

Curriculum vitae

Andrew Philip Carter

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Date of Birth: 6th July 1975

CAREER AND EDUCATION:

- 2015 – present: MRC Program Leader, MRC LMB, Cambridge UK.
The structure and mechanism of dyneins
- 2010 – 2015: MRC Program Leader Track, MRC LMB, Cambridge UK.
Structural and single molecule studies on cytoplasmic dynein.
- 2003 – 2010: Post-doctoral research with Prof Ron Vale, UCSF, San Francisco, USA. The structure and mechanism of cytoplasmic dynein.
- 1999 – 2003: MRC PhD Studentship with Dr Venki Ramakrishnan, MRC LMB, Cambridge, UK. X-ray crystallographic studies of the bacterial small ribosomal subunit.
- 1994 – 1999: First Class Honours Degree in Biochemistry (M_{Biochem}), The Queen's College, University of Oxford, UK.

HONOURS AND AWARDS:

- Jul 2024 Fellow of the Royal Society
- Jun 2023 Wellcome Discovery Award
- Jan 2023 BSCB Hooke Medal
- Apr 2018 Wellcome Investigator Award
- May 2016 EMBO Membership
- Dec 2012 Wellcome Trust New Investigator Award
- Nov 2012 EMBO Young Investigator Program
- Oct 2010 Elected Fellow of Clare College, Cambridge
- Jul 2006 The Leukemia & Lymphoma Society Special Fellow Award
- Jul 2003 Agouron Institute / Jane Coffin Childs Memorial Fund Fellowship
- Oct 2002 Max Perutz PhD Student Prize (MRC Lab of Molecular Biology)
- Oct 2001 Clare College, Cambridge: Junior Research Fellowship
- Jun 1999 University of Oxford, Department of Biochemistry: Project Prize

SELECTED INVITED TALKS (SINCE 2019):

- Mar 2026 Indian Institute of Science, India
- Nov 2025 Academia Sinica, Taiwan
- Jun 2025 Imperial College, London
- Jun 2025 University of Edinburgh
- Apr 2025 Cell Biology of the Neuron, Chile
- Mar 2025 Iiser Pune, India

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Feb 2025	Harvard University, USA
Jul 2024	Motors Gordon Research Conference, USA
Jun 2024	University of Dundee, UK
Jan 2024	NeCEN Leiden EM-meeting, The Netherlands
Dec 2023	Biological Structures Group Winter Meeting, UK
Sep 2023	EMBO Lecture Course, Turkey
Apr 2023	Dynamic Cell, UK
Mar 2023	MPI Schloss Ringberg, Germany
Feb 2023	Duke University, USA
Feb 2023	UNC Chapel Hill, USA
Sep 2022	NKI, Amsterdam, The Netherlands
Sep 2022	University of Michigan, USA
Jul 2022	Cell Biology of the Neuron GRC, USA
Mar 2022	MPI Dortmund, Germany
Mar 2022	Accademia Nazionale dei Lincei Workshop, Italy
Sep 2021	Reese Series Seminars, USA
Jun 2021	PSI, Switzerland
Oct 2020	Next Generation Biophysics Symposium, UK
Feb 2020	University of Colorado Boulder, USA
Feb 2020	Biophysics Motility Subgroup, USA
Nov 2019	Zurich University, Switzerland
Oct 2019	New York University, Abu Dhabi
Jun 2019	Francis Crick Institute, UK
May 2019	University of Warwick, UK
May 2019	Vienna BioCenter cryo-EM Symposium, Austria
Apr 2019	Tri-Institutional Structural Biology Seminar, New York, USA

PROFESSIONAL ACTIVITIES:

Funding agency and advisory boards

2025	Wellcome Discovery Award Panel Chair
2025 – 2028	EMBO Installation Grantee Committee Chair
2025	EMBL Cell Biology and Biophysics Unit Review
2023 – 2025	eBIC Peer Review Panel
2022 – 2024	EMBO Installation Grantee Committee Member
2020 – present	Bristol Wellcome PhD Program SAB Chair
2017	HCERES evaluation committee for IGBMC (Strasbourg)
2016 – 2019	Wellcome Trust Multi-user Equipment Committee Member

Journal editorial boards

2017 – present	Life Science Alliance – Advisory Editorial Board Member
2017 – 2022	Board of Reviewing Editor for eLife

