Principles of Human Nutrition

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This book is dedicated to Jenny for all
the reasons she knows and without
whom it would not have been possible.

1

Introduction and overview

This book looks at nutrition as an exciting discipline that draws on all branches of biology. Nutrition is both an art and a science: it observes, measures and tries to explain the constantly changing process of the optimal mix of chemicals necessary for the functioning of an individual at all stages of life.

This book is written at a number of levels to encompass:

- traditional nutrition (Chapters 2–6, 8–17, 39–45)
- evolving nutrition (Chapters 20, 22–26, 31–37, 46)
- complex concepts, which although not currently central will influence the future of nutrition: an awareness of these will be necessary for the next generation of nutritionists (Chapter 7, and parts of Chapters 11, 18, 19, 21, 27–30, 38).

Take what is appropriate for your requirements at different stages of your development in nutrition.

The selection, processing and manner of eating food will be strongly influenced by what is available and by the history, social stability and economy of the community. What and how a person eats is significantly affected by their family background and traditions, although travel is increasingly changing food choices. War, pestilence and famine can restrict food availability, and food may also be contaminated by pollutants from the environment.

Being able to eat optimal amounts is dependent on agriculture and the political, educational and social organisation in which the person lives. The chemical substances should be available in optimal amounts and in an attractive form for metabolism. Nutrition identifies, measures and recommends optimal dietary intakes of the nutrient chemicals in health and disease.

All living creatures require a range of dietary chemicals for metabolism, growth and activity. These chemicals are obtained from a range of sources. The digestion, absorption and metabolism of ingested nutrients are determined in each individual by many factors, including inherited constitution, gender, age, activity, growth, fecundity and lactation. A person needs an adequate energy intake as well as essential nutrients to provide for the needs and control of a genetically determined constitution (genome), which dictates protein and enzyme structure and hence metabolism. This brings nutrition to a central role in the story. The synthesis, maintenance, functioning and control of the protein complex and hence overall metabolism rely on ingested nutrients.

This book is written in the belief that the basis of nutrition lies in molecular biology, genetic make-up, biochemistry and physiology. Even the mysteries of the cooking art are dependent on physicochemical transformations of raw food into available edible food.

The book is divided into seven parts.

Parts I and II deal with food in the community. The first part deals with the historical influences that decide what food a community eats and how it is cooked. This is followed by a description of those environmental factors that can adversely affect food availability. Part II looks at the calculation of how much food a community requires and actually eats. The remaining parts deal with the individual.

Part III looks at how a person metabolises nutrients in an individual manner dictated by genetic make-up, then Part IV describes the measurement of the individual nutritional status.

Part V describes the core nutrients, essential, non-essential and non-nutrients, and Part VI their selection for eating, ingestion and subsequent digestion, absorption and metabolism. Part VII looks at special nutritional requirements in the normal condition and for some specific diseases.

At the end of each part there are key points for understanding and learning, and thinking points. Important references are listed at end of each chapter.

Some companion material relating to this book will be available on Blackwell Publishing's web pages: please look at details of the book, which can be found on the publisher's website: www.blackwellpublishing.com.

LITERATURE

The enjoyable and productive analysis of the literature is important, and there are many great books and journals. The following may be of help and interest to the reader:

- **Biological dictionary**
  Oxford Dictionary of Biochemistry and Molecular Biology (1997). Oxford University Press, Oxford.
- **Nutrition reference books**
  Sadler, M.J., Strain, J.J. and Caballero, B. (eds) (1999) *Encyclopedia of Human Nutrition*. Academic Press, San Diego, CA.
- **Biochemistry and biology reference books**
  Nelson, D.L. and Cox, M.M. (eds). (2000) *Lehninger's Principles of Biochemistry*, 3rd edn. Worth, New York.
- Lodish, H., Berk, A., Zipursky, S.L. *et al.* (eds) (2000) *Molecular Cell Biology*, 4th edn. WH Freeman, New York.
  Jones, L. and Atkins, P. (2000) *Chemistry, Molecules, Matter and Change*. WH Freeman, New York.
- **Journals**
  American Journal of Clinical Nutrition, British Journal of Medicine, British Medical Journal, Nutrition Journal, Nutrition Review, New England Journal of Medicine, Science, Annual Review of Nutrition, British Journal of Nutrition, European Journal of Clinical Nutrition, Lancet, Nature and *Proceedings of the Nutrition Society.*
- **The Internet**
  The manner in which written information is handed on is changing rapidly with the availability of the World Wide Web. The printed textbook can be seen as a primer, an introduction at varying levels of sophistication. From this sound knowledge base educated forays can be made into the Internet for retrieval of information. This book is intended to provide a good basic knowledge for such rewarding searches. It is recommended that this book is supplemented by using Medline and other searches, e.g. Google or Metacrawler. These are a starter pack and it is suggested that readers develop their own list of favourite websites which can be upgraded. The website associated with this book will be kept up to date with new references and links. Navigating around the Internet is facilitated by the use of helpful search engines. Even so, the top 11 search engines only reach 42% of the Web. The search engines can be based on the directory model placing sites into categories and subcategories. This requires human input and has the potential for error. 'Robots', 'spiders' and 'crawlers' navigate through the following links pages and return to the database with the result.

  Specialist sites dealing with a subject are more specific, e.g. PubMed and Medline. PubMed was developed by the National Library of Medicine and developed in conjunction with publishers of biomedical literature as a search tool for accessing literature citations and linking to full-text journals at websites of participating publishers.

  Medline is the National Library of Medicine's premier bibliographic database covering the fields of medicine, nursing, dentistry, veterinary medicine, the health-care system and the preclinical sciences. Medline contains bibliographic citations and author abstracts from more than 4000 biomedical journals published in the USA and 70 other countries. The file contains over 11 million citations dating back to the mid-1960s. However, it is important to appreciate that the citations miss the massive literature preceding the 1960s and these have to be traced by traditional library methods. Coverage is world-wide, but most records are from English-language sources or have English abstracts.

WEBSITES OF INTEREST

www.arbor.com Clinical information
www.health.gov.au/index.htm Australian Government Health and Ageing
www.bda.uk.com British Dietetic Association
www.eufic.org European Food Information Council
www.europa.eu.int European Communitiy
www.afssa.fr Agence Française de Sécurité Sanitaire des Aliments (France's food safety agency)
www.defra.gov.uk UK Department for Environment and Rural Affairs (DEFRA)
www.foodstandards.gov.uk UK Food Standards Agency
www.nutrition.org.uk British Nutrition Foundation: general food and nutrition information
www.nutrition.org American Society for Nutritional Sciences
www.nutsoc.org.uk British Nutrition Society
www.usda.gov USA Department of Agriculture
www.healthfinder.gov US Department of Health and Human Services, US dietary advice
www.who.int World Health Organisation
www.soilassociation.org UK Soil Association
www.medbioworld.com Medical and biosciences journal link system, 25 000 links
www.FreeBooks4Doctors.com Free medical texts online
www.canada.gc.ca/depts/major Canadian government site

OVERVIEW

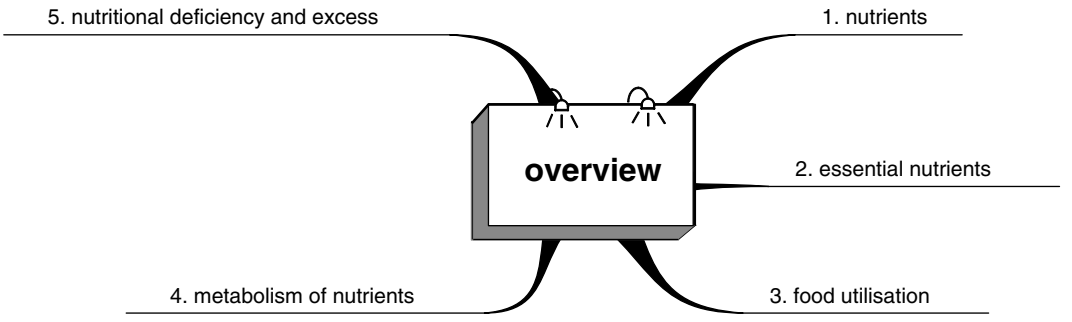

Fig. 1.1 Chapter outline.

NUTRIENTS

A definition of a nutrient is any chemical substance that can be used by an organism to sustain its metabolic activities. These metabolic activities in humans and other animals include the provision of energy, growth, renewal of tissues, reproduction and lactation.

