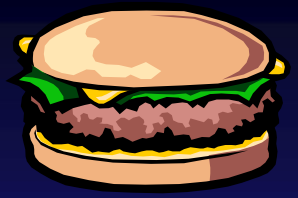
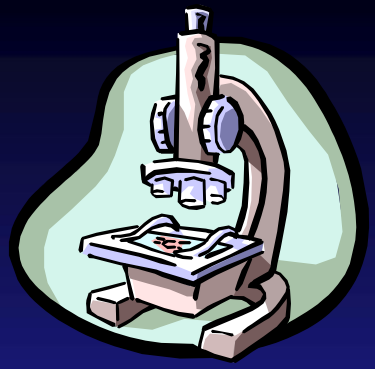
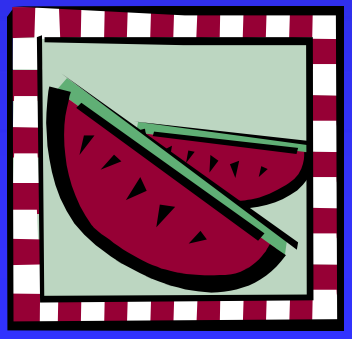




FOOD MICROBIOLOGY



WHAT IS FOOD MICROBIOLOGY???

A Brief History

- Early Food Preservation
- 900 AD – “Food Poisoning” Recognized
- 1795-Appert Developed Canning
- 1854-1864-FOOD MICROBIOLOGY BECOMES A SCIENCE
  - Louis Pasteur

Why Study Food Microbiology?

- Provide Clean, Safe, Healthful Food to Consumer
  - Food Permits Growth
  - Control of Microbial Growth
- Prevent Food Spoilage
- Prevent Food-borne Illnesses
- Food Preservation and Production

Food-Borne Illness

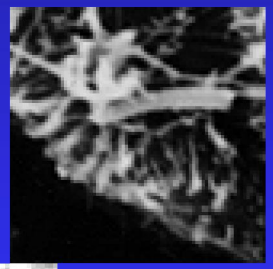
- ERS Estimates
  - $6.9 Billion/Year Cost of FBI
- CDC Estimates
  - 76 Million Cases of FBI Annually
  - 325,000 Hospitalizations
  - 5,000 Deaths

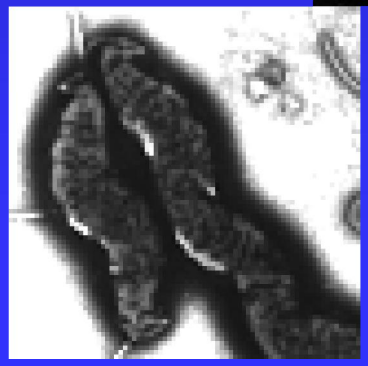
What Organism Causes the Most Cases of Food-Borne Illness Annually?

What Organism Causes the Most Deaths Due to Food-Borne Illness?

Review of Microbiology

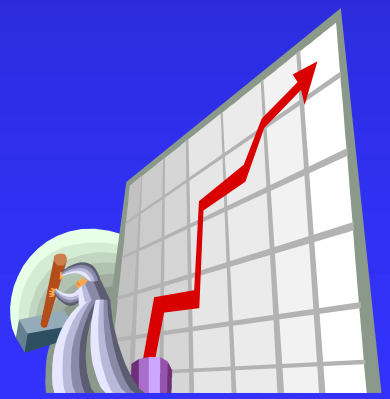
- Mostly Single Celled
- Groups
- Morphologies
- Gram Reactions
- Size
- Growth Rate



