



# Women's Health + Blood Sugar

---

Periods, PCOS, Menopause + more!



# Morgan Willard, MS, RD, LN



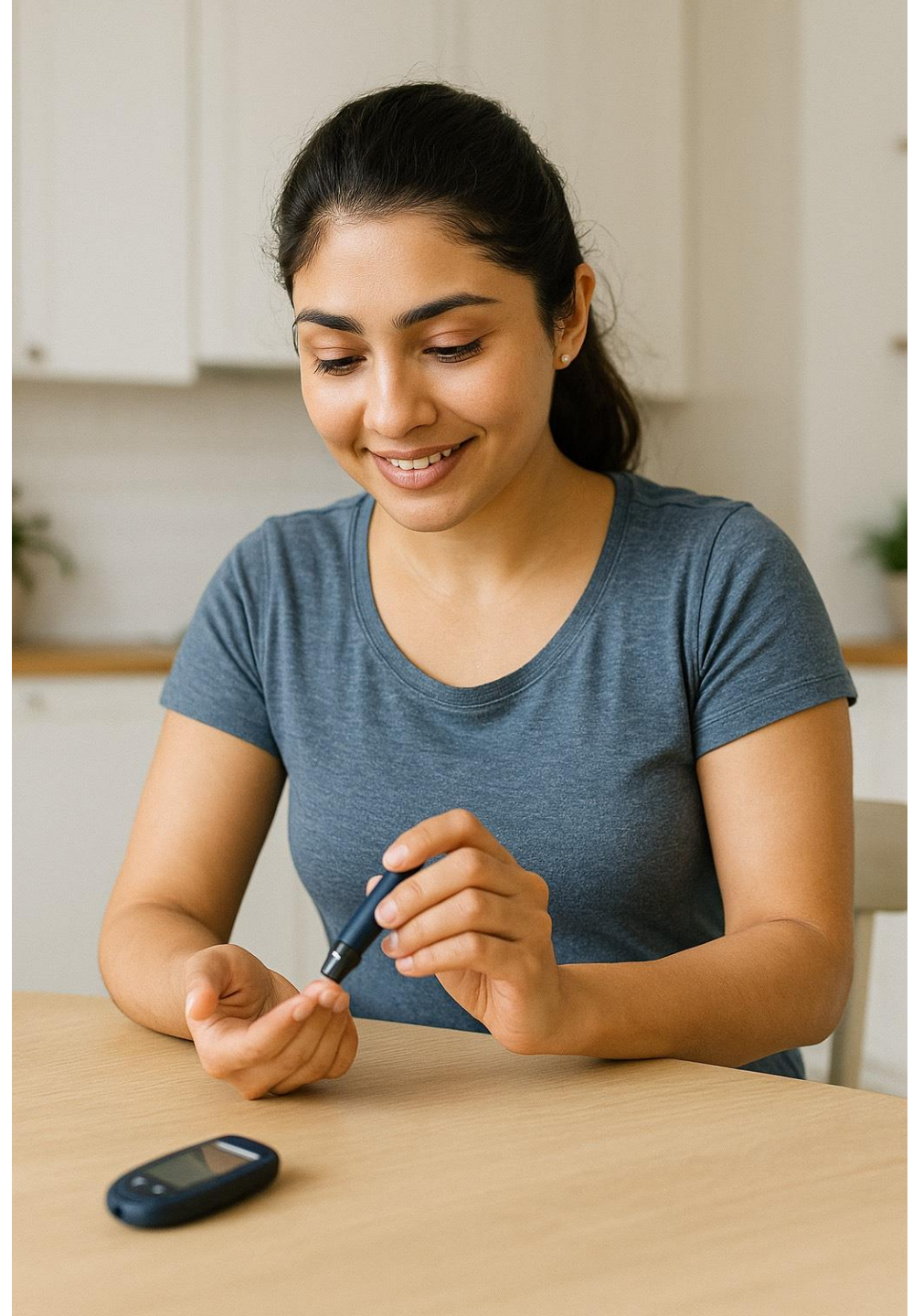
- Registered Dietitian + Licensed Nutritionist – 10 years
- Diabetes Dietitian AND Women's Health + Hormone Dietitian
- Mom of 2
- PCOS Warrior



# Objectives

---

- Understand blood sugar basics and the concept of insulin resistance
- Recognize the periods of time in a women's life when hormone fluctuations effect blood sugar regulation
- Explain the bidirectional relationship between insulin resistance and conditions such as PCOS, perimenopause and gestational diabetes.
- Describe nutrition and lifestyle strategies that support balanced blood sugar in women



# Women + Blood Sugar

---

*Why are we so\*unique\**

1. Body Composition
2. Stress and Cortisol Sensitivity
3. Hormonal Fluctuations
  - During our Menstrual Cycles
  - During Pregnancy
  - During Peri/Post Menopause
  - PCOS – Polycystic Ovarian Syndrome

