



IMK 407

ENVIRONMENTAL MONITORING

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30122020

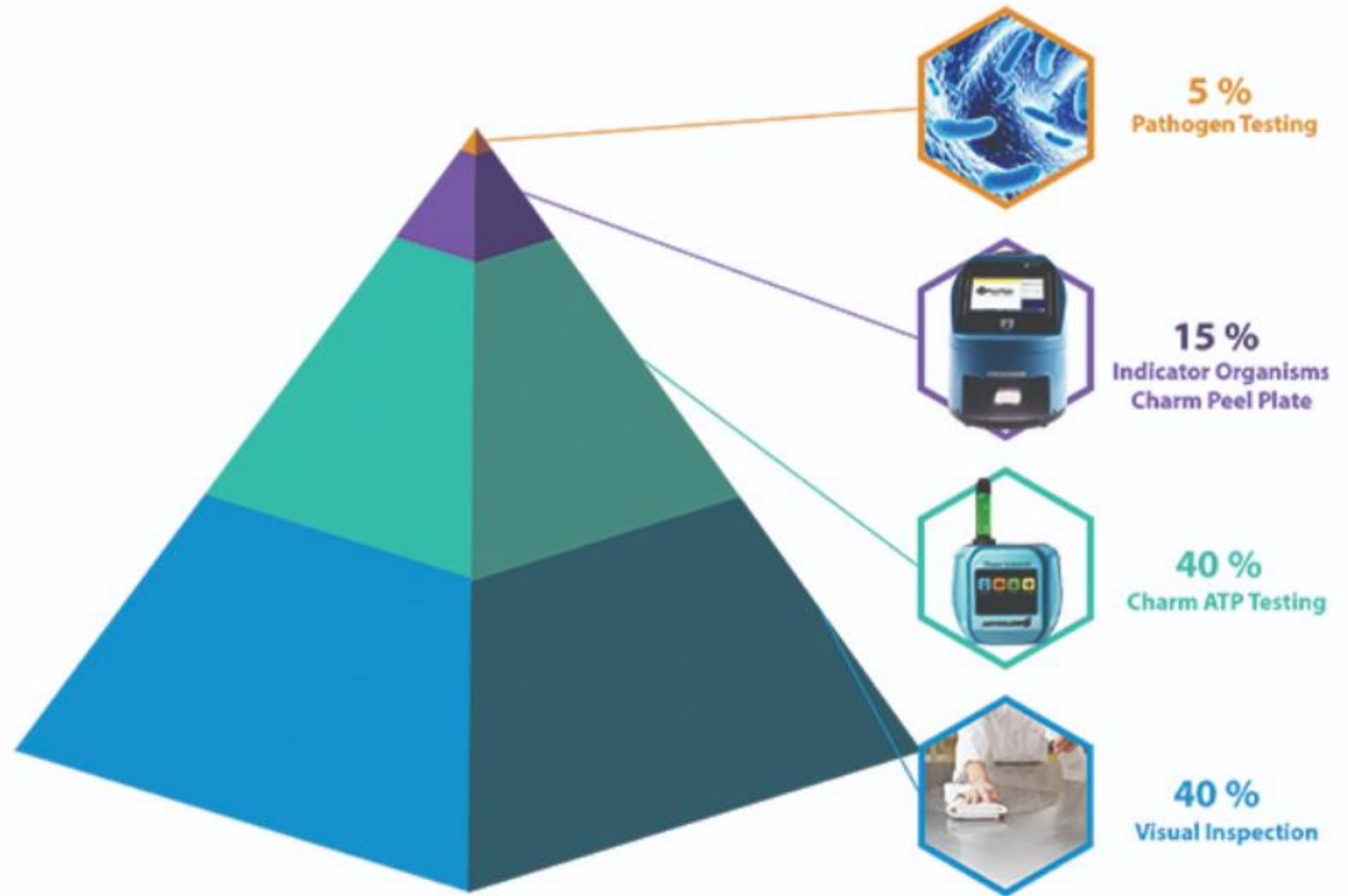
CONTENT

ENVIRONMENTAL MONITORING (EM)

- ATP Based Hygiene Monitoring
- EM for Indicator organisms
- EM for Pathogens
- EM for Spoilage Organisms

https://www.3m.com/3M/en_US/food-safety-us/resources/education/environmental-monitoring/

An Environmental Monitoring Program **assesses the effectiveness of the overall hygienic practices in a facility** and provides the necessary information to prevent possible microbial contamination of food products.



Preventative Control Pyramid

ATP BASED HYGIENE MONITORING

- Rapid, simple-to-use methods to determine the hygienic status of surfaces in the food processing facilities
- To provide a measurable and objective assessment of the cleanliness of equipment and surfaces prior to food processing
- Why cleaning is very important???
 - Removing the organic matter on food contact surfaces will reduce the opportunity of microorganisms to grow and enhance the efficacy of sanitizers



ATP testing is used to validate CLEANING

Principle of ATP testing

ATP (adenosine triphosphate)

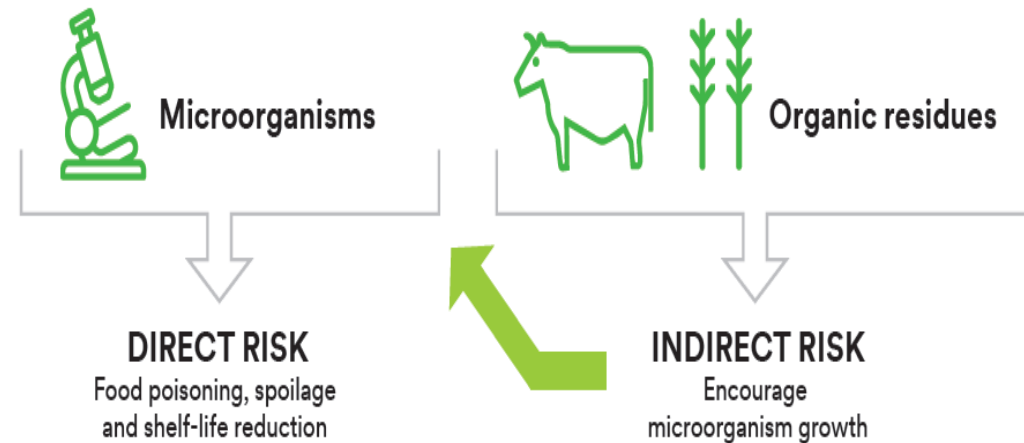
- energy molecule that is present in every living cell
- ATP is broken down to ADP and release energy for the cell to utilize

