Concept of Prebiotics, Probiotics and Synbiotics

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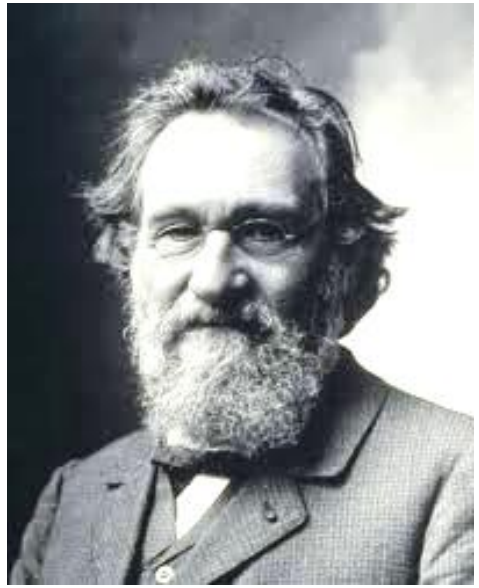
Definitions

- **Prebiotic-(**Greek-**before life)** a substance (usually an oligosaccharide) that **cannot be digested** but does **promote the growth of beneficial bacteria** or **probiotics**

- **Probiotic- (for life)** a substance that contains **microorganisms** or **bacteria that are beneficial to the host organism**

- **Symbiotic- (plus life)-** a substance **containing both pre** and **probiotic**

History



Elie Metchnikoff

- In **1907, Russian Nobel prize winner** and **father of modern immunology, Elie Metchnikoff,** proposed that **the acid producing bacteria** in **fermented milk products could prevent " fouling"** in the **large intestine** and **if consumed regularly lead to a longer, healthier life**. He was the first to conceptualize "**Probiotics**".

History

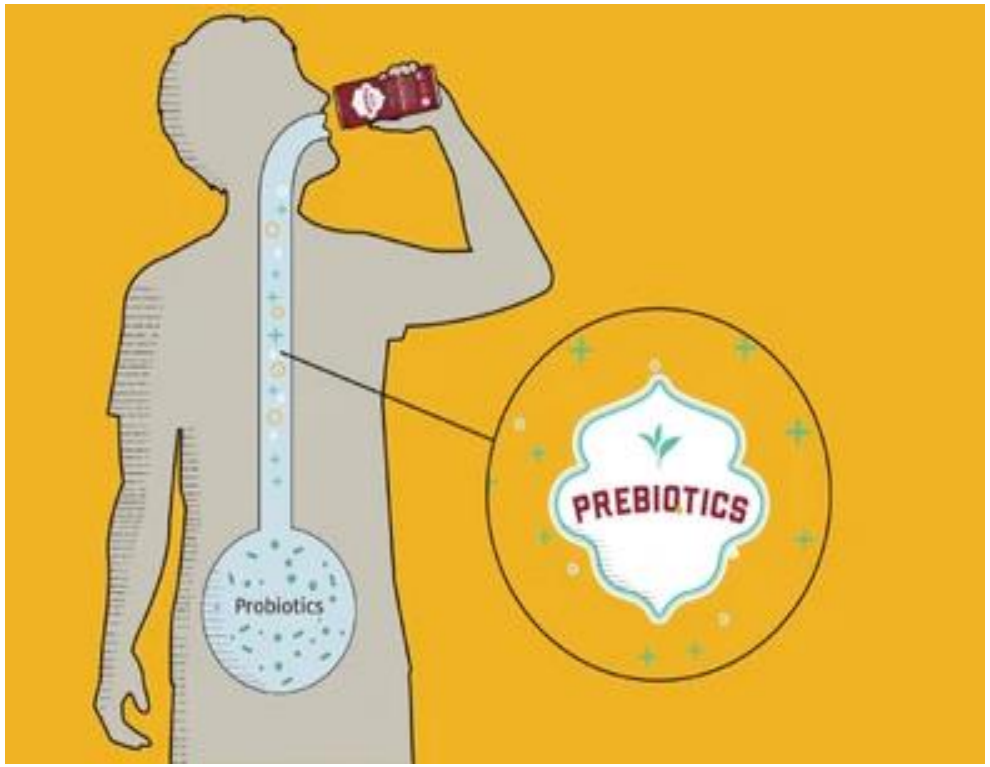
- In early **1930's** in Japan, **Minoru Shirota** developed a **fermented milk** product called **Yakult.**
- In **1935** he started marketing **Yakult** as a **probiotic** yogurt like product made by fermenting a mixture of **skimmed milk** with a special strain of ***Lactobacillus casei Shirota*.**
- **Bulgarian yoghurt (sour milk),** commonly consumed plain, is popular for its taste, aroma, and quality. **The qualities arise from the *Lactobacillus bulgaricus*** and ***Streptococcus thermophilus*** culture strains used in **Bulgaria.**

Prebiotics

Prebiotics

- The **prebiotics concept** was introduced for the **first** time in **1995** by **Glenn Gibson** and **Marcel Roberfrois.**
- They are defined as **non-digestible** or **low-digestible food ingredients that benefit the host organism** by **selectively stimulating the growth** or **activity of one** or **a limited number of probiotic bacteria in the colon.**
- **Fermentable carbohydrates (oligosaccharides)** are the generally used prebiotics.

