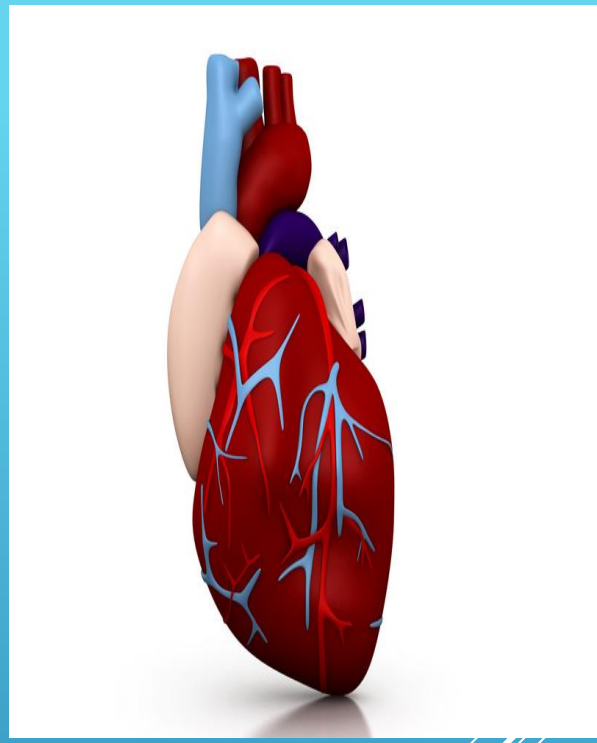
CARDIOVASCULAR SYSTEM & EXERCISE

Dr/ Rehab F. Gwada

OBJECTIVES OF LECTURE

- Identify components & important functions of the cardiovascular system.
- Outline classification of blood pressure and factors affect it.
- Describes the BP response during exercise .
- Detect the factors that regulate HR.
- Compare average values of cardiac out put during rest & exercise for an endurance trained athletes and a sedentary person.
- Identify Cardiac Output Distribution during rest and exercise .



COMPONENTS OF CARDIOVASCULAR SYSTEM

- Heart- circulates blood through vessels
- Blood vessels
  - Arteries ➡ conduct oxygen –rich blood to tissue
  - Veins ➡ conduct deoxygenated blood towards heart
  - -Capillaries-site of exchange

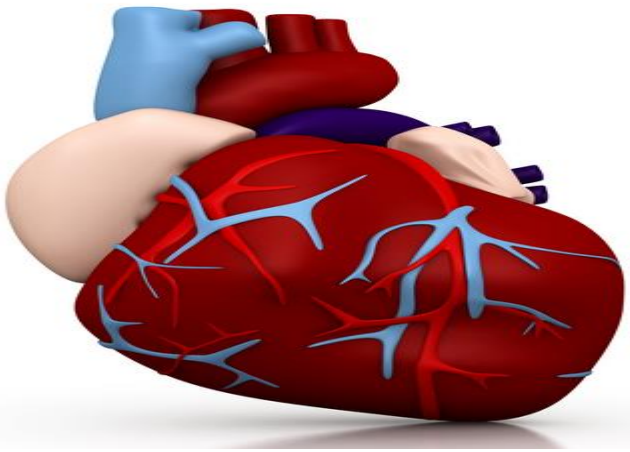
Blood- transport medium

- which work together to supply the body tissues with nourishment and collect waste materials.

Heart →arteries →arterioles

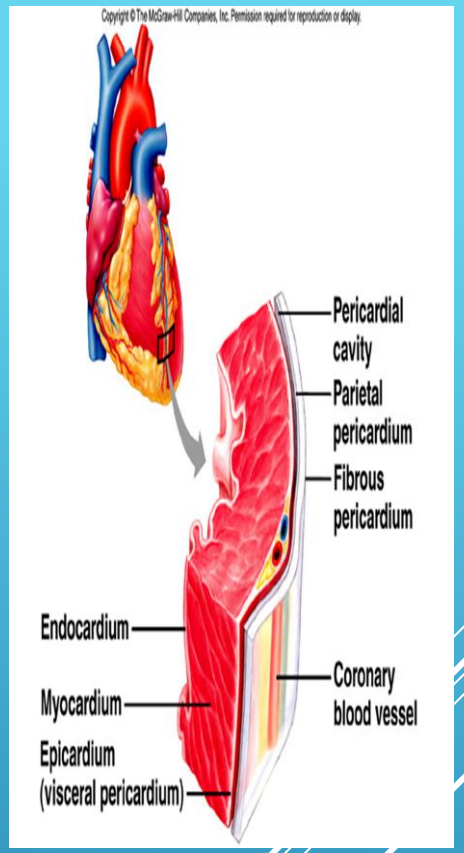
↑ ↓

Veins ←venules ←capillaries



2-STRUCTURE OF THE HEART

1- COVERINGS OF THE HEART

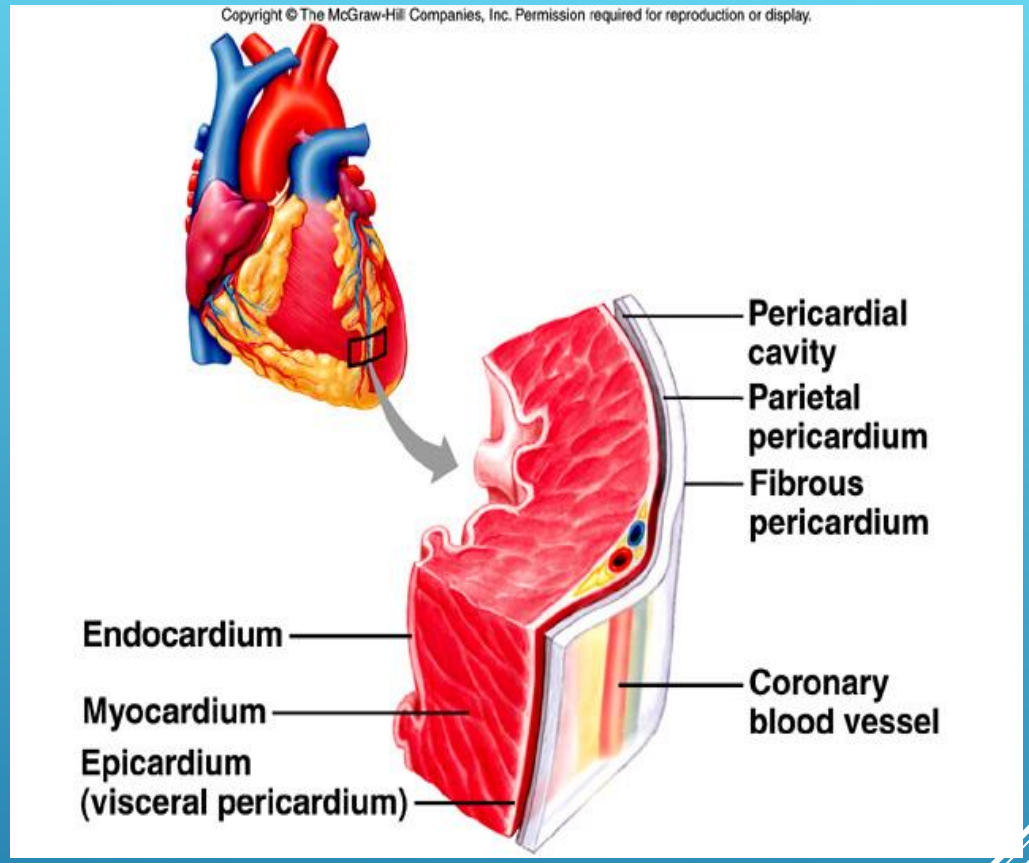


- Pericardium-loose fitting, double layered sac
  - Visceral pericardium-
  - Parietal pericardium-

  Pericardial fluid- in-between which prevents friction as the heart beats.

