



Almighty Astaxanthin: Over view on nutraceutical based approach to aim to combat cancer

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INTRODUCTION

WHAT IS CANCER ?

“Cancer is a disease where cells grow out of control and invade, erode and destroy normal tissue”



WHAT IS CANCER ?

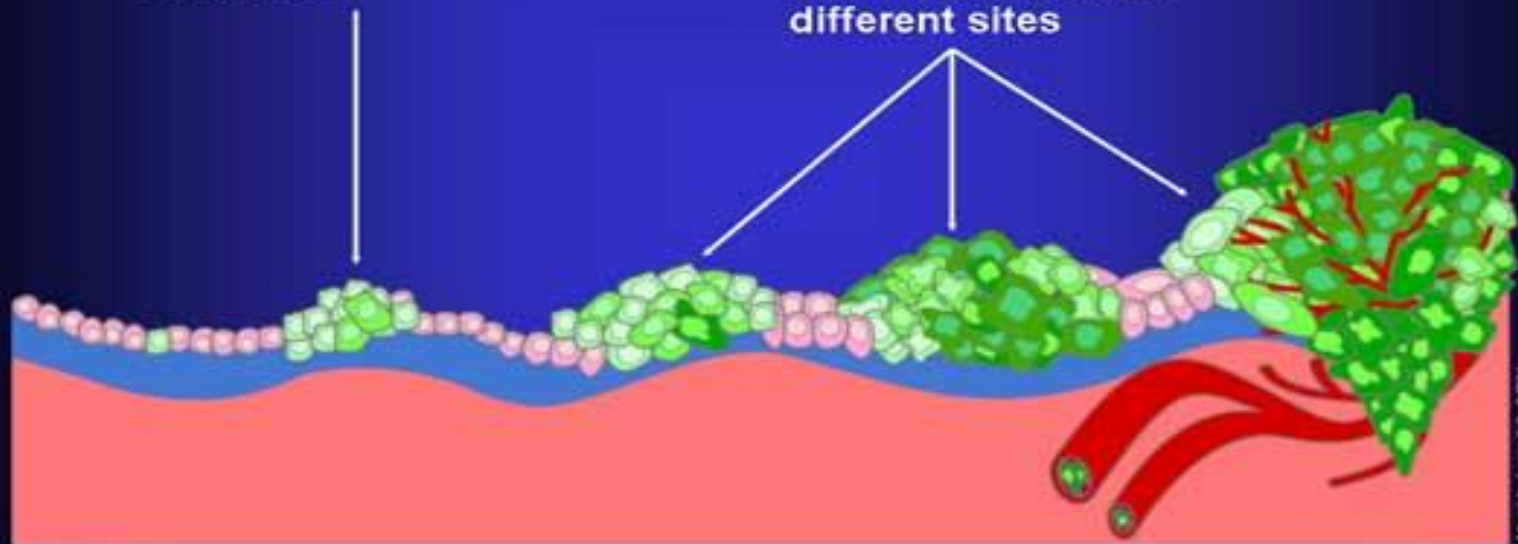
- **Cancer may be regarded as a group of diseases characterized by an**
 - **Abnormal growth of cells**
 - **Ability to invade tissue and even distant organs**
 - **The eventual death of the affected patient if the tumor has progressed beyond the stage when it can be successfully removed**

TYPES OF TUMORS

Malignant versus Benign Tumors

Benign (not cancer)
tumor cells grow
only locally and cannot
spread by invasion or
metastasis

Malignant (cancer)
cells invade
neighboring tissues,
enter blood vessels,
and metastasize to
different sites



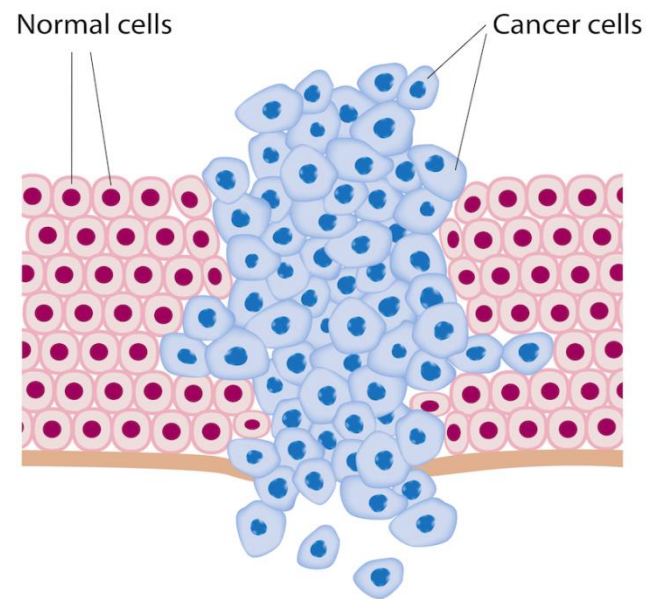
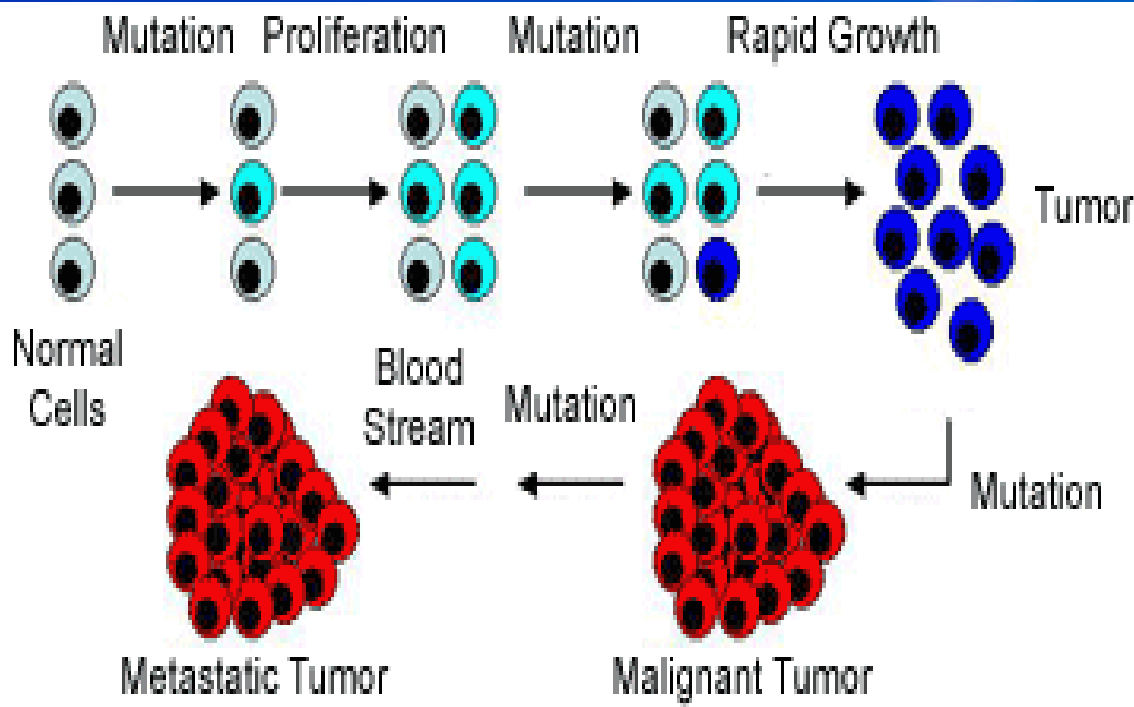
Time →

TYPES OF CANCER

- Lung cancer
- Breast cancer
- Colon and rectal cancer
- Endometrial cancer
- Pancreatic cancer
- Kidney cancer
- Prostrate cancer
- Thyroid cancer
- Leukemia

What causes cancer?

- Cancer arises from the **mutation** of a normal gene.
- A factor which brings about a mutation is called a **mutagen**.
- It is thought that several mutations need to occur to give rise to cancer
- Mutated genes that cause cancer are called **oncogenes**.



What causes cancer?

