Design and Modeling of Therapeutic Ophthalmic Lenses for Controlled Drug Release

From the Equation to the Eye

Andreia Pimenta

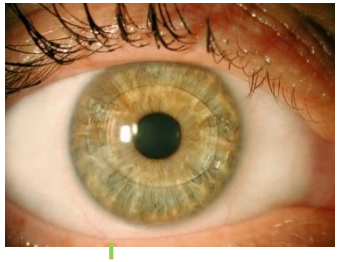
2018 NanoMatLab/BioMat Meeting

- December 6th 2018 -

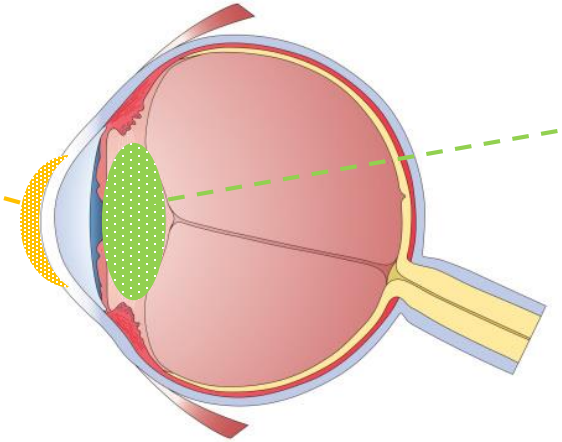
Alternative ocular drug delivery systems

CONTACT LENSES (CL)

INTRAOCULAR LENSES (IOL)

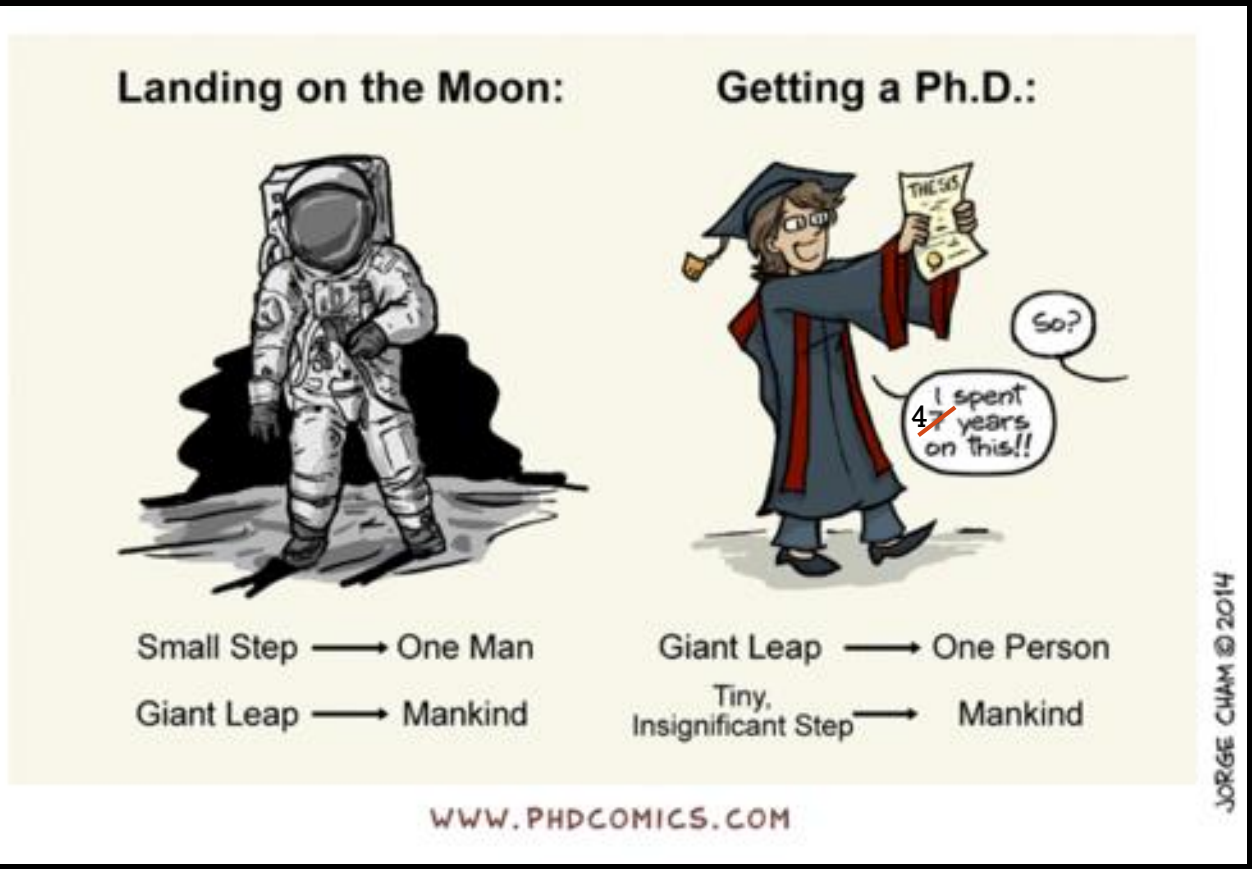


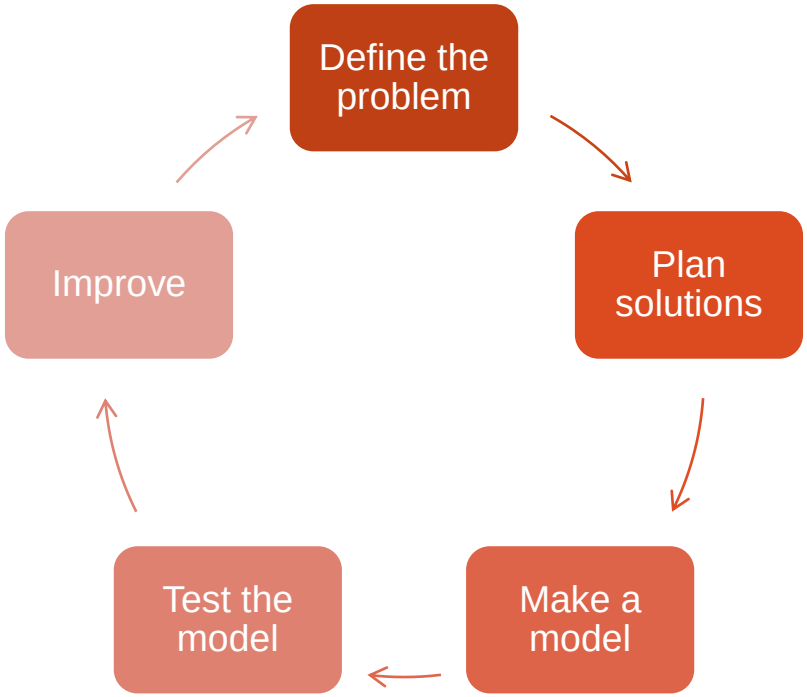
Approved by regulatory authorits and largely accepted



↑ Bioavailability
Controlled release rate
Easy to use

↑ Bioavailability
Controlled release rate
Placed in situ


Landing on the Moon:
Getting a Ph.D.:
THESIS
So?
I spent 4 years on this!!
Small Step ⟶ One Man
Giant Leap ⟶ Mankind
Giant Leap ⟶ One Person
Tiny, Insignificant Step ⟶ Mankind
JORGE CHAM © 2014
WWW.PHDCOMICS.COM


Define the problem
Plan solutions
Make a model
Test the model
Improve

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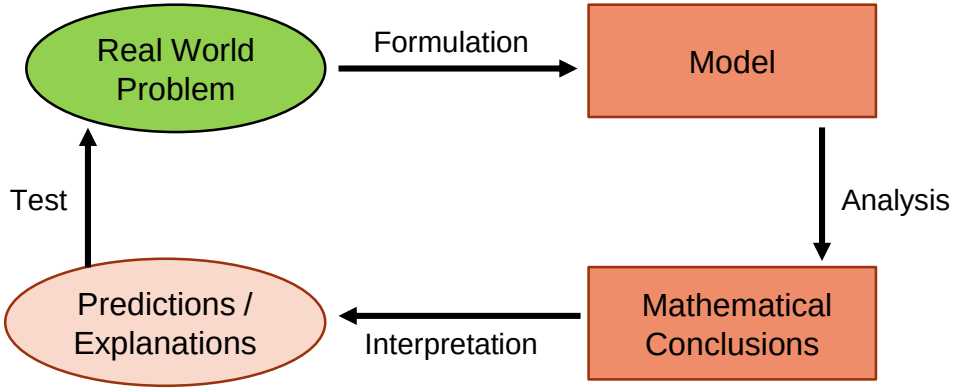
Real World Problem

Post-cataract endophthalmitis and cystoid macular edema after cataract removal surgery

