The distribution of ABO blood groups among patients afflicted with *acquired hemolytic anemia* was found to parallel closely the distribution of ABO blood groups among individuals who are *non-secretors of type A group-specific substance*. Preliminary experiments in our laboratory have indicated a possibility that susceptibility to acquired hemoyltic anemia may be related to the status of nonsecretion of type A group-specific substance.

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Small-Volume Dosimeter for X-Rays and Gamma-Rays

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A new system of x-ray and gamma-ray dosimetry for the monitoring of personnel exposed to A-bomb attack was proposed at this laboratory in 1947 and has since been described in a number of publications (*1–3*). This method of dosimetry employs the phenomenon of radiophotoluminescence (*4*), which may be defined as the creation of new, stable luminescent centers in a material by the photochemical action of ionizing radiations. Before exposure to such radiations, an ideal radiophotoluminescent material is nonluminescent under ultraviolet light; after exposure to ionizing radiations, it can be repeatedly or continuously excited to luminescence by ultraviolet light. It has been shown (*2, 3, 5*) that the luminescence intensity of a radiophotoluminescent material, under fixed conditions of ultraviolet light illumination, is proportional to the dosage of ionizing radiation to which the material has been exposed. Visual or photoelectric means may be used for measuring this luminescence and interpreting it in terms of dosage. Of the many synthetic materials found that show this effect (*5, 6*), the one selected as most economical and practical for large-scale manufacture was a silver-activated phosphate glass (*1–3, 5, 6*). This glass, prior to treatment with ionizing radiations, is almost devoid of luminescence under 3650A excitation; after x-ray or gamma-ray exposure, 3650A excitation produces an orange luminescence. The undosed glass retains its sensitivity to ionizing radiations apparently indefinitely, and the dosed glass retains its ability to luminesce under ultraviolet excitation for at least many months when stored in the dark. The response of the glass is linear with dosage, cumulative, and independent of dose rate over a wide range of dose rates. The temperature at which the dose is delivered has a measurable effect on the yield of luminescence centers, and the temperature at the time of measurement of the luminescence of the glass likewise has an effect on the intensity of luminescence. Both temperature effects are comparatively small and can be taken into account in estimating the dosage from the luminescence intensity.

With a $1 \times 1 \times 0.1$-cm plate of the sensitive glass, used in conjunction with a 100-watt C-H4 ultraviolet lamp and a photomultiplier tube, one can detect the luminescent centers produced by as little as 10R of radium gamma-rays (*2, 3*). In the dosimeter adopted for use by the U. S. Navy (*7*), a $\frac{3}{4} \times \frac{3}{4} \times 3/16$-in. rectangular parallelopiped of the glass is used as the sensitive element. With this larger block of glass it is easier to detect the fluorescence, hence the Navy instrument for measuring the brightness and interpreting it in terms of dosage contains a small 4-watt ultraviolet lamp (Type RP-12) instead of a 100-watt source.

In connection with radiation injury studies on small animals being conducted by the Biology Department, Boston University, it became of interest to explore the feasibility of reducing the size of the sensitive glass element, so that it might be possible to implant it in body tissue. This note presents the results of preliminary efforts toward such size reduction.

Although fine filaments of the glass, of the order of 0.20 mm diameter, gave a strong fluorescence after a dose of approximately 100 roentgens of soft (110 kvp) x-rays on visual inspection under a 100-watt C-H4 "blacklight" lamp, it was decided that specimens of somewhat larger size would be more suitable for measurement in a photoelectric fluorometer. A rod 1 mm in diameter and 6 mm in length was considered to be of satisfactory size. Random lengths of such rods, with diameters between 0.95 and 1.05 mm, were cut to proper length and the end terminations polished.[1]

A photoelectric fluorometer, shown schematically in Fig. 1, and basically identical with the fluorometers previously described (*2, 3, 7*), was constructed to accommodate the rods. A rod, held in any one of the holes in a movable slide, can be interposed between the 100-watt C-H4 ultraviolet lamp and the 1P21 photomultiplier tube, in such a way that the ultraviolet radiation impinges on the rod normal to its axis, while the photomultiplier collects fluorescent light emitted through one of the flat ends of the rod. Visible light from the lamp itself is excluded by an ultraviolet transmitting filter such as Corning 9863 placed between the lamp and the glass rod. Scattered ultraviolet light is excluded from the photomultiplier by an orange filter placed between it and the glass. Variable high voltage for the photomultiplier is provided by a regulated power supply or by batteries, and the photomultiplier current is measured with a suitable galvanometer.

[1] The glass rods were provided through the courtesy of Warren Beck, of the Minnesota Mining and Manufacturing Company, and Norbert Kreidl and Gerald Blair, of the Bausch & Lomb Optical Company.

