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An introduction to nutrition for an optometrist

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1 CET point for UK optometrists

The world of nutrition and nutritional supplements can sometimes be a minefield for both patients and optometrists. Whilst there is no formal training in this area for undergraduate optometrists, as primary healthcare professionals there is an existing duty to be able to advise patients on products which may help maintain the health of their eyes and vision (General Optical Council 2016).

This article provides a basic introduction to health and nutrition, specifically with the optometrist in mind. Firstly, it explores what a healthy diet is and defines some commonly used terms; then it will go on to the role of nutritional supplements and how nutritional supplements are regulated. Finally it will discuss which professionals are able to give specialist nutritional advice.

So what is a healthy balanced diet?

To maintain our general health, weight and bodily functions we must have a steady inflow of oxygen, water, energy and nutrients balanced with an outflow of carbon dioxide, water, solutes and solids, as shown in Figure 1. It is important to remember, however, that the level of each input and output needed to maintain health and weight can vary between individuals due to numerous factors.

Our daily diet provides the body with both energy and essential nutrients. The level of energy and nutrients an individual will need to maintain weight and health can vary due to many factors, including genetics, past diet, nutritional status and levels of physical activity. In addition, for certain groups of the population there may be a need to improve health and/or gain/lose weight. For children, diet must maintain general health and bodily functions whilst allowing for growth and development. Later in life or during a state of damage or disease, diet may need to be altered in order to prevent or treat certain pathologies.

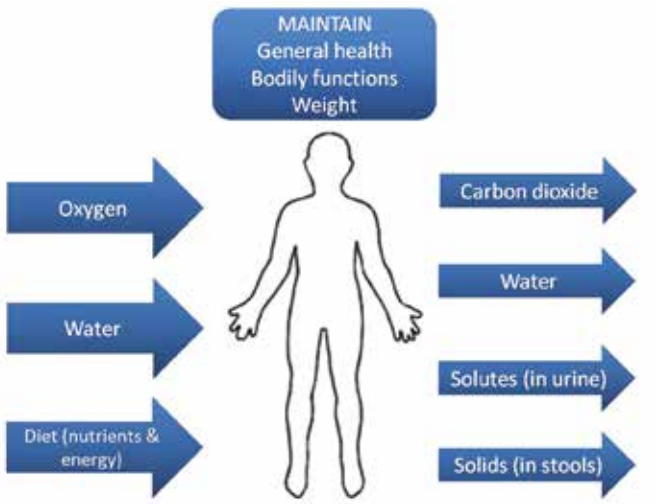

Figure 1. The inputs and outputs that need to be balanced to maintain a healthy adult.

Food types are categorised into three groups, classed as macronutrients: carbohydrates, proteins and fats (lipids). In short:

1. Carbohydrates are used in the body as an energy source for working muscles, provide fuel to the central nervous system, enable fat metabolism and prevent protein being stored as energy (FAO/WHO 1998).
2. Proteins are used in the body for transport, enzyme synthesis, growth and repair, structural purposes and in the body's defence systems (forming cellular and physical barriers, eg skin and tears) (Panel on Macronutrients 2005). Twenty-five per cent of the body's protein is collagen, which is found in abundance in the eye structures (Oyster 1999).
3. Fats are insoluble in water and are often used to enhance the flavour and palatability of food. In the body they are used as a source of energy, during metabolic and physiological processes, to maintain the structural and functional integrity of cell membranes and as insulation (Alabdulkarim et al. 2012).

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Figure 2. The Eatwell Guide, as recommended by the NHS and British government (Public Health England 2016).

All food provides us with energy, measured commonly in calories. A calorie is a unit of heat energy, or, more precisely, the amount of energy required to heat 1 gram of water by 1°C (at normal atmospheric pressure at sea level). The higher the calorific value per gram of food, the more energy there is available from that source (eg there are 9kcal/g fat, 4kcal/g protein, 3.75 kcal/g carbohydrate and 7kcal/g alcohol).

Food also contains essential micronutrients, which are chemical substances used by the body to sustain health and bodily functions. Vitamins and minerals are essential nutrients; in most cases these cannot be synthesised in the body in high enough concentrations and therefore must be obtained from our diet. A vitamin is an organic compound which is required to maintain health and growth. A mineral is a naturally occurring, inorganic compound which is required to maintain health and growth (Mann and Truswell 2007).

As well as essential nutrients, our diet must contain food components such as dietary fibre to maintain health and reduce the risk of chronic diseases (American Institute for Cancer Research and the World Cancer Research Foundation 2007; Panel on Macronutrients 2005).

