The purpose of the chapter is to summarise the key points of this report using a question-and-answer format. Many of the questions used are commonly asked by medical journalists. The questions are grouped under headings, and generally follow the same order as the chapters in the report.

18.1 Nutrition and development

Q1: How does nutrition during fetal life influence our long-term health?

Strong evidence from studies in humans and animal models shows that if a baby is exposed to too little or too much nutrition during fetal life he/she is more likely to develop conditions such as type 2 diabetes, heart disease and osteoporosis in later life.

However, it remains to be seen whether altering the mother’s nutrient intake during pregnancy can influence her offspring’s risk of these conditions.

Q2: At what age does nutrition begin to have an impact on health in later life?

The quality of a mother’s diet impacts on her baby’s health in early life but there is also evidence that her diet and lifestyle habits (e.g. maternal weight and nutrition), even pre-pregnancy, can impact on her offspring’s health in later life. In fact, there are also intergenerational effects: the impact of nutrition on the health of offspring in later life is likely to be influenced by the diet and lifestyle of their grandparents. This is because the nutrition and lifestyle of the grandmother can impact on the development of the offspring’s mother, as the egg from which the offspring was formed was created in the offspring’s mother while she was developing in the grandmother’s womb.

18.2 Developmental programming hypotheses

Q1: What is developmental programming?

The mechanism that underpins the associations between early experience and later disease is described as programming. Developmental programming (also known as fetal programming) is a process whereby a stimulus or insult acting at a critical phase of fetal development or in early postnatal life results in long-term changes in the structure or function of the offspring (see Chapter 1 and Chapter 4).

18.3 Normal growth

Q1: What is an ideal or optimal birthweight?

The ideal birthweight is the weight at birth that is associated with the lowest associated perinatal mortality. The ideal birthweight varies between different populations, as does the average birthweight. The average birthweight of White infants in the UK was
reported to be 3.416 kg. Low birthweight is defined by the World Health Organization as a birthweight of less than 2.5 kg at term. High birthweight is defined as a birthweight of more than 4.0 kg at term. There is no ideal birthweight as such, but rather a range of normal birthweights. These are shown on the growth charts used by midwives and health visitors when they assess how a baby is growing. The growth charts and information for parents and carers on what the growth charts mean are available at www.growthcharts.rcpch.ac.uk. Doctors will often make a correction for birthweight which makes allowance for the week of pregnancy at which the baby was born; a baby may therefore be ‘small for gestational age’ or ‘large for gestational age’. This helps more correctly identify those babies that have been adversely influenced by conditions during development (see Chapter 2, Section 2.6).

Q2: Has birthweight been increasing over the last few decades?

There is no clear evidence of an increase in average birthweight over the last decade. However, two factors in recent years are likely to affect such a trend. First, there has been an increase in very premature births due to medical advances that have enabled babies with a very low birthweight to now have a reasonable chance of survival when born as early as 24 weeks’ gestation. Second, the proportion of overweight and obese mothers has increased, which impacts directly by increasing the birthweight of their babies. Therefore, the lack of any change in average birthweight over recent decades may have been influenced by changes in birthweight in both directions (see Chapter 2, Section 2.9).

18.4 How development occurs and factors that can affect it

Q1: How much does the environment in which the fetus develops influence the growth of the fetus?

The growth of the fetus is influenced by its genes. However, the environment in which the fetus develops in the womb appears to have a greater effect on the growth achieved than the genetic influence. Evidence suggests that around 62% of the variation in birthweight is the result of the environment in the womb, 20% the result of maternal genes and 18% is due to fetal genes (see Chapter 1, Section 1.3.1).

Q2: What is the role of the placenta?

The placenta has several important roles (see Chapter 4, Section 4.3). First, the placenta transfers nutrients to the fetus, transports waste away from the fetus, and allows gas exchange between mother and fetus. Second, the placenta releases hormones into the maternal circulation, which affect metabolism in mother and fetus. The placenta plays a key role in the production of the hormones, progesterone and oestrogen, which are essential for a healthy pregnancy. Some placental hormones also help nutrient transfer from mother to fetus and others stimulate blood vessel and placental growth.

Q3: At what stage of pregnancy do the organs begin their development?

Rapid growth of the embryo occurs during the first 3 months of pregnancy. Different types of cell such as blood cells, kidney cells and nerve cells are being formed during this period. Organs begin to take shape around 4 weeks after fertilisation of the egg and develop at different rates throughout pregnancy and during early life. The heart (and cardiovascular system) is the first organ to function in the embryo, with other organs such as the kidney developing later on in pregnancy (see Chapter 4).

Q4: Why are different organs affected differently in terms of growth and development at different stages in pregnancy?

When the embryo becomes a fetus (at around 8 weeks), it signifies that all the major systems have formed. Organs and tissues develop from embryonic cells. These cells follow a distinct pathway. First they develop into different types of cell (e.g. blood cells, kidney cells, heart cells). This stage is known as cell differentiation. Following this, the number of each different type of cell increases. This stage is known as cell proliferation. The timing of the differentiation and proliferation stages is different for each tissue and organ. If the fetus receives poor nutrition during an organ’s differentiation stage then it would be expected that the organ would be of normal size, but would have an altered profile of cells. On the other
hand, if the fetus receives poor nutrition during an organ’s proliferation stage, the organ would have the normal profile of cells, but a reduced total number of cells, which may result in a smaller organ (see Chapter 4, Section 4.5.1).

Q5: How should pregnant women minimise the risk of fetal growth restriction during pregnancy?

