mal is clearly indicated by the limited survival periods of the small specimens. The apparent stimulatory effect of ingested red cells on the larger worms requires further investigation. It is to be noted that Moore and Meleney(10) have suggested that the defective maturation of *S. mansoni* in the peritoneal cavity of the mouse may be a reflection of the absence of blood upon which to feed. Although not yet ideal, the *in vitro* system here described offers a convenient means for the direct and prolonged observation of feeding schistosomes. The technic should, therefore, prove useful for a variety of experimental purposes, as well as offering a baseline for the development of improved media in the future.

Summary. Preliminary investigations on the growth of *Schistosoma mansoni in vitro* are reported. In a nutrient medium composed of bovine amniotic fluid, beef embryo extract, and horse serum, schistosomulae generally showed evidence of growth. The duration of survival was directly related to initial size. Worms that initially approximated 1.0 mm or greater in length were found to survive many weeks *in vitro;* the survival period of smaller schistosomulae was of much shorter duration. The addition of red cell suspensions to the basic medium was followed by active feeding and accelerated somatic movements. Growth of the schistosomes *in vitro* was manifested by increases in length of male worms to a maximum of 168%, and of female worms to 367%, and also by the observed regeneration of amputated portions of certain of the worms.

1. Lee, C. U., and Chu, H. J., PROC. SOC. EXP. BIOL. AND MED., 1935, v32, 1379.

2. Chu, H. J., *China Med. J.*, 1938, Suppl. 2, 411.

3. Ross, O. A., and Bueding, E., PROC. SOC. EXP. BIOL. AND MED., 1950, v73, 179.

4. Newsome, J., and Robinson, D. L. H., *Ann. Trop. Med. and Parasit.*, 1954, v48, 194.

5. Robinson, D. L., *Trans. Royal Soc. Trop. Med, and Hyg.*, 1954, v48, 283.

6. Bueding, E., and Ruppender, H., cited in *Ann. Rev. Microbiol.*, 1953, v7, 307.

7. Smyth, J. D., *Exp. Parasit.*, 1956, v5, 260.

8. Enders, J. F., PROC. SOC. EXP. BIOL. AND MED., 1953, v82, 100.

9. Weller, T. H., Enders, J. F., Robbins, F. C., and Stoddard, M. B., *J. Immunol.*, 1952, v69, 645.

10. Moore, D. V., and Meleney, H. E., *J. Parasit.*, 1955, v41, 235.

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Action of Thyroid Hormones on Brain Metabolism of Newborn Rats. (22650)

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Investigations have shown that the metabolism of the brain is better protected against interference, especially of the thyroid hormone, than other tissues(1a). It was reported(1) that thyrotrophic hormone can increase the brain oxidation of hypophysectomised rats, although it can seldom influence that of normal adult rats. It seemed that after hypophysectomy a regulating mechanism, which is responsible for the constancy of the brain metabolism, is disturbed. During the last few years it seemed promising to continue these experiments on animals whose anterior pituitary function was not yet fully developed. The brain of newborn rats seemed also to be particularly interesting owing to the extraordinary resistance of these animals to anoxaemia which enables them to survive in a carbon monoxide atmosphere(2).

Contrary to previous experiences with adult animals these investigations showed some significant changes after treatment with thyroid hormones.

Methods. Litters of Wistar rats were 5 to 11 days old at investigation, and weighed 8 to 20 g each. Each litter was divided equally,

TABLE I. O_2 Consumption of Cerebral Cortex of Newborn Rats after Thyroxine Treatment.

	Controls (saline treated)			Thyroxine treated animals				
				Thyroxine treatment				
Litter No.	Age in days	No. of animals	Avg O_2 consumption/ hr/100 mg fresh tissue, $mm^3 \pm$ S.D.	No. of animals	Total dose, mg	No. of single daily doses	Avg O_2 consumption/ hr/100 mg fresh tissue, $mm^3 \pm$ S.D.	% differences as compared with controls
I	8	4	81.5 ± 5.5	4	.15	1	84.7 ± 7.5	+ 3.9
II	7	6	76.5 ± 7.0	6	.15	1	86.2 ± 5.8	+12.7*
III	8	4	84.0 ± 3.7	5	.15	2	93.6 ± 9.7	+11.4
IV	9	4	89.5 ± 5.7	4	.15	2	99.2 ± 1.7	+10.8*
V	8	4	78.0 ± 4.1	5	.15	3	91.2 ± 6.5	+16.9†
VI	8	6	97.2 ± 2.6	6	.25	3	109.8 ± 4.7	+13.0†
VII	9	5	92.2 ± 2.4	7	.25	5	102.1 ± 6.8	+10.7†
VIII	9	3	88.3 ± 2.6	3	.25	5	105.0 ± 1.7	+18.9†

* Significant at P 0.05. † Significant at P 0.01.

TABLE II. O_2 Consumption of Cerebral Cortex of Newborn Rats after Treatment with Thyroxine and Triiodothyronine.

