# Nutrition in Paediatrics

Nabil El-Lababidi

# Nutrition in Paediatrics

- The goals of nutrition in paediatrics are:
  - Securing sufficient energy for the immediate use of the body
  - Securing enough nutrition for the growth and the development of a child
  - Prevention of nutrition deficiencies

# Basic Components of Nutrition

- Water:
  - Water makes up 75 – 80% of an infant's body weight
  - In comparison, the percentage of water in adults is 55 – 60%
  - The daily requirements of water in children is higher compared with adults
  - Daily requirement of water in an infant is 10 – 15% of his weight, while it is only 2 – 4% in adults

# Basic Components of Nutrition

- Energy:
  - Energy requirements in children differ depending on the age and physical activity
  - In children between 6- and 12-years energy is spent:
    - Basal metabolism ~ 50%
    - Growth ~ 12%
    - Physical activity ~ 25%
    - Loss of energy with the stools ~ 8%

# Basic Components of Nutrition

- Energy:
  - Daily energy requirement in the first year of life is 80 – 120 kcal/kg
  - It decreases by 10 kcal/kg for each 3 years of life until reaching adult energy requirements

# Basic Components of Nutrition

- The basic sources of food are:
  - Proteins
  - Sugars
  - Fats
- Ideal composition of food intake:
  - Proteins ~ 9 – 15%
  - Sugars ~ 45 – 55%
  - Fats ~ 35 – 45%

# Basic Components of Nutrition

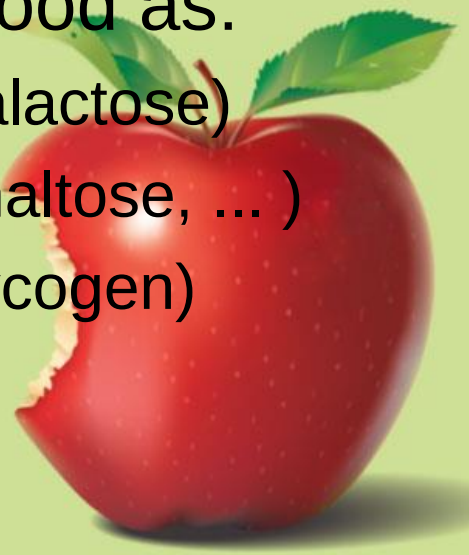
- Energy content in nutrients:
  - 1 g of proteins = 4 kcal
  - 1 g of sugars = 4 kcal
  - 1 g of fats = 9 kcal

# Basic Components of Nutrition

- Proteins:
  - Proteins make 25% of adult body weight
  - They are built from a combination of 24 amino acids
  - 9 amino acids are essential:
    - The body cannot build them again

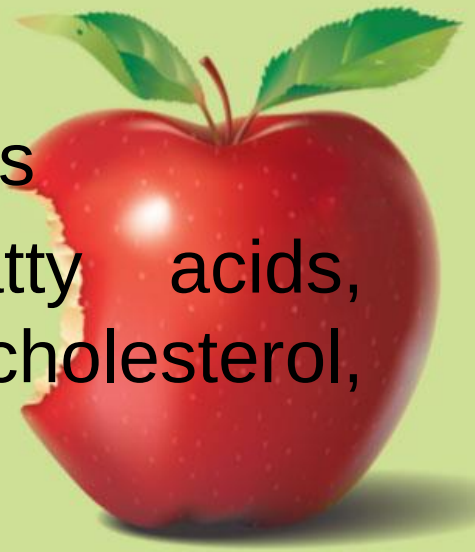
# Basic Components of Nutrition

- Sugars:
  - Sugars are an essential source of energy
  - Reservoirs of sugar make only 1% of body weight
  - Sugars are stored in the body as glycogen
  - Sugars are contained in children's food as:
    - Monosaccharide (glucose, fructose, galactose)
    - Disaccharides (lactose, saccharose, maltose, ... )
    - Polysaccharides (starch, dextrines, glycogen)



# Basic Components of Nutrition

- Fats:
  - Fats are an important energy source
  - Fats and their metabolites are important for the structure of cell walls
  - Fats increase the taste of foods
  - Fats help in transporting fat soluble vitamins (A, D, E, K)
  - 98% of fats in foods are triglycerides
  - 2% are made from free fatty acids, monoglycerides, diglycerides, cholesterol, phospholipids



