Microfluidic Device For Sperm Chemotaxis

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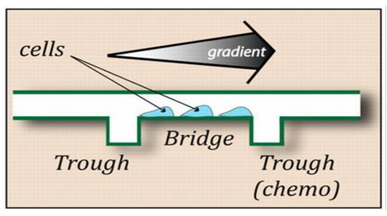
1. Introduction

Spermatozoa follows a concentration gradient of the oocyte chemoattractant

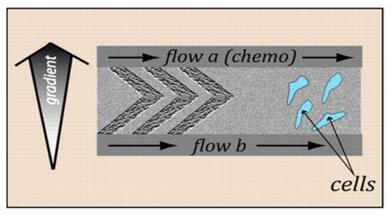
CASA(Computer Assisted Sperm Analyzer) for snap shot of sperm motility - Does not allow real time quantification

Classical methods like Zigmond and Dunn chamber - No stable gradient

Aim: To develop a microfluidic device to generate a stable linear gradient for sperm chemotaxis



Zigmond chamber



Microfluidic chamber

2. Objectives

1. Develop a microfluidic device that can generate linear gradient
2. To track single sperm chemotaxis in progesterone (P_4) gradient

3. Methodology

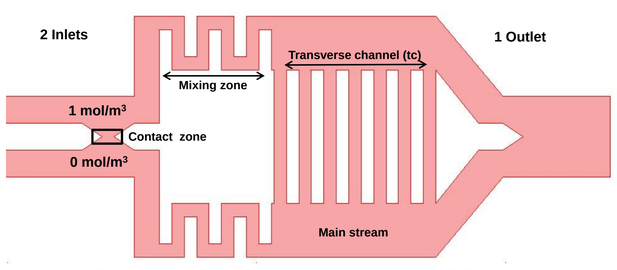
Microfluidic Device simulation

FEM simulation using Comsol Multiphysics
- Incompressible navier stoke
- Convection diffusion equation

Inlet concentrations : 1 and 0 mol/m^3

Diffusion coefficient : 1E-10 m^2/s

Contact zone length : 0, 5,15, 25 and 50 µm



Sperm Motility Device (SPM)

Test device for linear gradient formation (simulation)

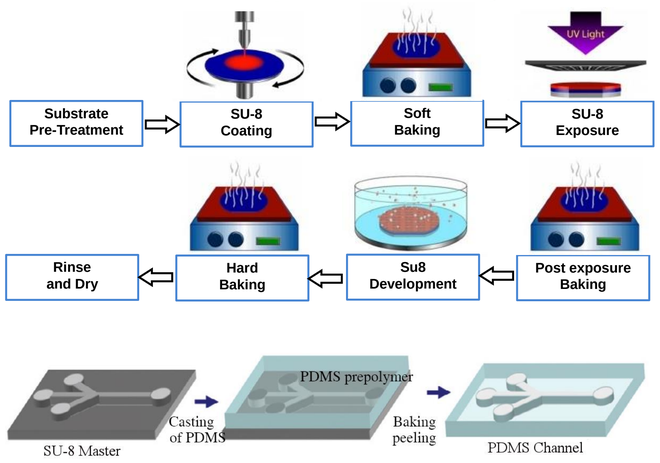
↓

Selected device is fabricated Photolithography (SU8 Mould)

