

biochemical society
TRANSACTIONS

649th Meeting Imperial College, London

Keilin Memorial Lecture

The Merger of Bioenergetics and Molecular Biology

Jubilee Lecture

Pathway and Stability of Protein Folding

colloquia

Host/Pathogen Interactions

Photosynthetic Oxygen Evolution

Advances in Structural Glycobiology

Elicitors in Plant and Microbial Metabolism

Regulation of Fatty Acid Oxidation

G-Proteins and Secretion

Structure and Regulation of Cation Channels

The Role of Cell Volume Changes in Metabolic Regulation

Recent Biochemical Applications of Mass Spectrometry

communications

■ *Biochemical Society Transactions* (ISSN 0300-5127) is published by Portland Press Ltd on behalf of the Biochemical Society. Each issue contains the lectures, colloquia and communications presented at a meeting of the Biochemical Society or one of its constituent interest groups and, occasionally, the colloquia of other scientific meetings of biochemical interest held in the U.K. or elsewhere. Submitted primary research papers are not published and authors are reminded that detailed presentation of new experimental data may prejudice its subsequent publication in precisely that same form elsewhere. Lectures and colloquium contributions are published subject to editorial acceptance and authors will be issued with instructions on the format of their article before the meeting. Authors intending to present communications at Society meetings should consult the instructions for authors which appear in the Society's membership journal, *The Biochemist*, and occasionally in this journal. Although the publication of colloquia is by invitation, organizers of scientific meetings who would be interested in publishing their colloquia presentations in the journal are invited to discuss this possibility with the Executive Editor in the first instance.

■ For information about the advantages of membership of the Biochemical Society, contact the Executive Secretary, The Biochemical Society, 59 Portland Place, London W1N 3AJ, U.K. (telephone 071-580 5530).

■ Editorial and publishing office: *Biochemical Society Transactions*, 59 Portland Place, London W1N 3AJ, U.K. (telephone 071-637 5873; facsimile 071-323 1136).

Subscription rates

■ Subscriptions department: Portland Press, P.O. Box 32, Commerce Way, Colchester CO2 8HP, U.K. (telephone 0206-796351; facsimile 0206-799331). *Biochemical Society Transactions* is published in February, May, August and November of each year. Subscription rates for volume 22, parts 1-4 (1994):

	North America	Rest of world
Volume 22	\$225.00	£130.00
Single issues	\$58.00	£35.00

Subscribers to the *Biochemical Journal* may take a joint subscription to that journal and to *Biochemical Society Transactions*, saving \$25 (North America) or £15 (rest of world). North American subscription rates include airfreight delivery, and those for Japan include Accelerated Surface Post; other overseas locations are serviced by surface mail. Airmail delivery is available at extra cost. Back issues are available. Subscribers in Japan should send orders to Kinokuniya Company Ltd, Journal Department, P.O. Box 55, Chitose, Tokyo 156.

■ All rights reserved. Apart from any fair dealing for the purposes of research or private study, or criticism or review, as permitted under the Copyright, Designs and Patents Act, 1988, this publication may be reproduced, stored or transmitted, in any form or by any means, only with the prior permission in writing of the publishers, or in the case of reprographic reproduction in accordance with the terms of permissions granted by the copyright clearing houses such as the Copyright Licensing Agency (U.K.) or the Copyright Clearance Center (U.S.A.). The CCC item-fee code for this publication is 0300-5127/94/\$5.00 + 0.00. Inquiries concerning reproduction outside those terms should be sent to the publishers at the London address.

■ Although, at the time of going to press, the information contained in this publication is believed to be correct, neither the authors nor the publisher nor the editor assume any responsibility for any errors or omissions herein contained.

■ Display advertising is accepted; information is available on request from the London office of Portland Press.

■ Second-class postage paid at Rahway, NJ, U.S.A.

■ U.S. Postmaster: send address changes to *Biochemical Society Transactions*, c/o Mercury Airfreight International Ltd, 2323 Randolph Avenue, Avenel, NJ 07001, U.S.A.

■ Typeset by Unicus Graphics Ltd, Horsham, and printed in Great Britain by Whitstable Litho Printers Ltd, Kent.

