List of RGJ advisors 2023/2024

Name: Prof. Dr. Praneet Opanasopit

Program: - Department: Industrial Pharmacy

Faculty: Pharmacy University: Silpakorn University

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Keywords: Niosomes, chitosan, mucoadhesive polymeric materials, nanofibers, polymeric micelles, lipid base nanocarriers, anticancer drug, gene/siRNA, 3D printing technology

Education:

Degrees Attained	Schools/Universities	Year Graduated
B.Pharm.	Silpakorn University (Thailand) / Faculty of Pharmacy	1992
MSc in Pharmacy (Industrial Pharmacy)	Chulalongkorn University (Thailand) / Faculty of Pharmacy	1995
PhD (Pharmaceutical Sciences)	Kyoto University (Japan) / Department of Drug Delivery Research, Faculty of Pharmaceutical Sciences	2002
Postdoctoral Research Associate	Tokyo Women's Medical University (Japan)/Institute of advanced biomedical engineering and science	2004

Awards and Honors:

Award Received	Given By	Date/Venue
Annual Award for outstanding academic performance	Pharmacy faculty. Silpakorn university, Thailand	1990/Silpakorn university, Thailand
King Bhumipol Scholarship awards for outstanding students scholarships	Silpakorn university, Thailand	1992 / Silpakorn university, Thailand
Research Award [Research title: Targeting to the liver by mannose receptor-mediated endocytosis	Japan Society for the Promotion of Science (JSPS)	1997 / Kyoto university, Japan
Research Award [Research title: Involvement of serum mannan binding proteins and membrane mannose receptors in uptake of mannosylated liposomes by macrophages]	Millennial world congress of pharmaceutical sciences	April 2000/ San Francisco USA

Faculty of pharmacy outstanding alumni award 2005 (Research)	Faculty of pharmacy and silpakorn university pharmacy alumni association, Thailand	2005 / Nakornpathom, Thailand
Research Award 2007 [Research project: Effect of chitosan salts on physicochemical properties and protein release from chitosan nanoparticles]	Silpakorn University Research and Development Institute, Silpakorn University, Thailand	October 2007 / Nakhon Pathom, Thailand
Nagai Award Thailand 2008 (Outstanding Research) [Research title: Chitosan - thiamine pyrophosphate as a novel carrier for siRNA delivery]	Nagai Foundation Tokyo, Japan	December 2008 / Chulalongkorn University, Thailand
Research Award 2009 [Research project: Development of a novel gene delivery carrier using chitosan derivatives]	Silpakorn University Research and Development Institute, Silpakorn University, Thailand	October 2009 / Nakhon Pathom, Thailand
Outstanding Silpakorn University alumni award:2009	Silpakorn university alumni association, Thailand	October 2009 / Nakhon Pathom, Thailand
The best poster presentation award:2009 [Research title: Self-assembling poly-l-arginine/chitosan/ DNA complexes as a novel gene carrier.]	Faculty of Pharmaceutical Sciences, Chulalongkorn University, Bangkok	December 2009 / Chulalongkorn University, Thailand
TRF-CHE-Scopus Researcher Awards:2009 [Research title: Nonotechnolofy for drug/gene delivery]	TRF-CHE-Scopus	October 2009/ Petchaburi, Thailand
Research Council Award: Research Award 2009 in Chemistry and Pharmaceutical Sciences [Research title: Development of a novel gene delivery carrier using chitosan derivatives]	National Research Council of Thailand	February 2010 / Bangkok, Thailand
The best poster presentation award:2010	Faculty of Pharmaceutical Sciences, Chulalongkorn University, Bangkok	December 2010 /Chulalongkorn University, Thailand

[Research title: Development of lipid nanoparticles for all-trans retinoic acid]		
Nagai Award Thailand 2011 (Co-author of outstanding Research) [Research title: Microscale chemistry-based design of eco-friendly, reagent-saving and efficient pharmaceutical analysis: a miniaturized Volhard's titration for the assay of sodium chloride]	Nagai Foundation Tokyo, Japan	January 2012/ Chulalongkorn University, Thailand
The best poster presentation award:2012 [Research title: Fabrication and evaluation of cationic exchange polystyrene nanofibers for oral drug delivery]	Faculty of Pharmaceutical Sciences, Chulalongkorn University, Bangkok	December 2012 /Chulalongkorn University, Thailand
Nagai Award Thailand 2012 (corresponding author of outstanding Research) [Research title: N-(4-N,N-dimethylaminobenzyl) chitosan coated liposomes for oral protein drug delivery]	Nagai Foundation Tokyo, Japan	December 2012 /Chulalongkorn University, Thailand
The best poster presentation award:2014 [Research title: Fabrication and evaluation of clotrimazole-loaded PVP/HPβCD nanofiber mats for oral candidiasis]	Faculty of Pharmaceutical Sciences, Chulalongkorn University, Bangkok	January 2014/ Chulalongkorn University, Thailand
Research Award 2014 [Research project: Development of cationic polymer coated liposomes for gene delivery]	Silpakorn University Research and Development Institute, Silpakorn University, Thailand	October 2014 / NakhonPathom, Thailand
The best oral presentation award: in The 7th Annual Northeast Pharmacy Research Conference of 2015	Faculty of Pharmaceutical Sciences, Khon Kaen University	March 2015/ Khon Kaen University, Thailand

