

**Dr. R.MURUGESAN****Emeritus Professor**

Center for Excellence in Genomic Sciences  
School of Biological Sciences  
Madurai Kamaraj University, Madurai 625 021

**RESEARCH AREAS:**

Nano-Pharmaceuticals for drug delivery and therapeutics  
Molecular Modeling and Drug Design  
Electron Magnetic Resonance Imaging for Biomedical Applications

**CONTACT DETAILS:**

Email: rammku@eth.net

**RESEARCH INTERESTS:**

Photodynamic therapy (PDT) is an emerging modality for the treatment of neoplastic and nonneoplastic diseases such as cancer, skin disorders, and macular degeneration. It involves the administration of a photosensitizing drug and its subsequent activation by light to produce reactive oxygen species or/and free radicals that selectively destroy target cells. Although this therapy is becoming an established modality treatment for a variety of diseases, its widespread clinical application remains limited, because of the numerous drawbacks of the commonly used photosensitizers. Our project aims in exploration and improvisation of new and existing compounds. Series of compounds like, quinones, hypocrellins and phycocyanins are being investigated in our lab for their photodynamic action and potential use as novel phototherapeutic agents.

**Nano-Pharmaceuticals for drug delivery and therapeutics**

Numerous investigations have shown that both tissue and cell distribution profiles of anticancer drugs can be controlled by their entrapment in submicronic colloidal systems (Nanoparticles). The rationale behind this approach is to increase antitumour efficacy, while reducing systemic effects. Colloidal carrier-associated photodynamic therapeutic agents have shown to exhibit greater photodynamic efficiency and selectivity of tumour targeting as compared with the dye administered in a homogenous solution. We are interested in the construction of suitable nano-biomaterials which consists of a polymer shell and inner volume that can be loaded with different materials such as photosensitizing agents for Photodynamic Therapy and image contrast agents for monitoring, diagnosis and therapy.

**Molecular Modeling and Drug Design**

Chem-informatics is emerging technology for drug discovery with vast potential to reduce the time and cost involved in drug discovery process, to custom design drugs and to develop personalized medicine. Simultaneous advances in molecular and cell biology techniques, the ability to decode entire genomes, and the unraveling of the molecular pathways of many diseases have generated enormous potential targets for drug development. Some of the works we complicated in this direction are given below.

- Molecular modeling of mif inhibitors in glioblastoma multiforme angiogenesis
- *In silico* simulation of cap43 dna – hif-1 protein interaction: Potential application in cancer therapy.
- Structure Modeling The Yb1 Protein: A Potential New Target For Cancer Therapeutics
- Molecular modeling of mutant pfcr1 and its interaction with viable chloroquine resistance reversal agents

### **Electron Magnetic Resonance Imaging for Biomedical Applications:**

Development of specialized small animal imaging methodologies is of current interest for highly sensitive and quantitative measurement of a wide range of tumor related parameters. Small animal models are being used increasingly as research tools in several human diseases such as neurodegenerative disorders, cardiovascular disorders, obesity, and cancer. Electron paramagnetic resonance imaging (EPRI) is a novel imaging modality, and can probe physiological functions by monitoring the behaviour of small quantity of an administered paramagnetic agent (spin probes). Studying various physiological parameters like pO<sub>2</sub>, pH, redox status, viscosity etc. gives valuable information about the efficacy of different cancer treatment modalities. Our lab is involved in developing new methodologies for *in vivo* physiological imaging.

