

Mycotoxins

July 2019

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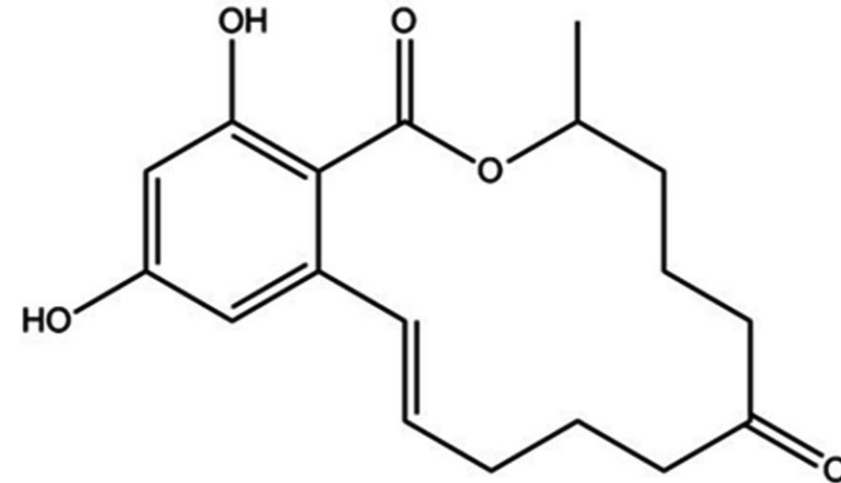
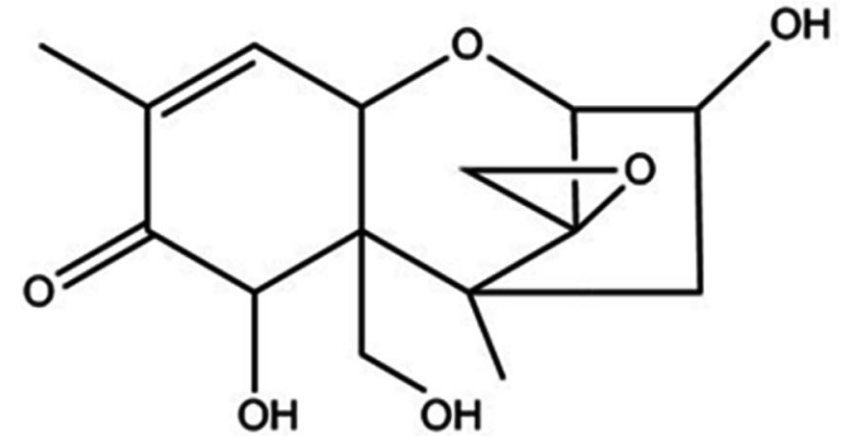
Mycotoxins Definition:

Mycotoxins are secondary metabolic products (metabolites) of moulds which are present in almost all agricultural commodities.



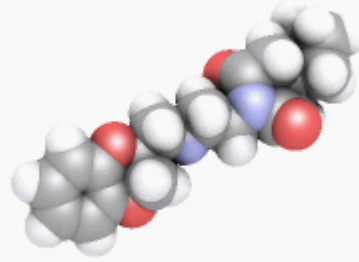
About Mycotoxins

- Currently there are around 400 mycotoxins reported.
- They occur under natural conditions in feed as well as in food.
- Mycotoxins are produced by different strains of fungi and each fungi strain can produce more than one mycotoxin.
- Each plant can be affected by more than one fungus and each fungus can produce more than one mycotoxin thus there is a high probability many mycotoxin are present in one feed ingredient hence increasing chances of occurrence of synergistic effects which are of great concern in livestock health and productivity.



Characteristics Of Mycotoxins

- Invisible (clean Vs dirty raw materials)
- Tasteless
- Chemically stable
- Resistant to temperature and storage
- Resistant to normal feed manufacturing processes.



Classification Of Mycotoxins

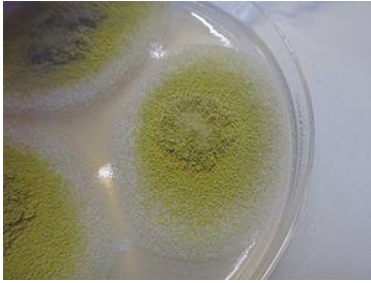
- *Field Fungi (Fusarium) – Pre Harvest*
Typically produce mycotoxins in the field.
- *Storage – Post Harvest*
Aspergillus and penicilliumsp.

NB: Under unusually hot or dry conditions, Aspergillus and penicillium sp can affect crops during growing season. Fusarium Sp (field fungus) can continue growing during storage and transport.



Major classes of Mycotoxin Producing Fungi

Genera Producing Fungi



Aspergillus



Claviceps

Species	Mycotoxins
A. Flavus A. Parasiticus A. Nomius A. pseudotamarii	Aflatoxin (B ₁ , B ₂ , G ₁ , G ₂)
A. ochraceus	Ochratoxin (Ochratoxin A)
A. Clavatus A. terreus	Patulin
A. Flavus A. versicolor	Cyclopiazonic acid (CPA)
C. Purpurea C. Fusiformis C. Paspali C. africana	Penitrem A Ergot alkaloids: Clavines (Argroclavine), Lysergic acids, Lysergic acid amides (Ergine), Ergopeptines (Ergotamine, Ergovaline)

Major classes of Mycotoxin Producing Fungi

Genera Producing Fungi

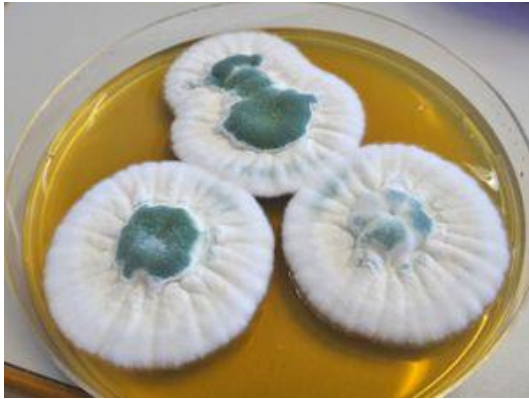


Fusarium

Species	Mycotoxins
F. verticillioides (Syn. F. moniliforme) F. proliferatum	Fumonisin (B ₁ , B ₂ , B ₃) Fusaric acid Acid
F. graminearum F. avenaceum F. culmorum	Type A Trichothecenes: T-2 toxin, HT-2 toxin, diacetoxyscirpenol
F. poae F. equiseti F. crookwellense F. acuminatum F. sambucinum F. sporotrichioides	Type B Trichothecenes: Nivalenol, Deoxynivalenol, Fusarenon-X
F. graminearum F. culmorum F. sporotrichioides	Zearalenone

