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The developmental stages at which mutations occur in the germ tract.

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In the fruit-fly *Drosophila melanogaster* about 300 primary mutations have been found, most of which arose in cultures carried on in the laboratory. A study of the critical cases among these mutations has shown that a large majority of them originated at or very near the maturation stage; that a few occurred in the gonial cells some time prior to maturation; and that a few occurred early in the segmentation stage.

The conclusion that most mutations occur at the maturation stage is based largely on the proportion of sex-linked recessives and of dominants that have been first found as a single individual. Approximately half of the sex-linked recessives have been discovered as a single male. This is a surprisingly large proportion and clearly means that in these cases the actual mutation occurred in the mother, and at, or not more than a very few cell generations before, the maturation of the egg. Those sex-linked recessives that did not first appear as a single male have in the main appeared as half the sons of a female already heterozygous for the gene. In these cases the actual mutation had occurred at some indeterminate stage one or more generations previous to the appearance

of the character. There are now about 30 known dominants in *Drosophila melanogaster*, of which fully two-thirds were first found as single heterozygous individuals. This very large proportion of dominants appearing as single individuals means that the actual mutation has occurred very close to the final stage in the formation of the gamete—probably little if any prior to maturation.

That mutations may occur in the oögonial cells prior to maturation is proved by a few cases in which a single female has given rise to more than a single individual of a new sex-linked recessive character. In the first of these cases the mutant called "cut" occurred as six males among the 131 sons of a particular female. The mutation "tiny-wing" occurred as two sons among about 150; "sable-duplication" occurred as three males among 133; and "ivory" as about 10 per cent. of the sons. There are one or two other such cases known. In all of these cases the facts are in accord with the hypothesis that the actual mutation occurred in the oögonial cells of particular females, and from one to a few cell-generations prior to maturation. There has been one case in which a female homozygous for an autosomal recessive was outcrossed to a wild-type male, and produced among 61 offspring 6 flies that were heterozygous for a new allelomorph of the recessive. The mutation responsible for the new allelomorph occurred in the wild-type male in the spermatogonial stage far enough previous to spermatogenesis so that approximately a sixth of the sperm carried the gene. The proportion of gametes that carry the mutant character corresponds to the time previous to maturation at which the particular mutation occurred.

That mutation may occur in the zygote immediately after fertilization is proved by the discovery of nearly a dozen mosaic individuals in which a new mutant has appeared as part of a fly. If the new mutant is a dominant it may appear as part of a female, and if a sex-linked recessive as part of a male. Such mosaics arise by mutation in the zygote, and the parts descended from the mutant cell show the new character while the remainder of the animal shows the original type.