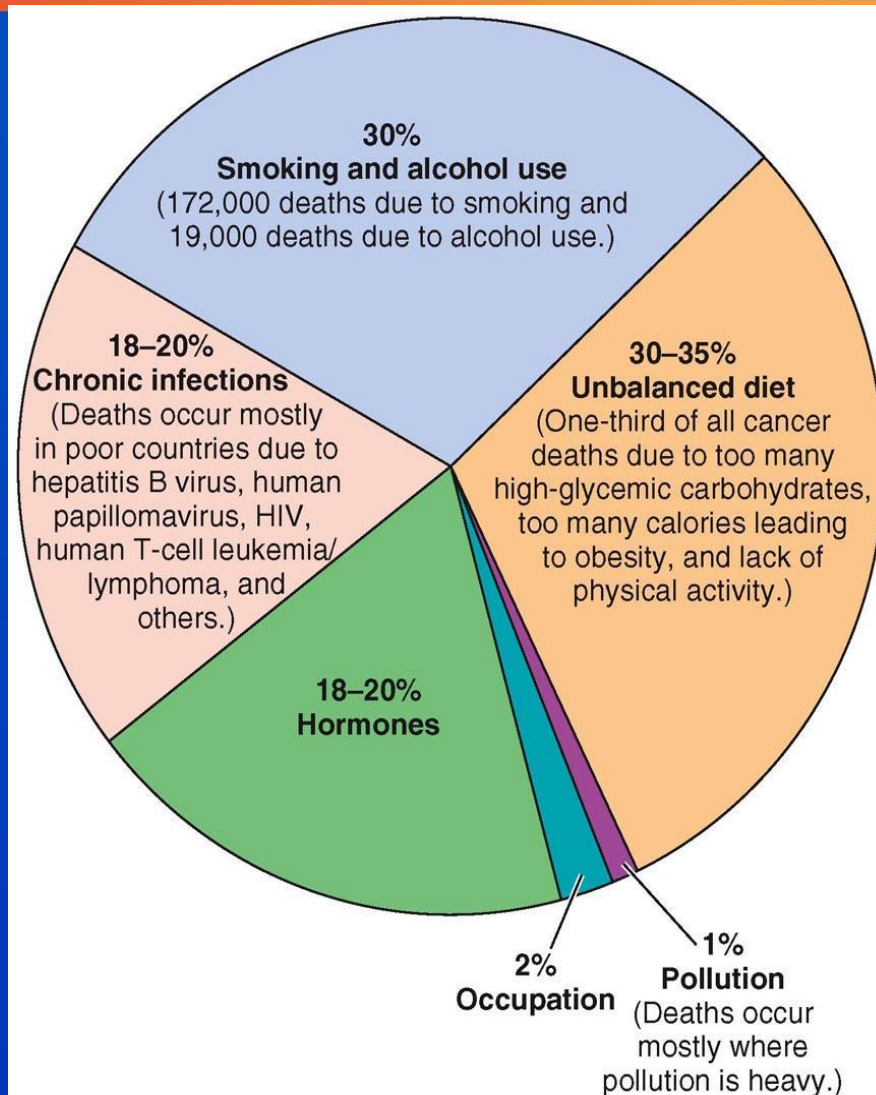
Around one third of cancer deaths are due to the 5 leading behavioural and dietary risks:

- High Body Mass Index (BMI)
- Low fruit and vegetable intake
- Lack of physical activity
- Tobacco use
- Alcohol use

Dietary risks are mainly:

- Intake high fatty and low fiber diet
- Low intake of antioxidants

Factors Believed to Contribute to Global Causes of Cancer



Cancer Statistics

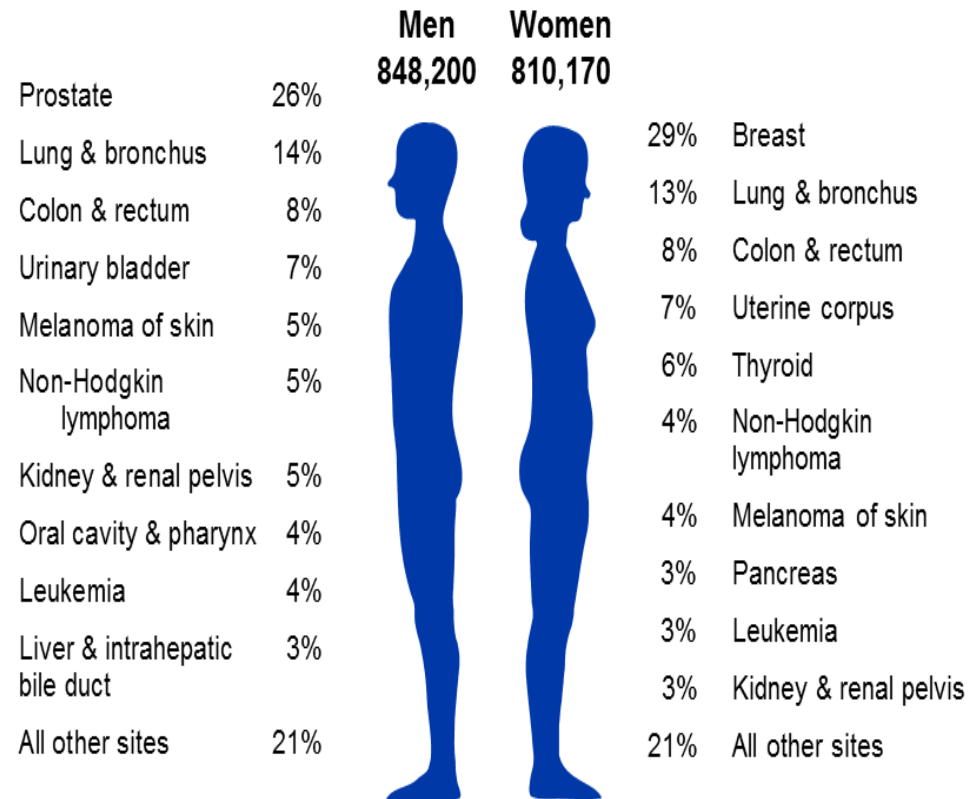
- 14 million new cases and 8.2 million cancer-related deaths worldwide in 2012.
- The number of new cases is expected to rise by about 70% over the next 2 decades
- Globally cancer is the second leading cause of death.

Cancer Statistics Contd...

It is estimated that more than 1.6 million new cases of cancer will be diagnosed in 2015.

Prostate cancer is the most common cancer among men (26%), followed by lung (14%) and colon & rectum (8%) cancers. Among women, breast (29%), lung (13%), and colon & rectum (8%) cancers are the most common cancers.

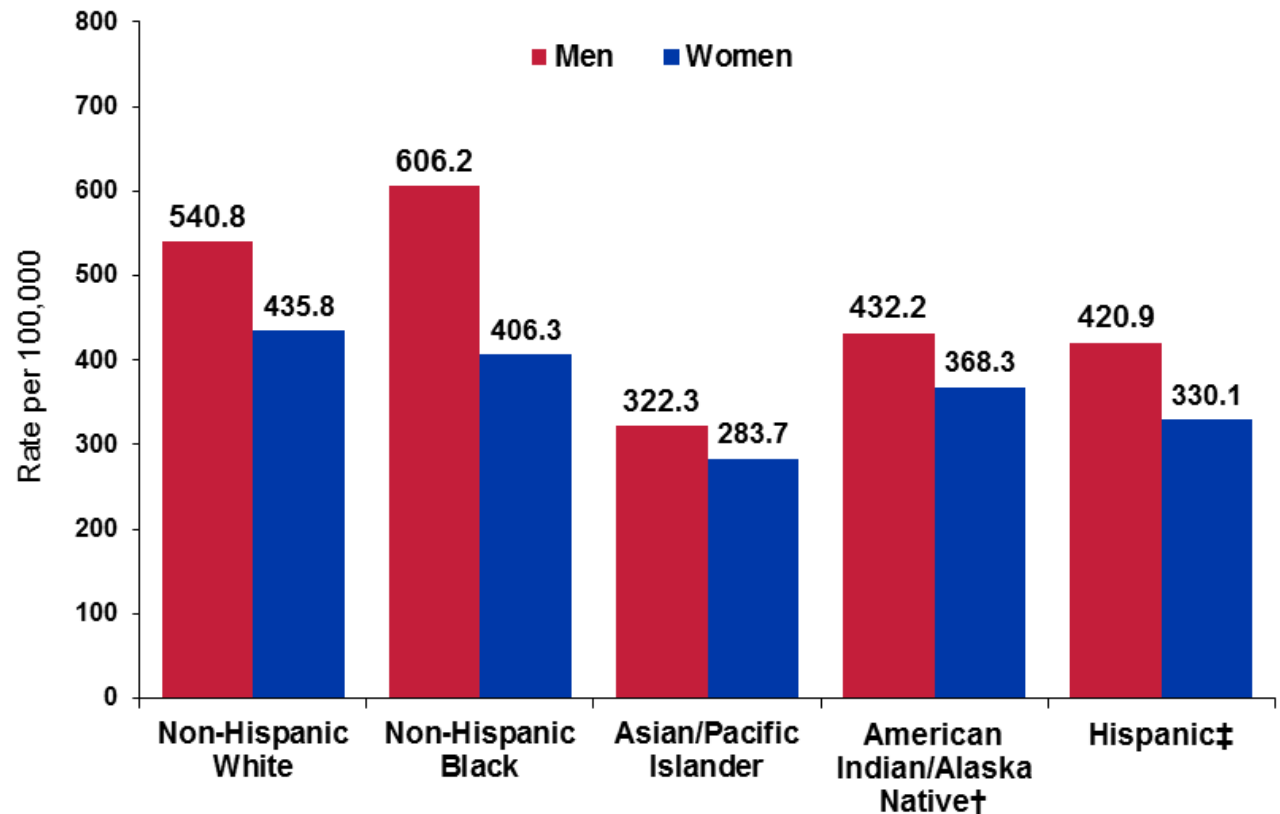
Estimated New Cancer Cases* in the US in 2015



