



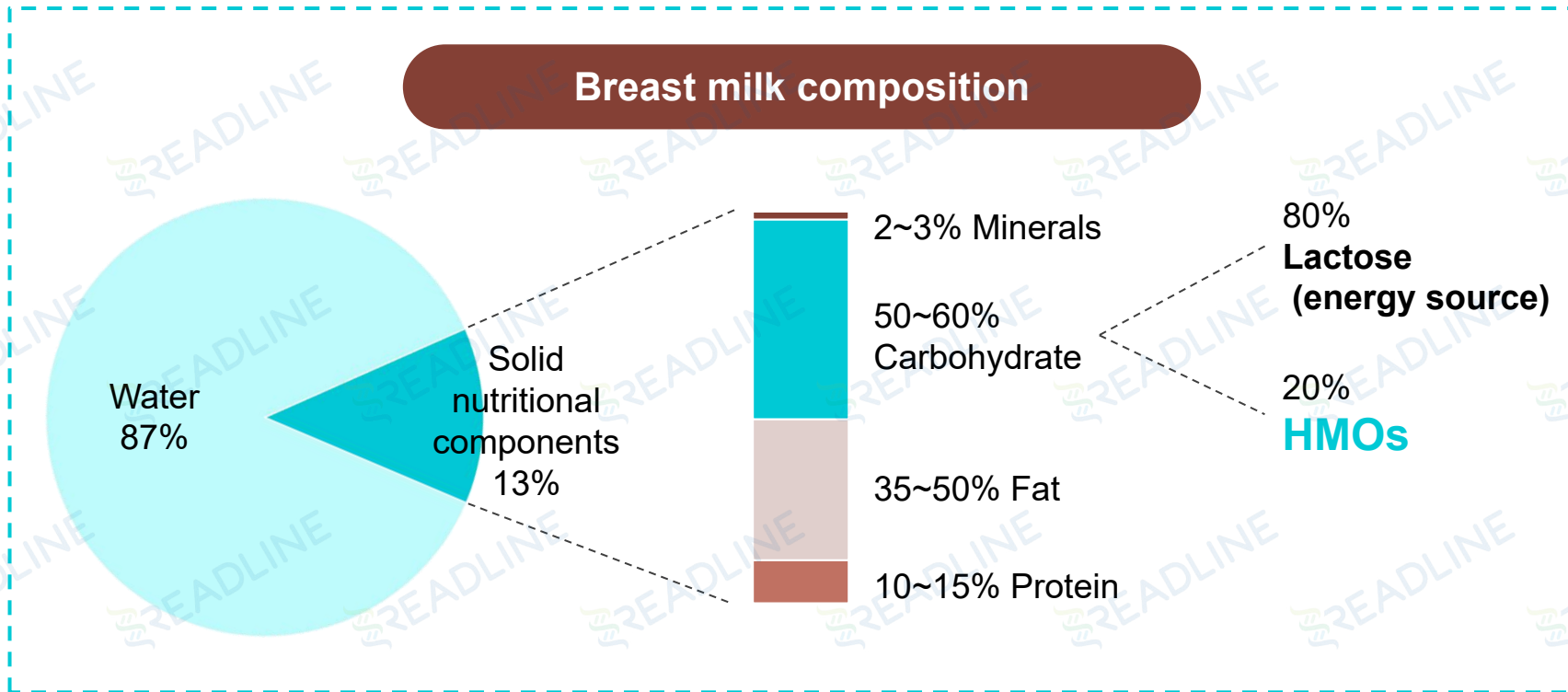
Green Active Ingredient Leader

Sialylated HMOs (3'-SL & 6'-SL)

Readline® Healthcare

HMOs are important bioactive components in breast milk

- Carbohydrates in breast milk occur in many forms, including simple sugars (such as glucose and galactose), lactose (a disaccharide), oligosaccharides, glycoproteins, glycopeptides, and glycolipids
- Human milk oligosaccharides (HMOs) are oligosaccharides containing three or more monosaccharide units



Research history of HMOs

Escherich, an Australian pediatrician and microbiologist, discovered a link between infant gut bacteria and digestive function

1886

1900

1926

1930

1954

1954

1956

Today

Schönfeld Breast milk whey was found to contain factors that promote the growth of *Bifidobacterium bifidum*

György confirms the factor "Bifidobacterium" that promotes the growth of *Bifidobacterium* is a beta-linked N-acetylglucosamine (GlcNAc) oligosaccharide found in breast milk

Two researchers, Moro and Tissier, respectively confirmed that the composition of bacteria in the feces of breastfed and artificially fed infants is different

French scientists Polonowski and Lespagnol detected a component with carbohydrate characteristics from breast milk whey and named it "Gynolactose"

Two scientists, Polonowski and Montreuil, used two-dimensional paper chromatography to separate oligosaccharides (a mixture of more than a dozen species) from milk oligosaccharides

