Electroporation

- Formation of pores in the cell membrane due to exposure to high voltage electric fields

- How does this occur?
  - Local instabilities arise from dielectric breakdown: separation of charge on either side of membrane
    - \( \rightarrow \) membrane grows thinner
    - \( \rightarrow \) ruptures, a pore is created

- Integrity of membrane is important for maintaining homeostasis within cell (maintain chemical environment and osmotic pressure req for proper cell function)

Low Electric Field Strengths

- "Reversible breakdown": pores are small → able to close back up

- Advantages:
  by increasing cell porosity, increase its rate of uptake
    → lower doses of antibiotics/chemicals are needed
    → opportunity to introduce foreign material, e.g. genes
High Electric Field Strength

- Pores are so large/numerous → cell lysis

- Factors that determine the critical field strength needed for lysis
  1) electric field strength
  2) cell size: the smaller the cell, the lower the transmembrane potential, req stronger electric field before rupture
  3) charge on cell and the surrounding solvent: some say the presence of salts increase the cell’s permeability, others say that you need deionized, nonconductive water in order to achieve high voltage gradients
  4) type of electric field: AC have lower lysis rates compared to DC b/c it has varying field strengths—if cell passes the electrodes during a time of low field strength (deadband region), will survive
  5) duration of electric field/ rate of fluid flow: pop of cell lysis is proportional to current duration and intensity—how much exposure

- for 1 cm electrode gap: \( E = 0.2 \text{ kV/cm} \) reversible breakdown
  \[ = 5 \text{ kV/cm} \] cell lysis
Cell Lysis

-TEM of bacteria, V. Parahaemolyticus, suspended in sea water and treated at 12V and 1A for 1s

-A portion of the cell membrane has ruptured and much of its cell contents have leaked out