FOOD SAFETY AND NUTRITION

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UNIT: 1

1. INTRODUCTION TO HYGIENE

1.1 Rules & importance of hygiene
1.2 Personal Hygiene
1.3 Cleaning of premises
1.4 Pest Control
1.5 Waste disposal
1.6 Dishwashing methods

1.1 Rules & Importance of Hygiene

Maintaining safety and quality is essential in the entire chain of food production ranging from primary food production at the level of farmers, primary food processing at the farm, dairy, abattoir, and grain mills etc. Secondary food processing level such as canning, freezing, drying, and brewing, food distributors at the national and international level of import / export, food retailing and catering and also domestic food preparation. Safe food is food which is free of contaminants and will not cause illness or harm. Our food is devitalized, colored, filled with chemicals, drugs and synthetic ingredients, polluted by agricultural and environmental chemicals and are grown on impoverished land puffed up by chemical fertilizers. Moreover the chemicals used are known to cause adverse effects in humans and animals. Therefore all individuals involved in food handling should be trained in handling food safety. It is necessary to create and maintain hygienic and sanitary conditions to safeguard the food.

This involves:
•Protecting food from risk of contamination, i.e. preventing objectionable matter getting into food, including harmful bacteria, poisons and foreign bodies.
• Preventing any bacteria present multiplying to a level which would result in illness of consumers or the early spoilage of food.
• Destroying any harmful bacteria in the food by thorough cooking, processing or irradiation; and
• Discarding unfit or contaminated food.

Sanitary practices and hygienic conditions are becoming more and more important because food is being processed, prepared and sold in larger volumes than before. Some microorganism cause food spoilage and food borne diseases, but others are beneficial n food processing and preparation. Sanitation can reduce the growth of microorganisms on equipment and dirt on the food. This can reduce contamination of food by microorganisms that cause food borne diseases and food spoilage. Sanitary principles also apply to waste disposal and can help reduce pollution and improve ecological balance.

1.2 Personal Hygiene

In catering, hygiene and sanitation play a vital role in promoting and protecting the health and wellbeing of hundreds of people. The foods, materials and equipment are subject to constant handling by people at every stage of food production and service. Thus it is the duty of every

caterer to ensure that personal hygiene becomes a habit of all food handlers. All food handlers reporting for duty must be fresh, well groomed and clean.

Few points for personal hygiene that food handlers must follow:

1. Bathing: Workers must bathe daily (even twice) as body odour is offensive and skin is the main breeding ground for bacteria. Head bath again twice a week.
2. Hair: Wearing of clean head gear to be encouraged to prevent hair from falling in food, prevent from touching their scalp and also prevent long hair from getting entangled in machinery.
3. Teeth and Mouth: Teeth to be brushed thoroughly twice a day with a moderately hard brush – first thing in the morning and after dinner.
4. Hands: Hands are in direct contact with food, so can transfer bacteria and cause illness. To prevent this, hands should be washed:
• Before beginning work and after break.
• After eating or smoking.
• After using the toilet.
• After touching infected or unsanitary areas of the body or combing hair or using
mobile phones.
• After using a handkerchief, sneezing or coughing into the hands.
• After handling raw foods, especially meat, fish and poultry.
• After handling waste food or refuse.
• Whenever they are dirty.

Hands should be washed thoroughly with plenty of soap and water – preferable rinsed in running water or water stored in clean covered containers with a tap fixed on them. If soap cakes are used, they should be kept dry. Liquid soap is more hygienic and economical to use. Hands must be thoroughly dried by using a roller towel, disposable paper, towels or a hot air dryer.
Exposed wounds, cuts, burns can harbor bacteria. They need to be covered with a water proof dressing. Pus formation, inflammation indicates infection. Such people should not be allowed to handle food for some time.
5. Finger Nails: Nails should be trimmed as they harbor germs and can also chip and fall in the food and kept clean. Nail polish use should not be allowed.
6. Feet and Footwear: Feet should be washed and kept clean. Always wear socks with shoes to keep away dirt and perspiration. Shoes should from a part of the uniform, sturdy, well fitting, and well-polished, with a low heel.
7. Jewelry: Food handlers should not wear any jewelry as they tend to harbor bacteria and small parts may sometimes drop food into food.
8. Reporting Illness: If the food handler feels unwell he/she should report it to his or her supervisor. Such food handlers should be excluded from work until medical clearance is taken.

Habits to be avoided

• Washing hands in sinks used for food preparation. In case there is no separate

• All catering staff should need to be periodically put through a medical check up to ensure that they are not suffering from worms, T.B, skin or other infections. People with colds, sore throat,boils, and diarrhea should not handle food.

1.3 Cleaning of Premises & Food Safety in Kitchens

Food Hygiene

Food hygiene may be defined as the sanitary science which aims to produce food which is safe for the consumer and is of good keeping quality.

1. Procurement of raw material: Freshness, quality, quality of packaged food products (e.g. Appearance, temperature, packaging and pack seals are intact).
2. Storage of Raw Materials: Storage areas (temperatures, products should be completely covered, FIFO (first in first out) & FEFO (first expired first Out), 6" above the ground, veg & non-veg to be kept separate, all products with the label of expiry date, delivery date, cold storage at 5°C or below for chillers and -18°C for freezers.
3. Preparation of raw material :
a. General – Use of only potable water from safe source, clean work area, equipment, product cover after preparation / cooking.
b. Sieving/sorting or cleaning – use potable water, uncooked, ready to eat – fruits and vegetables are disinfected with 50ppm chlorinated water before cutting, peeling or serving. Do not reuse this chlorinated water for other purposes.
4. **Cooking/Processing:** Temp. of cooked food should reach 70°C, cooking in hygienic area, was basin in the kitchen (e.g. In a dhaba or kiosk), then put a small tap outside and segregate it. Tasting food with fingers or with the same spoon: is the most unhygienic thing to do. Leaving cooked food uncovered for a long time.
Blowing air from the mouth over the hot food. separate equipments and utensils for vegetarian and non-vegetarian product, potable water, frying oil/fat should be changed immediately when there is colour change, foiling, syrupiness scum formation, ice should be prepared from potable water.
5. **Storage of cooked food:** Cooked food should be stored covered and at appropriate temperature, cold foods at 5°C or below hot foods at 60°C or above. Veg & non- veg products should be stored separately and properly labeled with day and date of preparation, salads, garnishes or ready to eat foods are immediately stored in clean covered containers and refrigerated.
6. **Preparation of cooked food before serving:** Cold foods are served cold, hot foods hot (up to 70°C), and cooked food is not left at room temp. For more than 2 hours, surplus food is discarded and not mixed up with freshly prepared food; transported cooked food is consumed/used within 4 hours of its arrival.

7. **Serving of Cooked Food:** Use clean & intact utensils/ one time use disposables, clean and non-toxic material is used for packing food. Printed paper is not used for wrapping. All tables and food serving counters are to be kept clean, use spatula/spoon/hand gloves etc. for serving and not with bare hands.
8. **Storage of surplus food:** surplus food is consumed before expiry/use by date, surplus foods are stored in the refrigerator, surplus food is discarded, perishable products are consumed immediately. Canned products once opened should be transferred in the suitable covered containers and kept refrigerated.
9. **Quality of water & ice**: Municipal water supply should be used as it is safely treated in the water plant, ice should be handled hygienically with clean scoops.
10. **Utensils & Equipment:** Equipment cleaning and hygiene of establishment, surrounding/ environment, good lighting facility, pest control, insect electrocuting device (IED) on the entrance of Kitchens, Air screens, maintenance & cleaning. Last but not the least personal hygiene.

1.4. PEST CONTROL

Rodents and insects infestation have been a nuisance to humankind and have destroyed and contaminated food at all stages of food production and service. The presence of pests, their body parts or dropping in food served will not only result in contamination and spread disease but can ruin the reputation of any catering establishment. So it is important food service worker to maintain the premises pest free.

CLASSIFICATION OF PEST Pests commonly found in catering facility can be divided into the following categories:

INSECTS which include houseflies, fruit flies, cockroaches, silverfish, firebrats and stored grain insects.

HOUSEFLY: The housefly is one of the filthiest of pests and is found all over the world. Secretions from these pads enable dirt and germs to stick to it, which is later transferred to food, equipment or any other surface it lands on.

CONTROL MEASURES FOR HOUSEFLY

1. Environmental sanitation can be achieved by proper disposal of garbage, decaying food and animal carcasses and other wastes.
2. All food wastes should be held in tightly covered bins and clean garbage container thoroughly.
3. Protective display of food using fly proof cupboards, wire gauze covers etc, should be practiced.
4. Adequate fly proofing of doors and windows kitchen and food service areas helps prevent their access of to food. Self closing doors and windows prevent their entry.
5. Destruction of flies could be brought about by the following means

I. Various insecticidal sprays, aerosols and pellets are effective in controlling flies.
II. Poisonous bait and fly strips.
III. Insects Light Traps (ILTs)

FRUIT FLY: These are seasonal, coloured and smaller than the housefly. They are most attracted to overripe and decaying fruits. These pest are transmit less number of micro organism.

CONTROLED MESURES FOR FRUIT FLY

1. Check fruits supplies for sings of infestation
2. Get rid of decaying fruit and other fermenting foodstuff,
3. Used screens, wire meshes and air currents to prevent their entry.
4. Electric fly traps to a certain extent, are useful in exterminating them.

COCKROACHES: is another resilient pest, it is filthy and give off a foul odour. Cockroaches contaminate unprotected food, utensils and other surfaces. They travel from sewers to garbage dumps. En –route they collect numerous disease causing microorganisms on their bodies and their stomachs. Uncontrolled cockroach infestation could spread diseases such as diarrhea, dysentery, typhoid fever, intestinal worms and food poisoning.

CONTROLED MESURES FOR COCKROACHES

1. Persistent efforts at maintaining good sanitary conditions are the key to cockroaches' control. Covering dustbin at night, keeping food service areas free from dirt and food particles as well as prompt garbage disposal are essential.
2. pathogen
3. Good lighting and ventilation prove to be deterrent to. Pests favoring dark, damp places to rest and breed.
4. Protect food from contamination by proper storage. Scrutinizing bags and sacks for insect eggs and body parts, helps check the entry of these pests into the premises.
5. Permitted insecticides should be applied to cracks and crevices ,undersides of tables,cupbords,equipment,behind sink and other areas likely to harbor these pests.
6. Cockroach traps should be installed over drains.

RODENTS which include rats and mice, and animals and birds which include cats, dogs, crows, sparrows, pigeons. It is mainly the rats and mice belonging to this group that trouble human kind. Rats are voracious eaters and are known to destroy food grains and standing crops. They devour egg, attack poultry and their burrowing habit causes structural damage to building. Rodents are host to many disease, knowledge of the habits of rats and mice would render rodent – control more effective.

CONTROLED MESURES FOR RODENTS

1. Deny entry : Rodents gain entry through open drains ,doors windows, ventilators, around water pipes, sewers, by burrowing around weak construction points and faults in the foundation . Good planning, designing and engineering at the time of construction would deny rats entry.
2. Deny breeding space: Store rooms and kitchens provide perfect sanctuaries for rats and mice. Rodents preferences for dark, dirty, undisturbed places would imply that ample lighting, good housekeeping and high standards of tidiness could get rid of their breeding areas.
3. Making the environment less attractive to rodents :This can be achieved by protecting the food supply using wire meshing and by keeping sacks of flour off the floor and away from the wall.
4. Using of traps and poisons is an effective method of eliminating and killing a rat population.

PESTICIDES: These include insecticides and rodenticides. They are substance which has 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 recommended for use of Kitchen

PEST	PESTISIDE 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, boric powder, neem guard, tulsi leaves.**
6. Rats and mice	**Warfarin , bromadiolone**

1.5 Waste Disposal

Cleanliness and sanitation in catering establishments include adequate treatment and safe disposal of all wastes arising from the kitchen, dining areas, wash up area, sanitary conveniences, etc. without endangering human life or polluting the environ ment. It is classified into three main groups

- Solid waste

- Liquid waste
- Gaseous waste

- Solid Waste: there are two types -

1. Garbage – It is the waste mater result from the preparation, cooking & consumption of food. It includes inedible scraps of food which needs to be disposed off. It includes vegetable & fruits, skin, rotten & spoil food. Bones skin feather etc.
2. Refuse – Any waste material that is not a food item. Example – bottle, cans, bag, napkin, toothpick, tissue paper etc.

Garbage and refuse should be removed from the premises promptly. The wastes should be stored in proper containers till they are disposed of. Kitchen waste can be fruitfully used in vermiculture technology or for feeding pigs and poultry. Biogas can be generated with the combined use of kitchen waste and sludge. The residue left after gas production is used as manure.

- Liquid waste: is usually disposed off through underground sewers. Sewage includes wastewater from all sinks and drains as well as water closets. It needs adequate treatment before it is disposed of as it contain human pathogens.

- Gaseous waste: It includes smokes &fumes come out from kitchen especially when wood or cool is used. This will pollute the environment so proper layouts of chimney & exhaust fans are required.

It is the responsibility of all employees to see that garbage is collected, stored and disposed of properly.

TYPES OF WASTE AND ITS DISPOSAL

Sr. no	Method of disposal	Type of Waste

I.	**Land filling** (dumping and controlled dumping)	All type of solid waste
II.	**Burial**	Dry garbage, wet garbage, dead pests
III.	**Incineration**	Dry garbage, dry leaves, soiled cotton, dirty rags, outdated pesticides
IV.	**Composting**	Garbage, toilet waste or sluge,dry plant matter
V.	**Mechanically disposing (pulpers,compacters)**	Soft food waste, dry bulky waste,i.e, cartons ,cans
VI.	**Vermiculture**	Food waste, sewage
VII.	**Biogas**	Toilet waste, agriculture waste, dung
/III.	**Recycling**	Paper, cardboard, cartons, plastic,polythene,glass,metal, waste food
IX.	**Sewers and drainpipes**	Waste water, sewage, crushed soft food waste
X.	**Soak pit**	Waste water, from kitchen, bathroom and wash up area
XI.	**Exhaust fans and ventilator hoods**	Strong fumes,smoke,food odourand grease

1.6. Dishwashing Methods

The object of dish washing or cleaning utensils is to remove any dirty material from them on which micro-organisms can develop, and to destroy any micro-organism which are already present in the service ware by sterilizing. Usually dishwashing is of two types:

Manual Dishwashing
Mechanical Dishwashing

Manual Method: Dishwashing by hand can be done by the two-sink method or by the three-sink method. Both these systems start with the removal of leftover food, followed by a preliminary wash under running hot water, which helps to preserve the cleanliness. The dirt is removed from the utensils by scraping and then rinsing under the forced water stream.

Two - Sink Method: The simplest way of having germ-free cutlery and utensils is the two-sink method. Washing and rinsing of service ware is done in the first sink that contains hot water at 45^0C. Rinsed service ware is then sanitized in the second sink containing hot water at 77^0C and above with sanitising solution.

Three - Sink Method: After the dishes have been sorted out and the debris has been removed, the utensils are washed in warm detergent solution in the first compartment, and then rinsed in second compartment at the temperature of 45^0C. Service ware is then transferred to third sink for sanitization at 77^0C and above.

The other method of sterilizing service equipment is treating them with a chemical solution prepared with lukewarm water and chlorine or iodine solution or tablets.

Machine Method

After removing the debris, the plates are stacked into wooden or wire racks and then are passed through the dishwashing machine. The chinaware is washed, rinsed and sterilized in the washing machine. After passing through the machine, the china is left to drain for two to three minutes and is then stacked on respective shelves.

The **dish wash machine** usually consists of a conveyor belt that assists in transporting the tableware through the machine. In the dish washing machine, washing happens in four stages – pre wash stage, wash stage, pre rinse stage and final rinse.

In pre-wash chamber, sprays of hot water re-circulated by the pump, removes most of soil from the dishes. The soilage, mostly greasy in nature floats to the top of solution in the machine and is removed through an overflow pipe. In the wash stage, the dishes are washed with detergent solution. Here, all the soil and stains are completely removed. The conveyor then passes through the pre-rinse stage, where hot water is sprayed to remove most of the washing solution.

In the final rinse stage, the dishes are rinsed with hot water to remove any of the detergent that is remaining. The water at this stage is hot enough to act as a sanitizer. A rinse additive is injected into the final rinse water to provide a sheeting effect for quick drying and to prevent water spotting.

2. HACCP

(Hazard Analysis Critical Control Point)

2.1 Introduction
2.2 Importance
2.3 VII Critical Control Points

2.1 Introduction

The term quality and its significance in catering is being recognized and food establishment are taking measures to ensure that the food prepared and served in their organization is safe and wholesome. In order to ensure that food served is safe, it is necessary to establish a food safety control system. The HACCP approach is one management technique that may be useful to caterers. It is mainly used to guarantee microbiological safety of foods. HACCP approach involves the identification and analysis of hazards associated with the stages of all food production all through the process of manufacturing ,i.e., raw material procuring to the consumption of the finished product. It is most effective way of controlling food-borne illness. HACCP is a system of food safety control that is accepted internationally.

- **What is Hazard Analysis? (HA)**

  Hazard analysis is the identification of all ingredients, stages in process, environmental features and human factors that can lead to hazards for the consumer. The risks and likelihood of them occurring is estimated.

- **What is Critical Control Points? (CCP)**

  These are the points at which control is essential to guarantee that potential hazards do not become actual hazards. A CCP is a location, a practice, a procedure or a process which , if not controlled, could result in an unacceptable safety risk. The term CCP draws attention to the fact that not all hazards are necessarily critical to the safety of the end product.

1.2. **Importance:**

It is a systematic science based approach. HACCP offer a number of advantages –

---- Preventing food born diseases outbreak.

Despite progress in food science & technology, food born diseases remain one of the most widespread public health problems in the contemporary world. As per WHO , up to 1/3 of population of developed countries are affected by the food borne illness each year.

- Food & water born diseases is one of the leading causes of illness & death in developing countries.

- One of the most important challenges is the increasing number of food born pathogen.
- To be careful of food contaminants & different types of hazardous item in food.
- Cross contamination & toxic effects.
- To increased consumer awareness of food safety.

Benefits of HACCP –

a) Benefit to consumers -

- Reduced the risk of food born diseases.
- Increased confidence in food supply.
- Increased awareness of basic hygiene
- Increased quality of life (health & socio economic)

b) Benefit to industry –

- Increased marketing access
- Reduction in production costs through reduced wastage.
- Increased consumer & government confidences.

c) Benefits of government –

- Important public health
- Enhanced international trade
- Confidence on food supply

HAZARDS: The HACCP approach involves the identification and analysis of hazards associated with the stages of all food production, all through the process of manufacturing that is from the farm to the table.

Three types of Hazards are considered to affect fod o safety:

1. Physical hazards: Any foreign materiel not normally found in food, which may causes illness, injury or damage during or after consumption.

Example - glass, hair, stones, plastic, bone fragments, jute, matchstick, feathers, nails, stems, seeds, etc

2. Chemical hazards: Any chemical contaminants introduced in food system which may cause illness to the individual using the products. They can be visible or invisible.

Examples- Visible: colours, flavours, additives.

Invisible: pesticides, adulterants, cleaning chemicals

3. Biological hazards: Biological hazards occur when hazardous or pathogenic organisms are introduced to food and thus pose a food safety concern to consumers. Biological hazards include bacteria, viruses and parasites of public health significance. Biological hazards can be further divided into visible and invisible hazards.

Example – Visible: worms, fly, cockroaches, caterpillars, etc.

Invisible: bacteria, yeast, moulds, protozoa, microbial toxins, viruses, etc.

1.2. **VII Critical Control Points**

There are seven steps to be followed in HACCP process. They are:

1. Conduct a Hazard Analysis: The hazard analysis process identifies significant hazard estimates the likelihood of occurrence and their severity if they do occur and develops preventive measures for a process or product to ensure or improve food safety. HACCP focuses on high risk hazards that are likely to happen. It includes an analysis of ingredients and pinpoints sensitive ingredients used, such as raw egg white in soufflé, which can create a microbiological hazard in food.

2. Identify the CCPs --are in the Food Process: CCPs are the points at which control is essential to ensure that potential hazards do not become actual hazards. The CCP is thus a steps or procedure at which control can be applied and that can help to prevent a food safety hazard by eliminating it or reducing it to acceptable levels. Some e.g. of CCPs are cooking, chilling, sanitary procedures, prevention Of cross –contamination and certain aspects of personal and environmental hygiene.

3. Define critical limits for each identified CCP: A critical limit is a boundary of safety. Some control measures have upper and lower critical limits. The temperature danger zone is 5^0C to 63^0 C and potentially hazardous food should not be held within this range of temperature for more than 4 hrs . Both upper and lower temperature limits must be observed along with the time limit. Apart from time and temperature there are other critical limits.

4. Establish procedures to monitor CCPs: Monitoring is done by conducting a planned sequence of observation or measurement of control parameters to assess whether a CCP is under control. Monitoring procedures establish an accurate record for future verification. Records of date, time, and temperature measured, etc., help in identifying any trend indicating loss of control and corrective action taken to bring the process back into control before a deviation occurs.

5. Establish corrective action in case of default when Monitoring Shows that a Critical limit has Exceeded: Corrective action is necessary when a deviation occurs and critical limits are exceeded. Corrective action taken needs to be documented.

6. Establish Effective Record Keeping Procedures that Document the HACCP system: The management of the food establishment for the preparation and maintenance of the written HACCP plan. The implementation strategy has to be worked out. If the system has to work, records need to be maintained.

7. Establish Procedures to Verify that the HACCP System is Working Correctly: The first stage to the verification process involves technical validation. Second stage of verification ensures that the HACCP plan is working efficiently. The third stage includes periodic revalidation by the HACCP team or internal audit. While fourth stage is verification by the regulatory body or external audit.

3. MICROORGANISMS

3.1 Introduction (Bacteria, Yeast, Mould)
3.2 Classification
3.3 Factors for growth
3.4 Role of microbes in manufacture of fermented foods
(Dairy products, Veg. & bakery preparations, alcoholic Bev. vinegar, fermented Indian foods)

3.1 Introduction

Every year thousands of people all over the world fall ill after consuming food that seemed absolutely normal but actually contaminated by harmful organisms. With more people eating away from home, outbreaks of food – borne disease are now becoming more frequent an outbreak of disease caused by contaminated food it is necessary to know something about the organisms responsible. These organisms are too small to be seen with the unaided eye and can only be seen under a microscope. That is why they are called microorganisms or microbes and their study is called microbiology.

3.2 Classification

There are five groups of microorganisms of importance in food microbiology. They are **viruses, bacteria, fungi, algae, and protozoa.**

1. VIRUSES: Viruses are strictly parasitic and cannot be cultivated outside the living host cell. They feed on living cells of plants and animals and are pathogenic. They are very minute in size and can only be observed under an electron microscope. Some viruses are harmful to food industry. They attack the bacteria used as a starter in the manufacture of cheese and yoghurt. The bacteria are then incapable of fermenting lactose to lactic acid and this affects the overall quality of the product. Poliomyelitis and infectious hepatitis are vital 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.

2. BACTERIA: Bacteria found everywhere; they are both useful and harmful to humans. They are capable of fermenting sugar to lactic acid. This makes them important in the manufacture of dairy products like curds, yoghurts, buttermilk and cheese, and fermented vegetable products like sauerkraut and dill pickles. Some bacteria can oxidize ethyl alcohol to acetic acid and are necessary for the manufacture of vinegar. They leaven idli, dosa and dhokla batter and develop desirable flavors in them. They help in fermenting and curing coffee and cocoa beans and in the production of enzymes, acids and other substance like glutamate and certain stabilizers added to food. Most food borne diseases are caused by bacteria, tiny one-celled organisms so small; they can only be seen under the microscope. They can be identified by their shape, size, and cell arrangement. Four shapes are observed: rod shaped (flagella), spherical (cocci), spiral (spirilla), comma shaped (vibrios).

There are several types of bacteria:

1. Harmless Bacteria – Most bacteria fall into this category. They are neither helpful nor harmful. We are not concerned with them in food sanitation.

2. Beneficial Bacteria – These bacteria are helpful to us. For example, many live in the intestinal tract, where they fight harmful bacteria, aid in the digestion of food and produce certain nutrients. In food production, bacteria make possible the manufacture of many foods, including cheese and yogurt.

3. Undesirable Bacteria – These are the bacteria that are responsible for food spoilage. They cause souring, putrefying and decomposition. These bacteria may or may not cause diseases, but they have built in safety factors: they announce their presence by sour odors, sticky or slimy surfaces, and discoloration. As long as we use common sense and follow the rule: 'when in doubt, throw it out', we are relatively safe from bacteria.

We are concerned with these bacteria for two reasons:

a. food spoilage costs money

b. Food spoilage is a sign of improper food handling & storage. This means the next type of bacteria is also present.

4. Disease-causing bacteria – are also called pathogens. These are the bacteria that cause most food borne illnesses. Pathogens do not necessarily leave detectable odors or tastes in food. In other words, you can't tell whether the food is contaminated by smelling, tasting or looking at it. The only way to protect against pathogenic bacteria is by proper hygiene and sanitary food handling and storage techniques.

3. FUNGI: Fungi include the lower plants and are usually multicellular, they are mainly saprophytes and lack chlorophyll. 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 molds.

Yeast: are unicellular and are found naturally in soil and dust. Yeast is much larger in size than bacterial cells; vary in shape from ovoid, lemon shaped, pear-shaped, triangular or elongated. Budding is a common method of reproduction in yeast. Yeast cells are capable of fermenting sugars an aerobically to alcohol and carbon dioxide. This makes them important in making bread and alcoholic beverages. Food yeast is rich in B- complex vitamins. Certain yeasts rich in protein can be cultivated on industrial wastes as sources of food. They are useful in beer and wine making and as a first steps in manufacture of vinegar. Yeast can grow on the surface of high acid and salt containing pickles and chutneys and spoil them, they also spoil dry fruits, fruit juices, squashes, honey and soy sauce by forming alcohol and carbon dioxide.

Molds: molds are multicellular. Their bodies are thread like filamentous. The filaments are hyphae and the entire body is called mycelium. Hyphae may be submerged, i.e., growing within the food, or aerial, i.e., growing into the air above the food. The body is filamentous with spore heads of varying shapes and size. They grow readily on bread, jam, cheese, lather, cow dung etc. They are responsible for spoilage of fruits and vegetables, giving them either a water soaked, mushy appearance or forming dry, hard, discolored patches.

4. ALGAE: algae include both unicellular and multicellular organisms found naturally in water. They contain chlorophyll and are photosynthetic. Algae vary in shape and size from one micron to many feet in length. Red and brown algae are for used as a source of food and blue green algae as fertilizers because they are rich in protein. Alginic 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.

