Assuming homogenous flow in the muscularis, the two fast components (I, II) must, by exclusion, be located in the mucosal and submucosal layers. If the tissue/blood partition coefficient is close to one the half-time values of components I and II correspond to blood flows of 400–1400 and 30–70 ml/min · 100 g, respectively.

The fastest component (I) may indicate the existence of a shunting mechanism which would then be of considerable magnitude judging by the percentage of initial activity (Table). Theoretically, the shunting of krypton could be explained in terms of an arterio-venous blood flow shunt, but it is a priori unlikely that as much as 35–50% of the intestinal blood flow should be distributed to such a bypass and there are no other data to support this possibility. Another explanation seems more plausible. Preliminary experiments in this laboratory indicate the existence of a counter-current exchange between the arterial and venous ends of the hairpin-like vascular loops of the intestinal villi[8]. Such an arrangement would facilitate a diffusion transfer from the arterial to the venous end of easily diffusible and/or lipid-soluble substances in the blood. These substances would, instead of passing along the long axis of the vessels, tend to be shunted between the arterial and venous ends of capillary loops, as is the case in the renal medulla[9,10]. It is suggested that intraarterially injected krypton is shunted in the intestine of the cat by such a mechanism[11].

Zusammenfassung. Der zeitliche Verlauf der Elimination von intraarteriell injiziertem Krypton aus den Geweben des Katzendarmes wurde untersucht. Die gefundene Eliminationskurve konnte in vier Teilkurven aufgelöst und die anatomische Lokalisierung und funktionelle Bedeutung dieser Komponenten kurz diskutiert werden.

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STUDIORUM PROGRESSUS

The Effect of Acute Starvation on Thyroid Function in Rodents

Atrophy and colloid retention in the thyroid as a consequence of starvation was first reported by JACKSON in 1916[1]; STEPHENS[2] reported similar results in 1940. In 1949, WILLIAMS et al.[3] demonstrated diminished ^{131}I uptake by the thyroid gland in the starved animal. RIVERO-FONTAN et al.[4] reported comparable results. However, VAN MIDDLESWORTH[5,6] and MONEY[7] found diminished uptake by the thyroid in starvation. DONATI et al.[8] in 1963 reported diminished oxygen utilization, decreased erythrocyte radiotriiodothyronine uptake, diminished plasma levels of triiodothyronine and thyroxine, as well as increases in the 24 h ^{131}iodide thyroid uptake and thyroid concentrations of iodide, moniodotyrosine (MIT), diiodotyrosine (DIT), triiodothyronine (T_3) and thyroxine (T_4) in acutely starved rats. The explanation of these results was not immediately apparent, and the present study was undertaken to clarify the mechanisms involved.

Materials and methods. Female Sprague-Dawley rats weighing 180–200 g were utilized in all experiments. Starvation was for a 96 h period with water ad libitum. TSH treated rats received 0.5 unit bovine TSH/0.5 ml 0.9% saline solution intraperitoneally at the same time intervals. Litter mates fed a diet of Purina Laboratory Chow served as controls. Oxygen uptake was determined by means of 1 min oxygen uptake spirometer using 100% oxygen with anhydrous potassium hydroxide as the CO_2 absorber. The erythrocyte radiotriiodothyronine uptake (ET_3) was determined by a modification[8] of the method of HAMOLSKY et al.[9]

24 h following the administration of 1 μc of carrier free $Na^{131}I$ the amount of radioactivity in surgically removed rat thyroids was measured and the thyroid uptake calculated. 4 thyroid glands were subsequently homogenized and hydrolyzed for a 40 h period at 37 °C in a buffered solution with pancreatin added to a final concentration of 1% at a pH of 8.5. Aliquots of the hydrolysate and a non-radioactive concentrate of 50 μg each of MIT, DIT, T_3, T_4, and potassium iodide were then applied to Whatman No. 1 chromatography paper. Bidimensional ascending chromatography was carried out for 18 h at 20 °C in an *n*-butanol dioxane, 2 normal NH_4OH system

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(40:10:50)[10] and after the chromatogram was turned 90 degrees in an *n*-butanol glacial acetic acid and water system (78:5:17) for 18 h at 20 °C[11]. Radioautographs of the chromatogram were prepared, the carriers were located, and superimposition of the radioautograph on the chromatogram indicated the areas of radioactivity which were removed and the radioactivity determined.