# Nutrition of Newborns and Infants

- Foods received by babies in their first year of life can be divided into:
  - Natural
  - Artificial
  - Mixed
- The highest energy requirements are in the first years of life
- 85 – 90% of energy is used for growth
- 5 – 10% is used for motion and thermoregulation

# Natural Nutrition of Newborns and Infants

- The natural and most preferable nutrition method for newborns and small infants is breastfeeding
- Breast glands prepare for lactation during pregnancy
- Milk creation is influenced by estrogens and prolactin
- Oxytocin causes contraction of the ducts and ejection of the milk

# Breast Milk

- The first stages of breast milk are called colostrum:
  - Has high density in small volumes
    - Has higher contents of protein and salts
- Colostrum is replaced during the second week of a newborn's life by mature milk

# Composition of Breast Milk

- Low concentration of proteins:
  - 1.15 g per 100 ml
  - This amount is sufficient for growth while not overloading for the kidneys
  - Whey to casein ration = 60 : 40
    - Cow's milk in comparison = 20 : 80

# Composition of Breast Milk

- Fat makes 55% of breast milk energy
- Fat content is 4 g per 100 ml of mature breast milk
- The content of fat changes even during one breast feeding session!

# Composition of Breast Milk

- The only sugar in breast milk is lactose
- Lactose content is 5 – 6 g per 100 ml
- Lactose makes 40% of breast milk energy

# Composition of Breast Milk

- Concentration of minerals is low in breast milk in comparison with cow's milk
- Calcium to phosphorus ratio = 2 : 1
  - Making it easy to absorb
- 70 % of breast milk iron is absorbed
  - In comparison, only 10 % are absorbed from cow milk-based formulas
- Iodine is the only mineral with insufficient concentrations in breast milk

# Composition of Breast Milk

- Vitamin concentrations depend on the nutrition of the mother
- Under normal circumstances, infants need to be supplemented by vitamins D and K only
  - Vitamin D is given as drops starting the 3rd week of life until 1 year of age
  - Vitamin K is supplemented once a week for 12 weeks
    - Unless it was applied i.m. at the delivery room

# Composition of Breast Milk

- Breast milk plays a vital role in the immune system of newborns and young infants:
  - It contains humoral substances (secretory IgA, lactoferrin, lysozyme, oligosaccharides, fatty acids)
  - It contains immune cells (macrophages, lymphocytes, neutrophils)
  - It contains immunoregulatory factors (hormones, growth factors)
  - It contains anti-inflammatory substances

# Advantages of Breast Feeding

- For the infant:
  - Decreased incidence of:
    - Diarrhoea
    - Respiratory infections
    - Middle ear infections
    - Urinary tract infections (UTIs)
    - Bacterial meningitis
    - Necrotizing enterocolitis (NEC)
    - Botulism
    - Sudden Infant Death Syndrome (SIDS)
    - Allergic diseases
    - Diabetes mellitus type 1

# Advantages of Breast Feeding

- For the mother:
  - Lower amounts of postpartum bleeding
  - More rapid decrease in size of the uterus
  - Development of lactic amenorrhea
  - More rapid return to pre-pregnancy weight
  - Lower risk of breast and ovary cancers
  - Lower risk of hip fractures during menopause

# Breastfeeding

- Maternal contraindications of breast feeding:
  - Serious infectious illness (TB, HIV)
  - Serious systemic illness (cardiovascular, chronic kidney insufficiency)
  - Using of certain drugs (chemotherapy, anti-convulsion drugs)
  - Lactic psychosis

# Breastfeeding

- Breastfeeding difficulties from the maternal side:
  - Inflammation of the breast
  - Fissures of the nipples
  - Inverted nipples

# Breastfeeding

- Breastfeeding difficulties from the infant's side:
  - Absence of suckling reflex
  - Cleft palate
  - Atresia of the choans
- Breastfeeding contraindications from the infant's side:
  - Galactosemia
  - Phenylketonuria

# Complimentary Foods in Breastfed Infants

- From the finished 6th month of age, non-milk based complimentary foods are introduced
- Vegetables are introduced first
- Meat and fruits are gradually introduced
- Gluten should be introduced between the finished 4$^{th}$ month and before 1 year of age
- Unmodified cow‘s milk should not be introduced before 1 year of age

