Introduction
Pregnancy is a dynamic state during which nutrient requirements are increased to support the growing foetus, placenta and maternal tissues. Maternal micronutrient status at the time of pregnancy can impact immediate, short-term, and long-term outcomes for the child. Adequate nutrition in the first 1000 days of life (from conception to 2 years) is crucial, and may play a vital role in the prevention of common chronic diseases in adulthood, such as type 2 diabetes and metabolic syndrome. Current research linking foetal nutrition with the risk of disease in later life has led to the hypothesis of 'foetal programming'. Foetal programming occurs during the critical period in which tissues and organs are created. When nutritional status is compromised, the foetus adapts in a way that may negatively impact foetal genomic expression and affect a wide range of physiological processes. The scientific literature widely supports the importance of good dietary habits during pregnancy and breastfeeding. However, for it to be of most benefit, women need to receive nutrition advice in time to enable them to make informed decisions regarding their pregnancy.

Maternal diet and nutrient requirements in pregnancy and lactation

Maternal nutrient intake during pregnancy can affect foetal development and may also affect the baby’s health later in life. Recognising this, health professionals recommend that women of childbearing age maintain higher levels of particular nutrients in order to best prepare for pregnancy. Pharmacists are often called on to answer questions on medicine use during pregnancy and lactation, and are therefore well placed to also provide information about nutrient requirements and the use of supplements. To ensure relevancy, it is important to understand the rationale behind these recommendations.

AFTER READING THIS ARTICLE, THE LEARNER SHOULD BE ABLE TO:
• discuss how maternal nutrition can impact on foetal development.
• describe the additional requirements for energy, macronutrients and micronutrients during pregnancy and lactation.
• discuss the 7 key micronutrients and the important role of these nutrients before, during and after pregnancy.

The 2016 Competency Standards addressed by this activity include: 1.4, 1.5, 3.1, 3.6

Accreditation number: A1910AJP3
This activity has been accredited for 1.5 hours of Group One CPD (or 1.5 CPD credits) suitable for inclusion in an individual pharmacist’s CPD plan which can be converted to 1.5 hours of Group Two CPD (or 3 CPD credits) upon successful completion of relevant assessment activities. Accreditation expires: 01/10/2020

Maternal nutrition
Australian women are falling short of current dietary recommendations
The Australian Guide to Healthy Eating (AGHE) provides a number of food and nutrition-related recommendations to help women optimise their dietary behaviour during pregnancy and breastfeeding (see Table 1). Familiarity with this guideline among pregnant women is low.
BACKGROUND
There is a large evidence base supporting the use of vitamin and mineral supplementation. However, sometimes the data appear conflicting leaving consumers with mixed messages about whether they should or shouldn’t take them.

This educational series, brought to you by Sanofi Healthcare Australia in concert with key experts, aims to summarise the science and answer key questions about a variety of different supplements. It provides pharmacists with up-to-date information to ensure that customers wishing to use these products to supplement their diet do so appropriately.

IN THIS ISSUE...
Dr Denise Furness describes the nutritional toll that pregnancy takes on the body, provides insights into how maternal nutrition affects oocyte, embryo and foetal development and discusses key micronutrient requirements for pre-conception care, as well as during pregnancy and beyond.

In the Australian Longitudinal Study on Women’s Health only half of the women adhered to the recommended intake of fruit, with much lower adherence in the other four groups (dairy: 22%, meat/meat alternatives: 2.5% and vegetables: 1.7%) during pregnancy.10 Survey data suggest that the majority of pregnant women in Australia believe their diets to be healthy and almost two-thirds report that they have made changes specifically for pregnancy.11 Nevertheless, none of the women met the AGHE recommended intakes for all five food groups.11,12 Furthermore, knowledge of multivitamin and mineral supplements and the importance of key nutrients was variable—in one survey 90% of women were aware of the need for folic acid supplementation but only 48.3% were aware of recommendations for iodine supplementation.9

