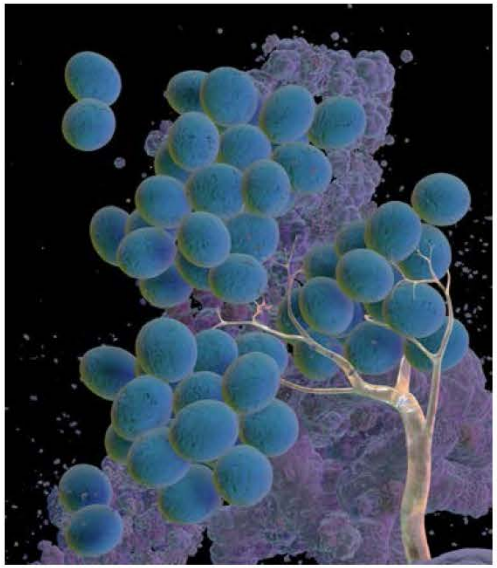
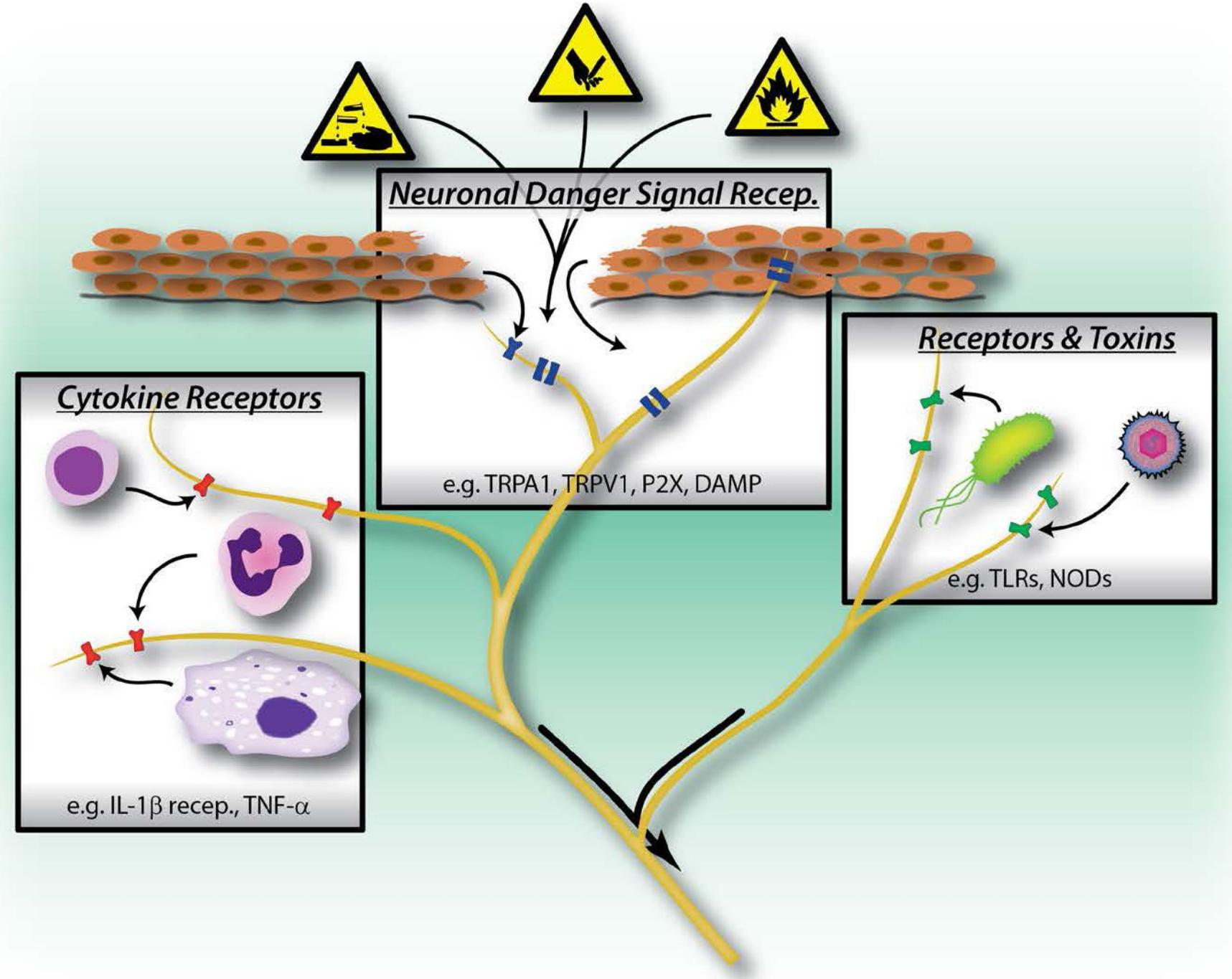
Bacteria Activate Sensory Neurons that Modulate Pain

