

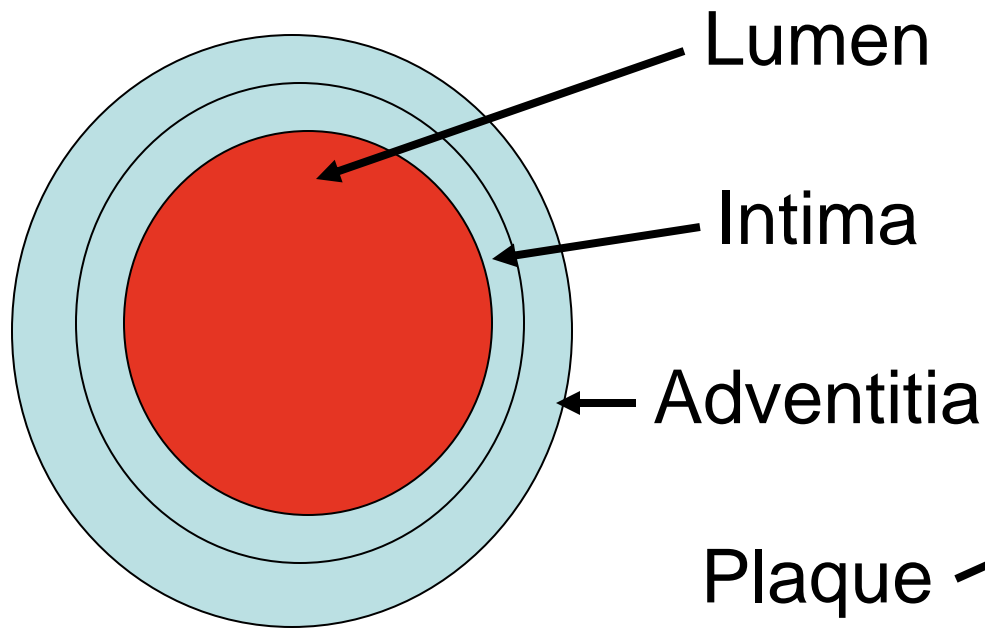
# Modeling of Diffusion of Anti-Restenosis Compounds Into Arterial Tissues From Drug-Eluting Arterial Stents

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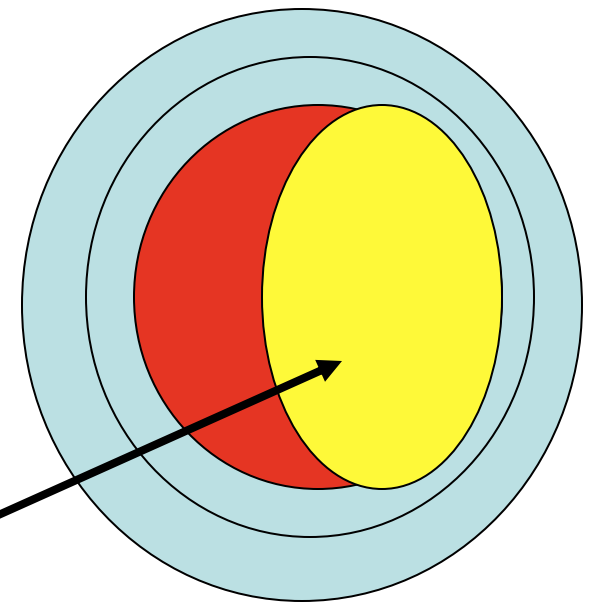
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Louisiana Tech University  
LA-SIGMA  
RET/STEM

