

Professor Denis Noble CBE FRS FMedSci FRCP (Hon)



Personal

Date of birth: 16 November 1936 in London. Parents: George & Ethel Noble, Tailors

Married, 1965, Susan Jennifer (née Barfield) BSc DPhil BA

Children: one daughter (Penelope Jean, 1967), one adopted son (Julian Aidan, 1970)

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Education

1947-55 Emanuel School, London (A levels in Chemistry, Physics, Botany & Zoology)

1955-1958 University College London. BSc (1st Class honours) 1958, Class Prize in Physiology

1958-1961 Bayliss-Starling Scholar, University College London

1961 PhD Supervisor: O.F. Hutter (later Regius Professor of Physiology in Glasgow)

Academic Posts

1961—1963. Assistant Lecturer in Physiology, University College London

1961—1963. Vice-Warden of Connaught Hall (University of London)

1963—1984. Fellow and Tutor, Balliol College, Oxford. University Lecturer in Physiology

1969—1970. Visiting Professor and Visiting Scientist of the Canadian MRC

1971—1989. Head (Praefectus) of the Balliol College Graduate Centre at Holywell Manor

1975—1985. Leader of MRC Programme Grant team

1983—1985. Vice-Master of Balliol College
 1984—2004 Burdon Sanderson Professor of Cardiovascular Physiology, Oxford University
 1984—2004 Professorial Fellow, Balliol College
 2004—now Emeritus Professor of Cardiovascular Physiology, Oxford University
 2004—now Emeritus Fellow of Balliol College, Oxford
 2004—now Director of Computational Physiology, Co-Director of e-science centre, Oxford
 2003-2007 Adjunct Professor *Xi'an Jiaotong University, Shaanxi province, China*
 2005—now Visiting Professor, Osaka University, Japan

Company Directorships

1984—now Chairman and Director, Oxsoft Ltd
 1994-2003 Founder and Director, Physiome Sciences Inc (became Predix Pharma in 2003, now EPIX Pharma, <http://www.epixmed.com/>)

Editorships

1968—now Chief Editor, *Progress in Biophysics and Molecular Biology*
 2001—now International Advisor, *Tsinghua Science and technology*
 2004-2006 Chief Editor, *Drug Discovery Today: Disease Models*
 2004—now Editorial Board, *Transactions on Computational Systems Biology*
 2004—now Advisor to Board of *Journal of Experimental Physiology*
 2005—now Chief Editor, *Faculty of 1000, Physiology*

International Committees

1993-2001 Secretary-General of International Union of Physiological Sciences (IUPS)
 2001—now Membre du Jury, Prix Lefoulon-Delalande, Academie des Sciences, Paris
 2009-2013 President of the International Union of Physiological Sciences (IUPS)

National Committees

Member of Advisory Group on non-ionizing radiation (AGNIR), Health Protection Agency (HPA); 1994-2004 Member of government Advisory Group on Korea (DTI); Executive Committee of Campaign for Science and Engineering (UK).

Main Previous Committees

MRC (former Chairman of Joint Dental Committee 1984-1990); Royal Society Committees; Member of Council, Oxford University 1989-2004; Member of Systems Biology Committee, Academy of Medical Sciences and Academy of Engineering Systems Panel of BBSRC.

Publications

Over 350 articles in academic journals, including *Nature*, *Science*, *PNAS*, *Journal of Physiology*, *Progress in Biophysics & Molecular Biology*; Many articles in national press; Author or Editor of 10 books, including *The Initiation of the Heartbeat* (OUP, 1975, 1979 and Japanese translation), sole author; *Electric Current Flow in Excitable Cells* (OUP 1975, 1988), author with JJB Jack and RW Tsien; *The Logic of Life* (OUP 1993), co-editor with CAR Boyd, and author; *The Ethics of Life* (UNESCO 1997) co-editor with J-D Vincent; *The Music of Life* (OUP 2006) sole author (*La Musique de la Vie*, Seuil, 2007; Italian & Spanish translations published, Japanese, Korean and Chinese translations in preparation).

