

Breast milk and infant nutrition

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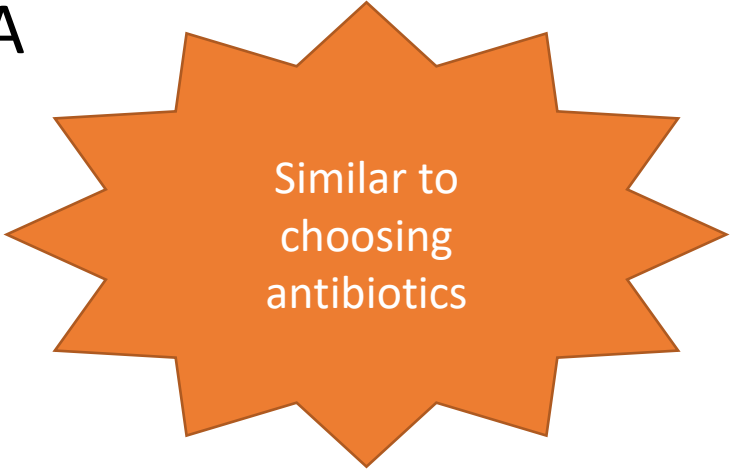
American board of pediatric gastroenterology

American board of general pediatrics



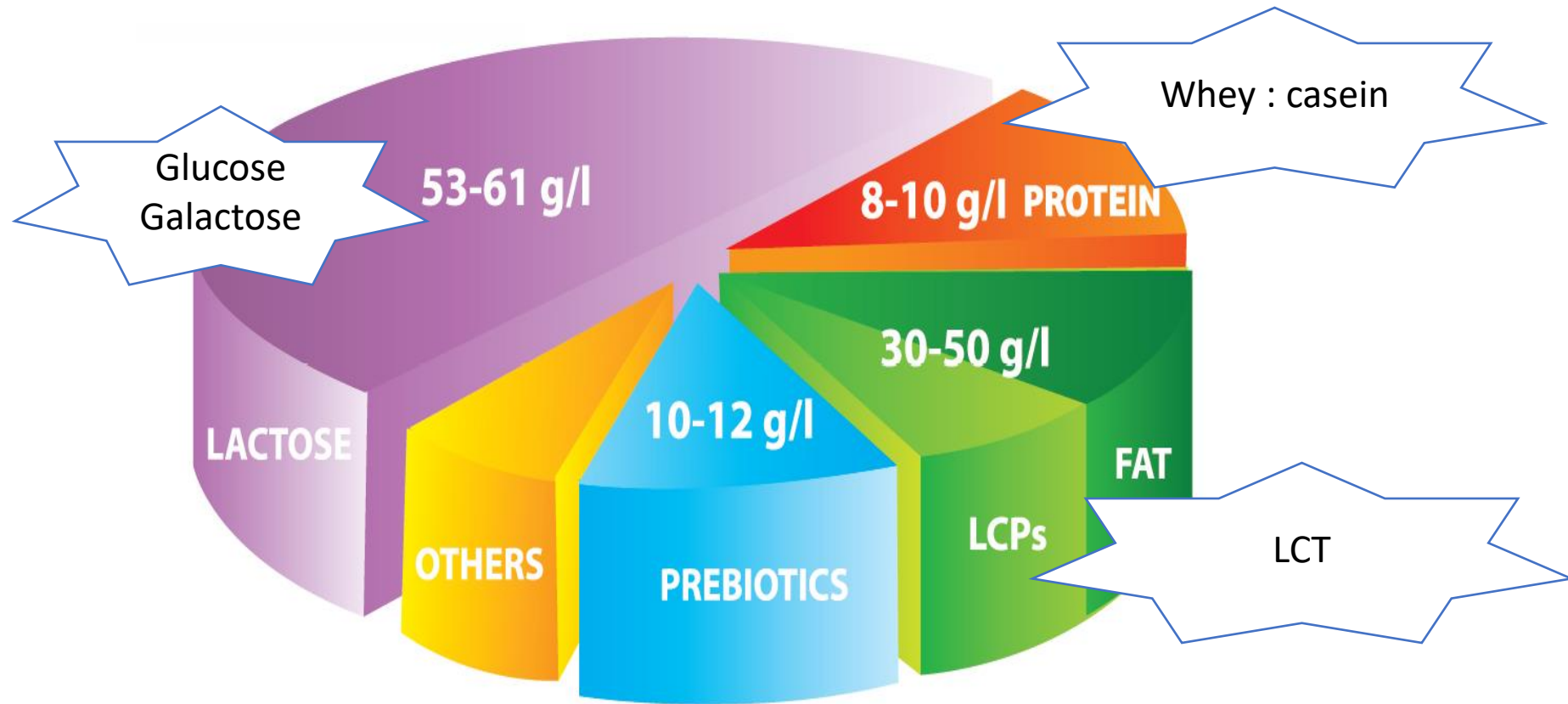
Contents

- Composition and benefits of breast milk
- Types of formulas
- Cow's milk protein allergy CMPA
- Practical approach to formulas
- Cases



