Interpretation of your 2 hour Glucose Tolerance Test (GTT)

Youngberg Lifestyle Medicine Clinic

To determine your current stage of high blood sugar compare your GTT results to the ten stages of high blood sugar listed below.

Find your stages based on each of the FOUR ways to assess high blood sugars:

1. Fasting Blood Glucose
2. 1-hour Blood Glucose
3. 2-hour Blood Glucose
4. Hemoglobin A1c

	Optimal	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6	Stage 7	Stage 8	Stage 9	Stage 10
	Optimal	Above Optimal	High	Pre Diabetes	Adv Pre Diabetes	Initial Diabetes	Adv Diabetes	Adv Diabetes	Severe Diabetes	Severe Diabetes	Critical Diabetes
Fasting BS	70-84 mg/dL	85-94	95-99	100-109	110-125	126-139	140-169	170-199	200-249	250-299	300+
1 Hour BS	80-119	120-139	140-159	160-199	200-239	240-279	280-319	320-359	360-299	400-439	440+
2 Hour BS	80-99	100-119	120-139	140-159	160-199	200-234	235-269	270-304	305-339	340-374	375+
A1C	4.7-4.9	5.0-5.3	5.4-5.6	5.7-6.3	6.3-6.4	6.5-7.1	7.1-8.2	8.2-9.3	9.3-10.9	10.9-12.6	12.6+
Heart Attack Risk Increase	None	Minor	20-40%		40-60%	50-80%	60-90%	60-100%	90-130%	100-250%	250%+
			Increased Heart Disease Risk				Increased Heart Disease Risk, Kidney Failure, Blindness, Amputation				

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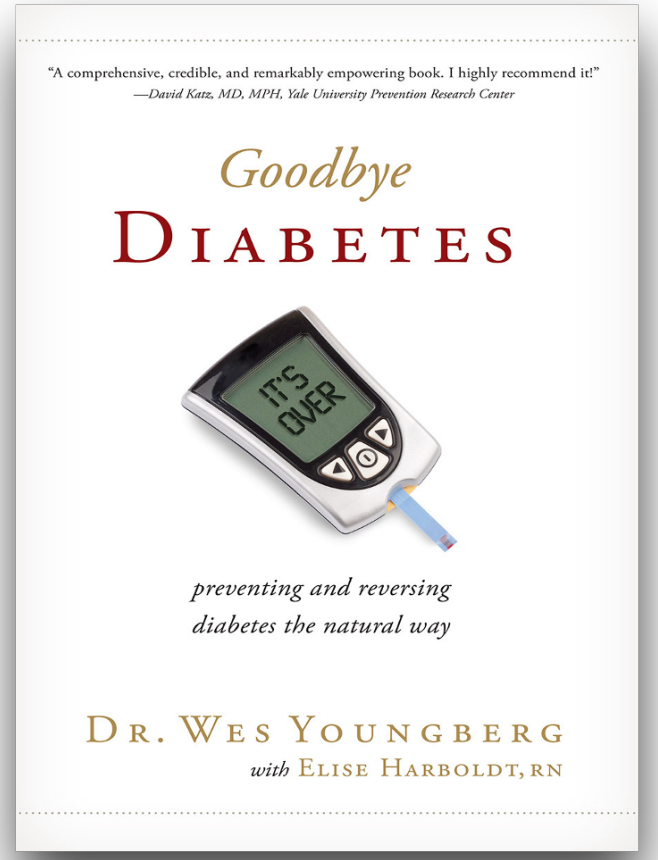
The ***Ten Stages of High Blood Glucose*** was developed by Wes Youngberg and John Vargas in 2016 as a patient education tool for E4 Diabetes Solutions - an on-line diabetes reversal clinic. It was adapted from: Youngberg, W., Brinegar, C., "Diabetes Care on Guam: Guidelines for Prevention, Early Detection, and Treatment," Governor's Vision 2001 Task Force on Health Care, Guam Department of public Health and Social Services, July 1997. Funded by CDC grant.

