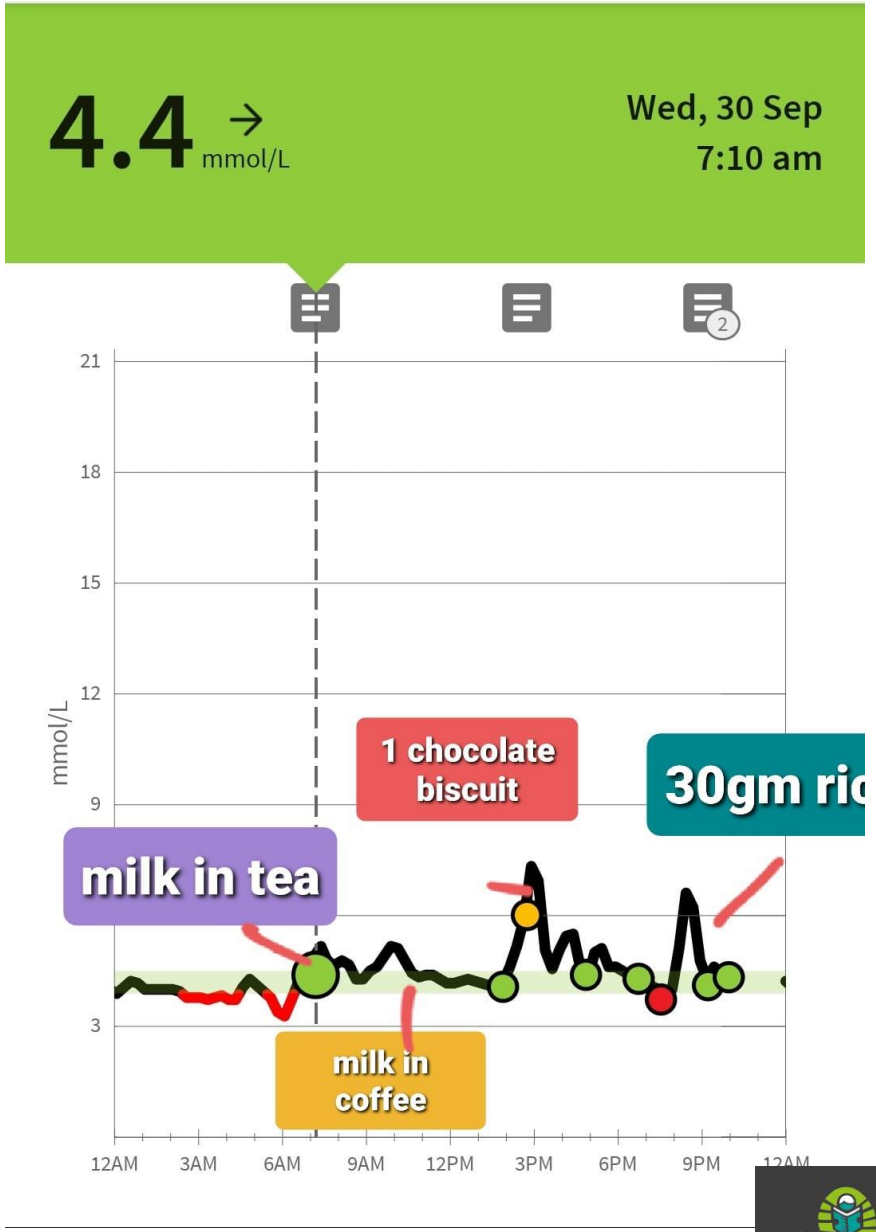
# Understanding Continuous Glucose Monitor Data

