ROYAL SOCIETY RESEARCH APPOINTMENTS

CURRENT HOLDERS

	Commencement of tenure
Foulerton Research Professorship	
(Vacant)	
Henry Dale Research Professorship	
PROFESSOR J. L. GOWANS, F.R.S.	1 Oct. 1962
Royal Society Research Professorships	
PROFESSOR M. F. ATIYAH, F.R.S.	1 Jan. 1973
PROFESSOR G. H. BEALE, F.R.S.	1 Apr. 1963
PROFESSOR R. H. DALITZ, F.R.S.	16 Sept. 1963
PROFESSOR E. J. DENTON, F.R.S.	1 Oct. 1964
PROFESSOR P. H. FOWLER, F.R.S.	1 Oct. 1964
PROFESSOR R. A. HINDE	1 Oct. 1963
PROFESSOR A. F. HUXLEY, F.R.S.	1 Oct. 1969
PROFESSOR H. C. LONGUET-HIGGINS, F.R.S.	1 Apr. 1968
PROFESSOR M. S. LONGUET-HIGGINS, F.R.S.	1 July 1969
PROFESSOR F. SONDHEIMER, F.R.S.	15 Aug. 1964
Wolfson Research Professorship	
PROFESSOR DOROTHY M. C. HODGKIN, O.M., F.R.S.	1 Oct. 1960
Henry Head Research Fellowship	
DR A. COWEY	1 Oct. 1968
Mr and Mrs John Jaffé Donation Research Fellowships	
DR E. A. DAVIS	1 Oct. 1968
DR A. E. HILL	1 Oct. 1970
Beringer Research Fellowship	
(Vacant)	
Johnston, Lawrence and Moseley Research Fellowship	
(Vacant)	
Locke Research Fellowship	
DR T. B. BOLTON	1 Oct. 1972
Tropical Research Fellowship (Medical Sciences)	
DR D. J. BRADLEY	14 Mar. 1969
Foulerton Gift Research Fellowship	
DR J. W. FABRE	1 Apr. 1973

	Commencement of tenure
Horace Le Marquand and Dudley Bigg Research Fellowship	
DR G. R. SHELLAM	17 July 1972
Mackinnon Research Studentship	
(Vacant)	
Pickering Research Fellowships	
DR M. R. DAVEY	1 Oct. 1972
DR B. J. HOWARD	1 Oct. 1972
DR P. J. LEA	1 Oct. 1972
DR A. J. REST	1 Oct. 1969
DR R. K. THOMAS	1 Oct. 1970
Rosenheim Research Fellowship	
DR A. R. SHELDRAKE	1 Oct. 1969
Rutherford Scholarships	
MR P. D. N. HEBERT	1 Oct. 1972
MR J. M. LUMLEY	1 Oct. 1970
Scientific Information Research Fellowships	
DR N. JARDINE	1 Oct. 1968
DR KAREN NEEDHAM	1 Oct. 1968
Stothert Research Fellowship	
DR D. G. LINDSAY	1 Oct. 1970
Weir Resedrch Fellowship	
MR A. C. S. READHEAD	1 Oct. 1972
Florey Fellowships	
From Australia:	
DR J. H. PEARN	21 May 1971
From United Kingdom:	
DR G. G. MACPHERSON	1 Oct. 1971
Bruno Mendel Travelling Fellowship	
PROFESSOR AVIVAH ZUCKERMAN	1 Sept. 1972

The following research appointments are made by, or on the recommendation of, Joint Committees:

Armourers and Brasiers' Research Fellowship (see p. 292)	
DR A. M. CAMPBELL	1 Oct. 1972
DR D. A. SMITH	1 Oct. 1972
Smithson Research Fellowship (see p. 236)	
(Vacant)	

Infrared spectra of complexes of hydrogen fluoride with hydrogen cyanide and methyl cyanide. *Proc. R. Soc. Lond.* A **325,** 133 (1971).

Place of Research: Physical Chemistry Laboratory, University of Oxford.

A. R. SHELDRAKE, Rosenheim Research Fellow

(1) I have re-examined the classical evidence for the production of auxin in coleoptile tips and have found much of it to be unreliable. Further experiments have shown that auxin, mostly in the form of indole-3-acetic acid, is carried upwards from the seed in the xylem sap and accumulates at the coleoptile tip. This accumulation at the tip is a general phenomenon and can be demonstrated by introducing dyes into the transpiration stream. To a small extent in *Avena* and to a larger extent in *Zea* certain bound forms of auxin also accumulate at the tip. The results suggest that it is unlikely that auxin is synthesized in coleoptile tips *de novo*, but that it accumulates there in both free and bound forms. It can then be transported downwards in the living tissues.

(2) Auxin is actively transported in many tissues of higher plants in a basipetal direction. This polar transport system plays an important part in the control of growth and differentiation. I am attempting to shed light on several aspects of this process.