The status of some chemicals as nutrients is assured: amino acids, carbohydrates, essential fatty acids, vitamins and trace elements. Other chemicals, such as dietary fibre and secondary plant metabolites, are part of the food but may not so readily be classified as nutrients.

ESSENTIAL NUTRIENTS

Some nutrients are essential in that these molecules cannot be synthesised within the body and can only be provided by the diet. Such essential nutrients provide for metabolic processes: vitamins, e.g. ascorbic acid, and trace elements, e.g. selenium; and for structure, e.g. proteins, essential amino acids, vitamins and trace elements.

The science of nutrition is devoted to defining requirements for essential nutrients, amino acids, essential fatty acids, vitamins and trace elements. Recommendations for daily requirements of nutrients made by expert committees are dependent on

diverse factors such as growth, pregnancy and illness and are only carefully determined approximations. Implicit in the requirement for essential dietary constituents is that the human race is not independent of the environment. Thus, people are part of a food chain as recipients or producers of food.

FOOD UTILISATION

An important aspect of nutrition is the availability of dietary sources of nutrients. Causes of dietary deficiencies range from a lack of all nutrients (famine), to absence or omission of individual food items from the diet for social, economic, cultural, religious or personal reasons. Nutrients may not be absorbed from the intestine in some illnesses. A deficiency or excess of overall calorie intake or of individual nutrients may result in nutritional disorders.

Ingested food is broken down to chemicals of a molecular size that is readily absorbed and utilised by the body. The process of absorption is dictated by the nutrient needs of the body and bioavailability value.

Bioavailability is a measure of the relative amount of the ingested nutrient that is absorbed from the intestinal content and reaches the systemic circulation. It is described as the rate and extent to which the nutrient is absorbed and becomes available to the body's metabolic processes.

In general, energy-providing nutrients are readily absorbed and have a high bioavailability value, whereas there are more controls on the absorption of micronutrients and their bioavailability value is lower and more variable. Some nutrients, e.g. divalent cations, calcium and magnesium, are only absorbed in an amount necessary for the needs of the body, as an excess can be toxic.

Waste products of metabolism are excreted in breath (carbon dioxide), urine [in general, water-soluble compounds of molecular weight less than 300 Daltons (Da: a unit of measure of atomic and molecular mass)] and bile (in general, fat-soluble, molecular weight more than 300 Da). The accumulation of metabolic waste products has disadvantageous effects on growth, metabolism and well-being.

Nutrients contribute to bodily needs in several ways:

- provision of energy
- creation of structure
- provision of essential small molecular substances that the body cannot synthesise.

Some nutrients are sources of carbon and nitrogen, which pass into the metabolic pool to meet the body's general needs, e.g. carbohydrates, fats and amino acids. Carbohydrates and lipids are necessary fuels for metabolic activity, to a variable extent for structure and in some instances in the synthesis of hormones. The whole range of amino acids is relevant for adequate structural growth. Amino acids may also be utilised at times of nutritional deprivation as a source of energy.

METABOLISM OF NUTRIENTS

The metabolism of nutrients by enzymes is dictated by the individual's gene structure and the induction of enzymes and, in turn, by species and gender. These distinctions are complex, subtle and only partially understood (Figure 1.2).

The nutrient needs and subsequent metabolism by the individual will be influenced by growth in the young and in pregnancy, and modified by disease, drugs, alcohol and tobacco. As the person ages there are important changes in the effectiveness of the absorption and utilisation of the nutrients consumed.

It has been suggested that diet may affect behaviour. In some ancient cultures certain foods were thought to have magical qualities capable of giving special powers of strength, courage, health, happiness and well-being. It is possible that some food constituents may affect the synthesis of brain neurotransmitters and thus modify brain functions. It is therefore important to integrate dietary effects on brain chemicals into our wider understanding of human behaviour.

Until there is an understanding of such nutritional and metabolic mechanisms, confused advice

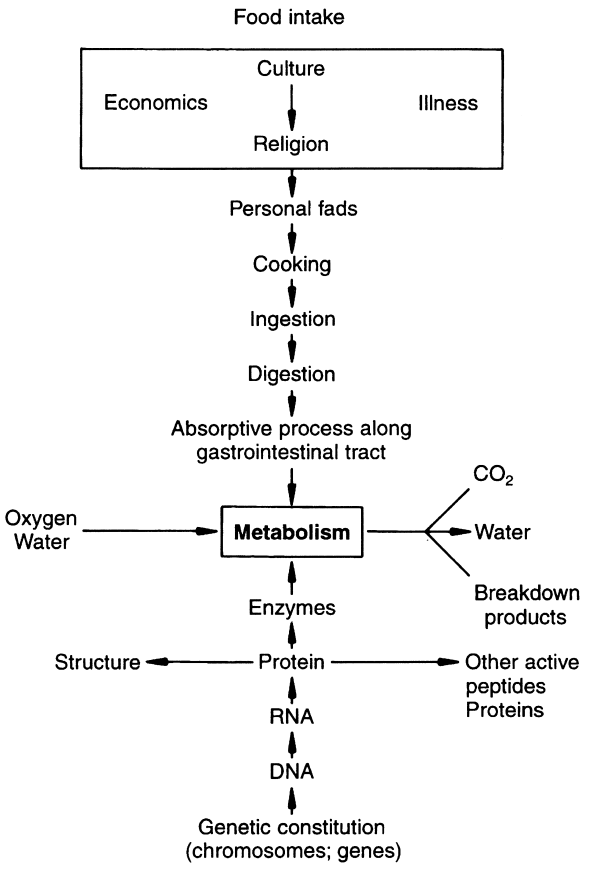

Fig. 1.2 Metabolism represents a relationship between food intake and the enzymes characteristic of an individual, which are dependent on genetic constitution. Also important are oxygen and water intake and the ability to excrete carbon dioxide, water and metabolic breakdown products.

may be disseminated. Pathology that is provoked by the metabolic response in even a small proportion of the population may erroneously be applied to the population as a whole.

NUTRITIONAL DEFICIENCY AND EXCESS

It is not possible to live for more than 2–3 min without oxygen. However, human life can continue without water for between 2 and 7 days, depending on the ambient temperature and the amount of exercise being taken. Survival without any food at all, but with water, may be for 60–120 days, depending on the body stores. Females and those with considerable subcutaneous fat generally survive for longer than slightly built males.

There are individual responses to nutritional deficiency and excess, although in general weight increase is associated with overall excessive eating and weight loss is associated with inadequate dietary intake. A failure to provide amino acids, fats, vitamins and trace elements leads to specific lesions which may progress to morbidity and death. There is no nutritional explanation for the apparent synthesis of essential vitamins by some individuals. When scurvy was a problem in the Royal Navy the fleet would come into land every 2 months to take on board provisions specifically to reduce the prevalence of scurvy. However, on the long sea voyages some individuals died quite quickly of scurvy, whereas others appeared to be unaffected. Similarly, the different types of beri-beri suggest individual metabolic responses to thiamin deficiency.

In general, the body copes better with an excess than with a deficiency of nutrients, with the exception of alcohol. Consequently, there is an inclination to eat somewhat more than is required. The body copes less well with an excess of dietary fatty or fat-soluble compounds than an excess of water-soluble dietary components. Fatty nutrients, e.g. lipids, are stored and, if the storage load becomes excessive, then the body is disadvantaged. Water-soluble dietary excesses may be excreted, metabolically modified or unchanged in the urine. Excess dietary protein and lipid intakes may be metabolically modified to structural or storage tissues, or possibly be excreted in bile and urine. The variable pathways whereby these processes occur will be determined by the range of variants of the same enzyme (isoenzymes) that forms the metabolic enzyme structure of the individual.

THINKING POINT

What are the criteria for classifying a dietary chemical as a nutrient?

Part I

Factors influencing the food that a community eats

- History of food
- Social, population and environmental influences on nutrition

2

History of food

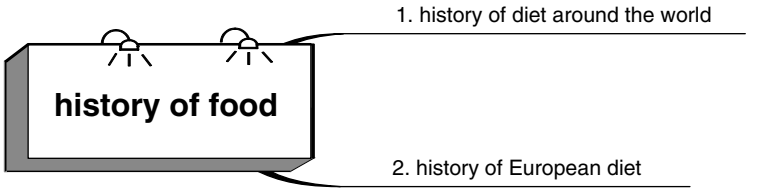

Fig. 2.1 Chapter outline.