[Research title: Inhibition effect of chitosan derivatives on SLC22A1 transport function]		
22th Science and Technology Research Grant recipient [Research title: Natural product-based drug discovery and development for treatment of anticancer drug-induced toxicity	Thailand Toray Science Foundation	March 2016 / Bangkok, Thailand
The 2016 FAPA Ishidate Award for Pharmaceutical Research	The Federation of Asian Pharmaceutical Associations (FAPA).	November 2016/ Bangkok, Thailand
Outstanding Pharmacy Award 2017: research and innovation	The Pharmaceutical Association of Thailand Under Royal Patronage	November 2017/ Bangkok, Thailand
Outstanding research Award 2018: research and innovation	The Silpakorn University	January 2019/ Nakornpathom, Thailand
TRF Senior Research Scholar 2019	Thailand Science Research and Innovation (TSRI)	August 2019
Annual Award for outstanding academic performance 2019	Faculty of Pharmacy, Silpakorn University, Thailand	2019 / Silpakorn University, Thailand
Outstanding Researcher Award 2023: Sciemce Chemistry and Pharmaceutics	National Research Council of Thailand (NRCT)	February 2023/ Bangkok, Thailand

Education and Research/Teaching Experiences:

Position	Institution / Establishment	Duration
Lecturer	Department of Pharmaceutical Technology, Faculty of Pharmacy, Silpakorn University, Thailand	1996 – 2002
Visiting researcher	Department of Drug Delivery Research, Faculty of Pharmaceutical Sciences Kyoto University, Japan	August-October 1997
Assistant Professor	Department of Pharmaceutical Technology, Faculty of Pharmacy, Silpakorn University, Thailand	2002 – 2006
Visiting researcher	Institute of advanced biomedical engineering and scienc, School of medicine, Tokyo Women's Medical University, Japan.	October 2003-March 2004

Visiting researcher	Nano-medical polymer project, at Kanagawa Academy of Science and Technoloty, Sakado, Kanagawa, Japan	April-June 2005
TRF Research Scholar	The Thailand Research Fund, Thailand	2005 – 2015
Visiting scientist	University of Applied Sciences Berlin, Germany	April 2006
Associate Professor	Department of Pharmaceutical Technology, Faculty of Pharmacy, Silpakorn University, Thailand	2006 – Present
Committee for TRF Research Scholar evaluation	The Thailand Research Fund, Thailand	2009 – present
Head of Department of Pharmaceutical Technology	Department of Pharmaceutical Technology, Faculty of Pharmacy, Silpakorn University, Thailand	2010-2011
Visiting scientist	Biomaterials Group, Materials Science, Manchester University, UK	April 2012
Coordinator/ Secretary of Research Program	Research Program on "Development of ion exchange for drug delivery and tablet excipient", Silpakorn University, Thailand	January 2012 – January 2015
Research Group Coordinator	Research and Development of Green Pharmaceutical Innovations Group (PDGIG), Faculty of Pharmacy, Silpakorn University, Thailand	January 2012 – Present
Curriculum committee of Doctor of Philosophy program in Pharmaceutical technology	Faculty of Pharmacy, Silpakorn University, Thailand	2013 – 2015
Visiting scientist	Jikei University, School of Medicine, Japan	April 2014
Program Director of Doctor of Philosophy program in Pharmaceutical technology curriculum	Faculty of Pharmacy, Silpakorn University, Thailand	August 2015 – Present
Professor	Department of Pharmaceutical Technology, Faculty of Pharmacy, Silpakorn University, Thailand	2016 – Present

Scientific Publications:

296 research papers (refereed)

20 review articles

Research papers (refereed)

