



## Session 4: Understanding Nutritional Ketosis and Our Mighty Mitochondria

### *This session's Mindfulness Activity: Diaphragmatic Breathing*

- Also Known as Eupnea: A natural & relaxed state of breathing in mammals
- Slows down our rate of breathing
- Increases oxygen intake
- Permits greater oxygen delivery through our systemic circulation
- Stimulates the parasympathetic nervous system thereby reducing our heart rate and BP
- A form of Biofeedback accessible to us at ALL TIMES!

### 1. *What is so exciting about our Mitochondria?*

- MITOCHONDRIA are responsible for ENERGY PRODUCTION** within the cell through a process called oxidative phosphorylation.
- The energy Mitochondria produce is called ATP –Adenosine Triphosphate, which allows us to breathe, talk, walk, digest, think, etc...
- Mitochondria produce 110 lbs of ATP (energy) daily.
- Most cells have anywhere from 80-2000 Mitochondria per cell.
- Mitochondria accounts for 10% of our body weight.
- 1 billion Mitochondria fit on the head of a pin. These guys are small, but mighty!!!
- The majority of disease processes BEGIN when damage occurs within our Mitochondria.**
- Although most DNA is packaged in the chromosomes within the nucleus, mitochondria also have a small amount of their own DNA. This is known as mitochondrial DNA.
- All mitochondria and mitochondrial DNA is passed exclusively from mother to offspring through the egg.
- The majority of disease processes begin when damage occurs within our Mitochondria.
- When mitochondria use glucose for fuel, they produce 30-40% more Reactive Oxidative Species than when they use fuel from FAT.
  - These Reactive Oxidative Species are damaging to the Mitochondrial DNA.
  - Damaged Mitochondria lead to disease development such as CANCER and AUTOIMMUNE DISEASE.**

*Reference: Dr. Joseph Mercola, Fat for Fuel*



**Review: What is the powerhouse of our cell and what is its main function?**

**Answers: The powerhouse of our cells are called \_\_\_\_\_.**

**The main function is \_\_\_\_\_.**

## **2. What is Nutritional Ketosis?**

- a. Nutritional ketosis occurs when the body shifts away from using primarily glucose (carbohydrate) as fuel. It begins to rapidly break down fat which produces Fatty Acids and Ketones. These fuel sources are used instead of carbohydrates.
- b. The body **naturally produces ketone levels** between **0.5-3 millimolar (mM)**.
- c. This is very different from **diabetic ketoacidosis (DKA)** where levels are **between 15-25 mM (5-10 fold higher than nutritional ketosis)**.
- d. **3 Types of Ketone Bodies: Acetoacetate, Beta-Hydroxybutyrate, Acetone**
  - i. Acetoacetate: precursor to all other ketone bodies
  - ii. BHB: Most effective ketone body for energy. This is the ketone we measure via blood meter.
  - iii. Acetone: Excreted in urine and produces fruity breath

## **3. When will my liver make ketones?**

- a. *We refer to this as **FAT ADAPTATION** – Burning your body fat to produce **KETONES** as an alternative energy source.*
- b. *Your body will convert to burning fat for energy when both **GLUCOSE** and **GLYCOGEN** (the storage form of glucose) are no longer available.*
- c. *Our body will always burn **GLUCOSE** and **GLYCOGEN** for energy before it ever taps into **FAT** stores. (An innate survival mechanism).*
- d. *This is why caloric-restrictive, high-carbohydrate, low-fat diets are typically not effective.*
- e. *You are probably eating just enough to get by without needing to resort to fat stores for energy.*

## **4. Fat Adaptation.**

- a. How much Glycogen must I burn through before I can tap into fat reserves?
- b. We typically store about 1,600-2,000 calories in the form of Glycogen within our liver and muscles.
- c. How many calories does my body store as FAT?
  - i. Thin habitus 30,000-60,000 kcal. as fat (15 days' worth of energy)
  - ii. Average habitus 100,000 kcal. as fat (50 days' worth of energy)
  - iii. Obese habitus 200,000kcal. as fat (100 days' worth of energy)



Review: What are Ketone bodies made from and in which organ are these ketone bodies made within?