Benefits of Prebiotics



Prebiotics nourishes certain probiotic bacteria. This may help **support gut health** and **promote overall health** by

1. Increasing and energizing **beneficial bacteria**
2. Normalizing the gut by **restoring** the **balance between good** and **bad bacteria**
3. **Positively impacting** the **gut environment** with **bacteria-derived compounds** like **short chain fatty acids** and **vitamins**

Prebiotic should be

- It **must** be **neither hydrolyzed nor absorbed in the upper part of the gastrointestinal tract.**
- **Selective fermentation by potentially beneficial bacteria in the colon**
- **Alternation in the composition of the colonic microbiota towards a healthier composition.**
- **Preferably induce effects which are beneficial to the host health**

Types of Prebiotics

- The majority of prebiotics are **carbohydrate groups** and mostly **oligosaccharide carbohydrates (OSCs**)
- **Fructans**
- **Galacto-Oligosaccharides**
- **Starch and Glucose Derived Oligosaccharides.**
- **Other Oligosaccharides**
- **Non-Carbohydrate Oligosaccharides**

Fructans

- This category consists of **Inulin** and **Fructo-oligosaccharide(FOS)** and **Oligofructose**.
- Their structure is a **linear chain of fructose with β(2→1) linkage**. They usually have **terminal glucose** units with **β(2→1) linkage**.
- **Inulin** has Degree of Polymerization(DP) of **upto 60**, while the DP of **FOS** is **less than 10.**
- The **chain length of Fructans** is an **important criterion** to determine which bacteria can ferment them.

Galacto-Oligosaccharides

- **Galacto-oligosaccharides (GOS),** the product of lactose extension are classified into two subgroups:

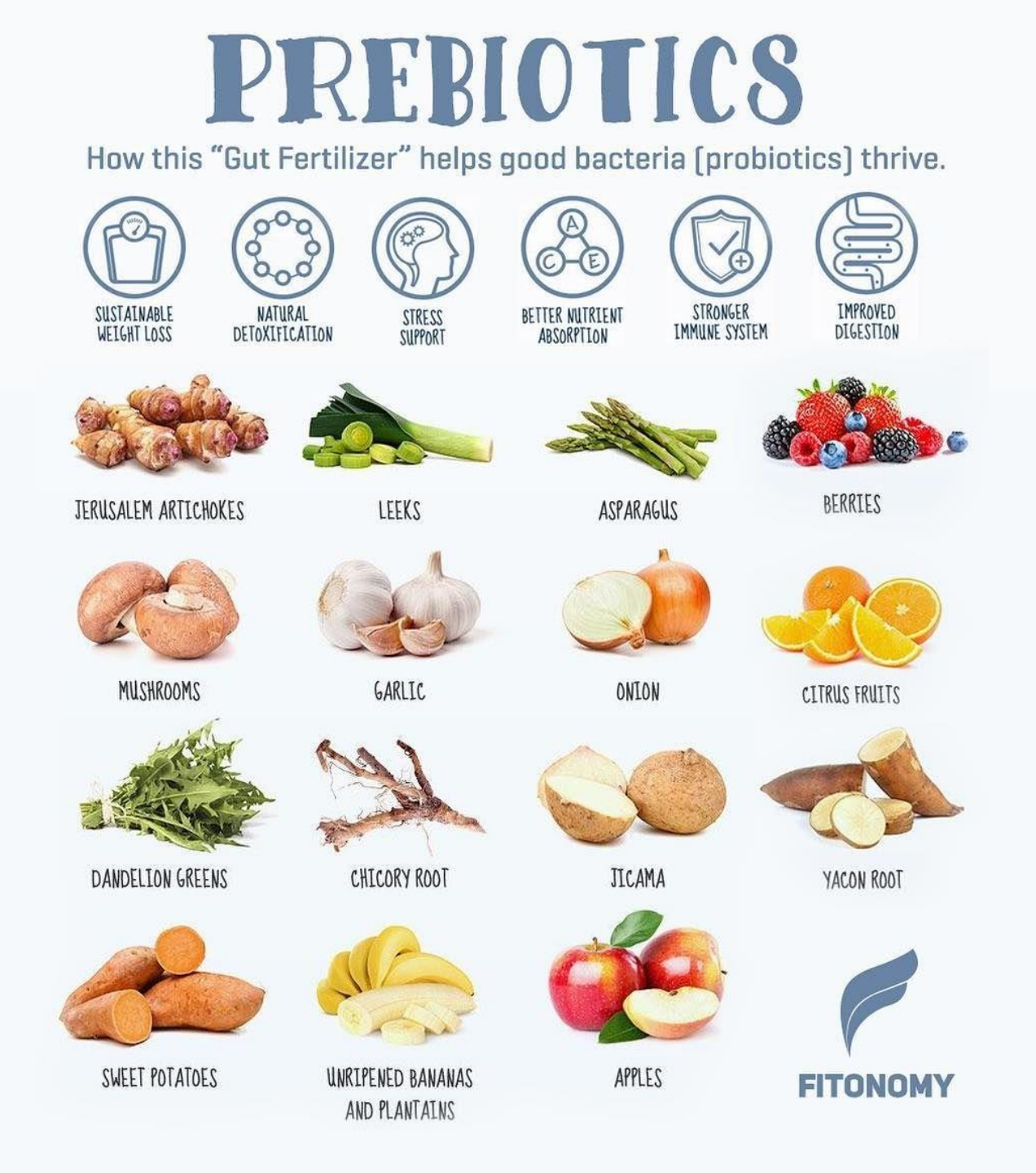
1. The **GOS with excess galactose** at **C3,C4** or **C6** and
2. The **GOS manufactured from lactose** through enzymatic trans-glycosylation. The end product of this reaction is mainly a **mixture of tri to pentascaaharides with galactose** in **β(1→6),β(1→3)** and **β(1→4) linkages.** This type of GOS is also termed as **trans-galacto-oligosaccharides** or **TOS**