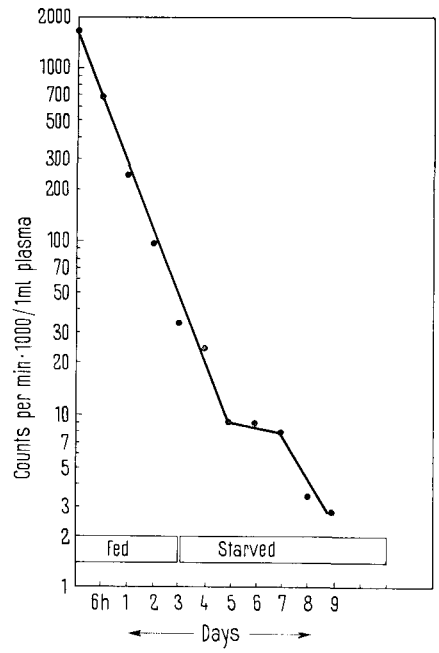
An aliquot of hydrolysate identical to that applied to the chromatography paper was counted and the radioactivity of MIT, DIT, T_3, T_4 and iodide recovered from the paper were expressed as % of this aliquot.

1 μc thyroxine ^{131}I/0.026 μg thyroxine ^{127}I was administered i.v. Total stool collection was made on each rat every 24 h and the amount of radioactivity of the total stool determined. At 96 h, the rats were killed, the gastrointestinal tract removed intact, opened longitudinally, and washed until free of all particulate matter. The radioactivity of the intact and the washed gastrointestinal tract and of the carcass was determined in a liquid scintillation counter[5]. Radioactivity of the total stool, and the difference between the washed and unwashed gastrointestinal tract was summed up and expressed as % of injected radioactivity. This represents the absolute enteric loss of T_4 ^{131}I less that reabsorbed.

10 μc ^{131}I thyroxine/0.67 μg ^{127}I thyroxine was given i.v. At 0.25, 6, 24, 48, 72 and 96 h, groups of 5 rats each were killed and the radioactivity of 1 ml of plasma from each rat was determined. Starvation was then instituted and groups of 5 animals each were killed at 120, 144 and 168 h and the radioactivity of 1 ml of plasma determined. 1 unit TSH[3] was administered i.p. at 168 h and groups of 5 animals each were killed at 192 and 216 h and the radioactivity of 1 ml of plasma measured.

Results. Determination of the enteric loss of radioiodinated thyroxine demonstrated no significant difference between the starved (73.0 $\pm$ 4.8%[12] in 8 rats) and the fed (72.1 $\pm$ 6.0%[12] in 8 rats) animals.

The distribution of ^{131}I in pancreatin digests of rat thyroids 24 h following the administration of ^{131}iodide is presented in the Table. The starved animals demonstrated an increase in the thyroid radioactivity of T_4 ($p < 0.5$) and an increase in the total 24 h ^{131}I uptake ($p < 0.001$) by the thyroid but only a slight non-significant diminution in the thyroid content of T_3 and T_4 compared with starved controls. Oxygen utilization diminished in the starved animals and increased after the administration of TSH by similar increments in both the fed and starved animals. The oxygen utilization of starved TSH treated rats did not increase to the level of the fed animal. The erythrocyte radiotriiodothyronine uptake of the starved rat was decreased. TSH administration to both the fed and starved animals augmented ET_3 uptake. However, the ET_3 uptake of the starved TSH treated rat did not increase to the level of the fed animal. Plasma from normal rats incubated with red blood cells from starved or normal rats produced ET_3 uptakes of 50.0 $\pm$ 5.2%[12] and 51.7 $\pm$ 6.0%[12] respectively; plasma from starved animals incubated with red blood cells from starved or normal animals gave ET_3 uptakes of 38.7 $\pm$ 3.4%[12] and 39.2 $\pm$ 2.8%[12] respectively. Thus, the alteration in the



Serum radiothyroxine disappearance. Each point represents the mean of the radioactivity in 1 ml of plasma from each of 5 rats. One unit of TSH was administered on day 7.

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[12] Standard deviation.

Results of oxygen utilization, 24 h ^{131}I iodide thyroid uptake, erythrocyte radio triiodothyronine uptake, and thyroid chromatography following the administration of radioiodine in starved and fed rats

	Fed rats				Starved rats			
	Control		TSH treated		Control		TSH treated	
		Results		Results		Results		Results
Oxygen uptake ml/g H[c]	8[a]	2.1 $\pm$ 0.6	12[a]	2.5 $\pm$ 0.3	8[a]	1.1 $\pm$ 0.3	12[a]	1.5 $\pm$ 0.4
24 h ^{131}I thyroid uptake %[c]	14[a]	7.5 $\pm$ 2.9	16[a]	11.0 $\pm$ 1.3	14[a]	20.6 $\pm$ 5.1	14[a]	31.1 $\pm$ 7.2
ET_3 uptake %[c]	24[a]	49.9 $\pm$ 6.6	12[a]	53.2 $\pm$ 4.1	24[a]	27.0 $\pm$ 3.4	12[a]	45.0 $\pm$ 2.7
Thyroid MIT % radioactivity recovered		25.89[b]		24.15[b]		29.13[b]		32.99[b]
Thyroid DIT % radioactivity recovered		36.98[b]		16.85[b]		38.31[b]		24.46[b]
Thyroid T_3 % radioactivity recovered		0.30[b]		0.11[b]		0.60[b]		0.56[b]
Thyroid T_4 % Radioactivity recovered		2.61[b]		1.25[b]		4.31[b]		3.15[b]

[a] Number of rats. [b] Mean of results for three chromatograms of the thyroid homogenate. [c] Mean $\pm$ S.D.

