

Structure-function studies on two phosphoenolpyruvate carboxylases

Lakshmi Dharmarajan

Dissertation submitted to the faculty of the Virginia Polytechnic Institute and
State University in partial fulfillment of the requirements for the degree of

Doctor of Philosophy

in

Genetics, Bioinformatics and Computational Biology

Biswarup Mukhopadhyay, chair

David R. Bevan

Alexey Onufriev

Robert H. White

Paul R. Carlier

October 29, 2010

Blacksburg, Virginia

Keywords: phosphoenolpyruvate, structure-function, active-site lid, anion-
quadrupole interaction, PEP-Mn²⁺ distance, inhibition

Copyright 2010, Lakshmi Dharmarajan

Appendix for all Citations of Copyrighted Works

Fig. 2.1. [used with permission]

Yang, J., Kalhan, S. C., and Hanson, R. W. (2009) What is the metabolic role of phosphoenolpyruvate carboxykinase?, *J Biol Chem* 284, 27025-27029, © the American Society for Biochemistry and Molecular Biology. Used with permission from ASBMB Journals, 2011.

Fig. 2.2. [used with permission]

Dunten, P., Belunis, C., Crowther, R., Hollfelder, K., KammLott, U., Levin, W., Michel, H., Ramsey, G. B., Swain, A., Weber, D., and Wertheimer, S. J. (2002) Crystal structure of human cytosolic phosphoenolpyruvate carboxykinase reveals a new GTP-binding site, *J Mol Biol* 316, 257-264. Used with permission from Elsevier, 2011.

Fig. 2.3. [used with permission]

Carlson, G. M., and Holyoak, T. (2009) Structural insights into the mechanism of phosphoenolpyruvate carboxykinase catalysis, *J Biol Chem* 284, 27037-27041, © the American Society for Biochemistry and Molecular Biology. Used with permission from ASBMB Journals, 2011.

Fig. 2.4. [used with permission]

Carlson, G. M., and Holyoak, T. (2009) Structural insights into the mechanism of phosphoenolpyruvate carboxykinase catalysis, *J Biol Chem* 284, 27037-27041, © the American Society for Biochemistry and Molecular Biology. Used with permission from ASBMB Journals, 2011.

Fig. 2.5. [used with permission]

A. Dharmarajan, L., Case, C. L., Dunten, P., and Mukhopadhyay, B. (2008) Tyr²³⁵ of human cytosolic phosphoenolpyruvate carboxykinase influences catalysis through an anion-quadrupole interaction with phosphoenolpyruvate carboxylate, *FEBS J* 275, 5810-5819. Permission from John Wiley and Sons, 2011.

B. Case, C. L., Concar, E. M., Boswell, K. L., and Mukhopadhyay, B. (2006) Roles of Asp⁷⁵, Asp⁷⁸, and Glu⁸³ of GTP-dependent phosphoenolpyruvate carboxykinase from *Mycobacterium smegmatis*, *J Biol Chem* 281, 39262-39272, © the American Society for Biochemistry and Molecular Biology. Used with permission from ASBMB Journals, 2011.

Fig. 2.6. [fair use]

Mecozzi, S., West, A. P., Jr., and Dougherty, D. A. (1996) Cation- π interactions in aromatics of biological and medicinal interest: electrostatic potential surfaces as a useful qualitative guide, *Proc Natl Acad Sci U S A* 93, 10566-10571. Fair use determination attached.

Fig. 7.1. [fair use]

Kraszewski, J. (2007) Enzymology and Physiology of a New Type of Phosphoenolpyruvate Carboxylase and the Development of a Pyruvate Carboxylase Expression System, In *Biochemistry*, Virginia Tech. Fair use determination attached.

Fig. 8.1. [used with permission]

Case, C. L., Concar, E. M., Boswell, K. L., and Mukhopadhyay, B. (2006) Roles of Asp⁷⁵, Asp⁷⁸, and Glu⁸³ of GTP-dependent phosphoenolpyruvate carboxykinase from *Mycobacterium smegmatis*, *J Biol Chem* 281, 39262-39272, © the American Society for Biochemistry and Molecular Biology. Used with permission from ASBMB Journals, 2011.