- Abdel-Wahab, Y. H. A.** 237S, 238S, 239S
Adams, J. 150S
Adcock, I. M. 186S, 187S, 188S
Addey, C. V. P. 178S
Ädelroth, P. 347
Agius, L. 118S, 516
Ah-Sing, E. 237S
Aidoo, M. 282
Akpoguma, C. I. O. 195S
Akrawi, M. 124S
Al-Habori, M. 516
Alba, R. 408
Albersheim, P. 374
Allen, A. 229S
Allsopp, C. E. M. 282
An, J. 374
Anderson, M. M. 217S, 224S
Andreasson, L.-E. 347
Archard, L. 176S
Armstrong, J. 460
Ashley, R. 221S
Ast, T. 217S, 224S
Avery, S. A. 200S
Azevedo, M. S. 222S
- Badakhchani, P.** 179S, 181S
Bailey, J. M. 168S
Baines, A. J. 177S
Banerjee, D. K. 89S
Barber, J. 313
Barlow, P. 85S
Barnes, J. M. 155S
Barnes, P. J. 186S, 187S, 188S
Barnett, C. R. 237S, 238S, 239S
Barrett-Jolley, R. 488
Bartlett, K. M. 119S, 432, 436
Beeson, D. 488
Bellincampi, D. 394
Bennett, A. J. 112S
Beresford, G. 516
Berry, M. 228S
Best, J. M. 197S
Billett, M. A. 112S
Billington, D. 230S
Bittner, T. 318
Blackman, M. J. 291
Blain, P. G. 130S
- Blommaert, E. F. C.** 509
Bomssel, M. 463
Bonaventura, C. 543
Bonaventura, J. 543
Bone, N. 460
Boobis, A. R. 128S
Boon, L. 508
Borre, M. 291
Botham, K. M. 108S
Bourgeois, C. S. 100S
Boussac, A. 352
Bowden, S. 460
Bowler, K. 207S
Bowman, A. S. 92S
Boyd, A. C. 239S
Bratt, P. J. 327, 335
Breed, J. 157S
Bright, J. R. 85S
Britt, R. D. 343
Brocklehurst, K. 212S, 213S, 214S, 215S
Brookes, S. T. 164S
Brooks, S. A. 95S
Brosnan, J. T. 529
Brown, C. R. 186S, 187S, 188S
Brown, G. R. 159S
Browne, M. J. 234S
Bruce, J. S. 104S
Buluwela, L. 183S
Bumrah, R. 86S
Burghaus, P. A. 291
Burgoyne, R. D. 468
Busch, G. 502
Butcher, P. D. 89S
- Calder, P. C.** 116S
Caldwell, J. 132S
Campbell, F. M. 117S
Campbell, I. C. 179S, 181S
Caprari, C. 394
Carden, M. J. 177S
Carlucci, F. 240S, 241S, 242S, 243S
Carr, R. E. 100S
Carrier, M. J. 136S
Carrington, S. 228S
Cartwright, I. J. 205S
Casado, J. 163S
Cason, J. 197S
Cassell, T. B. 115S
Castell, F. 150S
Castellano, A. 483
- Cervone, F.** 394
Chambat, G. 403
Changani, K. K. 126S
Chapman, C. G. 234S
Chappel, J. A. 291
Chazot, P. L. 153S
Chenery, R. J. 131S
Cheong, J.-J. 408
Chidwick, K. 204S
Cho, M. J. 378
Chong, N. W. S. 179S, 181S
Chowrimootoo, G. F. E. 190S, 191S
Ciaramella, G. 120S
Cik, M. 153S
Clair, P. 122S
Clapham, J. C. 216S
Clark, A. J. 394
Clark, M. A. 91S
Clegg, R. A. 211S
Clinkenbeard, H. E. 234S
Clunn, G. F. 145S
Coen, C. W. 179S, 181S
Collaço-Moraes, Y. 151S
Collingridge, G. L. 137S
Consolmagno, E. 240S, 241S, 243S
Cook, E. B. 172S
Cook, G. A. 113S
Corfield, A. 97, 228S
Cornish, T. J. 539
Cornish-Bowden, A. 451
Cortelazzo, A. 403
Cotter, R. J. 539
Côté, F. 408
Craig, K. S. 164S
Craighead, M. 460
Crosbie, S. J. 130S
Cummings, R. D. 378
Cunnane, S. C. 164S
- Daisley, J. N.** 160S
Dance, D. A. B. 88S
Dancer, J. E. 202S
Daniell, S. J. 144S
Daniels, R. H. 136S
Darvill, A. 374
Das, I. 185S
Davenport, M. 282
Davies, D. S. 128S, 199S
Davis, J. A. 142S
Davis, T. 134S
- de Bellerocche, J. S.** 147S, 148S, 149S, 150S, 151S
De Lorenzo, G. 394
Desborough, J. P. 133S
Desiderio, A. 394
Devoto, A. 394
Dillwith, J. W. 92S
Diner, B. A. 338, 343
Dismukes, G. C. 323
Dobbelaere, D. A. E. 234S
Dolly, J. O. 473
Drasar, B. S. 88S, 189S
Duncan, J. S. 161S
Durdey, P. 97S
Dutta-Roy, A. K. 117S
Dwek, M. V. 95S
- Eaglestone, S.** 306
Easty, D. L. 228S
Eaton, S. 119S, 432
Edwards, M. 120S
Edwards, P. 194S
Edwards, R. J. 199S
Egidio, D. 241S
Elia, A. P. 123S
Ellul, J. P. M. 114S
Elmore, M. A. 136S
Ernster, L. 253
Evans, E. H. 94S
Evans, M. C. W. 327, 335
Evans, M. 139S, 140S
Evans, T. W. 188S
- Faik, A.** 403
Fearnley, I. M. 551
Felipe, A. 163S
Fennel, T. R. 543
Fenselau, C. 547
Fersht, A. R. 267
Finnen, M. J. 136S
Fita-Robinson, E. 196S
Flatt, P. R. 237S, 238S, 239S
Fogg, F. J. J. 229S
Forrest, L. A. 125S
Forrest, R. 394
Foxall, P. A. 189S
Frayn, K. N. 100S
Frescura, M. 228S
Freshour, G. 376
Friedland, J. S. 310
Fuller, M. S. 374