*Excludes basal cell and squamous cell skin cancers and in situ carcinoma except urinary bladder.

Cancer Statistics Contd...

Cancer Incidence Rates* by Race and Ethnicity, 2007-2011



Note: Rates for populations other than white and black individuals may be underestimated due to incomplete information on race/ethnicity in medical records.

*Age-adjusted to the 2000 US standard population.

†Data based on Indian Health Service Contract Health Service Delivery Areas. Rates exclude data from Kansas.

‡Persons of Hispanic origin may be of any race.

Source: National American Association of Central Cancer Registries, 2014.

Cancer Statistics Contd...

Trends in Five-year Relative Cancer Survival Rates (%), 1975-2010

Site	1975-1977	1987-1989	2004-2010
All sites	49	55	68
Breast (female)	75	84	91
Colon	51	60	65
Leukemia	34	43	60
Lung & bronchus	12	13	18
Melanoma of the skin	82	88	93
Non-Hodgkin lymphoma	47	51	71
Ovary	36	38	45
Pancreas	3	4	7
Prostate	68	83	100*
Rectum	48	58	68
Urinary bladder	72	79	79

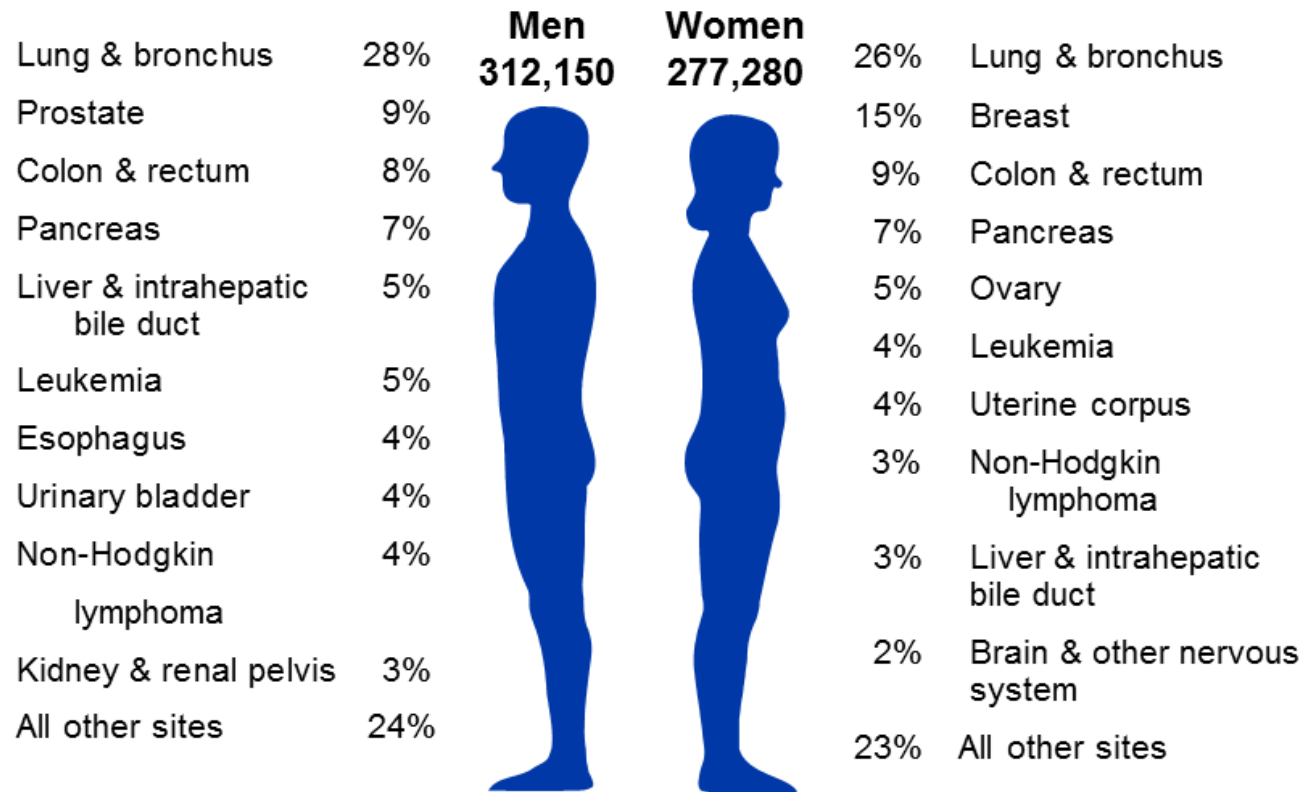
5-year relative survival rates based on patients diagnosed in the SEER 9 areas from 1975-1977, 1987-1989, and 2004-2010, all followed through 2011.

*99.6%

Source: Surveillance, Epidemiology, and End Results (SEER) Program, National Cancer Institute, 2014.

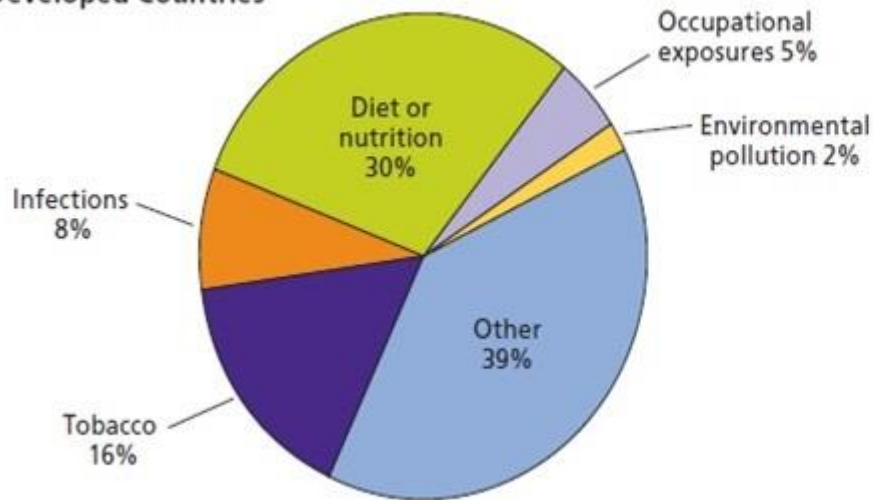
Cancer Statistics Contd...