Copyright Permission Policy

These guidelines apply to the reuse of articles, figures, charts and photos in the *Journal of Biological Chemistry*, *Molecular & Cellular Proteomics* and the *Journal of Lipid Research*

For authors reusing their own material:

Authors need **NOT** contact the journal to obtain rights to reuse their own material. They are automatically granted permission to do the following:

- Reuse the article in print collections of their own writing.
- Present a work orally in its entirety.
- Use an article in a thesis and/or dissertation.
- Reproduce an article for use in the author's courses. (If the author is employed by an academic institution, that institution also may reproduce the article for teaching purposes.)
- Reuse a figure, photo and/or table in future commercial and noncommercial works.
- Post a copy of the paper in PDF that you submitted via BenchPress.
 - Only authors who published their papers under the "Author's Choice" option may post the final edited PDFs created by the publisher to their own/departmental/university Web sites.
 - All authors may link to the journal site containing the final edited PDFs created by the publisher.

Please note that authors must include the following citation when using material that appeared in an ASBMB journal:

"This research was originally published in Journal Name. Author(s). Title. *Journal Name*. Year; Vol:pp–pp. © the American Society for Biochemistry and Molecular Biology."

For other parties using material for noncommercial use:

Other parties are welcome to copy, distribute, transmit and adapt the work — at no cost and without permission — for noncommercial use as long as they attribute the work to the original source using the citation above.

Examples of noncommercial use include:

- Reproducing a figure for educational purposes, such as schoolwork or lecture presentations, with attribution.
- Appending a reprinted article to a Ph.D. dissertation, with attribution.


For other parties using material for commercial use:

Navigate to the article of interest and click the "Request Permissions" button on the middle navigation bar. (See diagram at right.) It will walk you through the steps for obtaining permission for reuse.

Examples of commercial use by parties other than authors include:

- Reproducing a figure in a book published by a commercial publisher.
- Reproducing a figure in a journal article published by a commercial publisher.

Updated Nov. 10, 2009



The screenshot shows a vertical navigation bar with several sections:

- Services**
 - Email this article to a friend
 - Alert me when this article is cited
 - Alert me if a correction is posted
 - Alert me when eletters are published
 - Similar articles in this journal
 - Similar articles in PubMed
 - Download to citation manager
 - Request Permissions
- Responses**
 - Submit a Letter to the Editor
- Citing Articles**
- Google Scholar**
- PubMed**
 - PubMed citation
 - Articles by Neves, S. R.
 - Articles by Neves, P.

A red arrow points to the "Request Permissions" option in the Services section.

Advertisement



Advertisement

**ELSEVIER LICENSE
TERMS AND CONDITIONS**

Apr 13, 2011

This is a License Agreement between lakshmi dharmarajan ("You") and Elsevier ("Elsevier") provided by Copyright Clearance Center ("CCC"). The license consists of your order details, the terms and conditions provided by Elsevier, and the payment terms and conditions.

All payments must be made in full to CCC. For payment instructions, please see information listed at the bottom of this form.

Supplier	Elsevier Limited The Boulevard, Langford Lane Kidlington, Oxford, OX5 1GB, UK
Registered Company Number	1982084
Customer name	lakshmi dharmarajan
Customer address	1315 University City Blvd, Apt 5 blacksburg, VA 24060
License number	2647111504115
License date	Apr 13, 2011
Licensed content publisher	Elsevier
Licensed content publication	Journal of Molecular Biology
Licensed content title	Crystal structure of human cytosolic phosphoenolpyruvate carboxykinase reveals a new GTP-binding site
Licensed content author	Pete Dunten, Charles Belunis, Robert Crowther, Kurt Hofffelder, Ursula Kammlott, Wayne Levin, Hanspeter Michel, Gwendolyn B Ramsey, Amy Swain, David Weber, Stanley J Wertheimer
Licensed content date	15 February 2002
Licensed content volume number	316
Licensed content issue number	2
Number of pages	8
Start Page	257
End Page	264
Type of Use	reuse in a thesis/dissertation
Portion	figures/tables/illustrations

Number of figures/tables /illustrations	1
Format	electronic
Are you the author of this Elsevier article?	No
Will you be translating?	No
Order reference number	
Title of your thesis/dissertation	Structure-function studies on two phosphoenolpyruvate carboxylases
Expected completion date	Apr 2011
Estimated size (number of pages)	140
Elsevier VAT number	GB 494 6272 12
Permissions price	0.00 USD
VAT/Local Sales Tax	0.0 USD / 0.0 GBP
Total	0.00 USD
Terms and Conditions	

INTRODUCTION

1. The publisher for this copyrighted material is Elsevier. By clicking "accept" in connection with completing this licensing transaction, you agree that the following terms and conditions apply to this transaction (along with the Billing and Payment terms and conditions established by Copyright Clearance Center, Inc. ("CCC"), at the time that you opened your Rightslink account and that are available at <http://myaccount.copyright.com>).

