Inflammation

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Inflammation Lecture Objectives

- Define inflammation and explain its physiologic purposes.
- Describe the clinical manifestations of inflammation, including its four cardinal signs.
- List some causes of inflammation.
- Compare and contrast the cell types and time course of acute and chronic inflammation.
- List and describe the steps involved in acute inflammation, including the process of neutrophil extravasation.
- Compare and contrast the microscopic appearances of acute and chronic inflammation.

Inflammation Outline

- What is inflammation?
- Acute inflammation
- Chronic inflammation
- When is inflammation bad?

Inflammation Outline

- What is inflammation?

Inflammation, super-simplified

Inflammation is the body's normal, protective reaction to local injury.

Cells like neutrophils and lymphocytes travel through blood vessels to the injured tissue.

These cells help kill any infectious agents, and then they clean up the damage.

Inflammation is supposed to be helpful – but if it happens in the wrong place, or lasts too long, it can be destructive.

Some Causes of Inflammation

- Infections (bacterial, viral, fungal, parasitic)
- Physical trauma (burns, abrasions, cuts)
- Chemical agents (toxins, irritants)
- Unidentified immune-stimulating agents (leading to autoimmune and other diseases)

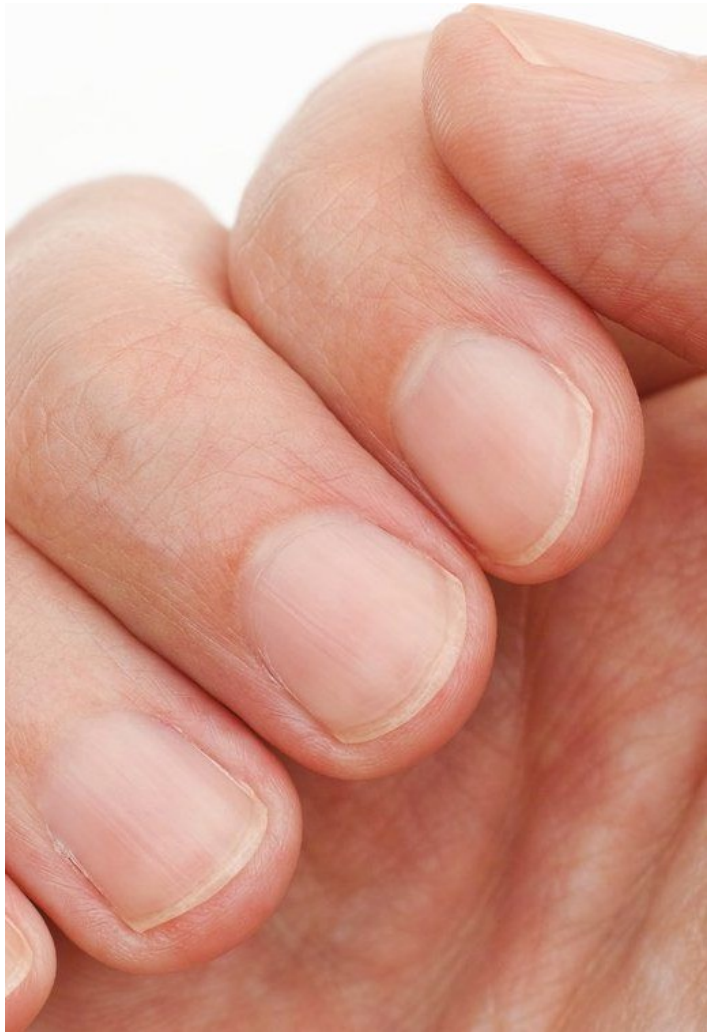
The Four Cardinal Signs of Inflammation

Rubor = redness

Dolor = pain

Calor = warmth

Tumor = swelling



Normally, inflammation kills the bug, cleans up the mess, and the tissue goes back to normal.

Sometimes, inflammation persists, and it ends up *causing* tissue damage.

“-itis” = inflammation

Appendicitis = inflammation of the appendix

Meningitis = inflammation of the meninges

Pneumonitis = inflammation of the lungs

Nephritis = inflammation of the kidney

Myocarditis = inflammation of the heart

Inflammation Outline

- What is inflammation?
- Acute inflammation

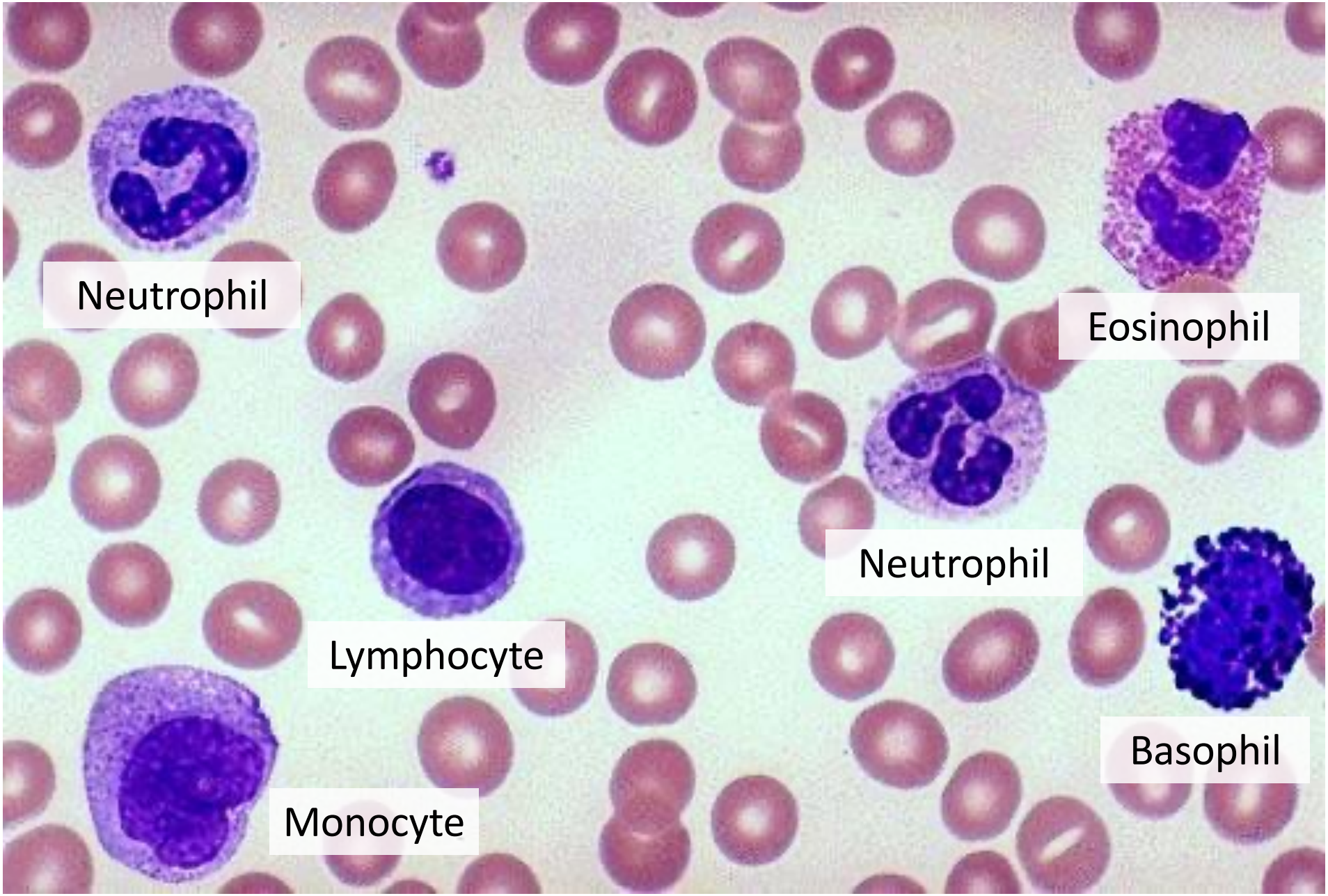
The Two Types of Inflammation

Acute inflammation

- Time course: begins immediately;
  ends within 48 hours
- Main cell: neutrophils

Chronic inflammation

- Time course: begins at 48 hours;
  can last days, weeks, even years!
- Main cells: lymphocytes and macrophages