In summary, our diet has three purposes: calorific values for energy, essential nutrients and certain food components to maintain health and bodily functions.

How healthy is the British diet?

A balanced diet is often thought to come from a variety of food sources. This thinking led to the UK government backing various campaigns in order to get us eating healthily. Possibly the two best known are the Eatwell Guide and the Five-a-Day campaign.

The Eatwell Guide (Public Health England 2016), as shown in Figure 2, was published by the government in association with the National Health Service (NHS), and recommends the constituents of a healthy balanced diet and is applicable to everyone over the age of 2 years. This replaced the previous Eatwell Plate. The newer Eatwell Guide encourages users to choose more wholegrains and less processed foods, and to eat foods lower in saturated fats and sugars.

The Family Food Report is produced annually by the Department for Environment, Food and Rural Affairs; it looks at expenditure and quantities, as well as nutritional value of the food bought by a sample of UK households within a fortnightly period. Figure 3 is from the latest report from 2014 and shows the purchase of food and drink in UK households as a whole, and how those considered to be on a low income compare to the previously recommended Eatwell Plate. From this graph it can be seen that, in comparison to the Eatwell Plate's recommendations, on average UK households:

- Bought fewer starchy foods and fruit and vegetables than recommended
- Bought more milk and dairy foods and foods high in fat and/or sugar than recommended.

This graph also shows that, in comparison to all households, households with low income purchased 4% less fruit and vegetables and 3% more foods and drinks high in fat or sugar (Department of Environment, Food and Rural Affairs 2015).

It should be noted that this report looks at food purchases and may not fully reflect the diets or nutritional status of the household, as this does not take into account when the food is eaten, the way food is prepared or food wastage.

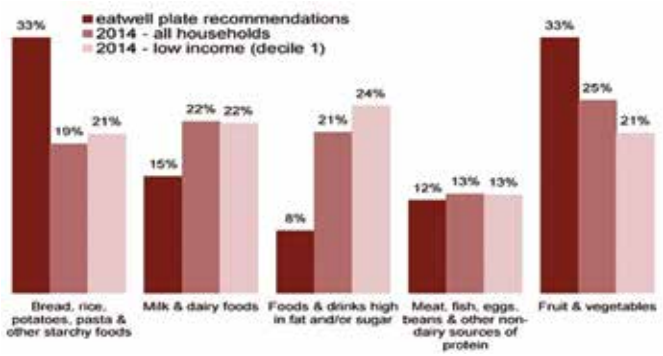

Figure 3. The Eatwell Plate comparison chart for low-income and all households from the Family Food Report 2014 (Department of Environment, Food and Rural Affairs 2015).

Fruit and vegetables contain a wide range of essential nutrients as well as dietary fibre and antioxidants. Numerous studies have shown that an increased intake of fruit and vegetables can reduce the risk of cardiovascular disease (Dauchet et al. 2006; He et al. 2007; Oude Griep et al. 2011b; Woodside et al. 2013), stroke (Dauchet et al. 2005; He et al. 2006; Hu et al. 2014; Oude Griep et al. 2011a; Woodside et al. 2013) and cancers (Leenders et al. 2013; World Cancer Research Fund/ American Institute for Cancer Research 2011). In fact, most of the understanding surrounding the health benefits of vitamins and minerals has come from cancer research (American Institute for Cancer Research and the World Cancer Research Foundation 2007). In an attempt to address the deficit in the population's consumption of fruit and vegetables, the British government adopted the Five-a-Day campaign in 2003 (Mosley 2013). The campaign recommends that every adult should eat five portions of different fruit and vegetables per day as a minimum (total 400 grams). This follows advice from the World Health Organization (WHO). The WHO recommendation was aimed at general populations after noting that worldwide diets were commonly deficient in fruit and vegetables and that an insufficient intake of fruit and vegetables has been linked to an increased risk of both cancers and cardiovascular disease (World Health Organization 2003).

Numerous studies into the number of fruit and vegetable portions which should be consumed by an individual per day have been conducted and there are varied findings and recommendations (He et al. 2006; Oyebode et al. 2014; Woodside et al. 2013). For example, the Australian government recommends five portions of fruit plus two portions of vegetables per day (Department of Health and Ageing, Australian Government 2016). It appears that the recommendation for five portions per day in the UK was selected not on the basis of the research, but because it was seen as an easy-to-remember, achievable target and still greater than the average number of portions currently consumed by a British adult. Some studies have also concluded that consuming a variety of different colours could be as important as the amount of fruit and vegetables consumed (Oude Griep et al. 2011a, b, 2012).