Answers: \_\_\_\_\_

## 5. What are the unique benefits of producing BHB?

### a. #1 BHB inhibits histone deacetylases

- Histone Deacetylases or HDACs are a class of enzymes that remove acetyl groups from an amino acid on a Histone.
- What is a Histone?
- Histones are proteins surrounded by DNA.
- DNA wraps around Histones.
- Histones play a role in how DNA is copied
- ***And How its instructions are carried out.***

### b. #2 BHB blocks HDAC!

- HDAC causes the DNA to wrap much more tightly around the Histone.
- When DNA wraps too tightly around the Histone, the DNA can no longer function correctly, and we see disruption in signaling pathways, mitochondrial function, and other markers needed for optimal health and longevity.
- BHB levels of just 1.0-2.0 mmol BLOCKS HDAC and preserves the DNA function.
- HDAC plays a role in many forms of cancer, longevity, and anti-aging pathways.
- BHB acts on numerous hormones contributing to appetite and satiety.
  1. Reduces Leptin resistance
    - a. Leptin is a hormone produced from fat cells and signals to our brain we are full. Obese individuals develop leptin resistance which leads to persistent hunger.
  2. Reduces Ghrelin Production
    - a. Ghrelin is called the hunger hormone.
    - b. Produced in stomach and is highest when hungry before meals.
    - c. Contributes to the addictive signaling from palatable foods and alcohol.
    - d. Increases gastric mobility and acid secretion.
  3. Increases GLP-1
    - a. Hormone produced in the small intestine.
    - b. Increases the secretion of insulin when glucose levels are elevated post meal.



- c. Delays gastric emptying, acid secretion and motility and collectively decreases appetite.
- d. Common medical therapy to manage diabetes. (Trulicity, Ozempic)
4. Increases PYY Production
  - a. PYY is a peptide released from the small intestine and colon in response to eating.
  - b. Obese individuals produce less PYY than those of non-obese individuals.
  - c. PYY acts to reduce appetite.
  - d. Dietary fibers from foods like *VEGETABLES*, increase the transit of intestinal chyme into the small intestine to raise PYY and induce satiety
- c. **#3 Our Brain Loves it!**
  - All ketone bodies are water soluble, which enables them to cross the blood brain barrier.
  - Once ketone bodies cross the blood brain barrier, they are then converted back to Acetyl-CoA (Fatty Acid).
  - From here the fatty acids enter to Krebs cycle and are then converted to energy (ATP).
- d. **#4 Ketones Block mTor!** Mechanistic Target of Rapamycin or mTOR is a complex ancient protein that serves as your body's most important signaling pathway.
  - WHEN WE BLOCK mTOR: Our cells turn on an array of repair and maintenance processes including Autophagy, Mitophagy, DNA repair, and activates intracellular antioxidants.
  - If you limit glucose, excessive amino acids, insulin, and insulin-like growth factor (indirectly increased by insulin), we can inhibit mTOR.
- e. **# 5 KETONES play an important role in reducing inflammation by reducing pro-inflammatory cytokines and increasing anti-inflammatory cytokines**
- f. **#6 KETONES have been shown to provide cleaner, more efficient energy** for our mitochondria, which reduces oxidative stress and prevent damage to our mitochondrial DNA.
- g. **#7 KETONES allow our bodies to get rid of our damaged cells through a process called Autophagy.**
  - Autophagy = "Self-Eating".
  - Cleans out and rids damaged cells. If we can get rid of the damaged cells early on, we can intervene before disease sets in and worsens.



- Allows our immune system to work more effectively and likely serves as a natural defense mechanism against most forms of cancer.
- In 2016, the Nobel Peace Prize went to Yoshinori Ohsumi who discovered the mechanism of Autophagy.