	Treatment control animals (saline treated)			.1 mg triiodothyronine, daily for 4 days			.1 mg thyroxine, daily for 4 days		
Litter No.	Age in days	No. of animals	mm^3 O_2/hr/ 100 mg fresh tissue, mean ± S.D.	No. of animals	mm^3 O_2/hr/ 100 mg fresh tissue, mean ± S.D.	% differences as compared with controls	No. of animals	mm^3 O_2/hr/ 100 mg fresh tissue, mean ± S.D.	% differences as compared with controls
1	10	5	85.2 ± 6.3	4	96.8 ± 15.2	+13.5			
2	10	4	83.2 ± 4.9	4	110.0 ± 4.8	+32.1*			
3, 4, 5 comb.	10	7	104.7 ± 6.5	6	114.8 ± 3.1	+11.0*	7	115.4 ± 8.7	+11.0*
							Idem for 6 days		
6	10	2	99.5 ± 6.4	2	126.5 ± 9.2	+27.1	3	124.0 ± 5.6	+24.6†

* Significant at P 0.01. † Significant at P 0.05.

TABLE III. O_2 Consumption of Cerebral Cortex of Newborn Rats after Treatment with Thyrotrophic Hormone.

	Controls (saline treated)			Animals treated with thyrotrophic hormone				
				T.S.H. treatment				
Litter No.	Age in days	No. of animals	Avg O_2 consumption/ hr/100 mg fresh tissue, $mm^3 \pm$ S.D.	No. of animals	Total dose, i.u.	No. of single daily doses	Avg O_2 consumption/ hr/100 mg fresh tissue, $mm^3 \pm$ S.D.	% differences as compared with controls
I	8	3	92.7 ± 6.0	4	1.6	3	98.5 ± 10.1	+ 6.3
II	8	4	91.2 ± 4.8	5	1.6	3	96.8 ± 6.5	+ 6.1
III	8	4	90.7 ± 5.2	5	1.6	7	104.6 ± 4.6	+15.3*

* Significant at P 0.01.

TABLE IV. O_2 Consumption of Cerebellum of Newborn Rats after Thyroxine Treatment.

	Controls (saline treated)			Thyroxine treated animals				
				Thyroxine treatment				
Litter No.	Age in days	No. of animals	Avg O_2 consumption/ hr/100 mg fresh tissue, $mm^3 \pm$ S.D.	No. of animals	Total dose, mg	No. of single daily doses	Avg O_2 consumption/ hr/100 mg fresh tissue, $mm^3 \pm$ S.D.	% differences as compared with controls
I	8	5	133.4 ± 15.7	6	.25	5	145.8 ± 12.6	+ 9.3
II	8	4	127.0 ± 11.1	4	.25	5	145.0 ± 21.8	+14.2
III	11	4	121.7 ± 23.6	4	.15	3	151.5 ± 11.8	+24.5

TABLE V. % Dry Substance of Cerebral Cortex, Cerebellum and Medulla Oblongata of Newborn Rats Treated with Thyroxine, Triiodothyronine and Thyrotrophic Hormone.

Litter No.	Age in days	No. of animals	% dry substance, mean ± S.D.			No. of animals	% dry substance, mean ± S.D.			% difference as compared with controls		
			Cortex	Cerebellum	Medulla oblongata		Cortex	Cerebellum	Medulla oblongata	Cortex	Cerebellum	Medulla oblongata
			Control animals, saline treated				.05 mg thyroxin daily, 3 days					
I	5	4	12.3 ± .25	12.7 ± .54	12.2 ± .27	4	12.8 ± .24	14.1 ± .27	12.9 ± .41	+5.9*	+11.5†	+ 5.6*
II	8	5	12.4 ± .25	13.2 ± .19	14.1 ± .32	4	13.2 ± .22	14.7 ± .20	14.9 ± .36	+6.4†	+11.0†	+ 5.8†
III	11	4	14.15 ± .31	14.3 ± .46	15.2 ± .36	4	14.7 ± .30	15.4 ± .38	16.8 ± .54	+3.5	+ 7.7†	+10.3†
							.1 mg tri-iodothyronine daily, 4 days					
IV	6	3	12.2 ± .12	13.9 ± .61	13.9 ± .73	4	13.2 ± .36	14.6 ± .22	14.3 ± .29	+8.7†	+ 4.9	+ 2.9
V	11	3	14.1 ± .33	15.1 ± .30	15.1 ± .29	3	15.0 ± .52	16.1 ± .21	16.3 ± .35	+6.1	+ 6.5†	+ 8.0†
							.2 i.u. thyrotrophic hormone daily, 7 days					
VI	10	5	13.6 ± .43	14.9 ± .20	15.1 ± .35	4	14.3 ± .15	15.7 ± .17	15.5 ± .24	+5.7†	+ 5.2†	+ 3.0
VII	10	6	13.2 ± .15	14.3 ± .29	14.6 ± .39	5	14.3 ± .49	15.1 ± .42	15.6 ± .25	+8.4†	+ 5.6†	+ 6.7†

