

What's in breast milk?

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Key learning points

- 1 Breast milk is the optimal food for infants providing all essential micronutrients including vitamins, minerals and trace elements. Exclusive breastfeeding is recommended for around the first six months of an infant's life
- 2 The composition of breast milk can change to meet the needs of an infant and transitions from colostrum initially to mature breast milk
- 3 The major nutritional components of breast milk include water, lactose (milk sugar), fats and protein
- 4 Breast milk delivers essential fatty acids during the early weeks of life and have a crucial role in brain and eye development
- 5 The most abundant fatty acid in breast milk is palmitic acid (PA), which appears to promote softer infant stool consistency, bone health and optimal gut microflora
- 6 Human Milk Oligosaccharides (HMOs) are bioactive components that enhance the infant's gut microbiome and immune system
- 7 Nucleotides present in breast milk support cellular and metabolic functions and stimulate the immune system
- 8 The fat in breast milk contributes to infant brain development and immune function
- 9 Immunoglobulins transferred via breast milk provide significant benefits to an infant's immune system
- 10 Short-term benefits of breastfeeding to the infant include reduced risk of ear infections, diarrhoea, necrotising enterocolitis (NEC) and sudden infant death syndrome (SIDS). Long term benefits include improved cognitive performance, healthy weight and reduced risk of some childhood illnesses
- 11 Breastfeeding benefits to the mother include reducing the risk of breast and ovarian cancers, type 2 diabetes and post-natal depression

The World Health Organisation (WHO) and UNICEF recommend exclusive breastfeeding for the first six months of an infant's life, followed by continued breastfeeding alongside complementary foods for up to two years and beyond ^{1,2}.

Despite over 30 years of best practice guidance, more recently driven by UNICEF'S Baby Friendly Initiative (BFI), breastfeeding rates in the United Kingdom fall short of these recommendations. Current data suggests that whilst 72% of babies born in the UK are breastfed within 48 hours of birth, only 1% are exclusively breastfed until 6 months of age ^{3,4}.

Having a greater understanding of the unique composition of breast milk could support parents to make informed choices around feeding and may benefit breastfeeding rates.

Breast milk benefits

Breast milk is unique in its properties. The nutritional composition is suited specifically to infants; alongside this, its non-nutritive bioactive factors also promote optimal infant and child health and development⁵.

The extraordinary health benefits of human breast milk and breastfeeding are well documented. In practice, professionals—including midwives, health visitors and general practitioners—are ideally placed to support parents with an understanding of these benefits to ensure parents can make informed choices about their baby's feeding.

To provide this support, a comprehensive understanding of the nutritional, health and psychological benefits of breastfeeding are essential. In addition, an appreciation of human milk composition from the perspective of the unique biochemical and physiological mechanisms that underpin human milk's superiority is also required.





Breast milk composition

Breast milk is a living biological fluid containing over 300 components. Its benefits extend beyond being an essential source of nutrients, to the inclusion of a huge number of bioactive components that lay the foundations for a range of health benefits.

Macronutrients in breast milk

Breast milk is uniquely suited to the nutritional needs of babies. It contains around 87% water, 7% lactose (milk sugar) 3.8% fat and 1% protein⁶ (see **Figure 1**).

The combination of fat and lactose provides around 90% of breast milk's energy content, which is around 0.66kcal/ml. Breast milk's composition is also not static. Part of its exceptional complexity is also linked to its ability to change over time, adapting to the fluctuating needs of the growing and developing infant. For example, the protein content of breast milk is higher during early infancy (when growth rates are the highest) compared to the later stages of infancy⁶. There are also notable changes to breast milk composition over the first days and weeks as breastfeeding becomes established.

