

*Dedicated to*

*My Mummy, Mrs. Bani Paul and Papa, Mr. Niranjan Paul*

## **Declaration**

I hereby declare that the thesis entitled “Antioxidant and immunomodulatory effects of lead acetate and sodium arsenite exposure on macrophage response in freshwater fish *Channa punctatus*” submitted to the Department of Biotechnology, Assam University for the award of Doctor of Philosophy (Sc.), is an original research work done by me under the supervision of Dr. Mahuya Sengupta (Supervisor), Assistant Professor, Department of Biotechnology, Assam University, Silchar and Prof. Gauri Dutta Sharma (Co-Supervisor), Vice- Chancellor, University of Bilaspur, and this work or any part thereof has not been submitted for any degree in any other University.

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## **List of abbreviations:**

%- Percentage

AAS- Atomic absorption spectrophotometry

Ar- Argon

As- Arsenic

CAT- Catalase

Cu- Copper

DNA- Deoxyribonucleic acid

DPA- Diphenylamine

DPBS- Dulbecco's phosphate buffered saline

EDTA- Ethylene diamine tetraacetic acid

ELISA- Enzyme- linked immunosorbent assay

ERK- Extracellular regulated kinase

FBS- Fetal bovine serum

GPx- Glutathione peroxidase

GR- Glutathione reductase

GSH- Reduced glutathione

GSSG- Oxidized glutathione

GST- Glutathione S- Transferase

H<sub>2</sub>O<sub>2</sub>- Hydrogen peroxide

HBSS- Hanks balanced salt solution

IFN- $\gamma$ - Interferon- gamma

IL- $\beta$ - Interleukin- beta

iNOS- Inducible nitric oxide synthase

L-15- Leibovitz-15 medium

LD50- Lethal dose<sub>50</sub>

LDH- Lactate dehydrogenase

LPO- Lipid peroxidation

LPS- Lipopolysaccharide

MAPK- Mitogen activated protein kinase

MCO- Metal catalyzed oxidative reactions

MDA- Malonaldehyde

MPO- Myeloperoxidase

MTT- 3-(4,5-Dimethylthiazol-2-yl)-2, 5-diphenyltetrazolium bromide

NADPH- Nicotinamide adenine dinucleotide phosphate

NFκB- Nuclear factor kappa-light-chain-enhancer of activated B cells

NK cells- Natural killer cells

NO- Nitric oxide

NOS2- Nitric oxide synthase 2

OPD- Orthophenylene dihydrochloride

PAMPs- Pathogen-associated molecular patterns

Pb- Lead

PBS- Phosphate buffer saline

PC- Protein carbonylation

PI3K- Phosphoinositide 3 kinase

PKC- Protein kinase C

PRRs- Pattern recognition receptors

ROS- Reactive oxygen species

S.E.- Standard error

SDS- Sodium dodecyl sulfate

SEM- Scanning electron microscopy

SOD- Superoxide dismutase

TBARS- Thiobarbituric acid reactive substance

TLR- Toll-like receptor

TNF- $\alpha$ - Tumor necrosis factor- alpha

Zn- Zinc

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