ATP is also present in residues from organic sources (due to inadequate cleaning)

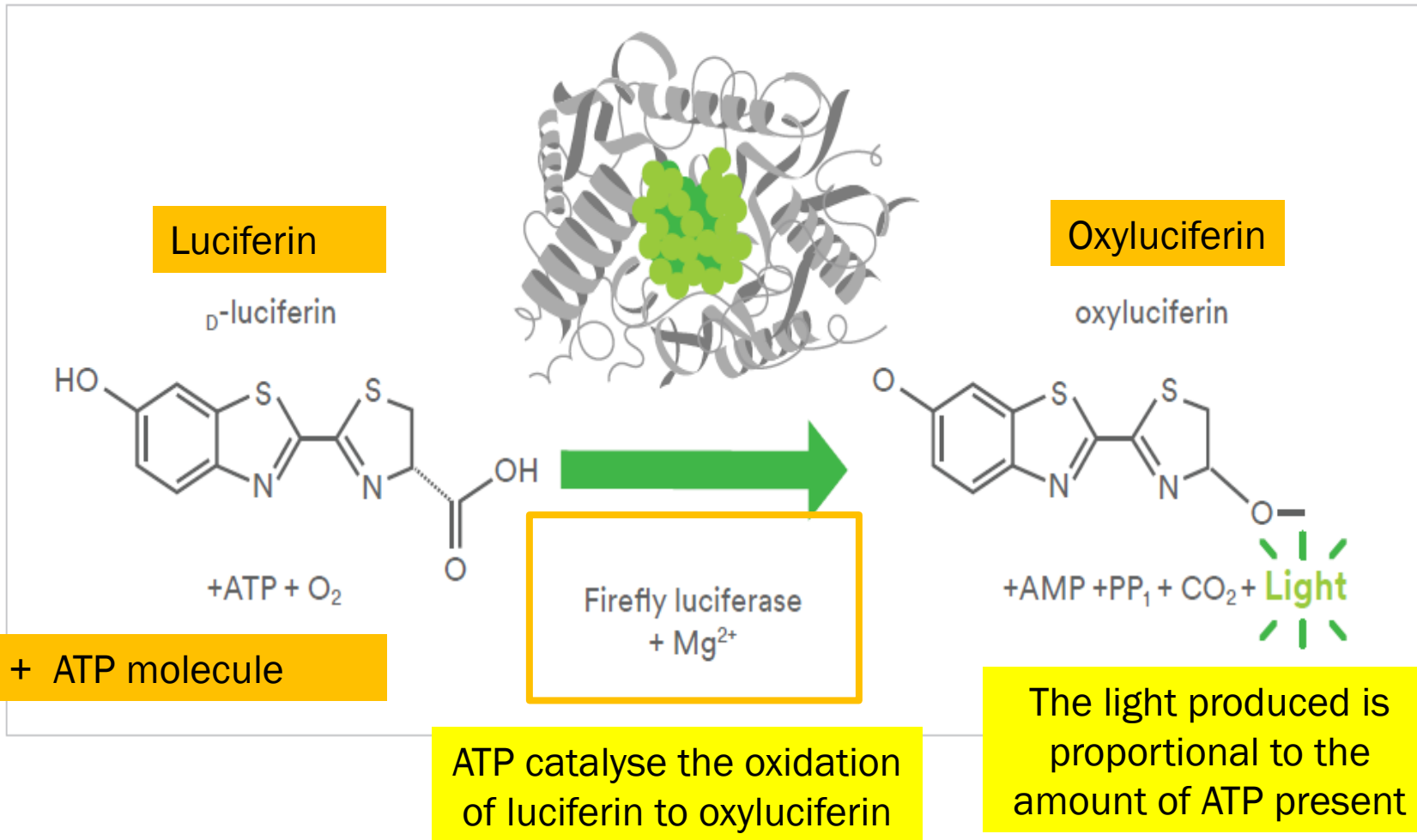
- Food debris on a surface after cleaning
- Biofilm of bacteria
- Surfaces touched by operators