The way in which the polarity of the cells becomes established is not known. It is apparently not related to the origin of cells from a polar meristem since tissues derived both from apical meristems and from basal meristems (for example the leaves of grasses) have the same polarity. Furthermore, I have shown that secondary tissues of stems and branches, which are derived from longitudinal cambial divisions, also transport auxin basipetally. Nor is the establishment of polarity brought about by gravitational forces, since branches which have developed for several years in an inverted position exhibit normal polar auxin transport. I have also found that the polarity of seedlings germinated and grown on a klinostat is unaffected.

The cellular basis of polarity, once it is established, is also unknown. Cells show no apparent structural differences at either end, even at the ultrastructural level. I have found that polar auxin transport is not affected in stems which have been exposed to forces of 100000*g* for one hour. This indicates that the structures responsible for polarity are in the cell membrane or closely associated cytoplasm, or else in the plasmodesmata.

I have studied the transport of auxin through sections of *Avena* mesocotyls both during and after plasmolysis with solutions of sorbitol. The results suggest that auxin moves from cell to cell through the plasmodesmata, rather than by secretion across the plasmalemma.

Publications

The occurrence and significance of auxin in the substrata of bryophytes. *New Phytol.* **70,** 519–526 (1971).

Auxin in the cambium and its differentiating derivatives. *J. exp. Bot.* **22,** 735–740 (1971).

Place of Research: Department of Biochemistry, University of Cambridge.

A. R. SHELDRAKE, Rosenheim Research Fellow

(1) The enzyme cellulase is widely distributed in higher plants. Its substrate, cellulose, is a major component of plant cell walls. Last year I showed that cellulase is involved in the differentiation of articulated laticifers, xylem and phloem cells, all of which processes involve the removal of wall material. More detailed investigations of differentiating xylem and phloem tissue of *Acer pseudoplatanus* have led to the conclusion that several different cellulases are probably involved, two of which are common to both tissues and also to the abscission zone of leaves. These two enzymes are bound in small vesicles and are perhaps exported across the cell membrane to attack their substrate in the cell wall. Phloem and xylem tissue also contain a cytoplasmic cellulase each; the phloem enzyme has a higher pH optimum than that of the xylem. It therefore seems that higher plant cellulase is not a single enzyme but a variable complex of enzymes, analogous to the cellulase complexes found in fungi.

(2) I believe that the hormone auxin is normally formed in higher plants as a consequence of cell death. Differentiating xylem tissue is an important site of cell death, since xylem cells die as they differentiate. Differentiating xylem, differentiating phloem and cambial tissue can conveniently be separated from each other by stripping the bark from trees in the summer. I have analysed tissues prepared in this way for auxin, and in all samples tested so far I have found the highest amounts in the differentiating xylem tissue, less in the cambium and least in the phloem. These results bear out the predictions of the dying cell hypothesis of auxin production, and would not be expected from rival hypotheses. The great majority of the auxin present has been identified chromatographically as indole acetic acid.

(3) If auxin is made by dying cells in higher plants, in which vascular differentiation involves cell death, in non-vascular plants where cells do not usually die in the course of growth and differentiation, auxin must either be made by a different method or not at all. There is in fact very little evidence to suggest that auxin is an important hormone for lower plants. One of the few well-documented responses is the induction of rhizoids in bryophytes by auxin at low concentrations. This could be explained without supposing that the plants themselves make auxin if auxin is frequently present in their environment. The immediate substrata on which various samples of bryophytes were growing in a number of different environments in Britain have been analysed, and in all cases indole acetic acid is present in concentrations sufficient to evoke the formation of rhizoids. The auxin is presumably liberated by microbial decay of organic matter, and is also present in soil and leaf litter. Environmental auxin may therefore be an important factor not only for bryophytes but also for the roots of higher plants, which are affected by very low concentrations of the hormone.

Publications

Cellulase in latex and its possible significance in cell differentiation. *Planta (Berl.)* **89**, 82–84 (1969).

A cellulase in *Hevea* latex. *Physiol. Plant.* **23**, 267–277 (1970). (With G. F. J. Moir.)

Cellulase and cell differentiation in *Acer pseudoplatanus*. *Planta (Berl.)* (in the press).

Place of Research: Department of Biochemistry, University of Cambridge.

A. R. SHELDRAKE, Rosenheim Research Fellow

(1) With Dr P. H. Rubery I have been studying the uptake and efflux of the auxin indol-3-yl acetic acid (IAA) in a variety of plant tissues. We have found that the uptake of IAA into resting yeast cells, whose cell walls are uncharged, follows the dissociation curve of IAA very closely; the undissociated form of the molecule is lipid soluble and penetrates the membrane rapidly. Accumulations of IAA against a concentration gradient can occur at low pHs as a result of the pH gradient across the membrane. It is well known that a similar pH dependence is found in the tissues of higher plants; but although the uptake parallels the dissociation curve of IAA we have found that it is displaced by about 0.7pH units towards higher pHs. The explanation of this phenomenon could lie in the effect of the ζ potential of the negatively charged cell walls on the effective pK of IAA. The uptake of IAA into callus cells grown in suspension culture shows deviations from the pattern of uptake that would be expected if diffusion across the membrane were the only means of entry. We have obtained evidence which suggests that a carrier is present in the membrane and also that an active export of IAA from the cells takes place. This can be inhibited by 2,3,5 tri-iodo benzoic acid, which is a specific inhibitor of polar auxin transport. We are continuing these investigations in the hope that they may shed some light on the mechanism of auxin transport in higher plants.

