Vitamin B12 Found to Drive Inherited Behavioural Changes Across Generations

A team of researchers from the Department of Integrative Evolutionary Biology at the Max Planck Institute for Biology Tübingen has discovered that vitamin B12 plays a key role in transmitting behavioural memories across generations. The study shows for the first time how a nutrient from the diet can, without altering the genome, influence behaviour over multiple generations.

To the point

- **Vitamin B12 drives inherited predation:** A bacterial nutrient induces a predatory form in *Pristionchus pacificus* that is passed to future generations.
- **Concentration-dependent metabolic signaling:** The effect depends on vitamin B12 levels and its role in methionine synthesis.
- **Maternal nutrient transfer mechanism:** Inheritance occurs through increased vitellogenin-mediated provisioning from mothers to offspring.
- **Linking environment to evolution:** The study shows how diet-driven changes can shape long-term adaptation via transgenerational memory.

It has long been known that environmental conditions can shape how traits are inherited, a phenomenon known as transgenerational epigenetic inheritance. However, the molecular signals responsible for encoding this biological "memory" have remained largely unknown.

In this new study, scientists used the nematode *Pristionchus pacificus*, a microscopic roundworm capable of developmental flexibility. Depending on its diet, *Pristionchus* can alter its mouth structure and adopt a predatory lifestyle, feeding on other nematodes.

When *Pristionchus* was fed the bacterium *Novosphingobium*, they developed exclusively into the predatory form. Interestingly, this increased tendency toward predation persisted across multiple generations even after the worms were returned to their standard diet.

The research team identified vitamin B12, a metabolite produced by the bacteria, as the key trigger of this inherited effect. When *Novosphingobium* was genetically modified to block vitamin B12 production, the transgenerational memory of predation was lost. Reintroducing vitamin B12 restored the effect, demonstrating that the vitamin B12 is both necessary and sufficient for this form of inheritance.

Further experiments revealed that vitamin B12 acts in a concentration-dependent manner and signals through methionine synthase, an essential enzyme in cellular metabolism where vitamin B12 functions as a critical cofactor.

Beyond its metabolic role, vitamin B12 was found to increase levels of vitellogenin, a yolk protein responsible for transporting nutrients from mother to offspring, across generations. Worms lacking the vitellogenin receptor, that is responsible for the uptake of yolk proteins into oocytes, failed to exhibit the inherited predatory behaviour. This provides strong evidence that the transgenerational memory induced by vitamin B12 acts through maternal nutrient provisioning from mothers to their offspring.

"Our findings show that vitamin B12 does not simply affect the individual consuming it, but can shape the biology of future generations," says Shiela Pearl Quiobe, the doctoral researcher working on the project "This reveals a direct molecular link between diet, metabolism, and inherited traits."

The study highlights a striking example of phenotypic plasticity, where organisms adapt their traits in response to environmental conditions. In rapidly changing or resource-limited environments, such as those encountered by *P. pacificus* in nature, the ability to pass on adaptive traits like predation can significantly enhance survival and reproductive success.

“These results demonstrate how immediate environmental responses can be extended across generations, potentially influencing evolutionary trajectories,” Ata Kalirad, a postdoc in the Department of Integrative Evolutionary Biology, adds.

Despite these advances, key questions remain. The precise amount of vitamin B12 transferred into nematode tissues and embryos is still unknown, and ongoing research aims to better understand the role of vitellogenin. The researchers hypothesize that these yolk proteins may act as central transport hubs, carrying not only nutrients but also other molecules, such as lipids and small RNAs, that could contribute to inherited traits.

This work provides a foundational step toward understanding how environmental signals are converted into heritable biological information, with implications extending beyond nematodes to broader questions of nutrition, development, and inheritance.

Original Publication

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