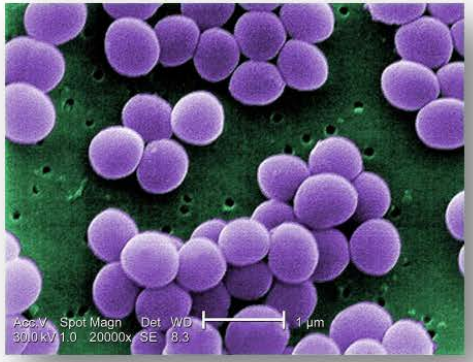


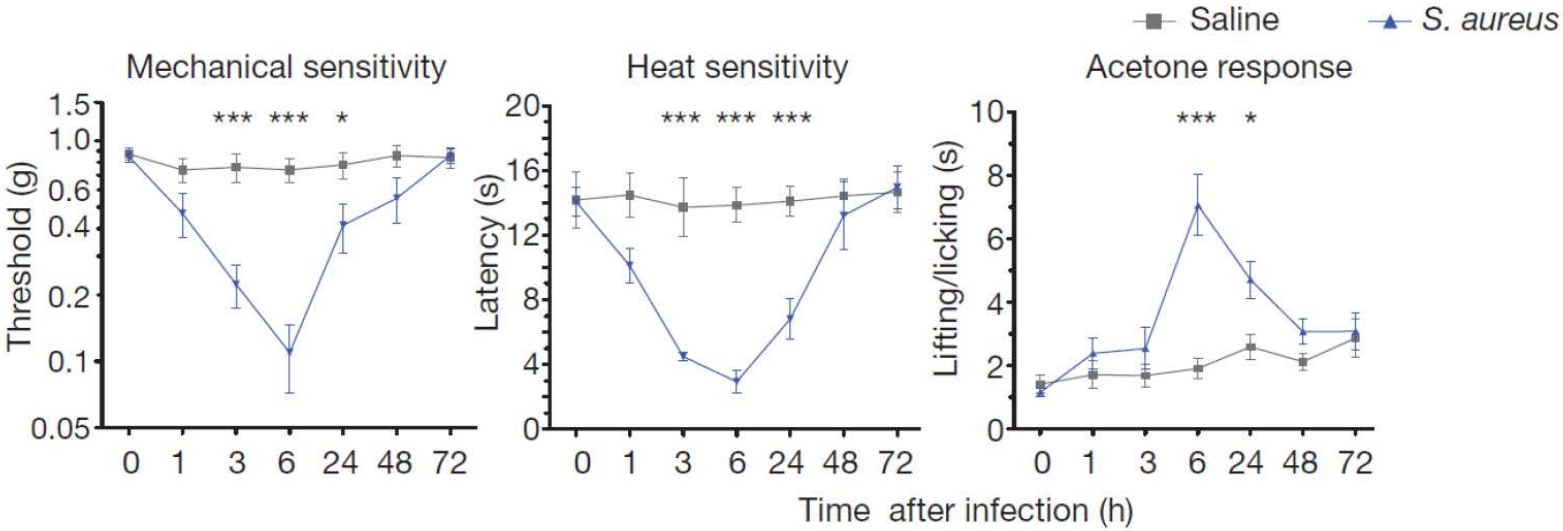
Clifford Woolf

Boston Children's Hospital
Harvard Medical School



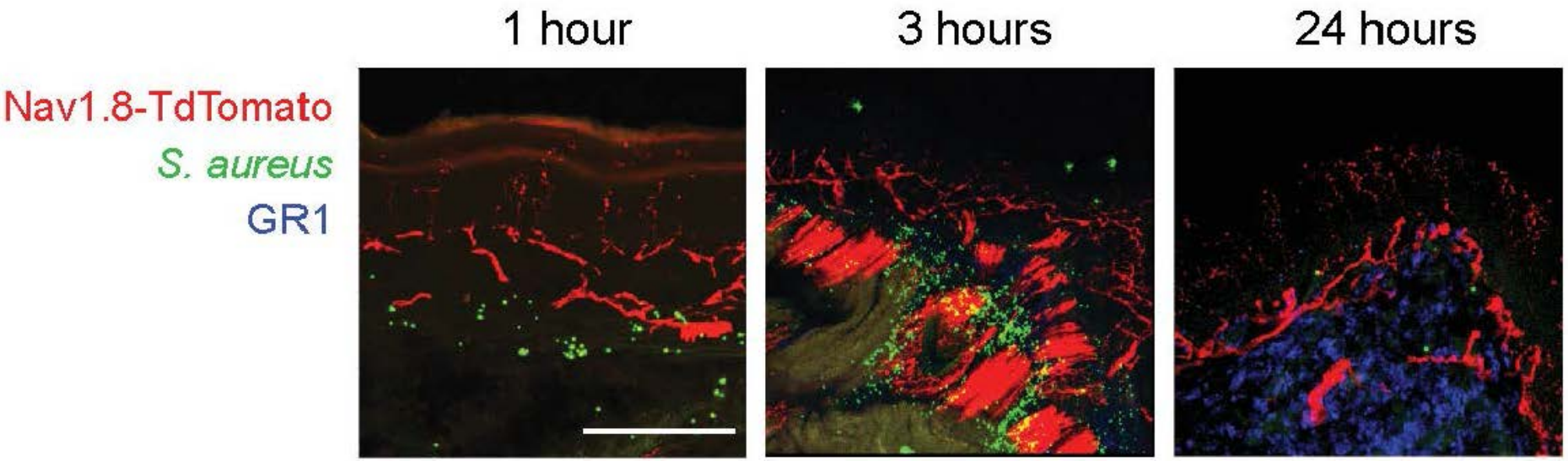
Chiu et al Nature Neuroscience 2012





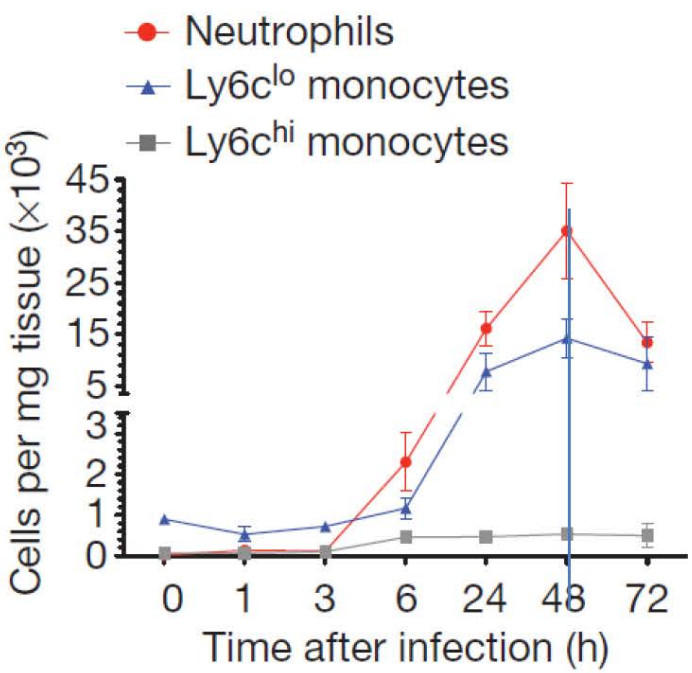
Live bacterial infection

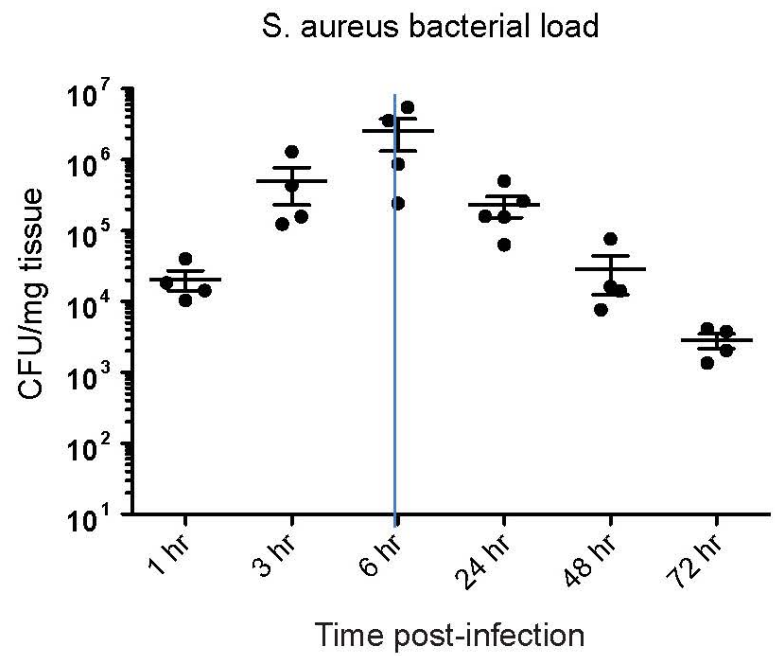
Chiu et al Nature 2013



Live bacterial infection

