
UNIT 18 ISSUES IN FOOD SAFETY

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18.1 INTRODUCTION

In our previous unit, we have learnt about plant and equipment maintenance and the ways by which they can be taken care of. Also, we read in Unit 17 about safety and sanitation issues that could be a cause of concern if not dealt with caution. This unit now could be considered a continuation with what we have learnt so far. In this unit we shall focus on food safety. Issues related to food borne infections and poisoning, different modes of transmission in food service institutions and conditions that could lead to food spoilage would be highlighted.

Food contamination with microorganisms is a major source of illness either in the form of infections or poisoning. You may recall reading about this in Unit 5 in the Food Microbiology and Safety Course, MFN-003, as well. Negligence on the part of the food handler can result in a large epidemic. The prime responsibility, as you would agree to break the chain of transmission of disease from carrier to food and from food to the consumer lies solely on the food handler. This important aspect has been covered in the next and final unit. However, you may find certain concepts, topics included here in this unit and in the next unit repetitive and you might be well aware of these, as they have already been covered in Food Microbiology and Safety Course, (MFN-003). Nevertheless, we strongly recommend that you read this unit carefully and perhaps it would be more useful to study this unit in combination with Units 2, 3 and 5 of the Food Microbiology and Safety Course. This will help you consolidate your understanding of issues in both worker and food safety.

Objectives

After studying this unit, you will be able to:

- recall the microorganisms that can cause infection and disease,
- differentiate between food borne infections and poisoning,
- discuss why and how to handle food to prevent infection,
- explain the various modes of disease transmission, and
- describe the conditions that can lead to food spoilage in a food service establishment.

18.2 MICROBIOLOGY AND FOOD SAFETY

You are already aware of the fact that microbiology and food safety are inter-linked. Many microorganisms are disease-causing yet, some others are beneficial for us in many ways. Can you think of any examples? Yes, for example moulds are useful to humans. They are used to ripen cheese and to add flavour and colour to it. At the same time some moulds are harmful because they produce toxins.

Like moulds, bacteria, viruses etc. are other microorganisms important from food safety view point. These are briefly highlighted in the subsequent sub-section.

18.2.1 Microorganisms in Foods

Microorganisms, as you must know by now, can be classified into five groups. These include:

- a) Viruses
- b) Bacteria
- c) Fungi
- d) Algae
- e) Protozoa

A detail review on these microorganisms is already presented in Unit 2 in the Food Microbiology and Safety Course. Hence we shall not repeat the review here. But certainly, we shall like to recapitulate what we have learnt earlier. Quickly go through the summarization presented herewith. We shall begin with viruses first.

- a) **Viruses:** Viruses are very minute in size, strictly parasitic and cannot be cultivated outside the living host cell. They feed on living cells of plants and animals and are pathogenic. Viruses attach themselves to plant, animal or bacterial cells and the nuclear material present in the virus is released in the cell. At the expenses of the host the virus multiplies inside the cell. When sufficient numbers of particles are formed, the cell bursts and the released viruses attack other cells. *Poliomyelitis* and *infectious hepatitis* are viral diseases caused by contaminated food and drinking water. *Shellfish* such as *oysters*, *cockles* and *mussels* from sewage polluted waters can cause *viral food poisoning* if food is not cooked thoroughly. Viruses are present in the nose and throat discharges and in the faces of infected.
- b) **Bacteria:** Bacteria are found everywhere – in and on soil, water, air, plants, animals, humans and their food. Bacteria are both useful and harmful to humans. Can you list down their benefits? They are capable of fermenting sugar to lactic acid. This makes them important in the manufacture of dairy products like curds, yoghurt, buttermilk and cheese and fermented vegetable products like sauerkraut and dill pickles. Some bacteria help in fermenting and curing coffee and cocoa beans.

Many bacteria are pathogenic to humans and animals. Most food infections and food poisonings are of bacterial origin. They are also responsible for spoilage of food. Canned foods, fruit juices and alcoholic beverages are spoiled by acid

producing bacteria. They spoil beverages and milk by forming rope or slime in them. They may cause surface discolouration on many foods or putrefy foods accompanied with the development of a foul smell. Some of the facts that a food handler must be aware are presented in Box 18.1.

Box 18.1 Important Facts for Food handlers

The food handler should know that:

- 1) Bacteria are the most common cause of food poisoning.
- 2) They are present everywhere.
- 3) We cannot see them.
- 4) They do not have legs or wings but are carried from one place to another by humans animals, water and wind.
- 5) Under favourable conditions they are present in large numbers.
- 6) An awareness of how they grow and reproduce is necessary if we want to control them.

Bacteria live and multiply in many foodstuffs. Very often the type of food, atmospheric temperature and humidity of the kitchen provide ideal conditions for multiplication of bacteria. Protein rich foods like meat, fish and poultry, whether raw or cooked, are excellent media for bacterial growth, especially when these foods are stored without refrigeration.

- c) **Fungi:** Fungi include the lower plants and are usually multicolour, but the plant body is not differentiated into roots, stem and leaves. They are saprophytes and lack chlorophyll. Some may be parasitic. They vary in size from the small microscopic yeasts to mushrooms in the fields. All of them are widely distributed in nature. Fungi include both yeasts and moulds. Let us get to know both.

Yeast: Yeast are unicellular and are found naturally in soil and dust.

Moulds: Moulds are multicolour. Their bodies are thread-like or filamentous. Moulds are useful to humans. They are used to ripen cheese and to add flavour and colour to it. Blue cheese or Roquefort cheese is ripened by *Penicillium roquefort* and Camembert cheese by *Penicillium camembert*. Some species of *Penicillium* produce life saving antibiotics. *Aspergillums orzo* is used for making soy sauce. Moulds are used in many oriental fermented foods like temper. Some moulds are harmful because they produce toxins. *Aspergillus* produce a toxic substance called aflatoxin when they grow on peanuts, corn, wheat grain and their meal. Some are parasitic, for example, ringworm is a mould which is parasitic on skin and hair. Certain varieties of mushrooms growing in the fields are highly toxic and can cause death, for example, *Amanita* Sp. Any food with plentiful mould growth should be discarded.

- d) **Algae:** Algae include both unicellular and multicolour organisms found naturally in water. They contain chlorophyll and are photosynthetic. Multicultural algae are of importance as a source of agar for microbiological media. Red and brown algae are used as a source of food and blue green algae as fertilizers because they are rich in proteins. Algonac acid and its salts are *made* from brown algae. This is used in ice creams to prevent ice crystal formation and to give a smooth texture. It is also used in cheese and frosting.

A pathogenic algae *Gonyaulaux catenulate* is found in seawater planktons. Mollusks who feed on this plankton become poisonous.

- e) **Protozoa:** Protozoan belong to the animal kingdom. They are unicellular. Some are parasitic.

Pathogenic varieties include *Entamoeba histolytica* which causes amoebic dysentery. *Trypanosoma* causing sleeping sickness and *Plasmodium* which causes malarial fever.

Amoebiasis occurs when drinking water is contaminated by sewage through salads and root vegetables grown on soil to which untreated excreta is applied as a fertilizer. *Entamoeba* forms cysts which require heat for their destruction.

Despite of varying characteristics and harmful/beneficial effects, we discussed above, all microbes have certain common characteristics such as nutrition and oxygen requirements. Though the nature of these requirements may vary and can be used to classify bacteria.

Microorganisms require their nourishment by any of the following three methods.

- 1) By feeding on dead and decaying organic matter. Such microorganisms are called *saprophytes*. Bacteria, yeasts and moulds are saprophytic.
- 2) By feeding on living host cells. Such microorganisms thrive at the expense of the host and are called *parasites*. Viruses, some bacteria, some fungi and protozoa are parasitic on plants and animals.
- 3) By manufacturing their own food, Green algae contain chlorophyll and can produce their own food by the process of *photosynthesis* just like plants.

On the basis of oxygen requirements, microorganisms are classified into three broad categories. These include:

- 1) *Aerobes*: These microorganisms use oxygen to release energy from food, for example, algae, protozoa and some bacteria like *Salmonella* which causes typhoid.
- 2) *Anaerobes*: These microorganisms obtain their energy without oxygen, for example, viruses, some fungi and bacteria such as *Clostridium* causing food poisoning.
- 3) *Facultative Organisms*: They can respire either aerobically or anaerobically like *Shigella* which causes bacillary dysentery and *Staphylococci* which causes food poisoning.

Most microorganisms are harmless to humans. The metabolic wastes produced by parasitic microorganisms like viruses, bacteria, fungi and protozoa are toxic to living cells. These poisons or toxins produce the symptoms of disease such as fever, inflammation, headache, nausea and gastrointestinal upsets.

While talking about microorganism, it would help us to know at what phase of microbial growth we need to take precautions to prevent food spoilage. Let us have a look at the growth pattern of bacteria. We have already discussed about it in Unit 2, Food Microbiology and Safety Course, (MFN-003). Let us once again refresh our understanding of the growth of bacteria.

18.2.2 Growth of Bacteria and the Factors that Affect the Growth of Microorganisms

Microbial growth as you would know is measured in terms of increase in cell number and the time period which lapses between two successive cell divisions is called *generation time*. It varies in different organisms. The environmental conditions available also determine the time required for cell division. Many common methods of preserving food and keeping it fit for consumption depend not on the destruction or removal of microorganisms but on: (a) delay in the initiation of growth, and (b) hindrance to growth once it has begun,

Most microorganisms, when added to food, multiply at a very rapid rate under favourable conditions. A single bacterial cell divides into every 20 to 30 minutes. If the rate of multiplication is maintained, a single will produce one billion new cells after a period of 10 hours.

If the logarithms of the number of organisms (per ml), and the time (in hours) is plotted on a graph, it is observed that the rate of multiplication is not maintained

indefinitely, but four distinct phases of growth are observed as indicated in Figure 18.1.

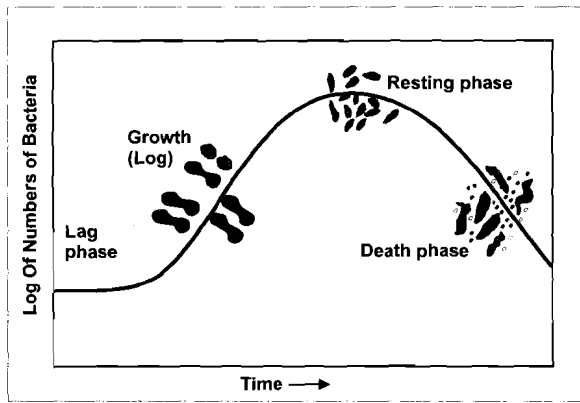


Figure 18.1: Four phases of bacterial growth

To control bacterial growth, therefore, we must first be familiar with these phases. The first phase, as you can see, is the *lag phase*, where there is no growth. The second phase is the exponential growth phase or *log phase* in which growth increases at a very rapid rate and growth rate is highest. The *stationery phase* is the third phase. The last phase is the *death phase*, in which the bacteria die because of a change in the environment such as: (a) exhaustion of nutrients, (b) accumulation of toxic metabolic waste products, or (c) alteration of pH etc.

The study of these phases will help us to prevent spoilage of foods at a much earlier stage, as well as, retard the further growth of microbes. How well we can apply this understanding to the food industry. This is the focus of the following discussion.

Applications of the Growth Phase to the Food Industry

To prevent spoilage of food it is important that the lag phase are lengthened as much as possible. This can be achieved by the following ways:

- 1) by reducing the amount of contamination, i.e. keeping contaminating organisms away from food.
- 2) by preventing addition of actively growing organisms which are already in the logarithmic phase of growth – unclean utensils, containers and equipment that come in contact with food may harbour such organisms.
- 3) by providing one or more unfavourable environmental conditions like low temperature, heat, unfavourable pH, reducing the moisture level, keeping oxygen away or adding inhibitors etc. The more unfavourable the conditions, the longer the time required for growth of microorganisms.
- 4) by actual damage to organisms by processing methods such as heating or irradiation.

To give food the desired storage life and delay the initiation of growth, it is better to use a combination of methods rather than a single method. Though the best approach would be not to allow the growth of the microbes. For this, we must be aware of the various factors that affect the growth and multiplication of microbes. You have already studied about these factors in Unit 3, Food Microbiology and Safety Course (MFN-003). Hence, here we shall not go into the details and just list down the factors to refresh your memory. However, we suggest you look up these in details in the Food Microbiology and Safety Course for a better understanding.

Factors that Effect the Growth of Microorganisms

Various environmental conditions affect the growth and multiplication of microbes. The important factors, which have an influence on growth, are listed as:

- 1) Food and Nutrients
- 2) pH level
- 3) Moisture
- 4) Temperature
- 5) Oxygen
- 6) Time
- 7) Osmotic pressure
- 8) Sunlight or UV rays

Let us now review a few methods, which would control growth of microbes in foods.

