PRACTICAL FOOD INSPECTION

C. R. A. MARTIN

Vol. I - MEAT INSPECTION

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BY

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IN TWO VOLUMES

VOLUME I

MEAT INSPECTION

FOURTH EDITION

With 138 *Original Illustrations By the Author*

LONDON
H. K. LEWIS & CO. LTD.
1950

First Edition	.	*November* 1932
Second Edition	.	*January* 1940
Third Edition	.	*August* 1947
Fourth Edition	.	*August* 1950

(*Translated into Spanish* 1949)

PRINTED IN GREAT BRITAIN FOR
H. K. LEWIS AND CO. LTD. BY
HAZELL, WATSON AND VINEY LTD., AYLESBURY AND LONDON

PREFACE TO FOURTH EDITION

THE rapidity with which the last edition has been exhausted clearly reveals the continued interest in the subject of meat inspection and the demand for this book in particular. In this edition the opportunity has been taken to do some re-writing, and as far as it is possible to do, in these times of transition and flux, to bring the work completely up to date.

C. R. A. M.

TANKERTON, KENT.
April 1950.

PREFACE TO FIRST EDITION

THERE is probably no phase of public health administration which has received greater attention in the past decade than that of food inspection. Since the War, numerous Departmental Committees have, from time to time, been set up to consider such important matters as meat inspection, preservatives in food, etc., and their findings have resulted in new and comprehensive legislative requirements. In addition, the provision of a pure food supply has never before excited so much interest in local administrative bodies, food manufacturers, educational societies, and the general public itself. My only desire in presenting a work on food inspection, of which this is the first volume, is that there shall be available to inspectors, students, and others at least one book, embracing these important post-war technical and administrative developments, written by a *practical inspector*. It comprises data collected during routine inspectorial work, extending over a period of many years.

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MEAT INSPECTION

CHAPTER I

PHYSIOLOGY AND COMPARATIVE ANATOMY

It would be impossible to treat physiology or anatomy in anything like a comprehensive manner in a single chapter, and only those parts and functions of the animal body as are requisite for the proper inspection of meat are discussed; for a fuller study of the subjects the student is recommended to any one of the well-known treatises. As regards a practical knowledge of comparative anatomy of animals, the only place where this can be obtained is, of course, the slaughterhouse. It is difficult to thoroughly understand the various pathological processes dealt with later without a fairly complete knowledge of the functions of the various organs of the body, as well as an acquaintance with their structures; the student is accordingly recommended to master these subjects before passing on to the various diseases affecting food animals. It has for too long been complained of "lay food inspectors" that their knowledge of animal diseases is not supported by a knowledge of the fundamental sciences.

SKELETON

More than two hundred bones make the animal skeleton, and these are at various places joined together by means of strong fibrous capsules, strengthened by ligaments or by cartilages. At those joints where the ends of the bones move freely over one another, a coat of articular cartilage covers the surfaces which come into contact. Movable joints have their non-articular surface lined with a delicate membrane, synovial membrane, which secretes a lubricating fluid—the synovia. This is the fluid which is seen to escape from the cut the butcher makes in front of the stifle joint when dressing a carcase of beef.

Bone consists of approximately two-thirds animal matter impregnated with one-third mineral matter, chiefly phosphate and carbonate of lime. A deficiency in these lime salts in the bones of young animals causes the disease known as rickets. The long, narrow bones (such as the bones of the extremities) are tubular, and the cavities are filled with marrow. The condition of this marrow is important from an inspector's point of view. In a fœtus the marrow is red and jelly-like, but after birth it becomes harder, and turns white and fatty. The marrow of certain bones is the site of production of the red cells of the blood.

The following table gives the number of vertebræ possessed by food animals and by those animals that are liable to be substituted for them.

Vertebræ.	Herbivorous or Ruminants.			Omnivorous.	Rodentia.		Equidi.	Carnivorous.	
	Ox.	Sheep.	Goat.	Pig.	Rabbit.	Hare.	Horse.	Dog.	Cat.
Cervical .	7	7	7	7	7	7	7	7	7
Dorsal .	13	13	13	14	12	12	18	13	13
Lumbar .	6	6	6	7	7	7	6	7	7
Sacral .	5	5	5	4	4	4	5	3	3
Coccygeal .	20	12–20	12	18	3–5	3–5	18	20	20

The frauds liable to be perpetrated in the substitution of the meat of one animal for that of another, which is better in flavour and not so coarse in texture, are horse-flesh for beef, goat-flesh for mutton, the flesh of kids or dog-flesh for lamb, and cats for rabbits. The sale of horse-flesh is regulated by the Food and Drugs Act, 1938, but there is nothing to prevent a butcher selling goat-flesh without the special identification which is necessary in the case of horse-flesh. From the above table it will be seen that there are some essential differences between the axial skeletons of these various animals.

