NC-IUPHAR

Annual Report

2015/16

IUPHAR

International Union of Basic and Clinical Pharmacology

Background to NC-IUPHAR

NC-IUPHAR was initiated in 1987 at the Xth International Congress of Pharmacology in Sydney. In 1989, the Executive Committee of IUPHAR named Paul Vanhoutte (Hong Kong) as Chair of a revised and enlarged committee, with Michael Spedding (France) as Secretary (1990). This committee energetically expanded its activities and the number of subcommittees (to 33), eventually producing the first official compendium on the occasion of the XIIIth International Congress of Pharmacology in Munich in 1998. Robert Ruffolo (USA) was Chair of NC-IUPHAR from 1998-2002. Michael Spedding became Chairman in 2002 and was elected again in 2006, and assumed the post of Secretary General of IUPHAR in July 2015.

In April 2015, Steve Alexander became Chair, and a new Executive Committee was formed comprising Steve (Chair), Arthur Christopoulos (Deputy Chair), Anthony Davenport (Funding Liaison), Doriano Fabbro (Industry Liaison) and Adam Pawson (Executive Secretary), tasked with overseeing the management and future direction of NC-IUPHAR.

NC-IUPHAR and its partners are developing a knowledge environment that will enable students and scientists in academia and industry, working in areas related to pharmacology and drug/target research, to exploit the full potential of the considerable amount of information on drug action available in the published scientific literature. This knowledge environment will be a valuable tool for basic and clinical scientists seeking new approaches for drug discovery research, and the diagnosis and treatment of disease, and a valuable teaching resource for students of pharmacology and translational medicine.

NC-IUPHAR has the objectives of:

1. Issuing guidelines for the nomenclature and classification of all the (human) biological targets, including all the targets of current and future prescription medicines
2. Facilitating the interface between the discovery of new sequences from the Human Genome Project and the designation of the derived entities as functional biological targets and potential drug targets
3. Designating polymorphisms and variants which are functionally important
4. Developing an authoritative and freely available, global online resource, originally called the IUPHAR database, in collaboration with the British Pharmacological Society (BPS), which is now accessible *via* the IUPHAR/BPS Guide to PHARMACOLOGY database (GtoPdb; http://www.guidetopharmacology.org), with a remit to:
    - provide access to data on all known biological targets
    - enable students and scientists in academia and industry, working in areas related to pharmacology and drug/target research, to exploit the full potential of the considerable amount of information on drug action available in the published literature
    - provide an entry point into the pharmacological literature for basic and clinical scientists from other disciplines
    - provide an integrated educational resource with access to high quality training in the principles of basic and clinical pharmacology and techniques
    - foster innovative drug discovery

Statement from the Chair

Since I have taken over from Michael Spedding the reins of NC-IUPHAR, I have been even more in awe of the masterful way in which he organised meeting after meeting with a full program of presentations of cutting edge scientific achievements at our twice-yearly committee meetings.

More than that, the breadth and depth of knowledge he was able to bring to bear allowed a continuing level of high achievement in terms of one of the major outputs of NC-IUPHAR – its publications. I'm looking forward to continuing our long collaboration even though our roles and titles have changed recently.

Our publications are a key feature of NC-IUPHAR, alongside the IUPHAR/BPS Guide to PHARMACOLOGY database (GtoPdb; http://www.guidetopharmacology.org/), of course. Our long-term relationship publishing reviews in Pharmacological Reviews, together with the more recent link with the British Journal of Pharmacology, are vital elements of our profile since they provide a feedback mechanism whereby we have an objective measure of our

usefulness for the pharmacological community (see Appendix III). As Michael has noted on many occasions, an H-index close to 80 is a testimonial to the work of NC-IUPHAR over the last two decades. A major consideration for the Executive Group of NC-IUPHAR is the continuation of the pipelines which feed into those two journals. We are working with Eliot Ohlstein, the Editor for NC-IUPHAR, to ensure these retain the same strength and currency which we have enjoyed with previous publications from NC-IUPHAR. Part of the forward strategy will be to explore how we might increase our coverage of non-traditional areas. Thanks to the hard work of colleagues like Bill Catterall and Rick Neubig, alongside Anthony Davenport, Tony Harmar, John Peters and many others (see the long list of NC-IUPHAR members and Subcommittee Chairs in Appendices I and II), we have had really good in-depth coverage of GPCR, nuclear hormone receptors and ion channels. We are looking to identify the scope for representing the enzymes and transporters, which present distinct challenges for the online database and for NC-IUPHAR publications.

