Milk contaminants

What is contaminant?

Biological, chemical, physical, or radiological substance (normally absent in the environment or food) which, in sufficient concentration, can adversely affect living organisms through air, water, soil, and/or food.

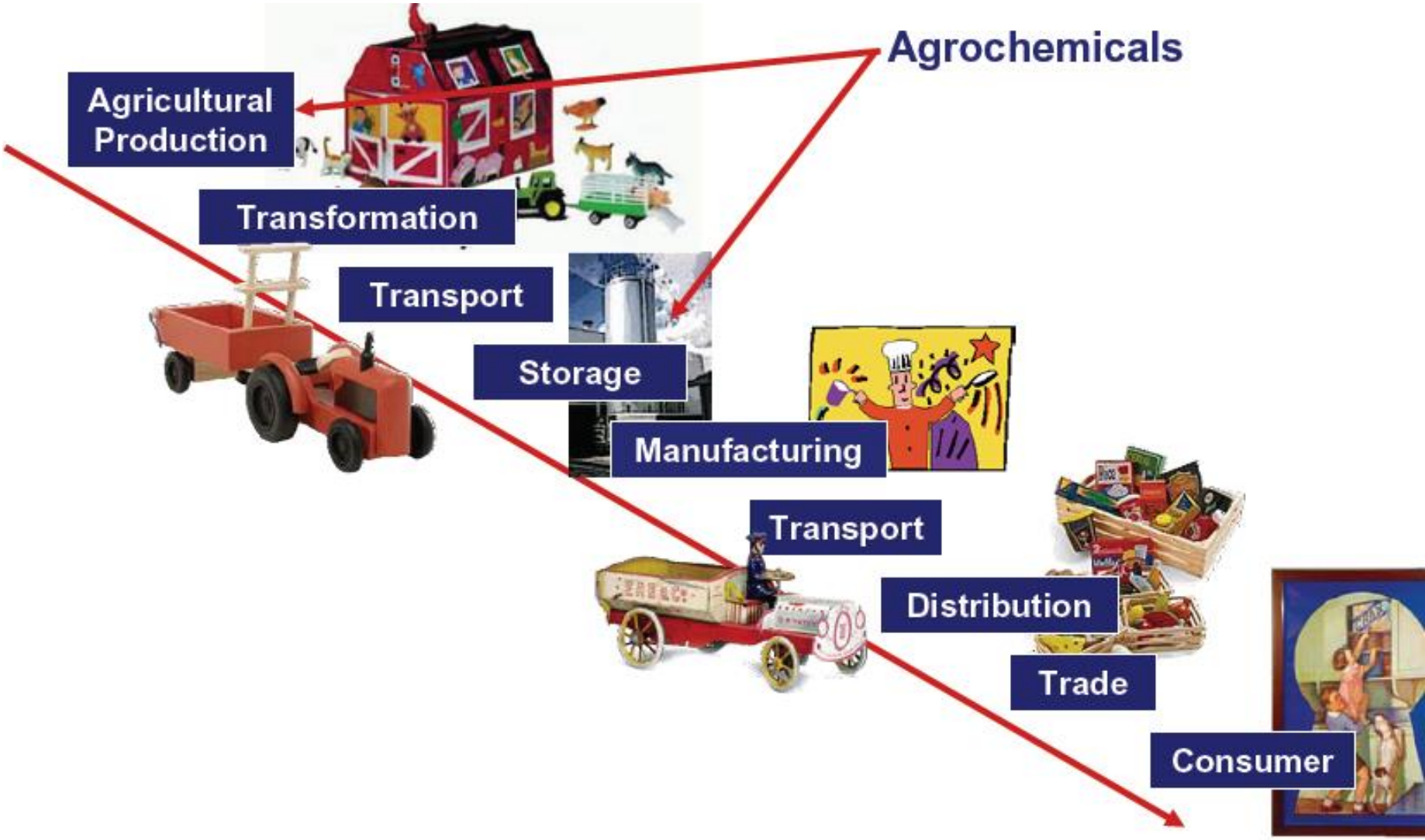
- Not added intentionally
- May enter in food as a result of the various stages of its production (including operations carried out in crop husbandry, animal husbandry and veterinary drugs) , packaging, transport or holding.

Term does not include insect fragments, rodent hairs and other extraneous matter

- **Agrochemicals:** Chemicals used in agricultural practices and animal husbandry with the intent to increase crops and reduce costs. Such agents include pesticides (e.g. insecticides, herbicides, rodenticides), plant growth regulators, veterinary drugs (e.g. nitrofuran, fluoroquinolones, malachite green, chloramphenicol), and bovine somatotropin (rBST).