Estimated Cancer Deaths in the US in 2015

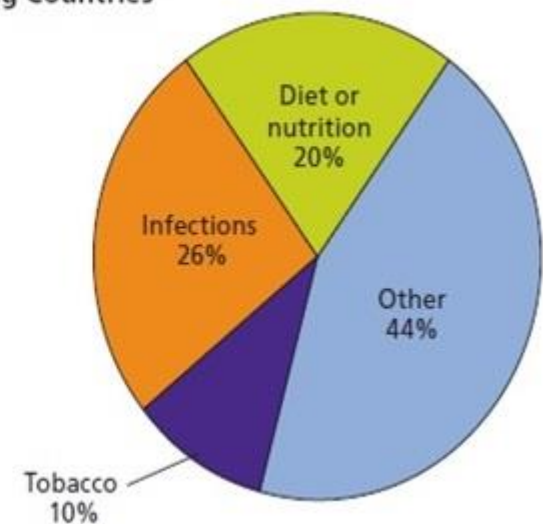


CANCER CAUSES IN DEVELOPED AND DEVELOPING ECONOMIES

Developed Countries

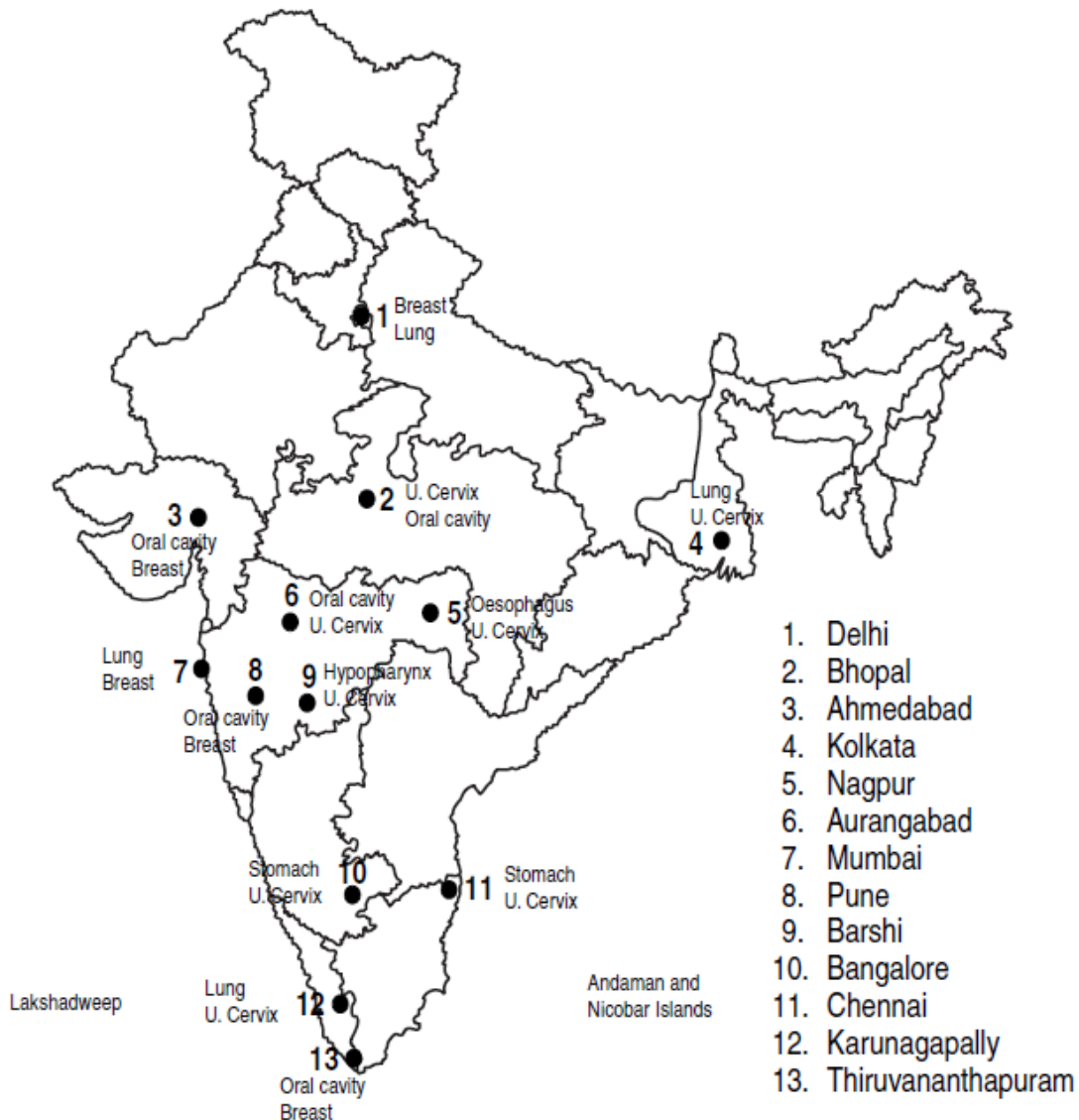


Developing Countries



Source: Cancer Atlas

Indian cancer statistics



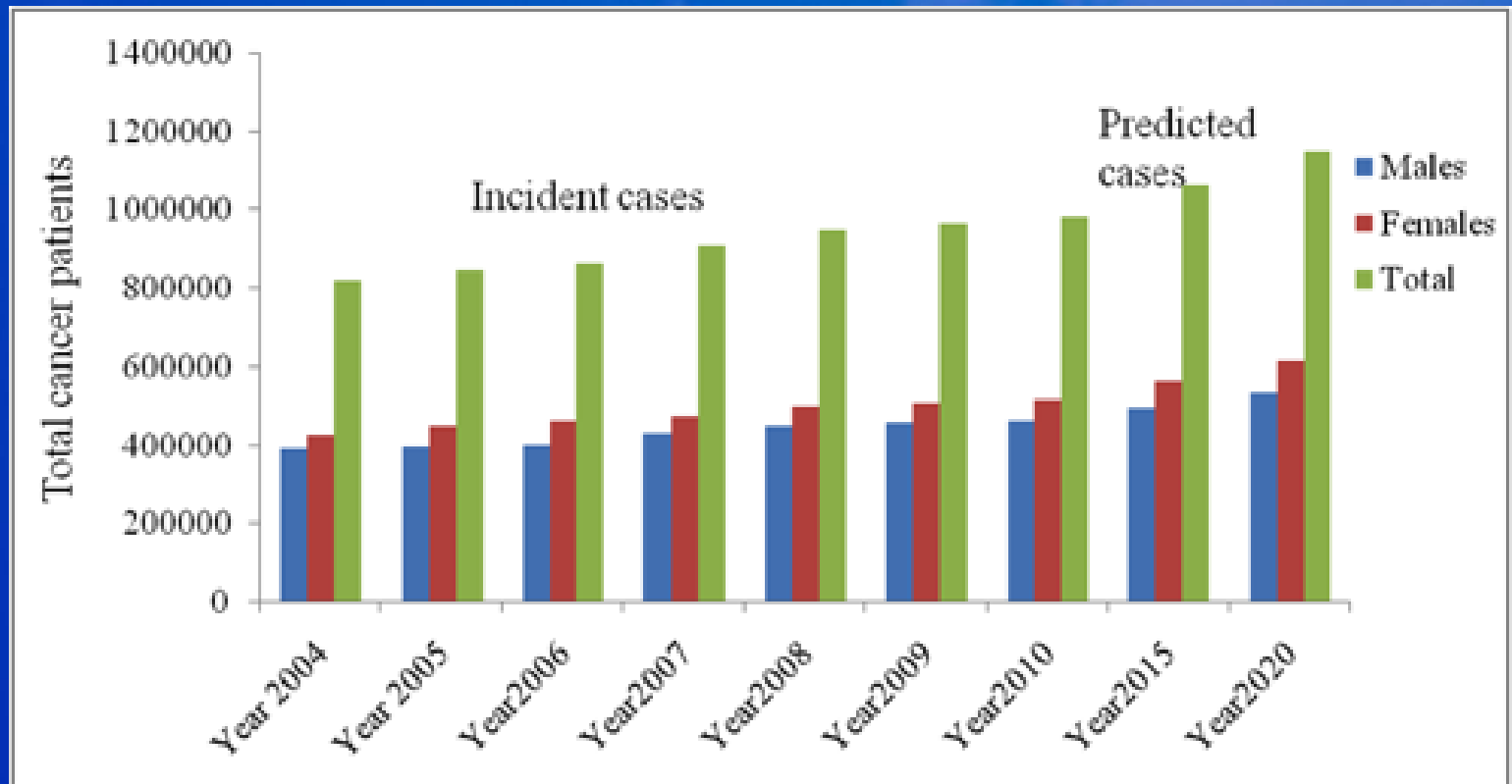
➤ **8 lakh new cases /year**

➤ **24 lakh prevalent cases**

➤ **13% in women (uterine cervix)**

➤ **9% in women (breast)**

Cancer scenario in India



Year wise total cancer prevalence in India [ICMR, 2006; ICMR, 2009]