# Anatomy of an Artery

Normal Artery

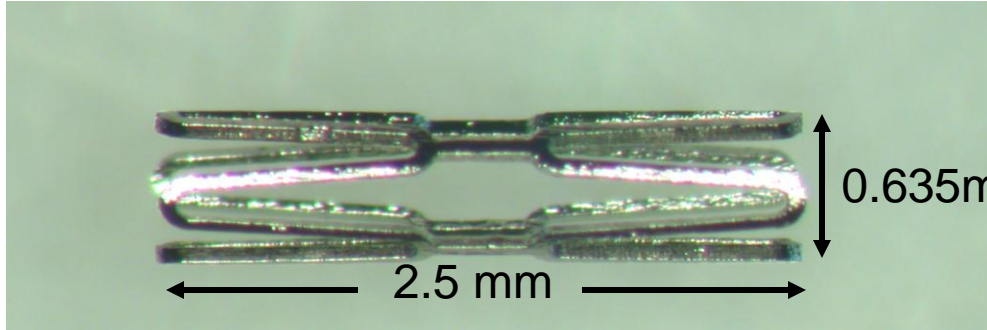


Plaque



Stenotic Artery

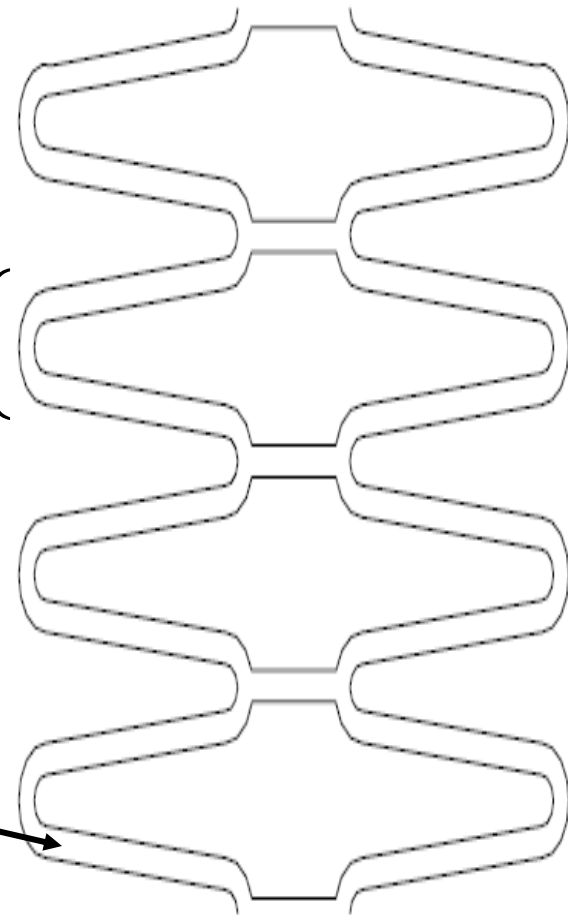
# Anatomy of a Stent



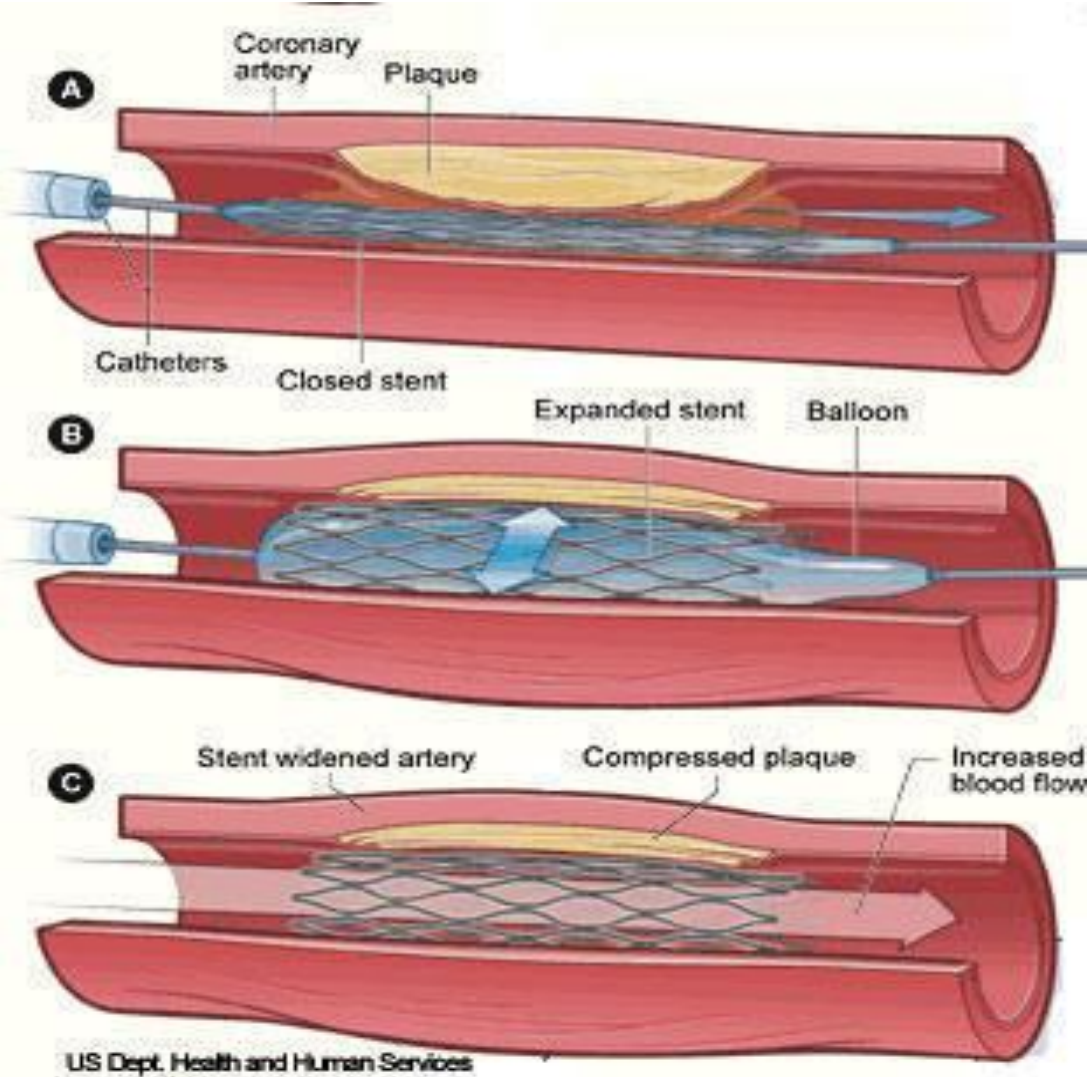
Cell



Strut (0.07 mm)