Titles of Research	Nature of Participation	Year

1. Kaisri Umprayn and Praneet Opanasopit. Development of a matrix-membrane transdermal delivery system for nicotine. Pharm Tech Europe. 2000; 12 (12): 54-59	Co-author	2000
2. Praneet Opanasopit, Keiko Shiraishi, Makiya Nishikawa, Fumiyoshi Yamashita, Yoshinobu Takakura, and Mitsuru Hashida In vivo recognition of mannosylated proteins by hepatic mannose receptors and mannan-binding protein. Am J Physiol Gastrointest liver Physiol. 2001; 280:G879-G889.	First author	2001
3. Praneet Opanasopit, Yuriko Higuchi, Shigeru Kawakami, Fumiyoshi Yamashita, Makiya Nishikawa, and Mitsuru Hashida Involvement of serum mannan binding proteins and mannose receptors in uptake of mannosylated liposomes by macrophages. Biochim. Biophys. Acta. 2001;1511(1):134-145.	First author	2001
4. Praneet Opanasopit, Makiya Nishikawa, Fumiyoshi Yamashita, Yoshinobu Takakura, and Mitsuru Hashida Pharmacokinetic analysis of Lectin-dependent biodistribution of fucosylated bovine serum albumin: A possible carrier for kupffer cells. J. Drug Targeting. 2001;9:341-351.	First author	2001
5. Praneet Opanasopit, Megumi Sakai, Makiya Nishikawa, Shigeru Kawakami, Fumiyoshi Yamashita, and Mitsuru Hashida Inhibition of experimental liver metastasis by lectin-mediated targeting of immunomodulators to liver nonparenchymal cells using mannosylated liposomes. J. Controlled Release. 2002; 80 (1-3): 283-294.	First author	2002
6. Praneet Opanasopit, Kenji Hyoudou, Makiya Nishikawa, Fumiyoshi Yamashita, and Mitsuru Hashida Serum mannan binding protein inhibits mannosylated liposome-mediated transfection to macrophages. Biochim. Biophys. Acta. 2002; 1570:203-209	First author	2002
7. Praneet Opanasopit, Makiya Nishikawa, and Mitsuru Hashida Factors affecting drug and gene delivery: effects of interaction with blood complements. Crit. Rev. Ther Drug Carrier Sys. 2002;19(3):199-233	First author	2002
8. Praneet Opanasopit, Makiya Nishikawa, Xhittima Managit, Fumiyoshi Yamashita and Mitsuru Hashida. Control of hepatic disposition of mannosylated liposomes by PEGylation: effect of molecular weight of PEG and the density of PEG and mannose. S.t.p.Pharma Sciences. 2003;13 (1):57-62	First author	2003
9. Tanasait Ngawhirunpat, Praneet Opanasopit, Sompol Prakongpan Comparison of skin transport and metabolism of ethyl nicotinate in various species. Eur J Pharm Biopharm. 2004;58(3):645-651	Co-author	2004
10. Praneet Opanasopit, Masayuki Yokoyama, Masato Watanabe, Kumi Kawano, Yoshie Maitani, Teruo Okano. Block copolymer design for camptothecin incorporation into polymeric micelles for passive tumor targeting. Pharm Res. 2004;21 (11):2001-2008.	First author	2004
11. Masayuki Yokoyama, Praneet Opanasopit, Teruo Okano, Kumi Kawano, Yoshie Maitani. Polymer design and incorporation methods for polymeric micelle carrier	Co-author	2004

system containing water-insoluble anti-cancer agent camptothecin. J Drug Target. Jul;12(6):373-84. (2004).		
12. Praneet Opanasopit, Masayuki Yokoyama, Masato Watanabe, Kumi Kawano, Yoshie Maitani, Teruo Okano. Influence of serum and albumins from different species on stability of camptothecin- loaded micelles. J. Controlled Release. 104(2), 313-321(2005).	First author	2005
13. Manee Luangtana-anan, Praneet Opanasopit, Tanasait Ngawhirunpat, Jurairat Nunthanid , Pornsak Sriamornsak, Sontaya Limmatvapirat, Lee-Yong Lim. Effect of chitosan salts and molecular weight on a nanoparticulate carrier for therapeutic protein. Pharm Dev Technol. 10(2),189-196 (2005).	Co-author	2005
14. Shigeru Kawakami, Praneet Opanasopit, Masayuki Yokoyama, Narin Chansri, Tatsuhiro Yamamoto, Teruo Okano, Fumiyoshi Yamashita and Mitsuru Hashida. Biodistribution characteristics of all-trans retinoic acid incorporated in liposomes and polymeric micelles following intravenous administration. J Pharm Sci. 94(12), 2606-2615 (2005).	Co-author	2005
15. Tanasait Ngawhirunpat, Suwannee Panomsuk, Praneet Opanasopit, Theerasak Rojanarata, Tomomi Hatanaka. Comparison of the percutaneous absorption of hydrophilic and lipophilic compounds in shed snake skin and human skin. Pharmazie. 61(4):331-335 (2006).	Co-author	2006
16. Masato Watanabe, Kumi Kawano, Masayuki Yokoyama, Praneet Opanasopit, Teruo Okano, Yoshie Maitani. Preparation of camptothecin-loaded polymeric micelles and evaluation of their incorporation and circulation stability. Int. J Pharm. 308(1-2),183-189 (2006).	Co-author	2006
17. Kawano K, Watanabe M, Yamamoto T, Yokoyama M, Opanasopit P, Okano T,Maitani Y. Enhanced antitumor effect of camptothecin loaded in long-circulating polymeric micelles. J Control Release. 112(3):329-332 (2006).	Co-author	2006
18. Wanlop Weecharangsan, Praneet Opanasopit, Monrudee Sukma, Tanasait Ngawhirunpat, Uthai Sotanaphun, Pongpan Siripong. Antioxidative and neuroprotective activities of the extracts from fruit hull of mangosteen (Garcinia mangostana Linn.). Med Princ Pract.;15(4):281-287 (2006).	Corresponding author	2006
19. Wanlop Weecharangsan, Praneet Opanasopit, Tanasait Ngawhirunpat, Auayporn Apirakaramwong, Theerasak Rojanarata. Chitosan lactate as non-viral gene delivery vector in COS-1 cells. AAPS PharmSciTech. 7(3) article 66 (2006).	Co-author	2006
20. Praneet Opanasopit, Tanasait. Ngawhirunpat, Amornrut Chaidedgumjorn, Theerasak. Rojanarata, Auayporn Apirakaramwong, Sasiprapha Phongying, Chantiga Choochottiros, Suwabun Chirachanchai. Incorporation of camptothecin into N-	Corresponding author	2006