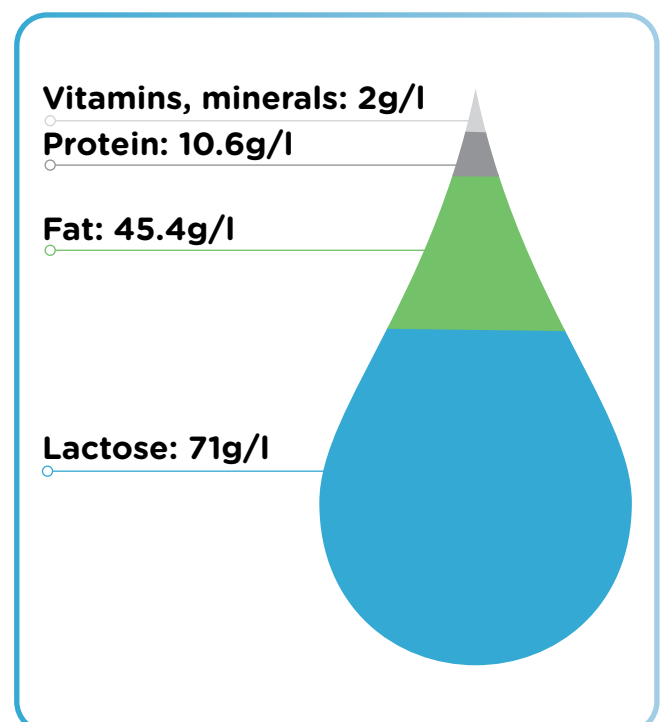


Figure 1: The composition of breast milk

Stages of lactation

First days	Colostrum (Sometimes referred to as 'liquid gold')	Produced in small amounts and rich in bioactive factors to support an infant's immature immune system (e.g. antibodies, white blood cells). High concentrations of certain vitamins and minerals are present (e.g. sodium, magnesium) but lower amounts of others (e.g. calcium). Lactose content is low.
5 days - 2 weeks	Transitional milk	Transition from colostrum to mature milk. Content of energy, fat and lactose increases to meet the needs of rapidly growing and developing infant.
2-4 weeks onwards	Mature milk	Nutritional composition of milk has largely been established. ⁷

In addition, the variability in breast milk composition has also been related to the development of healthier and more diverse taste preferences⁸. It will also change in composition during changes to external factors such as temperature or infant/child illness.

Although the composition of breast milk shows some variability in response to maternal diet, it is hugely resilient in its ability to nurture an infant. Studies have shown that even in circumstances where a mother's nutritional intake is compromised, her breast milk continues to contain most of the essential nutrients, vitamins, minerals, hormones and digestive enzymes necessary to support her growing infant.⁶



Micronutrients in breast milk

Breast milk is nutritionally complete, meaning that alongside the macronutrients provided, it contains all the vitamins, minerals and trace elements necessary to support optimal infant health and development. Vitamin D is known to occur in low quantities in breast milk, especially if the mother has low exposure to sunlight, thus mother and infant supplementation of Vitamin D from birth remains a recommendation [Access NHS link here](#) in place in the UK.⁹

Fatty acids

Fatty acids are a key component of breast milk, playing an essential role in newborn brain development when neural tissue is rapidly developing. Essential fatty acids, including docosahexaenoic acid (DHA) and arachidonic acid (AA), both of which are long chain polyunsaturated fatty acids (LCPUFAS), must be provided during feeding. DHA is a critical fatty acid for neural function and development alongside visual acuity.¹⁰

Of all the fatty acids provided in breast milk, palmitic acid (PA) is the most abundant. Within breast milk, around 70% of this fatty acid is present in a form known as SN-2. The relevance of this SN-2 fatty acid structure is its benefits to infant bone health, improved diversity within the gut microflora and softer stools.

Non-nutritive bioactive components of breast milk and their benefits

While many of the benefits of breast milk and breastfeeding are known by health professionals, further awareness can be acquired through an understanding of the role of some of the key bioactive components in breast milk.

There are four key bioactive components in breast milk with important roles for infant health:

1. Human Milk Oligosaccharides (HMOs)

HMOs are a type of complex indigestible sugar and the third most abundant solid component of breast milk after lactose and fats¹¹. Over 160 varieties of HMOs have been identified, and types are known to vary from mother to mother. Given their indigestible form, HMOs reach the infant's gut intact and confer a plethora of benefits to the infant's gut¹¹, including:

- Promoting the growth of healthy bacteria, e.g. *bifidobacteria* and *lactobacilli*. Both of these bacteria are found in the gut of exclusively breastfed infants, and protect against viruses and bacteria

- Reducing pathogens in the gut
- Supporting the development of the immune system (70% of immune cells are known to be present in the gut)

2. Nucleotides

Nucleotides have an essential role in the cellular and metabolic functions of the growing infant. They form the basis of DNA and RNA and are essential for rapidly dividing tissues, including the intestinal wall. They support the development of intestinal flora and stimulate immune functioning^{12, 13}.