Similar to
choosing
antibiotics

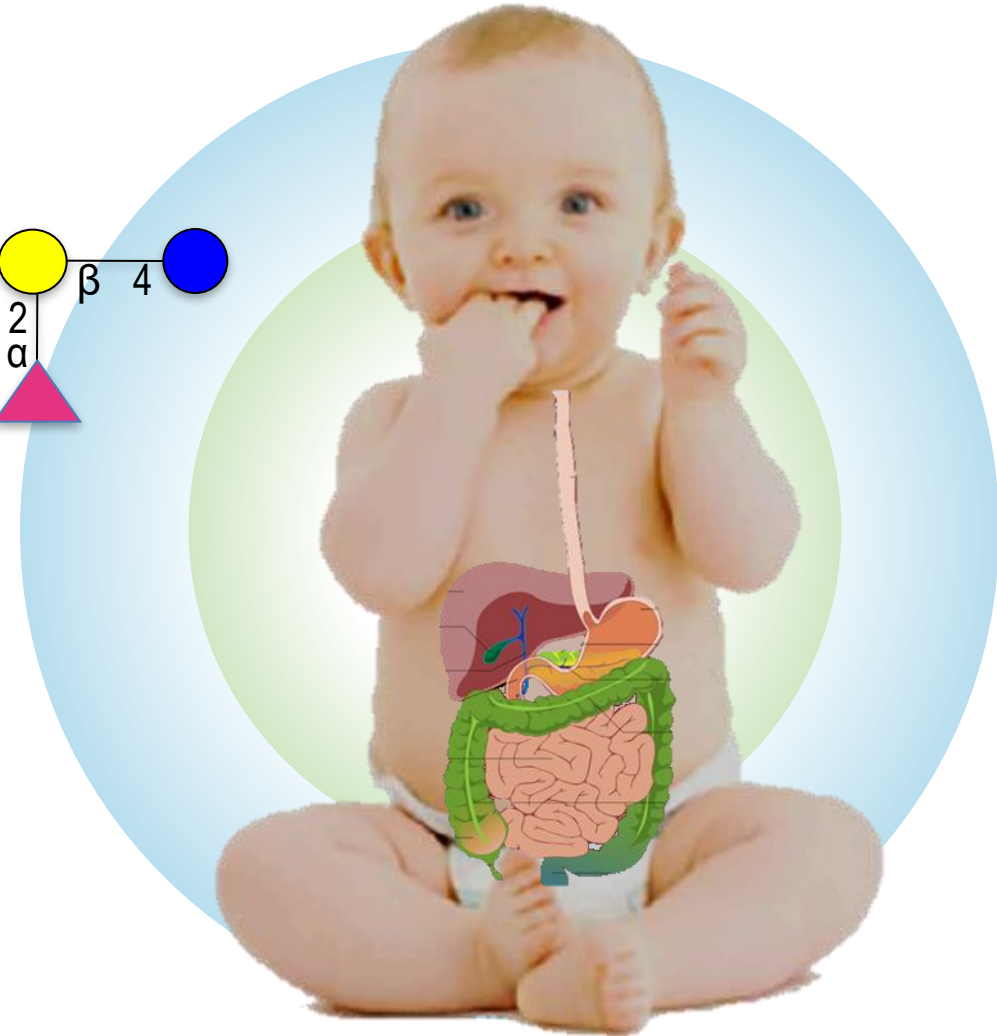
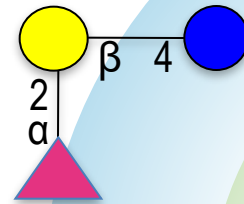
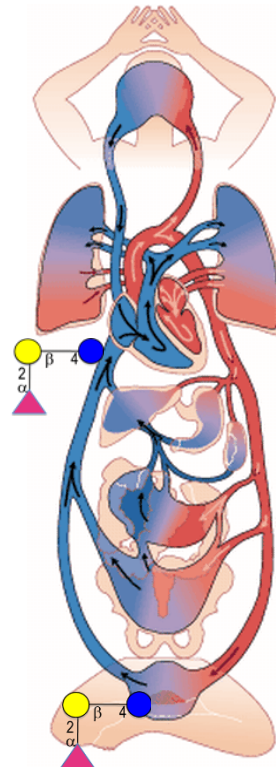
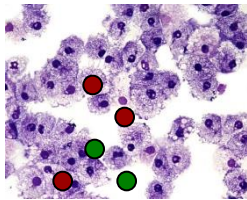
Composition of breast milk



