CHAPTER ONE

Microorganisms & Food

Learning objectives

- By the end of the chapter the student is expected to:
  - Describe the role and significance of microorganisms in foods
  - Identify some microorganisms common to foods
  - Identify the growth requirements of microorganisms
  - Discover the intrinsic and extrinsic parameters of foods that affect microbial growth

Learning objectives

- Explain the growth kinetics of microbes
- Illustrate the sources of microbial contamination of food
- Spot the different stages and processes at which food may be contaminated

Role and significance of microbes

- **What are microorganisms?**
  - ✓ tiny organisms
  - ✓ are ubiquitous
  - ✓ cause food spoilage
  - ✓ Food borne infections
  - ✓ also play positive role (food processing)







Cont'd

- **Key role**
- ✓ Decomposition of complex organic materials into simple compounds by heterotrophs

All organic matter (CHO, Proteins, lipids)



Energy + Inorganic compounds (NO3, SO4……)

Geo-chemical cycling

Assignment one

1. **List and discuss about geo-chemical cycle**

Microbes common to food

- Bacteria
- Fungi – yeasts & moulds
- Viruses

1. Bacteria

- ✓ Unicellular organisms
- ✓ Approximately 1 µm in diameter
- ✓ Morphology
  - Rod
  - Spherical





Bacteria (cont'd)

- ✓ Some species produce spores
- ✓ Some may produce toxins

Types according to their effect

1. **Harmful** - pathogenic bacteria
2. **Undesirable** - cause decomposition of food
3. **Beneficial** - used in the production of various foods (yoghurt, cheese, cultured milk)
4. **Benign** – neither helpful nor harmful (most bacteria)

Moulds

- Multi-cellular
- Mycelia(filamentous) morphology
- 30 -100 µm in diameter
- Characterized by their display of a variety of colours and recognized by their cotton like appearance
- They greater variations of pH (2 – 8) & temp
- Oxyg ute requi owth.

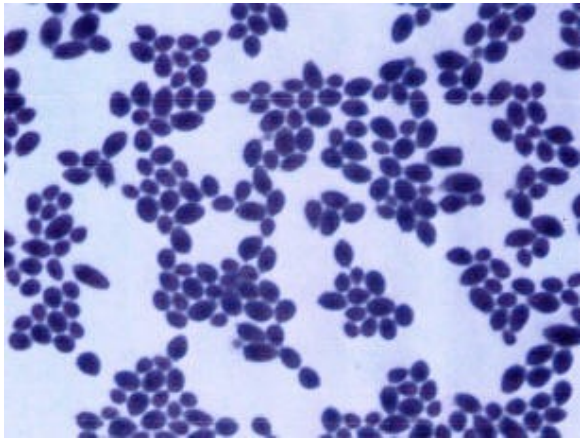




Yeasts

- Unicellular organisms (size > bacteria)
- Grow in an acidic pH range (4.0-4.5).
- Reproduce by forming buds
- They are creamy white in appearance.
- Act on sugar to give alcohol and CO2.





Viruses

- Are infective microbes with size of 20 - 300 nm (electron microscope)
- Obligate parasites
- Unlike bacteria, viruses cannot reproduce in the food.
- Food only serves as a reservoir and a transporting mechanism until it is ingested.
- Example – Infectious hepatitis A, Norovirus

What are the main sources of microbes for food contamination?

- The different habitats of microbes which could serve as sources for food contamination are:
  - Soil
  - Air
  - Water
  - Human and animal body
  - Sewage
  - Plants and plant products
  - Food utensils
  - Insects, vermin, birds and inanimate objects

Selected Infectious Agents and Their Main Habitats

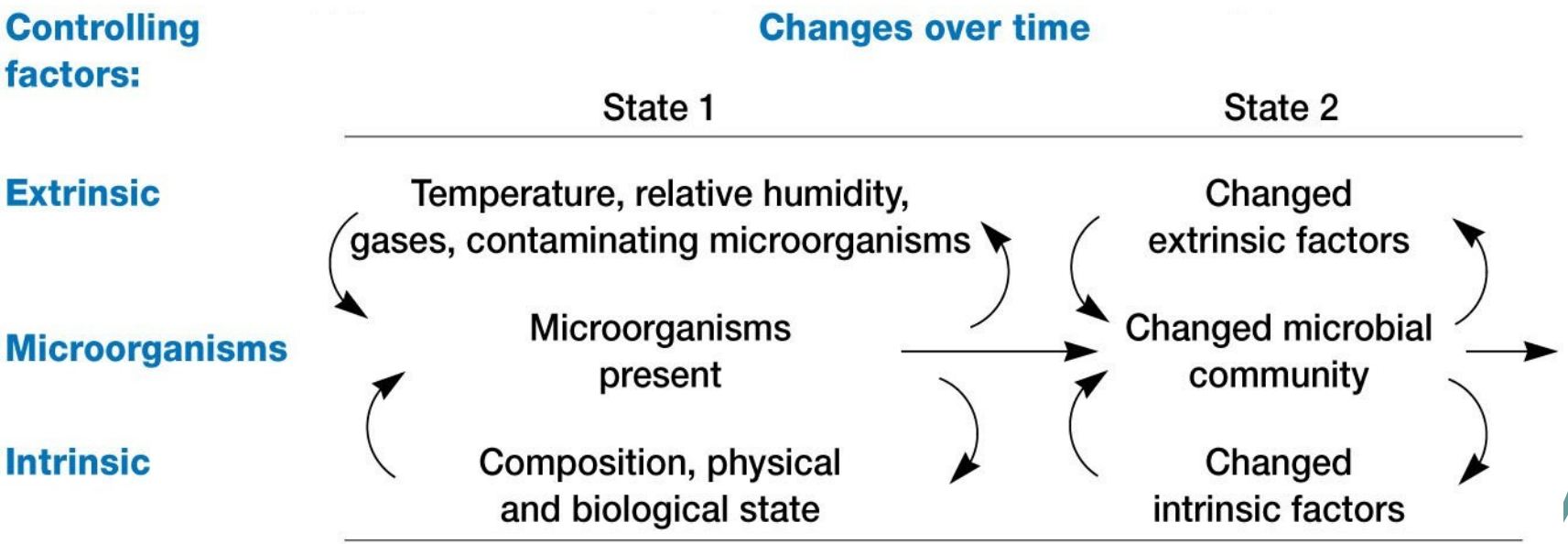
Microorganism	Main habitat
Bacillus cereus, *Clostridium botulinum*	Ubiquitous in soil and on vegetables
Campylobacter	Intestine of animals, fowl, and humans
E. coli, Salmonella	Lower intestine of humans, warm-blooded animals, birds
Shigella	Intestine of humans and primates
Staphylococcus aureus	Common on human skin and oropharynx
Vibrio cholerae	Intestine of humans

Selected Infectious Agents and Their Main Habitats

Microorganism	Main habitat
Giardia lamblia	Intestine of humans, beavers, and muskrats
Cryptosporidium	Intestine of humans and warm-blooded animals
Trichinella spiralis	Striated muscle of carnivorous and omnivorous animals
Hepatitis A virus	Intestine of humans
Norwalk virus	Intestine of humans

Growth Requirements of Microorganisms

- The growth and reproduction of microbes in food can be controlled by certain factors.
- These controlling factors can be internal or external.



Intrinsic factors

- relate to the characteristics of the substrates (food stuffs) that support or affect growth of microbes.
  - Moisture content
  - pH
  - Nutrients
  - Antimicrobial constituents
  - Biological structures

1. Moisture requirement

- Water requirement of micro organisms can be defined in terms of Water activity(Aw)

$$A_w = \frac{\text{Water vapor pressure of food}}{\text{Water vapor pressure of pure water}}$$

- Free water in food is necessary for microbial growth
- Each microbial species has an optimum, maximum, and minimum a_w for growth
- In general, a higher a_w facilitates microbial growth

Water Activity of Various Foods

Food	a_w
Fresh fruit, vegetables, meat, fish	$\geq$0.98
Cooked meat, bread	0.95–0.98
Cured meats, cheeses	0.91–0.95
Sausages, syrups	0.87–0.91
Rice, beans, peas	0.80–0.87
Jams, marmalades	0.75–0.80
Candies	0.65–0.75
Dried fruits	0.60–0.65
Dehydrated milk, spices	0.20–0.50

Lowest Aw Values Permitting Growth of Microbes

Group of microorganisms	Minimal a_w value
Many bacteria	0.91
Many yeasts	0.88
Many molds	0.80
Halophilic bacteria	0.75
Osmotic yeasts	0.60

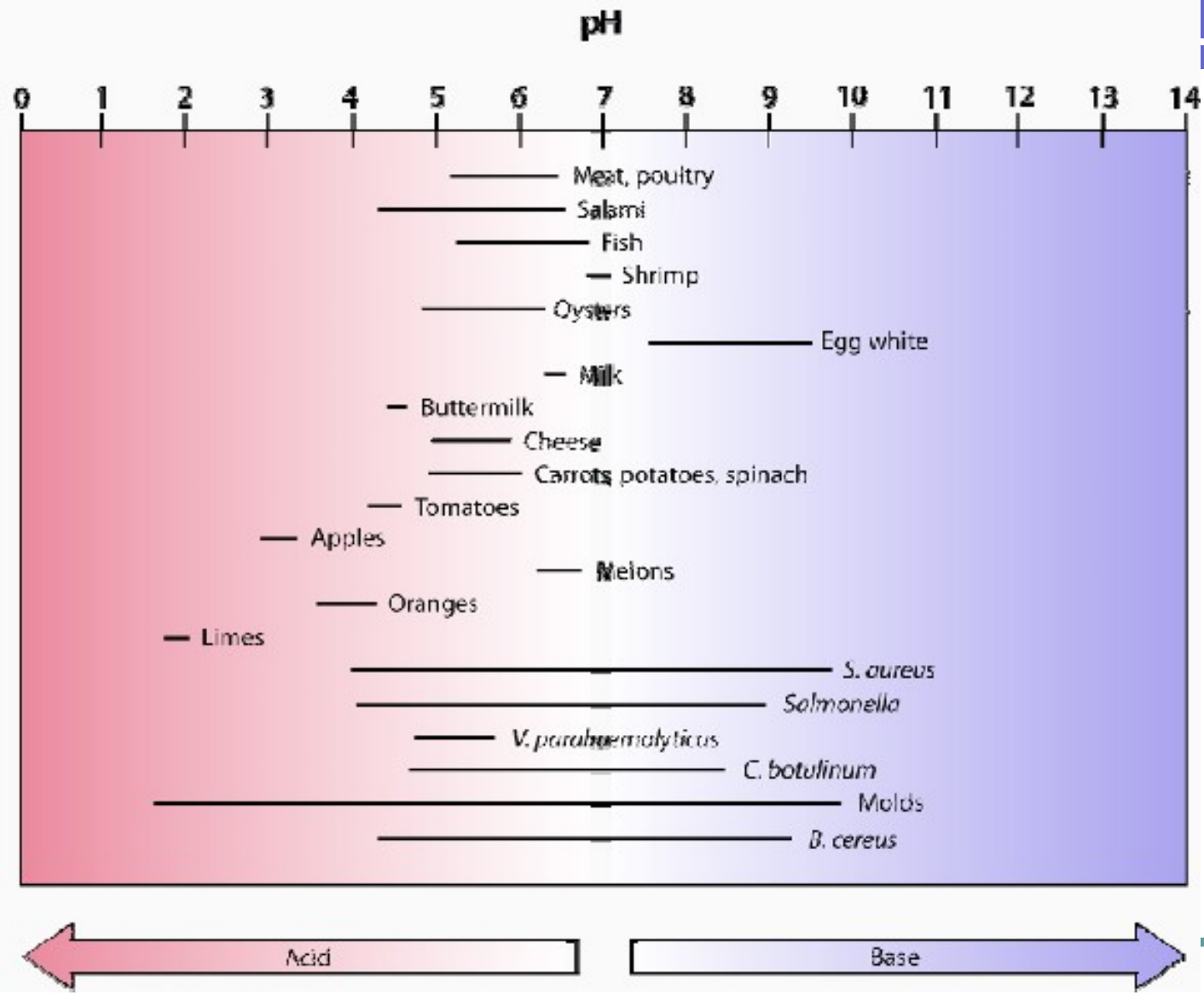
2. pH

pH Values of Some Popular Foods

Product	*Approximate pH range*
Ground beef	5.1 to 6.2
Ham	5.9 to 6.1
Fish (most species)	6.6 to 6.8
Clams	6.5
Oysters	4.8 to 6.3
Crabs	7.0
Butter	6.1 to 6.4
Buttermilk	4.5
Cheese	4.9 to 5.9
Milk	6.3 to 7.0
Yogurt	3.8 to 4.2
Vegetables	3.1 to 6.5
Fruits	1.8 to 6.7
Orange juice	3.6 to 4.3
Melons	6.3 to 6.7
Mayonnaise *(commercial)*	3.0 to 4.1

- Most microbes is near neutral (6.6-7.5)
- Most pathogenic microbes is around 6-8
- Yeasts - 4.0-4.5
- Moulds - 2.0-8.0 (but growth is greater in acidic range)
- Bacterial- near neutral pH

pH values of some popular foods & microbes



3. Nutrients

- Most microbes need external sources of nitrogen, energy, minerals and vitamins to support their growth
- They prefer organic group of foods
- They use carbohydrates and proteins to obtain carbon and nitrogen

4. Antimicrobial constituents

- Is the presence of certain naturally occurring substances in the food that have been shown to have anti-microbial activity.
- Some spices are known to contain essential oils that possess antimicrobial activity
- Example:
  - Coumarins – fruits and vegetables
  - Lysozyme – cow's milk and eggs
  - Aldehydic and Phenolic compounds – herbs and spices
  - Allicin – garlic
  - Polyphenols – green and black teas
  - Citric acid in fruits

5. Biological structures

- Are natural coverings of some foods and provides excellent protection against the entry and subsequent damage by spoilage organisms.
- Example:
  - Testa of seeds
  - Outer covering of fruits
  - The shell of nuts
  - Hide of animals
  - Shell of egg

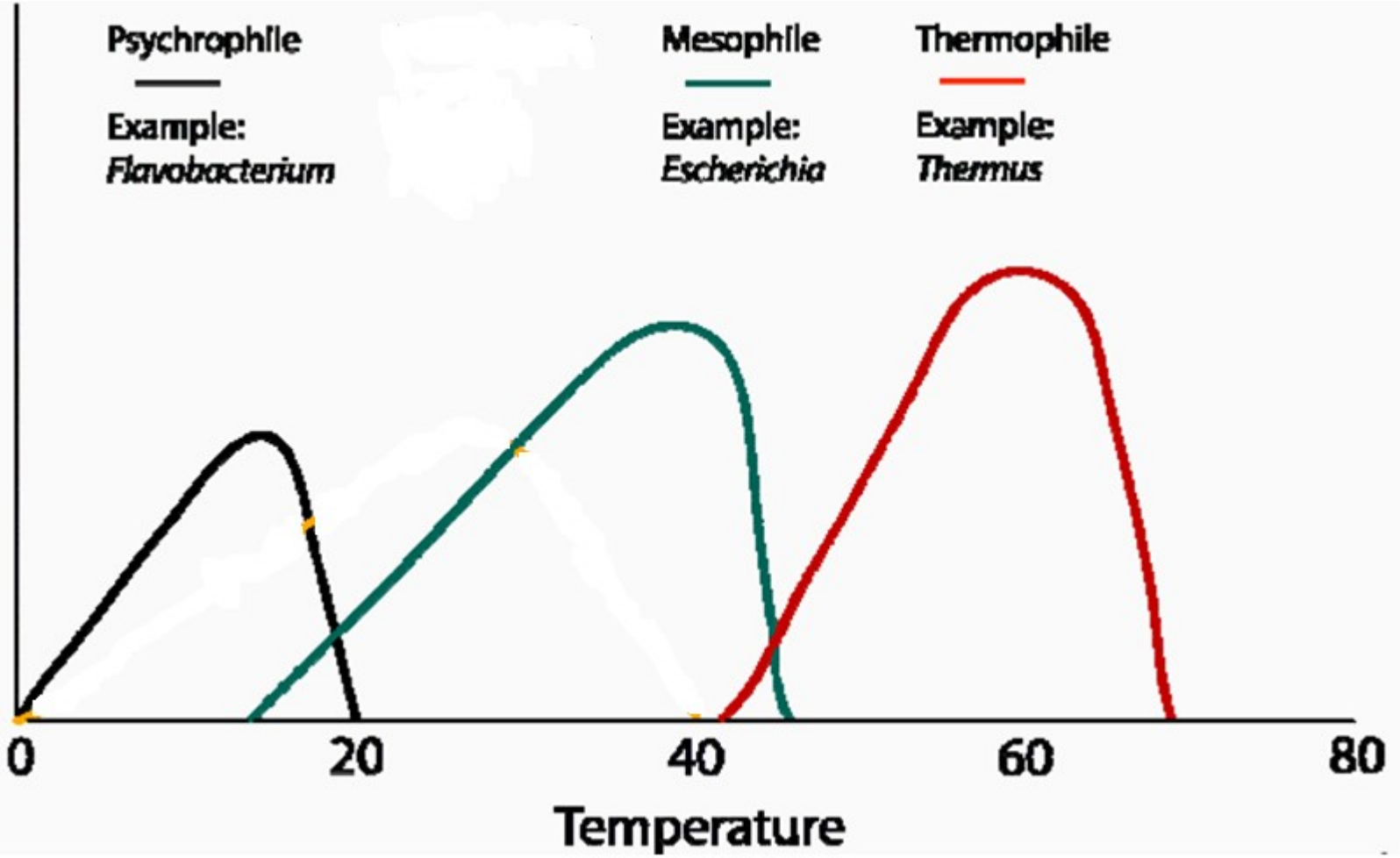
Extrinsic factors

- related to environmental factors that affect the growth rate of microbes.
- are those properties of the storage environment that affect both the foods and their organisms.
  - Temperature
  - Oxygen
  - Relative humidity
  - Presence and concentration of gases in the environment
  - Other factors (Osmotic pressure, light, chemicals….)