GENERAL TERMS

2. Elsevier hereby grants you permission to reproduce the aforementioned material subject to the terms and conditions indicated.

3. Acknowledgement: If any part of the material to be used (for example, figures) has appeared in our publication with credit or acknowledgement to another source, permission must also be sought from that source. If such permission is not obtained then that material may not be included in your publication/copies. Suitable acknowledgement to the source must be made, either as a footnote or in a reference list at the end of your publication, as follows:

“Reprinted from Publication title, Vol /edition number, Author(s), Title of article / title of chapter, Pages No., Copyright (Year), with permission from Elsevier [OR APPLICABLE SOCIETY COPYRIGHT OWNER].” Also Lancet special credit - “Reprinted from The Lancet, Vol. number, Author(s), Title of article, Pages No., Copyright (Year), with permission from Elsevier.”

4. Reproduction of this material is confined to the purpose and/or media for which permission is hereby given.
5. Altering/Modifying Material: Not Permitted. However figures and illustrations may be altered/adapted minimally to serve your work. Any other abbreviations, additions, deletions and/or any other alterations shall be made only with prior written authorization of Elsevier Ltd. (Please contact Elsevier at permissions@elsevier.com)
6. If the permission fee for the requested use of our material is waived in this instance, please be advised that your future requests for Elsevier materials may attract a fee.
7. Reservation of Rights: Publisher reserves all rights not specifically granted in the combination of (i) the license details provided by you and accepted in the course of this licensing transaction, (ii) these terms and conditions and (iii) CCC's Billing and Payment terms and conditions.
8. License Contingent Upon Payment: While you may exercise the rights licensed immediately upon issuance of the license at the end of the licensing process for the transaction, provided that you have disclosed complete and accurate details of your proposed use, no license is finally effective unless and until full payment is received from you (either by publisher or by CCC) as provided in CCC's Billing and Payment terms and conditions. If full payment is not received on a timely basis, then any license preliminarily granted shall be deemed automatically revoked and shall be void as if never granted. Further, in the event that you breach any of these terms and conditions or any of CCC's Billing and Payment terms and conditions, the license is automatically revoked and shall be void as if never granted. Use of materials as described in a revoked license, as well as any use of the materials beyond the scope of an unrevoked license, may constitute copyright infringement and publisher reserves the right to take any and all action to protect its copyright in the materials.
9. Warranties: Publisher makes no representations or warranties with respect to the licensed material.
10. Indemnity: You hereby indemnify and agree to hold harmless publisher and CCC, and their respective officers, directors, employees and agents, from and against any and all claims arising out of your use of the licensed material other than as specifically authorized pursuant to this license.
11. No Transfer of License: This license is personal to you and may not be sublicensed, assigned, or transferred by you to any other person without publisher's written permission.
12. No Amendment Except in Writing: This license may not be amended except in a writing signed by both parties (or, in the case of publisher, by CCC on publisher's behalf).
13. Objection to Contrary Terms: Publisher hereby objects to any terms contained in any purchase order, acknowledgment, check endorsement or other writing prepared by you,

which terms are inconsistent with these terms and conditions or CCC's Billing and Payment terms and conditions. These terms and conditions, together with CCC's Billing and Payment terms and conditions (which are incorporated herein), comprise the entire agreement between you and publisher (and CCC) concerning this licensing transaction. In the event of any conflict between your obligations established by these terms and conditions and those established by CCC's Billing and Payment terms and conditions, these terms and conditions shall control.

14. **Revocation:** Elsevier or Copyright Clearance Center may deny the permissions described in this License at their sole discretion, for any reason or no reason, with a full refund payable to you. Notice of such denial will be made using the contact information provided by you. Failure to receive such notice will not alter or invalidate the denial. In no event will Elsevier or Copyright Clearance Center be responsible or liable for any costs, expenses or damage incurred by you as a result of a denial of your permission request, other than a refund of the amount(s) paid by you to Elsevier and/or Copyright Clearance Center for denied permissions.