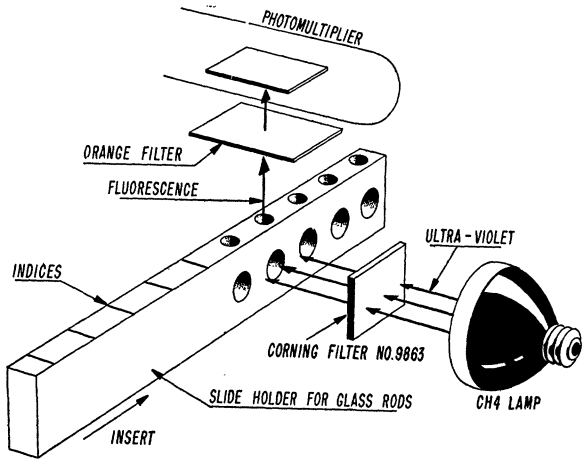

FIG. 1. Schematic diagram of fluorometer.

Since the reading obtained from any rod will depend on the ultraviolet light intensity and on the photomultiplier voltage, the fluorescence of an "unknown" specimen is always compared to that of a "standard" rod, i.e., a rod that has been exposed to a known dosage. Some light is detected by the photomultiplier even with an undosed rod, due either to the fluorescence of trace impurities in the glass or to other causes. The reading obtained with an undosed rod (the "predose fluorescence") must, therefore, always be subtracted from all other readings. The sliding rod holder with five holes makes it possible to load the instrument with three "unknown" rods, the "standard" rod, and an undosed rod, and read them all in quick succession. Somewhat more reproducible results are obtained, however, if the various rods are mounted in sequence in the same positioning hole.

The linearity of response of the silver-activated phosphate glass in the rod configuration is shown in Fig. 2. To obtain the data in this figure, rods were irradiated with 220 kvp x-rays in a direction perpendicular to their axes, the dosage being measured with a Victoreen r-meter. Three rods were exposed to each dosage indicated in the figure, and measured in the fluorometer in the above-described fashion. Due to the limited amount of glass available, the effect of orientation of the rods with respect to the direction of the x-ray beam was not explored.

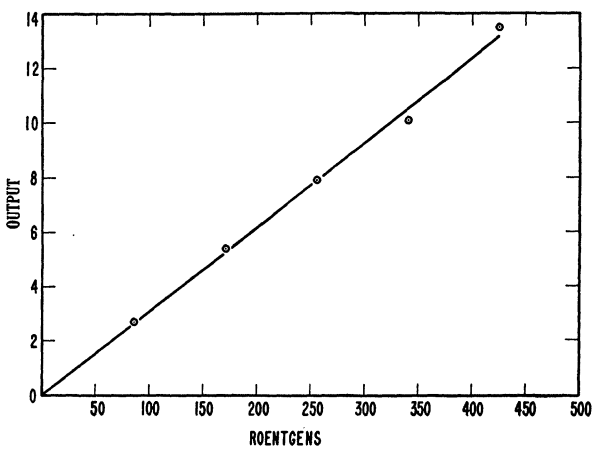

FIG. 2. Photomultiplier output vs dosage of 220-kvp x-rays.

It has been previously shown (*3*) that the response of the silver-activated phosphate glass in other sizes and configurations is strongly energy-dependent. The energy-dependence of the glass was redetermined for the millimeter-rod configuration through the courtesy of F. H. Attix, Radiation Laboratory of the National Bureau of Standards, who exposed pairs of the rods to Co^{60} radiation (average energy = 1.2 mev) and to various effective lower energies from a constant potential x-ray machine. The data obtained, shown in Fig. 3, is quite similar to the earlier results, but the ratio of peak sensitivity to sensitivity at 1.2 mev is approximately 35% greater with the rods. The sensitivity of the rods to Co^{60} radiation is approximately one twenty-fifth of their sensitivity to 70 kev x-rays.

Typical values of the photocurrents observed with 800 volts applied to the photomultiplier are: 0.03

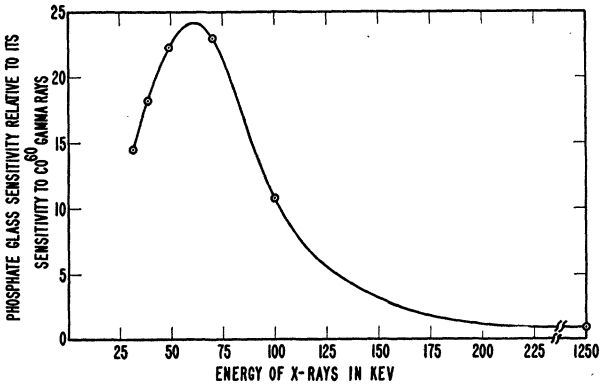

FIG. 3. Dependence of sensitivity of rods on x-ray energy.

