ture was reached on the ninth day after inoculation. Ammonia production increased from the first to the fourteenth day after inoculation at which time 18.0 γ of ammonia nitrogen per ml of culture were produced.

Fig. 2 shows the urea production and mean population plotted against time. The curve obtained is quite similar to that shown in Fig. 1. However, the lag phase is of extremely short duration. Maximum population of 67,000 organisms per ml of culture was reached on the sixth day after inoculation. The population gradually decreased after the sixth day. As is shown in Fig. 2 maximum urea production (1.81 mg of urea N/ml of culture) was reached 48 hours after inoculation. Urea production dropped quickly and was not recorded on the fifth day after inoculation or any day thereafter. No uric acid was detected throughout the 14 days of the experiment.

Discussion. From the results of the present investigations, it might be argued that urea is produced as the principal waste of protein metabolism, and is then hydrolyzed to ammonia. However, if this is true, one would expect a much greater quantity of ammonia than actually obtains. Fig. 2 shows that the amount of urea N present 2 days after inoculation is 1.812 mg per ml of culture. The urea N content drops the following day to 0.454 mg urea N per ml of culture; a decrease of 1.358 mg. Two days after inoculation the ammonia N content is 0.00071 mg per ml of culture. On the following day 0.00143 mg of ammonia N per ml of culture is found. If 1.358 mg of urea N (the decrease in urea N from the second to the third day) were completely hydrolyzed, more than 0.00072 mg of ammonia N per ml of culture would be released. It is therefore, concluded that urea and ammonia are both produced in *Colpidium campylum* and that urea is produced almost solely when metabolic activity is greatest: during the logarithmic phase of growth. Whether urease is present in *Colpidium* is not known. The subsequent fate of urea that is produced is not known at the present time. It must form some nitrogenous compound other than ammonia or uric acid.

Summary. Urea and ammonia were estimated every day for 14 days in sterile cultures of *Colpidium campylum*. Qualitative tests for uric acid were also made. Ammonia production increased linearly with age of culture. Urea was produced only during the logarithmic phase of growth. The cause of the disappearance of urea is unknown. No uric acid was present at any time.

Received May 26, 1950. P.S.E.B.M., 1950, v75.

A Scintillation Counter for Measurement of I^{131} Uptake in the Thyroid Gland.* (18266)

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The uptake of I^{131} by the thyroid is usually measured by a combination of a conventional Geiger counter and scaling circuit (1). In this case, as in most cases of *in vivo* assays of radioisotopes used for therapeutic purposes, the measurements are accomplished by detection of gamma rays, which undergo very little absorption in passage through a small amount of tissue.

The problem inherent in this type of measurement is three-fold: First, the detector cannot be placed in close proximity to the neck, since for accurate estimates the

* This work was performed under A.E.C. Contract No. W-31-109-eng-78 with Western Reserve University.

1. Symposium on Radioiodine, Brookhaven National Laboratory, July 28-30, 1948.

counter must be able to view the entire gland and detect activity originating in any part thereof. This necessitates counting at a fixed distance from the neck, usually 6 to 12 inches, and results in a deliberate low geometric efficiency. Second, large tracer doses cannot be given in order to obtain higher counter rates because of health hazards. Third, the efficiency of a Geiger counter for detection of gamma rays of I^{131} is low, usually estimated at a value of 0.1% to 1% detection of incident gamma rays from this isotope.

The high efficiency of scintillation phosphors to the detection of gamma rays(2-4) has made their application to this problem an obvious subject of investigation. Much work has already been done on the relative response of various scintillation phosphors (5); but since various phosphors seem to exhibit different relative efficiencies for different types of radiation(6) it seemed advantageous to determine the response of some of the more common commercially available crystals to the gamma radiation of I^{131}. Assuming the decay scheme of Metzger and Deutsch(7) this response would then be that arising from a beam of gamma rays 79% of energy 0.363 Mev, 15% of energy 0.638 Mev, and 6% of energy 0.283 Mev and 0.080 Mev.

