

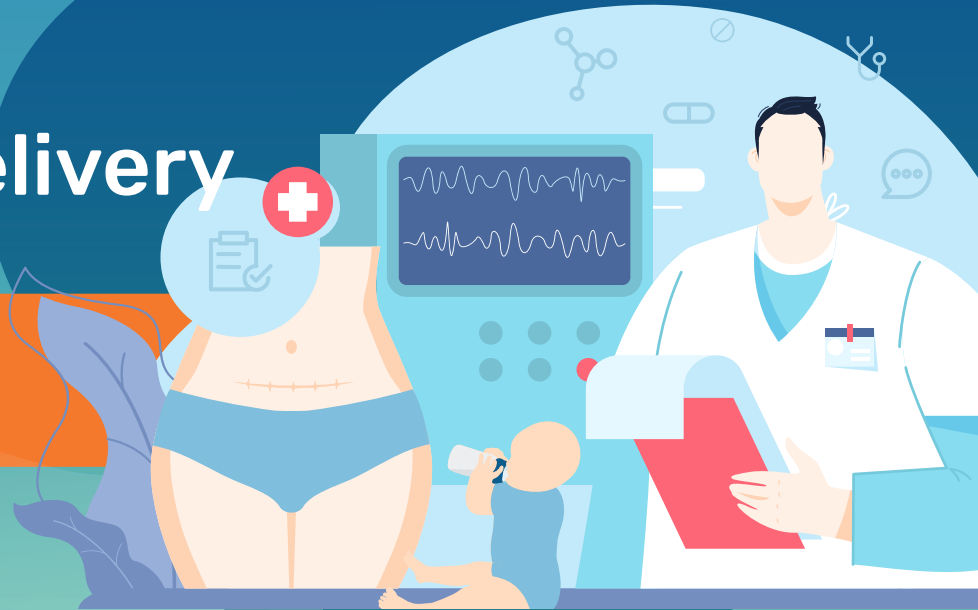


Danone Nutricia  
Campus

For healthcare professional use only

# Nutrition Essentials: C-Section Delivery

Strategies to rebalance  
the gut microbiome



# The role of the gut microbiome in infant development

**A balanced gut microbiota is essential** for proper immune, metabolic and cognitive development in infants and children.<sup>1</sup>

The gut microbiome plays an important role in regulating host processes such as:<sup>1</sup>



