3rd Edition

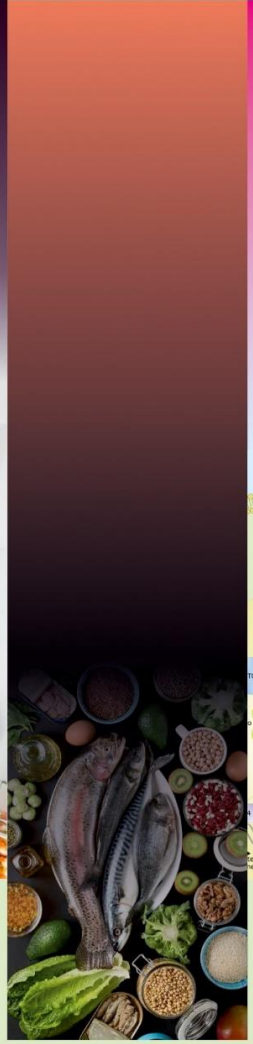
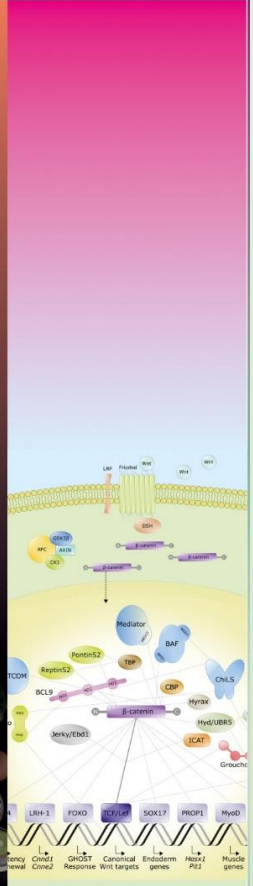
JIVANAM

Unveiling Life's Blueprint

FOOD AND NUTRITIONAL BIOCHEMISTRY





C O N T

E N T S

Minds behind Jivanam 3.0

Stavya Pathak

Hirva Bhavsar

Ami Patel

Shruti Joshi

Nisargi Trivedi

Sheetal Pradhan

Jayraj Rathva

Sneha Patel

Vihaan Jani

Pearl Patel

From Principal's Desk

Dear Students,

Welcome to another edition of Biochemistry Department's magazine '**Jivanam**'! Your intellect and creativity are the driving force behind this publication. I encourage you to contribute your scientific insights, innovative ideas, and a dash of creativity.
Let this magazine be a canvas for your academic achievements and unique perspectives. Share your stories, research findings, and experiences that make our science community thrive.
Looking forward to an inspiring work!

All the Best

Dr J. J. VORA
Principal
M. G. Science Institute

From Faculty Desk

Welcome to the Third Edition of the Magazine '**Jivanam**' from Biochemistry Department of M. G. Science Institute, Ahmedabad.

We are really proud and exuberant to announce the launch of our department's magazine '**Jivanam**'. The magazine is going to unfold and unravel the amazing world of Food and Nutritional Biochemistry.

The process of learning, experiencing and expressing is extremely important in life. Students learn to express themselves confidently and put their views on different aspects of science, which directly or indirectly affects our lives. What you learn and how you learn, play a crucial role in developing not only one's career, but also one's intellectual capabilities. This magazine is to be viewed as a launchpad for the students' creative and academic urges to blossom naturally.

The motive of our department since the last thirty-two years is to provide quality education and a holistic overall development of students. This magazine is an attempt to prepare the students to understand the development and research going on in different fields of science.

We hope that the scientific write ups of our young, enthusiastic writers will be indubitably sufficient to hold the interest and admiration of the readers. We wish them success in all their future endeavors.

PROF. H. V. PANDYA
PROF. D. T. CHOKSHI
PROF. S. V. JHA
PROF. V. R. NADAGOUDA

“The way to do research is to attack the facts at the point of greatest astonishment.”

- Celia Green

Nutritional Alchemy

Food is an integral part of our lives, nourishing our bodies and providing us with the energy we need to thrive. However, have you ever wondered what happens to the food we consume after it enters our system? How do the nutrients present in our meals contribute to our overall health and well-being? To unravel the mysteries of the human diet and delve into the intricacies of our body's biochemical processes, we embark on a captivating journey into the realm of Food and Nutritional Biochemistry.

Food and Nutritional Biochemistry is a fascinating field that examines the chemical composition of food and its impact on human physiology. By unravelling the complex relationships between nutrients and our bodies, this discipline offers profound insights into the science behind our daily fuel. From the essential building blocks of life to the intricate metabolic pathways that sustain us, Food and Nutritional Biochemistry provides a comprehensive understanding of the role of food in maintaining optimal health.

At its core, Food and Nutritional Biochemistry explores the chemistry of nutrients—proteins, carbohydrates, lipids, vitamins, and minerals—and how they interact within our bodies. Each nutrient plays a distinct role in our well-being, acting as catalysts for vital physiological processes. Proteins, for instance, serve as the building blocks of tissues and enzymes, enabling essential chemical reactions to occur. Carbohydrates act as the primary source of energy, fueling our daily activities. Lipids, or fats, provide insulation, protection, and a concentrated form of energy. Vitamins and minerals, in trace amounts, act as coenzymes or cofactors, facilitating various metabolic processes. Understanding the chemical properties and functions of these nutrients forms the foundation of Food and Nutritional Biochemistry.

Beyond merely examining the components of food, this discipline also delves into the intricate mechanisms by which our bodies digest, absorb, and utilize these nutrients. Biochemical pathways such as glycolysis, the citric acid cycle, and oxidative phosphorylation unravel the step-by-step breakdown of carbohydrates, providing energy to our cells. Similarly, the metabolism of lipids and proteins is meticulously orchestrated, ensuring the body's energy demands are met while maintaining vital functions such as cell growth and repair.

Food and Nutritional Biochemistry also addresses the intriguing concept of bioactive compounds, which extend beyond the basic nutrients we consume. These compounds, found in plants and certain foods, possess unique properties that promote health and prevent diseases. Examples include antioxidants that scavenge harmful free radicals, phytochemicals that exhibit anticancer properties, and dietary fiber that aids in digestion and maintains gut health. Exploring the multifaceted roles of bioactive compounds not only enriches our understanding of food but also highlights the potential therapeutic applications they hold.

In an era marked by the rise of chronic diseases, such as obesity, diabetes, and cardiovascular ailments, Food and Nutritional Biochemistry assumes even greater significance. By investigating the intricate relationship between diet and disease, researchers in this field strive to develop effective strategies for disease prevention and management. The insights gained through Food and Nutritional Biochemistry can empower individuals to make informed dietary choices, leading to improved health outcomes and enhanced quality of life.

As we embark on this enlightening exploration of Food and Nutritional Biochemistry, we will uncover the hidden secrets of the food we consume and discover the profound impact it has on our bodies. From unlocking the mysteries of nutrient metabolism to unravelling the potential of bioactive compounds, this field offers a captivating fusion of science, health, and the culinary arts. So, join us on this extraordinary journey and let us delve into the depths of Food and Nutritional Biochemistry to unravel the remarkable science behind our daily fuel.

Dr. Coluthur Gopalan: A Pioneer in Nutrition Research and Human Health

Coluthur Gopalan, born on November 5, 1918, in Chennai, India, was a distinguished scientist, biochemist, and nutritionist who made profound contributions to our understanding of the link between nutrition and health. His journey began with academic pursuits, earning a degree in medicine from Madras Medical College in 1941. Later, in 1949, Gopalan obtained a doctorate in biochemistry from the University of Cambridge, marking the commencement of a prolific research career. He returned to India, where he held prominent positions at institutions such as the Indian Council of Medical Research (ICMR) and the Nutrition Foundation of India.

Early Life and Education:

Gopalan's academic journey continued at the University of Madras, where he completed his Bachelor's and Master's degrees in Chemistry. His passion for scientific inquiry led him to pursue a Ph.D. in biochemistry at the University of Cambridge, England, under the guidance of renowned biochemist Sir Frederick Gowland Hopkins. Gopalan's time at Cambridge laid the foundation for his future contributions to the field of nutrition.

Nutritional Anthropology and Protein-Energy Malnutrition:

Upon returning to India, Gopalan dedicated himself to addressing the nutritional challenges facing the country. His pioneering work in nutritional anthropology involved studying the dietary habits and nutritional status of various communities. This research played a crucial role in shaping public health policies, particularly in addressing protein-energy malnutrition, a prevalent issue in India.

Gopalan's investigations into protein-energy malnutrition emphasized the importance of balanced diets and the role of essential nutrients in preventing and treating malnutrition. His work had far-reaching implications for national nutrition programs, influencing policies aimed at improving the nutritional status of vulnerable populations.

Burning Feet Syndrome and Gopalan's Work:

Burning Feet Syndrome (BFS) became a subject of intense interest for Gopalan, prompting him to embark on a series of studies to elucidate the role of diet in this neurological disorder. His meticulous research revealed a strong correlation between nutritional deficiencies and the onset of BFS. Specifically, Gopalan identified a deficiency in certain B-vitamins, particularly vitamin B12, as a key factor contributing to the development of neuropathic symptoms in the feet.

Gopalan's experimental approach involved controlled dietary interventions, where subjects with BFS were provided with targeted nutritional supplements. The results were compelling, demonstrating a significant improvement in symptoms among those who received vitamin B12 supplementation. Furthermore, he explored the broader implications of his findings, emphasizing the potential impact on public health. His research underscored the importance of a balanced diet in preventing not only BFS but also a spectrum of neurological disorders associated with nutritional deficiencies.

Indian Council of Medical Research (ICMR) and Institutional Leadership:

Coluthur Gopalan's commitment to advancing nutrition research led him to become the Director of the National Institute of Nutrition (NIN), Hyderabad, and later, the Secretary of the Indian Council of Medical Research (ICMR). Under his leadership, these institutions became hubs for cutting-edge research in nutrition and public health.

Gopalan's emphasis on interdisciplinary collaboration and the integration of basic and applied research significantly contributed to the growth of nutritional science in India. He fostered an environment that encouraged young researchers and provided them with the resources needed to explore innovative approaches to address health challenges.

Protein Quality and Protein-Energy Interaction:

Gopalan's contributions to the assessment of protein quality were pivotal. He played a key role in developing the Protein Efficiency Ratio (PER), a measure that evaluates the quality of dietary proteins based on their ability to support growth. His work significantly influenced international discussions on protein requirements and assessments. Additionally, Gopalan's research delved into the intricate interplay between protein and energy in the diet, highlighting the importance of understanding not only the quantity but also the quality of dietary proteins.

Legacy and Impact:

Coluthur Gopalan's legacy is multifaceted, encompassing his leadership, mentorship, and advocacy for evidence-based nutrition policies. His work in BFS has influenced clinical practice, guiding healthcare professionals in the diagnosis and treatment of the syndrome. Moreover, Gopalan's emphasis on the broader significance of nutrition in neurological health has spurred ongoing research and public health initiatives aimed at addressing nutritional deficiencies on a global scale.

In recognition of his outstanding contributions, Gopalan received numerous accolades, including the prestigious Padma Bhushan, one of India's highest civilian honours. His influence continues to shape the landscape of nutrition research, with scholars and practitioners building upon his foundational work to address contemporary challenges in global health.