18.2.3 Control of Microbial Growth in Foods

Microbial growth in foods can be controlled in a number of ways. When the conditions necessary for bacterial growth are not available, growth and multiplication will be restricted. Microorganisms can be prevented from growing by the following methods; *controlling temperature, removing oxygen, adding chemical preservatives, reducing the moisture content and exposure to ultraviolet rays.* A brief review follows.

A) Controlling Temperature

Most microorganisms require a warm temperature to multiply. Pathogenic microorganisms grow and multiply best at normal body temperature of 37°C. It has been seen that maximum number of microbes multiplies between the temperature ranges of 5°C to 63°C. This temperature range is known as the *danger zone*. Multiplication slows down towards both ends of the danger zone. Figure 18.2 depicts the various temperature zones for varying purposes. Here, you can locate danger zone, 45° - 140°F, It is imperative for all food handlers to realize that food should be stored outside this zone.

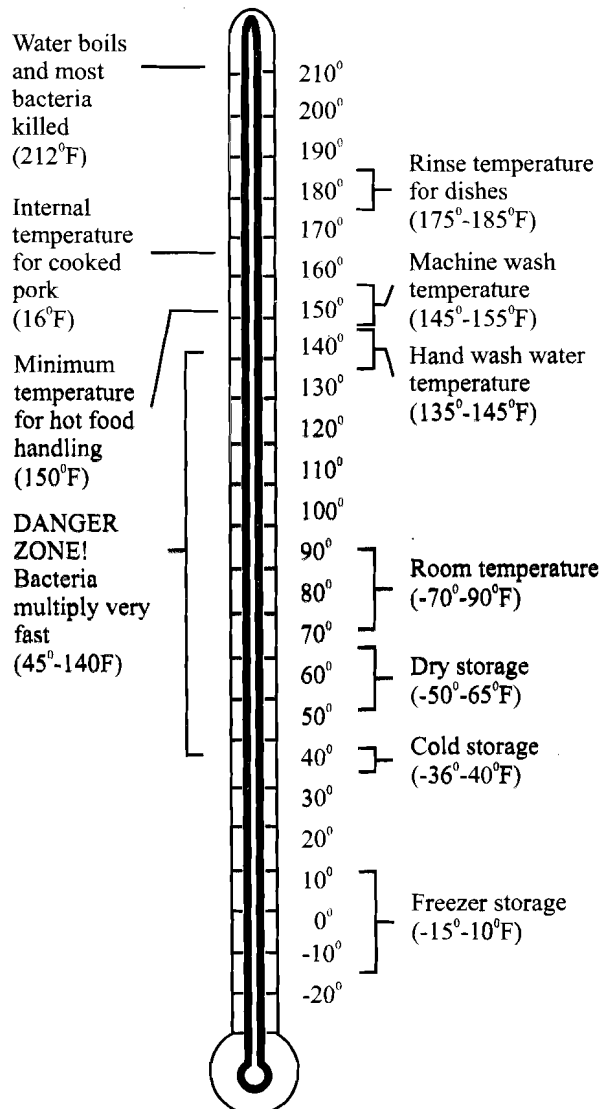


Figure 18.2: Temperature guide for food safety

- a) *Freezing*: At low temperatures microbes are not destroyed. Their growth rate is retarded and so their numbers in food is controlled. When food is thawed and temperatures become favourable, these microorganisms are capable of growth and reproduction once again.
- b) *Heat*: High temperatures destroy microorganisms by denaturation of cell proteins and inactivation of enzymes needed by them for their metabolism. At temperatures above 63°C bacteria stop multiplying and as the temperature increase, they are gradually destroyed. The thermal death time (TDT) is *the time need at a given temperature to kill a number of microbes*. Heat used to destroy microbes may be in the form of wet heat or dry heat. Let us understand these two heat conditions.
 - *Wet heat*: This is more commonly used in the food industry. If carefully administered, it is a useful method of controlling microorganisms. Wet methods include pasteurization, cooking and canning.
 - 1) *Pasteurization*: This method is used to control microorganisms in milk, fruit juices and wines. Food may be pasteurized by any one of the three methods listed below:
 - a) *LTH* (low temperature holding) method at 62°C for 30 minutes.
 - b) *HTST* (high temperature short time) or flash method at 72°C for 15 seconds.
 - c) *UHTS* (ultra high temperature sterilization) at temperatures above 135°C for two seconds. This method makes foods commercially sterile. Such foods are packed under aseptic conditions and can be stored at room temperature for three to six months.
 - 2) *Canning*: In this process, temperatures used are above 100°C. Heating the food in an autoclave at temperatures between 115°C - 125°C destroys all microorganisms that could spoil food under normal conditions of storage. The exact temperature and time required for canning depends on the type of food to be canned. Acidic foods such as fruit are heated to 100°C only because acid also helps in preventing microbial growth. A vacuum is created inside the can or the air in the headspace may be replaced by nitrogen gas to prevent growth of aerobic bacteria.
 - 3) *Cooking (boiling, steaming, stewing and poaching)*: In these methods of cooking, wet or moist heat is used. The temperatures attained are 100°C. At this temperature most microorganisms are destroyed but spores survive. Foods cooked by these methods cannot be stored for long.

Next, we shall review the dry heat methods.

- *Dry heat*: It comprises of the following methods.
 - 1) *Sun drying, smoking and freeze-drying*: In these methods, dry heat is used to control microorganisms. Dry heat brings about dehydration of the foods or of the surface of food. It destroys moulds, yeast and most bacteria and spores.
 - 2) *Cooking (baking, roasting, and grilling)*: In these methods of cooking, food is cooked by dry heat. The temperatures reached on the surface are approximately 115°C. Most bacteria are destroyed. Internal temperature of food is generally lower.

If food has to be kept for sometime, it should be cooked thoroughly. Foods cooked by dry heat methods do not spoil as moist heat methods as they lower moisture content.

Next, let us learn how to prevent growth of microorganisms by other methods.

B) *Removing Oxygen*

Removal of oxygen can stop aerobic microorganisms from growing. This can be done by packing foods in airtight containers or vacuum packing of foods as in canned foods. However, an aerobic microorganism can still grow in such foods, if these have been inadequately processed.

C) *Adding Chemical Preservatives*

These substances retard deterioration of food by preventing microbial growth. Law has restricted the use of Class II preservatives. If these preservatives are used in foods, they should be mentioned on the label. They are used to preserve food in the following ways:

- 1) They may be added to food, for example, sodium benzoate in tomato sauce and potassium metabisulphite in lemon squash.
- 2) They may be applied on the surface of foods. Sulphur dioxide is used on dry fruits and borax is used to wash vegetables and whole fruit.
- 3) Wrappers may be impregnated with sorbic acid to prevent surface spoilage of cheese.
- 4) The ice used to chill foods like fish may contain tetracycline, an antibiotic that is a permitted preservative.
- 5) They may be used as gases around food. Fruits and vegetables are stored in an atmosphere containing two to three per cent carbon dioxide to retard the ripening process.

D) *Reducing the Moisture Content*

The moisture content of food like milk is reduced by *evaporation*, *dehydration* or *desiccation* of the food. Microorganisms survive in such foods, but they remain dormant. When such foods are dehydrated, the microorganisms become active once again. Class I preservatives like sugar and salt are natural substances that bind water, which is present in the food, and make it unavailable to microorganisms like bacteria.

Moulds and yeasts, which are osmophilic, can grow on such foods. Milk, eggs, fruit and vegetables are some of the foods, which are preserved by reducing the moisture content. Such foods can be safely stored at room temperature till they are rehydrated.

E) *Exposure to Ultraviolet Rays*

Ultraviolet rays are lethal to bacteria. They have poor penetrating power and can be used only for surface sterilization or for sterilizing the air in a room. They are used to control mould growth on the surface of bakery products and to prevent spoilage of meat while tenderizing and ageing.

With a review of the various factors we end our study of the various methods, which can prevent the growth of microorganisms. What would be the consequences of microbial growth in foods? Certainly, it would lead to food borne illnesses. Next, let us get to know about the food borne illness.

18.3 FOOD BORNE ILLNESS

A food borne illness as you already learnt in Unit 5, Food Microbiology and Safety Course (MFN-003), is a general term applied to *all types of illnesses caused by an organism, substance or material of any kind which is present in food and gains entrance into the body when such food is consumed.*

The cause of contamination is generally faulty handling, poor sanitary practices, insects, rodents or microorganisms. The sources of contamination of food are shown in Figure 18.3. The natural decay that occurs in animal or plant tissues is accompanied by foul odours, and changes in appearance and taste. As the spoilage is visible, people

reject the food. The main cause for concern is food which is spoilt but where spoilage is not visibly noticeable. Such food is likely to be consumed and may result in disease.

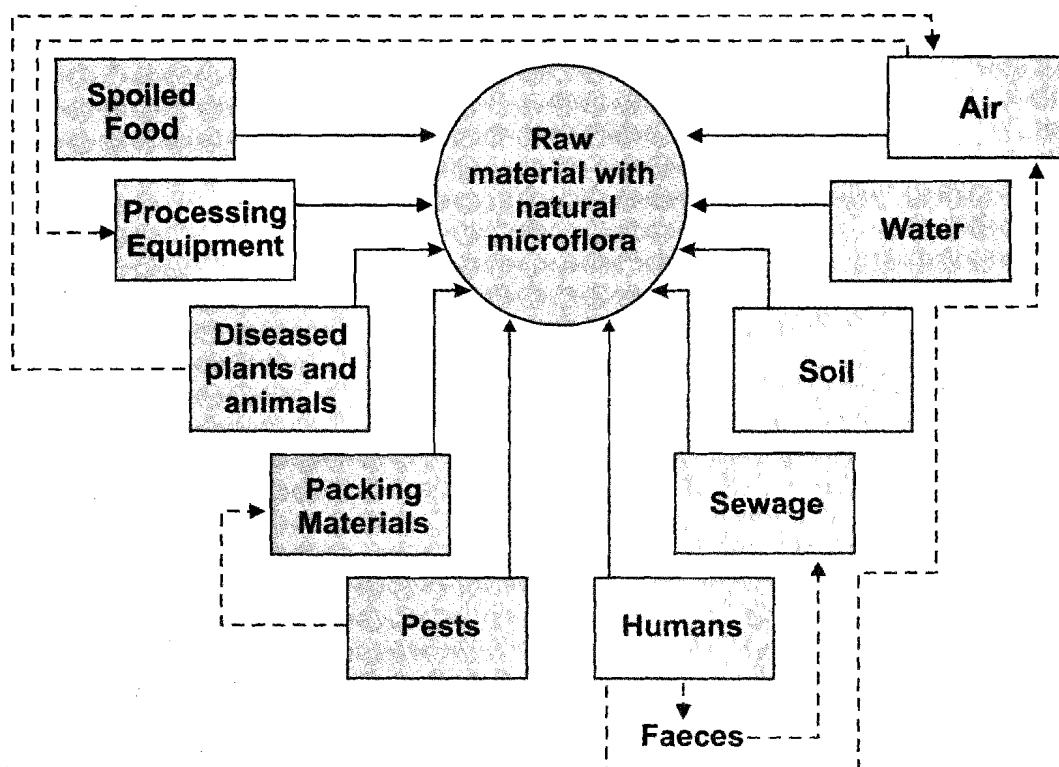


Figure 18.3: Causes of contamination

Food may be diseased by any of the following ways:

- 1) The food itself may be wholesome but may act as a vehicle of disease transmission. Pathogenic organisms can be transmitted from one person to another through many routes like soiled linen, unclean cups, handkerchiefs, door handles etc. Food handles with soiled hands or on which an ill person or a carrier has coughed or sneezed, can also cause illness. Diseases like tuberculosis, tonsillitis, typhoid and influenza can be easily transmitted this way.
- 2) The food may serve as an ideal medium for rapid growth and multiplication of large number of microorganisms like *Staphylococci* and *Salmonella*. This may result in food poisoning or food infection. These microorganisms can cause violent illness of the stomach and intestinal tract. Some of these bacteria release toxins into the food. The bacteria may die but the toxins formed cause food poisoning.

Other bacteria do not act until they are consumed alongwith food. They then cause an infection of the gastrointestinal tract.

- 3) Food poisoning may be caused by agents other than microorganisms. These include toxic chemicals, poisonous plants like poisonous mushrooms, insecticides and pesticides. Toxic metals such as cadmium, zinc, lead etc., or excessive use of mono sodium glutamate in Chinese food may lead to severe reactions. Some individuals may show abnormal sensitivity to certain foods and develop allergies. Common food allergens are egg white, shellfish and strawberries.

Food-borne hazards may thus result from microbial action, toxic metals and pesticides, animal parasites, natural poisons in foods are allergic reactions of a person due to sensitivity to a particular food. The food borne illnesses are summarized in Table 18.1.

