Nutrition in Paediatrics

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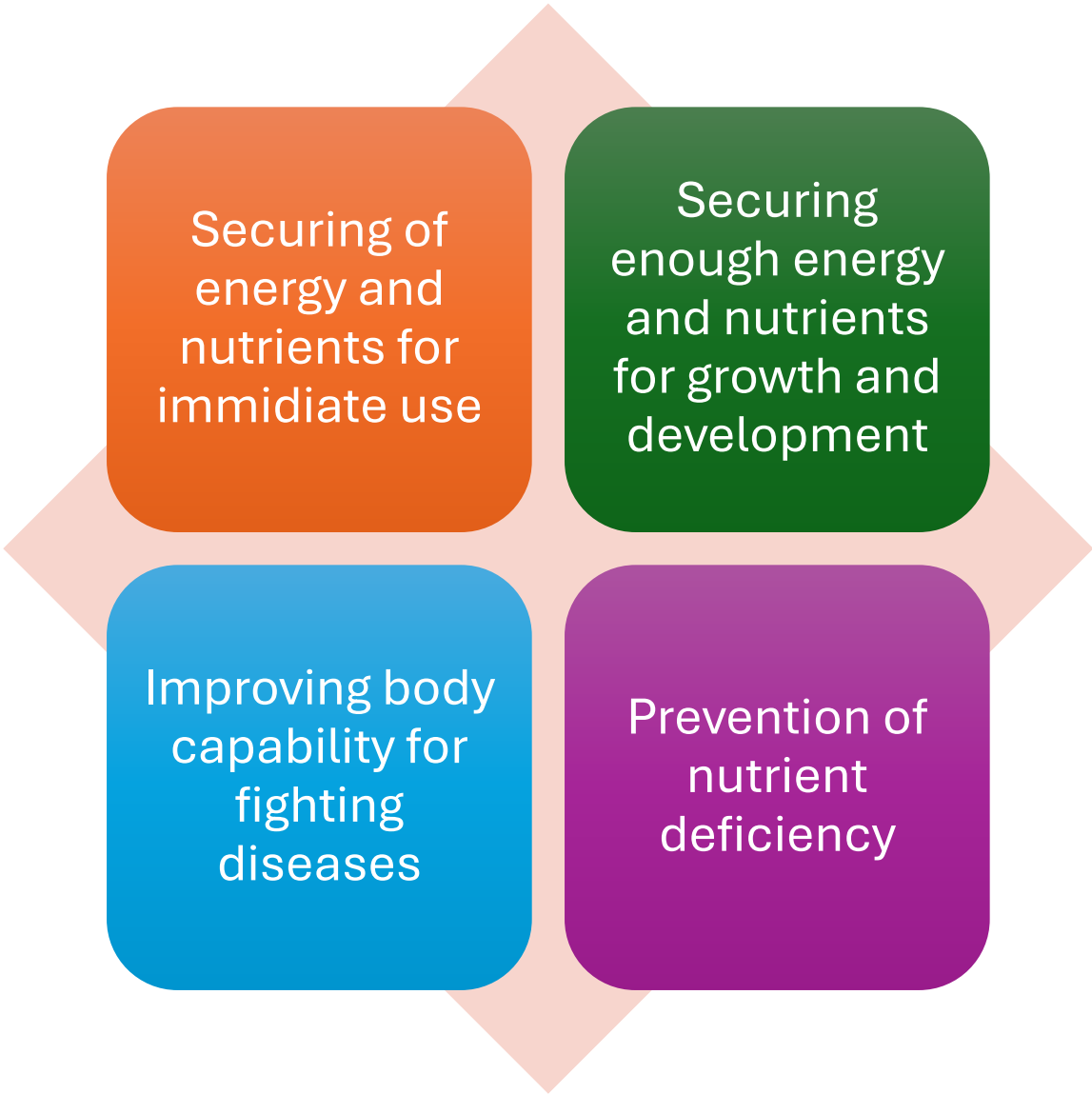
Importance of nutrition



Basic components of nutrition

- Water
- Macronutrients
- Micronutrients

Water

Makes up to 75-80 % of an infant‘s weight → higher daily water requirements → higher risk of dehydration development.

Daily water requirements in infants makes up to 10-15 % of their weight.

In comparison, water makes „only“ 55-60 % od an adult‘s weight.

Daily water requirements in adults are 2-4 % of their weight.

Water

Age	Weight	Basal water requirements
Newborn 1.-3. days	Approx. 2,5-4 kg	30-70 ml/kg/den
Newborn 4.-28. days	Approx. 2,6-4,5 kg	90-150 ml/kg/den
Infants 1.-6. months	4,6-6 kg	150-130 ml/kg/den
Infants 7.-12. months	7-10 kg	130-100 ml/kg/den
Children up to 5 years	11-20 kg	1000 ml+ 50 ml/kg above10 kg
Children older than 6 years	>21 kg	1500 ml+20 ml/kg above 20 kg*

Maximum recommended daily water requirements are 2500 ml/den.

Energy

Daily energy requirements varies based on age and physical activity.

Highest energy requirements are during the first year of life, moving between 80-120 Kcal/kg/day.

Energy requirements decrease by 10 Kcal/kg/day every 3 years until adult requirements of 30-40 Kcal/kg/day are reached.

Energy

- Energy consumption differs based on age.
- In newborns and infants:
  - 85-90 % is used for growth.
  - 5-10 % is used for thermoregulation and physical activity.
- In schoolchildren:
  - 50 % is used for basal metabolism.
  - 25 % for physical activity.
  - 12 % for growth.
  - 8 % is lost with sweat and stools.

Macronutrients

- Proteins
- Saccharides
- Fats

Ideal macronutrients composition

- Proteins: 9-15 %
- Saccharides: 45-55 %
- Fats: 35-45 %

Macronutrients

Nutrient	Energy content in kcal/g
Proteins	4
Saccharides	4
Fats	9

Atwater‘s macronutrients‘ energetic contents.

Recommended fats component of energy

Age	% of entire energy intake coming from fats
0-3 months	45-50
4-11 months	35-45
1-3 years	30-40
4-14 years	30-35
15-18 years	30[a]

[a] individuals with physical activity factor (PAL) >1,7 may require higher energy intake from fats

Nutrition of newborns and infants

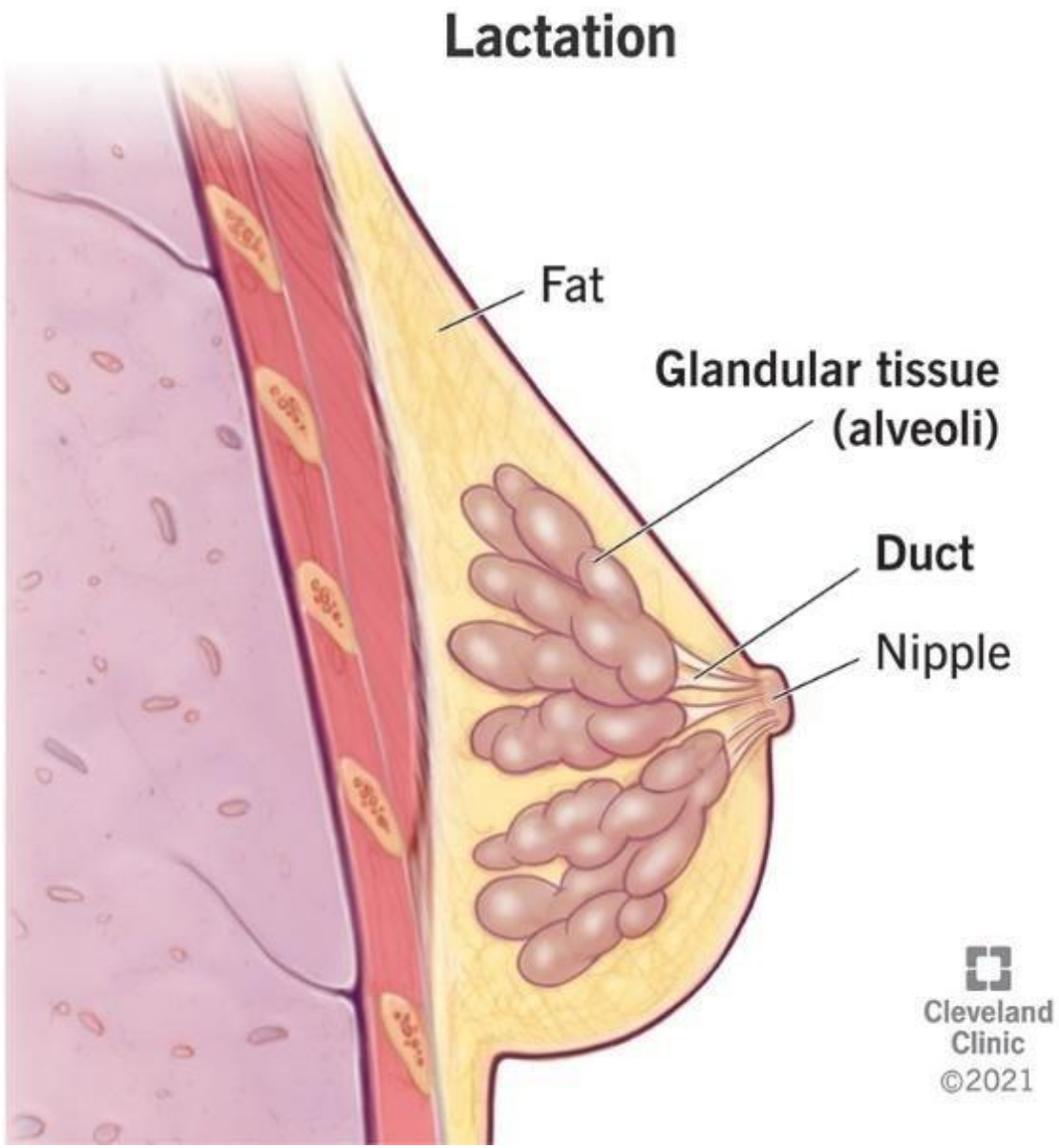
Dairy nutrition in newborns and infants

- Natural
- Artificial
- Mixed

Natural nutrition in newborns and infants

Maternal milk →breastfeeding.

Lactation


Lactation
Fat
Glandular tissue
(alveoli)
Duct
Nipple
Cleveland
Clinic
©2021

Lactogenesis 1

Breast gland prepares for lactation during pregnancy.

Creation of breast milk is influenced by oestrogens and prolactin.

Ejection of milk is controlled by oxytocin.

Starting the second trimester, a small amount of colostrum if being formed.

Lactogenesis 2

After delivery, progesterone levels decrease, along with oestrogen and HPL, but prolactin increases.

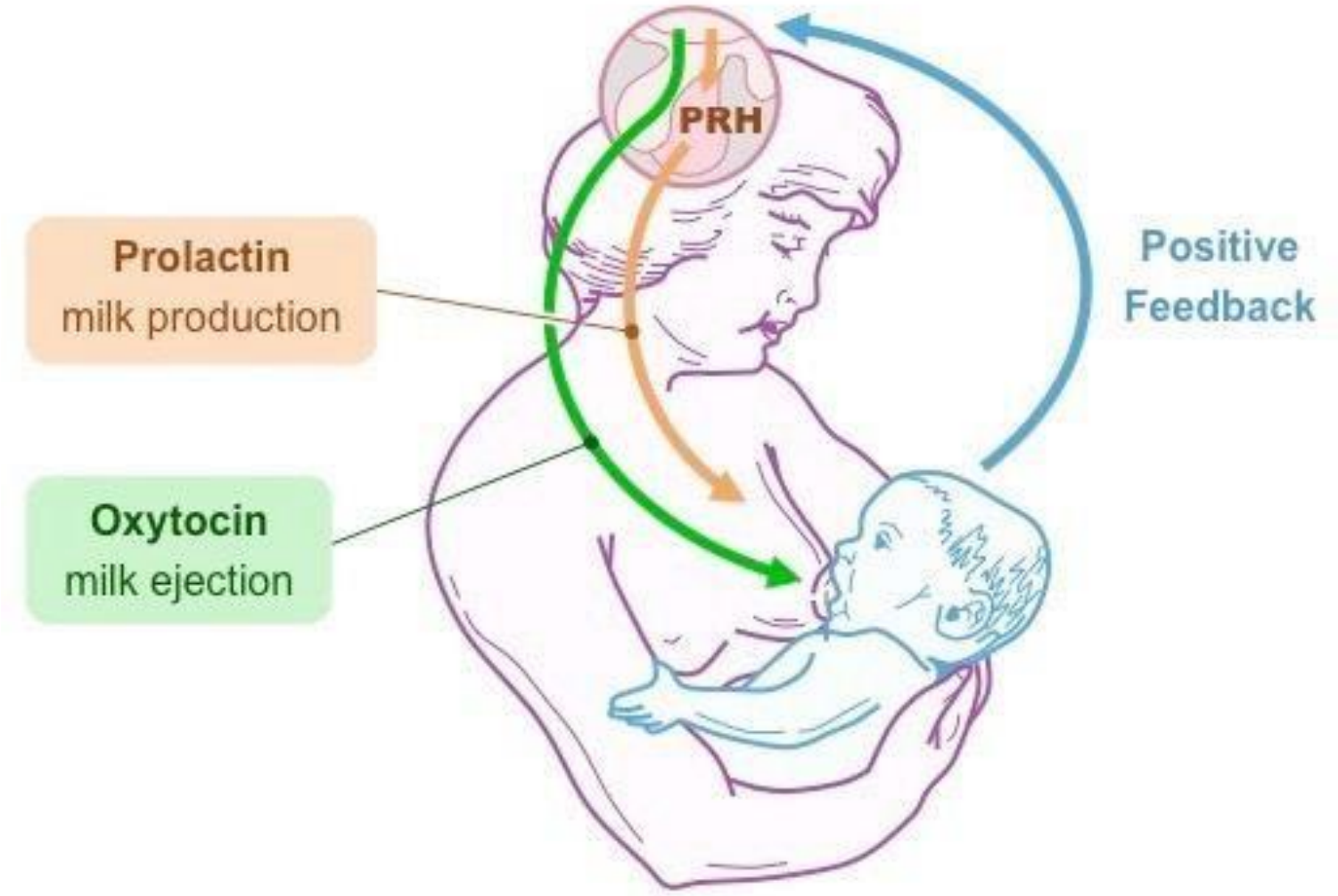
Prolactin levels increase after the first stimulation (maximum 45th minute).

Lactation reflex is started by suckling of the infant, also by his presence (crying).

Second phase of lactogenesis starts 30-40 hours after giving birth.

The feeling of full breast appears during the second of third day after delivery.

