NFS 484H1 F / 1484H1 F Midterm 2009 Answer Key

Table 1

0min: Blood glucose: - significantly higher on E1 vs all other days (E3, R1, R2, R3)
- significantly higher on R2 and R3 vs E3 and R1
- not significantly different (NS) between R2 and R3, nor E3 and R1

In other words →: E1 > R2 = R3 > E3 = R1

gAUC: Blood glucose: - significantly higher on R2 and R3 vs all other days (E1, E3, R1), but NS between R2 and R3
- significantly higher on E1 vs E3 and R1
- NS between E3 and R1
→ R2 = R3 > E1 > E3 = E1

Figure 1A

% Change GLUT4 protein - significantly higher on E3 and R1 vs all other days (E1, R2, R3), but NS between E3 and R1
- significantly higher on E1 and R2 than R3, but NS between E1 and R2
→ E3 = R1 > E1 = R2 > R3

Figure 1B

Glucose conc. quadriceps - significantly higher on E1, E3 and R1 vs R2 and R3
- NS among E1, E3 and R1
- NS among R2 and R3
→ E1 = E3 = R1 > R2 = R3

Figure 1C

Total glycogen conc. - significantly higher on R3 vs E1, E3 and R1
- NS between R2 and R3, and R2 and E1, E3 and R1
→ R3 > E1 = E3 = R1
R2 = R3
R2 = E1 = E3 = R1

Comments: must have equal signs or clearly state NS or the "same" to get full marks. If not, you were penalized for the first occurrence but not the rest if I can understand that you understood which ones were NS.

2. Important points from Table / Figures

- Glucose response / glucose tolerance improves in Type 2 diabetic patients (T2D) (Table 1, both at 0min after 2 hours of training, and in the gAUC after 2 hours of consuming the meal replacement), this persists on R1, but at R2 and R3 this effect is transient / temporary, because at 0min, blood glucose is almost back to the E1 levels,

while gAUC is worse than E1 levels, suggesting that benefits of exercise will not last if the exercise is not continued.
- Total GLUT4 protein levels increase (Figure 1A) during exercise, and persist to R1, but return to E1levels, and even lower levels. This suggests that exercise is causing higher total GLUT4 protein expression, which is what allows/ drives the improved glucose response seen in table 1. This lasts to R1, but on R2 and R3, when exercise is no longer happening (no more muscle contractions (lecture notes), there is fewer and reduced GLUT4.
- Total glucose concentrations in muscle cells are highest during exercise days, and R1 (Figure 1B), showing that more glucose is able to get into the cells when there is more GLUT4 expression. But R2 and R3 when there is no exercise, and fewer GLUT4 expression, there is a correspondingly less glucose in the muscle
- Total glycogen concentrations in muscle are lowest during exercise and R1 (Figure 1C) but then highest on last day of recovery, R3. With Figure 1B, this indicates that with exercise, more glucose is coming from blood rather than internal stores (e.g., glycogen), but exercise is no longer happening, and the higher need for energy is no longer a priority, the extra glucose in Figure 1B has now been converted to glycogen for storage (Figure 1C)

Thus exercise improves glucose response / sensitivity / tolerance in T2D by increasing GLUT4 expression, allowing for more glucose to enter the muscle cells for energy utilization, and less dependence on glycogen stores. When exercise stops, there is some persistence as GLUT4 levels are still elevated, but this effect "wears off" over the next few days and the extra glucose is stored as glycogen. Thus, need to keep exercising for longer lasting benefits.

3. Mr. Burns quitting after 2 weeks represents the effects observed on R3 from Study 1. Mr. Smithers staying on the exercise regime represents effects observed on E3 or R1.