The ox has a broader and shorter head than the horse and is, of course, devoid of incisor teeth on the upper jaw. The shortness of the cervical vertebræ in the ox and in their large arch-like construction in the horse explain the difference in shape of their necks. The horse has 18 dorsal vertebræ, and attached to each a pair of ribs, so that horses have 18 pairs and oxen only 13. The ribs of the latter are broad and flat, and not so arched as those of the horse, which are jointed to the cartilages, whereas in the ox there is a fixed union. The spinous processes of the lumbar vertebræ of the horse are close together and directed forwards, whilst in the ox they are

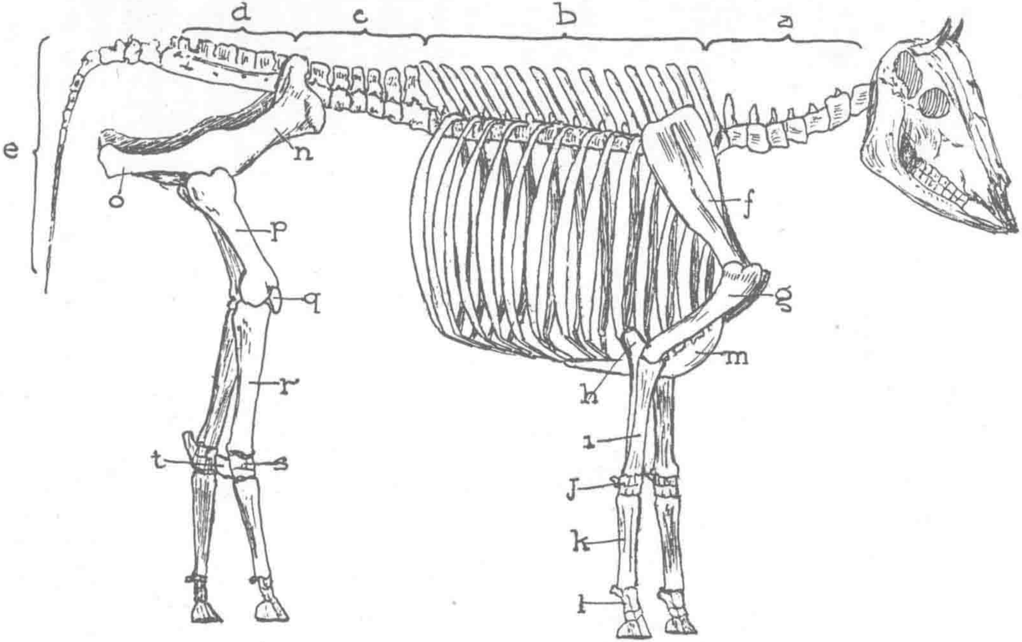

FIG. 1.—Skeleton of ox: a. Cervical vertebræ. b. Dorsal vertebræ. c. Lumbar vertebræ. d. Sacral vertebræ. e. Coccygeal vertebræ. f. Scapula. g. Humerus. h. Ulna. i. Radius. j. Carpus. k. Metacarpus. l. Digits. m. Sternum n. Ilium. o. Ischium. p. Femur. q. Patella. r. Tibia. s. Tarsus. t. Calcanium.

separated and point slightly backwards, as may be seen from Fig. 1. The sacrum of the ox is arched and the scapula differently shaped; it has a thinner neck, and the spine or ridge, a prominent groove, which is absent in the horse. The ulna of the ox is a more distinct bone and longer than that of the horse, whilst the radius is shorter and straighter. The sternum is flat and broad, but in the horse it is, as is well known, keel-shaped.

Fig. 2 shows the pelvic bones (pubis, ischium, and ilium) of a male sheep viewed from below. They are all fused together whereas the bones of the shoulder girdle are separate. The pelvic bones of the ox are longer and narrower than those of the horse, and the pubic symphysis of the latter, when split, has an almost straight section.