- **GOS** can greatly stimulate ***Bifidobacteria*** and ***Lactobacilli.***
- **Enterobacteria, Bacteroidetes** and **Firmicutes** are also stimulated by GOS but to lesser extent.
- Some GOSs derived from lactulose, the **isomer of Lactose**. The **lactulose derived GOSs are also considered as prebiotics.**

Prebiotics commonly used in human nutrition

- Lactulose
- Galacto-oligosaccharides
- Fructi-oligosaccharides
- Inulin and its hydrolysates
- Mato-oligosaccharides
- Resistant starch

Examples of Prebiotics



Prebiotics and health benefits

1. Reduce risk of Inflammatory and bowel diseases
2. Anti-hypertensive effects
3. Anti-diabetic effect
4. Hypocholesterolemic effect
5. Immunomodulatory effect

Prebiotic oligosaccharides can be produced in three different ways

- **By extraction from plant materials**
- **Microbiological synthesis or enzymatic synthesis**
- **Enzymatic hydrolysis of Polysaccharides**.

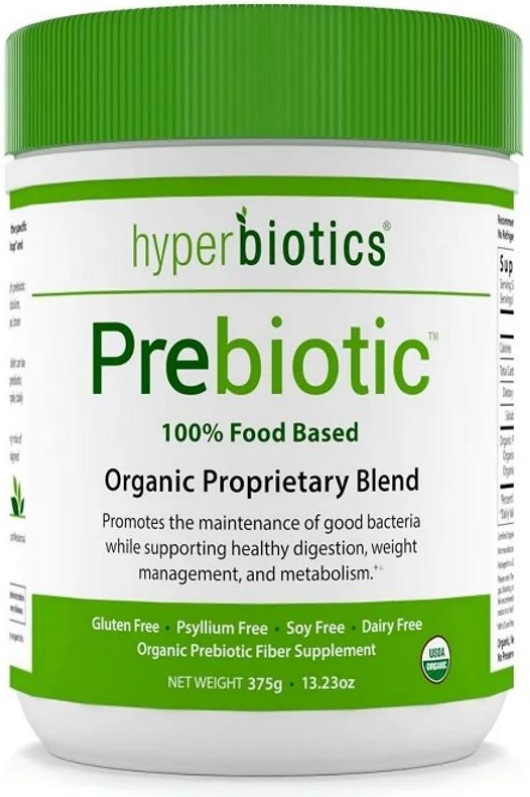
Case Studies

- **Gibson and Wang, 1994** conducted in vitro studies on **oligofructose** and **inulin** and found that it had **stimulatory effect** on ***Bifidobacteria***, while maintaining ***E.coli*** and ***Clostridium*** populations at relatively low levels.
- In vivo studies by Ohta et al., 1995 on **Fructo oiligosaccharides** (FOS) found **improved recover** from **anemia** and **increased absorption** of **iron (Fe), Calcium** and **Magnesium,** in **Fe-deficient anemic rats.**

Case studies

- Ozceliket al., 1996 shown (in vivo) that **oral lactulose** treatment prior to surgical trauma reduced bacterial translocation to mesenteric lymph nodes and prtal venous blood.
- Bovee Oudenhoven and Van der Meer, 1997 shown (In vivo) that combination of dietary **lactulose** and **calcium phosphate** were protective against Salmonella infection.

Commercially available Prebiotics



Probiotics

- The idea probiotics was first introduced by **Metchnikoff** in **1908**.
- **Probiotics** –Greek word meaning " **for life**"
- **Probiotics** can be defined as "**live organisms that when ingested in adequate amounts, exert a health benefit to the host** (Eamonn and Quigley, 2010)"
- We use the term probiotics to refer to **beneficial bacteria**
- Probiotics defined as "**micro-organisms that have a beneficial effect on the host intestinal microbial balance"**.
- Probiotics was meant to **contrast "antibiotics**" popularly prescribed and known to also destroy beneficial organisms and impact the immune system.
- **Large number of probiotics currently used and available in dairy fermented foods, especially in yogurts.**

Probiotics

- They possess **good sensorial properties**.
- **Fermentative activity**
- **Good survival** during freeze drying or spray-drying
- **Proper growth and viability in food products**
- **Phage resistance** and **high stability** during long-term storage

