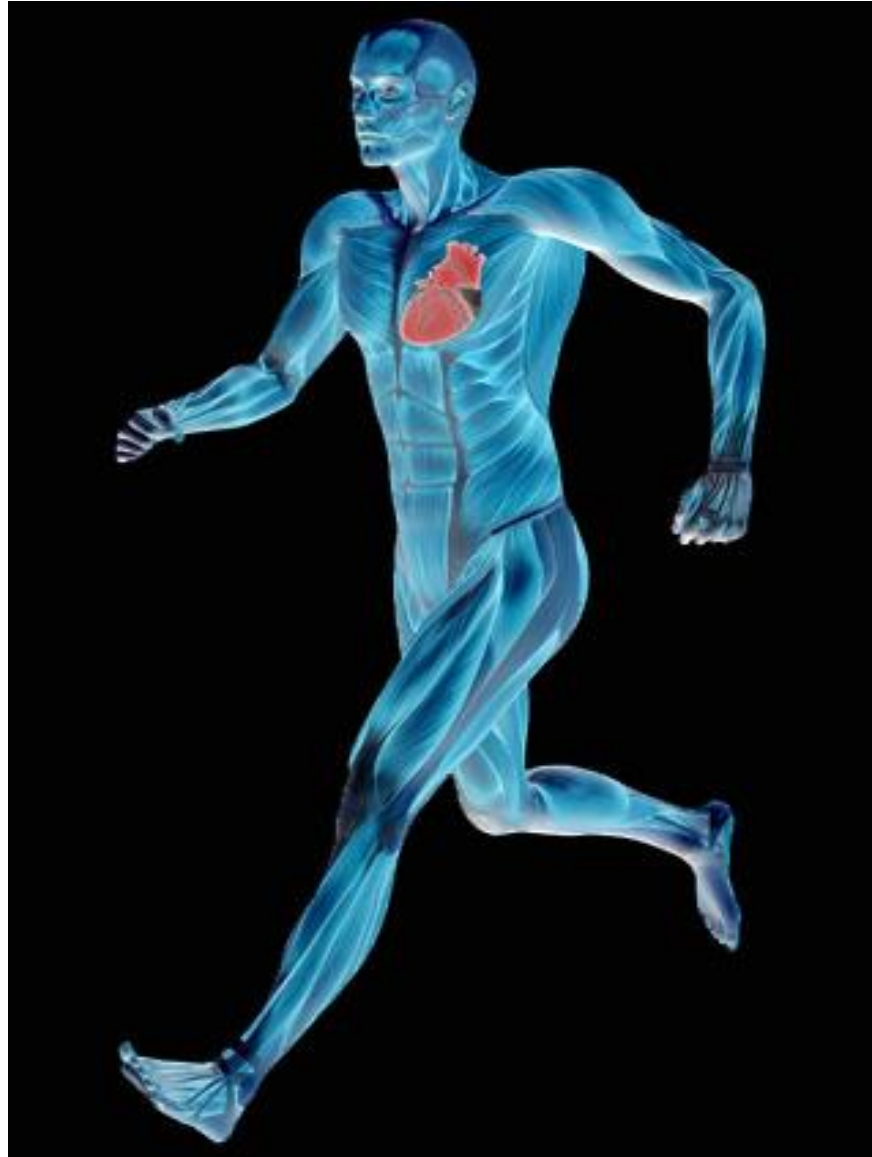


RESPONSES TO EXERCISE IN THE HEART



CARDIAC OUTPUT (Q)

- CARDIAC OUTPUT (Q) – THE VOLUME OF BLOOD THAT IS PUMPED OUT OF THE LEFT VENTRICLE IN 1 MINUTE
 - MEASURED IN L/MIN
 - TYPICAL PERSON = 5-6L/MIN
 - DURING HEAVY EXERCISE = AROUND 30L/MIN
- TWO OTHER FACTORS THAT CONTRIBUTE TO CARDIAC OUTPUT (Q) ARE STROKE VOLUME AND HEART RATE