Conclusion:

Coluthur Gopalan's life and research exemplify a lifelong commitment to advancing human health through the rigorous pursuit of scientific inquiry. His work in nutrition research, spanning from protein quality assessments to the intricate links between diet and neurological disorders like BFS, has left an indelible mark on the field. As we celebrate the legacy of Coluthur Gopalan, we recognize his pivotal role in shaping our understanding of nutrition and promoting a holistic approach to human health. His enduring contributions continue to inspire and guide researchers, clinicians, and policymakers in the ongoing quest for improved global health and well-being.

Nurturing Gut Harmony

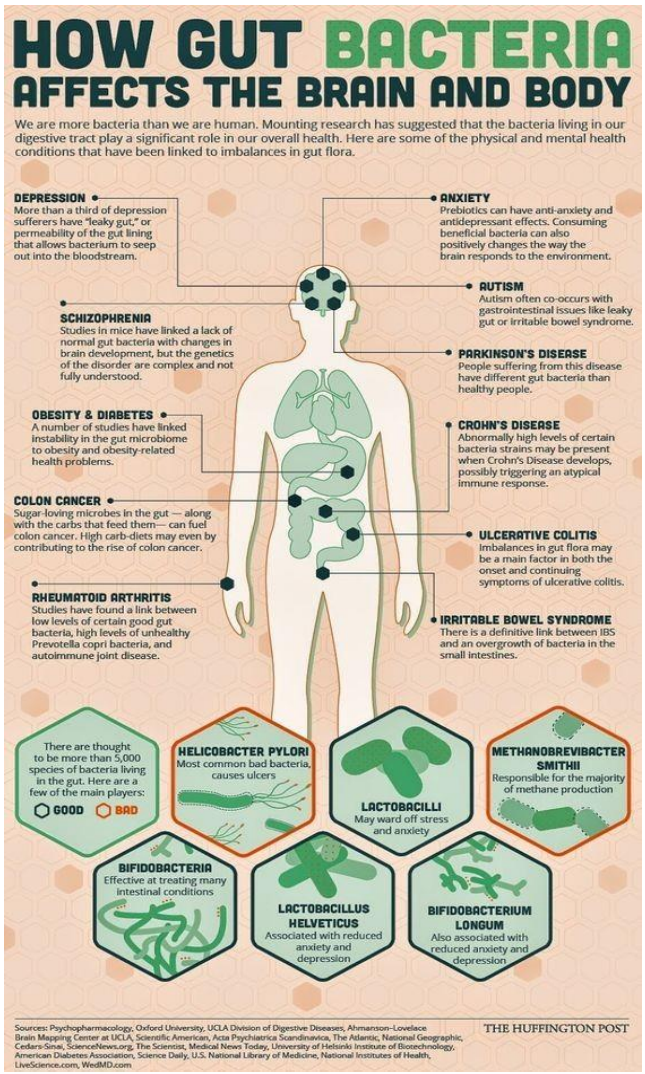
Have you ever considered the profound impact of your dietary choices on your gut flora and, consequently, your overall well-being? It's a captivating revelation! Within our gut resides a vast community of trillions of microbes known as gut flora, orchestrating a symphony of functions crucial to digestion, nutrient absorption, and immune system fortification. Let's embark on a journey to unravel the intricate connection between our diet and this extraordinary microbial ecosystem.

Diet and Gut Flora:
In simple terms, the food we consume intricately molds the composition of our gut flora. Opting for a diet rich in fiber, abundant in fruits, vegetables, and whole grains, provides the optimal fuel for our gut microbes. These microscopic allies thrive on dietary fiber, utilizing it as an energy source and, in return, producing beneficial byproducts known as short-chain fatty acids. These acids play a pivotal role in fostering a flourishing and harmonious gut environment.

Processed and High-Fat Diets:
Now, let's delve into less favourable culinary choices. Surrendering to the allure of processed foods, added sugars, and saturated fats can disrupt the delicate equilibrium of our gut flora. Such dietary indulgences may precipitate a decline in beneficial bacteria and an unwelcome surge in harmful microbes, thereby jeopardizing the delicate balance crucial for our gut's well-being.

Impact on Health:
Maintaining a resilient gut flora is a cornerstone of overall well-being. A diverse and thriving gut ecosystem not only facilitates optimal digestion but also acts as a stalwart defender of the immune system. Remarkably, it extends its influence to mental health, with imbalances linked to conditions such as obesity, inflammatory bowel diseases, and specific mental health disorders.

Tips for Promoting a Healthy Gut Flora:
Now, let's embark on a proactive journey to ensure the well-being of your gut flora with these thoughtful strategies:
1. Load up on fiber: Transform your plate into a colourful mosaic of fruits, vegetables, whole grains, and legumes. These fiber-rich delights are akin to a grand feast for your gut microbes, nurturing their vitality.
2. Embrace fermented foods: Infuse your diet with the goodness of yogurt, sauerkraut, and kimchi. These delectable options harbour beneficial probiotics, acting as allies in cultivating a thriving and balanced gut flora.
3. Beware of processed foods: Exercise caution in navigating the tempting world of processed foods, added sugars, and saturated fats. By doing so, you safeguard



your gut from potential disruptions, and in turn, it will express its gratitude through enhanced well-being.
4. Stay hydrated: Cultivate the habit of staying adequately hydrated. The elixir of water is more than just a thirst quencher—it is an essential component in supporting a robust and healthy gut.

In conclusion, our dietary choices wield profound influence over the intricate world of our gut flora, a realm essential to our holistic well-being. By making informed decisions, embracing a diverse and nutrient-rich diet, and staying mindful of the potential pitfalls of processed foods, we not only nurture our gut microbes but also fortify the foundation of our overall health. So, let's celebrate the symbiotic relationship between our dietary choices and our gut flora, paving the way for a flourishing and resilient well-being.

Shruti Joshi
Third Year

Prebiotics & Probiotics

Biotechnology related to gut microbiota is the application of biological techniques to investigate, manipulate, and enhance the microbial community residing in the gastrointestinal tract of an organism.

Wonders of Gut Microbiota:
- The gastrointestinal (GI) tract provides a conducive environment for approximately 95% of microorganisms, totalling around 300 to 1000 microbial species in the human body.
- Trillions of microbes, especially in the colon, metabolize and digest indigested food through a mutual symbiotic relationship, and their presence is essential as the body cannot exclude them.
- The gut flora comprises living bacteria, archaea, fungi, and some viruses, predominantly anaerobes.
- In infants, the microbiome is established within one or two years after birth alongside the development of the intestinal epithelium.
- The composition of microbiota changes over time with age, depending on the diet consumed, directly influencing overall human health.

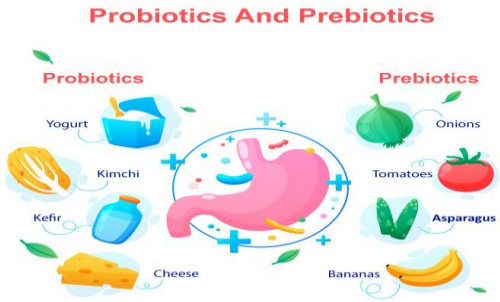
Contributions of Gut Microbiota:
Gut microbiota, in conjunction with digestion and absorption, plays a crucial role in:
a. Resisting pathogens
b. Maintaining the integrity of the intestinal epithelium
c. Regulating metabolism
d. Synthesizing vitamins like K and B complex
e. Detoxifying pharmaceuticals
f. Fermentation and the production of short-chain fatty acids
g. Assisting in hormone production
h. Recent studies show that gut microbiota helps elevate HDL (good cholesterol) levels.
i. Influencing neurotransmitter signalling in the Gut-Brain axis, affecting bodily activities
j. Maintaining gut homeostasis

Factors Affecting Gut Microbiota:
Various factors influencing gut microbes include diet, antibiotics and prebiotics, stress, age, and environmental factors.

Impact of Antibiotics on Gut Microbiome:
Antibiotics, substances that inhibit the growth of both harmful and beneficial bacteria, disrupt the microbial diversity of the gut. Their use should be limited to, when necessary, as restoring the balanced composition of microbes post-antibiotic treatment is challenging.

Effect of Diet on Gut Microbiome:
Diet is a major factor influencing gut microbes. Processed/fast food negatively impacts gut flora due to its lack of fiber, artificial trans fats, and inflammatory triggers. Healthy food choices, including healthy fats, fermented foods, fruits, and vegetables, positively impact gut health.

What are Prebiotics?
Prebiotics are high-fiber substances beneficial to gut microbiota, promoting their growth indirectly by serving as food for microbes. Sources include fruits, vegetables, pulses, and whole grains.



Roles of Prebiotics as Nutrients:
a. Promoting the growth of microbiota for gut health
b. Improving digestion and absorption, especially of minerals like Ca2+ and Mg2+
c. Supporting the immune system
d. Reducing obesity
e. Regulating blood sugar levels
f. Improving mental health through the Gut-Brain signalling axis

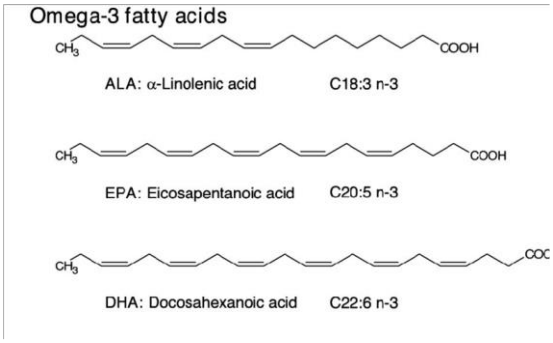
What are Probiotics?
Probiotics are living microorganisms conferring health benefits when administered in adequate amounts. They include bacterial species like Lactobacillus acidophilus, Bifidobacterium bifidum, and yeast species such as Saccharomyces boulardii. Sources include fermented products and dietary supplements.

Role of Probiotics in Human Health:
a. Increasing the cultures of gut microbes
b. Preventing allergies in children
c. Countering the effects of antibiotics on good bacteria
d. Some strains have anti-inflammatory properties

Conclusion:
Both prebiotics and probiotics contribute to maintaining the diversity of gut microbiota, emphasizing that a balanced diet and regular exercise are essential for good health.

Yash Soni
Third Year

Unraveling Omega-3 Fatty Acids



Omega−3 fatty acids are polyunsaturated fatty acids (PUFAs) characterized by the presence of a double bond, three atoms away from the terminal methyl group in their chemical structure. Omega-3 fatty acids, particularly eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA), are essential polyunsaturated fatty acids that play a crucial role in brain function and development. These fatty acids are abundant in the brain, making up about 60% of its structural lipids. They are involved in various cellular processes, including cell membrane formation, signal transduction, and gene expression.

Role in Cognitive Development:
Omega-3 fatty acids are essential for optimal cognitive development throughout life, from foetal development to late adulthood. They contribute to the formation of neural connections, enhance synaptic plasticity, and improve neurotransmitter signalling, all of which are critical for learning, memory, and overall cognitive function.
Studies have shown that higher levels of omega-3 fatty acids in pregnant women are associated with improved cognitive development in their offspring. Children with adequate omega-3 intake tend to perform better in tasks of attention, memory, and problem-solving.

