Exam 2 Answers
NESA – Fall 2001

Collaborative Section

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

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. Three glucose molecules are produced when raffinose is hydrolyzed. Each glucose is metabolized through Glycolysis, oxidative decarboxylation, the citric acid cycle, the electron transport chain, and oxidative phosphorylation.

Number for one glucose molecule:

Glycolysis –
Used: 2 ATPs
Produced:
- 4 ATPs
- 2 NADH
- 2 pyruvate

Oxidative decarboxylation
Used: 2 pyruvate
Produced:
- 2 NADH
- 2 Ac-SCoA

Citric Acid Cycle
Used: 2 Ac-SCoA
Produced:
- 6 NADH
- 2 $FADH_2$
- 2 ATPs

Electron transport and oxidative phosphorylation.
- TotalNADH: 2+2+6 = 10
- Total $FADH_2$: 2

Ideal (3 ATP/NADH, 2 ATP/ $FADH_2$)	Empirical (2.5 ATP/NADH, 1.5 ATP/ $FADH_2$
10 • 3 + 2 • 2 = 34 ATPs	10 • 2.5 + 2 • 1.5 = 28 ATPs
From *Glycolysis:* 4	4
Used in *Glycolysis*: – 2	– 2
From *CAC*: 2	2
Total/glucose: 38	32
Overall production: 114 ATPs	96 ATPs

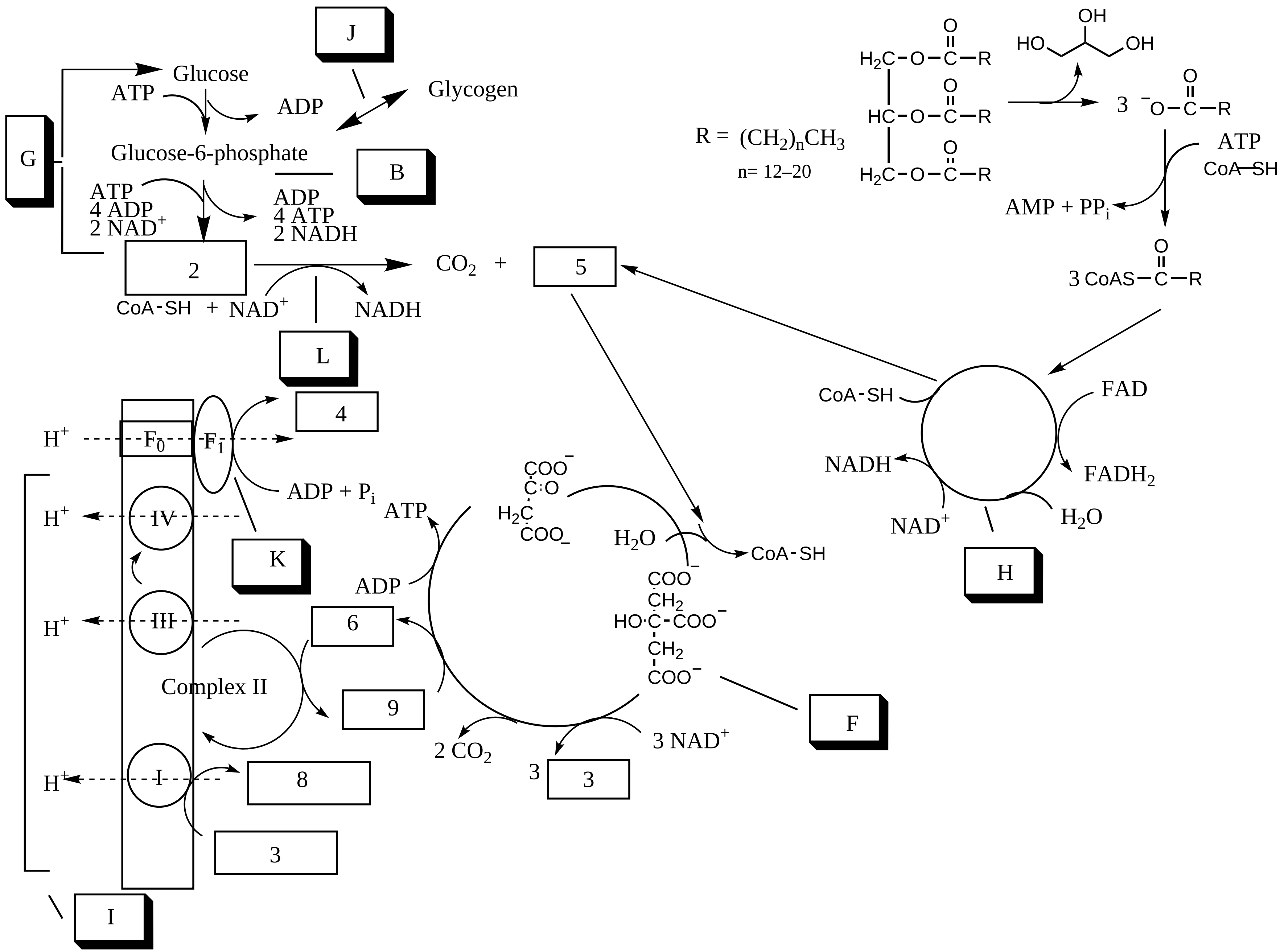
3. Cystine, reduction

4. All of the amino acids are both glucogenic and ketogenic. It is clear that Threonine is both glucogenic and ketogenic since it can eventually produce Ac-SCoA (used to synthesize fatty acids, triacylglycerols and possibly keytone bodies) and pyruvate (first reagent in the gluconeogensis chain). All of the other amino acids in the displayed pathway produce just pyruvate, making them glucogenic. Pyruvate can be converted to Ac-SCoA through oxidative decarboxylation. Thus the carbon atoms from these amino acids could find themselves within a fatty acid.

Individual Section

1. A 2. C 3. D 4. B 5. C 6. A 7. D
8. A
Fatty acids are synthesized from acetyl CoA, units of two carbon atoms. Palmitic acid has 16 carbon atoms, so it is synthesized form 8 acetyl CoA molecules. One Ac-CoA is produced from 1 pyruvate. Two pyruvate molecules are generated from the metabolism of 1 glucose molecule through glycolysis. Thus four glucose molecules would be needed to produce the Ac-CoA needed to synthesize palmitic acid. Since maltose is a disaccharide (two glucose molecules), 2 maltose molecules would be needed.

9. On the following page.



J
Glucose
ATP
ADP
Glycogen
G
Glucose-6-phosphate
B
ATP
4 ADP
2 NAD+
ADP
4 ATP
2 NADH
2
CO2 +
5
CoA-SH + NAD+
NADH
L
4
H+
F0
F1
ADP + Pi
ATP
K
IV
III
I
ADP
6
Complex II
9
8
3
2 CO2
3
3
3 NAD+
F
I
COO−
C O
H2C
COO−
H2O
CoA-SH
COO−
CH2
HO C COO−
CH2
COO−
R = (CH2)nCH3
n= 12–20
H2C-O-C-R
HC-O-C-R
H2C-O-C-R
O
HO
OH
OH
3 −O-C-R
ATP
CoA-SH
AMP + PPi
3 CoAS-C-R
CoA-SH
FAD
NADH
FADH2
NAD+
H2O
H