



**BSAVA**  
BRITISH SMALL ANIMAL  
VETERINARY ASSOCIATION

**Rowe**  
Referrals

# Managing challenging corneal disease

*“Black holes in dogs &  
Black spots in cats”*





**BSAVA**

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Referrals

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Clinic 01454 521000

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# “The complicated corneal ulcer”

**Black holes?**



**Black spots?**



# Corneal anatomy – in war and peace

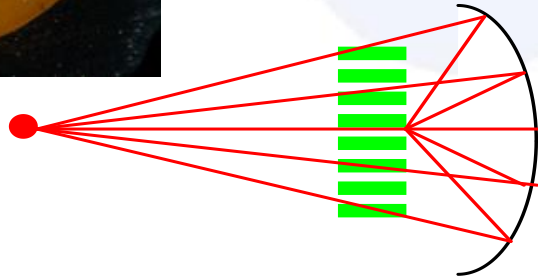


# Unique corneal anatomy: “form & function”

## Reflectance



Ron Douglas



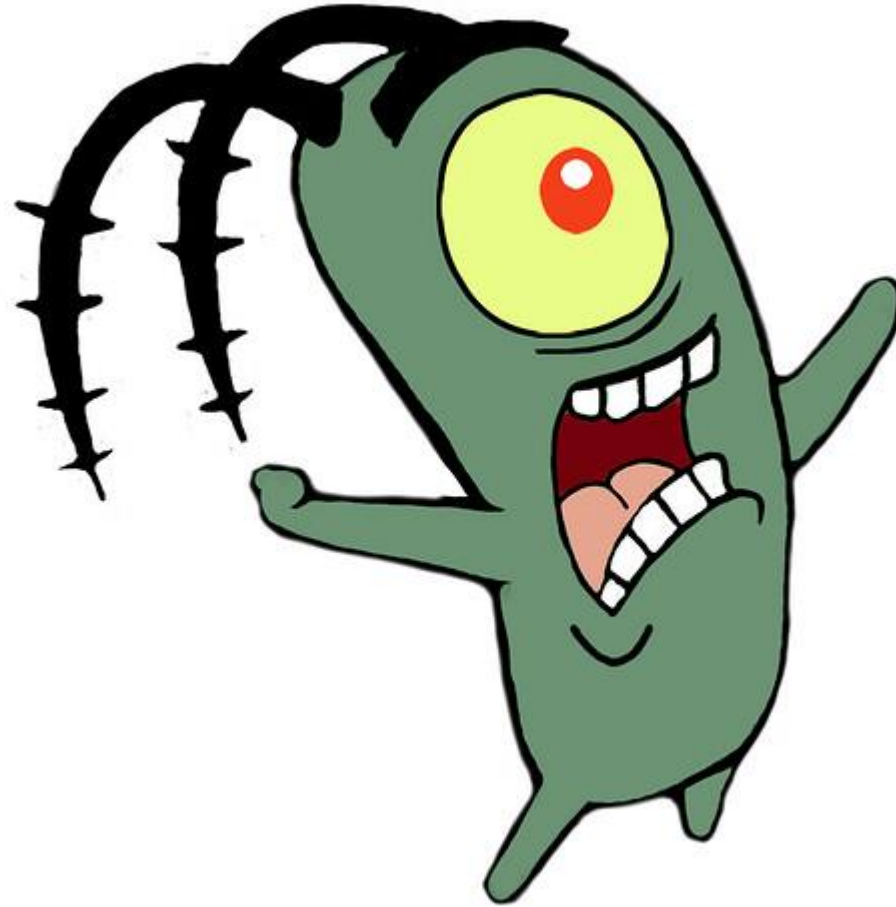
*Mirrors in nature: The ostracod (a type of deep sea crustacean), *Gigantocypris*, uses a mirror rather than a lens to focus light on the retina.*

## Transparency

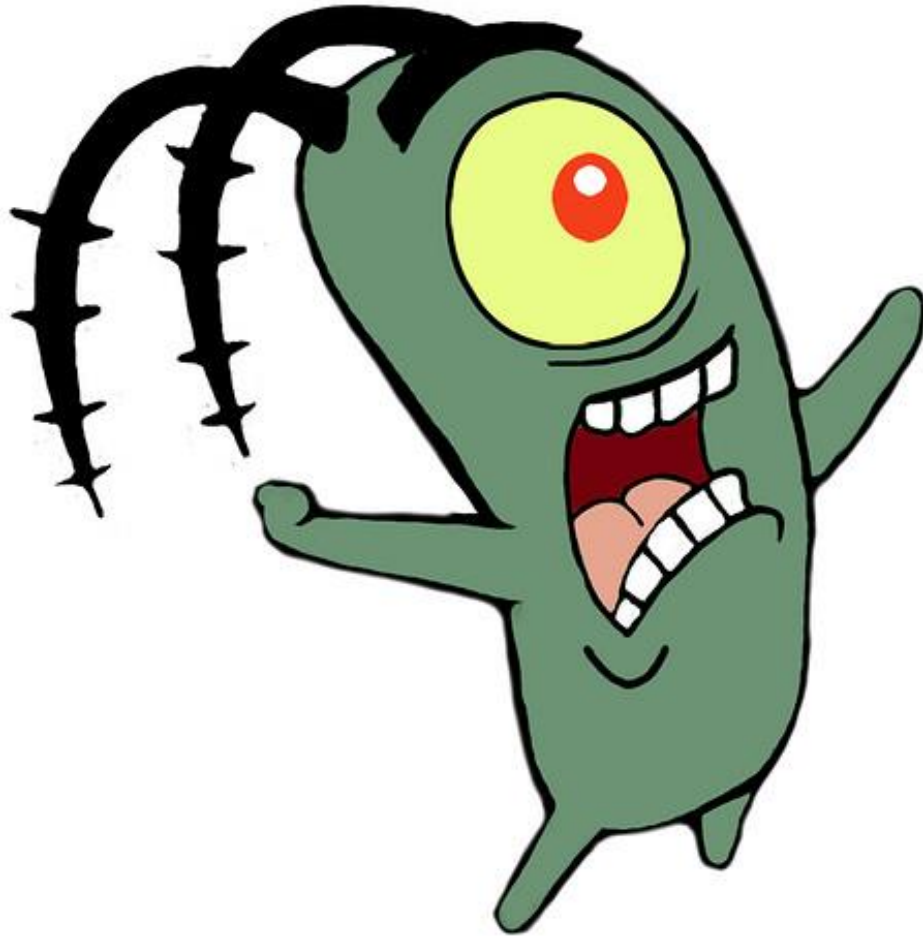


*These butterflies are known as *Greta oto* and are members of the clearwing clade. Due to their beautiful transparent wings, they are also called glasswing or espejitos (“little mirrors”).*

Name this guy?



# Sheldon J Plankton



# Sheldon J. Plankton

## Copepods

very small crustaceans related to crabs and shrimp. Sheldon J. Plankton from Sponge Bob Squarepants is modeled after a copepod.

*Like the Sponge Bob character Plankton, copepods only have one eye. Unlike Plankton, they do not operate their own restaurants*





## Cyclops

Copepods are the most numerous animals on the planet. They are the major food source for fish and even whales.





**TRIOPS**  
From The Age Of  
DINOSAURS

They're  
ALIVE!

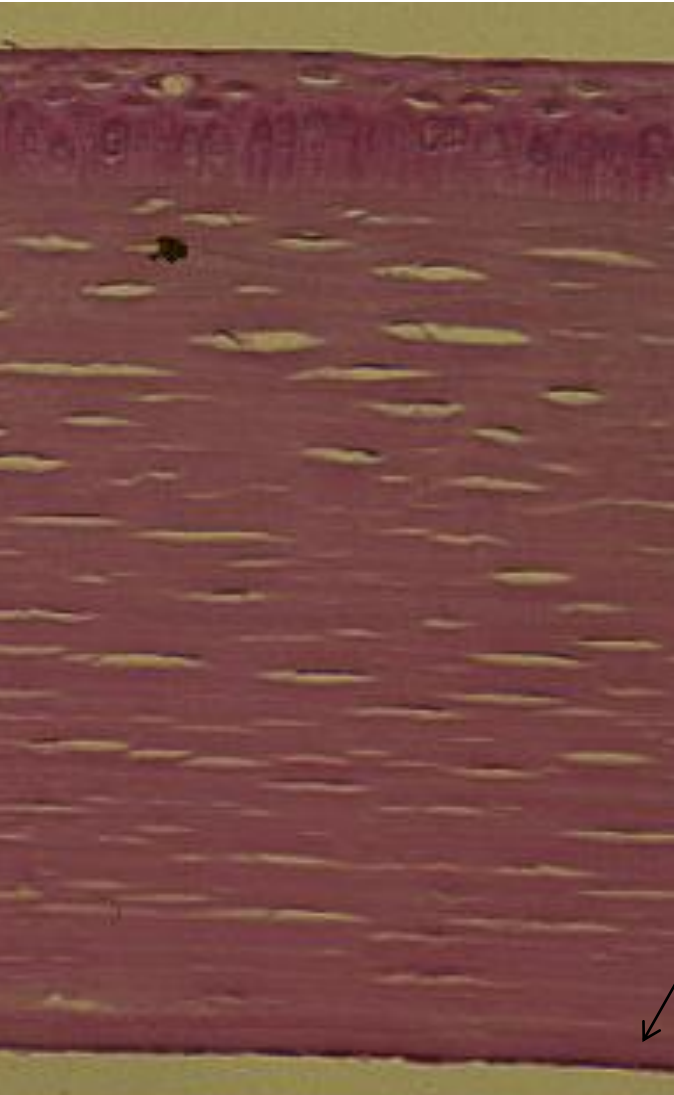
TRIOPS  
Just Add Water  
They Hatch In  
**24** HOURS

TRIOPS  
Watch  
their  
AMAZING  
AQUA-BATICS

EVERYTHING YOU NEED TO GROW PET TRIOPS



# Corneal anatomy



← Epithelium →

↖ Basement membrane ↗

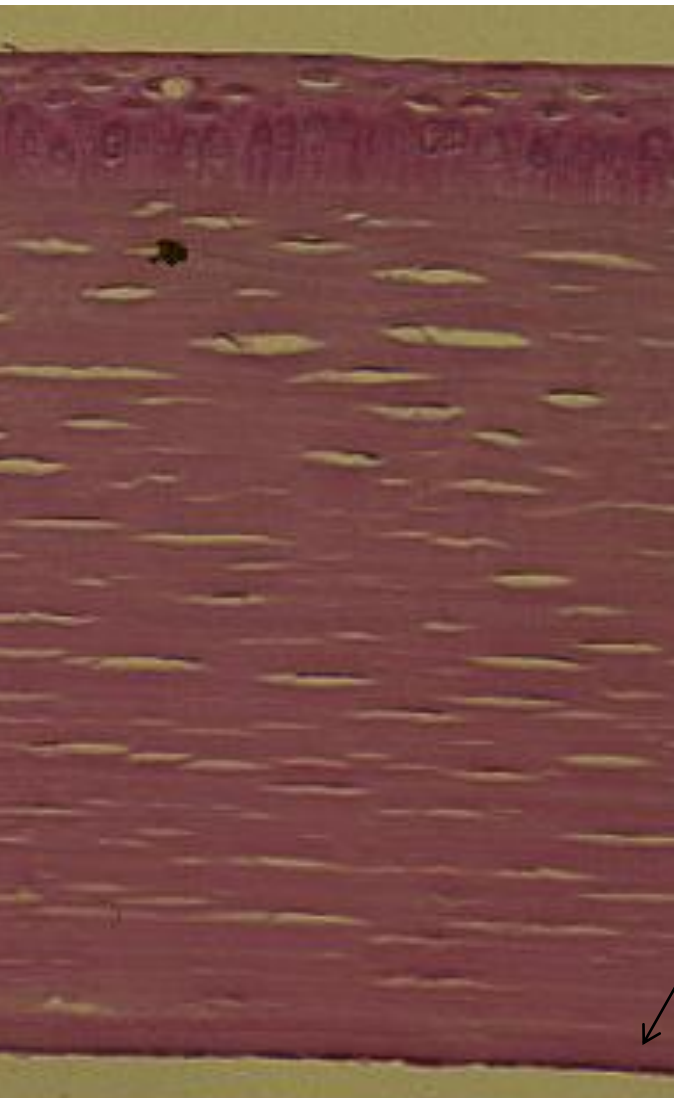
← Stroma →

Basement membrane  
(Descemet's)

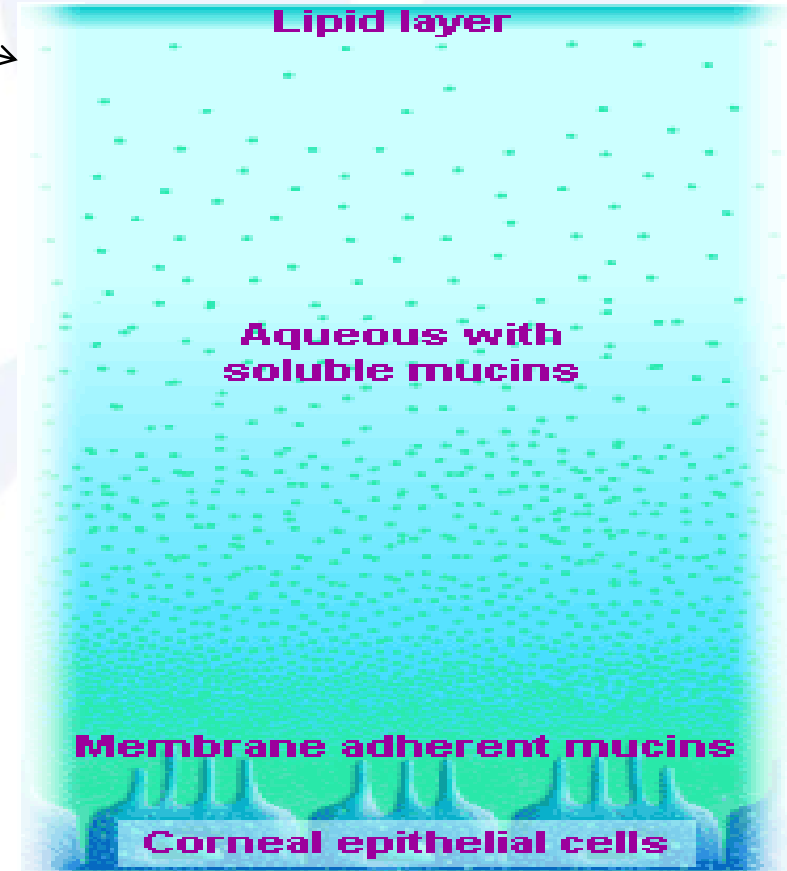
← Endothelium →



# Corneal anatomy



← Tear film  
← Epithelium  
← Basement membrane  
← Stroma  
← Basement membrane (Descemet's)  
← Endothelium

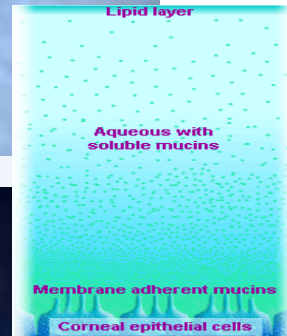


NB epithelial microvilli  
of gut epithelial cells

# Corneal reflectance



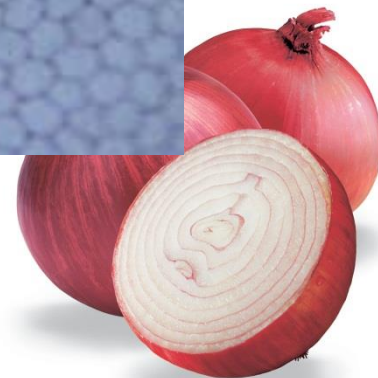
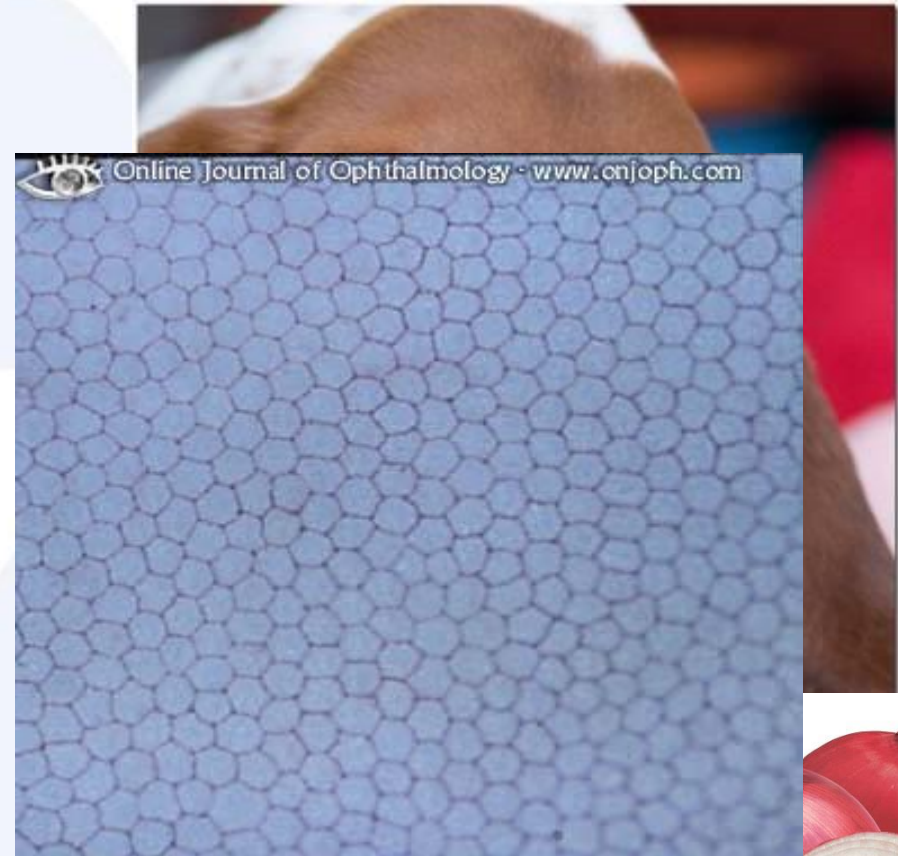
- Tear film function
  - Lipid
  - Aqueous
  - Mucin
- Epithelium
- Basement membrane
  
- “The corneal reflex”
- Corneal reflex unaffected by stromal disease **unless** corneal contour affected.



# Corneal Transparency



- “Why is the cornea clear and the sclera white?”
- Transparent tear film and epithelium
- **Regular arrangement** stromal fibres – slow turnover, relative dehydration
- Absence blood vessels, simple cellular structure
- **Relative dehydration** - functional endothelium
- Transparent endothelium



## Tear film

### Nutrition:

- Oxygen
- Glucose
- Growth factors

### Protection

- Macroglobulins
- Lysozyme
- IgA
- Protect against drying

### Repair:

- MMPs
- Growth factors





## Tear film

Nutrition:

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- Glucose
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Protection

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- Lysozyme
- IgA
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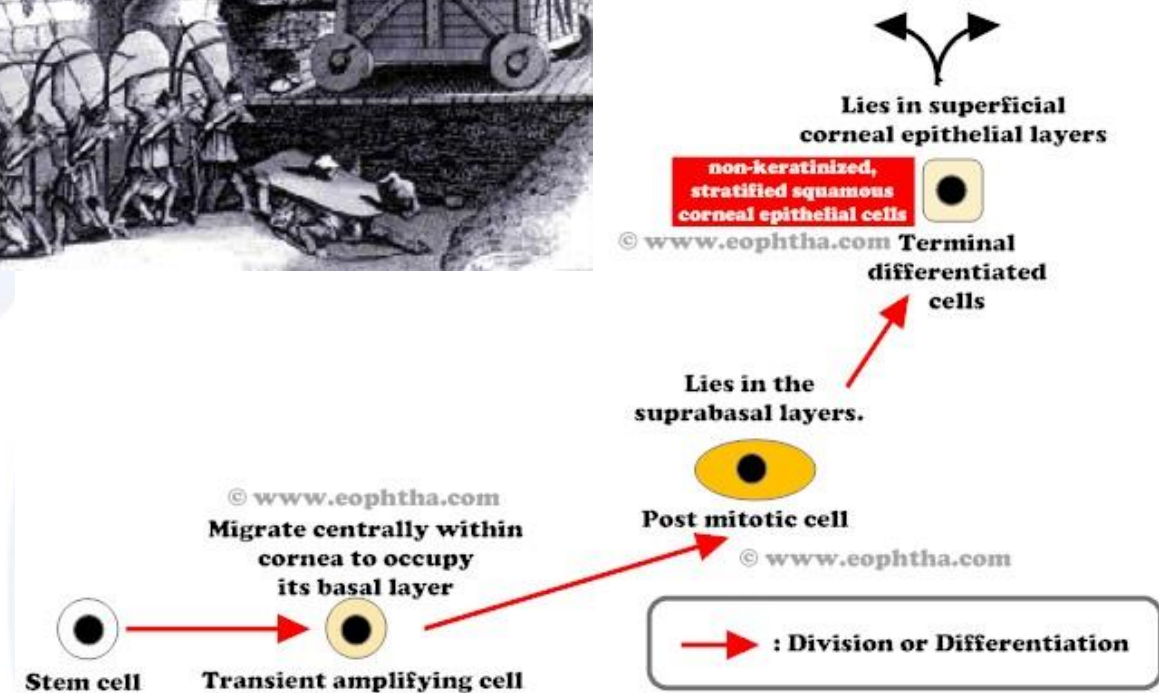
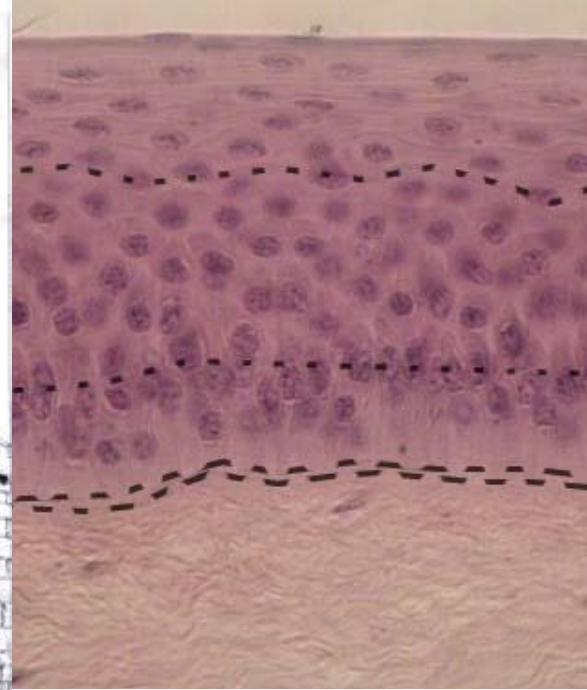
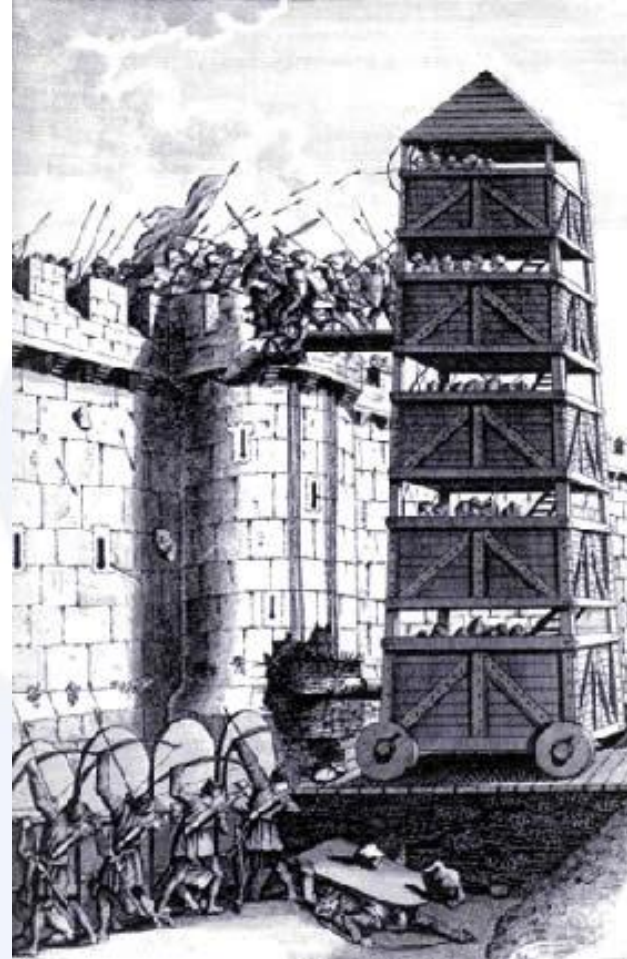
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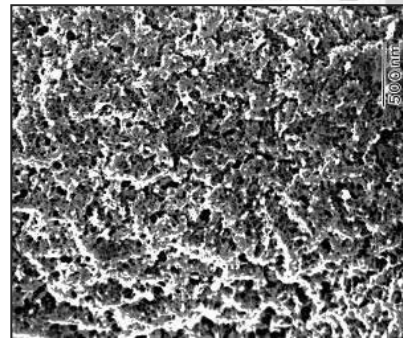
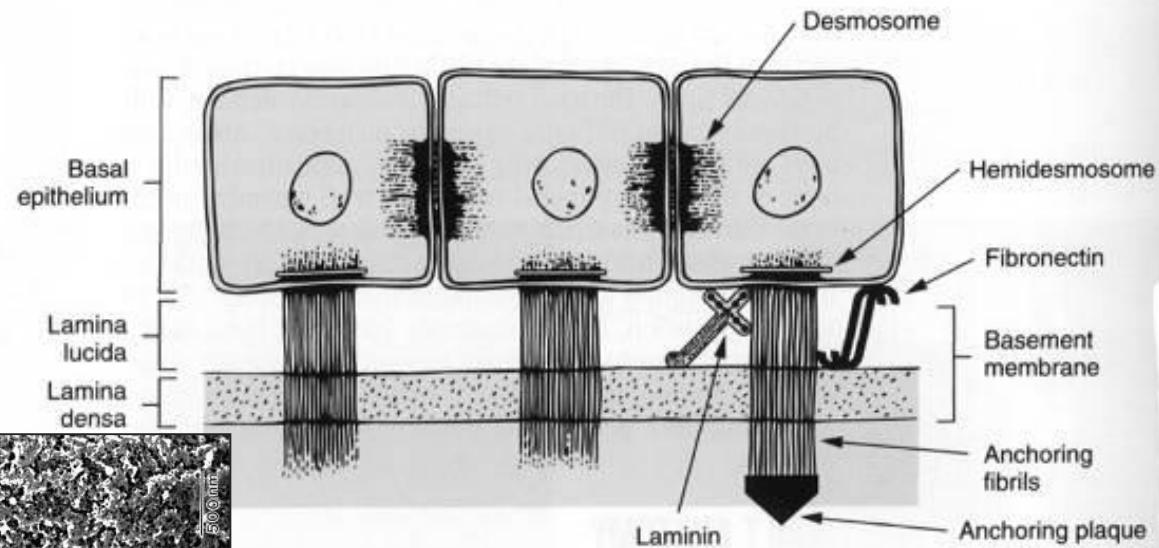
# Epithelium

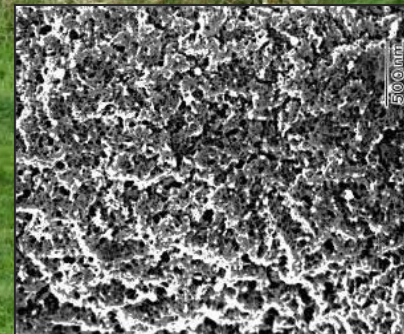
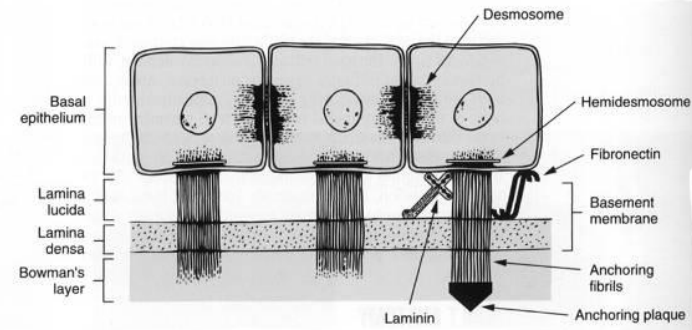
- “The soldiers on the battlements”
- Actively replicating
- Readily & routinely sacrificed at the “front line” (anterior corneal surface)
- Produced by basal cells. (“training ground”)
- Basal cells recruited from limbal stem cells (“raw recruits”)
- Attached to corneal stroma by the basement membrane
- **Reliant on :**
  - **healthy tear film.**
  - **basement membrane**



## Epithelial basement membrane

- “The battlements the epithelial cells stand on”
- **Secreted by healthy basal cells**
- Anchor epithelial cells to stroma
- The “glue” or “paste” which attaches the epithelium to the stroma
- Absent or abnormal in indolent ulceration







