



FDA/NSTA Web Seminar:
Teach Science Concepts and Inquiry with
Food

*Biological Hazards in Food: Survival and
Growth*

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Biological Hazards in Food: Survival and Growth

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Objectives

- At the conclusion of this presentation, you should be able to:
 - Name examples of biological food safety hazards
 - Describe growth and survival characteristics of various biological food safety hazards
 - Apply these concepts in your classroom



Biological Food Safety Hazards and Their Prevalence

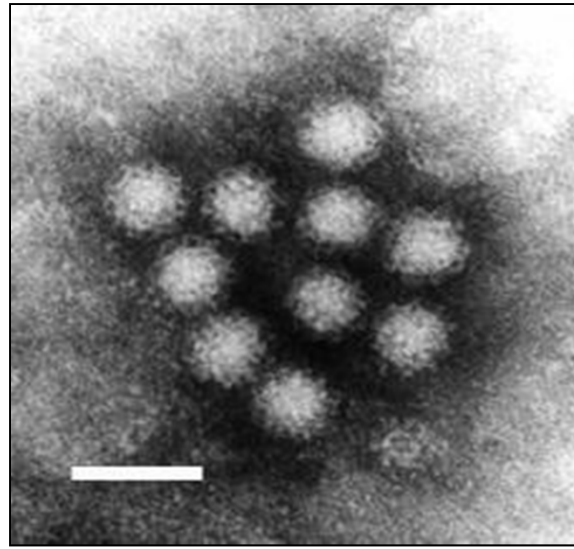


Biological Food Safety Hazards

- Include bacterial, viral, and parasitic organisms that cause illness



Dennis Kunkel



F.P. Williams, U.S. EPA



Dennis Kunkel

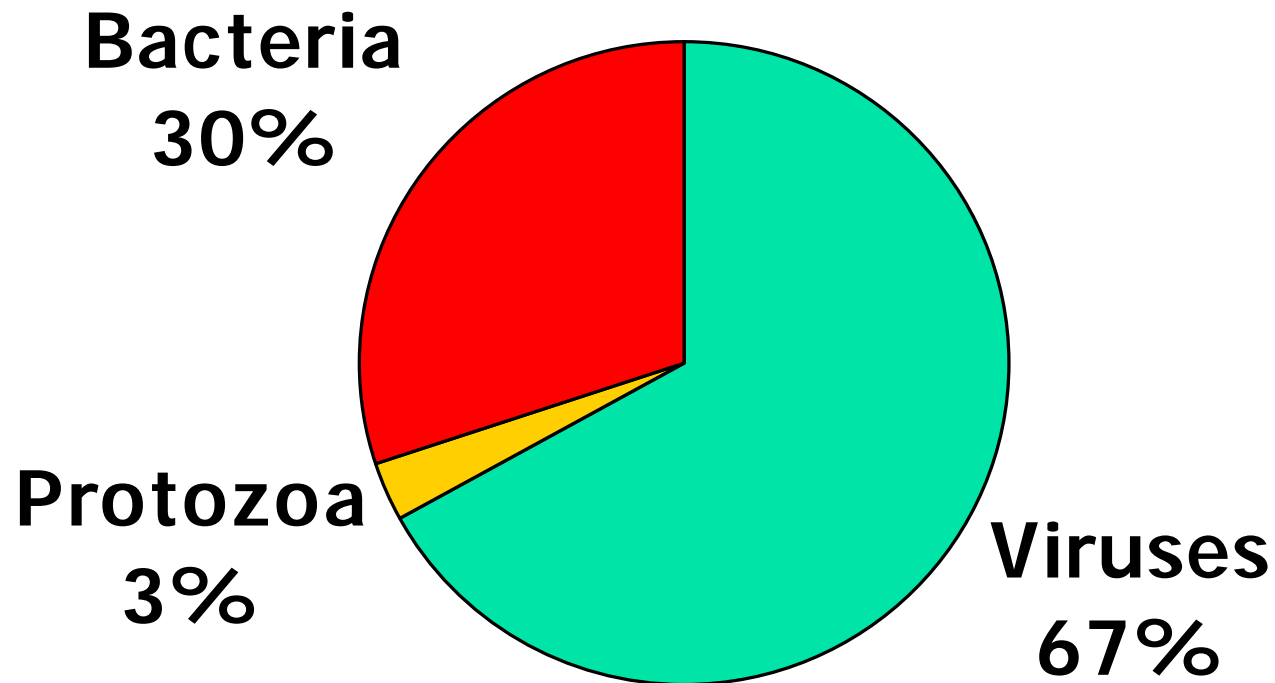


Foodborne Illness Caused By Bacteria, Viruses, and Parasites

- Bacteria grow in food and in the body.
 - Types of illnesses
 - Bacterial Infection
 - Intoxication
 - Toxicoinfection (toxin-mediated infection)
- Viruses and parasites cannot grow in food, only in the body. They do not produce toxins.



Percentage of Foodborne Illness Attributable to Various Pathogens



Mead et al., 1999



Foodborne Viruses



Foodborne Viruses

- Examples include norovirus, hepatitis A, rotavirus
- Shed primarily in human feces, but in the case of norovirus, can be shed in vomitus
- Norovirus survives heating at 140 F for 30 minutes
 - Inactivated by boiling at 212 F
- Hand sanitizers (hand antiseptics) are ineffective against viruses or parasites



Why Viruses are Such a Problem

- 1,000,000,000 - # of viral particles you start with in 1 ml of feces*
 - 10,000,000 - # of virus particles left after properly washing your hands (2 log reduction) (Ayliffe et al., 1978)
 - 1,000,000 - # of virus particles transferred from an ungloved hand to food (10%) (Montville, 2001)
- In contrast, it takes 1-10 virus particles to make you sick*

*Teunis & Moe, 2008



Activity

Let's pause for two questions from
the audience.



Foodborne Bacteria