5. PROTOZOA: Protozoan's belong to the animal kingdom. They are unicellular. Some are parasitic. Protozoa vary in shape and size; they are a source of food for fish and other aquatic animals. Amoebiasis occurs when drinking water is

contaminated by sewage or through salads and roots vegetables grown on soil to which untreated excreta is applied as fertilizer.

3.3 Factors for growth

Bacteria Growth Bacteria multiply by splitting into half. Conditions for growth include:

1. Food/Nutrition – Bacteria require some kind of food in order to grow. They like many of the foods we do. Food is food to human &microbes, be it carbohydrates, protein or fat. The nutritional requirements differ from species to species. (One microorganism to another.) The nutrition is required not only for the sources of energy but also for manufacturing the cellular components. Except carbohydrate, protein, fat some minerals are required such as – nitrogen,sulpher, iron etc.

2. Moisture - Bacteria require moisture in order to absorb food. water is important for living organisms. Organism contain 75-80% of water in cells. Organism needs the moist environment to grow.

3. Temperature – Bacteria grow best at warm temperatures. *Temperatures between 45^{o} and 140^{o}F (7^{o} to 60^{o}C) will promote the growth of disease causing bacteria*. This temperature range is called the *Danger Zone*. Microbial growth is retarded below 5^{o}C and they get destroyed beyond 63^{o}C. The temperature at which maximum growth occurs is known as optimal temperature. Based on the temp at which maximum growth occurs micro-organisms are divided into three main categories –

- Thermopiles – the bacteria which grow rapidly between 45 ^{o}C to 65^{o}C. (spoilages caused in canned food)

- Mesophilies - the bacteria which grow rapidly between 20 ^{o}C to 45 ^{o}C (diseases causing pathogens)

- Phychrophiles - the bacteria which grow rapidly below 20 ^{o}C. (spoilages in refrigerated and frozen food)

4. PH – This is an important factor. As every organism has a minimum, maximum,& optimal pH. PH scale extended from 0-14. The pH of water is neutral that is 7. The substance known as acidic whose pH is below 7 & Alkaline whose is above 7.

Most of the bacteria prefer the pH near 7.Where as some bacteria is acidic or alkaline in nature. Yeast &mould are more acidic then bacteria.

In general, disease causing bacteria prefer a neutral medium, neither too acidic nor alkaline.

5. Air – Most bacteria require oxygen to grow. These are called *aerobic*. Others are called *anaerobic*, which means they can only grow when no air is present,

such as in metal cans. Botulism is one of the most dangerous forms of food poisoning caused by anaerobic bacteria.

6. Time – When bacteria are introduced to a new environment, they need time to adjust to their new surroundings before they start multiplying. This time is called the *lag phase*.

7. Osmotic pressure – The osmotic pressure of foods varies with the amount of solute dissolved in food. Bacteria cannot grow in high concentration of sugar and salt. Yeasts can grow in fairly high concentration, whereas moulds grow in the highest concentration of sugar.

8. Sunlight or ultraviolet rays – Microbial growth is encouraged in dark humid places and not in well light and naturally ventilated places. This is because ultraviolet rays are present in sunlight. These rays destroy microbes.

Protection against Bacteria: Because we know how and why bacteria grow, we should be able to keep them from multiplying. There are three basic principles of food protection against bacteria.

1. Keep bacteria from spreading – Don't let food touch anything that may contain disease-producing bacteria, and protect food from bacteria in the air.

2. Stop bacteria from growing – Take away the conditions that encourage bacteria to grow. In the kitchen, our best weapon is temperature. The most effective way to prevent bacterial growth is to keep the food below 45F or above 140F (7C & 60C). These temperatures will not necessarily kill the bacteria but will at least slow down their growth considerably.

3. Kill bacteria – Most disease causing bacteria are killed if they are subjected to temperatures above 170F (77C) for 30 seconds or higher temperatures for shorter holding times. Certain chemicals also kill bacteria and can be used to sanitize equipment.

3.4 ROLE OF MICROBES IN MANUFACTURE OF FERMENTED FOODS

Fermentation is a chemical process that breaks down organic materials. This process is carried out by microbes such as bacteria, yeast and moulds. It is useful in the production of bread, cheese and yoghurts, and alcoholic beverages like wine and beer, etc. The microbes that bring about food fermentation may be added to the food in the form of a pure culture or mixed culture; or very often no culture is added as the desired microbes are naturally present in adequate numbers in the food. For example, while making idli, the bacteria Leuconostoc, Streptococcus and Pediococcus that bring about fermentation of rice and black gram paste are already present in sufficient numbers on the grains.

- **Some Important Microbial Reaction**

1. Bakery products: In bread dough, sugars are fermented by the yeast **Saccharomyces cerevisiae** to ethanol (Alcohol) and CO_2.

2. Alcoholic Beverages: Yeast for beer making --- **Saccharomyces carlsbergensis**

Sugar from grape juice ---**YEAST FERMENATION** ----→ Wine + CO_2

Sugar from malted grains of barley ---**YEAST FERMENATION** ----→ Beer + CO_2

3. Fermentation of milk:

- Microorganisms used in making **yoghurt**

Lactobacillus bulgaricus, Streptococcus thermophilus

- **Cheese** is ripened by bacteria or mold

Hard cheese – Lactobacillus casei

Lactobacillus bulgaricus

Swiss cheese – Propionibacterium

- Normal flora of **Curds** is species of

Lactobacilli, Leuconostoc, Streptococci and yeast

4. Manufacture of vinegar

The manufacture of vinegar involves two steps:

Step 1: $C_6H_{12}O_6$ ---**YEAST FERMENATION** ----→ $2C_2H_5OH + 2CO_2$

Sugar Ethyl alcohol + carbon-di-oxide

The yeast that brings about fermentation of any carbohydrate rich substrate such as sugarcane juice, fruit juice ect. Is Saccharomyces cerevisiae

Step 2: $2\ CH_3\ CH_2OH + 2O_2$ -------**BACTERIAL ACTION**-----→ $2CH_3\ COOH + 2H_2O$

Ethyl alcohol Acetic acid

Bacteria which are used to oxidize the alcohol formed in first step to acetic acid or vinegar are: Acetobacter aceti , Gluconobacter.

UNIT: 2

1. FOOD BORNE ILLNESS

1.1 Natural Toxins (Kesari Dal, Potatoes, Mushrooms, Shell Fish, Peanuts)
1.2 Chemical (Tin, Copper, Arsenic, Lead)
1.3 Bacterial toxins (staphylococcus, salmonella, Clostridium perfringens, Clostridium Botulinum)
1.4 Food poisoning & Infections • Definitions

A food-borne illness is a general term applied to all type of illness caused by an organism, substance or material of any kind which is present in food and gain entrance into the body when such food is consumed. The cause of contamination is generally faulty handling , poor sanitary practices, insects, rodents or microorganisms. Such food is likely to be consumed and may result in disease.

Food borne diseases are harmful illnesses mainly affecting the gastro intestinal tract and are transmitted through consumption of contaminated food or drink.

Diseases and their classification: A disease is a negative state of health .It is defined as a deviation from normal health which adversely influences the daily routine of a person.

Diseases are broadly classified into two categories:

- **Communicable Diseases**

Infectious Diseases: These are caused by microorganism and are transmitted by direct or indirect contact; these include typhoid, hepatitis and influenza.

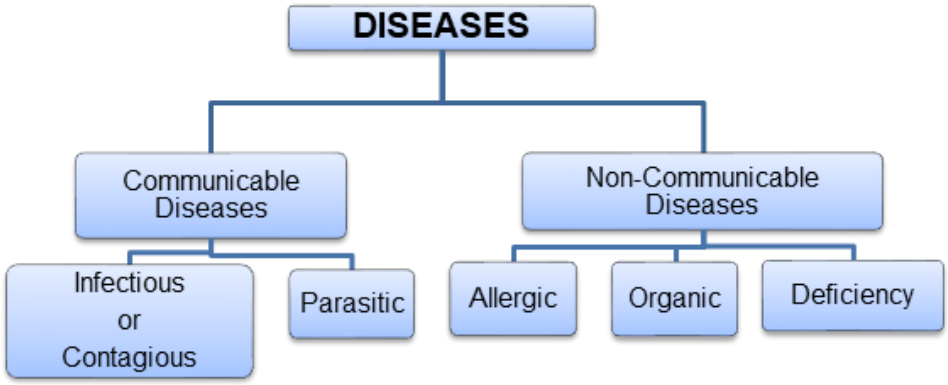
Parasitic Diseases: These are diseases which are caused by the presence of animal parasites like tapeworms, roundworms and pinworms.

- **Non-communicable diseases**

Deficiency Diseases: These occur because of a shortage of certain nutrient in our daily diet.

Organic Diseases: These are caused by malfunctioning of certain organs in our body e.g. pancreatic malfunction causes diabetes.

Allergic Diseases: These disorders occur because of the abnormal sensitivity of the body to certain foods which are normally consumed in diet.



Mode of Transmission Of Disease: Diseases are transmitted through food either directly or indirectly.

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. Diseases of the intestinal tract are transferred by unwashed or improperly washed hands.

Indirect transmission: The host of a communicable disease may transmit pathogens indirectly through various routes onto prepared food and from there to other people consuming the offending food. The other indirect routes of transmission of disease causing agents or pathogens are through:

- Contaminated utensils and equipment
- Sewage polluted water and food grown on polluted soil
- Soiled linen, door handles and taps
- Insects like flies and cockroaches
- Rodents like mice and rat
- Infected animals and their products

Contaminated food: The term contaminated is used for those foods that are not fit to be eaten for sanitary reasons. Although food may look, smell and taste good, it may contain harmful chemicals, non-food matter and bacteria.

Cross-contamination: It is the transfer of microorganisms from something dirty to something clean or from a food with many bacteria to a food with less bacteria by means of a nonfood vehicle, such as chopping boards, knives, utensils, equipment, work surface, dish cloth ,hands of food handler etc.

Natural toxin

Certain plants and animals may contain natural substances that are poisonous and may produce gastro- intestinal disturbances.

Naturally Occurring toxicants in plants

1. Kesari dal or Lathyrus Sativus: This dal used to adulterate turdal and besan. This dal contains a neurotoxin called **BOAA (beta-oxalyl amino alanine)**. The toxin causes a disease of the nervous system that result in paralysis of the lower limbs which is called Lathyrism.

2. Green Potatoes: Green, sprouting and damaged potatoes contain high amounts of **solanine** that is toxic to humans. It causes vomiting, abdominal pain and diarrhea within eight hours after consumption.

3. Cereals and Groundnuts: If these are improperly stored may have the mould growing on it. This mould produces a mycotoxin called **aflatoxin.**The toxin acts on liver and damages it.

4. Mushrooms: Mushrooms are edible fungi but some varieties are poisonous, they produce hepatotxic factors that damage the liver and result in death. The toxin **muscarin** is produced by **A. muscaria** that stimulates the nerves. Symptoms are nausea, headache, excessive salivation and tears, dizziness and confusion.

5. Mussels and clams (shellfish): They produce the heat stable toxin **PSP** (**paralytic shellfish poison**), which is extremely toxic for human. Symptoms include itching, numbness of lip and tongue, muscular weakness and respiratory paralysis that can be fatal.

Toxic Metals and chemicals

Metals, when consumed in excess of the requirements, could cause toxicity. These contaminates may be present in the environment and may accumulate during the different stage of food preparation.

1. Lead: Lead can contaminate food through various sources like:

- Lead pipes that convey drinking water
- Mineral pigment in food; lead chromate may be used as an adulterant in turmeric powder.
- Some pesticide contains lead arsenate.
- By exposure to dust containing lead.
- My contact with machines.

Symptoms of lead poisoning are: nausea, constipation, fatigue, abdominal pain, anaemia, poor reistance, brain damage and mental retardation.

2. Copper: This poisoning occurs when copper utensil are used to store cooked foods, especially those that are acidic, or when copper utensils are used to cook food. Symptoms of toxicity include vomiting, diarrhea, abdominal pain, astringent taste in mouth and constriction of the throat in acute cases.

3. Tin: Tin poisoning is seen in acidic canned foods or moist foods left in the canned after opening it. It also occurs in foods containing nitrates or oxalates.

Symptoms of poisoning include vomiting, diarrhea, constipation, headache , metallic taste in the mouth.

4. Arsenic: It is a chemical, many insecticides; weedkiller and rat poisons contain arsenic. It is also present in water from polluted streams. Fruits, vegetables and shellfish are likely to be contaminated with arsenic. Exposure to arsenic over years causes cancer of lungs and many other symptoms.

Bacterial Intoxication

1. Staphylococcus food intoxication: Staph food poisoning is one of the most common types of food poisoning caused by the toxin produced by Staphylococcus aureus.

Organism: stain of **Staphylococcus aureus**
Type of toxin: enterotoxin
Incubation period: two to six hours
Duration of illness: Six to 24 hours

Symptoms: Salivation, nausea,vomiting,abdominal cramps,diarrhea,sub-normal body temperatures; mortality is extremely low, in severe cases blood and mucous may be found in the stool.

Foods commonly involved: protein –rich foods like meat, fish, milk and poultry; cooked indented to be eaten cold custard, trifles etc.; foods insufficiently refrigerated.

Mode of transmission: sources from where microorganisms enter food are mostly human or animal and include droplet infection from nasal passages, e.g. sneezing and direct contact with boils and infected wounds.

Prevention:

1. Use raw ingredients free from staphylococcus e.g. Pasteurized milk, and keep employees with any infection like boils etc. away from food.
2. Prevent cross- contamination from raw meat to cooked meat and from contaminated equipment, utensils or hands to high risk foods.
3. Kill the organism by heat treatment, e.g. pasteurization.
4. The growth of Staphylococci can be controlled by rapid cooking, chilling and prompt refrigeration.
5. Practice personal hygiene.

2. Botulism: This is an uncommon type of food poisoning. It is produced by anaerobic spore-forming bacteria which are found in the soil.

Organism: **Clostridium botulinum**
Type of toxin: neurotoxin
Incubation period: 18 to 38 hours
Duration of illness: death in 24 hours to eight days

Symptoms: nausea, vomiting, diarrhea, fatigue, dizziness, double vision, difficult in swallowing and in speaking, dryness of the mouth and constriction of the throat, paralysis of involuntary muscles which spreads to the respiratory system and the heart. Death results due to respiratory failure.

Therapy: anti-toxin should be given immediately.

Food commonly involved: Inadequately processed home –canned foods, including low and medium acid foods, acid foods like canned tomatoes, peaches and pears in which other microorganisms are present; smoked products; damaged, leaky anda rusty cans or cans with broken seals.

Mode of transmission: The spores are transferred from the soil into food which is then consumed.

Prevention:

1. Use approved heat processes for canned food.
2. Reject gassy or spoiled canned food and refuse to taste doubtful food.
3. Avoid leftover cooked foods that are not well reheated or raw and precooked foods that have been frozen, thawed and held at room temperature.
4. Smoked fish should be heated to at least 85^0c for 30 minutes and should be frozen immediately after packaging.
5. Heat food to 100^OC for a few minutes to destroy toxin which is thermolabile.

3. Perfringens Food Poisoning: Clostridium perfringens is spore –forming anaerobe found in the human and animal intestinal tract, soil, dust, contaminated raw meat, poultry and some dried foods.

Organism: **Clostridium perfringens**
Type of toxin: enterotoxin produced in intestine
Incubation period: 8 to 24 hours
Duration of illness: 1 to 2 days

Mode of transmission: from human faeces via hands to the food by direct contact, vector transmission by flies sitting on excreta, cross contamination from raw to cooked meat, dusty kitchens and dirty cardboard boxes placed on work tables. In raw meat and excreta.

Symptoms: abdominal pain, diarrhea and nausea, vomiting rarely occur, mild vertigo; mortality rate may be as high as two per cent

Food commonly involved: meats dishes, reshuffle dishes or reheated dished, stewed and roasted meat and poultry sauces, gravies, pies, salads.

Prevention:

1. Through cooking of food, especially meat preparation.
2. Cool food rapidly to prevent multiplication of bacteria and reheat thoroughly just before serving.
3. Handle raw and cooked food separately to prevent cross- contamination.
4. Wash all fruits and vegetables thoroughly.
5. Kitchen and personal hygiene.

4. Salmonellosis food infections: this is the commonest cause of bacterial food – borne disease and the most serious. Organism of the salmonella group causes an infection in the intestine.

Organism:**viable cells of salmonella choleraesuis**
Type of toxin: produced in intestine
Incubation period: 12 to 24 hours
Duration of illness: 1 to 7 days

Mode of transmission: use of cracked eggs or seafood from polluted waters, vector transmission by rodents and flies from faecal matter, cross contamination :if the food handler does not wash hands after handling raw meat and poultry, after visit to the toilet or does adequately clean and sanities the chopping board and other equipment, Contact transmission: direct contact by food handler ill with salmonellosis or a carrier of the disease.

Symptoms: diarrhea, abdominal pain, chills, fever, vomiting, dehydration, enteritis or local infection may also occur, watery, greenish, foul smelling stools.

Food commonly involved: animal product , ducks egg, milk ,fish, mutton biriyani, seafood from polluted waters canned foods that are opened,have got contaminated and are held without refrigeration once opened.

Prevention:

1. Purchase meat, poultry, eggs and fish that have been thoroughly inspected for wholesomeness.
2. Wash hands often, especially after using the toilet and after handling raw meat, poultry and soiled objects.
3. The food handlers nail should be trimmed and clean.
4. Keep equipment clean and hygienic.
5.Growth of the organism may be prevented by adequate refrigeration as Salmonella are very sensitive to temperature and do not multiply in low temperatures.

Food –borne illness

Microorganisms which cause food borne illnesses are bacteria, viruses, protozoans. 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 intestine 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.

FOOD POISONING OR FOOD INTOXICATION:

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. In bacterial food poisoning, the toxin is produced during multiplication of 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 diarrhea. The incubation period for such food poisoning is comparatively shorter than that for bacterial food infection.

FOOD POISIONING	FOOD INFECTION
1. Caused by toxin	1. Caused by living microorganism
2. toxins irritate the stomach lining and cause vomiting	2. the gastric juices in stomach destroy the bacteria. Infection happens in small intestine.
3. Incubation period: two hours	3. Incubation period: 12 – 24 hours
4. Symptoms: nausea and vomiting diarrhea, usually no fever	4. Symptoms: diarrhea, abdominal pain, vomiting, fever
5. Duration: one day, sometimes longer	5. Duration: one to seven days, sometime longer,

Incubation time or period means: The time between the entry of infectious agent into the body and the appearance of symptoms.

FOOD INFECTIONS:

Food infections are 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. The irritates the lining of the intestines, resulting in nausea, diarrhea and abdominal pains. The incubation period for an infection occurs is 12 hours or more.

Incidental Poisoning

Food Borne Diseases Caused by Some Pathogenic Organisms

Pathogenic Organisms	Food Commonly involved	III effects and diseases
BACTERIAL		
Bacillus cereus	Cereal Products	Nausea, vomiting, abdominal pain.
Clostridium botulinum toxins	Defectively processed meat and fish.	Botulism (muscular) paralysis, death due to respiratory failure.
Clostridium perfringens (welchii)	Defectively processed meat and fish.	Nausea, abdominal pain and diarrhoea.
Salmonella	Defectively processed meat, fish and egg products, raw vegetables grown on sewage.	Salmonellosis (vomiting diarrhoea and fever)
Shigella sonnei	Foods kept exposed or sale in unhygienic surroundings.	Bacillary dysentery
Staphylococcus aureus	Foods kept exposed or sale in unhygienic surroundings.	Increased salivation, vomiting, abdominal pain and diarrhoea.
Streptococcus pyogenes	Foods kept exposed or sale in unhygienic surroundings.	Scarlet fever, septic sores throat.
FUNGAL		
Aspergillus flavus (aflatoxin)	Corn and groundnut	Liver damage and cancer
Claviceps purpurea (Ergot)	Rye and pearl millet infested with ergot. Peripheral gangrene	Ergotism (burning sensation in extremities)
Fusarium sporotrichiodies	Cereals and millets infected with fusarium.	Alimentary toxic aleukia.
Penicillium islandicum	Rice	Liver damage
PARASITIC		
Trichinella spiralis	Pork and pork products	Nausea,vomiting,diarrhoea, Colic and muscular pains(trichionosis)
Ascaris lumbricoides	Raw vegetables grown on sewage	Ascariasis

	farm.	
Entamoeba histolytica	Raw vegetables grown on sewage farm.	Amoebic dysentery
Ancylostoma duodenale (hookworm)	Raw vegetables grown on sewage farm.	Epigastric pain, loss of blood, anaemia.

Toxic Effects of Some Metals and Chemicals

Name	Foods commonlyinvolved	Toxic effects
Arsenic	Fruits sprayed by lead arsenate.	Dizziness, chills, cramps paralysis leading to death.
Barium	Foods contaminated by rat poison (barium carbonate)	Violent peristalsis, muscular twitching and convulsions.
Cadmium	Fruit juices and soft drinks that come in contact with cadmium and plated vessels.	Excessive sallvation, liver, kidney damage, prostate cancer, multiple fractures (painful 'Itai-Itai' disease reported from Japan due to cadmium poisoning)
Cobalt	Water, beer	Cardiac failure
Copper	Acid foods in contact with tranished copper ware.	Vomiting, diarrnoea, abdominal pain.
Lead	Some processed foods Lead water pipes.	Paralysis, brain damage.
Mercury	Mercury fungicide treated seed grains or mercury contaminated fish.	Paralysis, brain damage and blindness.
Tin	Canned foods	Colic, vomiting, photophobia.
Zinc	Foods stored in galvanised iron ware.	Dizziness, vomiting
pesticides	All types of foods	Acute or chronic poisoning causing damage to liver, kidney, brain and nerves leading to death.
Diethyl stilbestrol	Present in meat of stilbestrol fed animals and birds.	Teratogenesis, carcinogenesis.
antibiotics	Meat from animals fed antibiotics.	Drug resistance, hardening of arteries, heart disease.

3. MICROORGANISMS

3.1 Introduction (Bacteria, Yeast, Mould)
3.2 Classification
3.3 Factors for growth
3.4 Role of microbes in manufacture of fermented foods
(Dairy products, Veg. & bakery preparations, alcoholic Bev. vinegar, fermented Indian foods)

3.1 Introduction

Every year thousands of people all over the world fall ill after consuming food that seemed absolutely normal but actually contaminated by harmful organisms. With more people eating away from home, outbreaks of food – borne disease are now becoming more frequent an outbreak of disease caused by contaminated food it is necessary to know something about the organisms responsible. These organisms are too small to be seen with the unaided eye and can only be seen under a microscope. That is why they are called microorganisms or microbes and their study is called microbiology.

3.2 Classification

There are five groups of microorganisms of importance in food microbiology. They are **viruses, bacteria, fungi, algae, and protozoa.**

1. VIRUSES: Viruses are strictly parasitic and cannot be cultivated outside the living host cell. They feed on living cells of plants and animals and are pathogenic. They are very minute in size and can only be observed under an electron microscope. Some viruses are harmful to food industry. They attack the bacteria used as a starter in the manufacture of cheese and yoghurt. The bacteria are then incapable of fermenting lactose to lactic acid and this affects the overall quality of the product. Poliomyelitis and infectious hepatitis are vital 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.

2. BACTERIA: Bacteria found everywhere; they are both useful and harmful to humans. They are capable of fermenting sugar to lactic acid. This makes them important in the manufacture of dairy products like curds, yoghurts, buttermilk and cheese, and fermented vegetable products like sauerkraut and dill pickles. Some bacteria can oxidize ethyl alcohol to acetic acid and are necessary for the manufacture of vinegar. They leaven idli, dosa and dhokla batter and develop desirable flavors in them. They help in fermenting and curing coffee and cocoa beans and in the production of enzymes, acids and other substance like

glutamate and certain stabilizers added to food. Most food borne diseases are caused by bacteria, tiny one-celled organisms so small; they can only be seen under the microscope. They can be identified by their shape, size, and cell arrangement. Four shapes are observed: rod shaped (flagella), spherical (cocci), spiral (spirilla), comma shaped (vibrios).

There are several types of bacteria:

1. Harmless Bacteria – Most bacteria fall into this category. They are neither helpful nor harmful. We are not concerned with them in food sanitation.

2. Beneficial Bacteria – These bacteria are helpful to us. For example, many live in the intestinal tract, where they fight harmful bacteria, aid in the digestion of food and produce certain nutrients. In food production, bacteria make possible the manufacture of many foods, including cheese and yogurt.

3. Undesirable Bacteria – These are the bacteria that are responsible for food spoilage. They cause souring, putrefying and decomposition. These bacteria may or may not cause diseases, but they have built in safety factors: they announce their presence by sour odors, sticky or slimy surfaces, and discoloration. As long as we use common sense and follow the rule: 'when in doubt, throw it out', we are relatively safe from bacteria.

We are concerned with these bacteria for two reasons:

a. food spoilage costs money

b. Food spoilage is a sign of improper food handling & storage. This means the next type of bacteria is also present.

4. Disease-causing bacteria – are also called pathogens. These are the bacteria that cause most food borne illnesses. Pathogens do not necessarily leave detectable odors or tastes in food. In other words, you can't tell whether the food is contaminated by smelling, tasting or looking at it. The only way to protect against pathogenic bacteria is by proper hygiene and sanitary food handling and storage techniques.

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1. Food/Nutrition – Bacteria require some kind of food in order to grow. They like many of the foods we do. Food is food to human &microbes, be it carbohydrates, protein or fat. The nutritional requirements differ from species to species. (One microorganism to another.) The nutrition is required not only for the sources of energy but also for manufacturing the cellular components. Except carbohydrate, protein, fat some minerals are required such as – nitrogen,sulpher, iron etc.

2. Moisture - Bacteria require moisture in order to absorb food. water is important for living organisms. Organism contain 75-80% of water in cells. Organism needs the moist environment to grow.

3. Temperature – Bacteria grow best at warm temperatures. *Temperatures between 45^{o} and 140^{o}F (7^{o} to 60^{o}C) will promote the growth of disease causing bacteria*. This temperature range is called the *Danger Zone*. Microbial growth is retarded below 5^{o}C and they get destroyed beyond 63^{o}C. The temperature at which maximum growth occurs is known as optimal temperature. Based on the

temp at which maximum growth occurs micro-organisms are divided into three main categories –

- Thermopiles – the bacteria which grow rapidly between 45 °C to 65°C. (spoilages caused in canned food)

- Mesophilies - the bacteria which grow rapidly between 20 °C to 45 °C (diseases causing pathogens)

- Phychrophiles - the bacteria which grow rapidly below 20 °C. (spoilages in refrigerated and frozen food)

4. PH – This is an important factor. As every organism has a minimum, maximum,& optimal pH. PH scale extended from 0-14. The pH of water is neutral that is 7. The substance known as acidic whose pH is below 7 & Alkaline whose is above 7.

