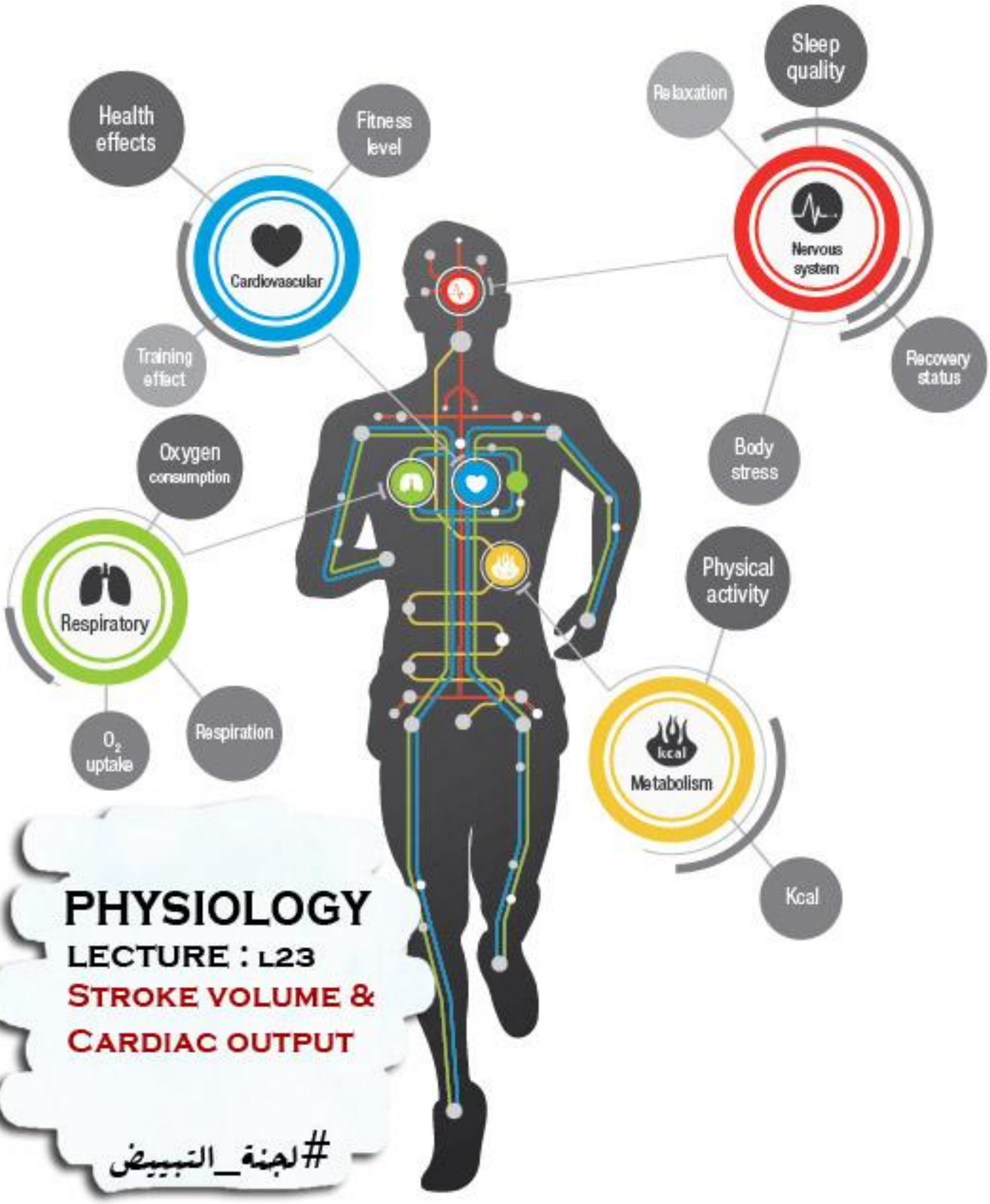


PHYSIOLOGY

LECTURE : L23

STROKE VOLUME & CARDIAC OUTPUT

#لجنة_التبييض

STROKE VOLUME & CARDIAC OUTPUT

- Remember that :

  The **stoke volume** (**SV**) = EDV – ESV .

  = input – output .