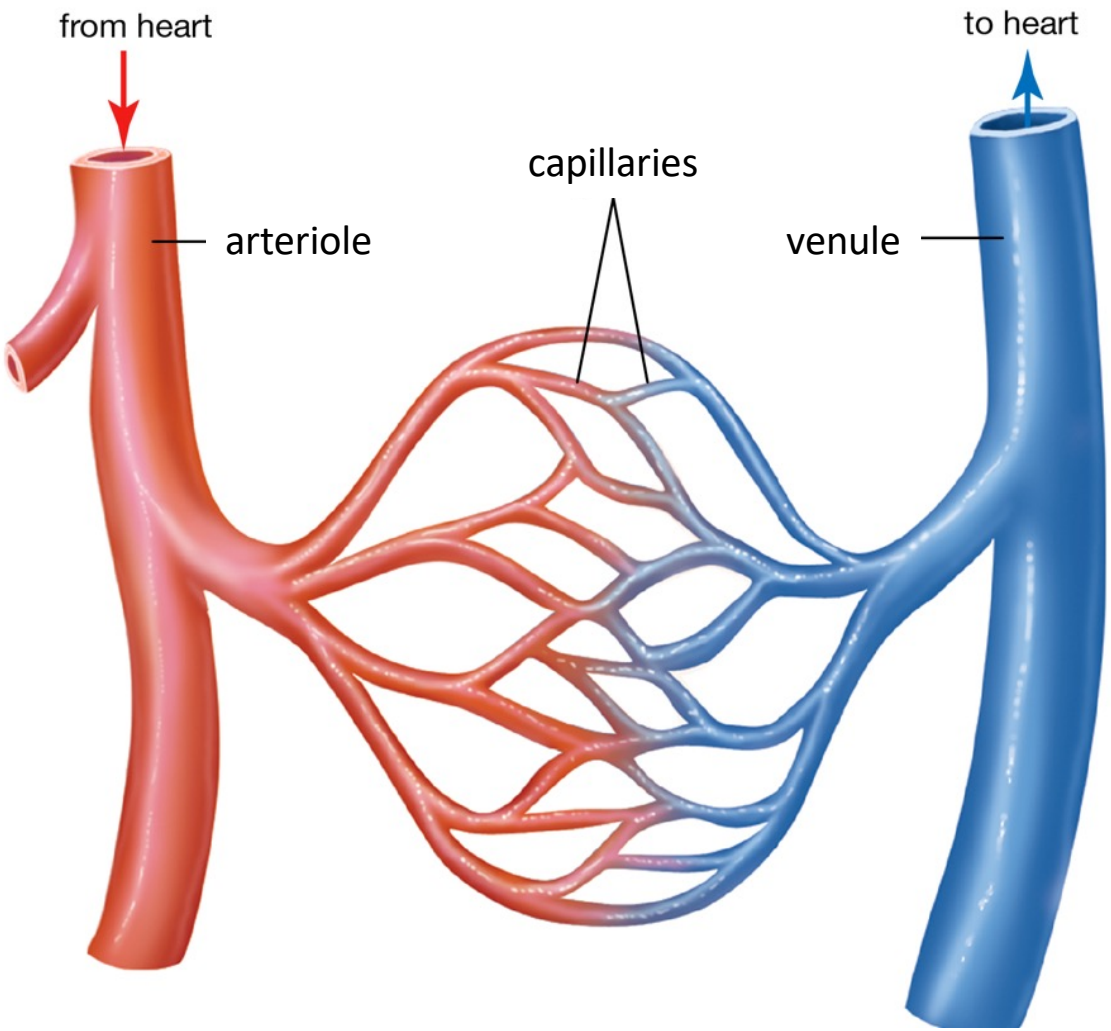


White blood cells

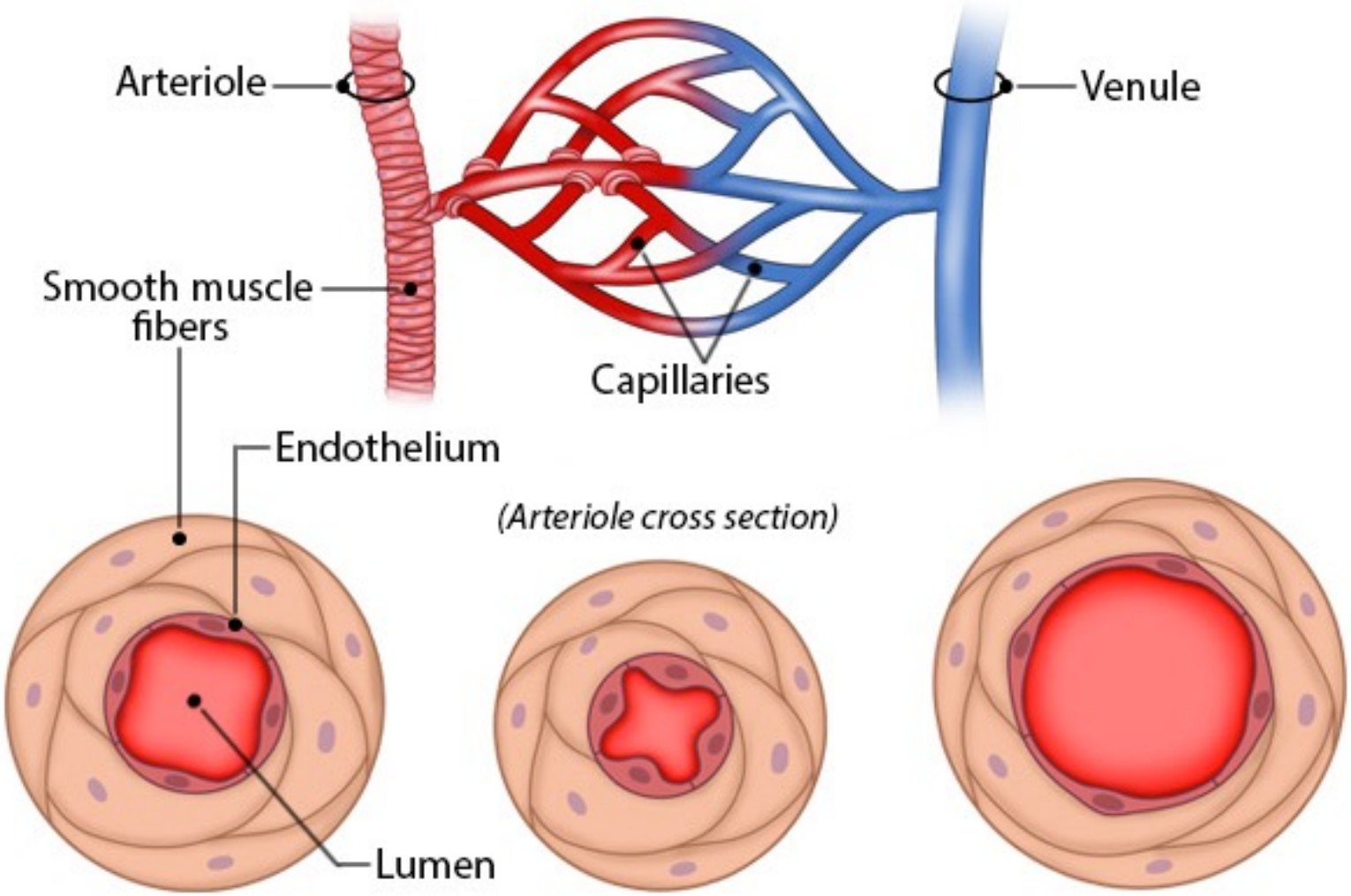
What happens in acute inflammation?

1. Vessels constrict (to staunch blood flow).
2. Vessels dilate (to become more permeable).
3. Neutrophils leave vessels and enter tissue.
4. Neutrophils kill any foreign invaders or substances, then take off.

