Diet preparation for pregnancy and lactation

Nutrition during pregnancy

- The period of 9 months gestation is a time for rapid growth.
- Starting from a single fertilized egg cell ‘ovum’, the life grows to a full-fledged infant baby weighing about 3 kg.
- Growth of the fetus and other developments that take place to facilitate its maintenance throughout pregnancy and delivery of the child involve an increase on the nutritional requirement of the pregnant women
- Water and the fat soluble vitamins diffuse to the fetal circulation
- Other nutrients such as amino acids, glucose, the water-soluble vitamins and minerals such as calcium, sodium and iron are actively transport

Nutrition during pregnancy

- So the increase in the nutritional requirements of a pregnant woman can be attributed to:
- Rapid growth of the fetus
- Development of the placenta
- Enlargement of maternal tissues namely the breast and uterine tissues
- Increase in maternal circulating blood volume
- Formation of amniotic fluid
- Storage reserves
- Mineralization of the skeletal and bone structure of the foetus as well as tooth buds

- To meet the additional nutritional requirement, foods which supply all the nutrients in greater amount to sustain and support the pregnancy must be consumed by the pregnant woman

Stages of pregnancy

- Pregnancy lasts about 40 weeks, counting from the first day of your last normal period. The weeks are grouped into three trimesters

✓ 1st trimester = week1 – week 12

✓ Second trimester = week 13 – week 28

✓ Third trimester = week 29 – week 40

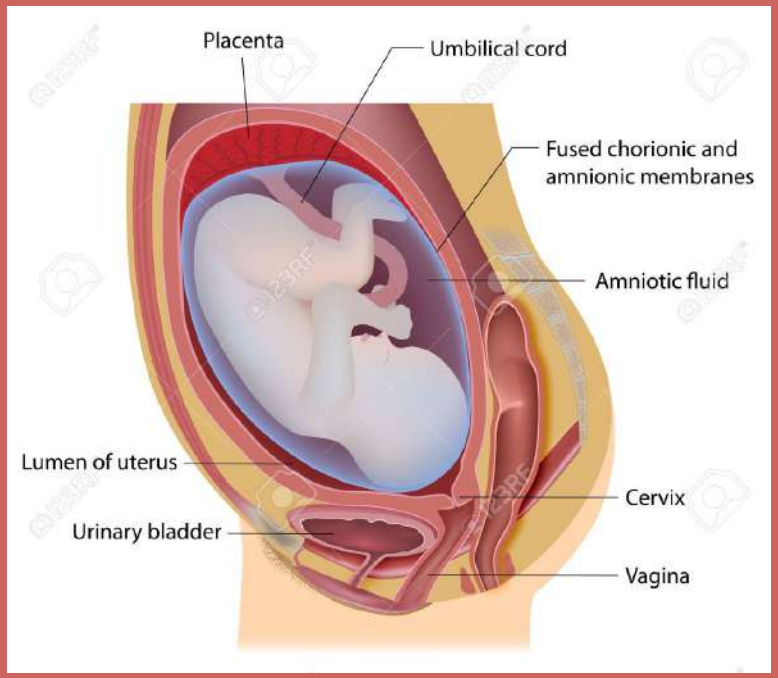
Weight gain during pregnancy

- It is normal for a woman to gain 3.5 kg in weight by the end of the first 20 weeks of pregnancy and thereafter to gain 0.5 kg a week until term, when the total weight gain is around 12.5 kg
- Components of weight gain are shown in the table

Components of weight gain

Contributors to Weight Gain During Pregnancy

Component	Weight (kg)	Weight (lb)
Fetus	3.2–3.6	7–8
Placenta and fetal membranes	0.9–1.8	2–4
Amniotic fluid	0.9–1.4	2–3
Breast tissue	0.9–1.4	2–3
Blood	1.4	4
Fat	0.9–4.1	3–9
Uterus	0.9–2.3	2–5
Total	10–16.3	22–36



Changes in body fluid & Body storage of fat

- During pregnancy, blood volume increases as the plasma increase a little more than the red cells
- It is normal for the hemoglobin concentration in the blood to fall slightly by the end of pregnancy
- In the last 10 weeks, there is an increase in the extracellular fluid, in addition to plasma
- The extra fat deposited is about 4 kg
- This is an energy store of 36000 kcal, enough to supply the needs of the body for 2 to 3 weeks in an emergency
- It is deposited throughout the pregnancy, especially between the 10^{th} and 20^{th} weeks

