currence of nearly planar H-bonded furanose rings, separated by approximately 5 A and tilted 20° to the fiber axis, is responsible for the great intensity seen in this area. It is these reflections, in fact, which constitute the most striking similarity between the diagrams of adenine polynucleotide and ribonucleic acid (RNA) and their greatest contrast to that of deoxyribonucleic acid (DNA).

Because the x-ray diffraction pattern of adenine polynucleotide resembles that of RNA (*16*) (and differs from that of DNA), it is expected that the structures of adenine polynucleotide and RNA are similar. The form of H-bonded backbone described for structure I above can serve as a basis for the structure of RNA, since any sequence of purines or pyrimidines can be accommodated on either chain and the configuration depends, for its regularity and stability, only on that feature of the chain which distinguishes RNA (and the synthetic polyribonucleotides) from DNA—namely, the hydroxyl group on C′-2 of the sugar moiety. Furthermore, the 6-keto and 6-amino groups of both purines and both pyrimidines would, in this kind of structure, fall at almost exactly equivalent positions. This offers the possibility of their bonding to amino acids or other molecules in a structurally regular way despite their seeming disparity of size. Chargaff and Elson (*17*), who have demonstrated the numerical equality of these groups, have also suggested such a type of bonding (*18*).

RICHARD S. MORGAN*
RICHARD S. BEAR†
Department of Biology, Massachusetts Institute of Technology, Cambridge

References and Notes

1. J. D. Watson, in *The Chemical Basis of Heredity* (Johns Hopkins Press, Baltimore, 1957), p. 522.
2. R. F. Beers, Jr., *Nature* 177, 790 (1956); *Biochem. J.* 66, 686 (1957).
3. L. Brown and I. F. Trotter, *Trans. Faraday Soc.* 52, 537 (1956).
4. S. Ochoa and L. A. Heppel, in *The Chemical Basis of Heredity* (Johns Hopkins Press, Baltimore, 1957), p. 615.
5. S. Furberg, *Acta Cryst.* 3, 325 (1950).
6. J. M. Broomhead, *ibid.* 1, 324 (1948).
7. W. Cochran, *ibid.* 4, 81 (1951).
8. J. D. Dunitz and J. S. Rollett, *ibid.* 9, 327 (1956).
9. D. H. R. Barton and R. C. Cookson, *Quart. Revs. (London)* 10, 44 (1956).
10. S.-I. Mizushima, *Advances in Protein Chem.* 9, 299 (1954).
11. R. S. Bear, *Symposia Soc. Exptl. Biol. No. 9* (1955), p. 97; *J. Biophys. Biochem. Cytol.* 2, 363 (1956).
12. A. Rich, in *The Chemical Basis of Heredity* (Johns Hopkins Press, Baltimore, 1957), p. 557.
13. T. R. R. McDonald and C. A. Beevers, *Acta Cryst.* 5, 654 (1952).
14. J. Donohue, *Proc. Natl. Acad. Sci. U.S.* 42, 60 (1956).
15. H. W. Wyckoff *et al.*, *J. Opt. Soc. Am.*, in press.
16. A. Rich and J. D. Watson, *Proc. Natl. Acad. Sci. U.S.* 40, 759 (1954).
17. E. Chargaff and D. Elson, *Biochem. et Biophys. Acta* 17, 367 (1955); *Nature* 178, 682 (1956).

18. This work was aided by research grant G2007 from the National Science Foundation and by research grant C2550 from the National Cancer Institute, National Institutes of Health.

* Present address. Children's Cancer Research Foundation, Boston, Mass.
† Present address: Division of Science, Iowa State College, Ames.

2 October 1957

Role of Parenchyma Cells in Graft Union in Vanilla Orchid

The successful grafting of numerous monocotyledons has been previously reported (*1, 2*). This work demonstrated that grafts could be made in several grass species and in certain monocotyledonous tropical lianas. It was shown that, contrary to accepted usage, a cambium was not essential for graft union but that any meristematic tissue was suitable for this purpose. The principle that any meristematic tissue is capable of forming a union between scion and stock was extended to another monocotyledonous group, the Orchidales, in the study described in this report.

The vanilla orchid of commerce, *Vanilla planifolia* Andr., is susceptible to a root rot, *Fusarium* sp., which has nearly destroyed the industry in Puerto Rico. Attempts were made, therefore, to graft *Vanilla planifolia* on another species, *V. phaeantha* Reichenb., which is resistant to the fungus. The method used was similar to that previously described for grafting lianas (*2*). Like the lianas, *Vanilla* has no definite intercalary meristem, but the actively growing tips remain meristematic. The stem of the *V. phaeantha* stock was broken in the third to fifth internode. A paper tube dipped in paraffin was slipped over the stock, and a scion of *V. planifolia* of equal diameter was inserted into the tube. The scion, also, had been obtained by breaking of the parent stem in the actively growing region. The scion was placed firmly in contact with the stock and tied, to hold it in place. Both intra- and interspecific grafts were attempted. The graft union in the *Vanilla* was different from that in the grasses and lianas in that the process of union was arrested at the point where parenchyma bridges were formed between scion and stock. Two months after grafting of the *Vanilla,* parenchyma bridges were found, but after 2 years there was no evidence of the formation of vascular tissues across the graft union. This was true both of intra- and interspecific grafts. In the grasses, vascular connections were found within 6 to 8 weeks after grafting and in the lianas, within 12 to 16 weeks.

