considered the polymerization factor. Uhlmann[30] has suggested that an isotopic fractionation occurs in the sublimation of ice and snow, which would mean that our aged ice samples contained more deuterium than the condensed water; and the first biological experiments[31] with heavy water showed that a concentration slightly higher than that in "ordinary" water (if there is such a substance) has a beneficial effect on *Spirogyra*.

The term "trihydrol" has been used for the highest polymer, but this may be an aggregate of as many as twenty-three molecules,[32] hexahydrol,[33] a quartz-like structure,[34] or a doublet of the pyramidal anion H_3O_2 with the hydrogen ion.[35] Since the polymers differ in density (Sutherland calculates the density of trihydrol as 0.88) separation might be effected by other methods. Berkeley[36] has suggested centrifugal force for the separation of isotopes and polymers, and perhaps ultracentrifuges like those of Svedberg[37] or Beams and Pickels[38] will ultimately develop fields of sufficient magnitude.

The conclusion appears to be that, although ice water and steam water have different biological effects, a good deal more information is needed on the physical side before definite rôles can be assigned to the many forms of water in living matter.

T. CUNLIFFE BARNES
OSBORN ZOOLOGICAL LABORATORY
YALE UNIVERSITY

A POSSIBLE EXPLANATION OF THE FUNCTION OF GLUTATHIONE IN DEVELOPMENTAL GROWTH

FOR the past two and a half years I have been studying the developmental reaction of *Obelia geniculata* to the naturally occurring tissue "Bausteine." Since some time must elapse before the data as a whole will be published, I am reporting the essence of the results with the three amino-acids of which glutathione is composed. These results derive from observation of the development of some thousands of animals under conditions described in previous papers. As has been told in many reports, the chief function of cystine or cysteine, its reduced form, in developmental growth is acceleration of cell multiplication. This derives from the SH group potentially or actually contained therein. Glycine, a second of the amino-acids of glutathione, has now been found to favor the regeneration of new hydranths from broken pedicels. No other amino-acid does this specifically. The finding suggests that glycine is concerned in the protein reconstitution essential for regeneration. It is perhaps a scientific demonstration of why gelatin with its high glycine content has been popularly supposed to be particularly useful as an article of diet in convalescence from wasting disease. It is consistent with the recent reports in medical literature that in some cases glycine is apparently of benefit in rebuilding muscle tissue. The third amino-acid of glutathione is glutamic acid. And this decidedly and definitely favors the process of differentiation and consequent organization. No other amino-acid yields like effect to like degree. It is this amino-acid which shows as its outstanding and specific influence upon developmental growth the acceleration of differentiation and consequent organization.

Thus, then, it seems as if in glutathione nature has developed in one and the same chemical compound a complex which conditions if it does not determine the course of the several basic and essential processes concerned in developmental growth. Through cysteine it accelerates cell proliferation, the first step; through glycine it accelerates that protein reconstitution which is an essential accompaniment to both cell division and cellular differentiation; and through glutamic acid it accelerates the progress of that selective building-up of the protein molecule which is the characterizing process of differentiation and its consequent organization.

There are those who deprecatingly insinuate that reports of what happens under certain conditions are of little value without explanations of the mechanism producing the given reaction. It takes but little clear thinking to realize that the first step in scientific inquiry is to find out what happens. Only when this has been done can there be found out how it happens. The why is so frequently a subject of metaphysics that it need not be discussed here.

FREDERICK S. HAMMETT
MARINE EXPERIMENTAL STATION
NORTH TRURO, MASS.

SCIENTIFIC APPARATUS AND LABORATORY METHODS

A METHOD FOR DESTROYING INTERNAL CELL MASSES

THE problem of destroying internal cell masses with a minimal destruction of the intervening layers of tissues has arisen in a number of different fields of research. Most of the techniques thus far devised have certain limitations which obviate their use in investigations where a precise control over the amount

[30] Uhlmann, *Naturwissenschaften*, 22: 119, 1934.
[31] Barnes, *Jour. Am. Chem. Soc.*, 55: 4332, 1933.
[32] Duclaux, *Compt. rend. Acad. Sci.* 152: 1387, 1911.
[33] Pennycuick, *Jour. Phys. Chem.*, 32: 1681, 1928.
[34] Bernal and Fowler, *Jour. Chem. Phys.*, 1: 515, 1933.
[35] Kinsey and Sponsler, *Proc. Phys. Soc.*, 45: 768, 1933.
[36] Berkeley, *Nature*, 120: 840, 1927.
[37] Svedberg, SCIENCE, 79: 327, 1934.
[38] Beams and Pickels, *Jour. Chem. Phys.*, 2: 143, 1934.