Table 18.1: Food borne illnesses at a glance

Bacterial Food Poisonings or Intoxications	
1. Staphylococcus food intoxication	3. Bacillus cereus food poisoning
2. Botulism	4. Perfringens food poisoning
Bacterial Food Infection	
1. Salmonellosis	6. Campylobacter Infection
2. Typhoid and Paratyphoid	7. Streptococcal Infection
3. Bacillary Dysentery	8. Brucellosis
4. Cholera	9. Listeriosis
5. Enteropathogenic Infection	
Viral Infections	
1. Infectious Hepatitis	2. Influenza
Parasitic Infestations	
1. Amoebiasis	4. Giardiasis
2. Trichinosis	5. Roundworm Infestation
3. Tapeworm Infestation	
Naturally Occurring Toxicants in Foods	
1. Lathyrus Sativus	5. Cereals and Groundnuts
2. Soyabeans	6. Poisonous Mushroom
3. Green Potatoes	7. Mussels and Clams
4. Argemone Oil	8. Ergot
Toxic Metals and Chemicals	
1. Selenium	8. Tin
2. Zinc	9. Brass
3. Arsenic	10. Fluoride
4. Lead	11. Barium
5. Cadmium	12. Mercury
6. Cobalt	13. Pesticides
7. Copper	
Food Allergies	
1. Eggs	4. Chocolates
2. Shellfish	5. Strawberries
3. Peanuts	

Let us review these food borne hazards briefly.

18.3.1 Types of Food Borne Illnesses

Of all the food borne hazards listed in Table 18.1 above, diseases caused by microbial action in food are most widespread. Microorganisms cause food poisoning and food infection and animal parasites cause infestation. Hygienic handling of food and good personal hygiene can control all these. Microorganisms, which cause food borne illnesses, are bacteria, viruses, protozoans and nematodes, as already mentioned earlier. Among all these microorganisms, *bacterial contamination is the most common cause of food poisoning in the catering industry*. It usually results from mishandling of food. These illnesses are characterized by a severe disturbance of the stomach and intestines, which occurs after consuming food in which the offending bacteria were given a chance to multiply. Such illnesses are broadly divided into two categories: *food poisoning* and *food infection*. Let us get to know about them.

a) Food Poisoning

Food poisoning or food intoxication is *an illness caused by toxins present in contaminated food*. The toxin may be a poisonous chemical toxin, which is accidentally or intentionally, added, a naturally occurring poison like solanine in green potatoes or a toxic metabolite excreted by bacteria. Some important facts about food poisoning are highlighted next.

SOME IMPORTANT FACTS

- Food poisoning causes more than 23 million lost working days in a year.
- The number of reported cases has doubled in the last ten years.
- In spite of more public awareness about hygiene, food poisoning is on the increase.
- The standard of food hygiene in most establishments is very poor.

In bacterial food poisoning the toxin is produced during multiplication cells. When food is consumed, the toxin already present irritates the lining of the stomach and causes vomiting. If the toxin reaches the intestine, it may cause abdominal pain and diarrhoea. The incubation period for such food poisonings is comparatively shorter (one-six hrs) than that for bacterial food infections. The offensive food may not contain any living bacteria, which may have been destroyed during heating.

Toxins need much higher temperatures to be destroyed than the bacteria, which produce them. They may thus be present in inadequately heated foods, even if the bacteria have been destroyed. However, some food poisonings occur only when large numbers of live bacteria are ingested. When these bacteria reach the intestinal tract they produce the toxin, for example, *Clostridium perfringens*. Refer to Table 18.2, which summarizes some common bacterial food poisoning. The causative agent, main source of infection, food involved and preventive measures are highlighted.

What are food infections? Let us get to know about them.

b) *Food Infections*

Food infection is *an illness caused by microorganisms*. It results from the *consumption of food that contains living bacteria, which are multiplying and capable of producing disease*. The illness, which results, is the reaction of the body to the presence of microorganisms or to their metabolites. The gastric juices secreted in the stomach are acidic and destroys some bacteria. In the small intestine the pH is neutral and bacteria multiply rapidly. This irritates the lining of the intestines, resulting in nausea, diarrhoea and abdominal pains. The incubation period for an infection to occur is 12 hours or more.

For bacteria must be present in food. It is likely that food could be contaminated with several hundred causative bacteria. If conditions for growth are favourable, these bacteria could multiply to over one million in a short span of three to four hours.

The time lapse between the consumption of food and the appearance of symptoms is called the *incubation time*. The incubation time and the severity of the attack of bacterial poisoning or infection will depend on several factors. Refer to Table 18.2, once again which summarizes some common bacterial food infections. The causative agent, main source of infection, food involved and preventive measures are highlighted as such.

As mentioned earlier besides microbial action the food borne hazards may also result from toxic metals and pesticides, animal parasites, natural poisons in foods and allergic reactions of a person due to sensitivity to a particular food. Let us briefly review these.

c) *Naturally Occurring Toxicants in Food*

Besides food poisoning and food infections, certain plants and animals contain natural substances that are poisonous and may produce gastrointestinal disturbances. Some may even prove fatal. These naturally occurring toxicants in food are summarized in Table 18.3. A detail review of the naturally occurring toxicants, as you may already know, is already included in the Food Microbiology and Safety Course (MFN-003) in Unit 7. You may have already gone through the unit. Hence, we shall not dwell further.

Next, let us briefly review the toxic metals and chemicals.

Table 18.2: Summary of common food borne illnesses

S.No.	Illness	Causative Agent	Main Source Infection	Symptoms	Preventive	Food Involved
1.	Bacterial Food Poisonings or Intoxications Staphylococcus food intoxication	<i>Staphylococcus aureus</i>	Throat, nose, nasal discharges of persons recovering from cold. Pimples, boils and infected wounds. Contaminated air, clothing.	Salivation, nausea vomiting, abdominal cramps, diarrhoea, sub-normal body temperature blood and mucous in stools.	Use of raw ingredients free from <i>S. aureus</i> , prevent cross-contamination, kill the organism by heat treatment boiling for 30 minutes, control growth of <i>S. aureus</i> by rapid cooking chilling and prompt refrigeration and personal hygiene.	Protein-rich foods, cooked foods, foods exposed to lukewarm temperature, foods insufficiently refrigerated, left-over foods along with gravy.
2.	Botulism	<i>Clostridium botulinum</i>	Vegetables, fish, canned, bottled and vacuum packed foods.	Nausea, fatigue vomiting, diarrhoea, dizziness, double vision, difficulty in swallowing and in speaking dryness of mouth and constriction of throat, paralysis of involuntary muscles, spreading to respiratory system and heart.	Use approved heat processes for canned food, reject gassy or spoiled canned food, and avoid left over cooked foods that are not well heated. Heating smoked fish to 85°C for 30 minutes and frozen immediately heat food to 100°C	Inadequately processed home-canned foods, Smoked products that have been under-processed, damaged leaky and rusty cans or cans with broken seals.
3.	<i>Bacillus cereus</i> food poisoning	<i>Bacillus cereus</i>	Soil, dust, water, cereal grains, rice.	Abdominal pain, acute vomiting, diarrhoea.	Cool cooked food rapidly and refrigerate promptly. Reheat food thoroughly and serve immediately keep interval between cooking and eating as short as possible.	Cereals like reheated boiled rice, cornflour sauce, chinese fried rice, and spices.
4.	Perfringens food poisoning	<i>Clostridium perfringens</i>	Cooked meat, human and animal intestinal tract, soil, dust, poultry and some dried foods.	Abdominal pain, diarrhoea, nausea, vomiting (rare) mild vertigo.	Thorough cooking of food, rapid cooling of food and through reheating just before serving, handle raw and cooked food, separately, kitchen and personal hygiene wash all fruits and vegetables.	Meat dishes, reheated dishes stewed and roasted meat & poultry, sauces, gravies, pies, salads and casseroles.

S.No.	Illness	Causative Agent	Main Source Infection	Symptoms	Preventive	Food involved
1.	Bacterial Food Infections Salmonellosis	<i>Salmonella typhimurium</i> , <i>Salmonella enteritidis</i>	Intestine of humans and animals, faeces.	Diarrhoea, chills, abdominal pain, fever, vomiting, dehydration enteritis or local infection, watery, greenish, foul-smelling stools.	Wash hands often, trimmed & clean nails of food handlers, purchase wholesome meat poultry eggs & fish, clean & hygienic equipment control of rodents and insects adequate refrigeration, thorough cooking at 66°C for 12 minutes, thoroughly reheating leftovers.	Seafood, canned foods that are opened animal products- meat, poultry, dirty shelled egg and its products, duck egg's high risk foods exposed to warm temperatures for long e.g. Milk, fish, mutton biryani.
2.	Typhoid	<i>Salmonella typhi</i>	Faeces and urine of patients suffering from typhoid or healthy carriers, water contaminated by sewage and food contaminated by food handlers directly or indirectly.	Malaise, headache high and continued fever, cough, anorexia, vomiting, diarrhoea, bleeding from the bowels.	Ill persons/carriers not to be allowed near food preparation and service areas, use boiled cooled water, proper sewage disposal and non-leaky sewer pipes, use of pasteurized milk and its products, control of rodents and insects, immunization.	Raw milk, vegetables grown on sewage farms and contaminated water.
3.	Paratyphoid	<i>Salmonella enteritidis</i> , <i>Serotype paratyphi A, B and C</i>	Contact by infected carriers, faeces and urine of infected persons, contaminated foods and through houseflies.	Same as for Typhoid.	Same as for Typhoid.	Contaminated foods esp. confectionery, frozen foods and ice creams.
4.	Bacillary dysentery or shigellosis	<i>Shigella sonnei</i> , <i>S. dysenteriae</i>	Direct contact with hands and clothing soiled with excreta of ill person or a carrier, contaminated food and water, houseflies.	Abdominal cramps, fever, chills, diarrhoea, watery stools, nausea, dehydration.	Personal hygiene cook foods thoroughly, chill foods promptly in small portions, protect and treat water, control flies and pests, disposal of sewage in a sanitary manner.	Moist, mixed foods like fish or macaroni salad, mutton cutlets, mutton pie, puddings, milk, beans and potatoes.

S.No.	Illness	Causative Agent	Main Source Infection	Symptoms	Preventive	Food Involved
5.	Cholera	<i>Vibrio cholera</i>	Direct contact with hands and clothing soiled with excreta of diseased person, ingestion of polluted and contaminated water, food and aerated water, contaminated equipment, houseflies.	Sudden onset of severe watery diarrhoea, vomiting, cramps in the leg, thirst and rapid dehydration, pain in abdomen.	Protect food & drink from flies and dust use suitable disinfectants and wash hands properly, dispose off wastes and excreta properly use chlorinated water and boil before use, thoroughly cook food, avoid consumption of raw, stale or overripe fruit.	Fish and shellfish from polluted water, aerated drinks prepared from polluted waters contaminated stale food.
6.	<i>Vibrio parahaemolyticus</i>	<i>Vibrio parahaemolyticus</i>	Contaminated seafood and sea water, cross-contamination from salt water fish and sea water.	Acute diarrhoea, abdominal pain, mild fever, chills vomiting, headache and prostration.	Thoroughly cook food, chill foods to be held, avoid cross-contamination, avoid use of sea water for washing foods, sanitize equipment and work surfaces, avoid use of sea water for cleaning production areas.	Salt water fish, prawns, crabs and other shellfish.
7.	Enteropathogenic Infection	<i>Escherichia coli</i>	Raw food contaminated with sewage, contaminated hands, cross-contamination of food and careless storage sewage pollution of water.	Cholera-like symptoms dysentery-like symptoms with fever, chills, profuse watery diarrhoea with mucous and blood and colitis.	Rapidly chill foods in small quantities, thoroughly cook food, practice personal hygiene wash all vegetables protect and treat water.	Raw meat and poultry contaminated with excreta, salads and raw vegetables.
8.	Listeriosis	<i>Listeria monocytogenes</i>	Milk and meat of infected animals; susceptible foods which are refrigerated, like soft cheese, salads, sausages.	Miscarriages and still births in pregnant women, meningitis and septicemia in infants.	Avoid refrigerated foods that are likely to be contaminated and cannot be heated; thoroughly heat cook-chill meals, use pasteurized milk.	Milk and meat, foods which are improperly refrigerated like soft cheese, salads, sausages etc.