(2) Different clones of *Hevea brasiliensis* exhibit different patterns of latex flow when the trees are tapped. In some, the initial flow rates are high and decline rapidly as the coagulation of latex plugs up the ends of the latex vessels; in others, initial flow rates are low, plugging is less rapid and the flow of latex continues for a relatively long time. The coagulation of latex is known to be brought about by the rupture of small vesicular organelles within the latex, known as lutoids. Two important factors which can cause their rupture are shearing forces and osmotic shock.

Working in the laboratory of Mr G. F. J. Moir at the Rubber Research Institute of Malaya and in conjunction with Mr S. Pakianathan, I attempted to find an explanation for these clonal differences in latex flow. It seemed likely that the initial flow rates would depend on the turgor pressure within the latex vessels, which would in turn depend on the osmotic pressure of the latex. Measurements of the osmotic pressure of the latex in trees of different clones strongly suggested that such a relationship does exist. The osmotic pressure of latex decreases when flow occurs, probably as a result of the osmotic entry of water into the latex vessels. Our observations indicate that the higher the initial osmotic pressure and flow rate, the greater is the dilution of latex that takes place during flow. Thus both the osmotic shock and shearing forces are greater in clones with high initial flow rates and coagulation of the latex due to the rupture of lutoids is more pronounced. These factors are of less importance in clones with lower latex osmotic pressures and lower initial flow rates, and the flow of latex is more prolonged.

For many years it has been known that latex of *Hevea brasiliensis* contains large quantities (*ca.* 2% w/v) of quebrachitol (methyl-L-inositol), but its role has never been explained satisfactorily. I found that the great majority of the quebrachitol was confined to the latex serum; relatively little was detected in the lutoids. Quebrachitol can account for over 30% of the total osmotic pressure of the serum. I found considerable differences in the quebrachitol content of latex from different clones. These were correlated with the clonal differences in latex

osmotic pressure, suggesting that quebrachitol is the major factor responsible for these differences.

Publications

Auxin transport in secondary tissues. *J. exp. Bot.* (in the press).
Polar auxin transport in leaves of monocotyledons. *Nature, Lond.* **238**, 352–353 (1972).

Place of Research: Department of Biochemistry, University of Cambridge.

J. M. LUMLEY, Rutherford Scholar

This year I have concentrated almost exclusively on the problem of the current-phase relation in superconducting weak links. Hence work on the following subjects has been because of their relevance to the current-phase problem and not so much for their intrinsic interest; small SNS junctions (superconductor, normal metal, superconductor), Dayem bridges (short narrow 'bridge' of superconductor connecting two bulk superconductors), and the displaced linear slope region observed in the characteristics of large Josephson junctions (SIS, where 'I' symbolizes an insulating layer).

The work on the current-phase problem has been complicated by numerous problems, mainly those of a technical nature associated with both the production and testing of the various sorts of weak links. On the testing side I have developed and improved a set of electronics, while on the production side I have been perfecting an extremely complicated evaporation procedure.

The samples are prepared by thin film techniques in a standard evaporation system. Evaporated thin films are used because the extreme sensitivity to magnetic flux of the junctions to be tested necessitates a layout where stray flux is minimal but that present is calculable. Since gauge invariance requires there to be a linear relation between the phase change around a superconducting loop and the magnetic flux enclosed thereby, a system has been devised (with J. R. Waldram) which allows the simultaneous evaporation on to the same glass slide of a junction to be tested and a null detector. The test junction and null detector, which is in fact a double SNS junction being used as an interferometer, are evaporated almost in parallel. Hence when there is no current across the double SNS junction it must all be going through the test junction. Thus from a knowledge of the magnetic flux produced by the various currents associated with the circuits the current-phase relation is determined. For the foregoing to be true the junction must contribute zero flux in the interferometer loop. Similarly the interferometer must neither by its operation affect the test junction nor introduce appreciable flux into the circuit of concern. The evaporation system achieving the above is now just about operational.

The current-phase relation is of interest because, although the simple Josephson relation ($J = J_0 \sin \phi$) is believed to be a good approximation for very weak links, what happens as the link is made progressively stronger is not known. Hence I am interested particularly in Dayem bridges and systems of the form SS'S (S', lower transition temperature superconductor). Most theoretical treatments assume that, at least to a first approximation, the Josephson relation holds good. Thus the investigation should prove generally enlightening and stimulating.

Place of Research: Cavendish Laboratory, Cambridge.