Immune  
function<sup>1</sup>



Stress  
responses<sup>1</sup>



Neuroplasticity<sup>2</sup>

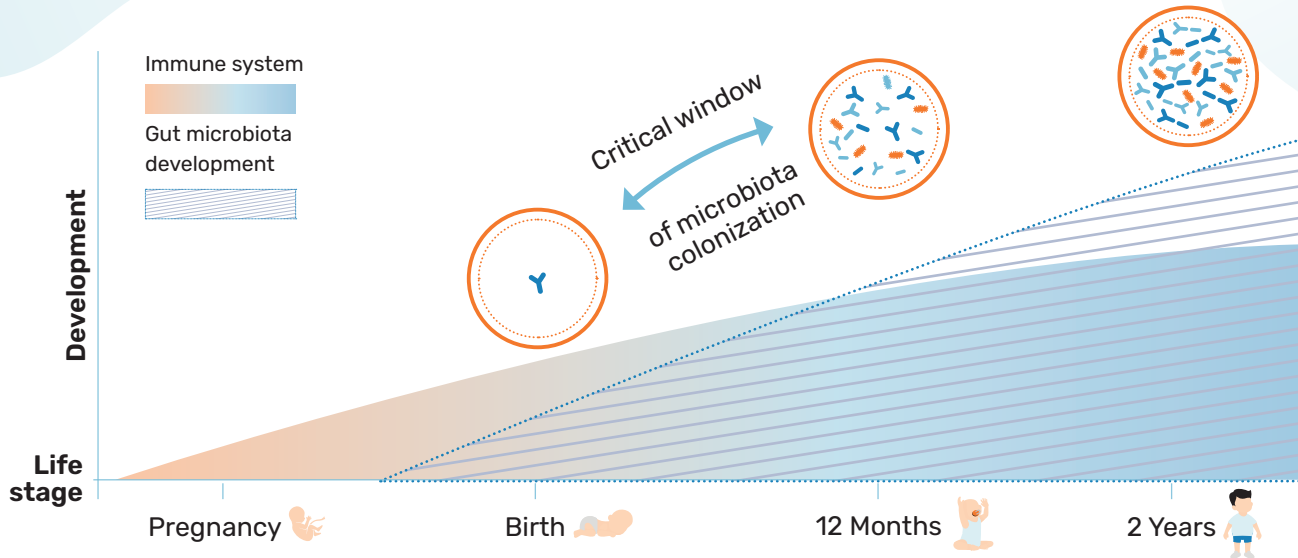


Energy  
metabolism<sup>3</sup>



Gene  
expression<sup>3</sup>

# Factors influencing the development of the gut microbiome in early life



## Neonatal factors<sup>4</sup>:

- Maternal microbiota
- Mode of delivery**
- Gestational age

## Postnatal factors<sup>4</sup>:

- Feeding type (breastfeeding vs formula feeding)
- Antibiotic use**
- Environment (for example, family lifestyle)

# How does mode of delivery affect microbiome colonization in the gut?

- Mode of delivery is generally accepted as a major factor that influences initial gut microbiota colonization.<sup>4</sup>
- Babies delivered by vaginal birth have a different gut microbiome than babies delivered by Caesarean-section (C-section).<sup>5</sup>
- Vaginally delivered infants are exposed to maternal vaginal and fecal microbes which then colonize the gut.<sup>4</sup>
- Babies delivered by C-section do not come into direct contact with maternal vaginal and fecal microbes and are more likely to be colonized by maternal skin and environmental microbes.<sup>4</sup>

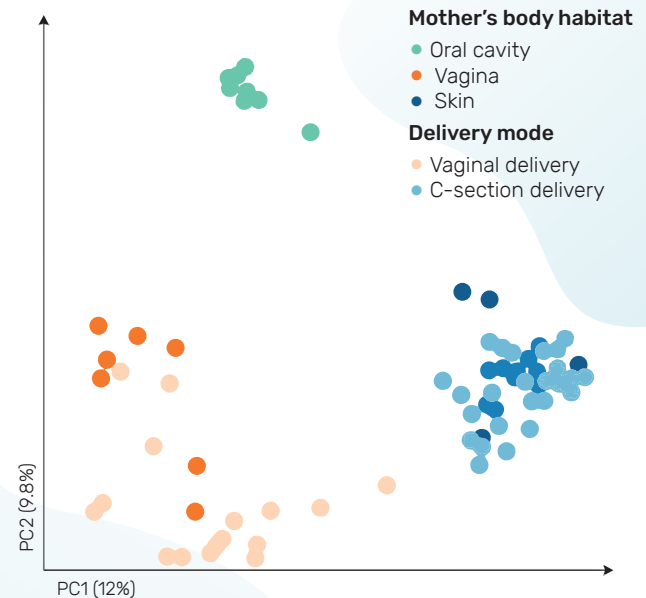
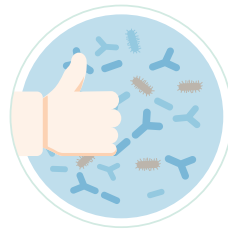


Figure adapted from Dominguez-Bello et al. PNAS 2020;107:11971-11975.

