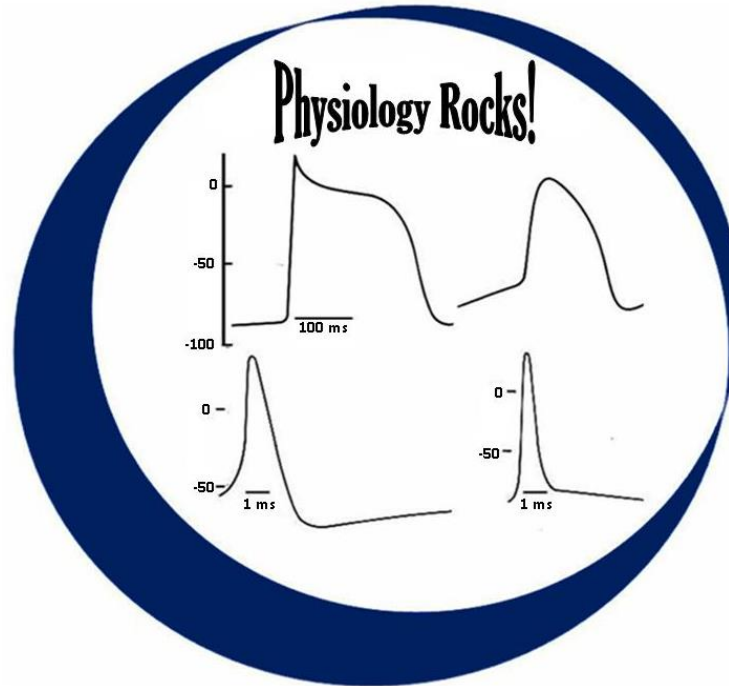


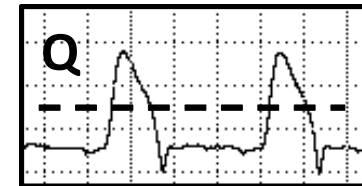
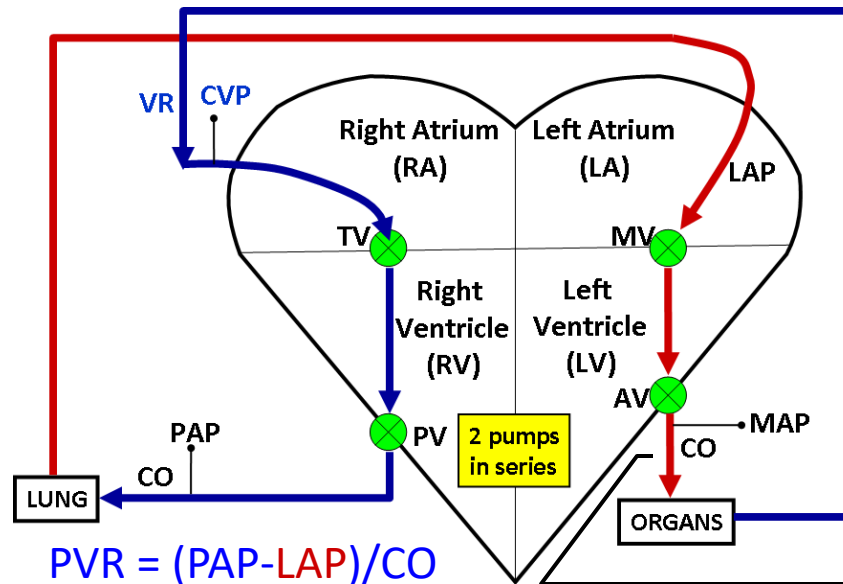
Lecture 19

Blood Flow, Pressure, Resistance - 2

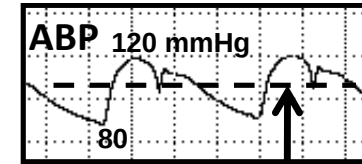


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Big Picture Hemodynamic Review

