МІНІСТЕРСТВО ОСВІТИ І НАУКИ УКРАЇНИ
ЧЕРНІГІВСЬКИЙ НАЦІОНАЛЬНИЙ ТЕХНОЛОГІЧНИЙ
УНІВЕРСИТЕТ

АНГЛІЙСЬКА МОВА
професійного спрямування

Методичні вказівки до практичних занять та самостійної роботи з англійської мови професійного спрямування для студентів освітньо-кваліфікаційного рівня магістр спеціальності 181 Харчові технології

Частина ІІ

FOOD PRESERVATION

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Укладач: Бараненкова Наталія Анатоліївна,
кандидат філологічних наук, доцент,
доцент кафедри іноземних мов професійного спрямування

Відповідальна за випуск: Литвин С.В., завідуюча кафедрою
іноземних мов професійного спрямування,
кандидат педагогічних наук, доцент

Рецензент: Гагіна Н.В.,
кандидат педагогічних наук, доцент
доцент кафедри іноземних мов професійного спрямування

ЗМІСТ

ВСТУП

Відповідно до Програми викладання англійської мови для професійного спілкування (2010 р.) вивчення іноземної мови повинно розвивати мовну компетенцію студентів, а також стратегії, необхідні для ефективної участі в процесі навчання та в ситуаціях професійного спілкування.

Методичні вказівки орієнтовані на студентів освітньо-кваліфікаційного рівня магістр спеціальності 181 Харчові технології денної форми навчання та мають на меті формування навичок англомовного професійного спілкування.

Методичні вказівки є складовою частиною навчально-методичного комплексу з дисципліни «Іноземна (англійська) мова за професійним спрямуванням» і, як допоміжний засіб навчання, забезпечують реалізацію всіх цілей навчання іноземних мов: розвиток навичок розуміння й аналізу оригінальних текстів на професійну тематику, подальше збагачення словникового запасу студентів сучасною англійською термінологічною лексикою, вдосконалення навичок усного та писемного мовлення, перекладу та розуміння оригінальних науково-популярних текстів з професійної тематики.

Навчально-методичне видання базується на лексичному матеріалі, що охоплює термінологію, пов’язану з майбутньою професійною діяльністю студентів. Комунікативно спрямовані вправи розділів посібника побудовані на автентичних матеріалах, що, в цілому, сприятиме ефективному оволодінню професійно зорієнтованою англійською мовою і формуванню навичок самостійної роботи студентів.

Завдання для самостійної роботи містять оригінальні тексти, що відображають новітні тенденції у розвитку харчової промисловості.

UNIT 1. FOOD PRESERVATION

Food spoilage is due to the growth of microorganisms in the food. In the course of their development these produce, in some cases, harmless products, such as acetic acid in *sour milk* or carbon dioxide and alcohol in *bread dough* made with yeast; in others harmless but undesirable products, such as the flavour which mold imparts to bread; while, in still other cases, harmful toxins are produced. Food preservation has both hygienic and economic aspects. From the point of view hygiene, food is preserved in order to prevent the formation of products which are harmful to the body. Many essential but *perishable foods* are preserved for the purpose of prolonging the period of availability. Oranges or tomatoes supply vitamin C from January to January, Green vegetables as well as the more stable root vegetables can be fresh or in cans at any time. Thanks to improved methods of food preservation, it is now possible for everyone at all times to have clean, wholesome food — a well-balanced diet.

Microorganisms. For those who have studied bacteriology, the ravages of food by microorganisms make an old story. In all *living tissues* microorganisms are found which assist either in the growth of the plant or animal or in their decay. In addition the air, water, and all other substances with which food comes in contact contain microorganisms foreign to the natural food but capable of reacting the solutions present in it.

Thus, any food is subject to either decay or spoilage by the growth of microorganisms. Our study of microorganisms will confine itself to a description of the different classes and the conditions which are favourable or unfavourable to their growth.

There are three classes — molds, yeast, and bacteria. All are characterized by their extremely *minute size* and their wide distribution. Microorganisms multiply more rapidly at moderate temperatures — for the most part about 40 °C and their growth is checked at very low temperatures.

Microorganisms may multiply in two ways. In one, a microorganism splits off a part of itself which resembles the original organism in appearance and method of reproduction. In the other, a rounded mass called a spore is developed, which is unlike the parent form but will develop into a similar organism, provided the conditions for growth are favourable. A spore differs from the microorganism from which it comes in being more resistant to conditions unfavourable to growth. Whereas most microorganisms are destroyed by boiling water, many types of spores which have been held at high temperatures will later grow and multiply, when the conditions of their environment become more favourable for growth. For this reason spore-bearing organisms are more difficult to destroy than those which multiply by simple cell division.

Molds. The conditions for the growth of mold are less rigid than for any other class of microorganisms. For this reason we may find well-established settlements of molds on almost any substances: they are found on acid foods, such as lemons,

oranges or tomatoes; on neutral foods, such as bread and meats; on sweets such as jellies and jams; and on salty food such as bacon or ham.

Most molds are spore bearing. Spores are clearly visible as the coloured specks which fringe the thread-like mold growth. The colour will vary with the kind of mold. The more common mold has bluish-green spores, but others with black or red spores are seen fairly often. Molds multiply most rapidly at temperatures varying from 20 to 35°C, and in damp, dark places in which there is little circulation of air. They will multiply on any substance which contains carbon, hydrogen, and oxygen, whether acid, neutral, or slightly alkaline. Molds may be destroyed or their growth checked by unfavourable conditions.

Low temperatures retard the growth of mold, but temperatures below that of an ordinary *ice chest* (10 to 15 °C) are necessary. Molds must have some moisture. A dry food will not mold unless it is kept in a damp place. Molds will form in darkness or light, but many species cease to grow if exposed to bright sunlight. Circulating air is destructive to mold growth.

Yeasts. Yeasts, unlike molds, will grow only on foods containing sugars. The reaction called *fermentation* changes the sugar to alcohol and carbon dioxide with minute quantities of other products. Although yeasts will grow only in the presence of sugar, they may be found widely distributed.

The mixture of various kinds of yeasts present everywhere in the air is called *wild yeast.* Yeasts multiply either by spores or by cell division. Among the essentials for the growth of yeasts are sugar, oxygen, water and certain inorganic sails such as those of calcium, nitrogen, and sulphur. They are easily destroyed by high temperatures (100 °C). The alcohol which they produce in their life processes slows down and, finally, completely checks further growth. For this reason beverages of high alcoholic content can be obtained only by distillation. In strong sugar solution yeasts multiply slowly.

All fruit juices are subject to fermentation, unless the yeasts which they naturally contain are destroyed, which may easily be done by bringing the juices to boiling temperatures and sealing in clean containers while hot. Apple juice which ordinarily becomes "hard" in a few days may be kept for months or years this method.

Bacteria. Although there are many properties which are characteristic of all bacteria, the differences in the behaviour of the different kinds of bacteria are greater than those of the different kinds of yeasts and molds.

Bacteria are widely distributed. Like yeasts and molds, they may be found anywhere — in the air, water, soil, and in all foods. In a less acid medium they multiply most rapidly, and, therefore, it is the less acid foods which are most subject to bacterial decomposition. The products of decomposition vary with the kind of food and the kind of bacteria. While in most cases we wish to decrease the bacteria content, certain foods are made desirable by products of bacteria growth. Sauerkraut owes its flavour and physiological effects to the lactic acid which is produced by the microorganisms in the course of its preparation. The flavours of cheeses, butter, and butter substitutes are also products of bacterial activity. On the other hand, the

spoilage of *canned foods,* meats, milks and vegetables is also due to the products of bacterial growth.

Bacteria require moisture for growth. Exposure to sunlight for sufficient length of time destroys bacteria but not their spores. The temperature for optimum growth will vary (20 to 55 °C) with the kind of bacteria. Bacteria are more difficult to destroy than the other microorganisms.

The methods of food preservation may give temporary preservation by checking the growth of microorganisms or permanent preservation by destroying them.

Refrigeration or cold storage is the most common method of temporarily preserving food. Indeed, it is one of the most satisfactory of all methods of food preservation, as it does not markedly alter either the taste, appearance, or *nutritive value* of the food. Refrigeration is practiced in the home and commercially. It is most successful with the foods which are least subject to bacterial decomposition, but other foods may be preserved a long time if freezing temperatures are used. Fish and animal products can be kept only by refrigeration at very low temperature. Considerable success is now being experienced in the preserving of fish and meat and of many fruits and vegetables by freezing. New methods of freezing and better storage facilities for frozen products have improved the flavour and texture of the food so treated. The electric refrigerators are somewhat colder and contain drier air and are, therefore, more successful for the preservation of foods which are subject to bacterial growth.

Other methods of food preservation are effective over a long period of time. By these methods either the microorganisms are destroyed, or the conditions are made unsuitable for their growth. There is a variety of methods for this more permanent type of food preservation.

Drying. Drying has been a means of food preservation for centuries and is still used for many foods. It promotes preservation by removing the water essential for the growth of all microorganisms. We find in the market dried fruits, milks, meats, and vegetables, but the varieties of each are few.

The method of drying varies greatly with the food. Foods containing sugar require less drying than others. Within the last few years, intensive efforts have been made to produce dried products which are not only clean but also will resemble fresh foods in appearance and nutritive value.

Dried foods occupy less storage space and may be stored without consideration of temperature. Most dried foods require soaking before cooking in order to restore the water lost by drying. The dried foods most commonly used are prunes, raisins, currants, apples, apricots, peaches, figs, dates, beans, fish, beef, and mushrooms.

Chemical preservation. Many foods are preserved by the use of added substances, which destroy or check the growth of microorganisms. Although many chemicals are known which could be used to help in the preservation of foods, few are allowed by government authorities.

Among the legal chemicals are benzoic acid and sodium benzoate. Sulphur dioxide ($S0_2$) and sodium bisulphate ($NaHSO_s$) are used in dried fruits such as apples,

because the darkening of the fruit is lessened by their presence. These sulphur compounds have also a preserving action.

Smoke contains phenols which help in the preservation of smoked products. The preserving action of *cloves* and *cinnamon* depends upon their *eugenol* or cinnamic aldehyde content.

Potassium nitrite and potassium nitrate, used in the curing *("corning")* of pork and beef, improve the taste and redden the colour. They have no preservative effect.

Salted products are usually partly dried as well as salted. Common examples are found in chipped beef and salt codfish. Less drying is necessary when salt is used, as the concentrated salt solution preserves by osmosis.

Canning. Canning is the most common form of food preservation. Preservation is insured by the use of sufficient heat to destroy all microorganisms which might develop in the canned product during storage. The temperature in the canning of food depends upon several factors, the hydrogen-ion concentration of the food, the number of microorganisms present in the uncooked food and the rate at which heat can penetrate the food to be canned.

It has already been stated that bacteria and their spores become less resistant to heat as the hydrogen-ion concentration of the media increases. Consequently, foods of high hydrogen-ion concentration may be preserved either by a low temperature for a long time or by a short heating period at a high temperature. In canning, boiling temperature 100 °C is considered low, 115 to 119°C high.

It may be noted that foods of high acid concentration require either less time, or lower temperature, or both, than the less acid foods.

The time allowed for processing is governed not only by the hydrogen-ion concentration but also by the rate at which the heat penetrates into the food. It is well known that metals are better heat conductors than asbestos.

Experiments have shown that the rate of heat penetration is governed by a number of factors, some of which are more predictable than others. It goes without saying that the food in the centre of a glass jar will take longer to reach sterilization temperature than that in a tin, can, that large-size containers require a longer time than small, that food which is processed at 115°C reaches 100°C sooner than that processed at 100°C, and that a jar of cold food requires a longer period than one of preheated food.

Formerly it was thought that this treatment "set the colour and flavour" of the food, but now it is known that blanching has no such exalted position in the canning ritual but serves merely to reduce the bulk (spinach), or to help remove the skins (tomatoes, peaches, beets), or to set vegetable protein solution (corn).

The *cook-in-the-kettle method* consists in cooking the food in an open kettle until all has reached sterilization point, or longer if desired. The food is then packed and sealed in clean sterile jars. From a bacteriological point of view it is obvious that this method of canning is applicable only to foods which provide a poor medium for the growth of microorganisms, such as acid fruits or fruits in sugar syrup. It has certain advantages over the other method in that it requires less apparatus and usually less time.

The *cook-in-the-can method* describes itself. Food to be canned is washed, blanched if necessary, cut into suitable pieces, and placed in either tin cans or glass jars. Hot water, usually containing either salt or sugar, or both, is added to fill completely the can or jar, which is placed in a suitable cooker to destroy the microorganisms present. Tin-canned food is sealed before processing. All food which is commercially canned in tin cans is heated previous to sealing.

Storage of Canned Food. While every effort is made to destroy the microorganisms of the food during the processing, it should be remembered that if any spores resist the temperature of the cooker, then development will be hindered by storing the canned food at low temperatures. Low temperatures are also unfavourable to the reactions which take place between the food and the tin or iron. It has been shown that the natural colour of fruits is preserved much better by storing fruits in a warehouse at 0°C, than at higher temperatures, no discolouration being observable after two and a half years of storage. It is recommended, therefore, that canned food which is not to be used within a very short time should be stored at a temperatures as near 5°C as possible.

