Managing of eye burns
Return to normal intraocular pH
First Aid
Experimental and clinical results

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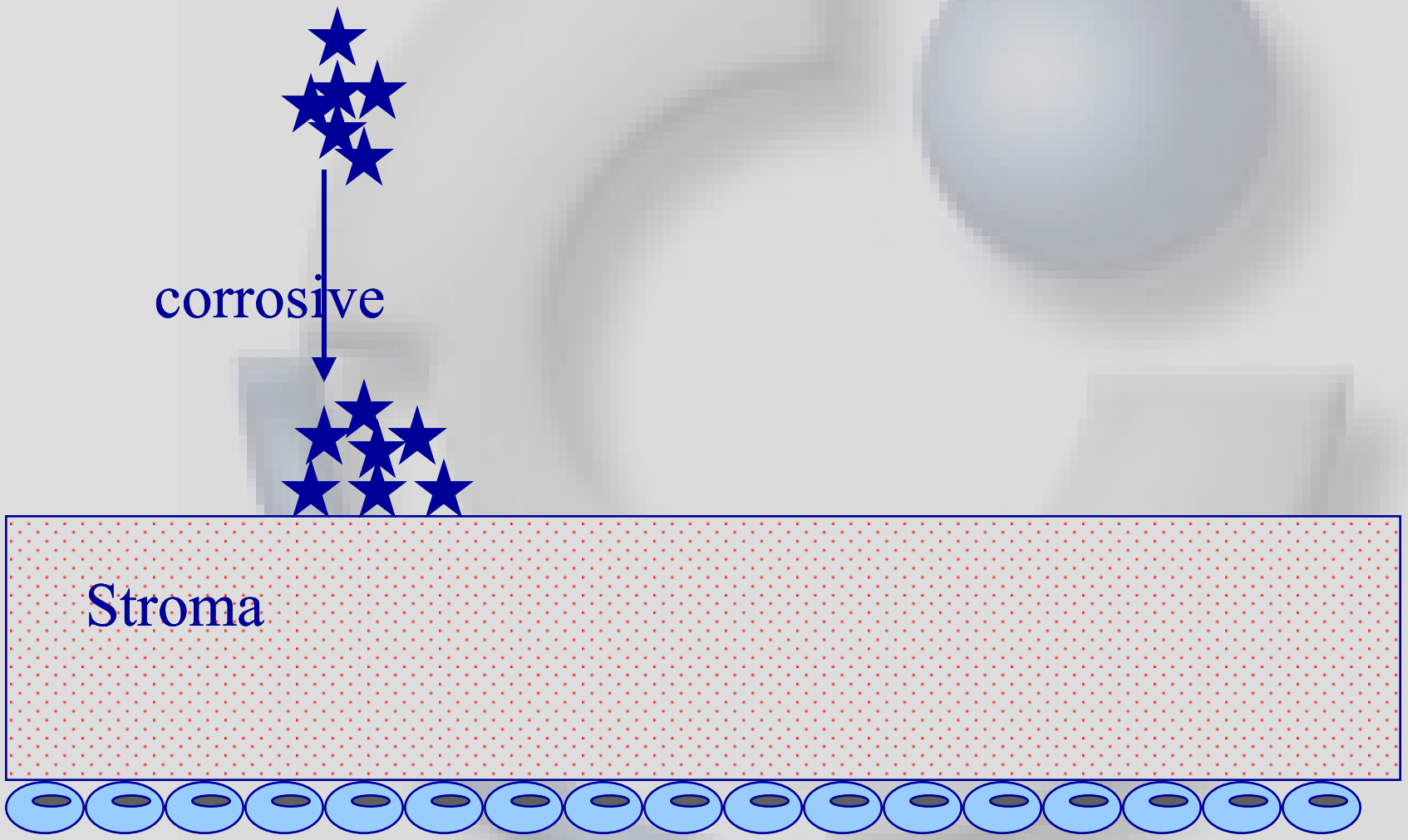
Young lady with a privat accident: Burn with NaOH
First aid: saline soaked cotton and sent to the Dept. of Ophthalmology

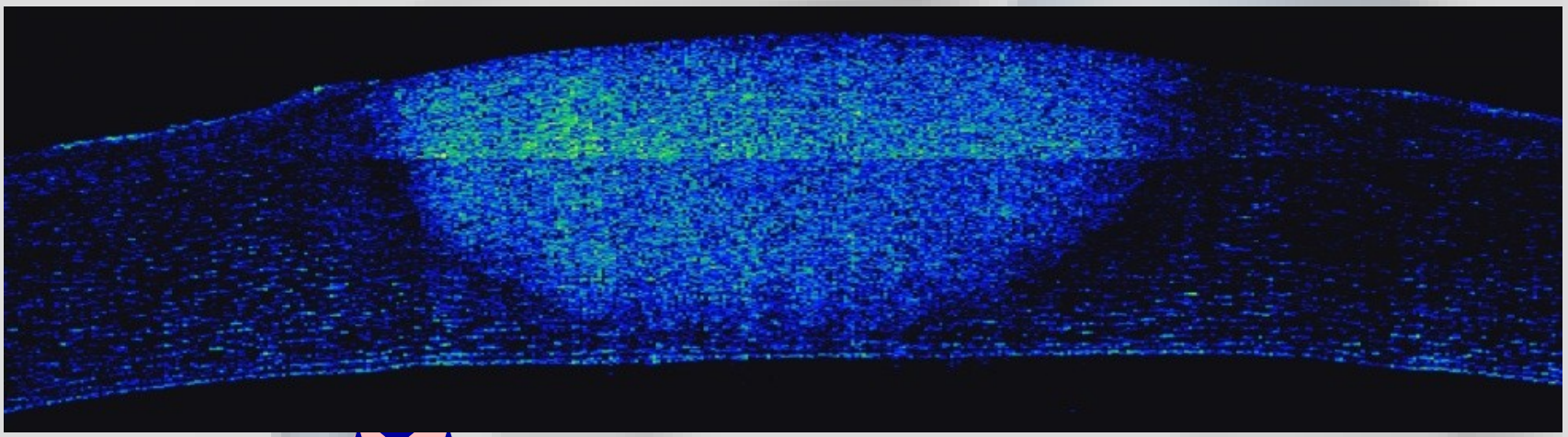
We as professionals should prevent such cases

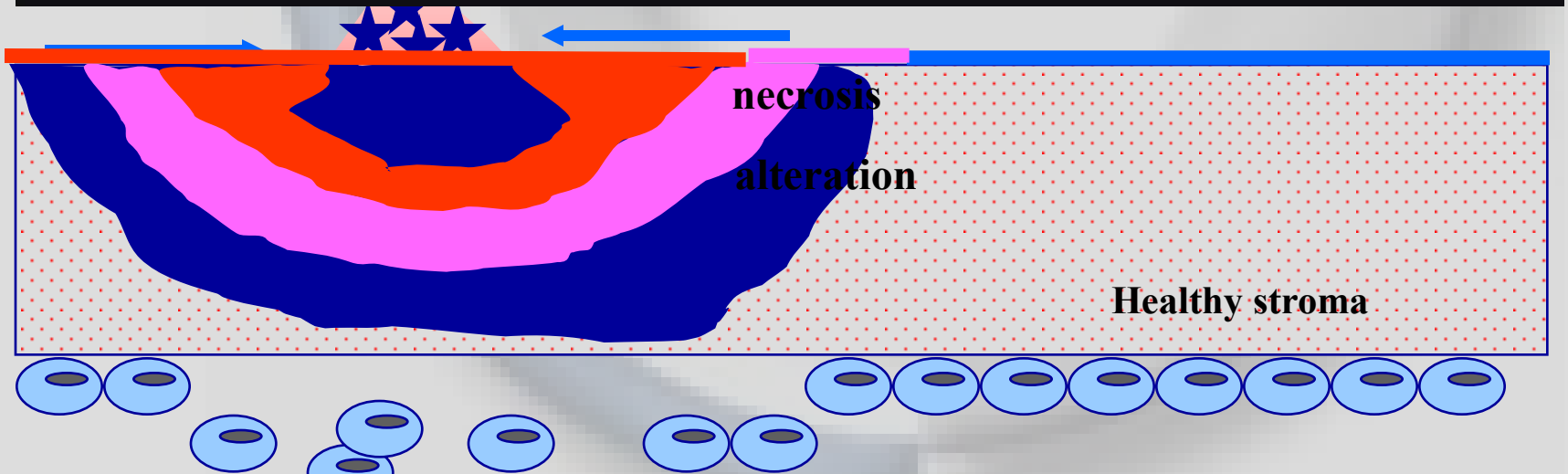
- Type of burns
- Mechanism of burns
- Dusts and Solid burns
- Burns with fluids
- Rinsing therapy
- Buffer or water ?
- Do and do not !

Schematic burn

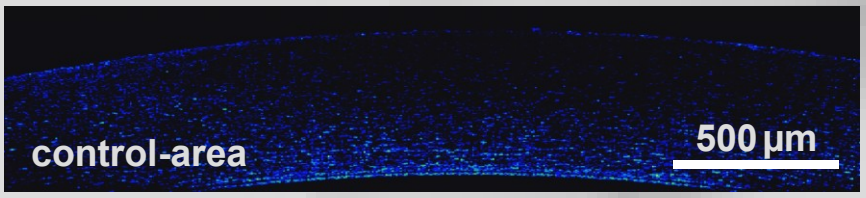


Zones of damage

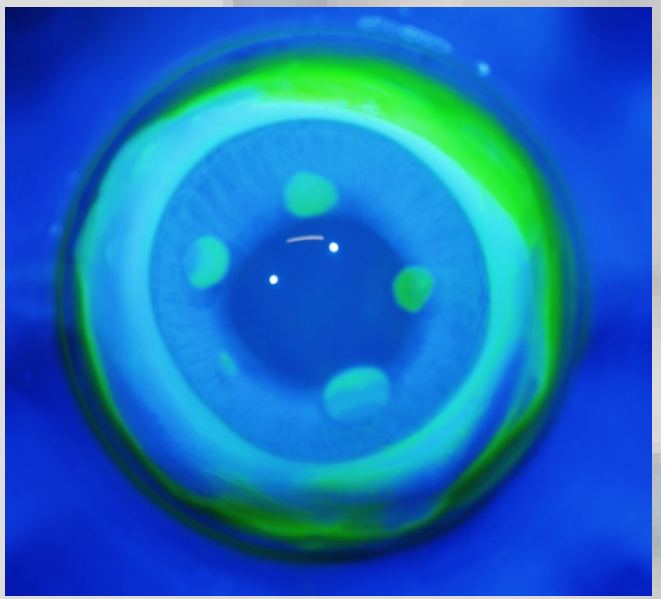


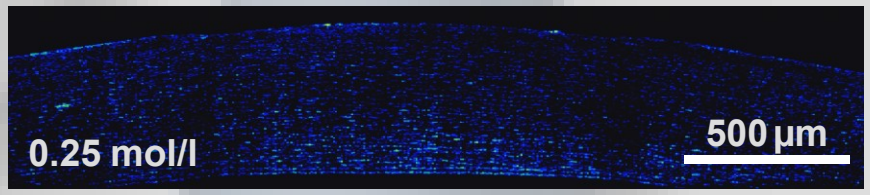


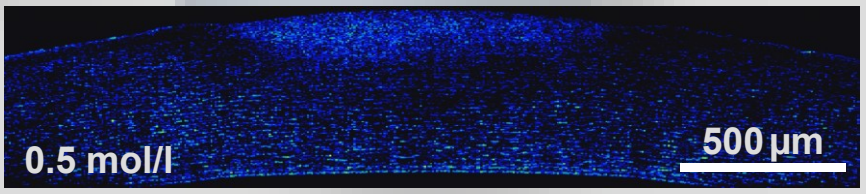
Affection of intraocular structures as a function of type of agent, concentration exposure time and temperature