Presented by

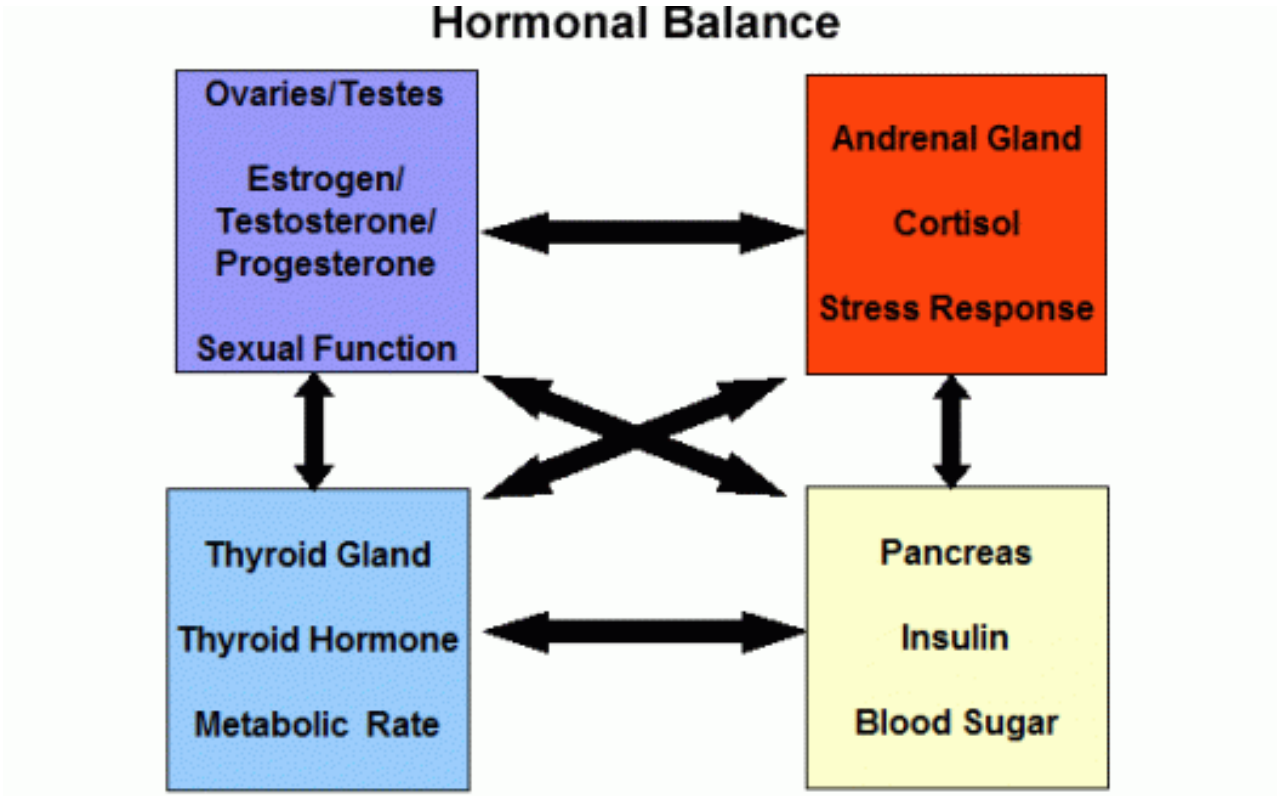
Brodie Cambourne MSc BSc

Accredited Exercise Physiologist



# Some of the environmental factors that may effect blood glucose response

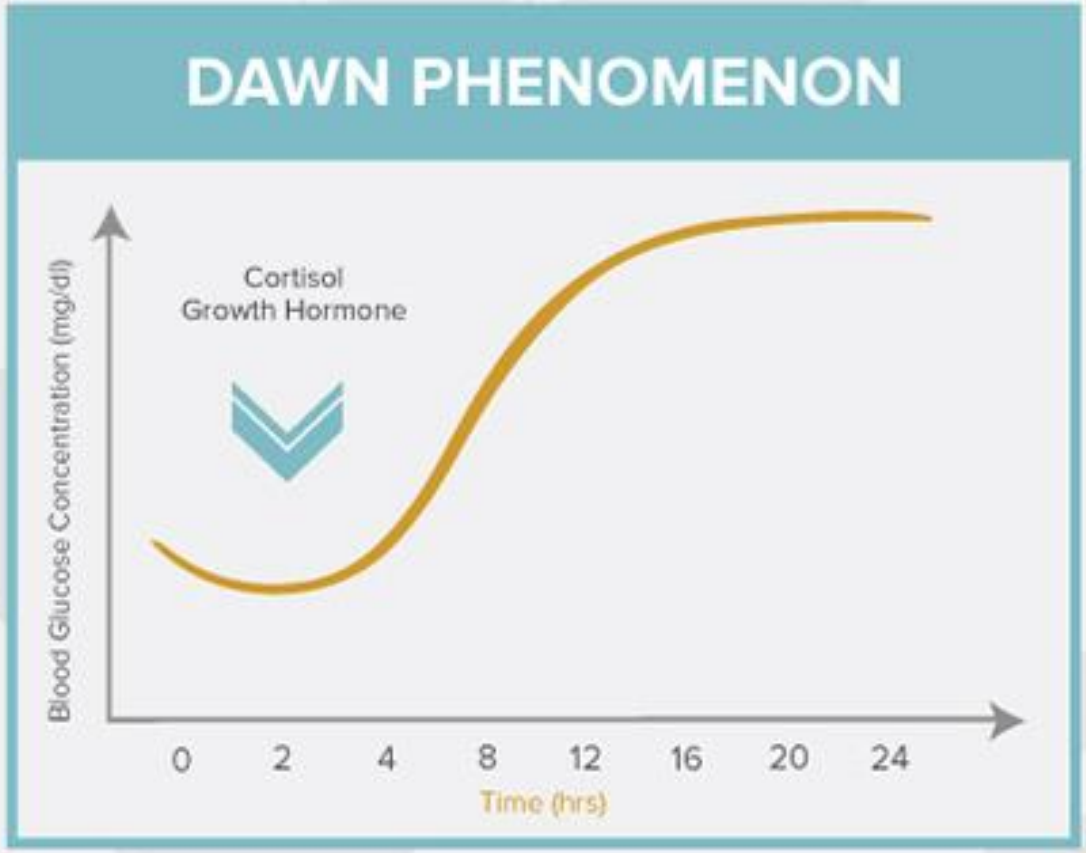
- Morning responses
- Hormonal responses
- Exercise responses
- Stress responses
- Temperature responses
- Effects of alcohol
- Effects of medications