There are three important steps that a woman should take when planning a pregnancy, that will minimise the risk of fetal growth restriction during pregnancy. Most important, they should not smoke. It is also important to have a healthy weight and to eat a nutritious, varied diet.

18.5 Influences of perinatal sex hormone exposure on programming of disease susceptibility

Q1: At what stage of fetal development is sex determined?

All fetuses will become female unless testis formation and hormone action (primarily androgen) occurs in fetal life to begin the process of becoming male (masculinisation). Masculinisation of the reproductive tract and genitalia occurs very early in gestation (approx. 8–12 weeks). This time period is known as the masculinisation programming window, when the action of male hormones (androgens) in the fetus are critical to the masculinisation process (see Chapter 5, Section 5.2).

Q2: How long does the process of masculinisation take?

The development of the fetus into a male (masculinisation) begins as the result of hormones (primarily androgens) in the fetus, although further androgen-driven development of masculine characteristics occurs immediately after birth (‘mini-puberty’) and at puberty. Although masculinisation of the reproductive tract and genitalia occurs very early in gestation (approx. 8–12 weeks), masculinisation of different organs and systems does not occur all at the same time. For example, masculinisation of the brain occurs late in gestation (27–35 weeks). It is therefore possible for the reproductive system and brain to be differentially masculinised if, for example, testosterone production by the fetal testis (which drives masculinisation) was impaired only in early or late pregnancy. Such a differential effect could account for gender dysphoria (when a person feels that they are trapped within a body of the wrong sex) (see Chapter 5, Section 5.2).

Q3: If fetal androgens are so important for the future normality and general well-being of males, is there anything that a pregnant woman can do to ensure maximum androgen exposure; for example, could she take androgens?

To support the masculinisation of her baby, mothers should maintain a healthy, varied diet and healthy lifestyle. Taking androgens should be avoided as these can impair the growth of the fetus (via effects on the mother) and would masculinise a female fetus, if present, resulting in an abnormally masculinised female child. The reproductive organs and genitalia develop at around 8–12 weeks’ gestation, so mothers will be unaware of the gender of the baby during early development.

Q4: What role do hormones play in the development of chronic diseases where there are male–female differences in the risk of developing a particular disorder?

We know that hormones play a role in some chronic diseases such as heart disease, as males are more at risk than females, particularly during middle age. In the UK, in 2009 around one in five (20%) deaths in men and one in eight (13%) deaths in women were from heart disease. For male-specific reproductive disorders we know that altered fetal hormones (androgens) are likely to be important, but for kidney, lung and heart disease, we do not know if altered hormones are involved. For cardiovascular disorders, there is more evidence of a relationship as birthweight is related to both adult blood pressure (i.e. lower birthweight is associated with higher adult blood pressure) and to testosterone levels (i.e. lower birthweight is associated with lower testosterone levels), but the interrelationship of the two is still not clear.
Q5: How does the sex of the fetus influence health in later life?

The male fetus grows faster and appears to be more vulnerable to growth restriction due to various factors, including maternal lifestyle choices. Masculinisation of the male fetus by androgens in fetal and early postnatal life exerts effects throughout the body on non-reproductive organs. This may partly explain the fact that being male or female determines an individual’s risk of certain diseases, for example, cardiovascular disease, autoimmune disease, asthma, depressive illnesses and kidney disease.

18.6 Cognitive and neurological development

Q1: When does the brain develop?

The time from the third trimester (around 26 weeks) of pregnancy through to birth is one of major and rapid growth of the brain. The brain continues its growth spurt during the first two postnatal years. In children aged 2 years, the human brain is already 80% of the adult weight.

Q2: Can the mother’s diet make her offspring more intelligent?

It is extremely difficult to assess whether the mother’s diet impacts on her offspring’s intelligence, due to the possibility that many other factors may influence intelligence. The mother’s diet can affect the brain development and function of the developing fetus in varying severity. Being undernourished, for example not having adequate energy or protein in the diet or not receiving the recommended nutrient intake for specific micronutrients or essential fatty acids, can affect the development and function of the fetal brain. Similarly, being over-nourished, for example having an excessive energy intake, or mothers having gestational diabetes or being overweight or obese during pregnancy, may have a detrimental effect on fetal brain development. Other factors may also affect brain structure and developmental processes and, therefore, influence the intelligence (or IQ) of offspring. These factors include being born small for gestational age, large for gestational age, or premature, as well as the early neonatal diet (milk feeding and early infant diet).

18.7 Influences of gut microbiota on programming of disease susceptibility

Q1: Why is attaining a healthy gut flora (bacteria) important for health?

Having healthy gut bacteria is essential as it reduces opportunity for the gut to be colonised by harmful microorganisms, it enhances the absorption of certain nutrients for the individual and is beneficial for the immune system. Furthermore, certain bacterial species and/or bacterial profiles have been associated with specific disorders (such as autism) and/or gastrointestinal disorders (including colorectal cancer, ulcerative colitis and Crohn’s disease), antibiotic-associated diarrhoea and acute diarrhoea. For example, there is good evidence that the probiotic strain called *Lactobacillus rhamnosus* GG (LGG) is effective in decreasing the risk of developing antibiotic-associated diarrhoea and in decreasing the duration of acute diarrhoea in children.

Q2: What are the major changes that occur in the gastrointestinal tract during birth and the first few years of life?

The development of gut bacteria can be described in three stages. The first stage is the birthing process and first hours of life, during which time the infant comes into contact with the maternal microbiota and environmental microorganisms. The second stage of bacterial succession is the period of exclusive milk feeding. The third stage comprises the introduction of solid food into the infant’s diet (i.e. weaning). The make-up of the gut bacteria is generally thought to stabilise around 2 years of age.