Next determine how much insulin your pancreatic Beta Cells were able to produce in order to prevent a further rise of your blood glucose/sugar. Optimal glucose and insulin ranges discussed below are based on Dr. Youngberg's clinical experience reviewing these tests with nearly every patient for the past 35 years as well as an ongoing review of the medical literature.

Your Fasting Insulin level is measured after an overnight fast and before any calories are consumed for that day. The minimal goal for insulin before a meal or drink is **< 10** microUnits/mL. Recommended goal is **<7** with **optimal goal is less than 5.0.** <u>However, insulin levels are determined to be healthy or unhealthy only by comparing them to the blood glucose level taken at the same time.</u>

For example, **if your insulin levels look ideal but your blood sugars are even slightly high**, this is a sign that you have a signifiant loss in ability to produce insulin that would then be able to keep your blood sugars in a lower and healthier range.

Your 1hr insulin <u>is measured one hour after initiating a 75 gram carbohydrate drink equivalent to 300 calories of pure carbohydrate from food.</u> **Goal is <30 (assuming a normal or near normal blood glucose)**.

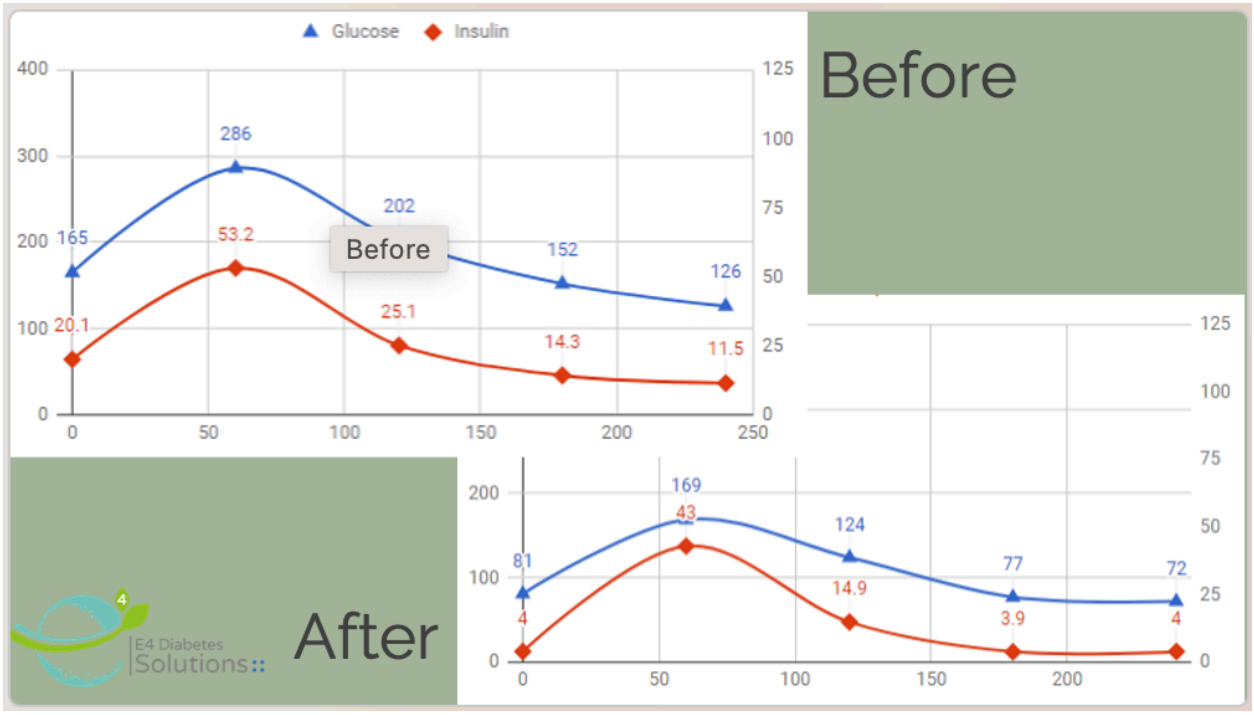


Tom's Labs

Test	5/22/13	5/29/13	7/15/13	9/13/13	12/20/13
Weight	220 lbs				
FBG/Insulin	135	144 / 10.5	107	105	102
1hr Gluc/Ins		261 / 36			
2hr Gluc/Ins		303 / 40			
3hr Glucose		293			
4hr Glucose		229			
HA1c		7.1	6.2	5.5	5.7
Test	**8/20/14**	**6/11/15**	**6/22/16**	**3/1/17**	**5/8/18**
FBG	102				
HA1c	5.6	5.1	5.2	5.2	5.1
Weight	160 lbs		154 lbs		

American College of Lifestyle Medicine


Case Study Participant 1
Male - Age 53


Glucose
Insulin
Before
286
202
165
53.2
152
126
20.1
25.1
14.3
11.5
400
300
200
100
0
125
100
75
50
25
0
50
150
250
Before
After
E4 Diabetes
Solutions::
169
43
124
81
77
72
4
14.9
3.9
4

Your 2hr insulin after initiating a meal or glucose drink should be **less than 25**.

Any increase above optimal insulin levels, at any time point, is associated with a continuum of potentially i**ncreasing risk for high blood pressure, weight gain, infertility, heart disease, stroke, dementia, certain cancers** and many other conditions.

High insulin levels (even if blood sugars are optimal) at any time, before or after meals, suggest tendency to insulin resistance which is a major risk factor for many health issues. However, **insulin resistance and resulting high insulin levels can be reverse**d and improved through consistent lifestyle and nutritional strategies.

When blood insulin levels are lower than normal but your glucose levels are high at any time after eating or drinking carbohydrates, this indicates **a loss of pancreatic function** where the insulin producing cells have been damaged or reduced in number, and are now unable to produce enough insulin to even moderately control rising blood glucose levels. Very low insulin levels (close to zero even after consuming carbohydrates) suggest the presence of type one diabetes representing complete or nearly complete destruction of insulin producing cells in the pancreas.