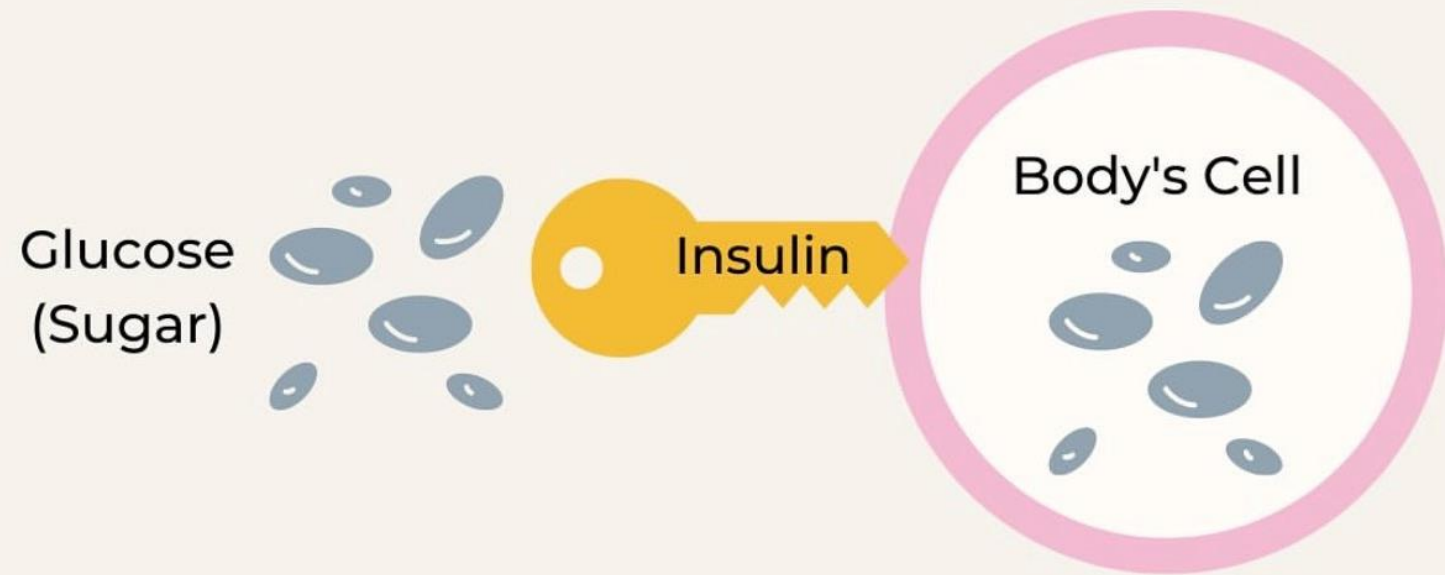
# Blood Sugar Basics

-What is insulin resistance?

1st things first:

When glucose (sugar) enters the blood- we can use this immediately for energy or store it.

We need insulin in order to do this. Insulin is released from the pancreas and acts as the "key" to unlock the cell in order to use or store glucose.

