

Scientific Basis Statement

Bacterial Requirements

Bacteria have specific requirements to sustain metabolic activity and growth. These requirements, common to all bacteria, are: 1) an energy source, 2) a carbon source, 3) a nitrogen source, 4) a terminal electron acceptor, and 5) water.

Bacteria require an energy source to power metabolic activity, and require a carbon source to provide the basic building block of cell growth. The bacteria associated with wastewater traps utilize organic compounds as both energy source and carbon source. Energy is extracted by oxidation, the removal of electrons, of reduced organic compounds, and carbon is provided by enzymatic mediated catabolism of the same organic compounds. Reduced or electron rich organic compounds include carbohydrates (sugars and starches) and lipids (fats and grease), which are common waste water trap compounds.

Bacteria also require nitrogen to manufacture the proteins and nucleic acids required for cell growth and reproduction. Nitrogen rich proteins are also abundant in wastewater traps and are readily broken down to provide the nitrogen required by the organism to produce unique proteins and nucleic acids.

The transfer of electrons, initially provided by the oxidation of reduced organic compounds, through metabolic pathways provides the energy required to sustain viability and growth. However, a terminal electron acceptor must be provided or metabolic activity ceases. The aerobic bacteria found in waste water traps utilize oxygen as the terminal electron acceptor, while the anaerobic bacteria utilize nitrates or sulfates. As oxygen accepts the terminal electrons it is reduced to water, while nitrates and sulfates are reduced to nitrites and sulfides which are malodorous.

Aerobic metabolic activity is highly efficient and will, under the appropriate conditions, completely convert organic compounds into carbon dioxide and water, a process known as mineralization. Anaerobic metabolic activity, on the other hand, is slow and produces intermediate organic compounds and less than complete mineralization.

Typical aerobic organisms capable of metabolizing the organic compounds commonly found in wastewater traps include *Bacillus* spp. and *Pseudomonas* spp. The optimum oxic environment for sustained metabolism and growth of these organisms is at oxygen saturation or approximately 6.0 mg/l. The organisms will continue to metabolize organic compounds at oxygen concentrations down to approximately 1.0 mg/l, but with reduced metabolic activity. At oxygen concentrations below 1.0 mg/l, aerobic metabolic activity essentially stops.

Wastewater traps contain high levels of organic matter. This organic matter is rapidly oxidized by the naturally occurring bacterial community, the available oxygen is depleted, and aerobic metabolic activity ceases. Atmospheric replenishment of oxygen is

hindered by the lipid layer at the water surface which perpetuates the anaerobic environment and limits further degradation of the organic matter.

Aerobic Carbohydrate and Lipid Metabolism

Typical carbohydrates include sugars and starches which are prime carbon sources for most bacteria. These simple compounds are readily introduced into the bacterial metabolic pathway where they are converted into glucose. Glucose is then converted to pyruvate with a consequent release in energy. Pyruvate is then metabolically converted to two-carbon acetyl CoA units which enter the tricarboxylic acid (TCA) cycle and finally the electron transport chain where the majority of energy is released (Figure 1).