TABLE 1: AUSTRALIAN GUIDE TO HEALTHY EATING: RECOMMENDED AVERAGE DAILY NUMBER OF SERVES FROM EACH OF THE FIVE FOOD GROUPS FOR WOMEN8

<table>
<thead>
<tr>
<th>Food Group</th>
<th>19–50</th>
<th>51–70</th>
<th>70+</th>
<th>PREGNANT</th>
<th>BREASTFEEDING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vegetables and legumes/beans</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>7.5</td>
</tr>
<tr>
<td>Fruit</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Grain (cereal) foods, mostly wholegrain</td>
<td>6</td>
<td>4</td>
<td>3</td>
<td>8.5</td>
<td>9</td>
</tr>
<tr>
<td>Lean meat and poultry, fish, eggs, nuts and seeds, and legumes/beans</td>
<td>2.5</td>
<td>2</td>
<td>2</td>
<td>3.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Milk, yoghurt, cheese and/or alternatives (mostly reduced fat)</td>
<td>2.4</td>
<td>4</td>
<td>4</td>
<td>2.5</td>
<td>2.5</td>
</tr>
<tr>
<td>Approx. number of additional serves from the five food groups for taller or more active women or discretionary choices</td>
<td>0–2.5</td>
<td>0–2.5</td>
<td>0–2</td>
<td>0–2.5</td>
<td>0–2.5</td>
</tr>
</tbody>
</table>

* Includes an allowance for unsaturated spreads or oils, nuts or seeds 2 serves [14–20g] per day.

Pregnancy and lactation place increased demands on maternal nutrition
Energy expenditure increases during pregnancy to account for the growing foetus. However, it does not increase immediately—energy requirements are the same as non-pregnant women in the first trimester, and then increase by an estimated 340kcal (1400kJ)/day in the second trimester and 452kcal (1900kJ)/day in the third trimester.13 Women who breastfeed need a further 500kcal (2000–2100kJ) per day beyond the recommendations for non-pregnant women.13,14 Multiple gestations further increase the demands on the mother’s body, metabolic rate is increased by around 10% versus a singleton pregnancy and it is suggested that a 40% higher-calorie diet may be required to adequately maintain a woman’s nutritional state during a twin pregnancy.11 Physiological changes during pregnancy alter normal ranges of several laboratory values. For example, haemodilution and anaemia may occur because there is a greater increase in plasma volume than there is in total red blood cell mass.15 Consequently, definitions of anaemia in pregnancy are different to the normal values in non-pregnant women. There is greater protein binding of corticosteroids, sex steroids, thyroid hormones, and vitamin D during pregnancy because oestrogen increases hepatic protein production, resulting in lower free levels.

Among the macronutrients, protein requirements increase considerably, especially later in the pregnancy and during breastfeeding. To meet these demands, the recommended daily protein intake should be increased according to trimester and during breastfeeding (see Table 2).14 Overall total fat intake does not need to change during pregnancy and lactation, but there should be increased focus on
the quality of fats with strategies to improve the relative proportion of polyunsaturated fats (long chain omega 3 fatty acids). Supplementation should be considered in women whose dietary intake of omega-3 fatty acids is low.

Micronutrient requirements before, during and after pregnancy

During pregnancy and lactation micronutrient requirements increase more than do macronutrient requirements. Micronutrients support a variety of biological roles that are vital to maternal health and foetal development.

Adverse health outcomes of gestational micronutrient deficiency include:

**Short-term**
- Miscarriage
- Stillbirth
- Birth defects
- Foetal growth restriction
- Preterm birth

**Long-term**
- Death
- Altered growth, body composition
- Compromised cardiometabolic, pulmonary and immune function
- Poor neurodevelopment and cognition

