

## ***CURRICULUM VITAE***

Name: Ying-Xian Pan, M.D., Ph. D.  
Office Address: Department of Neurology, Mail Box: 513  
Memorial Sloan-Kettering Cancer Center  
1275 York Avenue New York, NY 10065

Phone: Office: (646) 888-2167  
Lab: (646) 888-2180  
Fax: (646)-422-0271  
E-mail: pany@mskcc.org

### **Education:**

1978-1982 **B.S.(M.D.)** Medicine, Department of Medicine, Shanghai University of Traditional Medicine, Shanghai, China  
1983-1986 **M.S.** Biochemistry, Department of Biochemistry, Shanghai University of Traditional Medicine, Shanghai, China.  
1988-1993 **Ph.D.**, Department of Physiology & Biophysics, University of Cincinnati, College of Medicine, Cincinnati, OH. Mentor: Dr. Gary E. Dean  
1993-1996 **Postdoctoral Fellow**, The Aaron Diamond Foundation, Department of Neurology, Memorial Sloan-Kettering Cancer Center, New York, NY. Mentor: Dr. Gavril W. Pasternak

### **Academic Positions:**

1986-1988 **Assistant Professor**, Department of Biochemistry, Shanghai University of Traditional Medicine, Shanghai, China  
1988-1998 **Associate Professor**, Guest, Department of Biochemistry, Shanghai University of Traditional Medicine, Shanghai, China  
1994-1996 **Research Associate**, Department of Neurology, Memorial Sloan-Kettering Cancer Center, New York, NY  
1996-2000 **Assistant Laboratory Member**, Laboratory of Molecular Neuropharmacology, Memorial Sloan-Kettering Institute, New York, NY  
1999-2000 **Assistant Attending**, Department of Neurology, Memorial Hospital, New York, NY  
2000-Present **Associate Attending**, Department of Neurology, Memorial Hospital, New York, NY

### **Scientific Societies:**

1991-Present Member of the American Society for Biochemistry and Molecular Biology  
1995-Present Member of the Society of Neuroscience  
1996-Present Member of the American Society for Pharmacology and Experimental Therapeutics

### **Honors and Awards:**

1989 Second Scientific and Technological Award, National Education Committee, China, For the Research Program: Anti-aging effect of Essence-Restoring Decoction and its medical contents on hypothalamic-pituitary-gonadal-thymic axis.  
1993-1996 Postdoctoral Fellowship in the Biomedical and Social Science, The Aaron Diamond Foundation, NY  
1996-2001 K01, NIDA, NIH  
2002-2013 R01, NIDA, NIH  
2010-2012 R21, NIDA, NIH

**Service:**

Managing Editor of *Frontiers in Bioscience*

Ad hoc reviewer for NIH Study Section: MDCN-A (2007)

ZDA1 EXL-T (2008)

ZRG1 MDCN-N (2010)

Reviewer for *New England Journal of Medicine*, *Molecular Pharmacology*, *Journal of Neurochemistry*, *Neuropharmacology*, *Gene*, *Molecular Genetics and Metabolism*, *DNA and Cell Biology*, *BMC Pharmacology*, *BMC Neuroscience*, and *Synapse*.