____

* We can imagine that we have a syringe :
- If we fill it with blood , (End diastolic volume "EDV") .
- If we pump it to get the blood out (systole) .
- we can calculate the remaining blood in syringe by **stroke volume** .

____

* Stroke volume is one of the main component of **frank-starling mechanism** …

____

* The myocardic muscle must do (stretching) to be sustainable the force of pumping of the blood .

stretching : The cross bridge between *actin*&*myosin* keep away from each other to allow another *actin* liked the bridge .

The summary of this mechanism :

1.The amount of blood in the **Right** side should properte with amount of blood in the **Left** side. 2. We should make sure that there is equality between input and output (in proportion to the work of the heart " relax, exercise " .

SLIDE :

Factors affecting SV

Exercise

- Prolonged aerobic exercise training may also increase stroke volume .
- Reduced heart rate prolongs ventricles end-diastolic volume .

Preload

- The degree to which the ventricles are stretched prior to contracting.
- An increase in the volume or speed of venous return will increase preload .

Afterload

- Commonly measured as the aortic pressure during systole .
- Not usually affecting stroke volume in healthy individuals .
- Increased afterload will hinder the ventricles in ejecting blood, causing reduced stroke volume.
- Increased afterload may be found in aortic stenosis and arterial hypertension.

* Factor affecting **SV** :

1. **Prelooad** : An increase in the venous return from the **Vena cava** to the **Right** side of thE **Atrium** will increase the **EDV** .

(**SV**) = **EDV** – **ESV** → So that :

► The decreasingof amount of blood from the venous part will decrease**SV** ....

The amount of blood↓⟶**EDV**↓⟶**SV**↓(related to the equation)⟶(directly)

2. **Afterload** :

* **ESV** ↑ ⟶→**SV** ↓ ⟶ **Afterload** . ⟶(indirectly)

► An increase of blood in the **Left** side of the heart **ESV** ↑ , **SV** ↓ .

____

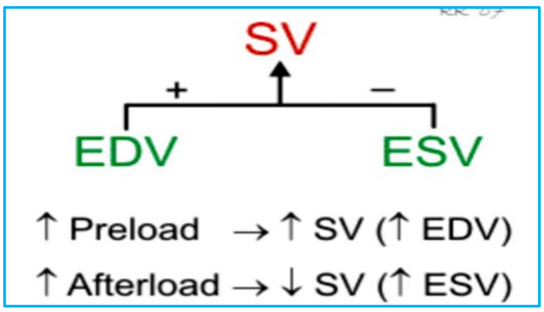
* Normally , venous return increases the blood volume into the Heart whenexercising.

As the normally exercising, the blood volume increase :

►venous return of blood ↑ **EDV**⟶↑ ⟶**SV**↑ .

Afterload there are NO increasing in the **ESV** at normal situations ((in contrast of the preload)) ⟶ If we have a kind of disease as (aortic stenosis) the blood will remain on the **Left** side of the Heart because of narrowing in the aortic valve ⟶**ESV** ↑ .

Or , if we have any kind of hypertension (for any reason) → **ESV** ↑⟶**SV**↓.



SLIDE :

Ventricular volumes

Stroke volume

- In a healthy 70-kg man, ESV is approximately 50 mL and EDV is approximately 120mL, giving a difference of 70 mL for the stroke volume.
  SV = EDV - ESV

Ejection fraction (EF)

- Volumetric fraction of blood ejected from a heart with each contraction (heartbeat).
- EF is widely used as a measure of the pumping efficiency of the heart and is used to classify heart failure types.
- The EF of the right heart, or right ventricular ejection fraction (RVEF), is a measure of the efficiency of pumping into the pulmonary circulation .
- The EF of the left heart (LVEF) is an indicator of the effectiveness of pumping into the systemic circulation .

$$EF(\%) = \frac{SV}{EDV} x100$$

* **Ejection fraction** (**EF**) :

- Eco cardio graph (Heart examination), then using ultra sound we can know exactly the amount of blood ⟶using this ratio of blood we can calculate the **EF** .

____

***Clinically**, the experts use echocardiogram to classify heart failure types. failure: the myocardium of the heart not able to pump enough blood which lead to decrease blood volume.