phthaloyl chitosan-g-mPEG self-assembly micellar system. Eur. J. Pharm. Biopharm. 64, 269-276 (2006). Impact factor 3.850		
21. Wanlop Weecharangsan, Praneet Opanasopit, and Robert J. Lee. In vitro Gene Transfer Using Cationic Vectors, Electroporation and Their Combination. Anticancer Res. 27, 309-314 (2007).	Corresponding author	2007
22. Praneet Opanasopit, Tanasait Ngawhirunpat, Theerasak Rojanarata, Chantiga Choochottiros, Suwabun Chirachanchai. N-phthaloyl chitosan-g-mPEG design for All-trans retinoic acid-loaded polymeric micelles. Eur J Pharm Science. 30, 424-431(2007).	Corresponding author	2007
23. Praneet Opanasopit, Potawan Aumklad, Jariya Kowapradit, Tanasait Ngawhirunpat, Auayporn Apirakaramwong, Theerasak Rojanarata, Satit Puttipipatkhachorn. Effect of salt forms and molecular weight of chitosans on in vitro permeability enhancement in intestinal epithelial cells (Caco-2). Pharm Dev Technol. 2007;12(5):447-55.	First author and Corresponding author	2006
24. Praneet Opanasopit, Tanasait Ngawhirunpat, Theerasak Rojanarata, Chantiga Choochottiros, Suwabun Chirachanchai. Camptothecin-incorporating N-phthaloyl chitosan-g-mPEG self assembly micellar system: Effect of degree of deacetylation. Colloid Surface B 2007 Oct 15;60(1):117-24.	Corresponding author	2007
25. Akkayachad Chinsriwongkul, Praneet Opanasopit, Warisada Sila-on, Tansait Ngawhirunpat, Uracha Ruktanonchai. Physicochemical properties of lipid emulsions formulated with high loaded-all-trans retinoic acid. PDA J Pharm Sci Tech. 2007; 61(6),461-471	Corresponding author	2007
26. Tatsuhiro Yamamoto, Masayuki Yokoyama, Praneet Opanasopit, Akihiro Hayama, Kumi Kawano and Yoshie Maitani. What are determining factors for stable drug incorporation into polymeric micelle carriers? Consideration on physical and chemical characters of the micelle inner core. J Control Release. 2007; 123(1):11-18	Co-author	2007
27. Orawan Suwantong, Praneet Opanasopit, Uracha Ruktanonchai and Pitt Supaphol. Electrospun cellulose acetate fiber mats containing curcumin and release characteristic of the herbal substance. Polymer. 2007; 48: 7546-7557.	Co-author	2007
28. Praneet Opanasopit, Uracha Ruktanonchai, Orawan Suwantong, Suwannee Panomsuk, Tanasait Ngawhirunpat, Chavalit Sittisombut, Tittaya Suksamran, Pitt Supaphol. Electrospun polyvinyl alcohol polymeric fibrous system as carriers for extracts from fruit hull of mangosteen. J. Cosmet. Sci. 59 (3):233-42 (2008)	First author and Corresponding author	2008
29. Jariya Kowapradit, Praneet Opanasopit, Tanasait Ngawhiranpat, Auayporn Apirakaramwong, Theerasak Rojanarata, Uracha Ruktanonchai and Warayuth Sajomsang. Methylated N-(4-N,N-dimethylaminobenzyl) chitosan, a novel chitosan derivative, enhances paracellular permeability across intestinal epithelial cells (Caco-2)" AASP PharmSciTech. 9(4)1143-1152 (2008).	Corresponding author	2008

30. Weecharangsan W, Opanasopit P, Lee RJ. Effect of depsipeptide on in vitro transfection efficiency of PEI/DNA complexes. Anticancer Res. 28(2A):793-798 (2008)	Co-author	2008
31. Nuttaporn Pimpha, Uracha Rattanonchai, Suvimol Surassmo, Praneet Opanasopit, Chonticha Rattanarungchai, Panya Sunintaboon. Preparation of PMMA/acid-modified chitosan core-shell nanoparticles and their potential as gene carriers. Colloid Polym Sci 286:907–916(2008).	Co-author	2008
32. Theerasak Rojanarata, Maleenart Petchsangsai, Praneet Opanasopit, Tanasait Ngawhirunpat, Uracha Ruktanonchai, Warayuth Sajomsang, Supawan Tantayanon. Methylated N-(4-N,N-di methylaminobenzyl) Chitosan for a Novel Effective Gene Carriers. Eur. J. Pharm. Biopharm. 70(1): 207-214.(2008)	Co-author	2008
33. Praneet Opanasopit, Warayuth Sajomsang, Uracha Ruktanonchai, Varissaporn Mayen, Theerasak Rojanarata, Tanasait Ngawhirunpat. Methylated N-(4-pyridinylmethyl) chitosan as a novel effective safe gene carrier. Int. J. Pharm. 368:127-134 (2008)	Corresponding author	2008
34. 34. Wanlop Weecharangsan, Praneet Opanasopit, Tanasait Ngawhirunpat, Auayporn Apirakaramwong, Theerasak Rojanarata, Uracha Ruktanonchai, Robert J. Lee. Evaluation of Chitosan Salts as Nonviral Gene Vectors in CHO-K1 Cells. Int. J. Pharm. 2008,348:161-168	Corresponding author	2008
35. Praneet Opanasopit, Auayporn Apirakaramwong, Tanasait Ngawhirunpat, Theerasak Rojanarata, Uracha Ruktanonchai. Development and characterization of pectinate micro/nanoparticles for gene delivery. AAPS PharmSciTech 9(1):67-74 (2008).	Corresponding author	2008
36. Akkaramongkolporn P, Ngawhirunpat T, Nunthanid J, Opanasopit P. Effect of a Pharmaceutical Cationic Exchange Resin on the Properties of Controlled Release Diphenhydramine Hydrochloride Matrices Using Methocel K4M or Ethocel 7cP as Matrix Formers. AAPS PharmSciTech. 9(3):899-908 (2008).	Corresponding author	2008
37. Tanasait Ngawhirunpat, Praneet Opanasopit, Theerasak Rojanarata, and Suwannee Panomsuk. Evaluation of Simultaneous Permeation and Metabolism of Methyl Nicotinate in Human, Snake, and Shed Snake Skin. Pharm Dev Technol. 13 (1):75-83 (2008).	Co-author	2008
38. Theerasak Rojanarata, Praneet Opanasopit, Sunee Techaarpornkul, Tanasait Ngawhirunpat, Uracha Ruktanonchai. Chitosan - thiamine pyrophosphate as a novel carrier for siRNA delivery. Pharm Res. 25(12):2807-14 (2008). impact factor 3.441	Corresponding author	2008
39. Praneet Opanasopit, Maleenart Petchsangsai, Theerasak Rojanarata, Tanasait Ngawhirunpat, Warayuth Sajomsang and Uracha Ruktanonchai. Methylated N-(4-N,N-dimethylaminobenzyl) chitosan as effective gene carriers: effect of degree of Substitution. Carbohyd. Polym. 75 (2009) 143–149.	First author Corresponding author	2009