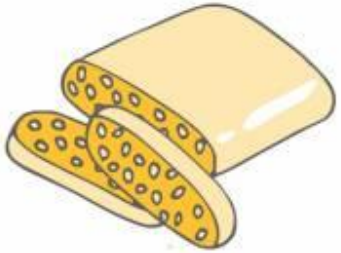
PROBIOTIC FOOD

kombucha

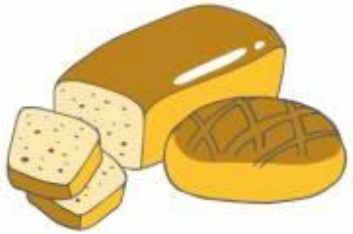
sauerkraut

dairy products

miso soup

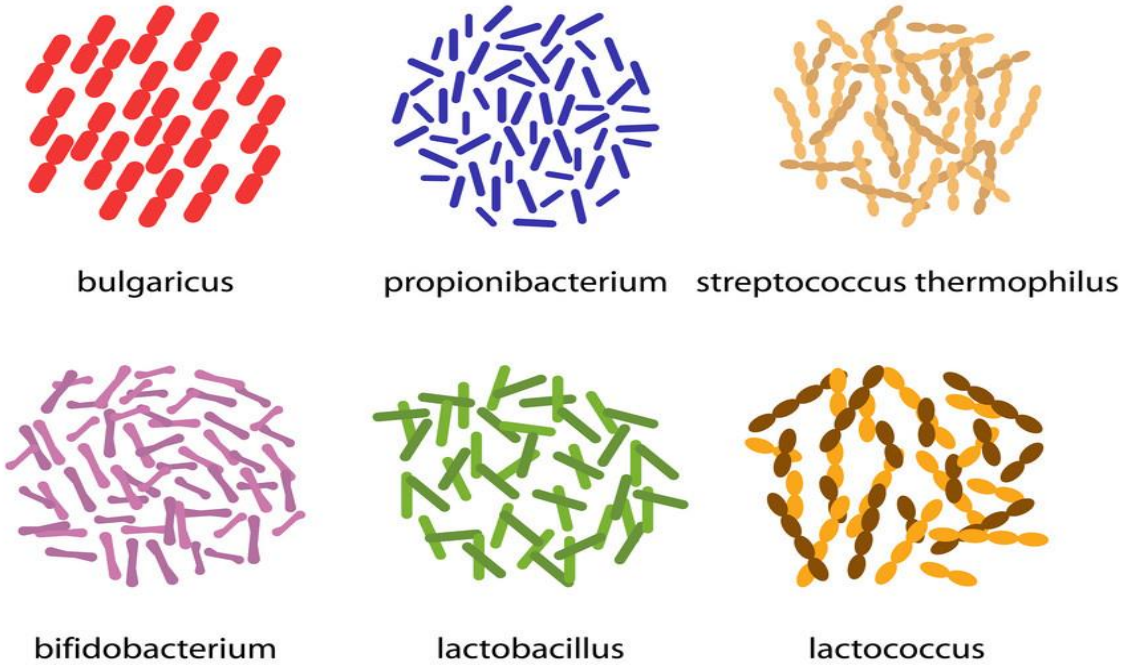


soy tempe



sourdough bread

Probiotics



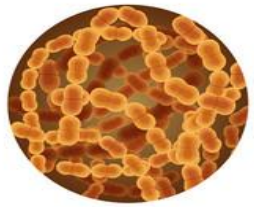
PROBIOTICS

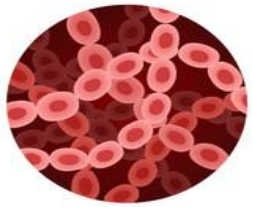
* WHAT ARE PROBIOTICS
* SOURCES OF PROBIOTICS
* PROBIOTICS HEALTH BENEFITS

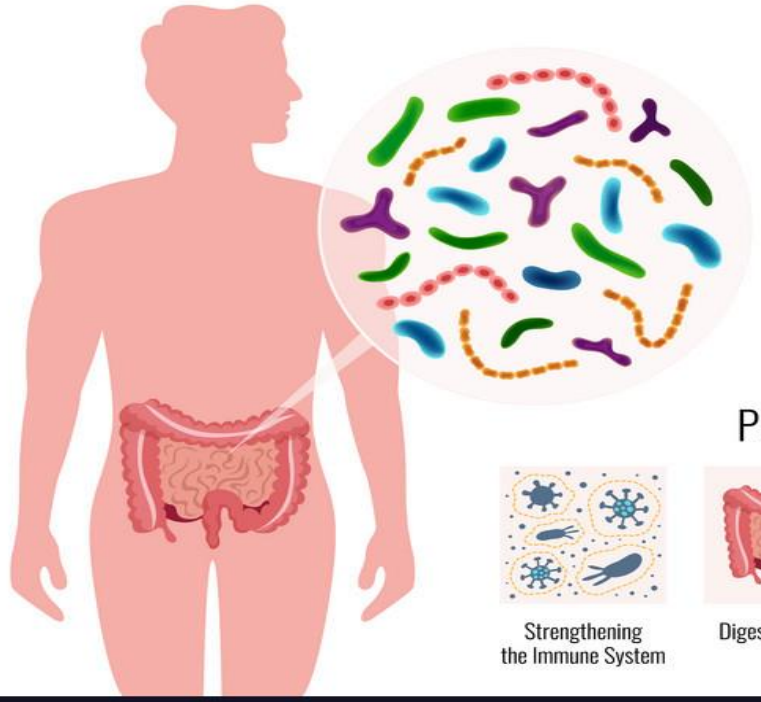

Lactobacillus


Bifidobacterium


Propionibacterium


Streptococcus Thermophilus


Lactococcus




Pickles


Cottage cheese


Kombucha


Chocolate


Sauerkraut

PROBIOTICS HEALTH BENEFITS

Strengthening the Immune System


Digestive Health


Weight Loss


Mental Health


Normalization of Blood Pressure

Initial Intentional Probiotic Use

Eli Metchnikoff observed

- **Bulgarians** who drank **milk fermented by lactic-acid producing bacteria** had **long lives**
- **Lactic acid lower gut pH** and **inhibits** the **growth of some pathogenic bacteria**

- **Lactic acid bacteria** beyond fermentation **positively influence our health** mainly by **improving the composition of intestinal microbiota.** For this reason they are called **probiotics**
- ***Lactobacillus*, *Bifidobacterium,* *Streptococcus,* *Lactococcus*** and ***Saccharomyces*** have been promoted in food product because of their reputed