# Baby Milk Formulas in Newborns and Infants

- Cow milk protein is the basis for the majority of baby milk formulas
- Unmodified cow milk protein is not suitable for newborns and infants:
  - High amounts of proteins
  - High amounts of salt
  - Low concentration of lactose
- Unmodified cow milk protein should not be introduced before reaching 12 (10) months of age

# Baby Milk Formulas in Newborns and Infants

- Cow‘s milk is modified in a process called adaptation:
  - Decreasing the amounts of proteins
  - Correcing the whey to casein ratio
  - Partial replacement of animal fat with polyunsaturated fatty acids of plant origin
  - Increasing the concentration of lactose
  - Decreasing the amount of salt
  - Increasing the amounts of vitamins and iron

# Types of baby milk formula

- Starter formula
- Continuing formula

# Starter Formula

- Fully adapted cow‘s milk
- Usually designated as no. 1
- Suitable until complimentary food is introduced
- Can be used for infant feeding till 1 year of age

# Continuing Formula

- Not necessarily fully adapted:
  - Have decreased amount of protein
  - Are enriched with vitamins, iron and micronutrients
  - Can be used after the introduction of complimentary foods

# Complimentary Foods in Bottle Fed Infants

- Complimentary foods are started after the finished 4th month of life
- Single component vegetables are the first complimentary foods
- Meat and fruits are added gradually
- Gluten should be added into the diet between the finished 4th and before 1 year of life.

# Special Baby Milk Formulas

- Are used for:
  - Cow's Milk Protein Allergy
  - Lactose Intolerance
  - Gastroesophageal reflux
- Special conditions:
  - Soy based formulas
  - Other mammal milk formulas

# Cow's Milk Protein Allergy

- Cow's milk protein is the first foreign protein that an infant encounters
- Is the most common food induced allergy in children up to 3 years of age
- Affects 1 – 3 % of infants
- 90 % of children manifest symptoms during the first 3 months of life
- Most common allergen is beta-lactoglobulin

