

CURRICULUM VITAE

Name: Ying-Xian Pan

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

Web: <https://www.mskcc.org/research-areas/labs/ying-xian-pan>

Education:

- 1978-1982 **B.S. (M.D. equivalent)** Medicine, Department of Medicine, Shanghai University of Traditional Chinese Medicine, Shanghai, China
- 1983-1986 **M.S.** Biochemistry, Department of Biochemistry, Shanghai University of Traditional Chinese Medicine, Shanghai, China. Advisor: Drs. Su-Yuan Wuan
- 1988-1993 **Ph.D.**, Department of Physiology & Biophysics, University of Cincinnati, College of Medicine, Cincinnati, OH. Advisor: 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 Chinese Medicine, Shanghai, China
- 1994-1996 **Research Associate**, Department of Neurology, Memorial Sloan-Kettering Cancer Center, New York, NY
- 1996-2000 **Assistant Laboratory Member**, Department of Neurology, Memorial Sloan-Kettering Cancer Center, New York, NY
- 1999-2000 **Assistant Attending Neuropharmacologist**, Department of Neurology, Memorial Sloan-Kettering Cancer Center, New York, NY
- 2000-2010 **Associate Attending Neuropharmacologist**, Department of Neurology, Memorial Sloan-Kettering Cancer Center, New York, NY
- 2010-2013 **Associate Member**, Department of Neurology, Memorial Sloan-Kettering Cancer Center, New York, NY
- 2013-present **Attending Neuropharmacologist**, Department of Neurology, Memorial Sloan-Kettering Cancer Center, New York, NY
- 2013-present **Member (Professor equivalent)**, Department of Neurology, Memorial Sloan-Kettering Cancer Center, New York, NY

Other Experience and Professional Memberships

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

Grant Review Panels:

2004-04 NIH Study Section: MDCN-A, Temporary member
2005-11 PSC-CUNY Research Awards
2007-03 CATALAN AGENCY FOR HEALTH TECHNOLOGY ASSESSMENT AND RESEARCH, SPAIN: REVIEWER
2008-06 NIH Study Section: ZDA1 EXL-T, Temporary member
2010-07 NIH Study Section: ZRG1 MDCN-N, Temporary member
2012-09 NIH Study Section: MNPS Temporary member
2016-05 Czech Science Foundation: reviewer
2018-06 VA CSR&D and BLRD Neurobiology NURA Merit Review: ZRD1 NURA-F
2019-06 NIH Study Section: ZTR1 TC-7, Temporary member

Journal Review Services:

2007-present Managing editor, *Frontiers in Bioscience*
Reviewer for *Neuron*, *New England Journal of Medicine*, *Journal of Neurochemistry*, *Neuropharmacology*, *Neurosciences*, *Gene*, *Molecular Genetics and Metabolism*, *RNA biology*, *DNA and Cell Biology*, *BMC Pharmacology*, *BMC Neuroscience*, and others.

Institute Academic Services:

2010-present: Member of IACUC Committee

Honors and Awards:

1980-1982 Outstanding student, Shanghai College of Traditional Medicine.
1988-1993 University Graduate Scholarship, University of Cincinnati College of Medicine
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 Research Fellowship in the Biomedical and Social Science, The Aaron Diamond Foundation, NY
1996-2001 Research Scientist Development Award (K01), NIDA, NIH

Research Support:

I. Completed research support

Aaron Diamond Fellowship 07/01/1993 – 06/30/1996

Aaron Diamond Foundation \$226,800 total costs

Molecular biology of mu and kappa opioid receptors

The goal of this project was to characterize the molecular biology of mu and kappa opioid receptors, with particular emphasis on kappa₃ receptor.

Ying-Xian Pan (PI)

K01 DA00296

09/01/1996 – 08/31/2001

NIH/NIDA \$1,062,500 total costs
Characterizing opioid receptor functions by gene targeting
The goal of this project is to understand the pharmacological and physiological significance of the KOR-3 (ORL-1) gene products by its targeted disruption in mice.
Ying-Xian Pan (PI)

R01 DA13997 09/27/2002 – 06/30/2007
NIH/NIDA \$1,531,000 total costs
Characterizing a novel promoter of mouse MOR-1 gene
The goal of this project is to obtain a better understanding of the mu opioid receptor (*Oprm*) gene regulation through molecular biological means and transgenic techniques.
Ying-Xian Pan (PI)

