Fasting

Fasting is the abstinence from consuming food and/or beverages for different periods of time. There are many different types of fasting: during holy month of Ramadan (absence of water and food intake from sunrise until sunset), intermittent fasting (short term fasting- less than 24 hours; long term fasting- longer than 24 hours), alternate day fasting, prolonged fasting (for more than 3 days) (1).

Ramadan

During the holy month of Ramadan, Muslims around the world abstain from water and food from sunrise to sunset.

Fasting is one of the Five Pillars of Islam, which form the basis of how Muslims live their lives. The other pillars are faith, prayer, charity and making pilgrimage to the holy city of Mecca in Saudi Arabia.

Ramadan is a time for reflection, prayer and spending time with family and friends. Fasting is important during Ramadan as it encourages Muslims to meditate on their faith, and cultivate a stronger spiritual connection with God. Some make a special effort to reach out to their communities and the needy. It is common to have a meal (known as suhoor) just before dawn and another (known as the iftar) directly after sunset.

What happens when we eat?

Every time we consume calories, an **insulin response** in our body is triggered and blood glucose levels rise, staying up for around 90 minutes to a couple hours. Insulin is tasked with carrying glucose to the cells and storing it in the liver and muscles, like glycogen. If blood glucose level is still high even after glycogen is replenished in the muscles and liver, the remaining glucose will be stored as **fat**. Therefore, when insulin levels increase, the body goes into fat-storing mode.

All foods raise insulin to some degree. In particular, refined carbohydrates (white flour, white bread, white rice, pastries, sodas, snacks, pasta, sweets, breakfast cereals and added sugars) tend to significantly raise insulin compared to other, healthier fats (avocado, cheese, dark chocolate, whole eggs, fatty fish, nuts, olive oil, coconut oil, full fat yogurt) but insulin still goes up in both cases.

Fasting is one of the mechanisms developed to lower blood glucose and decrease fat stores. Eating triggers the liver's natural response to break up and digest food (2)(3)(4)(5)(6)(7)(8)(9)(10)(11)(12)(13)(14).

What happens when we fast?

1. *Postabsorptive Phase*: Occurs 6 to 24 hours after fasting. Blood sugar and insulin levels fall. The liver breaks down glycogen for energy, stores last for approx. 24 to 36 hours (1).

2. *Gluconeogenesis*: Occurs 24 hours to two days after fasting. Glycogen stores have run out. The liver produces new glucose from amino acids in a process called **gluconeogenesis.** In non-diabetics, glucose levels fall but stay within the normal range (1).

3. *Ketosis* : Occurs 2 to 3 days after fasting. Low insulin levels stimulate **lipolysis**, the breakdown of fat for energy. Triglycerides, the main constituents of natural fats and oils., are broken into the glycerol backbone and three fatty acid chains. The glycerol is used for **gluconeogenesis,** so amino acids can be reserves for protein synthesis. The fatty acids are used directly for energy by most tissues of the body, excluding the brain. The body uses fatty acids to produce **ketone bodies**, which are capable of crossing the blood-brain barrier and are used by the brain for energy. After four days of fasting, approximately 75% of the energy used by the brain is provided by ketones. The two major types of ketones produced are **beta-hydroxybutyrate** and **acetoacetate**, which can increase up to time 70 times during fasting (1).

4. *Protein Conservation Phase:* Occurs 5 days after fasting. High levels of growth hormone maintain muscle mass and lean tissues. The energy for basic metabolism is almost entirely supplied by fatty acids and ketones. Blood glucose is maintained by gluconeogenesis. Increased norepinephrine levels prevent any decrease in metabolic rate. There is a normal amount of protein turnover, but it is not being used for energy (1).

Benefits of fasting

With the absence of glucose and fats from meals, fasting flips a metabolic "switch" liberating fat stores via **fatty acid oxidation** (fat burning, in other words) and **ketone production** while overall prioritizing the protection of lean muscle mass and function.

Fasting therefore provides a mechanism that not only improves overall body composition but also triggers the activation of biochemical processes and signaling pathways of aging and disease. Fasting also stimulates hormesis, a compensatory defense response following exposure to a mild stressor, in this case, short term food deprivation. Hormesis triggers a vast array of protective mechanisms that not only repair cell damage but also provide protection from subsequent exposure to more devastating stressors (2).

1. *Fasting decreases insulin levels which helps utilize stored body fat*

   Fasting is a mechanism used to lower blood glucose levels and decrease stored fat levels in the body. A study in which 10 people with type 2 diabetes showed that short-term intermittent fasting significantly decreased blood sugar levels. Another review found that both intermittent fasting and alternate-day fasting were just as effective as limiting calorie intake when it comes to reducing insulin resistance. Decreasing insulin resistance can increase your body's sensitivity to insulin, allowing it to transport glucose to cells more efficiently. Coupled with the potential

for lowering blood sugar, fasting can help keep blood sugar levels steady, preventing spikes and crashes (14)(15).