**Review: If we limit glucose, excessive amino acids, insulin, and insulin-like growth factor (Indirectly increased by insulin), we can inhibit which ancient protein?**

**Answer:** \_\_\_\_\_

***What does all this really mean?***

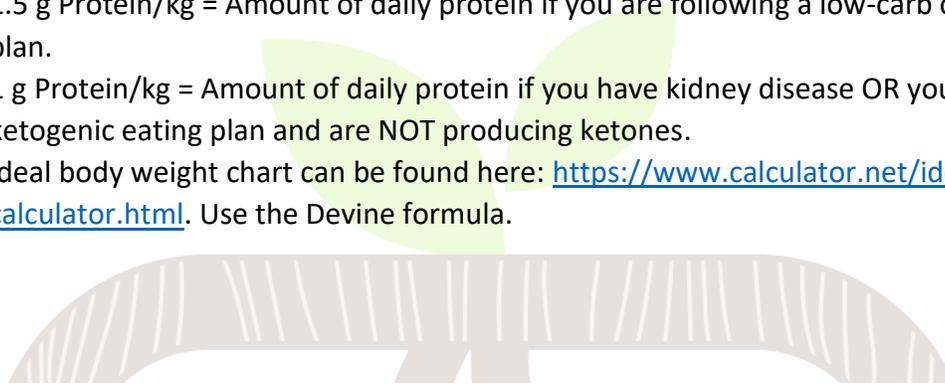
***A Ketogenic Diet will help prevent disease and promote greater longevity through its effects on the Powerhouse of our Cells... our Mitochondrial DNA!***

## **6. Why have a protein goal?**

- Adequate protein provides the necessary amount of amino acids (building blocks) that we need for:
- Growth and maintenance of muscle, tissues, and cells (strong muscles and healthy skin, hair, and nails).
- Body processes, including digestion, energy production, blood clotting, and muscle contraction (proper digestion and high energy).
- Antibody production, which strengthens our ability to fight illness (strong immune function).
- Hormone production (healthy amount of hormones, including human growth hormone and glucagon).
- Maintaining our body's pH and fluid balance (proper water balance).
- See Chart for your daily goal or:**
  - Ideal body weight in kg x 1.0
  - Ideal body weight in kg x 1.5
- Ideal weight is based on sex (male/female) and height using Devine formula.



- i. PROTEIN GOAL does not change based upon weight. Example: If I lose 10 pounds my daily protein goal remains the same.
- j. 1.5 g Protein/kg = Amount of daily protein if you are following a low-carb or ketogenic eating plan.
- k. 1 g Protein/kg = Amount of daily protein if you have kidney disease OR you are following a ketogenic eating plan and are NOT producing ketones.
- l. Ideal body weight chart can be found here: <https://www.calculator.net/ideal-weight-calculator.html>. Use the Devine formula.



**Daily Macronutrient Needs for Males and Females (1.5 g protein/kg ideal weight)**

Male		
Height	Grams Protein	Ounces Cooked Protein Food
4'8"	61	9 oz
4'9"	65	9 oz
4'10"	68	10 oz
4'11"	71	10 oz
5'0"	75	11 oz
5'1"	78	11 oz
5'2"	82	12 oz
5'3"	85	12 oz
5'4"	89	13 oz
5'5"	92	13 oz
5'6"	96	14 oz
5'7"	99	14 oz
5'8"	102	15 oz
5'9"	106	15 oz
5'10"	109	16 oz
5'11"	113	16 oz
6'0"	116	17 oz
6'1"	120	17 oz
6'2"	123	18 oz
6'3"	126	18 oz
6'4"	130	19 oz
6'5"	133	19 oz

