

# **Immunology 101: Implications for Medical Device Failure**

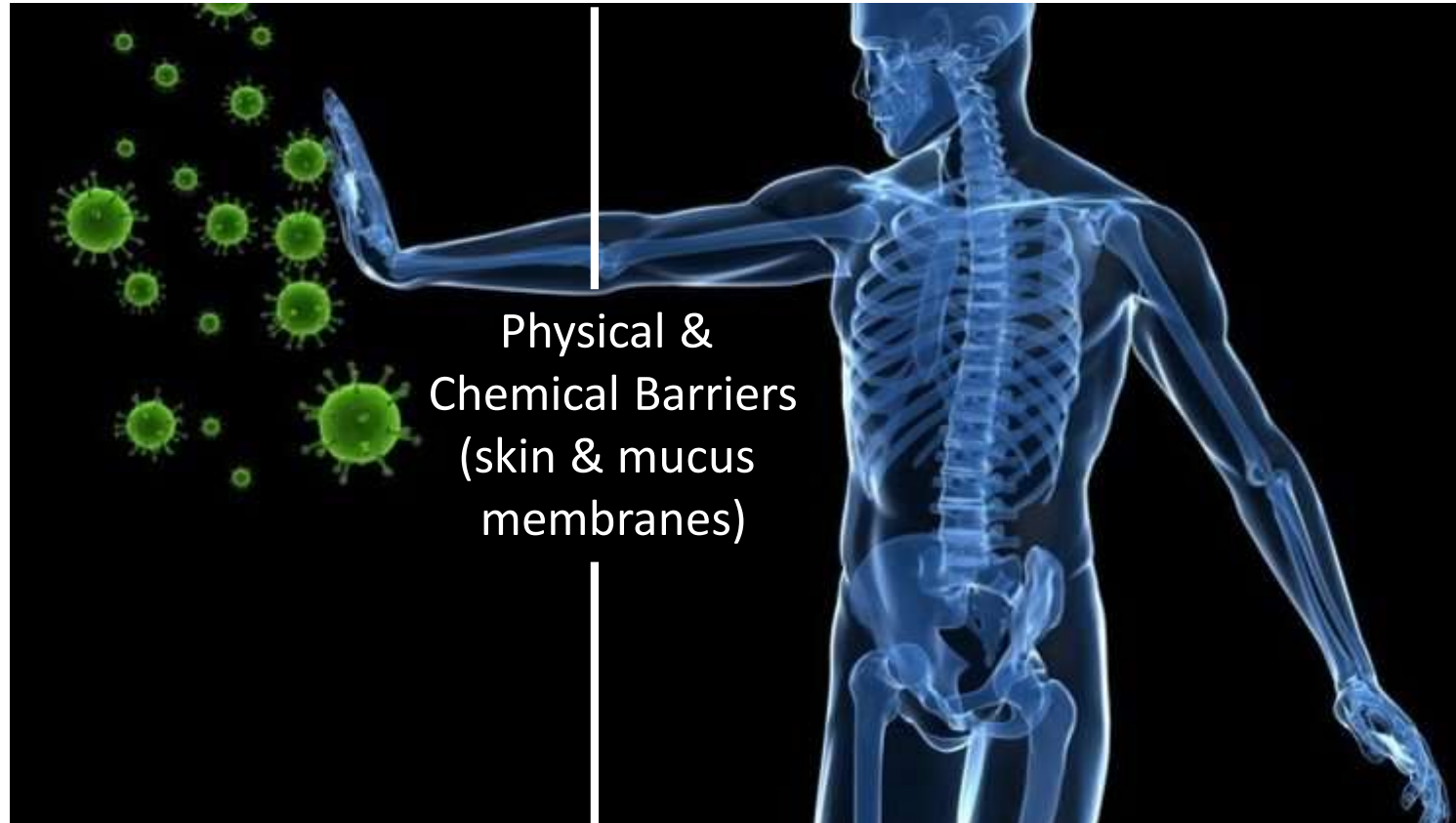
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Assistant Professor of Biology  
Chair, Department of Biology  
DeSales University



# Learning Goals

- Understand innate and adaptive immunity
- Explain how innate and adaptive immunity work together to fight infections
- Discuss how the inflammatory response can be regulated

# Basic Immunity



# Barriers to infection

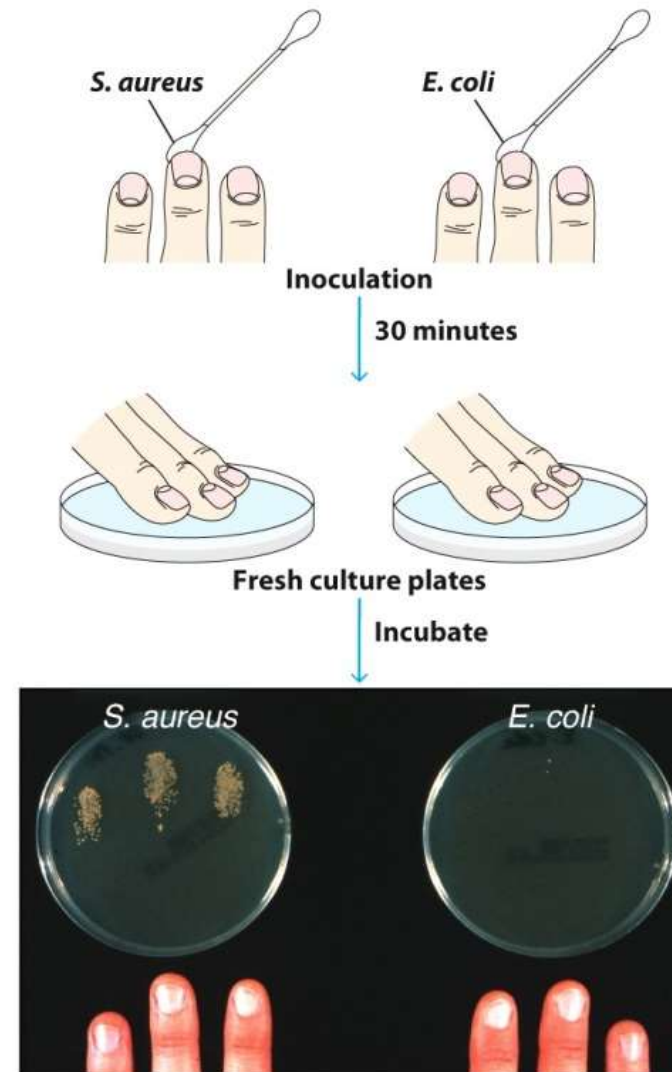
- Epithelial layers produce protective substances