**Publications:****I. Peer-reviewed Papers**

1. Pan Y-X, Wuan S-Y & Chao W-K. Experiment investigation on anti-aging effect of essence-restoring decoction (IV) -- Influence on E2 and DHT receptors and serum thymic factors of aged rats. *Shanghai J. Trad. Chinese Med.* 4, 46-47, 1986
2. Chao W-K, Pan Y-X and Xu F-X. Effect of essence-restoring decoction on thymic ultrastructure and sex hormone (E2 & DHT) receptors in senile rats. *Chinese J. Integ. Trad. Western Med.* 7, 226-229, 1987
3. Pan Y-X, Xu J, Strasser JE, Howell M, and Dean GE. Structure and expression of subunit A from bovine chromaffin cell vacuolar ATPase. *FEBS letter* 293, 89-92, 1991
4. Pan Y-X, Gu HH, Xu J and Dean GE. *Saccharomyces cerevisiae* expression of exogenous vacuolar ATPase subunits B. *Biochem. Biophys. Acta.* 1151: 175-185, 1993.
5. Chien C-C, Brown G, Pan Y-X and Pasternak GW. Blockade of U50,488H analgesia by antisense oligodeoxynucleotides to a kappa opioid receptor. *Eur.J.Pharmacol.* 253: R7-8, 1994
6. Rossi G, Pan Y-X, Cheng J, and Pasternak GW. Blockade of morphine analgesia by an antisense oligodeoxynucleotide against the mu receptor. *Life Sci.* 54: PL 375-379, 1994
7. Pan Y-X, Cheng J, Xu J, and Pasternak GW. Cloning, expression and classification of a kappa3- related opioid receptor using antisense oligodeoxynucleotides. *Regulatory Peptides* 54:217-218, 1994
8. Standifer KM, Jenab S, Su W, Chien C-C, Pan Y-X, Inturrisi CE and Pasternak GW. Antisense oligodeoxynucleotides to the cloned delta receptor, DOR-1: uptake, stability and regulation of gene expression. *J. Neurochem.*65, 1981-1987, 1995
9. Rossi G., Pan Y-X, Brown GP. and Pasternak GW. Antisense mapping MOR-1: Evidence for alternative splicing and a novel morphine-6 $\beta$ -glucuronide receptor. *FEBS letter* 369,192-196, 1995
10. Pan Y-X, Cheng J, Xu J, Standifer KM, Brooks AI and Pasternak GW. Cloning and functional expression through antisense mapping of a kappa3-related opioid receptor, *Mol. Pharmacol.* 47: 1180-1188, 1995
11. Leventhal L, Cole JL, Rossi GC, Pan Y-X, Pasternak GW and Bodnar RJ. Antisense oligodeoxynucleotides against the MOR-1 clone alter weight and ingestive responses in rats, *Brain Res.* 719: 78-84, 1996
12. Pan Y-X, Xu J, Ryan-Moro J, Mathis J, Hom J SH, Mei J and Pasternak GW. Dissociation of affinity and efficacy in KOR-3 chimeras, *FEBS Letters*, 395:207-210, 1996.
13. Pan Y-X, Xu J, and Pasternak GW. Cloning and expression of a cDNA encoding a mouse brain orphanin FQ/nociceptin precursor, *Biochemical J.* 315:11-13, 1996
14. Pan Y-X, Xu J, and Pasternak GW. Structure and characterization of the gene encoding a mouse kappa3-related opioid receptor, *Gene*, 171:255-260, 1996
15. King M, Pan Y-X, Mei J.F, Chang A, Xu J and Pasternak GW. Enhanced kappa opioid analgesia by antisense targeting the sigma<sub>1</sub> receptor, *Eur.J.Pharmacol.* 331:R5-R6,1997

