



**African
Neonatal
Nutrition
Network**

Nutrition in preterm and low birthweight infants in Africa

Module 1: Introduction

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Introduction to Module 1



Welcome to Module 1: Introduction.

In this introductory module, you will meet our learning coordinators and educators, before being introduced to some of the key terms and concepts that will be discussed throughout the rest of the course. This module will also include the first of our case studies, where you can decide on effective treatment plans and interact with other learners.

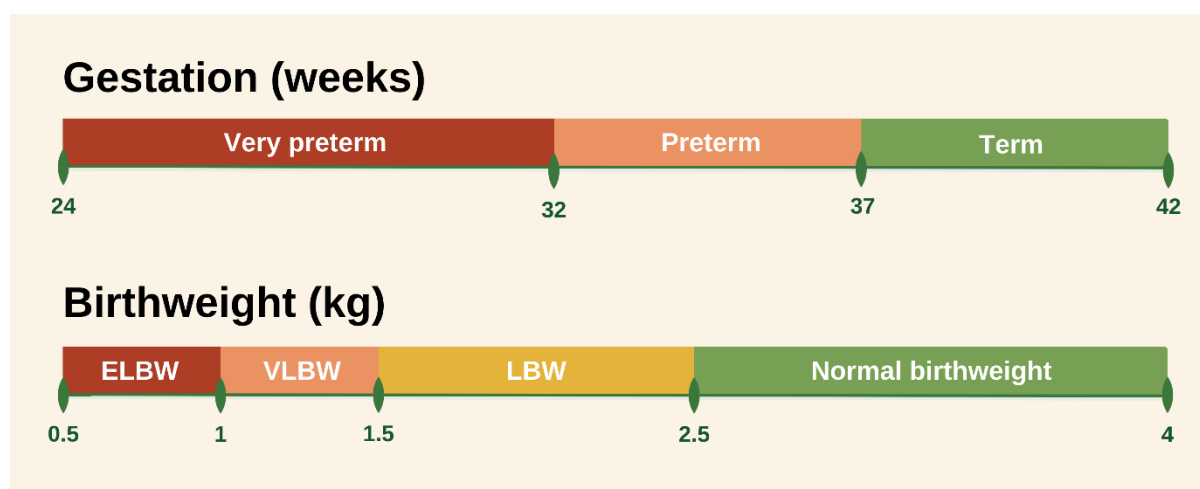
The key learning objectives from this module include:

- Define key terms relating to infant gestation and weight.
- Describe the key aims of nutrition in newborn care.
- Explain the purpose and benefits of kangaroo mother care (KMC).
- Recall the key components of a healthy newborn breastfed diet.

Nutrition in preterm and LBW infants - a global perspective

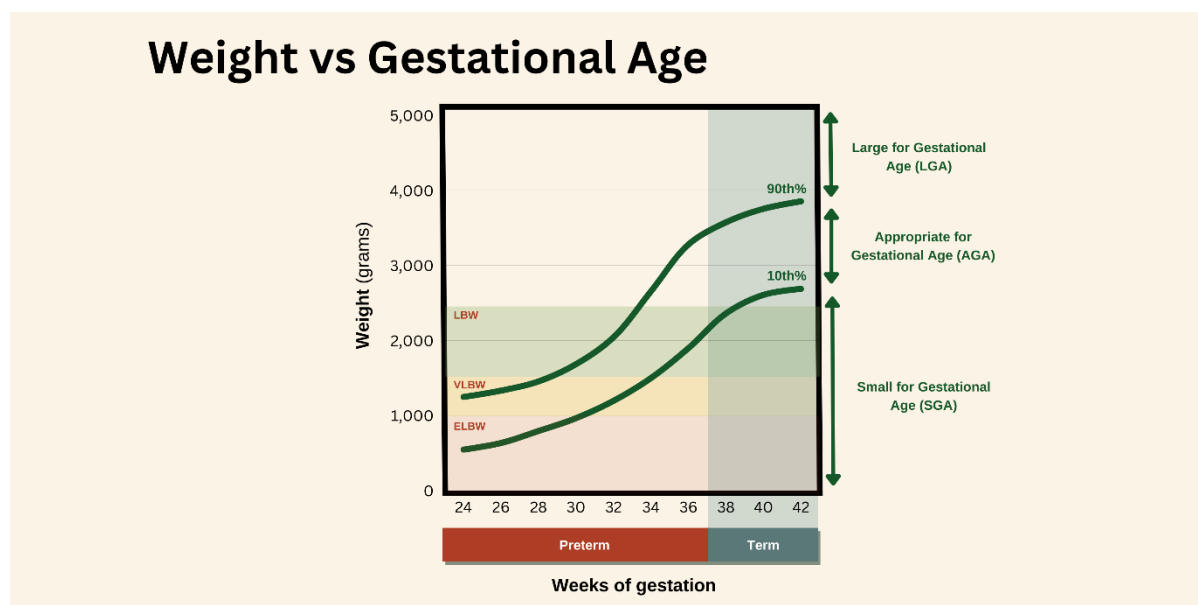
Key definitions

In this course, we will discuss all infants born preterm and/or low birthweight (LBW). It is important to understand the key terms used to describe different patients. Read below to learn how we define the different cases.



- Very preterm infants are born before 32 weeks
- Preterm infants are born before 37 completed weeks
- Term infants are born between 37 and 42 weeks
- Extremely low birthweight infants are born weighing under 1kg
- Very low birthweight infants are born weighing under 1.5kg
- Low birthweight infants are born weighing under 2.5kg
- A normal birthweight is considered to be between 2.5kg and 4.5kg

Infants can also be described as small for gestational age (SGA), meaning their weight is below the 10th centile. This is described in the graph below.



The two key factors that are relevant when describing a baby are gestation and birthweight. In the graph above, you can see that LBW infants may be term (37-42 weeks) or preterm (<37 weeks) gestation, however, almost all VLBW infants will have been born preterm. SGA refers to infants born below the 10th centile for that gestation and may be preterm or term. Many SGA infants (but not all) are small because of slow foetal growth that is usually due to placental dysfunction. This is termed in-utero growth restriction (IUGR).

In this course, we focus on nutritional care in preterm and low birthweight infants. The WHO describes this as feeding in exceptionally difficult circumstances. The nutrition and care advised is applicable to all preterm and low birthweight infants, however some infants, including extremely low birthweight infants <1000g, may need additional support that is not covered in this course.