***Arrhythmia**: problems on muscle of the Heart , in the valves or in the electricity of the heart .

____

SLIDE : PART 1

Cardiac output

- Cardiac output (CO) *ml/min* = heart rate (HR) *beats/min* x stroke volume (SV) *ml/beat* .
- Volume of blood pumped/min. by each ventricle.

* **Cardiac output:** the pumping of the blood of the heart .
(Volume of blood pumped/minute)

► The amount of blood that the person need in relaxation **differ** of it in any environmental condition .

***Relaxation** ⟶ the cardiac output equal 5 liter per day .

*** According to the cardiac output equation:**

Co(*ml/min*)= **HR**(*beat/min*) x **SV**(*ml/beat*)

When :

▶HR ↑ ⟶ CO ↑ .

▶SV ↑ ⟶ CO ↑ .

▶HR ↑ ⟶ SV ↓ .

▶In the case of aortic stenosis : **ESV** ↑⟶ **SV**↓ ⟶ **CO**↓ .

SLIDE : PART 2

❖ Ohm's Law $$F = \frac{\Delta P}{R}$$

Where ▶ F = Cardiac output | R= Resistance |ΔP= difference in vascular pressure .

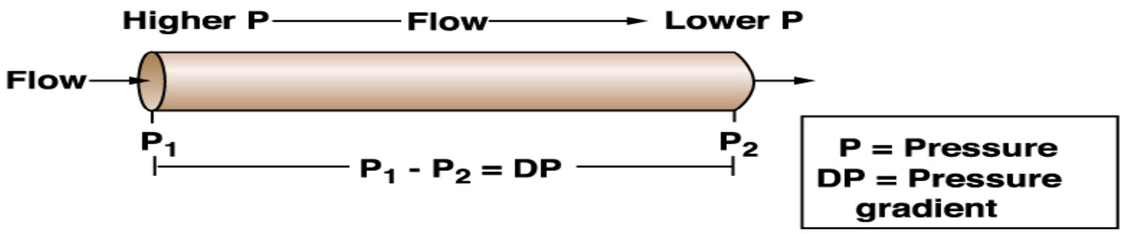
*** Resistances:**

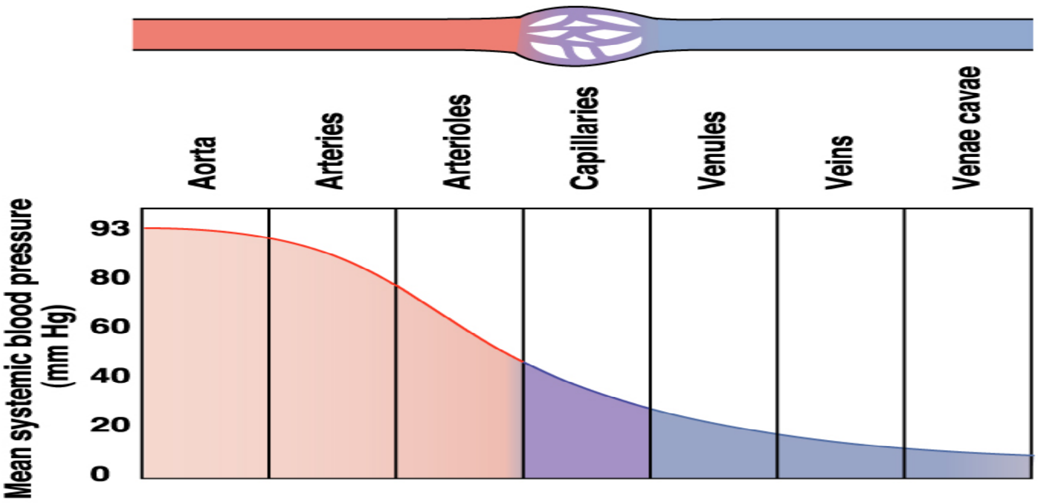
▶If the radius increase , the resistance decrease and vice versa ⟶ (Indirectly) .

▶If the radius increase , the Co increase ⟶ (Directly) .

SLIDE :

- Blood flows down a pressure gradient
- The absolute value of the pressure is not important to flow, but the difference in pressure (DP or gradient) is important to determining flow.