Canned food is graded. Many labels on canned foods do show a grade for the product. Definitions of these grades are given as follows: the *fancy grades* use uniformly perfect fruit in the best state of ripeness and of the largest size. The fruit is packed in a thick syrup. Cans of *choice grade* fruit contain nearly perfect fruit of average size in a medium syrup. Standard grade uses smaller, less uniform fruit in a thinner syrup.

In addition to these, there are two lower grades which are used largely for cooking.

Active Vocabulary

spoilage	псування
sour milk	кисле молоко
mold	цвіль, плісенний грибок
bread dough	хлібне тісто
perishable foods	їжа, що псується
yeast	дріжджі, закваска
decay	гниття, розпад
decomposition	розкладання; гниття
date	термін
sauerkraut	кисла капуста
soak	замочувати; усмоктувати; занурюватися
cure	заготовляти, консервувати
living tissues	живі тканини
minute size	найдрібніший розмір
ice chest	льодовик, холодильник
fermentation	бродіння, ферментація
wild yeasts	дикі дріжджі
canned foods	консервовані продукти

nutritive value	харчова цінність
clove	гвоздика (пряноші)
cinnamon	кориця
eugenol	хім. сполука евгенол
“corning”	засолювати, консервувати сіллю (м'ясо, рибу)
fancy grade	вищий ґатунок (екстра)
choice grade	кращий ґатунок (відбірний)
cook-in-the-can method	метод порційного консервування (по банках)
cook-in-the-kettle method	метод консервування в загальному котлі з подальшою розфасовкою

Task 1. Transcribe and pronounce correctly the following words:
decay, spoilage, cure, vinegar, tissues, sauerkraut, nutritive value, behaviour, multiply, choice grade

Task 2. Match the word or words with the definition.

1. choice	a. the things that something in science normally does
2. behaviour	b. small amounts of water in or on something
3. mould	c. the soft part inside a fruit or vegetable
4. moisture	d. a sour-tasting liquid made from malt or wine
5. flesh	e. a substance in foods such as bread, rice and potatoes
6. vinegar	f. the wine made in a particular year
7. vintage	g. a green or black substance that grows on old food
8. starch	h. high quality

Task 3. Fill in the gaps using the words in the box.

harmful, microorganisms, heat, hygienic, favorable, storage facilities preserving, freezing, dried, appearance

1. Food preservation has both _____ and economic aspects.
2. From the point of view of hygiene food is preserved in order to prevent the formation of products which are _____ to the body.
3. Bacteria grow very rapidly where conditions are _____.
4. Bacteria are more difficult to destroy than the other _____.
5. Considerable success is now being experienced in the _____ of fish and meat and of many fruits and vegetables by _____.
6. New method of freezing and better _____ for frozen products have improved the flavour and texture of the food.
7. Within the last years intensive efforts have been made to produce ___ products which are not only clean but also will resemble fresh foods in ___ and nutritive value.
8. The temperature in the canning of food depends upon several factors, the number of microorganisms present in the uncooked food the rate at which _____ can penetrate the food to be canned.

Task 4. Answer the questions:
1. How are foods temporarily preserved?
2. What chemicals are allowed as preservatives?
3. What can you tell about drying as a means of food preservation?
4. What do most dried foods require before cooking?
5. What two methods are in use today for canning?
6. Where do yeasts grow?
7. What do we call fermentation?

Task 5. Choose the correct form in bold.
1. Any food **is/are** subject to either decay or spoilage by the growth of microorganisms.
2. Microorganisms **must be/may** multiply in two ways.
3. A spore **differ/differs** from the microorganisms from which it comes in being more resistant to conditions unfavorable to growth.
4. Spore – bearing organisms are **more/most** difficult to destroy than those which multiply by simple cell division.
5. Molds **must/can** have some moisture.
6. The mixture of various kinds of yeasts present everywhere in the air **is/are called** wild yeast.
7. Like yeasts and molds, bacteria **may/must** be found anywhere – in the air, water, soil and in all foods.
8. The method of drying **vary/varies** greatly with food.
9. Many foods **are/is preserved** by the use of added substances, which destroy or check the growth of microorganisms.
10. Canning is **the most/more** common from of food preservation.

Task 6. Translate into English.
1. Як відомо, харчові продукти швидко псуються.
2. Для того, щоб довше зберегти харчові якості продуктів, їх консервують, засолюють, коптять, заморожують.
3. Псуванню харчових продуктів сприяє ріст мікроорганізмів.
4. Мікроорганізми поділяються на декілька класів: пліснява, дріжджі, бактерії.
5. Зазвичай пліснява утворюється в темряві, але іноді й на світлі. В більшості випадків пліснява припиняє рости, якщо вона піддається сонячному освітленню.
6. Смак сирів та масла змінюється під дією бактерій.
7. З іншого боку, псування консервованих продуктів – м’яса, молока, овочів – також відбувається під дією росту бактерій.
8. Найсприятливіший спосіб зберігання харчових продуктів у холодильниках; в цьому випадку, смак, вигляд і поживна цінність незначно змінюється.

Task 7. Read the text without a dictionary and discuss it.

METHODS OF MEAT PRESERVATION

There are different methods of preservation. They are: drying, smoking, salting, curing, refrigeration, freezing, canning, freeze-drying and irradiation.

Drying-removal of moisture from meat from its original water content to about 15%. Smoking-process of subjecting meat to the action of smoke and heat generated by burning hard wood and or saw dust.

Salting-simple method of dehydration in the salt causes the withdrawal of water from the tissue of both meat and spoilage organisms.

Curing-application of salt, sugar, nitrite (potassium or sodium nitrite) and other preservation and adjuncts.

Refrigeration-exposure of meat to the range of 36° to 50°F [2°C-10°C] to retard mold and bacterial growth for a limited period only.

Freezing-exposure of meat to a temperature rang of 0°F to 32°F [-18°C-0°C] resulting to crystallization of the water in the tissues, thus, inactivating the enzymes and the bacteria present.

Canning-hermetic or air tight sealing of food in cans or jars and heating under pressure (pressure cooker, retort, autoclave) to reach temperature above 100°C at specific period of time.

Freeze-drying-removal of moisture from the tissues by sublimation or the transformation of the moisture content into gas without passing the liquid state.

Irradiation-transfer of extremely large amount of energy to effect very rapid and selective biological and chemical changes in meat.

JUST FOR FUN

A quest: Why are dumplings cold?
Waiter: Because they are Siberian.

UNIT 2. FRUIT PRESERVATION

Preserved fruits are now numerous, but not every kind of fruit is suitable for preservation. Some fruits, of course, are preferred in their natural state, while others are preferable and sometimes only procurable, in a *preserved condition.*

As most fruits are seasonable, it follows that those demanding them out of season must accept them in a preserved form. There are at least four different methods of preserving fruits: by *desiccation* (drying); by utilization of cold air; by the use of chemicals; and by the exclusion of air.

The fourth method is that in general use by canners, as is also the third so far as vegetables are concerned, and in the case of some fruits, perhaps, when the preserves wish to maintain or to create a "colouring". The second method is that of cold storage and refrigeration in all their ramifications. The first method is applied to such fruits as we shall now proceed to consider. The "drying" and "evaporating" methods are practiced extensively in *fruit-producing countries*. The former method is followed in such regions as are favoured with plentiful sunshine, and the latter in those countries which cannot rely upon the aid of climate.

Evaporation was unknown 100 years ago. Many inventors have introduced processes from time to time, but the machinery in general favour consisted of a slat floor with a furnace below. The heat rises through the slats and dries the spread out fruit there on. A recent system consists of steam pipes in the evaporating plants, designed to give uniformity of heat and to overcome the possibility of scorching the fluid.

Currants are the most common of all dried fruits consumed by the human family. They are the products of the vine, just as raisins, as every schoolchild knows, are grapes in a dried conditions. Not all varieties of grapes, however, are suitable for drying. The grapes destined to be converted into raisins are invariably dried on the vines, after semi-cutting, or on the ground after the manner of currant-drying. The *drying process* takes some days to complete, after which the fruit is put into boxes holding about 150 lb. to be transported to the packing houses. Sorting is the next process. The choicest are packed in boxes made to hold five, ten, fifteen and twenty pounds, and other grades are stemmed, seeded and packed in cartons of one pound capacity.

Machines called "*stemmers*" are brought into use for removing the stems. Again the fruit is graded and passed to a "seeder", which flattens raisins and brings the seeds to the surface, while another piece of mechanism, a teeth-like roller, removes the seeds.

Plums destined for the *leading grades* of prunes are gathered by hand, laid in shallow utensils, and then placed in a cool and dry building to soften. Afterwards they are put into *spent ovens* for about twenty-four hours, a procedure which is repeated until the fruit is of the requisite dryness. Later comes the cooling process and the final packing into cans, jars, boxes, or whatever receptacle is considered most suitable for the various markets. The drying process naturally calls for the exercise of care and skill, so that the fruit may not

be deprived of its original flavour and fruity consistency. Usually three pounds of plums are necessary to yield one pound of prunes, the exact proportion being regulated by the degree of waste during the drying processes.

Citron peel and *lemon peel* are consumed in large quantities by the people of Europe and America. There is difference in colour and thickness between the two commodities, even enough both are members of the citrus family of fruits.

The lemon peel is candied, otherwise the process of preserving is similar to that applied to the citron.

The rind is left to pickle for a few weeks in a salt solution, afterwards being boiled until it is tender, and then it is soaked in water slightly sweetened. The first soaking removes the greater part of the salt, but a succession of solutions is necessary before the peel is ready for the final process of preserving. The final treatment is in the nature of boiling in thick syrup. From the vats it passes in specially constructed racks into a heating room, where it dries and crystallized in due course.

Crystallized fruits. *Crystallized fruits* are now a very popular dessert, or confectionary, and they are made in many European countries. The fruits are made by extracting the juice from the raw product and replacing it with sugar syrup. The hardening of the syrup preserves the fruit, and as the latter is solidified its natural form is retained.

Several methods of crystallizing are in vogue, but that in general practice is the boiling of the fruit for a certain length of time, after which it is suspended in syrup until saturated.

In due course it is removed from the syrup process and placed in drying ovens, or drying rooms, at a high temperature until crystallized. In some countries the drying is done in the open air upon trays.

Active Vocabulary

dried fruits	сухофрукти
preserved fruits	консервовані фрукти
preservation	зберігання
preserve	зберігати, консервувати
preserved condition	умова зберігання
desiccation	сушка
deterioration	погіршення
treatment	обробка
fruit producing countries	країни, що вирощують фрукти
drying process	процес висушування
“stemmer”	пристрій для відділення плодоніжок
leading grade	перший ґатунок
spent oven	сушильна піч, сушка
lemon peel	лимонна шкірка
crystallized fruits	зацукровані фрукти
prune	чорнослив
soaking	вимочування

Task 1. Transcribe and pronounce correctly the following words:

preservation, utilization, evaporation, through, procedure, crystallized fruits, drying process, syrup, drying oven, pickle

Task 2. Match the word or words with the definition.

1. storage	a. turn from solid or liquid into vapour
2. preservation	b. removing moisture from food, drying
3. desiccation	c. article of trade, product as opposed to a service
4. ramification	d. keeping safe or free from decay
5. evaporate	e. vegetables, preserved in brine, vinegar, mustard, etc.
6. raisins	f. storing of goods etc.
7. commodity	g. consequence, subdivision of a complex structure or process
8. pickles	h. dried grape.

Task 3. Fill in the gaps using the words in the box.

preserve, soaking, fruit juices, sugar solution, consistency, food preservation, thick syrup, making, deterioration, extracting

1. To prevent _____ through the growth of any microorganisms in jams, marmalades, and jellies sufficient amounts of sugar usually are used.
2. Jams are made up largely of fruits held together by a _____ or jelly.
3. Preserves resemble jams but are usually of thinner _____ .
4. Jellies are made from _____ only.
5. In the preparation of all of these products, efforts are made to _____ the natural colour and flavour of the fruit.
6. The crystallized fruits are made by _____ the juice from the raw product and replacing it with sugar syrup.
7. Any kind of fruit or combination of fruits may be used in the _____ of jams and preserves.
8. Drying has been a means of _____ for centuries and is still used.
9. Foods containing sugar require less drying than others, as drying concentrates the _____ .
10. Most dried fruits require _____ before cooking.

Task 4. Answer the questions:

1. How many methods are there of preserving fruits?
2. Are currants the most common of all dried fruits consumed by the human family?
3. How are the grapes converted into raisins?
4. What can you tell about plums' drying process?
5. Where are citron peel and lemon peel consumed in large quantities?
6. How can we obtain crystallized fruits?

Task 5. Choose the correct form in bold.

1. Some fruits **are/is** preferred in their natural state.
2. A recent system **consisting/consists** of steam pipes in the evaporating plants.
3. Currants are the **more/most** common of all dried fruits consumed by the human family.
4. Machines called "stemmers" **are/is** brought into use for removing the stems.
5. Plums destined for the leading grades of prunes are **gathered/gathering** by hand.
6. They are **put/putting** into spent ovens for about twenty four hours.
7. Usually three pounds of plums **are/is** necessary to yield one pound of prunes.
8. The lemon peel **is candied/candied**, otherwise the process of preserving is similar to that **applying/applied** to the citron.
9. The fruits **are making/are made** extracting the juice from the raw product and replacing it with sugar syrup.
10. In due course it is removed from the syrup process and placed in drying ovens, or drying rooms, at a high temperature until **crystallizing/crystallized**.

Task 6. Translate into English.