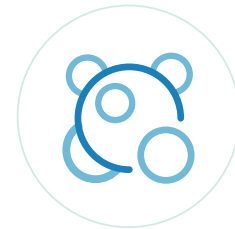
# Differences in gut microbiota composition between infants delivered vaginally and through C-section



Infants born by C-section have delayed gut microbiota colonization as well as lower levels of important 'keystone colonizers' such as *Bifidobacterium* and *Bacteroides*.<sup>5,6</sup>



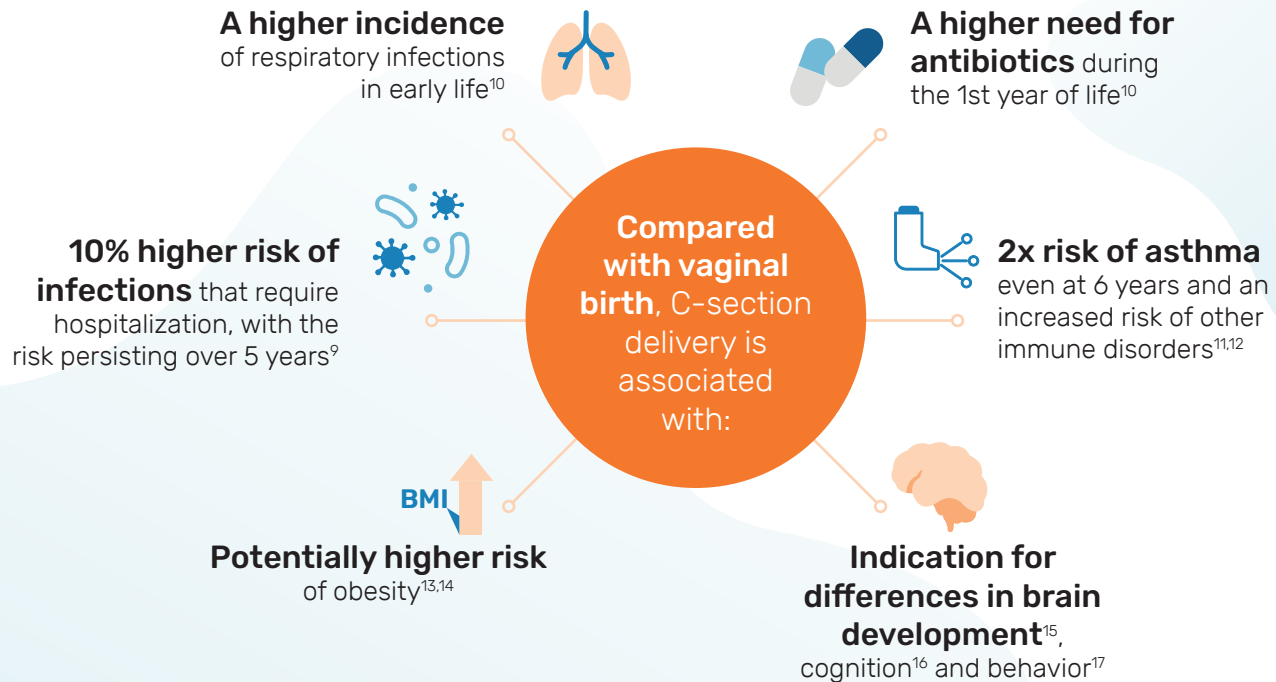
Vaginally delivered infants show a greater diversity of gut microbiota compared with C-section delivered infants.<sup>4</sup>



These differences in infant gut microbiome are present at 1 year and beyond.<sup>7,8</sup> This can have long-term effects on immunological and metabolic development of infants.<sup>7</sup>

The gut microbiota of C-section infants differs significantly from that of vaginally delivered infants, which may have serious consequences on the long-term health of C-section infants.

