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Arterial blood pressure

Editing File

Main text Female's slide Male's slide Important text Doctor's note Extra

Objectives:

- To define & understand the concept of arterial blood pressure.
- To identify normal values & variations of arterial blood pressure.
- To identify & measure pulse & mean arterial pressures & Describe how BP is measured
- To identify the affecting & determining factors of arterial blood pressure & Explain the effect of gravity on arterial blood pressure
- To understand the relationships between arterial blood pressure, cardiac output, & total peripheral resistance.
- Define Systolic and Diastolic blood pressure & the normal values
- Physiological significance, Describe physiological variation in arterial BP.
- Hypotension and Hypertension & Clinical features and complications of Hypertension

Recommended video by ninja nerd !

Female's slide

Components of Cardiovascular System

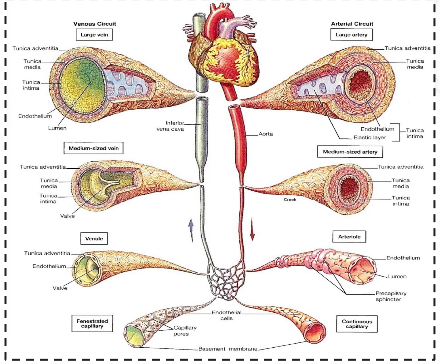
The cardiovascular system is part of the circulatory system.

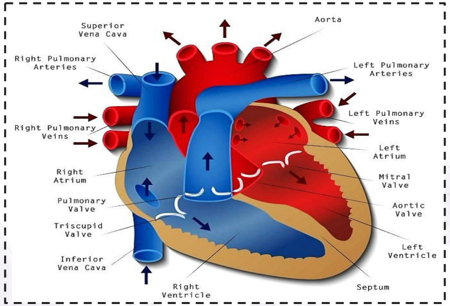
Anatomically, it consists of two components:

The vascular system

Consists of tubes of blood vessels:
Arteries, arterioles, capillaries, venules, & veins.

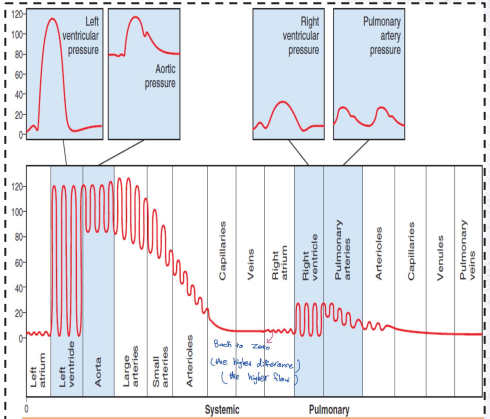
The heart





Pressure Changes Throughout The Systemic Circulation

- Blood flows down a pressure gradient.
- Pressure is highest at the Heart (driving pressure) & decreases over distance.
- Pressure decreases more than 90% from the Aorta to Vena cava.
- Greatest drop in pressure occurs in Arterioles (resistance vessels) which regulate blood flow through tissues.(when we say vasoconstriction we mean arterioles)
- No large fluctuations of pressure in Capillaries & Veins.
- Blood pressure reaches **120 mmHg** in the Aorta & drops to » **2 mmHg** in the Right Atrium.
- Veins have only 0 -10 mmHg Pressure.

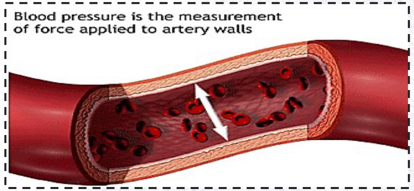


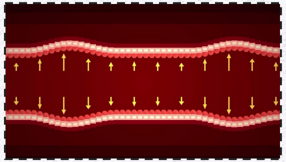
Blood pressure in different parts of the circulatory system.
~Guyton and Hall.

There are (3) Types of Blood Pressure depending on nature of blood vessels :

- arterial
- venous
- Capillary

Arterial Blood Pressure





- **Arterial blood pressure (ABP):** is the lateral pressure force exerted by the blood flow on the arterial wall against any unit area of the vessel wall.

- The created pressure force of blood flow is determined by the pumping force of the heart.

- Standard Units of Blood Pressure:

  - Measured in Millimeters of mercury (mmHg) and sometimes in Centimeters of water (cmH_2O). (1 mmHg = 1.36 cmH_2O) because the specific gravity of mercury is 13.6 times that of water and 1 centimeter is 10 times as great as 1 millimeter.

- Arterial blood pressure (ABP) is one of the most important vital signs

- It is important to keep normal levels of blood pressure for proper blood flow to the body's organs & tissues.

Measures of Arterial Blood Pressure

Pressure	Definition	Normal adult arterial pressure
Systolic BP	The maximum force (pressure) exerted by the blood flow against any unit area of the vessel wall during maximum contraction (systole) of the heart is called systolic BP	120 mmHg (80/90 -120 mmHg)
Diastolic BP	The minimum force (pressure) exerted by the blood flow against any unit area of the vessel wall during maximum relaxation (diastole) of the heart.	80 mmHg (60-80 mmHg)

- Normal adult arterial blood pressure measures 120 mmHg systolic/80 mmHg diastolic.
- Both numbers are important to determine the health state of the heart.

Arteries are **Pulsatile**, so arterial pressure varies. Normal adult Arterial Blood Pressure varies physiologically with an ideal range of 90 – 120 mmHg systolic, 60 – 80 mmHg diastolic. Higher numbers indicate that the heart is working too hard to pump blood to the rest of the body.