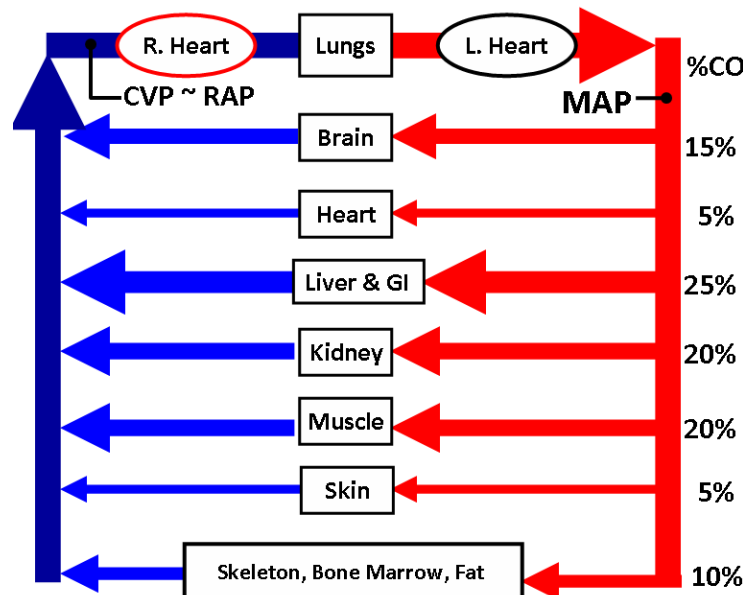


$CO = \text{avg } Q$
 $CO = SV \times HR$



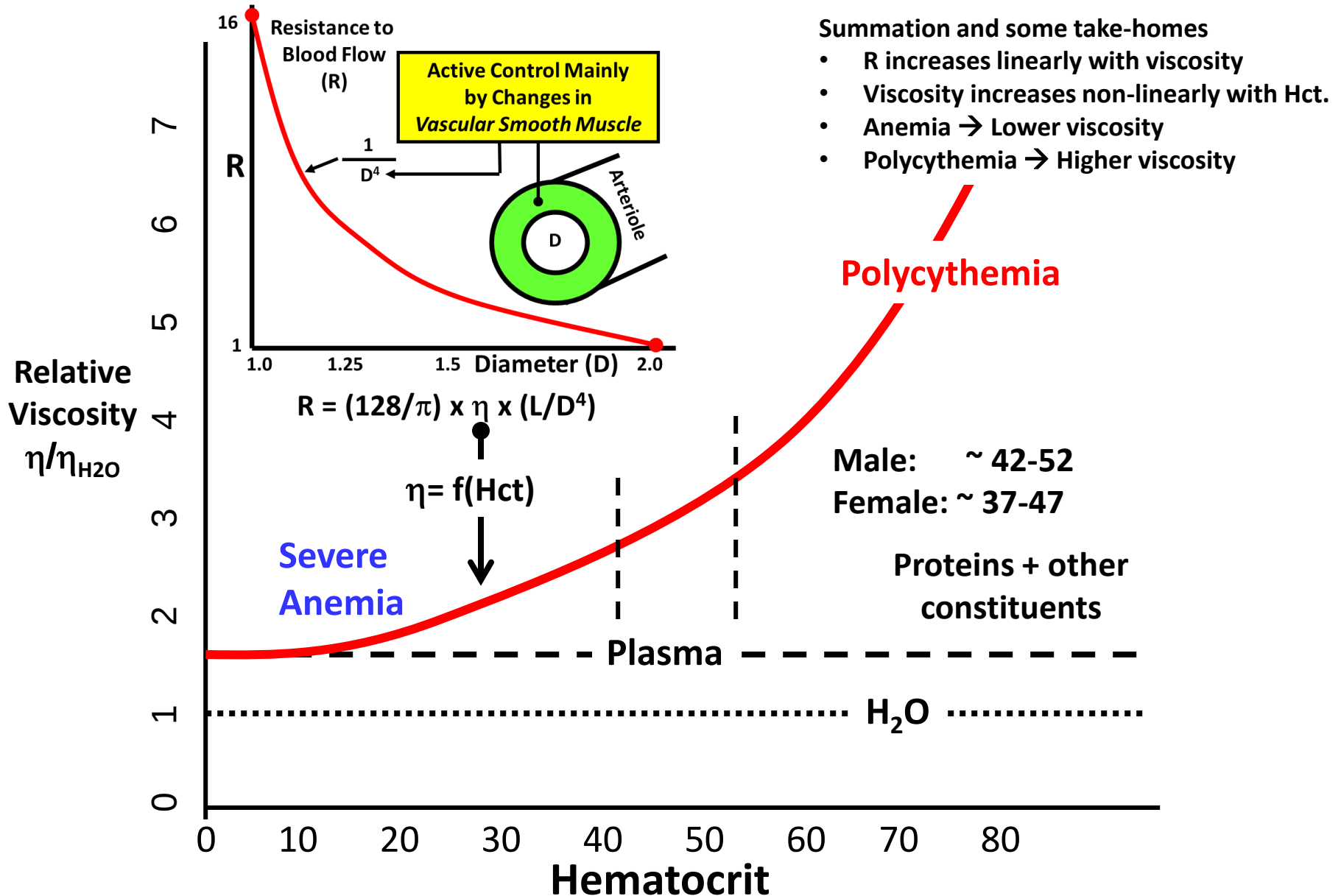
$MAP = \text{avg } ABP$

$TPR = (MAP - CVP) / CO$

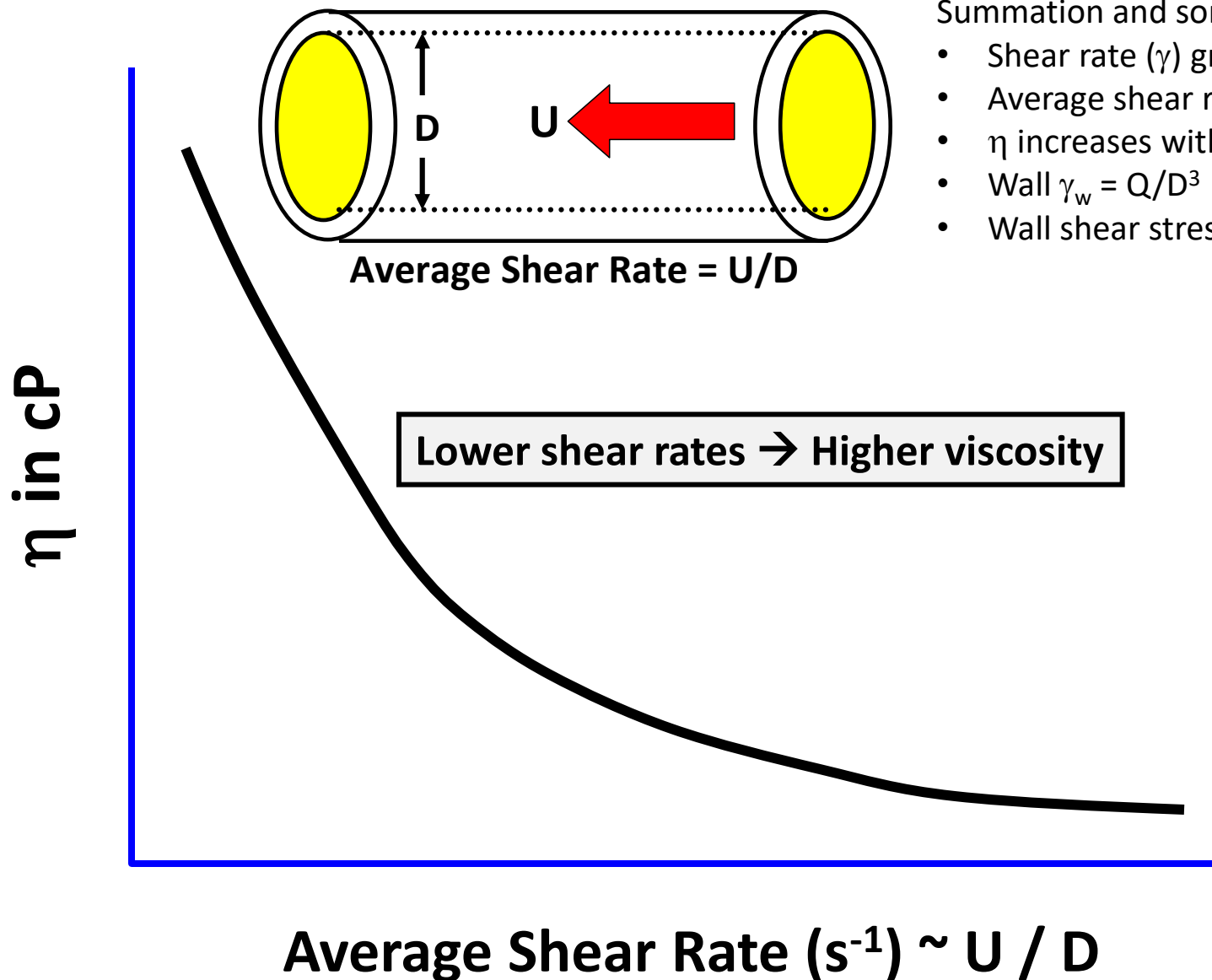


Organ Flow
 $Q = \Delta P / R$
 $(MAP - CVP) / R_x$

Resistance depends on Diameter (D) & Viscosity (η)



