

بِسْمِ اللّٰهِ الرَّحْمٰنِ الرَّحِیْمِ





Nutritional Composition of Human Milk (Infant and Maternal Benefits)

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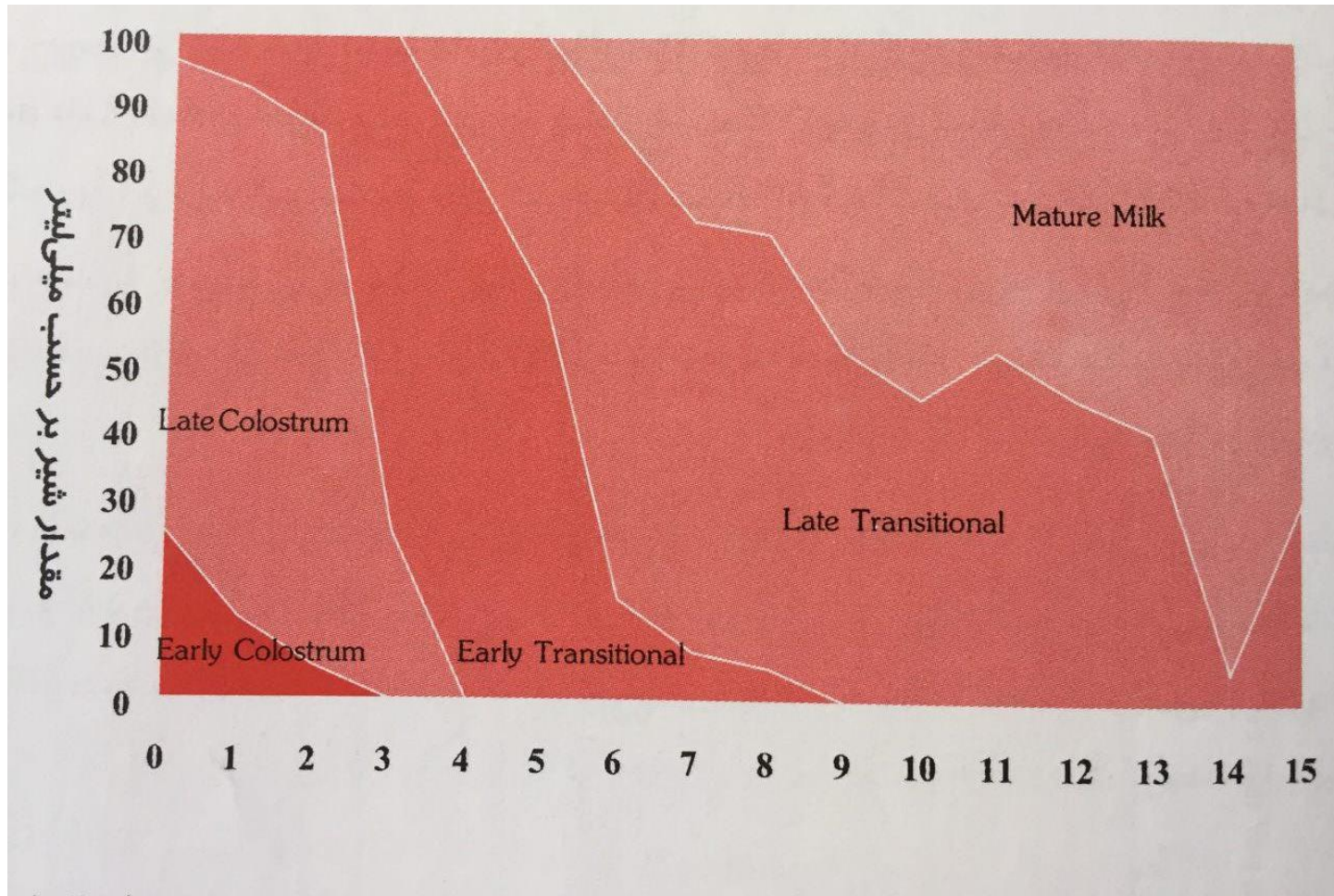
Breast milk benefits

- Human milk is the optimal source of nutrition for virtually all infants
- **Exclusive breastfeeding** is recommended for approximately the first six months of life, followed by continued breastfeeding, with the introduction of appropriate complementary solids for at least through the child's second birthday
- Benefits of breastfeeding that are specific to the infant and mother will be reviewed here

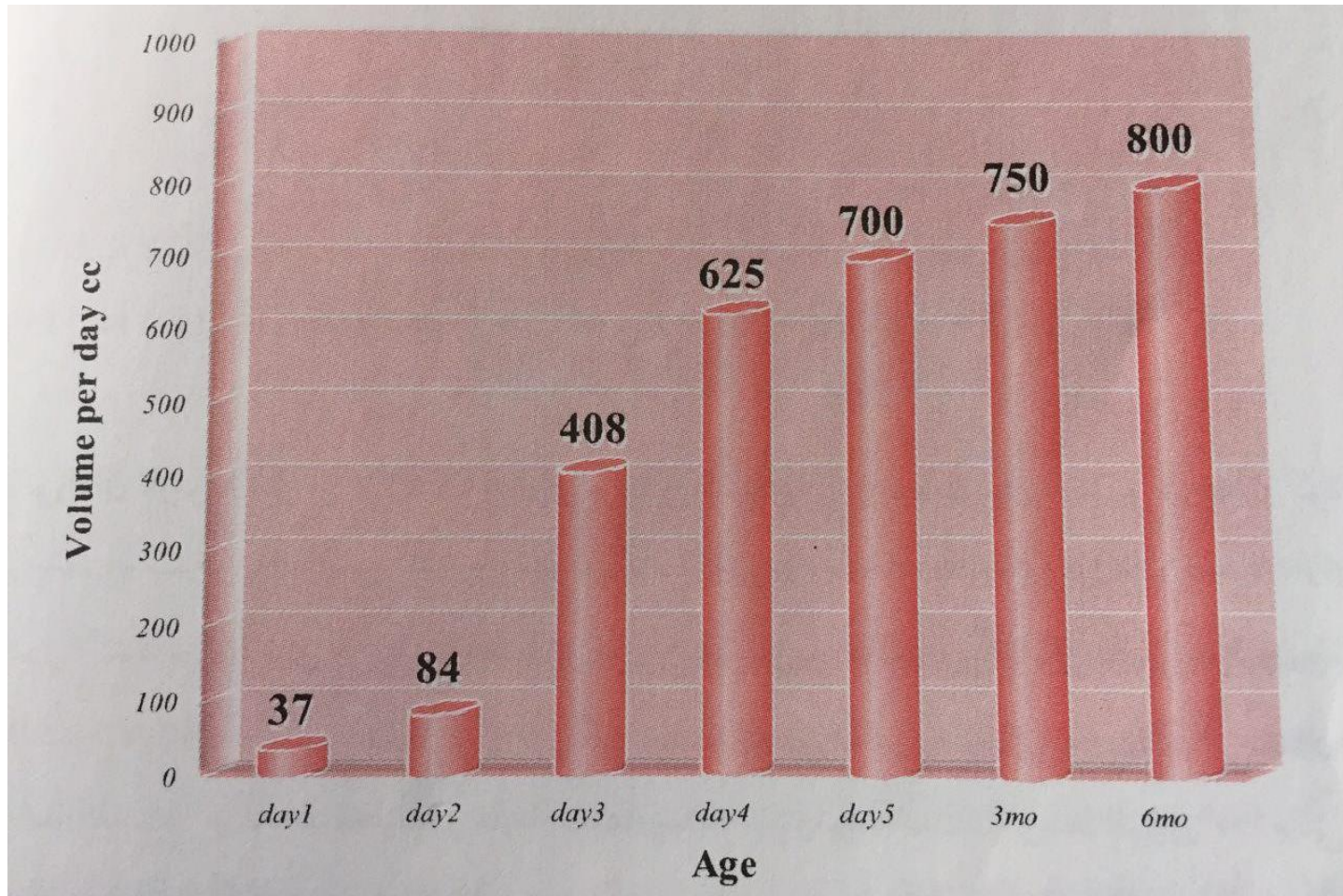
Nutritional and Biologically active components

