

Expo 2007

Laminar Flow in Microfluidic Channels

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Madison, WI, Apr. 19th – 21st, 2007

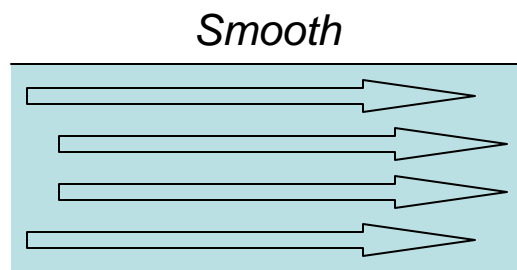
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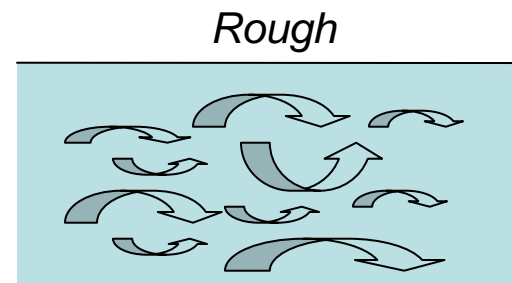
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Laminar and Turbulent Flow

- What is Laminar Flow?
 - Layers of liquid that flow in a uniform fashion
 - Layers do not mix with neighboring layers
 - Opposite of **turbulent flow**

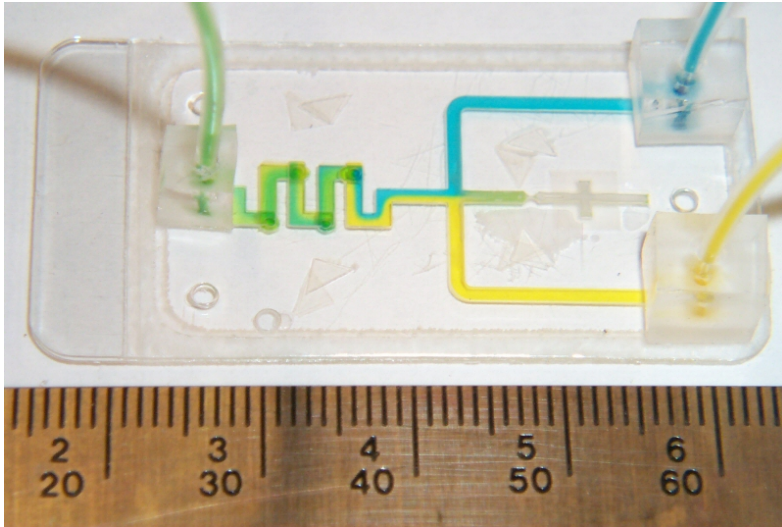


Laminar Flow



Turbulent Flow

Laminar vs. Turbulent Flow



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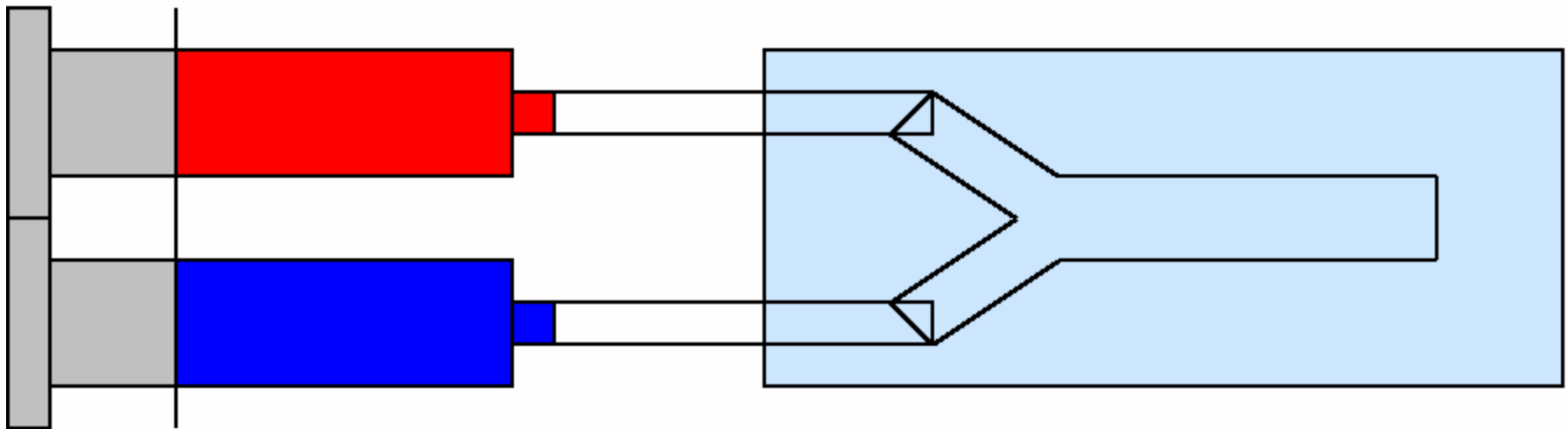
Sink