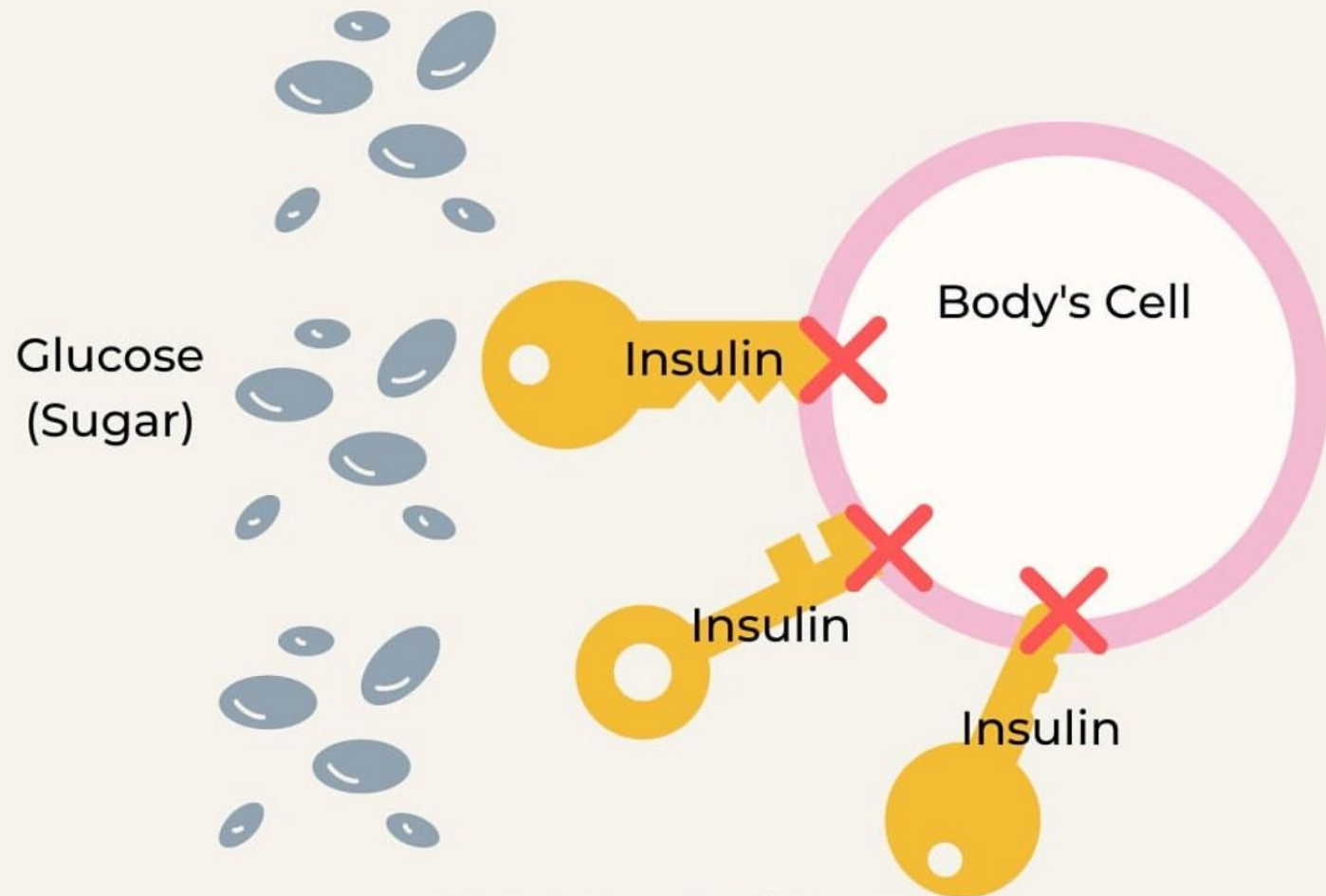


# Blood Sugar Basics

-What is insulin resistance?

## Insulin Resistance

In insulin resistance- the "keys" (insulin) are not working as well to get the glucose into the cell. The body will sense the excess glucose in the blood and the pancreas will start sending more "keys".



