Food Safety from Farm to Fork--Recent Public Health Concerns

Kalpagam Polasa, PhD, MBA

Scientist G and Director i/c (Retd)

National Institute of Nutrition

Hyderabad 500 007

kpolasa@yahoo.com

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Why We Need Food?

- **By Function:**

Body building foods – rich in proteins--meat, fish, milk, egg, pulses etc

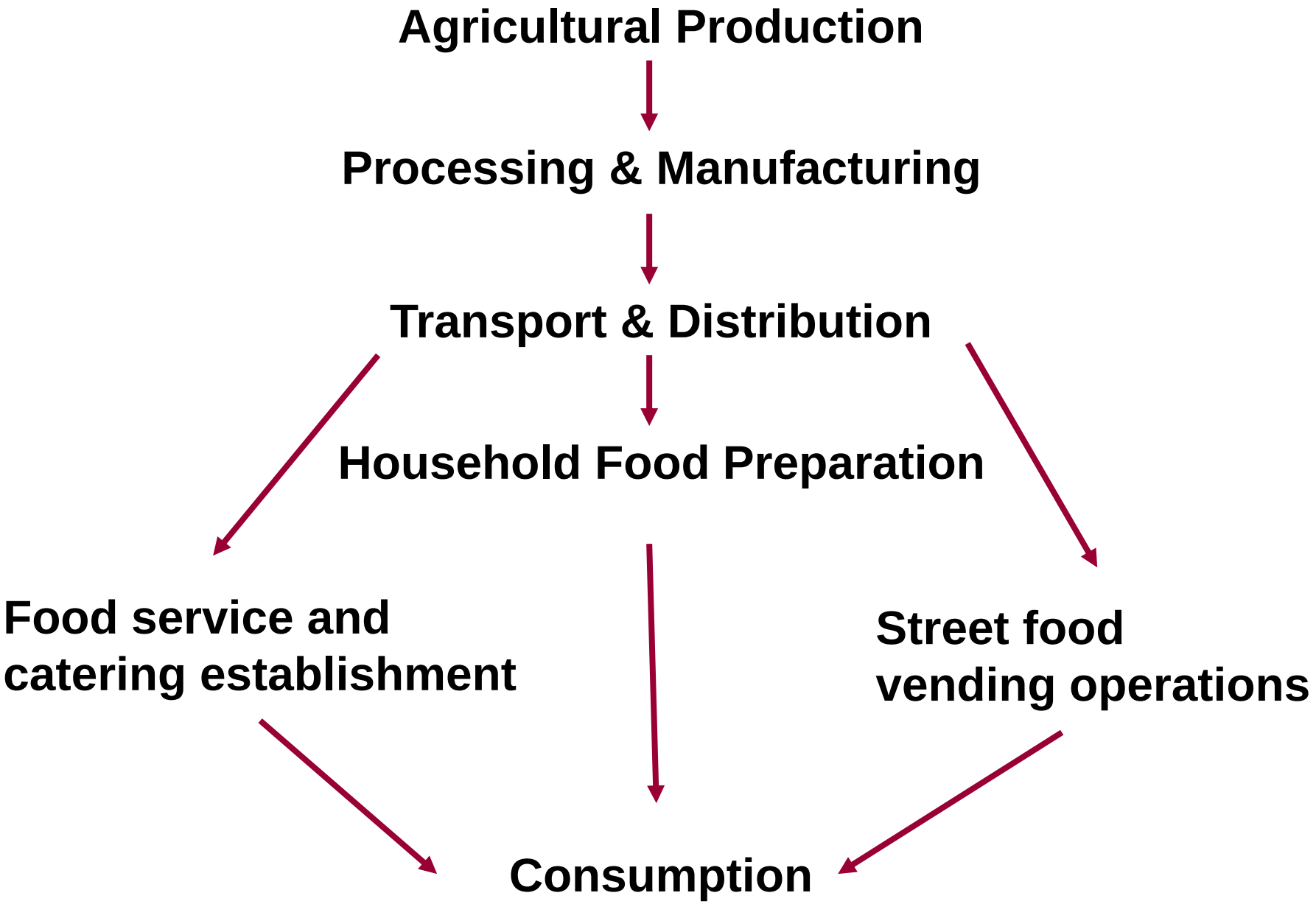
Energy yielding – rich in fats and carbohydrates, Ex cereals, sugars, ghee and oil etc

Protective food – rich in vitamins & minerals, Eg fruits, vegetables etc

- **By Nutritive values :**

Cereals & millets, pulses, vegetables, nuts and oil seeds, fruits, animal foods, fats and oils, sugar and jiggery, condiments and spices, miscellaneous foods.

Model Food Chain



Issues of Developing Nations

- **Food production, processing, marketing systems complex**
- **Small producers, highly fragmented, food passes through many food handlers and middlemen exposing the food to unhygienic environment, contamination and adulteration**
- **Inadequate storage conditions, shortage of safe water, electricity, non-availability of cold storage, transport facilities**
- **Majority of food producers and handlers lack knowledge and expertise in use of GAP, food safety and handling practices**

Challenges

- **Street Food**
- **Food Borne Illnesses -Emerging Pathogens**
- **Food Adulteration**
- **Chemical Contamination of Food Including Pesticides**
- **Effect of Climate Change on Food Safety**
- **Imported Food**

Indian Food Processing Industry

- **Indian food processing industry is one of the largest in the country and India is one of the important food producers in the world**
- **The Indian food processing industry accounts for 32 per cent of the country's total food market, and is ranked fifth in terms of production, consumption, export and expected growth**
- **It is valued at US$ 39.71 billion! is expected to grow at a Compounded Annual Growth Rate (CAGR) of 11 per cent to US$65.4 billion by 2018. The Indian food retail market is expected to reach Rs 61 lakh crore (US$ 894.98 billion) by 2020**
- **It contributes around 14 per cent of manufacturing Gross Domestic Product (GDP), 13 per cent of India's exports and six per cent of total industrial investment. Indian food service industry is expected to reach US$ 78 billion**
- **The online food ordering business in India is in its nascent stage, but witnessing exponential growth. The organized food business in India is worth US$ 48 billion, of which food delivery is valued at US$ 15 billion. With online food delivery players like FoodPanda, Zomato,TinyOwl and Swiggy building scale through partnerships, the organised food business has a huge potential and a promising future.**

Market Drivers for Innovation

- Increased burden due to FBD
- Emerging pathogens
- Newer contaminants
- Globalization of trade, TBT, SPS
- Introduction of novel foods, food supplements
- Increased urbanization

Adversaries for Growth

- **Availability Of Poor Infrastructure Facilities**
- **Scarcity Of Cold Storage And Electricity, Improper Storage And Warehousing**
- **Improper Quality Systems And Their Implementation/Enforcement**
- **Validated Testing Facilities**
- **Too Many Middle Men In Food Chain**
- **High Cost Of Transportation**
- **Inventory Carrying Cost And Fiscal Taxes**

Other Issues

- **Traceability**
- **Withdrawal & Recall**
- **Lab Information and Management system (LIMS) & IT**