HISTORY OF DIET AROUND THE WORLD

Cookery books are the recordings of how food was prepared and reflect the cooking practices of the era in which they were written. Babylonian clay tablets and Ancient Egyptian scrolls contain recipes. Cookery books in English are to be found from the fourteenth century from the cooks serving Richard II. Now cookery books are major sellers, being of universal interest.

Ancient Egypt

Grain, bread and porridge have been the basis of the human diet since the beginning of nutritional history. In Egypt, bread was made as flat cakes from toasted grains of barley, wheat or millet. The meal mixed with water in a paste was either dried in the sun or baked on the flat stones of the hearth. Primitive grains required toasting before the hard outer husks could be removed. However, the Egyptians found a strain of wheat that could be threshed without being toasted, and consequently dough could be made from a raw flour. Subsequently, the Egyptians found out how to produce beer and used this knowledge in bread making to create sponginess in the dough when baked, and so leavened bread was produced.

Egyptian bread is said to have had a sour taste, suggesting they used lees of beer or a sour dough for their leaven. Sour dough is a piece of fermented dough saved from a previous baking and is used to start the fermenting process of the new dough.

In thirteenth century BC Egypt, it was usual for people to eat two meals a day, a light morning meal and a more substantial evening meal consisting of several dishes.

Ancient Greece

The Greeks made unleavened bread from coarse wheat, which they favoured over barley meal, baking their bread in hot ashes and later in bread ovens. Increasingly, they used flour which had been finely sieved to remove most of the chaff. A wide range of breads was available to both the Ancient Greeks and the Romans. For leaven, like the Egyptians, both the Greeks and the Romans used sour dough.

The Roman Empire

The earliest Romans were a rural people who ate a thick porridge of barley or beans and green vegetables with flat barley bread, hard-baked in ashes. Cheeses were made from goat's milk, meat was a rarity and fish was hardly used. Food was flavoured with garlic, parsnip, olives and olive oil. When Rome became all-powerful, the poor still ate thick grain soups of millet and coarse bread, together with a little turnip or a few beans. Raw olives, goat's cheese and figs were delicacies, and occasionally cooked pork or meatballs were available; these were produced in cook shops which were found throughout the cities. For long periods in Rome bread was given without payment.

The wealthy few had food from all over the known world: spices from India, south-east Asia and China, wheat from Egypt, ham from Gaul and wine from Greece. Ginger came from China through central Asia; cloves from Indonesia by sea to Ceylon and then on by sea and land to Alexandria.

Pepper was a very important element in Roman cooking and was brought overland from India through Egypt. A meal might consist of hors d'oeuvres: a salad of mallow leaves, lettuce, leeks, mint and fish dishes, garnished with sliced eggs, rue and tuna. The main course included a kid, meatballs and beans, together with chicken and a ham. The meal finished with a dessert of ripe apples and vintage wines. The salads were dressed with wine, oil and vinegar and liquamen, a sauce made from fermented salted anchovies. Hams were boiled with dried figs and bay leaves, and baked with honey in a pastry coating. Chickens were roasted or boiled in a variety of spiced sauces. Roman manors had their own oyster tank to ensure a fresh supply. The Roman physician Galen taught his followers that it was harmful to eat fruit with a meal.

By the second century BC cooking had become an art in Rome. The Romans ate three meals a day. Breakfast, between 8 and 10 am, consisted of bread and cheese and a glass of water. Lunch, eaten at noon with little ceremony, was usually bread with cold meat and vegetables, and fruit with a little wine. Dinner was eaten at about 8 pm in winter and 9 pm in summer. Most food was eaten with the fingers, which were rinsed occasionally, although the diners were provided with knives, toothpicks, spoons and napkins.

The requirement for grain necessitated the importation of wheat on a large scale from Egypt, Sicily and north Africa. Special docks and lighthouses were built for these grain ships. Rotary mills powered by animals were used and sophisticated ovens with systems of draughts and chimneys controlled the heat. The flour was milled into various grades, ranging from the finest white to coarse flour considered suitable only for slaves.

The Roman army stretched from the Scottish border through to Egypt and as far east as the edge of the Black Sea. The soldiers were issued with daily rations of grain or bread, meat, wine and oil, and the cost was deducted from their pay. Cheese, vegetables and salt were included in their basic rations. When the legions were on the march they carried a scythe to cut crops, a metal cooking pot, a mess tin and 3 days' emergency food of hard tack, dried cooked grain which could be eaten without further cooking, salted pork and sour wine. Meat was boiled or grilled and the soldiers were issued with spits as standard equipment. A quern to grind flour and a portable oven were carried for every ten men. During peacetime a soldier was expected to grind his own grain and bake his own bread. Soldiers supplemented their diet by hunting. In wartime troops foraged from the enemy countryside. Soldiers made their own cheeses from the milk of animals kept at the forts.

Roman army officers lived on fresh meat and imported edible snails, olives, vintage wine, pepper, fish sauce, hams and oysters. The Roman army was huge: 300 000 men in the first century AD. This required substantial organisation in supplying the garrison and moving food around the Empire. The cost of such provision of food eventually became an intolerable burden on the Roman taxation system.

Mosaic dietary laws

The Jewish diet is established under Mosaic law, which defines clean and unclean food. Blood was seen as the life-force and was forbidden, so all food animals had their blood drained as in kosher ritual slaughter. Fish that swim with their fins and had scales were accepted as clean; shellfish that have neither fins or scales but swim in water were unclean. Cows, sheep and goats, which chew the

cud and have cloven hooves, were clean; the pig, which cannot live on grass, was difficult to herd and had little stamina for the nomadic way of life, was unclean. The modification to that diet depended on the dispersal of the Jewish race either to the north of Europe or along the southern shores of the Mediterranean Sea. Eastern European Jews adopted central European cooking, e.g. 'gefilte fish', poached fish cakes made with the flesh scraped from the skin and bones, and mixed with onions, seasoning and breadcrumbs bound with egg. The Jews of the Mediterranean lands used fish, fruit, nuts and vegetables.

India

Indian philosophers stressed the importance of food for the uplifting of the soul and the health of the body. They suggested that spices such as cloves and cinnamon were warming; coriander and cumin cooling. They also believed in pure and impure foods: rice and honey were considered purer than other foods.

The Indus valley was the centre of civilisation around 2000 BC, when it was invaded by Aryan invaders from Iran and Afghanistan. The economy of these Aryan warrior nomads was based on cattle. They lived primarily on meat and milk products. Barley was the staple grain, ground into flour and cakes and eaten with butter. Crushed toasted barley was mixed into a gruel with curds, clarified butter and milk. Food was eaten by hand. Thick gruels were licked off the fingers and thin ones drunk from bowls or cups made of clay. The inhabitants of the Indus valley were driven south into India. Aryans gradually adopted the use of rice, wheat and beans, and learned the use of spices, including tumeric, long peppers (pepper from vines similar to black pepper), sour oranges and sesame, but continued to use clarified butter for cooking. Rice was cooked with mung beans into a thick gruel or khicri. Raw ginger was eaten after meals to aid digestion. The juice of the soma plant was mixed with rice or curds.

The early Aryans were tribal and their society was divided into castes. The Brahmins were the highest caste, with strict rules of purity, particularly concerning food. Food could be polluted by being touched by lower caste people, as this was believed to affect its purity. To protect themselves from pollution, strict laws governing the toilet and behaviour of cooks were developed. Brahmins could only eat food prepared by other Brahmins. There were huge blood sacrifices, particularly of cattle, and until the end of the fifth century AD the meat was eaten after the sacrifice. As society developed, effigies of horses and cows made of dough were substituted and a ban on killing cattle was introduced.

Beliefs were very austere and did not allow the eating of meat, fish or eggs, and the people were consequently strict vegetarians. Other Hindus, also strict vegetarians, do not eat rank-smelling foods, and ban onions and garlic from their kitchens. There may be a separate side kitchen in which onions and garlic may be cooked for dishes not considered ritually pure.

The Buddhist diet was a compromise between the diets of the Hindus and Brahmins. Buddhists were not forbidden meat, merely not allowed to kill for food. Vegetarianism was, however, encouraged for all people. The cow was sacred and no longer killed for food or sacrifice. In the temple in modern India Hindu gods are offered vegetarian dishes.