- Acidic pH

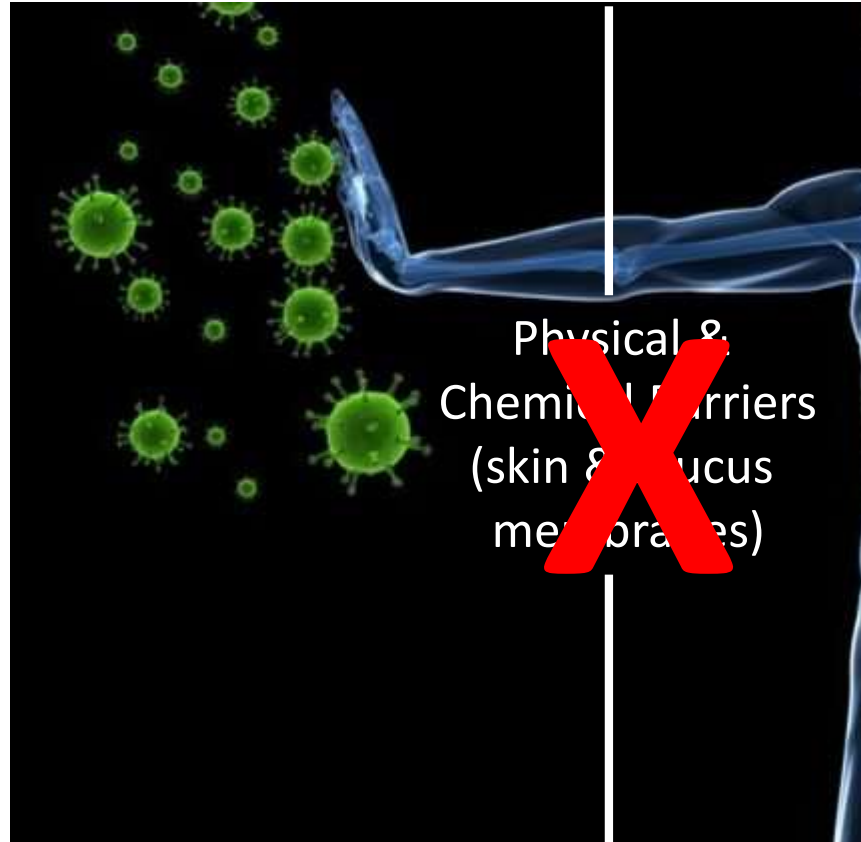
- Antimicrobial peptides

- Psoriasin

- Why does our skin secrete psoriasin?



# Immunity



## Innate Immunity

- First line of defense
- Non-specific
- No memory
- Same response to repeat infection

## Adaptive Immunity

- Max response in days
- Specific
- Memory
- More rapid response to repeat infection