Meeting Organization

2024	Organizer: Biological Structures Group Winter Meeting
2024	Organizer: Company of Biologists Workshop

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2021	Organizer: Dynein Online International Workshop 2021
2021	Initiated “The Cytoskeleton of Neurons and Glia” seminar series
2019	Initiated LMB cryo-electron tomography discussion group
2017	Organizer: EMBO YIP Structural Biology Sectoral Meeting
2015	Organizer: 2017 Spring Meeting for the BSCB
2015 – 2025	Organizer: UK Microtubule Meeting, Edinburgh
2013	Co-chair: ASCB Minisymposium

Committees

2021 – present	Oversight of LMB Electron Microscopy Facility
2021	Selection Committee: MRC LMB Head of Mass Spec
2021	Selection Committee: MRC LMB Group Leader recruitment
2020 – 2025	Member of Council, Clare College, Cambridge
2020	Diamond II BioImaging User Working Group
2020	New Master Shortlisting Panel, Clare College, Cambridge
2018 – present	LMB Structural Studies Committee
2017 – 2020	British Society for Cell Biology (BSCB) Membership Secretary
2016	Review panel for NMR provision at MRC LMB
2015 – 2020	British Society for Cell Biology (BSCB) Committee
2015 – 2022	MRC LMB Seminar Committee
2012 – 2017	Estates Committee, Clare College, Cambridge,

Outreach

2025	Advisory Board of CureMAPK8IP3 Foundation
2023	Neuronal transport stall (LMB Open Day)
2020 – 2021	Organizer: Know Your Neighbour: local online talks during Covid
2019 – 2020	Founder and Coordinator: Wilbraham’s Covid-19 support group
2018	Molecular Motors stall (SciLifeLab event at the Grafton Centre)
2017	Molecular Motors stall (LMB Open day)
2016	Organizer: Mighty Motors outreach event (Big Biology Day)
2015	Organizer: Motor protein outreach event (Diamond Open Day)

Other Activities

2026	Teaching: EMBO PhD Course, Bengaluru, India
2025	Teaching: EMBO PhD Course, Pune, India
2025	External AP evaluation of Prof Wiczorek (ETH)
2022 – present	Admissions Tutor, Clare College, Cambridge
2020 – 2022	External Mentor for new group leader: (Ian Cadby: Birmingham)
2019 – 2024	External Mentor for new group leader (David Haselbach: IMP)
2017 – 2025	Parish Councillor
2016 – present	Teaching: EMBO YIP PhD Program
2010 – 2022	Biology Admissions Coordinator, Clare College, Cambridge
2010 – 2025	Director of Studies, Clare College, Cambridge

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MENTORING:

Postdocs:

2025 – present	Verena Cmentowski
2025 – present	Chisato Tsuji
2024 – present	Guoling Fu
2022 – present	Ennio d’Amico (Marie Curie Fellowship)
2021 – present	Kashish Singh (EMBO Fellowship)
2019 – present	Sami Chaaban (EMBO Fellowship)
2019 – 2025	Alex Fellows
2018 – 2024	Ferdos Abid Ali (Lecturer, University of Bristol)
2017 – 2019	Grigory Sharov (CryoEM facility manager, MRC LMB)
2016 – 2021	Girish Mali (PI – University of Oxford)
2015 – 2022	Clinton Lau (PI – University of Oxford)
2015 – 2016	Edgar Morales (PI – CINVESTAV, Mexico)
2014 – 2018	Kai Zhang (PI- Yale University, USA)
2013 – 2015	Carina Motz (Lab Manager, TU Munich, Germany)
2011 – 2015	Max Schlager (Application specialist, Roche, Germany)
2010 – 2017	Helgo Schmidt (PI – IGBMC, France)

PhD Students:

2024 – present	Hannah Noor Verwei
2023 – present	Leon Michalski (Boehringer Ingelheim Fonds Fellowship)
2021 – 2024	Eleanor Johnson (Specialist, Delmic)
2020 – 2024	Giulia Manigrasso (Associate, Charles River Associates)
2019 – 2022	Camila Ventura Santos (Postdoc, MPI Frankfurt)
2018 – 2022	Chris van Hoorn (Scientist, Navira Ltd, UK)
2016 – 2020	Helen Foster (Lecturer, University of Leeds)
2015 – 2020	Sam Lacey (Postdoc, Human Technopole, Italy)
2013 – 2017:	Linas Urnavicus (Postdoc, Rockefeller University, USA)
2012 – 2016:	Ruta Zalyte (Argyle, Lithuania)
2011 – 2015:	Aristides Diamant (MD PhD, UCSF, USA)
2010 – 2014:	Emma Gleave (Astra Zeneca, UK)

