

EMORY UNIVERSITY SCHOOL OF MEDICINE

STANDARD CURRICULUM VITAE

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Name: Ichiro Matsumura

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Birthplace: Madison, Wisconsin

Citizenship: U.S.A.

Current Title And Affiliation:

2006-present Associate Professor of Biochemistry, Emory University School of Medicine

Previous Academic And Professional Appointments:

1988-90 Teaching Assistant in Biochemistry, University of California, Berkeley
1988-95 Graduate Research Assistant in Biochemistry, University of California, Berkeley
1995-2000 Post-doctoral Fellow, Indiana University and University of Texas at Austin
2000-2006 Assistant Professor of Biochemistry, Emory University School of Medicine

Education:

1984-88 B.S. Life Sciences, Massachusetts Institute of Technology
1988-95 Ph.D. Biochemistry, University of California, Berkeley
Thesis: The Roles of Aspartate 52 and Asparagine 46 in the Active Site of Chicken Egg-White Lysozyme. (Prof. Jack F. Kirsch)

Postgraduate Training:

1988-91 University of California, Berkeley, Department of Molecular and Cell Biology, Division of Biochemistry, Thesis advisor: Allan C. Wilson (deceased 1991)
1991-95 University of California, Berkeley, Department of Molecular and Cell Biology, Division of Biochemistry, Thesis advisor: Jack F. Kirsch

1995-2000 Indiana University, Department of Chemistry and University of Texas at Austin, Department of Chemistry. Post-doctoral fellow in the lab of Andrew D. Ellington.

Committee Memberships:

Institutional:

2001 Chemistry, Departmental Faculty Search Committee
 2001 Emory Office of Post-doctoral Education, Speaker in Workshop of Academic Careers: The Job Search
 2001-present Center for Fundamental and Applied Molecular Evolution, Co-founder and seminar coordinator (FAME has attracted ~\$2,700,000 in direct grant funding)
 2003-present Emory Office of Post-doctoral Education, internal evaluations of job application packages from Emory post-docs
 2003-present Biochemistry, Cell and Developmental Biology (BCDB) Graduate Research Program Executive Committee
 2005 Emory University, Predictive Health Symposium, Panelist, December 9.
 2006 Emory University, Computation and Biology Symposium, Panelist, March 30
 2006-07 Chemistry, Departmental Faculty Search Committee

National or International:

2001 Ad hoc member of NIH BNP Study Section
 2001-present NSF grant reviewer (3)
 2003 Proposal reviewer for Miller Institute for Basic Research, University of California, Berkeley, CA
 2004 Ad hoc member of NIH BBA Study Section
 2004 Session Chair, Gordon Research Conference on Biocatalysis, July 11-16
 2000-04 Petroleum Research Fund (ACS) proposal reviewer (2)
 2004-05 Ad hoc member of NIH BBA Study Section (2)
 2006 NASA grant reviewer
 2008 Ad hoc member of NIH GVE Study Section

Manuscript Reviewer:

1998 *RNA* (1)
 1999-present *Proceedings of the National Academy of Sciences* (2)
 1999-present *Journal of the American Chemical Society* (3)
 2000-present *Molecular Biology and Evolution* (1)
 2001-2002 Associate Editor of *Directed and Applied Evolution* (1)
 2001-present *Protein Science* (4)
 2002-present *Genetics* (1)
 2002-present *Biotechnology Progress* (1)
 2002-present *Journal of Molecular Evolution* (1)
 2003-present *Protein Engineering, Design and Selection* (3)
 2003-present *Nucleic Acids Research* (1)
 2003-present *Biotechniques* (1)
 2004-present *Journal of Molecular Biology* (4)
 2005-present *Enzyme and Microbial Technology* (1)

2006-present *Biochemistry* (1)
 2007-present *Biophysical Journal* (1)
 2007-present *BMC Biotechnology* (1)
 2007-present *Prot. Exp. Purif.* (1)
 2007-present *ACS Chem. Biol.* (1)
 2007-present *Chem. Biol.* (1)