1. Temperature

- T° outside the range for growth have a lethal or inhibitory action
- The optimum temperature for the proliferation of most microbes is from 14 - 40 °C.
  - **Psychrophilic** - <20 °C (10-20 °C)
    - Pseudomonas, Moraxella acinetobacter
  - **Mesophilic** – 20-45 °C
    - Lactobacilli, Staphylococci
  - **Thermophile** - >45 °C
    - Bacillus stearothermophilus, Bacillus coagulans, Lactobacillus thermophillus

Preferred temperature ranges for 3 types of Bacteria



2. Oxygen

- The presence or absence of oxygen or other gases may encourage or discourage the growth of a particular type of organism.
  - Aerobic - Pseudomonas, Moulds, Yeasts
  - Anaerobic - Clostridium species
  - Facultative - Lactobacillus species, Staphylococcus aureus

3. Relative humidity

- Foods with low water activity placed at high humidity environment take up water, increase their water activity and get spoiled easily.
- Bacteria require a higher moisture than do yeasts and moulds
- Optimum RH for :
  - Bacteria - ≥ 92
  - Yeasts - ≥ 90%
  - Moulds - 85-90%

4. Concentration of Gases

- Presence of gases like:
  - Oxygen
  - Carbon dioxide
  - Ozone in the environment may facilitate or inhibit micro organisms growth and multiplication.

5. Presence of other factors

- Osmotic pressure
- Light
  - UV light
  - X - rays
- Chemicals and chemotherapeutic agents like:
  - Acids
  - Alkalis
  - Alcohols
  - Salts
  - Heavy metals

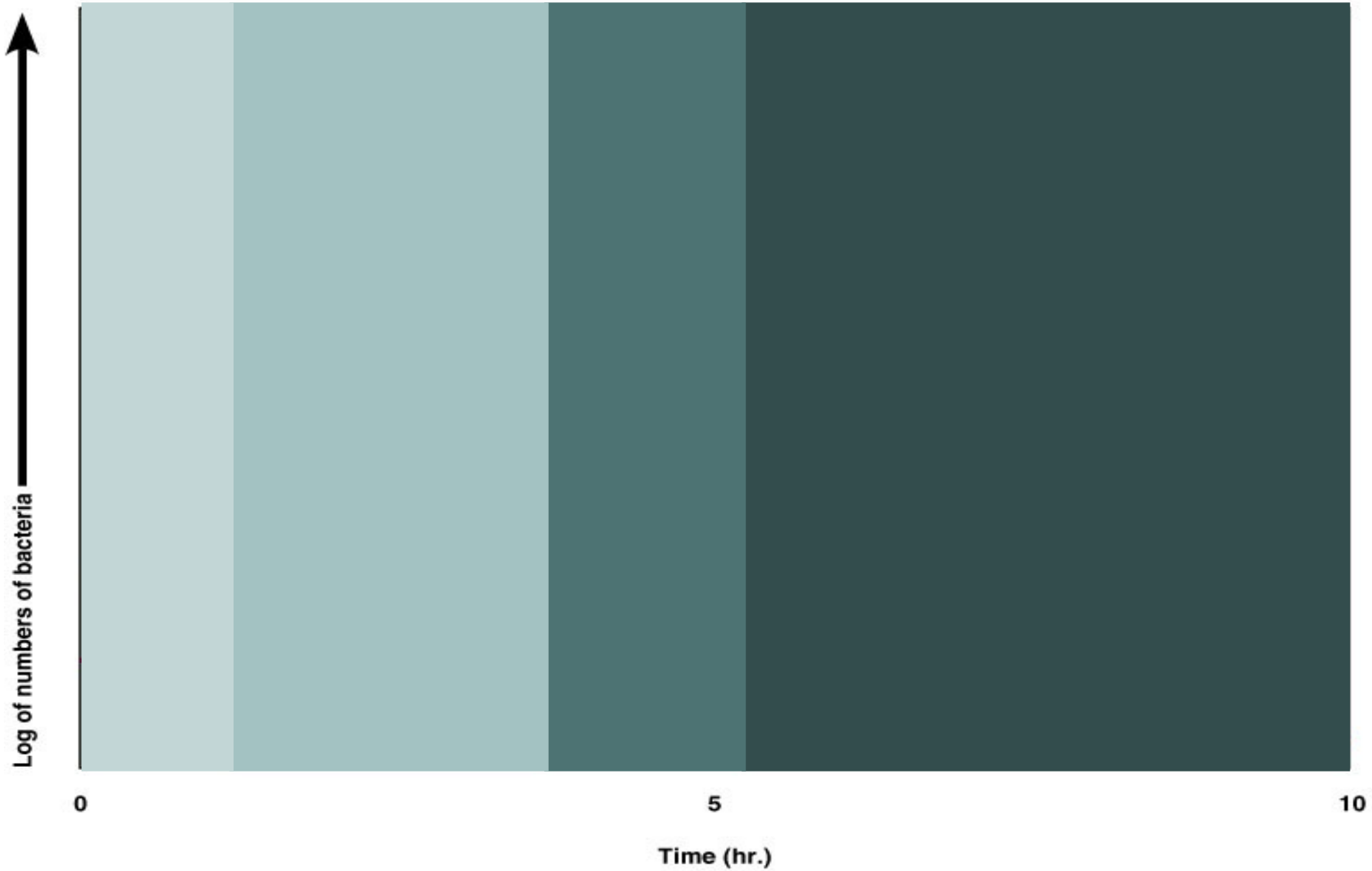
Bacterial Growth Kinetics

- Increase in number not size
- Multiplication of bacteria - Binary fission
- Under favourable conditions - every 20 or 30 minutes
- The growth is exponential
- The growth pattern exhibits fo phases:
  - Lag
  - Logarithmic
  - Stationary growth
  - Decline

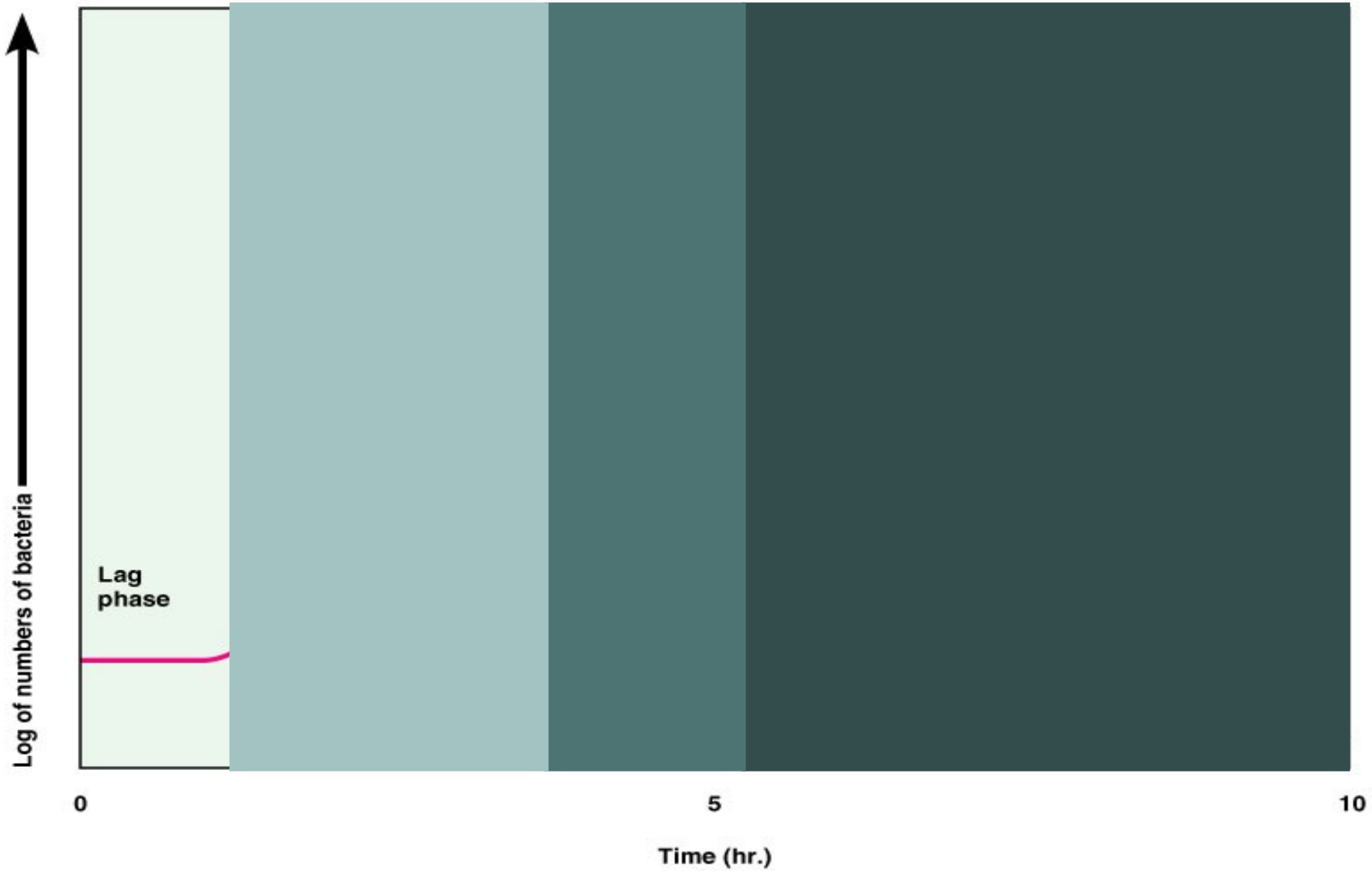
Growth of Bacteria

Time	*Number of Organisms*
30 minutes later	2,000
1 hour later	4,000
1 1/2 hours later	8,000
2 hours later	16,000
2 1/2 hours later	32,000
3 hours later	64,000
3 1/2 hours later	128,000
4 hours later	256,000