- Galán, J. E. 301
 Galieni, P. 241S
 Gallagher, J. T. 36S
 Gardiner, I. M. 150S
 Gardner, M. J. 99S
 Gardner, R. A. 211S
 Garrett, J. R. 96S
 Gibb, A. L. 85S
 Gibbons, G. F. 100S
 Gibbons, W. A. 217S, 224S
 Gilchrist, M. L. 343
 Ginocchio, C. 301
 Gokool, S. 286
 Gomez-Angelats, M. 163S
 Goodarzi, M. T. G. 98S
 Gooderham, N. J. 128S, 199S
 Goodfellow, J. M. 146S
 Gordon, M. J. 117S
 Goss, G. G. 512
 Gough, M. 97S
 Gould, B. J. 103S
 Gregson, N. 87S
 Griffin, G. E. 172S
 Griffith, G. S. 389
 Griffiths, D. E. 225S
 Grimshaw, R. M. 106S
 Grinstein, S. 512
 Gross, K. C. 398
 Grudzinkas, J. G. 218S
 Guillen, R. 374
 Gul, S. 213S, 214S
 Gunaratne, R. S. 231S
- Hahn, M. G. 374, 408
 Halestrap, A. P. 522
 Halliday, D. 101S, 102S
 Ham, K.-S. 374
 Hampton, S. M. 139S, 140S, 141S, 142S
 Handel, S. E. 468
 Harding, S. E. 229S
 Hare, K. 140S
 Harley, V. S. 88S
 Harper, K. 184S
 Hart, I. 488
 Harwood, J. L. 200S, 201S, 202S, 203S
 Hawksworth, G. M. 131S
 Hay, C. 148S
 Hayes, N. V. L. 177S
- Häussinger, D. 497, 502
 Hebbachi, A.-M. 205S
 Hemingway, J. 127S
 Henley, J. M. 138S, 154S, 155S, 227S
 Hickey, R. D. 92S
 Higgins, J. A. 205S, 206S
 Hill, A. V. S. 282
 Hill, M. E. 136S
 Hirst, B. H. 91S
 Hirst, T. R. 306
 Holder, A. A. 291
 Holmes, F. E. 177S
 Holness, M. J. 105S
 Hope, D. B. 220S
 Hovik, R. 436
 Howell, S. L. 133S
 Huang, J. 374
 Hue, L. 505
 Hughes, A. D. 145S
 Hughes, R. C. 359
 Humphries, M. J. 275
 Hutchins, R. 323
- Iles, R. A. 126S
 Imrie, H. 101S, 102S
 Inoue, Y. 331
 Irving, A. J. 138S
 Isherwood, TG. 103S
- James, C. 217S
 Jayawardena, K. G. I. 127S
 Jepson, M. A. 91S
 Jewers, R. J. 197S
 Jones, A. L. 202S
 Jones, J. 142S, 193S
 Jones, L. M. H. 99S
 Jones, P. M. 133S, 208S, 209S
 Joseleau, J. P. 403
- Kamalati, T. 183S
 Kapus, A. 512
 Karunaratne, S. H. P. P. 127S
 Keen, J. K. 286, 291
 Kell, B. 197S
 Kelly, J. M. 90S
 Kerr, I. D. 158S
 Ketterman, A. J. 127S
 Khalili-Shirazi, A. 87S
 Khan, A. H. 235S
 Khan, I. M. 183S
