Lipogenesis

Lipogenesis describes the process by which cells use acetyl-CoA to create triglycerides, which are energy storage molecules composed of fatty acids and glycerol. There are two main phases: fatty acid synthesis, followed by triglyceride synthesis. Fatty acid synthesis first requires acetyl-CoA, which can be obtained from citrate via the citrate shuttle. Next, acetyl-CoA is acted upon by acetyl-CoA carboxylase (using biotin as a cofactor) to create malonyl-CoA. Finally, fatty acid synthase acts on malonyl-CoA to create palmitate, the first fatty acid. The next phase is triglyceride synthesis. Here, glycerol is acted upon by glycerol-3-phosphate acyltransferase to combine it with three fatty acids. This combination results in the formation of triglycerides, which can be stored or distributed to the body.



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Fatty Acid Synthesis

Acetyl-CoA
Seagull Coin-purse
Fatty acid synthesis occurs in the cytoplasm. It occurs mostly in adipose tissue, the liver and lactating mammary glands. Acetyl-CoA is required to begin fatty acid synthesis. It can be obtained by converting citrate to acetyl-CoA through the action of ATP citrate lyase.

Citrate Shuttle to Cytoplasm
Citric-lemon Shuttle to Side-toe-plasma-TV
Acetyl-CoA is typically located in the mitochondrial matrix of cells, but must be shuttled to the cytoplasm in order to participate in fatty acid synthesis. This is done via the citrate shuttle, which forms citrate from acetyl-CoA and shuttles it through the mitochondrial membranes and into the cytoplasm. In the cytoplasm, ATP citrate lyase then converts citrate to acetyl-CoA.

Acetyl-CoA Carboxylase
Seagull Coin-purse Cardboard-lace
Acetyl-CoA Carboxylase is the rate-limiting enzyme in fatty acid synthesis. This enzyme processes acetyl-CoA with the help of biotin to create malonyl-CoA. Positive regulators for this enzyme include insulin and citrate, while negative regulators include glucagon and palmitoyl-CoA.

Biotin Cofactor
Bionic-tin-man Crow-flagger
Biotin is required as a cofactor for the enzyme acetyl-CoA carboxylase to function. Biotin provides a unit of CO2 to the reaction.

Malonyl-CoA
Melon Coin-purse
Malonyl-CoA represents the first dedicated molecule in the fatty acid synthesis pathway. It is acted upon by fatty acid synthase to form palmitate, a 16-carbon fatty acid which is the precursor to longer fatty acids.

Fatty Acid Synthase
Bacon Acidic-lemon Synthase
Fatty acid synthase is a complex of enzymes responsible for creating and elongating fatty acids. Malonyl-CoA is initially acted upon by fatty acid synthase to form palmitate, a 16-carbon fatty acid.

Triglyceride Synthesis

Glycerol
Glitter-roll
Triglycerides are energy storage molecules composed of three fatty acids attached to a glycerol. Glycerol is combined with fatty acids through the help of glycerol-3-phosphate acyltransferase.

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Glycerol-3-Phosphate Acyltransferase

Glitter-roll-3-Tree-P Axle-transformer-ace

Glycerol-3-phosphate acyltransferase is an enzyme which uses glycerol and fatty acids as substrates to create triglycerides.

Triglycerides

TAG-triceratops

Triglycerides are created when glycerol is combined with three fatty acids. Triglycerides can then be stored or packaged as lipoproteins (eg., VLDL) for distribution throughout the body.

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