# Stent Placement with Angioplasty



**Stenosis:**

**over and over and over again**

**Stenosis: narrowing of the vessel.**

**Restenosis: recurrence of stenosis.**

**Anti-Restenosis: inhibiting restenosis.**

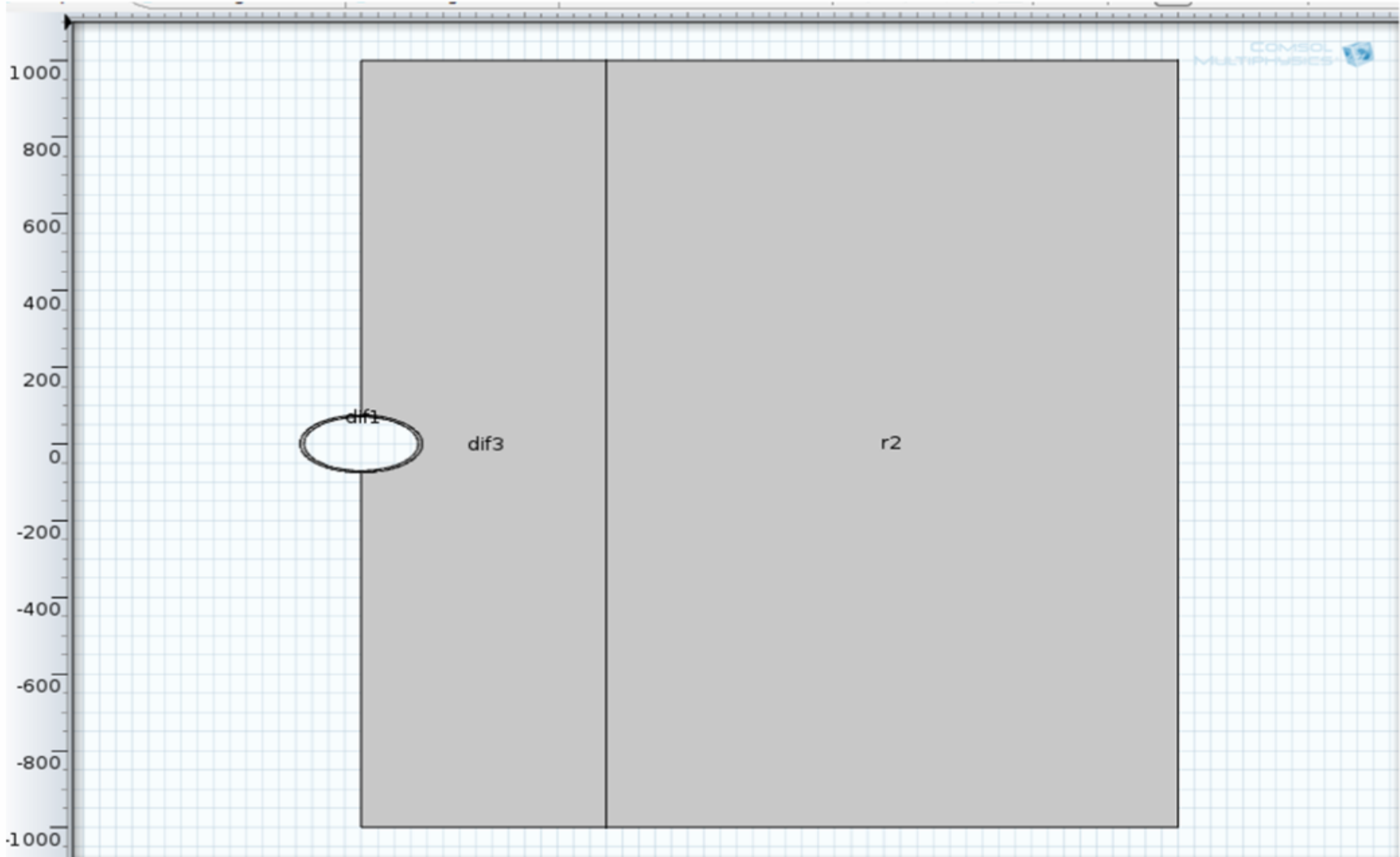
# Drug-Eluting Stents

- Sirolimus and Paclitaxel
- Originally marketed as cancer treatments
- Inhibit rapid tissue growth
- Drugs are infused within a polymer
- Stent is coated with the polymer
- Drug then elutes and diffuses into the surrounding tissue

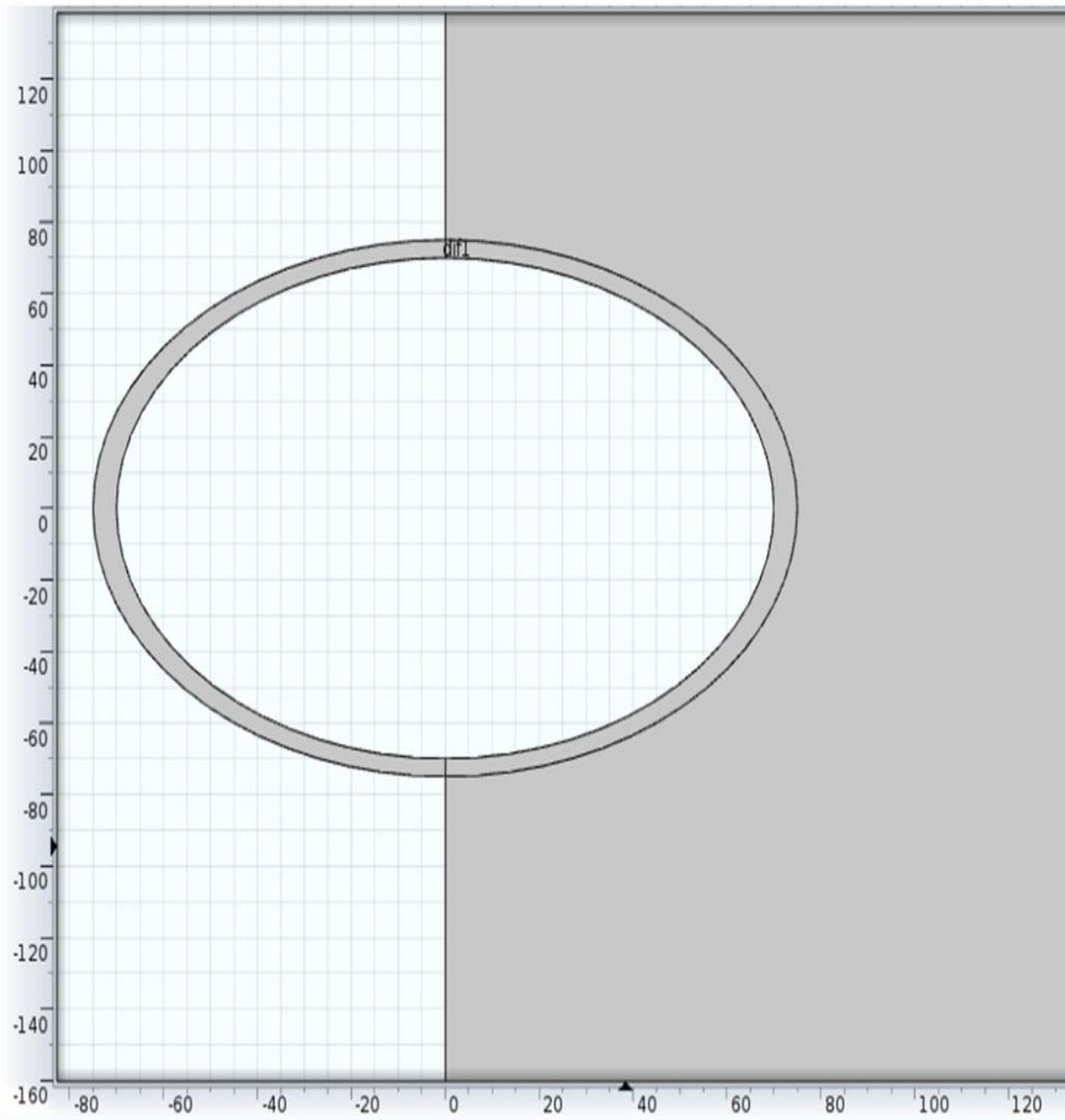
# Mathematics Issues During Modeling

- Plane Geometry: Circles, rectangles, dimensions.
- Standard Coordinate Systems: Plane and polar.
- Dimensional Analysis: Units and notation.