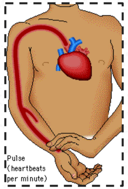
Pulse pressure & MAP

You have to understand the concept and the calculation !!

Female's slide

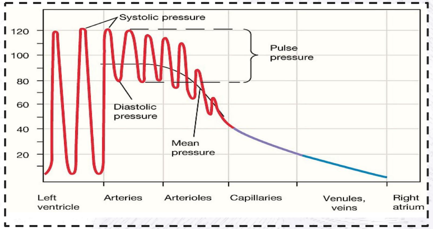
Pulse pressure

- The pulse rate is always the same as the heart rate.
- It is calculated as the number of beats per minute (bpm).
- Pulse Pressure = Systolic Blood Pressure – Diastolic Blood Pressure



Mean Arterial Blood Pressure

- As arterial pressure varies physiologically, a single value is used to represent the overall driving pressure. This value is called the Mean Arterial Pressure (MAP).
- The average of the arterial pressures measured in millisecond over a period of time.
- It is responsible for driving blood into the tissues throughout the cardiac cycle.
- It is better indicator of perfusion to vital organs than systolic blood pressure.
- It is not equal to the average of systolic and diastolic pressure. To calculate a mean arterial pressure, double the diastolic blood pressure and add the sum to the systolic blood pressure. Then divide by 3. For example, if a patient's blood pressure is 83 / 50 mmHg, his MAP would be 61 mm Hg.
- Another way to calculate the MAP is to first calculate the pulse pressure (subtract the DBP from the SBP) and divide that by 3, then add the DBP



MAP: mean arterial pressure
SBP: systolic blood pressure
DBP: diastolic blood pressure

MAP

- DBP + ⅓(SBP-DBP)
- $\frac{SBP + 2(DBP)}{3}$

MAP=50+⅓ (83-50)
MAP=61 mmHg

$MAP = \frac{SBP + 2(DBP)}{3}$

$MAP = \frac{83 + 2(50)}{3}$

$MAP = \frac{83 + 100}{3}$

MAP = 61

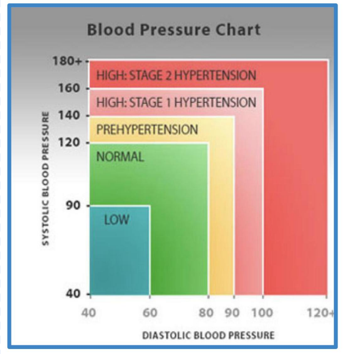
Arterial Blood Pressure Chart

Adult BP range: 90–120/ 60–80 mmHg

American Heart Association (AHA) Blood Pressure Categories Guidelines Nov 2017

The last update of the AHA/ACC was in 2017 & the major change at that time was:

1. **Re-classified "pre-HTN"** as elevated blood pressure (120-129/<80 mmHg).
2. **Lowering the definition of HTN** from ≥140/≥90 mmHg **to** ≥130/≥80 mmHg.



Blood Pressure Categories

American Heart Association | American Stroke Association

BLOOD PRESSURE CATEGORY	SYSTOLIC mm Hg (upper number)		DIASTOLIC mm Hg (lower number)
NORMAL	LESS THAN 120	and	LESS THAN 80
ELEVATED	120 – 129	and	LESS THAN 80
HIGH BLOOD PRESSURE (HYPERTENSION) STAGE 1	130 – 139	or	80 – 89
HIGH BLOOD PRESSURE (HYPERTENSION) STAGE 2	140 OR HIGHER	or	90 OR HIGHER
HYPERTENSIVE CRISIS (consult your doctor immediately)	HIGHER THAN 180	and/or	HIGHER THAN 120

heart.org/bplevels

Physiological Factors Affecting Arterial Blood Pressure

- **Sex :** Male > Female, (equal at menopause) Sex up to age of 40 years males have higher arterial values than women, becoming lower than women after age 50 (D'Alché 2008)
- **Age :** ABP rises with age, elderly > children, due to atherosclerosis, diabetes
- **Body mass index:** ABP rises with body size. For example Obesity ↑BP
- **Emotions**: ABP increases due to neural & hormonal factors.
- **Exercise**: increases ABP due to increased venous return.
- **Hormones**: Some hormones like adrenaline, noradrenaline & thyroid H increase ABP.
- **Gravity**: ABP is higher in lower limbs than upper limbs.
- **Stress:** increase BP
- **Sleep**: ABP decreases due to decrease venous return.
- **Race:** (? dietary factors, or stress)
- **Pregnancy**: ABP increases due to ↑ in metabolism / hemodynamics.
- **Temperature:** ABP decrease with Heat due to vasodilatation, & increase with Cold due to vasoconstriction.

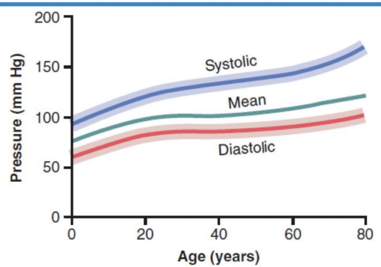


Figure 15-8. Changes in systolic, diastolic, and mean arterial pressures with age. The shaded areas show the approximate normal ranges.

