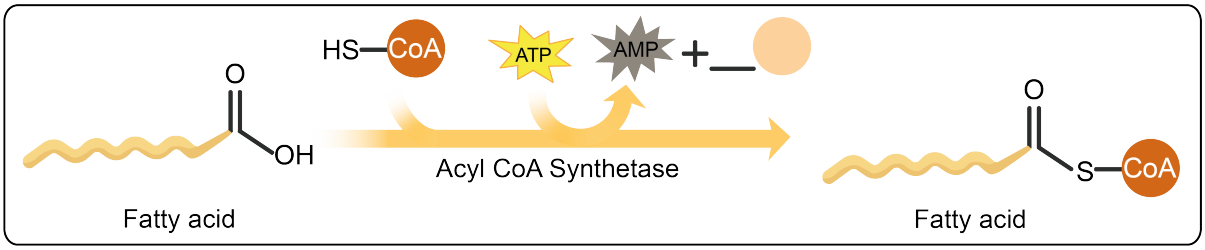
CONCEPT: OXIDATION OF FATTY ACIDS

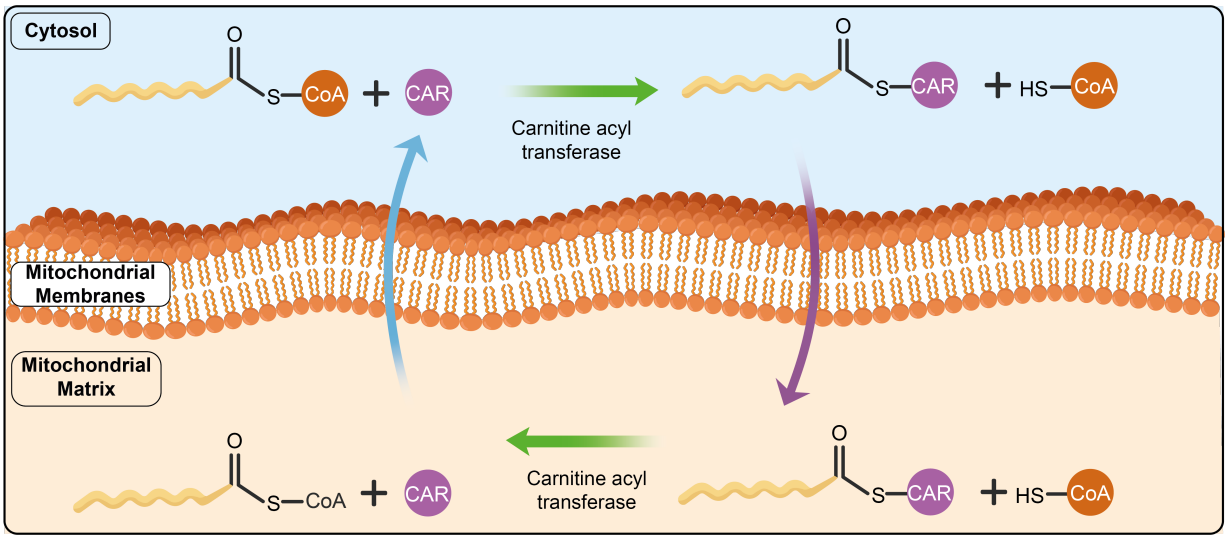
Phase A – Activation

- Similar to glycolysis, fatty acid activation is an energy-_____ step.
  - □ The enzyme acyl CoA synth_____ catalyzes the conversion of fatty acid to fatty acyl CoA.
  - □ 1 ATP is hydrolyzed to 1 AMP and 2 P_i.
    - Equivalent to ___ ATP ⟶ ___ ADP



Phase B – Transport

- Fatty acyl CoA cannot _____ cross the mitochondrial membrane.
  - □ The enzyme carnitine acyltransferase _____ the fatty acyl group from CoA to carnitine.
  - □ Fatty acyl carnitine moves from the cytosol into the mitochondrial matrix.
  - □ Fatty acyl carnitine reacts with CoA in the mitochondrial matrix to produce fatty acyl CoA.



EXAMPLE: Fatty acid activation requires hydrolysis: 1 ATP ⟶ 1 AMP, how is this equivalent to 2 ATP ⟶ 2 ADP?

a) One AMP molecule carries an amount of energy equivalent to two ADP molecules.

b) Conversion of 1 ATP to 1 AMP requires cleavage of 2 high-energy phosphoanhydride bonds.

c) Hydrolysis of ATP to AMP is accompanied by oxidation of an electron carrier (such as NADH).

d) None of the above.