LIST OF PUBLICATIONS:

- 1) Singh K*, Chilaeva S*, McClintock M*, Carter AP[‡], Bullock SL[‡] (2025) Cryo-EM structures of Egl–BicD–RNA complexes reveal how diverse mRNAs are selected for subcellular localization. *bioRxiv* doi:10.1101/2025.08.02.668268
- 2) Teixeira V, Singh K, Gama JB, Celestino R, Carvalho AX, Pereira P, Abreu CMC, Dantas TJ, Carter AP, Gassmann R. (2025) CDR2 is a dynein adaptor recruited by kinectin to regulate ER sheet organization. *J Cell Biol.* **224**:e202411034
- 3) Manigrasso G, Saharat K, Kullapanich C, Boulanger J, Morgan TE, Kramer H, Salje J[‡], Carter AP[‡] (2025) The intracellular bacterium *Orientia tsutsugamushi* uses the autotransporter ScaC to activate BICD adaptors for dynein-based motility. *Nat Commun.* **16**:6122.
- 4) Abid Ali F* Zwetsloot AJ*, Stone CE, Morgan TE, Wademan RF, Carter AP[‡] and Straube A[‡] (2025) KIF1C activates and extends dynein movement through the FHF cargo adaptor. *Nat Struct Mol Biol.* **32**:756–766
- 5) Slivka J, Gleave E, Wijewardena DP, Canty JT, Selvin PR, Carter AP, Yildiz A. (2024) Stepping dynamics of dynein characterized by MINFLUX. *bioRxiv* doi: 10.1101/2024.07.16.603667
- 6) Aslan M, d'Amico EA, Cho NH, Taheri A, Zhao Y, Zhong X, Blaauw M, Carter AP[‡], Dumont S[‡], Yildiz A[‡]. (2024) Structural and functional insights into activation and regulation of the dynein-dynactin-NuMA complex. *bioRxiv* doi: 10.1101/2024.11.26.625568.
- 7) Salvador-Garcia D, Jin L, Hensley A, Gölcük M, Gallaud E, Chaaban S, Port F, Vagnoni A, Planelles-Herrero VJ, McClintock MA, Derivery E, Carter AP, Giet R, Gür M, Yildiz A, Bullock SL. (2024) A force-sensitive mutation reveals a non-canonical role for dynein in anaphase progression. *J Cell Biol.* **223**:e202310022.
- 8) van Hoorn C[‡] and Carter AP[‡] (2024) A cryo-ET study of ciliary rootlet organization. *Elife* **12**:RP91642
- 9) Singh K[#], Lau CK[#], Manigrasso G, Gama JB, Gassmann R, Carter AP[‡] (2024) Molecular mechanism of dynein-dynactin activation by JIP3 and LIS1. *Science* **383**:eadk8544
- 10) Fellows AD, Bruntraeger M, Burgold T, Bassett AR, Carter AP[‡] (2024) Dynein and dynactin move long-range but are delivered separately to the axon tip. *J Cell Biol.* **223**:e202309084
- 11) Ventura Santos C, Rogers SL, Carter AP[‡]. (2023) CryoET shows cofilactin filaments inside the microtubule lumen. *EMBO Rep.* **24** e57264.
- 12) d'Amico EA, Ud Din Ahmad M, Cmentowski V, Girbig M, Müller F, Wohlgemuth S, Brockmeyer A, Maffini S, Janning P, Vetter IR, Carter AP, Perrakis A,