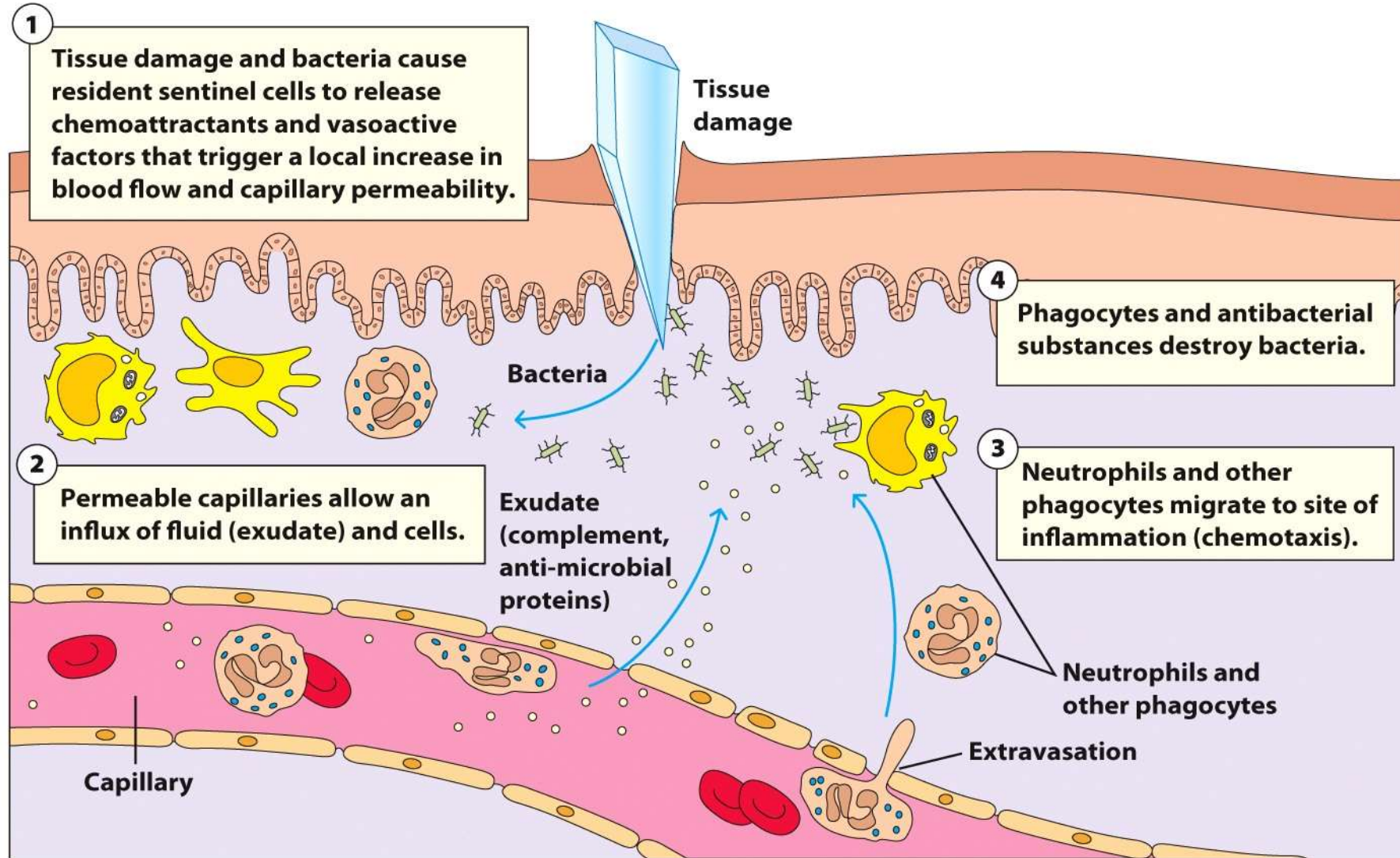
# Innate Pathogen Recognition



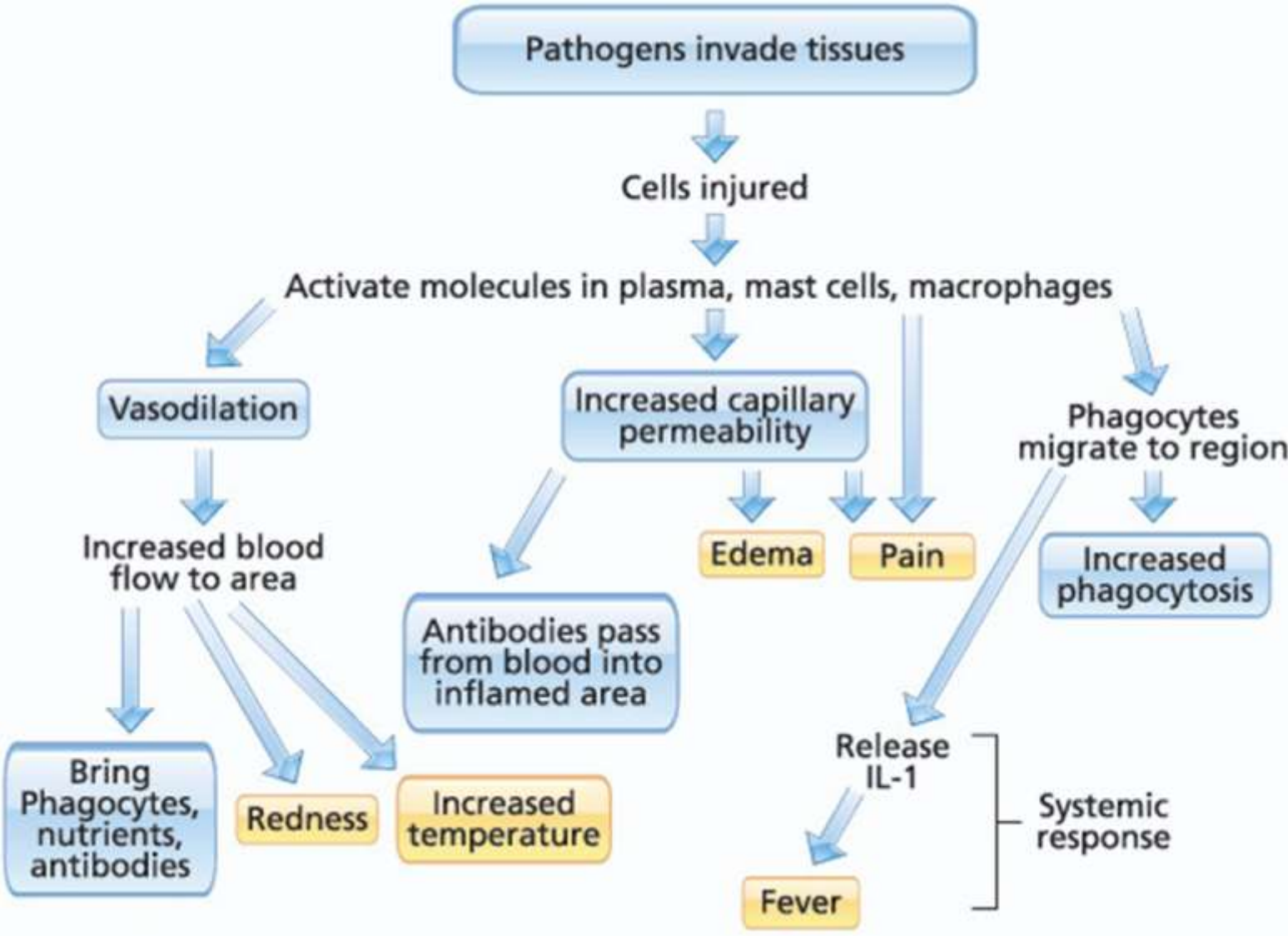
- **Innate Immune System**

- **PAMPs** – Pathogen-Associated Molecular Patterns
- **PRRs** – Pattern Recognition Receptors
  - Germ-line encoded recognition molecules
- **Host-Pathogen “Arms” Race**

# Inflammatory Response

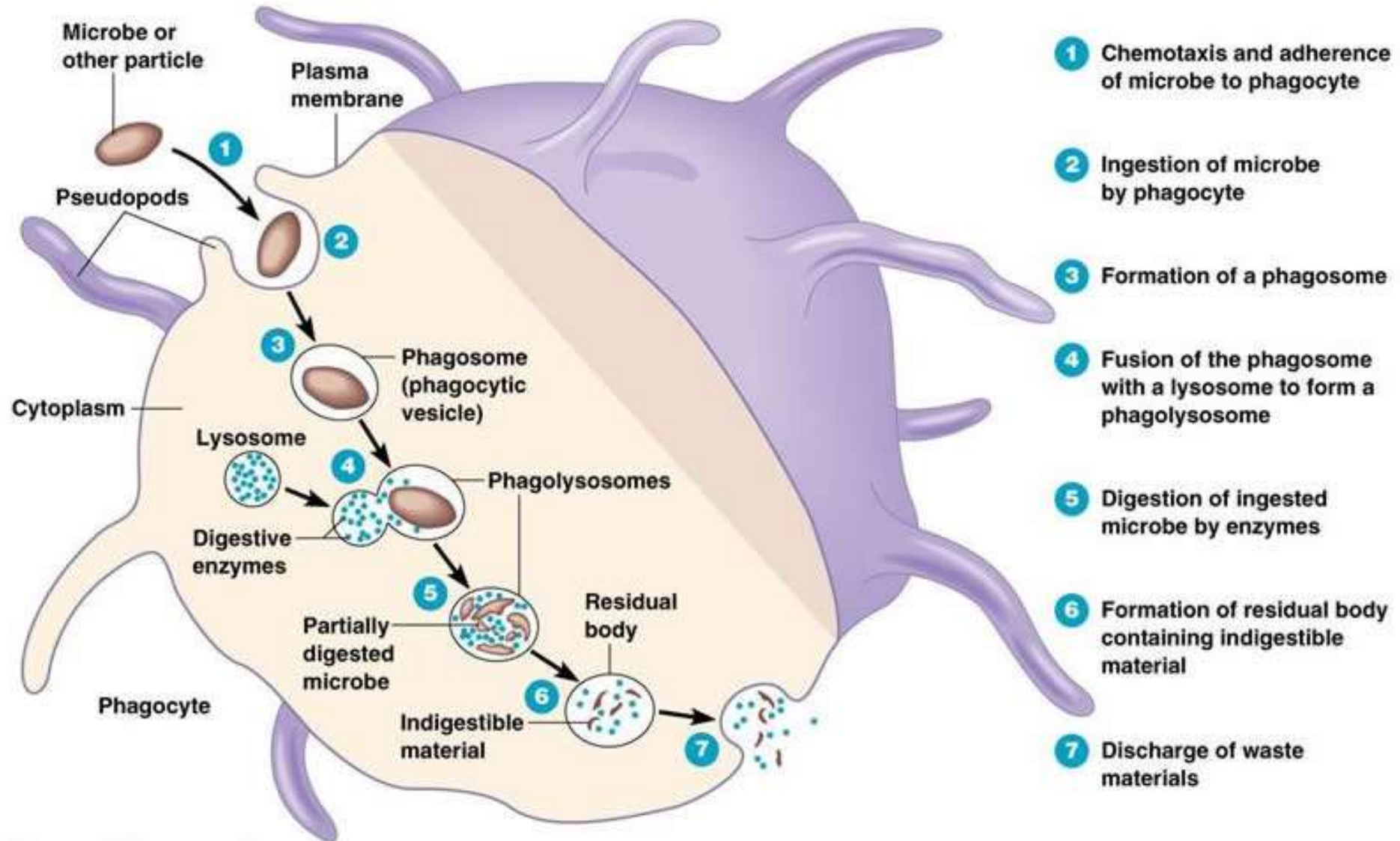


# Hallmarks of Inflammation





# Phagocytosis

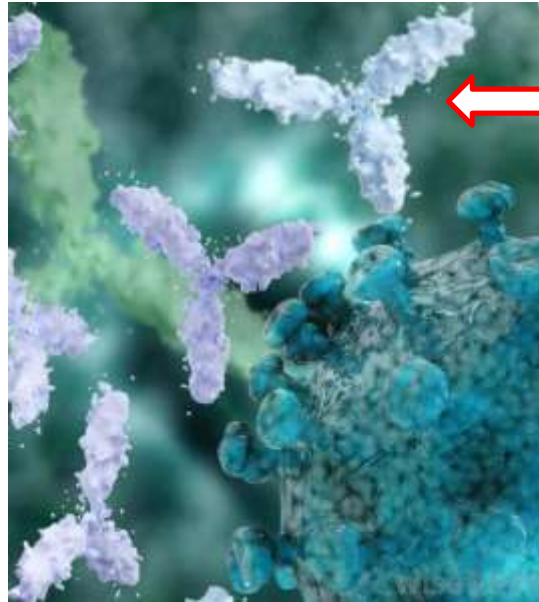


# Neutrophil - Phagocytosis

[www.BetaGlucans.info](http://www.BetaGlucans.info)