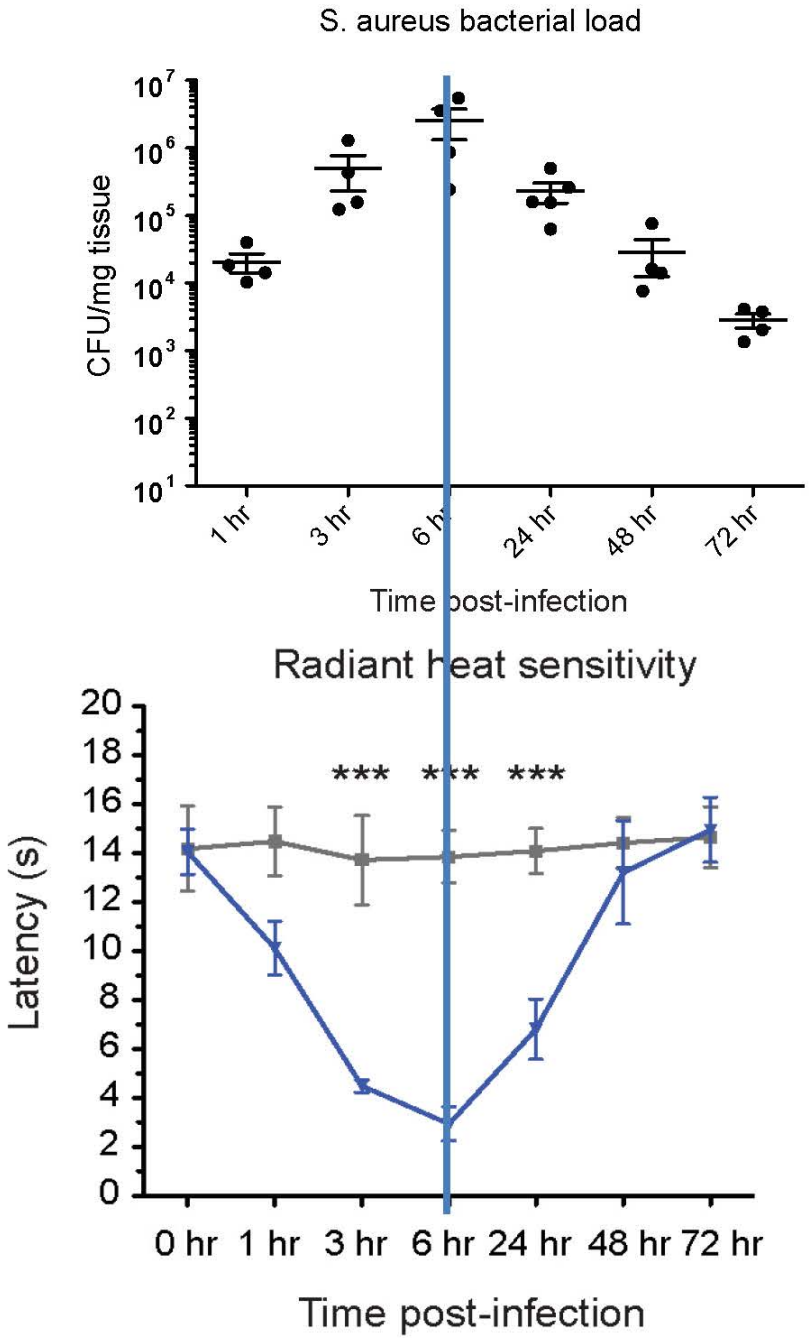
Chiu et al Nature 2013





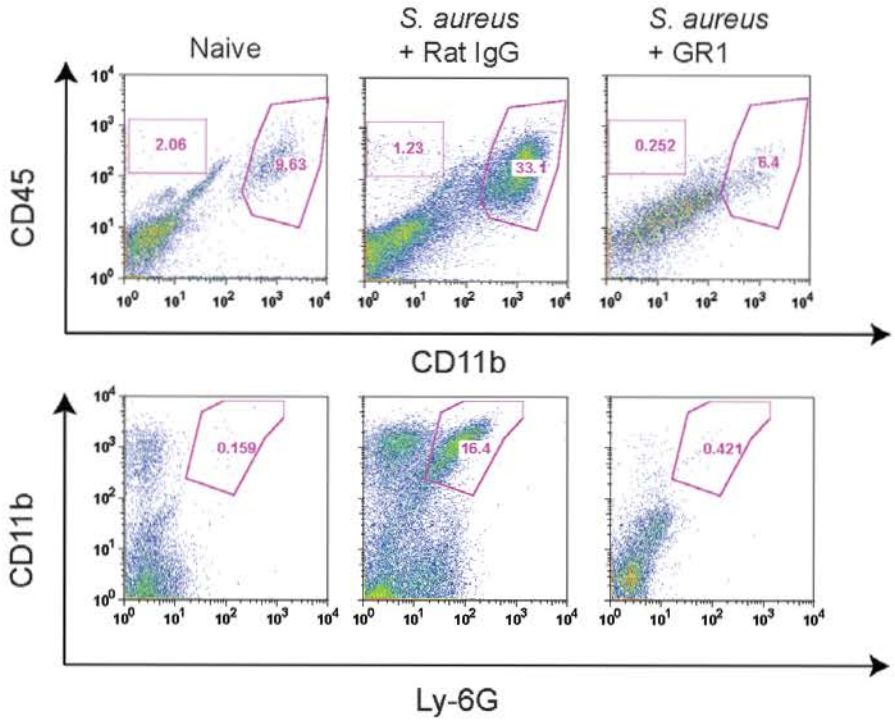
Live bacterial infection

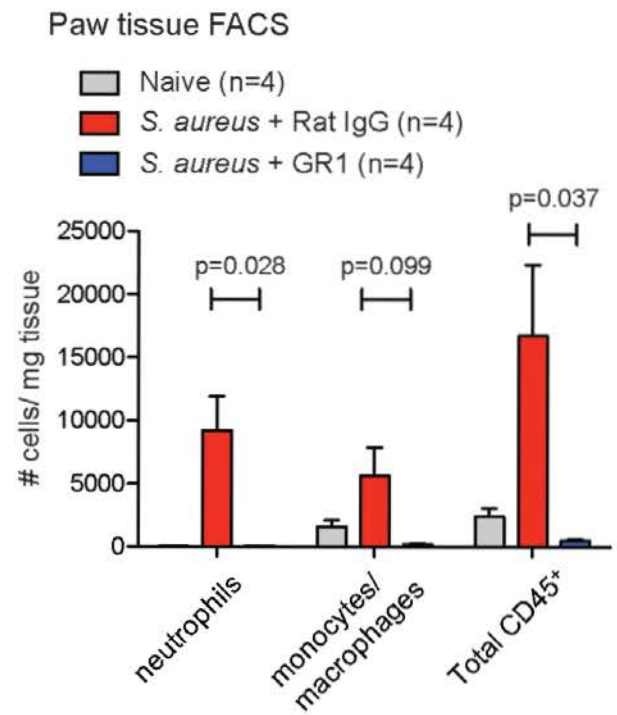
Chiu et al Nature 2013

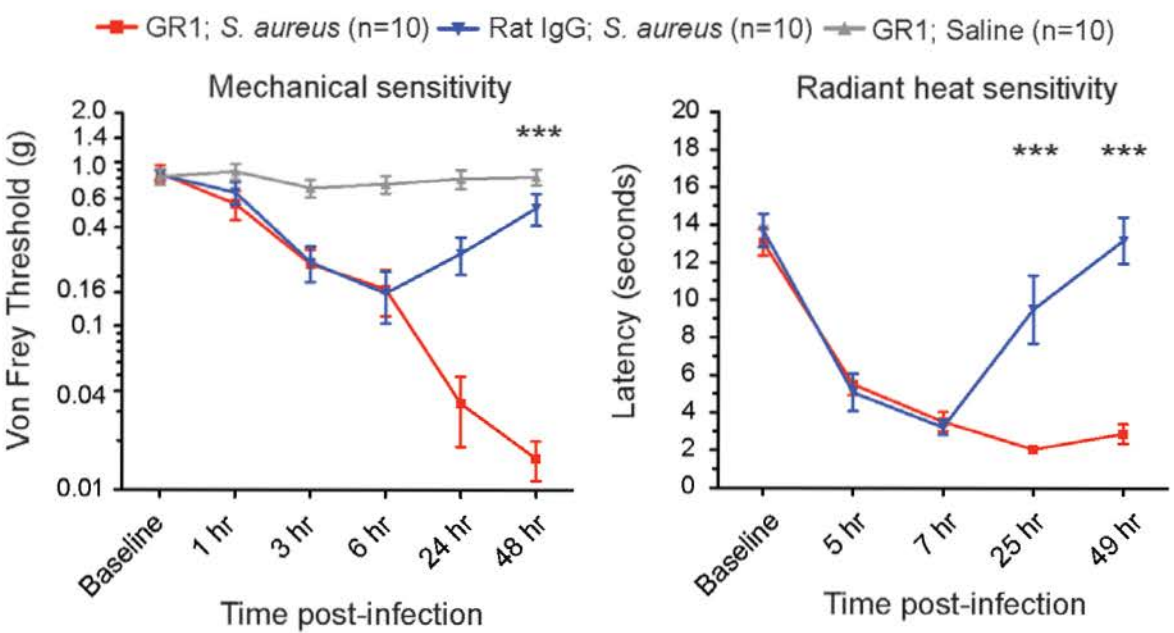


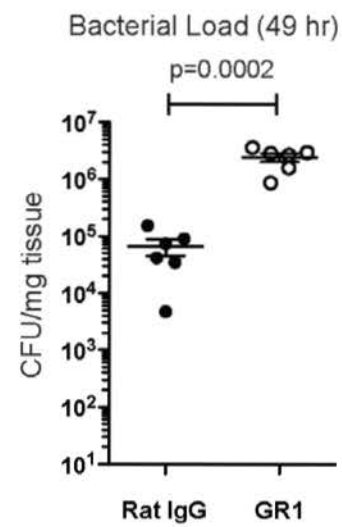
Live bacterial infection

Chiu et al Nature 2013

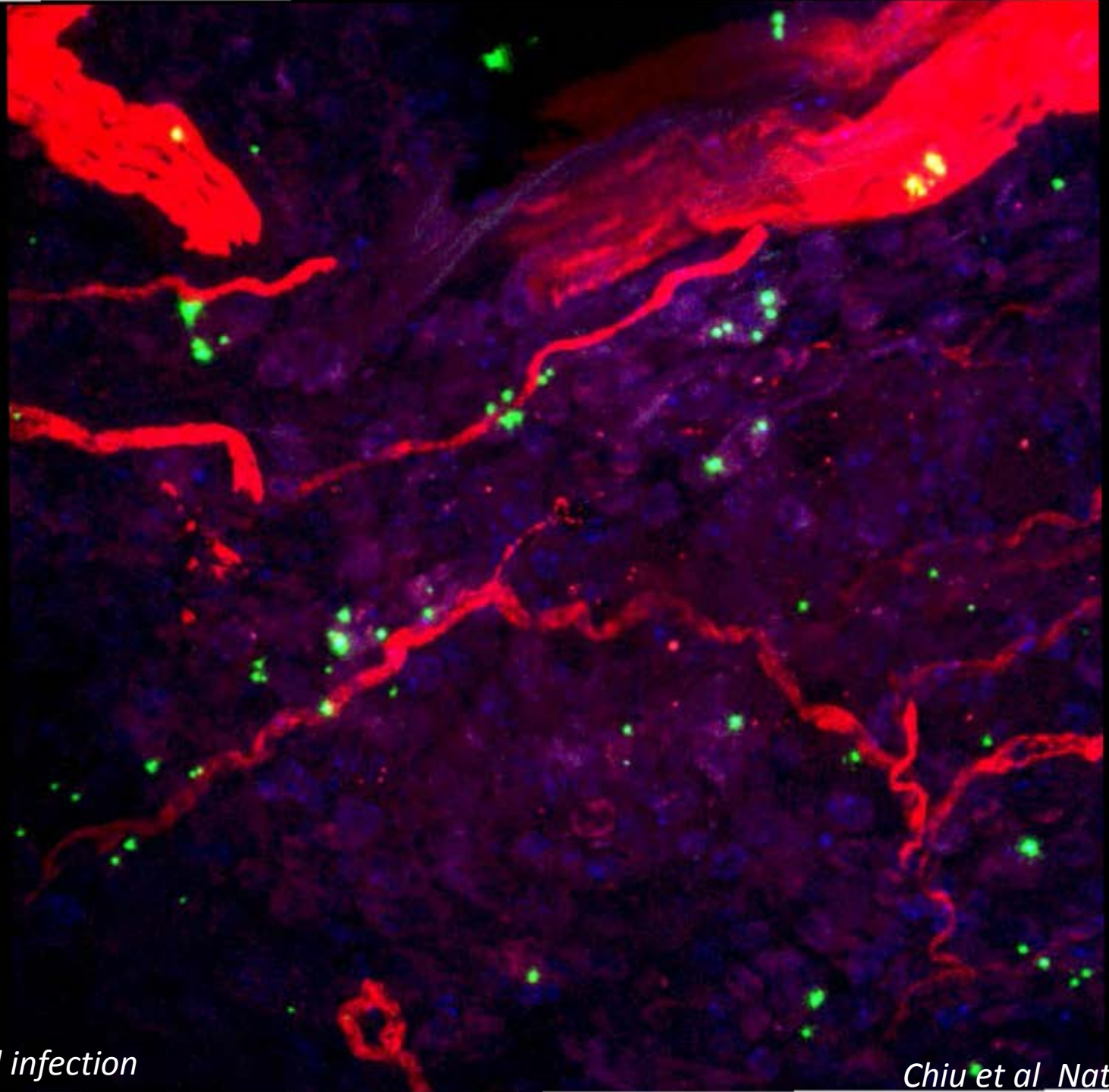








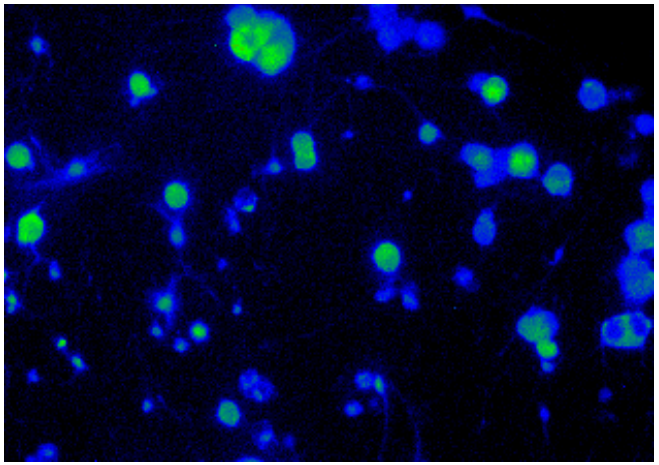