Normal capillary bed

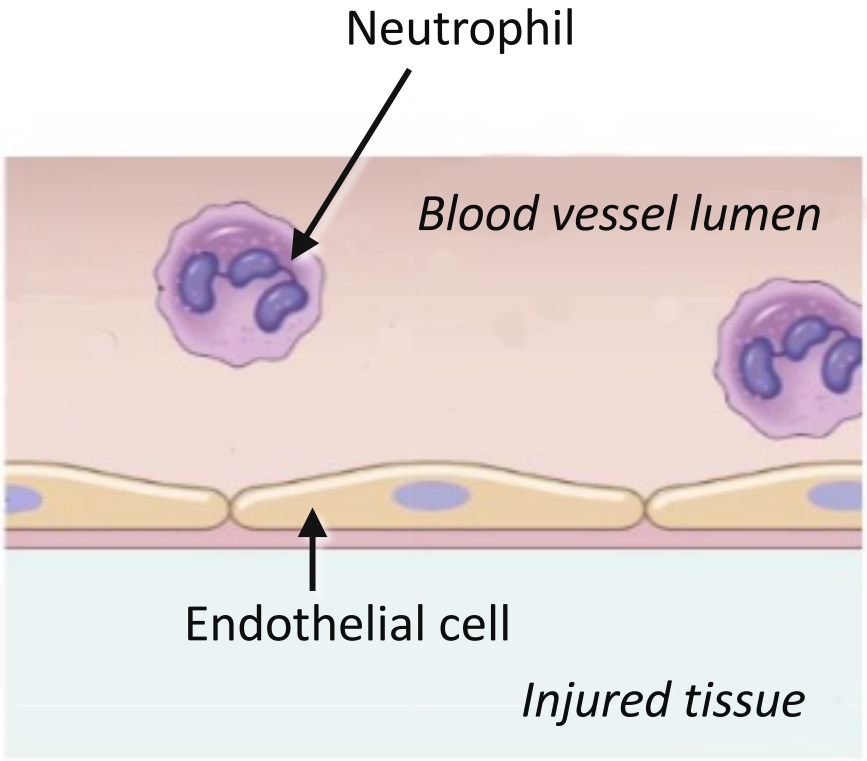


Vasoconstriction and Vasodilation

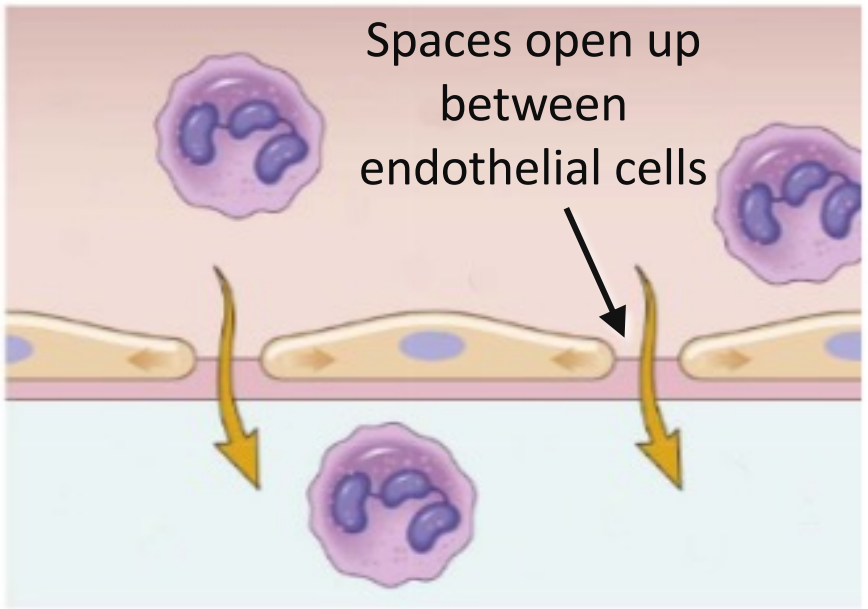


Normal Vasoconstriction Vasodilation

As vessels dilate, they become more permeable!



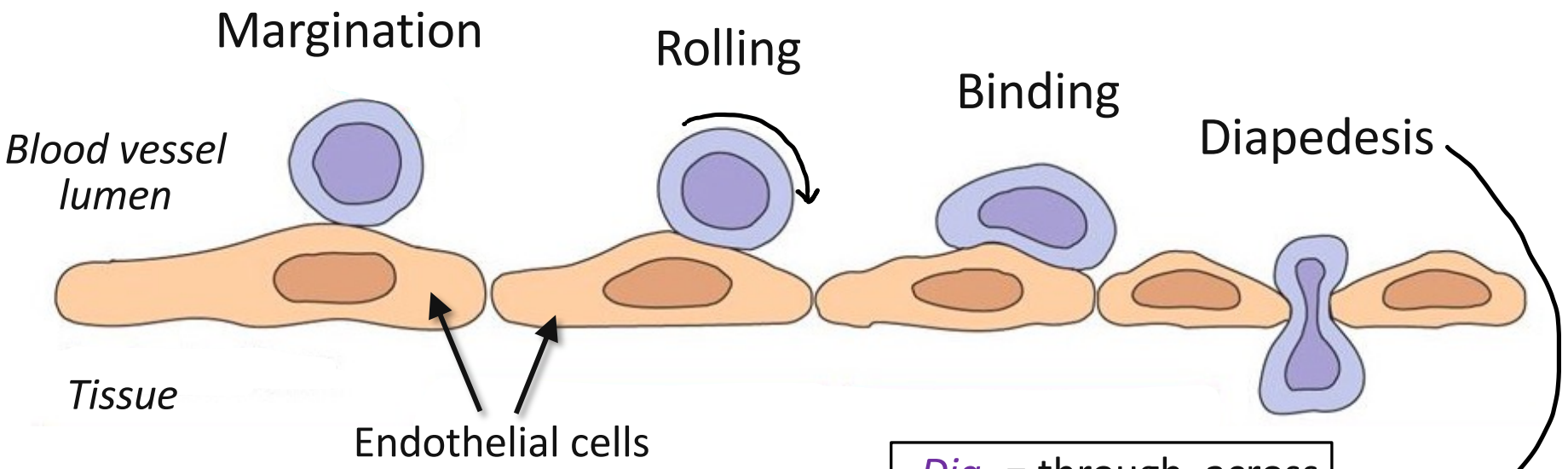
Normal blood vessel



Vessel with increased permeability

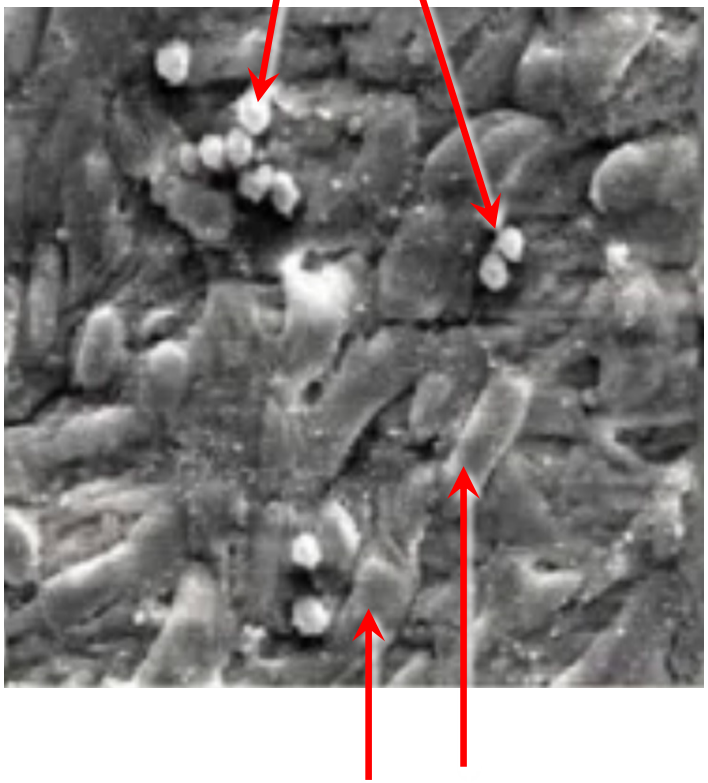
Vasodilation explains why inflamed tissue is swollen, red, and warm!

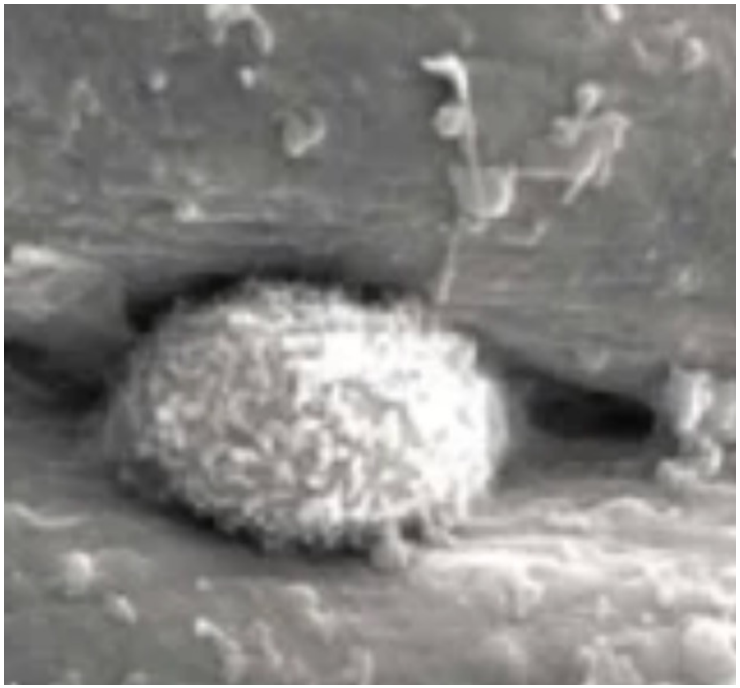
Neutrophils leave blood vessels ("extravasation")



Dia- = through, across
ped- = foot
-esis = the process of

Diapedesis = the process of putting your foot through something!