Why is it important to improve nutrition in preterm and LBW infants?

Premature birth and/or LBW is a common cause of serious illness and death. The statistics below highlight the importance of the issue both in Africa and worldwide:

Key statistics: The importance of improving care of low birth weight infants



Preterm infants

More than 15 million preterm infants are born too small every year.

Newborn deaths

Approximately 47% of all children under the age of five who die are newborns, and up to 80% of those newborns who die are premature and/or small for gestational age.



Mortality risk in Africa

Preterm and LBW infants have an up to 59-fold higher risk of mortality in hospital in Africa than infants born at term and with normal birth weight.

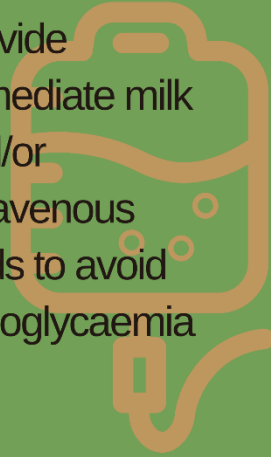
Optimising nutrition in preterm and LBW infants has potential to improve their survival, growth, and long-term health outcomes. Nutrition is critical to brain development in early life. However, providing adequate nutrition in this situation can be challenging as this group are particularly vulnerable to respiratory complications, poor body temperature regulation, feed intolerance, and infection.

Failure to meet recommended nutrient intakes results in poor growth and is associated with increased short-term risks, such as late onset sepsis, and predisposes them to long-term neurodevelopmental impairment and adult onset metabolic and cardiovascular disease.

There is strong evidence that neonatal complications and death are lower where “mother's own milk” (MOM) is the main source of nutrition. Therefore, a key principle of early nutritional care is the provision of MOM.

Providing adequate nutrition is an essential component of newborn care. The key aims of nutrition include:

KEY AIMS OF NUTRITION



Provide immediate milk and/or intravenous fluids to avoid hypoglycaemia



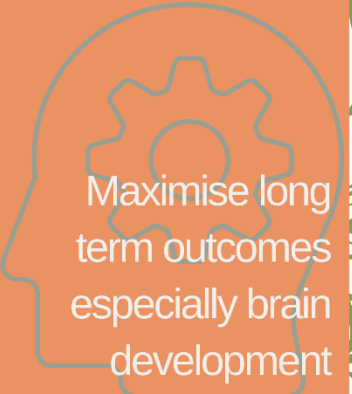
Ensure nutrient intake recommendations are met to enable adequate growth



Reduce the risk of death due to malnutrition



Reduce the risks of sepsis and necrotising enterocolitis (NEC)



Maximise long term outcomes especially brain development

It is important to note, however, that nutrition encompasses much more than just providing adequate nutrients.

Nutrition requires a holistic approach in which we consider a wide range of factors that we will discuss in this course, including:

- Kangaroo mother care (KMC)
- Macronutrients and micronutrients
- Maternal psychological status and support
- Parental involvement in decision making
- Infection control practices
- Anti-infective components in breastmilk
- The neonatal unit environment

Providing preterm and LBW infants with appropriate nutrition in hospitals or healthcare facilities with limited resources can be extremely challenging.

A downloadable summary of key WHO and ANNN recommendations for care of low birthweight infants is available in the 'downloadable resources'. We will highlight and share individual recommendations throughout the rest of the course.

Please note: The African Neonatal Nutrition Network (ANNN) is not responsible for the practices of physicians and provides recommendations as an indication of good clinical practice only. WHO recommendations should be checked against their latest guidelines. Diagnosis and treatment is at the discretion of local health care providers.

Kangaroo mother care (KMC)

Kangaroo mother care (KMC) refers to the care of preterm and LBW infants in continuous and prolonged skin-to-skin contact for 8-24 hours per day, initiated immediately after birth with support for exclusive breastfeeding or breast milk feeding (WHO, 2022). KMC provides the basis upon which nutritional care can be planned and provided.

