.). It also becomes very much enlarged ‡.

331. The position of the germinal vesicle does not change, but it becomes more determinately applied to the investing membrane than in the immature ovum; whence the peculiar form of this vesicle in fig. 159. The pellucid part of the altered germinal spot, at which the foundations of new cells arise, is directed towards the surface of the ovum (figs. 156 to 167.) §. More particularly, the part in question is directed towards an attenuated region or an orifice (figs. 165. 167.), to be presently mentioned as observed in the thick transparent membrane *f*. In one or two instances, indeed, this part appeared as if protruded into the orifice; and I could not discern a continuation over it of the membrane of the vesicle.

Preparatory Changes in the thick transparent Membrane, or "Zona Pellucida."—The Point of Fecundation.

332. In my "Second Series," it was stated that I had found Spermatozoa on the ovary ‖. From the facts just mentioned, and those about to be recorded, it may, I think, be inferred that the fecundating element of the seminal fluid penetrates, not only into the ovary, and into the interior of the ovum, but into the germinal vesicle,

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pearance after maceration ("Second Series," *l. c.*, Plate V. fig. 89. *b.*), for each of the several layers of incipient cells into which a nucleus resolves itself, we shall hereafter find frequently to become circumscribed by a proper membrane.

† Resembling that figured by R. WAGNER in a very mature ovarian ovum of the Frog. (Beiträge zur Geschichte der Zeugung und Entwickelung, tab. ii. fig. 6. *d.*).

‡ See the Table of Measurements, par. 429.

§ R. WAGNER remarks, with reference to the unaltered spot, that it appeared to him to be always directed towards the surface of the ovum (Beiträge, &c., p. 24.).

‖ A note was added, yielding the priority of this discovery—made, however, in another Mammal, the Dog—to Professor BISCHOFF.

and even into a certain part of the altered germinal spot. We have seen this part tending towards the surface of the ovum. I have now to add, that in that region of the thick transparent membrane *f*, towards which this part was tending, I have in many instances observed an attenuation or an orifice. This has been noticed not only as early as the fourth hour (fig. 165.), but in very mature ova †, even *ante coitum*. The form of the orifice in question is sometimes such as to suggest the idea of the membrane having become cleft; in some instances appearing to have been first attenuated also.

333. Should this observation be confirmed, I think we shall be in possession of very strong presumptive evidence that the central part of the altered germinal spot is the point of fecundation. In further proof that such really is the case, another fact will be hereafter given (par. 346.).

334. On one occasion, in an ovum of $5\frac{1}{4}$ hours (fig. 167.), I saw in the orifice of the membrane *f*, an object very much resembling a Spermatozoon which had increased in size. Its large extremity was directed towards the interior of the ovum. Fig. 168. represents a portion of this object; the remainder having been too indistinctly seen to admit of delineation. The part figured seemed discoid in its form, and appeared to contain a pellucid and nearly central cavity ‡.

335. Around the orifice in the membrane *f* (Plate XXIII. fig. 173.), the tunica granulosa presents the effects of the determinate pressure by which the ovum had been held in contact with the wall of the ovarian cavity §.

Preparatory Changes in the Substance by which the Germinal Vesicle is surrounded.

336. This substance, usually called the "yelk," was described in my last paper, as ceasing to contain separate oil-like globules when the ovum becomes mature; and as presenting a peripheral stratum which sometimes appears granular, and at others seems to consist of vesicles (cells), pressed together into a polyhedral form, its centre being fluid. The accuracy of this description, several conditions of the ovum represented in Plate XXII. confirm; and later observations enable me, I believe, to point out the order of these different appearances, as well as the process to which they are referable.

337. If fig. 156. be closely examined, the substance lying under the membrane *f* will be seen to have consisted of a layer of very regularly elliptical and flattened objects, each of which contained minuter objects of the same kind, concentrically arranged around a pellucid point. These discoid objects, the containing as well as the con-

† From the same Rabbit as the objects in figs. 158. 159. This Rabbit exhibited marks of the most perfect preparation for the male.

‡ I am not prepared to say that this was certainly a Spermatozoon, but it seems proper to record the observation.

§ See remarks on the office of the Retinacula ovi in my "First Series." Philosophical Transactions, 1838, Part II., p. 86.

tained, are the foundations of cells; and it is important to observe, that all the cells met with in the ovum in this "Third Series" of Researches, have at first the same remarkable form, and seem to pass through a state essentially the same as that now described, and which is represented in outline on a larger scale in Plate XXIII. fig. 177. In the ovum Plate XXII. fig. 157. the objects on the inner surface of the membrane *f* appeared to have undergone partial liquefaction. Sometimes these discoid objects constitute a layer of considerable thickness (figs. 160. 167.); at others, the outer discs—or cells into which the discs have passed—seem more or less broken down, and a globular mass of smaller discs has come into view in the interior (fig. 162. 165.); and these smaller discs, in their turn, become pushed out by a fresh set into the external situation previously occupied by others, which have disappeared by liquefaction. In all the ova just referred to, there appeared to exist a central cavity filled with fluid. In the ovum fig. 160, a few pale globules were observed in this fluid.

338. Layers of the discs or cells in question are frequently seen to have become circumscribed by a proper membrane—the membrane *e* of my "First" and "Second Series." Such was the case with the layer lying under the membrane *f* in the ova figs. 162. 164. 165. 167. In other states of the ovum no such membrane is present.

339. It appears that one of these membranes having formed around the discs or cells under the membrane *f*, it subsequently disappears on the liquefaction of the objects it surrounds; when a new set of discs or cells, taking their place, becomes in like manner circumscribed by a proper membrane, destined in its turn to disappear. In like manner several membranes (*e*) successively arise and disappear in a single ovum, as layers of discs or cells become pushed out and take the place of previous layers. This will, perhaps, serve to explain why some observers have never seen a membrane under the thick transparent membrane *f*; for, as several of the figures in Plate XXII. serve to show, there are periods when no such membrane is present.

CHANGES IN THE OVUM IMMEDIATELY AFTER FECUNDATION, AND BEFORE THE OVUM LEAVES THE OVARY.

(These are represented in Plate XXIII. The ova there seen were of periods varying from $5\frac{1}{2}$ to 10 hours, and they measured in diameter from $\frac{1}{15}'''$ to about $\frac{1}{12}'''$.)

Changes in the Position, Form, and Internal State, of the Germinal Vesicle immediately after Fecundation.

340. It will presently be obvious that, without a knowledge of the fact that the germinal vesicle returns to the centre of the ovum †, it is not possible to learn the

† This remarkable alteration—occurring while the ovum is still within the ovary—was mentioned in my "Second Series," among the facts rendering it probable that the ovary is the seat of impregnation.

mode, the period, or the place of origin of the new being; or indeed to understand the ovum in any of its future phases.

341. In Plate XXIII. fig. 169. is an ovum of $5\frac{1}{2}$ hours, in which the germinal vesicle was apparently undergoing this change of place; a change which appears to me sufficient in itself to show that an ovum has undergone fecundation †. The vesicle had begun to regain its globular form. The point of fecundation, however, was still visible at the periphery; whence, and from the unclosed state of the fissure in the membrane *f*, I am disposed to think the ovum had not been long fecundated, for the point of fecundation is subsequently seen to occupy the centre of the germinal vesicle, as was the case in the ova, figs. 171. 173. 174. 180.; and soon after fecundation the orifice in question is no longer seen.

Changes in the Substance by which the Germinal Vesicle is surrounded.

342. In the ovum fig. 170. the germinal vesicle, having receded from the surface into the interior of the ovum, had become closely surrounded by a layer of cells, each of which presented a remarkably opake nucleus ‡. Subsequently this nucleus seems to resolve itself into cells, and the same origin of new cells appears to take place in its interior, as that which I have described in a former page (par. 326 to 328.).

343. It appears also that new layers of cells come into view internal to the layer just described; when a succession of the same changes takes place as those already mentioned. Layer after layer of cells makes its appearance in the interior,—often seen to have become circumscribed by a proper membrane (*e*),—while cells occupying a more external situation undergo liquefaction. (See the explanation of figs. 170 to 176.)

† I quote the following from a high authority. "*Difference between the fecundated and unfecundated ovum.*— In the first place, in reference to this subject, it would be interesting to know whether any material difference exists between the structure of the fecundated and unfecundated egg. Did any difference of structure exist, we should be disposed to look for it first in that part of the egg which is more immediately connected with the new being, viz. in its germinal portion; but we regret to say that the investigations of naturalists have not as yet pointed out any marked difference in a satisfactory manner. Nor can we with certainty fix on what part of the egg the influence of the male semen more immediately operates. Since the fœtus grows from the centre of the germinal layer, it has been commonly supposed that this is the part of the egg which is most immediately effected by fecundation, but we know nothing of this; and it might be held on the other hand, that the effect of fecundation operates on the rest of the contents of the egg in enabling them to be assimilated round the germinal centre or rallying point of the development of the new being." ALLEN THOMSON, in Dr. TODD's Cyclopædia of Anatomy and Physiology, Article "Generation," pp. 462 and 467.

‡ In the ova, figs. 170. 171., the situation of the germinal vesicle was not quite central. The cells surrounding it in these figures correspond apparently to the ellipsoidal mass figured in my "Second Series" (*l. c.*, Plate I. figs. 96 and 97.), as seen with a lower magnifying power.

Disappearance of the Orifice in the thick transparent Membrane ("zona pellucida") after Fecundation.

344. This orifice I have in no instance seen after the discharge of the ovum from the ovary†. It was distinct in an ovarian ovum of six hours (figs. 173 to 175.), certainly fecundated; in another ovarian ovum from the same Rabbit, which had also undergone fecundation, no trace of it could be seen. It is very possible, however, that in the latter instance, as well as in others where I have failed to find it, the opening was situated on the under surface of the ovum. Very probably the fissure, for such it generally seems, closes before the ovum leaves the ovary.

Changes in the Tunica granulosa immediately after Fecundation.

345. The cells of this structure undergo a remarkable alteration in position, size, form, and internal condition. Being first loosened and made less adherent to one another, they become club-shaped, greatly elongated (some of those in Plate XXVIII. fig. 245. measured $\frac{1}{30}'''$ in length), and connected with the thick transparent membrane *f* by their pointed extremities alone (Plate XXIII. figs. 173. 181., Plate XXV. fig. 195.). They present in their interior, at the large extremity, a pellucid space (Plate XXVIII. fig. 245. α.), apparently corresponding to the *enlarged nucleolus* of other cells‡. This space is surrounded by dark globules. Subsequently there is seen instead of this pellucid space, a cell-like object which contains a colourless and transparent fluid (fig. 245. β.), but does not exhibit any proper nucleus or "cytoblast," and the surrounding globules become scattered. At a later period (fig. 245. γ.), these cells of the tunica granulosa are found filled with other cells§.

CHANGES IN THE OVUM AFTER ITS DISCHARGE FROM THE OVARY.—ADDITION OF THE CHORION.

(These changes are represented in Plates XXIV., XXV., XXVI., and XXVII. The ova there seen were of periods varying from 11 to $76\frac{1}{4}$ hours, and they measured in diameter from $\frac{1}{14}'''$ to $\frac{1}{5}'''$‖.)

The Germ or Foundation of the New Being; its Place of Origin and Form; the Germinal Vesicle not a Nucleus, but a Parent-cell.—Reproduction of succeeding Cells.

346. In a former page (par. 327.) it was shown that the free portion of the germinal

† See, however, "Second Series" *l. c.*, par. 178. fig. 109, and par. 190.

‡ Compare with "First Series" *l. c.*, fig. 44. g^1, and fig. 73, "Second Series" *l. c.*, figs. 102. *g*, *g*, 88. 89. 93. 96. 97. *b.*, $105\frac{1}{2}$. 114. 115. 116. *bb.*, 118. 120. 121 A. B. C. D., 122. bb^1. 129. 132. 135. 138. 139. 148. 149. 150. 152. 153. 154. See also a great number of figures in the present paper.

§ The second and third of these conditions, however, so far as my observations have extended, are not generally met with until the ovum has been discharged from the ovary.

‖ Figs. 198 and 201. in Plate XXV., represent ova of only $5\frac{1}{2}$ hours from the *ovary*. Their unusually advanced state rendered it proper to place them among ova from the Fallopian tube.

spot having resolved itself into cells, layers of the foundations of other cells come into view around a point which had been the centre of the spot; and that these, enlarging, are succeeded by layer after layer of the foundations of yet other cells. The central point, it will be recollected, lies immediately under the orifice in the thick transparent membrane *f*, apparently for the purpose of receiving the fecundating element of the seminal fluid. It must be the point of fecundation. Here we saw a minute cavity, with dark walls, and containing a pellucid fluid. This point, as already stated, subsequently passes from the periphery of the germinal vesicle to its centre. In the latter situation, two incipient cells come into view (Plate XXIV. fig. 187. *bs*), having essentially the same form and general appearance as the cells of other parts of the ovum described in this memoir; but in general attaining a more considerable size (Plate XXV. figs. 198, 199. *bs*.), and being objects of much more importance. These two cells constitute the foundation of the new being,—that is, the germ.

347. In the ovum, Plate XXIV. fig. 191. *bs*., they measured in length $\frac{1}{50}'''$, and contained in a transparent fluid, a nucleus having a central situation. The nucleus of one of them is represented more highly magnified in fig. 192. Its external part consisted of the foundations of new cells. Its interior presented a cavity, apparently globular in form and filled with fluid, which was colourless and remarkably pellucid. The nucleus in this instance measured in diameter $\frac{1}{150}'''$; from which it will be seen that the cavity in its interior could not have exceeded about one-third of this size, namely, $\frac{1}{450}'''$, as the proportions were carefully observed in the drawing†.

348. The nucleus in each of the twin cells, which together constitute the germ, undergoes essentially the same changes as those presented by the germinal spot (par. 327. 328.); but seems to pass sooner than the centre of the altered spot to the interior of its cell‡. The nucleus having increased in size, dark objects—the foundations of new cells—come into view in its interior (Plate XXV. fig. 199. *bs*.); and these, enlarging, present a set having a still more central situation (fig. 200.). The pellucid centre of the nucleus eventually increases considerably in size (Plate XXVI. fig. 206.).

349. The two cells (*bs*) which constitute the germ distend, until they nearly fill the germinal vesicle (*c*). This takes place at the expense of the surrounding cells, with which it will be recollected that the germinal vesicle had filled (par. 326.). These surrounding cells, having successively enlarged, disappear by liquefaction; the outer layer of them being apparently the first to undergo this change. The inner layers § are at first pushed forth by the two distending cells (Plate XXIV. fig. 193. *bs*), but

† This remark is applicable to every other figure; so that where the size of the whole object is given (see the Table of Measurements, par. 429.), that of its parts may be inferred.

‡ It will be obvious why the central portion of the altered germinal spot continues up to a certain period at the surface of its cell.

§ These layers of cells within the germinal vesicle, and around the germ, are sometimes seen to be circumscribed by a proper membrane (fig. 193.); so that here, within the germinal vesicle, we find apparently the same process in operation as that above described (par. 339.) as forming proper membranes (*e*) under the thick transparent membrane *f*.

eventually liquefy, and thus the contents of the germinal vesicle (*c*)—again reduced to fluid—enter into the formation of the two central cells, these being destined to succeed it. The membrane of the germinal vesicle (*c*), distended to a large size,—and still present in the ova, figs. 193. 195. 198—disappears by liquefaction. This vesicle is thus, not a "cytoblast," as supposed by SCHWANN, but a parent cell: and of the numerous progeny of cells which arise within it, only two remain as its successors†.

350. While the changes just described are in progress within the germinal vesicle, membranes (*e*) continue to form and then disappear successively around the layers of discs or cells, by which this vesicle is surrounded (par. 339.). Those membranes present at this period a high refracting power (Plate XXIV. fig. 193, Plate XXV. fig. 194. *e*.), and in some instances resist considerable pressure without being ruptured‡. Very soon, however, the substance they invest has wholly disappeared, and its place is occupied by colourless transparent fluid. In this fluid there are often found solitary cells, the remains of the substance just referred to (Plate XXVI. fig. 206.). It is also very common to meet with these solitary cells in previous conditions of the ovum (Plate XXIV. figs. 187. 193.), before the last of the membranes *e* has disappeared§.

351. An appearance frequently met with as the cells which surround the germ attain their greatest size, is represented in Plate XXIV. fig. 188, and more highly magnified in fig. 189. It seems to be produced in the following manner. Every cell within the ovum, which attains a size admitting of examination, appears to be filled with the foundations of other cells, arisen in the manner before described, and arranged in concentric layers around a pellucid cavity. The outer layers liquefy, leaving the central ones as dark isolated objects in a comparatively transparent fluid (fig. 189.). The membrane of the cell remains. Between the membranes of these cells there are also minute cells present in great number, which also have a high re-

† In my "Second Series" (*l. c.*, par. 317.) I erroneously applied the term "parent cell" to the membrane *e*.

‡ "Second Series," *l. c.*, par. 171, Plate VI. fig. 103. β.

§ The membranes *e*, instead of liquefying, may perhaps contribute to the thickening of the thick transparent membrane *f*. Some observations mentioned in my "First Series" (*l. c.*, Plate V. fig. 17. *f*, *e*.) suggest, indeed, the consideration whether the membrane *f* may not be *formed* by a succession of the membranes *e*. The membrane of the ovisac (*h*) was stated in that memoir (*l. c.*, par. 23.) to appear to form around a mass of granules, since found to be cells. I have now to add, that these cells seem to coalesce for the formation of that membrane; and not only for its formation, but for its thickening also (compare in my "First Series" the thickness of this membrane (*h*) in certain figures of Plate VIII. with its original condition in Plate V.); the membrana granulosa appearing to be the medium through which the latter part of the process is effected. It would thus appear that the ovisac (the foundation of the Graafian vesicle) is a great cell, as well as possibly the thick transparent membrane *f*. The substance surrounding the germinal vesicle in certain states, exhibits changes similar to those presented by a nucleus; namely, a succession of discs or incipient cells in concentric layers, and the formation of a membrane, or rather a succession of membranes, *e*, at the surface of those layers (par. 339.). So that the substance in question seems to be a great "cytoblast."

fracting power. The ovum Plate XXIII. fig. 179, from the ovary, presented an appearance which differed only in degree from that just referred to; and I do not recollect to have met with the twin cells in stages such as those represented in Plate XXIV. figs. 191. 193, Plate XXV. figs. 196. 199, without finding them invested by minute dark objects, of apparently the same nature.

351½. The greatest size to which the germinal vesicle distends I do not know. In the ovum Plate XXV. fig. 198. it had a diameter of $\frac{1}{25}'''$; that is, I believe, double what it had been seen to measure before fecundation in this animal†. In another instance (Plate XXIV. fig. 193.) it was as large as $\frac{1}{22}'''$. I am disposed to think that this vesicle sometimes attains a still greater size; and indeed that its membrane may continue until after the disappearance of the last of the membranes *e*; for states of the ovum are met with, in which it is not easy to determine whether the membrane surrounding the central sphere of cells (Plate XXV. fig. 204.) is that of the enlarged germinal vesicle, or the last of the membranes *e* in a very attenuated state. In those figures where neither *c* nor *e* is affixed to the representation of a membrane in this situation, it may therefore be inferred that I have felt uncertainty in this respect.

352. It has been already shown that the germinal vesicle—or original parent cell—disappearing, twin cells succeed it (Plate XXVI. figs. 206. 207. 208.). I have now to add, that each of these twin cells gives origin to two others, making four (fig. 209.); that each of these four, in its turn a parent cell, gives origin to two, by which the number is increased to eight (figs. 213 A. 213 B.); and that this mode of augmentation continues, until the germ consists of a mulberry-like object, the cells of which are so numerous as not to admit of being counted (Plate XXVII. figs. 230. 231.). Together with a doubling of the number of the cells, there occurs a diminution of their size. This will be easily seen on reference to the figures, these being for the most part on the same scale.

353. Nor does the mode of propagation continue the same with reference to number only. The process inherited from the germinal vesicle by its twin offspring, reappears in the descendants of these. Every cell, whatever its minuteness, if its interior can be discerned, is found filled with the foundations of new cells into which its nucleus has been resolved. These foundations of new cells at an early period (in the existence of a parent cell) are arranged in concentric layers around a pellucid point (Plate XXVII. fig. 230.); subsequently they are larger (fig. 231.); at a later period, when the outer layer has partially liquefied and presents its remains as minute cells (Plate XXVI. fig. 210.), the inner cells have increased in size; and at a period still more advanced, each cell presents two (fig. 222.) destined to succeed the parent cell, the others having disappeared by liquefaction. It is very possible, however, that though the same in kind, the process may, with a diminution in the size, lessen in degree. The number of concentric layers, for instance, arising in such minute cells as those

† The Rabbit.

Plate XXVII. fig. 230, may not equal the number arising in the germinal vesicle or original parent cell.

354. Very interesting states of the germ are met with, representing the transition between what in my last memoir, for a temporary purpose, were denominated "stages." Two or three of these will be found among the figures, and may serve as specimens of these transition states. Thus in the ovum Plate XXVI. fig. 211, there were present five cells, namely, three large ones, the membranes of each of which seemed about to liquefy and give birth to a progeny of two; and two small ones just brought forth by their now vanished parent cell, which (before its disappearance) had made the fourth of the large cells in the figure. Again, in the germ fig. 215. the number of cells was more than eight, but less than sixteen. Here most of the cells were of equal size; but among them were cells considerably smaller, so that the state seemed comparable to that in fig. 211, though differing from it in the size and number of the cells.

355. The cells are at first elliptical, like the discs of which they are an altered state. Their form is subsequently globular. In the first set (Plate XXVI. figs. 206. 207. *bs*), the dimensions of the containing cavity scarcely admit of this change in form. But there is sometimes observed a tendency to undergo it (fig. 208.), and flattening occurs where the two cells are in contact with one another (fig. 207. and "Second Series," *l. c.*, Plate VIII. fig. 143.)†. That such an alteration in the form (from elliptical to globular) takes place, we obtain an interesting proof on comparing figs. 207. 211 and 212. The cells contained in the twin cells of fig. 207. were elliptical; corresponding cells in fig. 211. had become globular. The two small cells of this figure, which had been liberated, were less elliptical than those still within the parent cells. The outer cells in the germ (*bs*) of fig. 212. corresponded to the elliptic cells in fig. 211, but had undergone the usual change in form. The *inner* cells of the germ (*bs*) in fig. 222. were still elliptical; those in fig. 208. had become nearly globular. And in all later stages of the germ where cells have reached their maturity, the same change in form is found to have taken place (Plate XXVI. fig. 220. Plate XXVII. figs. 223. 224.)‡.

356. A difference in size frequent in the first set of young cells (Plate XXVI. figs. 207. 208.), appears to be the cause of unequal size sometimes observed in the succeeding set (fig. 209.).

† Having in my "Second Series" (*l. c.*, par. 306.) expressed a doubt whether the two objects contained within the ovum in Plate VIII. fig. 143. of that memoir were two yelk-balls, I have now to state my conviction that such was not the case; but that the figure in question exhibits a condition of the germ approaching (but earlier than) that in the present paper, Plate XXVI. fig. 207, the interior of its two cells not having been distinctly seen, with the magnifying power then employed.

‡ The transitory cells which liquefy as the two essential cells advance (par. 349.) do not perhaps, in general, attain the globular form. They often resemble mere discs, the surface of which is membranous, and the most superficial part of the interior of which has passed into fluid. Where, however, such transitory cells escape liquefaction for a while (par. 350.), they become globular.

357. The outer cells of the germ are often more transparent in and near the centre than under their membrane (figs. 210. 216. *bs*). This seems referable to the presence, in and near the centre, of cells which are attaining their greatest size; while under their membrane there is a layer of dark objects. The latter seem to be the foundations of new cells, and probably formed the central part of the interior of larger cells, the membranes of which have disappeared by liquefaction. Subsequently these peripheral dark objects become situated *between* the advancing inner cells, and then we meet with such appearances as those in figs. 218. 221. We thus find that the process described as in operation within the germinal vesicle, and as producing the changes in appearance of the substance surrounding it (par. 351. and Plate XXIV. figs. 191. 193, Plate XXV. figs. 196. 199, Plate XXIV. figs. 188. 189. 179.), manifests itself even in the minutest cells which can be examined. States of the entire ovum are also met with, which, as viewed with a low magnifying power, very much resemble the condition of one of the minute cells in question, and undoubtedly from the same cause; namely, that which has been now described.

