the filum occurred, so that a short extra spur of filum tissue was present at the point of original injury. This short branch is histologically identical with the small vesicles hitherto interpreted as probably abortive ear vesicles. Moreover, the branch of the filum is morphologically identical with the vesicles previously described, except that the vesicles were not attached at any point to the host filum. In a large series of well over 100 experiments it seems clear that occasionally a small amount of filum tissue might be separated from the rest of the filum and reconstitute itself into a small vesicle.

This is now believed to be the explanation of the formation of small vesicles next to the grafted medullas for the following reasons: It clearly explains the sporadic and infrequent appearance of these vesicles in the original study. It explains the location of the vesicles adjacent to the medulla, since the grafts were purposely placed immediately adjacent to the injured notochord and filum. The method of formation of the vesicles, described in detail in the original report, is just what would be expected according to this explanation, whereas it is entirely different from the normal development of an ear vesicle. The histology of the wall of the small vesicles is identical with that of the wall of the filum terminale, even down to small cytological details. Finally, the results are now brought in line with all the subsequent blastema studies, which showed that blastema mesenchyme does not react morphogenically to such embryonic inductors as the eyecup, archenteron roof, or dorsal lip of the blastopore. It is concluded, therefore, that although induction is undoubtedly concerned in regeneration as well as in embryonic development, no specific inductive response by regenerating tissue to an embryonic inductor has yet been shown. On the other hand, the reciprocal effect, the inductive action of regenerating upon embryonic tissue, seems to have been clearly demonstrated.

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Mustard Gas Mutations in *Neurospora*

The production of mutations in *Drosophila* by treatment with mustard gas has been reported by Auerbach and Robson (*Nature, Lond.*, 1946, **157**, 302). (See also Gilman and Philips. *Science*, 1946, **103**, 409.) In view of the great potential significance of this discovery we have carried out an experiment designed to test the effectiveness of mustard gas in inducing mutations in *Neurospora*, with the results reported below.

Asexual spores of wild-type stock 1A of *Neurospora crassa* were placed in the side arm of a sterile Thunberg tube, and two drops of β,β′-dichlorodiethylsulfide (mustard gas) were placed in the main compartment. The tube was closed at atmospheric pressure and immersed in a constant temperature bath at 29° C. At the end of 30 minutes the spores were removed, suspended in sterile water, and applied to protoperithecia of wild-type strain E5297a. As a control, the same cross was made with untreated spores. Following sexual fusion and the development of ripe perithecia, single ascospores were isolated on "complete" medium for germination (Beadle and Tatum. *Amer. J. Bot.*, 1945, 32, 678). The isolation of only one ascospore from each perithecium insures that each mutation will be counted only once. The cultures were first examined for morphological (*i.e.* visible) variants and then were tested for biochemical mutations by the method of Beadle and Tatum (*loc. cit.*).

In the treated series, 760 spores germinated. Of these, 29, or 3.8 per cent, were mutants. In the control series, 769 spores germinated, of which one, or 0.13 per cent, was classified as a doubtful mutant. This spore germinated but grew so poorly on the complete medium that it could not be tested further.

The 29 mutants resulting from the treatment included 17 visible and 12 biochemical mutants. The visibles, together with the number of independent occurrences of each, were as follows: albino, 1; pink, 2; surface-growing types, 6; cauliflower types, 4; plumose, 1; crew cut, 3. Among the biochemical mutants, strains unable to synthesize the following substances occurred with the frequencies indicated: methionine, 4; cystine and methionine, 2; leucine, 1; adenine, 1; *p*-aminobenzoic acid, 2; thiamin, 1; unidentified amino acids, 1. Growth of each biochemical mutant takes place when the basal medium is supplemented with the substance it cannot synthesize but not on unsupplemented basal medium.

The frequency of mutant spores found in the treated series compares favorably with that obtained following irradiation with ultraviolet light (Beadle and Tatum, *loc. cit.*). The actual mutation rate is close to twice the percentage of mutants found, or about 7.6 per cent for the treated series. This is because the probability of choosing a mutant spore from a perithecium carrying a mutant gene is 0.5 when only one spore is isolated per perithecium. If the perithecium carries more than one mutant gene, the probability of recovering them in a single spore depends on the degree of linkage between the genes. We have not attempted to determine the maximum mutation rate attainable with mustard gas. It is possible that by varying the exposure time or other conditions a higher rate than that reported here might be obtained. In *Drosophila*, Auerbach and Robson found the frequency of sex-linked lethals to run as high as 24 per cent.

