

Phosphorus Uptake and Release

- a. certain bacteria of the genus *Acinetobacter* (and others) possess the special metabolic capability to store large quantities of polyphosphate.
- b. these bacteria are normally present in all aerobic suspended growth cultures, but only display enhanced biological phosphorus removal (EBPR) when they are cycled between aerobic and anaerobic zones. The following mechanism has been proposed to explain EBPR:

c. mechanisms in the anaerobic environment

- i. as wastewater travels to the wastewater treatment plant the organic matter undergoes a certain amount of fermentation under anaerobic conditions, producing acetic acid and short-chain volatile fatty acids (VFA's).
- ii. acetic acid in its undissociated form (H_3CCOOH) is transported across the cell membrane
- iii. the acetic acid dissociates to form acetate (H_3CCOO^-) and to maintain the hydrogen gradient, H^+ is expelled from the cell. This requires energy in the form of ATP.
- iv. the acetic acid is polymerized to form a long chain of poly- β -hydroxybutyrate. This also requires energy in the form of ATP.
- v. as the ATP to ADP ratio decreases, stored polyphosphate is hydrolyzed to regenerate the ATP, excess phosphate is released from the cell into the bulk solution.

Key Poly-P Reactions in Anaerobic Environment

1. Uptake of acetic acid
2. Stored polyphosphate is consumed
3. Storage polymer PHB is formed from acetic acid
4. Inorganic phosphorus is released into the bulk liquid

d. mechanisms in the aerobic environment

- i. soluble substrate is transported into the cell and ATP is produced through normal means (substrate level phosphorylation and respiratory chain linked phosphorylation).
- ii. due to the replenished supply of ATP, polyphosphate begins to be stored, and inorganic phosphate is taken up by the cells from the bulk solution.
- iii. once the supply of external substrate is exhausted, the cell uses its PHB reserves during endogenous metabolism to continue to manufacture polyphosphate and take phosphate into the cell.
- iv. the cycling between aerobic and anaerobic environments gives an advantage to those bacteria which can accumulate and store polyphosphate.

Key Poly-P Reactions in Anaerobic Environment

1. ATP is regenerated during the metabolism of *exogenous* substrate
2. Inorganic phosphorus is taken up by the cell from the bulk liquid and stored as polyphosphate
3. Once *exogenous* substrate is exhausted, the cell begins metabolizing its stored PHB reserves and continues to uptake phosphorus
4. Poly-P bacteria outcompete other bacteria without the ability to continue metabolism using stored energy reserves in the absence of exogenous substrate