Relative Rates of Biological Decay of Thyroidal I^{131} in Rat and Guinea Pig.* (20974)

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In the past a number of qualitative and quantitative estimates of thyroid gland activity has indicated that there is a considerable species difference between the rat and the guinea pig in the rate of production, secretion and utilization of thyroid hormone. Most parameters of thyroid function commonly measured (*e.g.* 24-hour I^{131} uptake, serum P.B.I., gland morphology) give a static picture of thyroidal activity rather than the dynamic one provided by measurement of rates of its biologic processes. In this work a modification of published technics(1-4) for measuring the I^{131} content of the thyroid *in vivo* over a period of weeks after injection has been applied to the normal rat and guinea pig. The results are used to estimate the rate of release of radioiodine from the thyroid which is considered to be a reflection of the tempo of hormone secretion(1-4).

Methods. The animals used were adult female guinea pigs (500-600 g body weight) fed *ad libitum* on a diet of Purina Omolene (Iodine; 1 μg/g)† and Rabbit Chow Checkers (Iodine; 5.2 μg/g),† tap water and fresh greens, and adult female albino rats (200-300 g body weight) of the Wistar strain, fed on Purina Dog Chow Checkers (Iodine; 1.5 μg/g)† and tap water. A single dose of carrier-free radioiodine (I^{131})‡ was injected intraperitoneally into guinea pigs (25-40 μc) and rats (25 μc). The radiation-detection apparatus consisted of an El-Tronics scaler and Tracer Lab TCG-8 stainless steel gamma sensitive Geiger-Muller tube. The tube was placed vertically with end-window facing upwards, and housed in a cylindrical lead jacket with walls of 20 mm thickness. A lead shield 12 mm thick covered the end of the tube except for a central area 22 mm in diameter which was bridged with cellophane tape. The upper surface of the shield was flush with a board on which the animal (with shaved neck) was placed prone after ether anaesthetization. The radioactivity of the thyroid region was measured for at least 1000 counts at several positions over the Geiger tube. The highest count was used. Such counts were made on 16 rats at 4 hours after I^{131} injection and once daily for 8 days. For 16 guinea pigs, counts were made at 4, 24, 48 and 72 hours after injection and at 3-4-day intervals thereafter over a period of approximately 3 weeks. Extrathyroidal radioactivity was measured over the thyroid and epigastric regions of thyroidectomized guinea pigs. The ratio of neck to epigastric counts was found to be 0.37 at 4 hours, 1.0 at 24 hours, and 1.4 at 2-6 days at which time radioactivity became negligibly low. Counts over the epigastrium of normal guinea pigs multiplied by these ratios gave values for the extrathyroidal radioactivity in the neck region. For rats, one half the epigastric count

TABLE I.
Loss of Radioactivity from the Thyroid.

Days after zero time*	Guinea pig	Rat
1		(16)† 78.4 ± 2.7‡
2	(8)† 94.0 ± 3.6‡	(16) 60.6 ± 2.7
3		(16) 55.6 ± 3.3
4	(8) 85.0 ± 2.9	(16) 48.2 ± 3.2
6	(8) 83.9 ± 2.6	(15) 36.3 ± 2.5
7	(8) 80.4 ± 1.8	(14) 33.4 ± 3.0
8		(10) 31.5 ± 3.7
10	(12) 73.1 ± 1.9	
11	(7) 77.9 ± 1.7	
14	(7) 74.2 ± 4.7	
15	(12) 71.6 ± 2.8	
18	(7) 59.3 ± 3.1	
19	(12) 61.1 ± 4.3	

* Zero time = Time after injection at which maximal radioactivity (100%) was found in the thyroid.
† No. of determinations.
‡ Mean I^{131} content in thyroid as % of that at zero time ± stand. error of the mean.

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† Commercial estimate.

‡ I^{131} was obtained from the Atomic Energy Commission, Oak Ridge, Tenn.

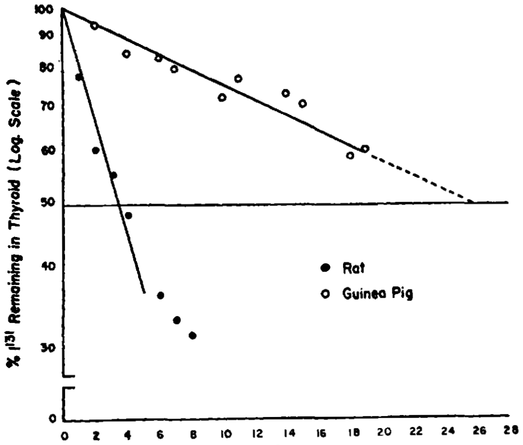

FIG. 1. Relative rates of biologic decay of thyroidal I^{131} in rat and guinea pig.

was used(1). The total radioactivity of the neck region was then corrected for these extrathyroidal values as well as for isotopic decay to give the theoretical thyroidal count.