Lactogenesis 2



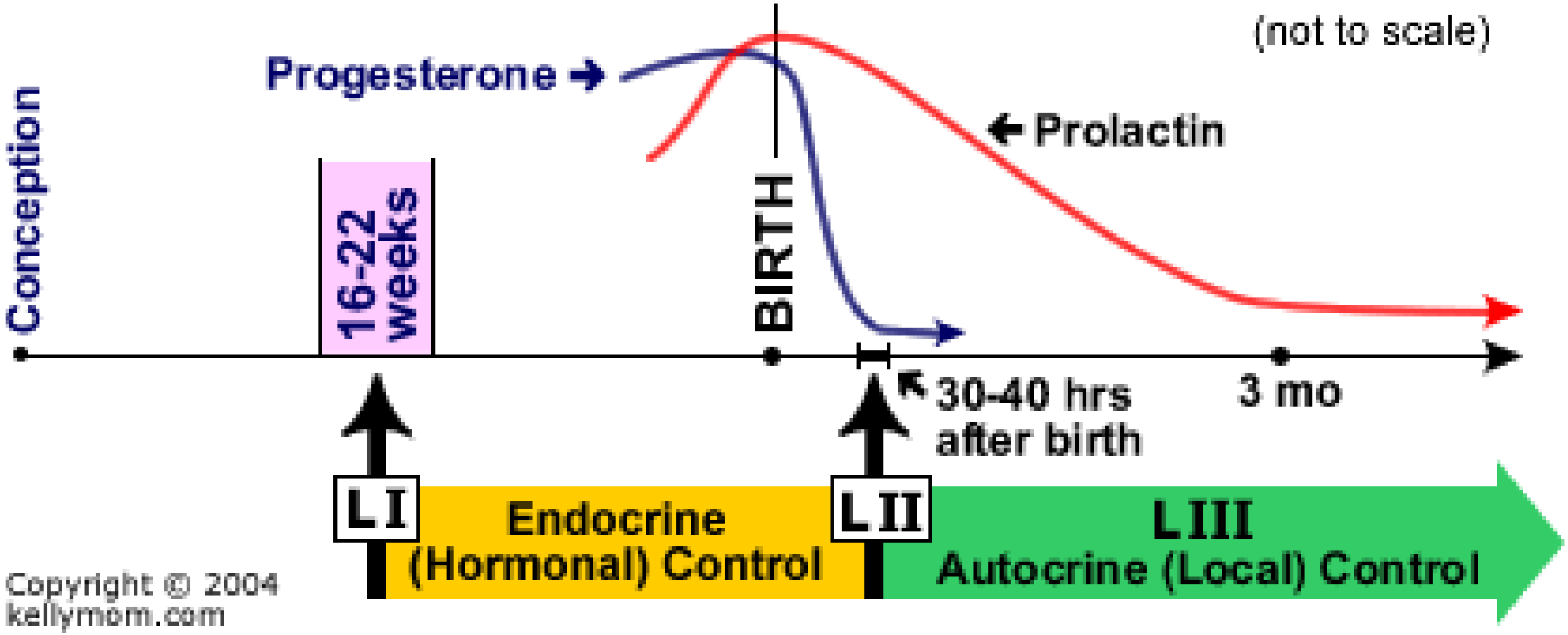
Lactogenesis 3

Creation of breast milk during pregnancy and the first days after birth is endocrine.

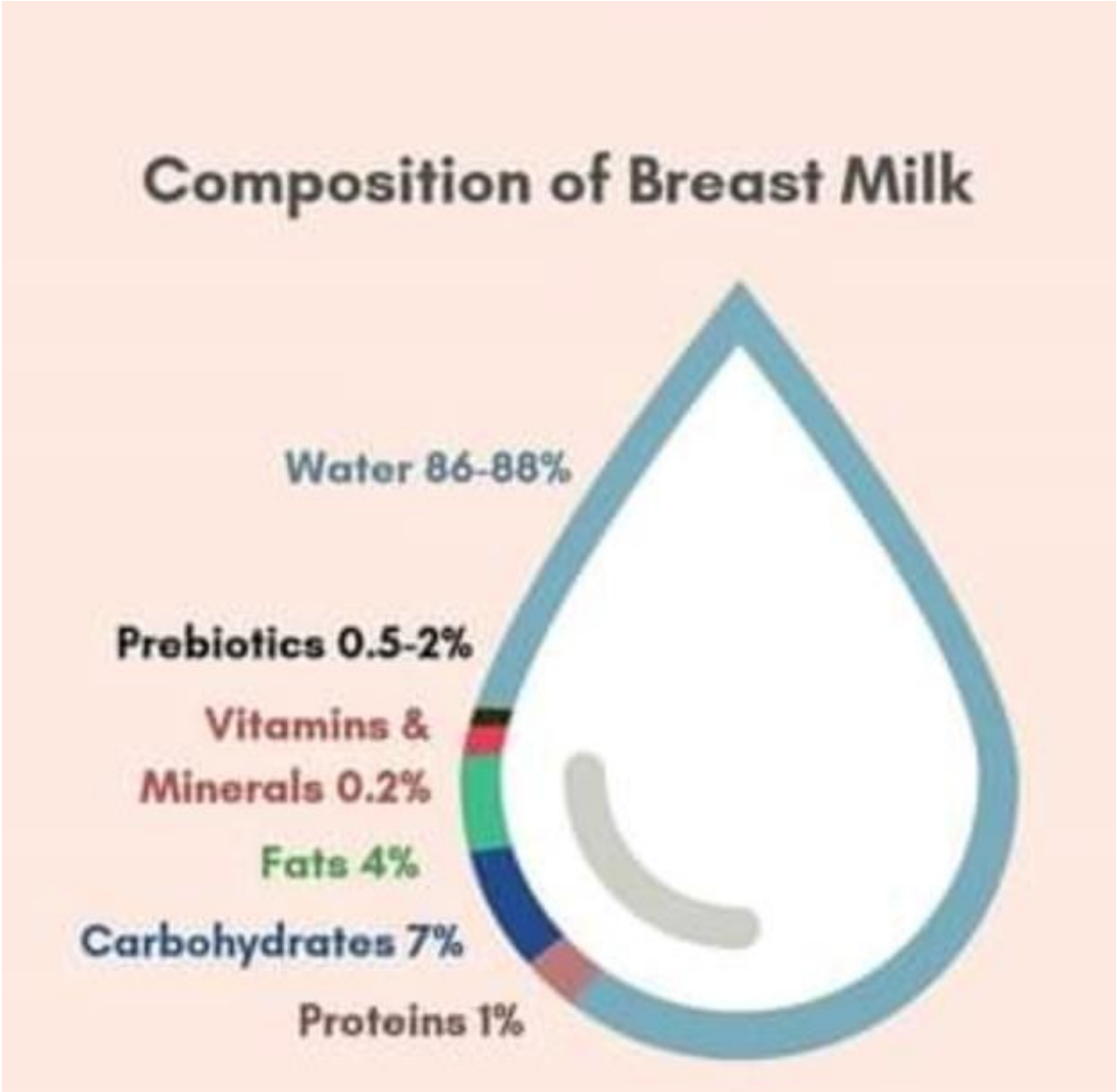
Afterwards, it changes into autocrine

Volume of breast milk after 1-2 weeks is 700-800 ml daily (450-1200 ml).

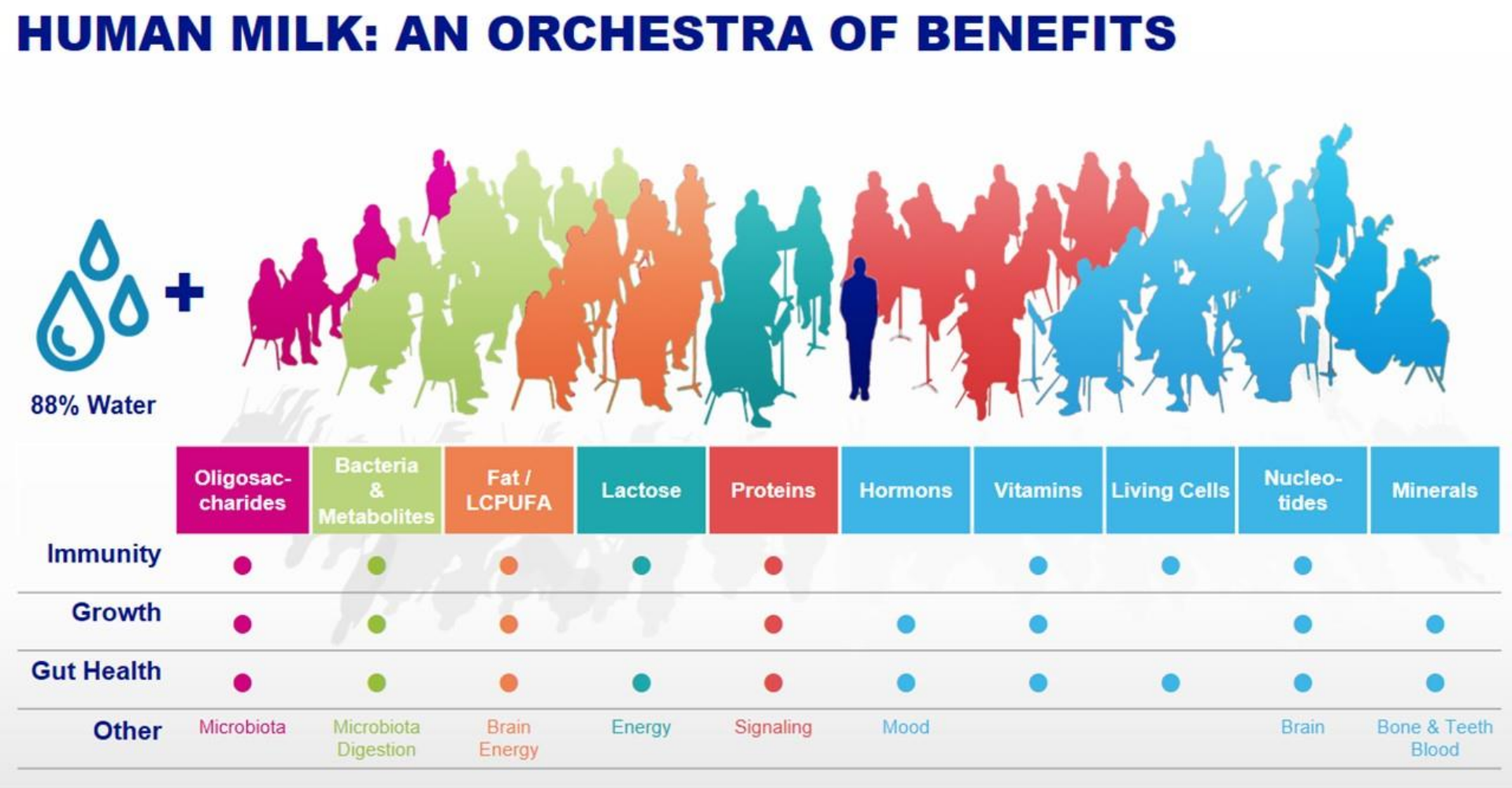
Lactogenesis phases



Composition of maternal milk



Composition of maternal milk



https://www.nutriciaresearch.com/gastrointestinal-health/the-impact-of-early-life-nutrition-on-immunity-through-gut/

Composition of maternal milk - saccharides

Main saccharide is lactose

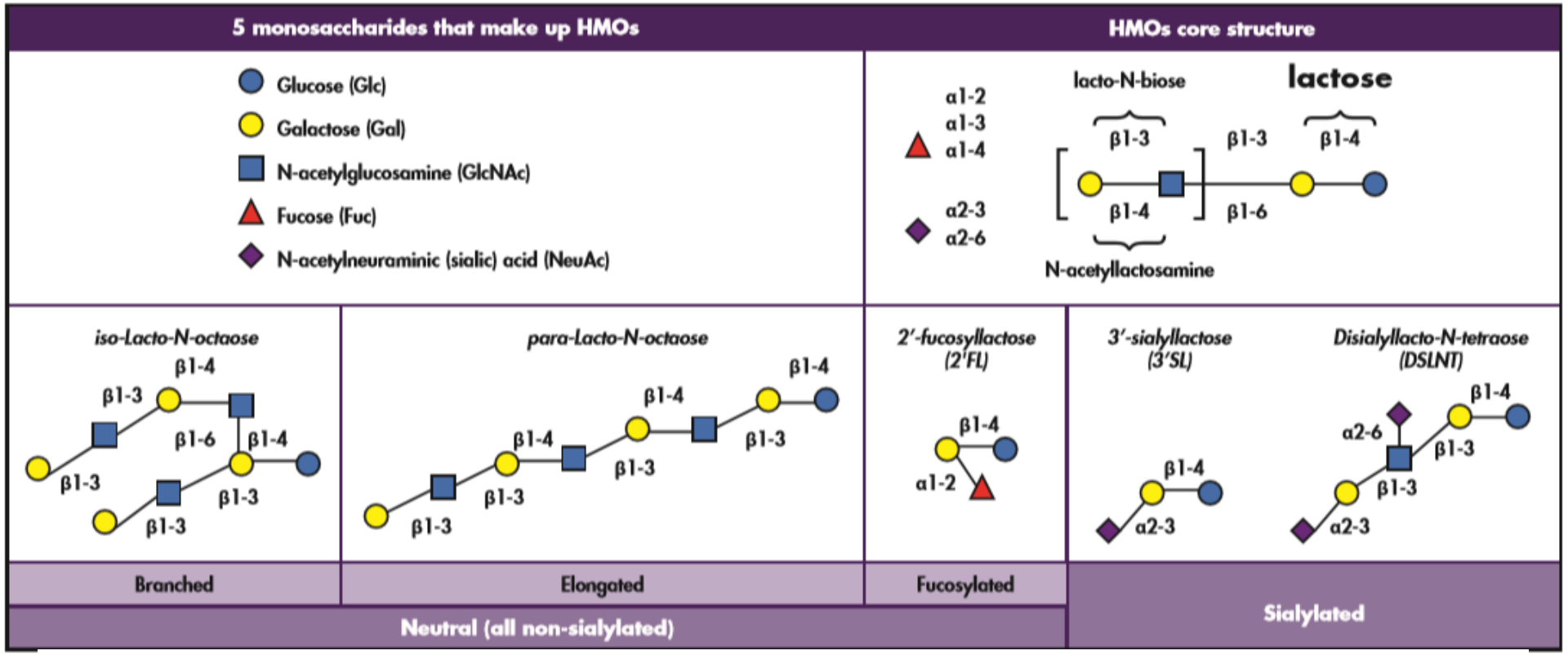
Lactose amount is 6,7-7,8 g/100 ml.

Other than nutrition, lactose plays a role in maintaining a physiological GIT and composition of gut microbiota.

Glucose levels and its metabolised are very low in breast milk and their role in nutrition is negligible.

Composition of maternal milk- saccharides

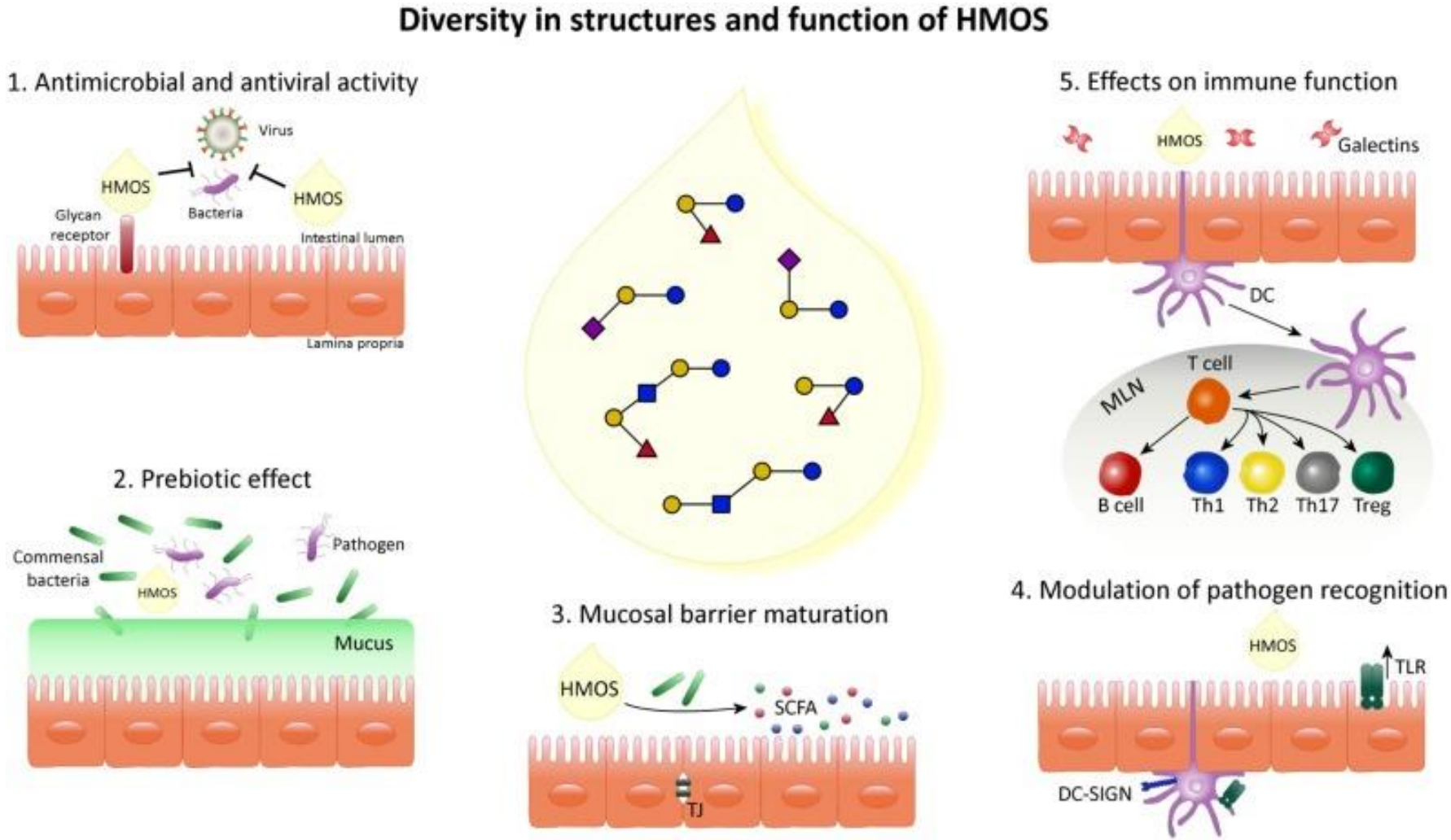
- The second most important saccharides are Human milk oligosaccharides (HMOs).