Hippocrates saying about food

Greek Physician Hippocrates,

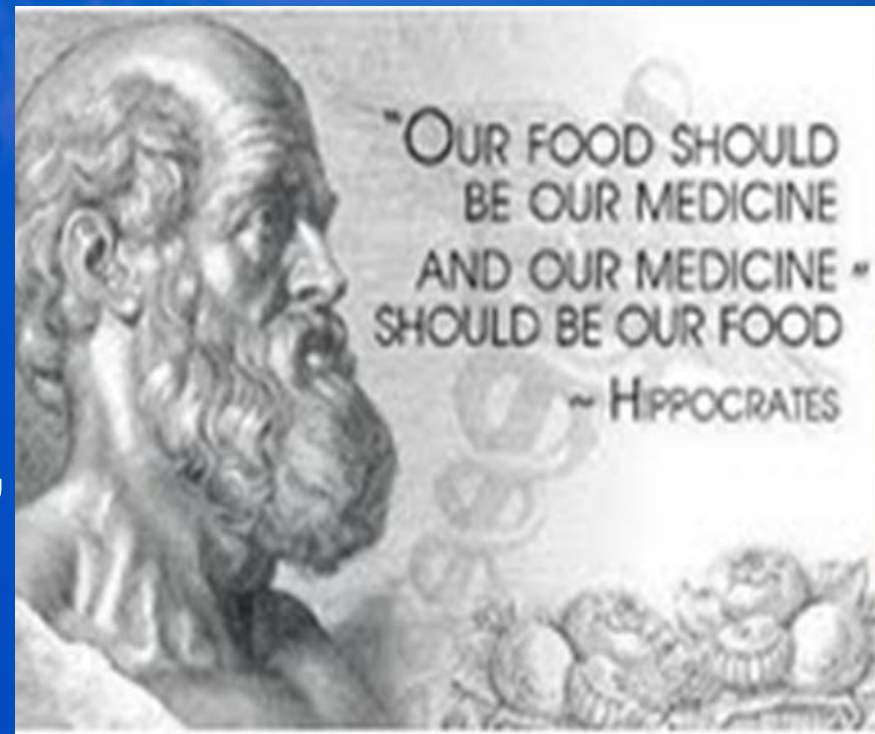
Known as father of Medicine.

(said several centuries ago)

**“Let Food be Your
Medicine”**

The Philosophy behind is:

“Focus on Prevention”



The term “Nutraceutical”

- The term “Nutraceutical” was coined from “Nutrition” & “Pharmaceutical” in 1989 by

Stephen DeFelice,

MD, Founder and Chairman of the
Foundation for Innovation in Medicine
(FIM).

- Other words used in the context:
Dietary supplementation, Functional,
Multi-functional Foods, etc.



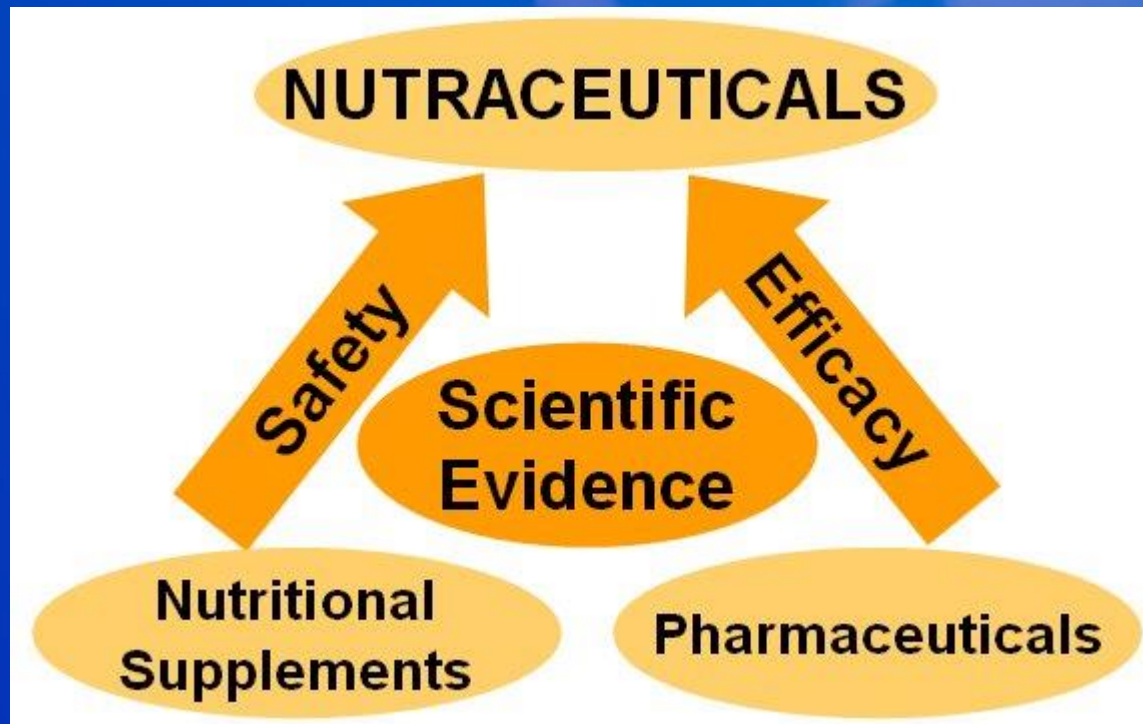
Nutraceutical can be defined as

“ A food or part of food or nutrient, that provides health benefits, including the prevention and treatment of a disease.”