- **Environmental contaminants:** chemicals that are present in the environment in which the food is grown, harvested, transported, stored, packaged, processed, and consumed. The physical contact of the food with its environment results in its contamination. Possible sources of contamination are:

- **Air**: radionuclides (^{137}Caesium, ^{90}Strontium), polycyclic aromatic hydrocarbons (PAH).
- **Water**: arsenic, mercury.
- **Soil**: cadmium, nitrates, perchlorates.
- Polychlorinated biphenyls (PCB) , dioxins, and polybrominated diphenyl ethers (PBDE) are ubiquitous chemicals, which are present in air, water, soil, and the entire biosphere.
- **Packaging materials**: antimony, tin, lead, perfluorooctanoic acid (PFOA), semicarbazide, benzophenone, isopropylthioxanthone (ITX), bisphenol A.
- **Processing/cooking equipment**: copper, or other metal chips, lubricants, cleaning and sanitizing agents.
- **Naturally occurring toxins**: mycotoxins, phytohaemagglutinin, pyrrolizidine alkaloids, grayanotoxin, mushroom toxins, scombrotoxin (histamine), ciguatera, shellfish toxins (see shellfish poisoning), tetrodotoxin, among many others.

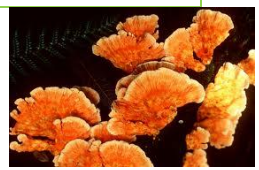

Agrochemicals
Agricultural Production
Transformation
Transport
Storage
Manufacturing
Transport
Distribution
Trade
Consumer

Pesticides

- **Pesticides:** defined as any substance or a mixture of substances used for preventing, destroying, repelling or mitigation of any pest including unwanted species of plants or animals during the production, storage, transport, distribution and processing of food, agricultural commodities, or animal feeds or which may be administered to animals for the control of ectoparasites.. They are often classified by the type of pest they control.

Herbicides

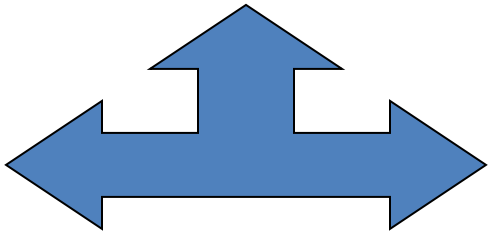
Fungicide



insecticides

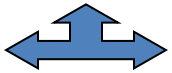
Acaricides: mites
Nematocides: worms or nematodes
Molluscicides: snails and slugs
Rodenticides: rodents

