

# MODULE ON CARDIOVASCULAR SYSTEM

## Phase - 1



**FACULTY OF MEDICAL SCIENCES  
UNIVERSITY OF SRI JAYEWARDENEPURA**



# Cardiovascular module – Phase 1

## **Introduction**

Welcome to the Cardiovascular Module! This is a very exciting module that will be very important to your future work as doctors. The module has been designed in a novel way that will make your learning both interesting and productive.

During this module, you will be encouraged to learn the structure and function of the cardiovascular system in an integrated manner: this means that what was previously categorized into subjects such as Anatomy, Physiology and Biochemistry, will be learnt and assessed together (horizontal integration). We will also help you learn the basic sciences in a way that is relevant to their clinical applications (vertical integration). We are taking this approach in order to prepare you better for your future work as doctors, where patients will come to you with clinical problems, which are not categorized by discipline names.

In order to help you learn in this integrated manner, we have arranged the learning of basic sciences around a few key health-related situations (real life situations), which you are likely to encounter as first year medical students. You will be expected to think about these scenarios and complete worksheets. You may do this individually or with your colleagues. The worksheets will help you understand the relevance and importance of what you are about to learn within the module. It will also help to focus your attention on what you need to gain from the lectures, practicals and tutorials that have been scheduled during this module.

## **Overall aim**

The overall aim of this module is to help you understand the basic sciences that underlie the practice of cardiovascular medicine. The module will prepare you for your future work in the medical course that will include learning in relation to the assessment and promotion cardiovascular health and management of a range of cardiovascular disease.

## **Process**

The above aims will be achieved by structuring your learning around a few key areas in cardiovascular health and disease.

- a. Hypertension and heart failure: This is a common clinical issue that you will encounter in future practice. Learning around this clinical issue will provide a means of contextualizing learning of key aspects of the cardiovascular system, for example the regulation of blood pressure, blood flow to various organs, and haemodynamics.
- b. Myocardial infarct: Many aspects of Physiology, Anatomy and Biochemistry will closely relate to this common and life threatening condition.
- c. Shock: Learning around this clinical situation will help you to contextualize key aspects of cardiovascular Physiology and Anatomy.

A Cardiologist, who will speak about the clinical situations that he encounters in everyday practice, will introduce the module. The aim of the introduction is to help you understand the relevance of what you are about to learn, and to help you understand which aspects of the sciences you need to pay most attention to. The introduction will be a reflection of realistic clinical practice, but it is not expected to burden you with complex clinical concepts. For instance, the clinician may introduce a clinical situation related to Myocardial infarction (heart attack), and then highlight how an understanding of cardiovascular physiology and anatomy is required in order to deal with this clinical situation. This introduction will be re-enforced through the provision of a real life situation that further demonstrates to you, the relevance and importance of what you are about to learn.

## **Objectives of Module on Cardiovascular System – Phase 1**

Upon completion of this module, you should be able to:

1. Explain the normal structure and function of the cardiovascular system by learning and applying the relevant basic sciences.
2. Apply the above knowledge to a few common real life situations (Hypertension, Myocardial Infarction, Shock) to explain how the anatomy, physiology and biochemistry are altered in the given situations.

In order to do the above, you should be able to:

1. Explain the normal cardiac cycle by using your knowledge of the
  - a. normal structure of the heart, including its musculature, coverings and surrounding thoracic structures
  - b. nerve supply of the heart, structure of the conducting system of the heart, the generation of a normal heart beat and genesis of ECG waves
  - c. mechanical events of the heart during a cardiac cycle
  - d. cardiac output and the factors that influence it
  - e. generation of normal heart sounds as well as murmurs
2. Explain blood pressure & blood flow to various organs by using your knowledge of
  - a. the normal structure of blood vessels
  - b. haemodynamics of circulation
  - c. factors that regulate blood flow to various organs and blood pressure in health and disease
3. Explain the development and effects of coronary arterial disease by using your knowledge of the
  - a. histology the circulatory system
  - b. coronary blood flow and the factors that regulate normal coronary circulation
  - c. development and effects of atherosclerosis
4. Apply the knowledge on the embryology of the heart to the development of congenital heart defects
5. Explain the alteration of normal physiology that occurs in shock, heart failure and syncope

### **Main content areas**

1. Structure of the heart and the arterial system of the heart
2. Embryology of the cardiac system & congenital heart defects
3. Structure & function of the conduction system of the heart and the generation of ECG waves
4. Cardiac cycle & cardiac output
5. Blood pressure & blood flow to organs
6. Coronary circulation in health & disease
7. Pathophysiology of syncope, shock, hypertension & heart failure

