Be Well with Kelly Leveque

Objective: the importance of diet in regulating blood glucose levels and why we should pay attention to it

Blood glucose regulation in the body

- What is glucose?
    - Glucose is a monosaccharide, which is a type of carbohydrate
    - Carbohydrates are categorized into simple carbohydrates and complex carbohydrates
        - Simple carbohydrates → monosaccharides (single sugar) and disaccharides (pair of monosaccharides)
        - Complex carbohydrates → polysaccharides (chain of monosaccharides)
    - Glucose is an essential source of energy in the body and is the main sugar found in the blood
    - It comes from the foods we eat

- Macronutrients → nutrients required by the body in large amounts
    - 3 types:
        - Protein → breaks down into amino acids (no to minimal effect on blood glucose)
            - Amino acids are essential → they are used to make cells in the body, make neurotransmitters, hormones, skin cells, muscle cells, etc. → this is why they are crucial components in our diet
        - Fats → break down to fatty acids (no effect on blood glucose) → we get the majority of our fats from our diet, and fats are an important source of energy in the body
        - Carbohydrates → breaks down to fructose and glucose (these can be sugars and starches - ex. potatoes, pasta, bread, fruits and liquid sugars)
        - Reasons for needing carbohydrates:
            - Phytonutrients
            - Fibres
            - Antioxidants
            - Enzymes
            - Polyphanyl

        - The benefits of carbohydrates come into play when they interact with your gut microbiome → the microbiomes ferment these foods and create postbiotics (which are chemicals that are anti-inflammatory - ex. Short-chain fatty acids that can be used as fuel in our body)

- What is blood glucose regulation?
    - It is the process of closely monitoring and regulating blood glucose levels
    - This is done through the endocrine hormones of the pancreas via a negative feedback loop
        - Endocrine: direct secretion into the bloodstream
    - Main hormones involved:
        - Insulin → lowers blood glucose
        - Glucagon → raises blood glucose
        - Somatostatin → balances insulin and glucagon by inhibiting both of them
        - Amylin → helps increase satiety or state of fullness from a meal to prevent overeating, it also helps slow the stomach contents from emptying too quickly to avoid a quick spike in blood glucose levels

    - What does this have to do with carbohydrates?
        - When a meal containing carbohydrates is eaten and digested → blood glucose levels rise and the pancreas turns ON insulin production and turns OFF glucagon production
        - Glucose from the bloodstream enters liver cells → this stimulates various enzymes that convert the glucose to chains of glycogen
        - During the “well-fed” state → the liver takes in more glucose from the blood than it releases to help regulate the conversion of glucose to energy (ATP)
        - After the meal has been digested and blood glucose levels begin to decrease → insulin secretion drops and glycogen synthesis stops
            - When it’s needed for energy, the liver breaks down glycogen and converts it to glucose for easy transport through the bloodstream to the cells of the body

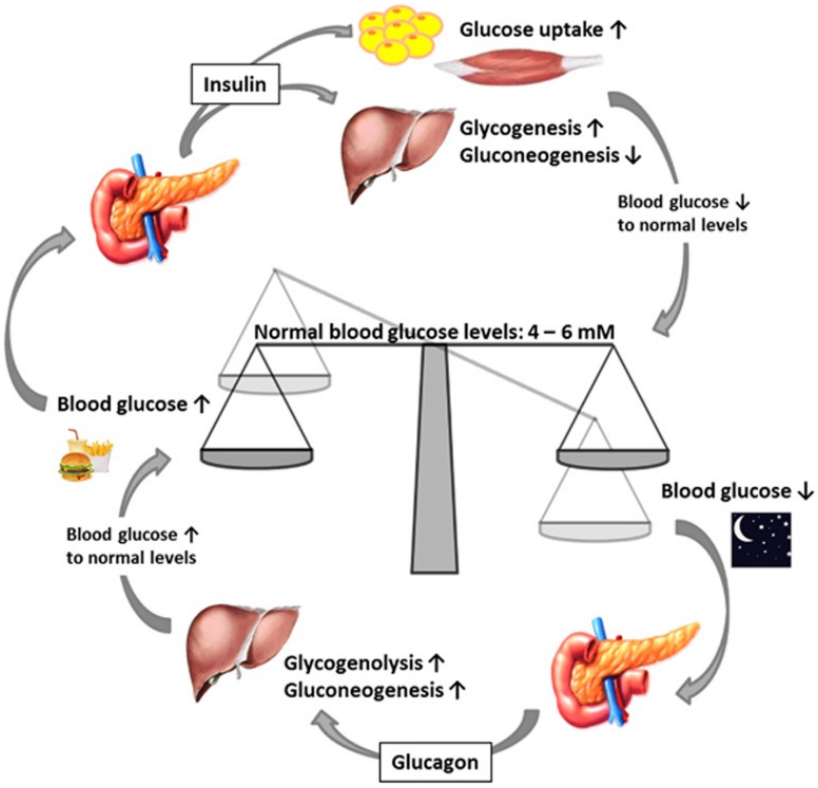

Figure 1
Maintenance of blood glucose levels by glucagon and insulin. When blood glucose levels are low, the pancreas secretes glucagon, which increases endogenous blood glucose levels through glycogenolysis. After a meal, when exogenous blood glucose levels are high, insulin is released to trigger glucose uptake into insulin-dependent muscle and adipose tissues as well as to promote glycogenesis. (Roder et al, 2016)