μamp for an undosed rod; 0.83 μamp for a rod dosed with 100 roentgens of 70 kev x-rays; and 0.06 μamps for a rod dosed with 100 roentgens of Co^{60} gamma-rays. For x-rays of energies near 70 kev, to which the glass is most sensitive, the "predose" fluorescence is thus equivalent to the fluorescence increment produced by a 4-roentgen dose. For the more penetrating radiations of about 300 kev and higher, the "predose" fluorescence is equivalent to the fluorescence increment produced by a 100-roentgen dose. The "predose" fluorescence can be measured with a precision of ±10%. Dosages producing about ten times the "predose" fluorescence can be determined with a precision of ±5%, while dosages that produce a fluorescence increment equal to or lower than the "predose" fluorescence may be measured with correspondingly poorer precision. Factors contributing to the errors of measurement include the presence of imperfections in the glass rods, such as small bubbles, cracks, striae, and scratches on the end faces, and play in the mechanics of the fluorometer, which may permit small variations in the positioning of the rods with respect to the ultra-

violet source and the photomultiplier. Improvements in the quality of the glass rods and in the mechanism for positioning them may be expected to increase the precision of measurement.

The energy dependence of the silver-activated phosphate glass appears to be a limitation on it use for *in vivo* dosimetry. The seriousness of this limitation can be more clearly assessed after the completion of depth dose experiments now in progress. The possibility exists that proper shielding can be devised for the rods which will minimize their energy dependence. Such shielding has already successfully reduced the energy dependence of larger rectangular blocks of glass to ±20% over the range 0.08–1.2 mev (*3, 7*). For problems in dosimetry where the energy dependence of the glass does not interfere, considerable advantages may be offered by the small size of the rods and the other excellent features of the radiophotoluminescent system of dosimetry.

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The Tetrazolium Test for Dormancy and Germinability of Gladiolus Cormels

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The need for a rapid method of estimating dormancy in gladiolus cormels has led to the adaptation for this purpose of the tetrazolium method for testing germinability of seeds (*1–3*). A standard procedure was developed and has been tested on a wide range of material over a 2-year period. It has given reasonably consistent estimates of the dormancy or germinability of nearly all lots of gladiolus cormels tested. In some instances, where germination tests gave a low proportion of emergence and the tetrazolium tests suggested a higher degree of germinability, the corms were found to have impermeable coats. When the husks were removed or cracked, germination rose to a level concordant with the results of the tetrazolium test.

The standard procedure is as follows. (1) A 1% aqueous solution of 2-3-5 triphenyltetrazolium chloride is prepared and kept in a stoppered bottle in the dark at room temperature. (2) A single sheet of filter paper is placed in each of 2 Petri dishes and soaked with solution. The minimum amount required is about 2½ ml per dish. The prepared dishes are kept in the dark if not used immediately. (3) Duplicate lots of 20 cormels, representative of the stock under test, are peeled (i.e., the dry husk is removed) and cut longitudinally with a razor blade to expose the central vascular region on one or both halves. Recent tests suggest that peeling may be unnecessary if a little extra tetrazolium solution is put in the Petri dish to allow for absorption by the husks. (4) Each pair of half cormels is placed radially on the outside border of the filter paper, cut surface down. Twenty pairs about fill the perimeter of the paper. Two dishes are thus prepared, each from one of the duplicate lots of 20 cormels. (5) The dishes are placed in the dark at approximately 70° F to incubate for 4 hr. (6) The cormels are rated according to the extent and intensity of the red color developing in the vascular region through the center of the cormel, and any additional coloration throughout the storage tissues. The rating given for the whole cormel is that of the half cormel with the more pronounced coloration. The rating standard may be described as follows. A value of zero is given to a cormel when there is no observable pink or red color from the dye; a faint coloration along the central vascular strand is rated 1; medium to strong color of the vascular strand, 2; strong color of the vascular strand plus some coloration throughout part of the parenchymatous storage tissues, 3; intense coloration of the central strand and medium coloration throughout most of the parenchymatous tissues, 4; and intense coloration over the whole surface, 5. The sums of the ratings, which range between 0 and 100 for a single dish, give an estimate of the mean germinability of the lot of corms from which the duplicate samples are taken.

The accuracy obtainable by taking readings with duplicate samples of 20 cormels is all that is required except in very critical work. Apart from samples of abnormally variable cormels significant differences are generally between 6 and 10 units on the 100-unit scale.

When a considerable proportion of the cormels have readings of 3, 4, or 5, satisfactory germination is usually obtained; when most of the cormels are rated 0, 1, or 2, germination is unsatisfactory. The relationship between ratings and germinability varies significantly with variety; some varieties germinate well when the rating is relatively low, others only when the rating is unusually high (Table 1). This difference appears to exist apart from the permeability of the outer coat. However, the degree of variability has not yet been sufficient to cause serious difficulty in predicting germinability. It is possible to discover by trial which varieties are likely to give abnormal readings.

At the time cormels are harvested, the tetrazolium test reveals considerable physiological activity in the