undergo rapid swelling which is due to the diffusion of dextrose and water into the cells. The process can be reversed by washing with isotonic saline. The addition of hypertonic dextrose solutions to blood-citrate produces hypertonic cell contents during storage. The transfusion of such cells results in intravascular hemolysis by action of the recipient's plasma. The osmotic activity of the erythrocytes thus becomes another criterion for the suitability of stored blood for transfusion. Blood collected in dextrose solutions should be chilled rapidly to avoid osmotic hemolysis during refrigeration.

13605

Study with Radioactive Isotopes of Excretion of Calcium and Strontium by Way of the Bile.*

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The significance of the bile as a pathway for the excretion of calcium has attracted attention because of the relatively high calcium concentration of gall bladder bile.[1] In experiments on 2 bile fistula dogs, Gillert[2] found that the calcium in the bile was about ⅔ the amount excreted in the urine.

Tracer studies with radioactive calcium and strontium offer a method of obtaining information on the excretion of these ions by way of the bile that simplifies many of the difficulties usually present in this type of experiment, such as the factor of reabsorption from the gall bladder[3] and the source of the calcium in the bile. Through the use of labeled ions, it is possible to determine the fraction of an administered dose of calcium or strontium that appears in the bile. The results of such experiments on bile fistula rats are described in this communication.

Methods. Rats weighing between 400 and 500 g, with an artificial gall bladder type fistula, prepared according to the operation of

* Aided by a grant from the Christine Breon Fund of the University of California Medical School.

1 Drury, D. R., *J. Exp. Med.*, 1924, **40**, 797.

2 Gillert, E., *Z. ges. Exp. Med.*, 1924, **43**, 539.

3 Johnston, C. G., Ravdin, I. S., Austin, J. H., and Morrison, J. L., *Am. J. Physiol.*, 1932, **99**, 648.

Sawyer and Lepkovsky[4] as modified by Harrington, Greaves and Schmidt,[5] were used in the experiments. After the operation, a saline-glucose solution containing dissolved bile, was administered to the animals by stomach tube at about 6-hour intervals, immediately after the collection of each bile sample from the artificial glass gall bladder. The radioactive elements as the lactate salts were injected intraperitoneally in single doses containing 3.4 mg of calcium or 2 mg of strontium. The radioactivity of the strontium samples (Sr^{89}) was measured on a Lauritzen electroscope and of the calcium samples on a Geiger-Müller counter. A bell type of counter tube† with a mica window was used to detect the soft radiation emitted by the Ca^{145}. Standards were prepared by adding suitable aliquot portions of the radioactive calcium or strontium lactate samples to bile collections obtained prior to the initiation of the experiments.

Results. The results of the experiments are shown graphically in Figs. 1 and 2. Fig. 1 shows the curves for the total of the amount of Ca*‡ and Sr* eliminated in the bile. The greatest rate of elimination of calcium or strontium by the bile occurs during the first 2 days. Thereafter, the amount falls off to very small values. The curves for calcium and strontium are nearly similar. Calcium shows

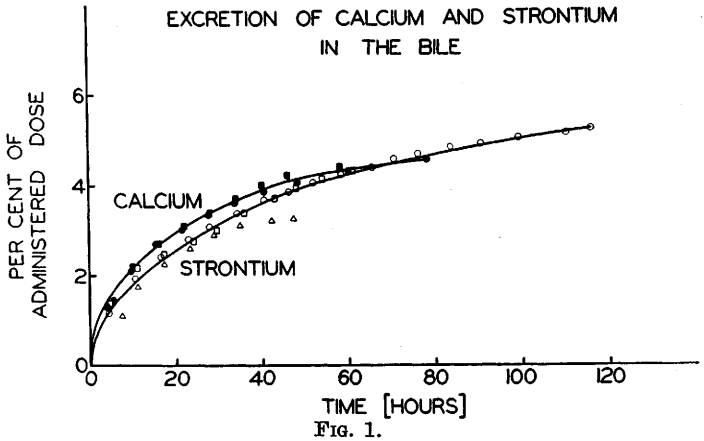

FIG. 1.

The rate of elimination of Ca* and Sr* in the bile. Full symbols represent individual calcium values, open symbols, strontium values.

[4] Sawyer, L., and Lepkovsky, S., *J. Lab. Clin. Med.*, 1935, **20**, 958.

[5] Harrington, F. G., Greaves, J. D., and Schmidt, C. L. A., PROC. SOC. EXP. BIOL. AND MED., 1936, **34**, 611.

† Developed by Dr. Dodson of the California Institute of Technology. Unpublished.

‡ Chemical symbol with asterisk is used to represent element labeled with radioactive isotope.