ET_3 uptakes was not due to the effect of starvation on the erythrocyte.

The T_4 ^{131}I plasma clearance curve is presented in the Figure. The plasma clearance of radiothyroxine diminished with the initiation of starvation. The administration of TSH to the starved rat produced augmentation of the clearance rate toward that of the fed animals.

Comment. Marked structural alterations of the thyroid in the starved animal characterized by atrophy and flattening of the acinar epithelium with retention of colloid[1,2,4,7] have been described. Studies of radioiodide uptake by the thyroid of starved animals have led to apparently contradictory results; some investigators demonstrating an increased[3,5,6], others diminished uptake[4,5]. In the present study, a marked augmentation of the 24 h ^{131}iodide uptake by the thyroid was demonstrated in acutely starved rats. These apparently contradictory results can be explained in the most part by alteration in the periods of starvation or variation in the time elapsed for determination of the radioiodine uptake. Studies in which ^{131}iodide uptake was determined 24 h following the administration of ^{131}iodide in starved animals[3,7] generally agree with the present findings. The augmentation of thyroid ^{131}I uptake coincident with starvation could be explained by a diminution in the iodide pool, altered renal clearance of iodide, reduced turnover of the iodide pool, alteration in TSH secretion or an increase in the enteric loss of thyroid hormones. Alteration in the enteric loss of T_4 ^{131}I was not found in the present study.

Increased 24 h thyroid ^{131}iodide uptake as well as increased thyroidal radioactivity of thyroxine suggest that the thyroid is concentrating iodine and producing hormone, but that there is altered release of the hormone in the starved animal.

Thyroid hormone release is under the control of TSH. Therefore, impaired release of thyroid hormones could be associated with a diminution of TSH. However, the increased radioiodine uptake and increased concentrations of thyroxine suggest that other mechanisms might be operative. In the present study, the administration of TSH to starved animals did not completely abolish the thyroidal effect of starvation. Indeed, TSH produced an augmentation of the 24 h ^{131}I uptake with non-significant diminution in the thyroid concentration of triiodothyronine and thyroxine in the starved animal. TSH administration in the starved animal, did, however, alter the plasma T_4 clearance curve toward the slope demonstrated by the fed animals.

Although acute starvation produced an augmentation of the thyroid ^{131}I uptake, the circulating hormone was diminished[4,7,8]. The decrease in erythrocyte radiotriiodothyronine uptake demonstrated in the starved animal substantiates these prior reports. The administration of thyroid stimulating hormone produced an increase in the radiotriiodothyronine uptake of starved animals, but not to the level of the fed controls. This result is reflected in the oxygen consumption in starved TSH treated animals which increased but not to the level of the fed control.

Résumé. Après 96 h de jeûne, le rat consomme moins d'oxygène et ses erythrocytes moins de radiotriiodothyronine. La thyroïde de l'animal en état de jeûne absorbe davantage d'iode radioactif administré pendant 24 h et la concentration thyroïdienne en thyroxine est augmentée. Le jeûne ne modifie pas la perte intestinale de la radiothyroxine. L'administration de TSH ne rétablit pas complètement la fonction thyroïdienne, bien que la courbe de la 'clearance' plasmatique de la radiothyroxine des rats affamés se rapproche alors de celle observée après l'administration de TSH chez les animaux nourris normalement.

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St. Louis University School of Medicine and Radioisotope Research Laboratory, Veterans Hospital, St. Louis (Missouri USA), August 16, 1965.

CONGRESSUS

EUCHEM Conferences in 1966

Stereochemistry

Burgenstock (Switzerland), May 8–13, 1966

Organised by: Prof. D. ARIGONI, Organic Chemistry Laboratory, Technical High School, Zürich (Switzerland).

Chemistry in Molten Salts

Ulvik, Hardanger (Norway), May 10–13, 1966

Organized by: Prof. H. FLOOD, Inorganic Chemistry Department, Technical University, Trondheim (Norway).

Far Infrared Spectroscopy

Great Britain, September 1966

Organized by: Prof. H. W. THOMPSON, St. John's College, Oxford (Great Britain).

Chemistry of Insects

Villa Monastero, Varenna (Italy), September 12–17, 1966

Organized by: Prof. A. QUILICO, Politecnico di Milano, Instituto di Chimica, Milano (Italy).

Synthesis and Characterization of Organic Radicals

Schloss Elmau b. Mittenwald (Germany), October 24–28, 1966

Organized by: Prof. K. DIMROTH, Chemical Institute of the University, 355 Marburg, Bahnhofstr. 7 (Germany).

General enquiries and suggestions for future conferences should be sent to Prof. H. W. Thompson, St. John's College, Oxford (Great Britain).