- A sink can display both laminar and turbulent flow
- Lets watch a **Movie!!!!**



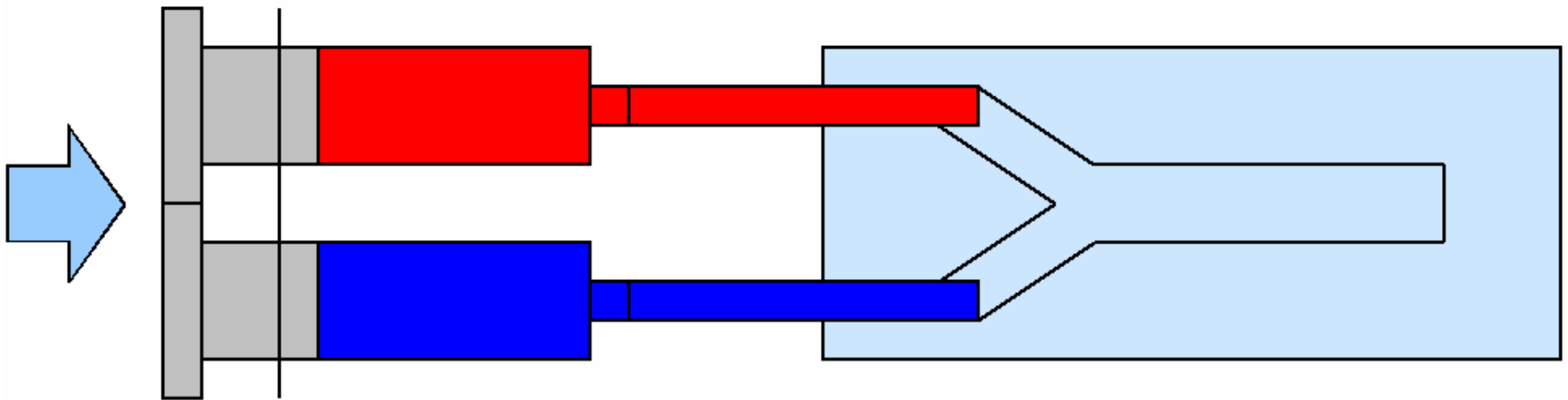
Micro Fluidics and Laminar flow

- Start with two syringes filled with blue and yellow water



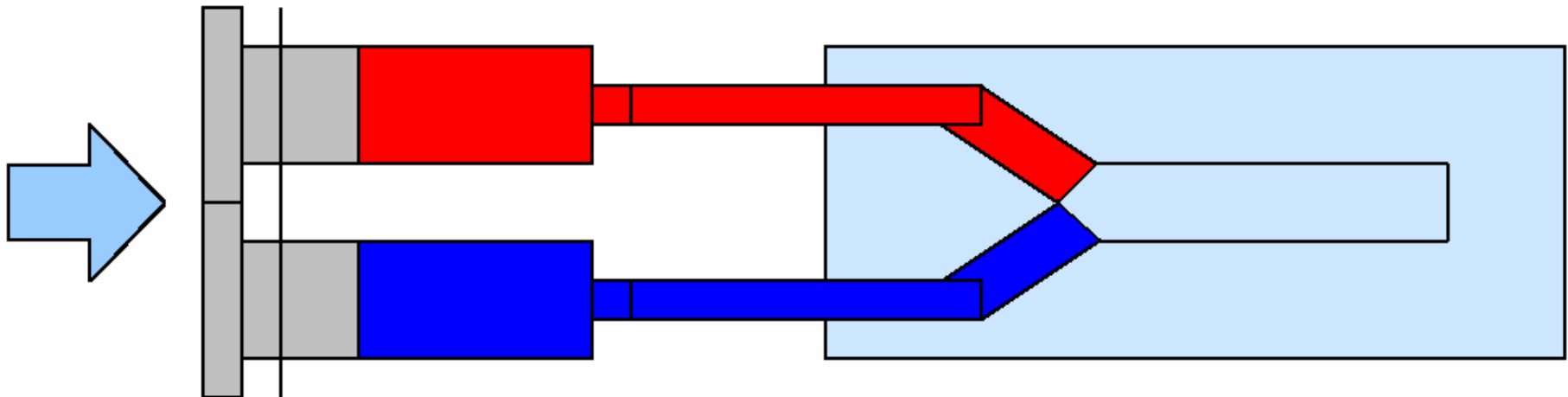
Micro Fluidics and Laminar flow

- Start to press the liquid into the channel



Micro Fluidics and Laminar flow

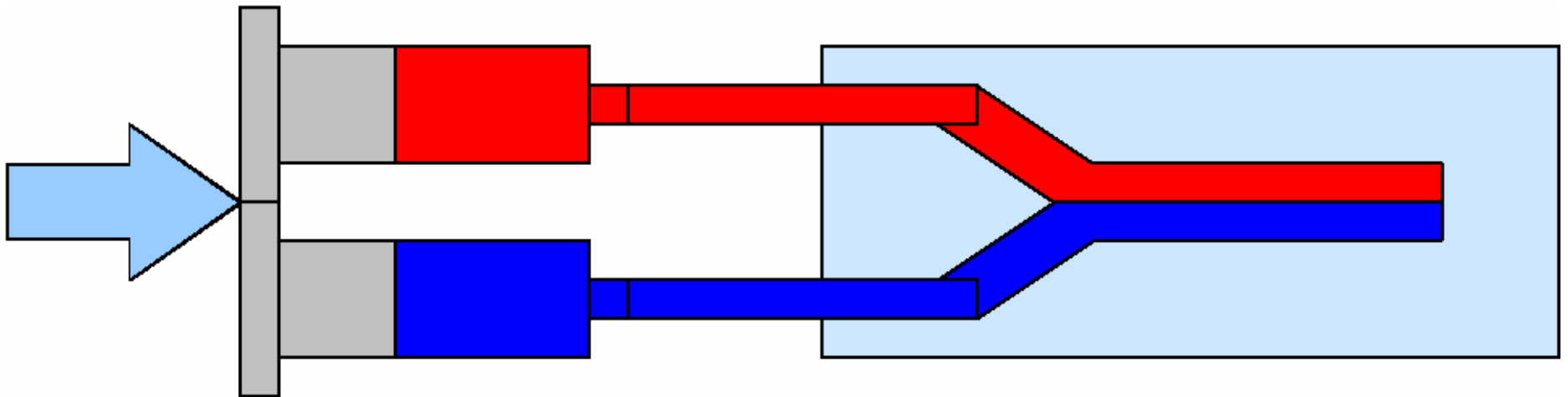
- The fluid starts to flow in the Microchannel



What Happens Next?

Flow Chart for Microfluidic channel

- It does not mix immediately because it is in laminar flow
- This is due to its small size of the channel



Reynolds Number and Stokes Flow

- Reynolds number is a ratio between inertial force (ρv_s) and viscous force (μ/L).

$$Re = \frac{\rho v_s L}{\mu} = \frac{v_s L}{\nu} = \frac{\text{Inertial forces}}{\text{Viscous forces}}$$

http://en.wikipedia.org/wiki/Reynolds_number

- Defines if a liquid will be laminar (Reynolds $\ll 1$) and turbulent (Reynolds $\gg 1$) flow.
- In Microfluidics the Length (L) or Diameter of the channel is what dominates the equation causing a low Reynolds number.