High insulin levels associated with high blood sugars indicates that the pancreas is still able to make lots of insulin but not enough to compensate for the level of insulin resistance. In this case, even though the pancreas is making lots of insulin, it has already lost a large share of its ability to produce insulin as needed to control blood sugars. For example, even before PreDiabetes is diagnosed, it is common that the pancreatic function and insulin producing ability is already compromised by of over 50%.

Professor Ralph DeFrozo, MD, an expert in insulin resistance, noted in 2011 that individuals in the upper third of **PreDiabetic blood sugars** [fasting blood glucose just above 110, 1hr glucose >200 or 2hr glucose from 160-199] are maximally or near-maximally insulin resistant and have **lost 70–80% of their β-cell pancreatic function [potential to produce insulin]**, and have approximately a 10% incidence of diabetic retinal damage. Therefore, preservation of the remaining 20–30% of β-cell function is critical to prevent future development of full blown type 2 diabetes and its complications. The good news is that with a comprehensive lifestyle medicine protocol and metabolic "tune up", it is very possible to regain much of the lost function!

Strategies to Reverse Insulin Resistance and Improve Pancreatic Function

1. **Follow the handout "Testing Blood Sugars to Optimize Your Success"** as follows, but NOTE that when following this lifestyle medicine intervention protocol you MUST have a plan discussed between you and your prescribing physician as to how to adjust your diabetes medications when your blood sugars improve. NOT adjusting your diabetes

medications could cause your blood sugars to become very low placing you at risk of diabetic coma and immediate need of emergency medical care. Regular and ongoing blood sugar checks before and after meals is the first defense against such concerns.

2. Step 1: **Don't change anything and just check your blood sugars for 2 days.** Start testing blood sugars before, 1 and 2 hours after the start of each meal. Document your results along with a simple outline of what you ate at each meal.

3. Step 2: After 2 days **add in after meal light or moderate walking** (or comparable form of exercise) for 10-30 minutes right away after each (or most meals) and keep records of what you ate along with how long you walked. Note the difference in the after meal blood sugars when walking compared to not walking. Eat the same as you did during days one and two. Expect to improve your after meal blood sugar level by 1 to 3 points for every minute you walk.