One of the milestones of last year was the successful application to the Wellcome Trust to fund a project termed 'The Guide to Immunopharmacology', led by Jamie Davies in Edinburgh and bringing together collaborators from six countries as co-investigators on the application.

A further milestone of 2015 was the publication of the Concise Guide to PHARMACOLOGY 2015/16. Amongst other properties of this publication, it represents the only remaining printed issue of the British Journal of Pharmacology. We anticipate another issue in this series in the summer of 2017; work towards this has already started.

I would like to welcome formally new colleagues to the membership of NC-IUPHAR (see Appendix I) and to the GtoPdb team in Edinburgh, and to thank a number of colleagues for their contributions to NC-IUPHAR in the last year, some of whom have decided to step down from the committee. Their altruism and dedication to NC-IUPHAR and pharmacology in general has made a significant contribution to help maintain the profile of the discipline at a time when there is fragmentation in both the industry and academia. I see part of the future role of NC-IUPHAR being to continue a trend propounded by Michael in the championing of good science and, principally, good pharmacology. This particular role is definitely a challenge for NC-IUPHAR, but working together with other IUPHAR committees and the huge numbers of scientists worldwide which are represented through IUPHAR.

Steve Alexander
Chairman of NC-IUPHAR

Current and future directions for NC-IUPHAR

NC-IUPHAR is perhaps the most public success of IUPHAR, and is engaged in a major task; to define all the main drug targets encoded by the human genome, and annotate them in a database freely accessible world-wide...and, importantly, link them to therapeutics and pharmacological target validation.

Major efforts continue to define the main variables in drug/receptor interactions including the parameters that can lead to variation in receptor function and pharmacology (*i.e.* biased signalling, splice variation, receptor polymorphisms, hetero-oligomerisation, allosteric modulation, post-translational modification, epigenetic targets, non-coding RNAs, and linkage to multiple signalling cascades). These areas are of great interest because they may considerably expand the repertoire of potential targets for drug development, and are under evaluation by working groups, which will lead to a number of reports about issues which are of crucial importance for pharmacology. All these areas have been or will be worked on for relevance for pharmacology, and additionally may be useful funding application areas to ensure the future sustainability of NC-IUPHAR activities, and the GtoPdb project.

The immense recent growth of knowledge about drug targets, with their crystal structures, has had a dramatic impact on drug discovery and pharmacology, and importantly, NC-IUPHAR classifications have been widely adopted. In the past year, we have made great strides to proactively include new drug targets in the GtoPdb, and recruit experts to advise on them; to date we have >2700 annotated protein targets in the GtoPdb, with >8300 ligands, including all

approved drugs (~1900) (See Appendix IV).

There is growing research interest, academically, clinically and industrially, in the pharmacology of immunity, inflammation and infection in defining the immunological/inflammatory targets in disease states, with their main pharmacology. Within the research community, there is an urgent need for a pre-competitive, unbiased resource that will integrate high-level expertise in immunity, inflammation and infection, pharmacology and medicinal chemistry. At present, immunological and pharmacological knowledge are held by separate communities and the best resources fall short of what is needed. GtoPdb is the best molecular pharmacology database, but is currently limited in the immunity, inflammation and infection area. We have successfully applied to the Wellcome Trust for funding to extend GtoPdb into this arena, and to produce a 'Guide to IMMUNOPHARMACOLOGY: Integration of targets, diseases and therapies into an expert-driven database'.

Immune/inflammatory/ infection responses and disorders have become an increasing focus of pharmacological R&D. We will enrich GtoPdb with kinome resources linking to diseases to assist selection of new targets, tool compounds and drugs. Suggested priorities are established (JAK, PI3K, IKK) and less validated (RIPKs, IRAKs, MAP3Ks) target kinases in innate immunity.