Nutrient sufficiency is paramount during the periconceptional period. This 5–6 month window around the time of conception is the primary time for subfertility, miscarriage, congenital malformations, foetal growth restriction and placental-related disorders to originate. One-carbon metabolism is fundamental for DNA synthesis, amino acid metabolism and methylation of a large number of nucleic acids, proteins and lipids. A deficiency in micronutrients involved in one-carbon metabolism (folate, vitamin B6 and vitamin B12) results in elevated systemic and follicular homocysteine, which in turn contributes to disturbances at key stages in the periconceptional period. High homocysteine is associated with semen abnormalities, early gestation complications such as miscarriage and late gestation complications such as foetal growth restriction. Disruption to one-carbon metabolism has also been implicated in epigenetic modifications to DNA methylation, with long-term consequences on the health of the child. In the second and third trimesters, there is emphasis on growth and accumulation of nutrient stores in the foetus. Adequate accumulation of foetal nutrients is related to maternal micronutrient status and gestation duration, and is of particular importance for micronutrients that are not available via breast milk after birth. For example, iron transfer to the foetus is at its peak in the third trimester, such that a pre-term baby born with limited iron stores is at high risk of anaemia by the time they reach 1 year of age.

Requirements of many micronutrients are increased further during breastfeeding compared to pregnancy. Water-soluble vitamins (C, B1, B6, B12, and folate) and fat-soluble vitamins (vitamins A, D, K) are secreted into breast milk, and levels are reduced in breast milk when there is a maternal vitamin deficiency.

**Recommendations—7 key micronutrients**

The National Health and Medical Research Council (NHMRC) recommends an increase in daily intake of most micronutrients during pregnancy. Currently, routine supplementation is only recommended for folic acid and iodine.

Established associations between pregnancy complications and deficiencies in folate, vitamin B12, vitamin D, calcium, iodine, iron, zinc and selenium make these the key micronutrients and most of these are included in leading Australian pregnancy multivitamin formulations.

Table 3 lists the recommendations for daily intake of these 7 key micronutrients for non-pregnant, pregnant and lactating women. Each is then discussed in further detail below.

**Folate**

Folic acid is the synthetic form of the naturally occurring B vitamin, folate. Folic acid is the form used in most vitamin supplements and food fortification. An adequate supply of folate is essential during pregnancy to support rapid cell growth, cell replication, cell division, and nucleotide synthesis for foetal and placental development.

However, it is estimated that around half of all pregnancies in Australia are unplanned, and many women may not realise they are pregnant until later in the first trimester. Folic acid fortification of all wheat flour used for bread was implemented in Australia in 2009 in an effort to reduce the risk of folate deficiencies.

Despite this, around 9% of women in Australia are reported to have inadequate dietary folate intake. Aside from inadequate dietary intake, some women may benefit from (or require) higher folate due to genetic polymorphisms such as the methylenetetrahydrofolate reductase (MTHFR) C677T, an important
### TABLE 3: RECOMMENDATIONS FOR INTAKE OF KEY MICRONUTRIENTS IN NON-PREGNANT, PREGNANT AND BREASTFEEDING WOMEN (AGED 19–59 YEARS)\(^4\)