Most of the bacteria prefer the pH near 7.Where as some bacteria is acidic or alkaline in nature. Yeast &mould are more acidic then bacteria.

In general, disease causing bacteria prefer a neutral medium, neither too acidic nor alkaline.

5. Air – Most bacteria require oxygen to grow. These are called *aerobic*. Others are called *anaerobic*, which means they can only grow when no air is present, such as in metal cans. Botulism is one of the most dangerous forms of food poisoning caused by anaerobic bacteria.

6. Time – When bacteria are introduced to a new environment, they need time to adjust to their new surroundings before they start multiplying. This time is called the *lag phase*.

7. Osmotic pressure – The osmotic pressure of foods varies with the amount of solute dissolved in food. Bacteria cannot grow in high concentration of sugar and salt. Yeasts can grow in fairly high concentration, whereas moulds grow in the highest concentration of sugar.

8. Sunlight or ultraviolet rays – Microbial growth is encouraged in dark humid places and not in well light and naturally ventilated places. This is because ultraviolet rays are present in sunlight. These rays destroy microbes.

Protection against Bacteria: Because we know how and why bacteria grow, we should be able to keep them from multiplying. There are three basic principles of food protection against bacteria.

1. Keep bacteria from spreading – Don't let food touch anything that may contain disease-producing bacteria, and protect food from bacteria in the air.

2. Stop bacteria from growing – Take away the conditions that encourage bacteria to grow. In the kitchen, our best weapon is temperature. The most

effective way to prevent bacterial growth is to keep the food below 45F or above 140F (7C & 60C). These temperatures will not necessarily kill the bacteria but will at least slow down their growth considerably.

3. Kill bacteria – Most disease causing bacteria are killed if they are subjected to temperatures above 170F (77C) for 30 seconds or higher temperatures for shorter holding times. Certain chemicals also kill bacteria and can be used to sanitize equipment.

3.4 ROLE OF MICROBES IN MANUFACTURE OF FERMENTED FOODS

Fermentation is a chemical process that breaks down organic materials. This process is carried out by microbes such as bacteria, yeast and moulds. It is useful in the production of bread, cheese and yoghurts, and alcoholic beverages like wine and beer, etc. The microbes that bring about food fermentation may be added to the food in the form of a pure culture or mixed culture; or very often no culture is added as the desired microbes are naturally present in adequate numbers in the food. For example, while making idli, the bacteria Leuconostoc, Streptococcus and Pediococcus that bring about fermentation of rice and black gram paste are already present in sufficient numbers on the grains.

- **Some Important Microbial Reaction**

1. Bakery products: In bread dough, sugars are fermented by the yeast **Saccharomyces cerevisiae** to ethanol (Alcohol) and CO_2.

2. Alcoholic Beverages: Yeast for beer making --- **Saccharomyces carlsbergensis**

Sugar from grape juice ---**YEAST FERMENATION** ----→ Wine + CO_2

Sugar from malted grains of barley ---**YEAST FERMENATION** ----→ Beer + CO_2

3. Fermentation of milk:

- Microorganisms used in making **yoghurt**

Lactobacillus bulgaricus, Streptococcus thermophilus

- **Cheese** is ripened by bacteria or mold

Hard cheese – Lactobacillus casei

Lactobacillus bulgaricus

Swiss cheese – Propionibacterium

- Normal flora of **Curds** is species of

Lactobacilli, Leuconostoc, Streptococci and yeast

4. Manufacture of vinegar

The manufacture of vinegar involves two steps:

Step 1: $C_6H_{12}O_6 \xrightarrow{\text{YEAST FERMENATION}} 2C_2H_5OH + 2CO_2$

Sugar — Ethyl alcohol + carbon-di-oxide

The yeast that brings about fermentation of any carbohydrate rich substrate such as sugarcane juice, fruit juice ect. Is Saccharomyces cerevisiae

Step 2: $2\,CH_3CH_2OH + 2O_2 \xrightarrow{\text{BACTERIAL ACTION}} 2CH_3COOH + 2H_2O$

Ethyl alcohol — Acetic acid

Bacteria which are used to oxidize the alcohol formed in first step to acetic acid or vinegar are: Acetobacter aceti , Gluconobacter.

3. FOOD ADDITIVES

3.1 Colours & Flavours
3.2 Browning reactions-causes, desirable &undesirable effects)

Food additives are chemicals added to foods to keep them fresh or to enhance their colour, flavour or texture. They may include food colourings (such as tartrazine or cochineal), flavour enhancers (such as MSG) or a range of preservatives. Most food additives are listed on the product label, along with other ingredients, in a descending order by weight (flavours are an exception and do not need to be identified). Sometimes, the additive is spelt out in full. At other times, it is represented by a code number: for example, cochineal may be listed as Colouring (120); sodium sulphite may be shown as Preservative (221).

Many people enjoy making bread, cakes, wine, beer, and ice cream at home. However, most of today's food is bought from shops and supermarkets. Food made at home is always at its best when eaten straight away. Food produced on the large scale that is needed to supply supermarkets and other food shops has to be transported and stored before it is consumed. It has to stay in top condition over a much longer period of time than home-cooked food. Additives are used so that these foods still have a consistently high quality. In some products, they are so essential that additives are used even in certain organic foods. In some countries, lots of food is lost because it 'goes off' due to microbial growth before it can be eaten. Food poisoning also shows the dangers of contaminated food and without the use of preservatives; it would quite likely

be more common. Preservatives, colours and flavors are the best known additives but in fact there are many categories of additives, each tailored to a specific purpose.

The different types of food additive and their uses include:

Anti-caking agents – stop ingredients from becoming lumpy.

Antioxidants – prevent foods from oxidising, or going rancid.

Artificial sweeteners – increase the sweetness.

Emulsifiers – stop fats from clotting together.

Food acids – maintain the right acid level.

Colours – enhance or add colour.

Humectants – keep foods moist.

Flavours – add flavour.

Flavour enhancers – increase the power of a flavour.

Foaming agents – maintain uniform aeration of gases in foods.

Mineral salts – enhance texture and flavour.

Preservatives – stop microbes from multiplying and spoiling the food.

Thickeners and vegetable gums – enhance texture and consistency.

Stabilisers and firming agents – maintain even food dispersion.

Flour treatment – improves baking quality.

Glazing agent – improves appearance and can protect food.

Gelling agents – alter the texture of foods through gel formation.

Propellants – help propel food from a container.

Raising agents – increase the volume of food through the use of gases.

Bulking agents – increase the volume of food without major changes to its available energy.

Flavorings

The acceptability of any food product greatly depends on the impression of taste when it is eaten. Our sense of taste is really a combination of two of our senses, taste and smell. Both of these senses respond to certain chemicals.

How do we taste?

Taste is a complex mixture of flavours and aroma, or smell. The receptors for the human sense of taste are located on the tongue and on the soft palate. There are just five stimuli to which these receptors respond. These are:
sweet (as in sugar) sour (as in acidic substances like lemon juice) bitter (strong coffee or quinine in tonic water) salt (table salt) umami (monosodium glutamate, savouries, soya sauce, crisps) The traditional view is that tastes are detected on different parts of the tongue.

Receptors for each taste are located in taste buds in specific areas of the tongue and each area can only detect one particular taste. However, more recent research suggests that this may not be the case. The taste buds are still found in the same areas on the tongue but each one can detect all five tastes (sweet, sour, bitter, salt and umami). The brain is able to recognise which receptors are being stimulated and this goes towards the flavour sensation that we experience. The way in which we taste foods and perceive flavours is clearly very complex. Our sense of smell also makes up a big part of how well we 'taste' food. Flavour molecules in the food enter the air in the nose and are detected by millions of receptors that feed information to the brain. Chewing helps to transfer more odour from the mouth to the back of the nose. The area which is sensitive to smell is located at the back of the nose where several million receptor cells per square centimetre respond to thousands of chemicals in the food.
Sight plays an unexpectedly important role in our perception of flavours. The taste of a colourless, shapeless food is extremely difficult to recognise. We may need visual "clues" to enable us to identify taste and flavour accurately. The brain interprets signals from taste, smell and even vision before turning them into an impression of the food's taste. Different people will find different tastes nice or unpleasant. Flavourings are added to food products to give, enhance or intensify flavour.

Flavourings in Food

Flavourings are used in a wide range of food products. Most flavourings are an imitation of the flavour of a known foodstuff. Some flavours are isolated from natural raw ingredients but this is costly and also wastes valuable natural resources. Flavourings used as additives are often developed by a Creative Flavourist . Their job is t o identify the substances present in the food that are the most important in producing its flavour and then to create a flavour profile which mimics the particular food in the most effective way. The average flavouring contains between 5 and 50 ingredients. A few flavourings contain many more.

Sources of Flavours

Foods may contain more than a thousand chemical compounds that contribute to their flavour. Many of these naturally occurring compounds may be too unstable to be used in commercial flavourings where they may need to be stored for some time before being used. For this reason, 'copies' of the natural flavour are often developed. Flavourings are used in food products at very low concentrations. They are normally made from a mixture of substances which provide a flavouring of suitable strength that can be stored and then used in the food production process.

There are four categories of flavourings:

- **Flavouring substances**
- **Flavouring preparations**
- **Process flavourings**
- **Smoke flavourings**

Food Colours - Food colours are divided into 3 main types: natural, nature identical and synthetic

Natural Colours

These are obtained from natural sources such as grasses, leafy vegetables, fruit skins, roots and seeds of plants. Animals can also be a source of food colourings. Cochineal, or carminic acid, is a red colour that is obtained from the bodies of certain scale insects. These feed off cactus leaves and their bodies are commercially harvested in Africa, Spain and Central America. Their bodies are dried and crushed to extract the red colouring.

Nature Indentical Colours

Obtaining colours from natural sources can be costly and their quality can vary. To overcome this, chemists have found ways to make identical colours in the laboratory. This improves their purity and may also cost less. Nature identical colours are exactly the same molecules found in natural sources but they are made synthetically.

The main chemical classes are:

flavonoids, found in many flowers, fruits and vegetables

indigoid, found in beetroot

carotenoids, found in carrots, tomatoes, oranges and most plants. Carrots contain an orange molecule called beta-carotene which is part of this group.

Most natural and nature identical colours can dissolve in oil but do not dissolve in water. This means it is difficult to add them directly to foods. They are usually processed to form their sodium or potassium salt. This makes them soluble in water and suitable for use in foods. They may also be dissolved in oil and incorporated into water-soluble beadlets.

Synthetic Colours

These are colours that do not occur in nature and have been made in a factory. They have been carefully tested to make sure that they are safe. The main examples of synthetic colours are: azo dyes, such as amaranth (colour for blackurrant jams). 'other' dyes, such as, quinoline, (quinoline yellow), xanthene, (erythrosine), triarylmethanes, indigoid, (indigo carmine). Synthetic colours are usually water soluble and can be used in foods without any further processing.

E-Numbers and Colours

Colours that are allowed to be used in foods are strictly tested . Some common food colourings are shown in the table.

Some common food colourings			
E Number	**Name**	**Description**	**Foods**
E100	Curcumin	Orange-yellow colour that is extracted from the roots of the turmeric plant.	Curry, fats and oils, processed cheese.
E101	Riboflavin	Riboflavin is also known as vitamin B2. It can be obtained by fermenting yeast or synthesised artificially. In foods, it is used as an orange-yellow colour.	Sauces, processed cheese and foods with added vitamins such as bread.
E102	Tartrazine	Yellow coloured synthetic azo dye. This colouring sparks controversy as some groups suggest it causes behavioural problems in children (see food issues).	Is no longer widely used. Now rarely used in curries and some ready-meals.
E160a	Beta-carotene	Orange-yellow colour found in plants such as carrots, tomatoes and oranges.	Soft drinks, margarine, butter, yoghurt.
E150a	Plain caramel	Dark brown to black colour. The most common colouring. 90% of all colouring used is caramel. Obtained by the heating of sugars.	Cola drinks, confectionery, baked-foods, ice cream, chocolate, beers, vinegar and whisky.

E123	Amaranth	Dark purple coloured synthetic colour. Similar in colour to blackcurrants.	Powdered soup, jam, ice cream, instant gravy.

BROWING REACTION

Browning is the process of becoming brown, especially referring to food. Browning foods may be desirable, as in caramelization, or undesirable, as in an apple turning brown after being cut. Foods, including beverages, can turn brown through either enzymatic or non-enzymatic processes. Browning has an important economic cost causing deterioration of the value of products in the market of food.

Enzymatic browning

Enzymatic browning is a chemical process, involving polyphenol oxidase, catechol oxidase and other enzymes that create melanins and benzoquinone from natural phenols, resulting in a brown color. Enzymatic browning generally requires exposure to oxygen, thus the browning that occurs when an apple, for example, is cut.

Enzymatic browning can be beneficial for:

Developing flavor in tea

Developing color and flavor in dried fruit such as figs and raisins.

Enzymatic browning is often detrimental to:

Fresh fruit and vegetables, including apples, potatoes and bananas

Seafood such as shrimp

A variety of techniques exist for preventing enzymatic browning, each exploiting a different aspect of the biochemical process.

- Lemon juice and other acids lower the pH and remove the copper cofactor necessary for the responsible enzymes to function
- Blanching to denature enzymes and destroy responsible reactants
- Low temperatures can also prevent enzymatic browning by reducing rate of reaction.
- Inert gas, like nitrogen, prevent necessary oxygen from reacting
- Chemicals such as sodium bisulfite and citrates

Nonenzymatic browning

Contrary to enzymatic or *oxidative* browning, non-enzymatic browning is a chemical process that produces a brown color in foods without the activity of

enzymes. The two main forms of nonenzymatic browning are caramelization and the Maillard reaction. Both vary in reaction rate as a function of water activity.

Caramelization is the pyrolysis of sugar. It is used extensively in cooking for the resulting nutty flavor and brown color. As the process occurs, volatile chemicals are released, producing the characteristic caramel flavor.

The Maillard reaction is a chemical reaction between an amino acid and a reducing sugar, usually requiring the addition of heat. The sugar interacts with the amino acid, producing a variety of odors and flavors. The Maillard reaction is the basis of the flavoring industry, since the type of amino acid involved determines the resulting flavor; it also produces toast.

4. FOOD PRESERVATION

 Methods of Preservation
4.1 Natural & Chemical Preservation
4.2 Low temperature (Refrigeration, Freezing)
4.3 High Temperature (Pasteurization, Sterilization, Canning)
4.4 Irradiation

Preservation usually involves preventing the growth of bacteria, fungi (such as yeasts), and other micro-organisms (although some methods work by introducing benign bacteria, or fungi to the food), as well as retarding the oxidation of fats which cause rancidity. Food preservation can also include processes which inhibit visual deterioration, such as the enzymatic browning reaction in apples after they are cut, which can occur during food preparation.

Many processes designed to preserve food will involve a number of food preservation methods. Preserving fruit by turning it into jam, for example, involves boiling (to reduce the fruit's moisture content and to kill bacteria, yeasts, etc.), sugaring (to prevent their re-growth) and sealing within an airtight jar (to prevent recontamination). There are many traditional methods of preserving food that limit the energy inputs and reduce carbon footprint.

Maintaining or creating nutritional value, texture and flavour is an important aspect of food preservation, although, historically, some methods drastically altered the character of the food being preserved. In many cases these changes have now come to be seen as desirable qualities – cheese, yoghurt and pickled onions being common examples.

NATURAL FOOD PRESERVATION

Naturally occurring substances such as rosemary extract, hops, salt, sugar, vinegar, alcohol, diatomaceous earth and castor oil are also used as traditional preservatives. Certain processes such as freezing, pickling, smoking and salting can also be used to preserve food. Another group of preservatives targets enzymes in fruits and vegetables that start to metabolize after they are cut. For instance, the naturally occurring citric and ascorbic acids in lemon or other citrus juice can inhibit the action of the enzyme

phenolase which turns surfaces of cut apples and potatoes brown if a small amount of the juice is applied to the freshly cut produce. Vitamin C and Vitamin E are also sometimes used as preservatives.

CHEMICAL PRESERVATION

Chemical food preservatives are substances which, under certain conditions, either delay the growth of microorganisms without necessarily destroying them or prevent deterioration of quality during manufacture and distribution. The former group includes some natural food constituents which, when added to foods, retard or prevent the growth of microorganisms. Sugar is used partly for this purpose in making jams, jellies, and marmalades and in candying fruit. The use of vinegar and salt in pickling and of alcohol in brandying also falls in this category. Some chemicals foreign to foods are added to prevent the growth of microorganisms. The latter group includes some natural food constituents such as ascorbic acid (vitamin C), which is added to frozen peaches to prevent browning, and a long list of chemical compounds foreign to foods and classified as antioxidants, bleaching agents, acidulants, neutralizers, stabilizers, firming agents, and humectants.

LOW TEMPRETURE

Storage at low temperatures prolongs the shelf life of many foods. In general, low temperatures reduce the growth rates of microorganisms and slow many of the physical and chemical reactions that occur in foods.

Refrigeration

The life of many foods may be increased by storage at temperatures below 4° C (40° F). Commonly refrigerated foods include fresh fruits and vegetables, eggs, dairy products, and meats. Some foods, such as tropical fruits (*e.g.,* bananas), are damaged if exposed to low temperatures. Also, refrigeration cannot improve the quality of decayed food; it can only retard deterioration. One problem of modern mechanical refrigeration—that of dehydration of foods due to moisture condensation—has been overcome through humidity control mechanisms within the storage chamber and by appropriate packaging techniques.

Freezing

Food is preserved for long periods by reducing its temperature to -18^0c or lower. At this temperature, water present in food is converted to ice and microbial growth stops. Freezing retains color, flavor and nutritive value. Frozen food has a shelf life of 3-12 months. Fruits, vegetables, meat, fish and poultry can be preserved in this way. Food to be frozen should be frozen quickly so that small ice crystals form in the cells of the food which is desirable.

Food is quickly frozen by using any one of the following equipments:

Blast Freezers: Extremely cold air at -32^{0}c is vigorously circulated over food while it passes through an insulated tunnel causing food to freeze swiftly. Freezing time varies from 75 to 90 minutes depending on type of packaging.

Plate Freezers: Food to be frozen is placed in contact with a metal surface that is cooled by a refrigerant. They are used for ice creams, juices etc., both packaged and unpackaged foods.

Immersion Freezer: Packed Or unpacked food is frozen by immersing it or spraying it with a freezing agent. It is used for freezing poultry.

Spray Freezer : This is the quickest freezing method in which liquid nitrogen or carbon dioxide is used. It is also called cryogenic freezing.

Freeze flow : In this food freezes but does not harden.

FOOD IRRADIATION

- Radiation of various frequencies ranging from low-frequency microwaves to high-frequency gamma rays are being used to preserve various foods.
- **Ultraviolet irradiation**

Ultraviolet rays are effective in killing bacteria and viruses, and can be used for surface sterilization of food, or for sterilizing the air in storage and processing rooms.

- **Microwave oven**

Microwaves are short radio waves which heat food by penetrating it.

- **Ionizing rays or cold sterilization**

Foods are exposed to ionizing radiation to extend its shelf life. These rays transfer some of their energy as they pass through food killing pathogenic and spoilage causing microorganisms.

HIGH TEMPRETURE

High Temperatures destroy microorganisms by denaturation of cell proteins an inactivation of enzymes needed by them for their metabolism. At temperature above 63^{0}c bacteria stop multiplying and as temperature increases they are gradually destroyed. The thermal death time (TDT) is the time needed at a given temperature to kill a number of microbes. Heat is used to destroy microbes may be in the form of wet heat or dry heat.

WET HEAT: This is more commonly used in the food industry. If carefully administered, it is a useful method of controlling microorganism.

1. **BLANCHING:** Foods that are to be frozen, dried or canned are immersed in hot boiling water for a few minutes prior to processing.
2. **PASTEURISATION:** The heat treatment kills pathogenic microorganisms and some spoilage organisms at temperatures below 100^{0}C for specified time and food is cooled promptly after heating. This method is used to control

microorganism in milk, fruit juices and wine. Food may be pasteurized by any one of the three methods:

- Low Temperature Holding (LTH) method at 62^0Cfor 30 min.
- High Temperature Short Time (HTST) OR FLASH METHOD AT 72^0C for 15 seconds.
- Ultra High Temperature Sterilization (UHTS) at temperatures above 135^0Cfor 2 seconds. This method makes foods commercially sterile. Such foods are packed under aseptic condition and can be stored at room temperature for three to six months.

3. **COOKING (Boiling, Steaming, Stewing, Poaching):** In these methods of cooking, wet or moist heat is used. The temperature attained is 100^0C.At these temperatures most microorganisms are destroyed but spores survive. Food cooked by these methods cannot be stored for long periods.

DRY HEAT: If food has to be kept for some time, it should be cooked thoroughly. Foods cooked by dry heat methods do not spoil as fast as food cooked by moist heat methods as they have lower moisture content. It brings about dehydration of the foods or of the surface of food.

Following are the different methods of dry heat:

- Sun drying, smoking and freeze drying
- Cooking (baking ,roasting, grilling

CANNING: In this process temperatures used are above 100^0C. All microorganisms that could spoil food under normal conditions of storage are destroyed by heating the food in an autoclave at temperatures between 115^0C and 125^0C. The exact temperature and time required for canning depends on the type of food to be canned.

STERLIZATION: Sterilization refers to complete destruction of microorganisms. It requires heat treatment of 121°C for 15 minutes which destroys all spores. But it has severe effect on heat sensitive nutrients and proteins through maillard reaction. The temperature and time required to sterilize the food varies with the type of food. Such high temperatures can be created by steam under pressure in steam pressure boilers/ sterilizers. Temperature at sea level is 100°C at atmospheric pressure but with 15psi temperature of 121.5°C can be achieved.

5. FOOD STORAGE

5.1 Dry food store
5.2 Refrigerated store
5.3 Freezer store
5.4 Holding at High Temperature

5.5 Stock Roatation & Cross Contamination

Proper food storage will eliminate contamination of foods and prevent the growth of bacteria already in the food.

5.1 Dry Food Storage: Dry food storage pertains to those foods not likely to support bacterial growth in their normal state. These would include flour, grain, sugar, dals, pulses, salt, fats and oils, canned and bottled products. Store these types of foods in a cool dry place, off the floor away from the wall and not under a sewer line. Keep all containers tightly closed to protect them from insects, rodents and dust. Remember that dry foods can get contaminated even if they do not require refrigeration.

5.2 Freezer Storage: All frozen food must be stored at 0F (-18C) or lower. All frozen food must be kept tightly wrapped or packed to prevent freezer burns. Label and date all items. Thaw frozen foods properly before use either in the refrigerator or in cold running water. The microwave oven could also be used to thaw food quickly. Do not thaw at room temperature because the surface temperature will go above 45F (7C) before the inside is thawed, resulting in bacterial growth.

5.3 Refrigerator Storage: Keep all perishable foods below 45F (7C). Do not overcrowd refrigerators. Leave space between foods so that air can circulate. Keep refrigerator doors shut except when putting in or removing foodstuffs. Keep shelves and interiors of the refrigerator clean. Store raw and cooked food separately. Keep food covered properly in the refrigerator and in suitable containers**.**

5.4 Holding at High Temperature:

Holding is a critical control point, or a point at which maintaining proper temperatures can help ensure that a food is safe to eat. Cooks must know the proper temperature for holding food, monitor the holding process, and record temperatures of foods during holding.

The FDA Food Code requires that all hot foods be maintained at 135 °F or above. When temperatures of food fall below 135 °F, they are in the temperature danger zone—temperatures at which bacteria grow rapidly.

Application:

Hold hot foods at 135 °F or above. • Preheat steam tables and hot holding cabinets. • Schedule food production to minimize the time that food is maintained on a steam table or other hot holding unit. Monitor holding process for hot foods. • Check temperature of hot holding units by placing a calibrated thermometer in the coolest part of the holding unit. • Check food temperatures with a clean, sanitized, and calibrated thermometer. • Check food temperatures when product is placed in steam table or hot holding unit and at least every 2 hours thereafter. • Take at least two internal temperatures from each batch of food during holding. • Insert thermometer into the thickest part of the food, which usually is in the center. • Record the temperature and the time the temperature was checked.

Take corrective action:

If appropriate holding temperature of the hot food is not met. • Reheat food to 165 °F for 15 seconds if the temperature is found to be below 135 °F and the last temperature measurement was 135 °F or higher and taken within the last 2 hours. • Repair or reset holding equipment before returning the food to the unit if temperatures are not maintained. • Discard food if it cannot be determined how long the food temperature was below 135 °F. • Record corrective actions taken.

5.5 Stock Rotation

Stock rotation is the process of organizing inventory to mitigate stock loss caused by expiration or obsolescence. Basic stock rotation entails moving products with impending sell-by dates to the front of the shelf and moving products with later expiration dates to the back.

Methods of Stock Rotation:

1. **FIFO (First In First Out)**

First in, first out (FIFO) is the preferred method of stock control for most retailers, especially in the food and beverage space. When new stock comes in, it gets put in the back, pushing the older stock forward to be sold first. While this may seem like a no-brainer and saves retailers thousands of dollars in lost product, not every store takes the time to do it.

2. **FEFO (First Expired First Out)**

First expired, first out (FEFO) takes into account that what retailers receive from the warehouse may not necessarily be the freshest product. Instead of defaulting to putting the newest incoming stock in the back, the expiration dates are checked. The freshest product goes in back and the oldest product goes in front. This technique takes more time to execute, but is worth it for perishable products with short-term shelf lives. If any accidental mixing has occurred, either by an associate or a customer, FEFO also helps catch it.

3. **LIFO (Last In First Out)**

Last in, first out (LIFO) is not used as commonly in stores, but is still worth noting. LIFO is more often used with heavier, fast-moving, non-perishable or homogeneous goods in warehouses, when rotating items is not essential, practical or time-efficient.

The benefits of LIFO are mostly associated with accounting because retailers end up matching the most recent cost against their revenue. If your costs are rising, this process makes for more accurate forecasting than using older pricing, and better forecasting = better reporting = less taxes.

5.5 Cross Contamination:

Cross-contamination is one of the most common causes of food poisoning. It happens when harmful germs are spread onto clean food from other contaminated food, surfaces, hands or equipment by careless food handlers.