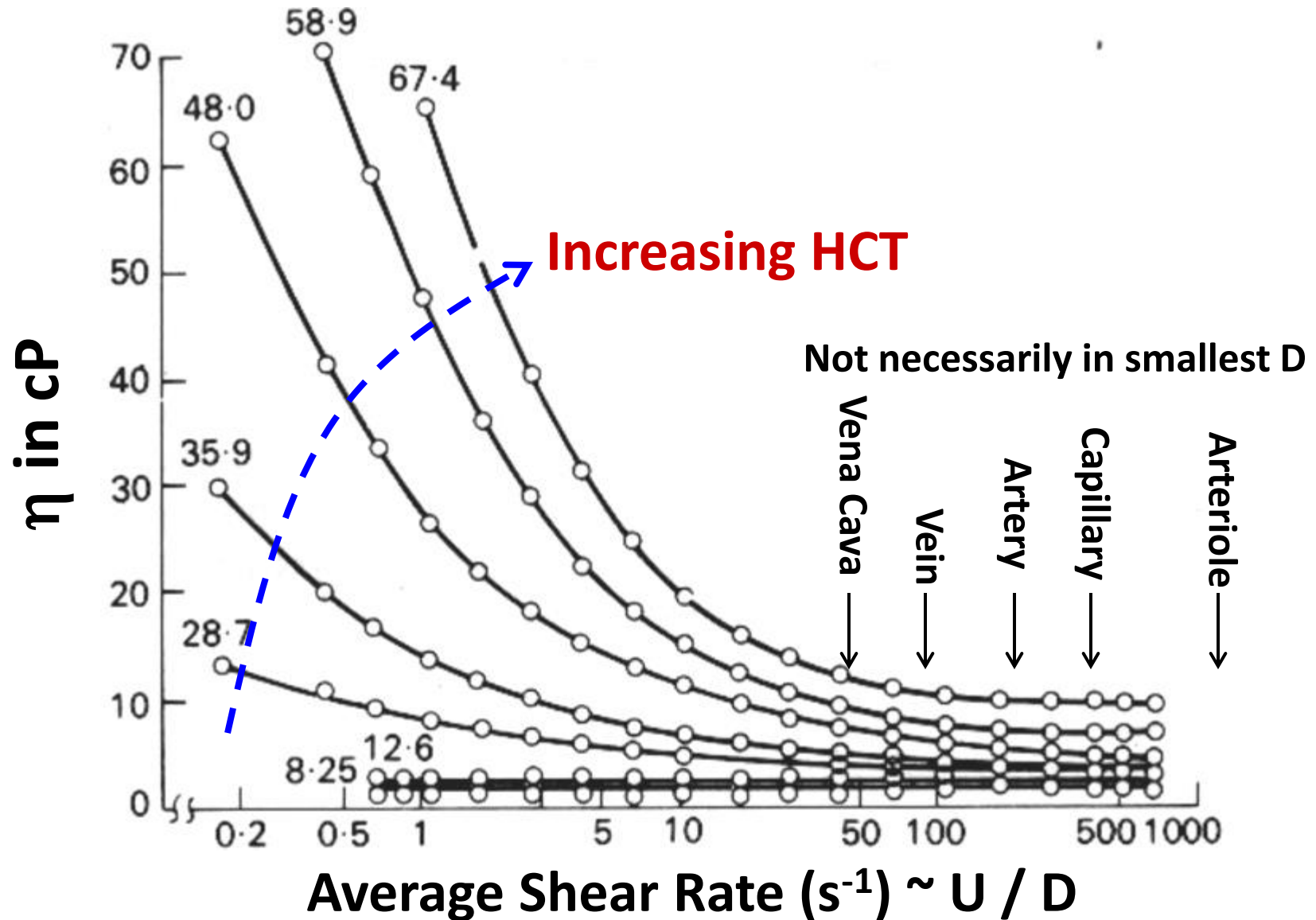
Blood Viscosity Depends on Shear Rate



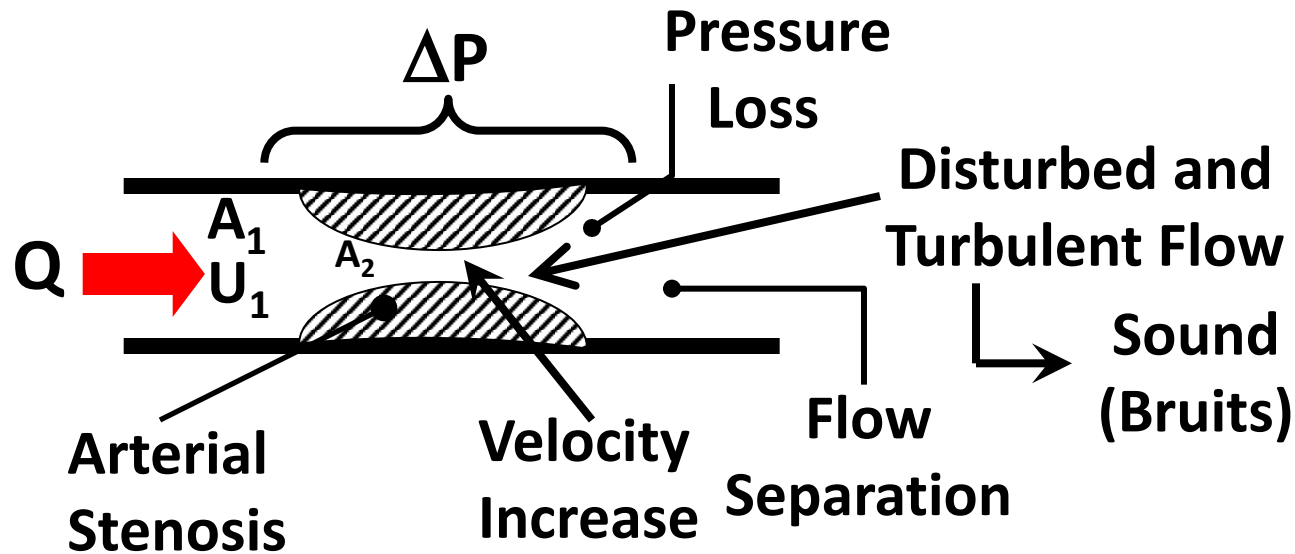
Summation and some take-homes

- Shear rate (γ) greatest at wall
- Average shear rate = U/D
- η increases with decreasing γ
- Wall $\gamma_w = Q/D^3$
- Wall shear stress = $\tau = \eta\gamma_w$