1. **Cardiac output** – the volume of blood pumped from each ventricle per minute:

$$\mathbf{CO} = \mathbf{SV} \times \mathbf{HR}$$

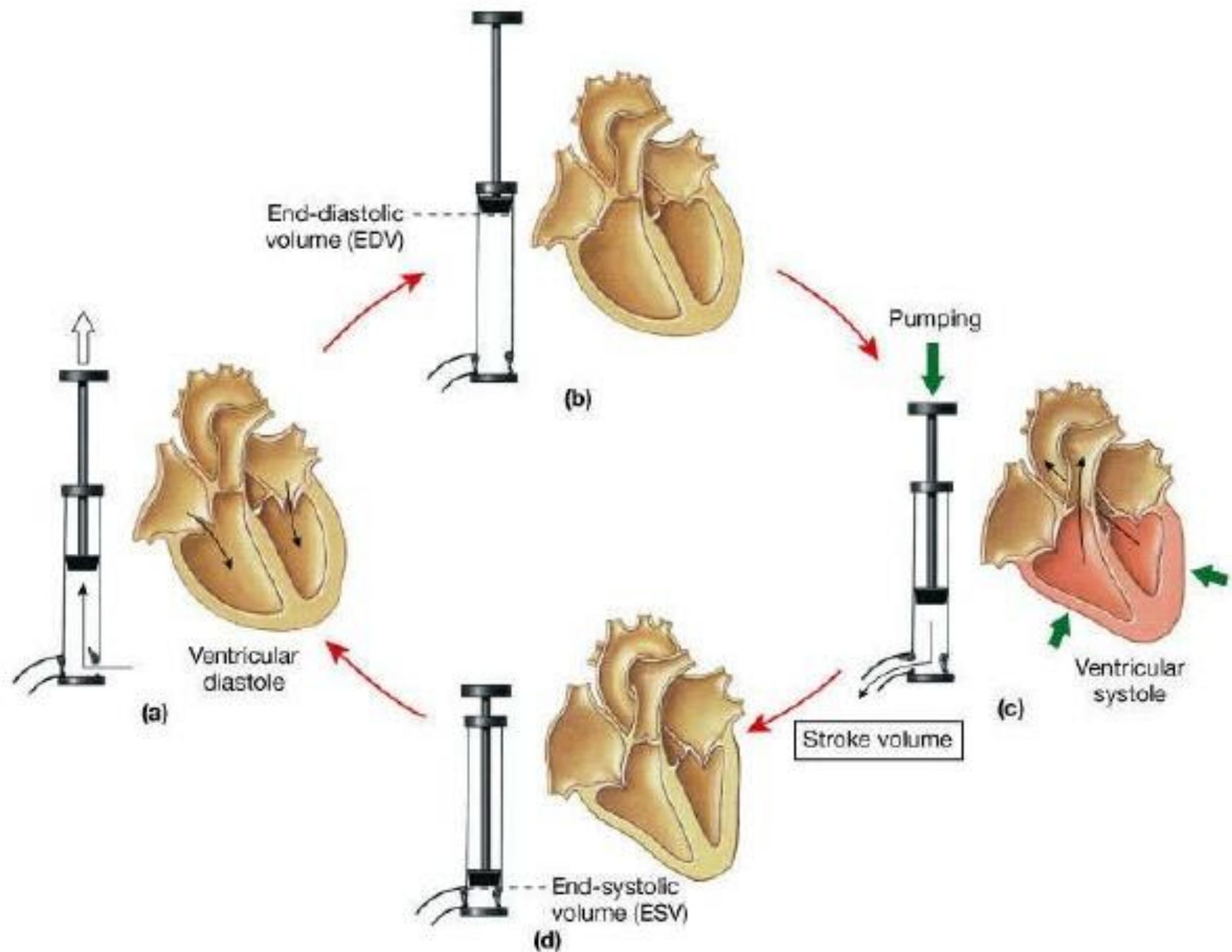
$$\begin{array}{l} \text{cardiac output} = \text{stroke volume} \times \text{heart rate} \\ \text{(ml/minute)} \quad \quad \quad \text{(ml/beat)} \quad \quad \quad \text{(beats/min)} \end{array}$$