Approximately 5 percent of the *V. planifolia* scions survived for over 2 years. Growth was extremely variable. Some scions began growth within 2 months and grew to a length of several feet, whereas others lived for a year or more before growing. During this time, they retained their original leaves. Growth was slow in the majority of cases. If the nodal roots which hold the plant to its support were permitted to grow into the soil, the stock died, and the scion then persisted on its own roots.

Tests were made in which the bases of scions were dipped in coconut milk, in coconut milk plus one part per million of 2,4-D, and in one part per million of 2,4-D in water solution. Coconut milk appeared to have a beneficial effect, and it was possible to pick out the scions dipped in coconut milk by their better color and vigor. Dipping in coconut milk plus 2,4-D, or in 2,4-D water solution, was deleterious.

Wardlaw (*3*) found that if the shoot apex of certain ferns was isolated from the surrounding leaf primordia and stelar tissue by vertical cuts, it continued to grow and produce both vascular tissue and leaf primordia. No connection took place between the newly formed vascular tissue and that formed prior to the surgery, and all translocation was across parenchyma cells. The experiments reported in the present paper demonstrate that *Vanilla* grafts can survive and grow for at least 2 years on parenchyma unions. These parenchyma cells must, therefore, serve for both upward and downward translocation, since they form the only union between scion and stock. These results suggest the possibility that parenchyma cells could play a similar role in intact plants.

THOMAS J. MUZIK*
Federal Experiment Station, Mayaguez, Puerto Rico

References

1. T. J. Muzik and C. D. La Rue, *Science* 116, 589 (1952).
2. ———, *Am. J. Botany* 41, 448 (1954).
3. C. W. Wardlaw, *Morphogenesis in Plants* (Methuen, London, 1952).

* Present address: Department of Agronomy, State College of Washington, Pullman.

12 August 1957

Amino Acid Factor in Control of Abscission

The role of indoleacetic acid in the control of abscission of plant organs has been demonstrated repeatedly since Laibach (*1*), in 1933, first observed that orchid pollinia retarded the abscission of debladed petioles. Addicott and Lynch (*2*) have reviewed other factors which may affect abscission, including acidity, ethylene, mineral metabolites, carbohydrate level, auxin gradients, oxygen, and carbon dioxide. Several of these have been shown to exert indirect effects in the control of abscission. The effect of

Table 1. Effects of amino acids upon the time required for abscission of unfertilized ovaries of two varieties of tobacco. The figures show average time in hours from anthesis to completion of abscission.

Lizard's Tail		Little Turkish	
0.01*M*	0.1*M*	0.01*M*	0.1*M*
	Methionine		
24	20	31	26
	Leucine		
50	38	80	40
	Alanine		
57	45	85	60
	Glutamic acid		
57	45	112	60
	Valine		
80	50	130	90
	Cystine		
98	89	170	161
	Cysteine		
94	No abscission	126	No abscission
	Control (water)		
99	93	176	165

others is uncertain at present, but it is generally agreed that indoleacetic acid plays a major role in the control.

The dissolution of the middle lamella of the cell wall during abscission was described first by Lee (*3*). Facey (*4*), through microchemical tests, characterized the dissolution as a change of calcium pectate into pectic acid which, in turn, is changed to water-soluble pectin. Recently Cormack (*5*) has emphasized the calcium pectate character of the cementing layer between cells. Ordin, Cleland, and Bonner (*6*) have reported that the methyl carbon atom of labeled methionine is rapidly incorporated into the pectic materials of cell walls of *Avena* coleoptile sections, and Byerrum and Sato (*7*) have also reported the incorporation of the methyl group of methionine in pectin isolated from radish plants. These observations suggest that methylation of the carboxyl groups of adjacent pectin molecules may be involved in the splitting of calcium bridges leading to abscission and that the amino acid methionine may serve as a methyl group donor. Experimental evidence indicates that an amino acid factor does, in part, control abscission.