Combined Shear Rate and Viscosity Effects



Arterial Stenosis: Increased Velocity - Turbulence

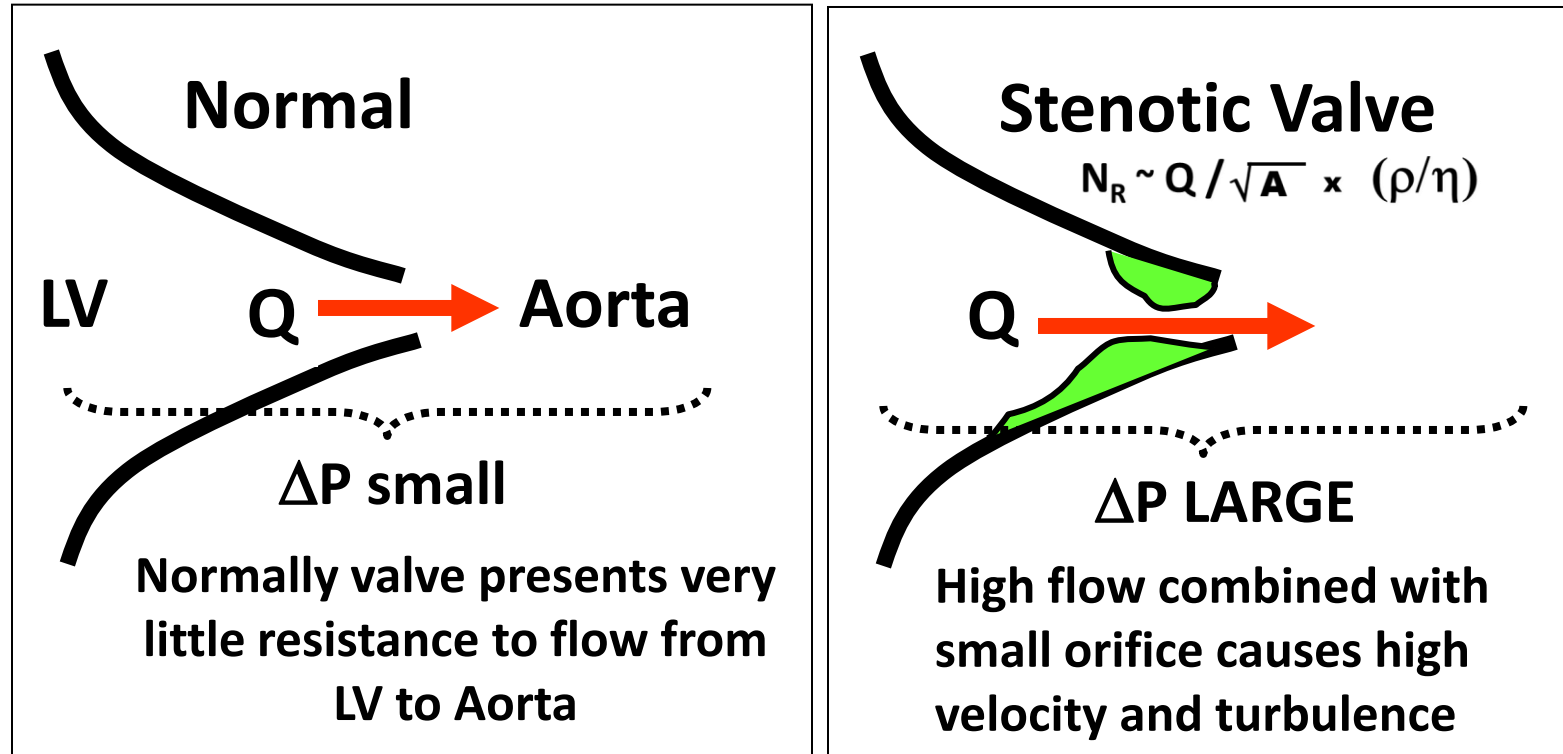


LARGER $N_R \sim$ **TURBULENT** flow more likely

Critical threshold $N_{RC} = 2000$

$$N_R \sim Q / \sqrt{A} \times (\rho/\eta)$$

Valve Stenosis: Turbulence & Increased Resistance

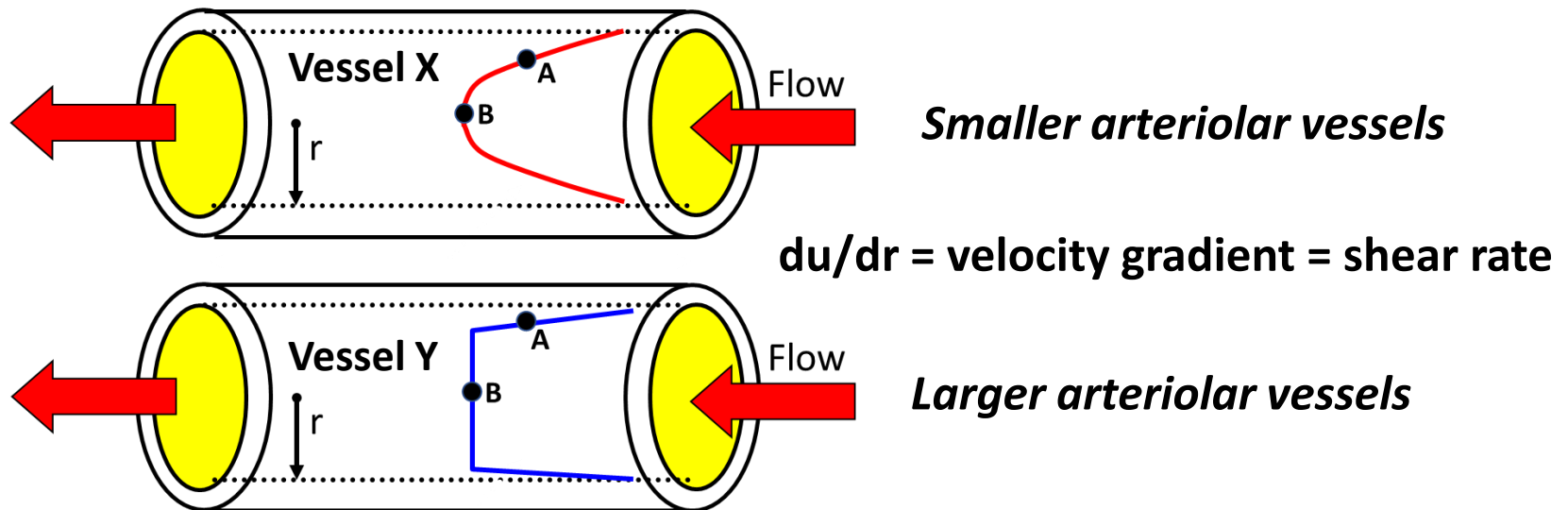


Flow through valve nearly same with or without stenosis until LV can no longer maintain CO

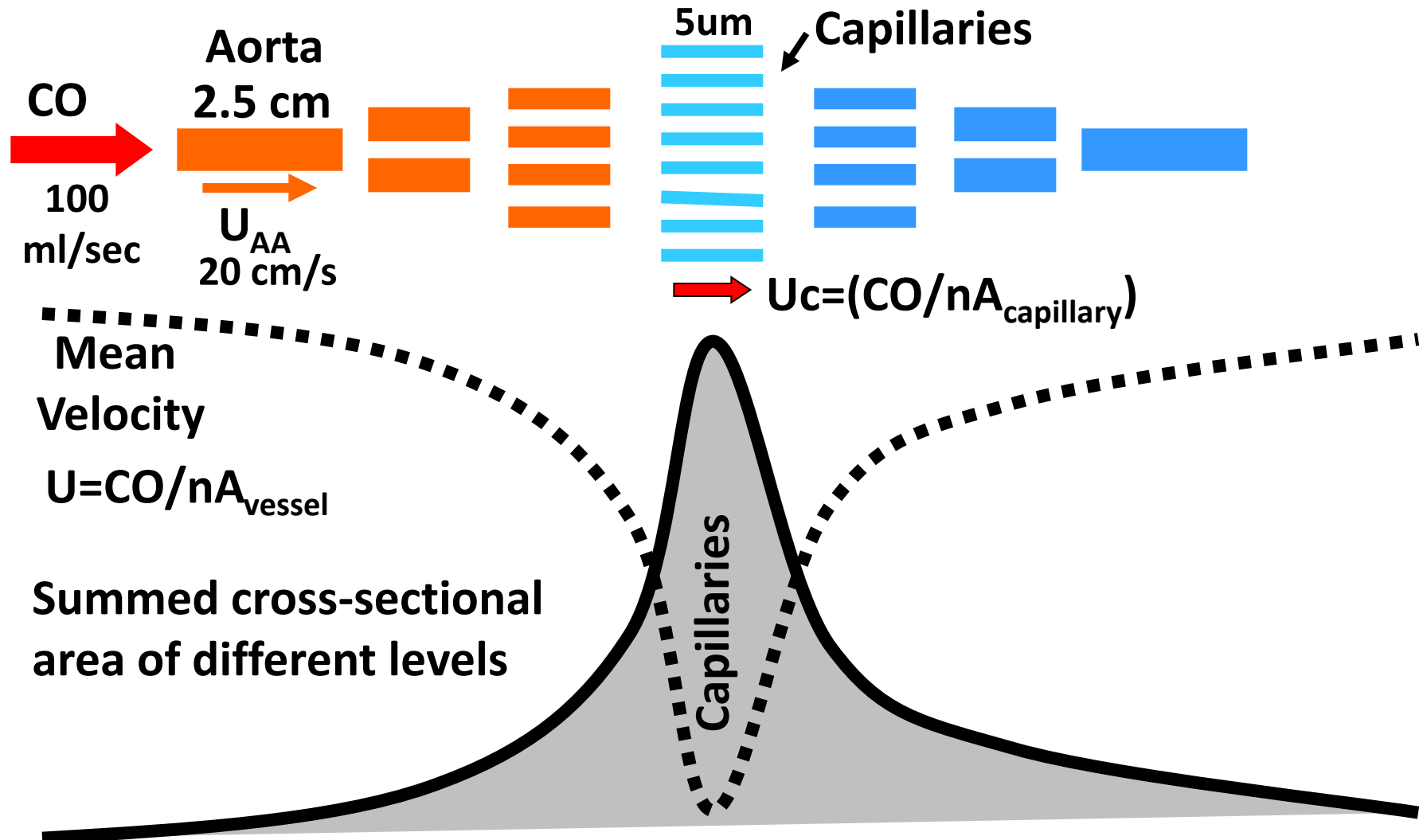
Velocity Profile Considerations

Two vessels of the same radius experience blood flow with differing velocity profiles as shown in **red** and **blue**. Considering the points A and B on the profiles:

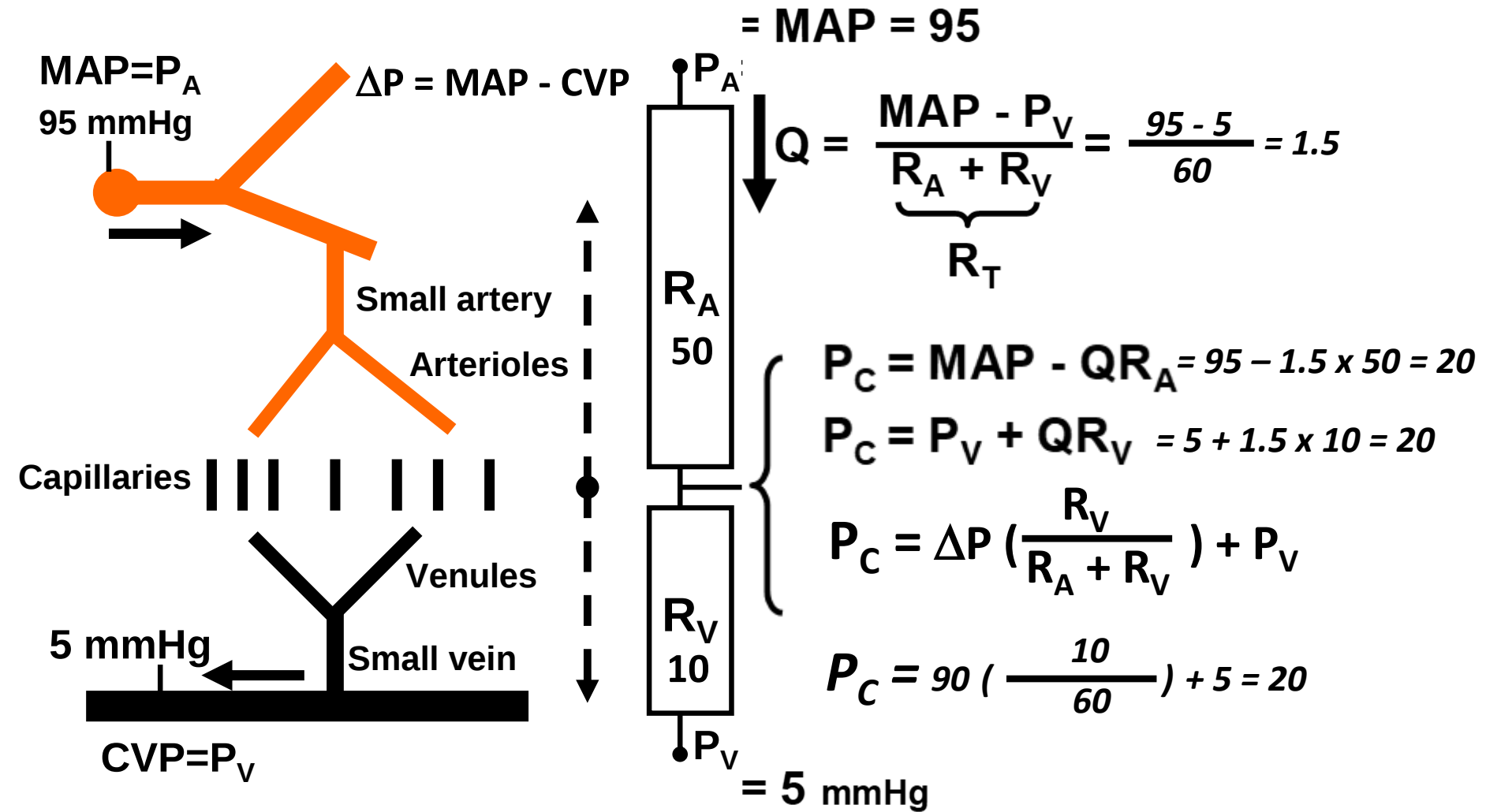
1. Which vessel has a greater shear rate at A? Vessel Y
2. Which vessel has a greater shear rate at B? Same = 0



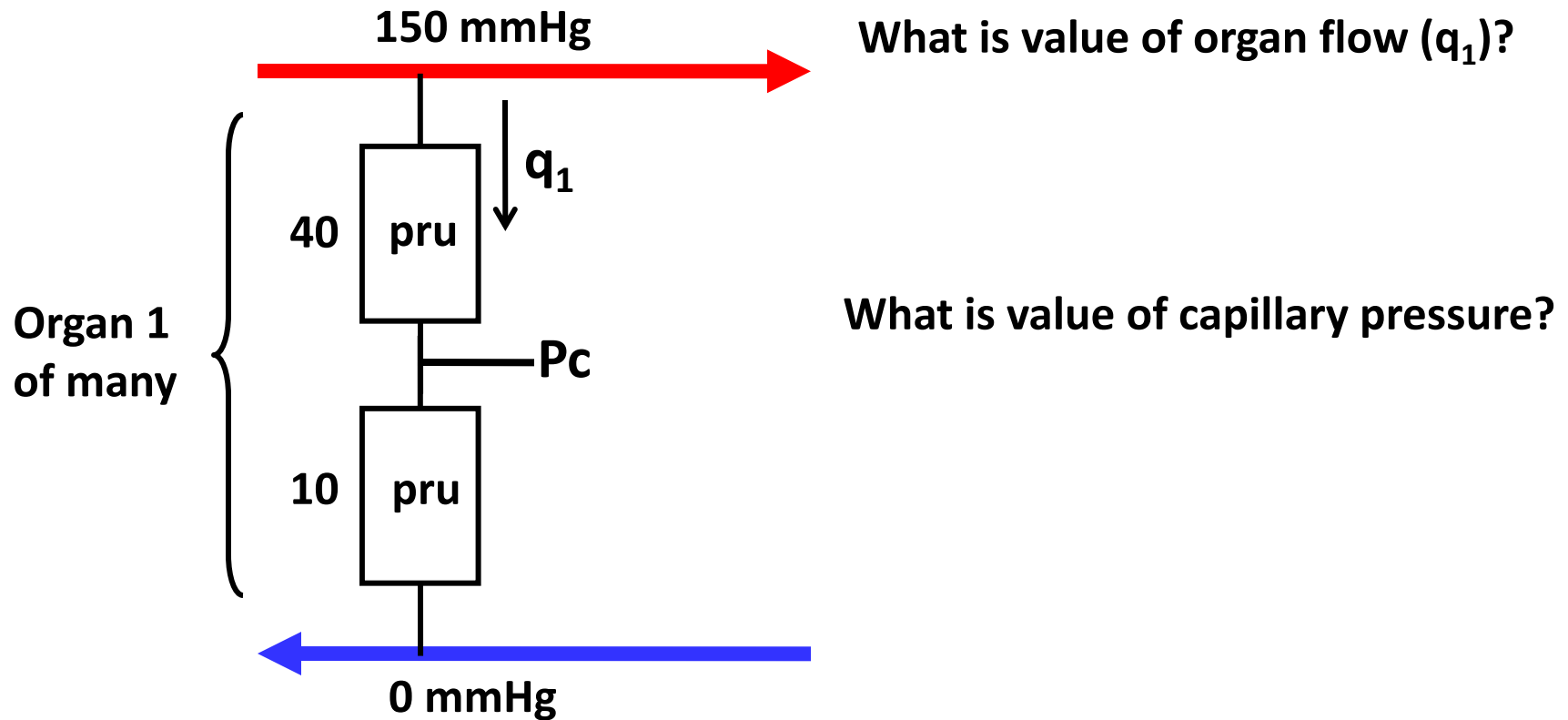
Blood Velocity Variations



Vascular Partitioning: Blood Flow & Capillary Pressure



Interactive Question



Interactive Question

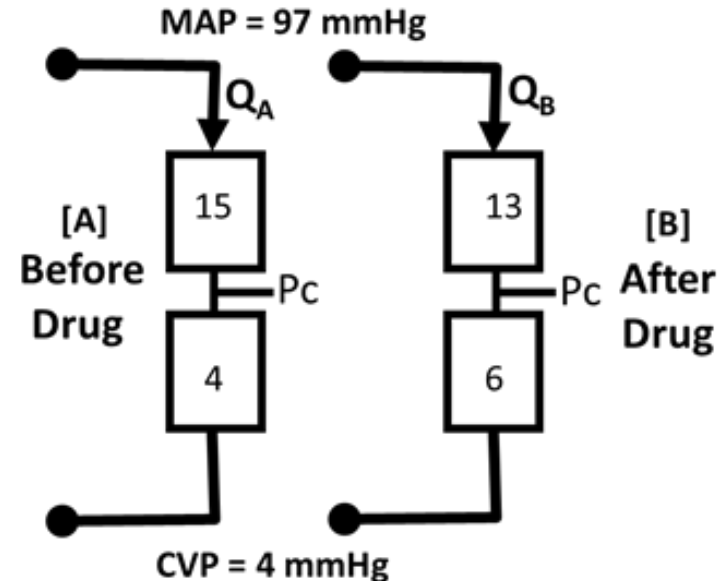


A 59-year-old male has a MAP and CVP as shown. His precapillary vascular resistance is 15 Wood units and his post-capillary vascular resistance is 4 Wood units.

He is given a vasoactive drug that causes the vascular resistance changes shown in part B of the figure. Average capillary pressure is denoted as P_c .