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- Musacchio A (2022) Conformational transitions of the Spindly adaptor underlie its interaction with Dynein and Dynactin. *J Cell Biol.* **221**:e202206131.
- 13) Chaaban S and Carter AP[‡] (2022) Structure of dynein-dynactin on microtubules shows tandem recruitment of cargo adaptors. *Nature* **610**:212-216
 - 14) He P, Liu B, Gao X, Yan Q, Pei R, Sun J, Chen Q, Hou R, Li Z, Zhang Y, Zhao J, Sun H, Feng B, Wang Q, Yi H, Hu P, Li P, Zhang Y, Chen Z, Niu X, Zhong X, Jin L, Liu X, Qu K, Ciazynska KA, Carter AP, Briggs JAG, Chen J, Liu J, Chen X, He J, Chen L, Xiong X. (2022) SARS-CoV-2 Delta and Omicron variants evade population antibody response by mutations in a single spike epitope. *Nat Microbiol.* **7**:1635-1649
 - 15) Foster HE^{‡*}, Ventura Santos C*, Carter AP[‡] (2022) A cryo-ET survey of microtubules and intracellular compartments in mammalian axons. *J Cell Biol.* **221**:e202103154
 - 16) Fermie J, de Jager L, Foster HE, Veenendaal T, de Heus C, van Dijk S, Ten Brink C, Oorschot V, Yang L, Li W, Müller WH, Howes S, Carter AP, Förster F, Posthuma G, Gerritsen HC, Klumperman J, Liv N (2022) Bimodal endocytic probe for three-dimensional correlative light and electron microscopy. *Cell Rep Methods.* **2**:100220.
 - 17) Lau CK, O'Reilly FJ, Santhanam B, Lacey SE, Rappsilber J, Carter AP[‡] (2021) Cryo-EM reveals the complex architecture of dynactin's shoulder region and pointed end. *EMBO J.* **40**:e106164.
 - 18) Mali GR*, Ali FA*, Lau CK*, Begum F, Boulanger J, Howe JD, Chen ZA, Rappsilber J, Skehel M, Carter AP[‡] (2021) Shulin packages axonemal outer dynein arms for ciliary targeting. *Science.* **371**:910-916.
 - 19) Fokin AI, David V, Oguievetskaia K, Derivery E, Stone CE, Cao L, Rocques N, Molinie N, Henriot V, Aumont-Nicaise M, Hinckelmann MV, Saudou F, Le Clainche C, Carter AP, Romet-Lemonne G, Gautreau AM[‡] (2021) The Arp1/11 minifilament of dynactin primes the endosomal Arp2/3 complex. *Sci Adv.* **7**:eabd5956.
 - 20) Pellegrini L, Albecka A, Mallery DL, Kellner MJ, Paul D, Carter AP, James LC, Lancaster MA[‡] (2020) SARS-CoV-2 Infects the Brain Choroid Plexus and Disrupts the Blood-CSF Barrier in Human Brain Organoids. *Cell Stem Cell.* **27**:951-961.e5.
 - 21) Xiong X, Qu K, Ciazynska KA, Hosmillo M, Carter AP, Ebrahimi S, Ke Z, Scheres SHW, Bergamaschi L, Grice GL, Zhang Y; CITIID-NIHR COVID-19 BioResource Collaboration, Nathan JA, Baker S, James LC, Baxendale HE, Goodfellow I, Doffinger R, Briggs JAG[‡] (2020) A thermostable, closed SARS-CoV-2 spike protein trimer. *Nat Struct Mol Biol.* **27**:934-941.
 - 22) Vincent J, Preston M, Mouchet E, Laugier N, Corrigan A, Boulanger J, Brown DG, Clark R, Wigglesworth M, Carter AP, Bullock SL[‡] (2020) A High-Throughput Cellular Screening Assay for Small-Molecule Inhibitors and Activators of Cytoplasmic Dynein-1-Based Cargo Transport. *SLAS Discov.* **25**:985-999.