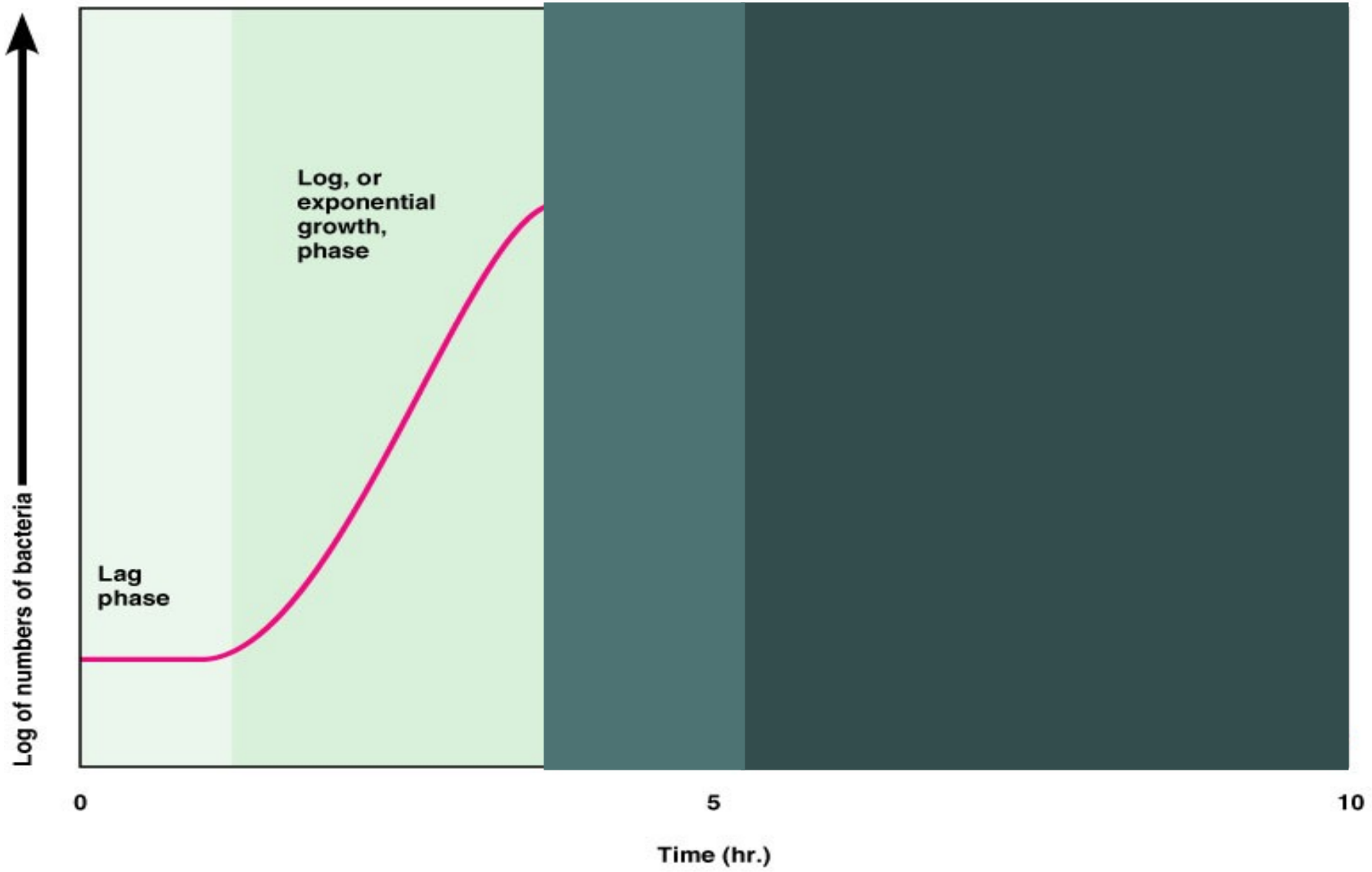
Bacterial growth curve



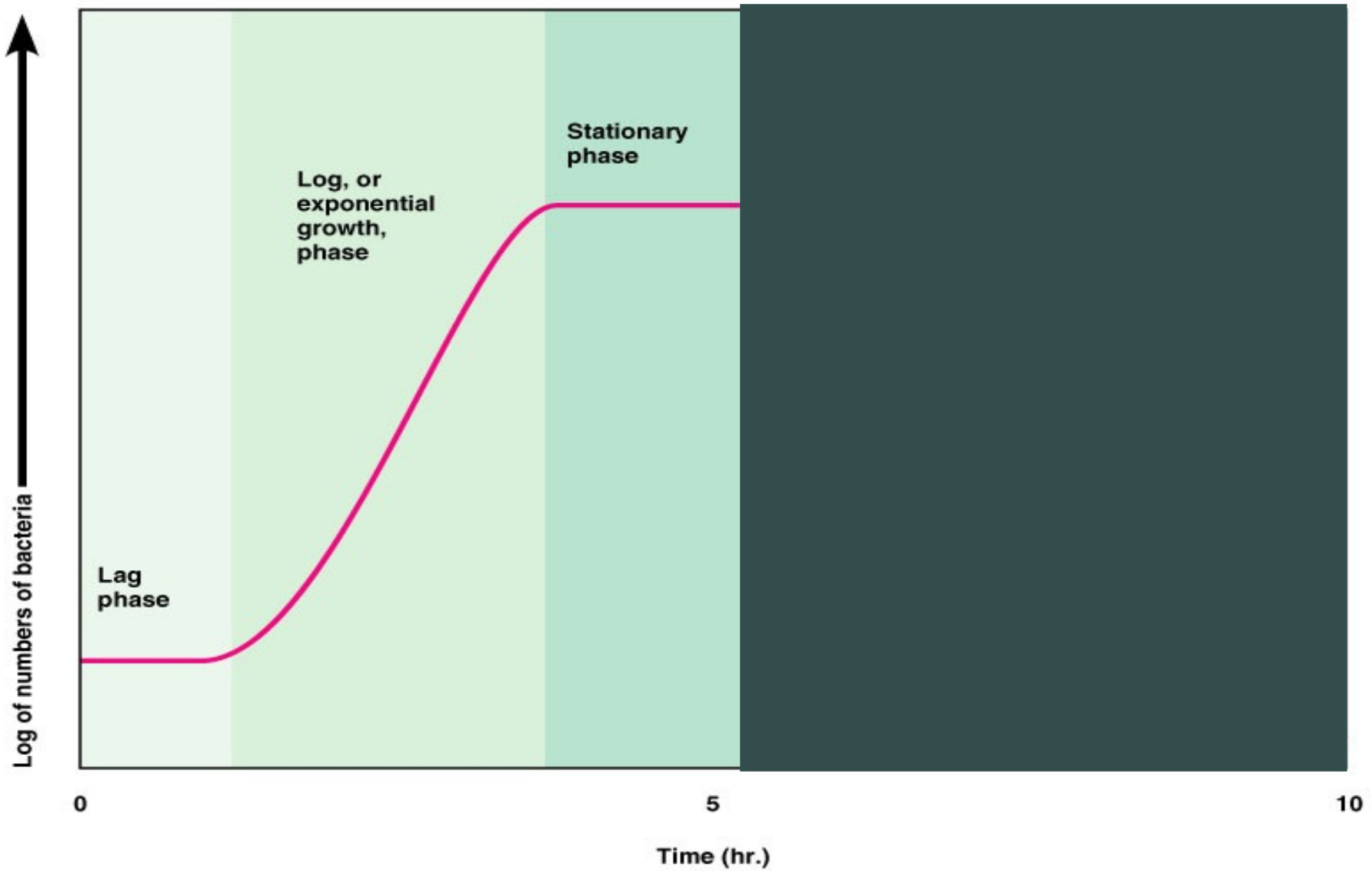
Bacterial growth curve



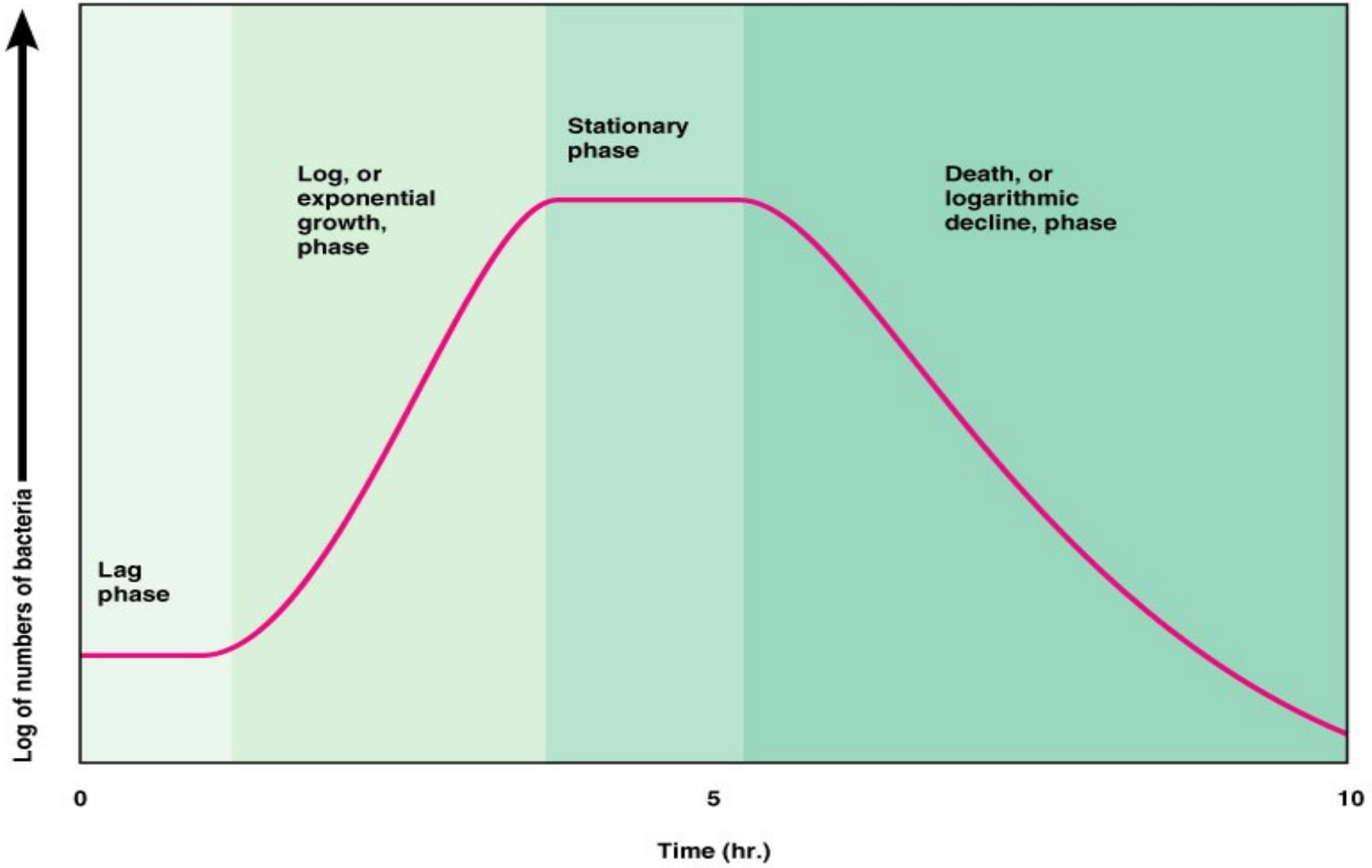
Bacterial growth curve



Bacterial growth curve



Bacterial growth curve



Stages of food contamination

- Contamination can occur at any point/stage along the chain.
  - Production
  - Processing
  - Distribution/transport
  - Storage
  - Preparation
  - Serving

Hazards	Stages	Control measures
Night soil, Chemicals, Poor PH, Irrigation water, Natural toxins	Production	Avoiding of food sources, practicing good PH
FP sanitation, Poor PH, additives	Processing	Validation of Processes T/T°, controlling of additives
Dirty vehicles, T°, breaking of equipment	Distribution	Sanitation of vehicles, T° control
Dirty storing area/premises, T°	Storage	Maintaining storing area/premises hygiene, T° control
T°, Poor PH, cross contamination	Preparation	Good PH, T° control
Poor PH of FH & consumer, equipment	Serving	Good PH, hygiene of utensils

CHAPTER TWO

FOOD SPOILAGE

Learning objectives

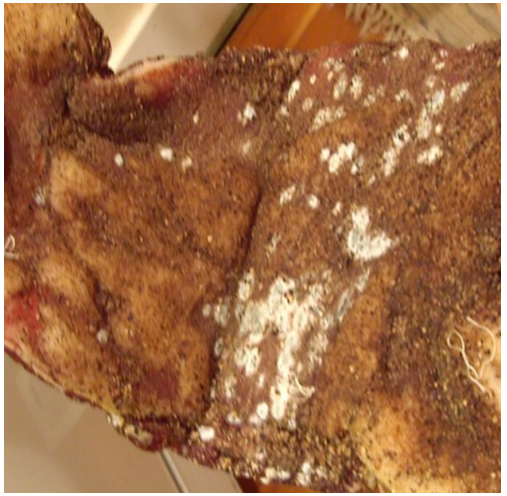
- At the end of the chapter the student will be able to:
  - ✓ Define food spoilage and its manifestations
  - ✓ Identify main causes of food spoilage
  - ✓ Differentiate the different categories of foods based on ease of spoilage
  - ✓ Know consequences of food spoilage and preventive measures

What is food spoilage?

- Undesirable deterioration of the physical and chemical properties of food, making it unsuitable for consumption.
- It leads to change in odour, colour, flavour or texture.







Food Spoilage ...

- Property changes of food may be exhibited as:
  - Decomposition
  - Decaying
  - Fermentation
  - Rotting
  - Souring &
  - Germination






- Changes not necessarily harmful - large number of microbes responsible for food spoilage are non- pathogenic to man







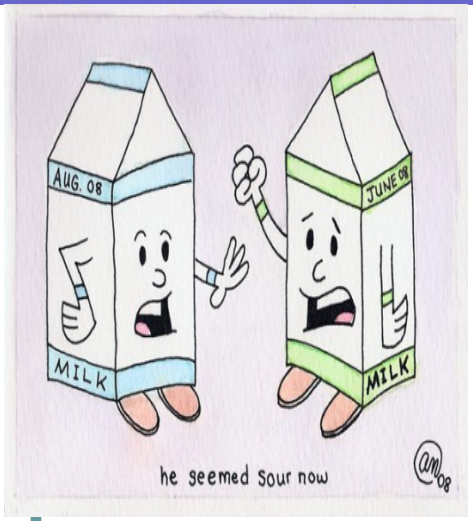


Spoilage signs

- **Odor**
  - Breakdown of proteins – putrefaction

    e.g. “rotten egg” smell
- **Sliminess/texture change**
- **Discoloration**
  - Mould on bread, blue and green mould on citrus fruit and cheese

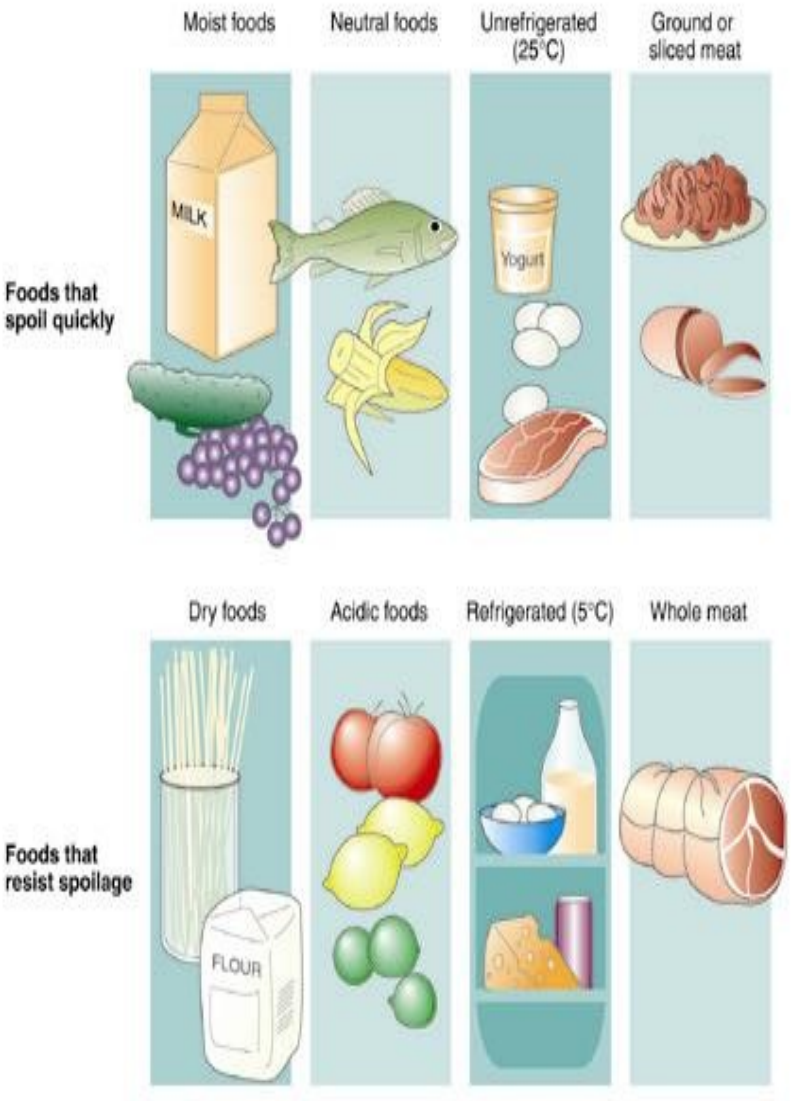
Spoilage signs...



- **Souring**
  - Production of acid
  - ✓ sour milk from production of lactic acid
- **Gas formation**
  - Meat becomes spongy
  - Swollen or bubbling packages and cans



Food Types: Based on rate of spoilage



1) Highly perishable
   - Meat
   - Fruit
   - Milk
   - Vegetables
   - Eggs

WET

2) Semi perishable
   - Potatoes
   - Nuts

3) Stable
   - Rice
   - Flour
   - Dry beans

DRY

Causes of Food Spoilage

1. Microbial
   - Bacteria
   - Yeasts
   - Moulds
2. Non-microbial
   - Enzymes
   - Parasites
   - Environmental factor
   - Insects

Microbial Food Spoilage

- Each food unique microbial environment
  - Unique spoilage agents for each
- Why do microorganisms spoil our food?
  - Food composition ideal source of nutrients for microbes
  - Availability of water and oxygen
  - Suitable pH
- Factors that affect spoilage:
  - Oxygen, T°, pH, Moisture content, Humidity

Spoilage by Enzymes

- Organic catalysts
- Speed up chemical reactions
- Lead to Autolysis
- Cause browning and ripening features in certain foods



Food spoilage causes...

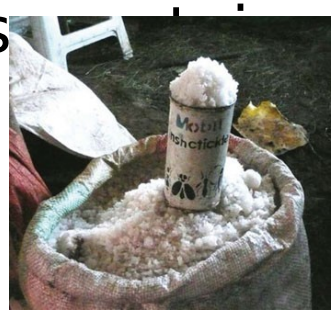
- **Parasites**
  - Parasites like tape worms, flukes and viral infections cause spoilage of meat and meat products
- **Chemical changes**
  - Occurs when there is reaction between food and the surrounding environment/oxygen
- **Physical changes**
  - When spoilage occurs due to dehydration, freezing, heating, drying

Food spoilage causes...

- **Spoilage by insects:**
  - Worms, bugs, weevils, fruit flies, moths cause extensive damage to food and reduce its nutritional value and make it unfit for human consumption.
- **External contaminants:**
  - This includes harmful chemicals like pesticides, insecticides









What happens when you eat spoiled food?

- Eating spoiled food caused by microbes can lead to food borne illness: But not always!
  - Food poisoning
  - Food borne infections



- Most cases of food poisoning are due to common bacteria such as:
  - Staphylococcus
  - Escherichia coli (E. coli)
  - Clostridium botulinum
  - Salmonella
  - Campylobacter



Reasons for keeping foods from spoilage

- Deterioration may cause food to be wasted
  - ✓ Approximately ⅓ of all food manufactured in world is lost to spoilage
- Contaminated food can cause illness
- Money is saved when food commodities are kept from spoilage
- When food is kept from spoilage, it maintains it nutritive value
- It also ensures food is available for use even during lean season

Control of Microbial Spoilage

- Cleaning and sanitation
  - Processing environment
  - Equipment
- Handling with minimal physical damage
- Washing (in some case)
- Proper storage temperature
- Rapid movement of food through processing plant
- Food preservation

Food Preservation techniques

Approach	Examples of Process
Removal of microorganisms	Avoidance of microbial contamination; physical filtration, centrifugation
Low temperature	Refrigeration, freezing
High temperature	Partial or complete heat inactivation of microorganisms (pasteurization and canning)
Reduced water availability	Water removal, as with lyophilization or freeze drying; use of spray dryers or heating drums; decreasing water availability by addition of solutes such as salt or sugar
Chemical-based preservation	Addition of specific inhibitory compounds (e.g., organic acids, nitrates, sulfur dioxide)
Radiation	Use of ionizing (gamma rays) and nonionizing (UV) radiation
Microbial product–based inhibition	The addition of substances such as bacteriocins to foods to control food-borne pathogens

THANK YOU!


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Shiell
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CHAPTER THREE

FOOD BORNE DISEASES

"WHAT YOU CAN'T SEE CAN HARM YOU"

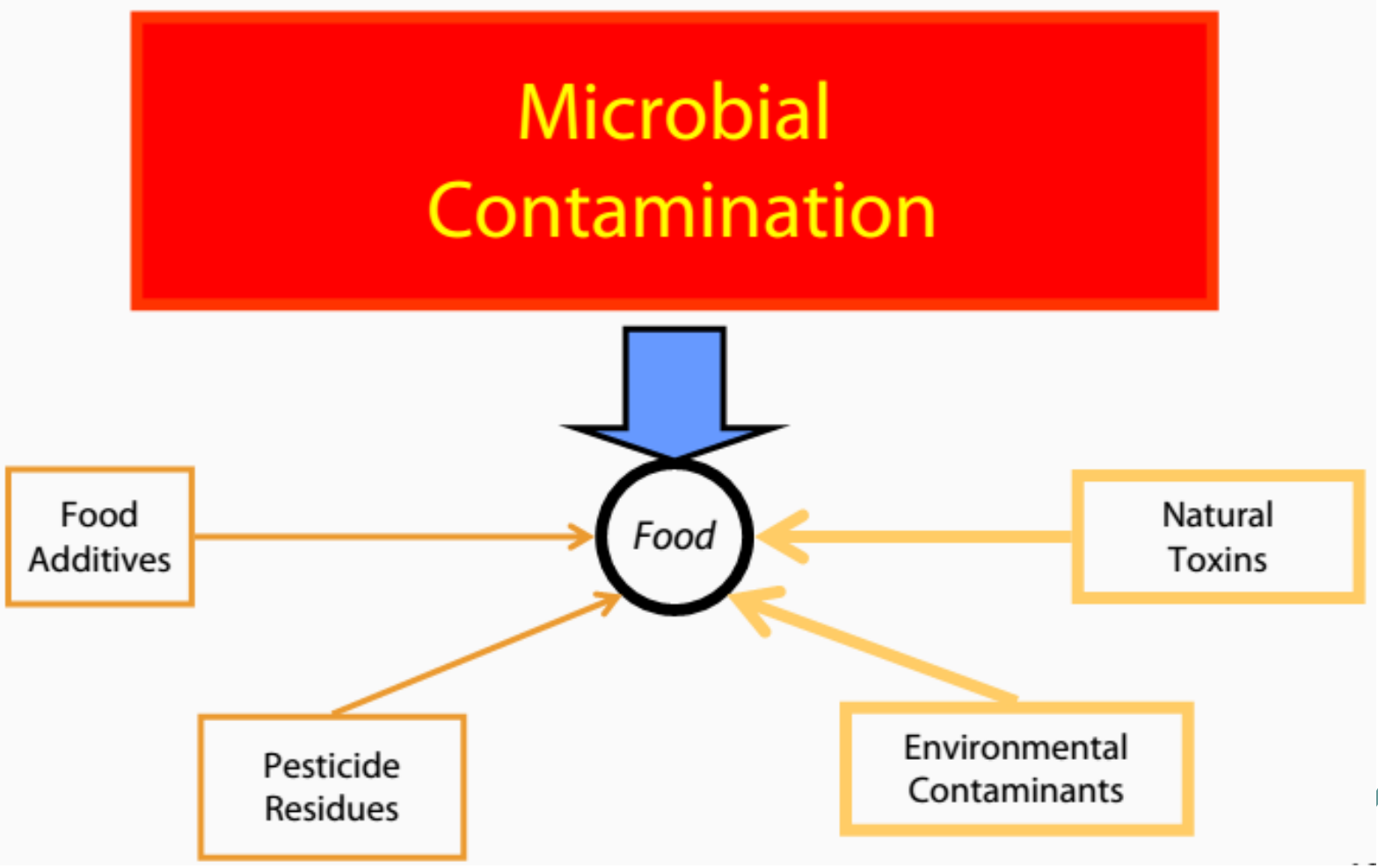
Learning Objectives

- At the end of the chapter you will be able to:
  - ✓ Define food borne disease/illness
  - ✓ Differentiate food borne infections and food borne poisoning/intoxication
  - ✓ Identify the causes, transmission method and control measures of food borne illnesses
  - ✓ Know what food borne outbreak is
  - ✓ Know the measures taken to manage food borne outbreaks
  - ✓ Understand what HACCP is & its elements

What is Food Borne Illness?

