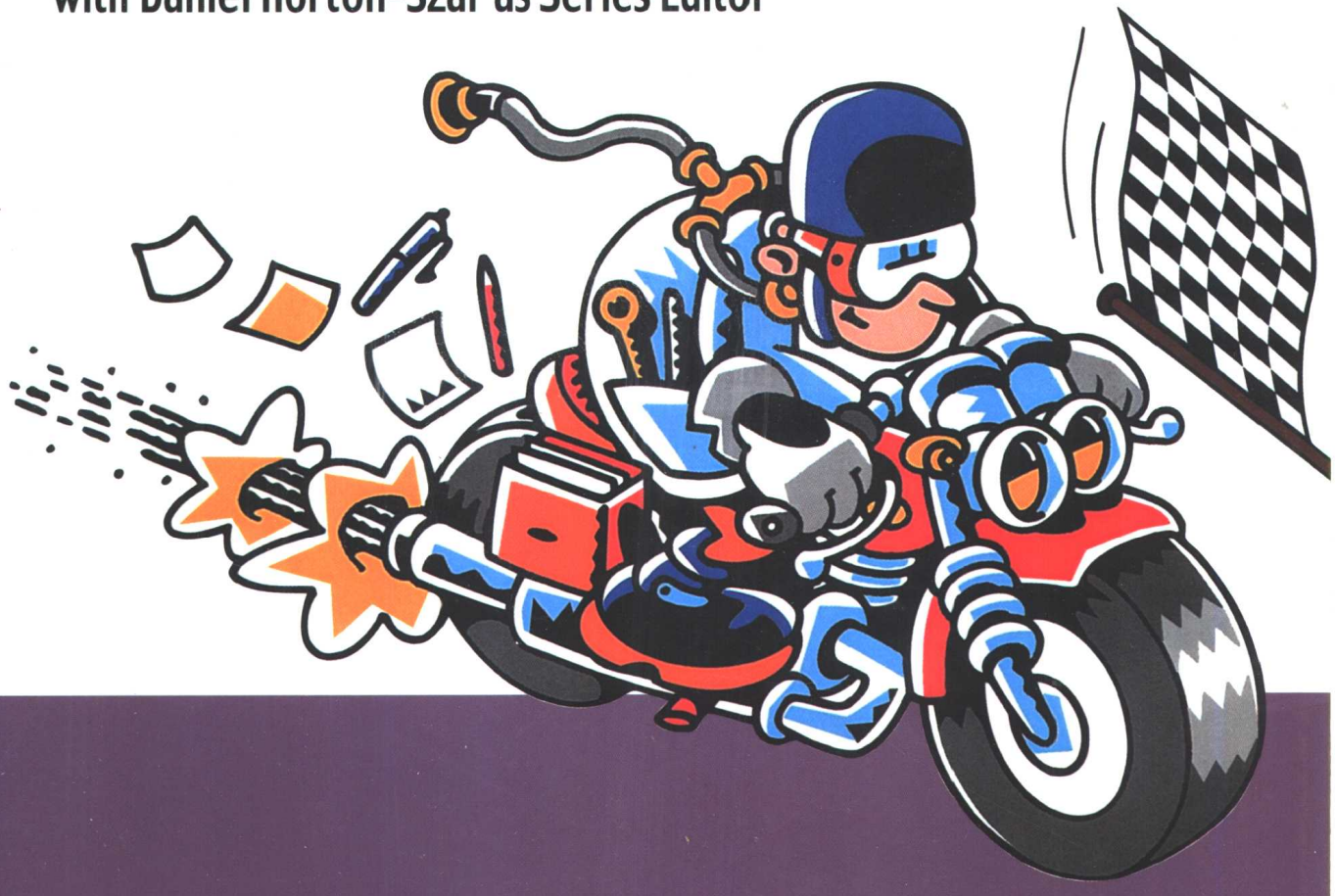
风暴式医学教程 MOSBY'S CRASH COURSE (原版英文医学教程)