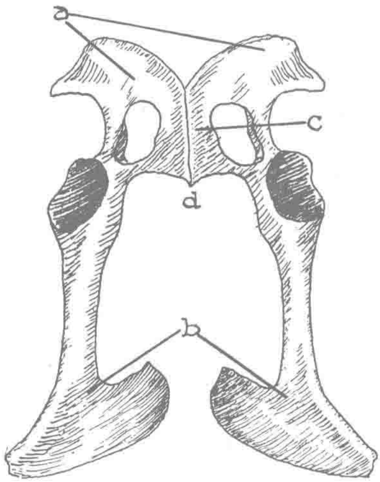

FIG. 2.—Pelvic bones of sheep: a. Ischium. b. Ilium. c. Pubis. d. Pubic symphysis. (Ball of femur fits into socket.)

The bones generally of the horse are more oily, the cartilaginous ends also being oily and yellow in colour. The bone-marrow is fatty and yellow, and has an unpleasant odour, but in the ox it has a fresh smell, and is firm and white in colour.

The differences between the skeletons of the sheep and goat are not so numerous; the leg bones of the goat are usually longer and the spinous processes more prominent.

There are one or two essential differences between the skeletons of rabbits and cats. As will be seen from the table, rabbits have only 12 pairs of ribs, whereas cats have 13, which are barrel-shaped. This differentiation is not entirely specific for cases of rabbits with 13 pairs of ribs have been reported. The hind-legs of rabbits are much longer than their front ones, but this difference in length is not so marked in the cat, which also has tibia and fibula as separate bones. Again, rabbits are always sold with their heads intact, but if a cat were offered for sale, this would surely be removed, owing to the great difference in shape, etc., and also to the greater development of the four canine teeth, or " fangs." Its tail would also be removed, the stump being thicker and more muscular than in the rabbit.

MUSCULAR TISSUE

Muscle consists of very delicate fibres bound together by connective tissue into small bundles; these small bundles are again united into larger bundles and lastly into the final muscle itself by connective tissue, and a tendon usually forms at one or sometimes both ends. Each ultimate muscle fibre is enveloped in an elastic and transparent membrane termed the sarcolemma. Muscle is of two varieties, striated or striped and unstriated or unstriped. All ordinary muscles are striated. The striation consists of a peculiar marking of the contracting muscle fibre, which shows through the transparent sarcolemma. The unstriated muscle fibre consists of elongated fibres with no sarcolemma. The layer of muscle in the walls of arteries consists of unstriated muscle fibres.

The muscle of meat should be firm and elastic to the touch, should not " pit " upon pressure of the fingers into it, should be of a bright uniform colour, and slightly mottled by fine lines of fat interspersed with the lean. These lines of fat disappear with age, and the meat becomes coarse, dry, and stringy. It also becomes sticky to the touch and much darker in colour. Bull-beef exhibits these characteristics much more than cow-beef. There should be a pleasant fresh smell from meat.

The muscle of meat contains several proteins, myosin, myogen, albumin, globulin, etc.; it also contains sodium and potassium salts in very small proportions, mostly potassium phosphate.

Differentiation between the muscular tissue of the horse and bovine is of first importance to the inspector, since the Food and Drugs Act, 1938, provides that horse-flesh cooked or uncooked, whether mixed with any other substance or not, must be sold only as horse-flesh. The texture of horse-flesh is very coarse and stringy, and is much darker in colour (almost bluish) than beef. It is sticky to the touch, has a characteristic odour, and is without the delicate lines of fat interspersed with the lean. Horse-flesh, when cooked, would never be mistaken for beef, owing to its coarse, stringy texture, and its sweet taste, which is due to glucose (monosaccharide); when mixed with other meats, for instance, in a sausage, it is impossible to detect its presence, except by chemical analysis. There are several tests for horse-flesh, all of which consist of making apparent the presence of glycogen which horse-flesh contains to a greater extent than beef. Glycogen or animal starch, a polysaccharide, is present in all skeletal muscle and provides the energy for muscle activity. After death, it is rapidly converted into glucose (monosaccharide), which gives horse-flesh its sweet taste, and also lactic acid. Its presence can be usually demonstrated before rigor mortis by colorimetric changes in iodine. Glycogen differs from vegetable starch in being stable in an alkali medium.