Honors And Awards:

1984 National Merit Scholar, Okemos High School Valedictorian (Michigan)
 1988 National Science Foundation Fellowship, honorable mention
 1993-1994 National Institutes of Health Bioengineering Trainee
 1994 White House Fellowship, Regional Finalist
 1996-1997 Walther Cancer Institute Post-doctoral Research Fellowship
 1997-1999 National Science Foundation-Alfred P. Sloan Foundation Post-doctoral Research Fellowship in Molecular Evolution
 2004 Alec E. Hodel Excellence in Teaching Award (Biochemistry Department)

Society Memberships:

1994-present American Association for the Advancement of Science
 1995-96 American Society for Microbiology
 2003-present American Chemical Society
 2003-06 Protein Society
 2004-06 American Society for Biochemistry and Molecular Biology
 2007-present Society for Biological Engineers

Organization of National or International Conferences:

2004 Chair of session, Gordon Research Conference on Biocatalysis

Research Focus:

My objective is to understand the adaptive evolution of protein structure and function. I recapitulate the evolutionary process in the laboratory, and identify the correlations between specific changes in tertiary structure and improvements in fitness. These experiments often yield proteins with enhanced industrial or pharmaceutical utility.

Grant Support:**Active Support:**

2004-08 "Towards synthetic biology: the replication of synthetic polymers"
 NSF/CHE-0404677, Co-PI (8% effort)
 Direct costs/year: \$309,465 to group (\$77,366 to Matsumura lab)

2005-10 "Directed evolution to diversify HIV protease function"
 NIH/NIGMS (1 R01 GM074264-01), Principal Investigator (42% effort)
 Direct costs/year: \$189,000

Previous Support:

- 2000-01 "In vitro evolution to redesign an enzyme's specificity"
University Research Council, Principal Investigator (0% effort)
Direct costs/year: \$30,000
- 2002-03 "Accelerating *In vitro* Protein Evolution"
Emory-Georgia Tech Biomedical Technology Research Center
Direct costs/year: \$17,000
- 2001-04 "In vitro evolution to diversity an enzyme's specificity"
NSF BIO/MCB (#0109668), Principle Investigator (15% effort)
Direct costs/year: \$75,000
- 2003-05 "Engineered alkaline phosphatases as biosensors"
NIH/NIAID (1 R21AI054602-01), Principal Investigator (50% effort)
Direct costs/year: \$175,000

Formal Teaching (Graduate and Medical School):

| | | | | |
|--|----------------|---------------|-----------------------|------------------|
| 2000-01: | | | | Total Hours: 4 |
| <u>Course</u> | <u>Program</u> | <u>Duties</u> | <u>Lecture Hours</u> | |
| IBS593 Molecular Evolution | Graduate | Lecturer | 2 | |
| IBS760R Evolution of Viruses | Graduate | Lecturer | 2 | |
| 2001-02: | | | | Total Hours:7.5 |
| <u>Course</u> | <u>Program</u> | <u>Duties</u> | <u>Lecture Hours</u> | |
| IBS593 Molecular Evolution | Graduate | Lecturer | 2 | |
| IBS520 Biochemistry | Graduate | Lecturer | 1 (small group) | |
| IBS700 Macromol structure/function | Graduate | Lecturer | 1.5 | |
| IBS760R Major Transitions in Evol | Graduate | Co-director | 3 | |
| 2002-03 | | | | Total Hours:13 |
| <u>Course</u> | <u>Program</u> | <u>Duties</u> | <u>Lecture Hours</u> | |
| BAHS501 Biochemistry | Allied Health | Lecturer | 5 | |
| IBS520 Biochemistry | Graduate | Lecturer | 4 (incl. small group) | |
| BCDB790R Graduate Seminar | Graduate | Co-director | 1 | |
| BCDB570R 1 st Year Journal Club | Graduate | Co-director | 1 | |
| IBS700 Macromol structure/function | Graduate | Lecturer | 3 | |
| 2003-04 | | | | Total Hours:15.5 |
| <u>Course</u> | <u>Program</u> | <u>Duties</u> | <u>Lecture Hours</u> | |
| BAHS501 Biochemistry | Allied Health | Co-director | 8 | |
| IBS520 Biochemistry | Graduate | Lecturer | 6 | |
| BCDB790R Graduate Seminar | Graduate | Co-director | 0 | |
| BCDB570R 1 st Year Journal Club | Graduate | Co-director | 1 | |