Composition of breast milk

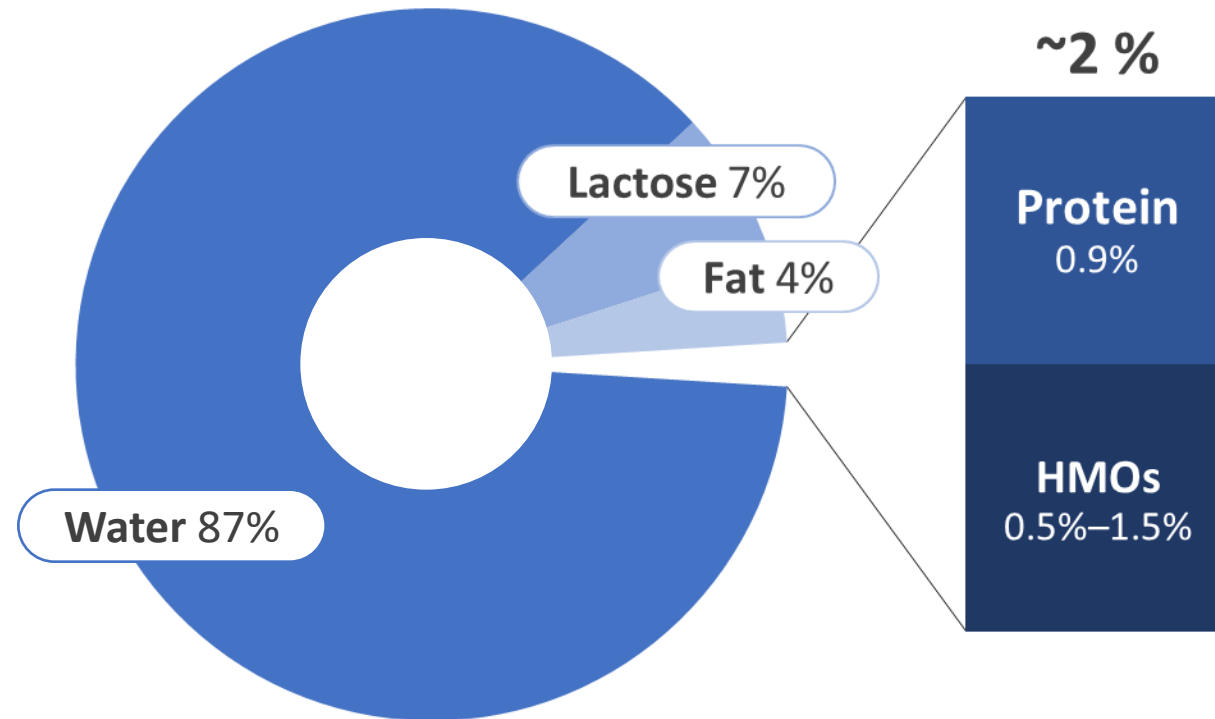
Antimicrobial factors	Hormones	Cytokines and anti-inflammatory factors	
Secretory IgA, IgM, IgG Lysozyme Complement C3 Leukocytes Lipids and fatty acids Antiviral mucins, GAGs Lactoferrin Nucleotides Human milk oligosaccharides	Feedback inhibitor of lactation Insulin Prolactin Thyroid hormones Corticosteroids, ACTH Oxytocin Calcitonin Parathyroid hormone Erythropoietin	Tumor necrosis factor Interleukins Interferon- γ Prostaglandins α 1-antichymotrypsin α 1-antitrypsin Platelet-activating factor: acetyl hydrolase Human milk oligosaccharides	
Digestive enzymes	Transporters	Growth factors	Others
Amylase Bile acid-stimulating esterase Bile acid-stimulating lipases Lipoprotein lipase	Lactoferrin (Fe) Folate binder Cobalamin binder IgF binder Thyroxine binder Corticosteroid binder	Epidermal (EGF) Nerve (NGF) Insulin-like (IGF) Transforming (TGF) Taurine Polyamines	Casomorphins δ -sleep peptides DNA, RNA Carotenoids

Human Milk Oligosaccharides **HMO**



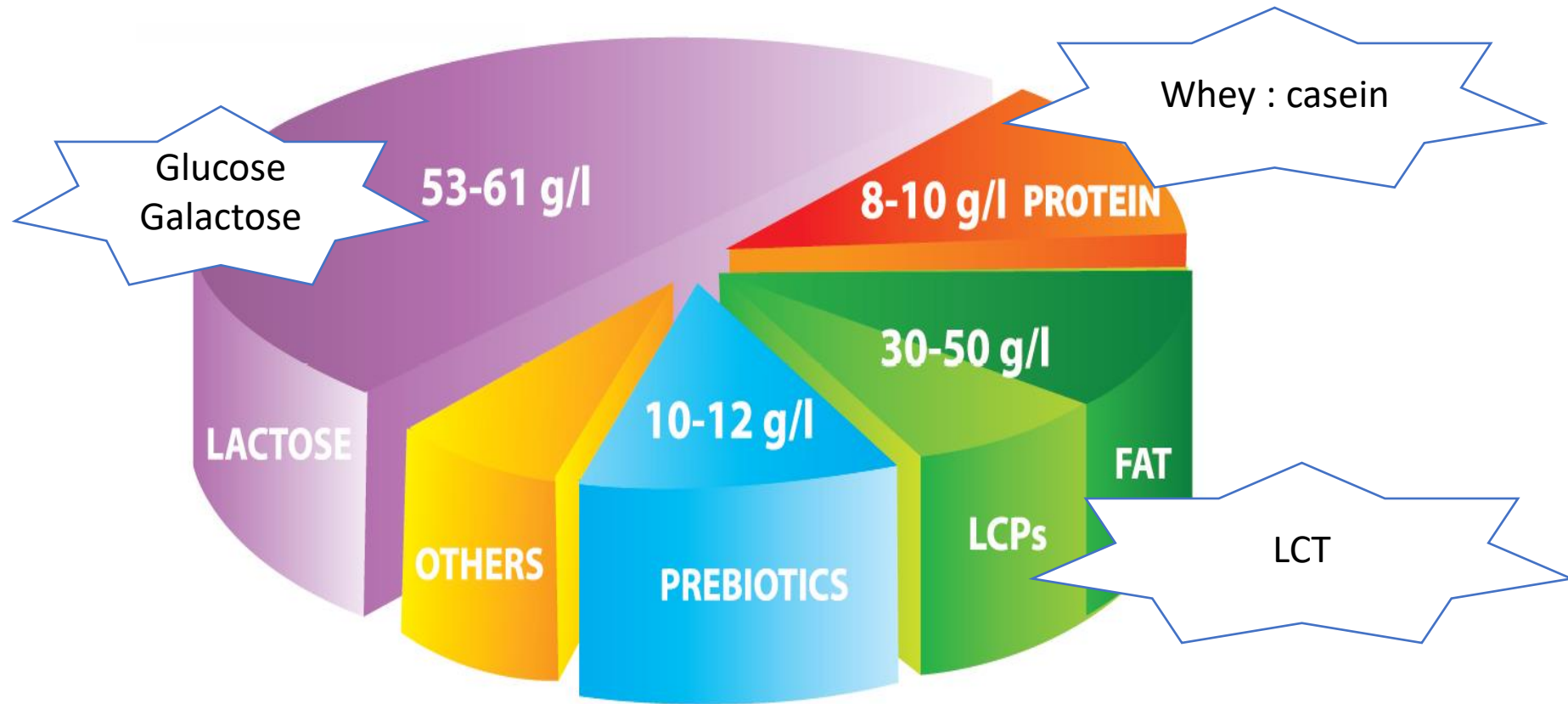
Human Milk Oligosaccharides (HMOs)

A Major Fraction of Human Milk



Oligosaccharide is the most common solid constituent
of human milk after lactose and lipid, similar to protein (~5-15 g/L).