# Cow's Milk Protein Allergy

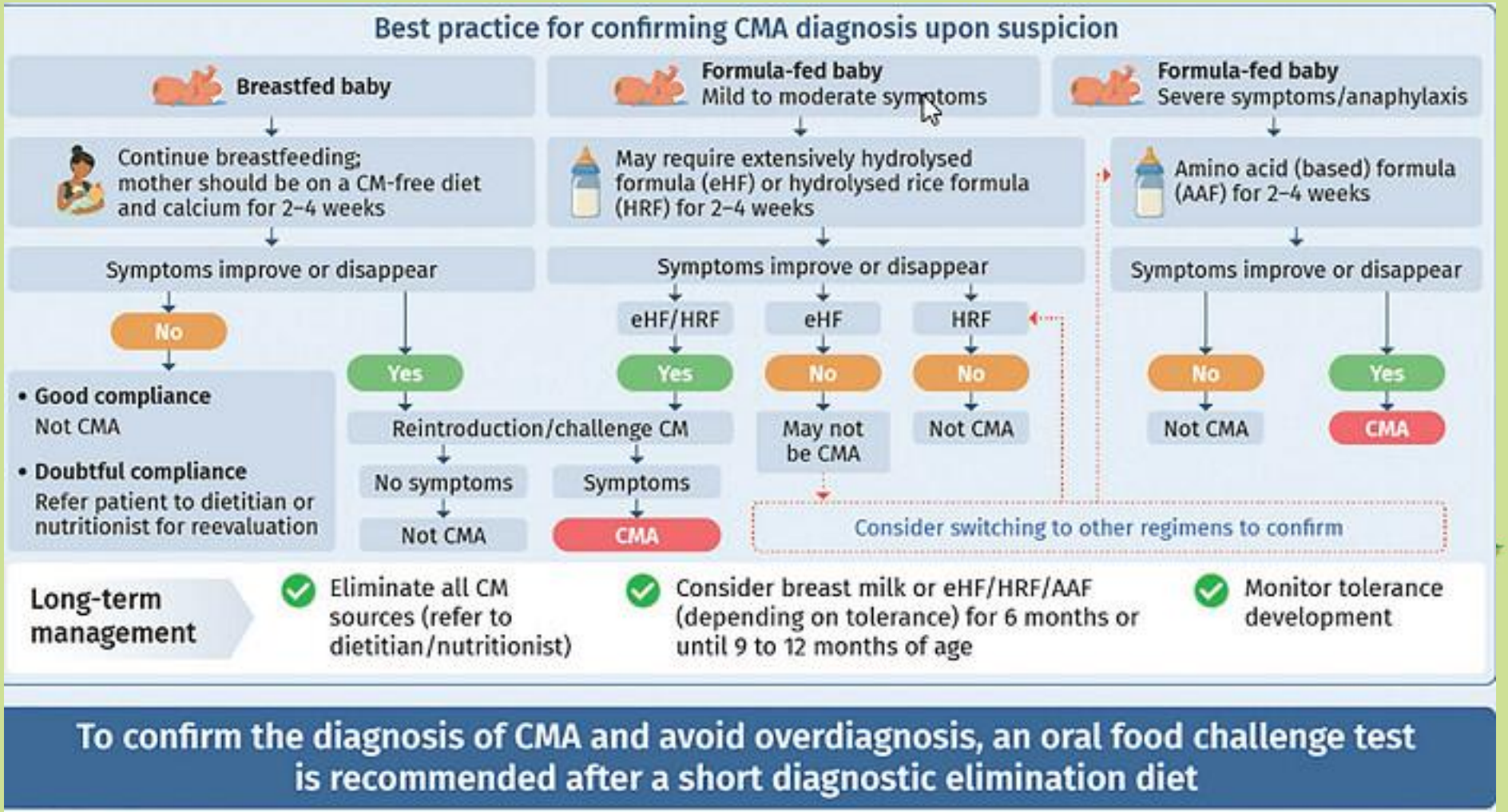
**Clinical manifestations**

- Gastrointestinal:
  - 50 – 80 % of affected children
- Skin related:
  - 20 – 40 % of affected children
  - Eczema, urticaria
- Respiratory:
  - 25 % of affected children
  - Wheezing, coughing, dyspnoea
- Anaphylaxis:
  - 7 % of affected children
  - Manifests within minutes from ingestion
  - Oedema of the lips
  - Laryngospasm

# Cow's Milk Protein Allergy

- Types of Allergic Reactions:
  - IgE mediated
  - Non-IgE mediated
  - Mixed IgE and non-IgE mediated

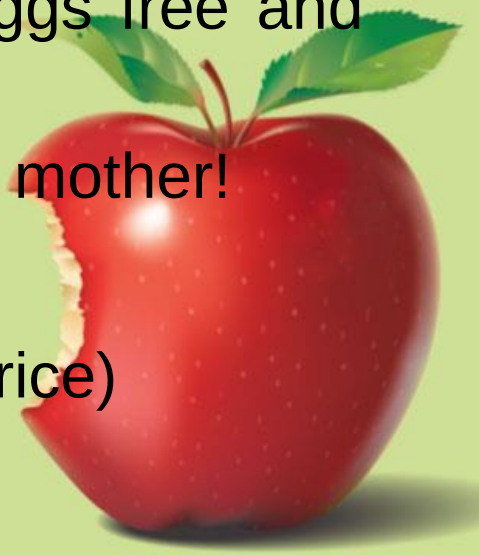
## Best practice for confirming CMA diagnosis upon suspicion




**To confirm the diagnosis of CMA and avoid overdiagnosis, an oral food challenge test is recommended after a short diagnostic elimination diet**

# Cow's Milk Protein Allergy Treatment

- Elimination diet without cow milk protein and its products
- Cow's milk substitution:
  - In breastfed infants:
    - Maternal diet: milk free, dairy free, eggs free and soy free
    - Essential substitution of calcium in the mother!
  - In bottle fed infants:
    - Extensive hydrolysates (cow's milk or rice)
    - Amino acid-based formulas



# Cow’s Milk Protein Allergy Prognosis

- Spontaneous remission by 5 years of age does not exceed 50 %.

