SECTION 2

FOOD SAFETY AND HYGIENE

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Date: July 2013

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MODULE 4

FOOD HYGIENE AND BASIC FOOD MICROBIOLOGY

OBJECTIVES

By the end of this module, participants should be able to:

a) Explain the role of food hygiene in preventing foodborne illness due to contaminated food

b) Explain the benefits of good food hygiene practices and the costs of poor hygiene practices

c) Explain the different causes of foodborne illness

d) Describe the different types of microorganisms found in food with appropriate examples

e) Describe the structure, shape and size of bacteria with appropriate examples

f) Explain the factors influencing growth of bacteria in food

g) Explain the process by which bacteria reproduce and the time for multiplication

h) Describe how microorganisms are spread and the preventive measures

i) Explain the methods used to control microbial growth
4.1 INTRODUCTION TO FOOD HYGIENE

In this fast moving, highly mobile world, international food trade and foreign travel are increasing, bringing important social and economic benefits to particularly developing countries. Eating habits too, have undergone major changes in many countries over the last two decades. Food consumption has increased due to a growing population worldwide and so have patterns of consumption. Eating out has become very popular as people want to experiment with new cooking styles, delight with new tastes and enjoy a range of products. The consumption of raw or undercooked vegetables to retain the natural taste and to preserve heat-labile nutrients is an increasing trend. This may be a risky practice especially if contaminated water is used for irrigation or washing of the vegetables. Cultural practices such as consumption of raw or undercooked meat, particularly from infected animals, may also be a source of microbial infection.

4.1.1 Evolution of customer expectations

Customer expectations regarding food are quality driven and at the same time people expect the food they eat will not make them ill and is safe for consumption. In fact, in the age of Internet and mass communication, food safety and hygiene are more and more in the news causing consumers to be more concerned and aware about food safety than ever before.

4.1.2 What is safe food?

A safe food product is one, which represents the minimum risk of illness or harm to the consumer when prepared and / or eaten according to its intended use.

Foodborne illness can result from:

- Micro-organisms, for example bacteria and their toxins (poisons), viruses, parasites
- Heavy metals such as lead and mercury that can cause neurological damage in infants and children
- Chemical residues such as pesticides, detergents, disinfectants, antibiotics, lubricants and illegal food additives as well as those used in concentrations higher than maximum regulated levels
Other chemicals such as mycotoxins produced by certain fungi under correct conditions

Foreign materials such as metal fragments, wooden splinters and glass fragments

Naturally poisonous foods such as poisonous mushrooms and certain types of fish

Allergens naturally found in certain foods such as milk, eggs, nuts, wheat, shellfish.

To prepare and supply food which is safe, careful food hygiene is required.

4.1.3 What is Food Hygiene?

Food hygiene involves all conditions and measures necessary to ensure the safety and suitability of food at all stages of the food chain. It is designed to ensure the safety and wholesomeness of food from receipt of raw materials to supplying the consumer.

Food hygiene is more than just cleanliness. An equally important part of food hygiene is the way in which food is handled, prepared and stored. Food hygiene includes all practices involved in:

- Protecting food from contamination, including harmful bacteria, toxins, allergens, undesirable chemicals and foreign bodies;
- Preventing any microorganisms present from multiplying to an extent that would cause illness of consumers or the early spoilage of the food;
- Destroying any harmful microorganisms in the food by thorough cooking or processing;
- Rejecting and discarding unfit / contaminated foods.

4.1.4 The costs of poor hygiene

Food safety involves often unseen hazards at every stage from “farm to fork” that could turn food, the stuff of life into a cause of severe illness and / or
death. Illnesses due to consumption of unsafe food can affect anyone and are a major cause of personal distress, preventable deaths and avoidable economic burden.

Poor food hygiene conditions can lead to the following consequences:

- **Foodborne Illness**
- **Customer / Consumer complaints**
- **Food recalls**
- **Loss of brand reputation and business**
- **Fines, legal costs**
- **Costs of civil action**
- **Closure of business**
- **Low staff morale**
- **Imprisonment**

### 4.1.5 The benefits of good hygiene

Practicing good food hygiene will benefit food business in many ways:

- **Customer / consumer confidence**
- **Good reputation**
- **Brand protection**
- **Increased productivity**
- **Less food recalls**
- **Legal and regulatory compliance**

One of the most successful methods of reducing the risk of foodborne illness is to ensure that food handlers receive **comprehensive training** in the aspects of hygiene relating to their work. Training and consistent re-training of staff is
regarded as one of the more critical legs upon which a successful food hygiene programme is based. These activities have also proven to be important in building a positive food safety culture in an organization.