LIMITED LICENSE

The following terms and conditions apply only to specific license types:

15. **Translation:** This permission is granted for non-exclusive world **English** rights only unless your license was granted for translation rights. If you licensed translation rights you may only translate this content into the languages you requested. A professional translator must perform all translations and reproduce the content word for word preserving the integrity of the article. If this license is to re-use 1 or 2 figures then permission is granted for non-exclusive world rights in all languages.

16. **Website:** The following terms and conditions apply to electronic reserve and author websites:

Electronic reserve: If licensed material is to be posted to website, the web site is to be password-protected and made available only to bona fide students registered on a relevant course if:

This license was made in connection with a course,

This permission is granted for 1 year only. You may obtain a license for future website posting,

All content posted to the web site must maintain the copyright information line on the bottom of each image,

A hyper-text must be included to the Homepage of the journal from which you are licensing at <http://www.sciencedirect.com/science/journal/xxxxx> or the Elsevier homepage for books at <http://www.elsevier.com> , and

Central Storage: This license does not include permission for a scanned version of the material to be stored in a central repository such as that provided by Heron/XanEdu.

17. **Author website** for journals with the following additional clauses:

All content posted to the web site must maintain the copyright information line on the bottom of each image, and the permission granted is limited to the personal version of your paper. You are not allowed to download and post the published electronic version of your article (whether PDF or HTML, proof or final version), nor may you scan the printed edition to create an electronic version,

A hyper-text must be included to the Homepage of the journal from which you are licensing at <http://www.sciencedirect.com/science/journal/xxxxx> , As part of our normal production process, you will receive an e-mail notice when your article appears on Elsevier's online service ScienceDirect (www.sciencedirect.com). That e-mail will include the article's Digital Object Identifier (DOI). This number provides the electronic link to the published article and should be included in the posting of your personal version. We ask that you wait until you receive this e-mail and have the DOI to do any posting.

Central Storage: This license does not include permission for a scanned version of the material to be stored in a central repository such as that provided by Heron/XanEdu.

18. Author website for books with the following additional clauses:

Authors are permitted to place a brief summary of their work online only.

A hyper-text must be included to the Elsevier homepage at <http://www.elsevier.com>

All content posted to the web site must maintain the copyright information line on the bottom of each image

You are not allowed to download and post the published electronic version of your chapter, nor may you scan the printed edition to create an electronic version.

Central Storage: This license does not include permission for a scanned version of the material to be stored in a central repository such as that provided by Heron/XanEdu.

19. Website (regular and for author): A hyper-text must be included to the Homepage of the journal from which you are licensing at <http://www.sciencedirect.com/science/journal/xxxxx>. or for books to the Elsevier homepage at <http://www.elsevier.com>

20. Thesis/Dissertation: If your license is for use in a thesis/dissertation your thesis may be submitted to your institution in either print or electronic form. Should your thesis be published commercially, please reapply for permission. These requirements include permission for the Library and Archives of Canada to supply single copies, on demand, of the complete thesis and include permission for UMI to supply single copies, on demand, of the complete thesis. Should your thesis be published commercially, please reapply for permission.

21. Other Conditions:

v1.6

JOHN WILEY AND SONS LICENSE TERMS AND CONDITIONS

Apr 13, 2011

This is a License Agreement between lakshmi dharmarajan ("You") and John Wiley and Sons ("John Wiley and Sons") provided by Copyright Clearance Center ("CCC"). The license consists of your order details, the terms and conditions provided by John Wiley and Sons, and the payment terms and conditions.

All payments must be made in full to CCC. For payment instructions, please see information listed at the bottom of this form.

