THE FINDINGS OF MODERN MICROSCOPY REVEAL A SEEMINGLY UNLIMITED PHYSICAL ORGANIZATION IN LIVING PROTOPLASM. AT THE SAME TIME, THEY POINT UP THE EXTREME LABILITY OF MANY PROTOPLASMIC STRUCTURES. FOR EXAMPLE, THE ENDOSPLASMIC RETICULUM, A CONTINUOUS NETWORK OF MEMBRANE-BOUND CAVITIES THAT PERMEATES THE CYTOSLASM OF ANIMAL CELLS, BREAKS DOWN ON INJURY OR CYTOLYSIS INTO A COLLECTION OF ISOLATED VESICLES (10). ALSO, IT IS WELL KNOWN THAT STRUCTURES SUCH AS THE MITOCHONDRIA MAY BE PROFUNDLY ALTERED AS A RESULT OF CELLULAR CHANGES OR VARIATIONS IN EXPERIMENTAL CONDITIONS (1).

However, some of the puzzling information concerning the absorption of inorganic ions by plant tissues becomes more comprehensible when viewed in terms of protoplasmic structures. That is, the mineral absorption and isotopic exchange data regarding root tissues suggest that inorganic ions may be laid down as component units of highly complex and unstable chemical arrangements in cells. Certain of the ideas to be presented are similar to those put forth a decade ago by Steinbach on the basis of the behavior of inorganic ions in striated muscle cells (11). A few examples of the mineral absorption data will serve to present the general concept.

It has been commonly observed that many plant tissues lose absorbed ions such as K⁺ to dilute solutions of HCl. With barley root tissue, essentially all of the absorbed K⁺ is released in a two-hour period to HCl solutions of normality 10⁻³ or greater (7). A further significant aspect of the K⁺ release is the concomitant and proportionate loss of a variety of other cellular constituents such as inorganic phosphorus, soluble organic phosphorus, soluble nitrogen, and Ca++. (7). That is, hydrogen ion concentrations that induce the release of a particular absorbed ion also affect a release of all other absorbed cations and anions as well as certain organic components of the cell. Conceivably, this experimental observation could be explained as the result of an effect of hydrogen ion on the properties of certain cytoplasmic membranes. In the writer's opinion, it could be equally well explained on the basis of an instability to H⁺ of a chemical structure in which all of the absorbed ions are represented.

The loss of K⁺, Ca++, and other cellular constituents to dilute HCl solutions can be offset completely or in part by the addition of K⁺ or Ca++ to the acid media (7). This is perhaps analogous to certain phenomena of simple inorganic chemistry. For example, the compound CaK₂(SO₄)₂·H₂O dissolves readily and is unstable in acid solutions because of the formation of HSO₄⁻ ions. However, in conformity with the laws of physical chemistry, the salt dissolves less readily in and is more stable with respect to acid solutions containing Ca++, K⁺, or SO₄²⁻ ions.

From rate studies of isotopic exchange between excised root tissue and the culture medium, it must be concluded that K⁺ ion is much more firmly bound within the tissue when it is absorbed along with Ca++ ion (9). To the writer this experimental fact suggests that both K⁺ and Ca++ are laid down in a single chemical structure and this structure is more stable than that formed when K⁺ is absorbed in the absence of Ca++. A similar hypothesis might be invoked to explain the marked stimulating effect that Ca++ ion can have on the absorption rates for K⁺ and Br⁻ ions (12). That is, when absorbed along with Ca++, K⁺ and Br⁻ ions are incorporated in a more stable structure and this fact is reflected in enhanced absorption rates for these ions.

However, since a number of polyvalent ions such as Al³⁺, Ce³⁺, and La³⁺ also have stimulating effects on the absorption of K⁺ (4), it appears necessary to envisage a series of possible chemical structures within the protoplasm of varying stability. In this series the amounts of component cations and anions can vary, subject of course to the overall restriction of electric neutrality of the unit. Instances of situations of this kind are common in crystal chemistry. For example, a series of aluminosilicates possessing the mica structure is known in which the proportions of Al³⁺, Mg²⁺, Fe²⁺ and K⁺ can vary widely.

For a given plant tissue and nutrient environment, it appears reasonable that cations and anions will be absorbed in such proportions and amounts as to form the most stable structure. Thus on this picture, competitions between ions of like sign and mutual effects between ions of unlike sign in absorption are to be expected. Specifically, this hypothesis allows for the experimental observation that K⁺ is less rapidly absorbed when Na⁺ is present or that K⁺ is more rapidly absorbed from a KCl solution than from a K₂SO₄ solution of the same equivalent concentration.

On the basis of the structural concept, one would...
further predict that when tissues are transferred from one nutrient environment to another, readjustments may occur involving the breaking down of old structures and the building up of new structures appropriate to the new environment. Also, when tissue is transferred from a relatively concentrated nutrient medium to a more dilute medium or to distilled water, the readjustments may involve releases of absorbed cations and anions to the culture solution. It has been observed in this laboratory that when barley root tissue which has been grown in a medium high in KBr is transferred to distilled water, important fractions of the total absorbed K⁺ and Br⁻ are readily released. A similar line of reasoning may serve to explain the presumed reversible diffusion of salts into the protoplasm of many cells upon which calculations of the so-called "apparent free space" are based (2, 5, 6).

Among recent workers in the field of mineral absorption by cells, the postulation of metabolically produced "carrier substances" is general. By carrier substances are understood organic compounds capable of forming complexes with or sequestering inorganic ions. According to some views the carriers possess discrete chemical structures such as can be attributed to enzymes (3). A theoretically necessary part of all accumulation models involving carriers is a barrier or membrane which is permeable to the carrier-ion complex but which is relatively impermeable to free ions (8). Thus at the outer boundary of the barrier, the ions combine with the carriers and the resulting complexes diffuse through the barrier. On the inner surface of the barrier, the complexes are broken down chemically and the ions are released.

The reasoning presented in this communication constitutes a modification of the usual concept of the carrier substance and, as regards the mechanism of ion accumulation, places more emphasis on structure than on membranes and limiting boundaries with special chemical and physical properties. On this approach, the carrier is the living protoplasm itself in which the nutrient cations and anions are pictured as not being free but held as integral parts of a highly complicated and labile chemical structure. This means that the carrier substance and the barrier are one and the same thing. Also, the carrier substance is the same for both cations and anions. Finally, the carrier is not a discrete chemical compound but may vary as to itsionic content, and perhaps in other respects, according to experimental conditions.

On this picture, the formation of vacuoles and the secretion of ions to vacuoles are secondary effects which correspond to a breakdown, perhaps as a result of enzymatic action, of protoplasmic structure.

**Literature Cited**


**Effects of Gibberelllic Acid on the Photoperiod-Controlled Growth of Woody Plants**

**James A. Lockhart and James Bonner**

Kerckhoff Laboratories of Biology, California Institute of Technology, Pasadena, California

The discovery that gibberelllic acid can replace the long day requirement for flowering in certain species of long day plants (2, 5, 6, 10), has suggested the further question of whether the long day requirement for vegetative growth characteristic of many species of woody plants (1, 4, 9) might also be replaced by applications of gibberelllic acid. Lona has reported that cuttings of *Fagus sylvatica* maintained in a dormant condition by short day resume growth as a re-

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