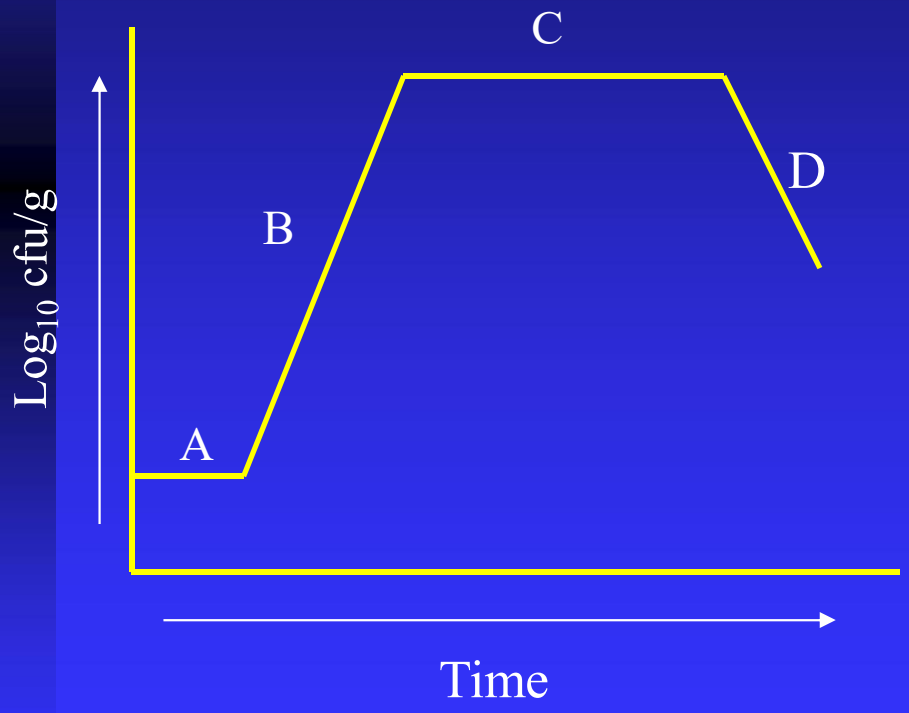


Exponential Growth

- 30 Minute Generation Time
  - Time 0 1000/g
  - 30 min 2000/g
  - 1 hour 4000/g
  - ……..
  - 5 hours 1,000,000/g



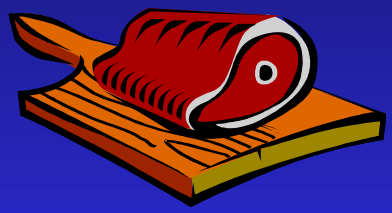
Microbial Growth Phases

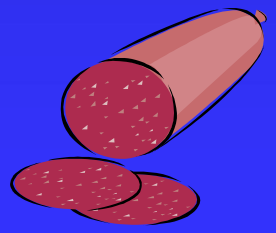


A=Lag Phase
B=Log/Exponential Phase
C= Stationary Phae
D= Death Phase

Intrinsic and Extrinsic Factors

- Intrinsic
  - pH
  - Moisture Content
  - Oxidation-reduction Potential
  - Nutrient Content
  - Antimicrobial Constituents
  - Biological Structures





pH

- Effects of pH
  - Enzymes
  - Nutrients
- Other Environmental Factors
  - Temperature
  - Salt
  - Age
- No known pathogen grows below pH of 4.6
  - *Clostridium botulinum*

Moisture

- Remove and/or Bind Moisture
  - Humectants
  - Dehydration
- Water Activity – Aw
- Most Fresh Foods - Aw > 0.99

Microbial Growth and Aw

- Halophilic 0.75
- Xerophilic molds 0.61
- Osmophilic yeasts 0.61

- Lowest Aw for Pathogen Growth
  - 0.86
  - Stapholococcus aureus

Oxidation- Reduction Potential

- O/R Potential - Eh
  - "…ease with which the substrate loses or gains electrons."
- Loss of electrons – oxidized
- Gain of electrons – reduced
- Aerobic
- Anaerobic
- Microaerobic
- Facultative anaerobes

Others

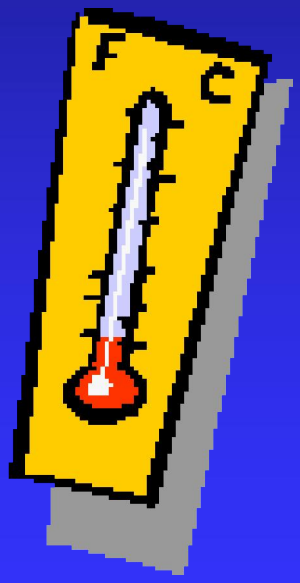
- Nutrients
  - Fastidius vs non-fastidious
- Biological Structure
- Antimicrobial Factors
  - Naturally occurring factors

Extrinsic Factors

- Temperature
- Relative Humidity
- Gases in the Environment
- Presence of Other Microorganisms

Temperature

- Microorganisms grow over a wide range of Temperatures
- Psychrotrophs
- Mesophiles
- Thermophiles
- Psychroduric
- Thermoduric



Other Factors

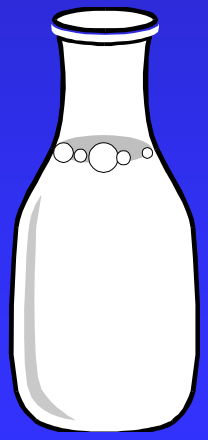
- Relative Humidity of Environment
  - Can change the Aw
- Environmental Gasses
  - CO_2, Ozone,

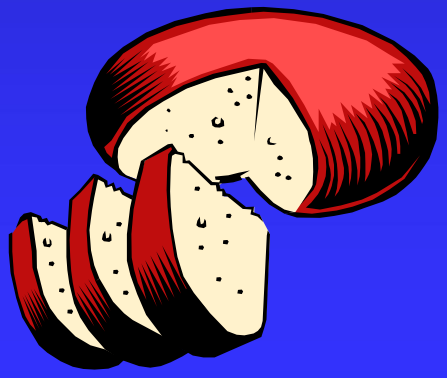
Presence of Other Microorganisms

- Competitive Exclusion
  - General microbial antagonism
  - Lactic Antagonism

Hurdle Concept

- Combine Intrinsic and Extrinsic Factors to Control Microbial Growth
- Combination requires less severe treatments to foods to get desired inhibition