In this work 5 phosphors (anthracene, naphthalene, naphthalene with anthracene activator, 0.1% thallium-activated potassium iodide, and dihydro-anthracene)† were compared by means of integral bias curves, plotting counting rate versus integral pulse height. The units of pulse height are arbitrary, since they are a function of amplifica-

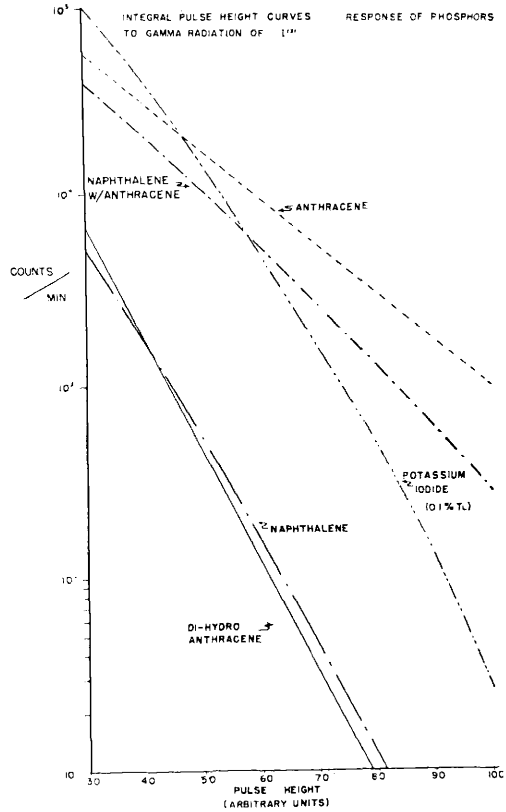

FIG. 1.

tion and not the magnitude of actual pulses received from the electron multiplier tube. The phosphors were mounted on the end of a 5819 electron multiplier tube and exposed to the same source of I^{131} at identical geometric and electronic conditions. Pulses from the tube were fed from a cathode follower preamplifier to a linear amplifier,‡ discriminator‡ and scaler. The electron multiplier was operated at room temperature, and at approximately 800 volts. Noise counts from the tube amounted to about one-tenth the total count and were subtracted from each reading.

The comparison curves as shown in Fig. 1 indicate anthracene to have the optimum pulse distribution. The potassium iodide crystal (Tl) shows a higher efficiency, as expected, over the organic crystals because of greater density, but a smaller number of

2. Hofstadter, R., *Phys. Rev.*, 1949, v75, 796.
3. Hine, G. J., *Science*, 1949, v110, 380.
4. Moon, R., *Phys. Rev.*, 1948, v73, 1210.
5. Gittings, H. J., *et al.*, *Phys. Rev.*, 1949, v75, 205 and others.
6. Davis, R. H. and Graves, J. D., *Nav. Rad. Def. Lab.* Report No. ADP-119, May 2, 1949; Franzen, W., Peele, R. and Sherr, R., *Bull. Am. Phys. Soc.*, 1950, v25, 18 and others.
7. Metzger, F. and Deutsch, M., *Phys. Rev.*, 1948, v74, 1640.

† All obtained from Harshaw Chemical Co., Cleveland.

‡ Linear Amplifier, Model 204-B, Atomic Instrument Co., Boston, Mass.

large pulses. Recently some 0.5% thallium-activated potassium iodide crystals† have been available and show an efficiency roughly four times higher than those with the smaller amount of thallium. The use of potassium iodide (Tl) crystals would be advantageous where low bias levels could be utilized were it not for the presence of naturally radioactive K^{40}. Assuming a 0.011% incidence of K^{40}, a cubic centimeter crystal of potassium iodide would have approximately 1000 disintegrations per minute, thus making this phosphor of little use for low activity assays. For the remainder of this work, anthracene was used throughout.

Recording equipment. Since the counting equipment was intended for clinical use, the recording circuits were selected with the view towards simplicity, commercial availability, and flexibility. Much of the work with scintillation counters by previous investigators has involved the reduction of tube noise by cooling with dry ice or liquid nitrogen. This was not attempted since the method was considered too unwieldy for clinical procedure. Operation of the tubes at room temperature and adjustment of the bias to eliminate the larger part of the noise such as accomplished by Cassen, Curtis, and Reed(8) was attempted. With the phosphors and tubes chosen, however, the stability and sensitivity desired was not obtained by this procedure.