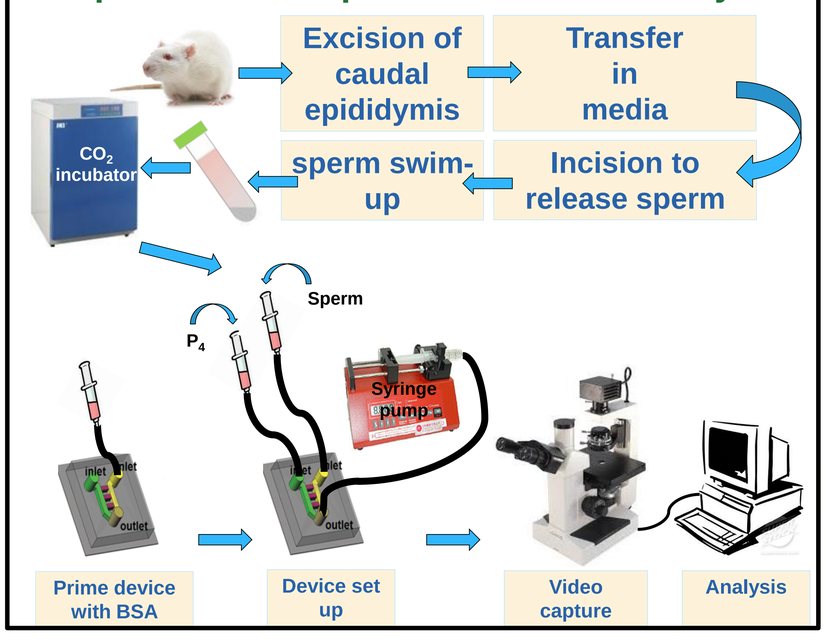
↓

PDMS Replica of SU8

Fabrication of Sperm motility device

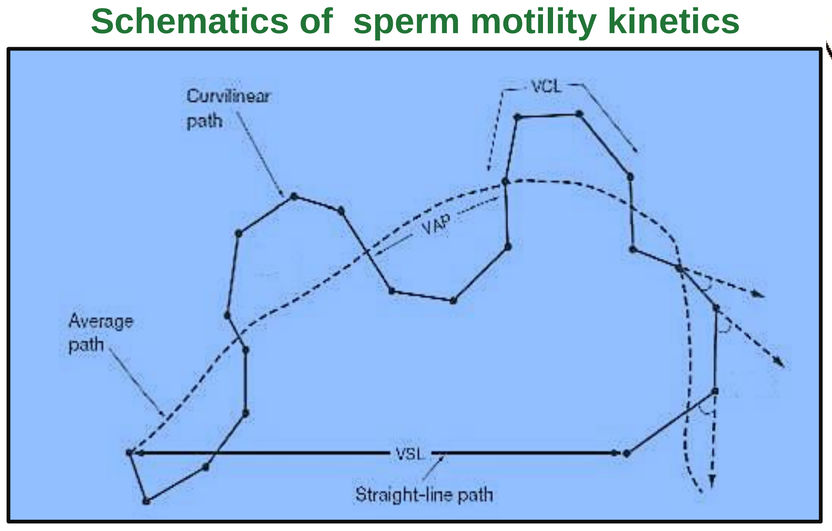


Experiment set-up for Chemotaxis analysis



Movement of sperm under the influence of P_4 was analysed using ImageJ software and the Manual Tracking plugin.

Schematics of sperm motility kinetics

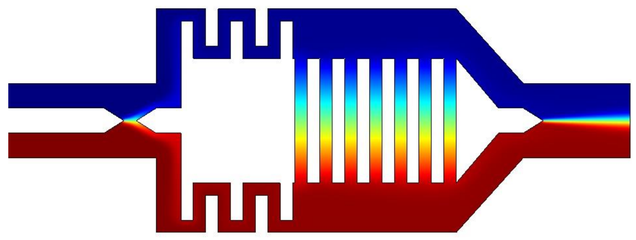


VAP: Smoothed Path Velocity (microns/sec)
VCL: Track Velocity (microns/sec)
VSL: Straight Line Velocity (microns/sec)