40. Praneet Opanasopit, Theerasak Rojanarata, Auayporn Apirakaramwong, Tanasait Ngawhirunpat, Uracha Ruktanonchai. Nuclear localization signal peptides enhance transfection efficiency of chitosan/DNA complexes. Int. J. Pharm. (2009) 382,291-295.	First author Corresponding author	2009
41. Tittaya Suksamran, Praneet Opanasopit, Theerasak Rojanarata, Tanasait Ngawhirunpat, Uracha Ruktanonchai, Pitt Supaphol. Biodegradable alginate microparticles developed by electrohydrodynamic spraying techniques for oral delivery of protein. J. Microencapsulation. 26(7),563-570 (2009).	Corresponding author	2009
42. Ngawhirunpat T, Opanasopit P, Rojanarata T, Akkaramongkolporn P, Ruktanonchai U, Supaphol P. Development of meloxicam-loaded electrospun polyvinyl alcohol mats as a transdermal therapeutic agent. Pharm Dev Technol. 2009;14(1):70-79.	Co-author	2009
43. Uracha Ruktanonchai, Piyawan Bejrapha, Usawadee Sakulkhu, Praneet Opanasopit, Bunyapraphatsara, Varaporn Junyaprasert, Satit Puttipipatkhachorn, Physicochemical characteristics, cytotoxicity and antioxidant activity of three lipid nanoparticulate formulations of alpha-liopic acid, AAPS PharmSciTech, 2009; 10(1):227-234.	Co-author	2009
44. Prasert Akkaramongkolporn Tanasait Ngawhirunpat and Praneet Opanasopit. Preparation and evaluation of differently sulfonated styrene-divinylbenzene cross-linked copolymer cationic exchange resins as novel carriers for drug delivery. AAPS PharmSciTech. 2009;10(2):641-8.	Co-author	2009
45. Tanasait Ngawhirunpat, Nanthida Wonglertnirant, Praneet Opanasopit, Uracha Ruktanonchai, Kaewkarn Wasanasuk, Suwabun Chirachanchai, Rangrong Yoksan. Incorporation methods for cholic acid chitosan-g-mPEG self-assembly micellar system containing camptothecin. Colloid Surface B Biointerfaces. (2009)74,253-259.	Co-author	2009
46. Uracha Ruktanonchai, Usawadee Sakulkhu, Piyawan Bejrapha, Praneet Opanasopit, Nuntavan Bunyapraphatsara, Varaporn Junyaprasert, Satit Puttipipatkhachorn and, Effect of lipid types on physicochemical characteristics, stability and antioxidant activity of gamma-oryzanol loaded lipid nanoparticles, J. Microencapsulation, 2009 Nov;26(7):614-626.	Co-author	2009
47. Prasan Tangyuenyongwatana, Jariya Kowapradit, Praneet Opanasopit and Wandee Gritsanapan. Cellular transport of anti-inflammatory pro-drugs originated from a herbal formulation of Zingiber cassumunar and Nigella sativa. Chin Med. 2009 Sep 25;4:19.	Co-author	2009
48. Amornrat Viriyaroj, Tanasait Ngawhirunpat, Monrudee Sukma, Prasert Akkaramongkolporn, Uracha Ruktanonchai, and Praneet Opanasopit. Physicochemical properties and antioxidant activity of gamma-oryzanol-loaded liposome formulations for topical use. Pharm Dev Technol. 2009;14(6):665-671.	Corresponding author	2009
49. Warayuth Sajomsang, Uracha Ruktanonchai, Pattarapond Gonil, Varissaporn Mayen, Praneet Opanasopit. Methylated N-aryl chitosan derivative/DNA complex	Co-author	2009