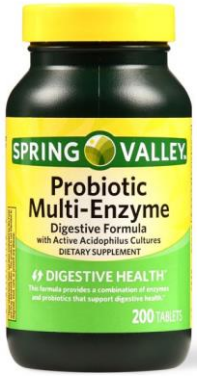
Requirement to be defined as an effective probiotic

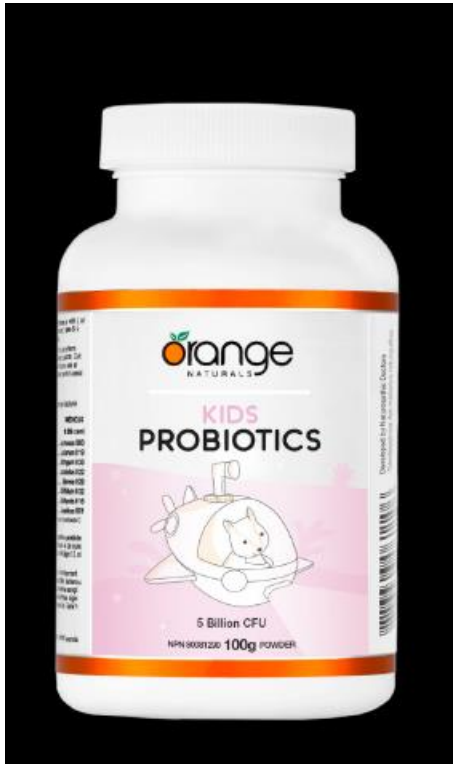
1. **Adhere to cells**
2. Exclude **or reduce pathogenic adherence**
3. **Persist and multiply**
4. **Produce acids, hydrogen peroxide** and **bacteriocins antagonistic** to **pathogen growth**
5. **Be safe, non-invasive, non-carcinogenic** and **non-pathogenic**
6. **Congregate to form a normal balanced flora**

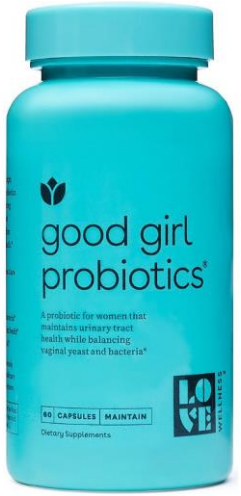
Beneficial Roles for probiotic strains

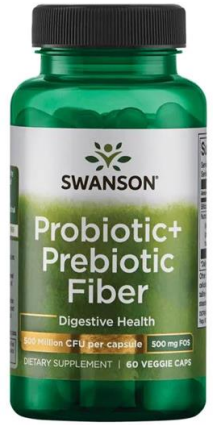
1. Re-establishment of balanced intestinal micro flora
2. Improving colonization resistance and /or prevention of diarrhea
3. Systemic reduction of serum cholesterol
4. Reduction of faecal enzymes, potential mutagens which may induce tumors
5. Metabolism of lactose and reduction of lactose intolerance
6. Enhancement of immune system response
7. Improved Calcium absorption
8. Synthesis of vitamins and predigestion of proteins

