Bacteria shown to 'smell' ammonia

August 18 2010, by Lin Edwards

(PhysOrg.com) -- A new study provides the first evidence that bacteria respond to odors, which according to one of the researchers may be the earliest evolutionary example of olfaction.

Microbiologist Reindert Nijland from the University Medical Centre at Utrecht in the Netherlands, and marine microbiologist Grant Burgess, from the University of Newcastle in the UK, were studying the formation of biofilms by common bacteria that live in soils (*Bacillus licheniformis*), and discovered the microbes were sensitive to the presence of ammonium sulfate, which bacteria metabolize and convert to ammonia, which is a valuable nutrient because it contains nitrogen, which is then used in the production of proteins and nucleic acids. Some ammonia is released to the air in the process.

In the study the researchers used an array consisting of 96 wells and filled one half with a culture medium intended specifically to promote biofilm formation, and the other half with a general, nutrient-rich culture medium. Biofilms were formed in the wells in the biofilm section, but formed best in the central wells closest to the nutrient-rich medium containing ammonium sulfate. Bacteria in these wells were releasing ammonia as they digested the ammonium sulfate.

Nijland and Burgess then experimented with different media and found that media with ammonium sulfate as one of the nutrients produced the greatest volume of biofilms in the central wells. The same pattern was produced if the media was a simple aqueous solution of ammonia, which suggests the bacteria can sense the volatile ammonia and react by

growing a biofilm towards its source. This would be an advantage to the bacteria as ammonia indicates the presence of a rich source of nutrients nearby.

Bacteria have previously been shown to respond to gases such as carbon monoxide and oxygen, but Nijland said these gases do not have odors and so the response to them cannot be olfactory. He said it makes no sense to "smell" oxygen as it is always around. "You smell things that give important information," Nijland said. He also countered criticism of the research suggesting the bacteria were responding to changes in pH of the solution as it absorbed ammonia, by saying the effect was observed even when concentrations were too low to have much effect on pH, and the culture medium was also buffered to ensure large pH shifts did not occur.

Nijland said he hoped the results might lead to ways of preventing the formation of biofilms, which are resistant to antibiotics and make bacteria that cause disease more of a threat.

The paper is to be published in the *Biotechnology Journal*.