Impact on Mental Health:
Omega-3 fatty acids have also been implicated in the maintenance of mental health. They play a role in regulating mood, reducing inflammation, and modulating neurotransmitter levels, all of which can contribute to mental well-being.
Clinical studies have demonstrated that omega-3 supplementation can improve symptoms of depression, anxiety, and bipolar disorder. These findings suggest that omega-3 fatty acids may have therapeutic potential for mental health conditions.

Prevention of Neurodegenerative Diseases:
Neurodegenerative diseases, such as Alzheimer's disease and Parkinson's disease, are characterized by progressive loss of brain function and neuronal death. Omega-3 fatty acids have been shown to have neuroprotective properties that may help prevent or slow the progression of these diseases.

Studies have found that individuals with higher omega-3 intake have a lower risk of developing Alzheimer's disease. Omega-3 fatty acids are believed to reduce inflammation, protect against oxidative damage, and promote the growth of new brain cells, all of which may contribute to neuroprotection.

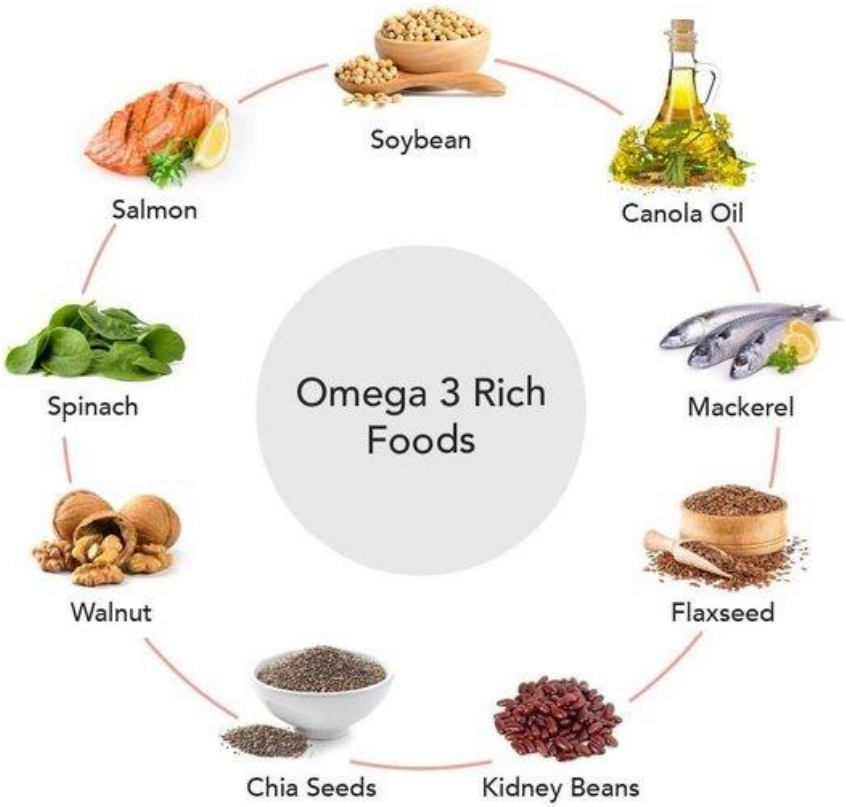
Mechanism of Action:
The mechanisms by which omega-3 fatty acids exert their beneficial effects on brain health are complex and still being elucidated. However, several key mechanisms have been identified:

a) Cell Membrane Structure and Function: Omega-3 fatty acids are essential components of cell membranes, where they influence fluidity and permeability. This, in turn, affects signal transduction, nutrient transport, and waste removal, all of which are critical for cellular function.
b) Neuroinflammation: Omega-3 fatty acids have anti-inflammatory properties that can help reduce chronic neuroinflammation, a contributing factor to neurodegenerative diseases. They modulate the activity of inflammatory cells and reduce the production of pro-inflammatory molecules.
c) Neurotransmitter Signalling: Omega-3 fatty acids can influence the synthesis, release, and reuptake of neurotransmitters, such as dopamine, serotonin, and norepinephrine. These neurotransmitters play essential roles in mood regulation, cognition, and motor function.
d) Neurogenesis and Synaptic Plasticity: Omega-3 fatty acids have been shown to promote neurogenesis, the formation of new brain cells, and synaptic plasticity, the ability of the brain to form and modify connections. These processes are crucial for learning, memory, and overall cognitive function.

Dietary Sources and Recommended Intake:
The primary dietary sources of omega-3 fatty acids are fatty fish, such as salmon, mackerel, tuna, and sardines. Other sources include flaxseeds, walnuts, and chia seeds, which contain alpha-linolenic acid (ALA), an omega-3 fatty acid that the body can convert to EPA and DHA.
The recommended daily intake of omega-3 fatty acids varies depending on age and gender. For adults, the recommended intake is 250-500 mg of EPA and DHA per day. Pregnant and breastfeeding women may require higher intakes due to the increased demand for omega-3 fatty acids during foetal and infant development.

Supplementation:

Omega-3 fatty acid supplements are available in the form of fish oil and algal oil capsules. These supplements can be a convenient way to increase omega-3 intake, especially for



individuals who do not consume enough fatty fish in their diet.
It is important to choose high-quality omega-3 supplements that are third-party tested for purity and potency. Consultation with a healthcare professional is recommended to determine the appropriate dosage and to rule out any potential interactions with medications.

Conclusion:
Omega-3 fatty acids play a vital role in brain function and development, influencing cognitive performance, mental health, and the risk of neurodegenerative diseases. Their mechanisms of action involve modulation of cell membrane structure, reduction of neuroinflammation, regulation of neurotransmitter signaling, and promotion of neurogenesis and synaptic plasticity.
Dietary intake of omega-3 fatty acids from fatty fish and other sources is recommended, and supplementation may be beneficial for individuals with low intake or specific health conditions.

Stavya Pathak
Third Year

Intricacies of Hormone Signalling

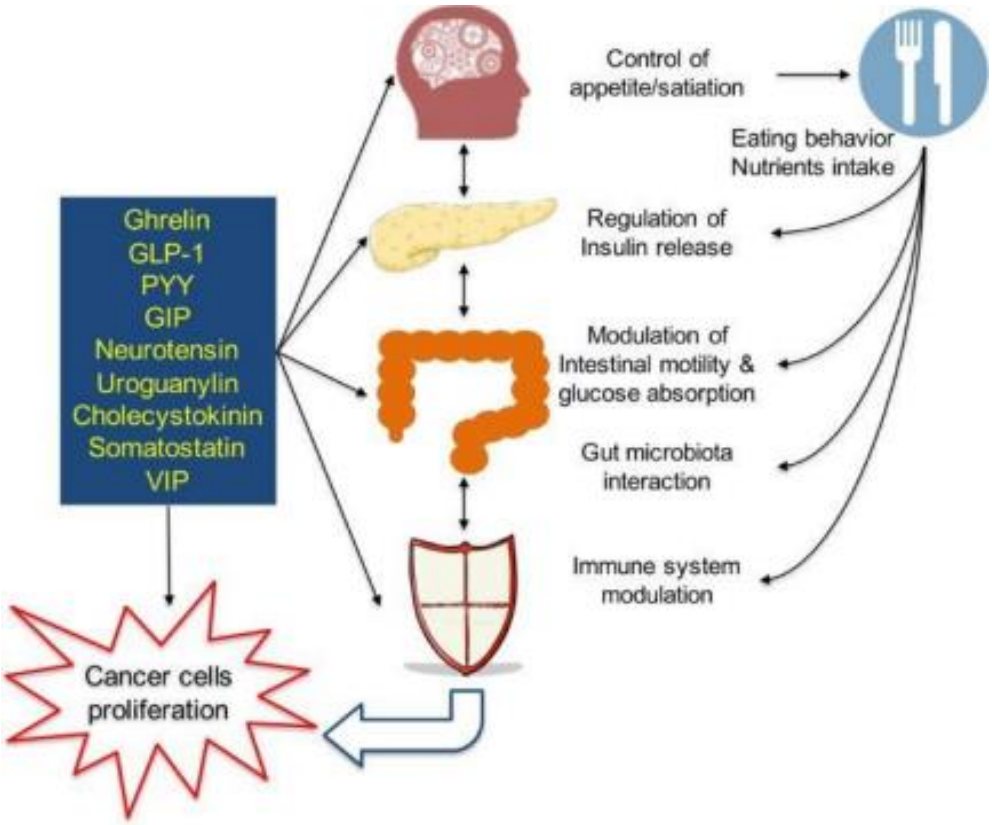
Specific nutrients, dietary patterns, and overall nutrition may play either beneficial or detrimental roles in hormonal balance. Various nutrition intake patterns, from fasting to excess calories, as well as foods with a higher glycaemic load, are known to impact circulating levels of certain hormones. Understanding potential nutrition-hormone relationships, including hormone signalling sensitivity, is a key part of the functional medicine approach to hormonal dysfunction.

Why does food have such a big impact on hormones?

There are around 200 different hormones in the human body. These are chemical messengers that control a number of systems, such as metabolism, the immune system, menstrual cycle, and reproduction. Consuming certain foods can provide the nutrients that we need to facilitate the production of hormones. Food can be considered as a cocktail of "hormones." A hormone is a regulatory compound produced in one organ that is transported in the blood to stimulate or inhibit specific cells in another part of the body. Hormones exert their effects on target tissues by acting on cell-surface receptors to alter activity through intracellular signalling cascades or via nuclear receptors to regulate gene transcription. Although food is not produced in the body, its components travel through the blood, and nutrient substrates can act as signalling molecules by activating cell-surface or nuclear receptors.

Best foods for hormone balance:

1. Organic Fruit and Vegetables
Non-organic produce can contain pesticides such as glyphosate, which act as hormone disruptors, negatively affecting fertility. Buy organic where possible and look out for non-GMO foods, as these are exposed to less glyphosate. Alongside eating organic, it is also important to avoid purchasing food that is plastic-wrapped. Bisphenols in hard plastics (such as drinking straws and water bottles) and phthalates in soft and flexible plastics are endocrine disruptors, which means that they interfere with the normal functioning of the endocrine system. Use glass, paper, or other natural materials to store your foods if possible, and certainly avoid microwaveable meals, as the plastic contains toxic chemicals that leach into the food during the microwaving process.
2. Prebiotic and Probiotic Foods
The gut not only produces certain hormones but also detoxifies hormones such as estrogen. Therefore, it is important to nourish your gut with prebiotic and probiotic foods, which are designed to regulate the gut microbiome. Probiotics are live microorganisms that can be ingested to benefit the gut. They are often found in fermented foods, including yogurt, miso, kefir, sauerkraut, kombucha, and kimchi. Prebiotics are consumed by probiotics to encourage growth and activity. These include garlic, asparagus, banana, leek, tomato, and oats.



3. Phytoestrogens

Phytoestrogens are dietary estrogens found in certain plants. They have the ability to modulate estrogen, so whether you are in an estrogen-dominant or deficient state, they may be beneficial for your diet. Sources of phytoestrogens include flaxseed, chia seed, fennel, lentils, pulses, alfalfa sprouts, and liquorice. Soy also contains a phytoestrogen called isoflavone, which can lower your risk of ischemic heart disease as well as relieve hot flushes.