S.No.	Illness	Causative Agent	Main Source Infection	Symptoms	Preventive	Food Involved
1.	Viral Infections Infections hepatitis	Hepatitis A virus	Food/ water contaminated by direct contact with faecal-oral route of diseased person or carrier, contact with hands of infected person, contaminated food, polluted drinking water or shellfish, houseflies.	Jaundice, loss of appetite, abdominal discomfort, severe nausea and vomiting resulting in dehydration, fever, weakness and marked weight loss.	Maintain proper standards of cleanliness, prevent entry of carriers in food preparation and service area, control growth of houseflies, thoroughly cooked shellfish and adequate heating of foods like milk prevent contact of sewage with food.	Milk and other beverages, shellfish, contaminated foods, contaminated water.
2.	* Influenza	<i>Influenza virus</i>	Direct contact, droplet infection, infected articles, contaminated food and utensils.	Fever, head cold, sore throat, respiratory infection, muscular pain and weakness.	Sick food handlers should be kept away from kitchen and service areas.	—
1.	Parasitic Infestations Amoebic dysentery	<i>Entamoeba histolytica</i>	Ingestion of cysts in food and drink, contaminated vegetables from fields irrigated with contaminated water, flies and rodents infected food handlers.	Abdominal discomfort, slight diarrhoea or constipation or severe diarrhoea.	Boiled drinking water, wash or disinfect uncooked fruits and vegetables, protect food against rodents and flies, periodic medical examination of food handlers, proper sewage disposal methods.	Water contaminated with sewage, moist foods contaminated with human faeces.
2.	Trichinosis	<i>Trichinella spiralis</i>	Consumption of raw or incompletely cooked pork.	Nausea, vomiting diarrhoea, colic fever and sweating muscle soreness, swelling, chills, skin lesions.	Purchase and serve inspected pork and pork products, cook pork and meats thoroughly to 66°C, freeze pork at -15°C for 30 days or -23°C for 20 days or -29°C for 12 days, eliminate rats, adopt effective methods of garbage disposal.	Raw or insufficient cooked pork or pork products containing live larval.

S.No.	Illness	Causative Agent	Main Source Infection	Symptoms	Preventive	Food Involved
3.	Tape worm infestation	<i>Taenia solium</i> and <i>Taenia saginata</i>	Raw or insufficiently cooked diseased pork or beef containing cysts.	Malaise, digestive disorder, abdominal pain, hungry feeling, vague discomfort.	Cook pork and beef thoroughly; purchase only from licenced shop.	
4.	Roundworm infestation Ascariasis	<i>Ascaris Lumbricoides</i>	Contaminated food that contains the eggs of this parasite, contaminated soil and water.	Worms infest small intestine, abdominal pain, pneumonia.	Personal hygiene; thorough hand washing.	
5.	Threadworm infestation	<i>Pinworms or threadworms</i> (Enterobius vermicularis)	Dirty finger nails harbouring eggs of the parasite, clothing, soil and sewage-contaminated foods.	Infest upper part of large intestine, cause itching and swelling near the anus when adult worm lays eggs.	Trim finger nails; wash hands after touching unsanitary parts; remove all soil from vegetables.	
6.	Giardiasis	<i>Giardia lamblia</i>	Cysts are transmitted through contaminated food and water.	Abdominal cramps, distension and tenderness, fatty diarrhea.	Use potable water, wash hands thoroughly after using the toilet and before handling food.	

- Although it is an airborne infection, it can be transmitted through food also, hence it is included here.

Table 18.3: Natural toxic substances in food

S. No.	Toxin	Food in which it is Present	Main Symptoms	Preventive Measures
1.	BOAA (β -oxaly amino-L-alanine)	Kesari dal or Lathyrus sativus used as an adulterant in tuvar dal	Lathyrism – paralysis of lower limbs	Steep or parboil dal before use; ban the crop
2.	Trypsin inhibitor	Soybeans	Indigestion, intestinal disorders	Heat treatment to inactivate the inhibitor; use processed soy products
3.	Solanine	Green Potatoes	Abdominal pain, vomiting and diarrhoea	Discard green, damaged or sprouting potatoes
4.	Mycotoxin	Ergot fungus infected cereals	Ergotism causing convulsions and gangrene	Control moisture level in grains to prevent mould growth
5.	Sanguinarine	Argemone oil used as an adulterant in mustard oil	Epidemic dropsy – swelling of legs, diarrhoea and difficulty in breathing	Purchase oil from reliable suppliers
6.	Aflatoxin	Mouldy peanuts and grains	Liver damage	Dry grains well; store at appropriate temperature
7.	Mscarin	Poisonous mushrooms of Amanita Sp. Like <i>Amanita muscaria</i>	Affects the nerves; liver damage, nausea, headache, excessive salivation and tears, dizziness and confusion	Purchase mushrooms or spawn for cultivation from recognized outlets
8.	PSP-Paralytic shellfish poison (an alkaloid)	Ocean mussels and clams	Itching, numbness of lips, tongue muscular weakness and respiratory paralysis	Avoid seafood at certain periods of the year e.g. during red tide, toxin is heat stable

Table 18.4: Toxic effects of some metals and chemicals

S.No.	Substance	Food Commonly Involved	Toxic Effect
1.	Selenium.	Food grains and fodder from excessive selenium in soil	Gastrointestinal disturbances, stunted growth, loss of appetite
2.	Zinc	Acidic foods stored in galvanized iron utensils	Dizziness, vomiting, anaemia, nausea, diarrhoea, drowsiness and growth depression
3.	Arsenic	Fruits sprayed with pesticides containing lead arsenate	Cutaneous lesions, lung cancer
4.	Lead	Drinking water, some processed food	Paralysis, brain damage, nausea, constipation, fatigue abdominal pain, anaemia, insomnia, reduction in body's resistance to fight disease and mental retardation
5.	Cadmium	Fruit juices and soft drinks in contact with cadmium plated vessels	Excessive salivation, liver and kidney damage headache, vomiting, diarrhoea, abdominal cramps
6.	Cobalt	Water, Beer	Cardiac insufficiency, cardiac Failure
7.	Copper	Acid food in contact with tarnished copperware	Abdominal pain, vomiting, diarrhoea, astringent taste in month and constriction of throat
8.	Tin	Canned food left in the opened can	Headache, diarrhoea, vomiting, metallic taste in the mouth, constipation and retention of urine.
9.	Brass	Acidic foods cooked in utensils which are not tinned	Astringent taste in the mouth, vomiting.
10.	Fluoride	Water with high levels of fluorine	Skeletal and dental fluorosis, mottling of teeth enamel.
11.	Barium ●	Food contaminated with rat poison	Violent peristalsis, abdominal pain, vomiting and diarrhoea, paralysis
12.	Mercury	Seed grains treated with mercury fungicide	Paralysis, brain damage
13.	Pesticides	Any type of food	Damage to liver, kidney, brain and nerves; can lead to death
14.	Monosodium-glutamate or Ajinomoto	Chinese food, especially soups, fast foods, gravies	Headache, burning and tingling in arms and neck; banned for infants in USA

d) *Toxic Metals and Chemicals*

Metals, when consumed in excess of the requirement, could cause toxicity. These contaminants may be present in the environment and may accumulate during the different stages of food preparation. By the time food is ready to be consumed, it can reach levels, which are toxic to humans. Some of the toxic metals are listed in Table 18.4. Table 18.4, in fact presents an outline of all toxic metals and chemicals their toxic effect and the food involved. For a detail review we suggest you look up Unit 7 in the Food Microbiology and Safety Course (MFN-003). Perhaps you may have already done that.

Finally, a word about food allergies.

e) *Food Allergies*

An allergy is defined as *a special reaction of an individual to some ingredient of food*. Some people show abnormal sensitivity to foods that are harmless to a non-allergic person. The substance that causes the allergy is called an allergen. Allergens may be present in foods like eggs, wheat, fish, shellfish, chocolate, strawberries and cow's milk. You may recall studying about food allergies and their management in the Clinical Nutrition and Therapeutic Course (MFN-005) in Unit 6. As described in this unit, symptoms of allergies vary from urticaria or hive to gastrointestinal upsets and may be mild to extremely severe. The food responsible for causing the allergy should be avoided.

In the catering industry, the service staff should have basic knowledge of various recipes in the menu in terms of ingredients used, so as to guide the customers about food selection in case of allergy. Next, let us find out how can we control these illnesses.

Having reviewed the food borne hazards, let us next get to know of measures which can be adopted for the control of the food borne illnesses.

18.3.2 Control of Food Borne Illnesses

Food borne diseases are generally transmitted through careless food handlers who are either suffering from the disease or are carries of microorganisms. A healthy food handler may transmit microorganisms indirectly through cross-contamination. These diseases are a constant threat to the food industry. Practicing the basic principles of hygiene listed herewith can prevent them:

- 1) Food should be handled in a hygienic manner by all food handlers and infected handlers should be kept away.
- 2) Cross-contamination from raw to cooked foods can be prevented by washing hands and all equipment or surfaces in contact with raw food.
- 3) The time gap between preparation and service of food should be reduced to avoid long storage in a warm environment.
- 4) Large masses of food, which have to be reheated later should be cooled quickly to 15°C and refrigerated immediately.
- 5) Food should be reheated thoroughly so that the center of the food gets heated to temperatures high enough to destroyed bacteria.
- 6) Frozen foods should be thawed carefully at temperatures between 10 to 15°C and frozen food should not be refrozen unless it has been cooked well after thawing.
- 7) Cooked foods, which are to be served hot, should be stored above 63°C. Avoid cooling and heating food repeatedly.
- 8) Leftover food should be refrigerated immediately to keep it out of the danger zone.

- 9) Food should be prepared in quantities required and quantities for which adequate refrigerated storage space is available. This will prevent perishable or high risk from spoiling.
- 10) Suspect food should be discarded immediately without tasting it.
- 11) The kitchen and cooking equipment should be cleaned daily and regular pest control measures should be taken.
- 12) Adequate toilet and washbasin facilities with a continuous supply of water should be provided.
- 13) High risk foods like meat, poultry, eggs and milk should be purchased from certified dealers only.

With a word on how to control the food borne illnesses we end our study on food borne illnesses. Next, we shall focus on the mode of transmission of diseases, since in the food industry this has a direct impact on food and worker safety.

18.4 MODES OF DISEASE TRANSMISSION

A communicable disease is *an illness caused by a specific infectious agent or its toxic products*. The disease occurs through transmission of that agent or its products from the source to the susceptible host either directly or indirectly. It includes contagious, as well as, infectious diseases.

A carrier is *a person who harbours a specific infectious agent in the absence of obvious signs and symptoms of the disease and serves as a potential reservoir of infection for other people*. Carriers are either *temporary carriers* or *chronic carriers* as enumerated herewith:

- 1) *Temporary Carriers*: They excrete the organism only for a short period of time. Temporary carriers may be of three types:
 - a) *Incubatory Carriers*: These carriers shed the organism during the incubation period of the disease.
 - b) *Convalescent Carriers*: These carriers continue to excrete organisms during the period of convalescence.
 - c) *Healthy or contact Carriers*: These carriers acquire the disease producing organism without suffering from the disease and may continue to excrete the disease agent for variable periods.
- 2) *Chronic Carriers*: They harbour and excrete the disease-producing organism for indefinite periods. The duration of the chronic carriers state varies with the disease. For example in the case of typhoid, the carrier state lasts for several years, whereas in chronic dysentery the carrier state lasts for one year or more.

From the point of view of spread of disease, chronic carriers are a far more important source of infection than people who are actually suffering from the disease. This is because chronic carriers are difficult to identify and it is likely that they may be handling food and spreading infection unknowingly.

The first known chronic carrier of typhoid fever was *Mary Mallon*, often referred to as *Typhoid Mary*. She worked as a cook in New York and infected at least 53 people with typhoid fever in the early 20th century, before she could be identified as the source of infection and removed from the job.

Another mode of transmission of diseases is through cross-contamination. Let us get to know about it.

Cross-contamination

Harmful microorganisms present in one food can contaminate another food. This process is known as *cross contamination* and is defined as *the transfer of bacteria*

from something dirty to something clean, or from a food with many bacteria to a food with fewer bacteria, by means of a non-food vehicle such as:

- 1) Chopping boards, knives, utensils and equipment,
- 2) Work surfaces, dish cloth etc,
- 3) Hands of the food handler,
- 4) Drops of liquid oozing from contaminated food, and
- 5) Infected droplets from cough and sneeze.

Cross-contamination can occur whenever clean and dirty operations are mixed or if the same equipment is used for handling raw and cooked meat without cleaning and sanitizing it between use. Raw meats and its juices contain many bacteria, which are transferred to cooked meat by using the same equipment. Cross-contamination of cooked meat can be prevented by:

- 1) Storing raw and cooked meat separately and not next to or on top of each other, to prevent drops of liquid oozing.
- 2) Colour coding equipment such as chopping boards and knives for handling only one type of food, for example using pink for raw meat and poultry and brown for cooked meat and poultry.
- 3) Preparing cooked and raw meats on separate tables.