Until the fifteenth century AD the rulers of northern India came into contact with and were influenced by Persian culture. Many of the dishes had a Persian origin, particularly the samusak pastries. Samosas made of meat, hashed and cooked with almonds, walnuts, pistachios, onions and spices, were presented. The word samusak comes from the Persian word sanbusa, a triangle, and is similar to the samosas sold as snack foods in modern times. Meals would start with sherbet and bread in the form of thin, round cakes. Roasted meat was cut into a large sheet, which was divided into six pieces, one piece being placed before each person. Round dough cakes made with ghee were stuffed with a mixture of flour, almonds, honey and sesame oil. On the top of each dough cake was a brick-shaped sweet cake made of flour, sugar and ghee. Meat was served in large porcelain bowls, and cooked with ghee, onions and green ginger. In addition, rice cooked in ghee was served with chicken.

At the end of the fifteenth century, northern India was invaded by the Mughals, who came from Uzbekistan in central Asia. Their cuisine was similar to that of the Persians, with a variety of grains, green vegetables and meats, which were oily, sweet and spicy.

China

In the China of the last millennium BC, grains were cooked whole as flour milling did not come into general use until about the first century AD. An Imperial Court banquet would include roast turtle and fresh fish, bamboo shoots and reed tips. Meanwhile, the common people lived on a diet of beans and grains flavoured with sour or bitter herbs. Salt and sour plums were the earliest seasoning used. Around the second century BC fermented salted soya beans became popular and were produced on a commercial scale. By the fifth century Chinese cooks had a choice of herbs and pickled meats for bitter flavours: honey and maltose from grains for sweet flavours, and prickly ash, mustard or ginger for hot flavours.

The Chinese knelt on mats or flat cushions to eat. The food was laid out either on the floor or on tables. Chopsticks were beginning to be widely used, but soup stews were eaten with spoons and grains were eaten with the fingers. Soup stews were very popular. For the rich there were beef soups seasoned with sour plums, pickled meat sauce and vinegar. Other soups contained venison, salted fish, bamboo shoots and rice, beef, dog or turnip. The poor had soups made of vegetables and grain without meat.

In the Imperial courts of China from AD 960 to 1280 Chinese cooking reached great heights. Seasoning was important, primarily sesame, anise, ginger, black pepper, onion, salt, cardamoms and vinegar. Other seasonings such as orange peel, soy sauce, peppermint, cinnamon and liquorice were used. Rice was brought in from Vietnam at the beginning of the eleventh century, with resulting nutritional advantage. China became one of the richest countries and as a result of trading, new foods and culinary skills were available. From India came the refining of sugar and black pepper; from Persia came coriander and pastries.

Stir-frying became a central cooking method. Woks came into common use and wheat-flour doughs and pastries were mastered. Bean curd was discovered and became increasingly popular, and noodles became generally used. Sweet sauces made from fermented flour were used to flavour stir-fry dishes. Raw meat and fish were both great delicacies, being flavours that were intense and natural. Preserved pickled meats and fish were very popular. Sparrows were pickled with fermented rice and barbecued.

As the Chinese Empire developed up to AD 1600, a very complicated system of cooking was developed by the northern Chinese aristocracy. Vinegar, fermented bean paste and soy sauces were developed. In the winter meat and fish were preserved by pickling or made into fermented sauces. Vegetables were pickled with salts. At festivals, popular foods included gruels and packets of grain wrapped in cucumber leaves. A small bear was steamed with onion, ginger, orange peel and salt after being marinated in fermented bean sauce. The fat from a boiled pig was skimmed off for separate use. Discs of boiled dough were made from wheat flour, and other doughs from a balm of white rice and wine were left to simmer by the fire. Dishes were spiced with ginger, rice wine, prickly ash pepper and fermented bean sausages, as well as the bitter bark of magnolia.

A Chinese proverb says: 'you are what you eat'. Chinese attitudes to food and health were dependent on this. The Chinese held to the humoral belief that the universe and everything in it was composed of four elements: fire, air, earth and water; and four qualities: heat, cold, moisture and dryness. Treatment for bodily disorders was based on the strength and interaction of these elements and qualities. The basic division of the Chinese beliefs was between the bright, dry, warm, male principle, Yang, and the cold, dark, moist, female principle, Yin (Yang and Yin).

The human body was a reproduction of the cosmos. To be healthy was a reflection of the general harmony among the various virtues, while illness was a sign of disharmony of heat, cold, moisture and dryness. These elements were controlled by food which also had the four qualities. Fundamental to the Chinese theories on nutrition was the idea that food and cures come from the same source. Cooling foods such as green vegetables and fruit treated fevers and rashes, while heating foods such as liver and chicken could treat debility and weakness.

In China, soup was used as a tonic to maintain health. A healthy soup proposed for the liver was made of dog meat, sour plums, Chinese leeks and hemp, while for the lungs a soup of yellow millet, chicken, peach and onion was recommended. Chicken soup was meant to be particularly good

after childbirth. (It is also interesting that the Jewish general belief is that chicken soup is a universal panacea.)

A goat's heart marinated in rose water and barbecued with safflower was a prescription for tachycardia, and a goat's leg and cardamom for strength. Tisanes made from ginger were recommended for general strengthening. Chestnuts or salted bamboo shoots and sesame were served several times a day, and the women of the house frequently drank strengthening gruels. A bean gruel made with a little salt and ginger was regarded both as being good for the kidneys and as a cure for vomiting.

Buddhism came to China from India at about the time of Christ. With it came preaching against the killing of animals for food. As Buddhism progressed in China the prohibitions of meat eating were not accepted generally, except in Buddhist monasteries, which were famous for the excellence of their cuisine where the cooking followed strict Buddhist regulations. However, they also insisted on five colours: red, green, yellow, black and white; five flavours: bitter, salt, sweet, hot and sour; and five styles of cooking: raw, simmered, barbecued, fried and steamed. All were represented in a temple meal. Dishes were contrived to create the illusion of eating meat; flour and water pastes were made to resemble animal barbecues. Gluten was used for both stir-fry dishes and barbecues.

In Europe during the Dark Ages trade with the east stopped and pepper disappeared from northern Europe. By the time of the Norman conquest of England, eastern spices and pepper were once again being traded by Arabs living in Spain and sending trading ships to India, south-east Asia and China. This trade was then developed in Venice, which eventually became dominant in trading, bringing food from the east to the markets of northern Europe.

When sweet potatoes were introduced into China they were an immediate success because they grew readily in poor soils and adverse weather conditions. They were also attractive because they were sweet, in an area where sugar and sweeteners were expensive. By the beginning of the nineteenth century sweet potatoes were a staple food for half of the population of northern China. Similarly, chillies arrived in China around AD 1700 and were introduced into Schezuan yunnan cooking. Maize was added to the Chinese diet around the middle of the sixteenth century, but was never as popular as rice, and wheat flour became more popular.

Japan

Buddhism moved to Japan from China and Korea during the seventh century. When Buddhism came to Japan the emperor forbade the eating of any meat except by the sick. Within 100 years both chicken and fish were exempted from this rule. A stricter interpretation of Buddhist law came in the twelfth century with the spread of Zen Buddhism from China. The attempts to introduce a rigid vegetarian diet were only partially successful.

Until the mid-nineteenth century the Japanese were somewhat reluctant to kill four-legged animals, particularly cattle, for food. However, most modern Japanese eat beef.

Zen Buddhism developed and formalised the tea ceremony which had been present in China some 700 years previously. Zen belief in restraint, and simplicity was expressed in the tea ceremony with its strict rules of formal behaviour. These ceremonies were undertaken in the Zen temples. Only foods in season could be used. Two main styles of tea ceremony cooking developed: one at the Daaitokuji temple near Kyoto in the fourteenth century and the other at the Obakusn temple near Tokyo in the sixteenth century. At Daaitokuji the meal was prepared in individual servings. The Obakusn meal was based on Chinese vegetarian cooking and retained the Chinese practice of serving all food in large dishes in the centre of the table, from which diners could help themselves. Such a meal started with green tea and a sweet cake served according to the formal tea ceremony style, followed by a plate of cold hors d'oeuvres and a clear soup with bean curd and ginko nuts. Next came a number of different foods cooked by simmering: bean curd balls, aubergine, rolls of thin bean curd sheets, mushrooms, bamboo, lotus roots, chillies, ginko nuts and pine needles. After this arrived a steamed dish followed by a dish of braised vegetables, a deep-fried dish, a salad of chrysanthemum leaves with a walnut dressing, a vegetable stew, fruit and finally rice cooked with a little green tea. Such a feast is known as Lohan's delight, Lohan being a Buddhist saint.

