

FOOD TOXICOLOGY

Unit V

CUTM1648: Concepts of Toxicology

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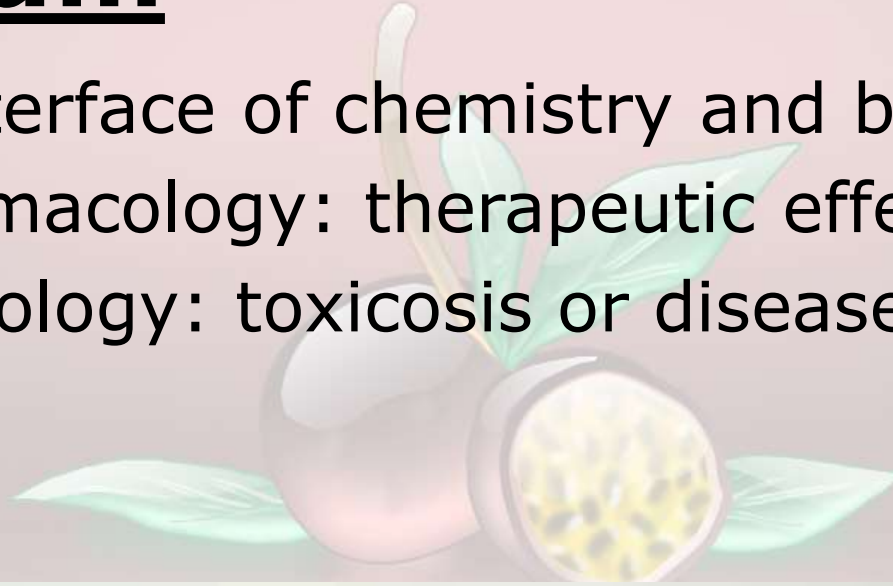
What is Toxicology?

- **Toxicology** (from the Greek words- *toxikos* "poisonous" and *logos* "to study") is a branch of biology, chemistry, and medicine concerned with the study of the adverse effects of chemicals on living organisms.
- It is the study of symptoms, mechanisms, treatments and detection of poisoning, especially the poisoning of people.

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Contd...

- The interface of chemistry and biology.
 - Pharmacology: therapeutic effect
 - Toxicology: toxicosis or disease effect



What is food toxicology?

- Food toxicology is the study of the nature, properties, effects, and detection of toxic substances in food, and their disease manifestation in humans.



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- This branch provides a general understanding of toxicology related to food and the human food chain. Fundamental concepts includes dose-response relationships, absorption of toxicants, distribution and storage of toxicants, biotransformation and elimination of toxicants, target organ toxicity, teratogenesis, mutagenesis, carcinogenesis, food allergy, and risk assessment.
- In this, we examine chemicals of food interest such as food additives, mycotoxins, and pesticides, and how they are tested and regulated. We explore the etiology of foodborne disease related to naturally-occurring toxins and