- Is a disease which is caused by ingesting of food which is contaminated by:
  - Microbial cells
  - Biological toxins
    - Microbial toxins
    - Poisonous plants
    - Poisonous animals
  - Harmful chemicals
    - Intentional
    - Accidental

Causes of Food Contamination



Common symptoms

Stomach Pain Diarrhea
Vomiting
Nausea
Headache



These are symptoms of a FOODBORNE ILLNESS

Microbial food contamination

- The common microbes causing food borne illness are:
  - **Bacteria**
    - ✓ Salmonella
    - ✓ Campylobacter
    - ✓ Bacillus
    - ✓ Staphylococcus
    - ✓ Clostridium
    - ✓ E-coli 0157:H7
  - **Viruses**
    - ✓ Hepatitis A
    - ✓ Norovirus

Epidemiology

- 2 million deaths/year due to contaminated food worldwide (WHO, 2014)
- They have significant impact worldwide including developed nation like the US.
- The Center for Disease Control and Prevention (CDC) estimates for the US:
  - ✓ 76 million cases/year
  - ✓ >300,000 hospitalization/year
  - ✓ 5000 deaths/year
  - ✓ 400-500 out breaks are reported each year

Epidemiology

- In developing countries like Ethiopia, the problem attains great proportions due to many reasons:
  - ✓ Poverty
  - ✓ Lack of public health awareness
  - ✓ Poor water supply
  - ✓ Poor personal hygiene and
  - ✓ Environmental sanitation

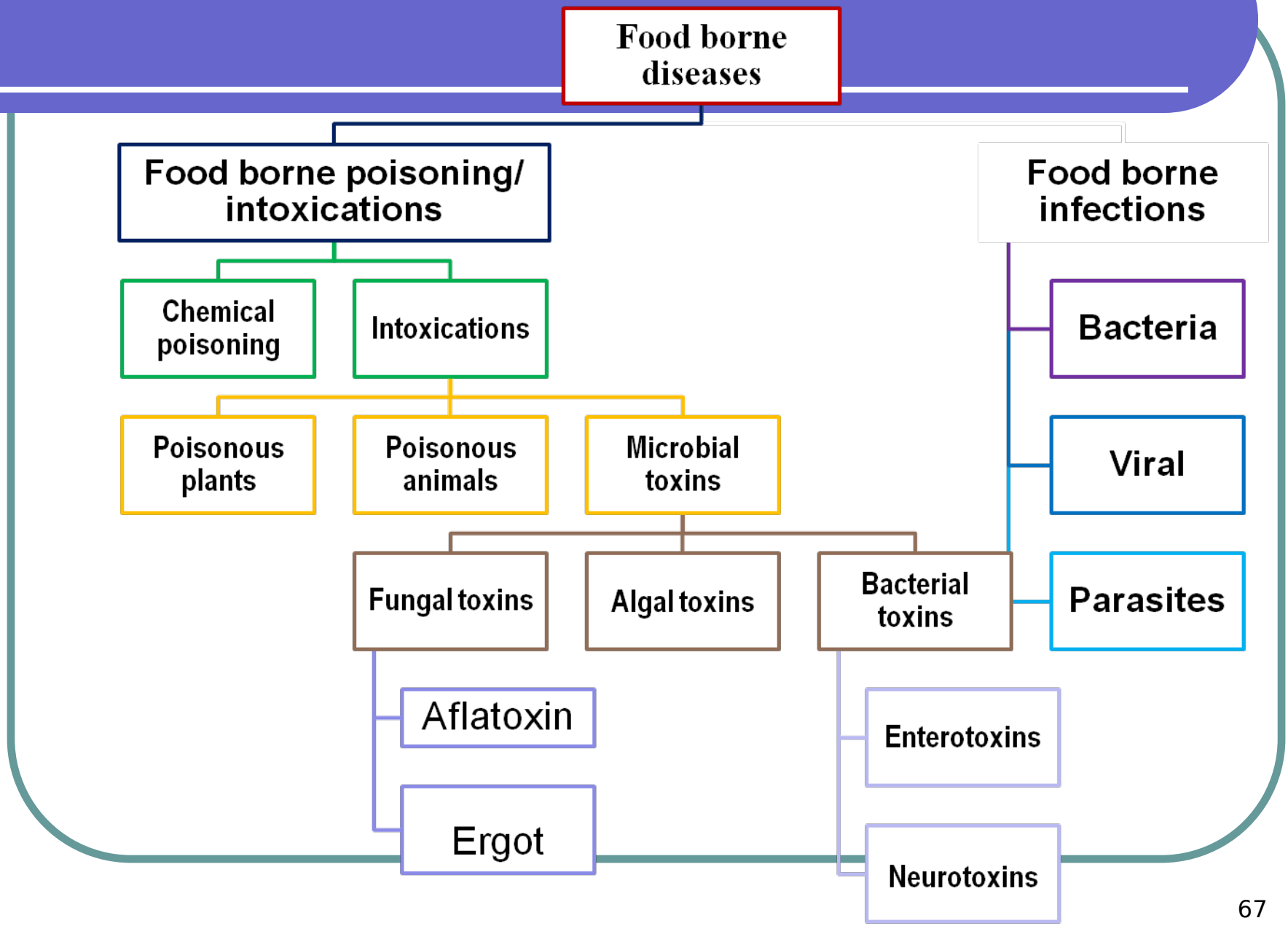
- According to the 2002-2003 *Health and Health-related Indicators* MoH of Ethiopia*:*
  - ✓ Dysentery and different parasitic infections were among the ten top causes of illness
  - ✓ Dysentery was among the leading causes of hospital admissions and deaths
  - ✓ The national average access to safe water was 28.4%
    - o 75.7% for urban &
    - o 19.9% for rural

Epidemiology

- National figure for safe excreta disposal was 11.5%
  - 49.7% for urban &
  - 3.9% for rural
- reported causes of outbreaks
  - Typhoid fever
  - acute diarrheal diseases
  - bloody diarrhoea
  - anthrax

Classification of Food Borne Diseases

- Depending on the causative agent they are grouped into two:
  1. Food-borne poisonings/intoxications &
  2. Food-borne infections


Food borne diseases
Food borne poisoning/ intoxications
Food borne infections
Chemical poisoning
Intoxications
Bacteria
Viral
Parasites
Poisonous plants
Poisonous animals
Microbial toxins
Fungal toxins
Algal toxins
Bacterial toxins
Aflatoxin
Ergot
Enterotoxins
Neurotoxins

1. Food Poisoning/Intoxication

- Caused by ingestion of microbial toxins, swallowing of poisonous plants and animal tissues or due to the consumption of food contaminated by chemical poisonous.
- The main causes of food poisoning are:
  - Staphylococcal food poisoning
  - E. Coli food poisoning
  - Gram positive spore forming bacteria
  - Poisonous plants
  - Poisonous animals
  - Harmful Chemicals

I. Staphylococcal Food Poisoning

- Disease which occurs after eating food which has been contaminated with staphylococcal organisms like:
  - S. aureus
  - S. epidermides
  - S. sapropyticus

Staphylococcus aureus

Toxin	Enterotoxin (heat stable)
IP	1-7 hrs (usually 2-4hrs)
Foods involved	Potato salad, Poultry, Sliced meat, Milk & Milk products
Source	Human & animal origin (human nose & skin/wound)
Contributing factors	Inadequate refrigeration & cooking or heat processing of foods, practicing poor personal hygiene, Keeping food at danger zone
Control measures	Practicing good PH, Exclusion of infected people from food handling, Proper handling of high risk foods, Refrigeration of foods

Haemorrhagic Colitis

Causative agent	Escherichia coli O157:H7 (Shiga toxin)
IP	2- 4 days
Symptoms	Severe abdominal cramps, Bloody diarrhoea, Nausea, Vomiting, Low-grade fever
Foods involved	Ground beef, Unpasteurized apple cider, Unpasteurized milk, Lettuce
Source	Intestinal tracts of infected animals, Fecally contaminated water
Control measures	Thoroughly cook ground beef products, Practicing good personal hygiene, Reheat foods to 165°F for 15 seconds, Refrigerate foods at 41°F or below.

II. Poisoning by Gram positive, Anaerobic Spore forming bacteria

- Common food borne poisonings caused by gram positive spore forming bacteria:
  1. Botulism – caused by Clostridium botulinum, rod shaped bacteria
  2. Perfringens – Clostridium perfringens rod shaped
  3. Cereus – Bacillus cereus rod shaped bacteria

Botulism

Toxin	Neurotoxin (heat liable)
IP	12- 72 hours (average 1-2 days)
Symptoms	Double vision, Difficulty speaking and swallowing, Difficulty with breathing, Paralysis
Foods involved	Home canned foods, Low acid (alkaline) vegetables, Corn, Peas & other cereals
Source	Soil, Plant crops, Intestine of animals
Control measures	Heating suspected food to boiling temperature for some time, Ensuring lower pH(<4.5), Destruction of spores or inhibiting of their growth, Creating aerobic conditions, Refrigeration of foods to below 5°C, Avoidance of home canned foods

Perfringens Food Poisoning

Toxin	Enterotoxin
IP	8-24 hrs (8-12 hrs)
Symptoms	Abdominal cramps, Watery diarrhoea, Nausea
Foods involved	Meat dishes prepared one day and eaten the next
Source	Soil, Spices, Human & animal intestinal tract, Sewage, Poultry, raw Meats
Control measures	• Proper waste management • Cold storage of foods • Adequate cooking of foods • Good personal hygiene of food handlers

Bacillus Cereus Food Poisoning

Toxin	Enterotoxin
IP	10-16 hours
Symptoms	• Abdominal cramps • Watery diarrhoea • Nausea • Vomiting
Foods involved	Meat pies, Rice, Starchy foods (potato, pasta) Food mixtures (soups, sauces)
Source	Soil, Dust and Water
Control measures	• Thoroughly cook ground meat products. • Cool cooked products to 41°F within 4hrs. • Hold hot foods at or above 140°F.

III. Chemical Food Poisoning

- ✓ Caused by ingesting different chemicals with food
- ✓ It may occur in either of the following ways:

I. **Accidental Poisoning**

- Carelessly stored chemicals in food premises might be mistaken for food ingredients and could be added to food during preparation

II. **Unauthorized additives**

- Additives should be added with the right dose with right person





Chemical Food Poisoning…

III. Residues of chemicals on raw food staffs

- This refers to chemicals which have been applied to control crops, vegetables and fruits during growing, storage or processing and remaining as residues which finally may reach mouth of consumers
- Chemicals applied in food service establishments to control rats, flies, cockroaches and oth in may c e carelessly exposed food finally gested with the food





Chemical Food Poisoning



IV. Poisons resulting from containers

- From food utensils & equipment
  - Toxic heavy metals (lead, cadmium, zinc, copper)
- Contamination from containers that are used to store / hold chemicals

V. Radiation accident food contamination

- Radionuclide (Radium 226, Iodine 131, Strontium 90, Cesium 137) in the fallout from a nuclear test explosion or a reactor accident can contaminate foods

Chemical Food Poisoning…

VI. Food sources polluted by toxic/hazardous chemicals such as pollution from industrial effluents

- In areas where there is extensive industry and mining, fish, vegetables and grains accumulate concentrations of toxic substances such as lead and mercury from industrial wastes/ discharges

IV. Poisonous Animals

1. **Paralytic shellfish poisoning**
   - ✓ By consumption of shellfish (mussels and clams)
   - ✓ Ganyaulax Cantanella (poisonous sea weed)
2. **Fish poisoning**
   - ✓ By eating of tetradon type of fishes





Poisonous Animals…

IP	5-30 minutes
Symptoms	Trembling lips, Complete loss of power in muscles of extremities and neck, Respiratory paralysis
Control measures	▪ Avoiding eating of shellfish when in doubt and give enough caution for such foods as to where they are harvested and whether the poisonous weed grows in the area. ▪ Cooking has no effect on poison

V. Poisonous Plants & Fungus

- Food poisoning due to the consumption of plants are commonly related to the ingestion of certain toxic fungi.
- The most common are:
  - Mushroom
  - Water hemlock
  - Grass pea







Mushroom Poisoning

- Certain species of mushroom, such as:
  - Amanita phalloides &
  - Amanita muscaria
- These fungi contain certain:
  - Phalloidine & other alkaloids which are poisonous in nature



Amanita phalloides



Amanita muscaria

Mushroom Poisoning…

- IP
  - ✓ 15 minutes to 15 hours
- Symptoms-
  - ✓ Salivation
  - ✓ abdominal pain
  - ✓ intense thirst
  - ✓ nausea
  - ✓ Vomiting
  - ✓ Watery stools
  - ✓ Excessive perspiration
  - ✓ Flow of tears &
  - ✓ Death in many instances
- Cooking has no effect on the poison

Fungal poisoning

- **Ergot**

- ✓ Ergot is produced by a group of parasitic fungus called Claviseps purpurea
- ✓ These fungi produce the ergot poison in certain cereal crops such as wheat, barely
- ✓ Ergotism is a crippling disease which affects different areas of the body such as the extremities, legs, arms, breasts

Ergotism…

- IP
  - Is very long as it is dependent on the consumption of several meals containing the toxin
- Symptoms
  - Gangrenous involvement of the limbs specially the fingers, toes, occasionally ears and nose
  - Weakness
  - Headaches
  - Painful cramps in limbs
  - Itching of the skin

Ergotism…

- Control measures
  - ✓ Protecting the cereal grains from contamination by ergot producing fungus during growing, storage and processing of the cereals by application of fungicides
  - ✓ If possible, avoiding consumption of single cereal grains such as barley & wheat for long period of time
  - ✓ Cooking or baking has no effect on the poison

Other fungal toxins

-
  - Carcinogens produced in fungus-infected grains and nut products
-
  - Carcinogens produced in fungus-infected corn

Food borne Infections

- Caused by consuming foods or liquids contaminated with:
  - Bacteria
  - Viruses
  - Parasites
- These pathogens cause infection by:
  - Invading and multiplying in the lining of the intestines and/or other tissues.
- Mode of transmission – indirect

Bacterial food borne infections

- The main causative agents of bacterial food borne infections are:
  - Salmonella
  - Vibrio
  - Shigella
  - Camphylocter
  - Listeria

Salmonellosis

Causative agent	Salmonella sps.
IP	6-72 hrs (12- 36 hrs)
Symptoms	Diarrhea, stomach cramps, fever, loss of appetite, headache, nausea & vomiting
Foods involved	Milk, Egg, Poultry
Source	Infected human & animal intestine
Control measures	Hand washing, Thoroughly cooking of all foods, Avoiding recontamination of cooked foods, Do not use raw/cracked eggs Use only pasteurized milk and milk products Keep cold food below 5°C and hot food above 60°C. Educating FH on how to

Typhoid Fever

Causative agent	Salmonella typhi
IP	1-3 weeks
Symptoms	Fever, headache, weakness, loss of appetite, cough & rash, constipation (in adults)
Foods involved	
Source	Intestine of infected human, Water, Soil
Control measures	• Practice good personal hygiene, Practice basic food safety precautions, Avoid water that might be contaminated, Do not drink untreated surface water • A vaccine for typhoid fever is available.

Shigellosis (Bacillary dysentery)

Causative agent	Shigella spp.
IP	1-7 days (1-3 days)
Symptoms	mild to severe diarrhea, fever, nausea, vomiting & cramps, Stools may contain blood, mucus and pus
Foods involved	
Source	Intestines of infected persons, soil, food, water
Control measures	Practice good personal hygiene, Practice basic food safety precautions, Avoid water that might be contaminated

Cholera

Causative agent	Vibrio cholerae
IP	Few hrs to 5 days (2- 3 days)
Symptoms	severe diarrhoea, vomiting, dehydration & shock, death (if untreated)
Foods involved	Seafood (fish, crab, shrimp, oysters), raw or undercooked
Source	Water, intestine of infected humans
Control measures	• Thoroughly cook seafood • Practice good personal hygiene • Proper sanitation of food contact surfaces and utensils • Use a safe water supply

Listeriosis

Cause	Listeria sps. (Listeria monocytogenes)
IP	2-21 days
Symptoms	Meningitis, Spontaneous abortions, Stillbirths, Nausea, Fever, Diarrhoea, Encephalitis, Vomiting
Foods involved	Unpasteurized milk, Soft cheeses made from unpasteurized milk, Raw fruits and vegetables Ready to eat deli meats & salads, Hot dogs
Source	Intestinal tracts of animals & humans, Soil, Contaminated water, Manure
Control measures	Thoroughly cook foods, Use pasteurized milk, Proper sanitation of food contact surfaces and utensils, Thoroughly wash fresh fruits and vegetables, Prevent cross contamination.