nanoparticles for gene delivery: Synthesis and structure–activity relationships. Carbohyd. Polym. 78 (Nov), 2009, 743–752.		
50. Hilal Bilek, Nanthida Wonglertnirant, Tanasait Ngawhirunpat, Praneet Opanasopit and Mont Kumpugdee –Vollrath.Effect of Terpenes on the Skin Permeation of Ketoprofen through Shed Snake Skin. Silpakorn U Science & Tech J. 3 (2) (2009) 33-41.	Co-author	2009
51. Jariya Kowapradit, Praneet Opanasopit, Tanasait Ngawhirunpat, Auayporn Apirakaramwong, Theerasak Rojanarata, Uracha Ruktanonchai and Warayuth Sajomsang. In vitro permeability enhancement in intestinal epithelial cells (Caco-2) monolayer of water soluble quaternary ammonium chitosan derivatives. AAPS PharmSciTech, 2010; Jun;11(2):497-508.	Corresponding author	2010
52. Sunee Techaarpornkul, Sirirat Wongkupasert, Praneet Opanasopit, Auayporn Apirakaramwong, Jurairat Nunthanid, Uracha Ruktanonchai Chitosan-Mediated siRNA Delivery in Vitro: Effect of Polymer Molecular Weight, Concentration and Salt Forms. AAPS PharmSciTech, 2010; Mar;11(1):64-72.	Corresponding author	2010
53. Theerasak Rojanarata, Praneet Opanasopit, Tanasait Ngawhirunpat, Choedchai Saehuan, Suthep Wiyakrutta, Vithaya Meevootisom. A simple, sensitive and green bienzymatic UV-spectrophotometric assay of amoxicillin formulations. Enzyme and Microbial Technology 46 (2010) 292–296.	Co-author	2010
54. Natthan Charernsriwilaiwat, Praneet Opanasopit, Theerasak Rojanarata, Tanasait Ngawhirunpat, Pitt Supaphol. Preparation and characterization of chitosan-hydroxybenzotriazole/ polyvinyl alcohol blend nanofibers by the electrospinning technique. Carbohyd. Polym. 2010; 80(3):675-680.	Corresponding author	2010
55. Jariya Kowapradit, Praneet Opanasopit, Tanasait Ngawhirunpat, Theerasak Rojanarata, Uracha Ruktanonchai and Warayuth Sajomsang. Methylated N-(4-N,N-dimethylamino cinnamyl) chitosan enhances paracellular permeability across Caco-2 cells. Drug delivery. 2010,17(5) :301-312	Corresponding author	2010
56. Praneet Opanasopit, Sunee Techaarpornkul, Theerasak Rojanarata, Tanasait Ngawhirunpat, Uracha Ruktanonchai. Nucleic acid delivery with chitosan hydroxybenzotriazole. Oligonucleotides. 2010, Jun; 20(3):127-136	Corresponding author	2010
57. Akhayachatra Chinsriwongkul, Praneet Opanasopit, Tanasait Ngawhirunpat, Theerasak Rojanarata, Warisada Sila-on, Uracha Ruktanonchai. Oleic acid enhances all-trans retinoic acid load in nano-lipid emulsions. PDA J Pharm Sci Tech. 2010; 64 (2): 113-123.	Corresponding author	2010
58. Theerasak Rojanarata, Praneet Opanasopit, Tanasait Ngawhirunpat, Choedchai Saehuan. Ninhydrin reaction on thiol-reactive solid and its potential for the quantitation of d-penicillamine. Talanta. 82 (2010) 444–449.	Co-author	2010

59. Tanasait Ngawhirunpat, Praneet Opanasopit, Monrudee Sukma, Chavalit Sittisombut, AtsushiKat, and Isao Adachi. Antioxidant, free radical-scavenging activity and cytotoxicity of different solvent extracts and their phenolic constituents from the fruit hull of mangosteen (Garcinia mangostana). Pharmaceutical Biology, 2010; 48(1): 55–62.	Co-author	2010
60. Kanistha Kawpoomhae, Monrudee Sukma, Tanasait Ngawhirunpat, Praneet Opanasopit and Areerut Sripattanaporn. Antioxidant and neuroprotective effects of standardized extracts of Mangifera indica leaf. Thai J. Pharm. Sci. 34 (2010) 32-43.	Co-author	2010
61. Wonglertnirant N, Todo H, Opanasopit P, Ngawhirunpat T, Sugibayashi K. Macromolecular delivery into skin using a hollow microneedle. Biol Pharm Bull. 2010;33(12):1988-93.	Co-author	2010
62. Akkaramongkolporn P, Wongsermsin K, Opanasopit P, Ngawhirunpat T. Comparison between the effect of strongly and weakly cationic exchange resins on matrix physical properties and the controlled release of diphenhydramine hydrochloride from matrices. AAPS PharmSciTech. 2010 Sep;11(3):1104-14.	Co-author	2010
63. Jariya Kowapradit, Praneet Opanasopit, Tanasait Ngawhirunpat, Theerasak Rojanarata, and Warayuth Sajomsang. Structure–activity relationships of methylated N-aryl chitosan derivatives for enhancing paracellular permeability across Caco-2 cells. Carbohyd. Polym. 83 (2011) 430–437.	Corresponding author	2011
64. Nanthida Wonglertnirant, Tanasait Ngawhirunpat, Praneet Opanasopit, Hiroaki Todo and Kenji Sugibayashi .A hollow microneedle carrier for enhancing skin penetration of large molecular compounds. Advanced Materials Research.194-196 (2011) 549-553.	Co-author	2011
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Review articles

