THE DIVING RESPONSE IN MAN, RAT AND ECHIDNA

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DECLARATION AND ACKNOWLEDGEMENTS

I declare that this thesis is of my own composition and that it is a record of original work conducted during the years 1968, 1969, 1970 and 1971 in the Department of Human Physiology and Pharmacology, University of Adelaide. The work described herein has not been submitted for any other degree, award or diploma.

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PREFACE

Oxygen is an essential ingredient for most life forms. How an animal obtains this vital element depends upon its natural external environment. Single celled creatures acquire oxygen by simple diffusion across the cell membrane from the surrounding fluid. In complex multicellular organisms, simple diffusion will not suffice, since cells deep within the body would not obtain sufficient oxygen to survive. These larger organisms must therefore provide their own method of distributing oxygen to all their tissues. This is the fundamental reason for the circulatory system. Such a system must be provided with a means for extracting oxygen from the external environment. In a liquid medium, this function is often served by gills and in air by the lungs. Each of these structures is beautifully adapted for extracting oxygen from its natural environment, but neither can operate effectively in the other medium. To transfer a fish to air, or an air-breathing animal to water, constitutes an immediate and critical threat to the creature's life. The time of survival in the foreign environment then depends upon how economically the creature uses its limited store of oxygen. Evolution has provided the more complex creatures with a defence mechanism for increasing their chance of surviving sudden loss of their oxygen supply. As might be expected, this mechanism is more pronounced in animals which are frequently subjected to changes in environment, such as flying fish

and seals. It consists of a profound adjustment of the circulatory system which conserves the oxygen supply by permitting blood to flow only to the vital tissues that require a continuous oxygen supply. This cardiovascular response has been elicited in a wide range of animals, including fish, amphibia, reptiles, birds and mammals. Most research into this phenomenon has been performed on air-breathing diving animals. This thesis describes studies performed on three terrestrial mammals - man, rat and echidna - to elucidate some of the physiological responses of these land animals to asphyxia in air and under water.