Resistance and Capacitance

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Isometric and isotonic contraction

W= F. D

Mechanical efficiency= W/ energyX100

Isometric= 0

Isotonic= 20-25%

Only the game in town

Blood pressure

- ❖ Blood pressure =cardiac output X total peripheral resistance
- $BP = CO \ X \ TPR$

First, we want to decide what CO and TPR is , then we get to the right meaning of BP

- ❖ Cardiac output (Flow)= Heart rate X Stroke volume

$CO\ (F) = HR\ X\ SV$

ml/min= Beat/min X ml/ Beat

Cardia out put

HR

- PSNS -
- SNS +
- Hormones (EPI, NE) +
- IONS: Ca++, Na+ , K+ dependents on their level increase or decrease

SV

+ Preload ; Increase the blood volume returns increase diastolic volume

+ Contractility ; SNS (EPI,NE+), Hormones (glucagon,T3 and T4), IONS like Ca++

- Afterload; Hypertension, Atherosclerotic plaques , TPR

Ejection Fraction = 60/100=60%

Resistance

- *How to relate TPR to blood pressure*
- $\boldsymbol{F = \Delta P / R}$ Ohm's Law
- $\boldsymbol{CO = \Delta P / TPR}$

- $\boldsymbol{R = 8nl / \pi r4}$ $Poiseuille's\ law$
- $\boldsymbol{n\ \alpha\ R}$
- $\boldsymbol{n =\ viscosity}$

Resistance

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- $\boldsymbol{n\ \alpha\ R}$
- $\boldsymbol{n = \ viscosity}$

Polycythemia (high Hct)$\alpha\ n$ *; a lot of friction between the layers, because whenever blood is flowing it flows in layers when there is a lot of friction rubbing up against between those layers because increase in viscosity and slow the flow down*

Anemia $\frac{1}{\alpha} n$

$\boldsymbol{L\ \alpha\ R}$

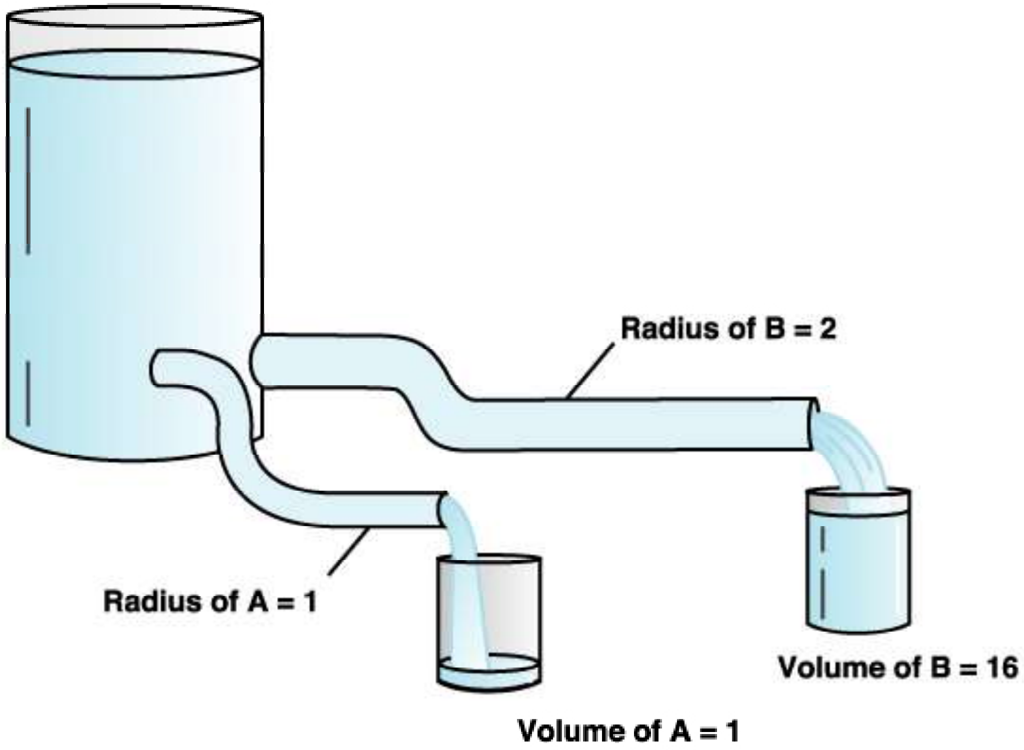
Increase in Weight and height increases in L

$\boldsymbol{r = 1/\alpha\ R}$ ***the most important factor that affecting the R because it is raised to power 4***

