THOMAS ADEWUMI UNIVERSITY
Science | Technology | Medicine

MCB 304-Food Microbiology (3 Units)

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Course Outline

- Introduction to food microbiology.
- Intrinsic and extrinsic factors that affect growth and survival of microbes in foods.
- Sources of microbial contamination in food.
- Microbial spoilage of foods
- Principles and methods of food preservation
- Foodborne diseases; Food-borne infection and Food intoxications.

What is food microbiology?

Introduction

- Food microbiology is the study of the microorganisms that inhabit, create, or contaminate food.
- It focuses on the general biology such as the growth, characteristics, identification and pathogenesis, of micro-organisms in food

Areas of interest which concern food microbiology are: food poisoning, food spoilage, food fermentation and biotechnology, food preservation, and food legislation

Useful Microorganisms in Foods

Examples of the beneficial microorganisms in food products:

Lactobacillus
Streptococcus
Propioniabacterium
Saccharomyces
Leuconostoc
Aerobacter

- Yogurt is produced by bacteria fermentation.
- This beneficial bacteria results in prolongation of the shelf life of raw milk and other dairy products.
- Lactic acid, bacteriocins and some essential amino acids are used in foods as by-products

TO DO: Find out other examples of beneficial microorganisms

Microorganisms causing spoilage of foods

Bacteria

Staphylococcus, *Clostridium* spp., *Listeria Salmonella* spp., *Shigella*, *Yersinia*, *Vibro.*

Fungi

Botrytis spp., *Penicillium* spp., *Fusarium* spp., *Geotrichum* spp., *Aspergillus* spp.

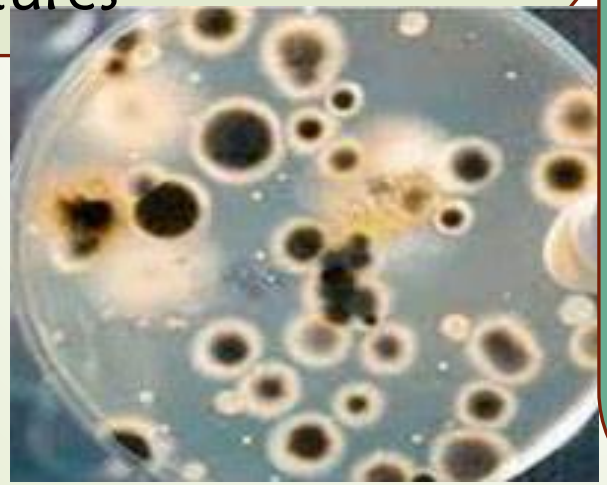
Protozoa

Apicomplexa, *Rhizopoda*, *Zoomastigina*, *Microspora* and *Ciliophora*

Factors affecting microbial growth in food

Intrinsic factors - properties inherent to the food

a. Nutrient composition
b. pH
c. Moisture content (Water activity)
d. Oxidation-reduction potential
e. Antimicrobial constituents
f. Biological structures



Extrinsic factors - environmental conditions

a. Storage temperature
b. Relative humidity
c. Presence/concentration of gases
d. Presence/activities of other microorganisms

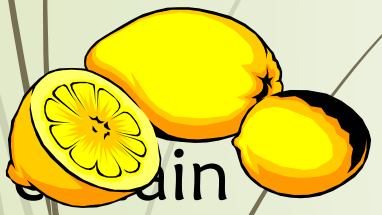
Nutrient

Microorganisms normally present in food vary greatly in nutrient requirements.

Nutritional requirements: bacteria > yeasts > molds.

Microbes also utilize large and complex carbohydrates, proteins, and lipids in varying ratios.

pH



The growth and survival of microorganisms depend on a pH range.

Most microorganisms grow best at pH values around 7.0 (6.6 – 7.5).

Microorganisms can be grouped according to their pH ranges:

1. Neutrophiles optimum pH 5-8
2. Acidophiles optimum pH 5.5
3. Alkaliphiles optimum pH 8.5

Water activity

Water activity is the amount of water required for biological functions that can be reduced by an osmotic effect.

Microorganisms need water in an available form to grow in food.

The water activity of the food can be expressed as the ratio of the water vapor pressure of the food to the pure water at the same temperature.

Lower water activity inhibits microbial growth

Oxidation-reduction potential

Altered by cooking

Presence of antimicrobial substances; allicin: garlic, polyphenols: green and black teas, lysozyme: cow milk, coumarins: fruits and vegetables.