Honours and awards

1970 Scientific Medal of the *Zoological Society*
 1979 Elected Fellow of the *Royal Society* (FRS)
 1982 Research Fellowship for Academic Staff (*Medical Research Council*)
 1985 *British Heart Foundation's* biennial Gold Medal and Prize
 1985 Correspondant Etranger de *l'Académie Royale de Médecine de Belgique*
 1986 Fellow of *University College London*
 1988 Honorary Member of the *Royal College of Physicians* (Hon MRCP)
 1989 Member of *Academia Europaea*

- 1989 Professorial Distinction Award, *Oxford University*
- 1991 Pierre Rijlant Prize (*l'Académie Royale de Médecine de Belgique*)
- 1993 Baly Medal of the *Royal College of Physicians* (London)
- 1993 Honorary Foreign Member of the *Académie Royale de Médecine de Belgique*
- 1994 Honorary Fellow of the *Royal College of Physicians* (Hon FRCP)
- 1996 Honorary Member of the *American Physiological Society*
- 1997 Honorary Member of the *Physiological Society* (UK & Ireland)
- 1998 Honorary Member of the *Physiological Society of Japan*
- 1998 Appointed CBE in Queen's Birthday Honours List, for 'services to science'
- 1998 Visiting Professor at *Johns Hopkins University, Baltimore, USA*
- 1999 Founding Fellow of the *Academy of Medical Science* (FMedSci)
- 2000 Founding Fellow of the *International Society for Heart Research*
- 2001 Honorary Fellowship of the *Institute of Physics and Engineering in Medicine*
- 2003 Appointed Adjunct Professor *Xi'an Jiaotong University, Shaanxi province, China* (2003-2007)
- 2004 Honorary Degree of Doctor of Science by *Sheffield University*
- 2004 Awarded *Russian Academy of Sciences Pavlov Medal* at Russian Physiological Society Congress
- 2004 Hodgkin-Huxley-Katz Prize, *The Physiological Society (UK)*
- 2005 MacKenzie Prize, *British Cardiac Society*, May 2005
- 2005 Docteur Honoris Causa, *Université de Bordeaux*, September 2005
- 2008 Medal of Merit, *EU-ISHR, Athens*, May 2008
- 2008 Honorary Degree of Doctor of Science *University of Warwick*, July 2008

Named invited Lectures

- 1962 Invited Lecture, *IUPS Congress*, Leiden
- 1966 Darwin Lecture, *British Association*
- 1977 Nahum Lecture, *Yale University*
- 1977 Invited review lecture, *IUPS Congress*, Paris (delivered in French)
- 1979 Conférence invitée. *Association des Physiologistes* (Delivered and published in French)
- 1981 Waller Lecture, *London University*
- 1983 Annual Review Lecture. *The Physiological Society* (Published as *The Surprising Heart*)
- 1984 Withering Memorial Lecture, *International Congress of Pharmacology*, London
- 1985 Lettura F. Botazzi. *Società Italiana di Fisiologia*, Pisa (Delivered in Italian)
- 1985 Ueda Lecture, *Japanese Society of Electrocardiologists*, Tokyo (given partly in Japanese)
- 1987 Lloyd-Roberts Lecture, *Royal Society of Medicine*, London
- 1988 Allerdale-Wyld Memorial Lecture, *Northern Industrial Societies*
- 1988 Bowden Lecture, *University of Manchester Institute of Science and Technology*
- 1989 Bacaner Research Awards lecture, *University of Minnesota*
- 1989 Distinguished visiting lecturer at the *Universities of British Columbia, Alberta and Calgary*
- 1989 Distinguished visiting professor at the *State University of New York at Stony Brook, USA*
- 1990 Oliver Sharpey Lecture, *The Royal College of Physicians*, London
- 1990 Butland Visiting Professor at the *University of Auckland*, New Zealand
- 1990 Annual Review Lecture, *Korean Physiological Society* (delivered partly in Korean)
- 1991 Invited lecturer at the 150th anniversary celebrations of the *Académie Royale de Médecine de Belgique*, Brussels (delivered in French)
- 1993 Annual Foundation Lecture of *International Science Policy Foundation*
- 1994 First triennial Rijlant Lecture to *International Congress of Electrocardiology* (Japan)
- 1995 First annual lecture at UCL on disabled students in higher education
- 1996 Frank May Public Lecture, *Leicester University*
- 1996 Conférence Claude Bernard, *Société de Physiologie*, Lille (delivered in French)
- 1996 Stevenson lecture, *University of Western Ontario*
- 2003 Magnes Lecture, *Hebrew University of Jerusalem and Israeli Physiological Society*
- 2003 Larmor Lecture, *Queen's University, Belfast*
- 2004 Conway Lecture, *University College Dublin*
- 2004 Hodgkin-Huxley-Katz Prize Lecture, *The Physiological Society*
- 2006 Woolmer Lecture, *Institute of Physics and Engineering in Medicine*, Cambridge