Composition of breast milk



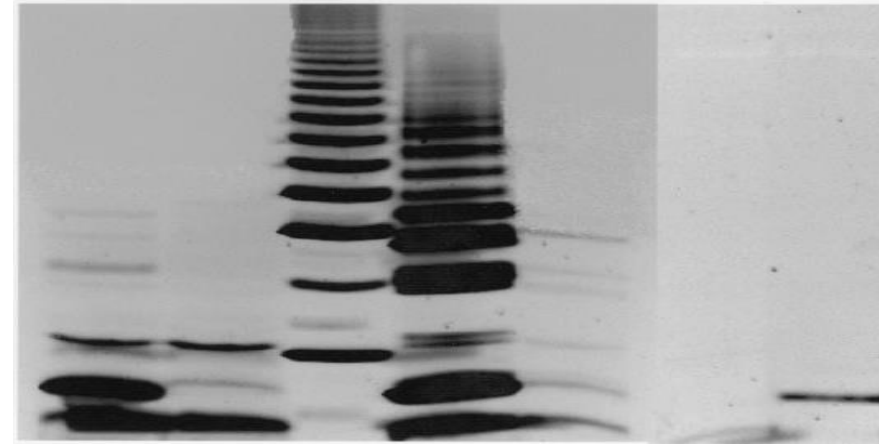
HMOs Across Species

Lactose is the most abundant carbohydrate in milk of all mammals (source of energy)

HMOs are all built on lactose

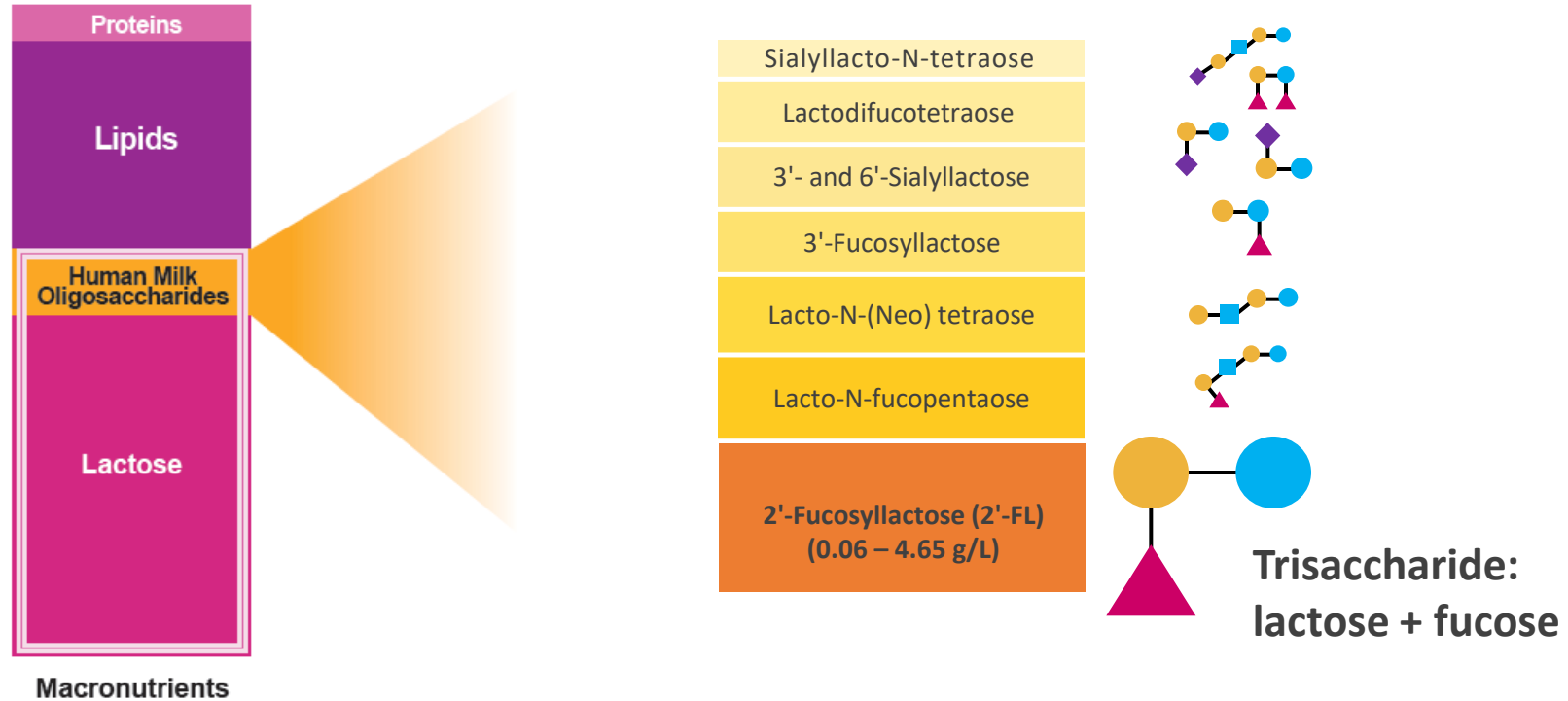
Human milk has highest concentration and most diverse repertoire of oligosaccharides

> 200 HMO structures identified
~20 Major Structures



What are the major HMOs?