R01 DA13997 02/01/2008 – 01/31/2014
NIH/NIDA \$1,969,750 total costs
Characterizing exon 11 promoter of the mouse mu opioid gene, OPRM1
The goal of this project is to investigate transcriptional regulation of the mu opioid receptor (*Oprm*) gene using transgenic and gene targeting approaches.
Ying-Xian Pan (PI)

R21 DA029244 05/01/2010 – 04/30/2013
NIH/NIDA \$481,250 total costs
Exploring functions of mu opioid receptor carboxyl termini by gene targeting
The goal of this project is to establish three gene targeting mouse models to study function of C-terminal splice variants of the mu opioid receptor gene, *Oprm1*.
Ying-Xian Pan (PI)

R21 DA040858 07/15/2016 – 06/30/2019
NIH/NIDA \$489,500 total costs
Exploring functions of mu opioid receptor splice variants in rat by gene targeting
The goal of this project is to generate three gene targeting rat models using CRISPR/Cas9 to investigate function of alternatively spliced variants of the mu opioid receptor gene, *Oprm1*.
Role: Principal Investigator

R01 DA006241-28 (PI: Pan) 07/01/2014 - 6/30/2019
NIDA \$ 2,305,500 total costs
Synthesis and pharmacology of novel opiates and their modulatory systems
The major aims of the proposal explore new compounds designed to target a novel receptor site capable of producing analgesia without respiratory depression, physical dependence, reward behavior and minimal effects on gastrointestinal transit. We also propose to generate a series of agents designed to facilitate the study of this new target.
Role: Principle Investigator

II. Ongoing Research Support

R21 DA046714-01 (PI: Pan) 9/30/2018 - 8/31/2020
NIDA \$ 161,199/year direct costs
Mapping mu agonist-induced receptor-protein interactions for OPRM1 7TM variants
The proposed studies will explore molecular mechanisms and functions of the OPRM1 carboxyl terminal variants in mu opioid actions using novel technologies including proximity biotinylation with an engineered ascorbate peroxidase (APEX2) couple with tandem mass tag (TMT) proteomics and NanoLuc binary technology (NanoBit).
Role: Principal Investigator

R01 DA042888-02 (PI: Pan) 9/1/2017 - 5/31/2022
NIDA \$ 240,300/year direct costs
Alternative pre-mRNA splicing of mu opioid receptor gene and mu opioid actions
The proposed studies aim to investigate mechanism and functions of OPRM1 alternative splicing, and provide potential targets for developing novel therapeutics for the treatment of pain and drug abuse.
Role: Principal Investigator

R01 DA007242-25A1 (PI: Pan) 07/01/2018 – 05/31/2023
NIH/NIDA \$230,000/year direct costs
Pharmacology of opioid receptor subtypes
This grant examines the behavioral pharmacology of opioids in vivo. It focuses upon regional and drug interactions and correlating the cloned receptors with function.
Role: Principal Investigator

UG3 DA048379-01 (PI: Pan) 12/15/2018 – 11/30/2020
NIDA \$ 2,078,187/year direct costs
Arylepoxamides: A new class of potent, safer analgesics
The opioid epidemic has reached crisis levels. Evidence suggests that up to 80% of addicts started with prescription drugs. Efforts to find substitutes to opioids and drugs able to minimize opioid usage would help address this crisis. This award addresses the problem through the development of a class of potent analgesic drugs acting through a new target unrelated to the actions of traditional opioids.
Role: Principal Investigator

The Mayday Foundation 10/01/2016 – 09/30/2019
\$71,500/year
A novel type of opioid analgesics targeting OPRM1 6TM variants
Role: Princepal Investigator

The Peter F. McMaus Trust Foundation 09/01/2013 – 08/31/2019
\$50,000/year
Opiate analgesics lacking side-effects and abuse potential
Role: Princepal Investigator

III. Pending Research Support

R01 DA046454-01A1 (PI: Pan) 02/01/2020 - 01/31/2025
NIDA \$ 250,000/year
Mechanisms and functions of alternatively spliced OPRM1 C-terminal 7TM variants

Morphine and most other clinical opioid analgesics, as well as heroin, act primarily through mu opioid receptors generated from the mu opioid receptor gene (OPRM1). This application is to examine the mechanisms and functions of C-terminal 7TM splice variants of the mouse Oprm1 gene.