358. In each of the cells Plate XXVII. fig. 229. *bs*, an object remained at the periphery; so that each cell with this object resembled the germinal vesicle with that particular state of the germinal spot in Plate XXII. fig. 156. The object in question in the cells fig. 229. corrresponded in its situation to that known as the nucleus of the cell, or "cytoblast"; but its free part seemed on the point of being resolved into other cells, the central part presenting a finely granular appearance, and a point in the middle, which in some instances was pellucid, and in others dark. In the cells fig. 230. *bs*, such an object was situated, not at the periphery, but in the centre of each cell. The object here seen, however, corresponded only in *appearance* to the object in fig. 229; for that portion which in fig. 229. seemed about to become resolved into new cells, had in fig. 230. actually formed them, and they filled the parent cell; while the inner portion, which in fig. 229. had a finely granular appearance, now presented in its turn the foundations of new cells.

The rudimental Embryo is the Nucleus of a Cell.

359. A vesicle discovered in my "Second Series" and described as containing "the true germ"† (*l. c.*, Plate VI. fig. 113.), is present in such states as those represented in Plate XXVII. figs. 223. 224, but not easily seen. It is shown in outline in fig. 223, in or near the centre of a group of cells (*bs*); and in fig. 225. is delineated its apparent state, as seen in the group fig. 224. The nucleus, however, was the only part of this cell which could be distinctly seen. Other appearances of this object are represented in figs. 226 and 228. In subsequent conditions the cell has sometimes appeared quite dark (fig. 232.), apparently from globules in its fluid; in other instances it has been found much more transparent (fig. 233.). In fig. 228. the nucleus

† In strictness, this term belongs rather to the objects to which I have applied it in the present memoir, namely, to the twin cells *bs* as well as to their successors *bs*, and therefore to the *whole group, or entire mulberry-like object*, containing the vesicle above referred to, and including that vesicle itself.

was still at the periphery of the cell. A nucleus resembling that in fig. 226. is seen more highly magnified in fig. 227.

360. This nucleus is the object which in my "Second Series" was traced from a spherical into a linear form; in some stage of which latter state, it appears to correspond to the "primitive trace" of authors on the ovum of the Bird; and, as then shown, it is the rudimental embryo. I then stated it to be the nucleus of a cell (*l. c.*, par. 300.); and from what has been made known in the present memoir in connexion with facts recorded in my last, it appears that the same process by which a nucleus in one instance transforms itself into the embryo, is in operation in another instance where the product does not extend beyond the interior of a minute and transitory cell. Making allowance, indeed, for a difference in form and size, the description given of the mode of production of the one, might be applied to the other†. It was shown (*l. c.*, par. 212.) that in the production of the embryo out of a nucleus, layer after layer of vesicles or cells comes into view in the interior, while layers previously formed are pushed further out; each of the layers being so distinctly circumscribed as to appear almost membranous at its surface. The same membranous appearance we now find to present itself at the surface of the several layers of a nucleus in many situations. See, for instance, the nuclei in the twin cells Plate XXV. figs. 199 and 201. And I have very often found that layers of incipient cells, arising as they do out of a nucleus, appear circumscribed by a membrane. Many instances of this kind have been referred to in former parts of this memoir (par. 349 *Note*.). We saw such membranes forming around the incipient cells within the germinal vesicle (Plate XXIV. fig. 193.), as well as around those of the so-called "yelk" (Plate XXII. figs. 162. 164. 165. 167, Plate XXIII. figs. 172 to 176. *e*.). Farther, in the formation of the embryo, it was shown that the new layers of altered nuclei or cells come into view around a pellucid centre‡; and we now find that a corresponding centre gives origin to similar appearances in every nucleus described in the present memoir§. The altered nuclei or cells, moreover, of which the layers of the embryo are composed‖, present an interior denoting a repetition of the same process. The same finely granular ap-

† In my "Second Series" a note was added (*l. c.*, par. 193. *Note*), admitting the possibility of the nucleus in question disappearing by liquefaction, and of a linear object—corresponding to the "primitive trace" of authors on the ovum of the Bird—arising in its place. The erroneous statement by authors on "cells," that the nucleus is absorbed, misled me into that admission; and I have now to state that I adhere to the opinion originally expressed, that the embryo is the altered nucleus of a cell, and that the "*primitive* trace" of authors appears to be no other than this same nucleus in a comparatively *advanced* stage.

‡ It was shown that this mysterious centre is present until it has assumed the form of the cavity, including the *sinus rhomboidalis*, in the central portion of the nervous system.

§ "Second Series," *l. c.*, pars. 197. 209. 212 to 215, Plate VII. figs. 118. 121 A. 121 B. 121 C. 122. 123.

‖ Ibid. pars. 300. 305. Plate VIII. fig. 149. The "vesicles" represented in this figure, as contained the one within the other, seem to have been the membranes with which the several portions of a nucleus may appear circumscribed, when resolved into cells. We are now also prepared to understand that in my "Second Series," the space between the membrane of an outer and the membrane of an inner "vesicle" should have *appeared* to be the place of origin of cells; and that they should have been first seen on the outer surface of the inner "vesicle" or "nucleus" (*l. c.*, pars. 303. 304.).

pearance, also, as that preceding the formation of discs or incipient cells in a nucleus, is met with, under the same circumstances, in the nucleus which gives origin to the embryo†.

361. In the ovum Plate XXVII. fig. 232. the germ (*bs*) was in a state assisting to describe the mode in which the membrane *f*, in some instances, becomes lined with cells. The group (*bs*) seemed to consist of two portions, an inner and an outer. The outer portion appeared to be expanding from the inner; that is, it was apparently on its way to the membrane *f*‡.

362. Another mode in which the cells of the mulberry-like group (*bs*) undergo the local change just referred to, is seen in Plate XXVII. fig. 233. Here a process was in operation, destined to bring most of them into contact with the membrane *f*, and at the same time to convey the elliptic cell into a like situation. This process consisted in the gradual formation of a cavity at a certain part of the interior (see the figure). Usually, however, I have seen the changes in question to take place in the manner represented in my last memoir §.

363. During the changes referred to in the two preceding paragraphs, the cells no doubt multiply by the origin of new ones in their interior ||, and in proportion to the extent of surface (*f*) which they are required to line. There is every reason for supposing that subsequently also, after reaching this situation, they increase in number by the same means.

364. The facts above recorded will show that I am not enabled to confirm Bischoff's conjecture, referred to in my last memoir: "that in the first place all the yelk-granules are inclosed in two, then in four, then in eight, &c. cells ¶." But these facts strengthen the analogy pointed out in that memoir, between the early changes in the ovum of the Mammifera and the divisions previously known to occur in the ovum of Batrachian Reptiles, and some other animals; and it is almost superfluous to add, that I suppose the process in all to be essentially the same††, and that it is in operation in the ova of other animals‡‡. I believe it has hitherto been usual to re-

† "Second Series," par. 197. (Plate VI. figs. 113 to 116. *bb*. Plate VII. fig. 121 C.).

‡ Compare in "Second Series," Plate VI. fig. 110. with fig. 111.; and see in that memoir remarks on the probable mode of origin of the cells lining the membrane *f*, par. 318. *Note*.

§ *L. c.*, Plate VI. figs. 111. 112. 113.

|| It will be recollected that in such a stage *two* nuclei were on one occasion seen in the same cell ("Second Series," *l. c.*, par. 180. *Note*, par. 318. *Note*).

¶ R. Wagner's Lehrbuch, &c., p. 101.

†† We can now understand the very large size of the germinal vesicle as observed by R. Wagner in the mature ovarian ovum of the Frog (Beiträge, &c., tab. ii. fig. 6. *d*.).

‡‡ Professor Rathke says, "The yelk of the Crustacea—and also the yelk of other animals—presents appearances, which warrant us in concluding, that at the time when the embryo forms and becomes developed, it [the yelk] is not merely a magazine of inert nutrient material, but rather leads a very powerful life, so that—at all events when the germ first arises—we might compare it to a particular organism, and subsequently to one of the organs of an animal being. For, in the first place, in the ova of *Palæmon* and *Crangon*, before a trace of the embryo is visible, the single grains, of which the yelk consists, are seen so to group themselves that they

gard the round white spot or cicatricula on the yelk of the Bird's laid egg as an altered state of the discus vitellinus in the unfecundated ovarian ovum. So far from thinking that such is the case, I venture to believe that the whole substance of the cicatricula in the laid egg of the Bird has its origin within the germinal vesicle in the same manner as in the ovum of Mammalia†, and therefore that the cicatricula in the Bird's laid egg may properly be called the germ‡.

No fixed Relation between the Degree of Development of Ova and their Size, Locality, or Age.

365. In my last memoir it was shown that at early periods the several parts of the ovum do not necessarily keep pace with one another, and that there is no fixed relation between the size of the entire ovum and the degree of development of its most essential part. Of the latter fact, many figures in the present paper afford further proof, and show that the statement is applicable to ova still within the ovary§. The ovarian ovum Plate XXII. fig. 162, measured $\frac{1}{11}'''$, though it had not undergone fecundation‖. That in Plate XXIII. fig. 172, was certainly fecundated, but it measured only $\frac{1}{15}'''$. The ovum Plate XXV. fig. 196, measured $\frac{1}{6}'''$, but was less advanced in the essential part than that in fig. 198, which had less than half its diameter. Several other instances of this kind will be found on comparing the figures. The large size, however, which ova in some instances attain without the germ being proportionably developed, is referable mainly to the quantity of fluid imbibed by the chorion; for before the formation of this membrane the irregularity in question is not so great. This will be seen on reference to the Table, par. 428, in which the measurements of the chorion and membrane *f* in many ova have been recorded¶.

366. There are two other ways in which irregularity occurs, namely, in regard to time and place. The ovum Plate XXV. fig. 196, was taken from a Rabbit killed sixty-six hours *post coitum*; that in fig. 198, though more advanced, was only 5½ hours old, that is one-twelfth the age. And if these two ova be compared with regard to their local situation, the difference will be found equally remarkable. The older and larger, but less developed ovum, fig. 196, was found in the uterus; the younger and smaller but more developed ovum, fig. 198, was still within the ovary. These, however, are

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enter entirely into the formation of single accumulations, which through furrows and a pellucid substance become separated from one another, but subsequently again become confluent and coalesce." (Zur Morphologie Reisebemerkungen aus Taurien, p. 102.)

† The principal of the changes producing it having, perhaps, taken place before the ovum left the ovary.

‡ See also "Second Series," par. 318. and *Notes*.

§ As the ova for the most part are shown as magnified the same number of diameters, the fact here referred to may be easily attested by inspection of the Plates.

‖ It was taken indeed from a Rabbit which had not had connexion with the male.

¶ If the figures in Plate XXVII. be compared, it will be seen, however, that fig. 234, an ovum among the most developed in its essential part, has a very small membrane *f*.

rare instances of deviation, and by far the most remarkable which I have met with in stages so very early.

367. There is yet another species of irregularity. Ova found with the one in Plate XXV. fig. 196, just referred to, were duly advanced in their development, though the less developed ovum had kept pace with them in its passage through the oviduct†.

368. Vesicles such as those mentioned in my last paper, *l. c.*, par. 227, as having been found in the Fallopian tube, I am now enabled to state are of frequent occurrence, and often measure $\frac{1}{8}'''$ to $\frac{1}{7}'''$. These vesicles generally contain only a transparent fluid: granules or cells, such as those in Plate VIII. fig. 136. of my "Second Series," being rarely seen. The resemblance between the vesicles in question and the thick transparent membrane (*f*) of the ovum, is too remarkable not to induce the belief that these objects are identical; and the vesicles occur so frequently, that I venture to regard them as the remains of ova escaping from the ovary without fecundation. Should others—on finding such vesicles—be of this opinion, physiologists may be thus assisted in determining a question on which they are not agreed.

The Chorion formed of Cells arising in the Oviduct.

369. The observations made known in my "Second Series" on the mode, the period, and the place of origin of the chorion, I now confirm. That the thin membrane there described, as rising from the thick transparent membrane *f*, and imbibing fluid, is really the incipient chorion, was shown by tracing it from stage to stage up to the period when villi form upon it. There remained, however, two questions undecided, namely, whether the chorion is formed of cells; and if so, whether the cells are those of the so-called "disc" brought with the ovum from the ovary.

370. I have now to state that the chorion *is* formed of cells; and that these cells are *not* those of the "disc" brought with the ovum from the ovary.

371. It has been already mentioned (par. 345.) that after the fecundation of the ovum, the cells of the tunica granulosa are found enlarged, club-shaped, in contact with the membrane *f* by their pointed extremities alone, and as it were radiating from the ovum (Plate XXV. fig. 195. g^1.). In this state of its surrounding cells—and accompanied by the retinacula, more or less advanced in liquefaction—the ovum leaves the ovary.

372. In Plate XXIV. fig. 185. is represented an ovum of 14 hours, found in the Fallopian tube at its middle part. The membrane *f* was invested by cells which together seemed to form a sort of mosaic work. On examining them closely, however, these cells were found at many parts to have coalesced, and this was especially the case on the left side (see the figure). Their appearance was very different from that of the cells surrounding the ovarian ovum; the former being much more minute, and having

† In this instance four ova were found at the uterine extremity of the Fallopian tube, and three in the beginning of the uterus; one of the latter having been that in Plate XXV. fig. 196.

a very different interior and form. Some of these cells are shown more highly magnified in Plate XXVIII. fig. 253. α.; which presents also a portion of the membrane *f*. Some of the same cells (fig. 253. β.) were observed lying near the ovum. These cells had sent out processes, which at α were seen to have become interlaced, and in part to have coalesced. A central pellucid space, present in each of these cells, and originally round (β), had changed its form in many of the cells α, and seemed to be following the direction of the interlacing processes. These cells having gradually collected around the thick transparent membrane (*f*), and interlaced, by coalescing form the incipient chorion.

373. In fig. 252. is seen a state rather earlier than that in fig. 253†. Here (α) the pellucid centres were still round, and the interlacing arms or processes of the cells had scarcely begun to coalesce. At β in this figure are some of these cells which had a more superficial situation on the same ovum. They were not so close together as the preceding (α), to which they had probably been *added*. It appears indeed to be by additions of cells, thus made externally, that the chorion thickens (see Plate XXVI. figs. 211. 212, Plate XXVII. figs. 229 to 234. *cho.*), and it would not be easy to determine when these additions cease, or indeed whether they cease at all before the addition of villous tufts, which I am very much disposed to think are formed by the same kind of cells. These cells will be particularly referred to in a future paper‡.

374. In Plate XXIV. figs. 186. 187 and 189. the incipient chorion is seen to have been just beginning to imbibe transparent fluid, and to rise from the membrane *f*. Whether the so-called "disc" brought with the ovum from the ovary contributes to supply this fluid, I do not know; but when the chorion is in an incipient state, many of the cells of the "disc" are sometimes found lying around it; and in other instances there is in the same situation, a transparent fluid, which may possibly have arisen from the liquefaction of those ovarian cells.

Application of some of the foregoing Facts to the Physiology of Cells.

375. Existing views regarding "cells" have been already briefly stated (par. 324). The Appendix contains them more in detail.

376. Presuming that what is known regarding cells warrants the conclusion that they have essentially the same structure in animals and plants, I offer the following remarks as applicable equally to the animal and vegetable cell§. And as researches have hitherto related chiefly to the cells of plants, I shall refer for the most part to what has been published respecting these.

377. That I have found the nucleus at the surface of its cell, is shown by figures in the present and in the two preceding memoirs. As this, however, rarely continues to be its situation at the period I have investigated, it may be proper to compare my

† Fig. 252. was taken from an ovum of 11 hours; fig. 253. from an ovum of 14 hours.

‡ I think it very probable however that there is an origin of new cells within those already coalescing.

§ Except in those instances where reference is made to structures belonging exclusively to plants.

observations with those of others, on the appearance and the destination of this very important structure, when it does not continue at the surface of the cell.

378. The first question is,—which of the objects figured by me in the present "Series," correspond to the nucleus of authors? No one will doubt that the object eccentric in one of the twin cells Plate XXV. fig. 203, is to be considered as so corresponding; an object resembling the "corpuscle" or nucleolus of SCHLEIDEN, being also present in its centre. Nor is it to be supposed that any question will arise as to the identity of that nucleus with the central nuclei in, for instance, the twin cells *bs* of Plate XXIV. fig. 191. It is obvious that they differed only in local situation; the nucleus in fig. 191. having passed to the centre of its cell. Thus far then my observations accord with existing views; but, I am compelled to say, not any farther.

379. SCHLEIDEN remarks, that in its original position the nucleus (or "cytoblast") "accompanies the cell which it has formed through the whole vital process, if it be not (as in cells destined for higher development) dissolved and absorbed—cast off as a useless member. This disappearance of the nucleus takes place either *in situ*, or it is first thrown into the centre of the cell†."

380. Let us now trace the appearances presented by the nucleus, according to my own observations, after it has passed to the centre of the cell. In the ovum Plate XXIV. fig. 191, as seen highly magnified (fig. 192.), the outer portion of the nucleus seemed to consist of the foundations of new cells. The corresponding part in Plate XXV. fig. 199. had enlarged, and an inner part come into view. Fig. 200. presents an ovum in which the twin cells had become filled with concentric layers of objects, which on close examination were found to be no other than the foundations of new cells. From the presence of such objects in the nucleus Plate XXIV. fig. 187, and from the condition of the latter in fig. 193, and Plate XXV. figs. 194. 196, it will perhaps be admitted that, in these instances, the place of the original nucleus of the cell, or "cytoblast," was occupied by the foundations of other cells, which, in some cases, had been pushed further out by fresh sets arising in the interior.

381. Now in this "Third Series" of researches, I have not met with any nucleus in which the same succession of appearances was not either directly witnessed, or to be inferred. The germinal spot—obviously a nucleus—was particularly traced (pars. 327. 328.), and the germinal vesicle found to fill with more or less incipient cells in a manner essentially the same as that just described. The substance surrounding the germinal vesicle, in the ovum Plate XXII. fig. 156, consisted of elliptical and flattened objects, having an interior not materially differing from that above referred to; and a similar condition of that substance will be found in many other figures.

382. But further, on closely examining the discs or foundations of cells successively coming into view in the manner above mentioned, we find in their interior a repetition of the same appearances—the foundations of yet other cells. This I have attempted to illustrate in outline in Plate XXIII. fig. 177, which I beg to state represents nothing theoretical,—nothing more than I have actually seen. For instance,

† Appendix, par. 425.

the interior of each of the larger objects in the germinal vesicle Plate XXIII. fig. 169. *c*, presented an appearance fully warranting the section fig. 177; though it was not possible to represent this appearance in that small figure. The section fig. 177. is, in fact, a delineation of one of the objects in the substance surrounding the germinal vesicle in an ovarian ovum of 8¼ hours. And in no object of the kind sufficiently advanced, and the interior of which the eye could reach, have I failed to find traces of a structure essentially the same (see Plate XXV. figs. 200. 201.).

383. Only a first and second order of discs or incipient cells have been exhibited in that section (Plate XXIII. fig. 177.), because I wish to figure nothing more than has been actually seen. But my experience of these objects is such as to warrant the belief that more orders might have been introduced. Indeed it is not possible to say where the process ends, except in liquefaction.

384. In following out this process we have thus seen the nucleus, and especially its centre, to be the seat of changes which were not to have been expected from the existing doctrine, that the disappearing nucleus has performed its entire office by giving origin at its surface to the membrane of a single cell. It is the mysterious centre of a nucleus—the germinal spot—which is the point of fecundation, and the place of origin of two cells constituting the foundation of the new being. The germinal vesicle is the parent cell, which, having given origin to two cells, disappears, each of its successors giving origin to other two,—and so on. Perpetuation, however, at this period consists, not merely in the origin of cells in cells, but as we have seen, in the origin of cells in the pellucid centres of the nuclei of cells†.

385. The quotations in the Appendix I think will be found to contain internal evidence of SCHLEIDEN having seen the nucleus undergoing changes such as those above described; but he was far from recognizing them. This author states that the nuclei —or, as he calls them, the "cytoblasts"— "grow and diminish in their size." He found his nucleolus to present various appearances. In well-developed "cytoblasts" it resembled "a thick ring or a thick-walled hollow globule;" in those less developed, there was seen "only the outer sharp contour of this ring, and in its middle an opake point;" in "cytoblasts" still smaller, "only a sharply circumscribed spot;" in others, no more than "a remarkable, minute, opake point;" and in the smallest and most transitory, "it was not to be detected." He observed the diameter of the nucleolus to vary "from half that of the cytoblast to points immeasurably small." Sometimes the nucleolus appeared to him to be "more opake, at others more pellucid than the rest of the substance of the cytoblast."—In connexion with these observations of

† Dr. HENLE has described the "nucleus" of pus and mucus globules as becoming cleft or divided by acetic acid into roundish or oval parts, each having a depression in the middle. (VALENTIN's Repertorium, 1839, II. pp. 224, 225.) Compare with the minutest discs in Plate XXII. fig. 162. I think, however, that acetic acid shows rather the *existing state* of the object in question; this being in pus the eccentric *nucleolus* of a *cell*. Besides, the present memoir is full of facts demonstrating that division is a natural mode of reproduction of the nucleus and nucleolus, and apparently common to these objects everywhere. (All the figures which accompany this paper represent objects as seen without the addition of any substance whatever. They were viewed lying either in fluid from the Graafian vesicle, or in mucus from the oviduct.)

SCHLEIDEN, I refer to what has been above stated regarding the changes in appearance presented by the nucleus, from the resolution of its outer portion into cells, and the continual origin in the interior of the foundations of new cells, and hence the varying size of the central pellucid cavity (par. 327.); believing that the apparent growth and diminution, and the final "absorption of the nucleus," supposed by SCHLEIDEN, as well as the nature of his nucleolus, are to be thus explained. If so, however, it will be seen that the formation of the nucleus precedes that of the nucleolus, instead of being consequent upon it, as supposed by SCHLEIDEN†. There seems, in fact, to arise at the surface of the nucleus a succession of objects, each of which, in turn, is a nucleolus: and this after the formation of the cell. More particularly considered, the process seems to be as follows. The progressive resolution of the germinal spot into layers of incipient cells, has shown us that the formation of each successive layer is preceded by a finely granular appearance, the latter surrounding a pellucid fluid‡. It seems to be in this finely granular part that the discs or incipient cells come into view (Plate XXIV. fig. 192.). On the enlargement of the latter, an inner part, previously pellucid, is found to have become finely granular; but this also surrounds a pellucid central fluid, and so on. It would thus seem that the central pellucid fluid *becomes* finely granular. The ever-varying appearance called the nucleolus, I apprehend to arise from the refraction of light; the degree of which, and the particular situation in which it occurs, depend chiefly on two circumstances, namely, the condition of the granular substance by which the pellucid fluid is immediately surrounded, and the quantity of this fluid which is present. SCHLEIDEN considered the presence of *two* (or more) nucleoli as *exceptions*. I am disposed to regard them as constant at a certain period; and as denoting the origin of the two (or more) essential cells.

386. The discoveries of my friend Professor SCHWANN§—on the correspondence in the elementary structure of Animals and Plants—were referred to on a former occasion‖, as being among the most important that had ever resulted from microscopic observation¶. That excellent observer, however, did not attempt to conceal the fact, that he had met with certain difficulties, and was obliged to leave them for future explanation. For instance, with reference to the objects he considered hollow and pellucid nuclei,—differing as he found these to do in their appearance from the ordinary "cytoblast,"—he remarks††: "Observation on the transition-steps from the characteristic form of the nuclei of cells, must furnish the required explanation of

† This view of SCHLEIDEN on the mode of origin of the nucleus of the vegetable cell has been adopted by authors on the cells of animal tissues. VALENTIN, having given an abstract of the work of SCHWANN on Cells, remarks, "Nach diesen, so wie nach den Erfahrungen von J. MÜLLER, HENLE und dem Ref. stellt es sich also als Grundschema der ersten Bildung der Gewebtheile in der Thierwelt heraus, dass in einer Flüssigkeit, cytoblastema, sich Körnchen, Nucleoli niederschlagen und dass um diese sich grössere feinere Körper, Nuclei bilden."—Repertorium, 1839, II. p. 284.

‡ See also the rudimental embryo, "Second Series," *l. c.*, Plate VII. fig. 121 B, 121 C.

§ Mikroskopische Untersuchungen, &c.

‖ "Second Series," *l. c.*, par. 290.

¶ Those discoveries have also been mentioned in the present memoir (par. 324.).