BCDB597R 1st Year Lab Rotations Graduate Coordinator 0.5

2004-05 Total Hours:14

| <u>Course</u> | <u>Program</u> | <u>Duties</u> | <u>Lecture Hours</u> |
|---|----------------|---------------|----------------------|
| BAHS501 Biochemistry | Allied Health | Lecturer | 9 |
| IBS555 Biochemistry | Graduate | Lecturer | 4.5 |
| BCDB570R 1 st Year Journal Club | Graduate | Lecturer | 1 |
| BCDB597R 1 st Year Lab Rotations | Graduate | Coordinator | 0.5 |

2005-06 Total Hours:14

| <u>Course</u> | <u>Program</u> | <u>Duties</u> | <u>Lecture Hours</u> |
|---|----------------|---------------|----------------------|
| BAHS501 Biochemistry | Allied Health | Director | 11 |
| IBS555 Biochemistry | Graduate | Lecturer | 3 |
| BCDB597R 1 st Year Lab Rotations | Graduate | Coordinator | 0.5 |

2006-07 Total Hours:14

| <u>Course</u> | <u>Program</u> | <u>Duties</u> | <u>Lecture Hours</u> |
|----------------------|----------------|---------------|----------------------|
| BAHS501 Biochemistry | Allied Health | Director | 16 |
| IBS555 Biochemistry | Graduate | Lecturer | 1.5 |

2007-08 Total Hours:7.5

| <u>Course</u> | <u>Program</u> | <u>Duties</u> | <u>Lecture Hours</u> |
|----------------------|----------------|---------------|----------------------|
| BAHS501 Biochemistry | Allied Health | Director | 6 |
| IBS555 Biochemistry | Graduate | Lecturer | 1.5 |

Supervisory Teaching:

Masters and Doctoral Students:

| Students | Degree/Program | Current Position |
|------------------|-----------------------|--|
| Dina Greene | Ph.D. BCDB | Ph.D. candidate, Guy Benian lab |
| Melissa Geddie | Ph.D. BCDB | Post-doc, Susan Lindquist lab (MIT) |
| Taryn O'Loughlin | Ph.D. BCDB | Managing Editor, Clinical Care Options |

Post-doctoral Fellows:

| Fellow | Degree/Yr/Institution | Current Position |
|---------------|--|--|
| Kristen Woods | Ph.D./2003/Georgia Institute of Technology | Research Associate, USDA (Peoria, IL) |
| Wayne Patrick | Ph.D./2002/Cambridge University | Assistant Professor, Massey University (Auckland, New Zealand) |
| Anton Bryksin | Ph.D./2007/Novosibirsk State University | Post-doctoral Fellow |

Other:

| Student | Program | Current Position |
|-------------------|----------------|-------------------------------|
| Jill Hibshman | undergraduate | Medical School, Emory |
| Shelley Elvington | BCDB rotation | Post-doc, Stanford University |
| Thomas Vanderford | PBEE rotation | Sylvia Staprans lab |
| Christina Tran | NSF REU | Medical School, UT Southwest |
| Charles O'Brien | GMB rotation | unknown |
| Justin Cotney | GMB rotation | Gerald Shadel lab |
| Ethan Bennet | GMB rotation | Scott Devine lab |
| Lori Rowe | BCDB rotation | Paul Deutsch lab |
| Marie Cross | BCDB rotation | Maureen Powers lab |
| Robert Lyng | BCDB rotation | Barry Shur lab |
| Christine Griffin | BCDB rotation | Grace Pavlath lab |
| Shivan Desai | undergraduate | senior Virginia Tech |
| Rebecca Iskow | GMB rotation | Scott Devine lab |
| Lauren Smith | GMB rotation | Jiao-Xiang Li lab |
| Dana Tucker | BCDB rotation | Andrew Kowalczyk lab |
| Dan Swartzlander | GMB rotation | Paul Doetsch lab |
| Myffy Hopkins | BCDB rotation | Nutrition program |
| Michael Legett | GMB rotation | John Lucchesi lab |
| Michael East | BCDB rotation | first year student |
| Michael Santoro | GMB rotation | first year student |

