pregnancy, Graves' disease and other associations. One of the conditions producing the relative iodine insufficiency now appears to be a deficiency in the reducing substance.

It is our present belief that plant juices prevent or cure thyroid hyperplasia by a thyroid-sparing acting, that is, by providing another mechanism for promoting tissue oxidations. On the other hand, iodine administration prevents thyroid hyperplasia by making it easier for the thyroid to produce more thyroxin.

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Action of X-rays on Glutathione Content and Oxygen Consumption of Normal and Regenerating Planarians.*

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Studies upon regeneration[1] have been carried out to test the hypothesis that persistent embryonic cells are responsible for the formation of new tissues during regeneration, and that the power or capacity for regeneration is to be correlated with the number of such cells present. It has been shown that in different species of planaria, cells of an embryonic type, called "formative cells," undergo rapid proliferation after cutting the planarian, migrate to injured areas, and differentiate into the new tissues characteristic of the regenerating part. Species of planarians that exhibit the greatest capacities for regeneration possess the greatest numbers of these formative cells. Hickman[2] destroyed the capacity for regeneration by the use of X-rays and radium, and histological studies of such irradiated worms showed a selective destruction of these formative cells.

Other investigators showed that the rate of metabolism and of oxygen consumption in particular, increase immediately after cutting and remain at a high level throughout regeneration. The important rôle of glutathione in the establishment of the metabolic level and in the utilization of oxygen indicated that important cor-

* Acknowledgements are due the Committee on Effects of Radiation, National Research Council, for support received through W. C. Curtis.

1 Curtis, W. C., *Proc. Boston Soc. Nat. Hist.*, 1902, xxx, 515.

2 Curtis, W. C., and Hickman, J. F., *Anat. Rec.*, 1926, xxxiv, 145.

relations might be found between the processes of regenerative development and the quantitative distribution of this compound. Numerous workers have found glutathione in greater concentrations in the tissues of embryos and in adult tissues capable of continued cell division than in adult tissues in general. Recently Hammett[3] has shown glutathione to be a stimulus to cell division.

Using a modification of methods of Joyet-Lavergne[4] and Hammett[3] the glutathione content was determined in two species of Turbellarians, *Planaria agilis*, and *Procotyla fluviatilis (Dendrocoelum lacteum)*. The former species possesses a high capacity for regeneration and shows a high concentration of glutathione; the latter, which exhibits a low capacity for regeneration, shows a lower content. In normal worms the formative cells are found in the parenchyma, principally in the dorsal region. This area corresponds to that showing the highest content of glutathione. In regenerating individuals greater numbers of differentiating formative cells and higher glutathione content are found in the regenerating areas that form the head, tail, and pharynx.

Quantitative examinations of the glutathione content of normal, regenerating, and irradiated specimens of *Planaria agilis* were made by colorimetric estimations and by the Tunnicliffe[5] method. The glutathione content was found to decrease after irradiation with heavy exposures of X-rays (approximately 2,000 R units). Some typical results are found in Table I.

TABLE I.
Glutathione Content of Planarians Before and After X-ray Treatment (in mg. per 100 gm. of tissue).

Animals	Normals	2 hrs. after Irradiation
Pure line R-1-3	73	65
" " R-2-4	86	53
" " R-1-4	79	66
Mixed culture	94	81
Mixed culture	94	81
Average	83	65.75

Determination by Tunnicliffe method.

The oxygen consumption of individual specimens of *Planaria agilis* of the above types has been determined by the Winkler method. A micro-adaptation was devised in which determinations were made on small samples of fluid in an atmosphere of pure hydrogen. The

[3] Hammett, F. S., *Protoplasma*, 1919, vii, 297.

[4] Joyet-Lavergne, Ph., *C. R. Soc. de Biol.*, 1928, xcviii, 658.

[5] Tunnicliffe, H. E., *Biochem. J.*, 1925, xix, 194.

results upon regenerating worms confirm those of other workers. Oxygen consumption remains above normal during regeneration. Oxygen consumption of both normal and regenerating worms is markedly decreased by heavy exposures with X-rays. The profound effect of this treatment on the oxygen consumption may be seen from Table II.

TABLE II.

Oxygen Consumption (cc. per hr.) of Individual Planarians Before and After X-ray Treatment.

Animals	Normals before irradiation	24 hrs. after irradiation
A	0.01472	0.00114
B	0.00924	0.00027
C	0.00876	0.00110
D	0.00559	0.00037
E	0.01186	0.00570

Determinations by a micro-modification of the Winkler method.

In view of the stimulating action of glutathione upon cell division and the high concentration of this compound in embryonic cells, the destruction of glutathione by X-rays or at least its inactivation offers an explanation of the selective action of X-rays upon cells undergoing mitotic division and upon embryonic cells of planarians and other forms.

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Action of Adrenalin on the Metabolism of Peripheral Tissues.

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It has been found impossible to affect the carbon dioxide or total acid production of excised frog muscles by placing them in adrenalin solutions.[1] The absence of a calorigenic effect[2] under such unphysiological conditions was not surprising; and more recent work has indicated that the absence of the viscera[3] and particularly of the liver[4] may have been as responsible for the negative result as the

[1] Griffith, *Am. J. Physiol.*, 1923, lxv, 15.

[2] Boothby and Sandiford, *Am. J. Physiol.*, 1923, lxvi, 93.

[3] Soskin, *Am. J. Physiol.*, 1927, lxxxiii, 162.

[4] Casky, *Am. J. Physiol.*, 1927, lxxx, 381.