UNIT-4 Basic Microbiology

Learning Outcomes
By the end of this unit the learner will be able to:
• Understand the differences between the different types of micro-organisms • Take preventative steps to prevent the growth of bacteria and pathogens • Discuss the potential risks associated with the consumption of spoiled food

Unit 4

Basic Microbiology

Micro-Organisms

A micro-organism is any living organism so small that, on its own, it is invisible. Individual micro-organisms can only be seen with the aid of a microscope. The micro-organisms of most concern in food service are:

- Viruses.
- Bacteria.
- Yeasts.
- Moulds.

Micro-organisms can be found everywhere in our environment - they are on us, in the air, soil and water. The effects of micro-organisms can be desirable or undesirable.

Beneficial Micro-Organisms

These micro-organisms can play a crucial role in:

- The breakdown of dead plant and animal matter.
- The production of certain foods such as microbial action in yoghurt, cheese, bread, wine.
- The production of some antibiotics eg penicillin.

Spoilage Micro-Organisms

These micro-organisms alter the appearance, texture, flavour and odour of food, making the food undesirable to eat. Consumption of spoiled food such as sour milk, does not result in illness or disease.

Pathogens

Less than 1% of all micro-organisms are harmful and produce disease. These are referred to as pathogens eg. Viruses, food poisoning bacteria.

Viruses

Viruses are the smallest of all micro-organisms. Viruses do not have their own cellular structure, and to become active must enter a living cell. Once a virus enters a host cell, it redirects the activities of that cell towards reproducing itself. Viruses are always pathogenic but are host specific ie. Animal cells are only susceptible to animal viruses. Most viral diseases affecting people are transmitted by contact eg measles, mumps, H.I.V., colds and influenza. However, a few viral

infections are transmitted by contaminated food or water. Both Hepatitis A and viral gastro-enteritis are food borne. Healthy humans produce antibodies, as a defence in response to invading viruses. Once exposed to a virus, either through an attack of the disease or artificially through vaccination, immunity is conferred.

Bacteria

Bacteria are single cell organisms and their name gives a clue to their shape. Bacteria are important for the ageing of meat and in producing foods such as cheese, yoghurt, sour cream, sauerkraut, pickled cucumbers, salami, peperoni and vinegar. Sometimes bacteria spoil food. Slime and 'off' smells indicate their action. Other bacteria can cause food poisoning eg. Salmonella. Regardless of their shape, bacteria have the same internal structure and reproduce in the same way. It reproduces by the one cell dividing into two parts. This is called binary fission. Under ideal conditions binary fission can be completed in 15-20 minutes. This means that a single bacteria can multiply to large numbers in a relatively short time. Under ideal conditions, bacterial population can grow from one thousand to over four million in under four hours. Between one and two million bacteria form a serious food poisoning threat.

Under adverse conditions, growth slows down, and many bacteria die. Bacillus and Clostridium have a special way of coping with adverse conditions. They form spores which is a protective means of survival. They go into a dormant state until conditions become favourable again. They are not killed by freezing or boiling while in this 'protective' state.

Yeasts

Yeasts are single celled organisms, larger than bacteria. Yeasts reproduce by a process called budding. A small growth appears on the 'mother' cell. As this bulge grows, the mother cell progressively cuts off the new 'daughter' cell. The daughter cell is about half the size of the original cell. It will increase in size until it is ready to 'bud' or reproduce. Yeasts breakdown sugars to produce carbon dioxide and alcohol. This reaction is utilised in the production of alcoholic beverages and bread.

Moulds

Moulds are usually multicellular but each cell is capable of growing independently. Moulds are often quite visible. They appear in various forms such as powdery blue-green-white patches on lemons, white fluffy patches on tomato paste or blackened areas along the rubber lining on refrigerator doors. Moulds consist of fine thread-like strands called hyphae. The hyphae grow in a mass either across the surface or down through the medium.

Undesirable Effects of Moulds

Many foods such as pumpkin, citrus fruits, zucchini and bread are susceptible to mould spoilage. Some moulds are pathogenic and can cause infections of the skin eg tinea and ringworm. A few moulds produce dangerous toxins. These are of concern in the bulk storage of peanuts and grains. It produces a toxin called aflatoxin. Long term consumption of aflatoxin causes liver cancer.

Desirable Application of Moulds

Moulds are responsible for the particular flavours and textures of the blue vein cheeses and the surface ripened cheeses, brie and camembert. A highly prized sweet dessert wine is made with grapes affected by a particular mould.

Moulds and yeasts are the microscopic members of the fungi group. Larger fungi, mushrooms and truffles are also used extensively as foods.

