Ethanol Metabolism

Ethanol is turned into acetaldehyde by alcohol dehydrogenase, which operates via zero-order kinetics. This reaction takes place in the cytoplasm. Acetaldehyde is then turned into acetate by acetaldehyde dehydrogenase in the mitochondria. NAD is the limiting reactant for both of these reactions. The metabolism of alcohol results in the consumption of NAD and the production of NADH. An increase in NADH diverts acetyl-CoA away from gluconeogenesis into ketogenesis and lipogenesis, which can result in hypoglycemia and hepatosteatosis (fatty liver). Acetyl-CoA is produced from acetate via thiokinase. Fomepizole is an antagonist of alcohol dehydrogenase hile disulfiram blocks acetaldehyde dehydrogenase.

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Characteristics

Zero Order Elimination

Order-Zero

Alcohol dehydrogenase acts via zero-order kinetics. Zero-order kinetics is characterized by the elimination of a constant quantity of the drug per time unit. Contrast this with first-order kinetics in which the proportion of the drug that is excreted is constant, but the actual quantity that is eliminated depends on the drug concentration.

Pathway

Ethanol

Alcoholic-martini

Metabolism of ethanol begins in the cytoplasm of cells, where it is converted into acetaldehyde by alcohol dehydrogenase.

Alcohol Dehydrogenase

Alcohol Dehydrator

Ethanol is turned into acetaldehyde by alcohol dehydrogenase, which operates via zero-order kinetics. This enzyme is located in the cytosol. CYP2E1 enzyme of Microsomal Ethanol-Oxidizing System (MEOS) also plays a role in the metabolism of ethanol into acetaldehyde, and its activation in chronic alcohol consumption results in depletion of NADPH and formation of free radicals, which can cause peroxidation of membranes and damage hepatocytes. Catalase enzyme also plays a minor role in alcohol oxidation and converts toxic hydrogen peroxide into water.

Produces NADH

Lemon-NADE

Alcohol dehydrogenase consumes NAD and forms NADH. This results in an increased NADH/NAD ratio, which decreases gluconeogenesis, increases ketogenesis and increases lipogenesis.

Acetaldehyde

Seagull-D

Acetaldehyde is produced by the metabolism of ethanol by alcohol dehydrogenase. Increased levels of acetaldehyde are responsible for the hangover symptoms.

Acetaldehyde Dehydrogenase

Seagull-D Dehydrator

Acetaldehyde is converted into acetate by acetaldehyde dehydrogenase. This enzyme is located in the mitochondria.

Produces NADH

lemon-NADE

Alcohol dehydrogenase and acetaldehyde dehydrogenase both consume NAD and produce NADH. Thus, the metabolism of ethanol results in an increased NADH/NAD ratio, which decreases conversion of oxaloacetate into malate. This, in turn, results in decreased gluconeogenesis, and increased risk of fasting hypoglycemia. Increased NADH/NAD ratio also increases conversion of pyruvate into lactate, which can result in lactic acidosis.

Acetate

Ass-T

Metabolism of acetaldehyde by acetaldehyde dehydrogenase results in the formation of acetate in the mitochondria.

Thiokinase

T-Ohio Kite-ace

Acetate thiokinase is an enzyme that converts acetate into acetyl-CoA.

Acetyl-CoA

Seagull CoA-purse

Acetate is converted to acetyl-CoA by the action of acetate thiokinase. Increased NADH/NAD ratio results in the diversion of acetyl-CoA into the synthesis of ketones instead of the TCA cycle. Increased NADH also results in the diversion of acetyl-CoA into fatty acid synthesis, which can result in hepatosteatosis (fatty liver).

Drugs

Fomepizole

Foam-pole

Fomepizole is a medication that is used for the treatment of methanol and ethylene glycol poisonings.
Fomepizole blocks alcohol dehydrogenase and prevents the conversion of ethanol into acetaldehyde; by blocking this enzyme it also prevents the metabolism of toxic byproducts of methanol and ethylene glycol.

Disulfiram

Dyed-shirt-surfer

Disulfiram blocks acetaldehyde dehydrogenase and prevents the conversion of acetaldehyde into acetate. Accumulation of acetaldehyde leads to symptoms of a hangover; this discourages patients from drinking alcohol.