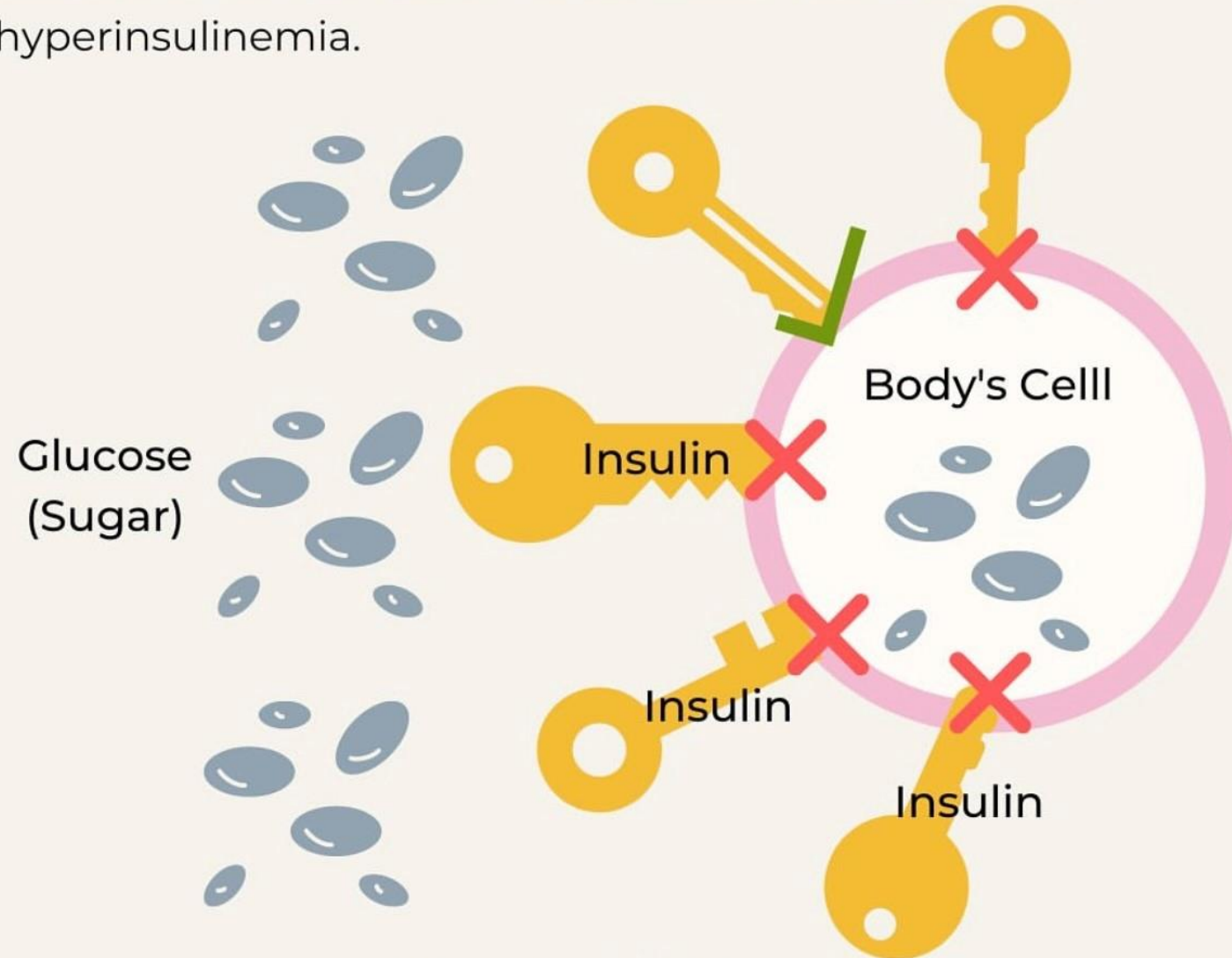


# Blood Sugar Basics

-What is insulin resistance?

## Insulin Resistance

This will eventually get the job done of getting the glucose into the cell, (aka: getting your "blood sugar" down) but excess insulin will remain in the blood- also known as hyperinsulinemia.



# Blood Sugar Basics

---

-What is insulin resistance?

Over time, if you continue to become increasingly resistant to insulin- resulting in a rise of both insulin and blood sugar levels, this will increase your risk of:

Various health conditions including prediabetes, type 2 diabetes and obesity

Elevated Triglycerides, Cholesterol + Blood Pressure

Systemic Inflammation

Disruptions in ovulation and elevated androgens  
-PCOS diagnosis



# Blood Sugar Basics

---

Why does it happen!?

## Multifactorial

- Diet- especially intake of refine carbs and sugars
- Chronic Caloric Surplus
- Physical Inactivity
- Poor Sleep
- Chronic Stress
  - \*\*All of which contribute to visceral fat storage which increases insulin resistance as well**
- Hormones!!
- Genetic History
- Inflammation

# Blood Sugar Basics



## Sleep, Stress + Exercise Impact

### *Exercise*

- Movement in general increases insulin sensitivity– muscles use more glucose during and after exercise
- Exercise can reduce blood sugar both immediately after a workout and long term.
- Research shows the best effects on blood sugar is a from a mix of both aerobic (walking) and resistance training. <sup>1</sup>
- MUSCLE- is a major site for glucose disposal.
  - The more muscle you have the more glucose you can store and burn
  - Muscle cells are highly sensitive to insulin (especially after exercise)

# Body Composition

## Lower muscle mass

Impact: muscle is a primary site for glucose uptake after meals. Women typically have less lean muscle mass than men, which can reduce glucose disposal efficiency

Result: may lead to high post-meal blood sugars and slightly reduced insulin sensitivity, especially if muscle mass is low

## Higher fat mass

Impact: Women tend to have more total body fat, especially subcutaneous fat. Women also store more fat in the hips, thighs and buttocks vs men who tend to store more in the abdomen.

Protective effect: This fat pattern is less metabolically harmful than visceral belly fat, which may be somewhat protective from insulin resistance despite high fat percentages. <sup>2</sup>

Risk factor: however, when visceral fat increases (e.g stress, menopause, PCOS) the risk for insulin resistance increases.

# Blood Sugar Basics



## Sleep, Stress + Exercise Impact

### *Sleep*

- Poor sleep (less than 6-7 hours)– increases insulin resistance + hunger hormones (increases ghrelin and decrease leptin) <sup>3,4</sup>
- Poor or insufficient sleep disruptions can cause issues with your natural cortisol (stress hormone) rhythm
  - Higher evening cortisol levels
  - Blunted or delayed morning cortisol rise
  - Overall dysregulated stress response
- Cortisol tells you liver to release stored glucose (gluconeogenesis)
- This can lead to high fasting glucose and impaired glucose intolerance through out the day



# Stress Hormone Impact

Stress hormones (like cortisol) are released by the adrenal glands in response to physical or emotional stress

If significant enough, this will stimulate glucose output by the liver and by reducing glucose uptake in the tissues

This is a survival mechanism to provide quick energy during acute stress “fight or flight”.

If you're in chronic fight or flight you can imagine the toll this can take on your glucose levels and eventually your insulin sensitivity.

For women specifically:

- Estrogen enhances cortisol receptor sensitivity- this means women's cells can respond more strongly to cortisol at certain times.