2-LAYERS OF HEART TISSUE

- Endocardium (inner lining)
- Myocardium (middle layer)
- Epicardium (protective, outer layer)

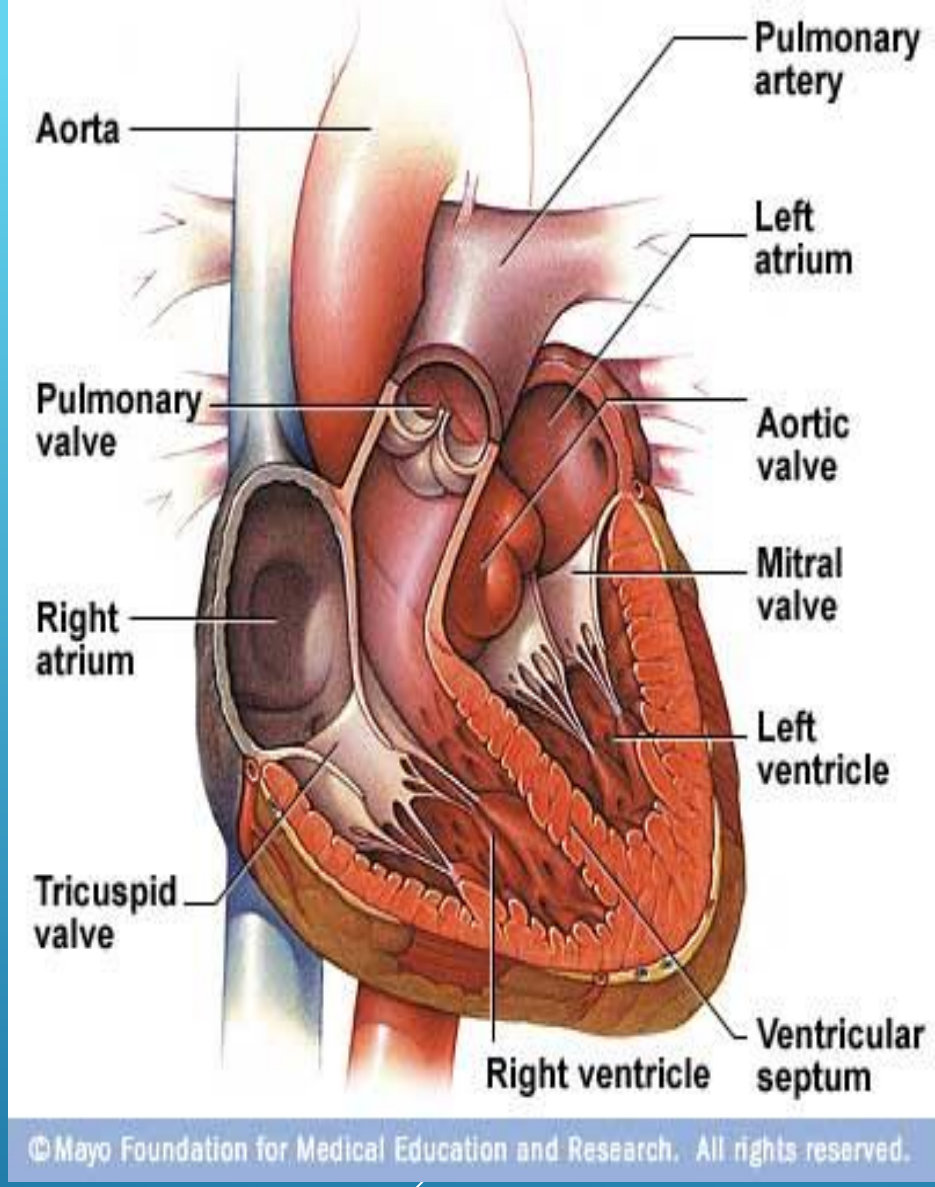


- The heart consists of 4 chambers –
  - Two atria (right & left)
  - Two ventricles (right & left)
- The chambers are separated by fibromuscular septum.

Two types of valves in heart

- **Atrio-ventricular valves (AV) (mitral and tricuspid)**
- **Semi-lunar valves (pulmonary and aortic valves)**
- **<u>Functions:</u>**

- **Valves control flow of blood from one chamber to another.**
- **Prevent backflow.**



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3-CHAMBERS& VALVES OF THE HEART

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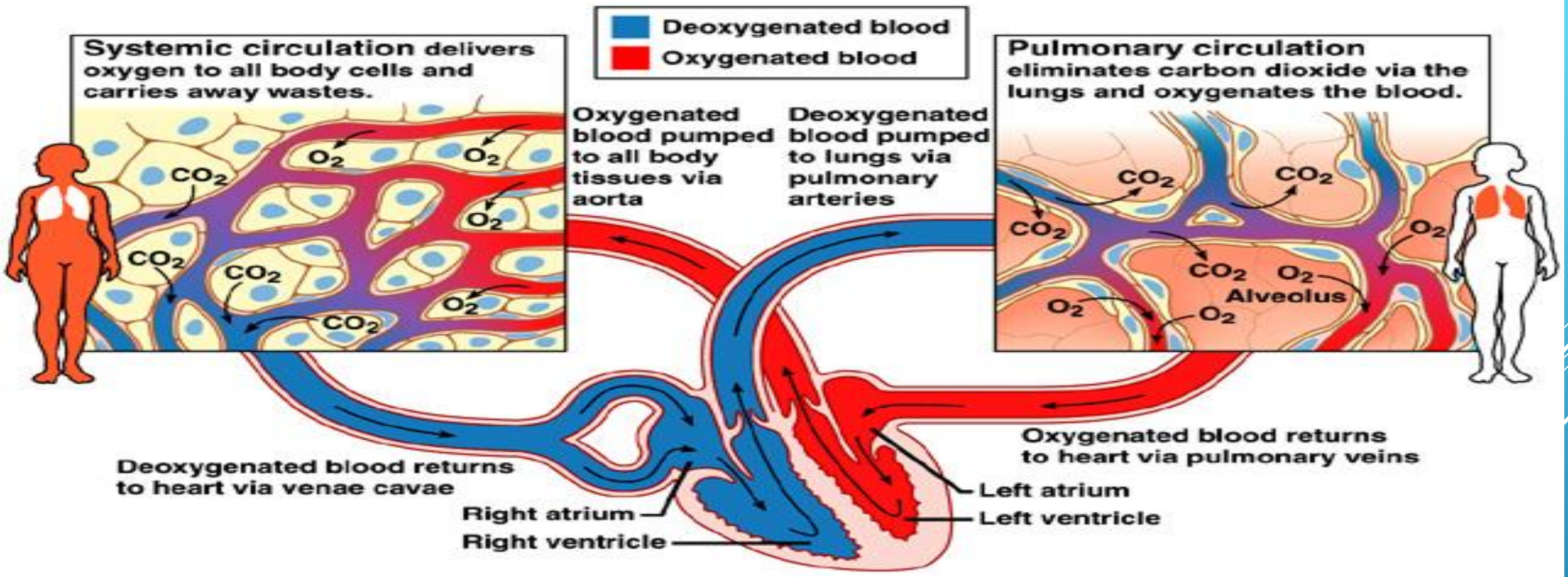