Plan Solutions

Use intraocular lens to deliver in situ *and simultaneously antibiotic and anti-inflammatory drugs*

Make a (mathematical) model



Test the model

Improve

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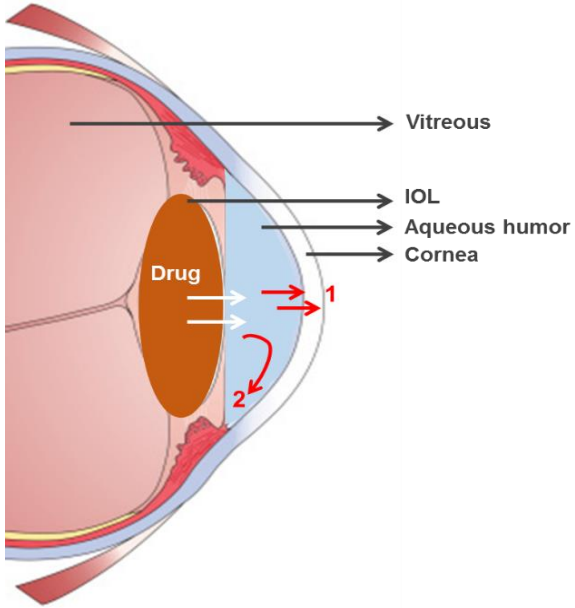
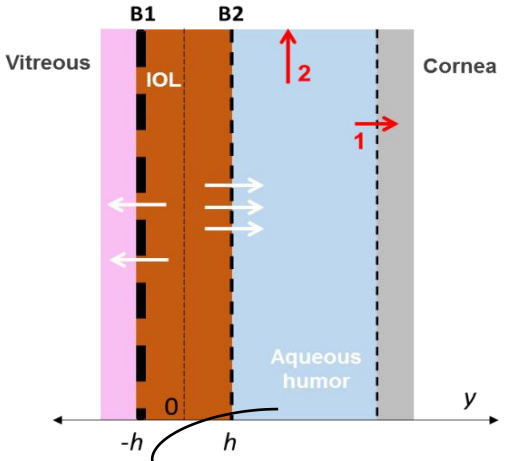
$$V_{aq}\frac{\boldsymbol{dC_{aq}}}{\boldsymbol{dt}} = A_{surface}D_e\frac{\partial C}{\partial y}\Big|_{y=h} - (k_{cornea}A_{cornea} + q)\boldsymbol{C_{aq}}$$





[Drug] ?

K
D_e
k_{cornea}
A_{cornea}
q
V_{aq}

Pimenta et al (2018) *Drug delivery to the eye anterior chamber by intraocular lenses: An in vivo concentration estimation model*. Eur J Pharma and Biopharma 133 (2018) 63–69

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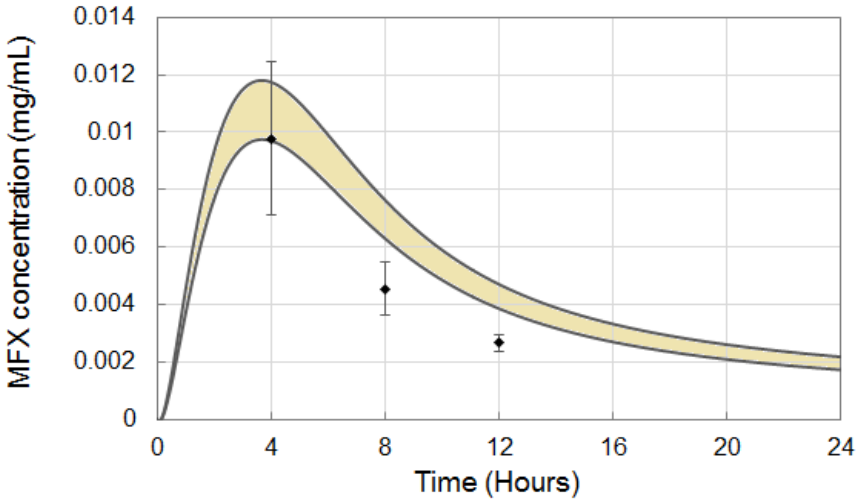
Study where MFX loaded **IOLs** were implanted in **rabbits** and **samples of the aqueous humor were collected**.

Aq. Hum. collected after 4, 8 and 12 hour of IOL implantation



Kleinmann, G., et al., *Hydrophilic acrylic intraocular lens as a drug-delivery system for fourth-generation fluoroquinolones.* Cataract Refract Surg, 2006. **32**(10): p. 1717-21.

Pimenta et al (2018) *Drug delivery to the eye anterior chamber by intraocular lenses: An in vivo concentration estimation model*. Eur J Pharma and Biopharma 133 (2018) 63–69

Real World Problem

Post-cataract endophthalmitis and cystoid macular edema after cataract removal surgery

Drugs
Moxifloxacin: antibiotic
Diclofenac: nonsteroidal anti-inflammatory

Materials
Lab-made HEMA/MMA based hydrogels

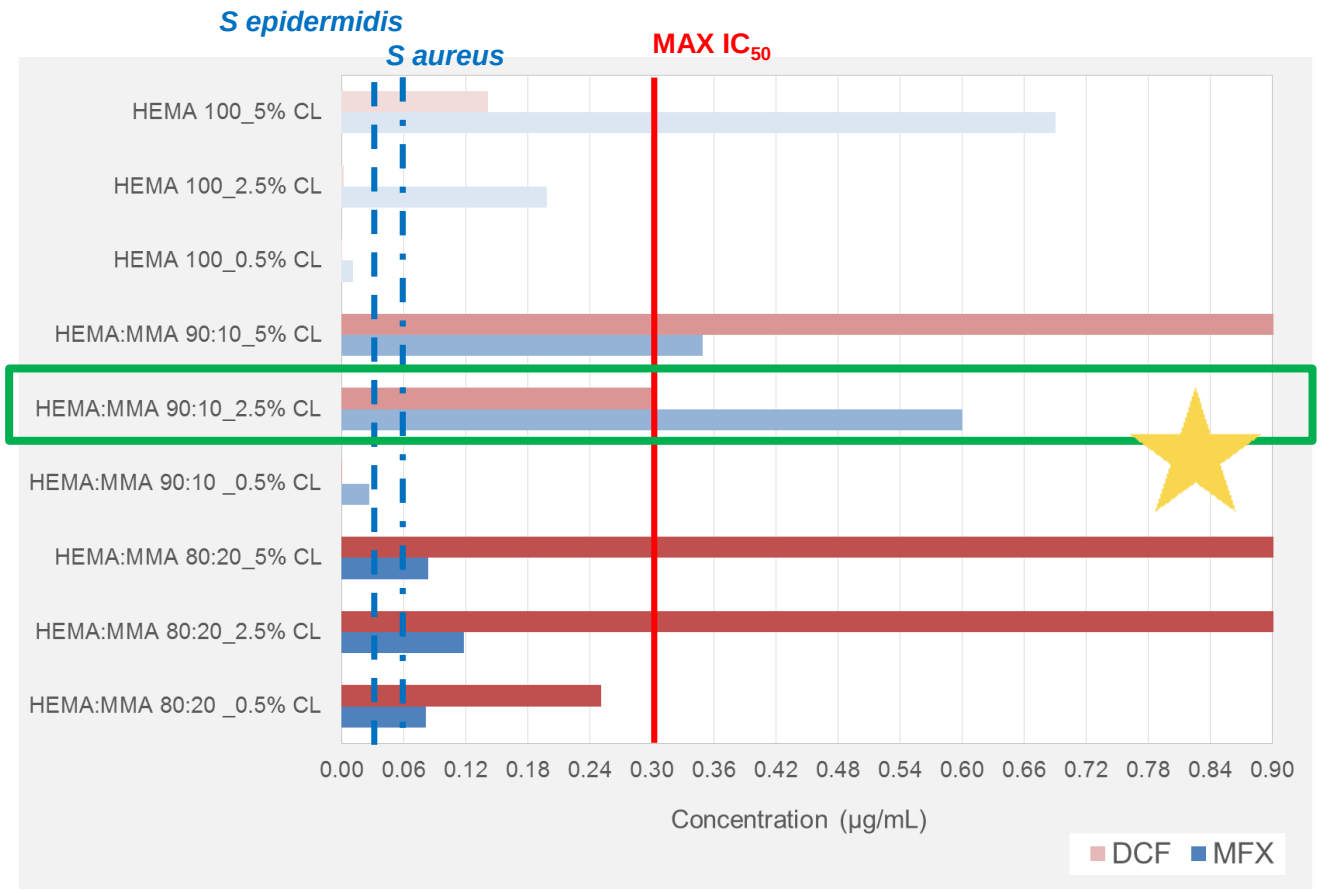
Antibiotic (2 – 3 weeks)
Nonsteroidal anti-inflamatory (3 weeks)

Pimenta et al (2018) *Antibiotic and nonsteroidal anti-inflammatory drugs simultaneous release for post-cataract endophthalmitis and cystoid macular edema prevention*. (Submitted)

Real World Problem

Post-cataract endophthalmitis and cystoid macular edema after cataract removal surgery

Predicted *in vivo* concentrations at day 21 (3 weeks) of release:



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Real World Problem

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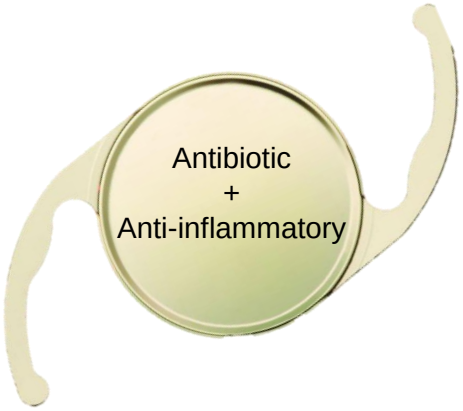

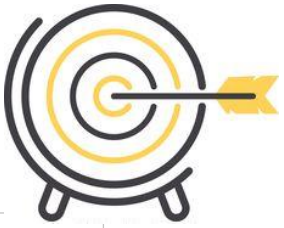

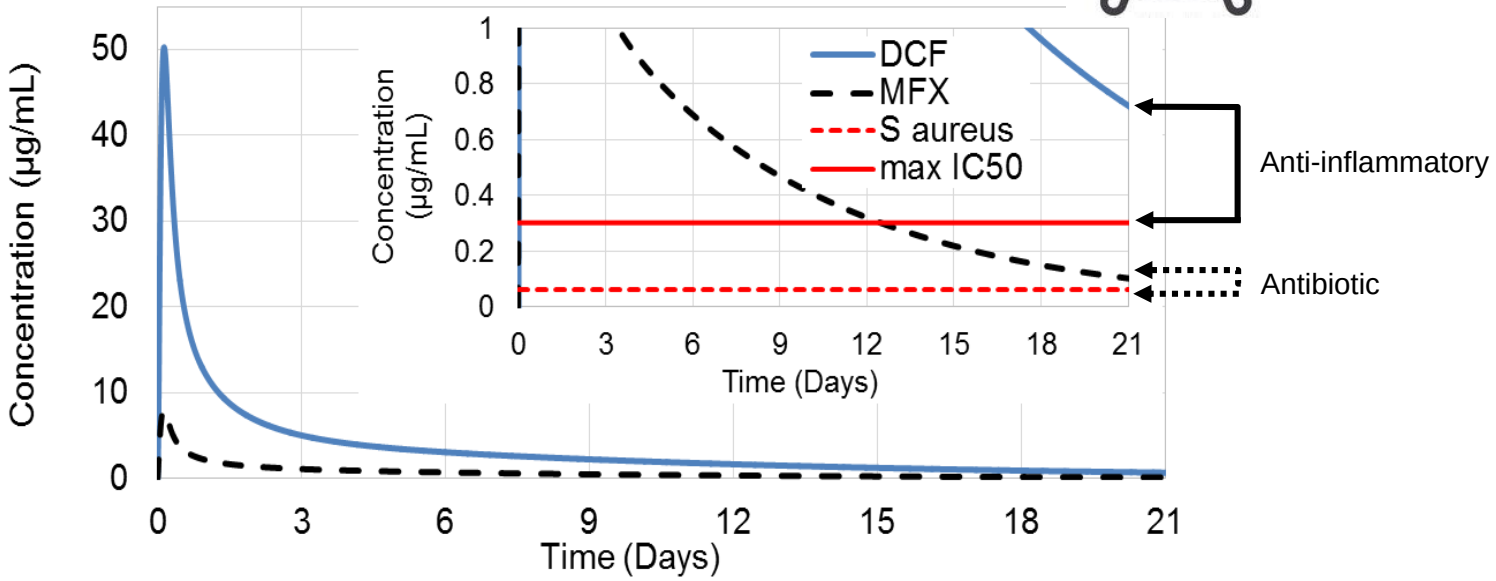

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thank you!

Projects UID/QUI/00100/2013, M-ERA.NET/0005/2012 and PTDC/CTMBIO/3640/2014

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