Can you list a few examples, which could lead to cross-contamination? Well, there could be many examples of cross-contamination, but simple handling of equipment, utensil, as enumerated herewith could be detrimental:

- 1) When a dishwasher places clean and sanitized plates on a table reserved for dirty plates, the plates get contaminated.
- 2) When a busboy brings used plates to the dishwashing machine and picks up clean plates without washing his hands, the clean plates get contaminated.
- 3) When the chef places a dirty cardboard box on a food preparation table, the table gets contaminated and any food kept on that table will also get contaminated.

Even when a potentially hazardous food gets contaminated, it does not become harmful immediately. Remember, the bacteria transferred to the food need time and a warm temperature to multiply before the food can cause a food borne illness when consumed.

In fact, besides the carriers and cross-contamination, in a food service establishment diseases may be transmitted by many routes. These are highlighted in the subsequent sub-section.

18.4.1 Routes of Disease Transmission

Diseases may be transmitted by more than one route. The common routes of transmission are:

- 1) *Contact transmission*: by direct or indirect contact with the source of disease.
- 2) *Vehicle transmission*: where milk, water and other foods act as vehicles for transmitting disease.
- 3) *Vector transmission*: by insects and other invertebrate hosts that transmit infection by inoculation into the skin, by biting or by depositing infective material on skin, food and other objects by their feet and bodies or by regurgitating on food.
- 4) *Air-borne transmission*: by droplet infection, droplet nuclei and infected dust. Droplet infection can occur when a person sneezes or coughs and expels particles of moisture containing a large number of organisms, up to a radius of 1 meter or more. When the moisture from smaller droplets evaporates, a minute particle of virus or bacteria which are called *droplet nuclei*, remain suspended in the air.

- 5) *Infected dust*: larger droplets of moisture settle down on the floor and become a part of dust. During dusting or sweeping these dust particles become air-borne and get inhaled or settle on uncovered food and drink.

In fact disease could be transmitted through food either directly or indirectly. Let us find out how.

Direct and Indirect transmission

Disease is transmitted through food either directly or indirectly. In direct transmission of disease, the pathway illustrated in Figure 18.4, is involved.

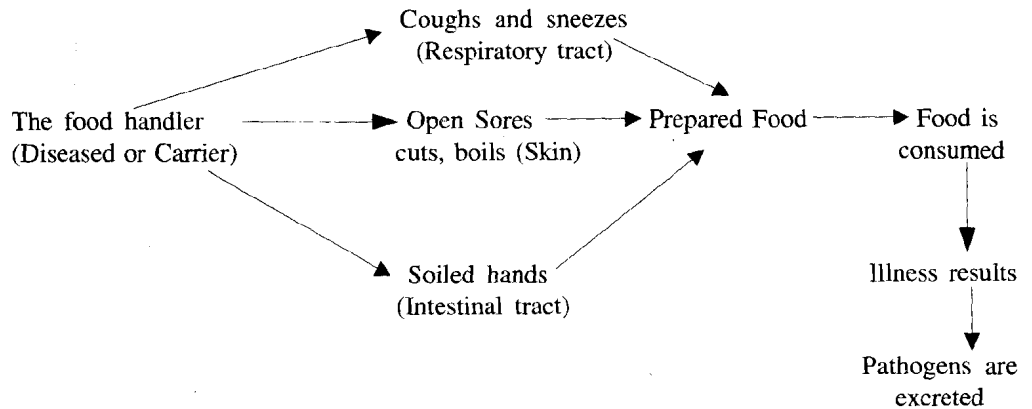


Figure 18.4: The direct transmission of disease

Let us get to know about it.

- *Direct Transmission*: The food handler transmits pathogens to food. Because of coughing or sneezing on or near the food, droplets containing microorganisms may fall on the food.

Unwashed or improperly washed hands transfer diseases of the intestinal tract. If hands soiled with faecal matter handle food, disease-causing agents are transferred to the prepared food. Consumption of such food causes illness. When food is openly displayed, the customer handling the food can contaminate it.

- *Indirect Transmission*: The host of communicable diseases may transmit pathogens indirectly through various routes onto prepared food and from there to other people consuming the offending food as highlighted in Figure 18.5. The other indirect routes of transmission of disease causing agents or pathogens are through:

- 1) contaminated utensils and equipment,
- 2) sewage polluted water and food grown on polluted soil or through faulty plumbing,
- 3) soiled linen, door handles and taps,
- 4) insects like flies and cockroaches,
- 5) rodents like rats, mice, and
- 6) infected animals and their products.

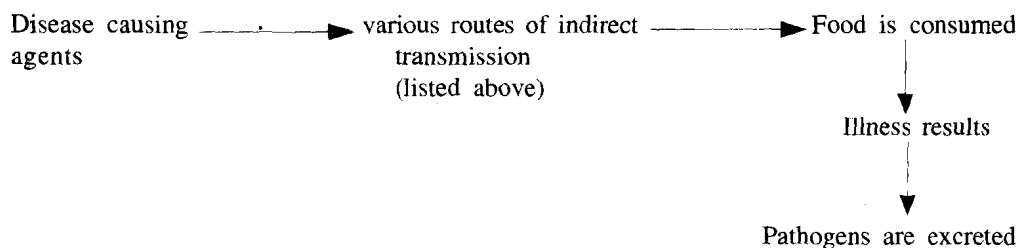


Figure 18.5: The indirect transmission of disease

Food may also be contaminated through unclean utensils and equipment as already mentioned earlier. The pathogenic organisms eliminated from the human body are found in sewage is mainly faecal matter. If untreated sewage is allowed to drain into any drinking water, the water, as well as, fish breeding in such waters gets contaminated. Salad vegetables, roots and tubers are at a greater risk of contamination as they are consumed raw and because they are in direct contact with the soil. Rats, mice, flies and cockroaches can also transmit disease. They live in sewers and garbage dumps. Un-pasteurized milk and meat from diseased animals can transfer pathogens of animal origin.

What could be the sources of contamination of food that would eventually lead to its spoilage? Let us know about this, next

18.4.2 Source of Contamination

Food can be contaminated or spoilt by any of the following sources and at any stage from the farm to the table till it is consumed. Sources of contamination of food include: air, water, plant, soil, food handler, machinery and equipment, sewage and trucks or carts during transport.

Contamination of food results in the spoilage. Food spoilage can be broadly classified into six groups. Foods spoil mainly because of any one or more of the following reasons. Let us see what are these.

- 1) *Microbiological action*: Microorganisms are present everywhere and in all the sources of contamination mentioned above. These organisms can contaminate food and spoil it. Milk turns sour because of bacterial action, yeasts ferment fruit juices and mould grows on bread, which has to be discarded. Microbial growth in foods may be obvious like the example listed above. Some bacteria, which cause food poisoning or food infection, may contaminate food, which is unhygienically handled. In such cases, microbial growth may not be obvious. Not all microorganisms can cause disease, in fact some are useful to the food industry. Foods having a high protein, moisture, vitamin and mineral content are an ideal media for bacterial growth.
- 2) *Presence of contaminants*: If any unwanted inedible matter is added to or is present in foods, the food is said to be *spoiled* and should be rejected. Contaminants present in food could be nail chippings, hair stones, grit, dirt or other extraneous matter. Accidental contamination by metallic fragments and shards of glass may render food harmful. Some common metal fragments are stapler pins, flexible aluminum wire, metal curls and fine filings from canned food opened with a defective opener. Glass chips may enter food from broken glassware or misuse of glass for taking out crushed ice.

Radiation used for preserving spices and those emitted by microwave ovens, although invisible, may also prove hazardous to health if used in excess. This kind of contamination occurs at any stage right from harvesting to food service

- 3) *Action of insects*: Foods are spoilt because of the presence of *worms, weevils, fruit, flies, moths* etc. These may damage the food and reduce its nutrient content. Food spoilt by insects is not fit for human consumption. The presence of insects or insect body fragments or droppings in food served to customers is highly objectionable and will affect the reputation of the catering establishment.
- 4) *Natural enzymes*: Foods spoil by autolysis or the action of various enzymes naturally present in them. After picking or harvesting, fruits and vegetables remain alive for sometime. They respire and ripen and if they are not consumed or processed soon they become over-ripe and ultimately spoil.

Enzymes naturally present in meat act on mutton fibers and bring autolysis. If these natural changes are not controlled, foods may spoil. As action of enzymes is influenced by temperature, refrigeration will retard the action and blanching will destroy the enzyme.

- 5) *Physical changes*: These changes occur in food by freezing, desiccation, evaporation and absorption of moisture. Freezer burn is a physical change seen in deep frozen foods.

Mechanical damage during harvesting and transporting foods, like bruising and crushing of fruits and vegetable, broken eggs and cracked shells, can accelerate spoilage by microorganisms because of easy access. It also results in greater susceptibility to decay and discolouration by enzyme action. This can be prevented by proper storage and transport facilities.

- 6) *Chemical reaction*: Chemical changes, which are not catalyzed by natural enzymes or action of microorganisms, can also result in chemical spoilage of foods. A reaction between acidic food and iron from the can causes hydrogen swell in canned foods. Development of oxidative rancidity in fats and the fatty phases of foods results in spoilage of fried snacks and oil-based pickles. Other changes include oxidative discolouration, flavour changes and nutritive loss.

Spoilt food can cause a great financial loss to the catering establishment. Spoilt food is best discarded. However, bacteria causing food poisoning may soil the food without showing any visible signs of spoilage. The caterer should take utmost care to prevent spoilage from occurring. It is best to remember that once a food is spoilt, no amount of cooking, freezing or proper handling can make the food fit for consumption.

In this context therefore it is important for us to understand or know about the conditions that lead to spoilage. These are described in the next section.

18.5 CONDITIONS THAT COULD LEAD TO FOOD SPOILAGE

We have already learnt about various modes of transmission of diseases caused due to infections agents, or their products. Also, we saw the sources of contamination. Next, how do we find out whether a food is suitable for consumption or not? We will soon find out by going through the discussion presented herewith in this section.

A food is wholesome and it fit for consumption if the following criteria are fulfilled.

- 1) Food should be at the desired stage of development, or maturity, for example, fruits should not be over-ripe.
- 2) Food should be free from pollution at any stage in production or handling, for example, vegetables grown in areas fertilized by sewage should not be consumed. Food handed by dirty and/or diseased workers, should be discarded. Food contaminated by flies or rodents should be considered as suspect food.
- 3) Food should be free from objectionable changes resulting from microbial attack or action of enzymes in the food.

So then what is spoiled food and what are the conditions that could lead to spoilage. Let us find out.

18.5.1 Categorization of Food on the Basis of their Shelf Life or Perishability and Conditions that could Lead to Food Spoilage

You would have realized that all foods don't spoil at the same rate and to the same extent. Certain foods like fruit and vegetables spoil more as compared to cereals, pulses etc. Why so? This is because based on this characteristic; foods can be categorized in to three main groups on the basis of their shelf life or perishability.

- 1) *Non-perishable or stable foods*: These foods do not spoil unless they are handled carelessly. They should be stored in a cool, dry place. They can be

stored for one year. They should be picked and cleaned before storage. If necessary, grains can be washed with water to remove any dust and dirt sticking to them. These should then be dried in the sun, allowed to cool and stored in containers with tight fitting lids.

Non-perishable foods include *sugar, jaggery hydrogenated fat, vegetable oil, ghee, whole grains, dals, whole nuts, dry salted fish and meat, papads, canned foods, preserves such as pickles, jams and murabbas.*

- 2) *Semi-perishable foods*: These foods do not spoil for a fairly long time, if stored properly. They are less likely to decay due to microbiological contamination than other perishable foods. Natural chemical breakdown is also slower in such foods. If they are stored in a cool place with adequate ventilation, they have a moderately long shelf life. Use of proper containers is equally important. *Semi-perishable foods include processed cereals, pulses and their products like flour, Bengal gram flour, millet flour, semolina, parched rice, popcorn etc.* Their shelf life depends on the storage temperature and moisture in the air.

Other semi-perishable foods are potatoes, onions, nuts, frozen foods kept solidly frozen at "zero" to 18°C and canned foods that need refrigeration, apples, citrus fruits, pumpkin etc. Foods in this group can be stored for a week to a couple of months at room temperature without the development of any undesirable changes in flavour and texture.

- 3) *Perishable foods*: This is the largest of the three groups and includes most of the food items we consume everyday, such as milk and products, eggs, poultry, meat, fish, most fruits and vegetables such as bananas, pineapple, papaya, green leaf vegetables etc. As these foods contain high amounts of protein, moisture and other nutrients, they are an ideal medium for bacterial growth. They also spoil easily by natural enzymatic changes. They have a very short shelf life of a few hours to a few days, after which they spoil rapidly. It is this group which is responsible for the outbreak of food-borne illness.

