Regenerative Medicine Program - Updates

Nora Sarvetnick

Transplant Division; Surgery Department

Mary and Dick Holland Regenerative Medicine Program

University of Nebraska Medical Center

Disclosures

None to disclose

Prevention of postoperative abdominal adhesions

Scar-like tissues → Abdominal tissues and organs stick together

Cause intestinal obstruction, chronic pain, and female infertility

Bin Duan, PhD, Associate Professor

Current clinical barrier materials have limited efficacy

Interceed ®

Seprafilm ®

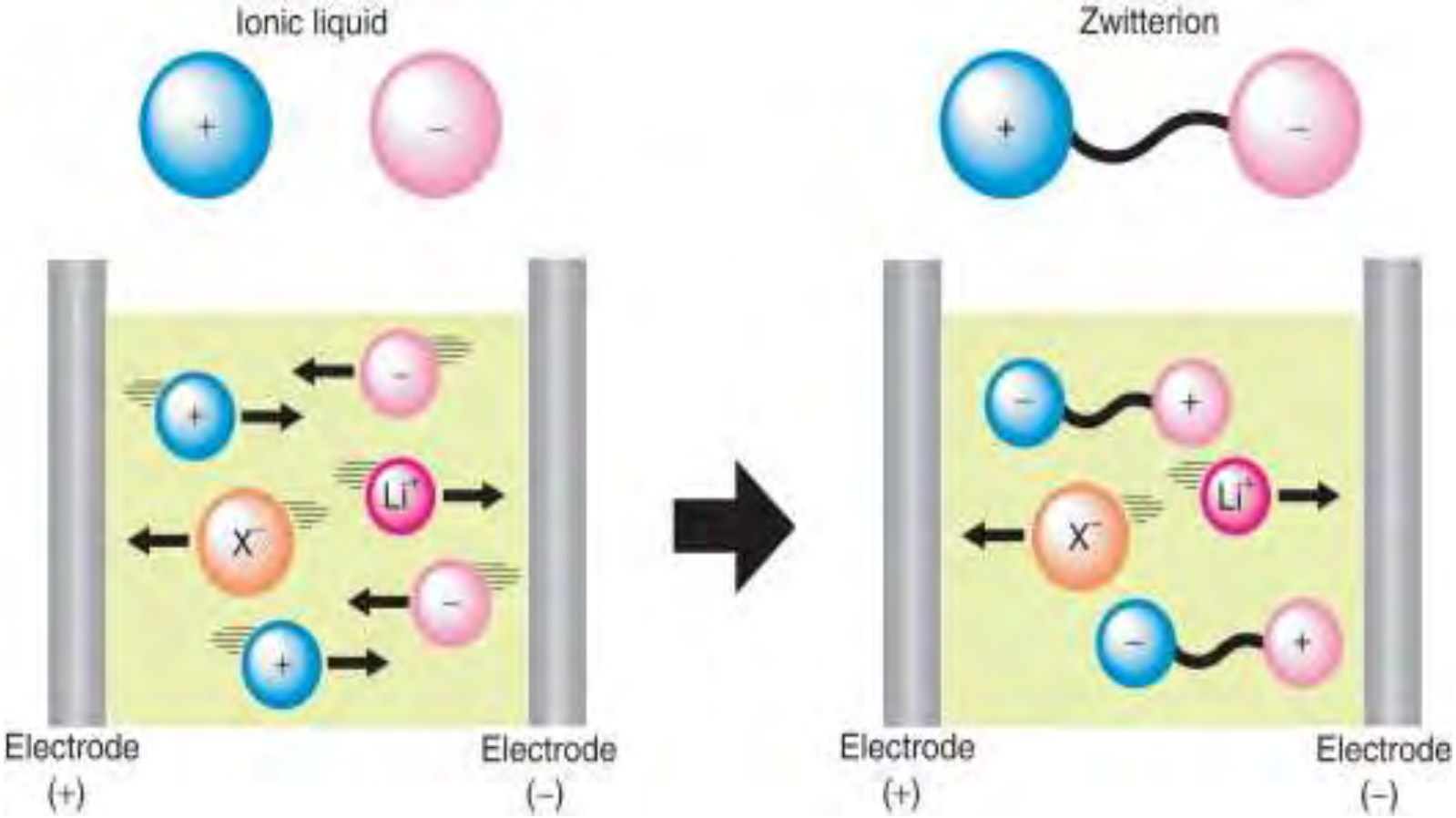
- Difficult to apply
- Incomplete coverage
- Only serve as physical barriers
- Relatively low efficacy (~50%)

Problems: when wet surface becomes sticky, extremely difficult to remove laparoscopically and separate from other organs

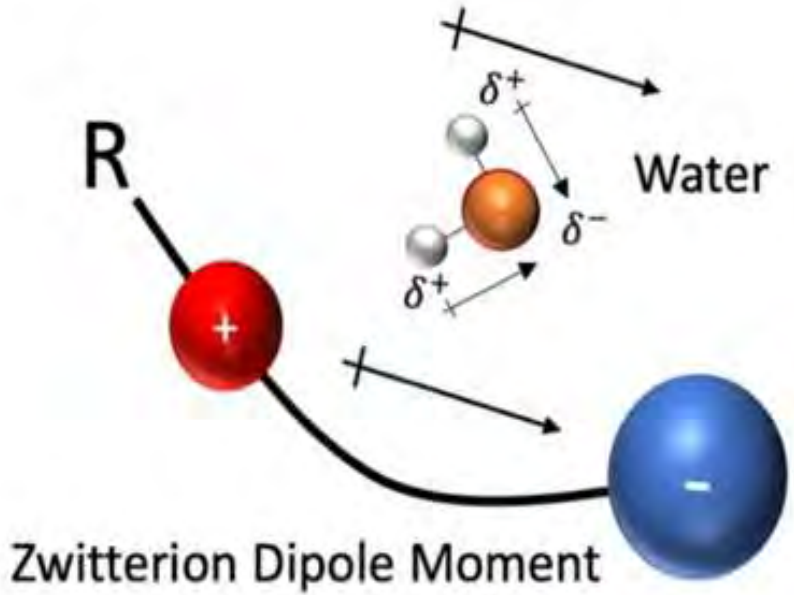
difficult to insert via a laparoscopic port: easily torn

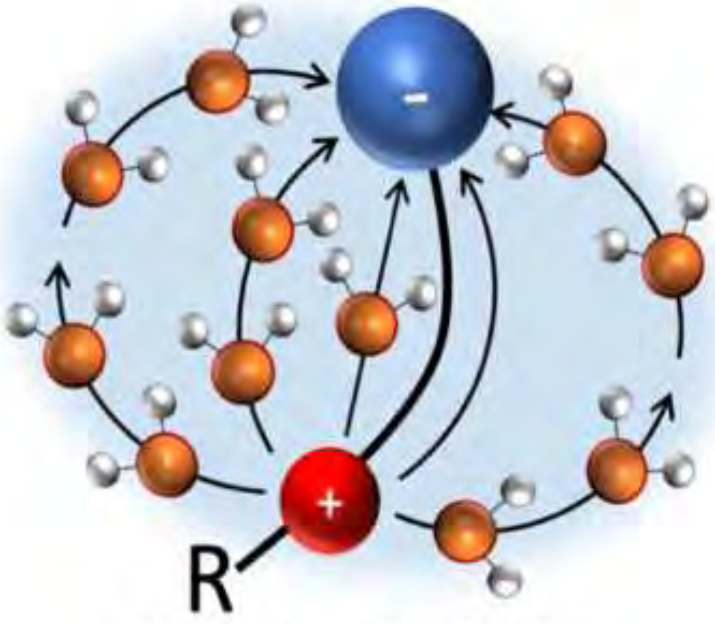
Although reduced adhesions; does not translate to clinically significant small bowel obstruction requiring