PESTICIDES



SYNTHETIC **NATURAL**

ORGANIC **INORGANIC**



Insecticides

- organo-phosohates
- carbamates
- Pyrethrins

Herbicides

- Triazine
- Dinitro compounds
- Phenoxy-acetic acid
- Bipyridinium

Rodenticides

- Inorganic agent
- Dicoumarol derivatives
- Glycosides

Fungicides

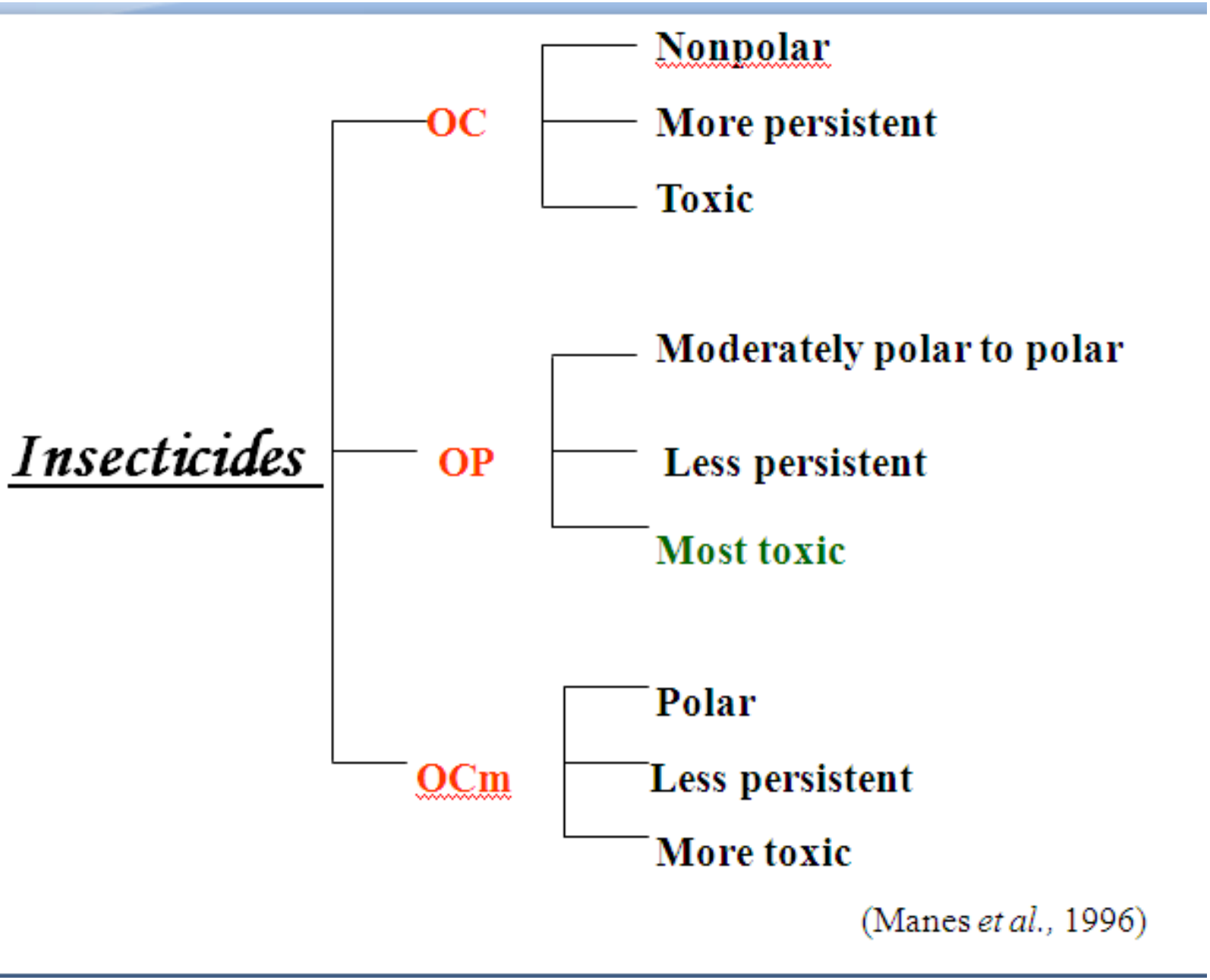
- **Arsenic**
- **Mercury**

Bio-pesticides

- Integral component of integrated pest management (IPM)

- Derived from three sources
  - Microbial : Bacteria, fungi, virus and protozoa
  - Botanical : *Azadiracta* spp.(Neem)
  - Bio-chemical : Insect pheromones

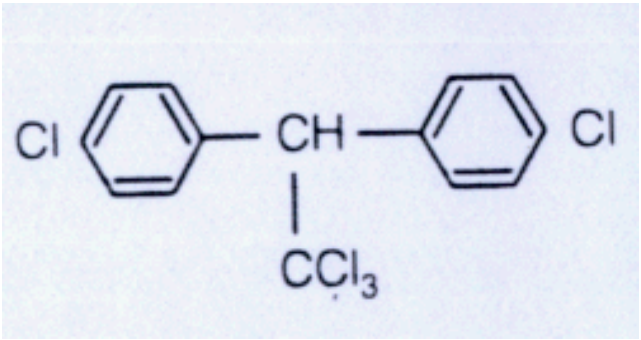
- The most commonly used bio-pesticides sources are : *Bacillus thuringiensis*, *Baculovirus*, Neem, *Trichoderma and Trichogramma*



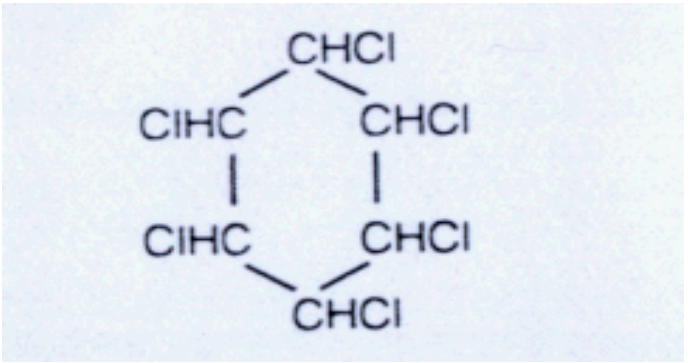
(Manes *et al.*, 1996)

Organochlorine(OC)

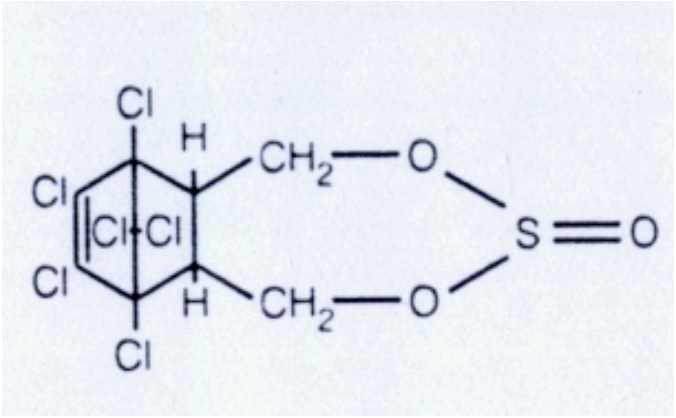
- Organochlorine(OC) pesticides are cyclical or condensed organic compounds in which chlorine averages 60% of the molecular weight.