Guyton and Hall, pp 183

Factors Determining Arterial Blood Pressure

Blood Pressure = CO x PR and Blood volume
(MAP)

Cardiac output (Flow)

depends on :

Stroke volume X Heart rate

Blood volume

depends on :

Balance between fluid intake & fluid loss

Peripheral Resistance

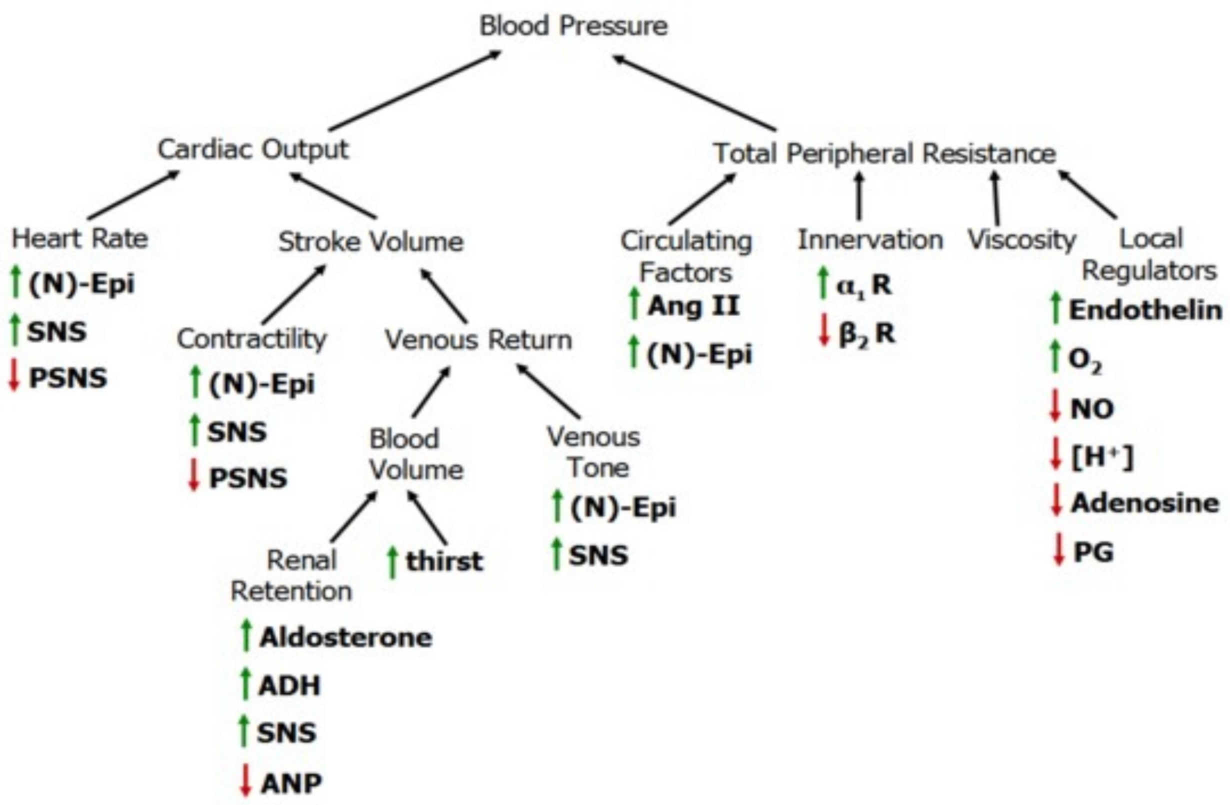
depends on :

$$\frac{\eta \, X \, L}{r^4}$$

- Thickness (viscosity) of blood (η)
- Length of the blood vessel (L)
- Size of the blood vessel (r^4)

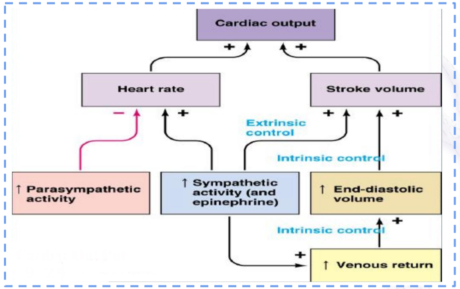
Blood pressure : (stroke volume X heart rate) X (η X L / r^4)

Physiologic factors affecting blood pressure



The Cardiac Output (CO)

- Cardiac Output (CO) is the amount or volume of blood pumped by the ventricle per minute
- CO is expressed in L/min.
- At rest, CO is (5 / 4 - 6) L/min (≈ 5 L/min) , in healthy adults, when the HR = 60 /70- 100 bpm (≈70-75 bpm)
- Since normal adult total resting blood volume ≈ 5 L, the blood volume circulates through the body once each minute
- Cardiac Reserve = Difference between a person's maximum & resting CO
- Cardiac reserve increases with fitness & decreases with disease.



General Principles

- Contraction of the heart generates pressure changes & blood movement
- Blood flows from an area of high pressure to an area of low pressure.

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Terminologies to Define

End- Diastolic Volume (EDV)

- Volume of blood in the ventricle at the end of diastole
- ≈ 110 -130 ml.

Stroke volume (SV):

- Amount of blood ejected from the ventricle per beat.
- SV = EDV - ESV
- ≈ 70 - 80 ml/beat.

End-Systolic volume (ESV):

- Amount of blood left in the ventricle at the end of systole.
- ≈ 40 - 60 ml.

Ejection fraction (EF):

- Is the Fraction (%) of ventricular EDV which is ejected with each stroke (beat).
- = SV/EDV X 100, or (EDV-ESV)/EDV X 100
- 55 - 70% (≈ 60 - 65 %)
- It is a good index of ventricular function

Cardiac index (CI):

- Is the cardiac output per square meter of body surface area.
- For a normal person weighing 70 Kg, his body surface area is about 1.7 m^2, & his normal average cardiac index is about 3L/min/m2 of body surface area.

