Science Diliman



ISSN 0115-7809

July-December 2015 • Vol. 27 No. 2

SCIENCE DILIMAN is published semi-annually (June and December) by the University of the Philippines Diliman through the Office of the Vice Chancellor for Research and Development. The journal features articles of pure and applied sciences.

Editorial Board

Editor-in-Chief Irene M. Villaseñor, Ph.D.

Associate Editors

Jose Maria P. Balmaceda, Ph.D.
Louis Angelo M. Danao, Ph.D.
Carlos Primo C. David, Ph.D.
Alonzo A. Gabriel, Ph.D.
Marco Nemesio E. Montaño, Ph.D.
Jonas P. Quilang, Ph.D.
Rene N. Rollon, Ph.D.
Arnel A. Salvador, Ph.D.
Terence P. Tumolva, Ph.D.

Managing Editor
Gonzalo A. Campoamor II, Ph.D.

Editorial Assistant Narita E.C. de las Alas

Layout Artist
Dercylis G. Mararac

Copyeditor Sarah Penir

On the Cover:

The cover image is an artist's rendition of the equations used in one of the main articles of this *Science Diliman* issue. Image by Aina Ysabel B. Ramolete, University of the Philippines Diliman.

Contents of this journal may not be reproduced without the publisher's written permission except for fair use, i.e., for personal, educational and research purposes, in accordance with copyright law. Reprinting and republication in any other journal or compilation is likewise prohibited except as provided in the Publication Agreement when the author reprints his/her article for inclusion in any publication where he/she is the author or editor, subject to giving proper credit to the original publication of the article in the journal.

The views expressed in the articles are those of the authors and do not necessarily reflect the views of the publisher and the editors.

INTERNATIONAL ADVISORY BOARD

Teofilo A. Abrajano, Jr., Ph.D. King Abdullah University of Science and Technology Kingdom of Saudi Arabia

Rigoberto C. Advincula, Ph.D. Case School of Engineering Case Western Reserve University Cleveland, Ohio, USA

Kenneth Buckle, Ph.D.
Food Science and Technology Group
School of Chemical Sciences and Engineering
The University of New South Wales
Sydney, Australia

Jose B. Cruz, Jr., Ph.D.
Department of Electrical and Computer Engineering
Ohio State University
University of California, Irvine
University of Illinois, Urbana, USA

John P. Encarnacion, Ph.D.
Department of Earth and Atmospheric Sciences
Saint Louis University, USA

Mihali A. Felipe, Ph.D. Gerstein Lab, Bioinformatics Yale University, USA

Robert J. Howell, Ph.D.
Department of Mechanical Engineering
The University of Sheffield
Sheffield, United Kingdom

Jeanmiare E. Molina, Ph.D.
Department of Biology
Long Island University, Brooklyn, USA

Rudolf A. Roemer, Ph.D.
Centre for Scientific Computing and
Department of Physics
University of Warwick
United Kingdom

Raul K. Suarez, Ph.D.
Department of Ecology, Evolution
and Marine Biology
University of California, Sta. Barbara, USA

Myra O. Villareal, Ph.D. Life and Environmental Sciences University of Tsukuba, Japan