

Curriculum Vitae, Iris Lindberg, Ph.D.

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Education

1975 A.B. Biochemistry University of California at Berkeley

1980 Ph.D. Pharmacology Univ. of Wisconsin-Madison Medical School

Post-Graduate Education and Training

1981 - 1984 Staff Fellow, NRSA Postdoctoral Fellow
and Pharmacology Research Associate Trainee (PRAT program)
Laboratory of Preclinical Pharmacology,
NIMH, St. Elizabeth's Hospital, Washington D.C.

Employment

1984 - 1989 Assistant Professor, Dept. of Biochemistry and Molecular Biology
Louisiana State University Medical School
New Orleans, LA

1989 - 1994 Associate Professor (tenured), Dept. of Biochemistry and Molecular Biology,
Louisiana State University Health Sciences Center (name changed)
New Orleans, LA

1994 - 2007 Professor, Dept. of Biochemistry and Molecular Biology
Louisiana State University Health Sciences Center
New Orleans, LA

2006 - 2007 LSUHSC Cancer Center Member

2007 - present Professor, Department of Anatomy and Neurobiology
University of Maryland Medical School
Baltimore, MD
Secondary Appointment: Department of Biochemistry
Member, Greenebaum Cancer Center

Professional Society Memberships

1978 - present Society for Neuroscience

1982-present Winter Conference on Brain Research

1985 - 2005; 2011-pres.	American Society for Biochemistry and Molecular Biology
1999 -2005	American Society for Cell Biology
2001 - present	The Endocrine Society
2013- present	American Society for Bone and Mineral Research

Career Development Awards

1981	NIH Individual Postdoctoral Fellowship (switched to PRAT)
1981-1983	Pharmacology Research Associate Traineeship (PRAT)
1988-1993	Research Career Development Award (NIDDK)
1993-1998	Research Scientist Development Award (NIDA)
1998-2003	Research Scientist Development Award (NIDA)

Administrative Service

Institutional Service (Committees)

1985-2007	LSUHSC Neuroscience Center Executive Steering Committee
1986-1988	Biochemistry Dept. Graduate Recruitment Committee
1992-1997	LSUHSC Graduate Council
1996-2000	LSUHSC Neuroscience Center Faculty Recruitment Committee
1997-2002	Neuroscience Center Graduate Program Recruitment Committee
2001	LSU School of Medicine Research Retreat Committee
2003-2004	Emergency Preparedness Faculty Committee, LSUHSC
2003-2005	LSUHSC Research Council
2004	Biochemistry Dept. Graduate Recruitment Committee
2004-2005	Faculty Search Committee, Biochemistry Department
2004-2005	Graduate Advisor, Biochemistry Department
2004-2005	LSUHSC Graduate Council
2005-2007	Faculty Assembly, LSUHSC
2007- present	Program in Neuroscience Seminar Committee, University of Maryland
2007- 2012	Program in Neuroscience Training Committee, University of Maryland
2007- present	Dept. Anatomy & Neurobiology Promotions Committee; Chair, 2010- 2014
2008- present	Dept. Anatomy & Neurobiology Faculty Search Committee
2008- 2011	Proteomics Core Steering Committee, University of Maryland
2009- present	Radiation Safety Institutional Committee, University of Maryland
2009- 2010	Pharmacology Head Search Committee, University of Maryland
2009- present	Departmental Representative or Alternate to School of Medicine Council
2009- present	Organizer , Departmental "Second Monday" Work-in-Progress seminar series
2010, 2012	Qualifying Exam Committee, Program in Neuroscience
2010- 2014	Chair , Program in Neuroscience Retreat Committee
2011	Univ. of Maryland Strategic Plan Subcommittee (Research)
2012- 2015	Univ. of Maryland Program in Neurosciences Postdoctoral Training Grant Steering Committee

2010- present Junior faculty mentoring committees, Drs. Elizabeth Powell; Marta Lipinski