To avoid cross-contamination, observe the following points:

- Raw food/ meat/poultry and ready-to-eat foods should be kept separate at all times.
- Hands should be thoroughly washed before switching from preparing non-vegetarian products to any other activity.
- Work surfaces, chopping boards and equipment should be thoroughly cleaned before preparing food and after it has been used.
- Separate colour coded chopping boards and knives should be used for raw fruit/ vegetables/ meat/poultry and ready-to-eat food.
- Raw meat/poultry should be kept below ready-to-eat food in the refrigerator.

UNIT: 2

1. FOOD BORNE ILLNESS

1.1 Natural Toxins (Kesari Dal, Potatoes, Mushrooms, Shell Fish, Peanuts)
1.2 Chemical (Tin, Copper, Arsenic, Lead)
1.3 Bacterial toxins (staphylococcus, salmonella, Clostridium perfringens, Clostridium Botulinum)
1.4 Food poisoning & Infections • Definitions

A food-borne illness is a general term applied to all type of illness caused by an organism, substance or material of any kind which is present in food and gain entrance into the body when such food is consumed. The cause of contamination is generally faulty handling , poor sanitary practices, insects, rodents or microorganisms. Such food is likely to be consumed and may result in disease.

Food borne diseases are harmful illnesses mainly affecting the gastro intestinal tract and are transmitted through consumption of contaminated food or drink.

Diseases and their classification: A disease is a negative state of health .It is defined as a deviation from normal health which adversely influences the daily routine of a person.

Diseases are broadly classified into two categories:

- **Communicable Diseases**

Infectious Diseases: These are caused by microorganism and are transmitted by direct or indirect contact; these include typhoid, hepatitis and influenza.

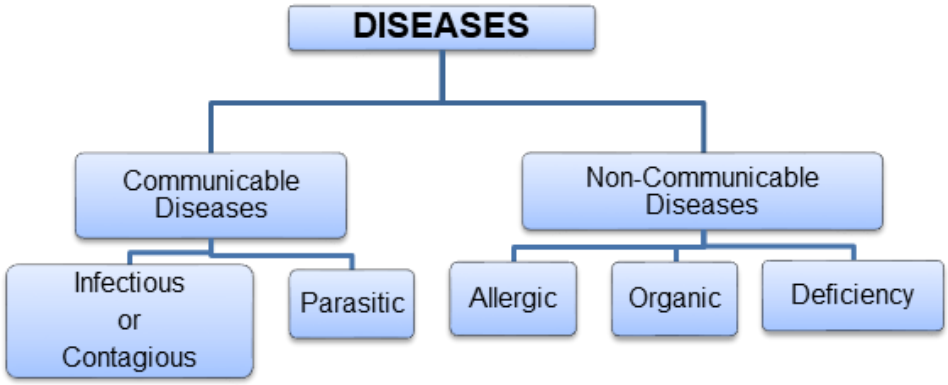
Parasitic Diseases: These are diseases which are caused by the presence of animal parasites like tapeworms, roundworms and pinworms.

- **Non-communicable diseases**

Deficiency Diseases: These occur because of a shortage of certain nutrient in our daily diet.

Organic Diseases: These are caused by malfunctioning of certain organs in our body e.g. pancreatic malfunction causes diabetes.

Allergic Diseases: These disorders occur because of the abnormal sensitivity of the body to certain foods which are normally consumed in diet.



Mode of Transmission Of Disease: Diseases are transmitted through food either directly or indirectly.

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. Diseases of the intestinal tract are transferred by unwashed or improperly washed hands.

Indirect transmission: The host of a communicable disease may transmit pathogens indirectly through various routes onto prepared food and from there to other people consuming the offending food. The other indirect routes of transmission of disease causing agents or pathogens are through:

- Contaminated utensils and equipment
- Sewage polluted water and food grown on polluted soil
- Soiled linen, door handles and taps
- Insects like flies and cockroaches
- Rodents like mice and rat
- Infected animals and their products

Contaminated food: The term contaminated is used for those foods that are not fit to be eaten for sanitary reasons. Although food may look, smell and taste good, it may contain harmful chemicals, non-food matter and bacteria.

Cross-contamination: It is the transfer of microorganisms from something dirty to something clean or from a food with many bacteria to a food with less bacteria by means of a nonfood vehicle, such as chopping boards, knives, utensils, equipment, work surface, dish cloth ,hands of food handler etc.

Natural toxin

Certain plants and animals may contain natural substances that are poisonous and may produce gastro- intestinal disturbances.

Naturally Occurring toxicants in plants

1. Kesari dal or Lathyrus Sativus: This dal used to adulterate turdal and besan. This dal contains a neurotoxin called **BOAA (beta-oxalyl amino alanine)**. The toxin causes a disease of the nervous system that result in paralysis of the lower limbs which is called Lathyrism.

2. Green Potatoes: Green, sprouting and damaged potatoes contain high amounts of **solanine** that is toxic to humans. It causes vomiting, abdominal pain and diarrhea within eight hours after consumption.

3. Cereals and Groundnuts: If these are improperly stored may have the mould growing on it. This mould produces a mycotoxin called **aflatoxin.**The toxin acts on liver and damages it.

4. Mushrooms: Mushrooms are edible fungi but some varieties are poisonous, they produce hepatotxic factors that damage the liver and result in death. The toxin **muscarin** is produced by **A. muscaria** that stimulates the nerves. Symptoms are nausea, headache, excessive salivation and tears, dizziness and confusion.

5. Mussels and clams (shellfish): They produce the heat stable toxin **PSP** (**paralytic shellfish poison**), which is extremely toxic for human. Symptoms include itching, numbness of lip and tongue, muscular weakness and respiratory paralysis that can be fatal.

Toxic Metals and chemicals

Metals, when consumed in excess of the requirements, could cause toxicity. These contaminates may be present in the environment and may accumulate during the different stage of food preparation.

1. Lead: Lead can contaminate food through various sources like:

- Lead pipes that convey drinking water

- Mineral pigment in food; lead chromate may be used as an adulterant in turmeric powder.
- Some pesticide contains lead arsenate.
- By exposure to dust containing lead.
- My contact with machines.

Symptoms of lead poisoning are: nausea, constipation, fatigue, abdominal pain, anaemia, poor reistance, brain damage and mental retardation.

2. Copper: This poisoning occurs when copper utensil are used to store cooked foods, especially those that are acidic, or when copper utensils are used to cook food. Symptoms of toxicity include vomiting, diarrhea, abdominal pain, astringent taste in mouth and constriction of the throat in acute cases.

3. Tin: Tin poisoning is seen in acidic canned foods or moist foods left in the canned after opening it. It also occurs in foods containing nitrates or oxalates. Symptoms of poisoning include vomiting, diarrhea, constipation, headache , metallic taste in the mouth.

4. Arsenic: It is a chemical, many insecticides; weedkiller and rat poisons contain arsenic. It is also present in water from polluted streams. Fruits, vegetables and shellfish are likely to be contaminated with arsenic. Exposure to arsenic over years causes cancer of lungs and many other symptoms.

Bacterial Intoxication

1. Staphylococcus food intoxication: Staph food poisoning is one of the most common types of food poisoning caused by the toxin produced by Staphylococcus aureus.

Organism: stain of **Staphylococcus aureus**
Type of toxin: enterotoxin
Incubation period: two to six hours
Duration of illness: Six to 24 hours

Symptoms: Salivation, nausea,vomiting,abdominal cramps,diarrhea,sub-normal body temperatures; mortality is extremely low, in severe cases blood and mucous may be found in the stool.

Foods commonly involved: protein –rich foods like meat, fish, milk and poultry; cooked indented to be eaten cold custard, trifles etc.; foods insufficiently refrigerated.

Mode of transmission: sources from where microorganisms enter food are mostly human or animal and include droplet infection from nasal passages, e.g. sneezing and direct contact with boils and infected wounds.

Prevention:

1. Use raw ingredients free from staphylococcus e.g. Pasteurized milk, and keep employees with any infection like boils etc. away from food.
2. Prevent cross- contamination from raw meat to cooked meat and from contaminated equipment, utensils or hands to high risk foods.
3. Kill the organism by heat treatment, e.g. pasteurization.
4. The growth of Staphylococci can be controlled by rapid cooking, chilling and prompt refrigeration.
5. Practice personal hygiene.

2. Botulism: This is an uncommon type of food poisoning. It is produced by anaerobic spore-forming bacteria which are found in the soil.

Organism: **Clostridium botulinum**
Type of toxin: neurotoxin
Incubation period: 18 to 38 hours
Duration of illness: death in 24 hours to eight days

Symptoms: nausea, vomiting, diarrhea, fatigue, dizziness, double vision, difficult in swallowing and in speaking, dryness of the mouth and constriction of the throat, paralysis of involuntary muscles which spreads to the respiratory system and the heart. Death results due to respiratory failure.

Therapy: anti-toxin should be given immediately.

Food commonly involved: Inadequately processed home –canned foods, including low and medium acid foods, acid foods like canned tomatoes, peaches and pears in which other microorganisms are present; smoked products; damaged, leaky anda rusty cans or cans with broken seals.

Mode of transmission: The spores are transferred from the soil into food which is then consumed.

Prevention:

1. Use approved heat processes for canned food.
2. Reject gassy or spoiled canned food and refuse to taste doubtful food.
3. Avoid leftover cooked foods that are not well reheated or raw and precooked foods that have been frozen, thawed and held at room temperature.
4. Smoked fish should be heated to at least 85^0c for 30 minutes and should be frozen immediately after packaging.
5. Heat food to 100^OC for a few minutes to destroy toxin which is thermolabile.

3. Perfringens Food Poisoning: Clostridium perfringens is spore –forming anaerobe found in the human and animal intestinal tract, soil, dust, contaminated raw meat, poultry and some dried foods.

Organism: **Clostridium perfringens**
Type of toxin: enterotoxin produced in intestine
Incubation period: 8 to 24 hours
Duration of illness: 1 to 2 days

Mode of transmission: from human faeces via hands to the food by direct contact, vector transmission by flies sitting on excreta, cross contamination from raw to cooked meat, dusty kitchens and dirty cardboard boxes placed on work tables. In raw meat and excreta.

Symptoms: abdominal pain, diarrhea and nausea, vomiting rarely occur, mild vertigo; mortality rate may be as high as two per cent

Food commonly involved: meats dishes, reshuffle dishes or reheated dished, stewed and roasted meat and poultry sauces, gravies, pies, salads.

Prevention:

1. Through cooking of food, especially meat preparation.
2. Cool food rapidly to prevent multiplication of bacteria and reheat thoroughly just before serving.
3. Handle raw and cooked food separately to prevent cross- contamination.
4. Wash all fruits and vegetables thoroughly.
5. Kitchen and personal hygiene.

4. Salmonellosis food infections: this is the commonest cause of bacterial food – borne disease and the most serious. Organism of the salmonella group causes an infection in the intestine.

Organism:**viable cells of salmonella choleraesuis**
Type of toxin: produced in intestine
Incubation period: 12 to 24 hours
Duration of illness: 1 to 7 days

Mode of transmission: use of cracked eggs or seafood from polluted waters, vector transmission by rodents and flies from faecal matter, cross contamination :if the food handler does not wash hands after handling raw meat and poultry, after visit to the toilet or does adequately clean and sanities the chopping board and other equipment, Contact transmission: direct contact by food handler ill with salmonellosis or a carrier of the disease.

Symptoms: diarrhea, abdominal pain, chills, fever, vomiting, dehydration, enteritis or local infection may also occur, watery, greenish, foul smelling stools.

Food commonly involved: animal product , ducks egg, milk ,fish, mutton biriyani, seafood from polluted waters canned foods that are opened,have got contaminated and are held without refrigeration once opened.

Prevention:

1. Purchase meat, poultry, eggs and fish that have been thoroughly inspected for wholesomeness.
2. Wash hands often, especially after using the toilet and after handling raw meat, poultry and soiled objects.
3. The food handlers nail should be trimmed and clean.
4. Keep equipment clean and hygienic.
5.Growth of the organism may be prevented by adequate refrigeration as Salmonella are very sensitive to temperature and do not multiply in low temperatures.

Food –borne illness

Microorganisms which cause food borne illnesses are bacteria, viruses, protozoans. 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 intestine 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.

FOOD POISONING OR FOOD INTOXICATION:

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. In bacterial food poisoning, the toxin is produced during multiplication of 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 diarrhea. The incubation period for such food poisoning is comparatively shorter than that for bacterial food infection.

FOOD POISIONING	FOOD INFECTION
1. Caused by toxin	1. Caused by living microorganism
2. toxins irritate the stomach lining	2. the gastric juices in stomach

and cause vomiting	destroy the bacteria. Infection happens in small intestine.
3. Incubation period: two hours	3. Incubation period: 12 – 24 hours
4. Symptoms: nausea and vomiting diarrhea, usually no fever	4. Symptoms: diarrhea, abdominal pain, vomiting, fever
5. Duration: one day, sometimes longer	5. Duration: one to seven days, sometime longer,

Incubation time or period means: The time between the entry of infectious agent into the body and the appearance of symptoms.

FOOD INFECTIONS:

Food infections are 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. The irritates the lining of the intestines, resulting in nausea, diarrhea and abdominal pains. The incubation period for an infection occurs is 12 hours or more.

Incidental Poisoning

Food Borne Diseases Caused by Some Pathogenic Organisms

Pathogenic Organisms	Food Commonly involved	III effects and diseases
BACTERIAL		
Bacillus cereus	Cereal Products	Nausea, vomiting, abdominal pain.
Clostridium botulinum toxins	Defectively processed meat and fish.	Botulism (muscular) paralysis, death due to respiratory failure.
Clostridium perfringens (welchii)	Defectively processed meat and fish.	Nausea, abdominal pain and diarrhoea.
Salmonella	Defectively processed meat, fish and egg products, raw vegetables grown on sewage.	Salmonellosis (vomiting diarrhoea and fever)
Shigella sonnei	Foods kept exposed or sale in unhygienic surroundings.	Bacillary dysentery

Staphylococcus aureus	Foods kept exposed or sale in unhygienic surroundings.	Increased salivation, vomiting, abdominal pain and diarrhoea.
Streptococcus pyogenes	Foods kept exposed or sale in unhygienic surroundings.	Scarlet fever, septic sores throat.
FUNGAL		
Aspergillus flavus (aflatoxin)	Corn and groundnut	Liver damage and cancer
Claviceps purpurea (Ergot)	Rye and pearl millet infested with ergot. Peripheral gangrene	Ergotism (burning sensation in extremities)
Fusarium sporotrichiodies	Cereals and millets infected with fusarium.	Alimentary toxic aleukia.
Penicillium islandicum	Rice	Liver damage
PARASITIC		
Trichinella spiralis	Pork and pork products	Nausea,vomiting,diarrhoea, Colic and muscular pains(trichionosis)
Ascaris lumbricoides	Raw vegetables grown on sewage farm.	Ascariasis
Entamoeba histolytica	Raw vegetables grown on sewage farm.	Amoebic dysentery
Ancylostoma duodenale (hookworm)	Raw vegetables grown on sewage farm.	Epigastric pain, loss of blood, anaemia.

Toxic Effects of Some Metals and Chemicals

Name	Foods commonlyinvolved	Toxic effects
Arsenic	Fruits sprayed by lead arsenate.	Dizziness, chills, cramps paralysis leading to death.
Barium	Foods contaminated by rat poison (barium carbonate)	Violent peristalsis, muscular twitching and convulsions.
Cadmium	Fruit juices and soft drinks that come in contact with cadmium and plated vessels.	Excessive sallvation, liver, kidney damage, prostate cancer, multiple fractures (painful 'Itai-Itai' disease reported from Japan due to cadmium poisoning)
Cobalt	Water, beer	Cardiac failure
Copper	Acid foods in contact with tranished copper ware.	Vomiting, diarrnoea, abdominal pain.
Lead	Some processed foods Lead water pipes.	Paralysis, brain damage.
Mercury	Mercury fungicide treated seed grains or mercury contaminated fish.	Paralysis, brain damage and blindness.

Tin	Canned foods	Colic, vomiting, photophobia.
Zinc	Foods stored in galvanised iron ware.	Dizziness, vomiting
pesticides	All types of foods	Acute or chronic poisoning causing damage to liver, kidney, brain and nerves leading to death.
Diethyl stilbestrol	Present in meat of stilbestrol fed animals and birds.	Teratogenesis, carcinogenesis.
antibiotics	Meat from animals fed antibiotics.	Drug resistance, hardening of arteries, heart disease.

2. FOOD ADULTERATION

2.1 Definition and types
2.2 Test to detect (coffee, semolina, flour, ghee, butter, margarine, oil, milk, turmeric, coriander powder, peppercorn, meat etc.
2.3 Food standards in India (PFA, FPO, MPO, BIS-ISI, AGMARK, ISO)

Introduction

Adulteration is as the process by which the quality or the nature of a given substance is reduced through (i) the addition of a foreign or an inferior substance and (ii) the removal of a vital element.

Adulteration in food is normally present in its most crude form, prohibited substances are either added or partly or wholly substituted. In India normally the contamination/adulteration in food is done either for financial gain or due to carelessness and lack in proper hygienic condition of processing, storing, transportation and marketing. This ultimately results that the consumer is either cheated or often become victim of diseases. Such types of adulteration are quite common in developing countries or backward countries. However, adequate precautions taken by the consumer at the time of purchase of such produce can make him alert to avoid procurement of such food. It is equally important for the consumer to know the common adulterants and their effect on health.

In our daily life there are so many unhygienic and contaminated things for our health. Most of our things our contaminated. Even the food, which we eat, is adulterated. Now a question arises that what is adulteration? The answer is that the ***deliberate contamination of food material with low quality, cheap and non-edible or toxic substances is called food adulteration.*** The substance, which lowers or degrades the quality of food

material, is called an adulterant. Adulteration brings a lot of easy money for the traders, but it may spoil many lives. **Food adulteration can lead to slow poisoning and various kinds of diseases, which can even result in death. Adulteration makes the food items used in our daily life unsafe and unhygienic for use. An easy example of food adulteration is vanaspati ghee in desi ghee.** The traders use it for their economic benefit without thinking about its effect on the common population of our country, which consumes it. For preventing it our government has made some certain commissions and laws. Still it prevails in our country on large scale. Adulteration should be checked properly in common food items so as to save people from its bad effects. Adulteration is the government and we for the common people therefore something should do a type of curse against it.

Types of food adulteration

- Intentional adulterants

Adding adulterants intentionally with the purpose of increasing profit. Examples: Sand, marble chips, stones, mud, other filth, talc, chalk powder, water, mineral oil

- Incidental adulterants

Due to negligence, absence of sufficient facilities, adulterants are discovered in food. Examples: Pesticide residues tin from can, droppings of rodents, larvae in foods.

- Metallic contamination

Purposely or accidentally adding metallic materials such as lead from water and mercury from effluents. Arsenic from pesticides, lead from water, mercury from effluent, from chemical industries, tins from cans.

Food adulteration detection methods

Adulterants, both harmful and simple, can be detected easily through small tests. Thefoose tests can be done at home too. What one needs is a set of equipment and chemicals and the culprits can be found out easily through these simple anti-adulteration tests.

Here are a few such tests as suggested by the Union Ministry of Health and Family Welfare, Government of India:

S.N	Food article	Adulteration	Test

o			
1	Vegetable oil	Castor oil	Take 1 ml. of oil in a clean dry test tube. Add 10 ml. Of acidified petroleum ether. Shake vigorously for 2 minutes. Add 1 drop of Ammonium Molybdate reagent. The formation of turbidity indicates presence of Castor oil in the sample.
		Argemone oil	Add 5 ml, conc. HNO_3 to 5 ml.sample. Shake carefully. Allow to separate yellow, orange yellow, crimson colour in the lower acid layer indicates adulteration.
2	Ghee	Mashed Potato Sweet Potato, etc.	Boil 5 ml. Of the sample in a test tube. Cool and a drop of iodine solution. Blue colour indicates presence of Starch. colour disappears on boiling & reappears on cooling.
		Vanaspati	Take 5 ml. Of the sample in a test tube. Add 5 ml. Of Hydrochloric acid and 0.4 ml of 2% furfural solution or sugar crystals. Insert the glass stopper and shake for 2 minutes. Development of a pink or red colour indicates presence of Vanaspati in Ghee.
		Rancid stuff (old ghee)	Take one teaspoon of melted sample and 5 ml. Of HCl in a stoppered glass tube. Shake vigorously for 30 seconds. Add 5 ml. Of 0.1% of ether solution of Phloroglucinol. Restopper & shake for 30 seconds and allow to stand for 10 minutes. A pink or red colour in the lower(acid layer) indicates rancidity.
		Synthetic Colouring Matter	Pour 2 gms. Of filtered fat dissolved in ether. Divide into 2 portions. Add 1 ml. Of HCl to one tube. Add 1 ml. Of 10% NaOH to the other tube. Shake well and allow to stand. Presence of pink colour in acidic solution or yellow colour in alkaline solution indicates added colouring matter.
3	Honey	Invert sugar/jaggery	1. Fiehe's Test: Add 5 ml. Of solvent ether to 5 ml. Of honey. Shake well and decant the ether layer in a petri dish.

			Evaporate completely by blowing the ether layer. Add 2 to 3 ml. Of resorcinol (1 gm. Of resorcinol resublimed in 5 ml. Of conc. HCl.) Appearance of cherry red colour indicates presence of sugar/jaggery.
			2. Aniline Chloride Test : Take 5 ml. Of honey in a porcelain dish. Add Aniline Chloride solution (3 ml of Aniline and 7 ml. Of 1:3 HCl) and stir well. Orange red colour indicates presence of sugar.
4.	Pulses/Besan	Kesari dal(Lathyrus sativus)	Add 50 ml. Of dil.HCl to a small quantity of dal and keep on simmering water for about 15 minutes. The pink colour, if developed indicates the presence of Kesari dal.
5	Pulses	Metanil Yellow(dye)	Add conc.HCl to a small quantity of dal in a little amount of water. Immediate development of pink colour indicates the presence of metanil yellow and similar colour dyes.
		Lead Chromate	Shake 5 gm. Of pulse with 5 ml. Of water and add a few drops of HCl. Pink colour indicates Lead Chromate.
6	Bajra	Ergot infested Bajra	Swollen and black Ergot infested grains will turn light in weight and will float also in water
7	Wheat flour	Excessive sand & dirt	Shake a little quantity of sample with about 10 ml. Of Carbon tetra chloride and allow to stand. Grit and sandy matter will collect at the bottom.
		Excessive bran	Sprinkle on water surface. Bran will float on the surface.
		Chalk powder	Shake sample with dil.HCl Effervescence indicates chalk.
8	Common spices like Turmeric, chilly, curry powder,etc.	Colour	Extract the sample with Petroleum ether and add 13N H_2SO_4 to the extract. Appearance of red colour (which persists even upon adding little distilled water) indicates the presence of added colours. However, if the colour disappears upon adding distilled water the sample is not adulterated.

9	Black Pepper	Papaya seeds/light berries, etc.	Pour the seeds in a beaker containing Carbon tetra-chloride. Black papaya seeds float on the top while the pure black pepper seeds settle down.
10	Spices(Ground)	Powdered bran and saw dust	Sprinkle on water surface. Powdered bran and sawdust float on the surface.
11	Coriander powder	Dung powder	Soak in water. Dung will float and can be easily detected by its foul smell.
		Common salt	To 5 ml. Of sample add a few drops of silver nitrate. White precipitate indicates adulteration.
12	Chillies	Brick powder grit, sand, dirt, filth, etc.	Pour the sample in a beaker containing a mixture of chloroform and carbon tetrachloride. Brick powder and grit will settle at the bottom.
13	Badi Elaichi seeds	Choti Elaichi seeds	Separate out the seeds by physical examination. The seeds of Badi Elaichi have nearly plain surface without wrinkles or streaks while seeds of cardamom have pitted or wrinkled ends.
14	Turmeric Powder	Starch of maize, wheat, tapioca, rice	A microscopic study reveals that only pure turmeric is yellow coloured, big in size and has an angular structure. While foreign/added starches are colourless and small in size as compared to pure turmeric starch.
15	Turmeric	Lead Chromate	Ash the sample. Dissolve it in 1:7 Sulphuric acid (H_2SO_4) and filter. Add 1 or 2 drops of 0.1% dipenylcarbazide. A pink colour indicates presence of Lead Chromate.
		Metanil Yellow	Add few drops of conc.Hydrochloric acid (HCl) to sample. Instant appearance of violet colour, which disappears on dilution with water, indicates pure turmeric. If colour persists Metanil yellow is present.
16	Cumin seeds (Black jeera)	Grass seeds coloured with charcoal dust	Rub the cumin seeds on palms. If palms turn black adulteration in indicated.
17	Asafetida(Heeng)	Soap stone, other earthy	Shake a little quantity of powdered sample with water. Soap stone or other earthy

		matter	matter will settle at the bottom.
		Chalk	Shake sample with Carbon tetrachloride (CCl_4). Asafoetida will settle down. Decant the top layer and add dil.HCl to the residue. Effervescence shows presence of chalk.
18	Food grains	Hidden insect infestation	Take a filter paper impregnated with Ninhydrin (1% in alcohol.) Put some grains on it and then fold the filter paper and crush the grains with hammer. Spots of bluish purple colour indicate presence of hidden insects infestation

- Name of the Food Article

Sweet meat, ice cream, sherbhat

Adulterant

Metanil yellow (a non permitted coal tar dye)

Detection of Adulterant

Extract colour with Luke warm water from food article. Add few drops of conc. Hydrochloric Acid. If magenta red colour develops the presence of metanil yellow is indicated.

- Name of the Food Article

Common salt

Adulterant

White powdered stone, chalk

Detection of Adulterant

Stir a spoonful of simple of salt in a glass of water. The presence of chalk will make the solution white and other insoluble impurities will settle down.