This group also includes all prepared menu items, opened canned foods and frozen foods, which have thawed. Foods in this group must be stored at low temperatures to retard the action of microorganisms and enzymes.

With a brief review of foods categorized into three main groups on the basis of their shelf life or perishability, next let us get to know about the conditions that could lead to spoilage.

Conditions that could Lead to Food Spoilage

Foods spoil easily if they are improperly handled. To prevent spoilage in foods, it is necessary that care should be taken to ensure purity, wholesomeness, taste and attractiveness of foods and beverages served. Food spoilage is hastened if conditions are favourable for microbial, enzymatic and chemical contaminants and insect action or if food is mechanically damaged.

Therefore, it is essential that foods are stored well. The following conditions could lead to spoilage of foods:

- 1) buying more food than required,
- 2) buying poor quality commodities due to lack of accurate purchase specification,
- 3) insufficient inspection of incoming commodities,
- 4) lack of promptness in storing delivered items,
- 5) inadequate storing facilities,
- 6) failure to separately store dairy products, meats, vegetables, and prepared foods,
- 7) failure to maintain refrigerators and freezers in good operating condition,

- 8) negligence in maintaining storage areas is a sanitary condition at all times,
- 9) insufficient training and supervision of personnel handling the food.

Next, what signs to look for to identify the spoiled foods? Let us find out.

18.5.2 Signs of Spoilage in Fresh, Dry and Preserved Foods

The signs of food spoilage vary with the type of food, the cause of spoilage and the environment. One can cause spoilage or more of the different factors mentioned earlier.

Signs of spoilage generally seen in foods are: *softening, hardening, discolouration, mould growth, fermentation, drying, oozing out of liquid, off odours such as mouldy, alcoholic putrid, and presence of insects.*

Let us then review the spoilage indicator in different categories of food.

Spoilage Indicator in Different Categories of Food

The various spoilage indicators in variety of foods are enumerated herewith.

- a) *Canned Food*: Although canned food have excellent keeping quality because the contents of the sealed cans are practically free from microorganism, some heat resistant spores may remain or bacteria may enter cans which are not properly sealed. If cans are stored at warm temperatures these heat resistant, anaerobic spores or bacteria may germinate, multiply and spoil the contents of the can. Sometimes the acid from the food reacts with iron of the container and spoils the food by forming hydrogen gas. The spoilage of canned foods result either from chemical or microbial spoilage or both.

Signs of possible canned food spoilage are:

- a puffy, swollen appearance because of bulging ends.
- leaky, corroded or rusty cans.
- contents spurt out when the can is opened.
- contents smell putrid or of hydrogen sulphide.
- brine or syrup looks cloudy, bubbly, slimy or mouldy.
- contents are discoloured.

Note, canned food which is doubtful should be discarded without tasting the contents.

- b) *Frozen Foods*: It is hard to detect spoilage in frozen foods unless there are changes in colour and smell. However, if the following precautions are taken food-borne illnesses can be prevented.

- Do not use frozen foods if off smell, taste or discolouration is there,
- Do not re-freeze food which has been thawed,
- Thaw only what you need,
- Do not purchase unsound packages,
- Do not keep frozen food out of the freezer for long before cooking or serving, and
- Do not accept food which has a large quantity of ice crystals formed inside the packets.

Note, frozen foods do contain some bacteria as freezing only retards bacterial growth and does not kill them. Bacteria multiply when food has thawed and is in the danger zone. Therefore, once frozen foods are thawed, they are highly perishable.

- c) *Fish*: Spoilt fish shows the following signs:

- dull or sunken eyes
- gills are grey or green
- off odour

- flesh separates from the bone and is flabby
 - depression remains in flesh when outer skin is pressed
 - few scales are left on fish
 - shellfish claws and tail lose their spring
- d) *Meat and Poultry*: Bad meat shows the following signs and spoils more readily when more surface area is exposed, as in minced meat. These signs include *discolouration, putrid smell and slimy appearance and feel*. Organ meats such as liver, kidney and brain are more perishable than muscle meat.
- e) *Eggs*: Stale eggs float in water. The eggshell is the spoilage indicator in whole eggs. Spoilt egg shows the following signs:
- Cracked Shell
 - Leaking contents
 - Egg yolk is exposed
 - Shell has a dirty discoloured appearance
 - Blood spot, meat spot, foul odour or other contamination
- f) *Milk and Dairy Products*: Milk and milk products, which are unfit for consumption may show any one or more of the following changes:
- Change in taste to sour or bitter, fat separates out into clumps, milk curdles when heated, butter tastes rancid
 - Change in smell
 - Rope formation
 - Discolouration
 - Cheese and curds develop off odours, mould growth and become a little slimy
- g) *Cereals and Pulses*: Although they do not spoil easily, signs of spoilage are:
- Musty odour and off flavour
 - Presence of weevils, beetles, moths and worms
 - clumping of wholegrain
 - presence of dirt, mud and stones
- h) *Vegetables and Fruit*: These show the following signs of spoilage:
- presence of mould, leading to rot
 - green leafy vegetables are wilted and limp
 - discolouration and mushy texture
 - presence of insects and worms
 - green potatoes, sprouted potatoes and over mature vegetables
 - skin or peel is damaged or bruised
- i) *Cooked Foods*: These foods are at high risk of getting spoilt. They show various signs of spoilage or may not show any visible signs and yet harbour microorganisms capable of causing food borne diseases. Leftover should be stored carefully and doubtful food should not be consumed. Very often there are no obvious signs of spoilage in cooked foods.

In the discussion so far we have focused on the point that following several basic rules to protect food from contamination can prevent food spoilage. Spoilage of food depends upon the perishability of food. The food handler should be able to select wholesome food and identify likely signs of spoilage in food. Now answer the questions included in the check your progress exercise 1.

Check Your Progress Exercise 1

- 1) How does a food handler transmit a food borne illness directly?
.....
.....
.....
- 2) List the factors that facilitate the growth of bacteria.
.....
.....
.....
- 3) Name the types of chemical food poisoning. How can they be prevented?
.....
.....
.....
- 4) State whether true or false.
 - a) All food borne illness can be prevented.
 - b) Protein rich foods are an excellent medium for bacterial growth.
 - c) Leftover food should always be mixed with fresh food for economical reasons.
 - d) Brass pots and pans should be lined with tin.
- 5) Differentiate between food poisoning and food infection.
.....
.....
.....

Besides being able to identify wholesome safe food, it is important that a food handler practices hygienic food handling practices. A detail review on this aspect is presented in section 18.7. Before we move on to this section we would also like to bring to your notice the importance of pest control in a food service operation since we have already learnt earlier that food contamination leading to food poisoning and other serious diseases in humans, is a major hazard of a pest infestation.

18.6 IMPORTANCE OF PEST CONTROL

The importance of pest control in food service operation is highlighted herewith.

- 1) *Contamination:* Food contamination leading to food poisoning and other serious diseases in humans is a major hazard of a pest infestation. This is so because pests move from dirt to food and transfer harmful microorganisms to it.
- 2) *Legal requirement:* According to the Prevention of Food Adulteration Act (1954), if any food article consist either wholly or in part of any filthy, putrid, rotten, decomposed or diseased animal or vegetable substance or is insect infested or is otherwise unfit for human consumption, it is deemed to be adulterated. Serving adulterated food is punishable by law.

- 3) *Wastage and destruction*: Ten per cent of the world's harvested cereals are destroyed by rodents and insects, which if saved could feed 260 million people. Rodents are known to destroy pipe, insulation and cables. *Termites* and *textile* pests cause grave damage to the woodwork and upholstery. *Beetle*, *weevils* and *warehouse moths* destroy commodities, making them unfit for consumption. *Rodents* contaminate much more food with their hair and droppings than they actually eat.
- 4) *Reputation*: The reputation of any catering establishment depends largely on the prevailing hygienic conditions. Flies hovering over uncovered food and insect body parts and droppings found in food can be very repulsive to the consumer, thus damaging the establishment's reputation. Hence, proper sanitary practices and pest control measures would go a long way in building up goodwill among customers and in turn will improve financial gains.

Having looked at the importance of pest control, let us get to know about pesticides and the different types.

18.6.1 Classification of Pesticides

Pesticides include insecticides and rodenticides. They are *substances, which have certain pharmacological effects on insects and rodents, either as poisons or as repellants*. Pesticides that are reliable, easily available, have a prolonged residual effect and are not highly toxic to humans are preferred. Pesticides can be categorized on the basis of the *nature of the substances, their effect on pests, and method of application*. Let us learn how.

- A) *Nature of the Substances*: Under this category, pesticides can be divided into three types as inorganic, organic and synthetic pesticides. Let us get to know them:
 - 1) *Inorganic pesticides*: These are natural chemical substances, for example, sulphur dust, arsenic, hydrogen cyanide and Paris green.
 - 2) *Organic pesticides*: These are mainly plant extract. They are least harmful and are also least effective against insects, for example, parathyroid. They have a quick 'knock-down' action but little residual effect hence repeated applications are necessary.
 - 3) *Synthetic pesticides*: As the name implies, these are manmade chemicals, are highly dangerous and should be stored away from food preparation areas. They include chlorinated hydrocarbons like Lindane, DDT and chlorophyriphos; organo-phosphates like malathion, phosphine and diazion and carbomates like carbandazim, aldicarb and carbaryl.
- B) *Effect on Pests*: Based on this criterion, pesticides can be divided into six types. What are these? Let us see next.
 - 1) *Stomach poisons*: These are applied to plants and ingested by insects while they feed on these plants, for example, arsenic, fluorides:
 - 2) *Contact poisons*: These are applied directly to pests. They penetrate and damage the insect body wall, for example, DDT, BHC (benzene hexachloride) and indiar.
 - 3) *Residual poisons*: These are applied to surfaces. Insects touching them pick up a lethal dose for example, DDT and BHC.
 - 4) *Systemic poisons*: These are applied to plants and animals. These poisons are absorbed and translocated to all parts of the organisms, so that insects feeding on them acquire a lethal dose.
 - 5) *Repellants*: These keep insects and other pests away from a given area, due to the odour they emanate, for example, Dimethyl phthalate (DMP), Dibutyl phthalate (DBP) and Tulsi leaves.

- 6) *Fumigants*: These poisons are inhaled by pests and cause death, for example, hydrocyanic acid gas and sulphur dioxide.
- C) *Method of Application*: This is the third criterion for classifying pesticides. Let us see, what are the different types under this classification method.
 - 1) Sprays, for example, lindane, pyrethrum
 - 2) Pellets, for example, boric acid, naphthalene
 - 3) Chalk coated or impregnated with insecticidal powder or dust
 - 4) Dusts, for example, BHC, DDT
 - 5) Meals, for example, zinc phosphide, warfarin
 - 6) Vapours, for example, lindane, DDVP (dichlorvos), hydrocyanic acid
 - 7) Lacquers, for example, insecticides mixed with lacquers, paints, and varnishes; these are effective for at least a year
 - 8) Liquids, for example, kerosene, mineral and tar oils
 - 9) Aerosols: They contain liquefied gas, for example, Freon, under pressure, which when released after the valve of the dispenser is opened, lets off the insecticidal solution mixed with it, for example pyrethrins, DDT.

After having knowledge about what are pesticides and their classification, let us have a look at the precautions that must be taken while handling pesticides.

18.6.2 Precautions to be Taken While Handling Pesticides

All pesticides are toxic to humans. Hence forth, use of certain pesticides has been banned. These are given in Table 18.5, for your reference. Food service workers need to be adequately instructed regarding the hazards involved and should be trained to avoid them.

These are some of the precaution needed: -

- 1) Using gloves and masks while handling these chemicals is essential.
- 2) Wash hands thoroughly after use.
- 3) Never use sprays when food is openly displayed.
- 4) Storage of insecticides away from food articles. Holding these poisons in a separate area with their proper labels is important to avoid accidental poisoning. Also, they are to be kept away from heat and open flames.
- 5) Knowledge of the type of pesticides banned and the specific residual limits permissible in food commodities as laid down by the Government of India is essential.
- 6) First-hand knowledge of antidotes to various poisons is necessary for food service workers.

Table 18.5: Pesticides banned by the Government of India

1) Aldrin	8) Pentachloron-nitrobenzene
2) Chlordane	9) Methyl parathion
3) Hetachlor	10) Nitrofen
4) Dibromo-chloropropane	11) Parquet dimethyl sulphate
5) Toxaphene	12) Nicotine sulphate
6) PCP	13) Tetradifon
7) PMA	

Use of DDT in agriculture and BHC on vegetables, fruits and oiled crops and in preservation of grains have also been banned because their safety is doubtful.

Table 18.6 suggests a few pesticides that have been recommended in kitchen against particular pests.

