identifiable ketone on heating with pyridine and acetic anhydride. The contrast between this and the result with *N*-acetylsarcosine is perhaps due to the presence of additional acetic acid (arising from the initial acetylation) in the reaction mixture from sarcosine. Acetic acid has been shown (*1*) to have a deleterious effect on the condensation of hippuric acid with acetic anhydride in the presence of pyridine.

We regard the Dakin and West reaction as a special case of the Erlenmeyer synthesis of oxazolones; we hope to have shown here that Wiley's observation is consistent with this view and does not require a separate hypothesis.

References

1. ATTENBURROW, J., ELLIOTT, D. F., and PENNY, G. F. *J. Chem. Soc.*, 1948, 310.
2. DAKIN, H. D., and WEST, R. *J. biol. Chem.*, 1928, **78**, 91, 757.
3. DEULOFEU, V. *Ber.*, 1934, **67**, 1542.
4. DYSON, P., and HAMMICK, D. LL. *J. Chem. Soc.*, 1937, 1724.
5. WILEY, R. *Science*, 1950, **111**, 259.

Electronic Radiography by Transmission Using Radioactive Monolayers

D. E. Beischer

U. S. Naval School of Aviation Medicine,
Pensacola, Florida

Herein is described a method of electronic radiography by transmission which may be compared with the photographic printing process, with the difference that electrons, or α particles, replace the light. The specimen is placed between, and in intimate contact with, a uniformly radiating source on one side and a photographic plate on the other. This method was made possible by the preparation of homogeneously radiating sources in the form of mono- or multilayers of molecules tagged with radioactive isotopes (*1*). The layers were prepared by using the technique developed by Langmuir and Blodgett (*2*) for ''built-up'' films.

A β-emitting source can be prepared by spreading C^{14} labeled stearic acid on the surface of an aqueous solution (10^{-4} *M* $CaCl_2$, 10^{-3} *M* $KHCO_3$) and transferring the monomolecular film of calcium stearate to a solid substratum by dipping a plate once or several times through the surface. In this way a mica plate of a few square centimeters in area can be covered on both sides homogeneously with one or several monolayers of radioactive calcium stearate. By cleaving the mica sheet, two sources buttered with radioactive material on only one side can be prepared. It is obvious that this method can be used for the preparation of homogeneous sources of α, β, or γ radiation, with wide variation in penetrating power, by incorporating various radioactive elements in the monolayers—for instance, by the use of radium, Sr^{90}, Ca^{45} stearate.

The picture of a thin specimen in the β light of C^{14} can be prepared by enclosing the specimen in a printing frame between the radioactive layer and a photographic emulsion (no-screen x-ray film or industrial x-ray film, Type M, from Eastman Kodak Company), as demonstrated in Fig. 1. An example of the results of this method is given in the picture of an unscaled wing of a butterfly reproduced in Fig. 2.

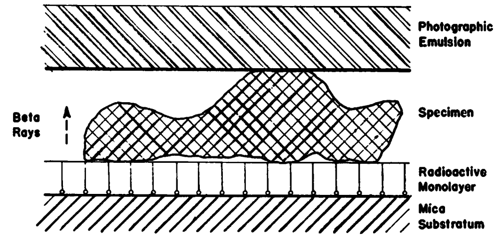

FIG. 1. Diagram of arrangement for electronic radiography by transmission (arbitrary measure).

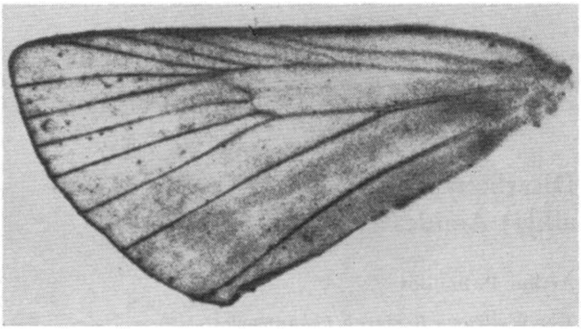

FIG. 2. Unscaled wing of butterfly depicted by electrons emitted from C^{14} (×5).

These electron radiographs can be explained in the same way as images obtained with the electron microscope. In fact, the mean velocity of the electrons emitted from C^{14} corresponds to the velocity of the electrons in the usual electron microscopes (50 kv). The shades in the picture are determined by the product of density and thickness of the specimen. When this product surpasses a certain value for a given electron velocity, only the outlines of the specimen can be made visible.

Compared with the electron microscope, the contact method is limited in resolving power and in magnification. The electrons are emitted from the source in all directions with different velocities. Under these conditions the resolving power is a complex function with a variety of factors. Some of these are the distribution of the electron velocity in the β spectrum, the thickness in g/cm^2 of the specimen and the photographic emulsion, and the grain size of the photographic material. From the separation of two points in Fig. 2 a resolving power of about 10–20 μ was estimated. Under these conditions the useful magnification cannot surpass the factor 10.

The contact method, however, has some marked peculiarities that may recommend its use in special cases. The wide variety of electron velocities from 0.015 to some million ev, which can easily be applied by changing the radiating element in the source, offers an inexpensive possibility (no machine) for studies of transmission of electrons over a considerable range. In this regard betagraphs of specimens with greater "thickness" will be of special interest.