License Number	2647250547203
License date	Apr 13, 2011
Licensed content publisher	John Wiley and Sons
Licensed content publication	FEBS Journal
Licensed content title	Tyr235 of human cytosolic phosphoenolpyruvate carboxykinase influences catalysis through an anion-quadrupole interaction with phosphoenolpyruvate carboxylate
Licensed content author	Lakshmi Dharmarajan, Christopher L. Case, Pete Dunten, Biswarup Mukhopadhyay
Licensed content date	Dec 1, 2008
Start page	5810
End page	5819
Type of use	Dissertation/Thesis
Requestor type	Author of this Wiley article
Format	Electronic
Portion	Full article
Will you be translating?	No
Order reference number	
Total	0.00 USD

[Terms and Conditions](#)

TERMS AND CONDITIONS

This copyrighted material is owned by or exclusively licensed to John Wiley & Sons, Inc. or one of its group companies (each a "Wiley Company") or a society for whom a Wiley Company has exclusive publishing rights in relation to a particular journal (collectively "WILEY"). By clicking "accept" in connection with completing this licensing transaction, you agree that the following terms and conditions apply to this transaction (along with the billing and payment terms and conditions established by the Copyright Clearance Center Inc., ("CCC's Billing and Payment terms

and conditions"), at the time that you opened your Rightslink account (these are available at any time at <http://myaccount.copyright.com>)

Terms and Conditions

1. The materials you have requested permission to reproduce (the "Materials") are protected by copyright.
2. You are hereby granted a personal, non-exclusive, non-sublicensable, non-transferable, worldwide, limited license to reproduce the Materials for the purpose specified in the licensing process. This license is for a one-time use only with a maximum distribution equal to the number that you identified in the licensing process. Any form of republication granted by this licence must be completed within two years of the date of the grant of this licence (although copies prepared before may be distributed thereafter). The Materials shall not be used in any other manner or for any other purpose. Permission is granted subject to an appropriate acknowledgement given to the author, title of the material/book/journal and the publisher and on the understanding that nowhere in the text is a previously published source acknowledged for all or part of this Material. Any third party material is expressly excluded from this permission.
3. With respect to the Materials, all rights are reserved. Except as expressly granted by the terms of the license, no part of the Materials may be copied, modified, adapted (except for minor reformatting required by the new Publication), translated, reproduced, transferred or distributed, in any form or by any means, and no derivative works may be made based on the Materials without the prior permission of the respective copyright owner. You may not alter, remove or suppress in any manner any copyright, trademark or other notices displayed by the Materials. You may not license, rent, sell, loan, lease, pledge, offer as security, transfer or assign the Materials, or any of the rights granted to you hereunder to any other person.
4. The Materials and all of the intellectual property rights therein shall at all times remain the exclusive property of John Wiley & Sons Inc or one of its related companies (WILEY) or their respective licensors, and your interest therein is only that of having possession of and the right to reproduce the Materials pursuant to Section 2 herein during the continuance of this Agreement. You agree that you own no right, title or interest in or to the Materials or any of the intellectual property rights therein. You shall have no rights hereunder other than the license as provided for above in Section 2. No right, license or interest to any trademark, trade name, service mark or other branding ("Marks") of WILEY or its licensors is granted hereunder, and you agree that you shall not assert any such right, license or interest with respect thereto.
5. NEITHER WILEY NOR ITS LICENSORS MAKES ANY WARRANTY OR REPRESENTATION OF ANY KIND TO YOU OR ANY THIRD PARTY, EXPRESS, IMPLIED OR STATUTORY, WITH RESPECT TO THE MATERIALS OR THE ACCURACY OF ANY INFORMATION CONTAINED IN THE MATERIALS, INCLUDING, WITHOUT LIMITATION, ANY IMPLIED WARRANTY OF MERCHANTABILITY, ACCURACY, SATISFACTORY QUALITY, FITNESS FOR A PARTICULAR PURPOSE, USABILITY, INTEGRATION OR NON-INFRINGEMENT AND ALL SUCH WARRANTIES ARE HEREBY EXCLUDED BY WILEY AND ITS LICENSORS AND WAIVED BY YOU.
6. WILEY shall have the right to terminate this Agreement immediately upon breach of this Agreement by you.
7. You shall indemnify, defend and hold harmless WILEY, its Licensors and their respective directors, officers, agents and employees, from and against any actual or threatened claims, demands, causes of action or proceedings arising from any breach of this Agreement by you.
8. IN NO EVENT SHALL WILEY OR ITS LICENSORS BE LIABLE TO YOU OR ANY OTHER PARTY OR