	Titles of Research	Nature of Participation	Year
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แบบเสนอโครงการวิจัย (Research Project)
ประกอบการเสนอขอทุนอุดหนุนการวิจัยของสำนักงานการวิจัยแห่งชาติ (วช.)
โครงการปริญญาเอกกาญจนาภิเษก (คปก.) ภายใต้ความร่วมมือไตรภาคีไทย-สวีเดน
ประจำปีงบประมาณ ๒๕๖๗

๑. **ชื่อโครงการวิจัย** Development of folic acid-decorated niosomes for targeted delivery of cytotoxic drug combining with lutein as pro-oxidant against breast cancer cells
การพัฒนาไนโอโซมที่ติดด้วยกรดโฟลิกสำหรับการนำส่งยาพิษต่อเซลล์เป้าหมายร่วมกับลูทีนเป็นสารโปรออกซิแดนต์สำหรับต้านเซลล์มะเร็งเต้านม

๒. **ชื่อ-สกุล อาจารย์ที่ปรึกษา** ศ.ดร.ภญ. ประณีต โอปณะโสภิต Prof. Dr. Praneet Opanasopit
หน่วยงาน Industrial Pharmacy, Faculty of pharmact, Silpakorn University
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๓. **กลุ่มสาขาวิทยาศาสตร์พื้นฐานที่สมัคร** (เลือกเพียง ๑ กลุ่ม)
☑ ชีววิทยา (Biology) ☐ เคมี (Chemistry)
☐ ฟิสิกส์ (Physics) ☐ คณิตศาสตร์ (Mathematics)

๔. **ผู้ใช้ประโยชน์ (Research stakeholders)** (กรณีมีความร่วมมือฯ) เช่น ความร่วมมือของหน่วยงานภาครัฐ (เช่น กระทรวง กรม)/เอกชนที่ร่วมสนับสนุนทุนวิจัย เช่น MOU เป็นต้น
☐ มี.....*(โปรดระบุชื่อความร่วมมือ และหน่วยงาน)*.....
☑ ไม่มี

๕. **คำสำคัญ (Keyword) ของโครงการ**
Keywords: folic acid, niosomes, pro-oxidant, lutein, breast cancer

๖. **ความสำคัญและที่มาของปัญหาที่ทำการวิจัย (Problem statement and significance of research)**

Breast cancer is a disease in which cells in the breast grow out of control. The poor efficacy of chemotherapy and its adverse effects on healthy cells (i.e., bone marrow suppression, hair loss, gastrointestinal reactions) are the main drawbacks of these conventional therapies. To bypass these drawbacks, targeted nano-delivery approaches, such as niosomes, have been extensively studied in an attempt to create a breakthrough in the bottleneck of chemotherapeutic treatment of breast cancer. Niosomes have been used to deliver both hydrophilic and hydrophobic drugs. The surface of niosomes is frequently functionalized with biomolecules to enhance their

endocytosis into cancer cells, especially those that contain over-expressed receptors on their cell membranes. A targeting system is a current approach to overcoming the complicated regulating molecular mechanisms of cancer. A drug targeting system is designed to administer pharmaceutical agents as an alternative form to increase safety and efficacy while remaining the therapeutic potential. Compared to conventional chemotherapeutic agents, nanoscale drug carriers have demonstrated the potential to address some of these challenges by improving treatment efficacy while avoiding toxicity in normal cells due to features such as high selective accumulation in tumors. Pro-oxidant agents increase the cellular levels of ROS to cytotoxic levels, these agents may induce selective killing of cancer cells and be therapeutically useful. It is important to mention that all these effects can be achieved by agents with both antioxidant and pro-oxidant properties (e.g. lutein), which can act as cancer chemopreventive, carcinogenic, and chemotherapeutic agents mainly depending on the concentration by which they are used. It is possible that some cancers may have a reduced capacity to repair ROS-induced DNA damage and be more vulnerable than normal cells to the cytotoxic activity of ROS.

In the present study, we develop a novel folic acid-decorated niosomes as a delivery platform for cytotoxic drug and lutein delivery and investigated the potential effectiveness of its combination applied in a concentration range against human breast cancer cells.

๗. ทฤษฎี/สมมุติฐานของโครงการ (Hypothesis)

1) Folic acid-decorated niosomes may be loaded and deliver both hydrophilic (cytotoxic drugs e.g. doxorubicin, 5-FU) and hydrophobic drugs (Lutein)
2) Folic acid-decorated niosomes may enhance the cellular uptake into over-expressed folate receptor breast cancer cells (MCF-7 cells)
3) Lutein may lutein sensitizes breast cancer cells to cytotoxic drugs e.g. doxorubicin, 5-FU

๘. วัตถุประสงค์ของโครงการ (Objectives)

1) To formulate folic acid-decorated niosomes for loading cytotoxic drugs e.g. doxorubicin, 5-FU, and lutein by using design of experiment
2) To evaluate intracellular ROS and anticancer activity in MCF-7 cells
3) To evaluate the combination therapy between cytotoxic drug and lutein

๙. การทบทวนวรรณกรรม/ผลงานวิจัยที่เกี่ยวข้อง (Literature Review)

