EMBRYOLOGY OF THE RHESUS MONKEY

Embryology of the Rhesus Monkey (*Macaca mulatta*) Collected Papers from the Contributions to Embryology, published by the Carnegie Institution of Washington. (Publication No. 538.) Pp. iii+148+52 plates. (Washington, D.C.: Carnegie Institution, 1941.) 1 dollar.

IN 1925 the Carnegie Institution of Washington undertook a programme of research into the problem of reproduction in monkeys. Its first step was to establish a colony of rhesus macaques in its Department of Embryology, which was then directed by Dr. George L. Streeter. The Department is next door to the Anatomy School of Johns Hopkins University, where a few years earlier Dr. George W. Corner had begun similar work on the same species of primate. The close affiliation of the two laboratories proved fortunate, and the success of the Institution's programme of research, now directed by Dr. Corner, is marked by a number of monographs published in its "Contributions to Embryology". Five of these monographs have now been collected in a single volume.

The volume opens with Hartman and Corner's paper on the first maturation division of the macaque ovum. Like the others of the series it is beautifully illustrated; and it demonstrates that, as in the vast majority of mammals, the first maturation division occurs within the Graafian follicle just preceding its rupture. The second paper, by Lewis and Hartman, takes the story a stage further and discusses fertilized and unfertilized ova recovered from the Fallopian tubes, and the further behaviour of which has been studied *in vitro*. The process of segmentation has been successfully filmed, but attempts to fertilize the eggs *in vitro*, unlike similar experiments with rabbit eggs, failed. The third monograph, by Heuser and Streeter, deals with the early development of the embryo. Cleavage of the fertilized ovum leads to a selective distribution of the complex material of the original one-cell egg into the daughter cells of, first, the morula, and then the blastocyst. This process represents the specialization of 'primary orders of tissue', a process which the authors point out depends on intrinsic genetic rather than environmental factors, and by which the auxiliary elements of the egg separate themselves from the true formative elements. Strictly speaking, it is a process which does not represent growth, since the mass of the cells of the free blastocyst is in fact less than that of the original egg cell. The moment this primary differentiation has occurred, its cellular products themselves begin to exert a mutual influence upon each others' further development.

The factors responsible for the transport of the blastocyst and the determination of its site of implantation, which occurs about the ninth day after ovulation, are unknown, but the process of implantation itself has been studied in the greatest detail. So, too, has the differentiation of the 'germ disc', which in its early stages is synonymous with the so-called 'embryonic ectoderm', and which the authors regard as exercising a function similar to that of the dorsal lip of the blastopore, in so far as the disc has a "dominating influence in determining the fate of the neighbouring auxiliary cells as well as those migrating out from the germ disc itself". During this early stage of development the disc is growing as a tissue culture in a fluid medium provided by the surrounding auxiliary cells. It owes its organizing propensity to the fact that its constituent cells represent an unspecialized residuum of the original germ plasm. Further segregation of cells, as development of the disc proceeds, brings these particular cells into relation with the primitive streak. It is not until the latter has given off definitive embryonic ectoderm, mesoblast and gut endoderm cells that the residuum of primordial germ plasm is finally used up. The endodermal contribution of the germ disc is no clearly distinguishable from the cellular proliferation perhaps induced by the germ disc, of the primitive endoderm cells—which are a direct product of the primary segregation and cleavage of the egg.

Heuser and Streeter thus define a first order of segregation or specialization in embryonic development in which the formative elements of the fertilized egg become separated from the auxiliary elements; a second order of segregation in which the formative elements containing the residuum of primordial germ plasm become organized as the primitive streak, which is the locus of the "second order of specialization"; and further orders of segregation, for example, the separation of the ganglion crest from the neural ectoderm, which finally become too numerous to be kept in serial levels. The general conclusions reached are of considerable importance to comparative embryology. The authors do not subscribe to any simple and far-reaching phylogenetic theory. As they put it, "the embryo at all stages is a living organism and is to be analysed as a biologic problem rather than purely a morphologic abstraction". For example, "what were thought to be vestiges of great phylogenetic importance appear, in many instances, to be temporary embryonic structures, essential to a particular period of development."

The fourth monograph of the series is by Schultz, and discusses fœtal growth, with special reference to body proportions, certain ectodermal structures and ossification. The rhesus monkey at birth is relatively much more advanced than a new-born human infant, but fœtal growth-changes in body proportions are much the same in both species. A notable exception is the brain, which in the new-born rhesus monkey is about half the final size achieved in post-natal life, and in man a quarter. The fifth and final monograph of the volume, by Wislocki and Streeter, is a very detailed discussion of placentation. It demonstrates clearly that, in the differentiation of the trophoblast, there is a striking similarity between man, anthropoid apes and the rhesus monkey. The human placenta can be regarded as having been derived from the catarrhine variety by the acquisition of an interstitial mode of implantation. Here the authors depart from a widely accepted view, in so far as they suggest that human interstitial implantation is not due to the trophoblast becoming more "invasive", but to the endometrium becoming less resistant to invasion —as shown by the absence in man of proliferation of the uterine epithelium at the site of implantation. This paper ends with a stimulating discussion of the functional relationships between egg and endometrium.

The Carnegie Institution is both to be congratulated on the achievement which the volume represents, and to be thanked for having made these five monographs available between the same covers. It is to be hoped that this is only the first of a series of similar ventures, and that other volumes will follow in which further related studies of primate reproduction and growth will be made available, in the same convenient form, to students of the subject. S. ZUCKERMAN.