Instead, the method of using 2 electron multiplier tubes to view the same crystal and reducing background noise by a coincidence circuit was selected. This fulfilled the requirements of simplicity and commercial availability since small amplifiers together with a coincidence circuit, have been recently manufactured.§ These units are small and compact and have given no trouble in operation. The power supply as provided with this unit is unregulated, however, and because of the instability of the power line and the large amount of transient electrical noise pulses, separate power supplies were constructed and employed. The high voltage negative supply was modeled after the circuit of Bair and St. John(9). This embodies a high frequency filter for the transient electrical noise and isolation from all grounds except at the output terminal to inhibit ground currents. The regulation is accomplished by miniature voltage regulator tubes. The low voltage power supply was a conventional regulated power supply based on the supply used for the linear amplifier of Jordan and Bell(10). This combination has performed satisfactorily with the coincidence amplifiers and has presented no problems of stability. The output of the coincidence circuit is fed to a scaling circuit of a negative 0.25 volt input. The detector head was designed to place the scintillation phosphor as close as possible to the 1P21 electron multiplier tubes and to eliminate any air-solid interface which might reflect the scintillations back into the crystal. To do this, the tubes were first placed with their cathodes at right angles and the tube bases in contact with each other. Over this a lucite block was mounted with 2 holes for the tube and a right-angled cut placed within one-eighth inch of the tube. The phosphors were then cut at right angles, polished, and placed in

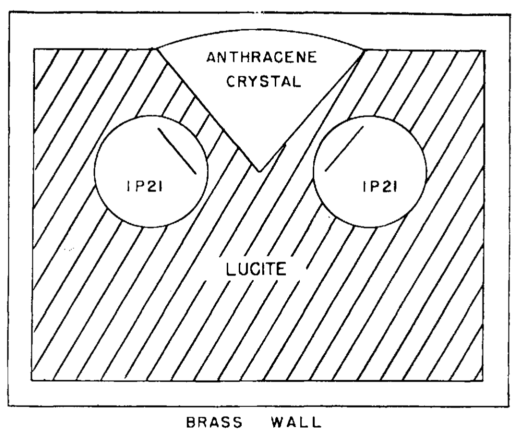

FIG. 2.
Schematic diagram of detector head.

8. Cassen, B., Curtis, L. and Reed, C. W., *Nucleonics,* 1950, v6, 78.

§ Coincidence amplifier Type 152A W. S. MacDonald Co., Inc., Cambridge, Mass.

9. Bair, J. K., St. John, E. E, NEPA Project Report, NEPA 1265-SER-8, January 20, 1950.

10. Jordan, W. H. and Bell, P. R., *Rev. Sci. Inst.,* 1947, v18, 703.

the right-angled groove in contact with the lucite. This is shown in Fig. 2. The air-solid interfaces are then kept at a minimum and can be entirely eliminated for permanent mounting by cementing the crystal and tube face to the lucite with some substance such as Canada balsam. This also keeps the phosphor close geometrically to both cathodes of the 1P21's.

The output from the detector head is fed by a 4 foot cable to the amplifiers and has given satisfactory results operated in this manner. However, a cathode follower pre-amplifier has been constructed and tests are underway to investigate possible improvements. The preamplifier presents a low capacitance to the anode and thus should give a larger pulse to the amplifier. This is consistent with results since it has been noted that the tubes may be run at voltages of 650 ~ 750 instead of the usual 850 volts. The investigation of actual improvements in counting efficiency by addition of the pre-amplifier has not been completed and the following measurements have been taken with direct coupling from the anode of the electron multiplier tube to the amplifier.

Clinical measurements. In the preliminary clinical measurements for uptake of I^{131} in the thyroid gland a triangular anthracene crystal with an outer face of dimensions, 2 inches by ½ inch, was mounted as shown in Fig. 2. In a comparison with a brass walled Eck and Krebs type Geiger counter and a conventional scaling circuit combination as used in the Department of Radiology, University Hospitals, Cleveland, Ohio, an improvement in sensitivity by a factor of 30 to 50 has been obtained. The Geiger counter is shielded by one inch of lead with a one inch diameter hole centered above the gland. As the sensitivity is a function of bias adjustment on the operation of the coincidence circuit the factor of sensitivity improvement is rather arbitrary. The optimum condition of operation has not yet been determined and at the present time the sensitivity selected is mainly determined by the counting rate to which the background is to be restricted.

In the 6-week period that this counter has been in operation, the uptakes of I^{131} in the thyroid glands of 23 patients have been measured and compared with the standard dose of 50 μc used. The average counting rate of the standard was found to be 13,490 c/m with an average uptake rate of 5,908 c/m. In the three months preceding the use of the scintillation counter, the standard Geiger counter as previously described was used. For 23 patients given a 200 μc dose the average uptake was 403 c/m with an average counting rate of the standard of 710 c/m. Thus the counting rate was increased by a factor 15 ~ 19 although the dose was decreased by a factor of four.

