# Biosecurity: principles, fundamentals and structure

Biosecurity is a general term that includes three major aspects: bio-exclusion, the prevention of any outside agent from entering a production animal operation; bio-management, the activities implemented to prevent agents from spreading within a facility (including the use of vaccines); and bio-containment, the protocols that prevent bacteria and viruses from spreading outside of the facility, even when their presence is unknown.

Bio-containment is probably the most difficult aspect to implement, and the one that is most often forgotten (Fig. 1).

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The first component of cleaning is the chemical action, which is the product being and its chemical effect on the surfaces and the environment used (detergents and disinfectants). The second is the time taken to clean, which allows the chemical to have more exposure to the surface being cleaned. The third is the mechanical action, which is the product surface contact and penetration as well as the forces applied for its incorporation and distribution or coverage.

The fourth component is the temperature of the water. Warm water will enhance the strength of surfactants, allowing the chemical and mechanical actions to be more effective in reducing the presence of biofilm. Finally, the quality of water used has an effect, depending on the water's own hardness and/or bacterial contamination (Fig. 2).

The final objective of a biosecurity programme should be to achieve lower to zero economical losses due to infectious disease exposure or spread within a population.

The disease(s) to list as a priority will depend on the local/regional endemic status and risk factors associated to the operations.

Biosecurity is integrated with three major components (Fig. 3). The first is the network of physical barriers and other lines of separation defined based on work flow, production flow, animal ages, susceptibility risk assessment and animals in need of quarantine, etc.

The second component is the range of cleaners, disinfectants and other products used to reduce any potential biological threat to the production facility.

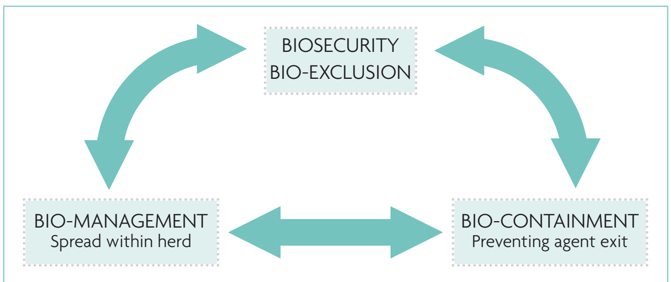
The third is the use of logic and common sense. We need to keep in mind the bigger picture regarding the final objective, which is not usually included in written protocols.

Protocols are not always adapted to changing conditions when a production unit faces unique circumstances.

## Biofilm and organic matter

One of the biggest challenges to biosecurity is the presence of biofilm and organic matter. These could become the substrate for bacteria growth and the development of microbiological

**Fig. 1. Three major aspects of biosecurity (Dr Butch Baker and Dr Tim Snider).**



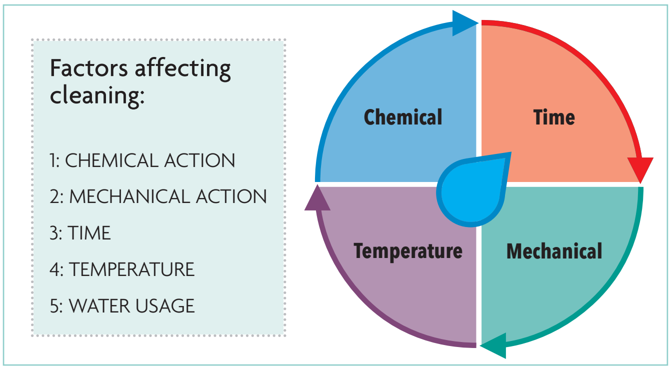




**Fig. 2. The five components affecting cleaning (Dr Herbert Sinner).**

challenges. Biofilm is the number one risk because it cannot be seen.

Biofilm accumulation becomes critical when it limits the effect that disinfectants have on a surface. Dry cleaning takes out dust and gross organic matter, and then a wet cleaning removes more organic matter and the biofilm.

If the biofilm is allowed to remain, it negatively impacts the performance of disinfectants, allowing surfaces (such as farrowing crate panels and the plastic surfaces on hatcheries) to become future challenges.

