

Mahmood Khan, *PhD*

Address for correspondence

420 West 12th Avenue, TMRF-116A
Columbus, Ohio 43210, USA

Tel: 614 292 8383 (work)

614 806 2138 (cell)

E-mail: mahmood.khan@osumc.edu

Present appointment

Research Scientist

Department of Internal medicine
Division of Cardiovascular Medicine
Davis Heart and Lung Research Institute
The Ohio State University
Columbus, Ohio 43210, USA

Education

2001- 2005 *Ph.D. (Clinical Pharmacology & Therapeutics)*
Department of Clinical Pharmacology and Therapeutics,
Nizam's Institute of Medical Sciences, Hyderabad, India

Ph.D dissertation: Evaluation of C-phycoyanin, a component of Spirulina, a blue-green algae, a potent antioxidant on prevention against Doxorubicin-induced Cardiotoxicity and ischemia-reperfusion induced injury in the rat heart

1998 - 2000 *M. Pharm. (Pharmacology)*
Department of Pharmacology and Toxicology
Rajiv Gandhi University of Health Sciences, Karnataka, India

1994 -1998 *B. Pharm. (Pharmacy)*
Gulbarga University, Karnataka, India

Awards and recognitions

- *Poster Winner*, First Prize and travel award (competing for research scientists), Ohio State University, Davis Heart and Lung Research Institute, College of Medicine, 3rd Annual Research Retreat, October **2008**. Columbus, OH, USA
- *Excellence Award* (oral presentation), US-JSPS EPR Core-to-Core Symposium, June **2008**.
- *James Warren Award* for Outstanding Post-doctoral Fellow in department of Internal Medicine, College of Medicine, June, **2007**, OSU, USA
- *Poster Winner*, First Prize and travel award (competing for post doctoral researchers), Ohio State University, Davis Heart and Lung Research Institute, College of Medicine, 2nd Annual Research Retreat, April **2007**. Columbus, OH, USA
- *Finalist*, Stem Cells and Myocardial Regeneration Session, *American Heart Association* (AHA) scientific sessions **2006**, poster presentation, Chicago, USA

- **Young Investigator Award**, 8th International EPR Spin Trapping Meeting & 11th *in vivo* EPR Spectroscopy and Imaging. **2005**, Columbus, Ohio, USA

Research & Professional Experience

- 2007 – present** *Research Scientist*, Davis Heart & Lung Research Institute, Ohio State University, Columbus, OH, USA
Specialization: Stem Cell Therapy in the Heart
- 2005 – 2007** *Post Doctoral Researcher*, Davis Heart & Lung Research Institute, Ohio State University, Columbus, OH, USA
Specialization: Stem Cell Therapy in the Heart
- 2004 – 2005** *Visiting Scholar*, Davis Heart & Lung Research Institute, The Ohio State University, Columbus, OH, USA
Specialization: Assessment of free radical generation in heart.
- 2001 – 2004** *Research Fellow*, Department of Clinical Pharmacology and Therapeutics, Nizam's Institute of Medical Sciences, Hyderabad, India
Specialization: Antioxidants and their role Cardioprotection

Expertise

- **Animal models for myocardial infarction:** Development of rodent animal models for myocardial infarction and heart failure. Ischemia-reperfusion injury model in isolated rat hearts and testing the efficacy of different antioxidant and anti arrhythmic drugs.
- **Stem-cell therapy:** Treatment of myocardial infarction model in mice and rats using bone-marrow derived Mesenchymal stem cells (MSCs). Micro-surgical procedures in mice. Development of myocardial infarction model, cannulation of carotid arteries and veins in rodents. Measurement of hemodynamic function by inserting catheters into the heart.
- **Hyperbaric oxygen therapy:** Treatment of rats after myocardial infarction in hyperbaric chamber and to asses whether hyperbaric oxygen therapy increases the survival of transplanted stem cells in the infarct heart.
- **Echocardiography:** Measurement of cardiac function (Ejection fraction, cardiac output, wall thickness etc.) in small animals using Vivid-7 (GE).
- **Oxygen Metabolism:** Monitoring pO₂ in rat heart before and after stem cell therapy using electron paramagnetic resonance (EPR) spectroscopy.
- **Cardiomyocyte and stem cell physiology:** Isolation of cardiomyocytes from rats, mice and maintenance in culture. Stem cells (Mesenchymal stem cells), Isolation, characterization and maintenance in culture.