†† *L. c.*, p. 211.

these cell-like nuclei. But a decision of the question is obtainable only through demonstration that the whole relation of such a cell-like nucleus is to a cell, the same as that of the ordinary nuclei of cells, namely, it must be shown that such a nucleus arises before the cell, that the cell forms itself as a layer around the nucleus, and that finally the nucleus is absorbed in the cell." Again, referring to the experience of SCHLEIDEN, that in plants it is nearly if not quite universal that new cells arise within previously existing cells, SCHWANN remarks†, "In animals—the formation of cells in cells is the rarer case, but happens in so far as that a three to four-fold generation may successively form in one cell.—In cartilage by far the most cells arise in the cytoblastema external to the cells already present." I shall think myself fortunate if any of the observations recorded in this or the preceding memoir, should contribute towards the solution of these and other questions.

387. In my "Second Series," after having applied the term "nucleus" to certain germinal vesicle-like objects observed in the cells of various parts‡, I suggested that perhaps the granules or globules surrounding those objects might, rather, have been the remains of a nucleus. I have now to state, that facts observed in the present "Series" confirm the view then taken. Thus the germinal vesicle-like objects in Plate XXVIII. fig. 245. α and β certainly correspond to those just referred to; and they are situated *in* that which had been the nucleus of the cell.

388. Now should it prove that I am right in considering the germinal vesicle-like objects of my "Second Series," and those in Plate XXVIII. fig. 245. of this memoir, as corresponding to the pellucid cavity in a nucleus, it will be obvious that the relation of such an object to a cell, is not "the same as that of the ordinary nuclei of cells." And since I cannot but regard those germinal vesicle-like objects as corresponding also to some of the "hollow," "pellucid," and "cell-like nuclei" of SCHWANN, I venture to believe that some light may have thus been thrown upon one of the difficulties left by that observer for future explanation.

389. From these remarks, however, it will be seen that I cannot adopt the opinion of SCHWANN, that the pellucid object in epithelium-cells is a "cytoblast." And facts made known in the foregoing pages show that the germinal vesicle itself cannot be so considered.

390. SCHWANN conjectures that the contents of the cell ("zellen-inhalt") may contribute to the secondary deposits observed to take place in plants on the inner surface of the membrane of the cell; and which, according to VALENTIN, always occur in spiral or other lines. SCHWANN had not observed such secondary deposits in animal cells; yet from the correspondence he has pointed out between elementary structures in the two kingdoms, I think the following may perhaps be worthy of consideration. SCHLEIDEN remarks§, "The formation of secondary deposits on the inner sur-

† *L. c.*, p. 204.

‡ *L. c.*, Plate VI. fig. 110, Plate VII. figs. 120. 121, Plate VIII. figs. 129. 130. 132. 150.

§ *L. c.*, p. 146.

face of the cell-wall does not commence, so far as I could observe, until after the absorption of the cytoblast." Now I would suggest that the "cytoblast," instead of being absorbed, resolves itself into discs or cells, thus furnishing in the first place the contents of the cell ("zellen-inhalt"), and, through these, the deposits in question. The same observer states "the interesting result, that the [spiral] fibres never form free, but always in the interior of cells;" and I would offer the same suggestion with respect to these.

391. SCHWANN† describes young cells in certain situations as at first perfectly transparent. "Gradually, however," says he, "they acquire a granular, yellowish appearance; and it is remarkable that this yellowish precipitate generally or always forms first around the nucleus." Does not such "precipitate" consist of the substance into which the free portion of the nucleus becomes resolved? The same observer states‡ that "In the gill-cartilage of the Tadpole many cells present a minute nucleus having lacerated contours, which is perhaps the cytoblast of these cells undergoing absorption." I venture to believe, that it may be the nucleus resolving itself into cells.

392. SCHWANN§ observed nuclei in some instances to enlarge, as SCHLEIDEN had done in plants. Compare in the present memoir the size and condition of the nuclei in the twin cells (*bs*) of Plate XXIV. fig. 191. with those in Plate XXV. figs. 199. 201.

393. SCHWANN has shown that in cartilage, cells occur in groups‖. With regard to these groups I would remark, that their appearance very much resembles that which would be presented by several generations of the twin cells of the germ (described in this memoir) inclosed the one within the other. And the resemblance suggests to me the idea that both result from the same process. SCHWANN offers as possible the following explanation. "These groups perhaps arise from two to four cells having formed in a parent cell, in which case each half of the cell-wall must consist of two layers, one of which corresponds to the wall of the parent cell, the other to the wall of the secondary cell; so that thus each partition wall of two groups must consist of four layers" (*l. c.*, p. 22.). Subsequently, however (pp. 113. 114.), he expresses doubt as to the sufficiency of such an explanation. We saw, in tracing the cells which successively enter into the formation of the germ, that very many of those into which the nucleus becomes resolved, disappear by liquefaction. Is it not possible—supposing cartilage to be formed by a like process—that, instead of liquefying, the supernumerary cells contribute to the thickening of the walls of the parent cell? We have seen too (pars. 351 and 357.) that minute cells (apparently from the interior of liquefied parent cells) become introduced between enlarging cells (Plate XXIII. fig. 179, Plate XXIV. figs. 188. 189.); and also that, however minute, cells seem to give origin in their interior to other cells. Now if, instead of disappearing by liquefaction, the minute cells so introducing themselves between larger ones were

† *L. c.*, p. 24. ‡ *L. c.*, p. 26. § *L. c.*, pp. 27, 28. ‖ *L. c.*, tab. i. figs. 8, 9.

to continue, and give origin to others in their interior, the resulting substance might increase to an indefinite amount. May not this be the mode producing the intercellular—that is, the real—substance of cartilage? I am the more disposed to think this possible, from the fact that in the gill-cartilage of fishes, SCHWANN found the intercellular substance to consist of the closely aggregated walls of cells.

394. Though ignorant of the precise nature of the process by which what were termed the divisions and subdivisions in the ovum were produced, I showed in my last memoir†, that it consisted in the origin of cells in cells; and suggested that it might admit of being extended to explain the increase of other cells. This opinion has been strengthened by the later observations,—which have enabled me in the present paper to communicate particularly the nature of the process,—as well as by the appearance of various cells incidentally observed. For instance, it has been very common to find the so-called epithelium-cells of the oviduct, filled with cells. Several of the varieties of these, some of them carrying cilia, are represented in Plate XXVIII. figs. 248 to 251. The cells of the so-called "disc" also (my tunica granulosa and retinacula), exhibit cells in their interior; and it is deserving of notice that in some instances the contained cells are only two in number (Plate XXVIII. figs. 245. γ, 247.). But on a former occasion we saw that the cells of which the entire embryo at certain periods is composed, are filled apparently with the foundations of other cells‡.

395. The experience of Professor SCHWANN, however, does not accord with these observations. He remarks§, "I have above mentioned an observation according to which, in the Tadpole, a young epithelium-cell formed within another. This, however, is a very rare case, and in all the Vertebrata most epithelium-cells decidedly do not form as cells in cells, but in a minimum of cytoblastema exuding from the cutis." And with reference to the experience of SCHLEIDEN, that in plants it is nearly or quite universal that new cells arise nowhere but in previously existing cells, SCHWANN remarks‖, "In animals—the formation of cells in cells is the rarer case, but happens in so far as that a three to four-fold generation may successively form in one cell.—In cartilage by far the most cells arise in the cytoblastema [intercellular substance, see par. 393.] external to the cells already present¶."

† *L. c.*, par. 314 to 317.

‡ "Second Series," *l. c.*, Plate VII. figs. 121 to 123, Plate VIII. fig. 150.

§ *L. c.*, p. 87.

‖ *L. c.*, p. 204.

¶ Judging from the delineations given by authors, I am more and more disposed to think the remarkable process of early development described in this memoir is in operation at all periods, and this for the production of morbid as well as healthy tissues. The process in question, as we have seen, consists first, in the foundations of young cells arising apparently in no other way than by divisions of the nucleus of a mother-cell, and secondly in the complete evolution of only two young cells, out of myriads which form. (The number continuing may in some instances be several; these two occupying a central situation.) That this process is not peculiar to the *period* which I have investigated, we have evidence I think in SCHWANN's delineations of the cells of cartilage (*l. c.*, tab. I. figs. 8. 9.) before referred to; and in figures by VALENTIN of ganglion-globules (Ueber die Scheiden der Ganglien-Kugeln und deren Fortsetzungen, in MÜLLER's Archiv, 1839, ii. p. 139. taf. VI. fig. 1. *a, b, e.*). And that it is not peculiar to *healthy* structures, is shown, I think, in some of the delineations given by MÜLLER of morbid growths. (Ueber den feineren Bau und die Formen der Krankhaften

396. The remarkable process described in this memoir as giving origin to the new being in the mammiferous ovum (as already said), is no doubt universal. I think that there is evidence of its operation in the ova of Batrachian Reptiles, some osseous Fishes, and certain of the Mollusca †; though the explanations given of these have been of a very different character ‡.

Comparison of the Germs of Animals and Plants.

397. SCHLEIDEN's description of the process by which the early changes in the vegetable germ ("embryo") are produced, is strikingly analogous in *some* respects to the one I have given of the incipient growth of the germ in the mammiferous ovum. This excellent observer, on the subject of the formation of cells in cells, states that the process "presents itself in the embryonal extremity of the pollen-tube, that is, in a very much elongated cell.***After the first cells, usually few in number, have formed, they rapidly distend so much as to fill the pollen-tube, and the latter soon becomes no longer visible as the old surrounding membrane. But immediately there arise in the interior of each of these cells several cytoblasts, which produce new cells, through the rapid distention of which the parent cells likewise cease to be visible and are absorbed. The same process is repeated, and so on. But as the newly arisen cells have less and less space for distention, and hence become more and more minute, the previous transparency ceases, through the constant generation of new cytoblasts taking place in the interior, and through the tissue becoming more and more compressed. From that period to the perfect completion of the embryo, the certainly logical inference leads us to the result, that the processes thus introduced continue the same, since no new force comes into action, which might determine us to admit a sudden change—more especially as we soon again meet with the same manifestation of vegetative power §." SCHLEIDEN then proceeds to show that the same process, by which the embryo arises, continues after the formation of the plant, and that cells never originate otherwise than in previously-formed cells. He says, in briefly summing up, "a simple cell—the pollen-tube—is its first foundation. In this arise cells; in them are developed other cells, and so on through life."

398. It will be seen that while it bears a general resemblance which is very striking, the description now quoted from Dr. SCHLEIDEN of the process to which the changes in the vegetable germ are referable, differs from that which I have given of

Geschwülste, I. Lief. Berlin, 1838; an excellent translation of which into English has been given by Dr. WEST.) I would refer particularly to the following figures of cells delineated by Professor MÜLLER; namely (WEST's translation) Plate II. fig. 14. (Carcinoma Mammæ simplex),—Plate III. fig. 2. (C. reticulare),—fig. 3^b. (C. alveolare),—fig. v. (Sarcoma of the Brain),—Plate IV. fig. 14. (Osteo-sarcoma),—Plate V. fig. 4. (Enchondroma).

† For instance, *Planorbis cornea* (JACQUEMIN, Nova Acta Acad. Cæs. Leopold. Nat. Cur. 1838, p. 637.).

‡ The last explanation is that of Professor BISCHOFF, quoted in my "Second Series" (par. 307. *Note.*).

§ *L. c.*, pp. 162. 163.

incipient growth in the germ of the mammiferous ovum, in the following respects; namely, SCHLEIDEN does not state that the nucleus performs any part in the formation of new cells; or that only two—of many cells arising—succeed the parent cell†.

399. Figs. 235 to 243 Plate XXVIII, copied from delineations by SCHLEIDEN‡, represent the vegetable "embryo" (germ) in very early stages. On comparing them with certain states of the mammiferous germ, I find it difficult to believe that they do not result from essentially the same process§. Thus the upper part of fig. 237. admits of comparison with the essential portion of the ovum in several figures of Plate XXIII.; the upper part of fig. 238. with *bs* in Plate XXVI. fig. 206; the upper part of fig. 239. with *bs* in Plate XXVI. fig. 212; the upper part of fig. 240. with *bs* in Plate XXVI. fig. 220; the upper part of figs. 241. 242. with Plate XXVII. figs. 233 and 234. In the last-mentioned figures, perhaps the "*punctum vegetationis*" of WOLFF (figs. 241. 242. *b*) is represented in the mammiferous ovum (Plate XXVII. figs. 233. 234.) by the rudimental embryo (*bb*), and the incipient cotyledons by the remainder of the germ.

400. Thus the germ of certain plants passes through states so much resembling those occurring in the germ of mammiferous animals, that it is not easy to consider them as resulting either from a different fundamental form, or from a process of development which, even in its details, is not the same as what has been above described; the fundamental form in question, in Mammalia, and therefore it may be presumed in Man himself, being that which is permanent in the simplest plants,—the single isolated cell||.

Recapitulation.

401. The almost universal supposition, that the Purkinjean or germinal vesicle is the essential portion of the ovum, has been realized in these investigations; but in a manner not anticipated by any of the numerous conjectures which have been published. The germinal vesicle becomes filled with cells, and these again become filled with the foundations of other cells; so that the vesicle is thus rendered almost opake. The mode in which this change takes place is the following, and it is one which, if confirmed by future observation, must modify the views recently advanced on the mode of origin, the nature, the properties, and the destination of the nucleus in the physiology of cells. It is known that the germinal spot presents, in some instances, a dark point in its centre. Such a point is invariably present at a certain period; it enlarges, and is then found to contain a cavity filled with fluid, which is exceedingly

† It is deserving of notice, however, that in reference to *Marchantia polymorpha* SCHLEIDEN states, "Of the cell-germs [cytoblasts] found in the spores, few only—at the most two to four—serve for the formation of cells; the others soon becoming covered with chlorophylle, and thus withdrawn from the vital process." (*l. c.*, p. 157.)

‡ *L. c.*, tab. iii. fig. 17. WIEGMANN's Archiv, 1837, tab. vii. figs. 13 to 15, and figs. 6. 7. 16. 17. 8.

§ See also a remark in my "Second Series," *l. c.*, par. 318. *Note.*

|| See remarks in my "Second Series," *l. c.*, par. 318. *Note*, par. 312.

pellucid. The free portion of the spot resolves itself into cells; and the foundations of other cells come into view in its interior, arranged in layers around the central cavity; the layers being pushed forth by the continual origin of new cells in the interior. The latter commence as dark globules in the pellucid fluid of the central cavity. Every other nucleus met with in these researches has seemed to be the seat of changes essentially the same. The appearance of the central portion of the nucleus is, from the above process, continually varying; and the nature of the nucleolus of SCHLEIDEN may perhaps be thus explained. The germinal vesicle, enlarged and flattened, becomes filled with the objects arising from the changes in its spot; and the interior of each of the objects filling it, into which the eye can penetrate, presents a repetition of the process above described. The central portion of the altered spot, with its pellucid cavity, remains at that part of the germinal vesicle which is directed towards the surface of the ovum, and towards the surface of the ovary. At the corresponding part, the thick transparent membrane of the ovum in some instances appears to have become attenuated, in others also cleft. Subsequently, the central portion of the altered spot passes to the centre of the germinal vesicle; the germinal vesicle, regaining its spherical form, returns to the centre of the ovum, and a fissure in the thick transparent membrane is no longer seen. From these successive changes it may be inferred that fecundation has taken place; and this by the introduction of some substance into the germinal vesicle from the exterior of the ovary. It may also be inferred, that the central portion of the altered germinal spot is the point of fecundation. In further proof that such really is the case, there arise at this part two cells, which constitute the foundation of the new being. These two cells enlarge, and imbibe the fluid of those around them, which are at first pushed further out by the two central cells, and subsequently disappear by liquefaction. The contents of the germinal vesicle thus enter into the formation of two cells. The membrane of the germinal vesicle then disappears by liquefaction.

402. Each of the succeeding twin cells presents a nucleus, which, having first passed to the centre of its cell, resolves itself into cells in the manner above described. By this means the twin cells, in their turn, become filled with other cells. Only two of these in each twin cell being destined to continue, the others, as well as the membrane of each parent cell, disappear by liquefaction, when four cells remain. These four produce eight, and so on, until the germ consists of a mulberry-like object, the cells of which do not admit of being counted. Nor does the mode of propagation continue the same with reference to number only. The process inherited from the germinal vesicle by its twin offspring, reappears in the descendants of these. Every cell, whatever its minuteness, if its interior can be discerned, is found filled with the foundations of new cells, into which its nucleus has been resolved. Together with a doubling of the number of the cells, there occurs also a diminution of their size. The cells are at first elliptical, and become globular.

403. The above mode of augmentation, namely the origin of cells in cells, appears

by no means to be limited to the period in question. Thus it is very common to meet with several varieties of epithelium-cells in the oviduct (including those which carry cilia) filled with cells; but the whole embryo at a subsequent period is composed of cells filled with the foundations of other cells.

404. In the Second Series of these researches, it was shown that the mulberry-like object above mentioned, is found to contain a cell larger than the rest, elliptical in form, and having in its centre a thick-walled hollow sphere, which is the nucleus of this cell. It was farther shown that this nucleus is the rudimental embryo. From what has been just stated, it appears, that the same process, by which a nucleus in one instance transforms itself into the embryo, is in operation in another instance, where the product does not extend beyond the interior of a minute and transitory cell. Making allowance, indeed, for a difference in form and size, the description given of the one might be applied to the other. It was shown in the Second Series, that in the production of the embryo out of a nucleus, layer after layer of cells comes into view in the interior, while layers previously formed are pushed further out; each of the layers being so distinctly circumscribed as to appear almost membranous at its surface. The same membranous appearance presents itself at the surface of the several layers of a nucleus in many situations. Farther, in the formation of the embryo, a pellucid centre is the point around which new layers of cells continually come into view; a centre corresponding to that giving origin to similar appearances in every nucleus described in the present memoir. It was shown that in the embryo this mysterious centre is present until it has assumed the form of the cavity, including the sinus rhomboidalis, in the central portion of the nervous system.

405. The process above described as giving origin to the new being in the mammiferous ovum, is no doubt universal. There appears to be evidence of its occurrence in the ova of Batrachian Reptiles, some osseous Fishes, and certain of the Mollusca; though the explanation given of these has been of a very different character. It has hitherto been usual to regard the round white spot, or cicatricula, on the yelk of the Bird's laid egg, as an altered state of the discus vitellinus in the unfecundated ovarian ovum. So far from such being the case, it is probable that the whole substance of the cicatricula in the laid egg has its origin within the germinal vesicle, in the same manner as in the ovum of Mammalia.

406. There is no fixed relation between the degree of development of ova, and their size, locality, or age. The variation with regard to size is referable chiefly to a difference in the quantity of fluid imbibed in different instances by the incipient chorion. Vesicles filled with transparent fluid are frequently met with in the Fallopian tube, very much resembling the thick transparent membrane of the ovarian ovum. These vesicles are probably unimpregnated ova, in the course of being absorbed. The so-called "yelk" in the more or less mature ovarian ovum, consists of nuclei in the transition state and exhibiting the compound structure above described. The mass of these becomes circumscribed by a proper membrane. They and their membrane

subsequently disappear by liquefaction, and are succeeded by a new set, arising in the interior, and likewise becoming circumscribed by a proper membrane, and so on. This explains why some observers have never seen a membrane in this situation. After the fecundation of the ovum, the cells of the tunica granulosa, that is, part of the so-called "disc," are found to have become club-shaped, greatly elongated, filled in some instances with cells, and connected with the thick transparent membrane by their pointed extremities alone.

407. That the thin membrane described in the Second Series of these researches as rising from the thick transparent membrane in the Fallopian tube, and imbibing fluid, is really the incipient chorion, was then shown by tracing it from stage to stage, up to the period when villi form upon it. There remained, however, two questions undecided; viz. whether the chorion is formed of cells, and if so, whether the cells are those of the so-called "disc," brought by the ovum from the ovary. It may now be stated that the chorion *is* formed of cells, which gradually collect around the thick transparent membrane, and coalesce; and that the cells in question are *not* those of the "disc" brought with the ovum from the ovary. The cells which give origin to the chorion are to be more particularly described in a future paper.

408. The existing view, namely, that a nucleus, when it leaves the membrane of its cell, simply disappears by liquefaction, is inapplicable to any nucleus observed in the course of these investigations. The nucleus resolves itself into incipient cells in the manner above described. In tracing this process, it appears that the nucleus, and especially its central pellucid cavity, is the seat of changes which were not to have been expected from the recently advanced doctrine, that the disappearing nucleus has performed its entire office by giving origin at its surface to the membrane of a single cell. It is the mysterious centre of a nucleus which is the point of fecundation; and the place of origin of two cells constituting the foundation of the new being. The germinal vesicle, as already stated, is the parent cell, which, having given origin to two cells, disappears, each of its successors giving origin to other two, and so on. Perpetuation, however, at this period, consists, not merely in the origin of cells in cells, but in the origin of cells in the pellucid centres of the nuclei of cells.

409. Neither the germinal vesicle, nor the pellucid object in the epithelium-cell, is a "cytoblast." The cells into which the nucleus becomes resolved, may perhaps enter into the formation of secondary deposits—for instance, spiral fibres; and they may contribute to the thickening which takes place, in some instances, in the cell-membrane.

410. The germ of certain plants passes through states so much resembling those occurring in the germ of mammiferous animals, that it is not easy to consider them as resulting either from a different fundamental form, or from a process of development which, even in its details, is not the same as what has been above described; the fundamental form in question in Mammalia, and therefore it may be presumed in Man himself, being that which is permanent in the simplest plants,—the single isolated cell.

Appendix.

Statements and Conjectures of Physiologists on the Nature, Office, and Destination of the Purkinjean or Germinal Vesicle (see par. 323, &c.).

411. The discoverer of this vesicle was Purkinje†, whose name physiologists have justly associated with it. The discovery was made in the ovarian ovum of the Bird. Never finding it in ova which had entered the oviduct, Purkinje supposed the vesicle to burst, and this from pressure of the oviduct. He supposed it to originate the colliquamentum. Subsequently he expressed the following opinion: "During the generative act and the impregnation following, it bursts and pours its fluid into the germinal layer. This process in Amphibia and Birds has been with certainty observed.***How the fluid operates, and whether and in what manner it corresponds to the male semen, is a subject for future inquiry, seeing that the effects of the latter (the semen) are still entirely unknown‡".

412. The discovery of this vesicle was extended to the ova of Mollusca, Annelida, Crustacea, and Insects, as well as of some oviparous Vertebrata, by Von Baer§. This naturalist supposes "that the vesicle of Purkinje is the important part of the ovum, performing in the female the function corresponding to that performed by the semen of the male‖." He conjectures "that in proportion as the ovum approaches maturity, the vesicle is driven forward and finally destroyed between the vitellus and its membrane, before fecundation¶." He states that the germinal vesicle "disappears towards the epoch of the maturity of the ovum, entirely leaves the vitellus (as I have," says he, "particularly observed in Frogs) and no doubt then bursts, since no traces of it are subsequently found††." He remarks, "Mature ova contained in the ovaries of insects have no [germinal] vesicle, while it is found in ova which are not mature‡‡." "Is the vesicle dissolved or destroyed by the *effect* of fecundation? I do not believe that this can be the case, for in Frogs the ova which have descended into the oviduct are deprived of the vesicle *long before* fecundation §§." Respecting the ova of certain Fishes the same observer remarks, "I have hitherto found the germinal vesicle in all ova which were still in their capsules, but never in such as were discharged‖‖." "The germinal vesicle of Serpents and Lizards does not develope the embryo; it disappears entirely as the germinal vesicle of Birds¶¶."

413. Rathke. "The last and most important changes, finally, which take place within the ovary, are the disappearance of the Purkinjean [or germinal] vesicle and

† Symbolæ ad ovi avium historiam ante incubationem, 1825.

‡ Article "Ei" in the "Encyclopädisches Wörterbuch," Band X. p. 112, 1834.

§ Subsequently, Purkinje discovered it in the ova of Entozoa and Arachnida.

‖ Lettre sur la Formation de l'Œuf, p. 31. ¶ Ibid. p. 30. †† Lettre, &c., Commentaire, p. 44.

‡‡ Lettre sur la Formation de l'Œuf, pp. 29. 30. §§ Ibid. p. 30.

‖‖ Untersuchungen über die Entwickelungsgeschichte der Fische, S. 44.