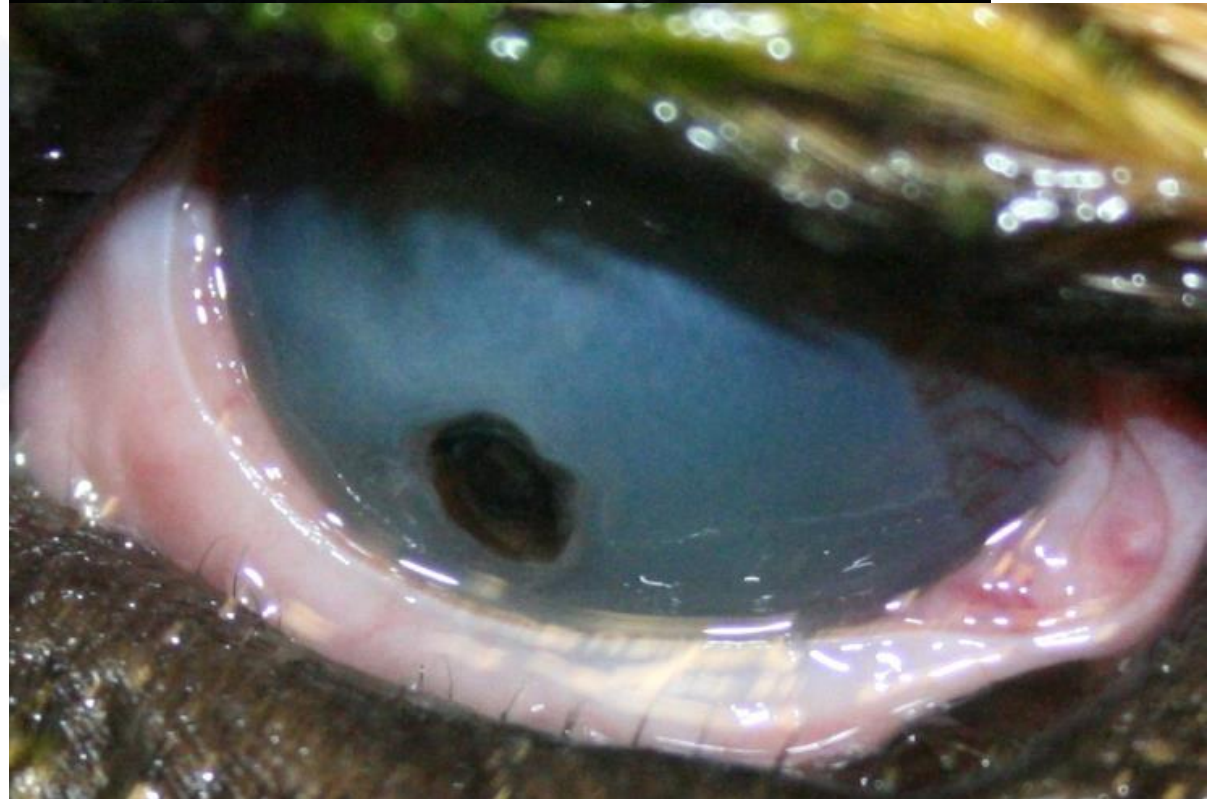
## Stroma

- “The castle walls”
- Once breached ocular catastrophe imminent
- Think of like a fracture
- Little defence from infection
- Tectonically strong but limited healing capacity
- First intention healing **very** slow
- 2<sup>nd</sup> intention healing faster
  - Requires vascularisation
  - Reduces function (scarring)
- Lamellar structure



## Descemet's membrane

- “The final defence”
- Once breached ocular catastrophe
- Endothelial basement membrane
- Transparent
- Does **not** stain with fluroscein



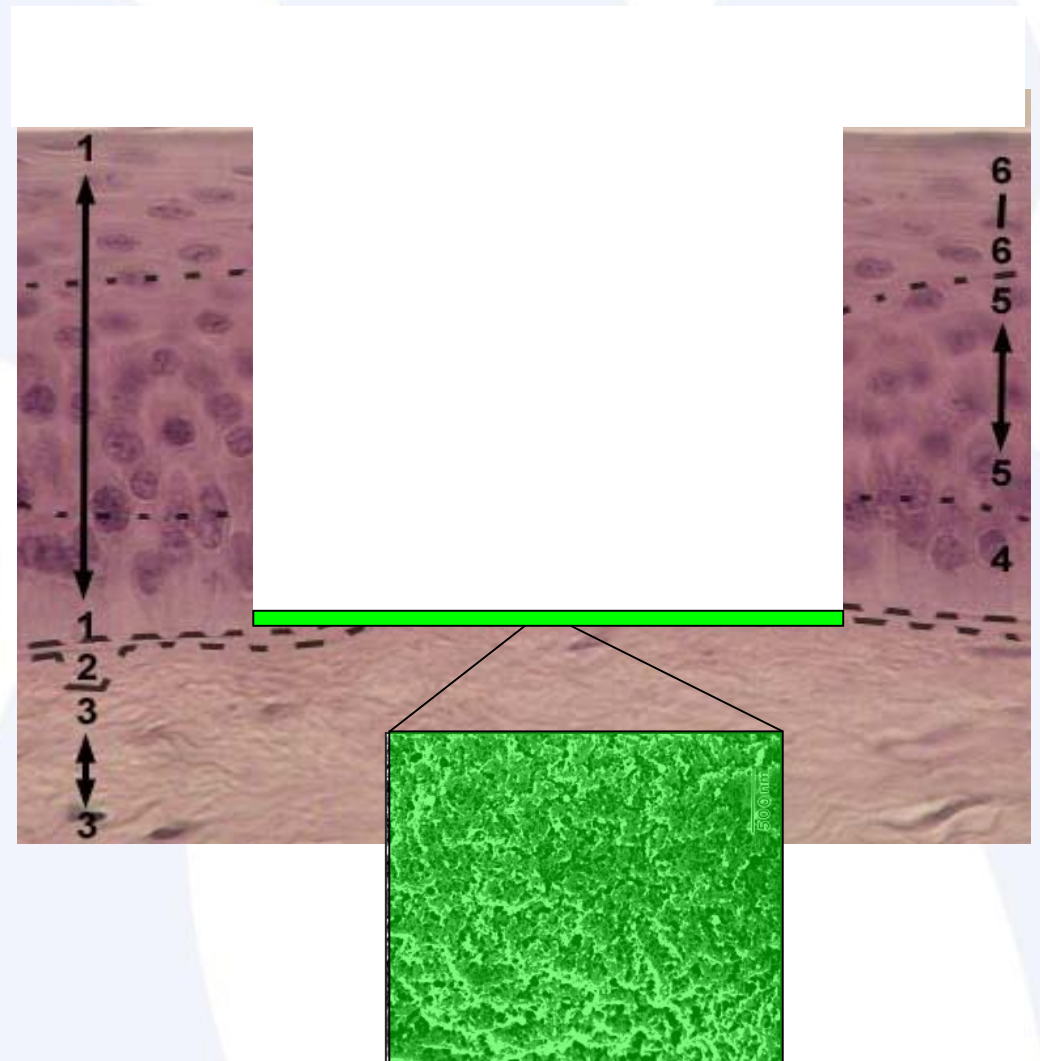




# Epithelial Repair

- 1) **Migration**– rapid (1 to 3 mm/day)
- 2) **Attachment** – slow (days to weeks)
- 3) **Division** – slow (30days)

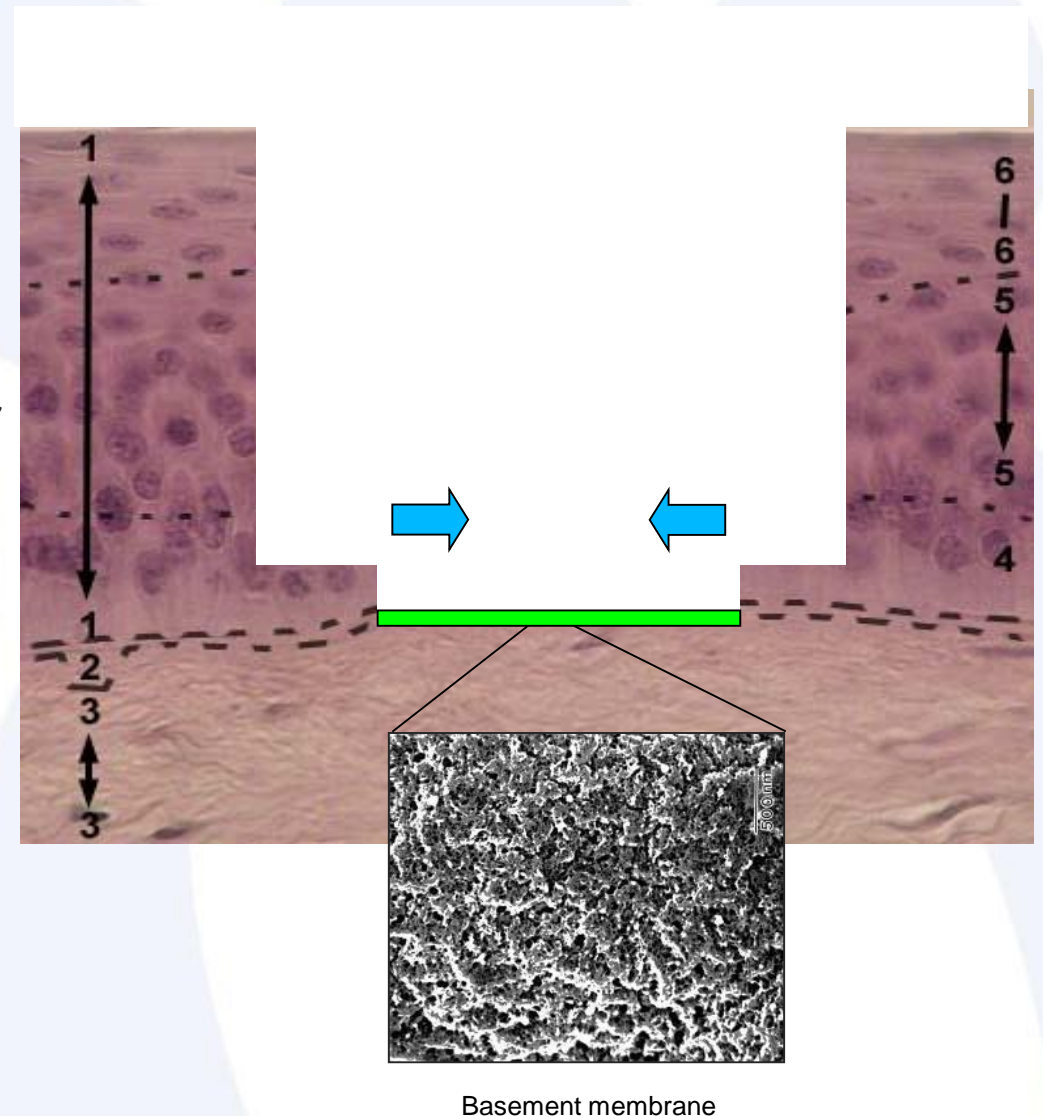
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- Scarring not a feature of epithelial wounds
- Remove cause then rapid healing the norm
- Environment key
  - Nutrition
  - Oxygen
- Lubricate for 30days post fluorescein negative



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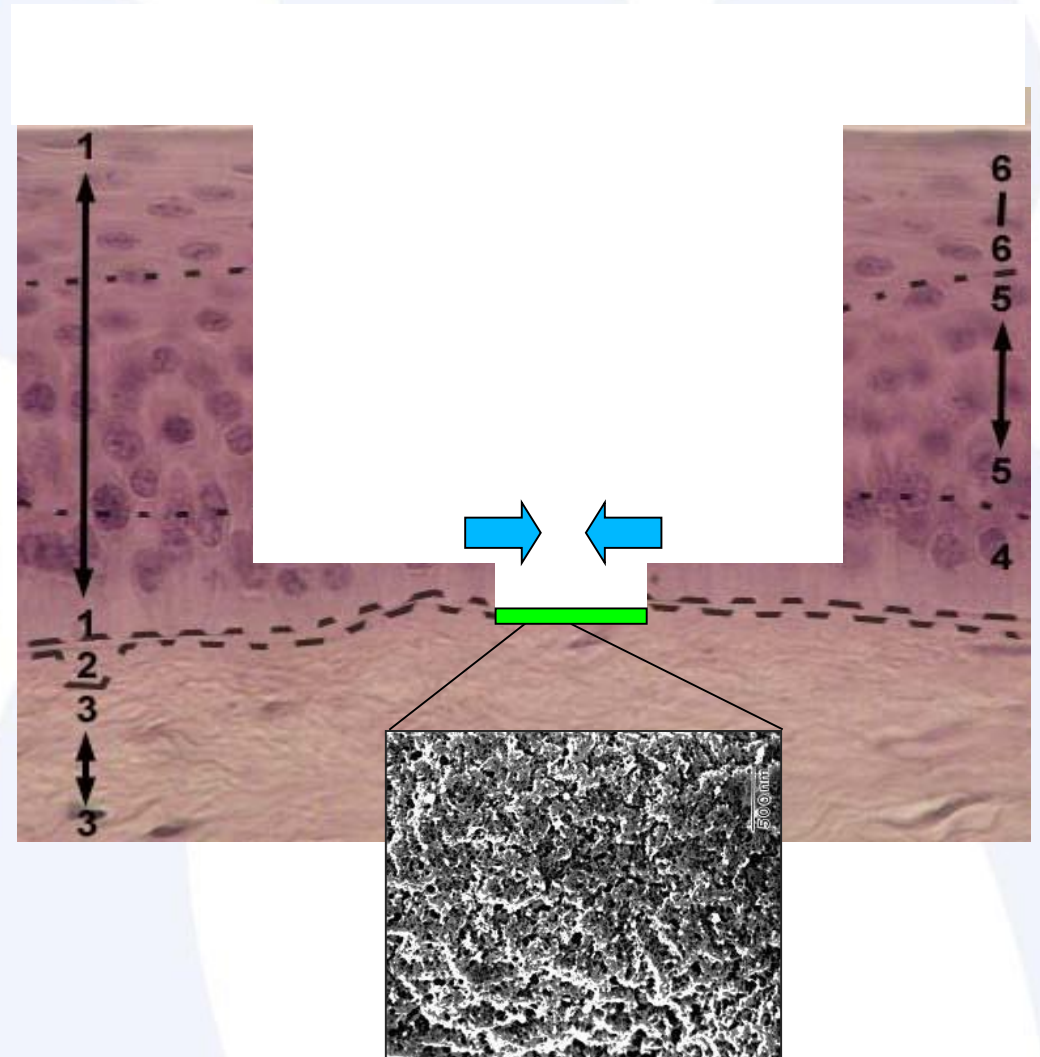
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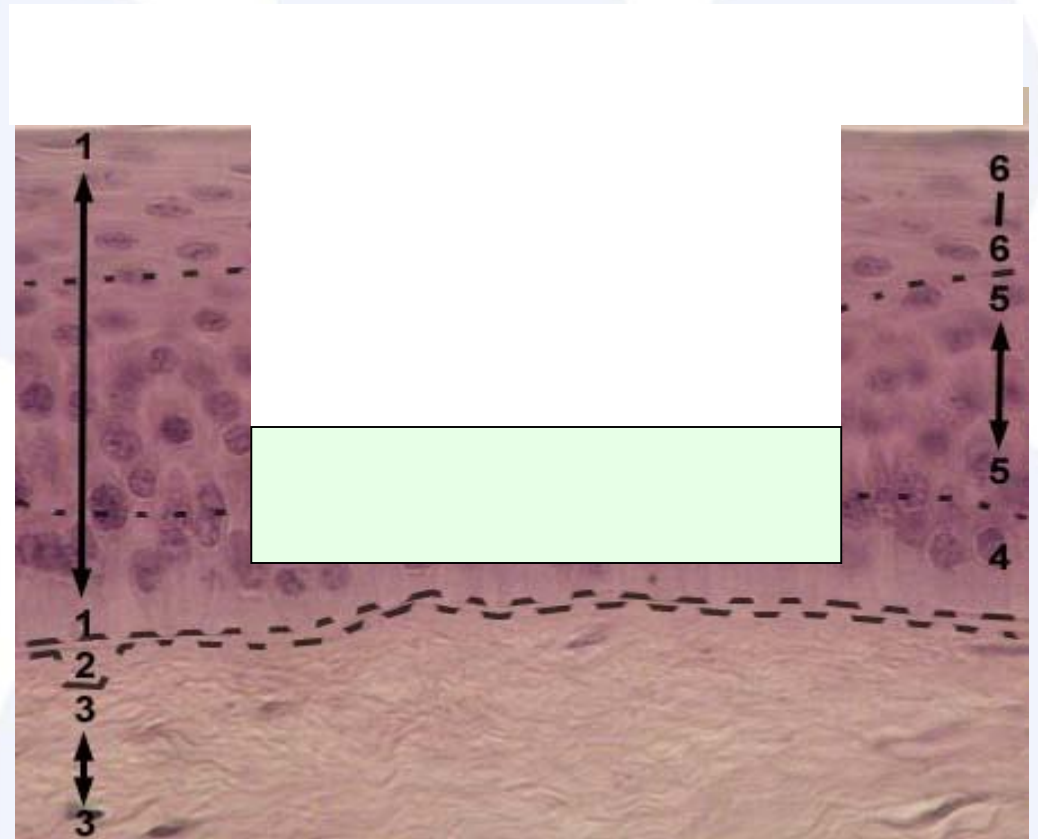


Basement membrane

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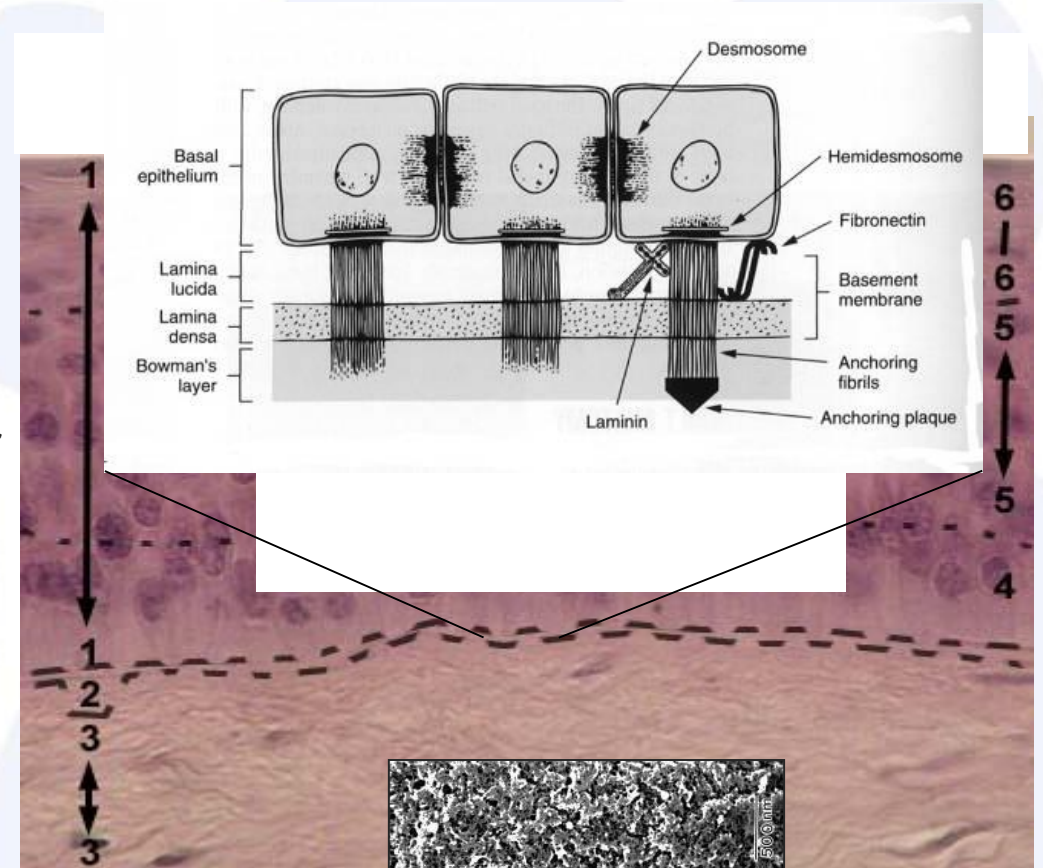
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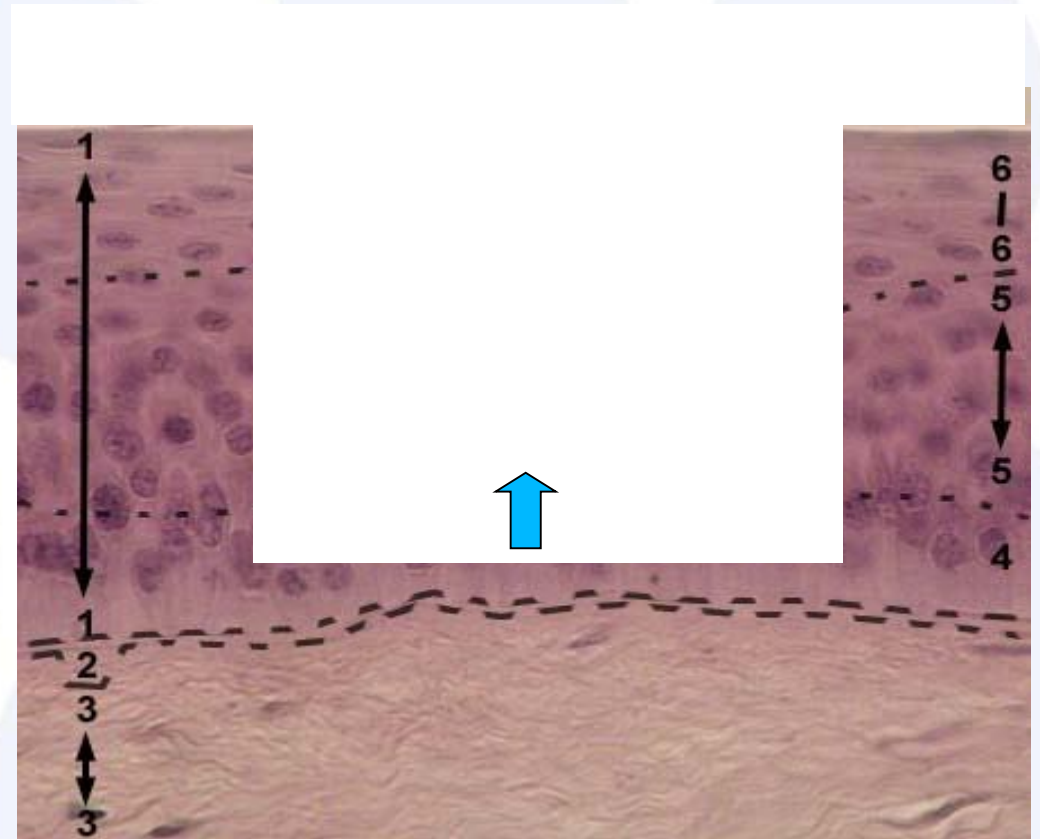
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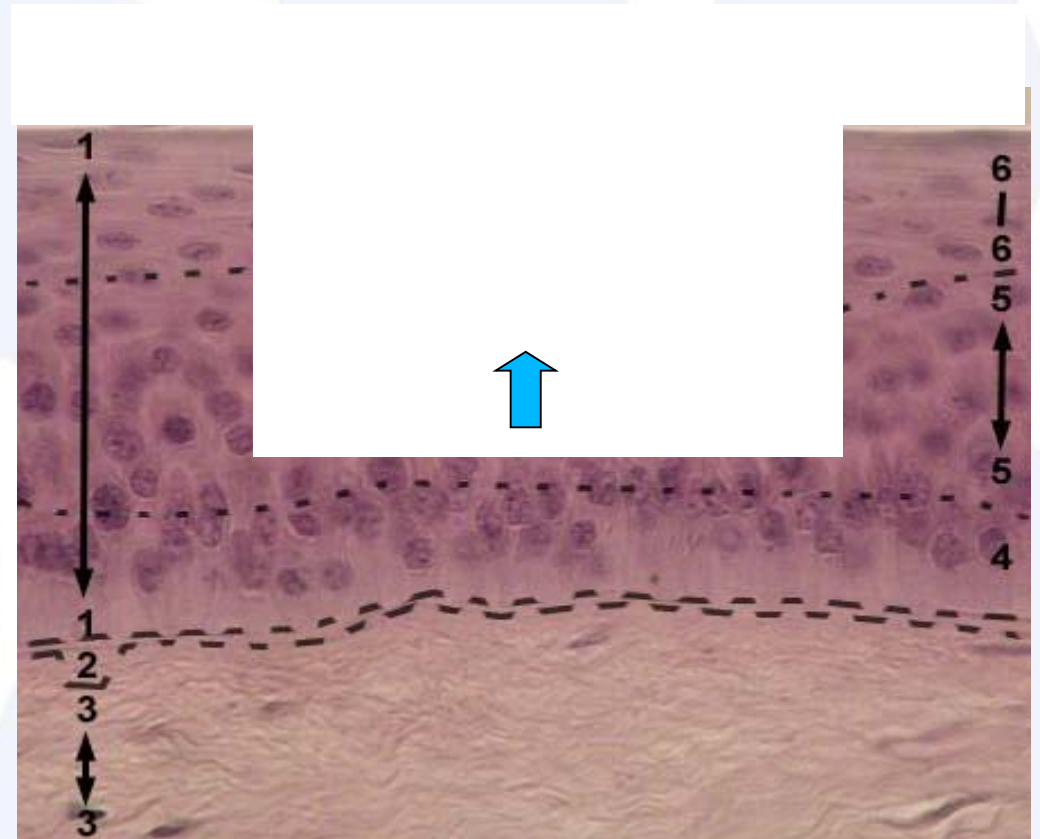
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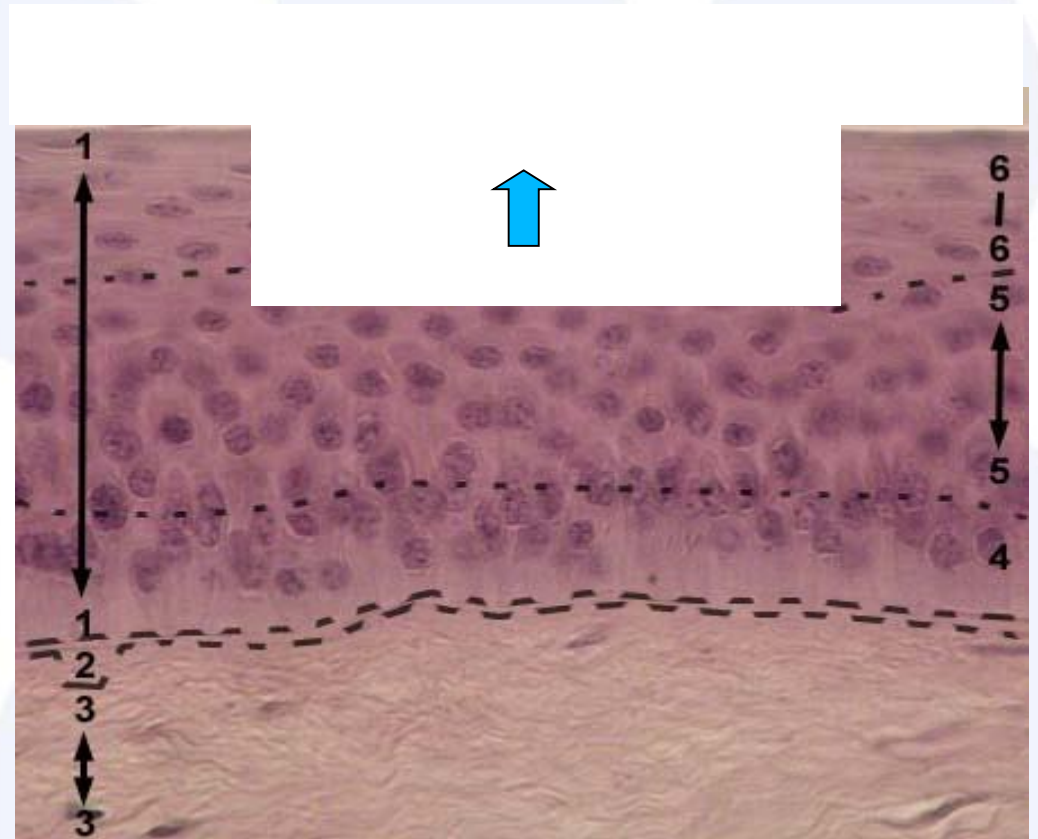
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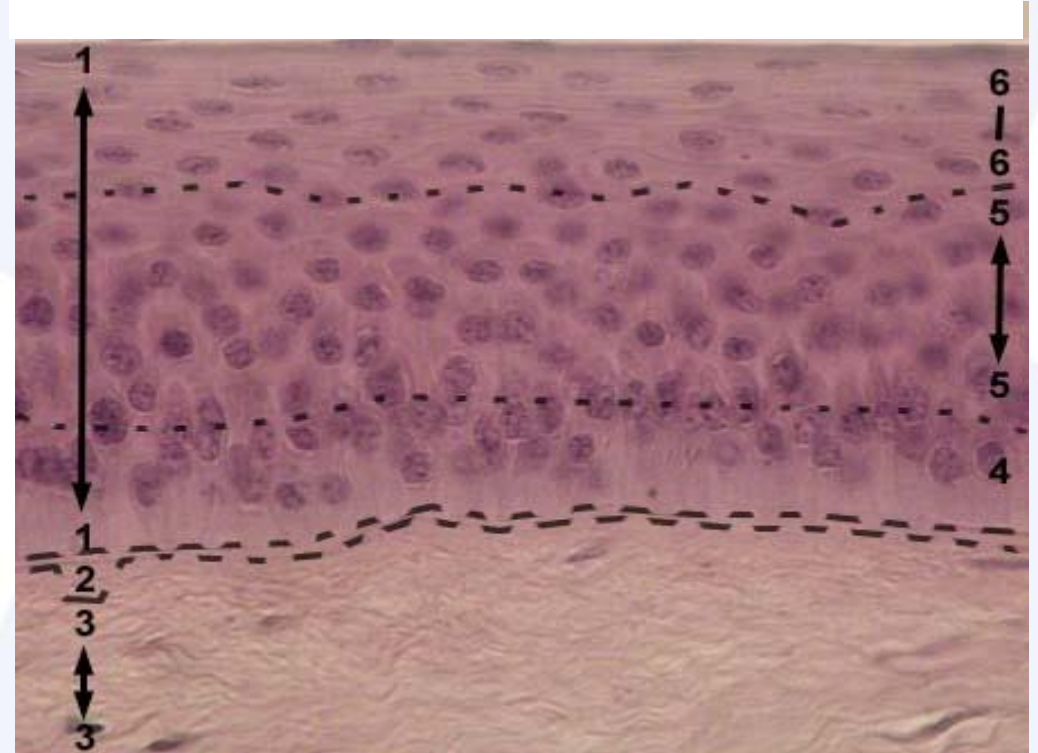