Human milk oligosaccharides (HMOs) are a key constituent of human milk. They are a structurally and biologically diverse group of complex indigestible sugars (7, 8). To date, more than 200 different oligosaccharides have been identified, varying in size from 3 to 22 monosaccharide units (9).

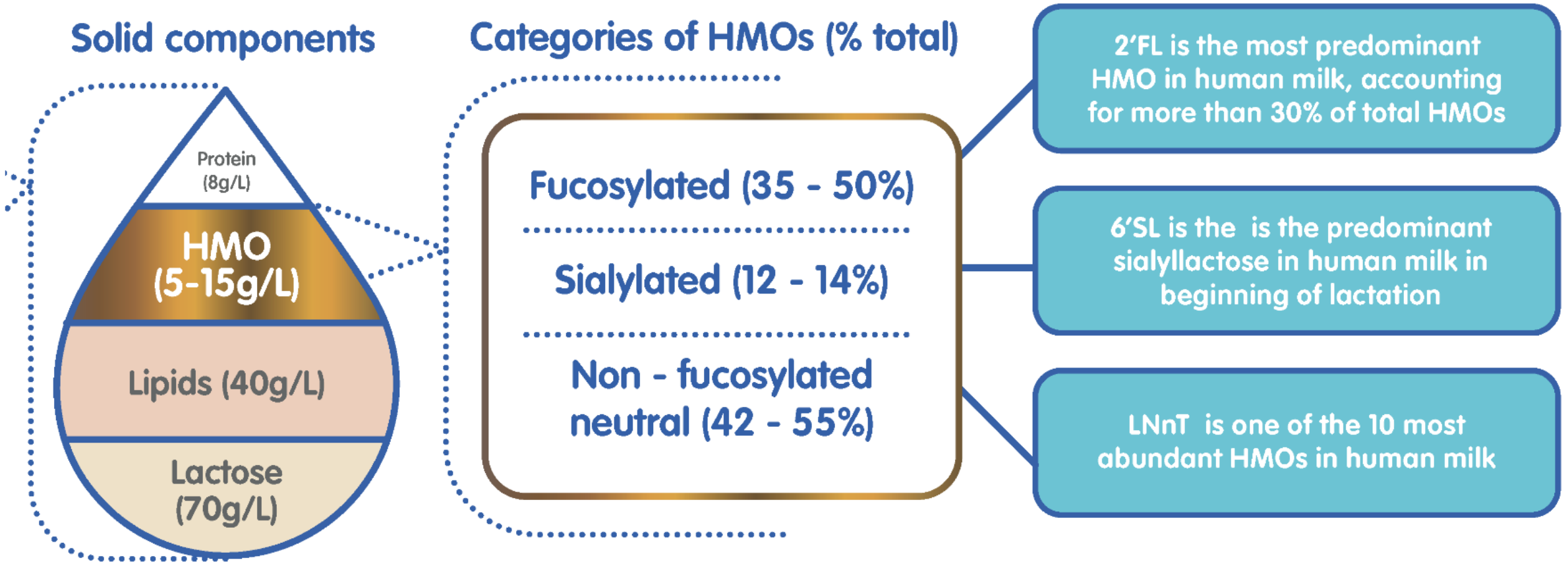
Bode I. *Glycobiology* 2012 Boherty AM, et al. *Front Pediatr* 2018

Roles of HMOs

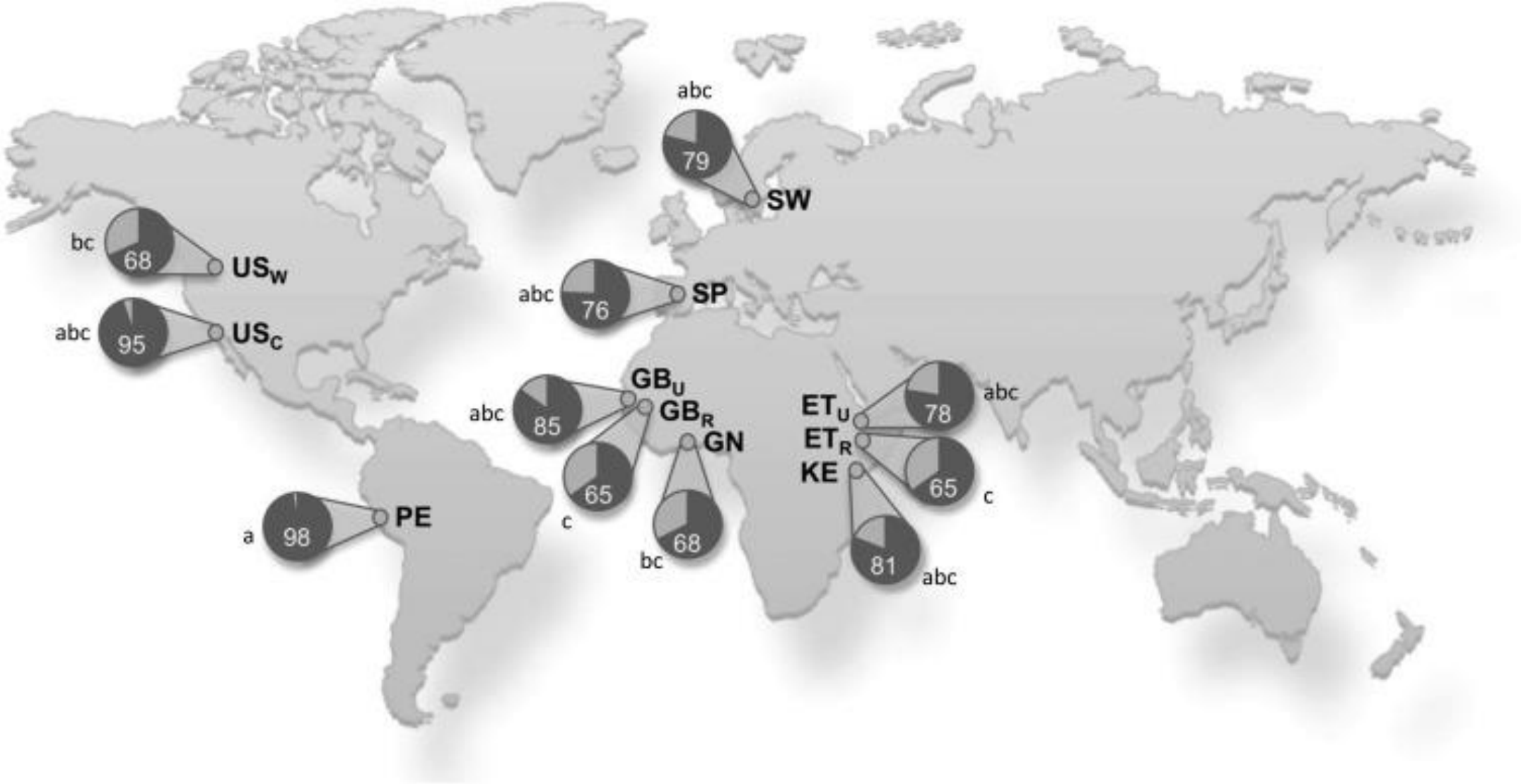


Ayechu-Muruzabal V, et al. *Front Pediatr* 2018

HMOs in maternal milk



https://www.nestlenutrition-institute.org/resources/infographics/details/human-milk-oligosaccharides-(hmos)-infographic



HMOS in breastmilk

McGuire MK, et al. *Am J Clin Nutr* 2017

Composition of maternal milk - proteins

They are important in the growth and development of a child.

The main maternal milk proteins are whey and casein.

Whey: casein ration changes, in colostrum 90:10 and in mature milk 60:40.

The most important whey proteins:

α-lactalbumin, lactoferrin and secretion IgA.

Composition of maternal milk - fats

Are the second largest macronutrient in maternal milk and make up to 50 % of energy intake.

Colostrum contains 2 g/100 ml and mature milk 4g /100 ml.

Maternal milk contains essential fatty acids linolic and α-linolenic acids.

Fats in maternal milk are better digested than in baby milk formula due to lipase content.

Composition of maternal milk – minerals and vitamins

Vitamins levels depend on the maternal diet.

Under normal circumstances, maternal milk includes enough of both vitamins and minerals.

Vitamins D and K are the only exceptions.

Maternal milk includes only 40 IU/l of vitamin D → supplementation with 400 IU daily is required.

Vitamin K has very limited placenta transportation → 0,5-1 mg i.m. after birth, or 1-2 mg p.o. 1x per week, for 12 weeks.

Maternal milk composition – hormones and growth factors

Maternal milk contains both hormones and growth factors.

E.g. IGF-I protects enterocytes against oxidation stress, stimulates erythropoiesis and increase haematocrit.

Vascular endothelial growth factor and its antagonists helps in regulating angiogenesis and decreases damage to the retina.

Erythropoietin increases erythrocytes numbers and helps in avoiding anaemia in premature infants and decreases the risk of NEC.

Maternal milk composition - Microbiota

Maternal milk includes bacteria, whicih are suitable for the infantile gut.

Bifidobacterium breve, *B. adolescentis*, *B. longum* a *B. dentium* are among maternal milk bacteria.

The aetiology of microbiota is unclear. Endogenous aetiology or from the maternal skin or infant mouth are considered.

Types of maternal milk

- Colostrum
- Mature milk

Colostrum

Is formed in small amounts a few weeks prior to delivery.

Has low fat and high protein content. Is also rich in immune contents.

Mature milk

In comparison with colostrum is more liquidy and bluish.

Quality of maternal milk changes during the day and even during one breast-feeding session.

„Front“ milk is rich in water and has lower fat content.

„Back“ milk is highly caloric and has a higher fat content.

Mature milk

- Energy: 65-70 Kcal/100 ml
- 50 % fats
- 40 % saccharides
- 10 % proteins

Advantages of breastfeeding

- Nutritional
- Immunological
- Psychological
- Economical
- Ecological
- Maternal morbidity
- Social effects

Support of breastfeeding

- Bonding.
- First attempt of breastfeeding within the first 60 minutes of life.
- Rooming in.
- Breast-feeding as often as the newborn requires.
- Correct technique of breastfeeding.
- Exprimated breast milk when Mom cannot breastfed.

Disorders of maternal milk production

From the infant‘s side: ineffective suckling.

From the maternal side:

- Endocrinopathies
- Insufficient development of breasts
- Surgical procedures on the breasts
- Caesarean section delivery
- Medications
- Maternal dehydration
- Insufficient support from the surroundings
- Obesity
- Stress

Contraindications of breastfeeding

Absolute	– Galactosemia. – HIV/AIDS (Human immunodeficiency virus/Acquired immune deficiency syndrome). – HTcLV (human T-cell lymphotropic virus I and II). – Drugs abuse (except for Methadone controlled administration in an HIV negative mother). – virus Ebola. – Medications: cytostatic, immunosuppressants, oestrogens, addictive substances (heroine, cocaine, amphetamine), alkaloids, lithium, radioactive isotopes therapy, gold salts.

Contraindications of breastfeeding

Relative	– Phenylketonuria. – Active tuberculosis. – Herpes simplex infection of the breast. – Herpes Zoster infection of the breast. – Varicella (possible after drying of the maternal blisters, the infant should be administered and immunoglobulin (VZIG)). – Cytomegalovirus in premature babies born prior to 32 weeks of gestation/weighing less then 1500 g. – Hepatitis B (positive HbsAg and HbeAg and anti-HBe negative), the child could be breastfed after both passive and active immunization. – Influenza H_2N_2. – Radioactive isotopes. – Medications: antidepressants, antipsychotics, Carbamazepine, Phenobarbital, Sulphonamide antibiotics, Chloramphenicol, Tetracycline, Metronidazole, Ebrantil.

Breastfeeding length

WHO recommends exclusive breastfeeding up to 6 months of age, with complimentary breastfeeding up to 2 years.

ESPGHAN regards breastfeeding up to 6 months as a preferred target.

AAP recommends breastfeeding till at least the age of one year.

Baby-milk formulas

- The majority is produced from cow‘s milk.
- Adaptation of cow‘s milk is necessary.

	Cow‘s milk	Maternal milk
Proteins	2,3-3,3 g/100 ml	0,9-1,2 g/100 ml
Casein	80 % of proteins	20 % of proteins
Whey	20 % of proteins	80 % of proteins
α – lactalbumin	25 % of whey	100 % of whey
β – lactalbumin	50 % of whey	5-800 µl/1ml

Upraveno dle Dokoupilová M: Alergie na bílkoviny kravského mléka. EEZY, 2023.

Cow‘s milk adaptation

Reduction of protein content.

Correction of casein-to-whey ratio.

Partial replacement of animal fat with polyunsaturated plant fat.

Increment of lactose content.

Reduction of salt.

Increment of both vitamins and iron.

Comparison of maternal milk and baby-milk formula

	Colostrum	Mature milk	Baby-milk formula
Energy kcal/100 ml	50–60	65–70	60–70
Saccharides (g/100 ml)	5,2 - 6,2	6,7 - 7,2	6,3 – 9,8
Proteins (g/100 ml)	1,4 - 1,6	0,8 - 1,2	1,26 - 2,1
Fats (g/100 ml)	1,5 - 2,0	3,5 - 4,2	3,0 – 4,2

Classification of baby-milk formulas

Starter „1“:

- Fully adapted.
- Up till 6 months of age, or introduction of complimentary feeds.
- Can be given till one year of age.

Continuing „2“:

- Incomplete adaptation.
- From 6 months, or since complimentary feeds introduction.

Toddler formula:

- „3“: 12-24 months.
- „4“: 24-35 months.

Additives to baby-milk formulas

- Prebiotics
- Probiotics
- Synbiotics
- Postbiotics
- HMOs

Prebiotics

Selectively fermented components, which cause specific changes in the composition and/or activity of gut microbiota with positive effect/s on the host organism.

They are resistant to acidic pH, are unhydrolyzable by mammal enzymes and are not absorbed in the GIT.

They are fermentable by gut microbiota.

Growth and/or activity of select gut microbiota is stimulated harnessing a positive effect on the host organism.