2. *Fasting decreases inflammation*

   Inflammation is part of the body's complex biological response of tissues to harmful stimuli, such as pathogens, damaged cells, or irritants. It is a protective response involving immune cells, blood vessels, and molecular mediators. Research shows that inflammation may be involved in the development of chronic conditions, such as heart disease, cancer and rheumatoid arthritis (16). Some studies have found that fasting can help decrease inflammation, with one study in particular monitoring 50 healthy adults and concluding that intermittent fasting for one month significantly decreased their levels of inflammatory markers. Another small study discovered the same effect when subjects fasted for 12 hours a day for one month (16)(17)(18).

3. *Fasting improves heart health*

   Through improving blood pressure, triglycerides and cholesterol levels, fasting lessens the potential for coronary heart disease, arrhythmia, heart valve disease, as well as cardiomyopathy, aortic aneurysm, and aortic valve problems. One small study showed that with eight weeks of alternate-day fasting, levels of "bad" LDL cholesterol and blood triglycerides lowered by 25% and 32% respectively. Another study of 110 obese adults showed that fasting for three weeks under medical supervision significantly decreased blood pressure, blood triglycerides, total cholesterol and "bad" LDL cholesterol. Furthermore, in a study of 4,629 individuals engaged in fasting revealed that subjects had a lower risk of coronary artery disease, as well as a significantly lower risk of diabetes, which is a major factor for heart disease (19)(20)(21).

4. *Fasting boosts metabolism and helps with decreasing body fat*

   The metabolism defines all chemical reactions involved in maintaining the living state of the cells and organism. It can be conveniently divided into two categories:

   a) **catabolism,** the breakdown of molecules for energy production
   b) **anabolism,** the synthesis of all compounds needed by the cells

   The metabolism is closely linked to nutrition. Energy formation is one of the vital components of metabolism. The pathways of the metabolism rely on nutrients breaking down in order to produce energy, that is then required by the body to synthesize new proteins and nucleic acids (DNA and RNA) for the building, upkeep, and repair of tissues, as well as for the efficient functioning of the body.

   Some research has also found that short-term fasting may boost the metabolism by increasing norepinephrine levels.
   Norepinephrine is an excitatory neurotransmitter, which means it stimulates activity in the brain, boosting the function of different cells to keep brain and body running efficiently.

   One study showed that whole-day fasting could reduce body weight by up to 9% over a period of 12 to 24 weeks. While another found that intermittent fasting over 3 to 12 weeks was as

effective in inducing weight loss as continuous calorie restriction. It decreased body weight and fat mass by up to 8% and 16% respectively. Fasting was found to be more effective than calorie restriction at promoting fat loss while simultaneously preserving muscle tissue (22)(23)(24).

5. *Fasting increases Human Growth Hormone (HGH) secretion*

   The Human Growth Hormone (HGH) is produced by the pituitary gland and plays a key role in growth, body composition, cell repair, and metabolism. HGH also boosts muscle growth, strength, and exercise performance and aids in recovery from injury and disease.

   Maintaining levels is especially important during weight loss, injury recovery, and athletic training (25)(26)(27)(28)(29)(30)(31).

   Intermittent fasting can help optimize HGH levels in two main ways. It can help **decrease body fat**, which directly affects HGH production. It also **maintains lower insulin levels** for most of the day, as insulin is released upon eating. Research suggests that insulin spikes can disrupt natural HGH production. One study observed large differences in HGH levels on days where fasting occurred compared with regular eating days. Shorter 12 to 16 hour fasts likely help as well, though more research is needed to compare their effects with full-day fasts (32)(33)(34)(35)(36)(37).

6. *Fasting induces various cellular repair processes (autophagy and apoptosis)*

   Autophagy is an intracellular system that involves the self-destruction of the cell through the degradation of its cellular components. During fasting, it can be used to generate energy in order to feed other, surviving cells while damaged ones are cleared away during the process (1). **Apoptosis** causes the cell to destroy itself after the damage has occurred. It is one of the ways that cellular organisms protect themselves from cancer (38)(39)(40)(41).

Metabolic flexibility, regular exercise and fasting

Metabolic flexibility describes the ability of an organism to respond or adapt according to changes in metabolism or energy as well as other prevailing conditions (in this case, fasting) or activity, such as exercise.

