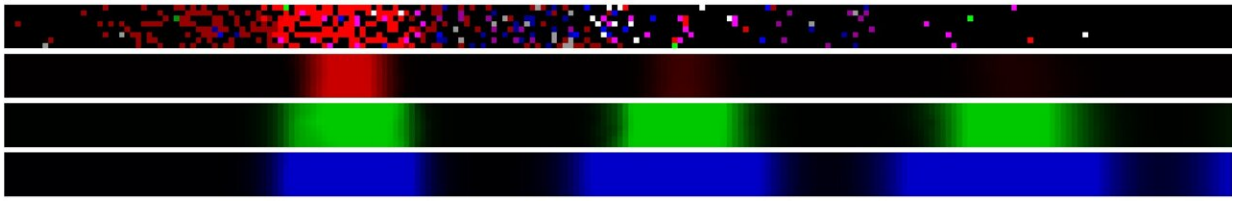
Simulation of infant gut makes predictions about optimal milk formula

April 25 2024, by Rianne Lindhout



A screenshot of the infant gut model. From top to bottom: bacteria, milk sugar, lactic acid, and acetic acid. Nutrients like milk sugar enter from the left and flow to the right. Meanwhile, bacteria convert them into substances like lactic acid. These substances also flow to the right and can be further converted by other bacteria. Ultimately, these substances form the simulated stool. Credit: David Versluis/Leiden University

Doctoral candidate David Versluis successfully simulated an infant gut. This is crucial for research on improvements in formula milk. Currently, such research primarily relies on diaper contents, which is not optimal. Versluis defended his doctoral thesis on April 23.

Versluis has uncovered intriguing facts about breast milk. "The milk of the fur seal, an Arctic marine mammal, is super thick. It's like brie or camembert." Versluis shares this with such enthusiasm; this biologist could easily trek through Antarctica like a sort of Freek Vonk. But he's doing something entirely different. He also studied computer science

and AI, combining his knowledge to create a simulation of the infant gut. And it's quite good.

Diaper contents as the best available research subject

Nature has excellently regulated the nutrition of baby mammals, but sometimes breastfeeding isn't possible. Nowadays, milk formula based on cow's milk is a good alternative when breastfeeding isn't feasible. However, this formula milk could be improved. "Some newborn babies develop allergies like asthma or skin rashes, for example, which might be alleviated with better milk."

Investigating what happens to that milk in the intestines is quite challenging, Versluis explains. "You can't discourage breastfeeding. In hospitals, you have to find expectant parents who already know they can't breastfeed." And even then, you can't burden those babies and their parents too much. The best available option: "Much of the research is done with diaper contents."

The model predicts the effect on gut bacteria

FrieslandCampina enlisted Professor of Mathematical Biology Roeland Merks to explore a new method of research. Versluis, as his Ph.D. candidate, succeeded in this endeavor. He created a simulation model capable of predicting the effect of varying amounts of different sugar or acid molecules.

The computer program had to simulate the infant gut microbiome as accurately as possible and understand how each bacterium reacts to all substances entering and forming in the gut.

Versluis explains, "The bacteria in the gut don't just consume what

enters the gut. They also consume substances produced by other bacteria and, for example, gut mucin, a protective layer produced by the gut itself."

To complicate matters further, an infant's gut is highly dynamic. "An adult gut is already a very complex system, but it's relatively stable. If an adult changes their diet, the composition of their gut bacteria changes. But in a baby, this gut microbiome changes in any case."

Yet, Versluis managed to simulate the infant gut quite well. This was evident when he asked the model to make predictions that were already known to be accurate.

Passing the test

Once the model passed its test, it was allowed to make unknown predictions. "One of those predictions is that the prebiotic milk oligosaccharide 2'-fucosyllactose, a complex sugar, can indirectly stimulate the production of butyrate even with various other bacteria present." This might assist bacteria capable of producing the butyratemolecule.

"That would be beneficial because human gut cells prefer to consume butyrate and become healthier as a result. Together with microbiologists from the University of Cincinnati in Ohio, colleagues are investigating whether these and other predictions are accurate."

Versluis isn't sure yet if he'll continue with (infant) gut simulation. "Modeling bacteria opens up many avenues. You can, for example, simulate bacteria in soil for research into better crop growth. Or in marshes, where we want to understand greenhouse gas formation. Bacteria simulations are also used for sewage treatment or biofuel production."

So, there's plenty to do in this field. However, "The gut is the most complex system. It has the highest density and the greatest variety of bacteria," says Versluis.

Whatever he chooses, Versluis is currently fully immersed in breast milk and complex sugars. "All mammals have milk with complex sugars," Versluis says excitedly, "So they must have evolved early in evolution. There's one exception: fur seals' milk contains no sugars at all. In biology, there are always exceptions."

Provided by Leiden University

Citation: Simulation of infant gut makes predictions about optimal milk formula (2024, April 25) retrieved 5 May 2024 from https://medicalxpress.com/news/2024-04-simulation-infant-gut-optimal-formula.html