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- 23) Toropova K, [Zalyte R](#), Mukhopadhyay AG, Mladenov M, [Carter AP](#), Roberts AJ[‡] (2019) Structure of the dynein-2 complex and its assembly with intraflagellar transport trains. *Nat Struct Mol Biol.* **26**:823-829
- 24) [Lacey SE](#), He S, Scheres SHW, [Carter AP](#)[‡] (2019) Cryo-EM of dynein microtubule-binding domains shows how an axonemal dynein distorts the microtubule. *Elife.* **8**:e47145.
- 25) Can S*, [Lacey SE*](#), Gur M, [Carter AP](#), Yildiz A[‡] (2019) Directionality of dynein is controlled by the angle and length of its stalk. *Nature.* **566**:407-410
- 26) Reck-Peterson SL[‡], Redwine WB, Vale RD, [Carter AP](#)[‡] (2018) The cytoplasmic dynein transport machinery and its many cargoes. *Nat Rev Mol Cell Biol.* **19**: 382-398
- 27) [Urnavicius L*](#), [Lau CK*](#), Elshenawy MM, [Morales-Rios E](#), [Motz C](#), Yildiz A, [Carter AP](#)[‡] (2018) Cryo-EM shows how dynactin recruits two dyneins for faster movement. *Nature.* **554**: 202-206
- 28) Nieuwburg R, Nashchekin D, Jakobs M, [Carter AP](#), Khuc Trong P, Goldstein RE, St Johnston D[‡] (2017) Localised dynactin protects growing microtubules to deliver oskar mRNA to the posterior cortex of the *Drosophila* oocyte. *Elife.* **6**:e27237
- 29) [Zhang K*](#), [Foster HE*](#), Rondelet A, [Lacey SE](#), Bahi-Buisson N, Bird AW, [Carter AP](#)[‡] (2017) Cryo-EM Reveals How Human Cytoplasmic Dynein Is Auto-inhibited and Activated. *Cell.* **169**: 1303-1314
- 30) Steinman JB, Santarossa CC, Miller RM, Yu LS, Serpinskaya AS, Furukawa H, Morimoto S, Tanaka Y, Nishitani M, Asano M, [Zalyte R](#), Ondrus AE, Johnson AG, Ye F, Nachury MV, Fukase Y, Aso K, Foley MA, Gelfand VI, Chen JK, [Carter AP](#), Kapoor TM[‡] (2017) Chemical structure-guided design of dynapyrazoles, cell-permeable dynein inhibitors with a unique mode of action. *Elife.* **6**: e25174
- 31) Hoang HT, [Schlager MA](#), [Carter AP](#), Bullock SL[‡] (2017) DYNC1H1 mutations associated with neurological diseases compromise processivity of dynein-dynactin-cargo adaptor complexes. *Proc Natl Acad Sci U S A.* **114**: E1597-E1606
- 32) Belyy V, [Schlager MA](#), [Foster H](#), Reimer AE, [Carter AP](#), Yildiz A[‡] (2016) The mammalian dynein-dynactin complex is a strong opponent to kinesin in a tug-of-war competition. *Nat Cell Biol.* **18**: 1018-24
- 33) [Schmidt H](#), [Carter AP](#)[‡] (2016) Review: Structure and mechanism of the dynein motor ATPase. *Biopolymers.* **105**: 557-67
- 34) [Carter AP](#)[‡], [Diamant AG](#), [Urnavicius L](#) (2016) How dynein and dynactin transport cargos: a structural perspective. *Curr Opin Struct Biol.* **37**: 62-70
- 35) See SK, Hoogendoorn S, Chung AH, Ye F, Steinman JB, Sakata-Kato T, Miller RM, Cupido T, [Zalyte R](#), [Carter AP](#), Nachury MV, Kapoor TM, Chen JK[‡] (2016)

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- Cytoplasmic Dynein Antagonists with Improved Potency and Isoform Selectivity. *ACS Chem Biol.* **11**: 53-60
- 36) Urnavicius L*, Zhang K*, Diamant AG*, Motz C, Schlager MA, Yu M, Patel NA, Robinson CV, Carter AP[‡] (2015) The structure of the dynactin complex and its interaction with dynein. *Science.* **347**: 1441-6
- 37) Schmidt H*, Zalyte R*, Urnavicius L, Carter AP[‡] (2015) Structure of human cytoplasmic dynein-2 primed for its power stroke. *Nature.* **518**: 435-438
- 38) Schlager MA*, Hoang HT*, Urnavicius L, Bullock SL[‡], Carter AP[‡] (2014) In vitro reconstitution of a highly processive recombinant human dynein complex. *EMBO J.* **33**: 1855-68
- 39) Gleave ES, Schmidt H, Carter AP[‡] (2014) A structural analysis of the AAA+ domains in *Saccharomyces cerevisiae* cytoplasmic dynein. *J Struct Biol.* **186**: 367-75
- 40) Carter AP[‡] (2013) Crystal clear insights into how the dynein motor moves. *J Cell Sci.* **126**: 705-13
- 41) Schmidt H, Gleave ES, Carter AP[‡] (2012) Insights into dynein motor domain function from a 3.3-Å crystal structure. *Nat Struct Mol Biol.* **19**: 492-7
- 42) Carter AP^{‡*}, Cho C*, Jin L, Vale RD[‡] (2011) Crystal structure of the dynein motor domain. *Science.* **331**: 1159-65
- 43) Carter AP[‡], Vale RD (2010) Communication between the AAA+ ring and microtubule-binding domain of dynein. *Biochem Cell Biol.* **88**: 15-21
- 44) Houdusse A[‡], Carter AP[‡] (2009) Dynein swings into action. *Cell.* **136**: 395-6
- 45) Carter AP^{*}, Garbarino JE*, Wilson-Kubalek EM, Shipley WE, Cho C, Milligan RA, Vale RD[‡], Gibbons IR (2008) Structure and functional role of dynein's microtubule-binding domain. *Science.* **322**: 1691-5
- 46) Gennerich A, Carter AP, Reck-Peterson SL, Vale RD[‡] (2007) Force-induced bidirectional stepping of cytoplasmic dynein. *Cell.* **131**: 952-65
- 47) Reck-Peterson SL, Yildiz A*, Carter AP^{*}, Gennerich A, Zhang N, Vale RD[‡] (2006) Single-molecule analysis of dynein processivity and stepping behavior. *Cell.* **126**: 335-48
- 48) Gibbons IR[‡], Garbarino JE, Tan CE, Reck-Peterson SL, Vale RD and Carter AP (2005) The affinity of the dynein microtubule-binding domain is modulated by the conformation of its coiled-coil stalk. *J Biol Chem.* **280**: 23960-23965.
- 49) Brodersen DE, Clemons WM, Jr., Carter AP, Wimberly BT and Ramakrishnan V[‡] (2003) Phasing the 30S ribosomal subunit structure. *Acta Crystallogr D Biol Crystallogr.* **59**: 2044-50

