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CERTIFICATION COURSES

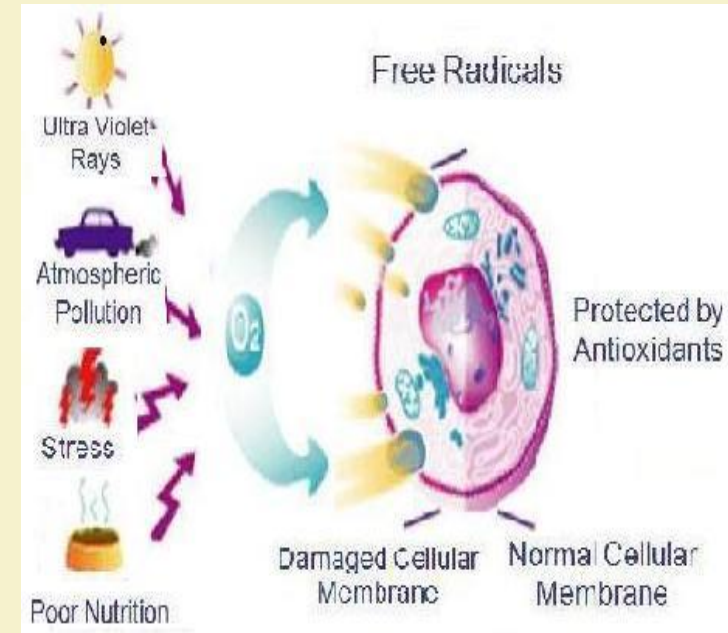
## Organic Farming for Sustainable Agricultural Production

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**Lecture 34 : Natural Sources of Antioxidants for Health Defense**

## *You are What you Eat*

- Various stresses and pollutants – excessive work, smoking, chronic infection, pollution, excessive sun stress, malnutrition etc. release free radicals in human body which cause damage to various organs.
- Free radicals are oxygen or nitrogen based molecules (di oxygen or peroxide molecule) with unpaired electron that are generated by a number of metabolic processes within the body.
- Preventive nutrition is proactive and holistic, generally boost human bodies own repair mechanism and defense against odd factors like stress generating free radicals.
- Plant antioxidant are vital constituents in food which promote health defense by neutralizing or scavenging action of free radicals to avoid cell damage.
- In general the consumer perceives organic food as being healthier and safer than conventional food.



# What is Antioxidant?

## ➤ Chemical definition:

A substance that opposes oxidation or inhibits reactions promoted by oxygen or peroxides.

## ➤ Biological definition:

Synthetic or natural substances that prevent or delay deterioration of a product, or are capable of counteracting the damaging effects of oxidation in animal tissues.

## ➤ Institute of Medicine definition:

A substance that significantly decreases the adverse effects of reactive species such as ROS or RNS on normal physiological function in humans

Huang, D., Ou, B., and Prior, R. L. (2005). The chemistry behind antioxidant capacity assays. *Journal of agricultural and food chemistry*, 53(6), 1841-1856.

## Reactive Oxygen Species

**Reactive Oxygen Species (ROS)** are highly reactive free radicals

- ✓ Superoxide ( $O_2^{\cdot-}$ )
- ✓ Hydroxyl radical ( $\cdot OH$ )
- ✓ Peroxyl radicals ( $\cdot OOH, \cdot OOR$ )
- ✓ Alkoxy radicals ( $\cdot OR$ )
- ✓ Peroxynitrite ( $ONOO^-$ )