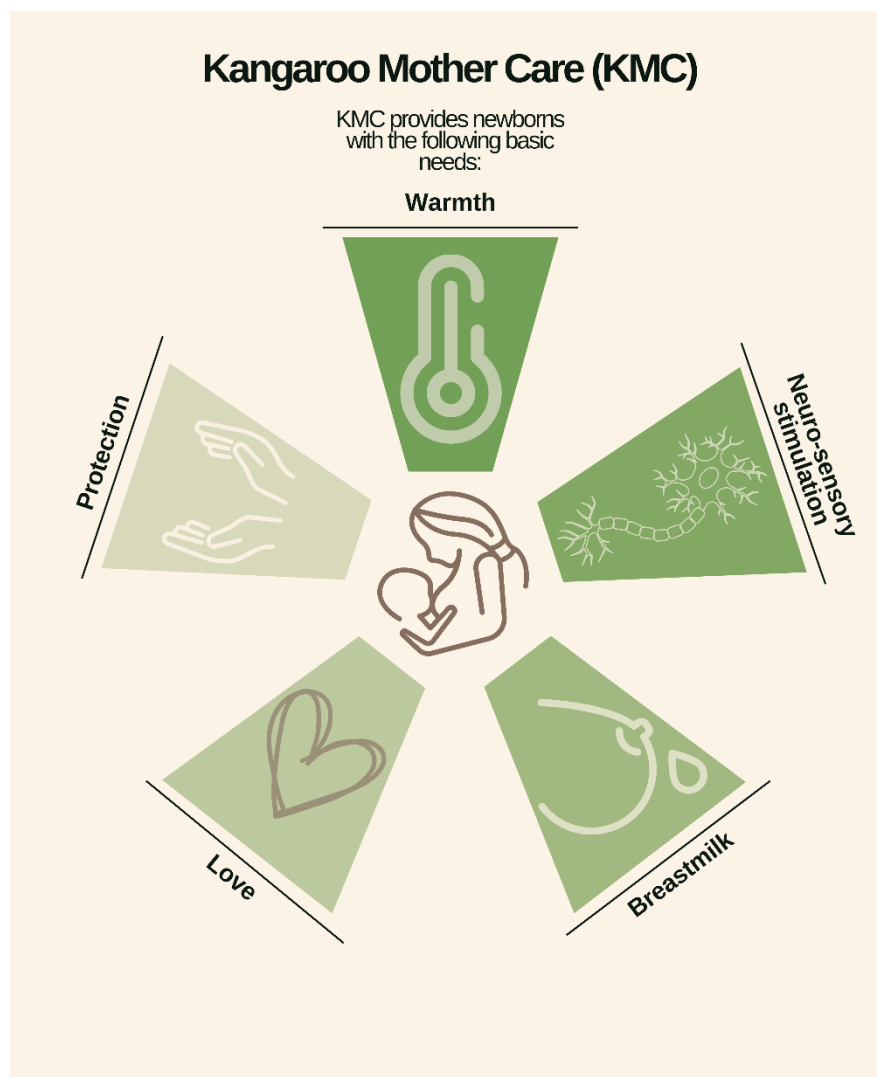


KMC - the best start for infant nutrition

Newborn infants who are born preterm and LBW require immediate care and this is best provided by KMC whenever possible. Infants receiving KMC may be managed on a postnatal ward with other infants, or some may require admission to a neonatal unit. Very sick or unstable infants will be placed in an incubator or cot, but many vulnerable newborn infants can still be effectively cared for using KMC.

KMC is one of the most important and effective interventions in neonatal care to reduce morbidity and improve continued breastfeeding, and it is estimated that KMC alone will save more than half a million lives between 2012 and 2025.

In all vulnerable newborns, except those who are critically sick, KMC should be considered and started immediately. Wherever possible, KMC should be provided by mothers, although fathers and other family members can participate depending on parental preference. Breastfeeding should be commenced as soon as possible, but KMC also supports the use of feeding with expressed breastmilk through feeding (gastric) tubes, spoons, or cups. It is also important that KMC is encouraged following hospital discharge.



High quality data show that immediate KMC in babies as small as 1000g reduces the risk of death and adverse outcomes such as sepsis and hypothermia, and that non-separation between mother and baby results in numerous physiological benefits.

You can learn more about these benefits through the [KMC resources](#) hosted on our website.

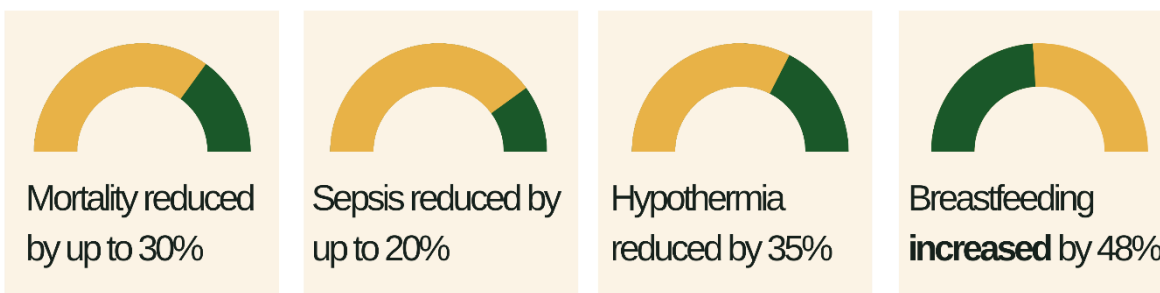
Why is KMC important to holistic nutrition?

Providing vulnerable infants with appropriate nutrition in hospitals or healthcare facilities with limited resources can be extremely challenging, and KMC provides the basis upon which nutritional care can be planned and provided.

KMC emphasises the importance of involving parents/carers in nutritional management and helps the mother to establish lactation and successful breastfeeding. It encourages healthcare professionals to work with parents/carers, avoid mother-infant separation (non-separation), and promote respectful care by being aware of specific cultural and religious aspects that may affect its practice.

Benefits of KMC

The proven benefits of KMC (WHO, 2023) include:



Immediate KMC

Immediate KMC involves initiating kangaroo mother care soon after birth and before stabilisation.

[An immediate KMC \(iKMC\) trial](#) was conducted in Ghana, India, Malawi, Nigeria, and Tanzania among infants who weighed 1-1.799kg. Results showed that infants who received immediate KMC had 25% lower mortality at 28 days of age, 35% lower incidence of hypothermia up to discharge, and 18% less suspected sepsis compared with control infants who received conventional newborn care.

This means that by utilising the benefits of iKMC, one newborn death can be prevented for every 30 babies born preterm or LBW, and iKMC demonstrates significantly greater benefits compared to later initiation.

Read below for the latest WHO recommendations for KMC.

RECOMMENDATION A.1a (UPDATED)

Any KMC:

Kangaroo mother care (KMC) is recommended as routine care for all preterm or low-birth-weight infants.

KMC can be initiated in the health-care facility or at home and should be given for 8–24 hours per day (as many hours as possible). (Strong recommendation, high-certainty evidence)

RECOMMENDATION A.1b (NEW)

Immediate KMC:

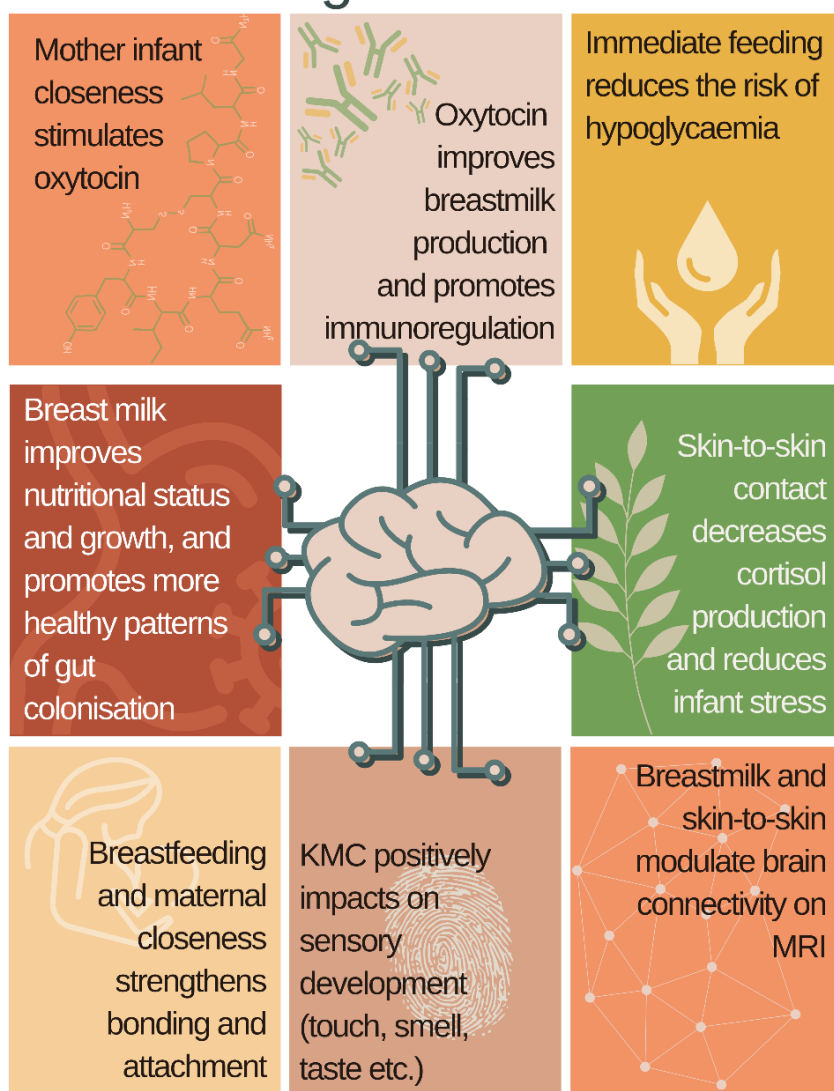
Kangaroo mother care (KMC) for preterm or low-birth-weight infants should be started as soon as possible after birth. (Strong recommendation, high-certainty evidence)
(Strong recommendation, high certainty evidence)