This will later extend to adaptive immunity and kinases in selected pathogens. New data will be linked according to the existing GtoPdb expert-curation model but with a strong focus on translational aspects (e.g. clinical benefit, biomarkers and biological endpoints). In addition an immunology-orientated portal will be developed.

Co-applicants include kinase, immunity/inflammation and parasite biology experts: Michael Spedding, Francesca Levi-Schaffer, Clare Bryant, Christian Doerig, Stephen Anderton, Steve Alexander, Doriano Fabbro and Anthony Davenport. Data selection will be guided by new IUPHAR expert subcommittees set up for this task.

We owe thanks to many folk for the success of this proposal, including for their inputs to the preparation phase and letters of support (to whom we have already communicated our appreciation).

Further details will be surfaced in due course but we are also pleased that the British Pharmacological Society will continue to support the core Guide to PHARMACOLOGY resource during and after this project.

While technical decisions remain on exactly what interfaces and data structures are instantiated, we envisage both resources will be dovetailed into an expanded central database with different front-ends for users.

Any parties with Immunopharmacology interests we have not yet engaged with are welcome to make informal contact as we go forward.

Finally, working with the University of Edinburgh Drupal Website Service, and with funding from ASPET, Simon Maxwell has spearheaded the development of the IUPHAR/ASPET Pharmacology Education Project, an education portal that will be closely linked with the GtoPdb. It will provide access to high quality training in the principles and techniques of basic and clinical pharmacology, and is due for public release shortly at Experimental Biology 2016.

Further details about the recent activities of NC-IUPHAR, updates and developments to GtoPdb, and activities of the GtoPdb team can be found in our March 2016 newsletter. Additionally, the guidetopharmacology blog allows the database team to share feature developments, technical updates, articles or events at a greater level of detail and cross-linking than shorter postings typical of the other three networks (guest posts are welcome).

Organisation of NC-IUPHAR

Core Committee

The Core Committee of NC-IUPHAR, comprising the Executive Committee and Core Members is listed in Appendix I. The biannual core NC-IUPHAR meetings are themed and we have established an alliance with the Japanese Pharmacology Society who pay the travel for two members*, but who are invited according to the meeting themes. We welcome our new Core Members, John Cidlowski, Francesca Levi-Schaffer, Joerg Striessnig and Mary Vore.

Corresponding Members

In order to broaden the expertise of the core committee, the number of corresponding members (see Appendix I). Corresponding members attend selected meetings of NC-IUPHAR and are invited according to the meeting themes.

They include representatives of the major pharmaceutical companies.

Evolving Pharmacology Group

Anthony Davenport leads a group which monitors the 'de-orphanisation' of GPCRs and evolving pharmacology of drug targets in general. Particularly important and timely breakthroughs are included in the Hot Topics section of the database along with email alerts.

Clinical Translational Pharmacology Group

In order to provide advice on the translational aspects of drug target pharmacology, a subgroup (see Appendix I) of clinical pharmacologists (core member, Sir Colin Dollery) discuss how best to respond to the wishes of our clinical colleagues and to translate activity at drug target sites to clinical efficacy.

Subcommittees

Chairpersons (see Appendix II) propose a list of experts, ratified by NC-IUPHAR, to ensure adequate representation of the field. The chairperson of each subcommittee plays a critical role co-ordinating the actions of the subcommittee, organising meetings, finalising documents and the website pages. However, we encourage postdocs to join the subcommittee, as chairs simply do not have enough time to fill in the various template fields - postdocs can therefore get publication credits, and several NC-IUPHAR publications have become citation classics. The h-index of NC-IUPHAR is >74. The subcommittees meet to establish consensus on classification, and to ensure that the NC-IUPHAR guidelines are complied with. We now have more >90 subcommittees (see Appendix II).

Acknowledgements

We are very grateful to our sponsors. We are also immensely grateful for the work done by our colleagues in NC-IUPHAR and all the contributing chairs and subcommittee members. It is a privilege to be associated with so much work freely given for the good of science. We repeat that NC-IUPHAR is a global resource and all scientists are welcome to contribute (contact: enquiries@guidetopharmacology.org).