Individual variation

Although there are numerous recommendations on the amounts and types of food we should consume, it is important to remember that nutritional requirements can vary greatly between individuals. In addition, the nutrients obtainable from a food source are determined by both bioavailability and absorption. Bioavailability is the percentage of the nutrient consumed that is available to be absorbed by the body (Expert Group on Vitamins and Minerals 2003). Bioavailability is determined by:

- Whether the vitamin or mineral is in its natural or synthetic form. Contrary to the assumption that 'natural is always best', some nutrients have greater availability in their synthetic form (Kelly 1998)
- The state of the food as it is eaten. For example, some nutrients are more readily available from raw foods, whereas others are more readily available from cooked food. The longer the time between when food is harvested to when it is eaten will lead to more nutrients degrading. It is also known that some minerals are more available from animal foods rather than plant foods; examples include iron (Hurrell and Egli 2010), calcium (Gueguen and Pointillart 2000) and zinc (Foster and Samman 2015)
- How the food has been processed. For instance, blanching is known to reduce vitamin and mineral content overall (Reddy and Love 1999); however, lycopene in tomatoes is known to have greater bioavailability from processed tomato products than in its unprocessed form (Shi and Le Maguer 2000)
- If the vitamins and minerals are being taken in tablet form, bioavailability is determined by the site and speed of absorption in the gastrointestinal tract.

There are additional factors that can affect an individual's ability to absorb the vitamins and minerals, including:

- Age
- Nutritional status: individuals who are malnourished will absorb nutrients more readily from their food
- Physiological status: during pregnancy, absorption of nutrients naturally increases in order to compensate for an increased need
- Other systemic diseases: for instance, coeliac disease (Aurangzeb et al. 2010) and individuals with cystic fibrosis or ulcerative colitis (Burke et al. 1997) are known to have malabsorption
- Medicine contraindications (Table 1)
- Levels of other nutrients in the diet: some minerals compete for routes of absorption, eg iron and zinc (Lind et al. 2003). Conversely, fat is known to increase the absorption of lutein (Roodenburg et al. 2000), vitamin C is known to increase the absorption of iron (Hallberg et al. 1989) and the absorption of vitamin E is affected by the presence of certain proteins (Borel et al. 2013). It has also been questioned whether fibre can aid the absorption of various antioxidants in the small intestine (Palafox-Carlos et al. 2011).

Table 1. The interactions and contraindications of nutrients commonly found in nutritional supplements for eye health, when taken in doses much greater than the dietary reference values

Nutrient	Contraindicated for	Consequences	Reference
Vitamin A	Tetracycline antibiotics Warfarin	Reduced antibiotic activities Increased risk of bleeding	 Ehrlich (2007)
Beta-carotene	Current/past smokers	Increased risk of lung cancer	Omenn et al. (1996); Tanvetyanon and Bepler (2008); The Alpha-Tocopherol, Beta Carotene Ccancer Prevention Study Group (1994)
Riboflavin	Antibiotics: streptomycin, erythromycin, tryothricin, carbomycin and tetracyclines	Reduced antibiotic activity	Expert Group on Vitamins and Minerals (2003); Velizhenko (1975)
Vitamin C	Males	Increased risk of kidney stones	Thomas et al. (2013)
Vitamin E	Anticoagulants Vitamin K supplementation Males	Increased risk of bleeding Increased risk of prostate cancer	Podszun and Frank (2014) Klein et al. (2011)
Folic acid	Vitamin B_{12} deficiency	Mask deficiency	Selhub and Rosenberg (2016)
Zinc	Risk of kidney failure	Kidney failure	Johnson et al. (2007)

So where do nutritional supplements fit in?

Nutritional supplements or food supplements can be defined as a single or combination concentrated source of vitamins, minerals or other substances which can have a physiological or nutritional effect (Department of Health 2012). Advice on the use of nutritional supplements can vary: the American Institute for Cancer Research and the World Cancer Research Foundation (2007) recommend that healthy adults should aim to get all the vitamins and minerals required through diet alone, due to lack of knowledge of the long-term effects of the supplementation of these substances. Although it is worth noting that the main source of vitamin D is through sunlight, a recent review of current literature linking vitamin D deficiencies and various diseases such as bone and calcium disorders highlighted that vitamin D deficiency is a public health concern within the UK (Gittoes 2016). It has been suggested that, as a nation, the UK is deficient in vitamin D, and therefore following a consultation with the government, strategies are being considered for how this should best be managed (Scientific Advisory Committee on Nutrition 2015). There are certain groups of people (eg very young children, individuals with deficiencies, women during pregnancy and older populations) who may need to rely on the use of supplements (American Institute for Cancer Research and the World Cancer Research Foundation 2007; NHS Choices 2012). On the whole, supplementation should be in addition to (and not a substitute for) a healthy balanced diet.