Long-term brain benefits

Several studies have shown KMC is associated with improved cognitive and motor development, and better longer-term social and behavioural outcomes. Studies conducted in Colombia have shown that preterm infants who received KMC had improved intelligence, attention, memory, and coordination 20 years later compared with those who received incubator care (Charpak et al., 2017). There will be multiple mechanisms that link KMC to better brain outcomes, including:

KMC - Long-term Brain Benefits

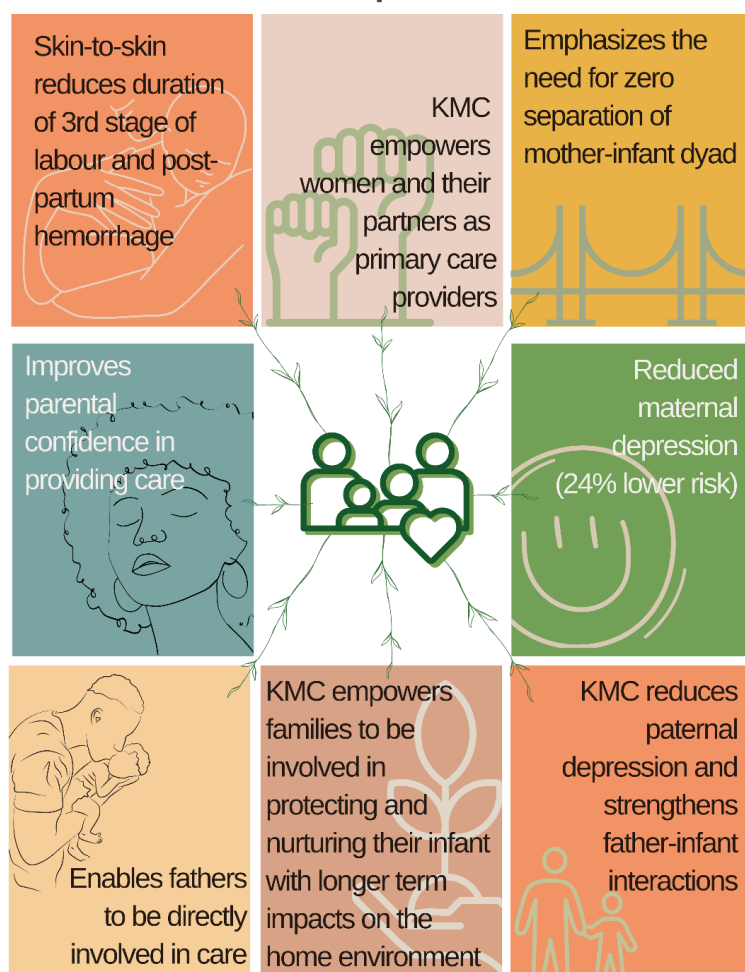


Benefits of KMC for mothers, fathers, families and hospitals

KMC allows parents/carers to feel intimately involved in care of their infant, which positively impacts on their own mental health, as well as decreases infant handling by multiple health workers (which may increase the risk of infections).

KMC is associated with multiple benefits for parents/carers and families, some of which are presented in the graphic below.