They form as the result of stress, inflammation, and poor nutrition

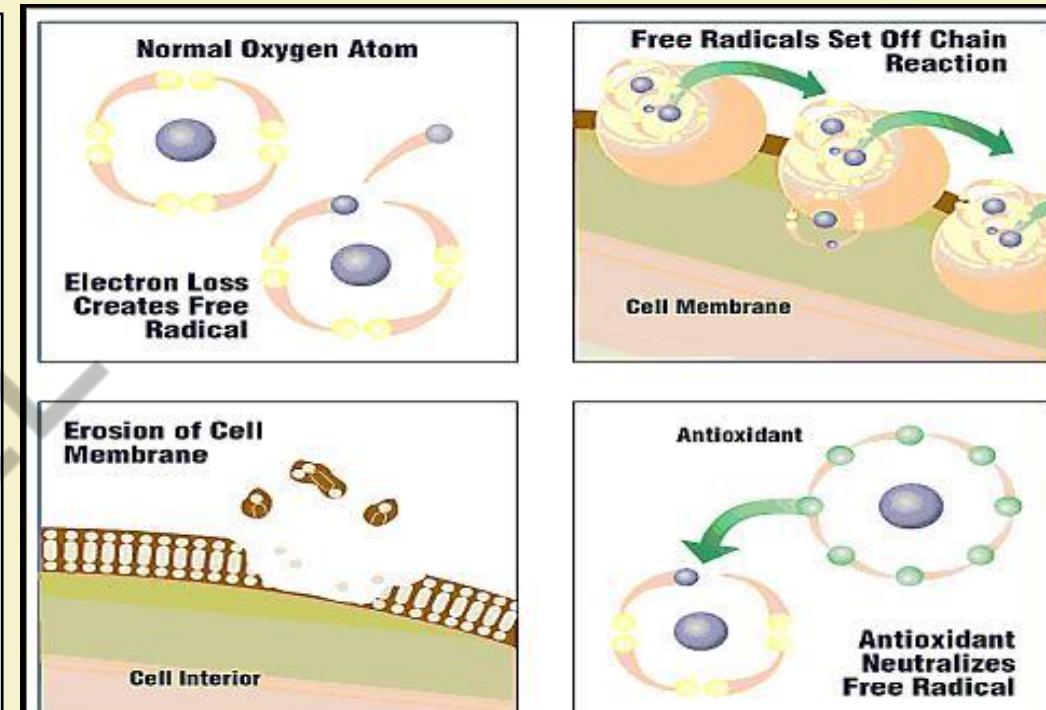
They target tissue, proteins, lipids and DNA

## What Antioxidants do?

- Prevent formation of ROS
- Scavenge/remove ROS before they can damage important biomolecules
- Aid the human body's natural defenses which includes enzyme such as Superoxide dismutase ( $O_2^{\cdot-}$ ), Catalase ( $H_2O_2$ ), Glutathione peroxidase, Glutathione reductase
- Repair oxidative damage
- Prevent mutations

# What is the role of Antioxidant?

- An anti oxidant is a molecule capable of inhibiting the oxidation of other molecules.
- Oxidation is a chemical reaction that transfers electrons or hydrogen from a substance to the oxidizing agent.
- Oxidation reactions can produce free radicals. In turn these radicals can start chain reactions.
- Antioxidants terminate this chain reaction by removing free radical intermediates and inhibit other oxidation reactions

