



# **Effect of Manganese Bionanoparticles and /or Low Dose of Gamma Radiation on Rheumatoid Arthritis in Rats**

*A thesis*

Submitted in partial fulfillment of the requirements  
for the Master degree of Science  
In Biochemistry

*By*

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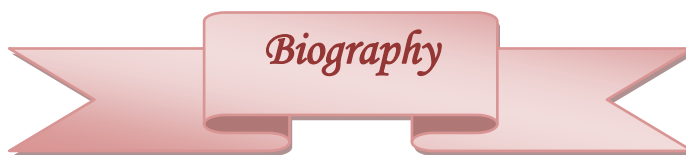
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## *Declaration*

I declare that this thesis has been composed by me and that the work which is recorded herein after has been done by me. It has not been submitted for a degree at this or any other university.

*Habiba Abd El-mahab Abd El-fatah*



I dedicate this work with all my love to the spirit of my dear father, deep thanks and appreciation to my beloved father for his kindness and continuous advice; god bless his soul, to all my family and my husband Ramy who helped me during my entire thesis and to all those who contributed towards my scientific knowledge, whenever and wherever they are.

*Habiba Abd El-wahab Abd El-fatah*

## *Acknowledgements*

First, foremost, and all thanks to **Allah** by whose grace this work had been completed and by whose grace all my life is arranged in the best. Nobody can imagine this way that had been drawn by the mercifulness of Allah.

My deep thanks and gratitude to Professor Dr. **Magda Kamal Ezz**, Professor of Biochemistry, Biochemistry Department, Faculty of Science, Ain Shams University, for her precious guidance. I owe her more than I can express for all the time, she spent in revising every detail, in spite of her busy schedule. In fact all credit goes to her in bringing this study to light.

It is great honor for me that I take this opportunity to express my sincere appreciation and my deep respect to Professor Dr. **Hanan Ahmed El-Kabany**, National Center for Radiation Research and Technology (NCRRT), Atomic Energy Authority, Nasr City, Egypt, for her precious guidance. Without her generous and valuable assistance, this work would lose its value. It is an honor working under her supervision.

I would like to express my deep thanks and my gratefulness to Dr. **Sawsan Mohammed Elsonbaty**, Assistant Professor of Biochemistry, National Center for Radiation Research and Technology (NCRRT), Atomic Energy Authority, Nasr City, Egypt, for her scientific advices, profound review of the thesis and many valuable discussion and professional guidance during all steps of the thesis preparation.



Special thanks to **all my colleagues** at National Center for Radiation Research and Technology, Atomic Energy Authority, for their sincere support and assistance.

**Thank you all from the bottom of my heart!**

*Habiba Abd El-wahab Abd El-fatah*

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## **List of abbreviations**

<b>ACD</b>	Anemia of chronic disease
<b>AD</b>	Atopic dermatitis
<b>ADP</b>	Adenosine diphosphate
<b>AFCs</b>	Antibody-forming cells
<b>AI</b>	Arthritic index
<b>AIA</b>	Adjuvant-induced arthritis
<b>AKT</b>	Protein kinase B
<b>ALT</b>	Alanine transaminase (aminotransferase)
<b>ANOVA</b>	One-way analysis of variance
<b>Anti-CCP</b>	Anti-cyclic citrullinated peptide
<b>ARDS</b>	Acute respiratory distress syndrome
<b>AST</b>	Aspartate transaminase (aminotransferase)
<b>B-cells</b>	B stand for maturation in the bone marrow
<b>CAMs</b>	Cell adhesion molecules
<b>CCL20</b>	Chemokine (C-C motif) ligand 20
<b>CD</b>	Cluster of differentiation (cell surface molecule)
<b>CD25+</b>	Cluster of differentiation 25 (surface marker protein on regulatory T-cells)
<b>CD36</b>	Thrombospondin receptor
<b>CD4+ T-cells</b>	Helper T-cells (T-lymphocyte)
<b>CD8+ T-cells</b>	Cytotoxic T-cells
<b>CFA</b>	Complete Freund's adjuvant
<b>COXs</b>	Cyclooxygenases
<b>CRP</b>	C-reactive protein
<b>Cu-Zn SOD</b>	Copper-zinc superoxide dismutase
<b>Cyt c</b>	Cytochrome c
<b>DCs</b>	Dendritic cells
<b>DLS</b>	Dynamic light scattering
<b>DMARDs</b>	Disease-modifying anti-rheumatic drugs
<b>DTNB</b>	5, 5' dithiobis-2-nitrobenzoic acid
<b>e<sub>aq</sub><sup>-</sup></b>	Hydrated electron
<b>EAEA</b>	Egyptian atomic energy authority
<b>EC-SOD</b>	Extracellular superoxide dismutase
<b>EDTA</b>	Ethylenediaminetetraacetic acid
<b>E-selectin</b>	Selectin expressed in endothelial cells
<b>ETC</b>	Electron transport chain