KMC - Benefits for parents and families

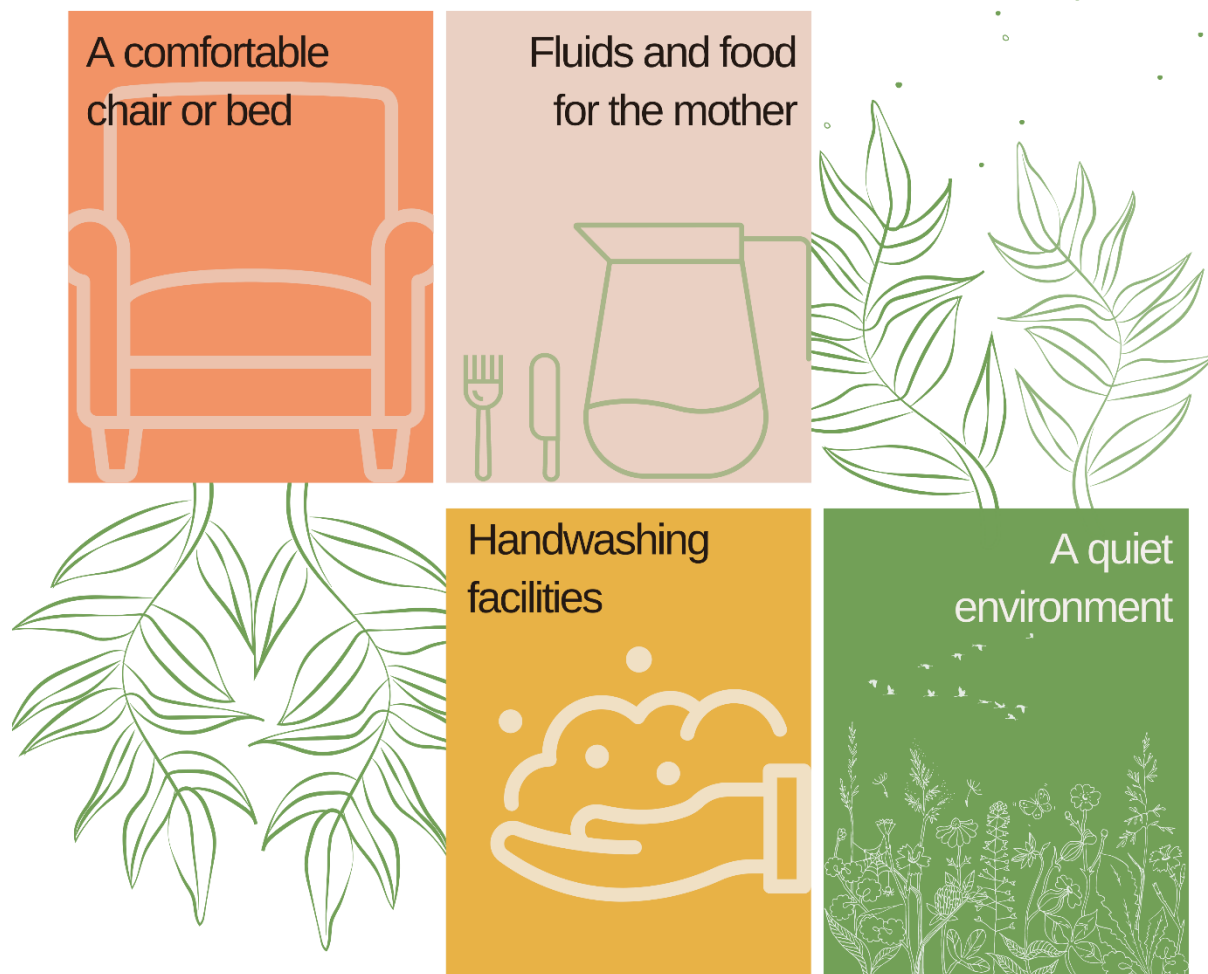


Qualitative studies show that parents/carers want to be actively involved in care of their preterm and LBW infants and view KMC as an opportunity to be directly involved in care and parenting. Caregiver knowledge of the processes and benefits of KMC improve practice and outcomes, and parents/carers deserve careful explanation of these aspects so they can make an informed choice. Economic analysis also shows that KMC is cheaper and more effective than traditional care.

Physical resources for parents/carers

Effective KMC also requires a number of physical resources for parents/carers, some of which are displayed in the graphic below:

PHYSICAL RESOURCES FOR PARENTS



The importance of involving parents/carers in preterm and LBW infant care is highlighted by the WHO recommendations below.

WHO recommendations: Parental involvement

Family involvement in the routine care of preterm or low-birthweight infants in health-care facilities is recommended. (Strong recommendation, low- to moderate-certainty evidence)



Families of preterm or low-birthweight infants should be given extra support to care for their infants, starting in health-care facilities from birth and continued during follow-up post- discharge. The support may include education, counselling and discharge preparation from health workers, and peer support. (Conditional recommendation, very-low-certainty evidence)



Which babies cannot have immediate KMC?

This may differ depending on healthcare resources and settings. In general, most infants, whether they are well or not, can receive iKMC when the healthcare team considers it safe to do so and when the parents/carers wish to do so.

iKMC may be considered unsafe in infants who are unstable, for example if they:

- are unable to breathe spontaneously after resuscitation.
- are in shock.
- require mechanical ventilation.
- However, KMC has been shown to be possible and effective in stable infants receiving respiratory support, especially those receiving non-invasive respiratory support such as continuous positive airway pressure (CPAP).

Where vulnerable infants are too sick or unstable to receive KMC, care should focus on their immediate needs, including:

- Avoiding hypothermia.
- Implementing infection control policies to reduce sepsis.
- Supporting mothers to express “mother's own milk” or MOM.
- Ensuring non-separation of the mother-infant dyad.
- Providing intravenous fluids if required to avoid dehydration and hypoglycaemia.

How to provide KMC

A detailed description of the practical processes involved in providing KMC is beyond the scope of this course, but further resources can be found as PDFs and links on our website. Providing KMC requires:

- Hospital policies and guidelines.
- Training and education for staff.
- Resources for parents/carers and staff.
- Respectful discussions with parents/carers.

For further detail on the WHO recommendations for KMC, please see page 12 of the 'WHO recommendations for care of the preterm or low-birth-weight infant', available in the downloadable resources.

References

1. WHO (2022). *WHO recommendations for care of the preterm or low-birth-weight infant*. World Health Organization. Available at: <https://www.who.int/publications/i/item/9789240058262>
2. WHO (2023). *Kangaroo mother care: a transformative innovation in health care*. World Health Organization. Available at: <https://www.who.int/publications/i/item/9789240072657>

Case study: Introduction

Abeni was born at 33 weeks' gestation weighing 1.6kg (25th centile). Her mother developed Pregnancy Induced Hypertension and she was treated with labetalol during the pregnancy. There was spontaneous labour at 33 weeks following prolonged rupture of the membranes for 36 hours. She is placed in immediate skin-to-skin contact with her mother.

At birth and at 20 minutes of age after birth, Abeni has a normal respiratory rate, has good tone, and appears well. However, the medical team note that Abeni's mother has a temperature of 38°C.

Case study: Initial care

What are Abeni's most important needs over the first 12-24 hours?

- Preventing hypothermia and hypoglycemia
- Optimising micronutrient intakes
- Observing for respiratory distress/infection
- Septic screen
- Oral antibiotics
- IV antibiotics

Go to the next page to see the correct answer



The correct answers are:

- Preventing hypothermia and hypoglycemia
- Observing for respiratory distress/infection
- Septic screen
- IV antibiotics

Abeni is preterm and LBW and is at risk of hypothermia and hypoglycemia. Although she has a normal respiratory rate, she requires careful observation for any signs of respiratory distress or infection. Given the maternal pyrexia, spontaneous labour, and prolonged rupture of the membranes, many hospitals would recommend a “septic screen” and start intravenous antibiotics. Use of oral antibiotics would not be appropriate in this case and optimisation of micronutrient intakes is not a top priority at this stage.

Case study: Discussion

Given her degree of prematurity and risks of infection, would KMC be safe and appropriate for Abeni? Consider what else you would recommend in the first few days, before reading the expert opinion on the next page.