Factors Affecting and Determining The CO

Factors directly affect the cardiac output:

Female's slide

1. Body metabolism.
2. Exercise:
   - During stress & exercise, CO may ↑ by 4-5 times of resting, = 20-25 L/min.
   - Athletes can ↑ CO by 7 times of resting, = 35 L/min (known as Cardiac Reserve)
3. Age decrease CO
4. Body mass index increases CO

Factors determining the cardiac output:

Cardiac output (CO) is determined by: The Stroke volume & the Heart rate.

Cardiac Output = Stroke Volume X Heart Rate

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Variables Affecting The Determining Factors of The CO

Cardiac Output = Stroke Volume X Heart Rate

Any factor affecting these variables/parameters will affect the CO.

Stroke Volume → Ventricular Myocardium

1- Ventricular End-Diastolic Volume (EDV), which is affected by the Preload (Venous Return)

2- Contractility (Myocardial function)

3- Afterload (Peripheral Resistance)

Heart Rate → SA node

1- Autonomic Innervation

2- Hormones/ Drugs

Regulation of The Cardiac Output

Important note :
Reduce
Increase

Peripheral Resistance (Afterload)
(Mean arterial blood pressure)

inversely proportional

Cardiac Output = Stroke Volume X Heart Rate

Strength of Contraction

End- Diastolic volume (EDV)

Intrinsic Stretch
Starling's law of the
heart, the more stretch
of cardiac Sympathetic
muscle, the stronger the
Intrinsic regulation
contraction

Sympathetic N

Hormones/Drugs

Parasympathetic N

The Stroke Volume

Stroke volume (SV) is the amount of blood pumped by ventricle per beat.

Stroke volume (SV) normal value / average is 70-80 mL/beat.

Stroke volume (SV) is determined by the:

- End- diastolic volume.
- End- systolic volume.

End-diastolic Volume (EDV) – End-systolic Volume (ESV) = The Stroke Volume

Volume of blood in ventricles at the end of The diastole Volume (End-Diastolic volume) ≈110-130 ml	−	Volume Amount of blood left in the ventricles at the end of the systole (End-Systolic volume) ≈40-60 ml	=	The Stroke diastole Volume (End-Diastolic volume.) (70-80ml)

Regulation of The Stroke Volume

Stroke volume is regulated by 3 variables:

will affect the ,

End- Diastolic Volume (EDV):	Affected by Venous return (Preload).	{EDV}
Contractility (Strength of contraction of heart itself) :	Affected by Starling's law & sympathetic innervation	{ESV}
Total Peripheral Resistance (Afterload):	Affected by size and length of blood vessel. Thickness (viscosity) of blood.	{ESV}

EDV= End- diastolic volume ; ESV= End- systolic volume.

The Stroke Volume

Preload: (Venous Return)

is the amount of blood returns to the heart from the veins, into the atria.

End- Diastolic Volume: (EDV)

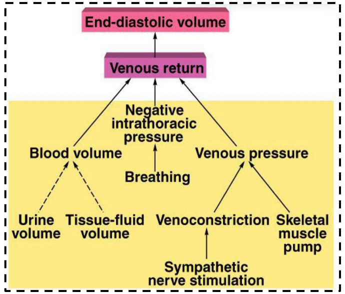
is amount of blood presented to the ventricles from the venous return at the end of diastole & prior to ventricular ejection.

When venous return (VR) increases, the ventricular muscle fibers will stretches/lengthens, thus the EDV will increase.

How Does The EDV Affects The SV & CO? Frank-Starling's Law of the heart

- SV & CO are controlled by the heart itself & the venous return (VR) which is normally the primary controller of the cardiac output.
- An increase in the VR will increase the End- Diastolic volume (EDV) leading to stretch the myocardial fibers, thus increasing the
initial fiber length..
- This increase in the initial fiber length will increase the strength of next myocardial contractility & so increasing the next SV. In addition, this stretch will stretch the SA- node leading to increase the heart rate as much as 10-15% (Frank-Starling Mechanism)

Factors Affecting End- Diastolic Volume

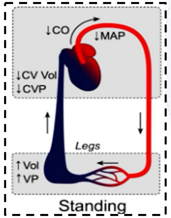


End-Diastolic Volume (EDV) Affected by Venous return (Preload)

The Venous Return is affected by :

1. Blood volume
2. Pressure gradient
3. Gravity
4. Venoconstriction: caused by sympathetic nervous system.
5. Presence of valves in the large veins
6. Skeletal muscles pump
7. Respiratory activity (Deep inspiration increases venous return)

Factors Affecting Venous Return (Preload):