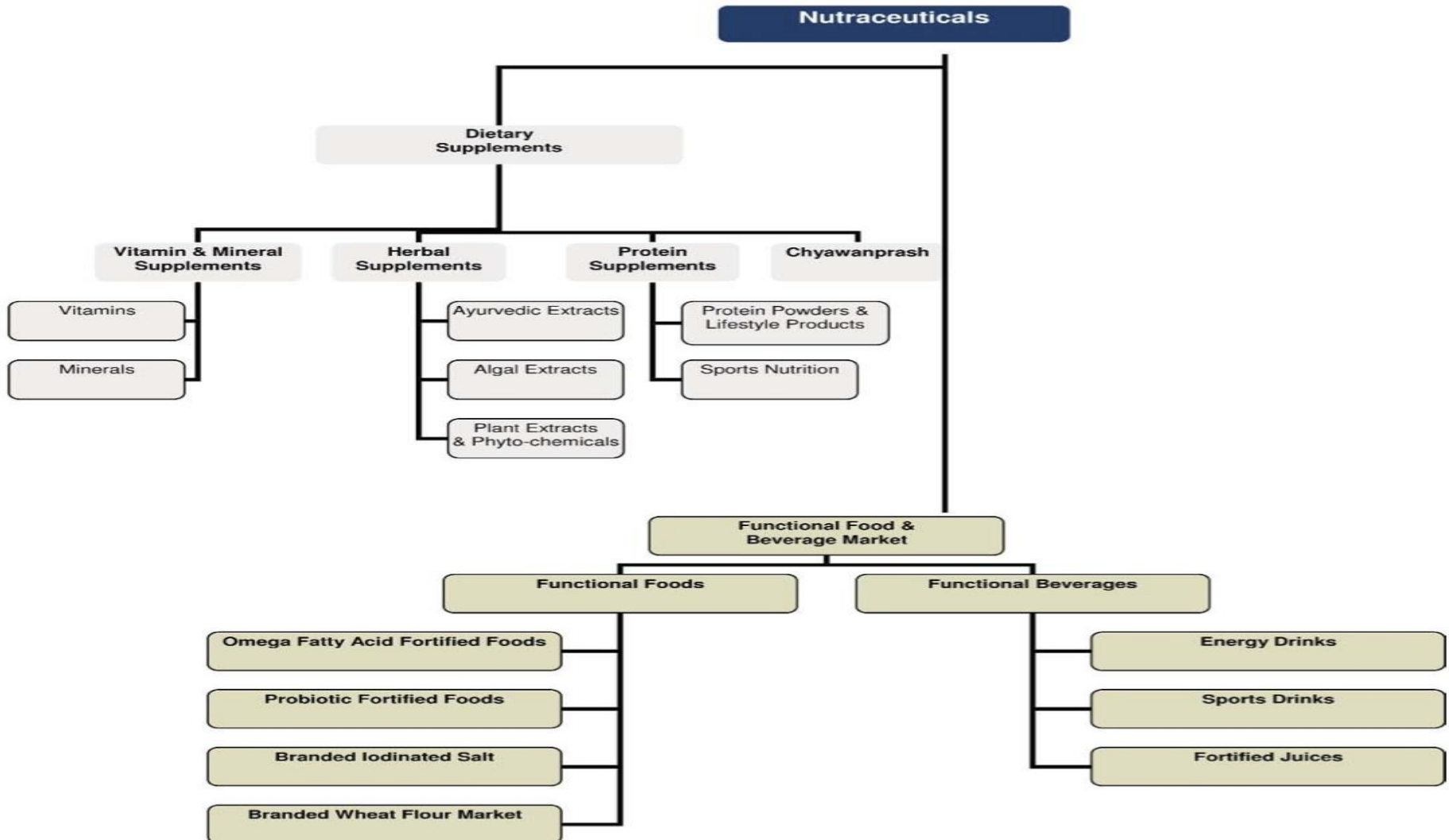
Nutraceuticals

- **What are nutraceuticals**
- **It is a broad term that is used to describe any product derived from food sources with extra health benefits**
- **Nutrient: a nourishing food component**
- **Pharmaceutical: a medical drug**

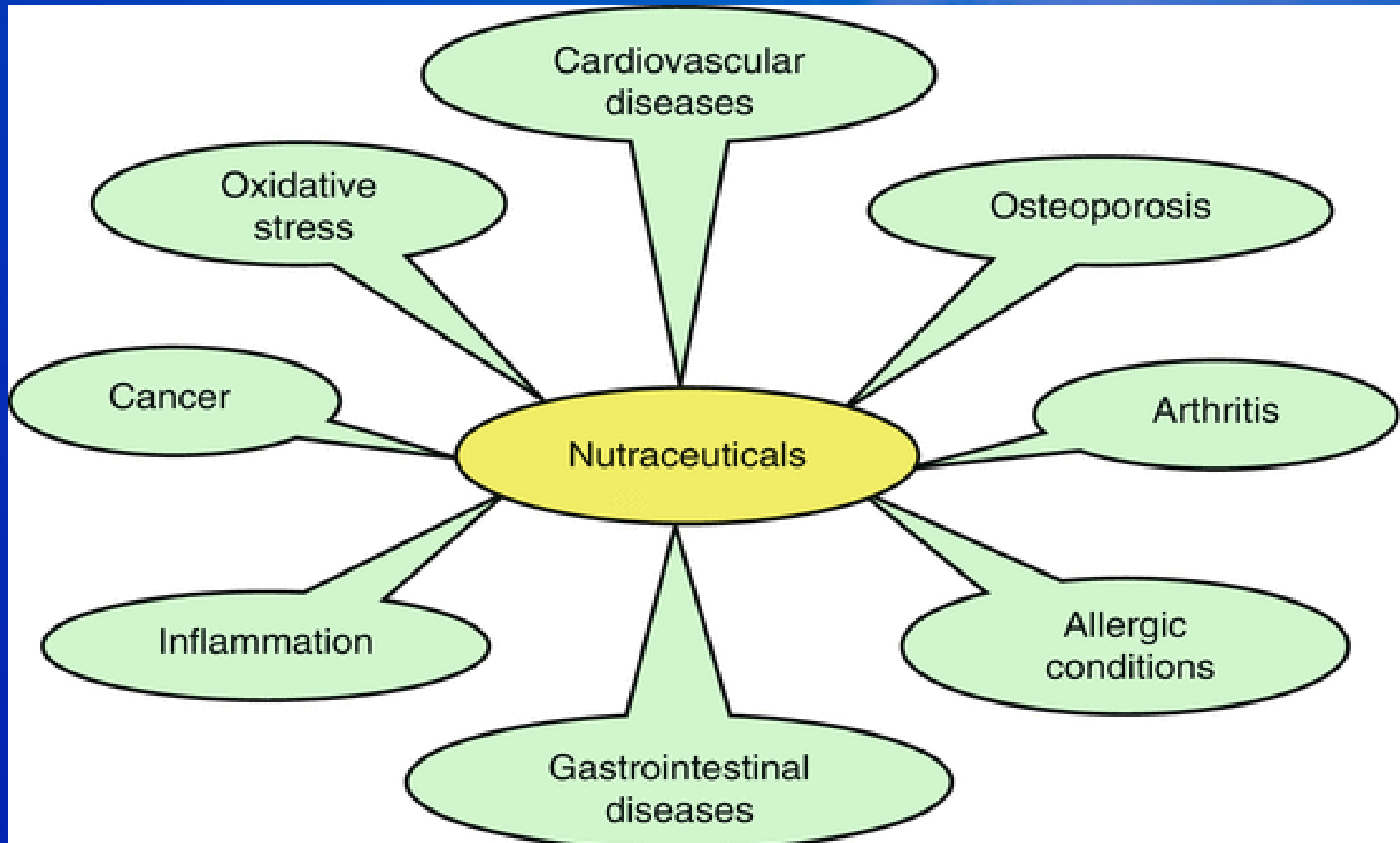
Why nutraceuticals are important



Nutraceuticals



Nutraceuticals Applications



Carotenoids as Nutraceuticals

Carotenoids

components	Source	Potential benefit
β - caroteine	Berseem,lucerne ,oat & maize fodder, Carrots, vegetabels,fruits	Nutralises free radicals
Luteine	vegetabels	Healthy vision
Zeoxanthine	Eggs,citrus,corn	
Lycopene	Tomatoes	Reduce prostate cancer
Astaxanthin	sockeye salmon, red trout, red seabream, lobster, shrimp, crawfish, crabs, salmon roe, algae and microbial source	astaxanthin is considered a super-antioxidant; it is ten to twenty times more powerful than many other carotenoids, including beta-carotene, lutein, and zeaxanthin, and a hundred-times more powerful than alpha-tocopherol.

CAROTENOID NUTRACEUTICALS AVAILABLE IN MARKET

Brand name	Components	Function
Betatene	Carotenoids	Immune function
BioAstin, EyeAstin, JointAstin, OmegaAstin	Fish, Prawn meat etc	Energy, Joint pains, Eye, Anticancer activity and anti lipid peroxidation

Benefits and risk for use of nutraceuticals by cancer patients

Nutraceutical	Active agent	Potential benefit	Potential risk
Chile pepper	Capsaicin	Anti-inflammatory	Irritant
Cloves	Eugenol	Anti-inflammatory	Not clear
Ginger	Gingerol	Suppresses nausea	Not clear
Fenugreek	Diosgenin	Limited data but maybe anti-inflammatory	Not clear
Grapes and muscadines	Resveratrol	Anti-inflammatory	Kidney damage
Green tea	EGCG	Anti-inflammatory, antiangiogenic	Poor absorption may require high doses
Pepper (black)	Piperine	Stem cell behavior	Not clear
Soy	Isoflavones	Selective stimulus of ER β	Antagonize SERMs
Turmeric	Curcumin	Anti-inflammatory and antiangiogenic	Poor absorption may require high doses