Other Institutional Service

1990, 1992, 1995, 1997 LSUHSC Design & production of Biochemistry Dept. recruitment brochure
 1997-2002 LSUHSC Neuroscience Center brochure production
 2004- 2006 LSUHSC Grantsmanship presentations to faculty and students
 2008 Presentation to UMB graduate students: "How to Succeed in Grad School"
 2010 "Getting an RSDA" (Wendy Sanders' Professional Skills program)

Ph.D. Thesis Committees

Louisiana State University Health Sciences Center:

Minetta Gardinier, Jeremy Springhorn, Richard Shen, Yi Zhou, John Mathis, Tamim Shaikh, Erik Pakarinen, Joomyeong Kim, Virginia Strand, Astrid Roy, Ping Wei, Mary Breslin, Neva West, Yolanda Fortenberry, Mike Serou, Changning Gong, Bin Tu, Peimin Zhu, Yuri Peterson, Faramarz Taheri, Eleanor Park, and Tanya Roy

University of Maryland-Baltimore:

Amanda Elson, Zhongping Liu, Akina Hoshino, Adam Clark, Erik Martin, Patricia Cunfer and Alexandra Winters

Other Local Service

1985-86, 1988-89 *Secretary*, Greater New Orleans Society for Neuroscience
 2005-2006 *President*, Greater New Orleans Society for Neuroscience
 In 2005-06, my major duty was to organize the distribution of \$100,000 in Katrina relief funds from the national Society for Neuroscience to local neuroscience graduate students.
 2008-2011 Winter Conference on Brain Research, *Scientific Board*
 2012-2013 *President*, Greater Baltimore Society for Neuroscience
 2014- present *Treasurer*, Greater Baltimore Society for Neuroscience

National Service

Journal Review

1990- present *Ad hoc* reviewer, *J. Biol. Chem.*, *J. Neurochem.*, *Peptides*, *J. Neurosci.*, *Analyt. Biochem.*, *FEBS Lett.*, *Protein Eng.*, *Design and Selection*, *Proc. Natl Acad Sci*, *Endocrine Rev.*, *Diabetes*, *Molecular Medicine and Metabolism*, *Mol. Cell. Endocrinol.*, *J. Endocrinol.*, *Endocrinol*, *PLoS ONE*, and others
 2000-2005 Editorial Board Member, *Journal of Biological Chemistry*
 2012-2017 Editorial Board Member, *Journal of Biological Chemistry*

Gordon Conference Service

1998, 2000 Advisory Committee Member, Gordon Conference:

Hormonal and Neural Peptide Synthesis

- 2002 Vice-Chair, Gordon Conference: *Hormonal and Neural Peptide Synthesis*
 2004 **Chair, Gordon Conference: *Proprotein Processing, Trafficking, and Secretion***
 2006-2016 Advisory Committee Member, Gordon Conference: *Proprotein Processing, Trafficking, and Secretion*

Grant Reviewer, NIH:

- 1987 Study section reviewer, NLS1
 1989, 1997 Study section reviewer, NIDA Biochemistry
 1989, 1990 Special emphasis panel member, NIDDK
 1991 Study section reviewer, NIMH career awards
 1994 Special emphasis panel member, NINDS
 1995 Study section reviewer, NLS1
 1995, 1996, 1998 Study section and special emphasis panel reviewer, NIDDK
 1996, 1997, 2002 Study section reviewer, NLS1
 1996-2000 **Standing member, Endocrinology study section**
 1999 Study section reviewer, ACS
 2000 NIMH Career Awards study section reviewer
 2000-2005 Endocrinology study section reviewer (about 1 panel per year)
 2007-2010 **Standing member, Molecular and Cellular Endocrinology study section**
 2010 Special Emphasis Panel reviewer, NIDDK 2/2010
 2011 *EUREKA* NIH review panel member
 2013 SBIR study section, 3/4/2013
 2015 MCE study section *ad hoc* service