- Progesterone- has more of a modulating effect—may buffer cortisol's impact

- \* This leads to fluctuations in cortisol levels and sensitivity throughout a women's menstrual cycle

Chronic elevated cortisol also promotes visceral fat (belly fat accumulation— which is strong linked to insulin resistance) <sup>5</sup>



MALE  
HORMONE  
LEVELS

Men: Daily rise  
and fall of  
testosterone

FEMALE  
HORMONE  
LEVELS

Women: Monthly  
ebb and flow

OVULATION

Period

Follicular

Luteal

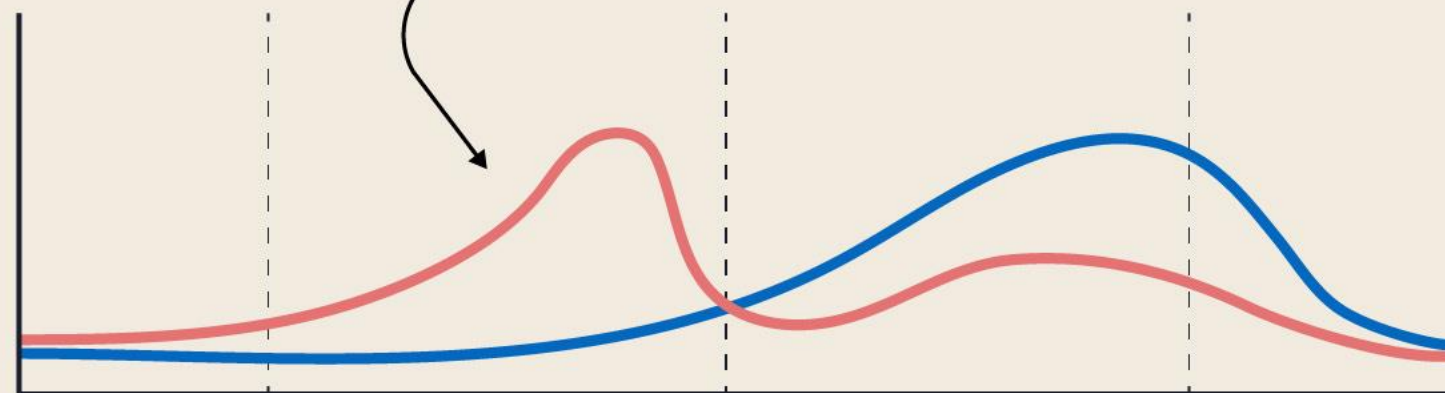
Pre-menstrual

DAY 1

LAST DAY  
OF CYCLE

● Oestrogen

● Progesterone



# Your Monthly Cycle and Glucose Shifts

---

## Follicular Phase (Day 1-14)

- Hormones: Estrogen low and starts to rise, low progesterone
- Glucose Impact:
- Estrogen promotes improved insulin sensitivity
- Stable blood sugar – often easier to manage glucose levels
- Some studies show there may be some increased chance of time below range 6, 7
- Practical tips:
- Focus on balanced meals with complex carbs
- High fiber intake (chia, oats, beans, berries etc.) and cruciferous vegetables to support estrogen metabolism
- Take advantage of higher energy levels-great time for more intense exercise – make sure to consume protein + carbs post exercise

## Ovulation ( ~14 days)

- Hormones: Estrogen peaks w/ an LH surge to trigger ovulation, hormone dynamics are shifting
- Glucose Impact:
- Still good insulin sensitivity, but some may see increased variability (spikes + dips)
- Potentially slight increase in appetite and energy needs
- Practical tips:
- Nutrition/Exercise tips same as follicular phase
- Mindful of rising carb cravings- estrogen can increase dopamine which may trigger more reward seeking behaviors (processed foods+ sweets) 8

# Your Monthly Cycle and Glucose Shifts

---

## Luteal Phase (15-28 days)

- Hormones: Progesterone rises, estrogen declines
  - Glucose Impact:
    - Promotes insulin resistance (body is less efficient at moving glucose into cells) Could result in higher fasting glucose or more pronounced post-meal spikes.
    - Likely increased fatigue (estrogen –gas pedal, progesterone breaks) which can indirectly effect glucose
    - PMS- if progesterone drops early, too fast or is low– increases anxiety, tension and cortisol surges which can impact blood sugar
  - Practical tips: -Introduce anti-inflammatory foods + iron rich foods support to help with energy
- Be strategic with carbs– avoiding high- glycemic carbs (like white bread and sweets) and be diligent about pairing carbs with protein
- Short walks or movement after meals can help improve glucose spikes
- Support your stress and sleep

## Menstruation (Days 1-5 -- also the beginning of luteal phase)

- Hormones: Progesterone + estrogen low – estrogen slowly on its way up
- Glucose Impact:
  - Mixed- some experience better glucose control during menstruation (there insulin sensitivity gets better because progesterone drops)
  - Some see higher blood glucose variability or slightly elevated blood sugars due to inflammation, sleep disturbances or stress responses
  - Increased cravings for carbohydrates/sweets (multi-factorial- progesterone withdrawal, drops in dopamine and serotonin, iron loss/nutrient depletion)
- Practical tips: To be safe, it may time to be more mindful of glucose support (balanced meals w/ more protein + healthy fats fiber, high fiber-moderate sized carb portions) Add more snacks, carbs if showing signs of low blood sugar
- Plan for cravings– don't fight them. Pair sweet treats with high protein + high fiber meal. Choose smart swaps- dark chocolate, lesser evil popcorn, whole grain crackers + cheese etc. )
- Keep up with Iron rich foods + magnesium rich foods- to reduce inflammation, pain, stabilize mood and blood sugar.