4.2 TYPES OF MICRO-ORGANISMS

4.2.1 What are micro-organisms?

Micro-organisms are living things which are individually too small to be seen with the naked eye and a microscope is needed. There are many different types of micro-organisms all around us. However, the vast majorities of these small organisms are harmless. They are part of the natural cycle of growth and decay in nature. In fact, most of them play such a vital part in natural cycles, that without them, such cycles would be severely disrupted.

4.2.2 Where are they found?

Micro-organisms are found everywhere, in the air, on the surface of foods, on our clothes, on the surface of the skin and inside our bodies.

4.2.3 Types of micro-organisms

There are 5 groups of micro-organisms most frequently found in food:

1. Bacteria
2. Moulds
3. Yeasts
4. Viruses
5. Parasites

4.2.4 How are micro-organisms associated with food?

These groups of microorganisms are concerned with food in a number of ways:

► as useful organisms - used in the production of foods such as yoghurt, cheese, wine, beer and in the production of various additives to enhance flavours or in preserving foods

► as spoilage organisms - causing deterioration/spoilage of food;
4.2.5 Structure, shape and size of bacteria

Structure of a bacterial cell

Bacteria are single-celled organisms, which are found everywhere, including on and in man, on food, in water, soil and air.

Example of the structure of a typical bacterial cell

Source: http://water.me.vccs.edu/courses/env108/lesson2_2b.htm
<table>
<thead>
<tr>
<th>Term</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Capsule</strong></td>
<td>a gelatinous slime layer which allows the bacterium to attach to surfaces and also protects the bacterium from harm; also responsible for clumping the organisms into flocs, aggregations or biofilms in the food industry</td>
</tr>
<tr>
<td><strong>Cell wall</strong></td>
<td>a rigid permeable structure which surrounds the bacterium and gives the cell its shape and length</td>
</tr>
<tr>
<td><strong>Cell membrane</strong></td>
<td>a semi-permeable membrane which controls the passage of nutrients and waste products both into and out of the cell</td>
</tr>
<tr>
<td><strong>Cytoplasm</strong></td>
<td>the major part of the cell and the medium within which the metabolic reactions take place</td>
</tr>
<tr>
<td><strong>Ribosome</strong></td>
<td>sites where proteins are synthesised</td>
</tr>
<tr>
<td><strong>Flagella</strong></td>
<td>present in some bacteria for locomotion – can be more than one at different places on the cell</td>
</tr>
<tr>
<td><strong>DNA</strong></td>
<td>the nuclear material of the cell which determines the genetic characteristics of bacterium</td>
</tr>
<tr>
<td><strong>Plasmids</strong></td>
<td>small loops of DNA which can be transferred to other bacteria, or in some cases into other organisms</td>
</tr>
<tr>
<td><strong>Pili</strong></td>
<td>hollow, hair-like structures which allow the bacterium to attach to other cells</td>
</tr>
</tbody>
</table>
Shape of bacterial cells

Bacteria vary considerably in shape:

- Cocci are spherical; some form chains e.g. streptococci and others form irregular clumps e.g. *Staphylococcus aureus* that produces a toxin that causes foodborne illness

- Bacilli are rod-shaped e.g. *Salmonella* and *Escherichia coli* (*E. coli*), both of which cause foodborne illness if the right types (strains) are present

- Spirochaetes are spiral shaped

- Vibrios are comma shaped e.g. *Vibrio cholerae* that causes cholera

Size of bacterial cells

The size of bacteria is measured in micrometres (µm) and 1µm = 1/1000 mm. Staphylococci have a diameter of around 0.75µm and salmonellae about 3µm in length. The naked eye can see to approximately 75µm and consequently bacteria are only visible in large numbers when they form clumps, better known as colonies or occasionally as slime on the surface of food.

To have an idea of the very small size of bacteria, approximately one million bacterial cells clumped together would cover a pin head!