### **Procedural skills to be acquired**

1. Placing electrodes and obtaining an electrocardiogram
2. Obtaining a basic cardiovascular history
3. Physical examination of the cardiovascular system - Examination of arterial and venous pulses, measuring blood pressure and auscultation of the heart
4. Perform autonomic function tests

### **Members of the module committee**

Chairperson	- Dr. Roshini Peiris-John	- Physiology
Convener	- Dr. Chamil Marasinghe	- Physiology
Members	- Prof Hemantha Peiris	- Biochemistry
	- Dr S G Yasarwardene	- Anatomy
	- Dr. M S M Rizny	- Anatomy
	- Dr. Aloka Pathairana	- Surgery
	- Dr. J Indrakumar	- Medicine

### ***Real life situation 1 – Myocardial Infarction***

You are a first year medical student. One evening, your friend from next door, who is also a first year medical student, rushes to your home saying that his father is ill. He asks you to come and help.

You find that your friend's father is complaining of a severe chest pain. You also notice that he is sweating, and he complains that he feels 'vomitous'.

You and your friend are unsure of what to do, but from what you have heard, you feel that the patient needs immediate medical attention. You calm the patient, and arrange for him to be transported to the teaching hospital of your medical faculty. The patient receives immediate treatment and undergoes a number of investigations.

After a few days, your friend comes over to thank you, and says that the diagnosis card indicated that his father had a 'myocardial infarct'. He says that he would like to know more about how to look after his father from now on, and also wants to understand more about the disease. He asks whether you could join him in finding out the relevant information.

You are keen to find out as much as possible to help your friend. You realise that you already know a few things about 'heart attacks', but you also know that you are unsure about many aspects. That evening, you decide to make a list of what you already know, and the issues that you would like to find out more about.

You then wonder how you can find out the necessary information. You are aware that a number of lectures, practicals and tutorials are scheduled in your medical course, and decide to look through your timetable to see whether they may be useful. You realise that these will help you with only some of the learning issues that you have listed above, but you decide to concentrate on these only at this stage.

You decide to look for other sources of information that may be helpful, at a later stage.

***Real life situation 2 - Hypertension***

Your uncle is thrilled to hear that you have entered the medical faculty. He comes to you and says that now he can depend on you to measure his blood pressure regularly, and provide necessary advice. You reluctantly tell him that you are only a first year medical student, and that you are as yet unable to help him. You advise him to continue visiting his regular doctor, but promise to start helping him as soon as possible.

You are now keen to find out more about blood pressure, how the body controls it normally, and what causes blood pressure to be high in some persons. You decide to make a set of notes that will help you understand this condition better. As a first step, you make a list of what you already know about blood pressure and what more you would like to find out in order to understand this condition better.

You are aware that a cardiovascular module is available in your medical course, and eagerly await its commencement. You learn as much as possible about the areas that you identified above, and complete your set of notes as far as possible. You become aware that you can only address some of the areas at this stage of your medical study, and decide that this is sufficient for now.

You carefully note down the areas that you want to learn about later in your medical course.

### ***Real life situation 3 - Shock***

You are a first year medical student. On your way to the hostel after lectures you see a group of people calling for help. When you go to the spot you see a middle aged man lying on the road with a stab injury on the left lower aspect of the chest. There is bleeding from the wound.

After a few minutes paramedics arrive at the scene and check his pulse and blood pressure. His blood pressure was 90/60mmHg and pulse rate was 120 beats / min. The paramedics mention the term “shock”. They elevate his legs and insert two cannulae and start transfusion of intravenous fluids. The patient is then rushed to the Kalubowila hospital.

Now you are interested in finding out what the paramedics meant by the term “shock” and how it occurs. You know your CVS module is the next module. Before the commencement of that module, you decide to list out what you would like to learn about shock and related topics. You then proceed to make some notes about “shock” with the help of reading material in the library and the IT lab.