# COMSOL Model







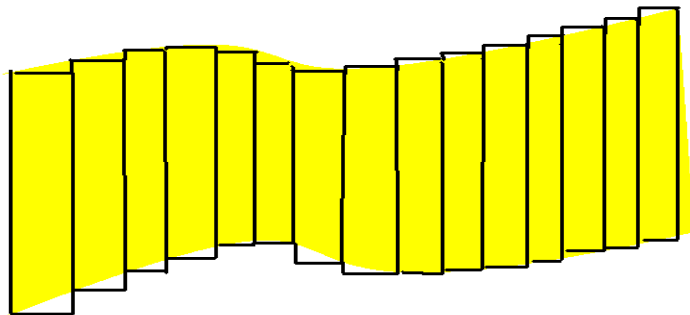
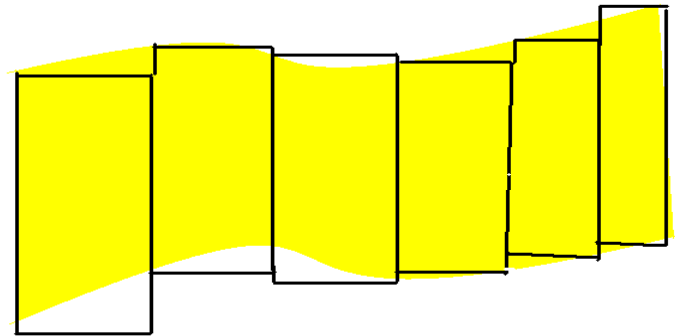
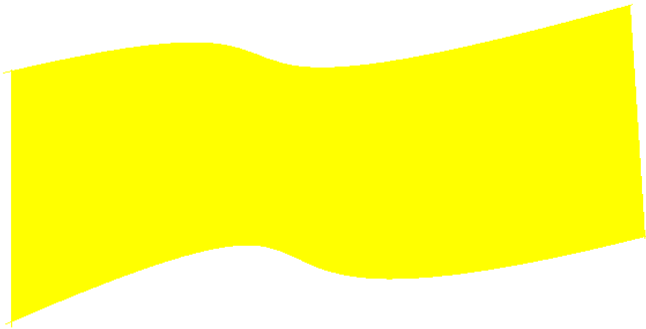
# Diffusion Equation

$$\frac{\partial C_w}{\partial t} = \mu_w \left( \frac{\partial^2 C_w}{\partial x^2} + \frac{\partial^2 C_w}{\partial y^2} \right)$$