4.2.6 Bacteria in food

Useful bacteria

Some bacteria are essential for certain processes:

1. The manufacture of cheese, yoghurt, bread, wine and beer

2. The production of some antibiotics, vitamins and industrial organic acids
Types of harmful bacteria

There are two main types of harmful bacteria encountered in food and a very important distinction must be made:

- Food spoilage bacteria
- Pathogenic bacteria

Food Spoilage Bacteria

Their presence is encouraged by poor, dirty working habits and conditions which lead to quick spoilage and ruin of large quantities of food. Their presence is usually easily detected because they cause visible discolouration and a bad smell.

For example, meat and fish start to smell and become slimy due to the waste products of the bacteria that are growing on them. Food spoilage bacteria are not typically pathogenic and do not usually cause foodborne illness, although, if there are enough of them, they can make us feel ill, due to their sheer numbers.

Table 1 below summarises the typical signs of spoilage caused by bacteria on different types of food.

<table>
<thead>
<tr>
<th>Food</th>
<th>Spoilage bacteria</th>
<th>Typical signs of spoilage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fresh meat &amp; poultry</td>
<td>Clostridium, Pseudomonas, Achromobacter, Micrococcus Acinetobacter</td>
<td>Slime, greenish discolouration, White spots, souring, putrefaction, off-odours and colours</td>
</tr>
<tr>
<td>Fish</td>
<td>Pseudomonas, Acinetobacter</td>
<td>Off-odours, discolouration</td>
</tr>
<tr>
<td>Raw milk</td>
<td>Streptococcus, Micrococcus, Lactobacillus, Bacillus, Pseudomonas</td>
<td>Tainting, off-flavours and odours, souring and rancidity</td>
</tr>
<tr>
<td>Processed meats</td>
<td>Achromobacter, Micrococcus, Pseudomonas, Clostridium, Lactobacillus, Streptococcus</td>
<td>Sourcing, gas production, discolouration, surface slime</td>
</tr>
<tr>
<td>Vegetables</td>
<td>Pseudomonas, Corynebacteria Erwinia, Leuconostoc, Bacillus Clostridium</td>
<td>Soft rot, foul-odour, discolouration, black spots</td>
</tr>
</tbody>
</table>
**Pathogenic bacteria or foodborne disease-causing bacteria**

Only a small number of the bacteria around us are responsible for causing illness. These are called **pathogenic bacteria** or **pathogens**.

Unlike food spoilage bacteria, these microorganisms are not so easily detected by taste, smell or sight.

> Food contaminated with pathogenic bacteria may **SMELL**, **LOOK** and **TASTE** normal

Several pathogenic bacteria or foodborne disease-causing bacteria produce toxins (poisons) either **in the food before consumption** or **inside the body after consumption**.

The number of pathogenic bacteria required to cause foodborne illness differs for different pathogens combinations and is also dependent on the targeted consumer. In some cases, very small numbers of pathogens can cause disease and in others, larger numbers are required.

The number of general bacteria present in food may be used to determine whether or not the food has been handled correctly and whether good hygiene practices were maintained. These would include good personal hygiene, correct handling of the food, wearing correct and clean protective clothing, good pest control, cleaning and disinfecting of food contact surfaces and premises and proper waste management, storage, distribution and transportation of the food.

**4.2.7 Moulds, yeasts and viruses**

► **Moulds**

Unlike bacteria, moulds are large enough to be obvious to the naked eye. Black or blue-green moulds are a familiar sight on bread and citrus fruits, where they cause spoilage.

Mould attack is responsible for considerable wastage of food at all stages of production from the farm to the kitchen, particularly where storage conditions are warm and humid. Moulds frequently spoil acid or fairly dry food.
Moulds pose a more sinister danger i.e. the production of mycotoxins (poisonous chemicals produced by moulds). Moulds present in grains such as maize or nuts such as peanuts stored in damp and warm conditions produce various mycotoxins which may cause cancer. Two important mycotoxins in this regard are aflatoxins and fumonisins; aflatoxins are often found in groundnuts and maize and fumonisins are mainly found in maize.

Some moulds are very useful and are used in the production of antibiotics and cheeses such as blue-mould and white-mould cheeses.

► Yeasts

Yeasts do not cause food poisoning but some types are capable of causing food spoilage. They usually spoil acid foods with high sugar content, e.g. fruit juices, jam, honey and wines, as yeasts are well-adapted to grow in these environments.