Results. Maximal uptake of radioiodine by guinea pig thyroids occurred between 48 and 72 hours and was followed by a slow progressive decline. In rats maximal uptake was usually attained by 24 hours. Inasmuch as there was considerable variation from animal to animal in degree of uptake, counts at 24 and 48-72 hours after injection for rats and guinea pigs respectively were expressed as 100% for each animal with subsequent values as a percentage of this maximum (Table I). The mean percentage values for radioactivity remaining in the glands were plotted on semilogarithmic paper against time. The graphed relationship for both species was approximately linear although in the rat values obtained towards the end of the experimental period resulted in a flattening of the curve (Fig. 1). The biological half-life of radioiodine in the thyroid, as calculated from the linear portion of the curve, was found to be approximately 3.5 days in the rat. The half-life value for the guinea pig was much longer, about 26 days. This figure had to be obtained by extrapolation, since the radioactivity remaining in the gland by the end of 3 weeks was too low for accurate measurement.

Discussion. The value of 3.5 days for the biological half-life of thyroidal radioiodine shown here for the rat lies between that of 4.5 days reported by Fish *et al.*(4) and 2.0 days (our calculation) by Taurog and Chaikoff(5) in animals fed a Purina diet, and approximates those obtained in other experiments for which dietary iodine was considered adequate(1,3). In rats with low iodine intake(2,4,6,7) biological half-life values are more variable (2-11 days) with the age of the animal apparently a complicating factor. The rate of disappearance of labelled iodine from the rat thyroid has recently been considered an indication of hormonal secretion rate even though recirculation of radioiodide through the gland introduces some error in the estimation of true hormonal release(1-4). Nevertheless, thyroxine secretory rates so calculated approximate those obtained with the classical goitre prevention method(8). It is evident that the biological half-life of radioiodine in the thyroid of the guinea pig exceeds even the highest estimates given for the rat. The slow rate of biologic decay in the guinea pig thyroid moreover can be accelerated by administration of thyrotrophin or by exposure to cold (unpublished experiments), conditions known to increase hormone release from the gland. Inasmuch as the thyroid I^{127} was not measured in this study no attempt will be made to calculate the daily thyroxine output for the guinea pig. It is highly probable, however, that it is much less than in the rat.

The relatively low rate of hormone secretion as postulated for guinea pig thyroid would be consistent with a number of other observations of thyroid function in this species. The I^{131} uptake per mg of guinea pig thyroid is appreciably less than that of the rat under both *in vivo*(9,10) and *in vitro*(11) conditions. The inactive histological picture of the guinea pig thyroid in contrast to that of the rat is well known. A comparison of conversion ratios (P.B.I. I^{131}/Total I^{131} of plasma) for rats and guinea pigs at 13-16 hours after injection reveals a much higher rate of release of thyroid hormone to the blood in the former species(12). Rates of oxygen consumption, often used as an indicator of the peripheral effects of thyroid hormone, also differ. Herrington(13) finds that for adult guinea pigs and rats at thermal neutrality the heat production is about 590 and 680 calories per square meter per 24 hours respectively. In this laboratory the oxygen consumption per hour per 100 g body weight for the guinea pig is approximately 40% less than that of the rat. TSH concentration in the pituitary and blood of the guinea pig is considerably less than that of the rat(9,14). The difference in the rate of decay of thyroidal radioiodine in the rat and guinea pig is therefore consistent with measurements of other parameters of thyroid-pituitary function in these species.

Summary and conclusions. 1. The rate of biological decay of thyroidal I^{131} was compared in rat and guinea pig by determining the reduction in radioactivity over the gland utilizing the *in vivo* detection technic. The biological half-life of radioiodine was estimated to be 3.5 and 26 days for the rat and guinea pig respectively. 2. The results are considered to suggest that thyroid hormone secretion in the guinea pig normally proceeds at a much slower rate than in the rat. Consideration of other parameters of pituitary-thyroid function for both species supports this view.

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Effect of Corticotropin and Cortisone on Globule Leucocytes of Rat.* (20975)

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Globule leucocytes are found frequently in the mucous membranes of the alimentary and lower respiratory passageways of various animals, including the rat. These cells are distinguished by the presence in their cytoplasm of acidophilic metachromatic granules (Fig. 1). Globule leucocytes appear to be normal cells and seldom, except under abnormal conditions, show evidence of degeneration. In this respect they differ from plasma cells which are undergoing transformation to Russell body cells. Globule leucocytes arise by direct transformation of other cells, many origins having been suggested, including eosinophilic leucocytes, wandering cells, plasma cells, mast cells, and lymphocytes. It is only between the small lymphocyte and the globule leucocyte, however, that a complete series of intermediate stages has been described(1).

The functional significance of globule leucocytes is unknown, although their occurrence in the urinary tract of the rat has been correlated with the presence of a nematode infestation(2). Since adrenocortical hormones

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