4. Good Fat

Omega-3 fatty acids cannot be produced by the body, so it's crucial to include them in a balanced diet. Foods that contain omega-3 include flaxseed, chia seeds, extra virgin olive oil, and avocados. Fatty fish is also a great source. Omega-6 is also essential for cell function, but it can be overconsumed in a diet that is high in fried or processed foods. It is important to maintain a balance between omega-3 and omega-6; therefore, processed foods should be replaced with healthier alternatives such as nuts, chicken, eggs, and seeds.

5. Cruciferous Vegetables

As well as being full of antioxidants that protect your body from free radicals, cruciferous vegetables also have beneficial effects on estrogen metabolism, specifically combating estrogen dominance. Cruciferous vegetables are any vegetables within the brassica family, which includes cauliflower, broccoli, kale, and Brussels sprouts. However, the highest levels of sulforaphane (the compound found in cruciferous vegetables that encourages estrogen detoxification) can be found in broccoli sprouts, which are easy to grow at home.

6. High Fiber Carbohydrates

Fruits, vegetables, and whole grains

Eating a diet high in fiber can help to clear excess hormones from the body.

Worst foods for hormone balance:

Eat fewer processed foods, fried foods, sugar, and artificial sweeteners—and drink less alcohol—to avoid hormone imbalances. Research suggests that downing artificial sweeteners may alter our gut bacteria, which may impact the balance of hunger and satiety, those same hormones leptin and ghrelin.

Conclusion:

Begin your hormone balancing journey.

When considering hormone balancing, your diet is just one part of a holistic approach.

Ami Patel
Third Year

Nutrigenomics

Nutrigenomics is like a detective investigating how the things you eat can directly or indirectly change the way your genes work. Our genetic code, like a master plan, determines if we stay healthy or face issues like diseases and developmental problems. The "fetal basis of adult disease" idea suggests that what we eat during early life can influence our genes, impacting our health as adults.

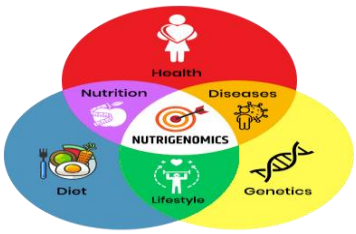
Five Key Principles of Nutritional Genomics:

1. Direct Influence on Genes: The chemicals in your food can affect your genes, messing with how they work or even changing their structure.
2. Diet as a Risk Factor: Sometimes, depending on your situation or genes, your diet can actually become a risk factor for different diseases.
3. Genes Controlled by Diet: Some genes, influenced by what you eat, might play a big role in causing chronic diseases.
4. Your Unique Genetic Background: How your diet affects your health can be different based on your individual genes.
5. Tailoring Nutrition for Prevention: Customizing your diet based on your unique needs, status, and genes can help prevent, ease, or even cure chronic diseases.

Nutrigenetics: How Your Genes Respond to Food: Nutrigenetics looks at how your genes influence how your body reacts to the stuff you eat. It's like figuring out why some people can handle certain foods better than others. Single Nucleotide Polymorphisms (SNPs) are like tiny changes in genes that can lead to specific conditions.

Real-Life Examples in Nutrigenetics:

1. Galactosemia and the GALT Gene: Changes in a gene called GALT can cause Galactosemia, showing how gene differences can lead to health issues.
2. G6PD Gene and Favism: Mutations in the G6PD gene can result in Favism, revealing how genetics can make certain foods harmful.
3. Lactose Intolerance and LPH Gene: Small changes in the LPH gene can affect how well you handle lactose, illustrating the link between genes and dietary responses.
4. Selenium and Glutathione Peroxidase Gene: Your genes can impact how well your body responds to selenium, affecting the risk of diseases like lung cancer. The association between selenium supplementation and reduced incidence of liver, colon, prostate, and lung cancer in humans has been shown. However, no individuals may respond equally. Glutathione peroxidase is a selenium-dependent enzyme that acts as an antioxidant enzyme. Polymorphism at codon 198 of human glutathione peroxidase results in a substitution of proline to leucine amino acid, and has been associated with an increased risk of lung cancer. Investigators showed that persons with (Pro/Lue) genotype were at 80% greater risk for lung cancer and (Lue/Lue) genotypes were at 130% greater risk compared to those with the (Pro/Pro) genotype. The leucine-coding allele was less responsive to increased activity because of selenium supplementation as compared with the prolin-containing allele.
5. MnSOD Gene and Breast Cancer Risk: Manganese superoxide dismutase (MnSOD) is a mitochondrial enzyme that plays a key role in detoxification of reactive oxygen species. A polymorphism valine to alanine substitution in this enzyme alters its transport into mitochondria, which has been associated with increased risk of breast cancer.



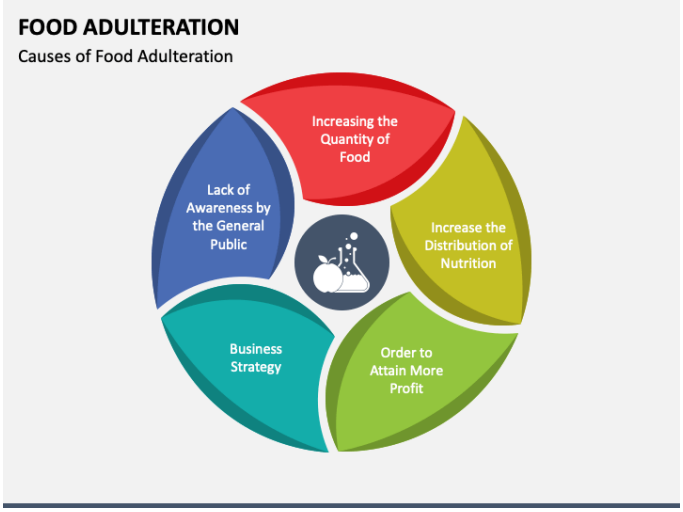
Keeping Your Genome Healthy: It is clear that even the small damages in the genome can cause crucial effects in whole human life. DNA metabolism and repair is depending on a variety of dietary factors that act as cofactors or substrates. Nutritional requirements are important for the prevention of DNA oxidation (i.e. antioxidants such as carotenoids, Vit E and C), prevention of uracil incorporation into DNA (i.e. folate), maintenance methylation of CpG in DNA (methionine, choline, folate and vitamin B12), as cofactors or as components of DNA repair enzymes (Zn, Mg), maintenance of telomere length (niacin, folate). Many chronic diseases are polygenic and result from interaction between genes and environmental factors. Dietary intervention based on nutritional requirement, nutritional status, and genotype (i.e., “individualized nutrition”), can be used to prevent, control or treat chronic disease such as cardiovascular diseases (CVD), metabolic syndromes, and cancer. These disorders are partly mediated by chronic exposure to certain food components. For example, the association between number of calories, the levels and types of vitamins, fat, and carbohydrates with atherosclerosis, diabetes, obesity, cancer, hypertension, and other chronic diseases are demonstrated.

Conclusion: In the puzzle of life, where your genes and your diet meet, nutrigenomics and nutrigenetics are like keys that can unlock a healthier you. By understanding how your unique genes interact with what you eat, you can tailor your diet to fit your individual needs. This personalized approach has the potential to shape a future where each person's health journey is as unique as their genetic code. As we explore the world of nutrigenomics, we discover the secrets to a healthier, more personalized path to well-being.

Hirva Bhavsar
Third Year

Tackling Food Adulteration

Food adulteration refers to the intentional or unintentional addition of substandard, harmful, or fraudulent substances to food products. Food adulteration, driven by economic incentives, has emerged as a pressing concern jeopardizing the integrity of our food supply and the well-being of consumers. This unethical practice involves the addition of substandard or harmful substances to food products, leading to far-reaching consequences, including foodborne illnesses and long-term health issues.



Methods of Food Adulteration:
The deceptive practices of food adulteration encompass a spectrum of methods aimed at enhancing the visual appeal of products or cutting production costs. Artificial colours are commonly added to manipulate the appearance of food items, masking inherent deficiencies or inferior quality. Substitution of high-quality ingredients with substandard alternatives further compromises the nutritional value and safety of consumables. Moreover, the introduction of contaminants, such as pesticides and heavy metals, amplifies the health risks associated with adulterated food.

Harmful Effects:
The consequences of consuming adulterated food extend beyond deceptive practices, manifesting in severe health implications for unsuspecting consumers. Adulterants can induce foodborne illnesses, ranging from gastrointestinal distress to more severe conditions. Chronic exposure to contaminants like pesticides and heavy metals is linked to long-term health issues, including neurological disorders and organ damage. It is imperative to underscore the gravity of these health risks to underscore the urgency of addressing food adulteration.

Recognizing Adulteration:
Vigilance on the part of consumers is paramount in identifying potential adulteration. Anomalies in taste, color, or texture in food products should serve as red flags, prompting cautious consumption. Scrutinizing labels and opting for products from reputable sources are proactive measures consumers can adopt to mitigate the risk of unwittingly ingesting adulterated items.

Role of Regulatory Agencies:
Food regulatory agencies play a pivotal role in upholding the integrity of the food supply. These entities serve as frontline defenders, implementing rigorous monitoring and enforcement measures to detect and deter adulteration. Active support from consumers, including advocacy for stricter regulations and penalties, is instrumental in reinforcing the effectiveness of these regulatory initiatives.

Consumer Awareness and Education:
Education serves as a powerful tool in the fight against food adulteration. Increasing awareness about the risks and consequences empowers consumers to make informed choices and demand accountability from food producers. By fostering a culture of responsibility, consumers can actively contribute to building a food system characterized by safety, transparency, and nutritional integrity.

Conclusion:
In conclusion, the insidious nature of food adulteration demands a comprehensive and collaborative approach to safeguard the quality and safety of our food supply. Recognizing the methods employed, understanding the harmful effects, and actively supporting regulatory measures are crucial steps. Empowering consumers through education and awareness is paramount, fostering a sense of responsibility that transcends individual choices and contributes to the establishment of a food system prioritizing safety, transparency, and nutritional integrity.

Drashti Joshi
Third Year

Biofortification Insights

In light of the escalating global population and its rising food requirements, addressing the challenges of food security and malnutrition has become increasingly urgent. Biofortification emerges as a potent solution, offering the prospect of improving human health by enriching crops with essential vitamins, minerals, and health-promoting proteins.

The Global Imperative for Biofortification:
Micronutrient deficiencies, particularly in vitamins A, iron, and zinc, afflict billions globally, leading to severe consequences such as impaired cognitive development and increased susceptibility to infections. Limited access to diverse, nutrient-rich diets, especially in developing countries, often stems from poverty, restricted agricultural land access, and reliance on nutrient-deficient staple crops. Conventional agricultural practices focused solely on high yields, coupled with soil depletion and climate change, further compound the problem by diminishing essential minerals in the soil.

Biofortification's Multifaceted Approach:

Biofortification employs diverse strategies to enhance crop nutritional value:

1. Conventional Breeding: This method involves selecting and crossbreeding plant varieties naturally rich in desired nutrients, resulting in crops like vitamin A-rich orange-fleshed sweet potatoes and high-iron beans.

2. Genetic Engineering: Precise gene insertion from other organisms is used to boost specific nutrient production, offering the potential for rapid development of crops with enhanced nutritional profiles.