Despite this advice, it is evident that the nutritional supplement industry in the UK is growing, with sales of £345.9 million in 2012, up by 5% on previous years (Proprietary Association of Great Britain 2015). With an ageing population (Office for National Statistics 2011), there has been a shift towards encouraging healthy ageing and a 'prevention is better than cure' mentality (Department of Health 2004), to help ease the potential burden on the NHS (Hughes and Pearson 2013). This has encouraged a greater public interest in health and disease prevention.

As a result, numerous studies have looked at the use of supplements within the adult population in the UK; these estimate use of supplements to be anywhere between 24% and 57% (Bates et al. 2012; Denison et al. 2012).

How are nutritional supplements regulated?

The regulation of each nutritional supplement is dependent on whether the supplement itself is classed as a 'food supplement' or 'medicine'. For example, if a food supplement makes a health claim, eg 'Supplement Y is important for the health of your eyes', then it would be classed as a food or nutritional supplement. However, if a supplement has a medicinal effect or makes medical claims, such as 'Supplement Z can prevent cataracts', 'Supplement Z can maintain your vision', 'Supplement Z can cure macular degeneration', then in order to comply with the Food Labelling Regulations 1996 (British government 1996), it would need to be classed as, and licensed as, a medicine and therefore regulated by the Medicines and Healthcare Products Regulatory Agency (MHRA) (Department of Health 2011a). Herbal products are also administered by the MHRA, as they are regulated by the Traditional Herbal Medicines Directive (European Commission 2004). Any claims made, whether classed as a medicine or food supplement, must be backed by evidence to support this claim, to a level

satisfactory to its respective legislation. Medicines normally have to have a higher level of evidence for any claims made than food supplements.

Legislation regarding food or nutritional supplements has been set both nationally (The Food Supplements (England) Regulations 2003: British government 2003) and by the EU (EU Food Supplements Directives 2002/46: British government 2011). The responsibility for regulating nutritional or food supplements in the UK falls to the department responsible to that individual country; ie in England, the Department of Health; in Scotland, the Food Standards Agency Devolved Administrations of Scotland; in Wales, the Welsh Assembly; and in Northern Ireland similar, but separate sets of legislation apply which are set by their own administration (Department of Health 2011b). These legislations cover:

- The vitamins and minerals (but not other substances, eg omega-3 fatty acids) which are allowed to be used in food supplements (The Food Supplements (England) Regulations 2003: British government 2003)
- The labelling of supplements, including units of measurement, the content on the label, presentation and advertising of specific products (Department of Health 2011c).

It is interesting to note that the term 'superfood', according to NHS Choices (2013), has been banned for use on food packaging by the EU, and has no specific definition. Although, by implication, it would suggest that any food referred to by these labels in some way improves or maintains health, this term has no scientific value and is thought to have been developed by the food industry to promote and market certain food types. However, in order to comply with the Regulation (EC) 1924/2006 on nutrition and health claims made on foods, any foods making specific health or nutritional claims should have scientific evidence before certain terms or statements may be used (Department of Health 2011c).

The European Food Standards Authority (EFSA) was founded in 2002 to provide scientific opinions and communication on the apparent risk in the food chain, for example, pesticides, genetically modified organisms, additives and allergenic food ingredients. The EFSA works independently of European institutions and legislation but is funded by the EU (European Food Safety Authority 2016).

How much of each nutrient should we have?

In the UK, dietary reference values are set by the Committee on Medical Aspects of Food and Nutrition Policy (COMA) in 1991. These are estimated values of nutritional and energy requirements for healthy adult populations in the UK. When setting recommended amounts for a nutrient, the following criteria are generally considered:

- The amount of a nutrient required to maintain a set circulatory level, enzyme level or tissue concentration specific to that nutrient
- The amount of the nutrient required by individuals within a healthy population and to prevent deficiencies
- The level of intake required to maintain the balance of the specific nutrient within the body
- Association with a certain biomarker of adequate nutrition for that specific nutrient.