Q3: Are there differences in gut flora (bacteria) of breast-fed and formula-fed infants?

There are clear differences in the microbiota of breast-fed and formula-fed infants. The bacteria in the gut of breast-fed infants are less diverse than the bacterial profile of formula-fed infants. The main type of bacteria in the gut of breast-fed infants is bifidobacteria, while a wider variety of gut bacteria are found in the gut of formula-fed infants. However, developments in modern milk formulas have led to the addition of prebiotics. These are non-digestible food components that promote the growth and activ-
ity of bacteria in the digestive system that are thought to be beneficial to health. These developments in milk formula, together with improved microbiological analysis, may explain why studies published more recently (in the last 20 years) generally demonstrate fewer differences between the gut flora of breast-fed and formula-fed infants (particularly in relation to bifidobacterial levels).

Q4: When do microbes first start to appear in the gastrointestinal tract?

The intestinal tract of unborn infants was thought to be sterile, with microbes starting to appear during or immediately after the birthing process (depending on the mode of delivery). As bacteria have been detected in the placenta and amniotic fluid, scientists now think that the intestinal tract of the fetus may contain microbes.

Q5: What factors influence the numbers and diversity of bacteria present in the gastrointestinal tract of infants?

The major factors affecting early colonisation of the infant intestinal tract include the gestational age, mode of delivery, exposure to bacteria and the genetic make-up of the infant. Babies born pre-term or with very low birthweight tend to have delayed bacterial colonisation of their intestinal tract and less variety of bacteria. This may partially be a result of administration of antibiotics in pre-term infants. The health, nutritional status and gut bacteria of the mother may also be important factors.

18.8 Obesity

Q1: How does what your mother eats during pregnancy influence your risk of obesity as an adult?

When a fetus is faced with inadequate nutrient availability, it can adapt to ensure that these nutrients are channelled to meet the needs of its vital organs such as the brain, heart, adrenal glands and placenta. But this may mean that other organs, such as the bone marrow, muscles, lungs, gastrointestinal tract and kidneys, receive inadequate nutrients. Although this survival strategy is advantageous for the fetus while it is in the womb, it is thought that it can have a longer-term disadvantage when the child experiences ample nutrient availability later in life.

Mothers who are obese in pregnancy are more likely to have high blood sugar levels which increase birthweight. This, in turn, may increase the risk of the child becoming obese as an adult. Animal studies suggest that increased appetite may be programmed in utero (in the womb). This may create a vicious cycle of maternal obesity leading to childhood obesity.

Q2: Does breastfeeding reduce the risk of the infant being overweight or obese later in life?

There are many benefits of breastfeeding which appear to include a reduced risk of obesity in later life. But the effect is likely to be more modest than originally thought. It is hard for studies to determine the true effects because of the potential for serious confounding due to the social class differences of women who do and don’t choose to breastfeed. The reasons behind the reduced risk of obesity in later life among infants who were breast-fed may be that breast-fed infants gain weight more slowly than formula-fed infants, or that breast-fed infants are likely to take in less milk when dependent on more natural cues to stimulate feeding than bottle-fed infants. Other proposed reasons include factors in breast milk such as leptin (a hormone involved in appetite control and energy expenditure) and insulin levels, or the higher protein content of formula milk (which can lead to accelerated growth – a risk factor for obesity in later life), although innovation in formula development has now resulted in the production of lower protein formulas supporting slower growth in infants.

Q3: Is a child with a higher than average birthweight more likely to be overweight or obese in later life?

There is some indication that babies who are born heavier at term may be more likely to develop obesity in later life. Also, babies who are very small at term also seem to show the same trend. Indeed some researchers suggest that the relationship between birthweight and later obesity follows a J- or U-shaped curve. Pre-term babies that catch up in terms of growth rapidly in early life also seem to have a higher risk for obesity in later life, although some
researchers suggest that heavier babies grow into more muscular rather than fatter adults. The more pertinent question is whether a fatter baby, rather than a heavier baby, is more likely to become overweight in later life (in other words, does excessive fat in the baby around the time of birth track into adulthood?). Unfortunately there is currently not enough evidence to be able to answer this question but it is something that should become clearer with further research.

**Q4: Are babies of obese mothers more likely to be obese themselves in later life?**

Current evidence suggests that babies of obese mothers are more likely to become obese themselves in later life. Obesity increases the risk of complications during early pregnancy, such as pre-eclampsia (where women have high blood pressure, protein in their urine, and may develop other symptoms and problems) that increase the risk of giving birth to a small, growth-retarded baby. If such a baby experiences rapid growth postnatally, it appears to be at greater risk of becoming obese later on. Obese mothers are also more likely to have a baby with an excessive birthweight (a condition known as macrosomia). This is also associated with increased risk of obesity in later life. However, it is very difficult to demonstrate a direct link between the fatness of a mother and the development of obesity in her child because there are so many environmental and lifestyle factors that can influence childhood obesity. Also, many studies investigating the link have used poor measures of body fat in both mothers and children. In obese women, pre-pregnancy body mass index (a measure based on weight and height) is thought to be a more important determinant of pregnancy outcome than weight gain during pregnancy. This is because weight gain during pregnancy is very variable – while many obese mothers gain excessive weight during pregnancy, some can put on less weight than leaner mothers.

**Q5: If babies are born with a low birthweight is it beneficial for them to ‘catch up’ rapidly in weight in the first year?**

Infants born small for gestational age who rapidly gain weight (‘catch-up’ growth) during the first 6–12 months of life are likely to develop an increased body weight or fatness in later life. It is beneficial to increase weight during infancy at a slower rate consistent with standard growth curves (i.e. to track on the same curve of the growth charts).