Lactose-N-tetraose (LNT)
2'-Furanosyl lactose (2'-FL)
Lactose-N-pentofuranose I (LNFP I)
3'-Furanosyl lactose (3'FL)

200+ species reported,
Structural elucidation
100+ types

HMOs have prebiotic functions

G. R. Gibson

The father of prebiotics

- University of Reading, UK
- Professor of Food Microbiology
- Head, Department of Food Microbiology



Probiotics

Probiotics refer to live microorganisms that are beneficial to the host. They colonize in the intestines and play a role in balancing intestinal flora and improving intestinal health

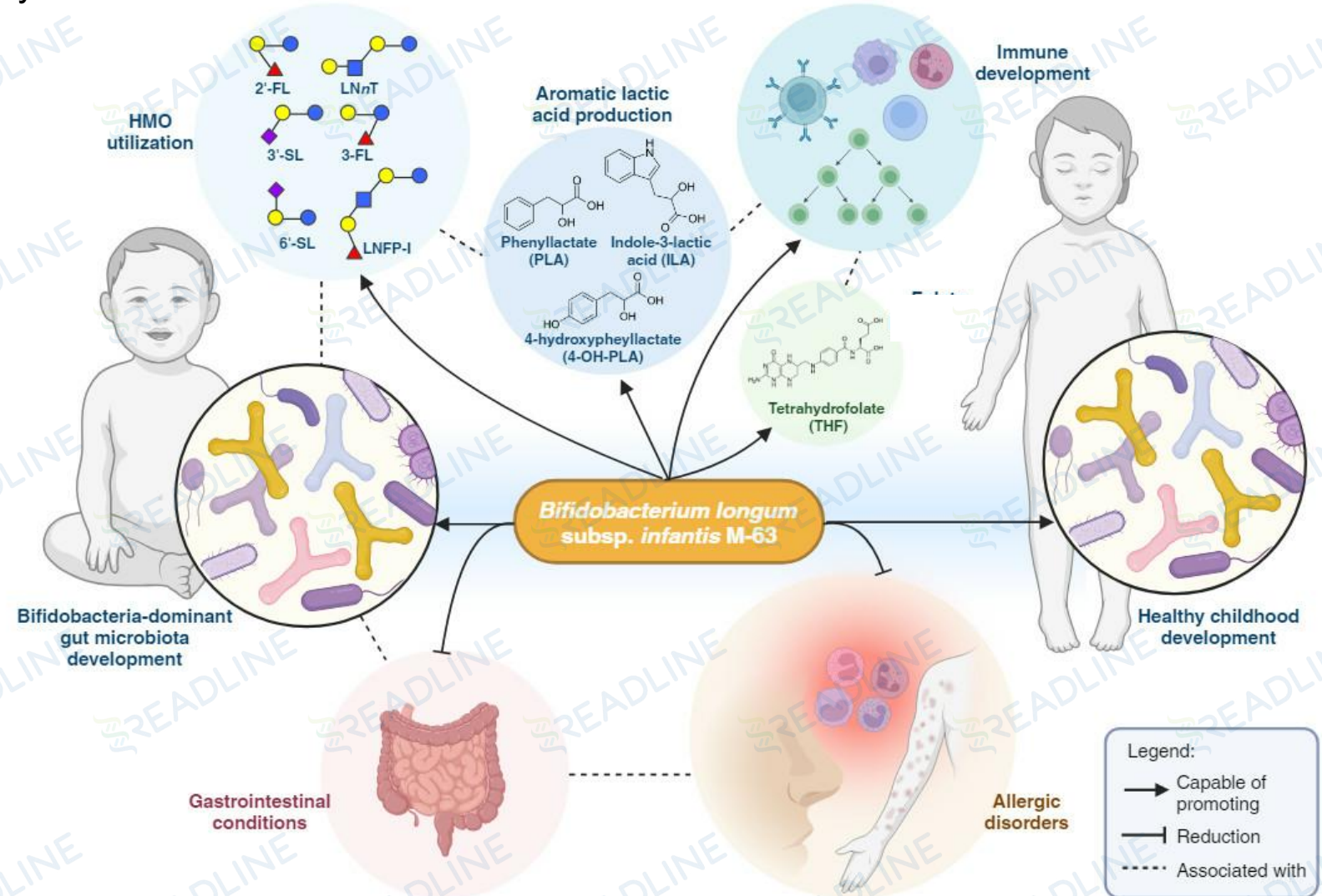
Prebiotics

Prebiotics are defined as “a selective fermentation substrate, which is a dietary component that cannot be directly digested and absorbed by the human body, but can be selectively utilized by beneficial bacteria in the intestine (such as bifidobacteria, lactobacilli, etc.)