Food	**Adulterant**
Red cheese	Coloured with red lead (Pb_3O_4), and vermilion (mercury sulphide, HgS)

Cayenne pepper	Coloured with red lead
Pickles	Coloured green by copper salts
Vinegar	'Sharpened' with sulphuric acid; often contained tin and lead dissolved when boiled in pewter vessels
Confectionery	White comfits often included Cornish clay Red sweets were coloured with vermilion and red lead Green sweets often contained copper salts (*eg* verdigris: basic copper acetate) and Scheele's or emerald green (copper arsenite)
Olive oil	Often contained lead from the presses

Product	**Adulterants for bulk and weight**	**Adulterants for colour, taste and smell**
Custard powders	Wheat, potato and rice flour	Lead chromate, turmeric to enhance the yellow colour
Coffee	Chicory, roasted wheat, rye and potato flour, roasted beans, acorns *etc*	Burnt sugar (black jack) as a darkener
Tea	Used tea leaves, dried leaves of other plants, starch, sand china clay, French chalk	Plumbago, gum, indigo, Prussian blue for black tea, turmeric, chinese yellow, copper salts for green tea
Cocoa and chocolate	Arrowroot, wheat, Indian corn, sago, potato, tapioca flour, chicory	Venetian red, red ochre, iron compounds
Cayenne pepper	Ground rice, mustard seed husks, sawdust, salt	Red lead, vermilion, Venetian red, turmeric
Pickles		Copper salts for greening
Gin	Water	Cayenne, cassia, cinnamon, sugar, alum, salt of tartar (potassium tartrate)

Porter & stout	Water	Brown sugar, *Cocculus indicus*, copperas, salt, capsicum, ginger, wormwood, coriander and caraway seeds, liquorice, honey, *Nux vomica*, cream of tartar, hartshorn shavings, treacle

Food standards of India

1. **PFA (Prevention Food ACT) :** To check the suppliers of food from doing so, the government has passed a stringent act which is known as preservation of food Adulteration Act. They has been implemented with the objective of providing safety to human beings in the supply of food. It covers safety from risks involved due to contamination of poisonous elements. The specification laid down of various foods under the provisions of PFA Act covers minimum basic characteristics Of the Products Below which it is deemed to be adulterated and also covers the maximum limit of contaminant not considered being safe for human beings beyond a certain level.

2. **FPO (Fruit Product Order) :** FPO standards are mainly concern with quality fruits and vegetable .The FPO also specify the hygiene and sanitation require to maintain by the manufactures , labeling and packaging of the product has also been laid under the FPO act.

3. **Agmark:** it is under the government agricultural produce act of 1937. This standard are formulated on physical and chemical characteristic of food both natural as well as during processing of the product. This standard issues accurate weight and selling price of agricultural and dairy products for e.g rice ,atta, butter, honey, ghee etc.

MPO (Meat Products Order): Regulation for the production of meat products are covered by the Meat Food Products Order, 1973. It is equally applicable to domestic processors and importers of meat products. MPO lays down rules for:

i. sanitation and hygiene requirements for slaughter houses and manufacture of meat products.
ii. It also contains packing, marking and labeling provisions for containers of meat products.
iii. Defines the permissible quantity of heavy metals, preservatives and insecticide residues in meat products.

The order also lays down rules and conditions for procedure to be adopted for the selection of disease- free animal, slaughter house practices for further treatment of the meat so as to maintain the meat in a wholesome manner and devoid of pathogens.

4. **BIS-ISI:** To maintain the service and quality of a product is the main job of Bureau of Indian Standards (BIS). BIS allot the ISI mark to any product as third party guarantee after ensuring its quality, reliability and safety. Another job of BIS is to take action on the consumer complaints after making proper inquiry. There are 16 broad categories, including textiles, packaged water, food, automobile components, plastic products and electronics, for which BIS has laid down standards.

Benefits of ISI mark product

• The quality and standards of products with ISI mark are set up as this mark is issued after proper investigation.

• If you are not satisfied with the quality of product with ISI mark, then the company will give you new product in return to it.

• An action can be taken against the manufacturer of the product with ISI mark in case of its bad quality.

5. **ISO:** ISO (International Organization for Standardization) is an independent, non-governmental, international organization that develops standards to ensure the quality, safety, and efficiency of products, services, and systems. ISO certification certifies that a management system, manufacturing process, service, or documentation procedure has all the requirements for standardization and quality assurance. It is headquartered in Geneva, Switzerland and works in 164 countries. It is the world's largest developer of voluntary international standards and it facilitates world trade by providing common standards among nations. More than twenty thousand standards have been set, covering everything from manufactured products and technology to food safety, agriculture, and healthcare.

Use of the standards aids in the creation of products and services that are safe, reliable, and of good quality. The standards help businesses increase productivity while minimizing errors and waste. By enabling products from different markets to be directly compared, they facilitate companies in entering new markets and assist in the development of global trade on a fair basis. The standards also serve to safeguard consumers and the end-users of products and services, ensuring that certified products conform to the minimum standards set internationally.

2. 3. FOOD ADDITIVES

3.1 Colours & Flavours
3.2 Browning reactions-causes, desirable &undesirable effects)

Food additives are chemicals added to foods to keep them fresh or to enhance their colour, flavour or texture. They may include food colourings (such as tartrazine or cochineal), flavour enhancers (such as MSG) or a range of preservatives. Most food additives are listed on the product label, along with other ingredients, in a descending order by weight (flavours are an exception and do not need to be identified). Sometimes, the additive is spelt out in full. At other times, it is represented by a code number: for example, cochineal may be listed as Colouring (120); sodium sulphite may be shown as Preservative (221).

Many people enjoy making bread, cakes, wine, beer, and ice cream at home. However, most of today's food is bought from shops and supermarkets. Food made at home is always at its best when eaten straight away. Food produced on the large scale that is needed to supply supermarkets and other food shops has to be transported and stored before it is consumed. It has to stay in top condition over a much longer period of time than home-cooked food. Additives are used so that these foods still have a consistently high quality. In some products, they are so essential that additives are used even in certain organic foods. In some countries, lots of food is lost because it 'goes off' due to microbial growth before it can be eaten. Food poisoning also shows the dangers of contaminated food and without the use of preservatives; it would quite likely be more common. Preservatives, colours and flavors are the best known additives but in fact there are many categories of additives, each tailored to a specific purpose.

The different types of food additive and their uses include:

Anti-caking agents – stop ingredients from becoming lumpy.

Antioxidants – prevent foods from oxidising, or going rancid.

Artificial sweeteners – increase the sweetness.

Emulsifiers – stop fats from clotting together.

Food acids – maintain the right acid level.

Colours – enhance or add colour.

Humectants – keep foods moist.

Flavours – add flavour.

Flavour enhancers – increase the power of a flavour.

Foaming agents – maintain uniform aeration of gases in foods.

Mineral salts – enhance texture and flavour.

Preservatives – stop microbes from multiplying and spoiling the food.

Thickeners and vegetable gums – enhance texture and consistency.

Stabilisers and firming agents – maintain even food dispersion.

Flour treatment – improves baking quality.

Glazing agent – improves appearance and can protect food.

Gelling agents – alter the texture of foods through gel formation.

Propellants – help propel food from a container.

Raising agents – increase the volume of food through the use of gases.

Bulking agents – increase the volume of food without major changes to its available energy.

Flavorings

The acceptability of any food product greatly depends on the impression of taste when it is eaten. Our sense of taste is really a combination of two of our senses, taste and smell. Both of these senses respond to certain chemicals.

How do we taste?

Taste is a complex mixture of flavours and aroma, or smell. The receptors for the human sense of taste are located on the tongue and on the soft palate. There are just five stimuli to which these receptors respond. These are:
sweet (as in sugar) sour (as in acidic substances like lemon juice) bitter (strong coffee or quinine in tonic water) salt (table salt) umami (monosodium glutamate, savouries, soya sauce, crisps) The traditional view is that tastes are detected on different parts of the tongue.

Receptors for each taste are located in taste buds in specific areas of the tongue and each area can only detect one particular taste. However, more recent research suggests that this may not be the case. The taste buds are still found in the same areas on the tongue but each one can detect all five

tastes (sweet, sour, bitter, salt and umami). The brain is able to recognise which receptors are being stimulated and this goes towards the flavour sensation that we experience. The way in which we taste foods and perceive flavours is clearly very complex. Our sense of smell also makes up a big part of how well we 'taste' food. Flavour molecules in the food enter the air in the nose and are detected by millions of receptors that feed information to the brain. Chewing helps to transfer more odour from the mouth to the back of the nose. The area which is sensitive to smell is located at the back of the nose where several million receptor cells per square centimetre respond to thousands of chemicals in the food.

Sight plays an unexpectedly important role in our perception of flavours. The taste of a colourless, shapeless food is extremely difficult to recognise. We may need visual "clues" to enable us to identify taste and flavour accurately. The brain interprets signals from taste, smell and even vision before turning them into an impression of the food's taste. Different people will find different tastes nice or unpleasant. Flavourings are added to food products to give, enhance or intensify flavour.

Flavourings in Food

Flavourings are used in a wide range of food products. Most flavourings are an imitation of the flavour of a known foodstuff. Some flavours are isolated from natural raw ingredients but this is costly and also wastes valuable natural resources. Flavourings used as additives are often developed by a Creative Flavourist . Their job is t o identify the substances present in the food that are the most important in producing its flavour and then to create a flavour profile which mimics the particular food in the most effective way. The average flavouring contains between 5 and 50 ingredients. A few flavourings contain many more.

Sources of Flavours

Foods may contain more than a thousand chemical compounds that contribute to their flavour. Many of these naturally occurring compounds may be too unstable to be used in commercial flavourings where they may need to be stored for some time before being used. For this reason, 'copies' of the natural flavour are often developed. Flavourings are used in food products at very low concentrations. They are normally made from a mixture of substances which provide a flavouring of suitable strength that can be stored and then used in the food production process.

There are four categories of flavourings:

- **Flavouring substances**
- **Flavouring preparations**
- **Process flavourings**
- **Smoke flavourings**

Food Colours - Food colours are divided into 3 main types: natural, nature identical and synthetic

Natural Colours

These are obtained from natural sources such as grasses, leafy vegetables, fruit skins, roots and seeds of plants. Animals can also be a source of food colourings. Cochineal, or carminic acid, is a red colour that is obtained from the bodies of certain scale insects. These feed off cactus leaves and their bodies are commercially harvested in Africa, Spain and Central America. Their bodies are dried and crushed to extract the red colouring.

Nature Indentical Colours

Obtaining colours from natural sources can be costly and their quality can vary. To overcome this, chemists have found ways to make identical colours in the laboratory. This improves their purity and may also cost less. Nature identical colours are exactly the same molecules found in natural sources but they are made synthetically.

The main chemical classes are:

flavonoids, found in many flowers, fruits and vegetables

indigoid, found in beetroot

carotenoids, found in carrots, tomatoes, oranges and most plants. Carrots contain an orange molecule called beta-carotene which is part of this group.

Most natural and nature identical colours can dissolve in oil but do not dissolve in water. This means it is difficult to add them directly to foods. They are usually processed to form their sodium or potassium salt. This makes them soluble in water and suitable for use in foods. They may also be dissolved in oil and incorporated into water-soluble beadlets.

Synthetic Colours

These are colours that do not occur in nature and have been made in a factory. They have been carefully tested to make sure that they are safe. The main examples of synthetic colours are: azo dyes, such as amaranth (colour for blackurrant jams). 'other' dyes, such as, quinoline, (quinoline yellow), xanthene, (erythrosine), triarylmethanes, indigoid, (indigo carmine). Synthetic colours are usually water soluble and can be used in foods without any further processing.

E-Numbers and Colours

Colours that are allowed to be used in foods are strictly tested . Some common food colourings are shown in the table.

Some common food colourings			
E Number	**Name**	**Description**	**Foods**
E100	Curcumin	Orange-yellow colour that is extracted from the roots of the turmeric plant.	Curry, fats and oils, processed cheese.
E101	Riboflavin	Riboflavin is also known as vitamin B2. It can be obtained by fermenting yeast or synthesised artificially. In foods, it is used as an orange-yellow colour.	Sauces, processed cheese and foods with added vitamins such as bread.
E102	Tartrazine	Yellow coloured synthetic azo dye. This colouring sparks controversy as some groups suggest it causes behavioural problems in children (see food issues).	Is no longer widely used. Now rarely used in curries and some ready-meals.
E160a	Beta-carotene	Orange-yellow colour found in plants such as carrots, tomatoes and oranges.	Soft drinks, margarine, butter, yoghurt.
E150a	Plain caramel	Dark brown to black colour. The most common colouring. 90% of all colouring used is caramel. Obtained by the heating of sugars.	Cola drinks, confectionery, baked-foods, ice cream, chocolate, beers, vinegar and whisky.
E123	Amaranth	Dark purple coloured synthetic colour. Similar in colour to blackcurrants.	Powdered soup, jam, ice cream, instant gravy.

BROWING REACTION

Browning is the process of becoming brown, especially referring to food. Browning foods may be desirable, as in caramelization, or undesirable, as in an apple turning brown after being cut. Foods, including beverages, can turn brown through either enzymatic or non-enzymatic processes. Browning has an important economic cost causing deterioration of the value of products in the market of food.

Enzymatic browning

Enzymatic browning is a chemical process, involving polyphenol oxidase, catechol oxidase and other enzymes that create melanins and benzoquinone from natural phenols, resulting in a brown color. Enzymatic browning generally requires exposure to oxygen, thus the browning that occurs when an apple, for example, is cut.

Enzymatic browning can be beneficial for:

Developing flavor in tea

Developing color and flavor in dried fruit such as figs and raisins.

Enzymatic browning is often detrimental to:

Fresh fruit and vegetables, including apples, potatoes and bananas

Seafood such as shrimp

A variety of techniques exist for preventing enzymatic browning, each exploiting a different aspect of the biochemical process.

- Lemon juice and other acids lower the pH and remove the copper cofactor necessary for the responsible enzymes to function
- Blanching to denature enzymes and destroy responsible reactants
- Low temperatures can also prevent enzymatic browning by reducing rate of reaction.
- Inert gas, like nitrogen, prevent necessary oxygen from reacting
- Chemicals such as sodium bisulfite and citrates

Nonenzymatic browning

Contrary to enzymatic or *oxidative* browning, non-enzymatic browning is a chemical process that produces a brown color in foods without the activity of enzymes. The two main forms of nonenzymatic browning are caramelization and the Maillard reaction. Both vary in reaction rate as a function of water activity.

Caramelization is the pyrolysis of sugar. It is used extensively in cooking for the resulting nutty flavor and brown color. As the process occurs, volatile chemicals are released, producing the characteristic caramel flavor.

The Maillard reaction is a chemical reaction between an amino acid and a reducing sugar, usually requiring the addition of heat. The sugar interacts with the amino acid, producing a variety of odors and flavors. The Maillard reaction is the basis of the flavoring industry, since the type of amino acid involved determines the resulting flavor; it also produces toast.

4. FOOD PRESERVATION

 Methods of Preservation
4.1 Natural & Chemical Preservation
4.2 Low temperature (Refrigeration, Freezing)
4.3 High Temperature (Pasteurization, Sterilization, Canning)
4.4 Irradiation

Preservation usually involves preventing the growth of bacteria, fungi (such as yeasts), and other micro-organisms (although some methods work by introducing benign bacteria, or fungi to the food), as well as retarding the oxidation of fats which cause

rancidity. Food preservation can also include processes which inhibit visual deterioration, such as the enzymatic browning reaction in apples after they are cut, which can occur during food preparation.

Many processes designed to preserve food will involve a number of food preservation methods. Preserving fruit by turning it into jam, for example, involves boiling (to reduce the fruit's moisture content and to kill bacteria, yeasts, etc.), sugaring (to prevent their re-growth) and sealing within an airtight jar (to prevent recontamination). There are many traditional methods of preserving food that limit the energy inputs and reduce carbon footprint.

Maintaining or creating nutritional value, texture and flavour is an important aspect of food preservation, although, historically, some methods drastically altered the character of the food being preserved. In many cases these changes have now come to be seen as desirable qualities – cheese, yoghurt and pickled onions being common examples.

NATURAL FOOD PRESERVATION

Naturally occurring substances such as rosemary extract, hops, salt, sugar, vinegar, alcohol, diatomaceous earth and castor oil are also used as traditional preservatives. Certain processes such as freezing, pickling, smoking and salting can also be used to preserve food. Another group of preservatives targets enzymes in fruits and vegetables that start to metabolize after they are cut. For instance, the naturally occurring citric and ascorbic acids in lemon or other citrus juice can inhibit the action of the enzyme phenolase which turns surfaces of cut apples and potatoes brown if a small amount of the juice is applied to the freshly cut produce. Vitamin C and Vitamin E are also sometimes used as preservatives.

CHEMICAL PRESERVATION

Chemical food preservatives are substances which, under certain conditions, either delay the growth of microorganisms without necessarily destroying them or prevent deterioration of quality during manufacture and distribution. The former group includes some natural food constituents which, when added to foods, retard or prevent the growth of microorganisms. Sugar is used partly for this purpose in making jams, jellies, and marmalades and in candying fruit. The use of vinegar and salt in pickling and of alcohol in brandying also falls in this category. Some chemicals foreign to foods are added to prevent the growth of microorganisms. The latter group includes some natural food constituents such as ascorbic acid (vitamin C), which is added to frozen peaches to prevent browning, and a long list of chemical compounds foreign to foods and classified as antioxidants, bleaching agents, acidulants, neutralizers, stabilizers, firming agents, and humectants.

LOW TEMPRETURE

Storage at low temperatures prolongs the shelf life of many foods. In general, low temperatures reduce the growth rates of microorganisms and slow many of the physical and chemical reactions that occur in foods.

Refrigeration

The life of many foods may be increased by storage at temperatures below 4° C (40° F). Commonly refrigerated foods include fresh fruits and vegetables, eggs, dairy products, and meats. Some foods, such as tropical fruits (*e.g.,* bananas), are damaged if exposed to low temperatures. Also, refrigeration cannot improve the quality of decayed food; it can only retard deterioration. One problem of modern mechanical refrigeration—that of dehydration of foods due to moisture condensation—has been overcome through humidity control mechanisms within the storage chamber and by appropriate packaging techniques.

Freezing

Food is preserved for long periods by reducing its temperature to -18^{0}c or lower. At this temperature, water present in food is converted to ice and microbial growth stops. Freezing retains color, flavor and nutritive value. Frozen food has a shelf life of 3-12 months. Fruits, vegetables, meat, fish and poultry can be preserved in this way. Food to be frozen should be frozen quickly so that small ice crystals form in the cells of the food which is desirable.

Food is quickly frozen by using any one of the following equipments:

Blast Freezers: Extremely cold air at -32^{0}c is vigorously circulated over food while it passes through an insulated tunnel causing food to freeze swiftly. Freezing time varies from 75 to 90 minutes depending on type of packaging.

Plate Freezers: Food to be frozen is placed in contact with a metal surface that is cooled by a refrigerant. They are used for ice creams, juices etc., both packaged and unpackaged foods.

Immersion Freezer: Packed Or unpacked food is frozen by immersing it or spraying it with a freezing agent. It is used for freezing poultry.

Spray Freezer : This is the quickest freezing method in which liquid nitrogen or carbon dioxide is used. It is also called cryogenic freezing.

Freeze flow : In this food freezes but does not harden.

FOOD IRRADIATION

- Radiation of various frequencies ranging from low-frequency microwaves to high-frequency gamma rays are being used to preserve various foods.
- **Ultraviolet irradiation**

Ultraviolet rays are effective in killing bacteria and viruses, and can be used for surface sterilization of food, or for sterilizing the air in storage and processing rooms.

- **Microwave oven**

Microwaves are short radio waves which heat food by penetrating it.

- **Ionizing rays or cold sterilization**

Foods are exposed to ionizing radiation to extend its shelf life. These rays transfer some of their energy as they pass through food killing pathogenic and spoilage causing microorganisms.

HIGH TEMPRETURE

High Temperatures destroy microorganisms by denaturation of cell proteins an inactivation of enzymes needed by them for their metabolism. At temperature above 63^0c bacteria stop multiplying and as temperature increases they are gradually destroyed. The thermal death time (TDT) is the time needed at a given temperature to kill a number of microbes. Heat is used to destroy microbes may be in the form of wet heat or dry heat.

WET HEAT: This is more commonly used in the food industry. If carefully administered, it is a useful method of controlling microorganism.

1. **BLANCHING:** Foods that are to be frozen, dried or canned are immersed in hot boiling water for a few minutes prior to processing.
2. **PASTEURISATION:** The heat treatment kills pathogenic microorganisms and some spoilage organisms at temperatures below 100^0C for specified time and food is cooled promptly after heating. This method is used to control microorganism in milk, fruit juices and wine. Food may be pasteurized by any one of the three methods:

    - Low Temperature Holding (LTH) method at 62^0Cfor 30 min.
    - High Temperature Short Time (HTST) OR FLASH METHOD AT 72^0C for 15 seconds.
    - Ultra High Temperature Sterilization (UHTS) at temperatures above 135^0Cfor 2 seconds. This method makes foods commercially sterile. Such foods are packed under aseptic condition and can be stored at room temperature for three to six months.

3. **COOKING (Boiling, Steaming, Stewing, Poaching):** In these methods of cooking, wet or moist heat is used. The temperature attained is 100^0C.At these temperatures most microorganisms are destroyed but spores survive. Food cooked by these methods cannot be stored for long periods.

DRY HEAT: If food has to be kept for some time, it should be cooked thoroughly. Foods cooked by dry heat methods do not spoil as fast as food cooked by moist heat methods as they have lower moisture content. It brings about dehydration of the foods or of the surface of food.

Following are the different methods of dry heat:

- Sun drying, smoking and freeze drying
- Cooking (baking ,roasting, grilling

CANNING: In this process temperatures used are above 100^0C. All microorganisms that could spoil food under normal conditions of storage are destroyed by heating the food in

an autoclave at temperatures between 115^0C and 125^0C. The exact temperature and time required for canning depends on the type of food to be canned.

STERLIZATION: Sterilization refers to complete destruction of microorganisms. It requires heat treatment of 121°C for 15 minutes which destroys all spores. But it has severe effect on heat sensitive nutrients and proteins through maillard reaction. The temperature and time required to sterilize the food varies with the type of food. Such high temperatures can be created by steam under pressure in steam pressure boilers/ sterilizers. Temperature at sea level is 100°C at atmospheric pressure but with 15psi temperature of 121.5°C can be achieved.

5. FOOD STORAGE

5.1 Dry food store
5.2 Refrigerated store
5.3 Freezer store
5.4 Holding at High Temperature
5.5 Stock Roatation & Cross Contamination

Proper food storage will eliminate contamination of foods and prevent the growth of bacteria already in the food.

5.1 Dry Food Storage: Dry food storage pertains to those foods not likely to support bacterial growth in their normal state. These would include flour, grain, sugar, dals, pulses, salt, fats and oils, canned and bottled products. Store these types of foods in a cool dry place, off the floor away from the wall and not under a sewer line. Keep all containers tightly closed to protect them from insects, rodents and dust. Remember that dry foods can get contaminated even if they do not require refrigeration.

5.2 Freezer Storage: All frozen food must be stored at 0F (-18C) or lower. All frozen food must be kept tightly wrapped or packed to prevent freezer burns. Label and date all items. Thaw frozen foods properly before use either in the refrigerator or in cold running water. The microwave oven could also be used to thaw food quickly. Do not thaw at room temperature because the surface temperature will go above 45F (7C) before the inside is thawed, resulting in bacterial growth.

5.3 Refrigerator Storage: Keep all perishable foods below 45F (7C). Do not overcrowd refrigerators. Leave space between foods so that air can circulate. Keep refrigerator doors shut except when putting in or removing foodstuffs. Keep shelves and interiors of the refrigerator clean. Store raw and cooked food separately. Keep food covered properly in the refrigerator and in suitable containers**.**

5.4 Holding at High Temperature:

Holding is a critical control point, or a point at which maintaining proper temperatures can help ensure that a food is safe to eat. Cooks must know the proper temperature for

holding food, monitor the holding process, and record temperatures of foods during holding.

The FDA Food Code requires that all hot foods be maintained at 135 °F or above. When temperatures of food fall below 135 °F, they are in the temperature danger zone—temperatures at which bacteria grow rapidly.

Application:

Hold hot foods at 135 °F or above. • Preheat steam tables and hot holding cabinets. • Schedule food production to minimize the time that food is maintained on a steam table or other hot holding unit. Monitor holding process for hot foods. • Check temperature of hot holding units by placing a calibrated thermometer in the coolest part of the holding unit. • Check food temperatures with a clean, sanitized, and calibrated thermometer. • Check food temperatures when product is placed in steam table or hot holding unit and at least every 2 hours thereafter. • Take at least two internal temperatures from each batch of food during holding. • Insert thermometer into the thickest part of the food, which usually is in the center. • Record the temperature and the time the temperature was checked.

Take corrective action:

If appropriate holding temperature of the hot food is not met. • Reheat food to 165 °F for 15 seconds if the temperature is found to be below 135 °F and the last temperature measurement was 135 °F or higher and taken within the last 2 hours. • Repair or reset holding equipment before returning the food to the unit if temperatures are not maintained. • Discard food if it cannot be determined how long the food temperature was below 135 °F. • Record corrective actions taken.

5.5 Stock Rotation

Stock rotation is the process of organizing inventory to mitigate stock loss caused by expiration or obsolescence. Basic stock rotation entails moving products with impending sell-by dates to the front of the shelf and moving products with later expiration dates to the back.

Methods of Stock Rotation:

1. **FIFO (First In First Out)**

First in, first out (FIFO) is the preferred method of stock control for most retailers, especially in the food and beverage space. When new stock comes in, it gets put in the back, pushing the older stock forward to be sold first. While this may seem like a no-brainer and saves retailers thousands of dollars in lost product, not every store takes the time to do it.

2. **FEFO (First Expired First Out)**

First expired, first out (FEFO) takes into account that what retailers receive from the warehouse may not necessarily be the freshest product. Instead of defaulting to putting

the newest incoming stock in the back, the expiration dates are checked. The freshest product goes in back and the oldest product goes in front. This technique takes more time to execute, but is worth it for perishable products with short-term shelf lives. If any accidental mixing has occurred, either by an associate or a customer, FEFO also helps catch it.

3. **LIFO (Last In First Out)**

Last in, first out (LIFO) is not used as commonly in stores, but is still worth noting. LIFO is more often used with heavier, fast-moving, non-perishable or homogeneous goods in warehouses, when rotating items is not essential, practical or time-efficient.

The benefits of LIFO are mostly associated with accounting because retailers end up matching the most recent cost against their revenue. If your costs are rising, this process makes for more accurate forecasting than using older pricing, and better forecasting = better reporting = less taxes.

5.5 Cross Contamination:

Cross-contamination is one of the most common causes of food poisoning. It happens when harmful germs are spread onto clean food from other contaminated food, surfaces, hands or equipment by careless food handlers.

To avoid cross-contamination, observe the following points:

- Raw food/ meat/poultry and ready-to-eat foods should be kept separate at all times.
- Hands should be thoroughly washed before switching from preparing non-vegetarian products to any other activity.
- Work surfaces, chopping boards and equipment should be thoroughly cleaned before preparing food and after it has been used.
- Separate colour coded chopping boards and knives should be used for raw fruit/ vegetables/ meat/poultry and ready-to-eat food.
- Raw meat/poultry should be kept below ready-to-eat food in the refrigerator.