[https://www.youtube.com/watch?v=Z\\_mXDvZQ6dU](https://www.youtube.com/watch?v=Z_mXDvZQ6dU)

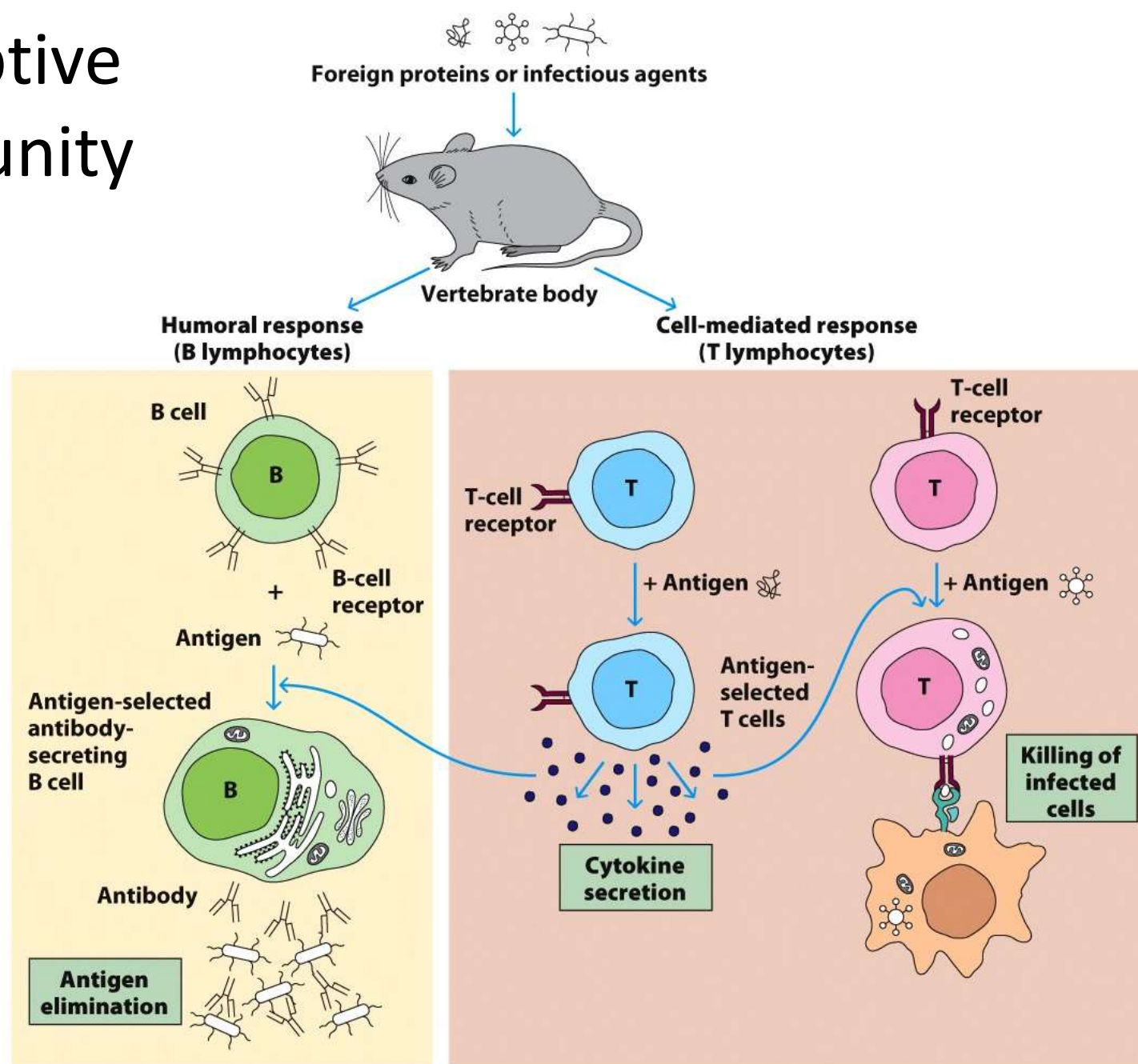
# Adaptive Pathogen Recognition



Antibodies  
(products of B cells)

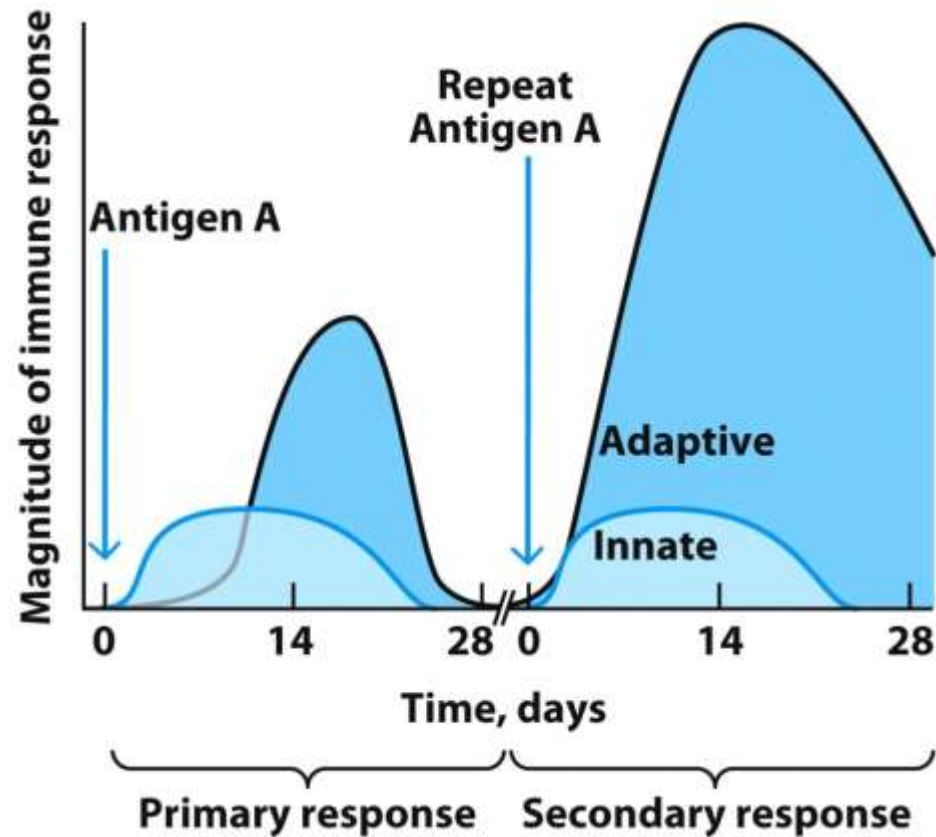
- **Adaptive Immune System**
  - **Randomly generated (B and T cell receptors)**
    - These bind to very specific antigens, rather than generic molecules found on many pathogens