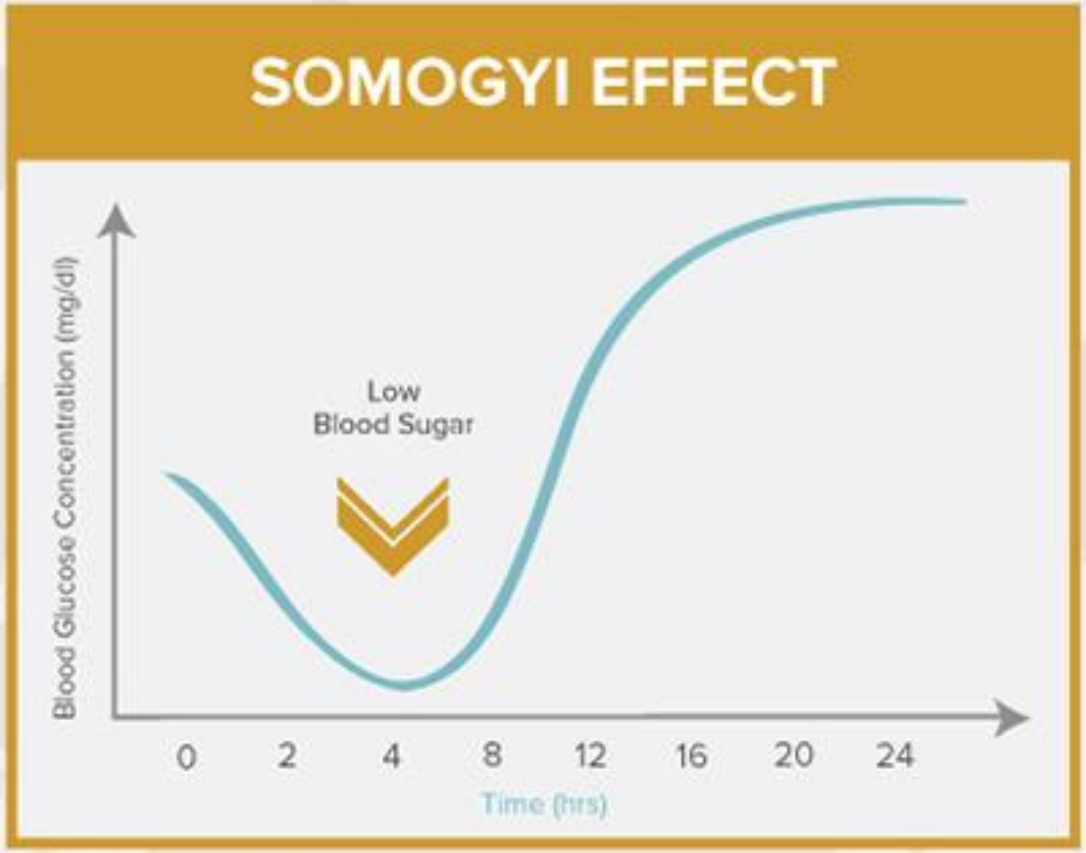



# All Systems are Connected

- Usually, we only think of one hormone at a time. Thyroid symptoms indicate a thyroid problem. Blood sugar symptoms means there is an insulin problem. Symptoms around sexual function indicate a sex hormone problem. And high stress means a cortisol problem. This simple model may help medical students learn about hormones, and is good for books that convince you that if just your thyroid hormone, or if just your testosterone was normalized, you would feel fine, but the hormonal system really does not work like this.
- In real life each these four systems affects the other three in a complex balance game. Basically, when one hormone goes up, another goes down to compensate. This continues until a patient becomes so sick, that almost all of these hormones go down.

# The Dawn Phenomenon and Glucose



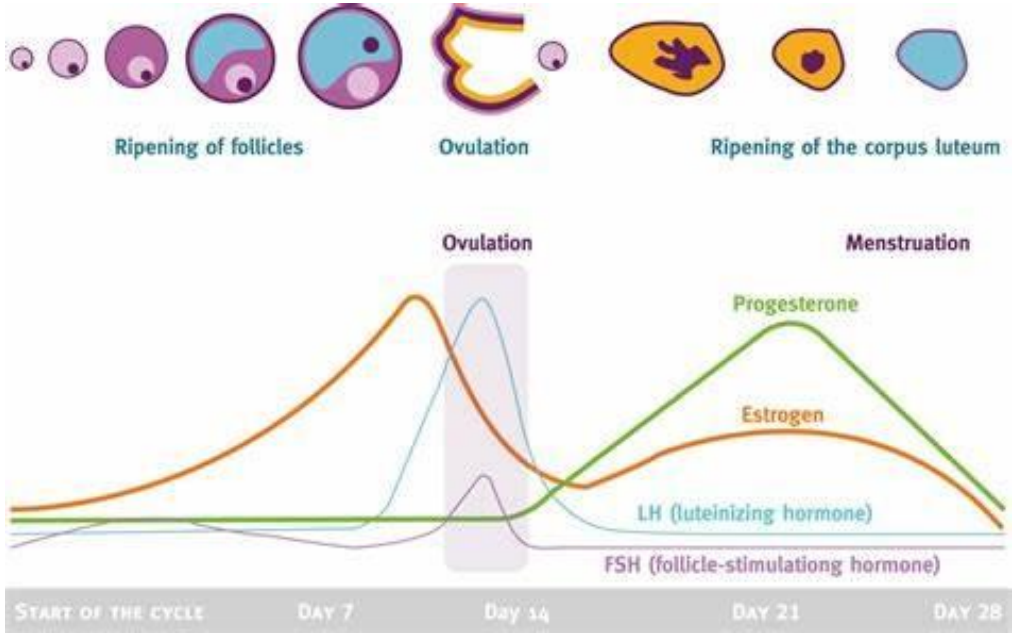




The dawn phenomenon, sometimes called the dawn effect, is an early-morning (usually between 2 a.m. and 8 a.m.) increase in blood sugar (glucose) which occurs to some extent in all humans. This is due to an increase in the fasting hormones glucagon, cortisol, norepinephrine and growth hormone during this period of time that causes gluconeogensis and the breakdown of glycogen to glucose from the liver.

