**Class -1**

* *Write down the term ‘nutraceutical’. Discuss about the history of development of nutraceuticals.*

The concept of **Nutraceuticals** went back as far as 3000 years ago. **Hippocrates** (460–377 B.C) stated *‘let food be thy medicine and medicine be thy food*’. In the early 1900s the American food manufacturers started adding small quantities of iodine to salt to prevent goiter.

Dr. Stephen DeFelice coined the term "Nutraceutical" from "Nutrition" and "Pharmaceutical" in 1989. He defined nutraceutical as a "food, or parts of a food, that provide medical or health benefits, including the prevention and treatment of disease"

* *What is a dietary supplement? Give examples of dietary supplements.*

Dietary supplements are any substances you take to improve your health or wellness. This includes vitamins, minerals, and herbs. The most common form is a pill, or capsule. You also can get them in powders, drinks, and foods.

**Or**,

 Dietary supplement is a manufactured product intended to supplement a person's diet to improve the health or wellness. This includes vitamins, minerals, and herbs. The most common form is a pill, or capsule. You also can get them in powders, drinks, and foods.

* *Explain the term ‘functional food’. Give examples of functional food.*

Functional foods are any fresh or processed food claimed to have a health-promoting or disease-preventing property beyond the basic function of supplying nutrients.

* **Probiotics and Fermented Foods:** Examples: Yogurt, kefir, kimchi.
* **Omega-3 Fatty Acid-Rich Foods:** Examples: Fatty fish (salmon, mackerel, sardines), flaxseeds, chia seeds.
* **Antioxidant-Rich Foods:** Examples: Berries, spinach, nuts.
* **Fiber-Rich Foods:** Examples: Whole grains, legumes, vegetables.
* **Functional Beverages:** Examples: Green tea, herbal teas.
* **Fortified Foods:** Examples: Iodine fortified salt, vitamin A fortified soybean oil etc.

*What is phytochemical? Give examples. What are the health benefits of phytochemical?*

The name phytochemical comes from Greek word (phyton) which means 'plant'. **Phytochemicals** are [chemical compounds](https://en.wikipedia.org/wiki/Chemical_compound) produced by [plants](https://en.wikipedia.org/wiki/Plant), generally to help them resist fungi, bacteria and [plant virus](https://en.wikipedia.org/wiki/Plant_virus) infections, and also consumption by insects and other animals.

**Phytochemicals** are [chemical compounds](https://en.wikipedia.org/wiki/Chemical_compound) produced by [plants](https://en.wikipedia.org/wiki/Plant) that may help in reducing the risk of developing certain diseases.

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| **Foods** | **Phytochemical** | **Reduce risk of** |
| Tomato | Lycopene | Cancer |
| Garlic | Alicin | Cancer |
| Grape | Resveratrol | CVD |

**Or,**

**Flavonoids:** include quercetin, catechins. Found in fruits, vegetables, tea, and red wine.

**Carotenoids:** include beta-carotene, lutein, and lycopene. Found in carrots, sweet potatoes, spinach, tomatoes, and other colorful fruits and vegetables.

**Glucosinolates:** Found in cruciferous vegetables like broccoli, cabbage, and Brussels sprouts.

**Saponins:** Found in legumes, such as beans and lentils.

**Alkaloids:** include caffeine, nicotine, and morphine (though not all alkaloids are beneficial). Found in various plants, including coffee, tea, and certain herbs.

**Terpenes:** include limonene, found in citrus fruits, and menthol, found in mint. Found in the essential oils of many plants.