- Khan, M. 176S
 King, A. W. 149S
 Kirkham, D. M. 227S
 Kobata, A. 360
 Kusunoki, M. 331
 Kwon, O. 186S
 Kwong, L. 207S
- Lamb, J. H. 165S
 Lambert, M. S. 108S
 Lane, R. 149S
 Lang, B. 497
 Lang, F. 488, 502
 Larsen, B. S. 343
 Leach, R. N. 492
 Leathem, A. J. C. 95S
 Leckie, F. 394
 Lencer, W. I. 306
 Lenton, J. R. 383
 Leoncini, R. 240S, 241S, 242S, 243S
 Lewin, S. 189S
 Lim, C. K. 165S
 Lindberg, K. 347
 Linderuth, K. 134S
 Ling, I. T. 291
 Liu, J. J. 219S
 Liu, S. 188S
 Lloyd, D. 200S
 Lorigan, G. A. 343
 Lovegrove, J. A. 142S
 Luckhaus, C. 171S
 Luiken, J. J. F. P. 508
 Lyke, S. 161S
 Lyon, M. 365
- MacAllan, C. D. 172S
 MacKinnon, K. L. 230S
 MacLachlan, D. J. 327, 335
 MacLennan, C. 488
 Mahmood, K. 235S
 Mahmood, Z. 235S
 Makheja, A. N. 168S
 Makins, R. A. 443
 Mangiapane, E. H. 104S
 Mann, A. J. 180S
 Manning, R. 207S
 Manso, C. F. 222S
 Marenah, C. 104S
 Marinello, E. 240S, 242S, 243S
 Marway, J. S. 166S, 167S, 169S, 193S, 194S, 232S
- Mason, R. 184S
 Mayers, E. 231S
 Mayes, P. A. 107S, 108S
 McClenaghan, N. H. 237S
 McColl, S. M. 94S
 McGivan, J. G. 163S
 McKean, P. G. 286
 McLennan, A. G. 219S, 231S
 Meijer, A. J. 508
 Mellor, G. W. 213S
 Messinger, J. 318
 Michelangeli, F. 152S, 159S
 Middleton, B. 210S, 427
 Miell, J. P. 174S, 193S
 Millington, D. S. 543
 Mindham, M. A. 107S
 Minson, A. C. 298
 Mitchell, C. G. 223S
 Monahan, I. M. 89S
 Morgan, A. 468
 Morgan, D. M. L. 236S
 Morgan, J. B. 139S, 140S
 Morgan, R. 159S
 Morris, B. A. 141S
 Morvan, H. 398
 Mostov, K. E. 463
 Mueller, S. 93S
 Muir, J. D. 183S
 Munro, L. H. 206S
 Murphy, G. M. 114S, 115S
 Myerscough, N. 97S
 Mynatt, R. L. 113S
- Nanji, M. 122S
 Nashar, T. O. 306
 Nasim, S. 135S
 Naylor, L. H. 143S, 144S, 180S
 Neese, P. A. 92S
 Neill, S. J. 383
 Newsholme, E. A. 116S
 Newsom-Davis, J. 488
 Newsome, W. 497
 Nicholson, R. A. 226S
 Nicolaou, A. 217S, 224S
 Nicolle, M. 488
 Nield, H. 210S
 Nixon, P. J. 338
 Noble, M. A. 213S, 214S
 Noe, B. 497