HMOs help babies build healthy gut flora and immune systems

- Breastfed babies have better immunity than formula-fed babies

- Babies are considered sterile in the womb and build up their microbiome from birth
- More than **80%** of the immune cells in infants and young children are concentrated in the intestines
- Bifidobacteria are the most critical bacteria in the early stages of a baby's life, accounting for **91%** of the bacterial flora



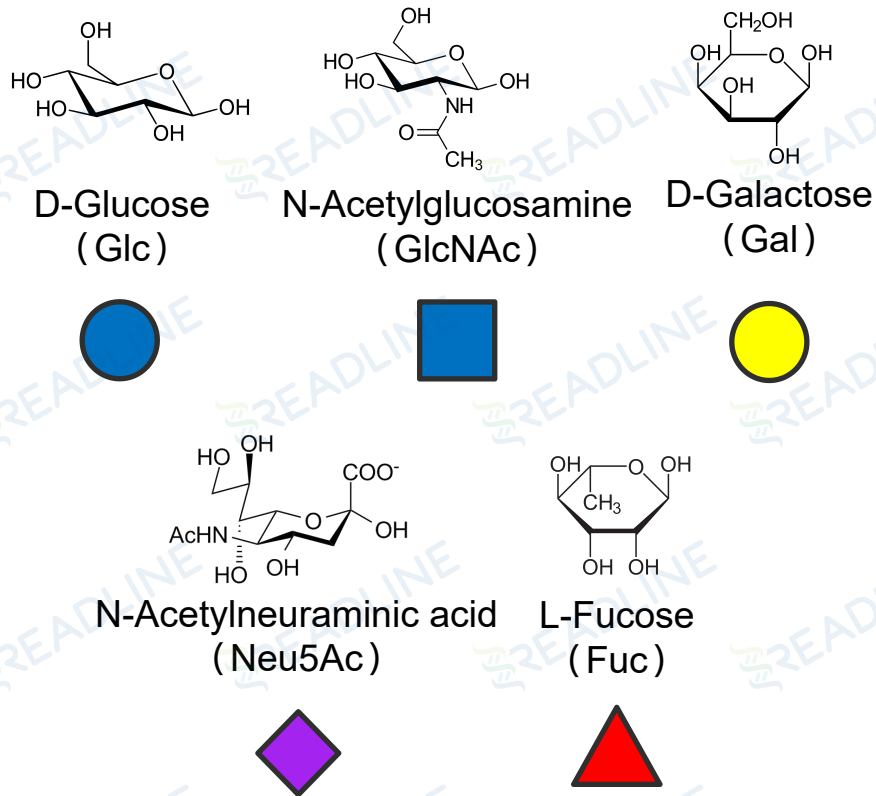
Diversity of HMOs

- HMOs have **5 monosaccharide building blocks** and **12 types of glycosidic bonds**. Hundreds of different structures can be produced depending on the length and sequence of the glycan.

Compared with livestock (e.g. cows) and other primates, human breast milk oligosaccharides:

- More content
- Composition is more complex
- More diversity
- Longer structure

Monosaccharide building blocks

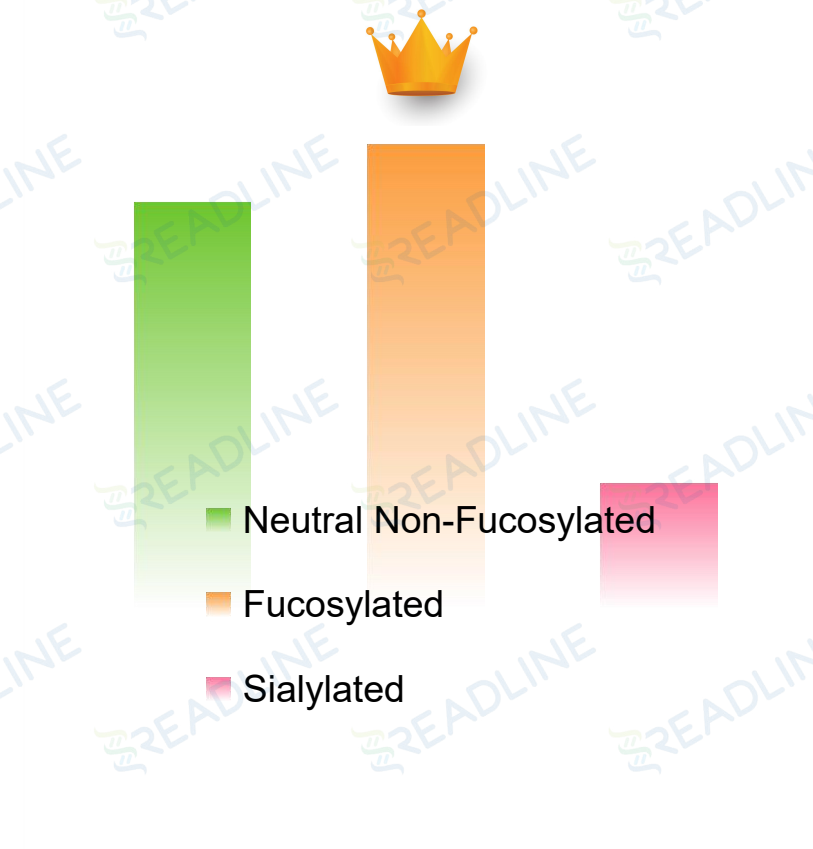


Connect key	Abbreviation	Symbol
Galactosidic bonds	Gal β 1–4Glc	
	Gal β 1–3GlcNAc	
	Gal β 1–4GlcNAc	
N-Acetylglucosaminidic bond	GlcNAc β 1–3Gal	
	GlcNAc β 1–6Gal	
Fucosidic bond	Fuc α 1–2Gal	
	Fuc α 1–3Glc	
	Fuc α 1–3GlcNAc	
	Fuc α 1–4GlcNAc	
Sialidic bond	Neu5Ac α 2–3Gal	
	Neu5Ac α 2–6Gal	
	Neu5Ac α 2–6GlcNAc	

Classification and proportion of breast milk oligosaccharides

- 2'-Fucosyllactose (2'-FL) is the most abundant HMO in breast milk, accounting for nearly 30% of all HMOs
- 3'SL and 6'SL account for about 3% and 6% respectively

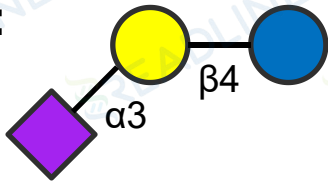
Type	Proportion	Represent
Neutral Non-Fucosylated	35–50%	LNT, LNnT
Fucosylated HMOs	42–55%	2'-FL, 3FL, DFL
Sialylated HMOs	12–14%	3'-SL, 6'-SL



Product information

3'-Sialyllactose Sodium Salt

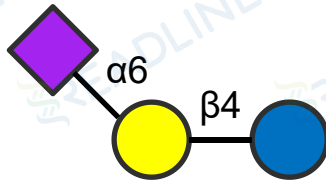
- **Common name:** 3'-SL
- **CAS No.:** 128596-80-5
- **Efficacy:** Support the growth of probiotics and enhance immunity
- **Recommended usage:**
Infants 20–50 mg/day, adults 100–300 mg/day
- **Molecular weight:** 655.5
- **Molecular formula:** $C_{23}H_{38}NNaO_{19}$
- **Structure:**



Product information

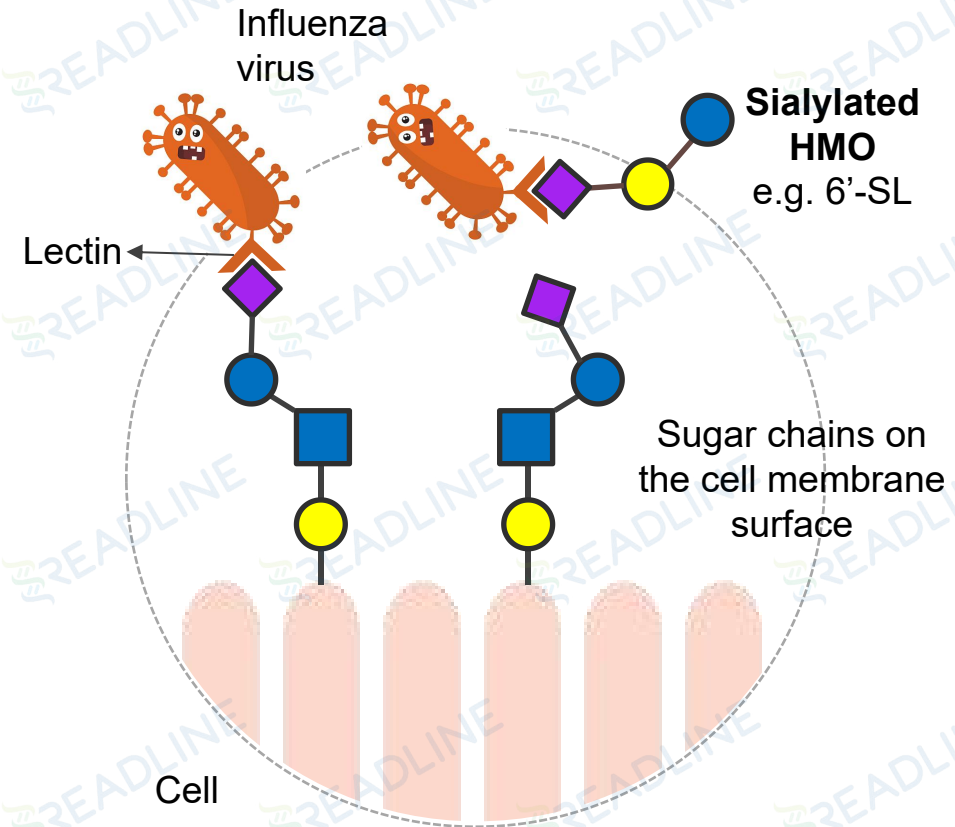
6'-Sialyllactose Sodium Salt

- **Common name:** 6'-SL
- **CAS No.:** 157574-76-0
- **Efficacy:** Support the growth of probiotics and enhance immunity
- **Recommended usage:**
Infants 40–100 mg/day, adults 200–500 mg/day
- **Molecular weight:** 655.5
- **Molecular formula:** $C_{23}H_{38}NNaO_{19}$
- **Structure:**



