



**PRINCIPLES OF FOOD SAFETY**



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**FOOD SAFETY**



- Chemical food safety
- Microbial food safety



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“All substances are poisons;  
there is none which is not a poison.  
The right dose differentiates a poison  
and a remedy.”

PARACELSUS  
(1493-1541)

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**Safety vs. Hazard**

- Safety is the freedom from danger, injury or damage.
- Approximately the reciprocal of hazard

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**Toxicant vs. Nutrient**

- Toxicant: A substance which when ingested at high levels, produces harmful actions on biologic mechanisms
- Nutrient: A substance which when not ingested in sufficient amount, produces harmful actions on biologic mechanisms.

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**10 Leading Causes of Death in 1997 (CDC)**

Heart Disease	726,974
Cancer	539,577
Stroke	159,791
Bronchitis, Emphysema, Asthma	109,029
Unintentional injuries	96,644
Pneumonia & Influenza	86,449
Diabetes	62,636
Suicide	30,535
Nephritis	25,331
Liver disease & Cirrhosis	25,175

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**Food Hazards**

- Microbiological
- Nutritional
- Environmental
- Natural Toxicants
- Pesticide Residues
- Food Additives

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**Food Hazards**

- Microbiological
- Nutritional
- Environmental
- Natural Toxicants
- Pesticide Residues
- Food Additives

↑  
Increasing concern by regulatory agencies such as the FDA & CDC

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**Food Hazards**

- Microbiological
- Nutritional
- Environmental
- Natural Toxicants
- Pesticide Residues
- Food Additives

↓  
Increasing concern by the public and news media?

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**Legislation and Regulatory Agencies**

- Food borne toxicants and adulterants have been aggressively regulated since the turn of the century as one of the most universally successful political actions of the federal government.

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**The first federal food law was the Pure Food and Drug Act of 1906 (Theodore Roosevelt)**



*Theodore Roosevelt*

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**The Pure Food and Drug Act of 1906**

- It passed because of:
  - ◆ Dr. Harvey W. Wiley (B. 1844) Chief Chemist of the USDA
  - ◆ The Jungle by Upton Sinclair (about food handling in the Chicago stockyards)



WILEY AT WORK  
The Chief of the Division of Chemistry at his desk

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**Food and Drug Act of 1906**

- First “pure food law”
- Provisions
  - ◆ Outlined standards for cleanliness
  - ◆ Prohibited misbranding
  - ◆ Prohibited food adulteration
  - ◆ Provided no power of enforcement

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**The 1906 bill  
was rewritten in 1938**

**- as amended, this is today’s law**

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**The Food, Drug and Cosmetic Act of 1938**

- It provides the basis for a sanitary and safe food supply
- It is administered by the Food and Drug Administration (FDA) of the U.S. Dept. Of Health and Human Welfare
- The Act controls all food in interstate commerce except meat and poultry
- The Act assures food that is safe, wholesome, fair value

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**■ ■ ■ ■ The Food, Drug and Cosmetic Act of 1938**

Definition of adulterated food  
(section 402)

A food may be deemed to be adulterated if it bears or contains any added:

1. Poisonous or deleterious substances
2. Filth
3. Decomposed or de ceased material

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**■ ■ ■ ■ The Food, Drug and Cosmetic Act of 1938**

Definition of adulterated food  
(section 402)

A food may be deemed to be adulterated if it has:

1. Subtracted value
2. Inferiority concealed

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**■ ■ ■ ■ Provisions of Special Interest**

- The Delaney clause
  - ◆ Prohibits the addition or presence of any carcinogenic (cancer-causing) substances in food
- Tolerances

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**Tolerances**

- Tolerances are legal levels of “adulterants” in food
- Levels must be deemed harmless to the consumer and technologically unavoidable
- A tolerance may be “zero”

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**Pesticide Chemicals Amendment of 1954**

- Provisions
  - ◆ Established levels of usage residuals in food
  - ◆ Disallowed foods from marketing if residues exceeded tolerance limits

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**Food Additives Amendment of 1958**

- Provisions
  - ◆ Any substance that becomes part of food cannot be used unless it is proven safe at established levels.
  - ◆ Safety and tolerance levels must be established by the industry.
  - ◆ Exceptions
    - » a. Generally Recognized as Safe (GRAS)

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**Food Additives Amendment of 1958**

- Based on hazard rather than toxicity
  - ◆ Toxicity: the capacity of a substance to produce an injury.
    - » Levels are not considered.
  - ◆ Hazard: Probability that injury will result.
    - » Level of consumption taken into account.
  - ◆ An exception to this is the “Delaney Clause”
    - » Any material containing any substance shown to cause cancer in man or animals may not be added to foods.
    - » No consideration is given to “hazard” vs. “levels”.

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**Other Organizations Involved with Food Safety**

- United States Department of Agriculture
- United States Public health Services
- Environmental Protection Agency

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**FOOD SAFETY**

- Regulatory categories
  - ◆ Direct additives: substances added for specific purpose
  - ◆ Indirect additives: substances that persist or migrate from processing and packaging
  - ◆ Unavoidable contaminants: naturally occurring substances in the raw or stored material

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**Acute vs. Chronic Toxicity**

- Poisonous mushrooms are an example of acute toxicity. i.e., manifesting symptoms in a short time period
- An example of chronic toxicity is the aflatoxins which may take years to manifest symptoms of cancer

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**TOXIC CHEMICALS IN FOODS**

- NATURAL
  - ◆ Normal components of natural food products
  - ◆ Natural contaminants of natural food products
    - » Microbiological origin: toxins
    - » Non-microbiological origin: toxicants (e.g., Hg, Se,...)