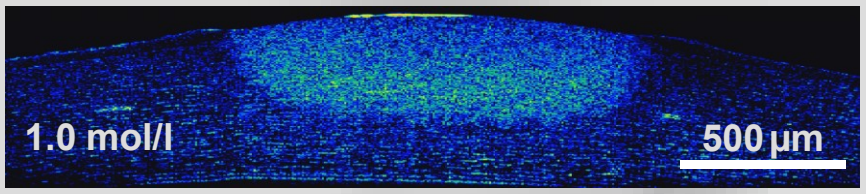


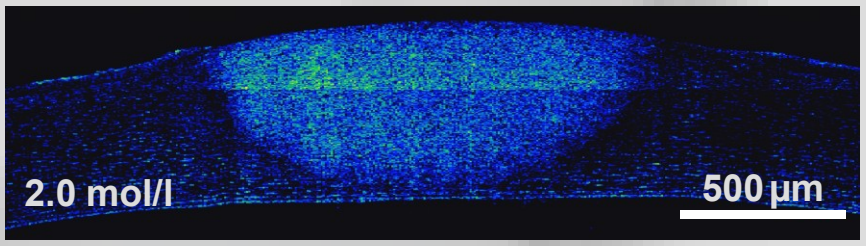
Experimental NaOH-burns of rabbit corneas being exposed 20 seconds

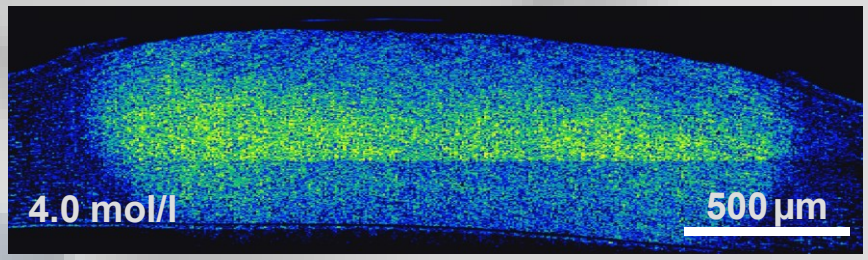












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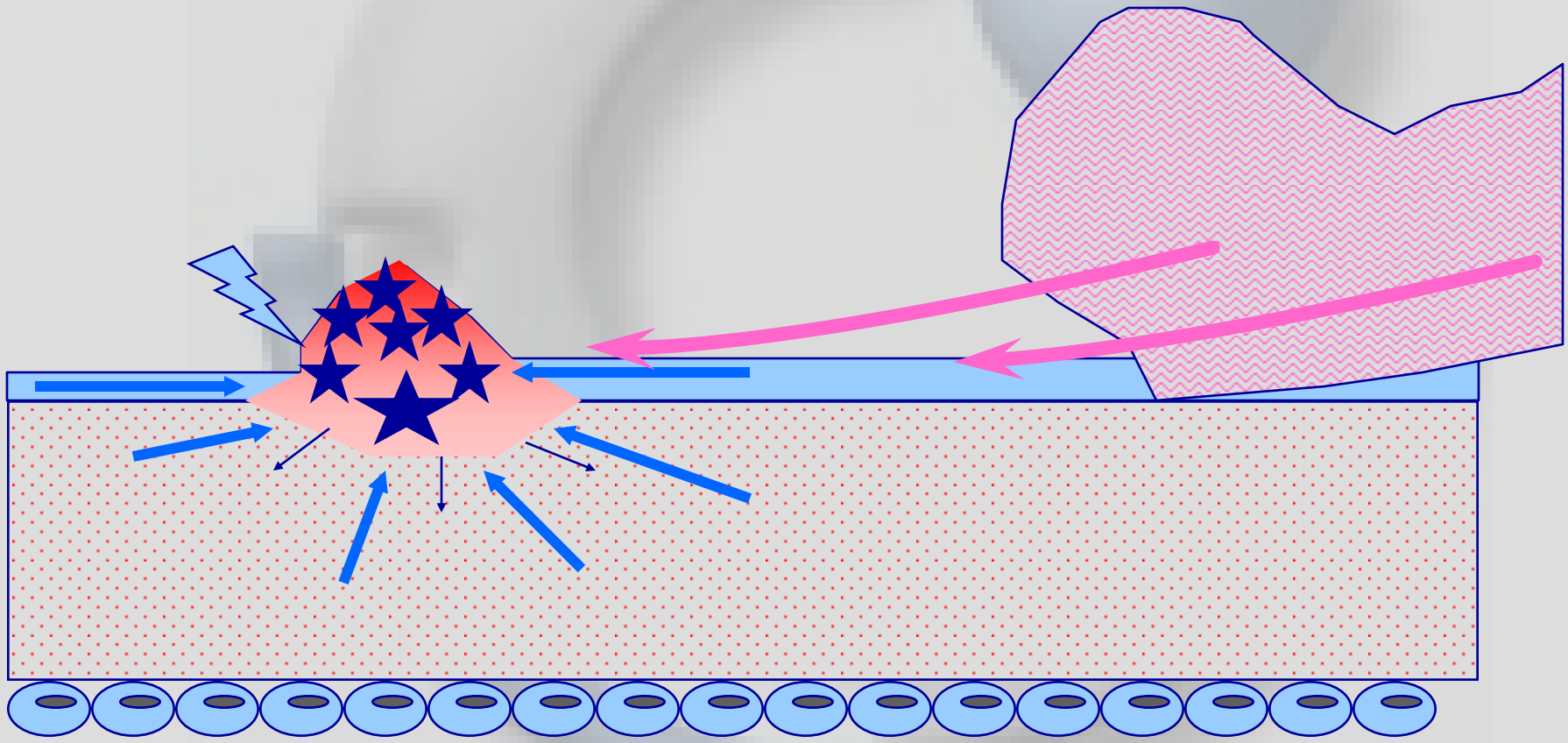
What to do ?

Rinse!!
Remove, dilute !!!
decontaminate !!



How to rinse ?

Take home!

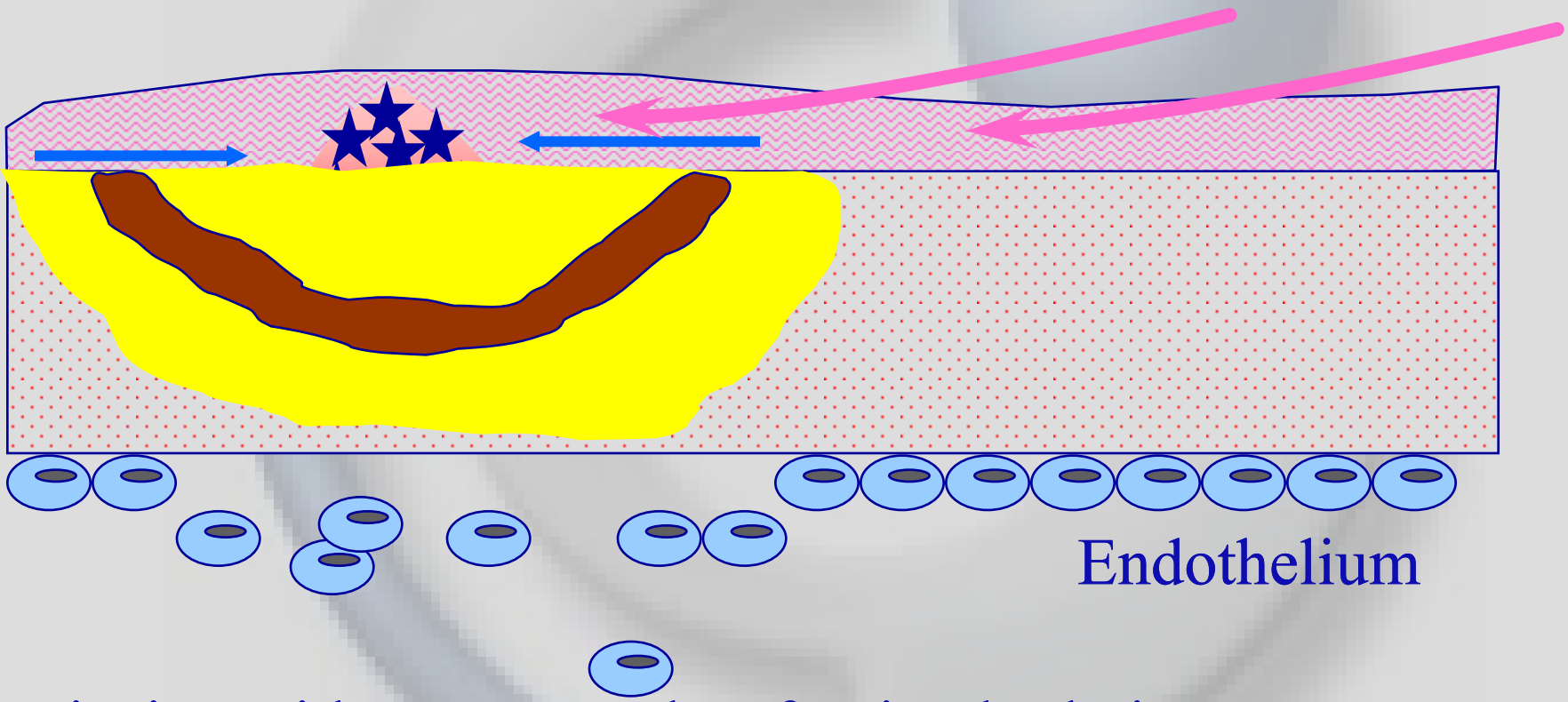
- **Rinsing is the best you can do !**
- Always right !
- **With nearby all you can drink**

  (except hot fluids, lemon juice, brandy, wodka, ….)