16. Kolesnikov Y, Pan Y-X, Babey AM, Jain S, Wilson R and Pasternak GW, Functionally differentiating two nNOS isoforms through antisense mapping: Evidence for opposing NO actions on morphine analgesia and tolerance, *Proc.Natl.Acad.Sci.UAS*, 94:8220-8225, 1997
17. Burdick K, Yu W-Z, Ragnauth A, Moroz M, Pan Y-X, Rossi GC, Pasternak and Bodnar RJ, Antisense mapping of opioid receptor clones: effects upon 2-deoxy-D-glucose-induced hyperphagia, *Brain Res.* 794:359-363, 1998
18. Pan Y-X, Mei JF, Xu J, Wan BL, Zuckerman A and Pasternak, Cloning and characterization of a mouse sigma<sub>1</sub> receptor, *J. Neurochem.* 70:2279-2285, 1998
19. Pan Y-X, Xu J, Wan B-L, Zuckerman A and Pasternak, GW. Identification and differential regional expression of KOR-3/ORL-1 gene splice variants in mouse brain. *FEBS Lett.* 435:65-8, 1998
20. Schuller A GP, King MA, Zhang J, Bolan E, Pan Y-X, Morgan DJ, Chang A, Czick ME, Unterwald EM, Pasternak GW and Pintar JE, Retention of heroin and morphine-6B-glucuronide analgesia in a new line of mice lacking exon 1 of MOR-1. *Nat. Neurosci.* 2:151-156, 1999
21. Pan Y-X, Xu J, Bolan E, Abbadie, C, Chang A, Zuckerman A, Wan B-L and Pasternak GW. Identification and characterization of three new alternatively spliced mu opioid receptor isoforms. *Mol. Pharmacol.* 56:396-403, 1999
22. Hom JS, Goldberg I, Mathis J, Pan Y-X, Brooks AI, Ryan-Moro J, Scheinberg DA, Pasternak GW. [<sup>125</sup>I]orphanin FQ/nociceptin binding in raji cells. *Synapse* 34:187-91, 1999
23. Pan Y-X, Xu J, Bolan E, Chang A, Mahurter L, Rossi G and Pasternak GW. Isolation and expression of a novel alternatively spliced mu opioid receptor isoform, MOR-1F. *FEBS Lett.* 466:337-340, 2000
24. Abbadie C, Pan Y-X, Pasternak GW. Differential distribution in rat brain of mu opioid receptor carboxy terminal splice variants MOR-1C-like and MOR-1-like immunoreactivity: evidence for region-specific processing. *J Comp Neurol.* 419(2):244-56, 2000
25. Abbadie C, Pan Y-X, Drake CT and Pasternak GW. Comparative immunohistochemical distributions of carboxy terminus epitopes from the mu opioid receptor splice variants MOR-1D, MOR-1 and MOR-1C in the mouse and rat central nervous systems. *Neuroscience.* 100(1):141-53, 2000
26. Pan Y-X, Xu J, Rossi G, Xu MM, Mahurter L, Bolan E and Pasternak GW. Generation of the mu opioid receptor (MOR-1) protein by three new splice variants of the *Oprm* gene. *Poc. Natl. Acad. Sci. UAS*, 98:14084-14089, 2001
27. Pan Y-X. Identification and characterization of a novel promoter of the mouse mu opioid receptor gene (*Oprm*) that generates eight new splice variants. *Gene.* 295:97-108, 2002
28. Pan Y-X, Bolan E and Pasternak GW. Dimerization of morphine and orphanin FQ/nociceptin receptors: generation of a novel opioid receptor subtype. *Biochem Biophys Res Commun.* 297:659-662, 2002
29. Pan Y-X, Xu J, Mahurter L, Xu MM, Gilbert AK and Pasternak GW. Identification and characterization of two new human mu opioid receptor isoform, hMOR-1O and hMOR-1X. *Biochem. Biophys Res Comm.*, 301:1057-1061, 2003
30. Hadjimarkou MM, Khaimova E, Pan Y-X, Rossi GC, Pasternak GW, Bodnar RJ. Feeding induced by food deprivation is differentially reduced by opioid receptor antisense oligodeoxynucleotide probes in rats. *Brain Res.* 987: 223-232, 2003
31. Bolan, EA, Pan Y-X, Pasternak GW. Functional analysis of MOR-1 splice variants of the mouse mu opioid receptor gene *Oprm*. *Synapse*, 51:11-18, 2004
32. Abbadie, C, Pan Y-X, Pasternak GW. Expression of exon11-containing mu opioid receptor variants in mouse brain. *Neuroscience*, 127:419-30, 2004
33. Pasternak D, Pan L, Xu J, Yu R, Xu MM, Pasternak GW and Pan Y-X. Identification and characterization of four new alternatively spliced variants from rat mu opioid receptor gene, *Oprm*. *J Neurochem.* 91:881-90, 2004