What is meant by Food safety

- **Food safety essentially has to be adhered to at all steps that are involved in the food chain, that is from cultivation to consumption or “farm to fork” as it is commonly referred to**
- **Good hygienic practices should be followed during transportation of raw food, storage, processing / cooking**
- **Raw food items or cooked food must be stored in hygienic manner. The conditions would vary depending on whether it is dry food items like cereals, pulses, oils etc, or highly perishable commodities like milk, fruits and vegetables, non-vegetarian items**

Food Safety Aspects

From consumers perspective

- **Food must be safe with zero toxicity and zero risk**
- **Toxicity - a substance that can produce harm/ injury either acute or chronic.**
- **Hazards - relative probability that harm or injury results when a substance is used in proposed manner and quantity.**

Hazards in Foods

- There are three types of hazards--Physical, chemical and biological
- Physical objects are visible to naked eyes and therefore most likely to be reported by consumer
- In view of their easy detection it is not possible to hide the contamination
- These contaminants are mostly found in the food as a result of willful adulteration
- Sometimes these can be found in the raw materials or foods as result of food processing for example iron filings in tea leaves(Permissible 150mg/kg)

Physical Hazards

Metals and other non-biologicals	Biologicals
Metal, glass, stones	Insects
Wood, plastics, jewelry	Hair
Gum,paint flakes, writing pen	Bone
Carcass tags, band-aid	Insects
Meat hooks, wire clips, Blades	Rodent droppings
Strings, thread	Feather

Definition of a Physical Hazard

- **Physical hazard is any foreign matter in a food item which may cause illness or injury to a person consuming the food**

- **Sources for contaminants are raw materials, badly maintained facilities and equipment, improper production procedures and poor employee practices**

Control of Physical Hazards

- **Processors must control physical hazards by developing hazard analysis at critical control points (HACCP), implement and monitor food production to exercise control at points where contamination occurs**
- **Control measures include raw material inspection and specification, vendor certification and letters of guarantees, metal detectors, x-ray technology (to detect bone fragments), and effective pest control in the facility, preventative equipment maintenance and sanitation procedures**
- **Hygienic handling of packaging material, proper shipping, receiving and storage practices in an appropriate manner and packaged finished products in tamper-proof or tamper-evident packaging**

Health Effects

- **Physical contaminants may not spoil food but may cause injury**
- **Contaminants like packaging material, insects, and rodent droppings spoil the taste and aesthetics**
- **Insect and rodent contamination may eat large volume of food and/or destroy food, secondly microbe may enter the food because of the insects or rodents.**
- **When flies walk on food, microbes can transfer from the flies' feet to the food.**
- **Insects and rodents also damage the surfaces of foods such as fruits and vegetables facilitating openings microbes to enter and multiply within the foods**
- **Insects and rodents can contaminate the food supply at any stage of growth or production. Some insects lay eggs in wheat while it is growing in fields**
- **On the other hand, cockroaches are likely to enter the wheat**

Chemical and Biological Contaminants

- **Severe accidents related to heavy metals (lead, methyl mercury, copper) are known**
- **Additives not approved/ above permissible levels of approved additives**
- **Toxic oil syndrome – intended adulteration of edible oils**
- **Mycotoxin contamination**
- **Microbial contamination (unintended) (Vibrio cholerae, salmonellosis Listeria monocytogenes).**

Materials Quality

Water

Only potable water should be used in food handling and processing

Ice and steam should be made from potable water adequate supply of potable water with appropriate facilities for its storage, distribution and temperature control, should be available at all times to ensure the safety

Establishment---Location

Food establishment must be located far from polluted areas

There should not be industries that are likely to pollute the environment

Personal Cleanliness

- **Food handlers should maintain a high degree of personal cleanliness and wear suitable protective clothing, head covering, and footwear**

- **Personnel should always wash their hands at the start of food handling activities, and after handling raw food or any contaminated material, as this could result in contamination of other food items**

- **The food handlers must use gloves while handling ready-to-eat food and not use bare hands**

Detecting and Eliminating Physical Hazards during Production

- Magnets can be used to attract and remove metal from products.
- Metal detectors can detect metal in food and should be set up to reject products if metal is detected. Equipment should be properly maintained and calibrated to ensure it is always accurate and doesn't produce false positives
- X-Ray machines can be used to identify hazards such as stones, bones and hard plastics, as well as metal

Detection of Food Hazards by Innovative Technologies

- **Quick and rapid methods of microbial pathogens in foods -- readymade kits are available for quick testing**
- **Methods such as Automated plating, dilution techniques aid in fast sample preparation for microbiological assay and are very much useful during outbreaks of food borne illnesses and in the recall of contaminated foods.**
- **Automated colony counters are used for plate counting and the data is fed directly into the computer.**
- **Hydrophobic grid membrane filter (HGMF) technique is a filtration based method to count very low numbers of microorganisms**

Heavy Metals & Toxins

- **Spectroscopic techniques based on ultraviolet (UV), Visible (Vis), infrared (IR), nuclear magnetic (NMR), Atomic Absorption and Atomic Emission (AAS),other instrumentation like Inductively Coupled Plasma Optimal Emission (ICP-OES), Head Space GC (HS-GC) are used in food analysis.**
- **ICP-OES are used for the measurement of metal contamination in raw foods such as lead (pb)**
- **Melamine and related adulterants in finished processed foods are analyzed by GC/MS.**
- **HPLC and immune based assays are used for analysis of aflatoxins.**

Pesticides

- **Pesticides residues in foods are globally occurring chemical contaminants**
- **Analysis of food matrices poses challenge, the analytical process involves sample preparation, homogenization, extraction, cleanup, concentration and quantification.**
- **LC/MS, GC, GEMS based methods are used for their detection**
- **Cost effective mobile minilab devices development are underway to carry out pesticide analysis in the field.**
- **QuEChERS methods are used for sample preparation followed by automated GC/MS and LC MS-MS analysis.**

PAC

- **Other contaminants like polyaromatic components (PACs) are analyzed using High Resolution Gas Chromatography (HRGC), Gas Chromatography and multidimensional chromatography.**
- **Other modern techniques that are used in food analysis are High Performance Liquid Chromatography (HPLC), Supercritical Fluid Chromatography (SFC) where supercritical carbon dioxide is the mobile phase GC or LC detector is used**

Nanotechnology in Food Industry

- **Nanotechnology can be used in processing industry.**
- **According to USDA by 2015 global impact of products in which nanotechnology will play a key role will be approximately $ 1 trillion annually.**
- **Nanosensors can be used to detect pathogens in processed food.**
- **Can be used in HACCP**

Nanosensors and Pathogen Detection

- **Detection of virus, bacteria or toxin**
- **Biosensor techniques-- Nanoparticles can be devised by using flavours, colors or can be manufactured out of magnetic material**
- **Nanoparticles can be tailor made to specifically attack any food pathogen**
- **Advantage of biosensor -- thousands of nanoparticles can be placed on a single nanosensor to quickly and accurately detect the presence of many microorganisms**
- **The application can be made to detect rapidly pathogens in routine drinking water and food analysis**
- **Nanotechnology can also be applied in order to detect low amounts of toxins produced by microbes in the foods.**