Major classes of Mycotoxin Producing Fungi

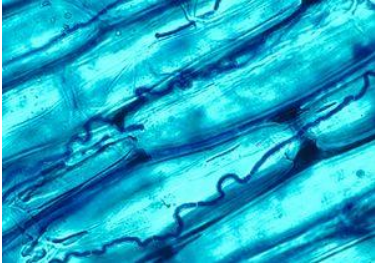

Genera Producing Fungi



Penicillium

Species	Mycotoxins
<p><i>P. verrucosum</i> <i>P. viridicatum</i></p>	<p>Ochratoxin (Ochratoxin A)</p>
<p><i>P. citrinum</i> <i>P. verrucosum</i></p>	<p>Citrinin</p>
<p><i>P. roqueforti</i></p>	<p>Roquefortine C PR toxin Penitrem A</p>
<p><i>P. cyclopium</i> <i>P. camemberti</i></p>	<p>Cyclopiazonic acid (CPA) Penitrem A</p>
<p><i>P. expansum</i> <i>P. claviforme</i> <i>P. roquefortii</i></p>	<p>Patulin</p>

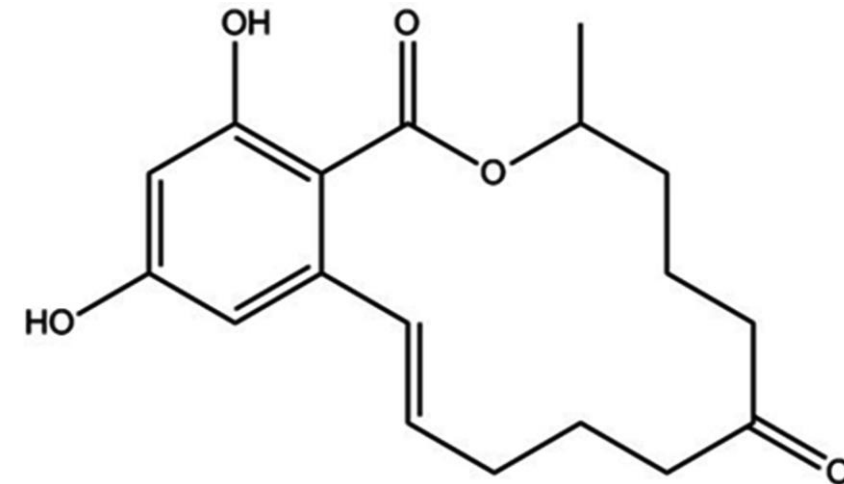
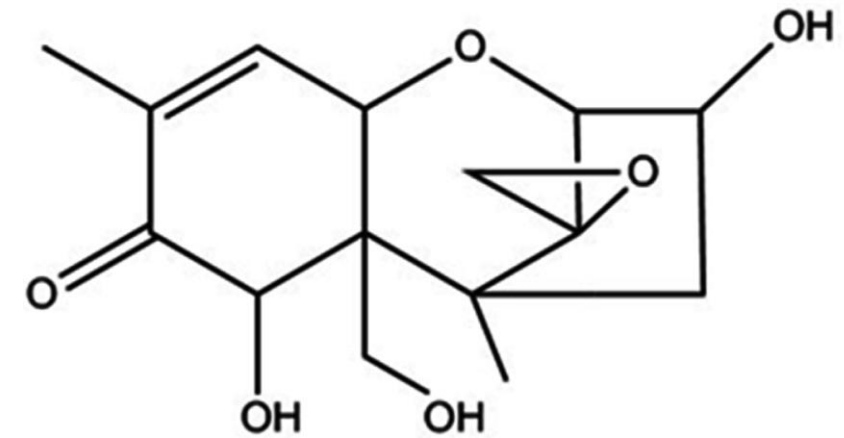
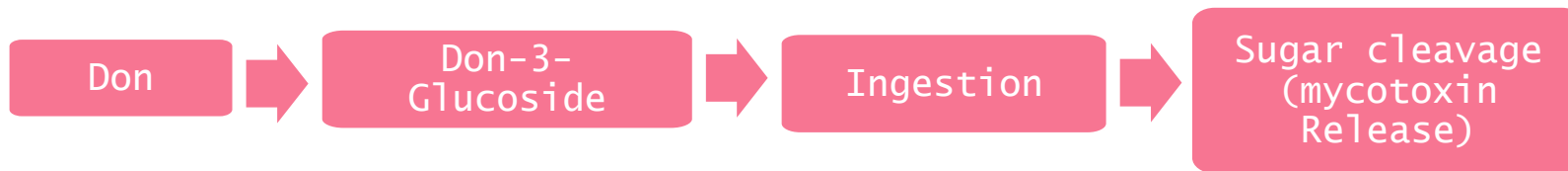
Major classes of Mycotoxin Producing Fungi

Genera Producing Fungi	Species	Mycotoxins
 <p data-bbox="254 631 540 674">Neotyphodium</p>	N. coenophialum	Tall fescue toxins: Ergot alkaloids, Lolines, Peramine
	N. lolii	Ryegrass toxins: Lolitrems, Peramine, Ergot alkaloids (e.g. Ergovaline)
 <p data-bbox="295 1310 504 1353">Pithomyces</p>	P. chartarum	

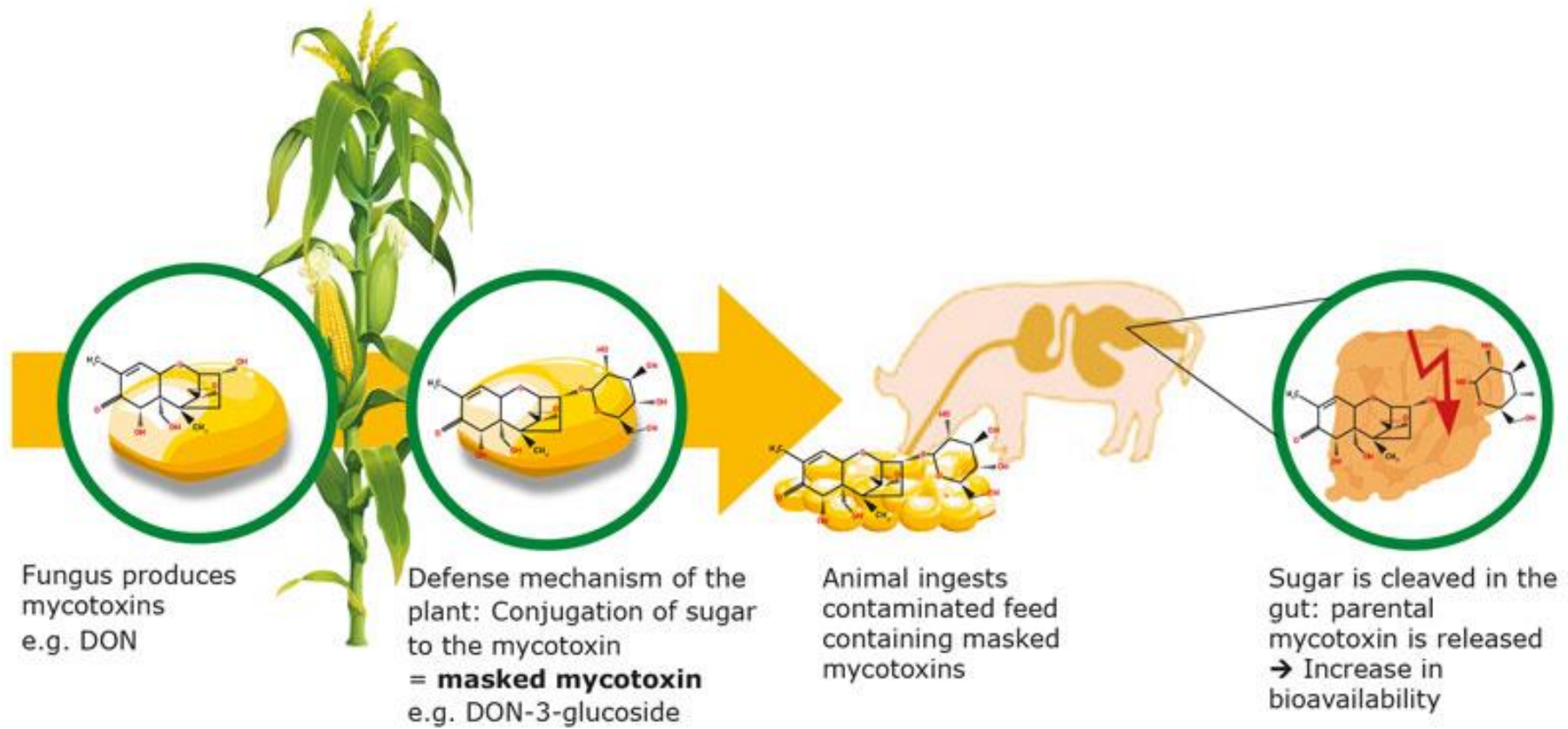
Masked Mycotoxins

- There are a product of specific biochemical reactions where mycotoxins can be bound to certain molecules including glycosides, glucuronides, fatty acid esters and proteins.
- These bonds can be cleared in the GIT and the mycotoxin released.

e.g



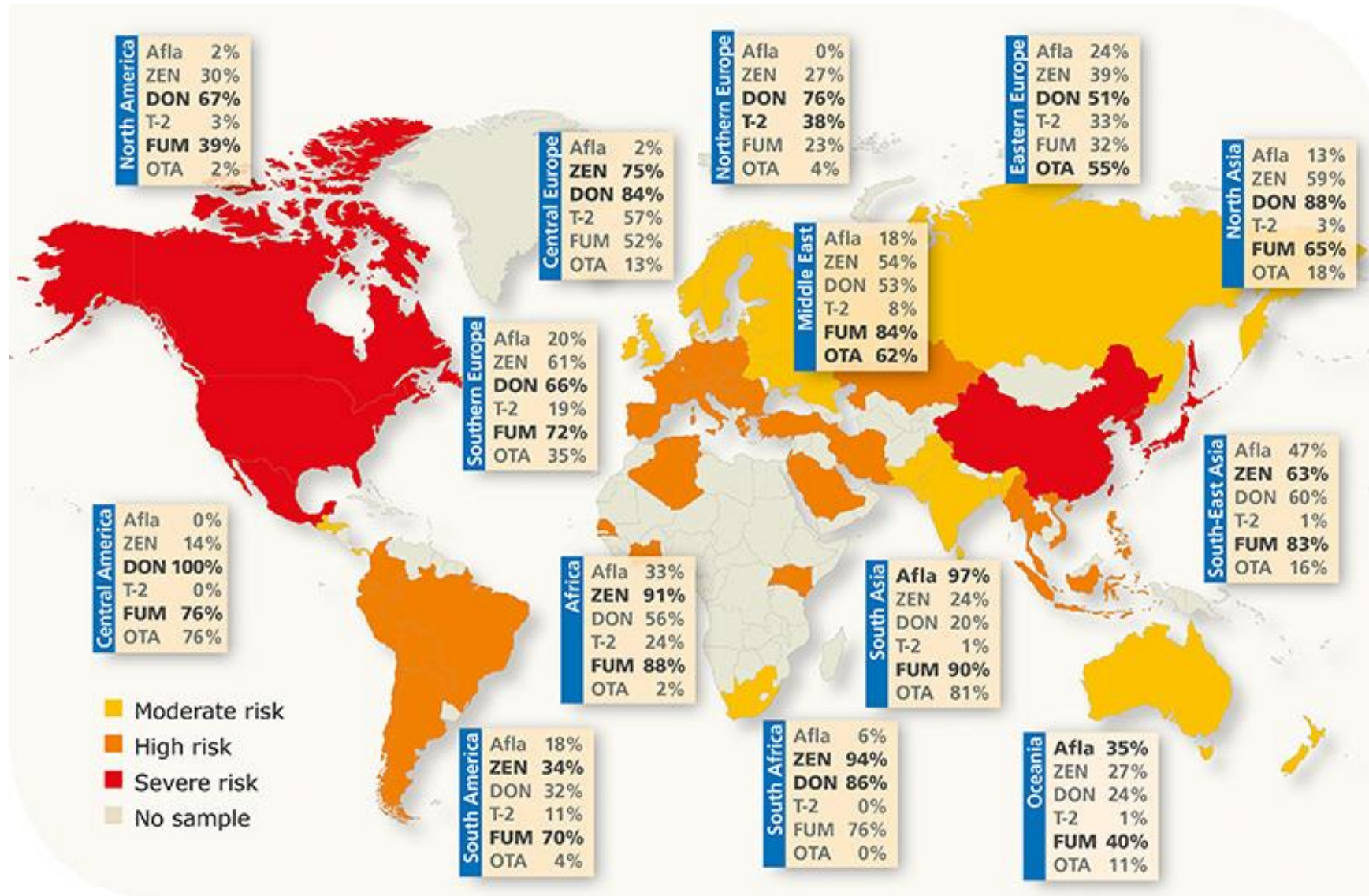
Masked Mycotoxins Process



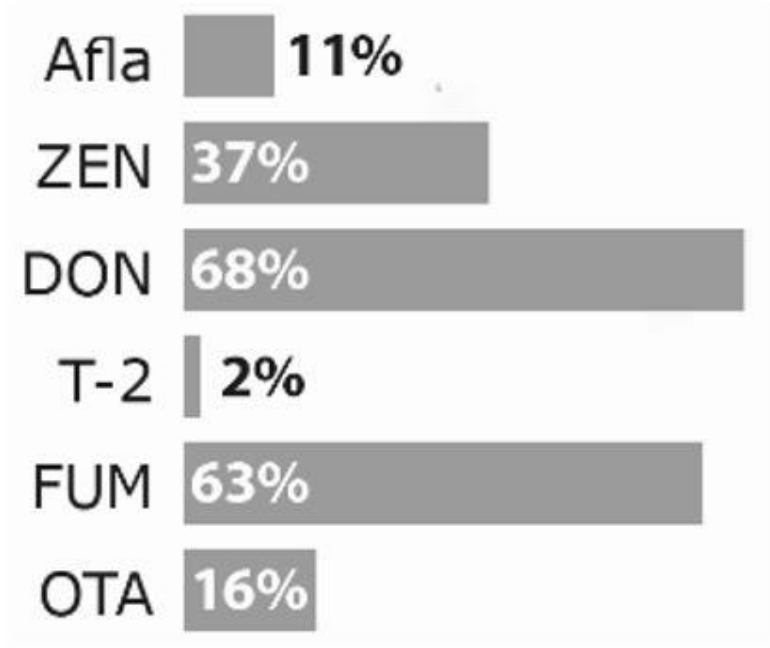
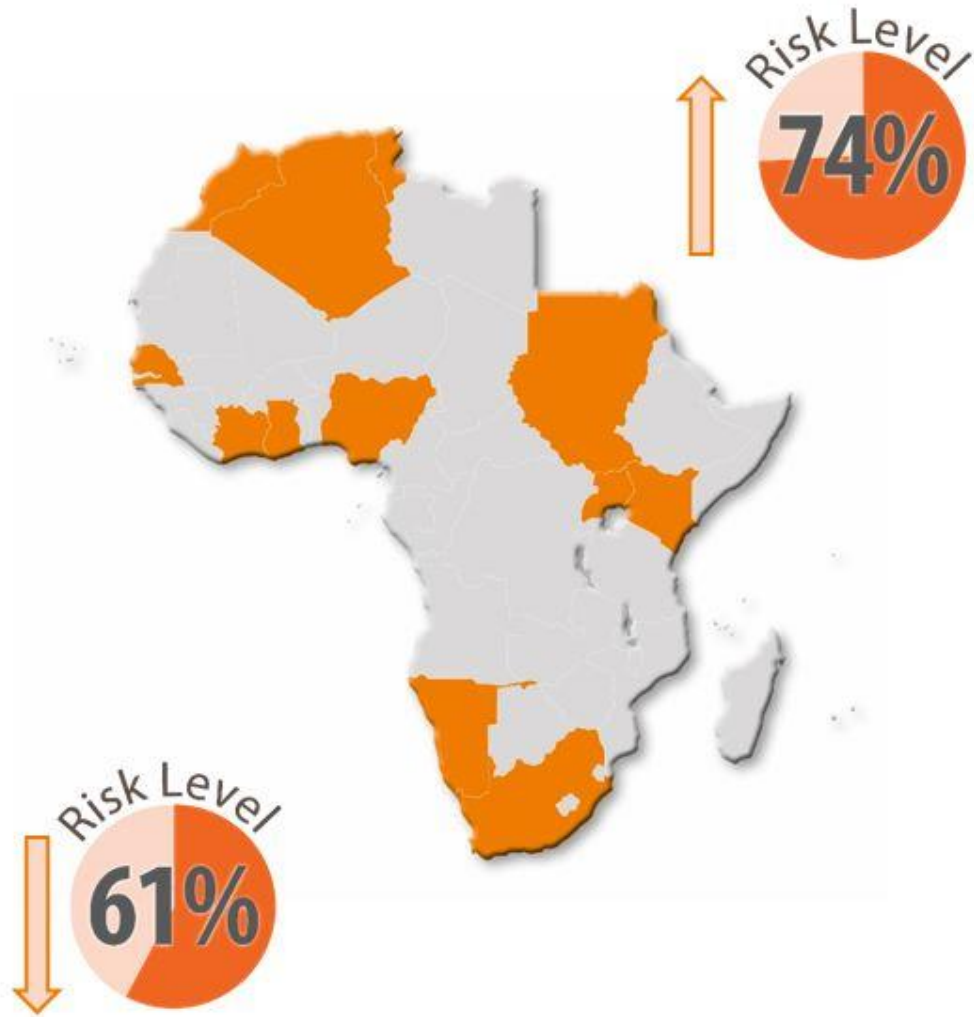
Scheme of mycotoxin conjugate formation in plants and mycotoxin release in the mammalian digestive tract.



Distribution Of Mycotoxins



Distribution Of Mycotoxins



Mechanisms Of Action

Primary toxic effects of mycotoxins are summarized in the table below:

Mycotoxin	Primary mechanism of action
Aflatoxin	Binds to guanine (DNA-adduct) after metabolic activation in the liver
Trichothecenes	Inhibition of protein synthesis
Zearalenone	Binds to mammalian estrogen receptor
Ochratoxins	Blocks protein synthesis
Ergot alkaloids	Binding to adrenergic, dopaminergic and serotonin receptors
Fumonisin	Inhibit ceramide synthase (sphingolipid biosynthesis)



Continuation.....

- Mycotoxins can either have:
 - Direct target toxicity i.e towards certain organs like liver, Kidney, skin cardio, reproductive or immune systems or;
 - Non direct target effects which includes: carcinogenicity, teratogenicity and mutagenesis.
- Mycotoxins are absorbed through GIT, lungs (ochratoxina), skin or eyes.

(GIT involves: Mouth, Oesophagus, stomach, small intestines (maximal absorption) and colon (Small fraction).)
- Transportation/distribution of mycotoxins takes place through the plasma (Ochratoxina).
- Lipophilic can penetrate blood brain barrier and placenta.



Excretion

- Urine Ochratoxins
 - Bile
 - Milk (Aflatoxin B1)
 - Faeces (Unabsorbed Mycotoxins)



Clinical Signs of Major Mycotoxins

Aflatoxin

Symptoms:

- ✓ Vomiting
- ✓ Necrosis
- ✓ Anorexia
- ✓ Fatty liver
- ✓ Liver cancer
- ✓ Diarrhea

Effects on the Reproductive System:

- ✓ Delayed testicular development and morphological changes
- ✓ Decline in the percentage of live sperm and reduced plasma concentration of testosterone

Immunosuppressive Effects

- ✓ Marked decreased resistance to secondary infections by fungi, bacteria and parasites.

Other Aflatoxin related Symptoms

- ✓ Encephalopathy with fatty degeneration of viscera
- ✓ Pulmonary interstitial fibrosis



Clinical Signs of Major Mycotoxins

Deoxynivalenol

DON Effects

- ✓ Immunosuppression and immunomodulation (Increased susceptibility to opportunistic and general pathogens)
- ✓ Cytotoxic effects

Effects on the gastrointestinal tract

- ✓ Gastroenteritis (Swelling of stomach and intestine)
- ✓ Impairment of gut integrity and impact on intestinal microflora
- ✓ Diarrhea
- ✓ Intestinal bleeding
- ✓ Anorexia
- ✓ Decreased nutritional efficiency
- ✓ Increased liver size
- ✓ Severe immunosuppression
- ✓ Decrease in feed intake and reduced weight gain

Other Effects

- ✓ General weakness
- ✓ Destruction of bone marrow
- ✓ Decline in serum proteins and albumin levels
- ✓ Decrease in hematocrit (red blood cells concentration in blood)
- ✓ Reduction of serum calcium and phosphorus
- ✓ Neurotoxic effects



Clinical Signs of Major Mycotoxins

Fumonisin

FUMS are:

- ✓ Hepatotoxic
- ✓ Nephrotoxic
- ✓ Immunosuppressive

Effects of FUMS

- ✓ Alteration of the intestinal barrier function
- ✓ Undergo synergistic effects with other mycotoxins like DON, contributing to the disruption of the intestinal barrier and favoring the translocation of other toxic entities and pathogens

Other Effects

- ✓ Cardiotoxicity
- ✓ Decreased feed consumption
- ✓ Dyspnea
- ✓ Weakness
- ✓ Cyanosis
- ✓ neural tube defects (NTDs)

Known Animal Diseases Caused By FUMS

- ✓ The Porcine Pulmonary Edema (PPE)
- ✓ The Equine Leukoencephalomalacia (ELEM)



Clinical Signs of Major Mycotoxins

Zearalenone

Estrogenic effects of ZEN differ from males and females

Effects Of ZEN On Males

- ✓ Immunosuppression
- ✓ Reduction in testosterone level
- ✓ Lower testes weight
- ✓ Reduced spermatogenesis
- ✓ Feminization
- ✓ Reduction of libido

Effects Of ZEN On Females

- ✓ Immunosuppression
- ✓ Reduced survival of embryos
- ✓ Reduced fetal weight
- ✓ Vulvar dilatation and redness
- ✓ Vulvovaginitis
- ✓ Retention or absence of milk
- ✓ Rectal prolapse

Other Effects Of ZEN

- ✓ Inducing Cancer
- ✓ Genotoxic effects
- ✓ endocrine effects



Clinical Signs of Major Mycotoxins

Ochratoxin A

Nephrotoxic (Kidney) Effects Of OTA

- ✓ Degeneration of the convoluted tubule of nephron
- ✓ Renal interstitial fibrosis
- ✓ Decrease in thickness of basal membrane and glomerular hyalinization
- ✓ Anemia
- ✓ Proteinuria
- ✓ Uraemia

OTA Displays

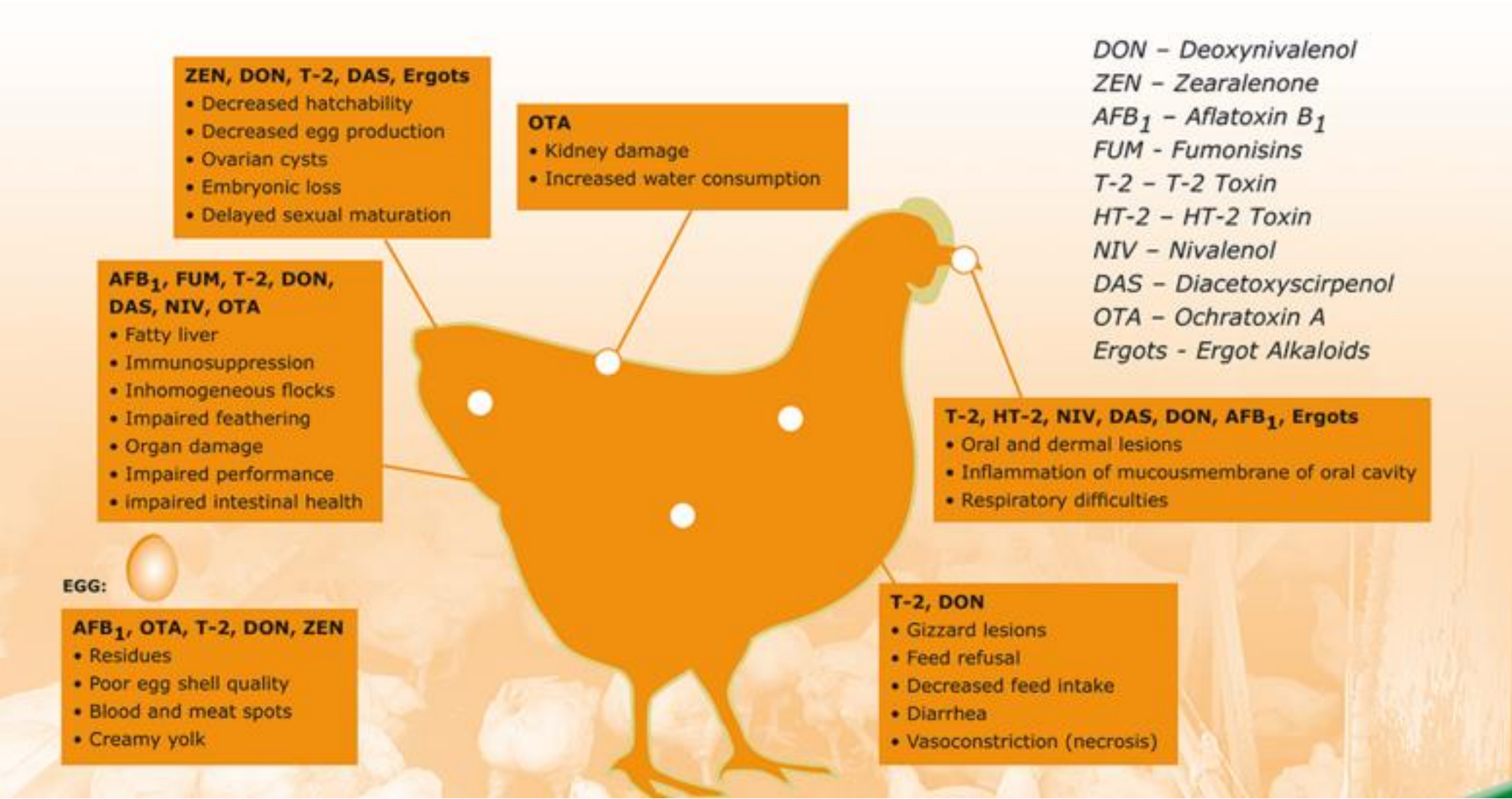
- ✓ Teratogenic
- ✓ Genotoxic
- ✓ Carcinogenic effects (i.e. multifocal hemorrhages in several organs, fibrin thrombi in spleen, brain, liver, kidney and heart)

OTA Is

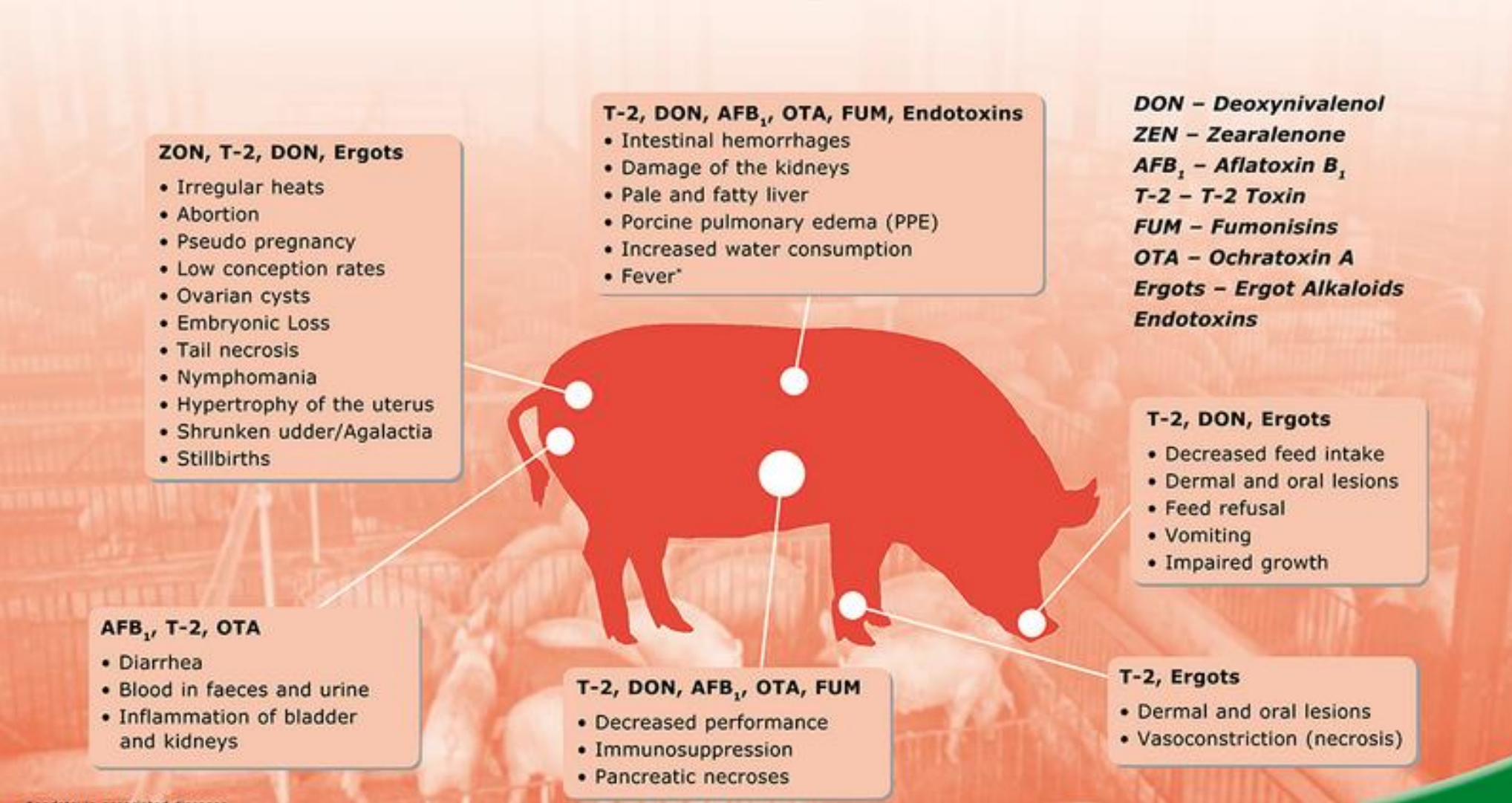
A potent immunosuppressor and immunomodulatory, giving rise to effects like the size reduction of thymus, spleen and lymph nodes, depression of antibody response, changes in immune cells number and function.



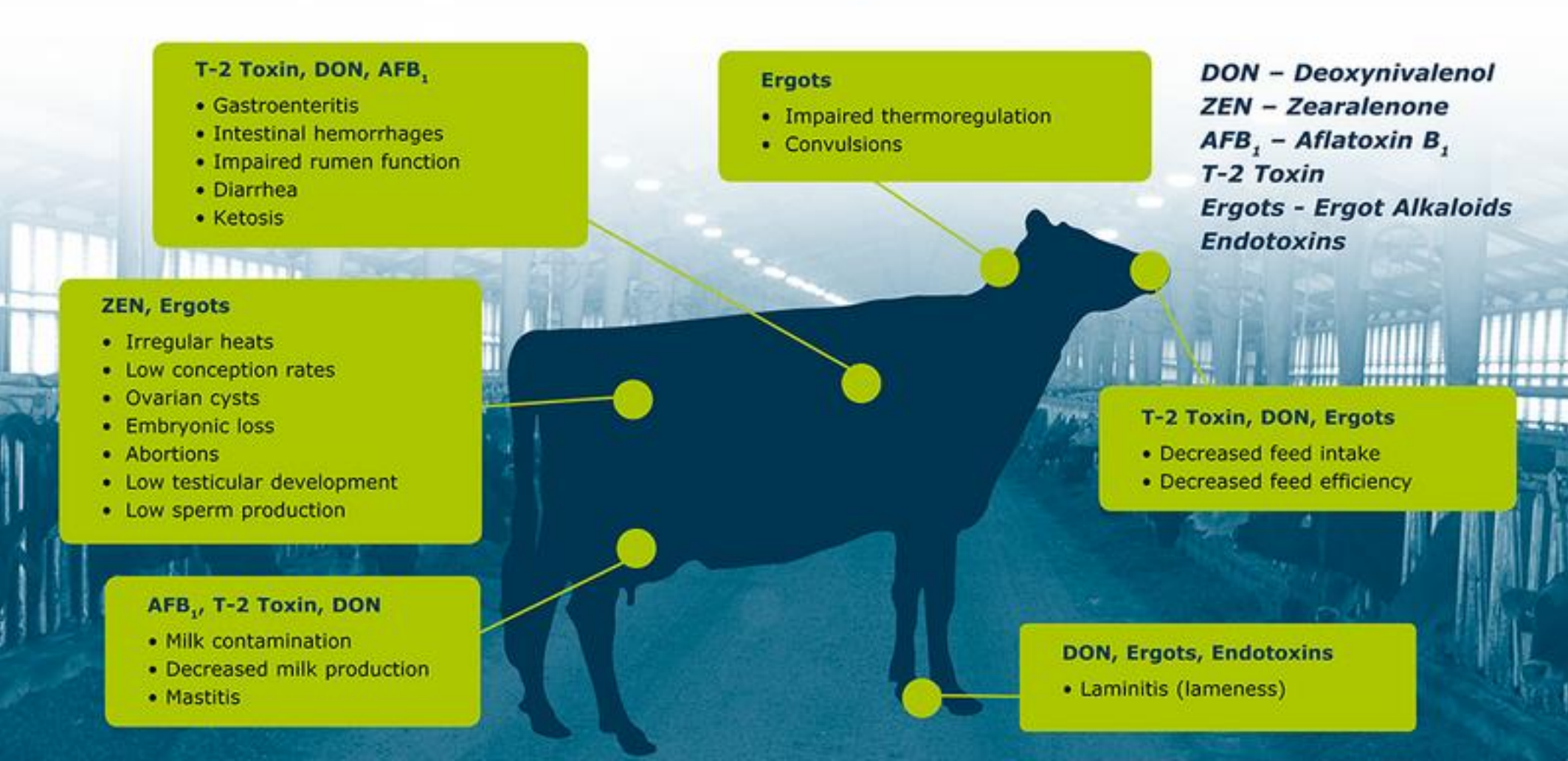
Adverse Effects of Mycotoxin in Poultry



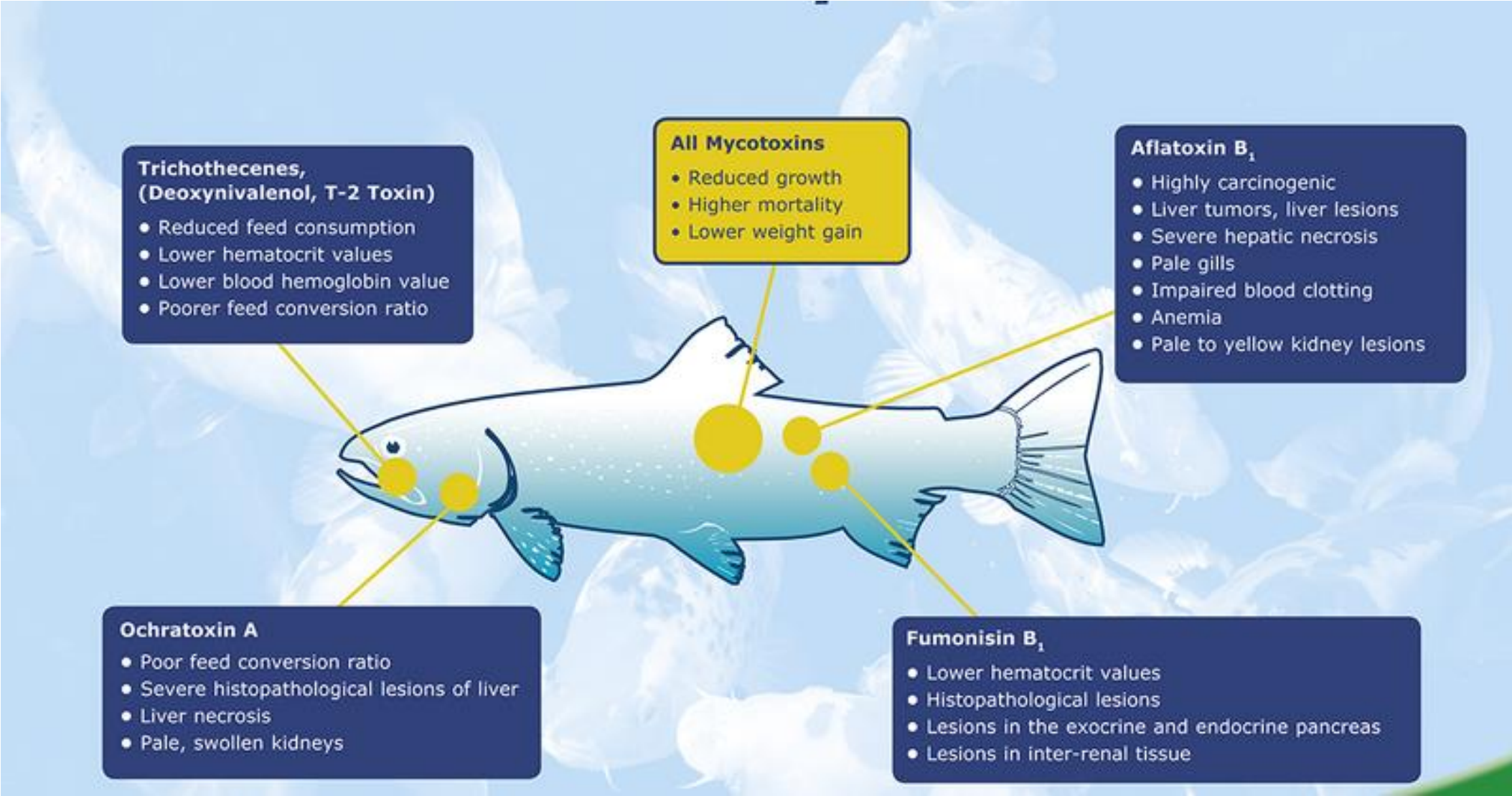
Adverse Effects of Mycotoxin in Pigs



Adverse Effects of Mycotoxin in Cows



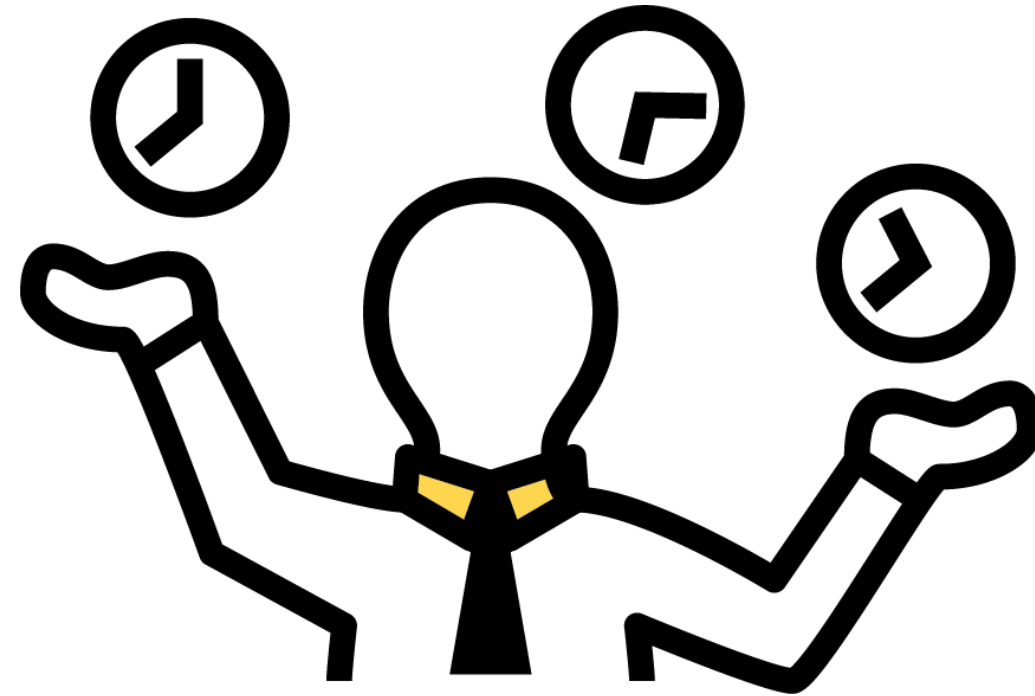
Adverse Effects of Mycotoxin in Fish



Mycotoxins Management

The existence of hundreds of mycotoxins with different frequencies and patterns of occurrence, coupled with synergistic complications calls for creature and targeted solutions in mycotoxin counteracting strategies.

- **Pre-harvest:** Good land management practices e.g proper tillage
- **Post-harvest:**
 - Good transport and handling
 - Proper storage
 - Mould inhibitors



Mycotoxins Management In Animal Feed Processing/Manufacturing

Various mycotoxins require different approaches to manage them since not all mycotoxins can be bound.

Main Methods / Modes / Approaches Include:

1) Biotransformation

It involves specific enzymes and biological components to convert mycotoxins into non – toxic environmentally safe metabolites like:

- Funzyme: Fumonisin to irreversibly non toxic metabolites
- BBSH: Tricothecenes to harmless metabolites
- MTV: Zearelenone and Ochratoxin A

2) Adsorption / Binding

Mainly mineral adsorbents, eubentomite, sepdolite.

NB: Should be selective

Binds polar mycotoxins like aflatoxins and ergot alkaloids



*Thank
you*



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