International Review Service

- 2002 Finnish National Academy of Sciences Review Panel, Helsinki, Finland
 2002, 2009 Canada Research Chairs, College of Reviewers, applicant reviewer
 2003 Chair, Finnish National Academy of Sciences Review Panel
 2005 Foundation for Scientific Research- Flanders, Belgium, grant reviewer
 2006 Wellcome Trust grant reviewer
 2008-2010 Foundation for Scientific Research- Flanders, Belgium, grant reviewer
 2011 Medical Research Council (U.K.), grant reviewer
 2013 Canadian Institutes of Health, grant reviewer
 2014 Danish Agency for Science Technology and Innovation

*Teaching Service***LSUHSC**

- 1985- 1986 Dental Biochemistry (17 lecture h per year) - 85 students

1985-2005	One lecture in "Methods in Neuroscience" - 15 students (course given at Tulane University in alternate years on protein expression methods) (2 h)
1987 -1999	Medical Biochemistry (17 h) -150 students
1991, fall	Graduate seminar in the cell biology of protein targeting (20 h) 8 students
1995 - 2001	Neuroscience Survey (2 h) 8 students
1997	Endocrinology (on radioimmunoassay and opioid peptides) (2 h) 10 students
1998- 2004	Molecular Neuroscience (on neurotransmitters) (4 h) 8 students
2000	Nursing Biochemistry (20 h) 80 students
2001	Graduate Seminar in Protein Motifs (20 h) 7 students
2001, 2002	Special Topics Graduate Seminar in Methods in Biochemistry; (Protein Expression and Purification) (2 h); 8 students
2003, 2006,2007	Endocrinology - Bioactive peptides and radioimmunoassay (4 h and 2h); 12 students
2003-2005	Graduate Seminar- "Professional Skills". Graduate student mentoring: giving talks, preparing grants, manuscripts, career choices (30 h); 12 students
2006	Dental Biochemistry (4 h); 85 students
2006	Molecular Neuroscience - Neuropeptides (4 h) and Grantsmanship (1 h)

University of Maryland

2008-2010	(UMB) Professional Skills course in Molecular Medicine "How to Write/Review Grants" (1 h) ; 20 students
2008- present	GPILS Core Course "Posttranslational Modifications" (1 h); 50 students
2009- present	Ethics Class, Discussion Leader (1.5 h) twice a year (small group of 6-10)
2010 -2014	Neuroscience (GPILS 641) "Peptides and Modulators" (1 1/2 h); 10-12 students
2010- present	Structure and Development "Endocrine Systems" (2 h); 180 students

Students and postdoctoral fellows supervised

Graduate Students supervised (rotation students not listed)

1. Fu-sheng Shen (1986- 1988) (Ph.D. 1990, from Institute of Physiology, Beijing)
2. John Mathis (1988- 1994) Ph.D. 1994
3. Yi Zhou (1990- 1994) Ph.D. 1994
4. Yolanda Fortenberry (1997- 2001) Ph.D. 2001
5. Maria Sayah (3/00- 12/00) (Master's thesis; French practical training)
6. Valery Iattignon (1/04- 4/04) (Master's thesis; French practical training)
7. Akina Hoshino (11/07- 4/2012)
8. Alexandra Winters (2013-present) (co-mentor with Dr. Toni Pollin)

Postdoctoral Fellows supervised

1. Dr. Nympha D'Souza (1987-1988)
2. Dr. Steven Roberts (1988- 1991)
3. Dr. Joseph Irvine (1989- 1991)
4. Dr. Fu-Sheng Shen (1991- 1992)