Biofilm is a layer made of polymeric extracellular secretion and micro-organisms that coats a surface. It occurs in an animal production environment due to, for instance, secretions accumulating on a matrix layer over time.

It acts as a mechanical barrier that lessens the effectiveness of disinfectants. Acid cleaners have the ability to penetrate the layer of slime, so disinfectants could be more efficient and demonstrate better effect on surfaces that have been prepared for disinfection.

Cleaning is the most important step. Before disinfection, we need to do the best dry and wet cleaning in order to reduce 90% of organic contamination and biofilm that could lessen the impact of any disinfectant. The difference between sanitation and disinfection results over an inner hard surface is the amount of bacteria or viruses reduction that one could achieve.

These results are expressed in logarithmic (logs) values. Sanitation reduces microbiological material by 99% (2 logs), and disinfection reduces it by 99.99% (4 logs). After a good dry and wet cleaning, we finalise the process with a disinfectant in order to achieve the best decontamination possible in animal production facilities.

## Further challenges

Another one of the biggest challenges comes from the surface types being cleaned. Some surfaces are more continuous, with less porosity and are more easily affected by cleaners and disinfectants. Another challenge is presented by water with a high content of minerals, such as manganese, iron and calcium, adding deposits of salt.

The mineral content of the water may interact negatively with the chemistry of products. Yet another challenge comes with the delivery of the cleaning product itself: proper equipment and correct pressure.

These aspects and others, such as droplet size and coverage area, are easy to evaluate and to adjust as needed. Besides using a suitable cleaning product, we need to have a reliable mechanical programme in place: one that uses the appropriate equipment and trained personnel to facilitate the incorporation of the chemistry into the surface.

Viruses and bacteria have different levels of sensitivity or resistance to cleaners and disinfectants. Viruses with lipid envelopes are more sensitive, because they can be destroyed with the action of their surfactants of their detergents.

Gram-positive bacteria are more sensitive than Gram-negative bacteria, which have a structure that is naturally more resistant to disinfectants. Endospores and mycobacteria are also more resistant.

Peptidoglycan is one of the wall cell components of bacteria. This component is easier to affect by disinfectants. Gram-positive bacteria are more easily destroyed because 90% of the dry weight of its cell wall is peptidoglycan, compared with Gram-negative bacteria which is just 10%. Disinfection is easier against Gram-positive bacteria.

Viruses can have two different types of external structures. Some are lipid, which means they are more susceptible to disinfectants. Other viruses are considered 'naked' and are more resistant. One example comes from viruses in swine and poultry that are more resistant, like circovirus. These viruses become more prevalent in production systems.

The Environmental Protective Agency (EPA) is the organisation that regulates and sets disinfection standards for bacteria. If you want to have any claim of activity that you are trying to address with a disinfectant, you need to achieve a reduction of 6 log of a specific bacteria. For viruses, the number needs to be 4 log, and the number is a minimum of 3 log for cystic forms.

## Structure

We have addressed the surfaces of the entire production facility, but we should not forget about water lines inside the buildings, which are sometimes more than 10-15 years old. Inside the water lines can be found the extra challenge of biofilm and other accumulation that can affect the quality and taste of water.

This potentially reduces optimum water consumption in animals. When water consumption is optimal, it assures better feed conversion for the herd.

Water line accumulation, and the byproducts formed by it, also pose a risk because they can lead to bacterial contamination in the farm and also the pressure for water access.

Water intake is an important part of production. We need to remember that production animals should drink water at least twice the volume of the feed they eat.

If access to water is limited on a farm because of the quality of the water's taste or the bacteria contamination the animals' feed conversion is affected, limiting genetic production.

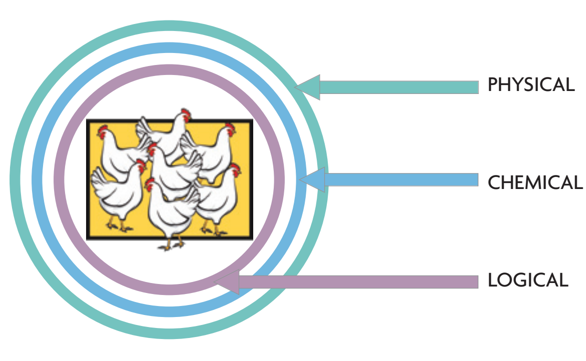



**Fig. 3. Three major components of biosecurity (Dr Gregory Martin, Pennsylvania State University).**

If waterlines are not cleaned appropriately, it may limit production performance because of potential bacteria contamination. Biosecurity does not stop at visible hard surfaces, but continues into water lines that are not disinfected by application of standard surface disinfectants.

## Five steps to cleaning and disinfection

When we talk about taking proper steps to clean, we need to talk about the first five steps in the process of cleaning and disinfection.

The cleaning section is the first major critical component. We dry clean to remove organic matter and minimise dust. Then, before applying detergent, we presoak the surface. Without the appropriate level of surface humidity, we cannot obtain better efficacy of the wetting agents in the detergent formulation.

We never go into the shower and apply soap and shampoo before turning the water on, so the same common sense and logic applies. When cleaning, we need to presoak and then descale, taking out the accumulation of the scale.

The next step is to rinse and remove the detergent. Sometimes an additional rinsing and second application of detergent are necessary (combining acid first, then alkaline).

After that, the next step is to dry the surface, allowing for a natural air dry, so that the surface does not retain any water that can affect the dilution of the disinfectant; and the final step is to disinfect.

The heavy work of cleaning has been done first, removing at least 90% of contamination. Disinfection is important, but it is only the cap on the entire cleaning and disinfection process.

A quick hygiene evaluation of any critical surfaces, with the purpose of verifying how well the cleaning process was performed, is possible with the use of AccuPoint Advanced to measure adenosine triphosphate (ATP).

Before applying disinfectant, you can use AccuPoint Advanced to evaluate how well the surface is prepared for disinfection, allowing for the maximum virus and bacteria elimination; efficacy of cleaning.

Monitoring and verification have become one of the key elements to move biosecurity programmes from a descriptive format to a more systematic programme.

In such a programme, protocols could generate metrics rather than just qualitative-descriptive assessments. As other farm processes such as vaccinations and intestinal integrity are evaluated, it is necessary and critical to start implementing numbers behind biosecurity protocols that could be evaluated in a continuous way.

Consistent levels of the main active ingredients in products are something that should be routinely verified to evaluate average/range of chemical concentration through pH strips.

Qualitative or semi-quantitative tests could help to achieve optimum dilutions and approximate end product in PPM at use.

## All In All Out systems

There are different types of cleaning and disinfection programmes: the ideal is All In All Out (AIAO). In this type of animal production system once the production cycle finishes, all the animals are removed from the facility. In this way it is possible to remove all the organic matter (dry cleaning) and proceed to the wet cleaning and disinfection.

Following these steps, the organic matter and the biofilm will not interfere with the efficacy of the disinfectants. However, that is not always possible, so there are different approaches, such as Semi-All in All Out for a building, a barn or AIAO room or aerospace. The success of these different scenarios depends on the definition of production flows, people/equipment flow, animal age, etc.

Animal production managers could structure the internal lines of separation with the support of biosecurity tools such as the Danish bench, foot baths, etc, to be able to reduce and eliminate the potential infectious disease exposure and/or spread within the production site (Fig. 4). It is difficult, but it is not impossible, and we can do it with descriptive protocols and monitoring of those protocols. ■

References are available from the author on request

**Fig. 4. Biosecurity lines of separation on the farm.**

CONCEPTUAL BIOSECURITY:

- Physical separation of production units.

STRUCTURAL BIOSECURITY:

- Design and architecture of each unit based on disease prevention strategies.
- Establishing external (- - -) and internal (- - -) lines of separation.

PROCEDURAL BIOSECURITY:

- Practising biosecurity programme.
- Sanitation and disinfection programmes.
- Continuous education and training.