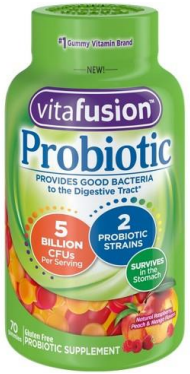
Commercially Available Probiotics

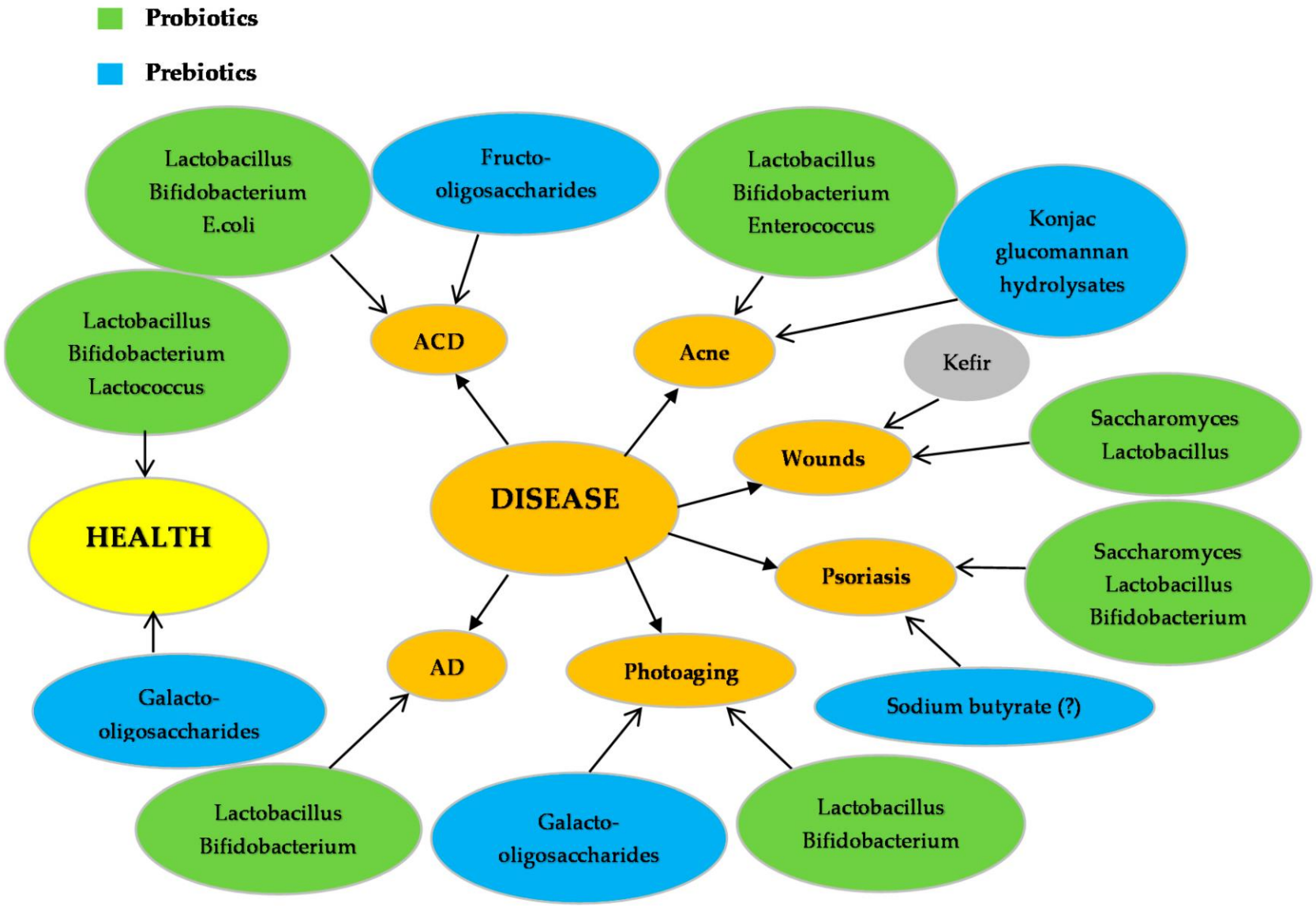


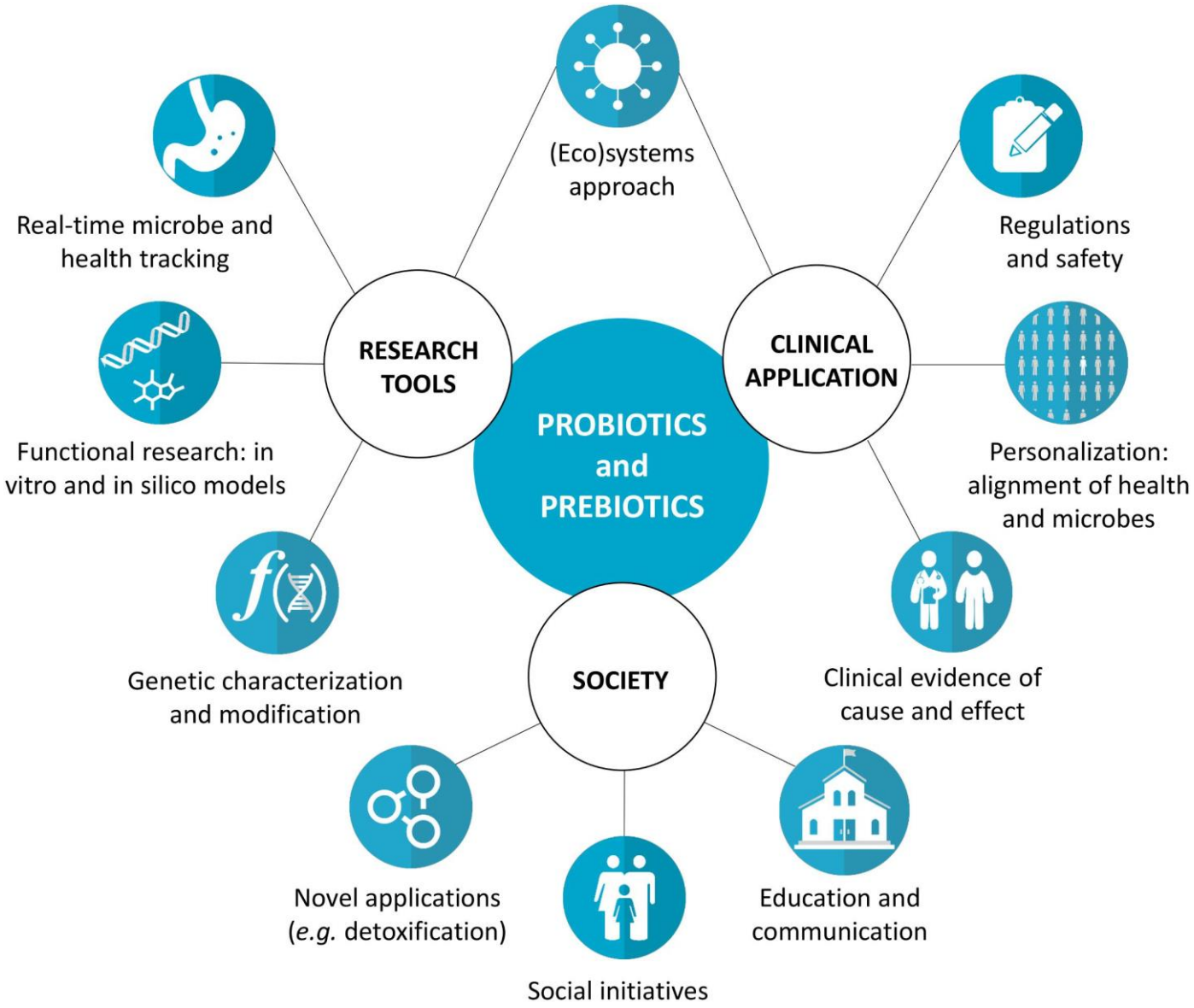









Probiotics
Prebiotics
Lactobacillus
Bifidobacterium
E.coli
Fructo-
oligosaccharides
Lactobacillus
Bifidobacterium
Enterococcus
Konjac
glucomannan
hydrolysates
Lactobacillus
Bifidobacterium
Lactococcus
ACD
Acne
Kefir
Saccharomyces
Lactobacillus
Wounds
HEALTH
DISEASE
Saccharomyces
Lactobacillus
Bifidobacterium
Psoriasis
AD
Photoaging
Sodium butyrate (?)
Galacto-
oligosaccharides
Lactobacillus
Bifidobacterium
Galacto-
oligosaccharides
Lactobacillus
Bifidobacterium


(Eco)systems approach
Real-time microbe and health tracking
Regulations and safety
RESEARCH TOOLS
CLINICAL APPLICATION
PROBIOTICS and PREBIOTICS
Functional research: in vitro and in silico models
Personalization: alignment of health and microbes
Genetic characterization and modification
Clinical evidence of cause and effect
SOCIETY
Novel applications (e.g. detoxification)
