ellipsoid of revolution or a flexible chain molecule. More work probably will have to be done before an ideal model can be designed. It is felt that the differences in observed viscosity values for the two desoxyribonucleates are real. The viscosity values are not considered to be absolute, because insufficient material was available for an investigation of the effect of shear gradient.

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Reversible Photoreaction Controlling Expansion of Etiolated Bean-Leaf Disks

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Several developmental responses of higher plants are known to be controlled by the same or a quite similar reversible photoreaction. Thus lettuce seed germination (*1*), cuticle coloration of tomato (*2*), photoperiodic induction (*3*), and auxin-induced growth of the oat coleoptile (*4*) are all dependent on reactions either promoted or inhibited by red light (6500 A). These red-light-induced reactions, whether promotive or inhibitory, are all reversed by subsequent exposure to far-red irradiation (7350 A). The expansion of etiolated leaves is also known to be light-dependent, with red light being maximally effective in promoting the expansion (*5*). The experimental results reported here (*6*) are the first demonstration that this red-light-promoted expansion is reversed by subsequent exposure to far-red irradiation.

Seed of Ferry-Morse dwarf stringless greenpod beans that had been sterilized in 15-percent Purex were thoroughly washed in distilled water, soaked for 3 hr, and then grown in a sand-vermiculite mixture kept in a darkroom maintained at 26° ±1°C. Disks, 5 mm in diameter, were prepared from the unexpanded simple leaves of these dark-grown beans according to the method of Miller (*7*). The leaf sections were then placed in petri dishes on filter-paper disks treated with 5 ml of solution at *p*H 5.6 containing 3 percent D-glucose, by weight, and 0.08*M* KNO_3. All manipulations prior to final measurement were performed under a dim green safelight (*4*). Durations of the red and far-red irradiations are indicated in Tables 1 and 2. All measurements were made after 48 hr with the aid of a binocular microscope equipped with an ocular micrometer.

The data of Table 1 show that red light (*4*) promotes expansion of etiolated bean-leaf disks and that this promotion is reversed by subsequent exposure to far-red irradiation (*4*). A comparison of treatments 5 and 6 of Table 1 shows that red light given continuously is more effective than a single short exposure. This is in agreement with Miller's finding (*8*) that an additional exposure to red light given on the second day of incubation causes a marked increase in expansion over that elicited by a single exposure.

The data of Table 2 summarize the results of a series of experiments in which red light alone, red light followed by far-red, or no irradiation were given to separate lots of leaf sections. These results are in agreement with those presented in Table 1. Downs

Table 1. Promotion of expansion of etiolated bean-leaf disks by red light and reversal of the red-light effect by far-red light. Results expressed as millimeters increase in diameter of 5-mm disks after 48-hr growth in darkness following exposure.

Treatment	Duration of treatment (hr)	Increase in diameter
1) Red (fluorescent source and filter)	0.5	1.7 ± 0.04*
2) Same as No. 1, followed by far red	1	1.1 ± 0.02
3) Red (Mazda and filter)	0.5	1.6 ± 0.03
4) Same as No. 3, followed by far red	1	1.0 ± 0.03
5) Red (photographic safelight, 60 w)	0.5	1.5 ± 0.04
6) Same as No. 5, given continuously	48	2.0 ± 0.02
7) Far-red control	1	0.9 ± 0.02
8) Dark control	48	1.0 ± 0.02

* Standard error.

Table 2. Suppression of the red-light-promoted bean-leaf disk expansion by far-red exposure. Results expressed as millimeters increase in diameter of 5-mm disks after 48 hr.

Experiment no. and conditions	Expansion in		
	Red	Red followed by far red	Dark
L-3 17.5-hr irradiation	2.6		1.2
L-8 20 min red, 40 min far red	1.53 1.62	1.19 1.08	1.01 1.04
L-10 30 min red, 45 min far red	1.86	1.13	1.05
Average of L-8 and L-10	1.67	1.13	1.03

(*9*) has confirmed these results and has shown in detail that the action spectrum for controlling the expansion of etiolated leaves on intact bean plants is identical to that for the other afore-mentioned morphological responses.

These results, then, add another morphological response to the ever-increasing list of responses that appear to be controlled through some primary photoreaction. However, one can only conjecture about the nature of the reactions that follow this primary light reaction and that eventually lead to the manifestation of the various responses.

References and Notes

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Communications

Prior Publication

This laboratory recently reported the production of cellotetraose during enzymatic hydrolysis of cellulose [*Science* **120**, 1033 (1954)]. Through *Chemical Abstracts* [**48**, 13746^h, (1954] we later became aware of related work by Kooiman *et al.* in a journal not available on this campus [*Enzymologia* **16**, 237 (1953)]. Since the abstract did not indicate that either the tetraose or other intermediate dextrins had been observed, we did not cite the Dutch paper.

When a reprint arrived from Kooiman, however, it became obvious that the tetraose and several other dextrins had been recognized. Our report, then, must be viewed as simply corroborating Kooiman's excellent initial observation. We have written to Kooiman apologizing for our error and would like to correct immediately the erroneous statement in our report that intermediate dextrins had not previously been observed in enzymatic cellulose hydrolysates.

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Spectral Absorption of Turbid Systems Using Diffuse Light

For a long time, absorption spectroscopy has found successful and even spectacular application to the measurement of the chemical composition and reaction kinetics of living cells. The effects of the turbidity of biological materials, which if ignored can lead to quantitative errors and even to qualitatively fallacious conclusions, have been widely realized in these researches, and artifices have usually been introduced in order to reduce turbidity, or to include much of the scattered light in the transmitted beam, or to insure that important changes of turbidity do not occur during the course of the reaction under investigation. Nevertheless, a method of general applicability has not emerged. In this paper we refer to preliminary experiments which suggest that such a general solution to the problem might be possible.

It is convenient to introduce the subject by referring to recent experiments by Burk (*1*) and Warburg and Krippahl (*2*), although our work was done without knowledge of theirs. In their experiments the vessel containing a turbid colored cell suspension was surrounded by a large spherical diffuse reflector. A measurement of the amount of light not absorbed by the cells when exposed to an incident monochromatic beam was obtained by measuring the light intensity at some point on the periphery of the globe, taking advantage of the fact (*3*) that the intensity at the wall of a diffusing sphere containing a source of radiation (the cell suspension in this case) is the same at all points even when the source does not emit equally in all directions.

In the other experiments (*1, 2*) the turbid absorber occupied only a very small fraction of the volume of the diffusing globe, so that the effect of double or multiple passage of diffusely reflected radiation through the absorber resulted in only a small correction term. In our own work the absorbers filled the globe, so that the process of diffuse reflection which gives the globe its essential "integrating" character for scattered radiation also has the effect of exaggerating the absorbing properties of the contents in a manner that may be expressed by comparing a globe of diameter d to a conventional absorption cell of thickness nd, where n is often much greater than unity.

The absorbing sphere with diffusely reflecting walls ("diffuse light absorption vessel," DLAV) was real-