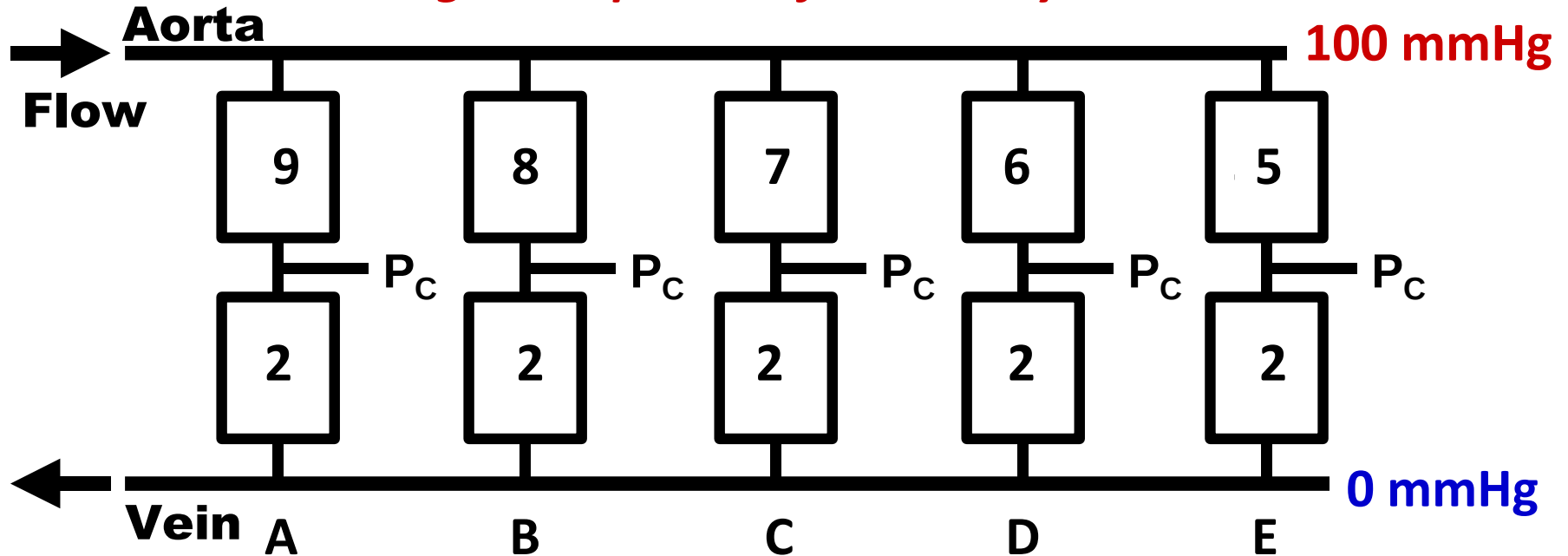
If his perfusion pressure does not change, which statements best describes the drug's action?

- A. increases blood flow
- B. decreases capillary pressure
- C. causes venous smooth muscle to contract
- D. causes arteriolar smooth muscle to contract
- E. increases total vascular resistance



Interactive Question

5 organs in parallel from artery to vein

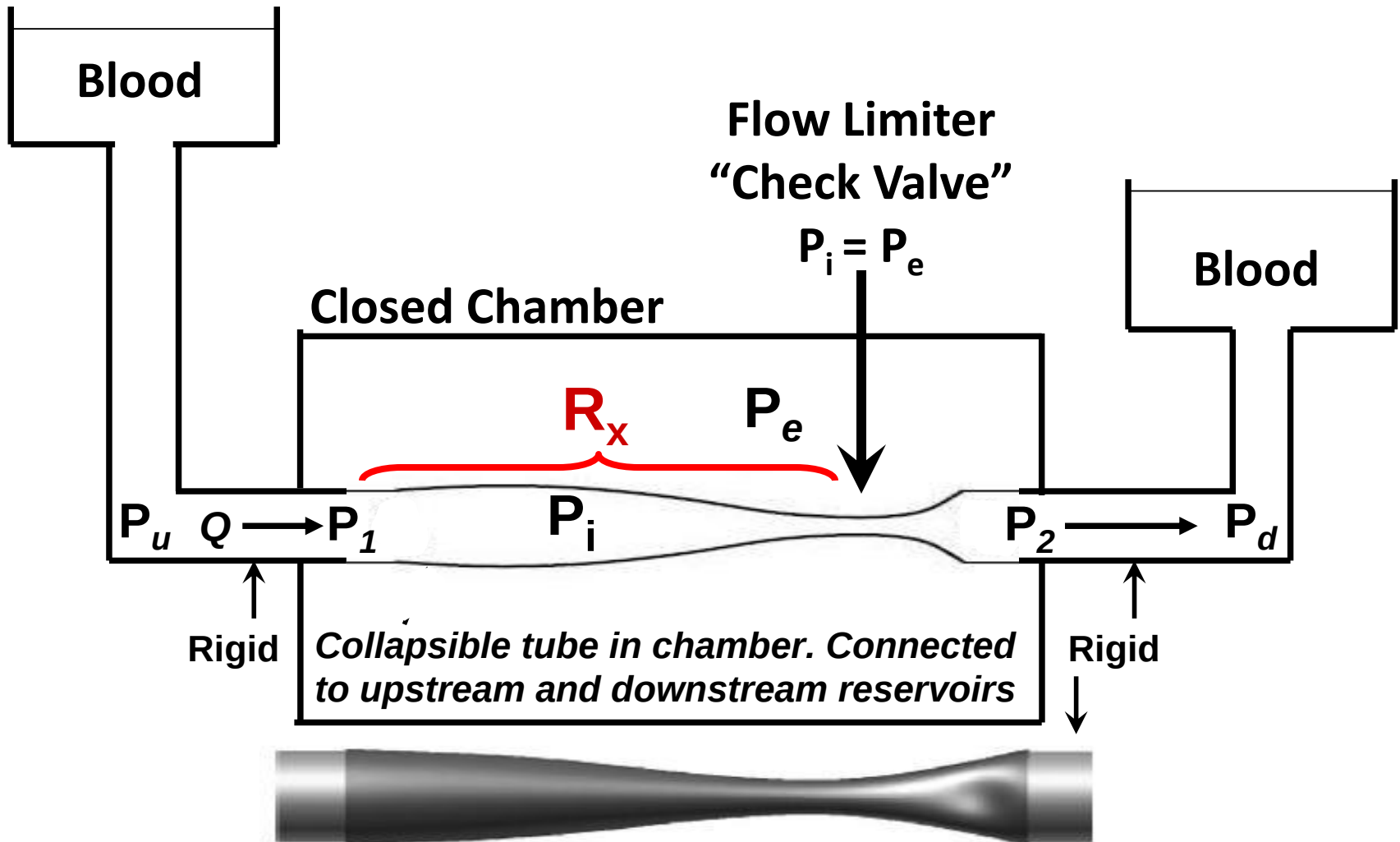


Which organ has the greatest blood flow?

Which organ has the least capillary pressure?

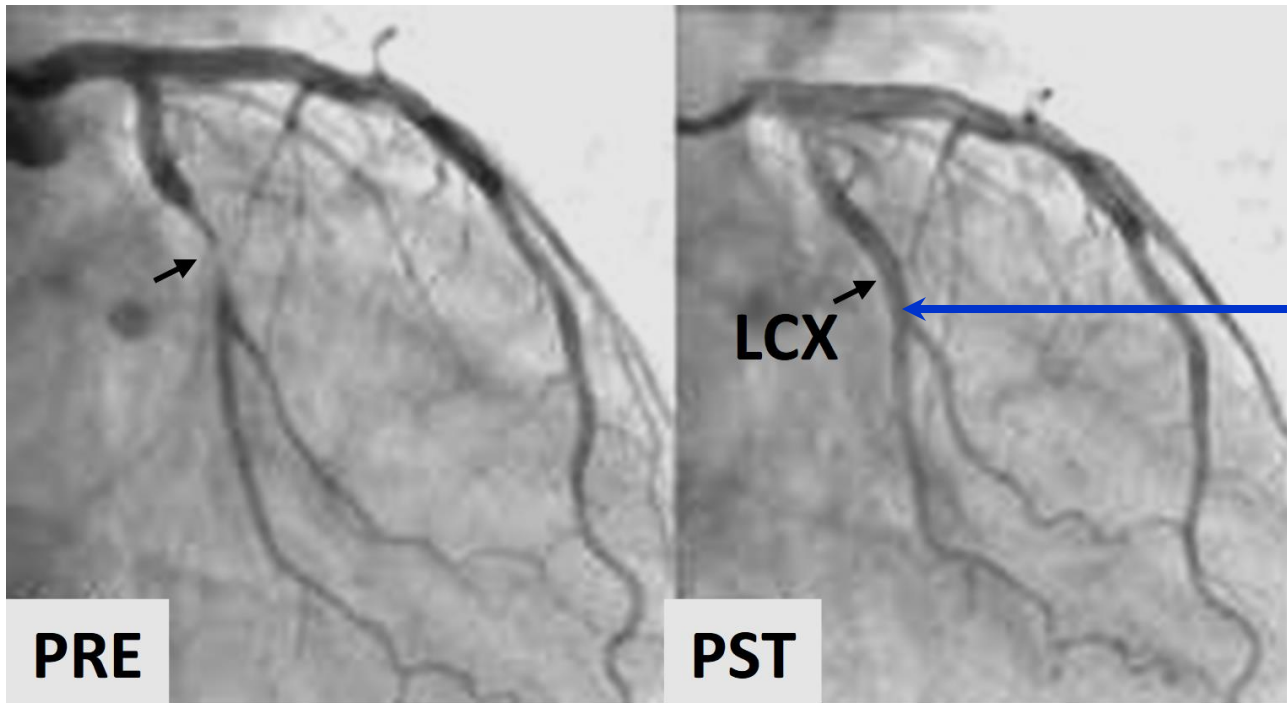
What is the value of blood flow in organ B?