Ancient Persia

The Persian Court in the sixth century AD regarded the rearing of animals and birds for the table as being very important. Wild asses were fattened with clover and barley and then cooked with yoghurt and spices. Chickens were reared on hemp, oil and olives and after being killed were hung for 2 days by the feet and then by the neck before they were cooked. Other dishes included milk-fed kids and calves and fat beef cooked in a broth of spinach, flour and vinegar. Hares and pheasants were made into ragouts. In the summer the Persians ate nut and almond pastries made with gazelle fat and fried in nut oil. Foods imported from Europe and Asia were available to the Persians. Fresh coconut was served with sugar and dates and stuffed with nuts. They also ate sweet preserves of lemons, quinces, Chinese ginger and chestnuts, and drank sweet wine.

Islam

Mohammed preached that food was a gift from God, 'So eat of what God has given you, lawful and good, and give thanks to God's favour if Him it is you serve'. Pork or any animal found dead, blood or animals killed as an offering to a pagan god, fish without scales (including shellfish), alcohol and fermented liquids were all forbidden, or halan. Carnivorous animals and birds were forbidden. Permitted foods were halal. Animals killed for food had to be slaughtered by an approved butcher who had to say 'In the name of God, God is most great', and cut the animal's throat to allow the blood to drain out. Animals who died by disease, strangulation or beating were not acceptable. This practice is still followed by modern Muslims.

The month-long fast of Ramadan is in memory of the prophet's revelations and is for the health of the soul. Fasting is a way of reaping spiritual rewards. Nothing is eaten or drunk during daylight hours in the month of Ramadan. Each evening after sunset the fast is broken with three dates and water, followed, after final sunset, by prayer and a meal. All Muslims must follow Ramadan after the age of responsibility, 12 years in girls, 15 years in boys. Exceptions are the elderly in poor health, pregnant and nursing women, menstruating women, the sick, travellers and labourers. The meal is of an ordinary size, not extra quantity to fill the stomach after fasting. In Saudi Arabia today people eat a meal of bread, milk or sour milk, together with a braised or stewed meat dish.

The lifestyle of the Arab Califs who ruled Egypt, Iran and the eastern Mediterranean in the thirteenth century AD was influenced by the Persian traditions, including cooking. Trade with the east brought a wide range of foods to the Arab world and was of a high level of sophistication and luxury. Cleanliness was all-important, in particular the cleaning and preparation of the food and handwashing. Meat, usually lamb, was cooked with fruit such as oranges, lemons, pomegranates, redcurrants, apples and apricots. Fresh vegetables such as carrots, onions, aubergines, spinach and leeks appeared in many meat dishes. Meat was fried in the rendered down fat from sheep's tails. Some meats were fried before boiling, and almonds and other nuts were used to make gravies. Spices such as ginger, cinnamon, pepper and caraway from China and India, as well as local spices, cumin and coriander, were used with meat dishes. Rice was a luxury and was mixed with meat into a pilau-style dish.

The New World

Many of the foods eaten in Europe, and which are regarded as Mediterranean foods, came originally from central or meso America. The early hunters in Central America lived on mammoth or barbecued bison and relied on gathering seasonally available plants. Alternative sources of protein were gophers, squirrels, rabbits and mice. These hunter–gatherers had necessarily to be nomadic.

In the warm, well-watered central valleys there was an abundance of fish and fowl. The new concept of returning seeds to the ground for harvesting was the beginning of agriculture. The avocado pear and some kind of squash were the first to be cultivated. Between 5000 and 3000 BC maize and beans were cultivated, but at that stage provided only 10% of the total diet. Even then, Mexican food was already heavily spiced with chilli.

Villages in this area date from approximately 3000 BC and a basic triad of maize, beans and squash was grown. Early maize was only the size

of a strawberry plant. The diet was supplemented with fish and deer from lagoons and neighbouring forests. Cannibalism may also have been practised.

During the Olmec period of middle America from 1500 to 100 BC the basic crop was maize, which even today accounts for 90% of the inhabitants' diet. It was possible to obtain two crops of maize per year. The agriculture was based on slash and burn; that is, a patch of forest was felled during the short dry season, the wood was burnt, seeds were sown using a simple digging stick and the crops were harvested. This was repeated until the ground became arid, when it was then allowed to rejuvenate over the next 5 years. Such a system supported both the Olmec and the Mayan civilisations. It sustained only a limited number of people, however, and both civilisations collapsed when it was no longer possible to grow sufficient food to sustain the populations. In the Olmec period the growth of food was complicated by the flooding of large rivers. At this stage, the dog and the turkey had been domesticated and served as sources of food. Limitations for these civilisations were that the plough had not been invented and there were no draught animals, the beast of burden being man. The cities of meso America had a carefully planned supply and control of water, with main aqueducts carrying water to the city.

After the land had been cleared, weeds would grow very readily and the great cities that developed would disappear quite quickly after the agricultural land had been exhausted and the population moved on to new and fertile land.

By the time of the Spanish conquest, the Aztecs grew maize as the main crop, chillies as seasoning, with additional squashes and beans. The latter provided nitrogen and protein in the diet. There were no dietary dairy products and very little meat was eaten. Chia was used to make a kind of porridge. Maguey was an all-purpose plant; the spikes served as needles, the fibre was used for making cloth and the juice from the heart of the plant was used to make the alcoholic beverage 'pulque', which is still drunk in Mexico. During the Aztec period pulque was used for ritual intoxication and may have been used to sedate people waiting to be sacrificed. Central to Aztec agriculture was human sacrifice, as it was believed that the safeguarding of the crop cycle depended on such rituals. At its most intense 50 000 people a year were sacrificed to ensure the rising of the sun and continued crops. Maize was the staple diet for the Mayans, but they ate domesticated plants such as the anone, avocado, tuayaba, passion fruits, zucchini, tomatoes, carrots, beans and sweet potatoes. The surplus of these crops was stored in underground rooms. This diet was supplemented with fish, crabs, molluscs and turtles.

The Spanish brought many of the foods grown in central America back to Spain. They were then grown in Spain and are now associated with what is called the 'Mediterranean diet'.

Other imports from the New World included nasturtiums from the West Indies, used for their flowers and leaves in salads, and potatoes, turkeys and chocolate from Central America. Potatoes also came to Europe from the mountainous parts of South America. Initially, they were a curiosity in English cooking and in mainland Europe potatoes were not eaten to any great extent. In Ireland, by the middle of the seventeenth century they were an established staple food. Turkeys were introduced into England about 1524, having been imported from Spain. They replaced swans, peacocks and bustards as festive foods, being relatively cheap, readily stuffed, roasted and baked in pies. Fruit and vegetables from Central America included sweet potatoes, peanuts, maize, chillies, tomatoes and kidney beans.

The Crusades

After the Crusades, spices and new foods were brought into northern Europe. Sugar was unknown until the eleventh century when it came to Europe, first from the Middle East and then from Spain, but by the seventeenth century, sugar plantations, run by slave labour in the Caribbean and Brazil, enabled Europe to indulge its fast growing taste for sugar. Spiced sugar comfits were nibbled in the long fasting hours of Lent as a medicinal aid.

Cooking practices began to change. Crusaders learned to cook meats in almond milk and to fry meat first without boiling. The Middle Eastern custom of cooking meat with fruit began to be adopted in European dishes. Rice grown by the Arabs in Spain was imported into French and English cooking. Another Arab custom of highly coloured

dishes was also imported into London and Paris; foods were dyed green with parsley, yellow with egg yolks, and red with sandalwood, cinnamon or alkenet.

Rice, oranges, figs, dates, raisins, spinach, almonds and pomegranates were all imported. Dishes were made with rose hips, shredded almond, chicken, red wine, sugar and strong pepper and thickened with rice flour. Other recipes included eels seasoned with ginger, cinnamon, cloves, cardamoms, galingale, long peppers and saffron. Galingale is a rhizome belonging to the ginger family. Cloves, cardamoms, nutmegs, mace and rose water were all Arab ingredients which were imported after the Crusades. Blancmange, made with rice sweetened with sugar and flavoured with almonds, is a Middle Eastern dish. The Arabs, who were the mainstay of culture in the European Dark Ages, maintained much of the Greek and Indian philosophies and science. They applied these philosophies to food, whereby foods were classified and used to balance the humours in people.