- Human milk is a living biologic substance that is much more complex than the sum of its nutritional components
- Human milk contains not just macro- and micronutrients but also living cells, growth factors, and immunoprotective substances
- Many of these factors are resistant to digestive enzymes in the infant's gastrointestinal tract and are biologically active at mucosal surfaces

تغییرات شیر مادر در دو هفته اول تولد



حجم شیر تولید شده از بدو تولد تا شش ماهگی



شیرمادران نوزادان نارس در مقایسه با نوزادان ترم:

▶ پروتئین، اسیدهای چرب با زنجیره بلند و متوسط و کوتاه، سدیم و کلر و منیزیم و آهن بیشتر دارد.

▶ سلول های دفاعی و IgA و لیزوزیم و لاکتوفرین بالاتری دارد.

▶ سلول های موجود در شیر نوزادان نارس توانایی تولید اینترفرون بیشتری دارند.

Colostrums – Transitional milk – Mature milk ❖

❖ **کلستروم** — $1w >$ ، **حجم** ↓ ، **بتا کاروتن** ↑ ، **Na** ↑ ،

▶ **K** ↑ ، **Cl** ↑ ، **Pro** ↑ ، **ویتامین محلول در چربی** ↑ ، **مواد معدنی** ↑ ،
60kcal/100cc

❖ **شیر انتقالی** — ۷ روز تا ۶ هفته ، **لاکتوز** ↑ ، **چربی** ↑ ، **کالری** ↑ ، **حجم** ↑ ،
ایمونوگلوبولین و پروتئین ها ↑

❖ **شیر رسیده** — $6w >$ ، **لاکتوز** ↑ ، **چربی** ↑ ، **کالری** ↑75

Estimates of breast milk composition per 100 mL at various postnatal ages

	Energy (kcal)	Protein (g)	Fat (g)	Calcium (mg)	Phosphorus (mg)
Preterm					
1st week	60 (45–75)	2.2 (0.3–4.1)	2.6 (0.5–4.7)	26 (9–43)	11 (1–22)
2nd week	71 (49–94)	1.5 (0.8–2.3)	3.5 (1.2–5.7)	25 (11–39)	15 (8–21)
Week 3/4	77 (61–92)	1.4 (0.6–2.2)	3.5 (1.6–5.5)	25 (13–36)	14 (8–20)
Week 10/12	66 (39–94)	1.0 (0.6–1.4)	3.7 (0.8–6.5)	29 (19–38)	12 (8–15)
Term					
1st week	60 (44–77)	1.8 (0.4–3.2)	2.2 (0.7–3.7)	26 (16–36)	12 (6–18)
2nd week	67 (47–86)	1.3 (0.8–1.8)	3.0 (1.2–4.8)	28 (14–42)	17 (8–27)
Week 3/4	66 (48–85)	1.2 (0.8–1.6)	3.3 (1.6–5.1)	27 (18–36)	16 (10–22)
Week 10/12	68 (50–86)	0.9 (0.6–1.2)	3.4 (1.6–5.2)	26 (14–38)	16 (9–22)