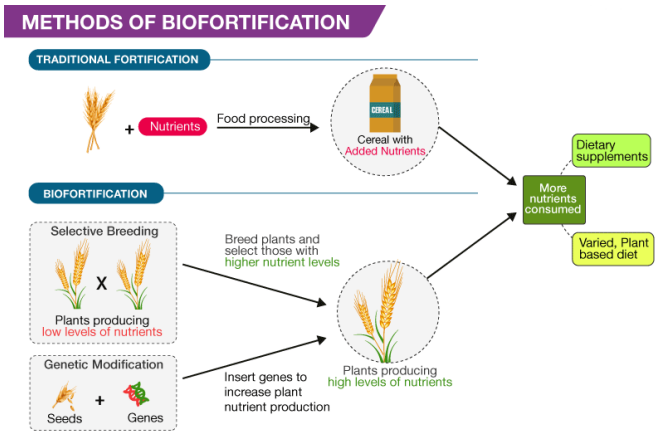
3. Agronomic Practices: Optimizing soil fertility, managing pests and diseases, and employing specific irrigation techniques collaboratively enhance crop nutritional content.

Advantages of Biofortification:
Biofortification presents several advantages over alternative approaches to combat malnutrition:

1. Cost-Effectiveness: In comparison to supplementation and dietary diversification, biofortification proves more cost-effective and sustainable, requiring minimal infrastructure and leveraging existing agricultural systems.

2. Increased Food Security: Biofortified crops contribute to improved food security by ensuring access to nutritious food even in situations of limited food availability or diversity, empowering individuals and communities for healthier and more productive lives.

3. Reduced Micronutrient Deficiencies: By elevating the intake of essential nutrients, biofortification significantly



reduces the prevalence of micronutrient deficiencies, resulting in improved public health outcomes.

4. Long-Term Sustainability: As a long-term solution, biofortification strengthens existing food systems, enabling communities to be self-sufficient in meeting their nutritional needs without reliance on external interventions or supplementation programs.

Global Collaborative Research and Development:
To unlock the full potential of biofortification, extensive research and development are essential. Key international organizations and institutions actively engaged in this endeavour include HarvestPlus, the International Rice Research Institute (IRRI), and the Indian Council of Agricultural Research (ICAR).

The Future of Biofortification:
Biofortification holds tremendous promise in transforming global food security and nutrition. By fostering research, encouraging international collaboration, and ensuring equitable access to biofortified crops, communities can be empowered to achieve optimal health and well-being. Moving forward, biofortification will undoubtedly play a pivotal role in establishing a world where everyone has access to the nutritious food necessary for thriving.

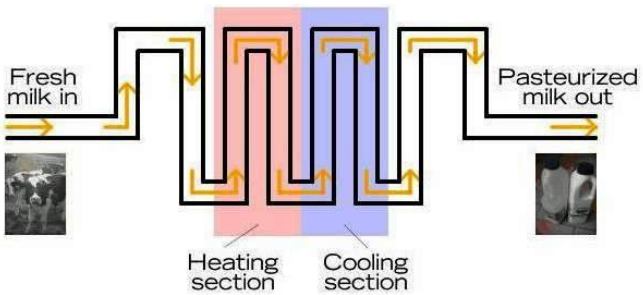
Akashi Panchal
First Year

Mastering Food Preservation

The preservation of food, a critical facet of food science, involves strategies to impede spoilage and maintain the inherent qualities of edibles. This article elucidates historical preservation techniques such as drying, refrigeration, and fermentation, while also delving into modern methods like canning, pasteurization, freezing, and irradiation. The importance of food preservation lies in its role in enhancing the food supply, extending shelf life, eliminating microbes, and facilitating time and energy savings.

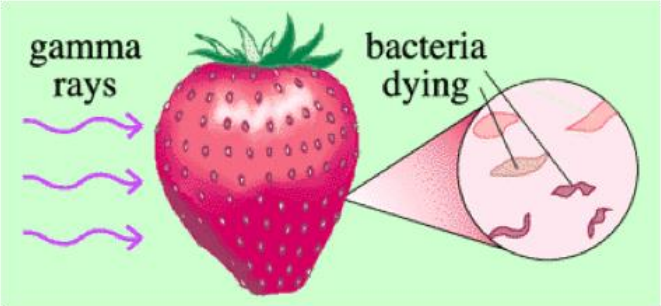
Historical and Modern Preservation Methods:
Historical Methods:
Drying, a method as ancient as human civilization, reduces water activity, inhibiting bacterial growth. Leveraging natural elements like sun and wind, this simple yet effective technique remains relevant today. Refrigeration, harnessing temperature control, and fermentation, employing beneficial microbial activity, have been integral to preservation throughout history.

Modern Preservation Methods:
Advancements in food preservation have introduced canning, pasteurization, freezing, irradiation, and chemical additives. Each method tackles specific challenges associated with spoilage and foodborne illnesses. Canning, pioneered by Nicolas Appert, involves high-heat treatment to annihilate microorganisms. Pasteurization, developed by Louis Pasteur, employs controlled heating to eliminate harmful bacteria. Freezing, based on Clarence Birdseye's theory, inhibits microbial growth by exposing food to sub-freezing temperatures.



Additional Preservation Methods:
Fermentation:
Fermentation, a traditional method, relies on the activity of microorganisms like bacteria, yeast, and molds to preserve food. This process not only extends shelf life but also enhances flavour and nutritional value. Common fermented foods include yogurt, sauerkraut, and kimchi.

Irradiation:
Irradiation involves exposing food to ionizing radiation, effectively killing bacteria, parasites, and insects. While controversial, it is a recognized method for reducing pathogens in certain foods without compromising nutritional quality.



Importance of Food Preservation:
Food preservation serves multifaceted purposes, including ensuring a consistent food supply, extending shelf life, eliminating harmful microbes, saving time and energy, and contributing to dietary variety and improved nutrition.

Principles of Food Preservation:
Four fundamental principles underpin effective food preservation:
1. Exclusion of Air: Prevents the activity of oxygen-dependent microbes.
2. Removal of Moisture: Inhibits microbial growth and spoilage.
3. Addition of Chemicals: Preservatives can be added to prevent microbial activity.
4. Control of Temperature: Vital for inhibiting microbial growth and enzymatic reactions.

In-Depth Exploration of Preservation Methods:
Canning:
Canning, introduced by Appert, involves placing food in sealed containers and subjecting it to high heat. While preserving safety and quality, considerations for nutrient loss and quality deterioration exist. Biochemical processes, including heat treatment, acidification, and vacuum sealing, collectively ensure the efficacy of canning.

Freezing:
Freezing, a method championed by Birdseye, exposes food to sub-freezing temperatures, preserving taste, texture, and nutritional value. Proper freezing techniques, including quick freezing and consistent temperature maintenance, are crucial. Biochemical processes, such as ice crystal formation and enzyme inactivation, contribute to maintaining quality.

Drying:
Drying, a dehydration process, removes moisture to inhibit bacterial growth. Various methods, including sun drying and dehydrators, offer benefits like energy efficiency and preserved taste and texture. Biochemical processes during drying involve dehydration, enzyme inactivation, and the Maillard reaction.

Conclusion:
From ancient practices to modern innovations, food preservation methods have evolved to meet the challenges of spoilage and foodborne illnesses. Understanding the principles and biochemical processes involved in drying, canning, freezing, fermentation, and irradiation enriches our comprehension of these methods, emphasizing their pivotal role in ensuring the safety and quality of preserved foods.

Vishwarajsinh Rahevar
First Year

Diabetes: A Global Health Challenge

Diabetes Mellitus, a chronic condition affecting millions worldwide, has emerged as a major global health concern. This metabolic disorder, characterized by abnormal insulin production or utilization, has significant implications for individual health and well-being. This article explores the prevalence, impact, recent findings, symptoms, treatment advances, preventive measures, and the hope for a cure in the context of diabetes.
India, notably, contributes to 17% of the global diabetes burden, earning the dubious title of the "Capital of Diabetes Mellitus."

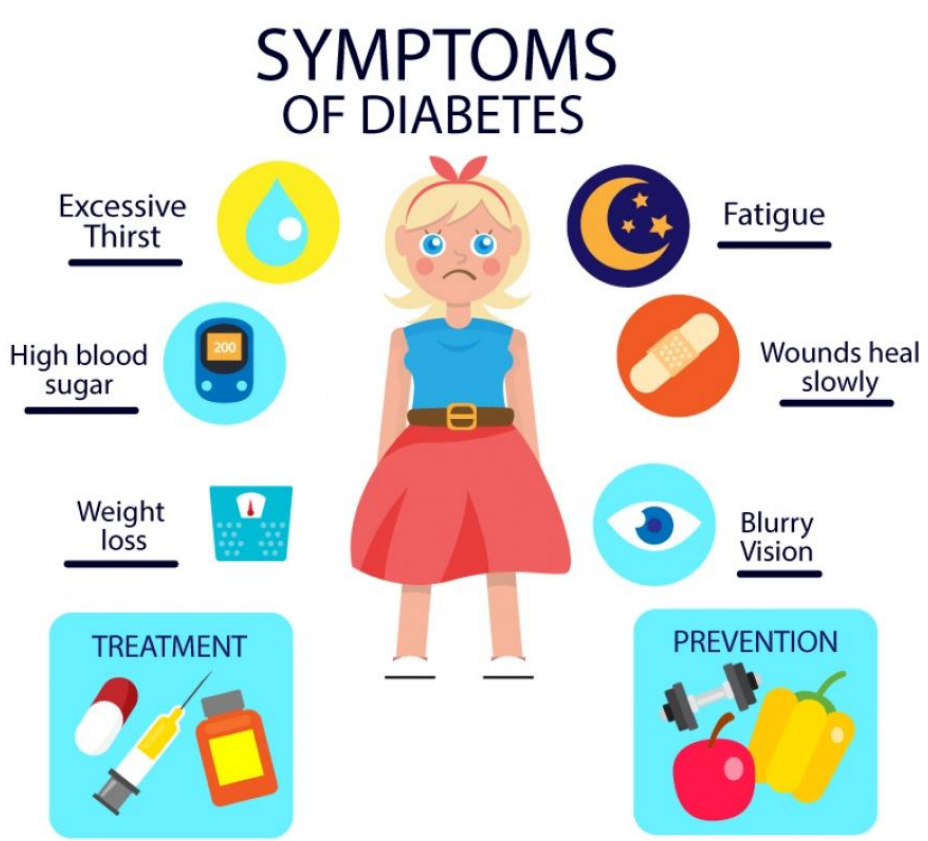
Understanding Diabetes:
Diabetes is a chronic condition arising when the pancreas fails to produce sufficient insulin or when the body cannot effectively use the insulin it produces. Insulin, a vital hormone, regulates blood glucose levels. Uncontrolled diabetes results in elevated blood sugar, leading to severe damage to the body's systems, especially nerves and blood vessels.