- **Free Radical Physiology and Pharmacology:** Measurement of free radicals in heart using fluorescence probes and EPR spin trapping techniques.
- **Molecular Biology:** DNA Sequencing, genotyping, fragment analysis, DNA fingerprinting, cell and tissue culture techniques, assessment of apoptosis, flow cytometry, confocal microscopy, fluorescence microscopy, Western blot analysis.

Teaching Experience

- Teaching and mentoring undergraduate and graduate students in physiology and pharmacology, conducting research orientation seminars (India & USA)
- Offering formal and informal practical training for graduate students in stem cell biology, cardiovascular pharmacology of drugs both, *in vitro* and *in vivo*

Clinical Experience

- Auditing clinical trials (phase I) during Ph. D work at Nizam's Institute of Medical Sciences, Department of Clinical Pharmacology and Therapeutics, India
- Completed the National Institutes of Health (NIH) online Clinical Research Training course (November 2006), USA

Invited Talks

- ***Role of hyperbaric oxygen therapy on survival and engraftment of Mesenchymal stem cells in the infarct heart.*** 3rd Annual Research Retreat, October **2008**, Davis Heart and Lung Research Institute, College of Medicine, The Ohio State University, Columbus, OH, USA
- ***Sulfaphenazole and cardioprotection: Modulation of myocardial oxygenation, iNOS and Akt in rat model acute of myocardial infarction.*** US-JSPS Core-to-core EPR symposium, June **2008**.columbus, OH. USA.
- ***Non-invasive measurement of myocardial oxygenation in the infarct heart after stem cell therapy.*** SFRR, Feb **2007**, Jaipur, India.

Session-Chair

- Chaired morning session, US-JSPS EPR Core-to-Core Symposium, June **2008**

Peer-reviewed Publications

2004

1. **Khan, M. Patil, P. A. Shobha, J. C.** "Influence of Bryophyllum pinnatum (Lam.) leaf extract on wound healing in albino rats". *Journal of natural remedies*, 14: 41-46, **2004**.

2005

2. **Khan M**, Shobha, J.C., Mohan, I.C., Naidu, M.U.R., Sundaram, I.C., Shashi Singh, Kuppusamy, P., Kutala, V.K. Protective effect of Spirulina against Doxorubicin-induced cardiotoxicity in mice. *Phytotherapy Research*, 19, 1030-1037, **2005**.

2006

3. **Khan M**, Saradhadevi Varadharaj, Jagdish C. Shobha, Maddireddi U. Naidu, Narasimham L. parinandi, Vijay K. Kutala, Periannan Kuppusamy. "C-phycoerythrin ameliorates doxorubicin-induced oxidative stress and apoptosis in adult rat cardiomyocytes". *Journal of Cardiovascular Pharmacology*, Vol. 47, no.1, Jan **2006**.
4. **Khan M**, Varadharaj S, Latha P. Ganesan, Jagdish C. Shobha, Maddireddi U. Naidu, Narasimham L. parinandi, Susheela Tridandapani, Vijay Kumar Kutala, Periannan Kuppusamy. "C-phycoerythrin protects against ischemia – reperfusion injury of heart through involvement of p38 MARK and ERK signaling". *Am J physiol Heart Circ Physiol*, 290:H2136-H2145, **2006**.
5. Kumar KV, **Khan M**, Rajarsi Mandal, Latha P. Ganesan, Susheela Tridandapani, Tamas Kalai, Kalman Hideg, and Periannan Kuppusamy "Attenuation of Myocardial Ischemia-reperfusion Injury by Trimetazidine Derivatives Functionalized with Antioxidant Properties". *Journal of Pharmacology and Experimental Therapeutics*, 317:921-928, **2006**.
6. **Khan M**, Shobha, J C., Mohan IK, Naidu, M.U.R., Prayag A, Kutala, V K , Kuppusamy P. "Spirulina attenuates cyclosporine-induced nephrotoxicity in rats. *Journal of Applied Toxicology*, Volume 26, Issue 5 , Pages 444 – 451, **2006**.
7. Kumar KV, **Khan M**, Rajarsi Mandal, Vandana Potaraju, Giuseppe Colantuono, Damodar Kumbala, Kuppusamy P "Prevention of post-ischemic myocardial reperfusion injury by the combined treatment of NCX-4016 and Tempol" *J Cardiovascular Pharmacology*, **2006** Sep; 48(3):79-87.
8. Mohan I.C., Kutala, V.K. Naidu, M.U.R, **Khan M**, Sundaram, C., Shashi Singh. "Effect of Cardipro on Doxorubicin- induced cardiotoxicity in mice". *Phytomedicine*, 13:222-229 **2006**.
9. Kalai T, **Khan M**, Balog M, Kutala K V, Kuppusamy P and Hideg K. "Structure–activity studies on the protection of Trimetazidine derivatives modified with nitroxides and their precursors from myocardial ischemia–reperfusion injury". *Bioorganic & Medicinal Chemistry*, **2006** 14(16): 5510-5516
10. Mohan IK, **Khan M**, Shobha, J C., Mohan, I C, Naidu, M.U.R., Prayag A, Kutala, V K , Kuppusamy P. "Protection against cisplatin-induced nephrotoxicity by Spirulina in rats. *Cancer Chemother Pharmacol*, **2006** Dec; 58(6):802-8.