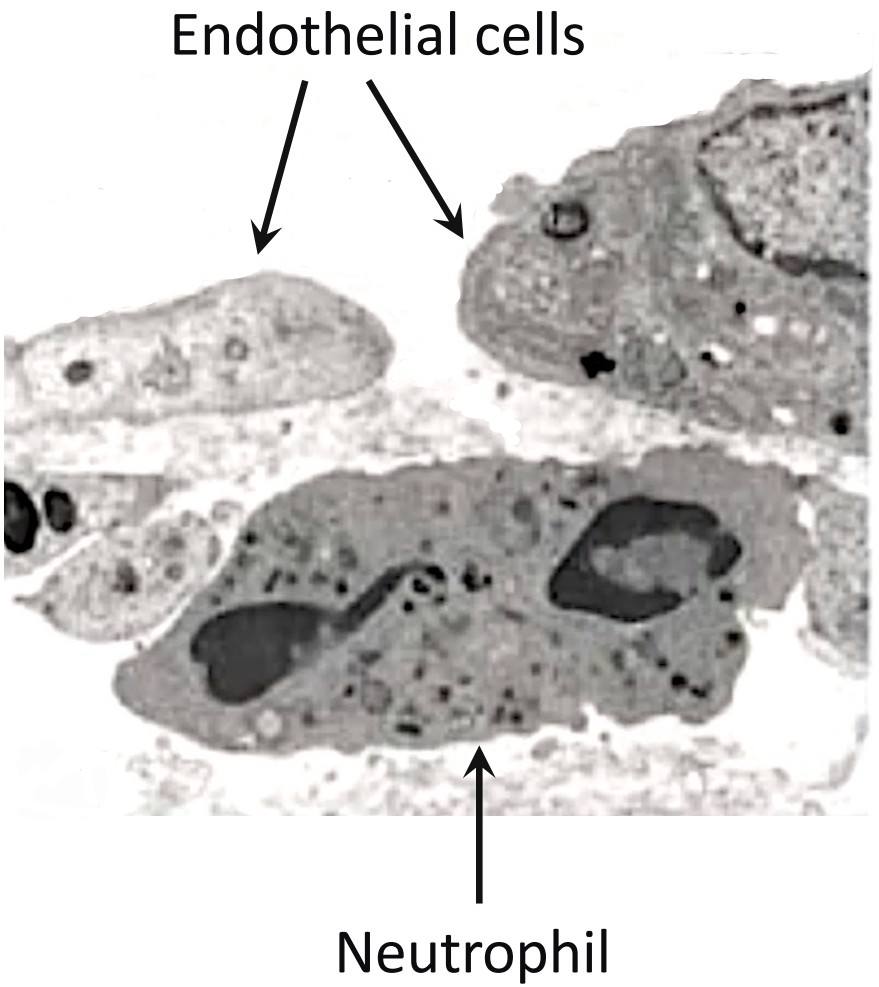




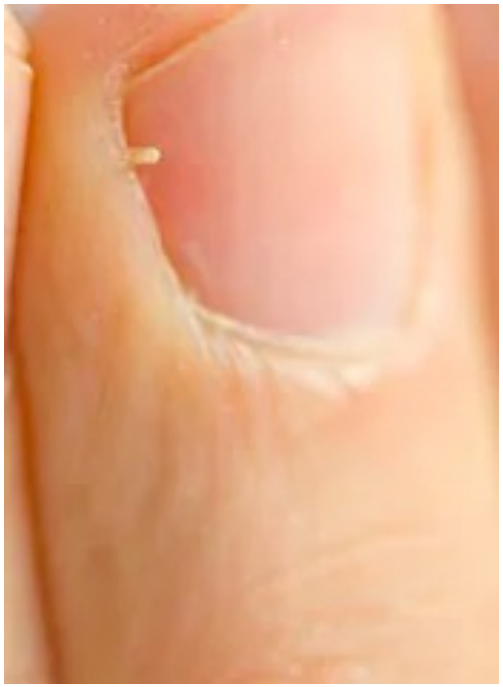
Neutrophil squeezing
between two endothelial cells


Neutrophil
Endothelial cell
Endothelial cell
Gap through which the neutrophil must squeeze!


Neutrophil
Endothelial cells


Endothelial cells
Neutrophil

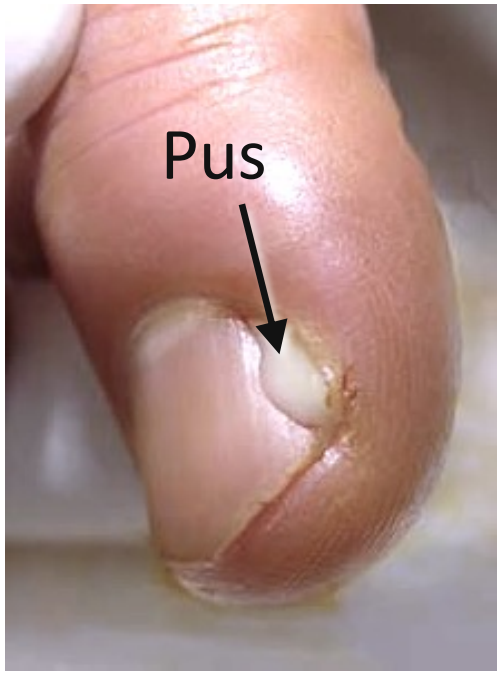
Inflammation is the first response after injury.



A little hangnail, not doing much.

Uh oh, there's a break in the skin!

Bacteria are getting in!

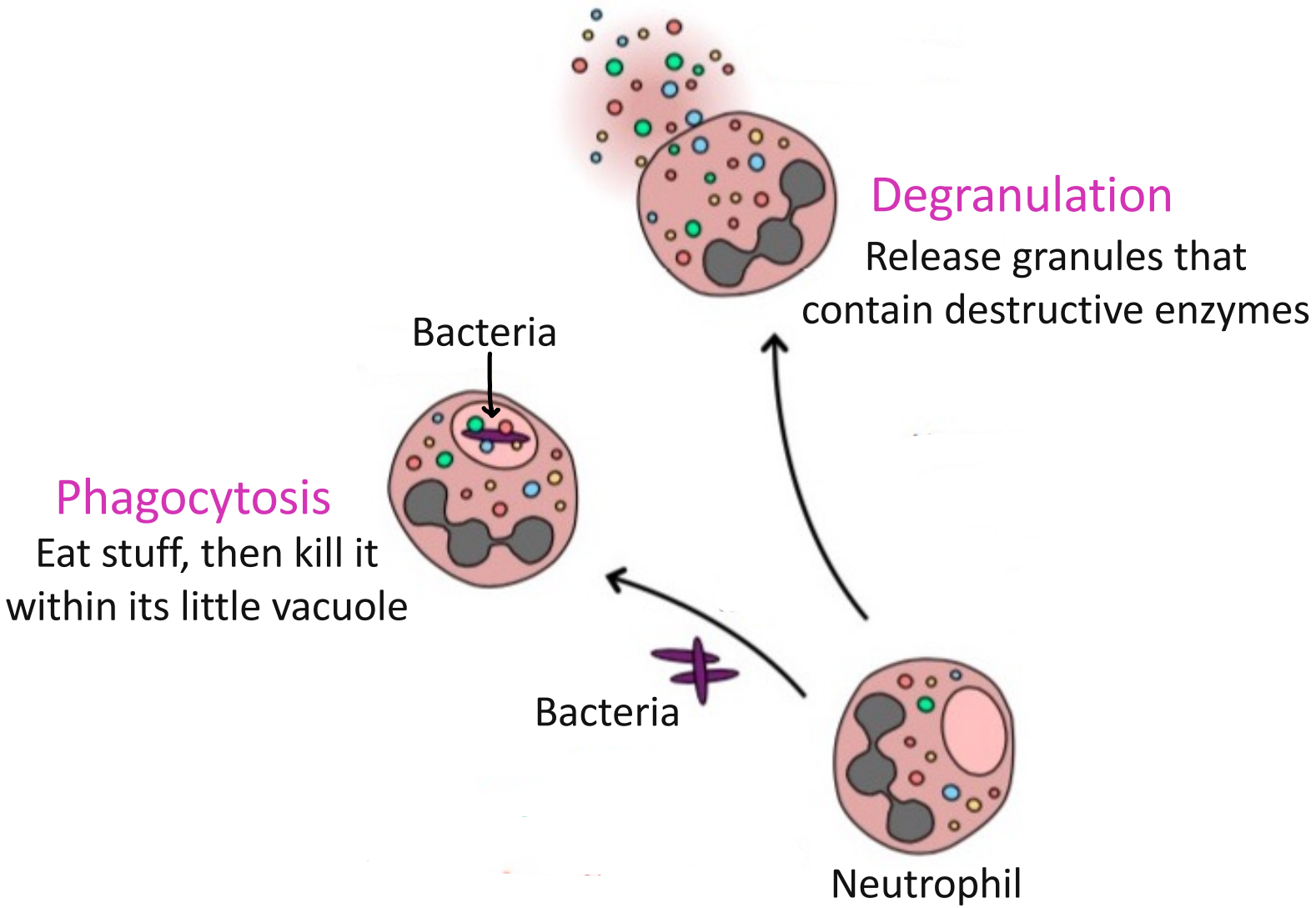


Inflammation to the rescue!

What happens in acute inflammation?

1. Vessels constrict, then dilate.
2. Neutrophils leave vessels and enter tissue.
3. Neutrophils kill any foreign invaders or substances, then take off.