# Hormonal Effects : Estrogen

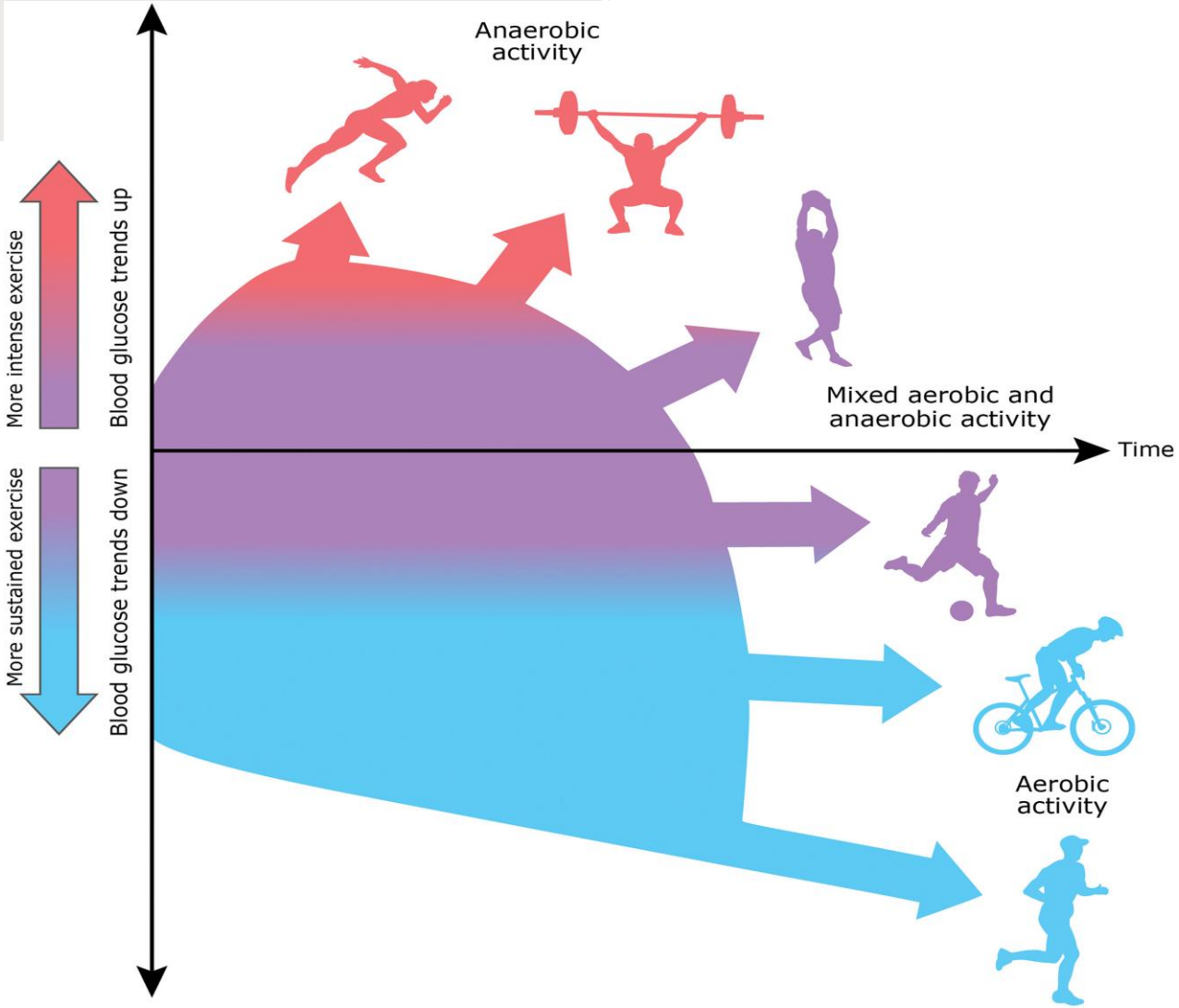
- **Estrogen and Insulin Resistance:**
  - Of all the essential functions estrogen performs in the body, one of the most critical is optimizing the action of insulin, the hormone that regulates blood sugar levels. Therefore, **low estrogen levels (like during menopause) may lead to increased insulin resistance** or impaired insulin action
  - **After women go through menopause, they often see a dip in their estrogen levels. This dip in estrogen has often been associated with insulin resistance.**
  - **Insulin resistance makes blood sugar regulation more difficult**
  - **Estrogen levels that are stable at a normal level will help improve insulin sensitivity.**

[Does Estrogen Affect Blood Sugar Levels? Estrogen and Insulin Resistance (prescriptionhope.com)]



# Exercise responses

- Aerobic/Moderate Intensity Exercise. For the most part, moderate intensity aerobic exercise leads to a decrease in blood...
- Anaerobic/High Intensity Exercise. Activities such as high intensity interval training, sprinting or lifting weights are...
- Mixed Intensity Exercise. Mixed intensity activities usually have a combination of both moderate and high intensity
- [Blood glucose response to different exercises - Diabetes Queensland (diabetesqld.org.au)]



# TYPE 1 DIABETES AND EXERCISE

- **TYPE 1 DIABETES AND EXERCISE**
- **Type 1 diabetes**
- For athletes living with type 1 diabetes, the cells of the pancreas that make insulin are destroyed which means no insulin is being made to regulate blood glucose levels. Blood sugar (or glucose) cannot enter the cells of the body for energy causing blood glucose to build up in the blood. Athletes living with type 1 diabetes require daily injections of insulin to help keep them alive, manage their blood glucose levels and prevent/ delay diabetes related complications.

# Stress Responses

- **The Effect of Long-Term Stress on Your Glucose Levels**
- Prolonged stress = blood glucose spikes
- When the body is under long term chronic stress, it produces larger quantities of cortisol (stress hormone) than released under any other type of stress.
- The body reduces insulin release when cortisol levels are high. impact blood sugar levels. ]

# Stress Effects on Cortisol

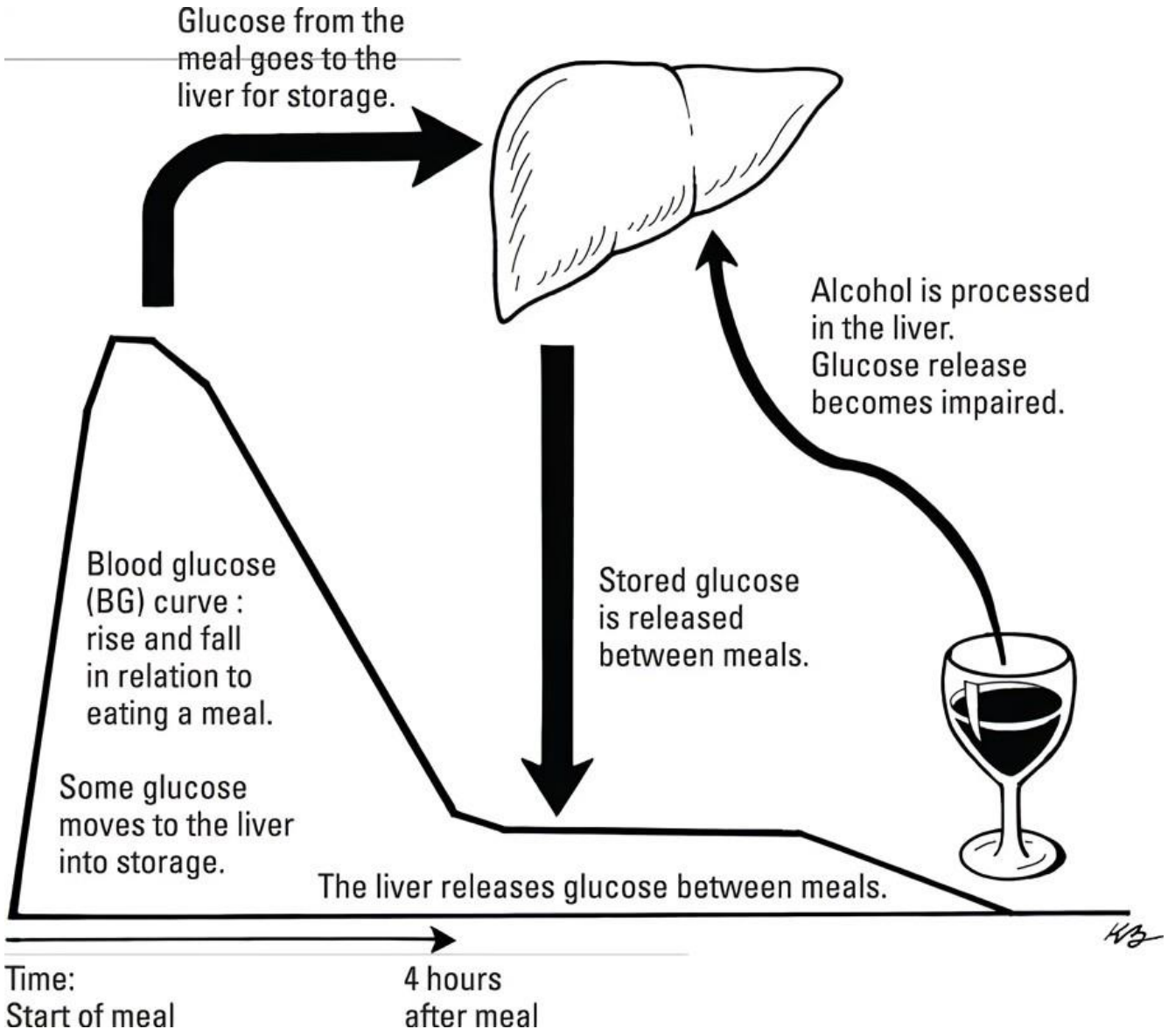
**Stress is ANY extra demand on the body, psychological, physical or biochemical.**