1. На даний час існує багато методів зберігання фруктів.
2. Фрукти можна сушити, консервувати, заморожувати.
3. Можна сушити сливи, вишні, яблука, груші, абрикоси, фініки та інші фрукти.
4. Для виробництва джемів використовуються будь-які фрукти.
5. Мармелад і желе виготовляють тільки з фруктів, які містять пектин та достатню кількість кислоти.
6. Зацукровані лимонні та апельсинові шкірки дуже популярні в Європі та Америці.
7. Необхідно зберігати природний колір і смак фруктів при виробництві з них джемів і желе.
8. При приготуванні компотів потрібно слідкувати за тим, щоб фрукти не переварились і не втратили свій смак.

Task 7. Read the text without a dictionary and discuss it.

ANTIDEPRESSANT CATERING

Black chocolate is one of the most popular anti-depressants. Bitter and extra-black chocolate with high content of cocoa beans without additives is the best choice.

Almonds are also good for fighting depression and they protect the immune system. Almonds are very rich in calories. 30-50 g of dried or roasted almonds is the daily requirement for preventing seasonal disorders and colds.

Bananas. One banana a day is better than a handful of medicines prescribed for preventing depression. Besides the well-balanced vitamin content, bananas are rich in three kinds of natural sugar – sucrose, fructose and glucose, which in combination with cellulose are capable of lifting one's spirits and soothing the central nervous system.

Oranges. Life-asserting oranges or freshly squeezed orange juice are full of vitamin C and B, rich in pectin and help to excrete cholesterol. Oranges are especially good in the morning 30 minutes before breakfast on an empty stomach or many other fruits between meals.

Pumpkin seeds contain microelements conducive to generation of serotonin, for this reason people in a bad mood are recommended to nibble pumpkin seeds as a snack. They are also used in soups, salads and sauces.

JUST FOR FUN

Aunt: Here's a good piece of bread and butter.
Johny: Thank you, auntie.
Aunt: That's good, Johny. I like polite children, I like to hear little boys say "thank you".
Johny: If you want to hear me say it again, then put some jam on that piece of bread.

UNIT 3. MEAT PRESERVATION

The preservation of meat may be accomplished in numerous ways including the use of refrigeration, canning, drying, and salting, pickling, and curing. The latter methods are of ancient origin and are widely used at present, both in the modern packing house as well as in rural communities.

Salting is often followed or combined with other processes, such as smoking, which improves both the flavour and *keeping qualities* of special products, including hams, and bacon. In the use of salt as a preservative, either alone or in combination with such compounds as saltpeter, nitrates of sodium or potassium, there are several objectives. It is necessary to prevent spoilage by microorganisms, but in addition the final product must have a desirable taste and flavour. The appearance must also be attractive. It has been common practice for many years to use the *pickling solution* because of increased efficiency in curing meat products. More recently, the nitrites have been found even more effective. The *nitrates* serve a useful purpose in respect to the appearance of the products because when they are present, certain changes take place where the hemoglobin of the meat tissues is chemically combined to form nitrosohemoglobin.

The nitrites are more effective than nitrates in checking spoilage and also have the colour fixing ability. Sugar is also used as a constituent of pickling solutions. Many of the solutions containing sugar are called sweet pickling processes. In some instances the so-called dry sugar cures may be used, in which case the meat is packed in tight containers and sprinkled with dry mixtures of salt, sugar and small quantities of nitrate or nitrite. It is a common practice of smoke some salt-cured meat and meat products.

The *smoking process* preserves not only on account of some drying of the meat through the heat applied during smoking but also on account of the chemicals

deposited on the surface. These compounds may penetrate somewhat into the meat and to inhibit bacterial growth and action, instead of smoking meats it is possible to use a specially prepared salt meat. Such salts have a pleasant smoked flavour which may be imparted to meat by using dry-curing processes and eliminating the smoking operation. Meats may be preserved by means other than refrigeration, although chilling is the first step, and preliminary to any further treatment.

In Europe a number of different methods have been suggested to accomplish the same purpose. One depends on injecting the *brine* by pressure into the heart of the still bleeding animal. Another depends on the injection of the brine into a *blood vessel* under pressure after *rigor mortis* has set in. A third method consists in subjecting the meat to a vacuum and then subjecting it to a brine under pressure for several hours.

Pork curing. Bacon and hams. Pork is sometimes dry-cured by rubbing with salt and piling-in stocks in curing cellars, which are kept at relatively low temperature. A small percentage of *saltpeter* may be added to the salt to assist in the colouring of the tissues. If the cuts are packed by layers and other curing agents added between the layers, there will eventually be a brine formed owing to the extraction of water from the tissues. This method is commonly used for bacon which requires several weeks to cure, after which it is removed from the brine, soaked in water for short time and smoked. The soaking may be omitted if the meat is subjected to a spray of hot water followed by drying with a compressed air jet which evaporates the excess moisture on the surface.

Bacon is usually aired for a number of hours in the warm air of the *smoking chamber* before the actual smoking is started. When the smoking is completed any salt which has crystallized on the interior is brushed off and the bacon packed in boxes, barrels, or other containers for shipment.

Some bacon, sliced or unsliced, is now packed in transparent parchment to keep it clean and preserve its appearance. Bacon may also be canned. Hams, which make up one of the most valuable meat products from hogs, are the hind legs of swine from above the hock. There are many kinds of hams depending largely on the type of curing process and the methods of smoking used. The flavours are due in part to the pickle, which may contain sugar. Along with the other agents mentioned above, flavours may also be due in part to the wood used in smoking.

Most hams contain an abundance of fat, but Virginia hams, which are quite noted for quality and flavour, are relatively lean. The function of the smoke is not merely to impart the characteristic flavour, but it also serves to inhibit the microorganisms, which gain access to the surface of the meat.

Lard. Lard is the fat separated from the *adipose tissues* of hogs for use as a food Three kinds of lard are manufactured on a commercial basis: prime steam, neutral, and kettle-rendered. Lard is packed and sold as smooth or grainy lard. Smooth lard is lard which is cooled quickly to prevent the separation of the oil and stearin. It is precooled to about 110 °F and further cooled by a lard roll, a metal cylinder cooled within by means of brine or by the direct expansion of amnionic.

Grainy lard is preferred by certain commerce. It derives its name from the grainlike appearance of the solid portion. Lard may be stored in tubs. Sodium silicate is sometimes used on the inside of wooden tubs and pails in order that lard may not be absorbed and thus wasted. Paraffin is employed often instead of silicate. Neutral lard is manufactured mainly from back fat and leaf fat. The material is chilled, cut up very fine, and placed in a *water-jacketed kettle.* The water in the jacket is slowly heated, causing the lard to separate from the fibrous material. Lard obtained by this process is white, but without definite flavour. It is used in the manufacture of margarine without treatment.

Kettle-rendered lard. Lard of this kind is made from the better grades of fats. The fats are basketed into steam-jacketed kettles, the fat separated from the fiber and then put up into packages while still hot.

Active Vocabulary

pickling	маринування
flavour	смак, аромат
keeping qualities	збереження якості
saltpeter	селітра
spoilage	псування
pickling solution	маринад
nitrate	нітрат, сіль або ефір азотної кислоти
potassium	калій
smoking process	процес коптіння
preserve	зберігати
surface	поверхня
brine	розсіл, рапа
blood vessel	кровоносна судина
rigor mortis	трупне задубіння
pork	свинина
soak	вбирати, всмоктувати
smoking chamber	коптильна камера
sliced	нарізаний
parchment	пергамент
ham	шинка
merely	тільки, просто
impart	давати, додавати
lard	сало
adipose tissue	жирова тканина
grainy lard	зернистий лярд, свиняче сало
tub	діжка, баддя
water-jacketed kettle	котел з водяним охолодженням
treatment	обробка
kettle-rendered lard	котельний лярд (пряжений у відкритому котлі)

Task 1. Transcribe and pronounce correctly the following words.

slice, nitrate, flavour, surface, saltpeter, brine, treatment, spoilage, impart, manufacture

Task 2. Match the word or words with the definition.

1. pickle	a. thick white fat used in cooking
2. brine	b. to preserve food in vinegar and salt
3. treatment	c. to cook something slowly
4. solution	d. processing
5. steam	e. a liquid in which a solid or a gas has been dissolved
6. stew	f. a type of Italian food
7. lard	g. the mist that hot water produces
8. lasagna	h. salty water, often used for preserving food

Task 3. Fill in the gaps using the words in the box.

low temperature, desirable, characteristic flavour, smoked, salted, methods of smoking, appearance, curing

1. The main aim of food preservation is to prevent spoilage by microorganisms, but in addition the find products must have a _____ taste and flavour.
2. Smoke contain phenols which help in the preservation of _____ products.
3. Potassium nitrite and potassium nitrate, used in the _____ of pork and beef, improve the taste and redden the colour.
4. _____ products are usually partly dried as well as salted.
5. The nitrates serve a useful purpose in respect to the _____ of the products because when they are present certain changes take place.
6. There are many kinds of hams depending on the type of curing process and the _____ used.
7. The function of the smoke is not merely to impart the _____, but also serves to inhibit the microorganisms, which gain access to the surface of the meat.
8. Pork is sometimes dry-cured by rubbing with salt and piling in stocks in curing cellars which are kept at relatively _____ .

Task 4. Answer the questions.

1. What methods of meat preservation do you know?
2. What does the smoking process preserve?
3. What is it possible to use instead of smoking meats?
4. What do you know about pork curing?
5. What is lard?
6. What kinds of lard do you know?
7. What lard is used in the manufacture of margarine?

Task 5. Choose the correct form in bold.

1. The preservation of meat may be **accomplish/accomplished** in numerous ways.
2. The appearance of the final product **must/may** have a desirable taste, flavour, appearance.

3. Sugar **is/are used** as a constituent of pickling solution.
4. In Europe a number of different methods **has/have been suggested** to accomplish the same purpose.
5. This method **is/are commonly used** for bacon which require/requires several weeks to cure.
6. Some bacon, sliced or unsliced, **is packed/is packing** in transparent parchment to keep it clean and preserve its appearance.
7. Lard is the fat **separating/separated** from adipose tissues of hogs for use as a food.
8. The water in the jacket is slowly heated, **causing/caused** the lard to separate from the fibrous material.

Task 6. Translate into English.

1. Копчене і мариноване м'ясо зазвичай зберігають в холодильниках і погребах.
2. В розсіл для засолювання м’яса обов’язково повинні входити цукор, а також селітра, яка надає м’ясу приємного кольору.
3. Бекон і окіст після маринування піддають в’яленню.
4. Новим методом засолення м’яса є вприскування. Спеціальним шприцом розсіл вводять у кровоносні судини під тиском одразу після забою тварини.
5. Лярд буває декількох видів: чистий, м’ясний, еластичний і зернистий.
6. Деякі сорти лярду використовують у виробництві маргарину без подальшої обробки.
7. Еластин не піддається впливу тепла, тому м'ясо, яке містить значний його відсоток, важко зробити м’яким при обробці.
8. Перед коптінням бекон провітрюють на теплому повітрі протягом декількох годин, а потім коптять.
9. Якщо після коптіння на беконі залишається сіль, її витирають і бекон складають в ящики або інші контейнери.

Task 7. Read the text without a dictionary and discuss it.

FOOD CELEBRATES LIFE

Have you ever noticed how much of our life is centered on food? Look at all the meeting held, decisions made, and mergers consummated over a meal: power breakfasts, power lunches, dinner, banquets, receptions, and those endless toasts. Consider all the celebrations where food is all-important: weddings, birthdays, religious feast days, national holidays, etc. Food is the great icebreaker when people meet for pleasure or business. Food is at the center of many of our important activities.

Often the difference among cultures in the foods they eat related to the difference in geography and local resources. People who live near water (the sea, lakes, and rivers) tend to eat fish and crustaceans. People who live in colder climates tend to eat heavier, fatty foods. However, with the development of a global economy, food boundaries and differences are beginning to dissipate: McDonalds is now on every continent except Antarctica, and tofu and yogurt are served all over the world.

JUST FOR FUN

A shop-assistant: What do you want, madam?
A customer: Cut me please, bit meat, so it is in harmony with blue and green flowers on my plates.

UNIT 4. FISH PRESERVATION AND COOKING

Fish is about 26 per cent protein, which is complete, well balanced and not easily affected by the usual cooking method. It is 85 per cent to 95 per cent digestible. Fish supply 5 per cent to 10 per cent of the National's supply of animal proteins for human food requirement. The amount of fat in fish is less than 1 per cent in cod, haddock, whiting, rockfish and sole; to 20 per cent in salmon, mackerel, lake trout and butter-fish. The fat is easily digested and is used readily by the body tissues.

Continuing research has established the nutritive value of some of the unsaturated fatty acids peculiar to some fish.

The vitamin content of fish varies an average serving of 3–5 ounces of cooked salmon and mackerel, which are fat fish, provides about 10 per cent of the daily requirement of vitamins A and D. The mineral content of the edible part of most includes satisfactory sources of magnesium, phosphorus, iron, copper and iodine.

Shellfish, clams, crabs, lobsters, oysters, scallops, and shrimp has an abundance of these minerals – about as much as milk. The softened bones in canned fish, which are good to eat, are good sources of calcium and phosphorus. An average serving of six oysters supplies more than the daily need of iron and copper.

There are about 200 commercial species of fish, but most people are familiar with fewer than 20 and recognize even fewer than that on a dinner plate.