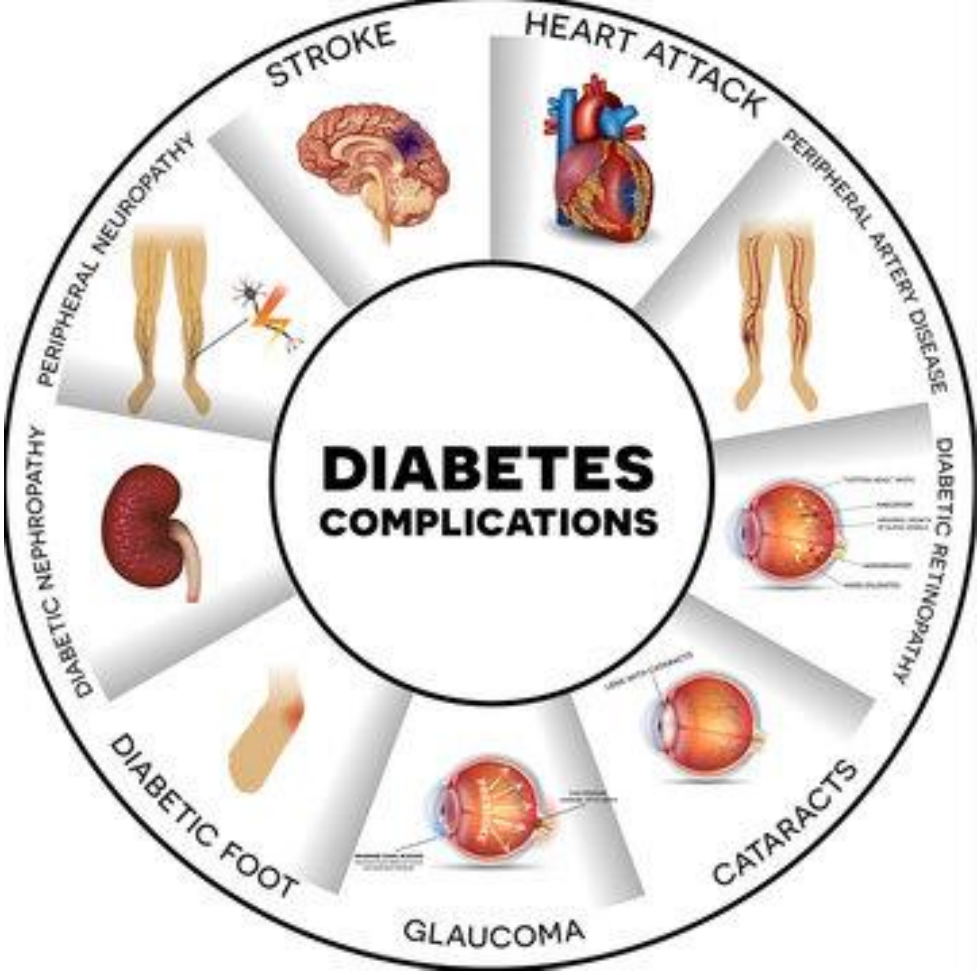
Recent Findings and Advances:
A recent breakthrough involves the discovery of asprosin, a hormone released by adipose tissue, influencing glucose release from the liver. Antibodies targeting asprosin show promise in improving blood glucose and insulin levels in diabetic mice, offering a potential treatment avenue.

In May 2022, the FDA approved a novel injectable medication, "MOUNJARO" (tirzepatide), the first dual GIP and GLP-1 agonist for type 2 diabetes. Additionally, cell therapy is being explored as a potential cure, particularly for type 1 diabetes.

The American Diabetes Association in 2022 endorsed "METFORMIN" as the safest diabetes medication due to its efficacy, affordability, and long-term use. Glenmark Pharmaceuticals introduced "Zita-PioMet," the first triple fixed-dose combination in India, incorporating Teneligliptin with Pioglitazone and METFORMIN.

Regenerative research targeting pancreatic beta cells is underway, aiming to protect and restore insulin production. However, a study underscores the potential negative impact of longstanding type 2 diabetes on brain structure, emphasizing the need for holistic diabetes management.





In June 2023, the FDA approved "Lantidra," an allogeneic pancreatic islet cellular therapy made from deceased donor cells, offering a new treatment avenue for type 1 diabetes.

Anticipated advancements include implantable drug delivery systems, automated closed-loop systems, miniaturized non-invasive glucose monitoring, and the promising role of whey protein in managing postprandial blood glucose.

Digital Health Technologies:
The integration of digital health technologies is heralding a new era in diabetes care. A "Digital Diabetes Ecosystem" is evolving to enhance, rather than replace, human care. This paradigm shift promises improved monitoring, personalized interventions, and greater accessibility to diabetes management resources.

Prevention Strategies:
The World Health Organization (WHO) spearheads efforts to combat diabetes by promoting effective surveillance, prevention, and control measures. Scientific guidelines for preventing major non-communicable diseases, including diabetes, are crucial components of this global initiative. World Diabetes Day on November 14 serves as a platform to raise awareness about the diabetes epidemic.

Lifestyle changes are pivotal in preventing type 2 diabetes and its complications. Maintaining a healthy body weight, engaging in regular physical activity, adopting a balanced diet, avoiding tobacco, ensuring adequate sleep, and managing sleep apnea collectively contribute to diabetes prevention.

Conclusion:
In conclusion, diabetes poses a significant global health challenge, with millions affected and an alarming rise projected in the coming years. However, ongoing research, technological advancements, and a concerted global effort offer hope for better management and potential cures. Emphasizing prevention through lifestyle changes and leveraging digital health technologies can pave the way for a healthier, diabetes-resistant future. As we navigate the complexities of diabetes, let us remember that life continues to hold promise, and gratitude for what we have can be a powerful ally in the face of this silent killer disease.

Sheetal Pradhan
Second Year

Unmasking Trendy Diets

We know that 'Health is Wealth'. However, in the context of current lifestyle trends amongst the millennials, this may have been stretched too far. I see a lot of misinformation circulating across the web, social media platforms and amongst local community groups, talking about various diet and exercise regimes, tips to reduce body weight. While one may be tempted to try them, it can have drastic, unintended consequences if not understood properly. In this article, I would like to discuss the biochemistry behind some of these practices, helping you take better decisions on adopting such trends.

#1 Alkaline water is good for health

Water is the most important part of diet and should be considered as a nutrient. While the acceptable limits for pH of drinking water is 6.5-8.51, commercially sold alkaline water is added with alkaline minerals, making its pH above 8. While WHO clearly states that pH has no direct effect on water consumers1, there are many articles claiming the benefits of alkaline water2-3. Most of them claim that because the normal pH of blood is 7.35-7.45, alkaline water helps to maintain this balance better than normal water. This is incorrect due to two reasons – 1. pH of our stomach is highly acidic (1.0-3.0), yet it is not affecting the blood pH and 2. pH of blood is well regulated by multiple factors like bicarbonate buffer, lungs, kidneys and proteins. Dietary water has a minimal role in regulating blood pH. Other claims of alkaline water on improving metabolism, ageing, reducing cancer risk, etc. lack thorough scientific research.

Water is the most important part of diet and should be considered as a nutrient. While the acceptable limits for pH of drinking water is 6.5-8.51, commercially sold alkaline water is added with alkaline minerals, making its pH above 8. While WHO clearly states that pH has no direct effect on water consumers1, there are many articles claiming the benefits of alkaline water2-3. Most of them claim that because the normal pH of blood is 7.35-7.45, alkaline water helps to maintain this balance better than normal water. This is incorrect due to two reasons – 1. pH of our stomach is highly acidic (1.0-3.0), yet it is not affecting the blood pH and 2. pH of blood is well regulated by multiple factors like bicarbonate buffer, lungs, kidneys and proteins. Dietary water has a minimal role in regulating blood pH. Other claims of alkaline water on improving metabolism, ageing, reducing cancer risk, etc. lack thorough scientific research.

#2 Vegan diet is very healthy

Vegan diet consists of food derived only from plants, such as vegetables, fruits and grains. One may find it difficult to find any issues with this, certain trends amongst vegan practitioners have resulted in drastic consequences. In this one particular case, a food influencer, who ate an exclusive vegan diet consisting only of raw fruits and vegetables, eventually died of starvation4. This is clearly a case of misinformed dietary practices, wherein only certain types of food are eaten in excess, depriving the body of essential nutrients. While fruits and vegetables are considered the healthiest amongst all food groups, a strict vegan diet not sufficient to provide enough calories to manage your minimum 2000 calorie/day benchmark. It may also affect your gut health as well as cause iron and Vitamin B12 deficiency5. If you are against milk product, at least include cereals, especially millets, in your diet.

#3 Keto diet or paleo diet is healthy

Both of these diet practices focus on consuming low-carbohydrate and high-protein, high-fat food products, such as meat, fish, eggs, certain fruits and vegetables. However, the science behind this diet plan is complex. When we starve our body of carbohydrates for several days, the liver begins to utilize fats as the main source of energy by converting them into ketone bodies, i.e. acetoacetic acid, b-hydroxybutyrate and acetone. Ketone bodies can be used as fuel in the heart, brain and muscle, but not the liver. It is believed that ketone bodies, as a fuel source, are better for both the heart and the brain. They prevent cardiovascular diseases, improve cognitive function and prevent cancer. However, practicing keto diet without consulting a professional dietician can be risky because increased levels of ketone bodies causing ketoacidosis and ketonuria – both of which can be harmful in the long run. Moreover, not selecting the right type of fats in your fat-rich keto diet can actually increase the risk of cardiovascular diseases.

What is the perfect diet plan?

Rather than focusing too much on specific food items and practices, a few general tips go a long way in keeping your body in shape and healthy.

1. Food intake is more about economics rather than science. We know that our body needs a certain set of nutrients daily. Calculate the total intake of nutrients from your daily food intake and adjust your diet plan accordingly. Keep in mind that every individual's calorie intake will depend on their body weight, age, gender, lifestyle and genetic factors such as food allergies. Do not blindly follow what someone else is doing. It may work for them but not for you.

2. Eat less processed foods and consume more natural foods. Please note that cooking is not considered a process here. Avoid buying canned, packaged foods from your supermarket, no matter how appealing they are. If you look at the nutritional information printed on the back of such items, you will realize that most of these items contain high amounts of refined sugar, which is the biggest deterrent towards a healthy diet.

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Editing Genomes, Boosting Nutrition

Functional foods are sources of nutrients that impart more physiological benefits along with basic nutritional needs. This definition was accepted in Japan during the mid-1980s. Briefly, the functional foods can be categorized according to the active part and its positive impact on human health. They are classified as natural (plant or animal origin) and synthetic (nutraceuticals). In terms of biochemistry, they may be referred to as secondary metabolites such as polyphenolic compounds, alkaloids, terpenoids, flavonoids, carotenoids, saponins, catechins, allyl sulphides and other nutraceuticals (Mohanti and Singhal, 2018). It is proven that plant-based diet can reduce the risk of chronic disease and disorders such as cancer, diabetes, obesity, cardiovascular ailments, and other effects on human health (Nayak et al., 2015). Since plant-based functional foods have become intrinsic part of healthy lifestyles, agronomist, breeders and agricultural biotechnologist aim to improve the nutritive value in them. Agronomists develop a good agricultural practice (GAP) so that nutritional values will be preserved. Breeders develop new varieties after stringent methods of selection so that the improved traits can be expected. Agricultural biotechnologists are also serving the same purpose but in a unique way. However, unlike breeders, they must go through strict regulatory protocols before releasing their varieties into the market (Sudha et al., 2018).