4. Step 3: **Optimize your diet** and keep checking your blood sugars. After 2 days of including after meal exercise, now add in changes to diet as discussed in the book *Goodbye Diabetes chapters 12-14.* See below for more specifics on optimizing your diet.

5. Step 4: **Optimize your fitness program** beyond simple after meal activities. After a week or so you can also **add in more intensive cardio workouts** that are prior to meals or 2+ hours after eating. Remember, **do not over exercise** and to listen to your body. Increase the intensity, duration and frequency of your workouts slowly. Do this once daily for 20+ minutes working up to a light sweat with an intensity that feels only somewhat hard.

6. Step 5: You may now also **add muscle toning exercises** like crunches, sit down squats, modified push up etc... You can use one of the many age and fitness sensitive "Seven Minute Workout" Apps or YouTube videos as a guide but don't push yourself too much, especially early on. Start slow for just a few minutes but do this every day. As you get stronger you can switch to a longer 20 minute workout three times a week. If you are new to this type of exercise you may want to hire a fitness trainer once or twice a week for a few months to get you started safely and effectively.

7. **Optimize your sleep**. It is during sleep that your body repairs itself. This includes your muscles, liver and pancreas. And your brain! Even one poor night of sleep creates significant insulin resistance the next day and forces your pancreas to work harder producing more insulin to compensate. Lack of sleep promotes diabetes! Optimal sleep time is a consistent early to bed and early to rise protocol ie) 10pm to 6am. In terms of melatonin release and repair potential, the hours before midnight have twice the healing/ benefit than the hours after midnight. Optimal sleep is key to lowering inflammation, improving insulin sensitivity so insulin is more effective in normalizing blood sugars, and is critical to a functional immune system in preventing and quickly overcoming infections that damage the pancreas.

8. **Get at least 30 minutes of daily sunlight exposure.** Early morning near infrared sunlight powerfully improves production of antioxidant melatonin defense in all cellular mitochondria thus **protecting Beta Cells from oxidative stress and actually increasing**

the production of insulin producing cells. Infrared light goes right through clothes and does not require exposure to the bare skin. Alternatively, you may use infrared lights or infrared saunas for this purpose.

8. **Optimal pure water intake is critical** especially for someone who has chronic health concerns like PreDiabetes and especially diabetes. On average optimal hydration requires one ounce for every two pounds of body weight. For instance, if you weight 180 pounds you goal is 90 ounces of water daily or just over 11 eight ounce cups total. If you weigh 120 pounds your daily goal is about 8 cups total. Of course many factors can increase or decrease the optimal intake. The key is to NOT "follow your thirst", because your thirst is not a good judge of your needs. By the time you feel thirsty you have been dehydrated for hours.

There are 3 most important times to drink water.

#1 is upon waking in the morning when your body is the most dehydrated. Soon after waking but at least 30 minutes before eating, work up to drinking 16 to 24 ounces (2-3 cups) of room temperature or better yet warm to somewhat hot water. Just warm up the water on the stove and drink it out of a coffee mug along with a slice or squirt of organic lemon. Believe it or not warmed up water will wake you up and clear your head as well as coffee but without the dehydrating and negative effects of caffeine. If this seems excessive, be aware that the average person loses 16 to 32 ounces of water over night via the urine production, perspiration, and normal breathing.

#2 Midmorning and midafternoon are the second most likely times to be significantly dehydrated typically about two hours after breakfast and lunch. Try to get another 16 ounces of cool water at these times.

#3 About 30 to 45 minutes before your lunch and dinner take in another 8 oz or more. By doing this you will not feel thirty or need to drink with you meal which would dilute your digestive enzymes impairing and slowing down your digestion.