DDT



BHC

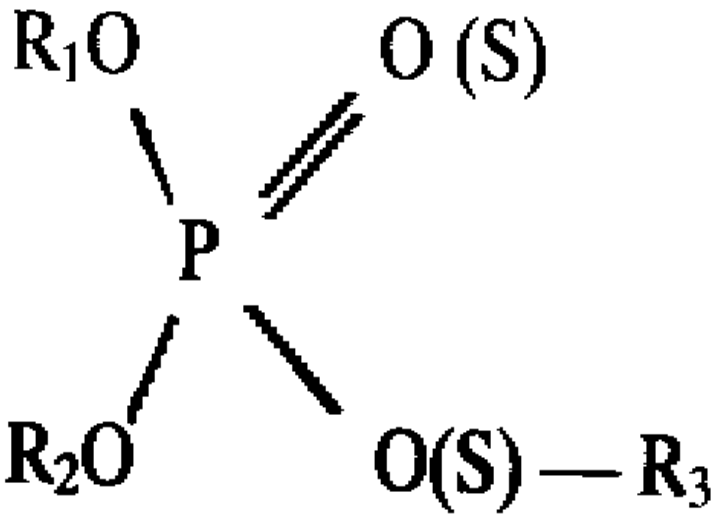


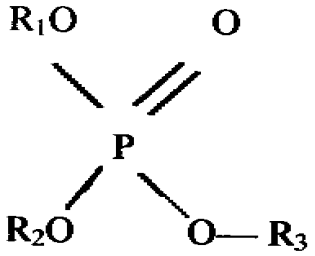
ENDOSULFAN

Organophosphate(OP)

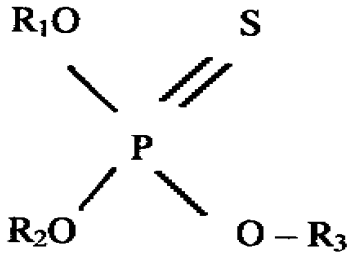
- Organophosphate(OP) are esters of phosphoric or related acids.R_1 and R_2 are usually alkyl groups (mainly methyl or ethyl) and R_3 represents a wide variety of organic substituents.

General Structure of Organophosphate

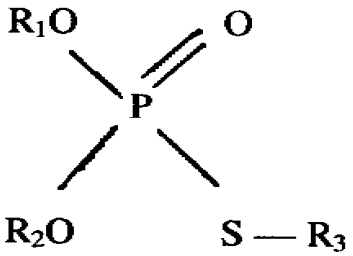




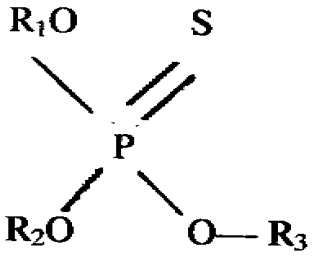
Phosphate



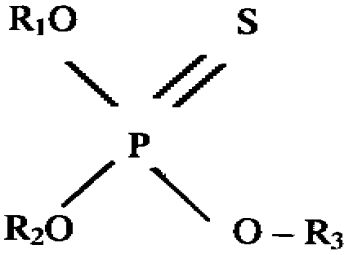
Phosphorothionates



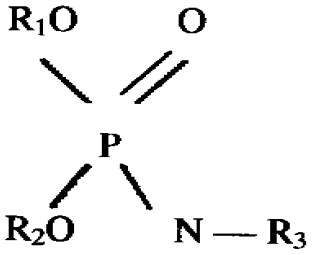
Phosphorothiolates



Phosphorodithionates



Phosphonate

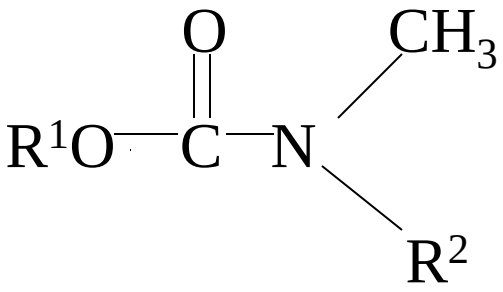


Phosphoramides

GENERAL STRUCTURE OF THE SIX PRINCIPAL GROUPS OF ORGANOPHOSPHATES (IDF 9101, 1990)