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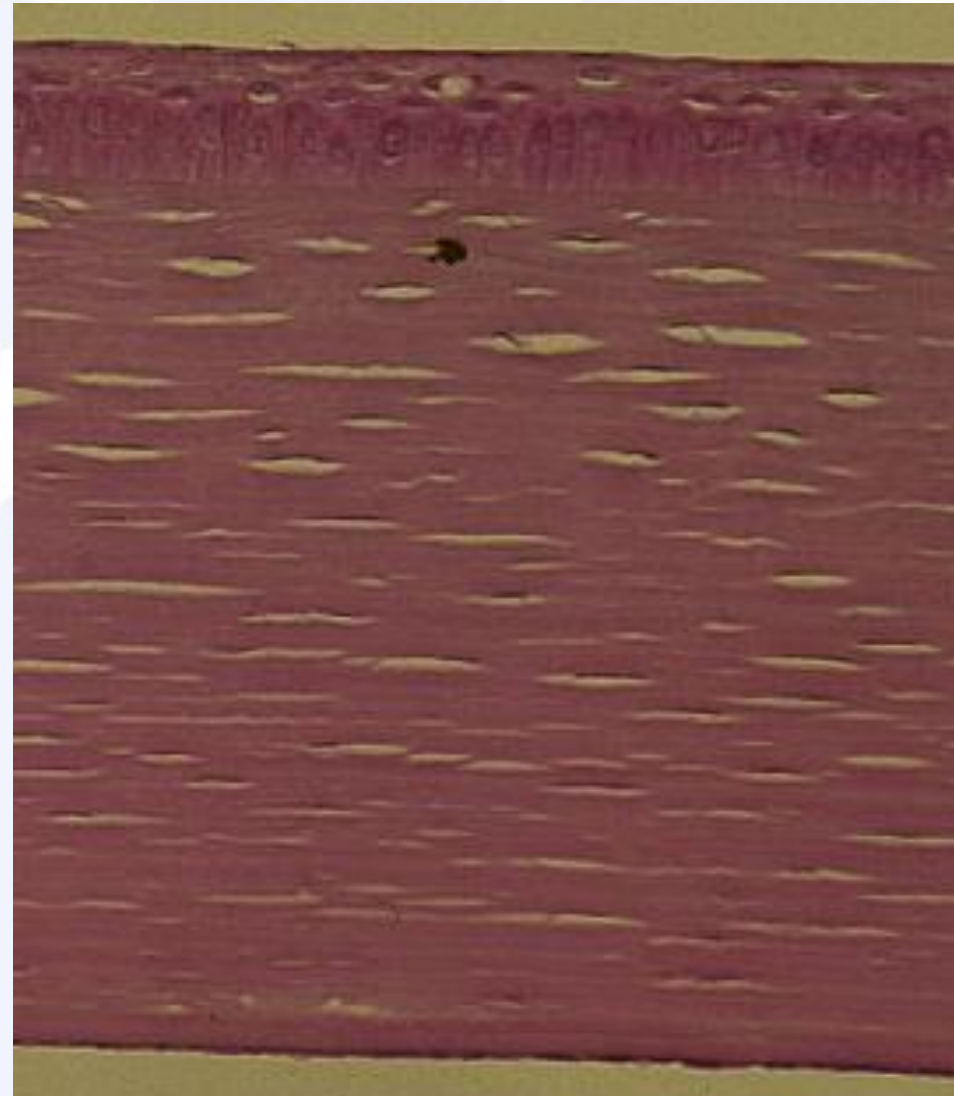
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# Stromal repair

- 4 stages
  - **Cell death** ! A depressing start.. Immediate
    - ✦ Stromal cytokines stimulate Neutrophils & MMP recruitment from tear film
    - ✦ Debride wound
    - ✦ *Further recruitment of MMP/PMNs until epithelium covers*
  - **Proliferation and migration**.. 5-7days
  - **Transformation** .. 30days
  - **Remodelling and scar formation**.. 12months
- Speed increases with vascularisation as does scarring



# Stromal repair

- 4 stages

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Immediate

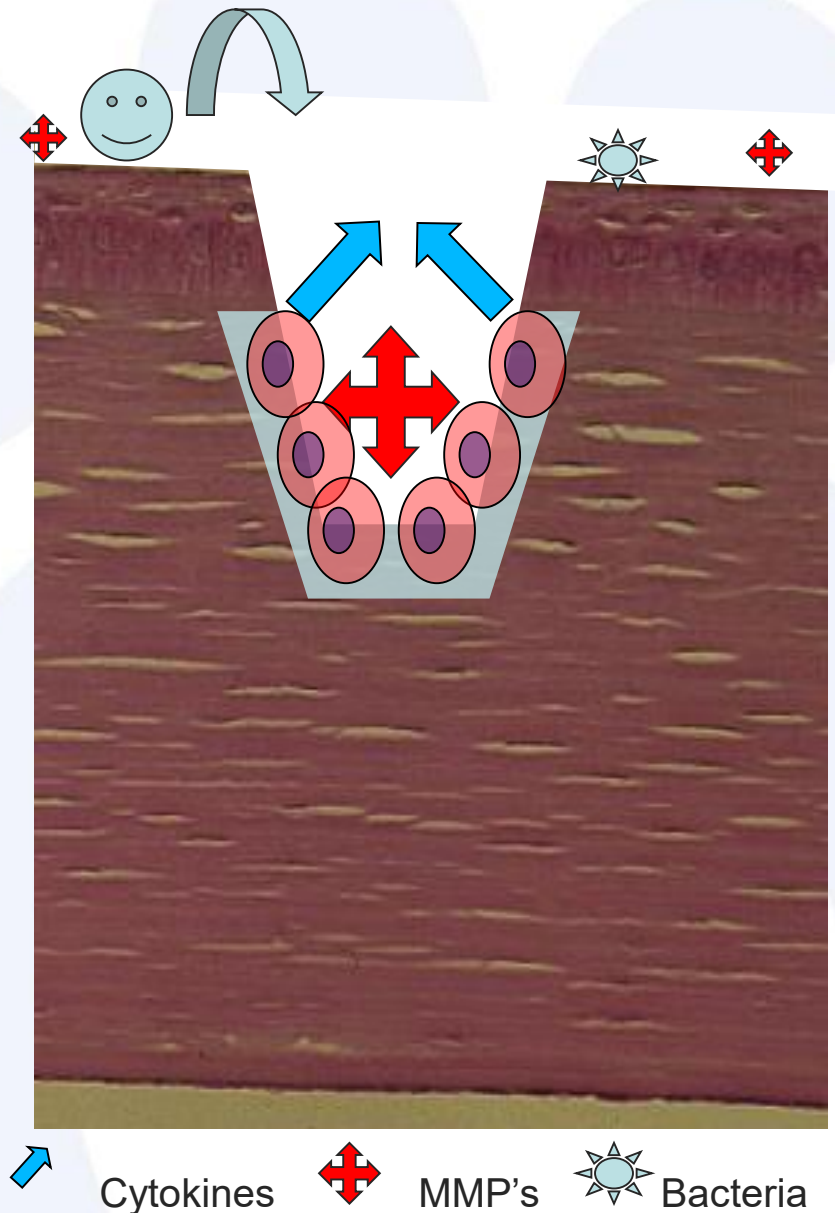
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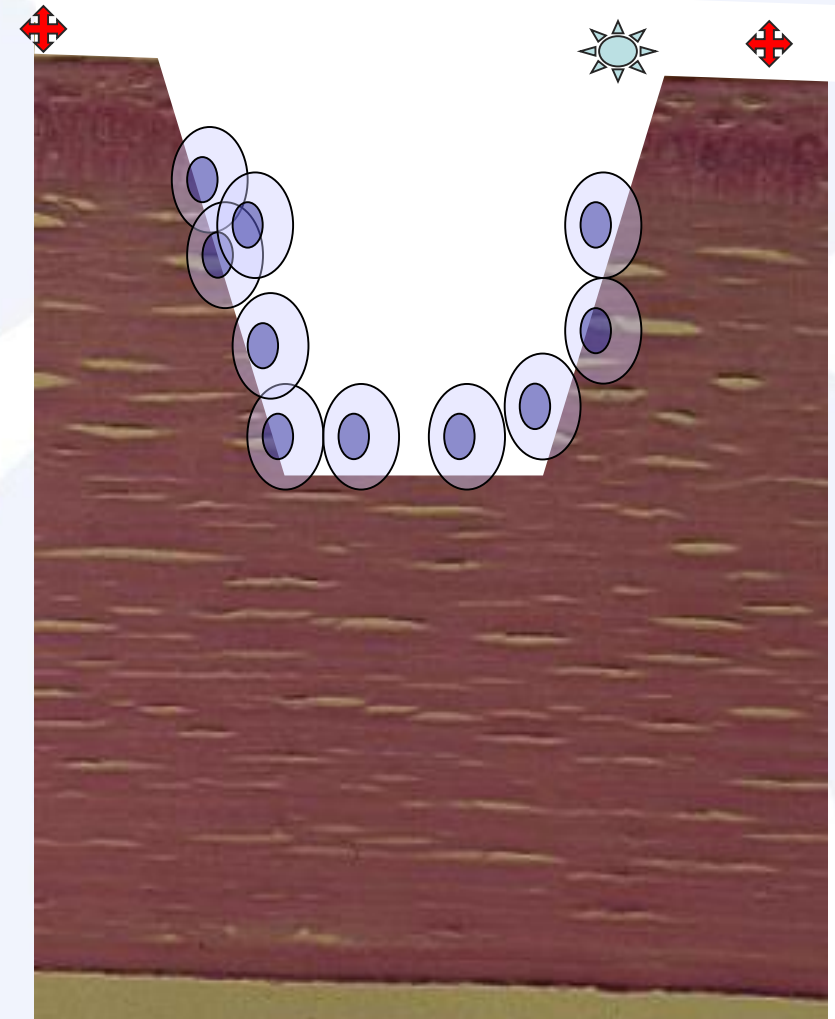
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Cytokines



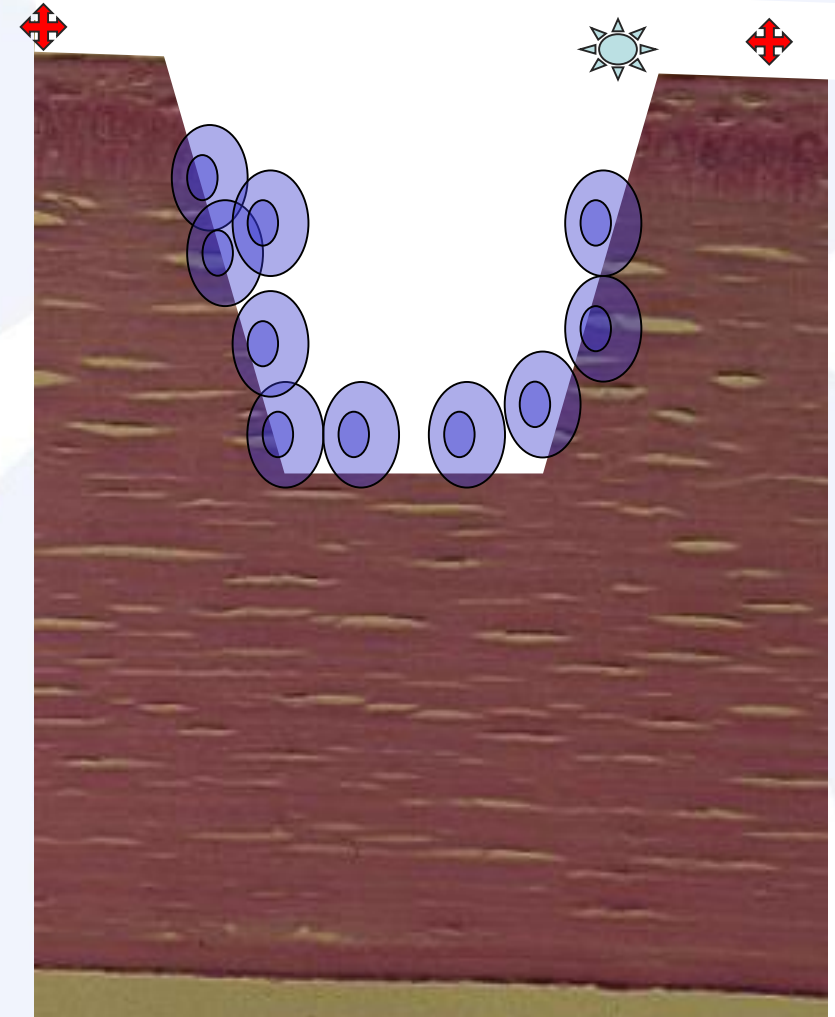
MMP's



Bacteria

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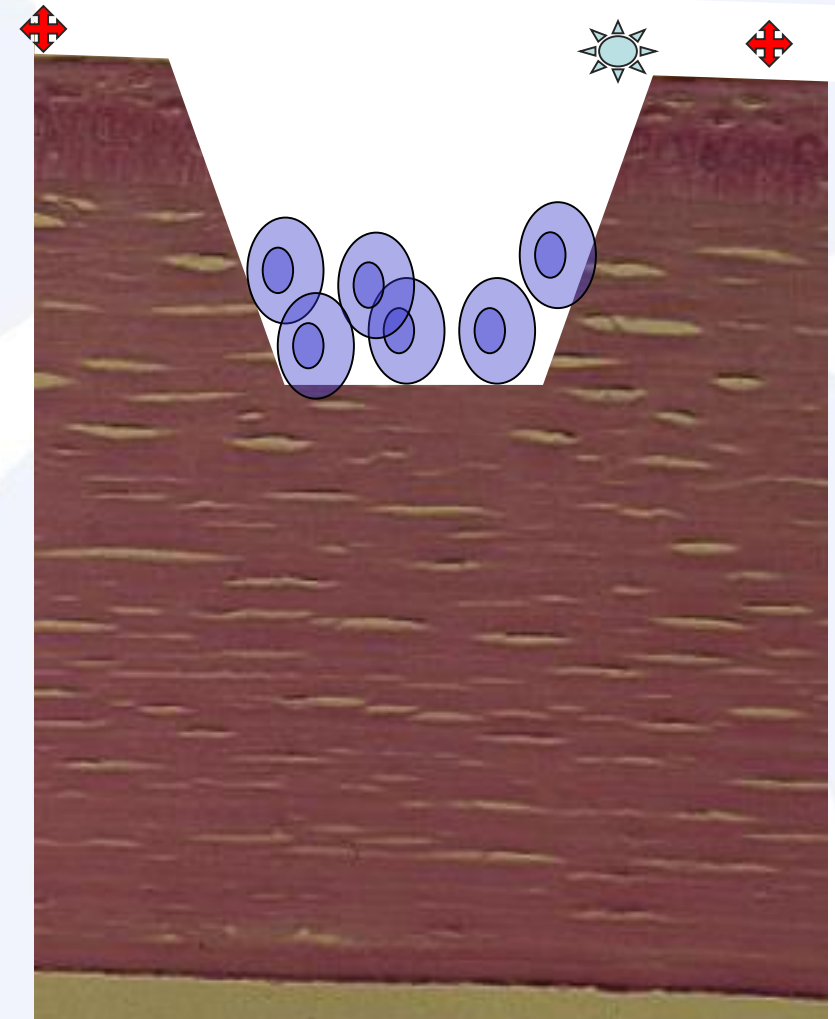
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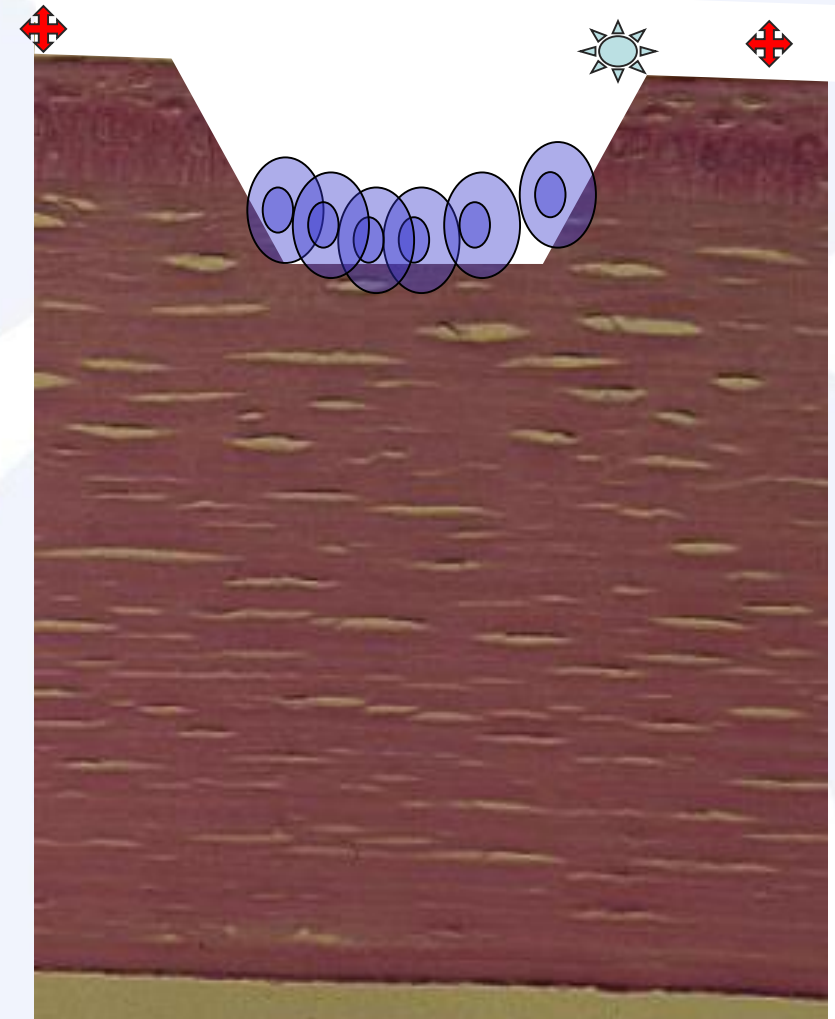
MMP's



Bacteria

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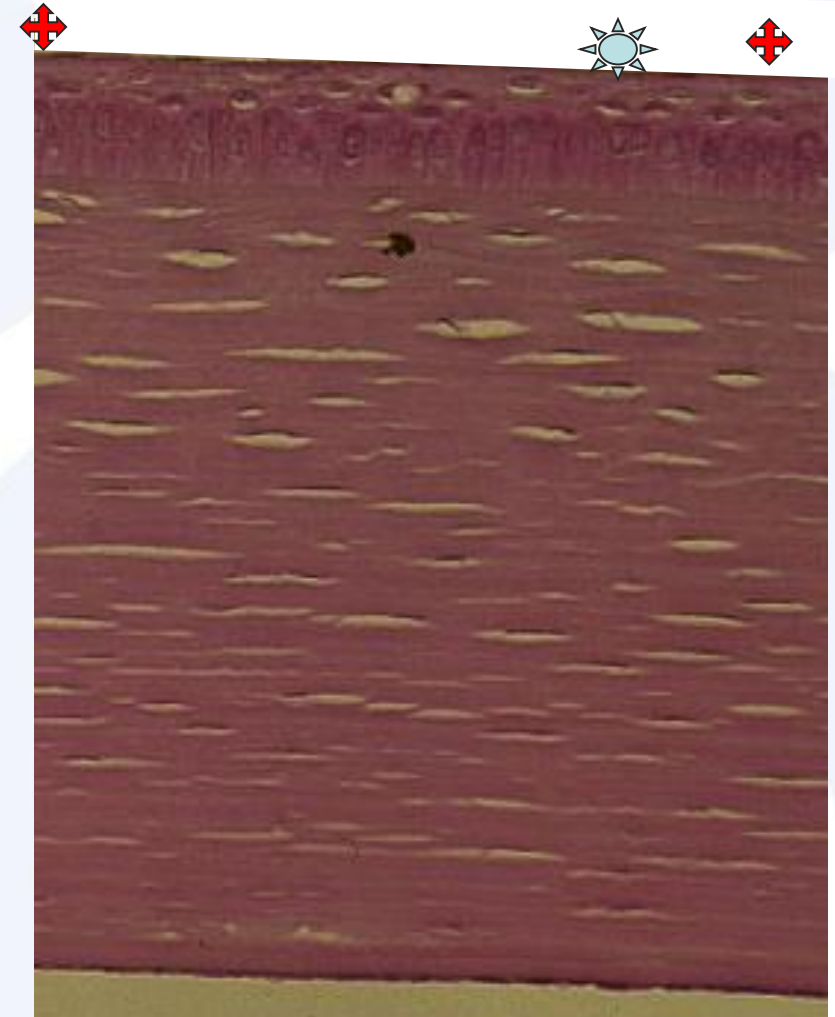
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➔ Cytokines    ✦ MMP's    ☀ Bacteria

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Cytokines



MMP's



Bacteria





# EXAMINATION

# How do we examine the cornea?

## Full ophth exam

- STT, always check symmetry – out to in

## Tear film

- Reflectance - Corneal reflex
- Meibomian lipid – look at mg's, evert lids, break up time
- Quantify aqueous comp – STT
- Mucus component – discharge, break up time
- Assess ability to blink

## Transparency?

- distant direct

## Shape?

- oblique examination

## Magnification

- otoscope, magnifying glass, direct ophthalmoscope +20D, digital photography (use flash)

## Cell type? cytology

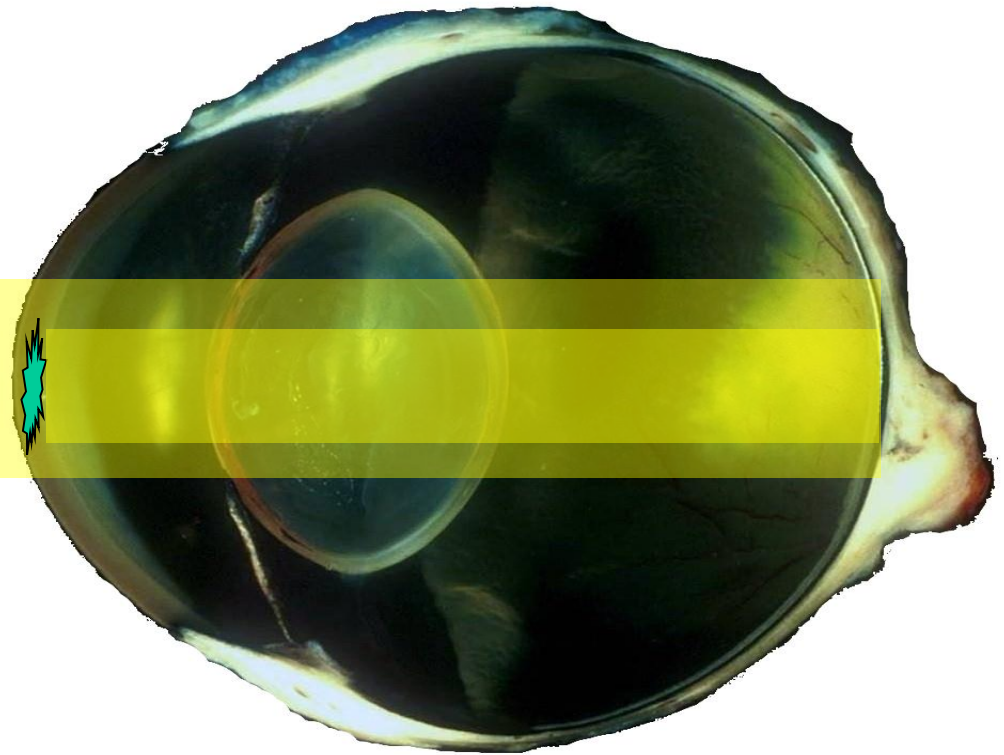
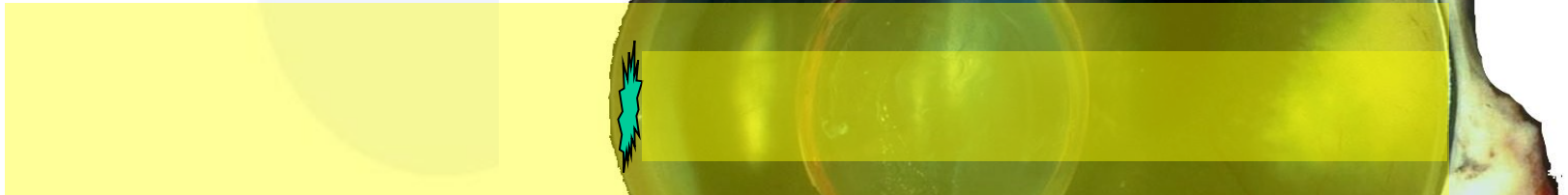
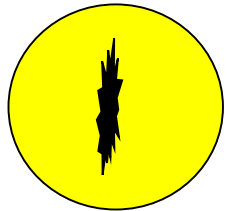
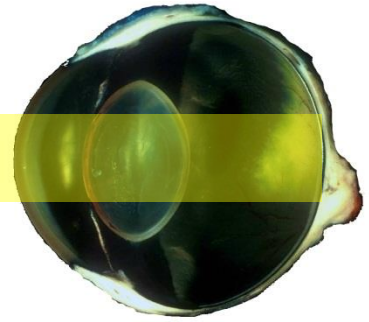
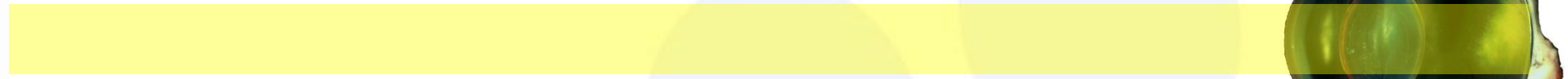
## Stains. Fluroscein (Rose Bengal)

# Is it reflective?: Corneal reflex

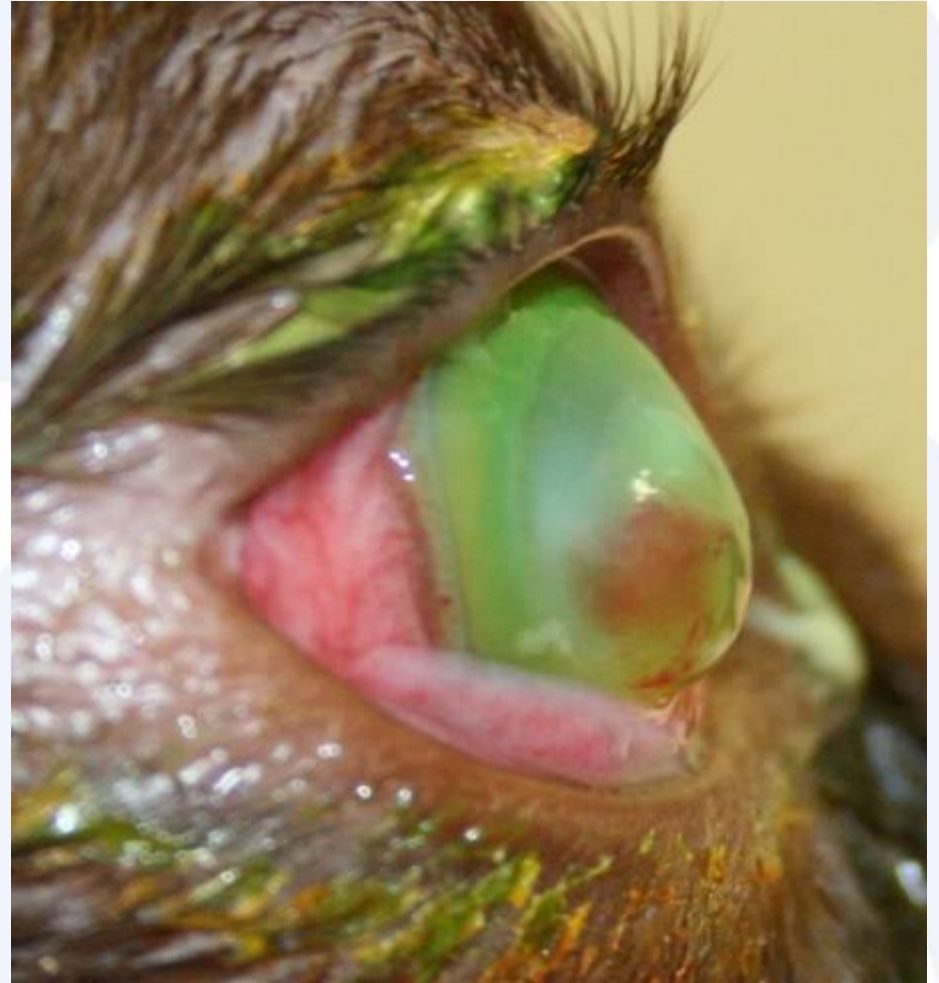
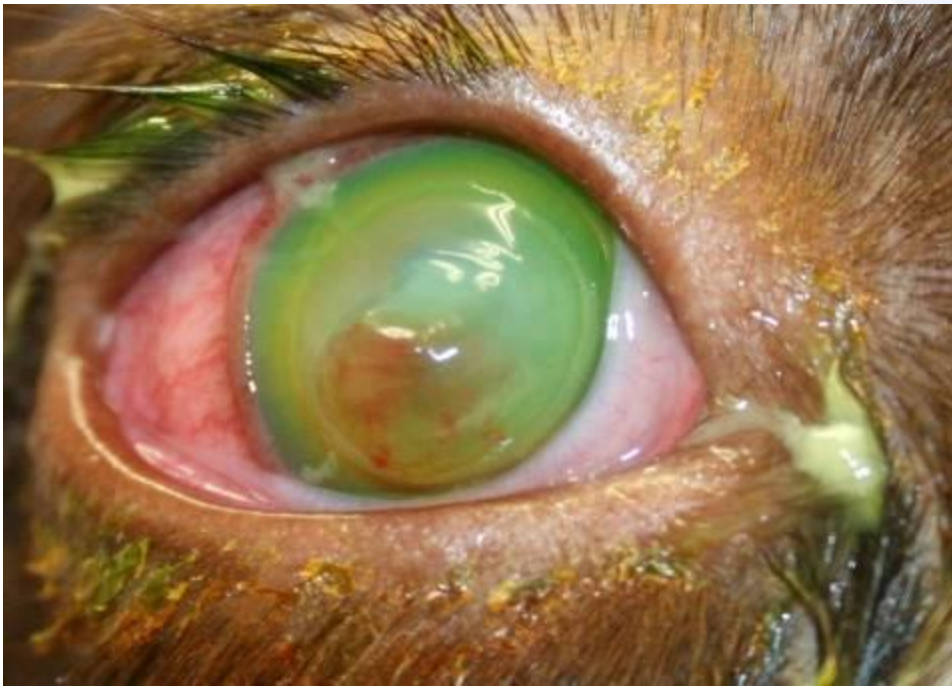
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- Epithelium
- Basement membrane