- What happens when the tight regulation of blood glucose levels is disturbed?
    - When there is a disturbance in the interplay of hormones and peptides due to constant elevation of glucose in the blood, this can lead to metabolic disorders such as type 2 diabetes mellitus (one of the most common chronic disorders that lead to a number of cardiovascular diseases)

- How does blood glucose regulation get disturbed? (ADA, 2018)
    - Increased or decreased glucose intake (from too much or too little food)
    - Excess adipose tissue associated with weight gain
        - Since adipose is also a secretory organ, changes to adipose secretions can lead to an increase in inflammatory signalling molecules, an increase in leptin and a decrease in adiponectin
    - Not enough activity or a significant increase in physical activity than usual

- Stress
- Overall, these changes all contribute to metabolic changes and over time, chronic diseases

- The importance of proteins and fat in our diet
  - The incorporation of macronutrients in a diet is essential to slow down digestion and minimalize the rate at which glucose is being digested → slowing down the rise in blood sugar helps prevent blood sugar spikes, which over time can lead to cardiovascular disease and insulin resistance (CDC, 2022)
  - Eating sufficient protein and fats, especially in the morning, prevent fatigue throughout the day → in comparison to carbohydrates, protein and fats take a longer amount of time to be broken down into energy → thus they are long-lasting energy sources
    - Fats → 9 kcal/g
    - Protein → 7kcal/g
    - Carbohydrates → 4kcal/g
      (USDA, n.d.)

- Example: Protein
  - How much protein do I need to make sure I provide my body with what it needs to function properly?

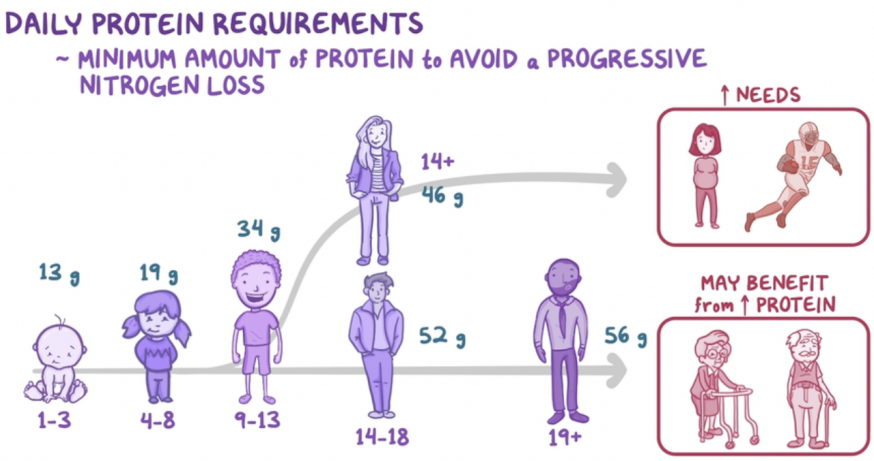

Figure 2 (International Food Information Council, Health Canada and Elsevier Publishing)

- What could this look like?

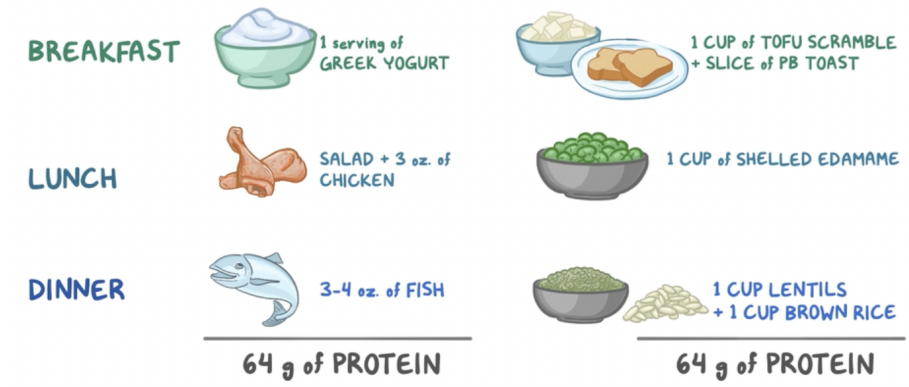

Figure 3 (International Food Information Council, Health Canada and Elsevier Publishing)

Metabolic hormones that regulate hunger and satiety

- Ghrelin
  - The "hunger hormone" → it tells your brain that you're hungry
  - Hormone produced by the stomach
  - Increases food intake and helps your body store fat
  - Helps trigger your pituitary gland to release growth hormones
  - Plays a role in controlling sugars and how your body releases insulin, the hormone responsible for processing sugar