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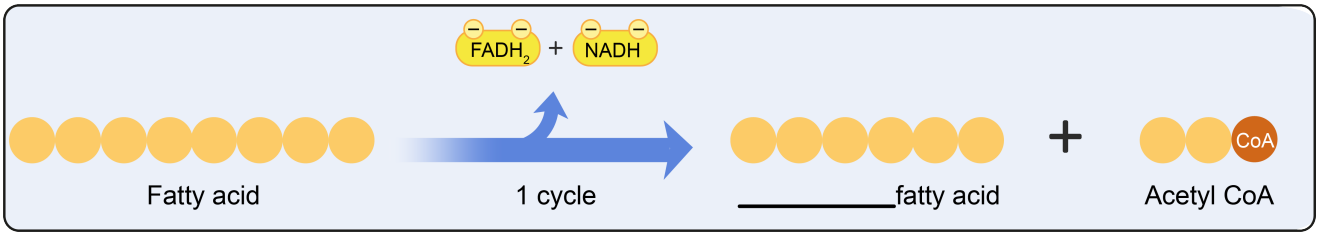
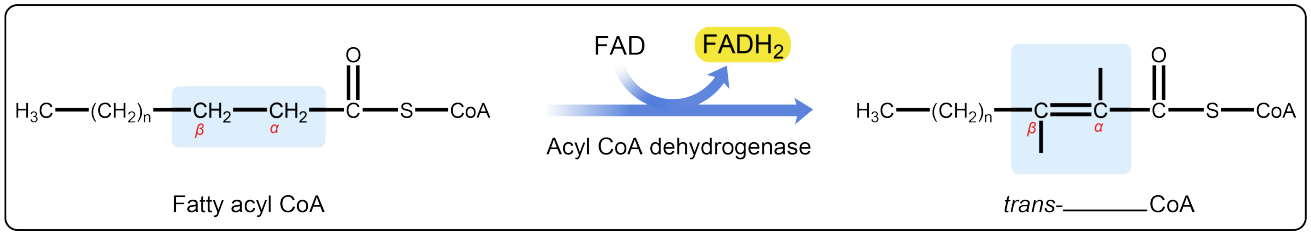
Phase C – Oxidation

- The β-oxidation pathway consists of ___ repeated reactions.
  - □ Cleaves ___ carbons (Acetyl CoA) from the fatty acid chain in each cycle.
  - □ __ cycle of the pathway produces __ $FADH_2$, __ NADH, and __ acetyl CoA.



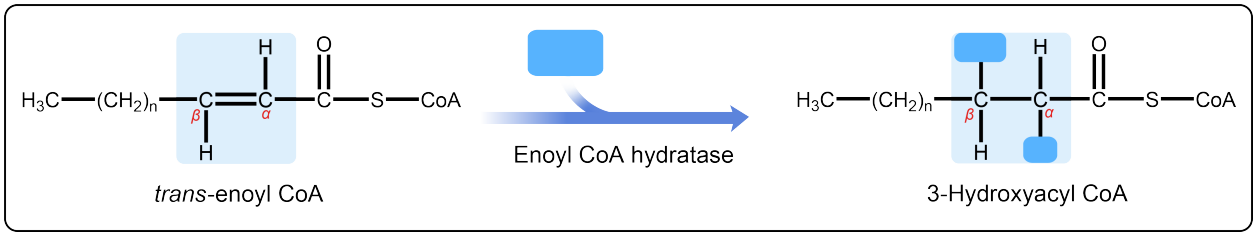
1 β-Oxidation # 1: the enzyme acyl CoA _____ removes ___ H atoms from α- and β-C atoms.

□ Double bond forms between α- and β-C atoms. □ 1 FAD is reduced to 1 _____.

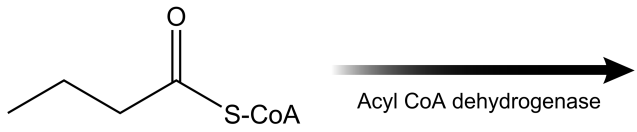


2 Hydration: the enzyme enoyl CoA _____ adds H_2O to the α,β-double bond.

□ Places the –OH at the ___-carbon. □ _____acyl CoA is produced.



EXAMPLE: Identify the α- and β-C atoms in the structure below and complete the reaction.



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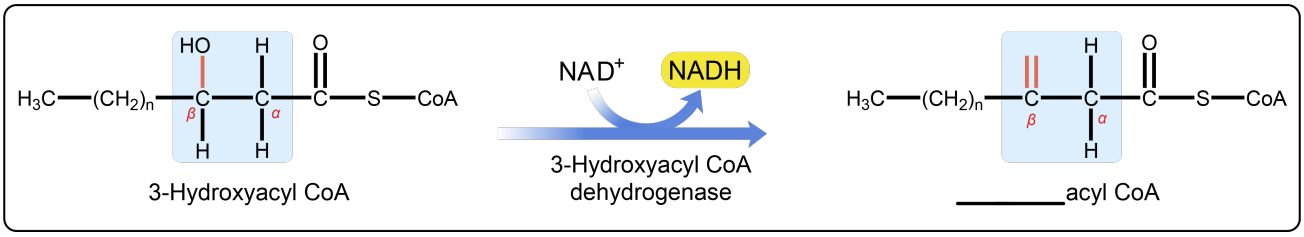
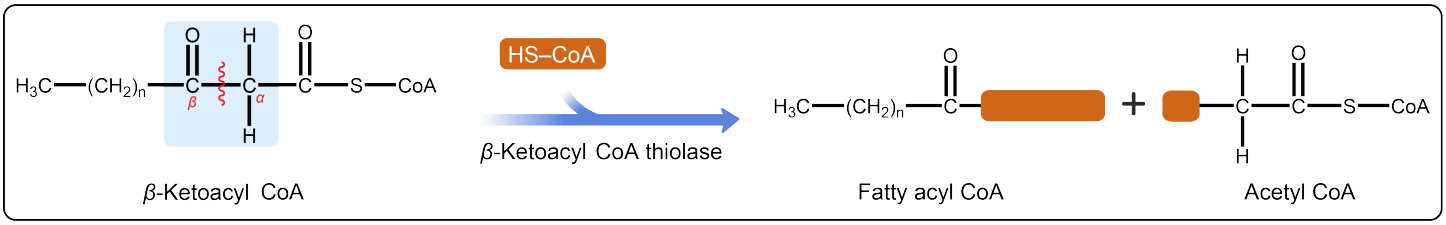
3 ***β*-Oxidation # 2:** the enzyme 3-hydroxyacyl CoA _____ catalyzes the oxidation of _____ group.

