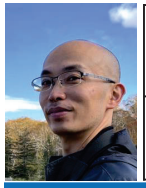
【Grant-in-Aid for Transformative Research Areas（A）】

Hibernation Biology 2.0 : understanding regulated hypometabolism and its function (Hibernation Biology 2.0)



Head Investigator	Hokkaido University, Institute of Low Temperature Science, Professor YAMAGUCHI Yoshifumi　Researcher Number:10447443
Research Area Information	Number of Research Area : 23A303　Project Period (FY) : 2023-2027 Keywords : Hibernation, Torpor, Hypometabolism, Hypothermia, Cold adaptation, Seasonality

Purpose and Background of the Research

●Outline of the Research

Hibernation is a fascinating phenomena, the regulative mechanism of which is still unknown. For homeothermic mammals maintaining their body temperature constant around 37ºC, it is a challenging issue how to survive the cold season when food, the energy source for heat production, is depleted. Torpor is a phenomenon of surviving in a state of hypothermia that deviates from normal homeothermia by actively suppressing heat production and basal metabolism, thereby reducing energy consumption under cold and/or starvation. When torpor occurs repeatedly and seasonally for several months, it is called hibernation. Although we humans cannot hibernate, hibernation and torpor are widely observed among mammals, including primates. However, due to various technical problems, mechanisms of hibernation and torpor remains to be elucidated.

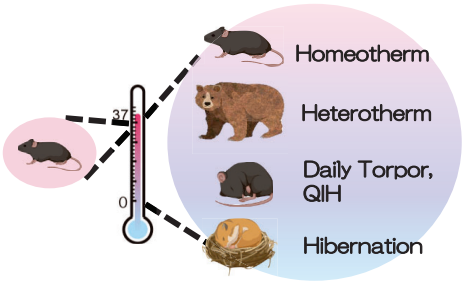


Figure 1. Extended homeodynamics in torpor, hibernation, and QIH.
QIH: Q-neuron induced hypometabolism and hypothermia (hibernation-like state that can be artificially induced).

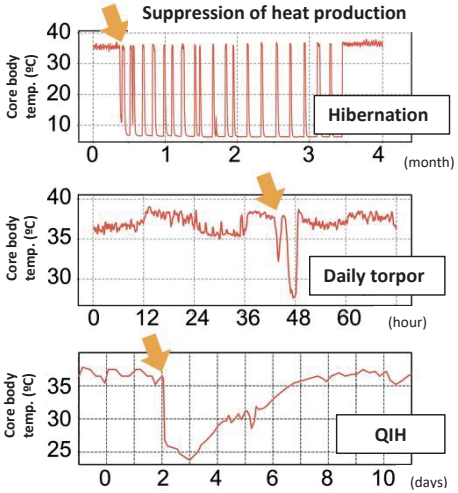


Figure 2. Core body temperature changes in hibernation, torpor, and QIH.

This research area aims to understand the principles of controlling and achieving hibernation and torpor, and mechanisms to respond to cold and low body temperature in hibernation and torpor using analytical methods and technologies provided by leading researchers in various fields. Basic scientific knowledge obtained in this field is expected to serve as a foundation for future development and spread to a wide range of fields, including medicine, drug discovery, environmental science, and space science.

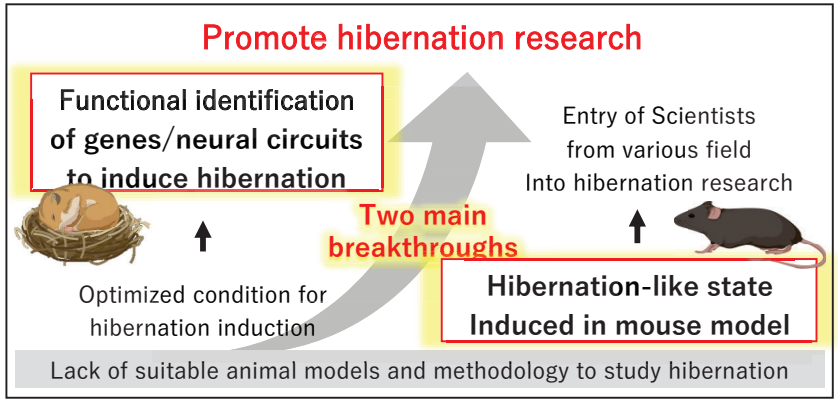


Figure 3. Foundation and evolution of this area

Expected Research Achievements

In this research area, three interrelated projects, "Molecular and Neural Basis," "Biological Response," and "Elemental Technology," are being promoted in parallel to elucidate the control mechanisms of hibernation and torpor as follows;

Project 1 "Molecular and Neural Basis for Hibernation" will promote research focusing on two main areas: identification of genes and signals important for inducing hibernation and torpor, and analysis of neural circuit mechanisms. By utilizing a genetic hibernator model and QIH, we aim to clarify how active hypometabolism is induced and what the differences are between hibernators and non-hibernators.

Project 2: "Biological Responses Induced by Hibernation" aims to elucidate how homeostasis of cells, tissues, organs, and individuals is maintained and how functions are performed under low temperature conditions, such as during hibernation and torpor, at the molecular, cellular, and network levels.

Project 3 "Elemental Technologies for Hibernation Research" aims to develop, improve, and put into practical use the analytical technologies and methods necessary for approaching the mechanisms of hibernation and torpor. Research will be promoted with a focus on genetic manipulation technology, neural circuit tracing, and transomics in hibernators and torpid animals.

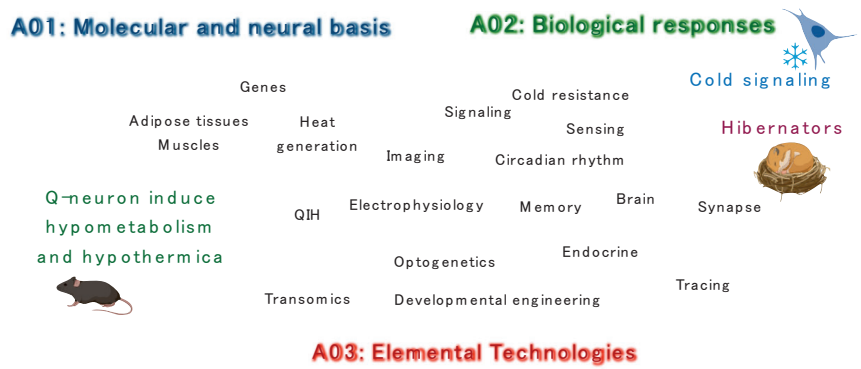


Figure 4. Focus and technologies of this area

Homepage Address, etc.	https://hibernationbiology.jp