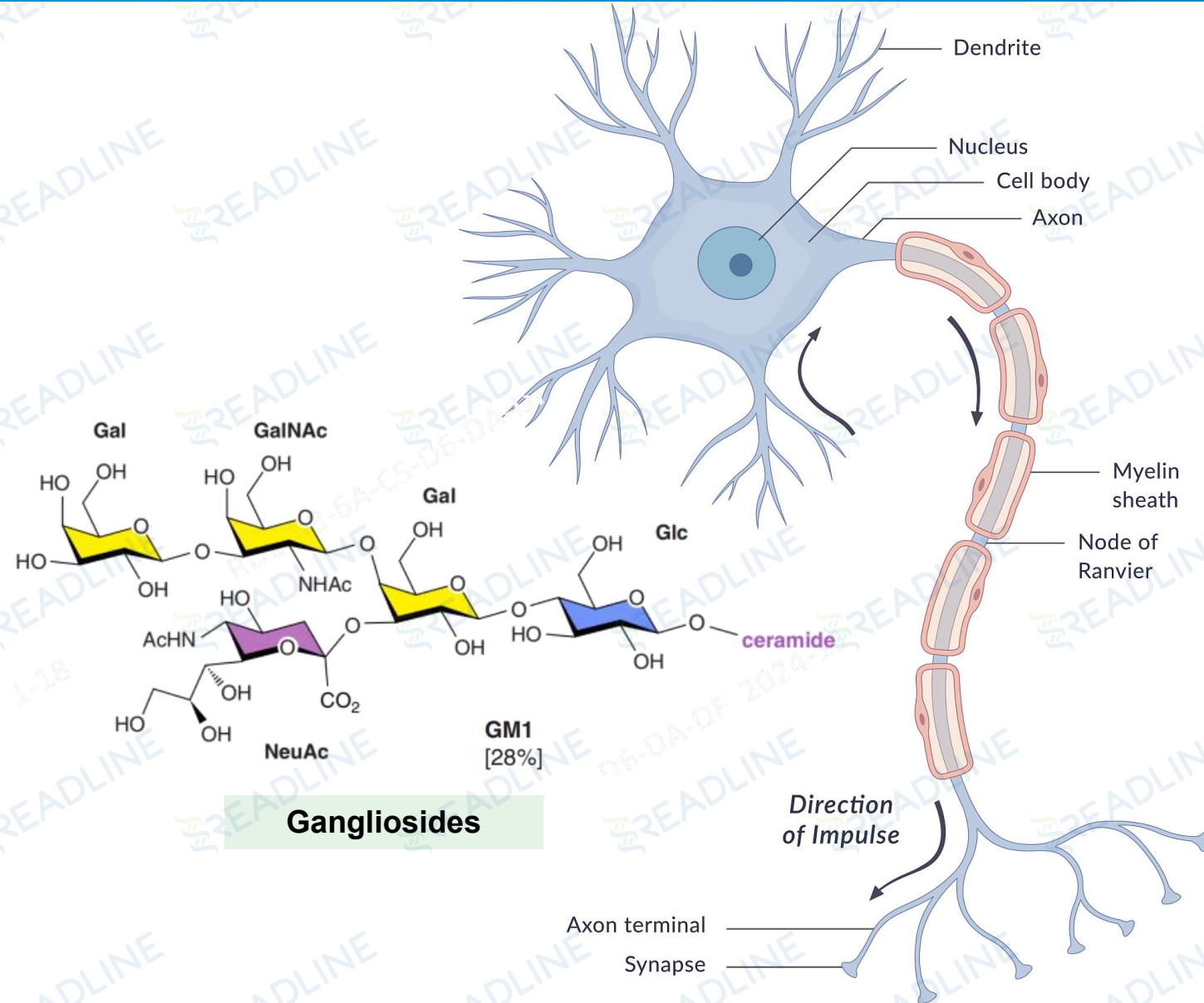
Sialylated HMOs can block influenza virus infection

- Many viral, bacterial or protozoan pathogens must first adhere to mucosal surfaces before they can colonize and invade the host, thereby causing disease
- Pathogen adhesion is often triggered by lectin-glycosyl interactions, such as norovirus or rotavirus (one of the major pathogens causing diarrhea in infants and young children)
- Influenza virus lectin specifically binds to sialic acid at the end of the sugar chain on the cell surface. HMOs containing sialic acid can inhibit the infection of cells by influenza virus.