Zwitterions (hermaphrodite): +/- neutral charge

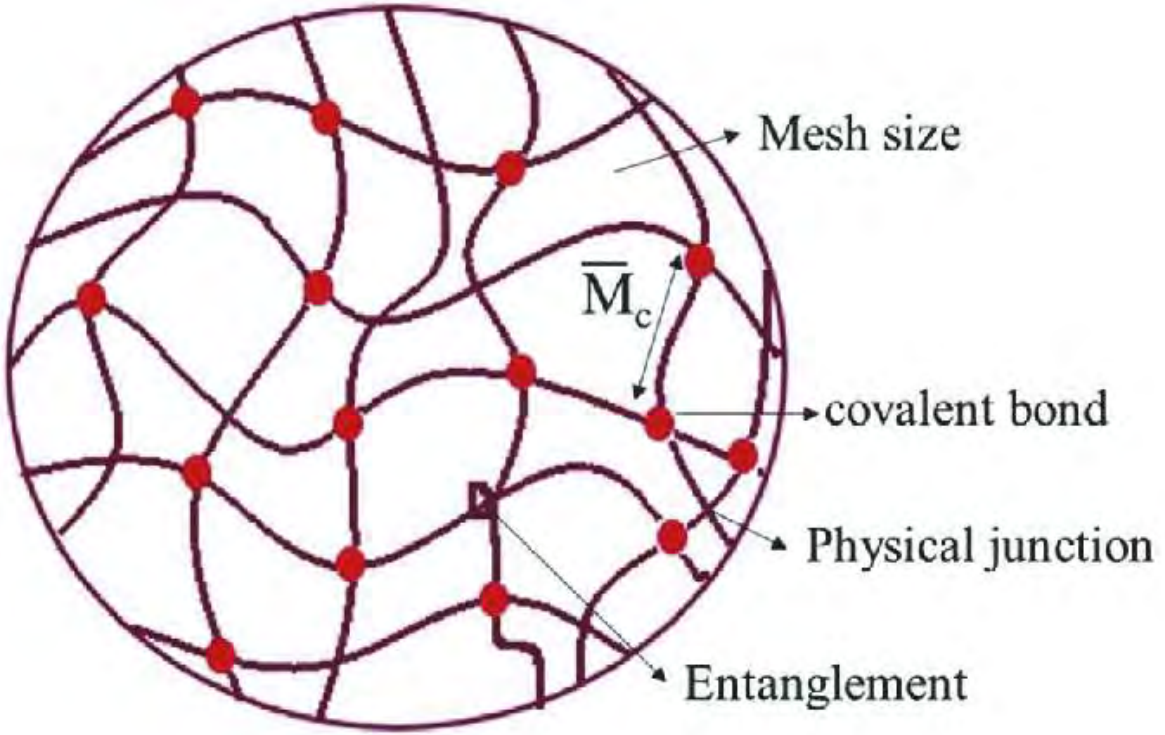


Zwitterions Attract Water

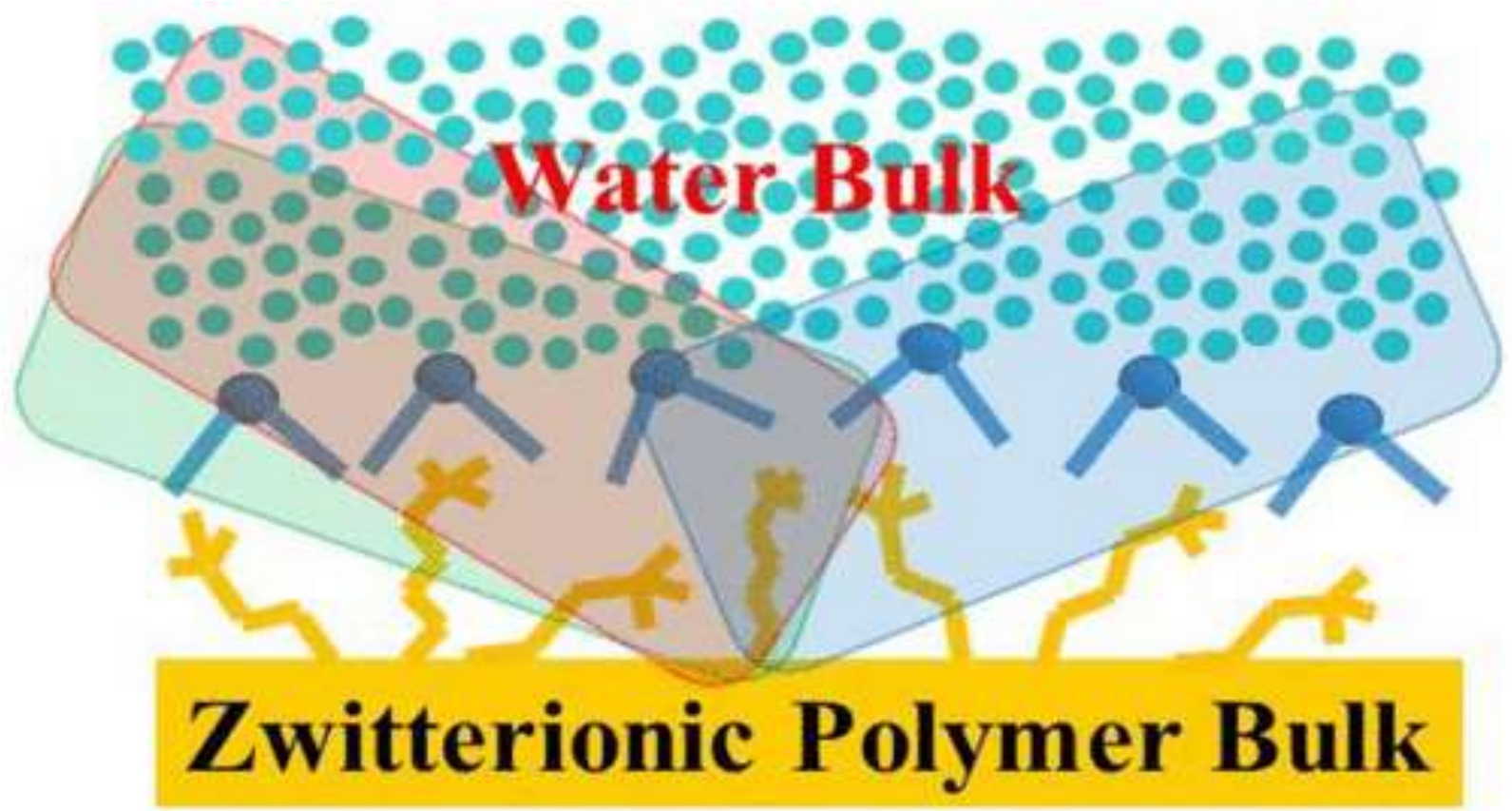




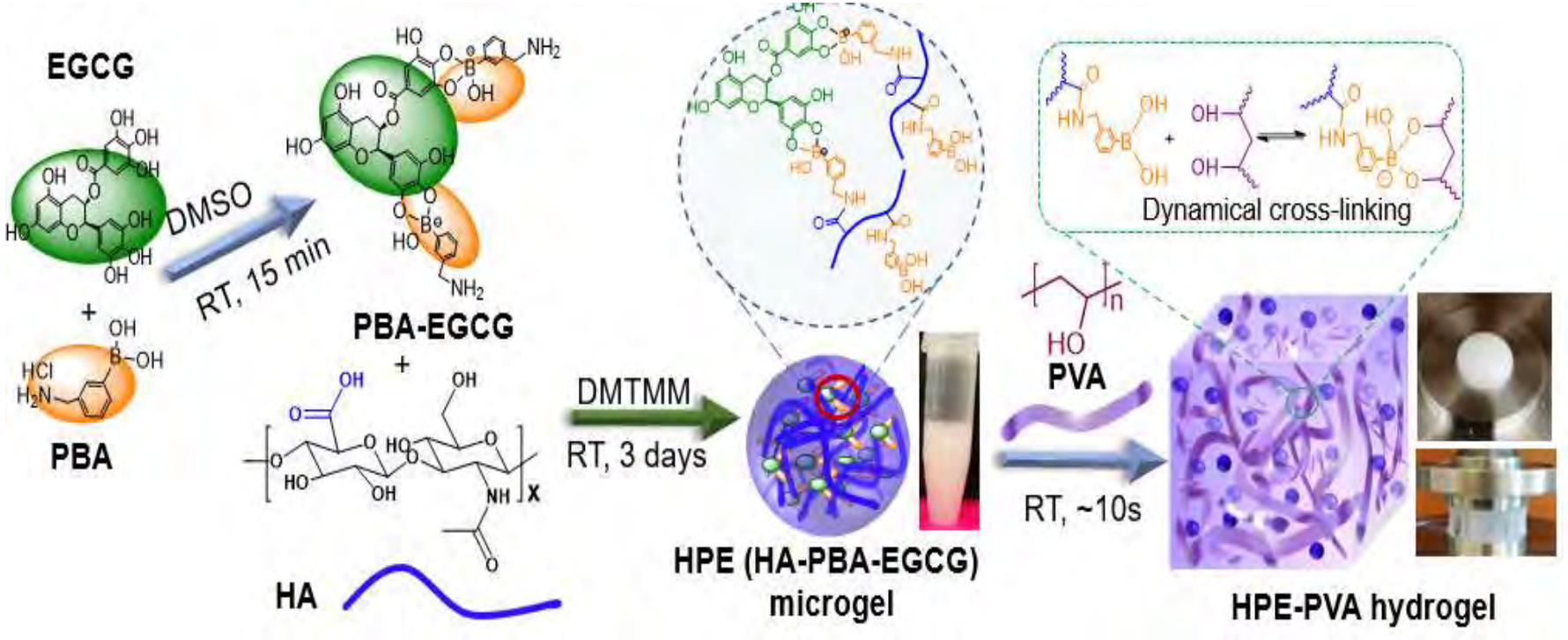
Hydrogels: water absorbing polymers (1894)
example: jello