Whilst setting these estimates, COMA looked at numerous other reference values, including: estimated average requirements, lower reference nutrient intakes (RNIs), safe intake levels and RNIs. RNIs are used by British dietitians as a starting point whilst treating specific disease and health conditions. RNIs are set for nutrients more specifically for different ages, sexes and other groups (eg breastfeeding and pregnant women) (Department of Health 1992). COMA has now been replaced by the Scientific Advisory Committee on Nutrition to advise the government on diet: they are currently reviewing dietary reference values.

Food and nutritional supplements in the UK are labelled with reference intakes which are set by European law. Reference intakes are a guide for the adult population as to the amount of energy and key nutrients to consume on a daily basis, and should not be seen as a level set for a specific individual. As discussed previously, an individual's nutritional needs can be dependent on many factors. Reference intakes are also not the level required to treat deficiencies.

Numerous tests exist to test nutritional status of an individual; dietitians use a combination of anthropometric assessments (eg body mass index, weight history, waist circumference), dietary assessment, body composition assessment (eg skinfold thickness, limb circumference and bone mineral density), biochemical assessment (specific to which nutrient is being tested, eg urine testing and blood plasma testing), clinical status (eg if there are underlying conditions such as diabetes, cystic fibrosis or coeliac disease) and specific signs for associated deficiencies. They also take into account the environment, such as socioeconomic status. Other tests which have been used include hair analysis; however, results can be ambiguous due to the uneven distribution of organic compounds in hair and the difficulty in removing contaminants which can stick to the hair sample (Mann and Truswell 2007). The repeatability of hair analysis has also been questioned (Steindel and Howanitz 2001), so urine and blood analysis are the preferred methods (Namkoong et al. 2013).

Too little or too much of a certain nutrient can cause health problems associated with deficiencies or toxicity. Some nutrients, for example, vitamin C, which has antioxidant properties and actions, under certain conditions (eg in very high concentrations) may exhibit the reverse behaviour and become oxidising, increasing the risk of oxidative stress and certain tissue sites (Jayasinghe et al. 2013). High doses of vitamin C supplementation in men have been associated with increased risk of kidney stones (Thomas et al. 2013). Toxicity tends to occur only at doses much greater than the dietary reference value for specific vitamins and minerals. The likelihood of adverse reactions to vitamins and minerals relies on three main factors:

1. whether the nutrient is fat- or water-soluble
2. the absorption efficiency of the nutrient. For many nutrients, as dose increases, it would be expected that the absorption rate increases; however, for some vitamins the converse occurs, eg as the dose of beta-carotene increases, the absorption of the nutrient decreases (Novotny et al. 2010)
3. the human body will also set a metabolic control level of the set nutrient. The tighter the metabolic control of the specific nutrient, the less chance there will be of toxicity occurring (Truswell 2007).

In May 2003 the Food Standard Agency published a report by the Expert Group on Vitamins and Minerals, which set upper safe limits for eight nutrients and guidance on another 22. The report was commissioned as it was noted that nutritional supplements that were being sold over the counter, classed as 'food items', had higher concentrations of specific nutrients than were in medicines prescribed to treat specific deficiencies (Expert Group on Vitamins and Minerals 2003). It should be noted that most modern multivitamin formulas do not exceed the RNIs and that it is single-nutrient supplements that may exceed the RNIs.

When supplementation doses of certain nutrients greatly exceed RNIs, this can cause contraindications for some individuals due to their medical or social history (Boullata and Hudson 2012). Some of the most relevant cases for optometrists are summarised in Table 1.

Who can give dietary advice?

If general practitioners (GPs) want a patient to receive specialist dietary advice they can refer to a dietitian working within the NHS or privately. Dietitians are qualified (with a minimum requirement of a BSc(Hons) in dietetics) healthcare professionals who are trained to assess, diagnose and advise to treat dietary and/or nutritional problems. Like optometrists, dietitians are regulated by law and work within strict ethical guidelines. They have to be registered with the Health and Care Professions Council to practise. There are a number of other professionals who are available to give nutritional advice to the general public. For example, nutritionists are qualified to give advice about healthy eating. However, anyone can call themselves a nutritionist and there is no requirement to be registered. The UK Voluntary Register of Nutritionists was established to protect the public by setting and advancing standards of evidence-based practice across the field of nutrition. Both the Health and Care Professions Council and the UK Voluntary Register of Nutritionists provide a searchable online register to allow the public to confirm the registration and qualifications of the healthcare professional from whom they are seeking advice. Both registered dietitians and registered nutritionists have to complete continuing professional development and have to work within their specific regulatory body code of conducts and guidelines. Those using the terms 'nutritional expert' or 'diet expert' do not need to have any specific qualifications and there is no regulation of their practice or the advice they provide.