**Phenolic Acids:** include ellagic acid and ferulic acid. Found in berries, nuts, and whole grains.

**Health benefits:** Phytochemicals could provide health benefits as:

1. Substrate for biochemical reactions
2. Cofactors of enzymatic reactions
3. Inhibitors of enzymatic reactions
4. Scavengers of reactive or toxic chemicals
5. Enhance the absorption or stability of essential nutrients
6. Fermentation substrate for beneficial bacteria
7. Selective growth factor for beneficial bacteria
8. Selective inhibitors of harmful intestinal bacteria

*Difference between Traditional nutraceutical vs non-traditional nutraceuticals*

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| --- | --- | --- |
| Properties | Traditional Nutraceuticals: | Non-traditional Nutraceuticals: |
| Definition | The nutraceuticals obtained from plants, animals, minerals, or microbial sources this can be referred as Traditional Nutraceuticals. | Nutraceuticals prepared via biotechnology this can be referred as Non-Traditional Nutraceuticals. |
| Sources | Derived from natural food sources, such as fruits, vegetables, herbs, and other traditional foods. For instance, vitamin C from citrus fruits or omega-3 fatty acids from fish oil. | These products may be derived from unconventional sources, including biotechnological processes, fermentation, or innovative extraction methods. |
| Usage | Consumers commonly use traditional nutraceuticals to fill nutritional gaps, support overall health, or address specific health concerns. | Non-traditional nutraceuticals often target specific health areas, such as gut health, cognitive function, or immune support. They may be developed based on emerging scientific research. |

**Class -2**

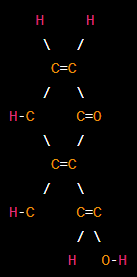
*What is microbiota? What is its beneficial role in human body?*

The microbiota refers to the diverse community of microorganisms, including bacteria, viruses, fungi, and archaea, that inhabit various parts of the human body, particularly the gastrointestinal tract. The microbiota plays a crucial and beneficial role in the human body in several ways

* Improved digestion and absorption of nutrients
* Reduced risk of certain gastrointestinal disorders, such as diarrhea, constipation, and irritable bowel syndrome (IBS)
* Boosted immunity

*What is curcumin and structure? What is physiological beneficial functions?*

Curcumin is a bright yellow chemical compound that is naturally present in the turmeric. It is known for its anti-inflammatory, antioxidant, and potential anticancer properties.



* Curcumin exhibits anti-inflammatory and antioxidant properties.
* It may support joint, cardiovascular, and brain health
* possess anti-cancer and antimicrobial effects, and aid digestion.

*Give some examples of phytochemicals with their natural sources and functions.*

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| Phytochemical | Natural Sources | Functions |
| Flavonoids | Citrus fruits, berries, onions | Antioxidant, anti-inflammatory, cardiovascular protection |
| Carotenoids | Carrots, spinach, tomatoes | Precursors to vitamin A, antioxidant, eye health support |
| Alkaloids | Coffee, tea, cocoa, potatoes | Stimulant effects (e.g., caffeine), potential medicinal properties |
| Phytosterols | Nuts, seeds, whole grains, vegetable oils | Cholesterol-lowering, heart health support |
| Polyphenols | Green tea, red wine, berries, dark chocolate | Antioxidant, anti-inflammatory, cardiovascular support |
| Terpenes | Citrus fruits, herbs (rosemary, basil), pine trees | Aromas and flavors in plants, potential antioxidant and anti-inflammatory effects |
| Curcumin | Turmeric | Anti-inflammatory, antioxidant, potential anti-cancer |
| Resveratrol | Red grapes, red wine, peanuts | Antioxidant, cardiovascular protection |

*What is probiotic microorganism? Give examples. Mention their beneficial role in human.*

Probiotic organisms are live microorganisms that, when consumed in adequate amounts, can provide health benefits to the host.

**Probiotic Microorganism**

* Lactobacillus
* Bifidobacterium
* Saccharomyces boulardii
* Streptococcus thermophilus
* Enterococcus faecium
* Lactococcus lactis

**Some of the health benefits associated with probiotics include:**

* Improved digestion and absorption of nutrients
* Reduced risk of certain gastrointestinal disorders, such as diarrhea, constipation, and irritable bowel syndrome (IBS)
* Boosted immunity
* Reduced risk of certain chronic diseases, such as heart disease, obesity, and type 2 diabetes
* Improved mood and cognitive function

Phytotoxin example- aristolochic acid. Antinutrients they inhibit the absorption of nutrients phytic acid is an antinutrient.