Organocarbamate(OCm)

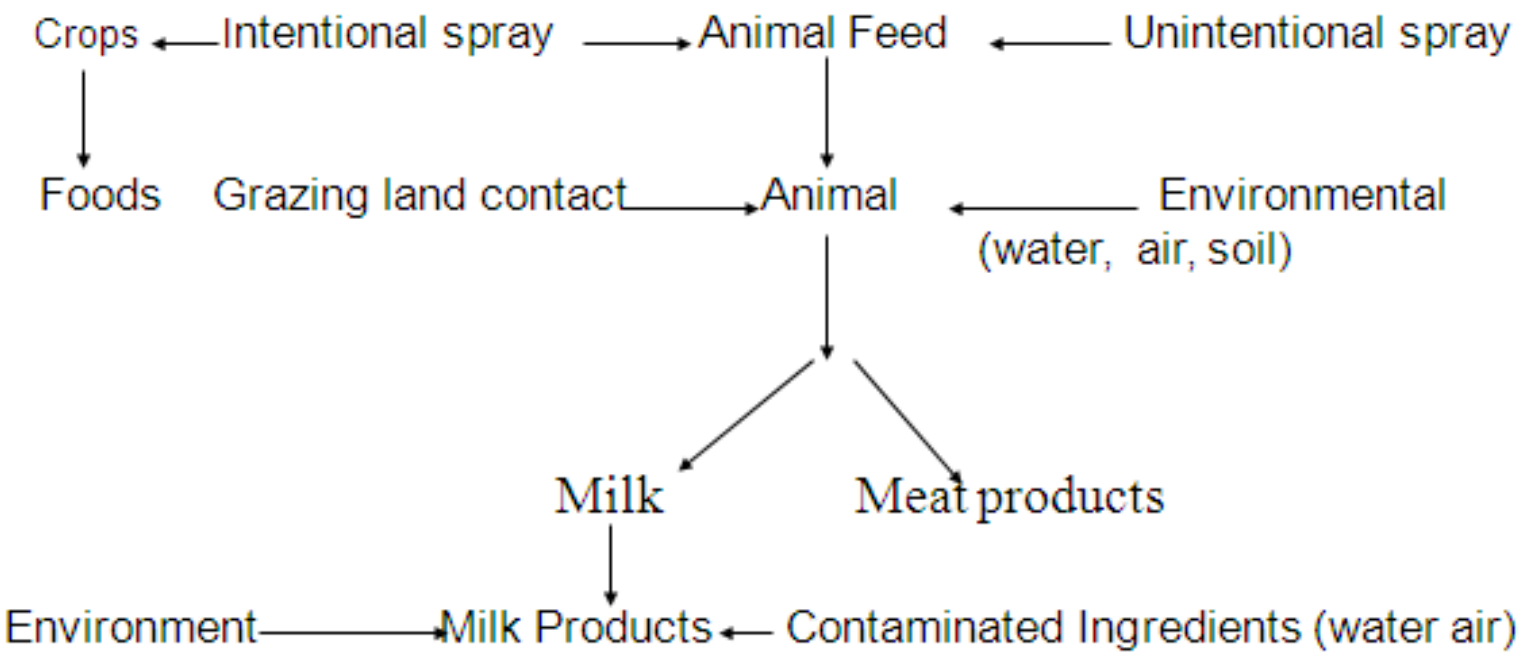
Organocarbamate(OCm) are derivatives of esters of carbamic acid HO-CO-NH_2



General Structure of OCm

R_1- Aryl moiety

R_2- H_2 -CH3



Sources of contamination of Pesticide Residues in food products.

Agricultural/Veterinary practices:

- *Antibiotics*
- *Hormones*
- *Agrochemicals*

Environment (air, feed, water, soil):

- *Radionuclides*
- *Organic pollutants*
- *Mycotoxins*
- *Agrochemicals*
- *Metals*

Indirect

RAW MILK

- *Metals*
- *Additives*
- *Sanitizers*
- *Disinfectants*
- *Mycotoxins*

← **Milking utensils**

← **Teat treatment**

← **Milk preservatives**

DAIRY PRODUCTS

- *Metals*
- *Additives*
- *Mycotoxins*
- *Migrants*
- *Process. chem.*

← **Processing**

← **Packaging**

Direct Contamination

From Benoit Schilter, R&D QS/2004

Pesticide residue

Pesticide residue means any specified substance in food, agricultural commodities, or animal feed resulting from the use of a pesticide. The term includes any derivatives of a pesticide, such as conversion products, metabolites, reaction products, and impurities considered to be of toxicological significance.

Codex maximum limit for pesticide residues (MRLP)

- MRLP is the maximum concentration of a pesticide residue (expressed as mg/ Kg), recommended by the Codex Alimentarius Commission to be legally permitted in or on food commodities and animal feeds. MRLs are based on GAP data and foods derived from commodities that comply with the respective MRLs are intended to be toxicologically acceptable.

MRL (ppm) of pesticide residues in milk and milk products by Codex Alimentarius Commission (CAC), 2008 and PFA, 2008.

Name of Pesticide	CAC,2008*	PFA,2008**
Acephate	0.02	-
Aldrin,Dieldrin	0.006	0.15 F
Carbaryl	0.05	-
Chlorpyrifos	0.01	0.01 F
D.D.T	0.02	1.25 F
Diazinon	0.02	-
Dichlorvos	0.02	-
Endosulfan	0.01	-
Ethion	-	0.5 F
Fenitrothion	0.002	0.05 F
HCH, α, β, γ(Lindane), δ	0.01 (Lindane)	0.05, 0.02, 0.01/0.2F, 0.02
Heptachlor	0.006	0.15 F
Monocrotophos	-	0.02***
Phorate	0.01	0.05 F

- *MRL are expressed in ppm i.e mg/Kg on whole milk basis
- ** Unless otherwise stated, MRL are expressed in ppm i.e mg/Kg on whole milk/ product basis; F- fat basis.*** Product basis

Antibiotics

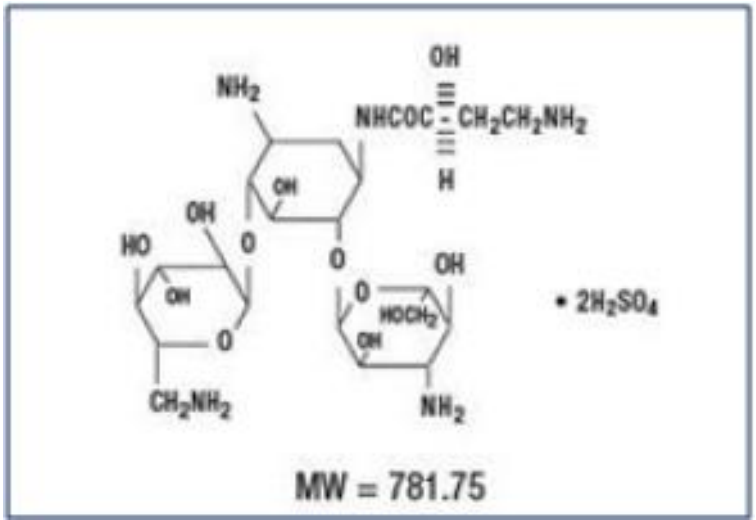
Antibiotic is a drug used to treat infections caused by bacteria and other microorganisms. Originally, an antibiotic was a substance produced by one microorganism that selectively inhibits the growth of another.

- Antibiotics are a boon for the maintenance of the health of the cattle as well as human beings.
- The judicious use of antibiotics has increased the life expectancy of the human beings as well as cattle.
- However, indiscriminate use of these life saving products i.e. antibiotics has created problems in the dairy as well as food industry due to there residues coming to milk and meat.
- The presence of antibiotic residues in milk has a great significance to the dairy industry as these residues may lead to inhibited starter activity, inadequate ripening of cheese and affect flavor and texture of milk products.
- These residues may also affect consumer's health by causing allergic reactions or by development of resistant microbial strains.

Classification of antibiotics

A) Aminoglycosides

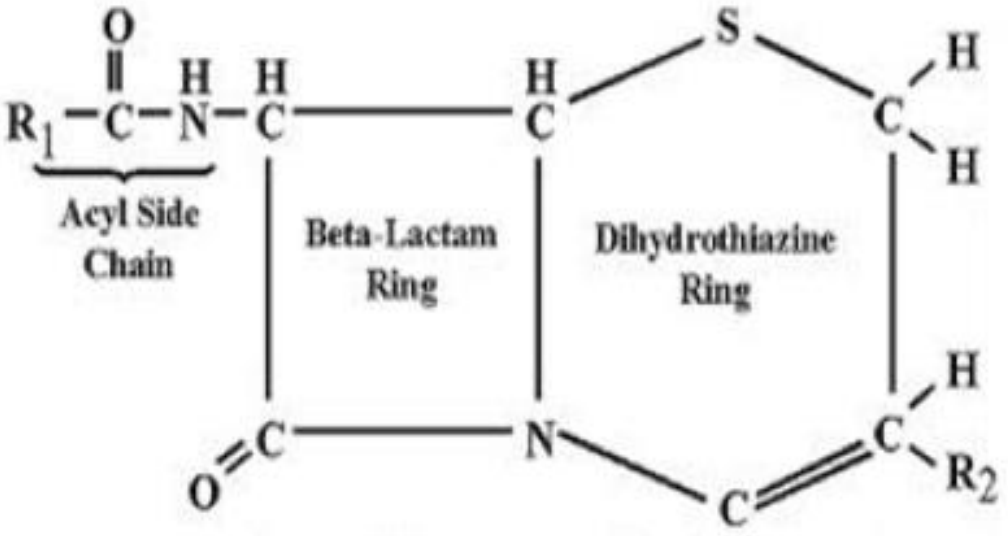
- Example: Apramycin, gentamicin, lincomycin, streptomycin, neomycin, amikamicin and kanamycin, are having complex but closely related structures.
- The aminoglycosides are broadspectrum antibiotics active against both gram-positive and gram-negative organisms but not effective against anaerobes and fungi.
- They are not well absorbed by alimentary tract or by topical application so they are usually administered intravenously or intramuscularly.
- This group of antibiotics poses great health hazards, if present in milk and milk products.



Amikacin sulfate

B) β- Lactam compounds

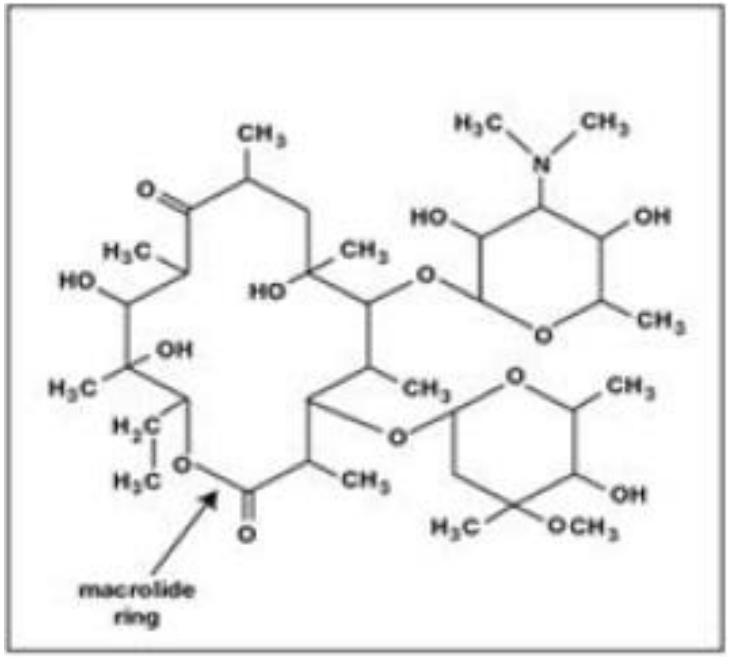
- This group consists of natural penicillin and semi-synthetic penicillin and cephalosporins.
- Penicillins and cephalosporins interfere in the development of bacterial cell wall and are widely used in the treatment of mastitis.
- After injection of penicillin-G, the milk of the treated animals' remains contaminated for several days.
- Cephalosporins are similar to Penicillin in antimicrobial action but less frequently used in veterinary medicine because of its high cost.



General structure of cephlosporine

C) Macrolides

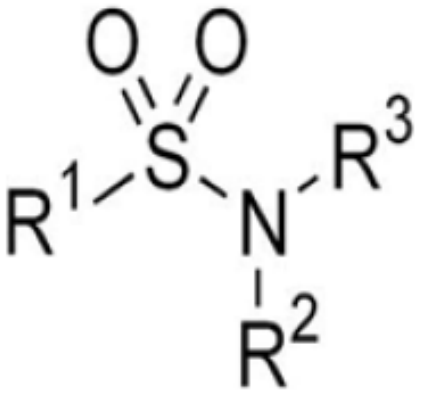
- Example: Erythromycin, spiramycin, tylosin, oleandomycin, clindamycin and roxithrocin
- This group consists of a large lactone ring attached with sugar moieties.
- The macrolides are active aginst gram-positive bacteria specially staphylococci which are resistant against penicillin.
- Many times these compounds are also used as growth promoter. They have better tissue penetration ability and frequently used in veterinary medicine.