Pathogenic Microbes & GM Foods

- **Rapid biochemical assays based on antigen-antibody precipitation principle, enzyme linked immune sorbent assay (ELISA), immuno chromatography, automated immune assays and electro immunoassays**
- **Polymerase chain reaction (PCR) and various nucleic acid based tests that are validated by AOAC International are available to detect pathogenic microbes in foods.**
- **The PCR based and immune assays are also applied to detect the novel proteins in genetically modified foods and food allergens**

Innovative Packaging to Ensure Food Safety

- Generally the packaging material is inert and is not supposed to react with the contents of packed material
- Innovations in packaging have been achieved so that the inner surface of the packaging material can contribute to food safety
- The inner surface is devised so as to exert antimicrobial activity so that packed food product has better shelf life
- The other usefulness of packaging is that surface can be used for communication and marketing

Packaging of Foods

- **Long chain polymer polyethylene terephthalate (PET) is one of the popular packaging polymer.**
- **Water, milk, juice etc. are packaged foods**
- **Contaminants in plastics which may be toxic can migrate into food.**
- **Migration studies in packed processed foods are important.**

Materials other than Plastic

- **Glass – has been used for many years, may result in leaching of lead.**
- **Ceramics – may result in leaching of heavy metals particularly when in contact with acidic beverages like fruit juices.**
- **Cans – food packed in tin cans with lead soldered seams are a source of a number of metals, including lead, chromium, tin and cadmium.**
- **Safety assessment of food packaging material requires knowledge of chemical toxicity, migration and technological developments.**
- **Human exposure data can be collected wherever possible**

Innovations in Packaging

- **Active packaging**

- **Packaging material contributes to much more than offering a barrier**
- **Inner surface may absorb oxygen or play some other functional role**

- **Intelligent packaging**

- **It has the potential to indicate some aspects of both the safety and quality of foods.**
- **Biosensors based on antibody or metabolite reactions offer potential for monitoring activity of enzymes in food or of microorganisms that may grow within the package. Besides indicators of microbial spoilage others like indicators of time plus temperature, gas composition, seal leakage,anti theft and RFID devices may be used**

Modified Atmosphere Packaging (MAP)

- **Head space gas modification is a method based on removal of oxygen, addition or removal of carbon dioxide, addition of ethanol vapor and addition or removal of water vapor**
- **Modified atmosphere packaging (MAP) is used commercially as part of multi hurdle approach to food safety in which several obstacles to microbial growth are used concurrently**
- **Oxygen scavenging sachets may be placed inside food package**
- **A number of desiccants are commercially available in sachet form and have potential of maintaining low water activity in packages of dried foods.**

Antimicrobial and Antimycotic Packaging

- **Nanoparticles of zinc oxide, magnesium oxide and silver oxide used for antimicrobial effects**
- **Nanomaterials are actively researched for specific functions such as microbial growth inhibition, as carriers of antibiotics and as microbicidal agents**
- **Silver infused into storage containers to retard bacterial growth. In a study reported, 24 hours growth of bacteria was reduced by over ninety eight percent because of silver nanoparticles**
- **In packed milk as milk begins to spoil, nanoparticles embedded in the milk carton can react with the changes resulting in change of colour of the carton. This would enable retailers and consumers to assess the quality of milk.**
- **Nanocomposite materials are currently being used in beer bottles allowing for a 6 month shelf life**

Applications of Active and Intelligent Packaging

- **The component of the packaging can inhibit microbial growth**
- **It can be devised to consume the oxygen present in the headspace or to modify the relative humidity so that organisms cannot grow**
- **The antimicrobial effect may be through release of permitted antimicrobials from the packaging material into the food**
- **Packaging of shelf stable foods, such as brick packed milk or juices may be by treatment of the packaging surface with hydrogen peroxide before filling to maintain sterility**
- **Alternate methods of exerting antimicrobial action involve use of agents such as lysozyme enzyme, natural and synthetic polyureas, polyhydrazides and polyurethanes. Other antimicrobials used are quaternary ammonium compounds, food acidulants and benzoic anhydride.**

Food Borne Diseases

- **Food borne diseases (FBD) result in considerable toll on public health.**
- **In India the food borne disease (Polasa etal 2006)**

  At the house hold level is 13.2% and

  At the community level is 3%
- **Risk of death from food borne illnesses is significantly higher for the elderly, the very young and those with poor immune status than the healthy adults.**
- **In India the Economic burden due to FBD may exceed the cost of acute illness**

New Food Borne Pathogens

- **Campylobacter jejuni-poultry meat and unpasteurised milk**
- **Listeria monocytogenes - milk, cheese, vegetables and meat products**
- **E.coli 0157:H7 Water and cooked maize, meat products**
- **E.coli104--produces shigtoxin,causes HUS**

High Risk Foods

What foods are risky?

When it comes to *Listeria*, some foods are more risky than others. Meet some of the other foods where *Listeria* is known to hide.

Sprouts

Raw Milk
(unpasteurized)

Soft Cheeses

Deli Meats and Hot Dogs
(cold, not heated)

Smoked Seafood

3

Outbreak Handling Mechanisms, Early Detection and Traceability

- **Develop new research methods that are rapid cost effective for presence of food pathogens.**
- **Document emerging pathogen resistance and develop techniques for prevention and control of pathogens.**
- **Improve inspection, compliance**
- **Strict implementation of HACCP wherever necessary (processed foods, meat products). Preventive measures for fresh fruits, juices, milk, milk products and other high risk commodities.**
- **Identify preventive measures to address public health problems associated with produce, eg. Staphylococcus, salmonella in khoa, hepatitis A in frozen strawberries. These measures will be identified by inspection, sampling and analytical methods.**
- **Mandatory Food safety education and licensing of all stake holders, starting from producers to consumers.**

Outbreak Handling Mechanisms, Early Detection and Traceability

- **Enhance surveillance and build an early warning system.**
- **Equip Central and other state health departments with state of the art technology – Rapidly Diagnose, Track, Communicate, Control and Prevent**
- **Create a national electronic network for rapid finger print comparison.**
- **Improve responses to food borne outbreaks -states and other governmental bodies with expertise and resources should share responsibility for outbreak response.**
- **Establish inter-state governmental food borne outbreak response coordinating group**
- **Impose risk assessment and establish an interagency risk assessment consortium.**

Safety Concerns Following Food Processing

Safety of bottled water

- **Water source**
- **Piping, treatment process and bottling equipment**
- **GMP**
- **Packaging**
- **Quality control system**

Safety Concerns Following Food Processing (Contd.)

Safety of soft drinks

- **Microbial contamination**
- **Packaging material**
- **Chemicals, additives**
- **Equipment used in processing**
- **Formation of mutagens / carcinogens like Nitrosamines in foods and beverages**

Safety Concerns Following Food Processing (Contd.)