The energy present in the ATP is utilized for the ATP hygiene monitoring

However, it cannot indicate the source of ATP

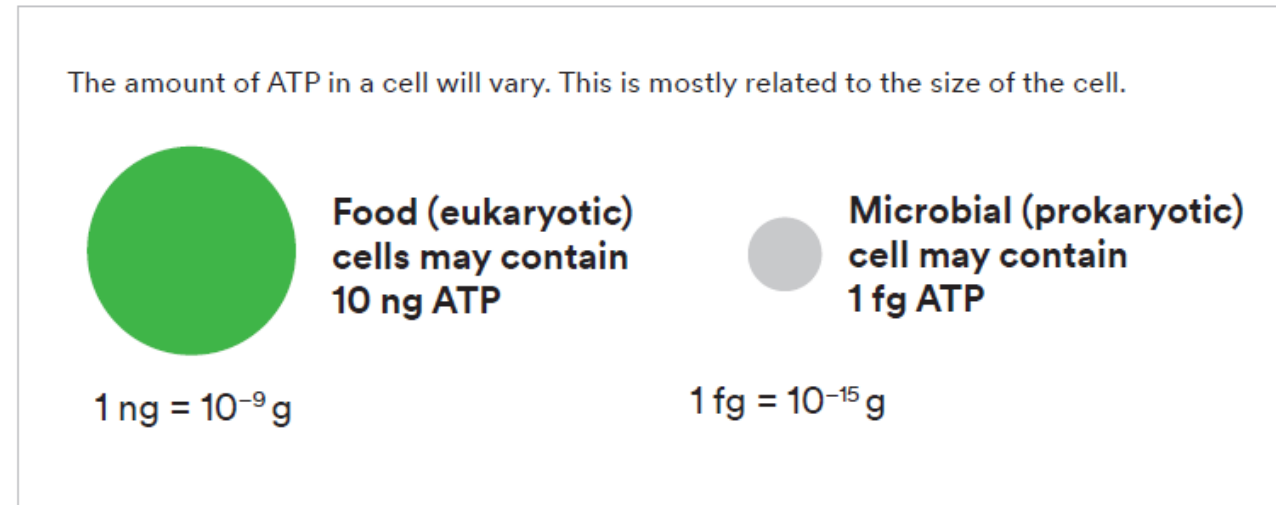


MEASURING ATP WITH BIOLUMINESCENCE



ATP VS. MICROBIOLOGICAL RESULT??

- The role of **ATP test** is to assess the **level of cleanliness**, which is related to the risk of microbial contamination
- 3 steps in the development of hygiene monitoring system
 - Initial validation
 - ❖ Involve higher testing frequency and sampling point
 - ❖ To establish baseline levels
 - Routine verification
 - ❖ Reduced frequency & fewer sampling point
 - ❖ Data is used to determine the pass/fail
 - Ongoing review and adjustment of the program

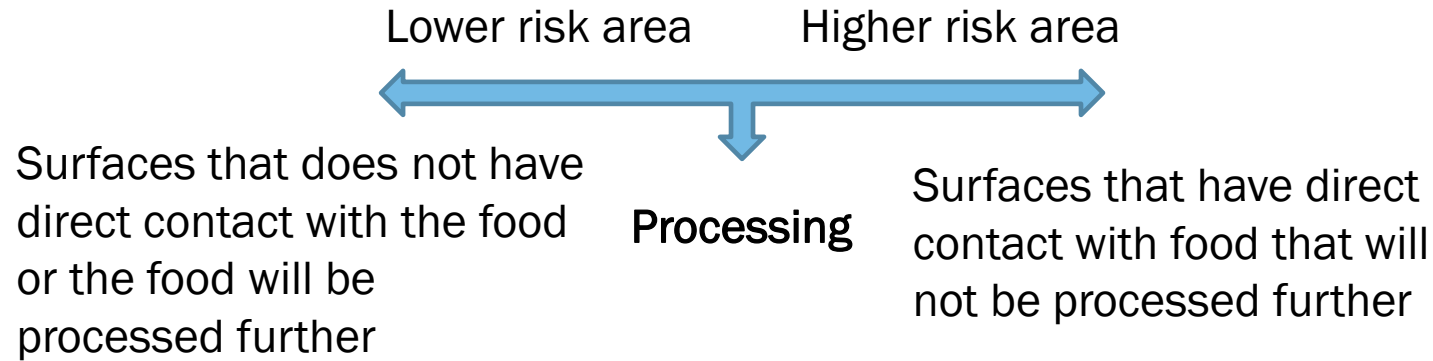


It is much easier to detect ATP from food cells than microbial cells!

BUT...

The **ATP result cannot be used as a replacement for microbiological result**

SELECTION OF SAMPLING SITES



Proximity to the food and potential for cross contamination

Stage of processing

The processing environment after the CCP step can be considered higher risk due to post-processing contamination

Lower risk area Higher risk area

CCP

Ease of cleaning and condition of the surface to be tested

- High risk area: surfaces which are difficult to clean
- E.g. old equipment, porous surfaces, etc..

Risk analysis:

- How close is the surface to the food?
- How hard is it to clean the surface?

ENVIRONMENTAL MONITORING SAMPLING ZONE



ZONE 1

Product Contact Surfaces

(Slicers, peelers, fillers, hoppers, screens, conveyor belts, air blowers, employee hands, knives, racks, work tables)



ZONE 2

Non-Food Contact Surfaces in Close Proximity to Food and Food Contact Surfaces

(Processing equipment exterior and framework, refrigeration units, equipment control panels, switches)



ZONE 3

More Remote Non-Food Contact Surfaces Located In or Near the Processing Areas

(Forklifts, hand trucks, carts, wheels, air return covers, hoses, walls, floors, drains)



ZONE 4

Non-Food Contact Surfaces Outside of the Processing Areas

(Locker rooms, cafeterias, entry/access ways, loading bays, finished product storage areas, maintenance areas)

