5.1  
**General Mechanisms of Action**

Food preservatives inhibit not only metabolism but also the growth of bacteria, molds and yeasts.

5.1.1  
**Inhibitory and Destructive Actions**

In practice, a distinction is frequently drawn between a fungistatic or bacteriostatic action (i.e. one that inhibits fungi or bacteria) and a fungicidal or bactericidal action (i.e. one that destroys fungi or bacteria). Close study reveals that such a distinction is unjustifiable. The former two differ from the latter in the death rate of the microorganisms. In the long term the effect of added preservative in food is either to kill the microorganisms or to allow them to grow despite its presence. The governing factor here is the dosage of preservative (see Fig. 3) (Schelhorn 1953).

Depending on the type of preservative used, all the microorganisms are killed within days or weeks at the usual applied concentrations. This is where the crucial difference exists between preservatives and disinfectants. The latter can be employed only if the microorganisms succumb within a very short period of time. The time scale for the killing of microorganisms under the influence of preservatives corresponds to the relationship for a monomolecular reaction.

![Fig. 3. Trend in microbe count relative to the presence and concentration of antimicrobial substances](image-url)
where

\[ K = \frac{1}{t} \log \frac{Z_0}{Z_t} \text{ oder } Z_t = Z_0 \cdot e^{-Kt} \]

K = death rate constant,
\( t = \) time,
\( Z_0 = \) number of living cells at the time the preservative begins to act,
\( Z_t = \) number of living cells after the time \( t \),

Strictly speaking, this rule is valid only for relatively high dosages of preservatives and a monoclonal population. It also presupposes a closed system, i.e. there must be no attenuation of the preservative, e.g. by evaporation; neither must there be any change in the pH value, nor ingress of further microorganisms, e.g. by reinfection. Even if these requirements are not met completely in the actual practice of food preservation, the foregoing “death rate kinetics” can still be regarded as a good basis for studying the action of preservatives in foods.

Preservatives perform a useful function in foods only if employed in adequate concentrations. The aim is to inhibit the microorganisms in the initial lag-phase and not in the exponential log-phase, since in the latter the dosages of preservative necessary in practice would be far too high. Preservatives are not designed to kill microorganisms in substrates already supporting a massive germ population, i.e. to return putrefying food to an apparently fresh state. Indeed, with the applied concentrations of most preservatives used, this is not even possible. Therefore, preservatives cannot be used to compensate for poor factory hygiene.

5.1.2 Action on Microorganisms

The action of preservatives on the cells of spoilage microorganisms is based on a multiplicity of individual influences. These include not only physical and physicochemical mechanisms but also biochemical reactions. Frequently, several individual factors may produce a cumulative effect, but sometimes only one single stage in a reaction in the microorganism cell is blocked. In the case of spore-forming bacteria, different preservatives develop their inhibitory action at varying stages of spore germination (see Fig. 4) (Gould 1964).

In essence, the antimicrobial action can be explained by the following phenomena (see Fig. 5):

1) influence on the DNA,
2) influence on protein synthesis,
3) influence on enzyme activity,
4) influence on the cell membrane,
5) influence on the cell wall,
6) influence on transport mechanisms for nutrients.

Substances which reduce the water activity of a substrate and thereby impede or inhibit microorganism growth have other criteria of action. Packaging, coatings, oils and some protective gases prevent oxygen from gaining access to foods and