In contrast, the early Christians believed that only Christ had healing powers. Illness was a punishment for wrong-doings, to be treated by fasting and prayer. However, by the time of the Crusades, some foods were seen as having medicinal properties. This all emanated from the Salerno School near Naples, founded by Benedictine monks. Knights returning from the crusades often stopped there and were cured. Even 400 years later, the English physician Andrew Boorde was influenced by the Salerno school of teaching. Foods were still regarded as hot or cold, dry or wet, according to the humoral theory. Fruits, milk products and red meat were all to be eaten with caution. Specific foods were believed to be suitable or unsuitable for different diseases and there were even different diets for different types of men. 'Sanguine men, who are hot and moist, should be careful in eating meat, but not eat fruit.' Such people had to be careful with their food or they would become fat and gross. 'Phlegmatic men are cold and moist and should not eat white meat, herbs or fruit, but only onions, garlic, pepper, ginger and hot and dry meats. Choleric men are hot and dry and should avoid hot spices and wine. Melancholic men are cold and dry and should not eat fried or salted meats and drink only light wines.'

Cannibalism

Cannibalism is a taboo subject, causing great distress when mentioned. It occasionally occurs with starving groups and is variably reported in various societies, e.g. the head-hunters of Papua New Guinea.

HISTORY OF EUROPEAN DIET

Mediaeval Europe

In late mediaeval Europe feast alternated with famine. Large trenches of hand-baked coarse bread were cut into oblongs to serve as plates. There were jugs of water and wine on side tables. Diners were provided with a broad knife and spoon, and rinsed and dried their hands after taking their place at the table for large and important meals. Most meals were taken by hand from the serving plates. Fine white bread was trimmed into finger-shaped sops and used to mop up liquid, including wine. Potage or soups were eaten with spoons from shared bowls and mopped up with sops. Meats and other foods were sliced and placed on the bread trenches. The meat slices were held with the fingers, and before being eaten, were dipped in a sauce the consistency of mustard. At the end of each course the softened trenches of bread were collected to be given to the poor. These were replaced by a soteley, which consisted of coloured scenes sculpted from marzipan made with ground almonds and sugar. These were often decorated with banners which might depict the four seasons or the Christmas story.

At large banquets there would be a boar's head with gilded tusks, a heron, a sturgeon and a pie made with cream, eggs, dates, prunes and sugar. The next course might include venison served in spice, wheat gruel, stuffed suckling pig and peacocks, skinned, roasted and served in their plumage. The third course had more roast birds, quinces in syrup, grilled pork rissoles, custard tarts and pies of dried fruit and eggs.

The essence of mediaeval cookery lay in mixture. The quantities of spices used were quite significant. For example, one fifteenth century house used five pounds (2.2 kg) of pepper, two-and-a-half pounds

(1.1 kg) of ginger, three pounds (1.4 kg) of cinnamon and one-and-a-quarter pounds (0.6 kg) each of mace and cloves in a year. Sugar was expensive and regarded in a similar fashion in cooking as a spice. Raisins, dates and saffron were introduced to northern Europe from the Middle East. Pastry and the stylish shaping of pies came from Persia, along with recipes for traditional Chinese pastries.

The diet of ordinary people was very different from the nobility at court. Such people lived on cheeses, curds, cream and oatcake. Others, more fortunate, ate two or three meals a day and enjoyed wine or beer, pork or meat, cheese, dried beans and bread, with the occasional chicken, eggs, pepper, cumin, salt, vinegar and sufficient vegetables.

Potage, a porridge-like soup thickened with cereal or bread, was popular in England. A porridge made of boiled ground wheat, moistened with milk and covered with saffron, was served with venison at the court of Richard II. The poor, when they could afford meat, made a potage of dried beans boiled in bacon stock, mashed and served with bacon.

Throughout Europe peasants lived on a similar diet of bread, cheese and pork, which was usually salted. In northern Europe peasants ate more rye or black bread than in the south. A Lenten bread was made of barley and oats. In times of shortage, bread was made of oats, peas or beans. The leaven would probably have been sour dough. The bread was heavy, hard-crusted and coarse. In England it was usually baked on a hearth, stone or in a pot buried in the fire embers. In France, peasants were forced to use bread ovens belonging to their landlords, for which they paid with a portion of bread dough. Rats and mice polluted the stored grain, weevils burrowed into the dried beans, bacon was rancid, cheese mouldy and wine sour. Bread was made from rye infected with ergot fungus, which brought with it the terrible consequences of induced abortions. There was never enough fodder through the winter to keep alive more than the few animals needed for breeding. In the autumn animals would be killed for their meat, salted or smoked, and preserved for the winter and spring. Turnips, beans and peas were dried. During times of famine the poor would only have cabbages and turnips without bread or salt.

In the Middle Ages, towns were relatively small. Within the city were private gardens and around the city walls were fields and vegetable gardens. The offal from various meats and fish was dumped anywhere, with resulting pollution of the streams.

In the Christian calendar there were 200 fast days a year, when meat, milk and eggs were all forbidden, and only fish or vegetables were allowed. There were particular privations during Lent at the end of winter, when food stocks were already low. The one meal a day allowed for the 6 weeks of Lent offered a daily diet of salted fish, stock fish or red salted herrings with mustard sauce. Fresh fish was also permissible; consequently, some monasteries had their own fish pools. The only soup allowed was dried peas boiled in water and flavoured with fried onions. More prosperous individuals could use dried fruit such as currants, figs and dates, and sweetmeats of crystallised ginger or candied violets.

Cooking techniques changed during Lent. Milk made from ground almonds replaced cow's milk for poaching and stewing. Oil was used rather than butter or lard. Sea-birds were sometimes allowed in religious houses because they were a form of water creature. Fast or fish days continued in England until after the Reformation and it was not until the mid-seventeenth century that statutory fish days were abandoned in England. The long fasts of Advent and Lent ended with Christmas and Easter. Christmas in England was celebrated not only with new wine from Gascogny, but also with certain days of feasting and entertainment. The end of Lent was celebrated with a great feast on Easter Sunday; meals on that day traditionally included a lamb or a kid in many European countries. In mediaeval times it was usual to give gifts of hard-boiled eggs painted with vegetable dyes on Easter Sunday. This practice has continued to the present.

Food supply and balances were at their limits. The supply of food to the developing cities was yet to reach levels of sophistication. Many countries experienced long periods of starvation. Bread, oats and cooked vegetables were the peasants' food, with water and whey for drinking.

Sixteenth and seventeenth century Europe

By the sixteenth century came the development of printing and cookery books. During this period English merchants became extremely rich, with for-

tunes made from trade to India and the West Indies. There was little ability to store food, so the diet reflected seasonal availability. Some of the cookery books discussed the curative properties of specific diets. A recipe for whitening and retaining teeth recommended rose water, sage, marjoram, alum and cinnamon. Rosemary was believed to have almost miraculous powers and was used to treat colds, toothache, aching feet, bad breath, sweating, lack of appetite, gout, consumption and madness. Bed-wetting could be cured by eating fried mice.

In England in 1603 breakfasts of cold meat, cheese and egg were eaten between 6 and 7 am. Dinner, the main meal of the day, was between 11 am and 12 noon, and a light supper was taken at about 6 pm. By the late eighteenth century fashionable people in London were eating as late as 7 pm, although this was not the pattern in the country. Breakfast was a meal of cold meats and ale, eaten at about 9 or 10 am in towns, and supper had become a late-night snack. Afternoon tea was taken between breakfast and dinner, with tea and bread and butter or buttered toast. Dinner plates of pottery or pewter replaced the mediaeval trench of bread, and forks were slowly introduced. Nevertheless, monarchs such as Louis XIV of France always ate with their fingers. The dishes, both sweet and savoury, were laid out on the table in geometric patterns. The third course of fish and confection was similarly presented.

Around the periphery of London there were small, intensive market gardens, manured by excrement. Fruit and vegetables were grown for the population of the capital and were sold from barrows or in markets, e.g. Covent Garden.