# Pregnancy

- First trimester:

**Hormone Shifts:** Rise in Estrogen and Progesterone

**Glucose Impact:**

- Slightly increased insulin sensitivity early on.
- Blood sugar often stable or lower
- Nausea may reduce food intake which increase the risk of hypoglycemia

- Second Trimester

**Hormone Shifts:** Placental hormones- hPl + cortisol start to rise

**Glucose Impact:**

- Insulin Resistance begins to increase
- Blood Sugar may start to trend higher
- Body compensates by producing more insulin

- Third Trimester

**Hormone Shifts:** At peak hormone levels of hPl, cortisol, estrogen and progesterone

**Glucose Impact:**

- Marked insulin resistance (can be up to 50% less sensitivity)
- Greater risk of gestational diabetes if pancreas can't keep up
- Glucose supply prioritized for fetal growth

# Gestational Diabetes

*Gestational diabetes is a warning sign– not just for the pregnancy, but for long-term metabolic health*

Gestational diabetes is evaluated between 24 and 28 weeks of gestation

Those at high risk will likely be checked earlier and at two points during the pregnancy.

## Risk Factors:

- Overweight/Obesity
- >25 years old
- Family hx of diabetes
- Hx of pre-diabetes, PCOS or previous gestational diabetes
- Certain ethnicities: Native American, African American, Hispanic
- Carrying twins/multiples



# Gestational Diabetes

## Practical Tips to prevent T2D:

- Prioritize balanced, blood sugar friendly meals – plenty of protein, non-starchy vegetables and high fiber carbohydrates
- Avoid liquid sugars long term, highly moderate refined carbs/simple sugars
- Find a movement/exercise routine you love and can keep up long term
- Stay on top of regularly screenings. (6-12 weeks after delivery, regular follow with PCP at least yearly moving forward)

## Long term risk factors:

- Gestational diabetes (GDM) carries a lifetime risk of progression to type 2 diabetes of up to 60%. One of the biggest risk factors for T2D!!
- Increased risk of metabolic disease and cardiovascular disease
- 50% risk of GDM recurrence
- Increased lifetime risk of insulin resistance/type 2 diabetes for baby

11



# Peri-Menopause

*the transitional period before menopause, marked by hormonal fluctuations and the eventual cessation of menstruation*

## Hormone shifts:

- Estrogen + progesterone levels start to fluctuate unpredictably
- Increased frequency of anovulatory cycles
- Cortisol and insulin resistance may rise

## Glucose Impact:

- Less estrogen= reduced insulin sensitivity
- Progesterone spikes may worsen glucose tolerance as well
- Sleep disturbances + hot flashes: less sleep and/or low-quality sleep -> increase in stress hormones like cortisol -> blood sugar dysregulation
- Cravings + appetite changes: cause is likely multifactorial. Hormonal shifts can increase hunger and cravings.

## Practical Tips:

- Balanced meals, start becoming more conscious of protein centered meals and assess where you are at with fiber intake.
- Watch for hidden sugars and cut out all liquid sugars
- Prioritize sleep hygiene
- Focus on building muscle mass
- Prioritize stress management and self-care



# Post -Menopause

---

The stage of life following menopause, which is marked by the cessation of menstrual periods for 12 consecutive months

## Hormonal Shifts:

- Decreased/Minimal Estrogen
- Decreased Progesterone
- Potentially increased cortisol

## Glucose Impact:

- Estrogen helps cells respond to insulin  
reduced estrogen = reduced insulin sensitivity
- Estrogen supports muscle protein synthesis so muscle mass starts decline. 80% of post meal glucose is taken up by muscle.

less muscle mass = less glucose uptake = increased blood sugar levels.

**\*\***less muscle mass also = decreased metabolic rate (how many calories you burn in a day!). This could promote fat gain which can further impair glucose balance.

- Low estrogen promotes that fat storage to the abdomen
- Low progesterone levels promote mood shifts, sleep changes and more stress reactivity which indirectly impacts your ability to regulate blood sugar
- Increased cortisol (stress hormones) promotes insulin resistance and viscera fat accumulation. Why high cortisol? Estrogen used to buffer cortisol and very likely less sleep

# Post -Menopause

---

Risk of type 2 diabetes:

Women are 3.7x more likely to develop diabetes after menopause then compared to before! <sup>12</sup>

## Practical Tips:

- Include protein, fiber and healthy fats at every meal.

  - \*Protein needs are HIGH to prevent muscle mass loss

- Important to prioritize “smart” (high fiber carbs- oats, sweet potatoes, beans, quinoa etc). Consider reducing carb portions.

- Do not skip breakfast + meals!!