Processed foods – Transfat

- **Intake of transfatty acids from partially hydrogenated vegetable oils have deleterious effect on cardiovascular health.**
- **TFA are more atherogenic and high intake can promote insulin resistance.**
- **Mandatory addition of the levels of TFA to nutrition labeling would enable consumers to make healthier choice. Innovative processing methods to be developed to reduce the TFA levels in Vanasapati**

Biotechnology Derived Foods and Products

- **Approved Vs unapproved**
- **Detection methods and limits**
- **Toxicity and Allergenicity data**
- **Labelling requirement**

Allergy Symptoms

- **The time to manifest allergic responses varies between individuals**
- **It can happen immediately after consuming it or after several hours**
- **The symptoms may be itching in around the mouth, hives, tightening of throat, vomiting, abdominal cramps, diarrhea, wheezing, shortness of breath, reaction on face, hands, loss of consciousness and even death**

Allergen Contamination

- **Allergen contamination can occur when food products are inadvertently contaminated with allergenic proteins that can cause reaction, even life threatening, in individuals having food allergies to those proteins**
- **Some of the most common food allergies are to milk, eggs, fish, shellfish, wheat, soy, peanuts, and tree nuts, egg, meat, pollen, chocolate, recombinant products**
- **Allergens are recognized as an important food safety issue. Hence all precautions must be taken to ensure safety from allergen point of view.**

Chemical Intolerance

- **Freeze dried egg may be more allergic than heated egg. Ovomucoid is the major allergenic protein in egg white.**
- **Allergic reaction to kiwi fruit is known in adults / children.**
- **Apple, banana are also known to cause allergenicity.**
- **Herbicides and Fungicides modulate allergenicty of apple.**
- **Allergies to carrot and garden herbs are linked to celery allergy.**
- **Other vegetables are lettuce, zucchini, tomatoes, potatoes**

Cereals and Baked Products

- **Inhalant respiratory reactions to wheat descried as baker's asthma.**
- **The water soluble wheat proteins and insoluble gliadins have been implicated in IgE mediated allergy; gluten and coeliac**
- **These are thermo stable and even long time baking under high temperature does not reduce their allergenicity**
- **In fact baking may increase the resistance of potential allergen in wheat flour by proteolytic digestion and allow them to reach GI tract intact.**

Functional Foods – Safety

Functional foods

- **Natural food,**
- **Food to which a component has been added,**
- **Food from which a component has been removed,**
- **Food where the nature of one or more components has been modified,**
- **Food in which the bioavailability of one or more components has been modified**
- **or any combination of these possibilities.**
- **Due to their diversity all functional foods require a case by case evaluation for their safety.**
- **This process must include both nutritional and toxicological evaluation.**

Functional Foods, Bioactive Constituents and Potential Health

Source	Functional Component	Health Benefit
CERALS		
Wheat Bran	Insoluble fibre	Reduces risk of colon cancer
Oats	Beta-glucan	Reduces risk of colon cancer
LEGUMES		
Soya bean and soya based foods	Isoflavones	Reduces menopausal symptoms, protects against heart disease and hormone dependent cancers
OIL SEEDS		
Flaxseed oil	Omega-3 fatty acids	Reduces risk of cardiovascular disease
VEGETABLES		
Carrots	Carotenoids	Counteract free radicals reduces cancer risk
Cruciferous vegetables	Dithiolthiones	Antioxidant & anti cancer properties

Functional Foods, Bioactive Constituents and Potential Health Benefits (Contd.)

Source	Functional Component	Health Benefit
Alliums	Diallylsulphide triallysmethyl sulphide, diallyl disulphide ajoene	Antioxidant anticancer hypocholesterolemic properties
Psyllium	Soluble fibre	Reduces risk of colon cancer
Green leafy vegetables	Beta-carotene, Lutein	Antioxidant
Tomatoes	Lycopene	Reduces risk of certain cancers
FRUITS		
Citrus	D-limonene	Anti-cancer property
DAIRY PRODUCTS		
Yogurt & other dairy products	Prebiotic and Probiotics	Improves intestinal microflora, immune function

Functional Foods, Bioactive Constituents and Potential Health Benefits (Contd.)

Source	Functional component	Health Benefit
BEVERAGES		
Green tea	Epigallocatechin gallate	Reduces risk of cardiovascular disease and certain cancers
FISHES		
Tuna, Soloman, Mackerel	Omega-3-fatty acids	Reduces risk of cardiovascular disease
HERBS AND SPICES		
Turmeric	Curcumin	Anti-inflammatory antioxidant, chemopreventer
Clove, Basil, Cinnamon	Eugenol	Antioxidant
Ginger	Gingerol, Shogol	Anti-inflammatory, Antioxidant
Fenugreek	Galactomannan	Hypocholesterolemic and Hypoglycaemic

Bioactive Compounds with Food and Drug Administration (FDA) – Approved Health Claims Based on Strong Evidence from Clinical Studies

Bioactive Compound	Food Sources	Health Claims	Recommended Amount or Frequency of Intake
β-Glucan	Whole grains	Total and LDL cholesterol	3 g/day
Soluble fiber	Psyllium	Total and LDL cholesterol	1 g/day
Phytosterols and phytostanols	Fortified margarines	Total and LDL cholesterol	1.3 g/day for sterols and 1.7 g/day for stanols
Protein	Soy	Totaland LDL cholesterol	25 g/day

Source: From Hasler. C.M.Bloch, A.S. Thomson, C. A., Enrione, E., and Manning, C., J.Am. Diet. Assoc. 104 (5), 814-826, 2004

Labeling of Packaged Foods

- **Packaged foods are regulated by the FSSAI Act of 2006**
- **It is required that product approval must be taken, it is important to know one cannot arbitrarily add “may contain” or other precautionary labeling**
- **Good manufacturing practice (GMP) is essential for effective reduction of adverse reactions, precautionary labeling should not be used in lieu of adherence to GMP**
- **Ensure product specification and formulation changes are reflected on labels**
- **Consider approaches to highlight newly introduced allergen components**

Ingredient Labeling

- **Is a very important risk management and label is risk communication tool**
- **Ingredients and processing aids originating from a substance or product causing allergies or intolerances are required to be declared for pre-packed food**
- **Labeling of these ingredients is obligatory when they are deliberately used in the manufacture or preparation of a food and are still present in the finished product, even if in an altered form**
- **Nutritional labeling**

Safety of Botanicals in Traditional Foods

1. **Different types of products fall under the umbrella of "natural products with health benefits".**
2. **Supplements or foods containing high levels of nutrients or other compounds can have effects on presence of other nutrients in adequate amounts. This can occur as a result of**
   - **destruction of nutrients**
   - **reduction of availability of nutrients**
   - **inference with utilization of nutrients**
   - **decrease in food intake**

Safety of Botanicals in Traditional Foods (contd)

3. Traditional foods are considered safe as they have long history of use. However, if they are modified by processing or by any other method their substantial equivalence and nutrient content analysis has to be done

4. For example, oats and psyllium have long history of safe use and now are claimed to reduce risk of CHD. In animals increased cell proliferation in GI tract, allergic reactions in some people and gastrointestinal obstruction have been reported when they were evaluated at the likely level of consumption

5. Consumption of fenugreek at high levels can cause crystaluria in some individuals

Traditionally consumed food components should be in levels consumed in age old practice, but not in high levels to ensure safety

Safety of Botanicals in Traditional Foods

6 **Method for safe preparation of some plants such as cassava are known in cultures that depend on it as a staple but its introduction into a naïve market place could cause cyanide poisoning.**