Unit: 03

Ch: 01 Introduction to Nutrition

1.1- Definitions (Food, balanced diet, nutrition, over nutrition, under nutrition, malnutrition, health)
1.2 - Balanced diet-Food pyramid

1.3 - Meal planning steps

Some important definitions

Food: Food can be defined as any substance which nourishes the body and is fit to eat. It may be solid or liquid. Food provides the body with materials for providing energy, growth and maintenance, and regulating various processes in the body. These materials of which food is made up of are termed nutrients. Different food contain different amounts of nutrients, hence no two foods have identical nutritive value.

Balanced diet: Balanced diet is a diet consists of food from different food groups in such quantities and proportion that the requirement of calories protein and other nutrients are adequately met and some extra nutrients are there to withstand short duration of leanness.

Nutrients: Nutrients are the chemical substance present in food, which the body needs to carry out its functions. There are six major groups of nutrients, includes, proteins and the amino acids of which they are composed, fats and fatty acids, carbohydrates, vitamins ,minerals and water. Each group has several nutrients in it, and each nutrient has specific functions in the body.

Nutrition: Nutrition is the "the science of foods, the nutrients and other substances therein; their action, interaction, and balance in relationship to health and disease; the processes by which the organism ingests, digests, absorbs, transports, and utilizes nutrients and disposes of their end products. In addition, nutrition must be concerned with social, economical, cultural, and psychological implications of food and eating."

Malnutrition: (mal means faulty) Malnutrition is an impairment of health resulting from a deficiency, excess or imbalance of nutrients. It includes both under nutrition or deficiency and over nutrition or excessive consumption

Under nutrition: it refers to a deficiency of calories and/or one or more essential nutrients in the diet. An undernourished person is underweight

Over nutrition: It is an excess of calories and /or one or more nutrients in the diet. An excessive intake of calories results in overweight which can lead to obesity.

Health: health is defined by the world health organization of the United Nations as a "state of complete physical, mental and social well-being and not merely the absence of disease or infirmity". A person must look healthy, feel healthy, and have a balanced mind and be a socially responsible individual.

Calorie: It is the amount of heat required to raise the temperature of 1gm of water through $10^{o}C$

Dietary Fiber: Dietary fibers include a no of polysaccharides and lignin that are not digested by the enzymes of the gastrointestinal tract.

BALANCED DIET

A balanced diet is one which includes a variety of foods in adequate amounts and correct proportions to meet the day's requirements of all essential nutrients such as proteins, carbohydrates, fat, vitamins, minerals, water and fiber. Such a diet helps to promote and preserve good health and also provides a safety margin or reserve of nutrients to withstand short durations of emergency.

The safety margin takes care of the days on which we fast, or on a certain day all nutrients may not be consumed. If the balanced diet meets the RDA for an individual, then the safety margin is already included as the RDA is formulated keeping extra allowances in mind.

A balanced diet takes care of the following aspects:

1. It includes a variety of food item
2. It meets the RDA for all nutrients
3. Nutrients are included in correct proportions
4. Provides a safety margin for nutrients
5. It promotes and preserves good health
6. Maintains acceptable body weight for height

Recommended Dietary Allowances (**RDA**)

While planning balanced diets, we need certain guidelines regarding the kinds and amounts of nutrients that require for maintenance of good health. The RDA is the guideline statingthe amount of nutrients to be actually consumed in order to meet the requirements of the body. The RDA is based on requirements. The requirement for a particular nutrient is the minimum level that needs to be consumed to perform specific functions in the body and to prevent deficiency symptoms. It should also maintain satisfactory stores of the nutrients in the body.

Recommended Dietary Allowances = Requirement + Margin of safety

The margin of safety is added to take care of factors such as:

1. Losses during cooking and processing
2. Short periods of deficient intake
3. Nature of the diet
4. Individual variations in requirements.

For example the requirement of iron in western countries is 10 mg for adult men and 15 mg for adult women respectively, while Indian RDAs suggest an intake of

28 mg for adult men and 30 mg for adult women. This is because the form of iron consumed varies and the factors interfering with absorption of iron such as phytates in cereals and larger proportions of nonhaeme iron present in Indian diets. The requirement for vitamin C or ascorbic acid is actually 20 mg, but since the vitamin is easily destroyed during pre-preparation, cooking, and storage. The recommended intake is twice the requirement and is 40 mg/day.

Basic Food Groups

One of the simplest ways to plan a balanced diet is to divide foods into groups. Foods are grouped on the basis of the predominant nutrients present in them. They may be classified into three, four, five, seven or eleven food groups. This classification varies from one country to another depending on many factors. For example, in India we do not have milk products or flesh foods as a separate food group because of religion, economic reasons, etc. The five food group classification is used in India as a guide to meal planning. Many factors have been considered while compiling these groups such as availability of food, cost, meal pattern, and deficiency diseases prevalent. Not all foods in each group are equal in their nutrient content. That is why a variety of foods from each group should be included in the diet.

A food group consists of a number of foods which have common characteristics. These common features may be the source of food, the physiological function performed, or the nutrients present.

On the basis of the source of food, at least fourteen groups can be identified, e.g. cereals, pulses, milk and milk products, egg, flesh foods, nujts and oilseeds, sugar and sweetness, fats and oils, root vegetables, other vegetables, green leafy vegetables, fruits, condiments and spices, and miscellaneous foods. This does not simplify the planning of balanced meals. A classification based on nutrients present will ensure that all nutrients made available to the body and offer greater variety within the group.

There are five basic food groups:

I. **Cereals and millets group**

☐ All these primarily supply energy.

☐ This group includes foods like wheat, jowar, bajra, ragi and other cereals.

☐ Tapioca, potato, sweet potato arbi and yam come under roots and tubers.

☐ This group provides calories, protein, iron and vitamins.

☐ These foods are cheap and are taken in large amounts by the low income groups.

☐ This group also provides thiamine and niacin.

II. **Protein or body building food group**

☐ The food stuffs in this group are primarily sources of protein though cereals also furnish protein.

☐ It provides protein both from the vegetable and animal kingdom.

☐ Dals, grains, peas, beans, groundnuts, cashew nuts, almonds, coconut, milk, curd, butter-milk, paneer (Cottage cheese) khoya, eggs, fish, mutton, chicken, pork and other flesh foods come under this group.

☐ Milk and dairy products also provide calcium and riboflavin.

☐ Meat fish and enggs are good sources of protein, iron and niacin.

III. **Protective Food Group (Vegetables and fruits)**

☐ These are rich sources of minerals and vitamins.

☐ These include green leafy vegetables, yellow or orange fruits and vegetables and citrus fruits.

IV. **Secondary Protective Food Group (Other Vegetables).**

☐ These provide variety in taste and texture and furnish roughage in the diet.

☐ These include fruits, stems, leaves and flowers of plants, ladies fingers, brinjals, bitter guards and other guords, cauliflower etc.

☐ They are fair sources of certain vitamins and minerals.

V. **Fats and Oils, Sugar and JAagery Group**

☐ All these food stuffs are concentrated sources of energy.

☐ These include – vegetable oils, vanaspati, ghee, butter, cream, sugar and jiggery.

☐ This group constitutes about 1/6th of the energy value of the diet but does not add appreciably to the protein, mineral or vitamin levels.

☐ Butter is also a good source of vitamin A & D.

☐ Vegetable oils are good source of essential fatty acids.

Guidelines for using the Basic Food Group for Menu Planning

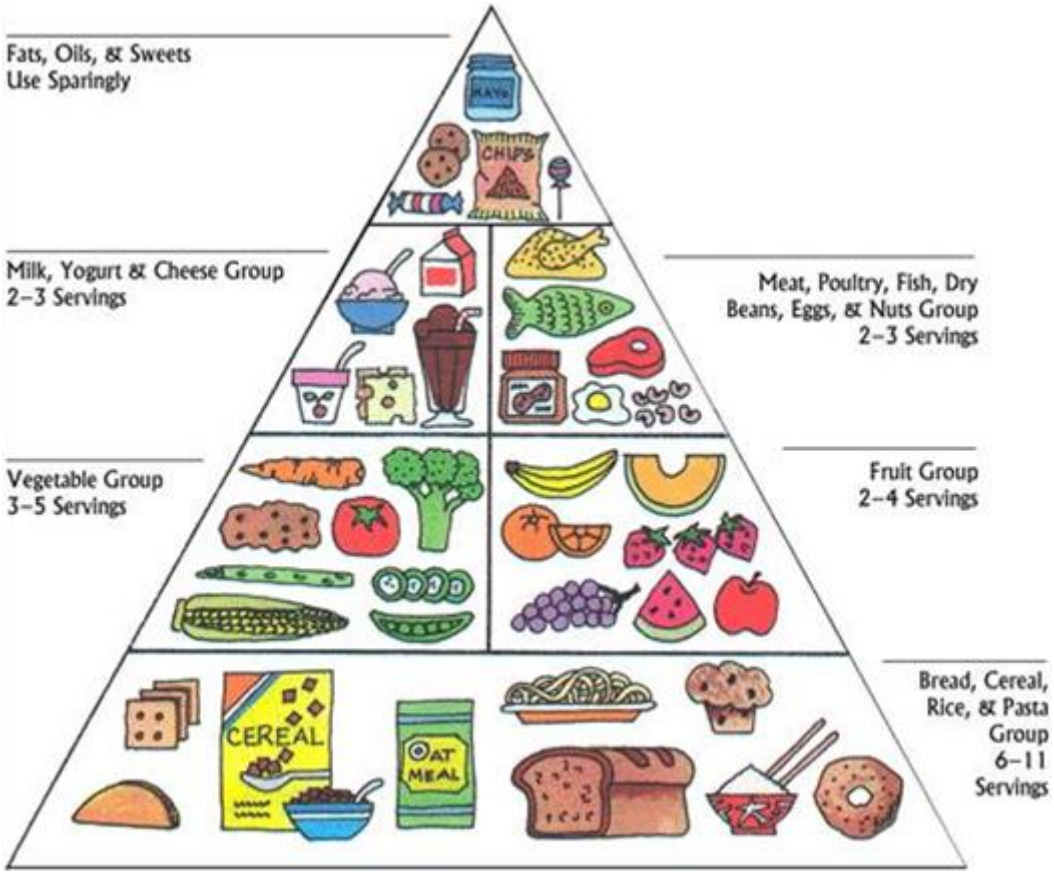
1. Include at least one or a minimum number of servings from each food group in each meal.

2. Make choices within each group as foods within each group are similar but not identical in nutritive value.
3. If the meal is vegetarian proteins with suitable combinations to improve the overall protein quality of the diet. For example, serving cereal, pulse combinations or including small quantities of milk or curds in the meal.
4. Include uncooked vegetables and fruits in the meals.
5. Include at least one serving of milk to ensure a supply of calcium and other nutrients as milk contains all nutrients except iron, vitamin C, and fiber.
6. Cereals should not supply more than 75% of total calories.

What is a Food Pyramid?

A food guide pyramid is a simple way of knowing what are the kinds of food one needs to consume and in what amounts to ensure good health. It is obvious that there is interplay of nutrients in the body. When we talk about nutrients it is important to know the quantity i.e. how much to take. This can be well understood by the concept of Food Guide Pyramid. This can form a foundation for a good diet selection, providing the essential nutrients.

The food guide pyramid is an educational tool that shows the dietary guidelines in the easily understand graphic format. It was originally prepared by the Human Nutrition Information Service and published in 1992 by the U.S. Department of Agriculture. It is meant for use by the general healthy population a guide for the amounts and types of foods to be included in the daily diet. The pyramid was designed to help teach the concepts of variety, moderation and the inclusion of food types in appropriate proportion in the total diet. The food guide pyramid can be modified for different age groups. Food guide pyramid helps to reduce the risk of chronic diseases and meets the RDA of different nutrients.



FOOD PYRAMID

Meal Planning Steps or Factors Influencing Meal Planning

Many factors influence the acceptability of a meal. Customers select what appeals most to them from a menu card based on individual likes and dislikes, budget, the popularity of items, etc.

However, while planning meals the following factors need to be considered:

Nutritional Adequacy
Economic Considerations
Food Service
Equipment and Work Space
Leftover Food
Food Habits
Availability
Meal Frequency and Pattern
Variety

Nutritional Adequacy

The most important consideration in menu planning is to ensure that the meal fulfills the nutrient needs of the individual consuming the meal. For example, if the meal is planned for industrial workers, it must meet the RDAs for that age

group. Foods from all basic food groups should be included in each meal so that the meal is balanced and nutritionally adequate. Nutrient needs may be modified for hospital diets (therapeutic diets).

Economic Considerations

The spending power of the clientele has to be kept in mind and meals have to be planned within the budget. Low-cost nutritious substitutes should be included in the menu to keep the costs low. The food cost should be maintained if the organization has to run profitably.

Food Service

Menus should be planned concerning the type of food service, whether it is a cafeteria, seated service, buffet, etc.

Equipment and Work Space

The menu should be planned, keeping the available equipment and workspace in mind. Deep freezers, refrigerators, grinders, dough kneaders, deep fat fryers, boilers, etc. should be adequate.

Leftover Food

An effective manager should consider as to how leftovers could be rotated to obtain maximum profit. Adequate storage space and hygienic standards should be ensured to minimize the risk of contamination and spoilage of food.

Food Habits

Food habits of the customer is another important criteria which need to be considered as food served has to be acceptable to the customer. Special attention should be paid when a particular type of community is catered to. Religious considerations should be known to the meal planner.

Availability

Some fruits and vegetables are seasonal. During the season the cost is reasonable and quality is better. Today, practically all fruits and vegetables are available throughout the year because of advanced preservation technology. However, seasonal fruits and vegetables should be given preference. Regional availability influences menu planning. For example, fish and seafood are fresh and cheaper in coastal areas.

Meal Frequency and Pattern

The meal timings and number of meals consumed in a day, whether meals are packed or served at the table, also influences the selection of food items on the menu. The age, activity level, physiological state, work schedule, and economic factors need to be known before planning meals for institutional catering.

Variety

This is one of the most important considerations while planning meals. A variety of foods from different food groups should be included.
The term variety means:
Variety in food ingredients
Variety in recipe
Method of cooking
Colour, texture, and flavour
Variety in presentation and garnish.
A meal should look attractive and be appetizing. A judicious blend of flavours, attractive colour combinations, and different textures make food enjoyable and interesting. The method of cooking used for different items on the menu should vary.

For example, two deep-fried items would make the meal heavy. Simple processes such as fermentation and sprouting not only contribute to improved flavour and digestibility but also enhance the nutritive value of the meal.

A well-planned meal that is nutritionally adequate would have a good satiety value and prevent the occurrence of hunger-pangs before it is time for the next meal. The nutritional adequacy of a meal in an ala carte service depends on the food choices made by the customer. The caterer must offer adequate, nutrient-dense foods to the clients, to choose from.

2. CARBOHYDRATES

2.1 - Classification & composition
2.2 - Functions & requirements, sources
2.3 - Excess & Deficiency
2.4 -Uses in food preparation
(Gelatinization, Gel formation, Dextrinization, Gluten formation, Caremelization)

Carbohydrates are a major source of energy for humans, providing approximately 45% to 80% of the total caloric intake in different income groups. Since they are a relatively inexpensive source of energy compared to fats and proteins, they form the bulk of the diet of humans throughout the world.

They are mainly present in food in the form of sugars, starches, and fibres. A study of the various types of carbohydrates is necessary because the kind and proportion of different forms of carbohydrate present in food have direct bearing on our health.

Three groups of carbohydrates are important in out diet from the nutritional point of view, namely, sugars, starches and fibers. The sugar and starch that we consume is ultimately broken down to glucose in the digestive tract and absorbed into the blood circulation. In the human body, glucose is removed from blood by the tissue cells and used as a source of energy. Some glucose is converted to glycogen, also called animal starch, and stored in the muscle and liver as a reserve store of energy.

Glucose Oxidised in Energy + CO_2 ↑ + H_2O

Tissues waste products of metabolism

COMPOSITION

Carbohydrates are organic compounds composed of carbon, hydrogen and oxygen, with the later elements in the ratio of 2:1. The general formula is $C_nH_{2n}O_n$. They are viewed as hydrated carbon atoms.

Types or Classification of Carbohydrates

Carbohydrates can be classified on the basis of their chemical composition. These are the most easily available and the largest set of compounds on the Earth. Based on the complexity of their structures, there are five major classes of carbohydrates. These are described in brief as follows.

Monosaccharides These are the basic compounds with a cyclic structure consisting of carbon, hydrogen and oxygen in the ratio 1:2:1. 'Mono' refers to single and saccharides means sugar. Glucose, fructose and galactose are types of monosaccharides.

Disaccharides These carbohydrates mean 'two sugars', which refer to the commonly available types such as sucrose, maltose and lactose. When two monosaccharides bond together by a condensation reaction, they release one molecule of water and a disaccharide is formed. This bond is called a glycosidic bond.

Oligosaccharides These are carbohydrates with more than two basic types of sugar molecules, usually between three and ten basic units. Their main function in the body is the storage of glucose. Raffinose and stachyose are the main types of oligosaccharides which consist of repetitive chains of fructose, galactose and glucose.

Polysaccharides These are also called monomers and are composed of thousands of molecules of the basic units of glucose. Carbohydrates stored in the form of starch contain these type of compounds. Amylose, which is a straight chain compound and amylopectin, which is a branched compound, are the most common types of polysaccharides.

Nucleotides It is another complex carbohydrate which contains many molecules of cyclic sugar. Deoxyribonucleic acid (DNA) and ribonucleic acid (RNA) are complex five sided sugars classified under this category. The difference between RNA and DNA is that the former has one extra hydroxyl group.

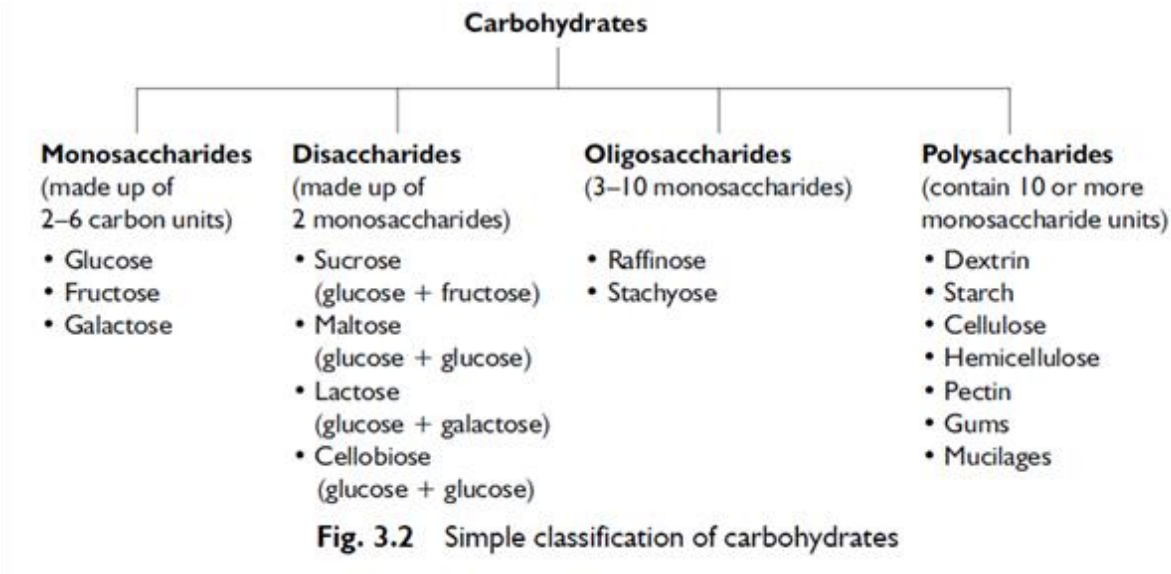


Fig. 3.2 Simple classification of carbohydrates

Classification of Carbohydrates

Carbohydrates which are of importance in the diet are classified on the basis of the number of sugar units present in them (Fig. 13.1, Table 13.1). they may also be classified as:

Available Carbohydrates: Carbohydrates which can be digested in the human body and yield energy when they are oxidized in the body.

Unavailable Carbohydrates: Carbohydrates which cannot be digested because the human body does not contain the enzymes necessary for their breakdown. Unavailable carbohydrates do not provide any energy to the body but are necessary as they perform some important functions in the body such as regular elimination of fecal waste.

Table 13.1 Classification of Carbohydrates

Category	Name of carbohydrate	Sources
Simple carbohydrates or sugars		
1. Monosaccharides (single sugar unit)	Glucose (dextrose)	Fruits, vegetables, honey
	Fructose (levulose)	
	Galactose	On hydrolysis of lactose
2. Disaccharides (two sugar units)	Sucrose (glucose + fructose)	Sugar cane, sugar beet
	Maltose (glucose + glucose)	Sprouted and malted grains, acid hydrolysis of starch
	Lactose (glucose + galactose)	Milk is the only source
Complex carbohydrates or polysaccharides		
1. Available	Starch	Cereals, pulses, roots, tubers, vegetables, and under-ripe fruits
	Glycogen (animal starch)	Liver and muscle of freshly slaughtered animals
	Dextrin	Partial breakdown of starch by dry heat or digestion
2. Unavailable or dietary fibres		
(a) Water insoluble	Cellulose Hemicellulose Lignin*	Structural fibre in whole-grain cereals, nuts, wheat bran, figs, vegetables, etc.
(b) Water soluble	Pectins Gums Mucilages	Non-structural fibres in apples, citrus fruits, guava, oats, barley, pulses, seaweeds, etc.

*Lignin is not a carbohydrate.

FUNCTIONS

Carbohydrates perform the following functions.

1. Energy:

The principle function of carbohydrates is to serve as a major source of energy for the body. Each gram of carbohydrate yields 4Kcal of energy regardless of its source. In Indian diets 60 – 80 % of energy is derived from carbohydrate.

2. Glucose:

Glucose is indispensable for the maintenance of the functional integrity of the nervous tissue and is the sole source of energy for the proper functioning of the brain. Prolonged lack of glucose may cause irreversible damage to the brain.

3. Protein Sparing Action:

Carbohydrates exert a protein sparing action. If sufficient amounts of carbohydrates are not available in the diet, the body will convert protein to glucose in order to supply energy. Hence to spare proteins for tissue building, carbohydrates must be supplied in optimum amounts in the diet. This is called the protein sparing action of carbohydrates.

4. Fat Metabolism:

Carbohydrates are essential to maintain normal fat metabolism. Insufficient carbohydrates in the diet results in larger amounts of fat being used for energy than the body is equipped to handle. This leads to accumulation of acidic intermediate products called ketone bodies.

5. Synthesis of Body Substances:

Carbohydrates aid in the synthesis of nonessential aminoacids, glycoproteins (which function as antibodies) and glycolipids (which form a part of cell membrane in body tissues especially brain and nervous system). Lactose remains in the intestine longer than other disaccharides and thus encourages growth of beneficial bacteria.

6. Precursors of Nucleic Acid:

Carbohydrates and products derived from them, serve as precursors of compounds like nucleic acids, connective tissue matrix and galactosides of nervous tissue.

7. Detoxification Function:

Glucuronic acid, a metabolite of glucose serves as a detoxifying agent. It combines with harmful substances containing alcohol or phenolic group converting them to harmless compounds which are later excreted.

8. Roughage of the Diet:

Insoluble fibres known as composite carbohydrates can absorb water and give bulk to the intestinal contents which aids in the elimination of waste products by stimulating peristalticmovements of the gastrointestinal tract.

Sources

Daily diet should provide up to 50-70% kCal of energy from carbohydrate, which means that the diet of an individual who needs 2,400 kCal should consume 60% of 2,400, i.e., 1,440 kCal or 360g of carbohydrates/day. Carbohydrates are not only an economical source of energy but are also readily available and easy to store as they have a long shelf life.

All foods of plant origin contain carbohydrates in varying amounts. With the exception of milk, animal foods do not contain carbohydrate. Although milk is not consumed as a source of carbohydrate, some milk products, such as khoa and milk powder, contain significant amount of carbohydrate lactose.

The important sources of carbohydrates in the diets of Indians are cereals and millets, roots, tubers, pulses, sugar and jiggery. All sugars provide 4 kCal/g of energy. the carbohydrate and

calorie content of a food can be reduced by using sugars which are sweeter than sucrose so that the quantity of sugar required will be less.

Some rich sources of carbohydrates

Cereals	Pulses	Fruits and vegetables	Nuts and oilseeds	Miscellaneous
Wheat Rice Jowar Bajra Ragi Oats Barley Corn	All whole grain and dehusked pulses and their by-products, e.g., rajma, Bengal gram, whole green gram, lentils, and besan.	Mango Chikoo Jackfruit Custard apple Banana Green peas Beans Potato Yam Colocasia	Cashew nuts Coconut Ground nuts Garden cress Seeds Gingelly seeds	Sugar Jaggery Honey Sago Tapioca Dates Raisins Skimmed milk powder

Table Calories supplied by alcohol

Beverage	Amount	Calories	Alcohol (%)
Lager beer	240ml	110	4 – 15
Ale	240ml	150	4 – 12.5
Gin 80 proof	30ml	65	40
Rum	30ml	70	42 . 8
Whiskey 86 proof	30ml	78	43
Wine red	90ml	145	12 – 15
Wine dry	90ml	90	12 – 15
Vermouth	30ml	50	18 – 22
Martini	90ml	140	12 - 13

Deficiency

The daily diet should not contain less than 100g of carbohydrate. Carbohydrate deficiency is uncommon in our country as diets are cereal based. A deficiency of carbohydrate in the diet results in utilization of fat for energy. In severe deficiency, incomplete oxidation of fats causes ketone bodies to accumulate in the blood.

Excess Carbohydrates

1. Excessive consumption of refined sugars could be one of the causes of dental caries or tooth decay.

2. Excessive sugar depresses the appetite, provides hollow calories, and could result in malnutrition.

3. High intake of sugar and refined carbohydrates increase the blood triglyceride levels leading to heart diseases.

4. When excessive carbohydrates are consumed they are converted into fat and deposited in the adipose tissue, which could lead to obesity, i.e., body weight of 20% or more than desirable weight.

5. Excessive fibre could irritate the intestinal lining causing cramps or bloating due to gas formation.

6. Excessive fibre interferes with the absorption and availability of mineral elements such as iron and calcium.

Role of Dietary Fibre in Prevention and Treatment of Disease

Dietary fibre refers to the total amount of naturally occurring material in plant foods, which is not digested. The terms roughage, bulk, and unavailable polysaccharides are synonymous with fibre. Fibres cannot be digested by human enzymes.

