RCVS KNOWLEDGE

Part 4
Infection control
Disinfectant types

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Infection control and biosecurity: Disinfectant types

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RCVS Knowledge Infection Control Working Party

Session will cover

- Disinfection terminology
- Action – how do disinfectants work?
- Active ingredients
- Appropriate selection

Terminology

Cleaning: physical removal of contaminants and the organic matter that protects them

Disinfection: a process which reduces the number of micro-organisms to a level which is not a threat to health

Sterilisation: a process which physically removes contaminants including spores

Terminology

- the active ingredients in disinfectants are ***biocides***

- generally broad-spectrum

    - kill microorganisms by deactivation

    - might be disinfectants, antiseptics or antibiotics

Terminology

- not just the bottled substances under the sink

  - **pesticides** - insecticides, herbicides, fungicides...

  - ant powder, weed-killer, insect-repelling wristbands

  - **antimicrobials** - antibacterial, antivirus, antifungal... ...

    examples of antibacterial products include.....

Terminology

Antibacterial socks - for smelly feet!

Klebsiella pneumonia: wound and bloodstream infections

E coli: intestinal and urinary tract infections, meningitis…

- confessed to sniffing socks

Terminology

- agents which **target and kill** particular organisms

  - *viru***cidal**

  - *fungi***cidal**

  - *bacteri***cidal**

- agents which **inhibit growth** of particular organisms

  - *viru***static**

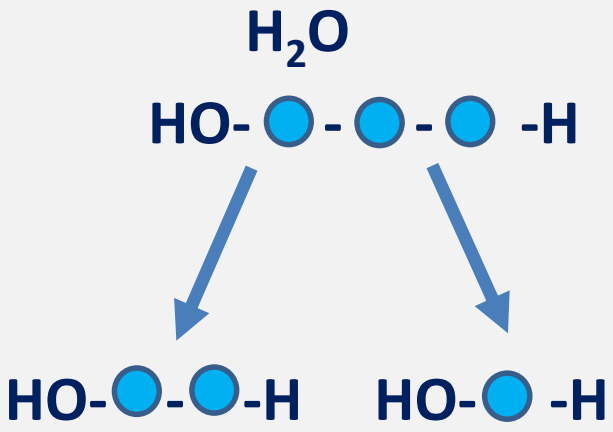
  - *fungi***static**

  - *bacterio***static**

How do disinfectants work?

- hydrolysis, oxidation, denaturation

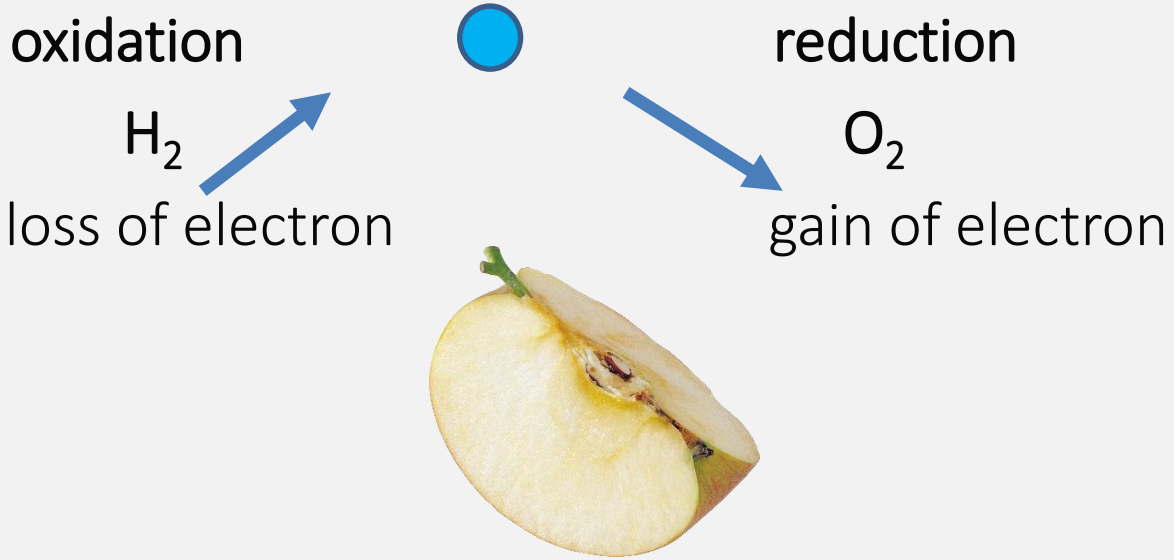
hydrolysis: "**breaking down**" of a chemical compound into two or more simpler compounds by reacting "**with water**"



How do disinfectants work?

- hydrolysis, oxidation, denaturation

oxidation: loss of electrons during a reaction by a molecule



How do disinfectants work?

- hydrolysis, oxidation, denaturation

denaturation: disruption of secondary and tertiary structures of microbe's proteins

How do disinfectants work?

- reduce the number of viable microbes present on apparatus to a level where they do not pose a threat to health

- "kill-count": 99.99 % = **4-log reduction**

99.999 % = **5-log** (stronger)

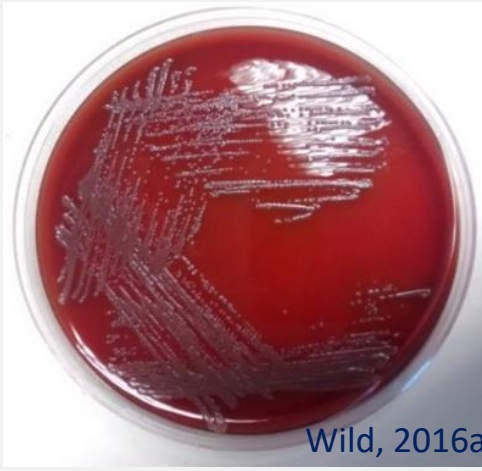
1-log reduction: germ-count becomes 10 times smaller

2-log reduction: germ-count 100 times smaller

3-log reduction: germ-count 1,000 times smaller

4-log reduction: 10,000 times smaller

5-log reduction: 100,000 times smaller



Wild, 2016a

How do disinfectants work?

How do disinfectants work?

- clear of any gross contamination

- thoroughly cleaned

    - using a soap or detergent

    - lowers the bioburden

Wild, 2016b

How do disinfectants work?

Surfactant: "**surf**ace **act**ive ag**ent**"

- lowers surface tension of the liquid in which it is dissolved

- comprise amphiphilic molecules

  - part hydrophobic

  - part hydrophilic

Wild, 2016c

How do disinfectants work?

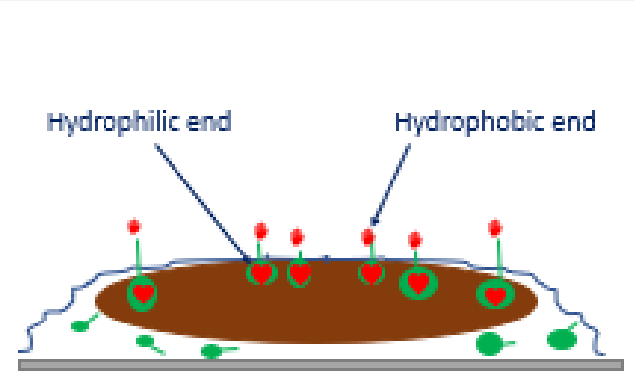
Surfactants work by:

- their molecules aligning themselves

    - hydrophobic end in the air

    - hydrophilic end in the (eg) faeces

- creates decrease in surface tension



Wild, 2016d

How do disinfectants work?

Disinfectants are poor at penetrating grime

- using detergent (surfactant) will facilitate closer and more effective contact between disinfectant and remaining target microbes

- minimise deactivation of disinfectant by organic matter

Introduction of organic matter	Main demonstration of ability to do required task Differences in reaction to organic matter
Effectiveness against particular microbes (Gram+/-, fungi, spores, bacteria)	In particular bacterial spores
Water hardness	Iodophores and quaternary ammonium compounds may demonstrate reduced effectivity when diluted with hard water (Bentley, et al., 2019)
Type and location of microbes	Clean-down apparatus for more effective intervention Presence of H_2O essential during chemical disinfection
Concentration of active ingredient	Some agents compromised by dilution; need +contact time
pH of environment	Phenols, hypochlorites and iodine: -activity with +pH QAC and glutaraldehydes: +activity with -pH
Effectiveness in a range of H_2O temps	Activity of a disinfectant generally +with + temperature (Wesche, Naylor and Wray, 2005)

Active ingredients

- low level
    - phenolics
    - quaternary ammonia compounds (QACs / quats)
    - aldehydes

- intermediate level
    - alcohol / ethanol
    - sodium hypochlorite

- high level
    - oxidising agents
    - sterilisation

Appropriate selection

- low level
  - phenolics
  - quaternary ammonia compounds (QACs / quats)
  - aldehydes
- intermediate level
  - alcohol / ethanol
  - sodium hypochlorite
- high level
  - oxidising agents
  - sterilisation

Appropriate selection: Low level

Phenolics

- carbolic acid derivatives
    - effective against
        - bacteria
        - fungi
        - enveloped viruses

Appropriate selection: Low level

Phenolics

- remain viable in presence of organic matter
  - blood
  - urine
  - saliva
  - serum
  - aqueous humour
  - bile… …

Appropriate selection: Low level

Phenolics

- generally safe

- not recommended for semi-critical items

- residue on porous materials may irritate tissue

- affect condition of rubber and synthetic

Appropriate selection: Low level

Phenolics

- use as soon as possible after prepared

- dilution reduces stability

Phenolics are highly toxic to cats and reptiles.

Appropriate selection: Low level

QACs (eg, Anistel, Distel, Trigene, Safe4)

- broad-spectrum, low toxicity

- effective against:

  - Gram-positive and Gram-negative bacteria

  - enveloped viruses

do not deactivate FCV, herpesvirus or parvovirus

Appropriate selection: Low level

QACs

- deactivated by:
  - organic material, hard water, soap

  - linked to antimicrobial resistance
  - no evidence re parvo effectivity

Appropriate selection: Low level

Aldehydes (formaldehyde, glutaraldehyde)

- wide range of bactericidal, virucidal and fungicidal activity
- good but slow activity against bacterial spores
- irritant to eyes, skin and respiratory mucosa

Appropriate selection: Low level

Chlorhexidine (CHG / “Hibi”)

- immediate bacterial reduction

- good fungicidal but limited against viruses

- povidone-iodine lacks cumulative and residual activity

  in comparison to chlorhexidine (Jarral, 2010)

Appropriate selection: Low level

- nosocomial outbreaks: contaminated chlorhexidine

(Weber, Rutala and Sickbert-Bennett, 2007)

- chlorhexidine-resistance has been identified

(Braoudaki and Hilton, 2004; Condell, et al., 2012)

- oto- and ocular toxicity

(Lai, et al., 2011; Greene, Weese and Calpin, 2012)

- ineffective against FCV

(Park, et al., 2010)

Disinfection

- low level
  - phenolics
  - quaternary ammonia compounds (QACs / quats)
  - aldehydes
- intermediate level
  - alcohol / ethanol
  - sodium hypochlorite
- high level
  - oxidising agents
  - sterilisation

Appropriate selection: Intermediate

Alcohol

- ethanol and isopropyl alcohols are:
  - denatured preparations
  - bactericidal, fungicidal and virucidal
    - effective against enveloped viruses
    - poor against non-enveloped viruses

- effective against MRSA on surfaces

(Monsey and Devaney, 2011)

Appropriate selection: Intermediate

Alcohol considerations:

- ineffective against parvo for up to five mins
- are non-corrosive, but
    - can damage mounts of lensed instruments
    - may not penetrate organic material
        - thermometers can be disinfected by immersion

Appropriate selection: Intermediate

- highly flammable
    - lethal if ingested
- optimal bactericidal concentration 60 to 91 % solution
- sharp reduction in efficacy if diluted to <50 % concentrate

Appropriate selection: Intermediate

Chlorine-based, eg, household bleach

- eliminate enveloped and non-enveloped viruses
- effective against fungi, bacteria and algae
- action is to oxidise proteins, lipids and carbohydrates

Appropriate selection: Intermediate

Considerations:

- biocidal properties are deactivated by organic matter

- loses potency if left

- can cause ocular and airway irritation

- oropharyngeal, oesophageal, gastric burns

(Rutala and Weber, 2015

Disinfection

- low level
  - phenolics
  - quaternary ammonia compounds (QACs / quats)
  - aldehydes
- intermediate level
  - alcohol / ethanol
  - sodium hypochlorite
- high level
  - oxidising agents
  - sterilisation

Appropriate selection: High level

Peroxygen compounds (eg, Virkon, hydrogen peroxide)

- broad-spectrum action, including:
  - enveloped and non-enveloped viruses
  - vegetative bacteria, fungi and spores
- can be used to clean nebulisers and anaesthetic equip

Appropriate selection: High level

Sterilisation (heat and steam)

- temperature is pathogen-led
  - 56 ˚c will kill 99 % of *Giardia* cysts
  - 60 ˚c or above will inactivate FCV (Nims and Plavsic, 2013)

Disinfection regulation

- governed by COSHH Regulations (2002)

- licenced by EU Biocides Regulations (2012)

    - control and safety measures stated within assessment

(University of Strathclyde, 2009)

- not harmful to staff or patients

- not cause corrosion, irritation or toxicity in environment

Appropriate selection

- choice should address:
    - effectivity
    - low hazard to patients, staff and environment
    - germicidal requirement

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Thank you

Coming soon

Part 5: Auditing infection control

More resources at www.rcvsknowledge.org/qi/infection-control

Questions? Email: ebvm@rcvsknowledge.org