Campylobacterosis

Causative agent	Campylobacter jejuni
IP	2-3 days
Symptoms	Abdominal cramps, Headache, Diarrhoea, Fever, Watery and occasionally bloody stools
Foods involved	Poultry, Unpasteurized milk, Raw meat (beef, pork, mutton), Shellfish
Habitat	Normal microflora of most animals & poultry, Contaminated water, Infected pets
Control measures	Thoroughly cook meat, poultry and fish, Proper hand washing after handling raw meat, poultry and seafood, Use pasteurized milk, Use a safe water supply

Viral Food borne infections

- The main are:
  - Norovirus
  - Hepatitis A
  - Rota virus

Rotavirus gastroenteritis

Cause	Rotavirus
IP	1–3 days
Symptoms	Vomiting, watery diarrhoea, abdominal pains and mild fever
Foods involved	Ready-to-eat foods such as salads, sandwiches, baked products, contaminated water
Habitat	Human faeces, faecal contaminated waters, faecal contaminated food
Control measures	Prevent ill food workers from working until fully Recovered, Ensure that food workers practice good personal hygiene, Avoid cross contamination, Clean and sanitize food contact surfaces, Use potable water

Hepatitis A

Causative agent	Hepatitis A virus
IP	10-50 days
Symptoms	Loss of appetite, Nausea, Vomiting, Fever, Jaundice
Foods involved	Seafood, Any food handled by an infected food handler
Habitat	Intestinal tracts of infected humans, Contaminated water
Control measures	Thoroughly cook seafood including oysters, Practice good personal hygiene

Parasitic food borne infections

- The main causative agents which lead to parasitic food borne infections include:
  - Giardia
  - Amoeba
  - Tania
  - Trichinella

Giardiasis

Causative agent	Giardia lamblia
IP	1-4 weeks
Symptoms	Diarrhoea, Bloating
Foods involved	Water, Any food handled by an infected food handler
Habitat	Intestinal tracts of infected animals & humans, Water
Control measures	Proper disposal waste, drinking of chlorinated water, Cooking contaminated foods, Boiling suspect water, practice good personal hygiene

Trichinosis

Causative agent	Trichinella spiralis
IP	1 day – 8 weeks
Symptoms	Diarrhoea, Fever, Profuse sweating, Weakness, Muscular pain, Swelling around eyes
Foods involved	Pork, Wild game (bear)
Habitat	Muscle tissue of infected animals
Control measures	• Thoroughly cook pork and wild game • Storing infected meat in a freezer with a temperature no higher than -13^{0}F for 10 days will also destroy the parasite


FOOD BORNE DISEASE OUTBREAK

What is food borne disease outbreak?

- Food borne disease outbreak:
  - The occurrence of two or more cases of a similar illness resulting from the ingestion of a common food.
  - An unexpected increase of a similar illness and food is a likely source.

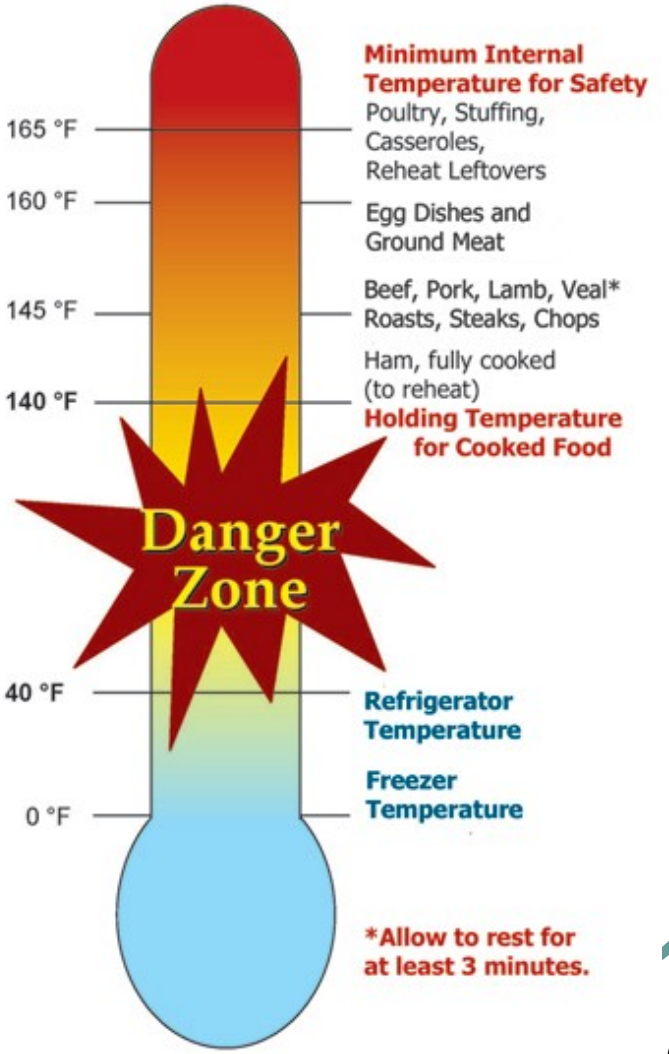
- These factors can be categorized into 3 groups:
  1. Microbiological contamination of food
  2. Improper time / temperature control
  3. Other sources of contamination

1. Microbiological contamination of food

- Use of risky foods (raw, undercooked, unpasteurized)
- Cross-contamination(The process by which bacteria are transferred from one area to another)
- Infected food handlers
- Poor personal hygiene
- Unsanitary dish ware & utensils
- Improper food handling procedures
- Unhygienic food preparation area
- Improper handling of leftovers

2. Improper time / temperature control

- ✓ Inadequate cooking
- ✓ Unsafe food holding (danger zone) - 4°C and 60°C
- ✓ Improper cooling
- ✓ Inadequate reheating



3. Other sources of contamination

- Insects and rodents
- Chemicals









How can we identify foodborne disease outbreaks?

- Food borne illness complaints from private citizens
- **Medical evaluations** of ill individuals from healthcare professionals at hospitals, clinics, or physician offices
- **Routine surveillance and case investigation** of reportable diarrheal illnesses by epidemiologists and public health nurses at state and local health departments

How can we identify foodborne disease outbreaks?

- **Routine laboratory testing** and techniques conducted by microbiologists
- Information received through the media and public information officers
- **Reports from state and federal food safety** regulators and environmental health specialists

Investigation of foodborne disease outbreaks

- Food borne disease out breaks are among the common occurrences everywhere.

- Why we do an investigation?

  - To **prevent reoccurrence** of food borne disease out breaks systematic investigations have to be made.

Objectives

- To identify the cause, the risk factor(s), or source of infection
- To **determine how the food staff became contaminated**
- To implement interventions or corrective actions to prevent others from becoming ill
- To fulfill statutory obligations and respond to public and political concern
- To evaluate existing recommendations or strategies for preventing similar outbreaks
- To **educate responsible** people in the prevention of similar occurrences

Investigation procedures

1. Take prompt action whenever outbreaks occurred or reported
2. **Immediately visit and make a complete inspection** of the places where the suspected foods were consumed and make a complete inspection
3. **Interview** as many persons as possible that partook of the suspected food
4. Prepare a questionnaire suitable for the outbreak to be completed for each person. It should contain pertinent questions
5. If patients to be visited are hospitalized or being treated, **obtain information from the responsible physician**

Investigation procedures

6. Obtain **specimens of stool/vomits** from ill persons
7. Collect and obtain for laboratory examinations from the suspected food or beverage that was served and appropriate specimen from the victims or the food handlers
8. Arrange for the **immediate laboratory examination** of the food samples and specimen collected for conformed diagnosis

Personnel involved in investigation

- Epidemiologist (public health practitioner)
- Environmental health officer (food safety controller)
- Laboratory professional (microbiologist, toxicologist)
- Physician (clinician)
- Others (community leaders, press officer, Hospital director, Secretarial and logistic support)

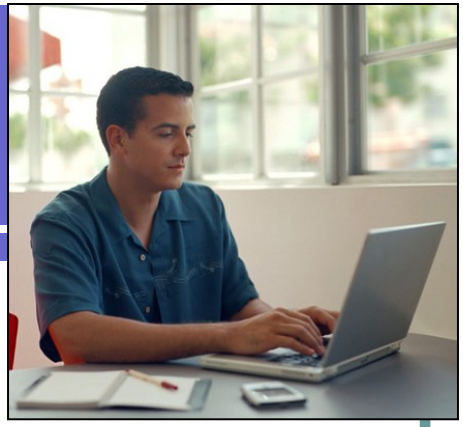
Env't Health Investigator



The Env'tal Health Investigator focuse
Contaminated food:

- Receives foodborne illness complaints
- Investigates suspected food and/or food establishment
  - Interviews food workers and managers
  - Examines food storage, handling, preparation
  - Identifies factors that resulted in food contamination
  - Collects environmental and food samples
  - Collects paperwork
- Implements control measures

Epidemiologic Investigator



The epidemiologist investigator focuses on cases:

- Analyzes data from pathogen- specific surveillance & identifies clusters
- Characterizes cases by time & place
- Plans epidemiologic studies
- Interviews cases and healthy controls
- Analyzes and interprets results of epidemiologic studies

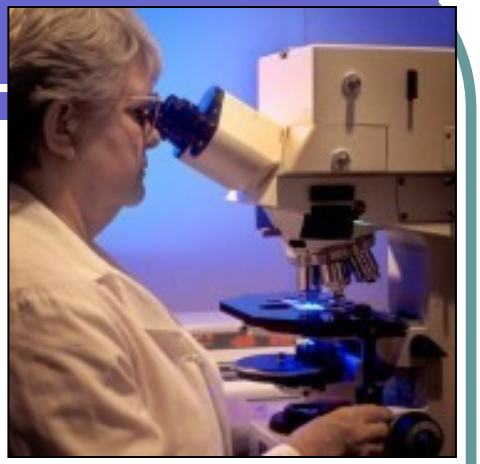
Public Health Nurse



The public health nurse focuses on patients:

- Interviews patients
- Collects clinical specimens from patients
- Administers questionnaires for epidemiologic studies
- Advises patients on how to prevent spread of illness
- Provides public health education

Laboratory Investigator



The laboratory investigator focuses on specimens:

- Analyzes clinical, food, and environmental specimens
- Interprets test results
- Advises team about tests and collection, handling, storage, and transport of specimens
- Coordinates additional testing by partner laboratories

Prevention Measures

Trace back Investigations

Epidemiologic Investigations

Environmental Assessments

Laboratory Investigations

FOOD BORNE OUTBREAK INVESTIGATION FLOW CHART

Outbreak investigation

- Conduct environmental assessment
- Contact supervisor
- Inspect food establishment and enforce safe handling practices
- Interview manager & distribute food employ surveys
- Obtain menu & collect food samples for testing
- Conduct HACCP inspection
- Report findings

- Conduct epidemiologic investigation
- Contact & coordinate with key personnel
- Obtain clinical specimens & food samples
- Implement control & preventive measures
- Define cases & conduct case finding
- Develop possible hypothesis
- Plan & conduct epidemiological study to test hypothesis
- Analyze data & interpret results
- Report finding

How we can prevent food borne disease?

THE BEST APPROACH IS APPLYING OF HACCP

Hazard Analysis and Critical Control Points (HACCP)

- **What is HACCP?**
  - **Systematic preventive approach** that identifies specific **hazards and measures** for their control to ensure the safety of food.
  - A tool to assess hazards and establish control systems from farm to table that focus on prevention rather than relying mainly on end-product testing.
  - Before doing HACCP Flow diagram should be developed

HACCP Principles

1. Assess the hazards and risks
2. Determine the CCP(s) required to control the identified hazards
3. Establish the critical limits that must be met at each identified CCP
4. Establish procedures to monitor the CCP(s)
5. Establish corrective actions
6. Establish procedures for **verification** that the HACCP system is working correctly
7. Establish effective **record-keeping systems** that document the HACCP plan

1. Conduct a Hazard Analysis

- Assess the hazards and risks associated with the growing, harvesting, raw materials, ingredients, processing, manufacturing, distribution, marketing, preparation, and consumption of the food in question.
- Hazard
  - Biological
  - Chemical
  - Physical

2. Determine Critical Control Points

- A CCP is an operation or step by which preventive or control measures can be exercised that will eliminate, prevent or minimize a hazard that has occurred prior to this point.
- All hazards identified in step #1 (Hazard Analysis) must be controlled at some point in the process
- 2 types of CCPs:
  - CCP1 – to control hazards
  - CCP2 – to minimize hazards

3. Establish Critical Limits

- Critical limits
  - ✓ One or more prescribed tolerances that must be met to ensure that a CCP effectively controls a hazard.
  - ✓ To prevent, reduce or eliminate hazards
  - ✓ These limits can be obtained **experimentally, from regulatory sources, expert opinions and surveys** of the literature pertaining to a particular product.

4. Establish Monitoring Procedures

- Monitoring is a scheduled observation of a CCP and its limits
- Monitoring is essential because it:
  - Tracks the operation of a process and predicts trends that might eventually result in exceeding limits previously set
  - Determines if a critical limits being exceeded
  - Provides confirmation or documentation of the HACCP plan

5. Establish Corrective Actions

- When there is **deviation from an established CCP**, corrective actions must be taken to prevent a product that may be unsafe from reaching consumers
- Corrective action must include:
  - Correcting the problem and putting the process back in control
  - Placing the product on hold pending evaluation of safety

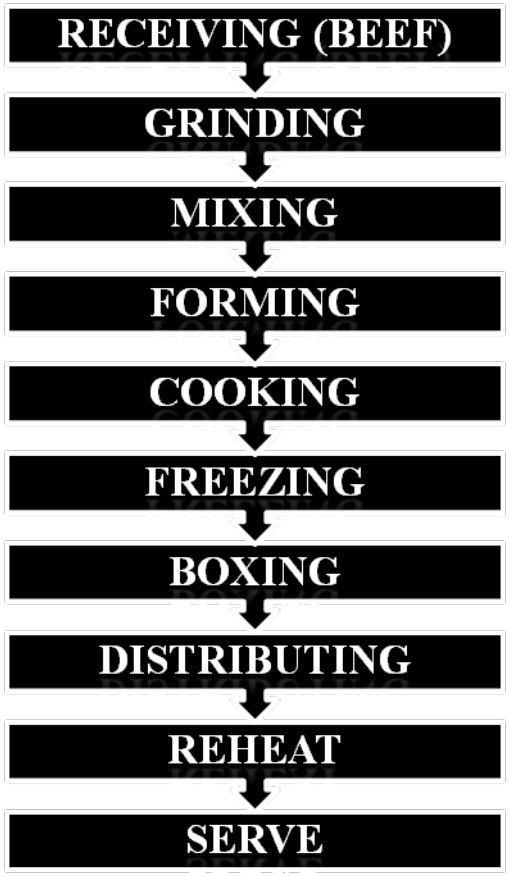
6. Establish Verification Procedures

- Every HACCP plan should be examined to validate its ability to control food safety hazards that are reasonably likely to occur, and that the plan is being effectively implemented
- Verification should include:
  - Reassessment of the HACCP plan
  - Review of CCP records
  - Review of deviations
  - Random sample collection and analysis
  - Records review

7. Establish Record Keeping & Documentation Procedures

- The HACCP plan must be on file at the facility
- It must include documentation relating to CCP's and any action on deviations and/or disposition of product
- Types of records could include:
  - Processing
  - Deviation
  - Ingredients
  - Product safety
  - Storage and distribution
  - Validation studies

Example of a flow diagram for the production of frozen, cooked beef patties



Limitations of HACCP

1. HACCP requires the education of non-professional food handlers
2. To be effective, this concept must be accepted not only by food processors but also by food inspectors and the public.
3. Expert variability - experts will differ as to whether a given step is a CCP and how best to monitor such steps
4. The adoption of HACCP by industry has the potential of **giving false assurance** to consumers that a product is safe, and, therefore, there is no need to exercise the usual precautions between the purchase and consumption of a product.

Merci!



CHAPTER FOUR

FOOD AND DRINKING ESTABLISHMENTS







Learning outcomes

- When you have studied this session, you should be able to:
  - Describe the categories of food and drink establishments
  - Explain the hygienic requirements that are applicable in food and drink establishments
  - Explain the hygienic behaviors required of food handlers
  - List the sanitary facilities required in food and drinking establishments
  - Describe the procedure for sanitary inspection in food and drinking establishments

What is a food and drink establishment?

- Are places where food and drink is prepared in large quantities for public consumption.
- Are also called food catering establishments.
- Food & drink establishments have a legal and moral responsibility to provide safe food and drink to the consumers.

Types of food and drinking establishments

- According to USA FDA divided into 3:

1. Establishments open to public patronage
   - These are establishments open to the public at large all the time.
   - Commercial establishments (Restaurants, cafes, fast food outlets, bars, hotels)
2. Establishments offering semi- public food service
   1. These are food establishments that give service to persons to whom other eating facilities are not available
   2. Health institutions, educational institutions, prison institutions and industrial plants

- Establishments providing a limited type of food service
  - Private clubs, fraternal orders, various societies, churches and religious affiliated organizations where service is provided to their members only.