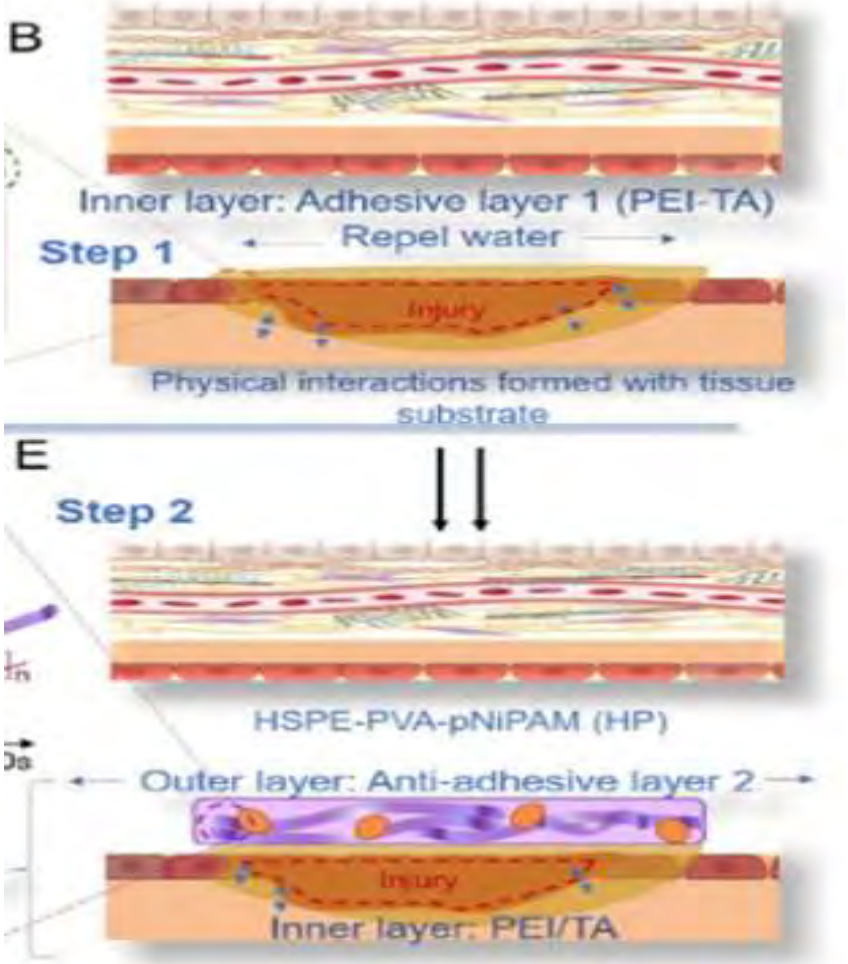
Zwitter ion polymers+hydrogel: anti-adhesive gel/slippery



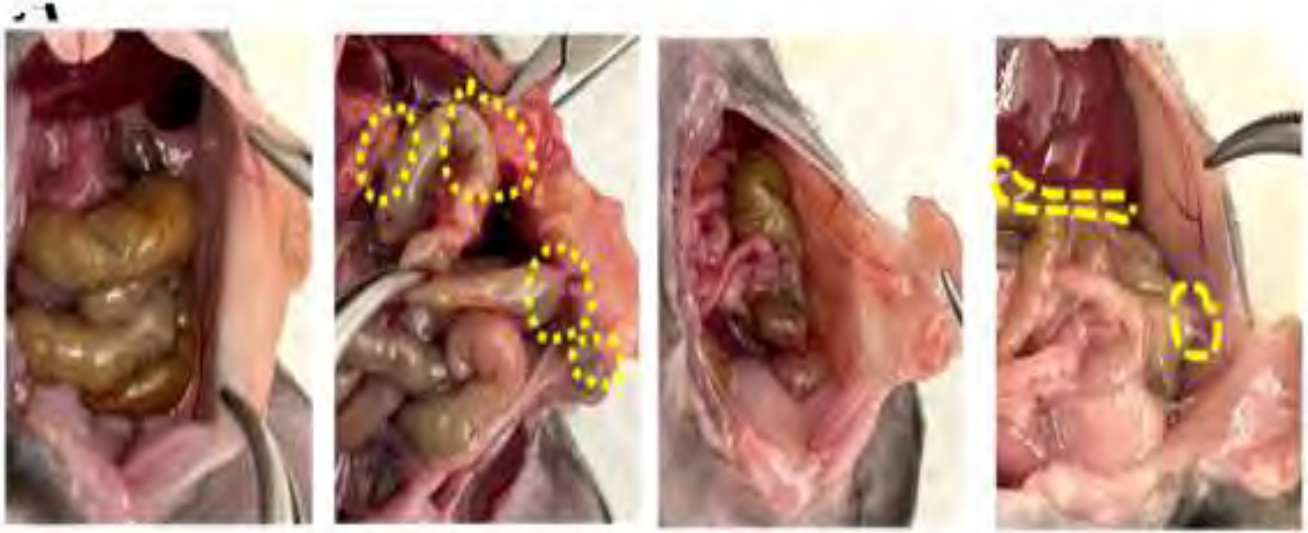
Synthesis of dual-sided hydrogels: adhesive/anti-adhesive sides

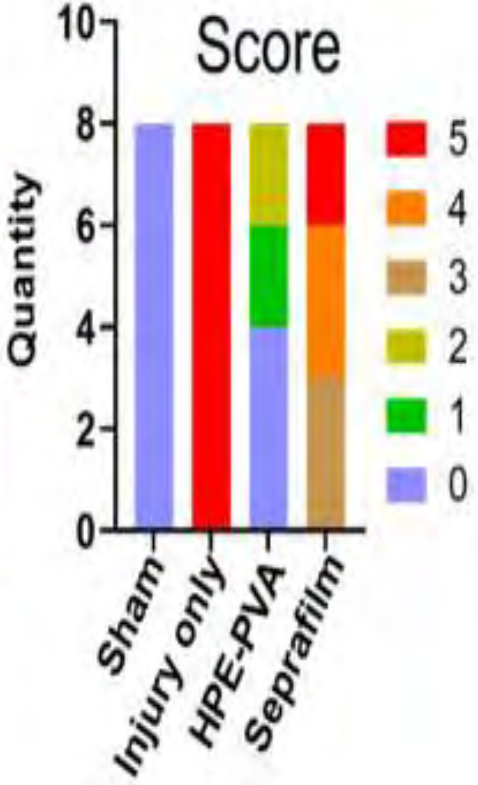


Sandwich structure

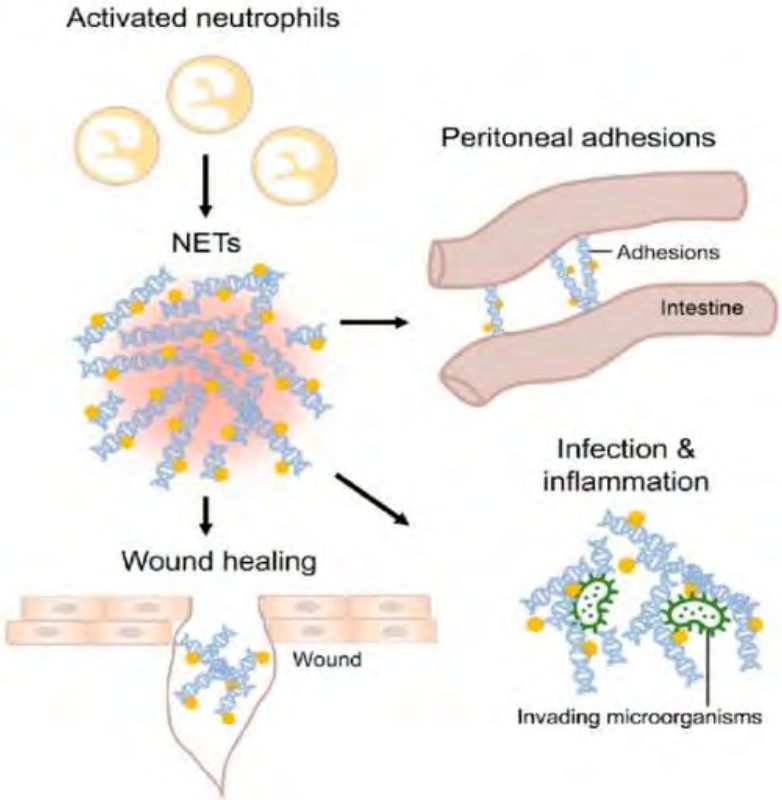


HPE-PVA hydrogels prevent adhesions in a mouse intestine-abdominal wall adhesion model