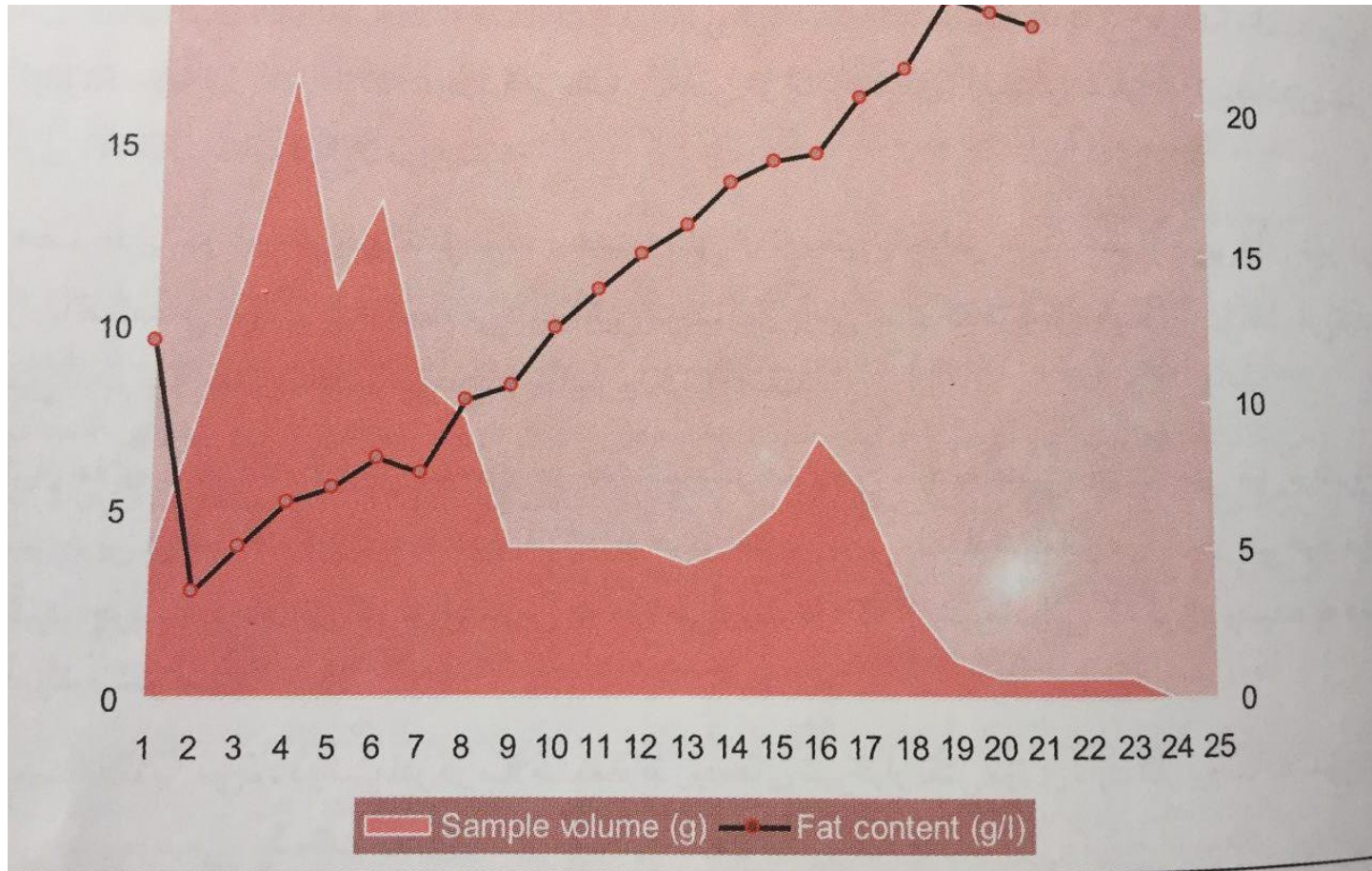
❖ بهترین منبع انرژی

❖ تفاوت در طی شبانه روز

❖ تفاوت در هر وعده شیردهی (fore milk , hind milk)

❖ TG : اسید چرب و گلیسرول (لیپاز)

تغییر حجم و چربی شیر در یک نوبت تغذیه با شیرمادر



❖ کلسترول شیر مادر ↑↑

❖ اسیدآراشیدونیک و PG به اندازه مناسب

❖ شیر مادر نوزاد نارس — ۳۰٪ ↑↑

❖ اسید لینولئیک شیر مادر ↑↑

❖ چربی اشباع نشده ↑↑

❖ چربی اشباع شده

لاکتوز

❖ لاکتوز شیر $\uparrow\uparrow$ \leftarrow تکامل مغزی $\uparrow\uparrow$

❖ تأمین ۴۰٪ انرژی مورد نیاز

❖ لاکتوز در آغوز CC $7/5 \text{ gr}/100$ و در شیر رسیده CC $7/1 \text{ gr}/100$

❖ افزایش رشد لاکتوباسیل روده

Composition of milks obtained from different mammals and growth rate of their offspring

Species	Days required to double birth weight	Content of milk (%)			
		Fat	Protein	Lactose	Ash
Man	180	3.8	0.9	7.0	0.2
Horse	60	1.9	2.5	6.2	0.5
Cow	47	3.7	3.4	4.8	0.7
Reindeer	30	16.9	11.5	2.8	----
Goat	19	4.5	2.9	4.1	0.8
Sheep	10	7.4	5.5	4.8	1.0
Rat	6	15.0	12.0	3.0	2.0

From Hambraeus L: *Pediatr Clin North Am* 24:17, 1977

پروتئین

❖ در شیر مادر کمتر از شیر گاو است

❖ وجود تورین و سیستین مناسب

❖ Casein < whey

❖ اسیدهای آمینه آروماتیک پائین

❖ در کلستروم (۳ برابر)، Ig ↑↑

❖ در شیر مادر نوزاد نارس ۲۰٪ ↑↑

Composition of protein nitrogen and nonprotein nitrogen in human milk and cow's milk

	Human milk		Cow's milk			
Protein nitrogen		1.43	(8.9)		5.3	(31.4)
Casein nitrogen	0.40	(2.5)		4.37	(27.3)	
Whey protein nitrogen	1.03	(6.4)		0.93	(5.8)	
α -Lactalbumin	0.42	(2.6)		0.17	(1.1)	
Lactoferrin	0.27	(1.7)		Traces		
β -Lactoglobulin	----	0.57		(3.6)		
Lysozyme	0.08	(0.5)		Traces		
Serum albumin	0.08	(0.5)		0.07	(0.4)	
IgA	0.16	(1.0)		0.005	(0.03)	
IgG	0.005	(0.03)		0.096	(0.06)	
IgM	0.003	(0.02)		0.005	(0.03)	
Nonprotein nitrogen		0.50			0.28	
Urea nitrogen	0.25			0.13		
Creatine nitrogen	0.037			0.009		
Creatinine nitrogen	0.035			0.003		
Uric acid nitrogen	0.005			0.008		
Glucosamine	0.047			?		
α -Amino nitrogen	0.13			0.048		
Ammonia nitrogen	0.002			0.006		
Nitrogen from other components	?			0.074		
	----			----		

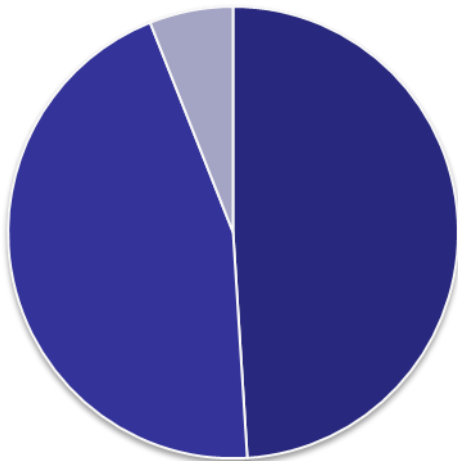
? E and Lonnerdal B: Protein evaluation of breast milk and breast milk substitutes with special reference to the ? nitrogen, unpublished data

Breast Milk Vs. Formula

What is the difference between BM & Formula
in terms of **macro-nutrient**?