Chiu et al Nature 2013



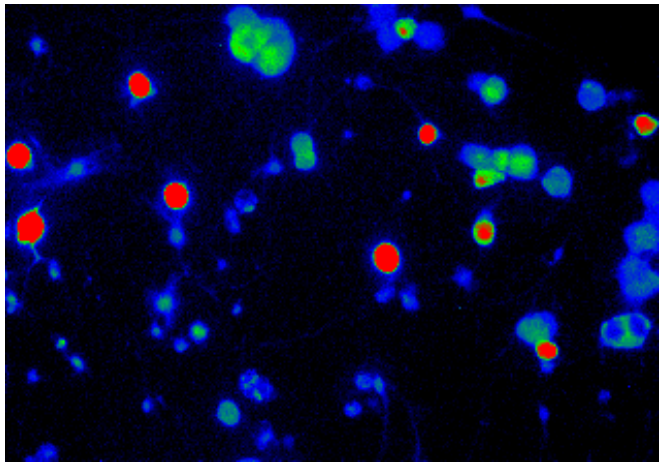
Live bacterial infection

Chiu et al Nature 2013

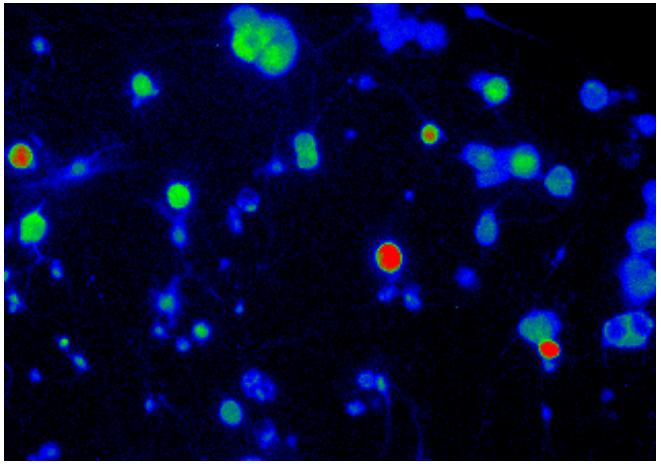
Basal

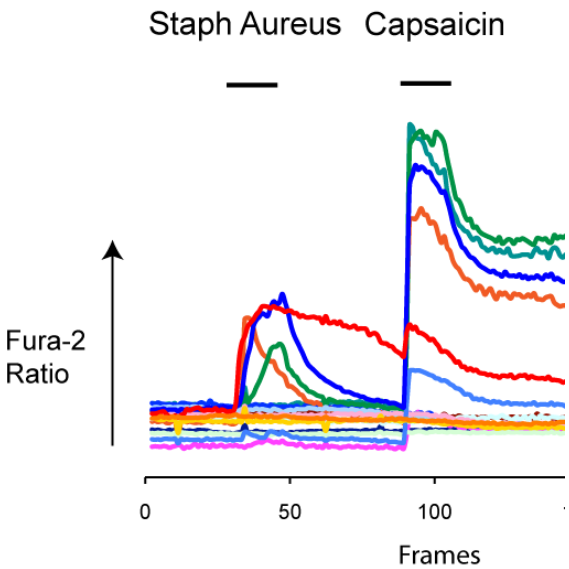


Capsaicin



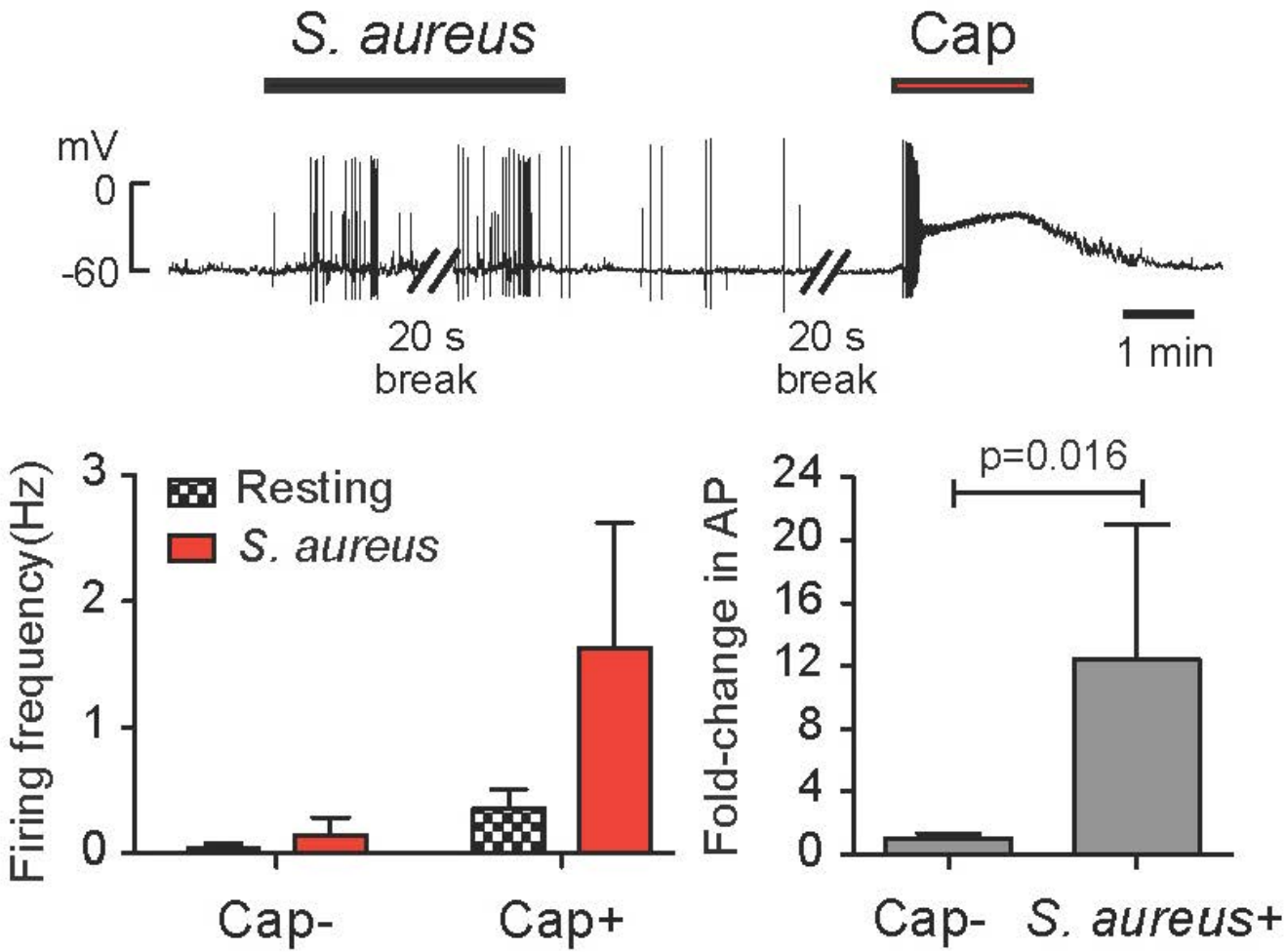
Staph. Aureus





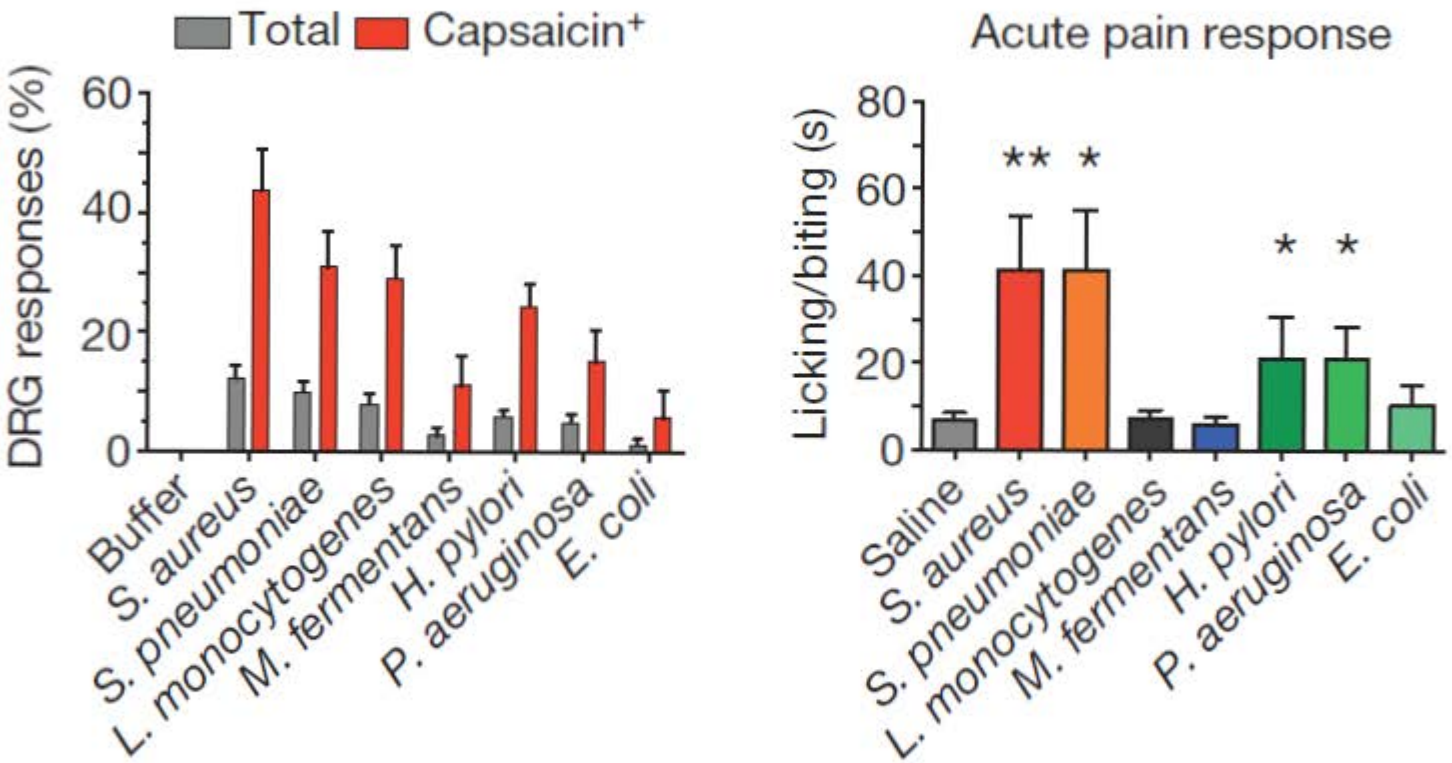
Heat-killed Bacteria

Chiu et al Nature 2013



Heat-killed Bacteria