# Is it transparent?: distant direct

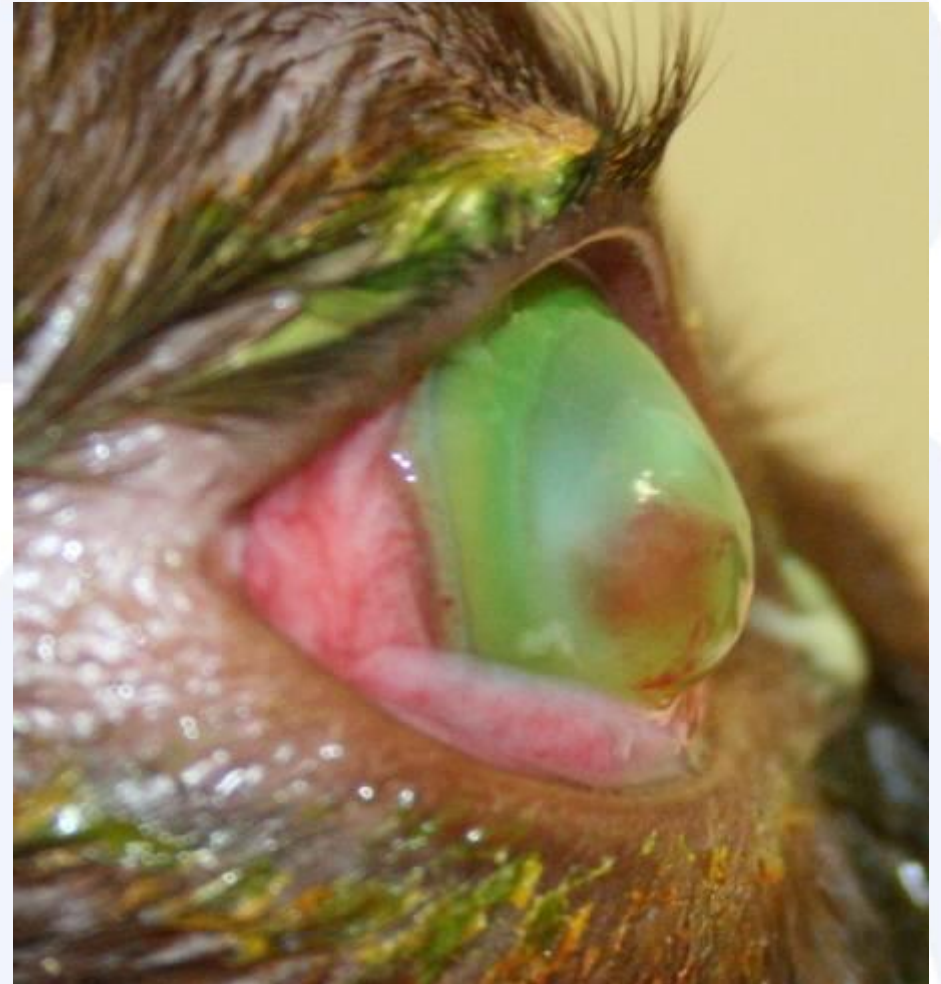
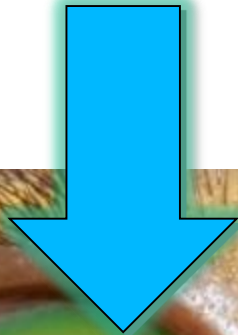


# Examine from an angle



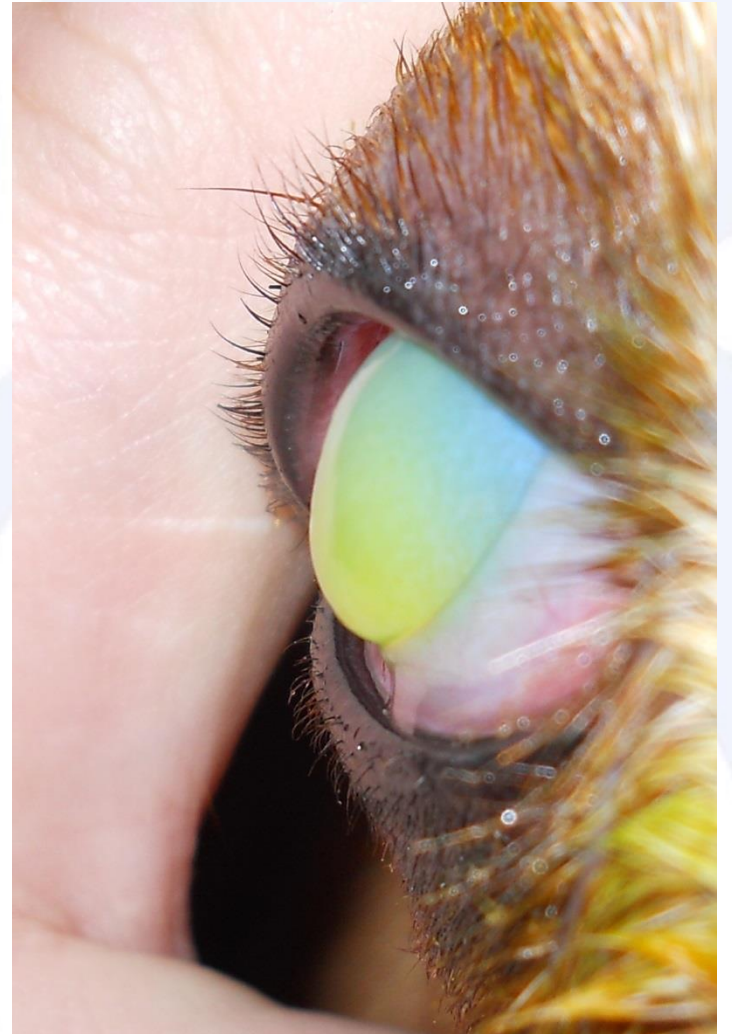
# Examine from an angle

*NB Corneal reflex*



# Examine from an angle

*NB Corneal reflex*



# Biomicroscopy (the slit lamp) in Corneal examination

## Broad slit

3d optical cross section

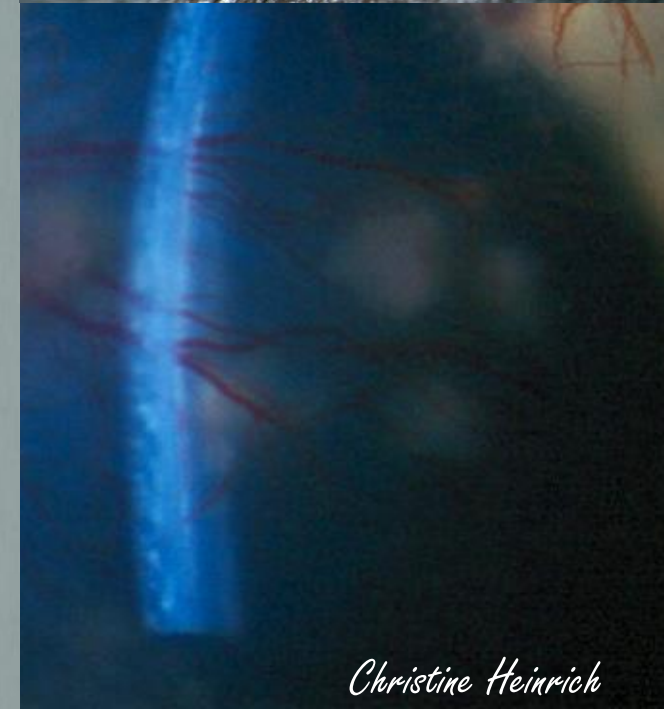
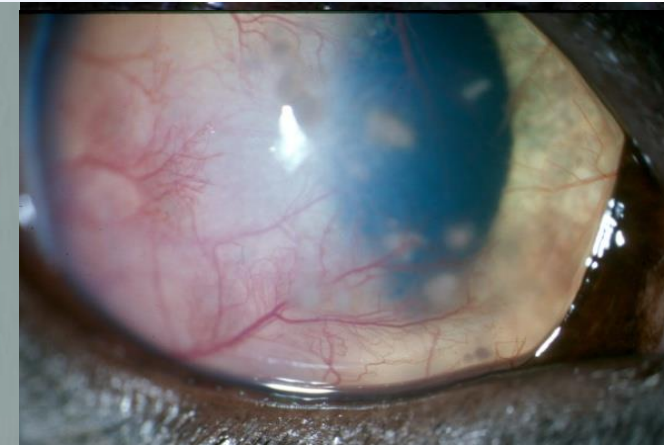
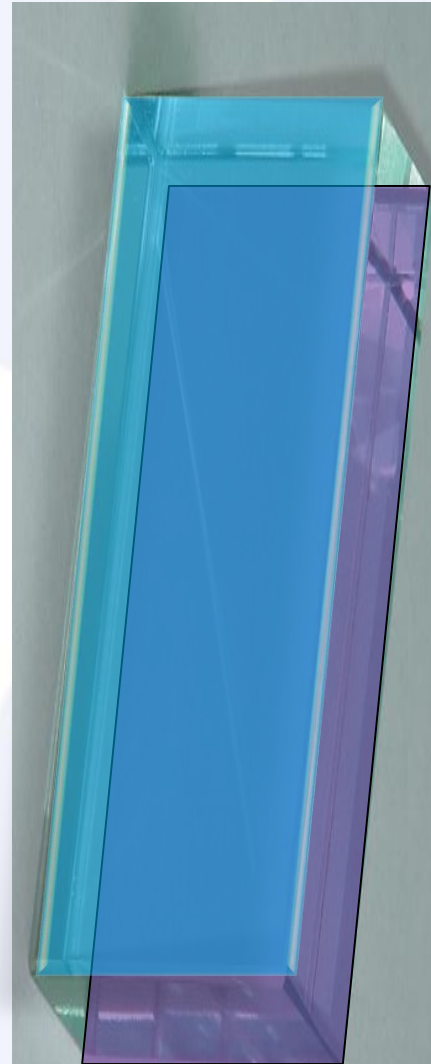
Parallelepiped

epithelium

Stroma

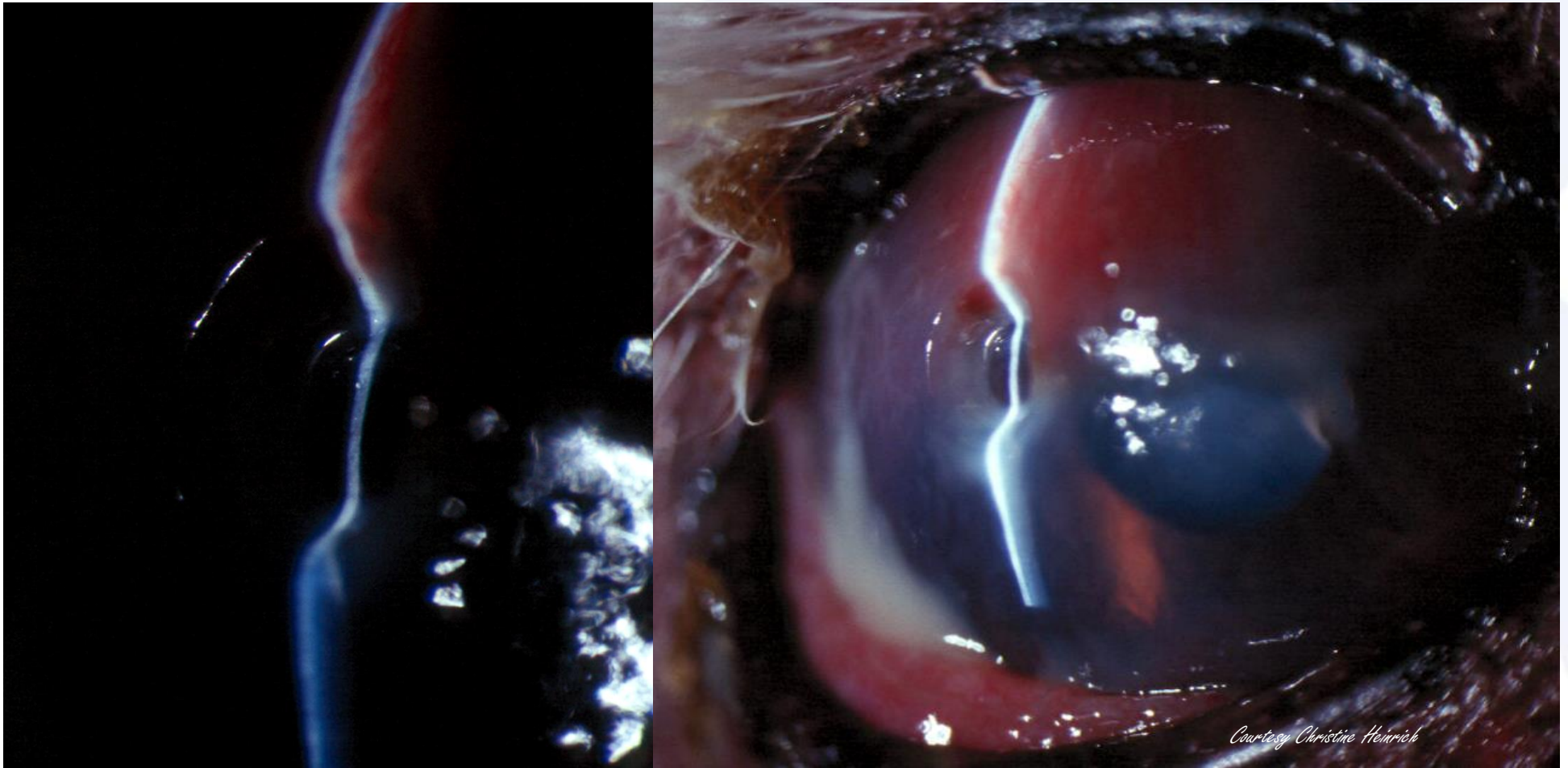
endothelium

45 degree angle – increase to separate components





# Corneal examination: depth & thickness



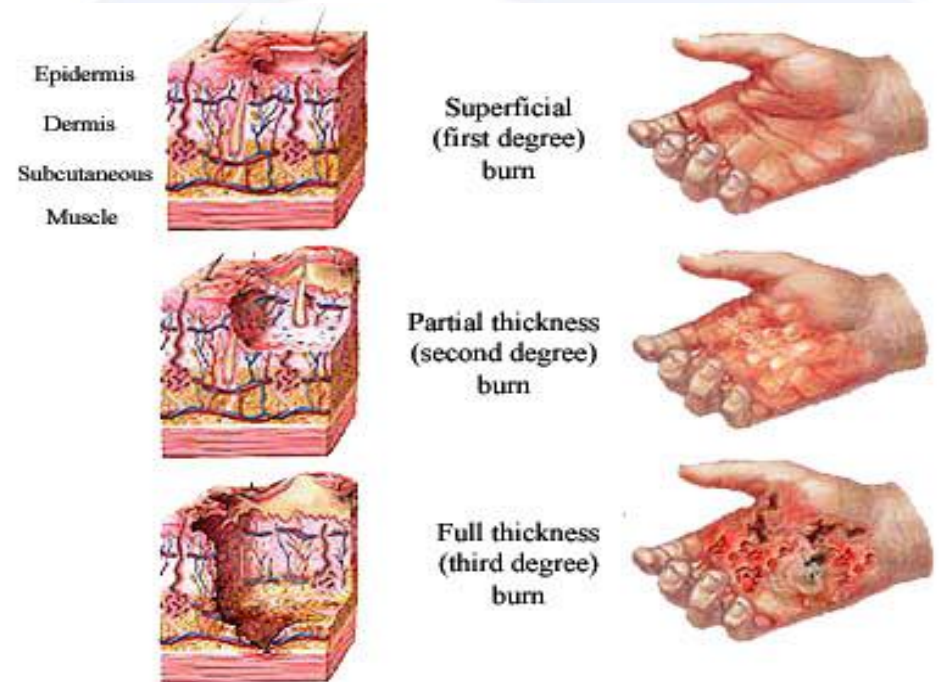
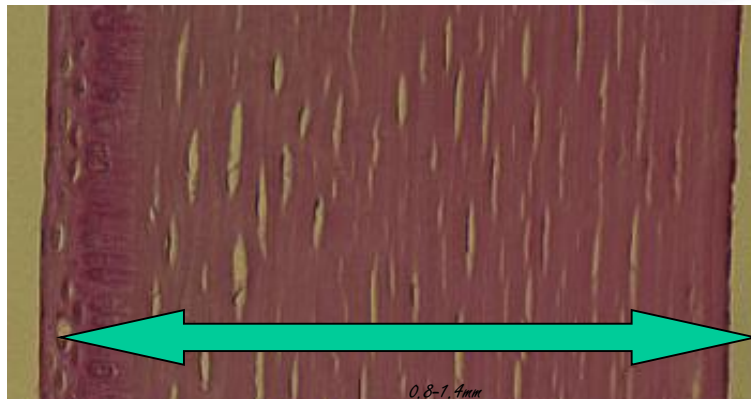


# DIAGNOSIS & TREATMENT OF CORNEAL ULCERATION

# What is an ulcer?

Loss of corneal tissue

- Superficial
- Deep
- Full thickness



# What causes ulcers?

## Trauma

### “External”:

- Foreign body
- Cat scratch/thorn
- Blunt
- Chemical – detergents, ear cleaner!

### “Internal”:

- Trichiasis
- Entropion
- Ectopic cilia

## Epithelial disease

### Nutrition

- Tear quality
- Tear quantity
- **Tear spreading - brachycephalics**
- **Exposure - brachycephalics**

### Infectious

- FHV

### (Immune mediated)

- eosinophilic dz,

### Failure natural repair mechanisms

- Indolent ulceration

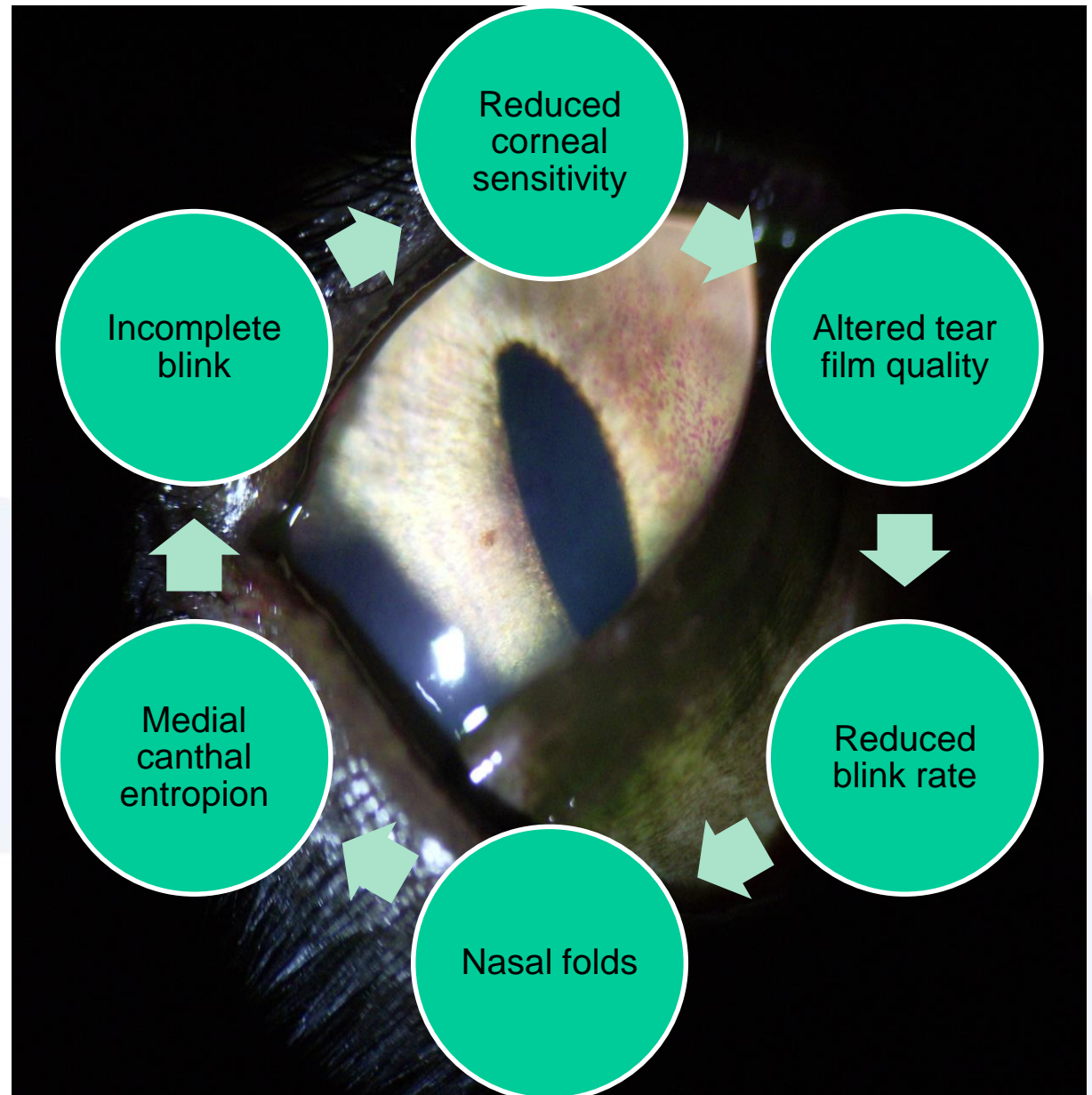
### Iatrogenic

- Steroids, preservatives

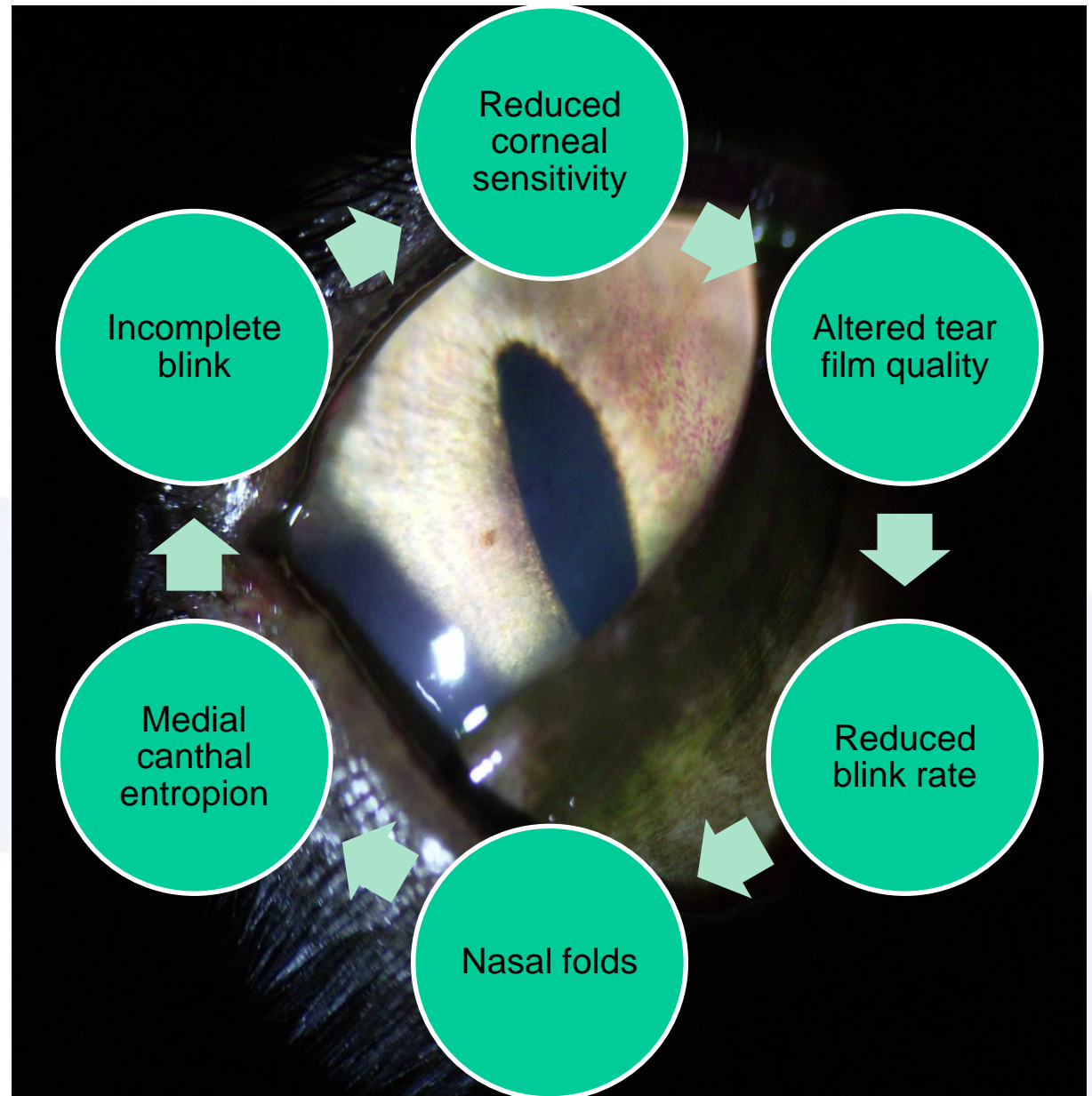
# Brachycephalic ocular syndrome



Note: Sticky brown ocular discharge and corneal sequestrum above  
Rose bengal uptake right.