* The ***highest*** pressure is in the Aorta , and the ***lowest*** is in the vena cava .
So, if we calculate $\Delta\mathbf{P}$ it will be about 93 .
* The pressure in vena cava drops near to ZERO .

$$\Delta P = p1 - p2$$
$$= 93 - 0 = 0$$

____

When:
$\Delta\mathbf{P}$ ↑ ⟶ **CO ↑ .**
$\Delta\mathbf{P}$ ↑ ⟶ **R ↑ .**
R ↓ ⟶ Radius (r) ↑

* In the healthy status, if there are any change in the blood pressure *this is the stimulus* which stimulate **2** kind of receptors :

1. **Carotid artery**

(these two areas are sensitive to any change in pressure)

2. **Aortic artery**

____

*** Any stimulus ⟶ receptor ⟶ sensation ⟶ center** *(Medullary cardiovascular)*
*** Medulla (area in the hind brain): responsible of regulating the pressure in the *CNS* .**

____

SAMMARY :

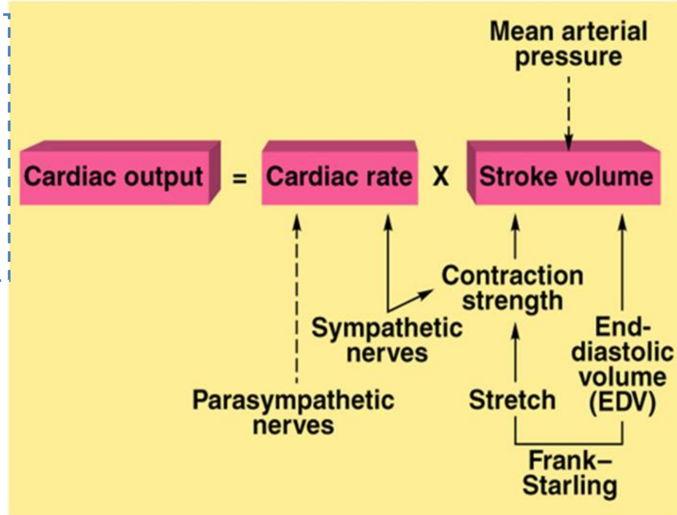
If $\Delta\mathbf{P}$ ↑ ⟶ **CO** ↑	If **r** ↓ ⟶ **R** ↑	If **HR** ↑ ⟶ **CO** ↑
If $\Delta\mathbf{P}$ ↑ ⟶ **R** ↑	If **r** ↑ ⟶ **CO** ↑	If **SV** ↑ ⟶ **CO** ↑
If **R** ↑ ⟶ **CO** ↓		If **HR** ↑ ⟶ **SV** ↓

CO (F) : Cardiac output | P : Pressure | R : Resistance | HR : Heart rate | SV : Stroke volume | r : Radius of blood vessels .

SLIDE :

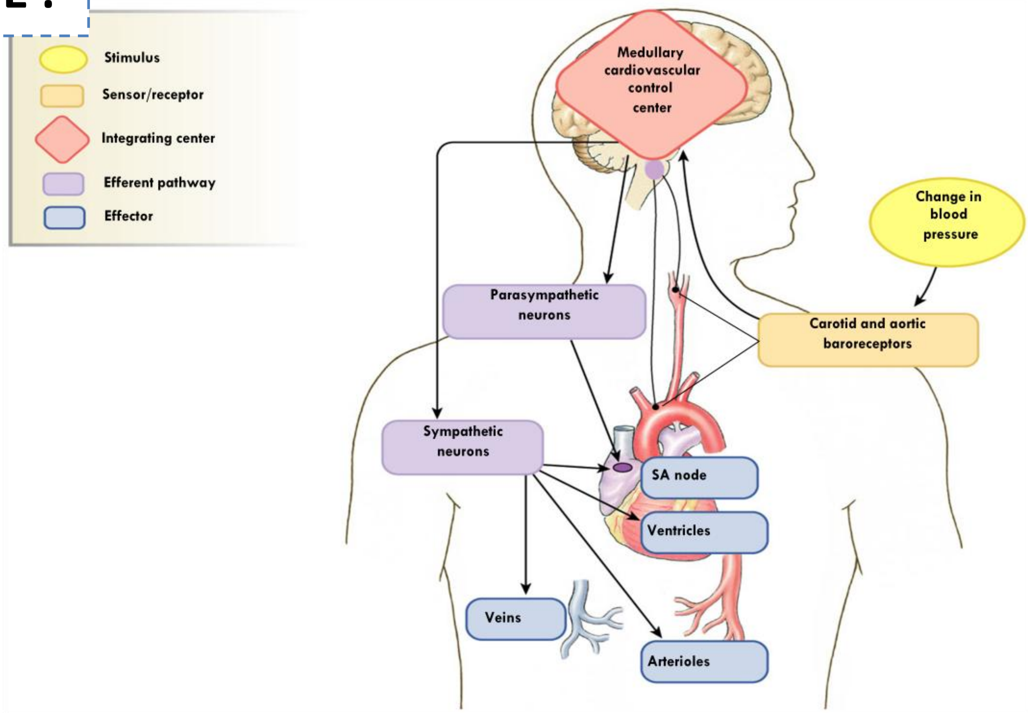
NOTE: Effect of the sympathetic on the cardiac out put increasing effect of the parasympathetic on the CO decreasing .

