Quiz 3 answers

1. The diglyceride is first hydrolyzed producing two fatty acids, one of 14 carbons (C_{14}) and one with 12 carbons (C_{12}). The glycerol produced in this reaction could further be metabolized to pyruvate (this portion of the answer was not required), though it is more likely that it would be used in triacylglycerol synthesis. These fatty acids must be activated using an equivalent of 2 ATPs in the process before they enter β-oxidation. The products of this cycle are then processed in the citric acid cycle, the electron transport chain, and oxidative phosphorylation.

C_{14}

β-oxidation – 6 cycles

- 7 Ac-SCoA
- 6 NADH
- 6 $FADH_2$

Citric Acid Cycle (CAC)– Ac-SCoA processed (7 cycles)

- 21 NADH
- 7 $FADH_2$
- 7 ATP

Electron Transport Chain and oxidative phosphorylation – All NADH and $FADH_2$ oxidized

- Total NADH: 6 + 21 = 27
- Total $FADH_2$: 6 + 7 = 13

Ideal (3 ATP/NADH, 2 ATP/ $FADH_2$)	Empirical (2.5 ATP/NADH, 1.5 ATP/ $FADH_2$
27 • 3 + 13 • 2 = 107	27 • 2.5 + 13 • 1.5 = 94
From *CAC:* 7	7
Activation: –2	–2
Total: 112	92

For activation ATP is used in the reaction, but pyrophosphate is released instead of just phosphate, yielding AMP. To regenerate AMP to ATP would take two ATP. So if one is considering the net amount of ATP yielded from the metabolism of fatty acids, activation is considered to take the equivalent of 2 ATPs. This is the way the calculation is depicted above and is a common method of calculating energy yield from β oxidation. Another way to analysis this same problem is to consider the total amount of ATP used and not the net amount produced. In this case only one ATP is considered to be used during fatty acid activation. For our purposes both approaches will be considered correct

C_{12}

β-oxidation – 5 cycles

- 6 Ac-SCoA
- 5 NADH
- 5 $FADH_2$

Citric Acid Cycle (CAC)– Ac-SCoA processed (6 cycles)

- 18 NADH
- 6 $FADH_2$
- 6 ATP

Electron Transport Chain and oxidative phosphorylation – All NADH and $FADH_2$ oxidized

Total NADH: 5 + 18 = 23

Total $FADH_2$: 6 + 5 = 11

Ideal (3 ATP/NADH, 2 ATP/ $FADH_2$)	Empirical (2.5 ATP/NADH, 1.5 ATP/ $FADH_2$
23 • 3 + 11 • 2 = 91 ATPs	23 • 2.5 + 11 • 1.5 = 80 ATPs
From *CAC:* 6	6
Activation: –2	–2
Total: 95	78

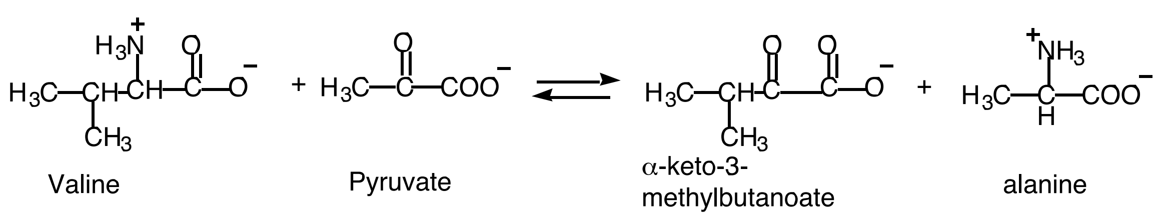
Total amount of ATP:

Ideal (3 ATP/NADH, 2 ATP/$FADH_2$)	Empirical (2.5 ATP/NADH, 1.5 ATP/ $FADH_2$
C_{14} : 112 ATPs	92 ATPs
C_{12} : 95	78
Total: 207 ATPs	170 ATPs

2. Each cycle of lipogensis uses two NADPH molecules. For the synthesis of palmitic acid, which requires 7 cycles of lipogensis, 14 molecules of NADPH are needed. The first cycle of the synthesis combines of two compounds made from acetyl-SCoA and HCO_3^- (acetyl-SACP and malonyl-SACP), reduces them, and produces a fatty acid of four carbons (one carbon is removed in CO_2) as the product. Thus a four-carbon fatty acid is made and only 2 NADPH molecules are used. Each following cycle adds two carbon atoms to the growing carbon chain (using 2 NADPH molecules per cycle). In the end it is seen that $n/2 - 1$ cycles (n=number of carbons in the acid) of fatty acid synthesis are need to yield a given fatty acid.

3. Since β oxidation is an energetically favorable reaction, its exact reverse is energetically unfavorable and this doesn't occur. Fatty acid synthesis must take a different pathway than β oxidation. The same logic that explains why gluconeogensis is not the exact reverse of glycolysis.

4.



The enzyme that catalyzes the transamination is either valine aminotransferase or alanine aminotransferase.