- 2006 Plenary Lecture, *FAOPS Congress*, Seoul
- 2007 Jacques Morgenstern Colloquium, INRIA Sophia-Antipolis
- 2007 Paton Lecture, *The Physiological Society*
- 2007 McDowall Lecture, King's College London
- 200 Distinguished Invited Lecture, EMBL Heidelberg
- 2008 Public Lecture, Museum of the History of Science, Oxford
- 2008 George Cecil Clarke Lecture, Nottingham University
- 2009 Foster Lecture, Cambridge University
- 2009 Kroto Lecture, Sheffield University

Many other Congress and Symposia Plenary lectures. Denis Noble gives about 50 public invited lectures per year in Universities, Congresses, Foundations and Societies worldwide.

Current Funding

EPSRC eScience Pilot Project in Integrative Biology 2003-2008, £2,798,950; Wellcome Trust Cardiac Physiome programme grant £1.2 million; EU 6th Framework Programme, Biosimulation network 2004-2009, Euros 300,000; EU 7th Framework Programme PreDiCT 2008-2011 Euros 500,000; EU 7th Framework Programme Virtual Human Network of Excellence 2008-2013, Euros 500,000 (as part of Oxford ICT led programmes).

Professional Societies

The Physiological Society (Hon Secretary 1974—80; Foreign Secretary 1986—92; Honorary Member 1997)); *The Royal Society* (Member of various committees); *The Royal College of Physicians* (Honorary Fellow); *British Biophysical Society* (past member of Committee); *British Cardiac Society Mind Association*; *Académie Royale de Médecine de Belgique*; *Academia Europaea* (past Convenor in Physiology and Biophysics); *CaSE*, (*Campaign for Science and Engineering* founded as *Save British Science*, Founder and member of Executive Committee); *American Physiological Society* (Honorary Member 1996); *International Union of Physiological Sciences (IUPS)* (Secretary-General, 1994—2001); *Japan Physiological Society* (Honorary Member, 1998); *Academy of Medical Sciences* (Founder Fellow, 1998); *International Society for Heart Research* (Founding Fellow 2000); *Institute of Physics and Engineering in Medicine* (Honorary Fellow).

Other interests and activities

Philosophy: Publications in professional journals of philosophy and books.

Cooking French & Indian.

Classical Guitar: player and owner of Rubio, Ramirez and Fischer guitars.