Vegetative Bacteria

- Found on many raw animal foods (meat, fish, eggs, milk), as well as processed foods
- Examples
 - Salmonella
 - *E. coli* O157:H7
 - *Listeria monocytogenes*
- Control Measures
 - Cooking
 - No Bare Hand Contact with RTE
 - Handwashing
 - Employee Health
 - Temperature Control



Bacteria that Produce Spores

- Spore – survival mechanism for certain bacteria
- Heat resistance exceeds normal cooking temperatures
- Spore-forming organisms
 - *C. perfringens*
 - *C. botulinum*
 - *B. cereus*
- Control Measures
 - Proper Cooling
 - Hot and Cold Holding



Bacteria that Produce Toxin in Food

- *Staphylococcus aureus*
 - High numbers of cells per gram needed to produce toxin
 - Poor competitor on raw foods
 - Reheating will not destroy toxin
- *Bacillus cereus*
- *Clostridium botulinum*



Activity

Let's pause for two questions from
the audience.



Which would more likely have toxins in it if temperature-abused?



Use a clip art to indicate your answer.



Factors Affecting Bacterial Growth



Factors Needed for Bacterial Growth

- Food
- Acidity
- Time
- Temperature
- Oxygen
- Moisture – Available Water



Necessity of Food (Nutrients) on Bacterial Growth



Food (Nutrients)

- Protein
- Carbohydrates (sugars)
- Fats
- Vitamins
- Minerals



Effect of Acidity (pH) on Bacterial Growth



Acidity (pH)

- pH is the measure of the hydronium ion (H^+) concentration of a product.
- pH scale is 0-14
- Below 7 is acidic, 7 is neutral, above 7 is basic
- Most bacteria prefer to grow in a relatively neutral environment.
- Foods may be made shelf stable by adding acid.
- At a pH of 4.1 or below, foodborne bacterial pathogens do not grow but may survive.



Approximate pH Values of Some Foods

ground beef	5.1-7.2
ham	5.9-6.1
chicken	5.5-7.0
fish	7.0-7.3
clams	6.5
oysters	4.8-6.3
butter	6.1-6.4
buttermilk	4.5
cheese	4.9-5.9
milk	6.6-6.8
vegetables	4.2-6.5
fruit	1.9-6.7
egg albumen	7.6



Activity – Multiple Choice

- Foodborne bacterial pathogens will not grow, but may survive, below which pH value?
 - A) 4.6
 - B) 7.0
 - C) 4.2
 - D) 5.1