2'-FL is the most abundant HMO in most mothers' breast milk^{*,1,2}



*2'-FL present in ~75-80% mothers' breast milk.

Sources: 1. Erney RM, et al. *J Pediatr Gastroenterol Nutr.* 2000;30:181-192; 2. Thurl S, et al. *Br J Nutr.* 2010;104:1261-1271.

Benefits of breast milk

- Immunity and protection against infection:
 - Antibodies in the milk
 - Cytokines
 - Normal flora growth factors

The Power of Human Milk

Saving Lives



Diarrhea

Children who are breastfed have a substantially lower risk of suffering and dying from infectious diarrhea as well as respiratory infections.

The Power of Human Milk

Saving Preterm Lives



Necrotizing Enterocolitis

Preterm infants who
receive human
milk are at six- to ten-
fold lower risk to
develop
necrotizing
enterocolitis.

The Power of Human Milk

Benefits for Life



The Power of Human Milk

Good for Mothers



Breastfeeding Reduces Infant Risks of Major Infectious and Inflammatory Diseases

Severe lower respiratory tract infections (LRTI)

Acute gastroenteritis (AGE)

Acute otitis media (AOM)

Necrotizing enterocolitis (NEC): preterm

Sudden infant death syndrome

Atopic dermatitis

Childhood asthma

Childhood leukemia

Type 1 diabetes

Breastfeeding and Maternal and Infant Health Outcomes in Developed Countries
Evidence Reports/Technology Assessments, No. 153. Investigators: Ip, Chung, et al, [Agency for Healthcare Research and Quality \(US\)](#); April 2007.

(Bartick & Reinhold, Pediatrics, 2010)

Mother- Baby Bonding



Benefits of breast milk to the mother

- Helps with mother weight loss
- Helps uterine contraction post delivery
- Helps with to get rid of pregnancy hormones
- Act as contraceptive : Lactation induced amenorrhea [LAM](#)

Other Benefits of breast milk

- Available 24/7
- Cheaper!
- No need for preparation : bottle/ water

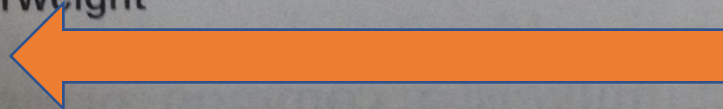
Table 42-3 CONDITIONS FOR WHICH HUMAN MILK HAS BEEN SUGGESTED TO HAVE A PROTECTIVE EFFECT

Acute disorders

- Diarrhea
- Otitis media
- Urinary tract infection
- Necrotizing enterocolitis
- Septicemia
- Infant botulism

Chronic disorders

- Insulin-dependent diabetes mellitus
- Celiac disease
- Crohn's disease
- Childhood cancer
 - Lymphoma
 - Leukemia
- Recurrent otitis media
- Allergy
- Obesity and overweight
- Hospitalizations
- Infant mortality



Adapted from the Schanler RJ, Dooley S: *Breastfeeding handbook for physicians*, Elk Grove Village, IL, 2006, American Academy of Pediatrics.

BREAST IS BEST

Patterns of milk supply

Table 42-5 PATTERNS OF MILK SUPPLY

DAY OF LIFE	MILK SUPPLY
Day 1	Some milk (~5 mL) may be expressed
Days 2-4	Lactogenesis, milk production increases
Day 5	Milk present, fullness, leaking felt
Day 6 onward	Breasts should feel “empty” after feeding



Colostrum
milk

Adapted from Neifert MR: Clinical aspects of lactation: promoting breastfeeding success, *Clin Perinatol* 26:281–306, 1999.

INFANT FORMULAS

Infant formulas

- Can be classified according to their content:
- Protein content
- Carbohydrate content
- Fat content



How to think about formulas

Formula type	Prtn content	CHO content	fat content

Infant Formulas – Protein Content

- Divided into 4 classes of formulas
 - Cow's milk based formulas
 - variable prtn content
 - variable whey: casein ratio
 - Soy formulas
 - Casein **hydrolysate** formulas
 - Extensive **Vs** partial
 - Amino acid based formulas



Indiana University School of Medicine
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Protein Content of Infant Formulas			
Protein Source	Examples	Indications	Price*
Cow's Milk	Enfamil with Iron	Normal GI tract; Enfamil AR used for gastroesophageal reflux	\$
	Enfamil Lipil		
	Similac with Iron		
	Similac Advance		
	Carnation Good Start		
	Good Start Supreme		
	Enfamil Gentlease		
	Enfamil AR		
	Store Brands		
Soy	Prosobee	Cow's milk protein allergy, Lactose malabsorption, or Galactosemia	\$
	Isomil		
	Alsoy		
	Store Brands		
Casein Hydrolysate	Nutramigen	Cow's milk and/or soy allergy; Alimentum and Pregestimil are also used for malabsorption	\$\$
	Alimentum		
	Pregestimil		
Amino Acids	Neocate	Severe protein allergy not responsive to casein hydrolysate formula	\$\$\$-\$\$\$\$
	Elecare		

Primilac CMA

Bebelac HA

Nan HA

Similac total comfort

S26

Nan

Bebelac

Seha

Similac

Ronlac

AR formulas

"Sensitive" / LF/

* Each \$ = approximate cost of standard cow's milk based formula

As you move down this table from cow's milk to soy to hydrolysate to amino acid based formulas, the formulas become less antigenic; formulas within a class are similarly antigenic to one another. When choosing a formula to treat milk protein allergy, you should progress down the table. It is not beneficial to change to a different formula