*What is non-traditional nutraceuticals?*

Nutraceuticals prepared via biotechnology this can be referred as Non-Traditional Nutraceuticals.

*Give some examples (at least ten) of common herbals used as nutraceuticals.*

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| Herb | Active Compounds | Potential Benefits |
| Turmeric | Curcumin | Anti-inflammatory, antioxidant |
| Ginger | Gingerol, Shogaol | Anti-nausea, anti-inflammatory, digestive support |
| Garlic | Allicin | Cardiovascular support, immune system boost, antimicrobial |
| Green Tea | Catechins | Antioxidant, anti-inflammatory, cardiovascular health |
| Ginseng | Ginsenosides | Adaptogenic, energy boost, cognitive function support |
| Aloe Vera | Polysaccharides, Glycoproteins | Skin health, anti-inflammatory, digestive support |
| Ashwagandha | Withanolides | Adaptogenic, stress reduction, immune system support |
| Cinnamon | Cinnamaldehyde | Blood sugar regulation, anti-inflammatory, antioxidant |
| Peppermint | Menthol | Digestive support, anti-nausea, headache relief |

*How phytochemical can act as antioxidant?*

Phytochemicals act as antioxidants through mechanisms such as free radical scavenging, metal chelation, enhancement of antioxidant enzyme activity, reduction of inflammation, and regeneration of other antioxidants like vitamins C and E.

*What are fortified nutraceuticals?*

When vitamins, minerals, antioxidants, or other bioactive substances added to food to enhance its nutritional profile and health benefits it refers as fortified nutraceuticals.

*Which nutraceutical are available in the market?*

1. **Vitamins and Minerals:**
   * Multivitamins
   * Vitamin D supplements
   * Calcium supplements
   * Iron supplements
2. **Herbal and Botanicals:**
   * Echinacea
   * Ginseng
   * Turmeric/curcumin
   * Garlic
3. **Omega-3 Fatty Acids:**
   * Fish oil supplements
   * Algal oil supplements
4. **Probiotics:**
   * Probiotic yogurt
   * Probiotic capsules/powders
   * Fermented foods
5. **Antioxidants:**
   * Vitamin C supplements
   * Vitamin E supplements
   * Green tea extracts
6. **Fiber Supplements:**
   * Psyllium husk
   * Inulin supplements

*Give some examples of nutraceutical that are available in market?*

Given above

*What is moringa olifera?*

Moringa oleifera is a highly nutritious plant, often referred to as a "superfood" due to its rich content of vitamins, minerals, and antioxidants. **Moringa oleifera** is rich in various antioxidants, including quercetin and chlorogenic acid. It has various nutritional and medicinal properties.

**Class -3**

*What is fiber? Discuss its classification and importance with example.*

Dietary fiber, also known as roughage, is a type of carbohydrate that is not digested by the human digestive enzymes.

**Classification**

1. Water soluble
   1. Cellulose
   2. Hemicelluloses
   3. Lignins
2. Water insoluble
   1. Pectins
   2. Gums
   3. Mucilages

*Health benefit of dietary fiber?*

1. Prevents hemorrhoids and constipation
2. Prevention of diarrhea
3. Increase muscle strength of colon
4. Reduce the risk of heart disease
5. Prevent and manage diabetes
6. Enhance weight loss
7. Prevent colon cancer

*What is omega-3 and omega-6 fatty acid?*

**Omega−3 fatty acids** are [polyunsaturated fatty acids](https://en.wikipedia.org/wiki/Polyunsaturated_fatty_acid) (PUFAs) characterized by the presence of a double bond, three atoms away from the terminal methyl group in their chemical structure.

**Omega−6 fatty acids** are also [polyunsaturated fatty acids](https://en.wikipedia.org/wiki/Polyunsaturated_fatty_acid) (PUFAs) characterized by the presence of a double bond, six atoms away from the terminal methyl group in their chemical structure.