Appendix I: Membership of NC-IUPHAR

Executive Committee
Stephen Alexander, UK - Chair
Arthur Christopoulos, Australia - Deputy Chair
Doriano Fabbro, Switzerland - Industry Liaison
Anthony Davenport, UK - Funding Liaison
Adam Pawson, UK - Executive Secretary

Core Members
Stephen Alexander, UK
Arthur Christopoulos, Australia
John Cidlowski, USA - NHRs Liaison
Anthony Davenport, UK - Chair Evolving Pharmacology
Doriano Fabbro, Switzerland
Kozo Kaibuchi, Japan*
Yoshikatsu Kanai, Japan*
Francesca Levi-Schaffer, Israel
Eliot Ohlstein, USA - Editor
Joerg Striessnig, Austria - VGICs Liaison
John Peters, UK - LGICs Liaison
Alex Phipps, UK
Mary Vore, USA

Ex Officio
Sam Enna, USA - IUPHAR President
Michael Spedding, France - IUPHAR Secretary-General
Petra Thürmann, Germany - IUPHAR Treasurer
Simon Maxwell, UK - Educational Site Project Leader
Jamie Davies, UK - Database Chair/Principal Investigator
Joanna Sharman, UK - Senior Database Developer
Adam Pawson, UK - Senior Database Curator
Elena Faccenda, UK - Database Curator
Christopher Southan, Sweden - Senior Cheminformatician/Curator
Veronika Divincova, UK - Project Administrator
Elspeth Bruford, UK - representing HGNC
Amrita Ahluwalia, UK - BJP Editor-in-Chief

Past Chairs (Ex Officio)
Paul Vanhoutte, Hong Kong
Bob Ruffolo, USA

Corresponding Members
Susan Amara, USA
Tom Bonner, USA *(Past Core Member)*
Michel Bouvier, Canada
Thomas Burris, USA
William Catterall, USA *(Past Core Member)*
Steven Charlton, UK
Moses Chao, USA
Steven L. Colletti, USA
Graham Collingridge, UK
Sir Colin T. Dollery, UK *(Founder and Past Core Member)*
Richard Eglen, UK
Steven Foord, UK
David Gloriam, Denmark
Gillian Gray, UK
Debbie Hay, New Zealand
Allyn Howlett, USA
Franz Hofmann, Germany
Yu Huang, Hong Kong
Ad P. Ijzerman, The Netherlands
Michael F. Jarvis, USA
Bong-Kiun Kaang, Korea
Eamonn Kelly, UK
Terry Kenakin, USA
Janos Kiss, Hungary
Stefan Knapp, Germany
Chris Langmead, Australia
Vincent Laudet, France *(Past Core Member)*
Margaret (Mandy) MacLean, UK
Neil Marrion, UK
Fiona Marshall, UK
Alistair Mathie, UK
Ian McGrath, UK
Graeme Milligan, UK
Rick Neubig, USA *(Past Core Member)*
Stefan Offermanns, Germany
Richard Olsen, USA
Jean-Philippe Pin, France *(Past Core Member)*
Helgi Schiöth, Sweden
Graeme Semple, USA
David Searls, USA
Roland Staal, USA
Bart Staels, France
Georg Terstappen, Germany

Clinical Translational Pharmacology Group (core member Sir Colin Dollery)
Ed Bullmore, UK
Robert Dow, UK
Garrett Fitzgerald, USA
Alex Phipps, UK
Patrick du Souich, Canada
David Webb, UK
Don Birkett, Australia

Appendix II: NC-IUPHAR Subcommittees (listing of chairs)

G protein-coupled receptors Subcommittees

5-Hydroxytryptamine: Nick Barnes, John Neumaier
Acetylcholine (muscarinic): Arthur Christopoulos
Adenosine: Adriaan Izjerman

alpha$_1$-adrenoceptors: Dianne Perez
alpha$_2$-adrenoceptors: Mika Scheinin
Angiotensin: Sadashiva Karnik

Apelin: Anthony Davenport
beta-adrenoceptors: Terry Hébert
Bile acid: Anthony Davenport

Bombesin: Robert Jensen
Bradykinin: VACANT
Calcitonin: Debbie Hay, David Poyner

Calcium-sensing: Ed Brown, Hans Bräuner-Osborne
Cannabinoid: Roger Pertwee, Allyn Howlett
Chemokine: Philip Murphy