¶¶ Lettre, &c., Commentaire, p. 48.

the production of the germ. With regard to the former, I remain in a state of entire uncertainty, and can only say that I observed that vesicle in mature ova [of the Crafish] as late as in November, but have found no trace of it in the following March. The disappearance of the vesicle therefore takes place some time before the ovum leaves the ovary. With regard to the germ, it appears first to originate when the germinal vesicle disappears, and perhaps—as VON BAER with reference to animals in general has conjectured—since that vesicle bursts, its walls are dissolved, and its contents supply the foundation of the germ†". "Of the Purkinjean vesicle in the laid ova of *Oniscus aquaticus,* I have not been able to detect the least trace‡." "I remain in entire doubt whether the ovum [of *Oniscus asellus*] brings with it into the brooding cavity a germ. But when the ovum has reached that cavity a Purkinjean vesicle is no longer to be found§."

414. CARUS states that the germinal vesicle "on the separation of the ovum from the ovary***becomes destroyed, and forms the fluid (*Colliquamentum Malpighii*) under the germinal membrane, which then yields the essential substance for the formation of the embryo‖."

415. BURDACH. "But the ovum itself undergoes in its essential parts a change, through which the immediate foundation of the new being, namely, the germinal membrane, is formed: that is, the germinal vesicle, which has passed nearer and nearer to the circumference of the ovum and applied itself to the germinal layer, finally disappears, no doubt bursting and pouring its fluid into the germinal layer, whereupon the germinal membrane forms. Thus PURKINJE found in the ovum of the Bird, when the infundibulum of the oviduct had received it, that the germinal vesicle had disappeared, and the germinal elevation (Keimhügel) with its opening become, for the most part, effaced; but that in the passage of the ovum through the oviduct, the germinal elevation became fully dissolved, its accumulated granules gave way, and in their stead there appeared the uniform, dense, semi-transparent germinal membrane. Further observations have shown that in all other animals also, the germinal vesicle vanishes before the appearance of the germinal membrane; and we may, therefore, with PURKINJE and VON BAER, regard it as the bearer of the female generative power. But by what means its bursting is determined is still unexplained¶."

416. VALENTIN demonstrated the existence—first announced by COSTE—of a vesicle in the mammiferous ovum, corresponding to that of PURKINJE in the Bird. "The germinal vesicle [in the ovum of the Bird]" says VALENTIN, "becomes invisible. It probably bursts, and pours its fluid first of all into the disc. It is not, therefore,

† Ueber die Bildung und Entwickelung des Flusskrebses, p. 2, 1829.

‡ Abhandlungen zur Bildungs-und Entwickelungsgeschichte des Menschen und der Thiere. Erster Theil, p. 4, 1832.

§ Abhandlungen, &c., Zweiter Theil, p. 72, 1833.

‖ Erläuterungstafeln zur vergleichenden Anatomie. Heft III., p. 21, 1831.

¶ Die Physiologie als Erfahrungswissenschaft, Erster Band, S. 550. 551, 1835.

without reason that it has been regarded as analogous to the semen,—as a sort of female semen†." The same author on another occasion remarks, "That in the germinal spot alone lies the sole foundation of the future germinal membrane, is scarcely probable. It is rather probable that in the transition, the collective contents of the germinal membrane undergo an inward metamorphosis, comprehending, and in the same manner changing both parts [germinal vesicle and spot]. This indeed is shown by the fact, observed by Professor WAGNER himself, that at the period of maturity [of the ovum] the granules [of the spot] become separate from one another, and new granulations arise between them. Besides, the granules of the germinal membrane are very different from the granulated substance of the delicate germinal spot, in which all isolated corpuscles certainly for the most part fail. If the very fine and delicate peculiar granular layer on the inner surface of the vitelline membrane, pass into the future germinal membrane (which however is much to be doubted, and has more against than for it), the contents of the germinal vesicle after the act of conception, could only give the substance for the central portion of the germinal membrane, out of which indeed the new individual forms, and which therefore has the greatest dignity‡."

417. The germinal spot on the inner surface of the membrane of the germinal vesicle was discovered by RUDOLPH WAGNER, who on making known in 1834, the existence of this object, pronounced it to be "the germ." In a subsequent paper he remarks, "Germinal spot and germinal vesicle disappear indeed as soon as the ova have left the ovary and enter the oviduct. This seems to be a constant law in the animal kingdom, and I have never observed an exception, but both elements cannot in themselves be lost. They appear only to enter into the mass of the germinal disc and to form its central part§." "In mature ova, impregnated or susceptible of impregnation, the germinal vesicle disappears. How this takes place, whether in consequence of a sudden bursting, or through rapid dissolution and liquefaction, flattening down, diminution of its contents, &c., does not admit of being positively determined.***Thus much is certain, that the germinal vesicle has always disappeared as soon as the ovum has left the ovary.***The contents of the germinal vesicle,—in which with increasing maturity more consistent granulations frequently arise (when the germinal spot often dissolves away),—are obviously poured into the space occupied by the germinal layer, or disc, and from the anatomical situation must be first deposited in its central part.***Such increased granulations, with the disappearance of the original germinal spot, present themselves distinctly, for instance, in the scaled Amphibia; and in Birds and Mammals appear to be present as pale clear globules.*** On the immediate changes consequent upon the disappearance of the germinal vesicle we have no more than mere hypotheses; for observation has hitherto given no

† Entwickelungsgeschichte des Menschen mit vergleichender Rücksicht der Entwickelung der Säugethiere und Vögel, p. 28, 1835. Edinburgh Medical and Surgical Journal, No. 127.

‡ MÜLLER's Archiv, 1836. Heft II. pp. 168. 169.

§ Beiträge, &c., p. 40.

explanation of them.—The newer researches of SCHWANN appear to give to observation another direction, which will perhaps be more productive. It is thus possible, that the germinal vesicle is the parent cell for new cells of the germinal membrane. The new granulations into which, for instance in Amphibia and Fishes, I saw the germinal spot to become divided, are perhaps young cells in the parent cell†." The facts recorded in the present memoir show this conjecture, so far as it went, to have been very near the truth‡.

418. RICHARD OWEN, with reference to the germinal vesicle of Birds, justly remarks, "it is the essential element of the cicatricula, and the centre from which all subsequent development radiates§."

419. ALLEN THOMSON. "The vesicle of PURKINJE***has***received the name of germinal vesicle, a most appropriate term, since it may be regarded as the more immediate seat of the germ or germinating faculty of the egg‖." "We do not know with certainty what befalls the vesicle of PURKINJE in the ovulum of Mammalia at the time of its escape from the ovarium. The analogy of all oviparous animals is strongly in favour of the supposition that it bursts in the same manner.***While therefore, we feel disposed to adopt the opinion that the seminal fluid, in fecundating the egg, operates its peculiar change chiefly on the germinal part, and that the bursting of the germinal vesicle is very probably connected with the change of fecundation, it must be admitted that further observations are still wanting to afford a satisfactory proof of the correctness of these hypotheses¶."

420. COSTE, with reference to the germinal vesicle in the ova of Mammalia in general, remarks, "Après la chûte de l'œuf dans les trompes, on ne voit plus de traces de cette vésicule; nous chercherons à démontrer qu'à la manière de celle des oiseaux, elle se dissout pour la même finalité††." With regard to the ovum of the Sheep, the same author observes, "Lorsqu'il tombe de l'ovaire pour pénétrer dans les trompes utérines, la petite vésicule transparente (analogue de la vésicule de PURKINJE) se dissout, et ici encore se trouve confirmé ce que nous avous dit d'une manière générale de l'œuf des mammifères‡‡."

420½. JACQUEMIN. "La cicatricule et la vésicule de PURKINJE sont très développées dans l'œuf [*Planorbis cornea*] retiré de l'ovaire; ils disparaissent peu à peu pendant leur passage et leur séjour dans la matrice§§." "Le vitellus commence à se transformer en embryon immédiatement après la ponte§§."—"Le vitellus, parfaitement

† Lehrbuch der Physiologie. Erste Abtheilung, pp. 57. 58, 1839.

‡ It is due to Professor R. WAGNER to mention, that he had said it seemed to him probable, on many grounds, that the germinal vesicle is not a nucleus, as supposed by SCHWANN (par. 349.); and had stated that the germinal spot often appeared to him to contain minute nucleoli, as figured, for instance, in his Prodromus Historiæ Generationis, Tab. II. fig. xxx *b*. He had also proposed to denominate the germinal spot the "*nucleus germinativus*" (Lehrbuch, &c. p. 34.).

§ Dr. TODD's Cyclopædia of Anatomy and Physiology, Article "AVES," p. 356.

‖ Ibid. Article "GENERATION," p. 452.

¶ Ibid. p. 462.

†† Embryogénie Comparée, p. 83, 1837.

‡‡ Ibid. p. 421.

§§ *L. c.*, p. 674.

globuleux au moment de la ponte, présente bientôt après des taches arrondies et claires, qui ne surpassent guères 4; elles résultent de la disposition particulière des granules qui remplissent son intérieur, et qui se retirent de la circonférence vers le centre†."

421. T. WHARTON JONES. "It is known that in birds and reptiles the germinal vesicle disappears before impregnation. In the ova of the Frog, contained in the oviduct, and also in the more advanced of those contained in the ovary, no trace of the germinal vesicle is to be observed.***In the furthest advanced ova contained in the ovary of the Newt, the blastoderma was formed, and I think I perceived the place where the germinal vesicle had been. As to the ova of the Mammifera, I have found many in which there was no germinal vesicle, and which certainly had not been impregnated. It is to be remarked that in such ova the vitelline grains were for the most part coherent and formed the vesicular blastoderma. It being determined that the disappearance of the germinal vesicle is prior to impregnation and not dependent on it, the next question which arises is 'how does the germinal vesicle disappear?' My observations on the ova of the water Newt are the only ones I have which bear upon this question. From what I have observed in them I think the mode of disappearance is the following: The vesicle at first imbedded in the substance of the yelk, approaches more and more the surface of it, until it comes to lie immediately underneath the vitellary membrane, in the manner represented in fig. 12. The coat of the vesicle having become very soft and weak gives way, and the contained fluid is effused on the surrounding surface of the yelk. The coat of the vesicle being of extreme tenuity cannot be seen after it has given way. The small depression in which the vesicle was situate now forms the cicatricula, fig. 13. I think that the fluid contained in the germinal vesicle being effused gives a degree of consistence to the matter composing the surface of the yelk, and thus promotes the formation of the blastoderma‡."

422. SCHWANN. "It is of great importance to decide the question, what is the import of the germinal vesicle. Is it a young cell arising within the yelk-cell, or is it the nucleus of the yelk-cell? If the first, it is very probably the most essential foundation of the embryo; but if it be the nucleus of the yelk-cell, its importance ceases with the formation of the yelk-cell, and according to the analogy of most cell-nuclei it must subsequently be either entirely absorbed, or continue for a time, without forming any new essential object§."—"It is worth while to a certain extent, from the import of the germinal vesicle [in the physiology of cells] to determine *a priori* its subsequent destiny, and thereby to be able to give at least a clue to the much more difficult observations on the impregnated ovum||." SCHWANN subse-

† *L. c.*, p. 660.

‡ On the first Changes in the Ova of the Mammifera in consequence of Impregnation, and on the Mode of Origin of the Chorion. Philosophical Transactions, 1837. Part II. pp. 343. 344.

§ *L. c.*, pp. 49, 50.

|| *L. c.*, p. 51.

quently expresses the opinion that the germinal vesicle is "the nucleus of the ovum-cell †."

423. BISCHOFF. "All the ova [of the Dog] which I found in the oviduct, still resembled in a remarkable manner the ovarian ova, viz. they always had a granular disc, just as those in the ovary, and the yelk is always still dark and untransparent. Those of the earliest age presented also scarcely any change in size or in the appearance of the yelk. With all imaginable care and pains I sought in all for the germinal vesicle, but in vain. The disappearance of this structure therefore in mammals also (where hitherto it has been admitted only hypothetically), I believe myself enabled to pronounce as a decided fact. In an impregnated bitch, which I examined 19 hours after the first coitus, and where I found the ova still in the ovary, the germinal vesicle was present. It thus probably disappears just on the exit of the ovum from the ovary. What becomes of it, I cannot tell. I decidedly believe that it bursts, and that its contents, mixed with the semen, form the spot, from which the development of the embryo proceeds ‡."

Existing views regarding "Cells."

424. The nucleus of the vegetable cell received but little notice until its importance was conceived by our celebrated fellow-countryman ROBERT BROWN, who was the first to denominate this structure the *nucleus of the cell.* "This areola," says Dr. BROWN, "which is more or less distinctly granular, is slightly convex, and although it seems to be on the surface is in reality covered by the outer lamina of the cell §." "It is often nearly spherical, more or less firmly adhering to one of the walls, and projecting into the cavity of the cell §."

425. SCHLEIDEN, struck with the constant presence of the nucleus in the cells of the very young "embryo" and of the newly-formed albumen, conceived it to be intimately connected with the origin of the cell. "In consequence of which," says the same observer, "I directed my attention to this point, and was so fortunate as to see my labours crowned with success ||." "This structure," says SCHLEIDEN, "varies in its outline between the oval and the circular, as well as in its form it appears to do from the lenticular to the perfect sphere ¶." After giving the dimensions of this object in various instances, he proceeds, "yet upon the whole these measurements are of little importance as they [the nuclei] grow and decrease [in size], and it cannot be determined at what period of life it is that the cytoblast [nucleus] is found ††."—"In very large well-developed cytoblasts,***there is observed (whether in the interior or sunk into the surface is not yet clear to me) a minute sharply circumscribed body which, judging by the shadow, appears to present a *thick ring* or a thick-walled hollow glo-

† *L. c.*, p. 259.

‡ R. WAGNER's Lehrbuch, &c., p. 95, 1839.

§ Transactions of the Linnean Society, vol. xvi. p. 710, &c., to which I refer for further information communicated by the same author, on the Nucleus of the cell.

|| Beiträge, &c., MÜLLER's Archiv, 1838, Heft II. p. 139.

¶ Ibid. pp. 139. 140.

†† Beiträge, &c., MÜLLER's Archiv, 1838, Heft II. p. 140.

bule. In less developed cytoblasts there is observed only the outer sharp contour of this ring, and in its middle an opake point.***In cytoblasts still smaller, it appears only as a sharply circumscribed spot; which is most frequently the case.***Or finally there is seen only a remarkable, minute, opake point. In the very smallest and most transitory cytoblasts I have not hitherto been able to detect it†."—"From my observations in all plants which admitted of a complete tracing of the whole formative process, it follows that this minute body forms even earlier than the cytoblast.*** The size of this corpuscle also varies considerably, from the extent of half the diameter of the cytoblast to points immeasurably small.***Sometimes it appears more opake, sometimes more pellucid than the rest of the substance of the cytoblast. For the most part it is more consistent than the latter, and remains still sharply circumscribed, when this by pressure has become changed into an amorphous mucus‡." "As soon as the cytoblasts have attained their full size there rises upon them a fine, transparent vesicle. This is the young cell, which at first presents a very flat segment of a sphere, the plane side of which is formed by the cytoblast, and its convex side by the young cell which is situated on it, somewhat like a watch-glass on a watch.***Gradually now the entire cell grows out over the margin of the cytoblast, and speedily becomes so large, that at last the latter appears only as a minute body inclosed in one of the walls of the cell,***in which situation it accompanies through the whole vital process the cell which it has formed, if it be not (as in cells destined for higher development) either absorbed in its original situation, or—after having been cast off as a useless member—dissolved and absorbed in the cavity of the cell.—The formation of secondary deposits on the inner surface of the cell-wall does not commence, so far as I could observe, until after the absorption of the cytoblast§." "A cell never shows a trace of a spiral formation***until full-grown, that is, until it has absorbed the cytoblast‖." "The [spiral] fibres never form free, but in the interior of cells; and the walls of these cells in an early state are simple and for the most part very delicate¶."

426. *Ova found in the Fallopian Tube and Uterus of the Rabbit.*

The two following Tables are a continuation of those given in the "Second Series;" the object being, as then, to facilitate the discovery of the minuter ova in the Rabbit, by affording a general idea of their locality and size at different periods. They also serve to show that in both of these respects the ova of different individuals are subject to variation;—that there frequently exist considerable differences in the size and condition of ova destined to constitute the same litter of young;—and that there is no fixed relation between the degree of development of ova and their size, locality, or age.

† Beiträge, &c., Müller's Archiv, 1838, Heft II. p. 141. ‡ *L. c.*, pp. 141. 142.
§ *L. c.*, pp. 145. 146. ‖ *L. c.*, p. 150. ¶ *L. c.*, p. 153.

427. *Ova found in the Fallopian Tube of the Rabbit.*

Hours *post coitum.*	Number of ova found.	Diameter in fractions of a Paris line.	Condition of the *essential* portion of the ovum.	Locality.
Hours. 10 to $68\frac{3}{4}$	93	$\frac{1}{15}$ to $\frac{1}{5}$	Described in Table of "Second Series," par. 319.	Described in Table of "Second Series," par. 319.
10	4	?	Plate XXIV. fig. 191, &c.	Ovarian side of the middle of the tube.
11	8	$\frac{1}{13}$ to $\frac{1}{11}$	Plate XXV. figs. 194. 195. 199.	Occupying the second fourth of the tube.
12	8	about $\frac{1}{14}$	"Second Series," Plate XXVII. fig. 103.	Ovarian side of the middle of the tube.
13	6	about $\frac{1}{13}$ +	Plate XXIV. fig. 193. Plate XXV. fig. 200, &c.	Middle of the tube.
13	10	$\frac{1}{14}$ to $\frac{1}{11}$	Some of the upper figs. in Plate XXV.	Middle of the tube.
14	5	about $\frac{1}{12}$ +	Plate XXIV. fig. 185, &c.	Middle of the tube.
17	6	$\frac{1}{14}$ to $\frac{1}{12}$	Plate XXIV. figs. 188 to 192.	Near the middle of the tube.
$21\frac{1}{2}$	5	$\frac{1}{12}$ to $\frac{1}{11}$	Plate XXIV. fig. 191, &c.	Uterine side of the middle of the tube.
$23\frac{1}{2}$	11	$\frac{1}{14}$ − to $\frac{1}{12}$	Plate XXVI. figs. 206. 208. 209, &c.	Middle of the tube.
$24\frac{1}{2}$	8	about $\frac{1}{11}$	Plate XXIV. figs. 186. 187. Plate XXV. fig. 204. Plate XXVI. fig. 207, &c.	Between the middle of the tube and the uterus.
35	7	$\frac{1}{10}$ − to $\frac{1}{10}$	Plate XXVI. fig. 210. Plate XXIV. fig. 188, &c.	Between the middle of the tube and the uterus.
36	8	$\frac{1}{10}$ to $\frac{1}{8}$	Plate XXVI. figs. 211 to 213 B. Plate XXIV. figs. 188, &c.	Middle third of the tube.
52	8	about $\frac{1}{7}$ −	Plate XXVI. The lowest line of figures	Chiefly occupying the uterine fourth of the tube.
$57\frac{1}{2}$	7	$\frac{1}{10}$ + to $\frac{1}{8}$	Plate XXVI. figs. 214 to 219, &c.	Throughout the tube, except the ovarian fourth.
$57\frac{1}{2}$	5	$\frac{1}{7}$ − to $\frac{1}{7}$ +	Plate XXVII. figs. 223 to 228. 232. 233. &c.	Uterine third of the tube.
62	13	$\frac{1}{9}$ to $\frac{1}{8}$ +	Plate XXV. fig. 197. Plate XXVI. fig. 220, &c.	Uterine fourth of the tube.
62	6	$\frac{1}{9}$ to $\frac{1}{7}$	Plate XXVII. figs. 230. 231, &c.	Uterine extremity of the tube.
$64\frac{1}{2}$	6	$\frac{1}{9}$ to $\frac{1}{7}$	Plate XXVII. fig. 229, &c.	Uterine extremity of the tube.
66	4	$\frac{1}{9}$ − to $\frac{1}{6}$	Plate XXVII. Middle row of figures, &c.	Uterine extremity of the tube. Three others were found in the uterus. See next Table.
72	2	$\frac{1}{6}$ and $\frac{1}{6}$ +	Plate XXVII. fig. 232, &c.	Uterine extremity of the tube. Three others were found in the uterus. See next Table.
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Some of the Ova found in the Uterus of the Rabbit.

Hours *post coitum.*	Number of ova found.	Diameter in fractions of a Paris line.	Condition of the *essential* portion of the ovum.	Locality.
Hours. $79\frac{1}{2}$ to $131\frac{3}{4}$	163	$\frac{1}{11}$ to $1\frac{1}{4}$	Described in Table of "Second Series," par. 319.	Described in Table of "Second Series," par. 319.
52	5	$\frac{1}{6}$ to $\frac{1}{5}$ −	Plate XXV. figs. 202. 203. 205, &c.	Various.
66	3	about $\frac{1}{6}$ +	Plate XXV. fig. 196. Plate XXVII. middle row of figures, &c.	Near the Fallopian tube. Four others were found in the Fallopian tube. See Table above.
72	3	$\frac{1}{7}$ + to $\frac{1}{6}$ +	Plate XXVII. fig. 232, &c.	Near the Fallopian tube. Two others were found in the Fallopian tube. See Table above.
$76\frac{1}{4}$	7	$\frac{1}{7}$ + to $\frac{1}{5}$ +	Plate XXVII. fig. 234, &c.	All within $1\frac{1}{4}$ inch of the Fallopian tube.
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It will be seen from these Tables, that ova have been found in the Fallopian tube as late as 72 hours; and in the uterus as early as 52 hours, *post coitum.*

428. *Table, showing (from ova of ten Rabbits) that the diameter of the chorion is liable to much greater variation than that of the thick transparent membrane f.* (par. 365.) *An asterisk* (*) *denotes that the ovum was taken from the uterus, the other ova having been found in the Fallopian tube. The measurements are expressed in fractions of a Paris line.*

Hours *post coitum.*	Diameter of Chorion. *Cho.*	Diameter of *f.* Thick transparent membrane.
Hours. $57\frac{1}{2}$	$\frac{1}{8}$	$\frac{1}{11}$
	$\frac{1}{10}$ +	$\frac{1}{11}$
	$\frac{1}{9}$	$\frac{1}{11}$
	$\frac{1}{8}$ +	$\frac{1}{11}$
	$\frac{1}{7}$ −	$\frac{1}{11}$
	$\frac{1}{8}$	$\frac{1}{10}$
	$\frac{1}{9}$	$\frac{1}{11}$
62	$\frac{1}{9}$	$\frac{1}{12}$
	$\frac{1}{8}$	$\frac{1}{11}$
	$\frac{1}{8}$	$\frac{1}{11}$
	$\frac{1}{8}$ −	$\frac{1}{11}$ −
	$\frac{1}{8}$ −	$\frac{1}{11}$ +
	$\frac{1}{8}$	$\frac{1}{11}$
	$\frac{1}{8}$ −	$\frac{1}{12}$
	$\frac{1}{8}$ +	$\frac{1}{11}$ −
62	$\frac{1}{7}$ −	$\frac{1}{12}$ +
	$\frac{1}{8}$	$\frac{1}{12}$
	$\frac{1}{7}$ −	$\frac{1}{12}$
	$\frac{1}{8}$	$\frac{1}{12}$
	$\frac{1}{8}$	$\frac{1}{12}$
	$\frac{1}{7}$ −	$\frac{1}{12}$

Hours *post coitum.*	Diameter of Chorion. *Cho.*	Diameter of *f.* Thick transparent membrane.
Hours. $64\frac{1}{2}$	$\frac{1}{9}$	$\frac{1}{12}$
	$\frac{1}{8}$	$\frac{1}{12}$ +
66	$\frac{1}{9}$ −	$\frac{1}{11}$ −
	$\frac{1}{7}$ +	$\frac{1}{11}$
	$\frac{1}{6}$	$\frac{1}{11}$ −
	$\frac{1}{8}$ +	$\frac{1}{11}$ −
	*$\frac{1}{6}$ +	$\frac{1}{11}$ +
	*$\frac{1}{6}$ +	$\frac{1}{11}$ −
72	$\frac{1}{6}$	$\frac{1}{11}$ +
	$\frac{1}{6}$ +	$\frac{1}{11}$ −
	*$\frac{1}{7}$ +	$\frac{1}{11}$ −
	*$\frac{1}{6}$ +	$\frac{1}{11}$
	*$\frac{1}{7}$ +	$\frac{1}{12}$ +
$76\frac{1}{4}$	*$\frac{1}{5}$ −	$\frac{1}{10}$ +
	*$\frac{1}{5}$ −	$\frac{1}{10}$
	*$\frac{1}{5}$ −	$\frac{1}{10}$
	*$\frac{1}{6}$	$\frac{1}{14}$ +
	*$\frac{1}{7}$ +	$\frac{1}{10}$ +
	*$\frac{1}{5}$ +	$\frac{1}{10}$ +

Hours *post coitum.*	Diameter of Chorion. *Cho.*	Diameter of *f.* Thick transparent membrane.
Hours. $57\frac{1}{2}$	$\frac{1}{7}$	$\frac{1}{11}$ −
	$\frac{1}{7}$	$\frac{1}{11}$ −
	$\frac{1}{7}$ −	$\frac{1}{11}$ −
	$\frac{1}{7}$ +	$\frac{1}{11}$ −
	$\frac{1}{7}$ −	$\frac{1}{11}$ −
36	$\frac{1}{8}$ −	$\frac{1}{12}$
	$\frac{1}{8}$	$\frac{1}{12}$
	$\frac{1}{9}$	$\frac{1}{12}$
	$\frac{1}{10}$	$\frac{1}{12}$
	$\frac{1}{7}$	$\frac{1}{11}$ −
	$\frac{1}{8}$	$\frac{1}{12}$
$24\frac{1}{2}$	$\frac{1}{11}$	$\frac{1}{12}$ +
	$\frac{1}{11}$	$\frac{1}{11}$ −
	$\frac{1}{11}$	$\frac{1}{11}$ −
	$\frac{1}{11}$	$\frac{1}{11}$ −
	$\frac{1}{11}$ +	$\frac{1}{11}$
	$\frac{1}{11}$	$\frac{1}{11}$ −
	$\frac{1}{11}$	$\frac{1}{11}$ −

429. *Table of Measurements.*

The measurements are given in fractions of a Paris line ('''), the micrometer used, one of FRAUENHOFER'S, being divided according to French measure. The French inch (of twelve lines) is to the English inch, as 1·06575 is to 1·00000, or nearly one fifteenth more. Assuming it to be exactly one fifteenth more, the simplest mode of converting the fraction of a French *line* into the fraction of an English *inch*, will be to multiply the denominator of the former by the number 11·25 (or $11\frac{1}{4}$). Thus the actual length of the cell in Plate XXVII. fig. 225, which measured $\frac{1}{40}$ of a Paris line, is found to have been about $\frac{1}{450}$ of an English inch. (The nucleus of this cell is the rudimental embryo.)