Metabolic flexibility has tissue specificity, meaning that it responds differently to fast or fed conditions, as well as day time or night time (42). Skeletal muscle and adipose tissue play a crucial role in energy metabolism; regardless of tissue, metabolic flexibility is driven by cellular and organelle processes, perhaps most pertinently in the mitochondria. Exercise is a physiological condition requiring metabolic flexibility in order to match fuel availability with the metabolic machinery to meet enormous increases in energy demands. **Muscle plasticity** is a term that characterize muscle's ability to respond to a variety of stimuli, including metabolic flexibility (43).

Metabolic flexibility improves with regular exercise. Exercise, both aerobic and anaerobic, can alter fuel storage and availability. The duration and intensity can each profoundly influence energy demand, thereby affecting energy stores and catabolic pathways in very different ways. Enhanced metabolic flexibility improves **insulin sensitivity**, which allows the cells of the body to use blood glucose more effectively; reducing blood sugar, increasing muscle glycogen storage and improving exercise performance and endurance.

Exercise can promote higher rates of fatty acid oxidation during acute exercise and at rest. It also induces **mitochondrial biogenesis**, increasing mitochondrial mass and thereby allowing greater glucose intake for the muscles. Additionally, mitochondria content and function have been reported to explain improvements in both insulin sensitivity as well as an increased capacity for fatty acid oxidation.

Intermittent fasting enhances metabolic flexibility because it stimulates the body in the fasting and feeding phases to rely on different sources of energy. During sleeping/post-absorptive conditions, the skeletal muscle switches from higher rates of fatty acid oxidation to greater oxidation, storage of glucose and reduced fatty acid oxidation after feeding.

Adipose tissue shifts from higher rates of lipolysis during fasting to suppressing lipolysis and fat storage during feeding. From rest to exercise, skeletal muscle increases the rates of both fatty acid and glucose oxidation to support higher energy demands, while lipolysis in adipose tissue is drastically enhanced (44)(45)(46)(47)(48)(49).

Metabolically flexible individuals tend to maintain a healthy weight without trying too hard, because the body does not have to constantly maintain food-seeking mechanisms. When the body is metabolically flexible, it does not store extra fat to prepare for a constant need for energy. It burns whatever energy source is available.

Tips for fasting during Ramadan (50)

DO'S

1. *Balanced nutrient intake*

Ensure that the foods consumed during Suhoor and Iftar are balanced in their nutrients to fuel and replenish the body appropriately. This will include foods from all major food groups such as carbohydrates from wholegrain sources, proteins, low-fat dairy and fruits and vegetables. Choose **slow-energy releasing carbohydrates** which sustain body energy throughout the day. Slow-energy releasing, or low-glycemic index foods, include grains, such as barley, wheat, oats, beans, lentils and long grain basmati rice. Aside from meat, diversify protein consumption by looking for other sources such as cheese, Laban, yoghurt, eggs or beans (e.g. foul meddames, lentils or baked beans) as it promotes satiation during fasting hours. Additionally, choose healthier fats such as avocadoes, olive oil, raw nuts and fish.

2. *Hydration*

Drink lots of fluids, ideally water and sugar-free drinks, before meals to help hydrate your body faster. Try to increase your water intake further by consuming foods high in water content, such as watermelon and salads. 8-10 glasses are recommended during and between Iftar and Suhoor.

3. *Maintaining electrolytes*

Essential minerals dissolved in fluid. Electrolytes, found in blood, sweat and urine play a role in conducting nervous impulses, contracting muscles, keeping body hydrated and regulating your body's pH levels. Electrolytes balance can be maintained in the Suhoor period by eating fruits like bananas and kiwis, which will help keep your body hydrated throughout the day.

4. *Timing*

Break your fast with something light (e.g. 1 to 3 dates with a glass of water), and follow up with a healthy meal 1 to 2 hours later. Food should be chewed slowly in order to avoid overeating. Try to have Suhoor just before sunrise, instead of at midnight. This will spread out your energy intake more evenly.

5. *Volume*

Monitor the amount of food consumed during Suhoor and Iftar. Meal size should be reduced as stomach size will inevitably shrink throughout the month of fasting. Larger meals can also cause discomfort and indigestion.

6. *Stay active*

During fasting, exercise should be conducted at moderate intensity. 2 to 3 hours after Iftar is ample, as the food has had time to settle and the body has fully rehydrated. For early risers, before morning Suhoor is also sufficient. This way, you can utilize the excess energy from the previous night's meal, yet still have an empty stomach. You can hydrate while you exercise and once you are done you can eat again to refuel.

DONT'S

1. *Salty food*

Foods such as pickles, olives and salty cheeses will increase your thirst during fasting hours

2. *Excess sugar*

Keep sugary foods such as Loqaimat, Sago and custard to a minimum.

3. *Fats*

Fatty meats, fried food and pastries are low in nutritional value and can lead to bloating and fatigue the next day.

4. *Decreasing caffeine consumption*

Try to do this gradually, in order to avoid headaches during the day

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