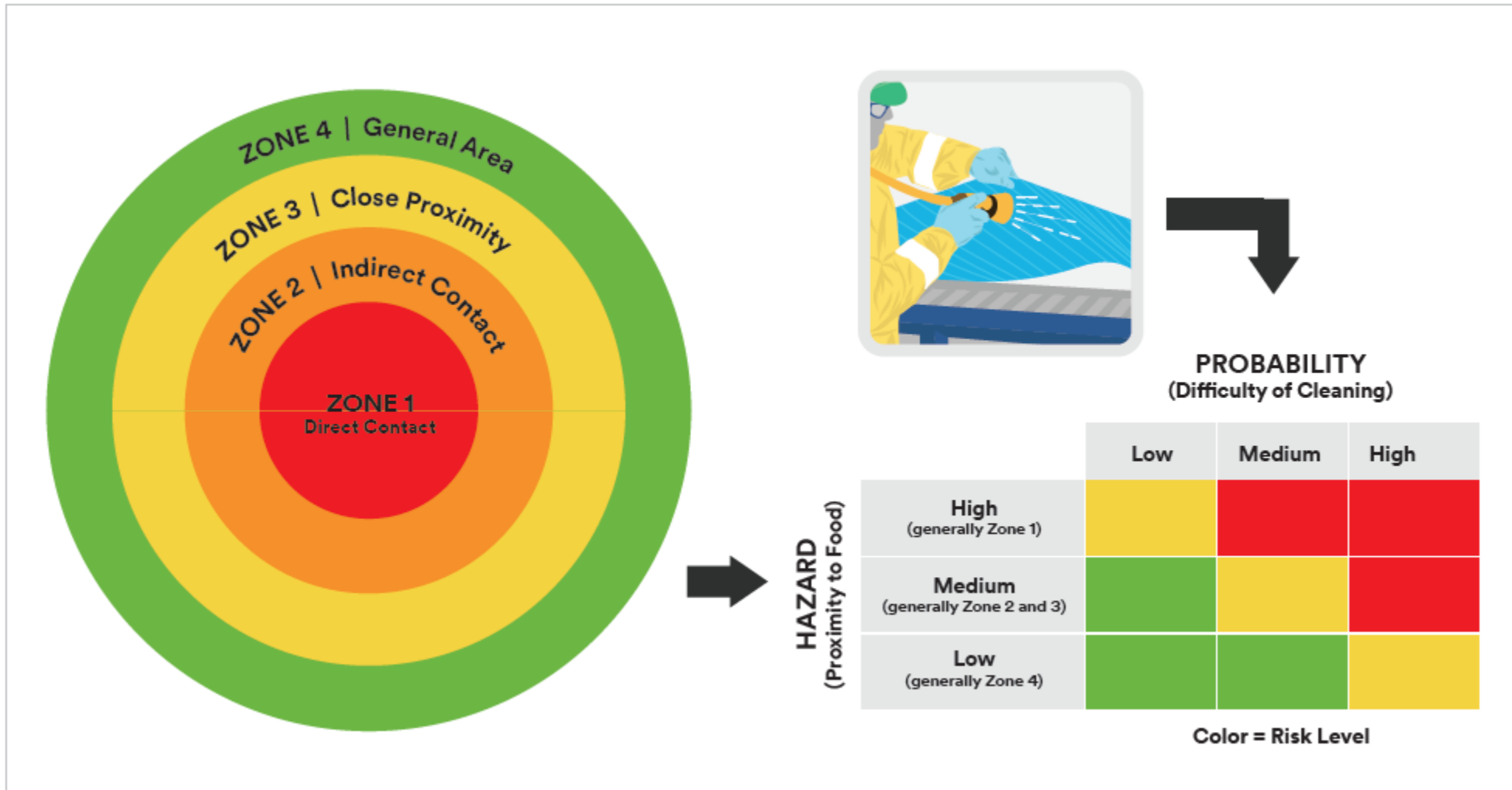
Identification of high risk sampling site

Zone 1

Should have the highest sampling frequency – conducted daily/as part of the production start-up routine. Zone 1 should be free of pathogens

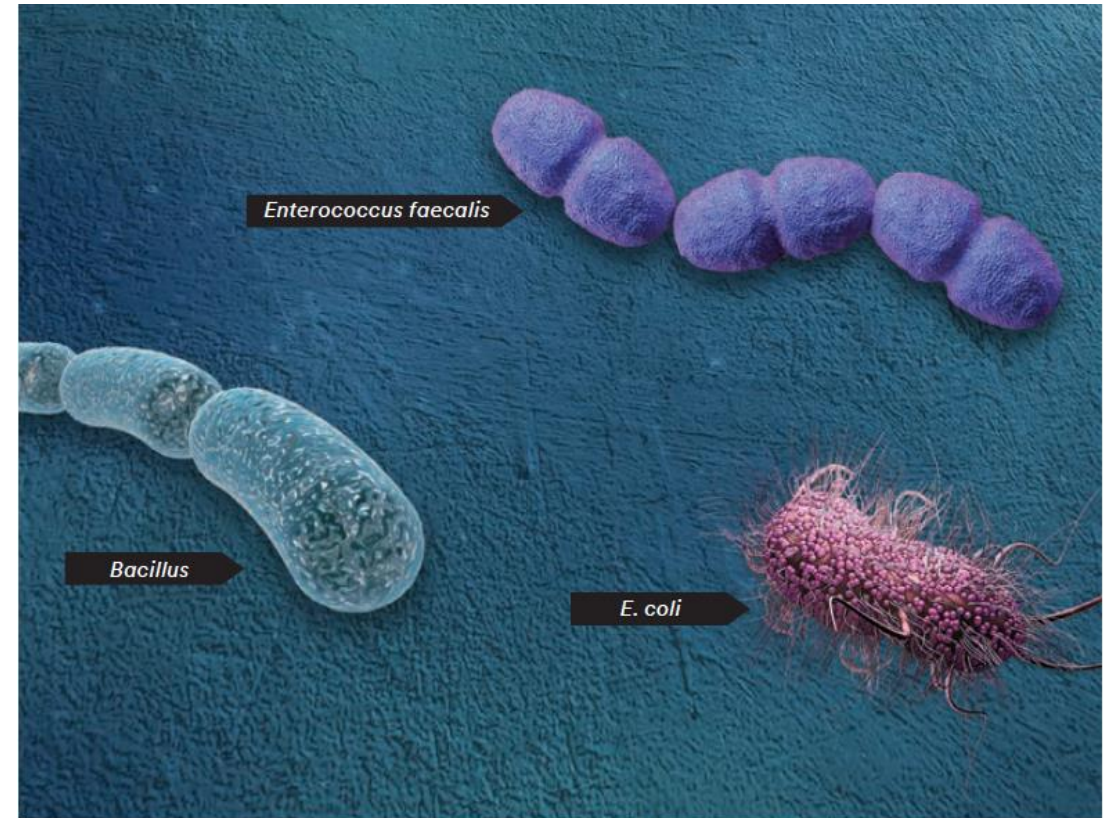
Zone 2

Lower frequency of sampling. E.g. weekly



ENVIRONMENTAL MONITORING FOR INDICATOR ORGANISMS

- Indicator organism is a group of organisms that reflect the **microbiological condition of a food or the environment**.
- It does not indicate the presence / absence of pathogens
- Data from indicator organisms can be used to:
 - Determine the hygienic status of the processing equipment and environment.
 - Understand the microbial ecology of the processing environment.
 - Validate and/or verify sanitation
 - Verify process control