When the object is not spherical, it is the long diameter, the measurement of which is given in the Table.

The diameter of many objects contained within larger ones has been omitted, because it may be inferred; the scale being the same.

Table of Measurements.

No. of Figure.	Diameters magnified.	Actual diameters in fractions of a Paris line.					
		Cho. Chorion.	*f.* Thick transparent membrane—"zona p."	*c.* Germinal vesicle.	*bs.* Germ.	Cells of the Germ.	Miscellaneous objects.
156	100	....	$\frac{1}{14}$ −				
157	100	....	$\frac{1}{15}$				
158	50	....	$\frac{1}{15}$ +				
159	100	....	....	$\frac{1}{30}$ −			
160	100	....	$\frac{1}{13}$	$\frac{1}{35}$			
162	100	....	$\frac{1}{11}$	$\frac{1}{30}$ +			
164	100	....	$\frac{1}{14}$				
165	100	....	$\frac{1}{13}$				
167	100	....	$\frac{1}{13}$				
169	100	....	$\frac{1}{13}$ −				
170	50	....	$\frac{1}{14}$				
171	50	....	$\frac{1}{14}$				
172	100	....	$\frac{1}{15}$				
173	50	....	$\frac{1}{15}$				
174	100	....	$\frac{1}{15}$				
175	100	....	$\frac{1}{15}$				
176	100	....	$\frac{1}{15}$ +				
178	100	....	$\frac{1}{13}$				
179	50	....	about $\frac{1}{12}$				
180	50	....	$\frac{1}{14}$				
181	100	....	$\frac{1}{14}$				
185	100	....	$\frac{1}{12}$ +				
186	100	about $\frac{1}{11}$					
187	100	about $\frac{1}{11}$	....	about $\frac{1}{25}$			
188	100	....	$\frac{1}{12}$				
189	300	....	$\frac{1}{12}$				
190	100	$\frac{1}{13}$					
191	100	....	$\frac{1}{14}$	....	......	$\frac{1}{50}$	
192	300	....	$\frac{1}{14}$	....	......	....	$\frac{1}{130}$
193	100	....	$\frac{1}{13}$ +	about $\frac{1}{22}$	......	$\frac{1}{50}$	
194	100	....	$\frac{1}{12}$				
195	100	....	$\frac{1}{13}$	$\frac{1}{25}$			
196	100	$\frac{1}{6}$ +					
197	100	$\frac{1}{8}$					
198	100	....	$\frac{1}{13}$	$\frac{1}{25}$	......	about $\frac{1}{35}$	
199	100	....	$\frac{1}{11}$				
200	100	....	$\frac{1}{13}$ +				

Table of Measurements. (Continued.)

No. of Figure.	Diameters magnified.	Actual diameters in fractions of a Paris line.					
		Cho. Chorion.	*f.* Thick transparent membrane—"zona p."	*c.* Germinal vesicle.	*bs.* Germ.	Cells of the Germ.	Miscellaneous objects.
201	100	....	about $\frac{1}{13}$				
202	100	$\frac{1}{6}$	$\frac{1}{10}$				
203	100	$\frac{1}{6}$	$\frac{1}{10}$				
204	100	about $\frac{1}{11}$					
205	100	$\frac{1}{5}$ −	$\frac{1}{14}$ +				
206	50	....	about $\frac{1}{13}$				
207	100	$\frac{1}{11}$					
208	100	....	$\frac{1}{12}$				
209	50	....	$\frac{1}{13}$				
210	100	about $\frac{1}{10}$	....	....	......	about $\frac{1}{33}$	
211	100	$\frac{1}{8}$ −	$\frac{1}{12}$				
212	100	$\frac{1}{7}$	$\frac{1}{11}$ −				
213 A	100	$\frac{1}{8}$	$\frac{1}{12}$	....	......	about $\frac{1}{40}$	
213 B	100	$\frac{1}{9}$	$\frac{1}{12}$	....	......	about $\frac{1}{40}$	
214	100	$\frac{1}{9}$	$\frac{1}{10}$	....	......	$\frac{1}{40}$ − to $\frac{1}{30}$	
215	100	$\frac{1}{8}$	$\frac{1}{10}$				
218	100	$\frac{1}{8}$	$\frac{1}{10}$	....	......	$\frac{1}{40}$ to $\frac{1}{30}$	
219	100	$\frac{1}{8}$	$\frac{1}{9}$				
220	100	$\frac{1}{7}$ −	$\frac{1}{11}$	....	$\frac{1}{17}$		
223	100	$\frac{1}{7}$	$\frac{1}{11}$	....	$\frac{1}{20}$	about $\frac{1}{65}$	
224	100	$\frac{1}{7}$ −	$\frac{1}{11}$	....	$\frac{1}{20}$ +		
225	100	....	....	....	......	....	$\frac{1}{40}$
228	300	$\frac{1}{7}$	$\frac{1}{11}$ −				
229	100	$\frac{1}{7}$	$\frac{1}{14}$				
230	100	$\frac{1}{7}$	$\frac{1}{14}$				
231	100	$\frac{1}{7}$	$\frac{1}{11}$				
232	100	$\frac{1}{6}$	$\frac{1}{11}$ +				
233	100	$\frac{1}{7}$ +	$\frac{1}{11}$ −	....	$\frac{1}{25}$		
234	100	$\frac{1}{6}$	$\frac{1}{14}$ +				
244	50	....	....	....	......	....	$\frac{1}{8}$
245	300	....	....	....	......	....	$\frac{1}{30}$ and less.
248	....	....	....	....	......	....	$\frac{1}{300}$ and larger.
249	....	....	....	....	......	....	$\frac{1}{200}$ and larger.
250	300	....	....	....	......	....	about $\frac{1}{200}$
251 α	....	....	....	....	......	....	$\frac{1}{300}$
251 β	....	....	....	....	......	....	$\frac{1}{100}$
251 γ	....	....	....	....	......	....	$\frac{1}{30}$
252	....	....	$\frac{1}{11}$ −				
253	....	....	$\frac{1}{11}$ +				

430. Explanation of the Plates.

N.B. In all the figures the same letters denote the same objects; as may be seen by the explanation at the foot of each Plate. The same letters are used as in the First and Second Series. (These remarks, however, do not apply to the letters α, β, γ, in Plate XXVIII.) *The term "Rudimental Embryo" is applied to the object bb, instead of "Germ," employed in the Second Series; and "Germ" is now applied to the object bs.*

b. Germinal spot beginning to resolve itself into cells.

bs. Twin cells—foundation of the new being—germ—group of cells—mulberry-like object.

bb. Rudimental embryo.—("Germ" of Second Series.)

c. Germinal vesicle, more or less filled with cells.

e. Proper membrane of the substance by which the germinal vesicle is surrounded.

f. Thick transparent membrane of the ovum—"zona pellucida."

f^1. Fluid imbibed by the chorion.

g^1. Cells of the tunica granulosa.

g^2. Cells of the retinacula ovi.

cho. Incipient chorion—chorion (becoming villous in the uterus).

PLATE XXII.

(*All the Figures are from the Rabbit* (*Lepus Cuniculus*, Linn.)).

Fig. 156. An ovarian ovum of $\frac{1}{14}$—'''. The Graafian vesicle—about $\frac{1}{3}'''$—from which it was taken, exhibited no appearance of preparation for discharging its ovum, while a number of others in the same ovary had obviously been destined to do so. (The animal was killed seven hours *post coitum.*) This figure represents the substance lying immediately within the thick transparent membrane *f*, namely a layer of regularly elliptical and flattened objects—discs—each of which contained minuter objects of the same kind, concentrically arranged around a pellucid point (par. 337.). The germinal vesicle (*c*) was spherical. The germinal spot (*b*), directed towards the surface of the ovum, exhibited incipient cells at its free part (par. 327.). The centre of the spot was pellucid. 100 *diameters*.

Fig. 157. An ovarian ovum of $\frac{1}{15}'''$. The Graafian vesicle containing it (about $\frac{1}{4}'''$) presented no appearance of preparation for discharging its ovum, while several others in the same ovary were in a state of forwardness in this respect. (The animal was killed $5\frac{1}{4}$ hours *post coitum.*) The objects on the inner surface of the membrane *f* differed from those of the preceding figure, in many of them appearing to have undergone partial

liquefaction (par. 337.). There was a cavity in the centre of the ovum, into which the germinal vesicle (*c*) projected. This vesicle, still globular, seemed filled with cells, into which the free portion of the germinal spot had been resolved (see the explanation of the preceding figure). 100 *diam.* (pars. 327.)

Fig. 158. An ovarian ovum of seven hours, and measuring in diameter $\frac{1}{15}'''+$. Its Graafian vesicle was of considerable size. (The membrana granulosa escaped nearly entire along with this ovum.) 50 *diam.*

Fig. 159. The germinal vesicle ($\frac{1}{30}'''-$) of the ovum in the preceding figure. As seen in profile, its form resembled that of the crystalline lens of the eye. 100 *diam.* (pars. 327. 330 and 331.)

Fig. 160. An ovarian ovum of $\frac{1}{13}'''$, in a state nearly prepared for fecundation. It was taken from a Rabbit in the state of heat. The germinal vesicle (*c*) had become flattened, but its size (about $\frac{1}{35}'''$) was less than that of the germinal vesicle in the ovum fig. 162. The free portion of the germinal spot had resolved itself into cells, and the foundations of other cells had come into view, arranged in concentric layers. (The altered spot thus fills the vesicle, and seems to keep pace with it in its enlargement by the origin of new cells in the centre (par. 327.). This centre of the altered germinal spot is the future point of fecundation. It continues at the periphery of the germinal vesicle until the ovum has been fecundated, being until then directed towards the surface of the ovum, and towards the surface of the ovary.) In this ovum, the discs immediately internal to the membrane *f* were indistinct from partial liquefaction. The ovum presented a cavity in its centre containing fluid, in which were a few pale globules (par. 337.). A sort of canal proceeded from this cavity to the germinal vesicle. (The cells of the tunica granulosa had become loosened. They are not represented in the figure.) 100 *diam.*

Fig. 161. The pellucid centre of the altered germinal spot in the ovum fig. 160. Around this point are two concentric layers of incipient cells (pars. 327. 328.). 300 *diam.*

Fig. 162. An ovarian ovum of $\frac{1}{11}'''$. The Graafian vesicle containing it was large and vascular, and found in the same ovary as that which yielded the objects in the two preceding figures. The animal was in the state of heat. This ovum seemed still more completely prepared for fecundation than that in fig. 160, from which it differed in the following respects; namely, the germinal vesicle (*c*) was larger ($\frac{1}{30}'''+$ in its transverse diameter), and the concentric layers of more or less incipient cells in its interior had increased in number, from the origin of new ones internal to the rest (par. 327.). Liquefaction of the objects immediately under

the membrane *f* was more complete, and a globular mass, having a cavity in its interior, occupied the centre of the ovum (par. 337.). This mass consisted of elliptical compound discs, resembling those described in the explanation of fig. 156 (par. 337.). (The cells of the tunica granulosa of the ovum in the present figure had become loosened. In two other ova in a similar condition, from the same ovary, the membrane *f* presented an orifice at the part immediately above the point of fecundation.) 100 *diam.*

Fig. 163. The pellucid centre of the altered germinal spot in an ovum from the same ovary which yielded the objects figs. 160. 161 and 162. (The germinal vesicle—about $\frac{1}{30}'''$—filled with incipient cells in concentric layers, resembled in position, form, and size, that (*c*) in fig. 162; but the ovum itself was smaller—$\frac{1}{13}'''$.) The space inclosed by the dotted line in the present figure, was pellucid and measured in diameter $\frac{1}{90}'''$. 300 *diam.* (par. 327.).

Fig. 164. An ovarian ovum of seven hours, and measuring in diameter $\frac{1}{14}'''$. Its Graafian vesicle was very large. The contents of the germinal vesicle (*c*) were less pellucid than those of the germinal vesicle represented in fig. 162, another layer of incipient cells having come into view (par. 326.). The objects (now cells) under the membrane *f*, very regularly elliptical and flattened, were circumscribed by a proper membrane (pars. 338. 339. 342. 343. 360.), which at a certain part presented a depression (orifice?). This part lay immediately under an opening in the membrane *f* (pars. 332 to 335.). 100 *diam.*

Fig. 165. An ovarian ovum of four hours, and measuring in diameter $\frac{1}{13}'''$, taken from a Graafian vesicle which was large but not particularly vascular. This ovum, though smaller than that in fig. 162, resembled it in general appearance. The membrane *f* exhibited an orifice (pars. 332 to 335.) at the part immediately under which was situated the pellucid centre of the altered germinal spot—the situation of the future point of fecundation. A little external to this centre there was also a pellucid space. The part surrounding the latter was obscure. 100 *diam.*

Fig. 166. The pellucid centre of the altered germinal spot in the ovum of the preceding figure, as seen lying immediately under the orifice in the membrane *f*: with a surrounding layer of incipient cells. About 300 *diam.* (par. 328.).

Fig. 167. An ovarian ovum of $5\frac{1}{4}$ hours, and measuring in diameter $\frac{1}{13}'''$. Its Graafian vesicle was vascular, but not very large. The objects corresponding to those which in the ova figs. 162 and 165. lay immediately under the membrane *f*, had undergone entire liquefaction—leaving a pellucid fluid in their place; and the globular mass—correspond-

ing to that which in the ova figs. 162 and 165. consisted of regularly elliptical compound discs—exhibited in the present ovum an irregular structure, the cells, into which its discs had passed, appearing to have become pressed into irregular shapes, or partially broken down; and the mass they constituted was distinctly circumscribed by a membrane, *e* (pars. 338. 339. 342. 343. 360.). Of the germinal vesicle (*c*) nothing could be distinctly seen besides its outline, and the pellucid centre of the altered germinal spot. This centre lay immediately under an orifice in the membrane *f* (pars. 332 to 335.). In this orifice an object was observed resembling a Spermatozoon in the act of entering the ovum (par. 334.). (Part of this object is represented in the next figure.) The orifice was very obvious in this ovum, and seen with more or less distinctness in five other ova of the same Rabbit. 100 *diam.*

Fig. 168. The large extremity of the object resembling a Spermatozoon, observed in the orifice of the membrane *f* in the preceding figure. It presented in its interior a pellucid point, similar to that seen in certain states of the germinal spot, and in the elliptical discs which occur in so many figures accompanying the present paper (par. 334.). About 300 *diam.*

PLATE XXIII.

All the Figures are from the Rabbit (*Lepus Cuniculus*, Linn.).

Fig. 169. A fecundated ovarian ovum of $5\frac{1}{2}$ hours, and measuring in diameter $\frac{1}{13}'''$—. (Its Graafian vesicle was large and vascular.) The germinal vesicle (*c*)—filled with cells (pars. 329. 382.)—appeared to be returning to the centre of the ovum. It is probable that the ovum had only just been fecundated, for the point of fecundation was still at the surface of the germinal vesicle. (It subsequently passes to the centre.) (par. 341.) The substance contained within the membrane *f* seemed to be surrounded by a proper membrane, *e* (pars. 338. 339. 342. 343. 360.). The membrane *f* was distinctly cleft above the point of fecundation (pars. 332 to 335.). (The cells of the tunica granulosa had become club-shaped, and radiated from the ovum in the manner shown at g^1 in figs. 173. 181 and 195 (par. 345.). The tunica granulosa also exhibited a depression similar to that represented in fig. 173, this being apparently the effect of pressure towards the exterior of the ovary.) 100 *diam.*

Fig. 170. A fecundated ovarian ovum of $8\frac{1}{4}$ hours, and measuring in diameter $\frac{1}{14}'''$. This figure presents a *superficial* view of the ovum. The germinal vesicle had left the surface of the ovum, but its situation was not quite central. It had become closely surrounded by cells, each of which pre-

sented a remarkable, opake nucleus (par. 342.). The space around these cells was occupied by larger cells, apparently undergoing liquefaction. 50 *diam.*

Fig. 171. A fecundated ovarian ovum of $8\frac{1}{4}$ hours, and measuring in diameter $\frac{1}{14}'''$, from the same ovary as that in the preceding figure. It was apparently in a similar condition. It is not (as in fig. 170.) the surface, but the interior of the ovum that is here seen. The point of fecundation had now reached the centre of the germinal vesicle (*c*). (See the explanation of fig. 169.) 50 *diam.* (par. 341.)

Fig. 172. A fecundated ovarian ovum of $8\frac{1}{4}$ hours, and measuring in diameter only $\frac{1}{15}'''$ (par. 365.). The cells under the membrane *f* were circumscribed by a proper membrane (*e*), between which and the membrane *f* there was a space filled with transparent fluid (pars. 338. 339. 342. 343. 360.). The centre of the ovum was occupied by the germinal vesicle, around which were large, regularly elliptical, and flattened cells. These cells possibly corresponded to those occupying a similar situation in figs. 170 and 171: but they were in a more advanced state. 100 *diam.*

Fig. 173. A fecundated ovarian ovum of six hours, and measuring in diameter $\frac{1}{15}'''$. (Its Graafian vesicle was large.) This ovum differed from that of the preceding figure in having a layer of minute cells around the germinal vesicle (*c*), not observed in the ovum of the preceding figure. The mass of large cells external to these was surrounded by a proper membrane (*e*) (pars. 338. 339. 342. 343. 360.). Immediately under the membrane *f*, were the remains of cells undergoing liquefaction. The membrane *f* still presented an orifice (par. 344.), not seen in the ovum fig. 172. (In the latter it had possibly closed) (par. 344.). At g^1 are the cells of the tunica granulosa, which had become elongated, and club-shaped, and were in contact with the membrane *f* by their pointed extremities alone (par. 345.). The tunica granulosa exhibited around the orifice, in the membrane *f*, a depression—apparently the effect of pressure towards the exterior of the ovary (par. 335.). 50 *diam.*

Fig. 174. The same ovum in outline, on a larger scale; the tunica granulosa being omitted. 100 *diam.* (pars. 344. 360.)

Fig. 175. A superficial view of the same ovum as that in the two preceding figures. 100 *diam.* (pars. 344. 360.)

Fig. 176. A fecundated ovarian ovum of $8\frac{1}{4}$ hours, and measuring in diameter $\frac{1}{15}'''+$. It differed from the ovum fig. 175. in the following respects, namely: The cells apparently corresponding to those, the remains of which in the ovum fig. 175. were seen immediately under the membrane *f*, had entirely liquefied, leaving a transparent fluid in their place; and cells possibly corresponding to the large ones which in the ovum fig.

175. entered into the formation of the central mass, appeared in their turn to be undergoing liquefaction, but were still circumscribed by a membrane (*e*) (pars. 338. 339. 342. 343. 360.) ; while another set of cells, perhaps corresponding to the minute ones surrounding the germinal vesicle (*c*) in the ovum figs. 173. (174. 175.), had become very large. 100 *diam.*

Fig. 177. Section showing the structure of one of the compound discs of which the substance surrounding the germinal vesicle in some states consists ; a structure which appears to be essentially the same—differing only in degree—in all the compound discs met with in the evolution of the ovum. This figure is for the most part in outline. 300 *diam.* (pars. 337. 382. 383.)

Fig. 178. A fecundated ovarian ovum of nine hours, and measuring in diameter $\frac{1}{13}'''$. Immediately under the membrane *f*—and without a proper investing membrane (pars. 338. 339. 342. 343. 360.)—were large cells, filled with the foundations of other cells ; the latter in concentric layers surrounding a pellucid point. 100 *diam.*

Fig. 179. A fecundated ovum of nine hours, and measuring in diameter about $\frac{1}{12}'''$. It was taken from the same ovary as the ovum in the preceding figure. The cells under the membrane *f*—without a proper investing membrane (pars. 338. 339. 342. 343. 360.)—were even larger than those in fig. 178, presented minuter cells between them (par. 351.), and were undergoing liquefaction. The point of fecundation was seen in the centre of this ovum. 50 *diam.*

Fig. 180. Another fecundated ovarian ovum of nine hours, and measuring in diameter $\frac{1}{14}'''$, from the same Rabbit as the ova in figs. 178 and 179. The large cells under the membrane *f* were not circumscribed by a proper membrane, and seemed to be undergoing liquefaction (pars. 338. 339. 342. 343. 360.). 50 *diam.*

Fig. 181. A fecundated ovarian ovum of ten hours, and measuring in diameter $\frac{1}{14}'''$. The substance under the membrane *f* seemed to be invested by a proper membrane, *e* (pars. 338. 339. 342. 343. 360.). This figure represents the cells of the tunica granulosa (g^1) in their altered, club-like form. Each of these cells, at this period, is in contact with the membrane *f* by its pointed extremity alone (par. 345.). 100 *diam.*

PLATE XXIV.

All the Figures are from the Rabbit (*Lepus Cuniculus*, Linn.), *except fig.* 183.

Figs. 182. 183 and 184, are copies of all the delineations of ova from the Fallopian tube which had been published before the Second Series of these researches (par. 322.).

Fig. 182. From CRUIKSHANK.

"The figures marked third day, are ova of the Fallopian tube, found after impregnation on that day. The three first are of the natural size; the three next are magnified, in the simple microscope. In all of them the chorion and amnion are even now distinct, and in some of them the *allantois*, as I suspect†.

"The figures marked $3\frac{1}{2}$ day, are ova still more advanced; similar to which I found many in the tubes, many in the horns of the uterus. The three first are of the natural size; the two following are magnified also in the simple microscope‡."

Fig. 183. From BAER. "Œuf de chien retiré de la trompe utérine.***Grossi trente fois" (par. 322.)§.

Fig. 184. From T. WHARTON JONES. "An ovum found in the Fallopian tube of a Rabbit the third day after impregnation; magnified forty diameters||" (par. 322.). This ovum is described by JONES as having measured in diameter "$\frac{1}{70}$th of an inch," that is about $\frac{1}{6}'''$; and being an ovum of "the third day," it admits of comparison with the delineations of ova in Plate XXVII. figs. 229 to 234. T. WHARTON JONES conjectures "that the gelatinous coat [see Plate XXIV. fig. 184.] acquired by the ovum in the ovary [as he supposes], and more especially circumscribed and defined after impregnation, constitutes the only covering of the vesicular blastoderma after the giving way of the vitellary membrane; that this gelatinous-looking coat forms the chorion, which in the rodents at a further stage of development presents itself under the form of a thin and transparent membrane, very like the vitellary membrane of the bird's egg, situated immediately outside the non-vascular and reflected layer of the umbilical vesicle" (*l. c.*, p. 342.). (Contrast this with the description of the mode, the period, and the place of origin of the chorion, as given in the "Second Series" of these researches, pars. 172. 173. 178. 182. 221 to 225, and in the present memoir, pars. 372 to 374.) With reference to the interior of the ovum Plate XXIV. fig. 184, T. WHARTON JONES remarks, "The granulary matter of the yelk was coherent" (*l. c.*, p. 339.).