General targets of appropriate weight gain

- Five maternal weight gain targets have been developed. These are as follows:

1. Target 1 – for women who enters her pregnancy at more than 120% of standard weight, the target is an obligatory weight gain of 7 to 8 kg at a weekly rate of no more than 300g/week
2. Target 2 – for women of normal percentage of standard weight, the target is 10 kg
3. Target 3 – for women who enters pregnancy between 90 and 110% of standard weight and is planning to breast feed her baby, the target is overall 12 kg of weight gain
4. Target 4 – for women who is going to have twins, the target is 18 kg of weight gain

Importance of nutrition during conception

Why is nutrition important at preconception?

A mother's nutritional status is critical prior to conception, (preconception is 3 months before conception), and immediately afterwards, (peri-conception is 2–3 months after conception). The foetus is most vulnerable to nutritional deficiencies in the first trimester of pregnancy, often before a woman realizes that she is pregnant.

There is evidence that poor maternal nutrition has both immediate (e.g. low birth weight) and long-term consequences. The so-called 'foetal origins' or 'Barker' hypothesis proposes that foetal growth plays a major role in determining the risk of some dietary related non-communicable disease, e.g. cardiovascular disease and type 2 diabetes in adulthood.

Importance of nutrition during conception

- Maternal nutritional status at the time of conception is an important determinant of embryonic and fetal growth.
- The embryo is most vulnerable to the effects of poor maternal diet during the first few weeks of development, often before pregnancy has been confirmed. Cell differentiation is most rapid at this time, and any abnormalities in cell division cannot be corrected at a later stage.
- Most organs, though very small, have already been formed 3–7 weeks after the last menstrual period, and any teratogenic effects (including abnormal development) may have occurred by this time.
- Good nutrient status prior to pregnancy is essential to ensure adequate fetal supplies during this critical period and to support maternal stores throughout pregnancy.