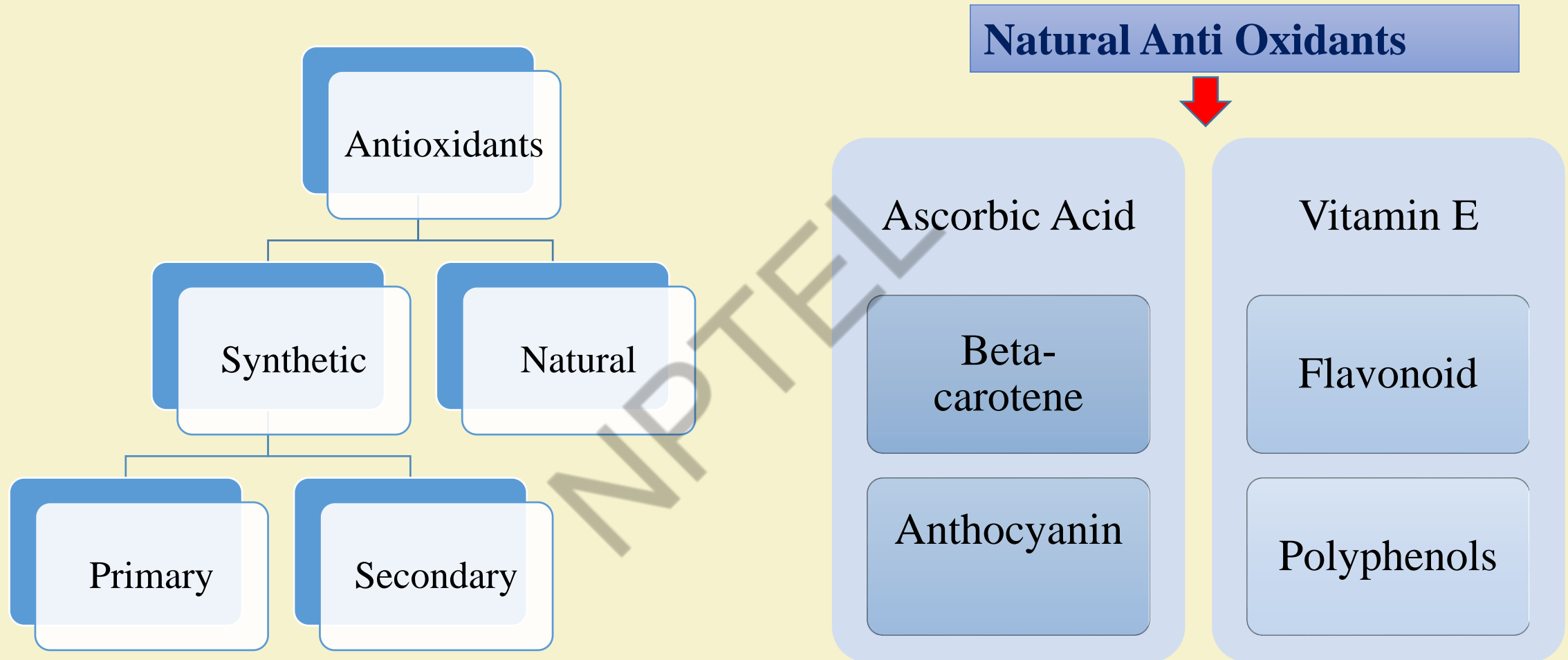


## Defensive mechanism of Antioxidants function through several roots:

- **First**, to inhibit the formation of active oxygen species and free radical
- **Second**, The radical-scavenging antioxidants method
- **Third**, by the repair and cleansing of oxidatively damaged lipids, proteins and DNA.



# Classification of Anti-oxidants



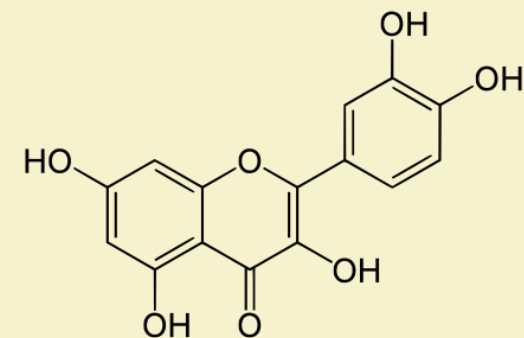
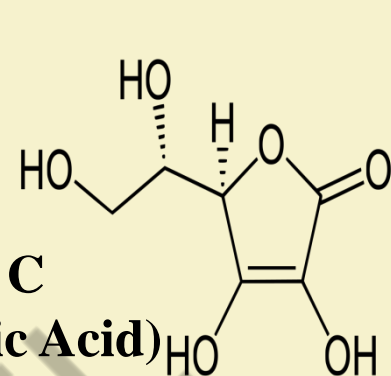
## Natural Anti Oxidants

Natural oxidants are those antioxidants that are found in natural sources such as fruits, vegetables, milk and meats

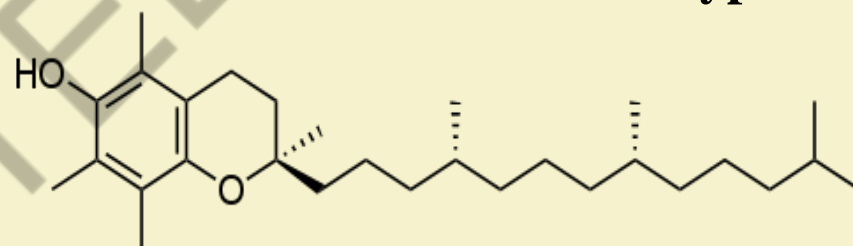
Most common antioxidants found in everyday foods are

- Vitamin C (Ascorbic acid)
- Vitamin E (tocopherols)
- Vitamin A (Carotenoids)
- Various polyphenols including flavonoids
- Anthocyanins (a type of flavonoids)

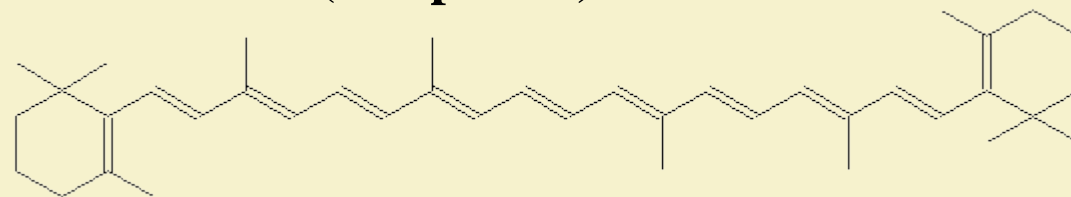
**Vitamin C  
(Ascorbic Acid)**



**Polyphenol (Quaracetin)**



**Vitamin E (tocopherol)**



**Vitamin A  
(Beta carotene)**

## Common Natural antioxidants and their sources

Compound Name	Natural source
Vitamin C (Ascorbic acid)	Most citrus fruits, some vegetables, tomatoes.
Vitamin E (tocopherols)	Cereal grains, broccoli, sprouts, cauliflower, cooking oils (olive, sunflower, safflower), almond, Black rice
Beta-carotene	Vegetables such as spinach, tomatoes, carrots, sweet potatoes, apricots, papayas,
Flavonoids (polyphenols)	Potatoes, tomatoes, lettuce, onions, wheat, dark chocolate, grapes, red wine, black tea, Black rice
Various polyphenols	Green tea, many red/ purple hued fruits or vegetables such as red cabbages, blue berries etc
Lycopene	Tomatoes, papaya, watermelon, pink grape fruit, guava etc.
CoQ10 (an antioxidant enzyme)	Wheat bran, fish, chicken liver.