34. Hadjimarkou MM, Singh A, Kandov Y, Israel Y, Pan Y-X, Rossi GC, Pasternak GW, Bodnar RJ. Opioid receptor involvement in food deprivation-induced feeding: evaluation of selective antagonist and antisense oligodeoxynucleotide probe effects in mice and rats. *J Pharmacol Exp Ther.* 311:1188-202, 2004
35. Pan L, Xu J, Xu MM, Yu R, Pasternak GW and Pan Y-X. Identification and characterization of six new alternatively spliced variants from the human mu opioid receptor gene, *Oprm*. *Neuroscience*, 133:209-20, 2005
36. Israel Y, Kandov Y, Khaimova E, Kest A, Lewis SR, Pasternak GW, Pan Y-X, Rossi GC and Bodnar RJ. NPY-induced feeding: Pharmacological characterization using selective opioid antagonists and antisense probes in rats. *Peptides*, 26:1167-75, 2005
37. Pan Y-X, Xu J, Xu MM, Bolan E, Moskowitz H, and Pasternak GW. Identification of four novel MOR-1B splice variants of the mouse mu opioid receptor gene: Functional consequences of C-terminus splicing. *Mol. Pharm.* 68:866-875, 2005
38. Zhang YH, Pan Y-X, Kolesnikov Y and Pasternak GW. Immunohistochemical labeling of the mu opioid receptor carboxyl terminal splice variant mMOR-1B4 in the mouse central nervous system. *Brain Res.* 1099:33-43, 2006
39. Xu J, Xu MM and Pan Y-X. Characterizing exons 11 and 1 promoters of the mu opioid receptor (*Oprm*) gene in transgenic mice. *BMC Mol Biol.* 3;7:41, 2006
41. Xu J., Xu M.M., Hurd Y.L., Pasternak G.W., and Pan Y.-X. Isolation and characterization of new exon 11-associated N-terminal splice variants of the human mu opioid receptor gene. *J. Neurochem.* 108:962-972, 2008
42. Pan Y-X, Xu J, Xu M.M., Rossi G, Matulonis J.E. and Pasternak G.W. Involvement of exon 11-associated variants of the mu opioid receptor MOR-1 in heroin, but not morphine, actions, *Poc. Natl. Acad. Sci. UAS*, 106:4917-4922, 2009
43. Hadjimarkou MM, Abbadie C, Kasselmann LJ, Pan Y-X, Pasternak GW, Bodnar RJ. Changes in mouse mu opioid receptor Exon 7/8-like immunoreactivity following food restriction and food deprivation in rats. *Synapse*, 63:585-597, 2009
44. Pan Y-X, Xu J, Xu M.M., Rossi G, Matulonis J.E. and Pasternak G.W. Involvement of exon 11-associated variants of the mu opioid receptor MOR-1 in heroin, but not morphine, actions. *Proc.Natl.Acad.Sci.UAS* 106:4917-4921, 2009
45. Kolesnikov YA, Chereshev I, Criesta M, Pan Y-X, Pasternak GW. Opposing actions of neuronal nitric oxide synthase isoforms in formalin-induced pain in mice. *Brain Res.* 1289:14-21, 2009
46. Xu J., Xu M.M., Pasternak G.W., and Pan Y-X. Identification and expression of seven alternatively spliced variant containing exon 11 from the rat mu opioid receptor gene. Submitted.
47. Xu J., Xu M.M., and Pan Y-X. Identification and characterization of a new promoter, exon 11 promoter, from the human and rat mu opioid receptor (*OPRM1*) genes. In preparation.
48. Pan Y-X, Jin Xu, Mingming Xu, Grace Rossi, Joshua E. Matulonis and Gavril W. Pasternak. Modulating the mu opioid receptor functions by the truncated splice variants. In preparation.
49. Xu J., Xu M.M., and Pan Y-X. Differential expression of the *OPRM1* splice variant mRNAs in brain regions of four inbred strains of mice. In preparation.
50. Xu J., Xu M.M., and Pan Y-X. Differential expression of the alternatively spliced variant mRNAs from the mu opioid receptor (*OPRM1*) gene in selected brain regions of mice chronically treated with morphine. In preparation.