The two major groups of fish – the finfish and shellfish (oysters, clams, blue crabs, lobsters) — have enough variety to suit every taste and meet every need. Among the shellfishes are frog legs, turtle steaks, octopus and squid. They are the less common foods; urchin, a spiny brittle shelled organism, is usually eaten raw. Sea cucumbers are better known as the dried and smoked «trepang» or beche-de-mer of the South Seas. Fresh and frozen fish are marketed in various forms for different uses.

Knowing these forms of «cuts» is important in buying fish. The best known are:

- *Whole.* As they come from the water. Before cooking must be scaled, and the insides removed, and usually the head, tail and fins removed.
- *Drawn*. Whole fish with insides removed. Generally scaled before cooking, and usually the head, tail and fins removed.
- *Dressed or pan-dressed*. Whole fish with scales and insides removed, usually with head, tail and fins removed. Ready to cook as purchased.
- *Steaks*. Cross-section slices from large dressed fish. Ready to cook as purchased.

- *Fillets.* Sides of the fish, cut lengthwise away from the back bone. Ready to cook as purchased. Practically boneless.
- *Sticks.* Pieces of fish cut from the blocks of frozen fillets into portions of uniform dimensions, usually about one half inch deep, and weigh approximately 1 ounce.
- *Canned fish*. Ready for use and includes many varieties of both fish and shellfish.

How to know good fish? In selecting whole fresh fish, look for bright, clear, bulging eyes, gills reddish, free from slime or odour; firm elastic flesh-springing back when pressed.

Amounts to buy. A serving of fish is generally one third to one half pound of edible flesh.

Therefore, for whole fish allow about one pound per person. For dressed fish allow one-half pound per person or three pounds for six people. For steaks, fillets or sticks, allow one third pound per person or two pounds for six people.

Active Vocabulary

balanced	збалансований
supply (n, v)	постачання, постачати
cod	тріска
haddock	пікша (вид тріски)
mackerel	макрель, скумбрія
whiting	мерланг (риба)
rock-fish	морський окунь
salmon	лосось
trout	форель
herring	оселедець
butterfish	маслюк (риба)
peculiar to	характерний (властивий) для
provide	забезпечувати
iodine	йод
finfish	плавникова риба
shellfish	молюск
clam	молюск
crab	краб
lobster	омар
oyster	устриця
shrimp	креветка (маленька)
scallop	гребінець (молюск)
squid	кальмар
an average serving	середня порція (їжі)
species	вид (и) (рослин, тварин)
remove insides	видалити нутрощі (тельбухи) у риби
fin	плавник
dressed fish	розділена риба (напівфабрикат)
drawn fish	вительбушена риба

boneless	без кісток
fillets	філе
scale fish	чистити рибу від луски, лускати рибу
caviar	ікра

Task 1. Match the word with its definition.

1. digest	number of
2. edible	portion
3. body tissue	the substance that human body cells are made of
4. amount	change easily food in one's stomach into the substances one's body needs
5. serving (food)	that can be eaten without any harm
6. shellfish	with fins (fish)
7. drawn fish	remove scale (of fish)
8. fin-fish	with insides removed
9. dressed fish	clams
10. scale fish	prepared (fish) in such a way (cleaned, taken out non-edible parts) that it can be cooked

Task 2. Fill in the gaps using the words in the box.

shellfish, nutrition, liver oil, caviar, amount, extractive substances, canned, prevention, herring, fin-fish

1. Fish takes an important place in food _____ .
2. A specific taste and aroma of fish meat are due to the _____ .
3. Salt-water fish generally contain large _____ of vitamin D.
4. Vitamin D is effective in _____ and cure of rickets.
5. It is present in cod _____ and other fish liver oils.
6. _____ , mackerel, canned salmon and sardines are good sources of this vitamin.
7. The softened bones in _____ fish, which are good to eat, are good sources of calcium and phosphorus.
8. The two groups of _____ and shellfish have enough variety to suit every taste.
9. There are some kinds of _____ caviar.
10. _____ supply satisfactory sources of magnesium, iron, copper.

Task 3. Choose the right answer.

1. I enjoyed this fish salad. Would you mind letting me have the _____ for it?
   a) menu b) receipt c) recipe
2. A food blender is very useful _____ to have in the kitchen.
   a) gadget b) equipment c) tool

3. The fridge was _____ with food.
a) affluent b) crammed c) full
4. We buy a month's supply of fish and keep it in the _____ .
a) freezer b) container c) cabinet
5. Would you put the water on, please, ready to _____ the potatoes.
a) brown b) bake c) boil
6. The recipe is a secret, it has been _____ from father to son for generations.
a) made up b) spoken of c) put off
7. How do you like your eggs _____ ?
a) ready b) done c) made
8. Frozen food should always be _____ before it is cooked.
a) defrosted b) softened c) melted
9. Chocolate _____ if you keep it in your pocket.
a) flows b) ripens c) melts
10. Can you give me a teaspoon to _____ my tea?
a) spin b) turn c) stir

Task 4. Answer the questions.
1. What is the protein content of fish?
2. What can you say about animal protein in fish?
3. What do you know about the shellfish?
4. What is the good source of calcium and phosphorus?
5. How many species of fish do you know? 6. What groups of fish do you know?
7. How can you tell good fish?
8. What can you say about vitamin and mineral content of fish?

Task 5. You and your partner are in the fish restaurant.
What is going to be on the menu today?

Menu

Soup of the day
(salmon soup)
Sea bass
served with spicy mango-salsa
Rock-fish fillet steak
with choice of pepper or red wine sauce
Fried trout *with vegetables*
Cod liver pate
Fish pie
Tuna salad
Prawn salad
Seasonal fruit compote
Ice cream

Look at the menu and discuss what you want to eat, using the prompts below:

Asking for information
What would you like?
What do you recommend?
What exactly is that?

Complaining
Excuse me …
Think this bill is wrong.
That's not what I ordered.
Can you change it?

Giving advice
I suggest …
It's a local dish
It's made of …
It's very spicy.

Paying
Do you take (Visa cards)?
Shall we split the bill?
I'm paying.
Is service included?
Can I have a receipt, please?

Ordering
To start … / As a starter …
As a main course …
For dessert …

Task 6. Complete the following:
1. Where can I buy …?
2. Will you help me to choose …?
3. What's the price of …?
4. Where can I get …?
5. I've run out of …
6. Where is the nearest …?
7. They sell a lot of delicious things at the …
8. Have you got …?

Task 7. Translate into English.
1. Рибні продукти посідають важливе місце в харчуванні людини.
2. М'ясо риб має специфічний смак і аромат, обумовлений своєрідним складом екстрактивних речовин і ліпідів.
3. М'ясо риб характеризується значним коливанням вмісту білків від 0,5 до 26%.
4. М'ясо різних видів риб містить від 1,5 до 5,5% колагену.
5. В процесі зберігання риби колаген та еластин не зазнають значних змін.
6. Проте білки м'язових волокон підлягають ферментативному гідролізу з утворюванням вільних амінокислот і пектидів.
7. Особливий специфічний смак риби пояснюється не тільки підвищеним вмістом в ній азотистих екстрактивних речовин, а й своєрідним їх складом.
8. Жир риб характеризується низькою температурою плавлення (12-28 C^o) і високим вмістом ненасичених жирокислот.
9. Серед молюсків високим вмістом холестерину відзначається м'ясо кальмара.
10. На заклади громадського харчування рибу привозять, як правило, замороженою, вительбушеною,

без голови.

Task 8. Read the text without a dictionary and discuss it.

DO YOU KNOW THAT...

A British institution is under threat. No, it is not the Royal Family, not the BBC, not red buses – it is more important than that: it is the fish and chip shops.

For over a hundred years, fish and chip shops up and down the country have supplied the less well – off with a cheap and nutritious meal. But now many people in Britain can't afford even this simple pleasure. Newspapers report that customers in many pooper areas are cutting back on their fish and chips. Many chip shops have already shut, with more closures to come. If the fish and chip shops die, it will be a sad day for a British popular culture. No one quite knows when fried potatoes were first united with fish, but fried fish was on sale in the streets of London in the 1830s. Fried chipped potatoes are thought to have been introduced into Britain from France in the 1870s.

However they started, fish and chip shops spread rapidly. By the end of the 19th century, there was on every second or third street corner in industrial towns. They soon became a very important part of working-class life – a social focus, as well as a source of cheap hot food.

But even if the traditional shops die out, fish and chips are now part of British culture – and even a tourist attraction – and they won't disappear. Restaurants chains all over London and other cities advertise "the great British dish" against a background of a Union Jack – and wrap their chips in imitation newspaper. It's not quite a real thing, but at least it's still there.

Task 10. Fill in the gaps using the correct words to form the idiom.

couch potato, cup of tea, bee, lump, pigs, tea, pinch of salt, road hog, sour, bottleneck

1. "Do you think I'll be a famous rock star one day?"
"_____ might fly! You can't even sing."
2. "She hasn't congratulated you on getting your book published because hers was turned down."
"It's only _____ grapes on her part."
3. "I wouldn't be married to Louis – not for all the _____ in China!" Kim told her best friend.
4. I don't like opera. It's not really my _____.
5. He looks puzzled. He might have a _____ in his bonnet.
6. Mother was treating her as a small child and she had a _____ in her throat.
7. He tends to exaggerate a lot. If I were you I'd take everything he says with a ____.
8. Try to avoid driving along the High Street in the mornings as it's a bit of a _____ during the rush hour.
9. "People like you shouldn't be allowed on the road because you're a real _____!"
10. "You should spend more time in the open or you might turn into a _____."

JUST FOR FUN

My mother never eats beef. She has a bee in her bonnet about it causing the human form of "mad cow disease."

UNIT 5. BALANCED FOOD IN HUMAN DIET

No one food furnishes all the necessary food elements. A day's, or even a week's menus should be considered as a unit, rather than one meal. By varying the foods from meal to meal, and day to day, one may include all the essential foods.

A thorough knowledge of the chemical composition of foods, and of the physiology of digestion, makes possible a wiser selection of food. One must maintain a good balance of carbohydrates, fats, proteins, and the regulatory elements, i.e., minerals, cellulose, water, and vitamins. The adult person requires a certain amount of fuel foods for the constant functioning of the many involuntary body activities, as muscular tone, secretion of fluids, respiration, and circulation of blood.

The big factor that increases the demand for fuel is exercises or work. Therefore, the more a person exercises, the more he requires fuel foods. These fuel foods are those foods which contain carbon, hydrogen, and oxygen. These elements are found in all fuel, such as wood, coal, alcohol, kerosene.

The food that contain carbon, hydrogen, and oxygen are classified as (1) the carbohydrates, i. e., starches and sugars, (2) the fats, and (3) the proteins: meat, milk, eggs. In the body these three classes of foodstuffs produce energy and leave, as waste, carbon dioxide, and water. These end products are easily disposed of through the lungs, skin, and kidneys.

Proteins, the animal foods, have an added element of nitrogen, and sometimes phosphorus, sulphur, and iron. Since the tissues of our bodies are composed of these same elements, proteins have a special function of building new tissues and of keeping in repair old tissues. If proteins are used for fuel in the body, only the carbon, hydrogen, and oxygen are used, and the nitrogen, sulphur, phosphorus, and iron are but waste products to be eliminated through the kidneys. Proteins are expensive foods, and if used as fuel, only part of the elements are really utilized in the body.

It is therefore wise to use carbohydrates and fats to furnish the fuel for the body, and to use just enough protein to keep the tissues in repair. Tissue building is fairly constant in the adult. It is only in case of actual body growth that extra supply of protein is necessary. Therefore children and invalids require a good supply of milk, eggs, and other simple proteins to build up new tissues.

Our bodies are so complicated in form, that starches, fats, and proteins are not sufficient to supply all our needs. Certain minerals, as iron, calcium, phosphorus, and iodine are equally important in the repair and functioning of the body. Calcium forms a large per cent of bones and teeth. Therefore no one can afford to overlook a generous amount of calcium foods, as milk, milk products, and oranges. Iron is needed in the blood, and in other body fluids. Sources of iron are eggs, fresh, leafy green vegetables onions, carrots, and the bran of cereals. In general we may say, the necessary minerals may be secured by using daily a variety of vegetables, fruits, whole cereals, and plenty of milk and eggs.

Another dietetic factor is cellulose, or bulk of the food. In recent years there has been a tendency to so refine our foods that we do not get the proper amount of bulk. The bulk is obtained from the fibrous part of fruits, and vegetables, and from

the outer coats of cereals. Cellulose is neither fuel nor tissue builder, but as waste it increases the rhythmic movement of the digestive tract and acts as a cleanser.

Much has been said in the past few years about a new set of necessary food constituents, called vitamins. Scientists have found that without these the body ceases to function properly. Many of the common diseases attributed to malnutrition are now said to be caused by a lack in the diet of one, or two, or all of the vitamins.

Vitamin A is found in leafy green vegetables, eggs, yolk, butter, cream, carrots, rutabagas, spinach, cabbage, yellow corn, and sweet potatoes. It is fairly stable to heat. Lack of this constituent causes eye diseases, and forms of rickets. Vitamin B is found in plant life, as oranges, spinach, cabbage, turnips, beets, tomatoes, carrots, potatoes, onions, and the embryo of cereals. Deficiency of vitamin B causes a lack of appetite, and general lassitude. Vitamin C is easily destroyed by heat, except in acid solution.