Gibson GR, et al. *Food Sci Technol Bull Funct Foods* 2010

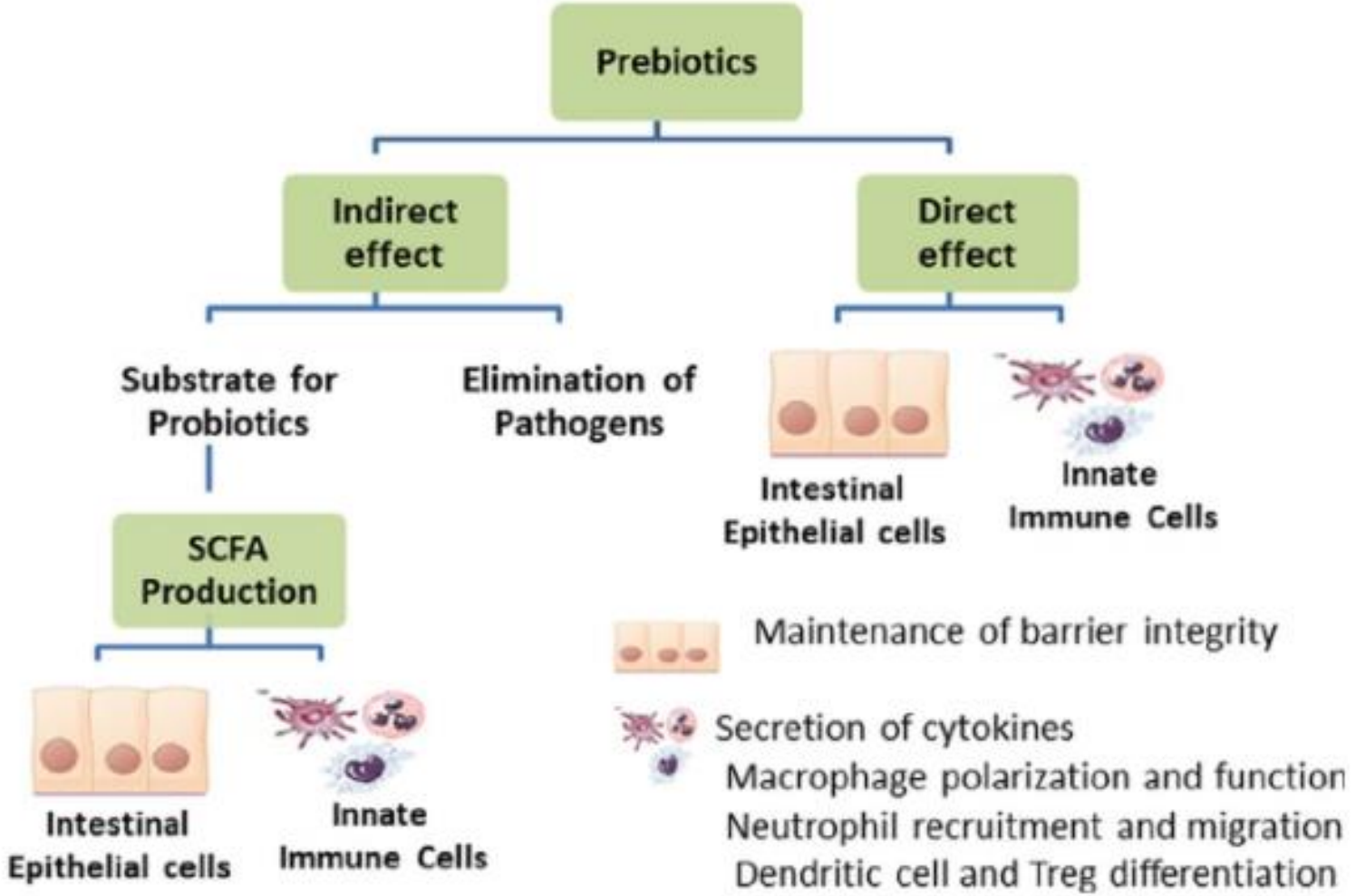
Prebiotics

Table 1. Prebiotics, their source[8–10] and health benefits

	Prebiotics	Source	Health benefit
1	Inulin	Chicory, asparagus, onion, garlic, artichoke	Treating symptoms of inflammatory bowel disease, immunomodulation[11,12]
2	Fructooligosaccharide	Sugar cane, asparagus, sugar beet, garlic, chicory, onion, Jerusalem artichoke, wheat, honey, banana, barley, tomato and rye	Bifidogenic, immunomodulatory, anti-inflammatory, effective in reducing Crohn's disease activity[13]
3	Galactooligosaccharide	Human milk and cow milk	Bifidogenic, increases calcium absorption, improves immunity[14,15]
4	β-Glucan	Cereal grains, mushrooms, algae and yeast cell wall, other marine plants	Decreases body weight, maintains body mass index[16]; acts as an immunoadjuvant in vaccines[17]; reduces the severity of upper respiratory tract infections, controls blood pressure[18]
5	Xylooligosaccharides	Bamboo shoots, fruits, vegetables, milk, honey and wheat bran	Improves blood sugar and lipid levels in diabetes patients[19,20]
6	Arabinoxylooligosaccharides	Wheat bran	Improves digestive health, management of blood sugars and lipids, modification of immune markers[20]
7	Isomaltooligosaccharides	Starch	Controls blood glucose levels by stimulating insulin as well as the incretins[21]

Pujari R, et al. *Immunol Cell Biol* 2020

Prebiotics



Pujari R, et al. *Immunol Cell Biol* 2020

Probiotics

Are live organisms, which when given in adequate quantities, have a positive effect on the body[1].

Microbes must be viable enough when given[2].

- Minimum of 10^6 CFU/ml at exspiration[3].
- Minimum effective dose 10^8-10^9 CFU[3].

The used genus must be clearly defined[2].

Supported by sufficient, high-quality studies[2].

Probiotics have specific effects[2].

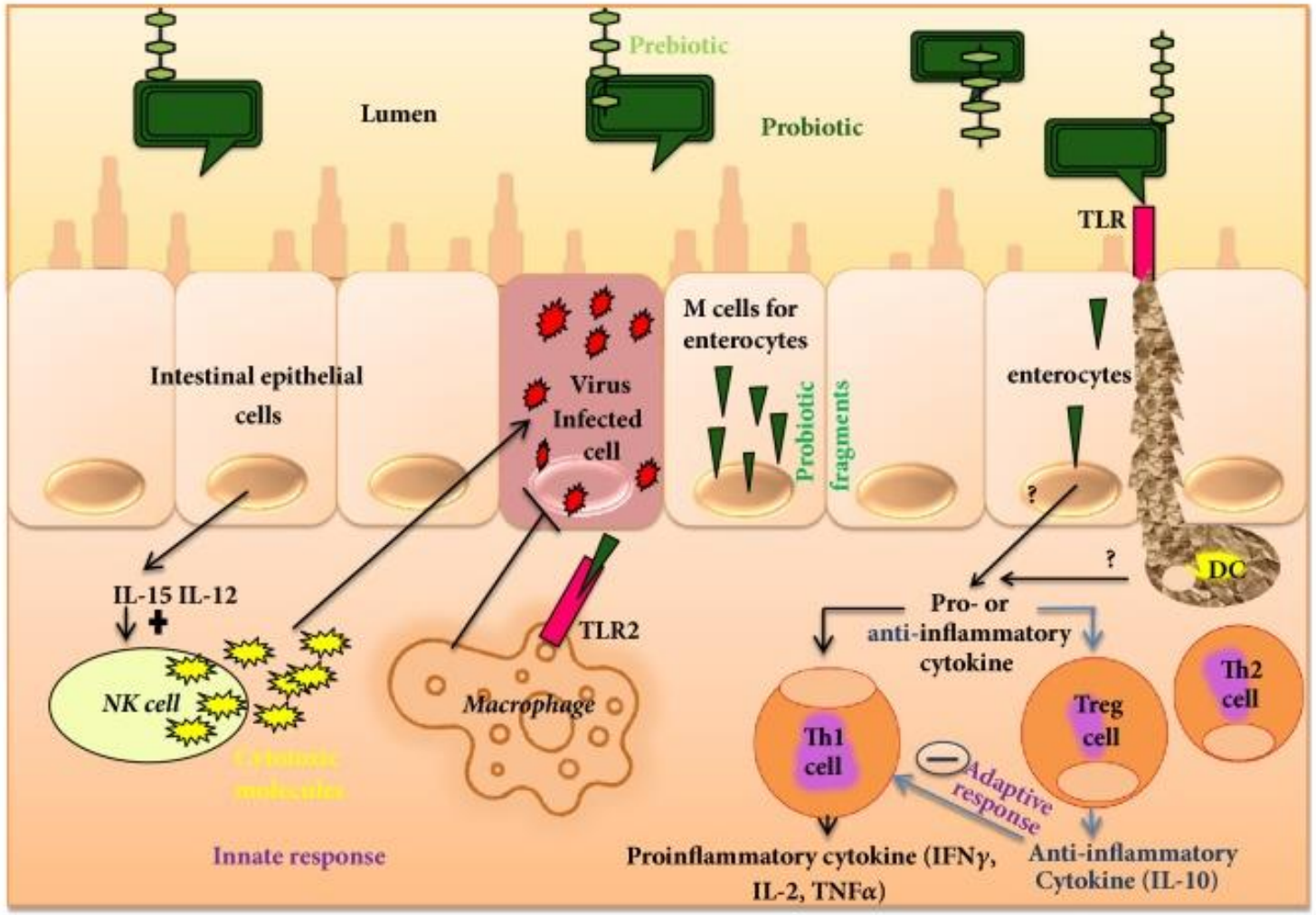
[1]Reid G, et al. *Front Microbiol* 2019
[2]Colin H, et al. *Nat Rev Gastroenterol Hepatol* 2014
[3]Shi LY, et al. *Trop Life Sci Res* 2016

Probiotics

Probiotic genera	Probiotic strains	References
Lactobacillus	*L. acidophilus, L. amylovorus, L. bulgaricus, L. crispatus, L. casei, L. gasseri, L. helveticus, L. johnsonii, L. pentosus, L. reuteri, L. paracasei, L. plantarum, L. rhamnosus*	[17, 18, 30]
Bifidobacterium	*B. animalis, B. breve, B. infantis, B. bifidum, B. lactis, B. catenulatum, B. longum, B. adolescentis*	[31–34]
Enterococcus	*Enterococcus faecium*	[35]
Streptococcus	*Streptococcus thermophilu*	[36]
Lactococcus	*Lactococcus lactis, L. lactis, L. reuteri, L. rhamnosus, L. casei, L. acidophilus, L. curvatus, L. plantarum*	[37]
Bacillus	*Bacillus clausii, B. coagulans, B. subtilis, B. laterosporus*	[38, 39]
Pediococcus	*Pediococcus acidilactici, P. pentosaceus*	[40]
Propionibacterium	*P. jensenii, P. freudenreichii*	[30]
Streptococcus	*Streptococcus sanguis, S. oralis, S. mitis, S. thermophiles, S. salivarius*	[36]
Bacteroides	*Bacteroides uniformis*	[41]
Enterococcus	*Enterococcus faecium*	[35]
Peptostreptococcus	*Peptostreptococcus productus*	[39]
Escherichia	*Escherichia coli Nissle 1917*	[38]
Faecalibacterium	*Faecalibacterium prausnitzii*	[42]
Akkermansia	*A. muciniphila*	[41]
Saccharomyces	*Saccharomyces cerevisiae, S. boulardi*	[43]

Azad MAK, et al. *Biomed Res Int* 2018

Probiotics



Azad MAK, et al. *Biomed Res Int* 2018

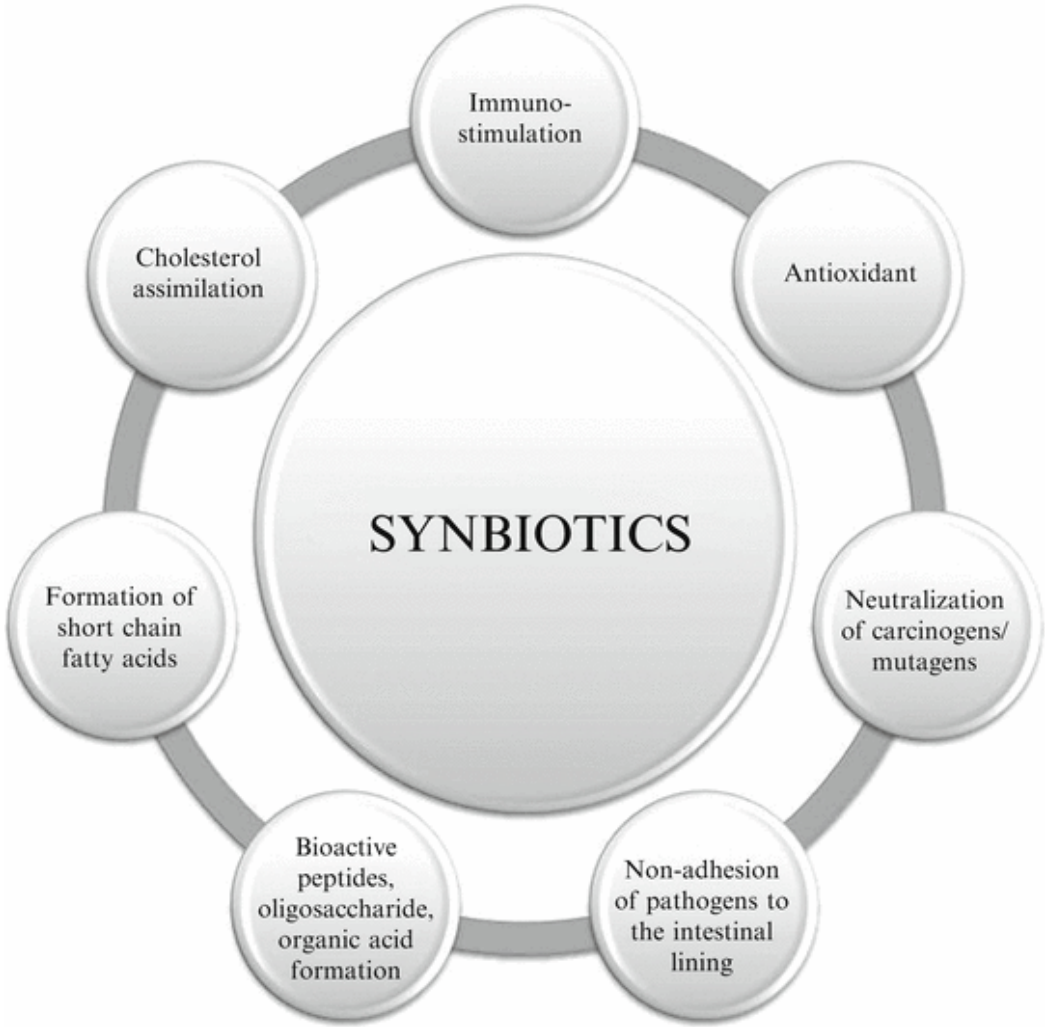
Synbiotics

A combination of a prebiotic and probiotic acting in synergy with a positive effect on the host organism[1].

They improve the survivability and implementation of microbial nutritional additives causing stimulation of their growth or activation of metabolism of select genus or narrowly defined microbes' groups with positive effects on host organism[2].