It should also be considered that some patients may do their own research and self-prescribe nutritional supplements or specialised diets; it would be advisable for patients who fall into either of these categories to discuss this further with their GP.

It is interesting to note that neither the General Optical Council (GOC) nor the College of Optometrists provides guidance specifically about giving dietary or nutritional advice to patients. However, the GOC *Standards of Practice for Optometrists and Dispensing* state that, as optometrists, we should 'keep professional knowledge and skills up to date' and we should 'assist patients in exercising their rights and making informed decisions about their care' (General Optical Council 2016). This is supported by the College of Optometrists' guidance section A1 (College of Optometrists 2014). Therefore, given the evidence providing links between certain nutrients and specific eye conditions, such as age-related macular degeneration (Chew et al. 2013; The Age-Related Eye Disease Study 2 Research 2013) and dry eye (Al Mahmood and Al-Swailem 2014; Bhargava and Kumar 2015; Bhargava et al. 2013; Liu and Ji 2014), an optometrist may consider discussing the role of nutrition, including the use of nutritional supplements, in appropriate cases (Ho et al. 2011). However, any nutritional advice given should be in accordance with the College of Optometrists' guidelines (specifically sections C4 and D3) (College of Optometrists 2014) and with section 6 of the GOC *Standards of Practice*, which states that optometrists should 'recognise, and act within, the limits of their professional competence' (General Optical Council 2016). Optometrists should advise all patients to seek advice from their GP before starting a new nutritional supplement, especially those who may be at risk from adverse reactions from increasing specific nutrients in their diet (Table 1) or who appear to be at risk of nutritional deficiencies.

Summary

This article provides a basic introduction to health and nutrition, specifically with the optometrist in mind. Firstly, it defines a healthy diet, how individual dietary requirements can vary and how the UK government recommendations are aimed at enabling people to make healthy food choices. The role of nutritional supplements and how they are regulated is discussed, along with potential adverse reactions and contraindications of some vitamins and minerals important for eye health. Finally, it discusses which healthcare professionals are able to give specialist nutritional advice.

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CET multiple choice questions

This article has been approved for one non-interactive point under the GOC's Enhanced CET Scheme. The reference and relevant competencies are stated at the head of the article. To gain your point visit the College's website www.college-optometrists.org/oip and complete the multiple choice questions online. The deadline for completion is 31 October 2017. Please note that the answers that you will find online are not presented in the same order as in the questions below, to comply with GOC requirements.

1. Which one of the following is correct?

- A mineral is a naturally occurring organic compound which is required to maintain health and growth
- Carbohydrates are used for transport, enzyme synthesis, growth and repair
- Proteins are used as an energy source for working muscles and provide fuel to the central nervous system
- Fats are used as a source of energy and maintain the structural and functional integrity of cell membranes

2. Which one of the following is correct?

- Blanching increases vitamin and mineral content overall
- Some nutrients have greater bioavailability in their synthetic form than in their natural form
- All nutrients have more bioavailability in their raw than in their cooked form
- All minerals are more available from plant than animal foods

3. Which one of the following is correct?

- Fat increases the absorption of lutein
- Vitamin E increases the absorption of iron
- People who are malnourished will absorb nutrients less well from their food than people who are not malnourished
- Vitamin C decreases the absorption of iron

4. By how much has the nutritional supplement industry in the UK grown in 2012 compared to previous years?

- 5%
- 10%
- 24%
- 57%

5. Which one of the following is correct?

- Food supplements are regulated by the MHRA
- Herbal products are regulated by the MHRA
- Medicines are not regulated by the MHRA
- Omega-3 fatty acids are covered by the Food Supplements (England) Regulations 2003

6. Which one of the following would not be a way to test the nutritional status of a person?

- Dietary assessment
- Biochemical assessment
- Hair analysis
- Anthropometric assessment

CPD exercise

After reading this article, can you identify areas in which your knowledge of nutrition in relation to optometry has been enhanced?

How do you feel you can use this knowledge to offer better patient advice?

Are there any areas you still feel you need to study and how might you do this?

Which areas outlined in this article would you benefit from reading in more depth, and why?