Vasodilation increase in r

Vasoconstriction decrease in r

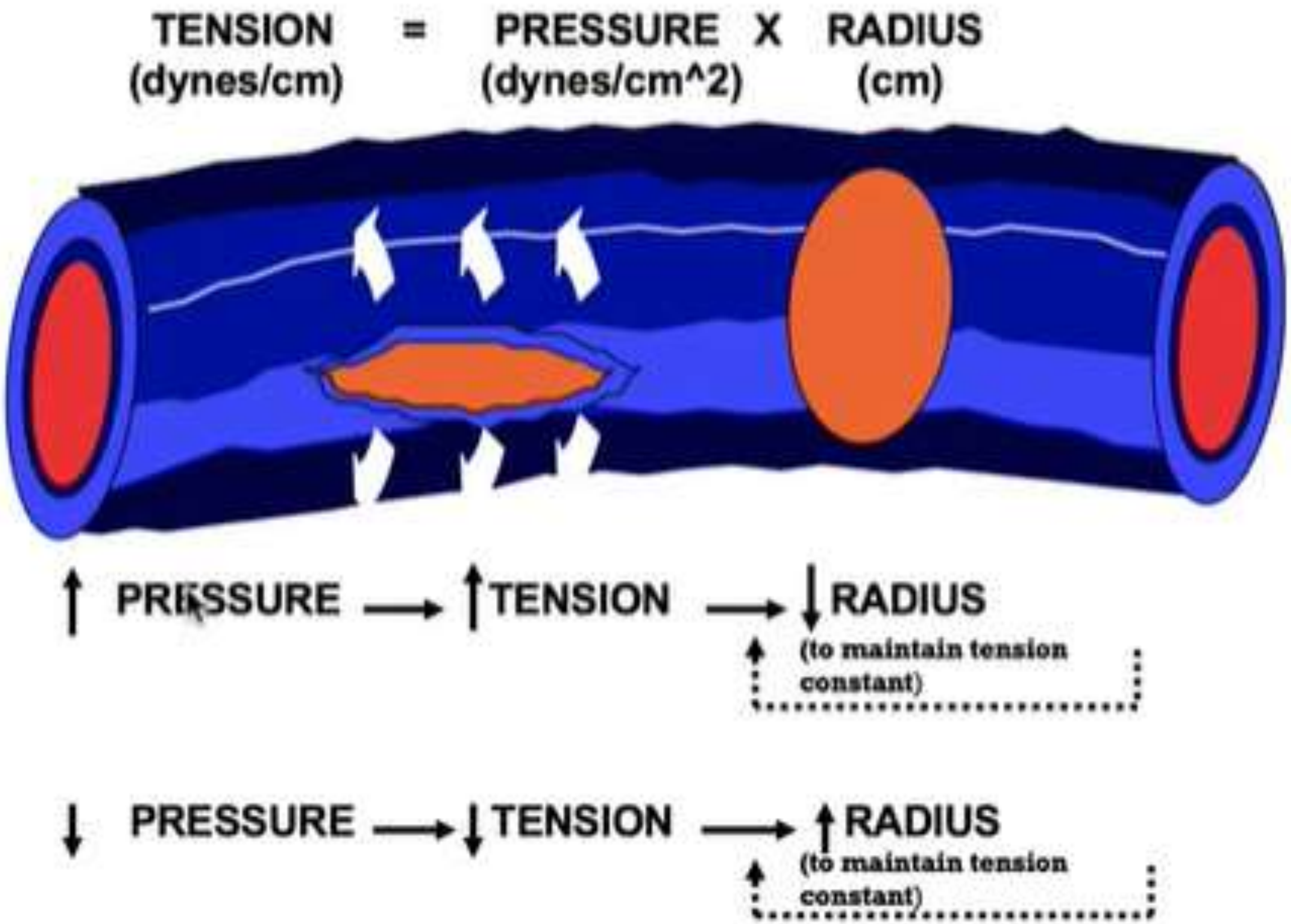
Effect of radius on resistance and blood flow



Resistance ~ $\frac{1}{radius^4}$	
Tube A	Tube B
R ~ $\frac{1}{1^4}$	R ~ $\frac{1}{2^4}$
R ~ 1	R ~ $\frac{1}{16}$

Flow ~ $\frac{1}{resistance}$	
Tube A	Tube B
Flow ~ $\frac{1}{1}$	Flow ~ $\frac{1}{\frac{1}{16}}$
Flow ~ 1	Flow ~ 16