**General Objective** – Students should be able to explain the normal cardiac cycle by using their knowledge of the normal structure of the heart, including its musculature, coverings and nerve supply, surrounding thoracic structures and surface marking of the heart & great vessels

Intermediate objectives		Detailed content areas	Learning activity	Dept	Time
Students should be able to 1. Define the mediastinum & its divisions	<b>A</b>	<b>-Divisions &amp; contents of the mediastinum</b> <b>-Heart</b> <b>Identify &amp; name structures constituting the borders &amp; surfaces of the heart &amp; cardiac apex</b>	Lecture	Ana	1 hr
	<b>A</b>		Dissection & prosected specimens	Ana	3 hrs
2. Describe the structure of the atria and ventricles	<b>A</b>	<b>-Openings of the SVC &amp; IVC into the right atrium, right Atrioventricular valve, coronary sinus, crista terminalis, muscoli pectinati, interatrial septum, fossa ovalis &amp; limbus, Value of the IVC and Coronary sinus.</b> <b>-Openings of the right ventricle, atrioventricular valve &amp; its opening, pulmonary valve &amp; its opening, Trabeculae carneae, chordae tendinae, Papillary muscles &amp; the conus arteriosus.</b> <b>-Opening of the left ventricle &amp; the features of their valves, Papillary muscles &amp; the muscular &amp; membranous parts of the interventricular septum</b> <b>- Internal features of left atrium &amp; its openings</b>	Tutorial	Ana	1 hr
	<b>A</b>				
	<b>A</b>				
	<b>A</b>				
3. Describe the pericardium and sinuses formed by it	<b>B</b>	Pericardium - fibrous and serous - oblique and transverse sinus			
4. Describe the nerve supply of the heart	<b>A</b>	<b>Sympathetic supply, parasympathetic supply and cardiac plexus</b>			
5. Describe the histology of cardiac muscle	<b>B</b>	Microscopy of cardiac muscle	Recall		
6. Surface mark the cardiac borders, heart valves, main arteries of the heart and the entrance of superior and inferior vena cava to the heart	<b>B</b>	Surface marking - Cardiac borders -atrioventricular, pulmonary and aortic valves -origin of aorta, brachiocephalic trunk, subclavian and common carotid arteries, pulmonary arteries - entrance of superior and inferior vena cava	Demonstration	Ana	1 hr
	<b>C</b>		Tutorial	Ana	1 hr
	<b>C</b>				
7. Interpret the imaging Anatomy of the Heart	<b>A</b>	<b>-cardiac borders, great vessels and cardiac chambers</b>	Demonstration		1 hr

### General Objective –

Students should be able to describe the course, relationship and distribution of the arterial system of the heart (pulmonary trunk, aorta and coronary arteries), the embryology of the cardiac system and apply this knowledge to the development of congenital defects.

Intermediate objectives		Detailed content area	Learning activity	Dept	Time	
Students should be able to 1. Describe the branches of pulmonary trunk and distribution of left and right pulmonary arteries	A	<b>Pulmonary trunk</b>	Dissection & prosected specimens	Ana	3 hr	
2. Describe the relationship and arrangement of aorta and Carotid arteries.	A	<b>Aorta</b> - Ascending aorta - Aortic arch - Thoracic aorta and branches A <b>Carotid arteries</b> - Common, internal, external				
3. Describe the arterial supply & venous drainage of the heart	A	<b>Coronary arteries</b>	Lecture	Ana	1 hr	
	A	<b>Coronary sinus &amp; great cardiac vein</b>	Tutorial	Ana	1 hr	
4. Describe the development of the heart	A	<b>Embryology of the heart</b>	Lecture Tutorial	Ana	2 hr	
5. Describe the development of sinus venosus, atria, ventricles and intracardiac septa and associated congenital heart defects	A	-right and left atria -right and left ventricles -inter-atrial & inter-ventricular septa -ASD, VSD, Fallot's tetralogy		Ana Paed	1 hr	
6. Describe the development of the atrioventricular, aortic and pulmonary valves and associated congenital heart defects	B	-Atrioventricular valves -Aortic & pulmonary valves				
7. Outline the development of the arterial & venous system and associated congenital heart defects	A	-PDA, Coarctation of aorta				

## General Objective

Students should be able to describe the anatomy of the conduction system of the heart, the generation of a normal heart beat and genesis of ECG waves