2007

11. Wisel S, Chacko SM, Kuppusamy ML, Pandian RP, **Khan M**, Kutala KV, Benjamin Sun, Pawel Kwiatkowski and Kuppusamy P "Labeling of skeletal myoblasts with nanoparticulate oxygen-sensing spin probes for long- term noninvasive monitoring of cell therapy and in situ oxygenation in the infarct myocardium" *Am J physiol Heart Circ Physiol* , **2007** Mar; 292(3):H1254-61.

12. Mark E Brauner, Micheal C Plewa, Kuppusamy P, **Khan M** “Effects of pulmonary-generated reactive oxygen species on left ventricular dysfunction associated with ischemia reperfusion in rats. *Acad Emerg Med*, Vol 13, No.5, Suppl.1, may **2006**.
13. Kutala VK, **Khan M**, Mark G. Angelos, and Periannan Kuppusamy. “Role of Oxygen in Post-ischemic Myocardial Injury”. *Antioxidants and Redox Signaling*, **2007** Aug; 9(8):1193-206.
14. Mandal R, Kutala KV, **Khan M**, Mohan IK et al. “A pro-nitroxyl modification of a verapamil exhibits antioxidant protection of heart against ischemia/reperfusion–induced cardiac dysfunction without compromising antagonistic activity, *Journal of Pharmacology and Experimental Therapeutics*. **2007** Oct; 323(1):119-27.
15. **Khan M**, Kutala VK, Kuppusamy P et al. “Skeletal myoblasts transplanted in the ischemic myocardium enhances in situ tissue oxygenation”, *Am J physiol Heart Circ Physiol* **293**, **2007**.
16. **Khan M**, Mohan IK, Kutala KV, Kuppusamy P. Cardioprotection by Sulfaphenazole, a Cytochrome P450 Inhibitor: Mitigation of Ischemia-reperfusion Injury by Scavenging of Reactive Oxygen Species, *JPET*, 323:1-9, **2007**.

2008

17. **Khan M**, Kutala VK, Wisel S, Chacko SM, Kuppusamy ML, Kwiatkowski P and Kuppusamy P. “ Measurement of myocardial tissue pO₂ after stem cell therapy using oxygen sensing probe by EPR spectroscopy” *Advances in Experimental Biology and Medicine*, Adv Exp Med Biol. **2008**; 614:45-52
18. **Khan M**, Mohan IK, Kutala KV, Kuppusamy P et al. Sulfaphenazole protects heart against ischemia-reperfusion injury and cardiac dysfunction by overexpression of iNOS leading to enhancement of nitric-oxide bioavailability and tissue oxygen. *Antioxidants and Redox signaling* (In press), **2008**.
19. Ryan Roberts, Eubank T, Jennifer Curry, **Khan M**, Periannan Kuppusamy, Clay Marsh. GM-CSF inhibits breast cancer and metastases in mice and induces hypoxia in the tumor proper via stimulation of the soluble VEGF receptor. *Cancer Research* (In press). **2008**.
20. Chacko SM, **Khan M**, Kuppusamy P et al. Myocardial oxygenation and functional recovery in infarct rat hearts transplanted with mesenchymal stem cells. *Am J physiol Heart Circ Physiol*, **2008**, communicated.

2009

21. **Khan M**, Mohan IK, Kutala KV, Kuppusamy P et al. Cardioprotection by HO-4038, a Novel Verapamil Derivative, Targeted against Ischemia and Reperfusion-mediated Acute Myocardial Infarction, *Am J physiol Heart Circ Physiol*. Jan; 296(1):H140-51, **2009**.
22. **Khan M**, Wisel S, Kuppusamy P, Hamlin RL et al. Hyperbaric oxygen enhances the Engraftment and survival of Mesenchymal stem cells in the infarct heart. *Journal of Molecular and cellular cardiology*. **2009**, communicated.
23. **Khan M**, Wisel S, Kuppusamy P et al Pharmacological preconditioning of mesenchymal stem cells with Trimetazidine protects hypoxic cells against oxidative stress and enhances recovery of myocardial function in infarcted heart through Bcl-2 expression. *Journal of Pharmacology and Experimental Therapeutics*. **2009**, Communicated.