- $T = (P X r)/H$



TENSION = PRESSURE X RADIUS
(dynes/cm) (dynes/cm^2) (cm)
↑ PRESSURE → ↑TENSION → ↓RADIUS
(to maintain tension constant)
↓ PRESSURE → ↓TENSION → ↑RADIUS
(to maintain tension constant)

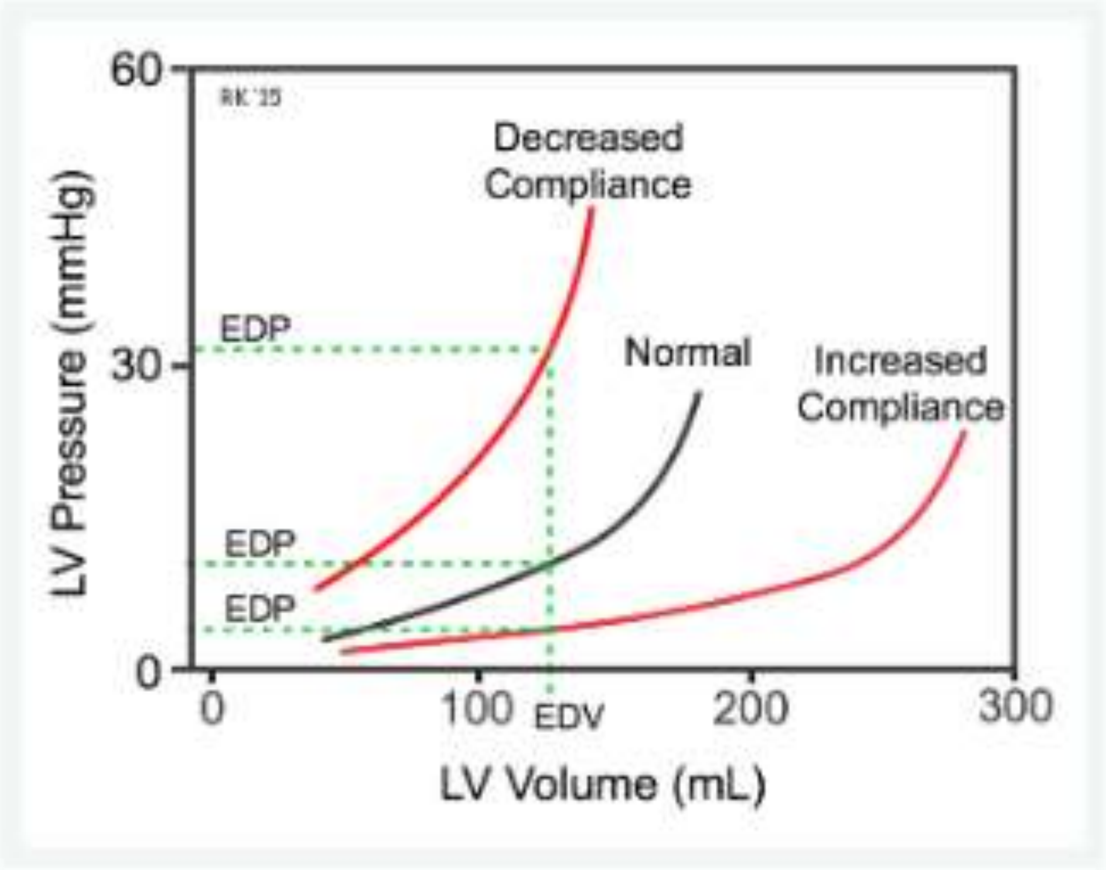
Ventricular Compliance

- As the ventricle fills with blood, the pressure and volume that result from filling are determined by the compliance of the ventricle. Normally, compliance curves are plotted as the change in volume (ΔV) over the change in pressure (ΔP). Therefore, the slope of the relationship is the reciprocal of the compliance, which is sometimes referred to as ventricular "stiffness.“

- As the ventricle fills with blood and its volume increases, the pressure within the ventricular chamber passively increases (see the Normal filling curve in the figure). The relationship is not linear, particularly at higher volumes, because the compliance of the ventricular wall decreases ("stiffness" increases) the more the ventricular wall is stretched. This occurs in most biological tissues.

- in ventricular hypertrophy the ventricular compliance is decreased (i.e., the ventricle is "stiffer") because the thickness of the ventricular wall increases; therefore, ventricular end-diastolic pressure (EDP) is higher at any given end-diastolic volume (EDV)

- In a disease state such as dilated cardiomyopathy, the ventricle becomes very dilated without appreciable thickening of the wall. This dilated ventricle will have increased compliance as shown in the figure; therefore, although the EDV may be very high, the EDP may not be greatly elevated.