Table 18.6: Pesticides recommended for use in the kitchen

Pest	Pesticide Recommended
1) Cockroaches	Pyrethrum extract, malathion, Indiara
2) Flies	Pine oil, cypermethrin, Indiara
3) Ants	Cypermethrin, malathion, Indiara
4) Silverfish	Cypermethrin, malathion
5) Stored grain insects	Ethyl dibromide (EDB), mercury tablets, castor oil, neem guard, boric acid, tulsi leaves
6) Rats and mice	Warfarin, bromadiolone

The non-poisonous nature of organic pesticides (Indiara, neem guard) calls for their extensive use in kitchens and foodgrain stores. Recent studies have indicated that pesticides like Indiara with a composition of diallyl disulphide, isothiocyanate, allylpropyl disulphide is non-toxic and non-poisonous. Also, neem oil, castor oil and ginger paste used as repellants and which are easily available in a catering facility, are recommended as replacements for the more toxic insecticides.

With this, we end our study on pesticides and their use in food operations. Next, let us move on to study about hygienic food handling.

18.7 HYGIENIC FOOD HANDLING

You would recall reading about food handling and storage in Units 6 and 7 earlier in this course. Here we shall first have a look at the general rules for hygienic storage and handling followed by specific rules/considerations for variety of foods.

Let us first consider a few rules regarding hygienic storage and handling.

General Rules for Hygienic Storage and Handling

- 1) There should be clean place for storage of cleaned and sanitized ware. Store all items either on clean dry shelves or in cart racks. Dusty or dirty shelves will quickly resoil cleaned and sanitized items.
- 2) Handle items as little as possible, taking care not to touch food or mouth contact surfaces.
- 3) Storage area must be dry and above the floor. Splashes from mopping solutions or food spillage, exposure to dust or floor dirt from sweeping must be avoided.
- 4) Pans or containers stored on low shelves should be placed inverted or covered.
- 5) Utensils etc. should be hung in a self-draining position on hooks or racks.
- 6) Glasses and cups should be inverted on racks or on shelves.
- 7) Silverware should be placed in perforated plastic containers to dry. Cutlery should be picked up by the handle.

Despite careful selection, storage of food, and good personal hygiene on the part of the food handler, outbreaks of food-borne illness can occur if unsafe procedures are followed in preparing and mixing food and if temperature is not controlled during preparing and holding food.

Sanitary procedures are very important during preparation, cooking and holding of food because of the following reasons:

- 1) Even if wholesome food is selected, microorganisms are still present in and on food.
- 2) Not all food items served on the menu are cooked, for examples, salads.
- 3) Normal cooking procedures destroy most pathogens but not necessarily spores or toxins.
- 4) Heating foods to safe temperatures is not always feasible as some foods may spoil at high temperatures, for examples hollandaise sauce.
- 5) Food can get decontaminated during preparation, mixing or holding.
- 6) The internal temperature of cooked foods may not reach the safe temperature level.
- 7) During preparation, food may get contaminated by other poisonous or harmful substances.

Some bacteria are likely to be present and will multiply rapidly when ingredients are mixed and their basic needs of (a) moisture, (b) nutrients, (c) temperature and (d) time are met.

In the kitchen, most pre-preparations provide microorganism with sufficient moisture and nutrients. The temperature in a hot, steamy, poorly ventilated kitchen is around 35°C the ideal temperature for microorganism to grow. If food is kept at this temperature long enough, microorganisms will multiply and spoil food. Once spoilage occurs, it cannot be rectified by freezing or pressure-cooking.

The majority of causes of food poisoning reported each year is caused by inadequate refrigeration of perishable food. In India climatic conditions, perishable foods left at room temperature for even three hours is at great risk as the ambient temperature is higher as compared to western countries. It is necessary to follow the time-temperature principles, especially when preparing perishable food. The food handler must observe two basic rules when food is to be held:

- 1) Keep food hot, [at an internal temperature above 63°C (145°F)]
or
- 2) Keep food cold [at an internal temperature below 5°C (41°F)]

During preparation, food should be exposed for a minimum possible time to temperatures between 50°C to 63°C. This is the danger zone. Some common procedures in preparation of food, which affect the microbial count, are highlighted herewith.

18.7.1 Procedures in Food Preparation which Affect the Microbial Count

The procedure to be followed will depend to a large extent on the food being prepared. Some common procedures, which affect the microbial count, are as follows:

- 1) *Cleaning*: Cereals and pulses are picked before they are milled or cooked, to remove grit, mud, stones, husk, mouldy and insect-infested grains. Green leaves are separated from the inedible roots and tough stalks.
- 2) *Washing*: Most foods need to be washed before preparation with potable cold water. Washing removes extraneous matter like surface dirt, soil and preservative and pesticide residue.

Fruits and vegetables to be consumed raw should be washed in a solution of 50 ppm chlorine for five minutes or in a dilute solution of potassium permanganate. Leafy and salad vegetables should be washed thoroughly.

In case of suspected insect or worm infestation, soak fresh vegetables like cauliflower in cold salted water for twenty minutes. If insects are present they will rise to the surface.

Wash the body cavity of poultry well. Let all washed items drain well.

- 3) *Pre-preparation*: This step includes peeling, trimming and soaking. Potable water must be used for pre-preparation and cooking. Fruits and vegetables need to be peeled, trimmed and cut to remove inedible or spoilt parts. Grains are soaked for sprouting. Potable water should be used for all pre-preparation. No food container should be placed on the floor as the floor is heavily contaminated. Keep all food on racks or shelves.
- 4) *Thawing*: Frozen foods should be thawed completely before cooking, unless the manufacturer's instructions are otherwise. Thawing large portions of food joints and poultry takes time. Freezing only prevents bacteria from multiplying it does not kill them. When a food is thawed, these dormant microorganisms start multiplying rapidly once again.

If food is cooked while it is partially or totally frozen, a large amount of heat will have to travel to the center of the food to melt the ice. The food may get cooked on the surface, but internal temperature will not be high enough to kill bacteria. The food is thus likely to reach a temperature within the danger zone, which is favourable for bacterial growth.

Meat may be thawed in a special thawing cabinet at a temperature of 10 to 15°C. The advantage of such a cabinet is that cross-contamination is prevented and thawing is faster and safer at a cool temperature of 15°C. A refrigerator may be used instead of a thawing cabinet. Care should be taken to prevent any liquid from raw meat dripping in the refrigerator and contaminating other foods. Raw meat can contaminate any and everything it comes in contact with in the kitchen, like hands, work table, chopping board, meat block, knives, cutters, utensils, dish cloth and dusters. These articles can further contaminate other foods.

Never thaw meat by immersion in warm water or near heat as the microorganism on the surface will grow rapidly while the center is still defrosting. Thawed meat should be cooked immediately or kept in the refrigerator for maximum 24 hours before cooking. Never refreeze meat, which has once thawed. If it has to be refrozen, then cook and freeze. There are certain rules that must be considered for thawing food. Let us see what these are.

Rules for Thawing Food

Thaw or defrost food in any one of the following ways:

- 1) In the refrigerator below 4°C (39°F).
- 2) In a thawing cabinet at temperatures between 10 - 15°C.
- 3) In potable running water at 21°C or below while it is still in the packet.
- 4) In a microwave oven, only when it has to be cooked immediately.
- 5) As per conventional cooking, for example, certain frozen foods like frozen vegetable and ready-to-eat chicken preparation are cooked in the frozen state and quickly thaw when they are cooked.

Let us next review the different types of cooking methods and the microbial contamination.

18.7.2 Cooked Food and Microbial Contamination

Food may be served uncooked, rare or medium cooked or well-cooked depending on the foodstuff and the recipe. Cooking reduces the number of bacteria present in food. The food handler should realize that conventional cooking procedures do not kill all bacteria and spores or inactivate them. Hence, even cooked food should be handled very carefully.

Food is a poor conductor of heat and for large pieces; longer time is needed for heat to reach the center of the food being cooked. Generally, there are more bacteria on

the surface than inside the food, unless it has been mashed, minced or rolled. In such foods, bacteria present on the surface get distributed throughout the food. It is necessary for the center of the food to reach temperature of at least 700°C for few minutes while it is being cooked. Internal temperature can be checked with the help of a probe thermometer. Wipe the probe with a sanitizing solution or isopropyl alcohol after every use.

Most harmful bacteria present on the surface of a food are destroyed when food is cooked. The microbial contamination in some common cooked preparations is enumerated herewith.

Stuffed Preparation: While cooking any stuffed preparation, like stuffed chicken or turkey, it is advisable to cook the stuffing and then stuff the bird. This is because stuffing slows down heat penetration and sometimes even if the bird is cooked, the temperature in the center may not be high enough to kill bacteria.

Food poisoning is more likely to occur from stuffed foods because:

- 1) Bare hands may be used to stuff the food.
- 2) Heat transfer is slow, permitting bacteria to remain in the danger zone for a longer time.
- 3) Adequate heat may never reach the center of the food while externally the food may be cooked to the desirable stage.

Although a final temperature of 63°C (145°F) is considered sufficient to prevent microbial growth, the following temperature chart as given in Table 18.7 is recommended for various meats.

Table 18.7: Ideal cooking temperatures for various meats

S.No.	Food Stuff	Internal	
		°C	°F
1.	Rare roast beef	54	130
2.	Pork and pork products	66	150
3.	Stuffed meat	74	165
4.	Pork (gray stage)	77	170

The larvae of *trichinella* are killed at 66°C (150°F). As a precaution, it is recommended that pork be cooked to the gray stage. It is preferable to cook or reheat food to at least 74°F provided culinary quality is not lost.

Coated Preparations: Many food items are coated with a protective covering before they are fried. This coating helps in retaining the juices and flavour of food and keeps excess fat out. They are usually coated with batter or dipped in egg and covered with breadcrumbs before they are cooked. These coverings act as good heat insulators and reduce the transfer of heat to the food being cooked. They may also add to the bacterial population. This can happen in conditions when:

- 1) the batter is mixed by hand,
- 2) food is repeatedly dipped in batter by hand,
- 3) microorganism from the raw food may contaminate batter,
- 4) if batter is stale, and
- 5) dry bread crumbs favour microbial growth when they are moistened with beaten egg and are left unused at room temperature. Excess batter or breadcrumbs should be discarded or refrigerated.

Mixing Raw and Cooked ingredients: When raw and cooked ingredients are mixed and the products is not refrigerated or consumed immediately, it can lead to food poisoning. Special care should be taken while preparing salads and sandwiches, which are made from highly perishable foods like egg, meat and poultry. They should be stored at refrigeration temperatures immediately. In sandwiches, the bread acts as a heat insulator and prevents the filling from cooling fast. Preparing trifles, sandwiches, etc. a day prior to use should be avoided.

Eggs may be contaminated with *Salmonella* which are destroyed only at 60°C (150°F). This temperature may not be reached while preparing meringues, soufflés, egg nag, soft cooked eggs and scrambled eggs. In such cases, use clean, whole shell eggs instead of dried or liquid eggs.

We have in our discussion above highlighted the cooking methods and how they influence the microbial growth. Once the food is cooked it is held at hot cold, temperatures before serving. Also sometimes the left over food left in hot-holding equipment during the entire lunch break is exposed to additional contamination. This also influences microbial growth. Let us study about this aspect in greater details.

Holding Food: Food, after being prepared, need not necessarily be served immediately. It may be held for sometime and then served. The holding can be for both cold and hot foods. Extra precaution is needed while handling and storing such foods, as they are prone to microbial attack. What are these precautions? Let us read and find out.

Precautions for Holding Hot Food

To maintain high culinary quality, food be prepared when it is needed and served as soon as it is prepared. But this situation is not feasible in most catering establishments as the volume of production is enormous and volume of sales cannot be accurately predicted. To serve hundreds of lunches in a two-hour lunch break, calls for preparing most of the items on the menu in advance. Foods which have to be served over an extended lunch hour can be held hot with the help of a bain marie, double boiler steam table or chaffing dish, The food handler should understand that these gadgets are not reheating food but only hot-holding of foods. If used for reheating, food will remain in the danger zone for a longer time.

The temperature at which food remains in the hot-holding equipment is very important and should not be less than 63°C. If this temperature is not maintained, it is likely that food spoilage will occur rapidly. Before keeping food in any of these equipments, it should be heated to 74°C (165°F) and transferred immediately.

The following precautions should be taken during hot holding of foods:

- 1) Keep food covered to prevent heat loss.
- 2) Check temperature with a thermometer and not by just touching it with hand.
- 3) Stir occasionally for even heating as lower surfaces get heated and upper surfaces get cooled by air.
- 4) use proper serving equipment like long-handled ladles and scoops to minimize hand contact. Keep in a clean place when not in use.
- 5) Prepare and keep only required amounts as extended heating will affect flavour and quality.
- 6) Dry preparations like chappatis, fried items and baked items may dry further, or get overcooked during hot holding.