- Type of burns
- Mechanism of burns
- Dusts and Solid burns
- Burns with fluids
- Rinsing therapy
- Buffer or water ?
- Do and do not !

$$CaO + H_2O \rightarrow Ca^{++} + 2\ OH^-$$

The amount of water limits the resulting hydroxyl ions



Rinsing without removal or foreign body increases the amount of hydroxyl ions

Subtarsal Lime

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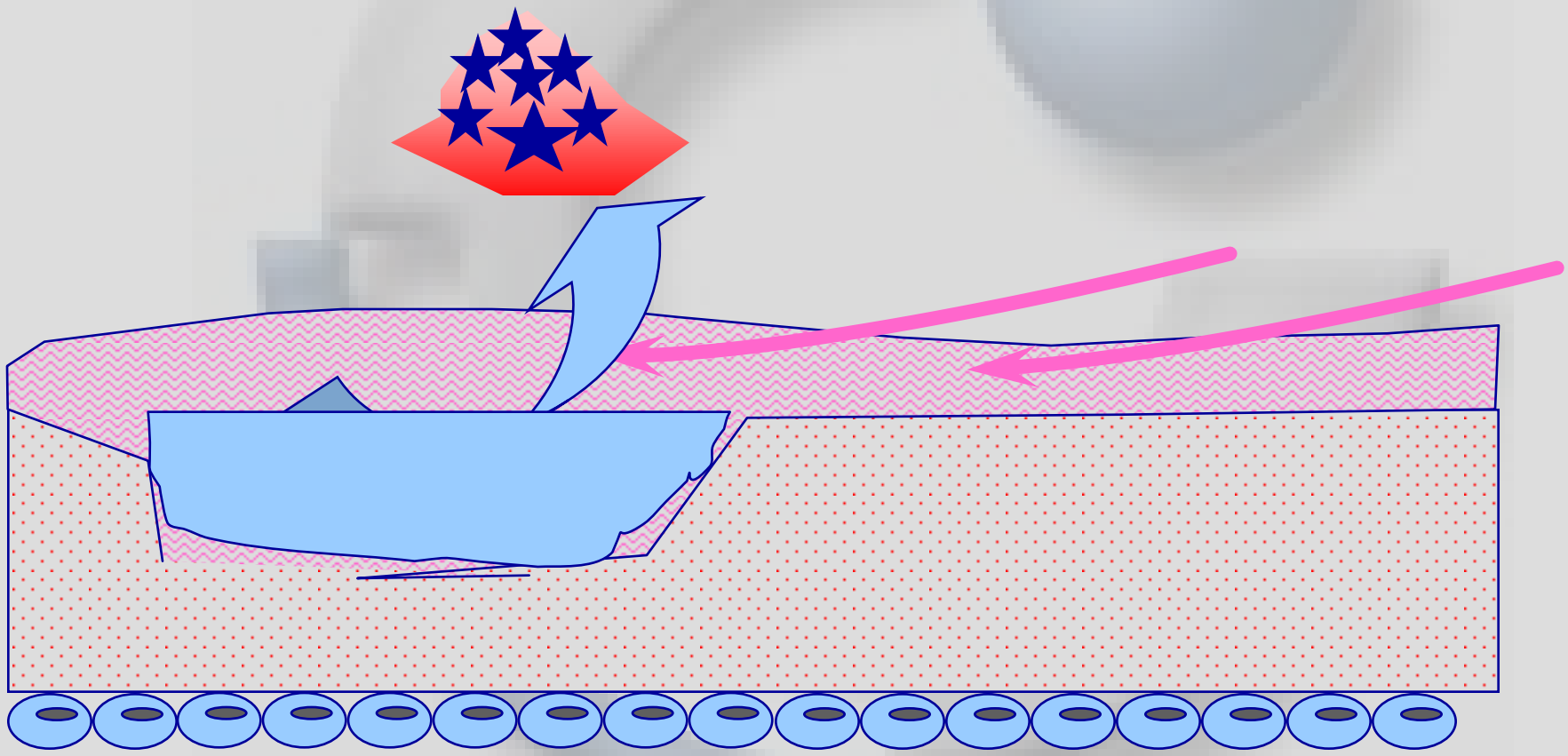
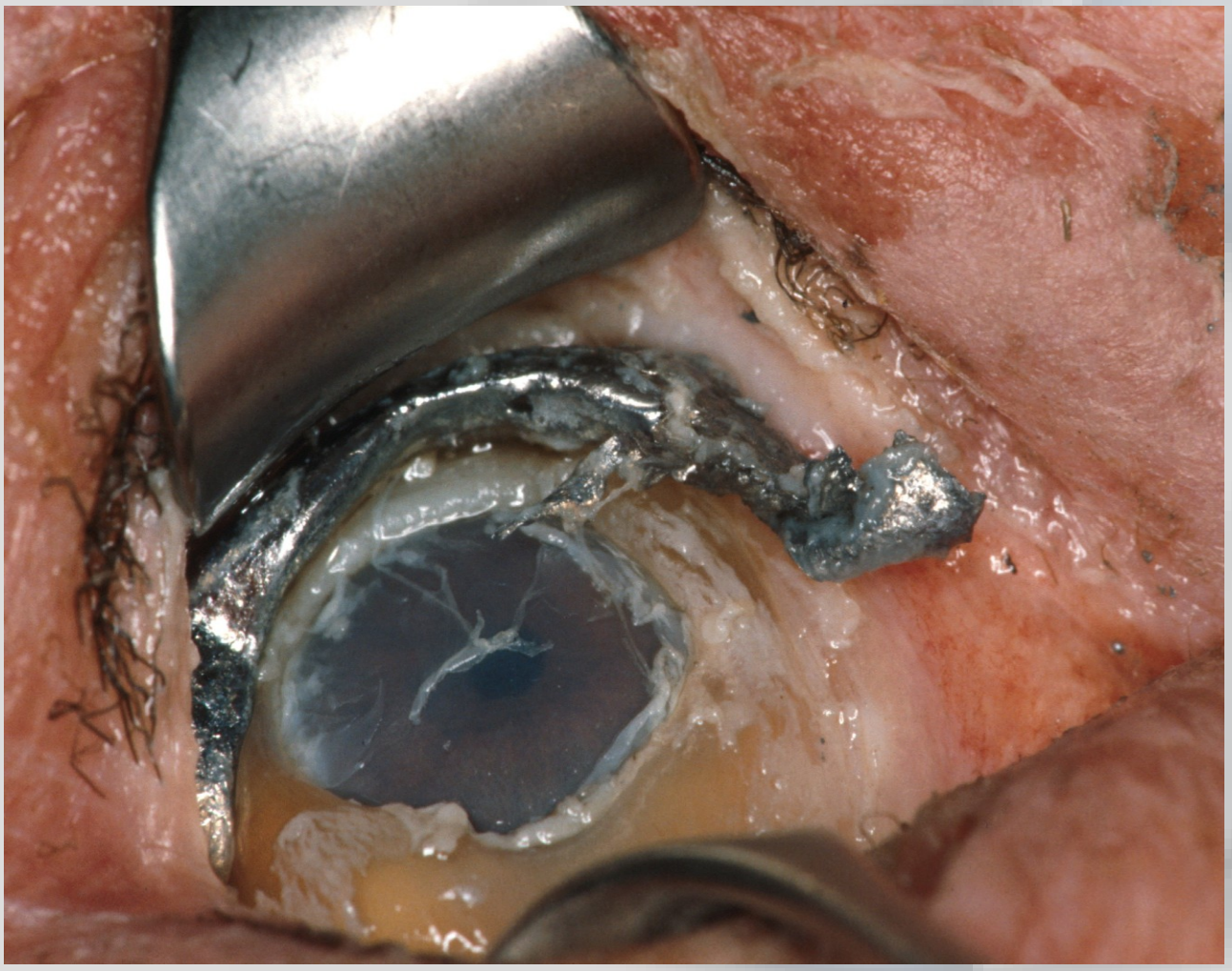
Remove foreign body and rinse to dilute and neutralize



Endothelium

Rinsing to cool !



Liquid metal

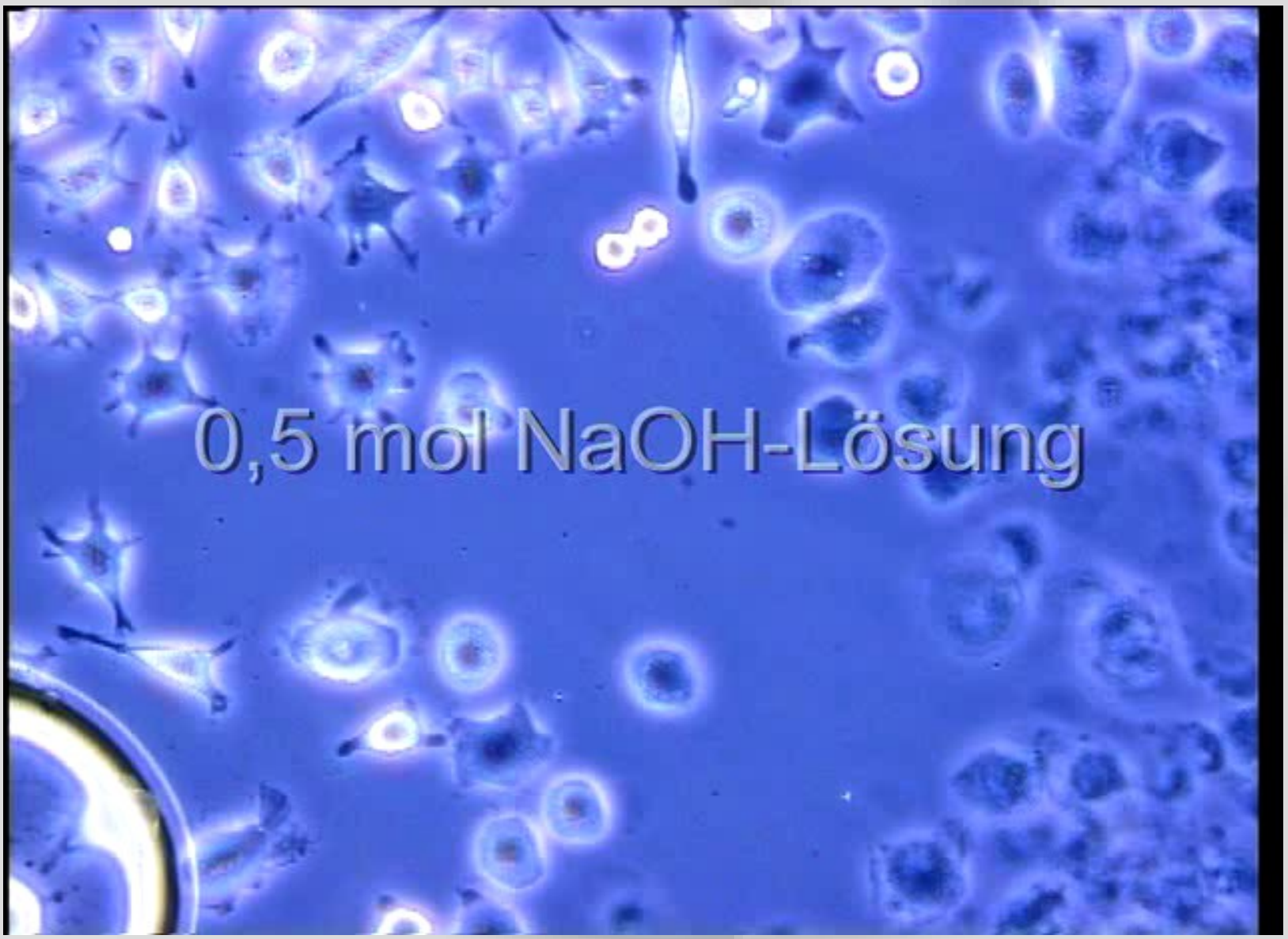
Take home!

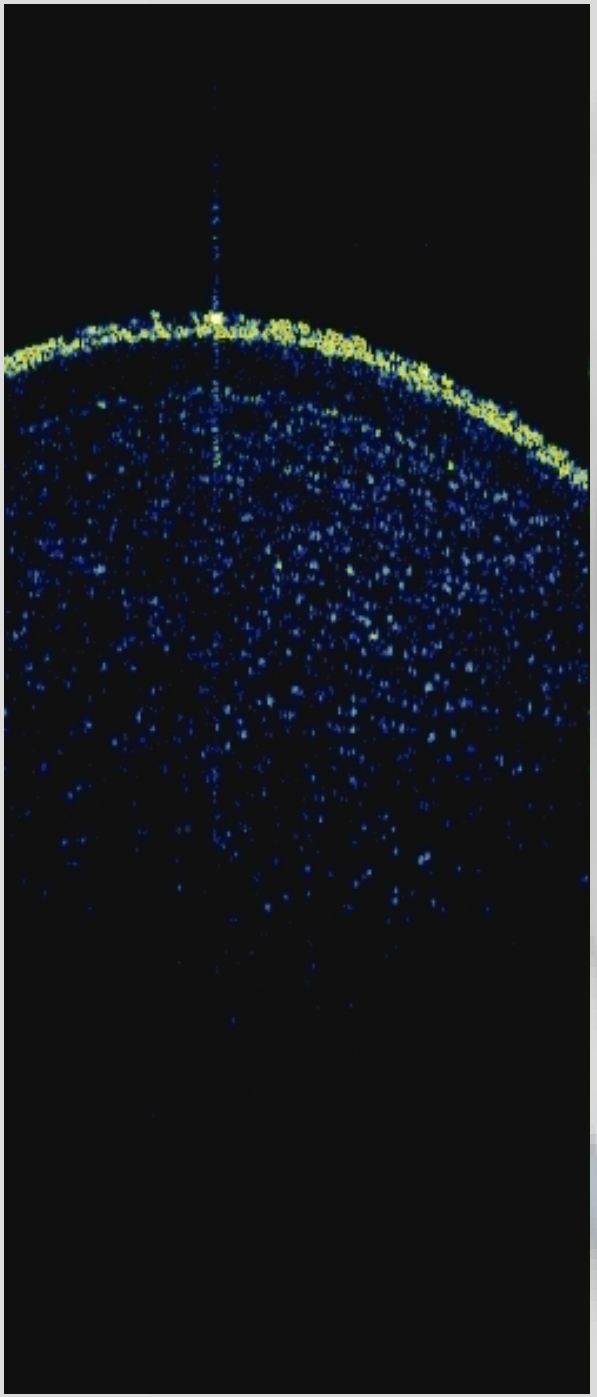
- **FIRST AID MEASURES:**

- **Rinsing**
- **Removal of foreign body**
- **Rinsing = cooling**

- Type of burns
- Mechanism of burns
- Dusts and Solid burns
- Burns with fluids
- Rinsing therapy
- Buffer or water ?
- Do and do not !

Action af alkali 0,5 mol NaOH





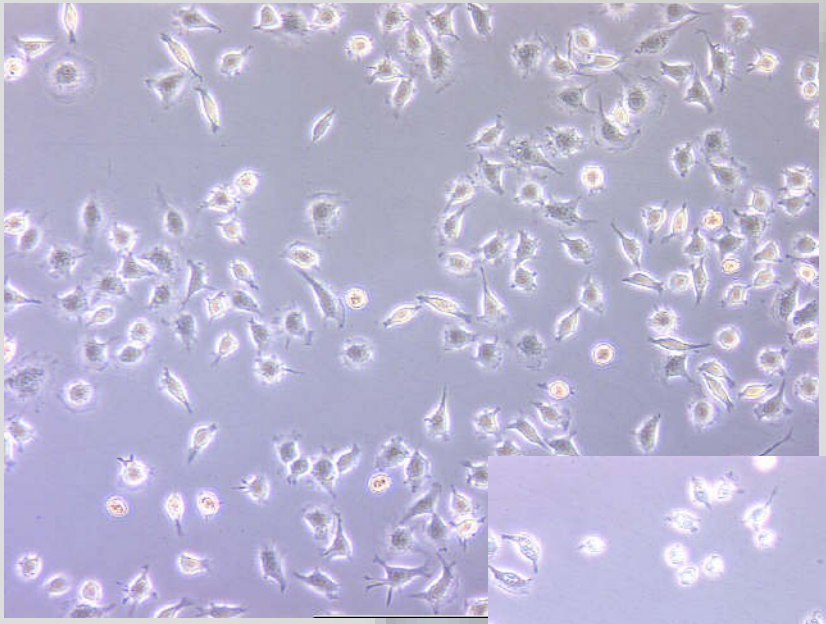
Eye burn video

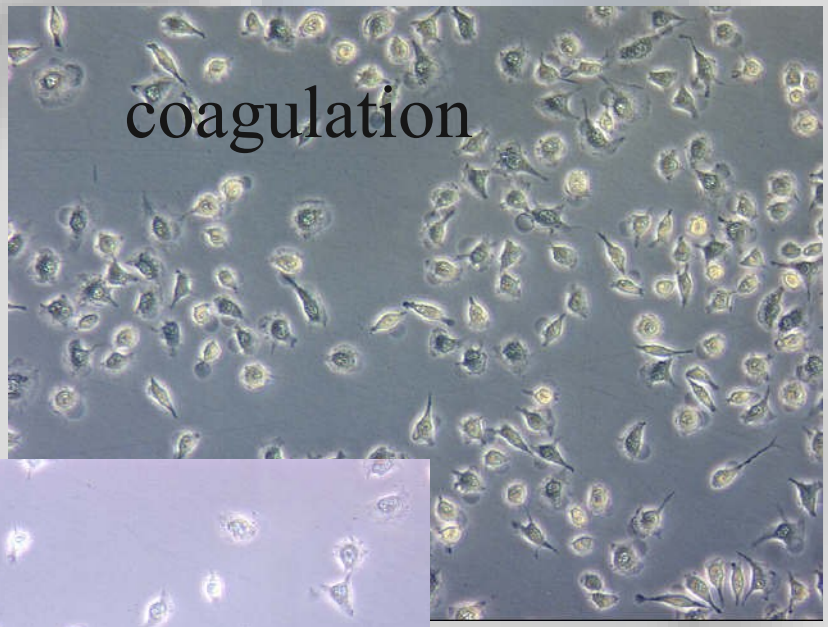
How long does it take to burn a cornea?

4 molar NaOH

Action of acids

0 min HCl isoosmolar, pH2, 1 h incubation 60 min



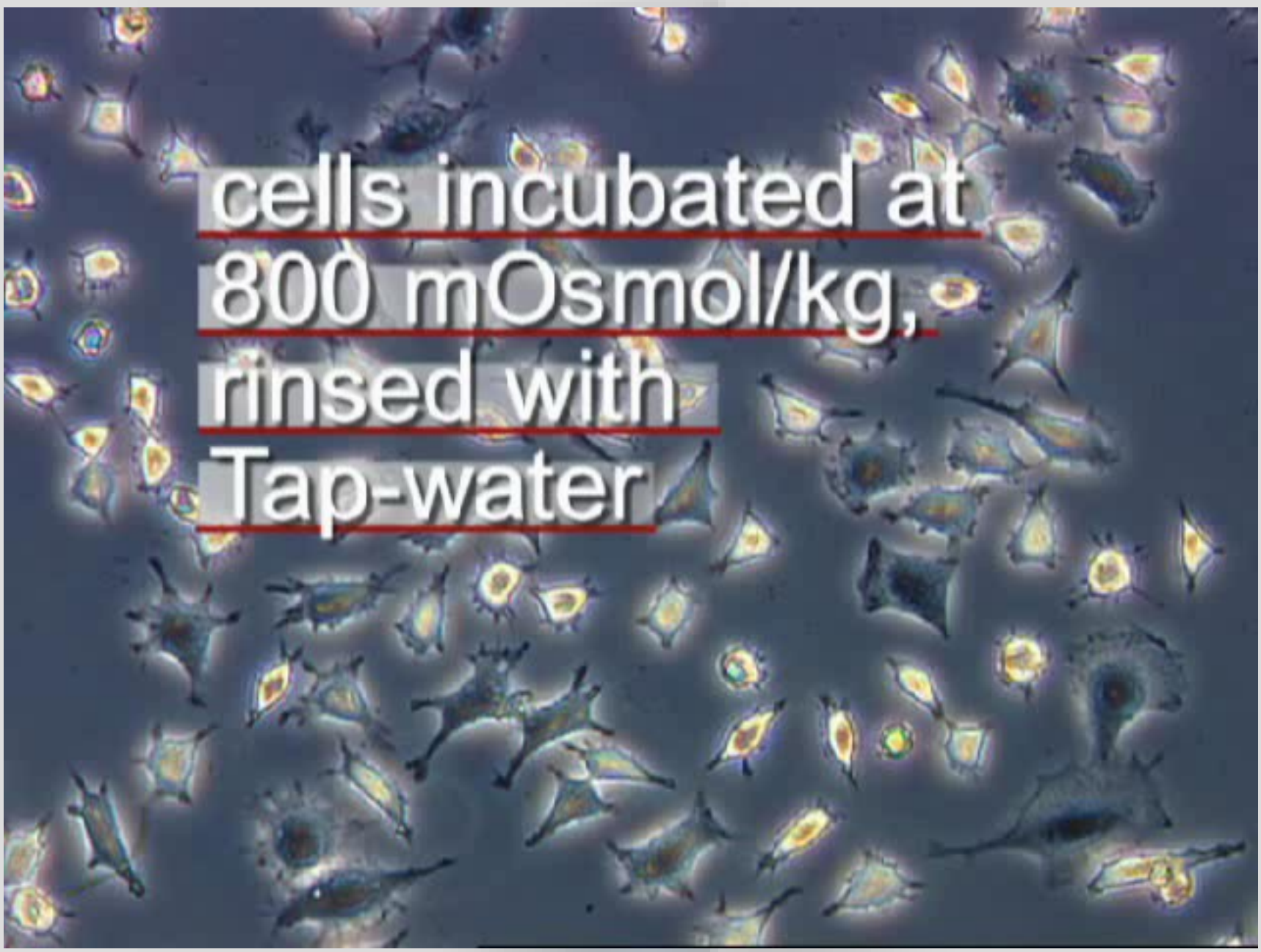


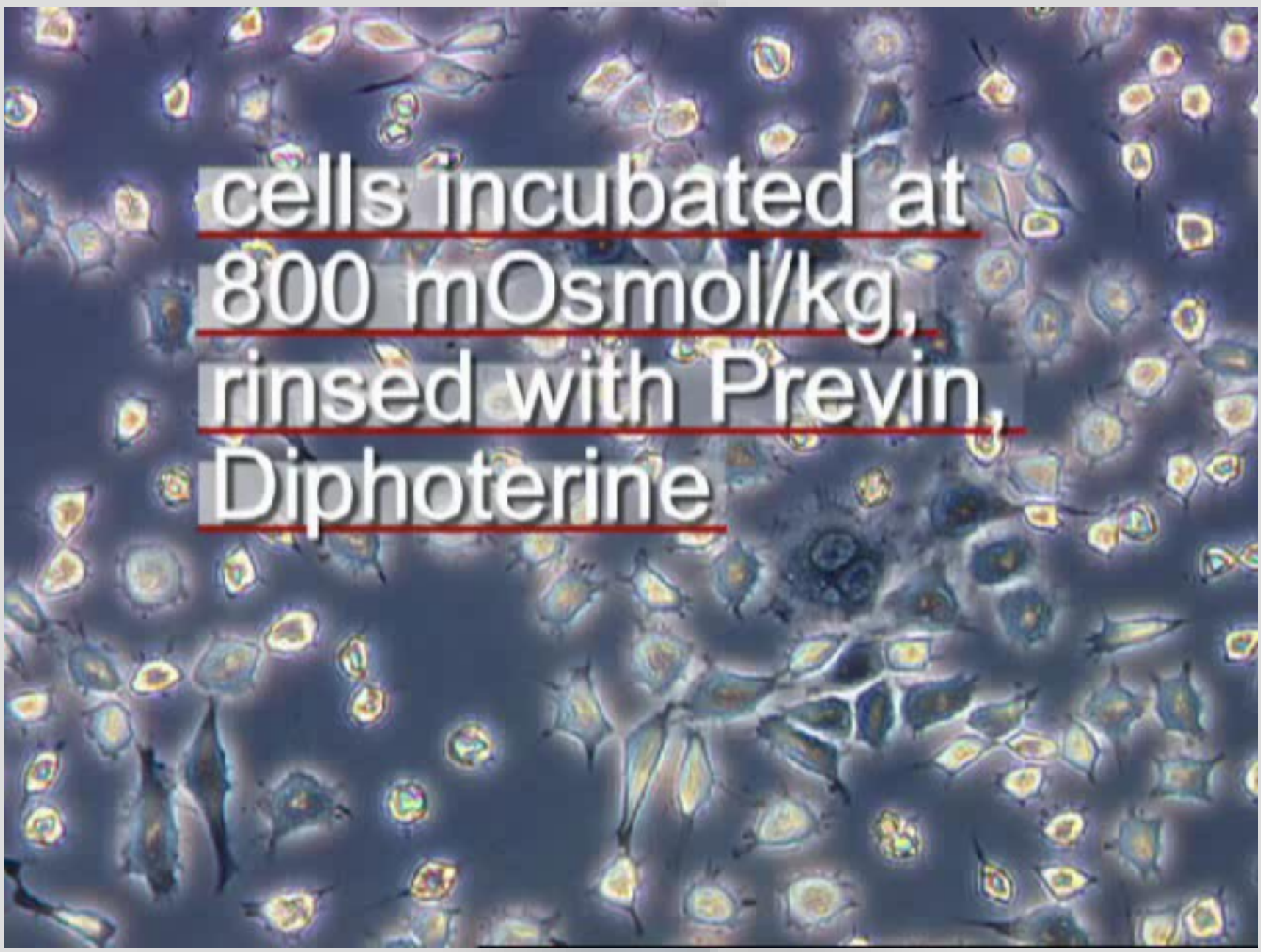
Take home !

Action of burns differs:

- **Membrane destruction (alcali)**
- **Structural maintenance but loss of function in acids**

- Type of burns
- Mechanism of burns
- Dusts and Solid burns
- Burns with fluids
- Rinsing therapy
- Buffer or water ?
- Do and do not !





Osmolarity considerations

Take home

- **Osmoshock causes additional trauma**
- **hyperosmolar solutions like Diphoterine ® physically stabilise tissues best**

- Diphoterine is not available in the US yet FDA process under consideration

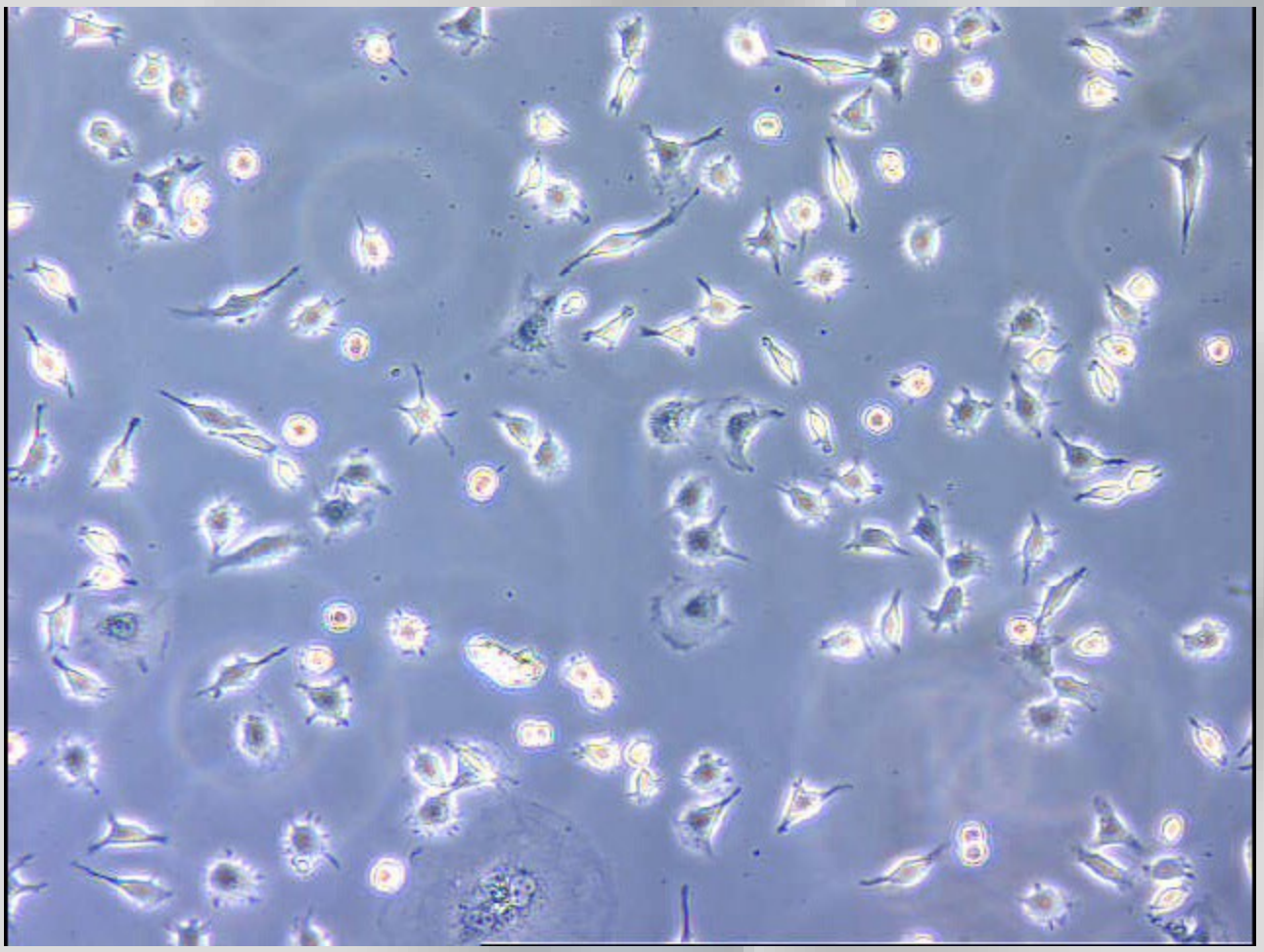
- Type of burns
- Mechanism of burns
- Dusts and Solid burns
- Burns with fluids
- Rinsing therapy
- Buffer or water ?
- Do and do not !

Buffer or Water? Dilution versus efficient decontamination

- Are there limits of survival ?
- If early rinsing wasn‘t done is late rinsing efficient?
- Case report: Merle et al. 4 mol NaOH burnt eye, Grad IV burn, resolved under conservative treatment rinsed with diphoterine ® (Burns 2006)

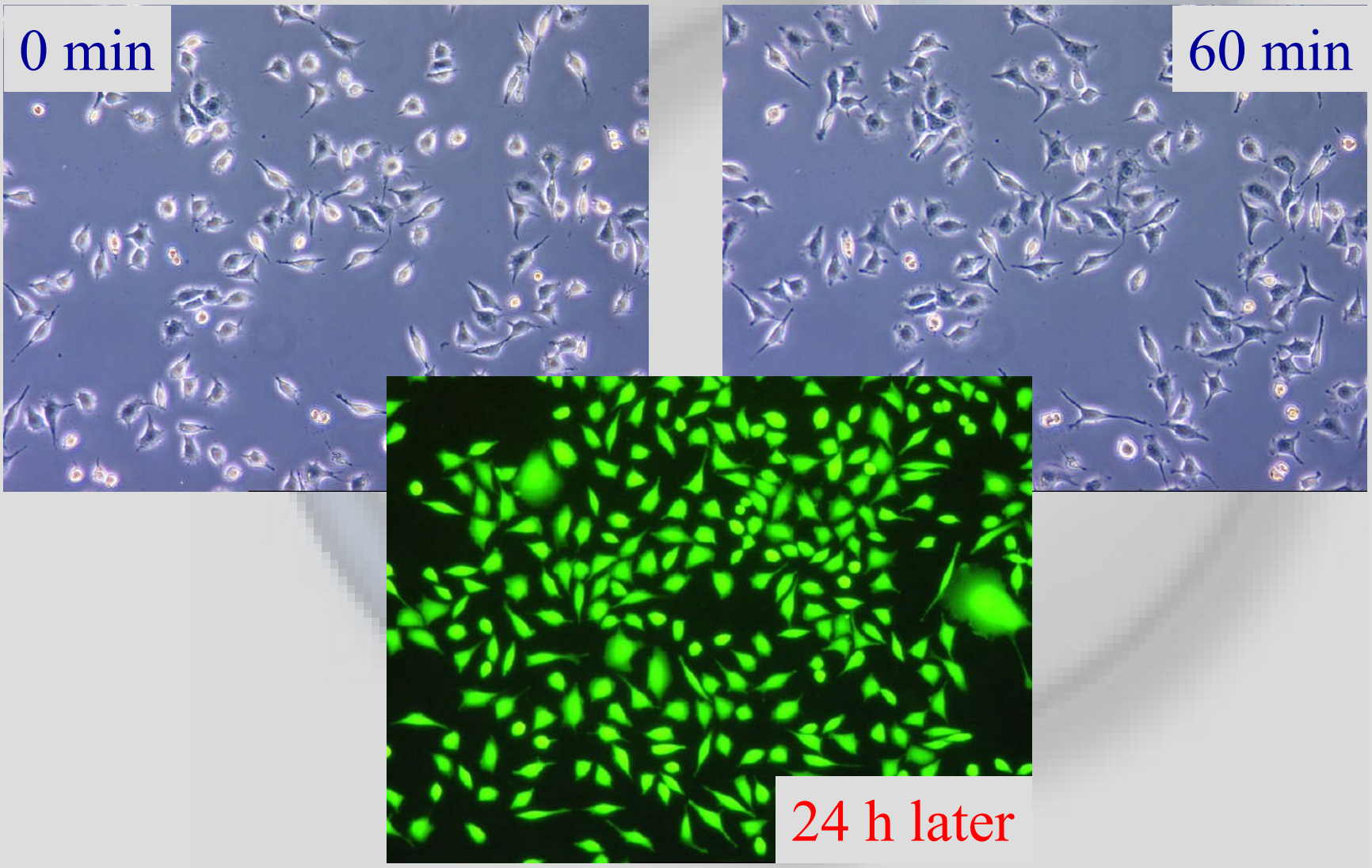
- It is never too late ! Why ?

Even under extreme pH cell death is not an immediate fact!

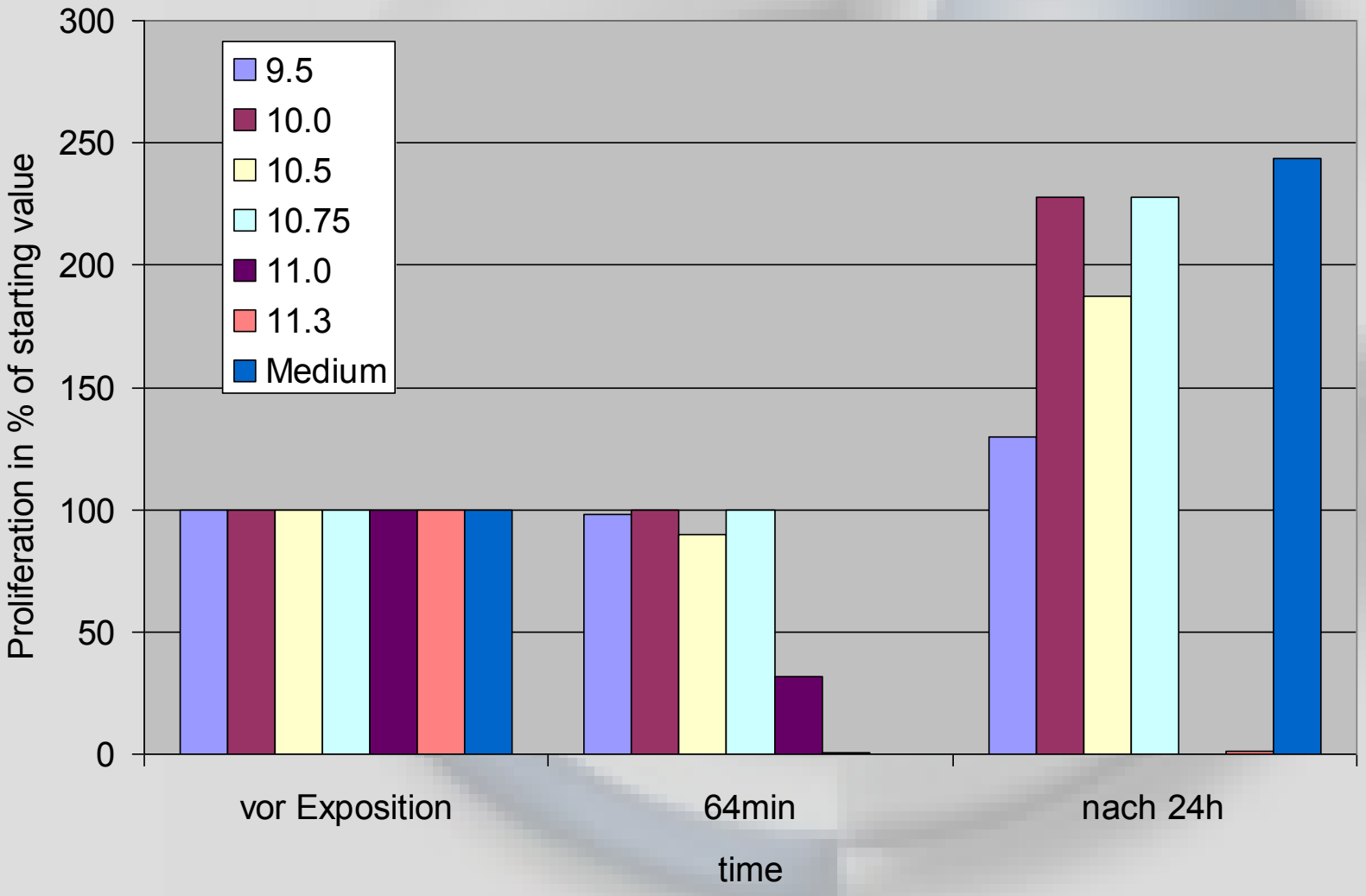


NaOH pH11.3 for 1 hour isoosmolar incubation

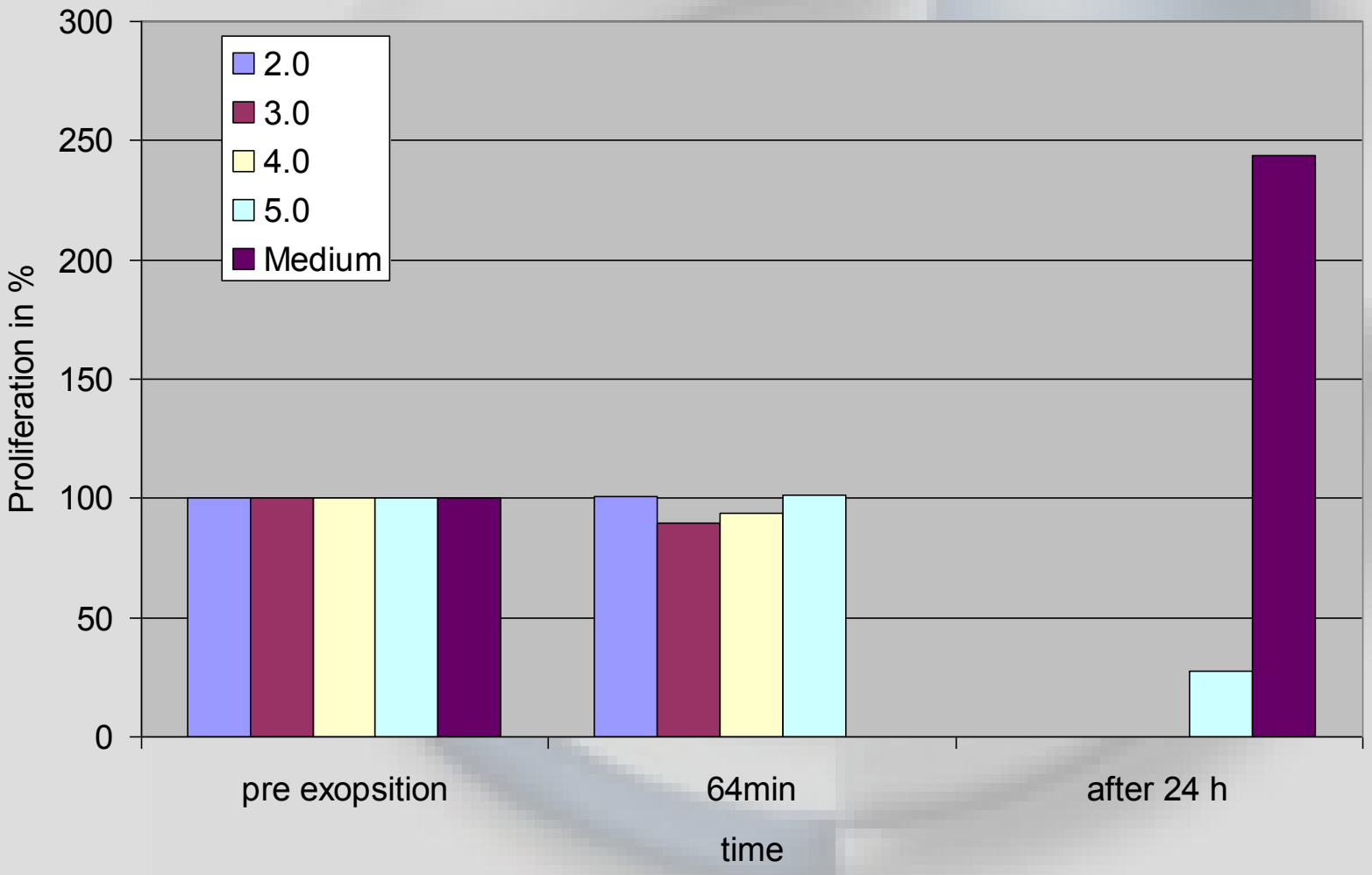
pH 9.1: survival of cells



Survival below pH of 9

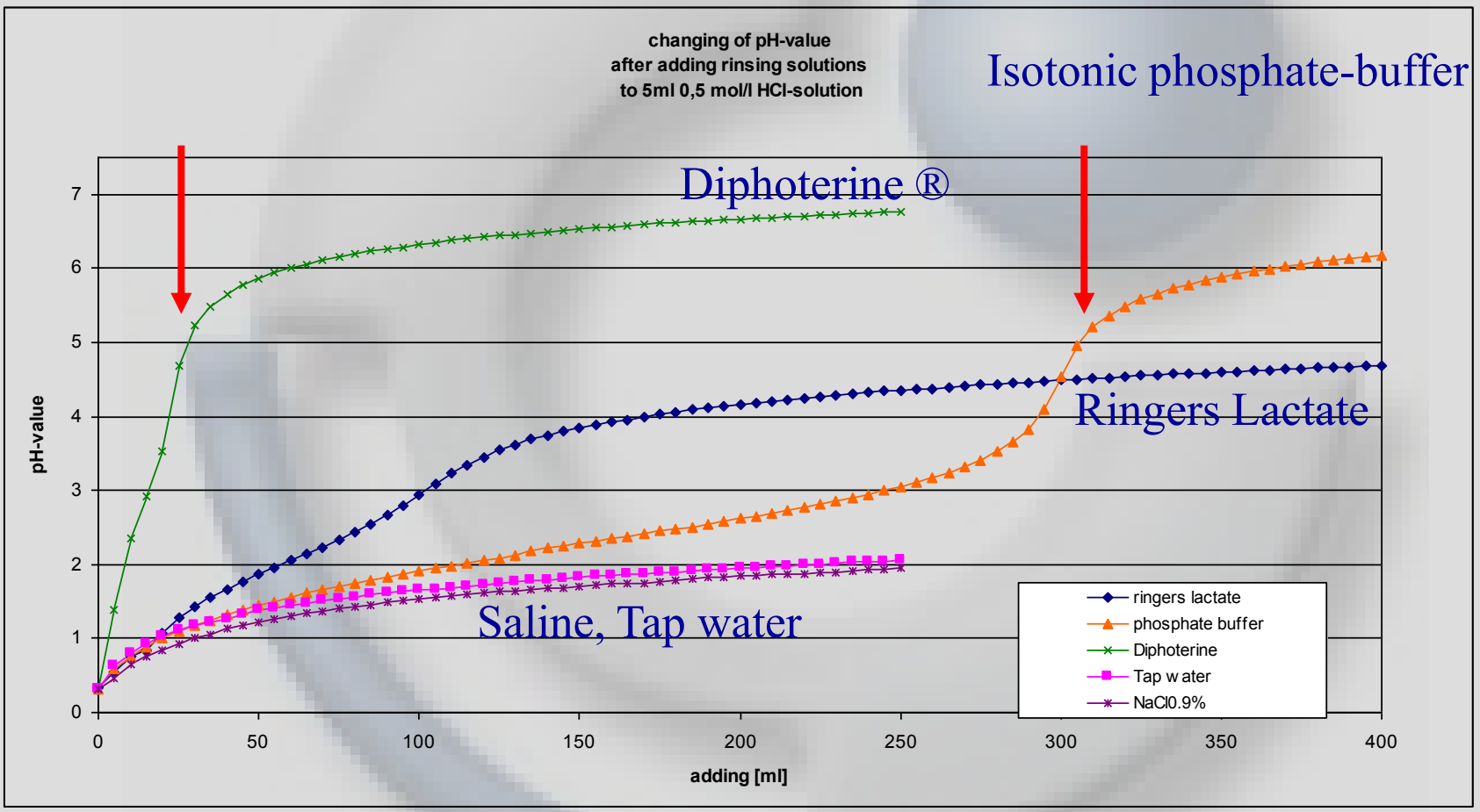


pH over 5 essential for survival



Which rinsing solution should we take?

Acids



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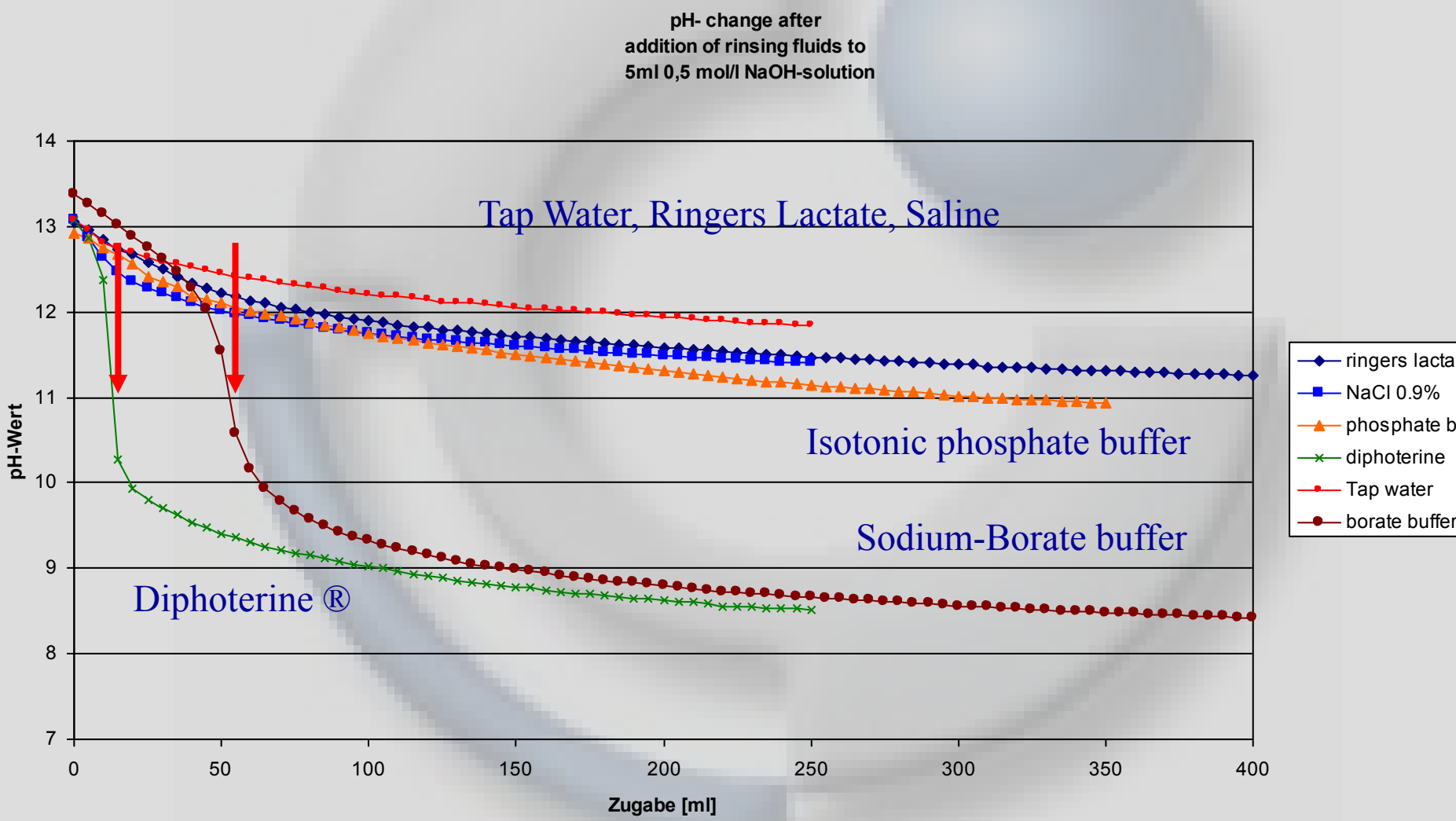
Alkali

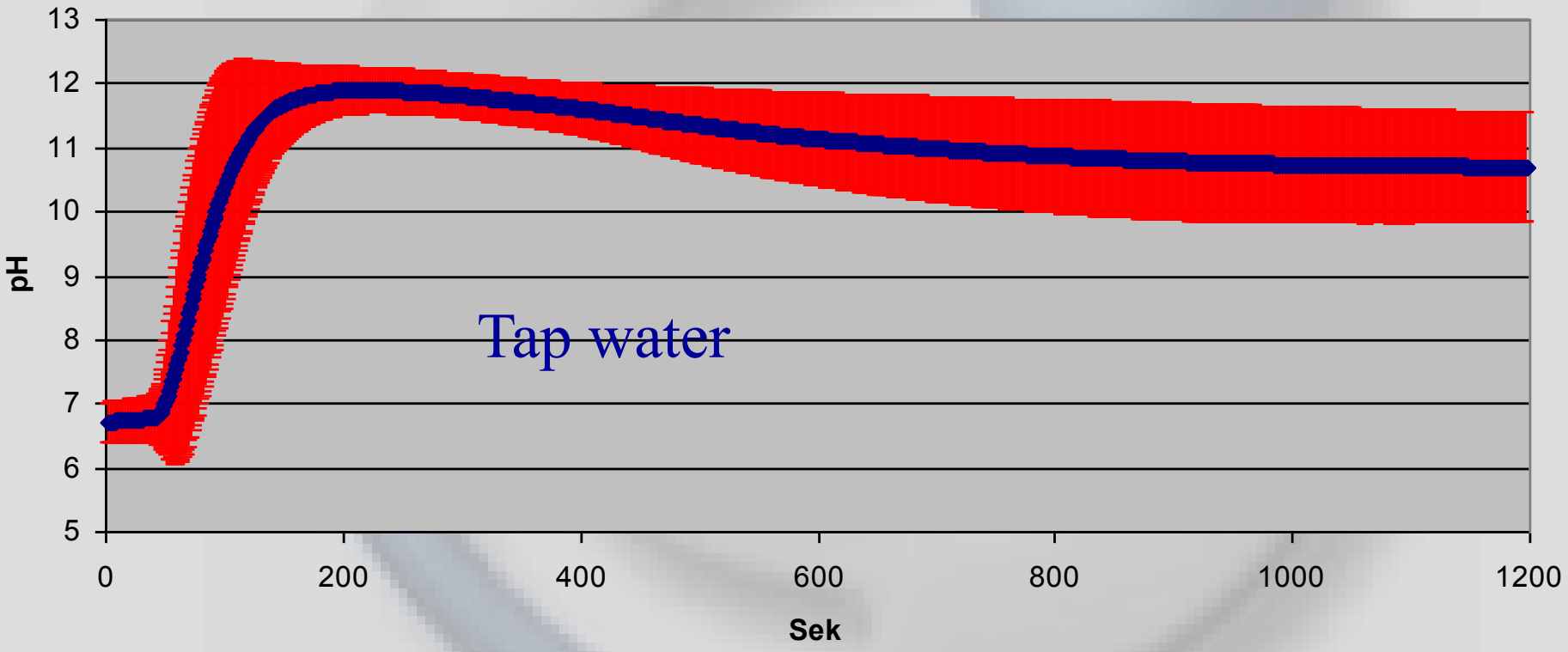


Take home!

- **Intraocular pH between 5.6 to 9.3 is important to achieve**
- **Only Diphoterine ® is acting on acids and bases**
- **Borate buffer (Cedderoths Eye wash solution ®) is doing well on alkali not on acids**

eye burns with 2 mol NaOH filter paper 10mm for 20s, immediate rinsing with tap water for 15 min