Macrolides

D) Sulfonamides

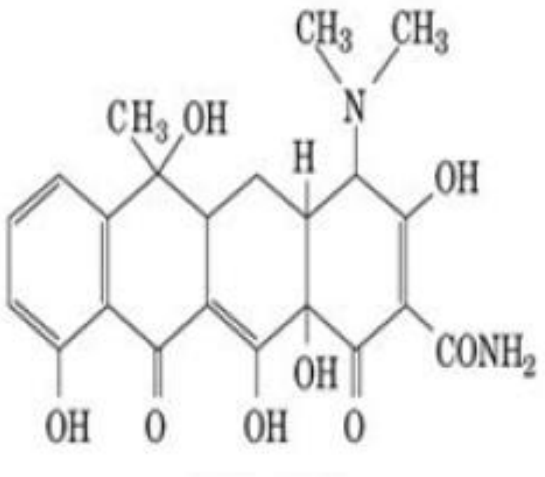
- Example: Sulfamethaxazole, Sulfadimidine, sulfamethoxypyridazine, sulfaethoxypyridazine incombination with trimethoprin are commonly used in the treatment.
- Sulfonamides interfere with folic acid synthesis thus inhibiting the bacterial growth.
- Sulfaguanidine and sulfaquinoxaline are also used as feed additive.
- They are broad spectrum and possess good tissue distribution.
- They have long half-life and have very good chance of its residues in milk of lactating animals.



Sulfonamides

E) Tetracyclines

- Example: Chlortetracycline, oxytetracycline, rolitetracycline, tetracycline, demethylchlortetracycline
- The structure consisted of basic naphthalene ring and possesses excellent solubility in aqueous medium.
- These compounds are active against both gram-positive and negative bacteria.
- However, their systemic absorption in tissues is slower as compared with penicillin, but are well distributed in tissues and less frequently excreted.
- Their residual occurrence may be more in milk, bones or calcified organs.



Tetracyclines

Important definitions

- For better understanding, it is necessary to understand the terminology by regulatory officials. These terms are designed by number of reports of joint meeting of Food and Agriculture Organization (FAO) and World Health Organization (WHO)

Residues

Parent compounds or metabolites of drugs/chemicals, having pharmacological action, if persisted in edible products and are likely to harm human health is called as residue. Residue of a drug is expressed in mg/kg or mg/1000ml (ppm) or μg/kg or μg/1000ml (ppb), ng/kg or ng/1000ml (ppt).

- **Unintentional residues**

Unintentional residue is that, which occur in feed and food (milk and meat) as a result of circumstances. Such chemicals are never added to protect the food or feed against infection of bacteria, fungus, or parasite. The unintentional residues also include the residue of a drug or chemical that occurs as environmental contaminants.

Tolerance levels

It is the maximum permissible residual level, which may be present in tissues or milk of animals.

There are four types of tolerance

- **Finite Tolerance**

It is defined as a measurable amount of drug (no-carcinogen) that is permitted in food. For this purpose the acceptable daily intake (ADI) of human is generally determined by applying the safety factor of 1:100. If the drug or chemical is teratogenic (substances or environmental agents which cause the development of abnormal cell masses during fetal growth) the safety factor of 1:1000 is applied.

- **Negligible Tolerance**

The toxicologically insignificant amount of residue, resulting in a daily intake of small fraction of maximum ADI is defined as negligible tolerance. Principle for determination of negligible tolerance is similar to that which is used to calculate finite tolerance except that a factor of at least 1:2000 is used and upper allowable limit is imposed.

- **Zero Tolerance**

Zero tolerance is determined on the basis of extent of toxicity of drugs/chemicals. For such chemicals no residue is permitted in feed or food because of extreme toxicity in most of the consumers. Zero tolerance is mostly applicable for carcinogenic drugs.

- **Temporary Tolerance**

The temporary tolerance is valid only for the restricted period and subjected to revision of availability of experimental data. Generally it is for new drugs and sometime it is also referred as Interim or Administrative tolerance.

Withdrawal time

Time required for a drug concentration to fall below the tolerance level is called as withdrawal time. Sometime it is also referred as “Discard Time” or “Withhold Time”. It is expressed in hours, days, weeks or months.

Acceptable daily intake (ADI)

The ADI is daily dose of a drug or chemicals residue, which is taken during the entire life-time of a person and appears to be without appreciable risks to health on the basis of all the facts known at that time. ADI value is always subject to revision whenever new information becomes available. It is expressed as mg/kg.

Maximum residue limit (MRL)

Maximum concentrations of individual chemicals, or groups of chemicals, especially metabolites, and including pharmaceutical and industrial chemicals, in commodities or tissues to be used as human or animal feeds, and as defined by the food standard codes of a particular country or state; permissible levels vary with local legislation.

THANK YOU