Education and communication
Social initiatives

Proofs

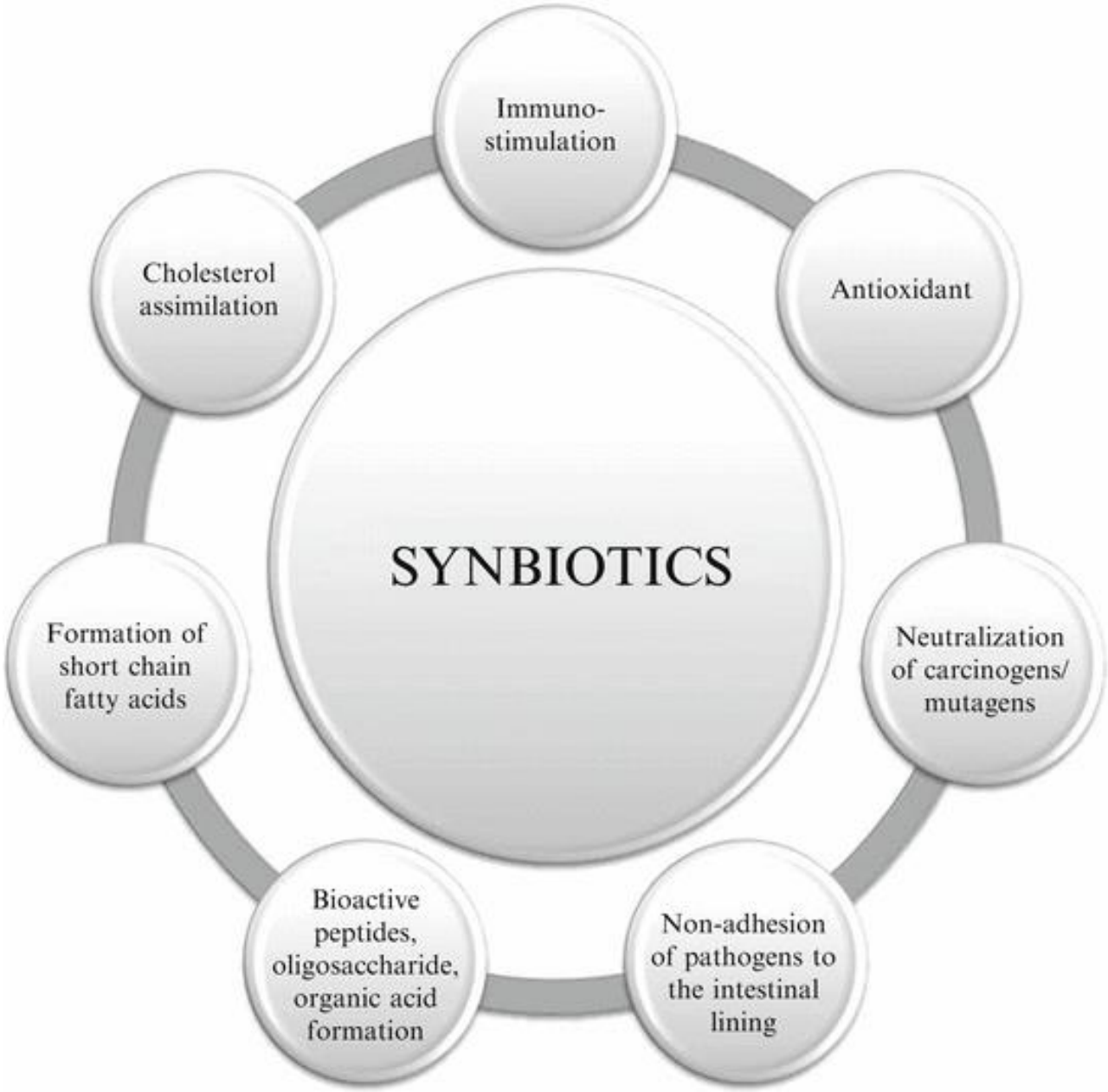
- Promising evidences have shown that **prevention of GIT colonizing** by a variety of pathogen is **primary mechanism of beneficial effects mediated by probiotics** (Lu and Walker, 2001; Forestier et al., 2001).
- **Probiotic bacteria attach to enterocytes** and thus **inhibit the binding of enteric pathogen to the intestinal mucosa by production of inhibitory substances** (competitive exclusion of pathogens. These inhibitory substances include **bacteriocins, lactic acid** and **toxic oxygen metabolites**) (Nemcova,1997; Kopp Hoolihan, 2001).
- Attachment of **probiotic bacteria to cell surface receptors of enterocytes** also **initiates signaling events** that results in the **synthesis of cytokines**. Furthermore the **production of butyric acid by some probiotic bacteria affects** the **turnover of enterocytes** and **neutralizes the activity of dietary carcinogens,** such as **nitrosamines (**Wollowski et al., 2001).