# Long term impact of C-section delivery



# Increasing C-section rates across the world are a cause for concern

- C-section can be a medically necessary intervention to prevent maternal and newborn mortality.<sup>18</sup>
- However, C-section delivery is associated with short- and long-term risks.<sup>18</sup>
- The World Health Organization (WHO) has stated that C-section use should not exceed 10%–15% of all births.<sup>18</sup>

In 2015, an estimated

**29.7  
million**

**babies were born  
through C-section,**  
almost twice as  
many as in 2000.<sup>19</sup>



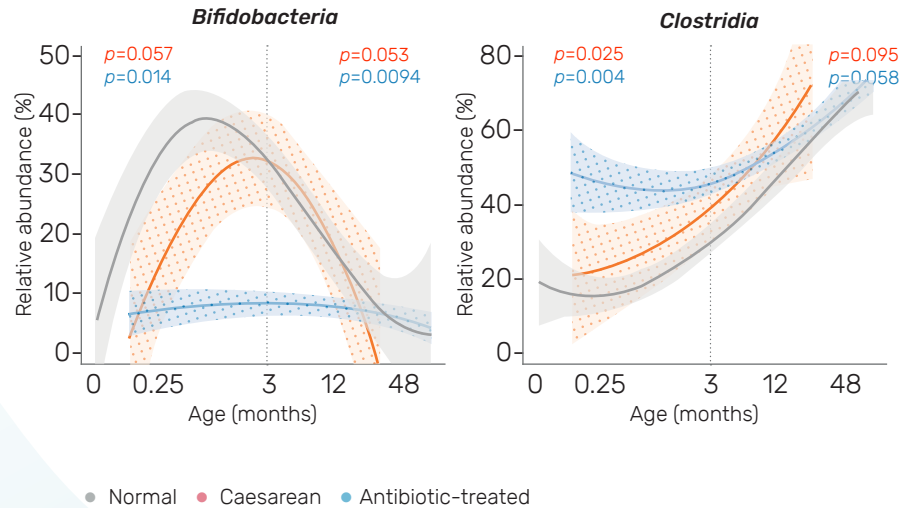
It is projected  
that by 2030,

**28.5%**  
**of pregnant  
women worldwide  
will deliver by  
C-section.**<sup>20</sup>

The impact of C-section delivery on infant health is thus becoming an increasing concern.


# Does early life antibiotic exposure impact gut microbiome development?

- Antibiotic use in infants reduces gut microbiota diversity and impacts abundance of *bifidobacteria* as important early life colonizers.<sup>58</sup>
- Infants treated with antibiotics showed reduced infant-type *bifidobacteria* while adult-type *clostridia* increased in abundance.<sup>58</sup>



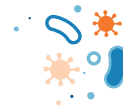


# Impact of antibiotic use in early life



Early life antibiotic use is associated with an increase in immune-related disorders and impacts metabolism. There is also some evidence that it can affect cognitive development.

## Impact of antibiotic use on:



Higher likelihood of *Clostridioides difficile* infection<sup>21</sup>



Metabolism<sup>26</sup>



Higher risk of developing allergies and asthma<sup>22-25</sup>



Increased susceptibility to obesity<sup>27,28</sup>



Higher susceptibility to develop auto-immune disease and non-communicable disorders<sup>25</sup>

