Math-in-CTE Lesson Plan–Culinary Arts

Lesson Title: Principles of Time and Temperature Relative to Pathogen Growth **Lesson Writers:** Donna Denault, Culinary Arts, Coal City High School Mark Morrey, Mathematics, Joliet Central High School	Lesson #3 **Common vocabulary:** exponential growth exponents log phase line segment logarithmic order of operations binary fission constant

Occupational Area: **Culinary Arts**
CTE Concept: **Garde manger**
Math Concepts: **Exponential growth**; **convert units of measurement**

Lesson Objective:	**Apply principles of time and temperature when handling food.**
Common Core Standards:	CC.9-12.A.SSE.3 (expressions) CC.9-12.F.LE.1, 1a, 1b, 1c (exponential models)
Supplies Needed:	1. "Food for Thought" Journals 2. Quats and testing strips 3. Paper towels 4. Hand soap 5. Glo germ 6. Glo light 7. Red and green buckets 8. Refrigerator and freezer thermometers 9. Notebook paper 10. Pen or pencil 11. Elmo or transparency of notes and overhead projector

THE "7 ELEMENTS"	**TEACHER NOTES (and answer key)**
1. Introduce the CTE lesson. Rub **glo-germ powder** over the front and back of a sheet of notebook paper. Pass it to one student and tell him/her to write **one sanitation concern** in the professional kitchen and then, pass it to the next student to do the same. Continue until all students have handled the paper and have written one concern. Read the list to the whole class, and then, tell them that they have just handled a piece of paper on which glo-germ was applied. Tell them the paper that was handled by everyone in this classroom is much like **handling a doorknob**. Ask students how many of them used the door handle to enter the room today. Ask them to estimate how many other students sat at their desks and didn't wash their hands after using the restroom or after sneezing or coughing.	Point out **white powder that might be present on some of the students' noses, hair, and eyes**. Each of us touches our faces subconsciously and when we do, we transfer germs, and those germs could be **contagious**. Students **1)** check their hands for "germs" under the glo-light, **2)** wash their hands, and then, **3)** re-check their hands to see how well they washed.

2. Assess students' math awareness as it relates to the CTE lesson. Have students take out a sheet of paper and write as many **facts that they know about food safety and sanitation in one minute**. (Set timer for one minute.) Next, give them one more minute to share what they wrote with their neighbor. As pairs, have students share their paired-discussion with the whole class. Each pair writes one food safety and/or sanitation fact on the board. Discuss **Teacher Notes** column.	**Notes:** 1) Hands need to be washed before cooking, after sanitizing, using the restroom, petting animals, eating, handling money or dirty dishes and garbage, smoking, touching nose or any other part of the body, and between different food preps. 2) Quats (Quaternary ammonia) is used in the third compartment of our three-compartment sink and must be tested to ensure it is at the recommended concentration. 3) **Quats, chlorine, & iodine** are approved sanitizers. 4) Both **temperature and time** must be controlled to prevent the pathogen contamination of food. 5) Danger zone: **41° to 135°F** 6) No more than 4 hours, total time, in the danger zone **Thawing** - Never on counter tops - Acceptable ways to thaw: ➢ Under cold, running water less than 70°F ➢ In the refrigerator, below 41°F ➢ Cook from frozen state to an internal temp of 45°F within 4 hours; not simply thawed ➢ Thaw in microwave only if cooking immediately following thawing **Cooking** - Heat destroys biological pathogens. - Most potentially hazardous foods must be cooked to an internal temperature above 145°F. In general: ➢ **165°F** = poultry, stuffing, stuffed foods, and leftovers ➢ **155°F** = hot-held eggs, ground meats, fish ➢ **145°F** = whole muscle meats and fish, and raw eggs that are broken and immediately cooked to order **Hot Holding** - Foods held hot must maintain an internal temperature of 135°F - Stir foods in steam tables frequently to distribute heat and ensure that all of the food product remains at 135°F internal temperature **Cooling** - Cool rapidly to ensure food does not sit more than 6 hours in the temperature danger zone - **STEP 1:** Cool foods from 135°F to 70°F in two hours or less. - **STEP 2:** Cool food to 41°F within the remaining 4 hours.