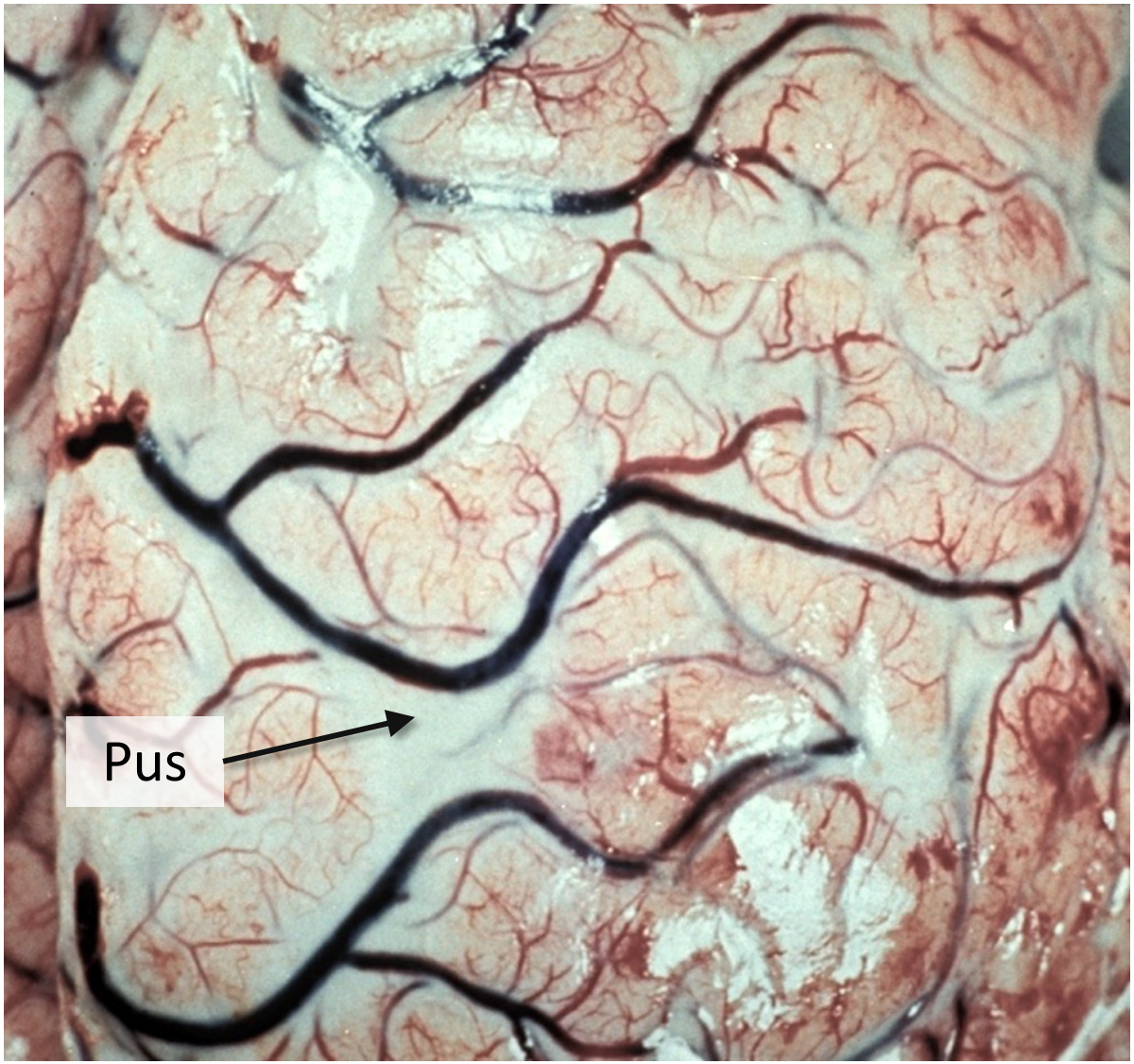
How do neutrophils kill stuff?



To the naked eye, acute inflammation shows up as PUS!
(a yellow-green, creamy, thick liquid)