心血管系统
Cardiovascular System

Romeshan Sunthareswaran
with Daniel Horton-Szar as Series Editor



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Preface

The cardiovascular system is one of the most important body systems to get to grips with. You need to have a basic knowledge of this system no matter which field of medicine you end up in, so it is important to grasp the subject now. You may find you are unable to attend all your lectures on this topic or that the content of a lecture is simply beyond your understanding. That's where this book will be useful. It is designed to be as comprehensive as possible while still being concise and easy to read. I hope it is short enough for you to read rather than use as a doorstop!

Regrettably, nowadays we are still assessed on how much information we remember rather than how much we really understand. I have written this book in the hope that you will comprehend the subject as well as retain the information. The cardiovascular system isn't actually complicated but it can appear quite daunting at first. Take every chapter in turn, using the diagrams to help, link it with your lectures and then test yourself at the end. When you've done all that, you'll wonder what all the fuss was about.

I hope this book allows you to enjoy yourself a little bit more at university and still get the results that you want. There are times when you have to work really hard and this book will hopefully make those times a little bit easier.

I wish you every success.

Romeshan Sunthareswaran

The *Crash Course Series* aims to provide the essential information in all subjects studied by medical students. The format of the series takes an approach that enhances learning through concise text, comprehension check boxes, and hints and tips boxes.

Every effort has been made to ensure that the text presents the latest consensus opinion about the subject. We have tried to make *Crash Course Cardiovascular System* as comprehensive as possible in relation to the new General Medical Council guidelines for undergraduate medical courses. This is the fundamental reason why *Crash Course* titles are arranged by body system—to address today's curricula rather than the previous discipline-based curricula.

In medical schools following the systems-based curricula recommended by the General Medical Council, students will have in-course assessments and examinations on the cardiovascular system. I hope *Crash Course Cardiovascular System* proves to be an excellent revision aid for these examinations.

Mark Noble
Faculty Advisor

Preface

OK, no-one ever said medicine was going to be easy, but the thing is, there are very few parts of this enormous subject that are actually difficult to understand. The problem for most of us is the sheer volume of information that must be absorbed before each round of exams. Its not fun when time is getting short and you realise that: a) you really should have done a bit more work by now; and b) there are large gaps in your lecture notes that you meant to copy up but never quite got round to.

This series has been designed and written by medical students and young doctors with recent experience of basic medical science exams. We've brought together all the information you need into compact, manageable volumes that integrate basic science with clinical skills. There is a consistent structure and layout across the series, and every title is checked for accuracy by senior faculty members from medical schools across the UK.

I hope this book makes things a little easier!

Danny Horton-Szar
Series Editor (Basic Medical Sciences)

Acknowledgements

I'd like to thank the Mosby team, Danny Horton-Szar, and Professor Noble for all their patience, advice, and constructive criticism. To all those at UMDS who lectured me, I thank you for your efforts to impart some knowledge on me; I apologise for the times your words fell on deaf ears! I also owe my family so much for their considerable support and unconditional loyalty. And last but not least all my friends, especially Pamela, for their helpful and critical comments, and support, without which I could never have written this book.

Figure Credits

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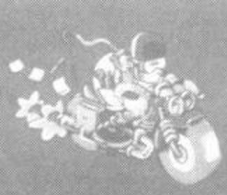
To my family, especially my mother,

who made me what I am.



