

03/6501 Mammalian Hibernation Mechanisms: Relevance to a Possible Human Hypometabolic Induced State

Type of activity: Small Study (2 months, 15 KEUR)

The ability to induce a hypometabolic state within astronauts during long – term space voyages would have a considerable effect on Life Support System resource requirements.

Hibernators exist in every phylum, and the behavioural and physiological mechanisms that animals use to hibernate are as diverse as the animals themselves (for examples of general metabolism suppression, see [1,2]). Because of their phenotypical/genotypical similarity to humans (belonging to the *mammalia* class), mammalian hibernation mechanisms [3] are considered to hold the most promise in application to human hibernation. Within the class *mammalia* hibernators exist in the orders *Monotremata*, *Marsupialia*, *Primates*, *Insectivora*, *Chiroptera*, *Carnivora* and *Rodentia*. There exist many different behavioural and physiological mechanisms peculiar to specific species within these orders, but there also exists a wide range of common behaviour and mechanisms that characterise mammalian hibernators as a whole.

Study Objectives

The objective of the study is to perform a review of knowledge gained to date concerning the mechanisms used by mammalian hibernators (such as the ground squirrel *Spermophilus tridecemlineatus*) and winter sleepers (typified by the Brown bear *Ursus arctos*). The review should cover general hibernation strategies common to all hibernators and general mechanisms of winter sleepers as well. Example areas include strategies such as lipid accumulation (white and brown), hibernation cues (photocues etc.), hibernation induction trigger molecules, non-shivering thermogenesis, protein synthesis from ureal nitrogen, reversible phosphorylation, and the role of differential gene expression (this list is not comprehensive, and many more mechanisms should be explored). For every mechanism identified, the suitability/practicality of applying similar mechanisms to human hibernation should be explored and gauged (for example, pharmaceutical mimicry of HIT molecules, gene therapy to allow differential expression of relevant genes and more). Of particular interest is to explore the potential suitability of hibernation and winter sleep to the human case, and a principal result from the study should be a reasoned argument in favour of one of these principle mechanisms.

In summary the study objectives are:

- Review of currently identified mammalian hibernation and winter sleep mechanisms
- Assessment of each mechanism's suitability and necessary pre-requisites towards inducing a hypometabolic state in humans.

References

[1] Storey, K. B., Storey, J. M. (1996). *Natural Freezing Survival in Animals*. Annual Review of Ecological Systems. Vol. 27, pp.365-386.

[2] Zachariassen, K. E. (1985). *Physiology of Cold Tolerance in Insects*. Physiological Reviews, Vol. 65, No. 4. The American Physiological Society.

[3] Boyer, B., Barnes, B. M. (1999). *Molecular and Metabolic Aspects of Mammalian Hibernation*. Bioscience, Vol. 49, No. 9.