Work is in progress to accomplish electron radiography by transmission on a quantitative basis. The uniform intensity of the sources was measured by the methods of absolute β-counting. These values can be compared with the electron intensities in the betagraph, determined with a microdensitometer. The results represent a measure for the absorption of electrons of a given mean velocity in small areas (limit, 30 μ diameter) which is related to the "thickness" of the structure of the specimen.

The application of α-emitting monolayers (radium, polonium, plutonium) opens up new possibilities for studies of specimens in α light. Pictures of butterfly wings depicted in the radiation from a radium stearate source show about the same shades as the betagraph in Fig. 2.

Descriptions of other applications of radioactive monomolecular films will appear elsewhere.

References

1. BEISCHER, D. E. Radioactive monomolecular layers. Project No. NM 000 007, Rep. No. 1, 1949.
2. BLODGETT, K. *J. Am. Chem. Soc.,* **57**, 1007 (1935).

Dicarboxylic Acid Bis-(β-Tertiaryaminoalkyl) Amides as Curare Substitutes

Arthur P. Phillips

The Wellcome Research Laboratories,
Tuckahoe, New York

A series of bis-(β-dimethylaminoethyl) esters of dicarboxylic acids was recently reported (*1*) to possess powerful curarelike activity. Concurrently with the esters, a group of bis-(β-tertiaryaminoalkyl) amides of the dicarboxylic acids was prepared and examined for curariform action.

The bis-amides were obtained in excellent yields by brief refluxing of a slight excess of the unsymmetrical disubstituted ethylene diamines with the dimethyl or diethyl esters of the dicarboxylic acids. In most cases the bis-amides were crystalline solids readily recrystallized from organic solvents. The bis-tertiary amino amides were transformed into bis-quaternary ammonium salts by refluxing in methanol solution with an excess of the appropriate alkyl halide, most commonly methyl or ethyl iodide.

Examples of the types of products made are: bis-dimethylaminoethyl oxamide (mp, 123°–124°; calcd.: C, 52.1; H, 9.6. Found: C, 52.1; H, 9.6); its bis-methiodide (mp, 288°–290°; calcd.: C, 28.0; H, 5.5. Found: C, 28.2; H, 5.5); bis-dimethylaminoethyl succinamide (mp, 134°–135°; calcd.: C, 55.8; H, 10.1. Found: C, 55.6; H, 9.9); its bis-methiodide (mp, 251°–252°; calcd.: C, 31.0; H, 5.9. Found: C, 31.1; H, 5.9); its bis-ethiodide (mp, 189°–190°; calcd.: C, 33.7; H, 6.4. Found: C, 33.7; H, 6.1); bis-diethylaminoethyl adipamide bis-methiodide (mp, 134°–135°; calcd.: C, 38.4; H, 7.1. Found: C, 38.9; H, 6.8); bis-morpholinoethyl malonamide (mp, 127°–128°; calcd.: C, 54.8; H, 8.6. Found: C, 54.8; H, 8.4); and its bis-methiodide (mp, 153°–154°; calcd.: C, 33.3; H, 5.6. Found: C, 33.7; H, 5.4).

Interestingly, both the bis-tertiary amino amides and the derived quaternary salts were relatively devoid of curarelike activity, requiring huge doses to produce any perceptible block of neuromuscular transmission in the cat. However, both in the tertiary and quaternary form these compounds have been found to possess the remarkable ability, anticholinesteraselike, to prolong the duration of the block produced in the cat by the bis-esters (*1*) as much as four or five times. Details of the pharmacological results will be published elsewhere by E. J. de Beer and J. C. Castillo of these laboratories. Further work along these lines will be reported later.

Reference

1. PHILLIPS, A. P. *J. Am. Chem. Soc.,* **71**, 3264 (1949).

The Enzymatic Dehydrogenation of Estradiol to Estrone[1]

Joseph A. Ledogar and Howard W. Jones, Jr.[2]

Department of Gynecology, The Johns Hopkins
University, Baltimore, Maryland

An enzyme system that catalyzes the conversion of α-estradiol to estrone, *in vitro,* was demonstrated by using a purified protein fraction of beef liver and rat tissue homogenates as enzyme sources.

A 2-mg sample of a crudely purified preparation from the acetone-insoluble, water-soluble fraction of beef liver was tested for ketosteroid and found to be negative (*1*). A 5-mg sample of crystalline α-estradiol[3] was likewise negative.

Five mg of the estradiol was added to 0.2 mg of the purified beef liver preparation in 20 ml of water and incubated for 12 hr under conditions previously found to be within the range of maximal enzymatic activity. Twenty ml of a 0.1% solution of 2-hyrdoxy-3-naphthoic acid hydrazide, containing 50% ethyl alcohol and 5% acetic acid, was stirred into the mixture, brought to boiling, and cooled to room temperature. The yellow precipitate formed was separated from both the excess hydrazide and any estradiol present by centrifugation, repeatedly washed with 50% ethyl alcohol, and refluxed with pyruvic acid for 30 min. Distilled water was added to saturation, and a white crystalline precipitate was formed on cooling (*3*). The crystals were purified by repeated washings with warm 5% sodium bicarbonate solution and warm distilled water. After drying in air, the crystals were examined microscopically and found to be colorless plates similar in form to estrone. The mp was 252°–254° C. When some of the crystals were mixed with a known sample of crystalline estrone[3] (mp 253°–

---

[1] Aided in part by a grant from the Maryland Division, American Cancer Society, to R. W. TeLinde and Howard W. Jones, Jr.

[2] Leslie Hellerman gave valued assistance in this work.

[3] Supplied by courtesy of Schering Corporation.