ring it into euchromatic regions, while heterochromatic regions alter the effects of position alleles either little or not at all.

We may summarize the main points briefly:

(1) One, two, or three doses of an allele may produce different effects. This means excess of substrate beyond that used in normal diploid cells. Some alleles act, with different degrees of success, toward normal venation; others, toward abnormal venation. In the latter case different competing reactions controlled by the same allele may be involved.

(2) Combinations of two alleles may be less effective than the "better" of the two or than either alone. There is, thus, not additive action of two alleles but interference, in some cases clearly of mutual nature.

(3) Position alleles also show interference with normally located alleles of their own kind. If different position alleles are arranged in two series according to grade of effect when they are heterozygous for a normal or a mutant allele, it is found that the two seriations do not agree with each other. It seems that qualitatively different phenomena are involved in the shifting of an allele to different positions.

(4) Certain chromosome regions have specific properties causing a specific type of position effect.

If we look back at the material presented, it appears that much can be learned still by genetic methods about the action and interaction of alleles. The genetic analysis, in spite of its lack of biochemical precision, remains at present a more delicate tool for the probing of immediate genic action than even the most advanced methods of the microanalyst. But the vagueness of the geneticist's results lets us look forward eagerly to the time when the biochemist has caught up with him.

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Foreword From *Vernalization and Photoperiodism*

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IT IS AN HONOR TO BE ASKED TO CONTRIBUTE a foreword to this stimulating publication. The book, of course, owes its inception to Dr. Verdoorn's enthusiastic interest in the documentation of plant science. As a matter of history, it is the last of a series of titles which were originally announced by him before the war and have one by one been published during the last seven years. The authors of these chapters have cooperated generously and have produced conscientious and thorough reviews of their several fields. They are authoritative and familiar with the ramifications of the work they discuss. One of them is himself the author of a book in the same general field (*8*). At the moment, therefore, these comprise almost the last word.

Nevertheless, although the present seems a particularly opportune moment for the appearance of this book, there can be no doubt that in this field, which is developing so rapidly, fundamental changes in outlook might well come at any moment. Such a highly flexible situation is of course typical of experimental plant science, which in many respects is still somewhat embryonic, but it is perhaps particularly so of the branches of plant physiology and agronomy which are discussed here.

The reasons for this are basically simple. The physiology of flowering, with which this book deals, has as yet no basis in the general physiology and biochemistry of the plant. The fundamental discoveries on which it rests are the effects of the chilling of germinating seeds and of the varying of the length of day in mature plants approaching the stage of "readiness to flower (Blühreife)." Both of these are essentially *ad hoc* discoveries which did not arise directly from a continuing chain of closely-knit research and deduction, such as, for instance, that on which genetics rests today, or even that which led

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to our rather extensive knowledge of the auxins. They have inspired a large amount of experiment and have led to very important practical applications in the agriculture of both temperate and tropical zones, which are discussed in the several chapters of this book. But the underlying problems are difficult to attack and, indeed, it is not quite clear that they can even be formulated. What, for instance, is the nature of the change from the vegetative to the flowering state? Is it localized in the buds themselves, as would be implied by the concept of a flowering hormone, of which the buds would be the receptors, or is it systemic—a symptom of an inner complete change in metabolism, as in the theory of phasic development? Curiously enough, these two viewpoints have each become associated with one of the two main fields of endeavor, namely, photoperiodism and vernalization, respectively.

Only recently have these two basic ideas shown signs of approaching one another. It should be pointed out that the demonstration by Gregory and Purvis that vernalization of cereals may be reversed points in the general direction of control by special substances rather than by the successive completion of determinative "phases." However, it is important to note that Sen and Chakravarti (*5*) have been unable to reverse the vernalization of mustard either by high temperature or by dry storage for a year. Mustard differs, however, from rye in that the excised embryos can be fully vernalized in pure water, while rye embryos require sugar for complete and rapid vernalization. Whether there is any connection between this need for carbohydrate and the reversibility of vernalization is, of course, not known yet. However, the metabolism which accompanies vernalization may well be worth analysis. Indeed, the way may have been opened to such an analysis by the recent experiments of Purvis (*4*), which indicate that, during a period of starvation of the rye embryo, some materials necessary not only for vernalization but also for growth are metabolized away. Perhaps at this point our developing knowledge of the special nutritional requirements of young embryos in culture may be brought to bear. A very recent paper by Lang and Melchers (*3*), unfortunately received too late for inclusion in the text, brings the two ideas together in another way. Biennial *Hyoscyamus niger,* which flowers after vernalization only if kept in long days, can be devernalized if given 10 short days at 38°. This treatment must, however, be applied immediately (within four days) after the vernalization by cold. Thus, the flowering condition or substance is destroyed before it has had time to act. Another recent piece of evidence strongly suggestive of the former, or hormonal, view is supplied by Holdsworth and Nutman's (*2*) study of the flowering of *Orobanche.* This parasite evidently initiates flowers only when its host, red clover, does so; in other words, the receptors for the flowering "hormone," whose production depends on day-length, are not only the buds of the host but also those of the parasite. The formation and destruction of special substances or, alternatively, the balance between their production and its inhibition is, of course, the general line of interpretation adopted by the workers in photoperiodism. The former of the two alternatives is essentially that of Hamner and of Borthwick, Parker, and their co-workers at Beltsville; the latter, that of Melchers and his collaborators. It is needless to add, however, that the nature of these hypothetical substances and the metabolic conditions under which they are produced remain completely unknown. Nevertheless, this vast hiatus does not at present interfere seriously with the development of the field, since these ideas are little more than interpretations and are not specifically formulated theories which can stand or fall by experiments designed to test them.