Fig. 185. An ovum of fourteen hours from the middle of the Fallopian tube; the membrane *f* measuring in diameter $\frac{1}{12}'''+$. The outer surface of this membrane was covered with cells (*cho.*), coalescing to form the rudi-

† Philosophical Transactions, 1797, p. 212. ‡ Ibid. p. 212.

§ Lettre sur la Formation de l'Œuf, p. 62. fig. III*.

|| Philosophical Transactions, 1837. Part II., p. 345.

mental chorion (par. 372.). On the left side, this process was more advanced than elsewhere (see figs. 252 and 253.). The cells internal to the membrane *f* were invested by a proper membrane, between which and the membrane *f* there was a considerable space filled with colourless and transparent fluid (pars. 338. 339. 342. 343. 360.). This fluid contained two minute cells which had escaped liquefaction (par. 350.). They presented objects in their interior. 100 *diam.*

Fig. 186. An ovum of $24\frac{1}{2}$ hours from the uterine side of the middle of the Fallopian tube, measuring in diameter about $\frac{1}{11}'''$. The incipient chorion (*cho.*) was beginning to imbibe a transparent colourless fluid (f^1), and to rise from the membrane *f* (par. 374.). The cells internal to the membrane *f* were invested by a proper membrane, between which also and the membrane *f* there was a colourless transparent fluid (pars. 338. 339. 342. 343. 360.). In this fluid there was a minute cell which had escaped liquefaction (par. 350.). This minute cell contained several still minuter cells. It is a superficial view of the ovum which is presented in this figure. 100 *diam.*

Fig. 187. An ovum of $24\frac{1}{2}$ hours from the uterine side of the middle of the Fallopian tube, measuring in diameter about $\frac{1}{11}'''$. The incipient chorion (*cho.*) was beginning to imbibe fluid (f^1), and to rise from the membrane *f* (par. 374.). The cells in the central portion of the ovum were invested by a proper membrane (*e*), between which and the membrane *f* there was a fluid (pars. 338. 339. 342. 343. 360.). In the latter were two minute cells which had escaped liquefaction (par. 350.), their interior presenting cells still more minute. This figure exhibits a section of the ovum through its centre. The germinal vesicle (*c*) was still visible, and measured in diameter about $\frac{1}{25}'''$. It was filled with cells, two of which (*bs*)—larger than the rest, but still incipient only (par. 346.)—occupied the place in which the point of fecundation is last seen. The minute cells immediately surrounding these two larger ones, were arranged in a layer. 100 *diam.*

Fig. 188. An ovum of seventeen hours from the Fallopian tube near the middle part, measuring in diameter $\frac{1}{12}'''$. It was taken from the same Rabbit as the ova of figs. 190 and 191. The cells in the central portion of the ovum were invested by a proper membrane, *e* ($\frac{1}{20}'''$), which however had become thin preparatory to its disappearance (pars. 338. 339. 342. 343. 360.). Those cells seemed to be undergoing liquefaction. Between them were minuter cells, which, as well as the objects in the centre of the larger cells, appeared like an assemblage of black points until viewed—as in the following figure—with a higher power (par. 351.). 100 *diam.*

Fig. 189. Part of the same ovum more highly magnified. The minute intermediate cells are here seen to have had essentially the same structure as the larger ones. The dark objects in the latter were composed of the foundations of cells, which seemed to surround a central space. 300 *diam.* (par. 351.)

Fig. 190. An ovum of seventeen hours from the Fallopian tube near its middle, and measuring in diameter $\frac{1}{13}'''$. It was taken from the same Rabbit as the ova in figs. 188 and 191. The incipient chorion (*cho.*) was beginning to imbibe fluid, and to rise from the membrane *f* (par. 374.). The cells in the central portion of the ovum were invested by a proper membrane, *e* ($\frac{1}{25}'''$). Those immediately within this membrane were pretty large, and seemed to be undergoing liquefaction (pars. 338. 339. 342. 343. 360.). Internal to these were smaller cells (surrounding two large ones corresponding to the two which occupied the centre of the ovum in fig. 191). 100 *diam.*

Fig. 191. An ovum of seventeen hours from the Fallopian tube near its middle, and measuring in diameter $\frac{1}{14}'''$. It was taken from the same Rabbit as the ova in figs. 188 and 190. The condition of the interior of the ovum appeared to be nearly the same as that of the ovum fig. 190. The most central part was occupied by two large elliptic cells (*bs*) of equal size ($\frac{1}{50}'''$ in length), surrounded by minute dark objects (par. 351.), and containing a colourless transparent fluid and a nucleus (par. 378.); the latter presenting in its centre a brilliantly pellucid space. These two large cells were in the same locality as the two in fig. 187; namely, that in which the point of fecundation is last seen. They constitute the essential portion of the ovum, that is, the germ (par. 347.). 100 *diam.*

Fig. 192. The nucleus of one of the twin cells represented in the preceding figure. It measured in diameter about $\frac{1}{150}'''$, and the pellucid space in its centre about $\frac{1}{450}'''$. The outer portion of this nucleus appeared to consist almost entirely of the foundations of new cells. 300 *diam.* (pars. 347. 380.)

Fig. 193. An ovum of thirteen hours from the middle of the Fallopian tube, measuring in diameter $\frac{1}{13}'''+$. The membrane *f* was surrounded by minute cells (*cho.*), destined to coalesce and thus give origin to the chorion (par. 372.). Only a few of these have been represented in the figure (see also figs. 252 and 253.). The cells in the central portion of the ovum were invested by a proper membrane (*e*), between which and the membrane *f* there was a fluid (pars. 338. 339. 342. 343. 360.), containing two or three minute cells which had escaped liquefaction (par. 350.). The cells immediately internal to the membrane *e* seemed to be

undergoing liquefaction. Internal to them was a delicate vesicle *c*, apparently the germinal vesicle enlarged to the diameter of about $\frac{1}{22}'''$. This vesicle contained, on the inner surface of its membrane, cells of considerable size, apparently liquefying. These surrounded a layer of minuter ones, having their nuclei in some instances on one side; and these minuter cells seemed also to be circumscribed by a delicate membrane (par. 349 *Note*, 360.). In the most internal part there were two large cells (*bs*), corresponding to those occupying the centre of the ova figs. 187 and 191. These twin cells—the essential portion of the ovum, that is, the germ—were of about the same size ($\frac{1}{50}'''$ in length) as those in fig. 191, but they were less transparent; a difference which perhaps arose from the outer portion of their nuclei having resolved itself into cells (see the explanation of fig. 192.), while another layer of the foundations of new cells, arisen in the interior (and presenting also the appearance of a nucleus) had succeeded it (par. 380.). (The ovum was surrounded by transparent fluid. Possibly this fluid arose from liquefaction of the tunica granulosa and retinacula). 100 *diam.*

PLATE XXV.

All the Figures are from the Rabbit (*Lepus Cuniculus*, Linn.).

Fig. 194. An ovum of eleven hours, found half-way between the infundibulum and the middle of the Fallopian tube, and measuring in diameter $\frac{1}{12}'''$. It was taken from the same Rabbit as the ova in figs. 195 and 199. The central portion of this ovum differed from that of the ovum fig. 193. in the following respects; namely, the twin cells (*bs*)—constituting the germ—were somewhat larger, and no vesicle was seen corresponding in appearance to *c* in that figure. The nuclei of the cells which closely invested the germ, seemed to be situated (as in the ovum fig. 193.) on one side of their cells. 100 *diam.* (par. 380.)

Fig. 195. An ovum of eleven hours, found at two-thirds of the distance between the infundibulum and the middle of the Fallopian tube, and measuring in diameter $\frac{1}{13}'''$. It was taken from the same Rabbit as the ova figs. 194 and 199. This ovum appeared to be in a state resembling that of the ovum fig. 193. The delicate vesicle *c*—apparently the enlarged germinal vesicle, now irregular in its form—measured in diameter $\frac{1}{25}'''$. On the inner surface of the membrane of this vesicle were cells of considerable size, having minuter ones between them. (Two large cells—constituting the germ—occupied the most central part. They are not shown in the present figure, because of its exhibiting a superficial

view.) On the membrane *f* are represented a few of the cells of the tunica granulosa (g^1), which after fecundation become very much elongated, assume a club-like form, and are connected with the membrane *f* by their pointed extremities alone (par. 345.). The largest seen on this ovum measured $\frac{1}{30}'''$ in length. (These cells in some instances contain a cell of considerable size, surrounded by dark globules, at their larger extremity. In other instances several cells are seen in their interior.) 100 *diam.*

Fig. 196. An ovum of (not less than) sixty-six hours (par. 366.) found in the uterus, and measuring in diameter $\frac{1}{6}''' +$. The outer surface of the membrane *f* ($\frac{1}{11}''' -$) was very rough; a state observed in all the ova (seven) found in this Rabbit. The chorion (*cho.*) had thickened, imbibed a large quantity of thick transparent fluid (f^1), and distended to the diameter above mentioned; but the essential portion of the ovum—the two elliptical cells (*bs*) in its centre—had advanced but little more than the corresponding part in the ovum fig. 194, of one-sixth the age; and still less than the corresponding part in the ova figs. 198 and 201. of only one-twelfth the age (par. 365.). (Six other ova were found in this Rabbit, namely, two in the uterus and four in the Fallopian tubes. These six were duly developed in the essential part (par. 367.). The inner surface of the now thickened chorion was seen in two ova from this Rabbit.) 100 *diam.* (par. 380.)

Fig. 197. An ovum of (not less than) sixty-two hours, found in the Fallopian tube, half-way between its middle and the uterus. It measured in diameter (as much as) $\frac{1}{8}'''$, the chorion (*cho.*) having imbibed fluid (f^1) and risen from the membrane *f*. The twin cells (*bs*) however—constituting the essential portion of the ovum—appeared less advanced than is generally the case at much earlier periods. With these twin cells there were smaller cells, presenting the same appearance as that described in the explanation of figs. 188 and 189; and the whole were circumscribed by a membrane (*e*), between which and the membrane *f* there was a space filled with transparent fluid. 100 *diam.*

Fig. 198. An *ovarian* ovum of (no more than) $5\frac{1}{2}$ hours, measuring in diameter $\frac{1}{13}'''$ (par. 365.). It was taken from the same Rabbit as the ovum of fig. 201. The two elliptic cells (*bs*) in its centre, constituting the essential portion of the ovum—that is, the germ—were more advanced than those in the ovum fig. 196, of no less than twelve times the age (par. 366.). These twin cells were not very transparent, which was perhaps owing to the outer portion of each of their nuclei having resolved itself into cells, and to their being surrounded by many dark globules. The remaining portion of each nucleus contained a pellucid cavity, larger

than the corresponding cavity in figs. 193. 194. 196. The germinal vesicle (c) was still present, distended to the diameter of $\frac{1}{25}'''$ (par. 351.), and nearly filled by the twin cells, or germ (bs). 100 *diam.*

Fig. 199. An ovum of eleven hours, found half-way between the infundibulum and the middle of the Fallopian tube, and measuring in diameter $\frac{1}{11}'''$. It was taken from the same Rabbit as the ova figs. 194 and 195. The membrane which in those ova circumscribed the most central portion, had disappeared in the ovum of the present figure, leaving the large twin cells (bs), surrounded by very minute dark cells (par. 351.). (There was a trace of investing membrane (c?) on the right side.) External to those minute cells were larger ones, apparently undergoing liquefaction. These were surrounded by a proper membrane (e), which had become very thin, and seemed about to disappear. Between this membrane and the membrane f, there was a space filled with transparent fluid. The nucleus in each of the large twin cells consisted of two parts,—an inner and an outer (pars. 360. 380.). In the centre there was a pellucid space (par. 348.). 100 *diam.*

Fig. 200. An ovum of thirteen hours found in the Fallopian tube at its middle part, and measuring in diameter $\frac{1}{13}'''+$. This ovum was taken from the same Rabbit as that in fig 193, from which it differed in the large twin cells (bs)—constituting the germ—having increased in size, and become filled with cells, or the foundations of cells, arranged in concentric layers (pars. 348. 380.). External to these large twin cells were minute dark cells; and these were surrounded by larger ones, undergoing liquefaction. The whole were invested by a membrane, between which and the membrane f there was a space filled with transparent fluid, and containing minute cells which had escaped liquefaction (par. 350.). These minute cells presented cells in their interior. (Cells were collecting around the membrane f, to form the chorion. These have not been represented in the figure). 100 *diam.*

Fig. 201. An *ovarian* ovum of (no more than) $5\frac{1}{2}$ hours, and measuring in diameter about $\frac{1}{13}'''$. The Graafian vesicle containing it was vascular, but not very large. This ovum was taken from the same Rabbit as the ova of figs. 169 and 198. Along with the large twin cells (bs), constituting the germ, were other cells of considerable size, destined probably to undergo liquefaction; the whole being surrounded by a proper membrane which was so large as to be in contact in the greatest part of its extent with the membrane f. 100 *diam.* (par. 360.)

Fig. 202. An ovum of (no less than) fifty-two hours, which had proceeded so far as *into the uterus*, though the large twin cells (bs), constituting the germ, were but little more advanced than those in the ovum fig. 195, of only

$5\frac{1}{2}$ hours, and *taken from the ovary*. The chorion (*cho.*) had a diameter of $\frac{1}{6}'''$. The membrane *f* ($\frac{1}{10}'''$) was unusually thick. This ovum was taken from the same Rabbit as the ova in figs. 203 and 205. 100 *diam.*

Fig. 203. An ovum of no less than fifty-two hours, and measuring $\frac{1}{6}$,''' found in the uterus with that in the preceding figure, and that in fig. 205. (See the remarks on development not keeping pace with locality and size, in the explanation of fig. 202.) The twin cells (*bs*, $\frac{1}{25}'''$ in length), constituting the germ, though smaller than those in fig. 202, seemed on the point of being liberated by the liquefaction of the cells surrounding them, and that of an investing membrane. The nucleus in one of the twin cells appeared to be situated at the surface of that cell (par. 378.). 100 *diam.*

Fig. 204. An ovum of $24\frac{1}{2}$ hours, found in the Fallopian tube between its middle and the uterus. It measured in diameter about $\frac{1}{11}'''$. The incipient chorion (*cho.*) had begun to imbibe fluid and to rise from the membrane *f*. (Some of the cells entering into the formation of the chorion, which had not fully coalesced, were still visible; but they have not been represented in the figure.) The large twin cells (*bs*), constituting the germ, were remarkably pellucid, though on the point of being liberated by the liquefaction of the surrounding cells, and of a previously investing membrane. This ovum was taken from the same Rabbit as that in fig. 207. 100 *diam.*

Fig. 205. An ovum of fifty-two hours, found in the uterus with the ova in figs. 202 and 203. The chorion (*cho.*) had attained the diameter of $\frac{1}{5}'''-$, but the drawing was not taken until six days after death, during which time it is possible that fluid had been imbibed; though this is not usually the case. The membrane *f* had an ellipsoidal form. The large twin cells (*bs*) had been liberated by the liquefaction of a previously circumscribing membrane, but the remains of cells were visible around them, and also two cells nearly perfect and of considerable size. 100 *diam.*

PLATE XXVI.

All the Figures are from the Rabbit (*Lepus Cuniculus*, LINN.).

Fig. 206. An ovum of $23\frac{1}{2}$ hours, from the middle of the Fallopian tube, and measuring in diameter about $\frac{1}{13}'''$. It was taken from the same Rabbit as the ova figs. 208 and 209. The pellucid centre in each twin cell had increased considerably in size (par. 348.). The objects previously surrounding the twin cells having liquefied, the latter (*bs*) alone occupied the centre of the transparent fluid contained within the membrane *f*

(par. 352.). There was present however a minute solitary cell, which had escaped liquefaction (par. 350.). 50 *diam.*

Fig. 207. An ovum of 24½ hours, found in the Fallopian tube, between its middle part and the uterus. It measured in diameter $\frac{1}{11}'''$. The twin cells (*bs*) which occupied its centre (par. 352.) were of unequal size, and filled with cells. Several of the latter, situated in the centre of each twin cell, were larger than the rest; but it was not easy to distinguish the two destined to survive the parent cell (see fig. 209.). The incipient chorion (*cho.*) had begun to imbibe fluid (f^1), and to rise from the membrane *f*. It presented indistinctly such of the cells, entering into its formation, as had not fully coalesced. Some of these have been represented in the figure. This ovum was taken from the same Rabbit as that in fig. 204. 100 *diam.*

Fig. 208. An ovum of 23½ hours, found in the Fallopian tube, on the ovarian side of its middle part, and measuring in diameter $\frac{1}{12}'''$. This ovum was taken from the same Rabbit as the ova in figs. 206 and 209. It was not figured until *between seven and eight weeks* after death, having been preserved in the manner recommended in the "Second Series" of these Researches par. 313. The twin cells (*bs*) corresponding to those in the preceding figure (par. 352.) were, like them, of unequal size (pars. 355. 356.) but considerably smaller. Their interior presented other cells, each of which had its nucleus. In the centre of the latter was a pellucid space. (On the membrane *f* were cells, collected to give origin to the chorion (par. 372.). These have not been represented in the figure.) 100 *diam.*

Fig. 209. An ovum of 23½ hours from the ovarian side of the middle of the Fallopian tube, and measuring in diameter $\frac{1}{13}'''$. It was taken from the same Rabbit as the ova in figs. 206 and 208. Twin cells, such as those in most of the figures from fig. 187 to fig. 208 inclusive, were now no longer seen (par. 352.), the number of cells present being four (*bs*). Thus two—and only two—of the cells with which each twin cell becomes filled, had survived their parent (twin) cell,—all the rest, as well as the membrane of the parent cell, having disappeared by liquefaction. (Two or three cells however of extreme minuteness had not yet disappeared (par. 350.). One of these is represented in the figure.) The four cells were not elliptical, as in the early state (see the corresponding objects with the twin cells of fig. 207.), but globular in form (par. 355.). Two of them were larger than the other two; a difference perhaps referable to an inequality in the size of the parent cells (see figs. 207 and 208.) (par. 356.). The interior of the four cells resembled that of the two in fig. 206, except that in one the central pellucid space

had disappeared. They were very transparent, and their membranes had a high refracting power. 50 *diam.*

Fig. 210. An ovum of thirty-five hours, found in the Fallopian tube between its middle and the uterus. It measured in diameter about $\frac{1}{10}'''$. The four cells (*bs*) constituting the essential portion of the ovum—each measuring about $\frac{1}{33}'''$—unlike those in the preceding figure, were of equal size. They were globular, except that where in contact with one another, some degree of flattening had occurred; though this was scarcely (if at all) perceptible when they were first seen. In their transparency and the high refracting power of their membranes, they resembled the cells of the preceding figure. Their contents seemed more advanced. In all, the minute central pellucid space had disappeared. A larger space now presented itself, filled with transparent cells of considerable size, around which were very minute ones comparatively opake (par. 353. 357.). The structure of all the cells contained within the four, appeared to be essentially the same as that of the cells represented in the preceding figures; and it is deserving of notice that the contained cells were not globular, like the parent cells, but elliptic in their form (par. 355.). 100 *diam.*

Fig. 211. An ovum of thirty-six hours, found in the Fallopian tube, and measuring in diameter $\frac{1}{8}'''$ —. It was taken from the same Rabbit as the ovum fig. 212, and the objects in figs. 213 A. and 213 B. In the centre of this ovum were five cells. Three of these, larger than the rest and globular, corresponded to three of the four in the preceding figure. The other two, smaller and elliptical, appeared to be a new generation that had been contained within a cell corresponding to the fourth of those in the preceding figure, the membrane of which had disappeared. The remaining three larger cells exhibited a generation of two cells (the intended successors of the parent cell), besides others of minuter size. (These minuter cells would have undergone liquefaction along with the membrane of the parent cell (par. 354.).) 100 *diam.*

Fig. 212. An ovum of thirty-six hours, found in the Fallopian tube, and measuring in diameter $\frac{1}{7}'''$. It was taken from the same Rabbit as the ovum in fig. 211, and the objects in figs. 213 A. and 213 B. Four cells—corresponding to those in fig. 210.—having each given origin in its interior to two (persistent cells), the number present in this ovum was eight (*bs*). These cells—originally elliptical (see the corresponding ones in fig. 211.)—were now globular, but flattened where in contact with one another. They were exceedingly transparent. Their membranes had a high refracting power, and they contained other cells. Among the latter, two were in most instances easily distinguishable by their central

situation and their greater size. These two constituted the essential portion of the contents of each parent cell. All the others, as well as the investing membranes, had been destined to disappear by liquefaction. Sixteen cells would thus have formed the succeeding set. The larger of the young cells presented irregularities in their membranes, as if thus prepared for rapid distention. Several minute cells, which had escaped liquefaction (par. 350.), were visible in the transparent fluid of the ovum. 100 *diam.*

Fig. 213 A. The germ in an ovum of thirty-six hours, found in the Fallopian tube, and measuring in diameter $\frac{1}{8}'''$. It was taken from the same Rabbit as the ova in the two preceding figures, and the object in fig. 213 B. This germ consisted of eight cells (par. 352.)—each about $\frac{1}{40}'''$—which were in a condition resembling that of the corresponding cells in fig. 212. They are here represented in outline only, to show the irregularity with which they are aggregated together. 100 *diam.*

Fig. 213 B. An outline representation of eight cells constituting the germ (par. 352.) in another ovum from the Rabbit which yielded figs. 211. 212. and 213 A. These cells corresponded in size and condition to those in the last figure, differing only in their mode of aggregation. 100 *diam.*

Fig. 214. The outline of cells constituting the germ in an ovum of $57\frac{1}{2}$ hours, found in the Fallopian tube, and measuring in diameter $\frac{1}{9}'''$. It was taken from the same Rabbit as the objects in figs 215 to 219. These cells varied in size from about $\frac{1}{40}'''$, and less, to $\frac{1}{30}'''$. (In another instance they measured $\frac{1}{90}'''$ to $\frac{1}{30}$, that is, the germ was in a more advanced state). Some of the cells in this figure (fig. 214.) seemed to correspond to the cells in figs. 213 A. and 213 B; while others, of a smaller size, appeared to be part of a new set. And this is the more probable, from the whole number having exceeded eight. (See the explanation of figs. 211. 212. 213 A. 213 B.). 100 *diam.*

Fig. 215. Outline of cells constituting the germ in an ovum of $57\frac{1}{2}$ hours, and measuring in diameter $\frac{1}{8}'''$, from the Fallopian tube. This ovum was taken from the same Rabbit as the objects in figs. 214. 216 to 219. The cells were rather more numerous than those in fig. 214, and the proportion of smaller ones had increased (par. 354.); denoting a more advanced state (see the mode of origin of new cells, in the explanation of many of the preceding figures). 100 *diam.*

Fig. 216. The same object on a smaller scale. The transparency in the centre of each cell was found to be referable to the presence there of cells of larger size than that of the cells in a more external situation. 50 *diam.* (par. 357.).

Fig. 217. One of the cells of the two preceding figures (see the explanation of fig. 216.). 100 *diam.*

Fig. 218. Cells ($\frac{1}{40}'''$ to $\frac{1}{20}'''$) from the germ in an ovum of $57\frac{1}{2}$ hours, and $\frac{1}{8}'''$, from the Fallopian tube of the same Rabbit as the objects in figs. 214 to 217. 219. The central *contained* cells were larger than those in fig. 217, and between them were myriads of dark cells of immeasurable minuteness. 100 *diam.* (par. 357.)

Fig. 219. A cell from a corresponding situation in another ovum of similar dimensions from the Fallopian tube of the same Rabbit. 100 *diam.*

Fig. 220. A group of cells (the germ) in outline from an ovum of fifty-two hours, and measuring in diameter $\frac{1}{7}'''-$. The ovum was taken from the same Rabbit as the ova in figs. 202. 203. 205; and like them had passed into the uterus. The cells represented in this figure were more numerous and smaller than those in fig. 215. They were globular in form, and of nearly equal size. 100 *diam.*

Fig. 221. Cells from the group in the preceding figure, represented on a larger scale. They contained elliptic cells, in no small degree transparent, between which were dark cells of extreme minuteness. 300 *diam.* (par. 357.)