Book Chapters

24. Kutala KV, Parinandi NL, **Khan M**, Iyyapu KM, Kuppusamy P. “*Recent Progress in Medicinal Plants*”, Volume22, Phytopharmacology and Therapeutics values IV, **2008**. Studium Press LLC, USA.
25. Kutala KV, Iyyapu KM, **Khan M**, Parinandi NL, Kuppusamy P. “*Drug-induced nephrotoxicity by Spirulina*”, Spirulina in Human Nutrition and Health, page 153-175, **2007**.

Published Abstracts

26. **Khan M**, Kutala VK, Vikram D, Wisel S, Pawel Kwiatkowski, Simi M Chacko, Kuppusamy ML, Jay L Zweier and Kuppusamy P. “Non-invasive Tracking of Cells and Monitoring of In Situ pO₂ during Engraftment of Skeletal Myoblasts in Infarct Mouse Heart”. *Circulation*, supplement II, Vol 114, No 18, **2006**.
27. Kumbala D, **Khan M**, Vijay Kumar Kutala, Periannan Kuppusamy Sulfaphenazole, a CYP2C9 Inhibitor, Protects Against Ischemia-Reperfusion-Induced Injury in Isolated Rat Heart. *Circulation Res.* **2006**, Volume 99 (5): 130A.
28. **Khan M**, Mohan IK, Kutala KV, Kuppusamy P et al. Sulfaphenazole protects heart against ischemia-reperfusion injury and cardiac dysfunction by overexpression of iNOS leading to enhancement of nitric-oxide bioavailability and tissue oxygen. *Journal of Molecular and Cellular cardiology*, June, **2008**.

Ongoing Research Support

GRANT TITLE	Role of hyperbaric oxygen therapy on survival and engraftment of stem cells
DESCRIPTION	The goal this study is to investigate the whether hyperbaric oxygen therapy can improve the survival of transplanted stem cells in the infarct rat heart.
FUNDING AGENCY	<i>American Heart Association (AHA)</i>
ROLE IN THE PROJECT	<u>Principal Investigator</u>
AWARD TYPE	<i>Scientist Development Grant (SDG)</i> , 0930181N
	PERIOD: 01/01/2009 –12/31/2012

Conference Presentations

1. **Khan, M.**, Patil, P.A. “Influence of Bryophyllum Pinnatum Lam on wound healing in albino rats”34th Annual conference (Indian Pharmacological Society), Nagpur, India, Oral Presentation, *Ind J Pharmacol*, 10-12 (Jan), **2002**.