3. The Milk Fat Globule Membrane (MFGM)

The structure of MFGM in breast milk is gaining interest. The fat globule's unique three-membrane structure (see **Figure 2**) is rich with proteins, cholesterol and phospholipids and is believed to have a role in infant brain development and immune functioning¹⁴.

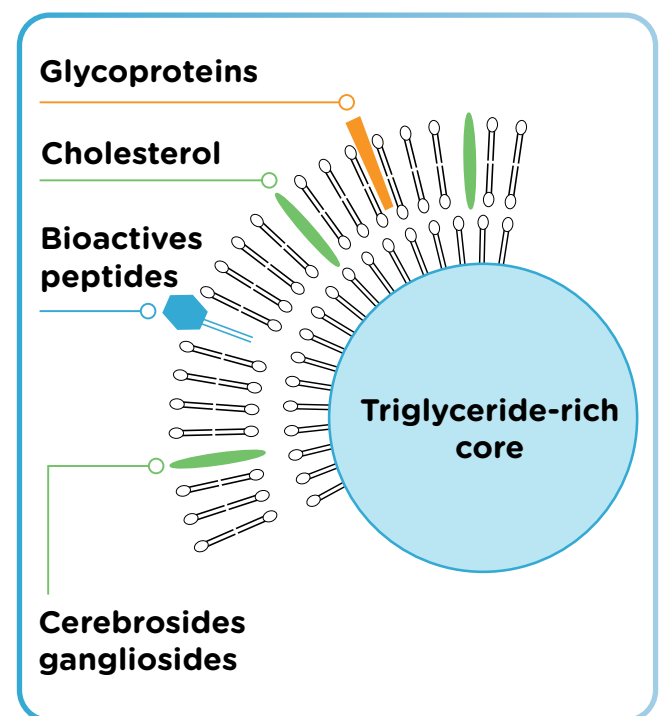


Figure 2: The milk fat globule membrane

4. Immunoglobulins

Immunoglobulins are also known as antibodies and have a well-recognised role in immune functioning. They protect the body against infections, viruses and bacteria. Breast milk is rich in immunoglobulins, which are crucial in shaping an infant's immature immune system. Immunoglobulins transferred via breast milk can support efficient protection for infants from illness-inducing pathogens.¹⁵

Benefits of breastfeeding - the infant

Both nutritive and non-nutritive factors in breast milk collaboratively benefit key aspects of an infant's health including optimising growth, brain and physical development, and immune and metabolic functioning. The outcome of the interplay between all of these factors is likely to be demonstrated in the observed short- and long-term benefits to infants.

Short-term health benefits in infants	Long-term health benefits in infants
Reduced incidence of diarrhoea, including hospitalisation due to diarrhoea ¹⁶	Protection against overweight and obesity in later life ¹⁶
Reduced incidence of necrotising enterocolitis by up to 58% ¹⁶	Positive links to higher performance scores in intelligence tests through childhood and adolescence ^{19,20}
Reduced risk of SIDs by a third (high-income countries) ¹⁶ and a reduced risk of mortality by a third in the post perinatal period (days 7-364) ¹⁷	Reduced risk of childhood infections, including gastrointestinal illness, lower respiratory tract infections and otitis media ²¹
Reduction in otitis media by up to 43% within the first two years of life ¹⁸	Reduced risk of developing asthma ²²



Benefits of breastfeeding - the mother

The benefits of breastfeeding are not limited to the infant, and research has identified key health outcomes that are improved for mothers who breastfeed.