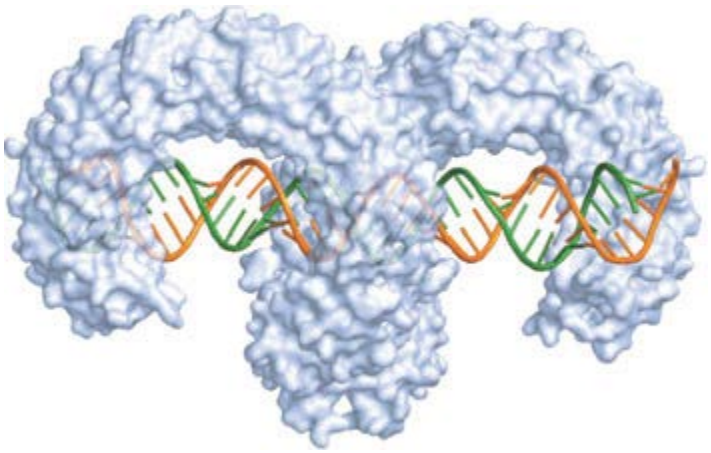
Chiu et al Nature 2013



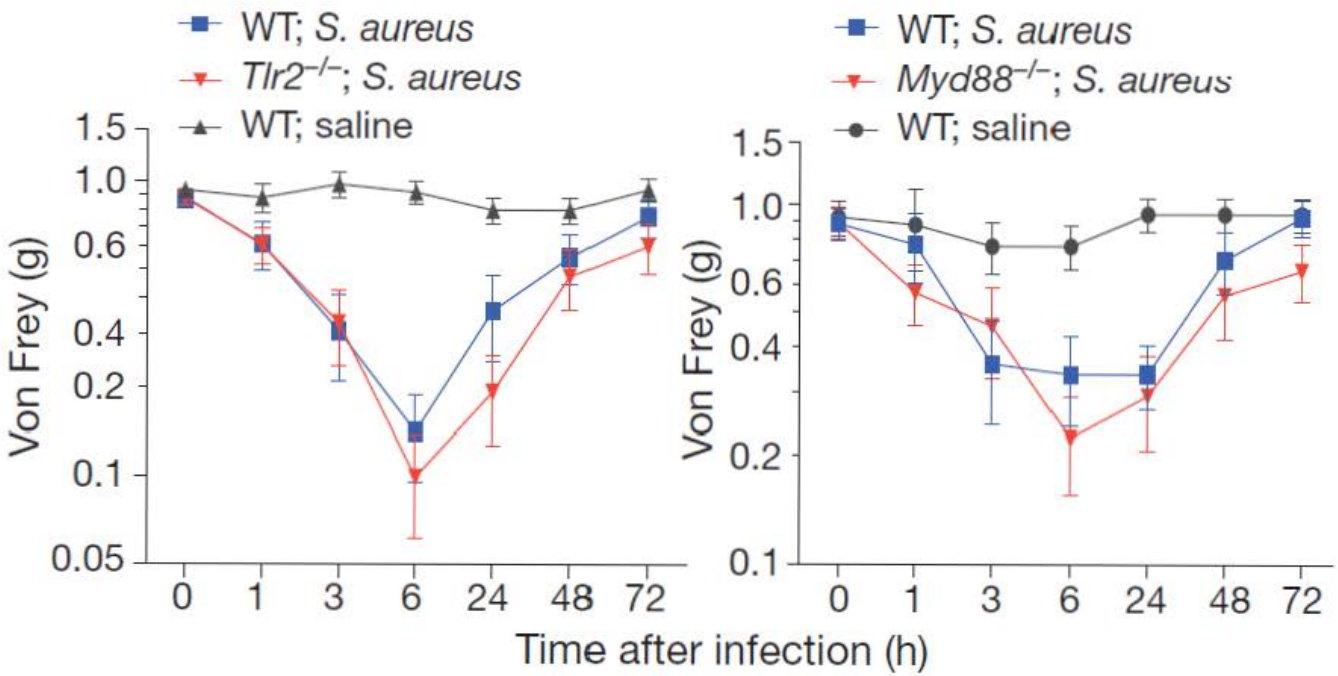
Heat-killed Bacteria

Chiu et al Nature 2013

Toll-like Receptor ligands



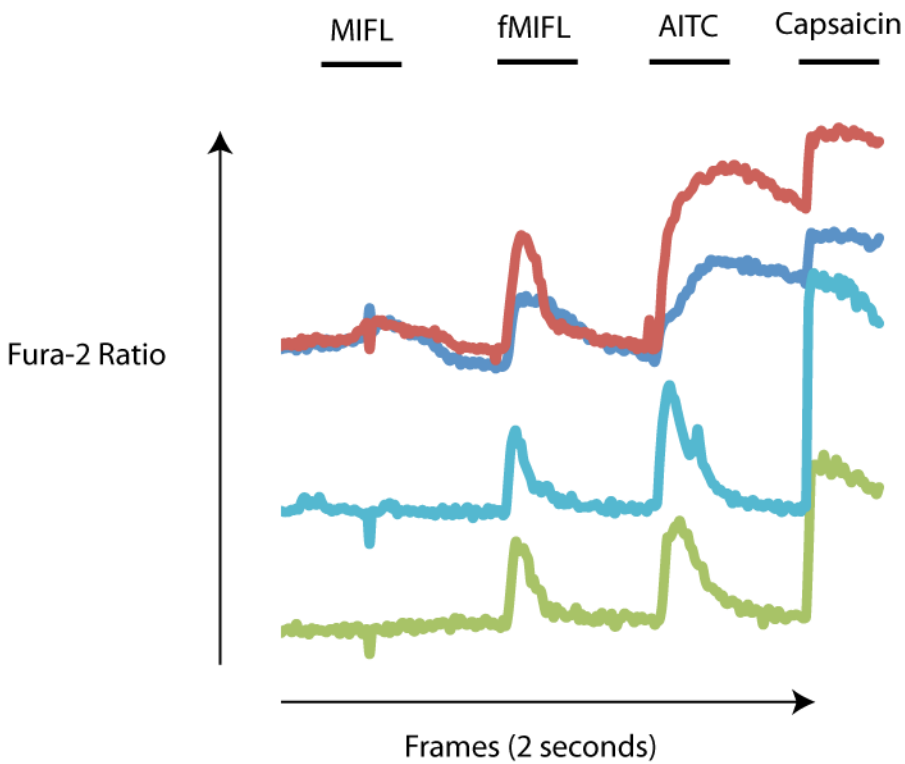
TLR3/7/9



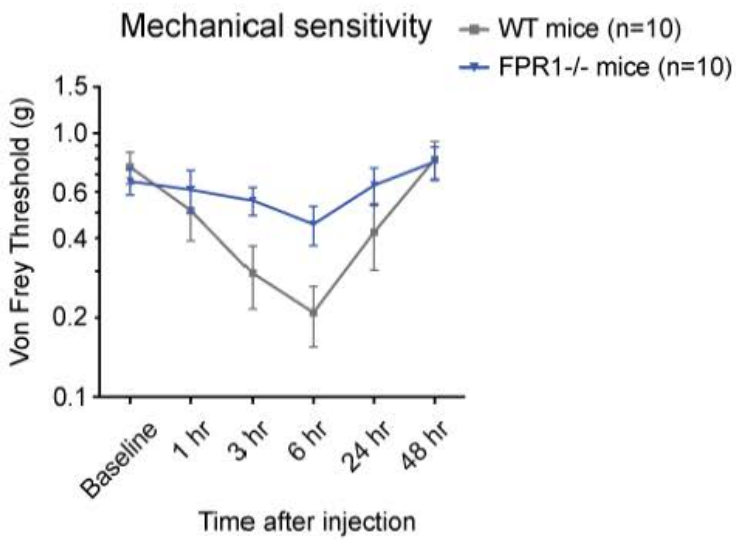
Live bacterial infection

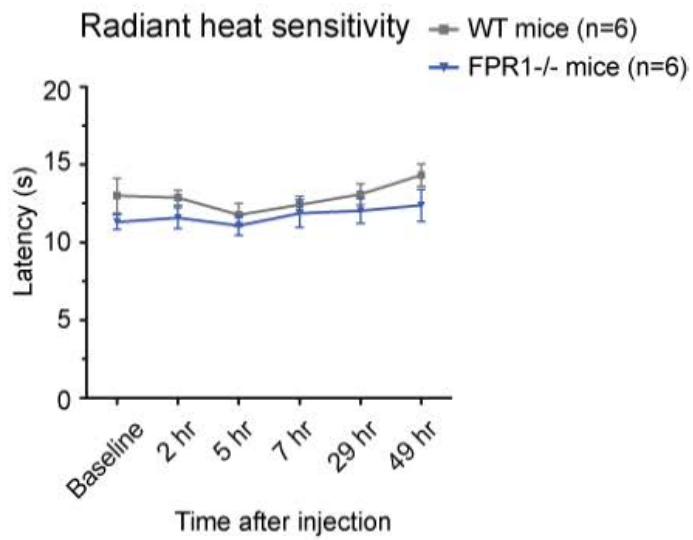
Chiu et al Nature 2013

Formyl peptides

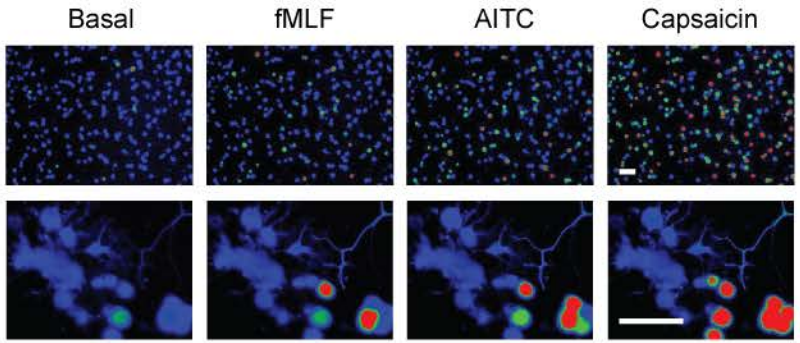