Languages: *French* – very highly fluent, able to give lectures and interviews without notes. Denis Noble was a member of the Committee of the *Maison Française d'Oxford* and has broadcast frequently in France; *Italian* – sufficient to give prepared lectures in Italian; *Occitan* – Good knowledge of most dialects and speaker of Limousin; Denis Noble has appeared on French Radio concerning Occitan language and music and has contributed to Occitan publications; *Japanese* – good knowledge of spoken and written language (including Kanji), sufficient to write and deliver prepared speeches and lectures in Japanese. Several publications in Japanese; *Korean* – good knowledge of written Korean (Hangul) and some knowledge of Chinese script. Sufficient knowledge of spoken Korean to give a speech or introduction to a lecture. Denis Noble is a UK Government Advisor on Korea; *Chinese* – some reading knowledge (through Japanese and Korean characters); *Maori* – delivered the reply to the Maori welcome (Powhiri) at the IUPS Congress in Christchurch, New Zealand, 2001; *Others* – some knowledge of many other languages (Denis Noble makes it a rule to learn something of the language in any country he visits)

Scientific publications (excluding short abstracts – less than 1 page)

- Hutter, O. F. and D. Noble (1959). "The influence of anions on impulse generation and membrane conductance in Purkinje and myocardial fibres." Journal of Physiology **147**: 16-17P.
- Hutter, O. F. and D. Noble (1960). "The chloride conductance of frog skeletal muscle." Journal of Physiology **151**: 89-102.
- Hutter, O. F. and D. Noble (1960). "Rectifying properties of heart muscle." Nature **188**: 495.
- Noble, D. (1960). "Cardiac action and pacemaker potentials based on the Hodgkin-Huxley equations." Nature **188**: 495-497.
- Noble, D. (1960). "A Description of cardiac pacemaker potentials based on the Hodgkin-Huxley equations." Journal of Physiology **154**: 64-65P.
- Hutter, O. F. and D. Noble (1961). "The anion conductance of cardiac muscle." Journal of Physiology **157**: 335-350.
- Noble, D. (1962). "Computed action potentials and their experimental basis." Proceedings of International Union of Physiological Sciences **1**: 177-182.
- Noble, D. (1962). "A modification of the Hodgkin-Huxley equations applicable to Purkinje fibre action and pacemaker potentials." Journal of Physiology **160**: 317-352.
- Noble, D. (1962). "The voltage dependence of the cardiac membrane conductance." Biophysical Journal **2**: 381-393.
- Hall, A. E., O. F. Hutter, et al. (1963). "Current-voltage relations of Purkinje fibres in sodium-deficient solutions." Journal of Physiology **166**: 225-240.
- Hall, A. E. and D. Noble (1963). "All-or-nothing repolarization in cardiac muscle." Journal of Physiology **165**: 18-19P.
- Hall, A. E. and D. Noble (1963). "The effect of potassium on the repolarizing current in cardiac muscle." Journal of Physiology **167**: 53-54P.
- Hall, A. E. and D. Noble (1963). "Transient responses of Purkinje fibres to non-uniform currents." Nature **199**: 1294-1295.
- Noble, D. and A. E. Hall (1963). "The conditions for initiating all-or-nothing repolarization in cardiac muscle." Biophysical Journal **3**: 261-174.
- McAllister, R. E. and D. Noble (1965). "Delayed rectification in cardiac Purkinje fibres." Journal of Physiology **182**: 36-37P.
- McAllister, R. E. and D. Noble (1965). "The time constants of the slow outward current in cardiac Purkinje fibres." Journal of Physiology **183**: 23-25P.
- Noble, D. (1965). "Electrical properties of cardiac muscle attributable to inward-going (anomalous) rectification." Journal of cellular and comparative Physiology **66 (Suppl 2)**(Suppl 2): 127-136.
- Noble, D. (1965). The use of mathematical models in the study of excitable tissues. Mathematics and Computers in Medicine and Biology. London, HMSO.
- McAllister, R. E. and D. Noble (1966). "The time and voltage dependence of the slow outward current in cardiac Purkinje fibres." Journal of Physiology **186**: 632-662.
- Noble, D. (1966). "Applications of the Hodgkin-Huxley equations to excitable tissues." Physiological Reviews **46**: 1-50.
- Noble, D. (1966). "The Initiation of the Heart Beat. (Darwin Lecture, British Association)." The Advancement of Science **23**: 412-418.
- Noble, D. and R. B. Stein (1966). "The threshold conditions for initiation of action potentials by excitable cells." Journal of Physiology **187**: 129-162.
- McAllister, R. E. and D. Noble (1967). "The effect of subthreshold potentials on the membrane current on cardiac Purkinje fibres." Journal of Physiology **190**: 381-387.