Cholecystokinin: Laurence Miller
Complement peptide: Peter Monk
Corticotropin-releasing factor: Richard Hauger, Frank Dautzenberg

Dopamine: Raul Gainetdinov
Endothelin: Anthony Davenport
Estrogen (G protein coupled): VACANT

Formylpeptide family: Richard Ye
Free fatty acid: VACANT
Frizzled: Gunnar Schulte

GABA$_B$: Bernhard Bettler
Galanin: Andrew Gundlach
Ghrelin: Birgitte Holst

Glucagon receptor family: Laurence Miller
Glycoprotein hormone: Deborah Segaloff
Gonadotrophin-releasing hormone: Adriaan Ijzerman

Histamine: Paul Chazot
Hydroxycarboxylic acid: Stefan Offermanns
Kisspeptin: Anthony Davenport

Leukotriene: Magnus Bäck
Lysophospholipid (LPA): Jerold Chung
Lysophospholipid (S1P): Sarah Spiegel

Melanin-concentrating hormone: Jean-Louis Nahon
Melanocortin: Tung Fong, Helgi Schiöth
Melatonin: Ralf Jockers

Metabotropic glutamate: Cyril Goudet
Motilin: Anthony Davenport
Neuromedin U: Gary Willars

Neuropeptide FF/neuropeptide AF: Jean-Marie Zajac
Neuropeptide S: Girolamo Calo'
Neuropeptide W/neuropeptide B: Anthony Davenport

Neuropeptide Y: Dan Larhammar
Neurotensin: Jean Mazella
Opioid: Larry Toll

Orexin: Christopher Winrow
P2Y: Geoffrey Burnstock
Parathyroid hormone: Jean-Pierre Vilardaga

Peptide P518: Jerome Leprince
Platelet-activating factor: VACANT
Prokineticin: Philippe Rondard

Prolactin-releasing peptide: Helgi Schiöth
Prostanoid: Xavier Norel
Protease-activated: Nigel Bunnett

Relaxin family peptide: Roger Summers
Relaxin-like: Nick Barker
Somatostatin: Stephan Schulz

Tachykinin: Susan Leeman, Steven Douglas
Trace amine: Janet Maguire
Thyrotropin-releasing hormone: Marvin Gershengorn

Urotensin: Hubert Vaudry
Vasopressin and oxytocin: Bernard Mouillac
VIP and PACAP: Joseph Pisegna

Ligand-gated ion channels Subcommittees
John Peters (Liaison for all LGIC subcommittees)

5-HT$_3$: John Peters
GABA$_A$: Richard Olsen
Glycine: Joseph Lynch
Ionotropic glutamate: Graham Collingridge
Nicotinic acetylcholine: Neil Millar
P2X: Charles Kennedy
ZAC: Timothy Hales

Voltage-gated ion channels Subcommittees
Joerg Striessnig (Liaison for all VGIC subcommittees)

Calcium-activated potassium: Len Kaczmarek
CatSper and Two-Pore: David Chapman
Cyclic nucleotide-regulated: Martin Biel
Inwardly rectifying potassium: Paul Slesinger
Transient Receptor Potential: David Clapham
Two-P potassium: Steven Goldstein
Voltage-gated calcium: William Catterall
Voltage-gated potassium: Lily Jan
Voltage-gated sodium: William Catterall

Nuclear hormone receptors Subcommittees
John Cidlowski and Thomas Burris (Liaisons for all NHR subcommittees

Androgen receptors: Nancy Weigel
Progesterone Receptors: Dean Edwards
Estrogen receptors: Kenneth Korach
Thyroid hormone receptors: Douglas Forrest
Vitamin D receptors: J. Wesley Pike
Mineralocorticoid receptors: Peter Fuller
LXR receptors: Donald McDonnell
Glucocorticoid receptors: Robert Oakley, Derek Cain
ROR receptors: Anton Jetten