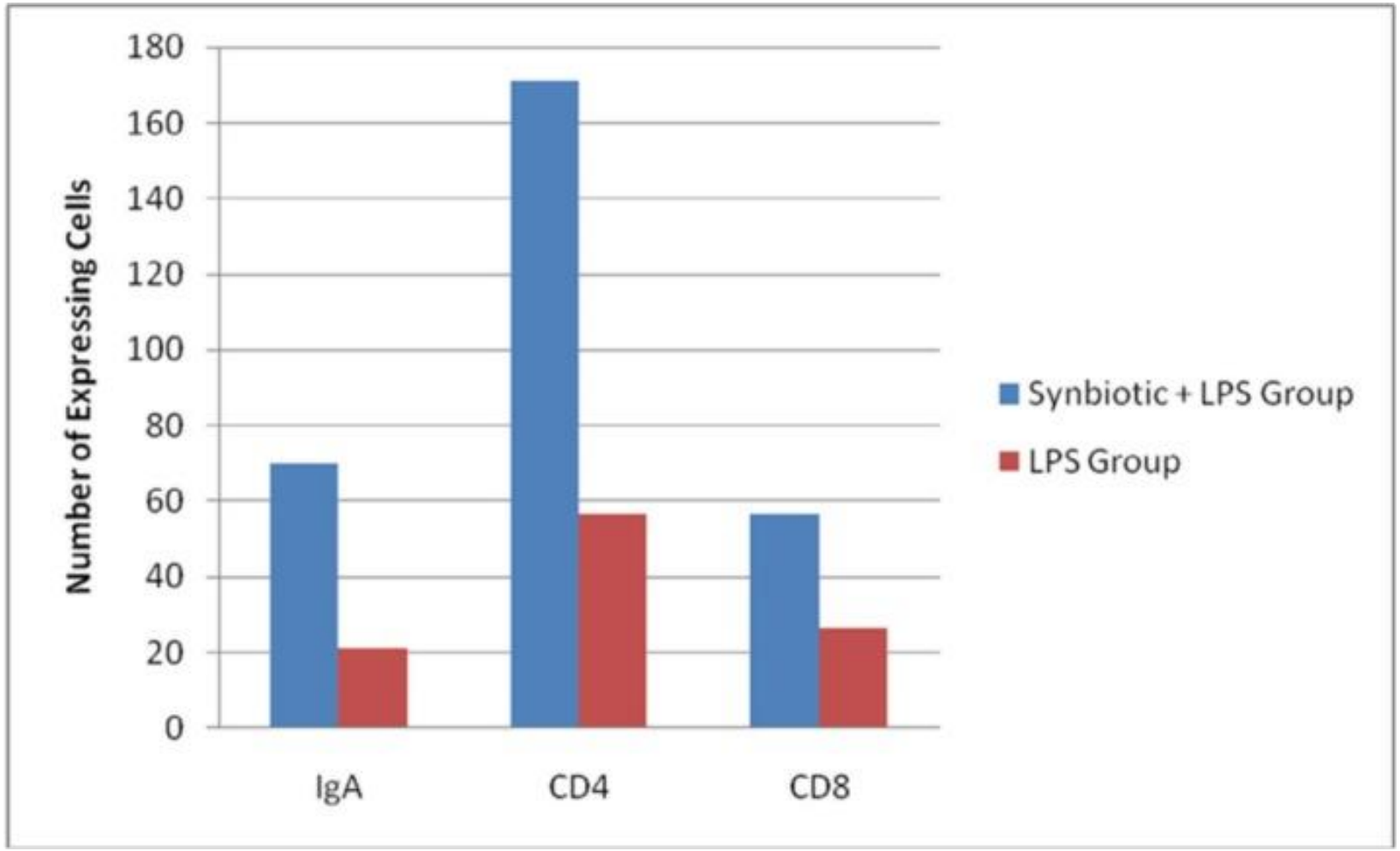
[1]Gurry T. *Microb Biotechnol* 2017
[2]Pandey KR, et al. *J Food Sci Technol* 2015

Synbiotics



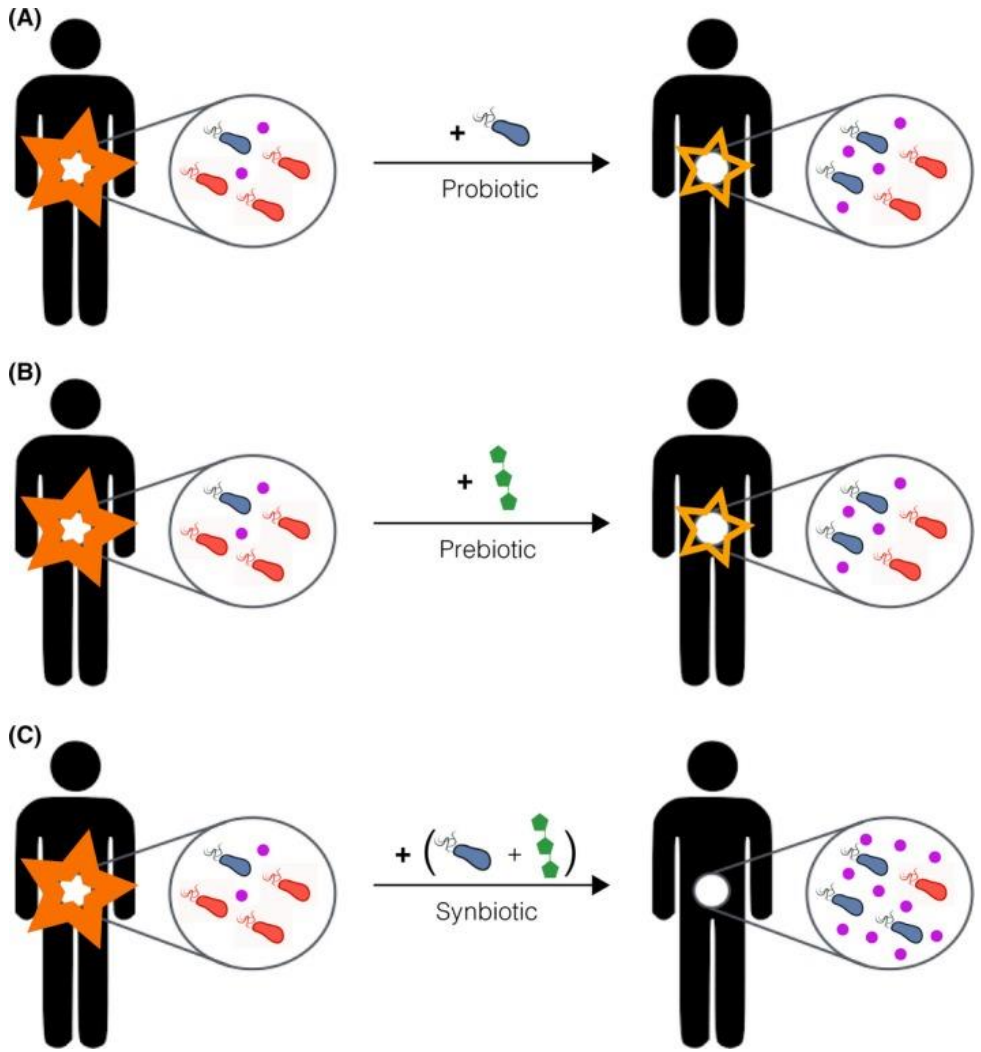
Raman M, et al. (2016) Synbiotics and Colorectal Cancer. In: Probiotics and Bioactive Carbohydrates in Colon Cancer Management. Springer, New Delhi

Synbiotics



Athiyyah AF, et al. *Iran J Microbiol* 2019

Effects of probiotics, prebiotics and synbiotics



Gurry T. *Microb Biotechnol* 2017

Postbiotics

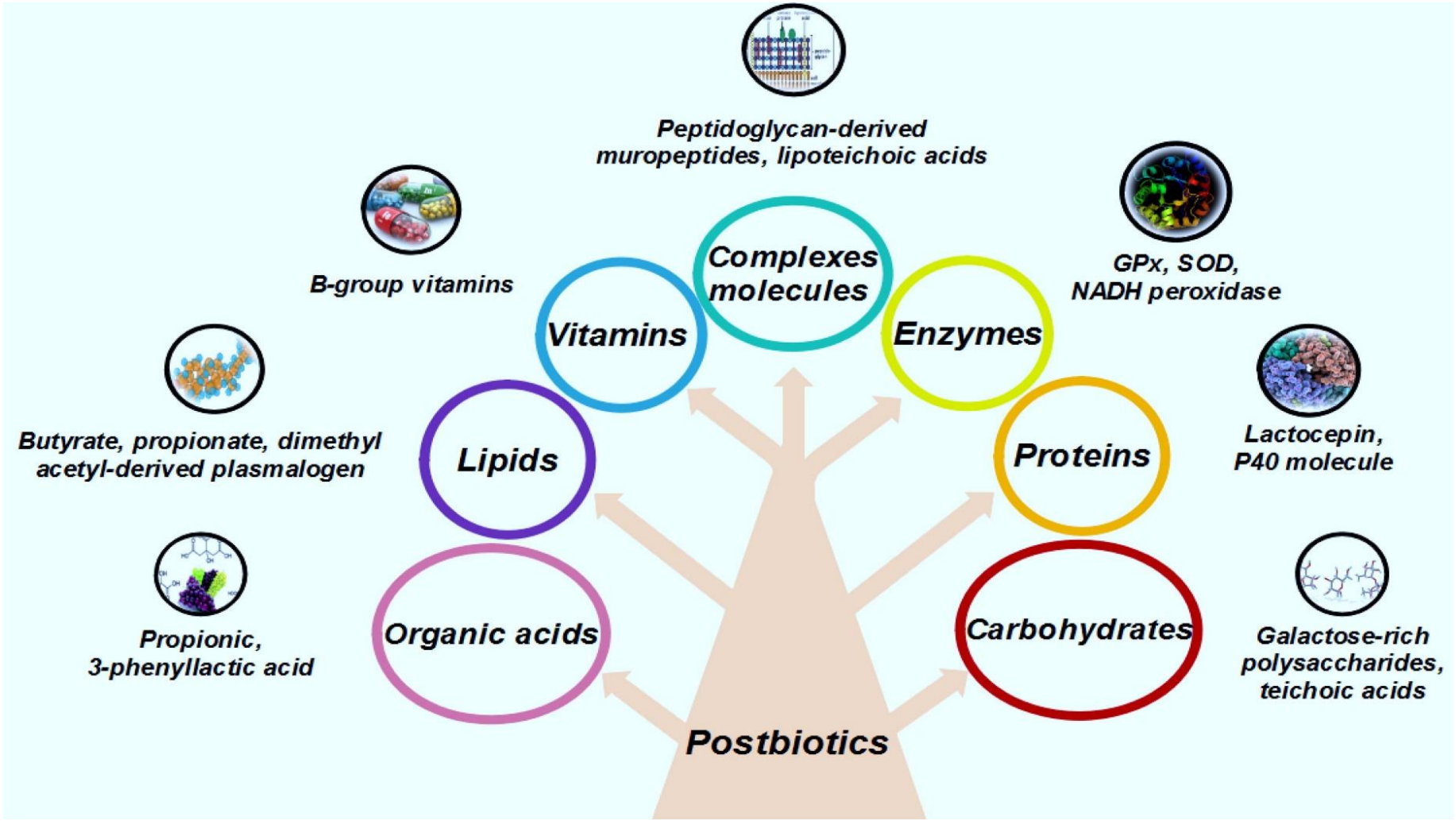
Are functional bioactive components produced during fermentation.

They can positively affect the organism.

Is a term including all microbial fermentation products.

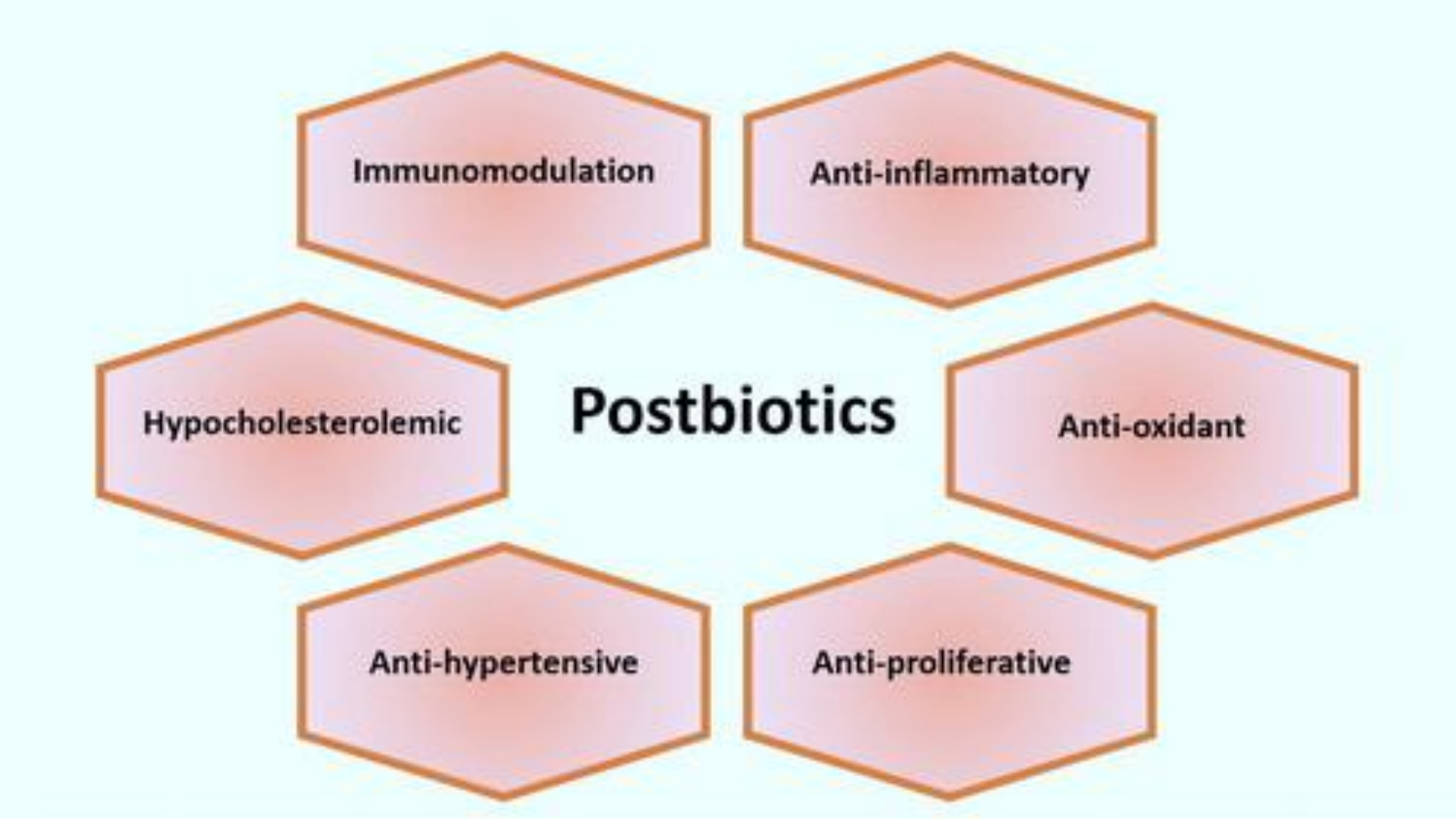
Wegh CAM, et al. *Int J Mol Sci* 2019

Postbiotics



Rad AH, et al. *Crit Rev Food Sci Nutr* 2021

Postbiotics



Rad AH, et al. *Crit Rev Food Sci Nutr* 2021

Baby-milk formula based on goat‘s milk

Similarly to cow‘s milk-based formulas, they require modification.

They secure adequate growth, are well tolerated and safe.

Baby-milk formula based on soy protein

Are not recommended for infants, mainly with congenital hypothyroidism.

Digestibility and biological value of soy protein is lower in comparison with cow‘s milk protein.

Can be recommended to vegetarians and vegans, when refusing cow‘s protein-based baby-milk formula.

Should not be confused with „soy milk“.

Volume of required milk

First 7 days of life: Finkelstein formula, required amount of milk in ml = (n-1)*70-80. n = age in newborn in days.

Followed by 150-180 ml/kg/den.

Baby-milk formulas for specific situations

- Formulas for gastroesophageal reflux (GER).
- Formulas for lactose intolerance.
- Formulas for cow‘s milk protein allergy.

GER

GER: is involuntary return of gastric content in the oesophagus with/out the presence of regurgitation and/or vomiting.

„Physiological“ GER is regurgitation with spitting in newborns and infants due to immaturity of antireflux mechanisms.

Gastroesophageal reflux disease(GERD): is GER associated with clinical discomfort, damage of tissue or both.

Physiological GER

Caused by immaturity of anti-reflux mechanisms.

