

1135-D1-2929 **Alan Garfinkel*** (agarfinkel@mednet.ucla.edu). *Teaching Modeling and Dynamics to Freshman Biology Students.*

We designed a class to teach modeling, using ordinary differential equations, to freshmen biology students. We designed a 2-quarter class that had

- multi-variable nonlinear differential equations, as models for biological and physiological processes
- numerical integration via Euler's method
- an introduction to bifurcation theory
- linear algebra including eigenvectors and eigenvalues

The key step is the 20th century concept of a **vector field**. A vector field is a rigorously defined notion that replaces the un-rigorous and unhelpful concept of a differential equation. A vector field is formally a cross-section of the tangent bundle of a differentiable manifold. Intuitively, a vector field is a function that assigns “change vectors” (elements of the tangent bundle) to points in state space. The state point, starting from an initial condition, everywhere follows the change vectors, a trajectory that is guaranteed to exist by theorem. We can approximate that trajectory to any desired degree, using Euler's method. Our experience at UCLA is that **these 20th century geometric concepts also make excellent pedagogy, even at the freshman level, far superior to traditional calculus.** (Received September 26, 2017)