Role: Principal Investigator

Publications (Complete List of Published Work in MyBibliography publications:

<https://www.ncbi.nlm.nih.gov/myncbi/ying-xian.pan.1/bibliography/public/>

I. Peer-reviewed Papers

1. Irie T, Shum R, Deni I, Hunkele A, LeRouzic V, Xu J, Wilson R, Fischer GW, Pasternak GW and Pan YX. *Mol Pharm*. 96:247-258, 2019
2. LeRouzic V, Narayan A, Hunkle A, Marrone GF, Lu Z, Majumdar S, Xu J, Pan YX and Pasternak GW. *Anesth Analg*. 128:365-373, 2019 PMCID: PMC6181797
3. Lu Z, Xu J, Xu M, Rossi GC, Majumdar S, Pasternak GW and Pan YX. Truncated mu-opioid receptors with 6 transmembrane domains are essential for opioid analgesia. *Anesth Analg*. 126:1050-1057, 2018. PMCID: PMC5820199
4. Baumann MH, Majumdar S, Le Rouzic V, Hunkele A, Uprety R, Huang XP, Xu J, Roth BL, Pan YX and Pasternak GW. *Neuropharmacology*. 134:101-107, 2018 PMCID: PMC5809328
5. Huang XP, Che T, Mangano TJ, Le Rouzic V, Pan YX, Majumdar S, Cameron MD, Baumann MH, Pasternak GW and Roth BL. Fentanyl-related designer drugs W-18 and W-15 lack appreciable opioid activity in vitro and in vivo. *JCI Insight*. 2017 Nov 16;2(22). pii: 97222. doi: 10.1172/jci.insight.97222. PMCID: PMC5752382
6. Marrone GF, Le Rouzic V, Varadi A, Xu J, Rajadhyaksha AM, Majumdar S, Pan YX and Pasternak GW. Genetic dissociation of morphine analgesia from hyperalgesia in mice. *Psychopharmacology*. 234:1891-1900, 2017. PMCID: PMC5520541
7. Pan L, Pasternak DA, Xu J, Xu M, Lu ZG, Pasternak GW and Pan YX. Isolation and characterization of alternatively spliced variants of the mouse sigma1 receptor gene, Sigmar1. *PLoS One*, 12(3):e0174694. doi: 10.1371/journal.pone.0174694. eCollection 2017. PMCID: PMC5370144
8. Xu J, Lu ZG, Narayan A, Le Rouzic VP, Xu M, Hunkele A, Brown TG, Hoefler WF, Rossi GC, Rice R, Martinez-Rivera A, Rajadhyaksha AM, Catergini L, Bassoni DL, Pasternak GW and Pan YX. Alternatively spliced C-termini of mu opioid receptors impact morphine action. *J Clin. Invest*. 127:1561-1573, 2017. PMCID: PMC5373896
9. Marrone GF, Lu Z, Rossi G, Narayan A, Hunkele A, Marx S, Xu J, Pintar J, Majumdar S, Pan YX and Pasternak GW. Tetrapeptide endomorphin analogs require both full length and truncated splice variants of the mu opioid receptor gene Oprm1 for analgesia. *ACS Chem. Neurosci*. 7:1717-1727, 2016. PMCID: PMC5177531
10. Varade A, Marrone GF, Palmer TC, Narayan A, Szabe MR, Le Rouzic V, Grinnell SG, Subrath JJ, Warner E, Kalra S, Hunkele A, Pagirske J, Ean SO, Medina JM, Xu J, Pan YX, Borics A, Pasternak GW, McLaughlin JP and Majumdar S. Mitragynine/Corynantheidine presudoindoxyls as opioid analgesics with mu agonism