The ‘Developmental Origins of Health and Disease’ Hypothesis

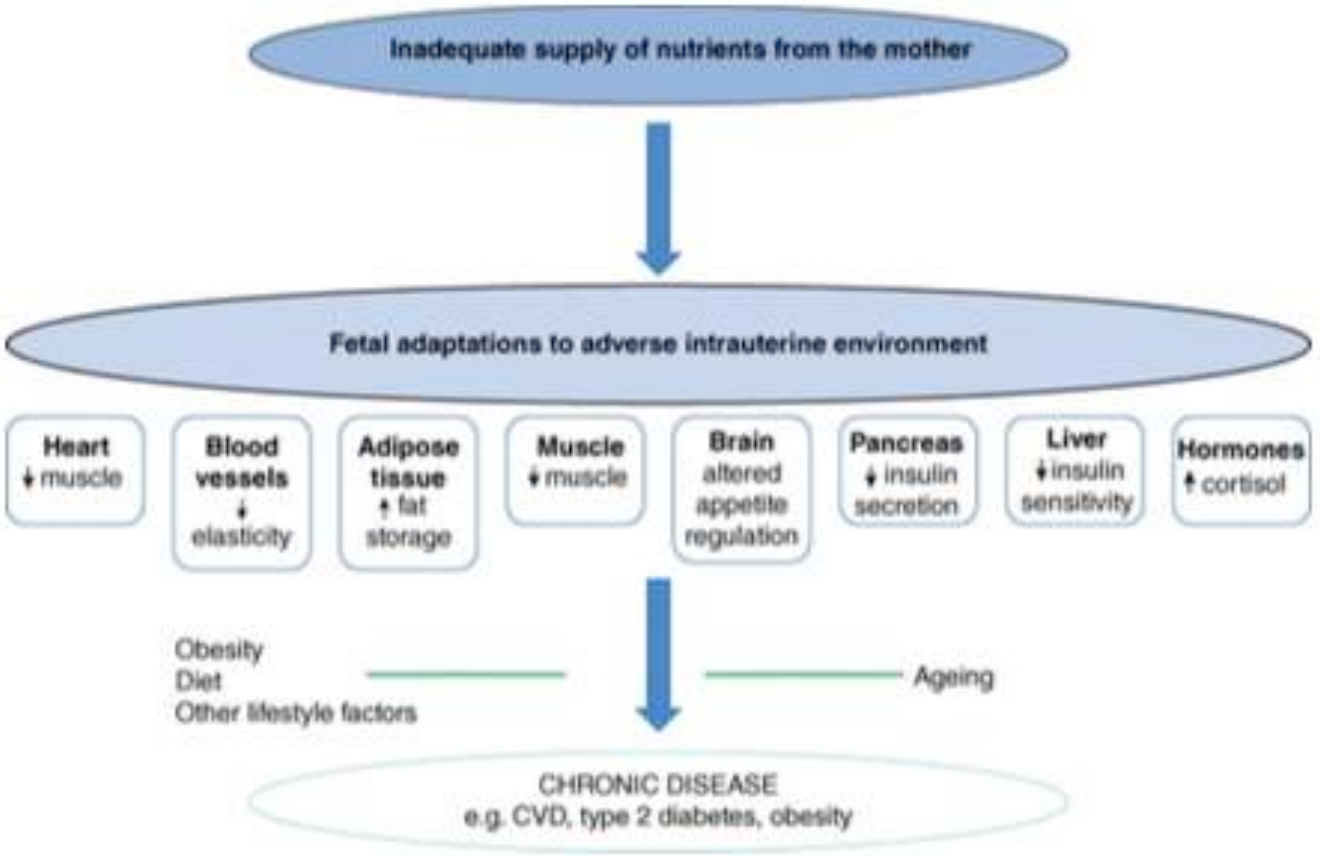


Figure 1 Simple schema illustrating the developmental origins of health and disease hypothesis.

The ‘Developmental Origins of Health and Disease’ Hypothesis

- The ‘fetal origins of adult disease’ hypothesis proposed that under nutrition in early development, particularly intrauterine life, could result in lower birth weight and permanent changes in physiology and metabolism, leading to increased disease risk in adulthood.
- Findings from cohort studies showed associations between low birth weight and increased risk of cardiac events and deaths, as well as with established CVD risk factors such as type 2 diabetes, higher adult blood pressure, reduced adult lean body mass and elevated serum cholesterol.

Pregnancy in adolescence

Teenagers have a higher incidence of delivering low birth weight infants. Low birth weight carries the highest risk for infant death and disability. Risk factors for poor pregnancy outcome in pregnant adolescents are-

I. Maternal age, especially 15 years or below
II. Pregnancy less than 2 years after onset of menarche
III. Poor nutrition and low pre-pregnancy weight
IV. Poor weight gain
V. Infection
VI. Pre existing anemia
VII. Substance abuse: smoking, drinking, drugs
VIII. Lack of education and social support
IX. Poverty
X. Late entry into health care system

Pregnancy in adolescence

- It is recommended that adolescents gain 13 to 18 kg during pregnancy. The recommended weight gain is modified according to the pre-pregnant weight and gynecologic age.

Nutritional requirements during pregnancy

Fetal growth and pregnancy demand additional nutrients. The recommended dietary allowances for pregnancy are as below:

- Energy :
- During pregnancy extra energy is needed for the growth of the fetus, placenta and associated maternal tissues. Basal metabolism rises partly due to the increased mass of active tissue (fetal, placental and maternal), the cost of increased maternal effort (eg. Cardiovascular and respiratory functions) and the cost of tissue synthesis. The average gain is about 80,000 kcal over the 9 month period distributed as an extra
- 150 kcal/day - during the 1st trimester and
- 350 kcal/day – during the 2nd and
- 450 kcal/day- during 3rd trimester
- According to ICMR, additional 300 kcal/day from the 2nd trimester is recommended.