Indicator is used to validate
SANITATION

INDICATOR ORGANISMS

Total Plate Count

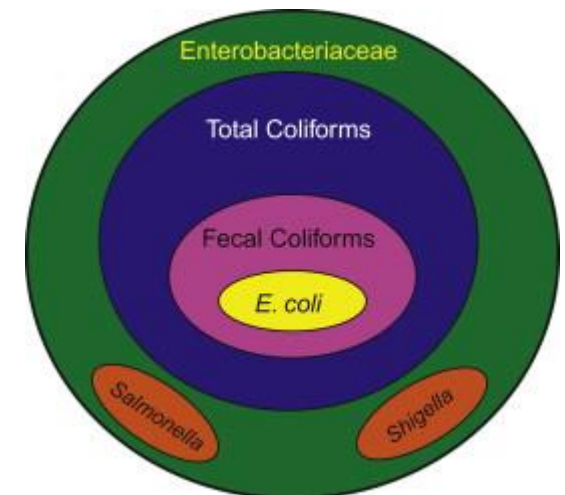
- Also referred to Aerobic Plate Count (APC), Standard Plate Count (SPC), Total Viable Count (TVC), Mesophilic Count (MC)
- Use non-selective nutrient medium (PCA) and incubated under aerobic conditions
- Purpose: to provide information on the total population of bacteria present in food / environment in the presence of oxygen and mesophilic temperature.
- These organisms can affect both quality and potential spoilage risk of finished product

Coliforms

- A diverse group of Gram-negative, non-spore forming, ferment lactose to produce acid and CO₂
- Certain species are fecal origin, while majority are environmental contaminants
- Indication of improper cleaning and sanitation, & post-process contamination
- Cannot detect non-coliform, e.g. *Pseudomonas* (spoilage organism) – need TPC

Enterobacteriaceae

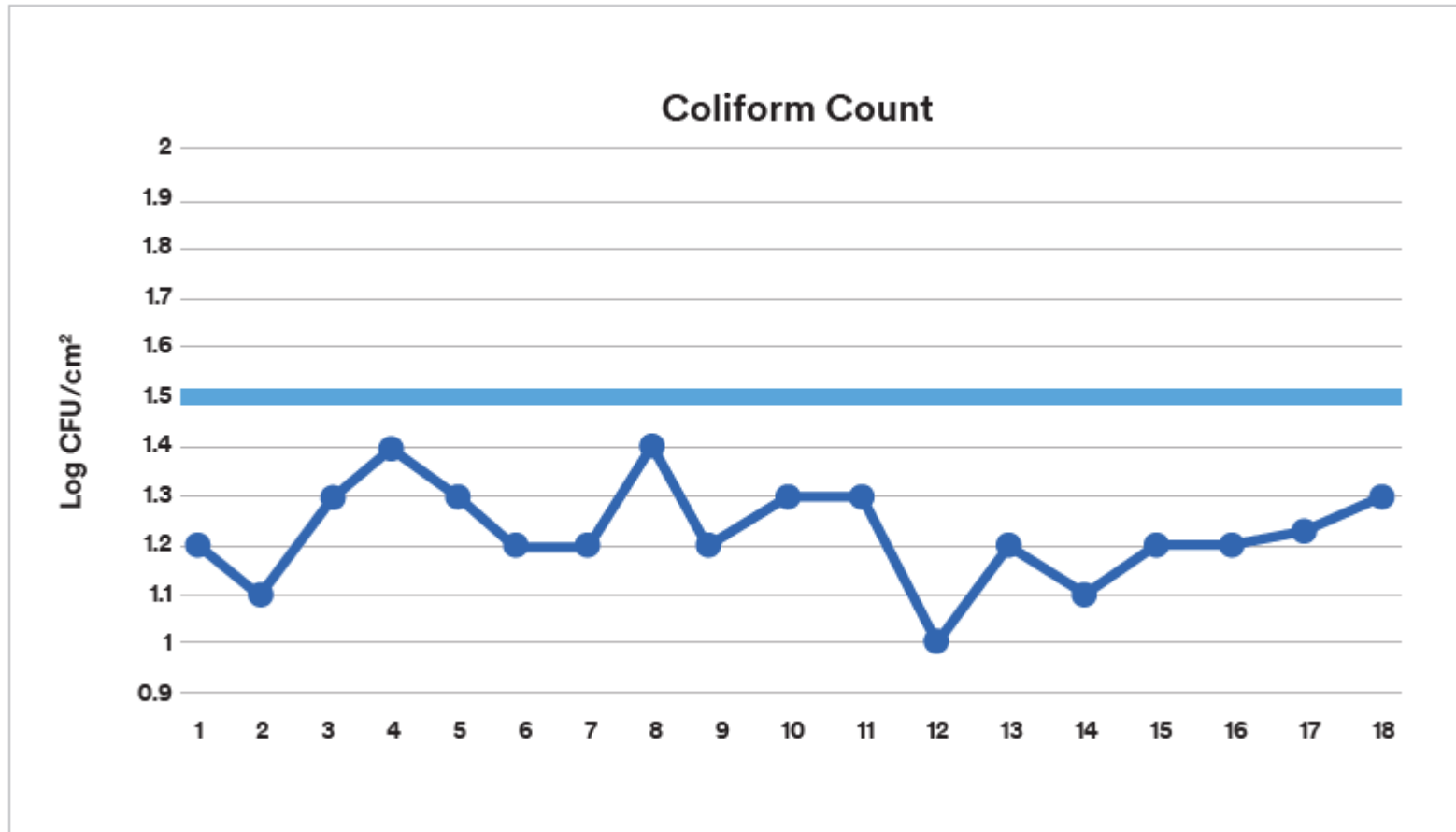
- A diverse group of Gram-negative bacteria which include all coliforms, include genera known to be pathogenic, e.g. *Salmonella*
- Indicator test – not a method for monitoring the presence of *Salmonella*