□ Forms a ketone at the ___-carbon. □ 1 NAD^+ is reduced to 1 _____.



4 **Bond Cleavage:** the enzyme *β*-ketoacyl CoA _____ cleaves the bond between *α*- and *β*-C atoms.

□ A _____ fatty acyl CoA is formed. □ 1 acetyl CoA is produced.



EXAMPLE: Identify each of the following statements about *β*-oxidation as true (T) or false (F).

a) ___ Hydration of *trans*-enoyl CoA in the second reaction of *β*-oxidation produces 3-hydroxyacyl CoA.

b) ___ The formation of *β*-ketoacyl CoA from the oxidation of 3-Hydroxyacyl CoA requires NAD^+ as the coenzyme.

c) ___ Bond cleavage to produce an acetyl CoA from *β*-ketoacyl CoA is catalyzed by *β*-ketoacyl CoA thiolase.

d) ___ Oxidation of the fatty acyl CoA by $FADH_2$ produces a *cis*-double bond between *α*- and *β*-C atoms.

PRACTICE: Which one of the following coenzymes is not a part of the *β*-oxidation pathway?

a) ATP

b) $FADH_2$

c) CoQ

d) CoA

e) NADH

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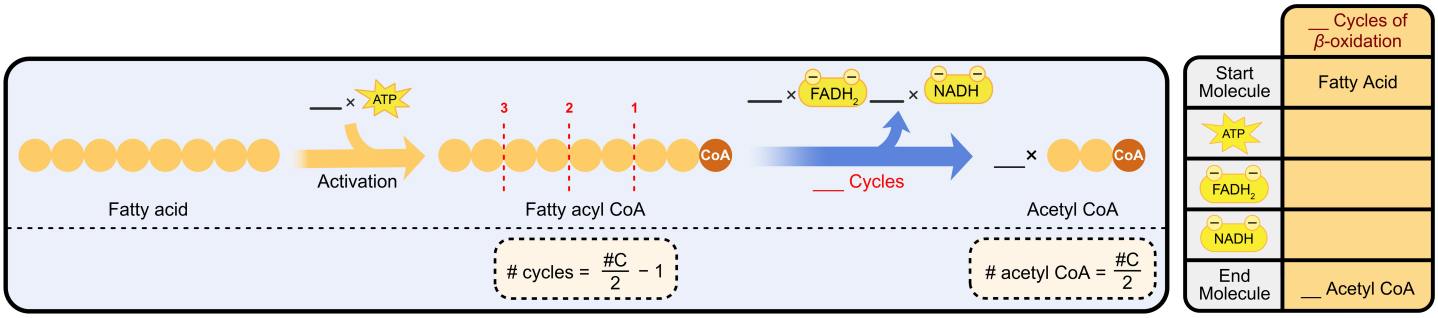
β-Oxidation Energy Output

- Energy output of the *β*-oxidation depends on the number of ___ atoms in the fatty acid.
  - □ Fatty acid activation is a _____-time expense of 2 ATPs.
  - □ Each cycle cleaves ___ C atoms.
  - □ 1 $FADH_2$ and 1 NADH in each cycle.



EXAMPLE: Behenic acid is a long-chain fatty acid containing 22 C atoms. How many cycles of *β*-oxidation are required to completely degrade behenic acid?

a) 10 cycles b) 11 cycles c) 9 cycles d) 12 cycles e) 22 cycles

PRACTICE: How many total $FADH_2$, NADH, and acetyl CoA molecules will be produced when stearic acid undergoes *β*-oxidation?

a) 10 $FADH_2$, 10 NADH, and 9 acetyl CoA

b) 9 $FADH_2$, 9 NADH, and 9 acetyl CoA

c) 8 $FADH_2$, 8 NADH, and 8 acetyl CoA

d) 8 $FADH_2$, 8 NADH, and 9 acetyl CoA

PRACTICE: Tripalmitin is a TAG formed by the esterification of glycerol with three palmitic acid molecules. How many acetyl CoA molecules will be produced by the complete oxidation of tripalmitin? (Hint: consider glycerol metabolism too)

a) 22

b) 24

c) 25

d) 26