ANY OTHER PERSON OR ENTITY FOR ANY SPECIAL, CONSEQUENTIAL, INCIDENTAL, INDIRECT, EXEMPLARY OR PUNITIVE DAMAGES, HOWEVER CAUSED, ARISING OUT OF OR IN CONNECTION WITH THE DOWNLOADING, PROVISIONING, VIEWING OR USE OF THE MATERIALS REGARDLESS OF THE FORM OF ACTION, WHETHER FOR BREACH OF CONTRACT, BREACH OF WARRANTY, TORT, NEGLIGENCE, INFRINGEMENT OR OTHERWISE (INCLUDING, WITHOUT LIMITATION, DAMAGES BASED ON LOSS OF PROFITS, DATA, FILES, USE, BUSINESS OPPORTUNITY OR CLAIMS OF THIRD PARTIES), AND WHETHER OR NOT THE PARTY HAS BEEN ADVISED OF THE POSSIBILITY OF SUCH DAMAGES. THIS LIMITATION SHALL APPLY NOTWITHSTANDING ANY FAILURE OF ESSENTIAL PURPOSE OF ANY LIMITED REMEDY PROVIDED HEREIN.

9. Should any provision of this Agreement be held by a court of competent jurisdiction to be illegal, invalid, or unenforceable, that provision shall be deemed amended to achieve as nearly as possible the same economic effect as the original provision, and the legality, validity and enforceability of the remaining provisions of this Agreement shall not be affected or impaired thereby.

10. The failure of either party to enforce any term or condition of this Agreement shall not constitute a waiver of either party's right to enforce each and every term and condition of this Agreement. No breach under this agreement shall be deemed waived or excused by either party unless such waiver or consent is in writing signed by the party granting such waiver or consent. The waiver by or consent of a party to a breach of any provision of this Agreement shall not operate or be construed as a waiver of or consent to any other or subsequent breach by such other party.

11. This Agreement may not be assigned (including by operation of law or otherwise) by you without WILEY's prior written consent.

12. Any fee required for this permission shall be non-refundable after thirty (30) days from receipt.

13. These terms and conditions together with CCC's Billing and Payment terms and conditions (which are incorporated herein) form the entire agreement between you and WILEY concerning this licensing transaction and (in the absence of fraud) supersedes all prior agreements and representations of the parties, oral or written. This Agreement may not be amended except in writing signed by both parties. This Agreement shall be binding upon and inure to the benefit of the parties' successors, legal representatives, and authorized assigns.

14. In the event of any conflict between your obligations established by these terms and conditions and those established by CCC's Billing and Payment terms and conditions, these terms and conditions shall prevail.

15. WILEY expressly reserves all rights not specifically granted in the combination of (i) the license details provided by you and accepted in the course of this licensing transaction, (ii) these terms and conditions and (iii) CCC's Billing and Payment terms and conditions.

16. This Agreement will be void if the Type of Use, Format, Circulation, or Requestor Type was misrepresented during the licensing process.

17. This Agreement shall be governed by and construed in accordance with the laws of the State of New York, USA, without regards to such state's conflict of law rules. Any legal action, suit or proceeding arising out of or relating to these Terms and Conditions or the breach thereof shall be instituted in a court of competent jurisdiction in New York County in the State of New York in the United States of America and each party hereby consents and submits to the personal jurisdiction of such court, waives any objection to venue in such court and consents to service of process by

registered or certified mail, return receipt requested, at the last known address of such party. . BY CLICKING ON THE "I ACCEPT" BUTTON, YOU ACKNOWLEDGE THAT YOU HAVE READ AND FULLY UNDERSTAND EACH OF THE SECTIONS OF AND PROVISIONS SET FORTH IN THIS AGREEMENT AND THAT YOU ARE IN AGREEMENT WITH AND ARE WILLING TO ACCEPT ALL OF YOUR OBLIGATIONS AS SET FORTH IN THIS AGREEMENT.

v1.4

Gratis licenses (referencing \$0 in the Total field) are free. Please retain this printable license for your reference. No payment is required.

If you would like to pay for this license now, please remit this license along with your payment made payable to "COPYRIGHT CLEARANCE CENTER" otherwise you will be invoiced within 48 hours of the license date. Payment should be in the form of a check or money order referencing your account number and this invoice number RLNK10969318.

Once you receive your invoice for this order, you may pay your invoice by credit card. Please follow instructions provided at that time.

**Make Payment To:
Copyright Clearance Center
Dept 001
P.O. Box 843006
Boston, MA 02284-3006**

For suggestions or comments regarding this order, contact Rightslink Customer Support: customer care@copyright.com or +1-877-622-5543 (toll free in the US) or +1-978-646-2777.