Intermediate objectives		Detailed Content Area	Learning activity	Dept	Time
Students should be able to	<b>A</b>	<b>Position of the SA node, AV node, AV bundle, bundle branches and their significance.</b>	Dissection  Lecture	Ana  Phy	3 hrs  1 hr
1. Describe the conduction system of the heart and spread of cardiac excitation within the heart.	<b>A</b>				
2. Explain the genesis of pacemaker potentials at the SA node	<b>A</b>				
3. Identify the factors affecting the discharge from the SA node	<b>A</b>				
4. Draw a diagram of the action potential of cardiac muscle.					
5. Describe the contractile process of cardiac muscle.	<b>A</b>		Recall		
6. Explain the genesis of the ECG wave in relation to it's cardiac electrophysiology	<b>A</b>	<b>Genesis of ECG wave</b>	Lecture	Phy	1 hr
7. Place the unipolar and bipolar leads in an adult & describe the appearance of the normal ECG recording from lead II and explain the waves. .	<b>A</b>	<b>Placing of electrodes and description normal ECG</b>	Demonstration of ECG	Phy	3 hrs
8. Calculate heart rate, PR interval and determine the mean electrical axis.	<b>A</b> <b>B</b> <b>B</b>	Calculation of <b>- heart rate</b> <b>- PR interval</b> <b>- Mean electrical axis</b>	Practical/Skills lab		
9. Outline the uses of ECG in diagnosis	<b>B</b>	<u>Diagnostic uses of ECG</u> - identify <b>-Abnormal spread of excitation</b> <b>-Changes in cardiac size</b> <b>-Damage to heart</b> <b>-Abnormally slow/ rapid/ irregular rhythm</b>			

**General Objective -**

Students should know to describe the mechanical events of the cardiac cycle and the cardiac output, generation of heart sounds and murmurs.

Intermediate objectives		Detailed content area	Learning activity	Dept	Time
Students should be able to			Recall/ Self study	Ana	
1. Describe the light & electron microscopic features of cardiac muscle					
2. Describe the sequence of events that occur in the heart during the cardiac cycle	A	<b>Cardiac cycle</b> - Mechanical events	lecture Tutorial	Phy Phy	2 hr 1 hr
3. Illustrate the pressure changes that occur in a single cardiac cycle	A	- Intra-atrial, intra-ventricular and aortic - pressure changes			
4. Relate the genesis of arterial & jugular venous pulses to underlying cardiac events & describe the JVP and the value of CVP measurement	A B	- <b>Genesis of arterial and venous pulses</b> - JVP/CVP	Lecture	Phy	1 hr
5. Explain the production of heart sounds and state their significance	A	Heart sounds	Combined tutorial	Phy Ana	2 hr
6. Describe the function of the heart valves and genesis of murmurs & state the timing of the murmur produced by valvular defects & congenital heart disease	A	Function of the heart valves & Murmurs			
7. Define cardiac output and state its relationship to stroke volume and heart rate	A	<b>Cardiac output – definition (CO)</b>	Lecture	Phy	1 hr
8. List and explain the factors that regulate cardiac output	A	<b>Factors that regulate CO</b>	Tutorial	Phy	1 hr
9. Explain the principles of measuring the cardiac output	A	<b>Principles of measuring CO</b>			
10. State the changes in cardiac output in selected conditions	B	Effect of selected conditions on CO			

### General Objective -

Students should be able to describe the structure of blood vessels, haemodynamics of the circulation, normal blood pressure, its regulation and variations in disease and examine the cardiovascular system.

Intermediate objectives		Detailed content areas	Learning activity	Dept	Time
Students should be able to 1. Describe the light & electron microscopic features of the arterial & venous system	<b>B</b> <b>C</b>	- Classification of arteries & veins - Features of 3 types of arteries and veins Light microscopic Electron microscopic	Lecture  Practical (Histology)	Ana	1 hr  3 hrs
2. Describe the types of blood flow	<b>B</b>	Haemodynamics -types of blood flow	Lecture Tutorial	Phy Phy	1 hr 1 hr
3. List the methods of measuring blood flow	<b>B</b>	Measurement of blood flow			
4. Describe the relationship between flow, pressure & resistance in the vascular system	<b>A</b>	<b>Factors maintaining volume of flow of blood</b>			
5. Compare Windkessel vessels & resistance vessels	<b>C</b>	Windkessel Vs resistance vessels -resistance -pressure -volume -flow			
6. Define circulation time and state conditions altering circulation time	<b>B</b>	Circulating time and conditions altering it			
7. Explain autoregulation	<b>A</b>	<b>Local regulation of blood flow</b>			
8. Define systolic blood pressure, diastolic blood pressure and mean arterial pressure.	<b>A</b>	<b>Definitions of Arterial blood pressure</b>	Lecture	Phy	1 hr
9. List the methods available to measure the blood pressure	<b>B</b>	Methods of blood pressure measurement			
10. Describe the physiological basis of measuring blood pressure using a sphygmomanometer	<b>A</b>	<b>Physiological principles of BP measurement</b>			
11. List the physiological & pathological variations in blood pressure	<b>B</b>	Variation of blood pressure - Physiological - Pathological			
11. Perform a physical examination of the cardiovascular system	<b>A</b>	<b>Cardiovascular system examination</b>	Practical	Phy	3 hrs

### General Objective

Students should be able to describe the regulation of blood flow to various organs and the disordered physiology in the development of hypertension.