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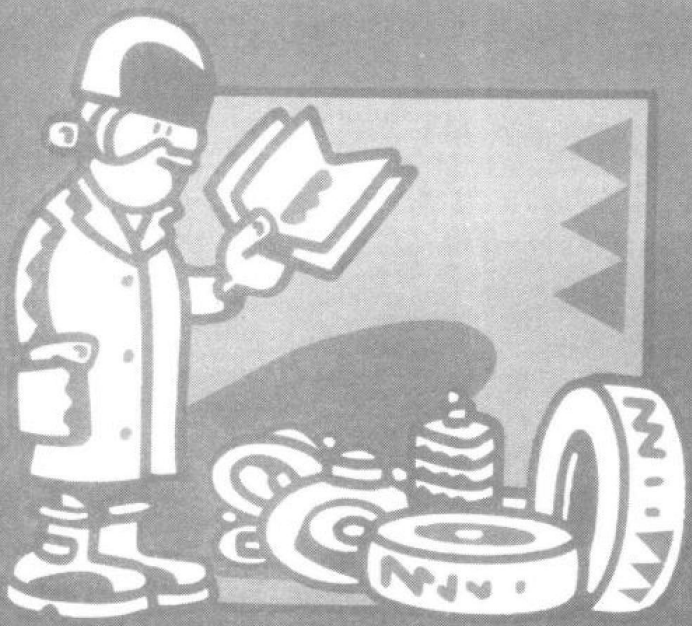
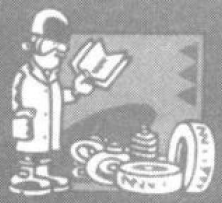


DEVELOPMENT, STRUCTURE, AND FUNCTION



1. Overview of the Cardiovascular System

WHY DO WE NEED A CARDIOVASCULAR SYSTEM?

The cardiovascular system serves to provide rapid transport of nutrients around the body and rapid removal of waste products. In smaller, less complex organisms there is no such system because they can supply their needs by simple diffusion. The human body, however, is too large for simple diffusion to be effective. Evolution of the cardiovascular system provided a means of aiding the diffusion process, allowing the development of larger organisms.

The cardiovascular system allows nutrients:

- To diffuse into the system at their source (e.g. oxygen from the lungs).
- To travel long distances quickly.
- To diffuse into tissues where they are needed (e.g. oxygen to working muscle).

This type of process is called convective transport and requires energy. This energy is provided by the heart, with the vessels being the mode of convection.

The functions of the cardiovascular system rely on a medium for transport. This medium is blood, which is made up of cells (mainly red blood cells) and plasma (water, proteins, etc.).

FUNCTIONS OF THE CARDIOVASCULAR SYSTEM

The main functions of the cardiovascular system are:

- Rapid transport of nutrients (oxygen, amino acids, glucose, fatty acids, water, etc.) and waste products (carbon dioxide, urea, creatinine, etc.).
- Hormonal control, by transporting hormones to their target organs and by secreting its own hormones (e.g. atrial natriuretic peptide).
- Temperature regulation, by controlling heat distribution between the body core and the skin.
- Reproduction, by producing erection of the penis.

HEART AND CIRCULATION

The heart is a double pump. It consists of two muscular pumps (the left and right ventricles). Each pump has its own reservoir (the left and right atrium).

The two pumps each serve a different circulation. A typical blood cell flows first in one circulation and then moves into the other.

The right ventricle is the pump for the pulmonary circulation. Blood is pumped into the lungs, where it acquires oxygen and removes carbon dioxide; it then returns to the left atrium of the heart. This blood then enters the left ventricle. The pulmonary circulation is usually of lower pressure than the systemic circulation.

The left ventricle is the pump for the systemic circulation. Blood is pumped from the left ventricle to the rest of the body. In the tissues of the body, nutrients and waste products are exchanged. Blood (which now carries less oxygen and more carbon dioxide) returns to the right atrium and then into the right ventricle.

The two circulations are operating simultaneously, with blood constantly flowing in each circulation. They can be thought of as being in series, with each circulation supplied by a different pump. This one-way, circular pathway for blood is brought about by the presence of valves in the heart and veins (Fig. 1.1).

The circulatory system is made up of arteries, veins, capillaries, and lymphatic vessels.

- Arteries transport blood from the heart to the body tissues.
- Capillaries are where diffusion of nutrients and waste products take place.
- Veins return blood from the tissues to the heart.
- Lymphatic vessels return to the blood any excess water and nutrients that have diffused out of the capillaries.