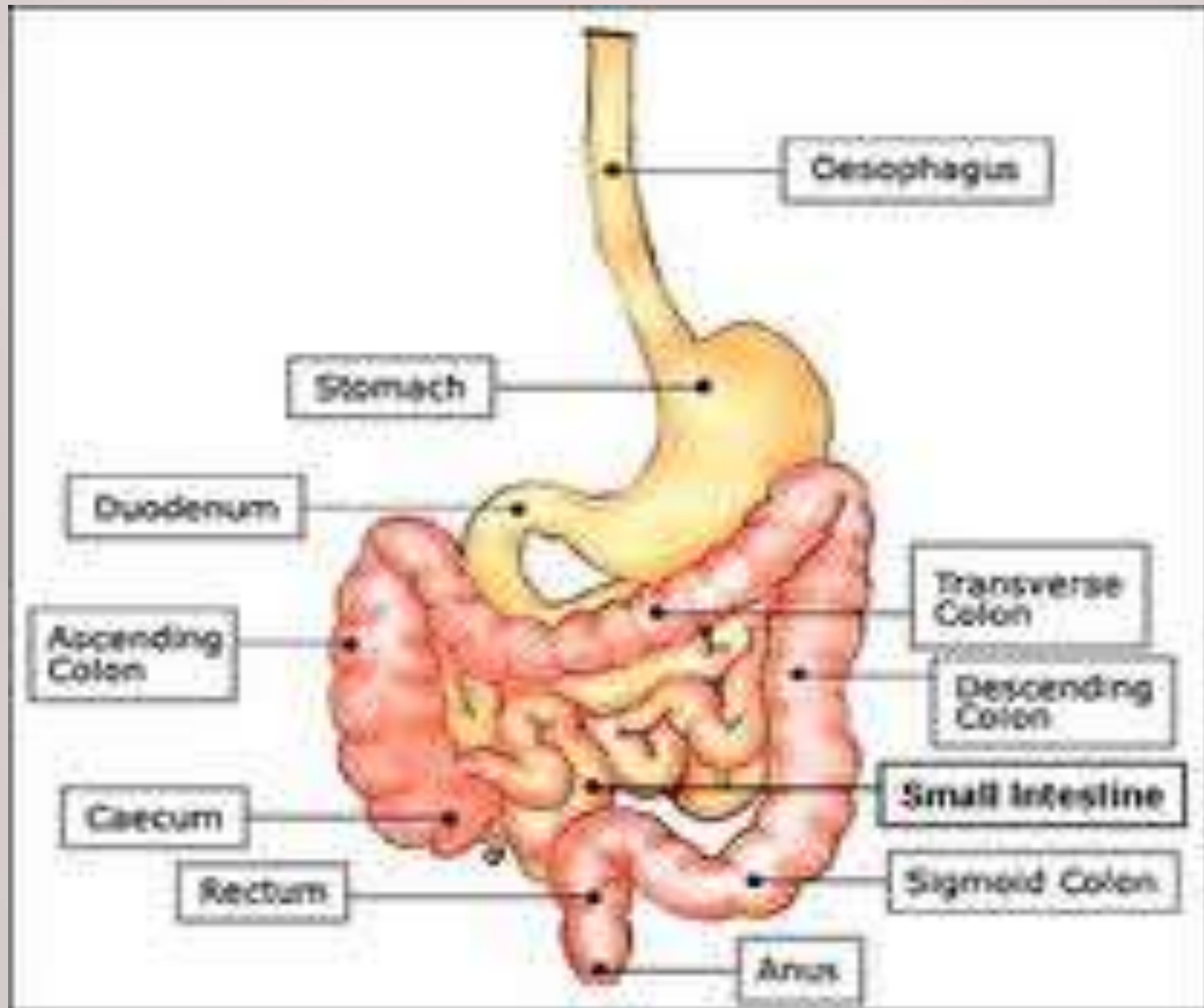
Uniqueness of Food Toxicology

- The nature of food is responsible for the uniqueness of food toxicology.
- Food occupies a position of central importance in virtually all cultures, and because most food cannot be commercially produced in a definable environment under strict quality controls, food generally cannot meet the rigorous standards of chemical identity, purity, and good manufacturing practice met by most consumer products.
- The fact that food is harvested from the soil, the sea, in land waters, or is derived from land animals, which are subject to the unpredictable forces of nature, makes the constancy of raw food unreliable. Experience has supported the safety of commonly consumed foods, and the good agricultural practices (GAP) under which food is produced mandates the need for quality controls (i.e. current Good

Importance of GIT track.

- Toxicology is mostly focused on the digestion and metabolism occurring on GIT track.
- Because in most of cases it is ingested substance that is absorbed through GIT track ,it is digestion product that are absorbed.