*Discuss the chemical source and important health benefits of omega 3 and omega 6 fatty acid?*

**Omega-6 fatty acid**

***Source***: Meat, vegetable oil

**Function:**

* Facilitate blood clotting
* Maintaining the structure and function of cell membranes.
* Play role in the immune response to infections and inflammation.

**Omega-3 fatty acid:**

***Source***: Egg, fish oil, flaxseed oil

**Function:**

* Reduce blood pressure, inflammation.
* Plasma triglycerides and cholesterol thereby reduce the risk of heart disease.

*Write a short note on probiotic and its health effect?*

The word 'probiotic' comes from the Greek word pro, meaning "promoting" and biotic, meaning "life".

FAO defines probiotics as" live micro-organisms, which, when administered in adequate amount produce beneficial effect to the host when taken orally".

**Sources of Probiotics:**

1. **Fermented Foods:** Yogurt, kefir, kimchi, etc. contain live beneficial bacteria.
2. **Dairy Products:** Some dairy products, like yogurt.
3. **Supplements:** Various forms supplement including capsules, tablets, and powders, containing beneficial bacteria.

**Probiotic Microorganism**

* Lactobacillus
* Bifidobacterium
* Saccharomyces boulardii
* Streptococcus thermophilus
* Enterococcus faecium
* Lactococcus lactis

**Some of the health benefits associated with probiotics include:**

* Improved digestion and absorption of nutrients
* Reduced risk of certain gastrointestinal disorders, such as diarrhea, constipation, and irritable bowel syndrome (IBS)
* Boosted immunity
* Reduced risk of certain chronic diseases, such as heart disease, obesity, and type 2 diabetes
* Improved mood and cognitive function

*What is vitamin? Discuss the classification and physiological functions of vitamin?*

Vitamins are vital accessory food factors occurring in different natural foods required in small quantity for growth, maintenance and development of the body.

1. Water-soluble
   1. Vitamin C
   2. B-complex
2. Fat-soluble
   1. Vitamin A
   2. Vitamin D
   3. Vitamin E
   4. Vitamin K

**Physiological Effects of Polyphenols:**

* Antioxidant Properties
* Anti-Inflammatory Effects
* Cardiovascular Health
* Cancer Prevention
* Neuroprotective Effects
* Metabolic Health
* Anti-Microbial Properties

*Explain the Antioxidant activity of vitamin C and E.*

**Vitamin C (Ascorbic Acid):**

* **Water-Soluble Antioxidant:** Vitamin C is water-soluble and primarily works in watery environments of the body, such as the cytoplasm and extracellular fluids.
* **Free Radical Scavenger:** As an antioxidant, vitamin C donates electrons to neutralize free radicals, preventing them from causing oxidative damage to cells.
* **Regeneration of Vitamin E:** Vitamin C can regenerate vitamin E. After vitamin E neutralizes a free radical, it becomes oxidized, and vitamin C helps convert it back to its active, antioxidant form.
* **Collagen Synthesis:** Apart from its antioxidant role, vitamin C is crucial for collagen synthesis, which is essential for skin, blood vessels, bones, and connective tissues.

**Vitamin E (Tocopherol):**

* **Fat-Soluble Antioxidant:** Vitamin E is fat-soluble and protects cell membranes, which are primarily composed of lipids (fats).
* **Lipid Peroxidation Inhibition:** Vitamin E intercepts and neutralizes free radicals generated during the peroxidation of lipids, preventing damage to cell membranes.
* **Protection of LDL Cholesterol:** Vitamin E is particularly known for protecting low-density lipoprotein (LDL) cholesterol from oxidative damage. Oxidized LDL is a risk factor for cardiovascular diseases.
* **Cell Membrane Stabilization:** By preventing lipid peroxidation, vitamin E helps maintain the structural integrity of cell membranes

*What is polyphenol? Give examples. Discus their importance in health system.*

Polyphenols are naturally occurring compounds found in plants, contain multiple phenolic (aromatic) rings and have antioxidant properties.