7. **Another example, hypoglycin A in unripe ackee fruit causes a devastating illness called Jamaican vomiting sickness. Ripe, seedless pericarp of this plant is desirable and safe and ackee is Jamaican National Fruit.**

8. **Canned ackee fruit is prohibited into US until a quality assurance that toxic levels of hypoglycin is not present in product is given.**

Nutritional Assessment For Novel Foods

- **Nutritional assessment is important for novel foods**
- **Novel foods may have high level of particular nutrient at high or low level**
- **Bioavailability of nutrients from novel foods**
- **Effect of cooking / processing on nutrients in novel food**
- **Its interaction with bioavailability of other nutrients in food matrix**
- **Whom it is intended**
- **Eg. Probiotics – effect on other intestinal flora, colonic fermentation, short chain fatty acid production**
- **For all nutrients for which there is an established RDA, consequences of consumption of novel food on total dietary intake.**

Factors for Substantiation of Nutritional Safety

Sl. No	Factors
1.	Source and origin of food
2.	Nutrient composition
3.	Presence of anti-nutritional factors
4.	Methods of production and / or preparation
5.	Technical specification including preparation
6.	Purpose to indicate rationale behind the development of functional food
7.	Instruction for storage and use including frequency, dose and duration in relation to dietary recommendations

Factors for Substantiation of Nutritional Safety

Sl. No	Factors
8.	Interactions with other components of diet and bioavailability
9.	Overall toxicological assessment including toxicokinetics, genotoxicity / intolerance
10.	Implications for possible changes in gut microflora
11.	History of safe use
12.	Effect on metabolism and physiological functions in human
13.	Potential effects on vulnerable groups like infants, elderly, etc.
14.	Relation to current dietary recommendations / targets

Fortified Foods - India

- Salt
- Ultra rice
- Paushtik atta
- Fortified breakfast cereals
- Beverages
- Oils enriched with AO etc
- Golden rice (GM)

Points to consider

- **Requirements Vs Deficiency**
- **Bioavailability**
- **Efficacy**
- **Toxicity**
- **Technological feasibility**
- **Vehicle**
- **Stability**

Nutrient Risk Assessment

- **Regulatory bodies worldwide are considering process for establishing upper level of intake for nutrients**
- **Dietary science based supplements, fortified foods, functional foods market is expanding**
- **Need for ensuring safety and harmonizing standards internationally**
- **In traditional approach, regulators provided arbitrary multiple of the intake level known to provide adequate intake of nutrient**
- **Helps policies for food standards and fortification guidelines.**

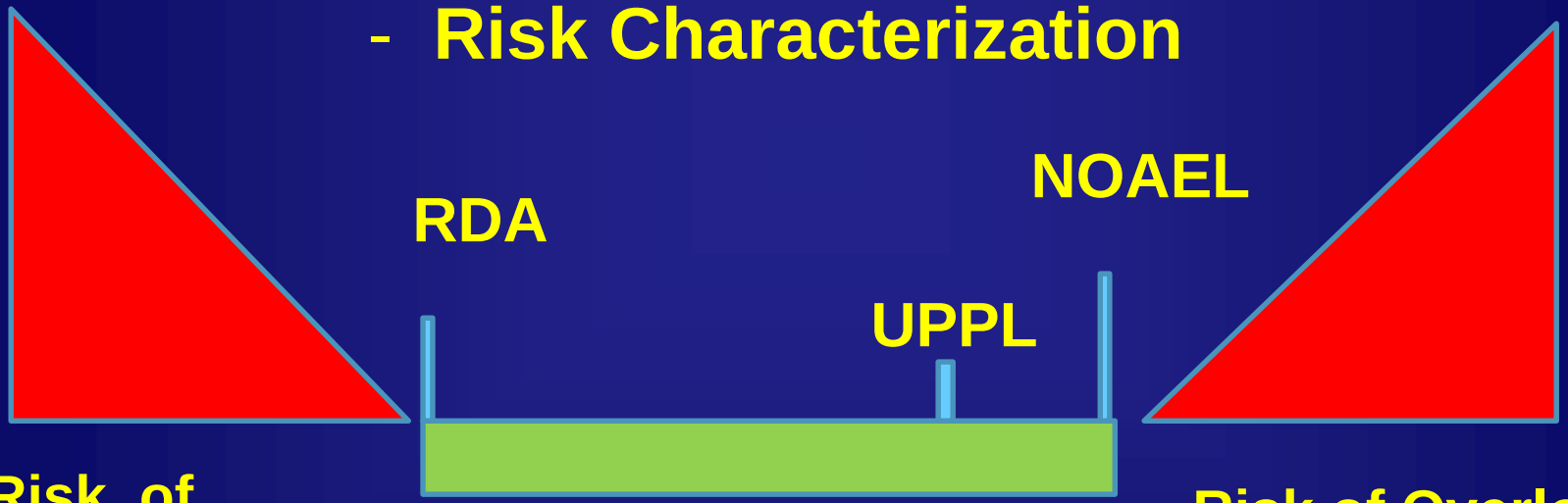
Steps in Risk Assessment

- **Hazard Identification- scientific review**
- **Specify Dose response- establish upper level**
- **Intake /Exposure assessment**
- **Risk characterization- public health impact**
- **Too little nutrients and too much nutrients – both are safety issues**
- **Nutrient risk assessments have to be life stage specific eg adolescents, lactating. Aging populations etc.**