**18.9 Diabetes**

**Q1: Why does nutrition during fetal life influence our risk of developing type 2 diabetes?**

If tissues, such as the pancreas, are exposed to inadequate levels of nutrients during critical periods of their development, they do not develop properly and, in the case of the pancreas, this can result in a reduced number of the cells that produce insulin.

Insulin is a hormone which helps the body utilise the energy (or glucose) from food. However, in people with diabetes, the body is unable to break down glucose into energy. This may be due to low muscle mass (due to low levels of physical activity) which can reduce the effectiveness of insulin (its ability to remove glucose from blood).

Another reason may be due to insulin resistance which develops in adult life due to unhealthy weight gain and low levels of physical activity. This is a condition in which the body’s cells are less responsive (or sensitive) to the action of insulin and, therefore, the pancreas has to secrete more insulin. Eventually, the capacity of the pancreas to secrete insulin fails, blood glucose levels rise and type 2 diabetes results.

**Q2: What can I do if I had a low birthweight to stop myself developing diabetes?**

Just because you had a low birthweight does not mean that you will definitely develop type 2 diabetes – it just increases your risk, especially if you are overweight and physically inactive. Maintaining a healthy weight, in particular ensuring your waist measurement does not exceed 80 cm for women and 94 cm for men, and doing regular physical activity (equivalent to 30 minutes brisk walking at least five times a week) will reduce your risk.

**18.10 Cardiovascular disease**

**Q1: Is birthweight linked to risk of cardiovascular disease in later life?**

Poor fetal growth increases the risk of heart disease and stroke in later life but the risk is much greater in those who become overweight or obese in adult life.
A poor diet and inadequate physical activity will therefore compound the risk.

Q2: If a mother has high blood cholesterol does this affect her offspring’s blood cholesterol as an adult?

A mother’s cholesterol level during pregnancy should not influence her offspring’s cholesterol level. However, if the mother has high blood cholesterol due to her genetic make-up, then her offspring may inherit this from her.

Q3: If a mother has high blood pressure in pregnancy, does this affect the blood pressure of her offspring later in life?

The offspring of mothers with raised blood pressure in pregnancy have increased blood pressure in later life. However, it is a relatively small increase of about 2 mmHg. Other factors, such as maternal obesity and low birthweight, have a greater effect in raising the blood pressure of offspring in adult life.

Q4: Are bottle-fed babies at greater risk of cardiovascular disease than breast-fed babies?

There is no direct evidence to support this. However, babies that put on large amounts of weight in the first 3 months are more at risk of developing metabolic syndrome (a cluster of factors, such as high blood pressure, high cholesterol and obesity, associated with risk of developing type 2 diabetes and heart disease).

Q5: Why are babies who are small at birth and who become overweight as adults more at risk of cardiovascular disease?

The increased risk of heart disease and stroke in babies who were small at birth and overweight as adults is believed to be influenced by increased risk of high blood pressure and developing an abnormal concentration of lipids (fats) in the blood (known as atherogenic lipoprotein phenotype). This is more likely to happen among children who were small at birth but then gained weight rapidly during early childhood (1–5 years). Poor fetal growth may also affect the development of the kidneys, making the offspring more sensitive to the blood pressure raising effect of salt.

Q6: What effects does maternal obesity have on the offspring’s risk of cardiovascular disease?

Although the evidence is not as clear as it is for a link between poor growth in pregnancy and risk of cardiovascular disease in later life, obese mothers are more likely to have high blood pressure in pregnancy and to give birth to large babies which, particularly in the case of female offspring, puts them at increased risk of cardiovascular disease, especially if they become overweight or obese as adults.

Q7: Children are taller nowadays than previous generations; does this affect their risk of cardiovascular disease?

Shortness in height is associated with a 55% greater risk of cardiovascular disease in later life compared with taller adults. Height is largely determined by growth in the first 2 years of life. Increased adult height is also associated with lower blood pressure in adult life.

18.11 Cancer

Q1: Is birthweight linked to risk of cancer in later life?

Most evidence relates to birthweight and risk of breast cancer, where higher birthweight is associated with an increased risk of breast cancer. Evidence on birthweight and risk of other cancers is less clear. Evidence suggests an increased risk of acute lymphocytic leukaemia with higher birthweights. Studies have been conducted to investigate birthweight and risk of colorectal cancer and prostate cancer, but the findings are inconclusive. Recent research suggests that very tall individuals are at increased risk of cancer.

Q2: How might nutrition lead to increased risk of cancer?

Early nutrition could influence cancer risk by selecting for embryos with particular genes that predispose to cancer. Suboptimal maternal diets can alter the epigenetic code. The epigenetic code is thought to be
an extra layer on top of genes (DNA) that can control which genes are switched on or off. Changes to the epigenetic code do not alter the basic structure of DNA; a gene that has had epigenetic changes will still make the same protein, but these changes may affect when the gene is switched on, and the amount of protein the gene makes. Early nutrition could influence cancer risk in later life by affecting body fatness and hormone exposure.

Q3: **Does breastfeeding influence the risk of cancer in later life?**

This is a difficult question to answer. Rates of breastfeeding tend to be higher among women of higher social class, who are more likely to eat a good diet and have a healthy lifestyle. Cancer rates tend to be lower among those in higher socioeconomic classes. Therefore, it is difficult to determine whether cancer risk is influenced by breastfeeding, or by other socioeconomic factors common to those who breastfeed. Studies in which people who already have cancer are asked about their breastfeeding history can be flawed by ‘recall bias’. The more robust data from prospective cohort studies (where people are asked if they were breast-fed and are followed up over time to see if they develop cancer) shows no significant difference.