5. Dr. Osvaldo Vindrola (1991- 1993)
6. Dr. Nazarius Lamango (1994- 1996)
7. Dr. Xiaorong Zhu (1994- 1997) (NRSA fellow)
8. Dr. Karla Johanning (1994- 1998)
9. Dr. Laurent Muller (1996- 1999)
10. Dr. Ekaterina Apletalina (1997- 2000)
11. Dr. Jae-Ryoung Hwang (1998- 2001)
12. Dr. Angus Cameron (1999- 2000)
13. Dr. Virginie Laurent (1999-2002)
14. Dr. Ashok Dubey (2000- 2001)
15. Dr. Miroslav Sarac (2000- 2003)
16. Dr. Emmanuel Prodhomme (2001-2002)
17. Dr. Weidong Liu (2001-2002)
18. Dr. Sang-Nam Lee (2002- 2007)
19. Dr. Juan Ramon Peinado (2003-2004)
20. Dr. Magdalena Kacprzak (2003- 2005)
21. Dr. Bainan Liu (2004- 2005)
22. Dr. Dorota Kowalska (2005) and (2008-2009)
23. Dr. Wagner Judice (2006- 2007) (NIDA INVEST Fellow)
24. Dr. Jin Liu (2006- 2008)
25. Dr. Akihiko Ozawa (2006- 2011)
26. Dr. Michael Helwig (2009- 2012) (supported by Leopoldina Fellowship)
27. Dr. Mirella Vivoli (2010- 2012)
28. Dr. Indrani Dasgupta (2011-2013)
29. Dr. Laura Sanglas (2011-2012) (supported by Danish Academy Fellowship)
30. Dr. Hiroyuki Yamamoto (2013; Visiting Assistant Professor, Shizuoka, Japan)
31. Dr. Elias Blanco (2013- 2015)
32. Dr. Yogikala Prabhu (2011; 2013)
33. Dr. Juan Ramon Peinado (2013; Visiting Assistant Professor, Ciudad Real University)
34. Dr. Bruno Ramos Molina (2014- 2015)
35. Dr. Tim Jarvela (2015-present).

Grant Support

Ongoing Research Support

Opioid Peptide Synthesizing Enzymes

04/01/88- 2/28/16

R01 DA05084-27 I. Lindberg (P.I) (30% effort)

NIH/NIDA \$337, 751 current year total costs

This grant was to identify regulatory mechanisms for PC1/3 activity; to identify small molecule convertase inhibitors using combinatorial compound screening; and to crystallize PC1/3. A renewal application was submitted in 2015.

The Secretary Chaperone 7B2 as an Endogenous Regulator of Amyloid Pathology

1R21AG045741-01 I. Lindberg, P.I. (20% effort)

09/01/14- 4/30/16

NIH/NIA \$199,950 current year total costs

This grant is to explore the idea that brain 7B2 levels modulate the pathologic aggregation of beta amyloid-derived peptides.

Completed Research Support (Competing applications and other grants.)

1/85 - 12/86	I. Lindberg, PI "Pharmacologic control of opioid peptide biosynthesis." Pharmaceutical Manufacturer's Association Starter Grant
4/85 - 11/88	I. Lindberg, PI (30% effort) "Biosynthesis of enkephalin in the adrenal medulla." R01 DK35199-01
4/88 - 3/91	I. Lindberg, PI (30% effort) "Opioid peptide-synthesizing enzymes" R01 DA05084-01
7/88 - 6/93	I. Lindberg, PI (90% salary) Research Career Development Award K04 DK01868 (salary award)
12/88 - 11/91	I. Lindberg, PI (30% effort) "Biosynthesis of enkephalin in the adrenal medulla." R01 DK35199-04
4/91 - 3/94	I. Lindberg, PI (30% effort) "Opioid peptide-synthesizing enzymes" R01 DA05084-04
10/93- 9/98	I. Lindberg, PI (75% salary) Research Scientist Development Award K02 DA00204-01 (salary award)
4/94 - 3/99	I. Lindberg, PI (30% effort) "Opioid peptide-synthesizing enzymes" R01 DA05084-07
7/96- 3/02	I. Lindberg, PI (30% effort) "Control of peptide hormone biosynthesis by PC2 and 7B2" R01 DK49703-01
10/98- 9/03	I. Lindberg, PI (75%) Research Scientist Development Award K02 DA00204-06 (salary award renewal)
4/99- 3/04	I. Lindberg, PI (30% effort) "Opioid peptide-synthesizing enzymes" R01 DA05084-12
4/02- 3/07	I. Lindberg, PI (30% effort) "Control of peptide hormone biosynthesis by PC2 and 7B2" R01 DK49703-06
2004	I. Lindberg, PI Gordon Conference support grant "Proprotein processing, trafficking and secretion" 5R13DK061936