Effect of Time and Temperature on Bacterial Growth



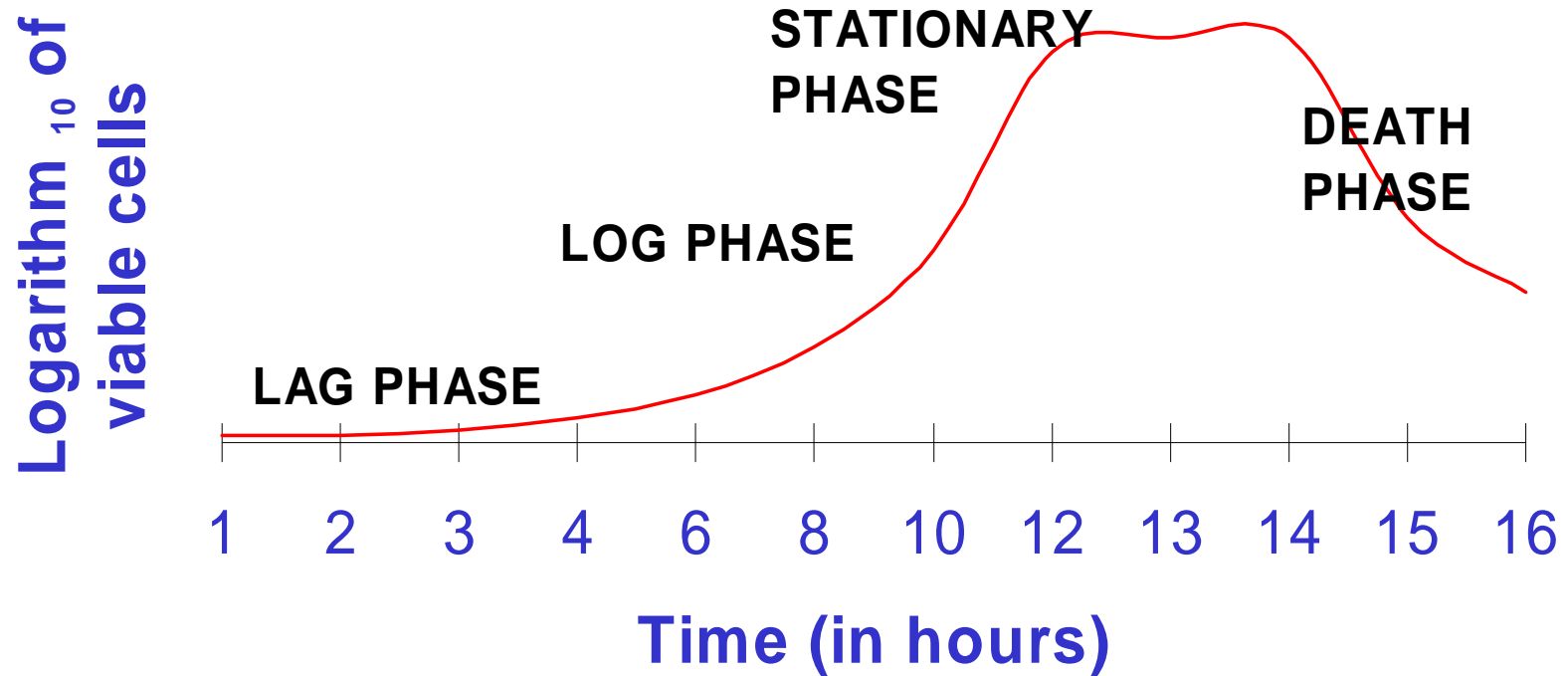


Time and Temperature

- Basis for most food safety rules and regulations.
- Easily monitored and implemented.
- Used to control almost all potential biological hazards except viruses.