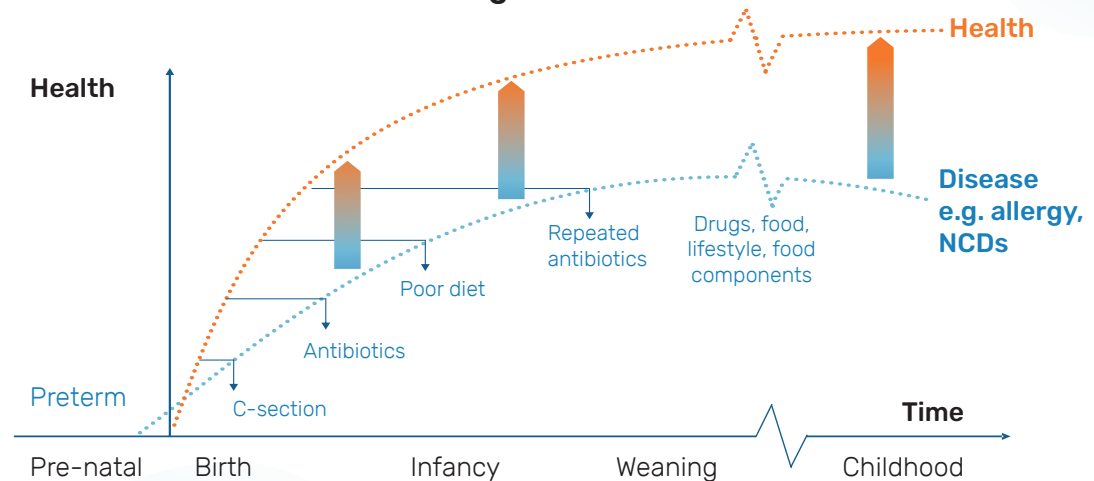


Cognitive development<sup>64</sup>

# Nutritional strategies offer a good opportunity to rebalance the compromised microbiota in early life<sup>65</sup>

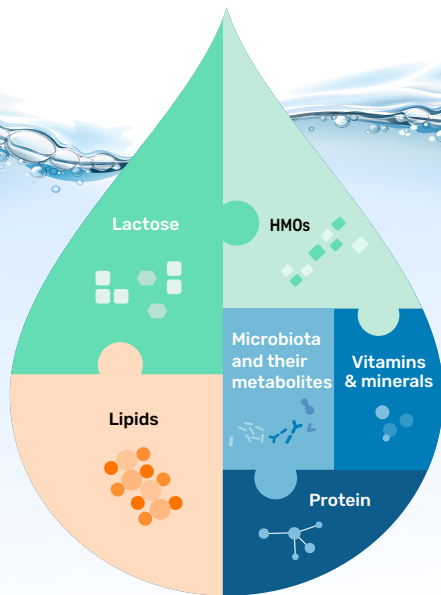
To support infant development, a nutritionally complete diet is important to ensure adequate intake of nutrients such as iron and vitamin D.<sup>30</sup>

## Microbiome modulation strategies



# Breast milk is the gold standard in infant nutrition

Breast milk contains nutritional and bioactive compounds that support development of a healthy gut microbiota and immune system<sup>31-45</sup>



\*88% water

## **Immune cells and other immune modulatory components**

Conferring active and passive immunity

## **>200 identified Human Milk Oligosaccharide (HMOs)**

Prebiotic effect, direct effect on immune cells and blocking the entry of pathogens to reduce infections

## **Bacteria and bacterial metabolites**

To support the development and functioning of a healthy gut and immune system

## **Unique lipids profile with essential fatty acids and complex lipid structures**

To support brain development

## **Nucleotides, vitamins, minerals, micronutrients**

Essential for growth and development

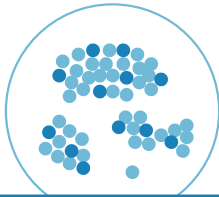
## **Carbohydrates (including lactose) and lipids**

Most important sources of energy

## **Proteins**

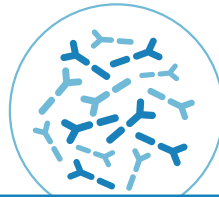
Essential for growth and development

# The role of prebiotic, probiotic and synbiotics in gut microbiota colonization



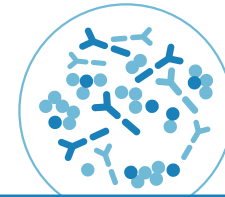
## Prebiotics

Substrates that are selectively utilized by host micro-organisms, conferring a health benefit.<sup>47</sup>



## Probiotics

Live micro-organisms which when administered in adequate amounts confer a health benefit on the host.<sup>66</sup>