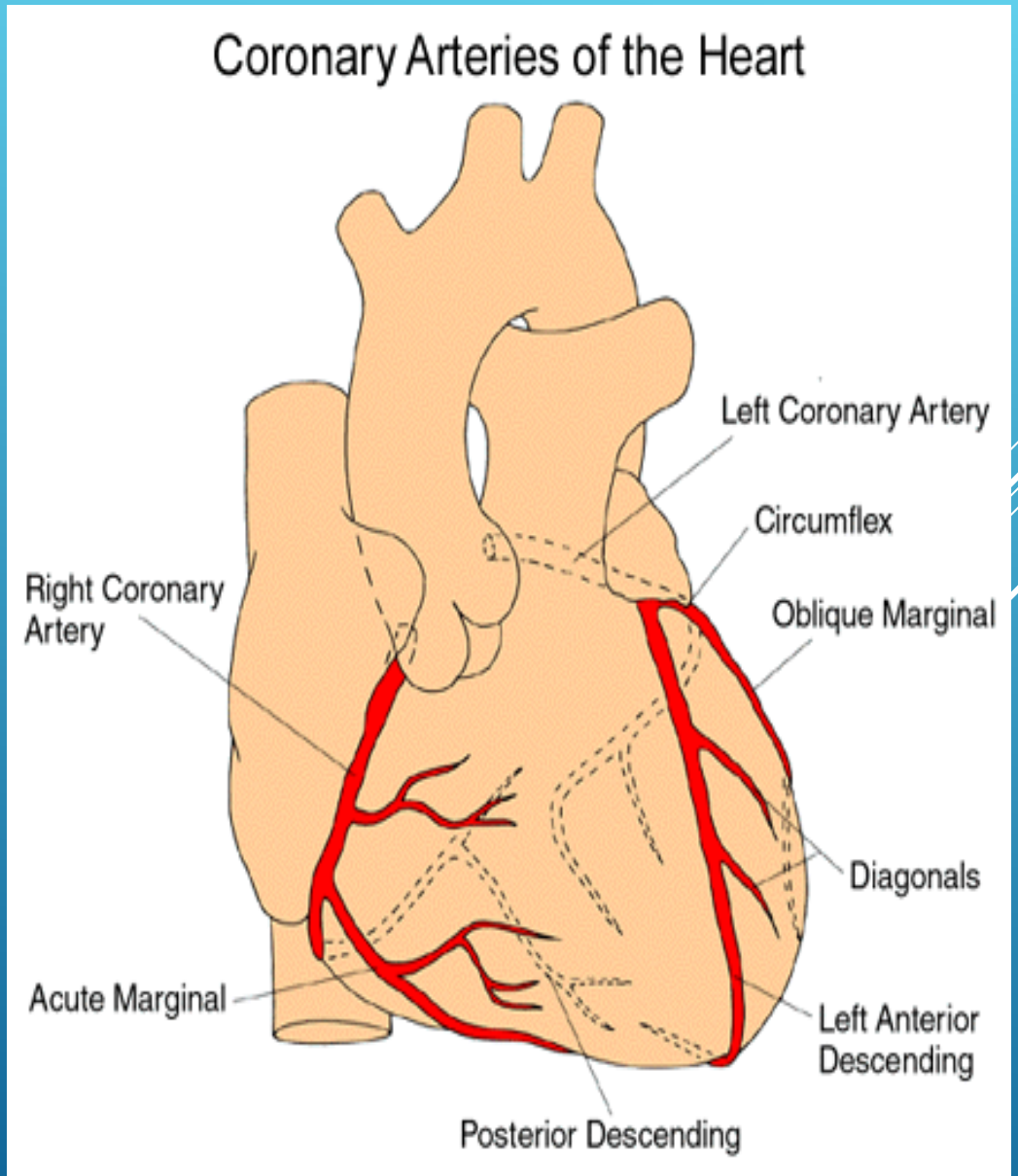
THE HEART IS A DOUBLE PUMP

BLOOD SUPPLY TO THE HEART

- provide by the right (RCA) & left (LCA) coronary arteries which arise from the base of the aorta.

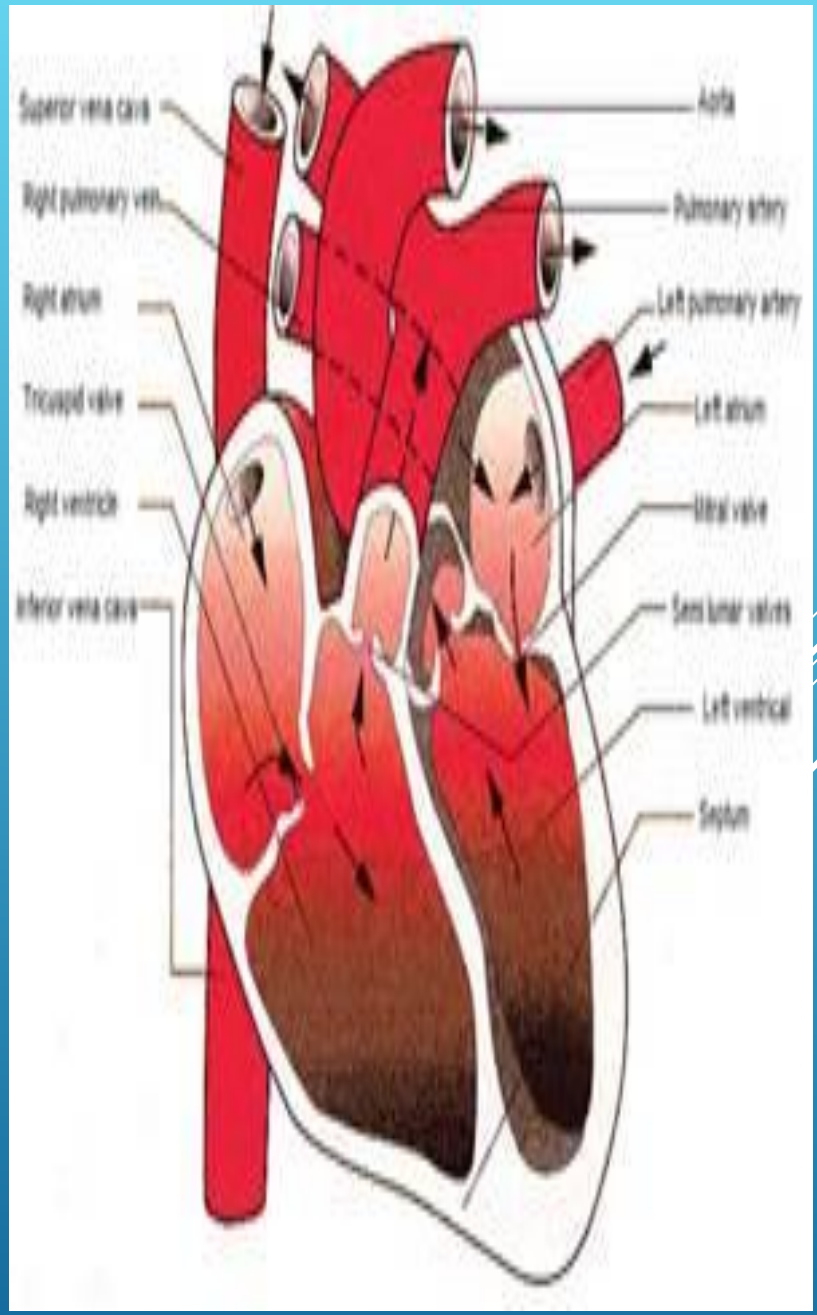
Innervation of Heart

Autonomic nervous system



MAIN FUNCTIONS OF THE HEART

- **Functions of right sides heart chambers :**
- Received deoxygenated blood from body
- Pump the blood to the lungs for aerations via pulmonary circulations
- **Functions of left sides heart chambers**
- Received oxygenated blood from lung
- Pump the blood into aorta for distribution throughout body via the systemic circulations