Blood Flow in Collapsible Vessels

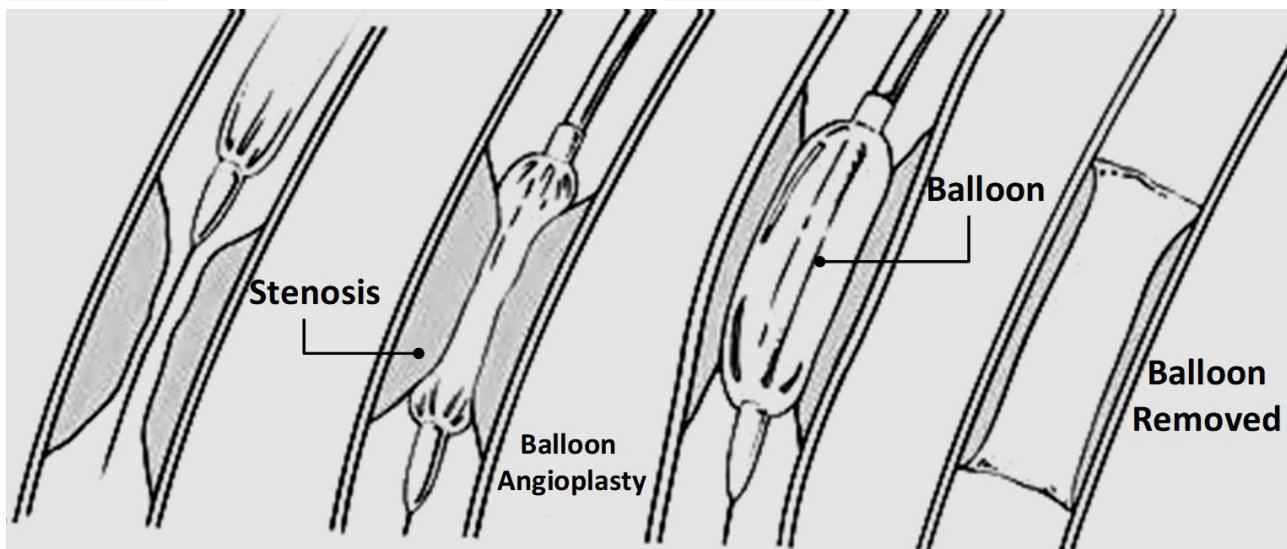


If $P_i < P_e$ at any point, then $Q = (P_1 - P_e) / R_x$

Interactive: LCX Stenosis: Pre & Post Angioplasty 😊



What change in
Distal Pressure?
Increase or
Decrease?

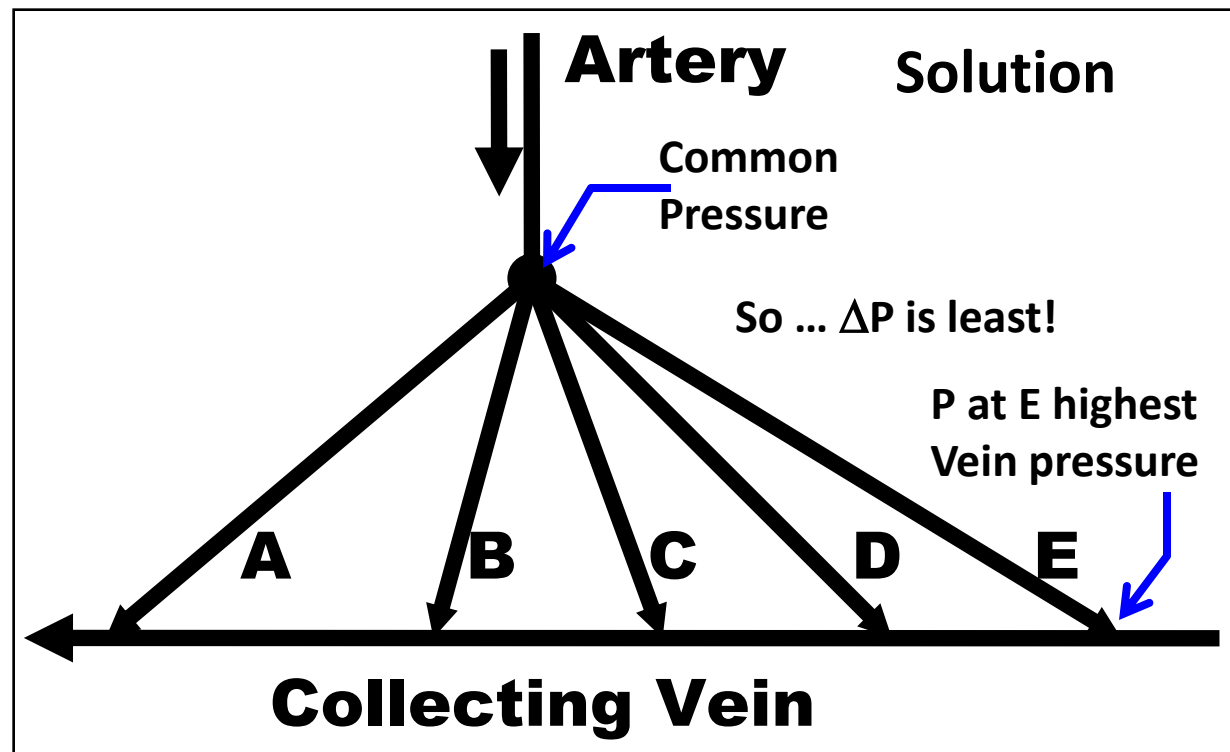


Interactive Question



The figure shows an artery with 5 arteriole branches A through E. Blood flows into a collecting vein.
Which Branch has the least perfusion pressure?