A variety of yeast species have great commercial importance because they are used for the production of bread and alcoholic drinks (beer, wine and cider).

► Viruses

Some viruses, which are even smaller living things, can cause food poisoning. They live inside cells and cannot grow on food and are known as obligate parasites. Very small numbers can make people ill, whilst ill people can shed very high numbers of viral particles in their faeces. Hand washing is therefore of vital importance. Viruses cannot grow in food as bacteria can and consequently use food as a “vehicle” to transmit themselves to their next host. They can only be detected using specialised laboratory tests, which are quite costly. Foodborne viruses are commonly found in raw oysters, shellfish, mussels and more recently, in other raw foods, such as vegetables and fruit. The heat of normal cooking can destroy them, but their heat resistance can differ.

4.3 FACTORS INFLUENCING MICROBIAL GROWTH

Six main factors control the growth of micro-organisms:

1. Nutrients (food)
2. Temperature
3. Water
4. Oxygen

5. Acidity/Alkalinity

6. Time

As illness resulting from bacteria is more prevalent and more well-known currently, the conditions required for bacterial growth will be discussed.

### 4.3.1 Food

Like all living things, micro-organisms need food (nutrients) for growth and energy production. Food is the most difficult factor to control since, if foods are nutritious for human beings, they will also sustain micro-organisms.

Since bacteria causing foodborne illness represent major health hazards, it is important to determine the type of food products encouraging bacterial growth.

**Are some foods more risky than others?**

Some foods are known as **high-risk foods**. This is because bacteria can easily grow on them and they may be eaten without further cooking.

- High-risk foods are usually moist and high in protein
- Low-risk foods are usually dry, low in protein and acidic

**High-risk foods include:**

1. Meat including poultry, meat products (meat pies, pasties, polonies, sausages etc).
2. Stocks, gravies, stews and sauces.
3. Milk, cream, eggs and egg products (custards, trifles, cream-filled pastries etc).
5. Raw foods.
**Low risk foods are:**

1. Acid foods (pickles, citrus fruits)
2. Foods with a high concentration of salt (salted meats, olives)
3. Foods with a high concentration of sugar (jams, syrups)
4. Fatty foods (butter, cooking oil)
5. Dry foods (biscuits, flour, cereal grains e.g. wheat, millet)
6. Foods that are processed in such a manner as to render them low risk e.g. canned fish and meat products which are shelf-stable and have a long shelf-life.

**4.3.2 Temperature**

The majority of bacteria causing foodborne illness prefer to live at the temperature of the human body, 37°C, and it is at this temperature that they will grow and multiply at the fastest rate.

To prevent their growth one must ensure that the temperature of food is kept (held) below 5°C or above 60°C (WHO recommendations). The temperature range of 5°C to 60°C is often referred to as the ‘danger zone’.
Below 5°C

If the temperature of a food product is decreased from 37°C to 5°C, the bacteria will continue to multiply but the rate of multiplication will slow down as the temperature decreases. The more rapidly one can decrease the temperature from 37°C to below 5°C, the better.

**NOTE:** Bacteria are not killed by low temperatures; they simply stop growing and multiplying. So thawing food at room temperature is not recommended as the bacteria can start growing and multiplying once more, once the temperature becomes favourable for them to do so.

Most bacteria causing foodborne illness will not grow in a refrigerator (1°C to 4°C), except for one notable exception i.e. *Listeria monocytogenes* and none in frozen food (-18°C), although many will survive and reproduce on thawing.

Between 5°C and 60°C

Bacteria causing foodborne illness reproduce rapidly in warm conditions (summer). For this reason, foods should not be allowed to stand for a long period of time under hot conditions. If those bacteria causing foodborne
illness are present in high risk foods kept between 5°C and 60°C for a few hours, they will multiply very rapidly to high numbers and/or produce dangerous toxins.

Above 60°C

Bacteria are gradually killed above 60°C. The length of time and the temperature required to kill them will depend on the type of bacteria and the food involved. They are normally killed in 1-2 minutes in boiling water, unless they are able to form spores. Only certain types of bacteria can form spores, which are heat resistant and many types of spores can survive exposure at rather high temperatures for a few minutes. This gives those bacteria a chance to survive the heating process and hence resume growth and multiplication when conditions become suitable once more.