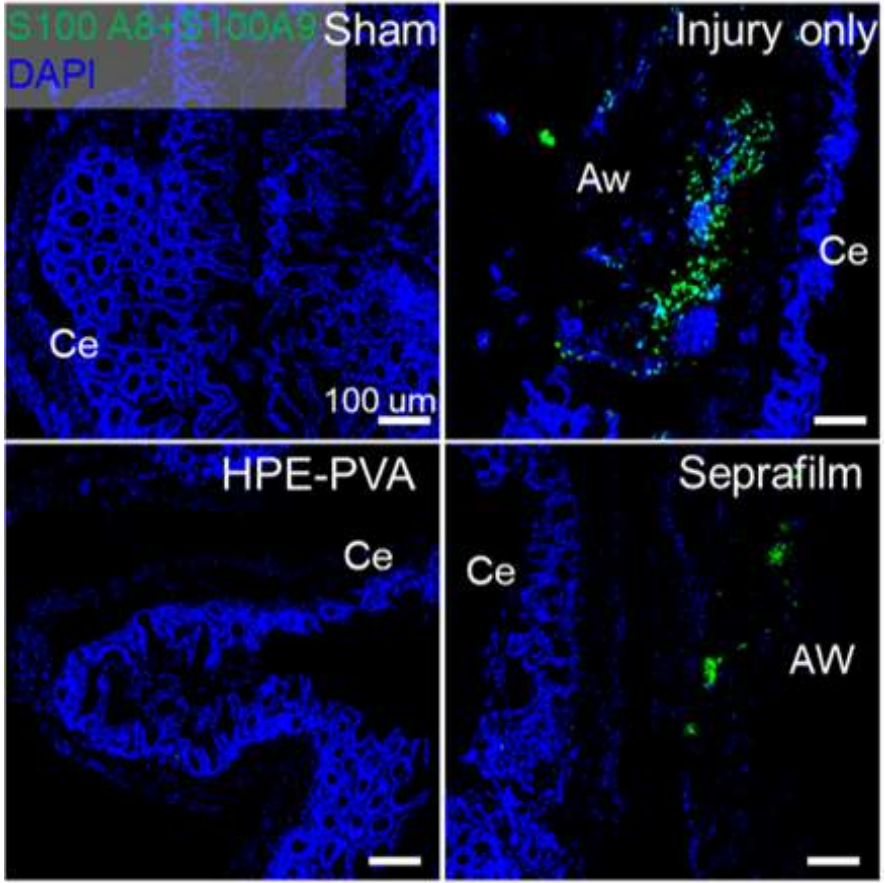


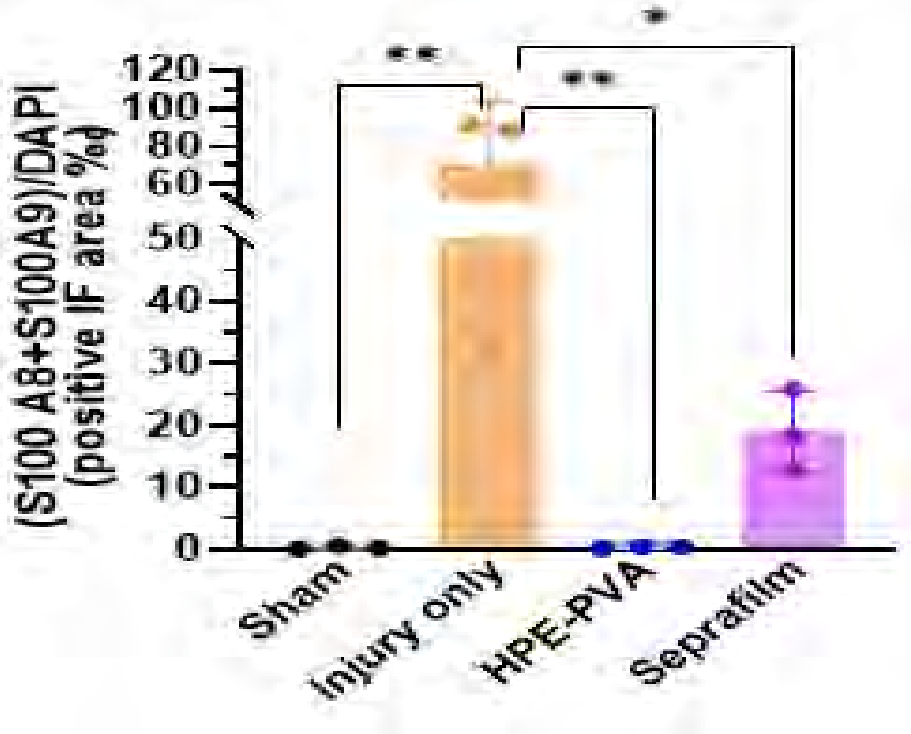


Neutrophils are critical for adhesion development.
-release NETS "neutrophil extracellular traps": DNA/protein mesh acts as adhesion substrates