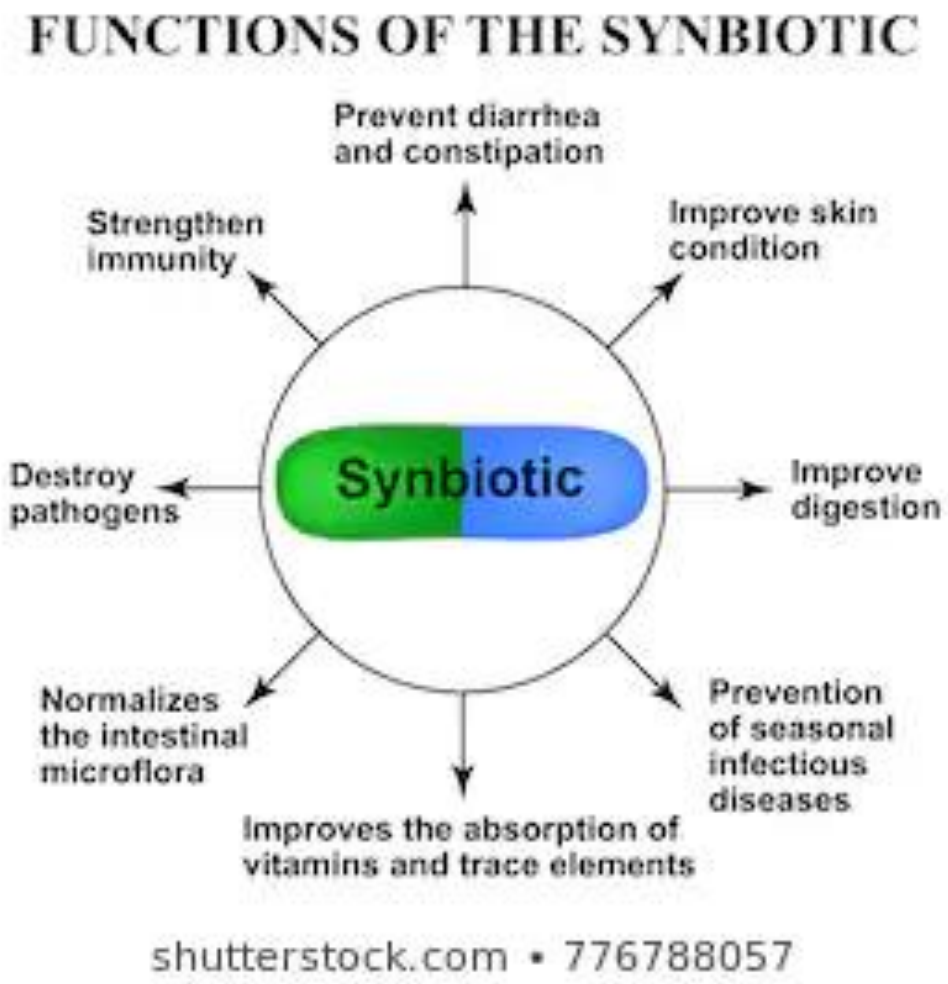
Synbiotics

- **Synbiotics** may be defined as **a mixture of probiotics and prebiotics that beneficially affects the host by improving the survival and implantation of live microbial dietary supplements in the gastrointestinal tract.**
- In other words the **live microbial additions (probiotics**) may be used in **conjunction with specific substrates (prebiotics**) for growth (e.g. a **fructo-oligosaccharide** in conjunction with a ***bifidobacterial strain*** or **lactitol** in conjugation with ***lactobacillus* organism**.)

Synbiotics and Health Benefits

- **Pediatric Surgery:** For Probiotics, live bacterial preparations of ***Bifidobacterium*** breve strain **yakult** and ***Lactobacillus casei*** strain **Shirota** were used, and **galacto-oligosaccharide** were supplemented as probiotics.
- As the **intestinal bacterial flora was improved by synbiotic therapy,** intestinal peristalsis recovered, intestinal expansion was reduced and the nutritional condition improved as reflected by gain in body weight (Kanamori et al., 2004; Kanamori et al., 2003).


Immuno-
stimulation
Antioxidant
Neutralization
of carcinogens/
mutagens
Non-adhesion
of pathogens to
the intestinal
lining
Bioactive
peptides,
oligosaccharide,
organic acid
formation
Formation of
short chain
fatty acids
Cholesterol
assimilation
SYNBIOTICS


FUNCTIONS OF THE SYNBIOTIC
Prevent diarrhea and constipation
Strengthen immunity
Improve skin condition
Synbiotic
Destroy pathogens
Improve digestion
Normalizes the intestinal microflora
Prevention of seasonal infectious diseases
Improves the absorption of vitamins and trace elements
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