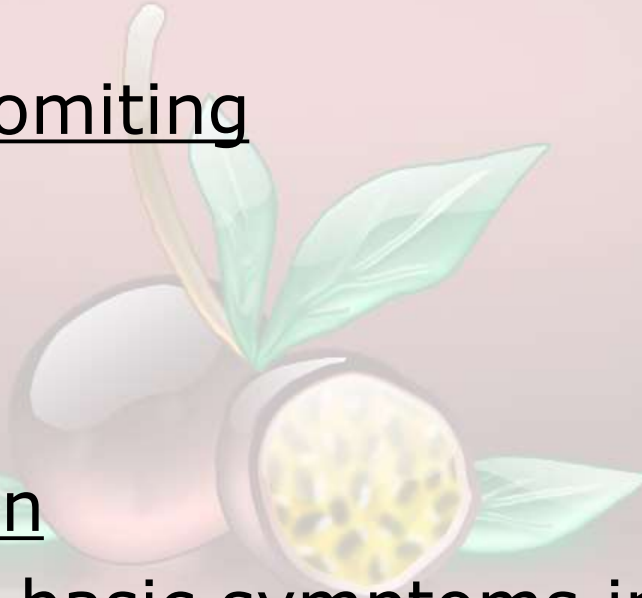
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GASTROINTESTINAL SYMPTOMS

- Nausea and Vomiting
- Bloating
- Constipation
- Diarrhea
- Abdominal Pain
- There are five basic symptoms indicating a GIT problem. These symptoms are generally associated with dietary problems or specific food allergies.

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Food Poisoning



- Food poisoning is a common, usually mild, but sometimes deadly illness. Typical symptoms include nausea, vomiting, abdominal pain, and diarrhea that occur suddenly (within 48 hours) after consuming a contaminated food or drink.
- Depending on the contaminant, fever and chills, bloody stools, dehydration, and nervous system damage may follow.
- These symptoms may affect one person or a group of people who ate the same thing (called an outbreak).

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- The Centers for Disease Control and Prevention (CDC) estimates that in the United States, 1 in 6 people becomes sick from eating contaminated food.
- In 2001, the CDC estimated that food poisoning causes about 48 million illnesses, 128,000 hospitalizations, and up to 3,000 deaths each year.



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- Norovirus and salmonella are the most common infectious forms of food-borne illness. Salmonella causes the most deaths followed by *Toxoplasma* and *Listeria*.
- Worldwide, diarrheal illnesses are among the leading causes of death. Travelers to developing countries often encounter food poisoning in the form of traveler's diarrhea or "Montezuma's revenge."

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Importance of the GRAS Concept

- The importance of the GRAS provision is obvious from its many applications. Many substances, for example, that are used in food processing have never received formal FDA approval. The use of these substances in the manufacture of food products is considered appropriate under cGMPs, while the substance itself is considered GRAS for such purposes.
- Similarly, certain substances are permitted as optional ingredients in standardized foods [foods with standards of identity specified by regulation (21 CFR 130-169)] even though they are not approved food additives and are not on any of the GRAS lists.

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Food additives and colour.

- **To provide nutrition – to improve or maintain the nutritional quality of food.** For example, the addition of iodine to salt has contributed to the virtual elimination of simple goiter. The addition of Vitamin D to milk and other dairy products has accomplished the same thing with respect to rickets.
- Niacin in bread, cornmeal and cereals has helped eliminate pellagra, a disease characterized by central nervous system and skin disorders. Other nutritional food additives (such as thiamine and iron) are used for further fortification in the diet and as a result, diseases due to nutritional deficiencies, common in lesser developed countries, are now very rare in the United States.

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- Anything consumed in excessive amounts will be toxic, even those substances with which we are most familiar and in daily contact. There are no exceptions; anything from vitamins to water, if consumed in large enough quantities, will cause illness, and sometimes fatal effects.
- The age-old adage, “solo dosis facit venenum” or “Only the dose makes the poison” is well worth noting here.

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- Toxic' is a relative term. The effects of any chemical substance or mixture depend not only on its composition and basic properties, but also on dosage, route and conditions of exposure, susceptibility of the organism exposed and other factors.
- It is not possible to categorize all chemical substances as 'toxic' or 'non-toxic' although some are more toxic than others during normal conditions of use and exposure and some are generally innocuous.