Health outcome for the mother	Benefits associated with breastfeeding
Breast cancer incidence	Risk reduced by 4.3% for every 12 months of breastfeeding ¹⁶
Ovarian cancer	Longer breastfeeding is associated with a 30% reduction The risk decreases by 8% for every five months' increase in the duration of breastfeeding ²³
Type 2 diabetes	Offers some protection from the development of Type 2 diabetes ²²
Postnatal depression	Breastfeeding linked with a reduction in postnatal depression ¹⁶

Benefits of breastfeeding - the mother/child

Breastfeeding also imparts positive behavioural and psychological benefits to the relationship between mother and child. Breastfeeding supports the development of a responsive feeding relationship between mother and infant. Responsive feeding describes a mother responding appropriately to their infant's cues and recognising when these are cues for hunger and satiety or cues for comfort and re-assurance²⁴.



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Understanding what's in breast milk

GUIDANCE & TIPS FOR PARENTS

The World Health Organisation recommends that babies are exclusively breastfed for the first six months of life, with ongoing breastfeeding alongside complementary foods (solids) up to two years of age or beyond

Although some mothers find it hard to initiate or maintain breastfeeding, and others cannot do so for medical reasons (such as significant illness, history of breast surgery e.g., mastectomy) with suitable support, most healthy term infants are able to breastfeed. Some mothers may also choose not to breastfeed.

- Breast milk contains over 300 components designed to support your baby's health and development. This makes it the best possible source of nutrition for your baby with a wide range of health benefits
- Breast milk contains all the nutrition your baby needs for the first six months of life, including water, naturally occurring sugar (lactose), fats and protein, alongside vitamins, minerals and smaller nutrients.
- Breast milk changes as your baby grows and develops. For example, the amount of protein in breast milk is higher in the early weeks of life. Breast milk will also adapt to environmental factors like temperature.
- In the first few days, breast milk is known as colostrum, sometimes referred to as liquid gold. This is produced

in small amounts but is enough for your baby's needs. It is rich in cells to support your baby's immune system. Between days 5-14, breast milk then starts to change, containing more nutrients like protein, fat, sugars (lactose) and vitamins and minerals. By week four, breast milk has reached what's known as mature milk and contains all the nutrients your baby will need to grow and develop.

- Breast milk provides more than just essential nutrition for your baby. Many other components of breast milk have specific benefits to your baby's short- and long-term health. Understanding what some of these key components are can help you appreciate the wider benefits of breastfeeding to your baby's health. Take a look at the table below for more information on some of these other components:

Component	What is this?	What benefits do they have?
Human Milk Oligosaccharides (HMOs)	A type of sugar found in large quantities in breast milk. It cannot be digested (breast milk's own prebiotic)	<ul style="list-style-type: none"> • Can support a baby's gut health by encouraging the growth of good bacteria and preventing the growth of 'bad' bacteria • Support the development of a baby's immune system and protect against infections
Nucleotides	Helps to form the building blocks of the DNA found in cells	<ul style="list-style-type: none"> • Help the growth of rapidly growing tissues in a baby's body, e.g. intestinal wall • Support the immune system and protect against infections
Milk Fat Globule Membrane (MFGM)	The membrane covering fat droplets in breast milk is highly unique to breast milk	<ul style="list-style-type: none"> • Supports a baby's brain development • Supports the immune system and protect against infections
Immunoglobulins	Also known as antibodies	<ul style="list-style-type: none"> • Protect the body against bacteria, viruses and infection

Many more active components of breast milk contribute to its unique composition and benefits to a baby.

Short-term health benefits for breastfeeding babies include:

- Reduced risk of ear infections, diarrhoea, sudden infant death syndrome (SIDS) and harmful bowel conditions in newborn or premature babies

Longer-term health benefits for breastfeeding babies include:

- Reduced likelihood of being overweight or obese in childhood and later life
- Improved outcomes in test scores, e.g. at school
- Reduced risk of common childhood illnesses and infections
- Reduced risk of developing asthma

The benefits of breastfeeding also extend to the mother and include:

- A reduced risk of breast and ovarian cancer,
- A drop in the likelihood of developing type 2 diabetes,
- A lower incidence of post-natal depression.

There are also behavioural and psychological benefits to breastfeeding. Breastfeeding can help you develop a strong responsive feeding relationship with your baby – this is where you recognise their needs ('cues') and respond to these. For example, learning when your baby is ready to feed and when he/she wants to stop feeding.

Breastfed babies can also be exposed to a wide variety of flavours and tastes via breast milk and are therefore more accepting of some new flavours and foods when solids are introduced at around six months of age.