Good sources of vitamin C are tomatoes, and uncooked greens, orange and lemon juice, fresh fruit, raw cabbage, and raw beets. Its absence is shown in skin diseases.

We may say that to avoid any dangers due to shortage of these protective foods, the diet must contain milk, fresh vegetables, leafy greens, eggs, butter fat, and whole cereals. Canned vegetables may lose much of their value as sources of vitamins, due to high pressure cooking, especially if one does not use the liquid in are canned.

For the growing child one must provide a goodly supply of foods rich in mineral and vitamins. In the delicate and intricate weaving of new body cells it is of the utmost importance that not one of the vital constituents be omitted. There is no one perfect food. No vegetable or fruit, can be used to the exclusion of all others. A variety of all the many fruits and vegetables is essential, not only for appetite's sake, but for the actual needs of the body.

A good balance between fat, sugar, and protein is to be desired. Excessive sugar ferments in the stomach cause distress from gas. FaT retards stomach digestion. Therefore, in a meal rich in fat and sugar, the action of the stomach is delayed until fermentation takes place. This is apt to happen after a holiday dinner.

Excessive use of meat tends to intestinal disorders, due to increased bacterial action. Meat is of such pleasing flavour that one must guard against the excessive use of meat to the exclusion of all essential vegetables, fruits, and dark breads.

It is not expected that every meal of the day will contain all the desired foodstuff in the proper amounts, but the day's meals, or the week's meals, can be considered as a unit. Surely in the course of a week the meals can have a good balance of starch, sugar, whole cereals, fat, milk products, eggs, meat, and variety of vegetables and fruits.

Active Vocabulary

almond	мигдаль
bulk of food	основна маса їжі
cereals	хлібні злаки

deficiency	відсутність, дефіцит
digestion	травлення
digestive tract	травний тракт
eliminate	виділяти, видаляти з організму
excessive	надмірний
fluid	рідина
foodstuffs	продукти харчування
fuel foods	їжа як джерело енергії
intestinal disorder	кишковий розлад
intricate	заплутаний, складний
involuntary	мимовільний, ненавмисний
iron	залізо
kidneys	нирки
leafy green vegetables	листові овочі
lungs	легені
malnutrition	недоїдання
meal	їжа
respiration	дихання
rutabaga	бруква
shortage	нестача, брак
skin	шкіра
waste products	відходи

Task 1. Transcribe and pronounce correctly the following words:

digestion, respiration, fuel, phosphorus, shortage, malnutrition, kidney, foodstuffs, rhythmic, desirable

Task 2. Match the word or words with the definition.

1. digest	a. liquid or secretion
2. malnutrition	b. too much or too great
3. fuel	c. breathing
4. respiration	d. assimilate (food) in the stomach and bowels
5. full-blooded	e. grain used for food
6. fluid	f. food as a source of energy
7. gravy	g. vigorous, hearty, sensual
8. effect	h. condition resulting from the lack of foods necessary for health

Task 3. Fill in the gaps using the words in the box.

desirable, sufficient, body fluids, minerals, decomposition products, skim milk, tissue builder, needs

1. The human bodies are so complicated in from, that starches, fats and proteins are not _____ to supply all our needs.
2. In the repair and functioning of the body certain _____ as iron, calcium, phosphorus are very important.

3. Iron is needed in the blood and in other _____.
4. Cellulose in neither fuel nor _____, but it increases the rhythmic movement of the digestive tract.
5. A variety of all the many fruits and vegetables is essential for the actual _____ of the body.
6. Dried _____ is a very economical source of milk proteins and minerals.
7. All cheeses may be considered as rich sources of protein and protein _____ and minerals, especially calcium.
8. The use of white bread is less _____ from nutrition point of view.

Task 4. Answer the questions:
1. What are the main principles of menu making?
2. What is required for the body activity of the adult person?
3. What do the fuel foods contain?
4. What special function have proteins as animal foods?
5. What is the reason of the common diseases?
6. What are the iron sources?
7. What is the role of cellulose in human diet?
8. What tends to intestinal disorders?

Task 5. Choose the correct form in bold.
1. The big factor that **increase/increases** the demand for fuel is exercises and work.
2. The **more/most** a person exercises, the more/most he requires fuel foods.
3. Proteins **have/had** a special function of building new tissues and of keeping in repair old tissues.
4. Calcium **form/forms** a large per cent of boo and teeth.
5. In recent years there **has/had** been a tendency to refine our foods.
6. Cellulose **increases/increasing** the rhythmic movement of the digestive tract and **acting/acts** as a cleanser.
7. Excessive use of meat **tend/tends** to intestinal disorders, due to increased bacterial action.
8. It is not **expected/expecting** that every meal of the day will contain all the desired foodstuffs in the proper amounts, but the day's meals can be considered as a unit.

Task 6. Translate into English.
1. Їжа є джерелом енергії для живого організму.
2. Молоко і молочні продукти мають важливе значення в щоденному раціоні людини.
3. Харчові продукти повинні містити білки і вітаміни.
4. В щоденний раціон харчування обов'язково повинні входити вітаміни оскільки їх нестача призводить до різних захворювань.
5. Фрукти і овочі є джерелом вітамінів і мінеральних солей.
6. Житнє борошно містить більше мінеральних солей, жирів, вітамінів, ніж біле і тому більш поживне.
7. Необхідно стежити за тим, щоб в тижневий раціон харчування людини входили всі необхідні для життєдіяльності організму речовини.

Task 7. Read the text and mark these sentence true (T) or false (F).

UKRAINIAN FOOD

Ukrainian cuisine is very varied, and Ukrainians are known for their hospitality. Though more and more cafes, bars and restaurants are opened offering excellent food at reasonable prices, Ukrainians will never miss a chance to invite you to a family gathering. Women gladly spend a lot of time and energy in the kitchen cooking for family and guests. Usually a traditional festive meal begins with a huge number of starters followed by the main course. The aim is to ensure that a guest's plate is never empty!

Borshch is a soup based on beetroot with meat and vegetables: served with sour cream.

Varenyky are ravioli-like pasta stuffed with mushrooms, meat, cottage cheese, potato, cabbage or cherries (as a dessert).

Holoobtsee – cabbage leaves stuffed with rice and vegetable, or with spicy minced meat.

Mlyntsee – pancakes, often made with sour milk.

At the risk of offending vegetarians, a description of the Ukrainian cuisine would be incomplete without salo – pork lard. Spices are rubbed into the skin and the lard then allowed to stand in cold place. It is eaten in salted thin slices with bread. The smoked version is especially delicious.

Ukrainians are very fond of milk and kefeer (sour version of yoghurt). They also like refreshing non-alcoholic kvas made from fermented brown bread. Uzvar is another summer favourite made from stewed fruit and very similar to iced fruit tea.

Ukraine has a tradition of drinking spirits. Horilka is a popular spirit for adults, mostly men. Women enjoy wine, nalyvka (infusion of fruit and horilka) or vyshnivka (especially tasty variety made from cherries).

1. Ukrainians will never miss a chance to invite you to a family gathering.
2. Borshch is usually served with sour cream.
3. At the risk of offending vegetarians, a description of Ukrainian cuisine would be incomplete without pork steak.
4. Ukraine has a tradition of drinking wines.
5. Coca-cola is a favourite spirit for adults.
6. Nalyvka is an infusion of fruit and horilka.

JUST FOR FUN

A young man who was a sports man went into a snack-bar for lunch and took off his overcoat. He knew the kind of people who went to that snack-bar so he took a piece of paper and wrote on it:

"This overcoat belongs to Bill Basher, the famous athlete, he will be back in ten minutes", and fixed this on the coat.

When he came back, the overcoat wasn't there, but on the paper someone had written:

"Overcoat taken by famous runner. He won't be back at all."

ЗАВДАННЯ ДЛЯ САМОСТІЙНОЇ РОБОТИ

ADDITIONAL READING

Food preservation

Preservation processes include:

Heating to kill or denature micro-organisms (e.g. boiling). Oxidation (e.g. use of sulfur dioxide).

Toxic inhibition (e.g. smoking, use of carbon dioxide, vinegar, alcohol etc.). Dehydration (drying).

Osmotic inhibition (e.g. use of syrups).

Low temperature inactivation (e.g. freezing).

Ultra high water pressure (e.g. fresherized, a kind of "cold" pasteurization, the pressure kills naturally occurring pathogens, which cause food deterioration and affect food safety).

Combinations of these methods.

Drying.

One of the oldest methods of food preservation is by drying, which reduces water activity sufficiently to prevent or delay bacterial growth.

Refrigeration

Refrigeration preserves food by slowing down the growth and reproduction of microorganisms and the action of enzymes which cause food to rot. The introduction of commercial and domestic refrigerators drastically improved the diets of many in the Western world by allowing foods such as fresh fruit, salads and dairy products to be stored safely for longer periods, particularly during warm weather.

Frozen food

Freezing is also one of the most commonly used processes commercially and domestically for preserving a very wide range of food including prepared food stuffs which would not have required freezing in their unprepared state. For example, potato waffles are stored in the freezer, but potatoes themselves require only a cool dark place to ensure many months' storage. Cold stores provide large volume, long-term storage for strategic food stocks held in case of national emergency in many countries.

Heat treating

Thermization, Pasteurization, and Sterilization (microbiology). This section requires expansion.

Vacuum packing

Vacuum-packing stores food in a vacuum environment, usually in an air-tight bag or bottle. The vacuum environment strips bacteria of oxygen needed for survival, slowing spoiling. Vacuum-packing is commonly used for storing nuts to reduce loss of flavor from oxidation.

Salt

Salting or curing draws moisture from the meat through a process of osmosis. Meat is cured with salt or sugar, or a combination of the two. Nitrates and nitrites are also often used to cure meat and contribute the characteristic pink color, as well as inhibition of Clostridium botulinum.

Sugar

Sugar is used to preserve fruits, either in syrup with fruit such as apples, pears, peaches, apricots, plums or in crystallized form where the preserved material is cooked in sugar to the point of crystallisation and the resultant product is then stored dry. This method is used for the skins of citrus fruit (candied peel), angelica and ginger. A modification of this process produces glacй fruit such as glacй cherries where the fruit is preserved in sugar but is then extracted from the syrup and sold, the preservation being maintained by the sugar content of the fruit and the superficial coating of syrup. The use of sugar is often combined with alcohol for preservation of luxury products such as fruit in brandy or other spirits. These should not be confused with fruit flavored spirits such as cherry brandy or Sloe gin.

Artificial food additives

Preservative food additives can be antimicrobial; which inhibit the growth of bacteria or fungi, including mold, or antioxidant; such as oxygen absorbers, which inhibit the oxidation of food constituents.

Freezing

Common antimicrobial preservatives include calcium propionate, sodium nitrate, sodium nitrite, sulfites (sulfur dioxide, sodium bisulfite, potassium hydrogen sulfite, etc.) and disodium EDTA. Antioxidants include BHA and BHT. Other preservatives include formaldehyde (usually in solution), glutaraldehyde (kills insects), ethanol and methylchloroisothiazolinone.

Pickling

Pickling is a method of preserving food in an edible anti-microbial liquid. Pickling can be broadly categorized as chemical pickling for example, In chemical pickling, the food is placed in an edible liquid that inhibits or kills bacteria and other micro- organisms. Typical pickling agents include brine (high in salt), vinegar, alcohol, and vegetable oil, especially olive oil but also many other oils. Many chemical pickling processes also involve heating or boiling so that the food being preserved becomes saturated with the pickling agent. Common chemically pickled foods include cucumbers, peppers, corned beef, herring, and eggs, as well mixed vegetables such as piccalilli. In fermentation pickling, the food itself produces the preservation agent, typically by a process that produces lactic acid. Fermented pickles include sauerkraut, nukazuke, kimchi, surstromming, and curtido. Some pickled cucumbers are also fermented. In commercial pickles, a preservative like sodium benzoate or EDTA may also be added to enhance shelf life.

Lye

Sodium hydroxide (lye) makes food too alkaline for bacterial growth. Lye will saponify fats in the food, which will change its flavor and texture. Lutefisk uses lye in its preparation, as do some olive recipes. Modern recipes for century eggs also call

for lye. Masa harina and hominy use agricultural lime in their preparation and this is often misheard as “lye”.

Canning and bottling preserved food

Canning involves cooking food, sealing it in sterile cans or jars, and boiling the containers to kill or weaken any remaining bacteria as a form of sterilization. It was invented by Nicolas Appert. Foods have varying degrees of natural protection against spoilage and may require that the final step occur in a pressure cooker. High-acid fruits like strawberries require no preservatives to can and only a short boiling cycle, whereas marginal fruits such as tomatoes require longer boiling and addition of other acidic elements. Low acid foods, such as vegetables and meats require pressure canning. Food preserved by canning or bottling is at immediate risk of spoilage once the can or bottle has been opened.

Lack of quality control in the canning process may allow ingress of water or microorganisms. Most such failures are rapidly detected as decomposition within the can causes gas production and the can will swell or burst. However, there have been examples of poor manufacture (underprocessing) and poor hygiene allowing contamination of canned food by the obligate anaerobe Clostridium botulinum, which produces an acute toxin within the food, leading to severe illness or death. This organism produces no gas or obvious taste and remains undetected by taste or smell. Its toxin is denatured by cooking, though. Cooked mushrooms, handled poorly and then canned, can support the growth of Staphylococcus aureus, which produces a toxin that is not destroyed by canning or subsequent reheating.