	➢ Place food in **shallow pans** for cooling ➢ Place a container of hot food in an **ice water bath and stir** the ingredients frequently. Place the container on a **perforated pan** to allow water to circulate beneath the pot. ➢ Food can be placed in a **blast chiller** or other rapid cooling equipment, but don't leave it too long or food will freeze. **Storing** - Store potentially hazardous foods below 41°F. - **Refrigeration <u>slows</u>** the growth of pathogens, so over time, foods will spoil under refrigeration. - **Freezing <u>stops</u>** the growth of pathogens and in some cases, it kills biological hazards - Thermometers are needed in freezers and refrigerators. **Reheating** - Leftovers must be reheated to internal temperature of 165°F within two hours - Reheat foods once only.

3. Work through the math example embedded in the CTE lesson. Draw one cylinder shape on the board and tell students that it is one *staphylococcus aureus* bacterium. Divide the cylinder shape in two–the cyliner has just swelled, divided, or reproduced. Do the same to the divided cylinders; now, those cylinders have also divided and we have four: **binary fission**. Drawing: **Log phase** of one *staphylococcus aureus*: o 30 ⇩ minutes o o 60 ⇩ minutes o o o o 90 ⇩ minutes o o o o o o o o 120 ⇩ minutes o o o o o o o o o o o o o o o o ⇩ AND SO ON…by the next day, one bacterium will have reproduced to well over 32 million.	**Activity:** Draw and discuss the log phase of a single *staphylococcus aureus* bacterium. **Log Phase** is the time period in which growth of a population of cells (such as a microorganism) in a culture medium during which numbers increase **exponentially** (a rapid increase in size or number) and is represented by a part of the growth curve that is a straight line segment if the logarithm of numbers is plotted against time. **Reproduction times for various bacteria:** ***E. coli*** can reproduce in 20 minutes and ***Staphylococcus aureus*** every 30 minutes ***M. tuberculosis*** every 24 hours So in just seven hours, one *E. coli* can become one million. Obviously **exponential growth, or decay** for that matter, cannot continue indefinitely. Eventually there would no longer be any space or nutrients available for the bacteria.

4. **Work through *related, contextual* math-in-CTE examples.**

Growth: **Decay:**

$y = a(1+r)^x$ $y = a(1-r)^x$

GROWTH: Number of Cell Phone Users by Year

Years	*x* = 1 1986	2 1987	3 1988	4 1989	5 1990	6 1991	7 1992	8 1993	9 1994
Number of Cell Phone Users	498	872	1527	2672	4677	8186	14325	25069	**43871**

There are 43871 subscribers in 1994. What is the number now?

Function: $y = a(1+r)^x$	*a* = the initial amount before the growth begins *r* = growth rate *x* = the number of intervals
$y = 285(1+.75)^x$	as *x* ranges from 1 to 9 for this problem

DECAY:

Each year the local country club sponsors a tennis tournament. Play starts with 128 participants. During each round, half of the players are eliminated. How many players remain after 5 rounds?

Rounds	1	2	3	4	5
Number of Players left	64	32	16	8	4

There are 4 players remaining after 5 rounds.

Function: $y = a(1-r)^x$	*a* = the initial amount before the growth begins *r* = growth rate *x* = the number of intervals
$y = 128(1-.50)^x$	as *x* ranges from 1 to 5 for this problem

Bacterial growth generally proceeds through a series of phases:

- **Lag phase:** Microorganisms become accustomed to a new environment. Little or no growth during lag phase.
- **Log phase:** Bacteria's logarithmic, or exponential, growth begins; the rate of multiplication is the most rapid and constant.
- **Stationary phase:** The rate of multiplication slows due to lack of nutrients and a build-up of toxins (poisons). At the same time, bacteria are constantly dying so the numbers actually remain **constant**.
- **Death phase:** Cell numbers decrease as growth stops and existing cells die off.