mean of 5 measurements on rabbit eyes



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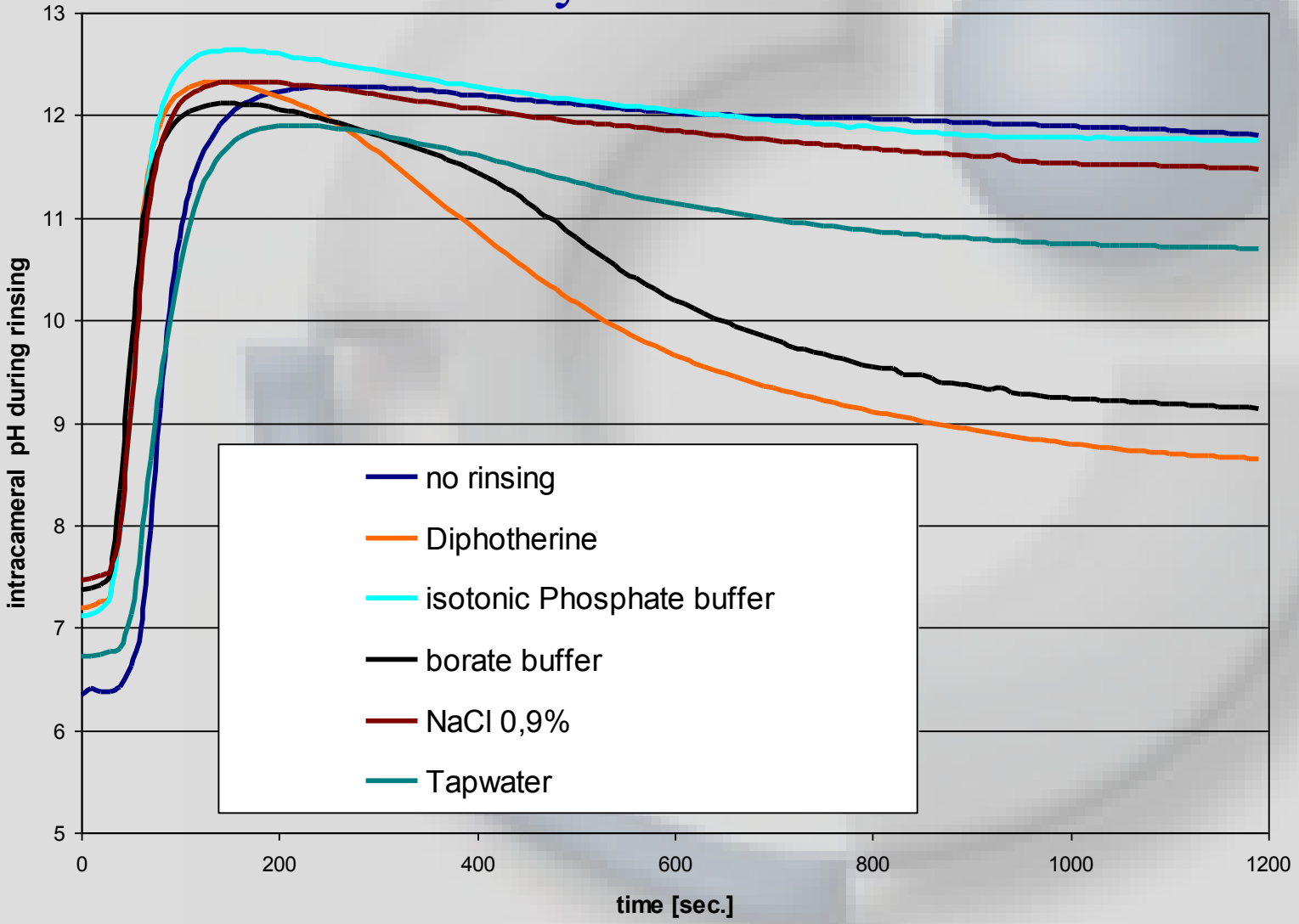
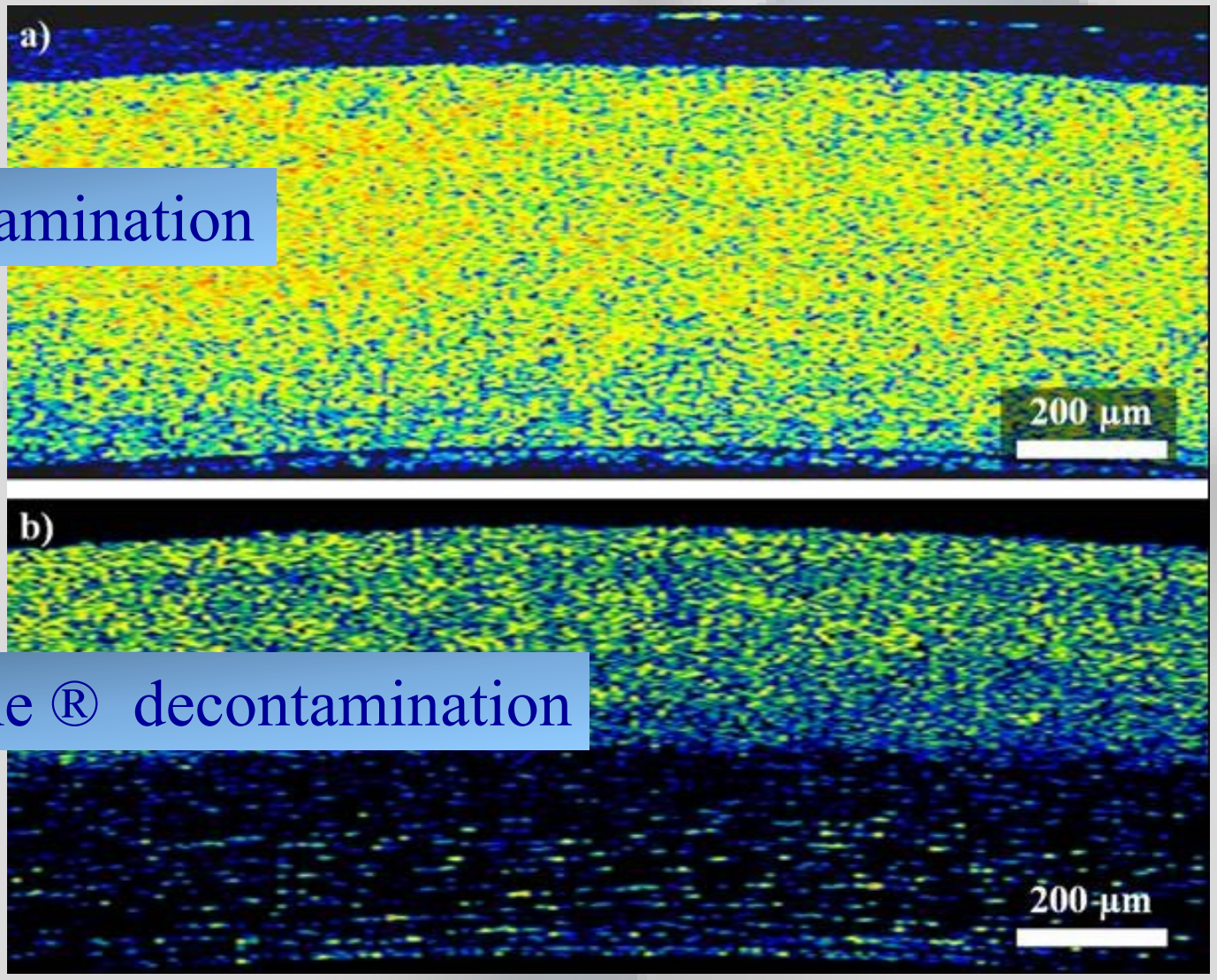
Decide yourself:
Which solution do you want to be rinsed with in first aid ?



Burns with 2 mol NaOH, stop with Diphoterine ® 1000 ml flow 66 ml/min (15 min)

No decontamination

Diphoterine ® decontamination

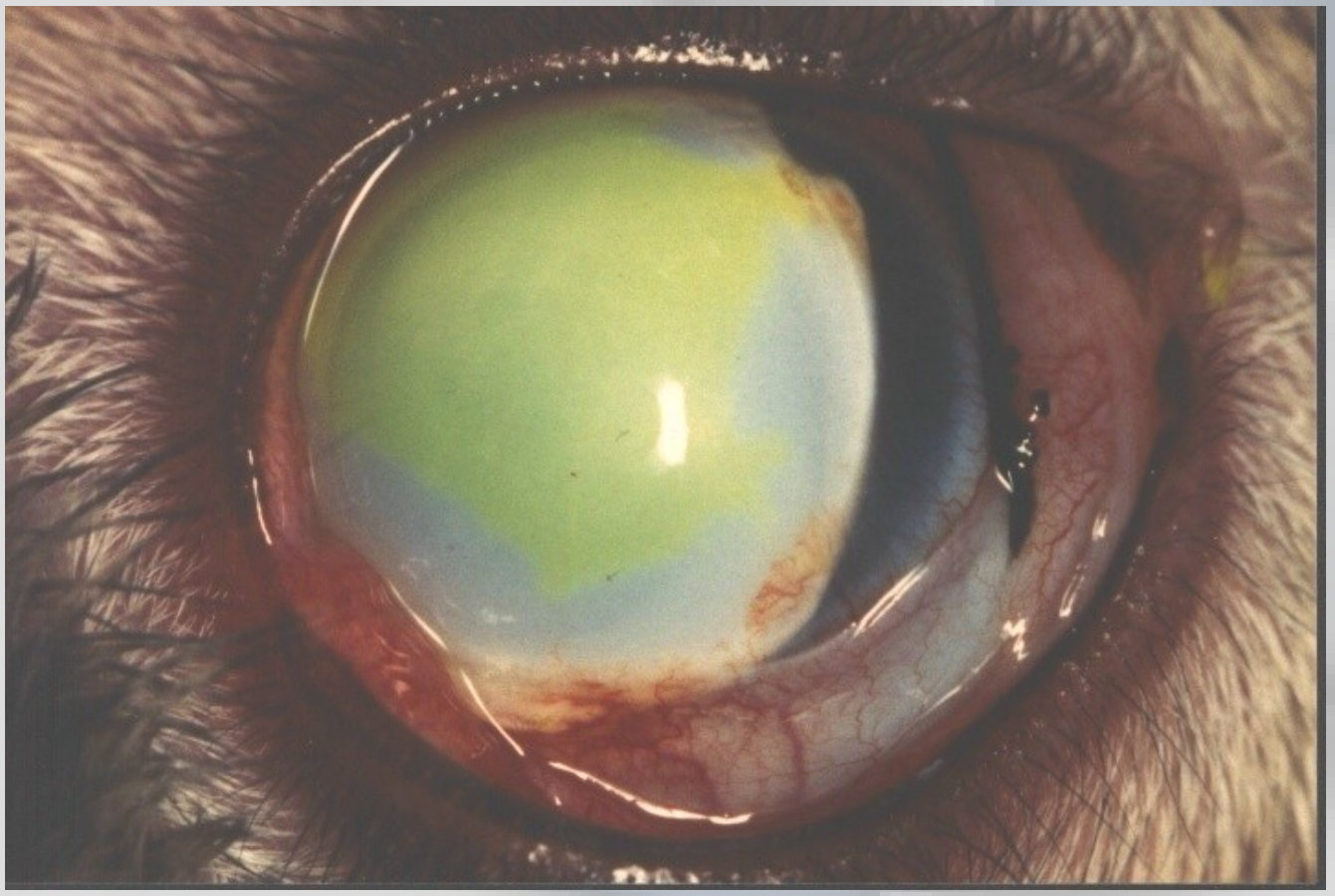


Take home !

- Diphoterine ® achieves physiological pH for acid and alkali
- Borate buffer does well for alkali
- Even with delay useful !
- As later rinsing starts as longer rinsing should be > 15 minutes !

- Type of burns
- Mechanism of burns
- Dusts and Solid burns
- Burns with fluids
- Rinsing therapy
- Buffer or water ?
- Do and do not !

Prospective double blind randomized therapy control study Burns with caustic soda (1 mol) rinsing therapy with saline or isotonic phosphate buffer. After 4 days 7 calcified and 7 non clacified corneas



Patient burnt by Spitacid® treated by continued rinsing with isotonic phosphate buffer for 48 hours
(8 weeks after burns)

Experimental rinsing with phosphate on a corneal erosion

Caustic soda burn rinsed once with physiological phosphate buffer

Clincial study

On 250 retrospective severe eye burns

Agent containing calcium:

-> corneal calcification ($p < 0.001$)

Eye drops with phosphate:

-> corneal calcification ($p < 0.05$)

Agent without calcium an first aid
contains phosphate buffer:

-> corneal calcification ($p<0.01$)

Graefes Archives Ophthalm. Schrage et al 2004

Take home

- **If you take phosphate buffer the cornea will calcify**
- **Better solutions Diphoterine, Previn are available (not in the US)**
- **Borate buffer (Cedderoths eye Wash) can be used for alkali**

Films and downloads at
www.acto.de