Jellying

Food may be preserved by cooking in a material that solidifies to form a gel. Such materials include gelatine, agar, maize flour and arrowroot flour. Some foods naturally form a protein gel when cooked such as eels and elvers, and sipunculid worms which are a delicacy in the town of Xiamen in Fujian province of the People's Republic of China. Jellied eels are a delicacy in the East End of London where they are eaten with mashed potatoes. Potted meats in aspic, (a gel made from gelatine and clarified meat broth) were a common way of serving meat off- cuts in the UK until the 1950s. Many jugged meats are also jellied.

Potting

A traditional British way of preserving meat (particularly shrimp) is by setting it in a pot and sealing it with a layer of fat. Also common is potted chicken liver.

Jugging

Meat can be preserved by jugging, the process of stewing the meat (commonly game or fish) in a covered earthenware jug or casserole. The animal to be jugged is usually cut into pieces, placed into a tightly-sealed jug with brine or gravy, and stewed. Red wine and/or the animal's own blood is sometimes added to the cooking liquid. Jugging was a popular method of preserving meat up until the middle of the 20th century.

Irradiation

Irradiation of food is the exposure of food to ionizing radiation; either high-energy electrons or X-rays from accelerators, or by gamma rays (emitted from

radioactive sources as Cobalt-60 or Caesium-137). The treatment has a range of effects, including killing bacteria, molds and insect pests, reducing the ripening and spoiling of fruits, and at higher doses inducing sterility. The technology may be compared to pasteurization; it is sometimes called 'cold pasteurization', as the product is not heated. Irradiation is not effective against viruses or prions, it cannot eliminate toxins already formed by microorganisms, and is only useful for food of high initial quality. Nitrogen gas (N2) at concentrations of 98% or higher is also used effectively to kill insects in grain through hypoxia. However, carbon dioxide has an advantage in this respect as it kills organisms through hypercarbia and depending on concentration hypoxia and, requiring concentrations of above 35%, or so. This makes carbon dioxide preferable for fumigation in situations where a hermetic seal cannot be maintained.

Burial of in the ground

Burial of food can preserve it due to a variety of factors: lack of light, lack of oxygen, cool temperatures, pH level, or desiccants in the soil. Burial may be combined with other methods such as salting or fermentation. Many root vegetables are very resistant to spoilage and require no other preservation than storage in cool dark conditions, for example by burial in the ground, such as in a storage clamp. Century eggs are created by placing eggs in alkaline mud (or other alkaline substance) resulting in their "inorganic" fermentation through raised pH instead of spoiling. The fermentation preserves them and breaks down some of the complex, less flavorful proteins and fats into simpler more flavorful ones.

Most foods can be preserved in soil that is very dry and salty (thus a desiccant), or soil that is frozen.

Cabbage was traditionally buried in the fall in northern farms in the USA for preservation. Some methods keep it crispy while other methods produce sauerkraut [citation needed]. A similar process is used in the traditional production of kimchi. Sometimes meat is buried under conditions which cause preservation. If buried on hot coals or ashes, the heat can kill pathogens, the dry ash can desiccate, and the earth can block oxygen and further contamination. If buried where the earth is very cold, the earth acts like a refrigerator.

Controlled use of micro-organism

Some foods, such as many cheeses, wines, and beers will keep for a long time because their production uses specific micro-organisms that combat spoilage from other less benign organisms. These micro-organisms keep pathogens in check by creating an environment toxic for themselves and other micro-organisms by producing acid or alcohol. Starter micro-organisms, salt, hops, controlled (usually cool) temperatures, controlled (usually low) levels of oxygen and/or other methods are used to create the specific controlled conditions that will support the desirable organisms that produce food fit for human consumption.

High-pressure food preservation

High-pressure food preservation refers to high pressure used for food preservation. "Pressed inside a vessel exerting 70,000 pounds per square inch (480 MPa) or more, food can be processed so that it retains its fresh appearance, flavour,

texture and nutrients while disabling harmful microorganisms and slowing spoilage." By 2001, adequate commercial equipment was developed so that by 2005 the process was being used for products ranging from orange juice to guacamole to deli meats and widely sold.

Food drying

There are many different methods for drying, each with their own advantages for particular applications; these include:

Bed dryers.
Drum drying.
Freeze Drying.
Shelf dryers.
Spray drying.
Sunlight.
Commercial food dehydrators.
Household oven.

Many different foods are prepared by dehydration. Good examples are meat such as prosciutto (a.k.a. Parma ham), bresaola, and beef jerky. Dried and salted reindeer meat is a traditional Sami food. First the meat is soaked / pickled in saltwater for a couple of days to guarantee the conservation of the meat. Then the meat is dried in the sun in spring when the air temperature is below zero. The dried meat can be further processed to make soup.

Fruits change character completely when dried: the plum becomes a prune, the grape a raisin; figs and dates are also transformed in new, different products, that can be eaten as they are or else after rehydration.

Home drying of vegetables, fruit and even meat (to produce jerky) may be carried out by a do-it-yourself practice, employing electrical dehydrators (household appliance). If the user does not like to use additives as potassium metabisulphite, or BHA, BHT for meats, dried products may be hermetically shelf stored if it is to be consumed soon, or else in the refrigerator or even freezer if a long storage is to be expected. Freeze dried vegetables are often found in backpackers food, hunters, military, etc. The exception to this rule are bulbs, such as garlic and onion, which are often dried. Also chilis are frequently dried. Edible and psilocybin mushrooms, as well as other fungi, are also sometimes dried for preservation purposes, to affect the potency of chemical components, or so they can be used as seasonings.

For centuries, much of the European diet depended on dried cod, known as salt cod or bacalhau (with salt) or stockfish (without). It formed the main protein source for the slaves on the West Indian plantations, and was a major economic force within the triangular trade. Dried shark meat, known as Hakarl, is a delicacy in Iceland.

Grain drying. Hundreds of millions of tonnes of wheat, corn, soybean, rice and other grains as sorghum, sunflower seeds, rapeseed/canola, barley, oats, etc., are dried in grain dryers. In the main agricultural countries, drying comprises the reduction of moisture from about 17-30%w/w to values between 8 and 15%w/w, depending on the grain. The final moisture content for drying must be adequate for

storage. The more oil the grain has, the lower its storage moisture content will be (though its initial moisture for drying will also be lower). Cereals are often dried to 14% w/w, while oilseeds, to 12.5% (soybeans), 8% (sunflower) and *9%* (peanuts). Drying is carried out as a requisite for safe storage, in order to inhibit microbial growth. However, low temperatures in storage are also highly recommended to avoid degradative reactions and, especially, the growth of insects and mites. A good maximum storage temperature is about 18°C. The largest dryers are normally used "Off-farm", in elevators, and are of the continuous type: Mixed-flow dryers are preferred in Europe, while Cross-flow dryers in the USA. In Argentina, both types are usually found. Continuous flow dryers may produce up to 100 metric tonnes of dried grain per hour. The depth of grain the air must traverse in continuous dryers range from some 0.15m in Mixed flow dryers to some 0.30 m in Cross-Flow. Batch dryers are mainly used "On-Farm", particularly in the USA and Europe. They normally consist of a bin, with heated air flowing horizontally from an internal cylinder through an inner perforated metal sheet, then through a annular grain bed, some 0.50 m thick (coaxial with the internal cylinder) in radial direction, and finally across the outer perforated metal sheet, before being discharged to the atmosphere. The usual drying times range from 1 h to 4 h depending on how much water must be removed, type of grain, air temperature and the grain depth. In the USA, continuous counterflow dryers may be found on-farm, adapting a bin to slowly drying grain fed at the top and removed at the bottom of the bin by a sweeping auger. Grain drying is an active area of manufacturing and research.

Now it is possible to simulate the performance of a dryer with computer programs based on equations (mathematical models) that represent the phenomena involved in drying: physics, physical chemistry, thermodynamics and heat and mass transfer. Most recently the evolution of quality indices is beginning to be predicted with some confidence, in order to add an essential performance parameter with which to establish a compromise of reasonably fast drying rate, limited energy consumption, and satisfactory grain quality. A typical quality parameter in wheat drying is the breadmaking quality and germination percentage whose reductions in drying are somewhat related.

Food freezing

Freezing food preserves food from the time it is prepared to the time it is eaten. Since early times, farmers, fishermen, and trappers have preserved their game in unheated buildings during the winter season. Freezing food slows down decomposition by turning water to ice, making it unavailable for most bacterial growth. In the food commodity industry, the process is called IQF or Individually Quick Frozen.

Clarence Birdseye, an American inventor, developed the quick-freezing system. He discovered that the combination of ice, wind, and low temperatures in the Arctic froze anything that was exposed to it almost instantly. Birdseye's soon realized that the quick freezing effectively prevented large ice crystals from forming. Other

attempts had resulted in the formation of large crystals, which destroyed the delicate cellular structure of the food. With only an electric fan, a few buckets of brine, and cakes of ice, Clarence Birdseye perfected his system of packing fresh food into waxed cardboard boxes and flash-freezing it under high pressure. He sold the patent to the Goldman-Sachs Trading Corporation (a subsidiary of Goldman Sachs & Company) and the Postum Company. In 1929 the first quick-frozen vegetables were sold to the public.

Modern Techniques

Manufacturers freeze foods by immersing them in very cold liquids, liquid nitrogen being the preferred medium. Nitrogen liquefies at about -320 °F (-195.5°C), making it useful for quickly freezing foods. When food is submerged in liquid nitrogen, it rapidly freezes. The faster food freezes, the smaller the crystals that form within it. High-Pressure Shift Freezing is another method used to manufacture frozen food. It uses the principles of water's phase diagram. At a very high pressure, 900 MPa, ice may be formed at room temperature. This is not an efficient way to create frozen foods, but it is being researched for future use.

Dehydrofreezing is a commercial method used to reduce the cost of shipping, handling, and storage of fruits and vegetables. During dehydrofreezing, food is first dehydrated to the desired moisture level and then frozen. Fruits and vegetables have a higher water content than meats, which makes them more susceptible to the formation of large ice crystals. Dehydrofreezing gives the manufacturer peace of mind and keeps produce fresher.

Preservatives

Frozen foods don't require many preservatives because the process of preparing the food for freezing kills much of the bacteria living on the food. Carboxymethylcellulose (CMC) is used as a stabilizer in frozen foods because of its tasteless and odorless properties.

Packaging

Frozen food packaging must maintain its integrity throughout machine filling, sealing, freezing, storage, transportation, thawing, and often cooking. [8] Most frozen foods are cooked in a microwave oven. To make it easier for the consumer, manufacturers have developed packaging that can go straight from freezer to microwave.

In 1974, the first differential heating container (DHC) was sold to the public. A DHC is a sleeve of metal designed to allow frozen foods to receive the correct amount of heat. Various sized apertures were positioned around the sleeve. The consumer would put the frozen dinner into the sleeve according to what needed the most heat. This ensured proper cooking.

Today there are multiple options for packaging frozen foods. Boxes, cartons, bags, pouches, heat-in-bag pouches, lidded trays and pans, crystallized PET trays, and composite and plastic cans.

Scientists are continually researching new aspects of frozen food packaging. Active packaging offers a host of new technologies that can actively sense and then neutralize the presence of bacteria or other harmful species. Active packaging can

extend shelf-life, maintain product safety, and help preserve the food over a longer period of time. Several functions of active packaging are being researched:

Oxygen scavengers.

Time.

Temperature indicators.

Digital temperature dataloggers. Antimicrobials Carbon Dioxide controllers. Microwave susceptors.

Moisture control. Water activity.

Moisture vapor transmission rate. Flavor enhancers.

Oder generators.

Oxygen-permeable films.

Oxygen generators.

Validation of cold chain.

With these new technologies, food may last longer and our knowledge about its safety will increase.

Effects on Nutrients. Vitamin Content of Frozen Foods

Vitamin C: Usually lost in a higher concentration than any other vitamin. A study was performed on peas to determine the cause of Vitamin C loss. A vitamin loss often percent occurred during the blanching phase with the rest of the loss occurring during the cooling and washing stages. The vitamin loss was not actually accredited to the freezing process. Another experiment was performed involving peas and frozen vegetable were stored at -10 °F and the canned vegetables were stored at room temperature (75°F). After 0, 3, 6, and 12 months of storage, the vegetables were analyzed with and without cooking. O'Hara, the scientist performing the experiment said, "From the view point of the vitamin content of the two vegetables when they were ready for the plate of the consumer, there did not appear to be any marked advantages attributable to method of preservation, frozen storage, processed in a tin, or processed in glass."

Vitamin B1 (Thiamin): A vitamin loss of 25 percent is normal. Thiamin is easily soluble in water and is destroyed by heat.

Vitamin B2 (Riboflavin): Not much research has been done to see how much freezing affects Riboflavin levels. One study found an 18 percent vitamin loss in green vegetables while another found a 4 percent loss. It is commonly accepted that the loss of Riboflavin has to do with the preparation for freezing rather than the actual freezing process itself.

Vitamin A (Carotene): There is little loss of Carotene during preparation for freezing and freezing of most vegetables. However, there is a danger of losing the vitamin during a long-continued storage period.