- Hauswirth, O., R. E. McAllister, et al. (1968). "Voltage clamp analysis of membrane currents in cardiac Purkinje fibres under normal conditions and under the influence of adrenaline." Journal of Physiology **198**: 8-10P.
- Hauswirth, O., D. Noble, et al. (1968). "Adrenaline: mechanism of action on the pacemaker potential in cardiac Purkinje fibres." Science **162**: 916-917.
- Noble, D. and R. W. Tsien (1968). "The kinetics and rectifier properties of the slow potassium current in cardiac Purkinje fibres." Journal of Physiology **195**: 185-214.
- Hauswirth, O., D. Noble, et al. (1969). "The mechanism of oscillatory activity at low membrane potentials in cardiac Purkinje fibres." Journal of Physiology **200**: 255-265.
- Hauswirth, O., D. Noble, et al. (1969). "Reconstruction of the actions of adrenaline and calcium on cardiac pacemaker potentials." Journal of Physiology **204**: 126-128P.
- Noble, D. (1969). Cell Biophysics. Scientific Thought 1900-1960. R. Harré. Oxford, OUP: 209-226.
- Noble, D. and R. W. Tsien (1969). "Outward membrane currents activated in the plateau range of potentials in cardiac Purkinje fibres." Journal of Physiology **200**: 205-231.
- Noble, D. and R. W. Tsien (1969). "Reconstruction of the repolarization process in cardiac Purkinje fibres based on voltage clamp measurements of the membrane current." Journal of Physiology **200**: 233-254.
- Tsien, R. W. and D. Noble (1969). "A transition state theory approach to the kinetics of conductance changes in excitable membranes." Journal of membrane biology **1**: 248-273.
- Brown, R. H. and D. Noble (1972). "Effect of pH on ionic currents underlying pacemaker activity in cardiac Purkinje fibres." Journal of Physiology **224**: 38-39P.
- Hauswirth, O., D. Noble, et al. (1972). "The dependence of plateau currents in cardiac Purkinje fibres on the interval between action potentials." Journal of Physiology **222**: 27-49.
- Hauswirth, O., D. Noble, et al. (1972). "Separation of the pacemaker and plateau components of delayed rectification in cardiac Purkinje fibres." Journal of Physiology **225**: 211-235.
- Noble, D. (1972). Conductance mechanisms in excitable cells. Biomembranes (Passive Permeability of cell membranes). Kreuzer and Slegers: 427-447.
- Noble, D. (1972). "The relation of Rushton's 'liminal length' for excitation to the resting and active conductances of excitable cells." Journal of Physiology **226**: 573-591.
- Noble, D. and R. W. Tsien (1972). The repolarization process of heart cells. Electrical Phenomena in the Heart. W. de Mello, Academic Press: 133-161.
- McNaughton, P. A. and D. Noble (1973). "The role of intracellular calcium ion concentration in mediating the adrenaline-induced acceleration of the cardiac pacemaker potential." Journal of Physiology **234**: 53-54P.
- Brown, H. F., D. Noble, et al. (1974). "The influence of non-uniformity on the analysis of potassium currents in cardiac muscle." Journal of Physiology **245**: 89-91P.
- Noble, D. (1974). Cardiac action potentials and pacemaker activity. Recent Advances in Physiology. R. J. Linden. London, Churchill: 1-50.
- Noble, D. (1974). The Nerve impulse. The Peripheral Nervous System. J. I. Hubbard, Plenum: 27-45.
- Noble, D. and S. Ginsburg (1974). "The activation enthalpies for ion conductance systems in lipid bilayer membranes." Journal of membrane biology **18**: 163-176.
- Brown, H. F., P. A. McNaughton, et al. (1975). "Adrenergic control of cardiac pacemaker currents." Philosophical Transactions of the Royal Society B **270**: 527-537.
- Cohen, I., J. Daut, et al. (1975). "The effects of ouabain on interval-duration relationships in sheep Purkinje fibres." Journal of Physiology **254**: 45-46P.
- Cohen, I., J. Daut, et al. (1975). "The influence of extracellular potassium ions on the action of ouabain on membrane currents in sheep Purkinje fibres." Journal of Physiology **249**: 42-43P.
- Hunter, P. J., P. A. McNaughton, et al. (1975). "Analytical models of propagation in excitable cells." Progress in Biophysics and Molecular Biology **30**: 99-144.
- Jack, J. J. B., D. Noble, et al. (1975). Electric Current Flow in Excitable Cells. Oxford, OUP.