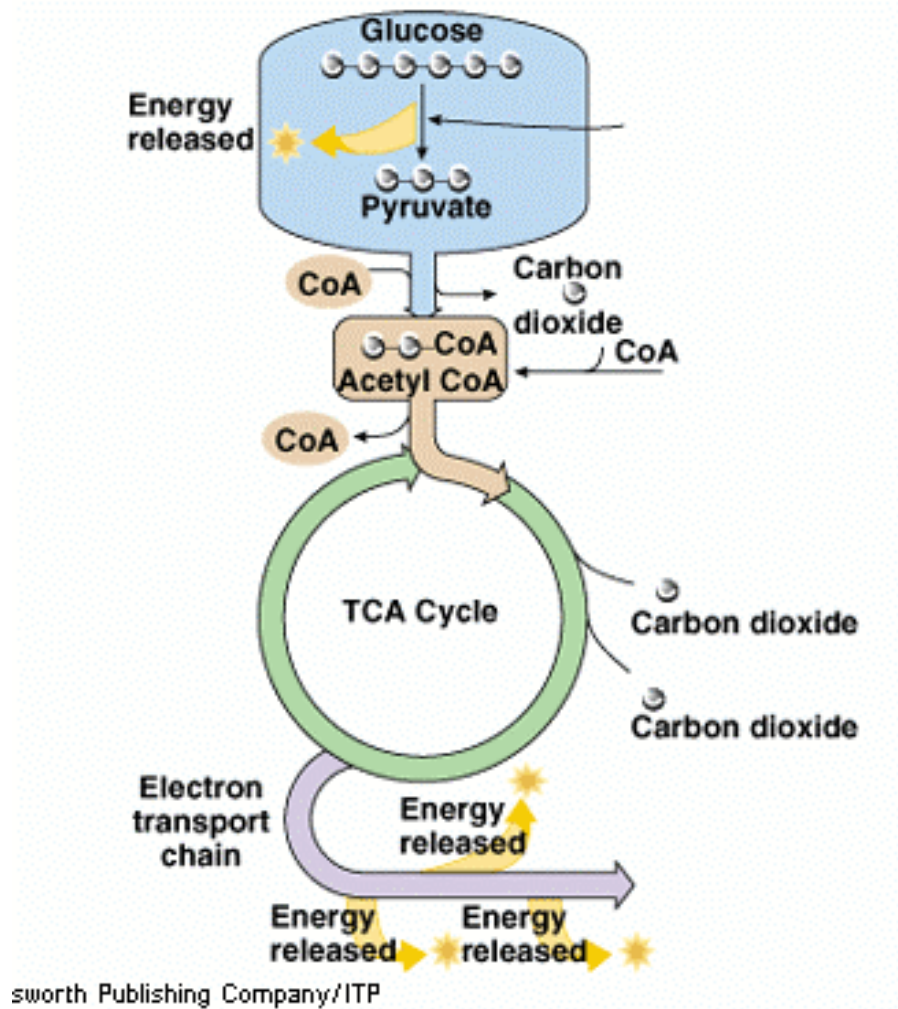


Figure 1. Carbohydrate metabolic pathway.

Most of the lipids found in waste traps are grease and fats, which exist as triglycerides and free fatty acids. The triglyceride and free fatty acid catabolic pathways in *Bacillus* spp. and *Pseudomonas* spp. are well known and elucidated in the literature.

The process of mineralization begins when bacteria exude lipase, cleaving individual triglyceride lipid molecules into glycerol and three free fatty acids. The glycerol molecule can now be metabolized to form products that can enter the metabolic pathway. Via beta-oxidation the fatty acid portion of the lipid molecule is broken down two carbons at a time into two-carbon acetyl CoA units (Figure 2), that can now enter the TCA cycle (Figure1).

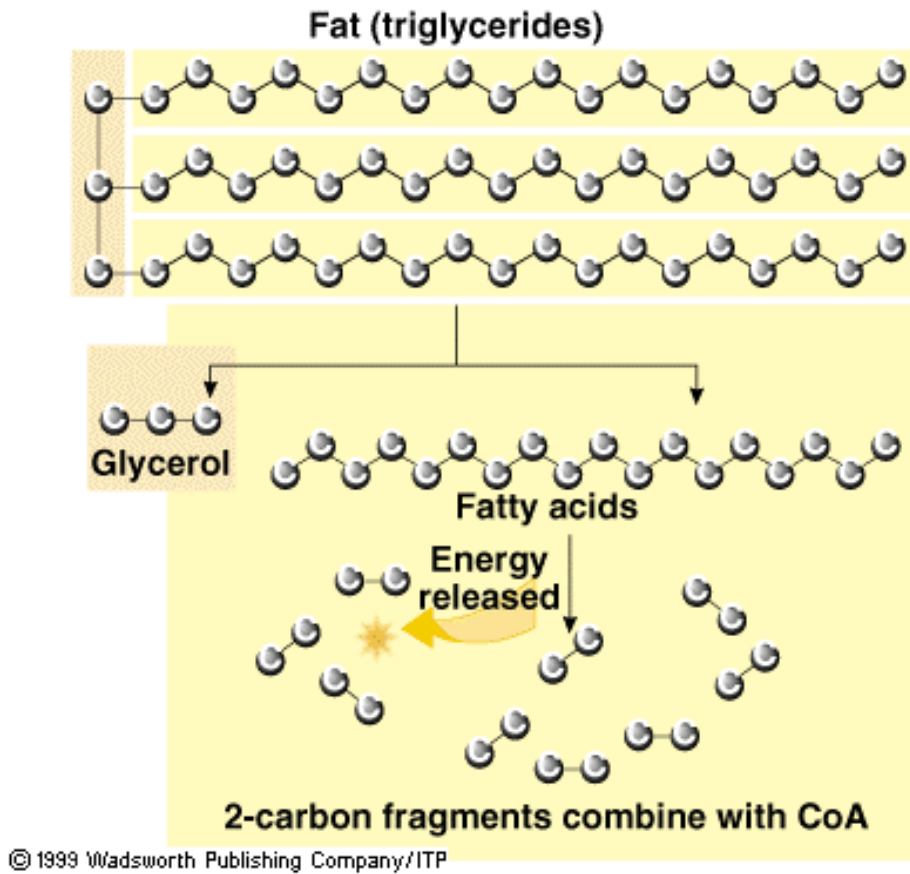


Figure 2. Lipid metabolic pathway.