Biological structures

Temperature

Lower temperature retard microbial growth

Relative humidity

Higher levels promote microbial growth

Atmosphere

Oxygen promotes growth

Sources of Microbial Contamination in Food

- Agricultural Contamination
- Contamination from Packaging Materials
- Cross Contamination
- Human Beings and Animals
- Dirty Environment/Utensils
- Water Contamination

Preventing Food Contamination

- Wash and scrub vegetables thoroughly.
- Properly wash and sanitize dishes and utensils.
- Keep chemicals away from food preparation areas.
- Keep fingers away from mouth, lips, face and soiled surfaces
- Avoid direct hand contact with food where possible.
- Maintain hygiene in food preparation areas.

What is food spoilage?

This is the degradation of food such that the food becomes unfit for human consumption

Causes of food spoilage

- Physical changes
- Chemical changes
- Microorganism proliferation
- Others.

Microbial food spoilage:

Results from growth of microbes in food;

-alters food by rendering it unsuitable for consumption

-It involves predictable succession of microbes

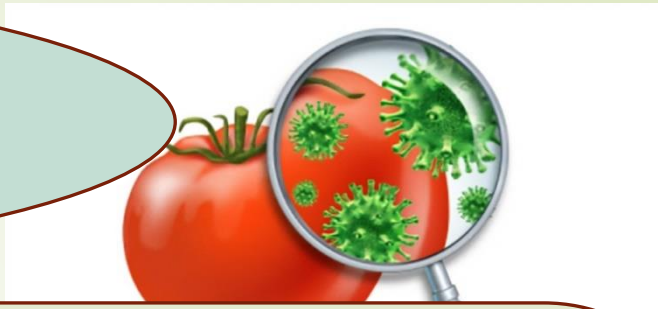
-Different foods undergo different types of spoilage processes

-Some produces toxins.

Signs of food spoilage

- Change in colour
- Change in texture
- Unpleasant odour
- Undesirable taste

Factors that cause microbial spoilage of food



- **Moisture loss:** Moisture loss primarily affects fruits and vegetables, which contain high water content.
- **Enzyme action in food:** Enzymes speed up chemical changes, causing loss of flavor, color, and texture. Some enzymes activate post-harvest, accelerating decay through oxidation, browning, and ripening.
- **Activity of microorganisms:** Molds, yeasts, bacteria.

Spoilage of different types of food

- **Dairy products:** Pasteurization kills the psychrophiles and mesophilic bacteria, but heat-tolerant species; *Alcaligenes*, *Microbacterium*, and the sporeformers *Bacillus* and *Clostridium* survive and may later cause spoilage in milk or other dairy products
- **Cereal and bakery products:** Cereal grains are exposed to a variety of bacteria, molds and yeasts during growth, harvesting, drying and storage. Molds are also the primary spoilage organisms in baked goods, with *Aspergillus*, *Penicillium*, and *Eurotium* being the most commonly isolated genera.
- **Vegetables:** Vegetables have neutral pH and high water activity. Although vegetables are exposed to a multitude of soil microbe
- **Fresh meat:** eats are composed mainly of protein and fat
- **Fish:** Microbes are found on the outer body covering and the inner surfaces of fresh fish, such as the skin, gills, and GI tract.

Control of food Spoilage

- Spoilage organisms are not initially part of foods but are commonly found in water, soil, air, and animals, therefore, proper care must be ensured in food processing.

- After harvest or slaughter, food tissues become vulnerable to spoilage microbes due to decreased defenses.

- Strict attention to sanitation and hygiene is therefore crucial in preventing colonization by microbes.

- Good manufacturing practices (GMP) is the primary step in delaying spoilage.

- Antimicrobial compounds may be added to foods or packaging to inhibit growth of many spoilage organisms.

Food Preservation

- Food preservation is the practice of treating and handling food to prevent or slow down spoilage, maintaining its quality, edibility, and nutritional value for longer storage periods

- It usually involves preventing the growth of bacteria, yeasts, fungi, and other microorganisms.

- Methods may include refrigeration, canning, heating, pasteurization, sugaring, radiation, salting, food additives, vacuum packaging and sealing within airtight containers

Food Preservation Methods

- **Drying**: Reduces water activity to prevent bacterial growth.
- **Refrigeration**: Slows down microbial growth and enzyme activity.
- **Freezing**: Preserves a wide range of foods by slowing down microorganisms.
- **Vacuum-Packing**: Creates an oxygen-free environment to slow spoilage.