- and delta antagonism, which do not recruit β -arrestin-2. **J Med. Chem.** 59:8381-8391, 2016. PMID: PMC5344672
11. Grinnell SG, Ansonoff M, Marrone GF, Lu Z, Narayan A, Xu J, Rossi G, Majumdar S, Pan YX, Bassoni DL, Pintar J and Pasternak GW. Mediation of buprenorphine analgesia by a combination of traditional and truncated mu opioid receptor splice variants. **Synapse.** 70:395-407, 2016 PMID: PMC4980214
 12. Marrone GF, Grinnell SG, Lu Z, Rossi GC, Le Rouzic V, Xu J, Majumdar S, Pan YX and Pasternak GW, Truncated mu opioid GPCR variant involvement in opioid-dependent and opioid-independent pain modulatory systems within the CNS. **Proc. Natl. Acad. Sci. USA.** 113:3663-3668, 2016. PMID: PMC4822618
 13. Lu ZG, Xu J, Rossi G, Majumdar S, Pasternak GW and Pan YX. Mediation of opioid analgesia by truncated six transmembrane GPCR. **J Clin. Invest.** 125:2626-2630, 2015. PMID: PMC4563690
 14. Xu J, Faskowitz AJ, Rossi GC, Xu M, Lu Z, Pan YX* and Pasternak GW*. Stabilization of morphine tolerance with long-term dosing: Association with selective upregulation of mu-opioid receptor splice variant mRNAs. **Proc. Natl. Acad. Sci. USA** 112:279-284, 2015. PMID: PMC4291645 (*: Co-corresponding author)
 15. Xu J, Xu M, Lu ZG, Rossi GC, Kest B, Waxman AR, Pasternak GW and Pan YX. Differential expressions of the alternatively spliced variant mRNAs of the mu opioid receptor gene, OPRM1, in brain regions of four inbred mouse strains. **PLoS One.** 9(10):e111267. 2014 PMID: PMC4208855
 16. Xu J, Lu Z, Xu M, Pan L, Deng Y, Xie X, Liu H, Ding S, Hurd YL, Pasternak GW, Klein RJ, Cartegni L, Zhou W, Pan YX. A Heroin Addiction Severity-Associated Intronic Single Nucleotide Polymorphism Modulates Alternative Pre-mRNA Splicing of the μ Opioid Receptor Gene OPRM1 via hnRNPH Interactions. **J Neurosci.** 34:11048-11066. 2014 PMID: PMC4131016.
 17. Wieskopf JS, Pan YX, Marcovitz J, Tuttle AH, Majumdar S, Pidakala J, Pasternak GW, Mogil JS. Broad-spectrum analgesic efficacy of IBNtxA is mediated by exon 11-associated splice variants of the mu-opioid receptor gene. **Pain.** S0304-3959(14)00333-9, 2014 PMID: PMC4372857
 18. Xu J, Xu M, Bolan E, Gilbert AK, Pasternak GW and Pan YX. Isolating and characterizing three alternatively spliced mu opioid receptor variants: mMOR-1A, mMOR-1O and mMOR-1P. **Synapse,** 68:144-152, 2014 PMID: PMC3926657
 19. Lu ZG, Xu J, Xu M, Pasternak GW and Pan YX. Morphine regulates expression of mu opioid receptor MOR-1A, an intron-retention carboxyl terminal splice variant of the mu opioid receptor (OPRM1) gene via miR-103/miR-107. **Mol Pharm.** 85:368-380, 2014 PMID: PMC3913361.
 20. Sullivan SE, Whittard JD, Jacobs MM, Ren Y, Mazloom AR, Caputti F, Horvath M, Keller E, Ma'ayan A, Pan YX, Chiang LW and Hurd YL. ELK1 transcription factor linked to dysregulated striatal mu opioid receptor signaling network and OPRM1 polymorphism in human heroin abusers. **Bio Psychiatry.** 74:511-519, 2013. PMID: PMC4070524.