**Stress Triggers the adrenal hormone cortisol** → **Cortisol engages the fight or flight response** → **Over time, cortisol lowers thyroid hormone as a protective measure**

# Effects of Alcohol


- Under normal conditions, the liver makes glucose from chemical building blocks like lactate, alanine, and glycerol in a process called *gluconeogenesis*. The liver also breaks down stored chains of glucose in the liver through *glycogenolysis*.
- Both of these processes are intended to release glucose into the blood to provide energy to our brain and muscles and prevent hypoglycemia, a sometimes-dangerous state when glucose levels are too low.
- The body tends to do a good job at regulating these processes and keeps glucose levels in a fairly narrow range under normal, healthy conditions. It's thought that drinking alcohol *decreases* the liver's ability to make new glucose via gluconeogenesis, which can lead to lower circulating glucose levels. To counter this decrease, alcohol stimulates the breakdown and release of stored glucose. This balance between impaired gluconeogenesis and increased glycogenolysis means that alcohol shouldn't significantly affect glucose levels for normal, healthy individuals eating a standard diet.
- However, the situation is different for those who've been fasting or are in a ketogenic state because these people already have much less glucose stored as glycogen in the liver and muscles. Normally this state prompts the liver to produce new glucose via gluconeogenesis, but, as noted above, alcohol inhibits this process.

# Alcohol and Glucose



# Effects of Medications

- Many can, including steroids, anxiety and depression medications, statins, beta-blockers, some acne & asthma medications. Knowing which drugs affect blood glucose levels is essential in properly caring for your diabetes patients. Some medicines **raise blood sugar** in patients while others might lower their levels

| Antidiabetic agent | Increase glucose lowering | Decrease glucose lowering |
|---|---|---|
| Any | Combination with other antidiabetic drugs<br>Minor insulin releasers (e.g. aspirin)<br>Minor insulin sensitivity enhancers, e.g. ACE inhibitors, magnesium or chromium supplements | Agents that impair insulin action (e.g. glucocorticoids, some antipsychotics, minor effects of diuretics, beta-blockers, some $\beta_2$-agonists)<br>Impair insulin secretion (e.g. octreotide, some calcium channel blockers) |
| Metformin | Renal cation secretion competition by cimetidine<br>Minor PK interaction with furosemide and nifedipine | – |
| Sulfonylureas | Reduce hepatic metabolism (e.g. some antifungals and MAOIs)<br>Displace plasma protein binding (e.g. coumarins, NSAIDs, sulfonamides)<br>Decrease excretion (e.g. probenecid) | $K^+$–ATP channel openers (e.g. diazoxide)<br>Metabolism secondary to enzyme induction (e.g. rifampicin) |
| Meglitinides | Reduce hepatic metabolism, gemfibrozil<br>Potentially displace plasma protein binding | Metabolism secondary to enzyme induction (e.g rifampicin, barbiturates, carbamazepine) |
| Thiazolidinediones | Reduce hepatic metabolism, gemfibrozil<br>Potentially displace plasma protein binding | Metabolism secondary to enzyme induction (e.g rifampicin) |
| Gliptins | Potential interactions with liver and renal metabolism and plasma protein binding | – |
| $\alpha$-Glucosidase inhibitors | Slow gut motility (e.g. cholestyramine) | Potentially with agents that increase gut motility |

ACE, angiotensin-converting enzyme; MAOI, mono oxidase inhibitor; NSAID, non-steroidal anti-inflammatory drug; PK, pharmacokinetic.