At least one of the mustard gas mutants appears to be of a new type. This is the "albino," which is not a true albino but has a yellow tint. This form has not been encountered previously in this laboratory. No new kinds of growth-factor requirements were positively identified among the biochemical mutants. The strain requiring unidentified amino acids responds to casein hydrolysate and to a synthetic mixture of the 10 "essential" amino acids but not to any single amino acid. The minimum number of amino acids required by this mutant has not yet been worked out. It does not grow on a mixture of isoleucine and valine, shown by Bonner, *et al.* (*Arch. Biochem.*, 1943, 3, 71) to be required by one *Neurospora* mutant. This strain cannot

be regarded as a new type until its growth-factor requirements and the number of genes involved are definitely known. The possibility exists that further studies on the other biochemical mutants listed will show that new genes controlling these syntheses are mutated.

The preponderance of mutants which are unable to synthesize methionine (50 per cent of all the biochemical mutants) is not a unique result of mustard gas treatment, since this class is also the most frequent among radiation-induced mutations.

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Book Reviews

Human embryology (prenatal development of form and function). **W. J. Hamilton, J. D. Boyd, and H. W. Mossman. Baltimore, Md.: Williams and Wilkins, 1945. Pp. viii + 366. (Illustrated.) $7.00.**

The objective of the authors of this book has been to present a thorough study of the fundamental morphological and physiological aspects of development of the human embryo and to show their relation to the changes occurring in the mother during pregnancy. Many new facts of development uncovered during the past 20 years have been incorporated in the volume along with modern theoretical interpretations suggested by the work of experimental embryologists. The book is intended primarily for medical students and hence its chief emphasis is on the human embryo.

The opening chapters are concerned with introductory concepts, such as the meaning and scope of the processes involved in embryonic development and the details of structure and formation of the germ cells. As an introduction to the subject proper, there is a detailed account of the cyclic changes in the female genital tract as related to the function of reproduction. In particular, the ovarian and menstrual cycles are discussed in relation to the endocrines controlling them.

Early development, including fertilization, cleavage, and formation of the blastocyst, is dealt with as fully as possible on the basis of information gained from the study of the Macacus and certain other mammals. A very extensive tabulation, accompanied by valuable descriptions of the earliest known human embryos, shows the great advance in this particular field in recent years. Some 50 embryos are listed. Similarly, a thorough discussion of implantation and formation of the fetal membranes has been given. The anatomy and physiology of the placenta are explained as well as the mechanism for the maintenance and termination of pregnancy. Further details of the development of the germ layers and the growth and early development of body form are presented on the basis of the early stages mentioned above and from material made available by the Carnegie Institution of Washington.

In the chapters on organogeny which follow, the subject matter has been most thoroughly and carefully presented. These chapters are well documented, and important references are listed. Tabular summaries, of great value to the student, have been utilized frequently. While some attention is given to anomalous conditions arising during development, this phase of the study is not overdone.

Throughout the book at appropriate places the authors have introduced discussions of the modern theoretical concepts of determination, differentiation, and the role of the organizer stemming from the important work of the experimental embryologists, from the early studies of Roux and Driesch to those of such modern investigators as Spemann and Vogt. These would probably be more profitable to the student if a more extensive background of comparative embryology were provided. Recognizing this fact, the authors have incorporated a brief outline (20 pp.) of comparative embryology emphasizing the earliest stages of development. About half of this outline is devoted to the subject of placentation in various mammals. The apparent inadequacy of this portion of the book is compensated for, however, by the excellence of the rest of the volume.

Although the book conforms to wartime standards of compactness, there is throughout a lavish use of colored figures. For some unknown reason the legends for many of these illustrations are printed in such small type that they are often difficult to read. American readers will also note the use of certain terms in the text which, though frequently employed in England, are not so commonly used in this country.

Mistakes and inaccuracies have been kept to a minimum throughout. In general, this book represents a valuable contribution to the field of human embryology and is remarkably complete and up to date.

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