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- 50) Ogle JM, Carter AP and Ramakrishnan V[‡] (2003) Insights into the decoding mechanism from recent ribosome structures. *Trends Biochem Sci.* **28**: 259-66
- 51) Brodersen DE, Clemons WM, Jr., Carter AP, Wimberly BT and Ramakrishnan V[‡] (2002) Crystal structure of the 30 S ribosomal subunit from *Thermus thermophilus*: structure of the proteins and their interactions with 16 S RNA. *J Mol Biol.* **316**: 725-68
- 52) Ouwens DM, de Ruiter ND, van der Zon GC, Carter AP, Schouten J, van der Burgt C, Kooistra K, Bos JL, Maassen JA and van Dam H[‡] (2002) Growth factors can activate ATF2 via a two-step mechanism: phosphorylation of Thr71 through the Ras-MEK-ERK pathway and of Thr69 through RalGDS-Src-p38. *EMBO J.* **21**: 3782-93
- 53) Brodersen DE, Carter AP, Clemons WM, Jr., Morgan-Warren RJ, Murphy FV, Ogle JM, Tarry MJ, Wimberly BT and Ramakrishnan V[‡] (2001) Atomic structures of the 30S subunit and its complexes with ligands and antibiotics. *Cold Spring Harb Symp Quant Biol.* **66**: 17-32
- 54) Carter AP, Clemons WM, Jr., Brodersen DE, Morgan-Warren RJ, Hartsch T, Wimberly BT and Ramakrishnan V[‡] (2001) Crystal structure of an initiation factor bound to the 30S ribosomal subunit. *Science.* **291**: 498-501
- 55) Clemons WM, Jr., Brodersen DE, McCutcheon JP, May JL, Carter AP, Morgan-Warren RJ, Wimberly BT and Ramakrishnan V[‡] (2001). Crystal structure of the 30 S ribosomal subunit from *Thermus thermophilus*: purification, crystallization and structure determination. *J Mol Biol.* **310**: 827-43
- 56) Ogle JM, Brodersen DE, Clemons WM, Jr., Tarry MJ, Carter AP and Ramakrishnan V[‡] (2001) Recognition of cognate transfer RNA by the 30S ribosomal subunit. *Science.* **292**: 897-902
- 57) Brodersen DE, Clemons WM, Jr., Carter AP, Morgan-Warren RJ, Wimberly BT and Ramakrishnan V[‡] (2000) The structural basis for the action of the antibiotics tetracycline, pactamycin, and hygromycin B on the 30S ribosomal subunit. *Cell.* **103**: 1143-54
- 58) Carter AP*, Clemons WM*, Brodersen DE*, Morgan-Warren RJ*, Wimberly BT* and Ramakrishnan V[‡] (2000) Functional insights from the structure of the 30S ribosomal subunit and its interactions with antibiotics. *Nature.* **407**: 340-8
- 59) Wimberly BT*, Brodersen DE*, Clemons WM, Jr.*, Morgan-Warren RJ*, Carter AP*, Vonrhein C, Hartsch T and Ramakrishnan V[‡] (2000) Structure of the 30S ribosomal subunit. *Nature.* **407**: 327-39
- 60) Guo Y, Wang Z, Carter A, Kaiser K and Dow JA[‡] (1996) Characterisation of vha26, the *Drosophila* gene for a 26 kDa E-subunit of the vacuolar ATPase. *Biochim Biophys Acta.* **1283**: 4-9

* These authors made equal contributions ‡ Corresponding authors