Effects on Children

- A recent research financed by Britain's *Food Standards Agency* has found that hyperactive behavior in a broad range of children was likely to increase because of common food additives and colorings. This leads to inattention and impulsivity among children and makes learning more difficult, at least into middle childhood.
- The Agency advised parents to monitor any changes in their children's activity following consumption of food containing additives and make efforts to avoid artificial colors and preservatives.



Food Additive Safety

- The question of food additive safety is one that has received widespread attention in recent years.
- While literally thousands of studies, conducted throughout the world, attest to the overall safety of additives as they are used in the food supply, it is important to understand the relativity of safety and be careful when using the words "toxic," "harmful" and "safe."
- Any substance whatsoever has the potential for being harmful. The controlling factor in determining the safety of substances in our diet is quantity.

Food additive

- As a food additive, it serves a dual purpose in the food industry since it both alters the color of preserved fish and meats and also prevents growth of *Clostridium botulinum*, the bacterium which causes botulism. In the European Union it may be used only as a mixture with salt containing at most 0.6% sodium nitrite.
- While this chemical will prevent the growth of bacteria, it can be toxic in high amounts for animals, including humans. Sodium nitrite's LD₅₀ in rats is 180 mg/kg and its human LD_{L0} is 71 mg/kg, meaning a 65 kg person would likely have to consume at least 4.615 g to result in death.
- To prevent toxicity, sodium nitrite (blended with salt) sold as a food additive is dyed bright pink to avoid mistaking it for plain salt or sugar.

Some times food are also toxic...



“Natural Toxins in Food”

Food Toxin Potential Reactions from Concentrated Non-Dietary Doses.

- Potatoes : Solanine* Interferes with transmission of nerve impulses
- Spinach: Oxalic acid Imbeds in mucous membranes of throat, causes swelling. Interferes with calcium metabolism
- Lima beans :Hydrogen cyanide Results in difficulty in breathing, discoloration of skin, eventual death
- Peanuts: Aflatoxin** Most potent liver carcinogen known
- Carrots : Myristicin Carotatoxin
Hallucinogenic nerve poison Neurotoxin

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- **Apple:** (*Malus domestica*). Seeds are mildly poisonous, containing a small amount of amygdalin, a cyanogenic glycoside. The quantity contained is usually not enough to be dangerous to humans, but it is possible to ingest enough seeds to provide a fatal dose.
- **Cassava:** (*Manihot esculenta*) Roots and leaves contain two cyanogenic glucosides, linamarin and lotaustralin. Chronic, low-level cyanide exposure is associated with the development of goiter and with tropical ataxic neuropathy, a nerve-damaging disorder that renders a person unsteady and uncoordinated.

Food

preservatives.



- **How do this affect us ?**
- Chemical preservatives are harmful because our body's digestive system doesn't know what to do with the stuff preservatives are made of and will either eliminate it or store it somewhere. And when it reacts in our body we suffer the consequences with illness.

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Some common preservatives.

- **Benzoates and sorbates**- used in the preservation of many beverages jams, pickled products, salads, cheese, meat and margarines.
- **Butylated hydroxytoluene/ hydroxyanisole; tert-butylhydroquinone; propyl gallate** - used in oils and lipids to prevent it from becoming rancid.
- **Citric and ascorbic acids (vitamin C)** - Used for cutting down the phenolase action in fresh cut vegetables and fruits.
- **EDTA (ethylenediamine tetra-acetic acid)** – Also used to preserve freshly cut fruits and vegetables
- **Nitrites and nitrates** – used mostly in packaged meat
- **Propionates** – used for preserving bakery products
- **Sulfites** - used as a preservative in dried fruits, wines (particularly red wines) and fruit juices.
- **Sulphur Dioxide** - preservative in a wide range of food products.

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- Among the above preservatives, apart from sulfites and propionates, which cause allergic reactions to a small percentage of people, and Nitrites, which react with amino acids to form cancer-causing nitrosamines, all other preservatives are not known to have any harmful side effects.

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So ,what to do?