2. **Khan, M.**, Shobha J C., K Vijay Kumar. "Antioxidant activity of Spirulina extract in-vitro" 35th Annual conference (Indian Pharmacological Society), Gwalior, India. Oral presentation, *Ind J Pharmacol.*, 26-29 (Nov), **2002**.
3. **Khan M**, Shobha, J. C., Kutala, V.K., Mohan, I.K., Prayag, A., Kutala, V.K. "Effect of spirulina on cyclosporine-induced nephrotoxicity in rats" *International Symposium on Recent Advances in Pharmacology*, New Delhi, India, poster presentation, 7-8 (Jan), **2004**.
4. **Khan M**, Varadharaj, S., Kutala, V.K., Shobha, J.C., Naidu, M.U.R., Parinandi, N.L., Kuppusamy, P. "C-phycoerythrin ameliorates doxorubicin-induced oxidative stress and apoptosis in adult cardiomyocytes *in vitro*. *Free radical biology and medicine*, Austin, Texas, USA, November 16-20, **2005**, poster presentation.
5. **Khan M**, Kutala, V.K., Hideg, K., Kuppusamy, P. "Attenuation of ischemia-reperfusion injury. In hearts by trimetazidine derivatives functionalized with antioxidant properties". *Free radical biology and medicine*, Austin, Texas, USA, November 16-20, **2005**, poster presentation.
6. Kutala V.K., **Khan M**, Varadharaj, S., Ganesan P.L., Shobha J.C., Naidu M.U.R., Parinandi, N.L., Susheela, T., Kuppusamy, P. "C-phycoerythrin improves cardiac dysfunction by attenuating oxidative stress and inhibition of p38 MAPK activity in isolated rat heart subjected to ischemia-reperfusion". *Free radical biology and medicine*, Austin, Texas, USA, November, **2005**, oral presentation.
7. **Khan M**, Kutala VK, Vikram D, Wisel S, et. Al. "Non-invasive Tracking of Cells and Monitoring of In Situ pO₂ during Engraftment of Skeletal Myoblasts in Infarct Mouse Heart". *American Heart Association*, scientific session-**2006**, Chicago, poster presentation.
8. Ryan Roberts, Eubank T, Jennifer Curry, **Khan M**, Periannan Kuppusamy, Clay Marsh. "GM-CSF inhibits breast cancer and metastases in mice and induces hypoxia in the tumor proper via stimulation of the soluble VEGF receptor", *2nd Annual Research Retreat*, April **2007**, Davis Heart and Lung Research Institute, Ohio State University.
9. Sulfaphenazole, a cytochrome P450 inhibitor attenuates ischemia-reperfusion injury through involvement of iNOS, AKT and p38 MAPK in a rat model of myocardial infarction. *American Heart Association*, **2007**, Orlando, Florida.
10. VK Kaushik Vedam, Yoshinori N, **Khan M**, Kuppusamy Zweier J, Ilangoan G. "Increased expression of heat shock protein 25 in doxorubicin treated failing hearts". *2nd Annual Research Retreat*, April **2007**, Davis Heart and Lung Research Institute, Ohio State University.
11. **Khan M**, Wisel S, Kuppusamy P, Hamlin RL et al. Hyperbaric oxygen enhances the Engraftment and survival of Mesenchymal stem cells in the infarct heart. *3rd Annual DHLRI retreat*, Oct. **2008**. Poster presentation, Davis Heart and Lung Research Institute, Ohio state university.
12. **Khan M**, Mohan IK, Kutala KV, Kuppusamy P et al. Sulfaphenazole protects heart against ischemia-reperfusion injury and cardiac dysfunction by overexpression of iNOS leading to enhancement of nitric-oxide bioavailability and tissue oxygen. *3rd Annual DHLRI retreat*, Oct. **2008**. Poster presentation, DHLRI, Ohio state university.
13. Wisel S, **Khan M**, Kuppusamy P et al. Trimetazidine (Vastarel®) Protects Mesenchymal Stem Cell against Oxidative Stress and Enhances Cell Therapy in Infarct Rat Heart by Activation of Akt and Bcl-2 Expression. *3rd Annual DHLRI retreat*, Oct. **2008**. Poster presentation, Davis Heart and Lung Research Institute, Ohio state university.

Professional Affiliations

- American Heart Association
- Free Radical Biology Medicine
- Indian Pharmacological Society
- Indian Pharmaceutical Association, Registered Pharmacist

Personal Information

Nationality: Indian
Visa Status: H1B
Marital Status: Married
Date of Birth: September 29, 1976
Place of Birth: Hyderabad, India

References

- 1. Periannan Kuppusamy PHD FACN**
William D. and Jacquelyn L. Wells Chair in Imaging Research
Professor of Internal Medicine & Biomedical Engineering
Associate Director, Division of Cardiovascular Medicine
Associate Director, Davis Heart and Lung Research Institute
The Ohio State University Medical Center
420 West 12th Ave, Room 114, Columbus, OH 43210
Tel: 614-292-8998; Fax: 614-292-8454
E-mail: periannan.kuppusamy@osumc.edu
- 2. Robert L. Hamlin**
Professor of Veterinary Biosciences
Diplomate, ACVIM (Cardiology/Internal Medicine)
Stanton Younberg Professor of Physiology/Pharmacology
480 VMAB, 1900 Coffey Road
Columbus, Ohio 43210
Phone: 614 5177 604
E-mail: robert.hamlin@cvm.osu.edu
- 3. N. Parinandi, PHD**
Associate Professor of Internal Medicine and Pharmacology
Division of Pulmonary, Critical Care, Allergy, and Sleep Medicine
Dorothy M. Davis Heart and Lung Research Institute
College of Medicine, The Ohio State University, Room 611-A
473 W. 12th Avenue, Columbus, OH 43210, USA.
Phone: (614) 292-8577
Fax: (614) 292-8778
Email: narasimham.parinandi@osumc.edu
- 4. P. A. Patil, MD**
Professor & Head of Pharmacology,
J N Medical College, Belgaum, Karnataka, India
Tel: 91 831 24091534
Cell: 91 94486 37511

E-mail:drpapatil@yahoo.com