Thesis Committees:**Current:**

Allison Lange (BCDB)
 Gary Ratner (BCDB)
 Kenyetta Johnson (Georgia Tech, Chemistry and Biochemistry)
 Justin Cotney (GMB, Yale University)
 Andrew Bennett (GMB)
 Rebecca Sanders (BCDB)
 Lyra Booker (GMB)
 Robert Collins (BCDB)
 Rebekah Kushner (BCDB)
 Anthony Luyai (BCDB)
 Rajindra Aryal (BCDB)

Previous:

Elaine Mills (BCDB, M.S.)
 Karen Polizzi (Georgia Tech, Chemical Engineering, Ph.D.)
 Shelley Elvington (BCDB, Ph.D.)
 Fatima Khwaja (GMB, Ph.D.)
 Dina Greene (BCDB)
 Melissa Geddie (BCDB)

Taryn O'Loughlin (BCDB)
John McQuiston (PBEE)

Lectureships, Seminar Invitations and Conference Invitations:

1. Gordon Research Conference on Microbial Population Biology, Plymouth, New Hampshire, August 1999.
2. University of Texas at Austin, Integrative Biology Departmental Seminar, October 14, 1999
3. Gordon Research Conference on Molecular Evolution, Hayama, Japan, October 26, 1999
4. RIKEN Institute Departmental Seminar, Tokyo, Japan, October 29, 1999
5. Johns Hopkins School of Medicine, Pharmacology and Molecular Sciences Departmental Seminar, Jan. 13, 2000.
6. Emory University, Department of Biochemistry Seminar, February 17, 2000.
7. Colorado State University, Cell and Molecular Biology Program Symposium, February 25, 2000.
8. IBC Fifth Annual World Congress on Enzyme Technologies, Las Vegas, NV, February 29, 2000.
9. Syracuse University, Department of Biology Seminar, March 3, 2000.
10. Evolution 2000 (Joint meeting of SSE, SSB, ATB and ASN), Bloomington, IN, June 26, 2000.
11. Michigan State University, Department of Microbiology (Student-invited seminar speaker) October 3, 2000.
12. Emory University, Population Biology, Ecology and Evolution Seminar, October 13, 2000
13. Emory University, Department of Chemistry Seminar, February 2, 2001
14. Annual Meeting of the Society for Molecular Biology and Evolution, Athens, GA, July 7, 2001
15. Emory University, Department of Pathology Seminar, November 27, 2001
16. The Evolvability and Robustness of Molecules and Microbes, Santa Fe, NM, February 27, 2002.