" Mince very finely 50 grams ($1\frac{3}{4}$ oz.) of the meat to be examined, and boil for 15 minutes in four times its volume of water. Meat preparations such as sausage should be boiled for 30 minutes. After the meat broth is cooled, it should be passed through moistened filter paper, to strain off any fatty bodies which might be contained in the emulsion. In broths prepared from meat preparations which contain starch, it is best to use a fine linen filter.

" Place a small quantity of the filtrate in a test tube and add a few drops of fluid, which contains 2 parts of iodine, 4 parts of potassium iodide, and 100 parts of water. If the meat is horse-flesh, the mixture will assume a dark brown colour, which disappears on heating to a temperature of 176° Fahr. An absence of this coloration indicates that no horse-meat is present.

" A blue coloration appears in the mixture when starch is present, and this obscures the glycogen reaction. The starch may, however, be precipitated by the addition of from two to three times the quantity of concentrated acetic acid and the mixture filtered and again treated with the iodine-potassium iodide solution." (Courtay and Coreman's method.)

From what has been previously stated, it will be seen that sausages made from horse-flesh will, if no other carbohydrate is added, have a higher sugar content. The test, however, is not specific and for positive determination, other and more complicated methods are necessary.

The character of the muscle of veal varies with the age of the calf. In good veal the muscle is very pale in colour, almost white, and is moist, but firm to the touch. These characteristics would be exhibited by a calf six weeks to three months old, but in a " bobby " calf, i.e. one week old and under, the flesh is greyish in colour, soft, and very moist.

The muscle of " slink " or fœtal veal is of a dull, dead colour, is very soft and flabby, and has a most offensive smell. It can also be recognized by its watery, soddened condition and gelatinous consistence of the intermuscular fatty septa. The meat of fœtuses has also a high glycogen content, but fœtal glycogen has a different molecular arrangement of glucose units to adult muscle glycogen. Fructose, as well as glucose, is said to be present in fœtal blood, whereas adult blood has only one sugar—glucose.

The muscle of mutton and lamb is reddish brown, bright and glistening, and mottled from the interspersion of fine lines of fat with the lean. It is fine in texture, smooth and firm to the touch. It is a little difficult to distinguish mutton from goat-flesh by examination of the muscle alone, but in the latter the muscle is generally darker and coarser in texture.

The muscle of pork is very pale in colour and rather moist but firm to the touch. The meat darkens a little and coarsens with age. In those parts of the country where "home-cured bacon" is prepared, the flesh of a pig weighing over five scores, i.e. 100 lb., is usually called "pig meat" to distinguish it from fresh pork.

All of the above are termed "red meats"; "white meats" include rabbit, chicken, turkey, etc.

ADIPOSE TISSUE

Adipose tissue is one of the connective tissues and consists of vesicular cells filled with fat and collected into lobules or masses. The cells are spheroidal in shape (on one side of which is the nucleus), and are enveloped in a delicate membrane. Large aggregations of fat cells are always present in certain parts of the healthy animal body, such as round the heart, omentum, mesentery, and kidney, but elsewhere their presence, in any quantity, depends very much upon the nutritional state and represents the nutriment which has been taken into the body in excess of its average consumption. So that the quantity of fat present in the animal body may be taken as a very good index of the general health of the animal.

The amount of fat generally present in meat, of course, varies to a considerable extent: in good beef about one-third is fat, whilst in pork about one-half is fat.

Horse fat can be distinguished from beef fat by reason of its yellow colour, peculiar smell, and sickly taste. It never sets firm, and is always oily. Beef fat, on the other hand, sets very firm, smells sweet, has a pleasant taste, and is yellowish white in colour. Store or depot fat of the body can be varied by feeding, e.g. the hard fat of grazing animals is due to carbohydrates (cellulose of grass) from which it is formed. The yellow colour produced by pasture feeding is due to the presence of carotene, a natural pigment of grass and other vegetable matter. Sometimes, however, its colour is yellow, due to fattening on rich oil cake, and also, in certain breeds, such as Jerseys, the fat is always yellow. Good beef fat sets moderately hard in three hours, if exposed, and in twenty-four hours is very firm. Mutton fat is pure white and tallow-like; it sets quickly, and becomes crisp and firm. Goat fat is not so white, may be yellow, and does not set so firm as mutton fat. Pork fat is pure white in colour; it never sets, and is always soft and greasy to the touch.

The preferred locations of fat in the animal carcase are around the kidneys (termed by the butchers the "kidney knob," retro-peritoneal), in the pelvis, the subcutis (panniculus adiposus), the mesentery ("crow-fat"), omentum ("caul" or "loose-fat"), and round the heart ("heart-fat"). In bullocks there is a deposit of fat in the scrotum, and in heifers in the fore udder. The influence of age, breed, and feeding upon the quantity of fat is very significant. In old age the fat becomes darker in colour, and is only present in the renal capsule and between the mesenteric and omentum membranes, with small deposits in the subcutis. It is commonly supposed among butchers that in cows there is a greater accumulation of subcutaneous fat than in bulls, bullocks, or heifers, but a diminution of the retro-peritoneal fat. In pigs fed on barley meal the fat is much firmer and more plentiful than in those fed on swill. Continued feeding of pigs upon raw fish and fish offals results in the fat having a distinct fishy odour and taste.

RESPIRATORY SYSTEM

The mechanism of respiration consists of the pharynx, which communicates with the outer air by means of the mouth and nasal passages; the glottis, which is immediately behind the tongue at the bottom of the pharynx, and is capable of being opened or closed by a projection called the epiglottis; the glottis opens into the larynx, or voice-box, and leading from this organ to the lungs is a circular tube called the trachea. The walls of the trachea (or wind-pipe as the butcher calls it) are firm and resisting, being strengthened by cartilages shaped like cartilaginous horse-shoes, joined together posteriorly by unstriated muscle. Attached to the back of the trachea is the œsophagus. The trachea passes into the thorax, and divides into two distinct tubes, the bronchi—one on the right and one on the left. In cattle, sheep, and pigs, however, there is an additional bronchus to the right lung. The bronchi then divide into a great many small branches called the bronchial tubes. As these get smaller, they lose the cartilaginous hoops in their walls, and consist only of membrane. The smallest bronchioles finally terminate into air-sacs, called infundibula. These air-sacs are subdivided into a number of small chambers, the alveoli. Into these air-cells of the lungs pass capillaries, which are the ultimate ramifications of the pulmonary arteries, the blood therein being separated from the inspired air by only the delicate membrane of the alveoli. At each inspiration pure air is brought into contact with the blood of the pulmonary arteries, which, by means of the hæmoglobin of its red corpuscles, takes up oxygen, and parts with some of its carbon dioxide. This purification of the blood goes on with each inspiration of pure air; if, by some means, such as choking, pure air is prevented from reaching the alveoli, the blood becomes poisoned by the excessive quantity of carbon dioxide, and the animal is said to be asphyxiated. Normal breathing is slow and regular, and brings into action the intercostal muscles (situated between the ribs) and the diaphragm.

The lungs, together with the heart and blood-vessels, completely fill the cavity of the thorax, and are enveloped in a very thin, glistening, serous membrane, the pleura. The lungs are really invaginations into the pleural cavity and after covering each lung, the two layers of pleura converge between the two lungs and become attached to the vertebral column, the cavity produced between them being known as the mediastinum. Situated here are the mediastinal lymphatic glands, surrounded by an accumulation of fat cells. The pleura then covers the walls of the thorax and thoracic surface of the diaphragm.

A small quantity of fluid, serum, is secreted by all serous membranes for the purpose of lubrication, and this, in the case of the lungs, allows of perfect respiratory movements. The intra-pleural cavity is at a slightly lower pressure than atmospheric pressure, sometimes called "negative pressure" so that healthy lungs are always in a stretched condition filling the cavity of the thorax. This is important in relation to lung disease. If an opening is made in the thoracic wall (pneumothorax), air rushes in and the lungs collapse.

When a pair of lungs is hung up with the œsophagus and the convex surfaces of the lungs facing one, the right lung is on one's right hand and the left lung on the left, the flat surface of the lungs being the ventral (or front) aspect of the body, and the curved or convex surface the dorsal (or back).

The lungs of cattle are soft and elastic, rose pink in colour, and have three lobes on the left lung and four on the right lung. Sheep's lungs are a little darker in colour, and not so spongy; they are dense and leathery to the touch, and possess the same number of lobes as ox lungs. Pigs' lungs are longer and broader than sheep's, and are soft and spongy, the interlobular tissue being well marked. They possess three lobes on the left lung and usually three on the right, although there may sometimes be four. Horses' lungs are very similar to the lungs of cattle, but may be distinguished from them by the absence of the extra right bronchus, which is, as has been stated before, present in the lungs of cattle, sheep, and pigs.