Starts subsiding by 6 months of age.

Disappears between 12 and 18 months of age.

Treatment is with milk thickeners with an extract of Midsummer bread:

- In breastfed infants is added into exprimated maternal milk.
- In bottle-fed infants anti-reflux formulas, „AR“.

AR formulas do not educe the absolute number of reflux episodes but decreases the number of visible ones.

Lactose intolerance

- Primary lactose intolerance:
  - Extremely rare.
  - Autosomal recessive (AR) inheritance.
  - Manifests with severe diarrhoea after first feeding.
  - When continuing feeds, rapid dehydration and severe metabolic acidosis occur.
  - Can be confirmed genetically.

Lactose intolerance

- Secondary lactose intolerance:
  - In diarrhoea.
  - In food allergies and intolerances.
  - In immunodeficiencies.
  - In chronic intestinal inflammation.
  - In primary malabsorption syndromes.
  - In eosinophilic gastroenteritis.

Lactose intolerance

- Treatment:
  - Low-/lactose-free formula.

Cow‘s milk protein allergy (CMPA)

CMPA is a reproducible immunologically mediated reaction, caused by contact with cow‘s milk.

CMPA is the most common food allergy in newborns, infants and toddlers.

Prevalence of 0,4-0,5 % of fully breastfed infants.

In 1,9-4,9 % of bottle-fed infants.

CMPA

Main allergens: α-lactalbumin, β-lactoglobulin and casein.

Sensibilization occurs by the GIT.

Goat and sheep milk are highly homologous, and a cross-reaction is very likely (up to 90 %).

CMPA

- CMPA mechanisms:
  - IgE-mediated.
  - Non-IgE-mediated.
  - Mixed.

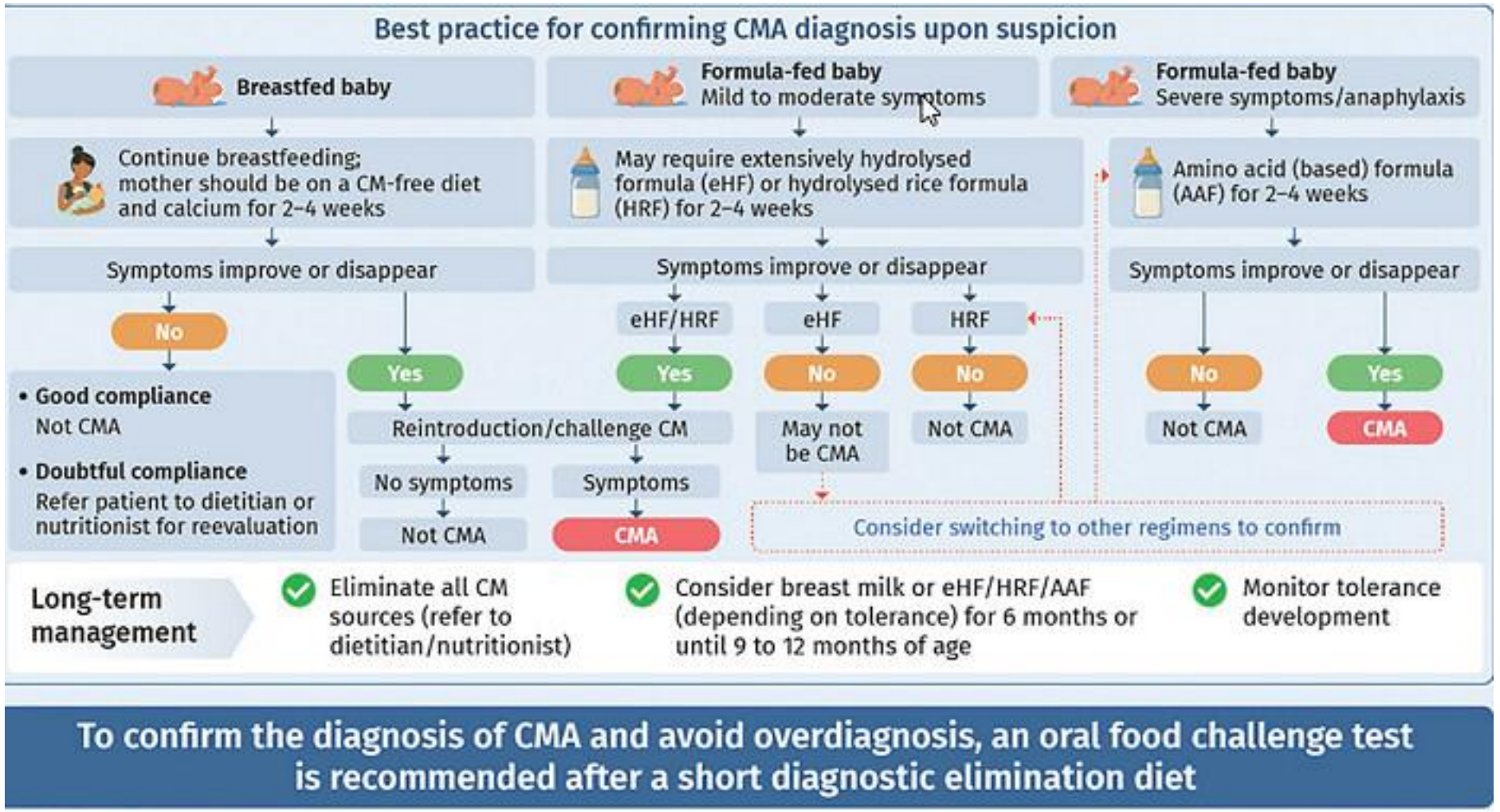
CMPA

	Infants and toddlers	Rapid reactions within 2 hours since cow‘s milk consumption
GI symptoms	Dysphagia Regurgitations Colic, abdominal pain Vomiting Loss of appetite, feeds refusal Diarrhoea±loss of protein and/or blood with stools Constipation±perianal exanthema Faltering growth Positive occult bleeding Sideropenic anaemia	Vomiting

CMPS

Respiratory symptoms	Runny nose Wheezing Chronic cough, not associated with infections		Wheezing or stridor Breathing difficulties
Skin symptoms	Urtica not associated with infections, medications or other causes Atopic eczema Angioedema		Hives Angioedema
General symptoms	Anaphylaxis FPIES	Anaphylaxis	Anaphylaxis FPIES

CMPA



Vandenplas Y, et al. *J Pediatr Gastroenterol Nutr*. 2024

Fully breastfed infant

Maternal elimination diet:

- Milk-free, dairy-free diet is sufficient in 90 % of breastfed infants.
- Supplementation by calcium, at least 1000 mg daily, is mandatory.
- Some infants require elimination of eggs.
- Soy elimination is less frequently required.
- Rarely wheat elimination.

Extensively hydrolysed baby-milk formula

AAP defines them as formulas with oligopeptides with molecular weight <3000 Da, BSACI <1000 Da.

They lead to CMPA symptom cessation in at least 90 % of newborns and infants.

Hydrolysed formulas based on rice protein

- Their advantage is total absence of cow‘s milk protein.
- L-lysine, L-threonine and L-tryptophan need to be added in production.
- Concerns regarding arsenic content were not proven.
- Seems to be a safe alternative to extensively hydrolysed formulas based on cow‘s milk.

Amino acid formulas (AAF)

The formulas only contain single amino acids.

Required by 10 % of CMPA infants.

CMPS

Baby-milk formula type	Primary indication	Secondary indication	Rare indication
AAF	Severe CMPA	CMPA with eHF intolerance	CMPA in a breastfed infant, who can‘t be breastfed anymore.
eHF	CMPA (in none breastfed infants)		
eHF with MCT	CMPA with malabsorption		
eHF with reduced lactose	CMPA with diarrhoea due to lactose intolerance		
pHF	Not indicated		
HRF		CMPA with eHF intolerance	

Vandenplas Y, et al. *J Pediatr Gastroenterol Nutr*. 2024

Exposition to cow‘s milk protein

In IgE-mediated CMPA after antibody cessation.

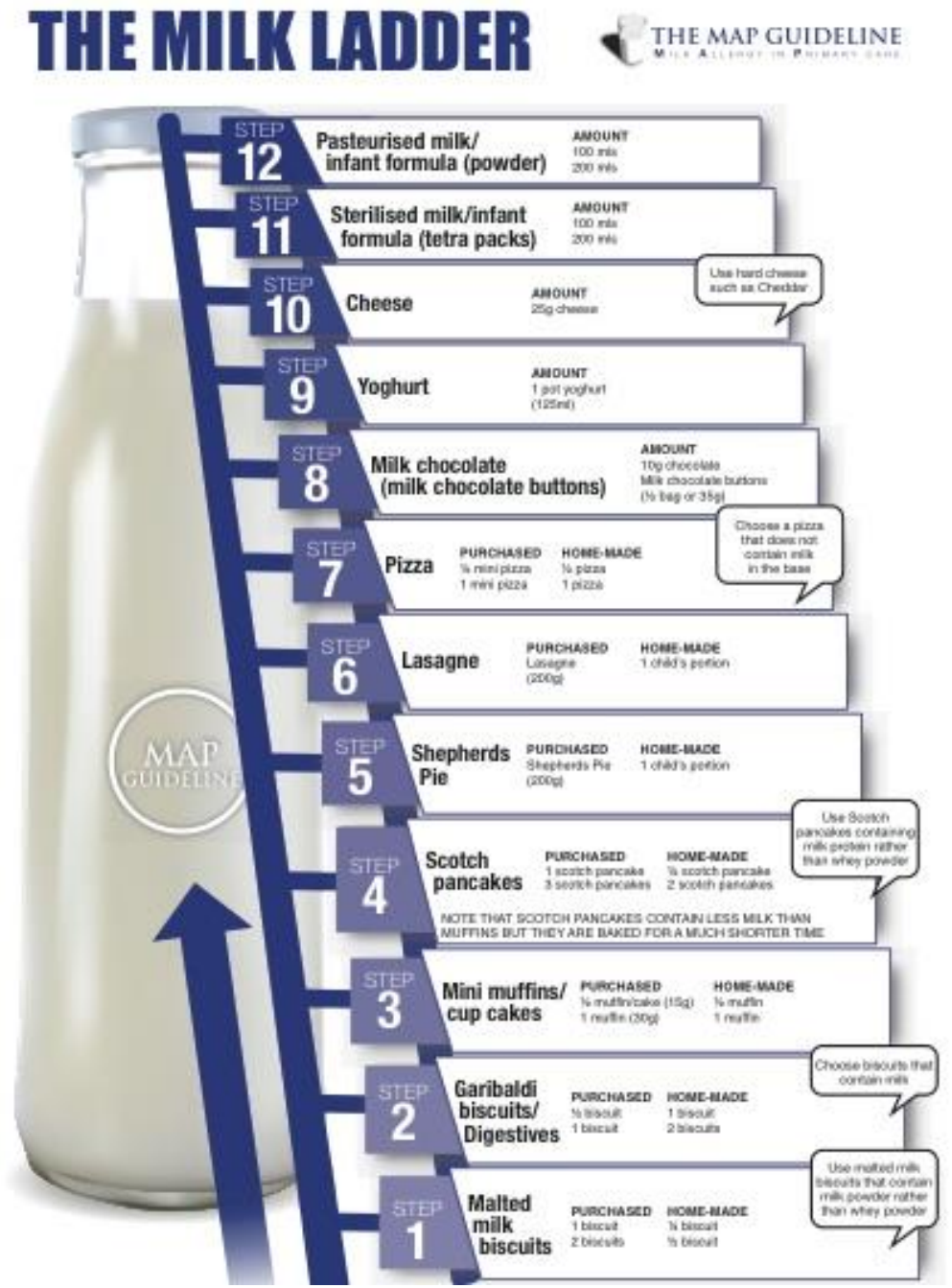
In fully breastfed infants via maternal diet.

In infants fed with eHF by formulas with intact cow‘s milk protein.

In infants on AAF, start with eHF, followed by formulas with intact cow‘s milk protein.

Exposition to cow‘s milk protein

- The milk ladder can be used in mild to moderate non-IgE mediated CMPA under the supervision of a medical professional or nutrition therapist.



iMAP MLÉČNÝ ŽEBŘÍK (cant.cz)

CMPA

- Prognosis:
  - Favourable.
  - Up to 50 % disappear by 1 year of age.
  - 80-90 % by 5 years.

Caffarelli C, et al. *It J Pediatr*. 2010

Complimentary feeds

Complimentary feeds are food given to infants as a complement to their dairy diet.

ESPGHAN recommends complimentary feeds introduction between the completed 17th week of life (completed 4th months and the 26th week (completed 6th month).

WHO a WHA:

- In fully breastfed by 6 months.
- In bottle-fed infants after completion of the 4th month of life.

Conditions for complimentary feeds commencement

Milk is insufficient for the infant.

Psychomotor development permits spoon-feeding introduction:

- Upright head and neck position.
- Active interest in feeds.
- Start of eye-hand-mouth synchronization.

The 4th month is usually the milestone, when expelling reflex diminishes and the GIT and kidneys have matured.

Consistency of feeds

- Pureed food to start with.
- Followed by well squashed food.
- Pieces, which can be held by the infant can be introduced after the 8th month.
- Late solid food's introduction (after 9.-10. months) increase the risk of solids tolerance.

Order of complimentary feeds introduction

- Monocomponent introduction.
- Starting with vegetables, followed by vegetable-meat mixtures and ending with fruits.
- Gluten should be introduced between the end of the 4th month of life and before the end of the first year.
- All foods should be introduced by 12 months of age.
- „Box“ milk after the 12th month of life.

Feeding of toddlers and preschool children

Feeding of toddlers and preschool children

Solid foods should form the majority of their dietary intake.

Milk volume of 250-500 ml or milk products equivalents should be given daily.

Food should be varied and rich in fibres.

Most common mistakes in feeding toddlers and preschool children

- Monotone diet.
- High intake of sweets, fried foods and sauces.
- Insufficient intake of milk, vegetables and fruits
- Bad food hygiene and habits.

Nutrition in puberty

Nutrition in puberty

- Puberty has the highest energy requirements.
- Teenagers influence their eating more.
- Experimentation with food might occur.
- Monotonous diet is possible.
- They regulate their food.
- They can develop feeding disorders.

Alternative diets

Alternative diets

- Most commonly:
  - Vegetarian
  - Vegan
  - Macrobiotic

Vegetarian

Excludes all types of meat, meat products, fish and crustaceans

Classification:

- Lacto-ovo-vegetarian, lacto-vegetarian, ovo-vegetarian.
- Flexitarian: sometimes consumes meat, fish or dairy products.
- Pescatarians: consume fish and animal products.

Vegans

Consumption of any meat, dairy products, seafood, eggs and honey is prohibited.

Fruitarians: consume only pulpy and dry fruits.

Macrobiotics

Is vegan diet with exclusion of some fruits and vegetables.

50-60 % of intake is from whole-grain cereals, vegetables, legumes, seaweed and fermented soy products.

Alternative diets

	Flexitarian/ Pescetarian	Lacto-ovo-vegetarian	Lacto-vegetarian	Ovo-vegetarian	Vegan
Mean	Sometimes/no	No	No	No	No
Fish and seafood	Yes/yes	No	No	No	No
Milk and dairy products	Yes/yes	Yes	Yes	No	No
Eggs	Yes/yes	Yes	No	Yes	No
Honey	Yes/yes	Yes	Yes	Yes	No

Světnička M, et al. *Pediatr praxi* 2020

Possible deficiencies when switching to a vegetable diet

Energy:

- Most at risk ages: toddlers and teenagers.
- Follow-up of growth charts is mandatory.

Proteins:

- Digestibility of vegetable proteins is mostly lower than of animal proteins:
  - Soy and gluten: similar digestibility (> 95 %).
  - Whole grain cereals and legumes: 80-90 %.
  - The rest: 50-80 %.
- Vegans should consume more proteins than RDI.