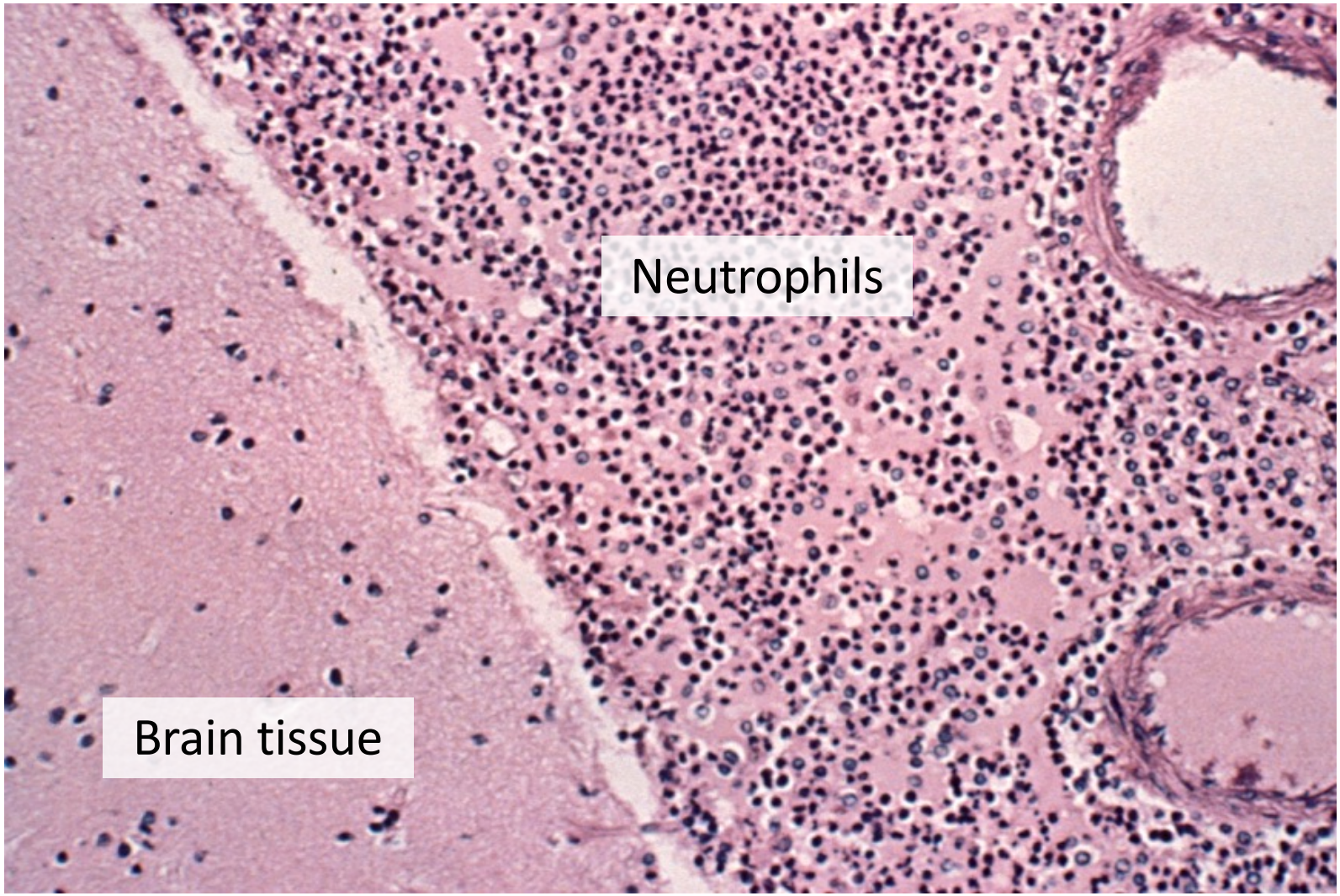
Pus in a zit

Pus in a perionychial
(tissue next to the nail) infection

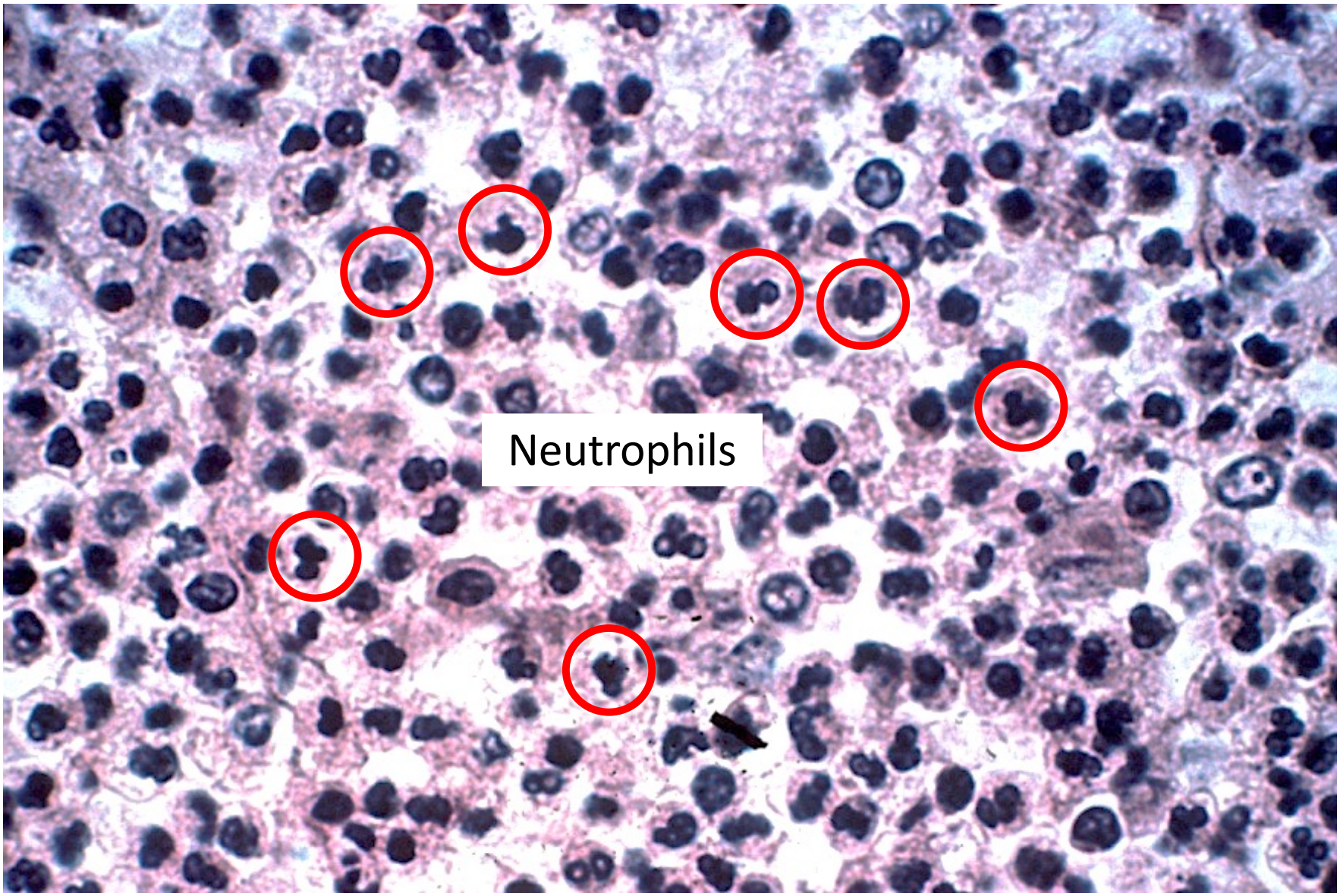


Acute bacterial meningitis: pus overlying brain surface

Underneath the microscope, acute inflammation looks like a bunch of neutrophils



Acute bacterial meningitis: neutrophils in subarachnoid space



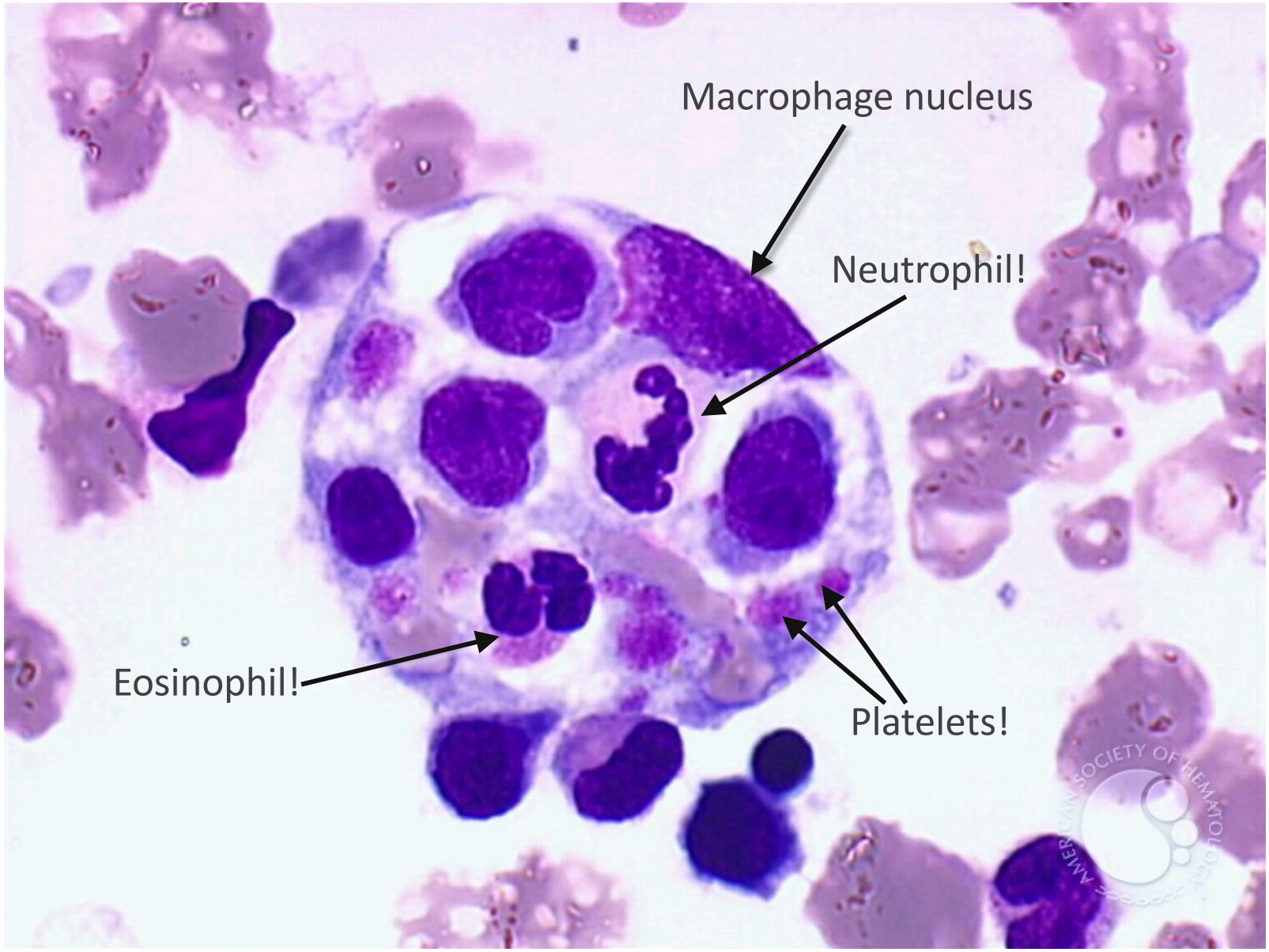
Same case, higher power: tons of neutrophils

Inflammation Outline

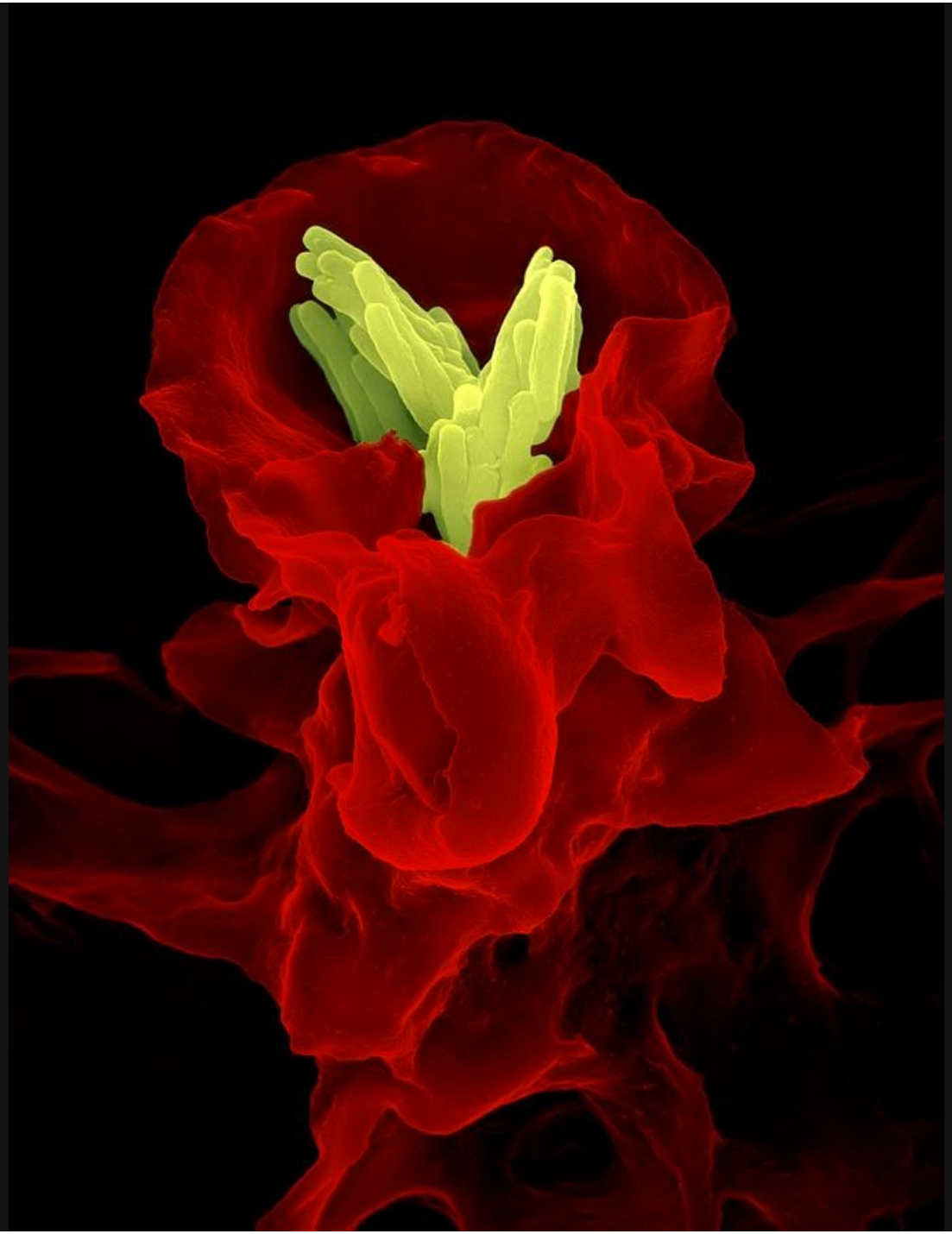
- What is inflammation?
- Acute inflammation
- Chronic inflammation

What happens in chronic inflammation?