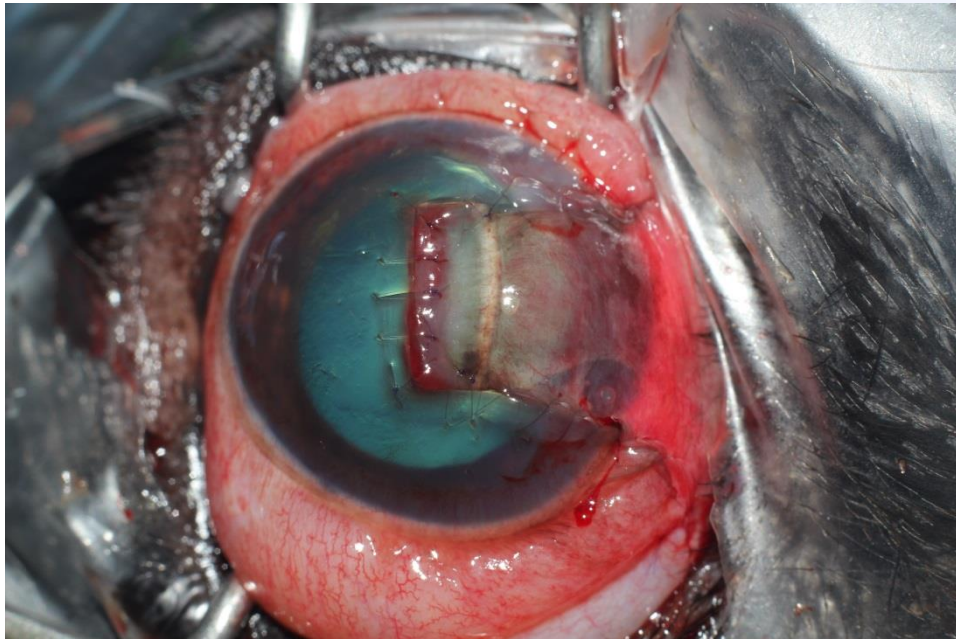
# Brachycephalic ocular syndrome





# A typical day in the eye clinic

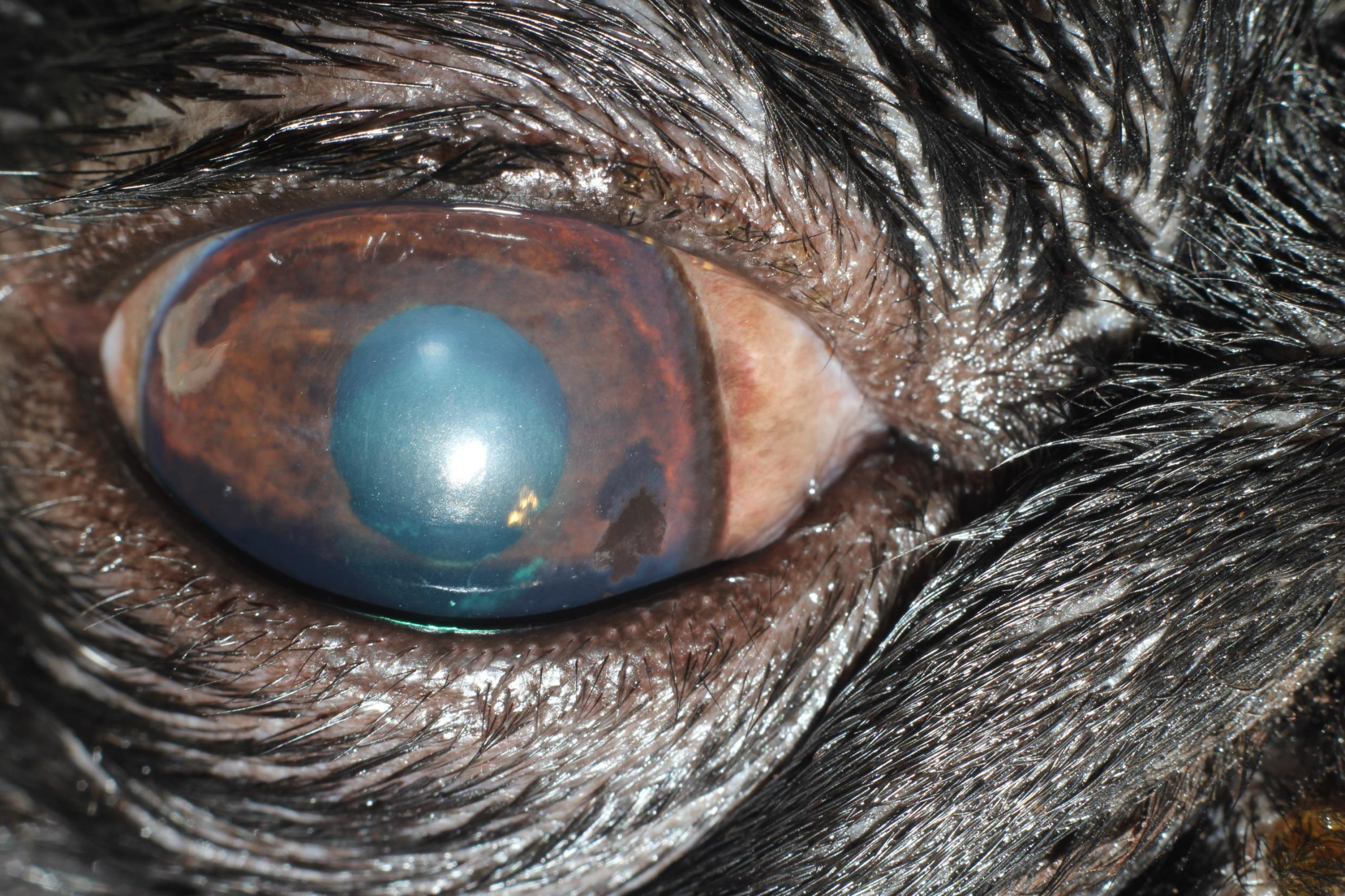
**CCT (sliding corneal graft)**



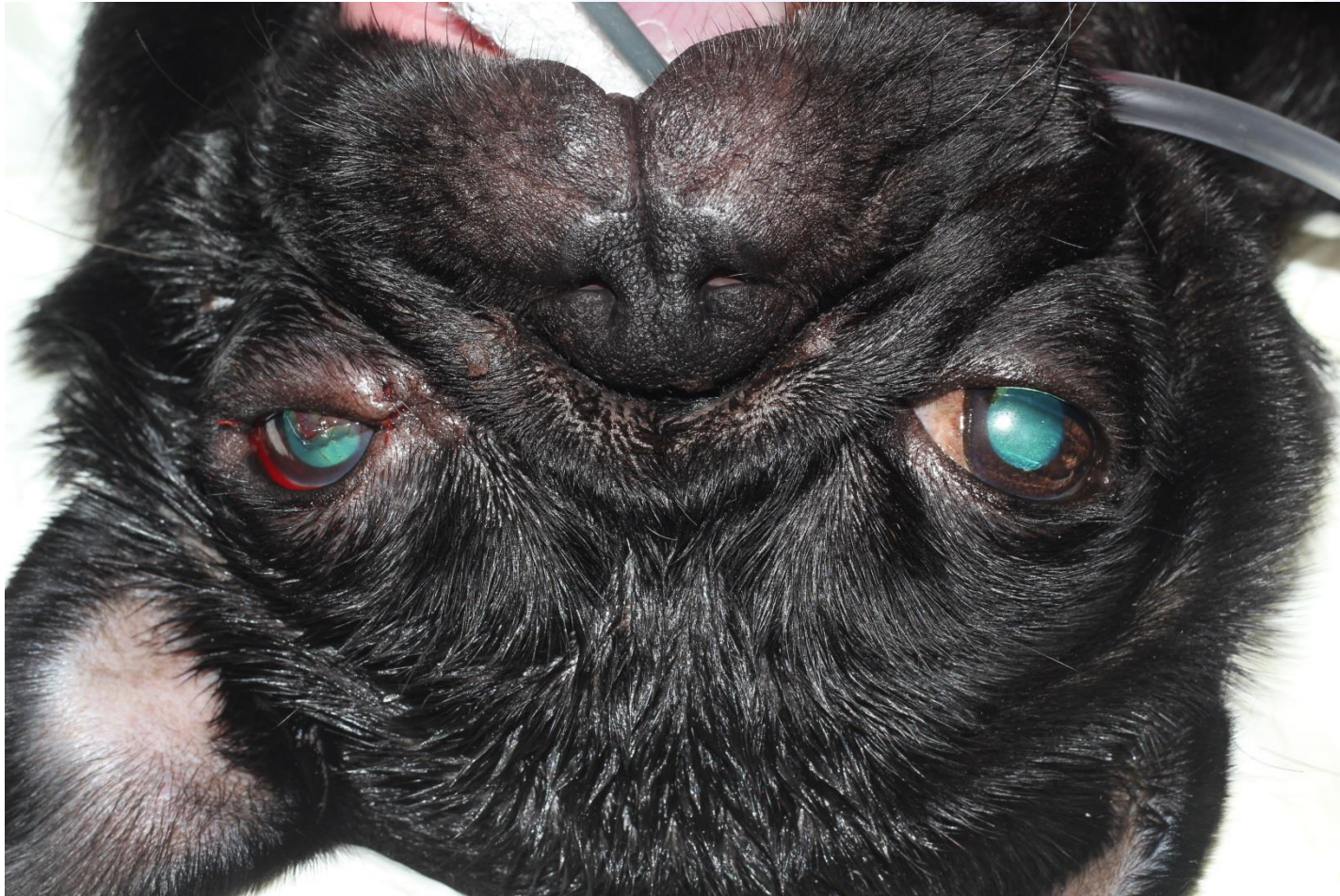
**“Pugoplasty”**



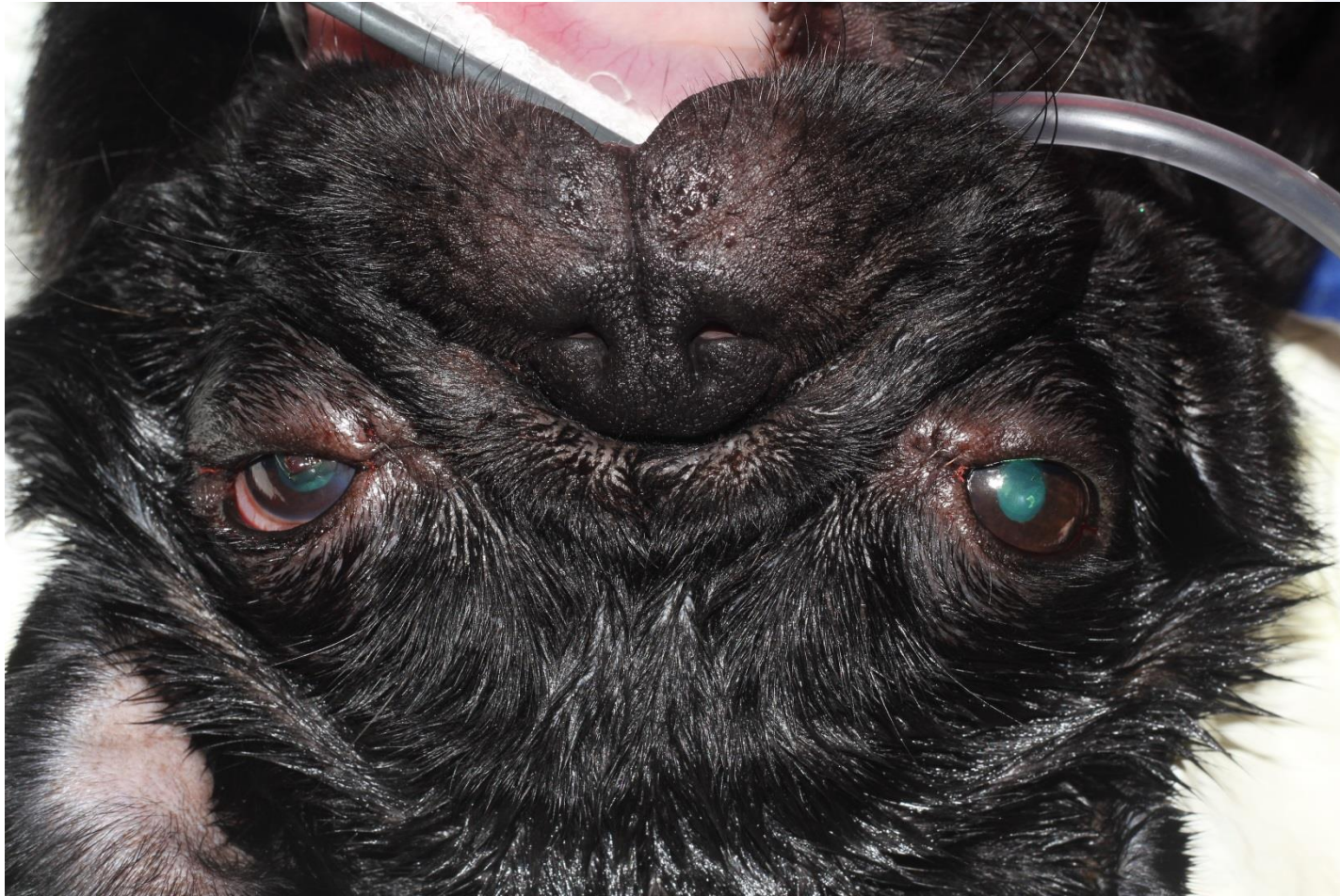




# A typical day in the eye clinic



# A typical day in the eye clinic



**IF YOU CAN'T  
BEAT THEM,  
JOIN THEM.**

*PictureQuotes.com*



# Clinical signs of ulceration?

## Pain

- triad ocular pain
- pain not related to severity

## “Conjunctivitis”

Change in transparency

Change in corneal reflection

Stain with fluroscein - **usually**



# We think it's an ulcer so what next?

Cause?

Simple ulcer? Complicated?

How deep is it?

Infection present? Corneal melting?

Concurrent disease? E.g. KCS, entropion

# Corneal disease: simple? Complicated?

## Ulcerative keratitis

- Superficial uncomplicated ulcer
- Dendritic ulcers
- Indolent ulcers
- Deep ulcers
- Descematoceles
- Corneal rupture
- Brachycephalics
- **Corneal sequestrum**

## Non-ulcerative disease

- Keratitis
  - Stromal keratitis
  - Eosinophilic keratitis
- Oedema
  - Severe – Intraocular disease

# So an ulcer is never *just* fluorescein +ve

## Pattern

- Shape, position and size:
- Linear?
- Geographic?
- Dendritic?
- Multiple?
- Horizontal?
- Vertical?
- Lateral?
- Central?

## Depth

- Superficial
- Indolent
- Stromal
  - Laceration
  - Penetration
  - excavation
  - Melt
- Descematocele
- Perforation



# Shape? Location?



# Shape? Location?



# Cause?



# Cause?





**SUPERFICIAL UNCOMPLICATED  
CORNEAL ULCER**

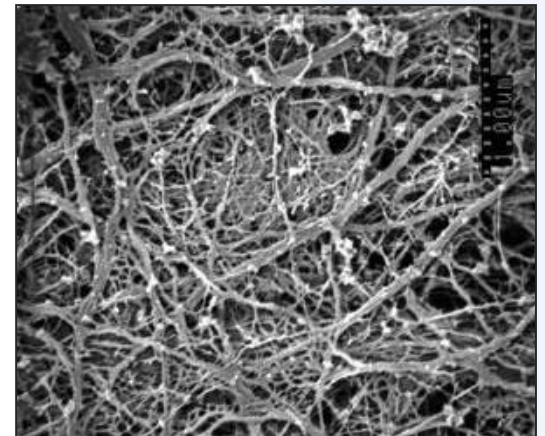
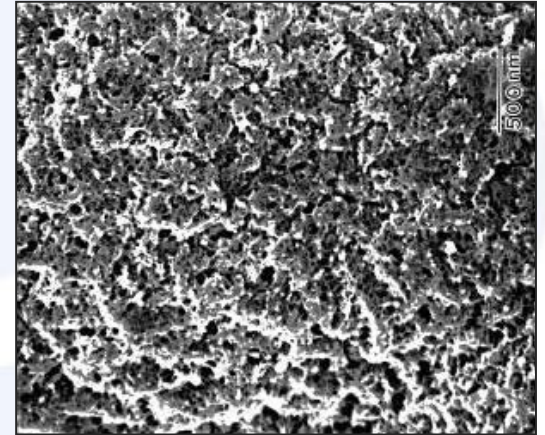
# Superficial uncomplicated corneal ulcer: Dx

- Visual eyes, often **very** painful.
- No cellular infiltrate
- Epithelium well attached
  - Sharp edge to stain pattern
- Mild or no corneal oedema
- No secondary uveitis
  - ddx reflex miosis
- Rapid healing (<7-10days)



# Superficial ulcers: Treatment

- **Identify and eliminate cause**
- Improve environment of epithelial cells
- Analgesia – atropine, TSCl
- Consider lens in large painful ulcers
- Lubrication (hyaluronate>carbomer gel> oil)
  - Remember environment – avoid oil based ointment?
- If not healed by 7days – look for reason why
  
- *Appropriate prophylactic antibiosis*
  - *E.g. Chloramphenicol drops QD*
  - *If not healing – find out why*
  - *DON'T just change the topical antibiotic*



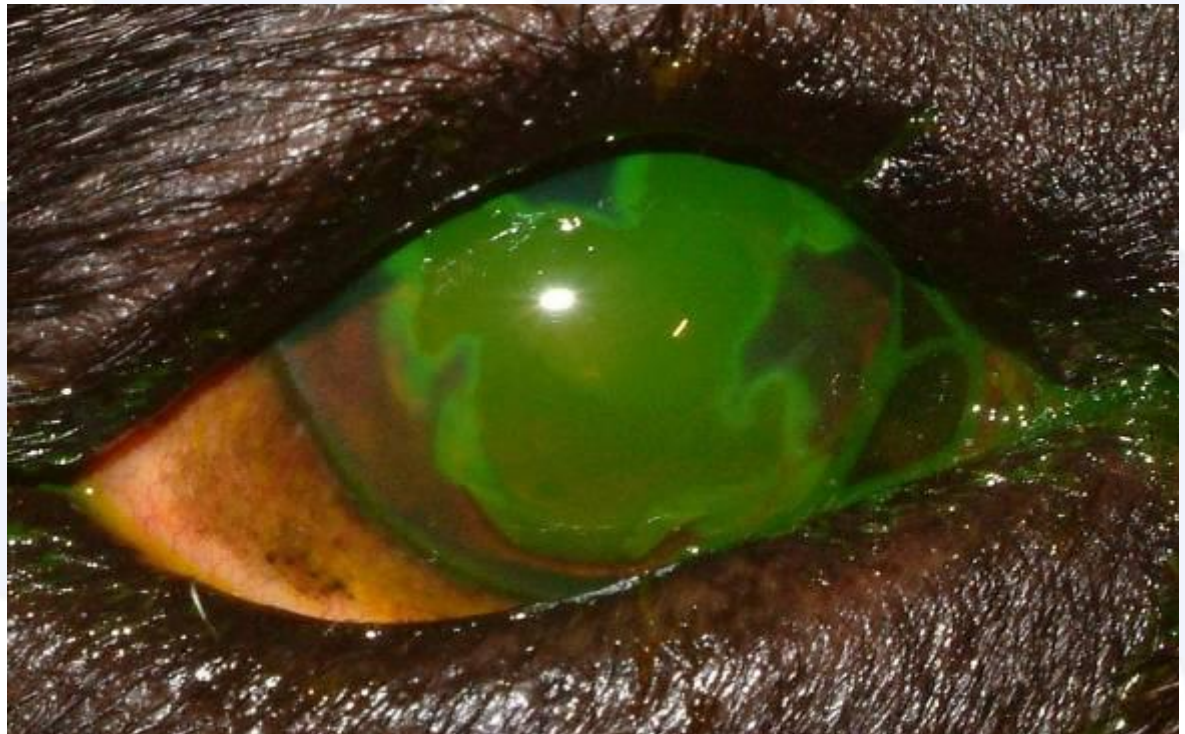
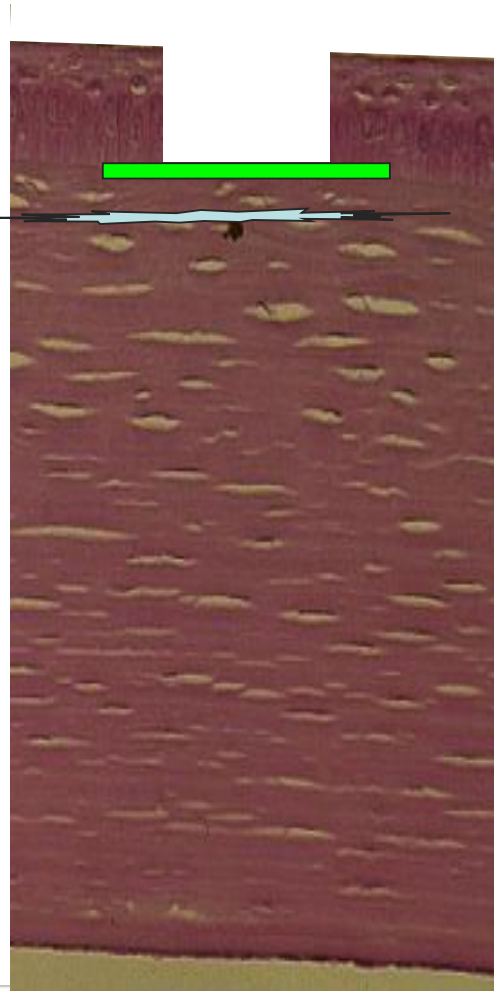


Recurrent or non-healing superficial erosions

# **INDOLENT ULCERS**



# Indolent ulcers: Recurrent or non healing corneal erosions



*Under-run epithelial edges*

# Indolent ulcers: **Aetiology**

1. Recurrent or ongoing corneal trauma
2. Spontaneous a.k.a. Boxer ulcer or **SCCED\***

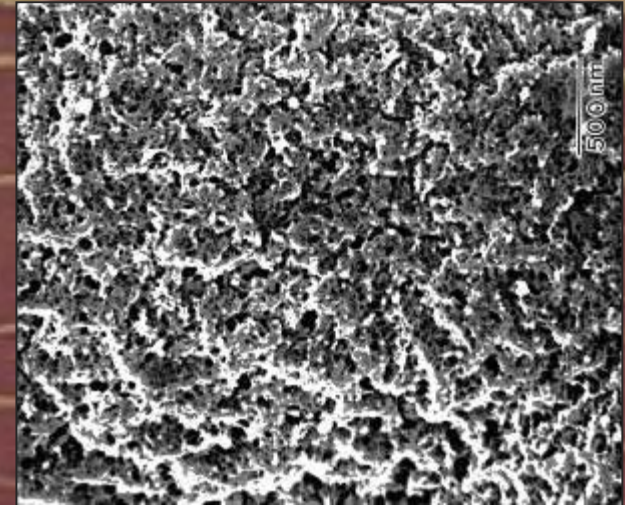
\*Spontaneous Chronic Corneal Epithelial Deficit



# Indolent ulcers I

Recurrent or ongoing  
corneal trauma

- Exposure (BOS\*)
- Entropion
- KCS (dogs)
- Senile change
- FHV (cats)

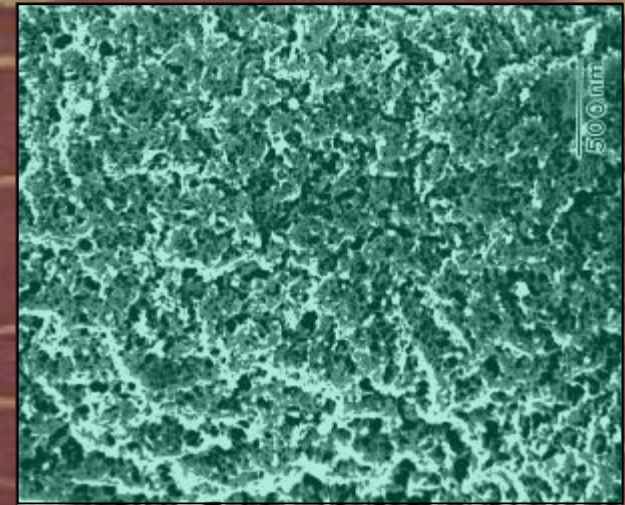


\*Brachycephalic Ocular Syndrome

# Indolent ulcers

Recurrent or ongoing corneal trauma

- Exposure (BOS\*)
- Entropion
- KCS (dogs)
- Senile change
- FHV (cats)



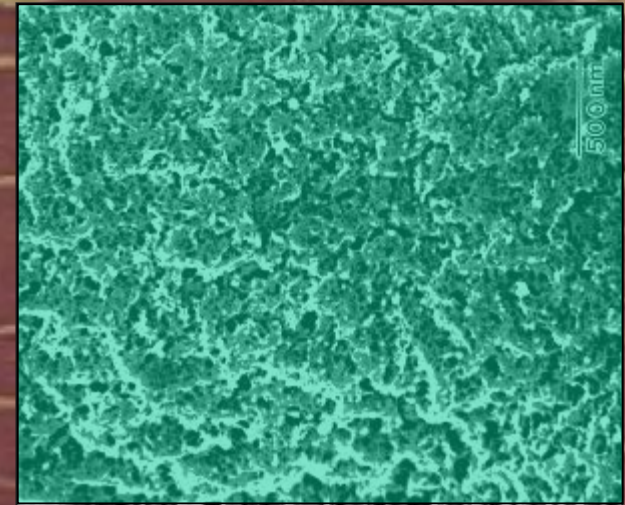
\*Brachycephalic Ocular Syndrome

# Indolent ulcers

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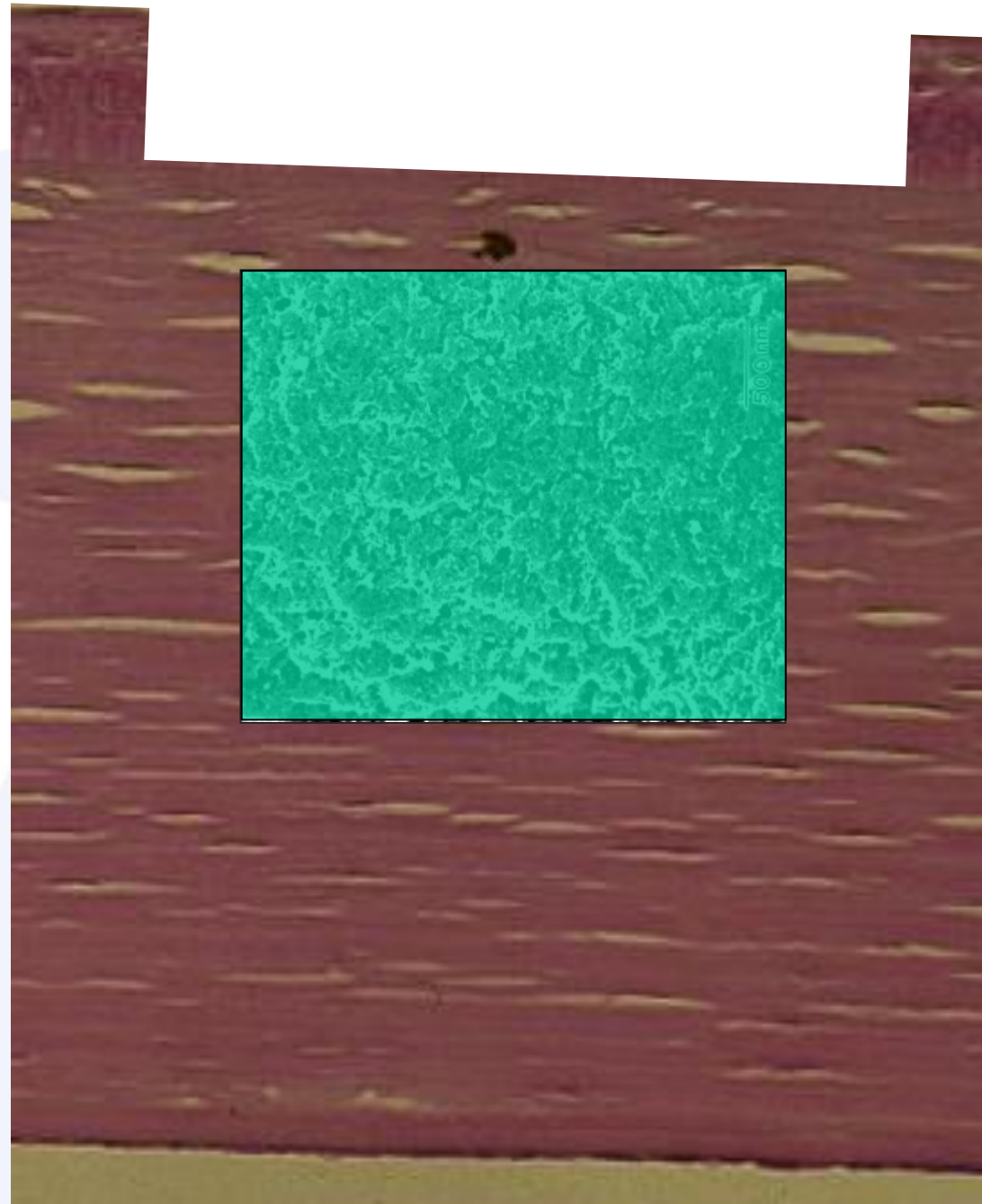


# Indolent ulcers

Recurrent or ongoing  
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- Exposure (BOS\*)
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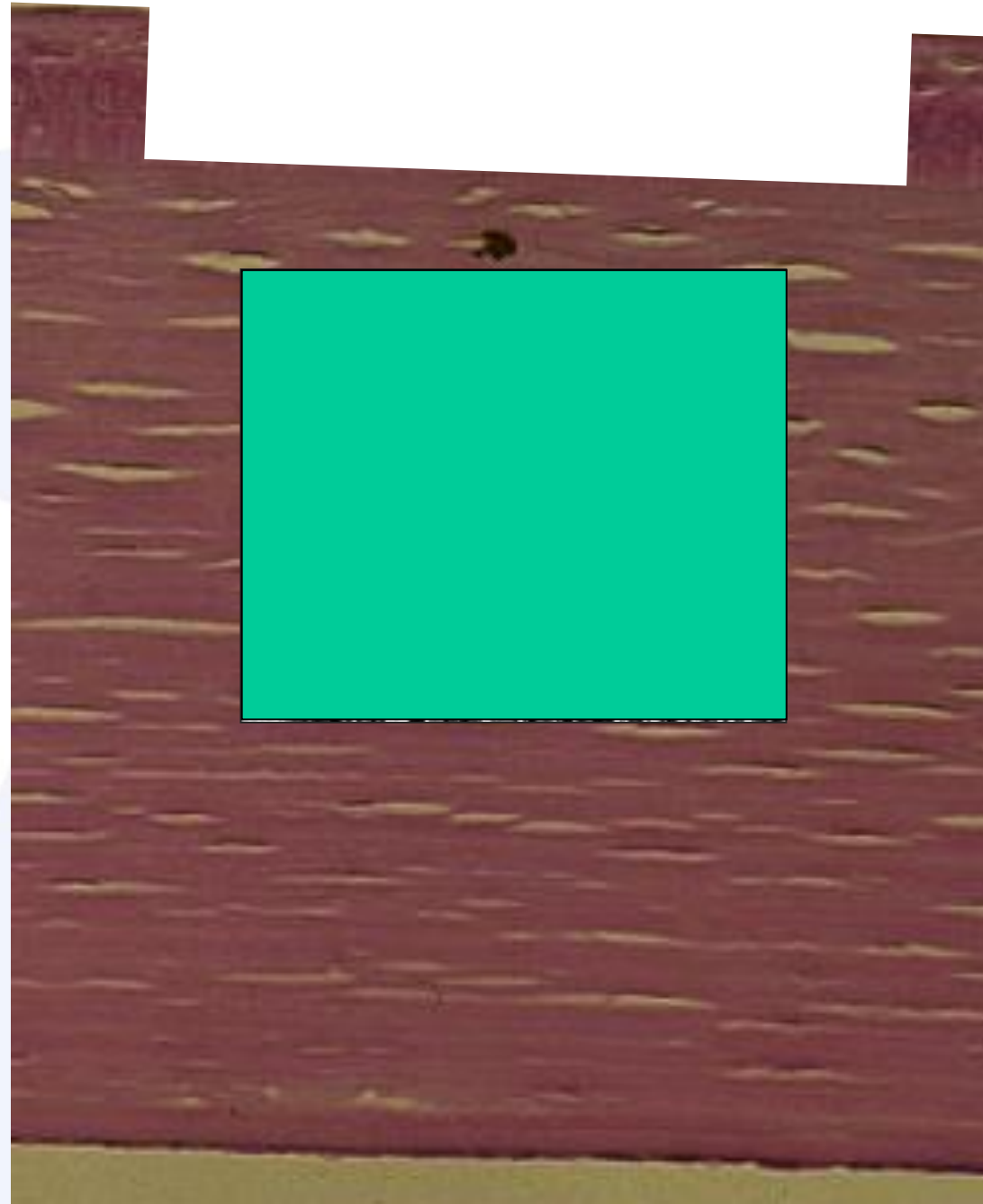


# Indolent ulcers

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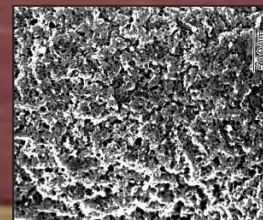
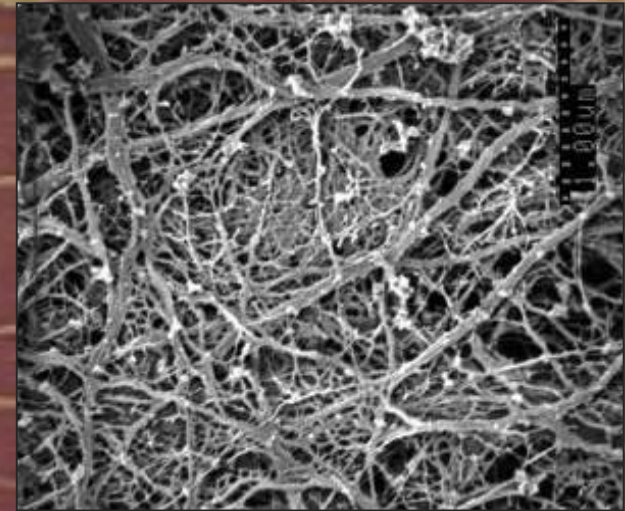
\*Brachycephalic Ocular Syndrome



# Indolent ulcers

Recurrent or ongoing  
corneal trauma

1. Loss basement membrane
2. Anterior stromal cell death
3. Anterior stromal membrane formation

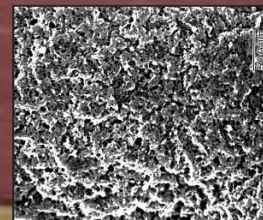
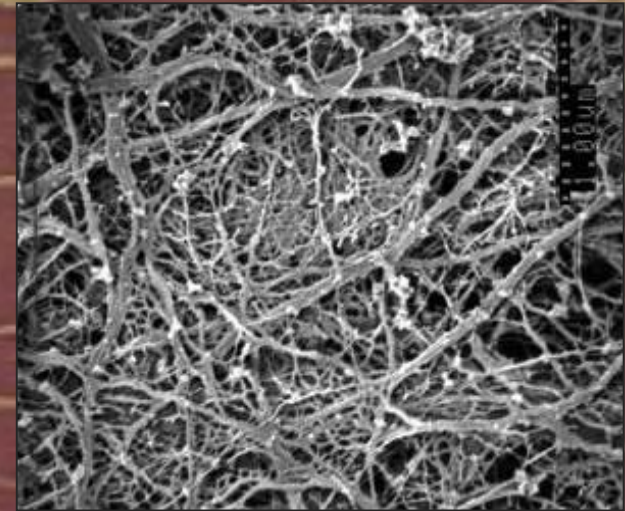




# Indolent ulcers

Recurrent or ongoing  
corneal trauma

1. Loss basement membrane
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3. Anterior stromal membrane formation



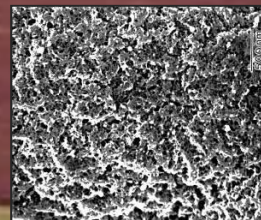
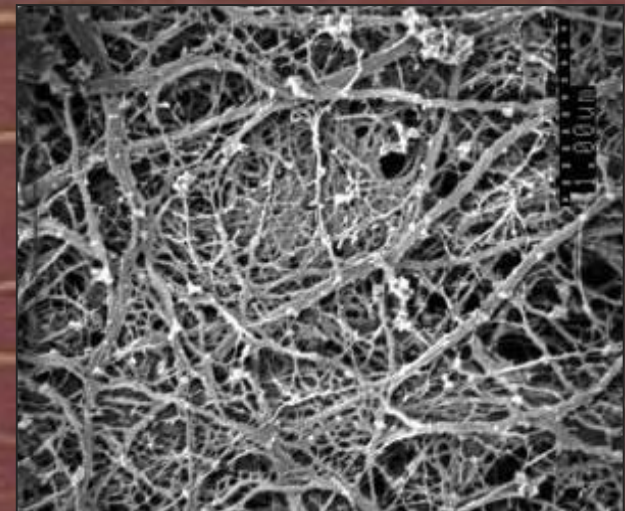
# Indolent ulcers 2

Spontaneous Chronic Corneal epithelial deficit (SCCED)\*

Aka “Boxer ulcers”

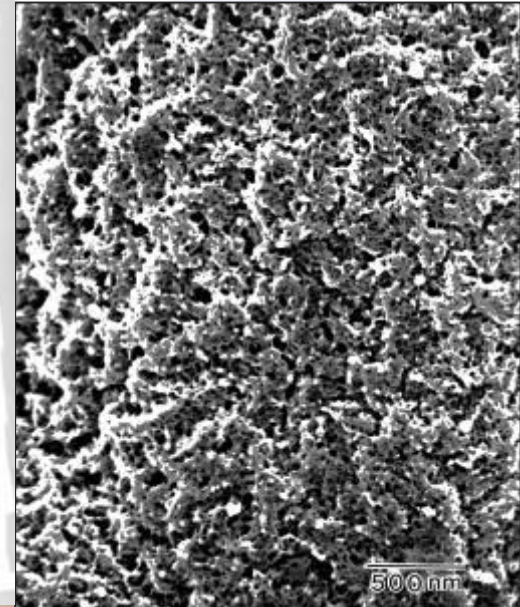
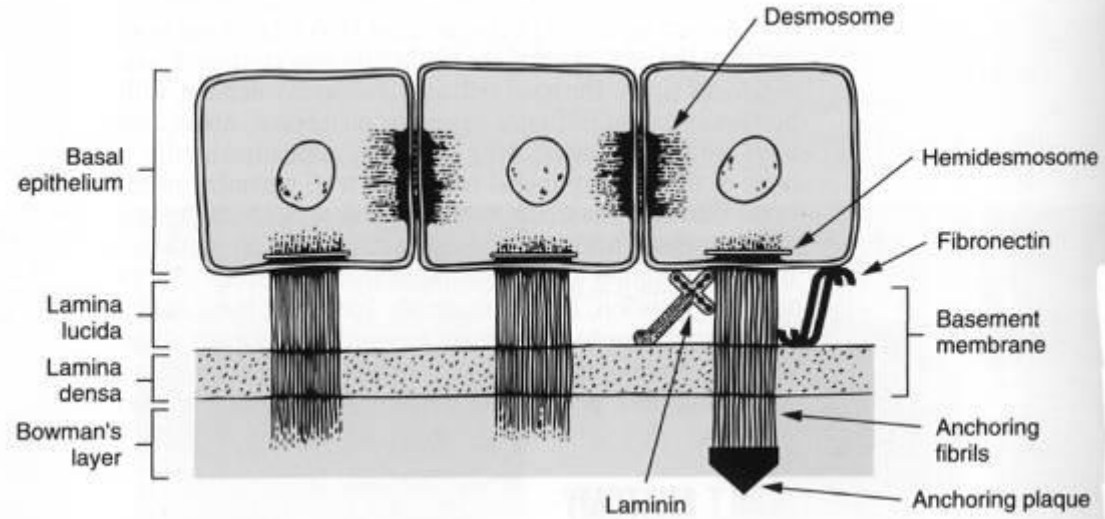
1. Abnormal corneal innervation
2. Progressive loss basement membrane
3. Anterior stromal cell death
4. Anterior stromal membrane formation
5. Spontaneous ulcer

\*NB the mechanism of SCCED formation remains to be fully elucidated



# Indolent ulcers: Basement membrane absence

Normal

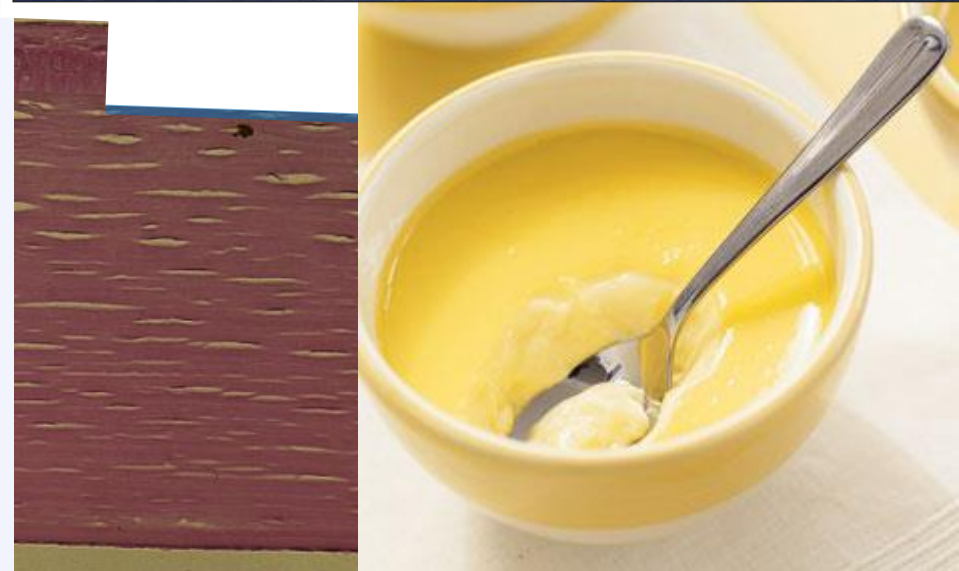
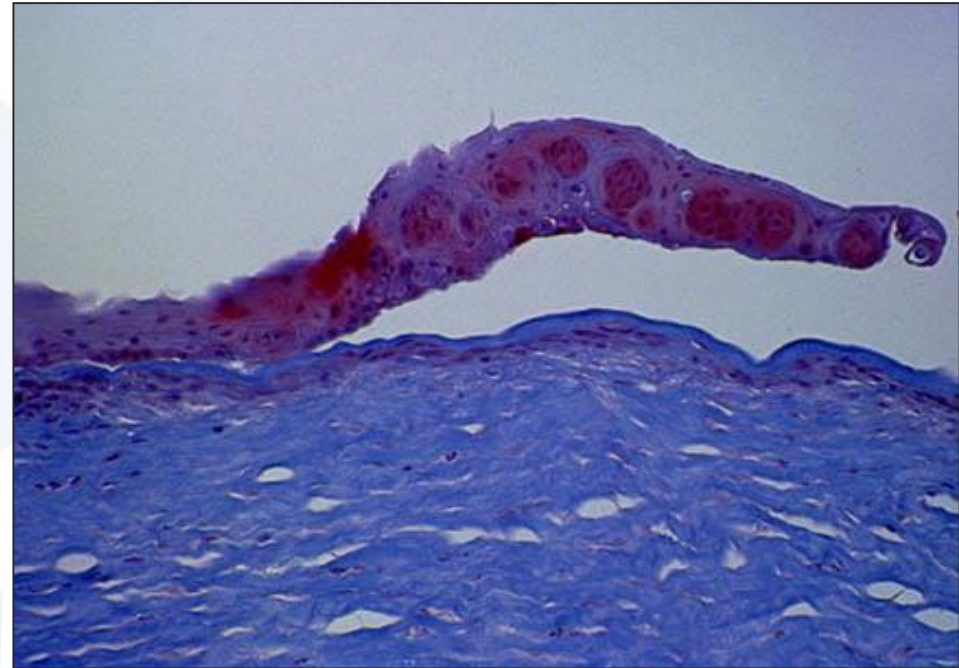


Epithelial non-attachment



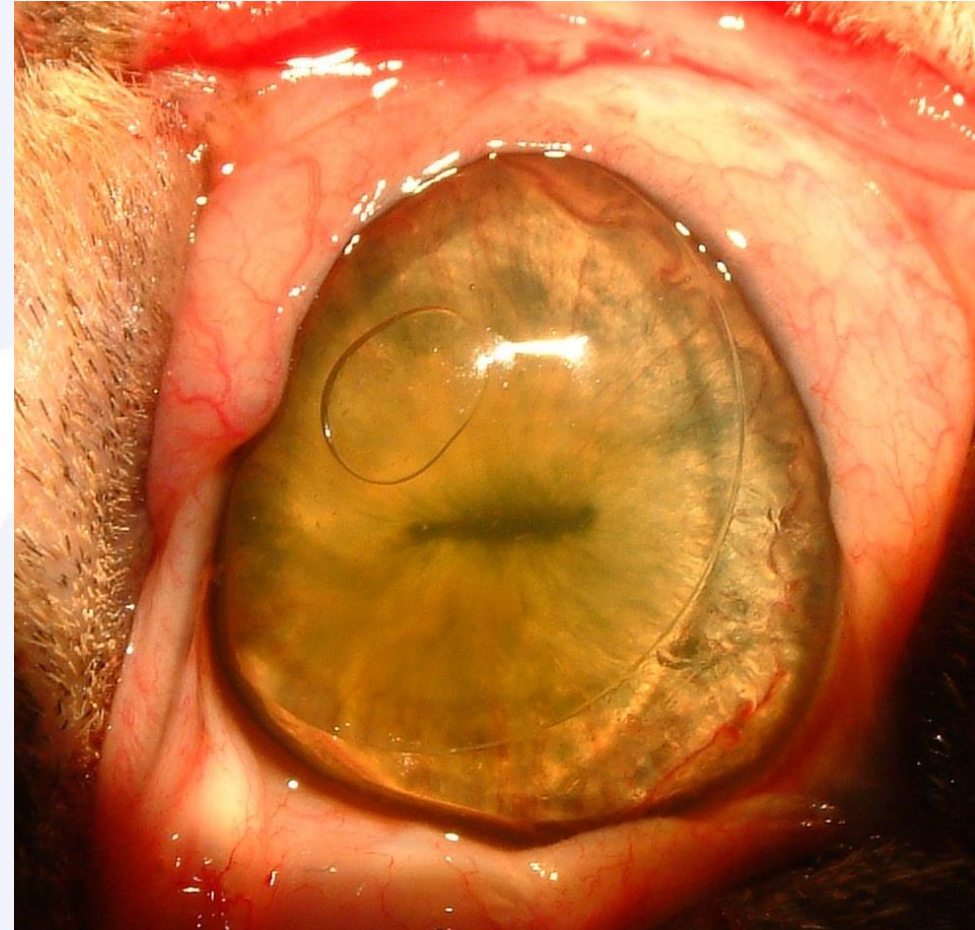
# Indolent ulcers: Anterior stromal membrane

- Dense anterior stromal membrane forms
  - Hyalinised membrane approx 12-20microns
  - Corneal epithelium approx 70microns
  - Corneal thickness approx 700microns
- Epithelial cells unable to attach



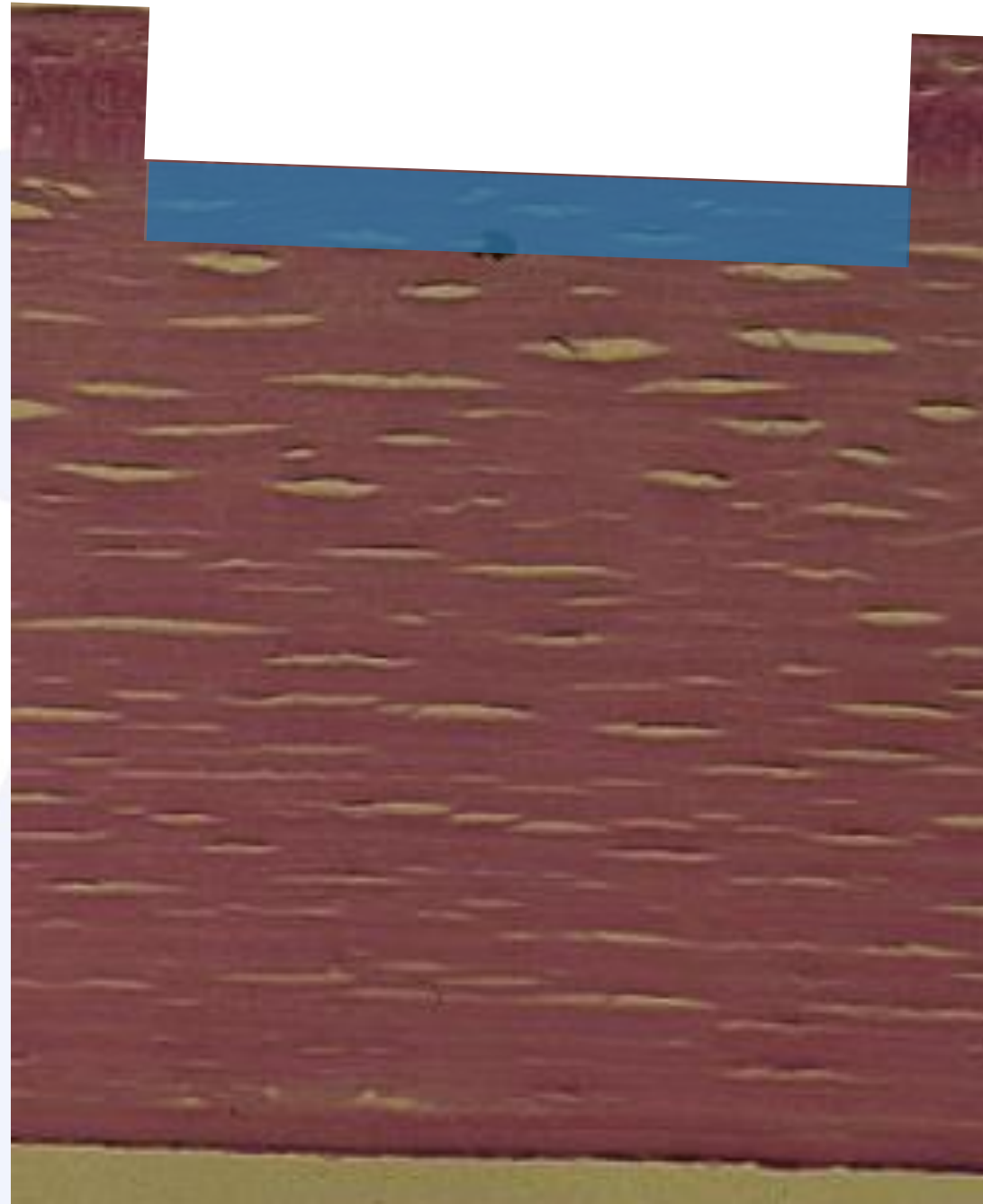
# Treatment of Indolent ulcers

- **Identify and eliminate cause**
- Educate owner
- Improve epithelial cell environment
- Remove non attached cells - debride
- Reduce “friction” damage – lens or lubrication
- Avoid epitheliotoxic meds
- Topical hyaluronate
- Repeat weekly
- Sometimes this doesn't work.....
  - Underlying cause not identified or eliminated
  - Insufficient debridement
  - Anterior stroma too damaged



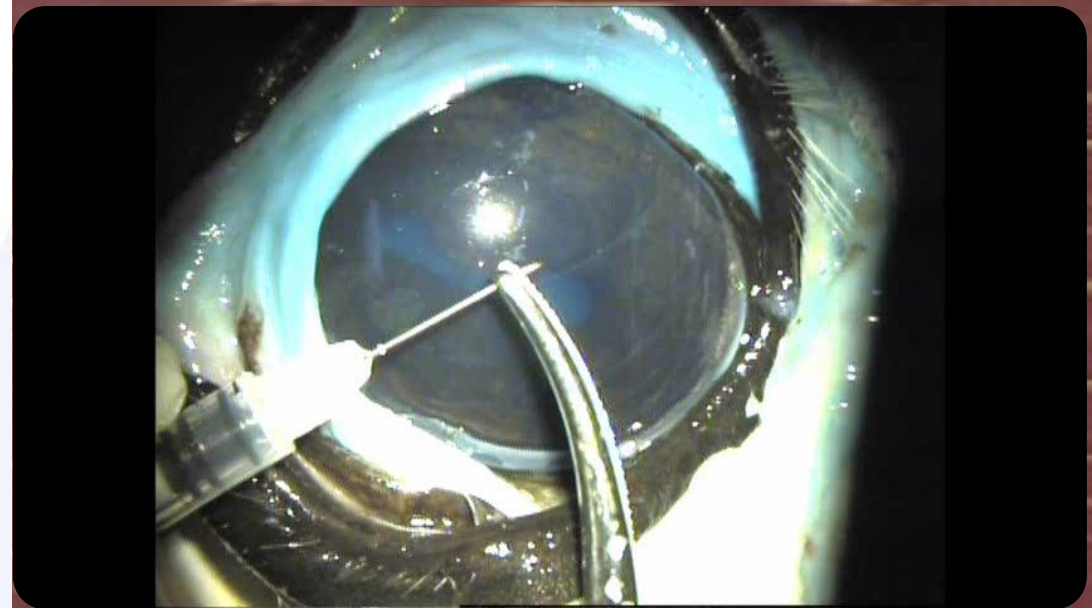
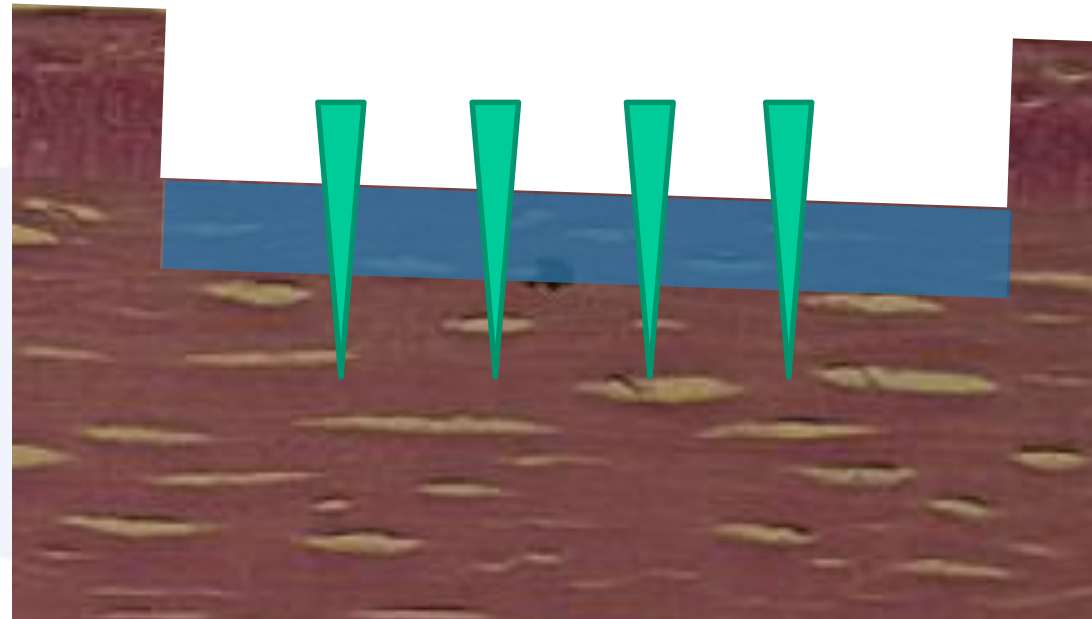
# Surgical treatment of indolent ulcers

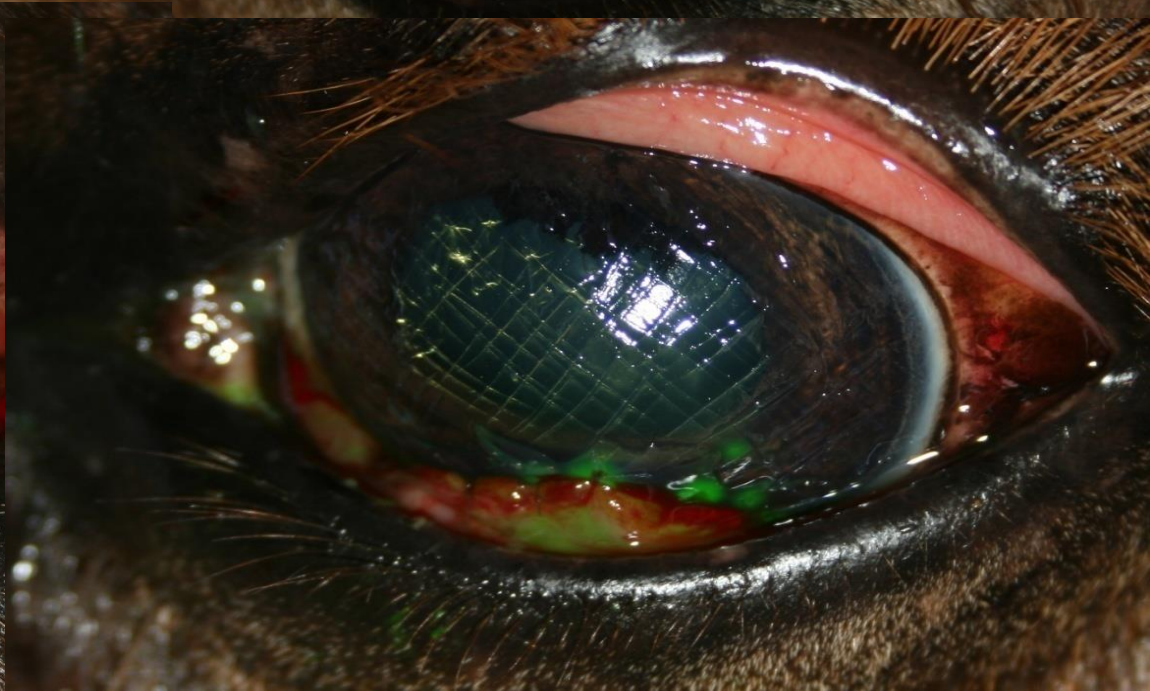
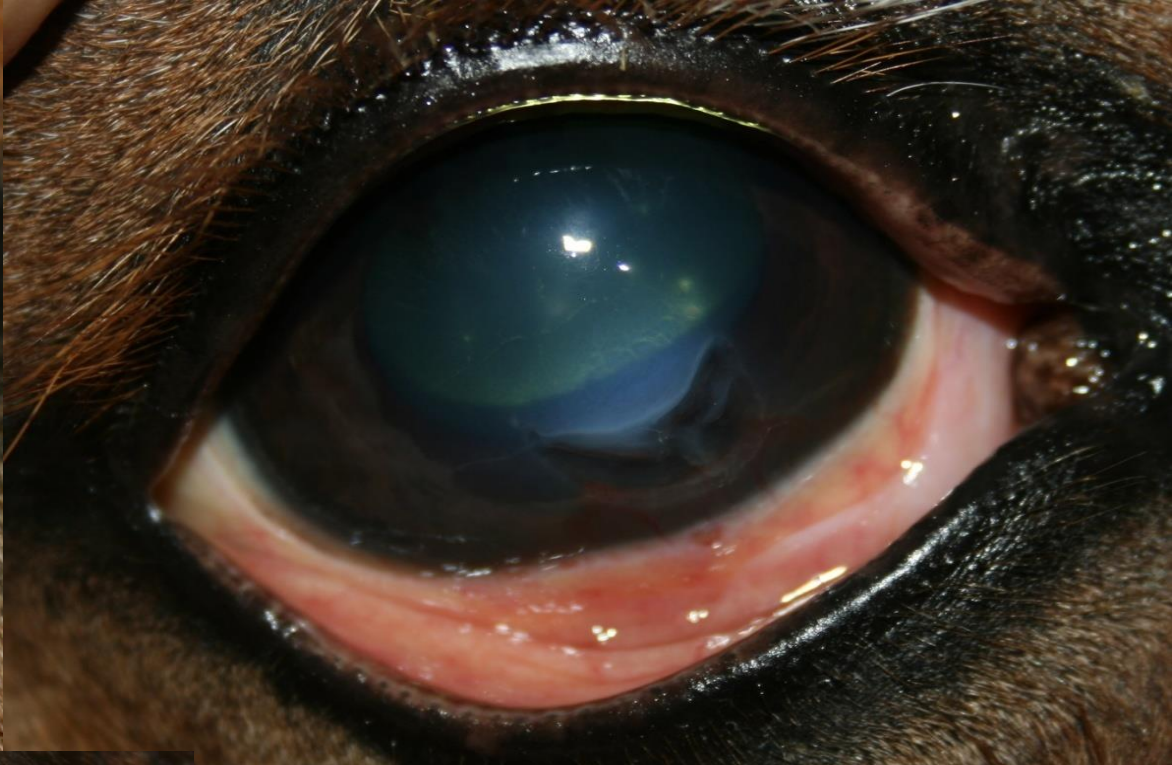
- Anterior punctate keratotomy
- Superficial keratectomy
- (Grid keratotomy, contraindicated in cats, performed with caution in dogs)



# Surgical treatment of indolent ulcers

- Anterior punctate keratotomy
- Superficial keratectomy
- (Grid keratotomy, contraindicated in cats, performed with caution in dogs)

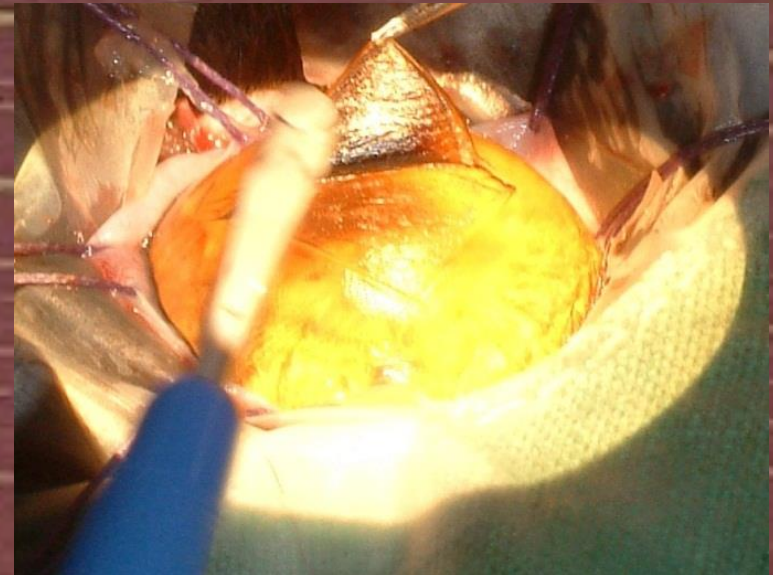
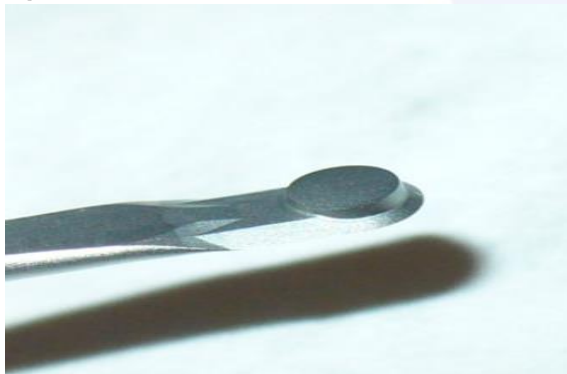






# Surgical treatment of indolent ulcers

- Anterior punctate keratotomy
- Superficial keratectomy
- (Grid keratotomy, contraindicated in cats, performed with caution in dogs)





# **CORNEAL SEQUESTRUM IN THE CAT**

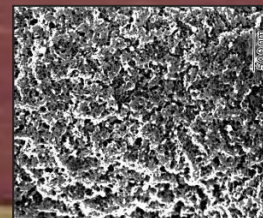
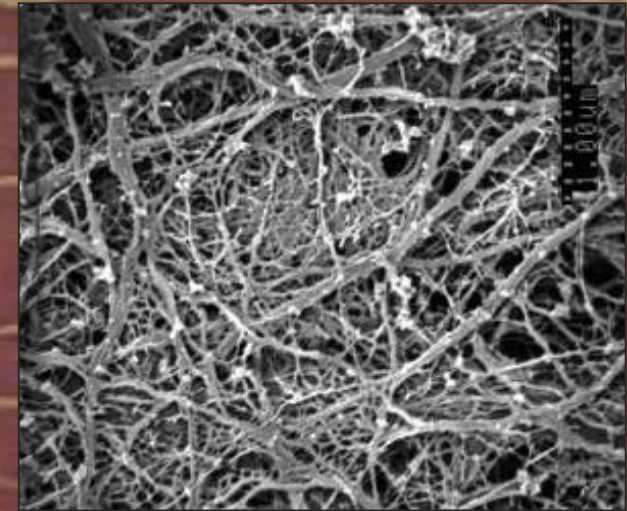
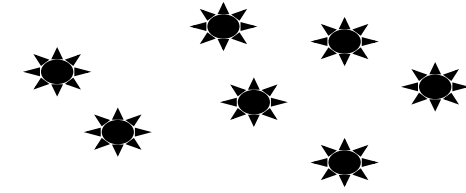


# Sequestrum formation\*

Recurrent or ongoing corneal trauma

1. Loss basement membrane
2. Anterior stromal cell death
3. Pigmentation

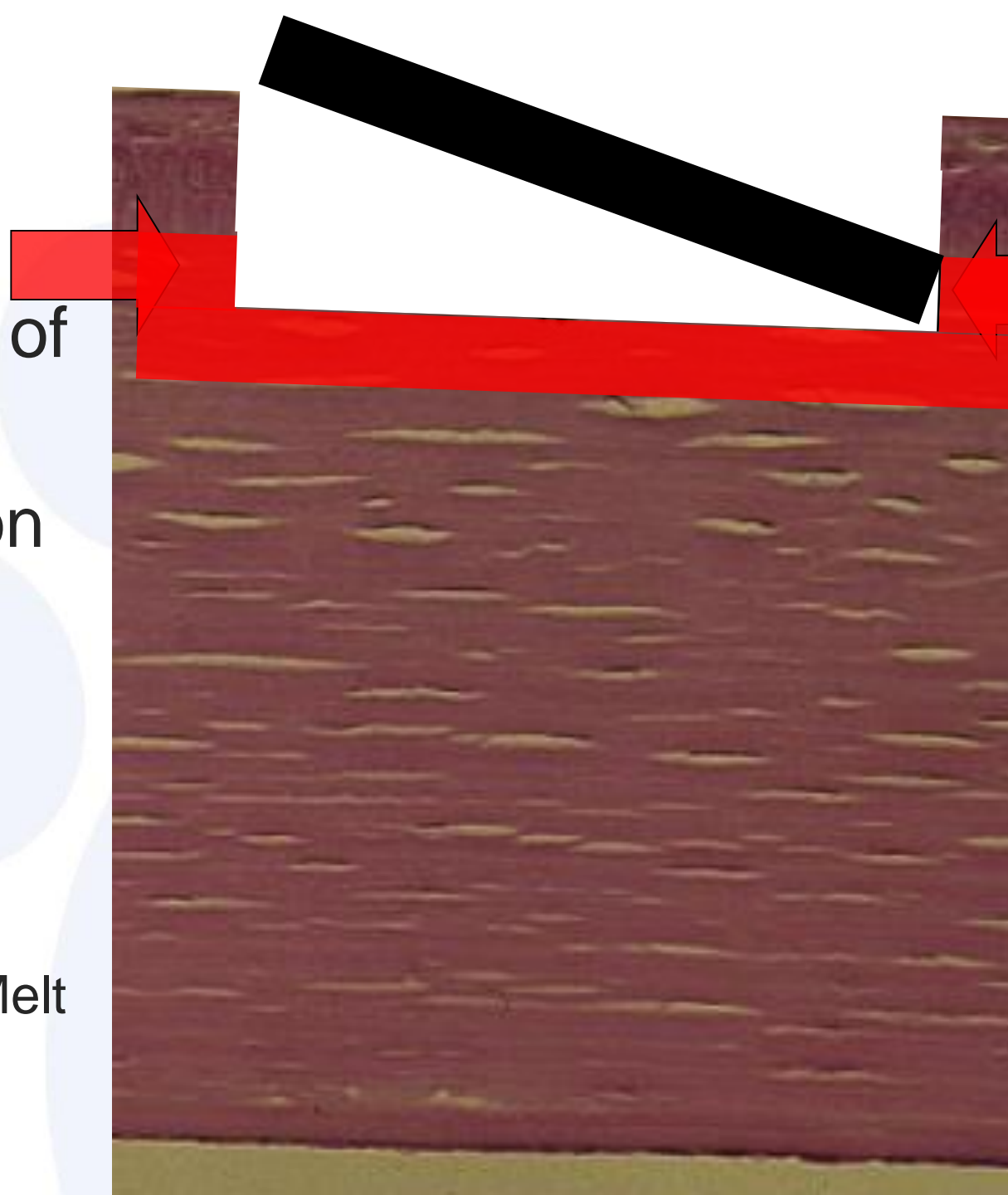
\*NB aetiology of sequestrum is still unclear



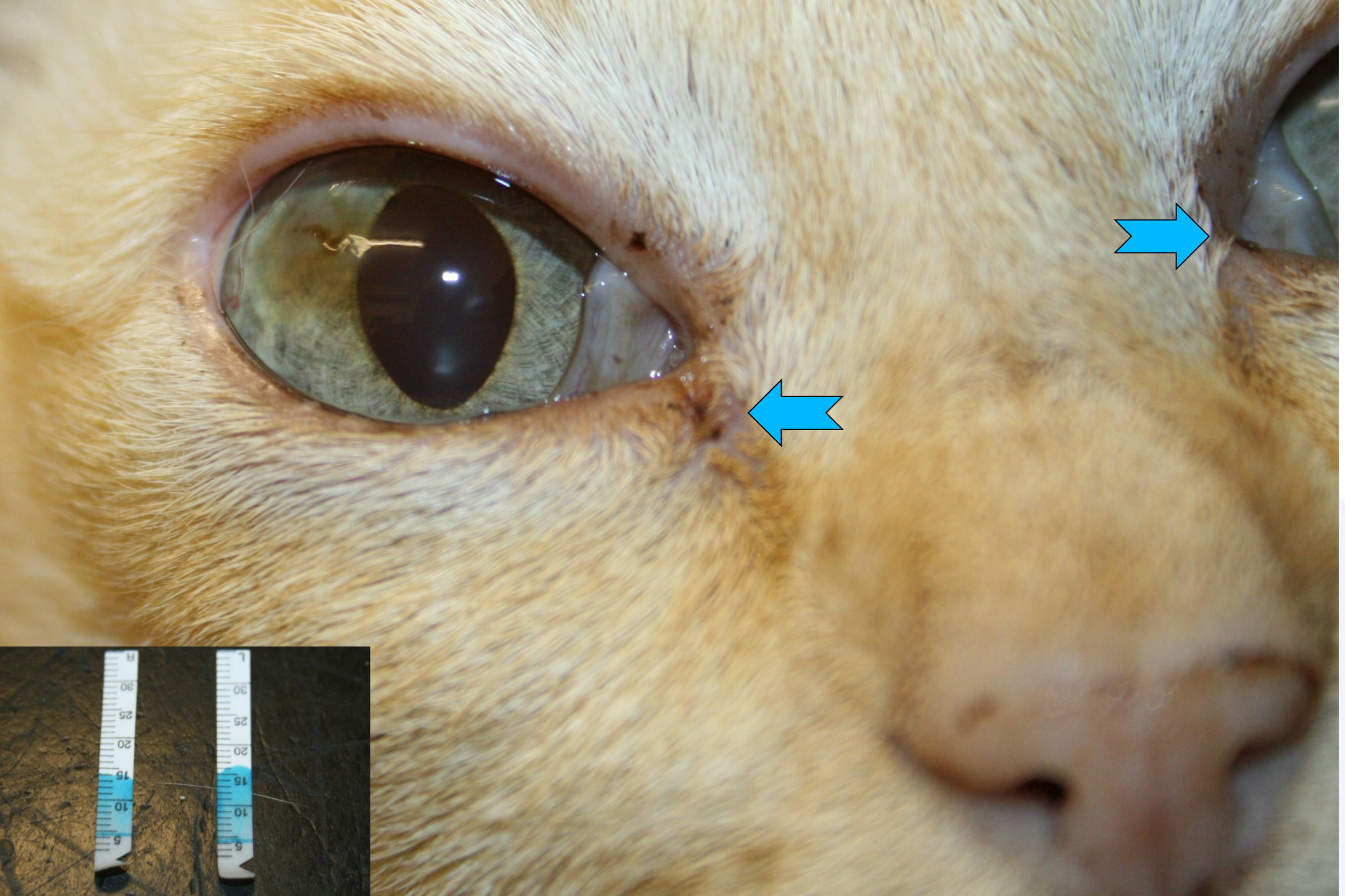
# Sequestrum sequelae

+/- progressive death of  
stroma

- Neovascularisation
- Sequestrum  
sloughed
- Sequelae:
  - Healing
  - Abscess formation or Melt
  - Rupture











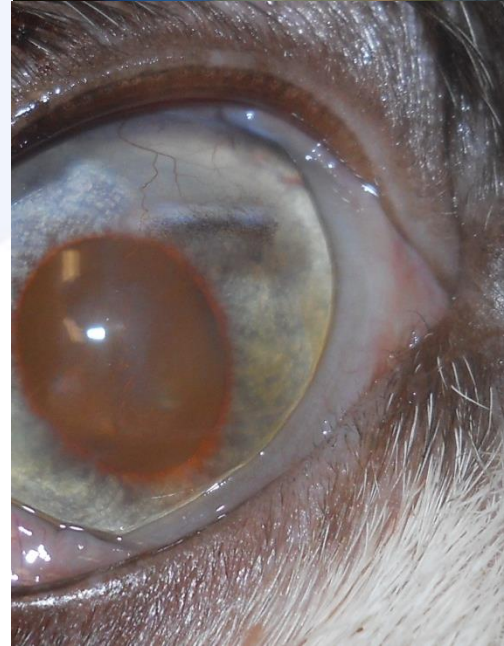
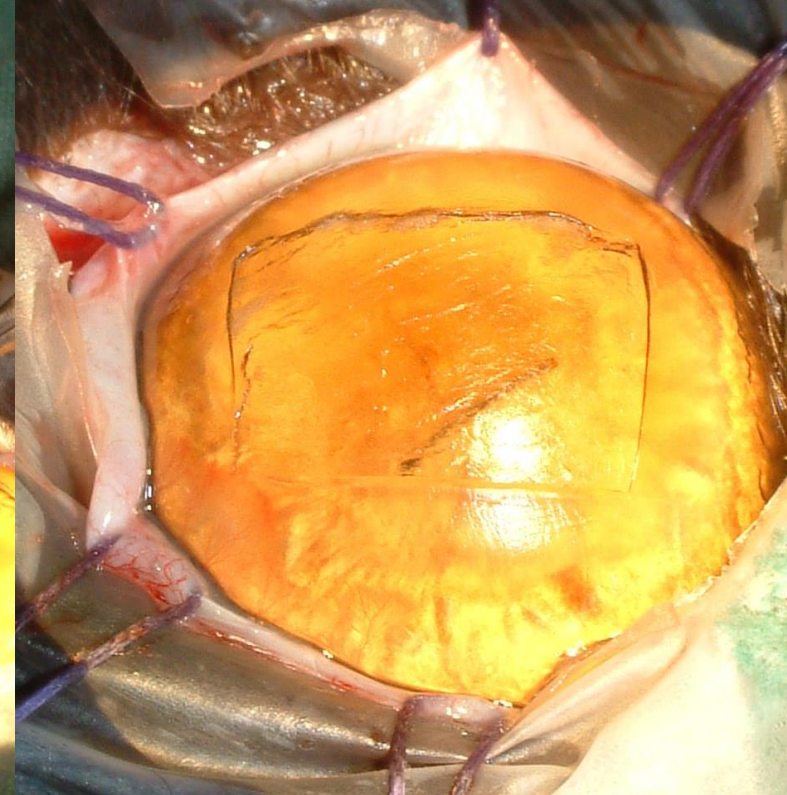
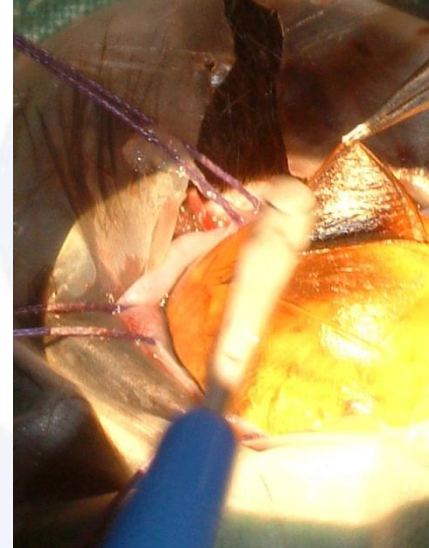
## Sequestrum treatment

A surgical disease in our clinic

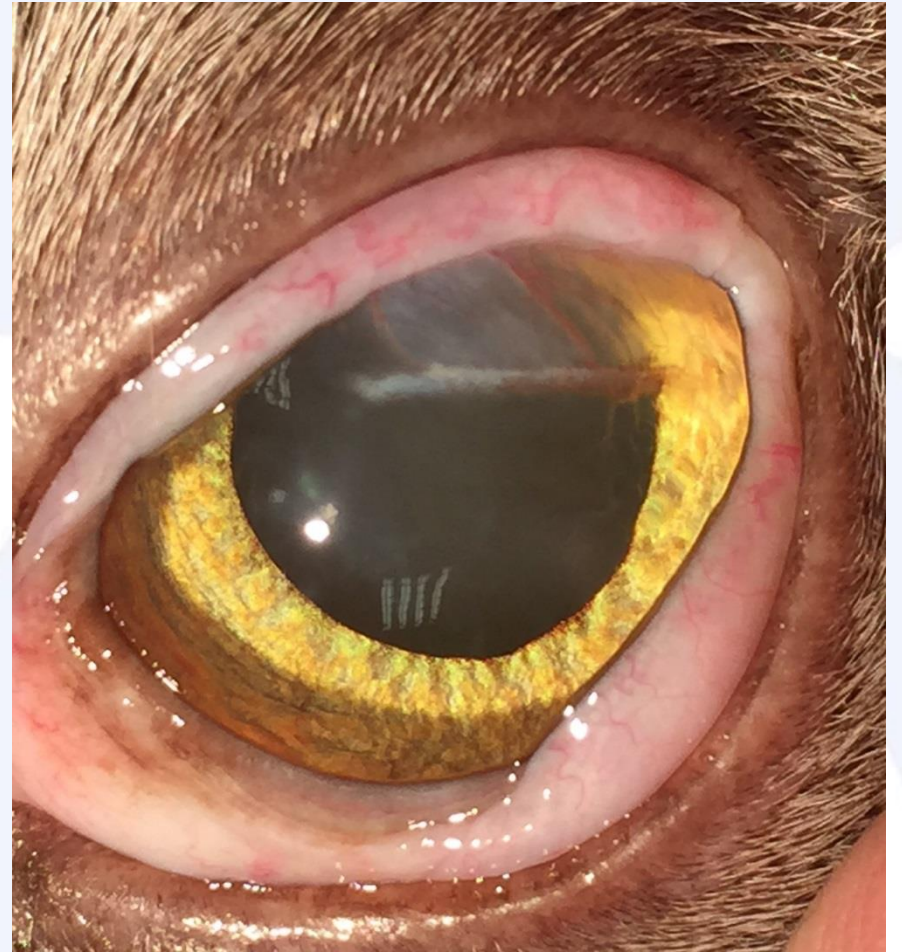
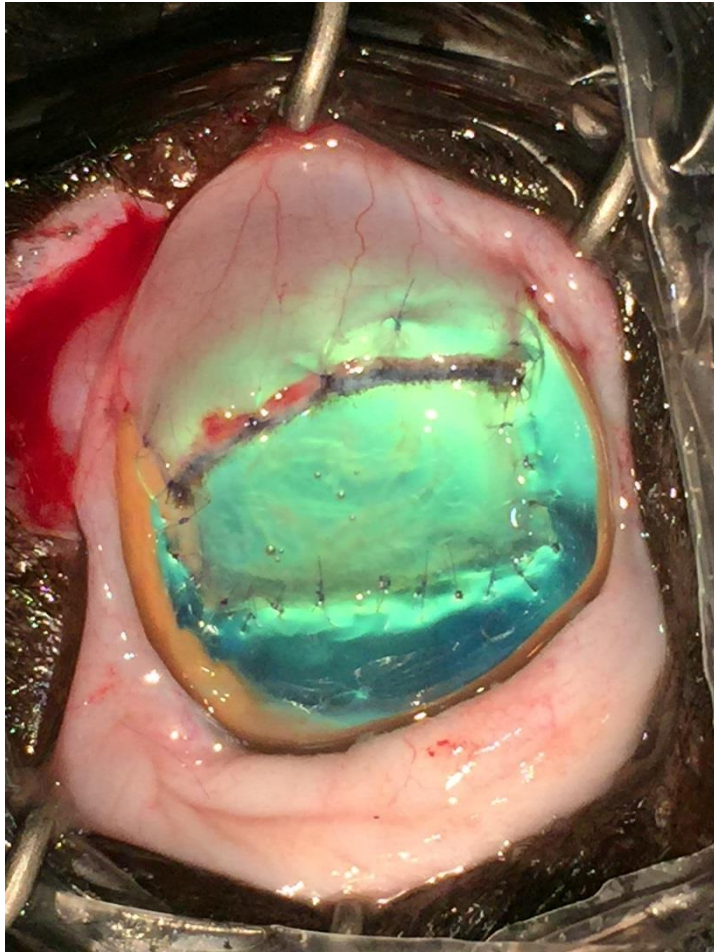
- Corneoscleral sliding graft (CCT)
- Superficial keratectomy
- Penetrating keratoplasty (corneal transplant)
- (Conjunctival graft)

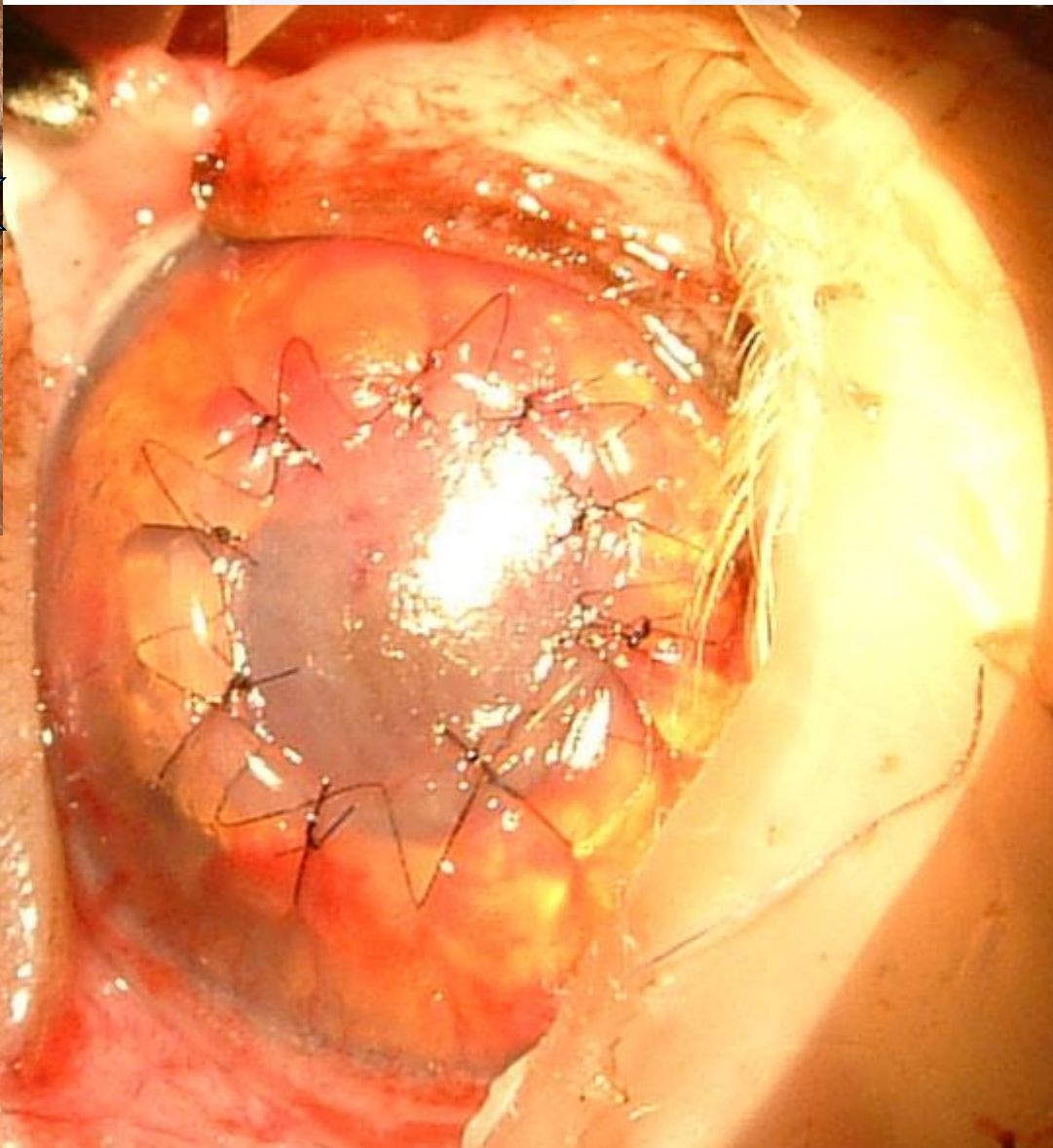
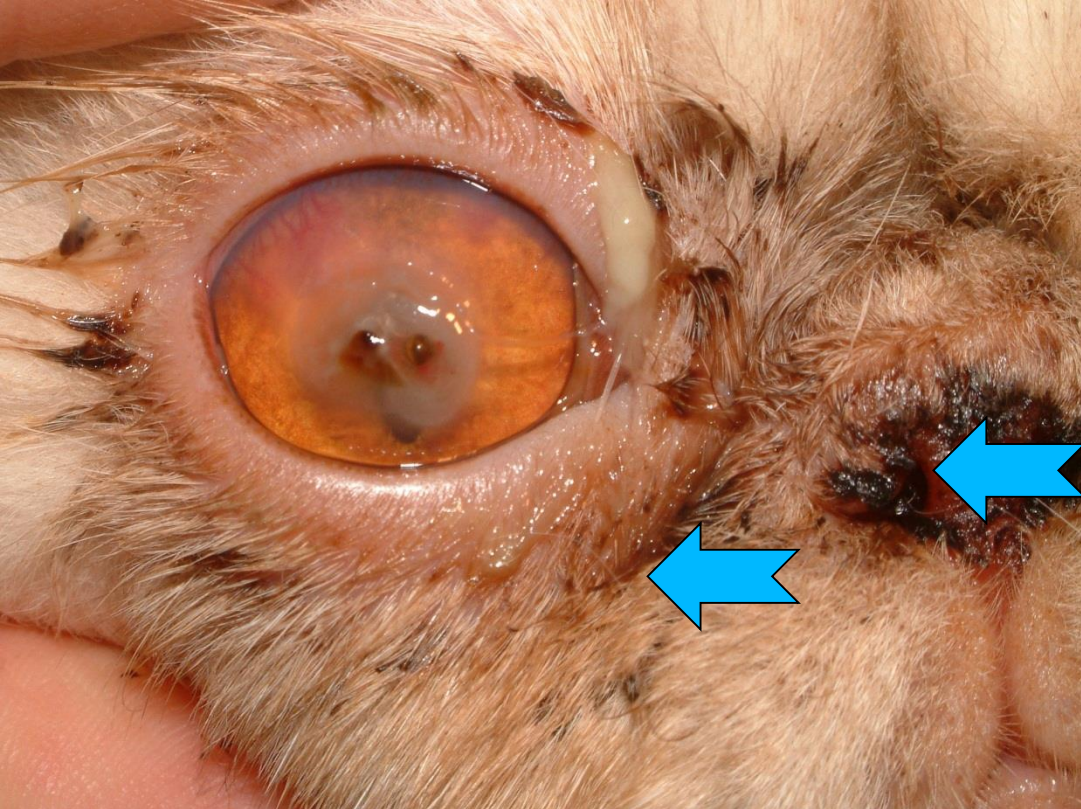
Medical treatment (lubrication, prophylactic antibiotics) lengthy and runs risk of:

- Uncontrolled sloughing
- Corneal melting
- Corneal abscess formation
- Corneal rupture