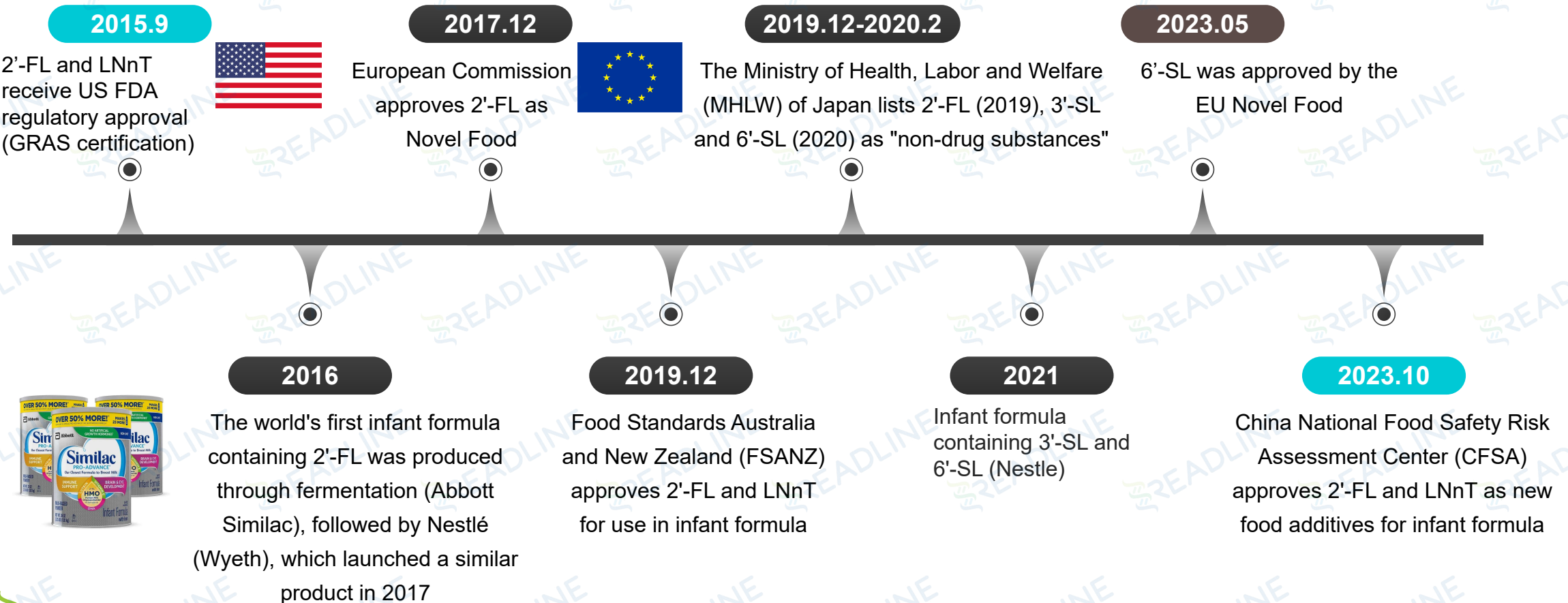
Sialylated HMOs can promote brain development

- The brain development of babies after birth is mainly the formation of myelin sheaths and neural networks, which are closely related to the conduction of nerve signals and the formation of synaptic connections
- Sialyl-containing gangliosides are important components of brain tissue
- Sialylated HMOs in breast milk are the primary source of sialic acid for infants



Regulatory status of HMOs

- Currently, there are 7 main additive forms of HMOS: 2'-FL, 3-FL, 3'-SL, 6'-SL, LNT, LNnT, DFL
- According to incomplete statistics, products containing HMOs have been produced and sold in 45 countries (regions) around the world since 2016.



Market application: Premium infant formula



\$ 83 / 800 g

per 100 g powder

2'-FL	155 mg
LNT	84 mg
3-FL	201 mg
6'-SL	28.5 mg
3'-SL	77.5 mg
DFL	21.2 mg
Total	567.2 mg