Risk Assessment Nutrients

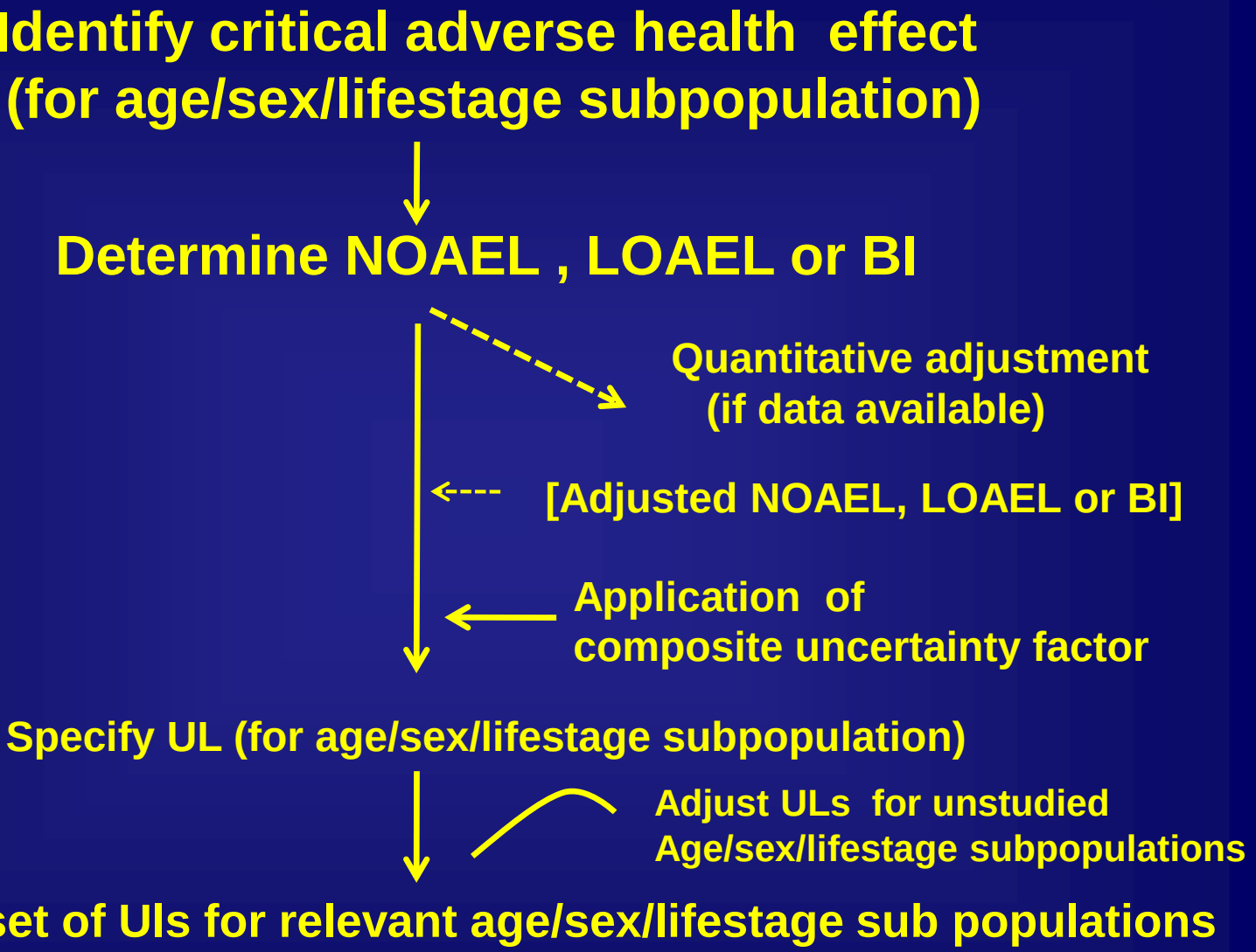
Assessment of

- **Hazard identification**
- **Dose – response**
- **Intake**
- **Risk Characterization**



RDA : Recommended Daily Allowance
UPPL : Upper Safe Level of Intake
NOAEL : No Observed Adverse Effect Level

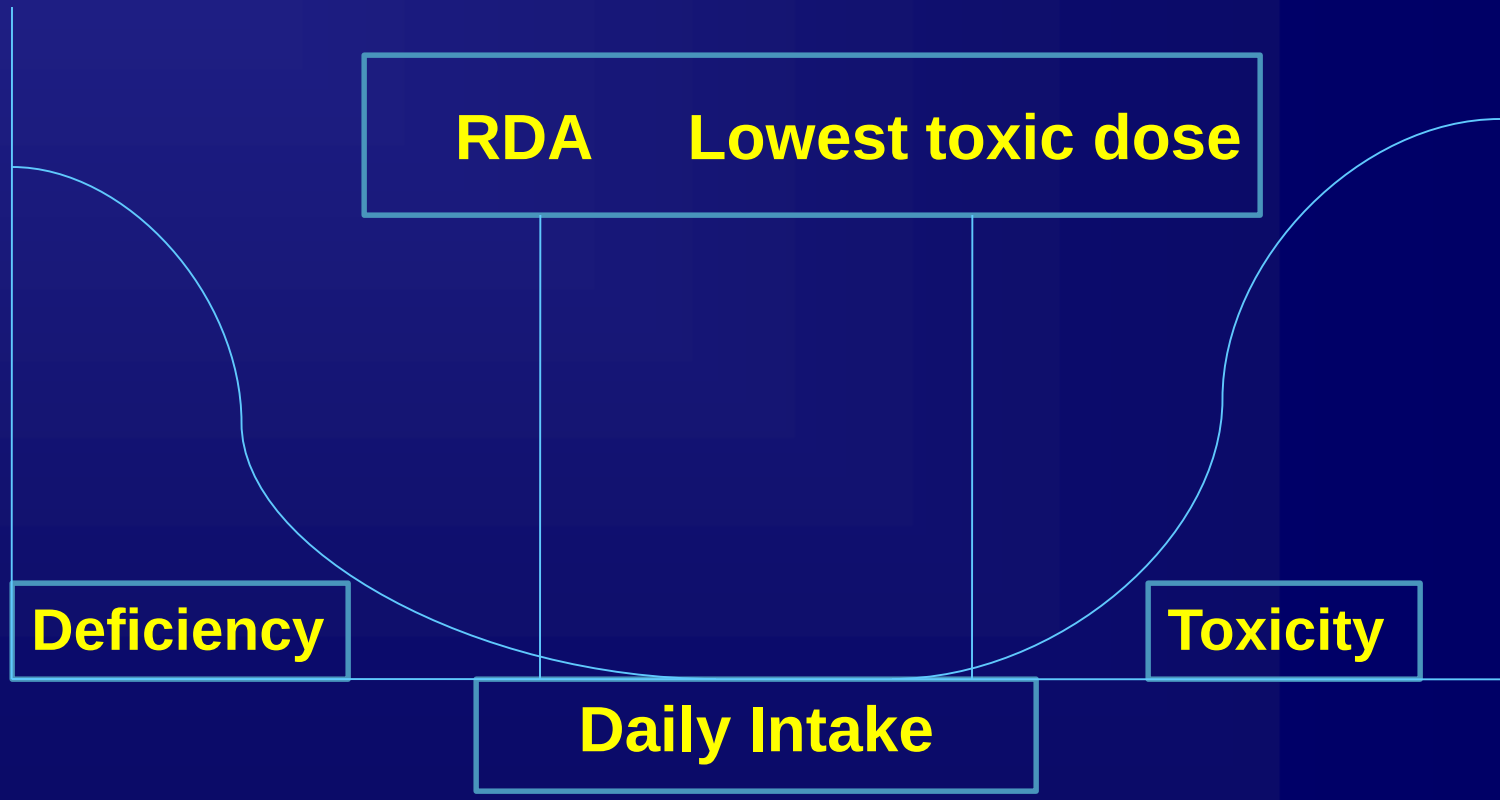
Steps in Quantifying the Upper Level of Intake



Note : BI = benchmark intake (called benchmark dose in other risk assessment reports); LOAEL = lowest observed adverse effect level ; NOAEL = no observed adverse effect level; UL = upper level of intake