Possible deficiencies when switching to a vegetable diet

- N-3 long-chained fatty acids:
  - In adequate quantities only α-linolenic acid (ALA) → eicosapentaenoic acid (EPA) a docosahexaenoic acid (DHA).
  - Process is elongated and enzyme activity is variable.
  - Production of EPA a DHA is suppressed by high intake of n-6 linolenic acid.
  - ALA intake increment is recommended.
  - Reduction of linolenic acid intake is advised (sunflower oil).

Possible deficiencies when switching to a vegetable diet

- Vitamin B_{12}:
  - Inadequate intake is the largest issue in vegan diets.
  - Insufficiency manifests after:
    - 4-6 months in infants.
    - 1-2 years in teenagers.
  - In sufficient amounts is only available in animal products.
  - In plants can be present in some seaweed (nori) and shiitake.
  - Adequate intake in vegans can be achieved only by food supplements.

Possible deficiencies when switching to a vegetable diet

Vitamine D:

- Similar recommendations like in non-vegan children.

Iron:

- Plant non-hem iron has lower availability than hem iron.
- Iron absorption is increased with ascorbic acid.
- Is lower by phytates, polyphenols, tannins, calcium, zinc and copper.
- Fully breastfed infants of vegan mothers should have iron supplementation started by 4 months of age.
- Older children should receive more iron than the RDI and with increased vitamin C intake.

Possible deficiencies when switching to a vegetable diet

Calcium:

- Lower intake in vegans is caused by exclusion of milk and dairy products and by low biologic availability due to oxalates and phytates.
- Not only calcium quantity, but also availability should be evaluated (from spinach 5-9 %, from cauliflower, broccoli and cabbage 40-48 %.

Zinc:

- Absorption from plant diet is lower.
- Vegans should consume higher amounts than RDI.

Possible deficiencies when switching to a vegetable diet

- Iodine:
  - Plant food has low iodine amounts and depends on the type of soil, used fertilizers and food supplements.
  - Iodine salt can be a source.
  - Lower biologic availability due to strumigens (cabbage, soy, sweat potatoes).

Macrobiotic diet

Absolutely not suitable for children and can lead to both physical and psychomotor development disruptions.

In infants and toddlers, deficiency of energy, proteins, vitamin B_{12}, calcium and magnesium is documented.

Enteral nutrition

Enteral nutrition

Enteral nutrition (EN) is administration of pharmaceutically produced therapeutical products into the GIT.

Is the method of choice in patients at risk of or with developer malnutrition.

Requires a functional GIT.

Can be given orally, by a tube, or via PEG/PEG-J.

Indications:

TABLE 1. Suggested criteria for nutritional support (4,11)

Insufficient oral intake
Inability to meet ≥60% to 80% of individual requirements for >10 days
In children older than 1 y, nutrition support should be initiated within 5 days, and in a child younger than 1 y within 3 days of the anticipated lack of oral intake
Total feeding time in a disabled child >4 to 6 h/day
Wasting and stunting
Inadequate growth or weight gain for >1 mo in a child younger than 2 years of age
Weight loss or no weight gain for a period of >3 mo in a child older than 2 years of age
Change in weight for age over 2 growth channels on the growth charts
Triceps skinfolds consistently <5th percentile for age
Fall in height velocity >0.3 SD/y
Decrease in height velocity >2 cm/y from the preceding year during early/mid-puberty

Braegger C, et al. *J Pediatr Gastroenterol Nutr* 2010

Specific indications

- Neurologically disabled child
- Cystic fibrosis
- Preterm newborns and infants.
- Crohn‘s disease: Exclusive enteral nutrition (EEN).
- Period surrounding surgery.

Contraindications

Absolute:

- Paralytic or mechanical ileus.
- GIT perforation.
- NEC.

Relative:

- GIT bleeding.
- Toxic megacolon.
- Peritonitis.
- Intestinal dysmotility.
- Intestinal fistulas with large secretions.
- Severe vomiting.
- Intractable diarrhoea.

Complications

- Are rare.
- Refeeding syndrome.
- Nausea and vomiting, regurgitations and aspiration.
- Frequent stools.
- Pancreas irritation.

EN classification

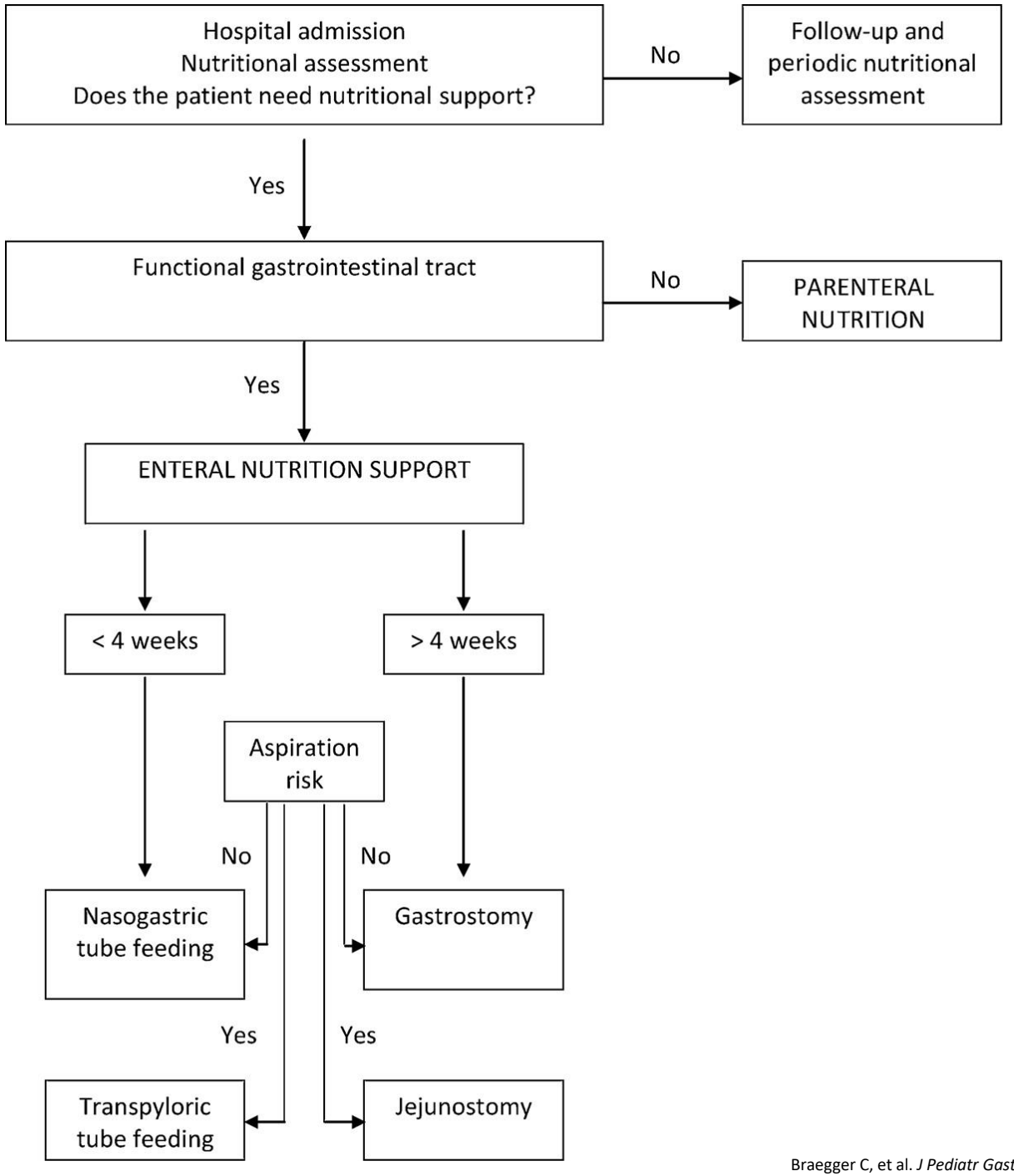
Based on caloric intake.

Based on age.

Methods of administration

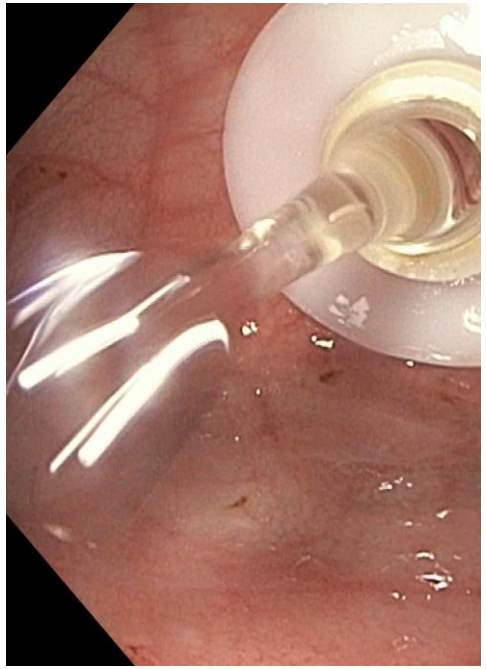
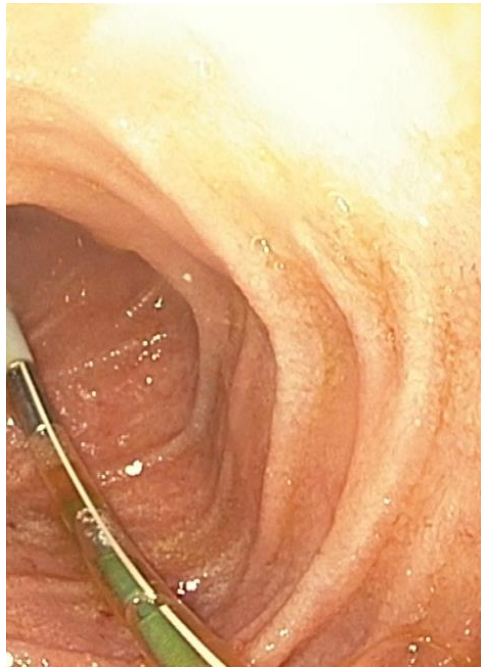
- Orally, sipping.
- NG/NJ tube.
- Per PEG or PEG/J.

Method of administration



Braegger C, et al. *J Pediatr Gastroenterol Nutr* 2010




Peg and PEG/J

Laskavě poskytnuto MUDr. Véghovou–Velgáňovou, FN Olomouc

Feeds administration into tubes or stomas

Bolus or continual feeds.

Jejunal feeds are always continual!!!

Based on caloric content

Isocaloric: 1 ml = 1 Kcal.

Hypercaloric: 1 ml = 1,5-3,2 Kcal.

Hypocaloric: 1 ml = < 1 Kcal.

Based on age

- For newborns and infants.
- For children between 1 and 6 years of age.
- For children older than 6 years.

For newborns and infants

- Up to 8 kg or 12 months of age.
- Isocaloric with intact protein.
- Isocaloric with partially hydrolysed protein.
- Isocaloric with extensively hydrolysed protein.

For children aged 1-6 years

In liquid or „yoghurt“ form.

Isocaloric with intact, partially or extensively hydrolysed protein, with/out fibre.

Hypercaloric with intact or partially hydrolysed protein.

For children older than 6 years

- Isocaloric with/out fibre.
- Hypercaloric with/out fibre.
- High protein content.
- Without fat.

Parenteral nutrition

Parenteral nutrition

Parenteral nutrition (PN) is administration of nutrients (proteins, fats, saccharides, vitamins and trace elements) intravenously.

Indications:

- Insufficient enteral intake (partial PN).
- In afunctional GIT, e.g. SBS or intestinal failure (total PN).

Classification

Based on route of administration: peripheral or central.

Based on administration schedule: continuous or cyclic.

Based on composition individually made or commercially produced.

Energy requirements

Age	Acute phase	Stabilization phase	Recovery phase
0-1 years	45-50	60-65	75-85
1-7 years	40-45	55-60	65-75
7-12 years	30-40	40-55	55-65
12-18 years	20-30	25-40	30-55

Joosten K et al. *Clin Nutr.* 2010

Composition of nutrients

Substrate	Percentage of energy intake
Proteins	10-20 %
Fats	20-50 %
Saccharides	40-60 %

www.uptodate.com/contents/parenteral-nutrition-in-infants-and-children

Requirements of proteins and fats

Age	Proteins
1 mont-3 years	1-2,5
3-12 years	1-2
Puberty	1-2

Goudoever JB, et al. *Clin Nutr*. 2018

Age	Fats
0-1 years	2,5-3 (max. 15 g/kg/hour)
1-10 years	2-2,5
Puberty	1-2

http://nutritotal.com.br/pro/wp-content/uploads/2019/04/PN-DosingASPEN.pdf

Glucose requirements

Age (weight)	Acute phase	Stabilization phase	Recovery phase
28 days - 10 kg	2-4 (2,9-5,8)	4-6 (5,8-8,6)	6-10 (8,6-14)
11-30 kg	1,5-2,5 (2,2-3,6)	2-4 (2,8-5,8)	3-6 (4,3-8,6)
31-45 kg	1-1,5 (1,4-2.2)	1,5-3 (2,2-4,3)	3-4 (4,3-5,8)
above 45 kg	0,5-1 (0,7-1,4)	1-2 (1,4-2,9)	2-3 (2,9-4,3)

Jmesotten D, et al. *Clin Nutr.* 2018

Liquids and ions requirements

	1 month -1 year	1-2 years	3-5 years	6-12 years	13-18 years
Liquids (ml/kg/day)	120-150	80-120	80-100	60-80	50-70
Sodium (mmol/kg/day)	2-3	1-3	1-3	1-3	1-3
Potassium (mmol/kg/day)	1-3	1-3	1-3	1-3	1-3
Chlorides (mmol/kg/day)	2-4	2-4	2-4	2-4	2-4

Jochum F, et al. *Clin Nutr.* 2010

Vitamins requirements

	Infants	1-18 years
Vitamin A	150-300 µg/kg/day or 2300 IU/day (697 µg/d)	150 µg/day
Vitamin D	400 IU/day or 40-150 IU/kg/day	400-600 IU/day
Vitamin E	2,8-3,5 mg/kg/day or 2,8-3,5 IU/kg/day	11 mg/day or 11 IU/day
Vitamin K	10 µg/kg/day	200 µg/day
Vitamin C	15-25 mg/kg/day	80 mg/day
Thiamine	0,35 -0,50 mg/kg/day	1,2 mg/day
Riboflavin	0,15-0,2 mg/kg/day	1,4 mg/day
Pyridoxin	0,15-0,2 mg/kg/day	1 mg/day
Niacin	4-6,8 mg/kg/day	17 mg/day
Vitamin B12	0,3 µg/kg/day	1 µg/day
Pantothenic acid	2,5 mg/kg/day	5 mg/day
Biotin	5-8 µg/kg/day	20 µg/day
Folic acid	56 µg/kg/day	140 µg/day

Bronsky J, et al. *Clin Nutr*. 2010

Trace elements requirements

	0-3 months	3-12 months	1-18 years	Maximum dose
Zinc	250	100	50	5 mg/day
Copper	20	20	20	0,5 mg/day
Iodine	1	1	1	
Selenium	2-3	2-3	2-3	100 µg/day
Mangan	≤1	≤1	≤1	50 µg/day
Molybden	0,25	0,25	0,25	5 µg/day
Chrom	-	-	-	5 µg/day

Domellöf M, et al. *Clin Nutr.* 2010

Complications

Related to i.v. lines

Metabolic:

- Overfeeding.
- Refeeding syndrome.
- Micronutrients deficiency.
- Incompatibility of some components.
- IFALD.