Breast Milk

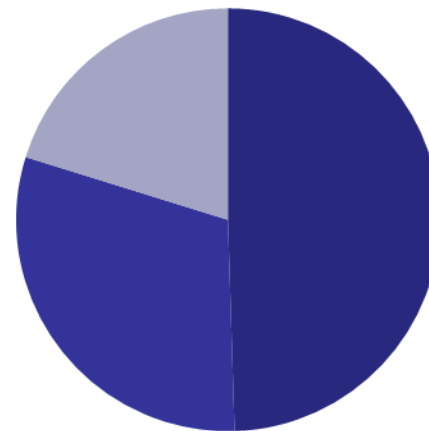
Percentage of macro-nutrients



- Fat: 49
- CHO: 45
- Protein: 6

Formula

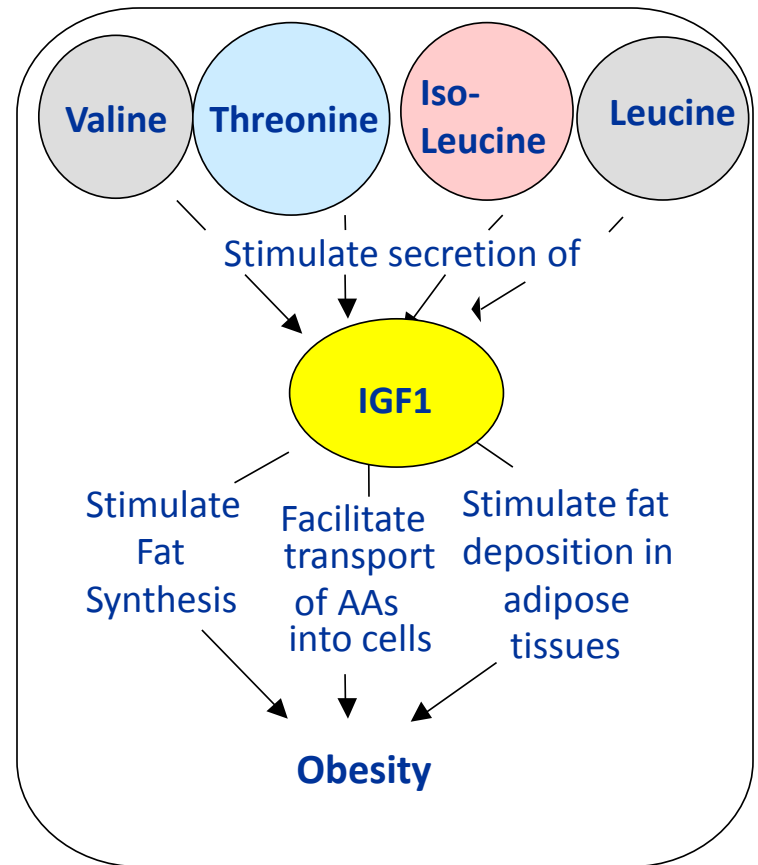
Percentage of Macro-nutrients



- Fat: 49
- CHO: 30
- Protein: 20

Excess Protein Hypothesis say ...

- Based on “Early Protein Hypothesis”, **high early protein supply** would lead to **increased levels of insulin-releasing amino acids and growth factors**, enhanced **early weight gain** and more **later obesity**



ویتامین ها

↑ Vit A در آغوز ۲ برابر شیر رسیده

↑ Vit E ❖ در کلستروم و شیر مادر بطور فراوان وجود دارد.

↑ آنتی اکسیدان ❖

Vit D ❖ تقریباً ۱/۲۵ u

Vit B12 ❖ + فاکتور انتقال دهنده (بیفیدوس)

Vit K ❖

↑ نیاسین ، اسید فولیک ، اسید اسکوربیک

Vitamins and other constituents of human milk and Cow's milk (per 100 ml)

Milk elements	Colosterm	Transitional	Mature	Cow's milk
Vitamins				
Vitamin A (μg)	151.0	88.0	75.0	41.0
Vitamin B ₁ (μg)	1.9	5.9	14.0	43.0
Vitamin B ₂ (μg)	30.0	37.0	40.0	145.0
Nicotinic acid (μg)	75.0	175.0	160.0	82.0
Vitamin B ₆ (μg)			12.0-15.0	64.0
Pantothenic acid (μg)	183.0	288.0	246.0	340.0
Biotin (μg)	0.06	0.35	0.6	2.8
Folic acid (μg)	0.05	0.02	0.14	0.13
Vitamin B ₁₂ (μg)	0.05	0.04	0.1	0.6
Vitamin C (mg)	5.9	7.1	5.0	1.1
Vitamin D (μg)	----	----	0.04	0.02
Vitamin E (mg)	1.5	0.9	0.25	0.07
Vitamin K (μg)	----	----	1.5	6.0
Ash (g)	0.3	0.3	0.2	0.7
Calories (k cal)	57.0	63.0	65.0	65.0
Specific gravity	1050.0	1035.0	1031.0	1032.0
Milk (pH)	----	----	7.0	6.8

مواد معدنی

- ❖ غلظت مواد معدنی در شیر انسان کمتر از شیر خشک است
- ❖ $Ca/P = 2/1$: جذب بهتر کلسیم
- ❖ آهن + لاکتوفرین و : جذب $\uparrow\uparrow$ (۸۰٪)
- ❖ Zn $\uparrow\uparrow$
- ❖ کرومیوم ، منگنز ، آلومینیوم کمتر
- ❖ مس ، کبالت و سلنیوم شیر انسان بیشتر از شیر گاو

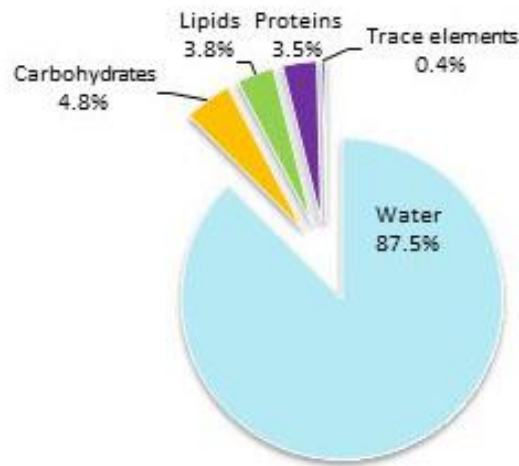
Minerals in human milk and cow's milk (per 100 ml)

Milk elements	Colosterm	Transitional	Mature	Cow's milk
Calcium (mg)	39.0	46.0	35.0	130.0
Chlorine (mg)	85.0	46.0	40.0	108.0
Copper (μg)	40.0	50.0	40.0	14.0
Iron (μg)	70.0	70.0	100.0	70.0
Magnesium (mg)	4.0	4.0	4.0	12.0
Phosphorus (mg)	14.0	20.0	15.0	120.0
Potassium (mg)	74.0	64.0	57.0	145.0
Sodium (mg)	48.0	29.0	15.0	58.0
Sulfur (mg)	22.0	20.0	14.0	30.0
Total ash (mg)	----	----	200.0	700.0

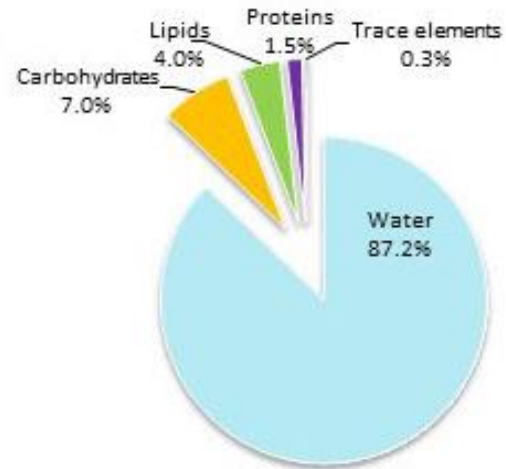
From Food and Nutrition Board, National Academy of Science: Recommended dietary allowances, 10th Washington DC, US Government Printing Office 1989.