[illegible]

Case study: Expert opinion

We will now look at an expert opinion of how to treat the infant and mother in this particular case study. Read through and consider any similarities and differences with your patient management.

“The iKMC trial showed that KMC reduces the risk of death and late onset sepsis. Abeni can be placed in the KMC position using an appropriate binder, by a trained member of staff. Mother should be informed about the practice of KMC and given advice about placing Abeni to the breast, or expressing colostrum if Abeni is not able to latch and suck.

Monitoring of respiratory distress and hypoxia is important and if needed, CPAP and/or oxygen can be given alongside intravenous antibiotics whilst still receiving KMC.

Abeni will require blood glucose monitoring because of the risk of hypoglycemia. KMC is more effective than other methods (e.g. heat pad) in avoiding hypothermia, but Abeni will still require regular temperature checks.

Abeni’s feeding and milk intake over the first few days will require careful observation.”

Professor Nick Embleton

Consultant Neonatologist and Professor of Neonatal Medicine

Introduction to dietary nutrient requirements

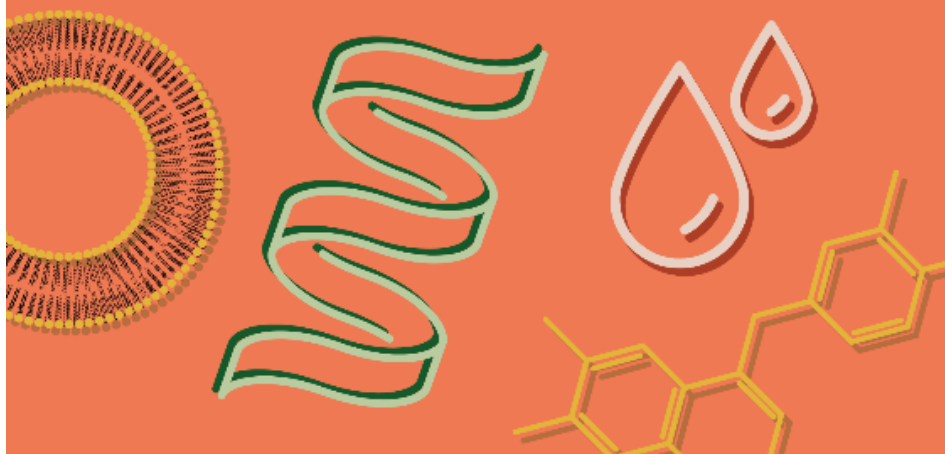
Overview of nutrients in an infant diet

Macronutrients and micronutrients are key elements of neonatal nutrition. Examples of what is included in these two groups is provided in the two graphics below:

Macro nutrients

Macronutrients include:

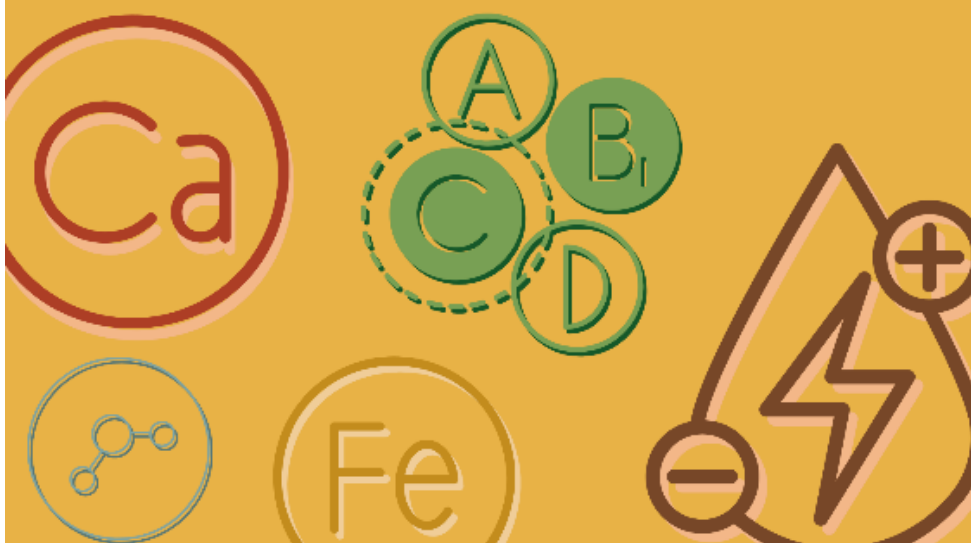
- Water, protein, carbohydrate and fats.
- Protein and fat in the diet is converted into new body tissue.
- Fats and carbohydrates provide energy for growth and repair.
- Breastmilk provides the optimal composition, although vulnerable infants require higher intakes compared to healthy term infants.



Micro nutrients

Micronutrients include:

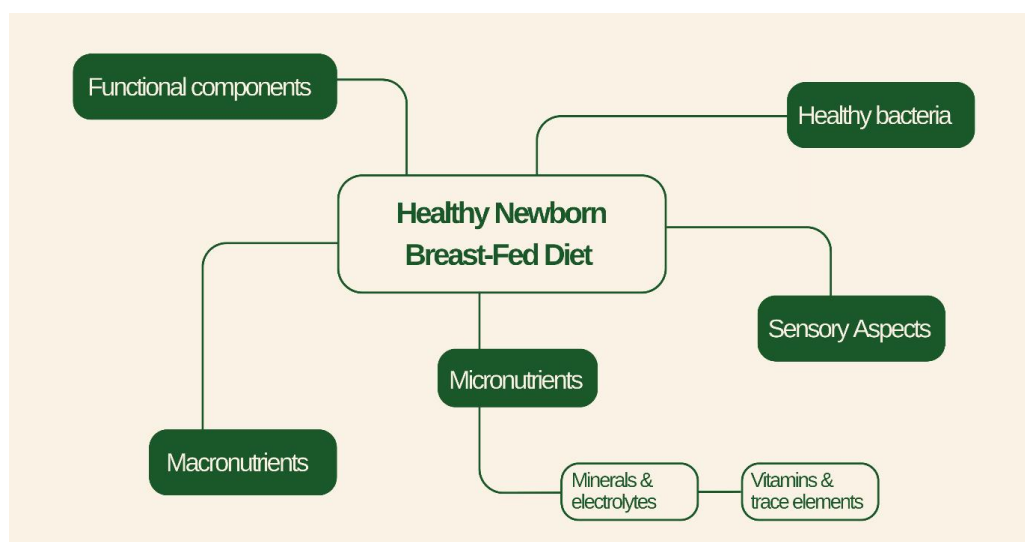
- Minerals such as calcium and phosphate which are essential for bone and muscle development.
- Electrolytes e.g. sodium.
- Vitamins including fat-soluble (A, D, E and K) and water soluble e.g. vitamin C.
- Trace elements such as iron and zinc



In this step, we will introduce the dietary nutrient requirements of newborns. We will explore the different components of breast milk and discuss why each of these is important for the development of the infant.