Environmentally, moulds are important because of their ability to change complex organic materials into simple substances eg the rotting and decay of dead matter.

Medically, moulds are significant for their antibiotic properties eg .Penicillium mould producing Penicillin.

Factors Affecting Microbial Growth

Micro-organisms form an invisible world around us. They are in the air, on us, on food, equipment and food preparation surfaces. It would be difficult to find an environment free of micro-organisms.

In some situations microbial growth will be encouraged eg. In the making of yoghurt or bread. At other times their presence will be actively discouraged eg. Taking precautions to prevent food poisoning. Either way, to understand how to control micro-organisms, the food worker needs to have some basic knowledge of the conditions required for microbial growth.

There are six factors required for the growth of micro-organisms:

1. Suitable food.
2. Suitable water.
3. Suitable temperature.
4. Suitable oxygen levels.
5. Suitable pH.
6. Time.

Suitable Food

Micro-organisms exhibit a wide variation of nutrient requirements. Some can be sustained on inorganic material. However, the bacteria responsible for food poisoning thrive well in the foods we like to eat, especially those high in protein, high in moisture and not very acidic.

Suitable Water

- Micro-organisms need liquid water for growth and multiplication.
- Dried foods will not support microbial growth providing they are kept dry, and tend to be spoiled by yeasts and moulds.
- The majority of microbes will not grow in high sugar foods.
- Freezing makes water unavailable to micro-organisms.
- Food is not the only aspect of a kitchen environment that may supply moisture for microbial growth. Soiled, wet tea-towels, dish cloths, and mops, as well as improperly dried items of small equipment provide suitable breeding grounds for micro-organisms.

Suitable Temperature

Micro-organisms vary in their temperature requirements. Some thrive at low temperatures eg. Listeria Monocytogenes, while others can live at higher temperatures. Pasteurisation will destroy pathogenic bacteria, but not spoilage bacteria in milk.
Bacterial spores can survive boiling. Each micro-organism has an optimum temperature for growth. Below a minimum temperature growth is halted, although the microbe does not necessarily die. Above a maximum temperature the microbe is likely to be destroyed. Bacteria that cause food poisoning grow well at the temperature between 4°C and 60°C.

This is called the **TEMPERATURE DANGER ZONE.** The temperatures in a commercial kitchen fall within the Temperature Danger Zone. Food should not be kept long in the Temperature Danger Zone.

- Cold foods are to be kept below 4°C.
- Hot foods are to be kept above 60°C. This refers to the internal or core temperature of the food.

Suitable Oxygen Levels

- Most microbes are aerobes i.e. need oxygen for respiration.
- Anaerobes do not use oxygen, and will not grow in the presence of it.
- A small group of bacteria are capable of growing in either aerobic or anaerobic conditions and are called facultative.
- All moulds are aerobic, which explains why they grow on the surface of foods.
- Yeasts are facultative.

Suitable Ph

- Bacteria prefer neutral or slightly acidic environments.
- Moulds and yeasts tolerate quite acidic environments.

Suitable Time

Given optimal conditions micro-organisms can reproduce rapidly. Bacteria are the fastest growing microbes. Growth relates to increase in numbers, not size. Micro-organisms need time to multiply enough to cause food poisoning or serious spoilage of food.

Food Spoilage

Food spoilage may be due to three separate but inter-related factors:

Physical Spoilage

- Damage to the protective surface layer of a food item eg. Cracked egg shell, dented cans, insect or rodent damage to packages. This increases the chance of chemical and/or microbial spoilage.
- Moisture loss eg. Wilted leafy vegetables, freezer burn on incorrectly packaged frozen goods, staling of bread.
- Moisture gain eg. Staling of biscuits.
- Aroma loss eg. Ground coffee.
- Odour absorption eg. Fruit salad prepared on board used previously for crushing garlic.
- Presence of undesirable objects eg. Stone in a packet of lentils, fish hook in canned fish.

CHEMICAL SPOILAGE

- Chemical contamination eg. Cleaning substances improperly removed from surfaces or equipment.
- Enzyme action eg. browning or ripening of fruit
- Rancidity of fats and oils.

Microbial Spoilage

The action of bacteria, yeasts and moulds is the major cause of food spoilage. When present in large numbers their activity is easy to detect. The appearance of the food is altered. There might be colour changes, visible whiskery growth, surface slime, softening of texture, off odours and off flavours.

How do these microbes get on to food? Contamination occurs through contact with soil, air, water, equipment, packaging materials and food handlers. To keep the microbial population small, care must be given to personal hygiene, the cleanliness of the premises and equipment and proper storage conditions and times. Otherwise microbial growth is encouraged and foods spoil faster.