- McAllister, R. E., D. Noble, et al. (1975). "Reconstruction of the electrical activity of cardiac Purkinje fibres." Journal of Physiology **251**: 1-59.
- Noble, D. (1975). Actions of catecholamines on ionic currents in cardiac muscle. Contraction and Relaxation in the myocardium. W. G. Nayler, Academic Press: 267-291.
- Noble, D. (1975). Chemical models of selectivity and conductance in excitable membranes. Biological Membranes. D. S. Parsons. Oxford, OUP: 133-144.
- Noble, D. (1975). The Initiation of the Heartbeat. Oxford, OUP.
- Noble, D. (1975). Physico-chemical properties of ionic channels in excitable membranes. Biological Membranes. D. S. Parsons. Oxford, OUP: 122-132.
- Adrian, R. H., R. C. Channell, et al. (1976). "The Einthoven String Galvanometer and the interpretation of the T wave of the electrocardiogram." Journal of Physiology **263**: 67-70P.
- Brown, H. F., D. Noble, et al. (1976). "The influence of non-uniformity on the analysis of potassium currents in cardiac muscle." Journal of Physiology **258**: 615-629.
- Cohen, I., J. Daut, et al. (1976). "An analysis of the action of low concentrations of ouabain on membrane currents in Purkinje fibres." Journal of Physiology **260**: 75-103.
- Cohen, I., J. Daut, et al. (1976). "The effects of potassium and temperature on the pacemaker current, i_{K2} , in Purkinje fibres." Journal of Physiology **260**: 55-74.
- Cohen, I., W. R. Giles, et al. (1976). "A cellular basis for the T wave of the electrocardiogram." Nature **262**: 657-661.
- Ginsburg, S. and D. Noble (1976). "The use of current-voltage diagrams in locating peak energy barriers in membranes." Journal of membrane biology **29**: 211-229.
- Attwell, D., I. Cohen, et al. (1977). "Activity dependent changes in mammalian ventricular muscle." Journal of Physiology **271**: 17-18P.
- Blood, B. E. and D. Noble (1977). "Glycoside induced inotropism of the heart -- more than one mechanism?" Journal of Physiology **266**: 76-78P.
- Blood, B. E. and D. Noble (1977). Two mechanisms for the inotropic action of ouabain on sheep cardiac Purkinje fiber contractility. Biophysical aspects of cardiac muscle. M. Morad. New York, Academic press: 369-378.
- Noble, D. (1977). 心臓拍動の生理 Shin-zou-hyou-dou-no-sei-ri (The Initiation of the Heartbeat) In Japanese. Tokyo, Tokyo University Press.
- Brown, H. F., D. Noble, et al. (1978). The initiation of the heartbeat and its control by autonomic transmitters. Developments in Cardiovascular Medicine. Dickinson and Marks: 31-52.
- Brown, R. H., I. Cohen, et al. (1978). "The interactions of protons, calcium and potassium ions on cardiac Purkinje fibres." Journal of Physiology **282**: 345-352.
- Brown, R. H. and D. Noble (1978). "Displacement of activation thresholds in cardiac muscle by protons and calcium ions." Journal of Physiology **282**: 333-343.
- Cohen, I., D. A. Eisner, et al. (1978). "The action of adrenaline on pacemaker activity in cardiac Purkinje fibres." Journal of Physiology **280**: 155-168.
- Noble, D. and I. Cohen (1978). "The interpretation of the T-wave of the electrocardiogram." Cardiovascular Research **12**: 13-27.
- Cohen, I., D. Noble, et al. (1979). "Actions of salicylate ions on the electrical properties of cardiac Purkinje fibres." Journal of Physiology **297**: 163-185.
- Cohen, I., D. Noble, et al. (1979). "The interaction of ouabain and salicylate on cardiac muscle." Journal of Physiology **297**: 187-205.
- DiFrancesco, D. and D. Noble (1979). "On the time course of extracellular ion concentration changes in frog atrium." Journal of Physiology **296**: 80P.
- Noble, D. (1979). The Initiation of the Heartbeat. Oxford, OUP.
- Taggart, P., M. Carruthers, et al. (1979). "Electrocardiographic changes resembling myocardial ischaemia in asymptomatic men with normal coronary arteriograms." British Heart Journal **41**: 214-225.

- Brown, H. F., D. DiFrancesco, et al. (1980). "The contribution of potassium accumulation to outward currents in frog atrium." Journal of Physiology **306**: 127-149.
- Brown, H. F., D. Noble, et al. (1980). Le rythme cardiaque: les mécanismes ioniques de son contrôle sous l'influence de l'adrenaline et de l'acetylcholine. La transmission neuromusculaire. Les médiateurs et le "milieu interieur". Paris, New York, Barcelona, Milan, Masson: 207-229.
- DiFrancesco, D. and D. Noble (1980). "If i_{K2} is an inward current, how does it display potassium specificity?" Journal of Physiology **305**: 14P.
- DiFrancesco, D. and D. Noble (1980). "Reconstruction of Purkinje fibre currents in sodium-free solution." Journal of Physiology **306**: 35P.
- DiFrancesco, D. and D. Noble (1980). "The time course of potassium current following potassium accumulation in frog atrium: analytical solutions using a linear approximation." Journal of Physiology **306**: 151-173.
- Earm, Y. E., G. Hart, et al. (1980). "Simultaneous measurement of tension and voltage clamp currents in sheep Purkinje fibres at low concentrations of ouabain and strophanthidin." Journal of Physiology **305**: 63P.
- Hart, G., D. Noble, et al. (1980). "Adrenaline shifts the voltage dependence of the sodium and potassium components of if in sheep Purkinje fibres." Journal of Physiology **308**: 34P.
- Noble, D. (1980). Biophysical mechanisms controlling heart-rate and its variability. The study of heart rate variability. R. I. Kitney and O. Rompelman. Oxford, OUP: 13-24.
- Noble, D. (1980). "Le couplage excitation-contraction: rôle des courants ioniques et des pompes ioniques." Journal de Physiologie (Paris) **76**: 89-95.
- Noble, D. (1980). "Review: Mechanism of action of therapeutic levels of cardiac glycosides." Cardiovascular Research **9**: 495-514.
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- DiFrancesco, D., G. Hart, et al. (1981). "Voltage clamp currents at positive potentials in sheep Purkinje fibres: influence of i_f and K accumulation." Journal of Physiology **318**: 29-30P.
- DiFrancesco, D. and D. Noble (1981). "A model of cardiac electrical activity incorporating restricted extracellular spaces and the sodium-potassium pump." Journal of Physiology **320**: 25-26P.
- Emanuel, R. W., D. Noble, et al. (1981). "Simulation of electrocardiogram by algebraic sum of monophasic action potentials in man." Journal of Physiology **312**: 36-37P.
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- DiFrancesco, D., G. Hart, et al. (1982). "Ionic current transients attributable to the Na-Ca exchange process in the heart." Journal of Physiology **328**: 15-16P.
- DiFrancesco, D. and D. Noble (1982). Implications of the re-interpretation of i_{K2} for the modelling of the electrical activity of pacemaker tissues in the heart. Cardiac Rate and Rhythm. L. N. Bouman and H. J. Jongasma. The Hague, Boston, London, Martinus Nijhoff: 93-128.
- DiFrancesco, D. and D. Noble (1982). "Reconstruction of voltage clamp currents in spherical cell aggregates from cardiac muscle." Journal of Physiology **326**: 65-66P.
- Hart, G., D. Noble, et al. (1982). "Analysis of the early outward currents in sheep Purkinje fibres." Journal of Physiology **326**: 68-69P.
- Taggart, P., R. Donaldson, et al. (1982). "Interrelation of heart rate and autonomic activity in asymptomatic men with unobstructed coronary arteries. Studies with atrial pacing, adrenaline infusion, and autonomic blockad." British Heart Journal **47**: 19-25.
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- Brown, H. F., J. Kimura, et al. (1983). "Two components of 'second inward current' in the rabbit S.A. node." Journal of Physiology **334**: 56-57P.
- Donaldson, R., F. S. Nashat, et al. (1983). "The effects of ischaemia on the paced evoked response and monophasic action potentials in the dog." Journal of Physiology **336**: 65-66P.
- Hart, G., D. Noble, et al. (1983). "The effects of low concentrations of cardiotonic steroids on membrane currents and tension in sheep Purkinje fibres." Journal of Physiology **334**: 103-131.
- Lee, K. S., E. Lee, et al. (1983). "A very slow inward current in single ventricular cells." Journal of Physiology **345**: 6P.
- Noble, D. (1983). "Ionic mechanisms of rhythmic firing." Symposium of the Society for Experimental Biology **37**: 1-28.

