Quiz 3 (Lecture 05 QBIO482)

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List and briefly explain the key steps or ingredients needed to set up a numerical simulation for the diffusion equation. [0.2 pt]

1. Define the equation: $\frac{dv}{dt} = D\frac{d^2u}{dx^2}$.
2. Discretize the domain: create spatial (x) and temporal (t) grids
3. Choose a numerical scheme (explicit, implicit, Crank-Nicholson)
4. Set initial conditions; define u(x, 0)
5. Set boundary conditions (Dirichlet, Neumann, or periodic)
6. Iterate over time; update solution using chosen scheme
7. Ensure stability; choose Δt, Δx to meet stability criteria
8. Analyze results (create a plot or compute metrics etc.)

What is the limitation of Fully Discrete Schemes? How can it be improved? [0.1 pt]

Fully discrete schemes can suffer from numerical instability and limited accuracy. These limitations can be improved by:

- Using implicit or semi-implicit methods for better stability
- Implementing adaptive time-stepping based on error control
- Applying finer or adaptive spatial grids to capture detailed behavior