مقایسه متابولیسم آهن در شیرخوارانی که با شیرمادر و یا شیر گاو تغذیه می شوند

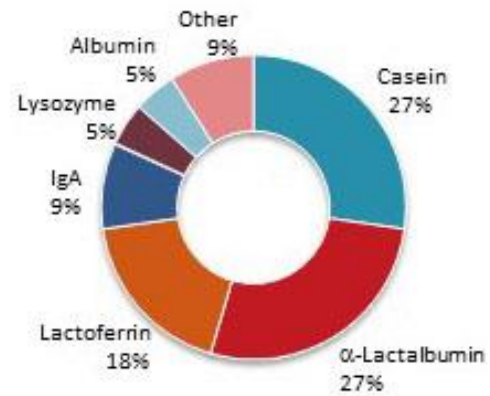
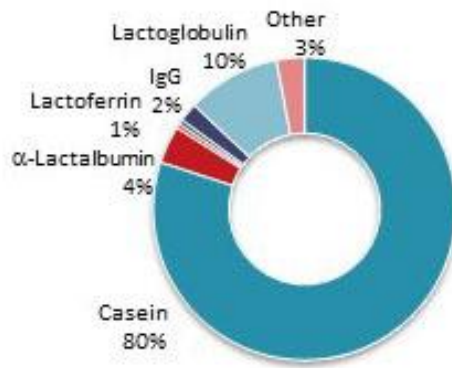
شیر گاو	شیرمادر	
کم	کم	میزان آهن شیر
۱۰٪	حدود ۵۰٪	جذب آهن
لاکتوز کمتر	لاکتوز بیشتر	عوامل تسهیل کننده جذب آهن
ویتامین C کمتر	ویتامین C بیشتر	
وجود دارد به علت ضایعات مخاطی روده‌ها	وجود ندارد	دفع نامحسوس آهن
شایع	غیر شایع	کم خونی ناشی از فقر آهن



Cow



Human



Biologically active components

Many of these factors are resistant to digestive enzymes in the infant's gastrointestinal tract and are biologically active at mucosal surfaces

These components include:

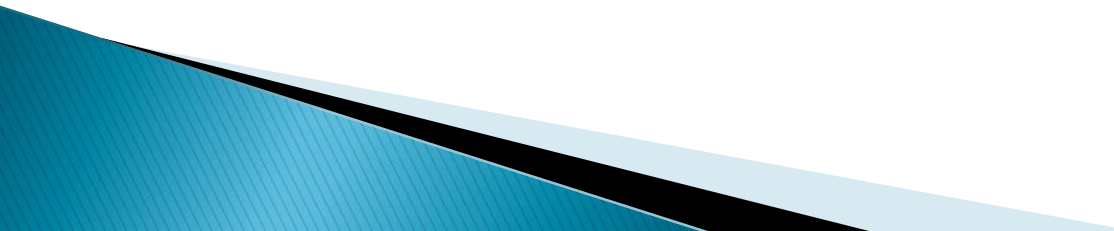
- Antimicrobial activity
- Immunomodulatory activity
- Factors that promote gastrointestinal development and function

Antimicrobial activity

- Immunoglobulins especially secretory IgA, lysozyme, lactoferrin, free fatty acids and monoglycerides, human milk bile salt-stimulated lipase, mucins, white blood cells, stem cells, human milk oligosaccharides (prebiotic and antimicrobial activities)
- These antimicrobial actions help to protect against gastrointestinal and other infections, as well as against developing NEC

Immunomodulatory activity

- ▶ Platelet-activating factor (PAF) acetylhydrolase
interleukin 10, polyunsaturated fatty acids,
glycoconjugates.

 - ▶ These factors help to protect against NEC
- 

Factors that promote gastrointestinal development and function:

- ▶ Proteases (enzymes that help digest proteins)
- ▶ Hormones (cortisol, somatomedin C, insulin-like growth factors, insulin, and thyroid hormone)
- ▶ Growth factors (epidermal growth factor and nerve growth factor)
- ▶ Gastrointestinal mediators (neurotensin, motilin)
- ▶ Amino acids that stimulate enterocyte growth (taurine and glutamine) .
- ▶ Human milk also influences optimal development of the **gut microbiome** and virome

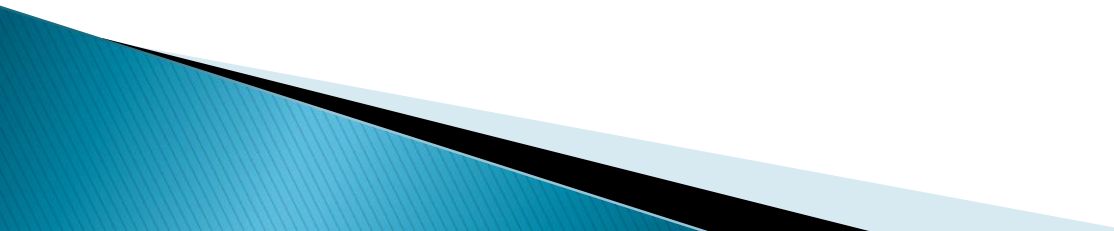
Infantile benefits

- ▶ Breastfeeding confers direct health benefits to the infant during the time of breastfeeding, some of which persist after weaning
- ▶ The best studied benefits are the impacts upon the development of the gastrointestinal and immunologic systems, as well as prevention of infection.

Neurobehavioral benefits

- Early skin-to-skin contact between mothers and newborns has some short-term neurobehavioral benefits and may program other benefits during this sensitive period of adaptation to extrauterine life.
- Early skin-to-skin contact appears to reduce infant crying, increase blood glucose levels, and promote greater cardiorespiratory stability in late preterm infants
- Higher salivary cortisol levels found in breastfed infants, compared with formula-fed infants, also are postulated to mediate the analgesic effect of breastfeeding

Gastrointestinal function

- Human milk stimulates optimal growth, development, and function of the GI system and influences optimal development of the **microbiota**
 - Exclusive, early breastfeeding protects the infant's gastrointestinal system from exposure to highly antigenic substances.
- 

Gastrointestinal function ...

- When compared with formula, human milk has been shown to:
 - Reduce the risk of gastroenteritis and diarrheal disease
 - Increase the rate of gastric emptying
 - Increase intestinal lactase activity in premature infants
 - Decrease the intestinal permeability early in life in premature infants
 - Reduce the risk of developing NEC in preterm infants

Several components of human milk stimulate gastrointestinal growth and motility, including:

- ▶ Growth factors and gastrointestinal mediators
- ▶ Other factors are protective and decrease the risk of NEC and other infections, including Ig, PAF, acetylhydrolase, polyunsaturated fatty acids, epidermal GF, and IL10.
- ▶ Human milk influences optimal development of the microbiota, including neonatal intestinal colonization by the beneficial microbes of the *Bifidobacteria* and *Lactobacillus* species rather than potential enteropathogenic bacteria, such as streptococci and *Escherichia coli*

Prevention of illnesses while breastfeeding

- ▶ Human milk, compared with infant formula, decreases the risk of acute illnesses during the time period in which the infant is fed human milk
- ▶ Most of these benefits are related to protection from **infectious diseases**
- ▶ In one study, BF was associated with fewer serious infections requiring hospitalization during the first year of life, with **a 4 percent reduction in hospitalization for every extra month of any BF**

The protective effect includes:

- ▶ **Gastroenteritis and diarrhea** : Decreased risk of severe or persistent diarrhea
- ▶ **Respiratory disease** : BF reduced the risk of respiratory infections in three- to six-month-old infants by approximately 20 percent
- ▶ **Otitis media**: for those younger than two years (34 versus 54 percent)
- ▶ **UTI**: Greater contents of oligosaccharides, lactoferrin, and secretory IgA in their urine
- ▶ **Sepsis** Bacterial, meningitis, Infant botulism
- ▶ **SIDS**

The protective effect includes...