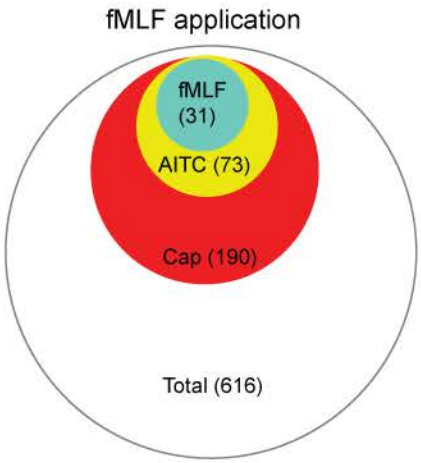
Chiu et al Nature 2013

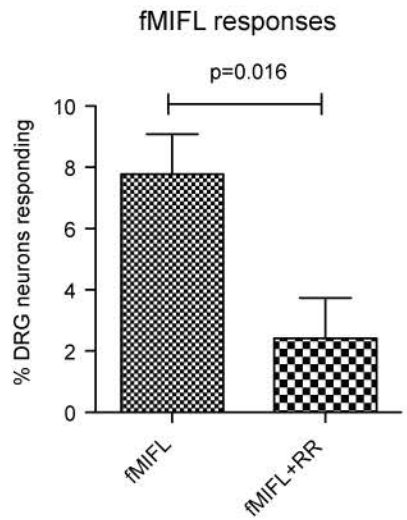


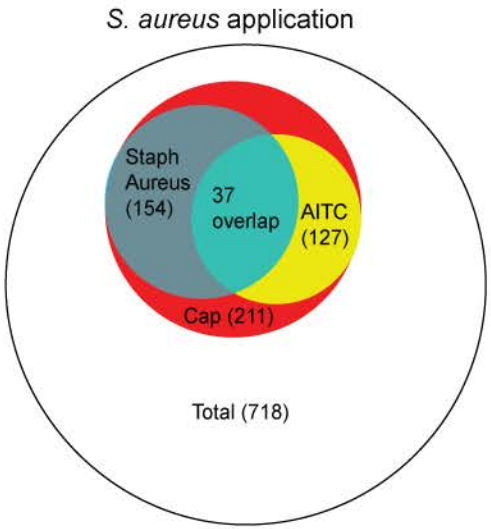


Chiu et al Nature 2013



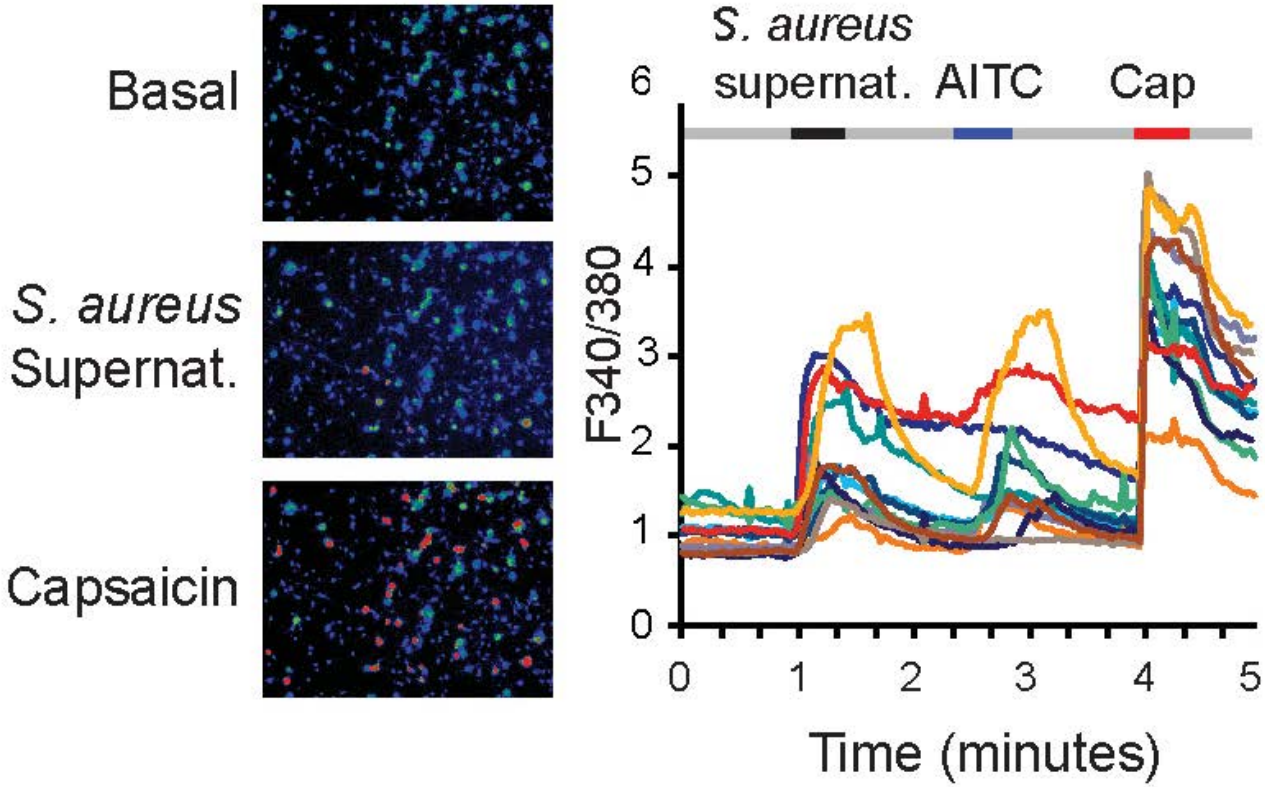






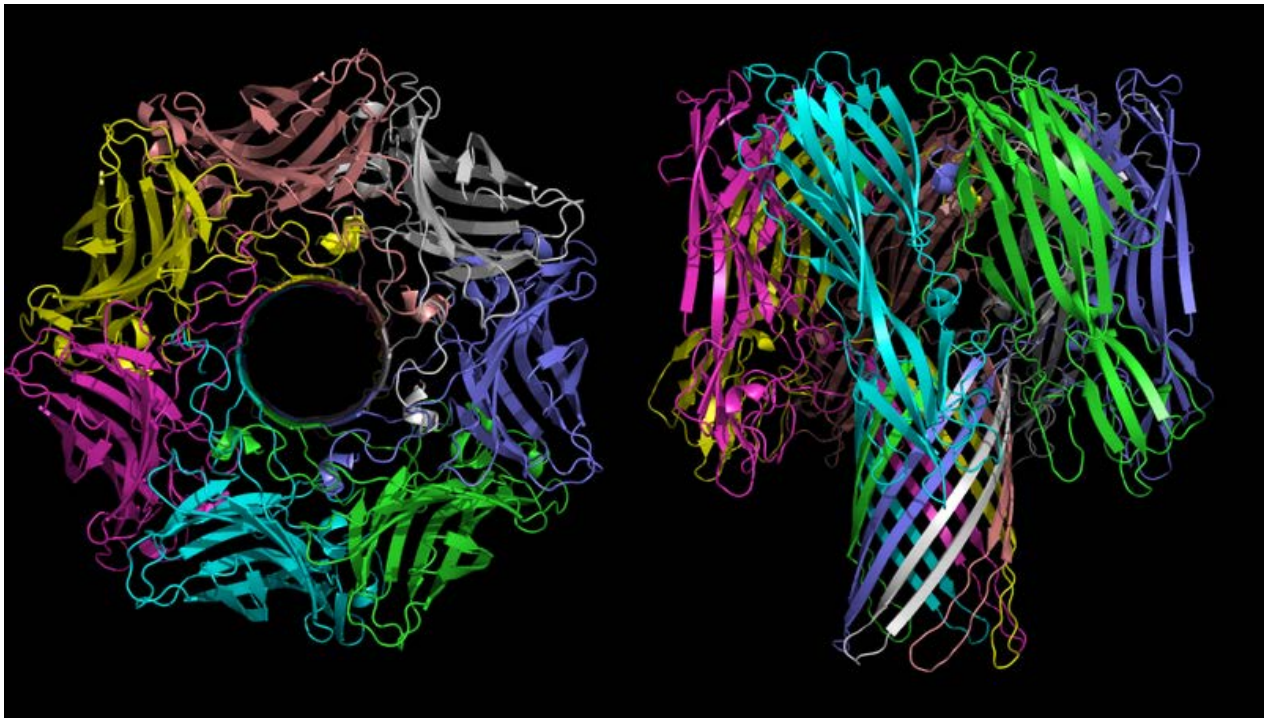
Heat-killed Bacteria

Chiu et al Nature 2013



Chiu et al Nature 2013

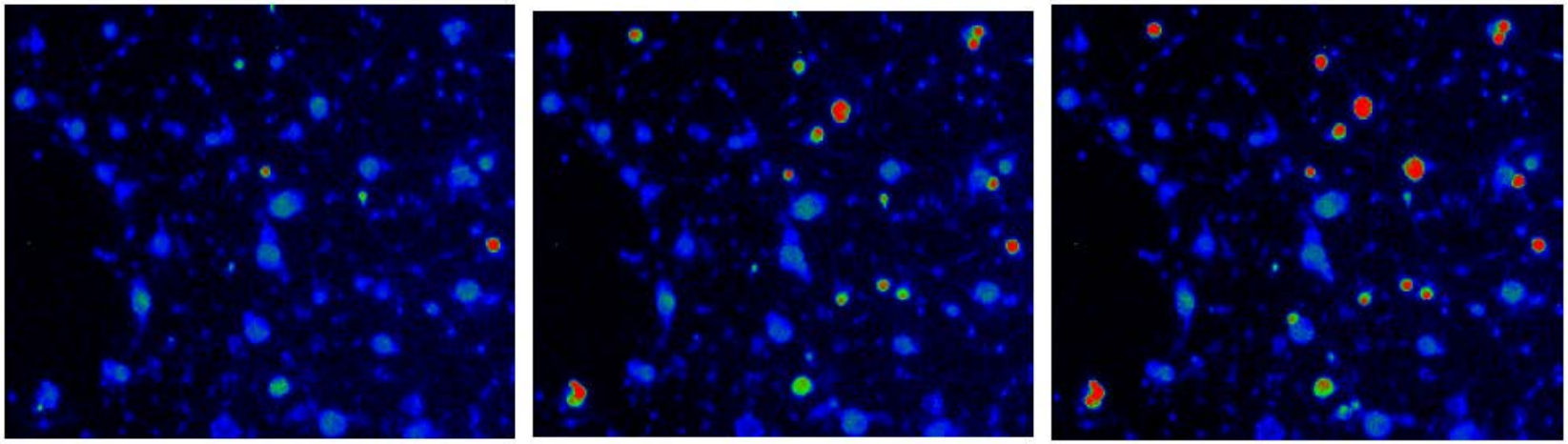
Alpha-Hemolysin (αHLa)

