sponding part of the visual cortex, the statistical result would be an approximately steady potential and an equally steady flow through and around the cortical counterpart of the image. If this is otherwise good reasoning, we have no cause for objection. The conclusion agrees with our own thesis. Elsewhere, we have given a derivation of steady potentials in the visual area, which refers to the much debated chemical action of nerve impulses (*5, 6, 7*). We need not choose between these two possibilities; the distribution of the resulting flow would be about the same in both cases, and this, from a psychological point of view, is the main issue.

More generally speaking, our results must be interpreted with some caution, just because they are related to important problems. The occurrence of direct currents in the cortex would probably have consequences in various parts of neurophysiology. In psychology, access to the cortical correlate of pattern vision would immediately affect the theory of psychophysical relations—and would affect first of all, the theory of perceptual space.

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TECHNICAL PAPERS

The Mutagenic Mode of Action of Formalin

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In 1946 Rapoport (*5*) reported that formalin, when mixed with the food of *Drosophila melanogaster* in sublethal concentrations, produces a high frequency of mutations. In the one experiment for which full data were given, the percentage of induced sex-linked lethals was 5.92. Kaplan (*2*) confirmed this finding, and similar results were obtained in this laboratory with a wild-type (OrK) stock. Rapoport attributes the mutagenic effect of formalin to a chemical reaction between the chromosomes and the CO group of the aldehyde. It seems rather unlikely that formalin as such would reach the chromosomes of the germ cells under the conditions of these experiments. Two other possibilities have to be considered. First, formalin might react with the food to produce a new mutagenic compound. Since formalin is added to the food while the agar is still well pourable, this reaction would take place at a temperature of about 60° C. Second, it also seems possible that a mutagenic substance is formed not in the food, but in the body of the fly either during digestion or in the germ cells.

In order to obtain information on this point, the effect of formaldehyde vapor on *Drosophila* was tested. A positive result with this method would prove that formaldehyde as such is a mutagen, which would make it at least probable that it is the effective agent in the feeding experiments also. A comparison of the effects of formaldehyde vapor on male and female germ cells in various stages of development should help to decide whether the action on the chromosomes is direct or mediated by the cytoplasm; for in the latter case female germ cells and spermatogonia should be more affected than mature spermatozoa. The OrK stock which had given 3–6% sex-linked lethals in previous feeding tests with formalin was used. Young adult ♂♂ and ♀♀ were exposed to formaldehyde vapor in the first series. Exposures lasted from 30 to 60 min, and the biologically effective dose was measured roughly by the survival rate during exposure and the first few hours afterwards. This does not take account of the fact that flies often die during the subsequent days. In all tests, ♀♀ survived in a larger proportion than ♂♂. In order to test germ cells which at the time of exposure had been at different stages of development, the treated ♂♂ were given fresh ♀♀ every fifth day, the treated ♀♀ were put on fresh food every fifth day, and mutation rates were recorded separately for the different broods. The untreated mates for both sexes were taken from the Muller-5 stock. Table 1 gives a short summary of the results.

The OrK stock used for these experiments has been tested repeatedly over the past few years. Sex-linked lethals in the ♂♂ arise at a fairly constant rate of about

0.3%. It is obvious that the treatment has remained ineffective, and that at doses which allow about 50% of the ♂♂ and about 75% of the ♀♀ to survive, formaldehyde neither reacts with the chromosomes directly to produce mutations nor with the cytoplasm of the germ cells to produce a mutagenic substance.

TABLE 1

THE EFFECT OF FORMALDEHYDE VAPOR ON MUTATION RATE IN GERM CELLS OF IMAGINES

Sex	Survival rate	No. of tested X-chromosomes	No. of lethals	Percent of lethals
♂♂	43/60	1172	1	
	7/24	451	0	
	13/28	983	3	
		2606	4	0.2
♀♀	22/28	1136	0	
	21/28	1342	1	
		2478	1	0.05

Since it seems legitimate to consider the experiments as tests for spontaneous lethals, an interesting incidental result consists in the confirmation of two previously reported features of the spontaneous mutation rate. First, the mutation rate is higher in ♂♂ than in ♀♀ (*1*). Second, when the mutation rate is recorded separately for the four successive broods from treated ♂♂, the following figures are obtained: first brood, three lethals in 860 chromosomes; second and third broods, no lethals in 1543 chromosomes; fourth brood, one lethal in 203 chromosomes. This curve of mutation rate with a peak for the first sperm used and an increase for spermatozoa which have been stored for a considerable time, has been described by Lamy (*3*), and Muller (*4*).

As the feeding method only treats larvae, the negative result obtained on adults did not seem conclusive. Additional tests on larvae were carried out with a new apparatus which allowed milder and therefore longer exposures to be made. In the first experiments old larvae were used, because these can stand a fairly long exposure. However, when feeding tests, carried out at the same time, indicated a sensitive period to the mutagen early in the third instar, tests were also carried out on younger larvae of this age. These larvae can stand only a much shorter exposure without being killed or sterilized.

TABLE 2

THE EFFECT OF FORMALDEHYDE VAPOR ON MUTATION RATE IN THE GERM CELLS OF LARVAE

Time in hr after laying of eggs	Length of exposure	No. of tested X-chromosomes	Lethals	
			No.	%
96–100	2 hr	2126	2	0.1
about 70	2 hr	138	0	0
46–56	2 hr	169	1	
	70 min	408	1	
	50 min	436	1	
		1013	3	0.3

In all tests, a considerable proportion of the larvae died either during exposure or later on. The two sexes had the same survival rate. Table 2 summarizes the data gained from exposure of larvae.

In all series, the results are negative. Thus, all attempts to induce mutations by formaldehyde vapor have failed, and it seems most likely that the effective mutagen is a compound formed by reaction of formaldehyde with one of the components of the food. Experiments to identify this component have been started.

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Inhibition of Phosphatases by Beryllium and Antagonism of the Inhibition by Manganese

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Beryllium poisoning has become a subject of considerable practical importance as a result of the use of beryllium compounds in the fluorescent light industry and in several other industrial processes. The occurrence of a number of cases of beryllium poisoning as a result of the industrial use of this metal has emphasized the necessity of obtaining detailed information on the toxicity and mode of action of beryllium in mammals. While numerous studies have been carried out on the toxicology of beryllium, little is known of its mechanism of action and no therapeutic measures for either acute or chronic beryllium poisoning are available.

In undertaking studies on the mechanism of action of beryllium, we were interested in examining its effect on enzymatic reactions with special attention being directed toward enzymes requiring metallic activators. The occurrence of beryllium in the same atomic group with calcium and magnesium and the many similarities in the chemical behavior of these three metals suggested that the toxic effects of beryllium might involve interference with the biological functions of calcium and magnesium. The present communication describes the results of experiments which demonstrate that beryllium inhibits alkaline phosphatases activated by magnesium and calcium, and that this inhibition can be prevented and re-

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