- **Mortality and hospitalization**
- It has been estimated that improving global BF could prevent 823,000 annual deaths in children younger than five years*

*Victora CG, Bahl R, Barros AJ, et al. Breastfeeding in the 21st century: epidemiology, mechanisms, and lifelong effect. Lancet 2016; 387:475.

LONG-TERM BENEFITS

- ▶ Possible mediators include:
 - Development of the microbiota in this early period
 - Modulation of the immune system development
 - Impact of skin-to-skin contact on maternal-child bonding and interactions
 - Potential decrease in toxic stress

LONG-TERM BENEFITS...

Studies demonstrate the importance of a critical period in the first year of life, during which BF can promote long-term effects

➤ **Acute illnesses :**

- Recurrent otitis media(10 versus 20.5 percent)
- BF for ≥ 9 months was associated with continued protection against ear, throat, and sinus infections through six years of age

LONG-TERM BENEFITS...

Chronic disease

- ▶ There are reported associations between the duration of BF and a reduction in incidence of certain chronic conditions :
 - Obesity(26 percent reduction)
 - DM(1,2)
 - Adult CVD
 - Allergic
 - CD
 - IBD

LONG-TERM BENEFITS...

Dental health

Malocclusion is more prevalent among children who are not breastfed.

Dental caries

BF lowers the risk for developing dental caries compared with formula feeding from a bottle

A systematic review showed that children with more breastfeeding exposure up to 12 months had reduced risk of dental caries

LONG-TERM BENEFITS...

Leukemia

- ▶ BF has been associated with a modest reduction in the risk of developing childhood lymphoma and leukemia.
- ▶ A meta-analysis of 18 studies reported that breastfeeding for six or more months reduced the risk of childhood leukemia by **19 percent**

Neurodevelopmental outcomes



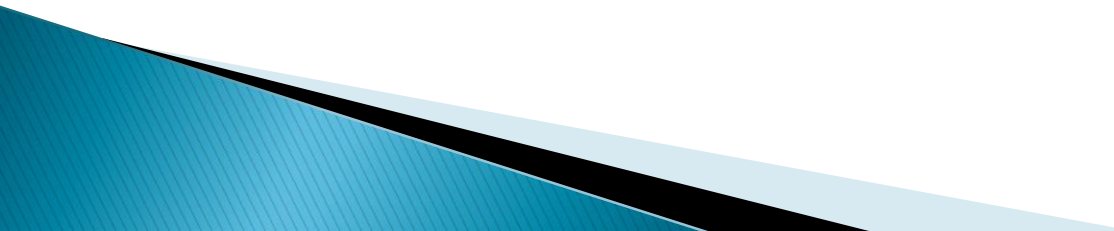
Cognitive development

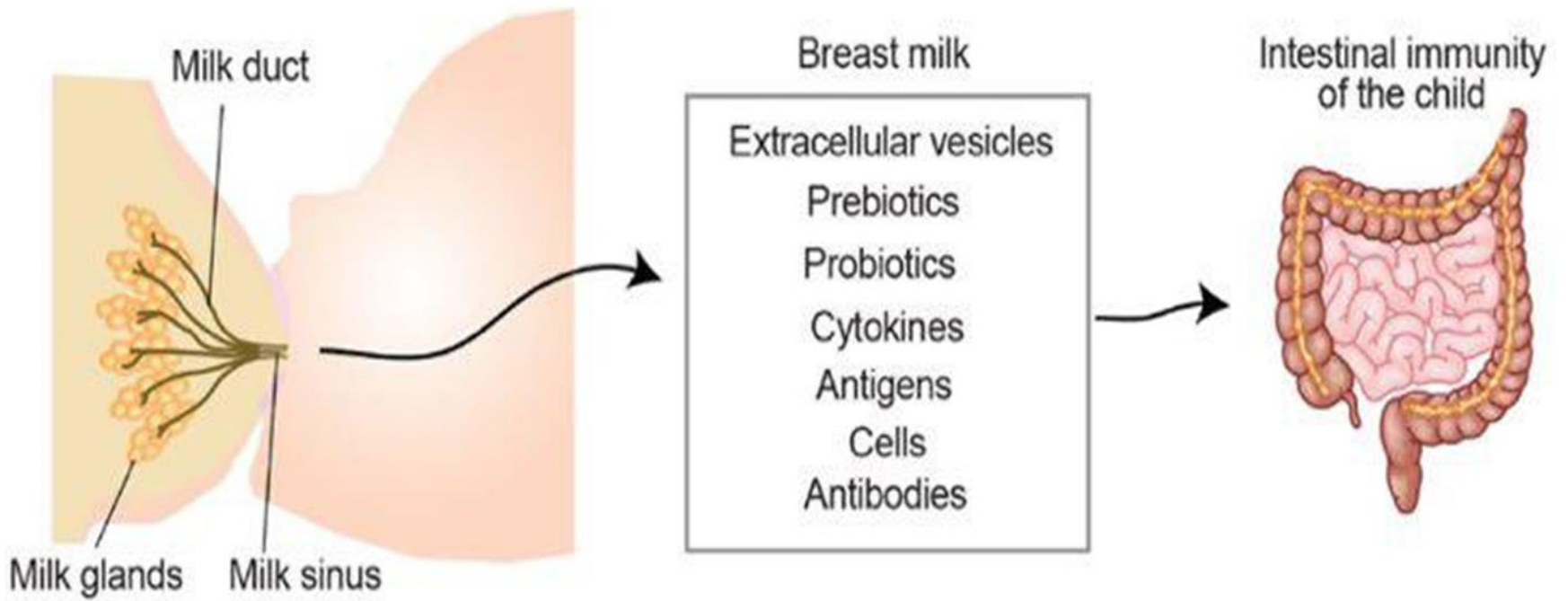
- ▶ BF may be associated with improved performance in intelligence tests, and this association persists after adjustment for maternal IQ
- ▶ A study from Brazil reported that by age 30 years, participants who were BF for 12 months or more had **higher IQ scores of 3.8 points**, more years of education, and higher monthly incomes compared with those who were BF for less than one month in the adjusted analysis
- ▶ The analysis suggested that IQ was responsible for **72 percent of the effect on income.**