* **Flavonoids:**  Flavonols, flavones, flavanones, isoflavones.
* **Phenolic Acids:**  gallic acid, caffeic acid
* **Polyphenolic Amides:**Capsaicinoids
* **Other Polyphenols:** Resveratrol, lignans

*Safety and Adverse Effects of Nutraceuticals:*

**Safety:**

* **Interactions with Medications:** Nutraceuticals may interact with medications, affecting their effectiveness or causing side effects.
* **Individual Variability:** People respond differently to nutraceuticals based on genetics, health conditions, and overall health.
* **Dosage Issues:** Excessive intake of some nutraceuticals can lead to adverse effects, so it's important to follow recommended doses.
* **Quality and Purity:** Ensure nutraceutical products are of high quality to avoid contaminants or impurities.
* **Allergic Reactions:** Those with allergies may react to nutraceuticals derived from allergenic sources.
* **Pregnancy and Health Conditions:** Safety during pregnancy, lactation, or specific health conditions may not be well-established, requiring consultation with a healthcare professional.

**Adverse Effects:**

* **Digestive Issues:** Some nutraceuticals may cause nausea, diarrhea, or constipation, especially in high doses.
* **Blood Clotting Interaction:** Certain nutraceuticals may interact with blood clotting, leading to bleeding issues.
* **Electrolyte Imbalance:** Excessive minerals may cause electrolyte imbalances affecting heart and muscle function.
* **Vitamin Toxicity:** Overconsumption of fat-soluble vitamins may lead to toxicity.
* **Stimulant Effects:** Nutraceuticals with stimulants can cause jitteriness, increased heart rate, and other side effects.
* **Immune System and Hormonal Effects:** Modulation of the immune system or hormones may have unintended consequences.

**Recommendations:**

* **Consult Healthcare Professionals:** Seek guidance before starting any nutraceutical regimen, especially with underlying health conditions or medications.
* **Choose Reputable Products:** Select high-quality nutraceuticals from reputable brands to ensure purity and accurate labeling.
* **Monitor Health:** Regularly monitor health status and report any adverse effects to healthcare providers.
* **Balanced Approach:** Nutraceuticals should complement a balanced diet, not replace it. A varied and nutritious diet is foundational for good health.

*Metabolism, bioavailability, and pharmacokinetics of nutraceuticals.*

1. **Metabolism of Nutraceuticals:**

* Phase I Metabolism: Nutraceuticals often undergo phase I metabolism, where enzymes, such as cytochrome P450, modify the chemical structure of the compound. This can make the nutraceutical more water-soluble and facilitate its excretion.
* Phase II Metabolism: Conjugation reactions occur in phase II metabolism, where the modified nutraceutical is combined with another molecule (e.g., glucuronic acid, sulfate). This further enhances water solubility and facilitates elimination.

1. **Bioavailability:**

* Absorption: The bioavailability of nutraceuticals depends on their ability to be absorbed in the gastrointestinal tract. Factors such as molecular size, solubility, and formulation influence absorption.
* First-Pass Metabolism: Nutraceuticals absorbed through the gut often pass through the liver before entering the systemic circulation. The liver may metabolize and reduce the bioavailability of certain compounds, a phenomenon known as first-pass metabolism.
* Transporters: Some nutraceuticals may utilize specific transporters for absorption in the gut, affecting their bioavailability.

1. **Pharmacokinetics:**

* Distribution: After absorption, nutraceuticals are distributed throughout the body. Factors such as blood flow, tissue binding, and the physicochemical properties of the compound influence distribution.
* Metabolism: Metabolism of nutraceuticals, as mentioned earlier, occurs primarily in the liver. Enzymes involved in these processes play a crucial role in determining the duration and intensity of the nutraceutical's effects.
* Elimination: Nutraceuticals are eventually eliminated from the body through processes such as renal excretion or biliary excretion. The rate of elimination impacts the duration of the nutraceutical's effects.