# Lactose Intolerance

- Primary lactase deficiency:
  - With inborn lactase deficiency:
    - Extremely rare
    - Autosomal recessive inheritance
    - Manifests as severe diarrhoea as soon as the newborn is breast/bottle fed
    - Severe metabolic acidosis, dehydration and failure to thrive develop
    - Can be diagnosed on a molecular genetic basis

# Lactose Intolerance

- Late on set primary lactase deficiency:
  - So-called adult hypolactasia
  - Autosomal recessive inheritance
  - Is a physiological decrease in lactase deficiency
  - Affects:
    - 20 – 25 % of Caucasians
    - 80 % of Afro-Americans
    - 100 % of South-East Asians

# Lactose Intolerance

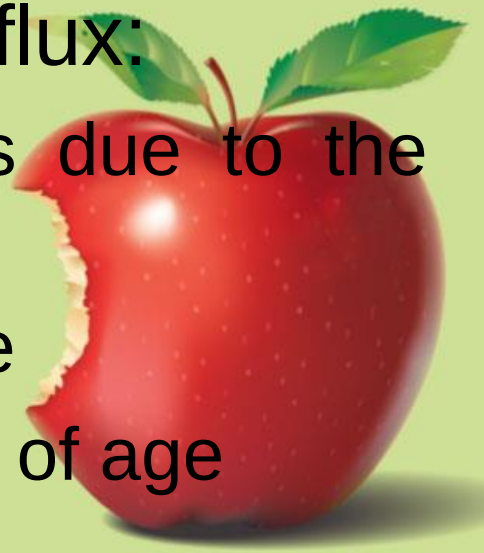
- Secondary lactase deficiency:
  - In conditions affecting the gut villi:
    - Chronic diarrhoea
    - Intestinal infections
    - Food allergies
    - Eosinophilic gastroenteritis
    - Chronic intestinal inflammations
    - Coeliac disease
    - Immune deficiencies

# Lactose Intolerance

- Diagnosis:
  - Thin intestine biopsies with measurement of lactase activity
  - Lactose breath test
- Treatment:
  - Low lactose formulas
  - No lactose formulas

# Gastroesophageal Reflux

- Gastroesophageal reflux (GER) is involuntary return of gastric content into the oesophagus and in some cases the mouth
- Gastroesophageal reflux disease (GERD) is associated with symptoms due to GER
- Physiological gastroesophageal reflux:
  - Occurs in all newborns and babies due to the immaturity of anti-reflux mechanisms
  - Starts decreasing by 6 months of age
  - Should disappear by 12 – 18 months of age



# Anti-Reflux Mechanisms

- Lower oesophageal sphincter (LES)
- Diaphragm surrounding the LES
- Angle of Hiss

# Diagnosis of GER

- Clinical presentation in newborns and infants is sufficient
- In some cases pH-metry or MII-pH-metry is indicated

# GER Treatment

- Diet changes:
  - In breastfed newborns and infants:
    - Thickening of breast milk: Nutriton
    - Gastrotuss Baby
  - In bottle fed newborns and infants:
    - Anti-reflux baby milk formulas
      - Artificially thickened
      - Designated as AR
    - Gastrotuss Baby

# GER Treatment

- Lifestyle modifications:
  - More frequent feeding with lesser amounts
  - Burping of the newborns and infants after feeding
  - Elevated higher half of the body in comparison with the lower while supine

# Soy Based Formulas

- Generally, not recommended in newborns and infants:
  - Not suitable for their GIT
  - 60% cross reactivity with cow milk protein
  - Reserved for:
    - Galactosemia historically
    - Children of strict vegans

# Other Mammal Milk Based Formulas

- Generally not recommended in newborns and infants:
  - Higher dose of proteins and salts in comparison with cow milk based formulas
  - 80% cross reactivity with cow milk protein

# Nutrition in Toddlers and Preschool Children

- Solid foods form the basis of the diet
- A daily intake of 250 – 500 ml of milk and dairy products is recommended
- Diet should be varied, rich in fibre
- Most common mistakes:
  - Monotonous diet
  - Too much sweets, fried foods and sauces
  - Insufficient intake of milk, vegetables and fruits
  - Bad hygiene and eating habits

# Diet in Adolescents

- Highest energy intake demands:
  - Increases growth speed
  - Allows the development of bone, muscle and fat tissues
- Experimenting with diet
- Regulation of food intake
- Manifestations of feeding disorders
- Monotonous diet