S100A8/9 protein: NET release; neutrophil activation; fibrinogen binding

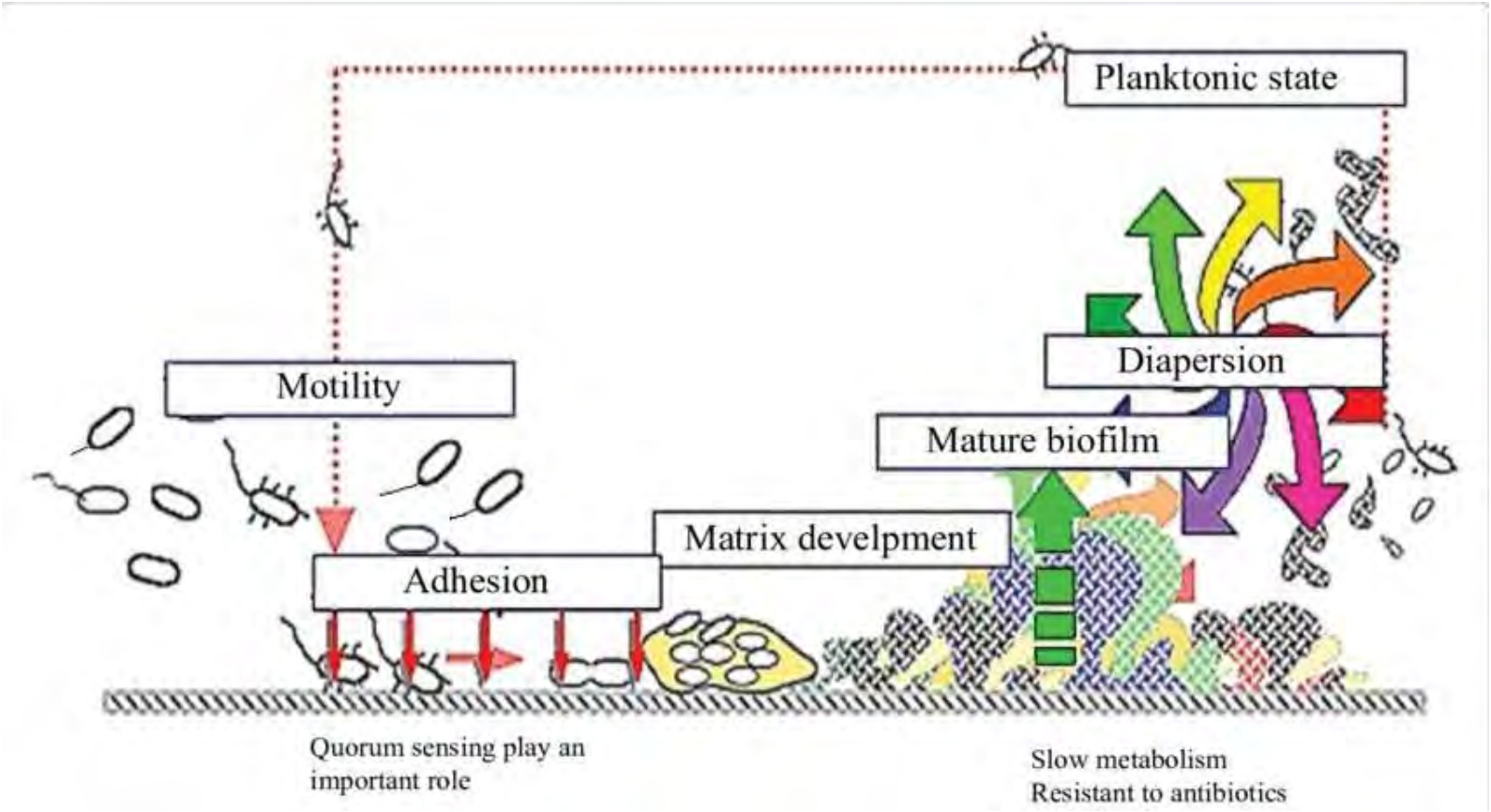




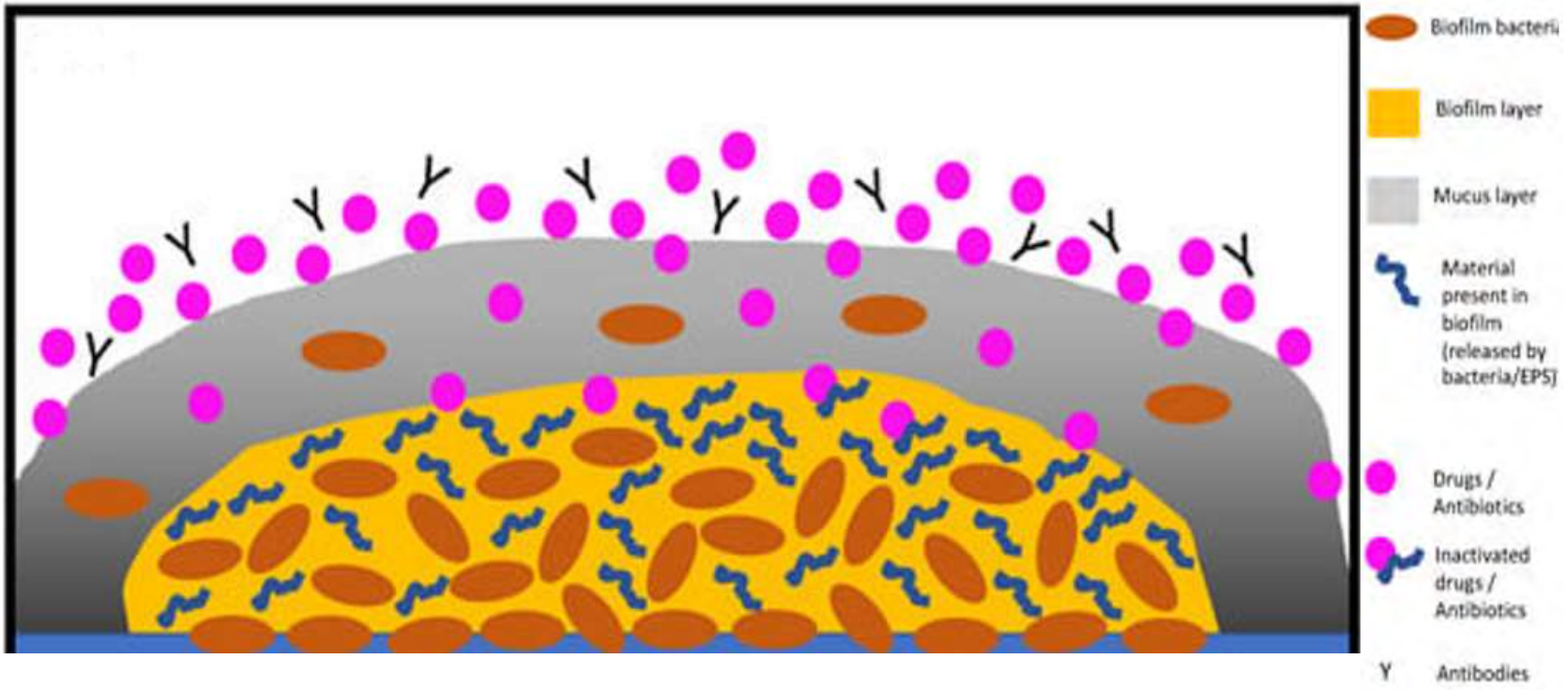
Biofilm: complex pathogenic microenvironment

Siwei Zhao, PhD, Assistant Professor

Surface wound: Biofilm development
polymicrobial community, extracellular polymeric matrix



Antibiotics do not penetrate biofilms



Clever biofilm bacteria can outsmart anti-microbials

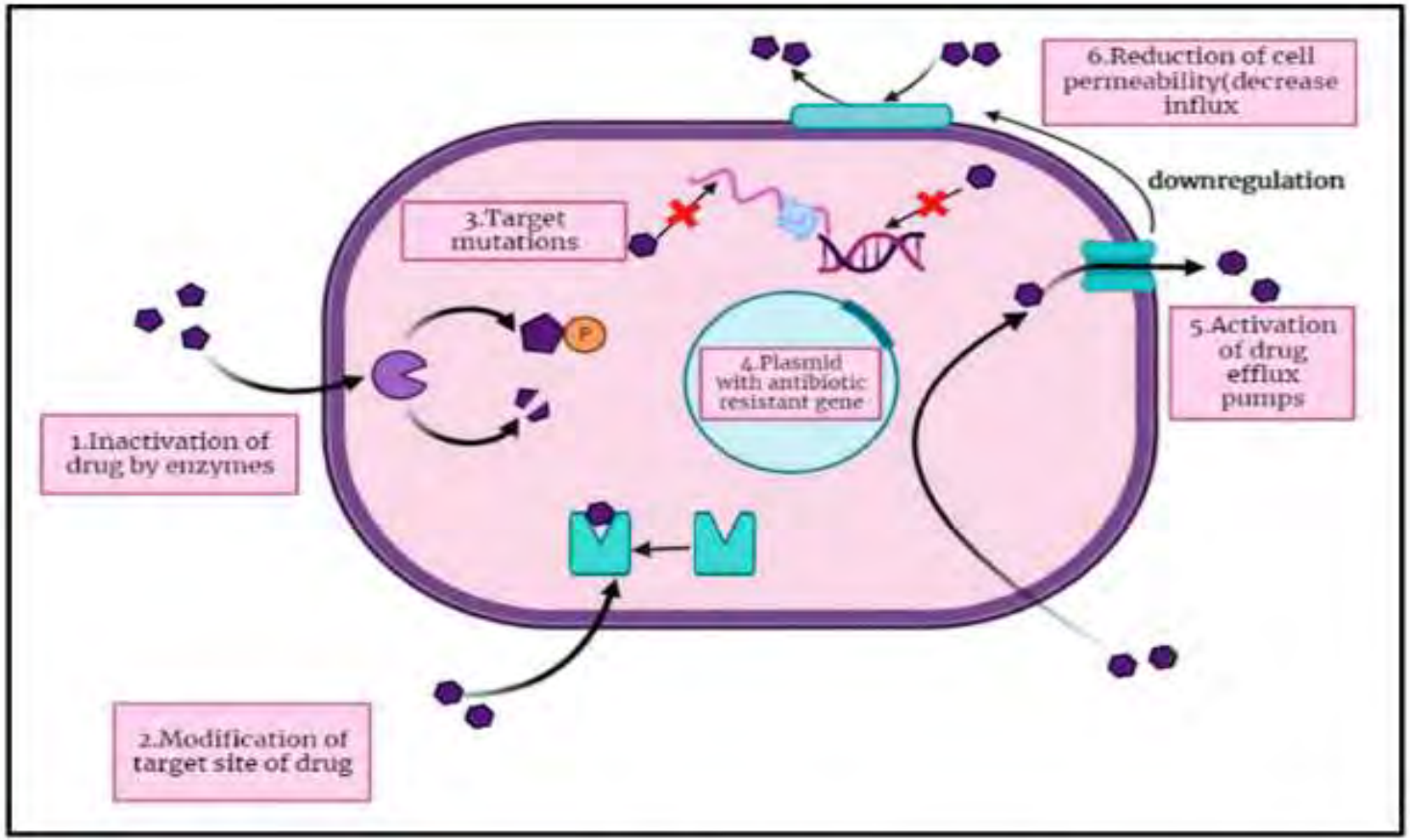
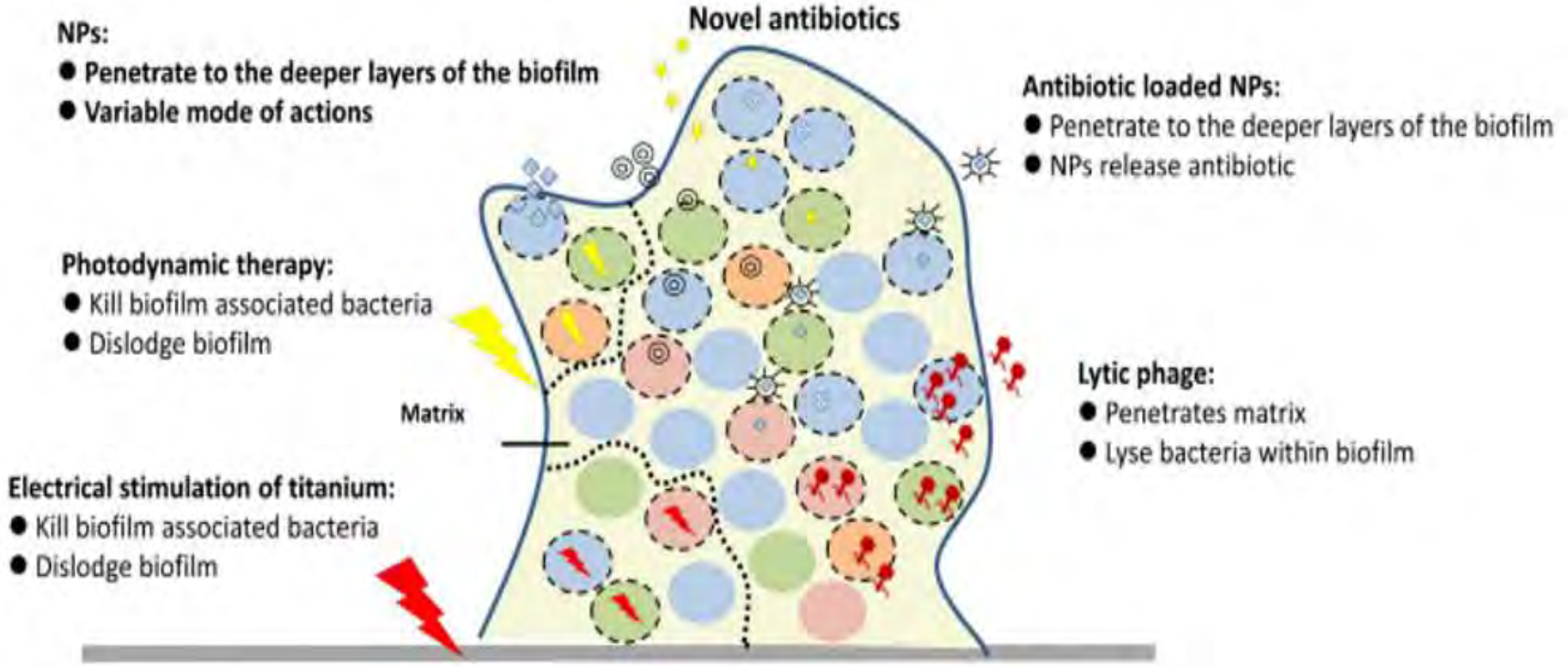