Adenylyl cyclases Subcommittee
Carmen Dessauer

Antibodies Subcommittee
Alex Phipps

Drug Target and Chemistry Curation Subcommittee
Christopher Southan

Non-coding RNAs Subcommittee
Andrew Baker

Gasotransmitters Subcommittee
Andreas Papapetropoulos, Csaba Szabo

Guanylyl cyclases Subcommittee
Adrian Hobbs, Scott Waldman

Kinases and Epiegentics Subcommittee
Doriano Fabbro and Stefan Knapp

Pattern Recognition Receptors Subcommittee
Clare Bryant

Proteases Subcommittee
Anthony Turner

Transporters Subcommittee
Stephen Alexander

Concise Guide to PHARMACOLOGY Editors
Stephen Alexander, John Peters, Eamonn Kelly, Neil Marrion

Appendix III: NC-IUPHAR publications

NC-IUPHAR publications in *Pharmacological Reviews* (2015/16)

Karnik SS, Unal H, Kemp JR, Tirupula KC, Eguchi S, Vanderheyden PM, Thomas WG. (2015) International Union of Basic and Clinical Pharmacology. XCIX. Angiotensin Receptors: Interpreters of Pathophysiological Angiotensinergic Stimuli. Pharmacol Rev. 67: 754-819. [PMID:26315714]

Panula P, Chazot PL, Cowart M, Gutzmer R, Leurs R, Liu WLS, Stark H, Thurmond RL, Haas HL. (2015) International Union of Basic and Clinical Pharmacology. XCVIII. Histamine Receptors. Pharmacol Rev. 67: 601-55. [PMID:26084539]

Prossnitz ER, Arterburn JB. (2015) International Union of Basic and Clinical Pharmacology. XCVII. G Protein-Coupled Estrogen Receptor and Its Pharmacologic Modulators. Pharmacol Rev. 67: 505-40. [PMID:26023144]

Bryant CE, Orr S, Ferguson B, Symmons MF, Boyle JP, and Monie TP. (2015) International Union of Basic and Clinical Pharmacology. XCVI. Pattern Recognition Receptors in Health and Disease. Pharmacol Rev. 67: 462-504. [PMID:25829385]

Halls ML, Bathgate RA, Sutton SW, Dschietzig TB, Summers RJ. (2015) International Union of Basic and Clinical Pharmacology. XCV. Recent advances in the understanding of the pharmacology and biological roles of relaxin family peptide receptors 1-4, the receptors for relaxin family peptides. Pharmacol Rev. 67: 389-440. [PMID:25761609]

Hamann J, Aust G, Araç D, Engel FB, Formstone C, Fredriksson R, Hall RA, Harty BL, Kirchhoff C, Knapp B, Krishnan A, Liebscher I, Lin HH, Martinelli DC, Monk KR, Peeters MC, Piao X, Prömel S, Schöneberg T, Schwartz TW, Singer K, Stacey M, Ushkaryov YA, Vallon M, Wolfrum U, Wright MW, Xu L, Langenhan T, Schiöth HB. (2015) International Union of Basic and Clinical Pharmacology. XCIV. Adhesion G Protein-Coupled Receptors. Pharmacol Rev. 67: 338-67. [PMID:25713288]

Gardella TJ, Vilardaga JP. (2015) International Union of Basic and Clinical Pharmacology. XCIII. The Parathyroid Hormone Receptors-Family B G Protein-Coupled Receptors. Pharmacol Rev. 67: 310-37. [PMID:25713287]

Vaudry H, Leprince J, Chatenet D, Fournier A, Lambert DG, Le Mével JC, Ohlstein EH, Schwertani A, Tostivint H, Vaudry D. (2015) International Union of Basic and Clinical Pharmacology. XCII. Urotensin II, urotensin II-related peptide, and their receptor: from structure to function. Pharmacol Rev. 67: 214-58. [PMID:25535277]

Kellenberger S, Schild L. (2015) International Union of Basic and Clinical Pharmacology. XCI. Structure, Function, and Pharmacology of Acid-Sensing Ion Channels and the Epithelial Na+ Channel. Pharmacol Rev. 67: 1-35. [PMID:25287517]

NC-IUPHAR reviews in the *British Journal of Pharmacology* (2015/16)

Carvalho S, Levi-Schaffer F, Sela M, Yarden Y. (2016) Immunotherapy of cancer: from monoclonal to oligoclonal cocktails of anti-cancer antibodies: IUPHAR Review 18. Br J Pharmacol. doi: 10.1111/bph.13450 [PMID:26833433]