 - This is also called Stokes flow

Large vs. Micro

- When dealing with cup of water the dominate force acting on the water is gravity causing the water to be turbulent.
- Where as in microchannels gravity is overcome by surface tension and capillary forces.
 - Surface tension is an effect within the surface layer of a liquid that causes that layer to behave as an elastic sheet
 - Capillary force is the ability of a substance to draw another substance into it



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Images and text from wikipedia.org

Oil and Water

- What will happen if you drop some ink into a glass of water?
- What will happen if you drop some olive oil into the water?



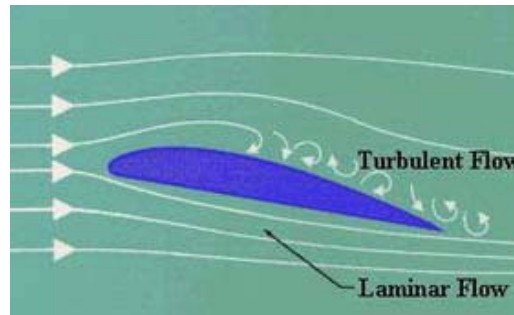
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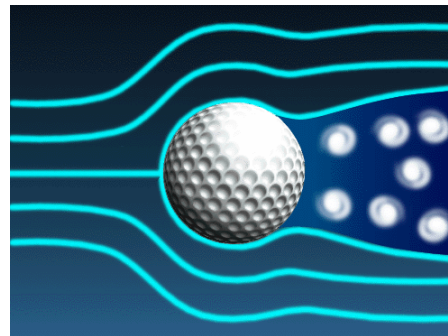


Laminar Flow in Our Daily Life

- Airplanes
 - Air flow from the wings has both laminar and turbulent flow



- Golfing
 - Airflow around the golf ball has both laminar and turbulent flow





Thank You!!!!

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