Breast milk has evolved over millennia to meet the nutrient needs of newborn infants as well as provide components that improve immunity and reduce infections, such as human milk oligosaccharides (HMOs). By providing healthy bacteria, along with other components (e.g. HMOs, enzymes), breast milk is able to promote gut health and optimal brain development. Finally, breastfeeding also promotes maternal-infant bonding, metabolic health, and sensory aspects, all of which are important elements of nutrition over the course of the infant's life. For example, specific breast milk components can affect appetite, taste preferences, and obesity. Most of these aspects are missing when formula milk is used.

Components of a healthy newborn breast-fed diet

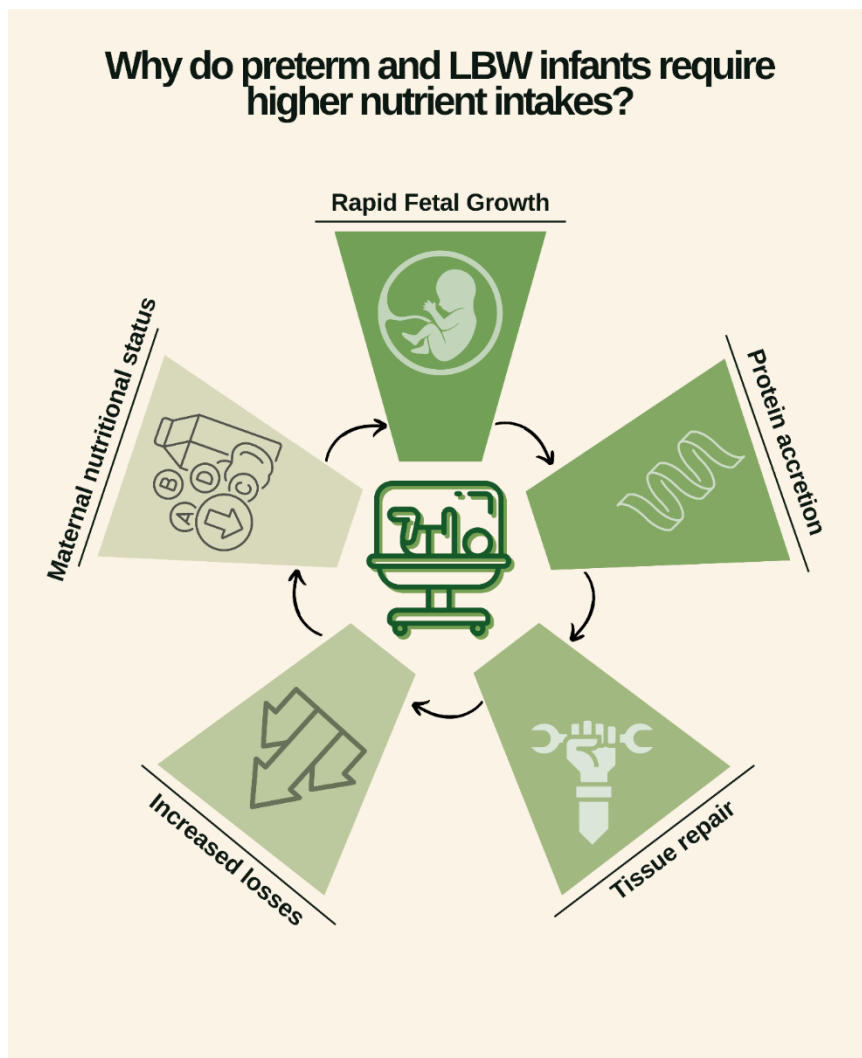


- **Functional Components** - Components of a healthy newborn breast-fed diet
- **Macronutrients** - e.g. protein and energy
- **Sensory aspects** - Smell, touch, and taste
- **Minerals & electrolytes** - e.g. calcium and sodium
- **Vitamins & trace elements** - e.g. iron and zinc

Vulnerable infants who are born preterm or LBW also require all of these components. However, compared to term infants they often require higher intakes on a per kilogram (kg) basis for macronutrients and many micronutrients. These higher requirements can be met by providing a higher volume of milk, or by providing supplements. You will learn more about this in module 4.

Why do preterm and LBW infants require higher nutrient intakes?

The higher nutrient intake requirements for preterm and LBW infants are due to several factors. Read below to learn more.



Rapid fetal growth: In-utero growth in the 3rd trimester is much greater than after 40 weeks.

Protein accretion: Higher weight gain velocity requires more nutrients (tissue substrate): more energy is needed to accrete proteins into new tissue.

Tissue repair: Preterm infants are more likely to have other problems such as lung disease: tissue repair requires additional energy.

Increased losses: Preterm infants have greater losses for example due to fat malabsorption (energy loss) or renal tubular losses (sodium loss).

Maternal nutritional status: Vulnerable infants may be born to mothers with poor nutritional status such as Vitamin D deficiency.

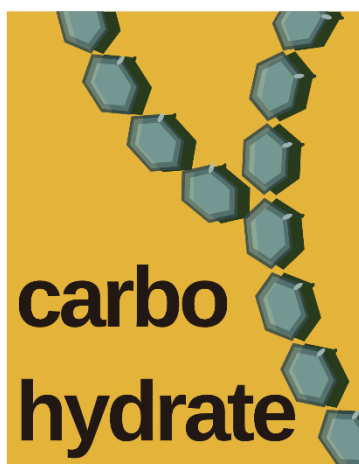
Macronutrients

Macronutrients include water, protein, carbohydrate, and fats.