Visual function

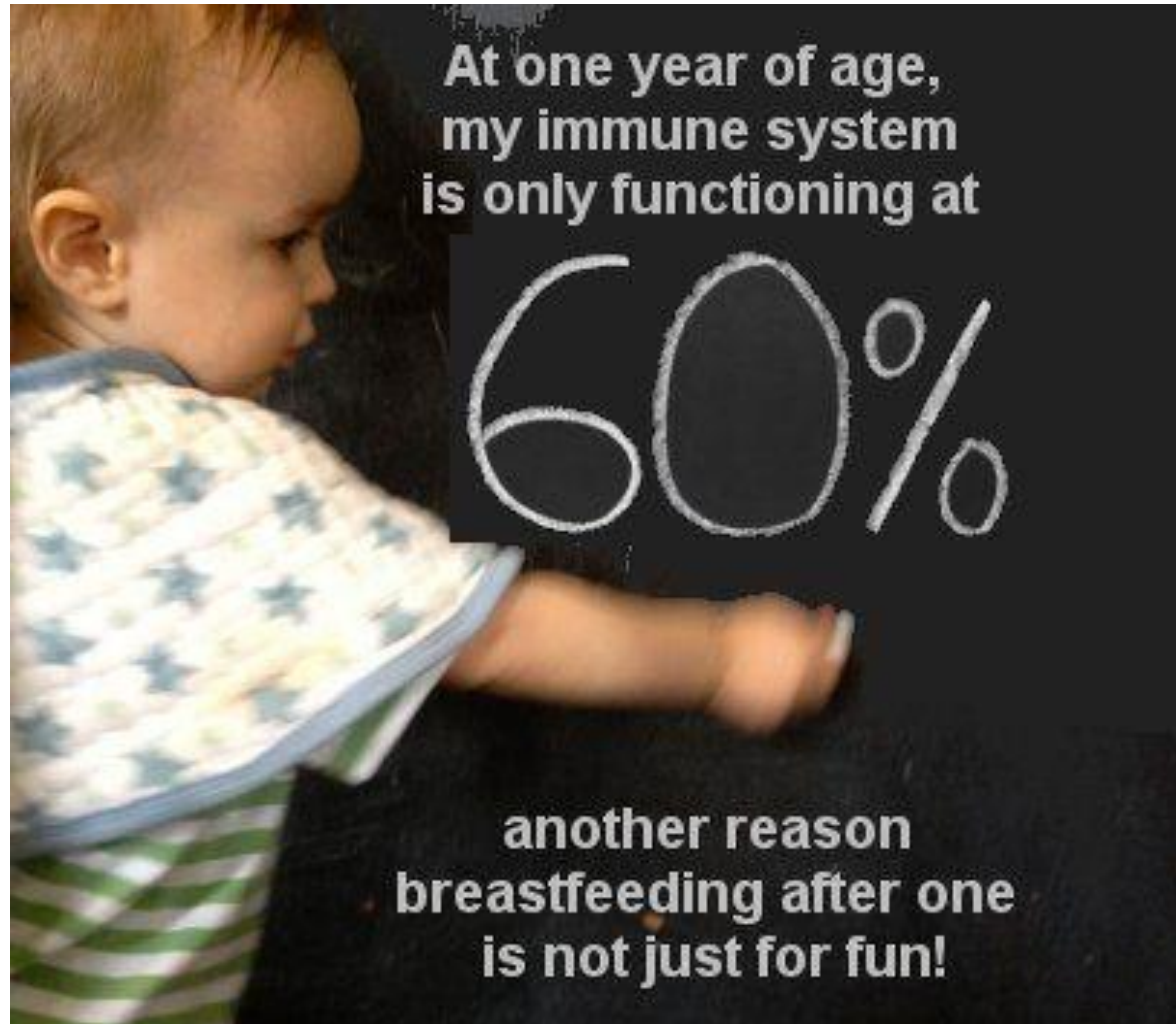
- ❖ Human milk-fed term and premature infants have improved visual function compared with FF infants
- ▶ The severity and incidence of retinopathy of prematurity is lower among BF compared with FF infants
- ▶ Severe retinopathy of prematurity was less common in infants fed mother's milk (5 percent) compared with preterm formula (14 percent)
- ▶ These benefits have been attributed to DHA, a component of phospholipids found in brain, retina, and red cell membranes and found in human milk but not in bovine milk

Neurodevelopmental outcomes ...

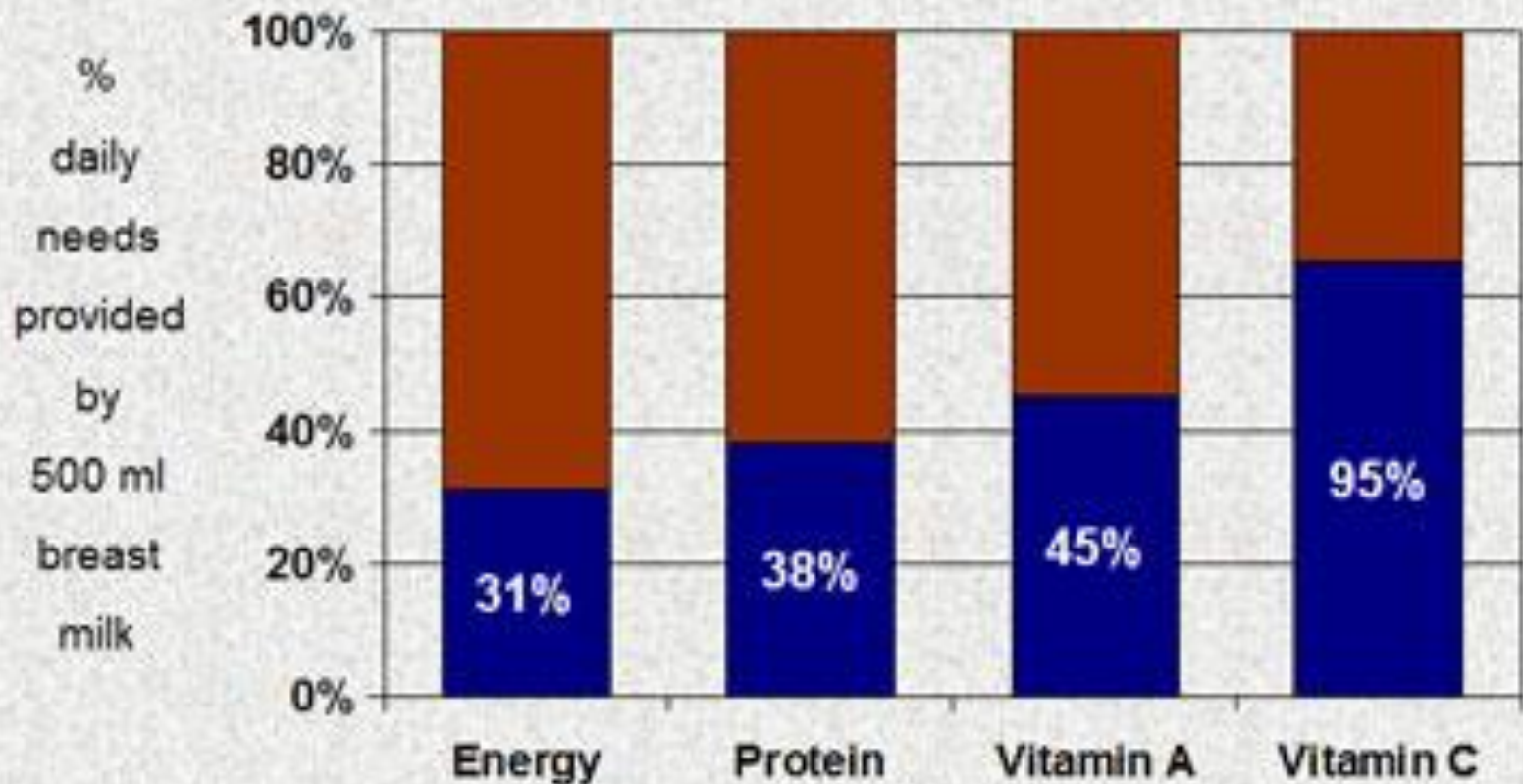
- ▶ **Auditory function**
 - ▶ **ADHD:** EBF was associated with a 60 percent reduction
 - ▶ **Autism spectrum disorder (ASD)**
 - ▶ **Child behavior**
 - ▶ **Abuse and neglect**
- 



