18.1 Goals to Guide How You Exercise			
Goal:	**How Often**	**How Intense**	**How Long**
Reduce Risk of Heart Disease and Illness	2-3 times a week	40% max heart rate	15–30 min
Get Physically Fit	4 times a week	70–90% max heart rate	15–30 min
Lose Weight	5 times a week	45–60% max heart rate	45–60 min
220 – your age = your maximum heart rate.			

18.2 TIR During Exercise Depends on:
• Your current IOB, glucose, and glucose trend • Timing of the exercise relative to recent meals and boluses • The duration and intensity of the activity • Your training level • Whether the exercise is aerobic or anaerobic • Stress hormone release in competitive sports

18.3 How Glucose and Insulin Levels Affect Performance		
Glucose	**Metabolic State**	**Performance Impact**
< 70 mg/dl (3.9 mmol/L)	Excess insulin without enough glucose for cells	Fatigue, poor performance
70-180 mg/dl (3.9-10 mmol/L)	**Efficient fuel flow, monitor IOB and trend line**	**Maximum performance**
> 180 mg/dl (> 10 mmol/L)	If insulin level is OK, glucose will come down	Performance may be reduced but exercise is OK.
> 250 mg/dl (13.9 mmol/L)	With no ketones, exercise should lower the glucose	Impaired performance – moderate exercise is OK
> 250 mg/dl (13.9 mmol/L)	With the presence of moderate or large ketones	Do not exercise. Address the cause for high ketones.

18.4 What Makes the Glucose Rise During and After Exercise with Diabetes	
Exercise usually lowers the glucose. These four things can make glucose rise with diabetes:	
Lack of insulin	This is the most common cause for a glucose rise during exercise. For example, if a person goes for a run before breakfast and their fasting glucose is above 140 mg/dL (7.8 mmol/L), their glucose may be more likely to rise because the liver will be releasing glucose with this relatively low insulin level. The same run on another morning with a fasting glucose below 140 mg/dL (7.8 mmol/L) may not do this.
Anaerobic exercise	With short, intense anaerobic exercises, like running the 100-yard dash or power weight-lifting, glucose is rapidly released into the blood by rising epinephrine levels. Epinephrine can raise glucose production seven or eight times higher than normal, while glucose uptake into cells increases only three to four fold.156 A normal pancreas can release extra insulin directly into the blood, but a pump cannot.
Competition	Large amounts of stress hormones are released in competitive events, like a swim meet, a 10K run, or a century bike ride. Stress hormones release large amounts of glucose in these "fight or flight" situations. The person without diabetes quickly releases insulin to balance this, but someone with diabetes may see their glucose rise rapidly.
Dehydration	Serious dehydration during hot weather or strenuous exercise can make glucose test higher than it actually is. If your urine looks like lemonade, dehydration is unlikely. If it looks like apple juice, dehydration may make the glucose test higher than it actually is. Thirst is a late sign of dehydration. Drink ample non-caloric fluids and retest your glucose 20 minutes later before you decide the correction bolus to give.

18.5 Match Carbs to Need

Not all carbs are the same, so it helps to know how quickly different foods raise glucose.

Fast carbs are ideal for raising low glucose levels before or during exercise and for exercises that consume carbs rapidly. Fast carbs include glucose tablets, Sweet Tarts, honey, corn flakes, raisin bran, athletic drinks (Gatorade™, Power Ade™), dried or ripe fruits, and regular soft drinks.

Slower carbs like PowerBars™, oatmeal, Swiss muesli, fruit, ginger snaps, pasta al dente, brown rice, and many candy bars help prevent glucose from dropping during longer periods of activity. They can be eaten before the start of some exercises, every 45 minutes during, and then afterward to replenish glycogen stores.

18.6 ExCarbs: Grams of Carb per Hour of Activity

These are the total grams of carb used in one hour of each activity at these weights. Can be eaten before, during, or after an activity, or used to guide insulin reductions or lower a high glucose.