- 2004 I. Lindberg, PI NSF Conference Support: received \$2,000 for
a poster award program for the same Gordon Conference cited above
- 4/04-3/09 I. Lindberg, PI (30% effort)
"Opioid peptide-synthesizing enzymes"
R01 DA05084-17
- 9/02-8/05 I. Lindberg, PI (20% effort)
"Blockade of anthrax toxin cytotoxicity using furin inhibitors"
R21 AI 053517-01
- 8/03-8/06 P. Sunkara, PI (5% effort)
"Hexa-D-Arg: a furin inhibitor for anthrax biodefense"
Subcontract, Molecular Therapeutics
SBIR R43 A1056850
- 9/04-3/06 S. Pincus, PI (5% effort)
"Furin Inhibition in HIV Disease"
R21 AI058714-01
- 3/06-6/06 I. Lindberg, PI (10% effort)
"Furin as an Anti-Cancer Target"
Louisiana Cancer Research Consortium
- 6/09- 5/11 I. Lindberg, PI (20% effort)
"Identification of Novel Peptide Hormones"
R21 DK084481-01
- 09/09- 03/14 I. Lindberg (P.I.) (30% effort)
"Control of Peptide Hormone Biosynthesis by PC2 and 7B2"
R01 DK49703-12
- 07/09-06/14 I. Lindberg and B. Roth (co-P.I.s) (30% effort)
"De-Orphanizing the Peptidome"
R01 DA027170-01

ARRA Supplement received in 2010 for purchase of AKTA FPLC (\$70,000)

Contributed sections to several **COBREs** and **equipment grants** awarded to LSUHSC faculty; also contributed to various **ARRA Equipment Supplement/ Multi-User Equipment** applications at the University of Maryland)

Research Support as Mentor

- 7/95-6/98 Mentor to Dr. Xiaorong Zhu, NRSA postdoctoral fellowship
- 10/97-8/00 Mentor to Ms. Yolanda Fortenberry, NRSA predoctoral fellowship
- 12/06-12/07 Mentor to Dr. Wagner Judice, NIDA INVEST fellowship
- 08/10-present Mentor to Dr. Michael Helwig, Leopoldina fellowship
- 06/11-6/2012 Co-mentor to Dr. Laura Sanglas, Danish Academy fellowship

Patents

1. Patent # 6,548,736 on the 7B2 null mouse as a model for pituitary Cushing's was granted to C.H. Westphal, **I. Lindberg**, and P. Leder.
2. Patent # 7,033,991 on polyarginine furin inhibitors in inhibiting bacterial disease and cancer was granted on April 25, 2006 to **I. Lindberg**, A. Cameron, J. Appel, and R.A. Houghten.