9. **Practice stress management**. Stress that is not resolved or properly addressed within a few minutes will activate a prolonged high production and release of cortisol from the adrenal glands stimulating an ongoing excess release of glucose from liver stores. In diabetics with impaired beta cell function an argument with a family member can increase blood sugars 50 to 100 points higher that it otherwise would be. Psychological stress lasting over an hour can increase blood sugar in a Type 1 Diabetic by over 300 points above their typical readings.

10. **Develop the skill of accepting and giving forgiveness** because un-forgiveness is a chronic toxin that does us more harm than it does to those we can't forgive. It can dramatically increase blood sugars until resolved. Forgiveness does not enable wrongs or remove the need for justice, it simply dissolves the inner hostility that is poisoning our body, mind and spirit. Forgiveness is the *only* solution in the universe that is powerful enough to unlock the chemical bonds of hostility, resentment, and bitterness. It is a medicine of the greatest importance. See *Goodbye Diabetes* Chapter 23.

11. **Avoid alcohol**. Alcohol is a natural toxic waste product of fermented sugar and is well documented to be harmful to beta cells causing pancreatic insulin producing cells to become dysfunctional, prone to premature cell death (apoptosis) and is therefore another key risk factor in promoting the development of diabetes over time. Wine and beer are also common sources of mycotoxins from mold that also damage beta cells.

Let your food be your medicine and your medicine be your food. —Hippocrates

12. **Eat 35 to 50 grams of whole food fiber** every single day. Fiber is the indigestible roughage or bulk found in plant foods—vegetables, fruits, legumes, grains, nuts, and seeds. Research shows that the health benefits of fiber aren't optimal until a person is consuming at least 25 grams per day but diabetics do much better by gradually increasing to 50 grams daily. Work toward eating at least 10 grams of fiber at breakfast and 15 grams at lunch and dinner. Pick the combination of high fiber foods that best improve your blood sugars.

Fiber Content in Foods

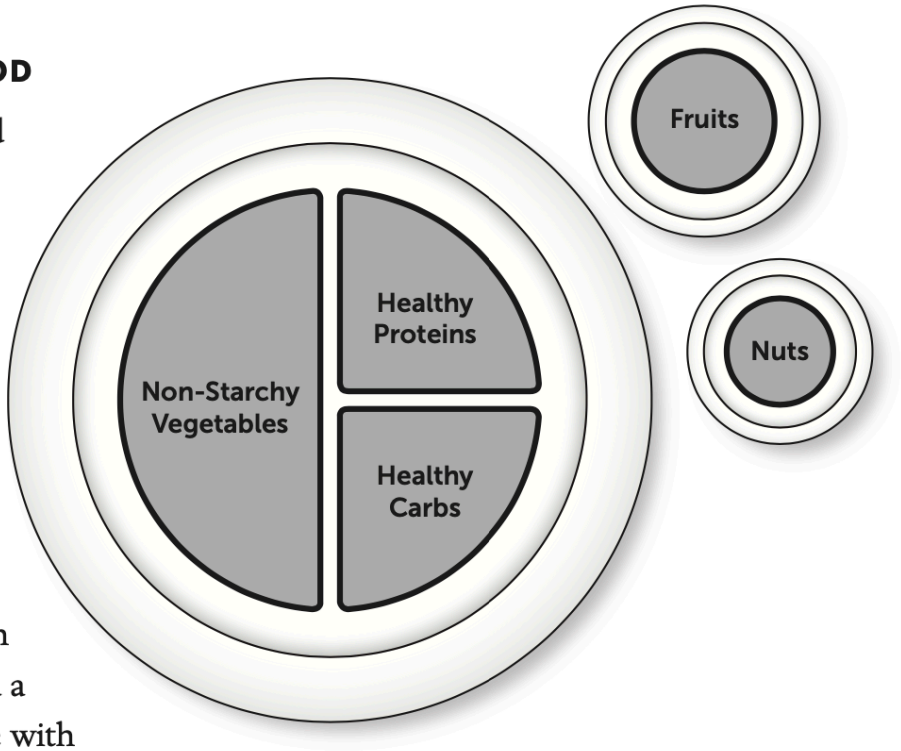
Food	Examples	Serving Size	Average Fiber Content
Beans and Lentils	Navy, pinto, black, kidney, white, great northern, lima, and soy beans; chickpeas; black-eyed peas; lentils, etc.	½ c. cooked	8 grams
Non-Starchy Vegetables	Lettuce, cucumbers, tomatoes, carrots, cabbage, celery, cauliflower, etc.	1 c. raw or ½ c. cooked or chopped	2 grams
Starchy Vegetables	Sweet potatoes, yams, baked potatoes, corn, peas, etc.	½ c. cooked or chopped	3 grams
Fruits	Fresh fruit	1 medium piece of whole fruit or ½ c. chopped	3 grams
Grains	Pasta, rice, cooked cereal, bread, etc.	½ c. cooked, hot cereal, 1 slice whole wheat bread, 1/3 c. brown rice or whole-grain pasta	3 grams