\$ 58 / 850 g

per 100 g powder

2'-FL	
LNT	
3-FL	1185 mg
6'-SL	
3'-SL	

Formula upgrade, the old version only contains one type of HMO: 2'-FL



per 100 g powder

2'-FL	710 mg
LNT	330 mg
3-FL	160 mg
6'-SL	73 mg
3'-SL	57 mg
Total	1330 mg

\$ 49 / 700 g

Aptamil Essensis NEO

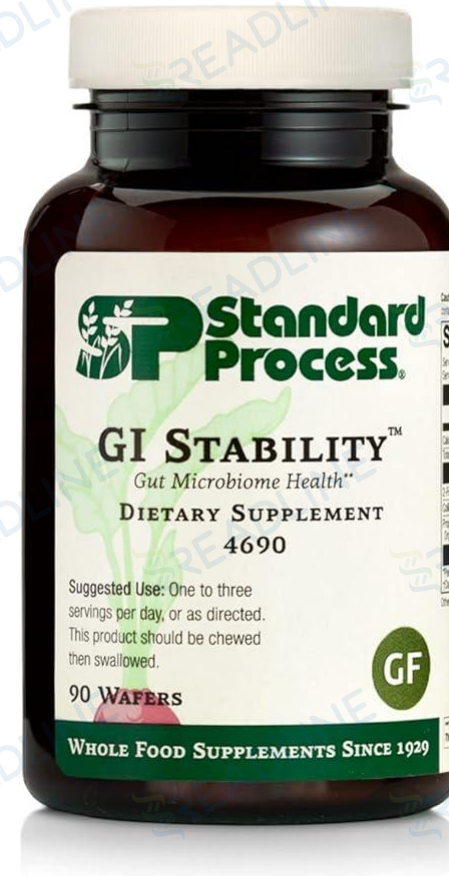
Contains 5 HMOs

It is an ultra-high-end milk powder product under the Essensis series of Aptamil.

Market application: from infant milk powder to adult health care



- In July 2020, Standard Process, an American nutritional supplement company with a history of nearly a century, launched the first dietary supplement containing 2'-FL: GI STABILITY™
- 2'-FL, together with beetroot and okra, increases the abundance of bifidobacteria in the intestine and improves digestive and immune system health in adults.
- The launch of this product marks the official expansion of functional foods containing HMOs into the adult field.



2'-FL amount per serving:
1666 mg

Market application: from infant milk powder to adult health care

- HMOs Efficacy: Regulate the intestinal microbiome, support the growth of probiotics, support the diversity of intestinal flora, support brain health, improve cognitive function, and improve immunity.



Amount per serving	
2'-FL	540 mg
LNT	150 mg
LNnT	140 mg
6'-SL	120 mg
3'-SL	50 mg

- Price: \$ 27.99
- Size: 1 Scoop (~1000 mg per time), 45 servings
- Suitable for children over one year old



Amount per serving	
2'-FL	2250 mg
LNT	650 mg
LNnT	600 mg
6'-SL	500 mg
3'-SL	200 mg

- Price: \$ 69.99
- Size: 2 Scoops (~4200 mg per time), 28 servings
- Tasteless and easy to mix, it can be mixed with hot and cold drinks, such as coffee, milk, juice, water, smoothies, hot chocolate, etc.

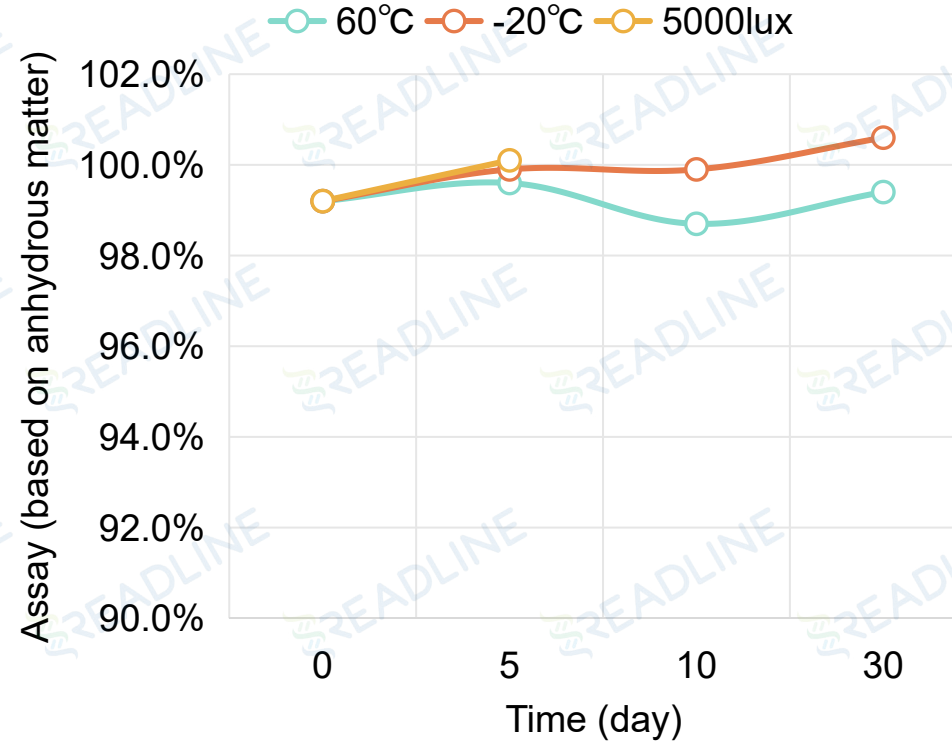


Amount per serving	
10 kinds of probiotics	40 Billion CFU
5 types of HMOs	500 mg
Dietary fiber	500 mg