4.3.3 Moisture

Like all living things bacteria require moisture for growth. Most foods contain sufficient water for bacterial growth, but dry products are poor media for the multiplication of bacteria. Foods such as dried milk powder will not allow the growth of bacteria.

However, once water is added to the powder, any bacteria present will start growing. It is essential, therefore, to use such food as soon as possible after adding water or store it in a refrigerator for a short period of time.

Moulds require less water than bacteria and can be found in dry products that were exposed to some moisture. It is therefore important to keep such products dry during storage.

4.3.4 Oxygen

- **Bacteria differ from one another in their requirements for oxygen:**
  - **Aerobes:** bacteria requiring the presence of air to grow and multiply
  - **Anaerobes:** bacteria which can grow and multiply in the absence of oxygen
  - **Facultative anaerobes:** bacteria which can multiply equally well in the presence or absence of oxygen.
Micro-aerophiles: bacteria requiring very small amounts of oxygen for growth.

4.3.5 Effect of acidity / alkalinity

The majority of food spoilage and foodborne illness-causing bacteria thrive in near neutral conditions and are less likely to grow in acidic foods.

This means that near neutral foods such as meat, fish, eggs and milk are most vulnerable to spoilage by bacteria and are capable of supporting the growth of pathogenic bacteria.

Moulds and yeasts on the other hand can tolerate quite acid conditions and so can spoil fruits, wines and some vegetables.

Source: [http://www.fcs.ext.vt.edu/fnh/food-innovations/basics/L_ph-scale.jpg](http://www.fcs.ext.vt.edu/fnh/food-innovations/basics/L_ph-scale.jpg)
4.3.6 Time

If bacteria are supplied with food, water and a warm temperature, they will grow and reproduce by a process known as **binary fission** by splitting into two. After cell division each daughter cell grows to maturity and divides.

The time between each division (known as the generation time) varies between species, but in optimum conditions (the very best conditions) for growth, bacteria will divide into two approximately every 10 - 20 minutes. Hence, it may take only 9 hours for one bacterium to become 100 million!

**Therefore the following points must be highlighted:**

- Generally, a few pathogenic bacteria cannot cause illness but if food contaminated with such bacteria is kept for a sufficiently long time in the right conditions the number of pathogenic bacteria will increase, making the food unsuitable for human consumption. The actual levels of bacteria that will most likely cause foodborne illness differs between the different types (species) of bacteria. Example: in some cases, 1,000,000 bacteria per gram of food may cause foodborne illness and in others, as few as 15 bacteria per gram may cause disease.

- If food is eaten shortly after it is cooked, the risk of foodborne illness is considerably reduced.

**Spore Formation**

- Some bacteria are able to produce spores that protect them against adverse conditions such as high temperatures, drying, acidic environments and disinfection. Spores are a resting phase / survival mechanism and they do not multiply. When favourable conditions return, the spore releases a bacterial cell, called a **vegetative cell**, which then starts to grow and multiply.
4.4 MICROBIAL CONTAMINATION AND ITS CONTROL

4.4.1 Types of contamination

Contamination of food is a major hazard and may be considered as the occurrence of any objectionable matter in or on the food. To prevent the consumption of unacceptable or unsafe food, contamination must be kept to a minimum.

There are three types of contamination (see note at bottom of page):

- **Biological contamination** i.e. bacteria, moulds, viruses or parasites

- **Physical contamination** by foreign bodies e.g. metal, glass, plastic

- **Chemical contamination** e.g. pesticide residues on fruits and vegetables; veterinary drug residues in meat; cleaning chemical residues from sanitizing.

**NOTE:** Allergens are integral components of certain foods (e.g. nuts, milk, eggs) or are ingredients that are added purposefully to food e.g. sulphites. The presence of nuts in foods as part of the recipe / formulation of that food is not contamination, but may be a food safety issue for individuals who are allergic to nuts. However, cross-contamination can occur where nuts land up accidentally in a product where nuts are not part of the recipe/formulation – this is a contamination issue. Allergens are therefore often placed in a separate food safety hazard category i.e. a fourth food safety hazard. Correct labelling of such products is therefore critical.
4.4.2 Sources of bacterial contamination

► People

- People commonly harbour micro-organisms, particularly foodborne illness-causing bacteria in the nose, mouth, intestines and also on the skin. Hence, it is possible that some of these bacteria are transferred to food.