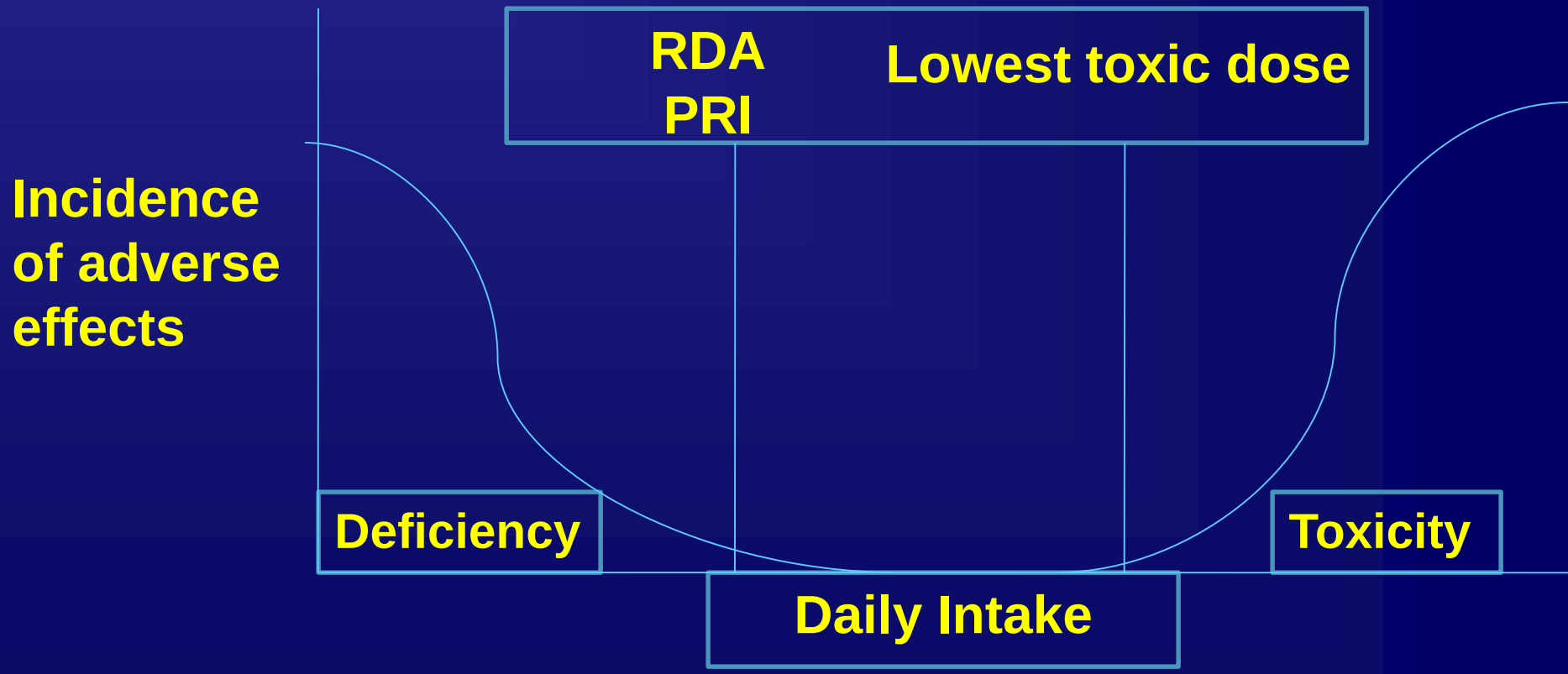
Risk Assessment of Food Fortification

Micronutrients with high safety index - unlimited addition possible:
Vit. B_1, B_2, B_6, B_{12}, E, phylloquinone, biotin, panthotenic acid, K, Mg



Risk Assessment of Food Fortification

Micronutrients with moderate safety index index -
Interactions with other nutrients affect the bioavailability :
Ca and P; Fe and Vit. C; folate and B12



→ **Definition of a NOAEL needed**

How much to Consume?

Maximum F* content per serving size =

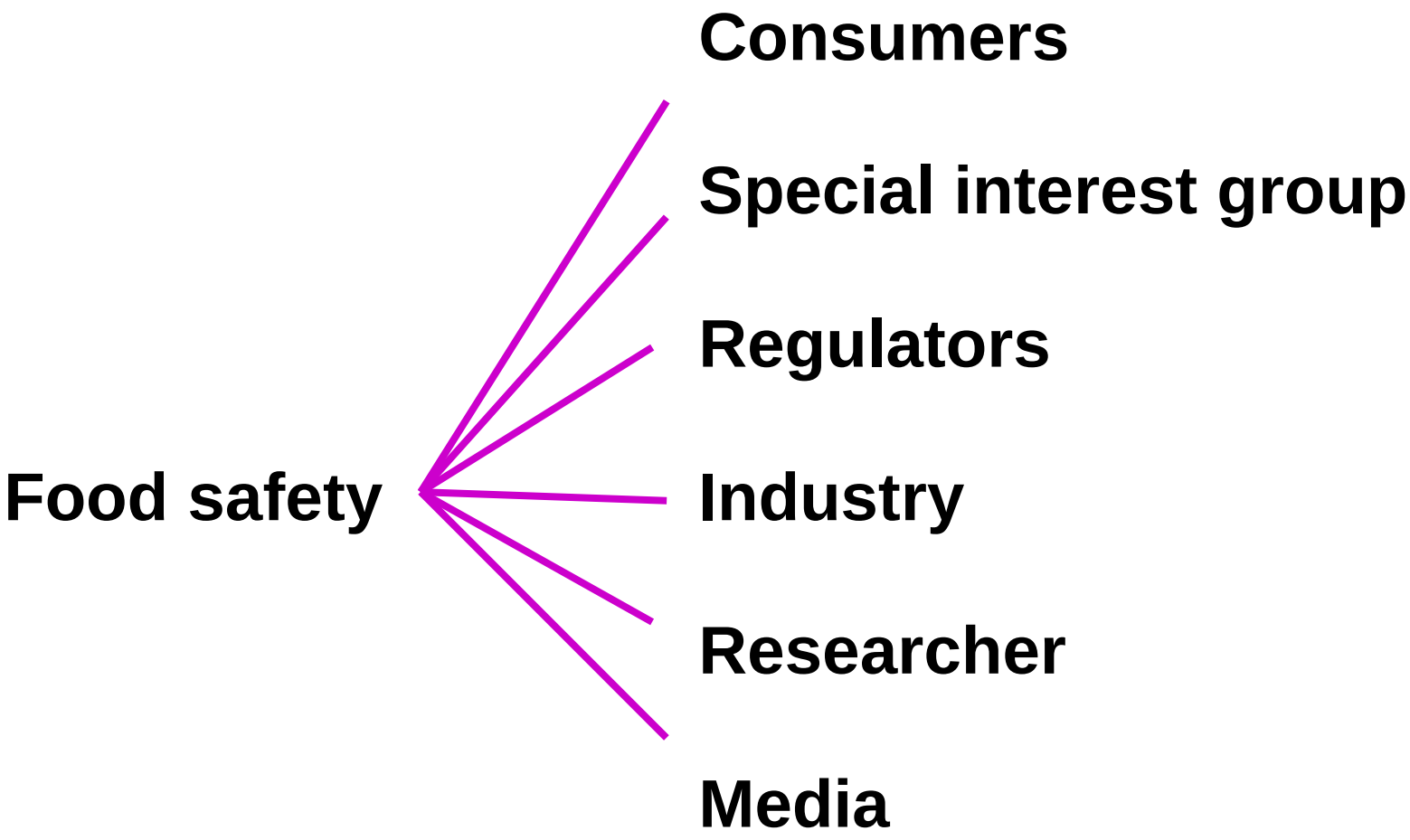
UL – (amount F consumed from diet

+ amount of F from Fortified food

No. of servings

*** F = Fortificant**

Food Safety


Consumers
Special interest group
Regulators
Food safety
Industry
Researcher
Media