Bacteria

Bacteria spoil food rapidly. Foods that support bacterial growth include meats, fish, poultry, milk and many vegetables. Often the food becomes slimy and develops an unpleasant odour. Bacteria require high levels of moisture, thus do not spoil dry foods. To minimise bacterial growth keep

food surfaces as dry as possible when storing. Foods that are acidic are less susceptible to bacterial spoilage. Also store foods out of the temperature danger zone. Ensure that cold foods are kept cold, and hot foods are kept hot.

Yeasts

Yeasts spoil foods that are acidic and high in sugar, such as jams, fruit, juices, syrups and alcoholic beverages. The product may develop a beery smell and show signs of gas bubbles. Yeasts grow well in warm, moist environments. Low temperatures inhibit their growth, while heating above 60°C will destroy them.

Moulds

Moulds are aerobic so they first appear as whiskery patches on the surface of the foods. Their mycelium will however spread down into the food. Moulds are slow growing and favour moist, slightly acidic foods, such as fruits, some vegetables and bread. Mould affected food has a musty odour. Cold, dry conditions inhibit mould growth.

Food Preservation

To minimise or prevent food spoilage the growth of micro-organisms must be inhibited. This can be achieved by altering one or more of the conditions necessary for microbial growth. Food preservation techniques are based on this principle.

Dehydration

Controlled condition: water.

Heat is applied to evaporate the moisture.

Bacteria can survive the drying process. Care must be taken with some rehydrated products. Once water is added, powdered milk must be treated as fresh milk.

- Sun drying - tomatoes, sultanas.
- Air drying in heated chambers - apples, bananas.
- Spray drying - used for liquids - milk, eggs, instant coffee.
- Roller drying - used for tomato paste, instant mashed potato and breakfast cereals.
- Tunnel drying - used for vegetables.
- Freeze drying - meat, instant coffee, instant meals.

Salting

Controlled condition: water.

In low concentration, salt binds with the moisture in the food thus making the water unavailable to microbes. At higher concentration salt will dehydrate the microbial cells.

- Brines – olives.
- Cures - salt in combination with potassium nitrate and potassium nitrite eg. corned beef, bacon.

The Addition of Sugar

Controlled condition: water.

- Sugar acts in the same way as salt -syrups, jams, glace fruits, candied fruits, crystallized fruits.

Pasteurisation

Controlled condition: temperature.
In this process heating destroys pathogens, but does not destroy spoilage organisms or bacterial spores.

UHT - Ultra High Temperature

Controlled condition: temperature.
Product is heated to 132°C for two seconds, then cooled to below 4°C. The item is sterilised. All micro-organisms, both spoilage and pathogenic are destroyed.

Examples include long life milk, fruit juices specially packed. Refrigeration is not required until opening.

Canning

Controlled condition: temperature. In this process, heat is used to destroy Clostridium Botulinium spores. The times and temperatures used in canning may vary depending on the acidity of the food. In the standard method, food is cooked in the can. For larger cans the food may be heat treated first, then canned.

Freezing

Controlled condition: temperature and water.
At -18°C the growth rate of micro-organisms is severely reduced. The low temperature inhibits growth and water in the frozen state is not available for microbial growth.

Note. Micro-organisms are not necessarily destroyed by freezing. Some may survive and can become active once the food is thawed.

Vacuum Packaging

Controlled condition: oxygen.
Oxygen is withdrawn. A special plastic packaging is used.
Anaerobic micro-organisms survive.

Examples include vacuum packaged meats, fish, cheese. These foods must be held at refrigeration temperatures. Items such as coffee beans can be stored at room temperature.

Controlled Atmosphere

Controlled condition: oxygen and temperature.

Oxygen levels are reduced and carbon dioxide levels are increased. Temperatures are kept low.

Examples include pears and apples which can be stored for many months under controlled atmospheric conditions. Further ripening is suspended, thus deterioration is slowed too.

Pickling

Controlled condition: pH.

Vinegar is most often used to change the pH of foods. Examples include pickled vegetables.

Smoking

Smoke contains anti-microbial substances formaldehyde and cresol. Nowadays, smoking is most often used for flavour, not primarily for preservation.

Chemical Preservatives

These are anti-microbial substances. Certain additives are used to control the growth of undesirable bacteria, yeasts and moulds.

Examples.

- Propionic acid used as a mould inhibitor in bread.
- Sulphur dioxide effective against bacteria, yeasts and moulds and used in dried fruits and peeled potatoes.
- Nitrates and nitrites used to cure meats to control Clostridium botulinium.

Controlling one or more conditions required for the growth of micro-organisms slows the rate of food spoilage.

Further Reading: