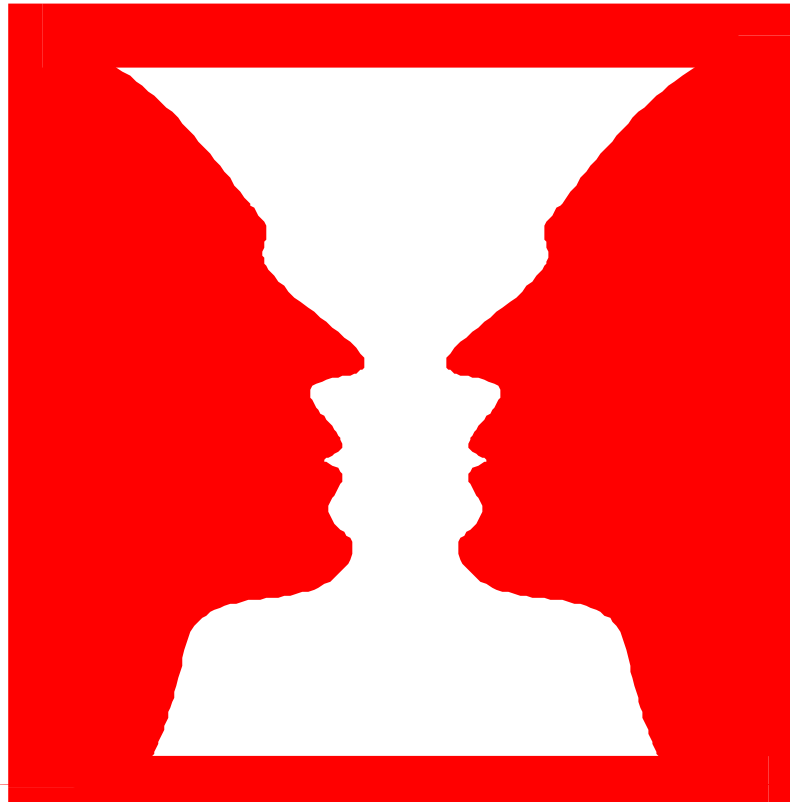


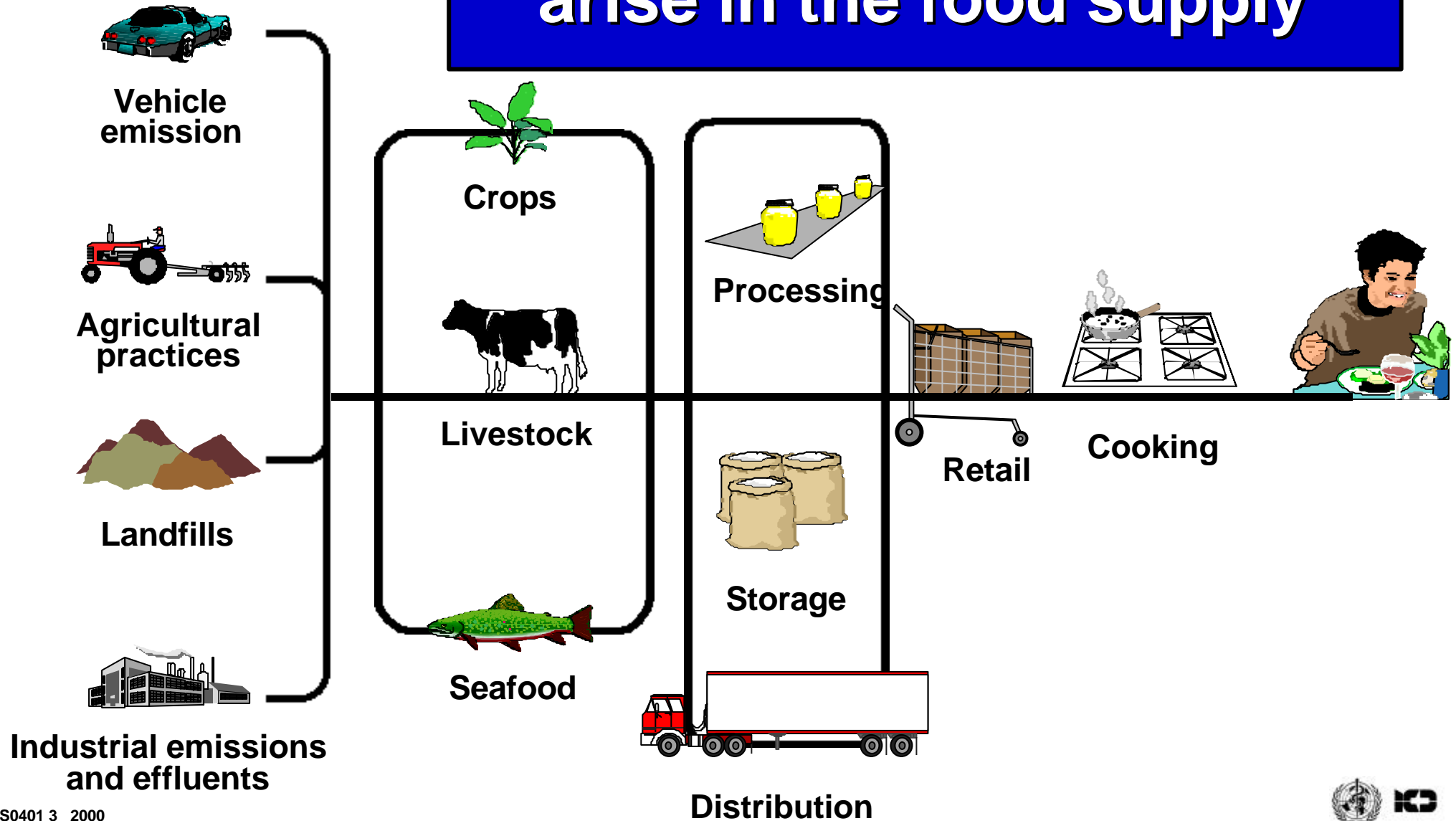
## **Module 04    Lecture 01**

# **Chemical and physical hazards in food**

# Perception of chemical hazards in food



# Where chemical hazards arise in the food supply



# Chemical hazards in food

- **industrial and environmental contaminants**
- **biologically derived contaminants**
- **contaminants produced during processing**
- **improperly used agrochemicals**
- **improperly used additives**

# Contaminants of industrial and environmental origin

<b><i>Chemical</i></b>	<b><i>Main source</i></b>	<b><i>Associated food</i></b>
<b>PCBs</b>	<b>Transformers</b>	<b>Fish, animal fat</b>
<b>Dioxins</b>	<b>By-product</b>	<b>Fish, animal fat</b>
<b>Mercury</b>	<b>Chlor - alkali</b>	<b>Fish</b>
<b>Lead</b>	<b>Vehicle emission, smelting, paint, glazes, solder</b>	<b>Canned food, acidic foods, drinking water</b>
<b>Cadmium</b>	<b>Sludge, smelting</b>	<b>Grains, molluscs</b>
<b>Radionuclides</b>	<b>Accidental release</b>	<b>Fish, mushrooms</b>
<b>Nitrate / nitrite</b>	<b>Fertilizers</b>	<b>Vegetables, drinking water</b>

# Inherent plant food toxicants

## *Chemical*

oxalates

glycoalkaloids

cyanoglycosides

phytohaemagglutinin

various carcinogens

## *Associated Food*

rhubarb, tea, cocoa, spinach, beet

green potato

lima bean, cassava

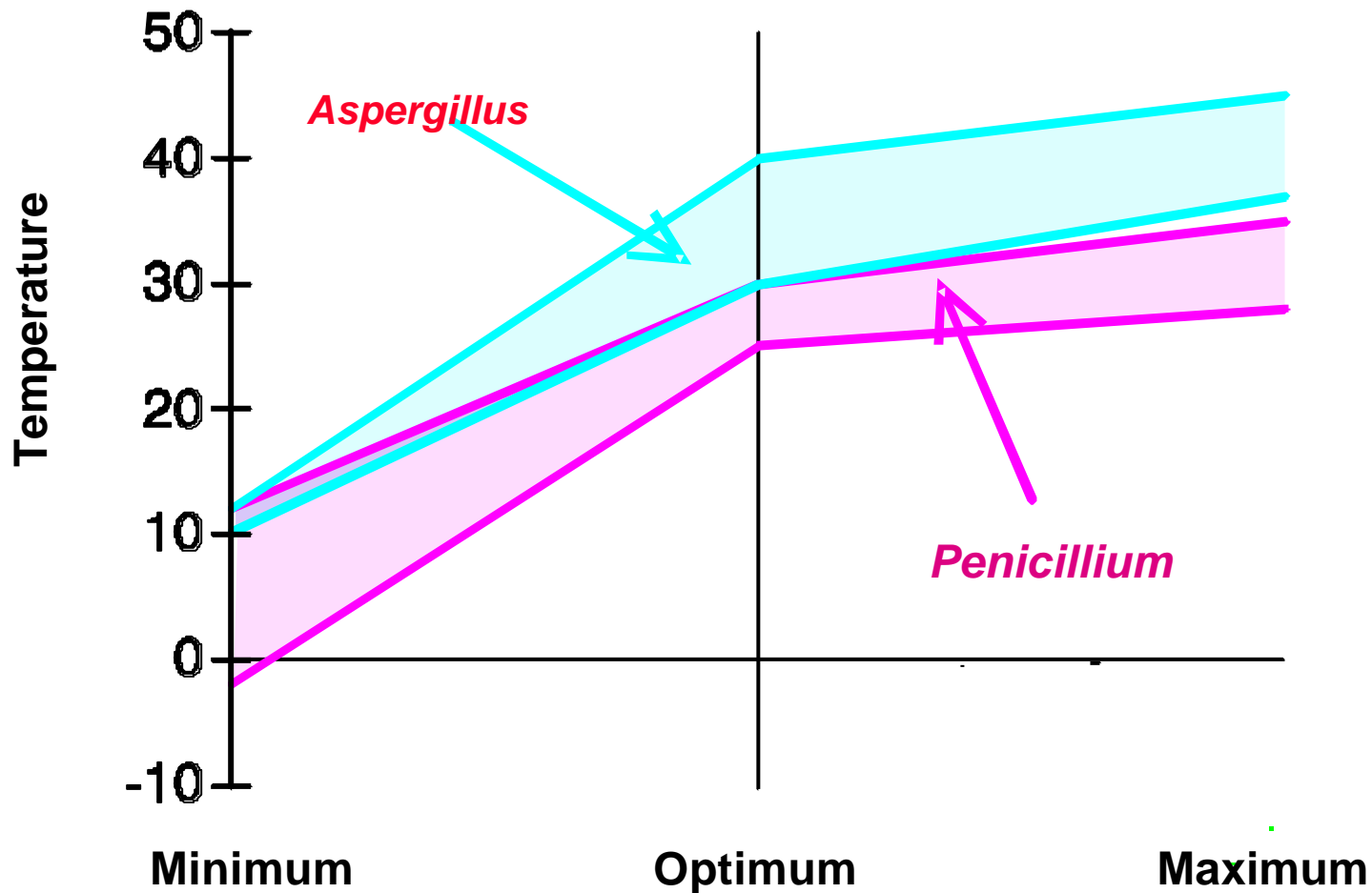
red kidney beans and other beans

spices and herbs

# Mycotoxins

<b><i>Chemical</i></b>	<b><i>Source</i></b>	<b><i>Associated Food</i></b>
<b>Aflatoxins</b>	<b><i>Aspergillus flavus</i> and <i>A. parasiticus</i></b>	<b>corn, peanuts, tree nuts, milk</b>
<b>Trichothecenes</b>	<b>Mainly <i>Fusarium</i></b>	<b>cereals and other foods</b>
<b>Ochratoxin A</b>	<b><i>Penicillium verrucosum</i> <i>A. ochraceus</i></b>	<b>wheat, barley, corn</b>
<b>Ergot alkaloids</b>	<b><i>Claviceps purpurea</i></b>	<b>rye, barley, wheat</b>
<b>Fumonisin</b>	<b><i>Fusarium moniliforme</i></b>	<b>corn</b>
<b>Patulin</b>	<b><i>P. expansum</i></b>	<b>apples, pears</b>
<b>Zearalenone</b>	<b><i>Fusarium</i> spp</b>	<b>cereals, oil, starch</b>

# Temperature range for growth of toxigenic moulds



# Minimum water activity for growth of toxigenic moulds

## *Mould*

## *Minimum Water Activity*

*Aspergillus ochraceus*

0.78

*Penicillium verrucosum*

0.79

*Aspergillus flavus*

0.80

*Fusarium moniliforme*

0.87

*Stachybotrys atra*

0.94

# Target organs of some mycotoxins

## *Mycotoxin*

## *Target*

Aflatoxin

liver

Ochratoxin A

kidney

Trichothecenes

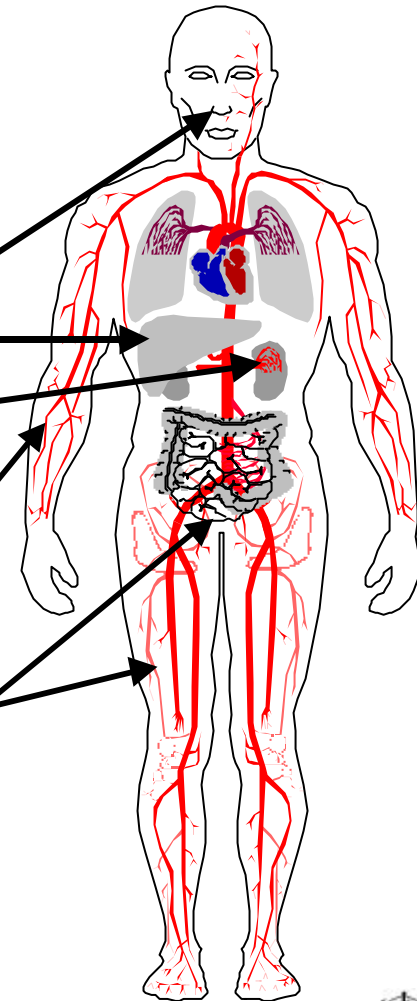
mucosa

Ergot alkaloids

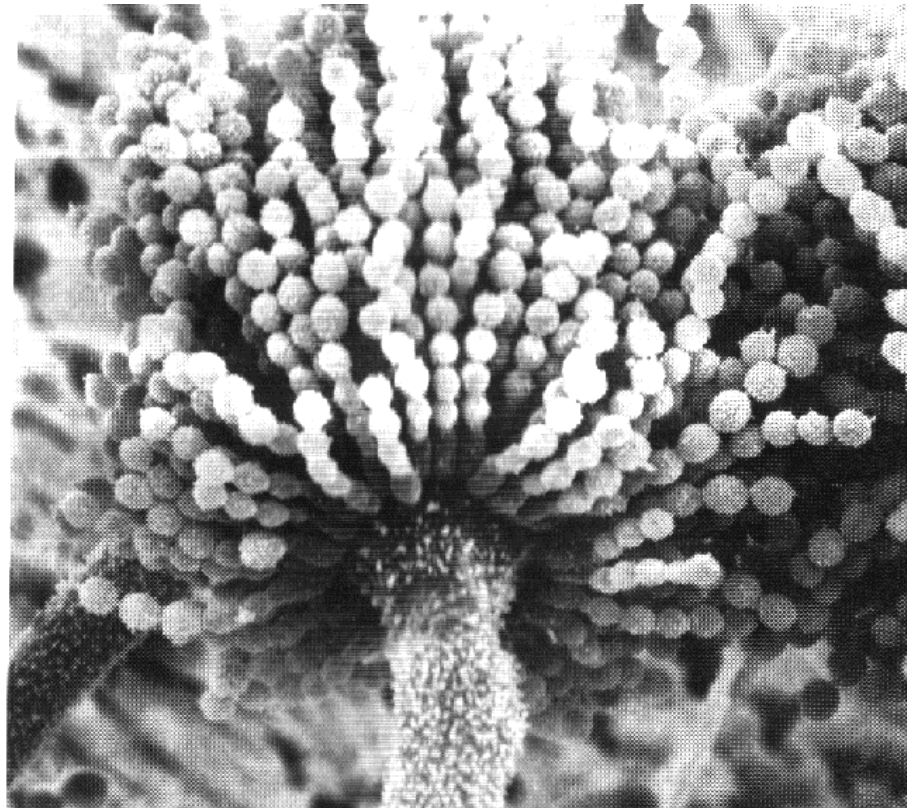
peripheral vascular system

Zearalenone

uro-genital tract



# Contaminants of biological origin



# Regulatory limits for mycotoxins in foods

<i>Mycotoxin</i>	<i>Limit (µg/kg)</i>	<i>Commodities</i>	<i>No. of Countries</i>
<b>Aflatoxins B+G</b>	<b>0 - 50</b>	<b>corn, peanuts, other foods</b>	<b>48</b>
	<b>0 - 1000</b>	<b>animal feeds</b>	<b>21</b>
<b>Aflatoxin M<sub>1</sub></b>	<b>0.05 - 1.0</b>	<b>milk, dairy</b>	<b>17</b>
<b>Ochratoxin A</b>	<b>1 - 300</b>	<b>rice, corn, barley, beans, pork kidney</b>	<b>6</b>
<b>Deoxynivalenol</b>	<b>1000 - 4000</b>	<b>wheat</b>	<b>5</b>
<b>Patulin</b>	<b>20 - 50</b>	<b>apple juice</b>	<b>10</b>
<b>Zearalenone</b>	<b>30 - 1000</b>	<b>all foods</b>	<b>4</b>

# Risk assessment for mycotoxin in foods

## *Mycotoxin*

## *JECFA Benchmark*

Aflatoxin B<sub>1</sub>

0.01 - 3 cancers per year  
per 100.000 people  
per **mg** of aflatoxin B<sub>1</sub>  
per kg bw/day

Patulin

0.4 **mg**/kg bw/day

Ochratoxin A

0.1 **mg**/kg bw/day

# Regulatory limits for aflatoxins in some Asian and Pacific countries

<b>Country</b>	<b>Limit (<math>\mu</math>/kg)</b>	<b>Commodity</b>
Australia/New Zealand	15 (T)	peanuts
	5 (T)	other foods
China	20 (B <sub>1</sub> )	maize, peanut
India	30 (B <sub>1</sub> )	all
Japan	10 (B <sub>1</sub> )	rice
	5 (B <sub>1</sub> )	other grains
Malaysia	35 (T)	all
Philippines	20 (B <sub>1</sub> )	coconuts, peanut products (export)
Singapore	Absence (B <sub>1</sub> )*	all
Sri Lanka	30 (T)	all
Thailand	20 (T)	all

\*Limit of detection is around 10  $\mu$ g/kg

B<sub>1</sub> = Aflatoxin B<sub>1</sub>  
T = Total Aflatoxins



# Other toxicants of biological origin

<i><b>Toxicant</b></i>	<i><b>Source</b></i>	<i><b>Associated food</b></i>
<b>Ciguatera</b>	<b>dinoflagellates</b>	<b>tropical Fish</b>
<b>Shellfish toxins: paralytic neurotoxic diarrhoeic amnesic</b>	<b>dinoflagellates</b>	<b>shellfish</b>
<b>Pyrrolizidine alkaloids</b>	<b>various toxic plants</b>	<b>cereals, honey</b>
<b>Histamine</b>	<b>spoilage bacteria</b>	<b>fish, cheese</b>

# Contaminants produced during processing

- **polynuclear aromatic hydrocarbons**
- **heterocyclic amines, nitropyrenes**
- **nitrosamines**
- **ethyl carbamate (urethane)**
- **chloropropanols**

# Improperly used agrochemicals

## *Insecticides*

organochlorine insecticides  
organophosphorus insecticides  
carbamate insecticides

## *Animal Drugs*

antimicrobials  
growth promotants  
anthelmintics  
therapeutics

fumigants

fungicides

herbicides

fertilizers

plant growth regulators

rodenticides

nematocides

molluscicides

# Food additives

**anti-caking agents**  
**antimicrobial agents**  
**antioxidants**  
**colours**  
**curing and pickling agents**  
**emulsifiers**  
**enzymes**  
**firming agents**  
**flavour enhancers**  
**flavouring agents**  
**humectants**  
**leavening agents**

**release agents**  
**non-nutritive sweeteners**  
**nutrient supplements**  
**nutritive sweeteners**  
**oxidising and reducing agents**  
**pH control agents**  
**propellants and gases**  
**sequestrants**  
**solvents and vehicles**  
**stabilisers and thickeners**  
**surface-active agents**  
**texturizers**

# Other potential hazards

## **processing Aids**

**ion-exchange resins, filter aids  
enzyme preparations  
microorganisms  
solvents, lubricants, release agents  
specific function additives**

## **food Contact Materials**

**utensils  
working surfaces  
equipment**

## **packaging Materials**

**metal, plastic, paper, wood, etc.**

## **cleaning Agents**

**detergents  
sanitisers**

# Improperly used additives

## *Adulterants*

- ◆ borax
- ◆ boric acid
- ◆ formaldehyde
- ◆ water
- ◆ unapproved colouring agents

# Improper use of food additives

## *Illegal use in Indonesia*

***Pom Aceh*** - 2734 sauce bottles - Rhodamine B

Red drinks containing Rhodamine-B :

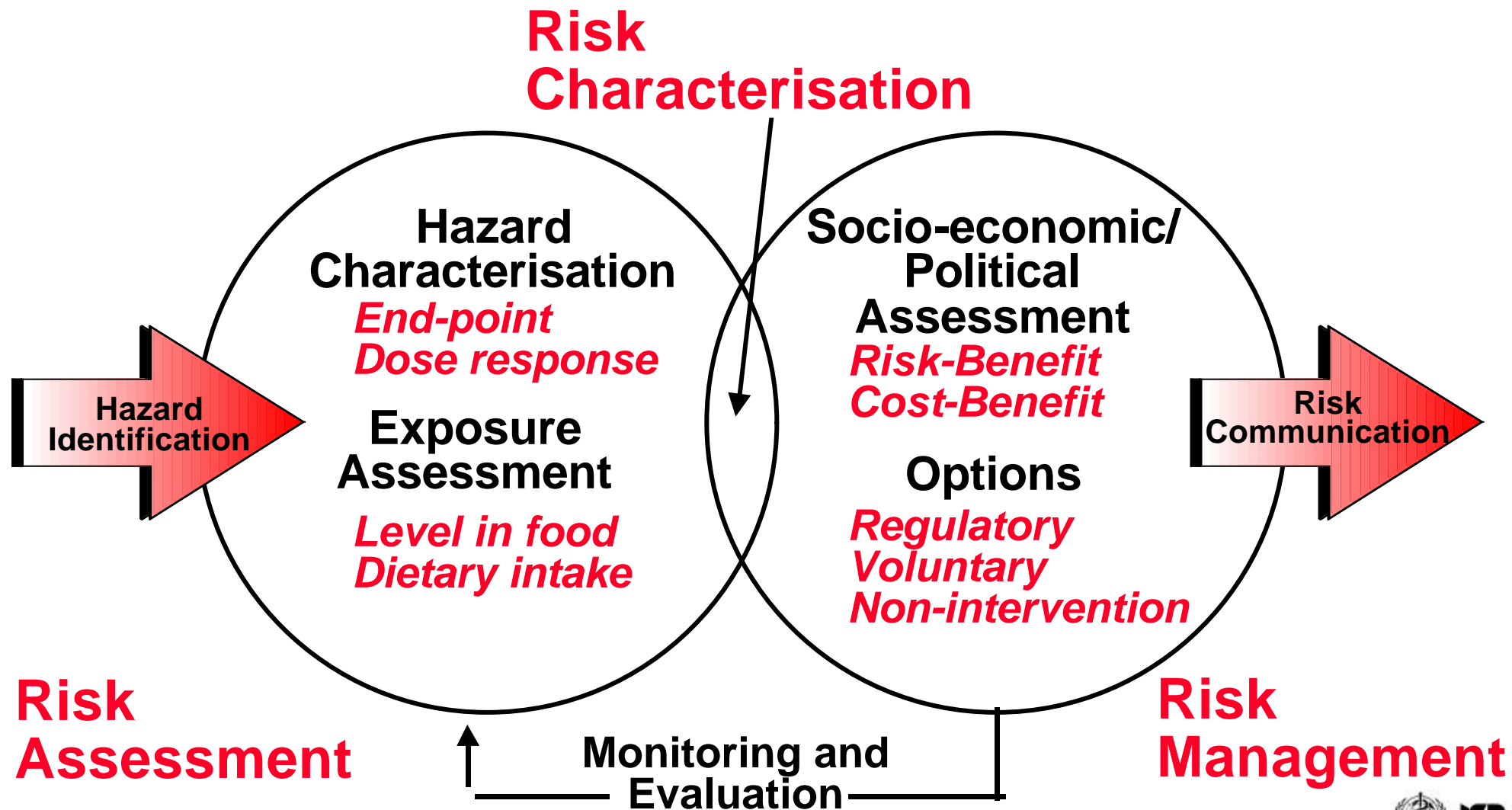
Bogor	15 %
Djakarta	8 %
Rankasbitung	17 %
Pacet	17 %
Cikampek	24 %

## ***Semarang***

**55% red drinks contained Rhodamine-B**

**31% food samples contained Rhodamine-B,  
Methanyl yellow or orange-RN**

# Risk analysis of chemicals in foods



# Monitoring points for chemical hazards

- **point source**
- **environmental compartments**
- **primary production**
- **import / export**
- **production and processing**
- **wholesale outlets and markets**
- **biomonitoring**

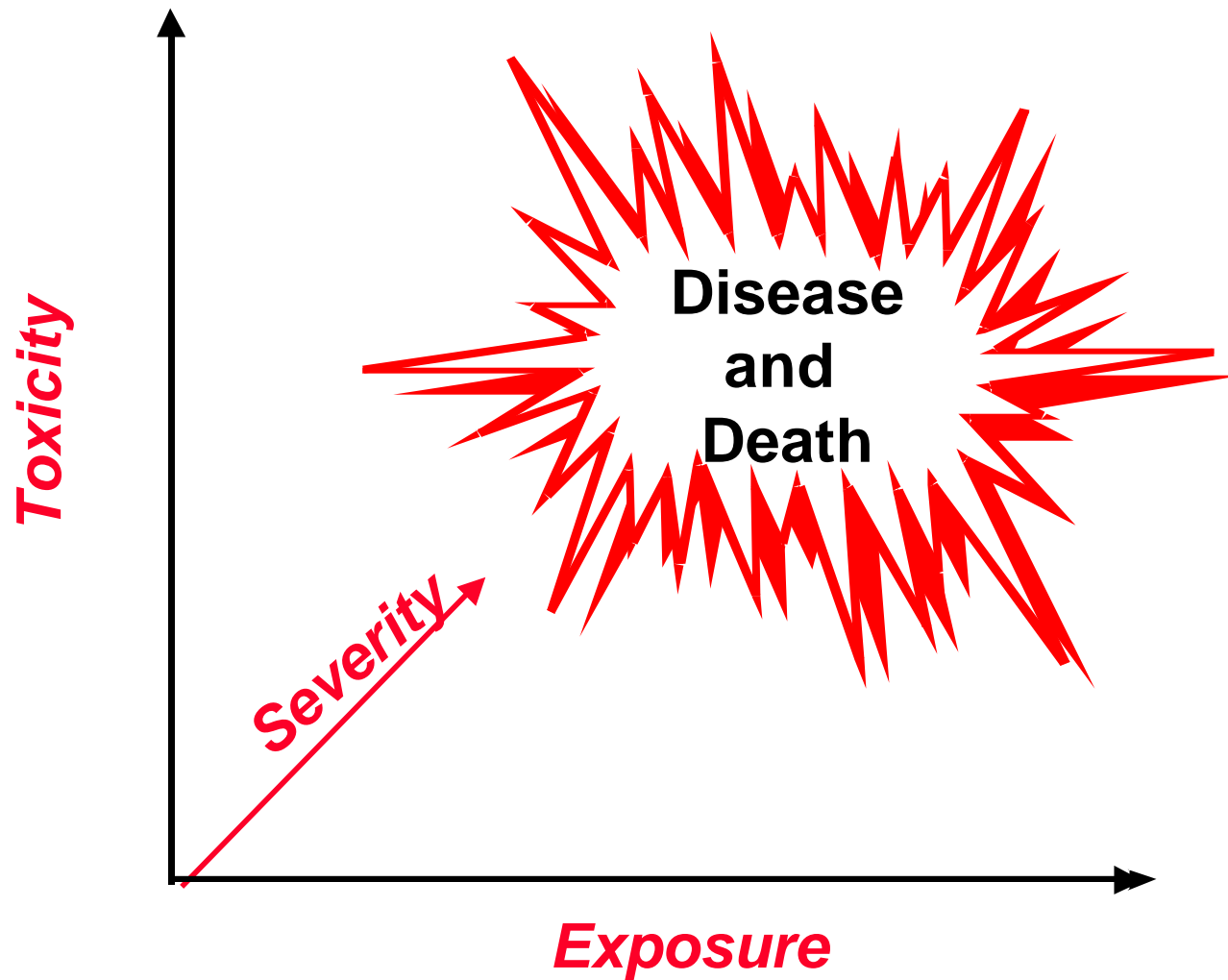
# Criteria for establishing priorities

- **severity of potential effects on health**
- **levels in individual foods and the diet**
- **size and susceptibility of the exposed population**
- **significance in domestic and international trade**
- **nature and cost of management options**

# Chemical hazards in the home

- **metal cookware contaminated with heavy metals**
- **ceramic or enamelled serving dishes with toxic glazes**
- **leaded crystal used with acid foods**
- **copper pans and utensils**
- **miscellaneous home-use chemicals**