5. Work through the *traditional math* examples. World Wide Web on Wheels has achieved its goal of only 100 computer illiterate citizens in Woodforest. Community leaders studied the monthly progress of World Wide Web on Wheels. According to the data, the decline of computer illiterate citizens can be described by the following function: **100 = *a*(1 - .12)10** **1. How many people are computer illiterate 10 months after the inception of World Wide Web on Wheels?** 100 people Compare this function to the original exponential growth function: 100 = *a*(1 - .12)10 *y* = *a*(1 + *b*)*x* The variable, y, represents the amount of computer illiterate people at the end of 10 months, so 100 people are still computer illiterate after World Wide Web on Wheels began to work in the community. **2. Does this function represent exponential decay or exponential growth?** **3. What is the monthly rate of change?** **4. How many people were computer illiterate 10 months ago, at the inception of World Wide Web on Wheels?** Use Order of Operations to simplify. 100 = *a*(1 - .12)10 100 = *a*(.88)10 (Parenthesis) 100 = *a*(.278500976) (Exponent) Divide to solve. 100(.278500976) = *a*(.278500976)/(.278500976) 359.0651689 = 1*a* 359.0651689 = *a* Use Order of Operations to check your answer. 100 = 359.0651689(1 - .12)10 100 = 359.0651689(.88)10 (Parenthesis) 100 = 359.0651689(.278500976) (Exponent) 100 = 100 (Multiply)	1. **100 people are still computer illiterate** 2. **This function represents exponential decay because a negative sign precedes the percent change, .12.** 3. **12%** 4. **359 people**

5. If these trends continue, how many people will be computer illiterate 15 months after the inception of World Wide Web on Wheels? Plug in what you know about the function. y = 359.0651689(1 - .12) x y = 359.0651689(1 - .12) 15 Use Order of Operations to find *y*. y = 359.0651689(.88)15 (Parenthesis) y = 359.0651689(.146973854) (Exponent) y = 52.77319167 (Multiply)	5. **52 people**
6. Students demonstrate their understanding. Farmer and Friends— *Use the information about the farmers' social networking site to answer questions 1-5.* **1. A farmer started a social networking site, farmerandfriends.org, that shares backyard gardening tips. When web site enabled members to post photos and videos, their membership grew exponentially. Here's a function that describes that exponential growth.** 120,000 = *a*(1 + .40)6 • 6a. How many people belong to farmerandfriends.org 6 months after it enabled photo- and video-sharing? • 6b. Does this function represent exponential growth or decay? • 6c. What is the monthly percent increase or decrease? • 6d. How many members belonged to farmerandfriends.org 6 months ago, right before photo- and video-sharing were introduced? • 6e. If these trends continue, how many members will belong to the website 12 months after the introduction of photo- and video-sharing?	

7. Formal assessment. **Quiz:** 1. How rapidly do bacteria grow? 2. Write the equation for the way bacteria reproduce? 3. Why should we, as culinary professionals, be concerned with how bacteria reproduce? 4. Solve: Each year the local country club sponsors a cooking competition. Competition starts with 20 participants. During each round, half of the players are eliminated. How many players remain after 3 rounds? 5. How do you prevent the growth of bacteria? 6. At what internal temperature should leftovers be reheated? 7. List 3 common sanitizers. 8. How do you know that a sanitizer is properly mixed? 9. List the steps to the 20-second scrub. 10. What is the temperature danger zone? 11. How does freezing foods affect pathogens? 12. How does refrigerating foods affect pathogens? 13. How can you make sure that cooked foods are safe to eat? 14. How long can most foods be in the danger zone before they must be discarded? 15. Hands should be washed often during food preparation. List five examples.	