## Natural antioxidants and techniques to optimize consumption

Compound Name	How to optimize consumption
Ascorbic acid (Vitamin C)	<ul style="list-style-type: none"><li>• Through fruit consumption particularly citrus fruits.</li><li>• Consume moderate quantities of citrus throughout the day to increase absorption.</li></ul>
Flavonoids ( a type of polyphenol)	<ul style="list-style-type: none"><li>• Consumption of whole grain foods such as whole wheat bread and consume lots of green vegetables</li><li>• Eat tocopherol-rich foods with some sort of unsaturated fat (such as olive oil)</li></ul>
Beta-Carotene	<ul style="list-style-type: none"><li>• Consume fruits and vegetables with a reddish-orange colour (such as carrots or papaya)</li></ul>
Tocopherol ( Vitamin E)	<ul style="list-style-type: none"><li>• Consume foods such as potatoes, onions, black tea, grapes</li><li>• Flavonoids are better absorbed when the molecule is not attached to any sugar molecules (So flavonoids obtained from onions would be better absorbed than those obtained from grapes)</li></ul>

## Natural antioxidants and techniques to optimize consumption

Compound Name	How to optimize consumption
Anthocyanins ( a type of polyphenol)	<ul style="list-style-type: none"><li>• Eat fruits, such as blueberries, blackberries, grapes as well as dark chocolate</li><li>• Though other foods such as strawberries contain anthocyanins the anthocyanins from darker foods are absorbed better</li></ul>
Various Polyphenols	<ul style="list-style-type: none"><li>• Consume foods such as teas, dark berries, grape fruit and juice etc.</li><li>• Consumption guidelines from anthocyanins and flavaonoids apply to most polyphenols</li></ul>
Lycopene	<ul style="list-style-type: none"><li>• Consume tomato products</li><li>• It is much easier to absorb lycopene from cooked tomato and products ( such as tomato sauce and ketchup) than from raw tomatoes</li><li>• Consuming tomatoes with dietary fat ( e.g cooking oils) increases absorption of lycopene</li></ul>
CoQ10 (an antioxidant enzyme)	<ul style="list-style-type: none"><li>• Consume whole wheat bread; meats (Liver)</li><li>• Organ meats contain more CoQ10 than do muscle-derived meats.</li></ul>

## Phytochemicals

- Phyto comes from greek word means 'Plant'
- Phytochemical means 'Plant Chemicals' and secondary metabolites
- Substances in plants that may help prevent diseases like cancer and heart disease.
- So far, scientists know of 3,000 different phytochemicals with possible health benefits
- More than 100 phytochemicals are from vegetable source
- Some foods, such as whole grains, vegetables, beans, fruits and herbs, contain many phytochemicals.
- The easiest way to get more phytochemicals is to eat more fruit (blueberries, cranberries, cherries, apple,) and vegetables (cauliflower, cabbage, carrots, broccoli).



## How do phytochemicals work?

**Antioxidant** - Most phytochemicals have antioxidant activity and protect our cells against oxidative damage and reduce the risk of developing certain types of **cancer**. Phytochemicals with antioxidant activity: **allyl sulfides** (onions, leeks, garlic), **carotenoids** (fruits, carrots), **flavonoids** (fruits, vegetables), **polyphenols** (tea, grapes)

**Hormonal action** - Isoflavones, found in soybean, imitate human estrogens and help to reduce menopausal symptoms and **osteoporosis**.

**Stimulation of enzymes** - Indoles, which are found in cabbages, stimulate enzymes that make the estrogen less effective and could reduce the risk for breast cancer.

**Interference with DNA replication** - Saponins found in beans interfere with the replication of cell DNA, thereby preventing the multiplication of cancer cells.

**Anti-bacterial effect** - The phytochemical allicin from garlic has anti-bacterial properties.

## Ten-Year Comparison of the Influence of Organic and Conventional Crop Management Practices on Flavonoids content in Tomato

Flavonoid	Conventional	Organic
Quercetin	64.6 (2.49)	115.5 (8.0)
Naringenin	30.2 (1.57)	39.6 (1.58)
Kampferol	32.06 (1.94)	63.3 (5.21)

**Source:** Mitchell, A. E., Hong, Y. J., Koh, E., Barrett, D. M., Bryant, D. E., Denison, R. F., & Kaffka, S. (2007). Ten-year comparison of the influence of organic and conventional crop management practices on the content of flavonoids in tomatoes. *Journal of agricultural and food chemistry*, 55(15), 6154-6159.