Intermediate objectives		Detailed content areas	Learning activity	Dept	Time
Students should be able to 1. Explain the effects of altered blood flow 2. Describe the importance of regulation of Cardiovascular system and the factors affecting it	A A	-Importance of regulation -Factors involved Local mechanisms - autoregulation, paracrine secretion Systemic mechanisms – circulating substances, neural mechanisms	Lecture Lecture Tutorial	Med Phy Phy	1 hr 3 hrs 1 hr
3. Describe the importance and regulation of blood flow to various organs.	A A B A B	- Regulation of blood flow to <b>a) Brain (Neurology module)</b> <b>b) Heart (CVS-Gen obj 7)</b> c) Gut (GIT module) <b>d) Kidney (Renal module)</b> e) Skeletal muscles (Resp module)			
4. Perform tests to determine the function of the autonomic system	B	Autonomic nervous system function tests	Practical	Phy	3 hrs

### General objective

Students should know to describe the coronary circulation and factors that regulate coronary circulation & describe the mechanism of atherosclerosis & effects of coronary artery occlusion.

Intermediate objectives		Detailed content areas	Learning activity	Dept	Time
1. Describe the anatomy of the left and right coronary arteries and their branches & describe venous drainage of the heart	A	<b>Anatomy of coronary circulation (CVS Gen. Obj. 2)</b>	Recall		
2. Describe areas of the myocardium supplied by these arteries					
3. Describe coronary blood flow in relation to the cardiac cycle	A	<b>Changes in coronary blood flow in relation to cardiac cycle</b>	Lecture	Phy	1 hr
4. Describe the regulation of the coronary blood flow	A	<b>Regulation -chemical &amp; neural factors that affect coronary bloods flow</b>			
5. Describe the mechanism of atherosclerosis and the factors affecting it	A	<b>- Classification of Hyperlipidaemia - Effects of oxidized LDL, Lp(a) and homocysteine</b>	Lecture	Bio	1 hr
6. Describe the effects of coronary artery occlusion and principles of diagnosis & management	A	<b>- Ischaemia and Myocardial infarction - Uses of ECG, plasma enzymes and proteins (AST, LDH, CK, troponins)in diagnosis of ischaemia and myocardial infarction</b>	Discussion on real life situation & case studies	Bio/ Phy	2 hrs
	B B	<b>- Selection of Diagnostic tests - Physiological basis for treatment modalities</b>			

### General Objective

Students should be able to describe the cardiovascular adjustments during exercise – These objectives will be learnt in your respiratory module.

<b>Intermediate objectives</b>		<b>Detailed content areas</b>	<b>Learning activity</b>	<b>Dept</b>	<b>Time</b>
1. Describe the blood flow to Skeletal muscle & regulation of flow at rest and exercise	<b>B</b>	Muscle blood flow			
2. Describe the circulatory, respiratory, metabolic and endocrine adjustments during exercise	<b>B</b>	Physiological adjustments during exercise			
3. Explain the O <sub>2</sub> consumption during exercise	<b>B</b>	O <sub>2</sub> consumption			
4. Describe isotonic and isometric exercise and the physiological changes that occur with each type	<b>A</b>	<b>Exercise types</b>			
5. Explain the physiological & anatomical adaptation and benefits of training in exercise	<b>A</b>	<b>Training</b>			
6. Explain the principles of the stress test	<b>B</b>	Stress test			