Infant Formulas – Carbohydrate Content

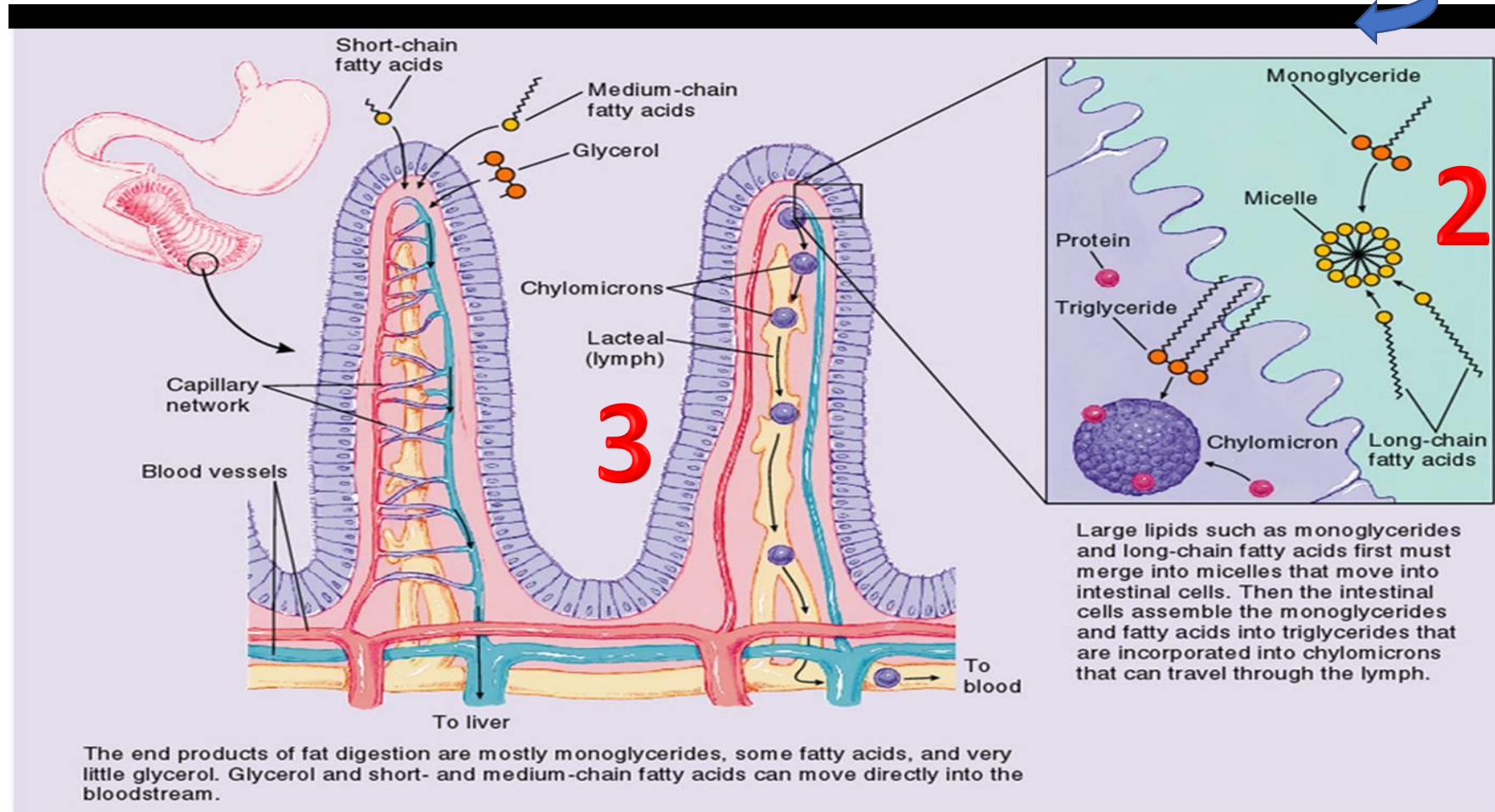
- Main types of carbohydrates in formulas
 - Lactose
 - Sucrose
 - Glucose polymers :
- What type of formula should be used in patients with galactosemia? Why?
 - formulas that do not contain lactose

Infant Formulas – Fat Content

- Main types of fats in formulas
 - Long chain triglycerides (LCTs)
 - Medium chain triglycerides (MCTs)

Absorption of MCT vs LCT

1
Lipase



- When are MCTs beneficial?
 - Impaired fat absorption or lymphatic abnormalities
- Which formulas contain MCTs?
 - Alimentum (33%), **Pregestimil (55%)** , Alfare 38%
 - Elecare (33%)
 - Portagen (87%), Vital HN (45%)



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	Alsoy		
Casein Hydrolysate	Store Brands	Cow's milk and/or soy allergy; Alimentum and Pregestimil are also used for malabsorption	\$\$
	Nutramigen		
	Alimentum		
Amino Acids	Pregestimil	Severe protein allergy not responsive to casein hydrolysate formula	\$\$\$-\$\$\$\$
	Neocate		
	Elecare		

Primilac CMA
Bebelac HA
Nan HA

S26
Nan
Bebelac
Seha
Similac
Ronlac
AR formulas
"Sensitive" / LF/

* Each \$ = approximate cost of standard cow's milk based formula

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Proper preparation of formula

- Hand washing
- **READ THE INSTRUCTIONS**
- Most formulas in the local market:
 - 1 scoop powder in 30 ml
(nan, babelac, seha, ronlac)
 - Except : S26, similac 1 scoop in 60 ml