21. Xu J, Xu M, Brown T, Rossi GC, Hurd YL, Inturrisi CE, Pasternak GW and Pan YX. Stabilization of the mu opioid receptor by truncated single transmembrane splice variants through a chaperon-like action. **J. Biol. Chem.** 288:21211-21227, 2013. PMID: PMC3774389
22. Majumdar S, Subrath J, La Rouzic V, Polikar L, Burgmen M, Nagakura K, Ocampo J, Haselton N, Pasternak AR, Grinnell S, Pan YX and Pasternak GW. Synthesis and evaluation of aryl-naloxamide opiate analgesics targeting truncated exon 11-associated mu opioid receptor (MOR-1) splice variants. **J Med Chem.** 55: 6352-6362, 2012. PMID: PMC3412067.
23. Lefave CV, Squatrito M, Vorlova S, Rocco GL, Brennan CW, Holland EC, Pan YX and Cartegni L. Splicing factor hnRNPH drives an oncogenic splicing switch in gliomas. **EMBO J.** 30:4084-4097, 2011. PMID: PMC3209773.
24. Majumdar S, Grinnell S, Le Rouzic V, Burgman M, Polikar L, ANsonoff M, Pintar J, Pan YX and Pasternak GW. Truncated G protein-coupled mu opioid receptor MOR-1 splice variants are targets for highly potent opioid analgesics lacking side effects. **Proc.Natl.Acad.Sci.UAS.** 108: 19778-19783, 2011. PMID: PMC3241767.
25. Pasternak GW and Pan YX. Mix and match: heterodimers and opioid tolerance, **Neuron.** 69(1): 6-8, 2011. PMID: PMC3027205.
26. Xu J, Xu M, Rossi GC, Pasternak GW and Pan YX. Identification and characterization of seven new exon 11-associated splice variants of the rat mu opioid receptor gene, OPRM1. **Mol Pain.** 7:9, 2010. PMID: PMC3057186.
27. Kolesnikov YA, Chereshnev I, Criesta M, Pan YX, Pasternak GW. Opposing actions of neuronal nitric oxide synthase isoforms in formalin-induced pain in mice. **Brain Res.** 1289:14-21, 2009. PMID: PMC2730432.
28. Pan YX, 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. PMID: PMC2660730.
29. Hadjimarkou MM, Abbadie C, Kasselmann LJ, Pan YX, Pasternak GW and 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. PMID: PMC2749570.
30. Xu J., Xu M.M., Hurd YL, Pasternak G.W., and Pan YX. Isolation and characterization of three alternatively spliced variants from the human mu opioid receptor, OPRM1, gene. **J. Neurochem.** 108: 962-972, 2009. PMID: PMC2727151.
31. Xu J, Xu MM and Pan YX. Characterizing exons 11 and 1 promoters of the mu opioid receptor (Oprm) gene in transgenic mice. **BMC Mol Biol.** 3;7:41, 2006. PMID: PMC1657025.
32. Zhang YH, Pan YX, 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

33. Pan YX, 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
34. Israel Y, Kandov Y, Khaimova E, Kest A, Lewis SR, Pasternak GW, Pan YX, Rossi GC and Bodnar RJ. NPY-induced feeding: Pharmacological characterization using selective opioid antagonists and antisense probes in rats. *Peptides*. 26:1167-75, 2005
35. Pan L, Xu J, Xu MM, Yu R, Pasternak GW and Pan YX. Identification and characterization of six new alternatively spliced variants from the human mu opioid receptor gene, *Oprm*. *Neuroscience*, 133:209-20, 2005
36. Hadjimarkou MM, Singh A, Kandov Y, Israel Y, Pan YX, 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
37. Pasternak DA, Pan L, Xu J, Yu R, Xu MM, Pasternak GW and Pan YX. Identification and characterization of four new alternatively spliced variants from rat mu opioid receptor gene, *Oprm*. *J Neurochem.* 91:881-90, 2004
38. Abbadie, C, Pan YX, Pasternak GW. Expression of exon11-containing mu opioid receptor variants in mouse brain. *Neuroscience*, 127:419-30, 2004
39. Bolan, EA, Pan YX, Pasternak GW. Functional analysis of MOR-1 splice variants of the mouse mu opioid receptor gene *Oprm*. *Synapse*, 51:11-18, 2004
40. Hadjimarkou MM, Khaimova E, Pan YX, 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
41. Pan YX, 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
42. Pan YX, 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
43. Pan YX. 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
44. Pan YX, 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
45. Abbadie C, Pan YX, 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.* 100:141-53, 2000
46. Bodnar RJ, Hadjimakou MM, Khaimove E, Pan YX, Rossi GC, and Pasternak GW. Feeding induced by food deprivation is differentially reduced by opioid receptor antisense oligodeoxynucleotides probes in rats. *Brain Res.* 955: 45-54, 2002.