<table>
<thead>
<tr>
<th>MINERALS</th>
<th>NON-PREGNANT</th>
<th>PREGNANT</th>
<th>BREASTFEEDING</th>
<th>RATIONALE FOR INCREASED REQUIREMENTS(^4)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Calcium</strong></td>
<td>EAR 840mg/day</td>
<td>EAR 840mg/day</td>
<td>EAR 840mg/day</td>
<td>N/A</td>
</tr>
<tr>
<td>RDI 1000mg/day</td>
<td>RDI 1000mg/day</td>
<td>RDI 1000mg/day</td>
<td></td>
<td>Increase of red blood cells; basal losses; foetal iron uptake, iron deposition in foetal and placental tissues; increased maternal absorption</td>
</tr>
<tr>
<td><strong>Iron</strong></td>
<td>EAR 8mg/day</td>
<td>EAR 22mg/day</td>
<td>EAR 6.5mg/day</td>
<td>Additional foetal requirement</td>
</tr>
<tr>
<td>RDI 18mg/day</td>
<td>RDI 27mg/day</td>
<td>RDI 9mg/day</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Iodine</strong></td>
<td>EAR 100µg/day</td>
<td>EAR 160µg/day</td>
<td>EAR 190µg/day</td>
<td>Additional foetal requirement for saturation of foetal selenoproteins</td>
</tr>
<tr>
<td>RDI 150µg/day</td>
<td>RDI 220µg/day</td>
<td>RDI 270µg/day</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Selenium</strong></td>
<td>EAR 50µg/day</td>
<td>EAR 55µg/day</td>
<td>EAR 65µg/day</td>
<td>Maternal and foetal tissue accumulation</td>
</tr>
<tr>
<td>RDI 60µg/day</td>
<td>RDI 65µg/day</td>
<td>RDI 75µg/day</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Zinc</strong></td>
<td>EAR 6.5mg/day</td>
<td>EAR 9mg/day</td>
<td>EAR 10mg/day</td>
<td>Enhanced single-carbon metabolism to support materno-placental tissue expansion and foetal growth; active materno-foetal folate transfer, but no gains in maternal absorption compared to non-pregnant state</td>
</tr>
<tr>
<td>RDI 8mg/day</td>
<td>RDI 11mg/day</td>
<td>RDI 12mg/day</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>VITAMINS</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>B9: Folate</strong></td>
<td>EAR 320µg/day</td>
<td>EAR 520µg/day</td>
<td>EAR 450µg/day</td>
<td>Foetal accumulation; maternal absorption improves and transcobalamin increase in 2nd and 3rd trimesters</td>
</tr>
<tr>
<td>RDI 400µg/day</td>
<td>RDI 600µg/day</td>
<td>RDI 500µg/day</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>B12: Cobalamin</strong></td>
<td>EAR 2.0mg/day</td>
<td>EAR 2.2mg/day</td>
<td>EAR 2.4mg/day</td>
<td></td>
</tr>
<tr>
<td>RDI 2.4mg/day</td>
<td>RDI 2.6mg/day</td>
<td>RDI 2.8mg/day</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Vitamin D</strong></td>
<td>AI 5µg (200IU)/day</td>
<td>AI 5µg (200IU)/day</td>
<td>AI 5µg (200IU)/day</td>
<td>N/A</td>
</tr>
</tbody>
</table>

**AI** = Adequate intake: an estimate of the nutrient intake necessary to maintain a healthy state.

**EAR** = Estimated Average Requirement: Daily nutrient level estimated to meet the requirements of half the healthy individuals in a particular life stage and gender group.

**RDI** = Recommended Dietary Intake: Average daily dietary intake level that is sufficient to meet the nutrient requirements of nearly all (97–98%) healthy individuals in a particular life stage and gender group.

- Folic acid should be taken for a minimum of one month before conception and for the first 12 weeks of pregnancy.\(^16\)
- The recommended dose of folic acid is at least 0.4mg daily to aid the prevention of neural tube defects (NTD).\(^16\)
- Where there is a known increased risk of NTD or a risk of malabsorption, a 5mg daily dose is recommended.\(^16\)
folate-metabolising enzyme, which occurs in approximately 10–40% of the population.20,21

Two Cochrane reviews state that maternal folate deficiency is associated with megaloblastic anaemia in pregnancy, but not with other adverse pregnancy outcomes such as preterm birth or stillbirths (see Table 4).22 Folic acid supplementation, alone or in combination with vitamins and minerals, leads to a 72% decrease in the risk neural tube defects (NTDs) (see Table 4).23

In order to reduce the risk for neural tube defects in their offspring, women are recommended to take folic acid from fortified food or supplements daily from one month before pregnancy.16 For women at increased risk of NTD should take a higher daily dose (5mg) of folic acid. These include:16

- pre-existing diabetes mellitus;
- family history of NTD or women with a child with NTD;
- women taking epilepsy medications (e.g. carbamazepine, valproic acid);
- increased BMI (>30kg/m²);
- malabsorption syndrome.