Dietary fibre or roughage does not provide humans with energy but performs many important functions in the body (Table 13.3). Fibre can absorb and hold water thereby increasing faecal bulk. This acts as a laxative and reduces intraluminal pressure in the colon preventing diverticulosis. Insoluble fibre prevents constipation by stimulating peristalsis in the large intestine. The contraction of muscular walls of the digestive tract is stimulated by fibre. Fibre increases water absorption, forming a larger, softer stool that rapidly passes through the colon. Soluble fibre binds bile acids and cholesterol and is beneficial to people suffering from coronary heart disease. Fibre reduces the triglyceride and cholesterol levels in blood.

Functions and sources of dietary fiber

Type	Functions	Food source
	Insoluble fibres	
Cellulose	• Insoluble fibre • Holds water • Increases stool bulk • Reduces intraluminal colonic pressure	Bran, wholegrain cereals, specially wheat, rye, apples, pears, tomatoes, cabbage, beans
Hemicellulose	• Prevents constipation • Binds minerals such as Ca and Fe	Bran, wholegrain cereals, specially millets—jowar, bajra, ragi
Lignin (non-carbohydrate source)	• Binds bile acids • Reduces transit time	Wholegrain cereals, pears, peaches, plums, mature vegetables
	Soluble fibres	
Pectins	• Soluble fibre • Binds cholesterol and bile acids	Guava, apple, citrus fruits, wood apple, berries, carrots, and green beans
Gums	• Holds water • Fermented in the colon to volatile fatty acids and gas by the normal bacteria flora of the colon	Oatmeal, pulses and beans, *dinkache ladoo,* processed foods
Mucilages, seaweeds, and algae		Thickener in food products, stabilizer, gelling agent in puddings

Fiber is beneficial to people on weight reduction regime. It provides satiety value to the meal because of more chewing required and at the same time does nto add to the calorific value of the meal.

It helps in lowering blood sugar levels in diabetic individuals by slowing down carbohydrate absorption and lowers the insulin requirement. Regular intake of fibre may prevent cancers of the colon and rectum.Although fibre is not a nutrient, because it cannot be digested by humans, it is nutrionally important. Foods such as whole grain cereals, fruits, and vegetables, specially when the peel and seeds are edible, are rich sources of fibre.The fibre content of the daily diet should be approximately 30-40 g/day

Recommended dietary intake for adults

Fiber – 40g/day is desirable

Carbohydrates

Minimum – 100g

Maximum – less than 70% of total calories from carbohydrates.

Effect of cooking on starch:

1. Dry Heat Effect

Dry heat brings about changes to starch granules through a process known as **DEXTRINIZATION**. When starch or product containing starch is subjected to dry heat, carbohydrate compounds called dextrin are formed, these substances are dissolved in water, they have a sweet taste. In this process colour and flavor changes occur, colour changes into golden brown to dark brown and a toasted or roasted flavor develops. Dextrin which are smaller units of starch breakdown and can be easily digested by the body. Extensive dextrinization decreases the thickening power of the flour.

2. Effect of Moist Heat

Gelatinization: Gelatinization is defined as a process by which starch granules, when heated in water, absorb water and swell up making the solution thick and translucent. This is an irreversible process. This process is partially observed when sufficient water is present along with starch in food itself as seen in baked potato or when corn flour is combined with water or any liquid such as milk to prepare corn flour custard, in boiled rice.

Gel Formation or Gelation: It is different from gelatinization. Gelation takes place on cooling of the starch paste after the starch granules have been gelatinized. Gel formation in cooked starch is a gradual process that continues over several hours as the paste cools. Waxy varieties of starch without amylase do not form gels. Corn starch forms firmer gel as compared to tapioca.

a. Retrogradation: After a cooked starch paste has been cooled or chilled, the starch may become less soluble and recrystallize to form solid or rigid gel. If it is unmolded, the gel will hold its shape. This recrystallization is known as retro gradation of starch.

b. Syneresis : When a cooled starch gel that has been standing for a while is cut, there is a leakage of liquid from the gel. This leakage or separation of fluid from gel is called as syneresis or weeping.

Lumping: When dry starch is mixed with warm or hot water, the exterior portion of the starch granules becomes sticky and the granules cling together in lumps.

Gluten Formation: Wheat flour contains two proteins called glutenin and gliadin. When water is added to wheat flour and then stirred, these two proteins grab each other and connect forming sheets of gluten. Gluten is tough and elastic, tough enough to hold bubbles of gases trapped inside bread. As the gluten forms, water will be released. Chapaties prepared from dough where gluten is well formed so that it puff up easily and remain soft. Different types of wheat contain different percentages of these proteins. Other grains do not contain enough of these proteins to make gluten (corn, rye, oats, barley, rice, and millet.)

Uses of Starches in Food Preparation:

1. **Thickening**: Starch in the form of the corn flour, refined wheat flour, rice flour and arrow root are used for thickening. The gravies, soups, puddings etc.

2. **Binding** : in cutlets

3. **Coating**: Starches are often used in the form of pabtis to coat food before frying. This gives the products crispness and seals in the flabour by forming a barrier to evaporation of food contents and provides smooth and golden apprearance to the product by any crevices or irregularities on the surface.

4. **Gelling**: Provides the gelling in porridge and puddings.

5. **Browning:** It provides the browning to the following products such as toast or chappati due to dextrinization.

PROTEIN

Definition – Protein come from a Greek word 'Proteo' means 'to take the first place.' are very complex nitrogenous organic compound. It is made up of carbon, hydrogen, oxygen, nitrogen. The present of nitrogen distinguished protein from carbohydrate& fats. Apart from nitrogen, elements like sulphur, phosphorous, copper, & iron are also found in some proteins. Lipid combined with protein formed lipo-protein.

The basic units from which protein are built are the amino acid. Each amino acid contains a carboxyl group (COOH) or acid group & an amino group or basic group.

Structure of amino acid given in class

Proteins consist of chains of amino acids that are linked to each other by a peptide linkage (-CO-NH-).

22 different amino acid are widely distributed in nature. The protein obtained from plants and animals are quite different both in amounts present & in quality. The protein contain of any food can be estimated by measuring the nitrogen contain of the food.

Essential Amino Acid – Those amino acids which cannot be synthesized in sufficient amounts by the body & must be provided by the diet are called essential amino acids. There are 10 essential amino acids. Among those 9 are essential for adults with it 1 for children.

Non essential amino acid – There are 12 non essential aminoacid**.**This Amino Acid can be synthesized in our body from other amino acid.(total – 22 amino acids)

Essential AminoAcid		Non essential amino acid
Adults	Additional for children	Alanine

· Isoleucine		Asparagine
· Leucine	Arginine	Aspartic acid
· Lysine		Cystine
· Methionine		Glutamine
· Phenylalanine		Glutamic acid
· Threonine		Trosine
· Tryptophan		
· Valine		
· Histidine		

Classification of protein – (follow class note)

1. According to nature – plant & animal
2. According to quality - 1st class, 2nd class & incomplete
3. According to structure – Simple, compound& derived

Functions of protein - Protein performs three main functions

· Structural function

· Regulatory function

· Energy

Structural function –

Growth –

· Protein helps us in growth & development.
· All body fluid except urine & bile are made up of protein
· Proteins are the major constituent of muscles, organs, endocrine gland, & collagen.
· Collagen is the main structural protein of bone, ligament, skin etc.
· All enzymes, some hormones are like insulin are made up of proteins

Maintenance or wear & tear It also helps to repair the dead cell.

Regulatory functions –

- **C**ertain amino acid & protein have highly specialized functions in the regulation of body process & protection against disease.

- Hemoglobin, an iron containing protein in the blood cells, performs an important role by transporting oxygen to the tissue cell.
- Plasma protein maintains water balance & regulates the osmotic pressure in blood.
- All enzymes & some hormones are made up of protein.

Energy – Like carbohydrate protein too provides 4kcal/gm.

Sources –

Food	gm/100gm
Rice	6.4
Wheat	11.8
Lentil	25.1
Rajmah	22.9
Cheese	24.1
Cow's milk	3.2
Egg (hen)	13.3
Mutton	18.5

Effect of deficiency & excess

- It is known as PCM (Protein calorie malnutrition) **OR** PEM (Protein energy Malnutrition)
- Protein deficiency is more marked during periods when protein needs are more specially among pre – school children in developing country.
- Leads with only protein deficiency known as Kwashiorkor symptom moon face, oedema,pot belly, irritated in nature, red colour hair etc.
- Marasmus is a combined disease of calorie + protein deficiency. Symptoms skeleton like features, very eager to take food,etc.
- Excess amount of protein causes kidney & cholesterol problem.

DENATURATION AND COAGULATION

The proteins in their original state are known as 'Native' proteins. The protein molecules undergo a change in their structure when they are subjected to different conditions such as exposure to heat, light and change in temperature, beating or agitation. These changes take place in two stages:

Denaturation-

The peptide chain of proteins unfolds itself to some extent but the linkage does not break, the properties of the denatured protein do not change to a large extent (the protein can come back to its original state if the conditions are mild and if the conditions are reversed particularly if the molecular weight of the of the native protein is large)

Coagulation-

The unfolded parts of the protein molecules recombine in different ways. New bonds are formed within the molecule and a new molecular shape is produced. Many protein molecules collect together to form a solid mass or gel. These changes are known as Coagulation of proteins.
Therefore, coagulation is the later stage of protein coagulation.

Factors affecting denaturation and coagulation:-

Heat
If milk is boiled for a short time then denaturation of protein takes place. But in preparations such as basenji and boiled egg, exposure to host for a longer time causes coagulation. This also happens in case of meat, fish and eggs during cooking.

Beating
When egg is beaten for a short period, denaturation of protein takes place. If left for some time it becomes liquid again due to reversibility of denaturation. But when beaten excessively the egg fist forms soft peaks and on further beating forms stiff peaks. At this stage the change is irreversible.

Acid or alkali
In the preparation of pander if a little lemon juice is added the milk gets denatured. If more lemon juice is added and the milk heated a solid mass of pander is formed due to Coagulation. In preparation of curd once the solid mass is formed the process is irreversible.

Note-
Amphoteric nature of proteins-
Proteins can act as acid or alkali due to the presence of both acid and basic groups.
This amphoteric nature can allow proteins to withstand sudden changes in ph. and prevent
Undesirable changes. They can bind +vet and –vet ions to maintain texture, volume and Appearance of food. For example in mayonnaise the addition of egg yolk serves as an emulsifying agent and stabilizes the emulsion. Milk also contains protein which stabilizes the fat and water emulsion. However at a specific pH (which differs for every protein) the electric charge on the protein is neutral (i.e. no positive or negative charge) this point is known as the ISOELECTRIC POINT. At the isoelectric point the protein molecules are very unstable. Then they precipitate or form curds. (This is because the molecules become close enough to form Hydrogen bonds that hold them into clumps) Curdling is used in making of curd, cheese etc.

GEL FORMATION

Not only starches, even proteins have the property of forming gels. When protein dispersion is heated and cooled, the viscosity (thickening) of the solution increases to a point at which some rigidity is obtained and a gel is formed. This is known as gel formation.

Some of the proteins are fibrous while others form fibers during gel formation. These fibrous proteins form a three dimensional network on cooling and water gets entrapped in between the network. Gel formation is used in the preparation of egg custard, Gelatin jelly, Bread pudding, etc.

The gel tends to shrink if the attractive forces between the protein molecules are increased, due to continuous standing or change in ph. The shrinkage results in expulsion of some of

the entrapped water. This is known as 'synergizes'. Gel formation is affected by a number of factors like:

1. **Temperature and time-** a gradual decrease in temperature below 35-40˚C is required over a period of time before chilling.
2. **Concentration-** the firmness of the gel depends on the percentage of gelatin as in ice-cream. The percentage of gelatin used is less than 1.5-2 per cent and a longer setting time is allowed. Excess gelatin in gelatin gels produces gumminess with longer storage.
3. **Acid-** the addition of acid produces softer gel. The acid gelatin dispersions take a longer time to set.
4. **Salts-** salts make the gel more firms. Milk contains some salts that are the reason why gel is more firm if milk is used for preparing gelatin mixtures.
5. **Sugar-** the rate of setting is decreased if higher concentration of sugar is used in preparations and more gelatin is also required.
6. **Enzymes-** enzymes present in fruits effects gel formation. Certain enzymes like bromine present in pineapple do not allow gel to form as they digest the protein. To avoid this fruit is heated and then added, so that the enzyme is destroyed. This is the reason why raw pineapple is not added to gelatin based desserts.

Foaming

Proteins act as foam-forming and foam-stabilizing agents in various foodstuffs, e.g., in baked products, sweets, desserts, and beer. Foams are dispersions of gases in liquids. Proteins stabilize such systems by forming flexible, cohesive films around the surface of the gas bubbles. During whipping, the protein is adsorbed at the interface via hydrophobic areas, followed by partial unfolding (surface denaturation). The decrease of the surface tension, caused by protein adsorption, facilitates the formation of new interfaces and further gas bubbles. The partially unfolded proteins associate under film formation.

FATS AND OILS

FATS&OILS
4.1- Classification & Composition
4.2 - Functions & requirements, Sources
4.3 - Excess & Deficiency
4.4 - Types, Sources, Uses
4.5 - Factors causing deterioration
4.6 - Rancidity
4.7 - Flavour reversion
4.8 – Shortening
4.9 – Polymerisation

Fats are an important component of the diet and are present naturally in many foods. Fats are solid at room temperature while oils are liquid. Fats in the diet can be of two kinds viz., the visible and the invisible fat. Invisible fats are

those present inherently in foods. Example of food containing appreciable quantities of invisible fat includes meat, poultry, fish, dairy products, eggs, nuts and seeds. Visible fats are those fats that are made from these products. They are cooking oils, salad oils, butter, ghee and margarine.

Classification of Fats:

- Based on origin fats can be Animal fats or plant fats.
- Based on degree of saturation there are three basic types of dietary fats:
  1. Monounsaturated fats (MUFAs),
  2. Polyunsaturated fats (PUFAs) and
  3. Saturated fats (SFAs)

The fat molecule is composed mostly of hydrogen atoms attached to carbon atoms in a carbon chain. On this molecule there are open spaces, like parking spaces.

- When all the available spots, or parking spaces, on the carbon atom are filled (i.e., saturated) with Hydrogenated atoms, the fat is said to be saturated.
- If one or more places on the carbon are not filled with hydrogen, the fat is called unsaturated.
- A fat molecule with one empty space is called a monounsaturated fat
- If two or more spots on the atom are empty, the fat is known as a poly unsaturated fat.
- Saturated fatty acids are firmer at room temperature. Each carbon atom has two hydrogen atoms attached making them very stable and those with 16 or more carbon atoms have a high melting point.

Saturated fats are mainly the animal fats. They are found in meat, seafood (especially the shell fish such as lobsters, crabs, etc.), whole-milk and milk products (cheese, pander, and ice cream), and egg yolks. Some plant foods which are high in saturated fats are coconut, coconut oil and palm oil.

Trans - fatty acids are fats produced by heating liquid vegetable oils in the presence of Hydrogen. This process is known as hydrogenation. The more hydrogenated an oil is, the harder it will be at room temperature.

Most of the Trans fats in our diets are found in commercially prepared baked foods like mawa cakes and patties, margarines, vanaspati ghee (dalda), snack foods (farsaan, French fries and onion rings, also contain a good deal of Tran's fats). Trans fats are the worst for cholesterol levels because they raise bad LDL and lower good HDL. While you should limit your intake of saturated fats, it is important to completely eliminate Trans fats or Partially hydrogenated oils from your diet.

Unsaturated fatty acids are fluid at room temperature. They have one hydrogen atom missing requiring the formation of a double bond. These are generally unstable as there are points in the molecule where addition of hydrogen /oxygen

or other reactive substances can take place. This can cause rancidity and flavor reversion.

Unsaturated Fats - Polyunsaturated and Mono-unsaturated Unsaturated fats are found in products derived from plant sources, such as vegetable oils, nuts, and seeds. There are two main types:-

A. Polyunsaturated fats (present in sunflower, corn, and soybean oils) and

B. Monounsaturated fats (present in rice bran, canola, peanut, and olive oils).

Studies on intake of these fats have shown to decrease LDL levels and increase HDL levels, hence are labeled as good fat. Common examples of cooking fats include olive oil, lard, canola oil, walnut oil, butter, Margarine and shortening....Fats are generally trimesters of glycerol and vegetable oils. Margarine and vegetable shortening, which can be derived from the above oils, are used mainly for baking.

NUTRITIONAL SIGNIFICANCE

1. They are a concentrated source of energy. One gram of fat contributes 9 kilocalories as against 4 kilocalories contributed by carbohydrates and protein.
2. They are a good source of vitamin A,D,E and K.
3. They provide essential fatty acids which are components of membranes of living cells.
4. They impart special flavour and texture to our foods, thus increasing palatability.
5. They are also used by the body to make prostaglandins involved in a large variety of vital physiological functions.

REFINED OILS Oils and fats do not occur free in nature. They occur in animal tissues and in seeds and fruits from which they are isolated. The extracted oils are crude and contain many constituents like free fatty acids, unsaponifiable matter, gums, waxes, mucilaginous matter, variety of colouring matter, metallic contaminants and undesirable odour producing constituents. In refining these constituents are removed by the following steps:

· Suspended particles are removed by filtration or centrifugation.

· Free fatty acids are removed by alkali treatment.

· Any remaining free fatty acids are removed by neutralisation.

· Pigments are removed by bleaching using adsorbents like activated earth or carbon and sometimes chemical bleaching agents.

· The oil is finally deodorized by injecting steam through the heated fat under reduced pressure to obtain refined oil.

HYDROGENATION – VANASPATHI AND MARGARINE

Plant oils contain a large percentage of unsaturated fatty acids and hence have a tendency to become rancid. These unsaturated glycerides in oil can be converted to more saturated glycerides by the addition of hydrogen. This process is known as hydrogenation. Hydrogenated fat is manufactured from vegetable oils by the addition of molecular hydrogen to the double bonds in the unsaturated fatty acids in the presence of nickel. The double bonds take up hydrogen and saturated fatty acids are obtained. By this process, liquid fats can be converted to semi solid and solid fats for use as shortening in the preparation of biscuits, cakes and butter substitutes. Hydrogenation is of great economic importance because it allows oils to be converted into fats, which have better keeping quality. As hydrogenated fats are prepared from refined deodourised oils, the resulting fats are odourless and colourless and blend well in several food preparations.

Vanaspathi: Hydrogenated oil in India is known as vanaspathi. It is manufactured by hydrogenating refined groundnut oil or a mixture of groundnut oil with other edible vegetable oils. According to vanaspathi control order, the melting point of vanaspathi should be between 31°C and 37° C and it should contain 5 percent sesame oil and should be fortified with vitamin A.

Margarine: Margarine is often used as a substitute for butter. It is made from vegetable oils or a mixture of vegetable and animal fat by hydrogenation. It is then blended with cultured skim milk and salt. The fats most commonly used in the manufacture of margarine are cotton seed oil, soyabean oil, corn oil, groundnut oil, coconut oil and meat fat. Additional additives may include diacetyl for butter flavour, sodium benzoate for preservation, mono and diglycerides or lecithin for emulsification, yellow colouring matter and vitamin A and D.

Leavening: When fats are creamed with sugars as in preparation of cake, butters, they help to incorporate air into the batter making it tight and foamy. On baking the protein films coagulate enclosing the air and making the end products light in texture and soft in mouthfeel. In biscuits since foaming is not required the fat is rubbed into the flour gently to provide slight aeration to impart a light crisp texture.

Shortening: Fats provide a crumbly texture to food by foaming a film around the starch and protein particles in flours preventing the formation of long gluten strands in them. This accomplished when fat is rubbed into a flour gently using the tips of the fingers only. Such treatment to flours before dough formation makes products soft and tender or short after cooking. This effect is called shortening and is used for making biscuits, cakes pie bases, pastry products etc. where a golden color and crisp texture is required through baking and frying.

Shortening is any fat that is a solid at room temperature and used to make crumbly pastry and other food products. Although butter is solid at room

temperature and is frequently used in making pastry, the term "shortening" seldom refers to butter, but is more closely related to margarine.

Winterization : some cooking oil become cloudy when they are stored in the reftrigerator. This occurs because some of the triglyceride molecules in the oil have higher melting points than other molecules in the mixture and crystallize or become solid at the lower temperature. In manufacturing oils intended to be used primarily for the making of salad dressings, a winterizing process is applied. In this process, the temperature of the oil is lowered to a point at which the higher melting triglycerides crystallize. Then the oil is filtered to remove the crystal the remaining oil has a lower melting point and does not crystallize at refrigerator temperature. It is referred to as salad oil. Removing the solid particles is called winterization.

RANCIDITY Fats and oils undergo certain undesirable changes during storage which result in spoilage. The major spoilage of fats and oils is rancidity. Rancidity refers to the development of disagreeable odour and flavour in fats and oils owing to specified chemical reaction such as oxidation and hydrolysis. Hydrolysis is the decomposition of fats into free fatty acid and glycerol by enzymes in the presence of moisture. These free fatty acids released are responsible for the unpleasant flavour and odour. During oxidation, oxygen is added to the unsaturated linkage and this results in the formation of peroxides. These peroxides decompose to yield aldehyde and ketones which are responsible for the pronounced off flavour. Rancidity may also be caused by the absorption of odour and action of micro organism and enzymes.

Prevention of rancidity:

· Storage in coloured glass containers prevent oxidation of fats by rays of light.

· Vacuum packaging retards rancidity by excluding oxygen.

· Naturally occurring antioxidants like vitamin C, b carotene and vitamin E protect against rancidity.

· Synthetic antioxidants like butylated hydroxy anisole (BHA), butylated hydroxy toluene (BHT) and propylgallate can also be added to prevent rancidity.

Types of Rancidity

There are 3 main types of Rancidity :

a) Hydrolytic Rancidity: Hydrolysis of fats by lipase need not always produce off flavours. Butter fat and coconut oil, butyric acid are set free by hydrolysis of lipase . the odours of these acids contribute largely to the smell of rancid butter.

b) Oxidative Rancidity : Common type of rancidity observed in all fats and oils. Addition of oxygen to the unsaturated linkage results in the formation of peroxide which on decomposition yields aldehydes and ketones having off flavor.

c) Ketonic Rancidity : As a result of action of fungi such as Aspergillus Niger, penicillium glaucum on coconut and other oil seeds.

SMOKING POINT When fats and oils are heated to a high temperature, decomposition of fat occur and finally a point is reached at which visible fumes are given off. This is called smoking point and the temperature is called smoking temperatures of fat. Smoking temperature is defined as the lowest temperature at which visible fumes consisting of volatile gaseous products of decomposition are evolved. Beyond the smoke point is the flash point where the combustion occurs.

Factors affecting smoking temperature of fats and oils :

1. The amount of free fatty acids present.

2. The surface of oil exposed while heating.

3. The presence of mono and diglycerides and foreign particles such as flour particles. Smoking temperature is important for fats used for frying. Fats with low smoke point are not suitable for frying because of the odour and irritating effect of the fumes. The decomposition products may also give an unpleasant flavour to the food. Hence it is preferable to use fats with relatively high smoking temperatures for frying.

The smoking points of some fats and oils are given below:

Smoking points of some fats and oils

Oil or fat Smoking temperature (° C)

Soyabean oil 230

Hydrogenated fat 221

Butter fat 208

Groundnut oil 162

Coconut oil 138

Flavour Reversion: Many refined oils undergo change in flavor before the onset of rancidity. This process is known as reversion. This is due to the fact that such fatty acids undergo oxidation rapidly when exposed to air and decomposition products termed contribute to the off flavor.

ROLE OF FAT / OIL IN COOKERY

· Fat is used as a medium of cooking in shallow and deep fat frying.

· Fat improves the texture of food. e.g., cake, biscuit, cookies.

· Fats help in leavening – in making cake, leavening occurs by incorporating air into the fat during the leavening process.

· Fat increases smoothness of the product e.g., Halwas, crystalline candies.

· Fats are shortening agents- one of the most important function of fat is to shorten baked products which otherwise are solid masses firmly held together by strands of gluten.

· Fat improves palatability – fat gives taste and flavour to the food.

Polymerisation: All commonly used fats and particularly those high in polyunsaturated fatty acids tend to form larger molecules (known broadly as polymers) when heated under extreme conditions of temperature and time. Under normal processing and cooking conditions, polymers are formed. Although the polymerization process is not completely understood, it is believed that polymers in fats and oils arise by formation of either carbon-to-carbon bonds or oxygen bridges between molecules. When an appreciable amount of polymer is present, there is a marked increase in viscosity.

Polymers are highly conjugated dienes and produce a brown, resin-like residue along the sides of the fryer, where the oil and metals come in contact with oxygen from the air. Resin-like residue is often produced when the oil does not release the moisture but keeps it trapped while also incorporating air.

VANASPATHI	MARGARINE
HYDROGENATED FAT IN INDIA AKA VANASPATHI	SUBSTITUTE OF BUTTER/ANIMAL FAT
MADE FROM GROUNDNUT OIL AND/OR VEGETABLE OIL	BLEND OF VEGETABLE OIL, ANIMAL FAT, SKIMMED MILK AND SALT
PARTIALLY HYDROGENATED HENCE SEMISOLID	FULLY HYDROOGENATED HENCE SOLID
FORTIFIED WITH VITAMIN A	FORTIFIED WITH VITAMIN A & D
DOES NOT CONTAIN ANIMAL FAT	CONTAINS ANIMAL FAT

VITAMINS, MINERALS, WATER & COLLOIDS

5.1 - Functions
5.2 - Sources

5.3 - Deficiency & Excess
5. 4 - Fat soluble & water soluble Vitamins(A,D,E,K,B1,B2,B3,C)
5.5 - Minerals (Ca,P, Na,K,Fe,I,Fl)
5.6 - Importance, balance & Sources
5.7 - Cooking losses & prevention
5. 8 - Definitions (sol, gels, foam, emulsion)
5. 9 - Examples(roasting, grilling, frying, baking,boiling, poaching, microwave)
5.10 - Importance in food industry

Vitamins

Vitamins are organic molecules that are essential for normal health and growth. They are required in trace amounts and must be obtained from the diet because they are not synthesized in the body.

- Organic molecules with a wide variety of functions.
- Cofactors for enzymatic reactions

Before vitamins were discovered, it was known that lime juice prevented the disease scurvy in sailors and that cod liver oil could prevent rickets. In 1912, scientists found that, in addition to carbohydrates, fats, and proteins, certain other factors called vitamins must be obtained from the diet.

Why are they good for us?