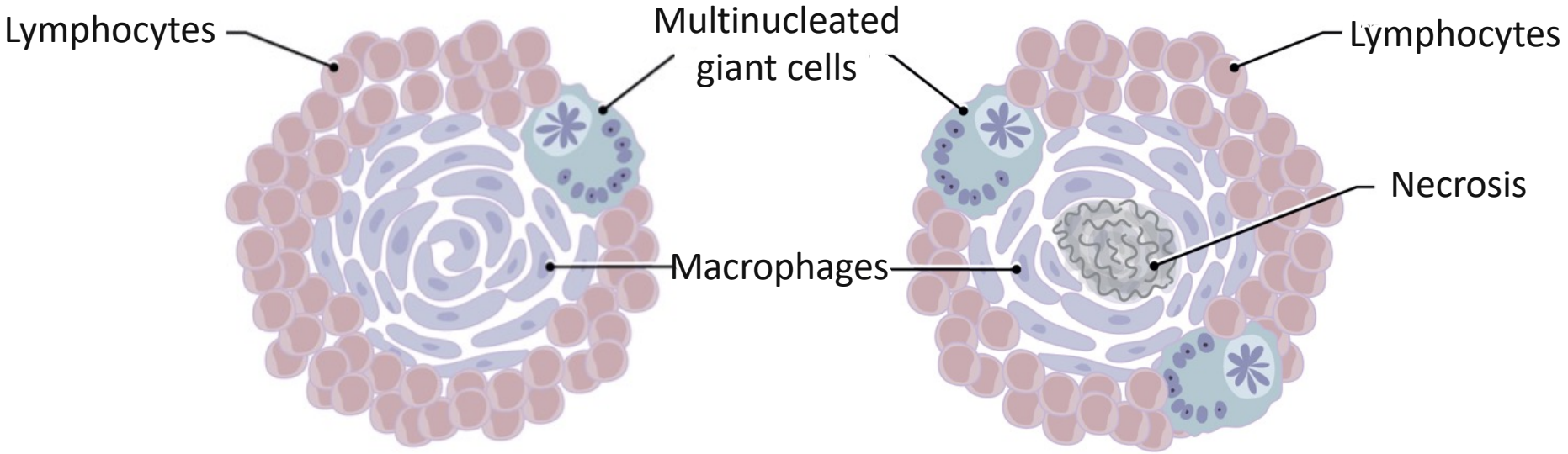
1. Macrophages eat things.
2. Lymphocytes fight any remaining foreign invaders.
3. Both cells can trigger the immune system (often in unhelpful ways).



A hungry macrophage in the bone marrow

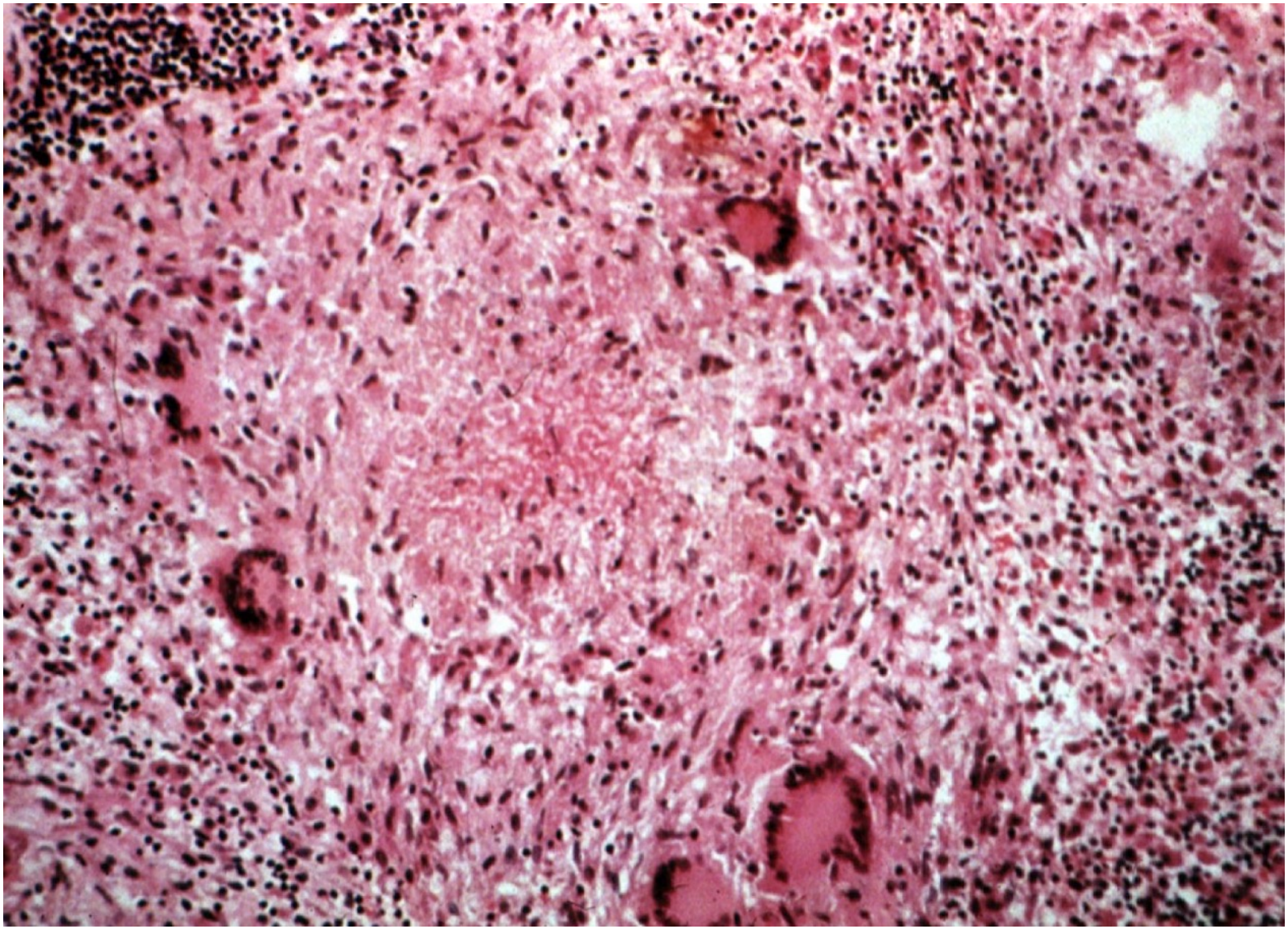


Granulomas

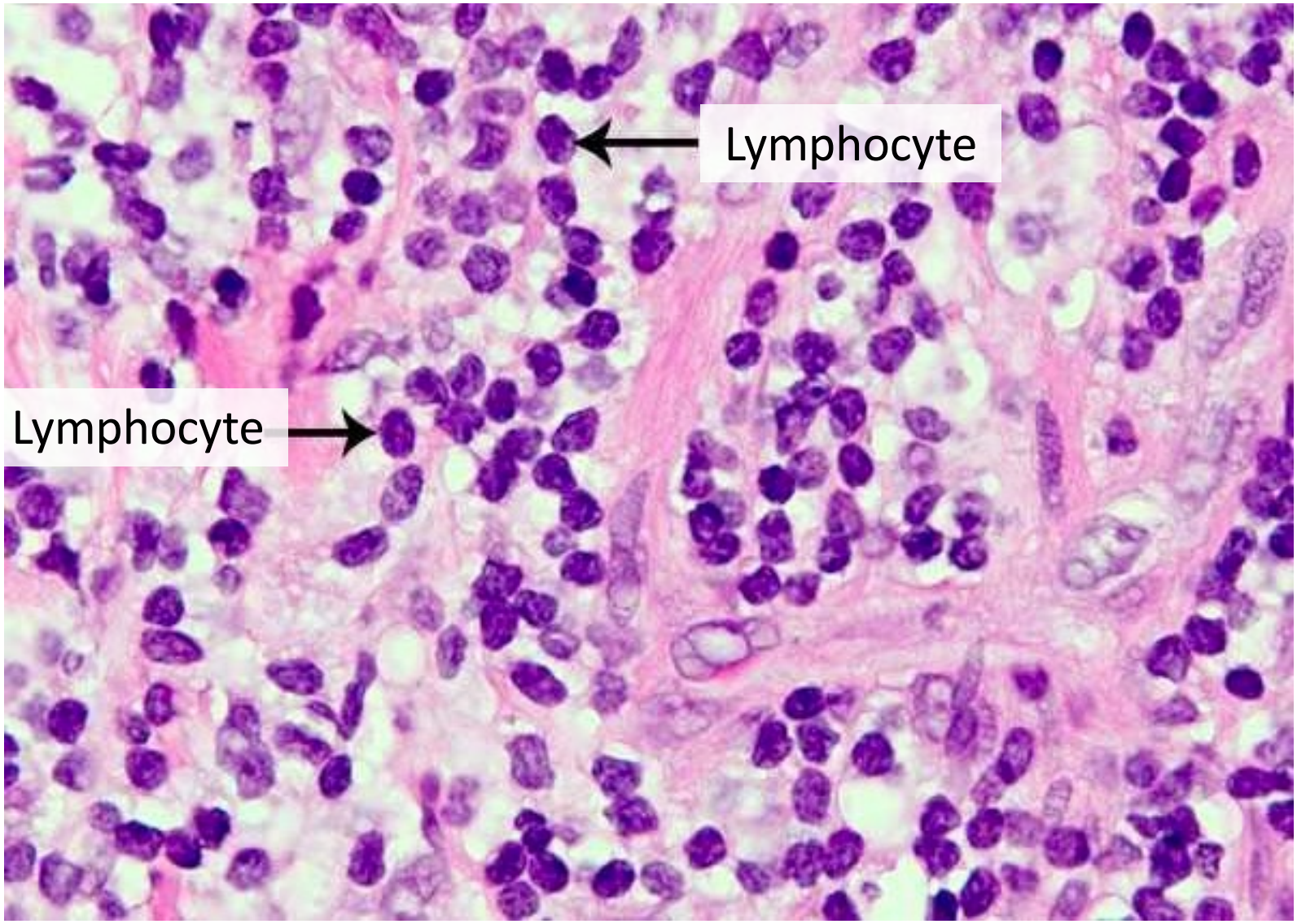


Regular granuloma

Caseating granuloma



Caseating granuloma



Finally, lymphocytes get rid of any remaining foreign invaders.