### **RECENT PUBLICATIONS:**

1. D. P. Padiyan, C. Muthukrishnan, R. Murugesan, EPR of VO<sub>2</sub><sup>+</sup> in calcium (picrate)<sub>2</sub>(2,2'-bipyridyl)<sub>2</sub>: studies on molecular orbital coefficients, J. Molec. Struc; 648, 1-8 (2003).
2. G. Taube, S. Subramanian, R. Murugesan, N. Devasahayam, J. B. Mitchell, and M. C. Krishna and J. A. Cook, An application system for automation of constant-time radio frequency electron paramagnetic resonance imaging, Comp. Methods and Programs in Bio. Med 72 (2): 127-138 (2003).
3. J. J. Inbaraj, M. V. Vinodu, R. Gandhidasan, R. Murugesan and M. Padmanabhan. Photosensitising properties of ionic porphyrins immobilized on functionalized solid polystyrene support, J. Appl. Polymer Sci. 89 (14): 29, 3925-3930 (2003).
4. M. Rajendran, S. Ramasamy, C. Rajamanickam, R. Gandhidasan and R. Murugesan Photodynamic effects of two hydroxyanthraquinones. Biochim. Biophys. Acta 1622 (2): 65-72 (2003).
5. K. K. Mothilal, C. Karunakaran, P. S. Rao and R. Murugesan. Single Crystal EPR of Cu(II) doped [Co(tbz)<sub>2</sub>(NO<sub>3</sub>)(H<sub>2</sub>O)]NO<sub>3</sub>: Probe into copper-thiabendazole interaction, Spectrochim. Acta Part A. 59 (14), 3337-3345, (2003).
6. K. K. Mothilal, J. J. Inbaraj, R. Gandhidasan and R. Murugesan. Photosensitization with anthraquinone derivatives: optical and EPR spin trapping studies of photogeneration of reactive oxygen species, J. Photochem. Photobiol. Chem. 162, 9-16 (2004).
7. M. Rajendran, J. J. Inbaraj, R. Gandhidasan and R. Murugesan. Photodynamic action of damnacanthal and nordamnacanthal, J. Photochem. Photobiol. Chem. 162, 615-623 (2004).

8. K. K. Mothilal, C. Karunakaran, and R. Murugesan, Synthesis, X-ray crystal structure, antimicrobial activity and photodynamic effects of some thiabendazole complexes, *J. Inorganic Biochemistry* 98, 322-332 (2004).
9. K. K. Mothilal, J. J. Inbaraj, C. F. Chignell, R. Gandhidasan and R. Murugesan, Photosensitization with naphthoquinones and binaphthoquinones: EPR spin trapping and optical studies-formation of semiquinone radical and reactive oxygen species on photoillumination, *J. Photochem. Photobiol. Chem.* 163, 141-148 (2004).
10. N. Devasahayam, R. Murugesan, K. Matsumotto, J. B. Mitchell, J. A. Cook, S. Subramanian and M. C. Krishna, Tailored Sinc Pulses for Uniform Excitation in Radio Frequency FT EPR Imaging, *J. Magn. Reson.* 168, 110-117 (2004).
11. M. Rajendran, R. Gandhidasan and R. Murugesan, Photosensitisation and photoinduced DNA cleavage by four naturally occurring anthraquinones, *J. Photochem. Photobiol. Chem.* 168, 67-73 (2004).
12. D. C. Durairaj, M. C. Krishna, and R. Murugesan, Integration of color and boundary information for improved region of interest identification in electron magnetic resonance images, *Computerized Med Imaging and Graphics* 28(8), 445-452 (2004).
13. M. Rajendran, R. Gandhidasan and R. Murugesan, Free radicals scavenging efficiency of a few naturally occurring flavonoids: A comparative study, *J. Agri. Food Chem.* 52, 7389-94 (2004).
14. K. I. Matsumoto, J. A. Cook, F. Hyodo, A. Matsumoto, R. Murugesan, J. B. Mitchell, A. Sowers, S. Subramanian, and M.C. Krishna, Estimation of redox status of a tumor tissue in mice using paramagnetic nitroxyl contrast agent, *Free Radical Biology and Medicine*, 39, Supplement 1, 110 (2005).
15. K. I. Matsumoto, S. Subramanian, N. Devasahayam, T. Aravalluvan, R. Murugesan, J. A. Cook, J. B. Mitchell, M. C. Krishna, Electron Paramagnetic Resonance Imaging of Tumor Hypoxia: Enhanced Spatial and Temporal Resolution for In Vivo pO<sub>2</sub> Determination, *Magn. Reson. Med.* 55:1157–1163 (2006).
16. M. Rajendran, J. J. Inbaraj, R. Gandhidasan and R. Murugesan, Photogeneration of reactive oxygen species by 3-arylcoumarin and flavanocoumarin derivatives, *Photo. Chem. Photo. Biol.* 182, 67-74 (2006).
17. M. F. Benial, K. Ichikawa, R. Murugesan, K. I. Yamada and H. Utsumi, Dynamic Nuclear Polarization Properties of Nitroxyl Radicals Used in Overhauser-enhanced MRI for Simultaneous Molecular Imaging, *J. Magn. Reson.* 182, 273–282 (2006).
18. T. Paul, A. Patel, G. S. Selvam, S. Mishra and R. Murugesan, Photodynamic action of C-phycocyanins obtained from marine and fresh water cyanobacterial cultures: A comparative study using EPR spin trapping technique, *Free Radical Research*, 40, 821-825 (2006).

