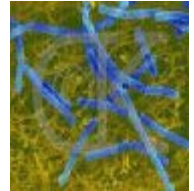


General Principles of Bacteria Heat Resistance

Are you aware of the general principles of heat treatment and bacterial resistance? As always in nature there is large variability, and organisms can live in nearly any natural condition. This includes thermal vents in the ocean that can reach upwards of 249 °F. That said, it is little surprise we encounter bacteria throughout the [food industry](#) that can survive and/or grow in pasteurizing equipment.

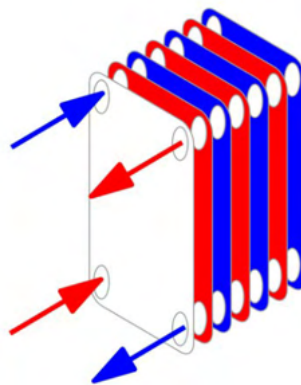
Some general terminology for bacteria and their *typical* temperature ranges:

- **Psychrophilic** bacteria are cold loving organisms growing from 30 °F to 68 °F. (ex. Listeria, Pseudomonas)
- **Mesophilic** bacteria love moderate temperatures of 68 °F to 113 °F. (ex. Salmonella, E. coli, Staphylococcus)
- **Thermophilic** bacteria want extreme temperature, growing 113 °F to 176 °F. (ex. Bacillus, Micrococcus, Streptococcus, several LAB - Lactic Acid Bacteria)
- **Thermoduric** bacteria are essentially a category mixing ranges and refers to the behavior of bacteria that can survive pasteurization to varying extent. (68 °F to 149 °F)
- Important Note: Most of these bacteria will produce enzymes that perform at their growth temperatures. (Spoilage & pH changes)
- Heat treatment effectiveness increases the further the temperature is from their natural state. **Psychrophilic** > **Mesophilic** > **Thermophilic**



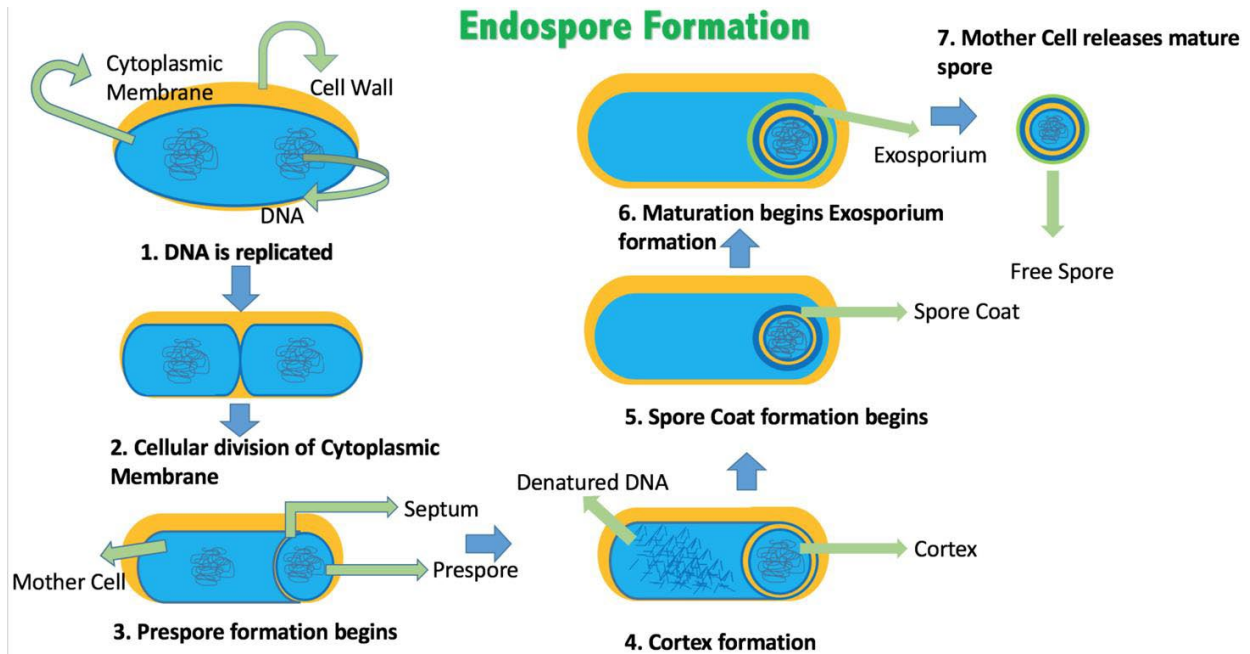
Beyond these categories there are many factors that will influence a bacteria's ability to resist higher temperatures and treatments. All the items listed below in the associated mediums (products) will typically increase the resistance to heat treatment.

- Low Water Activity (A_w)
- Higher Fat Content
- Higher Protein Content
- Higher Carbohydrate Content
- Higher Salt Content
- Higher Solids Content
- Increased Organism Population
- Optimal Organism pH (typically 7)



Note: Heat treatment effectiveness increases more with added temperature than by adding additional time.

When it comes to heat treatment, those additional protections from endospore formation allow bacteria to survive when they would otherwise be killed. In general, all spores will be more resistant to heat treatment than vegetative cells (those in natural growth form). Spores formed from mesophilic organisms will be less resistant than spores developed by thermophilic bacteria.



Testing for Thermophilic, Thermoduric, and the associated spores can be somewhat complicated due to the conditions required for spores to germinate. These conditions will vary from bacteria to bacteria and determine the method needed to recover and enumerate spore count. Understanding what is growing in these situations will help determine the remediation steps to remedy the situation. Some general guidance on this testing:

- Spore testing is performed by heating samples to high temperatures in efforts to eliminate the vegetive cells (175 °F - 225 °F for 12 - 30 minutes). Samples are then given incubation conditions best thought to allow spores to germinate. Colonies are counted and results distributed.
- Thermoduric and Thermophilic samples are incubated at the elevated temperatures without the need to eliminate vegetative cells.

Reach out to the **RITE team** for more information on preventing bacteria contamination in pasteurizing equipment.