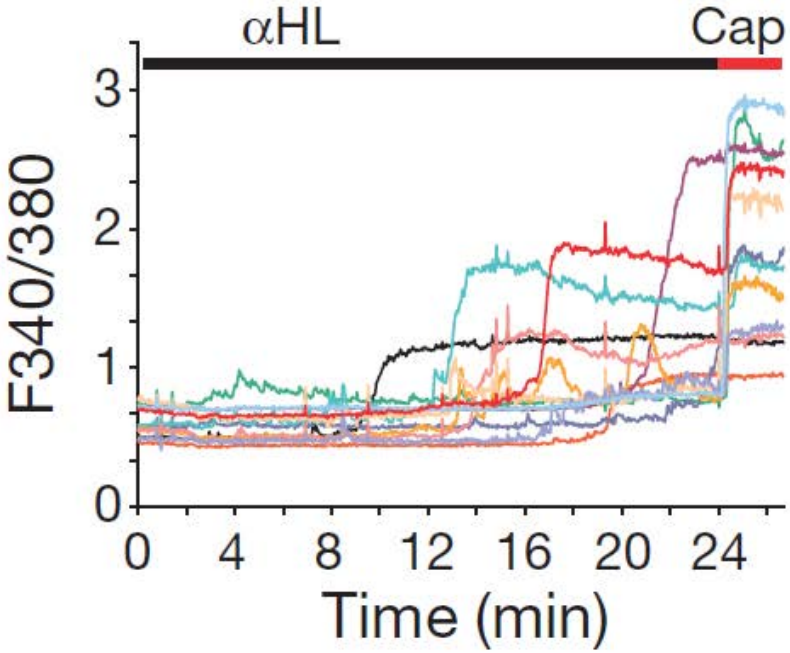


Staph. Aureus α-hemolysin

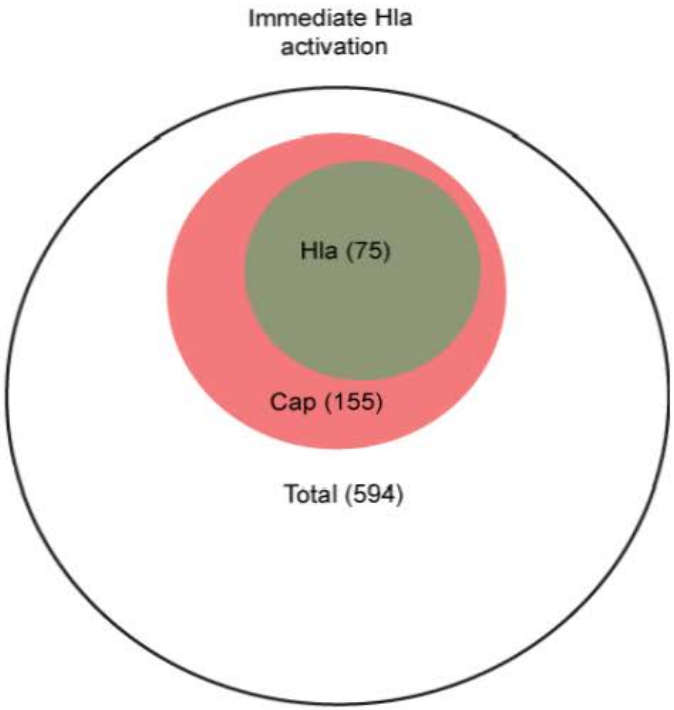
Song et al, Science 1996

Basal α-hemolysin Capsaicin

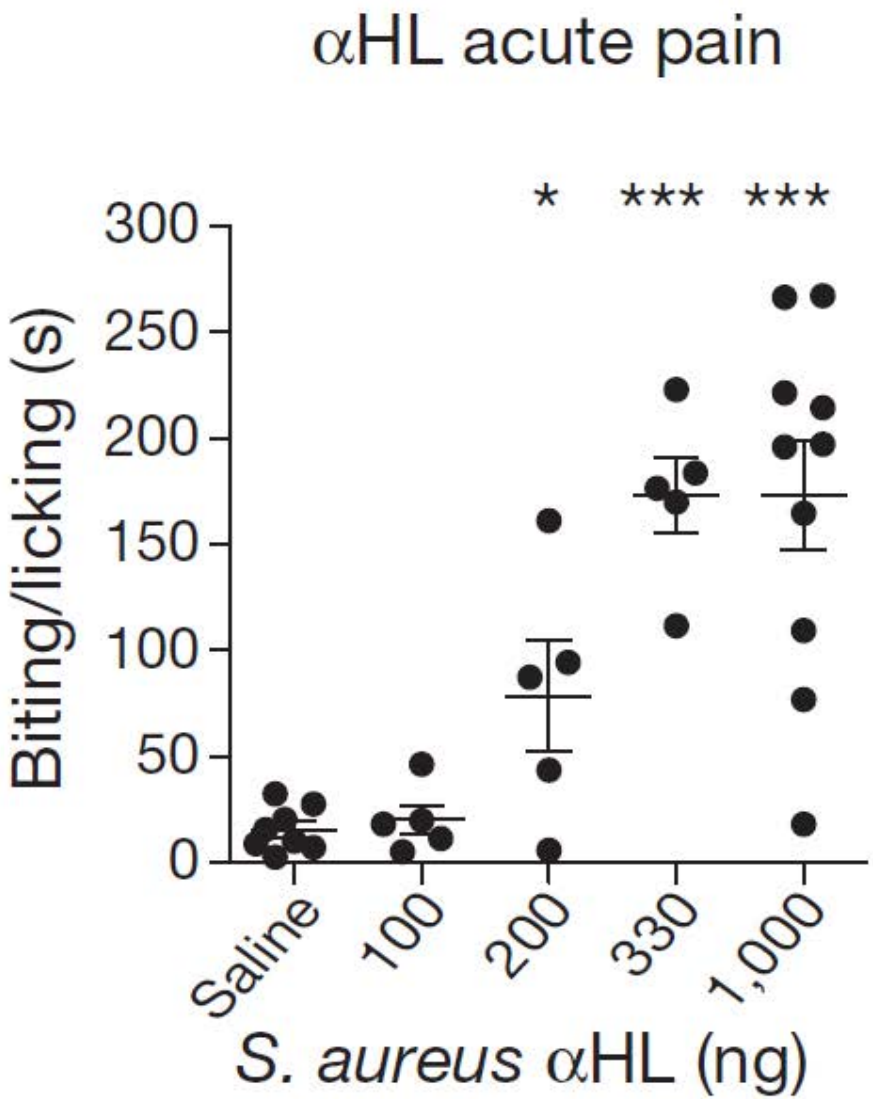




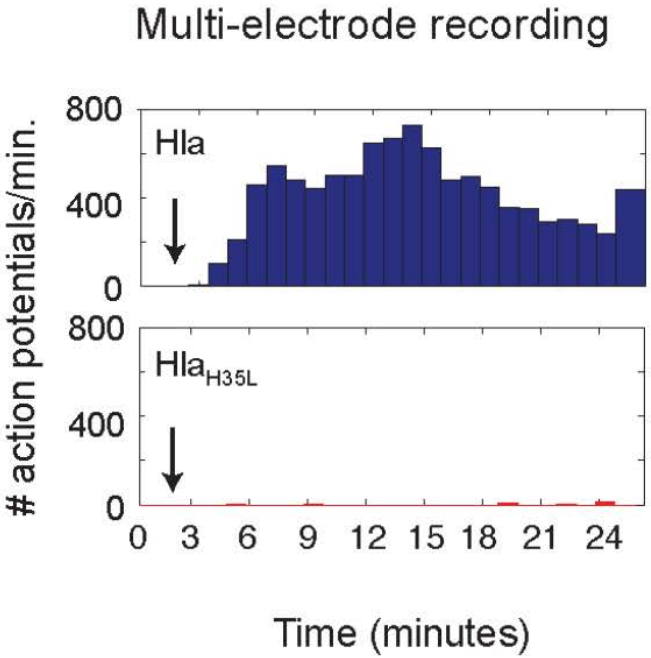
Chiu et al Nature 2013

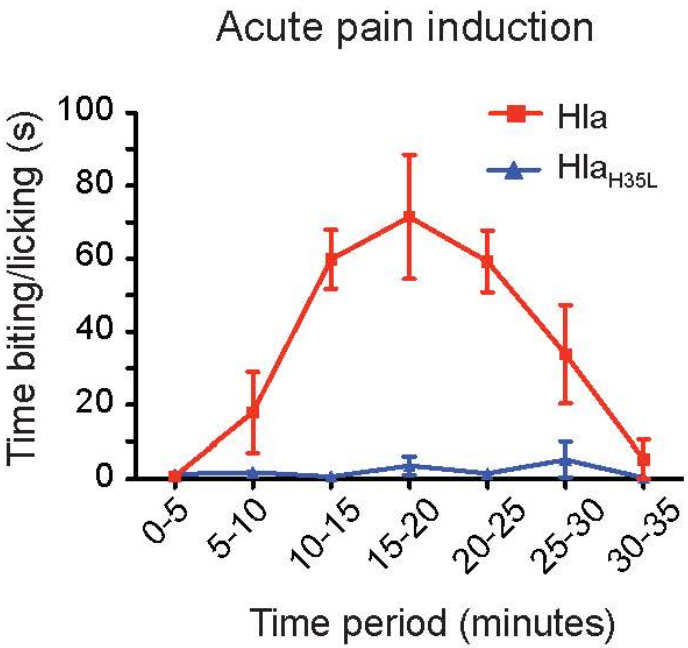


Chiu et al Nature 2013

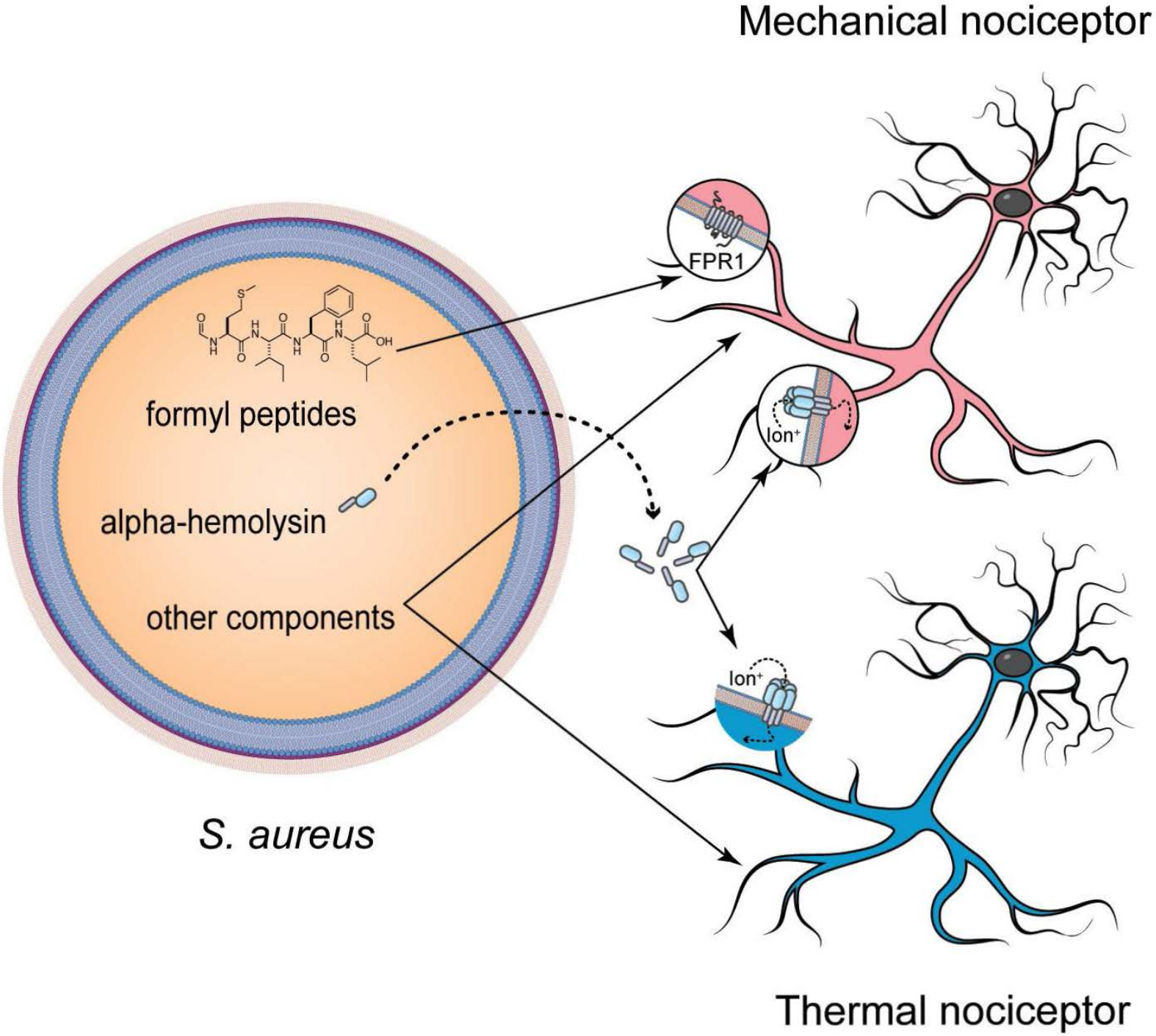


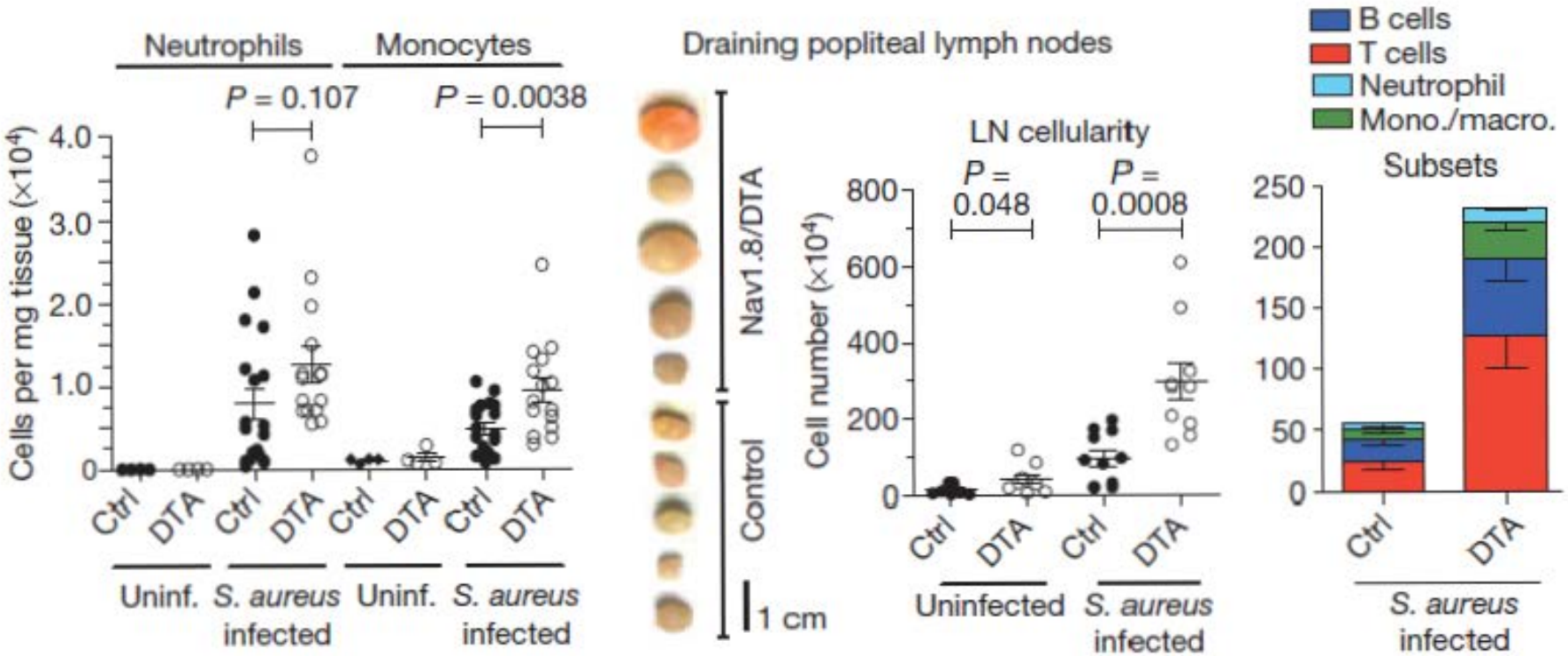
Chiu et al Nature 2013





Chiu et al Nature 2013


Mechanical nociceptor
FPR1
formyl peptides
alpha-hemolysin
other components
Ion+
Ion+
S. aureus
Thermal nociceptor


Neutrophils
Monocytes
P = 0.107
P = 0.0038
Cells per mg tissue (×10⁴)
4.0
3.0
2.0
1.0
0
Ctrl
DTA
Ctrl
DTA
Ctrl
DTA
Ctrl
DTA
Uninf.
S. aureus infected
Uninf.
S. aureus infected
Draining popliteal lymph nodes
Nav1.8/DTA
Control
1 cm
LN cellularity
P = 0.048
P = 0.0008
Cell number (×10⁴)
800
600
400
200
0
Ctrl
DTA
Ctrl
DTA
Uninfected
S. aureus infected
B cells
T cells
Neutrophil
Mono./macro.
Subsets
250
200
150
100
50
0
Ctrl
DTA
S. aureus infected

ARTICLE

doi:10.1038/nature12479

Bacteria activate sensory neurons that modulate pain and inflammation

Isaac M. Chiu[1], Balthasar A. Heesters[2,3], Nader Ghasemlou[1], Christian A. Von Hehn[1], Fan Zhao[4], Johnathan Tran[1], Brian Wainger[1], Amanda Strominger[1], Sriya Muralidharan[1], Alexander R. Horswill[5], Juliane Bubeck Wardenburg[6], Sun Wook Hwang[1,7], Michael C. Carroll[2] & Clifford J. Woolf[1]

NEWS & VIEWS

NEUROSCIENCE

Bacteria get on your nerves