Categories of FDEs

- There are several types of FDEs based on the service they are providi
  - Restaurants
  - Cafés
  - Grocery
  - Bakery
  - Hotel
  - Butcher shop
  - Tea houses
  - Tej bet
  - Areki bet







Hygienic requirements of FDEs

1. Licensing
   - ✓ There should be a system for licensing FDEs
   - ✓ *Woreda* health office is responsible
2. Location

- The FDE should be:
  1. Well away from any source of hazards (marshy areas, waste disposal sites and flooding).
  2. Conveniently accessible to staff and consumers.
  - ✓ At a distance from public institutes such as schools and health facilities.
  - ✓ Access to clean air and natural lighting

Hygienic requirements of FDEs

3. Sanitary facilities

I. Adequate & wholesome water supply from approved source
   - Hot and cold running water
   - Ice should be prepared from water of drinking quality

II. Adequate toilet and lavatory facilities for customers & workers
   - Conveniently located and accessible
   - Separate showers for males and females
   - Proper toilet seats which are easy to clean and urinals
   - Toilet not near and not opening to dining rooms or areas where food is prepared
   - Proper wash hand basins with soaps
   - Toilets having self- closing doors (if possible)
   - Hand drying facility(preferably machine otherwise towel)

Hygienic requirements of FDEs

III. Proper waste collection and disposal systems

- Properly drained
- Washable, easy to clean and convenient to handle waste containers(dust bins) with proper covers
- Wastes should be properly collected and disposed

IV. Proper plumbing connections(water & WW)

- Properly installed and maintained
- Proper types (non-corrosive or rusting types)
- No cross- connection of water and waste pipes

V. Proper insect & rodent proofing and control methods

VI. Keeping cleanliness of floors, walls and ceilings

Hygienic requirements of FDEs

VII. Adequate utensils of sanitary standard
VIII. Proper ventilation of all rooms

IX. Proper lighting of rooms, work areas, toilets

X. Dressing rooms together with lockers

XI. Properly trained, hygienic, and healthy food handlers

Recommended equipment and utensils

- Food equipment and utensils should comply with the following sanitary requirements:
  - ✓ Should be of good repair and with no cracks
  - ✓ No chips, pits or open seams that can hold microorganisms
  - ✓ Should be smooth and easily cleanable
  - ✓ The equipment and utensils should be of approved material
  - ✓ Cause no corrosion or rusting

Dish Washing in FDEs

- ✓ It has its own procedure and should be followed.
- ✓ Dish - plates, cups, glasses, spoons, forks and other utensils.
  - Significance of effective dish washing

1. Health aspect
   - Health vs disease: dishes may serve to transmit many diseases if they are not cleaned
   - Aesthetic reason: people like to be served with clean utensils
2. Economic aspect
   - The consumer may refuse to eat or pay food served with unclean dishes

Dish Washing in FDEs

- Two methods of dish washing:
  1. Manual - done by hands
  2. Mechanical - done by machine
- Two accepted dish washing svstems:
  1. The three compartment
  2. The two compartment







Dish Washing in FDEs

- Essential steps in dish washing

1. Get ready wash materials and equipment
   - Clean sinks or vats of 2 or 3 compartment
   - Hot wash water(43°C to 49°C)
   - Detergent or soap
   - Scraper
   - Garbage can
   - Drying racks
   - Sanitizing chemicals(disinfectants)
2. Scrap the dishes
3. Wash the dishes in compartment one
   1. Wash each dish separately

Dish Washing in FDEs

4. Rinse the dishes washed in compartment two
   - This helps to remove soap or detergent retained while washing at compartment one
   - Rinsing is done by dipping repeatedly the dishes in warm clean water

5. Sanitize the dishes in compartment three
   - ✓ To ensure the dishes are free of pathogenic organisms and the total bacteria count is also highly reduced
   - ✓ The procedure is performed by immersing the articles in hot water(77°C) or in a disinfectant solution such as Cl

- ➢ Dry the sanitized articles in air
- ➢ Store appropriately the sanitized dishes
- ➢ Clean the vats

Dish Washing in FDEs

Factors affecting cleaning performance

- **T**ime: contact time on the surface being cleaned
- **A**ction: physical force exerted on to the surface
- **C**oncentration: amount of cleaner used
- **T**emperature: temperature of the cleaning water
- **N**ature: composition of the dirt
- **S**urface: nature of cleaned material

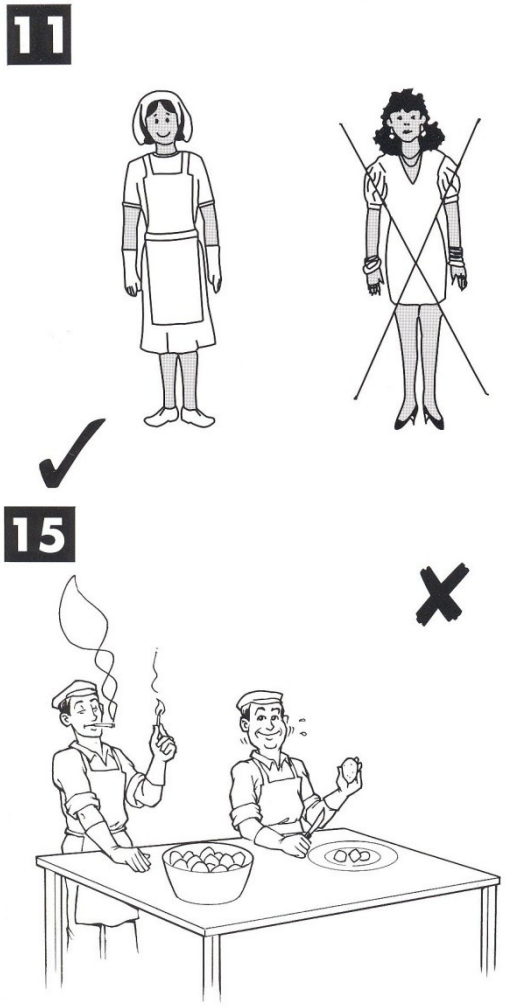
Food handlers’ health and hygiene

- Food handlers are a common source of food borne diseases.
- The practice of good personal hygiene is essential for anyone who handles food.
- A sick food handler with symptoms of diarrhoea, eye and ear discharges, skin infections, open cuts and wounds, or coughing should be excluded until full recovered.

Food handlers' health and hygiene

Unhygienic practices by food hand

- Poor personal hygiene practice
- Unguarded coughing or sneezing
- The habit of licking the fingers
- Nose picking or fingering the nose
- Handling of handkerchiefs
- Working in street clothing
- Spitting in food-handling areas
- Uncovered hair
- Smoking in kitchens





Sanitary Inspection of FDEs

- Is a set of activities concerned with the preservation of public health and the investigation of environmental hazards in food establishments.

Purpose of Inspection

- Sanitary inspection aims to investigate and detect:
  - Food spoilage and its sources
  - Food contamination and its sources
  - Provision for hygienic procedures (dish and hand washing, food storage)
  - Provision of sanitary facilities (latrine, water, shower, hand washing)
  - The proper location of the establishment
  - The hygienic practice of food handlers
  - Proper waste management (storage, collection and disposal)
  - The presence of vectors

Sanitary Inspection of FDEs

Types of Inspection

1. Initial/complete inspection
   - ✓ This is a detailed type of inspection, which should be made when a property or establishment is first brought under department control to determine compliance with the law of the government that regulates food and drinking establishments.
2. Routine inspection
   - ✓ These are usually regular inspection of establishments based on a field inspection form to determine compliance with sanitary rules and regulations

Sanitary Inspection of FDEs

3. Re-inspection

- A re-inspection would be made as a follow up on routine inspection, particularly when significant violations are noted to determine whether the needed correction have been made.

- Two forms of inspection:
  I. The planned form: this is the programmed and routine type
  II. The unplanned form: this is incidental, occasional or urgent type made based on call, information of an out break

Sanitary Inspection of FDEs

Preconditions for the inspection of FDEs

- Inspection should be purposeful:
  - To educate and persuade to monitor faults and to prevent the occurrence of food borne diseases
- It should be legal
  - An inspector should be licensed and carries the proper identification card and official letter of authorization
  - Inspections should involve as a committee representatives of the concerned legal authorities and offices such as the police, local administration and the municipality in order to facilitate good legal ground and backing
  - Inspections initiated after the proper polite introduction with the responsible management of the establishment

Sanitary Inspection of FDEs

Preconditions for the inspection of FDEs

- All establishments inspected with equal considerations under the law
- Inspections supported with a checklist besides to onsite observations of situations
- The presence of legal, original and timely work license should be checked prior to starting inspection
  - Unlicensed establishments should be reported to the responsible authorities for action

Sanitary Inspection of FDEs

Preconditions for the inspection of FDEs

- Observations and findings recorded in duplicate, discussed with the management of the establishment, signed by the inspector, the responsible management and subordinate observers present.
  - The copy should be left at the establishment with the proper recommendations and suggestions for correction and improvement
- Any actions of punishment should correspond to legal procedures
- All precautions considered when closing an establishment

CHAPTER FIVE

FOOD SAFETY & PRESERVATION











Learning objectives

- After the completion of this chapter you will be able to:
  - Identify the five keys for food safety
  - Analyze quality control of food at different stages
  - Define food protection and preservation
  - Identify different food protection methods
  - Analyze the difference between different food preservation methods

Food safety

- Sanitary practice in food industries is **the systematic control of environmental conditions** during at all stages of food chain in such a manner that avoid food contaminating agents.
- Generally the protection of foods from deleterious effects should begin at the source and should end when consumed.
  - Source
  - Processing
  - Transport
  - Storage
  - Distribution
  - Preparation
  - Serving

Five keys to Safer food

1. **Keep Clean**
   - **Wash hands** before handling food and often during preparation
   - Wash hands after going to toilet
   - Wash and sanitize all surfaces in equipment for food preparation-protect kitchen from insects , pets
2. **Separate raw and cooked food**-
   - Separate raw meat , poultry and seafood from other foods
   - Use separate utensils for handling raw foods
   - **Store food** in containers to avoid contact between raw and cooked foods

Five keys to Safer food

3. Cook Thoroughly

- Meat, poultry , eggs and Seafood
- Bring soups in stews to boiling (ensure>70degree temp)
- Reheat cooked food thoroughly

4. Keep food at safe temperature

- Don't leave cooked food at room T° >2 hours
- Prompt refrigeration of cooked and perishable food
- Keep cooked food piping hot (>60 °C) prior to serving
- Don’t store food **too long** even in refrigerator
- Don’t thaw frozen food at room temperature

Five keys to safer food

5. Use safe water and raw materials

- Use safe water or treat to make it safe
- Select fresh and wholesome fruits
- Choose foods processed for safety - **pasteurized milk**
- Wash fruits and vegetables if eaten raw
- Don’t use food beyond expiry date

Food Preservation

- Food preservation is a technique by which foods are kept for intended longer periods without altering their natural state by applying different techniques.
- The main objective is to:
  - Increase the storage life(shelf life) of foods and reduce wastage
  - Prevent the development of infectious agents in the foods
- By
  - Removing/inactivating of micro-organisms
  - Inactivating enzymes
  - Removal of insects, worms, rats and other vermin

What are the techniques?

- There are several techniques that may be applied to preserve food.

1. **Aseptic technique**
   - Is a technique of exclusion of contamination/contact with spoilage agents
   - Is by applying artificial covering for the food or consideration of the natural protective covering of some foods
2. **Removal of microorganisms**
   - This may involve techniques like the washing , trimming and filtration techniques
3. **Maintaining anaerobic conditions**
   - This is a technique of denial of access to oxygen for organisms that are aerobic

What are the techniques?

4. **Temperature control**
   - High temperature
   - Low temperature
5. **Reduced water availability**
   - Drying
   - Freeze-drying (lyophilisation)
   - Addition of high concentrations of solutes such as sugar or salt
6. **Chemical-Based Preservation**
   - GRAS (Generally Recognized As Safe)
7. **Radiation**
   - Ionizing
   - Non-ionizing
8. **Microbial Product-Based Inhibition**
   - Bacteriocins
   - Fermentation

Food Preservation Principles

- Two general principles are employed in food preservation.
  1. Inhibition priciple
  2. Killing principle

1. Inhibition principle

- Food preservation is achieved by inhibition of growth and multiplication of microorganisms.
  - Reduction of water activity (drying & salting)
  - Reduction in pH (fermentation & addition of acids)
  - Use of preservatives (Sodium benzoate)
  - Use of low temperatures (Chilling & freezing)
  - Smoking – which has a drying and preservative effect

Food Preservation Principles

2. Killing principle

- In this principle, spoilage microorganisms are destroyed (Killed) in the food, and the food protected against subsequent contamination by being enclosed in an air tight container.
  - Heat treatment (pasteurization or sterilization)
  - Irradiation
  - Use of gases (ethylene oxide or ozone)- The gases destroy both vegetative cells and spores.

Food Preservation Methods

- Food can be preserved for extended periods as much in its natural state with the application of different methods on the basis of the preservation techniques
- The application of these methods may vary with the different types of foods
- Preservation methods can work employing different techniques

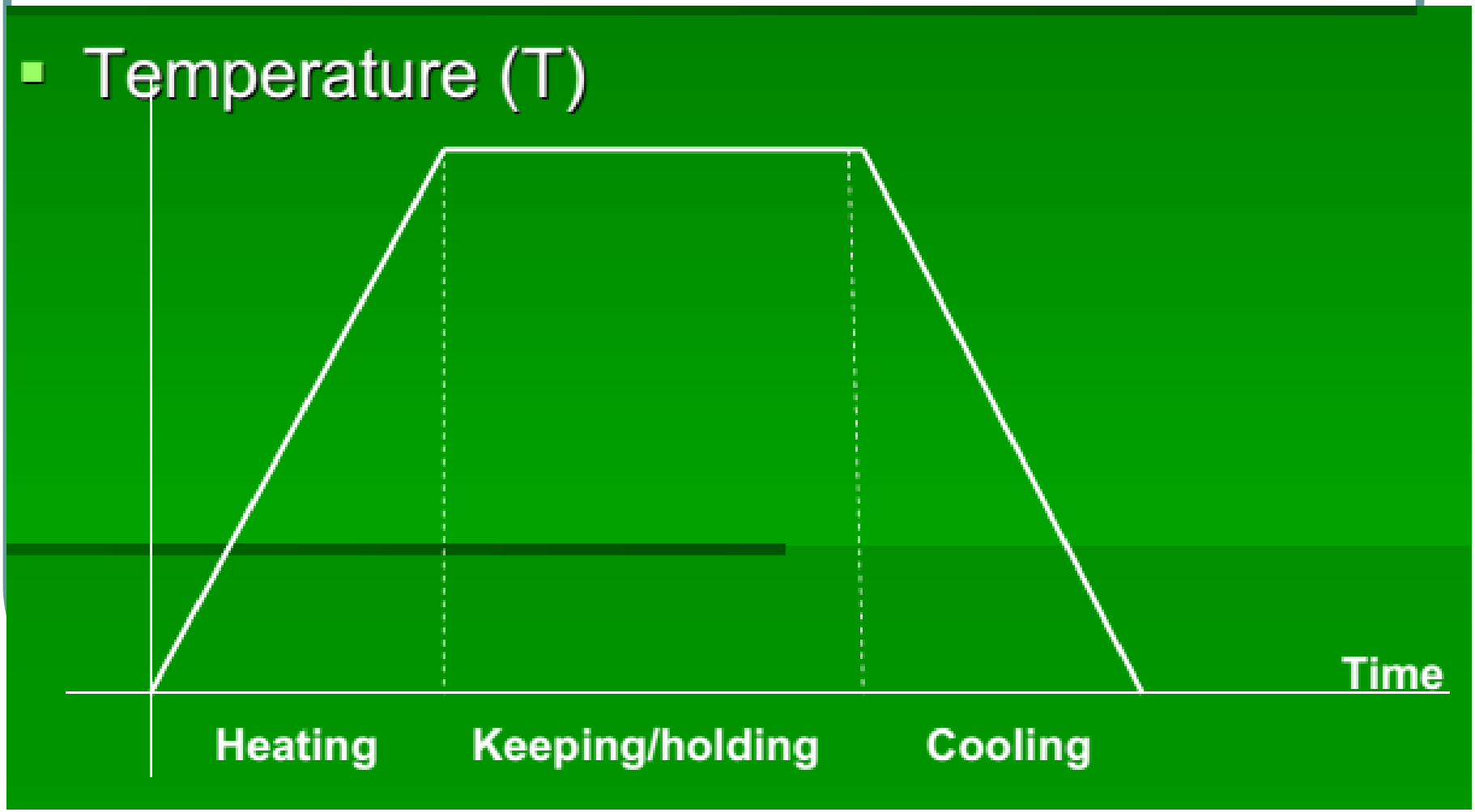
1. The use of high temperature

- ✓ Heat is one of the oldest methods of destroying microorganisms in food processing and preservation.
- ✓ Destruction of microorganisms by heat can be measured by three methods:

1. **Thermal death-time(TDT) -** time required at any specified temperature to inactivate an arbitrary chosen proportion of the spores
2. **Decimal reduction time(D-value) -** time in minutes required to destroy 90% of the cells at a given temperature.
3. **F-value** - time taken to expose food to destroy spores and vegetative cells of a particular organism using different temperatures (time equivalent of sterilization process).

Thermal profile of the heat treatment process

- ✓Bacterial destruction by heat is achieved due to the function of time and temperature variation



1. The use of high temperature

I. Cooking/boiling

- Is the process of heat application to temperatures of about 100°C for some time.
- Boiling of foods cannot completely destruct all microorganisms but the vegetative cells of bacteria, yeasts and moulds.
- Spore of some bacteria & heat resistant microbial toxins cannot be affected at this temperature except inhibition of their growth.

1. The use of high temperature

- **Disadvantage of cooking**
  - ✓ It affects the nutritive value of food
  - ✓ Gives cooked taste to food

II. Pasteurization

- ✓ Is a process of heat treatment of food with sufficient holding time to assure the thermal destruction of pathogens and organisms responsible for fermentation and spoilage without altering its nutritive value.
- ✓ Is a heat treatment process that kills part but not all of the microorganisms present



1. The use of high temperature

- Three methods of pasteurization
  - Low temperature long time (63°C for 30 minutes)
  - High Temperature short time (72°C for 15 seconds)
  - Flash method (88°C for 1-2 seconds)

III. Sterilization

- Is the use of physical or chemical means to eliminate all microorganisms that are present in the food.
- Sterilization can be achieved by:
  - Heating at high temperatures, e.g. 100-140°C
  - Irradiation - kills bacteria, spores, and insects as well as inactivates enzymes.