Vitamin B12
The metabolic roles of vitamin B12 are closely related to those of folate and homocysteine.24 Vitamin B12 is a coenzyme important in the formation of red blood cells and is essential for the metabolism of fats and carbohydrates and protein synthesis.

It is estimated that 8% of women in Australia have an inadequate dietary intake of vitamin B12.19 Vitamin B12 is mainly sourced from animal foods, hence inadequate intake is most common in people who follow vegetarian or vegan diets. Vitamin B12-deficiency during pregnancy is common.24

While a recent systematic review and meta-analysis did not find an association between vitamin B12 levels in pregnancy and birth weight, it did show that lower maternal B12 levels were associated with increased risk of preterm birth.21 Importantly, the risk of preterm birth was particularly high in the presence of B12-deficiency during pregnancy: 21% increased risk (adjusted risk ratio 1.21; 95% CI: 0.99 to 1.49).21

These results suggest that observations of a higher risk for low birth weight in B12-deficient women may be explained by preterm birth rather than by reduced foetal growth.21

Calcium and Vitamin D
Calcium is essential for bone development. Adequate intake is especially crucial during pregnancy and lactation because of the potential adverse effect on maternal bone health if maternal calcium stores are depleted.23 It is estimated that around 70% of women aged 18–30 years do not have adequate calcium in their diet.25 In women with low dietary calcium intake, supplementation has been shown to reduce the risk of pre-eclampsia by 88% (relative risk 0.22, 95% CI 0.12 to 0.42) and pre-term birth by 24% (relative risk 0.76, 95% CI 0.60 to 0.97).27

While an average baby has about 30g of calcium at birth, this is not gained uniformly throughout gestation—at least 80% is accreted during the third trimester.25 Despite this, women who obtain adequate dietary calcium do not need to increase their intake. This is because several adaptations take place during pregnancy (the efficiency of intestinal calcium absorption doubles to meet the foetal requirement for calcium).

**TABLE 4: OVERVIEW OF RESULTS FROM RECENT COCHRANE REVIEWS OF FOLIC ACID SUPPLEMENTATION DURING PREGNANCY**22,23

<table>
<thead>
<tr>
<th>OUTCOME</th>
<th>RISK RATIO (95% CONFIDENCE INTERVAL)</th>
<th>NUMBER OF STUDIES, PARTICIPANTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preterm birth</td>
<td>1.01 (0.73 to 1.38)</td>
<td>3 studies, 2959 participants</td>
</tr>
<tr>
<td>Stillbirths/neonatal deaths</td>
<td>1.33 (0.96 to 1.85)</td>
<td>3 studies, 3110 participants</td>
</tr>
<tr>
<td>Improving pre-delivery anaemia</td>
<td>0.62 (0.35 to 1.10)</td>
<td>8 studies, 4149 participants</td>
</tr>
<tr>
<td>Reduced incidence of megaloblastic anaemia</td>
<td>0.21 (0.11 to 0.38)</td>
<td>4 studies, 3839 participants</td>
</tr>
<tr>
<td>Preventing NTD</td>
<td>0.31 (0.17 to 0.58)</td>
<td>5 studies; 6708 births</td>
</tr>
<tr>
<td>Protective effect for reoccurrence of NTD</td>
<td>0.34 (0.18 to 0.64)</td>
<td>4 studies; 1846 births</td>
</tr>
<tr>
<td>Preventive or negative effects on:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• cleft palate</td>
<td>0.73 (0.05 to 10.89)</td>
<td>3 studies; 5612 births</td>
</tr>
<tr>
<td>• cleft lip</td>
<td>0.79 (0.14 to 4.36)</td>
<td></td>
</tr>
<tr>
<td>• congenital cardiovascular defects</td>
<td>0.67 (0.24 to 1.33)</td>
<td></td>
</tr>
<tr>
<td>• any other birth defects</td>
<td>0.94 (0.53 to 1.66)</td>
<td></td>
</tr>
<tr>
<td>Preventive or negative effects on miscarriages</td>
<td>1.10 (0.94 to 1.28)</td>
<td>5 studies; 7391 pregnancies</td>
</tr>
</tbody>
</table>