Fig. 222. Cells from a group presenting the same general appearance as those in fig. 220, and from an ovum found in the uterus of the same Rabbit. Their form was globular. One of them was seen to contain two elliptic cells, having essentially the same appearance as some of those which in the explanations of preceding figures have been represented as the destined successors of perfect cells (par. 353.). 300 *diam.*

PLATE XXVII.

All the Figures are from the Rabbit (*Lepus Cuniculus*, LINN.).

Fig. 223. Outline of cells grouped in a mulberry-like form (= the germ, $\frac{1}{20}'''$) in the centre of an ovum of $57\frac{1}{2}$ hours, and of $\frac{1}{7}'''$, found in the Fallopian tube between its middle and the uterus. (The objects in figs. 224 to 228, as well as the ovum fig. 233, were taken from the same Rabbit.) These cells were more numerous and smaller (about $\frac{1}{65}'''$) than those in fig. 215. They were globular in form. Within the group was seen an elliptic cell, which also is represented in the figure; its length equal to twice the diameter of one of the surrounding cells. (The nucleus of this elliptic cell is the rudimental embryo. This nucleus has not been represented in the figure.) 100 *diam.* (par. 359.)

Fig. 224. Outline of a group of cells constituting the germ in another ovum of $57\frac{1}{2}$ hours, and of $\frac{1}{7}'''$, from the same Rabbit, and the same locality as the object in the preceding figure (see the explanation of the latter). 100 *diam.* (par. 359.)

Fig. 225. Cell ($\frac{1}{40}'''$ in length) contained within the group exhibited in the preceding figure. The interior having been very indistinctly seen, its precise condition could not be ascertained. The appearance of the nucleus (*bb*), however, was such as the figure represents. This nucleus is the rudimental embryo. It had a finely granular appearance, and contained a pellucid central cavity. 100 *diam.* (par. 359.)

Fig. 226. Cell with its nucleus (*bb*)—the latter being the rudimental embryo—as seen in a situation corresponding to that of the object in the preceding figure (par. 359.). It was also observed in an ovum of the same Rabbit; the ovum being in a similar condition, and having the same size and local situation in the Fallopian tube. 100 *diam.*

Fig. 227. Nucleus (rudimental embryo) of a cell such as that in the preceding figure, on a larger scale. It was elliptical in form (par. 359.). 300 *diam.*

Fig. 228. Appearance of a cell with its nucleus corresponding to the objects in the three preceding figures, and taken from another ovum of the same Rabbit. The nucleus (rudimental embryo) *bb*, was at the surface of its cell (par. 359.). The ovum was of like dimensions ($\frac{1}{7}'''$), found in the same part of the Fallopian tube, and presented a similar condition. This figure does not represent particularly the interior of the cell, which could not be distinctly seen. 300 *diam.*

Fig. 229. An ovum of 64½ hours, and of $\frac{1}{7}'''$, found near the uterus in the Fallopian tube. The cells at the surface of the central group or germ (*bs*) were globular, or nearly so. Each of them presented a nucleus, which was not central but situated at the surface of the cell. These nuclei were yellowish-brown in colour, and appeared to consist of two parts; a free portion, composed of the foundations of new cells,—and a more central portion having a finely granular appearance. Within the latter was a point, in some instances dark, in others presenting the appearance of a pellucid cavity (par. 358.). (A larger elliptic cell—corresponding to that in fig. 223—was undoubtedly present, but could not be discerned.) 100 *diam.*

Fig. 230. An ovum of sixty-two hours, and of $\frac{1}{7}'''$, found near the uterus in the Fallopian tube. The nuclei (of the cells in the group or germ, *bs*) apparently corresponding to the nuclei at the surface of the cells in the ovum of the preceding figure—had now passed into the interior. The outer portion of each nucleus—presenting in fig. 229. merely the foundations of future cells—had expanded into cells which filled its vesicle; the inner portion (of each nucleus)—finely granular in the ovum fig. 229.—was now seen to be composed of the foundations of new cells. The appearance around the pellucid centre was that of a dark ring (par. 358.).

(A central elliptic cell was undoubtedly present in the group, but could not be discerned.) 100 *diam.*

Fig. 231. An ovum from the same Rabbit as that in the preceding figure, found in the same part of the Fallopian tube, and of the same size ($\frac{1}{7}'''$) ; but its thick transparent membrane (*f*) much more capacious. The cells of the central group or germ (*bs*) had ceased to present the remains of a nucleus (seen in the ovum fig. 230.), and in their interior were cells resembling those in figs. 218 and 221, but much more minute. 100 *diam.*

Fig. 232. An ovum of seventy-two hours, and of $\frac{1}{6}'''$, from the uterine extremity of the Fallopian tube. The cells of the central group or germ (*bs*) were globular. This group seemed to consist of two portions—an inner and an outer. The inner portion contained an elliptic cell of the same kind as the cells in figs. 225. 226 and 228; but its interior was dark, apparently from the presence of globules in its fluid (par. 359.). The outer portion of the group appeared to be expanding from the inner portion, to line the membrane *f* (par. 361.). 100 *diam.*

Fig. 233. An ovum of $57\frac{1}{2}$ hours, and of $\frac{1}{7}''' +$, from the uterine extremity of the Fallopian tube, in the same Rabbit as the ova from which figs. 223 to 228. were taken, but in a state rather more advanced. In the mulberry-like object or germ (*bs*) there had commenced a process of distention which, if continued, would have brought most of its cells—together with the contained elliptic cell—into contact with the membrane *f*, at the same time that a cavity was forming in its interior (par. 362.). The elliptic cell (the nucleus (*bb*) of which is the rudimental embryo) was more pellucid (par. 359.) than that in fig. 232. 100 *diam.*

Fig. 234. An ovum of $76\frac{1}{4}$ hours, and of $\frac{1}{6}'''$, from the uterus. The process mentioned in the explanation of fig. 233. had brought the outer portion of the mulberry-like germ (*bs*) into contact with the membrane *f*; and the contained elliptic cell into near approximation to the same. This elliptic cell (the nucleus (*bb*) of which is the rudimental embryo) was less pellucid than the corresponding cell in fig. 233, its fluid presenting a granular appearance. The membrane *f* was much less capacious than that in the preceding figure. 100 *diam.*

PLATE XXVIII.

All the Figures except those in the upper line are from the Rabbit (Lepus Cuniculus, LINN.).

Figs. 235 to 243. are copies of delineations given by SCHLEIDEN of some of the earliest appearances presented by the vegetable germ † (par. 399. 400.). It will be seen that SCHLEIDEN'S "embryo" corresponds to that which in this memoir I have denominated the germ.

Fig. 235. "Embryonal extremity of the pollen-tube of *Linum pallescens* together with an adherent portion of embryo-sac [α.]. The cell-forming process is incipient. At the upper part there is already a young cell with its cytoblast; and below it are several loosely floating cell-germs."

Figs. 236. 237. 238. 241. 242. "Formation of the embryo in *Oenothera crassipes*. α. Embryo-sac. β. Pollen-tube. γ. Embryo. δ. Germinal shoots (*punctum vegetationis*, WOLFF.). ε. Cotyledons."

Figs. 239. 240. "Early conditions of the embryo of *Potamogeton lucens*."

Fig. 243. "A later stage from *Potamog. heterophyllus*. δ. Plumula. ε. Cotyledon still unclosed."

Fig. 245. Cells of the tunica granulosa (part of the "disc" of BAER) of the form which they assume after the fecundation of the ovum,—the largest as much as $\frac{1}{30}'''$ in length (par. 345.). α. One of these cells from a fecundated ovum still in the ovary. β, γ. Several of these cells from ova which had passed into the Fallopian tube (par. 394.). (See also figs. 173. 181. 195.) 300 *diam.* (par. 387.)

Fig. 246. Cells of the retinacula ovi (part of the "disc" of BAER) as strewn around an ovum of twelve hours, from the Fallopian tube. They contained each an object having a vesicular appearance, with dark globules scattered on its surface. These cells of the retinacula, it will be observed, had not undergone the same change in form as those of the tunica granulosa (fig. 245.). 300 *diam.*

Fig. 247. Cells of the retinacula ovi (part of the "disc" of BAER) as strewn around an ovum of seven hours, from the Fallopian tube. They each contained other cells, the number of the latter in some instances being only two (par. 394.). In some of these contained cells, the nucleus was situated at the surface of the cell. 300 *diam.*

Fig. 248. Epithelium-cells from the fimbriated portion of the Fallopian tube of a Rabbit killed in the state of heat. They contained other cells, and one of them a central pellucid space. $\frac{1}{300}'''$ And upwards (par. 394.).

† Fig. 235. is taken from MÜLLER'S Archiv, 1838, Heft. II. Tab. III. fig. 17; and figs. 236 to 242, from WIEGMANN'S Archiv, 1837, viertes Heft, Tab. VII. figs. 14. 15, figs. 6. 7. 16. 17, and fig. 8.

Fig. 249. Another form of epithelium-cells from the Fallopian tube of the same Rabbit which yielded the objects in the preceding figure. These cells also contained other cells. $\frac{1}{200}'''$ And upwards (par. 394.).

Fig. 250. Epithelium-cells from the Fallopian tube of a Rabbit killed thirteen hours *post coitum*. They had become by pressure polyhedral. Length about $\frac{1}{200}'''$. They were filled with minuter cells. 300 *diam.* (par. 394.)

Fig. 251. Epithelium-cells from the Fallopian tube of the Rabbit which yielded figs. 248 and 249. They all contained minuter cells (par. 394.), and some of them spherical pellucid spaces, which in certain of those more advanced and carrying cilia had become elongated, in others were less distinct, and in some could not be discerned. α. $\frac{1}{300}'''$, β. $\frac{1}{100}'''$, γ. $\frac{1}{50}'''$.

Fig. 252. α. Cells collected together on the membrane *f* in an ovum of eleven hours, and of $\frac{1}{11}'''-$, from the middle of the Fallopian tube. The cells presented processes which had interlaced, and spherical pellucid objects in the centre. These cells by coalescing give origin to the chorion. β. Some of the same cells, which had a more superficial situation on this ovum (see also fig. 193.) (par. 373.).

Fig. 253. α. Cells collected together on the membrane *f*, and destined to give origin to the chorion, in an ovum of fourteen hours, and of $\frac{1}{11}'''+$, from the middle of the Fallopian tube. The processes (interlacing in fig. 252.) had become less distinct; and the pellucid central objects had in many instances undergone a change in form, and taken that of the containing cell. β. Some of the same cells as strewn around the ovum (see also fig. 185.) (par. 372.).

Additional Observations.

Received June 17,—Read June 18, 1840.

431. Should the facts made known in the foregoing memoir regarding the essential portion of the mammiferous ovum be confirmed, it will of course be inferred that the same changes take place, and for the same purpose, in other ova. Having however been so fortunate as to discover that such really is the case, I think it proper to record my further observations; more especially as some of them happen to have been made on ova which, when compared with the ovum of Mammalia, seem at first sight to present an important difference.

432. The principal observations hitherto published on the contents of the unfecundated germinal vesicle throughout the animal kingdom, were made by Professor RUDOLPH WAGNER †, to whom we are indebted for the discovery of the germinal spot. I am truly glad that it has fallen to my lot, as I venture to believe, to show the importance of this discovery, which has been questioned.

433. In the ovum of some animals the spot is single,—in that of others there are many spots; this being the apparent difference above referred to (par. 431.). R. WAGNER observed that the ova of certain animals in which originally there is only one spot, at a later period present a number; and he conjectured that this might be referable to a division of the primary spot into several parts ‡. It will be seen from what takes place in the mammiferous ovum, that this conjecture was very near the truth; and facts about to be made known, will serve to explain another observation of the same physiologist, namely, that the number of spots in some instances increases as the ovum ripens.

434. "In Birds," says WAGNER, "the germinal vesicle has always a germ-nucleus [germinal spot], which often forms a tolerably compact mass of finer molecules, but frequently consists of a very transparent and delicate tissue, and may thus be easily overlooked §." In scaled Amphibia the germinal spot is "at first single, but dissolves into several scattered points or globules, which adhere to the inner surface of the germinal vesicle ||." In naked Amphibia, "instead of a single germ-nucleus or spot, there are always—even in the very youngest ova—several shining globules having a high refracting power. In maturer ova these become more numerous, but they are relatively and absolutely smaller, and often pressed together, being everywhere situated—in general but slightly adherent—on the inner surface of the germinal vesicle ¶." The same author found the contents of the germinal vesicle in cartilagi-

† See the great work of WAGNER, "Prodromus Historiæ Generationis," before referred to in this memoir.

‡ Lehrbuch der Physiologie, I., pp. 57, 58.

§ A. Encykl. d. W. u. K. Erste Section xxxii. "Ei," p. 3.

|| Ibid. p. 3.

¶ "Ei," p. 3.

nous Fishes to resemble the corresponding parts in Birds. His description of these parts in osseous Fishes, is essentially the same as that of the corresponding parts in naked Amphibia.

435. On examining the germinal vesicle in a Bird†, in one of the Batrachian Reptiles‡, and in several osseous Fishes§, I find it in many instances to contain—not merely spots but—*nucleated cells*; the "shining globules" in naked Amphibia described by WAGNER as having a high refracting power, being obviously the nuclei of these cells. We thus find that, as in the mammiferous ovum at a certain period, the germinal vesicle of these animals contains cells.

436. But this is not all. When more closely examined, and especially after the addition of dilute spirit, many of the objects in question present an analogy still more striking, and one indeed which it is not presumption to consider perfect. Not merely does the germinal vesicle contain nucleated cells, but these cells are arranged in layers around a point which appears to be situated at the periphery of the vesicle; the layers nearest to this point being opaker than the rest. The interior of many of the contained cells also presents an appearance, indicating a process of the same kind as that implied by the state of the germinal vesicle or parent cell. In short, the contents of the germinal vesicle in Birds, Batrachian Reptiles, and osseous Fishes are often found to be in a condition so nearly resembling that of the contents of the mature germinal vesicle in Mammalia, that a description of the one would be almost applicable to the other; the difference consisting merely in the period at which the nucleus of the germinal vesicle resolves itself into incipient cells.

437. The analogy extends also to the substance surrounding the germinal vesicle, which is seen to consist of nucleated cells.

438. It is extremely satisfactory to be thus enabled to refer to ova which are so easily obtained, for a confirmation of my observations on the mammiferous ovum.

439. I have already alluded (par. 327 *Note.*) to a conjecture of Professor R. WAGNER, that the presence of "minute scattered globules" in the riper ova of certain animals|| may be referable to a division of the primary "spot;" which conjecture I think it will be seen was very near the truth. A previous suggestion, however, of the same author, it will be obvious, does not accord with my experience. He says with reference to ova of the naked Amphibia: "It is perhaps not unimportant for future investigations, if the views of SCHWANN should be confirmed, that sometimes in minute and unripe ova***one spot is remarkable from its being larger and opaker than the rest. It is perhaps the nucleus of the cell, while the others belong to the contents of the cell [zelleninhalt]¶." I do not think that the smaller "spots" just mentioned belong to the "zelleninhalt" or "contents of the cell," in the sense, in which this term is used in

† The Pigeon (*Columba domestica*, LINN.).

‡ The Frog (*Rana esculenta*, LINN.).

§ Among which were the Turbot and Plaice (*Pleur. maximus and Platessa*, LINN.).

|| *Squamous* Amphibia and *cartilaginous* Fishes.

¶ "Ei," p. 3.

the doctrine of "cells," namely, to denote a substance which is supposed to have arisen independently of the nucleus. From my observations, the smaller "spots" in the *naked* Amphibia and *osseous* Fishes also, are produced by a resolution of the nucleus; and the "larger and opaker" "spot" seen by WAGNER may have been, not as he conjectures the entire nucleus of the cell, but the central, unresolved, and most important portion of that nucleus.—As to the "zelleninhalt" or "contents of the cell," I may here remark that I do not recollect to have met with such a substance in a solid state, in which there was not every reason to believe that it had arisen from the resolution of more or less of a nucleus, or from that of the nuclei into which a nucleus becomes resolved†.

440. The following is the experience of R. WAGNER on the germinal spot in the ovum of some of the Invertebrata. If, in the perusal of it, my observations on the corresponding part in the mammiferous ovum be borne in mind, I think it will be found that here also the analogy is not wanting.

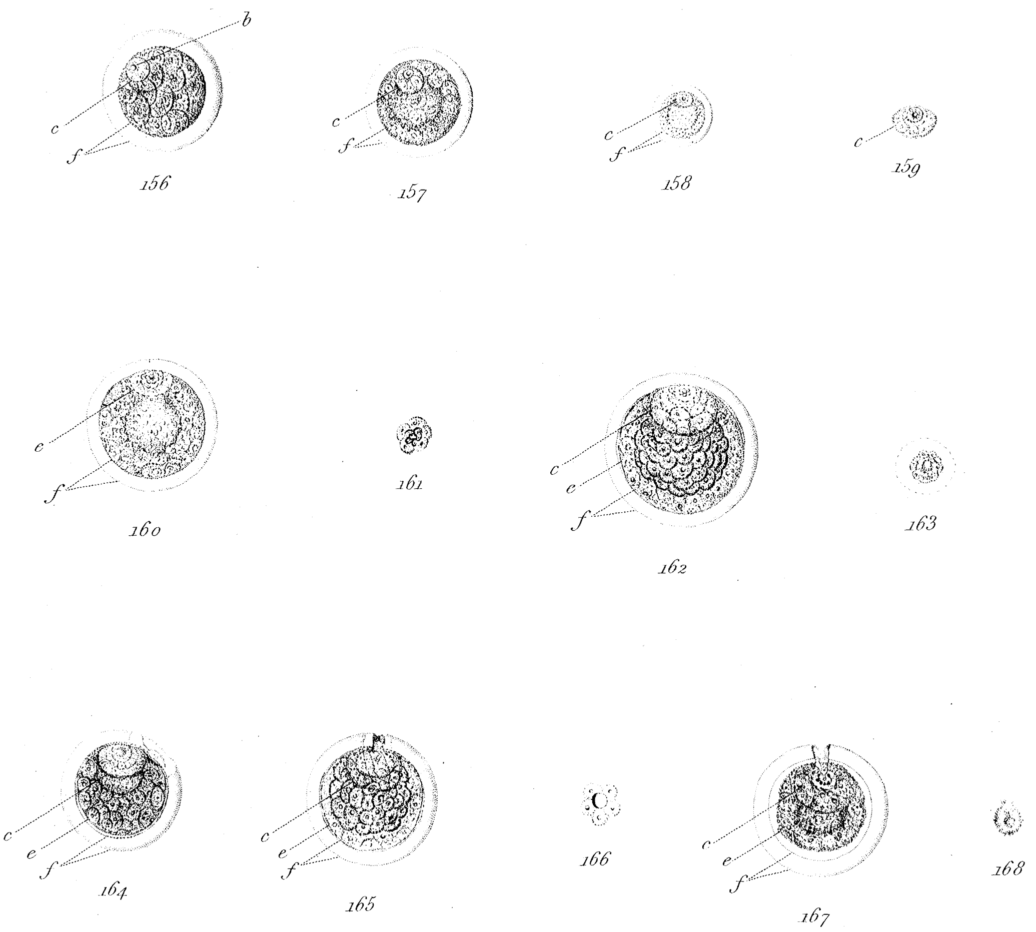
441. In Insects, "the germinal spot—or opaker portion of the contents of the germinal vesicle—in some instances appears as a single, dark, granular, spherical mass, which admits of being separated with the compressorium into different forms,***or it is an accumulation of minute isolated globules;—in some instances also, it is a delicate, finely granular, almost membranous-like layer, near which there sometimes appear one or more dark spots; or finally (in rare cases) there are present scattered germinal spots, as in osseous Fishes and naked Amphibia‡." In the Arachnida, "the germinal spot***sometimes appears as though it were an accumulation of grains, inclosed by a membrane; sometimes there are several accumulations of granules, and among them one or two larger spots§." In the Crustacea, "the germ-nucleus or spot is always present, and of manifold forms." It is sometimes "a large heap of grains" —in some instances "circumscribed by a membrane, rarely with some accessory spots"—in others, "an accumulation of twelve and more grains§." In *Astacus* and *Gammarus*, the same naturalist always found "minute spots on the inner surface of the germinal vesicle, as in Batrachians and osseous Fishes§;" which spots he de-

† The discoid objects constantly referred to in some parts of the foregoing paper, we have seen to pass into cells of the same form; and it is not easy to say where the disc terminates and the cell begins: so that in many instances I have been obliged to use almost indiscriminately the terms "disc" and "cell." I do not recollect indeed to have observed any of these discoid objects in the transition state in question, in which there was not an appearance in the most superficial part of the interior, denoting decomposition of the outer portion of the disc. So uniformly has this been met with, that I am ready to suppose the formation of the cell-membrane to be connected with such decomposition, or perhaps dependent on it. VALENTIN, though agreeing with other authors as to the order of formation of the parts connected with the cell, mentions not having observed the formation of the cell-wall to have taken place until the nucleus was everywhere surrounded with the future "zelleninhalt" or contents of the cell (Repertorium, 1839. II., p. 285.). Did not the "zelleninhalt," seen by VALENTIN, consist of the outer portion of the previous "cytoblast?"

‡ "Ei," p. 4. § Ibid. p. 4.

Embryology.

Ova from the Ovary, more or less prepared for Fecundation.



Actual Sizes. Largest Ovum (·) 162 Smallest (·) 157

(All the Objects are from the Rabbit; — in Fig. 158 magnified 50 diameters; in Figures 161, 163, 166, 168, mag.d 300 diam.; in all the other Figures, 100 diam.)

b Germinal Spot, beginning to resolve itself into Cells.

c Germinal Vesicle, more or less filled with Cells.

e Proper Membrane of the Substance by which the Germinal Vesicle is surrounded.

f Thick transparent Membrane of the Ovum — "Zona pellucida"

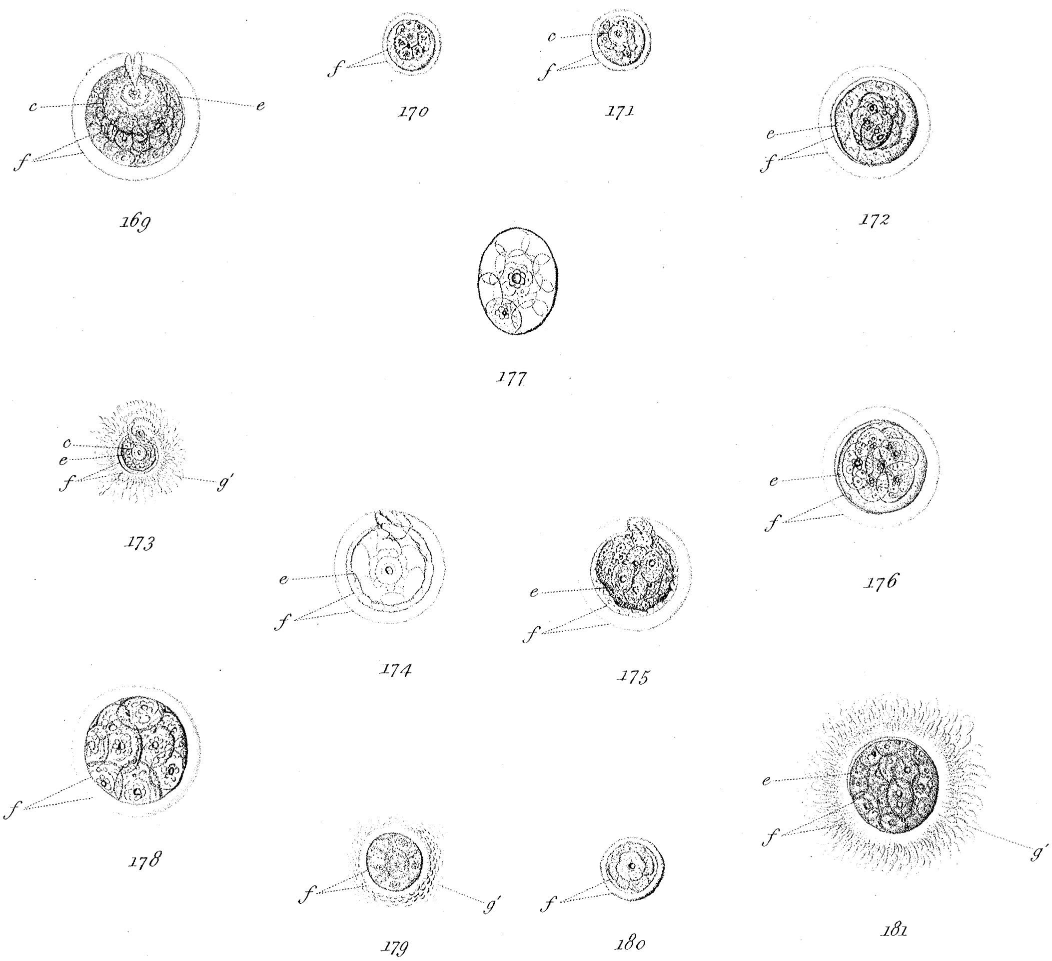
Fig.s 161, 163, 166, Central Portion of the altered Germinal Spot, its Centre the Point of Fecundation.