# Adaptive Immunity



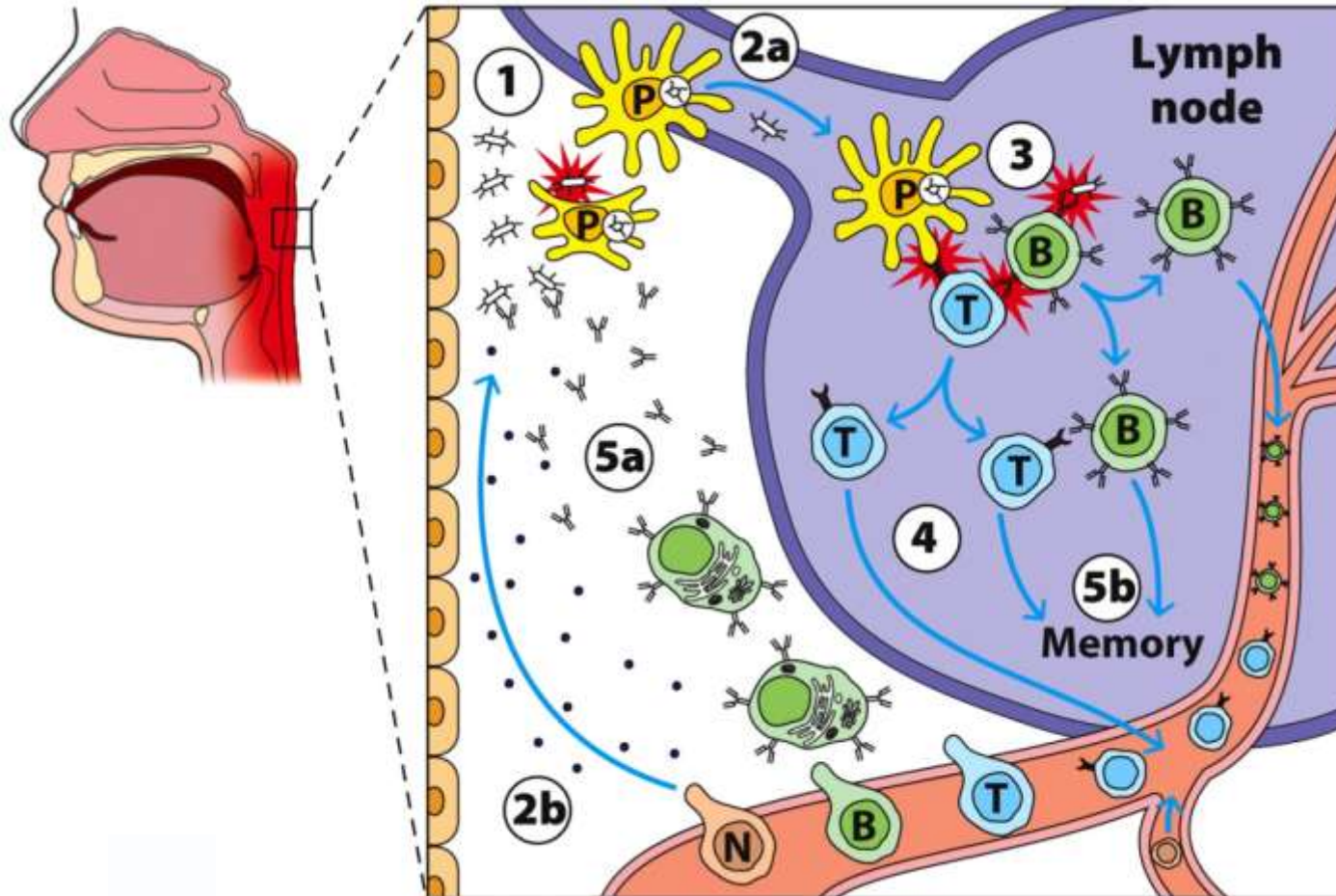
# Adaptive Memory

- Memory is the hallmark of adaptive immunity
  - Reason why vaccines work!



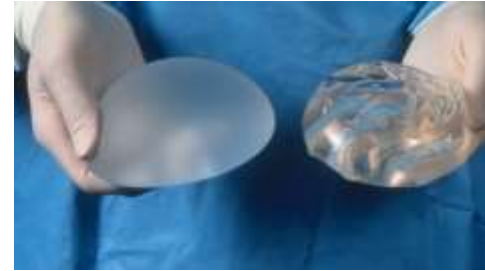
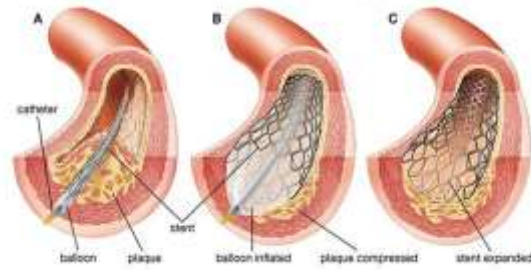
# Teamwork is Key!

- Innate and adaptive immunity work cooperatively
  - Activation of innate immune responses produces **cytokines** which communicates with the adaptive immune system



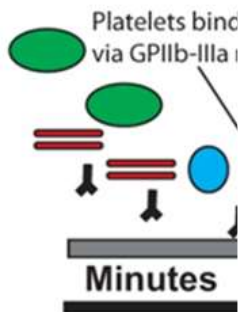
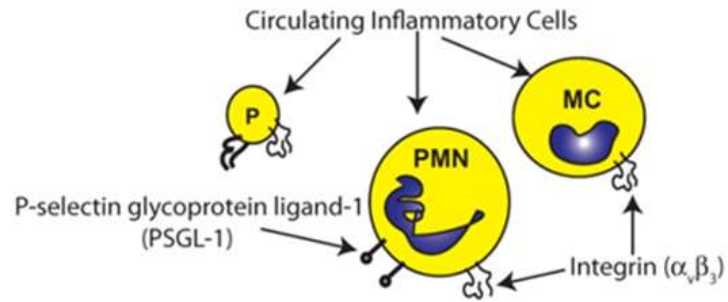
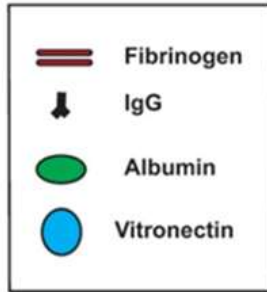


# Implantable Biomaterials and Biocompatibility



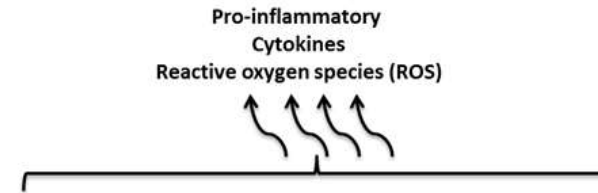
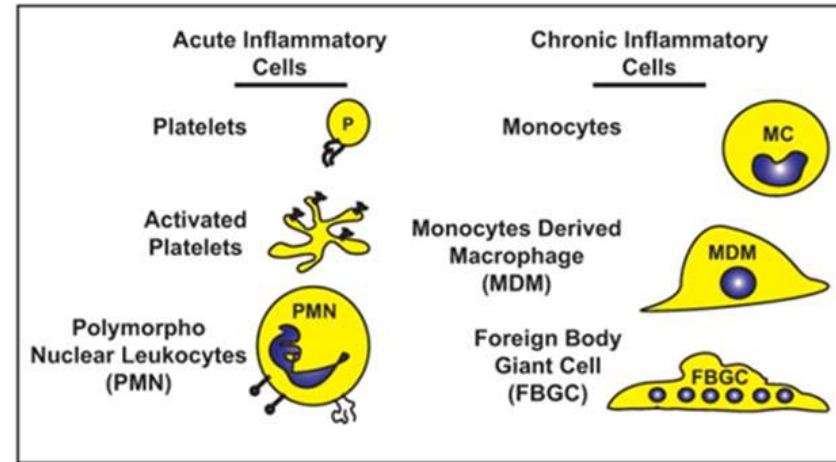


### Representative Blood Proteins



Blood Protein Adsorption

### Inflammatory Cells



# Biocompatibility

The condition of being compatible with living tissue or a living system by not being toxic or injurious and not causing immunological rejection