Efficiency

Freezing is an effective form of food preservation because the pathogens that cause food spoilage are killed or do not grow very rapidly at reduced temperatures. The process is less effective in food preservation than are thermal techniques, such as boiling, because pathogens are more likely to be able to survive cold temperatures rather than hot temperatures. One of the problems surrounding the use of freezing as

a method of food preservation is the danger that pathogens deactivated (but not killed) by the process will once again become active when the frozen food thaws.

Foods may be preserved for several months by freezing. Long-term frozen storage requires a constant temperature of -18 °C (0 °F) or less. Some freezers cannot achieve such a low temperature. The time food can be kept in the freezer is reduced considerably if the temperature in a freezer fluctuates; small ice crystals thaw as the temperature moves up, and re freeze onto larger crystals as the temperature declines. Fluctuations can occur by a small gap in the freezer door or adding a large amount of unfrozen food.

Sterilization (microbiology)

Sterilization is a term referring to any process that eliminates or kills all forms of life, including transmissible agents present on a surface, contained in a fluid, in medication, or in a compound such as biological culture media. Sterilization can be achieved by applying the proper combinations of heat, chemicals, irradiation, high pressure, and filtration.

The term has evolved to include the disabling or destruction of infectious proteins such as Prions related to Transmissible Spongiform Encephalopathies (TSE).

Foods

One of the first steps toward sterilization was made by Nicolas Appert. He learned that thorough cooking (applying a suitable amount of heat over a suitable period of time) slowed the decay of foods and various liquids, preserving them for safe consumption for a longer time than was typical. Canning of foods is an extension of the same principle, and has helped to reduce food borne illness ("food poisoning"). Other methods of sterilizing foods include food irradiation and pascalization (the use of high pressure to kill microorganisms).

Sterilization as a definition terminates all life; whereas sanitization and disinfection terminates selectively and partially. Both sanitization and disinfection reduce the number of targeted [pathogenic] organisms to what are considered "acceptable" levels - levels that a reasonably healthy, intact, body can deal with. An example of this class of process is Pasteurization.

Heat sterilization Steam sterilization utensils

A widely-used method for heat sterilization is the autoclave, sometimes called a converter. Autoclaves commonly use steam heated to 121-134 °C (250-273 °F). To achieve sterility, a holding time of at least 15 minutes at 121 °C (250 °F) or 3 minutes at 134 °C (273 °F) is required. Additional sterilizing time is usually required for liquids and instruments packed in layers of cloth, as they may take longer to reach the required temperature (unnecessary in machines that grind the contents prior to sterilization). Following sterilization, liquids in a pressurized autoclave must be cooled slowly to avoid boiling over when the pressure is released. Modern converters operate around this problem by gradually depressing the sterilization chamber and allowing liquids to evaporate under a negative pressure, while cooling the contents. Proper autoclave treatment will inactivate all fungi, bacteria, viruses and also

bacterial spores, which can be quite resistant. It will not necessarily eliminate all prions. For prion elimination, various recommendations state 121-132 °C (250-270°F) for 60 minutes or 134 °C (273 °F) for at least 18 minutes. The prion that causes the disease scrapie (strain 263K) is inactivated relatively quickly by such sterilization procedures; however, other strains of scrapie, as well as strains of CJD and BSE are more resistant. Using mice as test animals, one experiment showed that heating BSE positive brain tissue at 134-138 °C (273-280 °F) for 18 minutes resulted in only a 2.5 log decrease in prion infectivity. (The initial BSE concentration in the tissue was relatively low). For a significant margin of safety, cleaning should reduce infectivity by 4 logs, and the sterilization method should reduce it a further 5 logs.

To ensure the autoclaving process was able to cause sterilization, most autoclaves have meters and charts that record or display pertinent information such as temperature and pressure as a function of time. Indicator tape is often placed on packages of products prior to autoclaving. A chemical in the tape will change color when the appropriate conditions have been met. Some types of packaging have built-in indicators on them.

Biological indicators ("bioindicators") can also be used to independently confirm autoclave performance. Simple bioindicator devices are commercially available based on microbial spores. Most contain spores of the heat resistant microbe Geobacillus stearothermophilus (formerly Bacillus stearothermophilus), among the toughest organisms for an autoclave to destroy. Typically these devices have a self-contained liquid growth medium and a growth indicator. After autoclaving an internal glass ampule is shattered, releasing the spores into the growth medium. The vial is then incubated (typically at 56 °C (133 °F)) for 24 hours. If the autoclave destroyed the spores, the medium will retain its original color. If autoclaving was unsuccessful sterothermophilus will metabolize during incubation, causing a color change during the incubation.

For effective sterilization, steam needs to penetrate the autoclave load uniformly, so an autoclave must not be overcrowded, and the lids of bottles and containers must be left ajar. Alternatively steam penetration can be achieved by shredding the waste in some autoclave models that also render the end product.

Indicators should be placed in the most difficult places for the steam to reach to ensure that steam actually penetrates there.

For autoclaving, as for all disinfection or sterilization methods, cleaning is critical. Extraneous biological matter or grime may shield organisms from the property intended to kill them, whether it physical or chemical. Cleaning can also remove a large number of organisms. Proper cleaning can be achieved by physical scrubbing. This should be done with detergent and warm water to get the best results. Cleaning instruments or utensils with organic matter, cool water must be used because warm or hot water may cause organic debris to coagulate. Treatment with ultrasound or pulsed air can also be used to remove debris.

Food

Although imperfect, cooking and canning are the most common applications of heat sterilization. Boiling water kills the vegetative stage of all common microbes.

Roasting meat until it is well done typically completely sterilizes the surface. Since the surface is also the part of food most likely to be contaminated by microbes, roasting usually prevents food poisoning. Note that the common methods of cooking food do not sterilize food - they simply reduce the number of disease- causing microorganisms to a level that is not dangerous for people with normal digestive and immune systems.

Pressure cooking is analogous to autoclaving and when performed correctly renders food sterile. However, some foods are notoriously difficult to sterilize with home canning equipment, so expert recommendations should be followed for home processing to avoid food poisoning.

Other methods

Other heat methods include flaming, incineration, boiling, tindalization, and using dry heat.

Flaming is done to loops and straight-wires in microbiology labs. Leaving the loop in the flame of a Bunsen burner or alcohol lamp until it glows red ensures that any infectious agent gets inactivated. This is commonly used for small metal or glass objects, but not for large objects (see Incineration below). However, during the initial heating infectious material may be "sprayed" from the wire surface before it is killed, contaminating nearby surfaces and objects. Therefore, special heaters have been developed that surround the inoculating loop with a heated cage, ensuring that such sprayed material does not further contaminate the area. Another problem is that gas flames may leave residues on the object, e.g. carbon, if the object is not heated enough.

A variation on flaming is to dip the object in 70% ethanol (or a higher concentration) and merely touch the object briefly to the Bunsen burner flame, but not hold it in the gas flame. The ethanol will ignite and burn off in a few seconds. 70% ethanol kills many, but not all, bacteria and viruses, and has the advantage that it leaves less residue than a gas flame. This method works well for the glass "hockey stick"-shaped bacteria spreaders.

Incineration will also burn any organism to ash. It is used to sanitize medical and other biohazardous waste before it is discarded with non-hazardous waste. During the initial heating of the chamber, boiling in water for fifteen minutes will kill most vegetative bacteria and inactivate viruses, but boiling is ineffective against prions and many bacterial and fungal spores; therefore boiling is unsuitable for sterilization. However, since boiling does kill most vegetative microbes and viruses, it is useful for reducing viable levels if no better method is available.

Boiling is a simple process, and is an option available to most people, requiring only water, enough heat, and a container that can withstand the heat; however, boiling can be hazardous and cumbersome.

Tyndallization named after John Tyndall is a lengthy process designed to reduce the level of activity of sporulating bacteria that are left by a simple boiling water method. The process involves boiling for a period (typically 20 minutes) at atmospheric pressure, cooling, incubating for a day, boiling, cooling, incubating for a day, boiling, cooling, incubating for a day, and finally boiling again. The three

incubation periods are to allow heat-resistant spores surviving the previous boiling period to germinate to form the heat-sensitive vegetative (growing) stage, which can be killed by the next boiling step. This is effective because many spores are stimulated to grow by the heat shock. The procedure only works for media that can support bacterial growth – it will not sterilize plain water. Tindalization / tyndallization is ineffective against prions.

Dry heat can be used to sterilize items, but as the heat takes much longer to be transferred to the organism, both the time and the temperature must usually be increased, unless forced ventilation of the hot air is used. The standard setting for a hot air oven is at least two hours at 160°C (320°F). A rapid method heats air to 190°C (374°F) for 6 minutes for unwrapped objects and 12 minutes for wrapped objects. Dry heat has the advantage that it can be used on powders and other heat-stable items that are adversely affected by steam (for instance, it does not cause rusting of steel objects). Prions can be inactivated by immersion in sodium hydroxide (NaOH 0.09N) for two hours plus one hour autoclaving (121°C/250°F). Several investigators have shown complete (>7.4 logs) inactivation with this combined treatment. However, sodium hydroxide may corrode surgical instruments, especially at the elevated temperatures of the autoclave.

Chemical sterilization

Chemicals are also used for sterilization. Although heating provides the most reliable way to rid objects of all transmissible agents, it is not always appropriate, because it will damage heat-sensitive materials such as biological materials, fiber optics, electronics, and many plastics. Low temperature gas sterilizers function by exposing the articles to be sterilized to high concentrations (typically 5 - 10% v/v) of very reactive gases (alkylating agents such as ethylene oxide, and oxidizing agents such as hydrogen peroxide and ozone). Liquid sterilants and high disinfectants typically include oxidizing agents such as hydrogen peroxide and peracetic acid and aldehydes such as glutaraldehyde and more recently o-phthalaldehyde. While the use of gas and liquid chemical sterilants/high level disinfectants avoids the problem of heat damage, users must ensure that article to be sterilized is chemically compatible with the sterilant being used. The manufacturer of the article can provide specific information regarding compatible sterilants. In addition, the use of chemical sterilants poses new challenges for workplace safety. The chemicals used as sterilants are designed to destroy a wide range of pathogens and typically the same properties that make them good sterilants makes them harmful to humans. Employers have a duty to ensure a safe work environment (Occupational Safety and Health Act of 1970, section 5 for United States) and work practices, engineering controls and monitoring should be employed appropriately.

Ethylene Oxide

Ethylene oxide (EO or EtO) gas is commonly used to sterilize objects sensitive to temperatures greater than 60 °C and / or radiation such as plastics, optics and electrics. Ethylene oxide treatment is generally carried out between 30 °C and 60°C with relative humidity above 30% and a gas concentration between 200 and 800 mg/1, and typically lasts for at least three hours. Ethylene oxide penetrates well,

moving through paper, cloth, and some plastic films and is highly effective. EtO can kill all known viruses, bacteria and fungi, including bacterial spores and is compatible with most materials (e.g. of medical devices), even when repeatedly applied. However, it is highly flammable, toxic and carcinogenic.

A typical process consists of a preconditioning phase, the actual sterilization run and a period of post-sterilization aeration to remove toxic residues, such as ethylene oxide residues and by-products such ethylene glycol (formed out of EtO and ambient humidity) and ethylene chlorohydrine (formed out of EtO and materials containing chlorine, such as PVC). Besides moist heat and irradiation, ethylene oxide is the most common sterilization method, used for over 70% of total sterilizations, and for 50% of all disposable medical devices.

The two most important ethylene oxide sterilization methods are: (1) the gas chamber method and (2) the micro-dose method. To benefit from economies of scale, EtO has traditionally been delivered by flooding a large chamber with a combination of EtO and other gases used as dilutants (usually CFCs or carbon dioxide). This method has drawbacks inherent to the use of large amounts of sterilant being released into a large space, including air contamination produced by CFCs and/or large amounts of EtO residuals, flammability and storage issues calling for special handling and storage, operator exposure risk and training costs. Ethylene oxide is still widely used by medical device manufacturers for larger scale sterilization (e.g. by the pallet), but while still used, EtO is becoming less popular in hospitals. Since EtO is explosive from its lower explosive limit of 3% all the way to 100%, EtO was traditionally supplied with an inert carrier gas such as a CFC or halogenated hydrocarbon. This method is also known as gas diffusion sterilization, or bag sterilization. This method minimizes the use of gas.

In addition to being a primary irritant, EtO is now classified by the IARC as a known human carcinogen. The US OSHA has set the permissible exposure limit (PEL) at 1 ppm calculated as an eight hour time weighted average (TWA) [29 CFR 1910.1047] and 5 ppm as a 15 minute TWA. The NIOSH Immediately dangerous to life and health limit for EtO is 800 ppm. The odor threshold is around 500 ppm and so EtO is imperceptible until concentrations well above the OSHA PEL. Therefore, OSHA recommends that some kind of continuous gas monitoring system be used to protect workers using EtO for sterilization. While the hazards of EtO are generally well known, it should be noted that all chemical sterilants are designed to kill a broad spectrum of organisms, by exposing them to high concentrations of reactive chemicals. Therefore, it is no surprise that all the common chemical gas sterilants are toxic and adequate protective measures must be taken to protect workers using these materials.