Nutritional requirements during pregnancy

- Distribution of energy requirements are -
- For increase in maternal tissues e.g. expansion of blood volumes, during 1st and 2nd trimester
- For the growth of fetus
- Protein
- The protein intake must be increased in pregnancy due to its specific contributions to growth.
- A diet low in protein usually lacks other nutrients.
- The total protein requirement of a woman gaining 12.5 kg during pregnancy has been estimated to be 925g throughout the pregnancy is as follows: 0.64g, 1.84g, 4.76g and 6.1g per day
- The current RDA of 71g protein for pregnant females is based on 1.1g/kg/day using the pre-pregnant weight

Nutritional requirements during pregnancy

- Carbohydrate
- The recommended amount of 135 to 175g/day is the quantity needed to provide enough calories in the diet , prevent ketosis and maintain appropriate blood glucose levels during pregnancy
- Fiber
- The daily recommended intake for fiber during pregnancy is 28g/day. It can come from a daily consumption of whole grain breads and cereals leafy vegetables and fresh fruits
- Vitamins
- All vitamins are essential for the metabolism of living tissue and doubly so in growth. Certain vitamins have particular significance in an optimal pregnancy outcome, some are met through diets while some through supplements

Nutritional requirements during pregnancy

- Vitamin B6

- The increased requirement for protein necessitates an increase in vitamin B6 of 0.6mg/day than non-pregnant women during pregnancy. The extra vitamin helps the pregnant woman synthesize the non essential amino acids needed for growth

- Vitamin B12

- The added allowance of 1µg/day of vitamin B12 of the pregnant women is based on the fetal demands and the increased metabolic need of the mother

- Vitamin A

- The vitamin A allowance is increased during pregnancy to compensate for the storage of vitamin A in the fetus. The RDA for vitamin A is 750µg RE for pregnant females. In well-nourished population, vitamin A supplementation during pregnancy is not recommended as it may reach teratogenic levels.

Nutritional requirements during pregnancy

- Vitamin C
- During pregnancy, the placenta transfers ascorbic acid from the mother to the fetus at a rate that results in 50% higher plasma vitamin C in the fetal blood. An additional amount of 20 mg of ascorbic acid is recommended to provide for fetus
- Vitamins B1, B2 and niacin
- Since requirements of B-vitamins like thiamine (B1), riboflavin (B2) and niacin are related to calorie utilization, the additional amounts are based on the extra calories.

Additional requirements are:

- ✓ B1 = 0.2
- ✓ B2=0.2

Nutritional requirements during pregnancy

- Folic acid: it is important for all women of childbearing age to get 400 micrograms of folate per day prior to pregnancy and 600 micrograms per day during pregnancy.
- Folate, which is also known as folic acid, is crucial for the production of DNA and RNA and the synthesis of cells.
- A deficiency can cause megaloblastic anemia, or the development of abnormal red blood cells, in pregnant women.
- It can also have a profound affect on the unborn baby. Typically, folate intake has the greatest impact during the first eight weeks of pregnancy, when the neural tube closes. The neural tube develops into the fetus's brain, and adequate folate reduces the risk of brain abnormalities or neural tube defects.
- This vital nutrient also supports the spinal cord and its protective coverings. Inadequate folic acid can result in birth defects, such as spina bifida, which is the failure of the spinal column to close.
- Leafy green vegetables such as spinach and kale are excellent sources of it. Folate is also found in legumes, liver, and oranges.

Nutritional requirements during pregnancy

- Minerals

➢ Calcium = approximately 30g of calcium accumulates during pregnancy of which the fetal skeleton acquires 27.5g, the placenta 1g and the maternal fluids and tissues about 1g. Since most of the fetal growth occurs in the 3rd trimester, it is suggested that a total 1.0-1.2 g/ day be given in the second half of pregnancy. Available data suggests that there is no need for additional dietary intake in pregnancy, as maternal adaptive mechanisms, including enhanced efficiency of absorption, more than meet additional requirements in the last trimester. This means that normal calcium intake is sufficient to meet calcium requirements in the last trimester

Nutritional requirements during pregnancy

- Iron

- Infants are born with a supply of iron stored in the liver suffiecient to last fot 3-6 months. To achieve this storage, the mother must transfer 200-4– mg of iron to the foetus during gestation.
- The marked increase in the haemoglobin synthesis for increased maternal supply of blood during pregnancy, formation of placenta and compensation of blood loss during delivery greatly increases the demand for iron. A pregnant female must consume an additional 700-800 mg of iron throughout pregnancies. Therefore 3 mg of iron must be supplied each day either through diet or maternal stores.