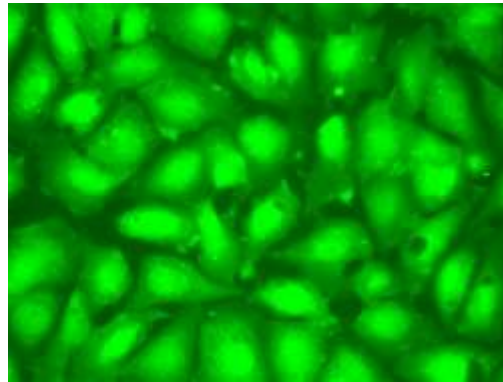
# Resveratrol



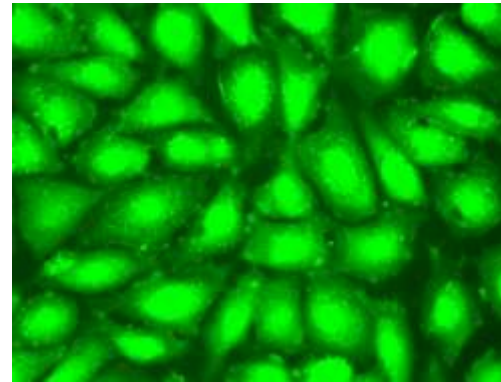
- Produced in plants during environmental stress
- Consuming red wine in high amounts (20-30 g per day) can lower the risk of coronary heart disease, a type of CVD, by at least 40%