17. Emory University, Department of Pediatrics Seminar, April 22, 2002
18. Emory University, Genetics and Molecular Biology Program, September 26, 2002
19. Southeast Regional Meeting of the American Chemical Society, Atlanta, GA, November 17, 2003
20. Annual Meeting of the American Institute of Chemical Engineers, San Francisco, CA, November 20, 2003
21. University of Wisconsin, Department of Pharmaceutical Sciences, Madison, WI, March 5, 2004
22. University of California, Berkeley, Jack F. Kirsch Symposium, Berkeley, CA, August 14, 2004
23. Sectional Meeting of the American Chemical Society, Atlanta, GA, December 13, 2004
24. Emory University, Genetics and Molecular Biology Program, March 17, 2005
25. Emory University, Department of Chemistry Seminar, March 21, 2005
26. Washington State University, Department of Biochemistry, Pullman, WA, March 27, 2005
27. Annual Meeting of the American Society for Biochemistry and Molecular Biology, San Diego, CA, April 5, 2005
28. University of Florida, Department of Microbiology, Gainesville, FL, October 24, 2005
29. Emory University, Department of Biochemistry Seminar, November 3, 2005
30. Georgia Institute of Technology, Department of Chemistry and Biochemistry, November 29, 2005
31. NIH/NIAID-Nordic Regional Research Networking Meeting, May 10-12, 2006, Helsinki, Finland
32. Rinat Neuroscience, South San Francisco, CA, May 23, 2006
33. Gordon Research Conference on Biopolymers, Newport RI, June 11, 2006.
34. University of Minnesota, Department of Biochemistry, Minneapolis, MN, February 7, 2007.
35. Georgia Institute of Technology, Suddath Symposium, March 29, 2007
36. Georgia State University, Biology Department, June 22, 2007

37. Clark Atlanta University, Biology Department, October 16, 2007

Patents:

- 2002 Co-inventor (Matsumura I, Ellington AD) U.S. Patent 6,429,298; International patents pending. Assays for identifying functional alterations in the p53 tumor suppressor.
- 2007 Co-inventor (Matsumura I, Geddie ML) Provisional patent pending. Effector-Activated Reporter Enzymes for Disease Diagnosis

Bibliography:**Peer-reviewed articles:**

1. Colina KF, Perler FB, Matsumura I, Meda M, Nutman TB. 1990. The identification of an *Onchocerca*-specific recombinant antigen containing a T cell epitope. *Journal of Immunology* **145**(5): 1551-1556.
2. Wedeen CJ, Kostriken RG, Matsumura I, Weisblat DA. 1990 Evidence for a new family of evolutionarily conserved homeobox genes. *Nucleic Acids Research* **18**(7):1908.
3. Lian C, Le H, Montez B, Patterson J, Harrell S, Laws D, Matsumura I, Pearson J, Oldfield E. 1994. A fluorine-19 nuclear magnetic resonance spectroscopic study of fluorophenylalanine and fluorotryptophan-labelled avian egg white lysozymes. *Biochemistry* **33**(17):5238-5245.
4. Matsumura I, Kirsch, JF. 1996 Asparagine 46 and aspartate 52 contribute synergistically to the substrate association and to the catalytic mechanism of chicken egg white lysozyme. *Biochemistry* **35**(6):1890-1896.
5. Matsumura I, Kirsch JF. 1996 Is aspartate 52 essential for catalysis by chicken egg white lysozyme? The role of natural substrate-assisted catalysis. *Biochemistry* **35**(6):1881-1889.
6. Matsumura I, Ellington AD. 1999. *In vitro* evolution of thermostable p53 variants. *Protein Science* **8**:731-740.
7. Matsumura I, Wallingford JB, Surana NK, Vize PD, Ellington AD. 1999. Directed evolution of the surface chemistry of the reporter enzyme, beta glucuronidase. *Nature Biotechnology* **17**:696-701.
8. Matsumura I, Ellington AD. 2001. *In vitro* evolution of beta-glucuronidase into a beta-galactosidase proceeds through non-specific intermediates. *J. Mol. Biol.* **305**: 331-339.
9. Matsumura I, Olsen, MJ, Ellington AD. 2001. Optimization of heterologous gene expression for *in vitro* evolution. *Biotechniques* **30**:474-475.