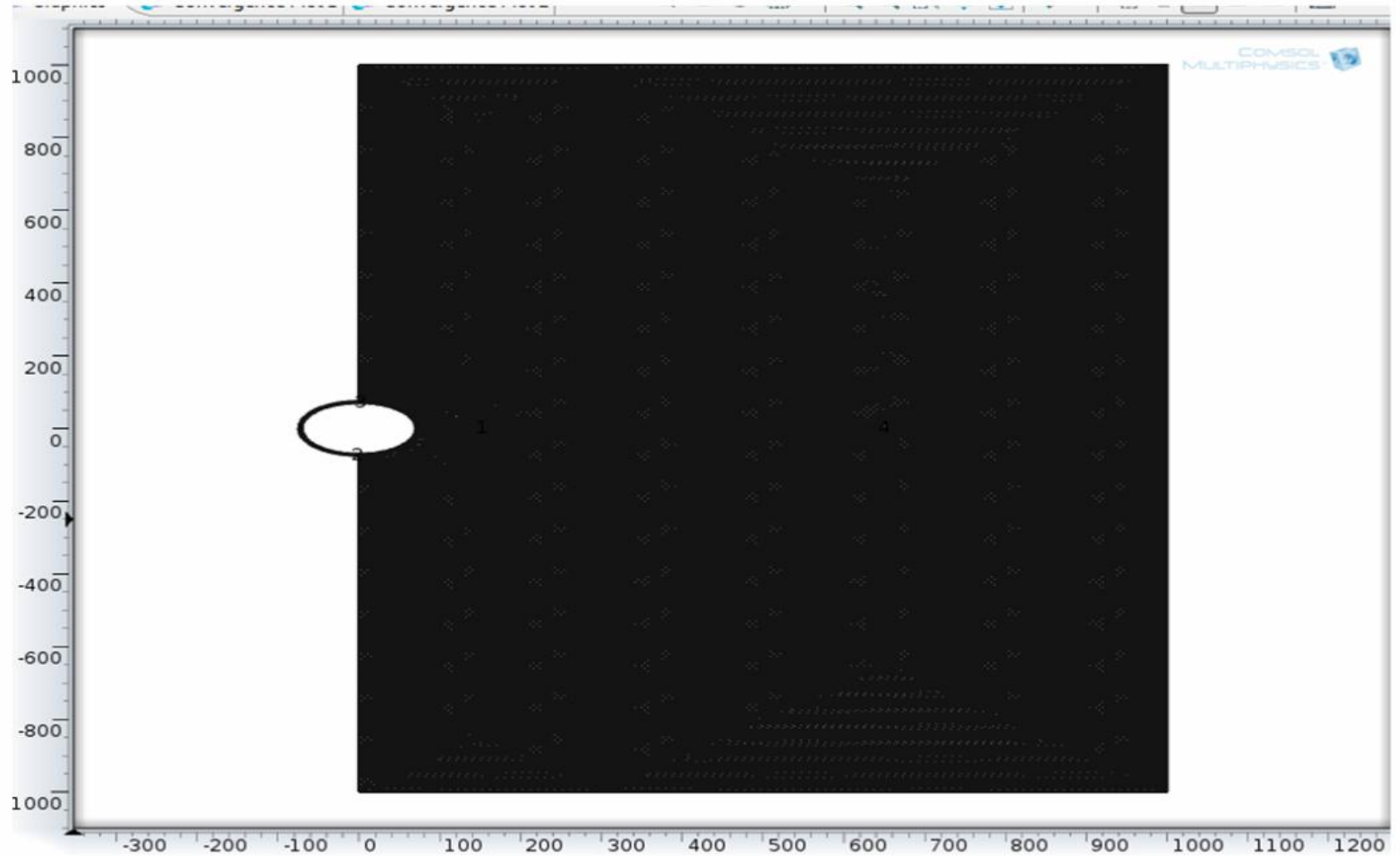
# Methods for Solving PDEs

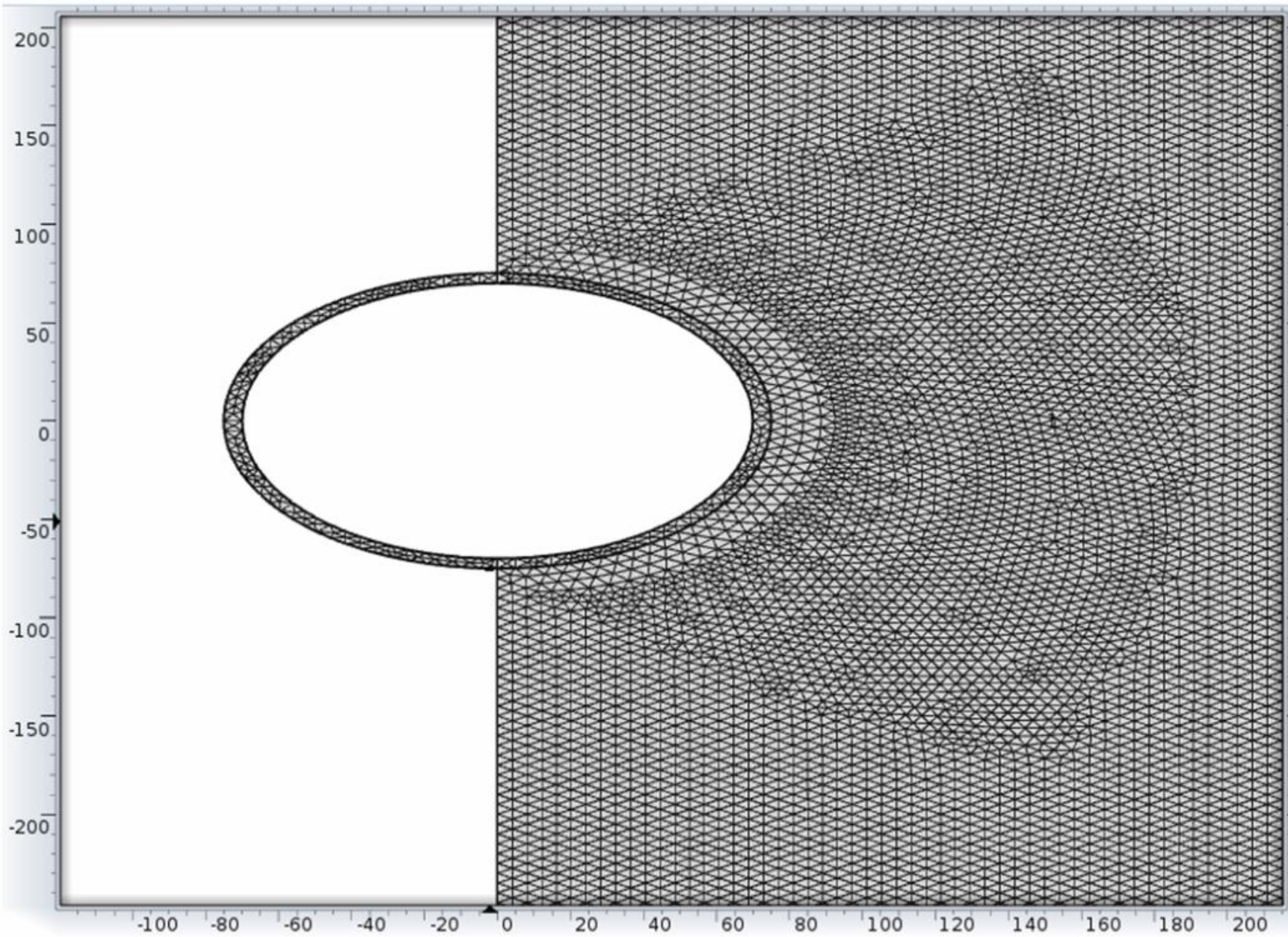
- Finite Difference Method (FDM)
- Finite Element Method (FEM)
- COMSOL software applies the FEM