<b>Fc</b>	Fragment crystallizable region of the antibody
<b>Fcγ</b>	Fragment crystallizable gamma receptors
<b>FMN</b>	Flavonoids mediated nanomaterial
<b>Fox p3+</b>	Forkhead box p3 (surface marker protein on regulatory T-cells)
<b>FTIR</b>	Fourier transform infrared analysis
<b>GFR</b>	Glomerular filtration rate
<b>GIT</b>	Gastrointestinal tract
<b>GPx</b>	Glutathione peroxidase
<b>GS</b>	Glutamine synthetase
<b>GSH</b>	Reduced Glutathione
<b>GSSG</b>	Glutathione disulfide (oxidized glutathione)
<b>HCl</b>	Hydrochloric acid
<b>HDR</b>	High-dose radiation
<b>HO-1</b>	Hemoxygenase-1
<b>HRP</b>	Horseradish peroxidase
<b>HT</b>	Hashimoto's thyroiditis
<b>ICAMs</b>	Intracellular adhesion molecules
<b>IFN-γ</b>	Interferon gamma
<b>Ig</b>	Immunoglobulin
<b>IκB</b>	Inhibitor of kappa B
<b>IL</b>	Interleukin
<b>IL-12p70</b>	Interleukin-12 protein of 70 kDa
<b>IL-1β</b>	Interleukin-1beta
<b>ILD</b>	Interstitial lung disease
<b>iNOS</b>	Inducible nitric oxide synthase
<b>IRR</b>	Irradiation
<b>ISO</b>	International organization for standardization
<b>LD<sub>50</sub></b>	Median lethal dose
<b>LDH</b>	Lactate dehydrogenase
<b>LDI</b>	Low-dose irradiation
<b>LDR</b>	Low dose radiation
<b>LD-RT</b>	Low-dose radiotherapy
<b>LOXs</b>	Lipoxygenases
<b>L-selectins</b>	Selectin expressed in lymphocytes
<b>M1</b>	Pro-inflammatory macrophages
<b>M2</b>	Anti-inflammatory macrophages
<b>MC</b>	Mononuclear cells

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*List of abbreviations & units*

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<b>MCP</b>	Monocyte chemoattractant protein
<b>MDH</b>	Malate dehydrogenase
<b>MIP-<math>\alpha</math></b>	Macrophage inflammatory protein- $\alpha$
<b>MMPs</b>	Matrix metalloproteases
<b>MnBNPs</b>	Manganese bionanoparticles
<b>MnCl<sub>2</sub></b>	Manganese chloride
<b>MnNPs</b>	Manganese nanoparticles
<b>MNPs</b>	Metal nanoparticles
<b>MnSOD</b>	Manganese superoxide dismutase
<b>MPCs</b>	Mononuclear phagocytes
<b>MS</b>	Multiple sclerosis
<b>NADPH</b>	Nicotinamide adenine dinucleotide phosphate (Reduced form)
<b>NBT</b>	Nitroblue tetrazolium
<b>NCRRT</b>	National center for radiation research and technology
<b>NF-kB p65</b>	65 kDa protein subunit of nuclear factor kappa B
<b>NF-<math>\kappa</math>B</b>	Nuclear factor- kappa B
<b>NK</b>	Natural killer cells
<b>NO</b>	Nitric oxide
<b>NPs</b>	Nanoparticles
<b>NQO-1</b>	NAD(P)H quinone dehydrogenase-1
<b>Nrf-2</b>	Nuclear factor E2-related factor-2
<b>NSAIDs</b>	Non-steroidal anti-inflammatory drugs
<b>OECD</b>	Organization for economic co-operation and development
<b>ONOO<sup>-</sup></b>	Peroxynitrite ion
<b>OS</b>	Oxidative stress
<b>p38 MAPK</b>	Class of mitogen-activated protein kinases (MAPK)
<b>p450</b>	Cytochrome protein shows maximum absorption at 450nm
<b>PBMC</b>	Peripheral blood mononuclear cells
<b>PG E2</b>	Prostaglandin E2
<b>PMNs</b>	Polymorphonuclear neutrophils (cells)
<b>P-selectins</b>	Selectin expressed in platelets
<b>RA</b>	Rheumatoid arthritis
<b>RANKL</b>	Receptor activator of nuclear factor kappa-B ligand
<b>RDA</b>	The recommended dietary allowances
<b>RF</b>	Rheumatoid factor

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*List of abbreviations & units*

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<b>RNS</b>	Reactive nitrogen species
<b>ROO<sup>•</sup></b>	Peroxyl radical
<b>ROS</b>	Reactive oxygen species
<b>SE</b>	Standard error
<b>SLE</b>	Systemic lupus erythematosus
<b>SLs</b>	Sesquiterpene lactones
<b>SOD</b>	Superoxide dismutase
<b>SOD-1</b>	Superoxide dismutase-1 (Copper-zinc superoxide dismutase)
<b>TAOC</b>	Total antioxidant capacity
<b>TBA</b>	Thiobarbituric acid
<b>TCA</b>	Tricarboxylic acid
<b>T-cells</b>	T stand for cells maturation in the thymus
<b>TEM</b>	Transmission electron microscopy
<b>TEs</b>	Trace elements
<b>TGF-<math>\beta</math></b>	Transforming growth factor-beta
<b>TLC</b>	Total leukocytic count
<b>TMB</b>	Tetramethyl-benzidine
<b>TNFR1</b>	Tumor necrosis factor receptor 1
<b>TNF-<math>\alpha</math></b>	Tumor necrosis factor-alpha
<b>Tregs</b>	Regulatory T-cells
<b>UDP</b>	Up-and-Down procedure
<b>UV-Vis</b>	Ultraviolet-visible spectral analysis
<b>VEGF</b>	Vascular endothelial growth factor
<b>VBs</b>	Vertebral fractures
<b>WBC</b>	White blood cells
<b>WHO</b>	World health organization
<b><math>\beta</math>-NADH</b>	Beta nicotinamide adenine dinucleotide (Reduced form)
<b><math>\gamma</math></b>	Gamma
<b><math>\gamma</math>-GCS</b>	Gamma-glutamylcysteine synthetase