Food Microbiology

- Microorganisms as causative agents of disease in Humans--Foodbourne pathogens
- Microorganisms and Food spoilage
- Microorganisms as Food sources
- Microorganisms exploited for the production of food
- Microbes and Agriculture

What is microbiology

Study of Micro-organisms: Organisms that *EXIST* as *Single Cells* or cell clusters and must be viewed individually with the aid of a Microscope

1. ***EXIST*** (Webster definition)To continue to be, have life; live

HALLMARKS OF LIFE

1. METABOLISM
2. DIFFERENTIATION
3. REPRODUCTION
4. COMMUNICATION
5. EVOLUTION

2. KEYWORD single CELLS
(OR cell clusters)

CHARACTERISTICS THAT MICROORGANISMS HAVE THAT MAKE THEM TRUE CELLS

1. **CELL MEMBRANE –barrier that separates the inside of the cell from the outside**
2. **NUCLEUS OR NUCLEIOD – location of genetic information (DNA)**
3. **CYTOPLASM –location of the machinery for cell growth and function**
4. **MACROMOLECULES – proteins, nucleic acids, lipids, polysaccharides**

3. **KEYWORD** exist as **SINGLE** cells
(OR cell clusters)

We are multicellular creatures—made up of many cells

What makes one of our cells different from a TRUE microbial cell??

A single microbial cell can have an independent existence—our cells need to other cells in order to carry out their cellular functions

What organisms are studied in food microbiology

1. **BACTERIA—***
2. **FUNGI—molds and yeasts ***
3. **ALGAE—dinoflagellates/shellfish ***
4. **PROTOZOA—amoeba, *Giardia* ***
5. **Viruses—Hepatitis/shellfish**
6. **Prions**
7. **Helminths—worms**

* **TRUE microbial cells**

Taxonomy

The study of **phylogenetic** relationships between organisms
(The sorting of all living things based on their related or differentiating features)

KINDOM the highest level in classification
PHYLUM related classes
CLASS related orders
ORDER related families
FAMILY related genera
GENUS closely related species
SPECIES organisms sharing a set of biological traits and reproducing only with their exact kind

Further classifications especially with bacteria and yeasts
Strain—organisms within a species varying in a given quality
Type—organisms within a species varying immunologically

Genus, Species, Strain and Type

All living organisms have a first name and a second name:

- **The first name is always capitalized (Genus)**
- **The second name is always denoted in lower case letters (species)**
- **Both names are always *italicized* or <u>underlined</u>**

Example

Lauren brandon **or** **<u>Lauren</u> <u>brandon</u>**

Strain refers to a genetic change made in an organism that makes it different from the predominant species organism

Type refers to surface changes that make the organisms distinguish able from others of its species

Scope of study in Food Microbiology

1. **BACTERIA--bacteriology**
2. **FUNGI--mycology**
3. **PROTOZOA—parasitology**
4. **ALGAE**
5. **VIRUSES--virology** (although not a cellular entity but an intracellular parasite)
6. **WORMS—parasitology (helminthology) --**not true micro-organisms—but included in food/medical microbiology
7. **PRIONS**—pathogenic neural derived proteins

8. **EPIDEMIOLOGY**—study of the source and prevalence of disease

Why study Food Microbiology??

- Microorganisms as causative agents of disease in humans--foodbourne pathogens
- Microorganisms and food spoilage
- Microorganisms as food sources
- Microorganisms exploited for the production of food
- Microbes and Agriculture

Agents of Disease (Foodbourne Pathogens)

BACTERIA ***E coli*** **O157:H7,** ***Salmonella*** **spp.,** ***Vibrio cholera*****,** ***Bacillus cereus*****,** ***Clostridium botulinum*****,** ***Listeria monocytogenes*****,** ***Staphylococcus aureus***

VIRUSES Enteroviruses, Norwalk virus, Hepatitis virus

PRIONS Mad Cow Disease (BSE) and Creutzfeldt-Jakob Disease

PROTOZOA ***Giardia lamblia*****,** ***Cryptosporidium parvum*****,** ***Entamoeba histolyticum*****,** ***Cyclospora cayetanesis***

HELMINTHS Tapeworms (Beef, Fish and Pork), Flukes (Fish and Shellfish), Roundworms and Hookworms

Food Spoilage

Fungi— Bread and Cheese Mold

Bacteria— *Erwinia caratova* soft rot in carrots and cucumbers

some Yeasts

Microbes we can eat

Fungi: Mushrooms are actually a microorganism— although the fruiting body is macroscopic!!!

Yeasts: Vegemite (Yeast Paste)

Bacteria: *Spirulina platensis* (a cyanobacterium)

Algae: *Chlorella* (fresh water), *Dunaliella* (salt water)

Microbes that we can exploit

Bacteria—cheese, yogurt, vinegar, bread and sauerkraut production

Yeasts—bread, beer, liqueurs, wine

Molds--cheeses

Bacteria in agriculture

Rhizobium **spp: Nitrogen fixation in root nodules of legumes alfalfa etc.**

Bacteria used in engineering produce that is resistant to adverse environmental conditions, pests pathogens and spoilage