What happens in chronic inflammation?

1. Macrophages eat things.
2. Lymphocytes fight any remaining foreign invaders.
3. Both cells can trigger the immune system (often in unhelpful ways).

Which brings us to...

Inflammation Outline

- What is inflammation?
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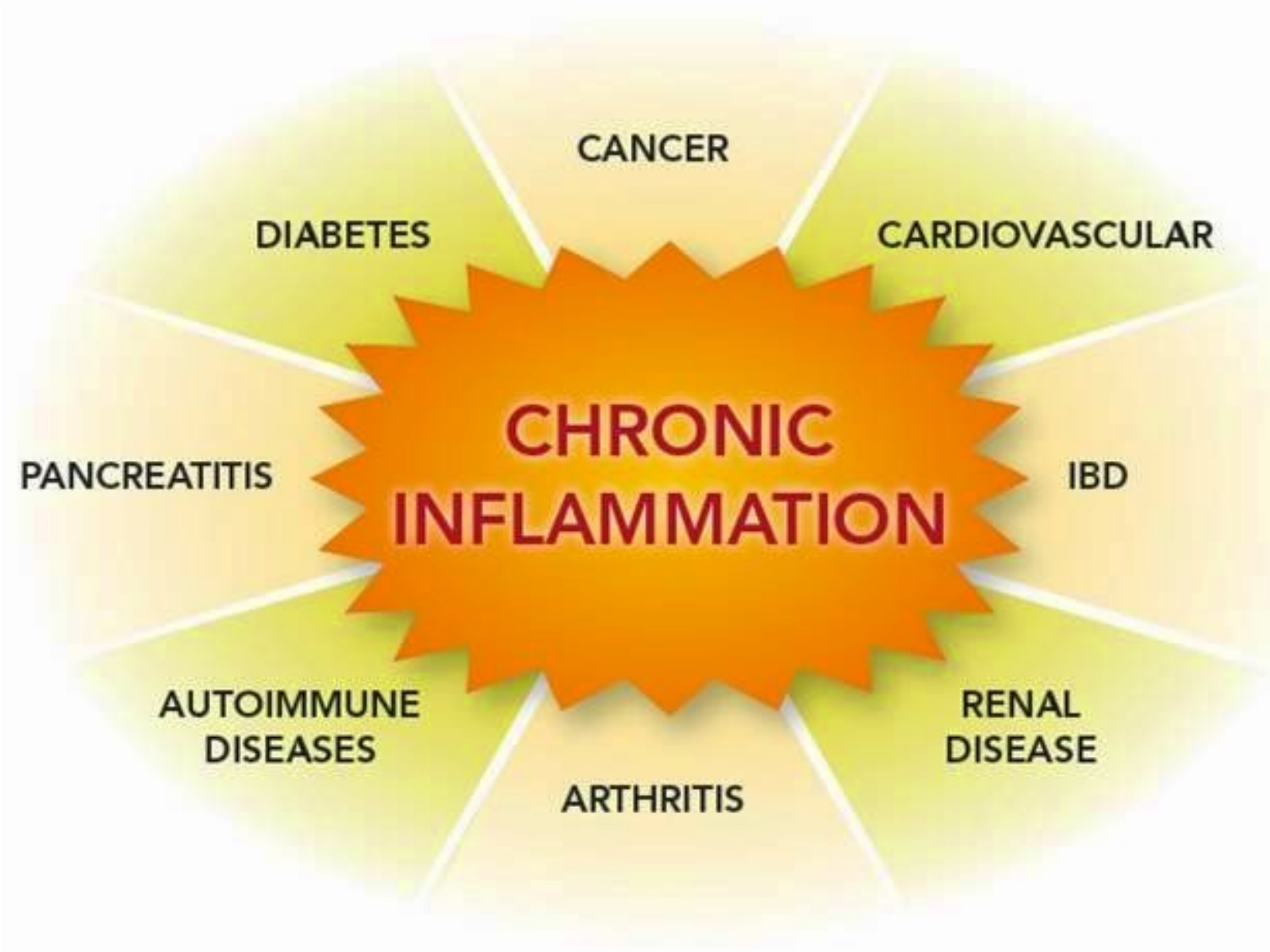
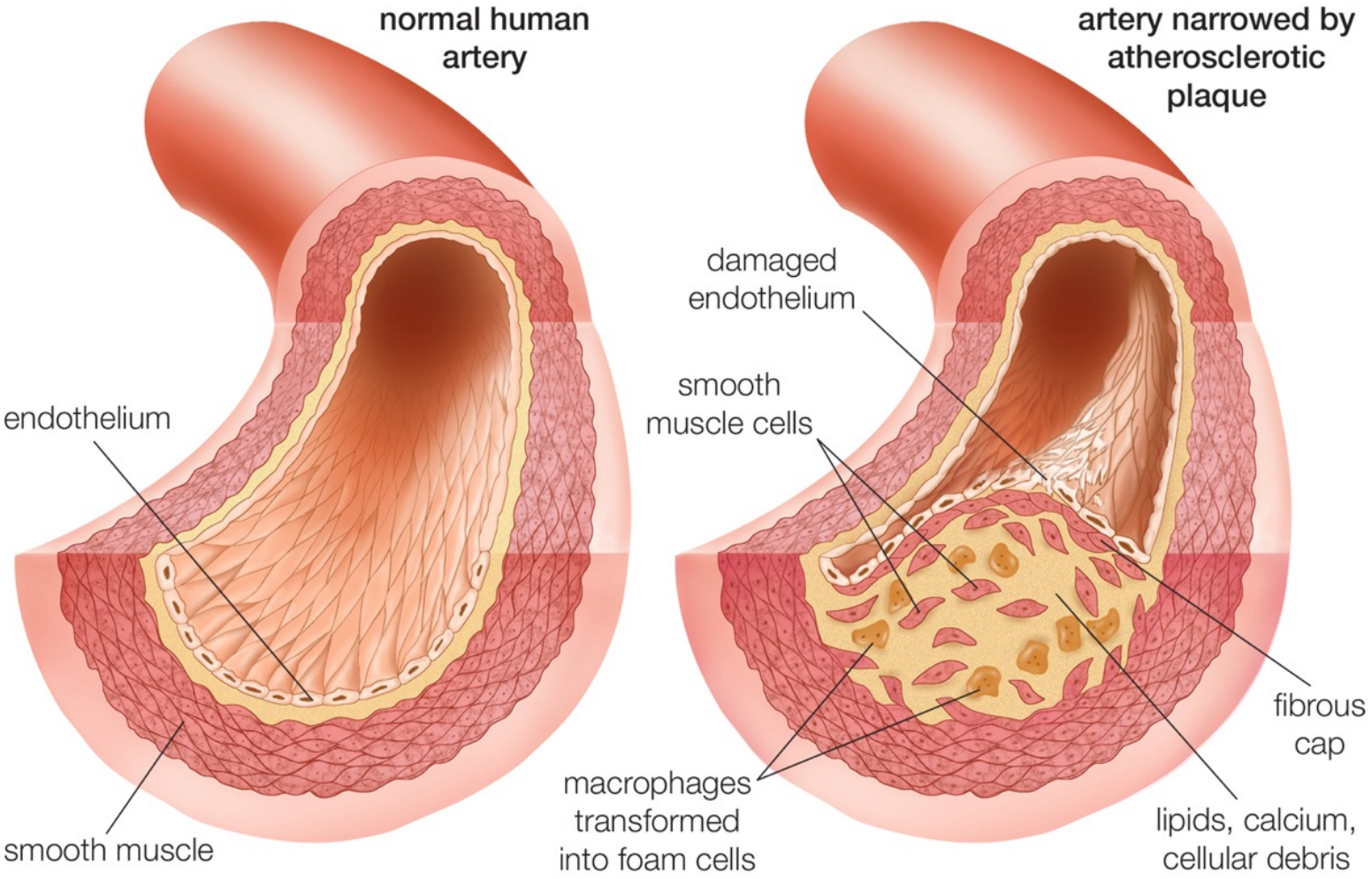


If chronic inflammation doesn’t go away, it can cause disease.



Atherosclerosis is a very common, very dangerous disease that is caused by inflammation in arteries.