1. The use of high temperature

IV. Blanching

- Is a mild pre- cooking operation, which is often used to reduce the bacterial load on vegetables by 90%
- It is the application of hot water or steam
- It wilts some bulky vegetables, prevents discolouring of others, and removes some of the air from the tissue

V. Canning

- Is the application of a thermal sterilization procedure to products packed in hermetically sealed containers
- It is one of the most widely used modern methods of processing and preserving food
- It involves the careful preparation of food packed into a sealed tin, glass or plastic container which is subjected to definite elevated temperatures(above100°C) for the proper period of holding time and then cooled

1. The use of high temperature

- Processes of canning

1. Preparation of the food - a variety of processes such as grading, trimming, washing, blanching, precooking, etc are employed
2. Filling of the container - this is accomplished mechanically or by hand, requires to be carefully controlled
3. Exhausting – is the removal of air from the container before it is sealed.
4. Sealing the container
5. Thermal processing- heating for an accurate predetermined time and temperature
6. Cooling of the container and contents
7. Coding of cans



Drying

- Drying is a process by which removing of water content of food through evaporation by using heat.
- Is most effective when combined with other methods of controlling microbial growth such as salting

Advantage

- Dried foods have low weight and reduced bulk therefore, easily stored and distributed
- End product may be stored at room temperature

Disadvantage

- It is a slow operation
- It is difficult to get uniform application of heat throughout the



2. The use of low temperature

- ***Low temperature*** preserve foods by retarding or preventing the growth of spoilage organisms and by inhibiting the action of natural autolytic
- Unlike ***high temperature***, cold is not an effective means of destroying pathogenic bacteria, viruses and toxins in foods except retarding their multiplication and metabolic activities
- Preservation by low temperature could be achieved by:
  - Chilling or
  - Freezing temperatures

2. The use of low temperature

I. Chilling(refrigeration)

- Involves reducing food temperatures to below danger zone, but above -1°C.
- Cold storage is normally used at 0°C to 8°C for preservation of wide variety of food products.
- This temperature range is bacteriostatic and at the same time slows the reaction rates of both enzymatic and chemical processes which lead to deterioration and spoilage.
- The temperatures for refrigeration are determined by the kind of food, the condition of the food and the desired time for keeping it.

2. The use of low temperature

II. Freezing

- Preservation by freezing is achieved by using temperatures below 0°C(32°F)
- Is a dehydration method because the water in the food is transformed to ice, thus making it unavailable for microbial function.
- Freezing temperature depend on the kind of food and the intended storage time
- Foods preserved for longer periods of time must be frozen to below -18°C.
- A low temperature is important if prolonged storage life is desired

4. Fermentation & Pickling

- ✓ Both methods work by lowering of the pH of foods.
- **Fermentation**
- ✓ The conversion of carbohydrates to carbon dioxide and alcohol by yeast or bacteria (helpful).
- **Pickling**
- ✓ Is the immersion of certain food in concentrated natural acid solution such as vinegar
- ✓ Fermented and pickled foods are semi perishable foods and must be protected from moulds





5. Chemicals

- **Mode of action:**

✓ Decrease Aw (salt, sugar)

✓ Influence of ion balnce & pH (organic acids, salt)

✓ Antimicrobial effect (salt, nitrites)

I. Acid preservatives

✓ The effects of acids in the development of microorganisms may be due to the hydrogen ion concentration or to the toxicity of the un dissociated molecule or the anion

✓ The acid preservatives most widely used are:

- Benzoates (Sodium benzoate) – yeast & moulds
- Sorbates (Sordid acid or potassium sorbate) - moulds
- Propionates (Na or Ca propionate) - moulds
- Acetic acid - bacteria
- Lactic acid - bacteraia

Chemicals

II. Salting

- Salting is the addition of salt(mostly NaCl) to food
- The action of salt on microorganisms is osmotic effect
- The growth of micro organisms is inhibited by creating hypertonic conditions
- Causes water to pass from bacterial cells to the medium thus reduce available water for growth

Methods of operation in salting

- Rubbing - rubbing adequate quantity of dry salt into foods
- Immersion - food item is immersed into a concentrated salt solution

Chemicals

III. Sugaring

- Action is similar to salt
- In concentrations of at least 65%, sugar inhibits the growth of bacteria, yeasts and moulds

IV. Spices

- Spices have inhibitory and toxic effects on microorganisms
- The effect is due to the presence of essential oils

V. Smoking

- Oldest methods used to improve the quality of food
- It accomplishes preservation into two ways:
  - Surface drying: removing moisture from the surface of the food
  - The deposition of a thick, brown, oily liquid containing the bactericidal substance, which act as antiseptic on the surface of the food

Chemicals

VI. Sulphur dioxide, carbon dioxide, benzoic acid

- **SO2:** control carbohydrate deterioration
  - is toxic to moulds and bacteria
- **CO2:** inhibits the growth of bacterial

VII. Fumigation

- Use gaseous chemicals like methyl bromide, hydrocyanic acid and ethylene oxide
- Used in the disinfecting of grain to destroy insect and microbial infestations
- ***Disadvantage:*** they can be absorbed readily by liquid or greasy food products

Chemicals

VII. Quality improving agents

- Is the use of chemical compounds, which are used as additives to protect the nutrient, flavour and physical property of foods
  - Antioxidant additives: maintain food freshness and prevent spoilage
  - Ascorbic acid: prevent or inhibit the activity of enzymes, prevents the browning of fruits
  - Poly-phosphates: control the growth of moulds

Radiations

- Radiation - is the emission & propagation of energy through space or material medium
- Radiations cause microbial death by inactivating cellular components through energy absorbed within the cell
- Two forms of radiation energy:
  - Ionizing energy(gamma rays, X- rays) and
  - Non ionizing energy(UV)
- The type of radiation of primary interest in food preservation is electromagnetic.

Radiations

- The effect of preservation by radiation is affected by wave length of radiation
- The shorter wave length being the most damaging to microorganisms

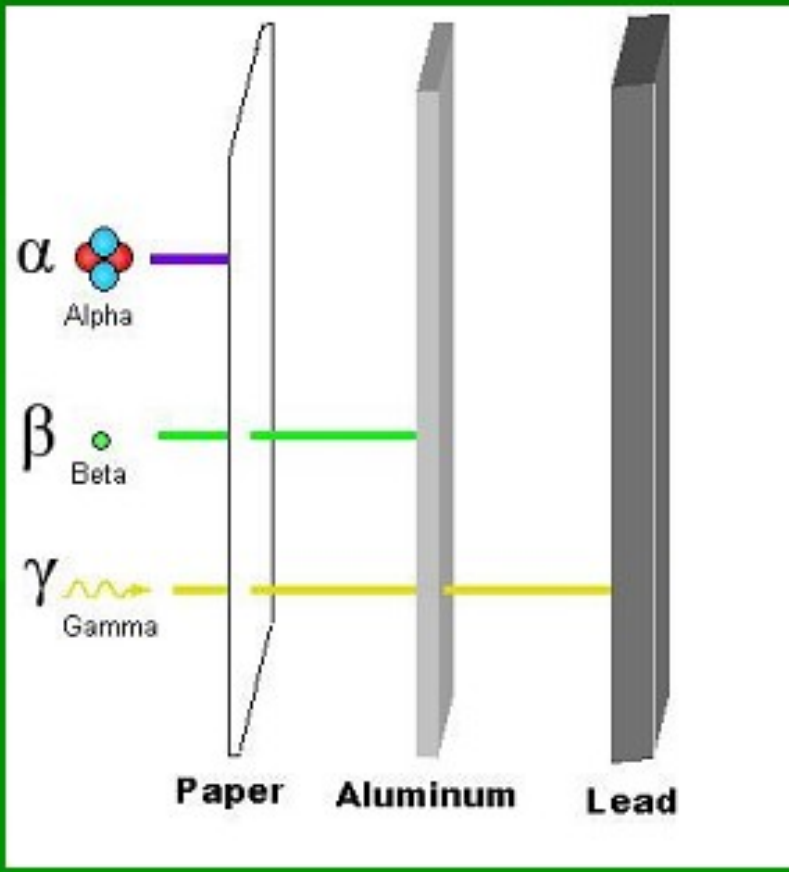
- ***UV light***
  - is a powerful bactericidal agent, with the most effective wavelength being 2600 A.
  - It is non ionizing and is absorbed by proteins and nucleic acids, which photochemical changes are produced that may lead to cell death.
  - The mechanism is due to the production of lethal mutations as a result of action on cell nucleic acids.

Radiations

- Gamma rays
  - are EM radiations emitted from the excited nucleus of elements such as Co and Cs, which are important in food preservation.
  - This is the cheapest form of radiation since the source elements are either by products of atomic fission or atomic waste products.
  - They have excellent penetration power
- Beta rays
  - a stream of electrons emitted from radioactive substances.
  - These rays posses poor penetration power
- X- rays
  - are produced by the bombardment of heavy metals with high velocity electrons(cathode rays) within an evacuated tube.
  - They are the same as gamma rays.

Ultraviolet and ionizing radiation

- UV radiation
  - 200-280 nm wavelength
  - energy and penetration low → reduction of microbial contamination in air (e.g., packaging of fluids)
  - Germicide effect (DNA)
- ionizing radiation
  - α-radiation → penetration poor → no importance
  - β-radiation → max depth of penetration 4-5 cm → surface treatment
  - γ-radiation → excellent penetration → 30-40 cm depth



Countries that have approved food irradiation (2002)

- Bangladesh
- China
- India
- Indonesia
- Iran
- Japan
- Korea
- Thailand
- Algeria
- South Africa
- Argentina
- Brazil
- Chile
- Peru
- Belgium
- Croatia
- Czech Republic
- Denmark
- Finland
- France
- Germany
- Hungary
- Israel
- Netherlands
- Norway
- Poland
- Ukraine
- United Kingdom
- Serbia
- Canada
- Cuba
- Mexico
- United States
- Philippines
- Russian Federation
- Syria
- Italy
- Spain
- Costa Rica
- Uruguay

Microbial Product-Based Inhibition

- **Bacteriocins**
  - Bactericidal proteins active against related species
  - Some lead to DNA mutations
  - Some inhibit protein or RNA synthesis
  - Example
    - Nisin - used in low-acid foods to inactivate *Clostridium botulinum* during canning process
    - Produced by some strains of Lactococcus lactis

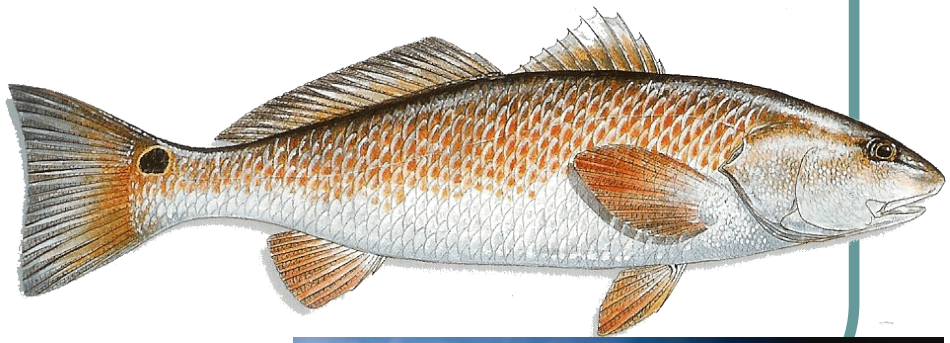


Thank you!

CHAPTER SEVEN

HYGIENE OF POTENTIALLY HAZARDOUS FOODS









Learning objectives

- At the end of the chapter, the students will able to:
  - ✓ Define and identify potentially hazardous food
  - ✓ Explain the sanitary practices and hygienic production of PHF
  - ✓ Know the different methods to make these group of food safe
  - ✓ Identify diseases associated with consumption of these foods if contaminated
  - ✓ Demonstrate different laboratory tests to check their quality

Potentially Hazardous Foods

- Are those foods that provide suitable conditions for rapid growth of microorganisms.
- These include foods that are high in protein and high moisture content.
- Need high care at all stages of food production chain.

  - Milk & its products
  - Meat
  - Fish
  - Poultry
  - Egg
  - Etc



Part I

MILK HYGIENE





Introduction

- Milk is the first natural food of all young mammals immediately after birth.
- The lacteal secretion of the mammary glands of a mammal, obtained by the complete milking of one or more healthy cows The food value of milk depends upon:
  - milk fat
  - milk solids-not-fat content
- If either of these contents is reduced its composition also affected.

Composition of Milk

- ✓ Milk is most nearly perfect food.
- ✓ It doesn't have Sufficient amount of Vitamin C & D and Iron.
- ✓ The composition of milk is extremely complex.
- Water – principal constituent
- Proteins - Casein, Lacto albumin and Lacto globulin
- Sugar – Lactose
- Fats – 25 fatty acids (olein, palanitin and stearin)
  - ✓ Highly variable
- Minerals - Ca, P, Na, K, Mg, Cl, SO4, Cu, Mn, I, Zn, Fe
- Vitamins- A, B2, B1, E, C, D
- Enzymes – Phosphatase, Lipase, Lactase
- Gases – CO2, O2, N2

Percentage composition of milk of different food animals

Source of Milk species	Water	Fat	Lactose	Protein	Minerals
Human	87.58	3.74	6.37	2.01	0.30
Cow	87.35	3.75	4.75	3.40	0.75
Sheep	80.25	6.97	4.96	6.72	0.90
Goat	81.04	4.63	4.22	4.35	0.76
Camel	87.10	2.91	5.39	3.90	0.70
Donkey	90.12	1.37	6.25	1.78	0.48

Physical Properties of Milk

- They are influenced by the composition of milk.
- They are also a great help in the processing and testing of milk for adulteration.
- The major physical properties of milk are:
  - Color
  - Specific gravity- 1.027-1.035 (lactometer)
  - Freezing point- -0.55°C (Cryoscopy)
  - Boiling point- 100.17°C (thermometer)
  - pH- 6.5 -6.8 (pH meter, pH colorimeter)





Milk Products

- Some of the common milk products that are made locally or commercially from whole milk are:
  - Cream
  - Curd
  - Whey
  - Cheese
  - Butter
  - Ghee











What is milk hygiene?

- It is a study of all the methods necessary to ensure the production, handling, and final delivery to the consumer of clean, wholesome and unadulterated milk or milk products.

  - Purpose of milk hygiene
    - Provision of safe and wholesome milk and its products for the consumers.

- To prevent contamination of milk proper practices should be followed from production to consumption.

Sanitary practices to be done during Production

- Sources of contamination

1. Contamination from human discharge and wastes
   - Construction of a proper waste disposal system
   - Prevention of human discharge and wastes from contacting animals and milk
   - Practices of good personal hygiene
   - Segregation of animals from human habitation
2. Contamination from air borne dust & droplets
   1. Proper construction of the milking area
   2. Sneezing or coughing away from milking containers during milking
   3. Provision of clean surroundings and avoidance of dusty conditions during milking

Sanitary practices to be done during Production

3. Contamination from animal bodies, hides, udder and teats
   - Clipping, brushing, cleansing and sanitizing before milking
4. Milk containers (milking utensils & dirty water)
   - Proper washing and storing of milking containers
   - Using proper and easily cleanable utensils
   - Using only safe water for washing and cleaning
5. Milk handlers and milkers
   - Keeping the milker's level of personal hygiene high
   - Washing of hands with detergents before milking
   - The milker should always wear clean garments while milking
6. Diseased cows
   - Detecting and isolating affected animals
   - Veterinary inspection and supervision of animals
   - Treatment and vaccination of animals.

Sanitary Requirements for Dairy Farms

- In addition, the cleanliness of the following places should be kept clean:
  - Animals shelter (Barn, cowshed)
  - Milking place
  - Milk storing place





Milk-borne diseases

- Milk is an excellent food for man but it is an ideal medium for the growth of micro-organisms.
- From the time milk leaves the udder of the animal, unless adequate safeguards are maintained, it may receive bacteria and other micro-organisms from the surroundings.

- Diseases resulting from infected carriers
  - Typhoid & paratyphoid fever
  - Tuberculosis (human)
  - Diphtheria
  - Scarlet fever
- Diseases transmitted from infected cows
  - Tuberculosis (bovine)
  - Undulant fever (Brucellosis)
  - Anthrax
  - Q-fever
  - Mastitis (bovine)
  - Foot & mouth disease

Methods of making milk safe

- The most common method of treating raw milk is by regulating the temperature.
- There are at least five methods of treating milk.
  - Boiling
  - Sterilization
  - Drying
  - Cooling &
  - Pasteurization

Boiling

- This is the easiest and most practicable method of making milk safe in every home.
- It is raising the T° of the milk to boiling point and maintaining the milk at this temperature for a few minutes.
- Then the milk should be immediately cooled.
- If it has to be stored the temperature should be maintained below 40°F.
  - Disadvantages
    - It affects the nutritive value of milk, its flavour and palatability and appearance.

Sterilization

- In this process milk is heated to destroy all micro-organisms including spore forming.
- It can only be done by keeping the milk at a temperature above normal boiling point for at least 20 minutes.

  - Disadvantages

  - Change in the taste of the milk
  - Affects nutritive value of the milk

Drying

- This is a method by which the entire water constituent is removed from the milk by evaporation.
- The solids remaining form milk powder (dry milk).
- Milk powder can then be made into liquid milk by adding a proper amount of water.
- There are two known methods of drying:
  1. Roller drying
  2. Spray drying
     - Drawbacks
       - Not a simple operation (untouchable at home)
       - Needs special equipment and arrangement

Cooling

- Is the process by which keeping the milk at 40°F or below starting immediately after milking.
- This temperature range is essentially needed to arrest the growth of micro-organisms specially Brucella organisms.
- However milk should not be allowed to freeze.
- This is very important especially if milk is going to be delivered raw to consumers.