47. Abbadie C, Pan YX, 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
48. Pan YX, 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
49. Hom JS, Goldberg I, Mathis J, Pan YX, Brooks AI, Ryan-Moro J, Scheinberg DA, Pasternak GW. [¹²⁵I]orphanin FQ/nociceptin binding in raji cells. **Synapse** 34:187-91, 1999
50. Pan YX, 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. Pharm.** 56:396-403, 1999
51. Schuller A GP, King MA, Zhang J, Bolan E, Pan YX, 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
52. Pan YX, 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
53. Pan YX, Mei JF, Xu J, Wan BL, Zuckerman A and Pasternak, Cloning and characterization of a mouse sigma₁ receptor, **J. Neurochem.** 70:2279-2285, 1998
54. Burdick K, Yu W-Z, Ragnauth A, Moroz M, Pan YX, 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
55. Kolesnikov Y, Pan YX, 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
56. Chien CC, Carroll FI, Brown GP, Pan YX, Bowen W and Pasternak GW. Synthesis and characterization of [125]3'-(-)-iodopentazocine, a selective sigma 1 receptor ligand. **Eur J Pharmacol.** 321:361-368, 1997
57. Rossi GC, Leventhal L, Pan YX, Cole J, Su W, Bodnar RJ and Pasternak GW. Antisense mapping of MOR-1 in rats: distinguishing between morphine and morphine-6beta-glucuronide antinociception. **J Pharmacol Exp Ther.** 281:109-114, 1997
58. King M, Pan YX, Mei J.F, Chang A, Xu J and Pasternak GW. Enhanced kappa opioid analgesia by antisense targeting the sigma₁ receptor, **Eur.J.Pharmacol.** 331:R5-R6, 1997
59. Pan YX, Xu J, and Pasternak GW. Structure and characterization of the gene encoding a mouse kappa3-related opioid receptor, **Gene,** 171:255-260, 1996
60. Pan YX, 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

61. Pan YX, 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.
62. Leventhal L, Cole JL, Rossi GC, Pan YX, 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
63. Pan YX, 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. Pharm.** 47: 1180-1188, 1995
64. Rossi G, Pan YX, Brown GP and Pasternak GW. Antisense mapping MOR-1: Evidence for alternative splicing and a novel morphine-6 μ -glucuronide receptor. **FEBS letter** 369:192-196, 1995
65. Standifer KM, Jenab S, Su W, Chien C-C, Pan YX, 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
66. Pan YX, 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
67. Rossi G, Pan YX, Cheng J, and Pasternak GW. Blockade of morphine analgesia by an antisense oligodeoxynucleotide against the mu receptor. **Life Sci.** 54: PL 375-379, 1994
68. Chien C-C, Brown G, Pan YX and Pasternak GW. Blockade of U50,488H analgesia by antisense oligodeoxynucleotides to a kappa opioid receptor. **Eur.J.Pharmacol.** 253: R7-8, 1994
69. Pan YX, Gu HH, Xu J and Dean GE. *Saccharomyces cerevisiae* expression of exogenous vacuolar ATPase subunits B. **Biochem. Biophys. Acta.** 1151: 175-185, 1993.
70. Pan YX, 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
71. Chao W-K, Pan YX 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
72. Pan YX, 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

II. Reviews and Monographs

1. Pasternak GW, Childers S and Pan YX. Emerging Insights into mu opioid pharmacology. Chapter 5, In **Substance Use Disorders: From Etiology to Treatment** (Nader MA and Hurd Y, ed), Springer 2019, In press

2. Pan YX. Alternative pre-mRNA splicing of mu opioid receptor gene: Molecular mechanisms underlying the complex actions of mu opioids. Chapter 6, In **Pain Genetics: Basic to Translational Science**, p80-98, (Belfer I and Diatchenko L, ed), John Wiley & Sons, Inc. 2014
3. Pasternak GW and Pan YX. Mu opioids and their receptors: Evolution of a concept. **Pharmacol Rev.** 65:1257-1317, 2013. PMID: PMC3799236.
4. Pasternak GW and Pan YX. Mu opioid receptors in pain management. **Acta Anaesthesiol Taiwan**, 49:21-25, 2011. PMID: PMC4014005.
5. Pan YX, Grinnell S and Pasternak GW. Part I.2: Alternative pre-mRNA splicing of G protein coupled receptors. In **New Methods for the Discovery and Characterization of G Protein-Coupled Receptor**, p19-34,s (CW Stevens, ed), Humana Press 2011
6. Pan YX and Pasternak GW. Ch.6: Molecular biology of mu opioid receptors in **The Opiate Receptors**, p121-160, (GW Pasternak, ed), Humana Press, 2010
7. Pan YX. Diversity and complexity of the mu opioid receptor gene: Alternative pre-mRNA splicing and promoters. **DNA & Cell Biology.** 24:736-750, 2005
8. Pasternak GW and Pan YX, 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
9. Pan YX. Expression of opioid receptors in mammalian cell lines. **Methods Mol Med.** 84:65-75, 2003
10. Pan YX. Identification of alternatively spliced variants from opioid receptor genes. **Methods Mol Med.** 84:17-28, 2003
11. Pan YX. Molecular cloning of opioid receptors by cDNA library screening. **Methods Mol Med.** 84:3-16, 2003
12. Pasternak GW and Pan YX, Antisense mapping: Assessing the functional significance of genes and splice variants. **Methods In Enzymol.** 314:51-60, 2000
13. Pasternak GW, Pan YX 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