- A. A
- B. B
- C. C
- D. D
- E. E

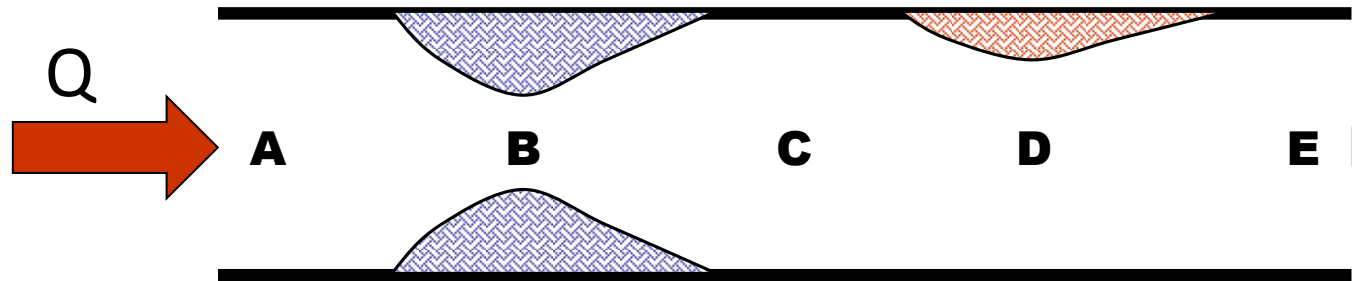


Interactive Question

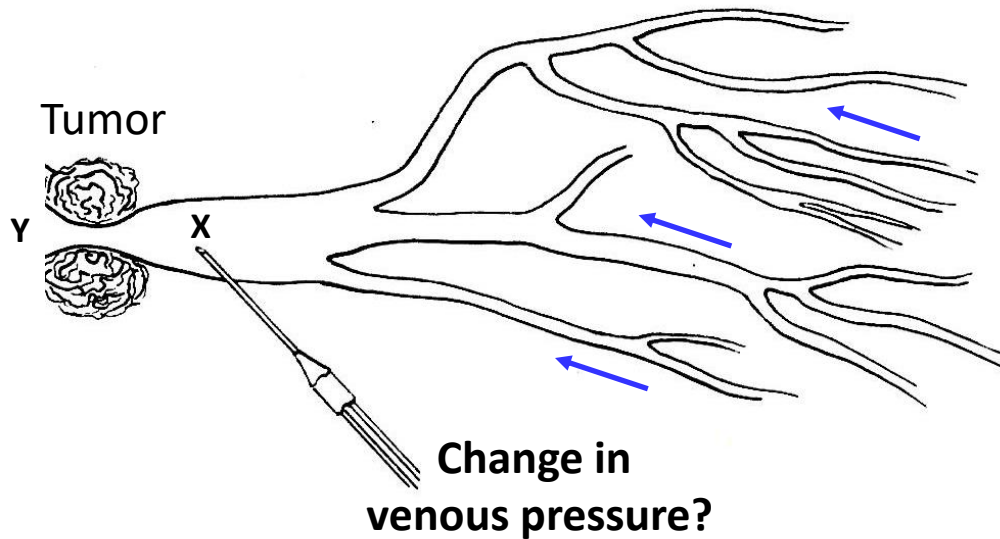


The figure shows a longitudinal section of a stenotic artery. 30s
At which site would you measure the greatest transmural pressure?

- A. A
- B. B
- C. C
- D. D
- E. E



What is your diagnosis?

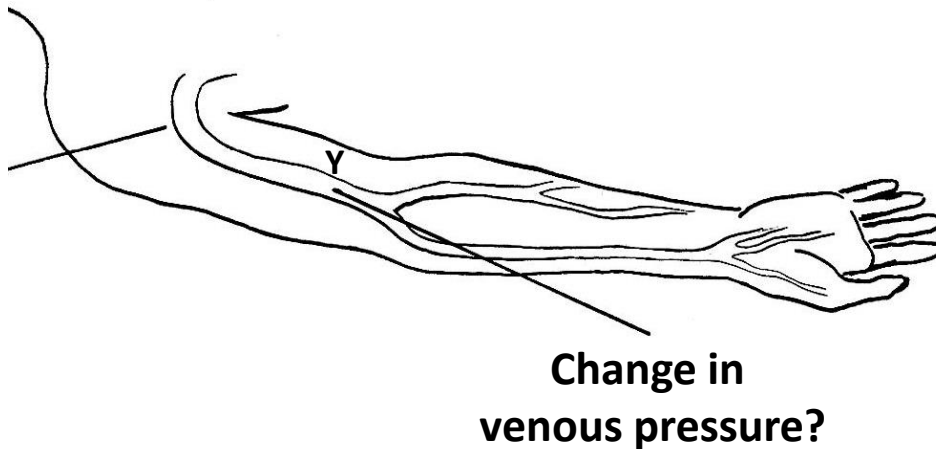
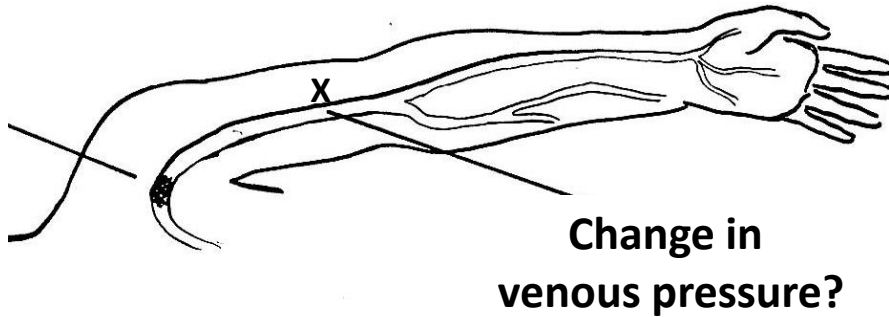


A growing tumor is compressing one of Mary's veins as shown.

What happens to pressures at X?

- A) Goes up
- B) Goes down
- C) Is little changed

What is your diagnosis?



Charles, a 23-year-old laborer, presents with swelling in his left forearm and hand. Ultrasound reveals a clot in his left axillary vein. What happens to pressures at X and Y?

- A) Goes up
- B) Goes down
- C) Is little changed

@X

- A) Goes up
- B) Goes down
- C) Is little changed

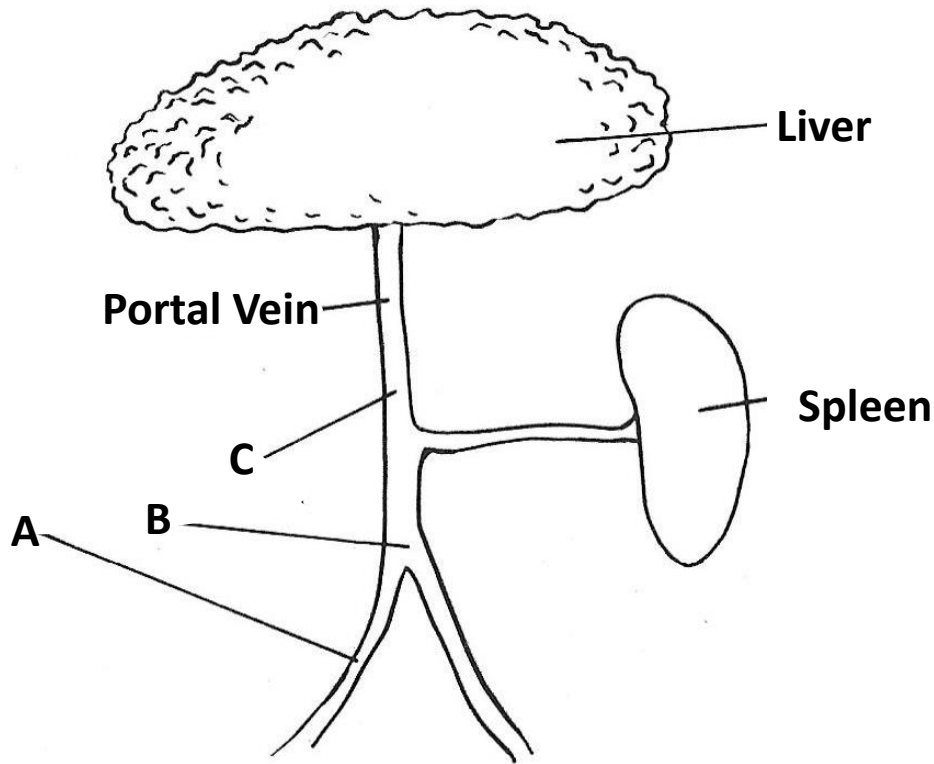
@Y

What is your diagnosis?



Andrew is a 66-year-old former heavy alcohol drinker who has been diagnosed with a cirrhotic liver. This condition is associated with an increase in liver vascular resistance among other things.

Because of this condition, which best describes the pressure(s) that is (are) elevated?



- A) Just C
- B) C and B
- C) C and A
- D) B and A
- E) A, B and C

End Lecture 19
or if time more
Interactive Questions