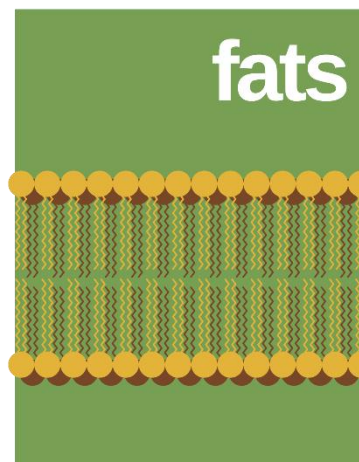
Water is essential as a 'carrier' of nutrients and to enable excretion of waste products, for example as urea in the urine. Preterm infants require higher water intake because they have both a higher surface area and thin skin, thereby resulting in greater water losses. Higher nutrient intake in preterm infants also requires a higher water intake.

Protein is made of long chains of amino acids. The precise combination and amounts of amino acids in body protein differ. For example, muscle cells have a different composition to immune cells. Milk protein is either casein or whey, and amino acid composition varies. Breastmilk protein is the ideal source for newborn infants as it is perfectly matched to needs and is therefore considered "high quality". Whilst the protein is still high quality in formula milk, the composition is not as well matched to the needs of newborn humans.



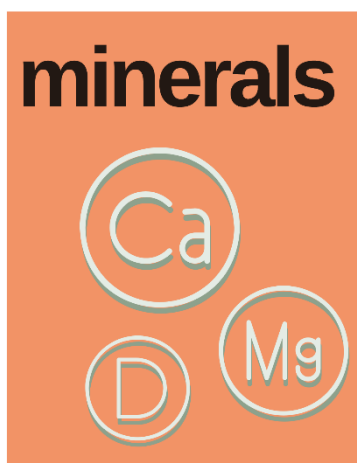
Carbohydrates, also called sugars, provide energy to grow; without energy, proteins cannot be made into tissue. Energy is also needed to maintain homeostasis (e.g. breathing, heart activity, digestion) and avoid hypoglycaemia (low blood glucose). Lactose is the main carbohydrate in breast milk and plays an important role in gut health and the maintenance of a healthy gut microbiome.

Fats provide energy alongside carbohydrates, but also provide 'building blocks' for new tissue, especially in cell membranes and the brain. Within breast milk, there are lots of different types of fat with different roles. Long-chain fatty acids such as docosahexaenoic acid (DHA) are essential for brain development.



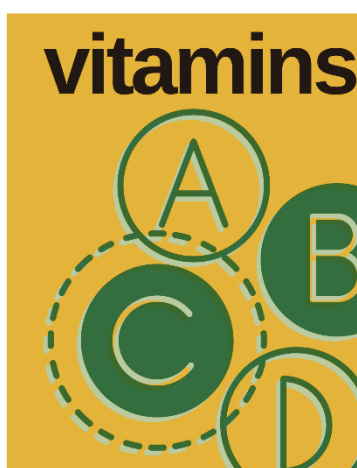
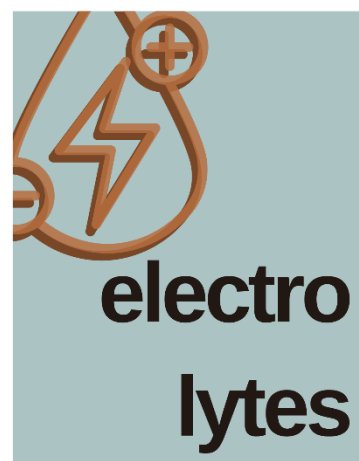
Micronutrients

Micronutrients include minerals, electrolytes, vitamins, and trace elements. Preterm and LBW infants often require additional supplements.



Minerals such as calcium, phosphate, and magnesium are essential for muscle function and, in combination with Vitamin D, support bone growth. Preterm infants may benefit from mineral supplements, although the availability of safe supplements might be difficult. Infants with symptomatic hypocalcaemia (e.g. tetany or convulsions) require calcium correction, but access to oral calcium and phosphate supplements is often limited.

Preterm infants have much higher requirements for sodium to support growth, and have higher losses of sodium in the urine. Many very preterm infants (<32 weeks) will require supplements. However, the needs for other electrolytes such as potassium and chloride will usually be met by the mother's own breast milk.



vitamins

Vitamin D is widely available and usually given as part of a multi-vitamin supplement. All infants require supplemental Vitamin D throughout early infancy. Water soluble vitamin supplements (e.g. Vitamins B and C) are rarely required.

Trace elements refer to compounds such as iron, zinc, and selenium. All preterm and LBW infants require iron supplementation. Iron is present in breast milk at low concentrations and, whilst this perfectly meets the needs of full-term babies, it is insufficient for preterm babies. Zinc is important for tissue repair, growth, and enzyme function. Routine zinc supplementation is not necessary, but some vulnerable infants, e.g. those with diarrhoea or intestinal stoma, may benefit from supplements.



We will discuss macro- and micronutrients in more detail later in the course, including common symptoms of deficiency.

Functional components in human milk

Functional components are also known as immunonutrients or bionutrients. Examples include specific proteins, fats, carbohydrates, hormones, enzymes, antibodies, and immune cells. They are one of the key reasons why breast milk fed infants have better outcomes compared to those fed milk formula. Most of these components are unique to human milk, and many are also present in amniotic fluid.

We will discuss breast milk composition in more detail in module 3. For now, take a look below to see a few examples of these components and their likely functions.

Functional components in human breast milk

Human milk component	Type	Example of function
Lactoferrin	Protein (whey)	Anti-bacterial
Milk fat globule membrane	Fat	Brain growth
Insulin-like growth factor (IGF1)	Hormone	Brain and muscle growth
Amylase	Enzyme	Digestion of carbohydrate
Immunoglobulin A (IgA)	Antibody	Anti-infective
Vitamins ADEK	Vitamin	Bone growth
Docosahexaenoic acid (DHA)	Fat	Brain & retinal growth
Stem cells	Human cell	Tissue repair
Lactobacillus	Healthy bacteria	Gut health
Human milk oligosaccharides (HMOs)	Carbohydrate	Promotes healthy bacteria

End of Module 1

In this module, we introduced the key concepts of nutrition in preterm and LBW infants. We introduced the key components of a newborn diet, whilst stressing the importance of a holistic view on nutrition. Aspects such as Kangaroo Mother Care can be vital to ensuring effective nutrition and growth.

After working through each step, you should now be able to:

- Define key terms including term, preterm, very preterm, LBW, VLBW, and SGA.
- Understand the difference between macronutrients and micronutrients.
- Understand the benefits of KMC.
- List the components of a healthy newborn breastfed diet.

If you are unsure about any of these goals, make sure to go back through the previous steps and refresh yourself.



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