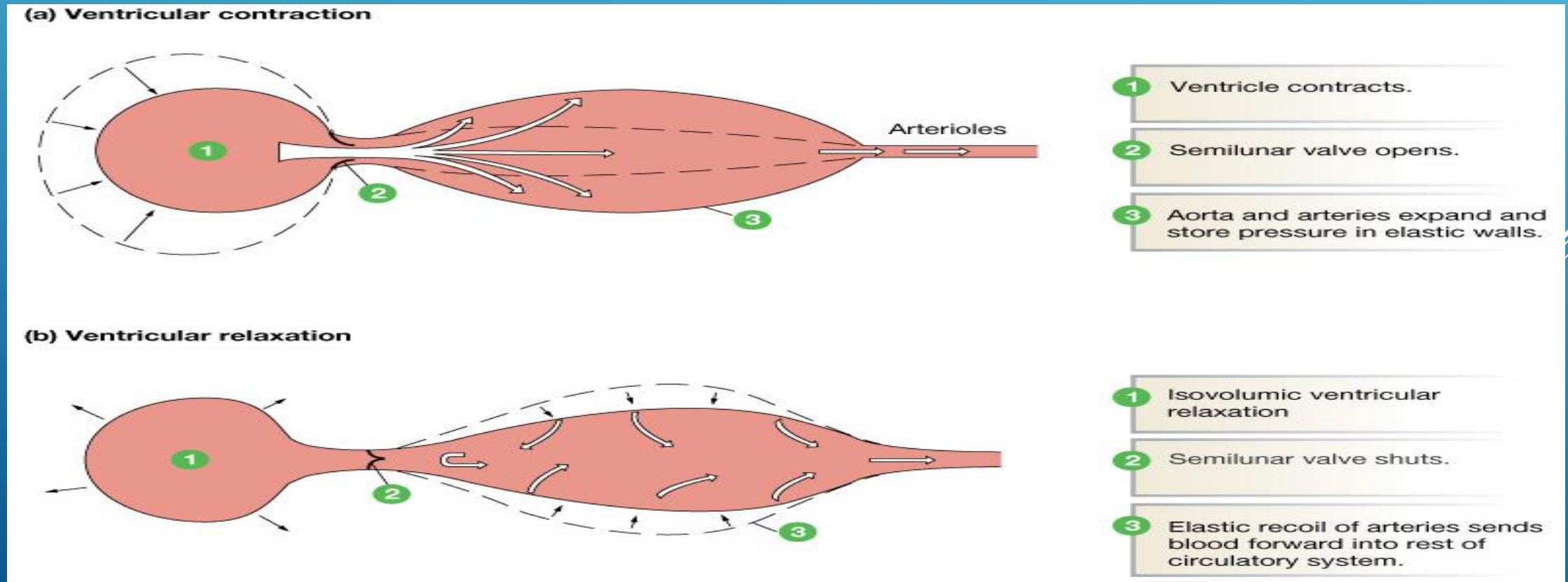


- Delivers oxygen to active tissues
- Aerates blood returned to the lungs
- Transports heat, a byproduct of cellular metabolism , from the body core to the skin
- Delivers fuel nutrients to active tissues
- Transport hormones

CIRCULATORY SYSTEM FUNCTIONS DURING PHYSICAL ACTIVITY

Blood pressure:

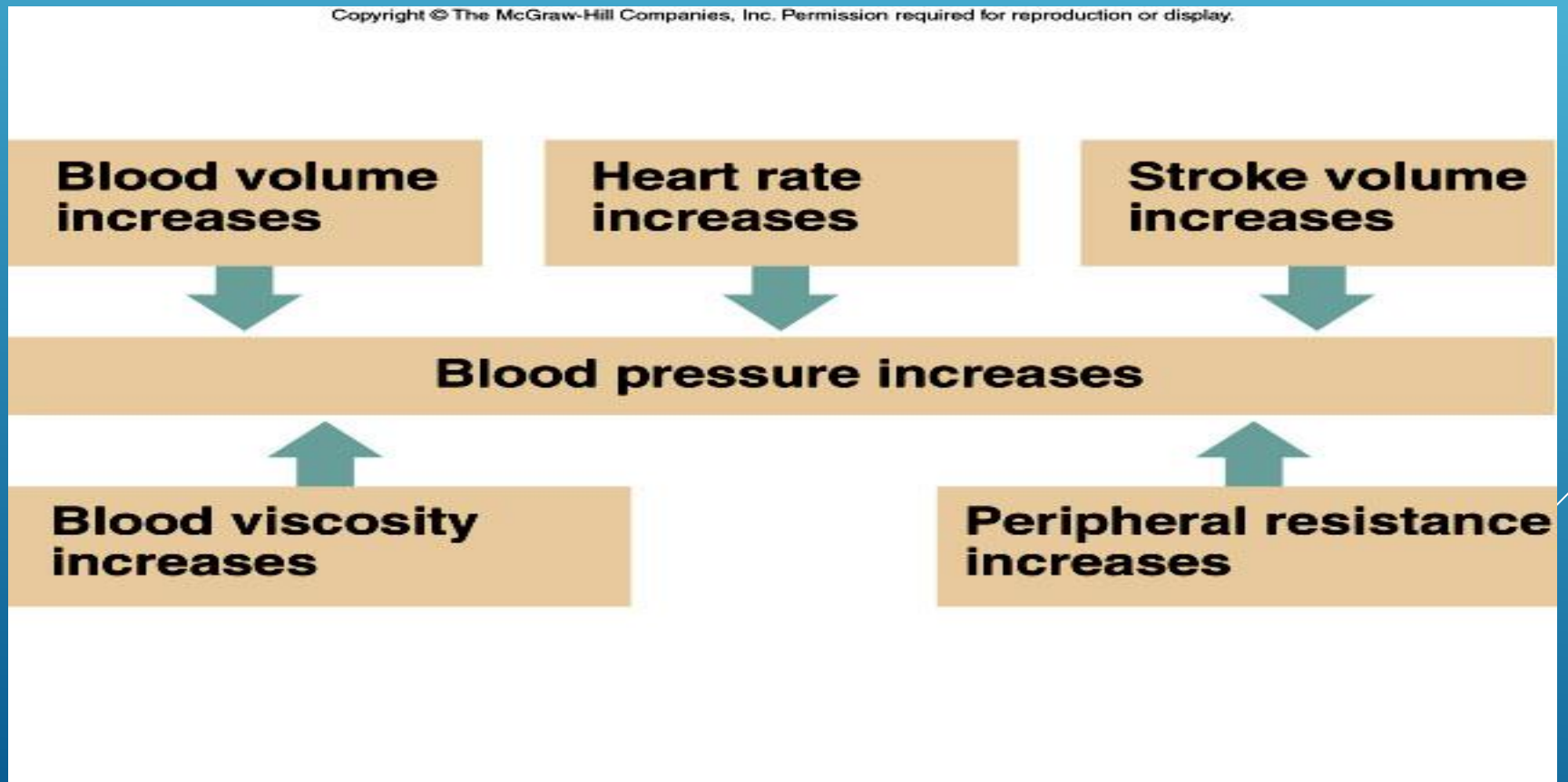
- the force that is exerted by blood against blood vessel walls
- Generated by Ventricular Contraction .
- AT Rest: Systolic over diastolic- About 120/80 mmHg
- pulse pressure is the difference between the two
- Measured by Sphygmomanometer



BLOOD PRESSURE CLASSIFICATION FOR ADULTS

BP classification	SPB	DBP
Hypotension	<90	<60
Normal	<120	<80
Prehypertension	120-139	80-89
Hypertension (stage 1)	140-159	90-99
Hypertension (stage2)	>160	>100

- Hypertension :-
- Hypertension imposes a chronic stress on cardiovascular functions . Regular aerobic training reduces systolic and diastolic pressures during rest & submaximal ex.