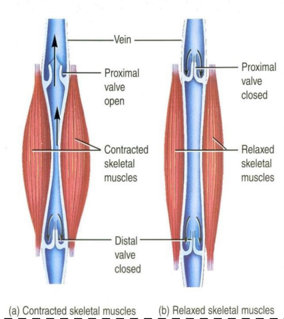
Blood volume	Pressure Gradient	Gravity	Venoconstriction
- At constant venous capacity, when the blood volume ↑ —> the Mean Circulatory Pressure ↑ —> ↑ Venous return (VR) . - At constant venous capacity, when the blood volume ↓ —> the Mean Circulatory Pressure ↓ —> ↓ Venous return (VR) • Note: Venous capacity is the volume of blood that the veins can accommodate	- ↑Pressure gradient » ↑ venous return. - Since the right atrium is the site of venous blood collection from all around the body » the pressure inside the right atrium i.e. Right Atrial Pressure (RAP) is called Central Venous Pressure (CVP). - The highest pressure in large arteries (120 mmHg) continues to drop throughout the vascular pathway, reaching » zero-2 mmHg at right atrium. - This drop in pressure will make a pressure gradient that forces the blood to continually move from areas of high pressure into areas of lower pressure.	**Standing:** - When a person initially stands, right atrial pressure (RAP) & ventricular EDV falls, which decreases stroke volume (SV) by the Frank-Starling mechanism. So, both the CO & arterial pressure will decrease. - The flow through the entire systemic circulation falls because arterial pressure falls, therefore the pressure gradient driving flow throughout the entire circulatory system will decrease. 	By sympathetic stimulation will ↑ venous return (VR)

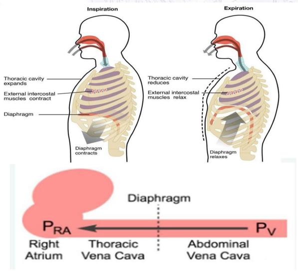
Female's slide

Factors Affecting Venous Return (Preload) cont:

Presence of valves	skeletal muscle pump	Respiratory Activity
Permit blood to move forward towards the heart & prevent it from moving back toward the tissues.	Rhythmical contraction of limb muscles (as occurs during walking, running or swimming) —> ↑ VR by the muscle pump mechanism that squeeze the blood vessels between muscle fibers.	Respiratory/Thoracic Pump - **Inspiration —> ↑ venous return** (VR) with a decrease in the right atrial pressure (RAP). - In Valsalva maneuver (forceful expiration against a closed glottis), intrapleural pressure become positive which is transmitted to the large veins in the chest —> ↓ VR.


Skeletal muscle pump enhancing venous return





Female's slide

Other Factors Affecting Venous Return (Preload) and EDV

Venous return (VR) is decreased when :

1. The Right Atrial Pressure (RAP) is increased
2. Pumping capability becomes diminished الانقباض نفسه يضعف
3. The Nervous circulatory reflexes are absent

EDV is ↑ with	EDV is ↓ with
* Increased total blood volume.	* Standing.
* Increased venous return.	* Decreased venous return.
* Increased venous tone.	* Increased intrapericardial pressure.
* Increased skeletal muscle pump (exercise).	* Decreased ventricular compliance.
* Increased negative intrathoracic pressure.	
* Stronger atrial contraction.	

Female's slide

End-Systolic Volume (ESV)

Factors affecting end-systolic volume	Factors that affect contractility and Total peripheral resistance
Cardiac Contractility Affected by Starling's law & sympathetic innervation.	**Intrinsically** affected by: Frank Starling's law of the heart, which is affected by the End Diastolic Volume (EDV). [Frank Starling's law states that the force of contraction depends on the initial length of the muscle]. **Extrinsically** affected by sympathetic stimulation, hormones & drugs. ↑↑ contractility → ↑↑ SV → ↓↓ ESV ↓↓ contractility → ↓↓ SV → ↑↑ ESV
Total peripheral resistance (afterload) Affected by size & length of blood vessel. Thickness (viscosity) of blood.	**Afterload** is the resistance to flow against (oppose) ventricular contraction. ▪ Afterload increases by any factor that restricts arterial blood flow: Such as an increase in arterial pressure (vasoconstriction). ▪ As the afterload increases, the stroke volume decreases. ▪ In response to all regulatory mechanisms: **Vasoconstriction** will ↑↑ Peripheral Resistance → ↓↓ peripheral Flow → ↓↓ SV → ↑↑ ESV. **Vasodilatation** will ↓↓ Peripheral Resistance → ↑↑ peripheral Flow → ↑↑ SV → ↓↓ ESV.

Female's slide

Heart Rate (HR)

Heart Rate (HR)

Definition and how it happens	is the calculated as the number of heart beats per minute. The heart rate is determined by the firing rate of the sinoatrial
Heart rate ranges	Normal heart rate = 60-100 beats/min > 100 beats/min » Tachycardia. < 60 beats/min » Bradycardia.
Relationship with Cardiac Output (CO)	As the HR increases, the CO increases (up to a limit). • ↑ HR up to » 180 bpm, ventricular filling is adequate & CO ↑ . • At very high HR, filling may be compromised to a degree that CO falls. As the HR decreases, the CO decreases.

The HR has an influence on cardiac contractility as well Frequency-Force Relation.

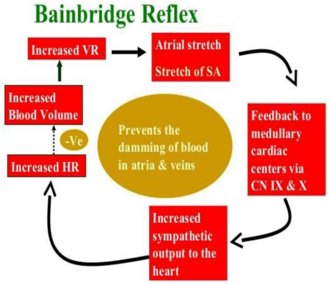
Regulation of Heart Rate

Sympathetic nervous system	Cardiac-accelerator Center (Vasomotor center) —>Sympathetic nerve fibers.
Parasympathetic nervous system	Cardiac-inhibitory Center —>Parasympathetic nerve fibers.

Heart rate is regulated by The autonomic nervous system through cardiac control centers in medulla oblongata in the brain stem.

- **Sympathetic nervous stimulation**, increases both the HR & contractility and constricts the arterioles and venules.
- **Parasympathetic nervous stimulation** (Vagus nerve) only slows the HR.