The amount of blood ejected from one ventricle during one minute is called the cardiac output. The cardiac output of each ventricle is equal overall, but there may be occasional beat-by-beat variation. The entire cardiac

output of the right ventricle passes through the lungs. The cardiac output of the left ventricle passes into the aorta and is distributed to various organs and tissues according to their metabolic requirements or particular functions (e.g. skeletal muscle gets a larger blood supply; the kidney receives 20% of cardiac output so that its excretory function can be maintained). This distribution can be changed to supply demand (e.g. during exercise, the flow to the skeletal muscle is increased considerably).

Blood is driven along the vessels by pressure. This pressure, which is produced by the ejection of blood from the ventricles, is highest in the aorta (about 120 mmHg above atmospheric pressure) and lowest in the great veins (almost atmospheric). It is this pressure difference that moves blood through the arterial tree, through the capillaries and into the veins. In the veins, the movement of blood is aided by one-way valves.

Arterial blood flow is pulsatile, with a higher pressure during systole than diastole.

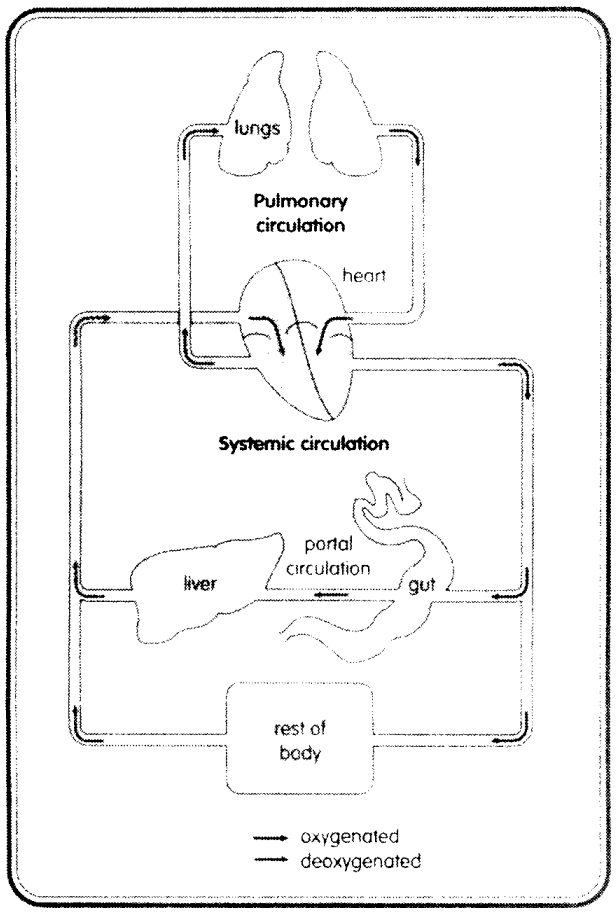


Fig. 1.1 Systemic and pulmonary circulations.

Systole is when the two ventricles contract simultaneously, whereas diastole is when the two ventricles relax together.

- **What are the functions of the cardiovascular system?**
- **How are the two circulations organized?**
- **How are the flow and distribution of blood through the two circulations governed?**

2. Structure and Function of the Heart

ORGANIZATION OF CARDIAC TISSUE

Anatomy of the heart and great vessels

Mediastinum

This is the space between the two lungs and pleurae. It contains all the structures of the chest except the lungs and pleurae (Figs 2.1 and 2.2).