  - How does it work?
    - Ghrelin levels increase when your stomach is empty → when it's time to eat, your body releases ghrelin to tell your brain
    - After eating, ghrelin levels decrease

  - What can I do to keep ghrelin levels healthy?
    - Avoid fad diets or yo-yo dieting, where you gain and lose weight frequently
    - Eat a diet high in healthy carbohydrates, such as whole grains and lean proteins, like chicken or fish
    - Limit processed foods, especially foods high in sugar, high-fructose corn syrup and salt
    - Stay hydrated
    - Control your stress responses as stress may increase ghrelin

- Why is this important?
    - Ghrelin does more than control hunger
    - It also signals your pituitary gland to release growth hormones, plays a role in insulin release and protects your cardiovascular health

(Cleveland Clinic, 2022)

- CCK (Cholecystokinin)
    - A satiety hormone
    - A hormone that works in your digestive system and is produced in the small intestine
    - CCK is released after food passes through the stomach into the first part of the small interesting (duodenum) → it releases as it detects the presence of proteins and fats

    - What does CCK do?
        - It suppresses your appetite while you're digesting, by making your stomach feel physically full and by activating vagal nerves in your stomach wall
        - It stimulates the release of bile into the small intestine and also stimulates the pancreas to release pancreatic enzymes
            - Bile and digestive enzymes are what help break down proteins and fats so that it becomes small enough to be absorbed in the small interesting
        - It also acts together with leptin to regulate hunger and satiety signals

    - Why is CCK important?
        - Since it works as an appetite suppressant, it essentially lets your body know that it's full
        - It plays a fundamental role in digestion, communicating with almost every organ in your digestive system
            - It is crucial to help you digest food

        (Cleveland Clinic, 2022)

- Leptin
    - A hormone that your adipose tissue (body fat) releases to help maintain your normal weight on a long-term basis
        - It does this by regulating hunger by providing satiation

- What does leptin do?
    - Regulates long-term balance between your body's food intake and energy use
    - It inhibits hunger and regulates energy balance so that your body doesn't trigger a hunger response when it doesn't need energy (calories)

- What happens when leptin levels are too high?
    - The amount of leptin in the blood is directly proportional to the amount of adipose tissue → thus if there are high levels of adipose tissue, there will be high levels of leptin
        - An excess amount of adipose tissue can lead to leptin resistance → similar to insulin resistance, in which the brain doesn't respond as it normally would to leptin → meaning, you wouldn't get the sensation of feeling full or satisfied leading to you to eat more even though your body has enough fat stores

- What are normal leptin levels?
    - Adults assigned female at birth: 0.5 - 15.2 nanograms per millilitre (ng/mL)
    - Adults assigned male at birth: 0.5 - 12.5 ng/mL
    (Cleveland Clinic, 2022)

- Why are leptin levels different for women?
    - Leptin levels in women are connected to their menstrual cycle, specifically their progesterone concentration
    - A number of studies have proposed that if leptin is the signal that there are adequate fat stores to start and maintain ovulation and menstruation, it may account for these changes through its effects on the ovary
    - It has been found that there is a relationship between estrogen and leptin that has been described during the follicular phase of both spontaneous cycles and cycles stimulated with exogenous follicular-stimulating hormone (FSH)
        - This could imply that leptin either has a direct effect or is regulated by gonadal steroids in the human ovary
    (Al-Harithy et. al, 2006)

        - There is also a difference between men and women during the onset of puberty
        - In prepubertal men and women, leptin concentration increases slowly with age and body-fat mass
            - In men, this increase is interrupted in early puberty → when testosterone and lean body mass increases
            - In women, leptin, along with the body-fat mass, continue to increase during puberty → this occurs as women naturally require a higher body fat percentage in comparison to men (Apter, 2003)

- What can women do to help regulate satiety, hunger and body fat in a healthy way?
    - Prioritizing fat and protein in the diet
    - Staying active and adding on more muscle mass → this increases metabolism in the body and improves insulin activity in the body (Mayo Clinic, 2021)
        - Trained muscle has a high capacity to store blood glucose in the form of glycogen, aiding in lowering blood glucose (Taha, 2021)
    - Moderate to low carbohydrate diet or a whole food diet
    - Time-restricted eating (eating in an 8-10 hour window)
        - These in combination will decrease body mass and decrease visceral fat → this in turn decreases your chances of retaining chronic disease and metabolic disorders
        - Decrease in inflammatory markers, lipid levels, uric acid and overall glucose levels
        - In order to see the benefits of this method, it should be taken carefully
            - For example, these benefits are likely to be seen in someone who eats between 10am to 5pm, or 9am to 6pm, rather than 2pm to 10pm → this allows time for the food to metabolize and for the body to bring down glucose levels in the body before retiring at night
            - To better maintain this, prioritize protein and fats in the first meal of the day

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