Calorie content of formulas

- Regular formula (breast milk)
- 67 kcal : 100 ml
- 20 Kcal : 30 ml (oz) 20 Kcal/ oz

Regular calorie needs for infant

- At least 100 kcal/ kg/ day
- We need to always calculate the calorie intake from formula
- Total volume / weight $\times$ formula calorie concentration
= Kcal / kg/ day

Example

- 1 month old infant
 - 4 kg
 - Regular Formula intake 90 ml q 3 hrs
 - What is the daily total caloric intake ?
-
- Total volume / weight X formula Conc.
 - $(90 \times 8) / 4 \times 67/100$
- = 120 kcal / kg/ day

COW'S MILK PROTEIN ALLERGY

CMPPA

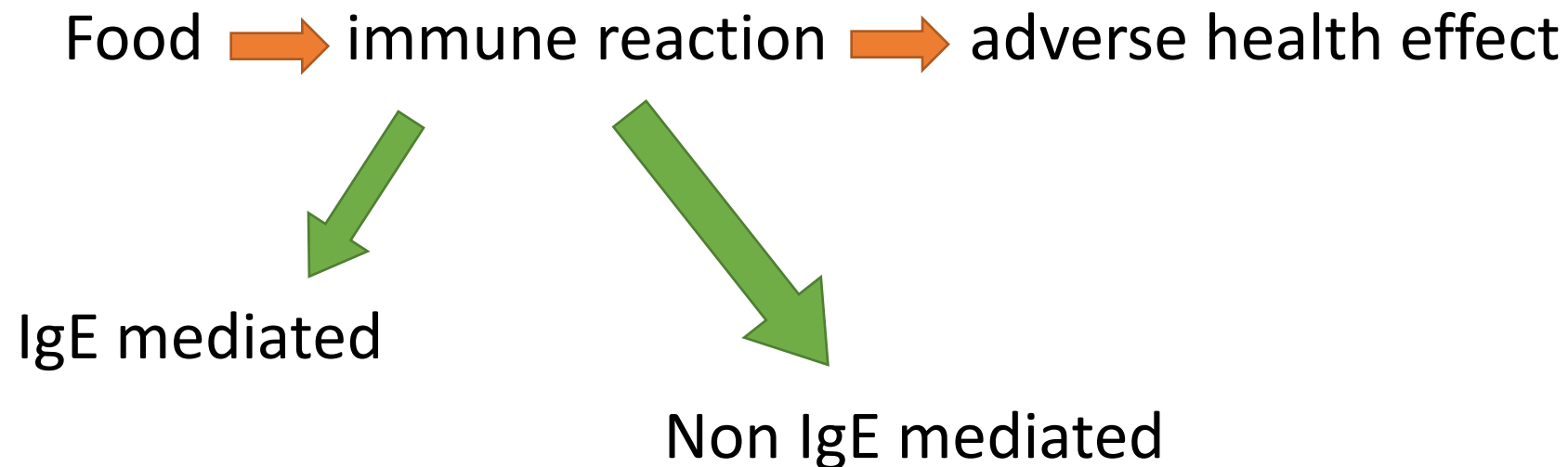
CMPPA

- What is it?
- How to diagnose?
- How to treat?

Cow's milk protein allergy

Food allergy :

- Adverse health effect
- Arising from a specific immune response
- Occurs reproducibly following exposure to a given food



CMPA

- The **leading cause** of food allergy in infants and young children younger than 3 years.
- GI tract manifestation alone can be diagnosed in all age groups
- Nonspecific!

CMPPA

- There is no single diagnostic test

- Risk for both :

over- and underdiagnosis

&

over- and undertreatment

Diagnostic Approach and Management of Cow's-Milk Protein Allergy in Infants and Children: ESPGHAN GI Committee Practical Guidelines

**S. Koletzko, [†]B. Niggemann, [‡]A. Arato, [§]J.A. Dias, ^{||}R. Heuschkel, [¶]S. Husby, [#]M.L. Mearin,
^{**}A. Papadopoulou, ^{††}F.M. Ruemmele, ^{‡‡}A. Staiano, ^{§§}M.G. Schäppi, and ^{||||}Y. Vandenplas*

Epidemiology of CMPA

- Infants : prevalence 2% - 3%
- Children 6 years and older : < 1%

Clinical manifestations

❖ Immediate / early reactions:

Occurs minutes – 2 hours after ingestion

IgE- mediated

❖ Delayed / late reactions:

Occurs 48 hrs – up to 1 week

Non- IgE mediated

Some food allergen
can have both
reactions

Clinical manifestations

- Involve different organ systems:

✓ skin , GI tract , and respiratory tract

✓ The involvement of >2 systems increases the probability of CMPA

TABLE 1. Some symptoms and signs related to CMPA

	Infants and toddlers	Older children	Immediate reaction (within min–2 h after ingesting CMP)
Digestive	Dysphagia Frequent regurgitation Colic, abdominal pain Vomiting Anorexia, refusal to feed Diarrhea ± intestinal protein or blood loss Constipation ± perianal rash Failure to thrive Occult blood loss Iron-deficiency anemia	Dysphagia Food impaction Regurgitation Dyspepsia Nausea, vomiting Anorexia, early satiety Diarrhea ± intestinal protein or blood loss Constipation Abdominal pain Occult blood loss Iron-deficiency anemia	Vomiting
Respiratory	Runny nose Wheezing Chronic coughing (all unrelated to infections)	Runny nose Wheezing Chronic coughing (all unrelated to infections)	Wheezing or stridor Breathing difficulties
Skin	Urticaria (unrelated to infections, drug intake, or other causes) Atopic eczema Angioedema (swelling of lips or eyelids)	Urticaria (unrelated to infections, drug intake, or other causes) Atopic eczema Angioedema (swelling of lips or eyelids)	Urticaria Angioedema
General	Anaphylaxis Shock-like symptoms with severe metabolic acidosis, vomiting, and diarrhea (FPIES)	Anaphylaxis	Anaphylaxis FPIES

CMPA = cow's-milk protein allergy; FPIES = food protein-induced enterocolitis syndrome.