Ozone

Ozone is used in industrial settings to sterilize water and air, as well as a disinfectant for surfaces. It has the benefit of being able to oxidize most organic matter. On the other hand, it is a toxic and unstable gas that must be produced on-site, so it is not practical to use in many settings. Ozone offers many advantages as a sterilant gas; ozone is a very efficient sterilant because of its strong oxidizing

properties (E = 2.076 vs SHE, CRC Handbook of Chemistry and Physics, 76th Ed, 1995-1996) capable of destroying a wide range of pathogens, including prions without the need for handling hazardous chemicals since the ozone is generated within the sterilizer from medical grade oxygen. In 2005 a Canadian company called TS03 Inc received FDA clearance to sell an ozone sterilizer for use in healthcare. The high reactivity of ozone means that waste ozone can be destroyed by passing over a simple catalyst that reverts it back to oxygen and also means that the cycle time is relatively short (about 4.5 hours for TS03's model 125L). The downside of using ozone is that the gas is very reactive and very hazardous. The NIOSH immediately dangerous to life and health limit for ozone is 5 ppm, much 160 times smaller than the 800 ppm IDLH for ethylene oxide.Documentation for Immediately Dangerous to Life or Health Concentrations (IDLH): NIOSH Chemical Listing and Documentation of Revised IDLH Values (as of 3/1/95) and OSHA has set the PEL for ozone at 0.1 ppm calculated as an eight hour time weighted average (29 CFR 1910.1000, Table Z-l). The Canadian Center for Occupation Health and Safety provides an excellent summary of the health effects of exposure to ozone. The sterilant gas manufacturers include many safety features in their products but prudent practice is to provide continuous monitoring to below the OSHA PEL to provide a rapid warning in the event of a leak and monitors for determining workplace exposure to ozone are commercially available.

Dry sterilization process

Dry sterilization process (DSP) uses hydrogen peroxide at a concentration of 30-35% under low pressure conditions. This process achieves bacterial reduction of 10-6... 10-8. The complete process cycle time is just 6 seconds, and the surface temperature is increased only 10-15°C (18 to 27°F). Originally designed for the sterilization of plastic bottles in the beverage industry, because of the high germ reduction and the slight temperature increase the dry sterilization process is also useful for medical and pharmaceutical applications.

Prions

Prions are highly resistant to chemical sterilization. Treatment with aldehydes (e.g., formaldehyde) have actually been shown to increase prion resistance. Hydrogen peroxide (3%) for one hour was shown to be ineffective, providing less than 3 logs (10-3) reduction in contamination. Iodine, formaldehyde, glutaraldehyde and peracetic acid also fail this test (one hour treatment). Only chlorine, a phenolic compound, guanidinium thiocyanate, and sodium hydroxide (NaOH) reduce prion levels by more than 4 logs. Chlorine and NaOH are the most consistent agents for prions. Chlorine is too corrosive to use on certain objects. Sodium hydroxide has had many studies showing its effectiveness.

Sterile filtration

Clear liquids that would be damaged by heat, irradiation or chemical sterilization can be sterilized by mechanical filtration. This method is commonly used for sensitive pharmaceuticals and protein solutions in biological research. A filter with pore size 0.2 jum will effectively remove bacteria. If viruses must also be

removed, a much smaller pore size around 20 nm is needed. Solutions filter slowly through membranes with smaller pore diameters. Prions are not removed by filtration.

Filters can be made of several different materials such as nitrocellulose or polyethersulfone (PES). The filtration equipment and the filters themselves may be purchased as pre-sterilized disposable units in sealed packaging, or must be sterilized by the user, generally by autoclaving at a temperature that does not damage the fragile filter membranes. To ensure sterility, the filter membranes need testing for punctures made during or prior to use. For best results, pharmaceutical sterile filtration is performed in a room with highly filtered air.

Cleaning methods that do not achieve sterilization:

This is a brief list of cleaning methods that may be thought to "kill germs" but do not achieve sterilization.

Washing in a dishwasher: Dishwashers often only use hot tap water or heat the water to between 49 and 60 °C (120 and 140 °F), which is not hot enough to kill some bacteria on cooking or eating utensils.

Bathing can not sterilize skin, even using antibacterial soap.

Disinfectants (for non-living objects) or antiseptics (for living objects such as skin) can kill or remove bacteria and viruses, but not all.

Pasteurization of food also kills some bacteria and viruses, but not all.

Vacuum packing

Vacuum packing is a method of storing food and presenting it for sale. Appropriate types of food are stored in an airless environment, usually in an air-tight pack or bottle to prevent the growth of microorganisms. The vacuum environment removes atmospheric oxygen, protecting the food from spoiling by limiting the growth of aerobic bacteria or fungi, and preventing the evaporation of volatile components. Vacuum packing is commonly used for long-term storage of dry foods such as cereals, nuts, cured meats, cheese, smoked fish, coffee, and potato chips (crisps). It is also for storage of fresh foods such as vegetables, meats, and liquids such as soups in a shorter term because vacuum condition cannot stop bacteria from getting water which can promote their growth. Vacuum packaging food can extend its life by up to 3-5 times.

Vacuum packing is also used to reduce greatly the bulk of non-food items. For example, clothing and bedding can be stored in bags evacuated with a domestic vacuum cleaner or a dedicated vacuum sealer. This technique is sometimes used to compact household waste, for example where a charge is made for each full bag collected. Vacuum packing can be used to reduce bulk of .inflatable items as well. Vacuum packaging products using plastic bags, canisters, bottles, or mason jars are available for home use.

Vacuum packaging delicate food items can be done by using an inert gas kit, typically available on chamber vacuum sealers. After air has been removed, an inert gas (such as nitrogen) is added to maintain the preservation of packaged food while preventing damage. An example of inert gas for packaging delicate foods is potato chips.

External Sealers

External vacuum sealers involve a bag being attached to the vacuum-sealing machine externally. The machine will remove the air and seal the bag, which is all done outside the machine.

Chamber Sealers

Chamber sealers require the entire product to be placed within the machine. Like external sealers, a plastic bag is typically used for packaging. Once the product is placed in the machine, the lid is closed and air is removed. Once the air is removed, the bag is sealed and the atmosphere within the chamber is returned back to normal. The lid is then opened and the product removed. Chamber sealers are typically used for higher-volume packaging.

Manufacturers of chamber type vacuum packing machines include: Cryovac, Multivac, Sammic, VC999, Sevana and several others.

Preventing Freezer Burn

When foods are frozen without preparation, freezer burn can occur. It happens when the surface of the food is dehydrated, and this leads to a dried and leathery appearance. Freezer burn also ruins the flavor and texture of foods. Vacuum packing prevents freezer burn by preventing the food from exposure to the cold, dry air.

Sous-vide Cooking

Vacuum packaging also allows for a special cooking method, Sous-vide. Sous-vide, meaning "under vacuum" in French, involves poaching food that is vacuum sealed in a plastic bag.

Security

Due to an oxygen-poor environment, anaerobic microorganism can proliferate, so vacuum packing is often used in combination with other treatment.

Freeze-drying

Freeze-drying (also known as lyophilisation, lyophilization or cryodesiccation) is a dehydration process typically used to preserve a perishable material or make the material more convenient for transport. Freeze-drying works by freezing the material and then reducing the surrounding pressure and adding enough heat to allow the frozen water in the material to sublime directly from the solid phase to the gas phase. The origins of freeze drying.

Freeze-drying was first actively developed during WWII. Serum being sent to Europe for medical treatment of the wounded required refrigeration. Due to the lack of available refrigeration, many serum supplies were spoiling before reaching the intended recipients. The freeze-drying process was developed as a commercial technique that enabled serum to be rendered chemically stable and viable without having to be refrigerated. Shortly thereafter, the freeze dry process was applied to penicillin and bone, and lyophilization became recognized as an important technique for preservation of biologicals. Since that time, freeze-drying has been used as a preservation or processing technique for a wide variety of products. Some of the

applications include the processing of pharmaceuticals, diagnostic kits, restoration of water damaged documents, river bottom sludge prepared for hydrocarbon analysis, ceramics used in the semiconductor industry, viral or bacterial cultures, tissues prepared for analysis, the production of synthetic skins and restoration of historic/reclaimed boat hulls.

There are four stages in the complete drying process: pretreatment, freezing, primary drying, and secondary drying.

Pretreatment

Pretreatment includes any method of treating the product prior to freezing. This may include concentrating the product, formulation revision (i.e., addition of components to increase stability and/or improve processing), decreasing a high vapor pressure solvent or increasing the surface area. In many instances the decision to pretreat a product is based on theoretical knowledge of freeze-drying and its requirements, or is demanded by cycle time or product quality considerations. Methods of pretreatment include: Freeze concentration, Solution phase concentration, Formulation to Preserve Product Appearance, Formulation to Stabilize Reactive Products, Formulation to Increase the Surface Area, and Decreasing High Vapor Pressure Solvents.

Freezing

In a lab, this is often done by placing the material in a freeze-drying flask and rotating the flask in a bath, called a shell freezer, which is cooled by mechanical refrigeration, dry ice and methanol, or liquid nitrogen. On a larger scale, freezing is usually done using a freeze-drying machine. In this step, it is important to cool the material below its triple point, the lowest temperature at which the solid and liquid phases of the material can coexist. This ensures that sublimation rather than melting will occur in the following steps. Larger crystals are easier to freeze-dry. To produce larger crystals, the product should be frozen slowly or can be cycled up and down in temperature. This cycling process is called annealing. However, in the case of food, or objects with formerly-living cells, large ice crystals will break the cell walls (a problem discovered, and solved, by Clarence Birdseye), resulting in the destruction of more cells, which can result in increasingly poor texture and nutritive content. In this case, the freezing is done rapidly, in order to lower the material to below its eutectic point quickly, thus avoiding the formation of ice crystals. Usually, the freezing temperatures are between -50°C and -80°C. The freezing phase is the most critical in the whole freeze-drying process, because the product can be spoiled if badly done.

Amorphous materials do not have a eutectic point, but they do have a critical point, below which the product must be maintained to prevent melt-back or collapse during primary and secondary drying.

Primary drying

During the primary drying phase, the pressure is lowered (to the range of a few millibars), and enough heat is supplied to the material for the water to sublimate. The amount of heat necessary can be calculated using the sublimating molecules' latent heat of sublimation. In this initial drying phase, about 95% of the water in the

material is sublimated. This phase may be slow (can be several days in the industry), because, if too much heat is added, the material's structure could be altered.

In this phase, pressure is control led through the application of partial vacuum. The vacuum speeds sublimation, making it useful as a deliberate drying process. Furthermore, a cold condenser chamber and/or condenser plates provide a surface(s) for the water vapour to re-solidify on. This condenser plays no role in keeping the material frozen; rather, it prevents water vapor from reaching the vacuum pump, which could degrade the pump's performance. Condenser temperatures are typically below -50°C (-60°F).

It is important to note that, in this range of pressure, the heat is brought mainly by conduction or radiation; the convection effect is considered to be inefficient.

Secondary drying

The secondary drying phase aims to remove unfrozen water molecules, since the ice was removed in the primary drying phase. This part of the freeze-drying process is governed by the material's adsorption isotherms. In this phase, the temperature is raised higher than in the primary drying phase, and can even be above 0°C, to break any physic-chemical interactions that have formed between the water molecules and the frozen material. Usually the pressure is also lowered in this stage to encourage desorption (typically in the range of microbars, or fractions of a pascal). However, there are products that benefit from increased pressure as well.

After the freeze-drying process is complete, the vacuum is usually broken with an inert gas, such as nitrogen, before the material is sealed. At the end of the operation, the final residual water content in the product is extremely low, around 1% to 4%.

Properties of freeze-dried products

If a freeze-dried substance is sealed to prevent the reabsorption of moisture, the substance may be stored at room temperature without refrigeration, and be protected against spoilage for many years. Preservation is possible because the greatly reduced water content inhibits the action of microorganisms and enzymes that would normally spoil or degrade the substance.

Freeze-drying also causes less damage to the substance than other dehydration methods using higher temperatures. Freeze-drying does not usually cause shrinkage or toughening of the material being dried. In addition, flavours, smells and nutritional content generally remain unchanged, making the process popular for preserving food. However, water is not the only chemical capable of sublimation, and the loss of other volatile compounds such as acetic acid (vinegar) and alcohols can yield undesirable results.

Freeze-dried products can be rehydrated (reconstituted) much more quickly and easily because the process leaves microscopic pores. The pores are created by the ice crystals that sublimate, leaving gaps or pores in their place. This is especially important when it comes to pharmaceutical uses. Freeze-drying can also be used to increase the shelf life of some pharmaceuticals for many years.

Freeze-drying protectants

Similar to cryoprotectants, some molecules protect freeze-dried material. Known as lyoprotectants, these molecules are typically polyhydroxy compounds such as sugars (mono-, di-, and polysaccharides), polyalcohols, and their derivatives. Trehalose and sucrose are natural lyoprotectants. Trehalose is produced by a variety of plant, fungi, and invertebrate animals that remain in a state of suspended animation during periods of drought (also known as anhydrobiosis). Applications of freeze-drying

Freeze-dried coffee, a form of instant coffee.

Freeze-drying is used to preserve food and make it very lightweight. The process has been popularized in the forms of freeze-dried ice cream, an example of astronaut food. It is also popular and convenient for hikers because the reduced weight allows them to carry more food and reconstitute it with available water. Instant coffee issometimes freeze-dried, despite the high costs of the freeze-driers used. The coffee is often dried by vaporization in a hot air flow, or by projection on hot metallic plates. Freeze-dried fruit is used in some breakfast cereal. Culinary herbs are also freeze- dried, although air-dried herbs are far more common and less expensive. However, the freeze-drying process is used more commonly in the pharmaceutical industry.

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