with the results of recent electron spin resonance spin-labeled studies of excitable membranes of nerve and muscle (*8*). Additional experiments, however, are needed in order to determine whether the phospholipid spectrum observed here is due to excitable membranes in the nerve or to myelin membranes of the Schwann cells.

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Thyrotropin-Releasing Hormone: Evidence for Thyroid Response to Intravenous Injection in Man

Abstract. *Administration of thyrotropin-releasing hormone to normal subjects causes a prompt rise in plasma thyrotropin concentration, followed by a significant increase in circulating plasma triiodothyronine. These observations may prove to be of value in simultaneously assessing the ability of the pituitary and thyroid glands to respond to their trophic hormones.*

Discovery of the hypothalamic releasing and inhibiting factors has broadened understanding of the control mechanisms of hormone release. Isolation and synthesis of thyrotropin-releasing hormone (TRH) (*1*) has permitted a closer scrutiny of this particular releasing factor in man. Studies from many laboratories have shown that intravenous administration of TRH causes prompt release of thyrotropin (TSH) from the pituitary gland (*2, 3*). This effect is probably mediated both by increased release of preformed TSH from the pituitary and by increased de novo synthesis (*4*). Since intramuscular administration of TSH in man leads to a rise in circulating thyroxine (T_4) concentrations after several hours, it would be anticipated that intravenous administration of TRH followed by a rise in endogenous TSH would also be followed by a rise in circulating thyroid hormone. Surprisingly, the effects of TRH on circulating thyroid hormone have not yet been clearly established. Some workers have found an increase in serum T_4 (*5*), but others have been unable to confirm the results (*6*). Failure to demonstrate a clear-cut rise in circulating thyroid hormone or any other definite effect of the TRH-induced elevations of TSH on thyroid gland function in man constitutes the most puzzling remaining question with regard to TRH action.

To clarify this important problem we administered TRH intravenously to normal male subjects and closely examined the changes in thyroid hormone during the first hour.

Eight males, aged 28 to 50 years, with no endocrinological problems, were studied. All subjects were clinically euthyroid, none had palpable enlargement of their thyroid glands, and all had normal concentrations of thyroxine and free thyroxine. After an overnight fast, an intravenous cannula was inserted in the antecubital fossa, and the subjects were allowed to rest quietly in bed for half an hour. Two baseline blood samples were collected at 15-minute intervals; then TRH (100 μg) was adminstered intravenously as a bolus. Blood samples were collected in heparinized syringes at 10, 20, 40, and 60 minutes, centrifuged immediately, and stored at −4°C until assayed.

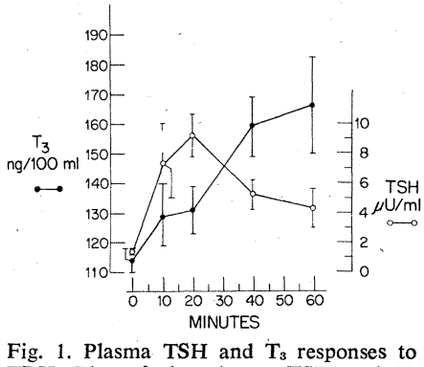

Fig. 1. Plasma TSH and T_3 responses to TRH. Plot of the plasma TSH and T_3 concentrations after an intravenous injection of 100 μg of TRH. Each point represents the mean value for the eight patients, and the height of the vertical line indicates the standard error about the mean.

Triiodothyronine (T_3) in plasma was measured by radioimmunoassay (*7*) as was plasma TSH (*8*). Plasma T_4 was assayed by competitive protein binding analysis (*9*) by the Boston Medical Laboratories. The percentages of free T_4 were determined by equilibrium dialysis in a dilute system (*10*) modified by adding T_3 labeled with ^{125}I as well as T_4 labeled with ^{131}I, prior to dialysis in order to simultaneously measure percentage of free T_3.

All eight subjects showed a rise in plasma TSH and T_3 (Fig. 1). Plasma TSH rose from 1.3 ± 0.8 μU/ml (mean ± standard error) to a maximum of 9.2 ± 1.4 μU/ml at 20 minutes and then fell toward control values during the remainder of the observation period. Plasma T_3 rose from a baseline of 118 ± 4 ng/100 ml to a plateau of 159 ± 10 ng/100 ml at 40 minutes. The change was highly significant ($P < .001$). Plasma T_4, not shown in Fig. 1, also appeared to rise at 60 minutes (from a mean of 4.9 ± 0.5 μg/100 ml to 5.7 ± 0.5 μg/100 ml). Although this increase was statistically significant ($P < .01$) by the paired *t*-test, it was not as great or as rapid as that of TSH or T_3. Indeed, individual changes were small: 6.5, 6.5, 3.5, 3.0, 4.0, 4.3, 6.8, and 4.5 μg/100 ml before TRH administration and 6.8, 8.3, 5.3, 4.3, 4.3, 5.0, 7.0, and 5.0 μg/100 ml afterward. No changes were found in percentage free T_3 and percentage free T_4.