Diagnosis of CMPA

- Based on History and physical exam

Specific IgE and skin prick test SPT

- Children with GI manifestations of CMPA are more likely to have negative specific IgE test results compared with patients with skin manifestations.
- Negative test result does not exclude CMPA
- Positive result indicates sensitization to CMP only. Oral challenge test is needed to confirm diagnosis.

Treatment for CMPA:

- In breast-fed infants:

➡ the mother should start a strict CMP free diet.

- Non-breast-fed

➡ infant should receive an extensively hydrolyzed protein-based formula

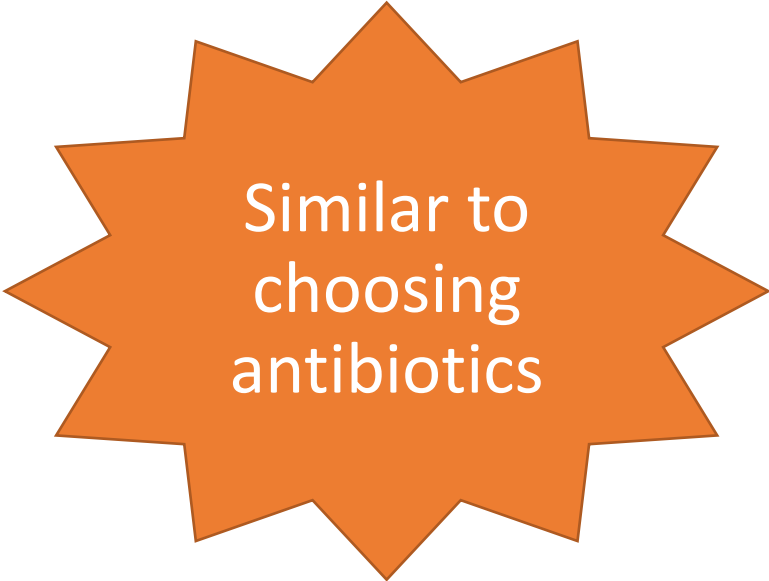
Rx CMPA

- ❑ Amino acids–based formulae : for certain situations.
- ❑ Soy protein formula, if tolerated, is an option beyond 6 months of age.
- ❑ Nutritional counseling and regular monitoring of growth are mandatory in all age groups requiring CMP exclusion.

Reevaluation

- Patients should be reevaluated every 6 to 12 months to assess for tolerance to CMP.
- This is achieved in >75% by 3 years of age and >90% by 6 years of age.
- Inappropriate or overly long dietary eliminations should be avoided. Such restrictions may impair the quality of life of both child and family, induce improper growth, and incur unnecessary health care costs.

PRACTICAL APPROACH

An orange starburst shape with multiple points, containing the text "Similar to choosing antibiotics".

Similar to
choosing
antibiotics

A child on TPN is being transferred to your care from an outside hospital with **Gram negative rods** growing from her blood culture. On your way to see the patient, you ask your 5th year medical student to make recommendations for antibiotic coverage. He recommends **vancomycin** because he has seen it used in other **central line infections**.

- Do you agree with his plan? Why or why not?
 - Vancomycin has no Gram negative coverage!
- Think about the process of choosing antibiotics
 - Determine what organism you are trying to treat
 - Pick an antibiotic that covers that organism
 - Assess the response to therapy
- Choosing a formula should follow a similar process!

Choosing an Infant Formula

- Therefore, if you believe that the patient's symptom(s) has a formula intolerance cause:
 1. Determine the most likely **cause** of the intolerance
 - protein **Vs** carbohydrate (sugar) **Vs** fat
 2. Change to a **formula** that will treat that condition
 - modified prtn **Vs** lactose free **vs** MCT fat
 3. Assess the response to the formula change
 4. Decide if another formula change is necessary

CASES

A 1-month-old male presents with a one week history of excessive irritability that occurs around the clock. The parents report seeing streaks of blood in the stool. The patient is currently taking regular formula. On exam the patient is irritable, but consolable by mom, and has a small amount of blood in the stool (heme +).

- What is the most likely cause of this patient's symptoms?
- How would you manage this patient?
- How about if he was exclusively breast – fed?

A 3-month-old female presents with spitting up that occurs 4-5 times per day after meals. The mom has tried multiple regular formulas. The patient is not irritable, is gaining weight well, and has no respiratory symptoms. Physical exam is unremarkable.

- What is the most likely cause of this patient's symptoms?
- How would you manage this patient?

A 5-month-old female with a history of biliary atresia status post Kasai procedure at 3 months of age presents with poor growth and diarrhea. She is currently taking regular formula which is concentrated to 24 kcal/ounce. On exam she is jaundiced, has hepatosplenomegaly, and has a weight:length ratio <3rd percentile.

- What is the most likely cause of this patient's symptoms?
- How would you manage this patient?

A 6-month-old boy presented with gastroenteritis (vomiting and diarrhea)and moderate dehydration. He was hospitalized for 3 days , and then was discharged home on solid food and regular formula. Mother noticed 2 days after discharge that he has frequent loose dirty diapers.

- What is the most likely cause of this patient's symptoms?
- How would you manage this patient?

THANK YOU

Questions?