Time and Temperature





Time and Temperature

- Temperature Danger Zone

41 F – 135 F



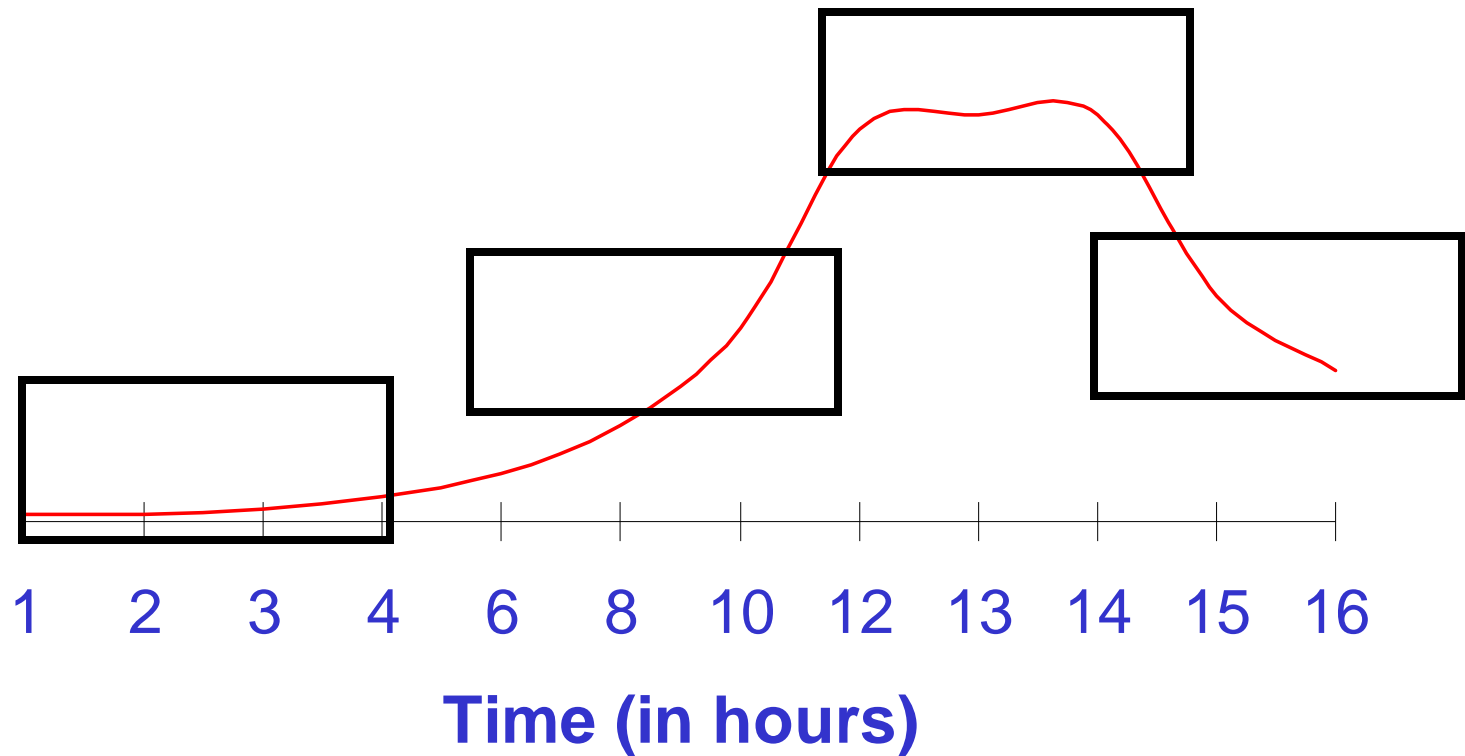
Activity

Let's pause for two questions from
the audience.



Which phase of growth do toxins
grow? Use a clip art to indicate your answer.