Molecular tools are used to detect, change or analyse biomolecules like DNA, RNA, proteins (including enzymes) and metabolites in order to monitor specific biochemical phenomena occurs in the living organisms. When we talk about improvement, it has two phases during which molecular tools are involved. First phase uses the tool(s) or technique(s) to improve the quality traits of the living organisms. These tools and techniques include genome engineering and editing. The second phase uses the tools to ensure that the improvement has been done properly. These tools include PCR, qRT-PCR, Sequencing, Microarray (Lowe et al., 2017). The scope of this article has been limited to the use of CRISPR-Cas9 genome editing tools that have promising and proven beneficial impacts on the trait improvement programs of the crop plants. In this article, how CRISPR-Cas9 tool can be used to improve the traits related to functional foods, has been discussed with examples.

CRISPR-Cas9

DNA metabolism consists of three phases viz., replication, recombination and repair. We have the ample understanding of replication and recombination as we know these processes are useful to make clones and hybrids, respectively. However, DNA repair mechanism has also a great advantage. The fact that DNA can repair its own strand when there is a double stranded break. This repair mechanism can be a template-based (Homology Directed Repair - HDR) or random (Non-Homologous End Joining - NHEJ). Furthermore, during NHEJ, the repair mechanism is also error prone and introduces (insertion) or removes (deletions) one or more nucleotides from the original strand. When we talk about plant-based functional foods, we know that plants can produce a completely new plant from the somatic cells if proper environmental conditions are provided. Another fact is that soil bacterium (Agrobacterium tumefaciens) can transfer the genetic material (plasmid) into host plant which is then integrated into the genome of the host plant. Up to this point, all the processes discussed are natural phenomena. Now let us understand how we have used all these processes for the betterment of our lifestyle.

Let's understand the genome editing with simple example of mustard oil. Mustard oil has erucic acid which is an anti-nutritional factor and causes myocardial lipidosis and heart lesions. The gene responsible for the conversion of erucic acid from oleic acid is called as fatty acid elongase (FAE1). We know the gene sequence and the part of the sequence that encodes for the active site of the enzyme fatty acid elongase 1. Changes in the gene sequence corresponds to active site of the enzyme will alter or remove the active site from the enzyme. The enzyme will no longer functional and hence the product (erucic acid) will not be formed. Now the question is how to change the gene sequence?

Jinek et al. (2012) synthesized a new molecule, called the single-guide RNA, which combines key features of the two bacterial RNAs and directs Cas9 to cut a specific site in DNA. For their work on CRISPR-Cas9 genome editing, Emmanuelle Charpentier and Jennifer A. Doudna were awarded noble prize in 2020. CRISPR-Cas9 genome editing tool includes of a plasmid construct which has a short guide RNA (20 nucleotides sequence complementary to the target sequence; in this case, sequence codes for the active site) followed by scaffold sequence to which Cas9 protein (known to introduce double stranded breaks in the DNA) gets attached. Both the Cas9 protein and guide RNA sequences are driven under constitutive promoter. So, in the process, first, guide RNA sequence is designed (from the available or isolated gene sequences) and then the plasmid carrying above mentioned machinery is prepared and transferred into Agrobacterium. The plant tissue, typically leaf (from mustard), is aseptically grown to produce identical mustard plants during which it is infected with Agrobacterium carrying CRISPR-Cas9 plasmid (transformation). After successful transformation, sufficient copies of guide RNA and Cas9 proteins are produced by the host organism (the plant). In a growing plant cell, guide RNA – Cas9 protein complex reaches to the nucleus and finds its complementary sequence in the gene to be altered. Cas9 protein then introduces double stranded break in the DNA at a specific site and the growing cell recognizes this invasion. Thus, it starts to repair the DNA at the double stranded break, and as mentioned, the process is also error prone so one or a few insertions and deletions are introduced, and the next growing cells will receive the

altered copies of the target gene. All we need to do is to screen the cells with edited gene and nurture them to produce a new (mustard) plant. There are plenty of methods available for that (Liu et al., 2021). Diagrammatic representation of the same with petal color (another trait) in sunflower plant is shown in the figure.

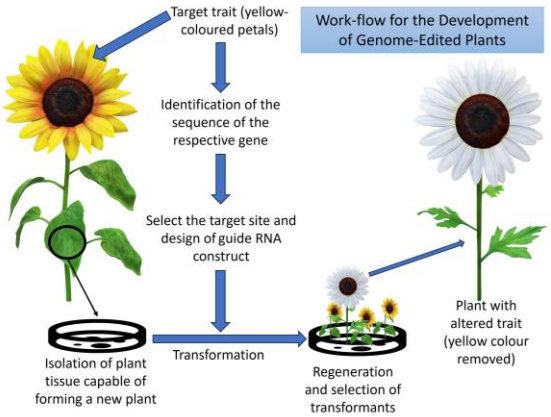

Figure 1: Development of the genome-edited plants with the altered trait. Yellow petal colour is a target. Gene responsible for the same trait is found and guide RNA construct is prepared from the selected region of the sequence. The construct is then transformed in the actively dividing plant cell that gives rise to a whole new plant. If editing works well, some of the transformants will lose the ability to show yellow colour on the petals and such transformants are screened based on molecular tools like PCR and sequencing and of course, morphologically too. To date, many plant species have been edited through CRISPR-Cas9 genome editing tool. However, their release as a variety for the crop production is still limited as it must go through regulatory approvals. Now, we shall see some case studies about how the technology helps in the value addition of functional food.

Applications

As mentioned, the functional foods hold extra trait apart from the regular nutritional impacts. In plant-based functional foods, these traits are vitamins, minerals, and secondary metabolites. Using the genome editing approach, enrichment of such metabolites is possible. In this section, we shall see how CRISPR-Cas9 genome editing tool helps in the fortification of plant-based functional foods with case studies.

Case study 1 – Vitamin A enrichment

Carotenoids, essential isoprenoid pigments for photosynthetic organisms, are not produced de novo by humans but are crucial for various biological functions. Vitamin A, derived from carotenoids like β-carotene in the diet, is vital for vision, embryonic development, immune function, and overall health, with deficiency leading to severe global health issues such as xerophthalmia, night blindness, paediatric blindness, and increased morbidity and mortality, particularly in young children. In the carotenoid biosynthesis pathway ß-carotene is synthesized from trans-lycopene with the action of lycopene beta-cyclase. However, α-carotene and lutein are competitive products of the ß-carotene which are synthesized through the action of lycopene epsilon-cyclase. Kaur et al. (2020) targeted fifth exon of the lycopene epsilon-cyclase in the Banana cultivar Rasthali. They successfully introduced indels in the targeted site and the result showed significant enhancement in ß-carotene content in edited lines while, α-carotene and lutein content were significantly reduced. This is one of the scopes of CRISPR technology in which the enhancement of metabolite of interests is done by blocking the other metabolites synthesized parallel in the pathway.

Case study 2 – Iron and Zinc enrichment

Low iron consumption is associated with anaemia and neurodegenerative disease. Iron content may be enhanced in plant-based diet through biofortification. Iron uptake during the grain filling stage in wheat is associated with the concentration of phytic acid in the plant. Phytic acid is an antinutritional factor which quench the iron and zinc, make it unavailable for the consumption. Therefore, Ibrahim et al. (2021) reduced the concentration of phytic acid by knocking down the gene TaIPK1 and thereby its product (the enzyme), inositol pentakisphosphate 2-kinase 1 in wheat. This enzyme handles the synthesis of phytic acid in the plant. Using CRISPR technology, they were able to reduce the phytic acid content up to 75% and due to this event, iron uptake was increased from 46 µg/g up to 65 µg/g, while zinc content was increased from 36 µg/g up to 64 µg/g in genome edited lines.

Case study 3 – Reduced enzymatic browning

Fruits and vegetables that are consumed fresh, have tendency to undergo enzymatic browning due to the release of an enzyme polyphenol oxidase (PPO). The product makes the food unhealthy. The enzyme is also released during the storage of the commodity. The activity of enzyme is greatly influenced by pH, temperature and oxygen, and thus they are treated with certain chemical or physical agents which again have a negative impact on nutrition and organoleptic properties of the food. In this context, Maioli et al. (2020) targeted SmelPPO1-10 genes in eggplant and they could successfully edit three genes (SmelPPO4, SmelPPO5 and SmelPPO6). These lines showed reduced activity of PPO up to second generation. Apart from the case studies mentioned above, there are numerous articles published on cereals, fruits and vegetables to enhance the nutritional value or to reduce the anti-nutritional factors from the plant to make them functional food.

Conclusion

Functional food is a part of the modern-day lifestyle and has tremendous scopes in the future as the awareness of healthy diet through various platforms increases. Plant based functional foods are preferred by many people due to their availability and accessibility. On the other hand, approaches are also made to enhance the nutritional content of the plant based functional foods. Conventionally, cereals, pulses, fruits and vegetables have been improved using breeding techniques and many varieties have been released. However, looking at the time needed for the development, biotechnological tools have been employed to serve the same purpose. Looking at the regulatory aspects

of the genetically modified plants, genome edited plants face less constraints during their development and release. CRISPR-Cas9 is a cutting-edge genome editing tool using which many genome-edited plants have been developed. These include the fruits and vegetables rich in vitamins and minerals or with reduced levels of anti-nutritional factors. With its simplicity and adaptability, CRISPR-Cas9 technology shows promising future especially for the consumption of plant based functional foods.

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Alumni Batch: 2002 – 2005

Current Position – Director, Axenic Agritech Private Limited.

Exploring Biochemical Realms

Biochemistry is akin to an intriguing detective story, delving into the intricate chemical processes within living things. It serves as the key to unveiling the secrets of life at its tiniest level. This article aims to provide a simple overview of why biochemistry is crucial and its connections to various aspects of our world.

Why Biochemistry Matters:
Biochemistry allows us to grasp the hidden world of molecules that constitute living things. It's akin to reading the instruction manual of life itself. This knowledge isn't just interesting; it's incredibly useful across different areas.

Where Biochemistry Fits In:
Picture biochemistry as a puzzle piece seamlessly connecting with other sciences like molecular biology and genetics. Together, they unravel the intricate details of life.

In Medicine:
Biochemistry plays a vital role in the medical world. It aids doctors in understanding what's happening inside our bodies at the molecular level. From diagnosing diseases to creating improved medicines, biochemistry is a linchpin. For example, in cancer treatment, understanding the biochemical processes helps develop targeted therapies that are more effective and have fewer side effects.

In Agriculture:
Farmers and scientists utilize biochemistry to enhance crop growth without harming the environment. It contributes to sustainable farming, ensuring we can feed the world intelligently. For instance, biochemistry is employed in the development of genetically modified crops that resist pests, reducing the need for harmful pesticides like BT- cotton.

In Nanotechnology:
Biochemistry collaborates with nanotechnology to address significant health challenges. This dynamic duo works together to combat diseases at a microscopic level. In the field of nanomedicine, biochemistry helps design nanoparticles for targeted drug delivery, enhancing treatment precision and reducing side effects.

In the Food Industry:
Biochemistry is pivotal in food production, ensuring safety and quality. It's involved in understanding and optimizing processes like fermentation and food preservation. For instance, in brewing, biochemistry is crucial for yeast fermentation, transforming ingredients into beer.