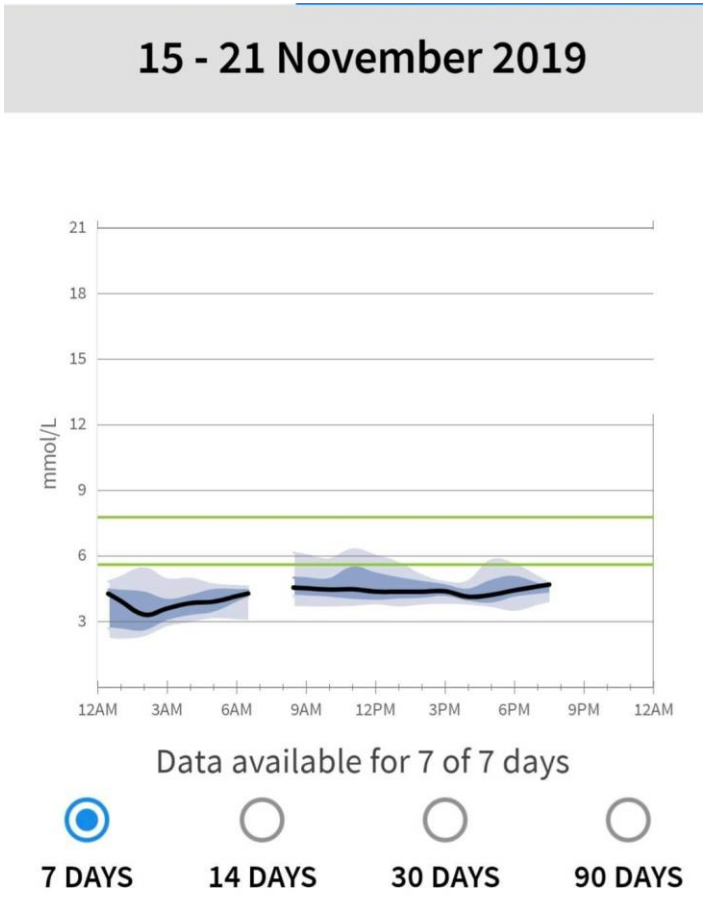
# Temperature Regulation and Blood Glucose Response

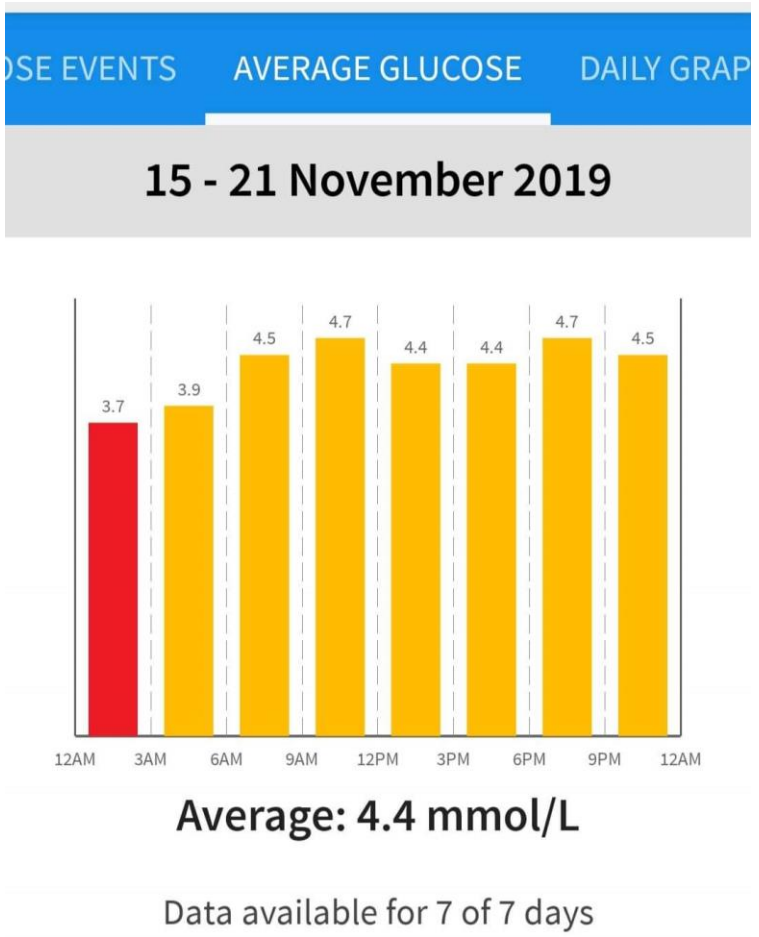
**High temperatures can also cause blood vessels to dilate, which can enhance insulin absorption, potentially leading to low blood sugar**. If you have diabetes, it is best to stay indoors during the hottest part of the day and monitor blood sugar closely for changes when temperatures start to rise

# Fat Adapted Glucose Response

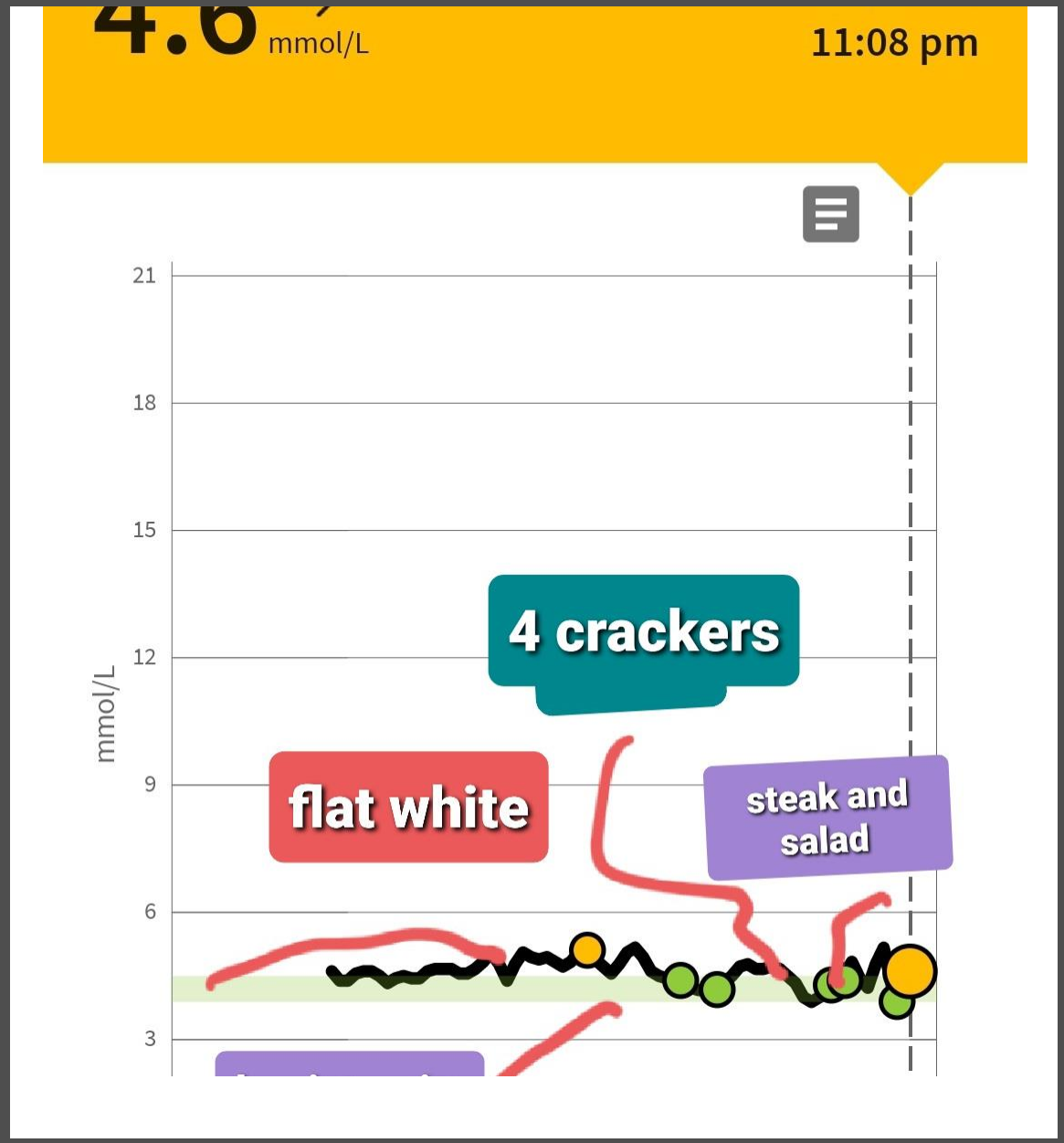
My glucose response during 7 hour race.
30 grams of carbohydrates over 7 hours
Heartrate 150 beats per minute for 7 hours straight.