Draft 09/01/2009

(Questions? Concerns? Contact Gail McMillan, Director of the Digital Library and Archives at Virginia Tech's University Libraries: gailmac@vt.edu)

(Please ensure that Javascript is enabled on your browser before using this tool.)

Virginia Tech ETD Fair Use Analysis Results

This is not a replacement for professional legal advice but an effort to assist you in making a sound decision.

Name: Lakshmi Dharmarajan

Description of item under review for fair use: Fig. 2 ; Mecozzi, S., West, A. P., Jr., and Dougherty, D. A. (1996) Cation-pi interactions in aromatics of biological and medicinal interest: electrostatic potential surfaces as a useful qualitative guide, Proc Natl Acad Sci U S A 93, 10566-10571.

Report generated on: 04-13-2011 at : 11:12:00

Based on the information you provided:

Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: *in favor of fair use*

Factor 2

Your consideration of the nature of the copyrighted work you used weighs: *in favor of fair use*

Factor 3

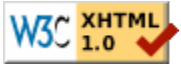
Your consideration of the amount and substantiality of your use of the copyrighted work weighs: *in favor of fair use*

Factor 4

Your consideration of the effect or potential effect on the market after your use of the copyrighted work weighs: *in favor of fair use*

Based on the information you provided, your use of the copyrighted work weighs:

in favor of fair use



Draft 09/01/2009

(Questions? Concerns? Contact Gail McMillan, Director of the Digital Library and Archives at Virginia Tech's University Libraries: gailmac@vt.edu)

(Please ensure that Javascript is enabled on your browser before using this tool.)

Virginia Tech ETD Fair Use Analysis Results

This is not a replacement for professional legal advice but an effort to assist you in making a sound decision.

Name: Lakshmi Dharmarajan

Description of item under review for fair use: Fig. 14A Kraszewski, J. (2007) Enzymology and Physiology of a New Type of Phosphoenolpyruvate Carboxylase and the Development of a Pyruvate Carboxylase Expression System, In Biochemistry, Virginia Tech

Report generated on: 04-28-2011 at : 08:08:36

Based on the information you provided:

Factor 1

Your consideration of the purpose and character of your use of the copyright work weighs: *in favor of fair use*

Factor 2

Your consideration of the nature of the copyrighted work you used weighs: *in favor of fair use*

Factor 3

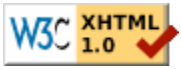
Your consideration of the amount and substantiality of your use of the copyrighted work weighs: *in favor of fair use*

Factor 4

Your consideration of the effect or potential effect on the market after your use of the copyrighted work weighs: *in favor of fair use*

Based on the information you provided, your use of the copyrighted work weighs:

in favor of fair use





permissions

Reuse permissions

Requests for permission to reuse material from this journal should be addressed to:

Managing Editor
IUCr Journals
5 Abbey Square
Chester CH1 2HU
UK

Email: med@iucr.org or click [here](#)

Please be sure to include the following information:

- The title, author(s) and page extent of the article you wish to republish, or, in the case where you do not wish to reproduce the whole article, details of the section(s) to be reproduced.
- The journal title, volume/issue number and year of publication in which the article appeared, and the page numbers of the article.
- Details of the publication in which you wish to reprint the Journal material.
- If the material is being edited or amended in any way, a copy of the final material as it will appear in your publication.
- Contact details for yourself, including a postal address.

If you wish to include material from **your own article** in a publication, prior permission is not required, subject to the following conditions:

- Reproduction is intended in a primary journal, secondary journal, CD-ROM, book or thesis.
- The original article in which the material appeared is cited.
- IUCr's copyright permission is indicated by the wording "Reproduced with permission of the International Union of Crystallography". In electronic form, this acknowledgement must be visible at the same time as the reused materials, and must be hyperlinked to **Crystallography Journals Online** (<http://journals.iucr.org/>).

Photocopying permissions

Teaching institutions with a current paid subscription to the journal may make multiple copies for teaching purposes without charge, provided such copies are not resold or copied. In all other cases, permission should be obtained from a reproduction rights organisation (see below) or directly from the Publisher.

Copyright Licensing Agency

Institutions based in the UK with a valid photocopying and/or digital license with the Copyright Licensing Agency may copy excerpts under the terms of their license. For further information go to [CLA](#).