	Weight		
Activity	**100 lbs.**	**150 lbs.**	**200 lbs.**
baseball	25	38	50
basketball			
moderate	35	48	61
vigorous	59	88	117
bicycling 6 mph	20	27	34
10 mph	35	48	61
14 mph	60	83	105
18 mph	95	130	165
20 mph	122	168	214
dancing			
moderate	17	25	33
vigorous	28	43	57
digging	45	65	83
golf (pull cart)	23	35	46
handball	59	88	117
jump rope 80/min	73	109	145
mopping	16	23	30
mountain climbing	60	90	120
outside painting	21	31	42
raking leaves	19	28	38
running 5 mph	45	68	90
8 mph	96	145	190
10 mph	126	189	152
shoveling	21	45	57
skating			
moderate	25	34	43
vigorous	67	92	117
skiing			
crosscountry 5mph	76	105	133
downhill	52	72	92
water	42	58	74
soccer	45	67	89
swimming			
slow crawl	41	56	71
fast crawl	69	95	121
tennis/volleyball			
moderate	23	34	45
vigorous	59	88	117
walking 3 mph	15	22	29
4.5 mph	30	45	59

18.7 Number of ExCarbs Needed for Exercise per 100 lbs. (45 kg) of Weight

For intensity, the number 1 represents a slight increase in activity like a casual walk. A 7 would be all-out exercise like running hard and barely able to talk between breaths.

Duration (minutes)	Exercise Intensity						
	1	2	3	4	5	6	7
15	4 g	9 g	13 g	17 g	21 g	26 g	30 g
30	9 g	17 g	26 g	34 g	43 g	51 g	60 g
45	13 g	26 g	39 g	51 g	64 g	77 g	90 g
60	17 g	34 g	51 g	69 g	86 g	103 g	120 g
75	21 g	43 g	64 g	86 g	107 g	129 g	150 g
90	26 g	51 g	77 g	103 g	129 g	154 g	180 g
105	30 g	60 g	90 g	120 g	150 g	180 g	210 g
120	34 g	69 g	103 g	137 g	171 g	206 g	240 g
150	43 g	86 g	129 g	171 g	214 g	257 g	300 g
180	51 g	103 g	154 g	206 g	257 g	309 g	340 g
210	60 g	120 g	180 g	240 g	300 g	360 g	420 g
240	69 g	137 g	206 g	274 g	343 g	411 g	480 g

A = carb intake B = carb intake + bolus reduction

C = carb intake + bolus reduction + basal reduction

18.8 Carb and Insulin Adjustments to Balance Exercise per 100 lbs. Weight

Exercise Duration	Exercise Intensity								
	Mild			Moderate			Intense		
	Carbs	Bolus	Basal	Carbs	Bolus	Basal	Carbs	Bolus	Basal
15 min	+ 0g	normal	normal	+ 0 g	normal	normal	+ 20g	- 10%	normal
30 min	+ 10g	normal	normal	+ 20g	- 10%	normal	+ 40g	- 20%	normal
45 min	+ 18g	- 10%	normal	+ 30g	- 20%	normal	+ 50g	- 30%	normal
60 min	+ 25g	- 15%	normal	+ 40g	- 30%	normal	+ 60g	- 40%	- 10%
90 min	+ 38g	- 20%	normal	+ 55g	- 45%	- 20%	+ 90g	- 50%	- 20%
120 min	+ 50g	- 30%	normal	+ 70g	- 60%	- 20%	+110g	- 70%	- 30%
240 min	+ 80g	- 50%	- 10%	+120g	- 60%	- 20%	+200g	- 70%	- 40%

These estimates must be adjusted for your weight and through testing.

18.9 Rebuild Glycogen Faster to Reduce Delayed Hypoglycemia

After prolonged or strenuous exercise, you want to rebuild muscle glycogen quickly once the exercise stops. There is a 20- to 30-minute window following exercise when muscles are primed to restore depleted glycogen. Consuming carbs and protein for muscle repair right after exercise lets muscle glycogen stores quickly rebuild. Chocolate milk provides a convenient way to provide both carbs and protein just after exercise.

Fast glycogen rebuilding means less glucose will be drawn out of the blood in the following hours, with less risk of a low glucose during the night, even on an AID system. Carb intake just after exercise reloads your glycogen and prepares you for exercise the next day. A small carb bolus may be needed to cover these carbs and improve glycogen uptake.

Higher carb intake increases muscle glycogen storage for endurance and performance. On a high-carb diet, a trained marathon runner can run for about four hours before exhaustion. Many athletes "fuel up" muscle glycogen stores to improve performance by eating a high-carb meal covered with a carb bolus the evening before major exercise events.