13. **Eat mostly First Class Foods**.

FIRST-CLASS FOODS[10]		
Food	**Examples**	**Benefits**
Fresh Fruits	Apples, oranges, tangerines, grapefruits, pears, grapes, berries, bananas, melons, apricots, cherries, coconut, kiwis, lemons, limes, nectarines, peaches, plums, strawberries	Good sources of energy with fiber, natural antioxidants, and vitamins, these fruits need to be balanced with healthy proteins and fats.
Whole, Unrefined Grains	Barley, oatmeal, oat groats, quinoa, brown rice, wild rice, Kamut®, bulgur (cracked wheat), buckwheat, millet, amaranth, spelt	Whole grains provide fiber and other nutrients missing in refined carbohydrates. These starches need to be balanced with healthy proteins and fats.
Raw Nuts and Seeds	Walnuts, almonds, pecans, cashews, hazelnuts, macadamia nuts, pistachios, pine nuts, pumpkin seeds, sesame seeds, flax seeds, chia seeds, poppy seeds, sesame seeds, sunflower seeds, old-fashioned peanut butter, almond butter, sunflower butter	Nuts and seeds are good sources of heart-healthy fats, protein, and other nutrients. Because of their high fat content, they should be used moderately.
Whole-Food Fats	Whole olives, whole avocadoes, whole coconuts, nuts, seeds	Good sources of healthy fat and other nutrients, but high in calories. Should be used moderately.
First-Class Beverages: Water, Fresh Pressed Vegetable Juices	A wide variety of vegetables can be included in these juices. Minimal fruit can be added to enhance flavor without spiking blood sugars.	Water is your beverage of choice. Be sure to stay well-hydrated by drinking plenty of water throughout the day. Fresh pressed vegetable juices are high in nutrients and phytochemicals.

14. **The Plate Method** for managing your main meals.

THE PLATE METHOD



The plate method can help you visualize these concepts in a more practical way by dividing up your plate into three sections. Fill half your plate with non-starchy vegetables, a quarter of your plate with healthy proteins, and a quarter of your plate with healthy carbohydrates (starches and/or whole grain carbohydrates). Fruit, also a carbohydrate, can be reserved as a healthy dessert option. Healthy fats and nuts can be incorporated to any part of your plate as appropriate. The illustration above shows the plate method in practice.

15. **Plant based proteins are best** for those with high blood sugars and lowers insulin resistance. Animal based protein from poultry or red meat causes insulin resistance and strongly promotes chronic kidney failure. Adequate healthy protein is abundant in plant-based foods such as beans/legumes, tofu, quinoa, nuts, seeds, humus, falafel, whole grains, and vegetables.

15. **Balance each meal with healthy proteins, fats and carbohydrates**. Optimize over time by checking your blood sugars and making adjustments that work for you.