Two varieties of *Nicotiana tabacum*, namely Lizard's Tail and Little Turkish, were grown under uniform greenhouse conditions and used as experimental plants. Various aqueous solutions of L-amino acids (DL-methionine, DL-leucine, DL-valine), after being adjusted to *p*H 6.0, were injected directly into the unfertilized ovaries of flowers at the time of anthesis by means of glass tubing drawn to a fine point. In 24 hours, 0.15 to 0.2 ml of the solution were taken up by the tissue. Fertilization was prevented by covering the stigma with a small foil cylinder. The results of such treatment upon the abscission of the flowers are tabulated in Table 1, for a representative experiment. Each value represents the average time required for abscission to occur for ten flowers on one plant. Cysteine at a concentration of 0.1*M* proved toxic, as evidenced by a shriveling of the tissue without the occurrence of abscission.

The effect of methionine is quite remarkable, the time for abscission of the ovary on Lizard's Tail plants being reduced from 4 days to 1 day, and the time for abscission of the ovary on Little Turkish plants being reduced from 7 days to 1 day. A significant acceleration of abscission was also obtained with leucine, alanine, and glutamic acid. Although the role of methionine as a methyl donor in organisms is well established (*8*), there is little or no information on the general aspects of methylation or transmethylating systems. The effects of amino acids other than methionine may result from their serving as methyl donors directly or from transformations giving rise to labile methyl radicals.

These observations suggest that methionine, as a methyl donor, and indoleacetic acid interact to control abscission (*9*).

ROBERT E. YAGER
ROBERT M. MUIR

Department of Botany,
State University of Iowa, Iowa City

References

1. F. Laibach, *Ber. deut. botan. Ges.* 51, 336 (1933).
2. F. Addicott and R. Lynch, *Ann. Rev. Plant Physiol.* 6, 211 (1955).
3. E. Lee, *Ann. Botany, London* 25, 51 (1911).
4. V. Facey, *New Phytologist* 49, 103 (1950).
5. R. Cormack, *Science* 122, 1019 (1955).
6. L. Ordin, R. Cleland, J. Bonner, *Proc. Natl. Acad. Sci. U.S.* 41, 1023 (1955).
7. R. Byerrum and C. Sato, *Plant Physiol.* 31, 37 (1956).
8. F. Haurowitz, *Progress in Biochemistry* (Interscience, New York, 1950).
9. A description of the result of our experiments on the interaction is in preparation.

28 October 1957

Production of Reversible Changes in the Central Nervous System by Ultrasound

For the past several years an intensive research effort has been in progress at the Bioacoustics Laboratory of the University of Illinois on the production of selective lesions in the tissues of the central nervous system by high intensity ultrasound (*1*). Considerable information has been obtained concerning the dosage conditions required for the production of such lesions, and neuroanatomical studies utilizing this technique are now in progress. Relatively recent electrophysiological investigations indicate that *reversible* suppression of transmission along neural pathways can be accomplished by applying a controlled dosage of ultrasonic radiation at various sites along these pathways (*2*). By irradiating with ultrasound in the lateral geniculate nucleus it is possible to suppress temporarily the potential usually evoked in the visual cortex in response to a light stimulus. It should be noted that this effect is produced by a dosage of ultrasound which does not cause any histologically observable lesion in the tissue. This ultrasonic technique of producing reversible changes offers unique opportunities for three-dimensional mapping of central nervous system function.

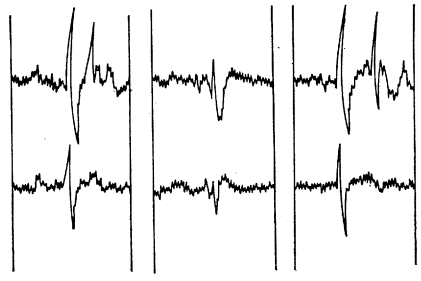

Fig. 1. Cortical potentials evoked by a flash of light (left) before irradiation, (middle) at the termination of irradiation, (right) 30 minutes after irradiation.

Bipolar recording electrodes are placed in the appropriate cortical areas on both hemispheres to detect the evoked potentials. The focused ultrasonic beam source is used to irradiate the region of one of the lateral geniculate nuclei of the animal (cat) since these nuclei are sites of synaptic stations along the visual pathway. The ultrasonic energy must be transmitted from the irradiator to the brain through degassed Ringer's solution, and the intervening skull bone must be removed.

Stimulation of the eye by light is repeated at fixed time intervals before, during, and after ultrasonic irradiation, and continuous electrical recording is in progress during the course of the experiment. A series of three light flashes, with approximately 3 seconds between flashes, is used to stimulate the eye of the animal. This series of flashes is repeated at variable intervals of time before, during, and after exposure to the ultrasonic radiation. The focus of the sound beam is placed successively in and around the region of the lateral geniculate nucleus. With a suitably chosen sound level and with an exposure time in the range from 20 to 120 seconds, it has been possible to produce reversible suppressions of various components of the elicited electrical response in the visual cortex. The type of result illustrated in Fig. 1 has been ob-