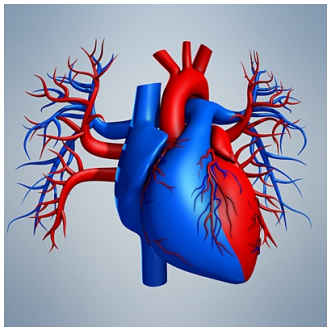
CARDIOVASCULAR LECTURE 1



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Objectives of this lecture

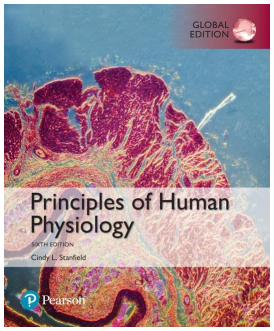
- Understand the functions of the CVS
- Describe the path of blood flow through the heart and vasculature
- Name the different valves in the heart and understand how they operate
- Understand the physiology of cardiac muscle
- Describe the nervous supply to the heart
- Define cardiac output
- Describe the distribution of systemic blood flow at rest and during exercise

References for these lectures

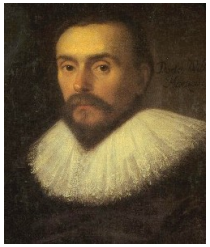
Principles of Human Physiology by Stanfield.

Global (6th) Edition.

Chapters 13 and 14



WILLIAM HARVEY (1578-1657)



Harvey's classic work – "On the Movement of the Heart and Blood in Animals" became the foundation for all modern research on the heart and cardiovascular medicine.

ROLE OF THE CVS

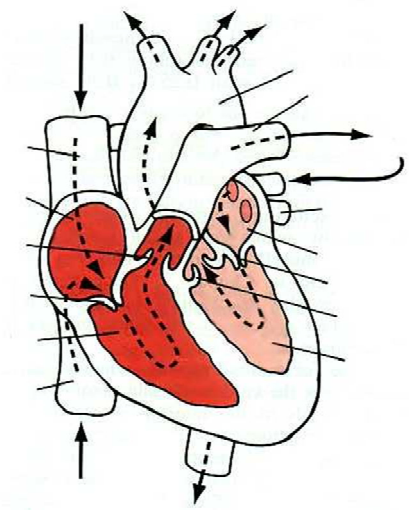
- supply of O_2 and other nutrients and removal of CO_2 and other waste products
- heart performs sensory and endocrine functions that regulate blood pressure and blood volume
- blood vessels regulate blood pressure and the distribution of blood to various parts of the body.
- blood also carries hormones and other substances to the tissues

THE HEART

- hollow muscular organ
- middle of the chest
- broad base at the top
- pointed tip or apex at the bottom
- weighs 250-350 grams

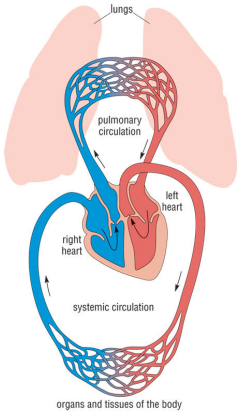
- heart is two separate pumps - right and left
- right ⇒ lungs - pulmonary circulation
- left ⇒ rest of body - systemic circulation

RIGHT LEFT



SYSTEMIC CIRCULATION

Left atrium ⇒ bicuspid/mitral valve ⇒ left ventricle ⇒ aortic (semilunar) valve ⇒ aorta ⇒ systemic arteries ⇒ arterioles ⇒ capillaries ⇒ venules ⇒ veins ⇒ superior & inferior vena cavae ⇒ right atrium



mean aortic pressure = 90mmHg

varies between 120 and 80mmHg

highest value = systolic pressure

lowest value = diastolic pressure

written 120/80 (systolic/diastolic)

PULMONARY CIRCULATION

right atrium ⇒ tricuspid valve ⇒ right ventricle ⇒ pulmonary valve ⇒ pulmonary trunk ⇒ pulmonary arteries ⇒ lungs ⇒ pulmonary veins ⇒ left atrium

REMEMBER

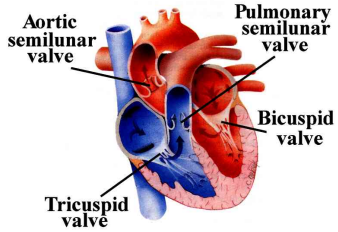
arteries carry oxygenated blood

veins carry deoxygenated blood

except for pulmonary vessels where it is the reverse

pulmonary artery pressure is low – about 15mmHg

HEART VALVES

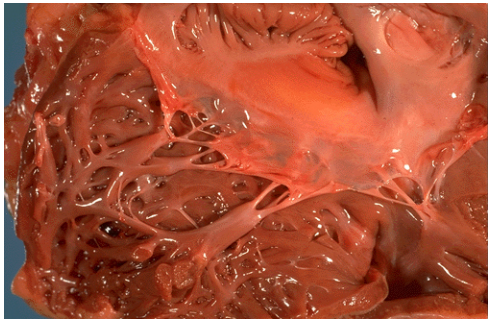


- heart has 4 valves
- all are one-way
- open & close passively due to pressure differences