In Cosmetics:
Biochemistry contributes to the development of cosmetic products. Understanding the biochemistry of skin allows for the creation of effective skincare formulations. For example, knowledge of biochemistry helps in designing anti-aging products that target specific molecular processes.

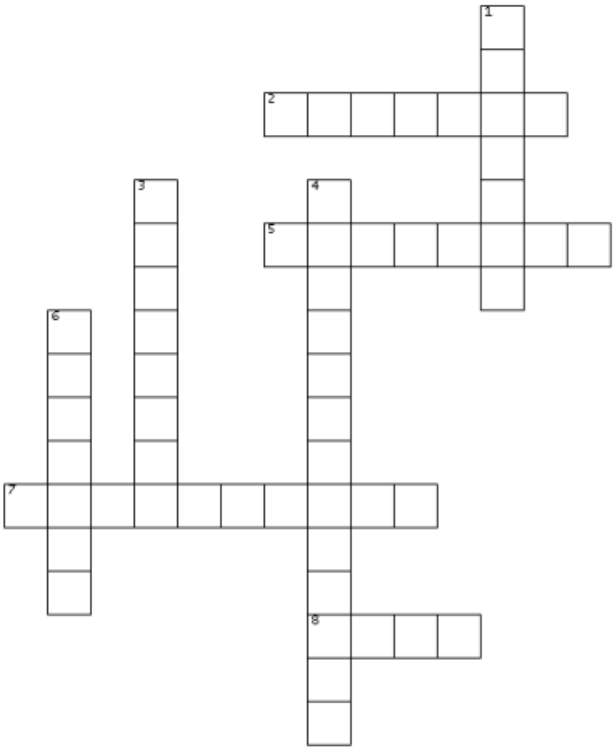
In Pharmacy:
Biochemistry is fundamental to the pharmaceutical industry. It guides the development of drugs by understanding how they interact with biological molecules. For instance, in drug design for cardiovascular diseases, biochemistry aids in creating medications that target specific biochemical pathways.

Jobs and Skills:
Studying biochemistry isn't just about labs and microscopes; it equips individuals with valuable skills like problem-solving and data analysis. These skills are applicable in various professions, not just in science.

In a Nutshell:
Biochemistry, resembling a captivating detective story in the scientific world, helps us understand life's secrets and addresses real-world problems in medicine, agriculture, food production, cosmetics, pharmacy, and more. By studying biochemistry, we unlock doors to a better and healthier future, contributing to advancements in diverse fields, one tiny molecule at a time.

BioBrain Bafflers

CrossWord



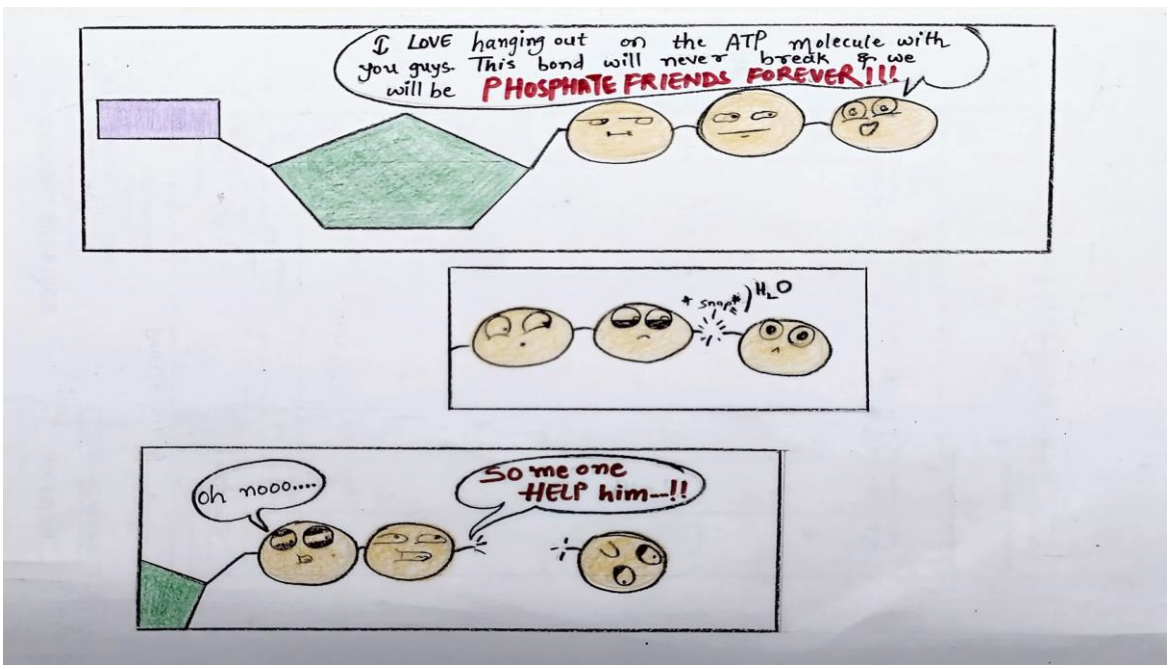
ACROSS

2. Type of sugar found in milk
5. Biochemical nature of enzymes
7. Building blocks of proteins
8. Mineral which is component of haemoglobin

DOWN

1. Hormone responsible for lowering blood glucose levels
3. Storage form of glucose in animals
4. Copying of DNA into RNA
6. Plant based protein source

SciToon



Fun Facts

Cucumbers are a Fruit: Cucumbers are classified as fruits because they develop from the flower of the cucumber plant and contain seeds. However, they are often treated as vegetables in culinary contexts.

The Nutrient-Packed Quinoa: Quinoa is a seed that is often referred to as a grain. It's a complete protein, meaning it contains all nine essential amino acids, and is rich in fiber, vitamins, and minerals.

Broccoli is Packed with Vitamin C: Broccoli contains more vitamin C than an orange. It's also a rich source of fiber, vitamin K, and various antioxidants.

Eating Celery Burns Calories: The act of chewing and digesting celery burns more calories than the celery itself contains. It's often referred to as a "negative calorie" food.

Bananas are Berries, but Strawberries Aren't: Botanically speaking, bananas qualify as berries, while strawberries do not. In botanical terms, a berry is a fleshy fruit produced from a single ovary, and bananas fit this definition.

Myth Busters

Myth: All fats are bad for you.
Fact: Not all fats are created equal. While saturated and trans fats can be harmful in excess, unsaturated fats (monounsaturated and polyunsaturated fats) are essential for a healthy diet. They support brain function, hormone production, and overall well-being.

Myth: Carbohydrates make you gain weight.
Fact: Carbohydrates are a primary source of energy for the body. It's the type and amount of carbs that matter. Whole grains, fruits, and vegetables provide fiber and essential nutrients. Processed and refined carbs, on the other hand, can contribute to weight gain.

Myth: Eating cholesterol-rich foods raises blood cholesterol levels.
Fact: Dietary cholesterol has less impact on blood cholesterol than saturated and trans fats. For most people, moderate consumption of cholesterol-containing foods doesn't significantly affect cholesterol levels.

For Cross Word answers, please scan the QR code.


M.G.
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STARTS
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TEACHING & NON-TEACHING STAFF

BATCH: 2021-2024

BATCH: 2022-2025

BATCH: 2023-2027

33RD ESTABLISHMENT DAY CELEBRATION OF BIOCHEMISTRY DEPARTMENT

GURUPURNIMA CELEBRATION




TEACHER'S DAY CELEBRATION

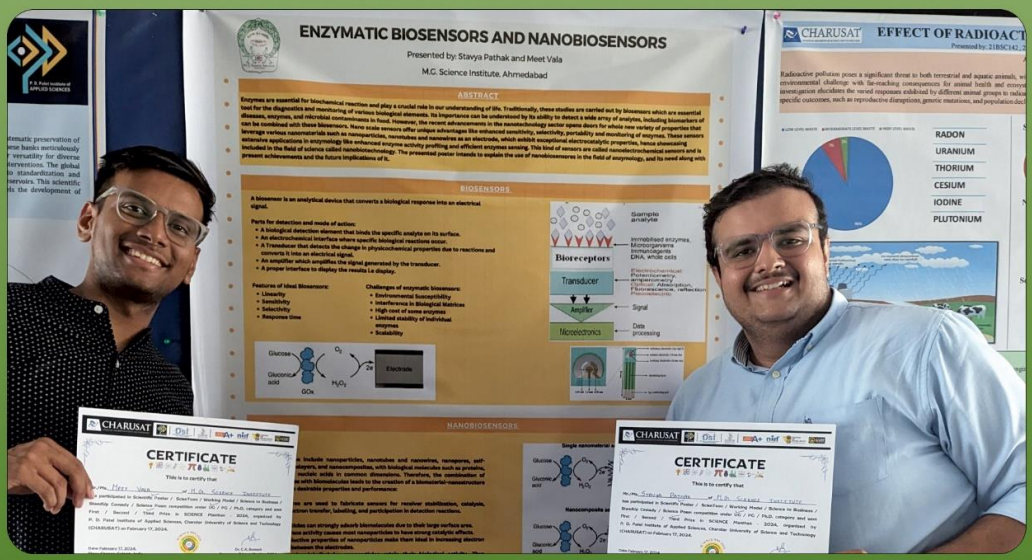
AU VISIT

NAVRATRI CELEBRATION

SPORTS WEEK

HIRVA BHAVSAR & NISARGI TRIVEDI PARTICIPATED IN GENE EXPLORE WORKSHOP

THOL TRIP



STAVYA PATHAK & MEET VALA PARTICIPATED IN SCIENCE MANTHAN POSTER PRESENTATION AND WON 3RD PRIZE

Note of Thanks

Dear Contributors,

The entire editorial team at '**Jivanam**' wishes to express our deep appreciation for your steadfast commitment and invaluable contributions to our magazine. Your dedication to creating insightful and thought-provoking articles has played a pivotal role in molding the success of '**Jivanam**' as a platform for fostering intellectual discourse and enriching the minds of our readers.

We are profoundly grateful for the time, effort, and expertise each of you has dedicated to crafting articles that resonate with our readers and spark meaningful conversations. Your diverse perspectives and insightful analyses have expanded our understanding of a wide array of topics, ranging from the complexities of scientific advancements to the profound depths of human experiences.

Our sincere thanks also go to our esteemed faculty members for their unwavering support and guidance throughout the editorial process. Your expertise and mentorship have been indispensable in ensuring the quality and integrity of the articles we publish. Your willingness to share knowledge and insights has played a crucial role in establishing '**Jivanam**' as a respected source of information and inspiration.

We would like to extend our heartfelt appreciation to Professor Nilesh Mulia from the Botany Department for his invaluable contributions to the design of '**Jivanam**.' His expertise and dedication have significantly elevated the quality and aesthetic appeal of the publication. We are truly thankful for his insightful guidance and collaborative efforts in making '**Jivanam**' a remarkable and well-crafted magazine. His commitment to excellence has been a driving force behind the success of this endeavor, and we express our sincere gratitude for his unwavering support.

A special thank you is also extended to Mr. Rajkumar Vasava for his generous sponsorship of our magazine. Your support is priceless and contributes significantly to the triumph of our publication.

With heartfelt appreciation,
The Editorial Team
Jivanam 3.0

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“Learn from yesterday, live for today, hope for tomorrow. The important thing is not to stop questioning.”

- Albert Einstein

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