Greater need due to worse environment
Improve immunity
Prevent illnesses
Slower aging

Two distinct types:
Water-soluble
Fat-soluble

Water-Soluble Vitamins
Soluble in aqueous solutions
Watersoluble vitamins Used as cofactors by many enzymes
Not stored in the body

The water-soluble vitamins, inactive in their so-called free states, must be activated to their co-enzyme forms:

Thiamin (vitamin B1)
Function:

It helps to convert food into energy. Needed for healthy skin, hair, muscles, and brain and is critical for nerve function.

Food Sources:
Pork chops, brown rice, ham, soymilk, watermelons, acorn squash

Deficiency:
Deficiency of thiamin results in beriberi and its symptoms are fatigue, weight loss, and nerve degeneration.

Riboflavin (vitamin B2)
Function:
It helps to convert food into energy. Needed for healthy skin, hair, blood, and brain.

Food Sources:
Milk, eggs, yogurt, cheese, meats, green leafy vegetables, whole, and enriched grains and cereals

Deficiency:
riboflavin deficiency also known as ariboflavinosis, include skin disorders, hyperemia (excess blood) and edema of the mouth and throat, angular stomatitis (lesions at the corners of the mouth), cheilosis (swollen, cracked lips), hair loss, reproductive problems, sore throat, itchy and red eyes, and degeneration of the liver and nervous system.

Niacin (vitamin B3, nicotinic acid)
Function:
It helps to convert food into energy. Essential for healthy skin, blood cells, brain, and nervous system.

Food Sources:
Meat, poultry, fish, fortified and whole grains, mushrooms, potatoes, peanut butter

Deficiency:
Deficiency of niacin can result in dermatitis, muscle fatigue and loss of appetite.

Pantothenic Acid (vitamin B5)
Function:
It helps to convert food into energy. It helps in making lipids (fats), neurotransmitters, steroid hormones, and hemoglobin.

Food Sources:
Wide variety of nutritious foods, including chicken, egg yolk, whole grains, broccoli, mushrooms, avocados, tomato products.

Deficiency:
Its deficiency may cause fatigue, retarded growth, insomnia, depression.

Pyridoxine (vitamin B6)
Function:
Aids in lowering homocysteine levels and may reduce the risk of heart disease. It helps in converting tryptophan to niacin and serotonin, a neurotransmitter that plays key roles in sleep, appetite, and moods. Helps in making red blood cells Influence cognitive abilities and immune function.

Food Sources:
Meat, fish, poultry, legumes, tofu and other soy products, potatoes, noncitrus fruits such as bananas and watermelons

Deficiency:
Vitamin B6 deficiency can result in microcytic anemia, electroencephalographic abnormalities, dermatitis with cheilosis (scaling on the lips and cracks at the corners of the mouth) and glossitis (swollen tongue).

Cobalamin (vitamin B12)
Function:
Aids in lowering homocysteine levels and may lower the risk of heart disease. Assists in making new cells and breaking down some fatty acids and amino acids. Protects nerve cells and encourages their normal growth Helps make red blood cells and DNA.

Food Sources:
Meat, poultry, fish, milk, cheese, eggs, fortified cereals, fortified soymilk

Deficiency:
The deficiency of cobalamin leads to pernicious anemia and nerve damage.

Biotin
Function:
It helps to convert food into energy and synthesize glucose. It helps in making and breaking down some fatty acids. Needed for healthy bones and hair.

Food Sources:
Many foods, including whole grains, organ meats, egg yolks, soybeans, and fish

Deficiency:
Biotin deficiency includes hair loss (alopecia) and a scaly red rash around the eyes, nose, mouth, and genital area. Neurologic symptoms in adults have included depression, lethargy, hallucinations, numbness, and tingling of the extremities, ataxia, and seizures.

Ascorbic Acid (vitamin C)
Function:
Foods rich in vitamin C may lower the risk for some cancers, including those of the mouth, esophagus, stomach, and breast. Long-term use of supplemental vitamin C may protect against cataracts. It helps to make collagen, a connective tissue that knits together wounds and supports blood vessel walls. It also helps to make the neurotransmitters serotonin and

norepinephrine Acts as an antioxidant, neutralizing unstable molecules that can damage cells. Bolsters the immune system.

Food Sources:
Fruits and fruit juices (especially citrus), potatoes, broccoli, bell peppers, spinach, strawberries, tomatoes, Brussels sprouts

Deficiency:
Vitamin C deficiency called Scurvy.
Excess of Vitamin C can cause Diarrhea, Nausea, Vomiting.

Folic Acid (vitamin B9)
Function:
It is vital for new cell creation, helps to prevent brain and spine birth defects when taken early in pregnancy; it should be taken regularly by all women of child-bearing age since women may not know they are pregnant in the first weeks of pregnancy. Can lower levels of homocysteine and may reduce heart disease risk May reduce the risk for colon cancer. Offsets breast cancer risk among women who consume alcohol.

Food Sources:
Fortified grains and cereals, asparagus, okra, spinach, turnip greens, broccoli, legumes like black-eyed peas and chickpeas, orange juice, tomato juice

Deficiency:
It causes Folate-deficiency anemia. Folate-deficiency anemia is the lack of folic acid in the blood.

Fat-Soluble Vitamins
Soluble in lipids, but not in aqueous solutions
Important in vision, bone formation, antioxidants, and blood clotting
Stored in the body
Vitamin A
vitamin A; includes retinol, retinal, retinyl esters, and retinoic acid and is also referred to as "preformed" vitamin A. Beta carotene can easily be converted to vitamin A as needed.

Function:
Essential for vision Lycopene may lower prostate cancer risk. Keeps tissues and skin healthy. Plays an important role in bone growth and the immune system. Diets rich in the carotenoids alpha-carotene and lycopene seem to lower lung cancer risk. Carotenoids act as antioxidants. Foods rich in the carotenoids lutein and zeaxanthin may protect against cataracts.

Food Sources:
Sources of retinoids: beef liver, eggs, shrimp, fish, fortified milk, butter, cheddar cheese, Swiss cheese
Sources of beta carotene: sweet potatoes, carrots, pumpkins, squash, spinach, mangoes, turnip greens, and almost all green vegetables.

Deficiency:
Deficiency of Vitamin A called Night Blindness.

Calciferol (vitamin D)
Function:
It helps to maintain normal blood levels of calcium and phosphorus, which strengthens bones. It helps in the formation of teeth and bones. Supplements can reduce the number of non-spinal fractures.

Food Sources:
Fortified milk or margarine, fortified cereals, fatty fish

Deficiency:
Deficiency can result in weakened bones.

Alpha-Tocopherol (vitamin E)
Function:
Acts as an antioxidant, neutralizing unstable molecule that can damage cells. Protects vitamin A and certain lipids from damage. Diets rich in vitamin E may help prevent Alzheimer's disease. Cures muscle, heart and skin diseases, burns.

Food Sources:
Wide variety of foods, including vegetable oils, salad dressings, and margarine made with vegetable oils, wheat germ, leafy green vegetables, whole grains, nuts

Deficiency:
Muscle weakness, Coordination, and walking difficulties, Vision deterioration

Phylloquinone, Menadione (vitamin K)
Function:
Activates proteins and calcium essential to blood clotting. May help prevent hip fractures. Vitamin K1 in plants has a saturated side chain. Vitamin K2 in animals has a long unsaturated side chain. Vitamin K2 is needed for the synthesis of zymogens for blood clotting. Higher need by newborns, people with liver diseases, or fat malabsorption.

Food Sources:
Cabbage, liver, eggs, milk, spinach, broccoli, sprouts, kale, collards, and other green vegetables

Deficiency:
Vitamin K deficiency is much more common in infants. In infants, the condition is called VKDB, for vitamin K deficiency bleeding.

Minerals
Mineral elements are inorganic substances found in body tissues and fluids. They occur in

foods as salts e.g. sodium chloride, calcium phosphate, and ferrous sulfate. They constitute 4% of our body weight. Unlike carbohydrates, fats, and proteins they do not furnish energy. They have many functions in our body such as tissue building, regulation of body fluids, and other functions. Like vitamins, they are required in small quantities and are vital to the body. They should be supplied daily as they are excreted through the kidney, the bowel and the skin.

Minerals are present in our body as:

a) Components of organic compounds, e.g. hemoglobin contains iron and thyroxin contains iodine.

b) In organic compound, e.g. calcium phosphate in the bones.

c) As free ions in every cell in the body and

d) In all body fluids

Sodium is the main electrolyte in the extracellular fluid, and potassium is the main electrolyte in the intracellular fluid.

The mineral elements are not destroyed by heat, oxidation, acid or alkali. Since they are soluble in water some loss occurs due to leaching when cooking water is discarded.

Minerals are inorganic elements require by the body in varying amounts to carry out various body functions. They remain largely as ash when plants and animal tissues are ignited.

Minerals may be classified into three groups:

Major minerals or macrominerals: Seven minerals are required in large amounts of over 100mg/day, e.g. calcium, phosphorus, sodium, chlorine, potassium, magnesium, and sulphur.

Minor minerals: These are required in small quantities, less than 100 mg/day, e.g. iron and manganese.

Trace elements: A few micrograms to a few milligrams are required per day e.g. iodine, fluoride, zinc, and molybdenum.

GENERAL FUNCTIONS OF MINERALS

1. Minerals form the structural components of bones, teeth, soft tissues, blood, and muscles, e.g. calcium, phosphorous, and magnesium in bones.

2. They regulate activity of nerves with regard to stimuli and contraction of muscles, e.g. calcium.

3. Maintain acid-base balance of body fluids, e.g. sodium and chlorine.

4. They control water balance by means of osmotic pressure and permeability of cell membranes, e.g. sodium and potassium.

5. They are constituents of vitamins, e.g. thiamine contains sulphur and cyanocobalamine contains cobalt.

6. They form part of molecules of hormones and enzymes, e.g. iodine in thyroxin and zinc in insulin.

7. They activate enzymes, e.g. calcium activates enzyme lipase.

8. They regulate cellular oxidation, e.g. iron and manganese.
9. Necessary for clotting of blood, e.g. calcium.

Calcium

The adult body contains 1.2 kg of calcium of which 99% is present in bones and teeth. It is the most abundant mineral in the body. The bones provide:

1. Rigid frame work for the body
2. Reserves of calcium and releases calcium on demand.

The remaining 1% is distributed in the extracellular and intracellular fluids and has the following functions:

1. Calcium acts as a catalyst in clotting the blood.
2. It increases the permeability of cell membranes thus helping in absorption.
3. It regulates contraction and relaxation of muscles including the heart beat.
4. It activated the number of enzymes such as pancreatic lipase and acts as a co-factor.

Factors affecting calcium absorption The amount of calcium absorbed by the humans depends on the body's need. Approximately 40% of calcium ingested is absorbed.

1. Phosphate and phytic acid is present in cereals and form insoluble calcium salts if present in excess.
2. An alkaline intestinal pH (above 7) reduces absorption by forming insoluble salts.
3. Excess fibers decreases absorption of calcium.
4. Oxalic acid in green leafy vegetables forms insoluble calcium oxalate, which is excreted.
5. Faulty absorption of fats and fatty acids form insoluble calcium salts, which are excreted
6. Lactose increases calcium absorption.
7. High protein intake increases absorption.
8. Caffeine increases urinary calcium salts and high sodium also.
9. Strenuous exercise increases the loss.

The parathyroids regulate the calcium level in blood and calcium metabolism in bone. The calcium to phosphorus ratio should always be 1:1

Sources Various sources of calcium are:

1. Milk and milk products excluding butter, ghee, and cream.
2. Ragi, green leafy vegetables especially drumstick leaves, cabbage, curry leaves, carrot and cauliflower tops and amaranth.
3. Small dried fish, nuts, and oilseeds such as gingelly seeds.
4. Betel leaf with slaked lime is a rich source of calcium.

Deficiency A severe deficiency of calcium leads to rickets in children and osteomalacia and osteoporosis in adults (refer chapter 17, vitamin D deficiency for symptoms of rickets and osteomalacia).

Osteoporosis In osteoporosis the bones become porous because of bone mineral loss. This causes compression of the vertebrate that result in loss of height, back and hip pain, and increased susceptibility to fractures. It is seen in post menopausal women and can be controlled by weight bearing exercises such as walking, calcium supplements and hormone therapy.

Tetany A decrease in serum calcium levels gives rise to a condition called tetany. The symptoms of tetany are severe intermittent spasms of the muscles of hands and feet accompanied by muscular pain. Twitching of facial muscles occurs.

Phosphorus

Phosphorus comprises 1% of total body weight. It occurs along with calcium in human nutrition and also has many other functions in the body.

1. Building bones and teeth along with calcium and magnesium.

2. DNA and RNA, nucleic acids needed for genetic coding contain phosphorus.

3. As phospholipids, they regulate the absorption and transport of fats.

4. Adenosine triphosphate (ATP) and adenosine diphosphate (ADP) are necessary for storing and releasing energy according to body needs.

5. As part of enzymes needed for the metabolism of carbohydrates, fats, and proteins.

Sources Phosphorus is widely distributed in foods. Milk and meat are rich in phosphorous. Whole grain cereals, legumes, nuts, carrots, and fish are also rich resources of phosphorus.

Deficiency Phosphorous deficiency is rare since a diet that contains adequate protein and calcium will be rich in phosphorus. Deficiency symptoms are similar to calcium deficiency.

Iron

The human body 3-5 g of iron of which 70% is in the circulating hemoglobin.

Functions:

1. Essential for carrying O2 to the lungs where O2 is released and CO2 is picked up to be exhaled by hemoglobin in the red blood cells.
2. It is an essential part of several oxidative enzymes.
3. It helps in specific brain functions such as good attention span and capacity to learn and memorize.
4. It facilitates the complete oxidation of carbohydrates, proteins, and fats within the cell and release of energy for performing physical energy.

Diet improves iron in two forms:

1. Haeme iron i.e. iron associated to the protein, globin, to form hemoglobin. Haeme iron is found in flesh food only.
2. Non-haeme iron is the form present in all plant sources plus 60% of animal sources.

Haeme iron is present in small quantities in food. About 40% iron in flesh food is haeme iron, while 60% is non-haeme iron. It is rapidly absorbed and transported. About 23% is absorbed.

Non-haeme iron is the larger portion of iron in food. It is tightly bound to organic molecules in the form of ferric iron (Fe+++). In the acidic medium of the stomach, it is dissociated and

reduced to its more soluble ferrous form (Fe++). The absorption rate of non-haeme iron is slow and approximately 8% is absorbed.
Vitamin C from the diet and hydrochloric acid in gastric juice help in converting ferric iron to ferrous iron.
Factors affecting iron absorption: The following factors enhance absorption:
Body need In periods of extra demand or in a deficiency, more iron is absorbed.
Acidic Medium Gastric acidity and ascorbic acid in the meal favour absorption.
Form of iron Haeme iron and ferrous iron are better absorbed.
Complete proteins Complete proteins such as meat favour absorption.
The following factors decrease absorption:
1. Ferric iron or non-haeme iron in the absence of proteins and ascorbic acid are poorly absorbed.
2. Achlorhydria or lack of hydrochloric acid in gastric juice and use of antacids with meal interfere with absorption.
3. Tea and coffee with meals.
4. Excessive intake of phytates and oxalates interferes with absorption.
5. Malabsorption due to intestinal disorders.
Iron is required for replacements of daily losses through excretion in urine, sweat, hair, and worn out cells. It is also needed for replacement of blood losses and an expanding blood volume in all stages of growth.

Sources Various sources of iron are:
1. Liver, organs meats, shellfish, lean meat, egg yolk are all good sources of iron.
2. Green leafy vegetables, whole grain, and enriched cereals, legumes and jaggery (50g will meet the requirement.
3. Garden cress seeds and niger seeds are excellent sources.
4. Peaches, apricots, manukas and figs
5. Use of iron cooking utensils contributes significantly to the iron content of the diet.
Non-haeme iron is present in plant food such as green vegetables, and cereals. 40% of iron in meat, poultry, and fish is haeme iron and 60% is non-haeme iron.
Deficiency Iron deficiency or anaemia is very common in the vulnerable age groups in all developing countries. Haemoglobin level may be as low as 5-9g. Normal haemoglobin levels for females are 11.5%-14.5% and for males 12.5%-16.5%.
Symptoms General fatigue, breathlessness on exertion, giddiness, and pallor of skin (paleness), oadema of ankles and spoon shaped nails are the common symptoms of iron deficiency.
Iron deficiency causes microcytic and hypochromic anaemia. Red blood cell's appear pale and smaller in size. Iron deficiency may also be seen if excessive blood loss occurs or because of faulty absorption, intestinal disease, or parasites especially hookworm and roundworm infestations.

Iodine

Most of the iodine in adult body is found in the thyroid gland. The only known function of iodine is as a constituent of thyroxin. The thyroid hormone regulates the rate of oxidation within the cells. The iodine absorbed is incorporated into the amino acid tyrosine to form the hormone thyroxin.

Iodine + Tyrosine ◊ Thyroxin

If intake of iodine is inadequate, the stores of thyroxin are gradually depleted and the thyroid gland enlarges in an attempt to produce the necessary thyroxin.

Sources Seafood contains maximum iodine and fruits contain the least. Wide variations are seen because food content of iodine depends upon the soil where they are grown. To provide sufficient iodine, salt is being iodized. Salt is a universally used dietary item. It is cheap and addiction of iodine does not affect its flavour. It is added in form of sodium or potassium iodide in the proportion of 1mg for every 10g of salt.

Deficiency Deficiency occurs when the iodine content of the soil is so low that insufficient iodine is obtained through food, e.g., the soil the Kangra valley in Himalayan region is deficient in iodine. Deficiency of iodine results in goitre.

Symptoms

1. Enlargement of thyroid gland.
2. Cretinism in children (stunted growth). Cretinism is characterized by a low basal metabolism rate (BMR), flabby and weak muscles, dry skin. Skeletal development stops and mental retardation is seen.

Goitrogens – are substances in food known to interfere with the use of thyroxin and can produce goitre. They are present in the red skin of peanuts and in vegetables such as cabbage and cauliflower, turnips and mustard.

Fluorine

Fluorine is the normal constituent of the body, found mainly in bones and teeth. Small amounts of fluorine brings about striking reductions in the tooth decay probably because the tooth enamel is made more resistant to the action of acids produced by bacteria in the mouth.

Sources Milk, eggs, and fish are important sources. Fluoridation of water to ensure a concentration of 1 ppm is a safe and economical way to reduce the incidence of dental caries.

Deficiency A deficiency results in dental caries and is seen in areas where drinking water contains less than 0.5 ppm of fluorine. Adding fluorine at a level of 1 ppm reduces the incidence of dental caries by 50%. Food as well as water contains varying amounts of fluorine.

Fluorosis Fluorosis or mottling of teeth occurs in parts of the world where drinking water contains excessive amounts of fluorine, i.e., 3-5 ppm. Teeth lose their lustrous appearance. Enamel becomes dull and unglazed and chalky white patches are seen. Sometimes enamel is

pitted giving the tooth surface a corroded appearance. Skeletal Fluorosis may also be seen. There is hypercalcification of the bones. Mottled areas may get yellow brown stains or discolored.

Sodium

Sodium chloride or common salt is a daily ingredient in our diet. The adult body contains 180g of sodium most of which is present in the extracellular fluid of the body.
The functions of sodium are as follows:
1. Maintaining fluid balance and normal osmotic pressure between intracellular and extracellular compartments.
2. It maintains normal irritability of nerves and helps in muscles contraction.
3. Regulates the alkalinity and acidity of body fluids along with the mineral chloride.
4. Regulates cell permeability or passage of substances into and out of the cell.
Sources Milk, egg white, meat, poultry, green leafy vegetables, Bengal gram dal, beetroot, and knolkhol are good sources.
The sodium from additives should also be included in the sodium content of a meal.
Deficiency A deficiency is seen in people engaged in heavy physical activities such as farm and mine workers and in athletes. It may also occur in cases of severe vomiting or diarrhoea. It results in weakness, giddiness, nausea, and muscles cramps. It can be treated by adding salt to water and lime juice and if this is not retained, intravenous saline could be given.
Excess An excessive intake of sodium should be avoided as it predisposes a person to hypertension. Salt is 40% sodium, which means that a teaspoon full of salt provides 2g or 2000mg of sodium. Sodium is present is food and as well as in many ingredient added to food such as sodium bicarbonate, monosodium glutamate, sodium benzoate, sodium propionate, and sodium nitrate. These need to be curtailed on a low sodium diet.

Potassium
It is present as the major electrolyte in all body cells.
Functions:
1. As a component of all living cells in the intracellular fluid it helps in regulating the water balance along with the sodium.
2. It regulates the acid-base balance like sodium.
3. It helps in transmitting nerve impulses and contraction of muscle tissues.
Sources Fruits, vegetables, pulses, nuts, flesh food, and whole grain are rich in potassium.
Deficiency Deficiency of potassium is unlikely in normal circumstances but may occur in severe malnutrition, chronic alcoholism, surgery and prolonged infection.

Magnesium

About 60% is found along with calcium and phosphorous in the bones and teeth. The remaining 40% is present in the tissues and the body fluids and performs the following functions:

1. It is present mainly in the intracellular fluid and helps in maintaining fluid balance along with sodium, potassium, and calcium.

2. It helps in transmission of nerve impulses, muscles contraction and regulation of the heart beat.

3. It acts as a co-factor in many metabolic reactions.

Sources Milk, cheese, fish, meat, whole grains, pulses, and nuts.

Deficiency Deficiency of magnesium is uncommon. It may not occur in malnutrition and alcoholism. Symptoms of deficiency are similar to tetany and include muscle tremors, spasms, and convulsions.

WATER

Water is so familiar and so large a constituent of the body that its fundamental importance in both structure and functioning of all tissues tends to be overlooked.

Water is the most essential constituent of our body. It accounts for 55%-70% of out total body weight. The total body fluid is distributed among two major compartments.

1. The extracellular fluid or water present outside the cells in the intestinal spaces and blood plasma.

2. The intracellular fluid or the water present inside the cells

Considering an average of 60% of body weight is contributed by water, an adult weighing 70kg has a total body water of 42 liters of which 28 is intracellular and 14 is extracellular.

Water present in the body has electrolytes dissolved in it. Thus when the body looses water, it looses electrolytes as well.

Sodium is the principal electrolyte of the extracellular fluid while potassium is predominant in the intracellular spaces. The normal concentration of ions in the intracellular and extracellular fluids needs to be maintained at all times. This concentration of ions is preserved by a balance between the intake of water and the output or loss of body water.

FUNCTIONS

1. Water quenches thirst and is the most refreshing and cooling of all liquids

2. It is a structural component of all cells. In the bone, water is tightly bound, but in most tissues, a constant interchange takes place between the body compartments of water.

3. It is the medium in which all chemical reactions take place

4. It is an essential component of all body fluids such as blood, lymph, bile etc

5. It acts as a lubricant and helps food to be swallowed and digested food to pass through the gastro intestinal tract.

6. It is essential to maintain the turgidity of cells

7. It acts as a solvent for the products of digestion and helps in transporting these

products to different tissues.
8. It regulates the body temperature by taking up and distributing heat produced in cells when metabolic reactions take place.
9. It helps in excreting waste products of metabolic reactions

DAILY INTAKE OF WATER

Apart from the water we drink during the day to relieve thrist between and during meals, there are three major sources of water.
Beverages and liquid foods: Hot and cold beverages such as tea, coffee etc. are largely made up of water. They are an important source of water and nutrients.
Water content of solid foods: Another important source of water is fruits, vegetables etc. Solid food contain varying percentages of water
The water consumed from beverages and solid food amounts to 2,100 ml/day approx.
Metabolic water: It is synthesized in the body as a result of oxidation of fat, proteins, carbohydrates adding to about 200 ml/day.
Oxidation of 100 g fat ► 107 ml water
100 g protein ► 41 ml water
100 g carbohydrate ► 56 ml water
The intake of fluid varies among different people and also varies according to the climate, habits and physical activity on a day to day basis.

DAILY LOSS OF BODY WATER
Insensible water loss: It is the loss of water we are not consciously aware of even though it occurs continuously in all living beings. It includes
(a) Continuous loss of fluid by evaporation frm the skin, which occurs independently of sweating and
(b) Insensible water loss though the respiratory tract, which is about 300-400 ml/day
Water loss through sweat: The extent of water loss through perspiration or sweat largely depends on physical activity and environmental temperature.

Water loss in urine: This is the most important mechanism by which the body maintains a balance between fluid intake and output as well as electrolyte homeostasis. Urine volume can be as low as 0.5 liters/day to as high as 20 liters/day. The rate of filtrations of water in the normal kidney is about 125ml/minute or approx. 180 liters a day for an adult. About 99% of the water filtered is reabsorbed into the blood while 500-2,000 ml is excreted as urine.
Water loss in faeces: Only a small amount of water is normally lost in faeces, The saliva, gastrointestinal secretion and bile may together add to 8 liters or more fluid per day. If there is diarrhea or vomiting, fluid losses may be large and cause dehydration.

WATER BALANCE

Deficiency of Water

1. Excessive loss of water could take place due to diarrhoea, vomiting, fever, excessive perspiration etc. It can result in dehydration. Dehydration can be classified as

Mild<5% fluid loss
Moderate 5-15% fluid loss
Severe 15-20% fluid loss

A dehydrated person feels thirsty, has a dry mouth, sunken and dry eyes and may feel restless, irritable, lethargic or unconscious in severe cases. The skin when pinched does not go back quickly. A dehydrated person is usually managed by Oral Rehydration Therapy (ORT). The WHO recommends Oral Rehydration Salts (ORS) that are to be dissolved to 1 litre of water.

ORS are most prescribed in cases of diarrhoea. Glucose present in ORS, ORT also includes any of the following.

1. Sugar and salt solution
40g sucrose + 4g NaCl in 1 litre of water
2. Rice water with salt
50g rice + 4 g salt in 1 litre of water
3. Dilute salted lassi
4. Plain water, lemon water, coconut water, thin soups or dal water may also be given along with ORT

If vomiting is severe, intravenous fluids such as normal saline and dextrose need to be given. When the body looses fluids, it looses both water and electrolytes, hence ORS or Dextrose Normal Saline (DNS) is given. Dehydration cannot be treated by giving pure water only

Retention of Water

Oedema is the retention of salt and water in the interstitial fluid giving rise to swelling of the skin. A pit of depression is formed when pressure is applied with the finger to the swollen skin and this is how oedema is distinguished from swelling. Water and salt may need to be restricted.

Daily Requirement

A minimum of six to eight glasses of water is recommended to enable the body to perform optimally and keep one active and refreshed throughout the day. It should be consumed at regular intervals so that the body is always well hydrated this quantity is independent of other fluids consumed.