- a. Average heart rate = 70 bpm
- b. Average stroke volume = 70–80 ml/beat
- c. Average cardiac output = 5,500 ml/minute

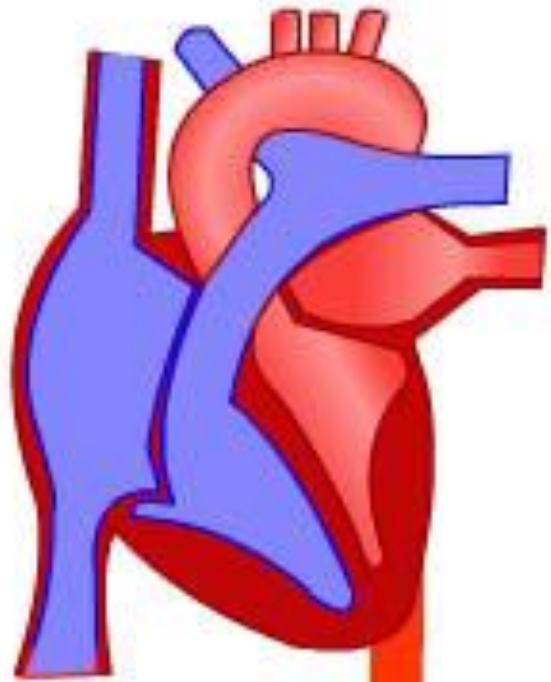
STROKE VOLUME

- AMOUNT OF BLOOD THAT IS EJECTED FROM THE LEFT VENTRICLE IN A SINGLE BEAT
- MEASURED IN MILLILITRES

A Simple Model of Stroke Volume



$$SV = \frac{\text{Cardiac Output}}{\text{Heart Rate}}$$



Stroke Volume



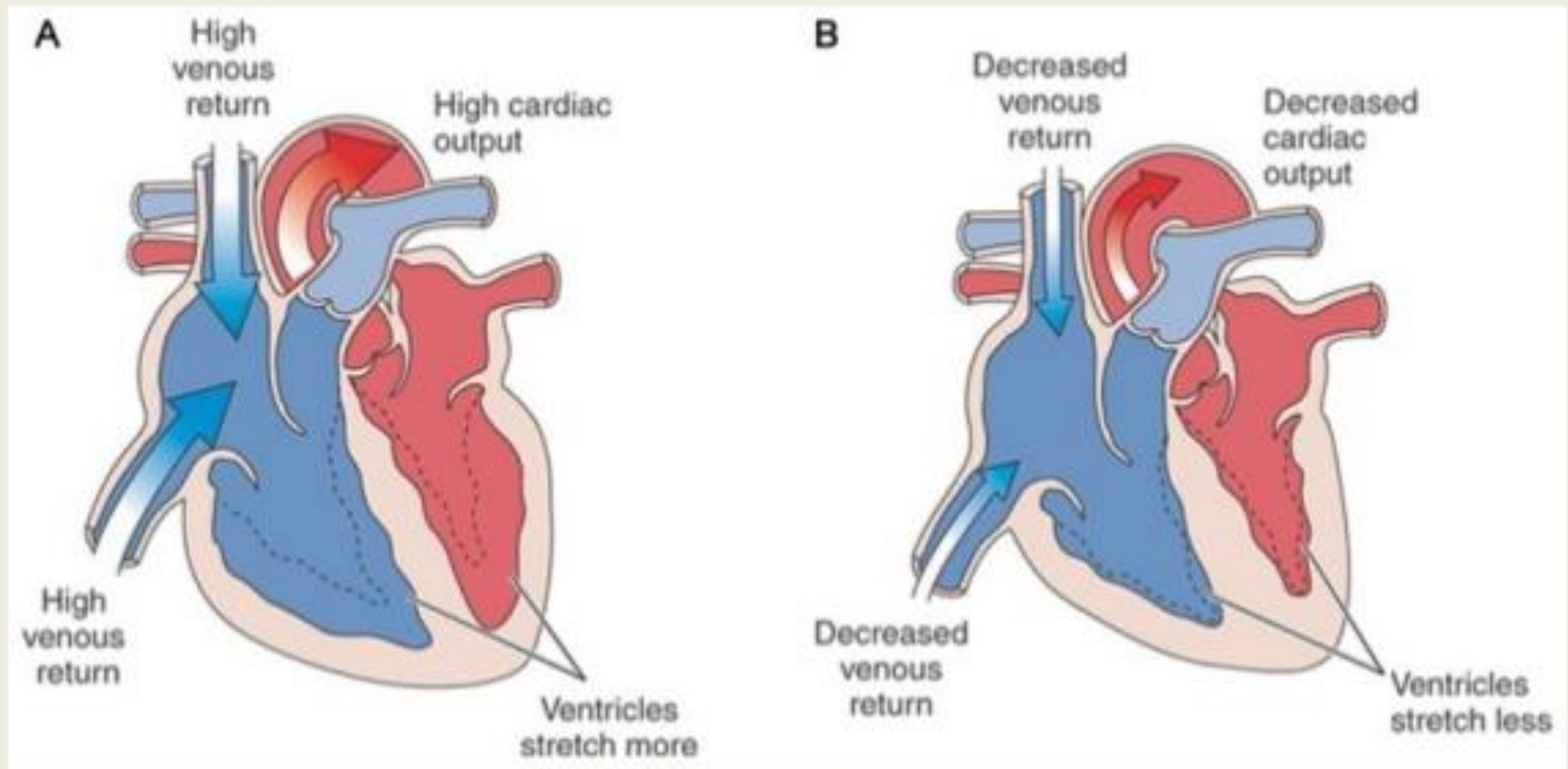
To increase cardiac output

Increase stroke volume
or

Increase heart rate
or
increase both

How to Change Stroke Volume

Starling's law of the heart: What goes in, comes out



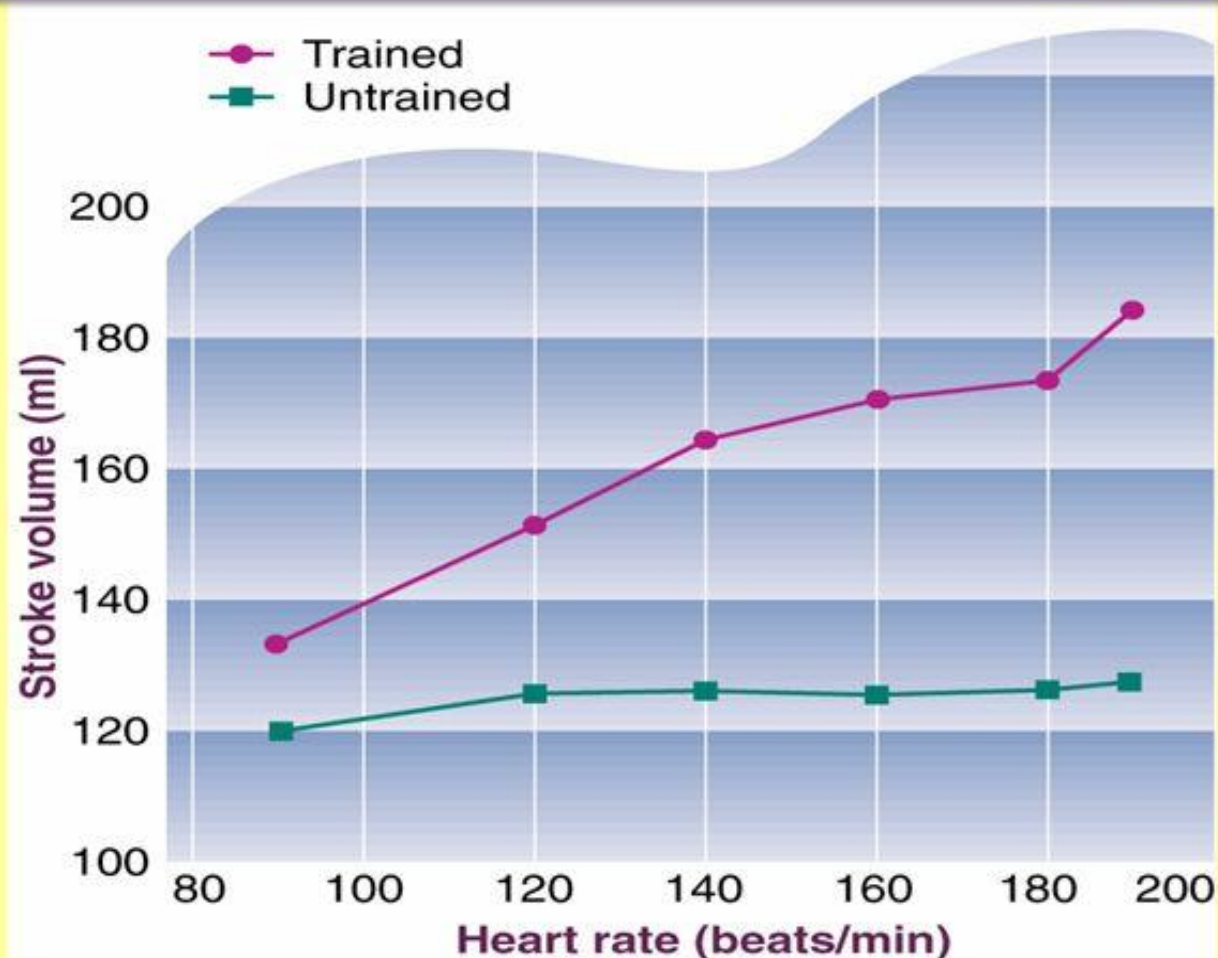
STROKE VOLUME

- SV IS CALCULATED BY SUBTRACTING THE LEFT VENTRICULAR END-SYSTOLIC VOLUME (LVESV) FROM THE LEFT VENTRICULAR END-DIASTOLIC VOLUME (LVEDV)
- $SV(ML) = LVEDV(ML) - LVESV(ML)$

WHAT'S THE DIFFERENCE IN SV
BETWEEN TRAINED AND UNTRAINED
INDIVIDUALS?

Stroke Volume Trained Vs Untrained

- **Trained individuals** have a larger SV than untrained as you can see from the graph!



HEART RATE

- NUMBER OF TIMES THE HEART CONTRACTS IN A MINUTE
 - BEATS PER MINUTE
- CARDIAC OUTPUT CAN BE CALCULATED AS THE PRODUCT OF STROKE VOLUME AND HEART RATE:
 - $Q = SV \times HR$



EFFECTS OF TRAINING

- MOST INFLUENTIAL CHANGES WITH AEROBIC TRAINING ARE ALTERATIONS IN THE STRUCTURE OF THE HEART
- INCREASES IN MASS AND DIMENSIONS OF THE HEART ARE OBSERVED
- SPECIFICALLY: VENTRICULAR VOLUME AND THICKNESS OF VENTRICLE WALLS

OTHER EFFECTS

- INCREASE IN # OF CAPILLARIES
 - DUE TO INCREASED OXYGEN DEMAND
- INCREASE IN VOLUME OF BLOOD
 - DUE TO INCREASED OXYGEN DEMAND
 - IF TRAINING STOPS, VOLUME WILL RETURN TO PRE-TRAINING LEVEL
- BRADYCARDIA – LOWER HR (60 BPM OR LESS AT REST)
- TACHYCARDIA – HR OF 100 BPM OR HIGHER AT REST

CARDIOVASCULAR DISEASE

- ATHEROSCLEROSIS – GRADUAL NARROWING OF THE CORONARY ARTERIES
 - DUE TO ACCUMULATION OF HARD DEPOSITS OF CHOLESTEROL ON THE LINING OF THE VESSELS
 - IF VESSEL BECOMES BLOCKED OR PARTLY BLOCKED MYOCARDIAL INFARCTION (HEART ATTACK) WOULD OCCUR
- RISK FACTORS: SMOKING, HIGH BLOOD PRESSURE, FAMILY HISTORY, LACK OF PHYSICAL ACTIVITY