Our results confirm previous reports of a prompt increase in TSH concentration in response to intravenous administration of TRH and extend these observations to include a rise in circulating T_3. The elevation in T_3 was seen in all subjects and occurred 20 minutes after the elevation in TSH. Plasma T_3 remained elevated throughout the observation pe-

riod. In three of the subjects, in whom the period of observation was extended 30 minutes, plasma TSH continued to fall to 3.1 μU/ml (3.2, 2.3, and 3.8 μU/ml) while plasma T_3 remained constant at 163 ng/100 ml (148, 200, and 140 ng/100 ml). The temporal relationship between elevations in plasma TSH and plasma T_3, and the known effects of TSH on thyroid function suggest that the T_3 rise is in response to the elevated TSH concentrations, although a direct effect of TRH on the thyroid gland cannot be entirely excluded. In contrast to the clear-cut elevation in plasma T_3, the increase in plasma T_4, though statistically significant, was quite small. This may explain the conflicting reports of effect, or lack of effect, of TRH on serum T_4 (*3, 5, 6*).

The dose of TRH employed in this study probably exceeds the concentrations achieved endogenously in the pituitary portal system. Therefore, studies are needed to establish whether the observed T_3 response reflects a rapid physiological adjustment of the TRH-TSH axis to the body's changing needs or whether it represents a pharmacological response.

However, many of the endocrinological tests in common use, such as the TSH and ACTH stimulation tests, have proved to be of considerable clinical value despite the pharmacological doses of hormone administered. In addition, the radioimmunoassay for T_3 in unextracted serum is sufficiently simple, sensitive, and accurate to permit its use for routine clinical testing, and the TSH radioimmunoassay is now available in many medical centers. Moreover, despite the observed rise in T_3 and TSH, the intravenous administration of TRH has been associated with only minor and tolerable side effects such as mild nausea and flushing (*11*). Therefore, whatever the physiologic import of these observations, short-term serial measurements of TSH and T_3 after administration of TRH may prove of clinical value in simultaneously assessing the ability of the pituitary and thyroid glands to respond to their trophic hormones.

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Interfacial Organisms: Passive Ventilation in the Velocity Gradients near Surfaces

Abstract. *A variety of animals, including certain sponges, tube-dwelling worms, tropical termites, and prairie dogs, either are themselves arranged or construct domiciles arranged to permit flow of fluid inside the system driven by a velocity gradient in an external stream of fluid.*

Where fluid flows along an unmoving surface, a velocity gradient ("boundary layer") exists in the fluid adjacent to the surface. Thus the many organisms living at a solid-fluid interface are exposed to such gradients; for these organisms the possibility exists of using the potential differences of the gradient to assist in their energy-requiring activities. We suggest, in particular, that the structure of certain animals and their lodgings is appropriate for exploiting the gradient in the external medium to augment flow within animal or burrow. For littoral organisms attached to solid substrata or for animals in burrows with multiple openings the existence of a gradient may be more certain than the direction of flow. It is therefore noteworthy that mechanisms exist which permit unidirectional internal flow, irrespective of the direction of the external stream.

One mechanism makes use of a

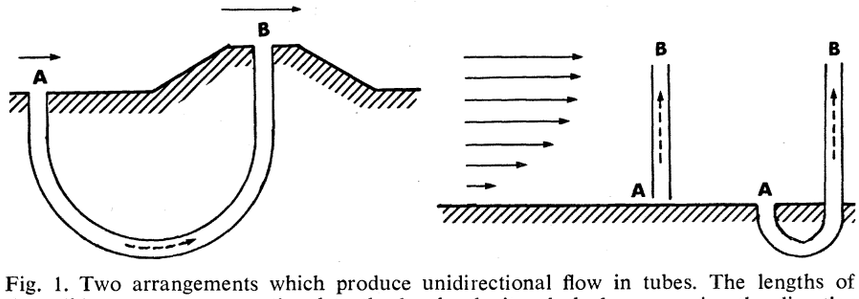

Fig. 1. Two arrangements which produce unidirectional flow in tubes. The lengths of the solid arrows are proportional to the local velocity; dashed arrows give the direction of flow in the tubes. At left, fluid moves from *A* to *B* when the free-stream velocity near *B* is greater than that near *A*. At right, fluid moves from *A* to *B* in either tube when opening *A* is sufficiently close to the wall so that the velocity near *A* is substantially less than that near *B*. In our model systems of this type, tubes were 2 to 3 cm long, 3 mm in internal diameter, and 4.75 mm in external diameter, in a long water-filled channel about 10 cm wide with mid-channel velocities of about 10 cm/sec.