- Pathogenic bacteria from food handlers can be spread into food, usually via the hands, or by sneezing and coughing, during preparation and service. The need for personal hygiene is therefore critical.

**Carriers:** Some people are carriers of pathogenic bacteria although they do not always have the symptoms of foodborne illness. Pathogenic bacteria are present in the intestinal tract and are therefore passed in their faeces. There are two types of carriers:

- A convalescent carrier is someone who has recently recovered from a foodborne illness but is still harbouring pathogenic bacteria in the intestinal tract.
A healthy carrier is someone who has not suffered from foodborne illness but is nevertheless carrying pathogenic bacteria in the intestinal tract.

Convalescent and healthy carriers run a high risk of contaminating their hands with pathogenic bacteria on visiting the toilet, which again underscores the importance of washing hands properly after visiting the toilet.

► Raw food

Raw food is particularly hazardous, particularly red meat, poultry, untreated milk, eggs and shellfish such as oysters.

Raw food should always be kept separate from other food. The liquid from defrosting foods, especially frozen poultry, must not be allowed to contaminate wiping cloths, high-risk food or equipment used for high-risk food.

► Pests

♦ Flies, mice, rats, birds, other insects and animals including domestic pets frequently harbour pathogenic bacteria in their intestines, on their feet, fur and must therefore not be allowed to come into contact with food or equipment which will be used for food preparation.

♦ Flies and cockroaches present the greatest hazard because of their feeding habits and the sites they visit. Flies often land on animal faeces where they pick up large numbers of bacteria on their hairy bodies.

► Environment

There are always large numbers of bacteria and spores in dust and moisture droplets floating about in the air. Soil harbours a considerable number of pathogens and care must be taken when handling raw vegetables such as potatoes, carrots and lettuce. Vegetables should be washed properly to remove any soil present.

Open food should always be covered when cleaning is carried out, especially dusting and sweeping. The quality and safety of irrigation water is critical to the safety of vegetables which are destined to be eaten raw - many cases exist where fresh produce has been contaminated with pathogenic bacteria, parasites and viruses transmitted via contaminated irrigation water.
Refuse and waste food

- Waste and unfit food for human consumption must not be allowed to accumulate in food preparation areas. Care must be taken to avoid contamination of food from waste either directly or indirectly.

- Food operatives must wash their hands after handling refuse. Refuse receptacles are a favourite breeding place for flies and must always have tight-fitting lids which are replaced after use.

- Refuse bins should be emptied and cleaned regularly to avoid build-up of waste where flies and other insects can breed.

4.4.3 Vehicles and routes of bacterial contamination

Sometimes bacteria pass directly from the source to high-risk food, but as bacteria are largely static and as the sources are not always in direct contact with food, the bacteria have to rely on other things to transfer them to food. These things are known as the vehicles and the main ones are:

1. Hands
2. Cloths and equipment
3. Hand-contact surfaces
4. Food contact surfaces

Cross-contamination

Cross-contamination is the transfer of bacteria from a contaminated source to an uncontaminated food (usually freshly cooked food).

This includes direct contact, drip and indirect contamination by, for example, hands, equipment or work surfaces.
Examples of cross-contamination

Micro-organisms, especially bacteria and viruses can be transferred from a contaminated source to an uncontaminated food by:

1. Using a chopping board, a working surface or other kitchen equipment for the preparation of raw and cooked foods without washing it thoroughly between each use.

2. Using a knife or other utensil without washing it thoroughly between each use.

3. The hands of a food handler which are not washed in between preparing different types of food, e.g. raw and cooked meat, or after touching any source of bacteria, e.g the nose, mouth, hair, pets.

4. Incorrect positioning of foods in a refrigerator. For example, raw meat must always be placed below cooked food so that blood cannot drip on to the cooked food.

The path along which bacteria are transferred from the source to the food is known as the route.

If this food is left in conditions suitable for microbial growth, the few micro-organisms which have been transferred to it will multiply to large numbers causing the food to be harmful.