10. Rowe LA, Geddie ML, Alexander OB, Matsumura I. 2003. A comparison of directed evolution approaches using the beta-glucuronidase model system. *Journal of Molecular Biology* **332**(4):851-60.
11. Geddie ML, Matsumura I. 2004. Rapid Evolution Of Beta-Glucuronidase Specificity By Saturation Mutagenesis Of An Active-Site Loop. *J. Biol. Chem.* **279**(25):26462-8.
12. Matsumura I, Rowe LA. 2005. Whole circle mutagenic PCR for directed protein evolution. *Biomolec. Eng.* **22**: 73-79.
13. Polizzi KM, Spencer CU, Dubey A, Matsumura, I, Lee JH, Realff MJ, Bommarius AS. 2005. Pooling for Improving Directed Evolution. *J Biomol Screen.* **10**(8):856-64.
14. Parikh MR, Matsumura I. 2005. Site-saturation mutagenesis is more efficient than DNA shuffling for the directed evolution of beta-fucosidase from beta-galactosidase. *J. Mol. Biol.* **352**(3):621-628.
15. Geddie ML, O'Loughlin TL, Woods KK, Matsumura I. 2005. Rational design of p53, an intrinsically unstructured protein, for the fabrication of novel molecular sensors. *J. Biol. Chem.* **280**(42): 35641-35646.
16. O'Loughlin TL, Matsumura I. 2006. HIV protease-activated molecular switches based on beta-glucuronidase and alkaline phosphatase. *Comb. Chem. High Throughput Screen* **9**(4): 313-20.
17. Parikh MR, Greene DN, Woods KK, Matsumura I. 2006. Directed evolution of RuBisCO hypermorphs through genetic selection in engineered Escherichia coli. *Protein Eng Des Sel.* **19**(3): 113-9.
18. O'Loughlin TL, Greene, DN, Matsumura I. 2006. Diversification and specialization of HIV protease function during *in vitro* evolution *Mol Biol Evol.* **23**(4):764-72.
19. Polizzi KM, Parikh MR, Spencer CU, Matsumura I, Lee JH, Realff MJ, Bommarius AS. 2006. Pooling for improved screening of combinatorial libraries for directed evolution. *Biotechnology Prog.* **22**(4):961-7.
20. Geddie ML, Matsumura I. 2007. Antibody-induced oligomerization and activation of an engineered reporter enzyme *J.Mol.Biol.* **369**(4):1052-9.
21. Greene DN, Whitney S, Matsumura I. 2007. Artificially evolved Synechococcus PCC6301 Rubisco variants exhibit improvements in folding and catalytic efficiency. *Biochem. J.* **404**(3):517-24..
22. Patrick WM, Quandt E, Swartzlander D, Matsumura I. 2007. Multicopy suppression underpins metabolic evolvability. *Mol Biol Evol.* **24**(12): 2716-2722.

23. Patrick WM, Matsumura I. 2008. A study in molecular contingency: glutamine phosphoribosylpyrophosphate amidotransferase is a promiscuous and evolvable phosphoribosylanthranilate isomerase. *J.Mol.Biol.* (in press)

Review articles:

24. Matsumura I, Ellington AD. 1996. DNA shuffling brightens prospects for GFP. *Nature Biotechnology* **14**(3):366.
25. Ellington AD, Matsumura I. 1997. Engineering evolution-with molecules. *Encyclopaedia Britannica: Science and the Future* pp 178-187 (Encyclopaedia Britannica, Inc., Chicago).
26. Osborne SE, Matsumura I, Ellington AD. 1997. Aptamers as therapeutic and diagnostic reagents: problems and prospects. *Curr Opin Chem Biol* **1**(1):5-9).
27. Matsumura I, Ellington AD. 2001. Mutagenic PCR of protein-coding genes for *in vitro* evolution. *Meth. Mol. Biol.* In vitro mutagenesis protocols (Braman, J., ed.), Vol.182, pages 261-269. Humana Press, Totowa, N.J.
28. Geddie M, Rowe LA, Alexander O, Matsumura I. 2004. A versatile semi-automated high throughput screen for directed protein evolution. *Methods Enzymol.* 388:134-45.
29. O'Loughlin TL, Patrick WM, Matsumura I. 2006. Natural history as a predictor of protein evolvability. *Protein Eng Des Sel.* 19(10):439-42.