Safe Food for All

Shared Responsibility

Government	Consumer	Industry/Trade
Food legislation and enforcement	Educated and knowledgeable public	Good practices by primary producers and distributors
Advice for industry/trade	Discriminative and selective consumers	Quality assurance and control of processed foods
Consumer Education	Safe food practice in the home	Appropriate process and technology

Safe Food for All

Shared Responsibility

Government	Consumer	Industry/Trade
Information gathering and research	Community participation	Train managers and food handlers
Provision of health related services	Active consumer groups	Information labeling and consumer education

Industry

- **Strengthen R&D**
- **Invest in establishing in accredited labs**
- **Submit proof of concept**
- **Evidence based product development**
- **Testing methods based on codex /national guidelines**
- **Methods of validation**
- **Quality assurance, global practices, process technology**
- **Corporate responsibility**

Academia

- **Conduct useful research**
- **Identify gaps by community need assessment**
- **If possible do intervention studies eg. RTE/RUTF**
- **Capacity building**
- **Method development, validation**
- **Meta analysis, risk assessment**
- **Dietary intakes/ consumption**
- **Aligning with NRV**

Government

- **Regulators to examine the research data, methods used, tests of analysis and international data/status available**
- **Modify codex/other guidelines to suit our population needs/reference values**
- **Introduction of food legislation and enforcement in consultation with other stake holders**
- **Advise industry and educate consumer**
- **Network with other departments of Government**

Current and Future Implications

- **Safe food is composites of all views / descriptions held by consumers, special interest groups, regulatory authorities, scientists and industry**
- **A single definition of safe food will be overly simplistic as safe food is complex, multifaceted concept.**
- **The criteria by which food is defined as safe will become more detailed and comprehensive as new steps are taken to improve safety.**
- **Industry & govt. have responsibility for improving safety as well as for educating consumers on practical aspects of safe food.**

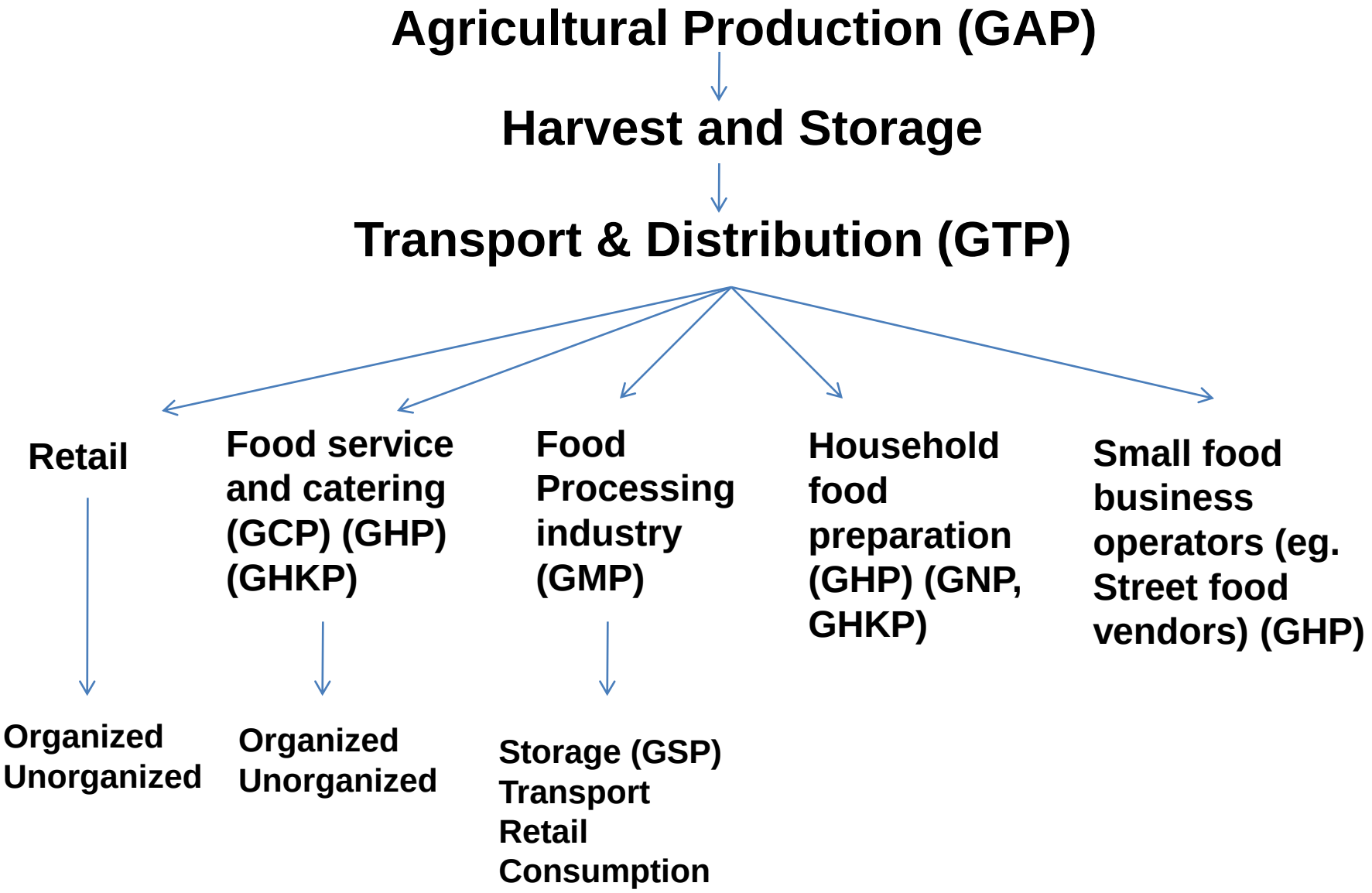
Future Requirements

- **Establishing Good Practices in Food Chain**
- **Risk Assessment and Management shall be a part of all regulatory approvals**
- **Monitoring, Sampling, Identifying,**
- **Documenting, Alerting, Acting, Tracking Preventing - Safety Net**
- **Data generation where there are knowledge gaps**
- **Effective communication mechanisms**
- **From reaction and response to anticipation and prevention**

Good Practices in Food Chain

- **Good Agricultural Practices - land use , pesticide use**
- **Good Catering Practices - ensure food served is safe and wholesome**
- **Good Hygiene Practices**
- **Good Laboratory Practices - Quality control and analytical labs**
- **Good Manufacturing Practices**
- **Good Retail Practices - tracing system to track faulty product- use RFID and GPS**
- **Good Storage Practices**
- **Good Transport Practices**
- **Good Nutrition and House keeping Practices**

Model food Chain & Good Practices



Summary

- Food safety from “farm to fork” implies that food can get contaminated during any step involved in food cycle
- Right from the time of procurement of the raw material till its consumption hygienic principles have to be observed
- The food handler has to scrupulously follow the hygienic principles, have clean personal hygiene and practices
- The food establishment must be located in environment devoid of pollution, with proper light, ventilation
- The surveillance of food handlers must be in place to curtail chances of food contamination
- The above measures will help in ensuring food safety

Thank You