4.4.4 Control of microbial contamination

Purchase food and raw materials from reputable suppliers:
- Check delivery vehicles
- Inspect food on arrival
- Store immediately at correct temperatures
Keep any unfit food, chemicals and refuse away from stored food.

Keep high-risk foods apart from raw foods at all times and always use separate utensils and equipment.

Maintain good personal hygiene standards.

Ensure good design of premises and equipment.

Always protect food from external sources of contamination (e.g. flies) and minimize handling.

Segregate fit and unfit food.

Implement appropriate cleaning programmes, with cleaning schedules and systematic cleaning methods.

Remove waste food and refuse from food areas as soon as practicable, but preferably at a minimum of daily.

Maintain an effective pest control programme.

4.5 THE CONTROL OF MICROBIAL GROWTH

4.5.1 How to control micro-organisms?

The control of microbial growth can be achieved by controlling the conditions needed for their growth. If the conditions can be controlled, then the micro-organisms can be controlled.

4.5.2 Food

Micro-organisms will seek out and contaminate any food left exposed in the kitchen / food preparation area.

Hence, it is very important that food is correctly stored as quickly as possible after cooking and handling preparations and is not exposed to unnecessary risks and left uncovered and exposed to the atmosphere.
4.5.3 Water

Water is vital for microbial growth. The simplest way of depriving microbes of the water essential for growth is to dry the food.

Foods such as pasta, dried pulses and milk powder will not support the growth of spoilage or organisms causing foodborne illness provided they are kept dry i.e. below a water activity of 0.6.

The addition of high concentrations of salt (salted fish) or sugar (jam, syrup) to certain food products withdraws water from the food resulting in a dehydrating effect and prevention of microbial growth.

1. The first golden rule: KEEP IT DRY

4.5.4 Temperature control of food

Micro-organisms grow best in warm conditions. The danger zone for rapid growth of microbes is between 5°C and 60°C. Hence, to control microbial growth, food must be kept either below 5°C or above 60°C.

Cooling foods

Most foods will stay fresher and healthier if kept in cool or refrigerated conditions. Perishable foods must not be allowed in the danger zone of 5-60°C for any longer than is necessary. So, keep it cool and restrict microbial growth.

It is important to realise that cooling does not kill micro-organisms, but only restricts their growth. The cooler the temperature, the longer the storage life of the food.

Refrigeration (1°C to 4°C) can only be used for short-term storage of fresh foods.

For long-term storage, foods should be frozen to a temperature of -25°C to -30°C.
2. The second golden rule: KEEP IT COOL

- **Heating foods**
  
  Increasing the temperature of a food above 70°C causes death of microorganisms. The rate of death of micro-organisms depends on the temperature of the heat treatment and its duration.

4.5.5 **The effect of acidity / alkalinity**

The majority of food spoilage and pathogenic bacteria causing foodborne illness thrive in near neutral conditions and are less likely to grow in acidic foods.

This means that near neutral foods such as meat, fish, eggs and milk are more easily contaminated by pathogenic bacteria. Moulds and yeasts on the other hand can tolerate quite acidic conditions and so can spoil fruits and some vegetables easier than what most bacteria can do.

Neutral or low acid foods such as meats and vegetables can be made safer by pickling in vinegar, whilst high acid foods such as citrus fruits have a natural resistance to the growth of pathogens and spoilage organisms.

4.5.6 **The time factor**

Micro-organisms need time to multiply to large numbers and cause harm. It is important to remember that if high-risk food is left lying about, it will only help encourage microbial growth.

Food should only be in one of 4 places:

1. In suitable storage
2. Undergoing preparation
3. Cooking
4. Or being served

Keep the time between these 4 activities as short as possible.

3. The third golden rule: DON'T GIVE THEM TIME
4.5.7 The importance of regular cleaning

Micro-organisms will also grow on the smallest food particle or dirt found on the floor, or work surfaces, utensils, clothes on hands and skin.

To deprive the micro-organisms of the food that is essential for their growth it is important to avoid any build-up of food particles or dirt anywhere for any length of time by cleaning regularly.

4. The fourth golden rule: CLEAN AS YOU GO

4.6 REFERENCES

Books – Please note: There are many more updated books and other resources on food safety and food microbiology that are available. The facilitator of this will be able to assist you with this information.


**Websites**

http://www.fao.org

http://www.who.int/mediacentre/factsheets