- Noble, D. and T. Powell (1983). "The effects of series resistance on second inward current recorded under voltage clamp in ventricular muscle." Journal of Physiology **345**: 7P.
- Brown, H. F., J. Kimura, et al. (1984). "The ionic currents underlying pacemaker activity in rabbit sino-atrial node: experimental results and computer simulations." Proceedings of the Royal Society B **222**: 329-347.
- Brown, H. F., J. Kimura, et al. (1984). "Mechanisms underlying the slow inward current, *i_{si}*, in the rabbit sino-atrial node investigated by voltage clamp and computer simulation." Proceedings of the Royal Society B **222**: 305-328.
- Brown, H. F., D. Noble, et al. (1984). "Transient inward current and its relation to the very slow inward current in the rabbit S.A. node." Journal of Physiology **349**: 47P.
- Donaldson, R., F. S. Nashat, et al. (1984). "Differential effects of ischaemia and hyperkalaemia on myocardial repolarization and conduction times in the dog." Journal of Physiology **353**: 393-403.
- Lee, K. S., E. Lee, et al. (1984). "Further properties of the very slow inward currents in isolated single guinea-pig ventricular cells." Journal of Physiology **349**: 48P.
- Lee, K. S., E. Lee, et al. (1984). "A new Ca current underlying the plateau of cardiac action potentials." Proceedings of the Royal Society B **223**: 35-48.
- Lee, K. S., E. Lee, et al. (1984). "A new, very slow inward Ca current in single ventricular cells of adult guinea-pig." Journal of Physiology **346**: 75P.
- Noble, D. (1984). "The electrogenic Na-K pump current and actions of the cardiac glycosides." Basic Research in Cardiology **79 (Suppl 2)**: 72-78.
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