Invited Talks:

1. Variation on a theme by OPRM1: It's all in telling the tail. Department of Pharmacology and Experimental Neuroscience, **University of Nebraska**, June 20-21, 2019
2. The Quest for Safer Opiates: A 40 Year Journey to the Promised Land. **American Pain Society Scientific Meeting**, Milwaukee, WI, April 3-6, 2019
3. Biased signaling at mu-opiate receptor splicing variants. **Henry Stewart Talks (HST) on GPCR drug discovery series**, September 2019
4. Alternatively spliced mu opioid receptor intracellular C-termini encoded by exon 7 impact fentanyl actions. **The 3rd Annual Chemistry & Pharmacology of Drug Abuse Conference**, Northeastern University, August 2-3, 2018

5. Alternatively spliced mu opioid receptor intracellular C-termini impact on mu opioid actions. **G-protein Signaling Workshop**, Thomas Jefferson University, June 18, 2018
6. Biased signaling at mu opioid receptor splice variants, **12th Annual GPCR-Based Drug Discovery**, Boston, September 27, 2017
7. Carboxyl termini of OPRM1/GPCR: Alternative splicing, function and beyond. Molecular Pharmacology and Chemistry Biology Program, **Memorial-Sloan-Kettering Cancer Center**, October 21, 2016
8. Exploring functions of mu opioid receptor splice variants by gene targeting, Department of Biology, **Seton Hall University**, March 31, 2016
9. Remodeling of GPCR functions: A case-study of OPRM1 alternative splicing. Molecular Pharmacology and Chemistry Program, **Memorial-Sloan-Kettering Cancer Center**, October 21, 2015
10. Truncated six transmembrane mu opioid receptors mediate opioid analgesia. **International Narcotics Research Conference**, Phoenix, Arizona, June 15-20, 2015
11. Alternative pre-mRNA splicing of the mu opioid receptor gene: insight into complex mu opioid actions, Julius Axelrod symposium: Expanding the repertoire of G-protein coupled opioid receptor targets, **Experimental Biology** 2013, April 21, 2013
12. Truncated OPRM1/GPCR and beyond. Molecular Pharmacology and Chemistry Program, **Memorial-Sloan-Kettering Cancer Center**, October 23, 2013
13. Diversity and complexity of the mu opioid receptor gene, OPRM1. Molecular Pharmacology and Experimental Therapeutic Center, **Memorial-Sloan-Kettering Cancer Center**, February 23, 2011
14. Exploring individuality of the opioid response: Functional diversity of the mu opioid receptor gene, Center for Neurosensory Disorders, Carolina Center for Genome Sciences, **University of North Carolina**, October 15, 2010
15. 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, 2007
16. Diversity and complexity of the mu opioid receptor gene: Alternative pre-mRNA splicing and Promoters, Department of Psychiatry, **Yale University**, November 22, 2006
17. Multiple mu opioid receptors: Targeting the old and the new. Department of Anesthesia and Critical Care, **The University of Chicago**, May 11, 2005
18. Regulation of the mu opioid receptor gene (*Oprm*). Department of Biology, **Seton Hall University**, November 3, 2004
19. 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
20. Mu opioid receptor gene (*Oprm*) diversity: Alternative splicing and Dual promoters. Department of Pharmacology and Toxicology, **University of Kansas**, June 5, 2004

21. Structure and characterization of the gene encoding a kappa₃-related opioid receptor. ***International Narcotics Research Conference***, University of St Andrews, FIFE, Scotland, July 9-13, 1995

Patents:

1. US Patent 5,747,279. May 5, 1998. Filed: November 5, 1993. Nucleic Acid Molecules Encoding Kappa₃ 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 Kappa3-Related (KOR-3) Opioid Receptor Gene. Gavril W. Pasternak and Ying-Xian Pan.