## General Objective

Describe the pathophysiology of shock, heart failure & syncope –

Intermediate objectives		Detailed content areas	Learning activity	Dept	Time
1. Define shock	<b>A</b>	<b>Shock - definition</b>	Lecture/		
2. Describe the four major causes of shock and explain giving examples the pathophysiology of each one.	<b>A</b>	<b>- Causes of shock with examples</b>	Discussion on real life situation & case studies	Phy	3 hrs
3. Explain the physiological basis of signs and symptoms of different types of shock	<b>A</b>	<b>- Physiological basis of clinical features</b>			
4. Describe the physiological basis of treatment of each type of shock	<b>B</b>	<b>- Physiological basis of treatment</b>			
5. List the factors that make shock refractory	<b>B</b>		SGD	Phy	1 hrs
6. Explain the short and long-term physiological compensation of shock	<b>A</b>	<b>- Physiological compensation</b>			
7. Define heart failure	<b>A</b>	<b>-Definition of Heart failure</b>	Lecture	Phy	2 hrs
8. Explain the physiological basis of the common clinical manifestations of heart failure	<b>A</b>	<b>- physiological basis</b>			
	<b>A</b>	<b>- common clinical manifestations</b>			
9. Describe the different types of heart failure	<b>A</b>	<b>Types - Left/right heart failure</b> <b>- Systolic/diastolic HF</b> <b>-Acute/chronic HF</b>			
10. Describe the haemodynamic, neuroendocrine & cellular changes that occur in heart failure	<b>A</b>	<b>haemodynamic, neuroendocrine &amp; cellular changes in heart failure</b>	Tutorial		1hr
11. Describe the physiological basis of the treatment principles in heart failure	<b>B</b>	<b>-Treatment principles</b>			

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12. Define Syncope		- Definition of <b>Syncope</b>	Lecture SGD	Phy	1 hr 1 hr
13. List the main causes of Syncope	A	- <b>Main causes</b>			
14. Explain the pathophysiological basis for the occurrence of syncope in each of these cases	A	- <b>Pathophysiological basis for syncope</b>			
15. Explain the compensatory measures that maintain the blood pressure on rising from supine positions	A	<b>Blood pressure regulation when rising from supine position</b>			
16. Define hypertension	A	<b>Hypertension - definition</b>	Lecture	Phy	1 hr
17. List the causes of hypertension	A	- <b>Causes</b>	Discussion on real life situation & case studies Tutorial	Phy	3 hr  1hr
18. Describe the pathogenesis of hypertension	A	- <b>Pathogenesis</b>			
19. State the ways in which hypertension can be caused in experimental animals & relate each one with hypertension in humans	C	Experimental hypertension in animals			
20. Explain the physiological basis of the treatment principles in hypertension	B	Treatment principles			
21. List the complications of hypertension (CVA, IHD etc.)	B	Complications			

Objective	Recommended reading
1	<ul style="list-style-type: none"> <li>• Cunningham's Practical Manual of Anatomy – Vol 2.-Thorax</li> <li>• Clinical Anatomy – A Revision of Applied Anatomy for clinical students - Ellis</li> <li>• Grant's Atlas of Anatomy – Anne M.R. Agur</li> </ul>
2	<ul style="list-style-type: none"> <li>• Human Embryology - Indebir Singh – Chapter on cardiovascular system</li> <li>• Langman's Medical Ebbryology – Chapter on cardiovascular system</li> </ul>
3	<ul style="list-style-type: none"> <li>• Cunningham's-Vol 2</li> <li>• Ganong's – Review of Medical Physiology – Chapter on circulating body fluids</li> <li>• NMS – Physiology – Chapter on electrical events</li> </ul>
4	<ul style="list-style-type: none"> <li>• Ganong's – Chapter on heart as a pump</li> <li>• Wheater's histology – Chapter on muscles</li> </ul>
5	<ul style="list-style-type: none"> <li>• Ganong's – Chapter on dynamics of blood &amp; lymph flow</li> <li>• Hutchison's Clinical methods – Chapter on cardiovascular system</li> </ul>
6	<ul style="list-style-type: none"> <li>• Ganong's - Chapter cardiovascular regulatory mechanism</li> </ul>
7	<ul style="list-style-type: none"> <li>• Ganong's - Chapter on circulation through special regions</li> <li>• Lecture notes on Clinical Biochemistry – Whitby, Smith, Beckett and Walker</li> <li>• Clinical Chemistry – Marshall</li> </ul>
8	<ul style="list-style-type: none"> <li>• Ganong's - Chapters on excitable tissue: muscles, the heart as a pump &amp; cardiovascular homeostasis in health &amp; disease</li> </ul>
9	<ul style="list-style-type: none"> <li>• Ganong's - Chapter on cardiovascular homeostasis in health &amp; disease</li> <li>• Pathophysiology of Disease – An introduction to clinical medicine – Chapters on cardiovascular disorders: vascular disease &amp; cardiovascular disorders: heart disease</li> <li>• Kumar &amp; Clark - Chapter on cardiovascular disease</li> <li>• NMS – Physiology</li> </ul>

## Electronic resources

1. Nucleus Medical Art – medical animations - website  
<http://catalog.nucleusinc.com/categories.php?P=2&TL=1&F=86&CatID=000&A=2>
2. Physio

logical origins of heart sound and murmurs – CD ROM