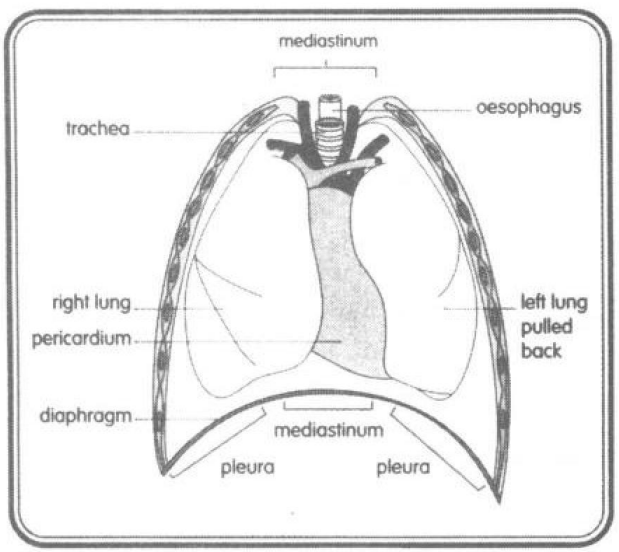


Fig. 2.1 Anterior view of the mediastinum.

The mediastinum extends from the superior thoracic aperture to the diaphragm and from the sternum to the vertebrae. The structures in the mediastinum are surrounded by loose connective tissue, nerves, blood, and lymph vessels. It can accommodate movement and volume changes.

The mediastinum is often subdivided into superior and inferior parts. The superior part contains:

- Anteriorly, the thymus.
- In the middle, the great vessels.
- Posteriorly, oesophagus, trachea, and thoracic duct.

Inferiorly, the mediastinum contains:

- Anteriorly, the thymus.
- In the middle, the heart and pericardium, great arteries, phrenic nerve, and main bronchi.
- Posteriorly, the oesophagus and thoracic aorta.

The heart is in the middle mediastinum and has the following relations:

- Superiorly, the great vessels and bronchi.
- Inferiorly, the diaphragm.
- Laterally, the pleurae and lungs.
- Anteriorly, the thymus.
- Posteriorly, the oesophagus.

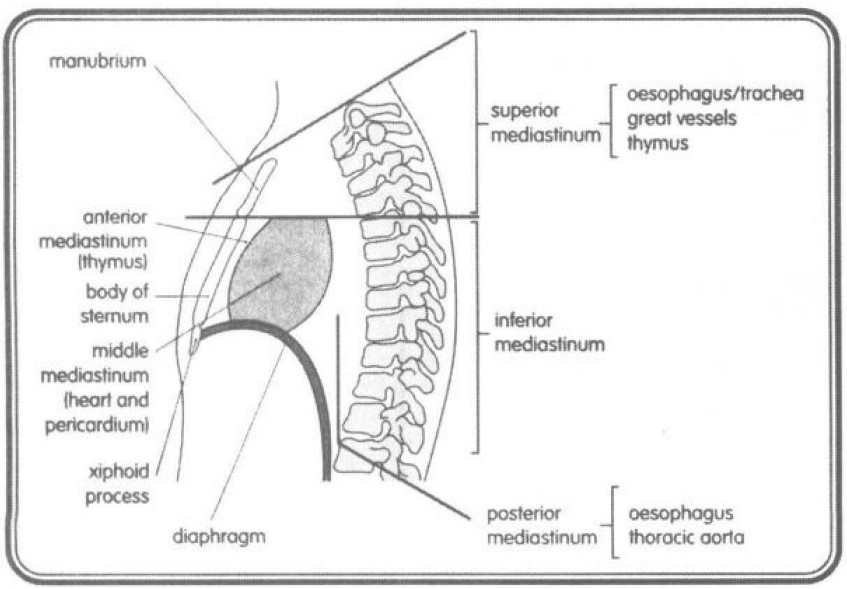


Fig. 2.2 Lateral view of the mediastinum.

Pericardium

The pericardium is a fibroserous sac, consisting of tough fibrous tissue, enclosing the heart. The outer surface of the heart and the inner surface of pericardium are covered with transparent layers of serous pericardium. Between these layers there is pericardial fluid.