Cooling Food: Any perishable food, which is not to be consumed immediately, should be kept outside the danger zone. Cold preparations like desserts should be cooled as soon as possible to 15°C and stored in the refrigerator. Food should not be refrigerated

while it is still hot, otherwise the maximum internal temperature in the refrigerator of 4°C would increase and favour spoilage of other foods stored in the refrigerator. Food must be cooled prior to refrigeration in the coolest part of the kitchen. Large columns cool faster when divided into smaller portions or when kept in shallow containers. Cooling can be hastened by keeping food containers in ice-cold water or in quick-chill units. Food cools faster when the container is placed in water, as water is a better conductor of heat than air.

Stirring food occasionally brings about a uniform drop in temperature and faster cooling. Other factors which influence the cooling process are

- 1) the type of food,
- 2) the temperature in the refrigerator or quick-chill unit, and
- 3) the container used- size of container, material it is made of and covering, if any.

Cooked food, which is not to be consumed immediately, should be refrigerated with 1½ hour at 4°C or below. If refrigerator space is inadequate, it is wise to purchase a quick-chill unit or extra bain maries for ice chilling. Large catering units should have walk-in chillers for rapid cooling of cooked food.

Leftover food: All food items have to be stored till they are consumed.

Left food or surplus food includes all items that have been:

- 1) displayed but not during meal time,
- 2) items prepared but not used in function, and
- 3) items produced in more than required quantities.

Leftover food, which has not been served and is left in hot-holding equipment during the entire lunch break, is exposed to additional contamination. Leftovers, which are highly perishable in nature and have been in the danger zone for more than two to four hours (depending on the nature of the food), should not be served. Most foods can be kept for a day if they are not handled much and are stored at the correct temperature and reheated adequately. Foods, which are usually contaminated with spore, like *Bacillus cereus* in rice and *Clostridium* in meat, require proper reheating. These foods are responsible for a number of cases of food poisoning. Conventional cooking practices do not destroy spores and as food is cooked and enters the danger zone, these spores germinate and bacteria begin to multiply and continues to do so till food is refrigerated or reheated. They remain dormant in the regulator and when food is reheated and passed through the danger zone, they multiply once again.

To control bacterial growth in leftover foods, the caterer should keep leftover to a minimum and highly perishable or high-risk foods should not be reheated more than once. With each reheating, the bacterial population increases. Surplus food should be reheated thoroughly to destroy all vegetative bacterial cells. Just warming up a dish before service would be doing it more harm than good, as bacterial growth would be favoured.

Food prepared too far in advance can cause embarrassment to the caterer, who may be tempted to use rather throw it away. It may be recalled that such food is one of the main cause of food poisoning. Careful planning can minimize over production.

To prevent surplus food causing food poisoning, the following points should be noted:

- 1) All food prepared but not should be stored at or below 5°C.
- 2) The caterer should judge the quality of leftover food and then decide whether it is to be used or not.

- 3) It is considered fit for consumption if it has not been handled excessively or exposed to high temperatures for long periods.
- 4) Surplus cold food should be returned to the chilled storage at or below 5°C until required.
- 5) Surplus hot food must be cooled as quickly as possible and retriggered below 5°C until it is to be reheated for service. It should then be heated to 74°C and kept at a temperature above 63°C until it is served. It should be reheated only once.
- 6) Surplus hot food like roast joints which have been held at or below 5°C can be served as cold food over the next two days, provided they are held at 5°C until required for service.
- 7) Leftover food should be handled carefully to avoid contamination through dirty knives, chopping board, equipment etc.
- 8) It should not be mixed with fresh food.
- 9) It should be carefully covered and stored away from fresh and war foods to avoid possible risk of cross-contamination.
- 10) All excess food should be sorted into categories and refrigerated as soon as possible and stored accordingly.

The management should look into the amount of overproduction and keep it to a bare minimum. If large quantities of leftovers are present, the food should be cooled, covered and labeled before returning the food to the refrigeration. The label should also record the date before which the food should be used. Such cases arise only when a function is cancelled or very few people turn up for a function because of bad weather, etc.

When deciding whether or not to use leftover food, always remember – ‘*if in doubt, throw it out*’.

Now let us see what should be the storage temperature so as to minimize microbial spoilage

Storage Temperature of Prepared Foods: The Food Hygiene (Amendment) Regulations, 1990 and 1991 have introduced a complex set of controls over the storage temperatures of prepared foods. Food is divided into two categories, some of which should be kept at 8°C or less and some that should be kept at 5°C or less. All hot foods must be kept above 63°C. There are exemptions from temperature control for limited control for limited periods of time for foods freshly prepared on site or on display for sale in catering outlets. The 5°C temperature requirement became effective on 01 April, 1993.

Though chilling helps in extending the shelf life of food products, it can be effective only when high standards of hygiene are observed. The caterer should store all perishable products below 5°C as soon as possible. The same chilled storage temperature is applicable to food in large delivery vehicles. Small vans making local deliveries are allowed to operate to a standard at 8°C for all foods, even those in the 5°C category. Caterers should check temperatures on receiving deliveries. All allowance at 20°C in the temperature is given for up to two hours for the following:

- 1) Defrosting of equipment.
- 2) Breakdown of refrigeration equipment.
- 3) During cold food preparation in the kitchen.
- 4) When food is moved around on the premises.

However, an exemption for certain foods from temperature control is permissible. These foods/dishes include:

- 1) Certain foods are processed in such a way that it prevents the growth of pathogens, for examples, sterilized canned food. Canned foods, which have been only pasteurized, should be refrigerated and this should be indicated on the label.
- 2) Sandwiches with perishable fillings can be held at 8°C or below for a period of 24 hours only.
- 3) Mawa or khoa should always be refrigerated and used within 24 hours.

In our discussion so far we have reviewed the cooking methods and how they influence the microbial growth. Further, we discussed the appropriate holding and storage temperature of prepared and leftover foods which any individual/caterer in a food service operation must follow. We would explore further and study about the preparation methods for certain foods which are highly perishable and may require careful handling.

Preparation of Specific Foods

In this section we will look at the preparation method of meat, fish fresh, fruits and vegetables. These foods bring highly perishable require careful handling. Let us find out.

- a) *Meat*: Meat is a highly perishable food and gets contaminated from various sources by the time it reaches the kitchen. It should be washed and trimmed as it is cooked. Separate knives, cleavers and chopping boards should be used for raw, and cooked meat to reduce chances of cross-contamination.

Bacteria from raw meat may remain on improperly washed equipment and if the same equipment is used for cutting ready-to-eat meat, like cold cuts which are eaten without further cooking, the chances of food poisoning occurring become very high. The bacteria on the raw meat are likely to get destroyed once meat is cooked. After handling raw meat, wash hands well before touching cooked meat or any other ready-to-eat foods which are not going to be heated again.

In the butchery, work table surfaces should be made of impervious material which is easy to clean. The chopping block can be made of hardwood and should be light enough to be removed for cleaning, scraping and rinsing after every use. While deboning meat and making rolled joints, chances of contamination increase. Such joints should be cut into small portions and cooked well to kill microorganisms that may be present in the center of the cut.

Minced meat is at a higher risk than meat because microorganisms present on the outer surface of meat get distributed throughout the entire mass of mince. Minced meat is also handled more and spoil much faster, leading to discolouration and foul odours and may cause food-borne illnesses. To reduce the chances of spoilages, the following precautions should be taken:

- 1) Mince the quality required for the day only.
 - 2) Cook mince thoroughly at sufficiently high temperatures.
 - 3) Surplus mince be cooled rapidly in small portions.
 - 4) Refrigerate surplus immediately.
 - 5) Reheat mince thoroughly before serving.
 - 6) If root vegetables like potatoes, carrots or onions are cooked along with mince, clean them thoroughly to remove heat-resistant soil organism.
- b) *Fish*: The best way to prepare fish is to place a stone slab long enough to fit across the sink used for fish preparation and about two-third the width of the sink. Place a hard wood board on it for cutting fish. This arrangement allows a continuous flow of clean water with the wash going down the drain of the sink.
 - c) *Fresh Fruit and Vegetables*: Vegetables should be thoroughly washed to remove traces of soil. If necessary, root vegetables may have to be soaked for sometimes

and scrubbed clean as soil may contain *Clostridium perfringens* and *Escherichia coli* along with other intestinal pathogens. Some vegetables, like carrots and ginger, may be scraped; fruits should be washed well and peeled, if required before they are served. Peelings help in reducing microbial load and preservative pesticide residue if any.

Green leafy vegetables should be washed under running water. Lettuce should be broken up and washed. Leaves should be drained well. A separate sink should be allotted for vegetables and fruit preparation. Spoilt, inedible portions be removed.

When food is handled carelessly, it is likely to get contaminated or spoilt and may result in food poisoning. Box 18.2 highlights some common faults in food preparation.

Box 18.2	Common Faults in Food Preparation
<p>The 10 most common faults responsible for outbreaks of food poisoning are:</p> <ol style="list-style-type: none"> 1) Food prepared much before serving time. 2) Storing perishable food at room temperature beyond four hours. 3) Slow cooling of food in the kitchen at room temperature before refrigerating it. 4) Inadequate storage facilities and reheating of leftover food. 5) Cooking frozen meat or poultry without thawing it completely. 6) Cross-contamination from raw to cooked food and use of cooked food contaminated with bacteria 7) Undercooking meat and poultry. 8) Holding hot food below 63°C during service. 9. Infected food handlers. 10. Surplus food production and use of leftovers without checking quality. 	

With this we end our study of hygienic food handling. Next, we shall review the personnel hygiene and sanitary practices linked with food safety in the next unit.

Check Your Progress Exercise 2
<p>1) What are pesticides? How are they classified?</p> <p>.....</p> <p>.....</p>
<p>2) List some common rules that a food service worker needs to adopt for hygienic storage and handling.</p> <p>.....</p> <p>.....</p>
<p>3) Give some examples of microbial contamination in some common cooked preparations.</p> <p>.....</p> <p>.....</p>

18.8 LET US SUM UP

Unit 18 focused on food safety. We learnt that microorganisms such as viruses, bacteria, yeasts, moulds, algae and protozoa affect humans and their food. The food handler should understand the importance of keeping food free from disease causing organisms and other harmful agents. The safety of foods must always be considered while storing, preparing and serving foods. The food handler should know that some

microorganisms are useful to us and affect the basic characteristics of food producers. Others are harmful and can cause spoilage of food and disease.

Food spoilage refers to decomposition or decay by microbes, animal parasites, natural enzymes, physical or chemical changes, as well as, external contaminants. In this context we learnt that spoiled food should always be discarded. Food that is decayed is easier to recognize than foods spoiled by microorganisms or unobvious contaminants. Foods have been categorized as perishable, semi-perishable and non-perishable on the basis of the ease with which they spoil. They need to be stored properly.

The other aspect covered in this unit was the importance of pest control. The presence of pests and their body parts or droppings in food served will not only result in contamination and spread in disease but can ruin the reputation of any catering establishment.

18.9 ANSWERS TO CHECK YOUR PROGRESS EXERCISES

Check Your Progress Exercise 1

- 1) The food handler can transmit pathogens to food directly because of coughing or sneezing on or near the food, droplets containing microorganisms may fall on the food. Further, unwashed or improperly washed hands transfer diseases of the intestinal tract. If hands soiled with faecal matter handle food, disease-causing agents are transferred to the prepared food. Consumption of such food causes illness. When food is openly displayed, the customer handling the food can contaminate it.
- 2) The important factors, which have an influence on growth, are food and nutrients, pH level, moisture, temperature, oxygen, time and osmotic pressure and sunlight or UV rays.
- 3) Refer to Table 18.4 and answer on your own.
- 4)
 - a) True
 - b) True
 - c) False
 - d) True
- 5) Food poisoning is *an illness caused by toxins present in contaminated food*. The toxin may be a poisonous chemical toxin, which is accidentally or intentionally, added a naturally occurring poison like solanine in green potatoes or a toxic metabolite excreted by bacteria. Food infection, on the other hand, is *an illness caused by microorganisms*. It results from the *consumption of food that contains living bacteria, which are multiplying and capable of producing disease*. The illness, which results, is the reaction of the body to the presence of microorganisms or to their metabolites.

Check Your Progress Exercise 2

- 1) Pesticides are *substances, which have certain pharmacological effects on insects and rodents, either as poisons or as repellants*. Pesticides include insecticides and rodenticides. Look up sub-section 18.6.1 and present the classification of pesticides on your own.
- 2) Refer to section 18.7 and list the rules that a food service worker needs to adopt for hygienic storage and handling.
- 3) Eggs may be contaminated with *Salmonella* which are destroyed only at 60°C (150°F). Pork can be contaminated with larvae of trichinella. Similarly give some more examples based on your understanding of the topic.