In the seventeenth century increasing trade meant a new concept of food storage for the mariners. Fish could be caught, but water and fresh fruit and vegetables could not be stored, with consequences for vitamin C status until the findings of Lind were adopted. A year's store of food was taken, the basic being hard tack, a cake of wheat flour baked twice for better preservation. Venetian ships carried salt pork, wine, cheese and broad beans. Protein-calorie malnutrition was a feature of the early, long voyages. Queen Elizabeth of England's fleet consisted of swift and small ships, limited in storage and hence ill-adapted for long journeys. The food at sea was salt beef and pork, beer, pease, cheese and butter, biscuit and salted fish. London was the only port large enough to victual a ship with these specialist foods. During the Napoleonic wars and the blockade of the French channel ports a major agricultural industry developed: the walking to London of cattle from the Scottish Highlands by drovers, and geese from East Anglia, all for the feeding of the fleet. This trade was central to the Highland economy.

In the seventeenth century increasing trade among European countries led to new diets. Trade with India and China resulted in tea being imported. A variety of beverages, such as tea, coffee and chocolate, was introduced into Europe.

The Chinese habit of drinking tea is believed to date from the time of Emperor Shen Nung (2737 BC). Japan, India and Sri Lanka have a long tradition of tea drinking. The Portuguese brought tea to Europe in the middle of the sixteenth century. The Dutch brought small quantities to France, and by the mid-seventeenth century large amounts were introduced into England by the East India Company. The first teas imported were green teas (now coming from the Zhejiang province of China). The leaves were picked, rolled and steamed to prevent further fermentation. Initially, very weak tea was made and drunk with sugar but no milk. By the end of the seventeenth century bohea or black tea (China, India and Sri Lanka), which is a stronger and less astringent tea, was available. Cream or milk was then added to the tea to counteract the acidic effects of the tannin. Oolong is a partially fermented red tea from the Fujian province of south-east China and Taiwan. Tea became popular throughout all social classes and was drunk throughout the day. Tea replaced beer as the drink for many English farm labourers.

Coffee was introduced into Europe during the seventeenth century. The coffee shrub is native to Ethiopia. By the sixteenth century coffee was drunk throughout the Muslim world. It was introduced to Europe through Venice by the beginning of the seventeenth century. The first coffee shop opened in Oxford in 1650. Many of the early coffee shops became associated with dining clubs and were important centres of political and social life.

Drinking chocolate became popular throughout Europe during the seventeenth century. Chocolate was initially imported by the Spanish from Mexico, where it had been drunk by the Mayans and

Aztecs. When first introduced into Spain it was a secret maintained by monasteries. The Spanish added sugar, cinnamon and vanilla in place of the chillies in the Aztec recipe. By the middle of the seventeenth century drinking chocolate was available throughout Europe, although it was not until the mid-eighteenth century that chocolate bars were produced.

Tea, coffee and chocolate replaced the previously widely drunk mulled wine. As they were rather bitter in flavour, sugar was taken to improve the flavour.

France was the most important European wine producer in the mediaeval era, sustaining a tradition that had existed since Roman times. Wines were exported to England from the Weine basin and from Gascogny. The new wines from Bordeaux arrived in England just in time for Christmas. Mediaeval wines were lighter than the modern ones and were at their best after about 4 months. They were stored in wooden barrels. The Parisians preferred light white wines, whereas the English liked red wines. By the end of the sixteenth century wines from the warm south were recognised as having a higher alcohol content than those grown in the north. These stronger wines could be kept for several years and would improve with keeping.

The favourite wine during the second half of the seventeenth century was champagne. Champagne wines were first developed under Henry IV of France at the beginning of the century. It was only slowly that their capacity to form a sparkling wine was appreciated, largely under the guidance of Dom Perignon from the Abbey of Hautvillers near Rheims. Champagne was the most popular wine at the court of Charles II in London.

Claret was imported in barrels from Bordeaux, usually drunk warmed with spices as mulled wine. Younger wines were more expensive than older wines because wines kept in barrels tended to deteriorate after a year or two. Maturing of wine in bottles later became more common and with this development the concept of wine improving with age.

By the mid-seventeenth century the great tradition of French cooking had begun. This was a cuisine based on a series of techniques: basic preparation, bouillon and roux, the use of bouquet garni, egg whites for clearing consommé, and stuffings made with mushrooms and other vegetables. Pieces of meat and mutton were slowly cooked. Eighteenth century French and subsequent cooking preferred the infusion of carefully selected flavours. The previous menus containing multiflavoured sauces and exotic game birds were thus replaced.

From the seventeenth century, with the increasing availability of sugar, puddings were slowly established as a regular feature of a meal and served with other savoury dishes in the second course. There was a wide range of fruit pies, fool's cream, syllabubs and fritters. The English pudding was transformed by the introduction of the boiling cloth. Before this innovation boiled puddings, both the sweet and spicy versions of sausage and savoury puddings, were cooked in animal intestines. These had to be fresh, so boiled puddings could only be made during the seasonal autumn slaughter of livestock for the winter. However, once boiled puddings were cooked wrapped in cloth, they could be enjoyed at any time of the year. Quaking or shaking puddings of cream, breadcrumbs, sugar and eggs flavoured with spices were cooked in well-floured bags in simmering water. Apple puddings of apple, sugar and butter were wrapped in pastry skin and boiled in a cloth. The boiled sweet pudding became the national dish, consisting of flour, suet, milk and eggs, and was usually boiled in the same utensil as the meat of the day, the square of bacon, cabbage or other green vegetables in one net, the potatoes in another and the roly poly in a cloth. Roly poly pudding with dried fruit was served as a first course, with a similar purpose to the Yorkshire pudding, to reduce the appetite for the more expensive later courses. Plum puddings with dried fruit developed during the seventeenth and eighteenth centuries, with fruit, sugar and spices such as cinnamon, nutmeg, ginger, cloves and maize.

Eighteenth and nineteenth century Europe

Butcher's meat required specialised killing and cutting, which often took place in remote towns, whereas rabbits, chickens and pigs were killed locally. During the Industrial Revolution in Britain, workers crowded into the rapidly growing towns to operate the new machines. Women worked in factories and were also responsible for the prepara-

tion and cooking of family meals, without the training they had previously received from their totally domesticated and now distant mothers. There was a resulting decline in nutrition.

In the eighteenth and nineteenth centuries rural life was very much dominated by the availability of seasonal fresh fruits and game from the rural activities of fishing and hunting. Fishing towns supplied cod, lobster, sole, skate and whiting. Fresh vegetables were grown in the garden, with strawberries and raspberries in June, and peaches, nectarines, plums and pears in September. Asparagus and cucumber were also grown.

The farmworkers had a very simple diet. There was bacon from the family pig, kept in a sty at the back of the cottage, eaten with fresh vegetables, bread and home-made lard flavoured with rosemary. However, many of the farmworkers came close to starvation, particularly during times of poor harvest. They lived on potatoes, and in Scotland on oatmeal, milk and sometimes fresh herrings. Potatoes were increasingly popular as they were easy to cook and provided the essence of a hot meal. They also had the advantage of lasting for three-quarters of the year. Fresh meat was a luxury, eaten only on Sundays. A pot roast was made by placing the meat with a little lard or other fat in a covered iron saucepan kept over the fire. In the north, oatmeal and tea were provided for workers. Rural workers in the south did not necessarily have gardens provided and lived almost exclusively on bread, with little salt, bacon or cheese.

The introduction of the potato into rural Ireland and Scotland gave a readily grown nutritious crop. By the nineteenth century the potato was a staple of the diet in both town and country. When the fungus *Phytopthora infestans* infected potatoes in Ireland, the resultant destruction of the crop resulted in widespread famine for poor Irish populations living on a marginal diet. The infection was increased during a period of high humidity which occurred during 1845–1847. The Irish famine ensued (1845–1852) and one million survivors of the potato famine emigrated. Later, potatoes resistant to the blight were developed in Scotland and the USA.

The development of restaurants followed the French Revolution when chefs, who had lost their aristocratic employers, opened restaurants, resulting in a more general, intense and continuing interest in recipes and food. There was a defining of cooking styles, with precise cooking instructions for the preparation of purées, essences, sauces and garnishes, with a perfect balance between well-chosen flavours. This led to an almost total domination by French cooking of food in Europe. It has been suggested that, by the mid-nineteenth century, the urban British middle-class, unlike the French, had lost contact with their own country origins and consequently an understanding of the origins of their foods. The British cooking pattern was plain, leaving foods to taste of themselves, whereas the French haute cuisine depended on the cook adding to their flavour.