**18.12 Bone health**

**Q1: What is the recommended dose of vitamin D supplements for pregnant and breastfeeding women?**

Recommended doses of vitamin D during pregnancy and before differ between countries. The current UK guidance is to take 400 IU/day (or 10 micrograms/day). The World Health Organization, the United Nations Food and Agricultural Organisation, and the governments of Australia and New Zealand suggest 200 IU/day (or 5 micrograms/day), which is the same amount these organisations and countries suggest for non-pregnant women aged 19–50 years. In the US and Canada 600 IU/day (or 15 micrograms/day) is recommended, assuming minimal exposure to sunlight. Across Europe, recommendations for women vary between 200 IU/day (or 5 micrograms/day) (for example, in Germany, Austria and Switzerland) to 400 IU/day (or 10 micrograms/day) (for example, in Belgium). A European project called EURRECA (EURopean micronutrient RECommendations Aligned), which aims to establish requirements and recommendations for micronutrients across Europe, suggests 400 IU/day (or 10 micrograms/day) for pregnant and breastfeeding women.

A possible link has been suggested between high levels of vitamin D in pregnant women and increased asthma in their babies, suggesting we must be careful about advising very high dose supplements, and instead aim to achieve adequate (rather than high) levels of the vitamin. In saying this, studies suggest that humans have evolved to cope with as much as 25 000 IU/day (6250 micrograms/day) of vitamin D formed in the skin. Currently, a large randomised controlled trial is under way in Southampton (MAVIDOS; Maternal Vitamin D Osteoporosis Study) which should help to answer this question.

**Q2: Should we screen for vitamin D deficiency in pregnancy and/or infancy?**

Before implementing a screening programme, there needs to be good evidence that screening for vitamin D would be beneficial to the mother and child. In cases where there is profound vitamin D deficiency with obvious clinical signs, e.g. low calcium levels (hypocalcaemia), bone pain and muscle weakness, treatment is advised for the immediate health of the mother and child. Clinical signs of vitamin D deficiency are likely to be more common in high-risk groups such as dark-skinned ethnic minorities. At the moment, however, where a low level of vitamin D is found incidentally on a blood test in the absence of clinical symptoms, there are very few existing data to inform the correct course of action.

**Q3: What aspects of child nutrition and lifestyle might influence their bone health?**

There is good evidence to suggest that calcium and vitamin D are necessary for adequate bone development through childhood and adolescence. Evidence suggests that children with greater calcium intake or vitamin D levels have stronger bones (greater bone mineral density). Evidence indicates that physical activity in infants and children has beneficial effects on bone mass in late childhood. Children who do regular physical activity tend to have stronger bones (more bone mineralisation). However, whether these
benefits seen in late childhood translate into long-term benefits or a reduction in fracture risk in later adulthood is not yet clear.

**Q4: Is there evidence that breast-fed babies are less likely to suffer from osteoporosis than formula-fed babies?**

Studies have suggested that bone development may be influenced by different patterns of infant feeding in the short term. However, in the longer-term there is no difference in bone strength among babies who were breast-fed compared to those who were formula-fed. The comparison between breast and bottle feeding may also depend on the calcium content of the formula milk. All infant formulas available in the UK contain levels of calcium set by the European Directive (between 50 and 140 mg calcium per 100 kcal [419 kJ]) (see Infant Formula and Follow-on Formula (England) Regulations, 2007. www.legislation.gov.uk/uksi/2007/3521/contents/made).

**18.13 Allergic diseases and asthma**

**Q1: Why is there an increasing number of people with asthma and allergic disease?**

Since the early 1960s there has been a marked increase in the prevalence of asthma and allergic disease throughout the world, particularly in richer, westernised countries. The rapid increase in asthma and allergic disease in recent decades is almost certainly a consequence of the changing environment and lifestyle and there is increasing evidence that exposure to such factors during fetal development and the first few years of life play a particularly important role in modifying the likelihood of asthma and allergic disease in later life.

**Q2: Can maternal diet influence the risk of the offspring having an allergy or asthma?**

The mother’s diet during pregnancy and the offspring’s early life nutrition during infancy and early childhood appear to influence the development of asthma and allergic disease. There is increasing interest in the possibility that the nutrient content of the maternal diet during pregnancy, in particular vitamin E, vitamin D, zinc, selenium and polyunsaturated fat, can influence the development of childhood asthma and allergic disease. However, current evidence relating to the effect of nutrients in the maternal diet on the development of asthma and allergic disease in offspring is limited and speculative.

**Q3: Should pregnant women avoid eating peanuts?**

In 1998, the UK government advised pregnant and breastfeeding women to avoid potential food allergens such as peanuts, as these were thought to increase the risk of childhood allergic disease. However, in 2009, following a review of available evidence, the government revised its advice. Current evidence does not suggest an adverse or a beneficial effect of maternal peanut consumption during pregnancy and lactation in relation to the development of peanut allergy in children. The new advice states that if mothers would like to eat peanuts or foods containing peanuts during pregnancy or breastfeeding, then they can choose to do so as part of a healthy varied diet, irrespective of whether their child has a family history of allergies, unless advised otherwise by their general practitioner.