Astaxanthin

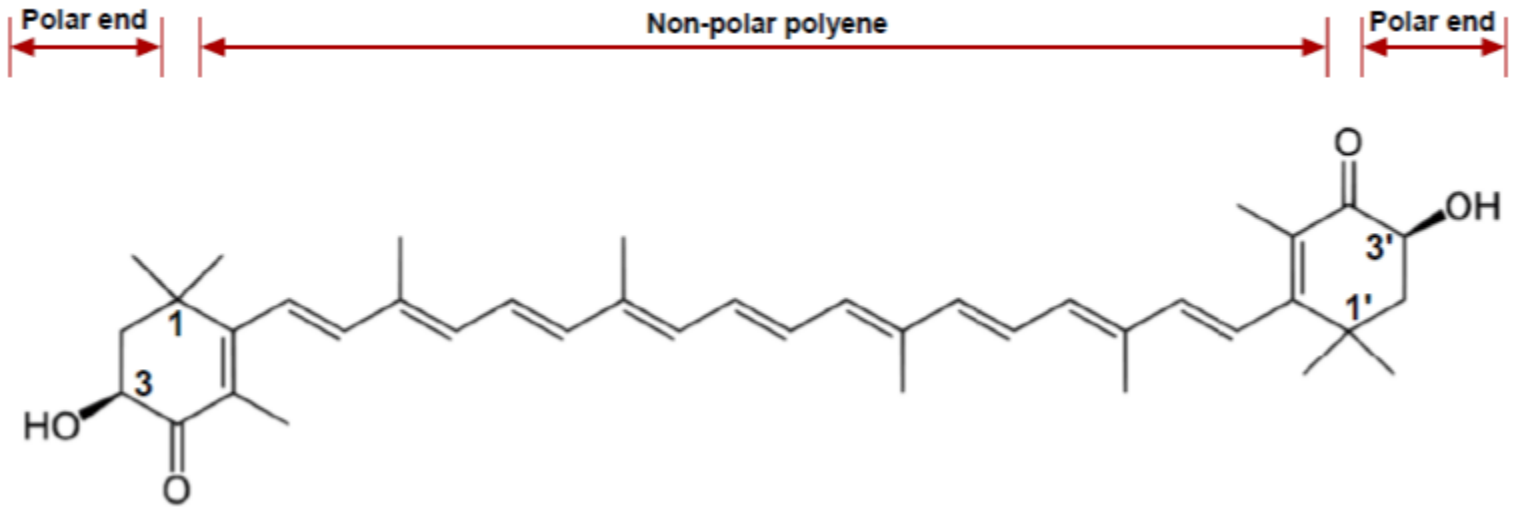
- Astaxanthin is the carotenoid pigment
- It provides red color.
- It is a fat soluble pigment
- Molecular formula is $C_{40}H_{52}O_4$

Astaxanthin – Chemical structure

- Astaxanthin is a red-pigment carotenoid occurring naturally in a wide variety of living organisms and classified as a xanthophyll.
- It has a chemical structure similar to that of the familiar carotenoid β -carotene.
- It is commonly found in crustaceans (e.g. shrimps, crawfish, crabs and lobster) and produced by microalgae.
- The pink flesh of a healthy wild salmon is due to the presence of astaxanthin. It has been suggested that
- astaxanthin protects muscle cells from damaging effects of active oxygen produced upon swimming upstream.
- Astaxanthin contained in salmon roe is considered to protect the roe from reactive oxygen species generated by UV rays.



Astaxanthin



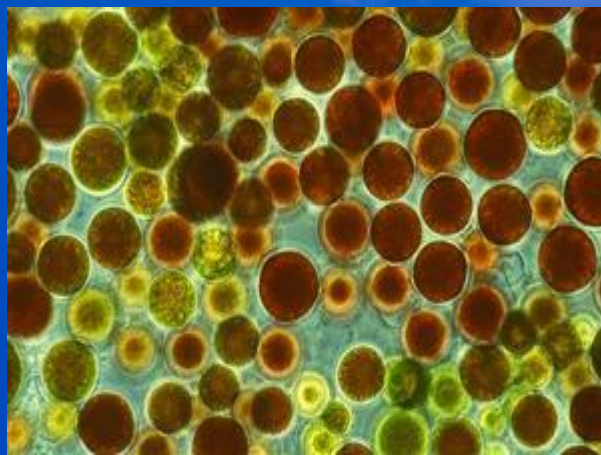
Plasma membrane



Where does Astaxanthin come from?



sockeye salmon



H. pluvialis



lobster



shrimp

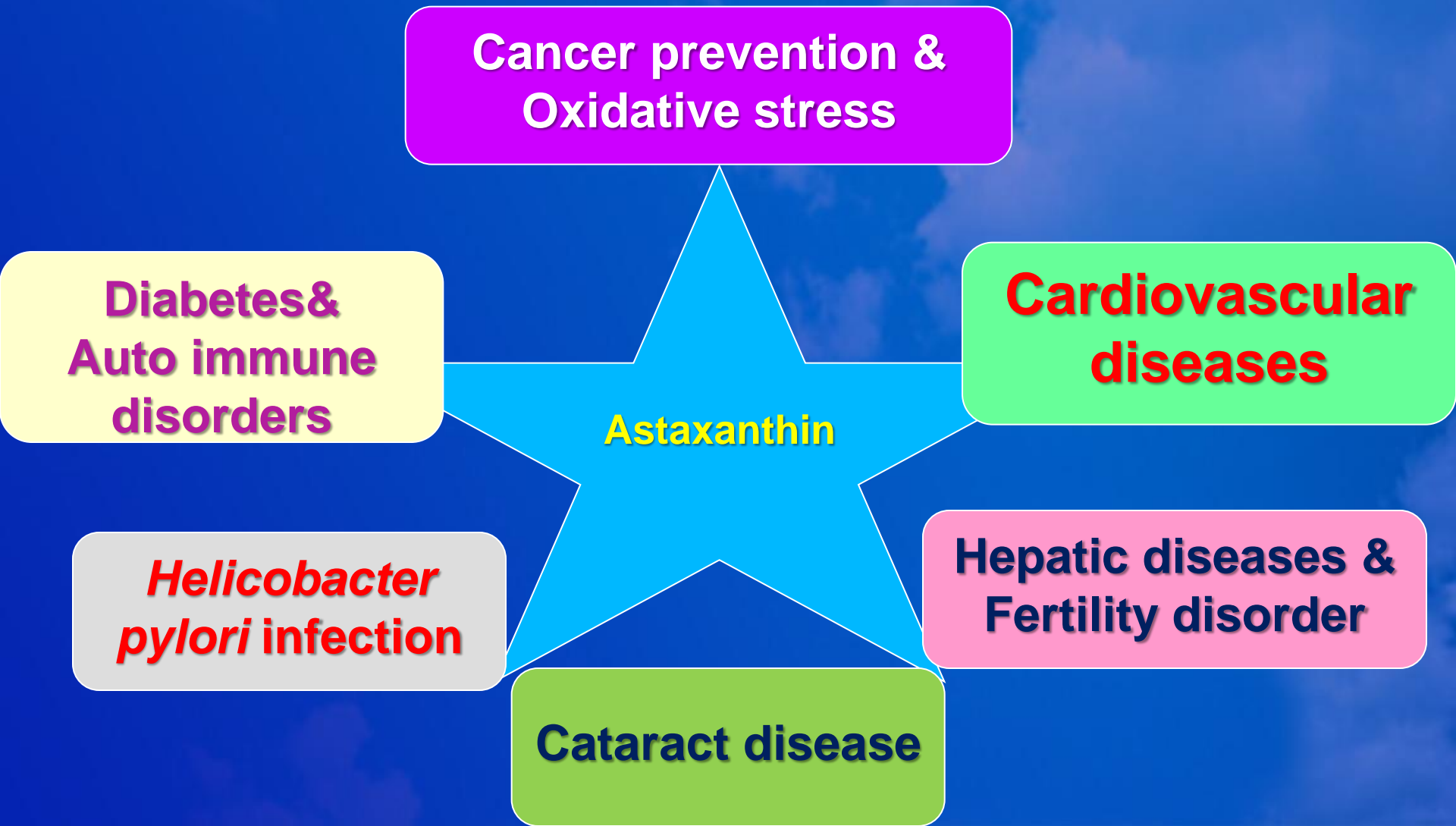


crab



crawfish

Applications of Astaxanthin



Cancer – Oxygen

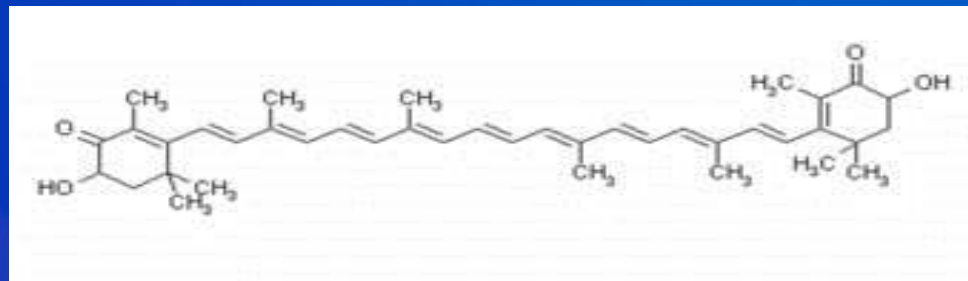
- The higher eukaryotic aerobic organisms cannot exist without oxygen
- Oxygen represents a danger to their very existence due to its high reactivity. It has been termed the paradox of aerobic life.
- Reactive oxygen species generated are: superoxide, hydrogen peroxide and the hydroxyl radical.
- In addition, singlet oxygen can be generated through photochemical events (such as in the skin and eyes), and lipid peroxidation can lead to peroxy radical formation.
- These contribute to aging and degenerative diseases: cancer and atherosclerosis through oxidation of DNA, proteins and lipids.