- Routine supplementation is not recommended in every pregnancy.16
- Supplements should be considered in women who follow vegetarian or vegan diets.16
Calcium is essential for bone development. Adequate intake is especially crucial during pregnancy and lactation because of the potential adverse effect on maternal bone health if maternal calcium stores are depleted.

and lactation (skeletal resorption increases to provide calcium to milk). Heartburn is common in pregnancy. Calcium-based antacids are a suitable option because they provide symptomatic relief while also serving as a dietary calcium supplement.28

Vitamin D is a fat-soluble vitamin, sourced from food or manufactured in the skin when exposed to sunlight it undergoes further processing in the liver and the kidney to create the active form, 1,25-dihydroxyvitamin D. This promotes calcium absorption from the intestines, facilitating appropriate bone mineralisation and growth.13

Around one-third of women aged 18–35 in Australia do not have adequate vitamin D.29 Insufficiency during pregnancy is associated with an increased risk of complications, including pre-eclampsia, preterm birth and low birth weights.3 Maternal vitamin D levels correlate with low neonatal levels, which predispose the baby to impaired skeletal development.16

There is insufficient evidence to recommend screening all pregnant women for vitamin D deficiency or routine supplementation during pregnancy.13 Targeted measurement is recommended for pregnant women with at least one risk factor for low vitamin D at the first antenatal visit.30 Risk factors for low vitamin D include: reduced skin exposure to sunlight, dark skin, conditions affecting vitamin D metabolism and storage (obesity) and being born to a mother with low vitamin D. Supplementation with doses higher than 400IU (10µg) should be offered in women with levels below 50nmol/L and paired with health education and advice about sensible sun exposure.

**Iodine**

Iodine is a major component of thyroid hormones, inadequate iodine availability in the body leads to a deficiency in circulating thyroid hormones and an increase in pituitary thyroid stimulating hormone.8

Iodine deficiency is the largest preventable cause of brain damage and mental impairment worldwide.31 However, nearly two-thirds of women of childbearing age in Australia have a urinary iodine concentration less than 150µg/L, which is the iodine level recommended by WHO for pregnant and breastfeeding women.29

Mandatory fortification of iodised salt in bread was implemented in Australia in 2009.31 Among women, consumption of fortified bread at ≥100g/day has been shown to be associated with five times greater odds of achieving an adequate iodine intake (odds ratio 5.0, 95% CI 4.96–5.13; p < 0.001) compared to lower bread consumption.30 But, only 8–9% of women are currently consuming bread at that level.

Foetal thyroid function starts at the end of the first trimester. Because iodine is also required for foetal thyroid hormones, maternal iodine intake needs to increase by at least 50%.32 Iodine deficiency during pregnancy increases the risk of spontaneous abortion, perinatal mortality, birth defects and neurological disorders.32 The consequences are dependent upon the timing and severity of the hypothyroxinaemia.

The mandatory fortification program was not designed to meet increased requirements during pregnancy and lactation,31 iodine supplementation is recommended instead.30

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**Calcium requirements:**
- Pregnancy: 1000mg/day
- Lactation: 1000mg/day

**Vitamin D requirements:**
- Routine supplementation is not recommended.16
- Women who avoid dairy in their usual diet and do not consume alternative high calcium foods, should take a calcium supplementation of at least 1000mg per day.16
- Serum vitamin D testing should be considered in pregnant women at increased risk of vitamin D deficiency and supplementation instituted where needed.16

**Vitamin D level below 50nmol/L**
- Vitamin D level 30–49 nmol/L commence 1000IU (25µg)/day.
- Vitamin D level < 30nmol/L should commence 2000IU (50µg)/day.
- Repeat the vitamin D level at 28 weeks gestation.