SAMPLING AND FREQUENCY

- Selection of sampling site
 - Identify the processing step, equipment, etc..
 - Sampling should focus on Zone 1 (product contact surface) and Zone 2 (surface adjacent to food contact surface)
 - Zone 3 & 4 sampling may be needed during investigations or root-cause analysis
- Sampling should take place after every sanitation cycle and prior to production start up.

Example of coliform counts and baseline-level post-sanitation




Baseline determination:

- Collecting samples after consecutive sanitation cycle from each test point
- The result then be plotted in a process control chart to establish the baseline

Table 3. Recommended Microbiological Indicator Limits for Equipment Cleaning Before and After Application of Sanitizer

Quantitative Microbiological Indicator Test	Target/ Acceptable Limits	Post-Heat Treatment Taken Before Sanitizer (cfu/40 in ²)	Post-Heat Treatment - Pre-op Taken After Sanitizer (cfu/40 in ²)
Aerobic Plate Count	Target	< 100	< 10
	Acceptable	< 500	< 100
Coliforms	Target	< 10	< 10
	Acceptable	< 100	< 50
Total Enterobacteriaceae	Target	< 10	< 10
	Acceptable	< 100	< 50



The presence of **indicator organisms** does not indicate the presence of a **pathogens**, but their **level above an acceptable limit** can indicate **insufficient cleaning and sanitation or operating conditions**.

This is an early warning system to identify and prevent potential product contamination issues

Thus appropriate corrective actions should be taken.



ENVIRONMENTAL MONITORING FOR PATHOGENS (PEM)

An ongoing sampling & testing process that measures the effectiveness of the contamination control measures in a food processing plant.

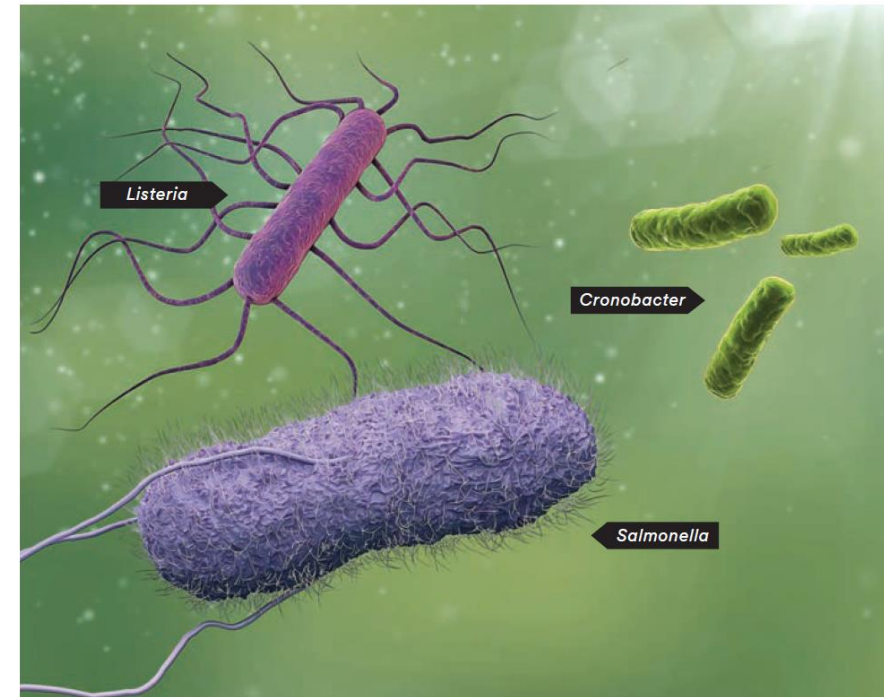
“SEEK AND DESTROY” CONCEPT

- To verify an overall food safety system
- To provide early indication of potential food safety hazards

High risk for pathogens

- RTE product facilities
- Institutional kitchens serving high risk population

The key part of a PEM program is to identify harborage sites where actual pathogens survive and grow and eliminate the growth niches (area that usually protected from sanitizers)



PEM is used to verify the overall
FOOD SAFETY system

Listeria monocytogenes

- Gram +ve; non-spore forming rods
 - Capable of growing at low temp (< 8°C)
 - Opt growth: 30 to 37 °C
 - Typically found in cool and wet production environment (drains, chillers, air conditioners)
- Targeted industries:
 - RTE meat and meals
 - Dairy (raw and pasteurized milk, cheese, ice cream)
 - Fresh produce etc.
- EM for pathogen typically test for *Listeria* spp. and it may or may not be *L. monocytogenes*

Salmonella spp.

