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THE ABSORPTION, DISTRIBUTION, AND EXCRETION OF TRITIUM IN MEN AND ANIMALS

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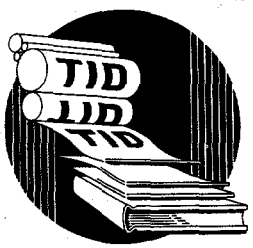

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ABSTRACT

(for APS meetings)

"The Absorption, Distribution, and Excretion of Tritium in Men and Animals"

The tritium absorbed by rats from inspired air containing HT or HTO is proportional to the tritium activity in the inspired air. When present as HTO a very high percentage of the tritium activity inspired is taken into the body fluids indicating rapid exchange and absorption of activity across respiratory membranes. If present as HT in inspired air only about 0.05% of the inspired activity appears in the body as HTO. Apparently, biological catalyzation of HT to HTO takes place in the body. The activities studied were not high enough for the absorption of HT per se in body fluids to be detected.

HTO ingested by man in 200 cc of water was completely absorbed in about 45 minutes. Absorption is linear with time. Absorbed tritium dilutes with 57 to 68 per cent of the body weight suggesting that body water is primarily involved.

Tritium elimination from the body in both rats and man is an exponential function of total water turnover. The reservoir calculated from the rate constant is again 57-68% of the body weight. The biological half-life of HTO in nine human subjects varied from 9 to 14 days on ad libitum water intake and was reduced to 2-1/2 days in one subject on high water intake. The biological half-life in rats ranged from 4 to 5 days on ad libitum water intake. The tritium activity in excreted sweat, insensible perspiration, expired water vapor, sputum, and urine is essentially the same as that in the blood.

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Tritium is the radioactive isotope of hydrogen of mass three with a half-life of 10.7 years. It omits soft beta particles of 18 Kev. maximum energy. No gamma radiation is emitted. It has been used in the experiments here presented in amounts up to 3 millicuries as a hydrogen tracer. Various physiological aspects of its absorption through the respiratory and gastro-intestinal systems, its distribution within the body, and its excretion from the body have been measured.

The method used for tritium assay in body fluids is as follows: Water from the body fluid concerned is obtained by complete distillation in a vacuum at room temperature. 0.1 cc. of the water sample thus obtained is allowed to evaporate into an evacuated system, the vapor passing through a furnace filled with powdered zinc on glass wool at 400-410 degree C. The reduced hydrogen and tritium are pumped into a 250 cc. Borkowski type ion chamber by means of a Toeppler pump, producing a pressure of about 380 mm Hg in the chamber at room temperature. The chamber is then filled to about 100 cm Hg pressure with CO_2 in order to obtain better ionization efficiency within the contained gas. The saturated ionization current is measured with a dynamic condenser electrometer with a sensitivity of 10^{-17} amperes. The observed ionization current was 1.5×10^{-12} amperes per microcurie. The background of the ion chamber was 2.4×10^{-16} amperes equivalent to 1.6×10^{-4} microcuries (360 dis. per minute) of tritium. The activities measured range from 10 to 100 times background. Duplicate analyses differed by less than 3%.

Rats have been exposed continuously to various concentrations of tritium in inspired air for periods up to 145 hours. The tritium concentration in the air breathed was varied from 10^{-6} to 3×10^{-2} $\mu c/cc$ different experiments but remained essentially constant throughout the period of exposure in any one experiment. When present as HTO in inspired air a major portion of all the activity inhaled is taken up in the body fluids indicating rapid exchange and absorption of activity across respiratory mem-

branes. If present as HT in inspired air less than 0.1% of the inspired activity appears in the body fluids as HTO. Apparently biological catalyzation of HT to HTO takes place in the animal body. The range of activities studied was not high enough for absorption of HT per se in body fluids to be detected. On either exposure to HT or HTO in inspired air it took about 100 hours to reach a relatively steady value for HTO in the blood. Beyond this time HTO excretion through the various water excretory routes balances HTO intake into the body. The equilibrium value reached varies 10-15% during the day due to short time variations in the water turnover rate. The rat feeds and drinks most of its daily turnover at night so that the tritium activity in body fluids is usually lowest in the morning and highest in the evening.

One experiment has been done on man in which 3 millicuries as HTO was ingested in 200 cc. of water, absorption into the blood stream was linear with time and was complete in about 45 minutes. The tritium was diluted with 57% of the body weight suggesting that body water is primarily involved. Body water turnover was measured over a period of six days by weighing all food and fluid intake and all excretory output. For four days water turnover was kept near normal (2.7 liters per day). During the last 2 days water turnover was increased to 12.8 liters per day. During both periods tritium excretion was exponential with water turnover. The reservoir calculated from the rate constant was 58% of the body weight. Tritium excretion rates determined on eight other human subjects in which water turnover was measured less precisely indicated reservoir ranging from 57 to 68% of body weight. Similar excretion data on rats give values in this same range. The biological half-life of HTO in nine human subjects varied from 9 to 14 days on ad libitum water intake and was reduced to 2-1/2 days in one subject on high water intake. The biological half-life of HTO in rats ranged from 4 to 5 days on ad libitum water intake.

The tritium activity in water from sweat, insensible perspiration, expired water vapor, sputum, and urine have been measured and found to be essentially the same as that in water from the blood.

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