Singlet oxygen quenching abilities – Astaxanthin

- Among series of studies, one research group compared the singlet oxygen quenching abilities of several carotenoids: astaxanthin, canthaxanthin, zeaxanthin, β -carotene, fucoxanthin and halocynthiaxanthin.
- Singlet oxygen (1O_2) was generated by naphthalene-derived endoperoxide; Then known amount of carotenoids was added and the quenching rate constant (K_q) was calculated from the decrease in singlet oxygen-generated infrared chemiluminescence.
- The K_q value of astaxanthin was reported to be the highest; 3.3×10^9 , while the commonly known β -carotene has a K_q value of 0.089×10^9 .
- Hence, astaxanthin has an increased singlet oxygen quenching ability over the corresponding alkyl carotenoid, β -carotene.

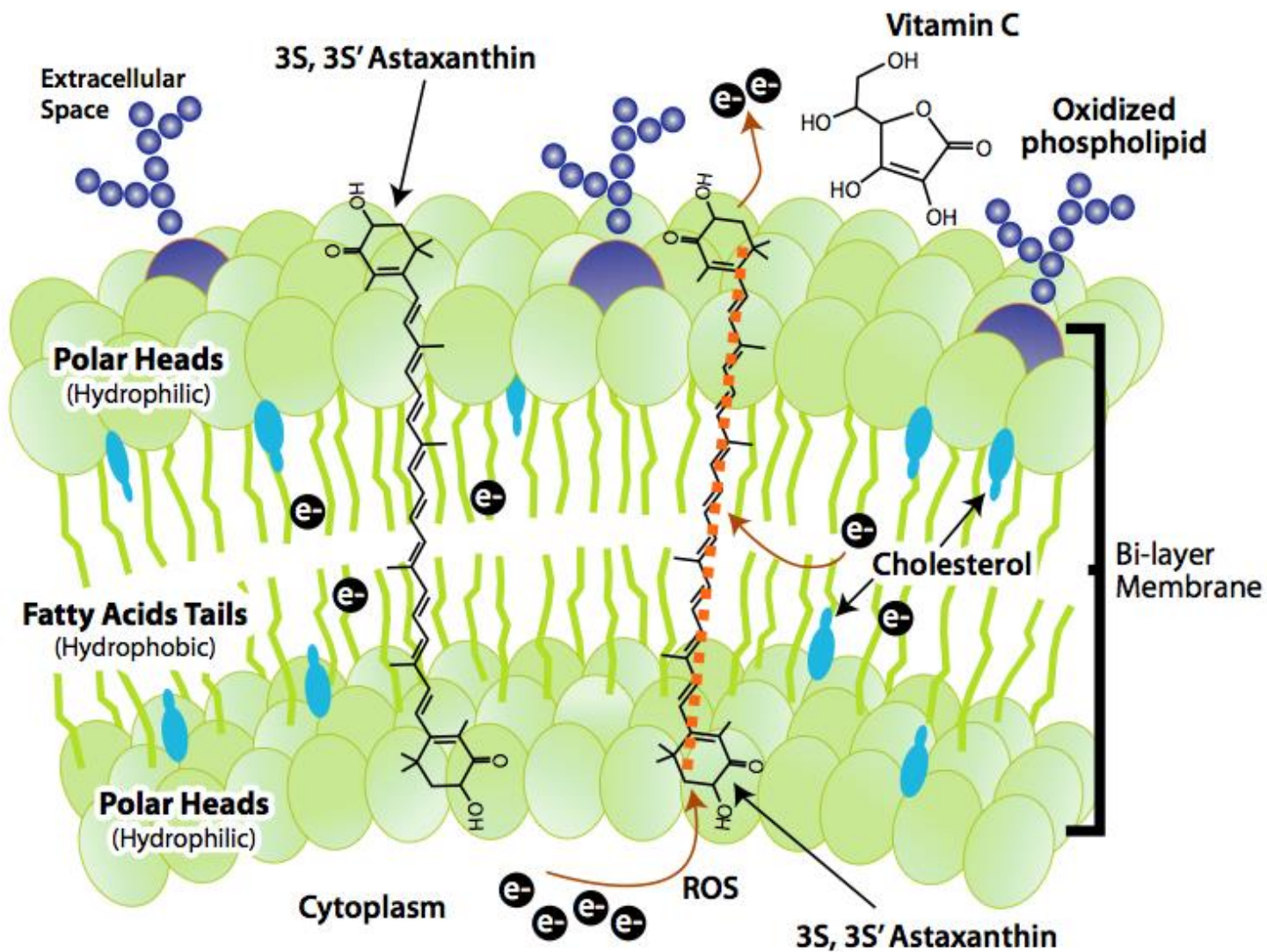
Antioxidant Effect – Astaxanthin

- Astaxanthin has unique chemical properties based on its molecular structure.
- The presence of hydroxyl (OH) and ketone (C=O) moieties on each ionone ring along with an extension of conjugated double bond system explained the potency of astaxanthin with higher antioxidant activity compared to β -carotene and vitamin E.
- 2 most prominent antioxidant activities of astaxanthin are quenching of singlet oxygen and inhibition of lipid peroxidation





Astaxanthin



Astaxanthin Extraction Methods

Currently astaxanthin extracted by the following methods

1. Fermentation
2. Solvent Extraction
3. Concentration by lyophilisation
4. Purification by chromatographic methods
5. Determination of purity

Method selection depends on the source from which extraction is done

Equivalent amount of Astxanthin in food relative to recommended daily intake of 6mg per day

Sockeye (1 piece 80g)	2.4 pieces
Kirk Salmon (1 piece 80g)	5 pieces
Salmon roe (1 table spoon 25g)	30 table spoons
Prawns (1 huge prawn weight 70g)	30 huge prawns
Crabs (1 cup 500g)	1.8 cups
Krill	30g

(equivalent to 30mg of Astaxanthin-20)

Astaxanthin Types

- **Astaxanthin-5 (Oil, Food Grade)**
- **Astaxanthin-20 (Oil, Food Grade)**
- **Astaxanthin-P1 (Powder, Food Grade)**
- **Astaxanthin-LS1 Water-soluble Liquid, Food Grade)**
- **Astaxanthin-5C (Oil, Cosmetic Grade)**
- **Astaxanthin-20C (Oil, Cosmetic Grade)**
- **Astaxanthin-PC1 (Powder, Cosmetic Grade)**
- **Astaxanthin-LSC1(Water-soluble Liquid, Cosmetic Grade)**

Future Studies

- **Novel technologies and strategies are critically required for isolation. Purification, characterization and quality improvement to meet the demands of medical field.**
- **Further studies should focus on astaxanthin for medical application is promising and prospective future in nutraceutical industry.**

Conclusion

- Astaxanthin is one of the important sources of natural carotenoids
- It produce yellow-red color in plant and animal products
- Astaxanthin is the major carotenoid pigment.
- An excellent antioxidant, Anti-carcinogenic, retina precursor
- Used in aquaculture, food colorant and cosmetics
- Use as a pigment source feed for cultured Salmon and Shrimps.

Conclusion

- In food science, the trends in production of foods with nutraceuticals have been increasing its demand in global market as food consumers are considering it for specific health needs.
- The greatest increase in natural nutraceuticals use in the next several years with a concept of intake of “ **a nutraceutical a day may keep the doctor away**”

Thank you