- Gram -ve; non-spore forming rods
- Opt. growth: 35-37°C; pH 7-7.5; aw 0.99
- Survive well in the environment and is known to tolerate heat and dry conditions
- Targeted industries:
 - Dairy
 - Meat and Poultry
 - Eggs
 - Chocolate
 - Fruits and vegetables
 - Flour
 - Spices, etc
- *Salmonella* has been shown to persist for at least 10 years in dry food processing facilities

***Chronobacter* spp.**

- Gram -ve; non-spore forming rods
- Opt growth: 37°C
- Primary sources: corn, soy, wheat, rice, herbs, spices
- Primary concern: milk powder and infant formula
- Highly resistance toward desiccation and able to survive spray drying process
- *Chronobacter* spp. have been found to be the cause of life-threatening illness in neonates, infants, and immunocompromised people

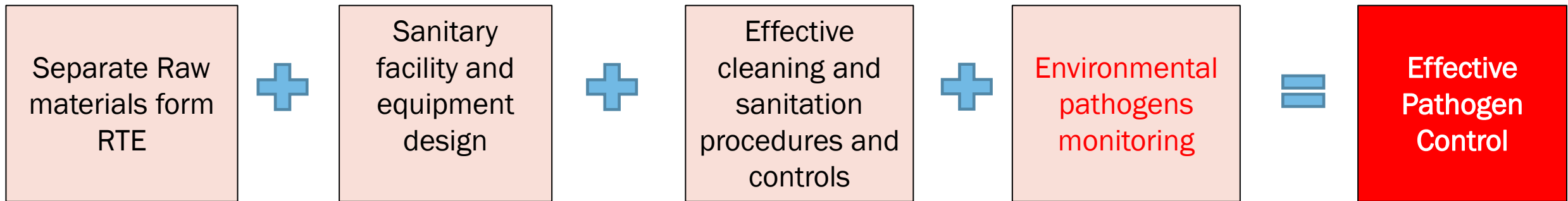


THE ENVIRONMENT OF FOOD PROCESSING PLANT

- Sources of pathogen in the plant – raw materials, ingredients, pest, workers, equipment
- The pathogens persist in niches and move through the facility (dust, traffic flow, condensation)
- Grow and survive within the plant
- It can re-contaminate the processed food



BASIC PROGRAMS RECOMMENDED TO ESTABLISH EFFECTIVE PATHOGEN CONTROL IN A MANUFACTURING FACILITY



ESTABLISH THE PATHOGEN EM PLAN

Pathogen EM Plan



ASSEMBLE TEAM

Cross functional team (microbiologist, QA, plant management etc)



ASSEMBLE DOCUMENTATION AND DETAILS

Floor plans, equipment and its locations, result from previous PEM in the facility etc.



IDENTIFY REGULATORY AND CUSTOMER REQUIREMENTS



KEY PARAMETERS

Target pathogens, testing procedures, sampling sites, and frequency, number of samples etc.



DEVELOP WRITTEN DOCUMENT

Recod keeping, SOP, corrective actions etc.



TRAIN SAMPLE COLLECTORS

Training SOP, records, and test records. Training should be delivered in easy and understandable manner



SCHEDULE REGULAR REVIEW

Review every 6-12 months: sampling plans, results , corrective actions. Third party assessment can be considered to see the efficacy of the current plan.

SAMPLING

Initial step in designing a PEM program is to select possible PEM sites and the frequency of sampling

- Master list of sampling site with a unique identifier for each site is developed
- Master list can includes 400 – 500 sampling sites for a medium-sized food processing facilities
- 40 – 50 samples were collected weekly
- Specifically, *Listeria* would be a target pathogen for weekly sampling for any such facility that either produces RTE foods that allow for *Listeria* growth

SAMPLING

Zone 1

- Direct food contact surfaces
- E.g. conveyor, utensils ,slicers, mixer, employee hands, fillers, etc.



Zone 2

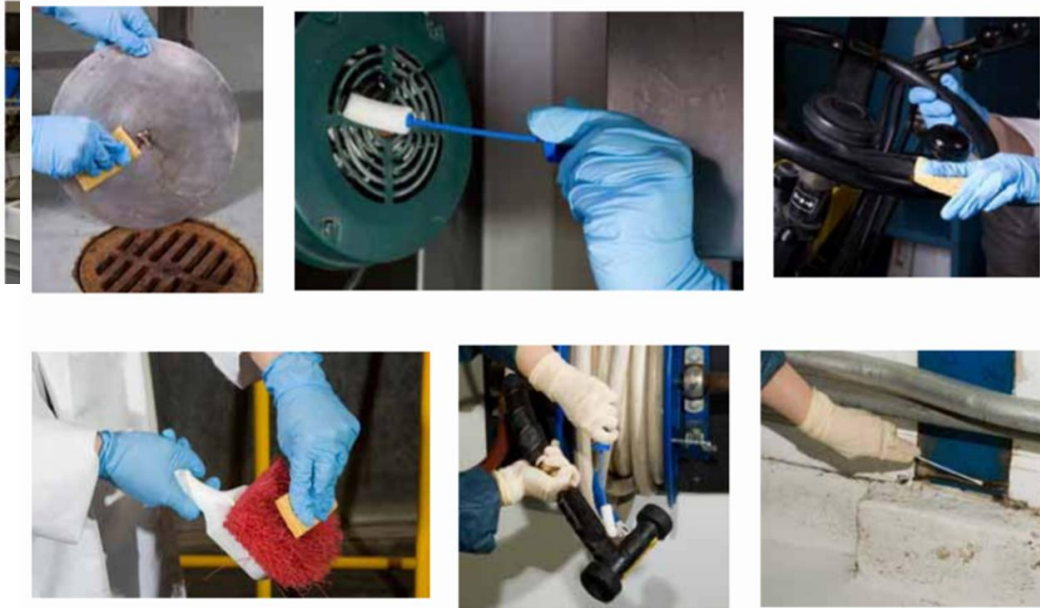
- Non-food contact site adjacent to Zone 1 (close proximity to food 7 food contact surfaces)
- E.g. control panels, processing equipment, refrigeration unit, etc.



SAMPLING

Zone 3

- Non food contact surfaces adjacent to Zone 2
- E.g. floors, wall, ceiling, drains, forklift, pallets, etc..