* Significant at P 0.05. † Significant at P 0.01.

one half receiving daily injections of either thyroxine, thyrotrophic hormone, or triiodothyronine, and the other, or control half, receiving normal saline. The litters remained with the mother throughout the period of treatment. The animals were killed by decapitation, the brain quickly removed and, in order to expedite the start of the experiment, small tissue snippets were cut with a pair of fine eye scissors. These snippets were sufficiently thin to show the same oxygen consumption as brain slices, as had been established in a number of preliminary investigations. The snippets were weighed on a torsion balance with a capacity of 100 mg. Ninety to 95 mg of tissue snippets were investigated in conical Warburg vessels. Krebs Phosphate Ringer containing 0.2% glucose was used as suspension fluid.

Results. In Table I changes in the oxygen consumption of the cerebral cortex after thyroxine treatment are recorded. There seems to be some relation between duration of treatment and extent of increase in oxygen consumption.

Table II shows the influence of triiodothyronine on oxygen consumption, and also a comparison between the action of equal weight doses of thyroxine and triiodothyronine. The experiments show that triiodothyronine increases rate of brain respiration in newborn rats, but does not permit a conclusion that it has, in this case, a greater effect than thyroxine.

The influence of thyrotrophic hormone (TSH) on the brain cortex of newborn rats is shown in Table III. A dose of TSH which in 3 doses over 3 days seemed to produce little effect, appeared to produce a larger and statistically significant difference from the controls when given in 7 doses over 7 days.

The cerebellum of the newborn rat has normally a considerably higher oxygen consumption than that of the cortex. Thyroxine appears to raise the oxygen consumption (Table IV). The results however, are not significant owing to the great scatter in the single results.

Changes in the dry substance content of cortex, cerebellum and medulla region were

investigated in 40 litters. A few representative results are given in Table V. This table shows that thyroxine, triiodothyronine and thyrotrophic hormone alike increase the dry substance content of all brain parts. Triiodothyronine does not appear to have a more marked action than thyroxine.

Discussion. It has been shown in these investigations that the oxygen consumption of the brain of the newborn rat can be increased under the influence of thyroid hormones. Thus it is considerably more sensitive to this treatment than the brain of the grown-up animal. It appears feasible that this action is equivalent to an acceleration of a physiological maturation process taking place in the brain. It is known(3) that the oxygen consumption of the brain rises during the first weeks of life.

It would be interesting to know why thyroid hormone acts as described on the brain of the newborn animal and not on that of the adult. It has been recently shown that the blood brain barrier is not yet established in newborn rats against glutamic acid(4) or Cl^{36}, or Thiocyanate(5). It would be tempting to assume that, similarly, during the first few days of life, thyroid substances can more easily contact the brain cells, owing to the fact that the blood brain barrier is not yet fully developed during this time.

Summary. 1. Thyroxine, triiodothyronine and thyrotrophic hormone significantly raise the brain oxidation of newborn rats; the dry substance content is also raised. These changes were regarded as an acceleration of normal maturation processes. 2. It is assumed that the described action of thyroid hormones on the brain of newborn animals is due to a still incompletely developed blood brain barrier.

1a. Hoexter, Frieda M., *Endocrinology*, 1954, v54, 1.

1. MacLeod, L. C., and Reiss, M., *Biochem. J.*, 1940, v34, 820.

2. Reiss, M., *Z. f. exp. Med.*, 1930, v77, 345.

3. Tyler, D. B., and van Harreveld, A., *Am. J. Physiol.*, 1942, v136, 600.

4. Himwich, H. E., and Himwich, W. A., in *Biochemistry of the developing nervous system*, Academic Press, 1955, p202.

5. Waelsch, H. in *Biochemistry of the developing nervous system*, Academic Press, 1955, p187.

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In vitro Effect of Soybean Phosphatides on Serum Lipoproteins of Normal and Hyperlipemic Subjects.* (22651)

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The oral administration of soybean lecithin has previously been reported to lower the serum cholesterol of man(1) and cholesterol-fed rabbits(2). The present study was initiated when preliminary experiments revealed that incubation of human serum, after addition of a fat emulsion prepared for intravenous administration, caused a shift of lipid from beta-globulin to alpha-globulin, as determined by paper electrophoresis. Because lecithin was used as a stabilizer in the fat emulsion, this phenomenon was investigated further using soybean phosphatides. The effects of not only the whole phosphatide complex, but also the alcohol-soluble and the alcohol-insoluble fraction were investigated.

Material and methods. 1. *Exp. A—Whole Phosphatide Complex.* A purified extract of natural soybean phosphatides† containing approximately equal quantities of lecithin, cephalin and lipositol was used as follows: Five mg of soybean phosphatides were dissolved in 1 or 2 ml of sera from 6 normal subjects in

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