“Conductance” of blood in a vessel and Its relation to resistance

Conductance (C_L) is a measure of the blood flow through a vessel for a given pressure difference. .

$$C = \frac{\Delta V}{\Delta P}$$

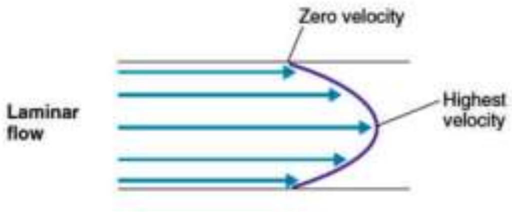
This is generally expressed in terms of milliliters per second per millimeter of mercury pressure, but it can also be expressed in terms of liters per second per millimeter of mercury or in any other units of blood flow and pressure.

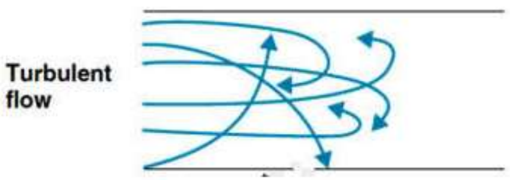
It is evident that conductance is the exact reciprocal of resistance in accord with the following equation:

Conductance= 1/Resistance

The vascular compliance is proportional to the vascular distensibility and vascular volume of any given segment of the circulation. The compliance of a systemic vein is 24 times that of its corresponding artery because it is about 8 times as distensible, and it has a volume about 3 times as great.

Blood flow



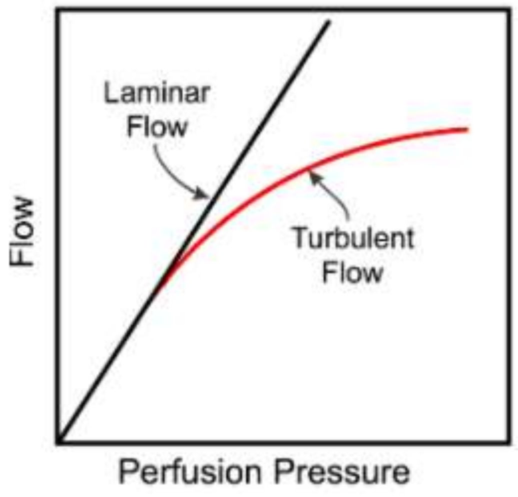


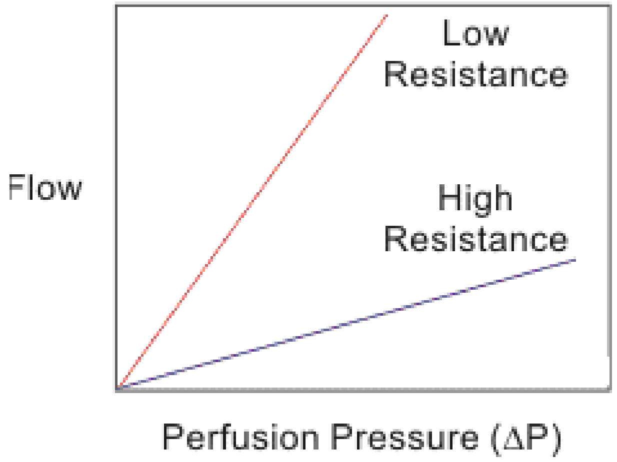
Laminar flow : normal blood flow in the blood vessels (physiological)

- *As you go toward the edges the velocity the blood is going to be slower and the velocity in the middle is highest*
- *So imagine you are looking to blood vessels as a circle, and you are looking at the flow from the back you are going to notice that is flow is very concentric and this type of flow is silent*

Turbulent flow : pathological and physiological one

- *Inside our heart you have a valves mitral valve and aortic valve whenever blood is being pumped upward right it can hit mitral valve as it hits mitral valve it can develop turbulent flow*
- *Imagine a blood vessels and plaques inside ; as the normal flow gets to the occlusion it start developing a turbulence and that gives a lot of heat and changes the action of perfusion pressure and produce what called brutes and can be heard at carotid artery so if you take a stethoscope and put it over carotid artery you can hear it as actual sounds that caused by turbulent flow. It also can produce murmurs*





If you look at the graph here ; as you increase the pressure the flow is increasing in laminar or turbulent flow, but you get to the point where the flow veers off and the flow start decreasing as the perfusion pressure start increasing

If there is a turbulent flow it decreases the actual flow the volume of blood that circulating through an area of blood vessel per a minute and increase the perfusion pressure and the resistance is going to be very high