- Price: \$ 35.99
- Size: 2 Capsules, 30 servings/bottle

3'-SL: Influencing factors experiment

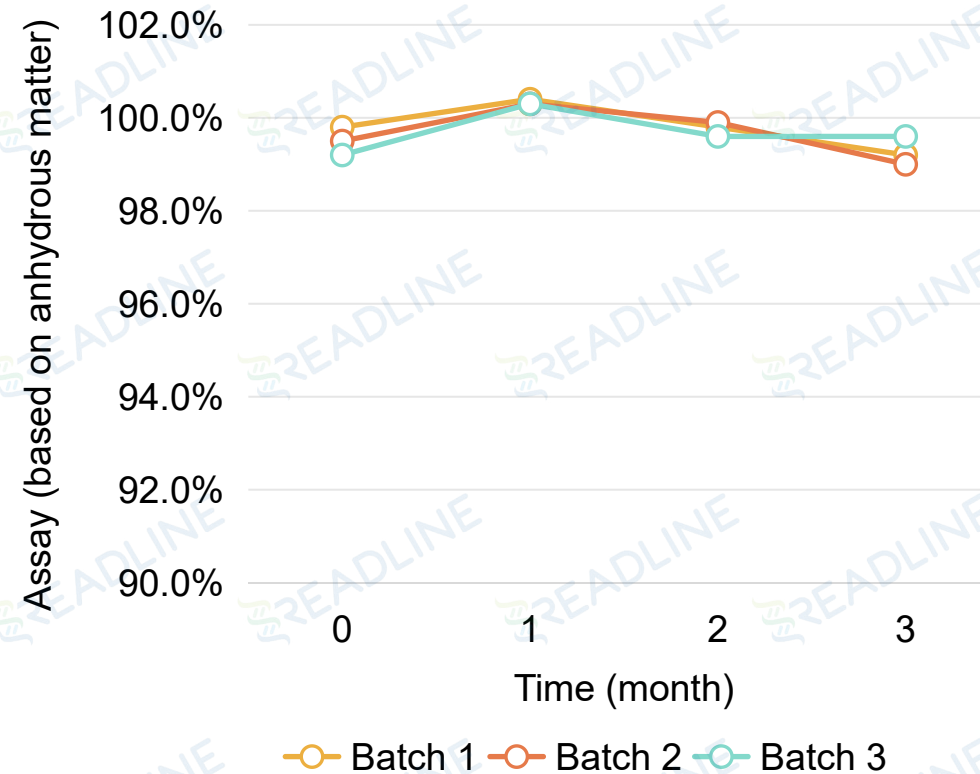
Analytical



3'-SL degrades slightly under high temperature conditions and is stable under low temperature and light conditions. It is recommended to store it in a sealed container at low temperature.

3'-SL: Accelerate stability inspection (40 °C)

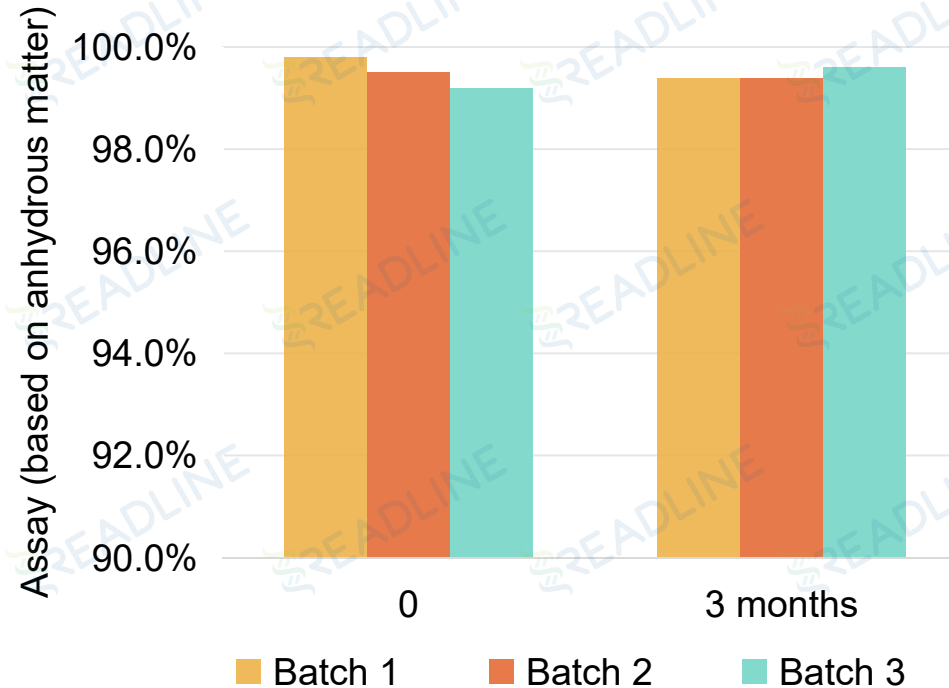
Analytical



3'-SL has stable product quality when stored for three months at 40 °C/75% RH.

3'-SL: Long-term stability inspection (25 °C)

Analytical



There is no significant change in the content of 3'-SL when stored in a sealed container at 25 °C.



Green Active Ingredient Leader



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