**Vitamin D level above 50nmol/L**
- Take 400IU (10µg) vitamin D daily as part of a pregnancy multivitamin.

**Iodine requirements:**
- Pregnancy: 220µg/day
- Lactation: 270µg/day

**Iodine requirements:**
- All women who are pregnant, breastfeeding or considering pregnancy, should take an iodine supplement of 150µg each day.16,30
- Women with pre-existing thyroid conditions should seek advice from their medical practitioner prior to taking a supplement.30
Iron
Iron is essential for good health. It plays an essential role in the transfer of oxygen to tissues, energy production, synthesis of DNA and neurotransmitters, growth and development.33 Iron deficiency anaemia (IDA), defined clinically as haemoglobin <110g/L with serum ferritin <30 μg/L and normal C-reactive protein, is one of the most common nutritional deficiencies globally. Estimates suggest that 12–15% of women in Australia have IDA.34 Iron requirements increase progressively during pregnancy in parallel with foetal growth. However, the amount of iron secreted in breast milk is low; iron requirements are therefore not as high during breastfeeding and may be offset to some extent by amenorrhea.15 Routine iron supplementation is not required in every pregnancy.16 All women should have their haemoglobin level checked at the first antenatal visit and again at approximately 28 weeks’ gestation and any anaemia investigated and treated.16

Zinc and selenium
Zinc and selenium are both trace minerals required in small amounts but essential in a wide range of antioxidant and cellular functions, including cell division and differentiation, which makes them essential for successful embryogenesis.39,40 Although deficiencies are considered scarce, inadequate zinc is associated with adverse pregnancy outcomes (prolonged labour, restriction of foetal growth and embryonic death) and reduced serum selenium concentrations are associated with recurrent early pregnancy loss.39 The concentrations required early in pregnancy in relation to the development of pregnancy complications remains to be established.

Zinc plays an important role in pregnancy and lactation and it is estimated that maternal zinc requirements in the third trimester are double that required by non-pregnant women.40 However, supplementation has been shown to reduce the risk of pre-term birth by 14% (relative risk 0.86, 95% CI 0.76 to 0.97), but not the incidence of low birth weight.41 Strong evidence to support routine zinc and/or selenium supplementation during normal pregnancy is lacking.40 Interventions to address overall nutritional status may be of more benefit than those focusing only on micronutrient supplementation.

Conclusion
To meet nutritional needs and maintain health during pregnancy it is recommended that women follow a balanced, diverse and nutritious diet.4 While the ability to achieve required micronutrient intakes may be challenging, high quality evidence to suggest that all women require the increased levels of all the nutrients in a typical prenatal vitamin is lacking.15 Currently, only folic acid and iodine are recommended for routine supplementation for all women during pregnancy. When dietary intake of other micronutrients is insufficient a supplement may be of value.
Micronutrient deficiencies in pregnancy worldwide: health and lactation.

• Energy, macronutrient, and micronutrient requirements increase during both pregnancy and lactation.

• A healthy, balanced diet is strongly recommended before, during and after pregnancy, however the majority of women of child-bearing age are not meeting the recommended guidelines for healthy eating.11,12

• Micronutrient deficiencies have been linked to compromised conception, length of gestation, and foetal development and growth, which can lead to pregnancy loss, preterm delivery, small birth size, birth defects, and long-term metabolic disturbances.4

• Practitioners should emphasise the importance of nutrition and how maternal diet impacts on the health of a child for life.

• The National Health and Medical Research Council (NHMRC) recommends an increase in daily intake of most micronutrients during pregnancy.14

• Routine supplementation during pregnancy is only recommended for folic acid and iodine.16

• Folic acid: Should be taken for a minimum of one month before conception and for the first 12 weeks of pregnancy. The recommended dose is at least 0.4mg daily to aid the prevention of NTD, this should be increased to 5mg daily where there is a known increased risk of NTD or a risk of malabsorption.

