

## 【Grant-in-Aid for Specially Promoted Research】

### Science and Engineering



#### Title of Project : Development of "super-bio-functions" by plasma-activated biological substances

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Keyword : plasma, Low-temperature Atmospheric Pressure Plasma, Plasma Medicine, Plasma Agriculture

#### 【Purpose and Background of the Research】

We found that biological liquids irradiated with plasma (aggregate of active particles [radicals, ions, electrons, light]) exhibit highly selective anti-tumor effects against various cancers. We also found that plasma propagates central nerve cells that could not be conventionally reproduced and surprisingly promotes plant growth. We have also systematically analyzed effects of plasma-activated liquids on biological systems (gene expression, metabolism, immunity, and signal transduction) by developing plasma science within the fields of medical science and molecular biology. In this project, we plan to investigate the molecular structures and physical properties of plasma-activated biological substances and to integrally understand interactions among the substances and biological system to elucidate the expression of "super bio-functions" by plasma as a universal molecular mechanism in eukaryotes for processes such as cell death, proliferation, and differentiation. Based on the findings, we expect to provide an academic foundation for "Plasma Life Science" as a compass for pioneering new industries such as plasma medicine and agriculture, and will produce innovations to resolve problems with intractable and food shortages.

#### 【Research Methods】

The primary objective is to focus on elucidating the molecular structure and physical properties of bioactive substances resulting from the interactions between plasma and biological fluids.

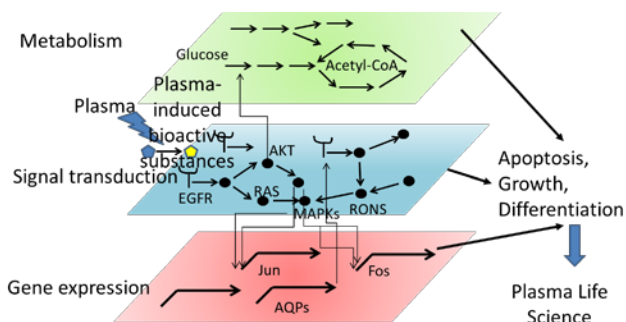


Figure 1 Molecular reactions between plasma-induced bioactive substances and living bodies.

Next, we will systematically investigate molecular reactions (signal transduction, gene expression, metabolism, immunity, hormones) between plasma-induced bioactive substance and the living body at the cellular level with

respect to selective death and regeneration/proliferation phenomena caused by interactions between each substance and animal and plant cells (Figure 1). The second objective is to clarify the mechanisms of death, regeneration and growth from the transcriptome (exhaustive gene expression) and metabolomic analysis in animal models (mouse, rat) and plant models (model plants, strawberry, rice). Finally, the third objective is to open up studies of plasma as a life science by clarifying the essence of the phenomenon.

#### 【Expected Research Achievements and Scientific Significance】

Our researches focusing on cell death and regeneration among phenomena caused by combined exposure to bioactive substances result in a comprehensive understanding of these phenomena and opening up the field (plasma life science) to clarify the "essence of living body" responses to plasma. These results will be a compass to approach to the Plasma Life Science producing the incredible academic impact.

#### 【Publications Relevant to the Project】

- F. Utsumi, H. Kajiyama, K. Nakamura, H. Tanaka, M. Mizuno, K. Ishikawa, H. Kondo, H. Kano, M. Hori, F. Kikkawa, Effect of Indirect Nonequilibrium Atmospheric Pressure Plasma on Anti-Proliferative Activity against Chronic Chemo-Resistant Ovarian Cancer Cells In Vitro and In Vivo, Plos One, 8 (2013) e81576/1-10.
- H. Tanaka, K. Nakamura, M. Mizuno, K. Ishikawa, K. Takeda, H. Kajiyama, F. Utsumi, F. Kikkawa, M. Hori, Non-thermal atmospheric pressure plasma activates lactate in Ringer's solution for anti-tumor effects, Sci Rep, 6 (2016) 36282/1-11.

【Term of Project】 FY2019-2023

【Budget Allocation】 464,100 Thousand Yen

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