with the views of Govier and Gibbon (*3*), support the idea that barbiturates may produce their effects by interfering with the activation of acetate and consequently the acetylation of choline. The active site in the barbiturate molecule may reside in the "urea" portion, as evidenced by the lack of any effect of the two nitrogen-free substances tested.

The contradiction of the results of Mendelson and Grenell (*4*) remains unexplained. Their procedure was very similar to that used here, the major difference being that the present results were obtained by using a somewhat more than half-activated system.

In summary, a series of barbituric acid derivatives has been shown to produce inhibition of acetylation in a relatively "pure" acetylating system. A convulsant barbiturate also produces marked inhibition, but compounds that might be considered as "urea-free" depressants and convulsants (*10*), respectively, do not produce significant inhibition. Inhibition produced by phenobarbital could be relieved by addition of extra coA, but was not found to be relieved by addition of ATP.

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References and Notes

1. H. McLennan and K. A. C. Elliott, *J. Pharmacol. Exptl. Therap.* 103, 35 (1951).
2. W. J. Johnson and J. H. Quastel, *Nature* 171, 602 (1953).
3. W. M. Govier and A. S. Gibbons, *Science* 119, 185 (1954).
4. J. Mendelson and R. G. Grenell, *ibid.* 120, 802 (1954).
5. N. O. Kaplan and F. Lipmann, *J. Biol. Chem.* 174, 37 (1948).
6. A. C. Bratton and E. K. Marshall, *ibid.* 128, 537 (1939).
7. Kindly supplied through the courtesy of K. K. Chen of the Lilly Research Laboratories.
8. Kindly supplied through the courtesy of B. Stearns of the Squibb Institute for Medical Research.
9. T. C. Chou and F. Lipmann, *J. Biol. Chem.* 196, 89 (1952).
10. I. H. Slater, D. E. Leary, P. E. Dresel, *J. Pharmacol. Exptl. Therap.* 111, 182 (1954).

* With the technical assistance of Robert McCoy.

6 September 1955

Color Autoradiography

Although the effect of radioisotopes on ordinary photographic emulsion is well known, there are no reports on results obtained with color film. It occurred to us that multilayer color film is, in effect, a stack of absorbers that should yield, after photographic development, a hue dependent on the ratio of absorption in the layers. This ratio should be a function of the energy spectrum of emitted radiation, and hence each radioisotope should produce a specific hue. Furthermore, the amount of radiation from a given isotope absorbed by the film should affect only the brightness but not the hue of the final product. The present study bears out these considerations and indicates that color-film autoradiography is practicable (*1*).

Table 1. Effect of radioisotopes on color film.

Isotope	$E_{max.}$* (Mev)	Trials (No.)	Munsell color No. (mean ± S.D.†)	Actual color range ± 1 S.D.†
Carbon-14	0.16	12	68.5 ± 4.7	Bluish, blue-purple to blue
Sulfur-35	0.17	16	64.4 ± 3.1	Purplish, blue to greenish blue
Calcium-45	0.25	8	51.9 ± 5.5	Bluish, blue-green to bluish green
Iodine-131	0.60‡	23	46.3 ± 10.6	Bluish, blue-green to greenish green-yellow
Phosphorus-32	1.7	8	35.9 ± 1.2	Greenish, green-yellow to green-yellow

* Values for $E_{max.}$ were obtained from *Isotopes* (Oak Ridge National Laboratory, Oak Ridge, Tenn., 1954). † Standard deviation. ‡ Most abundant β.

One-inch diameter filter paper disks (Whatman No. 1) were dipped into solutions of P^{32}, I^{131}, Ca^{45}, S^{35}, and C^{14} ($25–25 \times 10^{-5}$ μc/ml) and air-dried. Approximately 0.08 ml was absorbed per paper in this manner. The disks were pressed against the emulsion side of Ektachrome film (Eastman Kodak Company, daylight type), and the film was exposed from 1 to 40 days. Photographic development followed the manufacturer's recommendations (*2*). Classification of the resultant hues was made by visual comparison with Munsell color standards (*3*).

Table 1 lists the characteristic hue produced by each isotope. The range of color encompassed the blues for the least energetic particles to the green-yellows for the most energetic. The usable range appeared to be 10^7 to 10^{10} total disintegrations per square centimeter. Within this range, the characteristic hue for each isotope remained constant, regardless of the density of the image. It is interesting that thin absorbers (cellulose tape, 9 mg/cm²), when they were placed between the source and the film, produced an increased density with no appreciable change in hue. In the case of I^{131}, which emits both β and γ rays, the hue indicates that the former radiation was primarily responsible for exposing the film.

From these experiments, it is evident that color autoradiography will permit differentiation of isotopes, provided that sufficient difference exists between energy spectra. For example, a mixture of inorganic I^{131} and C^{14}-tyrosine was separated chromatographically on paper and identified by this technique.

Other possible applications for color autoradiography may be (i) demonstration of isotope emitter characteristics, (ii) determination of proportions of two or more isotopes in a mixture, and (iii) improvement of image detail in autoradiography of tissues. Of course, the value of such results must depend on the type of film that is available. The film used in these studies permitted only a limited approach to these applications. Furthermore, the complex method of photographic development is a decided deterrent to the use of color film as compared with standard film. Perhaps the introduction of special types of multilayered emulsions might make color autoradiography a valuable and convenient tool for the laboratory.

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References and Notes

1. An excellent discussion of the color film used in this study appears in *Kodak Color Handbook* (Eastman Kodak Co., Rochester, N.Y., 1953).
2. We are indebted to Kenneth S. Carnes and Earl E. Powers of the Medical Illustration Laboratory of this hospital for processing the film.
3. In the Munsell system, the complete visual color wheel is divided into 100 parts consecutively numbered 1 to 100 with each hue assigned a specific number within this range. See *Munsell Book of Colors* (Munsell Color Co., Baltimore, Md., 1942).

22 August 1955

I feel more vexed at impropriety in a scientific laboratory than in a church. The study of nature is intercourse with the Highest Mind.—LOUIS AGASSIZ.