• Iodine: All women who are pregnant, breastfeeding or considering pregnancy, take an iodine supplement of 150μg each day.16,30 Women with pre-existing thyroid conditions should seek advice from their medical practitioner prior to taking a supplement.30

• Vitamin B12: Supplements should be considered in women who follow vegetarian or vegan diets.16

• Calcium: Women who avoid dairy in their usual diet and do not consume alternative high calcium foods, should take a calcium supplementation of at least 1000mg per day.16

• Vitamin D: Serum vitamin D testing should be considered in pregnant women at increased risk of vitamin D deficiency and supplementation instituted where needed.16

• Iron: All women should have their haemoglobin level checked at the first antenatal visit and again at approximately 28 weeks’ gestation and any anaemia investigated and treated.16

• Optimal doses for therapeutic benefits of curcumin have not been established and the doses and formulations evaluated in clinical trials have varied.14

• Curcumin has a well-established safety profile and it is generally recognised that curcumin does not cause significant short-term toxicity at doses up to 8g/day.3

• Despite the intensity of the research to date, challenges remain predominantly around the establishment of an optimal dose and the development and testing of high-bioavailability formulations.14

### ABOUT THE AUTHOR

Dr Denise Furness is a molecular geneticist, nutritionist, medical researcher, author, public speaker and exercise professional. She conducted her PhD at CSIRO Human Nutrition investigating folate nutrigenomics, methylation and DNA damage in relation to late gestation pregnancy outcomes including pre-eclampsia, foetal growth restriction and preterm birth. Dr Furness then completed a postdoctoral fellowship with the University of Adelaide’s Research Centre for Reproductive Health expanding her work on folate nutrigenomics to include vitamin D and anti-oxidant genes in relation to miscarriage and foetal loss. She has won various awards for her research and published her work in medical and nutrition journals. In 2012 Dr Furness founded Your Genes & Nutrition, helping patients and practitioners understand the role of nutrigenomics and genetic profiling in relation to fertility and optimal health.

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1. When maternal nutritional status is compromised, the foetus:  
A. adapts and does not have any long-term complications or consequences.  
B. adapts by depleting all required nutritional stores from the mother.  
C. may have negative impacts on the foetal genomic expression and can affect a wide range of physiological processes.  
D. B and C

2. Which of the following statements is TRUE?  
A. In the first trimester, energy requirements are lower than in non-pregnant women.  
B. In the first trimester, energy requirements are the same as non-pregnant women.  
C. In the first trimester, energy requirements are the double that of non-pregnant women.  
D. In the first trimester, energy requirements are three times that of non-pregnant women.

3. Routine supplementation during pregnancy is only recommended for which of the micronutrients?  
A. Folate and vitamin B12  
B. Iodine and iron  
C. Calcium and vitamin D  
D. Folate and iodine

4. Which of the following statements is CORRECT?  
A. Maternal selenium requirements in the third trimester are double that required by non-pregnant women.  
B. Maternal zinc requirements in the third trimester are double that required by non-pregnant women.  
C. Maternal calcium requirements in the third trimester are double that required by non-pregnant women.  
D. Maternal vitamin D requirements in the third trimester are double that required by non-pregnant women.

5. In pregnant women, the requirements of which of the following macronutrients may have an impact on foetal development?  
A. Proteins  
B. Carbohydrates  
C. Fats  
D. All of the above

6. Supplementing with folic acid reduced the risk of neural tube defects by how much?  
A. 42%  
B. 52%  
C. 62%  
D. 72%

7. Which of the following statements is TRUE?  
A. Folic acid should be taken for a minimum of one week before conception and for the first 2 weeks of pregnancy.  
B. Folic acid should be taken for a minimum of one month before conception and for the first 12 weeks of pregnancy.  
C. Folic acid should be taken for a minimum of 6 months before conception and for the first 12 weeks of pregnancy.  
D. Folic acid should be taken for a minimum of one year before conception and for the first 12 weeks of pregnancy.

8. True or False? During pregnancy, maternal iodine intake needs to increase by at least 20%.  
A. True  
B. False