atrioventricular valves

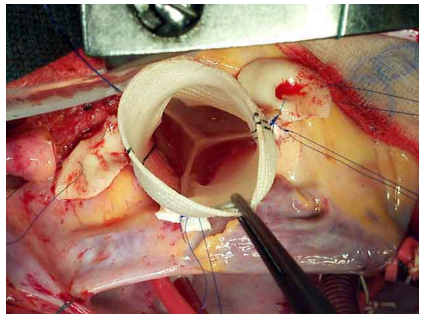
- between atria and ventricles
- flaps of endocardium with inner framework of fibrous connective tissue
- anchored to papillary muscles of ventricles by chordae tendineae
- between RA and RV = tricuspid
- between LA and LV = bicuspid/mitral

Mitral Valve



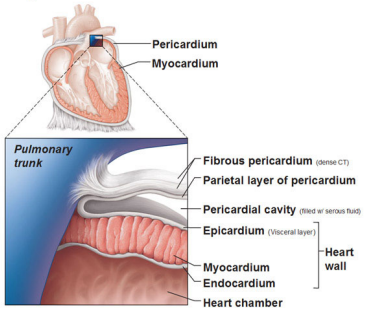
semilunar valves

- prevent blood returning to ventricles
- pulmonary valve – in proximal end of pulmonary trunk
- aortic valve – in proximal end of aorta
- both have 3 cusps



CARDIAC MUSCLE

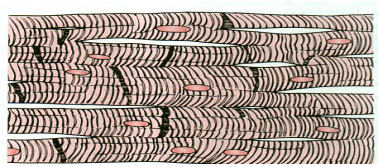
Heart wall has 3 layers – outer epicardium, middle myocardium and inner endocardium



Types of cardiac muscle

- **atrial**
- **ventricular**
- **specialised excitatory & conductive muscle fibres - contract feebly, exhibit rhythmicity & varying rates of conduction**

Cardiac Muscle Fibres



- **arranged in latticework**
- **muscle is striated**
- **muscle fibres made up of individual cardiac myocytes**
- **intercalated discs where cells meet end to end**
- **here cell membranes fuse to form permeable communicating junctions called gap junctions - low resistance bridges for spread of excitation**
- **functions as a syncytium**
- **atrial and ventricular syncytiums – atria contract a short time ahead of the ventricles**

NERVOUS SUPPLY OF THE HEART

Autonomic Nervous System

- **sympathetic nerves - excite the heart causing**
  - **↑ heart rate (from 70bpm up to 180 or 200bpm)**
  - **↑ force of contraction**

→ ↑volume of blood pumped (greater than 100%)

- **parasympathetic nerves (vagus)**
  - **↓ heart rate (down to about 40% of normal)**
  - **↓ force of contraction by 20-30%**

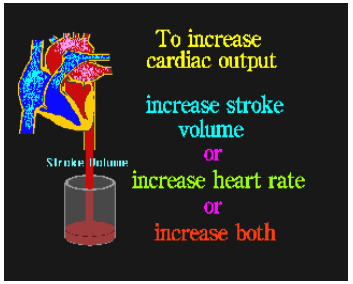
→ ↓volume of blood pumped (down to about 50%)

CARDIAC OUTPUT

= quantity of blood pumped into aorta each minute

Cardiac output (CO) determined by 2 factors

- **heart rate**
- **stroke volume – vol of blood pumped from each ventricle with each beat = 70mls/beat**



So,

cardiac output = heart rate x stroke vol

= 70 beats/min x 70 mls/beat

= approx 5L/min

There are 3 determinants of stroke volume

- preload – degree of stretching of myocardium prior to contraction
- afterload – the force opposing myocardial contraction
- contractility

CO varies with

- level of body metabolism
- level of muscular activity
- age
- body size
- emotional state

5L/min at rest (up to 25L/min in exercise)

Distribution of systemic blood flow to the various organs and tissues at rest and during exercise.

Organ	At Rest (5l/min)	Exercise (25l/min)
Brain	13-15% (750ml)	3-4% (750ml)
Heart	4-5% (250ml)	4-5% (1250ml)
Liver & GIT	20-25% (1250ml)	3-5% (1250ml)
Kidneys	20% (1000ml)	2-4% (1000ml)
Muscle	15-20% (1000ml)	70-80% (18,000ml)
Skin	3-6% (300ml)	13-15% (3,500ml)
Skeleton, marrow & fat	10-15% (750ml)	1-2% (500ml)