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**TOXIC CHEMICALS IN FOODS**

- MAN-MADE
  - ◆ Agricultural chemicals (e.g., pesticides, fertilizers)
  - ◆ Food additives
  - ◆ Chemicals derived from food packaging materials

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**TOXIC CHEMICALS IN FOODS**

- MAN-MADE
  - ◆ Chemicals produced in processing of foods (e.g., by heat, ionizing radiation, smoking)
  - ◆ Inadvertent or accidental contaminants
    - » Food preparation; environmental pollution; storage or transport

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**Lethal Dose**

- LD<sub>50</sub> — a statistically determined value that represents the best estimation of the dose required to produce death in 50% of the organisms (animals) tested

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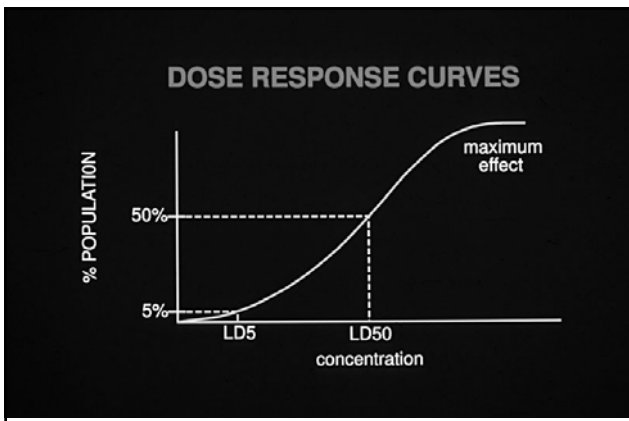
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**Acute LD<sub>50</sub> of Some Chemical Agents**

Agent	LD <sub>50</sub> (mg/kg)
Ethyl Alcohol	10,000
Sodium chloride	4,000
Ferrous sulfate	1,500
Morphine sulfate	900
Strychnine sulfate	2
Nicotine	1
Tetrodotoxin	0.1
Dioxin	0.001
Botulinum toxin	0.00001

From Casarett & Doull's Toxicology, 1986 ©2004 — Guinard— FST 100B 31

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**Probable Lethal Oral Dose for Humans**

Toxicity Rating or class	Dosage mg/kg	For average adult
1. Practically nontoxic	> 15,000	More than 1 quart
2. Slightly toxic	5,000-15,000	1 pint to 1 quart
3. Moderately toxic	500-5,000	1 ounce to 1 pint
4. Very toxic	50-500	1 tsp. to 1 ounce
5. Extremely toxic	5-50	7 drops to 1 tsp.
6. Supertoxic	< 5	A taste (< 7 drops)

From Casarett & Doull's Toxicology, 1986 ©2004 — Guinard— FST 100B 32

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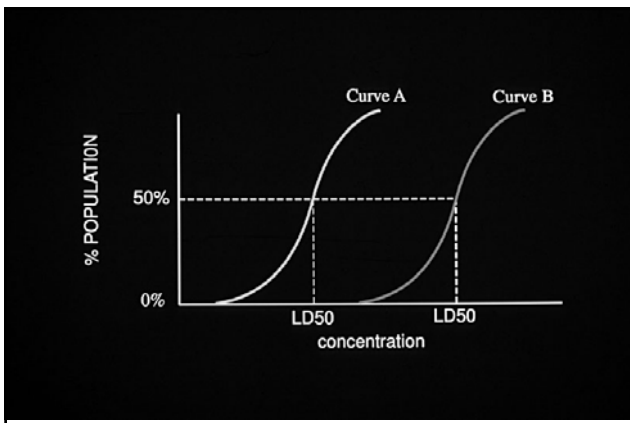
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**Mechanisms to establish safe dosages or levels**

- No Observed Adverse Effect Level (NOAEL):
  - ◆ A scientifically and experimentally determined dosage to humans

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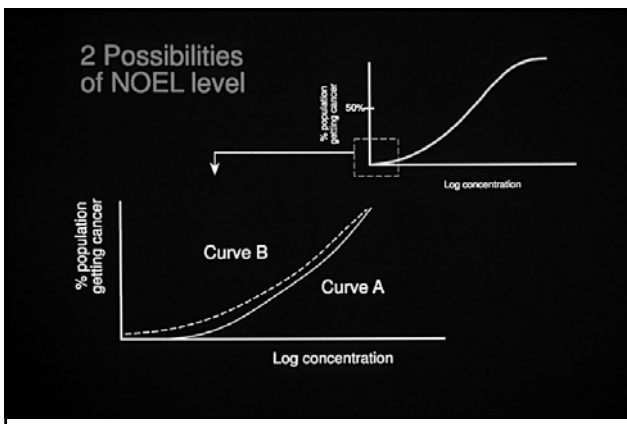
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**Mechanisms to establish safe dosages or levels**

- Safety Factor (SF):
  - ◆ A multiple that is added to account for variances in populations, duration of dosage and possible confounding effects
  - ◆ Typically set at 100

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**■ ■ ■ ■ ■** *Mechanisms to establish safe dosages or levels*

- Acceptable Daily Intake (ADI):
  - ◆ NOAEL/SF

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**■ ■ ■ ■ ■** *Mechanisms to establish safe dosages or levels*

- Maximum Potential Exposure (MPE):
  - ◆ The estimated maximum percentage of a daily intake of food that could consist of the food material in question

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**■ ■ ■ ■ ■** *Mechanisms to establish safe dosages or levels*

- Average Food Consumption (AFC):
  - ◆ Typical food consumption by an adult in kg per day
- Tolerance:
  - ◆  $(ADI * \text{avg. body weight}) / (MPE * AFC)$

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