Nutritional requirements during pregnancy

The EAR for zinc is 2.5 mg/day, at an absorption rate of about 30%, and is based on the needs of the additional maternal and foetal tissues. As absorption is higher from animal foods than plant sources, vegetarians will need to increase their intake of the set value by 50% or more. This is also true for iron recommendations.

The EAR for iodine is based on the thyroid content of newborns, iodine balance studies and iodine supplementation studies in pregnancy, and is estimated as 160 µg/day, 60% more than for non-pregnant women.

Food selection in pregnancy

- A list of foods and their quantities meeting the overall RDA of pregnancy is as below:
- Milk or milk products: 4 serving
- Lean meat, fish, poultry, egg, dried peas, beans and nuts: 3 serving
- Fruits : 2 or more servings
- Vegetables: 2 or more servings of raw or cooked veg
- Cereals and bread: 6-11 servings of whole grain or enriched breads
- Fats and oils: 1-2 tablespoons

Foods to be avoided during PREGNANCY

- Raw papaya
- Pineapple
- Tulsi Leaves
- Raw / Uncooked eggs
- Raw meats & poultry
- Artificial sweeteners
- Alcohol
- Unpasteurized milk
- Excess coffee and tea
- Chinese food
- Seafood and certain fish
- Canned / Readymade / Frozen Food
- Herbal Teas and Kadhas
- Soft Cheese like feta cheese
- High Salt

Complications of pregnancy

- **Vomiting**
- Morning sickness or nauseas is common during the 1st trimester of pregnancy and usually resolves around the 13th to 14th week of gestation. Fats are a common cause of upset. Fluids taken with meals also cause vomiting. Small frequent dry meals of easily digested carbohydrate containing foods are easily tolerated. Liquids are consumed between meals.
- **Anemias of pregnancy**
- During pregnancy, there is a slight lowering of the hemoglobin content of the woman's blood due to physiological adjustments.
- This is accompanied by a smaller increase in red blood cells.
- Anemia occurs in pregnancy mostly due to iron deficiency. An iron supplementation of 30-60 mg during the 2nd and third trimester is recommended
- Megaloblastic anemia may be due to poor food intake, vomiting or the fetal demands for folacin. It can be treated with folate supplments

Complications of pregnancy

- Toxemias (Preeclampsia and eclampsia) of pregnancy
- Formerly called toxemia, preeclampsia is a condition that a pregnant woman develops.
- The cause of toxemia is not known, and it usually occurs during the 3rd trimester of pregnancy.
- It is characterized by an elevation in blood pressure, proteinuria and rapid weight gain due to edema (swelling in the feet, legs, and hands)
- If undiagnosed, preeclampsia can lead to eclampsia, a serious condition that can put mother and baby at risk, and in rare cases, cause death. Women with preeclampsia who have seizures are considered to have eclampsia.
- Toxemias occurs in pregnant women consuming poor diets especially on low protein diets. Toxemia is directly related to an individual's state of per capita income. Recent studies have shown that calcium intake is related to toxemia of pregnancy

Complications of pregnancy

- Preeclampsia is most often seen in first-time pregnancies, in pregnant teens, and in women over 40. While it is defined as occurring in women have never had high blood pressure before, other risk factors include:
- A history of high blood pressure prior to pregnancy
- A history of preeclampsia
- Having a mother or sister who had preeclampsia
- A history of obesity
- Carrying more than one baby
- History of diabetes, kidney disease, lupus, or rheumatoid arthritis

Complications of pregnancy

- Heartburn
- Gastric reflux is common during the latter part of pregnancy and often occurs at night.
- In most cases it is an effect of pressure from the enlarged uterus on the intestines and stomach, which combined with the relaxation of esophageal sphincter, may result in the regurgitation of stomach contents into the esophagus
- Pregnancy-induced hypertension
- It includes gestational hypertension and preeclampsia or eclampsia. Gestational hypertension which develops after mid pregnancy is a maternal blood pressure of 140/90 mm Hg or higher with no proteinuria.
- Females with gestational hypertension may develop preeclampsia which is defined as a systolic blood pressure of 140 m Hg or higher or a diastolic b.p. of 90 mm Hg

Complications of pregnancy

- Diabetes mellitus
- Gestational diabetes usually develops after 20 weeks of gestation
- Infants born to diabetic mothers have greater risk of perinatal mortality and prematurity associated with complications
- Fetal macrosomia is caused by utero hyperglycemia from maternal blood
- Constipation
- Pregnant females may develop constipation and it usually occurs in the 3rd trimester. Causes include reduced gut motility, physical inactivity and pressure exerted on the bowel by the enlarged uterus. Increased consumption of fluids, fibre-rich foods and dried fruits usually control this problem

Nutrition during lactation

Why maternal nutrition requirement increases during lactation?