Fig. 168. Part of a Spermatozoon (?) seen in the Orifice Fig. 167.

Ad Nat. del. Martin Barry. J.s Basire sc.

Embryology.

Ova from the Ovary, after Fecundation.



Actual Sizes; Largest Ovum (·) Smallest (·)

(All the Objects are from the Rabbit; in Fig^{s} 170, 171, 173, 179, 180, magnified 50 Diameters; in Fig. 177, mag^{d} 300 Diam.; in all the other Figures, 100 Diameters.)

c Germinal Vesicle, filled with Cells.

e Proper Membrane of the Substance by which the Germinal Vesicle is surrounded.

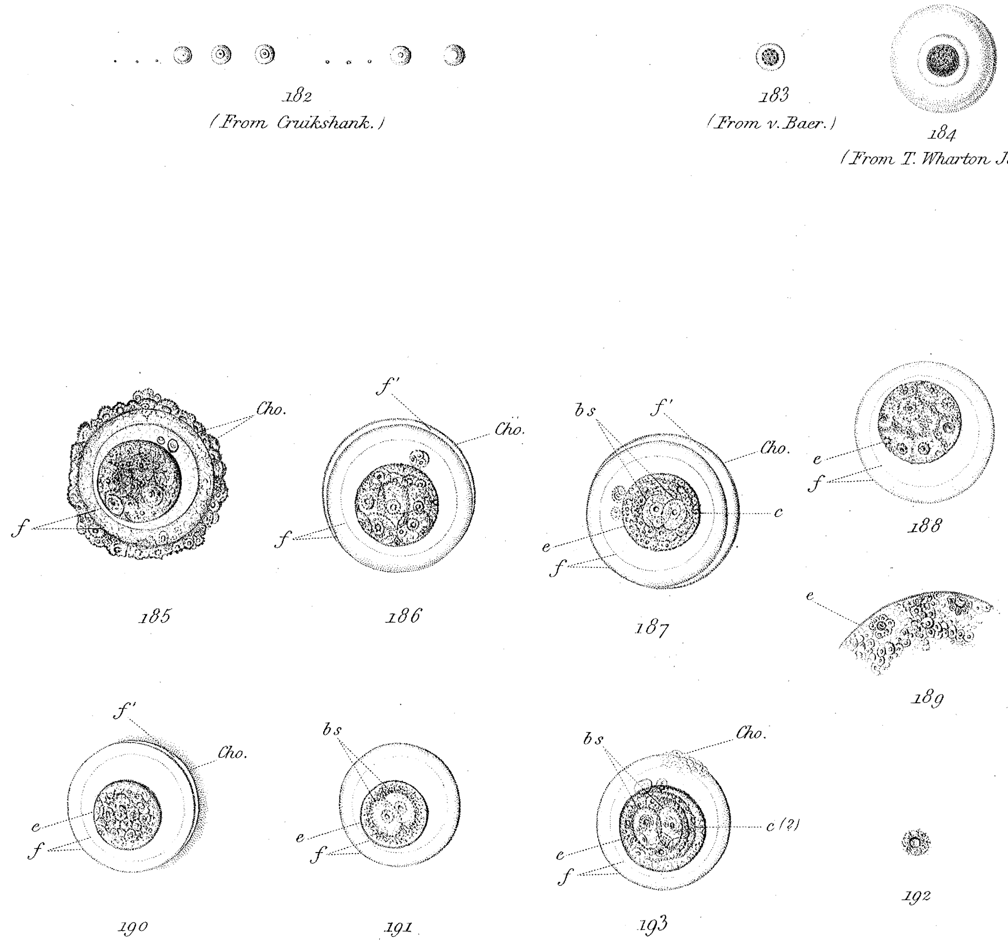
f Thick transparent Membrane of the Ovum _ _"Zona pellucida"

g′ Tunica granulosa; its Cells in an altered state.

Ad Nat. del. Martin Barry. J^{s} Basire sculp.

Embryology.

Ova from the Fallopian Tube.



Actual Sizes; Largest Ovum (·) Smallest (·)

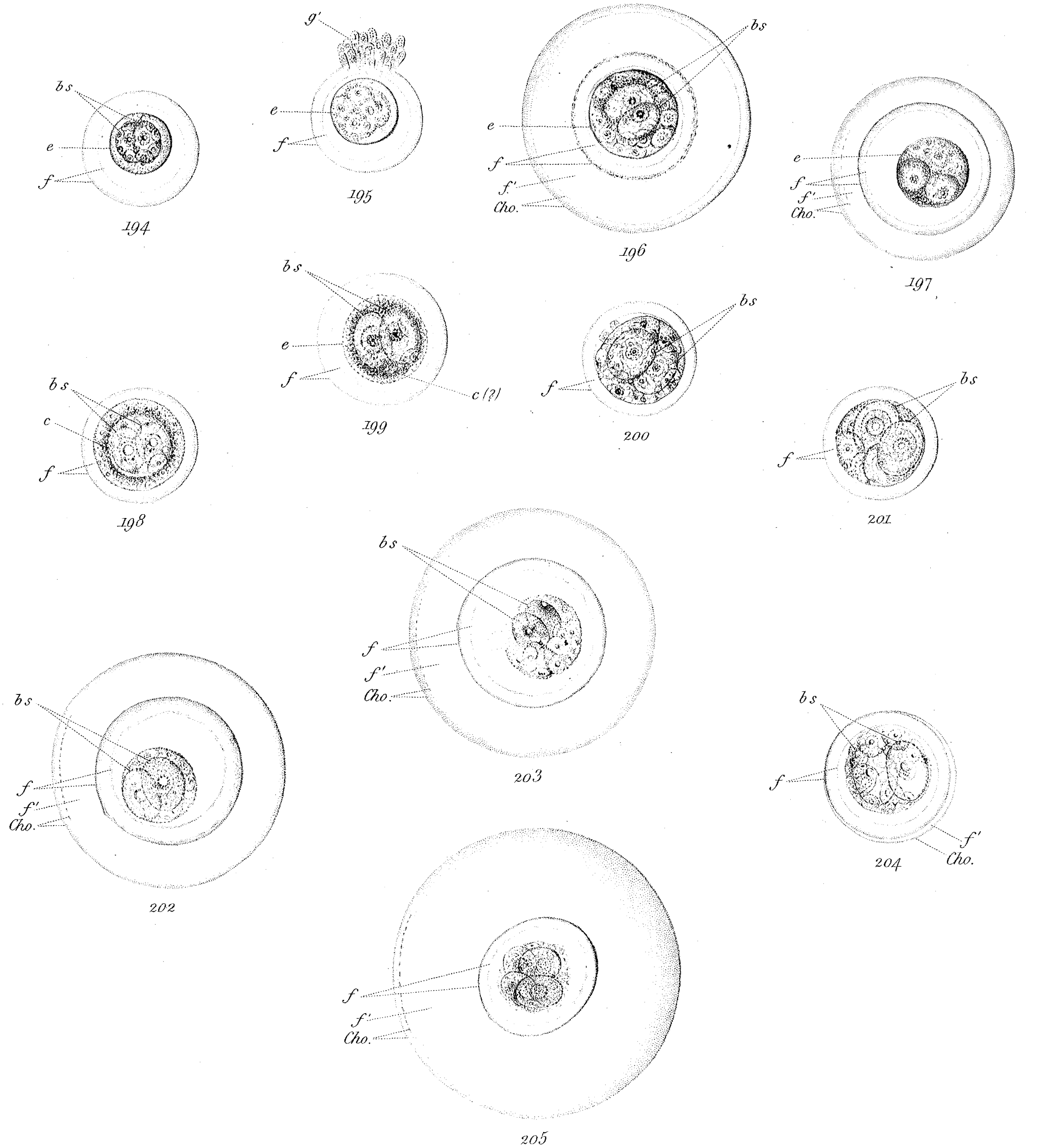
All the Objects are from the Rabbit, except Fig. 183. _ Figs. 185 to 188, 190, 191, 193, magd. 100 diamrs.

- *b s* The Germ.
- *c* Germinal Vesicle.
- *e* Proper Membrane of the Substance by which the Germinal Vesicle is surrounded.
- *f* Thick transparent Membrane of the Ovum _ "Zona pellucida".
- *f'* Fluid imbibed by the Chorion.
- *Cho.* Incipient Chorion (becoming villous in the Uterus.)

Ad Nat. del. Martin Barry. Js. Basire sculp.

Embryology.

Ova from the Fallopian Tube and Uterus.



Actual Sizes; Largest Ovum (·) Smallest (·)

(All the Objects are from the Rabbit; and all magnified 100 Diameters.)

bs *The Germ.*

c *Germinal Vesicle.*

e *Proper Membrane of the Substance by which the Germ. Ves. is surrounded.*

f *Thick transparent Membrane "Zona pellucida".*

f' *Fluid imbibed by the Chorion.*

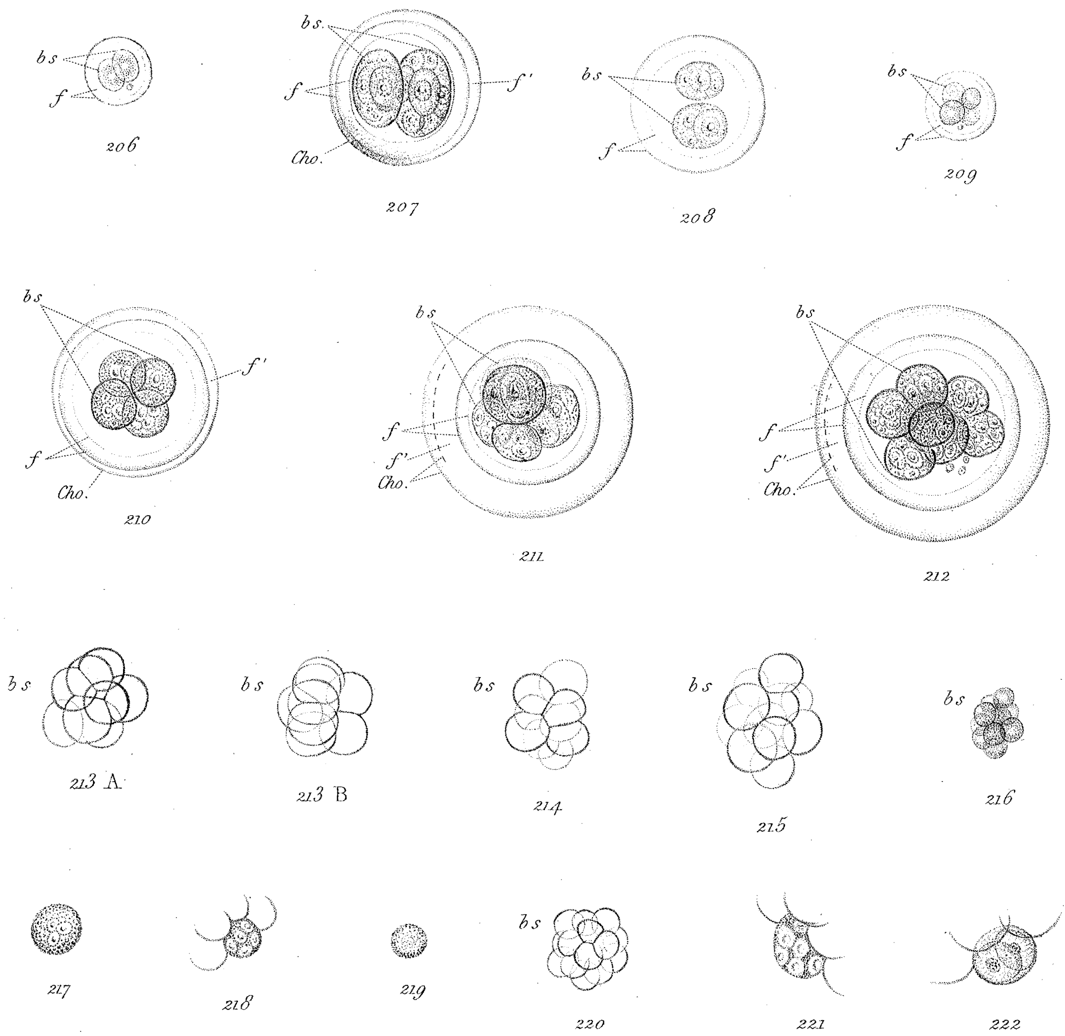
Cho. *Chorion (becoming villous in the Uterus.)*

g' *Tunica granulosa.*

Ad Nat. del. Martin Barry. *Jˢ Basire sculp.*

Embryology.

Ova from the Fallopian Tube and Uterus.



Actual Sizes; Largest Ovum (·) Smallest (·)

(All the Objects are from the Rabbit; — in Fig.s 206, 209, 216, magnified 50 Diameters; in Fig.s 221, 222, mag.d 300 Diam.; in all the other Figures 100 Diameters.)

bs The Germ.

f Thick transparent Membrane of the Ovum — "Zona pellucida".

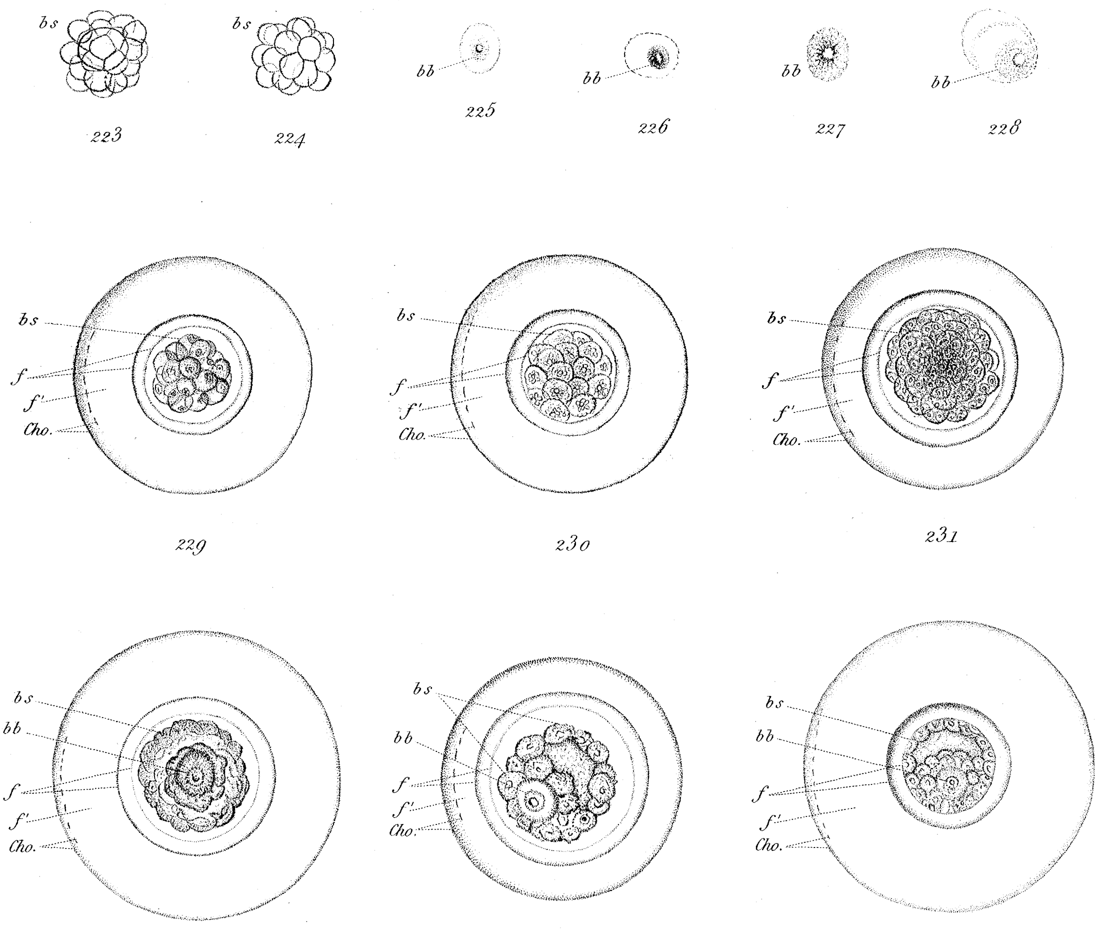
f' Fluid imbibed by the Chorion

Cho. Chorion (becoming villous in the Uterus.)

Ad Nat. del. Martin Barry. *J.s Basire sculp.*

Embryology.

Ova from the Fallopian Tube and Uterus.



Actual Sizes; Largest Ovum (·) Smallest (·)

(All the Objects are from the Rabbit; — in Fig.s 227, 228, magnified 300 Diameters, in all the other Figures, 100 Diameters.)

bs The Germ, — including

bb Rudimental Embryo —

— ("Germ" of second series.)

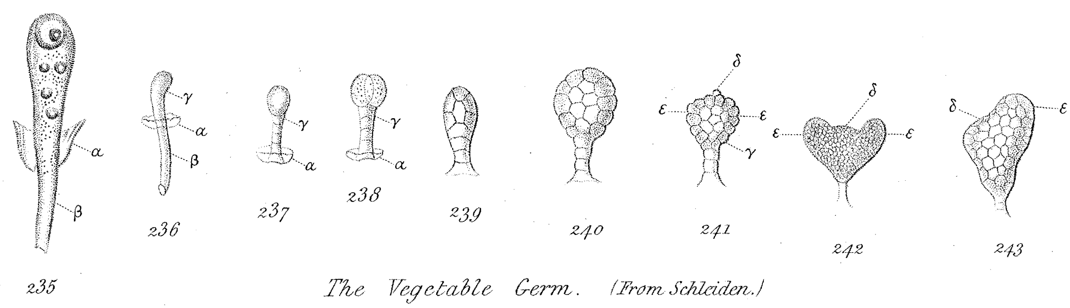
f Thick transparent Membrane of the Ovum — "Zona pellucida."

f' Fluid imbibed by the Chorion.

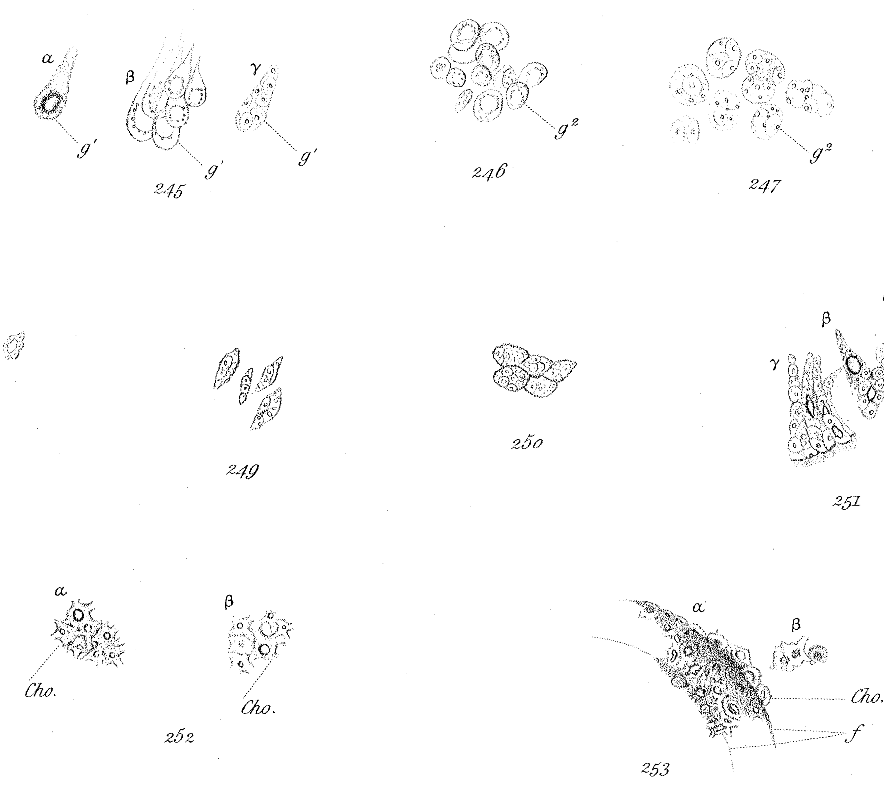
Cho. Chorion (becoming villous in the Uterus.)

Ad Nat. del. Martin Barry. J.s Basire sculp.

Embryology.



The Vegetable Germ. (From Schleiden.)



(All the Objects are from the Rabbit, except those in the upper line.)

f Thick transparent Membrane of the Ovum _ "Zona pellucida".

g′ Altered Cells of the Tunica granulosa.

g² Altered Cells of the Retinacula ovi.

Cho. Cells of which the Chorion is formed.

Ad Nat. del. Martin Barry.

Js. Basire sculp.

scribes as being "*originally* scattered†." In the Annelida, "the germinal vesicle is furnished with a minute, opake, single germ-nucleus or spot, which sometimes presents an accumulation of grains. In *Clepsine bioculata****the germinal vesicle presents numerous, minute, pale, scattered spots, as in the Batrachians‡." In some of the Mollusca, "the germ-nucleus or spot is usually a single, opake mass, which is sometimes granular, and in some instances surrounded by minuter appendages, or has the appearance of being invested by a membrane§."

442. With reference to ova in general at the period of their ripening, R. WAGNER remarks: "In the contents of the germinal vesicle, hitherto transparent, there takes place a coagulation; new globules present themselves near the single or manifold germinal spot (which is to be considered as the nucleus of the germinal vesicle),—or there are formed accumulations of granulated masses which sometimes constitute even membrane-like layers, as in many Insects. The germinal spot disappears as a single nucleus, or is no longer to be found among the other grains.***As soon as the ova have left the ovary***the germinal vesicle is no longer to be found. It has suddenly or at least rapidly disappeared. Whether it suddenly bursts, or quickly collapses, is doubtful. The latter, from observations on the ova of Frogs and other animals, appears to me the more probable. The thinly fluid contents are observed to diminish in quantity, while there arise more solid granular coagulations||."

443. A spot was described in my "First Series"¶ on the inner surface of the membrana vitelli in the ovum of the Frog. In the course of recent examinations it has seemed to me that the black layer—known to form at the periphery of the yelk in this ovum—comes into view as the spot in question disappears. The spot is composed of flat, elliptic objects such as those which become resolved into minuter objects, of the same kind, in the substance surrounding the germinal vesicle in the mammiferous ovum††.

† Is there not an earlier period in these, as probably in all other ova, when there is present only one spot or nucleus?

‡ "Ei," p. 5. § Ibid. || "Ei," pp. 7. 8.

¶ Philosophical Transactions, 1838, Part II., p. 313. par. 40. Plate VI. fig. 28 d^1.

†† When I communicated my last memoir ("Second Series," *l. c.*, par. 292. *Note*), the presence of this spot, in connexion with the new doctrine of "cells," seemed to require a modification of some of the conclusions in my "First Series," as to the order of formation of the several parts of which the ovum is composed. For, presuming the spot in question to be the nucleus of a cell—and (following SCHLEIDEN's views) necessarily existing before the membrane of its cell—I stated that if such spot were present in the corresponding membrane of other ova, the formation of this membrane is doubtless earlier than that of the germinal vesicle itself.—I have now to add, that later observations induce me to believe that the spot in question does *not* correspond to the nucleus of a cell, but seems (as above) to denote the commencement of the formation of the black layer, such formation appearing to begin in one of the discs by which the germinal vesicle is surrounded; which disc then presents the appearance of a lenticular and usually elliptic spot.—The existence of this spot, therefore, does not affect my conclusions as to the order of formation of the several parts of the ovum; nor do I see that the doctrine of cells—modified as it must be by the facts made known in this memoir—affects those conclusions.