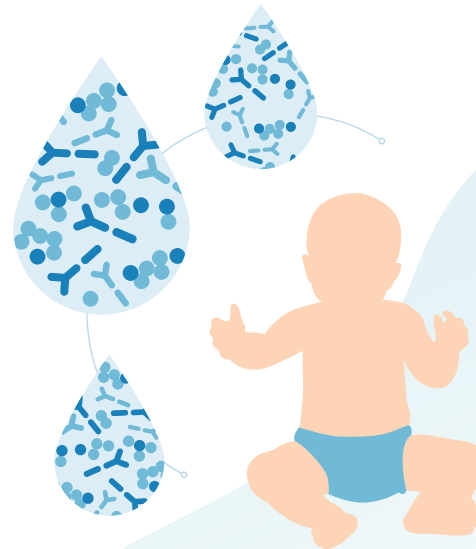
## Synbiotics

A mixture of pre- and probiotics that improve the survival of live microbial dietary supplements in the gastrointestinal tract by selectively stimulating the growth of health-promoting bacteria.<sup>67</sup>

# Biotics-containing formula: A valid nutritional alternative



When exclusive breastfeeding is not possible, biotics-containing formula could be considered as a valid nutritional alternative.



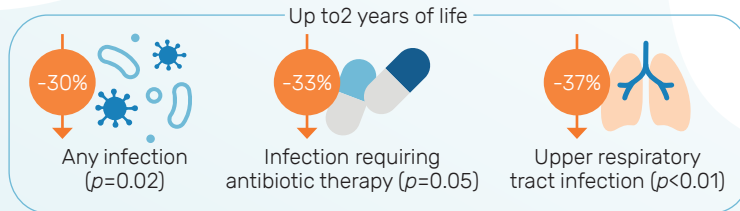
**Several biotics are available in the market,  
but only a few have been proven to provide health benefit to infants.**

# Prebiotics with proven benefits: scGOS/lcFOS (9:1) and 2'-FL

- Short-chain galacto-oligosaccharide (scGOS)/long-chain fructo-oligosaccharides (lcFOS) (9:1) is a unique blend of scGOS and lcFOS which has demonstrated positive effects on infant microbiota and health in over 40 studies.<sup>49-51</sup>
- 2'-fucosyllactose (2'-FL) is the most abundant HMO found in breast milk.<sup>52</sup>

## scGOS/lcFOS (9:1) in infant formula:

- Increased beneficial bacteria<sup>53,54,57</sup>
- Reduced infections<sup>55-57,68</sup>



- Suppressed the growth of harmful bacteria<sup>51,53,57,59</sup>

## Adding 2'-FL to scGOS/lcFOS enhances immune and microbiota benefits.

- Improved influenza vaccination response<sup>60,61</sup>
- More favorable microbial ecosystem<sup>60</sup>

# ***Bifidobacterium breve* M-16V is a probiotic with proven health benefits**



- *Bifidobacterium* are a family of beneficial bacteria naturally found in the gut of breastfed infants.<sup>62</sup>
- *B. breve* M-16V is a species originally isolated from a healthy infant gut.<sup>63</sup>
- *B. breve* M-16V has been extensively studied, with well-established clinical data on its safety and efficacy in infants.<sup>63</sup>

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## ***B. breve* M-16V dietary supplementation:**



Promotes early gut microbial colonization

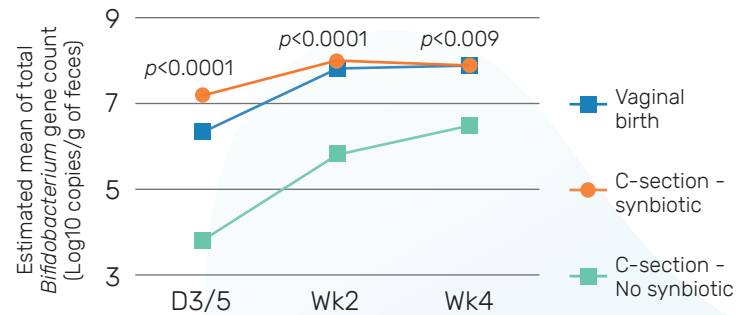


Regulates immune response to prevent allergic disorders

# Infant formula with *B. breve* M-16V and scGOS/lcFOS (9:1) corrects delayed gut colonization in babies born by C-section