Logarithm₁₀ of
viable cells





Activity – Multiple Choice

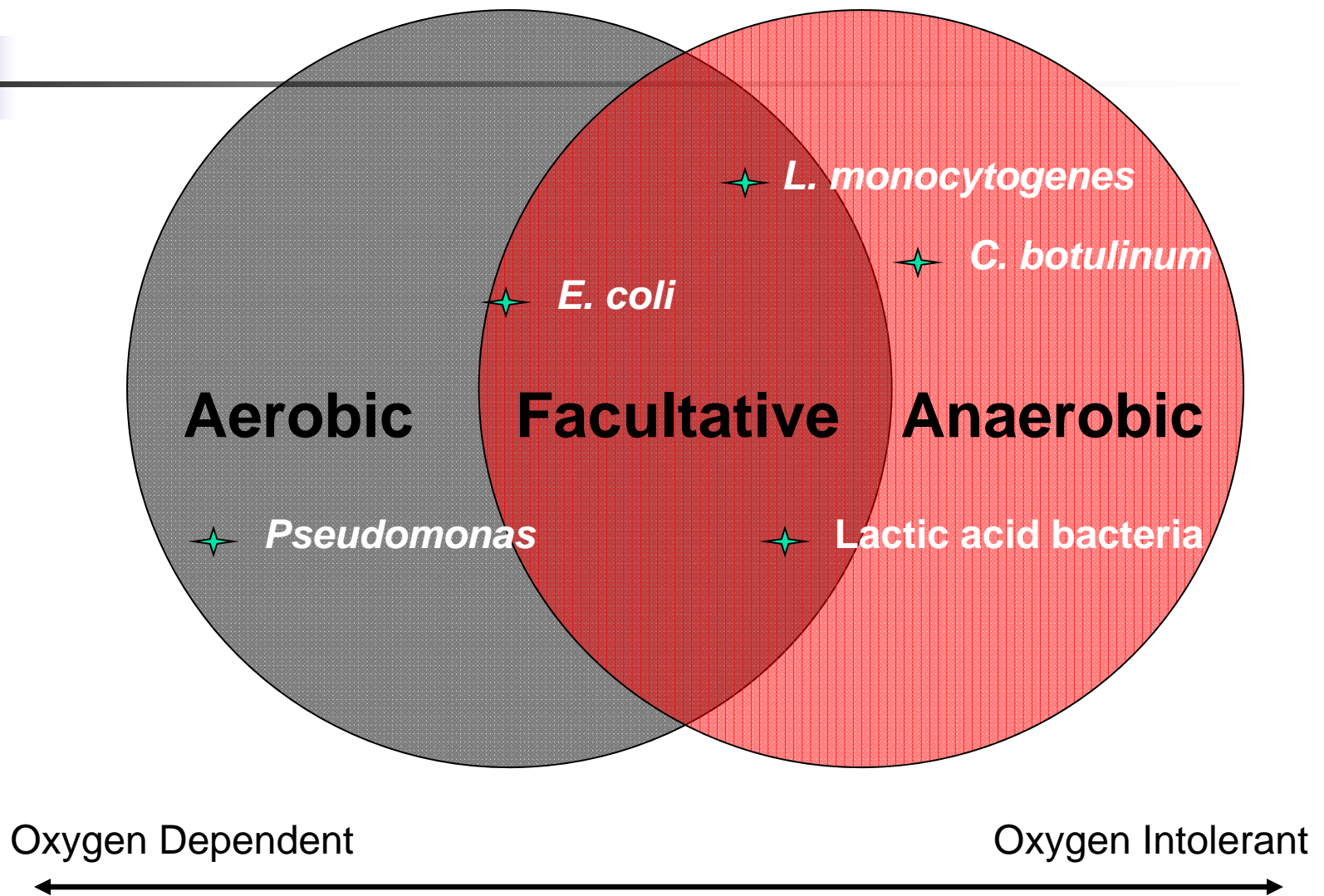
- Which of following most appropriately describes the highest temperature that foodborne bacterial pathogens will grow?
- A) 41 F
- B) 127 F
- C) 145 F
- D) 135 F



Effect of Oxygen, Water Activity, and Other Factors On Bacterial Growth



Oxygen Requirements of Bacteria





Moisture – Water Activity

- Amount of water available for bacteria to “live” or “grow”
- Generally, the lower the water activity, the lower the growth rate of organisms
- The minimum water activity threshold for bacterial pathogen growth in food is 0.87 or less.



Water Activity of Some Foods

Fresh Meat	0.95-1.00
Cakes	0.90-0.94
Cured Meat	0.87-0.95
Jam	0.75-0.80
Honey	0.54-0.75
Dried Milk	0.2
Crackers	0.1



Other Factors

- Interaction of pH and water activity
 - Also called “hurdle technology”
- Competitive microflora



Activity

Let's pause for two questions from
the audience.



Which of following presents a higher risk of causing botulism?



A.



B.



C.



Applicability to the Classroom



Applicability to the Classroom

- The effect of water and temperature on metabolic rates of living things
- The use of acids and salts in real world applications
- Bacterial growth and the effect of competition for available nutrients/food
- Adaptation
- Basic infection control



Activity - Volunteers

- Please use the chat window to explain other ways that the concepts covered during this presentation may be incorporated into your curriculum.



Thanks to our presenter,
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program



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