Noguchi, T. 331
 Norman, D. A. 143S
 Norman, R. I. 492
 Nugent, J. H. A. 327, 335
 Nuss, L. 394

O'Harte, F. P. M. 238S,
 239S
 O'Neill, M. 374
 Ogun, S. A. 291
 Ono, T.-A. 331
 Orfali, K. A. 106S, 162S
 Orrell, R. W. 149S
 Osmundsen, H. 436
 Owen, C. A. 291
 Oyanag, H. 331

Pagani, R. 240S, 241S,
 242S, 243S
 Paice, A. G. 169S, 174S,
 232S
 Palmer, N. T. 172S
 Paraskeva, C. 97S
 Parcej, D. N. 475
 Parker, K. E. 234S
 Parkes, H. G. 114S
 Parmelee, D. C. 199S
 Pastor-Anglada, M. 163S
 Patel, H. M. 86S
 Patel, M. 214S, 215S
 Patel, V. B. 169S, 173S,
 174S, 232S
 Pawson, T. 45S
 Peak, M. 516
 Pearson, J. D. 236S
 Pearson, J. P. 229S
 Pereira, S. P. 115S
 Perez-Reyes, E. 483
 Perry, H. J. 203S
 Persaud, S. J. 133S, 208S,
 209S
 Peters, T. J. 172S
 Phillips, I. R. 120S, 121S,
 122S, 123S, 124S, 125S
 Philo, J. S. 323
 Pidoux, A. 460
 Pinder, C. J. 142S
 Pinitglang, S. 215S
 Pizzichini, M. 240S, 241S,
 242S, 243S
 Pogson, C. I. 118S
 Pongs, O. 473
 Pouilly, N. 223S
 Pourfazam, M. 436

Powell, J. F. 179S, 181S
 Pows, R. 231S
 Prashad, D. N. 115S
 Preece, M. A. 193S
 Preedy, V. R. 166S,
 167S, 169S, 170S, 171S,
 172S, 173S, 174S, 175S,
 182S, 193S, 194S, 232S
 Prescott, M. 231S
 Price, K. M. 218S
 Priem, B. 398
 Proctor, G. B. 96, 171S,
 182S
 Pufal, D. A. 109S
 Pugh, C. E. 201S
 Punchard, N. A. 196S,
 197S, 198S

Qian, D. 529
 Quant, P. A. 441
 Quarrie, L. H. 178S
 Quinlan, P. 109S

Rahmani, F. S. 235S
 Rangarajan, D. 286
 Ray, K. P. 195S
 Rayner, A. D. M. 389
 Read, S. 102S
 Renger, G. 318
 Rettig, J. 473
 Rezaie, P. 236S
 Richardson, P. J. 169S,
 170S, 171S, 173S, 174S,
 175S, 176S, 232S
 Rigby, S. E. J. 327
 Roberts, M. 488
 Robinson, E. 460
 Robinson, J. H. 234S
 Roepstorff, P. 533
 Rogiers, V. 124S
 Rollins, P. J. 195S
 Roobol, A. 177S
 Rose, S. P. R. 160S
 Ruel, K. 403
 Ruffle, S. V. 327
 Ruiz-Montasell, B. 163S
 Rutherford, A. W. 353

Saddiq, T. 171S, 174S
 Salata, K. 168S
 Salter, A. M. 104S, 109S,
 112S
 Salvi, G. 394
 Sandkaramakrishnan,
 R. 156S, 158S