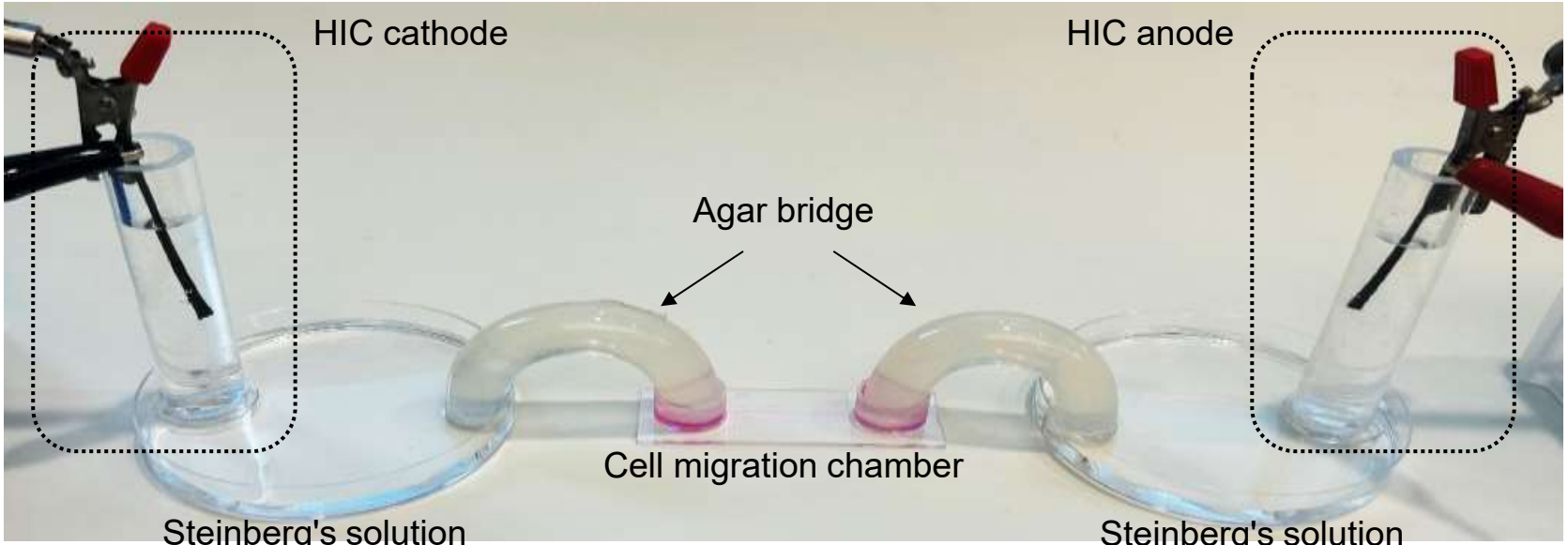
Figure 1. Different pathways of antibiotic resistance as antibiotic enters into the cell of bacteria

Approaches for Biofilm elimination



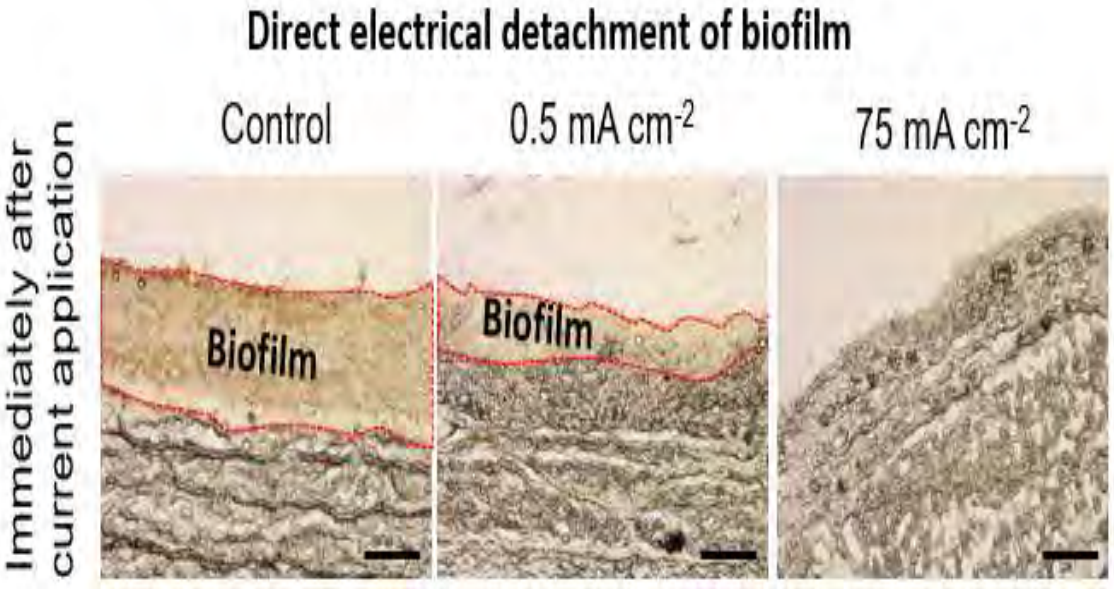
Iontophoresis: Electric current magnifies speed and penetration of transdermal antimicrobial delivery

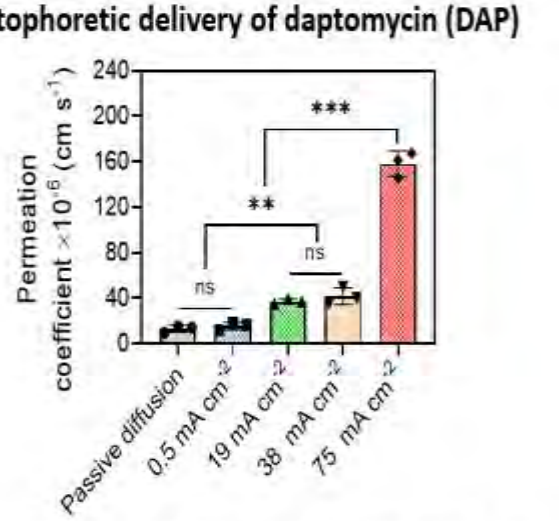
In vitro electrotaxis cell migration setup



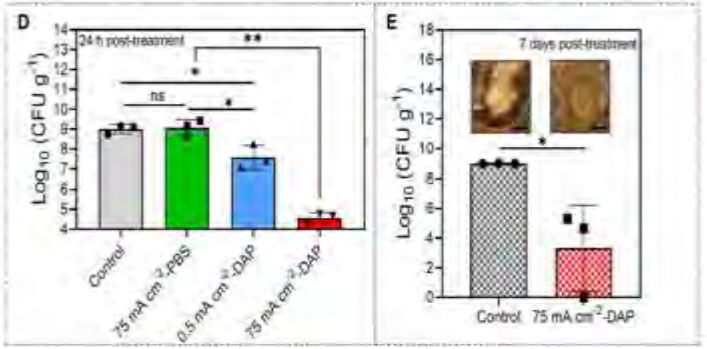
Electric Current-Based Wound Biofilm Treatment System

-high-intensity ion electric current reduces biofilm burden
-detachment of bacteria through electrostatic force
-delivery of antibiotics (daptomycin) into biofilm
-reduces bacterial count of MRSA biofilm



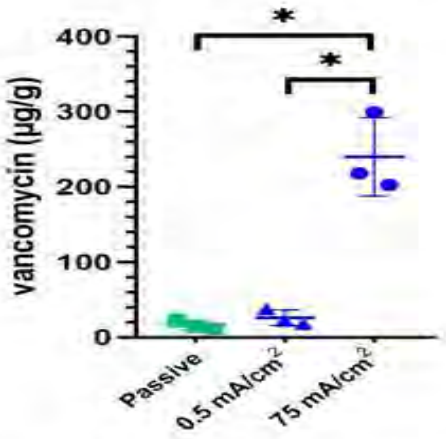


One 1-hour treatment with DAP reduced MRSA CFU (log10 scale) from 9.0 to 4.6 at 24 h and 3.3 at day 7