The ratios of the average uptake to average standard with the 2 different dosages and measurement are not identical. This is due to the fact that the 50 μc dose was given to individuals, many of whom were normals, while the 200 μc dose was given only to the patients who were to receive a therapeutic dose of I^{131}. These were thus expected to show a higher uptake of I^{131} and the average uptake would then be expected to show a higher percentage uptake than that of all patients.

Although for routine clinical measurements the counting rates of the standard and the thyroid at one fixed distance are taken, some measurements were taken on the same patient at various distances.

A typical measurement at various distances is shown in Table I together with a comparison of the same standard counted by both Geiger counter and scintillation counter.

TABLE I.

Distance (in.)	Standard: Scintillation counter, c/m	Standard: Geiger counter, c/m	Uptake in thyroid gland,* c/m	% uptake in thyroid*
16.5	4208	174	1644	39.1
13.5	6492	249	2466	38.1
10.5	10166	423	3831	37.8
7.5	20062	737	7902	38.4

Background: 175 c/m for scintillation counter.
35 c/m for Geiger counter.
* Measured with scintillation counter.

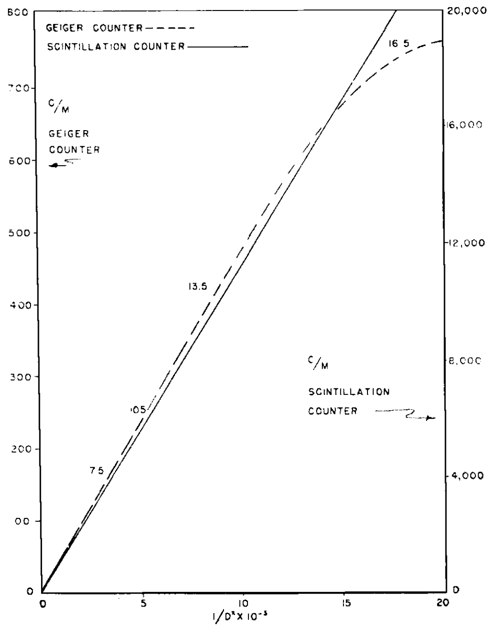

FIG. 3.
Comparison of scintillation and Geiger counter detection at various distances.

A comparison of the two counting rates is shown in Fig. 3 in which the counting rate is plotted versus the inverse square of the distance. At a distance of 7.5 inches, the Geiger counter is seen to deviate from the inverse square law while the scintillation counter is still accurate. The standard of I^{131} was measured in the above case in 50 cc of water to approximate roughly the conditions of actual measurement.‖

Summary. 1. The problems inherent to the measurement of I^{131} uptake in the thyroid gland have been reviewed and the applicability of the scintillation counter for this use discussed. 2. The selection of scintillation phosphor and construction of the counter has been described and compared in operation over a 6-weeks period with a conventional Geiger counter. This improvement of sensitivity has shown to be a factor of $30 \sim 50$. 3. The increased sensitivity described has shown to be sufficient to allow an immediate reduction of the tracer dose from 100 μc to 50 μc, with a recent reduction to 25 μc. It may be seen that the dose could be reduced to 10 μc with considerable ease. At the same time a decided improvement over the Geiger counter in counting statistics has been obtained. Based on the previous counting rates the 10 μc standard would exhibit a counting rate $\sim$ 2,700 c/m and an uptake rate $\sim$ 1,200 c/m. Background for such measurements would be $200 \sim 400$ c/m.

‖ These clinical measurements were made by John P. Storaasli, M.D. Department of Radiology, University Hospitals, Cleveland, Ohio.

Received August 14, 1950. P.S.E.B.M., 1950, v75.

Effect of Intravenous Injections of Casein Hydrolysate upon Electrocorticogram of the Rabbit.* (18267)

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Enzymatic casein hydrolysate is widely used in the intravenous feeding of protein depleted patients(1). If injected too rapidly side effects of nausea, vomiting and headache ensue. To test the possibility that these symptoms arise from central excitation, a commercial aqueous solution of enzymatic casein hydrolysate† (10% weight/volume,

* Aided by a grant from U. S. Veterans Administration for research in epilepsy.

1. Elman, Robert, Parenteral Alimentation in Surgery with Special Reference to Proteins and Amino Acids. Paul B. Hoeber, New York, 1947.

† The enzymatic casein hydrolysate was provided by Mead, Johnson and Co. We are indebted to Drs. K. S. Kemmerer and W. M. Cox of that company for extensive assistance in preparation of the concentrate.