# Resveratrol and Endothelial Cell Morphology

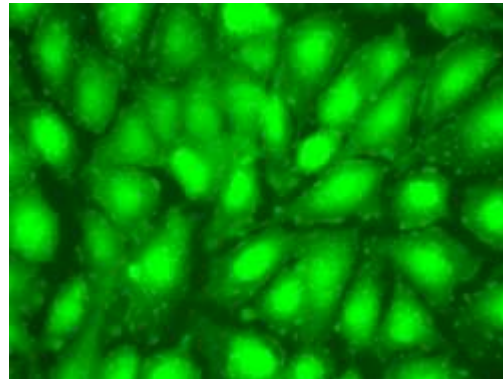
No  
Resveratrol



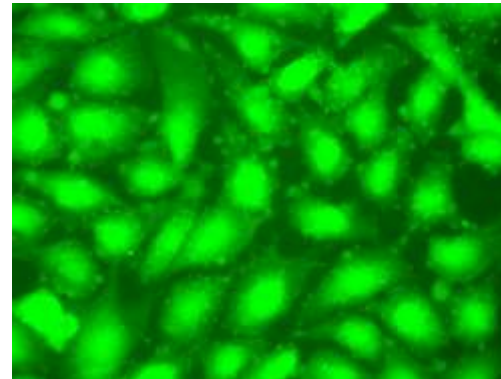
1  $\mu$ M  
Resveratrol



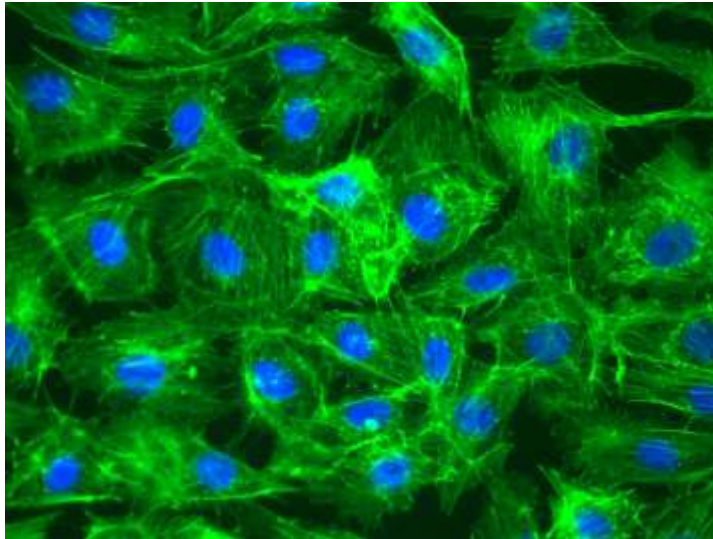
10  $\mu$ M  
Resveratrol



100  $\mu$ M  
Resveratrol



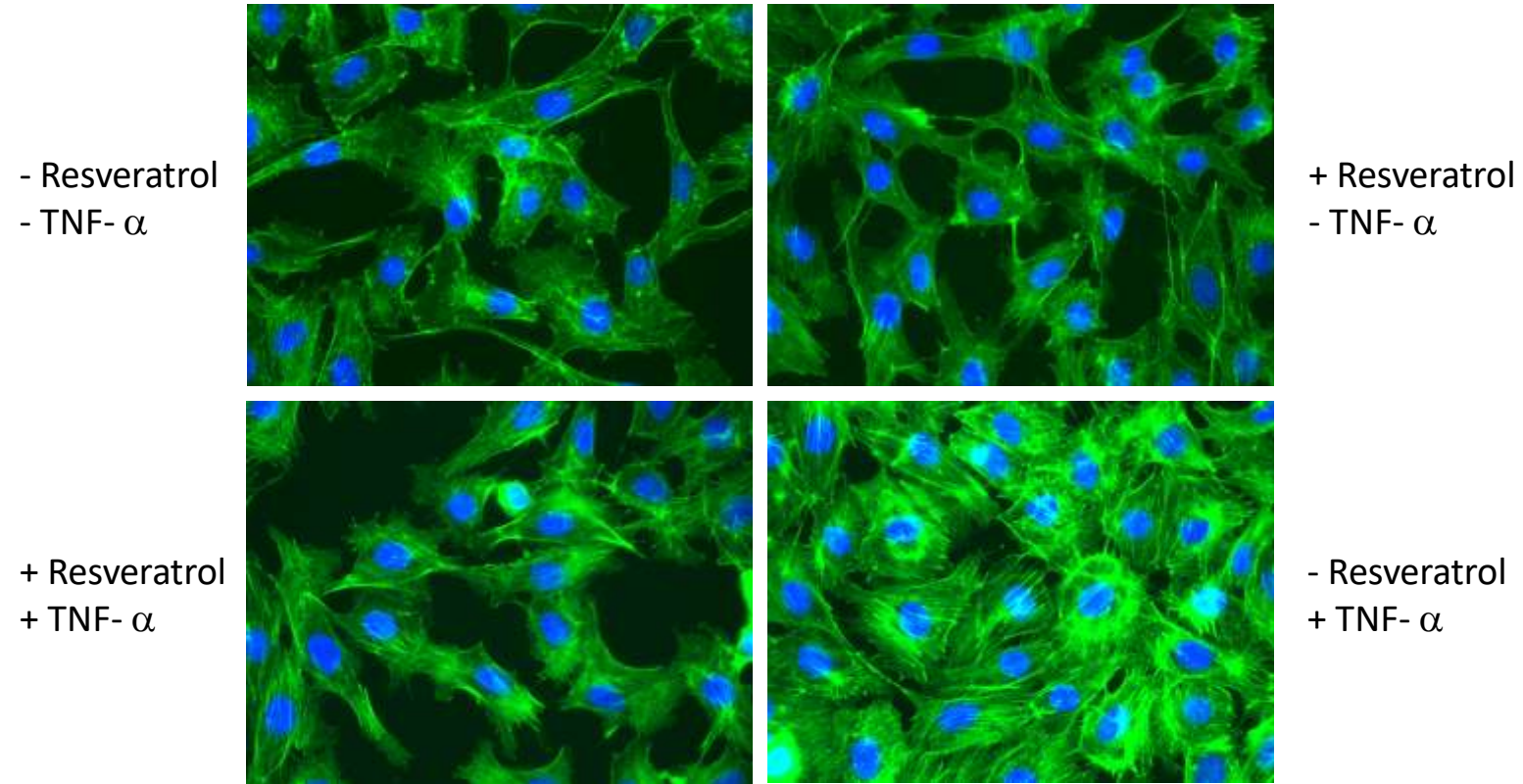
# Resveratrol and Cell Stress



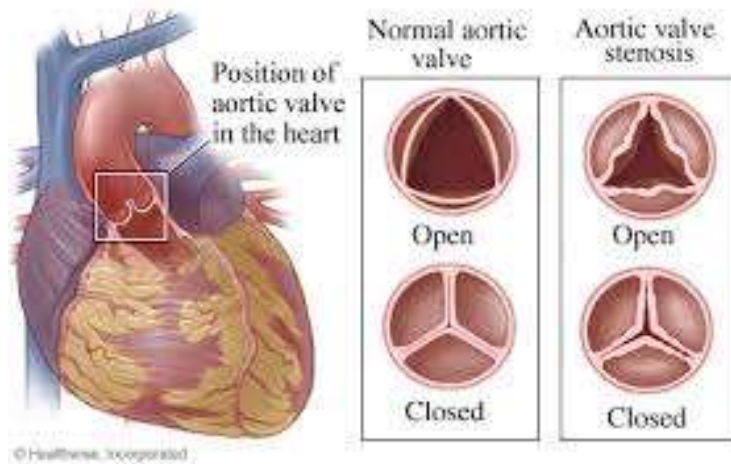
Blue: Nucleus  
Green: F-actin

- Tumor Necrosis Factor- $\alpha$  (TNF- $\alpha$ ) was used to induce cell stress
- Induces actin stress fiber accumulation in BAECs, mimicking the inflammatory response

# Resveratrol and Cell Stress

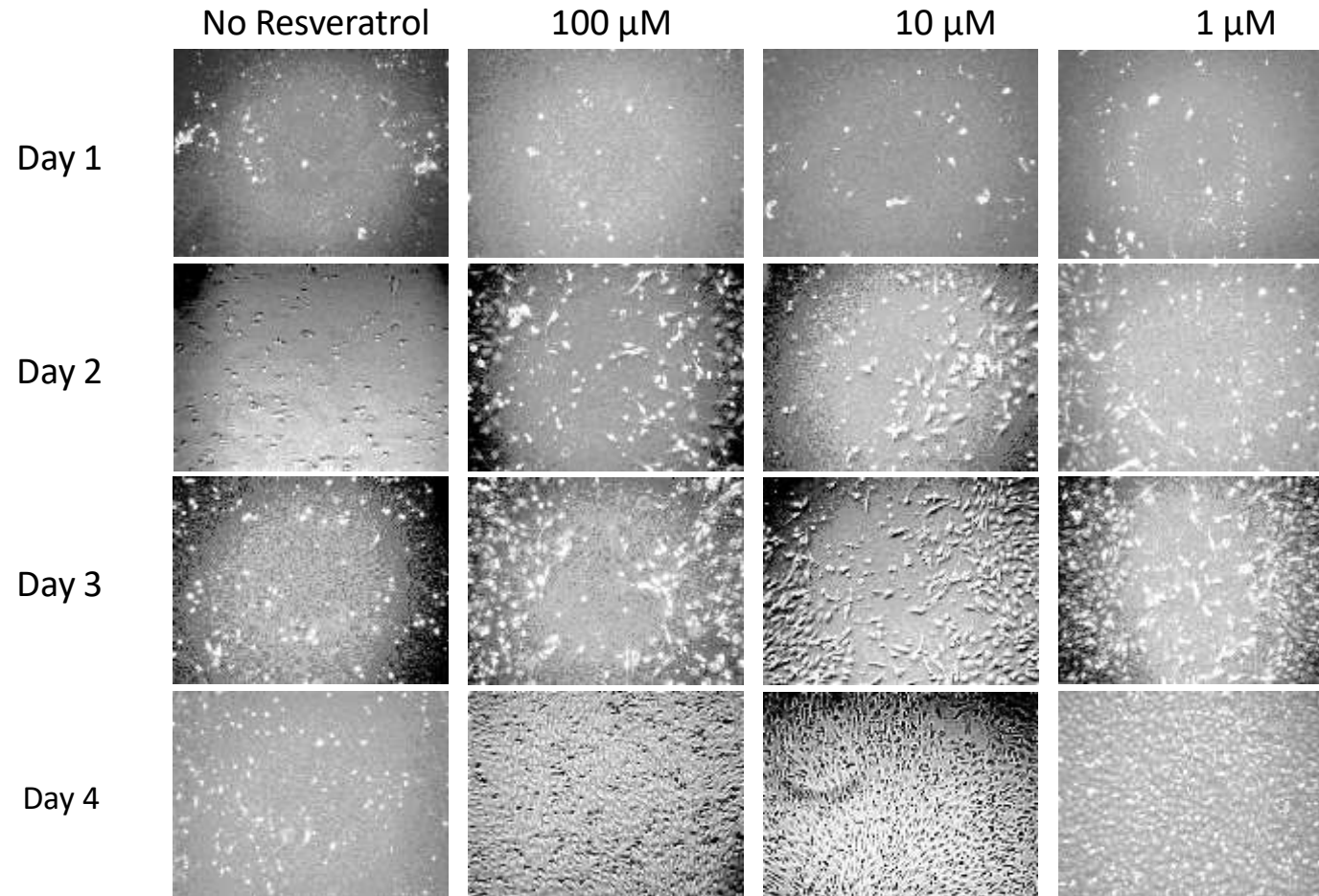


# Wound Healing



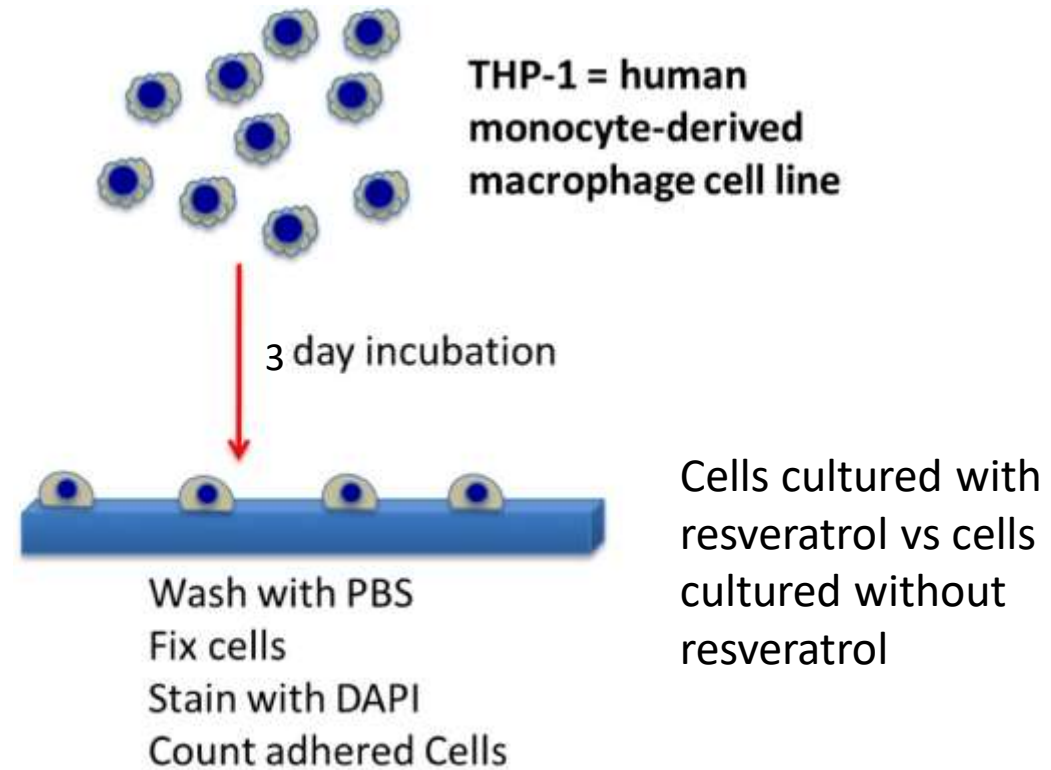
- Resveratrol facilitates the activation of vascular endothelial growth factor (VEGF) expression
- VEGF promotes angiogenesis