**Q4: Should the introduction of potential food allergens be delayed during weaning?**

The commonest allergies are to cows’ milk protein, egg, soya, wheat, nuts and shellfish. There is no convincing evidence that delaying the introduction of these potentially allergenic foods will reduce the likelihood of food allergy and allergic disease. In the UK, the advice from the Department of Health is that whole cows’ milk is not appropriate as the main drink for infants less than 1 year of age. However, it can be used in foods prepared for babies over 6 months of age. As a baby’s immune system is not yet fully developed, they should not be given wheat (including foods such as bread, pasta and breakfast cereals), eggs, fish and shellfish, and soft and unpasteurised cheese before 6 months of age. However, foods containing wheat, cooked eggs, fish (except shark, marlin and swordfish) and soft rind cheeses made with pasteurised milk are OK from 6 months of age. Peanuts or any other nuts or seeds (or foods containing these) should not be fed to a baby until after 6 months of age.
18.14 Mental health and cognitive behaviour

Q1: What is the difference between mental health and cognitive behaviour?

Mental health relates to our emotional well-being and how we behave. It can, therefore, have a major impact on lifestyle behaviours (including food choices), economic productivity, physical morbidity and ultimately life expectancy. Cognitive behaviour relates to the way someone processes information and becomes aware of, perceives or comprehends ideas. It involves all aspects of perception, thinking, reasoning and remembering. Cognitive skills in childhood are a strong predictor of educational achievement, and childhood cognitive ability tracks into adulthood and directly predicts dementia risk in later life.

Q2: How common are mental health problems?

Evidence shows that the prevalence of mental health problems increased between the 1970s and the 1990s. Nearly one in ten children aged 5–16 years has a clinically diagnosable mental health problem. Most childhood-onset emotional problems persist into adulthood. It is estimated that depressed adolescents are 2–7 times more likely to be depressed in adulthood, with 40–70% showing major depressive disorder during this phase of the life course. Major depressive disorder is characterised by a depressed mood, a lack of interest in activities normally enjoyed, changes in weight and sleep, fatigue, feelings of worthlessness and guilt, difficulty concentrating and thoughts of death and suicide. The World Health Organization has identified major depressive disorder as the leading cause of disease burden in middle- and high-income countries (see Chapter 14, Section 14.1). An estimated one in four people globally will experience a mental health condition in their lifetime.

Q3: What should pregnant women be eating to ensure their offspring receive adequate nutrition for their brain development?

All nutrients influence brain development, although nutrients of particular importance are energy, protein, long-chain fatty acids, iron, zinc, copper, iodine, selenium, vitamin A, choline and folate. Recommeniations from the European Commission state that pregnant and lactating mothers should consume the fatty acid equivalent of two portions of oil-rich fish per week, although the strength of the evidence is still being debated. One effect of this intake is to prolong pregnancy duration, with a beneficial effect on fetal development. During the third trimester the fetus grows rapidly and the brain has a high demand for DHA (a long-chain omega-3 fatty acid found in oil-rich fish).

Q4: Does being breast-fed improve cognitive function in childhood?

There is good evidence from studies that indicate breastfeeding benefits the baby’s cognitive development. Some studies have also suggested breastfeeding benefits the baby’s emotional and behavioural development. It is thought that the essential fatty acids found in breast milk are mainly responsible for these benefits. However, a wide range of factors may influence the findings of studies. For example, the benefits observed in some studies may be due to non-nutritional factors such as the mother’s socioeconomic status, maternal smoking history, maternal cognitive ability, maternal and paternal education, and family size.

Q5: Does the infant’s diet influence mental health in later life?

The effect of the infant’s diet on mental development is not well understood. However, evidence suggests that infants aged 6–12 months who are fed a diet high in fruit and vegetables and home-prepared foods are more likely to have a higher IQ. Micronutrients in the infant diet that are thought to be of importance to mental health in later life include the essential fatty acids, iron, zinc, iodine, folate and selenium.

18.15 Dietary and lifestyle advice for early life

Q1: What advice can be followed before becoming pregnant to enhance the health of offspring?

It is important for women to have adequate nutritional stores themselves before becoming pregnant.
This is best achieved by eating a healthy, varied diet. Women of childbearing age should take a daily supplement of 400 micrograms of folic acid. It is also important for women to do regular physical activity as this helps to maintain appropriate body weight. Ideally women should avoid alcohol while trying to conceive but, if drinking, limit consumption to one or two units of alcohol once or twice a week. Most importantly, women should try to be a healthy weight before becoming pregnant.

Q2: What nutrients do pregnant women often have low intakes of?

Low vitamin D status is common in pregnancy. In the UK, pregnant and lactating women are advised to take daily vitamin D supplements containing 10 micrograms (or 400 IU/day). However, awareness of the need for supplements and uptake of the advice by women remains low. This is particularly relevant for women at high risk of low vitamin D status, such as women with darker skin and women who are housebound or who conceal most of their skin. The main dietary sources of vitamin D are oil-rich fish, eggs, meat, fortified cereals and margarine. However, these dietary sources usually only provide 2–3 micrograms in total, and are therefore relatively insignificant compared with the vitamin D synthesised from exposure to sunlight. It is therefore important for pregnant women, especially women with darker skin who are likely to be at more risk of low vitamin D status, to get outside and expose their skin to sunlight on a regular basis, taking care not to burn in the summer months.

Many pregnant women, and women trying for a baby, are aware of the message that increasing folic acid intake in the early stages of pregnancy and before pregnancy is recommended in order to prevent neural tube defects. However, in the UK, a large proportion of pregnancies are unplanned and less than half of women take any folic acid supplements before becoming pregnant. Evidence suggests the use of folic acid supplements in the early stages of pregnancy is particularly low among West Indian and Asian mothers, and teenage mothers in the UK. Women should continue to take a 400 microgram folic acid supplement daily for the first 12 weeks of pregnancy and eat folate-rich foods on a daily basis such as green leafy vegetables, brown rice, peas, oranges, bananas and fortified breakfast cereals.