JULIUS study: Randomized, double-blind multicentre study<sup>29</sup>

- **153 infants delivered by C-section** randomized to receive synbiotic (n=52), prebiotic (n=51), or control formula (n=50)
- From day 3/5 to week 4, the **proportion of *bifidobacteria* in the synbiotic group was significantly higher than the control group.**<sup>29</sup>
- The delayed colonization of *bifidobacteria* in infants born by C-section was restored with synbiotic treatment resembled the vaginally born reference.<sup>29</sup>



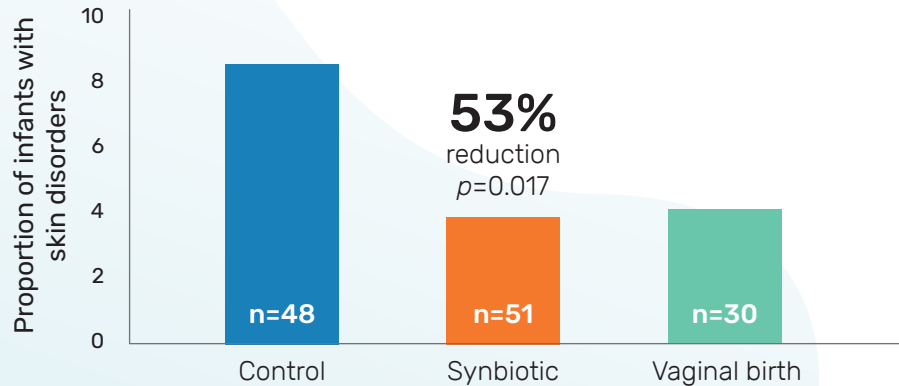


# Reduced incidence of skin disorders with infant formula containing *B. breve* M-16V and scGOS/lcFOS (9:1)



Compared with the control group, significantly fewer infants in the synbiotic group reported skin disorder-related adverse events.<sup>29</sup>

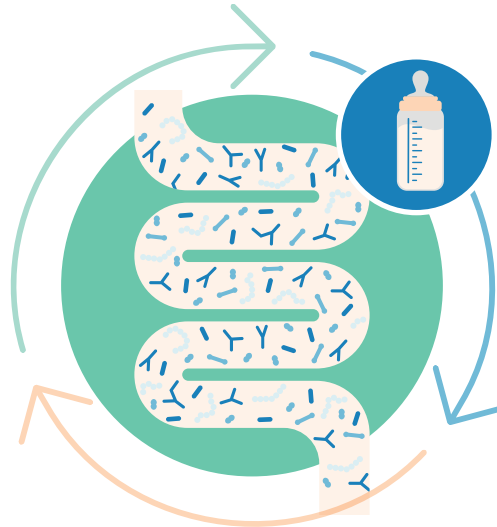
Incidence of skin disorders during 16 weeks of intervention (reported AEs)



# Summary

**The gut microbiota plays a key role in immunoregulation and normal development.**

The gut microbiome colonization is influenced by various factors such as mode of delivery at birth and feeding type during infancy.



Where breastfeeding is not possible, including babies delivered by C-section, choosing an evidence-based synbiotic infant formula can support the development of a healthy gut microbiome.

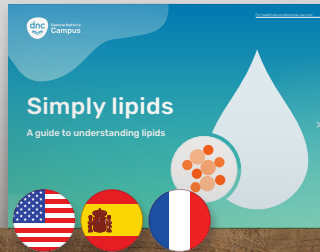
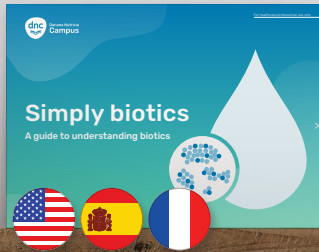
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## Early Life Nutrition

- Simply Biotics
- Simply Lipids
- Nutrition Essentials: Faltering Growth
- Nutrition Essentials: Iron Deficiency
- Nutrition Essentials: C-section Delivery



## Adult Nutrition

- Nutrition Essentials: Frailty
- Nutrition Essentials: Oncology
- Nutrition Essentials: Stroke