- Lactation is a normal physiological process.
- It makes considerable nutritional demands on the mother
- The physiological developments for lactation begin during later part of pregnancy
- Apart from the growth and development of mammary glands, energy reserves are laid down in the form of fat in the body of the mother and this may become available in part to provide the extra energy required during lactation

Energy

- The nutritional recommendations for lactating women are somewhat empirical and essentially based on the volume and composition of the milk produced. In the six months that follow birth, approximately 750 - 850mL of milk are produced per day, and 100mL of breast milk provide an average of 70kcal of energy to the child. It is estimated that approximately 700kcal are required to produce one litre of milk. But the energy requirements of a lactating mother should not be calculated simply as the sum of the requirements of an adult woman that is not lactating and the calories administered to the child through breast milk, as many nutrients stored during gestation are available to support milk production.
- A third of the additional energy expenditure (±150kcal/day) is due to the mobilisation of maternal stores.
- The total energy intake recommended for lactating mothers ranges between 2300 and 2500 calories a day for feeding a single child, and 2600 and 3000 calories a day for feeding twins.

Protein

- The increase in protein requirements during lactation is minimum compared to energy requirements. However, if the energy intake is low, protein will be used for energy production. The additional requirements during lactation can be satisfied by consumption of protein-rich foods (for example, one egg, 25g of cheese or 175g of milk).
- If the protein intake is insufficient, the concentration of casein in milk may be inadequate. Casein is an important nutritional component of milk, and it is needed for the absorption of calcium and phosphate in the gut of the infant and has immuno modulatory functions.
- Insulin resistance depends on the quality of the protein contributed by the diet rather than on its amount, and thus, consumption of fish-derived proteins during breastfeeding seems to have long-term beneficial effects on insulin regulation and sensitivity.

Carbohydrate

- Lactose is the predominant carbohydrate in human milk and is essential to the nutrition of the infant's brain. While the concentration of lactose is less variable than that of other nutrients, the total production is reduced in mothers with severe malnutrition

Fatty Acids

- The lipids in breast milk are the fraction that most contributes to its energy content, yet they are the components that vary most in their distribution and quality. Maternal malnutrition is associated with lower concentrations of lipids in breast milk. The distribution pattern of fatty acids in breast milk is also sensitive to the mother's diet. Docosahexaenoic acid (22:6, n3) is a nutrient with a limited endogenous biosynthesis, so it must be obtained through the diet, as it is the most important omega-3 acid for the optimal development of the brain, retina and ear. The cholesterol content of breast milk is highly variable and is related to the duration of breastfeeding, maternal age, maternal diet, season and place of residence.
- The relative contribution of fat to the total energy intake recommended during breastfeeding is the same as the one recommended for the general population. Foods that contain fat must be ingested in adequate amounts. Some studies have shown that maternal intake of fish and fish oils has a positive impact on birth weight and is associated with a lower risk of preterm birth and even with better neurodevelopmental outcomes.

- Water accounts for 85–95% of the total milk volume. There is a widespread belief that increasing water intake will increase milk production, but several studies have demonstrated that forcing the intake of fluids beyond that needed to quench thirst has no beneficial effects on lactation.18
- Salt
- The concentration of sodium is higher in colostrum than in mature milk. Research has found no evidence of an association between sodium intake during lactation and sodium levels in breast milk. However, it is always advisable to consume small amounts of salt, always enriched with iodine (iodised salt).