- To keep things simple just avoid the most questionable additives such as *sodium nitrite*, *saccharin*, *caffeine*, *olestra*, *acesulfame K*, and artificial coloring, used primarily in foods of low nutritional value.
- All of the chemical food coloring can be potentially harmful and are best avoided. Organic foods are not supposed to contain any chemical preservatives, but many natural products contain some natural and some synthetic additives. It is, therefore, advisable to check the labels for ingredients before using any such product.

Pesticides...

- Economic and public health poisons.
- – Control of insects, weeds, rodents and other pest animals.
- – Bacterial, fungal and viral infection in agriculture, homes and public health applications.
- Natural chemicals, synthetic chemicals, biological agents.

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Trends in Regulation and Use

- Lower use rate.
- Low-volume application.
- Risk mitigation requirements.
- Integrated Pest Management (IPM).
- Conditional registration (monitoring).
- Safer chemicals.
- Bio-pesticide use.
- Increased exposure concerns.
- Patterns, routes and levels

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Human Health

- Risk Assessment Process
 1. Hazard Identification.
 - Toxicity testing, adverse effects.
 2. Dose-Response Assessment.
 - Quantitative toxicity.
 3. Exposure Assessment.
 - Food, water, home, workplace.
 4. Risk Characterization.
 - Risk = Toxicity x Exposure.

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Dyes which are present in the food...

- Amaranth:Angioedema,Pruritus,Urticaria
Unspecified subjective symptoms
Bronchoconstriction .
- Erythrosine:Bronchoconstriction (combined with Brilliant Blue, Indigo Carmine)
Sequential vascular response,Elevation of protein-bound iodide,Thyroid tumors,Chromosomal damage .
- Citrus Red No.2:Cancer in animals
Used for dyeing skins of oranges

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- Allura Red AC: Tumors / lymphomas.
- Tartrazine: Allergies
Thyroid tumors, Lymphocytic lymphomas, Chromosomal Damage, Trigger for asthma, Urticaria (hives), Hyperactivity.
- Fast Green, FD&C Green No.3: Bladder tumors.
- Patent Blue: Purpura (bruising), Dermatitis
Unspecified subjective symptoms

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Packaging of food..

- Rigid and Flexible Plastics 38%
- Metal Containers 19%
- Glass 8%
- Paper/Paper Board 30%
- Other 5%
 - Film
 - Blister



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Typical Polymeric Packaging Materials

- Poly-olefins
 - PP: poly propylene
 - HDPE: high density poly ethylene
 - LDPE: low density poly ethylene
 - LLDPE : linear low density poly ethelene
- PET: poly ethylene terephthalate
- Styrene
- PVC: poly vinyl chloride
- Nylon
- EVA: ethylene vinyl acetate
- ABS: acrylonitrile butadiene styrene

Interior Can Coatings: Severe Coating Adhesion Loss



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Basic Tenets of Worldwide Packaging Regulations

- **Packaging shall not endanger the consumer through product adulteration by migration from packaging.**
- **The package will not detract from the organoleptic properties (taste/smell) of the food.**

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The purpose of the Food Toxicology division is aimed
at:

- Determination of persistent organic pollutants in food and exposure through the diet.



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- Environmental toxicity due to heavy metals.
- Risk assessment through the dietary intake of chemical pollutants.



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- Study of the dietary exposure of emerging organic pollutants (perfluorinated and derivatives).
- Development of friendly tools for the calculation of the toxicological risk derived from the foodstuffs.



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- Assessment of benefits through ingestion of omega-3 fatty acids in fish and seafood.



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Global Government and Regulatory Agencies that have reviewed BPA

- ✓ **US FDA: Feb. 2009**
- ✓ **EU EFSA: July 2008; Jan. 2007**
- ✓ **FSNAZ Food Stds. Australia New Zealand: March 2009**
- ✓ **Canada Health Protection Branch: Oct. 2008**
- ✓ **German Federal Institute of Risk Assessment: Sept. 2008; Jan. 2006**
- ✓ **Japanese Ministry of Health: March 2006**
- ✓ **UK Food Standards Authority: April 2001**
- ✓ **California Prop 65 review committee July 2009**
- ✓ **Re Review by US FDA and WHO/FOA to initiate**

Thank you...