Zone 2

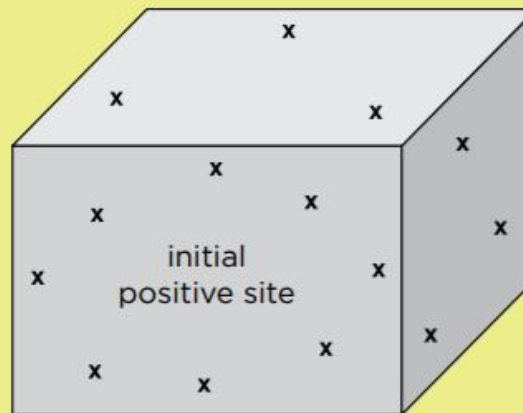
- Non-food contact outside the processing area
- E.g. lockers, cafeteria, offices, restroom, loading bays, etc.



CORRECTIVE ACTIONS BASED ON PATHOGEN TESTING RESULTS

- Stop the production
- Quarantine the affected area
- Vector swab to be collected after an initial positive pathogen is reported
- Deep cleaning procedures at the affected site
- Root-cause analysis
- Increase sampling frequency

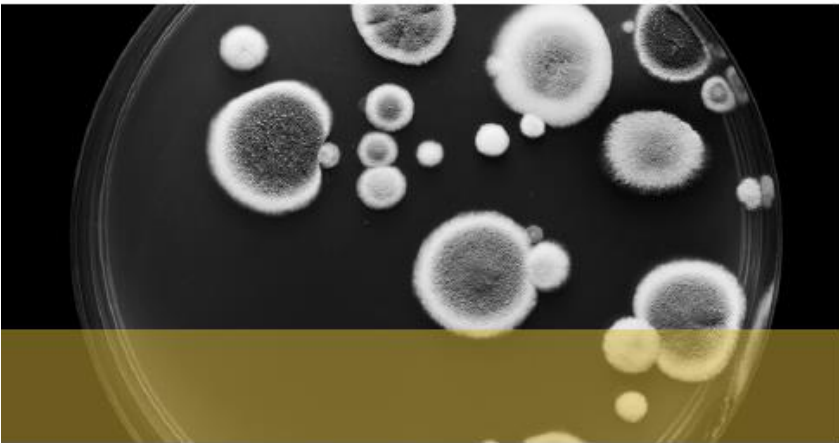
Figure 5. Vector Sponge/Swab Sampling Starburst Pattern Around the Initial *Salmonella* Presumptive Positive Site.



ENVIRONMENTAL MONITORING FOR SPOILAGE ORGANISM

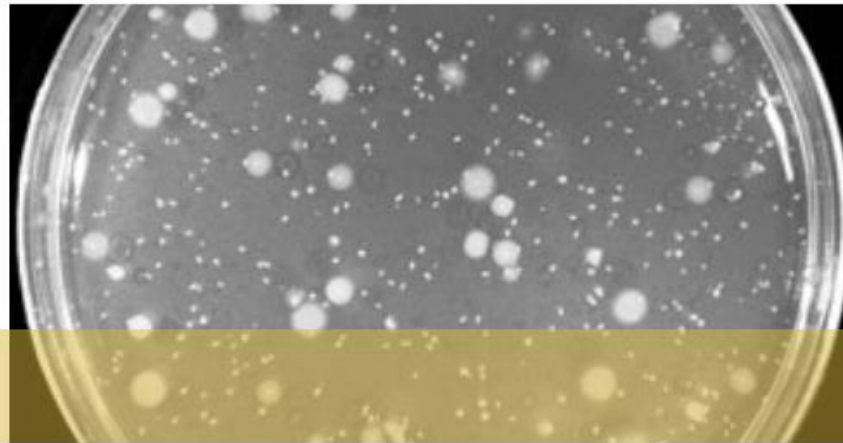
- Poor environmental hygiene –spoilage might occur
- Spoilage organism can survive in the product and environment
- Consequences:
 - Decreased shelf life
 - Undesirable organoleptic properties
 - Product recall

SPOILAGE ORGANISMS



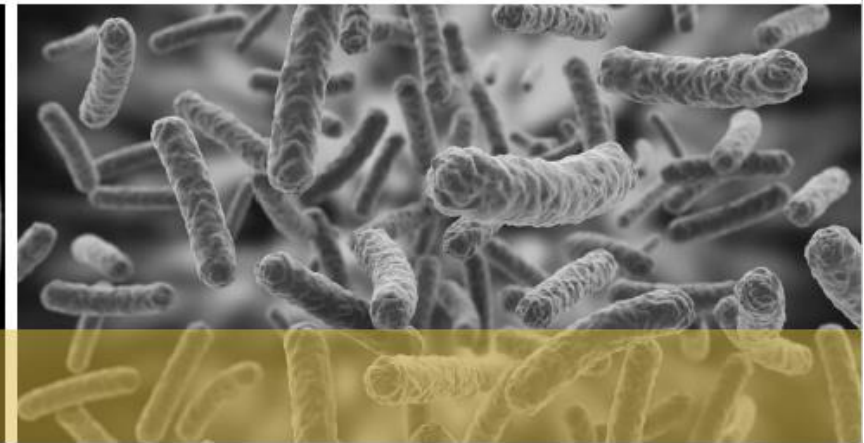
YEAST & MOLDS

- highly resistant to many processing and formulation controls
- resilient to low pH
- Yeast: spoilage of high-water activity and/or high-sugar foods
- Mold: ESL products



TOTAL PLATE COUNTS

- a diverse array of commensal organisms



LACTIC ACID BACTERIA

- cause spoilage of fresh meat and meat products, RTE products like fresh-cut fruit and modified atmosphere packed (MAP) lunch meats, beer, milk
- Manifest: off-flavors and aromas, slime (dextran), formation and package bloating due to carbon dioxide production among heterofermentative strains.

THANK YOU