# Chemical hazards in food



# Potential physical hazards

- **glass**
- **slime or scum**
- **metal**
- **bone**
- **plastic**
- **stones and rocks**
- **capsules or crystals**
- **pits or shell**
- **wood**
- **paper**
- **human and animal hair**

# Potential physical hazards

## *Distribution of complaints of foreign objects in food*

<b>soft drinks</b>	<b>19 %</b>
<b>infant foods</b>	<b>16 %</b>
<b>bakery</b>	<b>14 %</b>
<b>chocolate and cocoa products</b>	<b>7 %</b>
<b>fruits</b>	<b>7 %</b>
<b>cereals</b>	<b>5 %</b>
<b>vegetables</b>	<b>4 %</b>
<b>fish</b>	<b>3 %</b>
<b>others</b>	<b>25 %</b>

# Potential physical hazards

## *Possible control measures*

- ◆ **visual inspection**
- ◆ **filters or sieves**
- ◆ **metal detectors**
- ◆ **magnets**
- ◆ **separation by density**
- ◆ **personnel precautions (hair net, gloves)**

# Effect of thermal processing on nutrients

	Vitamin A	Vitamin B group*	Vitamin C	Vitamin E
Freezing	-	M	M	-
Pasteurisation	L	L	M	L
Boiling	L	M to H	H	L
Microwaving	-	L	L	-
Baking/Roasting	L	L to M	M	L
Ultra High temperature (UHT)	L	L	M	L
Canning	M	M to H	H	M

\*Comprises a number of water soluble, low molecular weight compounds and includes Thiamine (B<sub>1</sub>), Riboflavin (B<sub>2</sub>), Niacin, Folate, B<sub>6</sub> and B<sub>12</sub>.

# Effect of food processes on nutrients

	Vitamin A	Vitamin B group*	Vitamin C	Vitamin E
<b>Milling</b>	-	M to H	-	-
<b>Air drying</b>	M	L to M	H	M
<b>Freeze drying</b>	L	L	M	L
<b>Salting</b>	-	L	L	-
<b>A<sub>w</sub> reduction by sugars</b>	-	-	-	-
<b>Fermentation</b>	-	L	L	-
<b>Acid pH</b> (i.e. <4.6)	M	-	L	-
<b>Additives</b> (e.g. sulphite)	-	H e.g. B1 - Thiamine	-	-
<b>Irradiation</b>	-	L to M	L	-

\*Comprises a number of water soluble, low molecular weight compounds and includes Thiamine (B<sub>1</sub>), Riboflavin (B<sub>2</sub>), Niacin, Folate, B<sub>6</sub> and B<sub>12</sub>.

# Mineral loss during food processing

*Loss may be due to*

- ◆ **Physical removal**
- ◆ **Leaching into cooking water**
- ◆ **Shrinkage during cooking**

# Factors affecting mineral availability

## *Processes which may affect mineral availability*

- ◆ Reducing or removing ingredients which inhibit mineral absorption
- ◆ Fermentation and germination
- ◆ Heating (increases availability of some minerals, decreases availability of others)
- ◆ Addition of phosphates

# Macronutrients

- **Relatively stable to food processing**
- **Certain treatments physically remove macronutrients from the food (e.g. milling)**
- **Heat treatments can denature proteins, or cause fats to oxidise and degrade**
- **Certain treatments increase carbohydrate levels (e.g. adding sugar as a preservative)**

# Effect of nutrient loss on diet

- **If a food is a principal source of a particular nutrient, it is important to minimise the loss of this nutrient**
- **Processed foods sometimes retain more nutrients than fresh foods**
- **Strategies to minimise overall nutrient loss must look at each processing stage**

# Minimising nutrient losses

## *To reduce nutrient loss*

- ◆ Reduce water in cooking
- ◆ Minimise the time between harvest and eating
- ◆ Ensure optimum storage

# Free radicals and chronic disease

*Free radicals cause oxidative stress*

*Increasing evidence that free radicals may be responsible for and related to*

- ◆ **diabetes mellitus**
- ◆ **cardiovascular disease**
- ◆ **atherosclerosis**
- ◆ **tropical diseases**

# Counteracting oxidative stress

*Oxidative stress is counteracted by*

- ◆ **antioxidative enzymes**
- ◆ **non-enzymic antioxidants**  
(e.g. vitamins A, C, E and beta carotene)