and locus of the destroyed region is an important desideratum. The older methods of destruction by mechanical means, such as by the use of a scalpel, brain knife or especially devised trephine, do not allow for this precise control. They can not be used for destroying internal cell masses when the destruction of the overlying tissues is to be held at a minimum. Adequate control is also lacking in the method involving the injection of chemicals into the parts to be affected. Although the intervening tissue destroyed may be reduced to an exceedingly small amount, it is impossible to accurately control the locus and size of the regions infiltrated with the chemical.

The electro-cautery method offers a more accurate control over the amount of destruction and has proved extremely valuable for ablating external layers of tissue. It is not used for destroying internal masses. High frequency currents have likewise offered a means for attaining an accurate control over the amount and locus of the region affected. They have been used with marked success by surgeons in the removal of various types of neoplasms, and a rather refined technique of electro-surgery has resulted from this particular application. These currents have also been used for heating internal cells masses, even to lethal temperatures. No account has been found of high-frequency currents being conducted into the inner parts of a tissue by means of an insulated electrode, thus producing localized destruction of cells.

In endeavoring to study the functions of certain diencephalic centers in emotional responses of animals it became necessary to devise some technique for destroying these deeper nuclei of the brain without releasing them from the restraining influence of the higher cortical centers. This meant that the destruction of the intervening nervous tissue had to be held at a minimum. After considerable experimentation a technique has been devised utilizing high frequency electric currents, which accomplishes well-defined destruction in internal cell masses and which enables the operator to exercise a very precise control over the locus and the amount of the tissue affected.

The high frequency current is generated by a shielded thermionic oscillator[1] which has an output of 50 watts at a frequency of 3×10^6 cycles per second. Most of this energy is dissipated in a voltage stabilizing circuit. A relatively small amount of the current is applied to an electrode, which is insulated except for one or two millimeters at the tip. This electrode produces negligible mechanical injury when it is inserted into the tissue because of its small diameter, which is approximately 0.3 mm, including the insulation. By using the proper duration and density of current, a definite globular region of thermally coagulated tissue surrounding the electrode tip may be produced. A large indifferent electrode is used to complete the circuit. The amount of tissue destroyed varies with the amount of uninsulated electrode surface, as well as the current density. A thermionic voltmeter across the active and indifferent electrodes has proven more useful in controlling the current than has direct measurement of the current flow. Shreds of tissue adhere to the electrode tip if the voltage is too high, which is of course objectionable in many cases. This usually may be prevented if the proper voltage-duration ratio is used.

In operating upon the deeper nuclei of the brain the first step is that of trephining the cranium. Following this the electrode is inserted with a goniometer-manipulator, accurately oriented with respect to the animal's brain by various landmarks on the skull. The manipulator is designed so that the electrode can be placed in any position and inserted at any angle desired. The animal's head is immobilized by means of suitable clamping devices. The precise adjustments of the goniometer for accomplishing destruction in any desired area are previously worked out from the stained sections of the brain of another animal. The proper voltage-duration ratio for producing a given amount of destruction must also be worked out previous to the operation.

To date, the method has been used only for producing internal lesions in the encephalon. It should, however, prove serviceable wherever controlled lesions in the deeper structures of the body are required. Because of the accurate control over the amount of destruction, the method can be used for making extremely minute lesions which are difficult of accomplishment by mechanical means.

CLARENCE W. BROWN
FRANKLIN M. HENRY
UNIVERSITY OF CALIFORNIA

[1] The writers wish to express their appreciation to the National Research Council for a grant-in-aid for constructing the high frequency unit.

A SIMPLE CALIBRATION METHOD

I HAVE devised a method for calibrating pipettes which is so simple that any technician who can perform a determination of uric acid in blood may use it. The method is believed to be original.

The example which follows is based on the uric acid determination, but other substances may be used.

The stock standard solution of Folin and Wu[1] is a 0.1 per cent. solution of uric acid, 0.020 cc of which contains 0.020 mg of the substance—the amount contained in 5 cc of the dilute standard.

To calibrate a capillary pipette to deliver, say, 20 cmm, it is necessary first to mark it approximately

[1] *Jour. Biol. Chem.*, 54: 153, 1922.