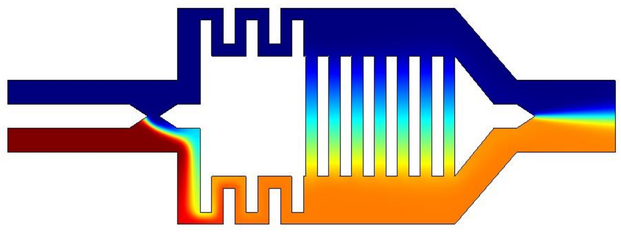
4. Results

Simulation data - Concentration profile

0% difference in flow

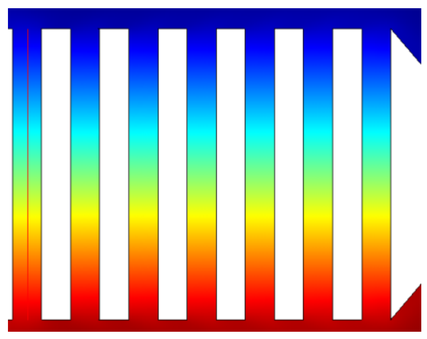


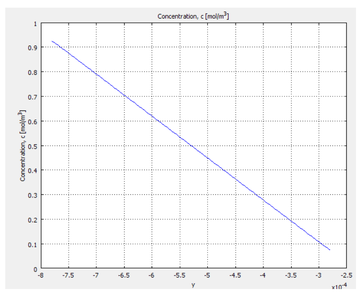
50% difference in flow



4. Results

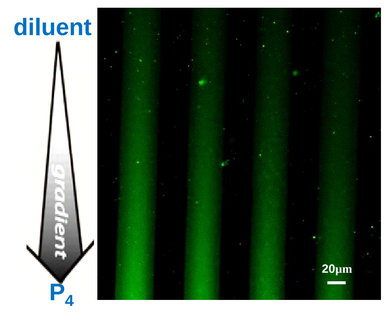
Simulation data – Concentration gradient



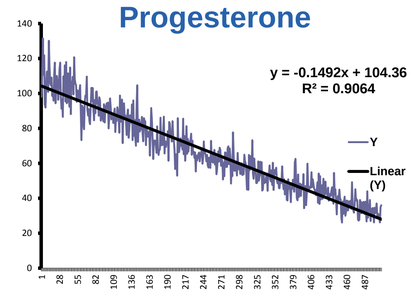


Experimental data – Concentration gradient

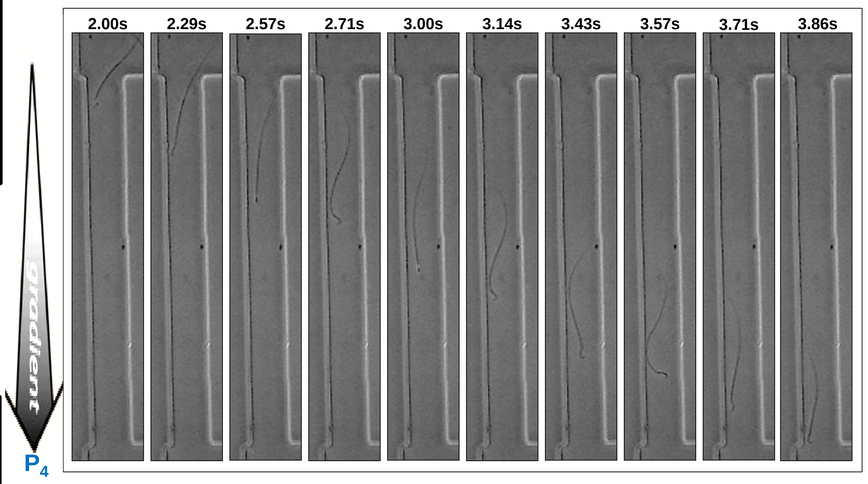
P_4 gradient in the channel



Linear gradient of Progesterone

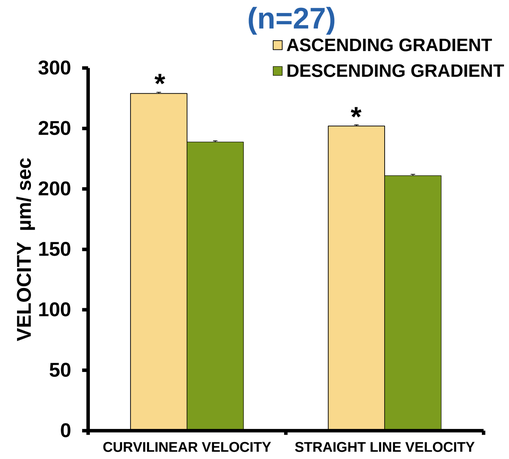


Tracking of Sperm in P_4 gradient



Sperm track

Tracking velocity of spermatozoa (n=27)



Sperm track was generated using Manual tracking plugin for a) Ascending gradient, and b) Descending gradient

5. Conclusions

- Sperm track in ascending gradient is linear as compared to that in the descending gradient.
- Sperm velocity significantly increased (p=0.006) in ascending gradient as observed in vivo.

6. Expected Outcome

Development of a microfluidic device that could be applied to:

- Study sperm chemotaxis
- Select good quality sperm for IVF

•Acknowledgments: The authors are thankful to CEN IITB for fabrication facility and IRCC Healthcare seed grant for the funding.