The introduction of spices into Britain came from exposure to India. The recipe for Worcester sauce was brought back from India and curries were introduced through the East India Company. The first recipes for mulligatawny soup, using curry powder, appeared at the beginning of the nineteenth century. Such soups were thickened with barley, bread or split peas. The British community living in India combined Indian and British foods, one such being the development and increasing popularity in the eighteenth century of chutneys made with tamarinds, mangoes, limes and aubergines. which were previously unknown in Britain at that time, although known in southern Europe.

In the industrial areas there was considerable starvation. During the 1840s the diet of the majority was stodgy and monotonous, and for many, deficient in both quantity and nutriment. Badly housed parents lost many of their children and those who survived were undernourished, rachitic and sometimes deformed. Meat was often eaten only two or three times a week, with the main or even sole food source being bread and potatoes.

At the beginning of the nineteenth century the British soldier's daily ration was one pound of bread (450 g) and a quarter of a pound (110 g) of meat. In the army barracks there were two coppers for each company, one for meat and the other for vegetables, so the food could only be boiled. There were no canteens. There were two meals, one at 7.30 am and the other at 12.30 pm. On overseas service soldiers were provided with salt pork, salt beef or dried biscuits.

There were considerable problems of storage during this period, with resulting mass adulteration

and upgrading of food. Bakers bleached inferior grades of flour with alum to make bread appear white. Flour was diluted with ground peas and beans, beer was adulterated with acids, milk was thickened with arrowroot, the skins of Gloucester cheese were coloured with red lead, and old port crusting was imitated by lining the bottle with a layer of super-tartrate of potash. Hedgerow clippings were used to adulterate tea; leaves of blackthorn, ash and elder were boiled, dried and coloured on copper plates. Ground coffee was diluted with chicory and toasted corn. Flour was mixed with chalk, pipe clay, powdered flints and potato flour. Second-hand tea leaves were sold by servants to merchants. The tea leaves were then mixed with gum and dried with black lead before being sold as fresh tea leaves. It was only in the 1870s that parliament legislated against food adulteration.

The introduction of the railways enabled food to be carried rapidly around the country. By the end of the eighteenth century, fresh salmon in ice could be brought from Scotland to London, initially by road and later by the railway. In the 1860s and 1870s the development of the railway system into the mid-west of the United States and the cattle lands of South America opened up new fertile sources of food. The railway and rapid ship movements meant that grain and cattle could be brought from North America and South America to the industrial areas of Europe. Later came the introduction of reaping machines and self-binders, requiring fewer workers, which increased the cheap production of wheat and other crops.

Canned meats and vegetables were used by the Royal Navy in the Napoleonic wars, but preservation through canning was only partially successful. By the late nineteenth century canned Californian pineapples and peaches were available in Britain.

The long period of urban malnutrition became apparent during the Boer war, when nearly 40% of the British volunteers had to be rejected because of being physically impaired by inadequate diet. The result of this and other findings, such as the Rowntree Report on poverty, resulted in parliamentary Acts providing free school meals for children of poor families and pensions for the elderly. By the middle of the nineteenth century, advances in the knowledge of nutrition enabled adequate nutritional provision to be made for developing schoolchildren.

Despite this knowledge, was the failure of one of the most famous expeditions of all times, Scott's attempt to be the first man to reach the South Pole. Not only was he beaten by Amundsen, but he and his party died on the way back through cold and poor nutrition. One of the early expeditions to climb Everest used hampers from Fortnum and Masons as the food supply.

Twentieth century Europe

The diet of the British working classes at the beginning of the twentieth century was dominated by bread, sugar, lard, cheese, bacon and condensed milk. Meat was brought chilled from Argentina or frozen from New Zealand.

In Europe, factories were attracting workers from the land, so that as the available agricultural production was reduced the diet was augmented by overseas food. Novel methods were found to preserve foods on long journeys. Cattle in Argentina were slaughtered solely for their skins for leather. Later, the development of a meat concentrate, e.g. Bovril, made the proteins available for use by distant populations. The introduction of refrigerated ships enabled meat to be carried over long distances in prime condition.

Later in the twentieth century, food could be carried by refrigerated lorries, so that lettuces, strawberries and melons could be brought in good condition from France to Britain. Successful canning was another important development. Canned salmon and canned peaches became the traditional Sunday tea for many people during the Second World War.

The long working hours in factories resulted in eating problems, because the traditional time for the working man's main meal was the middle of the day. Good employers provided canteens where workers could eat at that time. At the Cadbury's works canteen a meal of roast beef and two vegetables was available at midday. For the majority of workers, canteens were not available until the 1940s. Often food was taken to work to be eaten at midday. This might be a pie, a basin of meat and vegetable stew or cold sandwiches, and tea. Coal miners would take a bottle of cold tea and a tin of

sandwiches. There were no set meal breaks and they ate as they worked. Other workers relied on stalls in market places close to the factory. When possible, men returned to their homes for their midday meal. However, changes in working patterns altered eating patterns throughout the world. At the same time, the women, who were either working or having virtually annual pregnancies throughout their childbearing years, were not even given these facilities.

War makes great demands on a population's nutrition. The First and Second World Wars made great demands on both the civilian and military personnel. Civilians often experience famine during wars. One of the greatest nutrition experiments ever was food rationing in Great Britain during the Second World War, under the charge of J.C. Drummond. Many of the poor ate better than previously during this period, with an equitable sharing of food. The supply of food to armies moving over distances provides a constant problem for their generals. When Ghengis Khan entered Europe there were nearly half a million cavalry horses, which caused considerable feeding problems. The members of the Chinese Communist Army carried rice with them on the long march. In contrast, a British regiment facing an enemy charge opened their ammunition boxes to find that they had been provisioned with biscuits.

Concentration camps for civilians and prisoner of war camps resulted in controlled starvation beyond comprehension.

History of eating patterns in Scotland

An example of the development of eating patterns in an industrial society can be found in Scotland. In 1949, Kitchin and Passmore described three distinct eras of nutrition in the general Scottish population. The first era was that of a self-supporting agricultural community. The diet was in the Viking tradition, which included rye, wholemeal bread, oat and barley porridge; fish (especially herring); boiled meat and broths of sheep, lamb, goat, ox, calf and pig; cheese, butter and cream; beer and mead, and among the wealthy, wine. The most common vegetables were cabbage and onions; apples, berries and hazelnuts were also popular.

The second era was the age of the Industrial Revolution. As industry expanded and the population increased, so food requirements exceeded home food production, necessitating the import of food from overseas. Significant differences in health appeared between the urban and rural populations, in part because of the better quality of the country people's diet. During the nineteenth century, 10% of the population were too poor to buy sufficient food for themselves. Such malnutrition, in addition to bad sanitation, inadequate overcrowded housing, insufficient land for farming, and a host of acute and chronic infectious diseases, led to rickets, poor stature, and high maternal and infant mortality.

A study in 1903 by Patton, Dunlop and Inglis of the diet of the labouring classes in Edinburgh identified a large proportion of poorly developed and undersized children and adults. Two groups were studied: families with assured and adequate incomes, and the poor, who were unable to buy the necessities of life, either because of inadequate income or because of employment that was only casual. Some families living in poor housing on small, irregular wages refused to take part in the study. The range of expenditure on food varied from 2.5 to 9.5 pence per man per day. The daily nutrient intake per man varied from 1100 to 4800 kilocalories (kcal). The wife and children of the poor families lived on tea, bread and potatoes, the tradition being that the man ate butcher's meat daily. The larder was replenished with small quantities of food bought each day. Alcohol was a great problem, affecting work records and hence income. In contrast, the families of workmen receiving regular wages ate meals consisting of bread, potatoes, oatmeal, eggs, beef, mutton, ham, butter, herrings, cod, sugar, rice and barley. Fresh vegetables were confined to potatoes, cabbage and peas.

In Edinburgh before the First World War, over 12% of the milk contained tubercle bacilli. The consequence was that the bovine, milk-borne form of tuberculosis occurred in 32.4% of tuberculosis patients aged under 5 years, 29% aged 5–16 years and 2.9% of adults.

The third era was that of state planning. During and after the Second World War, the government was obliged to control and provide an adequate food supply for the whole population, so that malnutrition could, despite the obstacles to the