Bangladesh J Med Microbiol 2014; 08 (02): 01-02
Bangladesh Society of Medical Microbiologists

Editorial

Social intelligence of bacteria

The term social intelligence refers to human mental skills beyond the mathematical skills and academic ones connected with analytical intelligence that are required to conduct a successful social life[1]. Therefore, it is generally associated with special cognitive capacities of humans, such as perceiving self and group identity, perceiving self and group goals, engaging in adaptive social interactions and acting together for personal and group benefit[2].

By using linguistic communication, bacteria show patterns of collective behavior that might reflect some fundamental aspects of social intelligence. Additional clues are provided by the variety of strategies Myxobacteria can use when their social intelligence is challenged by cheaters-opportunistic individuals who take advantage of the group's cooperative effort. For example, they can single out defectors by collective alteration of their own identity into a new gene expression state. By doing so, the cooperators can generate a new dialect that is hard for the defectors to imitate[3,4]. The ongoing intelligence clash with defectors is beneficial to the group as it helps the bacteria to improve their social skills for better cooperation.

By contrast, in multi colonial communities (sub-gingival plaque) social intelligence is usually used for cooperation between colonies of different species. For example, each colony develops its own expertise in performing specific tasks for the benefit of the entire community and they all coordinate the work[5]. Some bacteria undertake the task of keeping valuable information that is costly to maintain and can be hazardous for the bacteria to store. Frequently, such information is directly transferred by conjugation following chemical courtship that is played by the potential partners; bacteria resistant to antibiotics emit chemical signals to announce this fact. Bacteria in need of that information, upon receiving the signal, emit pheromone like peptides to declare their willingness to mate. Sometimes, the decision to mate is followed by exchange of competence factors (peptides). This pre-conjugation communication modifies the membrane of the partner cell into the penetrable state needed for conjugation[6].

A third example is the non-winning rock-paper-scissors game played between strains of Escherichia coli: some strains(c) can produce colicins that kill other colicin-sensitive (s) strains; these then outcompete colicin resistant (R) strains that close the circle by out competing C strains. Expectedly, in this game of no prevailing strategy all these strains survived. However, in a recent in vivo version played by feeding the strains to different mice, strains (c) tend to loose with time[7].

Collective decision making:
When growth conditions become too stressful, bacteria can transform themselves into enduring spores. Sporulation is a process executed collectively and beginning only after consultation and assessment of the colonial stress as a whole by the individual bacteria. Simply put, starved cells emit chemical messages to convey their stress. Once all of the colony members have sent out their decisions and read all other messages, sporulation occurs if the "majority vote" is in favor[8].

To achieve the proper balance of individuality and sociality, bacteria communicate using a broad repertoire of biochemical agents. Each bacterium also has intricate intracellular signaling mechanisms involving signal transduction networks and genetic language[9]. These are used to generate intrinsic meaning for contextual interpretations of chemical messages and for formulating appropriate responses. Biochemical messages are also used in bacterial cell-cell talk to exchange meaningful information across colonies of different species and also with other organisms[10].

Using these advanced linguistic capabilities, bacteria can lead rich social lives for the group benefit. They can develop collective memory, use and generate common knowledge, develop group identity, recognize the identity of other colonies, learn from experience to improve themselves and engage in group decision making, an additional surprising social conduct that amounts to what should most appropriately be dubbed as social intelligence[11]. The last term, originally coined to describe special mental skills that only humans use to conduct successful social lives, has been used more recently to describe linguistic, communicative based group behavior of other organisms, from primates to birds and insects[12].

References:

1. Green M: On the autonomy of linguistics meaning. Mind. 1997; 217-243
2. Green M: Illocutions, implicate, and what a conversation requires. Pragmat. Cognit.1999;7:65-91
3. Strassmann J.E. Bacterial cheaters. Nature. 2000; 404:555-556.
4. Dworkin M. Recent advances in the social and developmental biology of the Myxobacteria. Microbial. Rev. 1996; 60:70-102.
5. Velicer G J: Social strife in microbial world. Trends Microbial. 2003;11:330-337
6. Brassler B L: Small talk: cell to cell communication in bacteria.Cell.2002;109:421-424
7. Kirkup B C and Riely M A. Antibiotic mediated antagonism leads to a bacterial game of rock-paper-scissors in vivo. Nature.2004;428:412-414
8. Stephen C. Bacterial sporulation: a question of commitment. Curr. Biol. 1998;8:45-48
9. Searls D B: The language of genes. Nature.420:211-217
10. Crespi B J: The evolution of social behavior in microorganisms. Trens.Ecol. Evol.2001;16:178-183
11. Ben-Jacob E,Beacker I, Shapira Y, Levine H. Bacterial linguistic communication and social intelligence. Trends in Microbiology. 2004; 12(8):365-372.
12. Queller D C & Strassmann J E: The many selves of social insects. Science. 2002;296:311-313

Prof. Dr. Md. Murshed
Department of Microbiology
Holy Family Red Crescent Medical College and Hospital,
1, Eskaton Garden Road, Dhaka, Bangladesh.
murshed77@hotmail.com