Heart Rate continued

Regulation of the Heart Rate	
Hormones and Drugs	- Epinephrine, Norepinephrine, or thyroxine hormone, increases the HR. - Increased calcium level concentration in the blood, causes prolonged contraction. - Reduced calcium level concentration in the blood, decreases the HR.
Physical factors	- **Age**: Resting HR is faster in fetus and then gradually decreases throughout life. - **Gender**: HR is faster in females (72-80 beats/min) than in males (64-72 beats/min). - **Temperature**: Heat increases HR as occurs in high fever. Cold has the opposite effect. - **Exercise**: Increases HR through sympathetic nervous system.
Blood volume	An increase in blood volume & venous return (VR) will stretch the right atrium & the SA-node which will stimulates stretch receptors in the right atrium & initiate a nervous reflex called the “Bainbridge reflex”. This reflex will increase sympathetic stimulation to trigger increase in the HR in response to the increase in the VR. 

Peripheral resistance

Resistance (R)	Tendency of the vascular system to oppose the blood flow (Q). Flow (Q) = 1/R
Vascular Resistance (R)	is affected by the pressure difference (ΔP) & the blood flow (Q). $R = \Delta P/Q$ Vascular flow (Q) is inversely proportional to the resistance
Poiseuille's Law	In a human, the length (L) of vascular system is fixed. Accordingly, the blood viscosity(η) & radius (r) of the blood vessels have the largest effects on the resistance. And poiseuille's law states: $R = \frac{8l\eta}{\pi r^4}$

When fluid flow in a cylinder
the resistance to flow is influenced by: Length of the tube (L), radius of the tube (r), & viscosity of the blood (η)

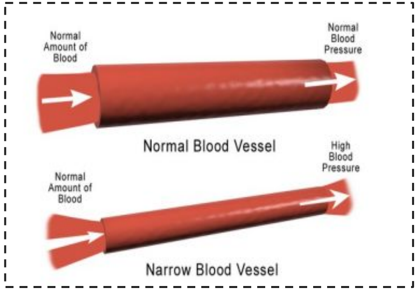
$R = \Delta P/Q \twoheadrightarrow Q = \Delta P/R$

Integration of Flow (Q) & Poiseuille's Law

$$R = \frac{8\eta L}{\pi r^4} \Rightarrow \frac{1}{R} = \frac{\pi r^4}{8\eta L}$$

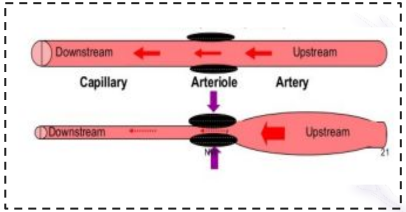
$$\Rightarrow \frac{\Delta P}{R} = \frac{\Delta P \times \pi r^4}{8\eta L} = Q$$

Blood flow(Q) and Pressure & Effect of Radius (r) on Flow & pressure

Blood Flow (Q) & Pressure	Effect of Radius (r) on flow & Pressure	
Blood flows down the pressure gradient. Pressure difference (ΔP) is directly proportional to the Flow (Q). $Q = \Delta P/R$ Absolute value of pressure is not important to flow (Q), but the difference in pressure (ΔP or gradient/driving pressure) is important to determine the flow (Q).	(r) is directly proportional to the flow (Q).	(r) is inversely proportional to the pressure (P). 

Increased tone (e.g. increased arteriolar tone)
» decreased radius » increased resistance » decreased flow

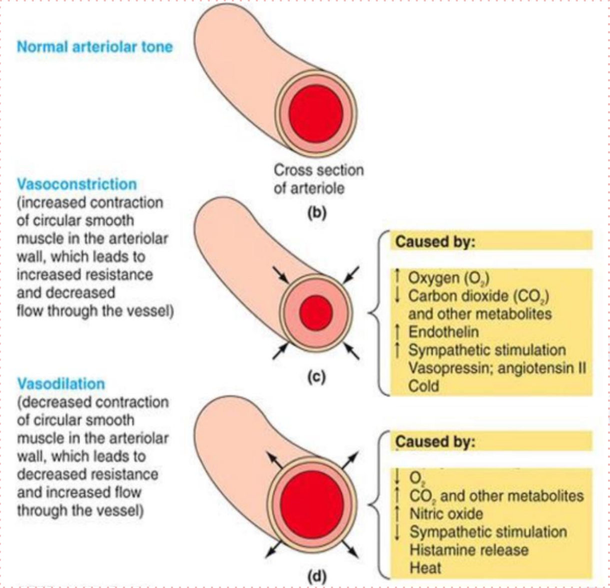
Effects on blood volume:
- Increased upstream (in artery)
- Decreased downstream (in capillaries)



Important slide

Factors Affecting Vessel Diameter: Radius(r)

Vasoconstrictors	Vasodilators
-Oxygen (O_2). -Epinephrine & Norepinephrine. -Angiotensin II. -Vasopressin (Antidiuretic hormone). -Endothelin-1. -Thromboxane A2. -Cold. -alpha 1 Receptor.	-CO_2 & other metabolites. -Nitric oxide (NO). -Histamine. -[H+] -Adenosine -Atrial Natriuretic Peptide (ANP). -Prostacyclin; PGI2. -beta 2 Receptor.



Effect of Viscosity (η) and Length (L) on flow

Viscosity	Length
-Blood viscosity (η) is the thickness & stickiness of the blood. -It is an important factor that determines the resistance of blood to flow. -Human blood is five times more viscous than distilled water. -Viscosity (η) of the whole blood is mainly due to cells, & that of plasma is due to plasma proteins. -Viscosity (η) is inversely proportional to the flow (Q).	Length (L) is inversely proportional to the flow (Q). N.B. In a normal human, length of the vascular system is fixed.