Publications

Peer-Reviewed Journals

1. **Lindberg, I.**, Smythe, S., and Dahl, J.L. (1979) Distribution of enkephalin in bovine brain. *Brain Research*, 168, 200-203.
2. **Lindberg, I.**, and Dahl, J.L. (1981) Characterization of enkephalin release from rat striatum. *J. Neurochem.* 36, 506-512.
3. Epstein, M., **Lindberg, I.**, and Dahl, J.L. (1981) Development of enkephalinergic neurons in the gut of the chick. *Peptides* 2, 271-276.
4. **Lindberg, I.**, Yang, H.-Y.T., and Costa, E. (1982) An enkephalin-generating enzyme in bovine adrenal medulla. *Biochem. Biophys. Res. Commun.* 106, 186-1934.
5. Dahl, J.L., Epstein, M.L., Silva, B.W., and **Lindberg, I.** (1982) Multiple forms of met⁵- and leu⁵-enkephalin in fetal and neonatal rat brain and gut. *Life Sci.* 31, 1853-1856.
6. **Lindberg, I.**, Yang, H.-Y.T., and Costa, E. (1982) Characterization of a partially purified trypsin-like enkephalin-generating enzyme in bovine adrenal medulla. *Life Sci.* 31, 1713-1716.
7. **Lindberg, I.**, Yang, H.-Y.T., and Costa, E. (1983) A high molecular weight form of met⁵-enk-arg⁶-gly⁷-leu⁸ in rat brain and bovine adrenal chromaffin granules. *Life Sciences* 33 Supp. I., 5-8.
8. **Lindberg, I.**, and Yang, H.-Y.T. (1984) Distribution of met⁵-enk-arg⁶-gly⁷-leu⁸-immunoreactive peptides in rat brain: presence of multiple immunoreactive forms. *Brain Research* 299, 73-78.
9. **Lindberg, I.**, Yang, H.-Y.T., and Costa, E. (1984) Further characterization of an enkephalin-generating enzyme from bovine adrenal chromaffin granules. *J. Neurochem.* 42, 1411-1419.
10. **Lindberg, I.**, Yang, H.-Y.T., and Costa, E. (1985) Release of multiple immunoreactive forms of met⁵-enk-arg⁶-gly⁷-leu⁸ from rat brain. *Neuropeptides* 5, 541-544.
11. **Lindberg, I.**, and White, L. (1986) Reptilian enkephalins: implications for the evolution of proenkephalin. *Arch. Biochem. Biophys.* 245, 1-7.
12. Wang, Y.N. and **Lindberg, I.** (1986) Distribution and characterization of met-enk-arg-gly-leu in the gastrointestinal tract of the rat. *Cell and Tiss. Res.* 244, 77- 85.
13. **Lindberg, I.**, and White, L. (1986) Distribution of immunoreactive Peptide B in the rat brain. *Biochem. Biophys. Res. Commun.* 139, 1024-1032.
14. **Lindberg, I.** (1986) Reserpine-induced alterations in the processing of proenkephalin in cultured chromaffin cells: increased amidation. *J. Biol. Chem.* 261, 16317- 16323.
15. Panula, P., and **Lindberg, I.** (1987) Pituitary enkephalins: biochemical and immunohistochemical observations. *Endocrinology* 121, 48-58.
16. Byrd, J., Naranjo, J., and **Lindberg, I.** (1987) Proenkephalin gene expression in the PC12 cell line: stimulation by sodium butyrate. *Endocrinology* 121, 1299-1305.
17. D'Souza, N. and **Lindberg, I.** (1988) Evidence for the phosphorylation of a proenkephalin-derived peptide, Peptide B. *J. Biol. Chem.* 263, 2548-2552.
18. Shen, F.S. and **Lindberg, I.** (1988) Characterization of enkephalin-immunoreactive peptides generated from plasma proteins by peptic digestion. *Endocrinology* 122, 2905-2910.