A DAY IN THE LIFE OF A FIRST-CLASS FOODIE

Food	Servings Per Day/Meal	Serving Size
Non-Starchy Vegetables (including green leafy and colored non-starchy vegetables)	6 or more servings (usually split between lunch and dinner)	1 cup raw or 1/2 cup cooked or chopped
Healthy Carbohydrates (whole-grain starches, starchy vegetables, fruits)	1–3 servings per meal (15–45 grams of carbohydrate). Carbohydrate needs can vary and may be increased for people who are more metabolically active.	1 serving = 15 grams of carbohydrate 1 slice whole-grain bread 1/2 cup cooked whole-grain cereal 1/2 cup corn, squash, or potato 1/3 cup brown rice
Healthy Carbohydrates (fruit)	1–2 servings per meal (3–5 servings per day.)	1 piece small fruit (apple, orange, pear, etc.), 1/2 banana, or 1/2 cup chopped fruit
Healthy Proteins	2 servings per meal (6 servings per day)	1 serving = 7 grams protein 1/2 cup beans or lentils 1 ounce nuts or 2 tablespoons nut butter 1/2 cup (4 ounces) tofu
Healthy Fats	No more than 15–25% of your total calories should come from fat. 2–3 servings per meal (25–42 grams per day on 1,500 calories) 3–4 servings per meal (33–55 grams per day on 2,000 calories)	1 serving = 5 grams fat 1/8 large avocado, 1 teaspoon oil, 7 large olives, 1/4 ounce nuts, 2 teaspoons old-fashioned peanut or almond butter, 1 teaspoon extra virgin oil.

16. **Time Restricted Eating:** In addition to eating the mostly first class foods, timing is important. For many reasons it is best to avoid eating any calories for 4-5 hours between meals and to either avoid an evening meal or eat a lighter earlier evening meal at least 3 hours before bedtime. The goal for time restricted eating is to eat two to three regular meals about 5 hours apart and so that your have no food for at least 12 hours between your last meal of the day and the first meal of the next day. This approach will significantly lower insulin resistance and support healing of your pancreas over time. However, if your blood sugars start crashing because of challenges associated with your medications you WILL NEED to eat a snack at times until your medication management has improved. **NOTE** that any change in what, how much or when you eat will require you to make adjustments to your diabetes medications. Always discuss changes with your prescribing doctor is you are on medications.

17. **Intermittent Fasting** can also help improve healing of impaired pancreatic function and reversing insulin resistance by doing a water only fast for 24 to 36 hours once a month or even once a week according to your goals and medical condition. Another option is to cut total calorie intake to under 500 calories once or twice a week or 5 days continuous once every 3 months or so. Intermittent fasting is much more dramatic at lowering blood sugars than the more stable and consistent Time Restricted Eating approach and therefore is much more challenging for individuals who are on diabetic medication. **Intermittent fasting requires ongoing medical supervision in order to prevent dangerously low blood sugars from over medication.**

Fighting Hidden Culprits - The unsung villains of diabetes

18. **Prevent and quickly treat all infections**. Even mild infections can be responsible for significantly higher blood sugars. A major cause of pancreatic beta cell failure and insulin resistance is unrecognized, non-diagnosed, chronic, low-grade infections. This includes sinusitis, ear or throat infections, lung infections, stomach infections with H-Pylori, gut dysbiosis, food poisoning (gastroenteritis), urinary tract infections, sexually transmitted infections, Herpes, EBV, Candidiasis, nail fungal infections, etc….

19. **Optimize your Vitamin D blood levels** to prevent and support reversal of diabetes. Check your blood levels twice per year until you consistently reach levels between 70 and 100 ng/mL. In diabetics this typically requires a minimum supplemental intake of 5,000IUs daily but often requires 10,000IUs daily.

20. **Minimize your exposure to toxins.** See ewg.org for list of the "dirty dozen" fruits and vegetables that contain the highest levels of diabetes promoting pesticides. All fish have mercury heavy metal contamination but predatory fish have very high levels of mercury and other toxins. Avoid exposure to mold which is a major source of diabetes promoting mycotoxins. Neutralize toxins by consuming a diet and supplements rich in antioxidants and anti-inflammatory nutrients.

21. **Practice daily hydrotherapy**. Take advantage of the healing, detoxifying and immune boosting effects of saunas, alternating hot and cold showers, and cold plunge.