فوائد ادامه تغذیه با شیرمادر در سال دوم



Breast milk in second year of life



From: Breastfeeding counselling: A training course. Geneva, World Health Organization, 1993. (WHO/CDR/93.6)

Maternal benefits of breastfeeding:

- **Benefits during lactation**
- **Long-term benefits**

Benefits during lactation

- **Reduced risk of postpartum blood loss**

Through the action of oxytocin, initiation of BF soon after delivery helps the uterus to return to its normal size sooner after birth

- **Delay in resumption of ovulation**

EBF significantly delays the return of ovulation after giving birth; the hormonal biologic mechanism by which it happens has been well elucidated

- **Reduced postpartum depression and stress**

- **weight change**

Long-term benefits

➤ Cancer

It has been shown to reduce the risk of breast, ovarian, and endometrial cancer

➤ Cardiovascular disease

- A reduced risk of hypertension among lactating women aged 40 to 49 years
- This association was stronger among those with longer cumulative breastfeeding durations, especially among those who had breastfed for ≥ 24 months.

➤ Osteoporosis

Long-term benefits...

Type 2 diabetes mellitus

- ▶ Lactation is associated with improved glucose tolerance and insulin sensitivity
- ▶ BF is associated with significantly reduced maternal risk of developing type 2 diabetes later in life (30%)
- ▶ This protection seems to be greater among those women with longer BF durations
- ▶ Studies found a significantly lower risk for developing DM2 among women with a history of GDM who BF compared with those who had not BF

ECONOMIC BENEFIT

- BF is associated with substantial economic benefits to both the family and society
- The economic costs of **not breastfeeding** come from a combination of sources, including:
 - ❖ **Direct health care**
 - ❖ **Costs to treat maternal and child morbidity**
 - ❖ **Lost economic productivity due to premature mortality**
 - ❖ **Costs associated with the decreases in cognitive development of the child.**

Societal Benefit

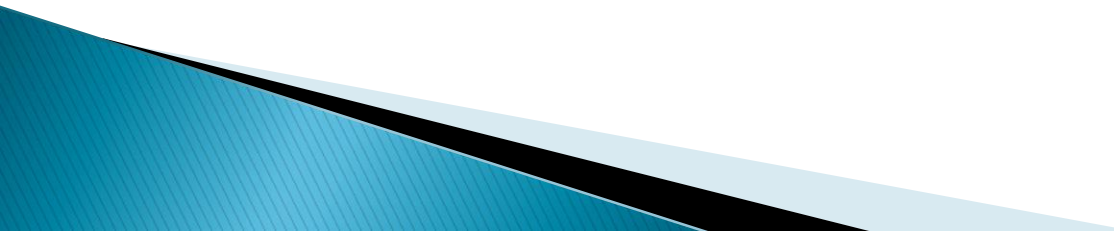
A comprehensive global analysis estimated the following **number of deaths could be prevented annually if all infants were breastfed** following the WHO and UNICEF recommendations which include EBF and continued BF until at least two years of age:

- 595,379 deaths due to diarrhea and pneumonia among children 6 to 59 months of age
- 974,566 cases of childhood obesity
- 98,243 deaths due to breast and ovarian cancer and type 2 diabetes

Societal Benefit...

- ▶ Adverse health effects due to lack of optimal BF practices translate to total estimated global economic losses of USD \$341.3 billion per year, (0.70 percent of the global GNI)
- ▶ Of this total, **\$285.4 billion were attributed to cognitive losses**, \$53.7 billion due to child mortality, and \$1.26 billion due maternal mortality
- ▶ The estimated direct cost to the health care system due to child diarrhea and pneumonia and maternal type 2 diabetes was estimated at \$1.1 billion per year

Societal Benefit...

- ▶ Breastfeeding also has substantial environmental benefit by :
 - Avoiding the extensive use of water needed for infant formula production and consumption
 - Plastic, paper, and metal waste from bottles and infant formula packaging materials
 - Carbon emissions associated with producing, packaging, transporting, and preparing the formula
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Familial Benefit

In a global analysis, the cost of formula was estimated to be an average of **6.1 percent of a household's wages**, with a higher percentage among low-income families or in low- and middle-income countries

- در سال ۱۹۹۸ در بیش از ۵۰ کشور میزان مرگ کودکان زیر ۵ سال بیش از ۱۰۰ مورد از ۱۰۰۰ تولد زنده بوده است.
- در سال ۱۹۹۹ در ایران میزان مرگ کودکان زیر ۵ سال به ازای هر ۱۰۰۰ تولد حدود ۵۶ و در سال ۲۰۱۷ به ۱۶ مورد رسیده است.
- توجه به تغذیه کودکان خصوصاً در ۱۰۰۰ روز اول زندگی و مراقبت های مورد نیاز از جمله ترویج تغذیه با شیرمادر در این روند تأثیر به سزایی داشته است.
- میانگین تغذیه انحصاری با شیرمادر در کشور ما از میانگین جهانی کمتر است و با توجه به تأثیر آن در کاهش مرگ و میر کودکان، ترویج تغذیه با شیرمادر اهمیتی ویژه دارد.

SUMMARY

- BF for virtually all infants is strongly supported by both governmental and medical professional organization
- The unique composition of human milk, which contains antiinfective and antiinflammatory factors, along with the skin-to-skin contact
- The best established health benefits of human milk feeding are prevention of illnesses(acute,chronic)
- BF offers short- and long-term health and developmental benefits to children and their mothers

با تشکر از توجه شما