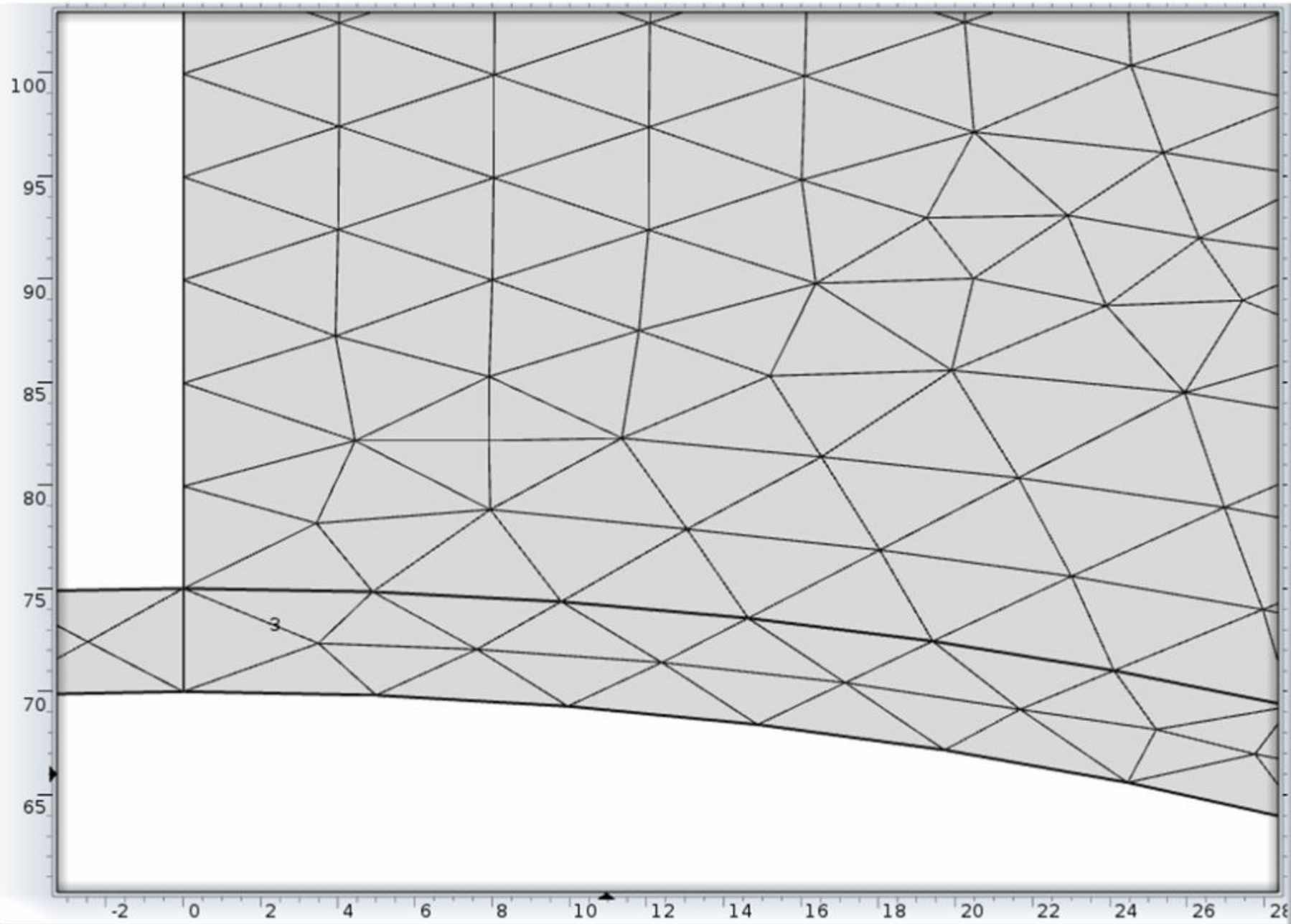
# Analogy of the Squigglagon



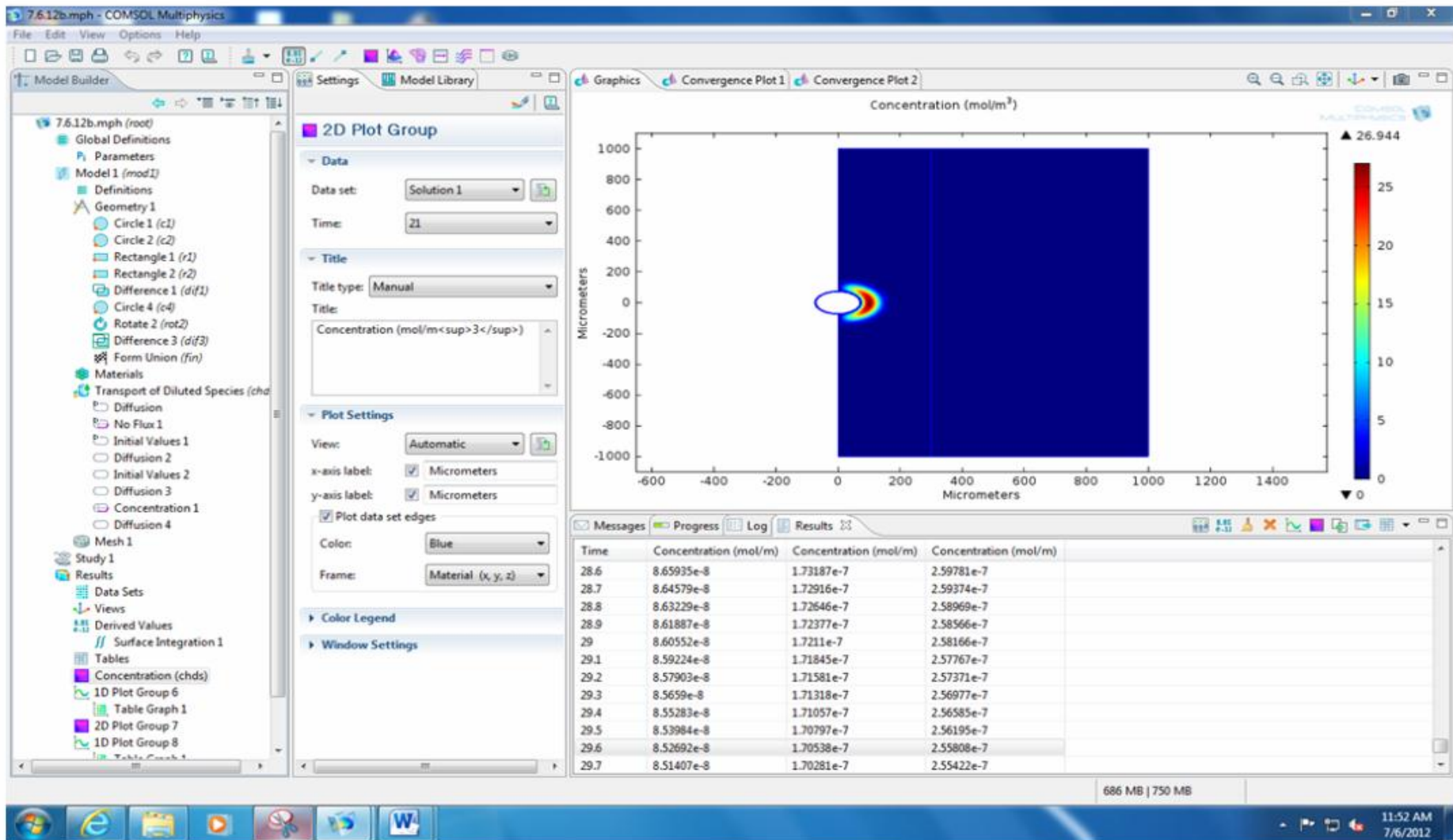
# The Mesh





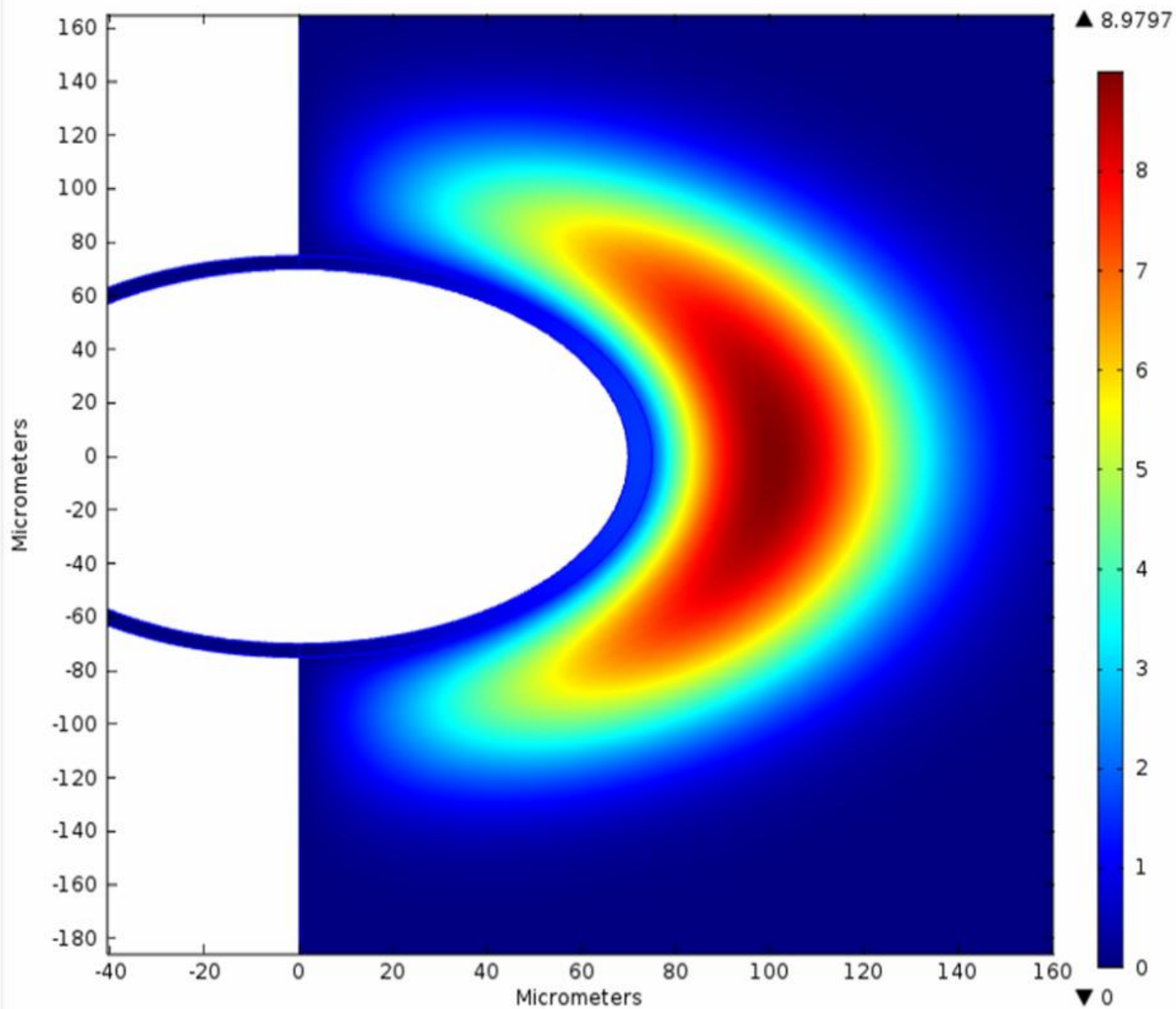




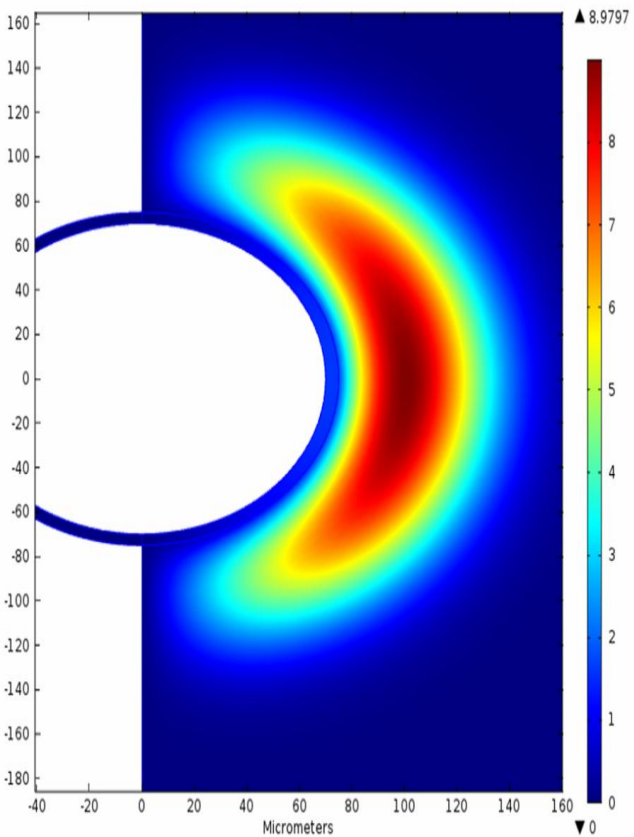




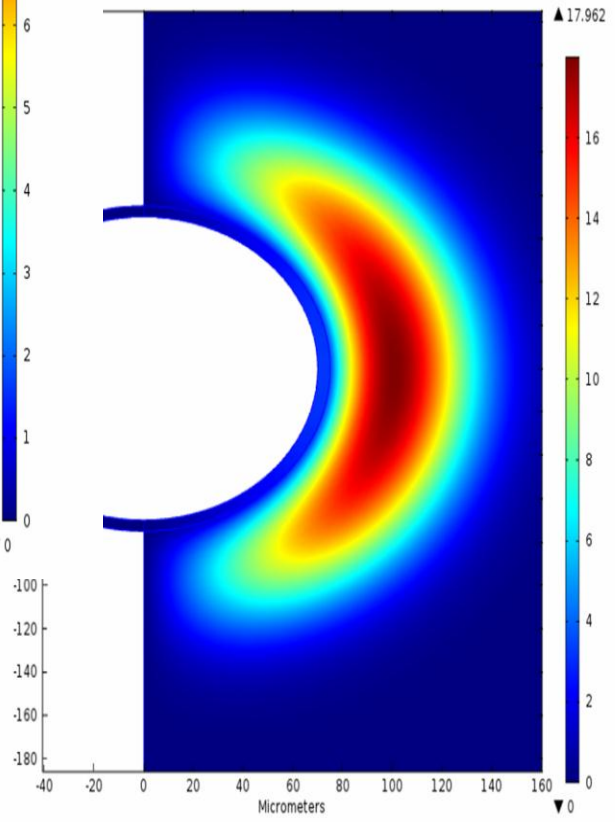
Concentration (mol/m<sup>3</sup>)