- Eliminate sugary beverages and limit refined carbohydrates and added sugars

- 10 min walk after meals can help blunt blood sugar spikes

- Participate in resistance training- 2-3x per week, light cardio activities like brisk walks, biking, water exercise etc.

- Stress + Sleep!

- Consider reduction in alcohol intake

# PCOS

---

## Polycystic Ovarian Syndrome

Hormonal/Metabolic Condition that is marked by:

- High androgens (like testosterone + DHEA-S)
- Irregular or absent ovulation/periods
- Cysts on the ovaries

Insulin resistance is common in women with PCOS – 60-80% of women with PCOS has some degree of insulin resistance

- Among those who are overweight or obese with PCOS= 95% with IR
- Among those that are at a normal body weight- 20-40% with IR

13, 14

### Hormonal Shifts:

- High Androgens (Like Testosterone + DHEA-S)
- Low/Imbalanced progesterone due to anovulation- which creates an unfavorable ratio of progesterone to estrogen
- LH can be elevated relative to FSH

### Glucose Impact:

- High androgens promote insulin resistance and increased visceral fat
  - \*\*This is a vicious cycle- high insulin levels stimulate ovaries to produce more androgens
- Lack of regular ovulation can create a hormone imbalance can disrupt insulin signaling and affects overall metabolic function
- Imbalanced LH to FSH ratio can promote androgen production and disrupt normal ovulation

# PCOS

Several studies show that PCOS has around a 4x higher risk of developing type 2 diabetes <sup>15</sup>

Risk may be 6-8x with women with obesity, high androgen PCOS phenotype or a family history of diabetes <sup>16</sup>

PCOS is associated with higher rates of anxiety, depression and poor body image (even independent of BMI) <sup>17</sup>

## How to lower type 2 risk:

1. Regular + Balance Meals for blood sugar
  - Prioritize protein + “smart carbs”, fiber + healthy fats
  - Avoid naked carbs → pair with protein/fat to blunt blood sugar spikes
  - Minimize all added sugar + refined carbohydrates
2. Build an exercise routine focused on strength training and low-mid intensity cardio.
3. Movement for 10 + minutes after meals
4. Lose weight– (if appropriate) 5 -10% weight loss can dramatically improve insulin resistance and testosterone levels.
5. Regulate stress/or cortisol \*\* foundational
  - Some studies indicate women with PCOS have altered HPA axis (hypothalamic-pituitary-adrenal) which regulates cortisol. In addition, PCOS women show exaggerated cortisol stress responses to psychological stress. <sup>18,19</sup>



# Type 1 diabetes

- Autoimmune condition where the body attacks the cells beta cells in the pancreas
- Result is not being able to produce enough insulin to keep blood sugars in a safe range
- Requires lifelong insulin therapy

## Practical tips:

-Should take hormones considerations similar throughout the life span. A person with T1D more sensitive or less sensitive to the insulin that they are giving themselves during different periods of their life.

- Puberty/Young Adult Hood

-Growth hormone and estrogen fluctuations increase insulin needs. The hormonal changes during this time can contribute to T1 onset or unmasking

- Overnight highs can be common due to GH surges

- Menstrual Cycle Awareness

-Follicular phase (first half, before ovulation) may need to adjust doses to prevent lows from happening

-Luteal phase (second half, after ovulation) may require slightly high basal or bolus insulin

\*\*\* Use CGM trend data to identify patterns and anticipate shifts

# Type 1 diabetes

- High cortisol=increased blood sugar– make it a mission to prioritize stress-reducing practices – gentle exercise, mindfulness, breathing techniques etc.
  - Pregnancy- intensive monitoring + support– insulin needs likely will increase in second and third trimesters. Watch for post partum insulin sensitivity – can rebound quickly.
  - Perimenopause + Menopause- hormonal irregularity will make blood sugar patterns less predictable. Watch out for night sweats + hot flashes which may look like hypoglycemia.
- 
- Adjust insulin with flexible dosing or pump settings accordingly– don't do this without adequate medical guidance, however.
  - Keep a pattern log, mood, symptoms, cycle, sleep, exercise, blood sugar numbers etc.
  - Don't underestimate the impact of sleep and recovery on insulin sensitivity

THANK YOU!!

- Questions... Comments....  
Discussion!