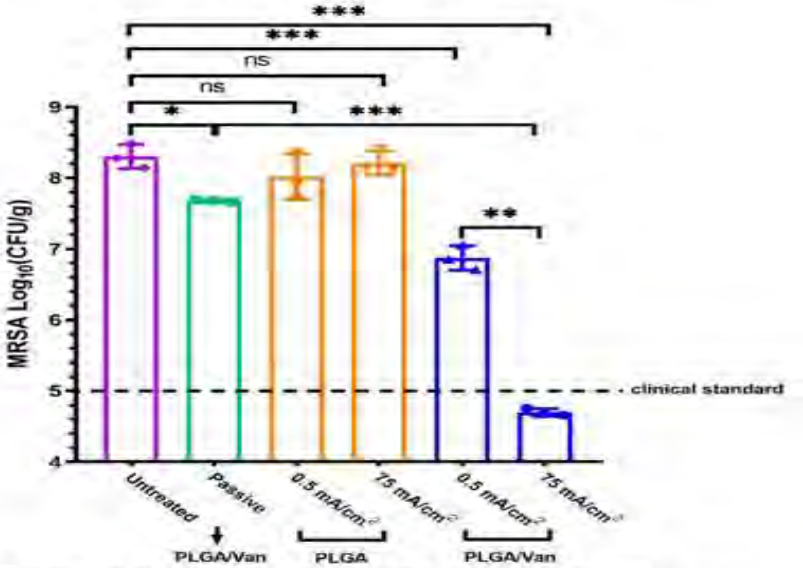
Antibiotic-containing nanoparticle delivery achieves long-term biofilm inhibition in chronic wounds

Vancomycin concentration in *ex vivo* porcine skin wound tissues



75 mA/cm² iontophoresis increased the vancomycin skin concentration (in NP formulation) by ~9-fold than 0.5 mA/cm² conventional iontophoresis, and by ~14-fold than passive diffusion

MRSA biofilm inhibition efficacy of delivered PLGA/Van

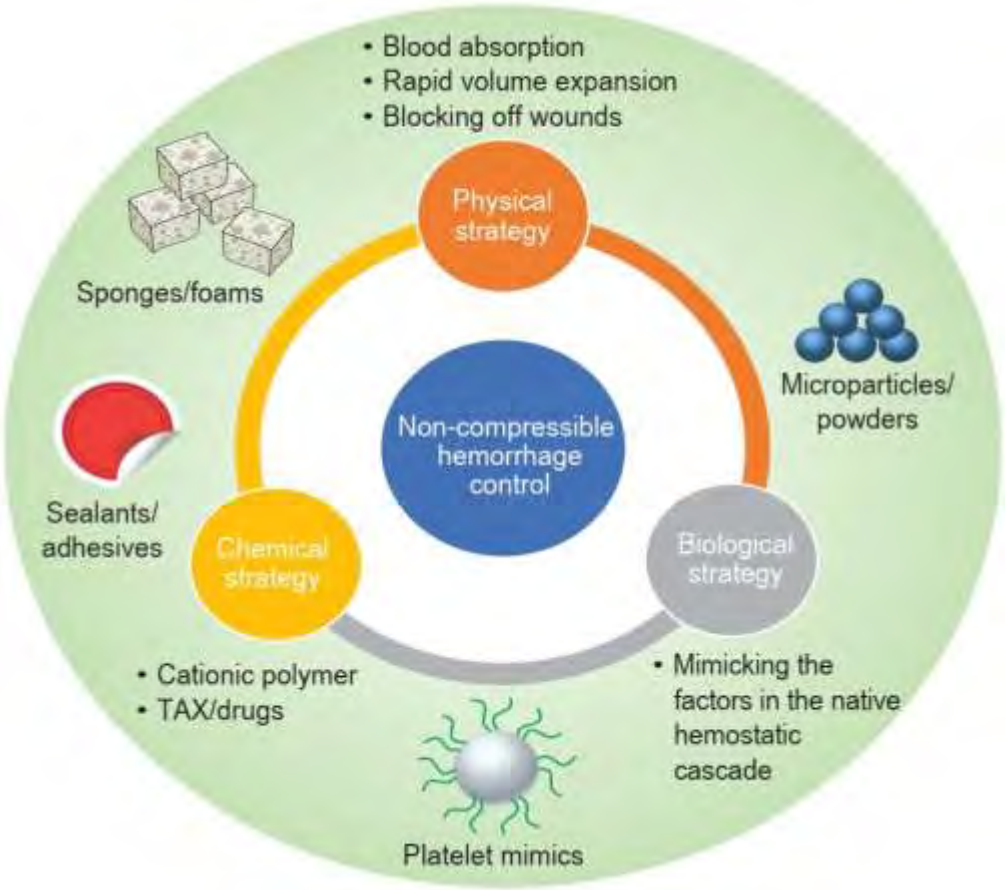


Porcine skin wounds were treated with iontophoretic delivery or passive diffusion of PLGA/Van and then challenged with MRSA inoculation. After 3 days, 75 mA/cm² iontophoresis maintained the lowest bacterial load at $10^{4.70}$ CFU/g (i.e. highest biofilm inhibition)