VITAMINS

- The concentration of some vitamins in breast milk depends on their levels in the mother, and deficiencies in the mother can lead to deficiencies in the infant. This is particularly relevant for thiamine (B1), riboflavin (B2), and vitamins B6, B12, E and A, and consequently an increase in their intake is recommended during lactation

- Vitamin A

- It is involved in the photochemical reactions of the retina, it is an antioxidant, and has antimicrobial properties. The vitamin A content in milk decreases as lactation progresses. The intake obtained with a balanced diet is adequate and supplementation is not necessary. However, in developing countries it is recommended that all mothers take a single supplementary dose of 200,000IU of vitamin A as soon as possible after delivery.

VITAMINS

- Vitamin D

- Vitamin D deficiency is fairly frequent in pregnant and lactating women. Mothers that have restricted diets, such as strict vegetarians, and those with limited exposure to UV radiation (mothers with limited exposure to sunlight, with dark skin, or that wear a veil) may have very low plasma levels. The transfer of maternal vitamin D to milk is poor, so it is recommended that all breastfed infants younger than 1 year receive supplementation with 400IU/day of vitamin D, starting its administration within a few days from birth. Supplementation will continue until the child starts consuming one litre of vitamin D-enriched formula a day

- Vitamin B6 (pyridoxine)
- In the early weeks of life, the vitamin B6 stores accumulated during pregnancy are crucial in maintaining adequate levels in breastfed children. The manifestations of vitamin B6 deficiency in infants also depend on its severity, although in general it presents with neurologic symptoms and different forms of dermatitis.

VITAMINS

- Vitamin B12 (cyanocobalamine)
- Vitamin B12 concentrations in the milk of well-nourished mothers are adequate. However, its levels are low in mothers that are strictly vegetarian (vegan), are malnourished or have pernicious anaemia, even if they do not show signs of deficiency. In these cases, it is important that mothers receive a vitamin B12 supplement the entire time they are breastfeeding, as vitamin B12 deficiency in the infant can have short- and long-term neurological effects.
- Vitamin C
- The plasma and tissue concentrations of vitamin C in smokers are lower than in non-smokers, so an increase in vitamin C intake is recommended in mothers that smoke.
- Folic acid
- The recommended concentration of folic acid in breast milk can be easily achieved through dietary intake or supplementation, if needed

DIETARY ELEMENTS AND MINERALS

- Compared to vitamins, the concentrations of minerals do not seem to be correlated to maternal intake, except for iron and iodine. Copper and zinc concentrations seem to correlate strongly to maternal stores in the liver during the third trimester of the pregnancy, and maternal intake has little influence on them, although their bioavailability in milk is very high. Iodine, iron, copper, magnesium and zinc have a high bioavailability in breast milk. The selenium content is strongly influenced by the mother's diet.

Dietary Elements and Minerals

- IRON
- Iron supplementation is usually recommended to make up for losses sustained during childbirth, although it must be noted that women that practise exclusive breastfeeding usually experience amenorrhoea for a minimum of six months and thus do not lose iron through menstruation during that time. Therefore, it could be said that breastfeeding exerts a protective effect against maternal iron deficiency
- Calcium
- Calcium is essential during lactation, during which it is subject to special regulatory mechanisms that lead to increased absorption, decreased renal excretion and greater mobilisation of bone calcium. To meet maternal calcium requirements, the American Academy of Paediatrics recommends lactating mothers to consume five servings a day of calcium-rich foods of any kind, such as low-fat yoghourt or cheese, and other nondairy foods that contain calcium, such as fish consumed with its bones (for example, canned sardines), salmon, broccoli, sesame seeds or cabbages, which may provide the 1000–1500mg daily recommended allowance for lactating women

Dietary Elements and Minerals

- Iodine
- The iodine requirements of lactating women nearly double those of healthy adult women, as in addition to meeting maternal requirements, iodine levels must guarantee that the baby receives sufficient iodine from the milk to synthesise thyroid hormones.35–37 The iodine content of human milk is variable and depends on maternal intake. In iodine-sufficient regions, the iodine content can reach 200µg/L in colostrum and 100–150µg/L in mature milk.
- Since the requirements of the infant are approximately 90µg/day, and the volume of milk ingested ranges between 600 and 1000mL/day, the minimum iodine concentration in breast milk should be 100µg/L. To achieve this, the mother must consume at least 250µg of iodine a day.