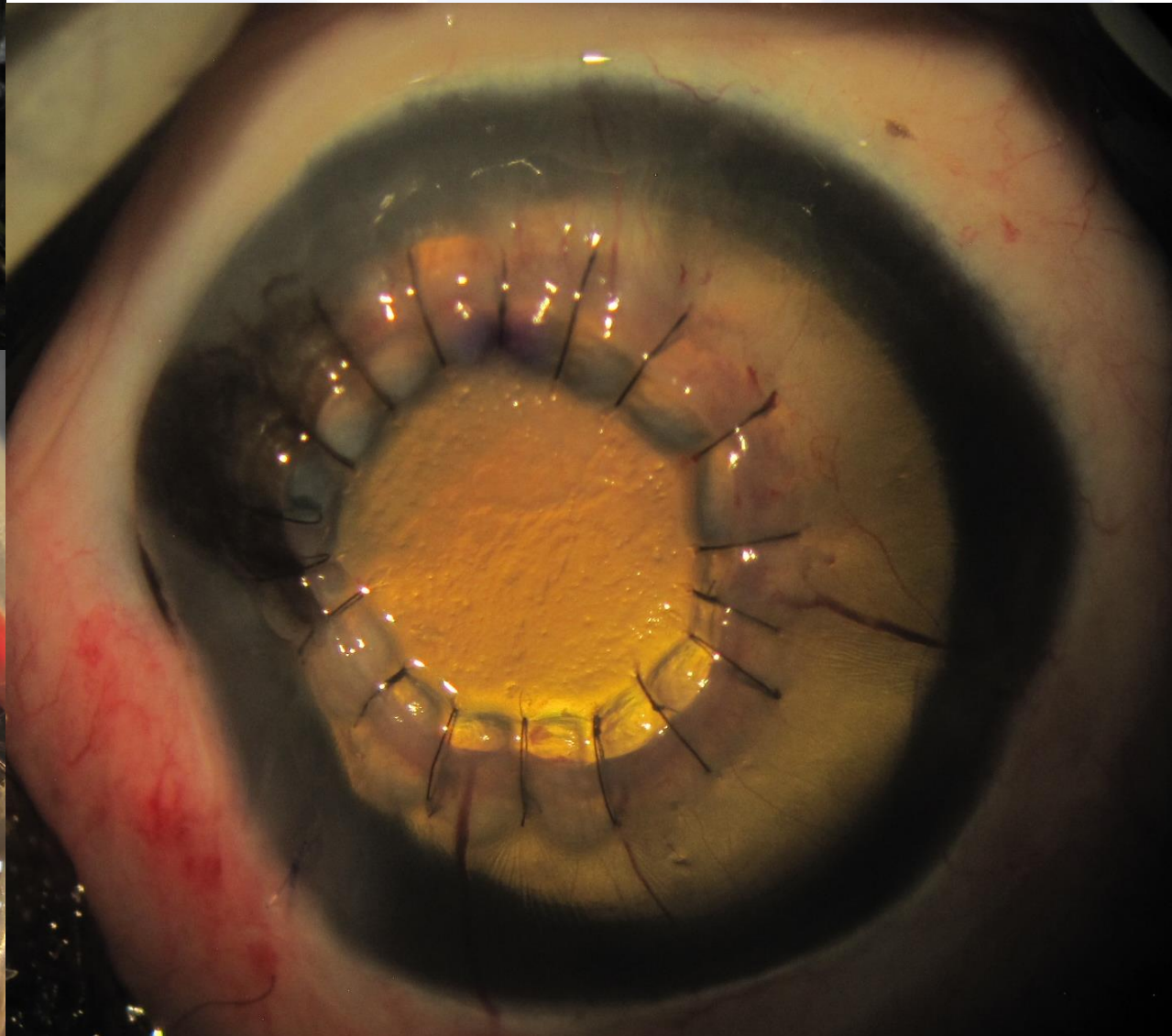
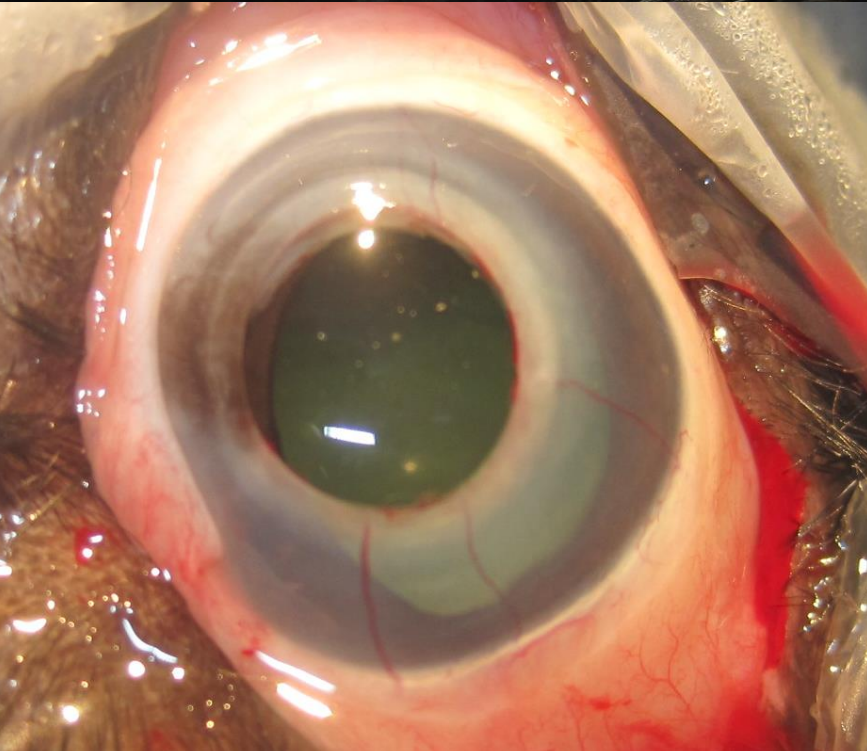
# Corneo-conjunctival transposition





Penetrating  
keratoplasty  
(frozen)

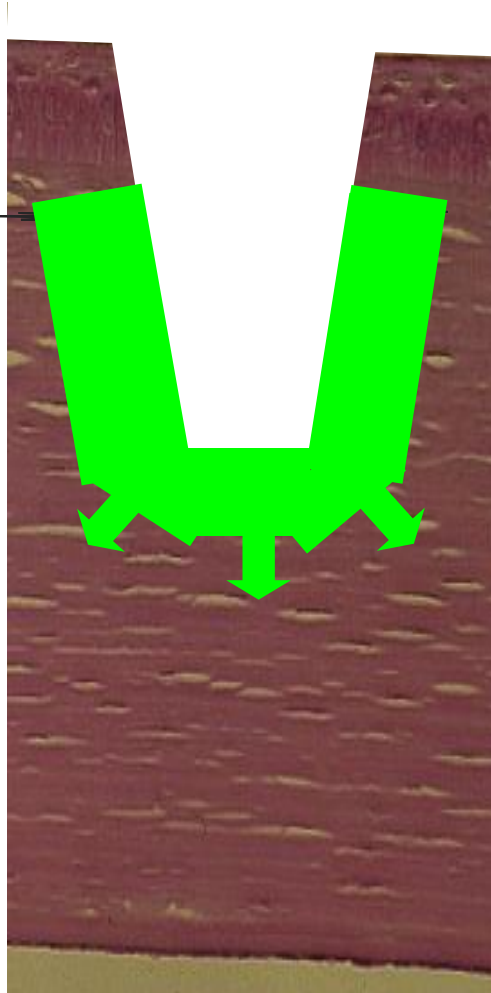
# Penetrating keratoplasty (fresh)



A large, faint, light blue paw print graphic is positioned in the background, centered horizontally and slightly above the text. It consists of four rounded, oval-shaped pads and a thick, curved line representing the arch of the paw.

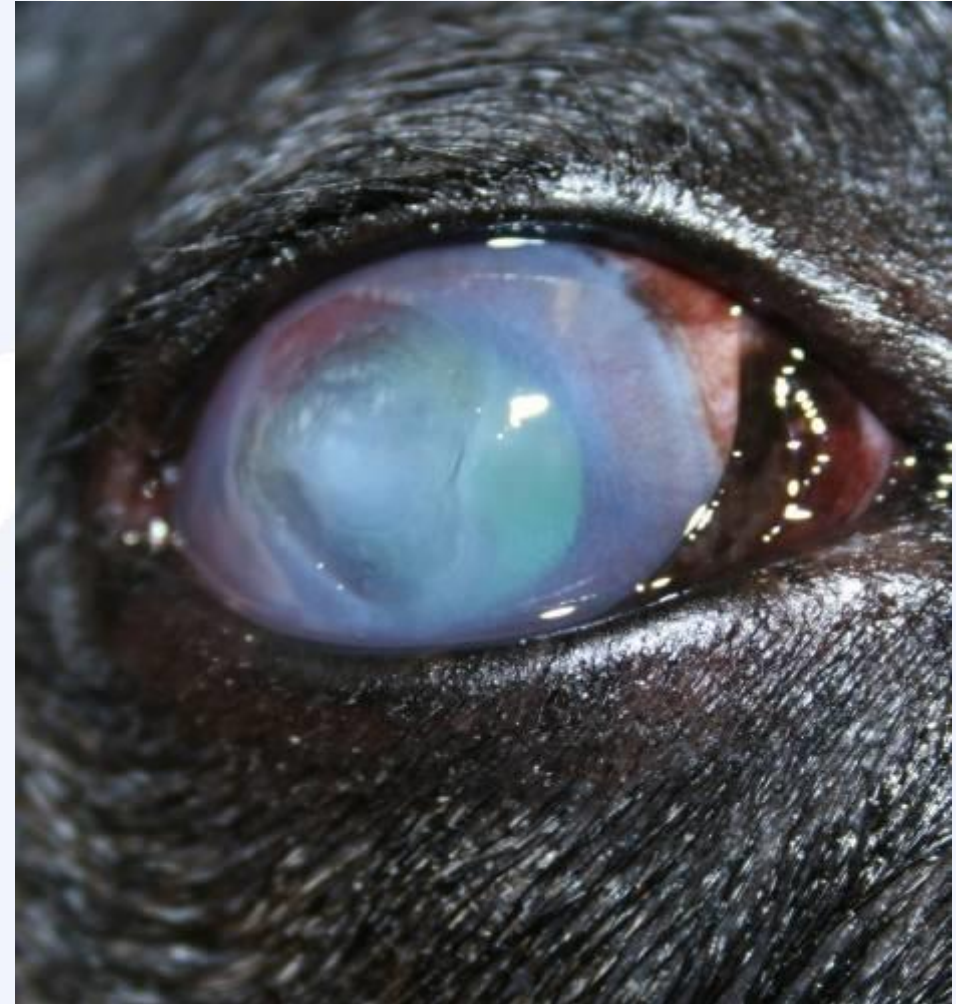
# **DEEP (STROMAL) ULCERS**

# Stromal ulcers



# Stromal ulcers: Treatment

- Treat as an ophthalmic emergency  
Melting can occur in <12hours – educate owner
- Assess depth – consider surgical repair if more than 50% depth or if predisposing factors to melting (brachycephalics, KCS, lagophthalmos etc)
- **Support** healing mechanisms – serum
- **Prevent** proteolysis – serum, EDTA, oral doxycycline
- **Prevent** infection – prophylactic broad-spectrum antibiotics
  - Chloramphenicol
  - Fluroquinilones if infection suspected (e.g. Ofloxacin q 2hours for 24 hours then qd)



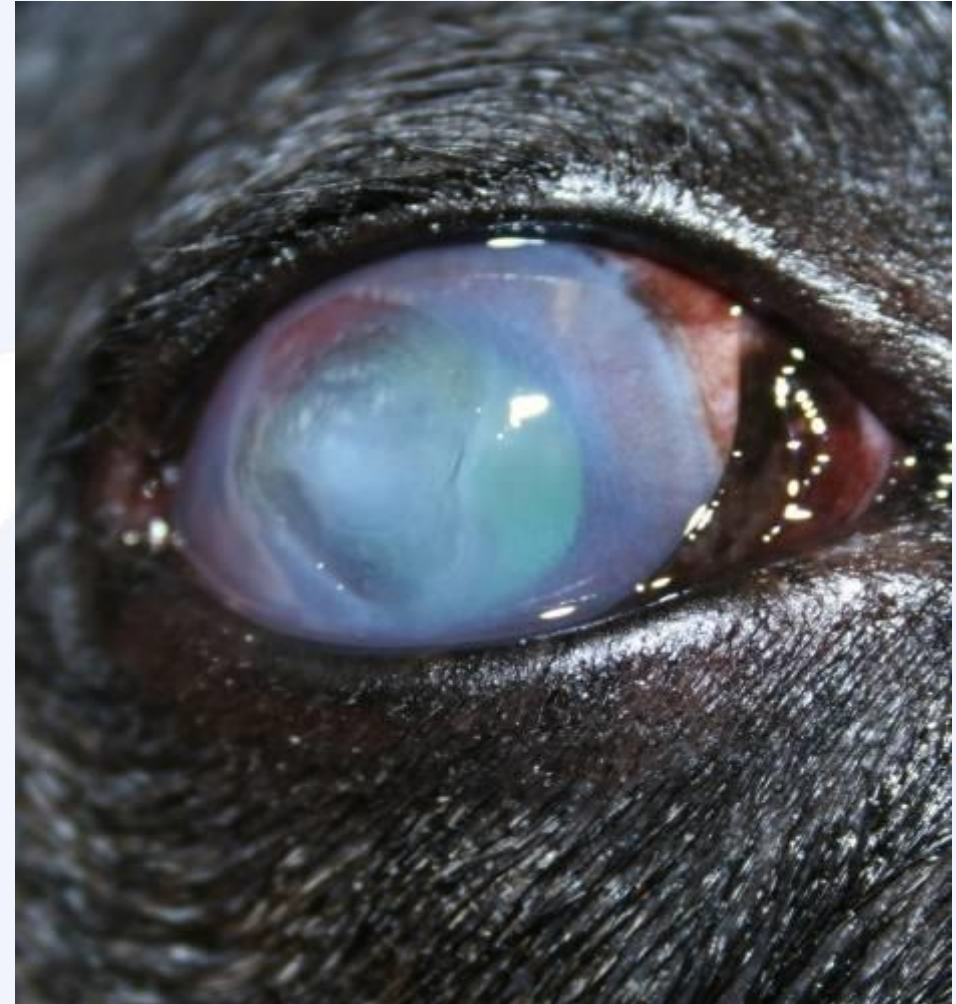
# Are there any miracle drugs for stromal ulcers?





# Stromal ulcers: Treatment

- Treat as an ophthalmic emergency  
Melting can occur in <12hours – educate owner
- Assess depth – consider surgical repair if more than 50% depth or if predisposing factors to melting (brachycephalics, KCS, lagophthalmos etc)
- **Support** healing mechanisms – serum
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- **Prevent** infection – prophylactic broad-spectrum antibiotics
  - Chloramphenicol
  - Fluroquinilones if infection suspected (e.g. Ofloxacin q 2hours for 24 hours then qd)



# Surgical treatment of stromal ulcers:

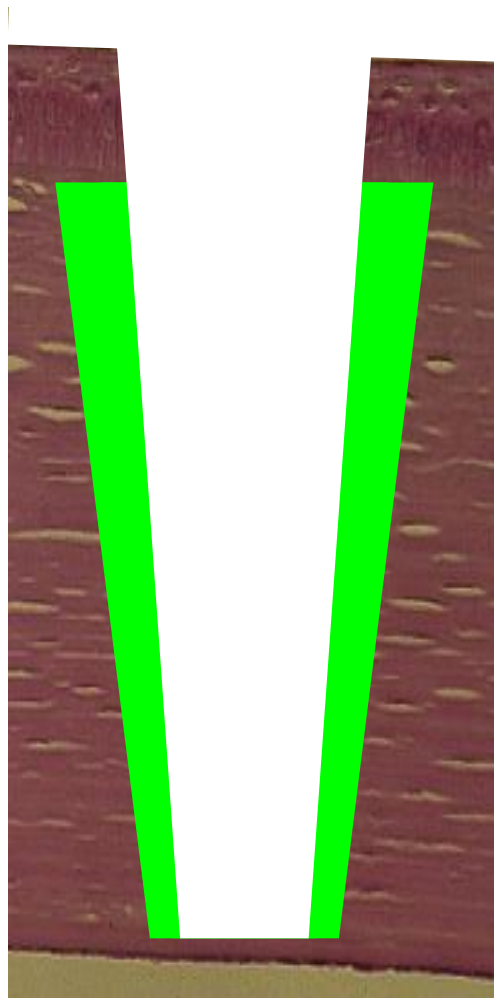
- Microsurgical techniques:
  - Conjunctival grafting
  - Corneal allograft techniques
- Aim to provide
  - Support
  - nutrition
- Magnification ESSENTIAL
- Correct instrumentation ESSENTIAL
- Correct suture material ESSENTIAL
- Third eye lid flaps not appropriate
  - Can't see cornea
  - Can't medicate cornea
  - Patient cannot see
- Contact lenses not appropriate
  
- Seek early advice from an ophthalmologist





**DESCEMATOCOELES**

# Descemetocoele



}Descemet's membrane



# Beware the dark centred ulcer



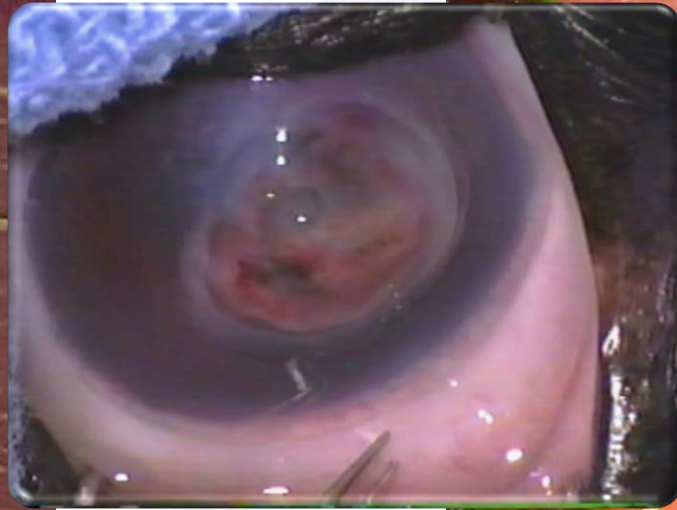
# Descematochoele

- An ophthalmic **emergency**
- **Rupture** common
- Remove collar
- E-collar
- Sedation if required
- Identify active melting process – treat if any concern (**serum**, edta, **topical fluroquinilones**, chloramphenicol or gentamicin and fucithalmic)
- Cytology and gram stain
- **Surgical repair** may be required
- Debridement of melting tissue adjacent may be of help but real risk of inducing rupture

# Corneal perforation



Siedel test



# Corneo-conjunctival transposition







# CORNEAL LACERATIONS

# Corneal laceration

Cat claw

- Cats
- Puppies

Thorn tip (black thorn)

- Working dogs

Hyphema – suspect perf

MUST ensure lens not damaged

Aggressive antibiotics

Manage uveitis

Repair cornea if required

Remove lens if lacerated



# Corneal laceration

Cat claw

- Cats
- Puppies

Thorn tip (black thorn)

- Working dogs

Hyphema – suspect perf

MUST ensure lens not damaged

Aggressive antibiotics

Manage uveitis

Repair cornea if required

Remove lens if lacerated



# Corneal laceration: Iris prolapse

An ophthalmic emergency

Suspect if :

- pupil distorted
- Dark coloured mass
- Often covered in coat of clotted aqueous

Often allows eye to re-inflate

Surgical repair required thus seek early advice from an ophthalmic surgeon.

Lens damage ?

Sedate and E collar

Systemic antibiotics and NSAID's

Topical broad spectrum antibiotics.





**Rowe**  
Referrals

*Thank you for listening*



timknott@rowevetgroup.com

eyes@rowevetgroup.com

Clinic 01454 521000

0778 2219868





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# Pugoplasty



# Pugoplasty





# Pugoplasty

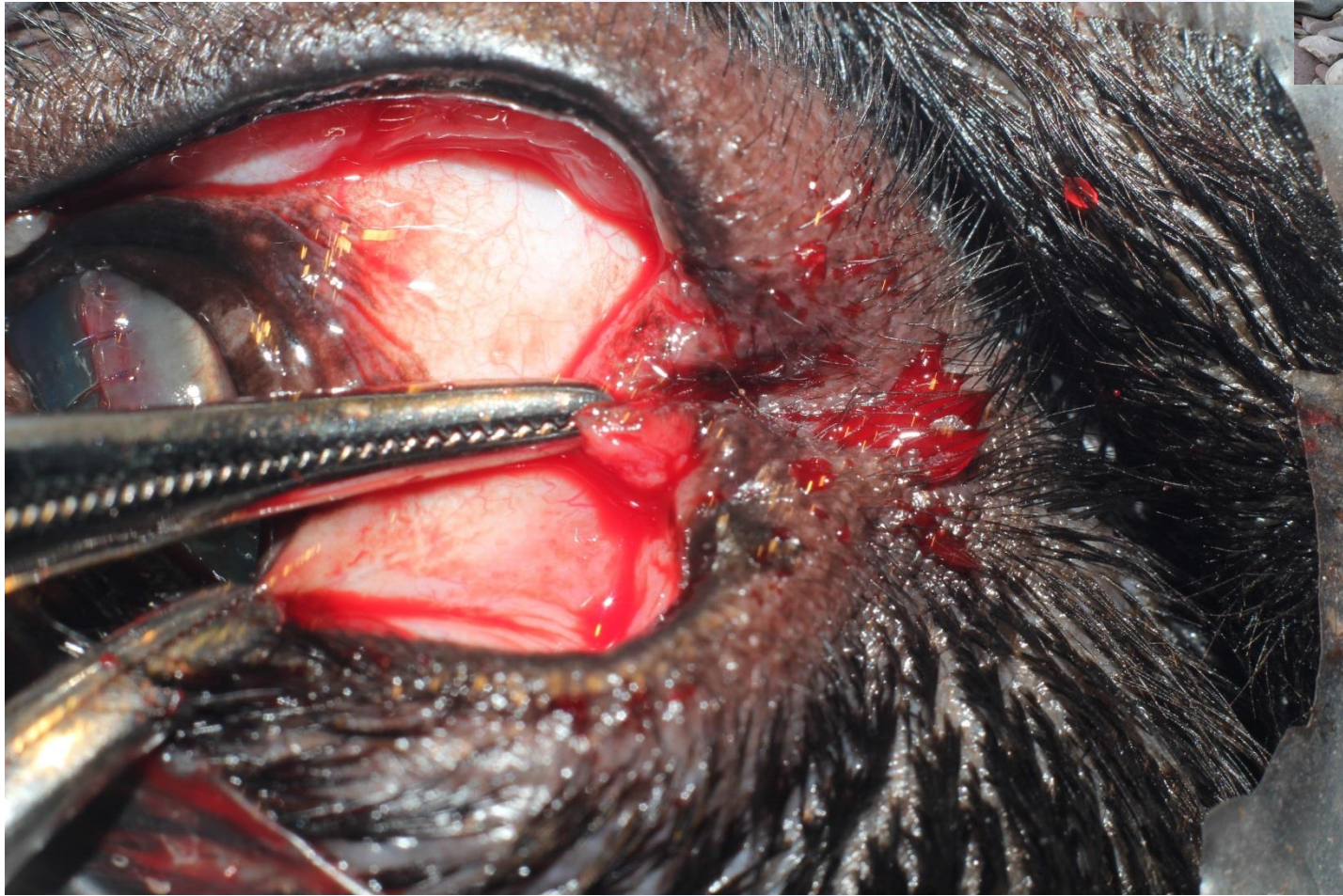


# Pugoplasty



# Pugoplasty





# Pugoplasty



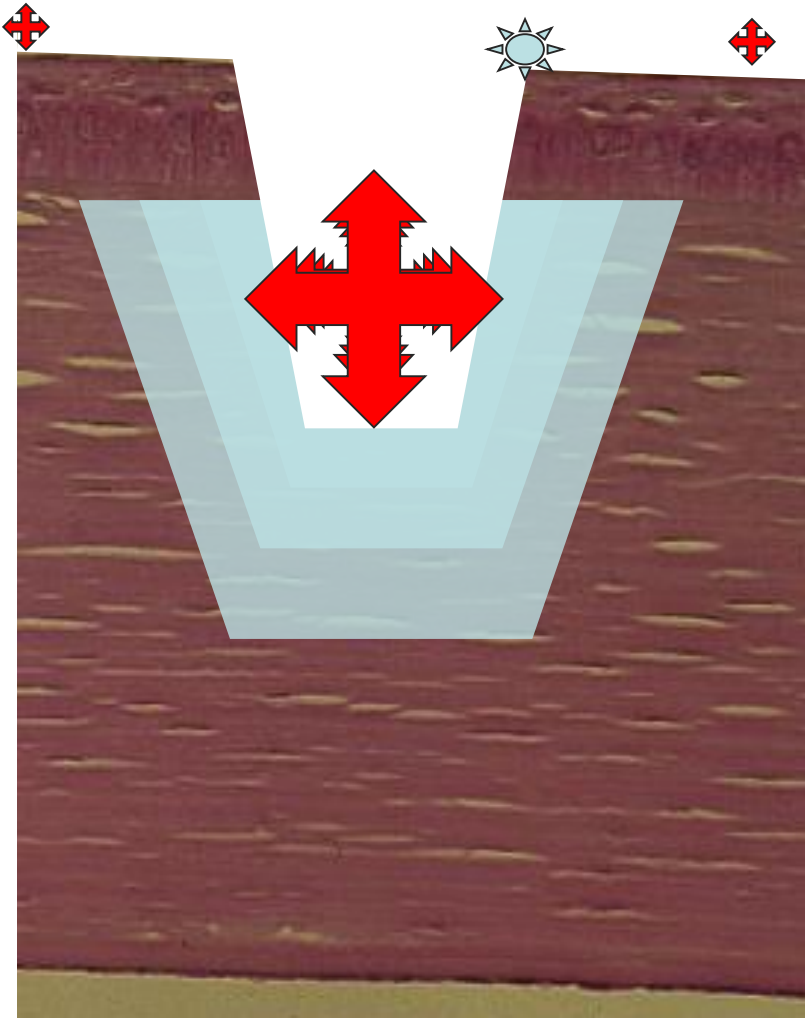
# Pugoplasty





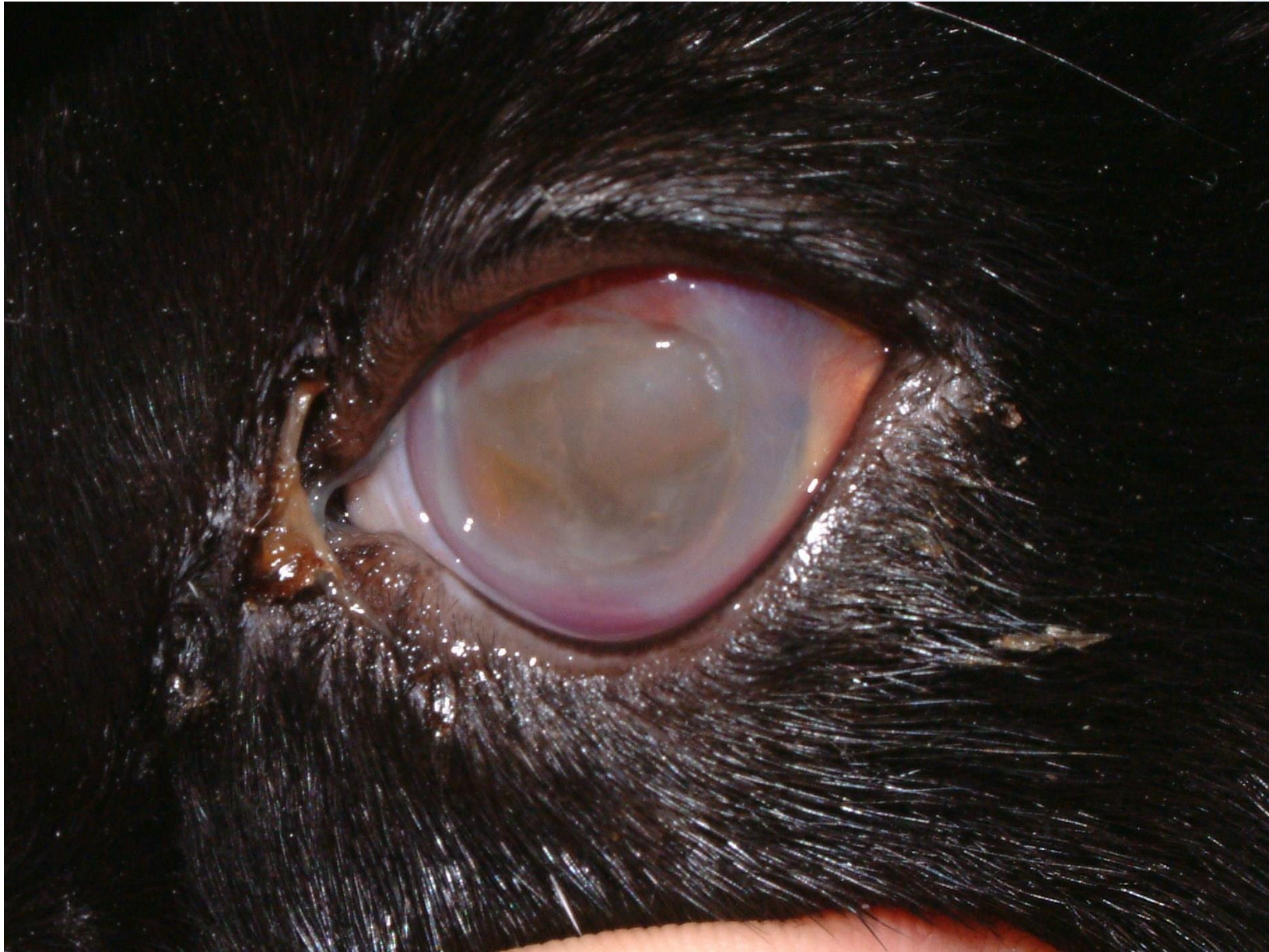
**MELTING ULCERS/  
KERATOMALCIA**

# Melting ulcer





# Beware increasing clarity





# **DENDRITIC ULCERATION**

# Dendritic ulceration: FHV



# Herpetic ulcers

- Rose Bengal stain may show ea
- Often self limiting
- Aetiology?
  - Primary
  - Secondary (FIV)
- Lubrication prophylactic antibiotics.
- Antivirals? Usually not.