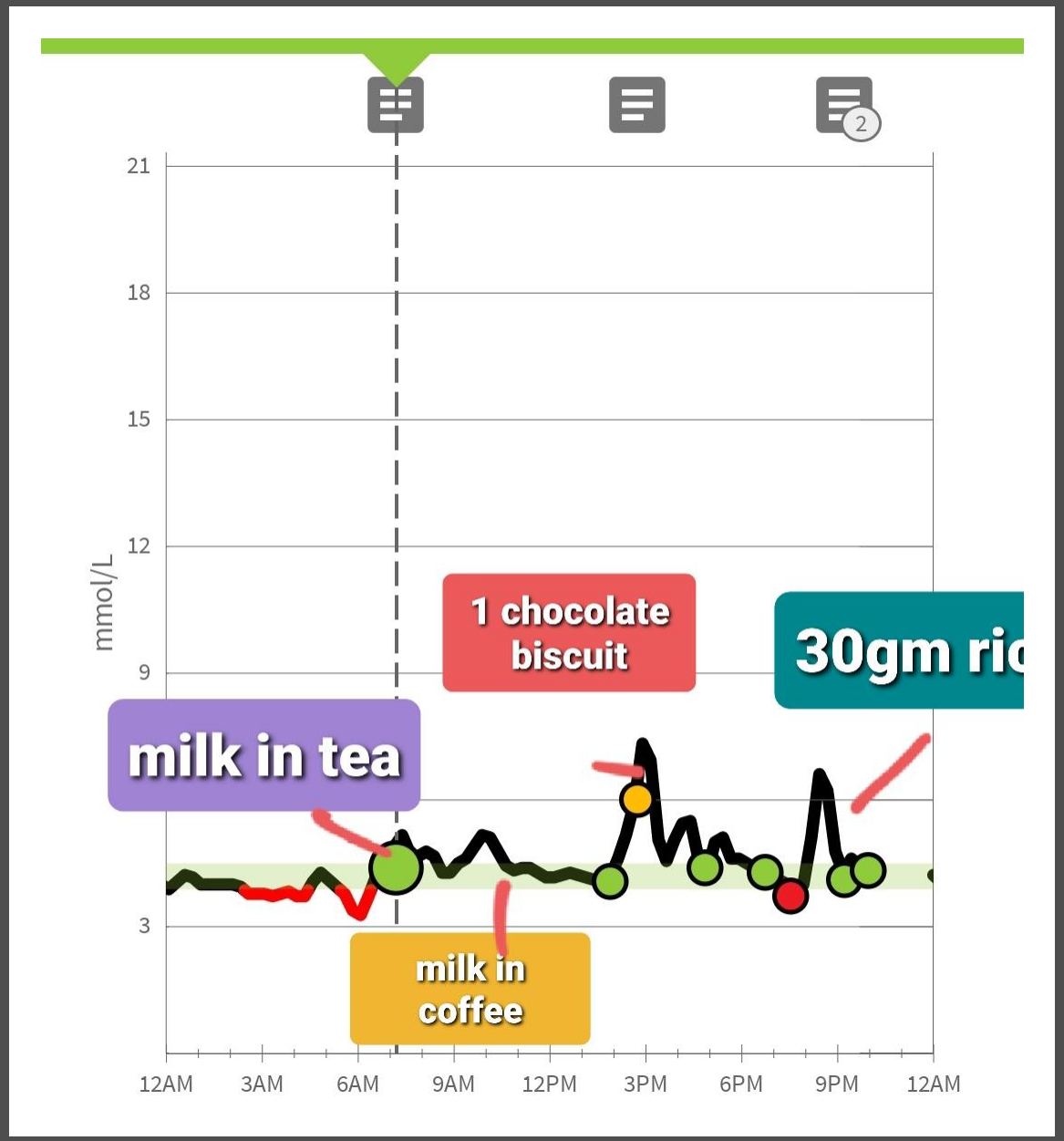
If I can paddle for 7 hours without loading up on carbs , surely we can walk around at a low heart rate all day on minimal carbohydrates