19. N. Devasahayam, S. Subramanian, R. Murugesan, F. Hyodo, K. I. Matsumoto, J. B. Mitchell, and M. C. Krishna, Strategies for improved temporal and spectral resolution in in vivo oximetric imaging using time-domain EPR. *Magn Reson Med.* 57, 776-783, (2007).
20. Y. Yesuthangam, K. K. Mothilal, R. Gandhidasan and R. Murugesan, Photodynamic action and antimicrobial activity of some excited metabolites of *Dalbergia sissooides* and their ability to cleave DNA. *Natural Product Communications.* 2, 159-168, (2007).
21. R. Murugesan, V. Thavavel and B. Meenakshi Sundaram, Dual Tree Complex Wavelet based Regularized Deconvolution for Medical Images, *GVIP Journal*, 7, 1-5 (2007).
22. D. C. Durairaj, M. C. Krishna, R. Murugesan A neural network approach for image reconstruction in electron magnetic resonance tomography. *Comput. Biol. Med.* 37, 1492-1501 (2007).
23. K. Matsumoto, S. Subramanian, R. Murugesan, J B Mitchell, M C Krishna, Spatially Resolved Biologic Information from In Vivo EPRI, OMRI, and MRI, *Antioxid Redox Signal.* 9, 1125-42 (2007).
24. Y. Hama, K. Matsumoto, R. Murugesan, S. Subramanian, N. Devasahayam, J. W. Koscielniak, F. Hyodo, J. A. Cook, J. B. Mitchell, and M. C. Krishna, Continuous Wave EPR Oximetric Imaging at 300 MHz Using Radiofrequency Power Saturation Effects, *Antioxid. Redox. Signal.* 9, 1709-1716 (2007).
25. R. Murugesan, and V. Thavavel, A Two-phase scheme for Microarray Image Restoration, *Journal of Information and Computing Science*, 2, 317-320 (2007).
26. V. Thavavel and R. Murugesan, Regularized Computed Tomography using Complex Wavelets, *Journal of Information and Computing Science*, 01, 027-032, (2007).
27. C. D. Dharmaraj, M. C. Krishna, and R. Murugesan, A Feature Identification System for Electron Magnetic Resonance Tomography: Fusion of Principal Components Transform, Color Quantization and Boundary Information, *J.Math. Imaging Vis.* 30, 284-297 (2008).
28. F. Hyodo, R. Murugesan, K. Matsumoto, E. Hyodo, S. Subramanian, J. B. Mitchell, M. C. Krishna, Monitoring redox-sensitive paramagnetic contrast agent by EPRI, OMRI and MRI, *J. Magn. Reson.* 190, 105-112 (2008)
29. F. Hyodo, S. Subramanian, N. Devasahayam, R. Murugesan, K. Matsumoto, J. B. Mitchell, and M. C. Krishna, Evaluation of sub-microsecond recovery resonators for in vivo electron paramagnetic resonance imaging, *J. Magn. Reson.* 190, 248-254 (2008).
30. Suganthi, M. Rajarajan and R. Murugesan, Electrochemical studies on  $[M(\text{diars})_2X_2]^+$  where  $[X = \text{Cl, Br}; M = \text{Os, Re, Ru, Rh}; \text{diars} = \text{o phenylenebis (dimethylarsine)}]$  at bare and Nafion modified electrodes, *J. Appl. Electrochem.* 37, 561-567 (2008).
31. Suganthi, M. Rajarajan and R. Murugesan, Photodynamic action of bis(tertiary arsine (diars)) metal(III) complexes  $\text{trans-}[M(\text{diars})_2X_2]^+$  ( $X = \text{Cl, Br, I}; M = \text{Co}^{3+}, \text{Cr}^{3+}, \text{Rh}^{3+}$ ): Optical and

EPR spin-trapping studies, *J. Photochem. Photobiol. Chem.* Available online 15, February (2008).