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Bacteria in the Gut May Influence Brain Development

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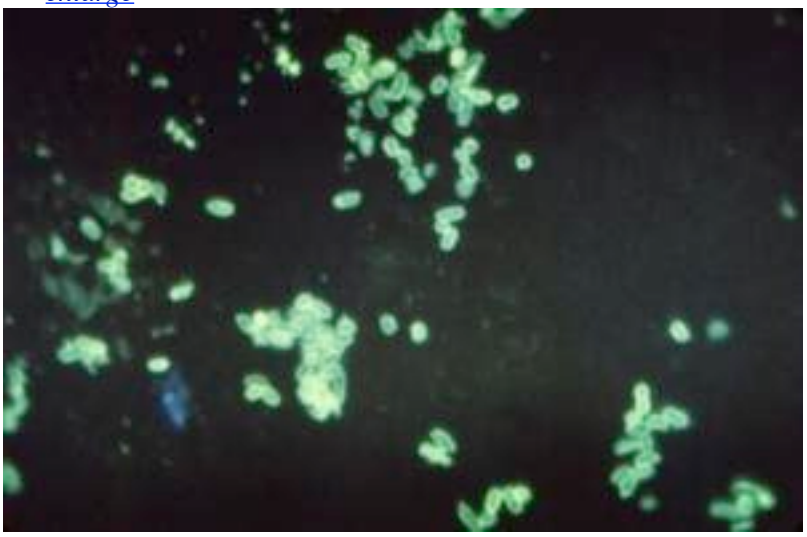

One type of bacteria normally found in the gut is E. coli. E. coli bacteria serve the useful task of keeping other bacterial organisms in check (however, the O157:H7 E. coli strain produces a potent toxin). (Credit: CDC/ Berenice Thomason)

ScienceDaily (Feb. 1, 2011) — A team of scientists from around the globe have found that gut bacteria may influence mammalian brain development and adult behavior. The study is published in the scientific journal *PNAS*, and is the result of an ongoing collaboration between

scientists at Karolinska Institutet in Sweden and the Genome Institute of Singapore.

The research team compared behavior and gene expression in two groups of mice -- those raised with normal microorganisms, and those raised in the absence of microorganisms (or germ-free mice). The scientists observed that adult germ-free mice displayed different behavior from mice with normal microbiota, suggesting that gut bacteria may have a significant effect on the development of the brain in mammals.

The adult germ-free mice were observed to be more active and engaged in more 'risky' behavior than mice raised with normal microorganisms. When germ-free mice were exposed to normal microorganisms very early in life, as adults they developed the behavioral characteristics of those exposed to microorganisms from birth. In contrast, colonizing adult germ-free mice with bacteria did not influence their behavior.

Subsequent gene profiling in the brain identified genes and signaling pathways involved in learning, memory and motor control that were affected by the absence of gut bacteria, highlighting the profound changes in the mice that developed in the absence of microorganisms. This suggests that, over the course of evolution, colonization of the gut by microorganisms (in total 1.5 kilograms) in early infancy became integrated into early brain development.

"The data suggests that there is a critical period early in life when gut microorganisms affect the brain and change the behavior in later life," says Dr. Rochellys Diaz Heijtz, first author of the study.

"Not only are signal substances like serotonin and dopamine subject to regulation by bacteria, synapse function also appears to be regulated by colonizing bacteria," continues Prof. Sven Pettersson, coordinator of the

study. "However, it is important to note that this new knowledge can be applied only to mice, and that it is too early to say anything about the effect of gut bacteria on the human brain."

In addition to Sven Pettersson and Rochellys Diaz Heijtz, Prof. Hans Forssberg at Stockholm Brain Institute (SBI) and Karolinska Institutet, and Dr. Martin Hibberd from the Genome Institute of Singapore (GIS) where involved in the research project. The findings presented are a result of a long-standing and ongoing collaboration between Karolinska Institutet and the GIS in Singapore aimed at exploring host-microbe interactions in a systematic manner.

Story Source:

The above story is reprinted (with editorial adaptations by Science*Daily* staff) from materials provided by **Karolinska Institutet**.

Journal Reference:

1. R. D. Heijtz, S. Wang, F. Anuar, Y. Qian, B. Bjorkholm, A. Samuelsson, M. L. Hibberd, H. Forssberg, S. Pettersson. **Normal gut microbiota modulates brain development and behavior**. *Proceedings of the National Academy of Sciences*, 2011; DOI: 10.1073/pnas.1010529108

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