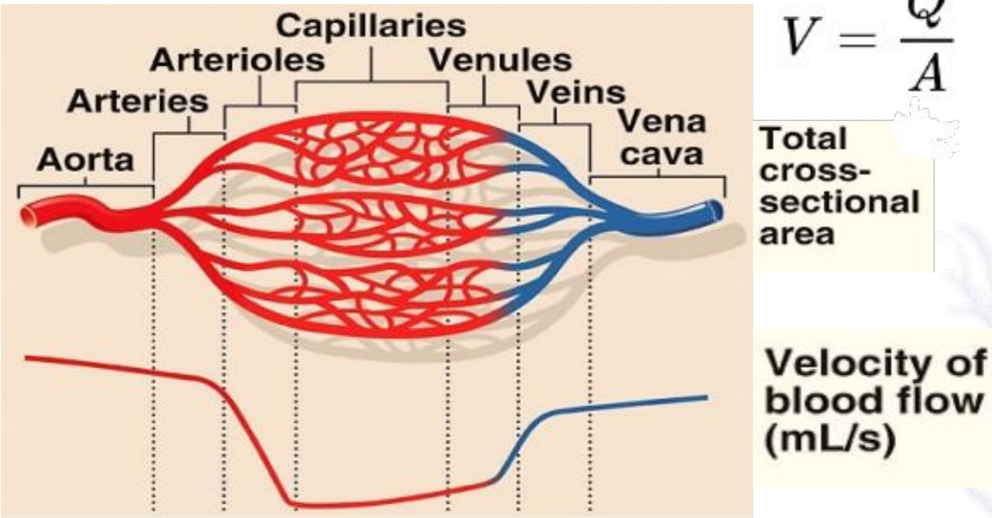
Flow (Q) and Cross-Sectional Area/Diameter

Male's slide

The velocity of blood flow within each segment of the circulatory system is inversely proportional to the total cross-sectional area of the segment. Because the aorta has the smallest total cross-sectional area of all circulatory segments, it has the highest velocity of blood flow.

The diameter of a single capillary is quite small, the number of capillaries supplied by a single arteriole is so great that the total cross-sectional area available for the flow of blood is increased. Hence, the pressure of the blood as it enters the capillaries decreases.

As diameter of vessels ↓, the total cross-sectional area ↑ & velocity of blood flow ↓



$$V = \frac{Q}{A}$$

Blood pressure and blood volume

Blood Volume:

An increase in blood volume ↠ ↑CO ↠ ↑ABP.

A decrease in blood volume as in hemorrhage, dehydration ↠ ↓VR ↠ ↓CO ↠ ↓ ABP.

Elasticity of blood vessels:

Changes in the elasticity of large vessels affects ABP.

In atherosclerosis (a subtype of arteriosclerosis, and they all are hardening of the arteries), decrease in arterial compliance ("hardening of the arteries"). This makes arteries like a tube, during systole, blood is ejected into the arteries, they don't distend as normal and pressure increases significantly ↠ ↑ PP.

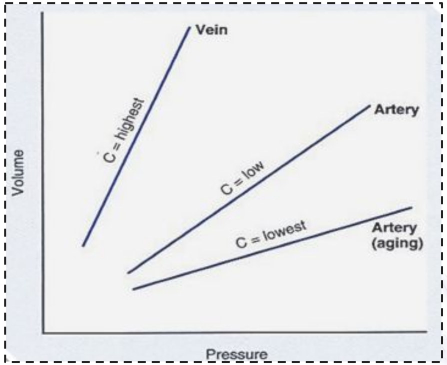
Female's slide

Compliance (C) of Blood Vessels and resistance types

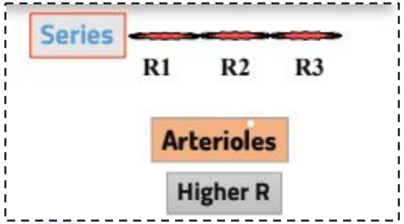
1 Compliance = Distensibility.

2 Compliance is the volume (V) of blood that the vessel can hold at a given pressure (P).
C = V/P

3 Venous system has a large compliance & acts as a blood reservoir (high volume & low pressure).
Venous system has the highest compliance (C), while the arterial system has a low compliance (C).



resistance

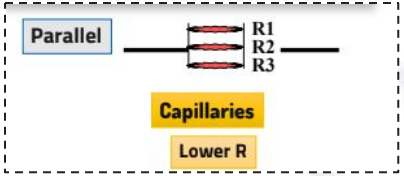


Series Resistance
RTotal = R1 + R2 + R3

More Resistance

Parallel Resistance
$1/R_{Total} = 1/R1 + 1/R2 + 1/R3$

Less Resistance



Total Peripheral Resistance (TPR)

Total Peripheral Resistance (TPR) is higher in the systemic circulation than the pulmonary circulation

$$R = \frac{\Delta P}{Q}$$

TSPR= Total Systemic Peripheral Resistance
T Pulm R= Total Pulmonary Resistance
RAP= Right Atrial Pressure
LAP= Left Atrial Pressure
PRU= Peripheral Resistance Units.