The number of respirations per minute in cattle, sheep, and pigs, when at rest, is 18, 28–30, 26 respectively.

CIRCULATORY SYSTEM

Almost all parts of the animal body are traversed by minute networks of tubes, about $\frac{1}{2000}$ of an inch in diameter, the capillaries. These capillaries have very delicate walls, which allow of the passage of fluids through them and the thorough irrigation of the surrounding tissues. There are two sets of capillaries, one containing blood and the other lymph ; the latter, however, will be dealt with when the lymphatic system is described. The capillaries thread their way through the tissues and continue on different sides into larger tubes, with thicker walls, which are the smaller arteries and veins ; the small venules unite with larger tubes and so on until the blood is emptied into the main blood-vessels communicating with the heart.

There are differences between arteries and veins besides the difference of one containing arterial or pure blood and the other venous or impure blood ; the smallest (arterioles) and (venules) have similar histological structures to the large arteries and veins ; in fact, arterioles contain relatively more muscle than large arteries because it is here that the great expansion of the vascular bed takes place. The cross-sectional area of arterioles to that of the aorta is said to be as 800 : 1. Larger arteries have thick walls which do not collapse when the vessel is empty ; this is due to layers of unstriated muscle fibres in the walls. Mixed with this muscular coat are layers of a strong elastic substance, which allow the arteries to expand at each impulse of blood sent into them. The walls of the veins, on the other hand, are thin and almost devoid of muscle. Another difference is the presence in veins of valves, small pouch-like folds on the inner walls, which prevent venous blood passing back into the capillaries, but allow of a free passage towards the heart.

All the veins of the upper half of the body (head, neck, thorax, etc.), excepting the lungs and heart itself, and all those of the lower half (hind-legs, pelvis, and lumbar regions, etc.), excepting certain abdominal viscera, unite into the superior and inferior venæ cavæ respectively, which discharge their contents into the upper right quarter of the heart (right atrium) (Fig. 3). The arteries from every part of the body, except the lungs, ultimately spring from the great artery, the aorta, which leaves the lower left quarter of the heart (left ventricle). Blood is delivered to the lungs by the pulmonary artery, which leaves the lower quarter of the right side of the heart (right ventricle), the purified blood being returned by four vessels (pulmonary veins) into the left atrium. Thus it will be seen that the venous vessels open into the two upper divisions of the heart, whilst the arterial vessels spring from the lower divisions.

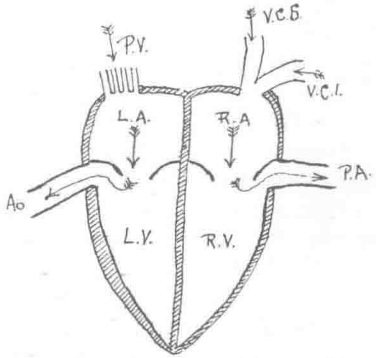

FIG. 3.—Diagram of heart, illustrating its action: L.A. Left atrium. R.A. Right atrium. L.V. Left ventricle. R.V. Right ventricle. P.V. Pulmonary veins. V.C.S. Vena cava superior. V.C.I. Vena cava inferior. Ao. Aorta. P.A. Pulmonary artery.

The arteries and veins of the heart itself do not communicate with the main vessels, but spring from the ascending aorta immediately above the left ventricle and discharge into the right atrium respectively. The abdominal viscera referred to above, the veins of which are separate from the vena cava inferior, are the stomach, intestines, pancreas and spleen. The veins of these organs unite to form the portal vein, which passes to the liver, breaking up into a large number of capillaries throughout its substance. These become linked up with the capillaries of the hepatic artery, which springs direct from the aorta, and from this double network of vessels veins arise finally emptying into the hepatic vein, which leaves the organ to enter the inferior vena cava. The liver is therefore rich in blood; actually it contains nearly one-quarter of all the blood in the body. The portal vein differs from other veins, in that it takes blood *to* an organ and not from it—and is the only great vein which produces a secondary circulation in this manner.

The heart is situated between the lungs, near to the sternal wall. The broad end, or base, is the upper part, and the pointed end, or apex, the lower portion. It tilts forward slightly and inclines to the left side, so as to lie opposite the fifth and sixth ribs. It is enclosed in an outer fibrous pericardium, within which is a double