BP DURING EXERCISE

- During graded exercise, SBP increase in proportional to oxygen uptake & cardiac out put(COP= ST. x HR).
- But DBP unchanged or slightly decrease at the higher ex. level

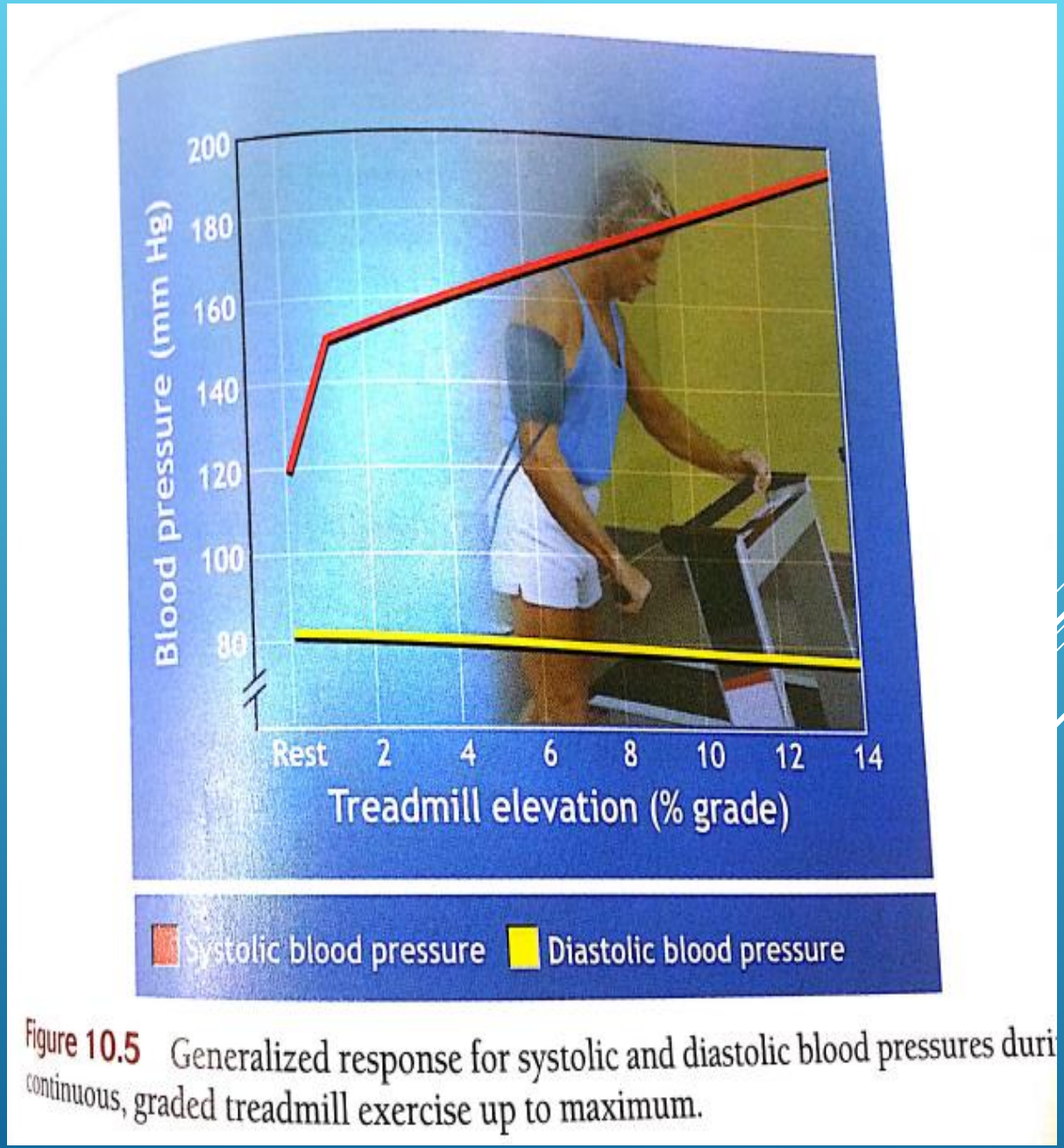


Figure 10.5 Generalized response for systolic and diastolic blood pressures duri
continuous, graded treadmill exercise up to maximum.

BP& RESISTANCE EX.

- Heavy resistance training increase SBP & DBP dramatically
- Because muscular force compresses peripheral arterioles increase resistance to blood flow
- Increase risk for hypertensive & coronary heart disease due to increase heart workload
- Individuals who regular engage in resistant training show less dramatically increase in BP
- The same relative ex. Intensity (aerobic ex.)produce large BP response with upper body compared with lower body ex.

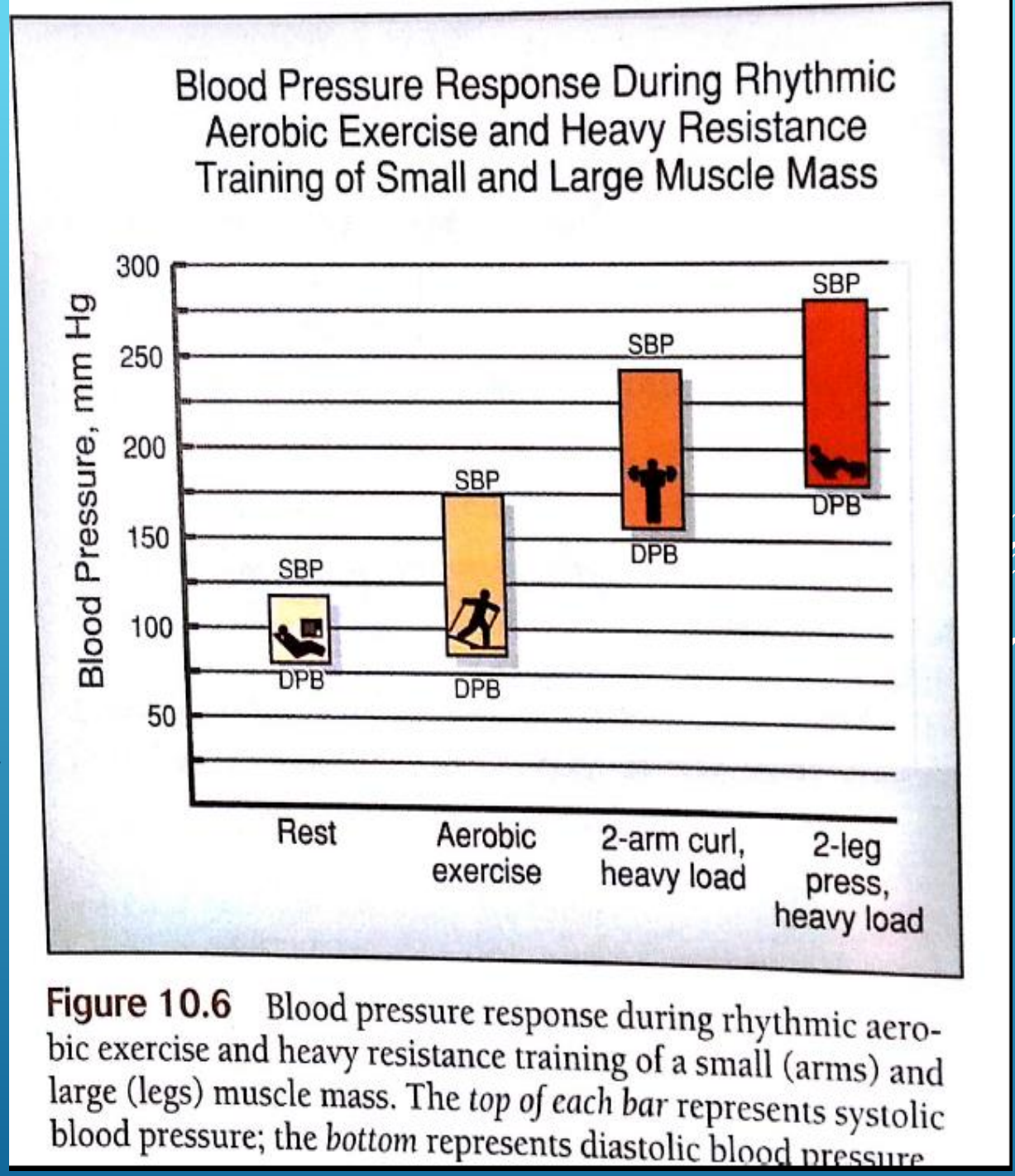


Figure 10.6 Blood pressure response during rhythmic aerobic exercise and heavy resistance training of a small (arms) and large (legs) muscle mass. The *top of each bar* represents systolic blood pressure; the *bottom* represents diastolic blood pressure