The surface of niosomes is frequently functionalized with biomolecules to enhance their endocytosis into cancer cells, especially those that contain over-expressed receptors on their cell membranes. For instance, Folic acid is an anionic molecule that does not diffuse across biological membranes quickly (1). This biomolecule meets the demand of cancer cells for folate by targeting overexpressed FA receptors on their cell surface. Folic acid is an anionic molecule that does not diffuse across biological membranes quickly. Also, folic acid attachment does not only benefit in drug targeting, but also it is useful for phototherapy, imaging, and diagnosis. Folic acid was acquired in many nano-formulations and showed improved cellular uptake, cytotoxic effect of the chemotherapeutic agents, and reduce undesired effects (1). Lutein, hydroxyl-carotenoid, has numerous health-promoting properties via a set of putative bioactions comprising antioxidation, anti-inflammation, anticancer and filtration of blue light to protect eyes and skin from oxidative stresses (2). The main challenge is its low water-solubility, limited chemical stability, and low oral bioavailability. Colloidal encapsulation systems can be used to overcome these difficulties and facilitate the incorporation of lutein. To raise the bioactivity, stability and liberation of lutein, Jiao et al. (2018) synthesized poly-L lysine (PLL) decorated nanoliposomes loaded with lutein (PLL–LUT-NLP). Furthermore, the decorated-nanoliposomes induced higher antiproliferative activity on human colon cells (Caco-2). Ribaya-Mercado et al. and Sindhu et al. pointed out that lutein induced cytotoxic and growth inhibitory effects in several cancer cell lines and animal models. Gong et al. have shown that lutein had efficient anti-proliferative and cytotoxic effects on breast cancer cells, but induced modest effects on normal human breast epithelial cell growth or viability (3). Lutein act as pro-oxidant agents that could increase the cellular levels of ROS to cytotoxic levels, these agents may induce selective killing of cancer cells and be therapeutically useful (2).

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๑๐. ระเบียบวิธีวิจัย (Methodology)

Formulation of anionic niosomes and folic acid-decorated niosomes: Niosomes are formulated by thin-film hydration method. Niosome solution containing oleic acids, Span20, and Chol is prepared in a methanol: chloroform mixture (1: 2 %v/v). Thin-film is prepared by solvent evaporation under N_2 gas and further hydrated with Tris-buffer. The resulting solution is sonicated at 4 °C to reduce particle size. The cationic niosomes is stored at 4 °C. The various concentration of synthesized folic acid-conjugated chitosan is used to decorate the anionic niosomes by incubating at room temperature for 30 min via electrostatic interaction.

Characterization of Carbon dots: Size and zeta potential measurements are acquired on a Zeta Nano-ZS Zetasizer (Malvern Instruments).

Loading efficiency and loading content: To evaluate drug loading efficiency (LE) and drug loading content (LC) of 5-FU in nanoconjugate materials, the amount of free drug outside of the dialysis membrane is measured by UV–Vis spectrophotometry.

In vitro biocompatibility and cytotoxicity using MTT assay: The cells are seeded into a 96-well plate. The samples (100 µL) are placed covering the cells for 24 h. The 0.5 mg/mL of MTT is pipetted into each well and further incubated for 3 h. The formazan crystals generated in the cells are dissolved with 100 µL of DMSO before prior to absorbance measurement at 550 nm using a multimode microplate reader.

Measurement of Intracellular ROS Levels: For the measurement of intracellular ROS, cells are loaded with 10 µM dichlorofluorescein diacetate (DCFH-DA; Sigma-Aldrich) for 30 min. Then, the cells are washed and scraped off using PBS. DCF fluorescence is measured.

ขอบเขตของการวิจัย (Scope of the study)

1) Optimization of drug-loaded niosomes by using design of experiment and Preparation of folic acid-decorated niosomes
2) Characterization of drug-loaded niosomes i.e. particle size and zeta potential, loading efficiency, loading capacity
3) Investigation of the combination therapy between cytotoxic drug and lutein, intracellular ROS induction, anticancer activity by using MTT assay

๑๑. ผลผลิต (Output) ผลลัพธ์ (Outcome) และ ผลกระทบ (Impact) ที่คาดว่าจะได้จากการวิจัย

Output: 1. Optimal formulation of Novel targeted lutein-loaded niosomes

2. Publication of research paper in national and international journal (Q1-Q2)

3. Participating in national and international conferences or seminars to disseminate the research outcomes or knowledge acquired from the research project through oral presentations or poster presentations, with a minimum of 2 conferences.

Outcomes and Impacts

1) **Research publication:** 2-3 papers in peer reviewed journals in international journal in web of science (Q1-2) or national journal.
2) **Innovation and knowledge transfer. Novel targeted lutein-loaded niosomes:** at least 1 formulation will be obtained as a targeted therapy for breast cancer cells, thereby enhancing the efficacy of cytotoxic drugs in combating cancer cells.
3) **Research collaboration development:** This research project will collaborate with researchers in the research field, leading to the knowledge transfer and the possibility of research collaboration in the future.
4) **Human resources development:** All students and assistant researchers collaborating in the project will be improved their knowledge and practical skills.
5) **Increase international visibility:** The output of this study is a challenge that significantly enhances the capabilities of researchers, while also expanding research collaboration networks both domestically and internationally.
6) **Impact worldwide and Thailand's medical innovation:** The project's outcome will impact Thailand's and worldwide medical innovation and healthcare systems.