## II. Reviews and Monographs

1. Pasternak GW, Pan Y-X and Cheng J. Correlating the pharmacology and molecular biology of opioid receptors: cloning and antisense mapping a kappa3-related opiate receptor. in *Functional Diversity of Interacting Receptors* (A. Lajtha and L. Abood, eds.) New York Academy of Sciences, New York, 757: 332-338, 1995

2. Pasternak GW and Pan Y-X, Antisense mapping: Assessing the functional significance of genes and splice variants. *Methods In Enzymol.* 314:51-60, 2000
3. Pan Y-X. Molecular cloning of opioid receptors by cDNA library screening. *Methods Mol Med.* 84:3-16, 2003
4. Pan Y-X. Identification of alternatively spliced variants from opioid receptor genes. *Methods Mol Med.* 84:17-28, 2003
5. Pan Y-X. Expression of opioid receptors in mammalian cell lines. *Methods Mol Med.* 84:65-75, 2003
6. Pasternak GW and Pan Y-X, Alternative splicing of mu opioid receptors. *The Genetics of Pain, Progress in Pain Research and Management* (J.S. Mogil ed), Vol. 28. 85-106, 2004
7. Pan Y-X. Diversity and complexity of the mu opioid receptor gene: Alternative pre-mRNA splicing and promoters. *DNA & Cell Biology.* 24:736-750, 2005
8. Pan Y-X and Pasternak GW. Ch.6: Molecular biology of mu opioid receptors, in *The Opiate Receptors*, (GW Pasternak, ed), Humana Press, 2010
9. Pan Y-X, Grinnell S and Pasternak GW. Ch.9: Alternative pre-mRNA splicing of G protein coupled receptors, in *G Protein-Coupled Receptor Technology*, (C Stevens, ed), Humana Press, 2010
10. Pan Y-X and Pasternak GW, Pharmacology of mu opioids and their receptors, *Pharmacological Reviews*, 2011, in preparation

#### Invited Talks:

1. Structure and characterization of the gene encoding a kappa<sub>3</sub>-related opioid receptor. International Narcotics Research Conference, University of St Andrews, FIFE, Scotland, July 9-13, 1995
2. Mu opioid receptor gene (*Oprm*) diversity: Alternative splicing and Dual promoters. Department of Pharmacology and Toxicology, University of Kansas, June 5, 2004
3. Characterization of the mouse mu opioid receptor exon 11 promoter and its relationships with exon 1 promoter in transgenic mice. International Narcotics Research Conference, Kyoto, Japan, June 18-23, 2004
4. Regulation of the mu opioid receptor gene (*Oprm*). Department of Biology, Seton Hall University, November 3, 2004
5. Multiple mu opioid receptors: Targeting the old and the new. Department of Anesthesia and Critical Care, The University of Chicago, May 11, 2005
6. Diversity and complexity of the mu opioid receptor gene: Alternative pre-mRNA splicing and Promoters, Department of Psychiatry, Yale University, November 22, 2006
7. Exploring complexity of the opioid actions: Alternative pre-mRNA splicing and promoters of the mu opioid receptor gene, Pain & Palliative Care Grand Rounds, Memorial Sloan-Kettering Cancer Center, March 7, 2009

#### Patents:

1. US Patent 5,747,279. May 5, 1998. Filed: November 5, 1993. Nucleic Acid Molecules Encoding Kappa<sub>3</sub> opioid Receptors, Receptors Encoded Thereby, and Uses Thereof. Gavril W. Pasternak and Ying-Xian Pan.
2. US Patent 6,500,927 B2. December 31, 2002. Filed: January 17, 2001. Identification and Characterization of Multiple Splice Variants of the Mu-Opioid Receptor Gene. Gavril W. Pasternak and Ying-Xian Pan.
3. US Patent 6,627,734 B1. September 30, 2003. Filed: July 15, 1999. Identification and Characterization of Multiple Splice Variants of the Kappa<sub>3</sub>-Related (KOR-3) Opioid Receptor Gene. Gavril W. Pasternak and Ying-Xian Pan.