PB DURING RECOVERY

- During recovery from light & moderate ex. , PB decreases below pre-exercise levels called hypotensive response and remain lower for up to 12 hours in normal and hypertensive subjects.
- That is due to pooling of blood → reduce central blood volume → decrease in blood presssure

HEART RATE

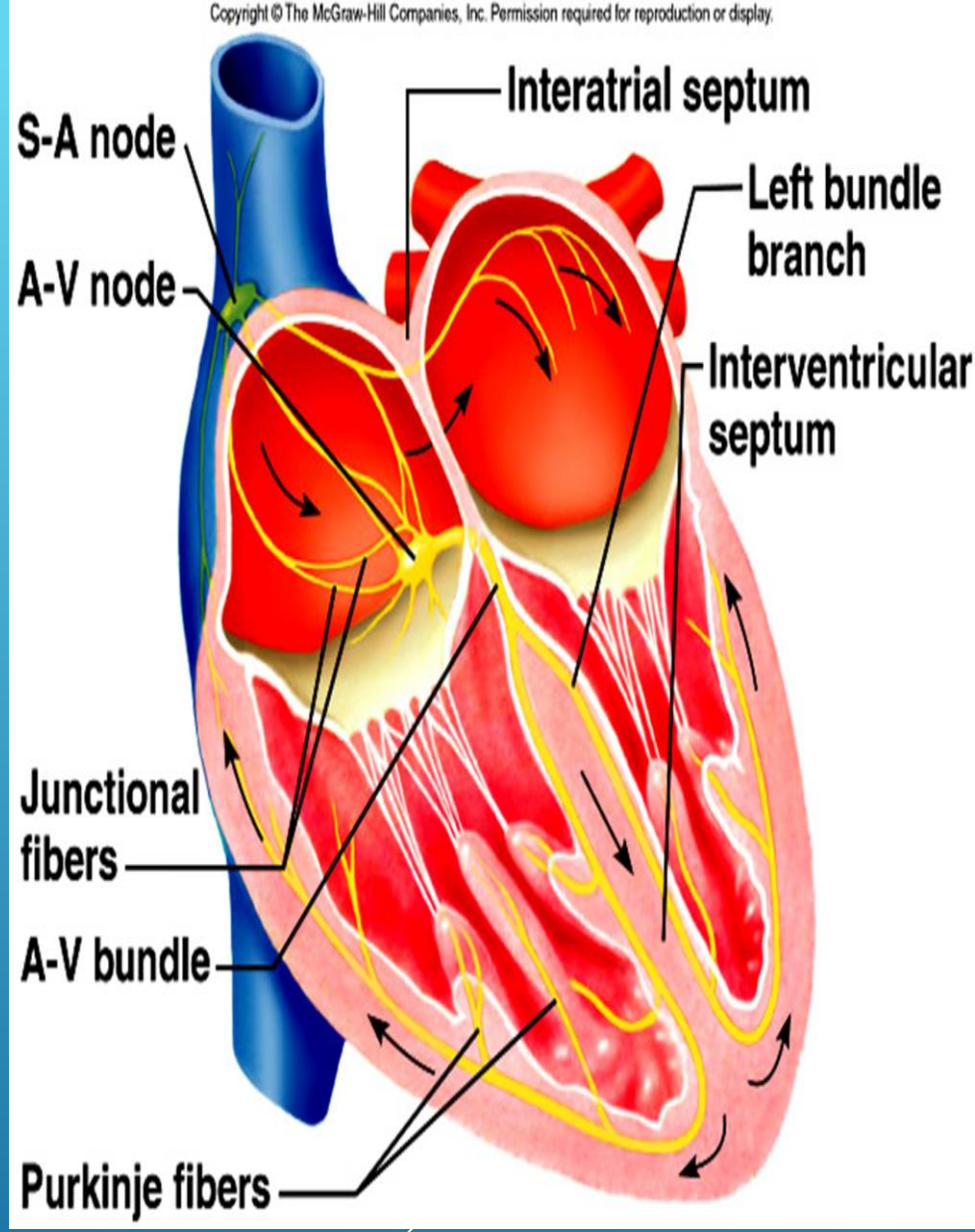
- **Heart rate** is the frequency of myocardium contraction, for one minute.
- measured as beats per minute.
- Heart rate has a direct relationship with cardiac output. An increase in heart rate will increase cardiac output.
- During exercise, heart rate is often measured as beats per 10 seconds then multiplied by 6 .
- Carotid artery palpation accurately measured HR during & immediately after ex. But don't apply excessive pressure that reflex slow HR.

RESTING HEART RATE

- The average heart rate when we are at rest is **60-80 BPM**
- Your resting heart rate can be a sign of fitness. People with high cardiovascular fitness have **lower resting heart rates** as the body is **more efficient** at transporting the blood around the body.

HEART RATE REGULATIONS

- Intrinsic Regulation
- Heart rate is initiated at the Sinoatrial (SA) Node, located in the right atrium (pacemaker). The unique property of the SA node is spontaneous depolarization. As the depolarization spreads through the myocardium, the heart beat is initiated
- SA node → atria → AV node → AV bundle Purkinje fibers → ventricles



HEART RATE REGULATIONS

Extrinsic Regulation

the SA node is influenced by the autonomic nervous system, both sympathetic and parasympathetic.

- **Sympathetic innervation is mediated through the neurotransmitter nor epinephrine**
- Speeds up heart rate and increases force of contraction
- **Parasympathetic innervation is mediated through acetylcholine**.
- Slows down heart rate

Table 10.1 The Autonomic Nervous System and Cardiovascular Function

SYMPATHETIC INFLUENCE	PARASYMPATHETIC INFLUENCE
Increase heart rate	Decrease heart rate
Increase myocardial contraction force	Decrease myocardial contraction force
Dilate coronary blood vessels	Constrict coronary blood vessels
Constrict pulmonary blood vessels	Dilate pulmonary blood vessels
Constrict blood vessels in abdomen, muscle, skin, and kidneys	Dilate blood vessels in abdomen, muscle, skin, and kidneys

EXERCISE HEART RATE

- HR increased with increase exercise demand in both trained & untrained person.
- Trained person achieves a higher level of ex. Oxygen uptake at a submaximal HR than sedentary person .
- HR for untrained person accelerate rapidly with increase ex. demand , a much smaller heart rate increase occurs for trained person.