Thus: Compared to Mr. Smithers, Mr Burns would have:

- Higher blood glucose at 0min, and higher gAUC (Table 1)
- Lower total GLUT4 (Figure 1A), lower total muscular glucose conc. (Figure 1B), and higher total muscular glycogen conc. (Figure 1 C)
- Many of the points from Q2 can be used to discuss this answer. The main key point is that the benefit that Mr. Smithers has by continually exercising is that the higher GLUT4 levels are sustained, allowing him to have better glucose handling / response / etc., better utilization of glucose from blood since more is getting into the cells and thus less storage of glucose as glycogen. Must clearly state the fate of glucose and how it differs in the exercise vs sedentary cases.
- Mr. Burns is more sedentary since quitting, so he has much lower GLUT4, thereby less glucose entering the cell, and but remember, he DID exercise for 2 weeks, meaning that any additional glucose that did enter the cells during this time, have now been converted into glycogen for storage.

4. Table 2

LFpost = LF post-training, LFbase = LF baseline, etc.

Fasting glucose (FG) and HbA1c:	- LFbase, HFbase, HFpost significantly higher than LFpost - NS among LFbase, HFbase and HFpost →: LFbase = HFbase = HFpost > LFpost
Triglycerides (TG) and total cholesterol (TC)	- LFbase, HFbase, significantly higher than LFpost and HFpost - NS among LFbase and HFbase nor LFpost and HFpost →: LFbase = HFbase > LFpost = HFpost

Figure 2: Lipid oxidation

60, 90, 120, 150min	- LFbase, HFbase, significantly lower than LFpost and HFpost - NS among LFbase and HFbase nor LFpost and HFpost →: LFbase = HFbase < LFpost = HFpost

5. Exercise increases lipid oxidation, and this in turn leads to lower TG and lower TC levels, and this impact is independent of the diet (LF versus HF). However, only those that were on the LF diet had improvements in glycaemia indicating that the diet is factor that determines whether or not exercise can improve glucose response.

6. Important points from Table 2 / Figure 2

Glucose metabolism - Exercise only improves glycaemia (reduces fasting glucose and HbA1c) when on the background of LF diet (Table 2), thus, HF diet is either interfering or confounding exercise benefits. Study One showed that exercise leads to higher expression of GLUT4, allowing more glucose to enter the muscle cells for utilization as energy. One may also say that in this study, diet, and not exercise, is the main factor that is improving glycaemia.

Lipid metabolism - Exercise improves lipid oxidation (Figure 2) independent of the diet (both LF and HF post-training curves high highest lipid oxidation), and this in turn, improves lipid metabolism (reduces TG and TC), also independent of diet (Table 2). Since HF diet is rich in fat, this maybe the preferred source of energy utilization (compared to glucose), which would explain why on an HF diet, you only see improvements in lipid oxidation. However, the data from this study is not enough to either confirm or refute this point.

Thus, those on the LF diet saw improvements in both glucose and lipid metabolism, while those on the HF diet, only saw improvements in lipid metabolism. The improvement in glycemia is due to higher GLUT4 and improved glucose uptake and utlization. In the background of a healthy (in this case LF) diet, then exercise improves both glucose (which is further supported by in study 1) and lipid metabolism. However if the diet is not healthy or very energy rich (the HF) diet then you lose the benefits of glucose metabolism while only seeing the benefits of lipid metabolism.

7. Main point is that exercise alone is not enough.

- Study 1 showed that exercise can improve glucose response (Table 1) via increased GLUT4 (Figure 1A), increased glucose uptake (Figure 1B), and better glucose utilization for energy with less glycogen storage (Figure 1C) → may reduce risk of diabetes

- Study 2 showed that background diet is important in establishing how exercise can improve glucose response, since only benefits (lower fasting glucose and HbA1c) are seen when on LF diet (Table 2). → dietary pattern may not reduce risk of diabetes

- Study 2 also showed that exercise improves lipid oxidation independent of the diet (Figure 2), which leads to improved lipid metabolism reduces TG and TC (Table 2). → may reduce risk of obesity

Thus, you need lifestyle improvements in addition to just increased physical activity (exercise). Data from Study 1 and 2 suggest that exercise increases lipid oxidation which will benefit those that are obese, and lower the risk, but if the dietary patterns are not altered, then exercise cannot benefit those that are diabetic, nor lower the risk.