# Wound Healing

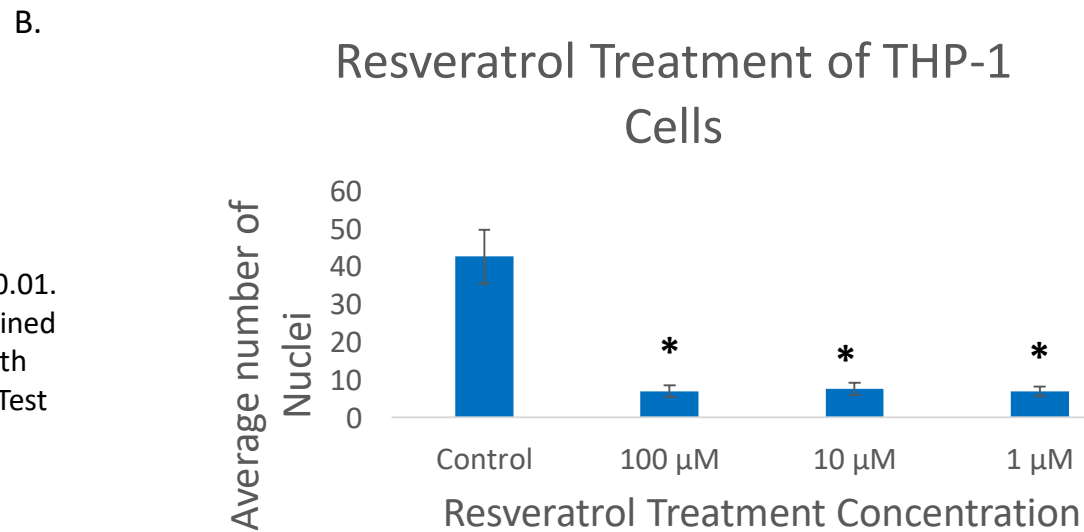
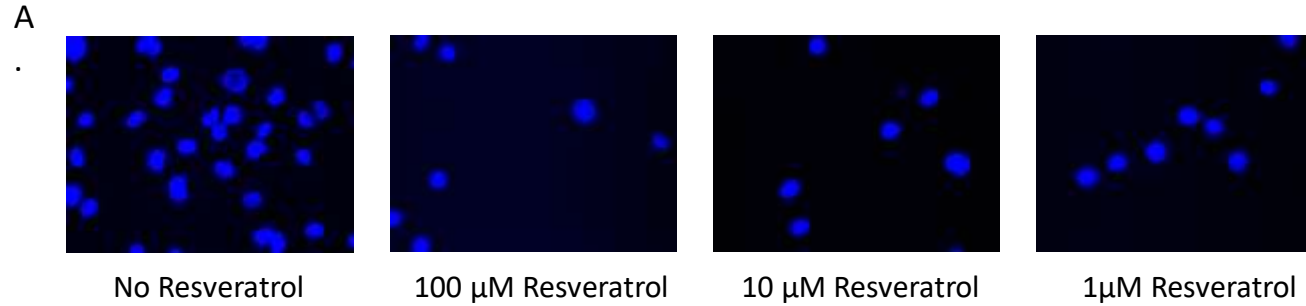




# THP-1 Adhesion Assay



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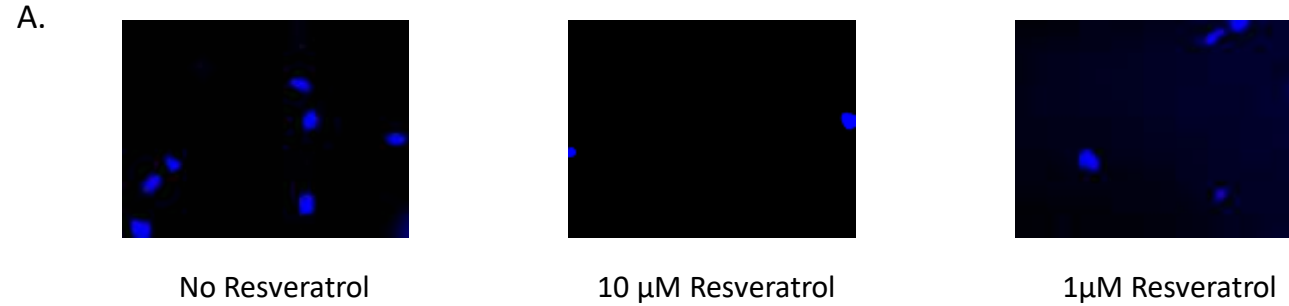


\* represents  $p < 0.01$ .  
P values determined using ANOVA with Tukey Post-Hoc Test

# Chandler Loop Assay

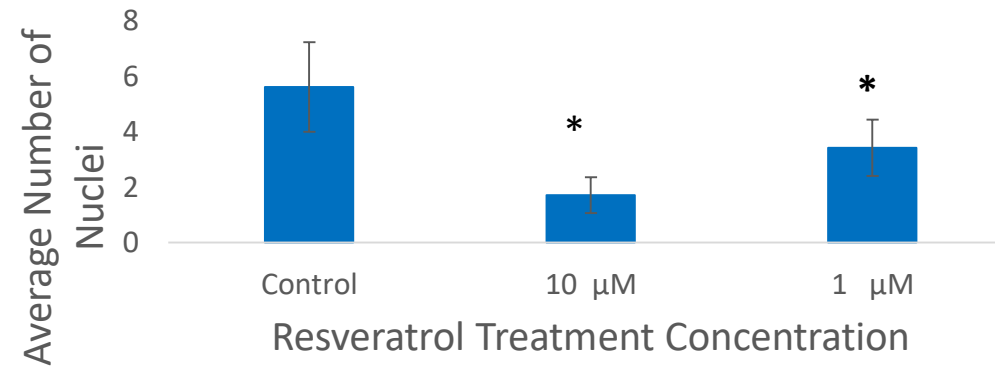


# Chandler Loop Assay



B.

Resveratrol Treatment of THP-1 cells  
in a Chandler Loop



\* represents  $p < 0.01$ .  
P values determined  
using ANOVA with  
Tukey Post-Hoc Test

# Summary

- Pathogens and foreign objects trigger an inflammatory response in the body.
- Innate Immunity is the “non-specific” way the body deals with eliminating pathogens and foreign objects from the body.
- Adaptive Immunity is the “specific” way the body deals with eliminating pathogens from the body.
- Resveratrol from red wine and grapes possesses anti-inflammatory properties that are worth investigating further.

# Thank You! Questions?

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