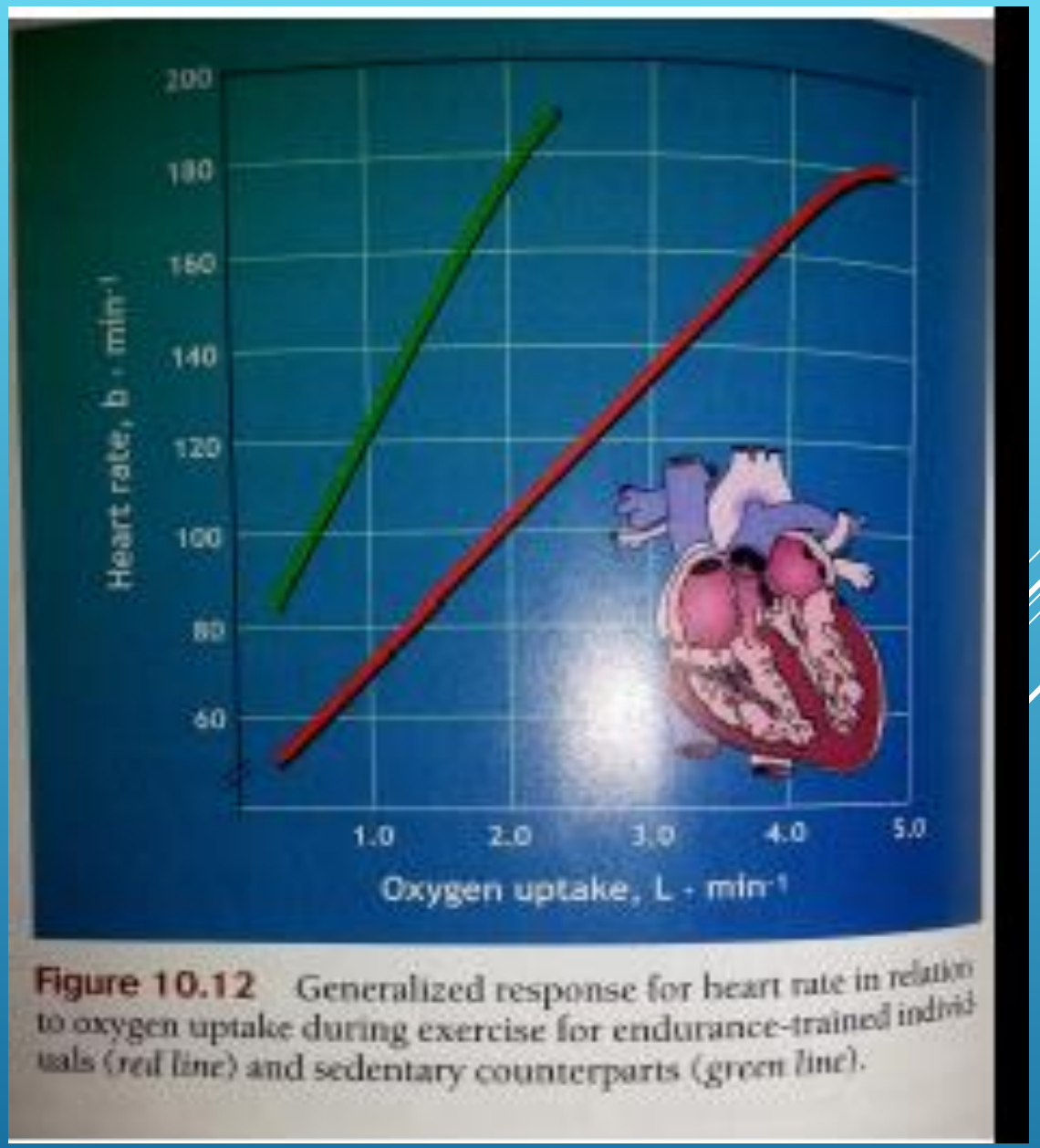


Figure 10.12 Generalized response for heart rate in relation to oxygen uptake during exercise for endurance-trained individuals (*red line*) and sedentary counterparts (*green line*).

CARDIAC OUTPUT

- The amount of blood ejected from the heart in one minute‘
- Two factors determine the magnitude of the cardiac output; these are the stroke volume and the heart rate

Cardiac Output = Stroke Volume x Heart Rate

- **Stroke volume** - ‘The amount of blood pumped out of the heart during **one contraction (beat).**

	Cardiac output (ml/m)	HR (b/m)	Stroke volume (ml/b)
Untrained	5000	70	71
Trained	5000	50	100

Factors interact as aerobic fitness improvement :

- Increased vagal tone w/decreased sympathetic drive, slow HR, allowing more time for ventricular filling
- Enlarged ventricular volume
- Increased myocardial contractility and a large volume of blood eject each systole-

RESTING CARDIAC OUTPUT : UNTRAINED VS TRAINED

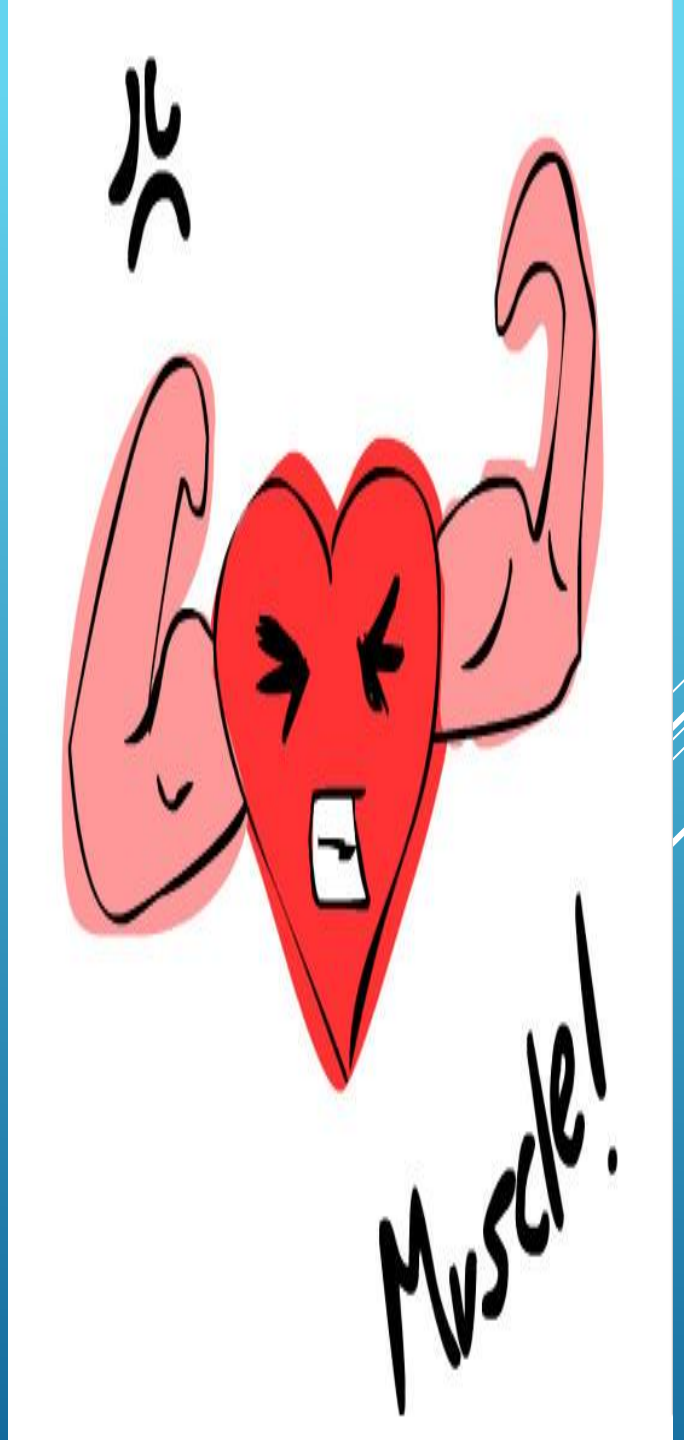
- Cardiac out put increases rapidly during transition from rest to exercise in both trained & untrained individuals .
- At max exercise increases up to 4 times
- Differences between both trained & untrained individuals related to stroke volume

	Cardiac output (ml/m)	HR (b/m)	Stroke volume (ml/b)
Untrained	22000	195	113
Trained	35 000	195	179