Female		
Height	Grams Protein	Ounces Cooked Protein Food
4'8"	54	8 oz
4'9"	58	8 oz
4'10"	61	9 oz
4'11"	65	9 oz
5'0"	68	10 oz
5'1"	72	10 oz
5'2"	75	11 oz
5'3"	78	11 oz
5'4"	82	12 oz
5'5"	85	12 oz
5'6"	89	13 oz
5'7"	92	13 oz
5'8"	96	14 oz
5'9"	99	14 oz
5'10"	103	15 oz
5'11"	106	15 oz
6'0"	109	16 oz
6'1"	113	16 oz
6'2"	116	17 oz
6'3"	120	17 oz
6'4"	123	18 oz
6'5"	127	18 oz

1.5 g Protein/kg = Amount of daily protein if you following a low-carb or ketogenic eating plan

1 g Protein/kg = Amount of daily protein if you have kidney disease OR you are following a ketogenic eating plan and are NOT producing ketones

g=gram kg=kilogram oz=ounce





**Daily Protein Needs for Males and Females (1 g protein/kg ideal weight)**

Male		
Height	Grams Protein	Ounces Cooked Protein Food
4'8"	41	6 oz
4'9"	43	6 oz
4'10"	45	6 oz
4'11"	48	7 oz
5'0"	50	7 oz
5'1"	52	7 oz
5'2"	55	8 oz
5'3"	57	8 oz
5'4"	59	8 oz
5'5"	61	9 oz
5'6"	64	9 oz
5'7"	66	9 oz
5'8"	68	10 oz
5'9"	71	10 oz
5'10"	73	10 oz
5'11"	75	11 oz
6'0"	77	11 oz
6'1"	80	11 oz
6'2"	82	12 oz
6'3"	84	12 oz
6'4"	87	12 oz
6'5"	89	13 oz

Female		
Height	Grams Protein	Ounces Cooked Protein Food
4'8"	36	5 oz
4'9"	39	6 oz
4'10"	41	6 oz
4'11"	43	6 oz
5'0"	45	6 oz
5'1"	48	7 oz
5'2"	50	7 oz
5'3"	52	7 oz
5'4"	55	8 oz
5'5"	57	8 oz
5'6"	59	8 oz
5'7"	62	9 oz
5'8"	64	9 oz
5'9"	66	9 oz
5'10"	68	10 oz
5'11"	71	10 oz
6'0"	73	10 oz
6'1"	75	11 oz
6'2"	78	11 oz
6'3"	80	11 oz
6'4"	82	12 oz
6'5"	84	12 oz

1.5 g Protein/kg = Amount of daily protein if you following a low-carb or ketogenic eating plan

1 g Protein/kg = Amount of daily protein if you have kidney disease OR you are following a ketogenic eating plan and are NOT producing ketones

**The week's Cognitive Action Plan**

- a. Meditate on and envision your **PURPOSE** and reasons why you want to be healthy daily.
- b. Identify triggers and practice your detours daily.
- c. Practice Diaphragmatic Breathing for 3 minutes twice a day.

**This week's Nutritional Action Plan**

- a. Increase to 4 servings of healthy fats per day.
- b. Reduce carbohydrates to 75g per day.
- c. Meet your daily protein goal (see chart)  
Continue with:
- d. Tracking all food and beverage intake.
- e. 64 oz. water daily.



- f. Consume at least 5 servings of non-starchy vegetables per day.**
- g. Consume fermented foods daily.**

**1 serving non-starchy vegetables = ½ cup cooked non-starchy vegetables OR 1 cup leafy greens**

**1 serving of healthy fats = 1 Tbsp. of olive oil, coconut oil, grass fed butter, ¼ avocado, 3 oz. Salmon, ¼ cup nuts or seeds**

Value	Levels Optimal Goal	Standard Range for Normal
Fasting glucose	72-85 mg/dl	<100 mg/dl
Pre-meal (baseline) glucose	72-90 mg/dl	72-90 mg/dl
Post meal glucose (Postprandial)	<110 mg/dl, with <30 mg/dl increase from pre-meal levels	<140 mg/dl
Mean 24-hour glucose	79-100 mg/dl	89-104 mg/dl
Recommended in app range	72-110 mg/dl	70-140 mg/dl

**Continue to check your blood sugar:**