## • References:

1. Davidson, L. E., Hudson, R., Kilpatrick, K., Kuk, J. L., McMillan, K., Janiszewski, P. M., ... & Ross, R. (2009). Effects of exercise modality on insulin resistance and functional limitation in older adults: a randomized controlled trial. *Archives of Internal Medicine*, 169(2), 122–131. <https://doi.org/10.1001/archinternmed.2008.526>
2. Manolopoulos KN, Karpe F, Frayn KN. Gluteofemoral body fat as a determinant of metabolic health. *Int J Obes (Lond)*. 2010 Jun;34(6):949-59. doi: 10.1038/ijo.2009.286. Epub 2010 Jan 12. PMID: 20065965.
3. Spiegel K, Tasali E, Leproult R, Van Cauter E. Effects of poor and short sleep on glucose metabolism and obesity risk. *Nat Rev Endocrinol*. 2009 May;5(5):253-61. doi: 10.1038/nrendo.2009.23. PMID: 19444258; PMCID: PMC4457292.
4. Van Cauter E, Spiegel K, Tasali E, Leproult R. Metabolic consequences of sleep and sleep loss. *Sleep Med*. 2008 Sep;9 Suppl 1(0 1):S23-8. doi: 10.1016/S1389-9457(08)70013-3. PMID: 18929315; PMCID: PMC4444051.
5. Cleveland Clinic. (2022, September 12). Visceral Fat: What It is & How to Get Rid of It. Cleveland Clinic
6. Goldner W.S., Kraus V.L., Sivitz W.I., Hunter S.K., Dillon J.S. Cyclic changes in glycemia assessed by continuous glucose monitoring system during multiple complete menstrual cycles in women with type 1 diabetes. *Diabetes Technol. Ther*. 2004; 6:473–480. doi: 10.1089/1520915041705875.
7. Barata D.S., Adan L.F., Netto E.M., Ramalho A.C. The effect of the menstrual cycle on glucose control in women with type 1 diabetes evaluated using a continuous glucose monitoring system. *Diabetes Care*. 2013; 36: e70. doi: 10.2337/dc12-2248.
8. Richard JE, López-Ferreras L, Anderberg RH, Olandersson K, Skibicka KP. Estradiol is a critical regulator of food-reward behavior. *Psychoneuroendocrinology*. 2017 Apr;78:193-202. doi: 10.1016/j.psyneuen.2017.01.014. Epub 2017 Jan 28. PMID: 28214679.
9. Trond M Michelsen, Ane M Holme, Maia B Holm, Marie C Roland, Guttorm Haugen, Theresa L Powell, Thomas Jansson, Tore Henriksen, Uteroplacental Glucose Uptake and Fetal Glucose Consumption: A Quantitative Study in Human Pregnancies, *The Journal of Clinical Endocrinology & Metabolism*, Volume 104, Issue 3, March 2019, Pages 873–882, <https://doi.org/10.1210/jc.2018-01154>
10. Quintanilla Rodriguez BS, Vadakekut ES, Mahdy H. Gestational Diabetes. [Updated 2024 Jul 14]. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2025 Jan-. Available from: <https://www.ncbi.nlm.nih.gov/books/NBK545196/>
11. Noctor E, Dunne FP. Type 2 diabetes after gestational diabetes: The influence of changing diagnostic criteria. *World J Diabetes*. 2015 Mar 15;6(2):234-44. doi: 10.4239/wjd.v6.i2.234. PMID: 25789105; PMCID: PMC4360417.
12. Muka T, Asllanaj E, Avazverdi N, et al. Age at natural menopause and risk of type 2 diabetes: a prospective cohort study. *Diabetologia*. 2017;60(10):1951–1960. doi:10.1007/s00125-017-4346-8

- 13. Samantha Cassar, Marie L. Misso, William G. Hopkins, Christopher S. Shaw, Helena J. Teede, Nigel K. Stepto, Insulin resistance in polycystic ovary syndrome: a systematic review and meta-analysis of euglycaemic–hyperinsulinaemic clamp studies, *Human Reproduction*, Volume 31, Issue 11, 21 November 2016, Pages 2619–2631, <https://doi.org/10.1093/humrep/dew243>
- 14. *Fertil Steril*. Author manuscript; available in PMC: 2013 Jan 1. Published in final edited form as: *Fertil Steril*. 2012 Jan;97(1):18–22. doi: 10.1016/j.fertnstert.2011.11.036
- 15. Glintborg, D., Rubin, K. H., Nybo, M., Abrahamsen, B., & Andersen, M. (2017). Cardiometabolic risk in polycystic ovary syndrome: A Danish nationwide cohort study. *The Journal of Clinical Endocrinology & Metabolism*, 102(2), 384–392. <https://doi.org/10.1210/jc.2016-3285>
- 16. Kakoly, N. S., Earnest, A., Teede, H. J., Joham, A. E., & Moran, L. J. (2020). The role of reproductive and metabolic factors in the risk of type 2 diabetes in women with and without polycystic ovary syndrome: A population-based cohort study. *Human Reproduction*, 35(7), 1665–1673. <https://doi.org/10.1093/humrep/deaa093>
- 17. Cooney, L. G., et al. (2017). High prevalence of depression and anxiety in women with PCOS: A meta-analysis. *Human Reproduction*, 32(5), 1075–1081. <https://pubmed.ncbi.nlm.nih.gov/28333286/>
- 18. Higher 24-hour cortisol secretion has been reported in women with PCOS compared to controls, even after adjusting for BMI.
- 19. Study: Women with PCOS demonstrated significantly greater cortisol reactivity to acute psychosocial stress (e.g., Trier Social Stress Test) compared to controls.