The base of the pericardium is fused with the central tendon of the diaphragm. The pericardium is also fused

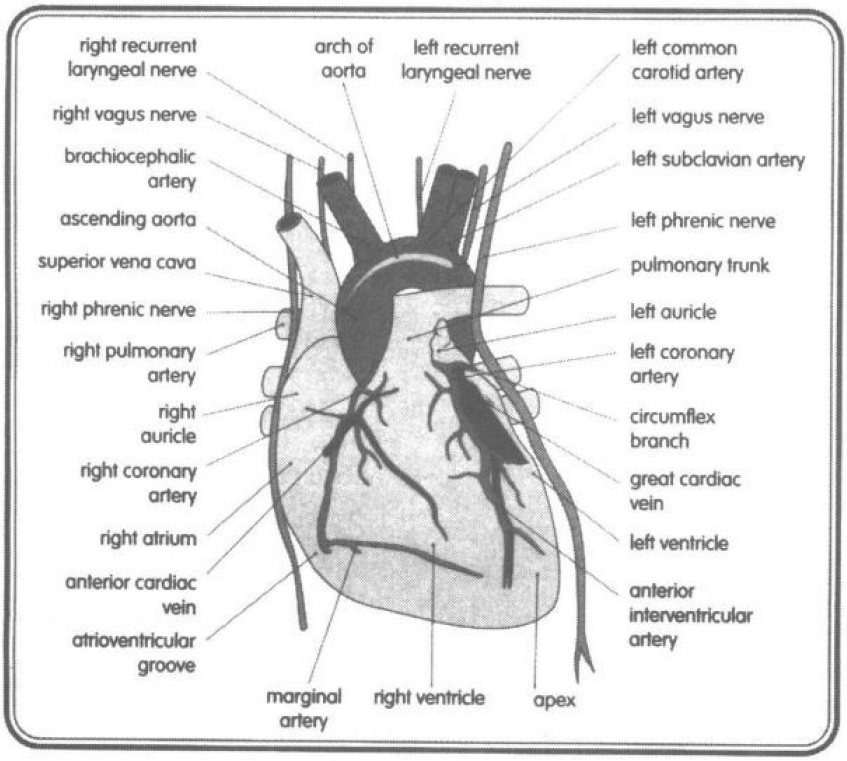


Fig. 2.3 Sternocostal external view of the heart.

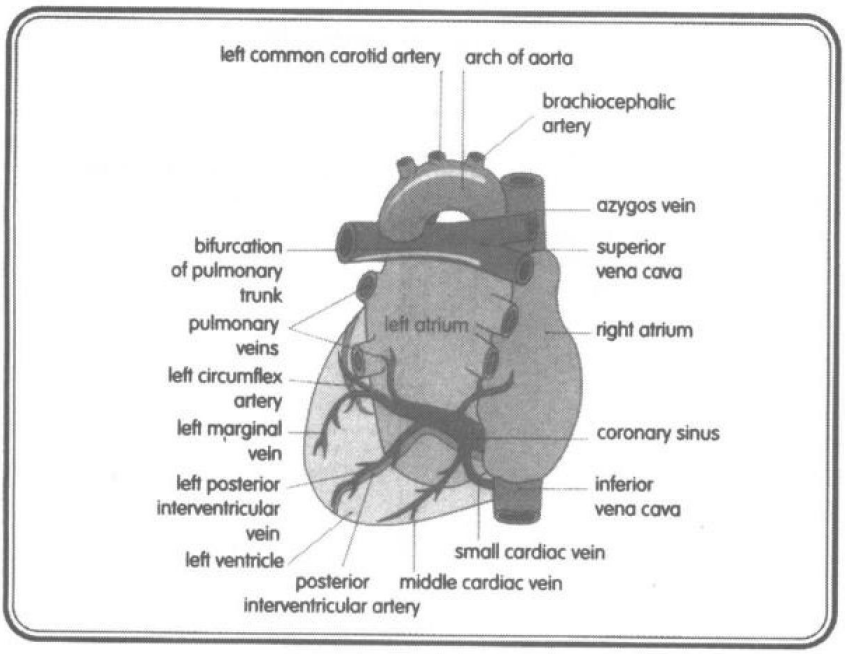


Fig. 2.4 Postero-inferior external view of the heart.

with the tunica adventitia of the great vessels entering and leaving the heart. Anteriorly, the pericardium is joined to the sternum by the sternopericardial ligaments.