TEXT

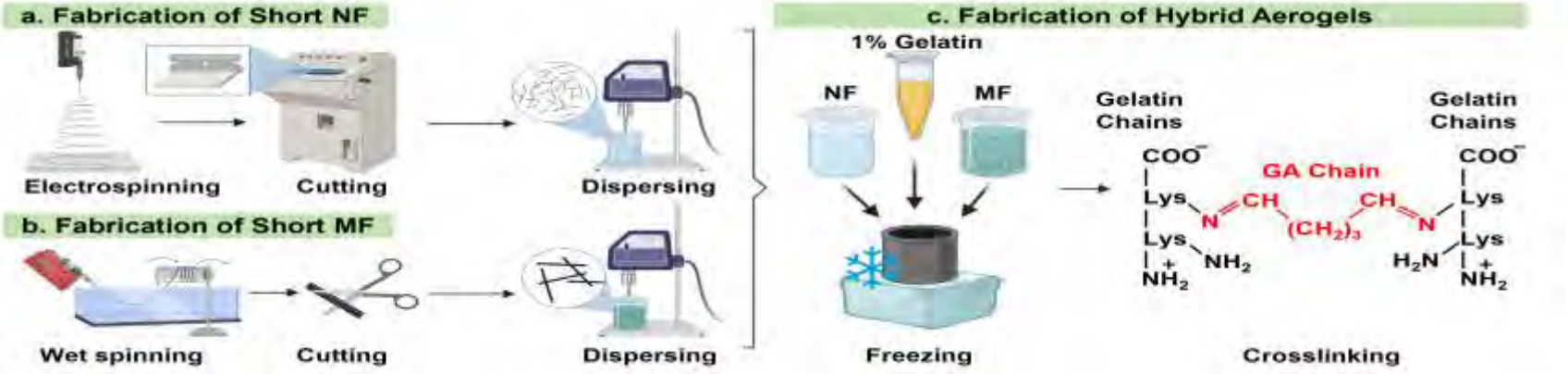
Hemorrhage

Current approaches for treating Hemorrhage

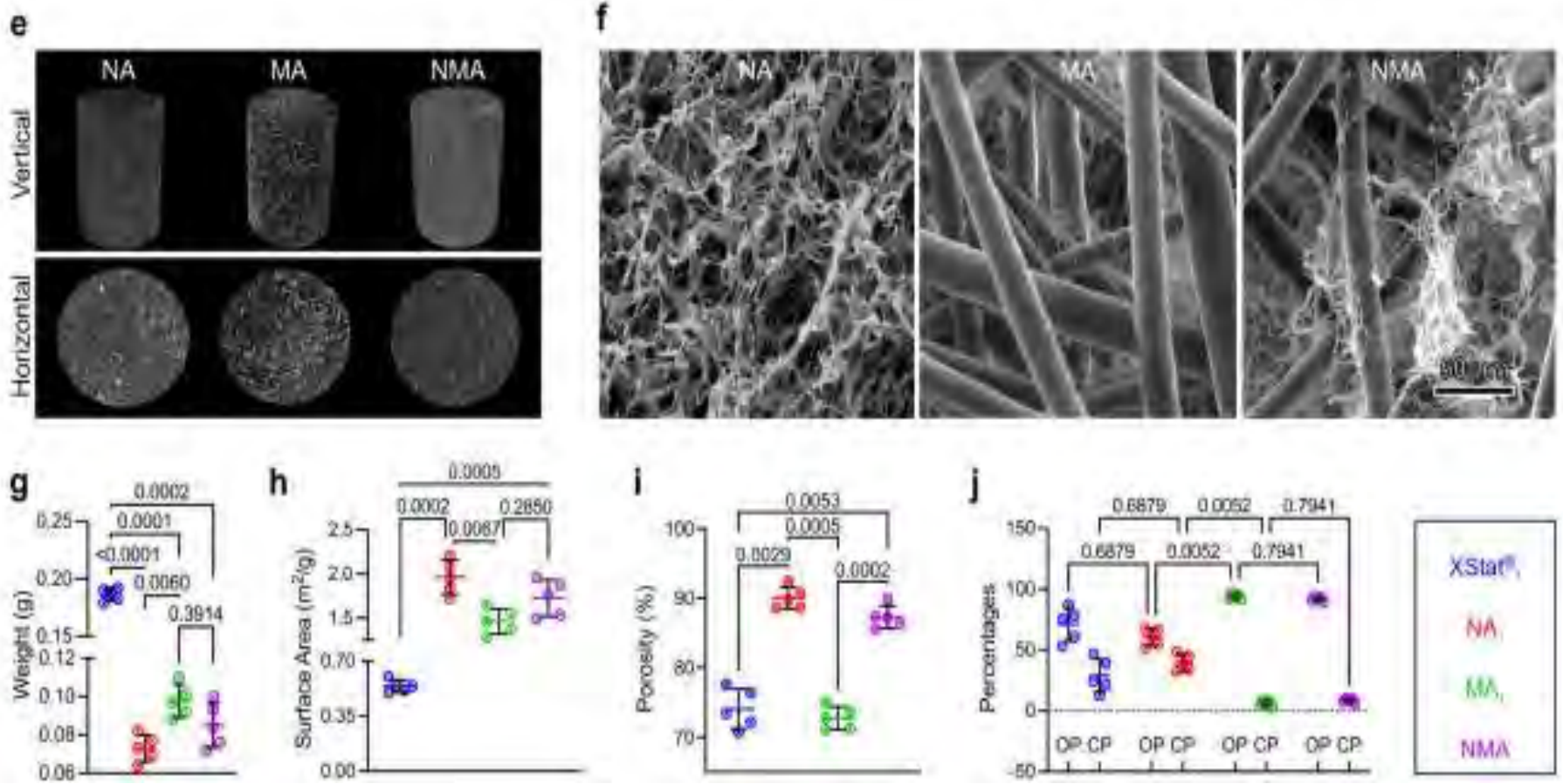


Jingwei Xie, PhD, Professor

Nanofiber/Microfiber Hybrid Aerogels

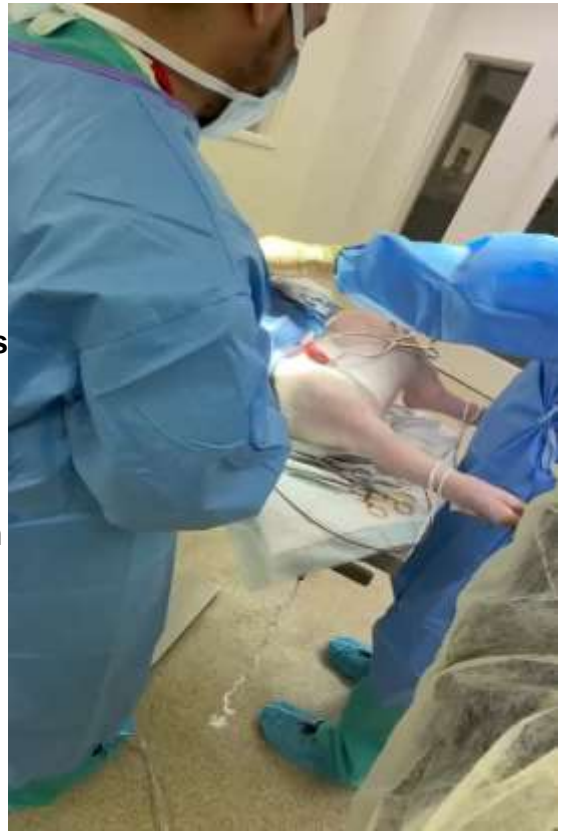


Structure/Function of aerogels

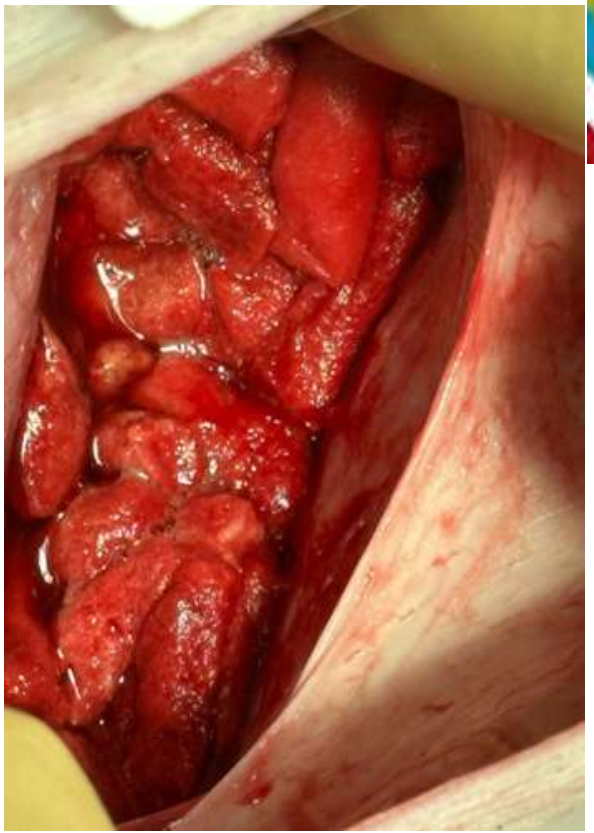


Porcine Junctional Hemorrhage Test

Injury
+
Free flow 30 s
+
Treatment
+
3 min of compression



Pig was stable and survived for 3 h



Expansion in the wound site

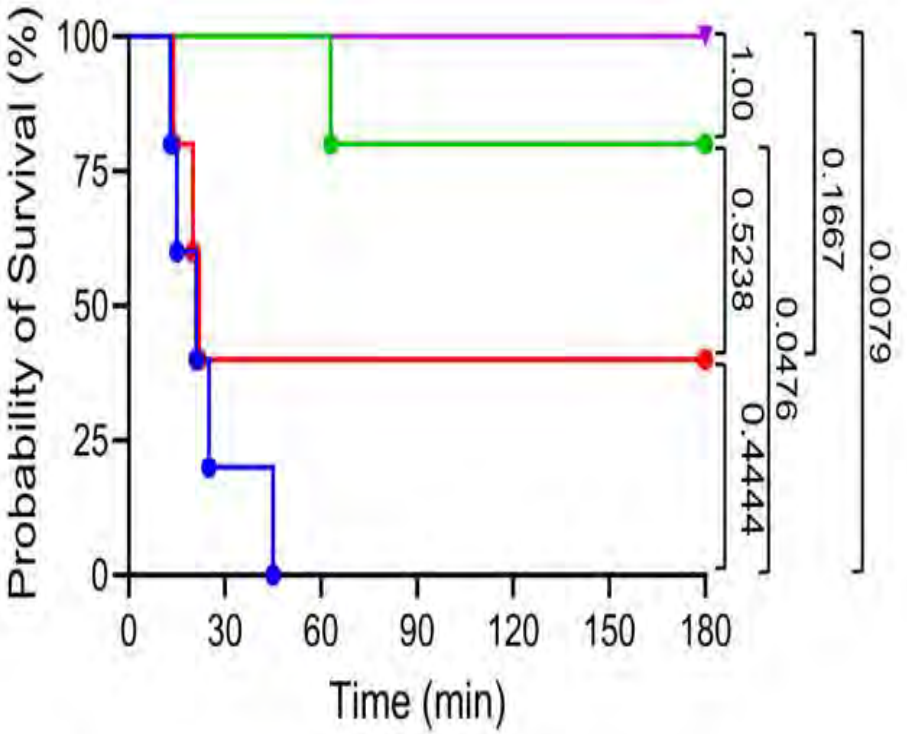
Shape recovery of NMA in water

University of Nebraska Medical Center

Results: Aerogel for Porcine Junctional Hemorrhage

Control, QCG®, XStat®, NMA

Groups	Blood Loss (mL)	"n"	p-Value
Control	1603.2 ± 343.0	5	0.0007
QCG®	1265.3 ± 559.0	5	0.0469
XStat®	634.9 ± 219.3	5	Ref.
NMA	42.9 ± 17.5	5	0.0003



NMA: nano-/microfiber aerogel

Xie et al. *Nat. Commun.* 2025

Thanks

Engineers:

Bin Duan: dual sided adhesion barrier

Siwei Zhao: iontophoresis for biofilms

Jingwei Xie: hemorrhage aerogel

Wei Shi: heart regeneration

+Their collaborators

Alan Langnas: wonderful continuous support

Hillary Piper: Administration

Shaheed Merani: Organizing this conference