# Some of Brodie's Glucose Charts



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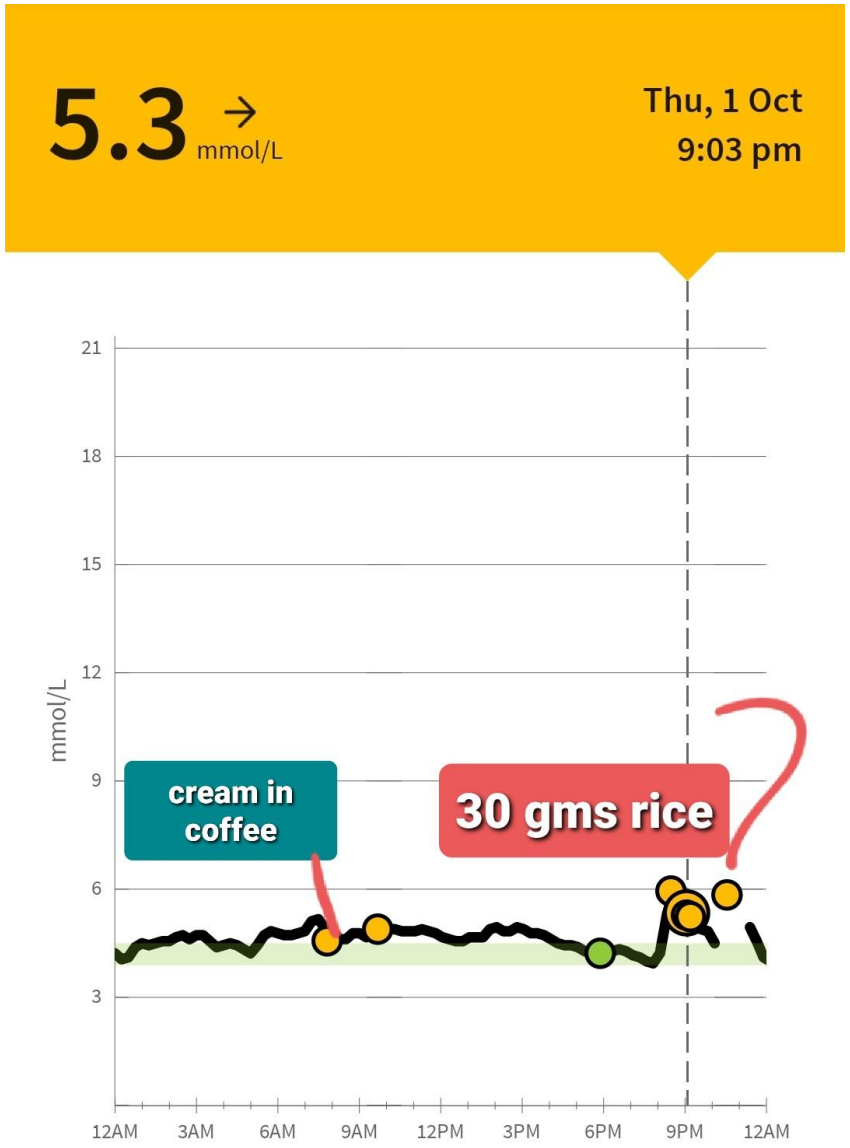


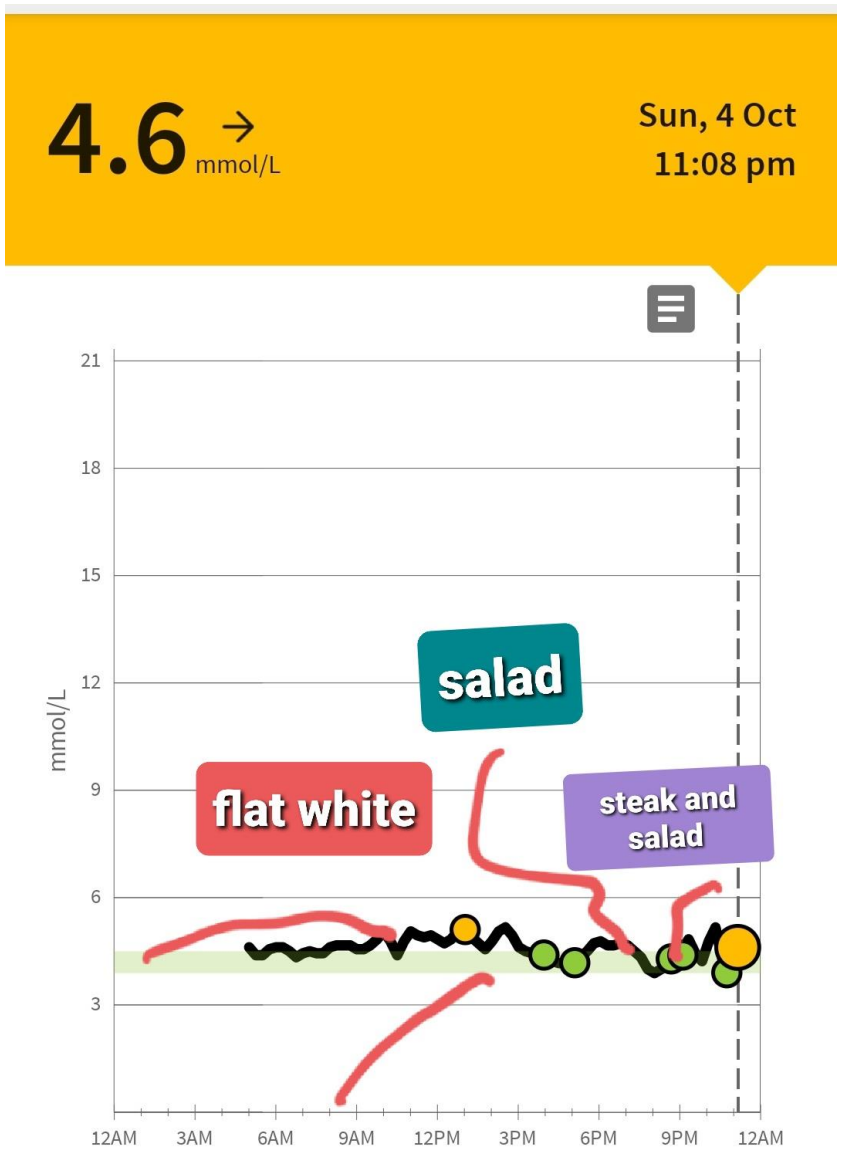

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