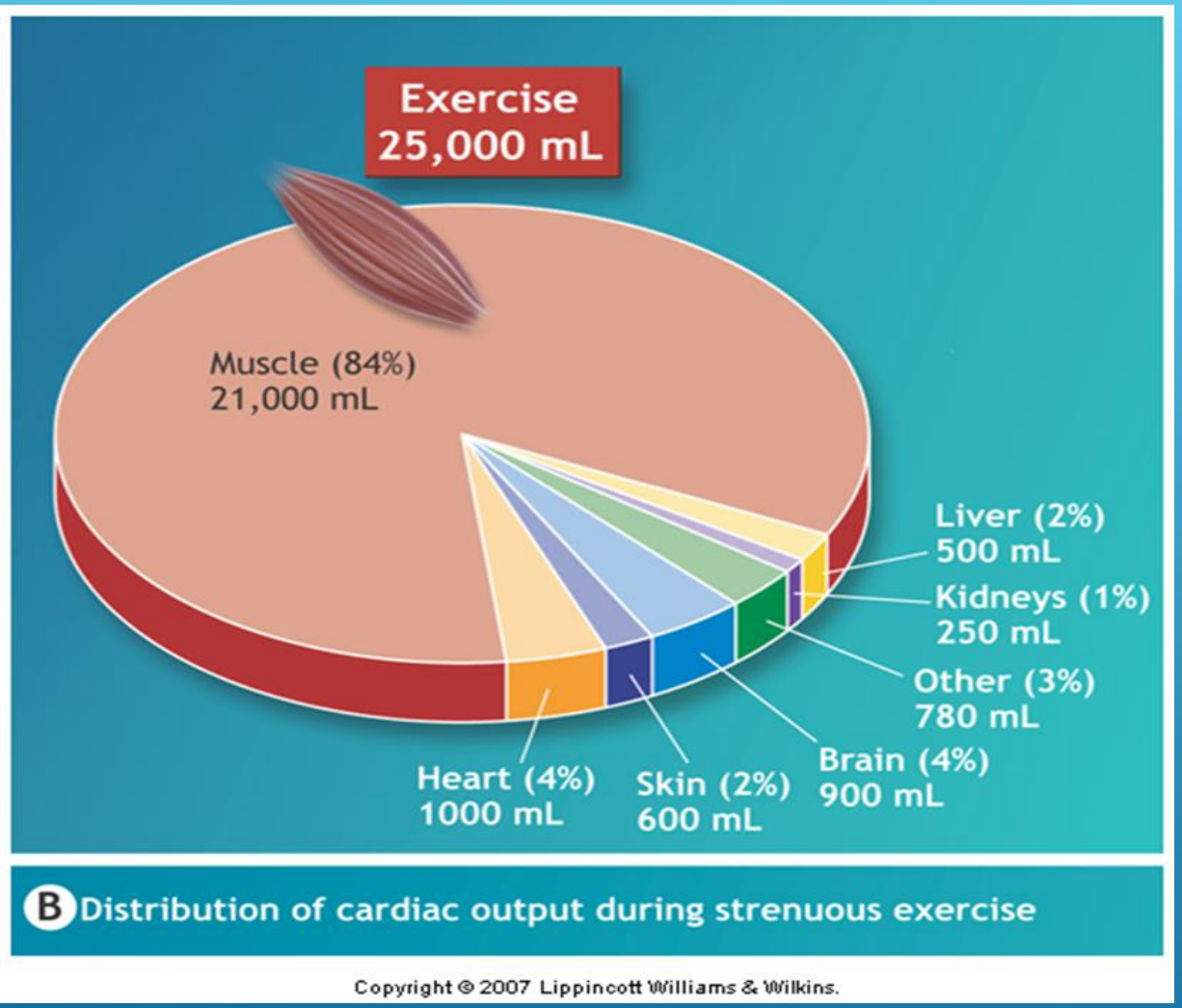
EXERCISE CARDIAC OUTPUT : UNTRAINED VS TRAINED

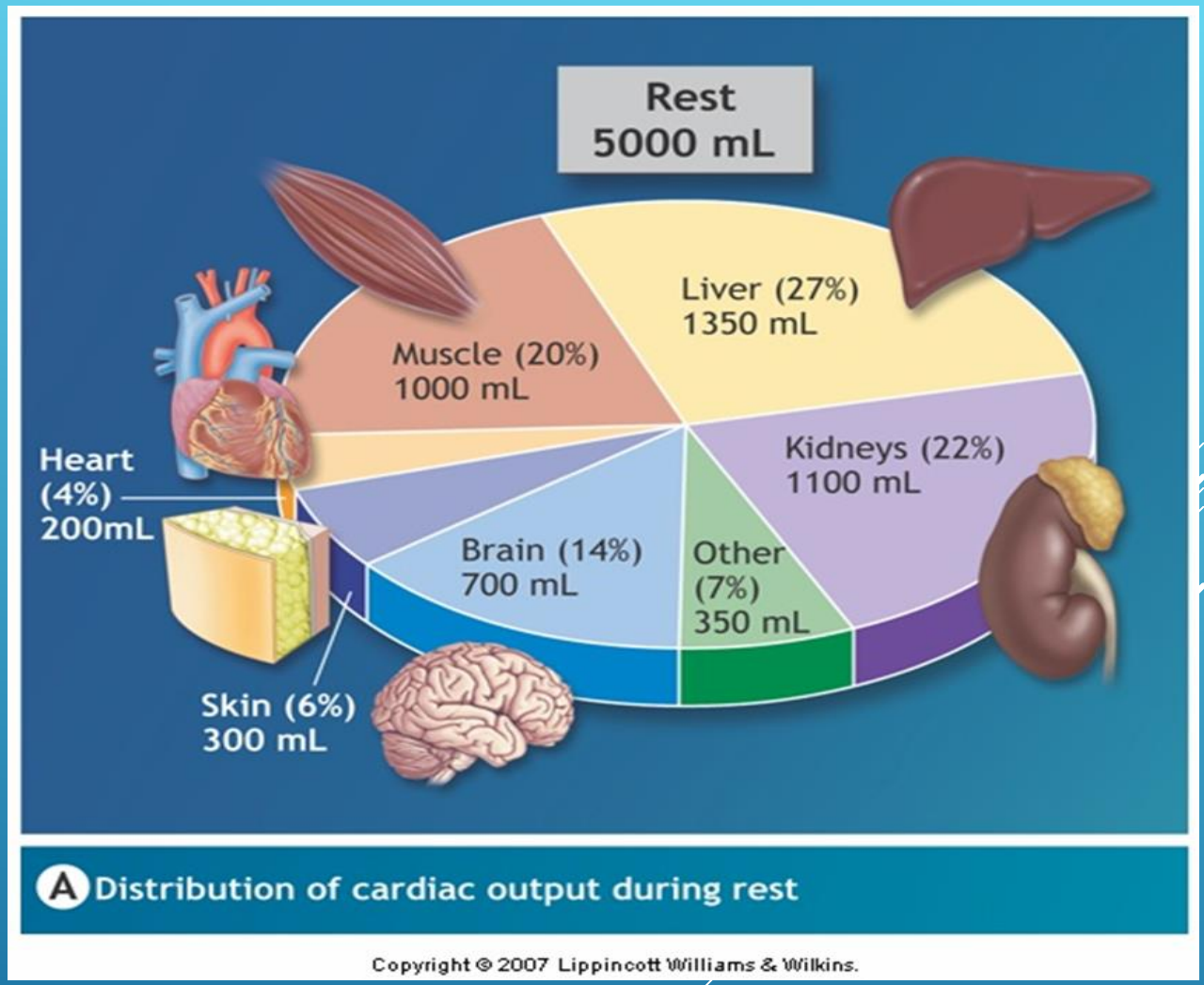
MECHANISMS FOR INCREASED STROKE VOLUME WITH TRAINING

- increase diastolic filling, Increased blood volume
- Increased Contractility – greater systolic emptying
- Training adaptation that expand blood volume and reduce resistance to blood flow in peripheral tissue.



- Blood flows to tissues in proportion to their metabolic activity





CARDIAC OUTPUT DISTRIBUTION

THANK YOU