Adequate omega-3 fatty acids are needed by the baby during pregnancy for healthy development of the brain and nerves. In particular the long-chain omega-3 fatty acids eicosapentaenoic acid (EPA) and docosahexaenoic (DHA) are important to include in the diet of pregnant women. Oil-rich fish, such as herring, mackerel and salmon, are the main dietary source of EPA and DHA. Eggs can also make a significant contribution to intake of DHA. In the UK, 450 mg a day of DHA and EPA is recommended for adults and pregnant women. This can be obtained by eating two servings of fish a week, one of which is oil-rich. Consumption of oil-rich fish should be limited to two portions per week (a portion is around 140 g when cooked) for girls and women of childbearing age. This is because oil-rich fish may contain low levels of pollutants that can build up in the body. Oil-rich fish include anchovies, carp, herring (e.g. kippers), mackerel, pilchards, salmon, sardines, sprats, trout and whitebait.

In the UK, it is thought that the body of pregnant (and lactating) women can adapt to ensure the baby receives an adequate supply of iron, even when the mother is iron deficient. For this reason, extra iron for all pregnant women is not considered necessary. However, pregnant women may develop low iron status, so plenty of iron-rich foods should be eaten and foods containing non-haem iron should be consumed alongside foods or drinks containing vitamin C, such as fruit or vegetables, or a glass of fruit juice, to aid iron absorption. The effect of tea and coffee on iron bioavailability is no longer considered to be of major concern, especially if advice from the Department of Health to limit caffeine intake to 200 mg a day (equivalent to two mugs of coffee/day) while pregnant is followed.

Q3: Is there any specific nutritional advice for particular groups of the population?

Dark-skinned ethnic minorities or women who conceal most of their skin from sunlight exposure are at particular risk of low vitamin D status and, in the UK, all Asian women and children are advised to take supplementary vitamin D. Exclusively breastfed babies may also be at increased risk of vitamin D deficiency if the mother has low levels. Fewer women from low-income groups take folic acid supplements. Mothers from low-income households are nutritionally vulnerable and may go short of food in order to
feed their children. Also, the duration of breastfeed-
ing is shorter among low-income groups. Support
and advice from health professionals to women from
low-income groups is important in order to lessen
inequalities in health. The diets of adolescent girls in
the UK are often low in nutrients, in particular
folate, iron and vitamin D. This has implications for
pregnant adolescents as they may still be growing
themselves. Obese women who become pregnant
have an increased risk of complications and long-
term health implications for their offspring (e.g.
increased risk of obesity and diabetes in offspring in
later life). Women who weigh over 100 kg (approx.
15 stone 10 lb) may require specific advice from a
health professional.

Q4: Should pregnant women ‘eat for two’?

No, pregnant women do not need to ‘eat for two’. In
fact, women do not need any extra energy during the
first 6 months of pregnancy. However, during the last
trimester (and during lactation) some extra energy
is required. An additional 200 calories per day is
required during the last trimester of pregnancy. This
equates to a small ham and cheese sandwich, or a
banana smoothie, or a medium bowl of porridge with
milk, or 30 g of mixed nuts.

Q5: How much physical activity should pregnant
women do?

Current recommendations suggest women should
aim for at least 150 minutes (2½ hours) of moderate
intensity activity per week. One way to approach this
is to do 30 minutes of physical activity on at least five
days a week. Currently, only around 3 in 10 women
of childbearing age meet these recommendations.
Women should try to keep active during pregnancy,
as well as during milk feeding and weaning. Physical
activity helps maintain an appropriate body weight
and enhances fitness. It also has many benefits during
pregnancy such as reducing muscle cramps and swell-
ing of the legs and feet. Women who have not been
habitually active should start by doing 15 minutes of
continuous aerobic physical activity, three times a
week, and gradually increase this to 30-minute ses-
sions four times a week or more. Contact sports are
not advised and hormonal changes cause joints to
be more mobile, increasing the risk of injury with
weightbearing physical activity. However, there are
many activities that are suitable during pregnancy,
for example, swimming, walking, jogging and taking
part in exercise classes. After 16 weeks of pregnancy,
physical activities that involve lying on the back are
not recommended as the womb is likely to put pres-
sure on major blood vessels. It is also important to
keep well hydrated and avoid hot humid conditions
when exercising. Women who have any complica-
tions or problems that may impact on their ability
to be active should seek advice from their GP or
midwife.

Q6: Which nutrients are important for women
who are breastfeeding?

During the first 6 months of lactation, women require
an additional 330 calories per day, if they are exclu-
sively breastfeeding. This is slightly more than the
200 additional calories women need during the last
trimester of pregnancy. Breastfeeding women need
even more nutrients than when pregnant. When
breastfeeding, women require an increased intake
of vitamin A, vitamin D, vitamin B₁₂, vitamin B₁₂,
calcium, magnesium and zinc. Adequate levels of
these nutrients can be achieved by eating a healthy,
varied diet, with the exception of vitamin D. Breast-
feeding women should continue to take a daily sup-
plement of 10 micrograms of vitamin D. Folate is one
nutrient often found to be low in diets of lactating
women. Evidence suggests that the level of folate in
breast milk is maintained at the expense of a mother’s
folate stores. When women do not take a folic acid
supplement during pregnancy, their own folate level
is likely to be low when breastfeeding.

Q7: How much fluid do pregnant and lactating
women need?