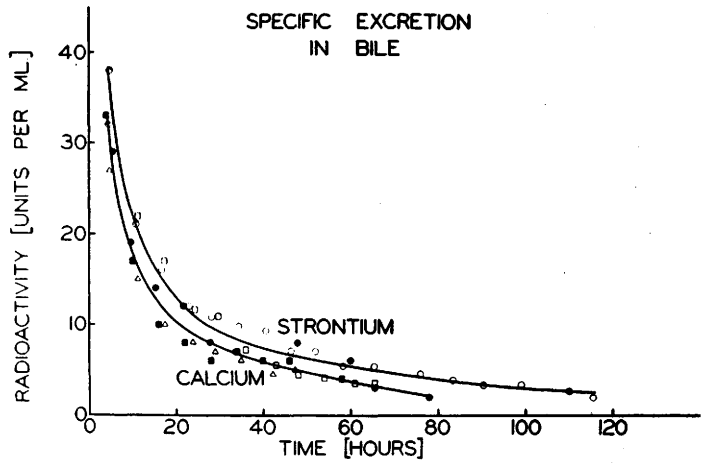

FIG. 2.

Specific excretion of Ca* and Sr* in the bile. The unit of specific activity (radioactivity per ml) is 1/10,000 part of injected dose. Full symbols represent individual calcium values, open symbols, strontium values.

a slightly faster rate of elimination initially, but the curve for strontium overtakes that for calcium in about 60 hours.

The total excreta was analyzed and yielded the following results: In 65 hours the Sr* in the excreta was 13.4, 22.0, and 25% respectively of the administered dose or an average of about 20%. In the same interval of time, there was an average elimination of about 4.5% of the Sr* in the bile. Thus the bile was the pathway for the elimination of about 20% of the injected Sr*. In the experiments with calcium, at the end of 60 hours, the excreta contained 7.3 and 19% respectively of the Ca*, while the amount in the bile was 4.5 and 4.4% respectively of the administered dose.

If the bile secreted by the fistula animals is even a rough measure of the normal bile output, then the present data indicate that the bile is a pathway of considerable importance for the excretion of the alkali earth elements.

The change in specific activity (radioactivity per ml) of the bile with the lapse of time after administration of the Sr* or Ca* is plotted in Fig. 2. Specific activities are represented in terms of a unit which is 1/10,000 part of the dose administered. The curve for the decrease in specific activity appears to approximate a parabola. The drop in the activity of Ca* is somewhat steeper than of Sr* although the curves for the two elements do not differ greatly. In the first sampling period the specific activity is over 0.3%. After 2 or 3 days it drops down to a few hundredths percent.

Summary. Between 4 and 5% of an injected dose of labeled

strontium or calcium is eliminated with the bile out of a total excretion of about 25% in bile fistula animals in a period of about 3 days.

We are greatly indebted to Professor E. O. Lawrence and the staff of the Radiation Laboratory of the University of California for the supply of radioactive calcium and strontium. We also are greatly indebted to Miss L. Morse for performing the surgical operations and to D. H. Copp and M. Murayama for valuable assistance.

13606

Radiation Effects on Nervous System and Roentgen-Pigmentation of Goldfish (*Carassius auratus*).

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A variety of stimuli has been employed for the study of the relationship between the nervous system and the chromatophores in fish. Smith[1] was the first to produce an eruption of corial melanophores in the goldfish. During studies concerning the suitability of the goldfish for problems of experimental radiation therapy,[2, 3, 4] one of the authors (Ellinger) made some observations on the roentgen pigmentation of goldfish.[5] This led to the assumption of a disturbance in the chromatomotoric nerve center in the medulla oblongata as a possible cause for the observed roentgen pigmentation. This pigmentation started on the head of the fish and spread caudally. To substantiate this assumption, a histopathologic study of the central nervous system of 10 goldfish (8 of which were irradiated) has been made.

Methods. The radiation factors were: 200 kv, 30 ma (mechanical rectification); filter (a) zero, H.V.L. 6 mm Al, corresponding to 0.233 mm Cu (intensity, 230-172 r/min); (b) 0.5 mm Cu and 1 mm Al, H.V.L. 1 mm Cu (intensity, 48 r/min). The distance was

* Aided by a grant from the Emergency Committee in Aid of Displaced Foreign Physicians.

1 Smith, G. M., *Am. J. Cancer*, 1932, **16**, 863.

2 Ellinger, F., PROC. SOC. EXP. BIOL. AND MED., 1939, **41**, 527.

3 Ellinger, F., *Radiology*, 1940, **35**, 563.

4 Ellinger, F., and Gross, R., *Radiology*, 1941, **37**, 717.

5 Ellinger, F., PROC. SOC. EXP. BIOL. AND MED., 1940, **45**, 148.