- **Salting/Curing**: Uses osmosis to draw out moisture, inhibits microbial growth.

- **Other methods are:** Sugaring, Smoking, Artificial food addictive, Pickling, Canning an bottling, Irradiation, Pulsed electric field processing, Modified atmosphere, High pressure food preservation, Controlled use of microorganism, bio-preservation and hurdle technology.

TO DO:

1. What is Hurdle Technology?
2. Submit a term paper on various methods of food preservation in the next class.

Food-borne diseases

They are acute illnesses associated with the consumption of food contaminated with a pathogen or toxicant.

Food-borne pathogens are the leading causes of illness and death in less developed countries, killing approximately 1.8 million people.

Classification of Food-Borne Diseases

Food-Borne Infections

- They are caused by pathogenic microorganisms in contaminated food entering the body and triggering a reaction in the tissues
- Ingestion of microbes, followed by the growth, tissue invasion and/or release of toxins
- **Detection:** Culture techniques, immunological techniques and molecular techniques.

Food-borne Intoxications

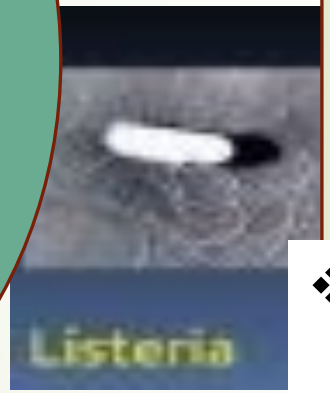
- Diseases caused by consuming food containing

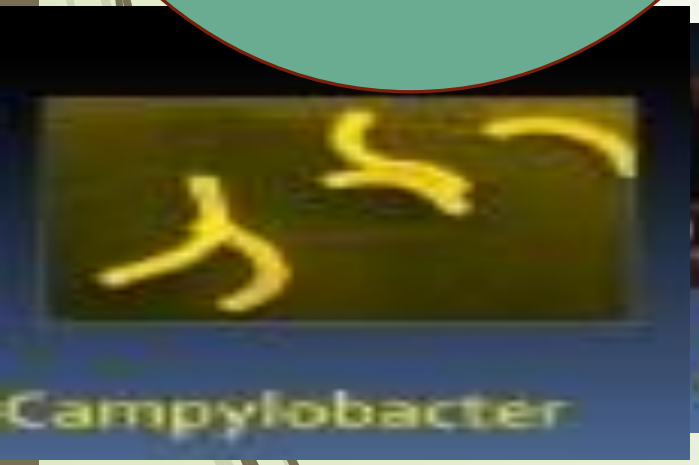
i. Biotoxicants
ii. Metabolic products
iii. Poisonous substances

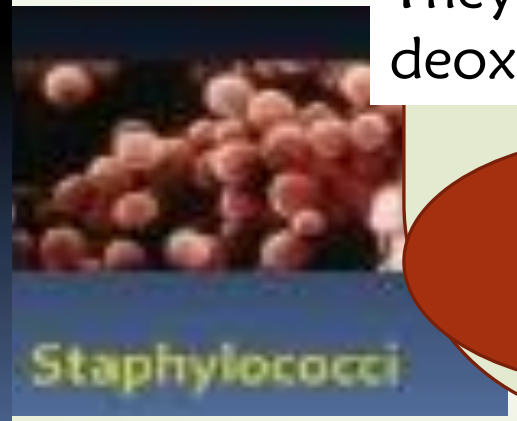
Food-borne intoxications can be classified into:

a. Bacterial intoxications
b. Fungal intoxications
c. Chemical intoxication
d. Plant toxicants

Food-Borne pathogen includes







- Enteric virus e.g Hepatitis A virus, Rotavirus, Astrovirus, Hepatitis E virus, and Human Caliciviruses (Noroviruses and Sapporo viruses).

- Protozoan parasites

In immune-compromised individuals, these diseases can be more severe and prolonged.

- Moulds e.g *Aspergillus*, *Fusarium*, *Penicillium*, *Claviceps*.

They produces mycotoxins which include aflatoxins, deoxynivalenol, ochratoxin A, and fumonisins,

- Bacteria e.g *Bacillus cerus*, *Clostridium botulinum*, *Escherichia coli*, *Shigella sp*, *Campylobacetr*, *Salmoella Leisteria*, *etc.*