1. **Factors Influencing Metabolism, Bioavailability, and Pharmacokinetics:**

* Individual Variability: Genetic factors can influence the activity of enzymes involved in metabolism, leading to variations in bioavailability and response.
* Interaction with Other Substances: Nutraceuticals can interact with drugs or other compounds, affecting their metabolism and bioavailability.
* Formulation and Delivery Systems: The form in which a nutraceutical is administered (e.g., capsule, liquid, food matrix) can affect its absorption and bioavailability.

*Limitations and relevance of Functional Foods:*

**Limitations of Functional Foods:**

1. **Different Reactions:**
   * People may respond differently to functional foods based on their health, genes, and lifestyle.
2. **Not Always Proven:**
   * Some functional foods may not have strong scientific proof of their health benefits.
3. **Rules and Regulations:**
   * Rules for making and labeling functional foods can vary, making it challenging to set standards.
4. **Taste Changes:**
   * Adding health ingredients might change the taste of foods, and not everyone may like it.
5. **Costly:**
   * Some functional foods can be more expensive than regular ones.

**Relevance of Functional Foods:**

1. **Health Help:**
   * Functional foods can help prevent or manage certain health issues like heart problems.
2. **More Nutrients:**
   * They add important nutrients to foods, helping people get what they need.
3. **Mixing It Up:**
   * Functional foods make diets more interesting by adding a variety of healthy ingredients.
4. **Easy and Available:**
   * They provide an easy way to get health benefits without needing extra supplements.
5. **Helping Everyone:**
   * Functional foods support public health by giving everyone a chance to eat healthier.
6. **Targeting Needs:**
   * They give specific nutrients to address certain health needs.
7. **Smart Choices:**
   * Functional foods let people make smart choices about what they eat to stay healthy.
8. **Learning and Improving:**
   * Making new functional foods helps scientists learn more about nutrition and make better foods

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| **Aspect** | **Functional Foods** | **Pharmaceuticals** |
| **Definition** | Natural or modified foods with health benefits | Drugs or medications for treatment, prevention, or diagnosis |
| **Composition** | Derived from whole foods, containing bioactive compounds | Formulated with specific chemical compounds or synthesized ingredients |
| **Mode of Action** | Acts through natural mechanisms, regular dietary consumption | Alters physiological processes, targeted effects on specific conditions |
| **Examples** | Yogurt with probiotics, fortified cereals, omega-3 enriched eggs | Antibiotics, pain relievers, cholesterol-lowering drugs |
| **Purpose** | Supports overall health, prevents diseases | Treats, cures, or manages diseases and medical conditions |
| **Regulation** | Governed by food regulations, generally considered safe | Subject to rigorous testing and health authority regulation |
| **Availability** | Widely available over-the-counter in grocery stores | Often requires a prescription, dispensed by healthcare professionals |
| **Administration** | Ingested as part of daily meals or snacks | Administered in specific doses, often with guidelines, potential side effects |

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| **Disease** | **Bioactive Compounds** | **Role in Prevention and Control** |
| **Cardiovascular Disease** | Omega-3 fatty acids (fatty fish, flaxseeds), antioxidants (berries, dark chocolate) | Reduce inflammation, lower blood pressure, improve lipid profiles, prevent oxidative stress |
| **Cancer** | Polyphenols (green tea, berries), carotenoids (tomatoes, carrots), sulforaphane (broccoli) | Exhibit antioxidant properties, inhibit cancer cell growth, support the body's defense against cancer |
| **Diabetes** | Flavonoids (citrus fruits, onions), resveratrol (grapes), fiber (whole grains) | Improve insulin sensitivity, regulate blood sugar levels, reduce inflammation |
| **Arthritis and Inflammatory Diseases** | Omega-3 fatty acids, curcumin (turmeric), gingerol (ginger) | Anti-inflammatory effects, reduce joint pain, contribute to the management of arthritis |
| **Liver Diseases** | Silymarin (milk thistle), curcumin, antioxidants | Support liver function, protect against oxidative stress, aid in prevention and management |
| **Gastrointestinal Diseases** | Probiotics (fermented foods), gingerol, curcumin | Promote a healthy gut microbiome, reduce inflammation, support gastrointestinal health |