19. Shen, F-S., and **Lindberg, I.** (1989) Purification and assay of opioid activity of low molecular weight enkephalin-immunoreactive peptides generated by peptic digestion of rat plasma proteins. *Neuropeptides* 13, 23-28.
20. Shen, F.-S., Roberts, S.F., and **Lindberg, I.** (1989) A putative processing enzyme for proenkephalin in bovine adrenal chromaffin granules- purification and characterization. *J. Biol. Chem.* 264, 15600-15605 (1989).
21. **Lindberg, I.**, and Thomas, G. (1990) Cleavage of proenkephalin by a chromaffin granule processing enzyme. *Endocrinology* 126, 480-487.
22. Irvine, J., Roberts, S.F., and **Lindberg, I.** (1990) Electrophoretic analysis of proteinases in sodium dodecyl sulfate polyacrylamide gels containing copolymerized radiolabelled protein substrates: application to proenkephalin processing enzymes. *Analyt. Biochem.* 190, 141-146.
23. **Lindberg, I.**, Shaw, E., Finley J., Leone, D., and Deininger, P. (1991) Posttranslational modifications of recombinant rat proenkephalin overexpressed in Chinese hamster ovary cells. *Endocrinology* 128, 1849-1856.
24. Irvine, J.W., and **Lindberg, I.** (1991) Partial purification and characterization of a putative prohormone processing enzyme complex from bovine pituitary. *Endocrinology*, 128, 2345- 2352.
25. **Lindberg, I.**, and Shaw, E. (1992) Posttranslational processing of proenkephalin in a human neuroblastoma cell line, SK-N-MC. *J. Neurochem.* 58, 458-453.
26. Roberts, S.F., Irvine, J.W., and **Lindberg, I.** (1992) Proteolytic activity in bovine adrenal chromaffin granules visualized using [³⁵S]methionine-labelled proenkephalin copolymerized into SDS-PAGE. *J. Neurochem.* 58, 593-599.
27. **Lindberg, I.**, Lincoln, B., and Rhodes, C.J. (1992) Fluorometric assay of a calcium-dependent, paired basic processing endopeptidase present in insulinoma granules. *Biochem. Biophys. Res. Commun.* 183, 1-7.
28. Vindrola, O., and **Lindberg, I.** (1992) Biosynthesis of the prohormone convertase mPC1 in AtT-20 cells. *Mol. Endocrinol.* 6, 1088-1094.
29. Mathis, J., and **Lindberg, I.** (1992) Posttranslational processing of proenkephalin in AtT-20 cells: evidence for cleavage at a Lys-Lys site. *Endocrinology* 131, 2287-2296.
30. Zhou, Y., and **Lindberg, I.** (1993) Purification and characterization of the prohormone convertase PC1 (PC3) *J. Biol. Chem.* 268, 5615- 5623.
31. Shen, F.S., Seidah, N.G., and **Lindberg, I.** (1993) Biosynthesis of the prohormone convertase PC2 in Chinese hamster ovary cells and in rat insulinoma cells. *J. Biol. Chem.* 268, 24910-24915.
32. Breslin, M., **Lindberg, I.**, Benjannet, S., Lazure, C., Mathis, J.P., and Seidah, N.G. (1993) Processing of proenkephalin by PC1(PC3), PC2, and furin. *J. Biol. Chem.* 268, 27084-27093.
33. Vindrola, O., and **Lindberg, I.** (1993) Release of the prohormone convertase PC1 from AtT-20 cells. *Neuropeptides* 25, 151-160.
34. Hornby, P.J., Rosenthal, S.D., Mathis, J.P., Vindrola, O., and **Lindberg, I.** (1993) Immunocytochemical analysis of the neuropeptide-synthesizing enzyme PC1 in AtT-20 cells. *Neuroendocrinol.* 58, 555-563.
35. Dupuy, A., **Lindberg, I.**, Zhou, Y., Akil, H., Lazure, C., Chretien, M., Seidah, N.G., and Day, R. (1994) Processing of prodynorphin by the prohormone convertase PC1 results in high molecular weight intermediate forms: cleavage at a single arginine. *FEBS Lett.* 337:60-65.
36. O'Hara, B.F., Donovan, D., **Lindberg, I.**, Brannock, M.T., Ricker, D.D., Moffatt, C.A., Klaunberg, B.A., Schindler, C., Chang, T.S.K., Nelson, R.J., and Uhl, G.R. (1994) Proenkephalin transgenic mice: a short promoter confers high testis expression and reduced fertility. *Mol. Reprod. and Devel.* 38, 275-284.