Another group of questions which we are perhaps not yet ready to formulate concerns the mode of action of the stimulus (or the substances). In the case of vernalization of the grasses the impetus to flower formation seems to appear as a change in the primary meristem; in the dicotyledons the contribution of Roberts and Struckmeyer suggests that it may be the secondary meristem which shows the initial and determining responses. If it be the meristems which are initially changed, then the subsequent reactions leading to flowering may result from differences in the supply system and therefore in the materials made available to the developing initials. Similar effects exerted through the transporting system may be operative in the thermoperiodic phenomena described by Went.

Some of the questions are less broad and are susceptible of immediate attack. One of these is the nature of the photo-receptor pigment, the measurement of whose absorption spectrum by the Beltsville group is described in one of the chapters of this volume. Another is the role of sugar-feeding and induced fermentation studied by Melchers, Lang, and Claes and discussed in the articles by Murneek and Hamner. Still another is the relation of auxin production to flowering; it is a striking fact that, in pineapple, auxin greatly hastens flowering, while in other plants its effect tends to be in the opposite direction. Indeed, Galston (*1*) has ascribed the effect of triiodobenzoic acid in increasing the number of flower-buds in soybeans to the antagonistic effect of this substance on the auxin of the plant. The reduction of cambial activity preceding flowering in the plants studied by Roberts and Struckmeyer would also indicate an opposition between auxin and flowering. The very rapid reactions to change in day-length in such plants as the soybean, of course, would not suggest that such cambial changes were causative in themselves, but they could certainly be an indication of decreased auxin production. Very recently, both Thurlow and Bonner (*7*) and Leopold (unpublished data) have found, using different plants and different methods, that auxin, applied externally, may inhibit to some extent the normal process of flowering. A number of older observations, both botanical and horticultural, point in the same direction, while the peculiar and (at present) isolated case of pineapple, whose flowering is promoted by auxin, cannot be overlooked. Whether auxin (either as a promoter or an inhibitor) plays a major role in the flowering process, however, is far from established, though there is doubtless an interesting avenue here to be opened up. A more extensive discussion of this phase of the problem has been given elsewhere (*6*).

It may be—and this is undoubtedly the usual course of research—that further study of these more concrete problems will lead to a gradual elucidation of the broader and more intangible unknowns. But, as was stated at the outset, the state of the field is such that a single clear-cut result might change its whole aspect almost overnight.

The consequences of major progress in this area are very great, not only for pure science but for agriculture. In these days when so much of the world is near to starvation no worker can fail to carry this thought in the back of his mind, in spite of the frequent statement that research is its own reward and that no further incentive is necessary. One purpose of a symposium like the present publication is to enable the individual student to effect something of a synthesis in his views. Such a synthesis can hardly fail to engender new ideas and thus to quicken the pace of progress.

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TECHNICAL PAPERS

Mechanical Transmission of a Virus Disease to Cucumber From Sour Cherry

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Investigations of yellows and necrotic ring spot, virus diseases of sour cherry (*Prunus cerasus* L.), have been sharply limited because the only known mode of transmission of these diseases has been by grafting, and the known host range has been limited to stone fruits (*1–4*). Since mechanical transmission to herbaceous plants would open many possible avenues of investigation, experiments with this objective were undertaken.

In greenhouse studies in the spring of 1947 it was found possible to transmit mechanically a virus disease to cucumber (*Cucumis sativus* L. variety Ohio) from sour cherry (variety Montmorency). This was accomplished by grinding very young cherry leaves that were just beginning to show the initial symptoms of necrotic ring spot and by rubbing, with carborundum dust as an abrasive, the undiluted expressed juice on the cotyledons of young cucumber plants. While the percentage transmission in any single inoculation experiment was low, transmission was accomplished from 8 cherry trees known to be affected by both necrotic ring spot (*2*) and yellows (*3*) and from one known to be affected by necrotic ring spot but not by yellows. Similar tests of 8 cherry trees free from necrotic ring spot and yellows gave no symptoms on cucumber. Adequate numbers of uninoculated control cucumber plants remained, without exception, free of virus symptoms. Similar attempts to transmit disease from older cherry leaves have been unsuccessful. Mechanical transmission from cucumber to cucumber was obtained readily.

There has been some variation in symptoms on the cucumber with different temperatures, ages of the cucum-