‘Fluid’ includes not only water from the tap or in a
bottle, but also other drinks that contain water
such as tea, coffee, milk, fruit juices and soft drinks.
Pregnant women are advised to consume no more
than 200 mg of caffeine a day. This is equivalent
to about two mugs of instant coffee or about two
and a half mugs of tea. Foods can also provide
water – on average food provides about 20% of total
fluid intake. The amount of fluid required by
adults depends on many things including physical
activity levels and the weather, but in general adults
should drink about 1.2 litres (6–8 glasses) of fluid per
day (on top of the water provided in food). Women need slightly more fluid when pregnant, and significantly more when breastfeeding. The estimated additional requirement is 0.3 litres per day (about 2 glasses) during pregnancy and between 0.7 and 1.1 litres per day (about 6 glasses) during lactation.

Q8: When is the best time to wean babies on to solid foods?

The UK’s Departments of Health currently recommends that weaning should start at around 6 months. Breastfeeding (and/or breast milk substitutes, if used) should continue beyond the first 6 months, along with appropriate types and amounts of solid foods. Despite this recommendation, virtually all mothers (more than 99%) in the UK report introducing other foods before 6 months, often because they consider their babies to be hungry and not satisfied on breast milk alone. There is a need for clearer advice to mothers and health professionals on weaning. However, this is difficult to provide as there is a lack of up-to-date information about the diets and nutrient intakes of infants. There is also a lack of official guidance from the Department of Health on what appropriate portion sizes are, how long the weaning process should take and when foods with different textures should be offered. The government’s advisory body, the Scientific Advisory Committee on Nutrition, is currently reviewing the evidence on complementary and young child feeding, which should help inform future policy and government advice, including the best time to wean.

Q9: What nutrients are most important to include in the weaning and infant diet?

A baby’s diet should be varied and balanced as this will help him or her grow up into a healthy child and adult by providing adequate amounts of all of the nutrients an infant needs. Long-chain fatty acids should be included in the weaning diet as these are important for brain development. Rapid brain development occurs during the last trimester of pregnancy and the first year after birth. Oil-rich fish are a great source of long-chain fatty acids. Boys can have up to four portions of oily fish (such as mackerel, salmon and sardines) a week, but girls should have no more than two portions a week. This is because oil-rich fish may contain low levels of pollutants that can build up in the body and may affect the development of the girl child’s future potential offspring already present as eggs in her reproductive system. Vitamin D is also found in oil-rich fish. However, we obtain most of our vitamin D from the action of sunlight on the skin, so playing outdoors should be encouraged. The Department of Health also recommends vitamin drops for infants from 1 month to 5 years of age. In the UK, the ‘Healthy Start’ vouchers and vitamin supplements are available to pregnant women under 18 years and those on low income (www.healthystart.nhs.uk). The Healthy Start children’s vitamin drops contain vitamin A, vitamin C and vitamin D. Children having more than 500 mL (one pint) per day of infant formula do not need to take these vitamins until they are weaned off formula milk.

Other nutrients such as iron and zinc are important for an infant’s development. A lack of iron can delay the child’s physical and mental development. The iron found in meat and fish is absorbed more easily by the body, compared to the iron found in plant foods. Infants who do not eat meat or fish should be given other sources of iron on a frequent basis (e.g. dark green vegetables, bread, beans, lentils and dhal, and dried fruit such as apricots, figs and prunes). Zinc is important for making new cells and enzymes, healing wounds and helping the body to process carbohydrate, fat and protein in food. Infants at increased risk of having low iron and zinc intakes if there is a delay in weaning onto foods such as meat.

Q10: How much physical activity should infants and young children do?

Physical activity should be encouraged from birth, particularly through floor-based play and water-based activities in a safe environment. Being active will help the infant develop motor skills, improve cognitive development, support a healthy weight, enhance bone and muscle development and support learning of social skills. Children of pre-school age who are capable of walking unaided should be physically active daily for at least 180 minutes (3 hours) spread throughout the day. For all under-5s, the amount of sedentary time (being restrained or sitting) for extended periods should be minimised, with the exception of time spent sleeping.
18.16 Policies relating to early life nutrition and development

Q1: Are current policies adequately addressing the increasing levels of obesity in pregnancy?

Obese pregnant women are at an increased risk of suffering from complications related to their pregnancy (e.g. stillbirth, maternal and infant mortality and congenital anomalies) and they are more likely to need a caesarean section. The prevalence of gestational diabetes is higher among obese women, which has long-term health implications due to an increased risk among women and their children for developing type 2 diabetes. There is also a lower breastfeeding rate among obese women compared with women with a healthy weight. Policy makers need to place greater focus on interventions and messages to control pre-pregnancy weight, or if approached sensitively, extra support and advice to encourage healthy behaviour changes during and after pregnancy. However, there is currently a lack of officially accepted guidance in the UK for weight gain during pregnancy. To improve the situation, there is a need for a clear policy on weight control and avoidance of obesity in pregnancy, including the need for better services for women before they become pregnant and support for women in achieving and maintaining a healthy body weight after pregnancy.

Q2: Are current policies relating to breastfeeding and bottle feeding adequate?

Breastfeeding has a major role in promoting health in both the short and long term for both the baby and the mother. Therefore, policies that promote breastfeeding should come high up on the public health agenda. This is particularly important among groups where breastfeeding rates are often low (e.g. women from low-income groups, obese mothers and teenage mothers). Activities that raise awareness of the health benefits of breastfeeding, increase its social acceptance and promote support for breastfeeding mothers are essential and should continue. While all health professionals should continue to promote and support breastfeeding, infant formula is an important source of nutrition for many infants. Mothers who cannot breastfeed or who choose to formula feed need education and support in using it appropriately and safely. It is important that health professionals have good, up-to-date knowledge of the different formulas available and are able to provide advice and support to mothers about safely preparing and storing formula.