Regulation of cardiac output



Frank-Starling Mechanism

SLIDE :



MCQ :

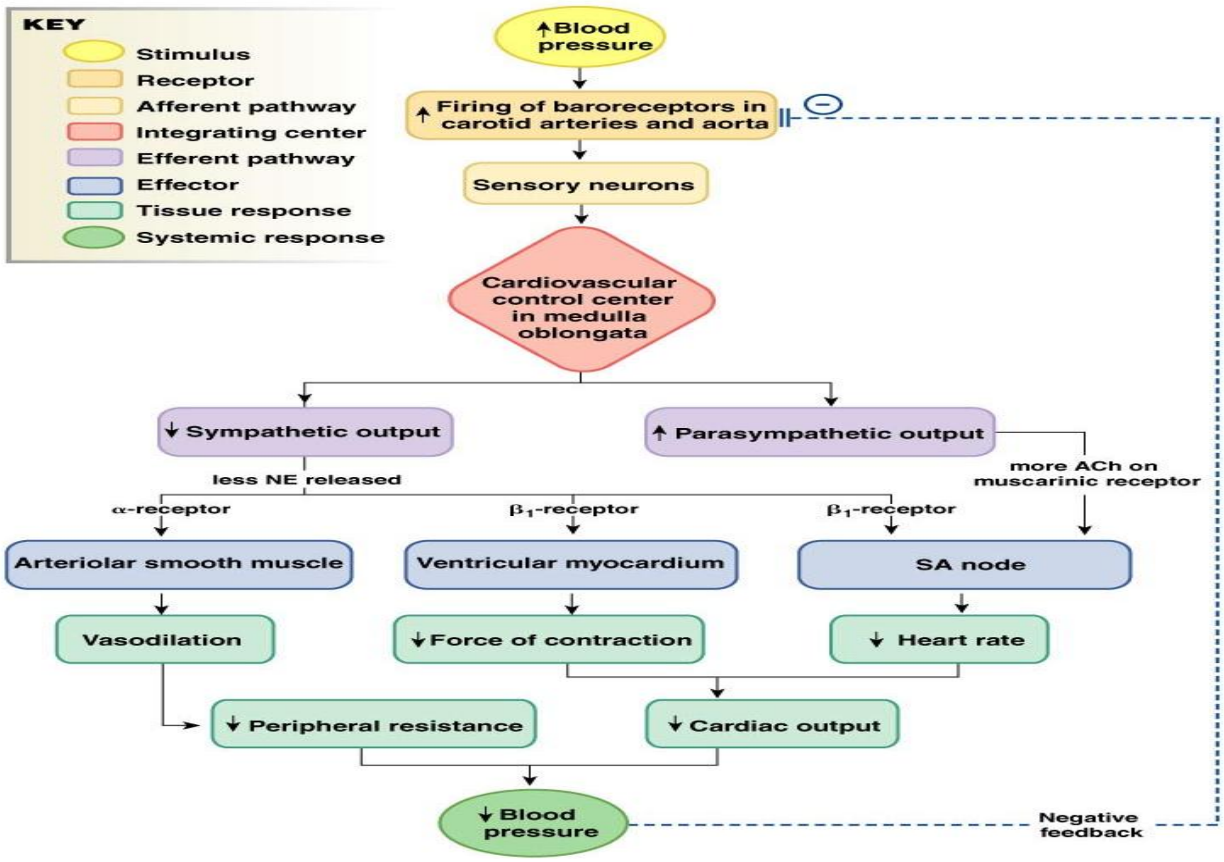
the systematic changes due to decreases the blood arterial blood , all of these correct except:

1. vasodilatation by sympathetic output.
2. decrease the force of contraction by sympathetic output.
3. decrease the heart rate by sympathetic output.
4. decrease the force of contraction by parasympathetic output ✔

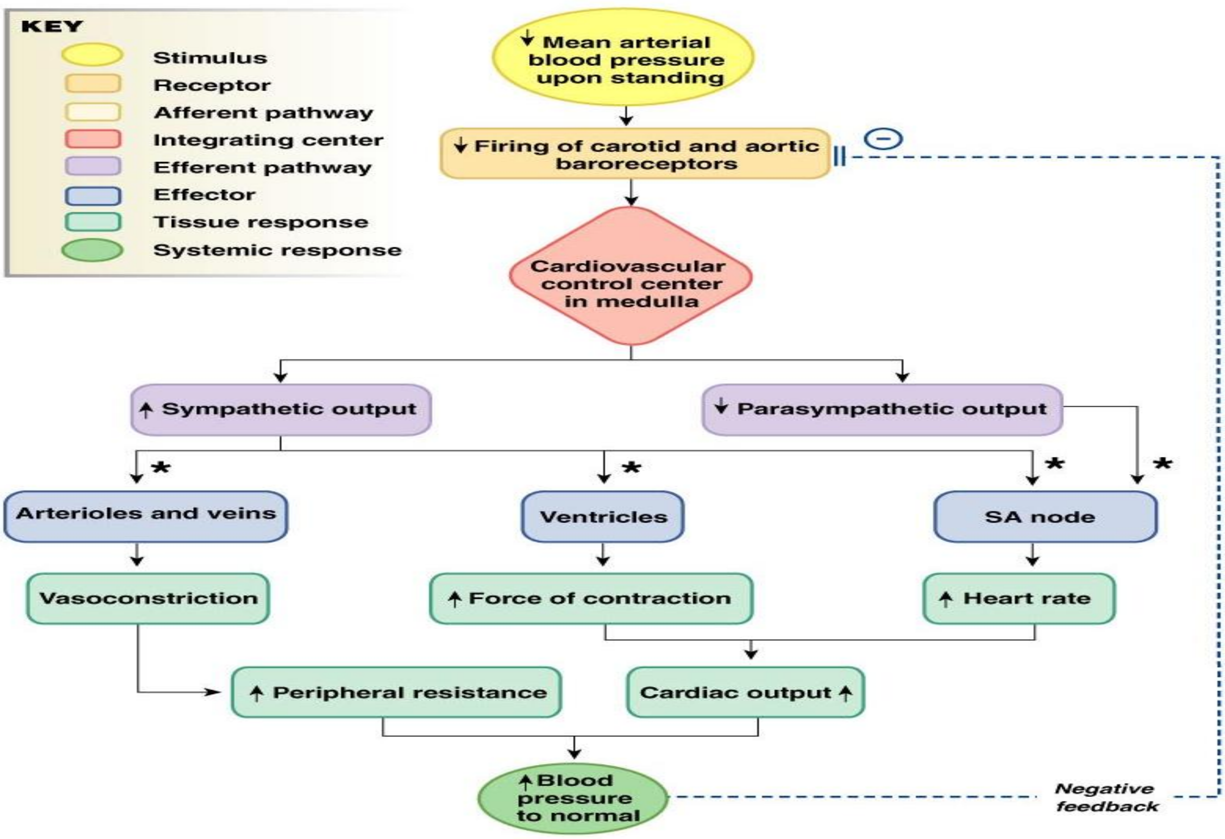
Reason : parasympathetic output doesn't have a receptor in the ventricle

note: in decreasing or increasing the cardic output, autonomic output (sympathetic and parasympathetic) work in it. الا اذا خصصت بالسؤال ، زي السؤال اللي فوق

SLIDE :



SLIDE :



- كان معكم زملائكم : Rand Bumadian , Reef ALQaissi , Laith Najada & Monther Qatawneh

#لجنة_التبييض