Sansom, M. S. P. 156S,
 157S, 158S
 Sansonetti, P. J. 295
 Sauer, J. R. 92S
 Sayers, L. G. 152S
 Schachter, M. 145S
 Scheuer, T. 479
 Schiffmann, Y. 192S
 Schmidt, W. 224S
 Schofield, J. G. 137S
 Schreiber, R. 497
 Scott, V. E. S. 473
 Seal, A. J. 138S
 Sequeira, S. S. 114S
 Sethi, S. 103S
 Sewing, S. 473
 Seymour, C. A. 190S,
 191S
 Shah, H. N. 212S
 Shand, J. H. 110S, 111S
 Shaunak, S. 199S
 Shephard, E. A. 120S,
 121S, 122S, 123S, 124S,
 125S
 Sherratt, A. 118S
 Sherratt, H. S. A. 421,
 423
 Shervington, A. 121S,
 125S
 Shillito, P. 488
 Shipley, M. M. 92S
 Shori, D. K. 96, 171S,
 182S
 Siddiq, T. 167S, 169S,
 170S, 171S, 173S, 174S,
 175S, 194S, 232S
 Silman, R. 218S
 Silva, I. J. 222S
 Silvestro, A. M. 221S
 Sim, E. 85S
 Simmons, N. L. 91S
 Simpson, R. J. 93S
 Sinha, K. A. 291
 Skehel, J. M. 551
 Smart, O. S. 146S
 Smethurst, P. 101S
 Smith, C. J. 414
 Smith, D. F. 286
 Smith, L. L. 165S
 Snakey, M. D. 197S
 Spackman, V. M. 234S
 Spurway, T. D. 118S, 423
 Sreedharan, S. K. 212S
 Srere, P. A. 447

Stafford, S. J. V. 137S
 Stanley, H. 118S, 421,
 423
 Stephenson, F. A. 153S
 Stevens, R. D. 543
 Stoll, B. 497
 Strachan, G. 129S
 Strange, P. G. 144S
 Sugden, M. C. 106S, 162S
 Sumegi, B. 447
 Swanston-Flatt, S. 237S

Tabucchi, A. 240S, 241S,
 242S, 243S
 Tang, X.-S. 343
 Teale, D. 141S
 Teare, J. 182S, 196S
 Thatcher, N. J. 132S
 Thomas, E. W. 213S,
 214S, 215S
 Thomas, M. P. 213S,
 214S
 Thomas, T. H. 516
 Thompson, R. P. H.
 196S, 197S, 198S
 Thomson, J. 139S
 Tomas, A. M. 90S
 Tovey, G. 88S
 Trayhurn, P. 161S
 Trotter, S. E. 175S
 Turconi, S. 327
 Turnbull, D. M. 119S
 Turner, G. A. 98, 99S
 Turner, S. J. 195S

Ud Din, F. 235S
 Ud Din, N. 235S

Vale, V. L. 220S
 van Heyningen, S. 135S
 van Woerkom, G. M.
 508
 Venkatesan, S. 101S,
 102S
 Vercruysse, A. 124S
 Vertessy, G. G. 233S
 Vestling, M. M. 547
 Vincent, A. 488
 Virgo, L. 147S
 Vliegthart, J. F. G. 370
 Völkl, H. 502
 von Dahl, S. 497

Walker, J. E. 551
 Walker-Nasir, E. 235S

contents — index of authors

Wallace, B. A. 146S
Wallace, H. M. 129S
Watson, D. J. 196S, 197S,
198S
Watson, K. 199S
Webb, H. E. 87S
Webb, H. M. 306
West, D. W. 110S, 111S,
112S
Wettstein, M. 497
Whitcombe, A. 374
White, D. 104S

White, K. N. 220S
Whiting, P. H. 129S
Why, H. 176S, 232S
Wibberley, M. S. 383
Wilde, C. J. 178S
Wilderspin, A. F. 216S
Wildman, H. G. 389
Wilkinson, J. 206S
Williams, C. M. 103S
Williams, F. M. 130S
Williams, J. A. 131S
Williams, M. V. 374

Williams, S. C. R. 126S
Willis, A. C. 85S
Willison, H. 488
Wilson, A. M. 237S
Withey, L. M. 141S
Wittkat, R. 73
Woods, A. S. 539
Woodside, M. 512
Wright, J. 103S

Yamaguchi, H. 331
Yaqoob, P. 116S

Yates, S. N. R. 282
Yeboah, A. 224S
Yoon, T.-W. 237S
York, W. S. 374
Yu, J. 306
Yuan, Z. X. 165S

Zeppezauer, M. 233S
Zhang, X. S. 96S
Zhao, K. 128S
Zheng, M. 323
Zuzel, K. A. 230S