Lab-10 Practical Bacterial physiology

Effect of starvation and hydration on bacterial growth.

What is starvation in bacteria?

Starvation in bacteria is a complex adaptive response to deprivation of nutrients that has been shown to implicate a number of stress networks that modulate pathogenicity and antibiotic resistance. Starvation in nature is qualitatively different from in-culture late stationary phase energy source depletion.

Starvation and dehydration impact bacterial growth, often leading to a dormant or spore-forming state to survive prolonged nutrient and water deprivation. Bacteria can enter a state of plasmolysis where the cytoplasm contracts, and in some cases, they can form specialized structures like spores for survival.

Note: The factors that affect bacterial growth

Environmental factors influence rate of bacterial growth such as:

1- acidity (pH), 2-temperature, 3-water activity, 4-macro and micro nutrients, 5-oxygen levels, 6-toxins.

Effects of Starvation:

- **Dormancy:**

Bacteria can enter a dormant state characterized by reduced metabolic activity and growth.

- **Morphological Changes:**

Some bacteria, like *Bacillus subtilis*, may change shape to a coccoid form and slow down their growth rate to conserve energy.

- **Spore Formation:**

Genera like Bacillus and Clostridium can form spores, which are highly resistant to environmental stresses, including starvation.

- **Metabolic Adjustments:**

Starving bacteria can adjust their metabolism, potentially increasing antibiotic tolerance and survival during nutrient depletion.

- **Plasmolysis:**

This process, where the cytoplasm shrinks, is an active, ATP-consuming state essential for survival.

- **Ion Homeostasis:**

Maintaining plasmolysis requires energy, and ion homeostasis plays a crucial role in regulating bacterial death rates during starvation.

Nutrient-Specific Effects:

- **Carbon and Phosphorus starvation:**

Starvation for different nutrients can have varying effects on bacterial survival, growth lag, and ribosome content.

- **Nitrogen starvation:**

Starvation for nitrogen can significantly alter bacterial surface properties and attachment capabilities.

Other Factors:

- **pH and temperature:**

Environmental factors like pH and temperature also influence bacterial growth and survival during starvation.

- **Biofilms:**

Starvation can trigger the detachment of bacteria from biofilms, which are communities of bacteria attached to a surface.

- **Transport in porous media:**

Starvation can affect how bacteria move through soil and other porous materials

Effects of Dehydration:

- **Reduced Growth:**

Low water activity , often associated with dehydration, inhibits bacterial growth.

- **Survival in Low-Moisture Foods:**

While growth is inhibited, many bacteria can survive for extended periods in low-moisture foods.

- **Desiccation:**

Desiccation, or extreme drying, is a method used to control microbial growth by reducing water availability.

- **Impact on Thermal Resistance:**

The moisture content of bacterial cells can influence their resistance to heat.

Procedure for Studying the Effects:

1. **Prepare Bacterial Cultures:**

Start with a culture of the desired bacteria (e.g., *Escherichia coli*, *Bacillus subtilis*).

2. Create Starvation Conditions:

Grow bacteria in nutrient-rich media and then transfer them to media lacking specific nutrients (e.g., carbon, nitrogen) or to distilled water for dehydration.

3. Monitor Growth:

Track bacterial growth over time using techniques like :

1-Optical density measurements.

2- Colony counts.

3- live/dead cell staining.

4. Observe Morphological Changes:

Use microscopy techniques (e.g., SEM, TEM) to examine changes in cell shape and structure.

5. Assess Survival:

Determine the survival rate of bacteria under starvation and dehydration conditions by assessing their viability after a certain period.

6. Analyze Physiological Changes:

Measure metabolic activity (e.g., ATP levels, enzyme activity) and gene expression to understand how bacteria respond to nutrient and water deprivation.