Systemic Circulation

$$\text{TSPR} = \frac{\text{Aortic pressure} - \text{RAP}}{\text{FLOW}}$$

$$\text{TSPR} = \frac{120-2 \text{ mmHg}}{83.3 \text{ ml/sec}(5\text{L/min})}$$

TSPR= 1.2(PRU's)

Pulmonary Circulation

$$\text{T Pulm R} = \frac{\text{pulmonary pressure} - \text{LAP}}{\text{FLOW}}$$

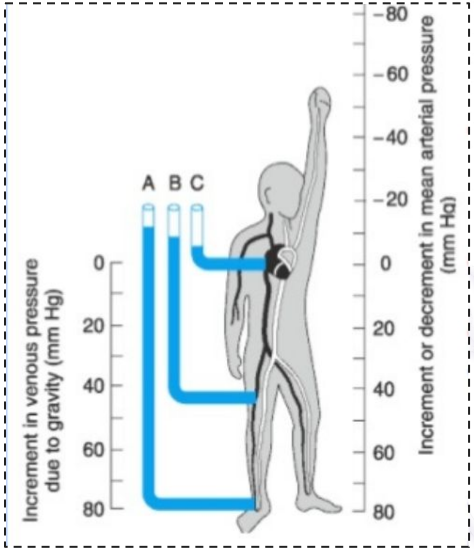
$$\text{T Pulm R} = \frac{15-3 \text{ mmHg}}{83.3 \text{ ml/sec}(5\text{L/min})}$$

T Pulm R= 0.12 (PRU's)

Effect of Gravity on blood pressure

- The pressure in any vessel below the level of the heart is increased
- The pressure in any vessel above the level of the heart is decreased
- These phenomena are due to the effect of Gravity.
- Gravitational effect = 0.77 mmHg/cm at the density of normal blood. In an adult human in the upright position, if mean MAP at heart level = 100 mmHg, the MAP in an artery at the head (50 cm above heart) = 100-[0.77X 50] = 62 mmHg.

Above heart level	Below heart level
50cm = 100 – [0.77 X 50] = 62 mm of Hg	105cm = 100 + [0.77 X 105] = 180 mm of Hg



Male’s slide

Measurement of Blood Pressure

blood pressure cuff/Sphygmomanometer

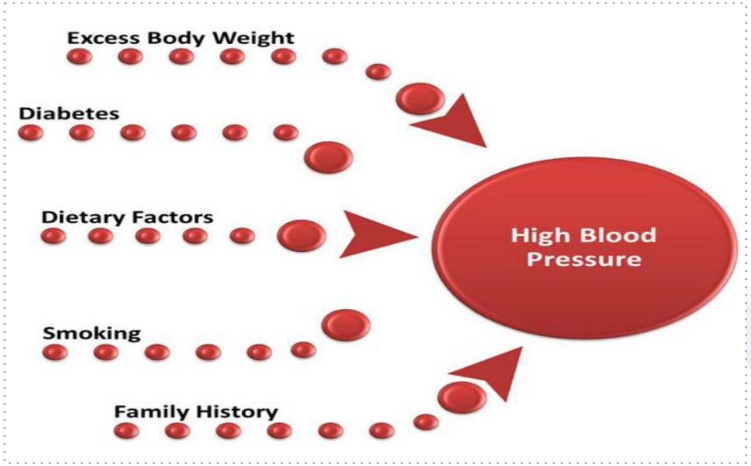
Types:
Mercury sphygmomanometer
Aneroid equipment
Automatic equipment

Blood Pressure Cuff/Sphygmomanometer Size:
Small – children & small adults
Average
Large – overweight & large adults

CLINICAL FEATURES-COMPLICATIONS OF HYPERTENSION

complications

- Headache dizziness and confusion
- Shortness of breath and chest disfunction
- sleepiness
- May be asymptomatic
- Visual disturbance
- Nausea and vomiting



Check here for our summary
Highly recommended !!!!!!

Sorry but if you will not check it راحت عليك المليون

MCQs:

Answers

For more question check our summary file!

1/C
2/A
3/C

1 main factor responsible for the Viscosity of blood is .... ?

A	Hematocrit values	B	WBC	C	RBC and plasma proteins (fibrinogen)	D	All

2 ....is a vasoconstrictor?

A	Angiotensin II	B	Atrial natriuretic	C	Histamine	D	Adenosine

3 ....is a vasodilator ?

A	Endothelin-1	B	Thromboxane A2	C	Nitric oxide (NO)	D	Norepinephrine

MCQs:

Answers

For more question check our summary file!

4/A
5/B
6/A

4 Radius is ____ proportional to flow

A	directly	B	indirectly	C	----	D	----

5 Heart rate is determined by ____

A	AV node	B	SA node	C	Purkinje fibers	D	His bundle

6 Cardiac output (CO) is directly proportional to Heart rate (HR) except in ____

A	High heart rate	B	Low heart rate	C	Normal heart rate	D	----

SAQ

what’s the normal arterial blood pressure range?

Answer:
90 – 120 mmHg systolic. 60 – 80 mmHg diastolic.

enumerate factors that affecting arterial BP?

Answer:
Slide 9

Explain the frank starling law

Answer:
slide 19

What is the bainbridge reflex

Answer:
slide 26

Finally you have arrived , we have been waiting for you !!

Meet our team !

Team leaders

Rimaz Alhammad
Noreen Almaraba
Rayan Alshehri
Omar Albaqami
Aljoharah Alyahya

Heroes of the lecture :

Abdulmohsen Alrahaimi
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Did you like the lecture ? we mean our work :)

Contact with us! physiology.444ksu@gmail.com