There are two sinuses (pouches or pockets) in the pericardium; they are formed by the folding of the embryological heart, which produces reflections in the pericardium.

- The transverse pericardial sinus is a recess within the pericardium, posterior to the aorta and pulmonary trunk and anterior to the superior vena cava.
- The oblique pericardial sinus is a blind recess formed by the inferior vena cava and pulmonary veins.

External structure of the heart

The heart lies obliquely about two-thirds to the left and one-third to the right of the median plane (Figs 2.3–2.5). It has the following surfaces:

- The base of the heart is located posteriorly and formed mainly by the left atrium.
- The apex of the heart is formed by the left ventricle and is posterior to the 5th intercostal space.
- The sternocostal surface of the heart is formed mainly by the right ventricle.
- The diaphragmatic surface is formed mainly by the left ventricle and part of the right ventricle.
- The pulmonary surface is mainly formed by the left ventricle.

The heart borders of the anterior surface are as follows:

- Right: right atrium.
- Left: left ventricle and left auricle.
- Inferior: right ventricle mainly and part of left ventricle.
- Superior: right and left auricles.

Internal structure of the heart

The internal structure of the heart is shown in Fig. 2.6. The right atrium contains the orifices of the superior and inferior venae cavae and coronary sinus.

The right ventricle is separated from the right atrium by the tricuspid (three cusps) valve. The right ventricle is separated from its outflow tract (the pulmonary trunk) by the pulmonary valve. This has three semilunar valve cusps.

The left atrium has the orifices of four pulmonary veins in its posterior wall. The left atrium is separated

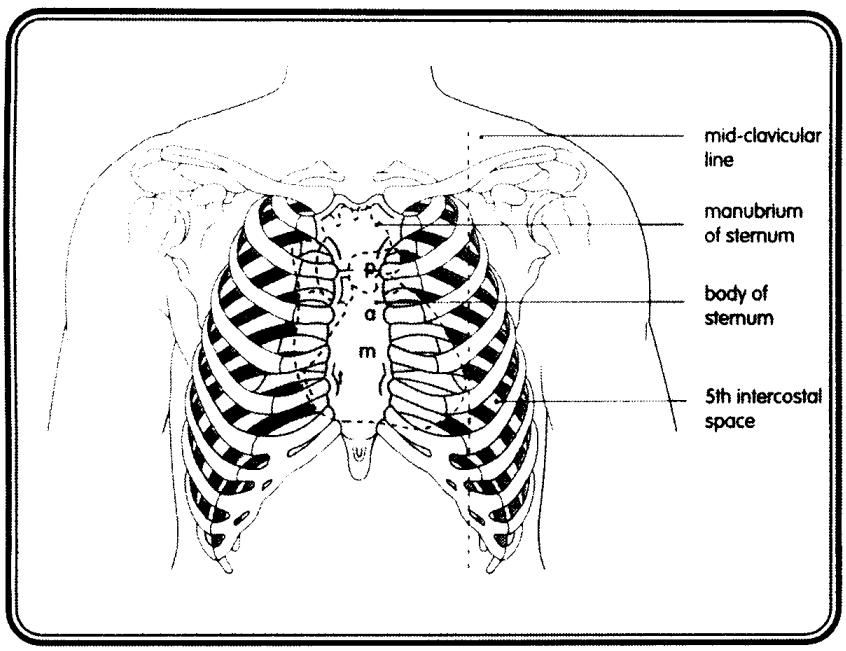


Fig. 2.5 Surface markings of the heart. (a, aortic valve; m, mitral valve; p, pulmonary valve; t, tricuspid valve.)