

# **CHAPTER 7**

# **CONCLUSION**

Heavy metals are natural constituents of the earth's crust, but indiscriminate human activities have drastically altered their geochemical cycles and biochemical balance. Intense anthropogenic activity in industrial and agricultural sectors has inexorably increased the levels of toxic heavy metals in aquatic environment. Heavy metals like mercury and cadmium affect various systems. Mercury and cadmium mediated cellular response involve marked changes in antioxidant defence system as well as in innate immune response. Functions of intestinal macrophages from mercuric chloride and cadmium chloride exposed fishes have been examined and any alteration in the antioxidant defence system and innate immune responses have been determined and reported for the first time.

Macrophages have been regarded as an important part of the cellular immune system in fish and functions to protect the host by phagocytosing foreign materials including disease causing agents. Macrophages constitute the first line of defense against antigenic insults in an organism and also participate in cellular immunity as antigen presenting cells; Cytokines released from macrophages harness the dual branches of immune status viz. humoral and cell mediated immunity. The present study suggests that mercury (Hg) and Cadmium (Cd) exert oxidative stress and adversely alters both the defense mechanisms of innate immunity as well as antioxidant system in fish. A variation in ultrastructure, morphology and functional activities of macrophages including enzyme release suggests that both the antioxidant and immune defense systems of *C. punctata* intestine are compromised by metals (Hg and Cd) exposure at low concentrations, probably by compromising the molecular cross-talk between signaling molecules. Up regulation of pro-inflammatory cytokine release (TNF- $\alpha$  and IL-6) implicates the involvement of MAPK cascades and up regulation of NF $\kappa$ B genes. The study also reports that a simultaneous exposure to mercury and cadmium has a

synergistic effect as compared to the effects of independent exposure to them after 4 days and 7 days of exposure.

In the present study, the exposure of *Channa punctatus* to mercury and cadmium for 7 days caused a general increase in TNF- $\alpha$  and IL-6 mRNA expression indicating a stimulatory action upon pro-inflammatory processes. Mercury and cadmium interact positively, inducing an increase in cytokine expression suggesting a possible increase in inflammatory status.

Fish are important components of human nutrition, and those from contaminated sites present a potential risk to human health. Since fish occupy the top of the aquatic food chain, they are suitable bioindicators of metal contamination. Also, the alterations in the innate immune functions and antioxidant status with the oxidative stress parameters can be used as potential biomarkers for risk assessment in aquatic ecosystems. Moreover, the study of the immune responses can also be used as ecotoxicological markers of predicting the impacts of toxicants on fish populations in particular and aquatic ecosystem health in general.