Landolina N, Levi-Schaffer F. (2016) Monoclonal antibodies: the new magic bullets for allergy: IUPHAR Review 17. Br J Pharmacol. doi: 10.1111/bph.13396: first published online 1 Feb 2016 [PMID:26620589]

Tiligada E, Ishii M, Riccardi C, Spedding M, Simon HU, Teixeira MM, Cuervo ML, Holgate ST, Levi-Schaffer F. (2015) The expanding role of immunopharmacology - IUPHAR Review 16. Br J Pharmacol. 172: 4217–27. [PMID:26173913]

McGrath JC, Pawson AJ, Sharman JL, Alexander SP. (2015) BJP is linking its articles to the IUPHAR/BPS Guide to PHARMACOLOGY. Br J Pharmacol. 172: 2929–32 [PMID:25965085]

Bachelerie F, Graham GJ, Locati M, Mantovani A, Murphy PM, Nibbs R, Rot A, Sozzani S, Thelen M. (2015) An atypical addition to the chemokine receptor nomenclature: IUPHAR Review 15. Br J Pharmacol. 2015 May 11. DOI: 10.1111/bph.13182 [Epub ahead of print] [PMID:25958743]

Fabbro D, Cowan-Jacob SW, Moebitz H. (2015)10 things you should know about protein kinases: IUPHAR Review 14. Br J Pharmacol. 172: 2675–700 [PMID:25630872]

Additional GtoPdb Team publications

Davenport AP, Hyndman KA, Dhaun N, Southan C, Kohan DE, Pollock JS, Pollock DM, Webb DJ, Maguire JJ. (2016) Endothelin. Pharmacol Rev. 2016 Apr;68(2):357-418. [PMID:26956245]

Southan C, Sharman JL, Benson HE, Faccenda E, Pawson AJ, Alexander SPH, Buneman OP, Davenport AP, McGrath JC, Peters JA, Spedding M, Catterall WA, Fabbro D, Davies JA; NC-IUPHAR. (2016) The IUPHAR/BPS Guide to PHARMACOLOGY in 2016: towards curated quantitative interactions between 1300 protein targets and 6000 ligands. Nucl. Acids Res. (Database Issue): doi: 10.1093/nar/gkv1037 Epub ahead of print. [PMID:26464438]

Babbitt PC, Bagos PG, Bairoch A, Bateman A, Chatonnet A, Chen MJ, Craik DJ, Finn RD, Gloriam 8, Haft DH, Henrissat B, Holliday GL, Isberg V, Kaas Q, Landsman D, Lenfant N, Manning G, Nagano N, Srinivasan N, O'Donovan C, Pruitt KD, Sowdhamini R, Rawlings ND, Saier MH Jr, Sharman JL, Spedding M, Tsirigos KD, Vastermark A, Vriend G. (2015) Creating a specialist protein resource network: a meeting report for the protein bioinformatics and community resources retreat. Database. bav063. [PMID:26284514]

Southan C. (2015) Expanding opportunities for mining bioactive chemistry from patents. Drug Discovery Today: Technologies. 2015 Feb 10. doi:10.1016/j.ddtec.2014.12.001 [Epub ahead of print]

Appendix IV: Database Statistics

Target class	Number of targets
7TM receptors	395
G protein-coupled receptors including orphans	389
Orphan G protein-coupled receptors	129
Other 7TM proteins	6
Nuclear hormone receptors	48
Catalytic receptors	239
Ligand-gated ion channels	81
Voltage-gated ion channels	144
Other ion channels	47
Enzymes	1168
Transporters	508
Other protein targets	139
Total number of targets	2769

Chemical class	Number of ligands
Synthetic organics	5303
Metabolites	582
Endogenous peptides	763
Other peptides including synthetic peptides	1236
Natural products	241
Antibodies	169
Inorganics	34
Approved drugs	1256
Withdrawn drugs	67
Drugs with INNs	1942
Labelled ligands	594
Total number of ligands	8328

Number of curated binding constants	14249
Number of binding constants from large scale screens	31207
Number of references	29049

This report was compiled by Adam Pawson and Steve Alexander, March, 2016