Contribution ID: **518** Type: **Oral Presentation**

Transport network designed by current-reinforcement rule

Monday, 9 July 2018 13:30 (1 hour)

Network of transport is found in a wide range of living system. The typical examples are vascular network in vertebrates and tracheal network in vascular plants, and mycelial network in fungi. Such a network structure is found in self-organized colony of unicellular bacteria: a biofilm that is a sheet-like aggregate of many bacteria and sticky polysaccharides secreted from the bacteria. Comparative study of various kinds of bio-network of transport along phylogenetic tree is probably interesting since an insight into evolutionarily sophisticated designing of adaptive network is obtained in a wider perspective.

At the interface between unicellular and multicellular branches, there is an unique organism with highly flexible body shape with network structure, true slime mould Myxomycete (or Mycetozoa). *Physarum polycephalum* Schw. is a well-studied species of true slime mould in cell biology and biophysics last seventy years although several hundreds of species are known. By using this organism, comparative study of bio-network rises for the last one or two decade(s).

A kind of huge amoeboid organism named *Physarum* plasmodium constructs a intricate network of veins for circulating nutrients and signals over the entire body. The network shape (topology of connectivity, and sequence of branching in vein network, for instance) is drastically re-organized within hours in response to external conditions. The past studies showed that the network shape was optimized to maximize possibility of survival, in some senses. So we may extract an algorithm for optimal design of functional network from the primitive organism. The key thing is adaptive dynamics of current-reinforcement rule: each vein of network becomes thicker when current is large enough through the vein itself, while it becomes thinner and dies out otherwise.

We propose the equations of motion for this simple rule, and functions and formation of transport network is analyzed. We will show that the rule is applicable to the other bio-systems: (1) social dynamics of public transportation, (2) formation of network structure in porous tissues bone (bone remodelling in other words). A tractable perspective to think similarly of a variety of bio-network is given from the viewpoint of current-reinforcement rule.

Primary author: Dr NAKAGAKI, Toshiyuki (Hokkaido University)

Presenter: Dr NAKAGAKI, Toshiyuki (Hokkaido University)

Session Classification: Plenary

Track Classification: Other Mathematical Biology