Rizikové faktory IFALD

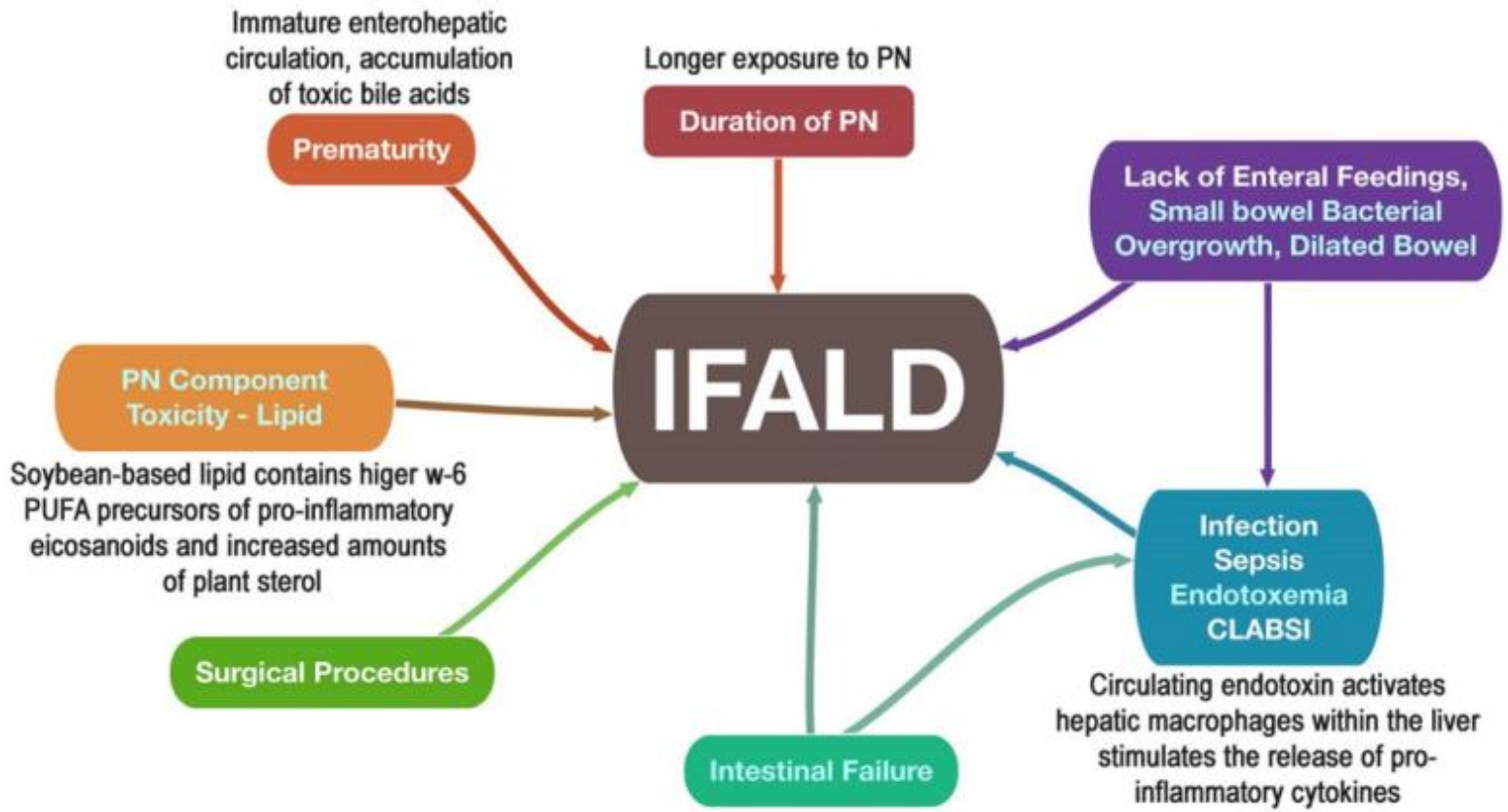


Fig. 1 Risk factors for developing intestinal failure-associated liver disease. *CLABSI* central line-associated blood stream infection, *IFALD* intestinal failure-associated liver disease, *PN* parenteral nutrition, *PUFA* polyunsaturated fatty acid

Lee WS, et al. *Clin Nutr*. 2010

Complications

- Metabolic:
  - Kidney disease.
  - Metabolic bone disease.
  - Growth failure.
  - SIBO.
  - D-lactic acid acidosis.

Refeeding syndrome

Refeeding syndrome (RS) is the sum of metabolic and electrolyte changes in malnutrient patients, in whom nutrition intake was renewed or significantly increased.

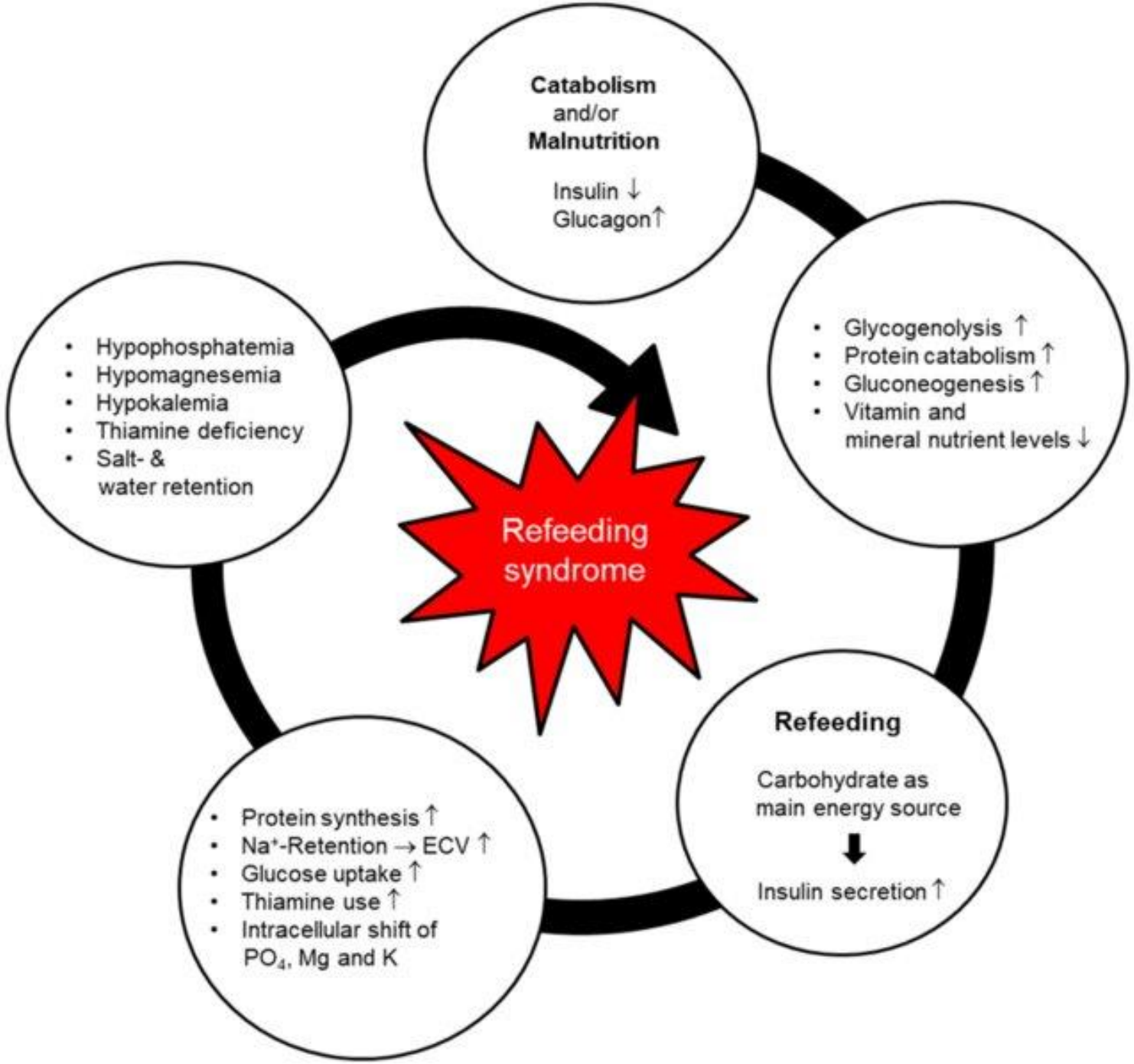
Hypophosphatemia is a landmark, hypokalaemia and hypomagnesaemia may be also present.

Risk groups

Food intake disorders, mainly mental anorexia.
Malabsorption (SBS, coeliac disease, Crohn‘s disease, cystic fibrosis).
Dysphagia (EoE, achalasia).
Neurological disease (CP, mental retardation).
Psychiatric disorders.
Postoperative conditions (complications, insufficient perioperational nutrition).
CAN.
Drug addiction, ethylism.
Oncological disease.
Chronic organ dysfunction (kidney, heart failure, liver cirrhosis)

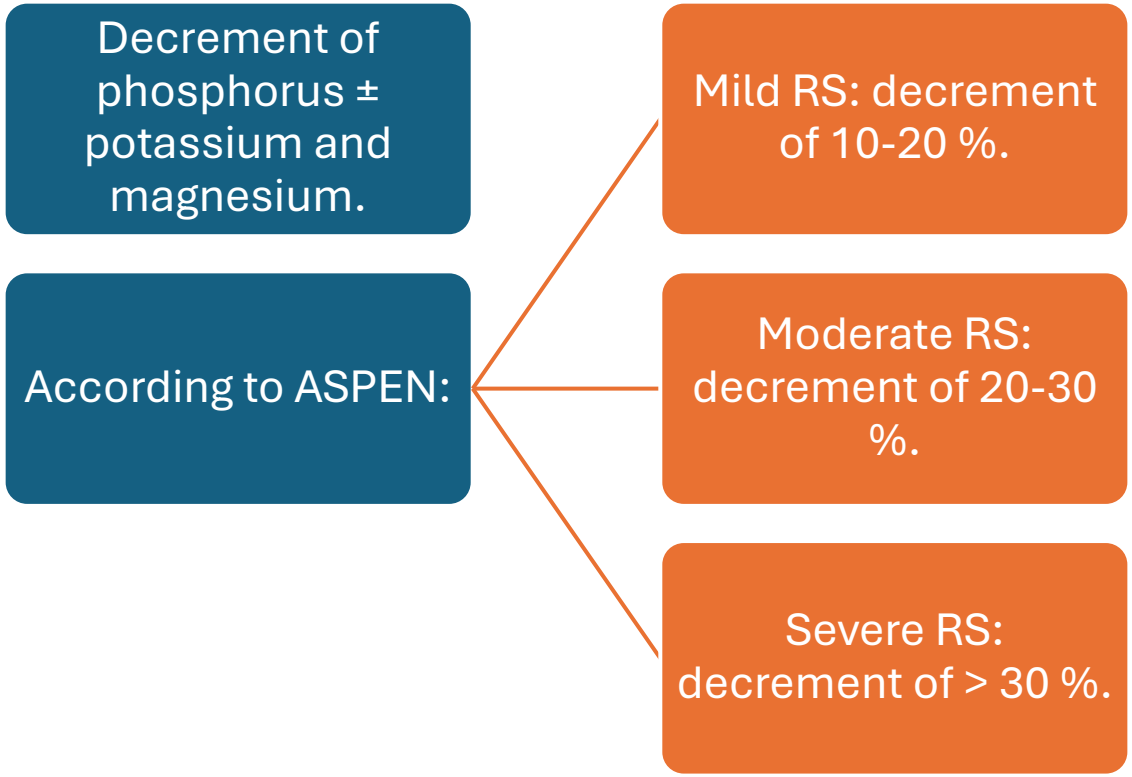
Ševela S, et al. *Nutr Clin Pract*. 2020

Pathogenesis of RS



Aubry ER, et al. *J Clin Med.*. 2018

Diagnostics



Risk factors

	Moderate RS risk (presence of at least 2 criteria)	**High RS risk (presence of at least one criteria)**
BMI (z-score)	z – score -2 up to - 2,9	z-score ≥ -3
Weight loss	< 50 % of expected weight gain	< 25 % of expected weight gain
Energy intake	5-7 days, energy intake < 75 %	>7 days, energy intake < 75 %
Ions levels (K, P, Mg)	Low levels	Low levels
Loss of subcutaneous fat and muscle mass	Arm circumference: z-score -2 up to -2,9	Arm circumference: z-score ≥ -3
At risk diagnoses	Moderate disease	Severe disease

Ševela S, et al. *Cas Lek Cesk* 2016

Clinical approach to RS

Evaluation of energy intake and ion levels.

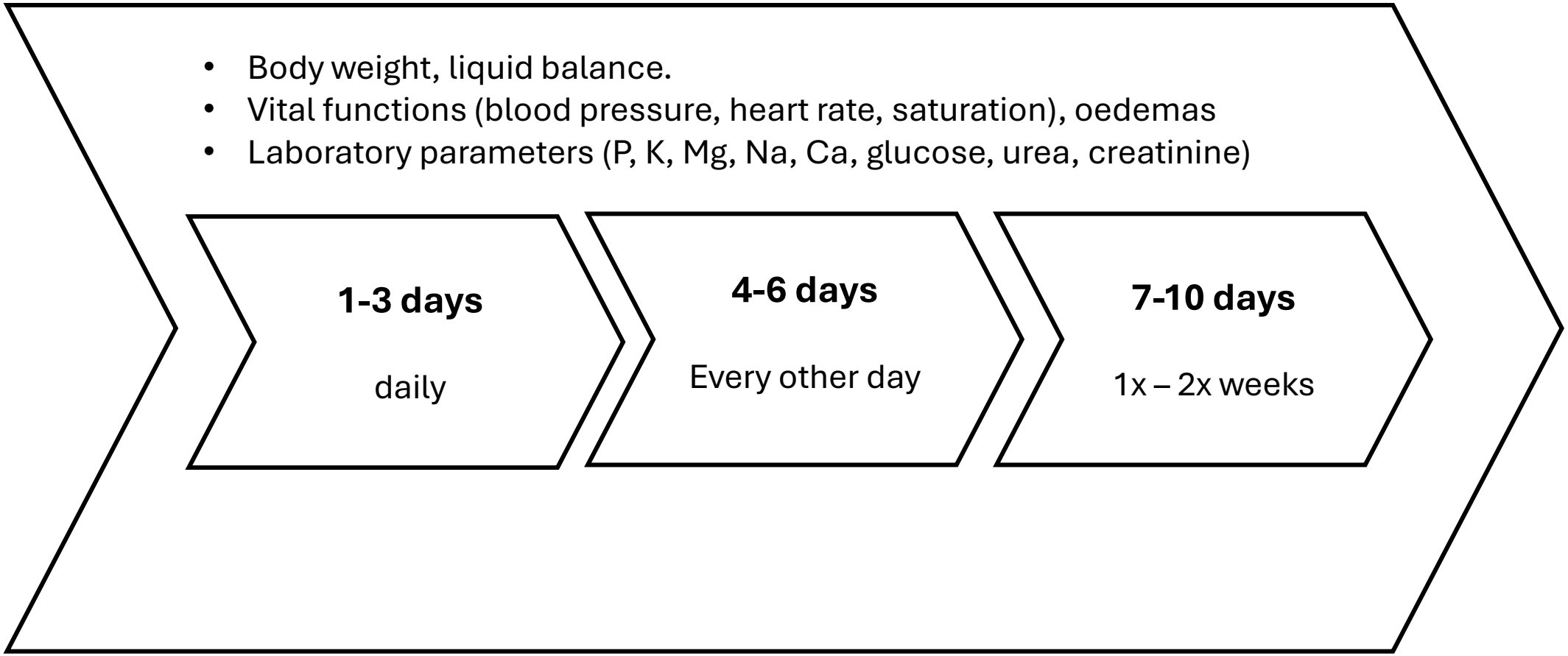
Commencement of realimentation with 10-20 Kcal/kg/day, in infants 50-75 % energy intake.

Daily Thiamine 100-200 mg.

Full nutrition within 5-7 days.

Monitoring a patient with RS

- Body weight, liquid balance.
- Vital functions (blood pressure, heart rate, saturation), oedemas
- Laboratory parameters (P, K, Mg, Na, Ca, glucose, urea, creatinine)



Thank you for your attention!