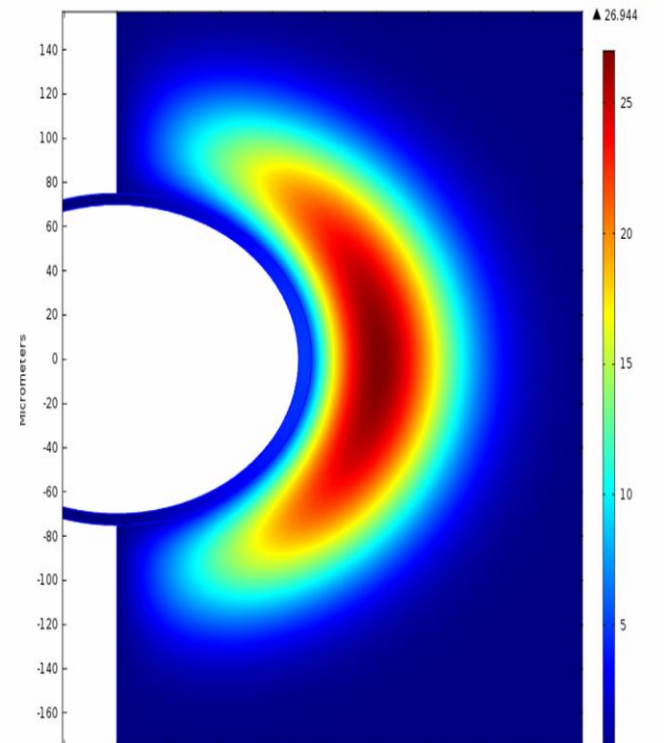
Concentration (mol/m<sup>3</sup>)

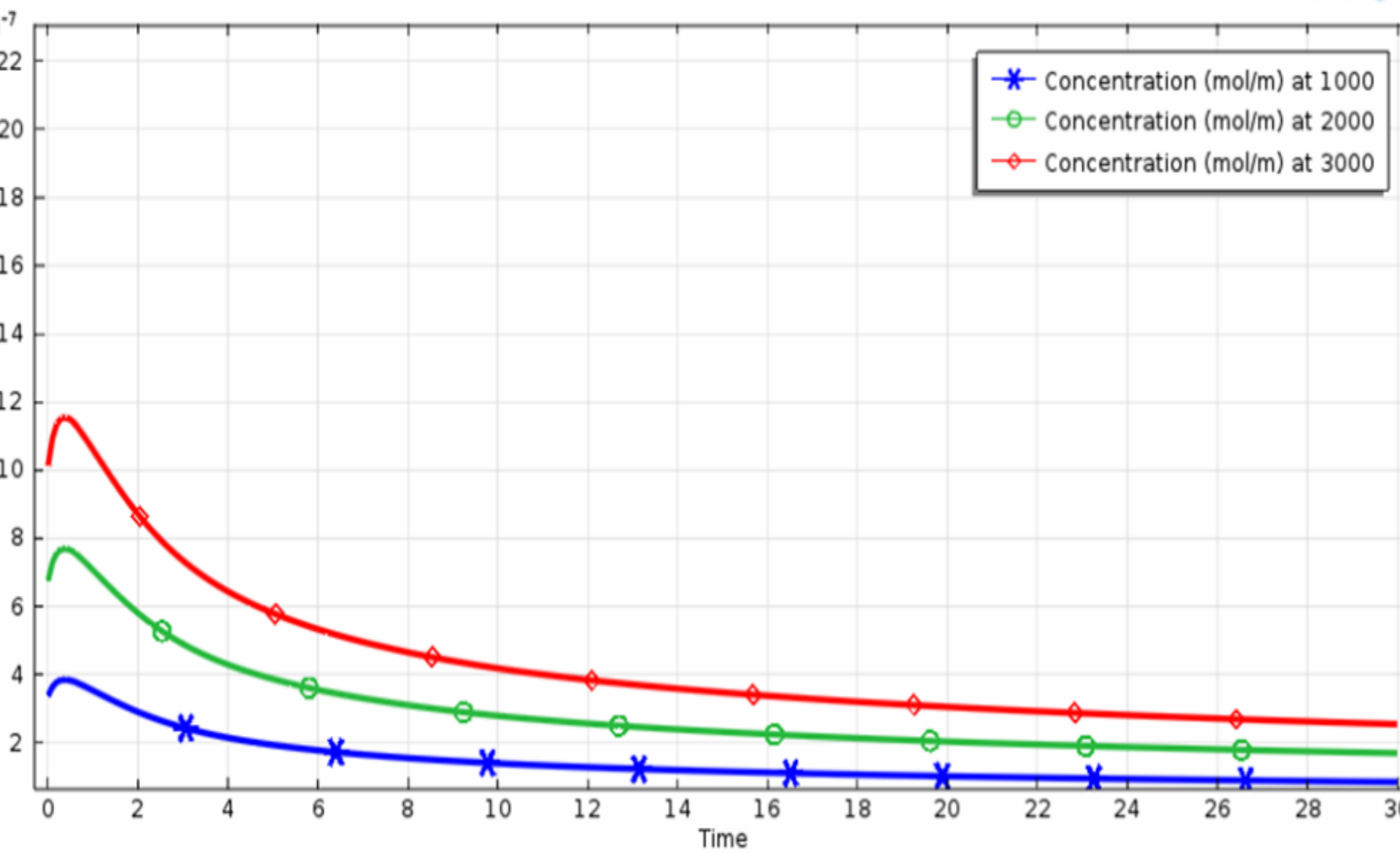


Concentration (mol/m<sup>3</sup>)



Concentration (mol/m<sup>3</sup>)





# Conclusions

- The drug does, in fact, diffuse from the stent coating into the surrounding tissues.
- The diffusion exhibits a burst phase of diffusion characterized by a positive rate of change followed by a secondary phase of gradual diffusion of negative rate of change.
- The drug is present in the surrounding tissues 30 days after placement.

# Directions for Future Study

- Increase the time frame of the study.
- Test different drugs at various initial concentrations.
- Test multi-layer coatings.
- Change the perspective of the model.

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