  - Drawback
    - Doesn’t kill microbes

Pasteurization

- The process of heating every particle of milk and milk products to a predetermined temperature and holding this temperature for a predetermined time.
- Pasteurization:
  - Destructs:
    - All pathogenic micro-organisms
    - A good number of other non-pathogenic and non-spore forming bacteria and certain undesirable enzymes
  - Keeps the nutritive value of the milk



Pasteurization

- Objectives of Pasteurization

- It has three objectives:
  - to ensure that all pathogenic micro-organisms commonly found in milk are completely destroyed.
  - to safeguard the food value of milk
  - to ensure that other non-pathogenic bacteria and certain undesirable enzymes, which may cause spoilage, are inactivated or reduced to optimal levels

Pasteurization

- Basically pasteurization of milk involves three essential steps:
  - Heating raw milk to a predetermined temperature
  - Holding at this temperature for a predetermined time
  - Immediately cooling down to at least below 40°F

- two most important variables are:
  - Pasteurization temperature &
  - Exposure or holding time

Methods of Pasteurization of Milk

1. The holding or vat method
   - ✓ Is a method of holding the milk in a vat (container) to a temperature of 63°C (145°F) for 30 minutes.
2. The high temperature-short time method
   - ✓ Milk is rapidly brought to a temperature of 71°C (161°F) and heated continuously for 15 seconds.
3. The ultra-high temperature (UHT) method
   1. In this method the milk is heated to at least 88°C (191°F) for at 1-2 seconds.

Pasteurization

- Milk is said to be properly pasteurized it must satisfy the following three conditions:
  - The milk must be cooled adequately (50°F or less) before pasteurization so as to prevent the formation of heat resistant staphylococcal enterotoxin.
  - The pasteurization equipment should function properly and adequately.
  - Precautions should be taken to prevent any post pasteurization contamination.

Pasteurization

- **Limitations**

- It can only be effectively done on a commercial basis
- It requires special and expensive equipment and budget
- It requires skilled technicians to operate

Milk Testing

- The laboratory examination of milk is one of the most valuable and necessary aids to the overall milk quality control program.
- The laboratory tests are used to:
  - Know the chemical composition
  - Determine the bacteriological quality
  - Check the presence of extraneous substances
  - Check the effectiveness of pasteurization of a sample milk

Microbial milk testing

- There are four methods of determination of microorganisms in food.
  1. Standard plate counts for viable cells
  2. The most probable numbers method as a statically determination of viable cells
  3. Dye reduction techniques to estimate numbers of viable cells that posses reducing capacities
  4. Direct microscopic counts for both viable and non viable cells

Common Tests of Milk Quality

1. The alcohol- alizarin test

- ✓ This test is used to know the acidity of milk
- ✓ Procedure:
  - Take about 5 ml of milk in a test tube
  - Add equal amount of alcohol alizarin solution (0.2%)
  - Mix the contents well
  - Observe for presence of flakes and color of the contents

Parameter	Normal milk	Slightly acid milk	Acid milk	Alkaline milk
pH	6.6 – 6.7	6.4 – 6.6	≤ 6.3	≥ 6.8
Color	Red brown	Yellowish brown	Yellow	Lilac
Appearance of milk	No coagulation	No coagulation	Coagulation	No coagulation

Common Tests of Milk Quality

2. Methylene-blue reduction test

- Is used to determine the bacterial quality of raw milk.
- It involves determination of time required for the disappearance of color when methylene blue thiocynate solution is added to raw milk
  - Procedure
  - In a test tube add 10 ml of milk
  - Add 1 ml of standard methylene blue solution
  - The sample is mixed and placed either in a hot water bath or in an incubator at 35-37°C
  - Observations are made at intervals of 15 – 20 minutes for an 8 hour period

Common Tests of Milk Quality

- Milk with a high bacterial content will decolorize the dye quite rapidly whereas milk with low bacterial content retains the blue color for several hours.
- Based on this test, milk can be graded as follows:
  - Excellent: very low bacterial count
    - Its decolorized time is about 8 hours
  - Good: low bacterial count
    - Decolourization time is 6 – 8 hours
  - Fair: high bacterial count.
    - Decolourization time is 2 – 6 hours
  - Poor: very high bacterial count
    - Decolourization time is below 2 hours

Common Tests of Milk Quality

3. Resazurin test

- ✓Is the most widely used test for hygiene and the potential keeping quality of raw milk.
- ✓Resazurin can be carried out in different time ranges:

1. The 10 min resazurin test
   - Is useful and rapid, screening test used at the milk platform
2. The 1 hr & 3 hr tests
   - Provide more accurate information about the milk quality, but after a fairly long time.
   - They usually carried out in the laboratory

Common Tests of Milk Quality

- Procedures

- ✓ Add 10 mls of milk into a sterile test tube
- ✓ Add 1 ml resazurin solution
- ✓ Stopper with a sterile stopper and mix gently the dye into the milk
- ✓ Mark the test tube and incubate it

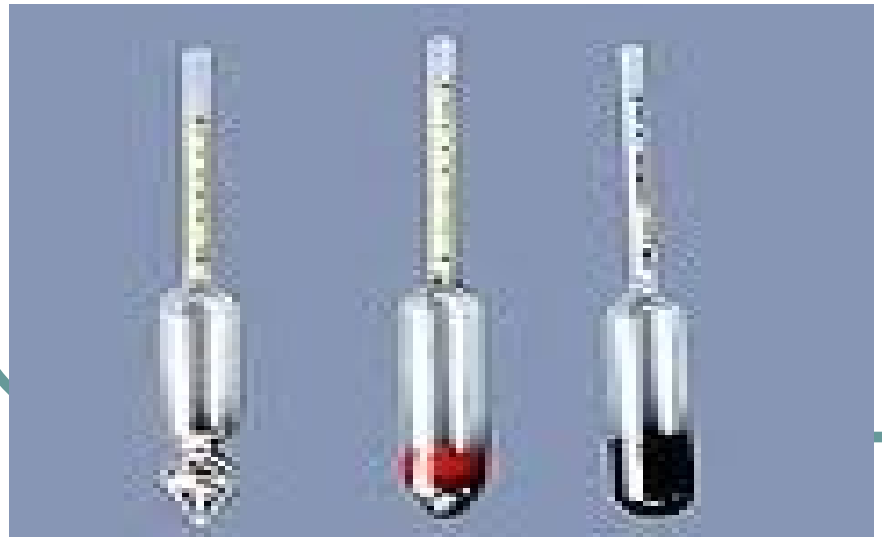
- Interpretation

Color	Grade of milk	Remark
Blue	Excellent	Accept
Light blue	Very good	Accept
Purple	Good	Accept
Purple pink	Fair	Separate
Light pink	Poor	Separate
Pink	Bad	Reject
White	Very bad	Reject

Common Tests of Milk Quality

4. Lactometer test and Freezing point determination

- ✓Both tests are used to detect adulteration of milk.
- ✓The lactometer test is designed to detect the changes in density.
- ✓Cryoscopy is used to measure the freezing point of milk which is -0.55°C for normal milk





Common Tests of Milk Quality

5. Inhibitor test

- Used to check the presence of chemicals in milk.
- Milk collected from producers may contain drugs or pesticide residues.
- These when present in significant amounts in milk may inhibit the growth of lactic acid bacteria used in the manufacture of milk products like cheese, besides being a health hazard.
- The suspected milk sample is subjected to a fermentation test with starter culture and the acidity checked after three hours.
- The value of the acidity obtained is compared with acidity of a similarity treated sample, which is free from any inhibitory substance.

Common Tests of Milk Quality

- Procedure
  - Three test tubes are filled with 10 ml of sample to be tested and three test tubes filled with normal milk
  - All tubes are heated to 90°C by putting them in boiling water for 3-5 minutes
  - After cooling to optimum temperature of the starter culture, 1 ml of starter culture is added to each test tube, mixed and incubated for 3 hours.
  - After each hour, one test tube from the test sample and the control sample is determined
- If acid production in suspected sample is the same as the normal sample, then the suspected sample does not contain any inhibitory substances
- If acid production in suspected sample is less than in the normal milk sample, then the suspected sample contains antibiotics or other inhibitory substance

Common Tests of Milk Quality

6. Phosphatase test

- ✓This test is used to determine the efficiency of pasteurization.
- ✓The test depends up on the hydrolysis of a disodium phenyl phosphate to form phenol and phosphate.
- ✓The addition of BQC(Dibromo Quimone Chloramines) causes a blue colour reaction to occur with the phenol.
- ✓The presence of Phosphatase is demonstrated by a blue reaction while the destruction of Phosphatase by proper pasteurization fails to produce a blue colour.

Common Tests of Milk Quality

- The intensity of colour is measured by a colorimeter.
- If no Phosphatase, it indicates that the milk was adequately heated
- But if is present, it means that pasteurization was incomplete or that raw milk has been added to pasteurized milk.

PART III

EGG & POULTRY HYGIENE





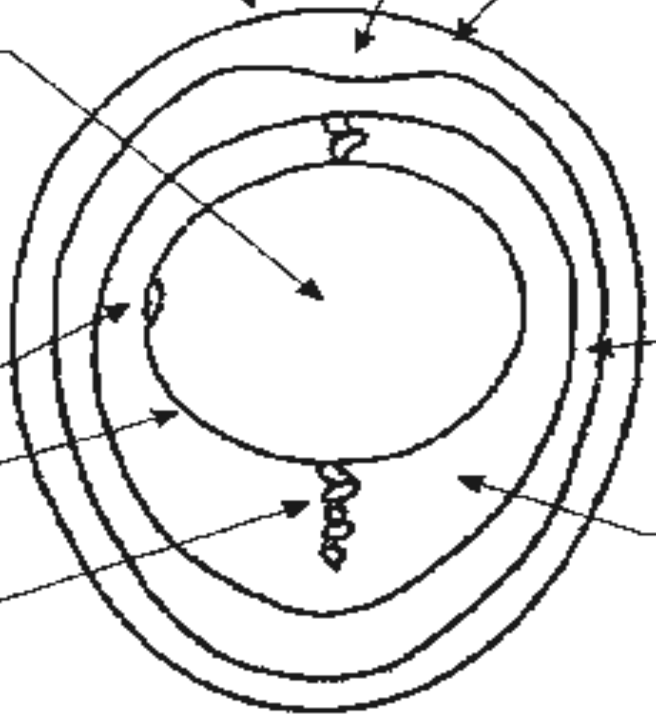
Introduction

- **Egg -** is a body consists of an ovum surrounded by layers of membranes and an outer casing of some type, which acts to nourish and protect a developing embryo.
- Every part of egg is edible except the egg shell.
- Nutritionally eggs are a good source of protein and choline.

Components of Egg

- An egg consists of:
  - Shell
  - Membrane
  - Albumin
  - Yolk
  - Chalazae

COMPOSITION



Shell
- Outer covering of egg, composed largely of calcium carbonate.
- May be white or brown depending on breed of chicken.
- Color does not affect egg quality, cooking characteristics, nutritive value or shell thickness.

Yolk
- Yellow portion of egg.
- Color varies with feed of the hen, but doesn't indicate nutritive content.
- Major source of egg vitamins, minerals, and fat.

Germinal Disc

Vitelline (Yolk) Membrane
- Holds yolk contents.

Chalazae
- Twisted cordlike strands of egg white.
- Anchor yolk in center of egg.
- Prominent chalazae indicated freshness.

Air Cell
- Pocket of air formed at the large end of egg.
- Caused by contraction of the contents during cooling after laying.
- Increases in size as egg ages.

Shell Membranes
- Two membranes – inner and outer shell membranes surround the albumen.
- Provide protective barrier against bacterial penetration.
- Air cell forms between these two membranes.

Thin Albumen (White)
- Nearest to the shell.
- Spreads around thick white of high-quality egg.

Thick Albumen (White)
- Major source of egg riboflavin and protein.
- Stands higher and spreads less in higher-grade eggs.
- Thins and becomes indistinguishable from thin white in lower-grade eggs.

Nutritional value of eggs

- Protein - 12.85%
- Fat - 11.15%
- Water - 73.80%
- Mineral salts - 1.60%
- Vitamins – A, B2, D & E

✓ Eggs are deficient in carbohydrates

Microbial spoilage of eggs

- Although most freshly laid eggs are sterile inside, the shells soon become contaminated by fecal matter from the hen and the lining of the nest.
- The main cause of contamination is washing of eggs
- An egg shell has a natural protective coating called cuticle or bloom that resists the entrance of bacteria and retains moisture inside

Microbial spoilage of eggs

- So when the eggs are washed this cuticle removes from the shell and makes MOs to penetrate the shell easily and multiply inside
- This causes egg spoilage
- Common symptoms of spoiled egg are green, black and red rots, mustiness and sourness
- Washed eggs should be eaten as soon as possible

Quality maintenance

- Maintaining fresh egg quality from producer to consumer is one of the major problems facing those engaged in marketing eggs.
- Proper attention to production, distribution and point of sale phases are vital importance in maintaining egg quality
- The main production factors that affect the quality of egg are the following:
  - Breed of hen
  - Age
  - Feed
  - Disease
  - Handling/collecting eggs
  - Housing conditions

Egg Storage

- Some of the traditional egg storage methods used are:
  - Clay pot
  - Oil coating
  - Water glass paste
  - Water glass solution
  - Lime water solution
  - Refrigeration

Egg Storage

- All egg storage systems must meet the following requirements:
  - Minimize water loss by evaporation
  - Mould and bacteria growth to be minimized
  - Interior quality to be maintained
- The first two requirements can be met by (3-5 months)
  - Coating eggs with oil or water glass
  - Immersing eggs in lime water or water glass solution
- But all the three requirements can only met by:
  - Refrigeration is best storage method

Packaging of Eggs

- Packaging is an important component in delivering quality eggs to buyers.
- Packaging protects the eggs from:
  - Micro organisms
  - Natural predators
  - Loss of moisture
  - Tainting
  - Temperature
  - Crushing

Transport of Eggs

- For the successful transport of shell eggs three essential requirements must be met.
  - The containers and packing materials must be protect the eggs against mechanical damage
  - Care should be taken at all stages of handling and transport
  - The eggs must be protected at all times against exposure to temperature that cause deterioration in quality as well as contamination.

Egg Inspection Methods

- Eggs should first be inspected for cracks, leaks, stains or dirt on the exterior and general bloodiness or translucent spots in the yolk when candled.
- The most accurate test of interior quality is the break- out method.
- In this test, around 10 eggs out of 100 are taken randomly and checked for spoilage by breaking them open to see what is inside.

Egg Inspection Methods

- In marketing, however, the above method can only be used on a sample basis.
- It is not cost-effective
- There are three types of egg inspection methods:
  - Candling
  - Shaking using hand
  - Brine test or immersing in water

Egg Inspection Methods

1. Candling/natural light

- ✓ Is the only method of testing eggs both internally and externally, without breaking them.
- ✓ It is projecting of light through eggs that makes the interior quality visible
  - Fresh egg – translucent
    - Yolk is faintly yellow in color
  - egg – dark o ot seen



Fresh egg



Stale egg

Egg Inspection Methods

2. Shaking using hands
   - Fresh egg – gives no sound when shaken
   - Stale(bad) – makes sound

3. Brine test or immersing in water
   - Fresh egg – will sink in water or 10% salt solution
   - Stale(bad) – floats

Poultry Hygiene

- Due to poor hygiene, poultry and poultry products are responsible for a number of food borne illnesses including salmonellosis, staphylococcal food poisoning and botulism.
- The production of healthy poultry depends on the maintenance of health and hygiene throughout the entire production system.
- Contaminations from external sources should be prevented, reduced or controlled.

Poultry Hygiene

- External contamination of live birds can come from different sources like:
  - Transport vehicles
  - Poultry crates or modules
  - Visitors or from the staffs
- Both ante mortem and postmortem inspection should be applied for safety.
- Otherwise the poultry may be contaminated by pathogenic microbes.



Microbial Spoilage of Poultry

- There are many types of spoilage organisms, but pseudomonas is the most important.
- They are found in large numbers on feathers but rarely in the alimentary tract.
- There are also other species like:
  - Salmonella
  - Clostridia &
  - Staphylococcus
- Pathogenic organisms in poultry are responsible for gastro intestinal disturbances in humans.

Part IV

FISH HYGIENE

Introduction

- Fish are cold blooded aquatic vertebrates covered with scales and with gills
- It provides prime source of high quality protein and vitamin D
- There are 27,000 species of fish (see foods)
- However, only a small number of the total species are commonly eaten
- Some of these are: Cod, Tuna, Carp, Trout, Mackerel, Snapper, Tilapia, Crab, Shrimps & Haddock, Catch fish, Nile perch

Spoilage of fish

- The factors which principally contribute to the spoilage are:
  - Autolysis
    - Self- degradation of protein with a subsequent formation of various products by the action of some undesirable enzymes
  - Microbiological actions
    - Are the main and fastest cause of spoilage
    - Bacillus group of bacteria are the main causes

Signs of fresh & decomposed fish

Body parts	Fresh	Stale
Eyes	Full and bright	Gray and sunken
Flesh	Firm, solid & elastic when pressed	Soft
Scales	Full & firm	Easily rubbed off
Abdominal cavity	Clean, not discolored	Smell with reddish discoloration
Gills	Clean, bright, not swollen	Gray, brownish slimy, swollen
Fresh fish	Will sink if placed in water	Floats in water

Fresh



Stale



Inspection of Fish

- Check the condition of the eyes, scales and flesh of the fish
- Check if gills are firm and elastic, test with fingers if any doubt exists
- Split the fish and examine backbone for decomposition.
- If bone is pink or red from end of the tail towards the head condemn it
- Test the blood of the fish with the fingers, if the fish is stale there is a faint smell on the fingers
- The abdominal cavity shows discoloration when the fish are stale.

Methods of Preservation of Fish

1. **Salting**

- ✓ Is a traditional processing method in most countries of the world
- ✓ It is used in combination with drying and smoking

2. **Canning –** Promotes international trade
3. **Refrigeration**

Methods of Preservation of Fish

4. Drying

- Is the removal of water from fish by evaporation
- Factors which affect the rate of drying are:
  - Relative humidity of the air
  - Air velocity
  - Air temperature
  - Surface area of fish

5. Smoking

- Combines 3 effects:
  - Antimicrobial effect
  - Drying
  - Cooking

Many thanks for your attention!