37. Martens, G.M., Braks, A.M., Eib, D., Zhou, Y., and **Lindberg, I.** (1994) The neuroendocrine polypeptide 7B2 is a naturally occurring inhibitor of the prohormone convertase PC2. *Proc. Nat. Acad. Sci.* 91, 5784-5785.
38. **Lindberg, I.** (1994) Evidence for cleavage of the PC1/PC3 prosegment in the endoplasmic reticulum. *Mol. Cell. Neurosci.* 5, 263-268.
39. Zhou, Y., and **Lindberg, I.** (1994) Enzymatic properties of carboxy-terminally truncated prohormone convertase 1 (PC1/PC3). *J. Biol. Chem.* 269, 18408-18413.
40. **Lindberg, I.**, Ahn, S.C. and Breslin, M.B. (1994) Cellular distributions of the prohormone processing enzymes PC1 and PC2. *Mol. Cell. Neurosci.* 5, 614-622.
41. **Lindberg, I.**, Van den Hurk, W.H., Bui, C.B., and Batie, C.J. (1995) Enzymatic characterization of immunopurified prohormone convertase PC2: potent inhibition by a 7B2 peptide fragment. *Biochemistry* 34, 5486- 5493.
42. Rothenberg, M.E., Eilertson, C.D., Klein, K., Zhou, Y., **Lindberg, I.**, McDonald, J.K., and Noe, B.D. (1995) Processing of mouse proglucagon by recombinant PC1 and PC2. *J. Biol. Chem.* 270, 10136-10146.
43. Van Horssen, A. M., Van den Hurk, H., Bailyes, E.M., Hutton, J.C., Martens, G.J.M., and **Lindberg, I.** (1995) Identification of the region within the neuroendocrine polypeptide 7B2 responsible for the inhibition of prohormone convertase 2. *J. Biol. Chem.* 270, 14292-14296.
44. Zhu, X., and **Lindberg, I.** (1995) 7B2 facilitates the maturation of proPC2 in neuroendocrine cells and is required for the expression of enzymatic activity. *J. Cell Biol.* 129, 1641-1650.
45. Zhou, Y., Rovere, C., Kitabgi, P., and **Lindberg, I.** (1995) Mutational analysis of PC1 in PC12 cells: 66 kDa PC1 is fully functional. *J. Biol. Chem.* 270, 24702-24706.
46. Johanning, K., Mathis, J.P., and **Lindberg, I.** (1996) Role of the prohormone convertase PC2 in proenkephalin processing: antisense and overexpression studies. *J. Neurochem.* 66, 898-907.
47. Zhu, X., Rouille, Y., Lamango, N. S., Steiner, D. F., and **Lindberg, I.** (1996) Internal cleavage of the PC2 inhibitor 7B2 CT peptide: a potential inactivation mechanism. *Proc. Natl. Acad.Sci.* 93, 4919-4924.
48. Lamango, N., Zhu, X., and **Lindberg, I.** (1996) Purification and enzymatic characterization of recombinant PC2: stimulation of activity by 21 kDa 7B2. *Arch. Biochem. Biophysics* 330, 238-250.
49. Zhu, X., Lamango, N.S., and **Lindberg, I.** (1996) Involvement of a polyproline helix-like structure in the interaction of 7B2 with prohormone convertase 2. *J. Biol. Chem.* 271, 23582-23587.
50. Johanning, K., Mathis, J.P., and **Lindberg, I.** (1996) Processing site blockade results in more efficient conversion of proenkephalin to active opioid peptides. *J. Biol. Chem.* 271, 27871-27878.
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RESEARCH INTERESTS

My research focuses on the molecules within the secretory pathway required for the successful production of bioactive peptide hormones and neuropeptides from precursor proteins. These include secretory chaperones; abundant secretory proteins such as granins; and precursor processing enzymes- in particular, the proprotein convertases furin, PC1/3 and PC2. We study how these convertases are regulated within the cell; we are attempting their crystallization; and we are working on identifying activators and inhibitors through various pharmacological collaborations. Two new projects focus on a) endogenous secretory chaperone proteins which block the aggregation of

neuronal and endocrine proteins, especially those involved in neurodegenerative processes; and b) the interesting secretory biology of the bone peptide hormone FGF23. The widespread involvement of proprotein convertases in the physiology of nearly every tissue means that our work is directly linked to many different pathological processes, including neurodegenerative diseases; obesity and diabetes; cancer; and bone disease.